# NATIONAL SCIENCE FOUNDATION

# FY 2013 Budget Request to Congress

***February 13, 2012***

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# NSF FY 2013 Budget Request to Congress

*The National Science Foundation Act of 1950 (Public Law 81-507) sets forth our mission:* ***To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.***

*The National Science Foundation Strategic Plan for FY 2011 – 2016, "Empowering the Nation Through Discovery and Innovation," defines our vision: "****a nation that capitalizes on new concepts in science and engineering and provides global leadership in advancing research and education."***

For over 60 years, the National Science Foundation (NSF) has had a profound impact on our Nation's innovation ecosystem by funding the transformative, fundamental research that has become the agency's hallmark. Just as previous NSF investments in fundamental research have led to path-breaking societal advances, from barcodes to web browsers and search engines, NSF's continuing commitment to supporting a wide range of fields and disciplines helps to secure and sustain U.S. competitiveness and economic growth. Similarly, NSF's strong support for science, technology, engineering, and mathematics (STEM) education at all levels provides the nation with a globally-competitive workforce.

NSF's FY 2013 Request reflects wise stewardship of federal funding through innovative, targeted investments that closely align with both agency and Administration priorities. It totals $7.373 billion, an increase of $340.0 million (4.8 percent) over the FY 2012 Estimate, consistent with the Administration's commitment to doubling funding for NSF and other key basic research agencies.

The Request emphasizes the myriad of ways that fundamental research can contribute directly to addressing national challenges:

- Fostering the development of a clean energy economy.
- Supporting future job creation through advanced manufacturing and emerging technologies.
- Protecting critical infrastructure.
- Promoting multidisciplinary research in new materials, wireless communications, cyberinfrastructure, and robotics.
- Developing the next generation of scientific leaders through support for graduate fellowships and early career faculty.
- Advancing evidence-based reforms in science and mathematics education.

At the same time, the request reflects a rigorous prioritization of activities across the Foundation. Approximately $67 million in lower priority education, research, and outreach programs are terminated or consolidated.

These priorities are coupled with NSF's continuing commitment to supporting a broad base of investments in fundamental research and education. As shown below, the Request emphasizes investments made through NSF's two principal accounts: Research and Related Activities (R&RA) and Education and Human Resources (EHR), which support NSF's core programs in fundamental research, human capital development, and the infrastructure needed to pursue learning and discovery at the frontiers of science and engineering.

- In FY 2013, an estimated $3.2 billion is provided for core fundamental research grant programs in R&RA and EHR.
- FY 2013 funding for Major Research Equipment and Facilities Construction (MREFC) fully funds established commitments to ongoing major facility construction projects.
- Support for Agency Operations and Award Management (AOAM) is at the FY 2012 level, which will allow NSF to sustain critical agency operations and address key workload challenges while achieving efficiencies and reducing administrative costs, consistent with Administration-wide efforts.

**NSF Funding by Account**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Research & Related Activities | $5,608.38 | $5,689.00 | $5,983.28 | $294.28 | 5.2% |
| Education & Human Resources | 861.04 | 829.00 | 875.61 | 46.61 | 5.6% |
| Major Research Equipment & Facilities Construction | 125.37 | 197.06 | 196.17 | -0.89 | -0.4% |
| Agency Operations & Award Management | 299.29 | 299.40 | 299.40 | - | - |
| National Science Board | 4.47 | 4.44 | 4.44 | - | - |
| Office of Inspector General[1] | 14.00 | 14.20 | 14.20 | - | - |
| **Total, NSF** | **$6,912.55** | **$7,033.10** | **$7,373.10** | **$340.00** | **4.8%** |

Totals may not add due to rounding.

[1] FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

# OneNSF Framework

A major emphasis in FY 2013 is the OneNSF Framework, which aims to enable seamless operations across organizational and disciplinary boundaries. OneNSF empowers the Foundation to respond to new challenges in a changing global environment, leverage resources and opportunities for maximum impact, and provide leadership to establish innovative practices, programs, and paradigms that advance scientific knowledge and science, technology, engineering, and mathematics (STEM) education.

**FY 2013 OneNSF Framework Priorities**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS)[1] | - | 141.65 | 257.42 |
| Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) | - | 78.00 | 106.08 |
| Expeditions in Education ($E^2$) | - | - | 49.00 |
| NSF Innovation Corps (I-Corps) | 1.06 | 7.50 | 18.85 |
| Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) | - | 20.35 | 63.00 |
| Secure and Trustworthy Cyberspace (SaTC)[1] | - | 111.75 | 110.25 |
| Science, Engineering, and Education for Sustainability (SEES)[1] | 87.96 | 157.00 | 202.50 |
| **Total, NSF** | **$89.02** | **$516.25** | **$807.10** |

Totals may not add due to rounding.

[1] The FY 2011 number shown above for SEES, and the FY 2012 numbers for CEMMSS, SaTC, and SEES, represent estimated levels for directly related activities in these areas.

In FY 2013, the OneNSF Framework encompasses a set of investments that create new knowledge, stimulate discovery, address complex societal problems, and promote national prosperity. Priorities include:

- **Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS**) ($257.42 million) will transform static systems, processes, and edifices into adaptive, pervasive "smart" systems with embedded computational intelligence that can sense, adapt, and react. The smart systems of tomorrow, created through CEMMSS, will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, and usability. CEMMSS plays a key role in NSF's growing portfolio of advanced manufacturing investments.

- **Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)** ($106.08 million) aims in FY 2013 to more deeply address a highly science-driven integration of cyberinfrastructure (CI), supporting development of new statistical, mathematical, and computational methods, algorithms, and tools, as well as the cultivation of the next generation of computational and data-enabled researchers who prototype, develop, and use CI in all disciplines.

- **Expeditions in Education ($E^2$)** ($49.0 million) establishes a partnership between the Directorate for Education and Human Resources (EHR) and other research directorates and offices. $E^2$ will integrate, leverage, and expand STEM education research and development to improve learning in science and engineering disciplines and capitalize on the scientific assets across NSF to enhance EHR investments in learning and education.

- **NSF Innovation Corps (I-Corps)** ($18.85 million), launched in FY 2011, will continue to establish opportunities to assess the readiness of emerging technology concepts for transitioning into valuable new products through public-private partnerships. I-Corps will bring together technological, entrepreneurial, and business know-how to move discoveries toward commercialization.

- **Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)** ($63.0 million) integrates NSF's existing interdisciplinary efforts with a suite of new Foundation-wide activities. INSPIRE encourages research that involves multiple disciplines, connects disciplines, or creates new disciplines. It aims to widen the pool of prospective discoveries that may be overlooked by traditional mechanisms.

- The **Secure and Trustworthy Cyberspace (SaTC)** ($110.25 million) investment aligns NSF's cybersecurity investments with the four thrusts outlined in the December 2011 national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC directly addresses the critical Administration priority of cybersecurity issues by supporting research that seeks to protect the Nation's critical information technology infrastructure, including the Internet, from a wide range of threats that challenge its security, reliability, availability, and overall trustworthiness.

- **Science, Engineering, and Education for Sustainability (SEES)** ($202.50 million) focuses on targeted programs that promote innovative interdisciplinary research to address pressing societal issues of clean energy and sustainability. In FY 2013, SEES includes five programs that are consistent with the SEES long-term vision: Coastal SEES; Arctic SEES; Sustainable Chemistry, Engineering, and Materials (SusChEM); Creating a More Disaster-Resilient America (CaMRA); and a program on the Role of Information Sciences and Engineering in SEES (RISES).

In addition to the OneNSF Framework investments, NSF's multifaceted portfolio will continue to advance all fields of science and engineering and educate the workforce of tomorrow. A few key highlights:

- **Clean Energy** ($355.38 million): NSF's clean energy investments include research related to sustainability science and engineering, such as the conversion, storage, and distribution of diverse power sources (including smart grids), and the science and engineering of energy materials, energy use, and energy efficiency.

- **Advanced Manufacturing** ($148.90 million): Advanced manufacturing research invests in emerging technologies that promise to create high quality manufacturing jobs and enhance our global competitiveness. As noted above in the discussion on CEMMSS, these investments are directly linked to research in areas of national importance such as cyber-physical systems and advanced robotics research; materials processing and manufacturing; and advanced semiconductor and optical device design. Investments in advanced manufacturing are found throughout NSF's portfolio, in activities such as Nanoscale Science and Engineering Centers (NSECs), the National Nanotechnology Initiative (NNI), and the Small Business Innovation Research/Small Business Technology Transfer programs (SBIR/STTR).

- **The Faculty Early Career Development program (CAREER)** ($216.49 million) develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the research with teaching and learning. In FY 2013, NSF will support approximately 40 more CAREER awards than in FY 2012, for a total of 440 new awards. The CAREER portfolio includes projects that range across all fields of science and engineering supported by the Foundation, including high priority fields such as clean energy, climate change, STEM education, and cybersecurity.

- **The Graduate Research Fellowship program (GRF)** ($242.98 million) supports the development of students and early-career researchers in order to cultivate the next generation of STEM professionals. In FY 2013, 2,000 new fellowships will be awarded, maintaining the doubling of new fellowship awards achieved in FY 2010. To address inflationary pressures on the long-stagnant GRF stipend level, the FY 2013 Request increases the stipend to $32,000.

- **Science and Technology Centers (STCs)** ($74.39 million total for all cohorts) in FY 2013, a new cohort of STCs is initiated ($25.0 million) that will continue the tradition of conducting world-class research through partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities**,** and via international collaborations. STCs provide an innovative way for researchers to conduct investigations at the interfaces of disciplines and to invest in high-risk, potentially transformative science.

- **Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS*)*** ($30.17 million), is a collaboration among the Directorates for Biological Sciences, Engineering, and Mathematical and Physical Sciences that aims to accelerate the understanding of biological systems, and then apply that knowledge into fundamental understanding and new technologies, particularly clean energy.

- **Experimental Program to Stimulate Competitive Research (EPSCoR)** ($158.19 million) assists NSF in its mandate to promote scientific progress nationwide. EPSCoR effects lasting improvements in the research capacity of institutions in participating jurisdictions to promote broader engagement at the frontiers of discovery and innovation in science and engineering.

- **Enhancing Access to the Radio Spectrum (EARS)** ($50.50 million), begun in FY 2012, continues to partner the Directorates for Engineering, Computer and Information Science and Engineering, Mathematical and Physical Sciences, and Social, Behavioral, and Economic Sciences in supporting the basic research that funds research and development of spectrum-sharing technologies.

- **US Ignite** ($10.0 million) leverages NSF's mid-scale research infrastructure investment in the Global Environment for Network Innovations (GENI). US Ignite provides a unique, at-scale, network testbed for foundational research in networking, distributed systems, cloud computing, and security and for public sector gigabit application development, (i.e., in areas such as advanced manufacturing, health, education, energy, transportation, public safety and emergency preparedness), especially those applications not possible to deploy on today's Internet.

- **Science, Technology, Engineering, and Mathematics (STEM) Education:**
  - **K-16 Math Education:** As part of the nation's strategic plan in STEM education, NSF is partnering with the Department of Education (ED) to launch an evidence-based initiative to improve K-16 mathematics education and knowledge building. This new endeavor will support researchers and educators who have the greatest potential to transform mathematics learning. In FY 2013, NSF's Directorate for Education and Human Resources (EHR) and ED will each

contribute $30.0 million. EHR's contributions will be through support for the Discovery Research K-12 (DR K-12), and Transforming Undergraduate Education in STEM (TUES) programs.

- In FY 2013, the **Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) program** ($20.0 million) will fund research and demonstration projects exploring how to achieve widespread sustainable implementation of evidence-based undergraduate instructional practices to improve student outcomes.

- **Transforming Undergraduate Education in STEM (TUES)** ($61.46 million) aims to improve the quality of STEM education for all undergraduate students by supporting efforts to create, adapt, and disseminate new learning materials and teaching strategies to reflect advances both in STEM disciplines and in what is known about teaching and learning.

- **Federal Cyber Service: Scholarship for Service (SFS)** ($25.0 million) seeks to increase the number of qualified students entering the fields of information assurance and computer security and to increase the capacity of the United States higher education enterprise to continue to produce professionals in these fields to meet the needs of our increasingly technological society. SFS directly addresses the Nation's increasing need for innovative solutions to potential cybersecurity concerns.

## Major Research Equipment and Facilities Construction

In FY 2013, NSF will continue construction of four projects: the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO), the Advanced Technology Solar Telescope (ATST), the National Ecological Observatory Network (NEON), and the Ocean Observatories Initiative (OOI).

All of the projects in the MREFC account undergo major cost and schedule reviews, as required by NSF guidelines.

- **Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO).** A planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO), AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection.

- **Advanced Technology Solar Telescope (ATST).** ATST will enable study of the sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affect Earth's civil life and may impact its climate.

- **National Ecological Observatory Network (NEON).** NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research.

- **Ocean Observatories Initiatives (OOI).** OOI will enable continuous, interactive access to the ocean via multiple types of sensors linked by cutting-edge cyberinfrastructure, which will produce never-before-seen views of the ocean's depths.

**MREFC Account Funding, by Project**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) | $23.58 | $20.96 | $15.17 |
| Atacama Large Millimeter Array (ALMA) | 13.92 | 3.00 | - |
| Advanced Technology Solar Telescope (ATST) | 5.00 | 10.00 | 25.00 |
| IceCube Neutrino Observatory | 5.29 | - | - |
| National Ecological Observatory Network (NEON) | 12.58 | 60.30 | 91.00 |
| Ocean Observatories Initiative (OOI) | 65.00 | 102.80 | 65.00 |
| **Total, MREFC** | **$125.37** | **$197.06** | **$196.17** |

Totals may not add due to rounding.

# Model Organization

To "Perform as A Model Organization" (Model Organization), one of NSF's three strategic goals, is an internally focused goal that emphasizes the agency's desired outcome of attaining excellence in all aspects of its operations. Model Organization underpins NSF programmatic activities and encompasses all the agency's management activities. It also includes support for the activities of the Office of Inspector General (OIG) and the National Science Board (NSB), which are provided in separate appropriations.

**Workforce**
The FY 2013 Budget Request includes $209.47 million, or $6.56 million over the FY 2012 Estimate, for funding NSF's federal workforce. The Request will support 1,352 regular full-time equivalents (FTE), an increase of 25 over the FY 2012 Estimate allocation of 1,327 FTE.

**iTRAK**
FY 2013 is the first year of iTRAK implementation. iTRAK will transition NSF from its legacy financial and property management systems to a fully integrated financial management solution. In FY 2013, the total request for iTRAK is $11.70 million.

**Promoting Efficient Spending**
In conjunction with the President's efforts to reduce spending across several administrative areas, NSF has launched its own efficiency initiative to strengthen operations and management and to increase accountability and responsibility for the resources entrusted to it. This effort will entail streamlining administrative and programmatic business practices to reduce and avoid costs and identifying common sense approaches to achieve savings where possible. In response to Executive Order 13589, *Promoting Efficient Spending*, NSF is planning to reduce spending by $18.90 million in FY 2013. This reduction goal represents a 20 percent reduction below actual FY 2010 levels in areas targeted government-wide for savings and efficiencies. These efforts to reduce administrative costs will require an aggressive review and prioritization of current activities so that funds are devoted to the most critical aspects of NSF's operations.

**Model Organization by Appropriations Account**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Agency Operations and Award Management | $299.29 | $299.40 | $299.40 | - | - |
| Office of Inspector General[1] | 14.00 | 14.20 | 14.20 | - | - |
| National Science Board | 4.47 | 4.44 | 4.44 | - | - |
| Research & Related Activities | 89.19 | 94.12 | 94.75 | 0.63 | 0.7% |
| Education and Human Resources | 15.19 | 15.39 | 15.48 | 0.09 | 0.6% |
| Subtotal, Program Support | 104.39 | 109.51 | 110.23 | 0.72 | 0.7% |
| **Total** | **$422.14** | **$427.55** | **$428.27** | **$0.72** | **0.2%** |

Totals may not add due to rounding.

[1] FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

# Evaluation and Performance

NSF embraces the use of goals to drive performance improvements. For FY 2012 – FY 2013, NSF has established the following three priority goals, in keeping with the GPRA Modernization Act (P.L. 111-352).

**Priority Goal: Access to Digital Products of NSF-Funded Research**
NSF has set a goal to establish policies for public access to high-value data and software in at least two data-intensive scientific domains. Digital data are increasingly one of the primary products of scientific research, and should be accessible and linked to one another so that scientists can verify and reproduce major findings in the literature and repurpose the data to enable new discoveries. Simultaneously, access to digital products of research enhances openness and transparency in the scientific enterprise and enables new types of multi-disciplinary research and education. The priority goal supports this vision of increasingly collaborative and multi-disciplinary science by assuring that knowledge and data can flow easily across traditional disciplinary boundaries.

**Priority Goal: Undergraduate Programs**
As part of NSF's long-term core commitment to develop a diverse and highly qualified science and technology workforce, NSF will measure the percent of institutions funded through NSF undergraduate programs that document the extent to which they use proven instructional practices. The FY 2013 goal is to reach 80 percent. Research shows that evidence-based instructional practices lead to improved student learning, and thus are a useful metric for assessing impact on a well-prepared workforce. One way that NSF can advance its efforts to invest in the preparation of a strong science and engineering workforce is by encouraging and facilitating the use of empirically-based instructional practices in undergraduate science, technology, engineering, and mathematics (STEM) education.

**Priority Goal: NSF Innovation Corps**
NSF has set a priority goal to increase the number of entrepreneurs emerging from university laboratories. Through the NSF Innovation Corps (I-Corps) program, NSF seeks to accelerate the development of new technologies, products, and processes that arise from fundamental research. With I-Corps, NSF supports NSF-funded researchers whose efforts will be augmented – in the form of mentoring and funding – to accelerate the translation of knowledge derived from fundamental research into emerging products and services that can attract subsequent third party funding. NSF investments will strategically strengthen the innovation ecosystem by addressing the challenges inherent in the early stages of the innovation process. NSF will track achievement of this goal by measuring the percent of I-Corps teams that have tested the commercial viability of the product or service. The FY 2013 goal is to achieve 80 percent.

Please refer to Performance.gov for information on Federal Priority Goals and NSF's contributions to those goals.

## Cuts, Consolidations, and Savings

NSF's FY 2013 Request follows a thorough examination of programs and investments across NSF to determine where the potential exists for more innovative investments.

This Request includes eleven recommended cuts and consolidations, totaling $67.0 million. These are described here, including: elimination of three Computer and Information Science and Engineering Research Programs; termination of the Cyber-enabled Discovery and Innovation (CDI) program; elimination of four Mathematics and Physical Sciences Research Programs; reduced funding for Nanoscale Science & Engineering Centers (NSECs); and elimination of two public outreach programs.

**Computer and Information Science and Engineering Research Programs** (-$17.0 million total): Three programs within the Directorate for Computer and Information Science and Engineering (CISE) are eliminated since they have reached their planned endpoints and have achieved their original goals. These programs are: Network Science and Engineering (NetSE) (-$3.0 million); Social-Computational Systems (-$7.0 million); and the Interface between Computer Science and Economic & Social Sciences (ICES) (-$7.0 million). Support for these research areas will be absorbed into CISE core programs.

**Cyber-enabled Discovery and Innovation (CDI)** (-$29.0 million total): NSF eliminates funding for the agency-wide CDI program, as the program has reached its planned conclusion and has achieved many of its original goals. Funding will be redirected to support new efforts in two NSF cross-agency initiatives (CEMMSS and CIF21) in FY 2013 that will build on the accomplishments made in the CDI program.

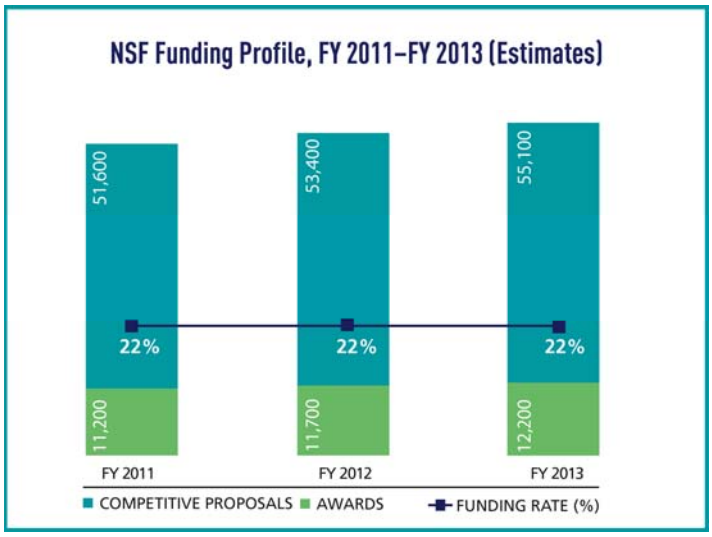
**Mathematical and Physical Sciences Research Programs** (-$10.0 million total): Four programs within the Directorate for Mathematical and Physical Sciences (MPS) are eliminated because they overlap with larger core disciplinary programs or they have achieved their original goals. Two programs are eliminated as they are no longer needed as stand-alone programs: Mathematical Physics (-$2.0 million) and Grid Computing (-$2.0 million). Research conducted under the third program, Cultural Heritage Science (-$4.0 million), will be funded through regular MPS disciplinary programs. Lastly, the CHE-DMR-DMS Solar Energy Initiative (SOLAR) (-$2.0 million) will be subsumed within the broader framework of NSF's SEES investment through the Sustainable Energy Pathways solicitation.

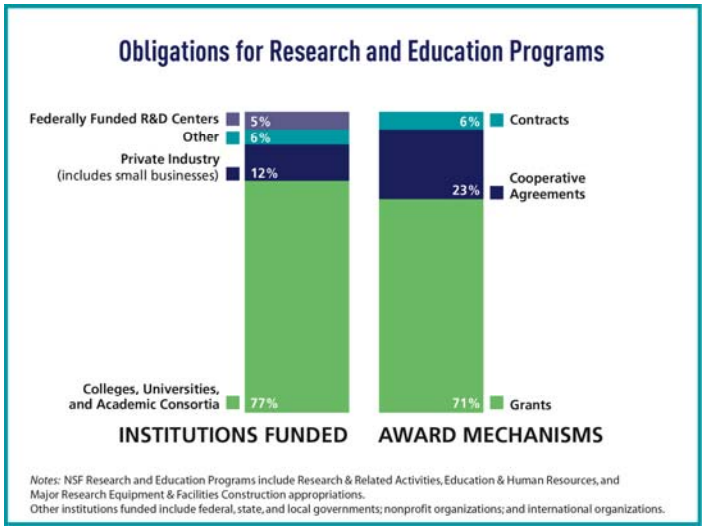
**Nanoscale Science & Engineering Centers (NSECs)** (-$5.0 million total): NSF reduces support for the NSEC program because the state of the research in this area has matured significantly and the research should advance more rapidly in a different, more use-inspired research center program. Several NSEC grants may transition to the Nanosystems Engineering Research Centers (NERCs) as the nano-devices and processes created at graduating NSECs move to the systems level and potential commercialization. NSF will continue to support eleven continuing NSECs in FY 2013.

**Public Outreach terminations** (-$6.0 million total): NSF eliminates two small stand-alone public outreach programs because they lack rigorous evaluation and are duplicative of the larger, well-established peer-reviewed Advanced Informal STEM Learning (formerly, Informal Science Education) program. The eliminated programs are: Communicating Science Broadly (-$2.0 million) and Connecting Researchers with Public Audiences (-$4.0 million).

# NSF by the Numbers

**NSF by The Numbers:** In FY 2013 NSF expects to evaluate over 55,000 proposals through a competitive merit review process and make over 12,000 new awards. This will require over 260,000 proposal reviews, engaging on the order of 40,000 to 50,000 members of the science and engineering community participating as panelists and proposal reviewers. In a given year, NSF awards reach nearly 1,900 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. In FY 2013, NSF support is expected to reach approximately 285,000 researchers, postdoctoral fellows, trainees, teachers, and students.



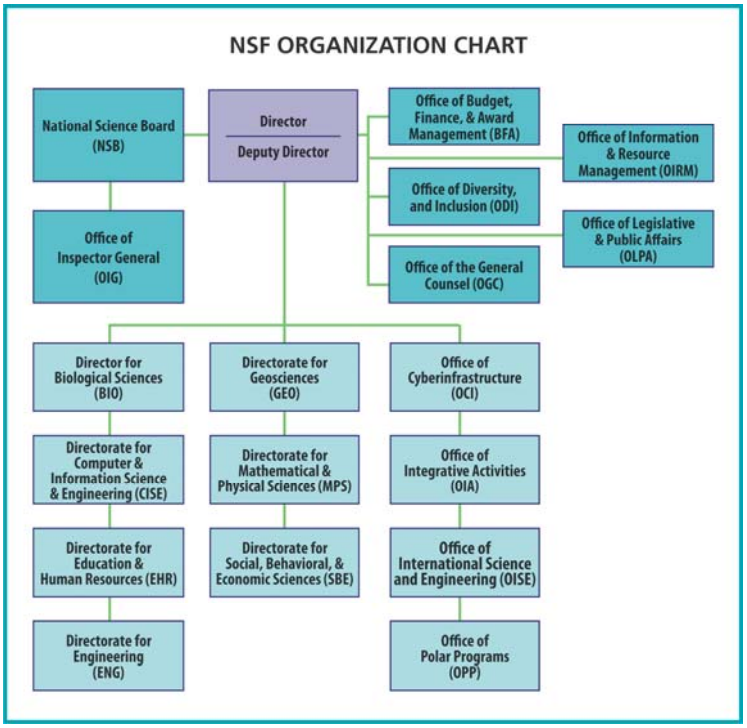




The chart on the left shows the distribution of NSF's obligations by institution type and funding mechanism. While the data are based on FY 2011, the relative shares should provide a good indication of the FY 2013 distribution. As shown on the graph, 94 percent of NSF's FY 2011 projects were funded using grants or cooperative agreements. Grants can be funded either as standard awards, in which funding for the full duration of the project is provided in a single fiscal year, or as continuing awards, in which funding for a multi-year project is provided in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g., research centers, multi-user facilities, etc.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

Most NSF awards are to academic institutions. Nonprofit organizations include state and local governments and international organizations. For-profit businesses include private and small businesses. Federal agencies and laboratories include funding for Federally Funded R&D Centers.

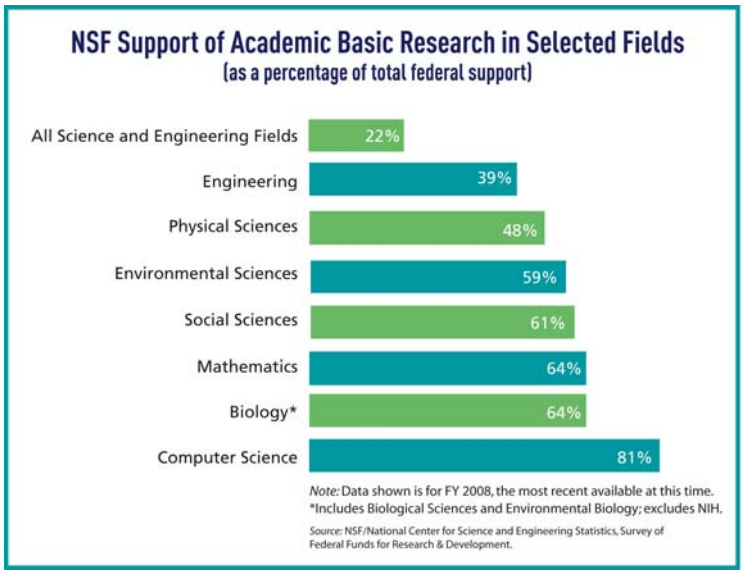
## Organization and Role in the Federal Research Enterprise

NSF's comprehensive and flexible support of meritorious projects with broad societal impacts enables the Foundation to identify and foster both fundamental and transformative discoveries within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes – and even transforms – the very frontiers of knowledge. In these ways, NSF's discoveries inspire the American public – and the world.

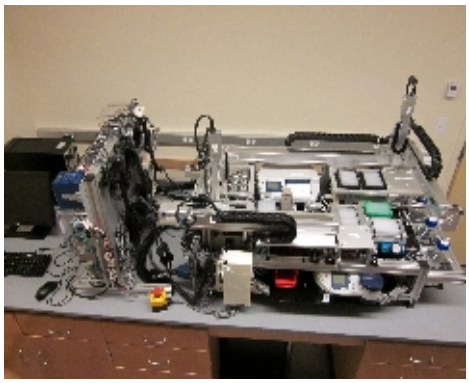



NSF's organization represents the major science and engineering fields, including: biological sciences; computer and information science and engineering; engineering; geosciences; mathematical and physical sciences; and social, behavioral, and economic sciences. NSF also carries out specific responsibilities for education and human resources, cyberinfrastructure, integrative activities, international science and engineering, and polar programs. The 25-member National Science Board sets the overall policies of the Foundation.

NSF's annual budget represents 22 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to 61 percent when medical research supported by the National Institutes of Health is excluded. In many fields NSF is the primary source of federal academic support.



# Highlights

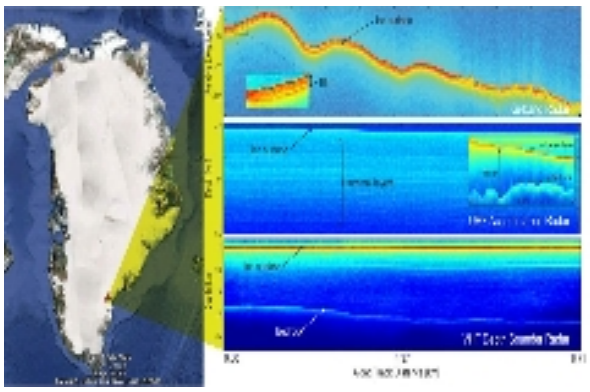


*Credit: Dr. Harris Wang, Harvard University*

### The Design and Evolution of Organisms Through Genome Programming

NSF Graduate Research Fellow Harris Wang invented the Multiplex Automated Genome Engineering (MAGE) platform, an engineering technique that allows researchers to rapidly increase "the design and evolution of organisms with new and improved properties." Engineering bacterial cells by manipulating their genomes is a very slow and laborious process. The MAGE platform allows efficient development of customized microorganisms for bioengineers. MAGE is applied towards solving global challenges by enabling bioengineers to program cells quickly and easily. Examples of the future applications from the lab's research include: production of pharmaceuticals, including artemisinin for malaria treatment, Taxol to fight cancer, and lycopene as an anti-oxidant dietary supplement; production of biofuels such as ethanol, butanol, diesel, and other hydrocarbons; and cell-based therapies.

### Multi-Radar Mapping of Polar Ice

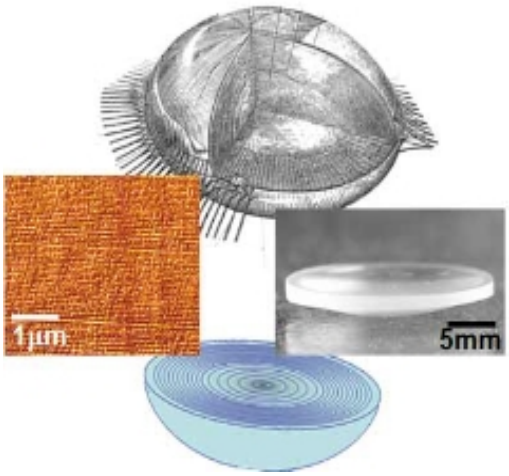


*Credit: CReSIS, the University of Kansas; map from Google maps*

The NSF-supported Center for Remote Sensing of Ice Sheets (CReSIS) has developed several types of radar (Ku-band radar, ultra high frequency accumulation radar and very high frequency depth sounder) to probe the ice on land and sea in Greenland and Antarctica. Researchers apply advanced signal processing techniques to radar data to create images of the interior structure of the ice sheets and hidden terrain below. The data collected with CReSIS radars provide ice sheet modelers with information essential to developing more accurate estimates of the contributions of the Antarctic and Greenland ice sheets to climate change and to better capture rapid changes currently observed. In the future, the radars will fly on remotely operated aircraft to acquire detailed ice sheet maps at times and places otherwise difficult to cover.

# Highlights

## Polymer Research Leads to New Commercial Technologies




*Credit: Professor Eric Baer, Case Western Reserve University*

Cutting-edge research--the result of collaborations within NSF's multi-institution Center for Layered Polymeric Systems (CLiPS) at Case Western Reserve – has led to two new U.S. start-up companies, one dedicated to improving water filtration systems and the other to advances in surveillance systems and solar cell equipment. The first company, Advanced Hydro, seeks to extend the lifetime and cost efficiency of membrane-based water filtration systems. It uses "bio-inspired," multilayer, polymer coatings that interact favorably with water. The second company, PolymerPlus, is dedicated to developing a new class of light-weight, polymer lenses with improved optical performance, to be used in miniaturized surveillance and solar-cell devices. PolymerPlus will use a technique developed by CLiPS that produces films with hundreds or even thousands of layers.

## At the Forefront of Cybersecurity Research

From advances in operating systems, software, and hardware to understanding the underlying motives of attacks, NSF-funded research is helping to ensure the security, reliability, availability, and overall trustworthiness of information technology resources. The Team for Research in Ubiquitous Secure Technology (TRUST), established as an NSF Science and Technology Center, is a university and industry consortium that supports cybersecurity research and education. TRUST, led by the University of California Berkeley, addresses technical, operational, privacy, and policy challenges via interdisciplinary projects that combine fundamental science and applied research to deliver breakthrough advances in trustworthy systems. Cybersecurity experiments require secure testbeds, such as the cyber-Defense Technology Experimental Research (DETER) testbed, which provides a safe venue to explore cyber security vulnerabilities since it is isolated from the outside internet.

*Credit: DETER Testbed*

# Highlights

*Credit: Zhijian Pei, Kansas State University*

## Harvesting Fuel from Green Algae

NSF-sponsored researchers at Kansas State University have developed a cost-effective way to harvest renewable fuels from algae grown in the sea, based on observations of algae growth on solid materials. In this technique, algae are restricted from moving and attached to a solid carrier material for growth. Immobilizing the algae increases their concentration at harvest and eases extraction of the generated fuel. The researchers studied four different types of materials for algae immobilization and found that different species of green algae favor different solid carrier materials. Their research will allow for future advances to overcome the challenges of harvesting large quantities of algae as an alternative energy source.

## Mesoporous Material Transforms Solar Energy Into Fuel

A research team in South Dakota has developed a method to rapidly create a novel material that generates hydrogen in the presence of water and sunlight. This research expands our understanding of how to generate fuel using visible sunlight rather than ultraviolet light. Because the hydrogen generation occurs at room temperature, the process will easily scale up to large production volumes. Applications of the new material range from removal of carbon dioxide from the atmosphere to the mitigation of environmental pollution.

*Credit: Ranjit T. Koodali*
*University of South Dakota*

*Credit: Andrew Whitehead*

## Gulf of Mexico Deepwater Horizon Spill Effects on Fish Revealed

Despite low concentrations of oil constituents in Gulf of Mexico waters from the Deepwater Horizon spill, fish were dramatically affected by toxic components of the oil. So found a team led by scientists Fernando Galvez and Andrew Whitehead of Louisiana State University (LSU). Galvez, Whitehead and colleagues undertook a combined field and laboratory study. It showed widespread effects of the Deepwater Horizon oil spill on fish in Louisiana marshes. Gene expression in tissues of the fish studied--in this case killifish--was predictive of oil spill responses such as developmental abnormalities and death, say the biologists. "It also indicated impairment of fish reproduction," says Whitehead. The study was funded by a National Science Foundation (NSF) rapid response grant.

## Highlights

### Wind Tunnel Gives Students Hands-on Design Experience

*Credit: Martin Wosnik, University of New Hampshire*

Teams of University of New Hampshire undergraduate students designed and built the supporting infrastructure for the Flow Physics Facility, the world's largest boundary layer wind tunnel. Projects included a three-meter diameter computer-controlled turntable, a prototype drag plate to measure surface skin friction in the tunnel, and hot-wire sensors with a measurement volume of half a millimeter. The wind tunnel will advance our understanding of the high Reynolds number boundary layers that are present on ships and aircraft, and are the primary contributor to drag.

### Global Education, Awareness, and Research Undergraduate Program

*Credit: Lorraine N. Fleming, Howard University*

Twenty-four Howard University engineering students are conducting research jointly with students from six universities in Africa, South America and Southeast Asia. Research mentors are faculty from Howard and from the six host universities-Ateneo de Manila University (Philippines); Bahir Dar University (Ethiopia); Universidad Andrés Bello (Chile); Université Cheikh Anta Diop (Sénégal); University of Indonesia; and University of Nairobi (Kenya). The results of the research will broaden the Howard University engineering curriculum, with an infusion of global engineering topics into a number of courses, including senior capstone design. Some examples of the engineering problems that Howard students are studying are: challenges of water treatment plants in Nairobi, traffic jams in Jakarta, flooding of the Blue Nile in Ethiopia, and earthquakes in Chile.

### Vision Scientists Demonstrate Innovative Learning Method

*Credit: Nicolle Rager Fuller, NSF*

It may be possible to use brain technology to learn to play a piano, reduce mental stress or hit a curve ball with little or no conscious effort. Experiments conducted at Boston University (BU) and ATR Computational Neuroscience Laboratories in Kyoto, Japan, recently demonstrated that through a person's visual cortex, researchers could use decoded functional magnetic resonance imaging (fMRI) to induce brain activity patterns to match a previously known target state and thereby improve performance on visual tasks. The National Science Foundation, the National Institutes of Health and the Ministry of Education, Culture, Sports, Science and Technology in Japan supported the research.

# Highlights

**First Global Picture of Greenhouse Gases Emerges from Pole-to-Pole Research Flights**

*Credit: Carlye Calvin, UCAR*

A three-year series of research flights from the Arctic to the Antarctic has successfully produced an unprecedented portrait of greenhouse gases and particles in the atmosphere. The far-reaching field project, known as HIPPO (for HIAPER Pole-to-Pole Observations), relies on the capabilities of a specially equipped Gulfstream V aircraft, owned by NSF and operated by NCAR in Boulder, Colo. The research jet (High-performance Instrumented Airborne Platform for Environmental Research or HIAPER) is outfitted with a suite of specially designed instruments to sample a broad range of atmospheric constituents. The team measured a total of more than 80 gases and particles in the atmosphere. One of HIPPO's most significant accomplishments has been quantifying the seasonal amounts of carbon dioxide taken up and released by land plants and the oceans.

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# National Science Foundation
## Summary Table
## FY 2013 Request to Congress

(Dollars in Millions)

| NSF by Account | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request over: FY 2011 Actual Amount | FY 2011 Actual Percent | FY 2012 Estimate Amount | FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|---|
| BIO | $712.27 | $712.38 | $733.86 | $21.59 | 3.0% | $21.48 | 3.0% |
| CISE | 636.06 | 653.59 | 709.72 | 73.66 | 11.6% | 56.13 | 8.6% |
| ENG | 763.33 | 826.17 | 876.33 | 113.00 | 14.8% | 50.16 | 6.1% |
| *ENG Programs* | *636.86* | *673.41* | *711.13* | *74.27* | *11.7%* | *37.72* | *5.6%* |
| *SBIR/STTR* | *126.47* | *152.76* | *165.20* | *38.73* | *30.6%* | *12.44* | *8.1%* |
| GEO | 885.32 | 885.27 | 906.44 | 21.12 | 2.4% | 21.17 | 2.4% |
| MPS | 1,312.42 | 1,308.94 | 1,345.18 | 32.76 | 2.5% | 36.24 | 2.8% |
| SBE | 247.33 | 254.25 | 259.55 | 12.22 | 4.9% | 5.30 | 2.1% |
| OCI[1] | 300.75 | 211.64 | 218.27 | -82.48 | -27.4% | 6.63 | 3.1% |
| OISE | 49.03 | 49.85 | 51.28 | 2.25 | 4.6% | 1.43 | 2.9% |
| OPP[2] | 440.70 | 435.87 | 449.74 | 9.04 | 2.1% | 13.87 | 3.2% |
| IA | 259.60 | 349.59 | 431.52 | 171.92 | 66.2% | 81.93 | 23.4% |
| U.S. Arctic Research Commission | 1.58 | 1.45 | 1.39 | -0.19 | -11.8% | -0.06 | -4.1% |
| **Research & Related Activities** | **$5,608.38** | **$5,689.00** | **$5,983.28** | **$374.90** | **6.7%** | **$294.28** | **5.2%** |
| **Education & Human Resources** | **$861.04** | **$829.00** | **$875.61** | **$14.57** | **1.7%** | **$46.61** | **5.6%** |
| **Major Research Equipment & Facilities Construction** | **$125.37** | **$197.06** | **$196.17** | **$70.80** | **56.5%** | **-$0.89** | **-0.4%** |
| **Agency Operations & Award Management** | **$299.29** | **$299.40** | **$299.40** | **$0.11** | **0.0%** | **-** | **-** |
| **National Science Board** | **$4.47** | **$4.44** | **$4.44** | **-$0.03** | **-0.7%** | **-** | **-** |
| **Office of Inspector General** | **$13.92** | **$14.20** | **$14.20** | **$0.28** | **2.0%** | **-** | **-** |
| OIG FY 2011 ARRA Obligations | $0.08 | - | - | - | - | - | - |
| **Total, NSF** | **$6,912.55** | **$7,033.10** | **$7,373.10** | **$460.55** | **6.7%** | **$340.00** | **4.8%** |

Totals may not add due to rounding.

[1] FY 2011 Actual for OCI includes $90.50 million in funds that were obligated in FY 2010, deobligated in FY 2011, and then obligated in FY 2011 to other projects in the OCI portfolio.

[2] Funding for OPP for FY 2011 excludes a one-time appropriation transfer of $53.892 million, $54.0 million less the 0.2% rescission, to U.S. Coast Guard per P.L. 112-10.

## NSF Funding Profile

The Funding Profile presents a high level, agency-wide estimate of proposal pressure, funding rates (or proposal "success"), and award statistics. These indicators are useful in gauging the relative efficacy of different funding levels.

*Statistics for Competitive Awards*: The Number of Proposals is based on several factors, including past actual activity, planned competitions, and research trends within the various disciplinary communities. External factors, such as the state of the national economy and other sources of funding, also play a part. The Number of Awards is also based on several factors, including estimated funding and expected proposal pool. The Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. This indicates the probability of receiving an award when submitting proposals to NSF.

*Statistics for Research Grants*: The Number of Proposals is based on several factors, including past actual activity, planned competitions, and research trends within the various disciplinary communities. External factors, such as the state of the national economy and other sources of funding, also play a part. The Number of Awards is also based on several factors, including estimated funding and expected proposal pool. Research Grants are grants limited to research projects and exclude other categories of awards that fund infrastructure-type activities, which do not require multi-year support, such as equipment and conference awards. Annualized Award Size shows the annual level of research grants provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Both the average and the median annualized award size for competitively reviewed awards are shown. Average Duration is the length of awards in years.

**NSF Funding Profile**

| | FY 2011 Actual Estimate[1] | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards** | | | |
| Number of Proposals | 51,400 | 53,400 | 55,100 |
| Number of Awards | 11,150 | 11,700 | 12,200 |
| Funding Rate | 22% | 22% | 22% |
| **Statistics for Research Grants** | | | |
| Number of Research Grant Proposals | 38,600 | 40,050 | 41,350 |
| Number of Research Grant Awards | 7,550 | 7,850 | 8,150 |
| Funding Rate | 20% | 20% | 20% |
| Median Annualized Award Size | $125,950 | $128,500 | $128,700 |
| Average Annualized Award Size | $156,200 | $161,250 | $160,500 |
| Average Duration (years) | 2.9 | 2.9 | 2.9 |

[1] The FY 2011 Actual Estimate does not capture actions within Integrative Activities (IA), which includes the Experimental Program to Stimulate Competitive Research.

## Number of People Involved in NSF Activities

NSF estimates that in FY 2013 more than 284,500 people will be directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. Beyond these figures, NSF programs indirectly impact millions of people. These programs reach K-12 students and teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods.

**FY 2013 Request**
**Number of People Involved in NSF Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 53,073 | 53,930 | 55,660 |
| Other Professionals | 14,441 | 14,595 | 14,975 |
| Postdoctoral Associates | 6,855 | 6,935 | 7,135 |
| Graduate Students | 40,163 | 40,885 | 42,160 |
| Undergraduate Students | 27,039 | 27,400 | 28,090 |
| K-12 Teachers | 48,086 | 48,115 | 48,850 |
| K-12 Students | 86,225 | 86,310 | 87,645 |
| **TOTAL, PEOPLE** | **275,882** | **278,170** | **284,515** |

**Senior Researchers** include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

**Other Professionals** are individuals who may or may not hold a doctoral degree or its equivalent, are considered professionals but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

**Postdoctoral Associates** are individuals who have received Ph.D., M.D., D.Sc., or equivalent and are not faculty members of the performing institution. About 98 percent are supported through funds included in research projects, centers, or facilities awards. Others are recipients of postdoctoral fellowships.

**Graduate Students** include those compensated from NSF grant funds. About 30 percent receive support through programs such as NSF Graduate Research Fellowship and NSF Integrative Graduate Education and Research Traineeship. Other graduate students supported assist senior researchers or postdoctoral associates in performing research through awards for research projects, centers, or facilities. NSF provides support for about 5 percent of the science and engineering graduate students in the U.S.

**Undergraduate Students** include students compensated from NSF grant funds who are enrolled in technical colleges or baccalaureate programs. They may be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs aimed at undergraduate students, such as Research Experiences for Undergraduates.

**K-12 Teachers** include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in the sciences and mathematics.

**K-12 Students** are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences.

# NSF By Account

Obligations, FY 1980 - FY 2013 Request

(Actual Obligations in Millions - Current Dollars)

| Fiscal Year | Research & Related Activities | Education & Human Resources | Academic Research Infrastructure[1] | Major Research Equipment & Facilities Construction | Agency Operations & Award Management | Office of Inspector General | National Science Board | NSF |
|---|---|---|---|---|---|---|---|---|
| 1980 | 836.83 | 80.06 | - | - | 58.24 | - | - | 975.13 |
| 1981 | 900.36 | 75.70 | - | - | 59.21 | - | - | 1,035.27 |
| 1982 | 909.75 | 26.20 | - | - | 63.18 | - | - | 999.14 |
| 1983 | 1,013.02 | 22.98 | - | - | 65.70 | - | - | 1,101.69 |
| 1984 | 1,177.70 | 62.97 | - | - | 66.26 | - | - | 1,306.92 |
| 1985 | 1,344.56 | 90.56 | - | - | 71.95 | - | - | 1,507.07 |
| 1986 | 1,329.64 | 91.69 | - | - | 71.84 | - | - | 1,493.17 |
| 1987 | 1,439.97 | 109.88 | - | - | 77.77 | - | - | 1,627.62 |
| 1988 | 1,481.31 | 156.79 | - | - | 84.47 | - | - | 1,722.57 |
| 1989 | 1,600.53 | 194.06 | - | - | 91.29 | - | - | 1,885.88 |
| 1990 | 1,696.56 | 230.41 | 0.41 | - | 96.35 | 2.33 | - | 2,026.06 |
| 1991 | 1,868.45 | 331.91 | 39.02 | - | 101.23 | 2.89 | - | 2,343.49 |
| 1992 | 1,940.48 | 459.44 | 33.36 | - | 109.99 | 3.86 | - | 2,547.13 |
| 1993 | 2,046.31 | 505.06 | 49.75 | 34.07 | 110.84 | 3.69 | - | 2,749.73 |
| 1994 | 2,168.36 | 569.03 | 105.38 | 17.04 | 123.49 | 3.92 | - | 2,987.21 |
| 1995 | 2,281.46 | 611.88 | 117.46 | 126.00 | 129.01 | 4.46 | - | 3,270.27 |
| 1996 | 2,327.80 | 601.16 | 70.89 | 70.00 | 132.50 | 3.98 | - | 3,206.33 |
| 1997 | 2,433.93 | 619.14 | 30.02 | 76.13 | 134.27 | 5.33 | - | 3,298.82 |
| 1998 | 2,572.62 | 633.16 | - | 78.21 | 136.95 | 4.80 | - | 3,425.73 |
| 1999 | 2,821.61 | 662.48 | - | 56.71 | 144.08 | 5.41 | - | 3,690.28 |
| 2000 | 2,979.90 | 683.58 | - | 105.00 | 149.28 | 5.60 | - | 3,923.36 |
| 2001 | 3,372.30 | 795.42 | - | 119.24 | 166.33 | 6.58 | - | 4,459.87 |
| 2002 | 3,615.97 | 866.11 | - | 115.35 | 169.93 | 6.70 | - | 4,774.06 |
| 2003 | 4,054.43 | 934.88 | - | 179.03 | 189.42 | 8.70 | 2.88 | 5,369.34 |
| 2004 | 4,293.34 | 944.10 | - | 183.96 | 218.92 | 9.47 | 2.22 | 5,652.01 |
| 2005 | 4,234.82 | 843.54 | - | 165.14 | 223.45 | 10.17 | 3.65 | 5,480.77 |
| 2006 | 4,351.03 | 798.48 | - | 233.81 | 247.06 | 11.47 | 3.94 | 5,645.79 |
| 2007 | 4,656.33 | 797.76 | - | 166.21 | 248.49 | 11.92 | 3.65 | 5,884.37 |
| 2008 | 4,853.24 | 766.26 | - | 166.85 | 282.04 | 11.83 | 3.82 | 6,084.04 |
| *2009 Omnibus* | *5,152.39* | *845.52* | - | *160.76* | *294.09* | *11.99* | *4.02* | *6,468.76* |
| *2009 ARRA* | *2,062.64* | *85.00* | - | *254.00* | - | *0.02* | - | *2,401.66* |
| 2009 Total | 7,215.03 | 930.52 | - | 414.76 | 294.09 | 12.01 | 4.02 | 8,870.42 |
| *2010 Omnibus* | *5,615.33* | *872.77* | - | *165.90* | *299.85* | *13.97* | *4.38* | *6,972.20* |
| *2010 ARRA* | *439.17* | *15.00* | - | *146.00* | - | *0.05* | - | *600.22* |
| 2010 Total | 6,054.50 | 887.77 | - | 311.90 | 299.85 | 14.03 | 4.38 | 7,572.42 |
| *2011 Omnibus* | *5,608.38* | *861.04* | - | *125.37* | *299.29* | *13.92* | *4.47* | *6,912.46* |
| *2011 ARRA* | - | - | - | - | - | *0.08* | - | *0.08* |
| 2011 Total | 5,608.38 | 861.04 | - | 125.37 | 299.29 | 14.00 | 4.47 | 6,912.55 |
| 2012 Estimate | 5,689.00 | 829.00 | - | 197.06 | 299.40 | 14.20 | 4.44 | 7,033.10 |
| 2013 Request | 5,983.28 | 875.61 | - | 196.17 | 299.40 | 14.20 | 4.44 | 7,373.10 |

Totals may not add due to rounding.

[1] In addition to the specific appropriations for Academic Research Infrastructure (ARI) from FY 1990 to FY 1997, $200.0 million was provided for ARI in the R&RA account under ARRA.

# NSF By Account

Obligations, 1980 - FY 2013 Request
(FY 2012 Constant Dollars in Millions)

| Fiscal Year | Research & Related Activities | Education & Human Resources | Academic Research Infrastructure[1] | Major Research Equipment & Facilities Construction | Agency Operations & Award Management | Office of Inspector General | National Science Board | NSF |
|---|---|---|---|---|---|---|---|---|
| 1980 | 2,057.35 | 196.83 | - | - | 143.18 | - | - | 2,397.36 |
| 1981 | 2,015.08 | 169.42 | - | - | 132.51 | - | - | 2,317.00 |
| 1982 | 1,905.73 | 54.89 | - | - | 132.35 | - | - | 2,092.96 |
| 1983 | 2,032.71 | 46.11 | - | - | 131.83 | - | - | 2,210.64 |
| 1984 | 2,278.66 | 121.83 | - | - | 128.20 | - | - | 2,528.69 |
| 1985 | 2,519.86 | 169.71 | - | - | 134.84 | - | - | 2,824.41 |
| 1986 | 2,435.53 | 167.95 | - | - | 131.58 | - | - | 2,735.07 |
| 1987 | 2,568.97 | 196.03 | - | - | 138.74 | - | - | 2,903.74 |
| 1988 | 2,560.67 | 271.04 | - | - | 146.01 | - | - | 2,977.73 |
| 1989 | 2,663.41 | 322.93 | - | - | 151.91 | - | - | 3,138.25 |
| 1990 | 2,723.06 | 369.82 | 0.66 | - | 154.65 | 3.74 | - | 3,251.91 |
| 1991 | 2,889.24 | 513.24 | 60.34 | - | 156.53 | 4.46 | - | 3,623.80 |
| 1992 | 2,924.48 | 692.42 | 50.27 | - | 165.77 | 5.81 | - | 3,838.76 |
| 1993 | 3,017.62 | 744.80 | 73.37 | 50.24 | 163.45 | 5.44 | - | 4,054.92 |
| 1994 | 3,131.41 | 821.76 | 152.18 | 24.61 | 178.34 | 5.65 | - | 4,313.95 |
| 1995 | 3,226.36 | 865.30 | 166.10 | 178.18 | 182.45 | 6.31 | - | 4,624.70 |
| 1996 | 3,229.58 | 834.05 | 98.36 | 97.12 | 183.82 | 5.51 | - | 4,448.45 |
| 1997 | 3,315.66 | 843.43 | 40.90 | 103.71 | 182.91 | 7.26 | - | 4,493.88 |
| 1998 | 3,460.64 | 851.71 | - | 105.20 | 184.22 | 6.45 | - | 4,608.22 |
| 1999 | 3,745.97 | 879.51 | - | 75.28 | 191.28 | 7.18 | - | 4,899.23 |
| 2000 | 3,879.20 | 889.88 | - | 136.69 | 194.33 | 7.29 | - | 5,107.38 |
| 2001 | 4,289.26 | 1,011.70 | - | 151.66 | 211.56 | 8.37 | - | 5,672.55 |
| 2002 | 4,524.16 | 1,083.64 | - | 144.32 | 212.61 | 8.38 | - | 5,973.12 |
| 2003 | 4,971.25 | 1,146.28 | - | 219.51 | 232.25 | 10.67 | 3.53 | 6,583.50 |
| 2004 | 5,134.28 | 1,129.02 | - | 219.99 | 261.80 | 11.32 | 2.65 | 6,759.07 |
| 2005 | 4,904.77 | 976.99 | - | 191.27 | 258.80 | 11.78 | 4.23 | 6,347.83 |
| 2006 | 4,873.66 | 894.39 | - | 261.89 | 276.74 | 12.85 | 4.41 | 6,323.94 |
| 2007 | 5,065.72 | 867.90 | - | 180.82 | 270.34 | 12.97 | 3.97 | 6,401.72 |
| 2008 | 5,160.22 | 814.73 | - | 177.40 | 299.88 | 12.57 | 4.07 | 6,468.86 |
| *2009 Omnibus* | *5,400.45* | *886.22* | - | *168.49* | *308.25* | *12.57* | *4.22* | *6,780.20* |
| *2009 ARRA* | *2,161.95* | *89.09* | - | *266.23* | - | *0.02* | - | *2,517.29* |
| 2009 Total | 7,562.40 | 975.31 | - | 434.72 | 308.25 | 12.59 | 4.22 | 9,297.49 |
| *2010 Omnibus* | *5,831.85* | *906.42* | - | *172.29* | *311.41* | *14.51* | *4.55* | *7,241.04* |
| *2010 ARRA* | *456.10* | *15.58* | - | *151.63* | - | *0.06* | - | *623.36* |
| 2010 Total | 6,287.95 | 922.00 | - | 323.92 | 311.41 | 14.57 | 4.55 | 7,864.40 |
| *2011 Omnibus* | *5,711.95* | *876.94* | - | *127.69* | *304.82* | *14.17* | *4.55* | *7,040.11* |
| *2011 ARRA* | - | - | - | - | - | *0.08* | - | *0.08* |
| 2011 Total | 5,711.95 | 876.94 | - | 127.69 | 304.82 | 14.26 | 4.55 | 7,040.20 |
| 2012 Estimate | 5,689.00 | 829.00 | - | 197.06 | 299.40 | 14.20 | 4.44 | 7,033.10 |
| 2013 Request | 5,885.71 | 861.33 | - | 192.97 | 294.52 | 13.97 | 4.37 | 7,252.87 |

Totals may not add due to rounding.

[1] In addition to the specific appropriations for Academic Research Infrastructure (ARI) from FY 1990 to FY 1997, $200.0 million was provided for ARI in the R&RA account under ARRA.

## National Science Foundation
## Selected Cross-Cutting Programs
## FY 2013 Request to Congress

(Dollars in Millions)

| Selected Cross-Cutting Programs | | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request change over: FY 2011 Actual Amount | FY 2011 Actual Percent | FY 2012 Estimate Amount | FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|---|---|
| ADVANCE | Research & Related Activities | 18.27 | 16.42 | 15.53 | -2.74 | -15.0% | -0.89 | -5.4% |
| | Education & Human Resources | 1.52 | 1.53 | 1.53 | 0.01 | 0.8% | - | - |
| | **Total, NSF** | **$19.79** | **$17.95** | **$17.06** | **-$2.73** | **-13.8%** | **-$0.89** | **-5.0%** |
| Research at the Interface of Biological, Math, and Physical Sciences (BioMaPS) | Research & Related Activities | 8.94 | 20.00 | 30.17 | 21.23 | 237.5% | 10.17 | 50.9% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$8.94** | **$20.00** | **$30.17** | **$21.23** | **237.5%** | **$10.17** | **50.9%** |
| Climate Change Education Program | Research & Related Activities | 4.06 | 4.50 | 1.50 | -2.56 | -63.0% | -3.00 | -66.7% |
| | Education & Human Resources | 5.43 | 5.50 | 4.76 | -0.67 | -12.4% | -0.74 | -13.5% |
| | **Total, NSF** | **$9.49** | **$10.00** | **$6.26** | **-$3.23** | **-34.0%** | **-$3.74** | **-37.4%** |
| Enhancing Access to the Radio Spectrum (EARS) | Research & Related Activities | 0.03 | 15.00 | 50.50 | 50.48 | N/A | 35.50 | 236.7% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$0.03** | **$15.00** | **$50.50** | **$50.48** | **N/A** | **$35.50** | **236.7%** |
| Faculty Early Career Development - CAREER | Research & Related Activities | 229.33 | 206.35 | 216.49 | -12.84 | -5.6% | 10.14 | 4.9% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$229.33** | **$206.35** | **$216.49** | **-$12.84** | **-5.6%** | **$10.14** | **4.9%** |
| Graduate Research Fellowship - GRF | Research & Related Activities | 44.40 | 88.50 | 121.49 | 77.09 | 173.6% | 32.99 | 37.3% |
| | Education & Human Resources | 93.27 | 109.64 | 121.49 | 28.22 | 30.3% | 11.85 | 10.8% |
| | **Total, NSF** | **$137.67** | **$198.14** | **$242.98** | **$105.31** | **76.5%** | **$44.84** | **22.6%** |
| Graduate STEM Fellows in K-12 Education - GK-12 | Research & Related Activities | 6.30 | - | - | -6.30 | -100.0% | - | N/A |
| | Education & Human Resources | 48.18 | 26.95 | 27.00 | -21.18 | -44.0% | 0.05 | 0.2% |
| | **Total, NSF** | **$54.48** | **$26.95** | **$27.00** | **-$27.48** | **-50.4%** | **$0.05** | **0.2%** |
| Integrative Graduate Education and Research Traineeship - IGERT | Research & Related Activities | 31.46 | 28.62 | 25.42 | -6.04 | -19.2% | -3.20 | -11.2% |
| | Education & Human Resources | 29.60 | 31.20 | 26.27 | -3.33 | -11.3% | -4.93 | -15.8% |
| | **Total, NSF** | **$61.07** | **$59.82** | **$51.69** | **-$9.38** | **-15.4%** | **-$8.13** | **-13.6%** |
| Total, Graduate Fellowships & Traineeships | Research & Related Activities | $82.17 | $117.12 | $146.91 | 64.74 | 78.8% | 29.79 | 25.4% |
| | Education & Human Resources | $171.05 | $167.79 | $174.76 | 3.71 | 2.2% | 6.97 | 4.2% |
| | **Total, NSF** | **$253.21** | **$284.91** | **$321.67** | **$68.46** | **27.0%** | **$36.76** | **12.9%** |
| Long-Term Ecological Research Sites - LTER | Research & Related Activities | 26.26 | 27.40 | 27.97 | 1.71 | 6.5% | 0.57 | 2.1% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$26.26** | **$27.40** | **$27.97** | **$1.71** | **6.5%** | **$0.57** | **2.1%** |
| Research Experiences for Teachers - RET | Research & Related Activities | 8.76 | 6.98 | 5.47 | -3.29 | -37.5% | -1.51 | -21.6% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$8.76** | **$6.98** | **$5.47** | **-$3.29** | **-37.5%** | **-$1.51** | **-21.6%** |
| Research Experiences for Undergraduates - REU - Sites Only | Research & Related Activities | 59.98 | 48.27 | 50.62 | -9.36 | -15.6% | 2.35 | 4.9% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$59.98** | **$48.27** | **$50.62** | **-$9.36** | **-15.6%** | **$2.35** | **4.9%** |
| Research Experiences for Undergraduates - REU - Supplements Only | Research & Related Activities | 18.66 | 17.72 | 17.78 | -0.88 | -4.7% | 0.06 | 0.3% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$18.66** | **$17.72** | **$17.78** | **-$0.88** | **-4.7%** | **$0.06** | **0.3%** |
| Total, Research Experiences for Undergraduates - REU | Research & Related Activities | 78.63 | 65.99 | 68.40 | -10.23 | -13.0% | 2.41 | 3.7% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$78.63** | **$65.99** | **$68.40** | **-$10.23** | **-13.0%** | **$2.41** | **3.7%** |
| Research in Undergraduate Institutions - RUI | Research & Related Activities | 58.63 | 40.15 | 40.15 | -18.48 | -31.5% | - | - |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$58.63** | **$40.15** | **$40.15** | **-$18.48** | **-31.5%** | - | - |
| Science and Technology Centers - STCs | Research & Related Activities | 66.10 | 50.75 | 74.39 | 8.29 | 12.5% | 23.64 | 46.6% |
| | Education & Human Resources | - | - | - | - | N/A | - | N/A |
| | **Total, NSF** | **$66.10** | **$50.75** | **$74.39** | **$8.29** | **12.5%** | **$23.64** | **46.6%** |

Totals may not add due to rounding.

# National Science Foundation
## NSTC Crosscuts Summary
## FY 2013 Request to Congress

(Dollars in Millions)

| | Climate Change Technology Program | | | | | | | U.S. Global Change Research Program | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FY 2013 Request change over: | | | | | | | FY 2013 Request change over: | | | |
| | FY 2011 | FY 2012 | FY 2013 | FY 2011 Actual | | FY 2012 Estimate | | FY 2011 | FY 2012 | FY 2013 | FY 2011 Actual | | FY 2012 Estimate | |
| | Actual | Estimate | Request | Amount | Percent | Amount | Percent | Actual | Estimate | Request | Amount | Percent | Amount | Percent |
| BIO | - | - | - | - | N/A | - | N/A | $81.00 | $89.00 | $91.00 | $10.00 | 12.3% | $2.00 | 2.2% |
| CISE | - | - | - | - | N/A | - | N/A | - | - | - | - | N/A | - | N/A |
| ENG | $28.50 | $28.50 | $29.00 | $0.50 | 1.8% | $0.50 | 1.8% | - | - | - | - | N/A | - | N/A |
| GEO | - | - | - | - | N/A | - | N/A | 194.00 | 194.00 | 194.00 | - | - | - | - |
| MPS | - | - | - | - | N/A | - | N/A | 3.32 | 5.03 | 8.03 | 4.71 | 141.6% | 3.00 | 59.6% |
| SBE | - | - | - | - | N/A | - | N/A | 20.73 | 22.23 | 23.23 | 2.50 | 12.1% | 1.00 | 4.5% |
| OCI | - | - | - | - | N/A | - | N/A | - | - | - | - | N/A | - | N/A |
| OISE | 1.85 | 1.21 | 1.16 | -0.69 | -37.4% | -0.05 | -4.1% | - | - | - | - | N/A | - | N/A |
| OPP | - | - | - | - | N/A | - | N/A | 18.52 | 23.10 | 16.65 | -1.87 | -10.1% | -6.45 | -27.9% |
| IA | - | - | - | - | N/A | - | N/A | - | - | - | - | N/A | - | N/A |
| **R&RA** | **$30.35** | **$29.71** | **$30.16** | **-$0.19** | **-0.6%** | **$0.45** | **1.5%** | **$317.57** | **$333.36** | **$332.91** | **$15.34** | **4.8%** | **-$0.45** | **-0.1%** |
| **EHR** | **-** | **-** | **-** | **-** | **N/A** | **-** | **N/A** | **-** | **-** | **-** | **-** | **N/A** | **-** | **N/A** |
| **NSF Total** | **$30.35** | **$29.71** | **$30.16** | **-$0.19** | **-0.6%** | **$0.45** | **1.5%** | **$317.57** | **$333.36** | **$332.91** | **$15.34** | **4.8%** | **-$0.45** | **-0.1%** |

| | Networking and Information Technology Research and Development | | | | | | | National Nanotechnology Initiative | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FY 2013 Request change over: | | | | | | | FY 2013 Request change over: | | | |
| | FY 2011 | FY 2012 | FY 2013 | FY 2011 Actual | | FY 2012 Estimate | | FY 2011 | FY 2012 | FY 2013 | FY 2011 Actual | | FY 2012 Estimate | |
| | Actual | Estimate | Request | Amount | Percent | Amount | Percent | Actual | Estimate | Request | Amount | Percent | Amount | Percent |
| BIO | $93.00 | $99.00 | $99.00 | $6.00 | 6.5% | - | - | $56.36 | $56.10 | $57.10 | $0.74 | 1.3% | $1.00 | 1.8% |
| CISE | 636.06 | 653.59 | 709.72 | 73.66 | 11.6% | $56.13 | 8.6% | 17.45 | 17.75 | 17.75 | 0.30 | 1.7% | - | - |
| ENG | 21.00 | 18.30 | 19.80 | -1.20 | -5.7% | 1.50 | 8.2% | 181.59 | 166.37 | 174.37 | -7.22 | -4.0% | 8.00 | 4.8% |
| GEO | 22.98 | 22.98 | 26.98 | 4.00 | 17.4% | 4.00 | 17.4% | 0.85 | 0.85 | 0.75 | -0.10 | -11.8% | -0.10 | -11.8% |
| MPS | 83.88 | 93.75 | 94.75 | 10.87 | 13.0% | 1.00 | 1.1% | 224.56 | 183.16 | 183.16 | -41.40 | -18.4% | - | - |
| SBE | 22.21 | 29.51 | 29.20 | 6.99 | 31.5% | -0.31 | -1.1% | 1.67 | 1.67 | 1.67 | - | 0.0% | - | - |
| OCI | 300.75 | 211.64 | 218.27 | -82.48 | -27.4% | 6.63 | 3.1% | - | - | - | - | N/A | - | N/A |
| OISE | - | - | - | - | N/A | - | N/A | 0.10 | 0.10 | 0.10 | - | - | - | - |
| OPP | - | - | - | - | N/A | - | N/A | - | - | - | - | N/A | - | N/A |
| IA | - | - | - | - | N/A | - | N/A | - | - | - | - | N/A | - | N/A |
| **R&RA** | **$1,179.88** | **$1,128.77** | **$1,197.72** | **$17.84** | **1.5%** | **$68.95** | **6.1%** | **$482.58** | **$426.00** | **$434.90** | **-$47.68** | **-9.9%** | **$8.90** | **2.1%** |
| **EHR** | **$9.50** | **$9.50** | **$9.50** | **-** | **-** | **-** | **-** | **$2.50** | **-** | **-** | **-$2.50** | **-100.0%** | **-** | **N/A** |
| **NSF Total** | **$1,189.38** | **$1,138.27** | **$1,207.22** | **$17.84** | **1.5%** | **$68.95** | **6.1%** | **$485.08** | **$426.00** | **$434.90** | **-$50.18** | **-10.3%** | **$8.90** | **2.1%** |

Totals may not add due to rounding.

**National Science Foundation**
**Homeland Security Activities Summary**
**FY 2013 Request to Congress**
(Dollars in Millions)

| | BIO | CISE | ENG | GEO | MPS | SBE | OCI | OPP | IA | R&RA | EHR | AOAM | Total, NSF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FY 2011 Actual** | **$15.00** | **$179.80** | **$157.30** | **-** | **$1.09** | **$4.50** | **$4.84** | **$2.68** | **$2.58** | **$367.80** | **$15.17** | **$2.79** | **$385.76** |
| **Protecting Critical Infrastructure & Key Assets** | **-** | **$179.80** | **$157.30** | **-** | **$1.09** | **$4.50** | **$4.84** | **$2.68** | **$2.58** | **$352.80** | **$15.17** | **$2.79** | **$370.76** |
| Antarctic Physical Security | - | - | - | - | - | - | - | 0.28 | - | 0.28 | - | - | 0.28 |
| Counterterrorism | - | 27.00 | - | - | - | - | - | - | - | 27.00 | - | - | 27.00 |
| Cybersecurity | - | 123.50 | 3.10 | - | - | - | 4.84 | - | - | 131.44 | - | - | 131.44 |
| Electronic Commerce | - | 4.50 | 3.40 | - | - | - | - | - | - | 7.90 | - | - | 7.90 |
| Emergency Planning & Response | - | 24.80 | 25.80 | - | 0.29 | - | - | - | - | 50.89 | - | - | 50.89 |
| Energy Supply Assurance | - | - | 28.50 | - | - | - | - | - | - | 28.50 | - | - | 28.50 |
| IT Security | - | - | - | - | - | - | - | 2.40 | 2.58 | 4.98 | 0.38 | 2.79 | 8.15 |
| Resilient Infrastructure (Risk Mgmt, Modeling, Simul) | - | - | 96.50 | - | 0.81 | 4.50 | - | - | - | 101.81 | - | - | 101.81 |
| Scholarships for Service / Cybercorps | - | - | - | - | - | - | - | - | - | - | 14.79 | - | 14.79 |
| **Defending Against Catastrophic Threats** | **$15.00** | - | - | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| Research to Combat Bioterrorism | 15.00 | - | - | - | - | - | - | - | - | 15.00 | - | - | 15.00 |
| *Microbial Genomics, Analysis & Modeling* | *15.00* | - | - | - | - | - | - | - | - | *15.00* | - | - | *15.00* |
| **FY 2012 Estimate** | **$15.00** | **$179.80** | **$156.70** | **-** | **$4.80** | **$11.50** | **$21.00** | **$4.30** | **$2.58** | **$395.68** | **$45.38** | **$2.79** | **$443.85** |
| **Protecting Critical Infrastructure & Key Assets** | **-** | **$179.80** | **$156.70** | **-** | **$4.80** | **$11.50** | **$21.00** | **$4.30** | **$2.58** | **$380.68** | **$45.38** | **$2.79** | **$428.85** |
| Antarctic Physical Security | - | - | - | - | - | - | - | 0.30 | - | 0.30 | - | - | 0.30 |
| Counterterrorism | - | 27.00 | - | - | - | - | - | - | - | 27.00 | - | - | 27.00 |
| Cybersecurity | - | 123.50 | 5.05 | - | 1.00 | 6.00 | 21.00 | - | - | 156.55 | - | - | 156.55 |
| Electronic Commerce | - | 4.50 | 3.35 | - | - | - | - | - | - | 7.85 | - | - | 7.85 |
| Emergency Planning & Response | - | 24.80 | 25.30 | - | 3.10 | - | - | - | - | 53.20 | - | - | 53.20 |
| Energy Supply Assurance | - | - | 28.00 | - | - | - | - | - | - | 28.00 | - | - | 28.00 |
| IT Security | - | - | - | - | - | - | - | 4.00 | 2.58 | 6.58 | 0.38 | 2.79 | 9.75 |
| Resilient Infrastructure (Risk Mgmt, Modeling, Simul) | - | - | 95.00 | - | 0.70 | 5.50 | - | - | - | 101.20 | - | - | 101.20 |
| Scholarships for Service / Cybercorps | - | - | - | - | - | - | - | - | - | - | 45.00 | - | 45.00 |
| **Defending Against Catastrophic Threats** | **$15.00** | - | - | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| Research to Combat Bioterrorism | 15.00 | - | - | - | - | - | - | - | - | 15.00 | - | - | 15.00 |
| *Microbial Genomics, Analysis & Modeling* | *15.00* | - | - | - | - | - | - | - | - | *15.00* | - | - | *15.00* |
| **Delta from FY 2012 Estimate to FY 2013 Request** | - | **$4.50** | **-$0.80** | - | **$0.50** | **-$0.50** | **$0.00** | **-$1.62** | - | **$2.08** | **-$20.00** | - | **-$17.92** |
| **Protecting Critical Infrastructure & Key Assets** | **-** | **$4.50** | **-$0.80** | **-** | **$0.50** | **-$0.50** | **-** | **-$1.62** | **-** | **$2.08** | **-$20.00** | **-** | **-$17.92** |
| Antarctic Physical Security | - | - | - | - | - | - | - | -0.02 | - | -0.02 | - | - | -0.02 |
| Counterterrorism | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cybersecurity | - | 4.50 | -0.80 | - | 1.00 | - | - | - | - | 4.70 | - | - | 4.70 |
| Electronic Commerce | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Emergency Planning & Response | - | - | - | - | -0.50 | - | - | - | - | -0.50 | - | - | -0.50 |
| Energy Supply Assurance | - | - | - | - | - | - | - | - | - | 0.00 | - | - | 0.00 |
| IT Security | - | - | - | - | - | - | - | -1.60 | - | -1.60 | - | - | -1.60 |
| Resilient Infrastructure (Risk Mgmt, Modeling, Simul) | - | - | - | - | - | -0.50 | - | - | - | -0.50 | - | - | -0.50 |
| Scholarships for Service / Cybercorps | - | - | - | - | - | - | - | - | - | - | -20.00 | - | -20.00 |
| **Defending Against Catastrophic Threats** | **$0.00** | - | - | - | - | - | - | - | - | - | - | - | - |
| Research to Combat Bioterrorism | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Microbial Genomics, Analysis & Modeling* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **FY 2013 Request** | **$15.00** | **$184.30** | **$155.90** | **-** | **$5.30** | **$11.00** | **$21.00** | **$2.68** | **$2.58** | **$397.76** | **$25.38** | **$2.79** | **$425.93** |
| **Protecting Critical Infrastructure & Key Assets** | **-** | **$184.30** | **$155.90** | **-** | **$5.30** | **$11.00** | **$21.00** | **$2.68** | **$2.58** | **$382.76** | **$25.38** | **$2.79** | **$410.93** |
| Antarctic Physical Security | - | - | - | - | - | - | - | 0.28 | - | 0.28 | - | - | 0.28 |
| Counterterrorism | - | 27.00 | - | - | - | - | - | - | - | 27.00 | - | - | 27.00 |
| Cybersecurity | - | 128.00 | 4.25 | - | 2.00 | 6.00 | 21.00 | - | - | 161.25 | - | - | 161.25 |
| Electronic Commerce | - | 4.50 | 3.35 | - | - | - | - | - | - | 7.85 | - | - | 7.85 |
| Emergency Planning & Response | - | 24.80 | 25.30 | - | 2.60 | - | - | - | - | 52.70 | - | - | 52.70 |
| Energy Supply Assurance | - | - | 28.00 | - | - | - | - | - | - | 28.00 | - | - | 28.00 |
| IT Security | - | - | - | - | - | - | - | 2.40 | 2.58 | 4.98 | 0.38 | 2.79 | 8.15 |
| Resilient Infrastructure (Risk Mgmt, Modeling, Simul) | - | - | 95.00 | - | 0.70 | 5.00 | - | - | - | 100.70 | - | - | 100.70 |
| Scholarships for Service / Cybercorps | - | - | - | - | - | - | - | - | - | - | 25.00 | - | 25.00 |
| **Defending Against Catastrophic Threats** | **$15.00** | - | - | - | - | - | - | - | - | **$15.00** | - | - | **$15.00** |
| Research to Combat Bioterrorism | 15.00 | - | - | - | - | - | - | - | - | 15.00 | - | - | 15.00 |
| *Microbial Genomics, Analysis & Modeling* | *15.00* | - | - | - | - | - | - | - | - | *15.00* | - | - | *15.00* |

Totals may not add due to rounding.

## NSF Programs to Broaden Participation
## FY 2013 Request to Congress

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request change over: FY 2011 Actual Amount | FY 2011 Actual Percent | FY 2012 Estimate Amount | FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|---|
| ADVANCE | $19.79 | $17.95 | $17.06 | -$2.73 | -13.8% | -$0.89 | -5.0% |
| *ADVANCE - R&RA* | *18.27* | *16.42* | *15.53* | *-2.74* | *-15.0%* | *-0.89* | *-5.4%* |
| *ADVANCE - EHR* | *1.52* | *1.53* | *1.53* | *0.01* | *0.8%* | - | - |
| Advanced Technological Education (ATE) | 64.35 | 64.00 | 64.00 | -0.35 | -0.5% | - | - |
| Alliances for Graduate Education and the Profession (AGEP)[1] | 16.69 | 7.84 | 7.84 | -8.85 | -53.0% | - | - |
| Alliances for Graduate Education and the Profession (AGEP) Graduate Research Supplements[1,2] | - | 2.00 | 2.00 | 2.00 | N/A | - | - |
| Broadening Participation in Computing (BPC) | 8.00 | - | - | -8.00 | -100.0% | - | N/A |
| Centers of Research Excellence in Science and Technology (CREST) | 30.43 | 24.24 | 24.24 | -6.19 | -20.3% | - | - |
| Computing Education for the 21st Century (CE21) | 13.14 | 12.50 | 16.00 | 2.86 | 21.8% | 3.50 | 28.0% |
| *CE21 - R&RA* | *13.14* | *12.50* | *16.00* | *2.86* | *21.8%* | *3.50* | *28.0%* |
| *CE21 - EHR* | - | - | - | - | *N/A* | - | *N/A* |
| Transforming Broadening Participation through STEM (TBPS) | - | - | - | - | N/A | - | N/A |
| Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM) | 5.12 | 4.00 | - | -5.12 | -100.0% | -4.00 | -100.0% |
| Experimental Program to Stimulate Competitive Research (EPSCoR) | 146.82 | 150.90 | 158.19 | 11.37 | 7.7% | 7.29 | 4.8% |
| GEO LSAMP Linkages | 1.00 | 1.00 | 1.00 | - | - | - | - |
| Graduate Research Diversity Supplements (GRDS) - ENG | 1.57 | 1.50 | 1.50 | -0.07 | -4.3% | - | - |
| H-1B Nonimmigrant Petitioner Fee programs | 96.30 | 100.00 | 100.00 | 3.70 | 3.8% | - | - |
| Historically-Black Colleges and Universities-Undergraduate Program (HBCU-UP) | 31.93 | 31.94 | 31.94 | 0.01 | 0.0% | - | - |
| Advancing Informal STEM Learning (AISL)[1] | 64.21 | 61.40 | 47.82 | -16.39 | -25.5% | -13.58 | -22.1% |
| Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) | 2.74 | - | - | -2.74 | -100.0% | - | N/A |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 45.63 | 45.62 | 45.62 | -0.01 | 0.0% | - | - |
| Math and Science Partnership (MSP) | 57.12 | 57.08 | 57.08 | -0.04 | -0.1% | - | - |
| Minority Post-Docs | 3.86 | 3.50 | 3.60 | -0.26 | -6.7% | 0.10 | 2.9% |
| *BIO Minority Post-Docs* | *2.91* | *2.50* | *2.50* | *-0.41* | *-14.0%* | - | - |
| *SBE Minority Post-Docs* | *0.95* | *1.00* | *1.10* | *0.15* | *15.7%* | *0.10* | *10.0%* |
| Noyce Scholarships | 54.90 | 54.89 | 54.89 | -0.01 | 0.0% | - | - |
| Ocean Sciences Postdoctoral Fellowship[3] | - | 1.90 | 1.90 | 1.90 | N/A | - | - |
| Ocean Sciences Research Initiation Grants (OCE-RIG)[4] | - | 0.60 | 0.60 | 0.60 | N/A | - | - |
| Opportunities to Enhance Diversity in the Geosciences (OEDG) | 3.65 | 3.60 | 3.60 | -0.05 | -1.3% | - | - |
| Partnerships for Innovation (PFI) | 7.67 | 8.00 | 8.20 | 0.53 | 6.8% | 0.20 | 2.5% |
| Partnerships in AST & Astrophysics Rsch Educ (PAARE)[5] | 0.99 | 1.00 | 1.00 | 0.01 | 1.2% | - | - |
| Partnerships for Research and Education in Materials (PREM) - MPS | 2.66 | 5.58 | 6.00 | 3.34 | 125.6% | 0.42 | 7.5% |
| Pre-Engineering Education Collaboratives (PEEC)[6] | 1.00 | 1.00 | 1.00 | - | - | - | - |
| Research in Disabilities Education (RDE)[1,7] | 6.53 | 6.50 | 6.50 | -0.03 | -0.5% | - | - |
| Research Initiation Grants in Biology (RIG) | 0.56 | - | - | -0.56 | -100.0% | - | N/A |
| Research on Gender in Science and Engineering (GSE)[1,7] | 10.42 | 10.50 | 10.50 | 0.08 | 0.8% | - | - |
| Science, Technology, Engineering and Math Talent Expansion Program (STEP) | 33.23 | 25.30 | 17.30 | -15.93 | -47.9% | -8.00 | -31.6% |
| *STEP - R&RA* | *1.00* | *1.00* | *1.00* | - | - | - | - |
| *STEP - EHR* | *32.23* | *24.30* | *16.30* | *-15.93* | *-49.4%* | *-8.00* | *-32.9%* |
| Significant Opportunities in Atmospheric Research and Science (SOARS) - GEO | 0.60 | 0.62 | 0.62 | 0.02 | 3.3% | - | - |
| Tribal Colleges and Universities Program (TCUP) | 13.33 | 13.31 | 13.31 | -0.02 | -0.1% | - | - |
| Undergraduate Research Mentoring in Biology (URM) | 9.81 | - | - | -9.81 | -100.0% | - | N/A |
| **Subtotal, R&RA** | **$228.45** | **$215.12** | **$221.74** | **-$6.71** | **-2.9%** | **$6.62** | **3.1%** |
| **Subtotal, EHR** | **$429.31** | **$403.15** | **$381.57** | **-$47.74** | **-11.1%** | **-$21.58** | **-5.4%** |
| **Subtotal, H-1B Nonimmigrant Petitioner Fees** | **$96.30** | **$100.00** | **$100.00** | **$3.70** | **3.8%** | **$0.00** | **0.0%** |
| **TOTAL, NSF** | **$754.05** | **$718.27** | **$703.31** | **-$50.74** | **-6.7%** | **-$14.96** | **-2.1%** |

Please note that this table displays a subset of the overall Broadening Participation portfolio. This list comprises the standard set of programs that have been historically tracked as Broadening Participation for budget purposes.

[1] In FY 2013, new program names are proposed: Advancing Informal STEM Learning (AISL), for Informal Science Education (ISE); Research on Education and Learning (REAL), for Research & Evaluation on Education in S&E (REESE), including Research on Disabilities in Education (RDE) and Research on Gender in Science and Engineering (GSE); and Alliances for Graduate Education and the Profession (AGEP), for Alliances for Graduate Education and the Professoriate (AGEP).

[2] Alliances for Graduate Education and the Profession (AGEP) Graduate Research Supplements is a new MPS program beginning in FY 2012.

[3] The Ocean Sciences Postdoctoral Fellowship is a new program beginning in FY 2012.

[4] Ocean Sciences Research Initiation Grants is a new program beginning in FY 2012.

[5] Partnerships in Astronomy and Astrophysics Research Education (PAARE) replaces Research Partnerships for Diversity (RPD).

[6] Pre-Engineering Education Collaboratives (PEEC) replaces Tribal College Pathways in ENG.

[7] Funding for Research in Disabilities Education (RDE) and Research on Gender in Science and Engineering (GSE) is proposed to reside in the Research on Education and Learning (REAL) program (formerly Research & Evaluation on Education in S&E (REESE) in EHR.

## NSF STEM Education Programs by Level of Education
## FY 2013 Request to Congress

(Dollars in Millions)

| | | | | FY 2013 Request change over: | | | |
|---|---|---|---|---|---|---|---|
| | | | | FY 2011 Actual | | FY 2012 Estimate | |
| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Amount | Percent | Amount | Percent |
| K-12 Programs | $267.50 | $244.63 | $262.84 | -$4.66 | -1.7% | $18.21 | 7.4% |
| Undergraduate Programs | 523.06 | 483.86 | 500.63 | -22.43 | -4.3% | 16.77 | 3.5% |
| Graduate & Professional Programs | 327.79 | 373.64 | 395.10 | 67.31 | 20.5% | 21.46 | 5.7% |
| Outreach and Informal Education Programs | 74.74 | 70.79 | 56.21 | -18.53 | -24.8% | -14.58 | -20.6% |
| **TOTAL, NSF** | **$1,193.09** | **$1,172.92** | **$1,214.78** | **$21.69** | **1.8%** | **$41.86** | **3.6%** |

**National Science Foundation**
**FY 2013 STEM Education Programs by Level of Education**
(Dollars in Millions)

| Level of Education | Program Name | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|
| | **Minority-Serving Institutions** | **$45.26** | **$45.25** | **$45.25** | **-** | **N/A** |
| UG | Historically-Black Colleges and Universities Undergraduate Program (HBCU-UP) | 31.93 | 31.94 | 31.94 | - | N/A |
| UG | Tribal Colleges and Universities Program (TCUP) | 13.33 | 13.31 | 13.31 | - | N/A |
| | **Fellowships/Scholarships** | **$428.29** | **$473.97** | **$492.73** | **$18.76** | **4.0%** |
| UG | Broadening Participation in Computing (BPC) | 8.00 | - | - | - | N/A |
| G | East Asia & Pacific Summer Institutes for U.S. Graduate Students (EAPSI)[1] | 1.50 | 2.40 | 2.40 | - | N/A |
| G | Enhancing the Mathematical Sciences Workforce in the 21st Century (EMSW21) | 15.48 | 11.77 | 13.77 | 2.00 | 17.0% |
| G | Federal Cyber Service: Scholarship for Service (SFS) | 14.79 | 45.00 | 25.00 | -20.00 | -44.4% |
| G | Graduate Research Fellowship Program (GRFP) | 137.67 | 198.14 | 242.98 | 44.84 | 22.6% |
| G | Graduate Teaching Fellows in K-12 Education (GK-12) | 54.48 | 26.95 | 27.00 | 0.05 | 0.2% |
| UG | Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences | 2.74 | - | - | - | N/A |
| G | Integrative Graduate Education and Research Traineeship (IGERT) Program | 61.07 | 59.82 | 51.69 | -8.13 | -13.6% |
| UG | NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) | 77.67 | 75.00 | 75.00 | - | N/A |
| UG | Robert Noyce Scholarship (Noyce) Program | 54.90 | 54.89 | 54.89 | - | N/A |
| | **Other Grant Programs** | **$693.42** | **$631.98** | **$652.38** | **$20.40** | **3.2%** |
| UG | Advanced Technological Education (ATE) | 64.35 | 64.00 | 64.00 | - | N/A |
| G | Alliances for Graduate Education and the Profession (AGEP)[2] | 16.69 | 7.84 | 7.84 | - | N/A |
| O&I | Centers for Ocean Sciences Education Excellence (COSEE) | 5.35 | 4.24 | 3.24 | -1.00 | -23.6% |
| UG | CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) | 1.37 | - | - | - | N/A |
| UG | Cyberinfrastructure Training, Education, Advancement & Mentoring (CI-TEAM) | 5.12 | 4.00 | - | -4.00 | -100.0% |
| UG | Climate Change Education (CCE) | 9.49 | 10.00 | 6.26 | -3.74 | -37.4% |
| UG | Computing Education for the 21st Century (CE21)[3] | 13.14 | 12.50 | 16.00 | 3.50 | 28.0% |
| K-12 | Discovery Research K-12 (DR-K12) | 120.00 | 99.23 | 114.23 | 15.00 | 15.1% |
| UG | Engineering Education (EE) | 10.47 | 11.10 | 11.10 | - | N/A |
| O&I | Excellence Awards in Science and Engineering (EASE) | 5.18 | 5.15 | 5.15 | - | N/A |
| UG | Geoscience Education[4] | 1.49 | 1.50 | 1.50 | - | N/A |
| K-12 | Geoscience Teacher Training (GEO-Teach) | 2.00 | 2.00 | 2.00 | - | N/A |
| K-12 | Global Learning and Observations to Benefit the Environment (GLOBE)[4] | 1.06 | 1.10 | 1.10 | - | N/A |
| O&I | Advancing Informal STEM Learning (AISL)[2] | 64.21 | 61.40 | 47.82 | -13.58 | -22.1% |
| K-12 | Innovative Technology Experiences for Students and Teachers (ITEST) | 18.62 | 25.00 | 25.00 | - | N/A |
| UG | International Research Experiences for Students (IRES)[1] | 4.47 | 3.15 | 2.25 | -0.90 | -28.6% |
| UG | Louis Stokes Alliances for Minority Participation (LSAMP) | 45.63 | 45.62 | 45.62 | - | N/A |
| K-12 | Math and Science Partnership (MSP) | 57.12 | 57.08 | 57.08 | - | N/A |
| UG | Nanotechnology Undergraduate Education in Engineering (NUE)[4] | 1.67 | 1.50 | 1.50 | - | N/A |
| UG | Opportunities for Enhancing Diversity in the Geosciences (OEDG) | 3.65 | 3.60 | 3.60 | - | N/A |
| K-12 | Research Experiences for Teachers (RET) in Engineering and Computer Science[1,4] | 6.16 | 5.50 | 4.00 | -1.50 | -27.3% |
| UG | Research Experiences for Undergraduates (REU) - Sites and Supplements | 78.63 | 65.99 | 68.40 | 2.41 | 3.7% |
| K-12 | Research in Disabilities Education (RDE)[2] | 6.53 | 6.50 | 6.50 | - | N/A |
| K-12 | Research on Education and Learning (REAL)[2] | 45.58 | 37.72 | 42.43 | 4.71 | 12.5% |
| K-12 | Research on Gender in Science and Engineering (GSE)[2] | 10.42 | 10.50 | 10.50 | - | N/A |
| UG | Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) | 33.23 | 25.30 | 17.30 | -8.00 | -31.6% |
| UG | Transforming Undergraduate Biology Education (TUBE) | 10.71 | 13.00 | 6.50 | -6.50 | -50.0% |
| UG | Transforming Undergrad Education in STEM (TUES) | 41.25 | 39.46 | 61.46 | 22.00 | 55.8% |
| UG | Undergraduate Research and Mentoring in the Biological Sciences (URM) | 9.81 | - | - | - | N/A |
| UG | Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)[3] | - | 8.00 | 20.00 | 12.00 | 150.0% |
| **Subtotal, Above Categories** | | **$1,166.98** | **$1,151.20** | **$1,190.36** | **$39.16** | **3.4%** |
| G | **NSF Postdoctoral Programs** | **$26.12** | **$21.72** | **$24.42** | **$2.70** | **12.4%** |
| | *BIO Postdoctoral Research Fellowships in Biology* | 5.29 | 3.80 | 3.80 | - | N/A |
| | *GEO Postdoctoral Fellowships Programs*[3] | 2.29 | 3.09 | 3.52 | 0.43 | 13.9% |
| | *MPS American Competitiveness in Chemistry Fellowships* | 2.03 | - | - | - | N/A |
| | *MPS Astronomy and Astrophysics Postdoctoral Fellowships* | 1.83 | 2.40 | 2.40 | - | N/A |
| | *MPS Math Sciences Postdoctoral Research Fellowships* | 5.40 | 3.93 | 4.10 | 0.17 | 4.3% |
| | *SBE Minority Postdoctoral Fellowships* | 0.95 | 1.00 | 1.10 | 0.10 | 10.0% |
| | *OCI Cyberinfrastructure Postdoctoral Fellowship (CI TRaCS)* | 2.64 | 2.00 | 4.90 | 2.90 | 145.0% |
| | *OISE International Research Fellowship program* | 4.66 | 4.50 | 3.60 | -0.90 | -20.0% |
| | *OPP Polar Postdoctoral Fellowships* | 1.04 | 1.00 | 1.00 | - | N/A |
| **K-12 STEM Education Programs (K-12) Subtotal** | | **$267.50** | **$244.63** | **$262.84** | **$18.21** | **7.4%** |
| **Undergraduate STEM Education Programs (UG) Subtotal** | | **$523.06** | **$483.86** | **$500.63** | **$16.77** | **3.5%** |
| **Graduate STEM Education Programs (G) Subtotal** | | **$327.79** | **$373.64** | **$395.10** | **$21.46** | **5.7%** |
| **Outreach & Informal Ed STEM Education Programs (O&I) Subtotal** | | **$74.74** | **$70.79** | **$56.21** | **-$14.58** | **-20.6%** |
| **TOTAL, NSF STEM Education** | | **$1,193.09** | **$1,172.92** | **$1,214.78** | **$41.86** | **3.6%** |

Totals may not add due to rounding.

[1] East Asia & Pacific Summer Institutes for US Graduate Students (EAPSI), International Research Experiences for Students (IRES), and Research Experiences for Teachers (RET) Sites - ENG are existing programs added to the inventory in FY 2012.

[2] In FY 2013, new program names are proposed: Advancing Informal STEM Learning (AISL), for Informal Science Education (ISE); Research on Education and Learning (REAL), for Research & Evaluation on Education in S&E (REESE), including Research on Disabilities in Education (RDE) and Research on Gender in Science and Engineering (GSE), shown separately here; and Alliances for Graduate Education and the Profession (AGEP), for Alliances for Graduate Education and the Professoriate (AGEP).

[3] Computing Education for the 21st Century (CE21), GEO Postdoctoral Fellowships Programs, Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) are new programs proposed in the FY 2012 Request.

[4] Geoscience Education, Global Learning and Observastions to Benefit the Environment (GLOBE), Nanotechnology Undergraduate Education (NUE), and Research Experiences for Teachers (RET)-CISE are programs newly added to the inventory for the FY 2013 Request.

**National Science Foundation**
**Education and Human Resources (EHR) by Division and Program**
**FY 2013 Request in the FY 2013 Budget Structure**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Current Plan Estimate | FY 2013 Request | FY 2013 Request change over: FY 2011 Actual Amount | FY 2011 Actual Percent | FY 2012 Current Plan Estimate Amount | FY 2012 Current Plan Estimate Percent |
|---|---|---|---|---|---|---|---|
| **DUE** | **$217.28** | **$235.65** | **$246.65** | **$29.37** | **13.5%** | **$11.00** | **4.7%** |
| **Core R&D Programs[1]** | **147.59** | **127.76** | **146.76** | **-0.83** | **-0.6%** | **19.00** | **14.9%** |
| Core Launch:STEM Learning Environments[2] | - | - | 5.00 | 5.00 | N/A | 5.00 | N/A |
| Advanced Technological Education (ATE) | 64.35 | 64.00 | 64.00 | -0.35 | -0.5% | - | 0.0% |
| STEM Talent Expansion Program (STEP) | 32.23 | 24.30 | 16.30 | -15.93 | -49.4% | -8.00 | -32.9% |
| Transforming Undergraduate Education in STEM (TUES) | 41.25 | 39.46 | 61.46 | 20.21 | 49.0% | 22.00 | 55.8% |
| National STEM Education Distributed Learning (NSDL) | 9.75 | - | - | -9.75 | -100.0% | - | N/A |
| **Expeditions[1]** | **-** | **8.00** | **20.00** | **20.00** | **N/A** | **12.00** | **150.0%** |
| Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)/E[2]: Transforming Undergraduate STEM Learning[3] | - | 8.00 | 20.00 | 20.00 | N/A | 12.00 | 150.0% |
| **Leadership Programs[1]** | **69.69** | **99.89** | **79.89** | **10.20** | **14.6%** | **-20.00** | **-20.0%** |
| Robert Noyce Scholarship Program (NOYCE) | 54.90 | 54.89 | 54.89 | -0.01 | 0.0% | - | 0.0% |
| Federal Cyber Service: Scholarship for Service/Cybercorps (SFS) | 14.79 | 45.00 | 25.00 | 10.21 | 69.0% | -20.00 | -44.4% |
| **DGE** | **$176.58** | **$173.29** | **$184.82** | **$8.24** | **4.7%** | **$11.53** | **6.7%** |
| **Core R&D Programs[1]** | **29.70** | **31.20** | **28.16** | **-1.54** | **-5.2%** | **-3.04** | **-9.7%** |
| Core Launch: STEM Professional Workforce Preparation[2] | - | - | 5.00 | 5.00 | N/A | 5.00 | N/A |
| NSF Innovation Corps (I-Corps)[4] | 0.10 | - | 0.30 | 0.20 | 196.8% | 0.30 | N/A |
| Integrative Graduate Education and Research Traineeship Program (IGERT) | 29.60 | 31.20 | 22.86 | -6.74 | -22.8% | -8.34 | -26.7% |
| **Expeditions[1]** | **5.43** | **5.50** | **8.17** | **2.74** | **50.4%** | **2.67** | **48.5%** |
| Climate Change Education (CCE)/E2: Learning and Understanding Sustainability[5] | 5.43 | 5.50 | 4.76 | -0.67 | -12.4% | -0.74 | -13.5% |
| Integrative Graduate Education and Research Traineeship Program (IGERT)/E[2]: Learning and Understanding Sustainability | - | - | 3.41 | 3.41 | N/A | 3.41 | N/A |
| **Leadership Programs[1]** | **141.44** | **136.59** | **148.49** | **7.05** | **5.0%** | **11.90** | **8.7%** |
| Graduate Research Fellowship (GRF) | 93.27 | 109.64 | 121.49 | 28.22 | 30.3% | 11.85 | 10.8% |
| Graduate STEM Fellows in K-12 Education (GK-12) | 48.18 | 26.95 | 27.00 | -21.18 | -44.0% | 0.05 | 0.2% |
| **HRD** | **$144.71** | **$129.63** | **$134.63** | **-$10.08** | **-7.0%** | **$5.00** | **3.9%** |
| **Core R&D Programs[1]** | **139.53** | **124.48** | **129.48** | **-10.05** | **-7.2%** | **5.00** | **4.0%** |
| Core Launch: Broadening Participation and Institutional Capacity in STEM)[2] | - | - | 5.00 | 5.00 | N/A | 5.00 | N/A |
| ADVANCE | 1.52 | 1.53 | 1.53 | 0.01 | 0.8% | - | 0.0% |
| Alliances for Graduate Education and the Profession (AGEP)[6] | 16.69 | 7.84 | 7.84 | -8.85 | -53.0% | - | 0.0% |
| Centers for Research Excellence in Science and Technology (CREST)/E[2]: Learning and Understanding Sustainability | 30.43 | 24.24 | 24.24 | -6.19 | -20.3% | - | 0.0% |
| Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) | 31.93 | 31.94 | 31.94 | 0.01 | 0.0% | - | 0.0% |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 45.63 | 45.62 | 45.62 | -0.01 | 0.0% | - | 0.0% |
| Tribal Colleges & Universities Program (TCUP) | 13.33 | 13.31 | 13.31 | -0.02 | -0.1% | - | 0.0% |
| Transforming Broadening Participation through STEM (TBPS) | - | - | - | - | N/A | - | N/A |
| **Leadership Programs[1]** | **5.18** | **5.15** | **5.15** | **-0.03** | **-0.6%** | **-** | **0.0%** |
| Excellence Awards in Science and Engineering (EASE)[7] | 5.18 | 5.15 | 5.15 | -0.03 | -0.6% | - | 0.0% |
| **DRL** | **$322.47** | **$290.43** | **$309.51** | **-$12.96** | **-4.0%** | **$19.08** | **6.6%** |
| **Core R&D Programs[1]** | **303.87** | **272.43** | **281.23** | **-22.64** | **-7.4%** | **8.80** | **3.2%** |
| Core Launch: STEM Learning[2] | - | - | 5.00 | 5.00 | N/A | 5.00 | N/A |
| Discovery Research K-12 (DR-K12) | 120.00 | 99.23 | 109.90 | -10.10 | -8.4% | 10.67 | 10.8% |
| Advancing Informal STEM Learning (AISL)[6] | 64.21 | 61.40 | 47.82 | -16.39 | -25.5% | -13.58 | -22.1% |
| Math and Science Partnership (MSP)[8] | 57.12 | 57.08 | 57.08 | -0.04 | -0.1% | - | 0.0% |
| Research on Education and Learning (REAL)[6,9] | 62.53 | 54.72 | 59.43 | -3.10 | -5.0% | 4.71 | 8.6% |
| INSPIRE[10] | - | - | 2.00 | 2.00 | N/A | 2.00 | N/A |
| Teacher Learning for the Future (TLF) | - | - | - | - | N/A | - | N/A |
| **Expeditions[1]** | **-** | **-** | **4.33** | **4.33** | **N/A** | **4.33** | **N/A** |
| DR-K12/E[2]: Cyberlearning, Data, and Observations for STEM Education | - | - | 4.33 | 4.33 | N/A | 4.33 | N/A |
| **Leadership Programs[1]** | **18.60** | **18.00** | **23.95** | **5.35** | **28.8%** | **5.95** | **33.1%** |
| Project and Program Evaluation (PPE) | 18.60 | 18.00 | 23.95 | 5.35 | 28.8% | 5.95 | 33.1% |
| **EHR** | **$861.04** | **$829.00** | **$875.61** | **$14.57** | **1.7%** | **$46.61** | **5.6%** |

Totals may not add due to rounding.

[1] In FY 2013, EHR programs in all divisions are aligned with the new budget activity lines of 'CORE R&D Programs', 'Expeditions', and 'Leadership Programs'. The existing budget activity lines in DUE ('Curriculum, Laboratory and Instructional Development', 'Workforce Development', and 'Teacher Education') and HRD ('Broadening Participation at the Core' and 'Research and Education Infrastructure') are dissolved.

[2] 'Core Launch' is a new program proposed for FY 2013. It is funded by all of EHR's divisions with each division heading a different thematic area.

[3] Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) and Teacher Learning for the Future (TLF) are new programs proposed for FY 2012.

[4] NSF Innovation Corps (I-Corps) is a new NSF-wide program developed in FY 2011.

[5] In FY 2013, the Climate Change Education (CCE) program moves from DUE to DGE.

[6] In FY 2013, new program names are proposed: Advancing Informal STEM Learning (AISL), for Informal Science Education (ISE); Research on Education and Learning (REAL), for Research & Evaluation on Education in S&E (REESE); and Alliances for Graduate Education and the Profession (AGEP), for Alliances for Graduate Education and the Professoriate (AGEP).

[7] In FY 2013, the Excellence Awards in Science and Engineering (EASE) program moves from DUE to HRD.

[8] In FY 2013, the Math Science Partnership (MSP) program moves from DUE to DRL.

[9] Funding for Research and Evaluation on Education in Science & Engineering (REESE) is restated for FY 2011 to include Research on Gender in Science & Engineering (GSE) and Research in Disabilities Education (RDE) as proposed for FY 2012.

[10] INSPIRE is a new NSF-wide program proposed for FY 2012.

**National Science Foundation**
**Research Infrastructure (RI) Funding, by Account, Activity and Subactivity**
**FY 2013 Request to Congress**
(Dollars in Millions)

| | **FY 2011 Actual** | FY 2011 Actual RI Funding | **FY 2012 Estimate** | FY 2012 Estimate RI Funding | **FY 2013 Request** | FY 2013 Request RI Funding | FY 2013 Request RI Change over FY 2011 Actual RI | | FY 2013 Request RI Change over FY 2012 Estimate RI | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Amount | Percent | Amount | Percent |
| BIO | **$712.27** | $98.73 | **$712.38** | $128.82 | **$733.86** | $140.63 | $41.90 | 42.4% | $11.81 | 9.2% |
| CISE | **636.06** | 31.58 | **653.59** | 34.60 | **709.72** | 41.60 | 10.02 | 31.7% | 7.00 | 20.2% |
| ENG | **763.33** | 31.04 | **826.17** | 31.33 | **876.33** | 31.33 | 0.29 | 0.9% | - | - |
| GEO | **885.32** | 380.27 | **885.27** | 355.25 | **906.44** | 341.18 | -39.09 | -10.3% | -14.07 | -4.0% |
| MPS | **1,312.42** | 331.58 | **1,308.94** | 292.71 | **1,345.18** | 306.67 | -24.91 | -7.5% | 13.96 | 4.8% |
| SBE | **247.33** | 42.80 | **254.25** | 43.49 | **259.55** | 42.15 | -0.65 | -1.5% | -1.34 | -3.1% |
| OCI[1] | **300.75** | 221.35 | **211.64** | 116.56 | **218.27** | 117.00 | -104.35 | -47.1% | 0.44 | 0.4% |
| OISE | **49.03** | 0.10 | **49.85** | 0.10 | **51.28** | 0.10 | - | - | - | - |
| OPP[2] | **440.70** | 307.25 | **435.87** | 305.61 | **449.74** | 307.88 | 0.63 | 0.2% | 2.27 | 0.7% |
| IA | **259.60** | 93.01 | **349.59** | 93.14 | **431.52** | 93.14 | 0.13 | 0.1% | - | - |
| U.S. Arctic Research Commission | **1.58** | - | **1.45** | - | **1.39** | - | - | N/A | - | N/A |
| Research & Related Activities | **$5,608.38** | $1,537.71 | **$5,689.00** | $1,401.61 | **$5,983.28** | $1,421.68 | -$116.03 | -7.5% | $20.07 | 1.4% |
| Education & Human Resources | **$861.04** | $9.45 | **$829.00** | - | **$875.61** | - | -$9.45 | -100.0% | - | N/A |
| Major Research Equipment & Facilities Construction | **$125.37** | $125.37 | **$197.06** | $197.06 | **$196.17** | $196.17 | $70.80 | 56.5% | -$0.88 | -0.4% |
| Agency Operations & Award Management | **$299.29** | - | **$299.40** | - | **$299.40** | - | - | N/A | - | N/A |
| National Science Board | **$4.47** | - | **$4.44** | - | **$4.44** | - | - | N/A | - | N/A |
| Office of Inspector General | **$14.00** | - | **$14.20** | - | **$14.20** | - | - | N/A | - | N/A |
| OIG FY 2011 ARRA Obligations | $0.08 | - | - | - | - | - | - | N/A | - | N/A |
| **Total, National Science Foundation** | **$6,912.63** | **$1,672.54** | **$7,033.10** | **$1,598.67** | **$7,373.10** | **$1,617.85** | **-$54.69** | **-3.3%** | **$19.18** | **1.2%** |

Totals may not add due to rounding.

[1] FY 2011 Actual for OCI includes $90.50 million in funds that were obligated in FY 2010, deobligated in FY 2011, and then obligated in FY 2011 to other projects in the OCI portfolio.

[2] Funding for OPP for FY 2011 excludes a one-time appropriation transfer of $53.892 million, $54.0 million less the 0.2% rescission, to U.S. Coast Guard per P.L. 112-10.

**National Science Foundation**
**Research Infrastructure Summary**
**FY 2013 Request to Congress**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request change over: FY 2011 Actual Amount | FY 2011 Actual Percent | FY 2012 Estimate Amount | FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|---|
| **Facilities** | **$843.66** | **$910.91** | **$927.76** | **$84.10** | **10.0%** | **$16.86** | **1.9%** |
| Academic Research Fleet | 81.67 | 78.75 | 73.00 | -8.67 | -10.6% | -5.75 | -7.3% |
| *Regional Class Research Vessels*[1] | - | *2.00* | *1.00* | 1.00 | N/A | -1.00 | -50.0% |
| *RHOV Construction (R/V Alvin Replacement)* | *8.00* | *2.40* | - | *-8.00* | *-100.0%* | *-2.40* | *-100.0%* |
| *R/V Langseth Construction (R/V Ewing Replacement)* | - | - | - | - | *N/A* | - | N/A |
| *Ship Operations and Upgrades* | *73.67* | *74.35* | *72.00* | *-1.67* | *-2.3%* | *-2.35* | *-3.2%* |
| Cornell High Energy Synchrotron Source (CHESS) \ Cornell Electron Storage Ring (CESR) | 14.12 | 19.67 | 20.00 | 5.88 | 41.7% | 0.33 | 1.7% |
| EarthScope: USArray, SAFOD, PBO | 26.02 | 25.05 | 26.17 | 0.15 | 0.6% | 1.12 | 4.5% |
| Gemini Observatory | 19.50 | 22.07 | 18.15 | -1.35 | -6.9% | -3.92 | -17.8% |
| IceCube Neutrino Observatory (IceCube) | 6.90 | 6.90 | 6.90 | - | - | - | - |
| Incorporated Research Institutions for Seismology | 12.37 | 12.36 | 11.25 | -1.12 | -9.1% | -1.11 | -9.0% |
| Integrated Ocean Drilling Program | 53.35 | 44.40 | 38.90 | -14.45 | -27.1% | -5.50 | -12.4% |
| Large Hadron Collider | 18.00 | 18.00 | 18.00 | - | - | - | - |
| Laser Interferometer Gravitational Wave Observatory | 30.30 | 30.40 | 30.50 | 0.20 | 0.7% | 0.10 | 0.3% |
| Arecibo Observatory (was National Astronomy & Ionosphere Center) | 9.26 | 8.70 | 8.20 | -1.06 | -11.5% | -0.50 | -5.7% |
| National High Magnetic Field Laboratory | 32.68 | 25.80 | 31.75 | -0.92 | -2.8% | 5.95 | 23.1% |
| National Nanotechnology Infrastructure Network (NNIN) | 16.36 | 15.86 | 15.36 | -1.00 | -6.1% | -0.50 | -3.2% |
| National Solar Observatory | 9.10 | 9.10 | 8.00 | -1.10 | -12.1% | -1.10 | -12.1% |
| National Superconducting Cyclotron Laboratory | 21.50 | 21.50 | 21.50 | - | - | - | - |
| Network for Earthquake Engineering Simulation | 20.10 | 20.50 | 20.50 | 0.40 | 2.0% | - | - |
| Other Facilities[2] | 4.86 | 2.52 | 2.66 | -2.20 | -45.2% | 0.14 | 5.6% |
| Polar Facilities and Logistics[3] | 297.54 | 295.79 | 297.51 | -0.03 | 0.0% | 1.72 | 0.6% |
| Other Facilities Investments | | | | | N/A | | N/A |
| Major Research Equipment & Facilities Construction[4] | 152.53 | 248.79 | 271.66 | 119.13 | 78.1% | 22.88 | 9.2% |
| Pre-construction Planning[1,5] | 17.50 | 4.75 | 7.75 | -9.75 | -55.7% | 3.00 | 63.2% |
| **Federally Funded R&D Centers** | **$198.29** | **$198.99** | **$194.85** | **-$3.441** | **-1.7%** | **-$4.14** | **-2.1%** |
| National Center for Atmospheric Research | 98.10 | 98.60 | 92.29 | -5.81 | -5.9% | -6.31 | -6.4% |
| National Optical Astronomy Observatories | 29.50 | 25.50 | 25.50 | -4.00 | -13.6% | - | - |
| National Radio Astronomy Observatories[6] | 67.65 | 71.75 | 73.92 | 6.27 | 9.3% | 2.17 | 3.0% |
| Science and Technology Policy Institute | 3.04 | 3.14 | 3.14 | 0.10 | 3.3% | - | - |
| **Other Research Instrumentation and Infrastructure** | **$630.90** | **$488.77** | **$495.24** | **-$135.66** | **-21.5%** | **$6.47** | **1.3%** |
| Major Research Instrumentation | 89.99 | 90.00 | 90.00 | 0.01 | 0.0% | - | - |
| National Stem Education Distributed Learning | 9.75 | - | - | -9.75 | -100.0% | - | N/A |
| Networking & Computational Resources Infrastructure & Services | 221.35 | 116.56 | 117.00 | -104.35 | -47.1% | 0.44 | 0.4% |
| Polar Environment, Health & Safety | 6.26 | 6.37 | 6.92 | 0.66 | 10.5% | 0.55 | 8.6% |
| Research Resources[7] | 268.64 | 240.24 | 247.06 | -21.58 | -8.0% | 6.82 | 2.8% |
| National Center for Science & Engineering Statistics | 29.46 | 29.65 | 29.31 | -0.15 | -0.5% | -0.34 | -1.1% |
| NCSES Science of Science & Innovation Policy Activities | 5.45 | 5.95 | 4.95 | -0.50 | -9.2% | -1.00 | -16.8% |
| **Subtotal, Research Infrastructure Support** | **$1,672.85** | **$1,598.67** | **$1,617.85** | **-$55.00** | **-3.3%** | **$19.18** | **1.2%** |
| **Research Infrastructure Stewardship Offset** | **-$0.31** | - | - | **$0.31** | **-100.0%** | - | **N/A** |
| **RESEARCH INFRASTRUCTURE TOTAL** | **$1,672.54** | **$1,598.67** | **$1,617.85** | **-$54.69** | **-3.3%** | **$19.18** | **1.2%** |

Totals may not add due to rounding.

[1] Regional Class Research Vessels are a Pre-construction Planning project for potential MREFC funding. This funding is shown here (Academic Resesarch Fleet) and is not included in the Pre-construction Planning line.

[2] Other Facilities includes support for other physics and materials research facilities.

[3] Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Polar Facilities and Logistics excludes a one-time appropriation transfer of $53.892 million, $54.0 million less 0.2% rescission, to U.S. Coast Guard per P.L. 112-10.

[4] Funding levels for MREFC Projects in this table include support for: a) concept and development associated with ongoing and requested MREFC projects provided through the R&RA account, specifically for NEON; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) implementation support provided through the MREFC account.

[5] Preconstruction planning includes funding for potential next generation multi-user facilities. Not included in this line are Regional Class Research Vessels, shown here under the Academic Research Fleet.

[6] Funding for the National Radio Astronomy Observatory (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC projects line above.

[7] Funding for Research Resources includes support for the operation and maintenance of minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.

## National Science Foundation Current Authorizations

(Dollars in Millions)

| LEGISLATION | FY 2011 Actual | FY 2011 ARRA Actual | FY 2012 Estimate | FY 2013 Request | Authorization Levels FY 2011 | FY 2012 | FY 2013 |
|---|---|---|---|---|---|---|---|
| **National Science Foundation Act of 1950 (P.L.81-507)[1]** | | | | | | | |
| *Scholarships and Graduate Fellowships* | | | | | *within limits of funds made available for this purp* | | |
| *General Authority* | | | | | *within the limits of available appropriations* | | |
| *Administering Provisions* | | | | | *to make such expenditures as may be necessar* | | |
| *International Cooperation and Coordination with Foreign Policy* | | | | | *within the limit of appropriated funds* | | |
| *Contract Arrangements* | | | | | *utilize appropriations available* | | |
| **America COMPETES Reauthorization Act of 2010 (P.L.111-358)[2]** | **$6,912.55** | | **$7,033.10** | **$7,373.10** | **$7,424.40** | **$7,800.00** | **$8,300.00** |
| **Account and Program Specific** | | | | | | | |
| **Research and Related Activities** | **$5,608.38** | | **$5,689.00** | **$5,983.28** | **$5,974.78** | **$6,234.28** | **$6,637.85** |
| **Education and Human Resources** | **$861.04** | | **$829.00** | **$875.61** | **$937.85** | **$978.96** | **$1,041.76** |
| *STEM-Training Grant Program* | | | | | $10.00 | $10.00 | $10.00 |
| **Major Research Equipment and Facilities Construction** | **$125.37** | | **$197.06** | **$196.17** | **$164.74** | **$225.54** | **$236.76** |
| **Agency Operations and Award Management** | **$299.29** | | **$299.40** | **$299.40** | **$327.50** | **$341.68** | **$363.67** |
| **National Science Board** | **$4.47** | | **$4.44** | **$4.44** | **$4.80** | **$4.81** | **$4.91** |
| **Office of the Inspector General** | **$13.92** | **$0.08** | **$14.20** | **$14.20** | **$14.72** | **$14.73** | **$15.05** |
| **Federal Ocean Acidification Research and Monitoring Act of 2009 (P.L.111-11)** | **$9.28** | | ***** | ***** | **$12.00** | **$15.00** | |
| **SBIR and STTR reauthorized under the National Defense Authorization Act for Fiscal Year 2012,(P.L. 112-81)** | | | | | | | |
| *Small Business Innovation Research (SBIR) Program[3]* | **$113.23** | | **$134.87** | **$146.47** | *2.5% of research funds in 2011, 2.6% in 2012, 2.7% in 20* | | |
| *Small Business Technology Transfer (STTR) Program[4]* | **$13.24** | | **$17.89** | **$18.73** | *0.3% of research funds in 2011, 0.35% in 2012, 0.40 % in* | | |

[1]Organic language establishing NSF, authorization and appropriation language may not correspond to current accounts and programs.

[2]Authorizes agency funding for FYs 2011-13; authorizes agency, account, and various program levels.

[3]SBIR is currently authorized through September 30, 2017

[4]STTR is currently authorized through September 30, 2017

*Actual amounts will be reported after awards are completed.

## RESEARCH AND RELATED ACTIVITIES (R&RA) $5,983,280,000
## +$294,280,000 / 5.2%

The FY 2013 Budget Request for the Research and Related Activities (R&RA) Appropriation is $5,983.28 million, an increase of $294.28 million, or 5.2 percent, above the FY 2012 Estimate level of $5,689.00 million. Support from the R&RA Appropriation enables U.S. leadership and progress across the frontiers of scientific and engineering research and education.

Sustained, targeted investment by NSF in fundamental science and engineering advances discovery and learning and spurs innovation. Such transformational work holds great promise for meeting the myriad social, economic, and environmental challenges faced by both the Nation and the world.

In FY 2013, funding within the broad and flexible R&RA portfolio highlights the Administration's priorities for science and innovation, including a focus on interdisciplinary science and engineering; innovative research on clean energy and sustainability; key investments in advanced manufacturing, break-through materials, wireless communications, and smart systems; an emphasis on bolstering our Nation's cybersecurity; strong support for new faculty and young investigators; and vital evidence-based educational activities at every level of learning that build the science and engineering workforce of tomorrow.

**R&RA Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Biological Sciences | $712.27 | $712.38 | $733.86 | $21.48 | 3.0% |
| Computer & Information Science & Engineering | 636.06 | 653.59 | 709.72 | 56.13 | 8.6% |
| Engineering | 763.33 | 826.17 | 876.33 | 50.16 | 6.1% |
| Geosciences | 885.32 | 885.27 | 906.44 | 21.17 | 2.4% |
| Mathematical & Physical Sciences | 1,312.42 | 1,308.94 | 1,345.18 | 36.24 | 2.8% |
| Social, Behavioral & Economic Sciences | 247.33 | 254.25 | 259.55 | 5.30 | 2.1% |
| Office of Cyberinfrastructure | 300.75 | 211.64 | 218.27 | 6.63 | 3.1% |
| Office of International Science & Engineering | 49.03 | 49.85 | 51.28 | 1.43 | 2.9% |
| Office of Polar Programs[1] | 440.70 | 435.87 | 449.74 | 13.87 | 3.2% |
| Integrative Activities | 259.60 | 349.59 | 431.52 | 81.93 | 23.4% |
| U.S. Arctic Research Commission | 1.58 | 1.45 | 1.39 | -0.06 | -4.1% |
| **Total, R&RA** | **$5,608.38** | **$5,689.00** | **$5,983.28** | **$294.28** | **5.2%** |

Totals may not add due to rounding.

[1] Funding for FY 2011 Actual excludes a one-time appropriation transfer of $54.0 million, less the 0.2% rescission, to the U.S. Coast Guard per P.L. 112-110.

## RESEARCH AND RELATED ACTIVITIES

### Appropriation Language

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; ~~$5,719,000,000,~~*$5,983,280,000*, to remain available until September 30, ~~2013,~~*2014*, of which not to exceed ~~$550,000,000~~*$500,000,000* shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program: *Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.~~: *Provided further*, That not less than $150,900,000 shall be available for activities authorized by section 7002(c)(2)(A)(iv) of Public Law 110-69: Provided further, That up to $50,000,000 of funds made available under this heading within this Act may be transferred to "Major Research Equipment and Facilities Construction": *Provided further*, That funds so transferred shall not be subject to the transfer limitations described in the Administrative Provisions in this Act for the National Science Foundation, and shall be available until expended only after notification of such transfer to the Committees on Appropriations.~~

**Research and Related Activities**
**FY 2013 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Rescission | Carryover/ Recoveries | Transfers[1] | Expired | Total Resources | Obligations Incurred/ Est. |
|---|---|---|---|---|---|---|---|
| FY 2011 Appropriation | $5,575.03 | -$11.15 | $100.77 | -53.89 | | $5,610.76 | $5,608.38 |
| FY 2012 Estimate | 5,719.00 | | 2.38 | -30.00 | - | 5,691.38 | 5,691.38 |
| FY 2013 Request | 5,983.28 | | - | - | - | 5,983.28 | 5,983.28 |
| $ Change from FY 2012 Estimate | | | | | | | $291.90 |
| % Change from FY 2012 Estimate | | | | | | | 5.1% |

Totals may not add due to rounding.

[1]In FY 2011, $53.89 million was transferred to the U.S. Coast Guard for ice breaking services, P.L. 112.10.

[1] In FY 2012, $30.0 million was transferred from the Research and Related Activities (R&RA) account to the Major Research Equipment and Facilities Construction (MREFC) account, as provided by the Science Appropriations Act, 2012, P.L. 112-55.

### Explanation of Carryover

Within the **Research and Related Activities (R&RA)** appropriation, NSF carried over $2.38 million (i.e., 2-year: $1.31 million; and no-year: $1.07 million) into FY 2012. The major items include awards and contracts from various programs throughout NSF that were not ready for obligation in FY 2011. Obligation of these funds is expected by the second quarter of FY 2012.

## DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO) $733,860,000
## +$21,480,000 / 3.0%

**Biological Sciences Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Molecular and Cellular Biosciences MCB) | $123.93 | $125.79 | $132.68 | $6.89 | 5.5% |
| Integrative Organismal Systems (IOS) | 212.56 | 212.33 | 220.52 | 8.19 | 3.9% |
| Environmental Biology (DEB) | 142.72 | 142.56 | 143.73 | 1.17 | 0.8% |
| Biological Infrastructure (DBI) | 129.28 | 126.18 | 129.68 | 3.50 | 2.8% |
| Emerging Frontiers (EF) | 103.79 | 105.52 | 107.25 | 1.73 | 1.6% |
| **Total, BIO** | **$712.27** | **$712.38** | **$733.86** | **$21.48** | **3.0%** |

Totals may not add due to rounding.

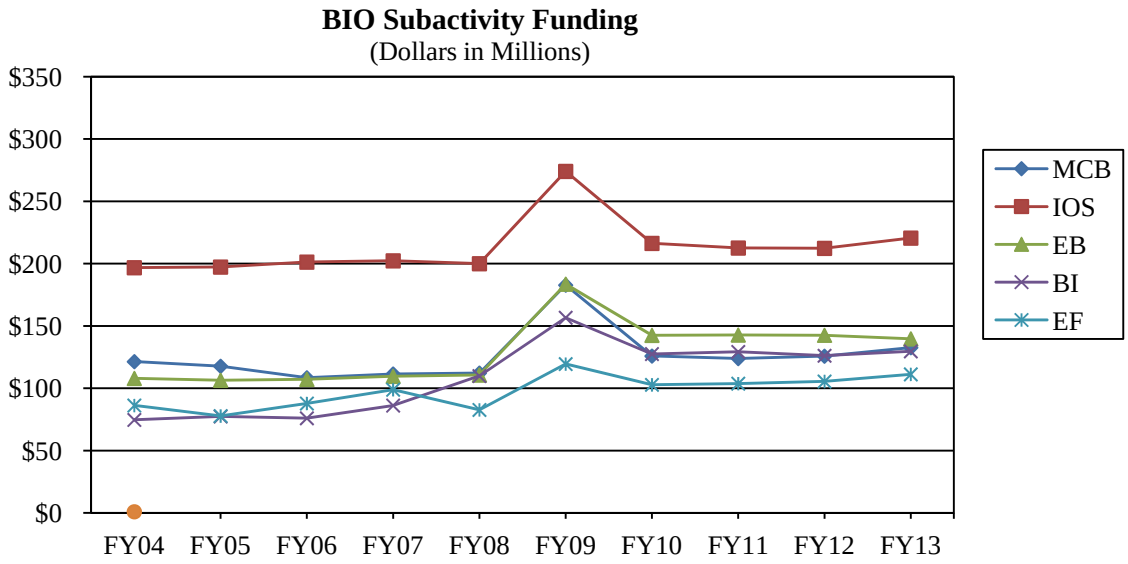
## About BIO

BIO's mission is to enable discoveries for understanding life. Through investments in innovative and transformative research, BIO advances the frontiers of knowledge in the life sciences by increasing our understanding of complex living systems. BIO-supported projects also provide the theory, data, and other research resources that advance research in other science and engineering fields. These fields are adapting and employing principles and processes derived from biological systems to answer fundamental questions, develop practical applications, and solve problems.

Issues of national importance related to the environment, economy, agriculture, and human welfare require an understanding of how complex living systems function and interact with each other and with non-living systems. Research supported by BIO enhances this understanding. As the physical, computational, mathematical, and engineering fields increasingly use living systems to address their major questions, NSF's robust investment in the non-medical biological sciences becomes increasingly relevant to tackling these multidisciplinary challenges.

Biological concepts are integral to wide-ranging areas of science essential to human welfare and the bio-economy, including national priorities such as climate science, biotechnology, and bioengineering. Over the last 3.5 billion years, living organisms have evolved mechanisms for efficiently using energy, producing an endless array of novel compounds, and storing information in a highly compact, adaptable format. Fundamental biological research makes these innovations available to inform the next generation of nano-, bio-, and information technologies. For example, research funded through a BIO CAREER award recently showed that simple and efficient algorithms can be developed using insights derived from discoveries about how a nervous system develops. BIO's investment portfolio includes projects on understanding the changing dynamics of the biosphere, research on the fundamental characteristics of biological energy systems, and efforts to broaden participation and develop the next generation of biological researchers.

BIO provides about 62 percent of federal funding for non-medical, basic research at academic institutions in the life sciences, including environmental biology, a research area critical for addressing questions related to climate science.




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary by Division

- BIO's FY 2013 Request prioritizes contributions to the OneNSF Framework through support for innovative, interdisciplinary activities including Innovation Corps (I-Corps), INSPIRE, Science Engineering and Education for Sustainability (SEES), Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21), Expeditions in Education ($E^2$), and Cyber-enabled Materials and Manufacturing and Smart Systems (CEMMSS). BIO also focuses investments on research to address the five Grand Challenges in Biology: synthesizing life-like systems; understanding the brain; predicting organisms' characteristics from their DNA sequences; elucidating interactions between the earth, its climate and its biosphere; and understanding biological diversity (2010 National Research Council report, "Research at the Intersection of the Physical and Life Sciences"). In addition, BIO's enhanced support for Research at the Interface of Biological and Mathematical and Physical Sciences and Engineering (BioMaPS) advances the knowledge frontier and bolsters the foundation of the OneNSF Framework.

- MCB's FY 2013 requested increase of $6.89 million, or 5.5 percent, is focused on support for fundamental research to understand the dynamics and complexity of living systems at the biochemical, molecular, and cellular level, which is important foundational research at the heart of the grand challenges. In addition, MCB will enhance support for BioMaPS. This interdisciplinary effort, in collaboration with MPS and ENG, will result in accelerated understanding of biological systems, leading to innovations in manufacturing in such areas as renewable fuels, bio-based materials, bio-imaging, and bio-inspired sensors. MCB will also fund advanced manufacturing through the CEMMSS activity and its breakthrough materials component. An example of the MCB-relevant research includes computational mining of the genomic data from diverse biological systems to identify inspirations for the design and synthesis of new materials with defined properties and capabilities, and predictive synthetic biology to design new nanomaterials, particularly based on photosynthesis and other biological processes.

- IOS's FY 2013 requested increase of $8.19 million, or 3.9 percent, is aimed at fundamental research on organisms as complex integrated systems, and their interactions with their social and physical environments especially as they adapt to climate variability and other environmental factors. IOS also maintains its commitment to support for fundamental plant genome research. The activities of the Plant Genome Research Program (PGRP) support genome-scale research to accelerate discoveries about basic plant biology, as well as downstream applications of societal benefit such as crop improvement, new sources of bio-based energy, and development of novel bio-based materials. IOS participation in BioMaPS and the BIO Five Grand Challenges are important components of these activities. One of the grand challenges, understanding the brain, will be supported through enhanced activity in the neurosciences.

- DEB's FY 2013 increase of $1.17 million, or 0.8 percent, will sustain research on complex ecological and evolutionary dynamics to improve our ability to understand the reciprocal interactions between living systems and the environment, and inform essential considerations of environmental sustainability. To allow for enhanced support for SEES and the BIO Five Grand Challenges, the Assembling the Tree of Life (AToL) program will be moved towards a biennial competition from an annual. DEB programs provide essential research support towards understanding the grand challenge questions regarding interactions of the earth, its climate and biosphere the environmental link between genotype and phenotype, and understanding biological diversity. Enhanced support is provided to continue international partnerships with Brazil and China related to the Dimension of Biodiversity program activity.

- DBI's FY 2013 requested increase of $3.50 million, or 2.8 percent, empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. It also reflects funding for the OneNSF investment, Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) through support for the Software Infrastructure for Sustained Innovation program (SI2). To allow for enhanced support for CIF21 and the BIO Five Grand Challenges, the Collections in Support of Biological Research program will be moved towards a biennial competition from an annual. Infrastructural support either through research resources, centers, or support of STEM activities is essential to all priority activities in OneNSF or BIO Grand Challenges science support.

- EF's FY 2013 requested increase of $1.73 million, or 1.6 percent, enhances support for developing priorities and increases the National Ecological Observatory Network (NEON) infrastructure investment. In FY 2013, support includes: focused activities within SEES; continued coordination of cross-directorate innovation activities, including INSPIRE and I-Corps; and oversight of Transforming Undergraduate Biology Education (TUBE). Enhanced support for BioMaPS in MCB and IOS will be matched by continued investments from EF. Funding for TUBE will be decreased and support in these areas will be redirected towards the developing Expeditions in Education in an effort to integrate support across Research and Related Activities (R&RA) within NSF. NEON concept and development (C&D) and early operations and maintenance (O&M) will be supported through EF. As NEON enters year three of construction, operations will be enhanced as more sites and domains go on-line, providing a continuous stream of data and access broadly to the science community. Continued C&D will be used for advanced tool development and educational programming in FY 2013.

## Major Investments

**BIO Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | - | $2.00 | $2.60 | $0.60 | 30.0% |
| BioMaPS | 5.57 | 9.00 | 13.57 | 4.57 | 50.8% |
| CAREER | 32.70 | 31.13 | 32.63 | 1.50 | 4.8% |
| CEMMSS | - | 3.00 | 5.00 | 2.00 | 66.7% |
| CIF21 | - | 2.00 | 4.00 | 2.00 | 100.0% |
| Clean Energy Technology | 35.75 | 39.00 | 45.00 | 6.00 | 15.4% |
| $E^2$ | - | - | 2.00 | 2.00 | N/A |
| I-Corps | 0.05 | 0.50 | 2.00 | 1.50 | 300.0% |
| INSPIRE | - | 2.00 | 4.00 | 2.00 | 100.0% |
| SEES | 24.59 | 27.25 | 34.75 | 7.50 | 27.5% |
| BIO 5 Grand Challenges | - | - | 20.00 | 20.00 | N/A |

Major investments may have funding overlap and thus should not be summed.

- Advanced Manufacturing: BIO will provide $2.60 million in advanced manufacturing through support for research as part of BioMaPS and CEMMSS. Both investments are described in more detail below.

- BioMaPS: Research at the Interface of Biological, Mathematical and Physical Sciences Engineering (BioMaPS) seeks to discover fundamental new knowledge to enable innovation in national priorities such as clean energy, climate science, and advanced manufacturing. This interdisciplinary interface is fertile ground for new technologies than can address societal problems through predictive modeling and disruptive solutions in biotechnology and could lead to new industry that is inspired by biology. In FY 2013, BIO will increase support by $4.57 million for a total of $13.57 million.

- CAREER: BIO's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations. In FY 2013, BIO will increase support for CAREER by $1.50 million for a total of $32.63 million. This will make approximately 46 awards in FY 2013.

- CEMMSS: BIO support will enable breakthrough materials through research on topics such as computational mining of genomic data from diverse biological systems to identify inspirations for design of new materials; or predictive synthetic biology to design new nanomaterials, particularly based on photosynthesis and other biological processes. BIO will invest $5.0 million in this activity.

- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21): BIO support for CIF21 (+$2.0 million to a total of $4.0 million) will focus on software infrastructure for sustained innovation and data-enabled science.

- Clean Energy Technology: BIO support for clean energy technology (+$6.0 million to a total of $45.0 million) occurs through support for fundamental research in programs such as biomolecular systems, photobiology, genetic engineering and metabolic biochemistry with relevance in areas such as fuel cells, hydrogen, and biomass and other energy efficiency and use.

- Expeditions in Education ($E^2$): BIO will initiate investment ($2.0 million) in this new OneNSF investment, which seeks to generate a stronger and more deliberate infusion of cutting-edge science, engineering, and innovation into programs aimed at preparing a world-class science workforce.

- I-Corps: BIO will support ($2.0 million) I-Corps grants to test the feasibility of commercial prototypes developed from NSF/BIO-supported research.

- INSPIRE**:** BIO will provide support (+$2.0 million to a total of $4.0 million) to co-fund larger cross-disciplinary grants that embody unusually creative high-risk / high-reward research.

- Science, Engineering, and Education for Sustainability (SEES): SEES coordinates and enhances research and education on the environment, energy, and sustainability. BIO will enhance support for Sustainability Research Networks (SRNs) and Coupled Natural and Human systems (CNH). Other programs will be maintained, including SEES Fellows, Dimensions of Biodiversity, Research Collaboration Networks (RCN) and research on ocean acidification. In FY 2013, BIO increases investment in this activity by $7.50 million, to a total of $34.75 million.

- BIO Five Grand Challenges: 21st Century biology must provide the knowledge needed to understand living systems and the role of the living world in shaping and adapting to a changing planet. The comprehensive grand challenges described in the 2010 NRC report are envisioned as the way to create opportunities for innovative research. BIO will prioritize a focus across all divisions ($20.0 million total) on research relevant to the five grand challenges: synthesizing life-like systems; understanding the brain; predicting organisms' characteristics from their DNA; interactions of the earth, its' climate and its biosphere; and understanding biological diversity.

## BIO Funding for Centers Programs and Facilities

**BIO Funding for Centers Programs**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$39.06** | **$42.22** | **$42.40** | **$0.18** | **0.4%** |
| Centers for Analysis & Synthesis (DBI) | 22.94 | 26.12 | 26.30 | 0.18 | 0.7% |
| Nanoscale Science & Engineering Centers (DBI) | 5.12 | 5.10 | 5.10 | - | - |
| Science & Techology Centers (DBI) | 9.00 | 9.00 | 9.00 | - | - |
| Science of Learning Centers (DBI) | 2.00 | 2.00 | 2.00 | - | - |

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Centers for Analysis and Synthesis: Funding increases by $180,000 over the FY 2012 Estimate, to a total of $26.30 million. The program will support four centers in FY 2013. The increased support

represents annual increments including support for the new National Socio-Environmental Synthesis Center (SESynC) established in FY 2012.

- Nanoscale Science and Engineering Centers (NSEC): Support will be maintained at $5.10 million for the Center for Environmental Implications of Nanotechnology (CEIN).

- Science and Technology Centers (STCs): Support will be maintained at $9.0 million for two STCs; Science and Technology Center for Microbial Oceanography Research and Education (C-MORE) and Bio/computational Evolution in Action CONsortium (BEACON).

- Science of Learning Centers: Support will be maintained at $2.0 million.

**BIO Funding for Facilities**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Facilities (Total)** | **$10.02** | **$23.28** | **$33.74** | **$10.46** | **44.9%** |
| Nanofabrication (NNIN) | 0.35 | 0.35 | 0.35 | - | - |
| National Ecological Observatory Network (NEON) | 9.67 | 22.93 | 33.39 | 10.46 | 45.6% |

For detailed information on individual facilities, please see the Facilities chapter.

## Summary and Funding Profile

BIO supports investment in core research and education, as well as research infrastructure such as NEON and iPlant ($12.0 million, level with the FY 2012 Estimate).

In FY 2013, the number of research grant proposals is expected to increase by 360 compared to the FY 2012 Estimate and BIO expects to award about 1,020 research grants. Average annual award size and duration are not expected to materially fluctuate in FY 2011 through FY 2013.

In FY 2013, BIO will invest $42.40 million for centers, accounting for 5.8 percent of the BIO budget. Centers are an important modality for biosciences, since research in many BIO-supported disciplines has evolved to be more collaborative and interdisciplinary.

Operations and maintenance funding for BIO-supported user facilities comprises 4.6 percent of BIO's FY 2013 Request. BIO has increased the operations and maintenance budget for NEON consistent with the planned ramp-up of operations as construction continues as scheduled.

**BIO Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 7,440 | 7,640 | 8,000 |
| Number of New Awards | 1,311 | 1,350 | 1,440 |
| Funding Rate | 18% | 18% | 18% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 6,431 | 6,570 | 6,880 |
| Number of Research Grants | 982 | 985 | 1,020 |
| Funding Rate | 15% | 15% | 15% |
| Median Annualized Award Size | $173,904 | $185,000 | $185,000 |
| Average Annualized Award Size | $226,246 | $230,000 | $230,000 |
| Average Award Duration, in years | 3.2 | 3.1 | 3.1 |

## Program Monitoring and Assessment

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):

- In 2011, COVs reviewed Molecular and Cellular Biosciences division (MCB) and Integrative Organismal Systems division (IOS). The COVs presented their reports to the BIO Advisory Committee, which convened in April and December of 2011. Recommendations included: develop grand challenge foci; continue efforts to collaborate both within NSF and across agencies; provide clearer instructions to reviewers on broader impacts; and provide information on balancing the portfolio, including impacts of breadth versus depth.
- In 2012, COVs will review the Environmental Biology (DEB) division and the Office of Emerging Frontiers (EF).
- In 2013, a COV will review the Biological Infrastructure (DBI) division.

Workshops and Reports:

- A number of recent workshops and reports have informed programmatic portfolio development. The workshop, held on January 6-7, 2011, "Research Frontiers in Bioinspired Energy: Molecular-level Learning from Natural Systems," was sponsored by NSF and the Department of Energy (DOE), and was jointly organized by the National Academies of Science (NAS) Boards on Life Sciences and Chemical Sciences and Technology. Its focus was to explore the molecular-level frontiers of energy processes in nature.

  The 2010 NAS report, *Research at the Intersection of the Physical and Life Science*, has informed the development of two major emphases: the BioMaPS program beginning in FY 2011 and continuing and expanded in FY 2013; and the new BIO Five Grand Challenges in Biology activity. Other workshops that have shaped the BIO grand challenge activity have included: How Molecules Come to Life: Biophysics Vision (2011) and Phenomes – Beyond Genomes (April 2011).

Several workshops informed the BIO involvement in CIF21: NSF-Workshop on Creating Scientific Software Innovation Institutes for the Environmental Observatory Communities (October 2010); Data-Intensive Sciences Workshop I and II (September 2010 and May 2011); Cyberinfrastructure for Collaborative Science (May 2011).

Other workshops continue to help frame the Dimensions of Biodiversity program (a SEES activity) and the Digitization program in BIO. Those include: Digitization Workshop on Best Practices Development Session (April 2011); Dimensions of Biodiversity Charrette (September 2010); and Fostering Brazil-USA Scientific Exchange through Dimensions of Biodiversity (July 2011).

Science and Technology Policy Institute (STPI) Reports and Evaluations:

- In FY 2010, BIO initiated a STPI study to assess the need for and feasibility of evaluation of the impact of support for plant genome research programs. A final report of this study is currently in preparation for expected delivery early in 2012.

**Number of People Involved in BIO Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 6,871 | 6,890 | 7,000 |
| Other Professionals | 1,784 | 1,800 | 1,875 |
| Postdoctorates | 1,546 | 1,560 | 1,640 |
| Graduate Students | 2,878 | 2,900 | 3,100 |
| Undergraduate Students | 4,601 | 4,630 | 4,760 |
| K-12 Teachers | - | - | - |
| K-12 Students | - | - | - |
| **Total Number of People** | **17,680** | **17,780** | **18,375** |

## DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB)

**$132,680,000**
**+$6,890,000 / 5.5%**

**MCB Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, MCB** | **$123.93** | **$125.79** | **$132.68** | **$6.89** | **5.5%** |
| **Research** | **122.68** | **124.56** | **131.45** | **6.89** | **5.5%** |
| *CAREER* | *13.38* | *12.74* | *13.35* | *0.61* | *4.8%* |
| **Education** | **1.25** | **1.23** | **1.23** | **-** | **-** |

Totals may not add due to rounding.

MCB supports fundamental research and educational activities that promote understanding of complex living systems at the molecular, subcellular, and cellular levels. The division gives high priority to interdisciplinary research projects that will lead to predictive, quantitative, and theory-based understanding of major biological questions. Research supported by MCB typically combines integrated theoretical and experimental approaches with technologies derived from biological, physical, mathematical, computational, and engineering sciences. Projects are particularly encouraged in emerging areas such as integration across scales from single molecules to cellular complexity, synthetic biology, and genomic basis of phenotypic diversity and properties. The MCB research portfolio also emphasizes projects aimed at understanding and predicting the molecular and cellular foundation of causes and consequences of environmental change. MCB continues to forge partnerships to support research that intersects biology and fields such as physical sciences and engineering, to introduce new analytical and conceptual tools for biological research, and to provide unique education and training opportunities for the next generation of researchers, scientific educators, and scientifically literate citizens.

In general, 39 percent of the MCB portfolio is available for new research grants and 61 percent is available for continuing grants.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- In the FY 2013 Request, there is a general reduction to areas of lower priority to provide resources to other programs related to NSF and directorate priorities.
- MCB will provide support ($4.17 million) for research that addresses the FY 2013 BIO priority in grand challenges at the interface between life and physical sciences. Of particular emphasis are the grand challenges on synthesizing life-like systems and deciphering the genome to phenome relationship.
- In FY 2013, MCB will join the Emerging Frontiers (EF) division in supporting the BioMaPS program, a partnership with the Engineering and Mathematical and Physical Sciences Directorates ($2.28 million). These investments will strengthen research programs in development of new biophysical technologies and computational molecular and cellular biology.

- Because support for early-career researchers is a priority for MCB, the division will increase its investments in CAREER awards (+$610,000 to a total of $13.35 million). This funding is consistent with MCB objectives and contributes to NSF's goal for CAREER award support.
- MCB will contribute $5.0 million (an increase of $2.0 million) to CEMMSS via the National Nanotechnology Initiative, by supporting fundamental research on predictive synthetic biology to design and produce new nanobiomaterials relevant to clean energy, and research on mining of genomic information from diverse biological sources to discover new materials of defined properties.
- MCB will demonstrate global leadership in strategic research technologies of economic importance by investing $3.0 million in collaborative research projects with international partnerships including a nitrogen-fixation Ideas Lab in collaboration with the Biotechnology and Biological Sciences Research Council (UK) and supporting Science across Virtual Institutes (SAVI) projects in synthetic biology, photosynthesis and metabolomics.
- MCB continues to invest in clean energy through support for research on fuel cells, biomass, and the BioMaPS activity.
- MCB will give high priority to research of societal importance, particularly related to economy, energy and environment. Fundamental knowledge about how organisms capture and convert energy will help us develop sources of clean energy. For example, fundamental research funded by MCB on synthesis of peptides on chips has provided the basis for a startup company that is generating peptide chips for diagnostic and other commercial applications.

**Education**

- In addition to continuing investments in Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities, MCB will continue to support educational activities as broader impacts of many research projects funded in the division.

## INTEGRATIVE ORGANISMAL SYSTEMS (IOS) $220,520,000
**+$8,190,000 / 3.9%**

**IOS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, IOS** | **$212.56** | **$212.33** | **$220.52** | **$8.19** | **3.9%** |
| **Research** | **183.19** | **174.69** | **182.88** | **8.19** | **4.7%** |
| *CAREER* | *8.64* | *8.22* | *8.62* | *0.40* | *4.9%* |
| **Education** | **2.26** | **1.75** | **1.75** | **-** | **-** |
| **Infrastructure** | **27.11** | **35.89** | **35.89** | - | - |
| *Research Resources* | *27.11* | *35.89* | *35.89* | - | - |

Totals may not add due to rounding.

IOS supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems interacting with their environments. Reaching a systems level understanding of organisms will require a new emphasis on interdisciplinary approaches and development of new tools. These approaches span computational, molecular, cellular, individual organism, and population levels of inquiry. Many activities supported by IOS focus on biological processes that affect organismal development, structure, performance, and interactions under varying environmental conditions. IOS-supported research focuses on investigating organismal performance in an environmental context, which is significant for understanding reciprocal interactions between the biosphere and drivers of global climate change.

In general, 41 percent of the IOS portfolio is available for new research grants and 59 percent is available for continuing grants.

### FY 2013 Summary

All funding decreases/increases represent changes over the FY 2012 Estimate.

**Research**

- In the FY 2013 Request, there is a general reduction to areas of lower priority to provide resources to other programs related to NSF and directorate priorities.
- In FY 2013, IOS will join the Emerging Frontiers (EF) division in supporting the BioMaPS program, which emphasizes research at the interfaces of biology, engineering, and the mathematical and physical sciences in recognition of its potential value in addressing issues of societal importance ($2.29 million). In FY 2013, IOS will prioritize modeling of multi-scale network integration and function.
- The Basic Research to Enable Agricultural Development (BREAD) Program will continue support for basic research to test innovative, early-concept approaches and technologies for sustainable, science-based solution to problems of agriculture in developing countries. BREAD is jointly supported by NSF ($3.0 million) and the Bill & Melinda Gates Foundation ($3.0 million), through funding provided to NSF.

- IOS will contribute to the FY 2013 research focus on all five of the Grand Challenges in biology ($7.50 million), with an emphasis on basic research directed towards comparative neurobiology and the study of biological mechanisms responsible for complex brain functions. Such mechanisms provide the basis for adaptive responses to changing environments and also drive the evolution of animal behavior.
- International leadership ($3.0 million) will be emphasized through continued support of metabolomics research, the systematic study of all of the molecules in an organism, as well as research on improvements in nitrogen fixation and nitrogen utilization in plants and microbes through the support of a nitrogen fixation Ideas Lab in collaboration with the Biotechnology and Biological Sciences Research Council (UK) and supporting a Science Across Virtual Institutes (SAVI) project in photosynthesis.
- In addition, IOS will maintain its support of research and coordination activities in neuroinformatics. These studies contribute to a greater understanding of organismal structure and function and provide new insights into materials and processes of potential economic value.
- Support for CAREER ($8.62 million total) will be continued in recognition of the importance of supporting junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and integration of education and research activities.
- IOS invests in clean energy through support for research in biomass and also through increased support for the BioMaPS activity.
- Broadening participation will be emphasized across all IOS activities. IOS will have an emphasis on supporting networking efforts focused on increasing participation and retention of underrepresented groups and women in science.

**Education**

- IOS includes support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities ($1.75 million).

**Infrastructure**

- The IOS request includes investments in research resources supported through the Plant Genome Research Program. The Plant Genome Research Program (PGRP) supports genome-scale research to accelerate basic discoveries in basic plant biology as well as downstream applications of potential societal benefit such as crop improvement, development of new sources of bio-based energy, development of sources of novel bio-based materials, and adaptation to global climate change.

## DIVISION OF ENVIRONMENTAL BIOLOGY (DEB) $143,730,000
**+$1,170,000 / 0.8%**

**DEB Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DEB** | **$142.72** | **$142.56** | **$143.73** | **$1.17** | **0.8%** |
| **Research** | **140.43** | **141.06** | **142.23** | **1.17** | **0.8%** |
| *CAREER* | *3.66* | *3.43* | *3.60* | *0.17* | *5.0%* |
| **Education** | **2.29** | **1.50** | **1.50** | **-** | **-** |

Totals may not add due to rounding.

DEB supports catalytic and transformative research to inventory life on earth, to discover life's origins and evolutionary history, and to understand the dynamics of ecological systems. Ecological systems, in turn, provide goods and services that form the foundation of the bioeconomy and its support of human health and welfare (e.g., breathable air, potable water, food and fiber, crop pollination, disease control). Scientific foci in DEB address the process of evolution; describe the genealogical relationships of all life; elucidate the spatial and temporal dynamics of species interactions that govern the assembly of functional communities; and determine the flux of energy and materials through ecosystems. This theoretical and empirical research in ecology, evolution, and biodiversity is enhanced by dynamic interactions with the fields of genomics, computer science, and mathematics.

In general, 46 percent of the DEB portfolio is available for new research grants and 54 percent is available for continuing grants.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**
An increase to the DEB budget (+$1.17 million to a total of $143.73 million) will support core activities in support of the SEES portfolio and the new BIO 5 grand challenge activity.

- Funds will continue to support innovation in review processes ($1.0 million) that is matched by the innovation activities in Emerging Frontiers.
- DEB will invest in SEES through continued support ($15.0 million) for the Dimensions of Biodiversity program, an activity in its third year of a campaign to identify the scale of global biodiversity.
- $3.0 million of the Dimensions in Biodiversity investment described above will contribute to international leadership by supporting research partnerships with Brazil and China. Projects include such research as how plant and drought defense may help prepare society for future global food security challenges, and prediction of patterns of range shifts and species extinctions through research on the evolutionary capacity of various aquatic and terrestrial organisms to adapt to changing conditions.

- Support for the Assembling the Tree of Life (AToL) program will continue with an every-other-year competition that combines two years of funding into each set of awards. The next competition will be held in FY 2014.
- DEB will participate in the FY 2013 research focus on BIO's five grand challenges. $4.17 million will support DEB programs that address grand challenges of understanding biodiversity and increasing our knowledge of how the biosphere interacts with earth systems such as climate. For example, a new study concludes that some global climate models may be flawed, as they may incorrectly predict releases of atmospheric carbon dioxide because they don't adequately reflect variable temperatures that can affect the amount of carbon released from soil.
- Responding to the national priority of supporting young investigators, DEB support for CAREER increases (+$170,000 thousand to a total of $3.60 million).

**Education**

- DEB's investment includes support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.
- DEB is funding a distributed graduate seminar as part of a novel effort to integrate education with research while testing a new approach to the assessment of our portfolio of investments in Dimensions of Biodiversity. This seminar is developing a baseline against which research advances supported by this and complementary programs can be assessed.

## DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI) $129,680,000
**+$3,500,000 / 2.8%**

**DBI Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DBI** | **$129.28** | **$126.18** | **$129.68** | **$3.50** | **2.8%** |
| **Research** | **47.08** | **46.13** | **49.78** | **3.65** | **7.9%** |
| *CAREER* | *5.40* | *5.14* | *5.44* | *0.30* | *5.8%* |
| *Centers Funding (total)* | *39.06* | *42.22* | *42.40* | *0.18* | *0.4%* |
| *Centers for Analysis & Synthesis* | *22.94* | *26.12* | *26.30* | *0.18* | *0.7%* |
| *Nanoscale Science & Engineering Centers* | *5.12* | *5.10* | *5.10* | - | - |
| *STC: Center for Microbial Oceanography (C-MORE)* | *4.00* | *4.00* | *4.00* | - | - |
| *STC: BEACON* | *5.00* | *5.00* | *5.00* | - | - |
| *Science of Learning Centers* | *2.00* | *2.00* | *2.00* | - | - |
| **Education** | **30.71** | **20.50** | **19.00** | **-1.50** | **-7.3%** |
| **Infrastructure** | **51.50** | **59.55** | **60.90** | **1.35** | **2.3%** |
| *Nat'l Nanotechnology Infrastructure Network* | *0.35* | *0.35* | *0.35* | - | - |
| *Research Resources* | *51.15* | *59.20* | *60.55* | *1.35* | *2.3%* |

Totals may not add due to rounding.

DBI empowers biological discovery by funding the development and enhancement of biological research resources, human resource activities, and centers. DBI supports the development of, or improvements to, research infrastructure; the development of human capital through support of undergraduate and postdoctoral researchers; and centers and center-like activities that create opportunities to address biological questions that have major societal impact. In addition, BIO's participation in a variety of cross-cutting activities such as Integrative Graduate Education and Research Traineeship program (IGERT) and the Major Research Instrumentation Program (MRI) is managed in DBI.

DBI investments underpin advances in all areas of biological research. Support for research includes development of informatics tools and resources, development of new instrumentation, the curatorial improvement and digitization of research collections, and improvements to research facilities at biological field stations and marine laboratories. Support for education includes research experiences for undergraduates and postdoctoral research fellowships.

In general, 25 percent of the DBI portfolio is available for new research grants and 75 percent is available for continuing grants. Approximately 30 percent of the DBI portfolio is comprised of centers and center-like activities, while the remainder is distributed through grants for various DBI and BIO priorities and continuing funds for grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Because DBI investments underpin advances in all areas of biological research, DBI will provide support ($4.17 million) for the FY 2013 focus on projects related to all five of the BIO priority grand challenge questions at the intersection of the life and the physical sciences.
- Funding for the Centers for Analysis and Synthesis increases (+$180,000 to a total of $26.30 million) as part of the planned ramp up for iPlant and the National Institute for Mathematical and Biological Synthesis (NIMBioS).

**Education**

- Within BIO, some human resource/education programs are centralized within DBI. Support will be sustained across those activities including, IGERT, RET, and REU-Sites (Research Experiences for Undergraduates-Sites) for a total of $19.0 million. The Climate Change Education (CCE) program, supported through DBI, is no longer a part of SEES portfolio, so DBI's investment in CCE will conclude. (-$1.50 million).

**Infrastructure**

- DBI investments in infrastructure will be increased (+$1.35 million to a total of $60.90 million) to further advances in databases, resources and tools for the entire biology community.
- BIO continues to be active in all aspects of the CIF21 investment, as its components are important to advancement across all of the biological sciences. Increased support (+$2.0 million to a total of $4.0 million) will focus on data-enabled science and the new Software Institutes activities.
- DBI investments in the Collections in Support of Biological Research will not be funded in FY 2013 (-$4.0 million). Support for this program has been moved from an annual to a biennial competition; when competed, the program is funded at $4.0 M. Funds from this reduction will be used to support activities related to the BIO priority investments at the intersection of the life and the physical sciences and in the grand challenges.

## EMERGING FRONTIERS (EF)

**$107,250,000**
**+$1,730,000 / 1.6%**

**EF Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EF** | **$103.79** | **$105.52** | **$107.25** | **$1.73** | **1.6%** |
| **Research** | **74.46** | **59.14** | **56.91** | **-2.23** | **-3.8%** |
| *CAREER* | *1.62* | *1.60* | *1.62* | *0.02* | *1.3%* |
| **Education** | **9.20** | **13.00** | **6.50** | **-6.50** | **-50.0%** |
| **Infrastructure** | **20.12** | **33.38** | **43.84** | **10.46** | **31.3%** |
| *Research Resources* | *10.45* | *10.45* | *10.45* | *-* | *-* |
| *Facilities Pre-Construction Planning (total)* | *9.67* | *7.00* | *3.00* | *-4.00* | *-57.1%* |
| *National Ecological Observatory Network* | *9.67* | *15.93* | *30.39* | *14.46* | *90.8%* |

Totals may not add due to rounding.

EF is an incubator for new infrastructure and research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology. One such project was the creation of novel bio-films capable of increased solar energy capture and storage by photosynthesis for diversion to more efficient processes.

Typically, new programs and priority areas that begin in EF mature and transition to other BIO divisions to become part of the disciplinary knowledge base. For example, both the Assembling the Tree of Life and Ecology of Infectious Diseases programs began in EF and transitioned to DEB in 2010. Supporting fundamental biological research that crosses scales of organization and engages multiple disciplines continues to be a high priority, and is particularly relevant to strategic research areas such as global change and the intersection of the life and physical sciences. EF also facilitates the development and implementation of new forms of project development and merit review, such as the Ideas Labs, which stimulate imaginative approaches and creative solutions to difficult research questions by promoting new and inventive collaborations across scientific disciplines. EF will continue to explore original mechanisms and investments at the frontiers of biological research, and facilitate support of research relevant to all of biology with targeted co-funding throughout the directorate.

In general, 74 percent of the EF portfolio is available for new research grants. The remaining 26 percent funds continuing grants made in previous years.

### FY 2013 Summary

**Research**

- In the FY 2013 Request, there is a general reduction to areas of lower priority to provide resources to other programs related to NSF and directorate priorities.
- EF will support SEES (+$9.0 million for a total of $19.75 million) through Sustainability Research Networks; SEES fellows; Dynamics of Coupled Natural and Human Systems (CNH); Research Collaboration Networks (RCNs); and through the Dimensions of Biodiversity and Ocean Acidification programs, which are designed to provide an enhanced and integrated understanding of the natural variation and function of life on Earth, across genetic, taxonomic, and functional dimensions.

- Continued support for research activities relevant to NEON, including MacroSystems Biology (-$5.0 million, to a total of $15.0 million).
- EF will continue to support BioMaPS with $9.0 million.
- EF will support clean energy through investments in BioMaPS and new support for SEES Sustainability Research Networks.
- EF will provide an increase of $2.0 million (to a total of $4.0 million) in support for INSPIRE.
- EF will provide an increase of $1.5 million (to a total of $2.0 million) for I-Corps. In FY 2012, EF made its first I-Corps award, which supported a prototype instrument for an automated high through-put measurement of membrane ion channels in primary cells or sub-cellular organelles not possible with current technology.
- EF will decrease the innovation fund by $9.0 million (to a total of $7.0 million), as some activities have transitioned to the other BIO divisions.

**Education**

- EF is reducing support for Transforming Undergraduate Biology Education (-$6.50 million to a total of $6.50 million).
- New pilot programs such as Expeditions in Education ($E^2$) aimed at improving undergraduate STEM education are being developed in partnership with EHR and in response to the recommendations of the "Vision and Change: A Call to Action" conference, supported by the National Science Foundation and the American Association for the Advancement of Science (AAAS). (Report: http://visionandchange.org/files/2010/03/VC_report.pdf)

**Infrastructure**

- In FY 2013, management and operations funding for NEON will continue to ramp-up as construction moves into year three, with multiple site and domain construction, and cyberinfrastructure development, data products will begin to come on line.
- Funding continues ($10.0 million total) for an activity in support of digitization of scientific information associated with biological specimens held in U.S. research collections. This program was begun in FY 2009 with funding from the American Recovery and Reinvestment Act of 2009 (ARRA). A strategic plan developed by the community and released in FY 2010 will continue to guide investments in FY 2013.
- Funding continues for NEON-related concept and development for advanced tool development ($3.0 million total), as construction continues on NEON. Project development costs will continue as the NEON project transitions into construction and operations; the advanced concept and development will allow for advanced infrastructure development and educational programming for the project.

## DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE) $709,720,000 +$56,130,000 / 8.6%

**CISE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Computing and Communication Foundations (CCF) | $175.93 | $179.13 | $195.00 | $15.87 | 8.9% |
| Computer and Network Systems (CNS) | 210.26 | 212.50 | 233.50 | 21.00 | 9.9% |
| Information and Intelligent Systems (IIS) | 169.14 | 176.50 | 193.00 | 16.50 | 9.3% |
| Information Technology Research (ITR) | 80.73 | 85.46 | 88.22 | 2.76 | 3.2% |
| **Total, CISE** | **$636.06** | **$653.59** | **$709.72** | **$56.13** | **8.6%** |

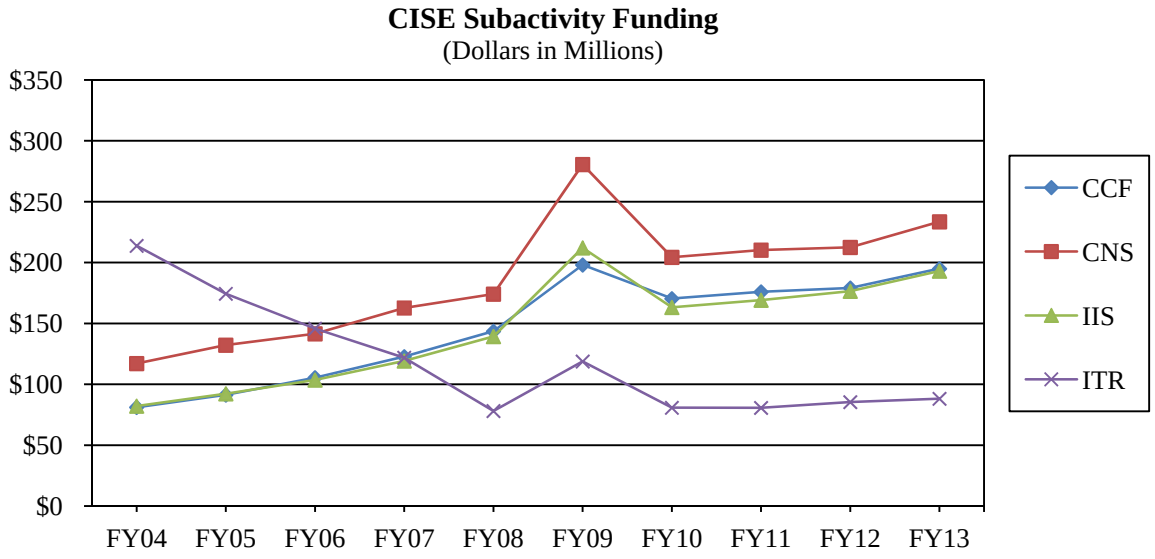
Totals may not add due to rounding.

## About CISE

CISE's mission is to promote the progress of computer and information science and engineering research and education; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in an information-based society. CISE supports ambitious long-term research and research infrastructure projects within and across the many sub-fields of computing, contributes to the education and training of computing professionals and, more broadly, informs the preparation of a U.S. workforce with computing competencies essential to success in an increasingly competitive global market. CISE's FY 2013 Request is shaped by investments in NSF's three strategic goals in addition to investments in its core research, education, and infrastructure programs.

CISE continues to play a leadership role in the multi-agency Subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the CISE Assistant Director. All research, education, and research infrastructure projects supported by CISE enrich the agency's NITRD portfolio. As noted by the President's Council of Advisors on Science and Technology (PCAST) in their review of the NITRD program in December 2010, advances in Networking and Information Technology (NIT) are key drivers of U.S. economic competitiveness. Essentially all practical applications of Information Technology (IT) are based on ideas and concepts that emerged from investments in basic computing research. These fundamental ideas and concepts have enabled innovative products and applications that now permeate all areas of modern life. IT forms a sizeable portion of the economy, and it drives discovery and innovation in many other areas, e.g., advanced scientific research, advanced manufacturing, education and workforce development, health and wellness technologies, sustainability and energy science, transportation, national and homeland security research, and public and private organizational effectiveness and efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth in both the manufacturing and service sectors for many years to come, positioning NSF and CISE as central and essential actors in improving the Nation's economic outlook and advancing a highly trained, technologically astute workforce.

NSF provides approximately 79 percent of the total federal support for basic research at academic institutions in computer science.




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary by Division

- CCF's FY 2013 Request is focused on enhancing support for its core programs and on support for NSF-wide investment areas. CCF will support the NSF-wide Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) investment through foundational research advancing the science of big data including algorithms and software tools for managing massive amounts of heterogeneous and complex data; new functional capabilities in support of highly parallel computing; and multi-core and multi-machine data management systems. CCF will support Enhancing Access to the Radio Spectrum (EARS) research through investments in reliable wireless transmission; theoretical performance limits of spectrum sharing; and technical and economic models for flexible spectrum access, real-time auctions, and on-demand spectrum services. CCF, as part of the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio, will invest in the computational methods and models necessary to attain a sustainable future. CCF will support research on the foundations of Secure and Trustworthy Cyberspace (SaTC), including new theories, models, methods, architectures, and tools towards achieving security-aware computing, self-healing hardware, and self-protecting software. As part of the National Nanotechnology Signature Initiatives, CCF will focus on research in nanotechnology design automation and computer architectures.

- CNS's FY 2013 Request is focused on enhancing support for its core programs and on support for NSF-wide investment areas. CNS will lead the SaTC program in partnership with EHR, ENG, MPS, OCI, and SBE. SaTC aims to build a cybersecure society and provide a strong competitive edge in the Nation's ability to produce high-quality digital systems and a well-trained cybersecurity workforce. These efforts will maintain CISE's national leadership in developing the scientific foundations of cybersecurity as part of the Comprehensive National Cybersecurity Initiative (CNCI). In partnership with ENG, MPS, OCI, BIO, and other CISE divisions, CNS will support research in Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) through increased support for research on cyber-physical systems, advanced manufacturing, and critical infrastructure. CNS will partner with ENG, MPS, and SBE to support EARS research in new wireless communications and spectrum sharing architectures and services. CNS will also support the NSF-wide CIF21

investment through research on pervasive computing combining distributed sensing with data analytics and distributed response, and research on large-scale data management systems. In support of the NSF-wide SEES investment, CNS will support research in large-scale smart sensing and control systems that promise to increase resource sustainability. CNS will continue its investment in Computing Education for the 21st Century (CE21) with a goal to increase the pool of K-14 students with the computational competencies needed to successfully pursue degrees in computing and computationally-intensive fields. CNS will continue its support of the Global Environment for Network Innovations (GENI) activity by investing in transformational networking research infrastructure, and experimentation not possible elsewhere; phasing in full-time technical support for the increasing demand from experimenters; and expanding GENI to a national research testbed by research-enabling and integrating more partners at U.S. academic campuses, regional and backbone networks, and cities across the Nation.

- IIS's FY 2013 Request is focused on enhancing support for its core programs and on support for NSF-wide investment areas. IIS will participate in CEMMSS through leadership of the interagency National Robotics Initiative (NRI). The NRI aims to accelerate the development and use of co-robots, i.e., robotic systems and devices that work cooperatively with, or alongside, people, increasing their performance, productivity, and safety. IIS will participate in the NSF-wide CIF21 investment through research in data analytics and e-science, including new approaches to data mining, machine learning, knowledge extraction, visualization, predictive modeling, and automated discovery. IIS will continue to lead NSF's investment in Smart Health and Wellbeing research, partnering with ENG and SBE as well as CISE's other divisions. NSF seeks to address fundamental technical and scientific issues that would support much needed transformation of healthcare, from reactive and hospital-centered to preventive, proactive, evidence-based, and person-centered, as well as focus on wellbeing rather than disease. IIS, jointly with EHR and SBE, will participate in Expeditions in Education ($E^2$) through support of the Cyberlearning Transforming Education (CTE) program. CTE aims to integrate advances in technology with advances in what is known about how people learn by focusing on personalized learning experiences, access to learning resources anytime and anywhere, and providing new ways of assessing capabilities.

- ITR's FY 2013 Request will provide support for emerging high-priority areas of potentially transformative research. ITR will continue to invest in ongoing awards in the Expeditions in Computing program, which encourages researchers to come together to identify the compelling ideas that promise transformations in computing and information sciences for years to come. Through I-Corps, a cross-directorate investment in public-private partnerships, ITR will develop and nurture a national innovation ecosystem that builds on foundational research and guides the output of scientific discoveries to the development of technologies, products, and processes that benefit society. In collaboration with ENG, ITR will support investments in innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Center (I/UCRC) program. ITR will invest in a Virtual Institute (VI) as part of the Science Across Virtual Institutes (SAVI) activity, providing increased opportunities for international collaborations, especially for early career researchers. ITR also provides support for the development of novel mid-scale infrastructure and testbeds. Through US Ignite, ITR will leverage previous investments in GENI by expanding and research-enabling partners at U.S. academic campuses, regional and backbone networks, and cities; advancing networking and systems research through experiments conducted on wireline and wireless testbeds at scale; and jumpstarting public sector gigabit application development, deployment, and evaluation with the promise of long-term scientific, social, and economic benefit.

## Major Investments

**CISE Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | $15.72 | $27.80 | $37.88 | $10.08 | 36.3% |
| CAREER | 46.75 | 48.27 | 50.60 | 2.33 | 4.8% |
| CEMMSS | - | 50.00 | 91.00 | 41.00 | 82.0% |
| CIF21 | - | 12.00 | 16.00 | 4.00 | 33.3% |
| Clean Energy Technology | 15.75 | 18.00 | 21.50 | 3.50 | 19.4% |
| CNCI | 40.00 | 51.00 | 44.50 | -6.50 | -12.7% |
| $E^2$ | - | - | 4.00 | 4.00 | N/A |
| EARS | - | 7.00 | 24.00 | 17.00 | 242.9% |
| I-Corps | 0.20 | 2.50 | 6.00 | 3.50 | 140.0% |
| INSPIRE | - | - | 4.00 | 4.00 | N/A |
| NRI | - | 12.50 | 17.50 | 5.00 | 40.0% |
| SEES | 2.25 | 8.00 | 11.50 | 3.50 | 43.8% |
| SaTC | - | 55.00 | 69.00 | 14.00 | 25.5% |

Major investments may have funding overlap and thus should not be summed.

All CISE divisions will participate intellectually in the Major Investments noted above.

- Advanced Manufacturing: In FY 2013 CISE will invest in research that integrates ubiquitous sensors, computational tools, and highly connected cyber-physical systems in smart processing and advanced manufacturing systems, resulting in higher quality products with greater efficiency and sustainability produced by the factories of the future. CISE will also invest in basic research to advance robotics technology in order to enable new functionalities and provide the next-generation of products and services in various industries including advanced manufacturing. CISE will also support research aimed at the development of next generation robotics, conceived as co-robots that work alongside, or cooperatively, with people in manufacturing environments, increasing their productivity, performance, and safety. As part of this research activity, CISE will also synergize investments across multiple research communities and programs in order to transform static manufacturing systems, processes, and edifices into adaptive, pervasive "smart" systems with embedded computational intelligence that can sense, adapt, and react.

- CAREER: This program invests in the integration of research and education of early-career researchers and contributes to the development of future generations of computer and information scientists and engineers. CISE estimates that it will make approximately 100 CAREER awards in FY 2013.

- Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS): In FY 2013, the Cyber-Physical Systems (CPS) program, funded jointly with ENG, will be expanded by investments from MPS, SBE, and BIO to accelerate advances in 21st century smart engineered systems. CEMMSS aims to establish a scientific basis for engineered systems interdependent with the physical world and

social systems; synthesize multi-disciplinary knowledge to model and simulate systems in their full complexity and dynamics; and develop a smart systems technology framework. CEMMSS includes CISE investments in the National Robotics Initiative (NRI), an important multi-agency activity.

- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21): In FY 2013, CISE will support investments to advance big data science and engineering research through core scientific and technological means of managing, analyzing, visualizing, and extracting useful information from large, diverse, distributed, and heterogeneous data sets so as to: accelerate the progress of scientific discovery and innovation; lead to new fields of inquiry that would not otherwise be possible; encourage the development of new data analytic tools and algorithms; facilitate scalable, accessible, and sustainable data infrastructure; and promote economic growth and improved quality of life. CISE will also target new computational infrastructure through investments in: (i) new functional capabilities in support of highly parallel computing; and (ii) large-scale data management systems – multi-core and multi-machine systems – with computational models and new programming paradigms for distributed approaches, such as cloud and cluster computing.

- Clean Energy Technology: In FY 2013, CISE will support foundational research in energy-intelligent computing, the development of new theory, algorithms, and design principles to effectively tackle energy versus computation and communication tradeoffs, and the scalability and sustainability of smart energy production software and hardware. CISE research on clean energy is partially supported via investments in SEES.

- Comprehensive National Cybersecurity Initiative (CNCI): In FY 2013, CISE will focus on the development of the science of cybersecurity, as well as four game-changing research themes – designed-in security, moving target defense, tailored trustworthy spaces, and cyber economic incentives. In partnership with OCI, CISE will actively work to transition mature discoveries into a secure research infrastructure. In partnership with SBE, CISE will also invest in research at the interstices of economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior in cyberspace.

- Expeditions in Education ($E^2$): In FY 2013, CISE will invest in the Cyberlearning Transforming Education program, supported jointly with EHR and SBE, in order to integrate advances in technology with advances in the ways people learn; more effectively use technology for promoting learning; design new technologies for integration in learning environments; and evaluate their use.

- EARS: In FY 2013, CISE will continue support for research in wireless communication, spectrum sharing, and mobile computing, as well as the development of wireless and spectrum testbeds. Collaborations with ENG, MPS, and SBE in EARS will strengthen U.S. leadership in the global wireless technology marketplace.

- I-Corps: In FY 2013, CISE will develop and nurture a national innovation ecosystem that builds upon fundamental research to guide the output of scientific discoveries closer to the development of technologies, products, and processes that benefit society. The CISE activities funded through I-Corps will identify NSF-funded researchers who will receive additional support – in the form of mentoring and funding – to accelerate innovations that can attract subsequent third-party funding.

- INSPIRE: In FY 2013, CISE will catalyze interdisciplinary research by seamlessly integrating a suite of new activities with existing efforts to foster and support transformative research. In FY 2013, CISE will invest in several mid-scale awards to surface and build a new pool of potential innovators and transformative interdisciplinary researchers.

- National Robotics Initiative (NRI): The NRI is a national multi-agency research program including the National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), and Department of Agriculture (USDA) that aims to accelerate the development and use of co-robots. In FY 2013, CISE and ENG will support fundamental robotics science and engineering; will partner with EHR to fund robotics education; and will partner with SBE to enhance understanding of human interaction with co-robots. NRI is a primary component of the smart systems research investments in CEMMSS.

- SEES: In FY 2013, CISE will create a research community engaged in cyber-enabled sustainability to advance research in: large-scale, intelligent, data management and analysis; widespread, heterogeneous sensing and control; and optimization, modeling, and simulation of large, complex problems, including energy, computation and communication trade-offs.

- Secure and Trustworthy Cyberspace (SaTC): SaTC aligns NSF cybersecurity investments (including investments from OCI, SBE, MPS, and ENG) with the President's national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC aims to support scientific foundations, induce change, maximize research impact, and accelerate the transition to practice. This investment also includes support for the Comprehensive National Cybersecurity Initiative (CNCI). CISE will collaborate with EHR to support rigorous evaluation of cybersecure workforce development to enable a growing pipeline of researchers and educators, and to develop a citizenry that understands the security and privacy of the digital systems on which society depends.

## CISE Funding for Centers Programs and Facilities

**CISE Funding for Centers Programs**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$14.16** | **$11.50** | **$10.47** | **-$1.03** | **-9.0%** |
| *STC: Center for Embedded Networked Sensing (CCF)* | 2.66 | - | - | - | N/A |
| *STC: Team for Research in Ubiquitous Secure Technology (CCF)* | 4.00 | 4.00 | 3.32 | -0.68 | -17.0% |
| *STC: Science of Information (CCF)* | 5.00 | 5.00 | 5.00 | - | - |
| *SLC: Pittsburgh Science of Learning Center for Robust Learning (ITR)* | 2.50 | 2.50 | 2.15 | -0.35 | -14.0% |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- In FY 2013, CISE will provide the ninth year of funding, at a decreased level as the project ramps down as planned, for the Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley. TRUST is focused on the development of cybersecurity science and technology that will radically transform the ability of organizations to design, build, and operate trustworthy information systems for the Nation's critical infrastructure by addressing the technical, operational, legal, policy, and economic issues affecting security, privacy, and data protection, as well as the challenges of developing, deploying, and using trustworthy systems.

- In FY 2013, CISE will provide the third year of funding for the Center for the Science of Information

at Purdue University. The center's goal is to develop a new science of information that incorporates common features associated with data/information, such as space, time, structure, semantics, and context that are not addressed by earlier mathematical theories, e.g., data obfuscation and hiding techniques that enhance robustness and the principles of redundancy and fault tolerance found in natural systems.

- In FY 2013, CISE continues to support the Pittsburgh Science of Learning Center (SLC) for Robust Learning at a reduced level as the project begins to ramp down. The Pittsburgh SLC leverages cognitive theory and cognitive modeling to identify the instructional conditions that cause robust student learning in order to enhance scientific understanding of robust learning in educational settings and create a research facility to support field-based experimentation, data collection, and data mining.

**CISE Funding for Facilities**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Facilities (Total)** | **$0.60** | **$0.60** | **$0.60** | **-** | **-** |
| National Nanotechnology Infrastructure Network (CCF) | 0.60 | 0.60 | 0.60 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

## Summary and Funding Profile

CISE supports investments in core and interdisciplinary research and education as well as in computing research infrastructure.

In FY 2013, the number of research grant proposals is expected to increase by approximately 7.3 percent compared to FY 2012. CISE expects to award approximately 1,320 research grants in FY 2013. Average annualized award size and duration are expected to rise slightly from FY 2011 to FY 2013.

**CISE Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 5,996 | 6,500 | 7,000 |
| Number of New Awards | 1,378 | 1,420 | 1,540 |
| Funding Rate | 23% | 22% | 22% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 5,720 | 6,200 | 6,650 |
| Number of Research Grants | 1,173 | 1,210 | 1,320 |
| Funding Rate | 21% | 20% | 20% |
| Median Annualized Award Size | $149,998 | $150,000 | $150,000 |
| Average Annualized Award Size | $182,863 | $180,000 | $190,000 |
| Average Award Duration, in years | 2.9 | 3.0 | 3.0 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):
In FY 2012, CISE plans to hold a Committee of Visitors (COV) review, which will examine and assess the quality of the entire CISE portfolio. For the first time, data-driven portfolio analysis will be conducted to more effectively enable recommendations for future portfolio management and priority-setting. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are reported in each division's annual report and factored into an annual performance assessment conducted by CISE senior management.

STEM Evaluation:
Evaluation is a vital part of CISE's STEM education programs, including Computing Education for the 21st Century (CE21), which is a partnership with EHR and OCI. Each CE21 project will provide a rigorous research and/or evaluation plan designed to guide project progress and measure its impact. The plan will include a description of the instruments/metrics that will be used. A set of common core metrics has been developed and is now being collected across the set of projects. A contract for external evaluation of the overall CISE education portfolio is currently being competed. Results will be available twelve months from execution of the contract.

As part of the CTE program, in FY 2012, jointly with EHR, a Cyberlearning Resource Center (CRC) will be funded as a cooperative agreement to support Cyberlearning programmatic efforts. The CRC is expected to carry out evaluation of the Cyberlearning program. While each project will have its own individual evaluation plan, the Resource Center is tasked with developing a plan to collect data across projects and to address overall impact, success in meeting Cyberlearning goals, and practices for moving results from research to practice. Proposals must also include evaluation of the impacts of the CRC by an external evaluator.

Reports:
To better assess the long-term economic impact of CISE investments, CISE funded the National Academy of Sciences (NAS) Computer Science and Telecommunications Board (CSTB) to study the IT innovation ecosystem. The report, *Assessing the Impacts of Changes in the Information Technology R&D Ecosystem*, published in 2009, includes a depiction of the creation of almost twenty billion dollar IT industries since 1965 (i.e., figures popularly referred to as the "tire tracks diagrams"). To update this study, CISE recently asked CSTB to identify new IT industries; develop a brief report that highlights the updated figures; and summarize results-to-date of IT research, including the nature and successes of U.S. research partnerships among government, industry, and universities, and the economic payoffs of these research investments. The update is expected in FY 2012.

**Number of People Involved in CISE Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 6,812 | 7,020 | 7,620 |
| Other Professionals | 605 | 620 | 670 |
| Postdoctorates | 371 | 380 | 410 |
| Graduate Students | 4,882 | 5,030 | 5,460 |
| Undergraduate Students | 1,818 | 1,880 | 2,040 |
| **Total Number of People** | **14,488** | **14,930** | **16,200** |

## DIVISION OF COMPUTING AND COMMUNICATION FOUNDATIONS (CCF)

**$195,000,000**
**+$15,870,000 / 8.9%**

**CCF Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CCF** | **$175.93** | **$179.13** | **$195.00** | **$15.87** | **8.9%** |
| **Research** | **167.50** | **171.03** | **187.40** | **16.37** | **9.6%** |
| *CAREER* | *14.75* | *15.37* | *16.11* | *0.74* | *4.8%* |
| *Centers Funding (total)* | *11.66* | *9.00* | *8.32* | *-0.68* | *-7.6%* |
| *STC: Center for Embedded Networked Sensing* | *2.66* | - | - | - | *N/A* |
| *STC: Team for Research in Ubiquitous Secure Technology* | *4.00* | *4.00* | *3.32* | *-0.68* | *-17.0%* |
| *STC: Science of Information* | *5.00* | *5.00* | *5.00* | - | - |
| **Education** | **7.83** | **7.50** | **7.00** | **-0.50** | **-6.7%** |
| **Infrastructure** | **0.60** | **0.60** | **0.60** | - | - |
| *Nat'l Nanotechnology Infrastructure Network* | *0.60* | *0.60* | *0.60* | - | - |

Totals may not add due to rounding.

CCF supports research and education activities that explore the foundations and limits of computation, communication, and information; advance algorithmic knowledge for research areas both within and outside computer science; and advance software, hardware, and computer system design. CCF's research investments support advances in the design and analysis of algorithms, computational complexity, theoretical and experimental studies of algorithms and their resource requirements, and research on formal models of computation, including models for parallel, distributed, and heterogeneous multi-core machines. CCF invests in research that addresses the theoretical underpinnings and enabling technologies for information acquisition, transmission, and processing in communication and information networks, such as sensor networks, wireless and multimedia networks, biological networks, and networks of quantum devices. CCF investments advance the design, verification, evaluation, and utilization of computing hardware and software through new theories and high-leverage tools that focus on performance, correctness, usability, dependability, reliability, and scalability. CCF also invests in research that explores the impact of emerging technologies on computation and communication, including nanotechnology, biotechnology, and quantum systems.

In general, 72 percent of the CCF portfolio is available for new research grants. The remaining 28 percent is used primarily to fund continuing grants made in prior years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

### Research

- CCF continues support for early-career researchers through increased investments in the CAREER program.
- CCF will support the NSF-wide CIF21 portfolio (+$2.0 million to a total of $6.0 million) through foundational research advancing the science of big data including algorithms and software tools for

managing massive amounts of heterogeneous and complex data; models and theories for massive data sets; streaming, sub-linear, space-limited, and probabilistic algorithms; algorithmic methods to corroborate, validate, and verify data; and algorithms and tools to enable new discoveries and extraction of knowledge from massive data sets. Also as part of the CIF21 portfolio, CCF will focus on highly parallel computing focused on fully exploiting the parallelism in existing hardware. Research will seek a paradigm shift in the way we think, teach, and develop parallel languages and algorithms; support computational models that reduce low-level details of specific parallel hardware; and support reasoning about correctness and parallel performance.

- CCF will support the NSF-wide EARS program (+$8.0 million to a total of +$8.0 million) through research in wireless communication with a focus on reliable transmission in the presence of channel impairments; the theoretical performance limits for communication systems under spectrum sharing; and managing spectrum sharing based on the principles of cognitive networking, game-theoretic and economic models, and computationally efficient algorithms.
- CCF will support the NSF-wide SaTC program (+$3.0 million to a total of $14.50 million) through research on the foundations of secure and trustworthy computing, including theories, models, cryptography, algorithms, architectures, languages, and tools, which will enhance the CNCI portfolio.
- CCF will support the NSF-wide SEES portfolio (+$1.50 million to a total of $5.0 million) through research on cyber-enabled sustainability with an emphasis on the role of information sciences and engineering in sustainability. CCF will support research that will develop the theory and design principles to effectively tackle energy versus computation and communication tradeoffs; address large-scale sustainability challenges based on modeling, simulation, and optimization strategies; and develop the software and hardware that support smart management of energy production, energy harvesting, and smart distribution and consumption networks.
- As part of the National Nanotechnology Initiative (NNI) (+$1.17 million to a total of $5.0 million) CCF will support research on emerging technologies in design automation and computer architectures, with a focus on nanotechnology and on a cross layer approach for achieving reliable hardware design. This funding also contributes to the CEMMSS portfolio.
- CCF will participate in the NSF-wide CEMMSS portfolio through NRI (+$1.0 million to a total of $3.0 million) and CPS (+$2.0 million to a total of $6.0 million). In the area of Smart Systems, research will focus on formal and semi-formal methods for the specification, development, and verification of software, hardware, and embedded systems for various industries, including advanced manufacturing.
- CCF will support INSPIRE (+$1.0 million to a total of $1.0 million).
- CCF will continue to support the STC Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley (-$680,000 to a total of $3.32 million). Support is at a reduced level as this center ramps down as planned. CCF will also continue support for the Center for the Science of Information (CSoI) at Purdue University at the FY 2012 Estimate ($5.0 million).
- CCF will participate in the CISE cross-cutting Smart Health and Wellbeing program ($3.0 million, unchanged from the FY 2012 Estimate).

**Education**

- CCF will provide support for Computing Education for the 21st Century (CE21) ($4.0 million, unchanged from the FY 2012 Estimate) in partnership with the other CISE divisions. (See the CNS section for additional details.)
- Along with CNS and IIS, CCF will continue support for Research Experiences for Undergraduates (REU) sites and supplements ($3.0 million, level with the FY 2012 Estimate).

**Infrastructure**

- CCF co-funds the National Nanotechnology Infrastructure Network, supported primarily by ENG, at a level of $600,000.

## DIVISION OF COMPUTER AND NETWORK SYSTEMS (CNS) $233,500,000
**+$21,000,000 / 9.9%**

**CNS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CNS** | **$210.26** | **$212.50** | **$233.50** | **$21.00** | **9.9%** |
| **Research** | **156.60** | **166.60** | **187.30** | **20.70** | **12.4%** |
| *CAREER* | *13.42* | *15.15* | *15.88* | *0.73* | *4.8%* |
| **Education** | **28.52** | **15.90** | **16.20** | **0.30** | **1.9%** |
| **Infrastructure** | **25.14** | **30.00** | **30.00** | - | - |
| *Research Resources* | *25.14* | *30.00* | *30.00* | - | - |

Totals may not add due to rounding.

CNS supports research and education activities that advance understanding of the fundamental properties of computer systems and networks; explore new ways to address the limitations of existing computer and networked systems to make better use of these technologies; and develop better paradigms, abstractions, and tools for designing, analyzing, and building next generation computer and networked systems that are robust, secure, and trustworthy. CNS investments in computer systems research focus on: distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; and parallel systems. CNS investments in fundamental network research create new insights into the dynamics of complex networks and explore new architectures for future-generation networks and services. CNS provides scientific leadership in cybersecurity, supporting research and education activities that will ensure that society's increasingly ubiquitous and distributed computing and communication systems deliver the quality of service they are designed to achieve, without disruption, while enabling and preserving privacy, security, and trust. CNS also plays a leadership role in coordinating CISE investments in research infrastructure resources and in the development of the computing workforce of the future.

In general, about 56 percent of the CNS portfolio is available for new research grants. The remaining 44 percent is used primarily to fund continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CNS continues support for early-career researchers through increased investments in the CAREER program.
- In partnership with EHR, ENG, MPS, OCI, SBE, and the other CISE divisions, CNS will lead the SaTC program (+$8.0 million to a total of $44.0 million), which aligns with the President's national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC will invest in game-changing research topics in support of CNCI, develop scientific foundations, maximize research impact, and accelerate transition to practice, in addition to addressing education and workforce issues. CNS plans to fund large-scale collaborations requiring multi-disciplinary teams to focus on grand challenge research problems in cybersecurity.

- CNS will expand support for research in wireless communication, spectrum sharing, and mobile computing and the development of wireless testbeds. CNS will collaborate with ENG, MPS, and SBE in EARS (+$7.0 million to a total of $10.0 million), including research in quantifying the value of spectrum, advancing spectrum sensing techniques, exploring machine learning and game theory for dynamic spectrum management, understanding incentive mechanisms, and developing mid-scale experimental infrastructure to test theoretical innovations, wireless devices, protocols, and algorithms.
- In partnership with ENG, MPS, and the other CISE divisions, CNS will expand on the strong portfolio that has been developed under the CPS program (+$6.0 million to a total of $24.0 million) as part of CEMMSS. CNS will support the foundational interdisciplinary research and education necessary to transform static systems, processes, and edifices into adaptive, pervasive "smart systems," as well as to further understanding of the fundamentals arising from grand challenge applications, ranging from advanced manufacturing and transportation to critical infrastructure, such as Smart Grid, medical devices, and disaster response. As part of the CEMMSS portfolio, CNS will also invest in NRI (+$1.50 million to a total of $5.0 million).
- CNS will participate in the CIF21 investment ($3.0 million, equal to the FY 2012 Estimate) through research in pervasive computing, combining distributed sensing with data analytics and distributed response. CNS will support work on large-scale data management systems, including programming support for multi-core, multi-machine, cloud, data-intensive, and highly concurrent systems.
- CNS will support the NSF-wide SEES investment (+$1.0 million to a total of $3.50 million) through research in large-scale intelligent data management and analysis; widespread, heterogeneous sensing and control; new methods for addressing power, thermal, and sustainability issues in the design and operation of computing systems at all scales; and disaster avoidance through advanced sensing.
- CNS will support INSPIRE (+$1.0 million to a total of $1.0 million).
- CNS will participate in CISE cross-cutting research and infrastructure programs, including Smart Health and Wellbeing ($3.0 million, equal to the FY 2012 Estimate) and CTE ($2.0 million, equal to the FY 2012 Estimate).

**Education**

- CNS will provide leadership for the cross-cutting CE21 program that seeks to increase computational competencies for all students (+$4.0 million to a total of $8.0 million). The goal of CE21 is to increase the pool of K-14 students and teachers who develop and practice computational competencies in a variety of contexts, and increase the pool of early postsecondary students who are engaged and have the background in computing necessary to successfully pursue degrees in computing-related and computationally-intensive fields of study.
- With CCF and IIS, CNS will continue support for REU sites and supplements ($3.50 million, equal to the FY 2012 Estimate).
- CNS continues support for the ADVANCE program at the FY 2012 Estimate level of $2.95 million to increase the participation and advancement of women in academic science and engineering careers.
- CNS will support IGERT (-$3.20 million to a total of $1.0 million).

**Infrastructure**

- Through the Computing Research Infrastructure program ($18.0 million, equal to the FY 2012 Estimate), CNS supports acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects.
- CNS will support development of world-class, mid-scale computing research infrastructure through GENI ($12.0 million, equal to the FY 2012 Estimate) by investing in 1) transformational research and infrastructure experimentation not possible elsewhere; and 2) a wireline and wireless suite of interconnected testbeds, integrating campuses, cities, research backbones, and regional optical networks.

## DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS)

**$193,000,000**
**+$16,500,000 / 9.3%**

**IIS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, IIS** | **$169.14** | **$176.50** | **$193.00** | **$16.50** | **9.3%** |
| **Research** | **159.97** | **168.50** | **185.50** | **17.00** | **10.1%** |
| *CAREER* | *16.63* | *17.75* | *18.61* | *0.86* | *4.8%* |
| **Education** | **9.17** | **8.00** | **7.50** | ***-0.50*** | ***-6.3%*** |

Totals may not add due to rounding.

IIS supports research and education that develops and applies information technology to enhance the capabilities of people and machines to create, discover, and reason by advancing their ability to represent, collect, store, organize, visualize, and communicate data and information; develops new knowledge to support people in the design and use of information technology; and advances knowledge about how computational systems can perform tasks autonomously, robustly, and flexibly.

IIS research investments support the exploration of novel theories and innovative technologies that advance our understanding of the complex and increasingly coupled relationships between people and computing. Investments in information integration and informatics focus on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content as it relates to individuals, groups, organizations, and societies, and as it is hosted on engineered systems ranging from personal devices to globally-distributed systems. IIS also invests in research on artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas leading to the computational understanding and modeling of intelligence in complex, realistic contexts.

In general, 67 percent of IIS funding is available for new research grants. The remaining 33 percent is used primarily to fund continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- IIS continues support for early-career researchers through increased investments in the CAREER program.
- In partnership with other federal agencies (NIH, NASA and USDA), ENG, and the other CISE divisions, IIS will lead the multi-agency National Robotics Initiative (NRI) (+$2.50 million to a total of $9.50 million). IIS will focus on fundamental research in robotics science and engineering. NRI science and technology are underpinnings of the NSF-wide CEMMSS investment, which includes advanced sensing, control, and power sources; dynamical system mechanics; optimization, design, and decision algorithms; problem-solving architectures; hybrid architectures that integrate or combine methods (deductive, case-based, symbolic, etc.); safe and soft structures and mechanisms with reactive surfaces and elastic actuators; computational models of human cognition; integration of artificial intelligence, computer vision, and assistive robotics. Application domains include robots as

co-workers in advanced manufacturing environments, aides supporting emergency responders in the field, and service robots assisting the elderly and infirm to live independently.

- As part of the CEMMSS investment, IIS will support the CPS program (+$2.0 million to a total of $5.0 million). IIS will support basic research in smart systems with embedded computational intelligence that can sense, adapt, and react and that will enable new functionalities and provide the next-generation of products and services in various industries, including advanced manufacturing, that will vastly exceed those of today in terms of adaptability, functionality, reliability, safety, usability, and recyclability
- IIS will support the NSF-wide CIF21 investment (+$2.0 million to a total of $7.0 million) through research on data analytics across massive and diverse datasets. Core research includes cloud-database architectures, trusted and secure data, data mining methods, and data- and information-fusion techniques. The scientific scope of CIF21 will advance machine learning, predictive modeling, automated discovery of phenomena and causality in data, and the development of new technologies for twenty-first century data-enabled collaborative science ("eScience") and other areas of broad societal benefit, such as national and homeland security, smart transportation, healthcare, education, and energy.
- IIS will spearhead CISE's participation in Smart Health and Wellbeing research ($9.0 million, equal to the FY 2012 Estimate), partnering with ENG, SBE, and the other CISE divisions. IIS will pursue improvements in safe, effective, efficient, equitable, and patient-centered health and wellness technologies and services through innovations in computer and information science and engineering. Smart Health and Wellbeing acknowledges the changing demographics of an increasingly aging population with advances enabling assistive cyber-physical engineered systems that are embedded or distributed in the local physical environment.
- IIS will support the EARS program (+$2.0 million to a total of $2.0 million) through innovative wireless applications in areas of societal and economic benefit.
- IIS will support the NSF-wide SaTC program (+$3.0 million to a total of $10.50 million) through research in secure and privacy-protecting mechanisms for data aggregated across multiple sources, and user interfaces facilitating and visualizing complex levels of user-controllable access to personal information, which will enhance the CNCI portfolio.
- IIS will support the NSF-wide SEES investment (+$1.0 million to a total of $3.0 million) through research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems. Research will focus on the information processing dimensions of energy utilization.
- The IIS division will lead the Cyberlearning Transforming Education (CTE) program jointly with EHR and SBE (+$4.0 million to a total of $12.0 million). CTE focuses on technological advances that allow more personalized learning experiences, allow access to learning resources anytime and anywhere, and provide new ways of assessing capabilities and new metrics for measuring progress. In FY 2012, a Cyberlearning Resource Center will be funded as a cooperative agreement to support Cyberlearning programmatic efforts and to carry out evaluation of the Cyberlearning program. CISE research in CTE is partially supported via investments in $E^2$.
- IIS will support INSPIRE (+$2.0 million to a total of $2.0 million).

**Education**

- IIS will participate in the Computing Education for the 21st Century (CE21) program ($4.0 million, equal to the FY 2012 Estimate) in partnership with the other CISE divisions.
- With CCF and CNS, IIS continues support for REU sites and supplements ($3.50 million, level with the FY 2012 Estimate).

## DIVISION OF INFORMATION TECHNOLOGY RESEARCH (ITR) $88,220,000
## +$2,760,000 / 3.2%

**ITR Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, ITR** | **$80.73** | **$85.46** | **$88.22** | **$2.76** | **3.2%** |
| **Research** | **74.42** | **81.46** | **77.22** | **-4.24** | **-5.2%** |
| *CAREER* | *1.95* | *-* | *-* | *-* | *N/A* |
| *SLC: Pittsburgh Science of Learning Center for Robust Learning* | *2.50* | *2.50* | *2.15* | *-0.35* | *-14.0%* |
| **Education** | **0.48** | **-** | **-** | **-** | **N/A** |
| **Infrastructure** | **5.83** | **4.00** | **11.00** | **7.00** | **175.0%** |
| *Research Resources* | *5.83* | *4.00* | *11.00* | *7.00* | *175.0%* |

Totals may not add due to rounding.

ITR provides support for transformative explorations in computer and information science and engineering research and related education activities, emphasizing the funding of high-risk, multi-investigator, and multidisciplinary projects.

In general, about 56 percent of the ITR portfolio is available for new research grants. The remaining 44 percent is used primarily to fund continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- ITR will continue its investments in ongoing awards in the Expeditions in Computing program ($12.0 million, equal to the FY 2012 Estimate). This program identifies projects with transformative research agendas that promise to accelerate discovery at the frontiers of computing and communication. It will also continue to encourage researchers to come together within or across departments or institutions to identify the compelling ideas that promise transformations in computing and information sciences for many years to come.
- Through I-Corps (+$3.50 million to a total of $6.0 million), ITR will develop and nurture a national innovation ecosystem, by mentoring and providing funding support, which builds upon fundamental research to guide the output of scientific discoveries closer to the development of technologies, products, and processes that benefit society. I-Corps will identify NSF-funded researchers who will receive support to accelerate innovation that can attract subsequent third-party funding.
- ITR will invest in a Virtual Institute (VI), as part of the Science Across Virtual Institutes (SAVI) activity ($2.0 million, equal to the FY 2012 Estimate). VIs provide opportunities to explore international collaborations in areas of mutual interest, giving U.S. researchers and students access to complementary skill sets and broader environments in which to carry out their research. Early career researchers will be encouraged to participate in international workshops and seminars. Through this investment, ITR will foster globally-engaged researchers and educators in computing and information sciences and support a diverse portfolio of international activities.

- In collaboration with ENG, CISE will continue to support innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Centers (I/UCRC) program, which will continue to establish centers that partner industry with university research efforts. I/UCRC is funded at $7.0 million in FY 2013, level with the FY 2012 Estimate.
- ITR will continue to provide support for emerging high-priority areas of potentially transformative research through various award mechanisms, such as RAPIDs and EAGERS, and through co-funding of awards with other NSF directorates, to pursue important emerging areas in a timely manner.
- ITR will continue to support the EARS program at the FY 2012 Estimate level ($4.0 million) through integration and deployment of wireless and spectrum testbeds.
- CISE will continue its support of the Pittsburgh Science of Learning Center (SLC) for Robust Learning (-$350,000 to a total of $2.15 million). Support is at a reduced level in FY 2013 as the project begins to ramp down.
- Leveraging previous investments in GENI, ITR will invest in US Ignite, a research effort to ultimately promote U.S. leadership in developing applications and services for ultra-fast broadband and software-defined networks. As part of US Ignite, ITR will invest in foundational research and experimentation on wired, wireless, cloud computing, security, and distributed systems as well as public sector gigabit application development, initiated in FY 2013 at $3.0 million.

**Infrastructure**

- As part of US Ignite, ITR will expand the current CISE mid-scale infrastructure investment in GENI to a national-scale by research-enabling and integrating additional partners at U.S. academic campuses, regional and research backbone networks, commercial equipment and cities across the Nation to create a unique at-scale network infrastructure available for research and experimentation not possible elsewhere, initiated in FY 2013 at $7.0 million.

## DIRECTORATE FOR ENGINEERING (ENG) $876,330,000
## +$50,160,000 / 6.1%

**ENG Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Chemical, Bioengineering, Environmental, and Transport Systems (CBET) | $158.82 | $171.45 | $179.40 | $7.95 | 4.6% |
| Civil, Mechanical, and Manufacturing Innovation (CMMI) | 189.62 | 203.58 | 217.06 | 13.48 | 6.6% |
| Electrical, Communications, and Cyber Systems (ECCS) | 97.54 | 106.73 | 114.30 | 7.57 | 7.1% |
| Engineering Education and Centers (EEC) | 125.76 | 120.00 | 123.27 | 3.27 | 2.7% |
| Industrial Innovation and Partnerships (IIP) | 162.65 | 193.41 | 210.30 | 16.89 | 8.7% |
| *SBIR/STTR* | *126.47* | *152.76* | *165.20* | *12.44* | *8.1%* |
| Emerging Frontiers in Research and Innovation (EFRI) | 28.95 | 31.00 | 32.00 | 1.00 | 3.2% |
| **Total, ENG** | **$763.33** | **$826.17** | **$876.33** | **$50.16** | **6.1%** |

Totals may not add due to rounding.

## About ENG

The Directorate for Engineering (ENG) is a global leader in identifying and catalyzing fundamental engineering research, innovation, and education. To achieve this vision, the directorate leads in frontier engineering research, cultivates an innovation ecosystem, develops the next-generation engineer, and demonstrates organizational excellence.

Since its inception, ENG has provided substantial support for frontier research and education across all fields of engineering. Directorate-funded basic and use-inspired research, combined with the creativity of well-educated engineers and the resources of state-of-the-art facilities, have fueled many important innovations that in turn have stimulated economic growth and improved the health and quality of life for all Americans.

Many ENG programs and activities support national priorities and contribute to solutions to grand challenges. ENG is central to the OneNSF investments which are designed to create the knowledge and innovations required for these areas. These investments include Cyber-Enabled Materials, Manufacturing, and Smart-Systems (CEMMSS); Innovation Corps (I-Corps); Science, Engineering, and Education for Sustainability (SEES); and the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21

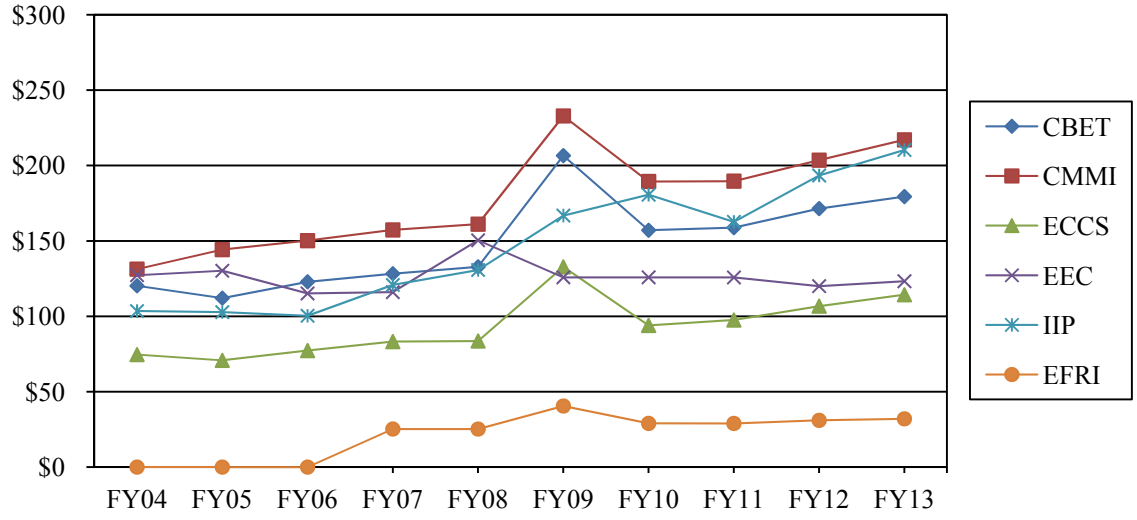
- ENG will be a major contributor in the CEMMSS OneNSF investment through interdisciplinary research in breakthrough materials and materials design, advanced manufacturing techniques and processes, and smart systems research, including robotics.
- The ENG role in SEES will continue with significant emphasis on sustainable research networks and investments in sustainable chemistry. Through coordination with all other NSF directorates,

especially the Directorate for Social, Behavioral, and Economic Sciences (SBE), ENG will be able to tackle the human dimensions of sustainability in the engineered or "built" environment.

- ENG leads the Foundation in strategic research investments focusing on innovations in manufacturing, in all its dimensions (advanced manufacturing, nanomanufacturing, and transformative technologies for traditional manufacturing).
- The ENG investment in CIF21 will build upon the directorate's support of groundbreaking work in cyber–physical systems, engineering modeling and simulation, smart networks, and sensors.

ENG provides about 35 percent of the federal funding for basic research in engineering at academic institutions.

**ENG Subactivity Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary by Division

- The FY 2013 Request for the Division of Chemical, Bioengineering, Environmental, and Transport Systems (CBET) will promote research and education for sustainability in the areas of water, climate, clean energy, and sustainable chemistry contributing to the NSF-wide SEES investment. CBET's request will bolster CEMMSS support through investment in robotics with research to assist those with physical disabilities or cognitive impairment. CBET will also enhance support for early-career researchers and support a Science and Technology Center (STC) from the Class of 2010.

- The FY 2013 Request for the Division of Civil, Mechanical, and Manufacturing Innovation (CMMI) will enable contributions to the CEMMSS OneNSF investment through research and education in advanced manufacturing, interdisciplinary research in advanced materials and manufacturing processes, as well as materials design, robotics, and cyber–physical system approaches to capitalize on interdisciplinary research opportunities arising in cyber-enabled smart manufacturing systems. CIF21 support will focus on research and education on computational-based approaches for engineering design, analysis, and predictive modeling, particularly under high degrees of uncertainty. CMMI's contribution to the SEES portfolio will include research for resilient and sustainable

buildings and infrastructure, disaster-resilient systems, energy systems manufacturing, and energy-efficient materials and processes.

- The FY 2013 Request for the Division of Electrical, Communications, and Cyber Systems (ECCS) will enable contributions to the CIF21 portfolio through support for research and education in advanced devices and systems directed towards computing, data storage, networking, and data management. The ECCS investment in the Enhanced Access to the Radio Spectrum (EARS) activity will support research on more efficient radio spectrum use and greatly improved low power energy-conserving device technologies. The division will also provide support for CEMMSS related work in the areas of robotics, smart health research, and cyber-physical systems in the area of integration of intelligent decision-making algorithms and hardware into physical systems. ECCS will also enhance support for early-career researchers and support an STC.

- The FY 2013 Request for the Division of Engineering Education and Centers (EEC) will maintain the existing portfolio of Engineering Research Centers (ERC) and provide planned growth supplements to the first class of Nanosystems Engineering Research Centers (NERCs) established in FY 2012. This investment will transition the nano-devices created at graduating Nanoscale Science and Engineering Centers (NSECs) to the systems level and commercialization. EEC will enhance support for early-career researchers and for activities that facilitate alternative pathways to engineering careers, especially for non-traditional engineering students such as veterans.

- The FY 2013 Request for the Division of Industrial Innovation & Partnerships (IIP) reflects its commitment to enhancing the Nation's innovation ecosystem. Through programs for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), IIP will continue to support technological breakthroughs that benefit society. Through the I-Corps, Partnerships for Innovation (PFI), and other activities, the division will enable academic researchers to begin translation of fundamental research discoveries, encourage academia and industry to collaborate (especially regionally), and prepare students to be entrepreneurial leaders in innovation.

- The FY 2013 Request for the Office of Emerging Frontiers in Research & Innovation (EFRI) will provide support for 15 interdisciplinary teams to pursue cutting-edge research with the potential for transformative impacts on national needs and grand challenges.

## Major Investments

**ENG Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | $40.36 | $48.42 | $68.42 | $20.00 | 41.3% |
| BioMaPS | - | 3.31 | 5.00 | 1.69 | 51.1% |
| CAREER | 57.16 | 50.34 | 52.78 | 2.44 | 4.8% |
| CEMMSS | - | 56.00 | 110.42 | 54.42 | 97.2% |
| CIF21 | - | 5.00 | 11.00 | 6.00 | 120.0% |
| Clean Energy Technology | 115.50 | 121.80 | 128.00 | 6.20 | 5.1% |
| $E^2$ | - | - | 1.00 | 1.00 | N/A |
| EARS | - | 4.00 | 14.00 | 10.00 | 250.0% |
| I-Corps | 0.45 | 2.50 | 6.00 | 3.50 | 140.0% |
| INSPIRE | - | - | 6.00 | 6.00 | N/A |
| NRI | - | 8.33 | 10.00 | 1.67 | 20.0% |
| SEES | 3.28 | 19.25 | 20.00 | 0.75 | 3.9% |
| SaTC | - | 3.25 | 4.25 | 1.00 | 30.8% |
| NNI | 181.59 | 166.37 | 174.37 | 8.00 | 4.8% |

Major investments may have funding overlap and thus should not be summed.

- ENG will strategically invest additional funds across the directorate in advanced manufacturing to support innovations in multi-scale modeling for simulation-based design and manufacturing across the supply chain, nanomanufacturing, innovative materials and manufacturing processes, energy systems manufacturing, and complex engineering systems design and manufacturing. The directorate will support industry–university partnerships and anticipates that at least one of the new NERCs will be in the area of advanced manufacturing. ENG's FY 2013 Request for Advanced Manufacturing is $68.42 million.

- ENG will invest $5.0 million in Research at the Interface of the Biological, Mathematical, Physical Sciences, and Engineering (BioMaPS) through the clean energy and advanced manufacturing activities as well as the core programs. Funding for this activity will be directed to CBET, CMMI, and ECCS.

- ENG's CAREER funding of $52.78 million will make approximately 125 awards in FY 2013 to support young investigators who exemplify the role of teacher–scholar through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

- ENG support of $110.42 million for CEMMSS will build upon existing frontier research and advance connections between robotics and manufacturing; materials and manufacturing; cyber–physical systems and robotics; robotics and the biological aspects of engineering. Activities that bring together potentially all of these research areas will be critical if this ambitious program is to succeed.

- ENG funding of $11.0 million in the CIF21 OneNSF investment will focus on three components: data-enabled science, new computational infrastructure, and access and connections to cyberinfrastructure facilities. Funding will be directed to CBET, CMMI, and ECCS.

- ENG support of $128.0 million for clean energy will enhance research and innovations in smart grid technologies, solar energy technologies, biofuels and bioenergy, wind energy generation, and renewable energy storage. The ENG clean energy investment will be strategically divided among all divisions.

- Initial funding of $1.0 million will support engineering contributions to the Expeditions in Education ($E^2$) OneNSF investment area.

- EARS support of $14.0 million represents a significant increase in FY 2013. The recent NSF supported workshop, *Enhanced Access to the Radio Spectrum: A Path Forward,* outlines the need for research on new and innovative ways to use the spectrum more efficiently. In partnership with Directorate for Computer and Information Sciences and Engineering (CISE) and the Directorate for Mathematical and Physical Sciences (MPS), ENG ECCS will initiate support for the basic research that underpins this effort.

- ENG investment in the NSF I-Corps program of $6.0 million will seek to identify NSF-funded researchers who will receive additional support – in the forms of mentoring and funding – to accelerate innovation that can attract subsequent third-party investment.

- ENG participation in INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education) will strengthen ENG's long-standing support for interdisciplinary, potentially transformative research by complementing existing efforts, such as EFRI, with a suite of new, highly creative Foundation-wide activities and funding opportunities. ENG's FY 2013 Request for INSPIRE is $6.0 million.

- ENG support of the National Robotics Initiative (NRI) will fund research on assistive mechanisms for those with physical disabilities and cognitive impairment as well as the elderly; on systems integration that enables ubiquitous, advanced robotics to be realized; and on next-generation robotics for manufacturing, healthcare and rehabilitation, surveillance and security, education and training, and transportation. This $10.0 million investment will be directed to CBET, CMMI, and ECCS. NRI is a cross-agency initiative involving NSF's CISE and ENG directorates along with external partners the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), and the U.S. Department of Agriculture (USDA).

- ENG will support the NSF-wide SEES investment by funding activities across the directorate that will lay the foundation for technologies to mitigate, and adapt to, environmental change that threatens sustainability. The greatest share of funding will be directed to CBET, CMMI, and ECCS, for investments in Sustainability Research Networks and Sustainable Chemistry research. ENG's FY 2013 Request for SEES is $20.0 million.

- ENG support of $4.25 million for the Secure and Trustworthy Cyberspace (SaTC) activity will focus on the engineering aspects of the Networking and Information Technology Research and Development (NITRD) Strategic Plan for the Federal Cybersecurity Research and Development Program (released December 2011). NITRD's research thrusts cover a set of interrelated priorities for U.S. government agencies that conduct or sponsor research and development in cybersecurity.

- The directorate will continue supporting the National Nanotechnology Initiative (NNI), with additional funding directed towards the NNI Signature Initiatives: Nanoelectronics for 2020 and Beyond; Sustainable Nanomanufacturing – Creating the Industries of the Future; and Nanotechnology for Solar Energy Collection and Conversion. ENG's FY 2013 Request for NNI is $174.37 million.

## ENG Funding for Centers Programs and Facilities

**ENG Funding for Centers Programs**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$97.88** | **$99.82** | **$93.83** | **-$5.99** | **-6.0%** |
| Engineering Research Centers (EEC) | 59.06 | 70.00 | 69.00 | -1.00 | -1.4% |
| Nanoscale Science & Engineering Centers (Multiple) | 23.84 | 17.62 | 12.63 | -4.99 | -28.3% |
| Science & Techology Centers (CBET and ECCS) | 12.78 | 10.00 | 10.00 | - | - |
| Science of Learning Centers (EEC) | 2.19 | 2.20 | 2.20 | - | - |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Engineering Research Centers (ERC): Support for the ERC program will decrease by $1.0 million, to a total of $69.0 million. Building on the long-standing ERC program model, ENG will maintain funding for the existing portfolio of ERC's and provide planned growth supplement to the first class of three Nanosystems ERCs (NERCs) funded in FY 2012. This investment will transition the nano-devices created at graduating NSECs to the systems level and commercialization.

- Nanoscale Science and Engineering Centers (NSEC): NSEC support will be reduced by $4.99 million, to a total of $12.63 million as two centers receive final funding in FY 2012.

- Science and Technology Centers (STC): ENG will continue to fund two STCs in FY 2013. CBET will support the Center on Emergent Behaviors of Integrated Cellular Systems, and ECCS will support the Center for Energy Efficient Electronics Science.

**ENG Funding for Facilities**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Facilities (Total)** | **$31.04** | **$31.33** | **$31.33** | **-** | **-** |
| NEES (CMMI) | 20.10 | 20.50 | 20.50 | - | - |
| NNIN (Multiple) | 10.93 | 10.83 | 10.83 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

ENG will maintain operations and maintenance budgets for facilities at the FY 2012 Estimate level. Notable items include:

- Support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2013 will be maintained at $20.50 million, equal to the FY 2012 Estimate. ENG will leverage investment in CIF21 to support NEES connections and foster data-enabled research within the earthquake engineering community. In response to recommendations by the Advisory Committee on Earthquake Hazards Reduction (ACEHR), NSF will organize a workshop to explore how NSF can better support Grants for Rapid Response Research (RAPIDs) for future events, and how the community can better organize in response to these events. NSF currently supports two studies to assess the future grand challenges in research and research infrastructure needs for earthquake engineering beyond 2014. These two studies are described in the NSF 10-071 Dear Colleague Letter, www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp. These NSF sponsored studies and workshops will identify research needs that are shared with the NEHRP agencies and earthquake engineering research community.

- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2012 Estimate level of $10.83 million. FY 2013 represents year ten of this planned ten-year investment.

## Summary and Funding Profile

ENG supports investments in core research and education as well as research infrastructure such as facilities.

In FY 2013 the number of research grant proposals is expected to increase by nearly 200 compared to FY 2011. ENG expects to award approximately 1,600 research grants in FY 2013. Average annualized award size and duration are estimated to be $122,000 and three years, respectively, in FY 2013.

In FY 2013, funding for centers accounts for over 13 percent of ENG's non-SBIR/STTR Request.

Funding for facilities accounts for less than 5 percent of ENG's non-SBIR/STTR FY 2013 Request.

**ENG Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 12,296 | 12,600 | 12,850 |
| Number of New Awards | 2,047 | 2,220 | 2,370 |
| Funding Rate | 17% | 18% | 18% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 9,362 | 9,450 | 9,600 |
| Number of Research Grants | 1,365 | 1,450 | 1,550 |
| Funding Rate | 15% | 15% | 16% |
| Median Annualized Award Size | $101,955 | $102,000 | $102,000 |
| Average Annualized Award Size | $122,194 | $122,000 | $122,000 |
| Average Award Duration, in years | 3.0 | 3.0 | 3.0 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory Committees. Please see this chapter for additional information.

In 2011, COVs reviewed EFRI and ECCS. The COVs presented their reports to the ENG Advisory Committee, which convened in April and October of 2011. ENG divisions are responding to and implementing recommendations from recent COVs.

In 2012, COVs will review CBET and CMMI. In 2013, COVs will review EEC and IIP.

ENG funded SRI International to evaluate the outcomes of ENG-supported Research Experiences for Undergraduates (REU) awards. In October 2010, ENG received SRI's report on the longer-term impacts of the ENG REU and other undergraduate research experiences, which was based on data collected from ENG REU students from 2006. ENG disseminated the report and received community input on how to accomplish the report's recommendations and is currently evaluating implementation strategies.

In FY 2010–2011, ENG funded the Science and Technology Policy Institute (STPI) to perform a formative assessment and evaluation of the processes by which topic areas and potentially transformative projects are selected by EFRI, and to design a protocol for future outcome evaluation of EFRI research projects. In response to this report and 2011 COV recommendations the directorate substantially revised the research topic selection process and instituted several internal process innovations in FY 2011–2012. The topic selection process frequency has been modified to every other year and external experts are being engaged in evaluating candidate topics. In order to enhance participation of underrepresented groups, the office is piloting a new opportunity to provide support to active EFRI projects for establishing summer institutes for mentored research experiences with groups including undergraduates, community college students, high school students, teachers, professors at minority serving institutions, and veterans.

In FY 2011–2012, the directorate supported two studies to assess future earthquake engineering research and research infrastructure needs. A National Research Council (NRC) committee prepared a workshop report on research grand challenges for networked earthquake engineering experimental facilities and cyberinfrastructure. To build on this work, STPI is developing potential scenarios for the future of NSF-supported earthquake engineering facilities. The Foundation is currently evaluating the NRC report and is awaiting arrival of the STPI report, expected in March 2012.

In FY 2011–2012, ENG is funding Manhattan Strategies, Inc. to evaluate the Nanotechnology Undergraduate Education (NUE) program with a final report expected September 30, 2012. This external evaluation of the 155 projects funded to date is being conducted to determine the outputs and outcomes resulting from NUE funding, the collaborating departments and colleges, the impact of the program on engineering education as reported by the funded projects, whether program outcomes have been disseminated throughout the academic community, and the level of K-12 outreach.

In addition to continuous ongoing evaluation within the ERC and Industry/University Cooperative Research Centers (I/UCRC) programs, the directorate has other plans for 2013 evaluation in development. ENG has hired a program director for evaluation and assessment who is leading a group charged with developing an overarching strategy for the directorate, which includes developing and ratifying logic models for the different engineering programs. The program director is working on pilot evaluation with selected fundamental engineering research and engineering education programs. The engineering evaluation and assessment plan will focus on immediate-, intermediate-, and long-term outcomes of

engineering investments on society. In addition, ENG is working with the Science of Science and Innovation Policy (SciSIP) program within SBE on a National Academies' study to evaluate the quality of research output and impact on society.

**Number of People Involved in ENG Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 10,309 | 10,770 | 11,310 |
| Other Professionals | 1,736 | 1,810 | 1,900 |
| Postdoctorates | 485 | 510 | 540 |
| Graduate Students | 7,008 | 7,330 | 7,700 |
| Undergraduate Students | 3,354 | 3,500 | 3,680 |
| **Total Number of People** | **22,892** | **23,920** | **25,130** |

## DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENATAL, AND TRANSPORT SYSTEMS (CBET)

**$179,400,000**
**+$7,950,000 / 4.6%**

**CBET Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, CBET** | **$158.82** | **$171.45** | **$179.40** | **$7.95** | **4.6%** |
| **Research** | **155.10** | **167.76** | **175.71** | **7.95** | **4.7%** |
| *CAREER* | *24.45* | *21.55* | *22.59* | *1.04* | *4.8%* |
| *Centers Funding (total)* | *12.60* | *11.08* | *9.08* | *-2.00* | *-18.1%* |
| *Nanoscale Science & Engineering Centers* | *4.87* | *6.08* | *4.08* | *-2.00* | *-32.9%* |
| *STC for Water Purification* | *2.68* | - | - | - | *N/A* |
| *STC for Emergent Behavior* | *5.05* | *5.00* | *5.00* | - | - |
| **Infrastructure** | **3.72** | **3.69** | **3.69** | - | - |
| *Nat'l Nanotechnology Infrastructure Network* | *3.72* | *3.69* | *3.69* | - | - |

CBET supports research to enhance and protect U.S. national health, energy, environment, and security. Through CBET, the physical, life, and social sciences are merged in engineering research and education, resulting in advances in the rapidly evolving fields of bioengineering and environmental engineering, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics.

CBET supports research in biotechnology and the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines. To serve these communities and achieve its goals, CBET has been organized into four thematic clusters each accounting for roughly 25 percent of the budget: Chemical, Biochemical, and Biotechnology Systems; Biomedical Engineering and Engineering Healthcare; Environmental Engineering and Sustainability; and Transport and Thermal Fluids Phenomena.

In general, 68 percent of the CBET portfolio is available for new research grants. The remaining 32 percent is used primarily to fund continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CAREER funding increases by $1.04 million to a total of $22.59 million in FY 2013. This increase is consistent with CBET's emphasis on supporting early-career researchers.
- CBET investment in SEES increases $500,000 to a total of $11.0 million in FY 2013 and will support the areas of water sustainability, climate engineering, and climate change mitigation and adaptation research with an emphasis in the energy area, to be supplemented by core investments in the areas of sustainable chemistry, water, energy, and the environment.

- Investments for CIF21 increase by $1.0 million, to a total of $2.0 million and will contribute to developing a cyberinfrastructure of "Sustainable Computation" that allows the use of "expert algorithms" by multiple groups (including undergraduates and industrial practitioners), less experienced than experts, to perform calculations after minimal instruction. Existing resources (envelopes, clouds, open source modules, etc.) will be used to create this environment of learning and discovery.
- CBET funding of the National Robotics Initiative, part of the ENG CEMMSS portfolio, increases $1.0 million to a total of $2.0 million and will include research on assistive mechanisms for those with physical disabilities and cognitive impairment as well as the aging population, especially through the Biosensing program and the General and Age-Related Disabilities Engineering (GARDE) program.
- The division will also provide $3.0 million in support of the national Materials Genome Initiative through a collaborative effort with MPS in Designing Materials to Revolutionize and Engineer our Future (DMREF) under the NSF-wide CEMMSS investment area.
- Support for BioMaPS − Research at the Interface of Biology, the Physical Sciences, and Engineering − is requested at $3.0 million in FY 2013 and will include research on nanoscale biosensing, neuro-engineering, and cellular biomechanics, as well as metabolic engineering and engineering aspects of synthetic biology.
- STC funding remains at $5.0 million, equivalent with FY 2012 to continue support for the STC on Emergent Behavior of Integrated Cellular Systems, led by the Massachusetts Institute of Technology.
- CBET support for the NSEC program will be reduced by $2.0 million, to a total of $4.08 million, as two centers supported by the division receive final funding in FY 2012.

**Infrastructure**

- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2012 Estimate level. FY 2013 represents year ten of this planned ten-year investment.

## DIVISION OF CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION (CMMI)

**$217,060,000**
**+$13,480,000 /6.6%**

**CMMI Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CMMI** | **$189.62** | **$203.58** | **$217.06** | **$13.48** | **6.6%** |
| **Research** | **167.60** | **181.18** | **194.66** | **13.48** | **7.4%** |
| *CAREER* | *19.07* | *16.76* | *17.58* | *0.82* | *4.9%* |
| *Centers Funding (total)* | *5.48* | *5.48* | *3.49* | *-1.99* | *-36.3%* |
| *Nanoscale Science & Engineering Centers* | *5.48* | *5.48* | *3.49* | *-1.99* | *-36.3%* |
| **Infrastructure** | **22.02** | **22.40** | **22.40** | - | - |
| *Nat'l Nanotechnology Infrastructure Network* | *1.92* | *1.90* | *1.90* | - | - |
| *Network for Earthquake Engineering Simulation* | *20.10* | *20.50* | *20.50* | - | - |

CMMI funds fundamental research in support of the Foundation's strategic goals directed at advances in the disciplines of civil, mechanical, industrial, systems, and manufacturing engineering, and materials design. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes and other hazards and disasters. CMMI encourages discovery enabled by the use of cross-cutting technologies such as adaptive systems, nanotechnology, and high-performance computational modeling and simulation. The division promotes cross-disciplinary research partnerships at the intersections of traditional research disciplines to advance transformative research results that promote innovative manufacturing technology; enable the design and analysis of complex engineering systems; enhance the sustainability and resiliency of the Nation's infrastructure (for example, buildings, transportation, and communication networks); help protect the Nation from extreme events; and apply engineering principles to improve the Nation's service enterprise systems such as healthcare.

In general, 74 percent of the CMMI portfolio is available for new research grants. The remaining 26 percent is used primarily available for continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CAREER funding increases by $820,000, to a total of $17.58 million, in FY 2013. This increase is consistent with CMMI's emphasis on supporting early-career researchers.
- Fundamental basic, core research in support of advanced manufacturing will be $50.0 million in FY 2013 as part of the NSF-wide CEMMSS activity. Areas of continued emphasis include nanomanufacturing, manufacturing enterprise systems and operations research, smart manufacturing, and design and manufacturing of complex engineered systems.
- Research to support the National Robotics Initiative will be funded at $5.0 million with advances helping to ensure continued U.S. leadership in the robotics field.
- The division will also provide $10.0 million in support of the national Materials Genome Initiative through the DMREF effort under the NSF-wide CEMMSS investment area.

- Investments in SEES, requested at $4.75 million in FY 2013 and an increase of $500,000, will continue to support research for resilient and sustainable infrastructure, disaster-resilient systems, energy manufacturing, and energy-efficient materials and processes.
- Support for CIF21 increases by $2.0 million, to a total of $5.0 million in FY 2013. CMMI will contribute to this OneNSF investment by supporting research on computational-based approaches for engineering design, analysis, and predictive modeling particularly under high degrees of uncertainty. Efforts will support research in the areas of data-enabled science and engineering, with emphasis on complex systems design and analysis and methods to utilize disparate and distributed data sets for CMMI relevant research. Linkages between these CEMMS-related research programs and elements of the CIF21 activity will be strengthened as researchers make greater use of modeling and simulation and data enabled capabilities made possible by CIF21 investments.
- CMMI support for the NSEC program will be reduced by $1.99 million, to a total of $3.49 million, as two centers supported by the division receive final funding in FY 2012.

**Infrastructure**

- Support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2013 will be maintained at $20.50 million, equal to FY 2012. ENG will leverage investment in CIF21 to support NEES connections and foster data-enabled research within the earthquake engineering community. In response to recommendations by the Advisory Committee on Earthquake Hazards Reduction (ACEHR), NSF will organize a workshop to explore how NSF can better support RAPIDs for future events, and how the community can better organize in response to these events. NSF currently supports two studies to assess the future grand challenges in research and research infrastructure needs for earthquake engineering beyond 2014. These two studies are described in the NSF 10-071 Dear Colleague Letter, www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp. These NSF sponsored studies and workshops will identify research needs that are shared with the NEHRP agencies and earthquake engineering research community.
- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2012 Estimate level. FY 2013 represents year ten of this planned ten-year investment.

## DIVISION OF ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS (ECCS)

**$114,300,000**
**+$7,570,000 / 7.1%**

**ECCS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, ECCS** | **$97.54** | **$106.73** | **$114.30** | **$7.57** | **7.1%** |
| **Research** | **92.25** | **101.49** | **109.06** | **7.57** | **7.5%** |
| *CAREER* | *13.64* | *12.03* | *12.61* | *0.58* | *4.8%* |
| *Centers Funding (total)* | *8.56* | *8.54* | *7.54* | *-1.00* | *-11.7%* |
| *Nanoscale Science & Engineering Centers* | *3.51* | *3.54* | *2.54* | *-1.00* | *-28.2%* |
| *STC for Efficient Electronics* | *5.05* | *5.00* | *5.00* | - | - |
| **Infrastructure** | **5.29** | **5.24** | **5.24** | - | - |
| *Nat'l Nanotechnology Infrastructure Network* | *5.29* | *5.24* | *5.24* | - | - |

ECCS addresses fundamental research issues underlying electronic and photonic devices and component technologies, radio frequency through terahertz (THz) circuit integration, nanoelectronics, bioelectronics, energy (including alternate energy sources), power, smart-grid, controls, computation, networking, communications, control, sensing, robotics, and cyber–physical technologies. The division supports fundamental research of novel electronic and photonic devices, the integration of these devices into circuit and system environments, and the networking of intelligent systems at multiple scales for applications in energy, healthcare, disaster mitigation, telecommunications, environment, manufacturing, and other systems-related areas. ECCS research and education investments emphasize interdisciplinary collaboration and the convergence of technologies to take on major technological challenges for the next generation of innovative devices and systems.

In general, 64 percent of the ECCS portfolio is available for new research grants. The remaining 36 percent is used primarily for continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- CAREER funding increases by $580,000, to a total of $12.61 million in FY 2013. This increase is consistent with ECCS's emphasis on supporting early-career researchers.
- ECCS will increase support for the NSF-wide CIF21 activity by $2.0 million to a total of $3.0 million through support for research in advanced devices and systems directed towards computing, data storage, networking, and data management.
- The division's investment in the NRI ($3.0 million) is part of the NSF-wide CEMMSS portfolio and will support the integration of electronic, mechanical, computing, sensing devices and systems, controls, and intelligent systems that enable ubiquitous, advanced robotics to be realized.
- In an ongoing collaboration with CISE, the division will increase support for research on cyber–physical systems (CPS) by $4.0 million, to a total of $8.0 million. The ECCS investment is part of the NSF-wide CEMMSS portfolio and will be directed towards the integration of intelligent decision-making algorithms and hardware into physical systems.

- ECCS support for CEMMSS-related smart systems research ($6.0 million), will include smart health research at the interface of biological and electronic systems and will focus on low cost electronic devices and circuits that can be fabricated on soft, flexible substrates, and areas such as distributed and ubiquitous computing and communications technologies to greatly expand the capability of current systems.
- The ECCS investment in EARS will increase by $10.0 million, to a total of $14.0 million and will support research on more efficient radio spectrum use and greatly improved low power, energy-conserving device technologies. Increased emphasis will be directed towards research of novel high linearity transistors, devices and circuits that will permit more efficient spectrum use, as well as research into new modulation techniques, circuits, and communications systems. Extension of the radio spectrum to bandwidth rich higher frequencies will be enabled with research of new types of transistors, electronic devices, and circuits that can operate at mm-wave and THz frequencies with enhanced efficiency. Research on novel integrated antenna technologies and investigations of electromagnetic propagation in lossy media will be increased.
- ECCS funding of $5.0 million in FY 2013 supports the STC for Energy Efficient Electronics Science led by the University of California at Berkeley and awarded in FY 2010.
- ECCS support for the NSEC program will be reduced by $1.0 million, to a total of $2.54 million, as two centers supported by the division receive final funding in FY 2012.

**Infrastructure**

- The division continues support of $5.24 million for NNIN user facilities. FY 2013 represents year ten of this planned ten-year investment.

## DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC)

**$123,270,000**
**+$3,270,000 / 2.7%**

**EEC Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EEC** | **$125.76** | **$120.00** | **$123.27** | **$3.27** | **2.7%** |
| **Research** | **71.23** | **74.72** | **73.72** | **-1.00** | **-1.3%** |
| *Centers Funding (total)* | *71.23* | *74.72* | *73.72* | *-1.00* | *-1.3%* |
| *Engineering Research Centers* | *59.06* | *70.00* | *69.00* | *-1.00* | *-1.4%* |
| *Nanoscale Science & Engineering Centers* | *9.98* | *2.52* | *2.52* | - | - |
| *Science of Learning Center* | *2.19* | *2.20* | *2.20* | - | - |
| **Education** | **54.53** | **45.28** | **49.55** | ***4.27*** | ***9.4%*** |

EEC integrates disciplinary basic research and education conducted in other divisions of ENG and across NSF, into strategic frameworks critical to addressing societal grand challenges and to promoting innovation. Research included in the EEC portfolio spans both the physical and life sciences and engineering, from nanostructured materials to new device concepts, subsystems, and systems. Applications range across a wide spectrum, including energy, medicine, telecommunications, nanoelectronics, manufacturing, civil infrastructure, the environment, computer networks, cyber security, and others. Also included are formal scholarly studies in engineering education and on how people learn.

The complex, integrative role of EEC requires a comprehensive infrastructure of people, equipment, and centers. Fresh, creative approaches to developing the engineering workforce are vital, as a lack of properly prepared engineers is a critical barrier to a healthy U.S. economy. EEC invests in faculty, graduate and undergraduate students, post doctoral scholars, and K–12 teachers. As nontraditional students comprise more than 70 percent of the general undergraduate population, EEC is defining unique alternative pathways for these students, especially veterans, to successfully earn degrees in engineering.

The programs in EEC are administratively managed within three categories: (1) Centers; (2) Engineering Education Research (EER); and (3) Engineering Career Development. The Centers category is comprised primarily of the signature Engineering Research Centers (ERC) program along with Nanoscale Science and Engineering Centers (NSECs) and a Science of Learning Center (SLC). They provide the framework for interdisciplinary research and education, development, and technology transfer in partnership with academia, industry, and government. The Engineering Education Research category advances new productive engineering pedagogy and learning strategies in traditional and non-traditional environments. The Engineering Career Development category includes programs such as Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET).

All programs in EEC have a significant education component, whether it is fundamental research in engineering education innovation (EER), integration of research and education (Centers), implementation strategies (EER), or human resource development (All). Thus, the emphasis on program evaluation is critical to ensure workforce development and U.S. competitiveness objectives are met. To that end, logic models with trackable indicators are being developed at this time for small-scale (projects) and large-scale (centers) programs.

In general, 20 percent of the EEC portfolio is available for new research grants. The remaining 80

percent funds continuing grants and cooperative agreements made in previous years. This high fraction of multi-year commitments is primarily a consequence of the center funding vehicle, which includes awards made as five-year cooperative agreements.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Support for the ERC program decreases by $1.0 million, to a total of $69.0 million. Building on the long-standing ERC program model, ENG will support planned growth of the first class of Nanosystems ERCs (NERCs) funded in FY 2012. This investment will transition the nano-devices and other nanotechnologies created at graduating NSECs into engineered systems and commercialization. It is expected that at least one of these new NERCs will be in the area of advanced manufacturing, and it is likely that one will be in a health-related area. The remaining portfolio of traditional Generation 3 (Gen-3) ERCs will be maintained. To encourage the customary open-topic submissions, the ERC program will defer a planned FY 2013 competition to position itself for a combined ERC and NERC competition in FY 2014.
- Funding of $2.20 million will provide continued support for an SLC — the Center of Excellence for Learning in Education, Science, and Technology (CELEST) led by Boston University.

**Education**

- Funding for the Engineering Education Research program totals $11.10 million, unchanged from the FY 2012 Estimate, and will provide support in the areas of education pedagogy and learning strategies, veterans in engineering programs, alternative pathways to engineering degree attainment, virtual learning, and others. The division will also continue to support a National Innovation Education Center ($1.0 million in FY 2013) jointly funded with EHR.
- Nanotechnology Undergraduate Education funding remains level at $1.50 million.
- Funding for the REU sites program increases by $750,000, to a total of $10.0 million. Since its inception in 1988 the REU sites program has made a tremendous impact on attracting – *and retaining* – U.S. citizens, permanent residents, and U.S. nationals into all areas of engineering. Over 60 percent of these undergraduate scholars have continued their studies at the graduate level because of the interdisciplinary research experience they gained through REU. The increase will support the growing demand in sustainability, energy, manufacturing, robotics, and other areas of national need as well as directly respond to President Obama's Jobs Council *10,000 Engineers Initiative*.
- Funding for the RET totals $4.0 million, which is unchanged from the FY 2012 Estimate. Over the past 10 years the RET in Engineering sites program has provided K-12 teachers and community college faculty with the opportunity to gain research experience in university laboratories. The professional development gained by the participants through this unique experience has enriched their performance in the classroom and their guidance of students toward engineering, thus impacting the current anemic engineering pipeline. The increase will support these participants in areas of national need such as sustainability, energy, manufacturing, robotics, and others.
- Initial funding of $1.0 million will support engineering contributions to the Expeditions in Education ($E^2$) OneNSF investment area and will focus on the integration of outreach and education efforts at ENG funded centers with other NSF education efforts and will leverage the data generated by ENG centers and facilities with advancements being made in cyberlearning research.
- EEC will also provide $1.0 million to support the directorate's involvement in the SEES Fellows program.

## DIVISION OF INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP)

**$210,300,000**
**+$16,890,000 / 8.7%**

**IIP Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, IIP** | **$162.65** | **$193.41** | **$210.30** | **$16.89** | **8.7%** |
| **Research** | **162.65** | **193.41** | **210.30** | **16.89** | **8.7%** |
| SBIR/STTR | 126.47 | 152.76 | 165.20 | 12.44 | 8.1% |

IIP contributes to the NSF innovation ecosystem by: (1) supporting innovation research that builds on fundamental research discoveries that exhibit potential for societal impact; (2) encouraging research partnerships between academia and industry; and (3) offering hands-on experience in the innovation process to entrepreneurs and future innovators.

IIP is home to two federal small business research programs, the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. These programs support innovation research that leverages academic research findings and builds partnerships between academia, small business, and large industry with the goal of achieving commercialization of new products, processes, or services. Technology topics draw upon the breadth of NSF scientific and engineering research disciplines and are aligned along national and societal priorities.

IIP supports academic research by leveraging industrial support through three research programs: the Industry/University Cooperative Research Centers (I/UCRC) program, the Partnerships for Innovation (PFI) program, and the Grant Opportunities for Academic Liaison with Industry (GOALI) program. University grantees in these programs work closely with industry to create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. Furthermore, these programs prepare students for innovation leadership in a globally competitive marketplace through opportunities to work closely with industry.

The division also manages the grant-making process, and is a strong intellectual contributor to the I-Corps OneNSF investment. The NSF I-Corps' purpose is to identify NSF-funded researchers who will receive additional support — in the forms of mentoring and funding — to accelerate innovation that can attract subsequent third-party funding.

In general, 90 percent of the IIP portfolio is available for new research grants. The remaining 10 percent funds continuing grants made in previous years, primarily due to the long-duration of I/UCRCs. All other programs are managed with standard grants.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- The SBIR/STTR program increase of $12.44 million, to a total of $165.20 million, and is consistent with the levels specified in the SBIR/STTR Reauthorization Act of 2011 (P.L 112-81). Increased

support for SBIR/STTR will provide an opportunity for greater collaboration with the disciplinary divisions across NSF in the spirit of bringing basic research to innovation research.

- Funding for Accelerating Innovation Research (AIR) in FY 2013 totals $14.25 million, representing an increase of $250,000, and will support projects that accelerate the process of innovation through the fostering of connections between an existing NSF innovation research alliance. The activity is designed to strengthen the U.S. innovation ecosystem. The increase will also allow support for the continuation and expansion of opportunities to encourage small business partnerships with ERCs. Outcomes resulting from the partnerships will be measured by the number of financial investments; additional partnerships will be collected such as strategic partnerships, people partnerships in-kind partnerships, lab sharing, and acquisitions.
- Funding for I-Corps increases by $3.50 million, to a total of $6.0 million, to give project team's access to resources to help determine the readiness to commercialize technology built on previously-funded or currently-funded NSF basic research projects.
- The I/UCRC program increases by $500,000, to a total of $10.50 million. The increased support will focus on topics related to advanced manufacturing, clean energy and cyberinfrastructure in line with NSF investments in CEMMSS, SEES and CIF21.
- Support for the PFI program component, Building Innovation Capacity (BIC), increases by $200,000 to a total of $8.20 million and will fund public-private partnerships composed of academic researchers and small business practitioners collaborating to further basic research toward market-accepted innovations.
- IIP Support for the GOALI program is maintained at $6.15 million, equal to the FY 2012 Estimate. ENG's total FY 2013 Request for GOALI will be $16.40 million.

## EMERGING FRONTIERS IN RESEARCH AND INNOVATION (EFRI)

**$32,000,000**
**+$1,000,000 / 3.2%**

**EFRI Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EFRI** | **$28.95** | **$31.00** | **$32.00** | **$1.00** | **3.2%** |
| **Research** | **28.95** | **31.00** | **32.00** | **1.00** | **3.2%** |

EFRI strategically pursues and funds projects in important emerging areas in a timely manner. Each year EFRI recommends, prioritizes, and funds interdisciplinary topics at the frontiers of engineering research and education that have the potential for transformative impacts on national needs and/or grand challenges.

Technological innovations have given rise to new industries, expanded access to quality healthcare, and fueled national prosperity even as global competition has grown. To help ensure the Nation's continued success, EFRI will provide critical, strategic support of fundamental discovery, particularly in areas that may lead to breakthrough technologies and strengthen the economy's technical underpinnings. EFRI will have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

EFRI encourages the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields in important emerging areas. Their ideas and discoveries may potentially lead to new research areas for NSF and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge.

Recent EFRI topics have included areas such as sustainable energy sources; integrated systems designed to make U.S. infrastructures more resilient to disasters; advances in robotics, manufacturing healthcare; and regeneration of some of the body's most complex tissues. In FY 2011, EFRI invested in two topic areas to use insights from biological world to inspire new engineering capabilities. These two topical areas were Engineering New Technologies Based on Multicellular and Inter-kingdom Signaling (MIKS), and Mind, Machines, and Motor Control (M3C) were the two topic areas, which were developed in close collaboration with the BIO, CISE, and SBE directorates. The results from these investigations will enable new biological energy sources and better protection for the environment, and human health, including new bionic prosthetics for amputees. In FY 2012, EFRI will invest in three topic areas, namely, Flexible Bioelectronics Systems (BioFlex); Origami Design for the Integration of Self-assembling Systems for Engineering Innovation (ODISSEI); and Photosynthesis Biorefineries (PSBR).

The Department of Energy (DOE) and the Environmental Protection Agency (EPA) have co-funded some of the current EFRI projects in sustainable energy and environmental design. The Air Force Office of Scientific Research (AFOSR) entered into a five-year Memorandum of Understanding with NSF in FY 2012 to help support projects of mutual interest related to this year's as well as future EFRI topics.

EFRI conducted an external formative assessment of its processes and projects in 2010 and was reviewed by an external Committee of Visitors (COV) in January of 2011. Based on the COV's recommendation, ENG will develop an outcome logic model for evaluation of EFRI and plans to conduct another external outcome evaluation of its projects funded during the first two years of EFRI's operation (FY 2007 and

FY 2008).

In general, 96 percent of the EFRI portfolio is available for new research grants. The remaining 4 percent funds continuing grants made in previous years.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**
FY 2013 funding will provide support for one additional interdisciplinary team project, for a total of 15 projects aimed at addressing national challenges such as renewable energy or advanced manufacturing.

## DIRECTORATE FOR GEOSCIENCES (GEO)

**$906,440,000**
**+$21,170,000 / 2.4%**

**GEO Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Division of Atmospheric and Geospace Sciences (AGS) | $257.65 | $258.66 | $264.06 | $5.40 | 2.1% |
| Division of Earth Sciences (EAR) | 183.83 | 183.50 | 189.20 | 5.70 | 3.1% |
| Integrative and Collaborative Education and Research (ICER) | 91.62 | 91.21 | 91.21 | - | - |
| Division of Ocean Sciences (OCE) | 352.21 | 351.90 | 361.97 | 10.07 | 2.9% |
| **Total, GEO** | **$885.32** | **$885.27** | **$906.44** | **$21.17** | **2.4%** |

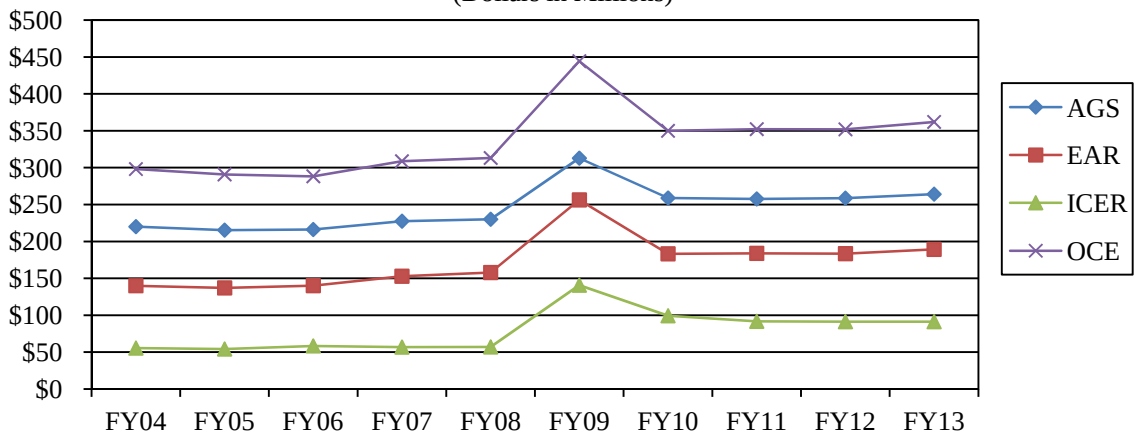
Totals may not add due to rounding.

### About GEO:

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and ocean acidification. Support is provided for interdisciplinary studies that contribute directly to national research priorities such as: understanding, adapting to, and mitigating the impacts of global change; developing and deploying integrated ocean observing capabilities to support ecosystem-based management; and understanding future availability of fresh water. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornados, hurricanes, tsunamis, drought, and solar storms. Basic research supported by GEO enables preparation for and subsequent mitigation of, or adaptation to, the effects of these and other disruptive natural events.

GEO provides about 55 percent of the federal funding for basic research in the geosciences at academic institutions.

**GEO Subactivity Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary by Division

- AGS's FY 2013 Request is focused on supporting emerging priority areas such as Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) and enhancing support of the NSF-wide Science, Engineering, and Education for Sustainability (SEES) investment, where emphases will include a new thrust on resilience to natural and technological disasters called Creating a More Disaster Resilient America (CaMRA) and a new activity focused on coastal systems. AGS will also continue support of the observational infrastructure required to conduct modern research including overseeing initial operation of the NCAR-Wyoming supercomputer center.

- EAR's FY 2013 Request is focused on supporting emerging priority areas such as CIF21 while enhancing support of the NSF-wide SEES investment where emphases will include a new thrust on CaMRA and a new activity focused on coastal systems. EAR will also modestly increase support for operation of the EarthScope facility, enabling a number of seismometers to collect extensive data in the Eastern U.S.

- ICER's FY 2013 Request is focused on enhancing support of the NSF-wide SEES investment, particularly a new thrust on Arctic systems, while maintaining support for GEO-wide education and international research activities.

- OCE's FY 2013 Request will support emerging priority areas such as CIF21 while enhancing support of the NSF-wide SEES investment where emphasis will be on understanding coastal systems and CaMRA. OCE is strongly supporting the President's Executive Order establishing a National Ocean Policy (NOP) through enablement of research, education, and infrastructure. OCE is continuing to invest in research infrastructure and to plan for potential new Regional Class Research Vessels.

## Major Investments

**GEO Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| CAREER | $12.72 | $13.08 | $13.71 | $0.63 | 4.8% |
| CIF21 | - | 4.00 | 12.00 | 8.00 | 200.0% |
| $E^2$ | - | - | 12.00 | 12.00 | N/A |
| I-Corps | - | 0.25 | 1.00 | 0.75 | 300.0% |
| INSPIRE | - | 2.00 | 5.00 | 3.00 | 150.0% |
| SEES | 28.85 | 44.25 | 70.75 | 26.50 | 59.9% |

Major investments may have funding overlap and thus should not be summed.

- Faculty Early Career Development Program (CAREER): This Foundation-wide activity offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations. Approximately 30 awards will be made in FY 2013.

- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21): GEO support for the NSF-wide CIF21 investment ($12.0 million) will enable development of EarthCube. A partnership with the Office of Cyberinfrastructure (OCI), EarthCube seeks transformative concepts and approaches to create integrated data management infrastructure across the geosciences.

- Expeditions in Education ($E^2$): Through $E^2$, GEO will partner with the Directorate for Education and Human Resources (EHR) to infuse current geosciences concepts into undergraduate education, while entraining a broader and more representative cross-section of Americans into science. Emphasis will be placed on rigorous evaluation, resources, and experiences relevant to preparation of a workforce to address complex problems in sustainability.

- I-Corps: GEO support of I-Corps gives project teams access to resources to help determine the readiness of technology developed by previously-funded or currently-funded NSF projects to transition from idea to product.

- Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE): Intended to encourage cross-disciplinary science, INSPIRE helps to break down disciplinary barriers and encourages program managers to use new tools, collaboration modes, and techniques in the merit-review process to widen the pool of prospective discoveries that may be hidden from or circumvented by traditional means. Leveraged by centralized support, scientists will utilize INSPIRE to pursue novel interdisciplinary research at the forefront of the geosciences.

- Science, Engineering, and Education for Sustainability (SEES): GEO supports a portfolio of activities that highlight NSF's unique role in helping society address the challenges of achieving sustainability. In FY 2013, new thrusts on improving resilience to natural and technological disasters and coastal and arctic systems will be initiated.

## GEO Funding for Centers Programs and Facilities

**GEO Funding for Centers Programs**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$18.30** | **$13.25** | **$13.25** | **-** | **-** |
| Nanoscale Science & Engineering Centers (ICER) | 0.25 | 0.25 | 0.25 | - | - |
| Science & Techology Centers (AGS, EAR, OCE) | 18.05 | 13.00 | 13.00 | - | - |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

**GEO Funding for Facilities**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Facilities** | $290.67 | $289.76 | $285.41 | -$4.35 | -1.5% |
| *Academic Research Fleet (OCE)* | 81.67 | 78.75 | 73.00 | -5.75 | -7.3% |
| *Arecibo Observatory (AGS)* | 3.07 | 3.20 | 3.20 | - | - |
| *EarthScope (EAR)* | 26.02 | 25.05 | 26.17 | 1.12 | 4.5% |
| *Incorporated Research Institutions for Seismology (EAR)* | 12.37 | 12.36 | 11.25 | -1.11 | -9.0% |
| *Integrated Ocean Drilling Program (OCE)* | 53.35 | 44.40 | 38.90 | -5.50 | -12.4% |
| *National Nanotechnology Infrastructure Network (ICER)* | 0.60 | 0.60 | 0.50 | -0.10 | -16.7% |
| *National Center for Atmospheric Research (AGS)* | 98.10 | 98.60 | 92.29 | -6.31 | -6.4% |
| *Ocean Observatories Initiative (OCE)* | 15.49 | 26.80 | 40.10 | 13.30 | 49.6% |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

- Funding for the Academic Research Fleet decreases by $5.75 million to a total budget of $73.0 million. This reflects the completion of support for the Replacement Human Occupied Vehicle (Replacement of the ALVIN) and savings through more efficient fleet management and utilization.

- Increased support for EarthScope will enable the capital acquisition, long-term siting, and operation of up to 250 EarthScope Transportable Array (TA) stations to be left in the central and eastern United States after the TA's proposed move to Alaska beginning in 2014.

- Support of Incorporated Research Institutions for Seismology (IRIS) is reduced by $1.11 million, to a total of $11.25 million in FY 2013, reflecting increasing efficiency and streamlining of operations with their new integrated management structure.

- Support ($38.90 million, a decrease of $5.50 million) is requested for the Integrated Ocean Drilling Program to continue to operate the drilling vessel *Joides Resolution.* FY 2013 is the final year of the current decadal program with the potential for a new program beginning in FY 2014. In FY 2013, NSF investments in IODP will be increasingly leveraged by support from international partners and industry.

- Support for NCAR is reduced (-$6.31 million, to a total of $92.29 million). This level of support protects the operations of the NCAR/Wyoming Supercomputer Center (NWSC), completed on schedule and within budget, and maintains support for other key community research infrastructure operated by NCAR.

- Support for operation and maintenance of the Ocean Observatories Initiative (OOI) increases to $40.10 million as planned.

## Summary and Funding Profile

GEO supports investment in disciplinary and interdisciplinary research and education, as well as investing in research infrastructure such as the National Center for Atmospheric Research, EarthScope, and the Academic Research Fleet.

In FY 2013, the number of research grant proposals is expected to stay about the same as the FY 2012 Estimate. A number of competitions are being held in FY 2012 that utilize funds from more than one year, in part as a method of managing workload; incremental funds in FY 2013 will largely support additional competitions, which again commit funds from future years. Average annual award size and duration are not expected to fluctuate significantly in FY 2011 through FY 2013.

In FY 2013, GEO will invest $341.18 million in Research Infrastructure, accounting for over 37 percent of the GEO budget. Inherently observational, the geosciences rely on an array of observing platforms and networks to enable researchers to advance the state of our understanding of the dynamic planet on which we live.

**GEO Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 4,512 | 5,100 | 5,100 |
| Number of New Awards | 1,413 | 1,500 | 1,500 |
| Funding Rate | 31% | 29% | 29% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 3,951 | 4,500 | 4,500 |
| Number of Research Grants | 1,167 | 1,300 | 1,300 |
| Funding Rate | 30% | 29% | 29% |
| Median Annualized Award Size | $128,231 | $130,000 | $130,000 |
| Average Annualized Award Size | $162,749 | $165,000 | $165,000 |
| Average Award Duration, in years | 2.6 | 2.8 | 2.8 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):

- In FY 2011 COVs reviewed the Integrative Projects Section in the Division of Ocean Sciences, the Geospace Section of the Division of Atmospheric and Geospace Sciences, and the Surface Earth Processes Section in the Division of Earth Sciences. The COV reports were accepted by the Advisory Committee for Geosciences and are available online. www.nsf.gov/geo/acgeo_cov.jsp. In FY 2012, the NCAR Section of AGS and Ocean and Marine Section of OCE will hold COVs. In FY 2013, the

Atmosphere Section of AGS, the Instrumentation and Facilities Section of EAR, and GEO-wide Education and Diversity Programs will be reviewed by COV.

Workshops and Reports:

- A charrette was held November 1-4, 2011 to frame a new activity called EarthCube. EarthCube, a part of NSF's CIF21 investment, is intended to transform the conduct of research by supporting the development of community-guided cyberinfrastructure to integrate data and information for knowledge management across the geosciences. In addition, two noteworthy reports were released by the National Research Council during 2011. The first, *Scientific Ocean Drilling: Accomplishments and Challenges*, presents a retrospective look at accomplishments enabled by ocean drilling and looks forward, examining the transformative potential of community plans for future ocean drilling. The second report, *New Research Opportunities in the Earth Sciences at the National Science Foundation*, is the first decadal study of research opportunities across the earth sciences since the influential BROES (Basic Research Opportunities in Earth Science) report was published in 2001.

**Number of People Involved in GEO Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 5,889 | 6,300 | 6,300 |
| Other Professionals | 2,638 | 2,800 | 2,800 |
| Postdoctorates | 689 | 700 | 700 |
| Graduate Students | 2,546 | 2,700 | 2,700 |
| Undergraduate Students | 1,973 | 2,100 | 2,100 |
| **Total Number of People** | **13,735** | **14,600** | **14,600** |

## DIVISION OF ATMOSPHERIC AND GEOSPACE SCIENCES (AGS) $264,060,000
## +$5,400,000 / 2.1%

**AGS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, AGS** | **$257.65** | **$258.66** | **$264.06** | **$5.40** | **2.1%** |
| **Research** | **123.26** | **124.28** | **139.95** | **15.67** | **12.6%** |
| *CAREER* | *4.98* | *5.48* | *5.78* | *0.30* | *5.5%* |
| *Centers Funding (total)* | *6.66* | *4.00* | *4.00* | - | - |
| *Integrated Space Weather Modeling* | *2.66* | - | - | - | *N/A* |
| *Multiscale Modeling of Atmospheric Processes* | *4.00* | *4.00* | *4.00* | - | - |
| **Education** | **1.95** | **1.96** | **1.52** | **-0.44** | **-22.4%** |
| **Infrastructure** | **132.43** | **132.42** | **122.59** | **-9.83** | **-7.4%** |
| *Arecibo Observatory* | *3.07* | *3.20* | *3.20* | - | - |
| *Nat'l Center for Atmospheric Research* | *98.10* | *98.60* | *92.29* | *-6.31* | *-6.4%* |
| *Research Resources* | *31.27* | *30.62* | *27.10* | *-3.52* | *-11.5%* |

Totals may not add due to rounding.

The mission of AGS is to extend the intellectual frontiers in atmospheric and geospace sciences by making investments in fundamental research, technology development, and education that enable discoveries, nurture a vibrant, diverse scientific workforce, and help attain a prosperous and sustainable future. AGS supports activities to further our understanding of the physics, chemistry, and dynamics of Earth's atmosphere, from the Earth's surface to the sun, on timescales ranging from minutes to millennia. AGS provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern-day atmospheric and geospace science research activities. Although the majority of AGS support is through individual investigator merit-reviewed multi-year grants, the division also supports small-scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular problem, subject, or activity; large center or center-like projects; and funding for the research conducted at facilities provided by the NSF-supported National Center for Atmospheric Research (NCAR), which extends and enhances research at universities. More information on NCAR is available in the Facilities chapter. The division will increase support in key areas of fundamental atmospheric and geospace science, including dynamics and predictability of high-impact atmospheric and space weather hazards, and support for research concerning the complex and dynamic interactions among natural and human-driven processes in coastal areas through its contributions to NSF's Science, Engineering, and Education for Sustainability (SEES) portfolio. AGS will also support NSF's Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) and other OneNSF investments.

Recognizing the close interplay between the division's support for science and the provision of facilities to support that science, AGS seeks a balance between its support for science and facilities. Approximately 50 percent of the annual budget of AGS is used to support observational and computational facilities, as well as the Arecibo Observatory and the Federally Funded Research and Development Facility, NCAR. The Arecibo Observatory is also supported by Division of Astronomy in the Directorate for Mathematical and Physical Sciences. The remaining 50 percent of the AGS budget is

for individual, small group, and center-like research grants. In general, of the 50 percent of the AGS budget available for research grants, about half (or 26 percent of the total AGS portfolio) is available for new research grants; the remaining half funds continuing grants made in previous years.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Support for early-career researchers is an AGS priority. The division increases its support for CAREER grants (+$300,000, to a total of $5.78 million).
- The Center for Multiscale Modeling of Atmospheric Processes, initiated in FY 2006, will be maintained at $4.0 million.
- In FY 2013 AGS will contribute $9.0 million in support of the cross-directorate research opportunities within the Science, Engineering, and Education for Sustainability (SEES) portfolio. AGS will support the SEES program, Creating a More Disaster Resilient America (CaMRA) at $5.50 million. For AGS, the overarching goal of SEES CaMRA is to catalyze basic research in hazard-related science to support a broad spectrum of research into the improved understanding and prediction of atmospheric and space weather hazards. In addition, AGS will support SEES Coastal at a level of $3.50 million. Among the goals of SEES Coastal are enabling place-based, system-level understanding of vulnerable coastal systems; yielding outcomes with quantitative predictive value; and identifying pathways to enhance coastal resilience.
- Support for Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is initiated in FY 2013 within AGS. AGS will contribute $2.70 million to this Foundation-wide activity through its support for EarthCube, which seeks to support the research, development, and provision of tools consistent with NSF's goal of facilitating data-enabled science.
- AGS seeks to increase its portfolio of cross-disciplinary science support by funding the INSPIRE program at $2.0 million in FY 2013.

**Education**

- AGS supports a number of education activities, including GEO Postdoctoral fellows, Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET). This portfolio will total $1.52 million (-$440,000) in FY 2013.

**Infrastructure**

- Funding for the Arecibo Observatory (formally the National Astronomy and Ionosphere Center) will remain level at $3.20 million.
- Support for the National Center for Atmospheric Research (NCAR) is reduced by $6.31 million, to a total of $92.29 million. This level of support protects the operations of the NCAR/Wyoming Supercomputer Center (NWSC), completed on schedule and within budget, and maintains support for other key community research infrastructure operated by NCAR.
- Support for Research Resources is reduced by $3.52 million, to a total of $27.10 million. This level of support represents an increased focus on research using existing instrumentation rather than instrumentation development.

## DIVISION OF EARTH SCIENCES (EAR)

**$189,200,000**
**+$5,700,000 / 3.1%**

**EAR Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EAR** | **$183.83** | **$183.50** | **$189.20** | **$5.70** | **3.1%** |
| **Research** | **116.59** | **117.09** | **123.91** | **6.82** | **5.8%** |
| *CAREER* | *4.40* | *4.80* | *5.00* | *0.20* | *4.2%* |
| *Centers Funding , Total* | *2.47* | - | - | - | *N/A* |
| *Center for Earth Surface Dyanmics* | *2.47* | - | - | - | *N/A* |
| **Education** | **4.47** | **4.93** | **5.00** | **0.07** | **1.4%** |
| **Infrastructure** | **62.78** | **61.48** | **60.29** | **-1.19** | **-1.9%** |
| *Incorporated Research Institutions for Seismology* | *12.37* | *12.36* | *11.25* | *-1.11* | *-9.0%* |
| *EarthScope* | *26.02* | *25.05* | *26.17* | *1.12* | *4.5%* |
| *Research Resources* | *24.38* | *24.07* | *22.87* | *-1.20* | *-5.0%* |

EAR supports fundamental research into the structure, composition, and evolution of the Earth, and the life it has sustained over the four and a half billion years of its history. The results of this research will lead to a better understanding of Earth's changing environment (past, present, and future), the natural distribution of its mineral, water, biota, and energy resources, and provide methods for predicting and mitigating the effects of geologic hazards such as earthquakes, volcanic eruptions, floods, and landslides.

Through its Surface Earth Processes section, EAR supports research in geomorphology and land use, hydrologic science, geobiology and low temperature geochemistry, and sedimentary geology and paleobiology. The division's Deep Earth Processes Section maintains programs in geophysics, tectonics, petrology and geochemistry, and continental dynamics. The newest program in EAR is EarthScope, a $200.0 million facility and science program focused on studying the structure and tectonics of the North American continent. In addition to these core programs, EAR has an Instrumentation and Facilities program that supports community-based, shared-use facilities, and the acquisition and development of instrumentation by individual investigators, and an education program that funds a number of activities to attract and support students and young investigators to the field of Earth science.

Approximately 66 percent of EAR's budget is used to support individuals and small groups of researchers, while about 34 percent of the budget goes to instrumentation and facilities. The two largest facilities supported by EAR are EarthScope and the Incorporated Research Institutions for Seismology (IRIS), a community-based seismic instrumentation facility. In general, 36 percent of EAR's portfolio is available for new research grants. The remaining 64 percent funds continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- EAR will continue its participation in Science, Engineering and Education for Sustainability (SEES) with $7.0 million for the Water, Sustainability and Climate solicitation.
- EAR will initiate support for two new SEES programs in FY 2013: Creating a More Disaster

Resilient America (CaMRA) and SEES Coastal at levels of $6.0 million and $2.50 million, respectively.

- EAR will increase support for GeoPRISMS, a joint OCE-EAR interdisciplinary program to study geodynamic processes at continental margins, by $500,000, to a total of $2.0 million.
- Support for Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is initiated in FY 2013 at a level of $2.60 million.
- In FY 2013, EAR will increase support for Creative Research Awards for Transformative Interdisciplinary Ventures (CREATIV), part of NSF's new INSPIRE program, by $500,000, for a total of $1.0 million.
- CAREER funding will be increased by $200,000 above the FY 2012 Estimate, to a total of $5.0 million, reflecting EAR's continuing commitment to supporting early career researchers.

**Education**

- EAR's support for Research Experience for Undergraduates (REU), EAR Postdoctoral Fellowships and other education, outreach and workforce development activities will increase by $70,000 to $5.0 million in FY 2013.

**Infrastructure**

- Support of Incorporated Research Institutions for Seismology (IRIS) is reduced in FY 2013 by $1.11 million, to a total of $11.25 million, reflecting increasing efficiency and streamlining of operations with their new integrated management structure.
- Total support for EarthScope operations will increase by $1.12 million in FY 2013, to a total of $26.17 million. This total includes $3.0 million for the first year of a 5-year, $15.0 million project for the capital acquisition, long-term siting and near-term operation of up to 250 EarthScope Transportable Array (TA) stations to be left in the central and eastern United States after the TA's proposed move to Alaska beginning in 2014.
- A decrease of $1.20 million, to a total of $22.87 million, is proposed to support multi-user research instrumentation, acquisition, or upgrading of research equipment, and development of new instrumentation, analytical techniques, and software.

## INTEGRATIVE AND COLLABORATIVE EDUCATION & RESEARCH (ICER) — $91,210,000 / $0 / 0%

**ICER Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, ICER** | **$91.62** | **$91.21** | **$91.21** | **-** | **-** |
| **Research** | **50.03** | **72.04** | **72.14** | **0.10** | **0.1%** |
| *CAREER* | *1.75* | - | - | - | *N/A* |
| *Centers Funding (total)* | *0.25* | *0.25* | *0.25* | - | - |
| *Nanoscale Science & Engineering Centers* | *0.25* | *0.25* | *0.25* | - | - |
| **Education** | **21.82** | **18.57** | **18.57** | **-** | **-** |
| **Infrastructure** | **19.78** | **0.60** | **0.50** | **-0.10** | **-16.7%** |
| *Nat'l Nanotechnology Infrastructure Network* | *0.60* | *0.60* | *0.50* | *-0.10* | *-16.7%* |
| *Research Resources* | *19.18* | - | - | - | *N/A* |

Totals may not add due to rounding.

ICER supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts. In FY 2013, the division will make strategic investments in climate research, international activities, education, diversity, and human resource development.

In general, 53 percent of the ICER portfolio is available for new research grants. The remaining 47 percent funds continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- ICER will support GEO's increased activities in Science, Engineering, and Education for Sustainability (SEES). Supported activities will lay the foundation for technologies to mitigate against, and adapt to, environmental change that threatens sustainability, with an emphasis in 2013 on vulnerable regions in the Arctic and along coasts. ICER will participate in activities to establish a robust suite of Sustainability Research Networks and in a program to identify clean energy sources and the impact of using those sources on the environment and society. FY 2013 SEES activities in ICER will total $16.75 million.
- ICER supports a varied portfolio of international collaborative activities. In FY 2013, this will total $6.50 million, and emphasize collaborative research across the Americas.

**Education**

- ICER is home to a number of cross-GEO education and diversity activities. This portfolio will total $18.57 million in FY 2013, including robust investment in the NSF-wide $E^2$ activity.

**Infrastructure**

- ICER provides GEO's contribution to the National Nanotechnology Infrastructure Network, decreasing $100,000, to a total of $500,000.

## DIVISION OF OCEAN SCIENCES (OCE)

**$361,970,000**
**+$10,070,000 / 2.9%**

**OCE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, OCE** | **$352.21** | **$351.90** | **$361.97** | **$10.07** | **2.9%** |
| **Research** | **177.92** | **183.21** | **195.70** | **12.49** | **6.8%** |
| *CAREER* | *1.58* | *2.80* | *2.93* | *0.13* | *4.6%* |
| *Centers Funding (total)* | *8.92* | *9.00* | *9.00* | - | - |
| *Coastal Margin Observation and Prediction* | *4.00* | *4.00* | *4.00* | - | - |
| *Dark Energy Biosphere Investigations* | *4.92* | *5.00* | *5.00* | - | - |
| **Education** | **9.01** | **7.94** | **8.47** | **0.53** | **6.7%** |
| **Infrastructure** | **165.28** | **160.75** | **157.80** | **-2.95** | **-1.8%** |
| *Academic Research Fleet* | *81.67* | *78.75* | *73.00* | *-5.75* | *-7.3%* |
| *Integrated Ocean Drilling Program* | *53.35* | *44.40* | *38.90* | *-5.50* | *-12.4%* |
| *Ocean Observatories Initiative* | *15.49* | *26.80* | *40.10* | *13.30* | *49.6%* |
| *Research Resources* | *14.77* | *10.80* | *5.80* | *-5.00* | *-46.3%* |

Totals may not add due to rounding.

Research, education, and infrastructure funded by OCE address the central role of the oceans in a changing Earth and as a national strategic resource, as recognized in the President's 2010 Executive Order establishing a National Ocean Policy (NOP) and creating a National Ocean Council (NOC) to implement the policy and its nine strategic objectives. OCE supports interdisciplinary research on the water column to better understand changing ocean circulation and temperature, the health of marine ecosystems, and changing ocean chemistry with implications for ocean acidification. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate past ocean and climate conditions, stability of methane hydrates, natural hazards associated with earthquakes and volcanic eruptions, and microbial life deep below the seafloor. Ocean education, formal and informal, draws on the interdisciplinary nature of ocean sciences, sophisticated visualization capabilities, and the impact of the oceans on environmental change. Since ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically advanced sensors and instrumentation. In FY 2013, OCE will allocate $54.0 million to emphasize research in support of the NOP objectives, especially those involving improved understanding through the advancement of knowledge, ecosystem-based management, coastal marine spatial planning, protection of marine biodiversity, the impact of increased atmospheric CO2 on ocean acidification, ocean observing and the enhancement of infrastructure, and changing conditions in the Arctic.

In general, 33 percent of the OCE portfolio is available for new research grants. The remaining 67 percent funds continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- OCE's research budget will increase moderately by $12.49 million, which includes a $2.0 million investment ($1.0 million above the FY 2012 Estimate) in NSF's INSPIRE program, which should be attractive to interdisciplinary ocean scientists. OCE will give high priority to research themes that emerge from both the NOP and the NSF SEES program. There are many crossovers between the NOP and SEES objectives as they relate to the oceans. These themes include ocean acidification, addressing the role of the oceans in climate change, the integration of marine ecosystem models with climate change models, interactions between warming oceans and ice-sheets, dimensions of biodiversity, and others.
- In FY 2013 a refreshed Ocean Research Priorities Plan and Implementation Strategy (ORPPIS) will be released by the Office of Science and Technology Policy (OSTP) Subcommittee on Ocean Science and Technology (SOST). OCE will give priority to the research areas identified in the new plan.
- OCE will invest $6.0 million in the new SEES Coastal program. It is expected that much of the new research called for by the NOP will be supported through this initiative.
- OCE will provide $4.50 million for a new GEO program, Creating a More Disaster Resilient America (CaMRA), to support research programs and facilities involving severe storms, tsunamis, long term effects of oil spills, and biotic hazards (e.g., harmful algal blooms (HABs), invasive species).
- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) will be supported at $2.70 million in FY 2013. OCE will contribute to this NSF-wide initiative by supporting research on geoinformatics, EarthCube, and the enhancement of access and connections to facilities and scientific instruments emerging from national data- and computation-intensive facilities such as the Ocean Observatories Initiative (OOI).
- The Center for Dark Energy Biosphere Investigations (C-DEBI) will be level funded at $5.0 million. This Center uses the highly advanced technologies of the Integrated Ocean Drilling Program (IODP) to pursue exploration of the nature and limits of life in the largest biome on earth.
- The division will continue to partner with OPP, BIO, and other agencies to fulfill priority research recommendations on the biological, ecosystem, and chemical processes involved with decreasing ocean pH and impacts to important marine resources. Divisional investments will be $6.0 million in FY 2013.

**Education**

- Funding for educational activities will increase slightly and will emphasize initiatives emerging from the NOP that aim to improve public understanding of the oceans, encourage broader participation, and provide additional opportunities for research experiences at the undergraduate level.
- Funding is provided for continuation of a program initiated in FY 2012, OCE Postdoctoral Fellowship and Research Facilitation Awards. This program aims to broaden participation in the ocean sciences through fellowships and research support to enhance opportunities for women and minority scientists.
- Funding for the COSEE program continues at a level of $3.24 million, representing a reduction of $1.0 million from FY 2012.
- Support for REU programs and other research experience activities will rise by $1.10 million.

**Infrastructure**

- Ongoing investment in fleet renewal will include $1.0 million for Regional Class Research Vessels (RCRVs) conceptual design and development activities as a potential future project. The Academic Research Fleet operations will be reduced by $4.75 million due to the completion of support for the replacement of the RHOV *Alvin* and from savings expected from increased efficiencies resulting from fleet coordination planning in concert with other federal agencies and the expected retirement of the R/V *Wecoma*.

- A $13.30 million increase for continued implementation of the Ocean Observatories Initiative (OOI) will bring the total for operations and maintenance to $40.10 million in FY 2013. These increased funds support the transition from the design phase to an active network build and deploy phase.
- Continued support of $38.90 million, a decrease of $5.50 million, is requested for the Integrated Ocean Drilling Program to continue to operate the drilling vessel *Joides Resolution.* FY 2013 is the final year of the current decadal program, with the potential for a new program beginning in FY 2014 currently under review. In FY 2013, NSF investments in IODP will be increasingly leveraged by support from international partners and industry.

## DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

**$1,345,180,000**
**+$36,240,000 / 2.8%**

**MPS Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Division of Astronomical Sciences (AST) | $236.78 | $234.55 | $244.55 | $10.00 | 4.3% |
| Division of Chemistry (CHE) | 233.55 | 234.06 | 243.85 | 9.79 | 4.2% |
| Division of Materials Research (DMR) | 294.91 | 294.55 | 302.63 | 8.08 | 2.7% |
| Division of Mathematical Sciences (DMS) | 239.79 | 237.77 | 245.00 | 7.23 | 3.0% |
| Division of Physics (PHY) | 280.34 | 277.37 | 280.08 | 2.71 | 1.0% |
| Office of Multidisciplinary Activities (OMA) | 27.06 | 30.64 | 29.07 | -1.57 | -5.1% |
| **Total, MPS** | **$1,312.42** | **$1,308.94** | **$1,345.18** | **$36.24** | **2.8%** |

Totals may not add due to rounding.

## About MPS

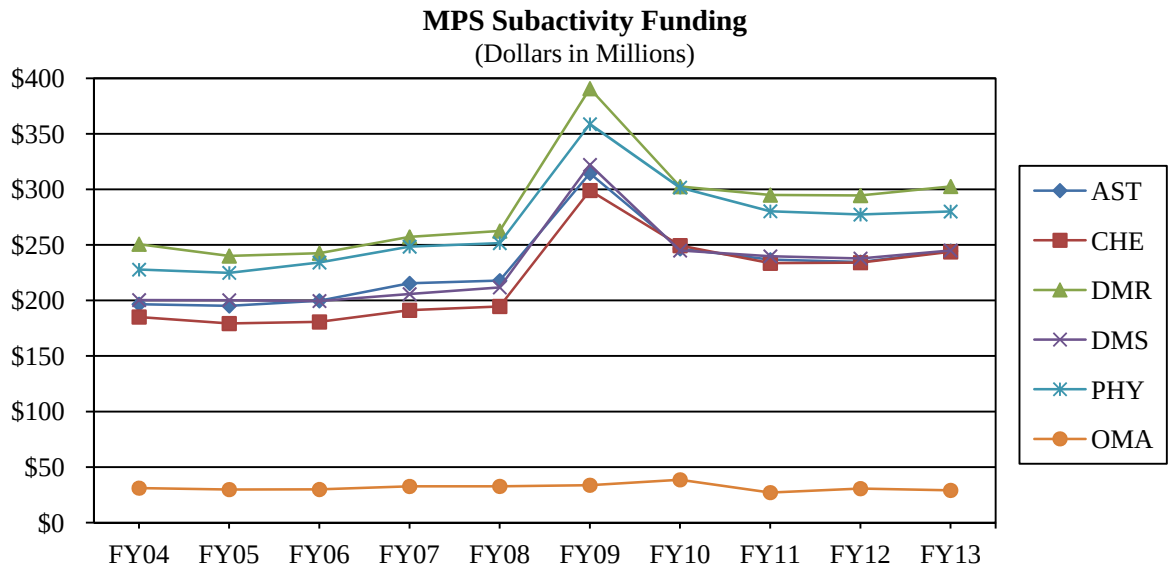
The Directorate for Mathematical and Physical Sciences (MPS) request of $1,345.18 million embodies the integrative OneNSF framework for FY 2013. Building on a foundation of robust scientific disciplines represented by its five divisions, MPS activities will address cutting-edge challenges in science and education through innovative investments and efficient organizational practices. MPS will focus on three key priorities: (1) *transforming frontiers* by strengthening innovation in basic research programs, by participating in re-envisioned interdisciplinary and educational programs including INSPIRE and Expeditions in Education ($E^2$), and by facilitating a highly integrative, computational and data-enabled approach to Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21); (2) *innovating for society* by providing funding for targeted basic research areas, including a new Sustainable Chemistry, Engineering, and Materials (SusChEM) effort under the NSF-wide Science, Engineering, and Education for Sustainability (SEES) investment area, the national Materials Genome Initiative through a new effort in Designing Materials to Revolutionize and Engineer our Future (DMREF) under the NSF-wide Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) investment area, the interface between biological and mathematical and physical sciences (BioMaPS), Enhancing Access to the Radio Spectrum (EARS), as well as directly feeding the innovation ecosystem by participating in the I-Corps program; and (3) *supporting essential facilities* for basic science.

A principal driver of the FY 2013 allocation is funding for core research programs, with all MPS divisions making substantial investments. These awards drive new discoveries in the mathematical and physical sciences, directly strengthening the building blocks of innovation. The MPS commitment to core research strengthens science, seeds longer-term innovation, and develops the foundation for translational activities in NSF as well as other agencies, industry, and society. MPS has reduced funding for the Office of Multidisciplinary Activities (OMA) to enhance core research programs in the MPS divisions.

MPS continues to fund the operations and management of 14 major multi-user facilities, allowing thousands of scientists and students to press the bounds of scientific knowledge, and to invest in potential future projects needed to remain at the cutting-edge of research, such as the Large Synoptic Survey

Telescope (LSST), which would rapidly scan the sky, charting objects that change or move and tracing billions of remote galaxies, providing multiple probes of the mysterious dark matter and dark energy.

MPS provides about 51 percent of the federal funding for basic research at academic institutions in the mathematical and physical sciences.




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary by Division

- AST's FY 2013 Request will provide support for individual investigator awards, astronomical observatories, and increased investment in the NSF priority areas of EARS and CIF21. Funding for individual research is balanced against funding for facilities, and among facilities, increased support for ALMA and LSST is requested.

- CHE's FY 2013 Request is focused on enhancing support for core programs and instrumentation, and features the launch of SusChEM, in response to the America COMPETES Reauthorization Act of 2011, as an important new thrust in the NSF-wide SEES investment. SusChEM will fund research in sustainable chemistry, and increased funding for Centers for Chemical Innovation (CCI) will provide a SusChEM focus to this program.

- DMR's FY 2013 Request includes plans to increase its portfolio of individual investigator awards, specifically in NSF focus areas where advanced materials are key such as SEES through SusChEM, BioMaPS, and CEMMSS through DMREF. The latter is initiated this year to support the national Materials Genome Initiative. Centers and facilities receive enhanced funding as well.

- DMS's FY 2013 Request is focused on enhancing support for frontier research, training a diverse group of researchers in mathematical and statistical sciences with computational skills, investing in mathematical sciences institutes and network structures, and providing support through efficient mechanisms to foster multidisciplinary research activities in, but not limited to, CIF21, SEES, BioMaPS, CEMMSS, and Secure and Trustworthy Cyberspace (SaTC).

- PHY's FY 2013 Request includes continued support for individual investigator awards, particularly those in NSF-wide priority areas such as CIF21 and BioMaPS, as well as divisional priorities such as quantum information science. PHY also requests sufficient funding for investigators using its major facilities, and for operations and maintenance of these facilities.

- OMA will continue its tradition of providing support for multidisciplinary research and activities in education and broadening participation. OMA will emphasize key NSF priorities such as SEES, CIF21, BioMaPS, and CEMMSS. OMA will coordinate MPS activities related to I-Corps and INSPIRE.

## Major Investments

**MPS Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| Advanced Manufacturing | $23.42 | $32.15 | $40.00 | $7.85 | 24.4% |
| BioMaPS | 3.37 | 7.69 | 11.60 | 3.91 | 50.8% |
| CAREER | 66.08 | 54.02 | 56.74 | 2.72 | 5.0% |
| CEMMSS | - | 32.15 | 50.00 | 17.85 | 55.5% |
| CIF21 | - | 11.50 | 19.55 | 8.05 | 70.0% |
| Clean Energy Technology | 132.00 | 137.31 | 137.31 | - | - |
| $E^2$ | - | - | 5.00 | 5.00 | N/A |
| EARS | 0.03 | 3.00 | 12.00 | 9.00 | 300.0% |
| I-Corps | 0.20 | 1.00 | 1.30 | 0.30 | 30.0% |
| INSPIRE | - | 3.00 | 7.00 | 4.00 | 133.3% |
| SEES | 2.72 | 16.50 | 27.20 | 10.70 | 64.8% |
| SaTC | - | 0.50 | 2.00 | 1.50 | 300.0% |

Major investments may have funding overlap and thus should not be summed.

- Advanced Manufacturing: MPS funding will be $40.0 million. These investments will be made in the areas of nanomanufacturing, industry/university partnerships, BioMaPS, DMREF, and Centers programs. Advanced manufacturing is an area of continued growth, especially in light of the heightened emphasis on sustainability (via SusChEM).

- BioMaPS: MPS support for BioMaPS will increase by 50.8 percent in FY 2013 to $11.60 million. The study of biological complexity necessitates new developments in mathematical and physical sciences, leading to new theoretical and experimental approaches. Interdisciplinary efforts in partnership with the Directorates for Biological Sciences (BIO) and Engineering (ENG) will result in accelerated understanding of biological systems, as well as uncovering of new mathematical and physical concepts, leading to innovations in such areas as renewable fuels, bio-based materials, bio-imaging, and bio-inspired sensors.
- CAREER: MPS continues its strong commitment to early career faculty development. CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations. MPS expects to make approximately 125 CAREER awards in FY

2013. The purpose and scope of the CAREER program varies across the cultures of the five MPS Divisions. In some disciplinary communities a CAREER award is a widely accepted mechanism for developing new faculty, while in others it is an honor reserved for a few exceptionally meritorious young scientists.

- CEMMSS: In partnership with ENG and the Directorate for Computer and Information Science and Engineering (CISE), MPS will launch the new CEMMSS investment area with an initial focus on Designing Materials to Revolutionize and Engineer our Future, in support of the national Materials Genome Initiative. This is a major new effort to design and synthesize materials with specific and desired functions or properties through synergistic integration of theory and computation, experiment, and data mining.

- CIF21: MPS support for this NSF-wide investment will nearly double in FY 2013 to $19.55 million. All Divisions in MPS will contribute to computational and data-enabled science and engineering activities, including fundamental mathematical algorithms, software, data services, and network infrastructure needed to serve scientists wherever they are located.

- Clean Energy Technology: MPS investment remains constant in FY 2013. The support is focused in core program research in fuel cells, solar research and development, hydrocarbon conversion, and energy storage.

- Expeditions in Education ($E^2$): All MPS Divisions will contribute to this new NSF-wide priority area through strategic partnerships with the Directorate for Education and Human Resources (EHR).

- EARS: MPS will quadruple its support in FY 2013 to $12.0 million for the basic research that underpins EARS, an on-going partnership with ENG, CISE, and the Directorate for Social, Behavioral, and Economic Sciences (SBE). The MPS investment will concentrate on the materials science, radio frequency interference mitigation, advanced receiver design, and mathematical foundations of radio spectrum access and hardware design, as well as key national and international regulatory and public policy foundations for radio spectrum management.

- I-Corps: MPS will increase its investment in the NSF-wide I-Corps program to $1.30 million in FY 2013 to stimulate innovative industrial partnerships.

- INSPIRE: All MPS Divisions will contribute to this NSF-wide priority area, which supports transformative, high risk, interdisciplinary research. MPS will increase its investment from $3.0 million to $7.0 million in FY 2013.

- SEES: MPS will increase its investment in SEES by $10.70 million to a total of $27.20 million to support the new SusChEM activity. Existing programs, including centers as well as core programs, will be re-focused to support sustainable chemistry, engineering, and materials, in response to the America COMPETES Reauthorization Act of 2011.

- SaTC: MPS will partner with CISE in launching SaTC in FY 2013, to support frontier research needed to keep the Nation's data confidential and transactions secure.

## MPS Funding for Centers Programs and Facilities

**MPS Funding for Centers Programs**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$104.11** | **$78.72** | **$90.47** | **$11.75** | **14.9%** |
| Centers for Analysis & Synthesis (DMS, OMA) | 0.10 | 0.20 | 0.10 | -0.10 | -50.0% |
| Centers for Chemical Innovation (CHE) | 26.28 | 24.00 | 29.25 | 5.25 | 21.9% |
| Materials Centers (DMR) | 61.33 | 44.35 | 51.20 | 6.85 | 15.4% |
| Nanoscale Science & Engineering Centers (CHE, DMR, PHY) | 7.12 | 6.17 | 5.92 | -0.25 | -4.1% |
| Science & Technology Centers (DMR, PHY) | 9.28 | 4.00 | 4.00 | - | - |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Centers for Analysis and Synthesis: Funding (-$100,000 to a total of $100,000) will extend support for a sixth year to the National Institute for Mathematical and Biological Synthesis, a Center for Analysis and Synthesis primarily managed by BIO.

- Centers for Chemical Innovation: The CCI program, which inspires research on strategic, transformative "grand challenges" in chemical research, increases by $5.25 million to $29.25 million. CCI awards are strengthened by direct links to chemical industry and governmental laboratories, which encourage successful transitions from the lab to innovation to societal applications.

- Materials Centers: In FY 2013, DMR requests an increase of $6.85 million to a total of $51.20 million for the Materials Centers, an interdisciplinary vehicle for increasing materials research and educating students.

- Nanoscale Science & Engineering Centers: DMR is slightly decreasing (-$250,000) its investment in FY 2013 bringing MPS' total investment to $5.92 million.

**MPS Funding for Facilities**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Facilities (Total)** | **$262.13** | **$260.24** | **$263.01** | **$2.77** | **1.1%** |
| Arecibo Observatory | 6.19 | 5.50 | 5.00 | -0.50 | -9.1% |
| Advanced Technology Solar Telescope (ATST) | 2.00 | 2.00 | 2.00 | - | - |
| Atacama Large Millimeter Array (ALMA) | 23.28 | 28.61 | 32.92 | 4.31 | 15.1% |
| Cornell High Energy Synchr. Source (CHESS) | 14.12 | 19.67 | 20.00 | 0.33 | 1.7% |
| GEMINI Observatory | 19.50 | 22.07 | 18.15 | -3.92 | -17.8% |
| IceCube Neutrino Observatory (IceCube) | 3.45 | 3.45 | 3.45 | - | - |
| Large Hadron Collider (LHC) | 18.00 | 18.00 | 18.00 | - | - |
| Laser Interfer. Grav. Wave Observatory (LIGO) | 30.30 | 30.40 | 30.50 | 0.10 | 0.3% |
| Nat'l High Magnetic Field Laboratory (NHFML) | 32.68 | 25.80 | 31.75 | 5.95 | 23.1% |
| Nat'l Nanotechnology Infra. Network (NNIN) | 3.38 | 2.98 | 2.58 | -0.40 | -13.4% |
| Nat'l Optical Astronomy Observatory (NOAO) | 29.50 | 25.50 | 25.50 | - | - |
| Nat'l Radio Astronomy Observatory (NRAO) | 44.27 | 43.14 | 41.00 | -2.14 | -5.0% |
| National Solar Observatory (NSO) | 9.10 | 9.10 | 8.00 | -1.10 | -12.1% |
| Nat'l Superconducting Cyclotron Lab (NSCL) | 21.50 | 21.50 | 21.50 | - | - |
| Other MPS Facilities[1] | 4.86 | 2.52 | 2.66 | 0.14 | 5.6% |

Totals may not add due to rounding.

[1] Other MPS Facilities are the Center for High Resolution Neutron Scattering (CHRNS) and the Chemistry and Materials Consortium for Advanced Radiation Sources (ChemMatCARS) for all years, and the Synchroton Radiation Center (SRC) for FY 2011 only.

For detailed information on individual facilities, please see the Facilities chapter.

- ALMA: FY 2013 support (+$4.31 million to a total of $32.92 million) is consistent with a planned ramp-up of operations as this observatory comes on line and continues early science activities.

- Gemini: FY 2013 support (-$3.92 million to $18.15 million) is primarily for observatory operations and maintenance, reflecting the international partner agreement, with a decreased contribution to the long-term instrumentation fund.

- Arecibo: Funding for the Arecibo radio telescope decreases (-$500,000 to a total of $5.0 million), with additional funding supplied from the Division of Atmospheric and Geospace Sciences in the Directorate for Geosciences (GEO/AGS) and NASA. A collaboration led by SRI International took over Arecibo management in FY 2012 as the result of a management recompetition.

- Funding for NHMFL (+$5.95 million to a total of $31.75 million) returns the activity to previous funding levels. The FY 2012 Estimate appears lower as it reflects forward funding of activities in prior years.

- Funding for NNIN (-$400,000 to a total of $2.58 million) as CHE follows a planned phase-out of its funding.

- NRAO: Funding in FY 2013 is reduced (-$2.14 million to $41.0 million) as part of the budget realignment plan to support ALMA operations.

- NSO: Funding (-$1.10 million to $8.0 million) assumes that closure of one or more current facilities begins in FY 2012 and is concluded in FY 2013, as planned for a long-term transition to the Advanced Technology Solar Telescope (ATST).

## Summary and Funding Profile

MPS supports investment in core research and education as well as research infrastructure such as centers and facilities.

In FY 2013 MPS will spend $90.47 million for Centers, accounting for 6.7 percent of the MPS budget. This total is up from FY 2012, as MPS is increasing its investments in the Centers for Chemical Innovation and Materials Centers. Centers are an important modality for MPS sciences as research in many MPS-supported disciplines has evolved to be more collaborative and interdisciplinary.

Operations and maintenance funding for MPS-supported user facilities comprises 19.6 percent of MPS's FY 2013 Request. MPS has increased operations budgets for facilities to maintain current operational capacity. Where increases were not possible, MPS has maintained operations budgets as close to constant as possible.

**MPS Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 8,798 | 9,000 | 9,200 |
| Number of New Awards | 2,355 | 2,355 | 2,375 |
| Funding Rate | 27% | 26% | 26% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 7,387 | 7,500 | 7,650 |
| Number of Research Grants | 1,813 | 1,813 | 1,830 |
| Funding Rate | 25% | 24% | 24% |
| Median Annualized Award Size | $110,000 | $110,000 | $110,000 |
| Average Annualized Award Size | $136,805 | $139,000 | $140,000 |
| Average Award Duration, in years | 3.1 | 3.1 | 3.1 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):

- In 2011, COVs reviewed AST and DMR. The COVs presented their reports to the MPS Advisory Committee, which convened in April and November of 2011. Recommendations from the DMR

COV included a review of the instrumentation and facilities portfolio, which is now underway as a subcommittee of the MPS Advisory Committee ("Materials 2022"). AST has also constituted a subcommittee of the MPS Advisory Committee to carry out a complete portfolio review.

- In 2012, a COV will review PHY.
- In 2013, COVs will review CHE and DMS.

Workshops and Reports:

- CHE sponsored a 2011 workshop on "Basic Research to Advance Sustainable Chemistry" hosted by the National Research Council Board on Chemical Sciences and Technology. The workshop was organized around four panels that discussed sustainable chemistry challenges in specific industrial sectors (electronics and telecommunications; traditional chemical industry; pharmaceuticals; and consumer products). The themes emerging from the workshop informed the division in strategizing FY 2013 investments in sustainable chemistry.
- CHE is planning to increase its focus on the development of graduate education in the chemical sciences. On January 23/24, 2012, the Board on Chemical Sciences and Technology (BCST) of the National Research Council will conduct a workshop to examine graduate education in chemistry in the context of current societal challenges and employment opportunities for Ph.D. chemists. The BCST will convene stakeholders from academe, industry, and government to discuss these issues and issue a summary report.
- CHE has requested that the American Chemical Society convene a Presidential Commission on Graduate Education in the Chemical Sciences to consider issues that affect the recruitment, retention, and development of high-quality graduate students. The goal of the Commission's work will be to identify a small number of innovative models for graduate education in the chemical sciences that will help CHE strategize investments in FY 2013.

Science and Technology Policy Institute (STPI) Reports and Evaluations:

- In FY 2012, DMS is conducting a STPI study to develop a strategy for evaluation of the mathematical sciences research institutes at the portfolio level.

Program Evaluations:

- In FY 2012, AST initiated a full portfolio review through a subcommittee of the MPS Advisory Committee. Final results from this study are expected during FY 2012.
- In FY 2012, DMR initiated a review of its instrumentation and facilities portfolio, "NSF Materials 2022," as a subcommittee of the MPS Advisory Committee. Final results from this study are expected during FY 2012.

**Number of People Involved in MPS Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 9,073 | 9,070 | 9,100 |
| Other Professionals | 2,785 | 2,780 | 2,800 |
| Postdoctorates | 2,362 | 2,370 | 2,380 |
| Graduate Students | 9,078 | 9,080 | 9,100 |
| Undergraduate Students | 6,782 | 6,780 | 6,800 |
| K-12 Teachers | - | - | - |
| K-12 Students | - | - | - |
| **Total Number of People** | **30,080** | **30,080** | **30,180** |

## DIVISION OF ASTRONOMICAL SCIENCES (AST) $244,550,000
**+$10,000,000 / 4.3%**

**AST Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, AST** | **$236.78** | **$234.55** | **$244.55** | **$10.00** | **4.3%** |
| **Research** | **65.52** | **73.23** | **83.86** | **10.63** | **14.5%** |
| *CAREER* | *4.28* | *4.30* | *4.60* | *0.30* | *7.0%* |
| **Education** | **6.14** | **6.65** | **5.80** | **-0.85** | **-12.8%** |
| **Infrastructure** | **165.12** | **154.67** | **154.89** | **0.22** | **0.1%** |
| *Adv. Technology Solar Tel. (ATST)* | *2.00* | *2.00* | *2.00* | - | - |
| *Arecibo Observatory* | *6.19* | *5.50* | *5.00* | *-0.50* | *-9.1%* |
| *Atacama Large Mm Array (ALMA)* | *23.38* | *28.61* | *32.92* | *4.31* | *15.1%* |
| *Gemini Observatory* | *19.50* | *22.07* | *18.15* | *-3.92* | *-17.8%* |
| *Nat'l Optical Astron. Obs. (NOAO)* | *29.50* | *25.50* | *25.50* | - | - |
| *Nat'l Radio Astron. Obs. (NRAO)* | *44.27* | *43.14* | *41.00* | *-2.14* | *-5.0%* |
| *Nat'l Solar Observatory (NSO)* | *9.10* | *9.10* | *8.00* | *-1.10* | *-12.1%* |
| *Pre-Construction Planning (Total)* | *5.31* | *4.75* | *7.75* | *3.00* | *63.2%* |
| *Giant Segmented Mirror Telescope (GSMT)* | - | *0.25* | *0.25* | - | - |
| *Large Synoptic Survey Telescope (LSST)* | *5.31* | *4.50* | *7.50* | *3.00* | *66.7%* |
| *Research Resources* | *25.87* | *14.00* | *14.57* | *0.57* | *4.1%* |

Totals may not add due to rounding.

AST is the federal steward for ground-based astronomy in the U.S., working in partnership with private institutions to enhance overall observing capacity and capability. Funding covers research to understand the origins and characteristics of planets, stars, and galaxies, as well as the structure and origin of the Universe through awards to individual investigators, small groups, and national facilities. AST supports the development of advanced technologies and instrumentation, the planning and design of future facilities, and management of the electromagnetic spectrum for scientific use. AST funds operations and maintenance for several world-class national and international facilities, which provide access to a wide range of observational resources on a competitive basis and serve thousands of users each year. In 2010, the National Academy of Sciences released a decadal survey report recommending a comprehensive ground-based astronomy program for the coming decade. In anticipation of funding that is more constrained than assumed in that report, AST is carrying out a community-based review of its entire portfolio in order to maximize the delivery of the recommended science. It is expected that this review will be completed during FY 2012, and its output will be used to inform FY 2013 budget execution and future budget requests.

Approximately 57 percent of AST's budget is used to support current operations and future development of large multi-user astronomy facilities, while 33 percent supports individual investigator grants and 6 percent supports the development and operation of advanced instrumentation and experiments based on such instrumentation. In general, about 19 percent of the AST budget is available for new research grants, while the remainder funds long-term facilities and continuing awards for grants made in previous years.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Enhancing Access to the Radio Spectrum (EARS) increases +$9.0 million, to a total of $12.0 million. AST is the home of radio spectrum management for the entire NSF, and is where the EARS program was founded. The AST EARS investment will concentrate on the radio-frequency-interference mitigation, advanced receiver design, propagation studies, and other radio-astronomy-related foundations of radio spectrum access and hardware design, as well as key national and international regulatory and public policy foundations for radio spectrum management.
- Cyberinfrastructure Framework for the 21st Century (CIF21) increases by +$1.48 million to $3.18 million; this includes $1.50 million to initiate the Theory and Computation Networks recommendation of the decadal survey, in collaboration with NASA.
- Other grants programs, including the Astronomy and Astrophysics Research Grants, remain approximately constant in the FY 2013 request. This stability is enabled by spending reductions in the AST facility infrastructure (see below), which have been made to support the AST commitment to maintaining the individual research that is critical to advancement in the field.

**Education**

- The reduction ($-850,000 to $5.80 million) reflects a cessation in contributions to funding of the ADVANCE program, in order to maintain the Research Experiences for Undergraduates (REU) and Astronomy and Astrophysics Postdoctoral Fellowship programs funded by AST.
- AST maintains its commitment to diversity through its Partnerships in Astronomy and Astrophysics Research and Education program, advancing the opportunities through institutions that historically serve under-represented minorities.

**Infrastructure**

AST oversees an array of infrastructure projects and programs. Reductions in facility funding reflect the maintenance of funding balance between facilities and individual research. Future trends for these facilities will depend critically on the results of the ongoing AST portfolio review, described above. For detailed information on individual AST facilities, please see the Facilities chapter.

- Gemini: FY 2013 support (-$3.92 million to $18.15 million) is primarily for observatory operations and maintenance, reflecting the international partner agreement, with a decreased contribution to the long-term instrumentation fund.
- ALMA: FY 2013 support (+$4.31 million to a total of $32.92 million) is consistent with a planned ramp-up of operations as this observatory comes on line and continues early science activities.
- Arecibo: Funding for the Arecibo radio telescope decreases (-$500,000 to a total of $5.0 million), with additional funding supplied from GEO/AGS and NASA. A collaboration led by SRI International took over Arecibo management in FY 2012 as the result of a management recompetition.
- NOAO: Funding in FY 2013 is the same as in FY 2012, pending the results of the ongoing AST portfolio review.
- NRAO: Funding in FY 2013 is reduced (-$2.14 million to $41.0 million) as part of the budget realignment plan to support ALMA operations.
- NSO: Funding (-$1.10 million to $8.0 million) assumes that closure of one or more current facilities begins in FY 2012 and is concluded in FY 2013, as planned for a long-term transition to the Advanced Technology Solar Telescope (ATST).
- ATST Operations: Funding is constant at $2.0 million, to mitigate effects of construction in Hawaii.
- LSST: Design and development (D&D) funding increases (+$3.0 million to $7.50 million) in the

wake of the successful NSF Preliminary Design Review and coordinated DOE camera review, for this top-ranked ground-based project in the decadal survey. This support covers enhanced systems management, continued work on critical data management issues, and improved project management and quality assurance, which were recommended by the reviews, and other D&D that will reduce the risk before a potential construction start. NSF expects DOE to request continued D&D and preliminary camera fabrication and integration support.

- GSMT: Funding initiated ($250,000) for a new solicitation for planning for a potential partnership solicitation.
- Research Resources: Funding growth (+$570,000 to a total of $14.57 million) reflects planned commitments to existing mid-scale experiment and instrumentation projects, together with a decrease (-$500,000 to $8.50 million) for the Advanced Technology and Instrumentation program.

## DIVISION OF CHEMISTRY (CHE)

**$243,850,000**
**+$9,790,000 / 4.2%**

**CHE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, CHE** | **$233.55** | **$234.06** | **$243.85** | **$9.79** | **4.2%** |
| **Research** | **209.14** | **224.07** | **225.46** | **1.39** | **4.2%** |
| *CAREER* | *24.24* | *21.38* | *22.28* | *0.90* | *4.2%* |
| *Centers Funding (total)* | *25.58* | *24.15* | *29.40* | *5.25* | *21.7%* |
| *Centers for Chemical Innovation* | *24.28* | *24.00* | *29.25* | *5.25* | *21.9%* |
| *Nanoscale Science & Engineering Centers* | *1.30* | *0.15* | *0.15* | *-* | *-* |
| **Education** | **11.87** | **6.95** | **7.50** | **0.55** | **7.9%** |
| **Infrastructure** | **12.54** | **3.04** | **10.89** | **7.85** | **258.2%** |
| *Nat'l Nanotechnology Infrastructure Network* | *0.40* | *0.40* | *-* | *-0.40* | *-100.0%* |
| *NHMFL* | *1.50* | *1.50* | *1.75* | *0.25* | *16.7%* |
| *Research Resources* | *10.24* | *1.14* | *9.14* | *8.00* | *701.8%* |

Totals may not add due to rounding.

CHE supports a large and vibrant research community engaged in fundamental research linked to key national priorities. Basic research supported by CHE will enable research in sustainability in general and sustainable chemistry in particular, providing molecules and materials that are essential to our economy and well-being. CHE strongly supports research at the interface of biology and chemistry. Chemistry's programs invite research in catalysis for power generation and storage as well as to enable the formation of new chemical bonds, appreciation of and insight into the chemistry of life processes, new nanostructured materials that will revolutionize electronics and photonics, and better awareness of how nanosized aerosols and particles impact our environment. In addition, CHE supports research that leads to increased understanding of molecules and materials and their chemical transformation and the development of new instrumentation to study and detect molecules.

Approximately 72 percent of CHE's budget is used to support individuals and small groups of researchers, about 8 percent of the budget goes to instrumentation, 11 percent to facilities and centers, and the remainder goes to education and outreach. About 47 percent of CHE's budget is targeted at new awards, and the remainder toward continuing grant increments. A small percentage (less than one percent) provides review panel support.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- An increase (+$1.39 million to a total of $225.46 million) for core research programs will enable greater support of projects at the frontier of chemistry, including strategic investments in SEES, (specifically initiating SusChEM), CIF21, CEMMSS, (specifically initiating DMREF), and BioMaPS.
- CAREER: This program is particularly important to the development of strong academic departments and the training of the next generation of scientists and engineers. CHE has a long and strong tradition in supporting junior researchers through the CAREER program. Funding will remain at 9

percent of the total CHE Request. The planned investment in FY 2013 increases by $900,000 over the FY 2012 estimate to $22.28 million.

- The Centers for Chemical Innovations (CCI) program, which inspires research on strategic, transformative "Grand Challenges" in chemical research, increases by $5.25 million to $29.25 million. CCI awards are strengthened by direct links to chemical industry and governmental laboratories, which encourage successful transitions from the lab to innovation to societal applications. CHE plans to initiate three new Phase I CCIs and fund one Phase II CCI in FY 2013. The Phase II awards will be selected competitively from a pool of Phase I awards and Phase II awards eligible for renewal.

**Education**

- Support will remain constant for the Integrative Graduate Education and Research Traineeship (IGERT) program and increase by $500,000 for Research Experiences for Undergraduates (REU) Sites to a total of $5.0 million.

**Infrastructure**

- NHMFL: Co-funding support increases by $250,000 to $1.75 million. This increase is to offset rising operating expenses for the 21 T magnet, and the staffing that is required to provide full access to the user community.
- Funding for Coherent Light Source (CLS) and ChemMatCARS continues at $400,000 and $740,000, respectively through continuing grant increments.
- Research Resources: The Chemistry Research Instrumentation and Facilities program was suspended in FY 2012 and will restart in FY 2013 at the FY 2011 level of $8.0 million, increasing the overall budget to $9.14 million. The remaining $1.14 million are continuing grant increments to support ChemMatCARS and CLS (see above).

## DIVISION OF MATERIALS RESEARCH (DMR)

**$302,630,000**
**+$8,080,000/ 2.7%**

**DMR Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DMR** | **$294.91** | **$294.55** | **$302.63** | **$8.08** | **2.7%** |
| **Research** | **227.15** | **231.84** | **233.13** | **1.29** | **0.6%** |
| *CAREER* | *21.78* | *18.00* | *18.75* | *0.75* | *4.2%* |
| *Centers Funding (total)* | *72.65* | *53.23* | *59.83* | *6.60* | *12.4%* |
| *Materials Centers* | *61.33* | *44.35* | *51.20* | *6.85* | *15.4%* |
| *Nanoscale Science & Engineering Centers* | *4.66* | *4.88* | *4.63* | *-0.25* | *-5.1%* |
| *STC: Ctr for Layered Polymeric Systems* | *4.00* | *4.00* | *4.00* | - | - |
| *STC: Materials & Devices for InfoTech* | *2.66* | - | - | - | *N/A* |
| **Education** | **10.54** | **9.06** | **9.06** | **-** | **-** |
| **Infrastructure** | **57.22** | **53.65** | **60.44** | **6.79** | **12.7%** |
| *Nat'l Nanotechnology Infrastructure Network* | *2.98* | *2.58* | *2.58* | - | - |
| *CHESS* | *14.12* | *19.67* | *20.00* | *0.33* | *1.7%* |
| *NHMFL* | *31.18* | *24.30* | *30.00* | *5.70* | *23.5%* |
| *Other MPS facilities* | *4.86* | *2.52* | *2.66* | *0.14* | *5.6%* |
| *Research Resources* | *4.11* | *4.58* | *5.20* | *0.62* | *13.5%* |

Totals may not add due to rounding.

[1] Other MPS Facilities are the Center for High Resolution Neutron Scattering (CHRNS) and the Chemistry and Materials Consortium for Advanced Radiation Sources (ChemMatCARS) for all years, and the Synchroton Radiation Center (SRC) for FY 2011 only.

DMR focuses on research aimed at advancing materials discovery and characterization, including condensed matter physics, solid-state chemistry, and the science of materials that are multifunctional, hybrid, electronic, photonic, metallic, superconducting, ceramic, polymeric, biological and nanostructured. DMR awards enable the community to advance understanding of electronic, atomic, and molecular mechanisms and processes that govern macroscale properties so that we can learn how to manipulate and control them, to discover new synthesis and processing strategies that lead to new materials with unique and novel properties, and to discover and to understand new phenomena. The discoveries and advancements transcend traditional scientific and engineering disciplines, and can result in elimination of roadblocks to enabling new technology including those with the goal of sustainability. A key and critical enabler to these scientific advances is the investment in development and support of the materials workforce, and in next-generation instruments and facilities. DMR will continue to educate the public about the benefits enabled by materials research..

In general, 22 percent of the DMR grant portfolio is available for new research grants and 78 percent for continuing grants.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- DMR leads the NSF investment in Designing Materials to Revolutionize and Engineer our Future (DMREF), which is in response to the national Materials Genome Initiative. DMREF, which is part of CEMMSS, is a major effort to accelerate the design and synthesis of new materials with a specific and desired function or property through synergistic integration of theory and computation, experiments, and systematic use of materials data. DMREF was run as a pilot in FY 2012 with the Directorate for Engineering (ENG) divisions of Civil, Mechanical and Manufacturing Innovation (CMMI), Chemical, Bioengineering, Environmental, and Transport Systems (CBET), CHE, and DMS. In FY 2013 DMR's request is +$10.50 million for a total of $10.50 million.
- DMR will participate in the new Sustainable Chemistry, Engineering and Materials (SusChEM), which is part of SEES. DMR's fundamental research in sustainability includes work to enable the capture and utilization of carbon dioxide (for new materials, for example), discovery of new materials withstanding extreme conditions, use of new (non-petroleum based) raw materials as feedstocks for society's materials, and materials synthesis and processing to optimize the use of raw materials, water, chemicals, and energy in an environmentally benign way. In lieu of Sustainable Energy Pathways in FY 2013, DMR will direct $5.0 million and request an additional $2.40 million for a total of $7.40 million for SusChEM.
- In CIF21, DMR will accelerate research, especially related to DMREF, by investing in new functional capabilities in computational methods, algorithms, tools, and data methods and technologies. Through partnership with the Office of Cyberinfrastructure and other NSF divisions, DMR will support these tools at individual investigator to focused research group levels of support, including EAGERs and CREATIVs. DMR requests an increase of $1.48 million for a total of $3.23 million.
- In FY 2013, DMR requests $51.20 million (+$6.85 million) for Materials Centers, an interdisciplinary vehicle for supporting materials research and educating students. No new awards will be made in FY 2013, as the program is competed triennially with the next competition planned for FY 2014. FY 2013 support is for continuing grant increments supporting 23 centers. (For more information, see the Centers narrative in the NSF-Wide Investments tab).

**Education**

- DMR will maintain its investments in REU Sites and Supplements, IGERT, and RET supplements at the FY 2012 Current Plan levels in the FY 2013 Request.
- DMR's focus on Expeditions in Education ($E^2$) will introduce Materials Genome Initiative concepts into student learning.

**Infrastructure**

- Increased funding of +$330,000 (for a total of $20.0 million) is requested for the synchrotron light source, CHESS. This will allow continued operation as a national user facility. The CHESS user program supports work in cancer research, new materials for electronics, aircraft, biotechnology, batteries, fuel cells, solar cells and other energy applications.
- The FY 2013 Request for NHMFL ($30.0 million) will allow the facility to continue operations, focus on magnet development, and strengthen education, training, user support, and in-house research. The FY 2012 Estimate appears lower as it reflects forward funding of activities in prior years. As noted in the Facilities chapter, a 5-year renewal proposal for the operation of the NHMFL beginning in FY 2013 was submitted to NSF in summer 2011 and is currently under review with results expected in summer 2012.
- An increase in DMR support for the Coherent Light Source (CLS) research project (+$620,000 for a total of $5.20 million) is requested as scheduled in the cooperative agreement. Additional funding in FY 2013 is provided by CHE ($400,000) and OMA ($2.0 million) for a total of $7.60 million.

## DIVISION OF MATHEMATICAL SCIENCES (DMS) $245,000,000
**+$7,230,000 / 3.0%**

**DMS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DMS** | **$239.79** | **$237.77** | **$245.00** | **$7.23** | **3.0%** |
| **Research** | **214.10** | **219.11** | **224.17** | **5.06** | **2.3%** |
| *CAREER* | *8.16* | *3.33* | *4.00* | *0.67* | *20.1%* |
| *Centers Funding (total)* | - | *0.10* | *0.10* | - | - |
| *Centers for Analysis & Synthesis* | - | *0.10* | *0.10* | - | - |
| **Education** | **25.69** | **18.66** | **20.83** | **2.17** | **11.6%** |
| **Infrastructure** | **-** | **-** | **-** | - | N/A |

Totals may not add due to rounding.

The National Science Foundation plays a critical role in the mathematical and statistical sciences, as it provides more than sixty percent of all federal support for basic research in the Nation's colleges and universities. In certain core areas of the mathematical sciences this percentage is much higher, since the NSF supports a broader range of fundamental and multidisciplinary research topics than do other federal agencies. DMS supports research at the frontiers of fundamental, applied, and computational mathematics and statistics and also enables discovery and innovation in other fields of science and engineering. In turn, advances in science and engineering, especially those generating big and complex data sets or that are driven by powerful computing environments, require development of ever more sophisticated mathematical and statistical tools. DMS plays a key role in training future researchers in the mathematical and statistical sciences, and in training the Nation's scientific and engineering workforce.

DMS supports core research programs in algebra and number theory; analysis; applied mathematics; computational mathematics; geometry and topology; mathematical biology; probability, combinatorics and foundations; and various areas within statistics. In addition, DMS supports national mathematical and statistical sciences research institutes; training and mentoring of a diverse group of postdoctoral, graduate and undergraduate students; and infrastructure, such as workshops, conferences, and equipment.

Approximately 60 percent of the DMS portfolio is available for new research grants. The remaining 40 percent is used primarily to fund continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Support for CIF21 increases by $3.11 million to a total of $6.41 million. DMS research will focus on mathematical, statistical, and computational sciences, supporting theoretical and methodological developments in mathematics and statistics, the development of new models and algorithms, and visualization methods and computational tools that help solve complex scientific problems involving big and complex data and that enable scientific discovery and innovation. This investment expands upon some existing programs supporting research in the analysis of large data sets, development of

novel algorithms, and new computational methods in mathematics and statistics. It will also support training and networking activities, and help develop new theoretical foundations in mathematics and statistics related to CIF21 goals.

- SEES increases by +$1.0 million to a total of $3.50 million. This activity addresses challenges in climate, sustainability, and energy research and education through data analysis, modeling, and simulation. The investment in SEES will also support effective training and networking opportunities for collaborations among mathematical and statistical scientists and with domain scientists.
- Support for DMREF under the NSF-wide CEMMSS investment area is initiated at a total of $4.50 million. DMS seeks to invest in innovative partnerships between academic mathematical and statistical scientists and other physical scientists, and to support research in Materials by Design as it relates to computational, mathematical, and statistical sciences in CIF21.
- BioMaPS support increases by $980,000 to a total of $2.90 million. DMS will invest in innovative research at the intersection of the mathematical and physical sciences and the biological sciences in a comprehensive new approach to acquire insight into and inspiration from the living world.
- SaTC is initiated at $2.0 million. Addressing the challenges of cybersecurity requires multi-disciplinary expertise in human, statistical, mathematical, computational, and computer sciences. DMS will invest in fundamental research in cryptographic methods, new algorithms, risk assessments, and methods for cybersecurity.
- Support for mathematical and statistical sciences institutes remains at $29.50 million. Eight domestic DMS-supported institutes will continue to catalyze frontier research through an array of varied scientific programs.
- Consistent with this longstanding priority, funding for CAREER will increase (+$670,000 to a total of $4.0 million).

**Education**

- Support for $E^2$ is initiated at $2.0 million. DMS will invest in the training through research involvement of the next generation of mathematicians and statisticians who are highly conversant in computational and data-enabled science and engineering.
- DMS invests in a number of additional education and diversity activities, including the Mathematical Sciences Postdoctoral Research Fellowships (MSPRF), Research Training Groups (RTG), Mentoring through Critical Transition Points (MCTP), and Research Experiences for Undergraduates (REU) programs. Investment in this portfolio increases by +$2.17 million to a total $20.83 million in FY 2013.

## DIVISION OF PHYSICS (PHY)

**$280,080,000**
**+$2,710,000 / 1.0%**

**PHY Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, PHY** | **$280.34** | **$277.37** | **$280.08** | **$2.71** | **1.0%** |
| **Research** | **179.03** | **193.68** | **196.29** | **2.61** | **1.3%** |
| *CAREER* | *7.42* | *7.01* | *7.11* | *0.10* | *1.4%* |
| *Centers Funding (total)* | *3.58* | *1.14* | *1.14* | - | - |
| *Nanoscale Science & Engineering Centers* | *0.96* | *1.14* | *1.14* | - | - |
| *STC: Cntr.for Bio. Sci.&Tech.* | *2.62* | - | - | - | *N/A* |
| **Education** | **9.62** | **5.34** | **5.34** | **-** | **-** |
| **Infrastructure** | **91.69** | **78.35** | **78.45** | 0.10 | 0.1% |
| *Large Hadron Collider (LHC)* | *18.00* | *18.00* | *18.00* | - | - |
| *Laser Interferometer Grav. Wave Obs. (LIGO)* | *30.30* | *30.40* | *30.50* | *0.10* | *0.3%* |
| *Nat'l Superconducting Cyclotron Lab. (NSCL)* | *21.50* | *21.50* | *21.50* | - | - |
| *IceCube* | *3.45* | *3.45* | *3.45* | - | - |
| *DUSEL* | *10.19* | - | - | - | *N/A* |
| *Research Resources* | *8.25* | *5.00* | *5.00* | - | - |

Totals may not add due to rounding.

PHY supports fundamental research addressing frontier areas of physics that lead to the understanding of the make-up of the Universe, from the formation of stars and galaxies to the principles of life processes on earth. This research is spread across a range of physics subfields: atomic, molecular, optical and plasma physics, elementary particle physics, gravitational physics, nuclear physics, particle and nuclear astrophysics, physics of living systems, physics at the information frontier, and theoretical physics. PHY is the primary supporter of all U.S. research in gravitational physics and the leading supporter of fundamental research in atomic, molecular, and optical physics in the U.S. PHY is a major partner with the Department of Energy (DOE) in support of elementary particle physics, nuclear physics, and plasma physics. PHY also has the only U.S. program designed for the support of physics research in living systems. The development of the most advanced cutting-edge computational resources, innovative technology, and new instrumentation is a key part of physics research, and tools developed by the physics community continuously have major impact in other scientific and engineering fields.

In general, 25 percent of the PHY portfolio is available for new research grants. The remaining 75 percent is used primarily to fund continuing grants made in previous years (50 percent) and to support operations and maintenance for four facilities that are a key part of the division portfolio (25 percent): the Laser Interferometer Gravitational Wave Observatory (LIGO), the Large Hadron Collider (LHC), the National Superconducting Cyclotron Facility (NSCL), and Ice Cube.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- An increase of $2.61 million to a total of $196.29 million for Research Grants will enable increased support of projects at the discovery frontiers of physics. Major changes include:
  - Increase of support for programs that support Cyberinfrastructure Framework for 21st Century (CIF21) (+$500,000 to a total of $3.50 million)
  - Increase of funding for programs that support research at the interface between the mathematical and physical sciences and the life sciences (BioMaPS) (+$970,000 to a total of $2.90 million)
  - CAREER funding increases by $100,000 to a total of $7.11 million in FY 2013, reflecting a continued emphasis on fostering career development of junior scientists.

**Education**

- Funding for Research Experiences for Undergraduates (REU) sites remains at the current level of $4.54 million in order to maintain the existing number of sites. PHY's remaining $800,000 investment in Education is for research grant supplements for Research Experiences for Teachers (RET) and REU, equal to the FY 2012 Estimate.

**Infrastructure**

- FY 2013 support for operations of the ATLAS and CMS detectors at the Large Hadron Collider (LHC) during the first period of data-taking remains at the current level ($18.0 million).
- Support for the Laser Interferometer Gravitational Wave Observatory is increased by $100,000 to a total of $30.50 million in accord with the agreed-upon funding profile for operations during the Advanced LIGO construction project. (See the MREFC chapter for more details on Advanced LIGO)
- Support for the National Superconducting Cyclotron Laboratory (NSCL) remains at the current level while design of the proposed new DOE-supported FRIB facility to be built on the NSCL platform continue.
- Funding for IceCube is maintained at $3.45 million as part of the NSB-approved post-construction ramp-up in operations.

## OFFICE OF MULTI-DISCIPLINARY ACTIVITIES (OMA) $29,070,000
**-$1,570,000 / -5.1%**

**OMA Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, OMA** | **$27.06** | **$30.64** | **$29.07** | **-$1.57** | **-5.1%** |
| **Research** | **21.93** | **25.44** | **24.87** | **-0.57** | **-2.2%** |
| *I-Corps* | *0.20* | *1.00* | *1.30* | *0.30* | *30.0%* |
| *Inspire* | *-* | *3.00* | *3.00* | *-* | *-* |
| *Centers Funding (total)* | *2.10* | *0.10* | *-* | *-0.10* | *-100.0%* |
| *Centers for Analysis & Synthesis* | *0.10* | *0.10* | *-* | *-0.10* | *-100.0%* |
| *Centers for Chemical Innovation* | *2.00* | *-* | *-* | *-* | *N/A* |
| **Education** | **2.13** | **2.20** | **2.20** | **-** | **-** |
| *REU Sites* | *2.00* | *-* | *-* | *-* | *N/A* |
| *Pan-American Advanced Studies Institutes* | *0.13* | *0.20* | *0.20* | *-* | *-* |
| *AGEP Graduate Research Supplements* | *-* | *2.00* | *2.00* | *-* | *-* |
| **Infrastructure** | **3.00** | **3.00** | **2.00** | -1.00 | -33.3% |
| *Research Resources* | *3.00* | *3.00* | *2.00* | *-1.00* | *-33.3%* |

Totals may not add due to rounding.

The Office of Multidisciplinary Activities (OMA) enables and facilitates MPS support of novel, challenging, or complex projects of varying scale, in both research and education, which are not readily accommodated by traditional organizational structures and procedures. This is done primarily in partnership with MPS disciplinary divisions and is especially directed at activities by multi-investigator, multidisciplinary teams, as well as cross-NSF and interagency activities.

In general, approximately 65 percent of the OMA portfolio is available for new research grants and 35 percent is available for continuing grants.

In FY2013, OMA will focus on: multidisciplinary research emphasizing the mathematical and physical scientific foundations of sustainability, including new synthetic methods to replace rare raw materials with abundant chemicals and to incorporate green principles in scaled-up processes; multidisciplinary research addressing the fundamental science critical to designing new materials; multidisciplinary research at the interface between the mathematical and physical sciences and the life sciences to provide insight into the molecular basis of life processes; computational and data-enabled science across the MPS divisions; multidisciplinary research into controlling, manipulating, and exploring the behavior of quantum matter and the limitations of quantum information processing; and team efforts aimed at developing next-generation instrumentation to enable fundamental advances across a wide spectrum of disciplines. OMA will also provide leadership and support for INSPIRE and I-Corps activities within MPS.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- In FY 2013, OMA will focus on multidisciplinary research addressing the key NSF-wide priority areas of I-Corps, INSPIRE, SEES, CIF21, CEMMS, BioMaPS, clean energy, and advanced manufacturing.
- OMA will increase its investment in I-Corps (+$300,000) to $1.30 million in FY 2013.
- OMA will maintain its investment in INSPIRE at $3.0 million in FY 2013.
- OMA completes its planned five-year investment to support the National Institute for Mathematical and Biological Synthesis (-$100,000 to zero), a Center for Analysis and Synthesis primarily managed by BIO, in FY 2012. No support is planned for FY 2013.
- In the area of CIF21 OMA will coordinate MPS' participation with OCI, BIO, CISE, and ENG, and provide funding for Software Infrastructure for Sustained Innovation (+$2.25 million) and Scientific Software Innovation Institutes (+$500,000).

**Education**

- Funding for the Pan-American Advanced Studies Institutes will be maintained at $200,000 in FY 2013.
- OMA launched a new investment AGEP Graduate Research Supplements at the level of $2.0 million in FY 2012. OMA will continue its $2.0 million investment in FY 2013.

**Facilities**

- OMA will invest $2.0 million (-$1.0 million below the FY 2012 Estimate) in co-funding with the Divisions of Chemistry (CHE) and Materials Research (DMR) for Coherent Light Source (CLS) in FY 2013.

## SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES (SBE) $259,550,000
## +$5,300,000 / 2.1%

**SBE Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Social and Economic Sciences (SES) | $95.68 | $97.18 | $100.25 | $3.07 | 3.2% |
| Behavioral and Cognitive Sciences (BCS) | 91.11 | 92.69 | 95.43 | 2.74 | 3.0% |
| SBE Office of Multidisciplinary Activities (SMA) | 25.10 | 28.23 | 29.11 | 0.88 | 3.1% |
| National Center for Science and Engineering Statistics (NCSES) | 35.44 | 36.15 | 34.76 | -1.39 | -3.8% |
| **Total, SBE** | **$247.33** | **$254.25** | **$259.55** | **$5.30** | **2.1%** |

Totals may not add due to rounding.

### About SBE

SBE's mission is to promote the understanding of people and their lives by supporting research that reveals basic facets of human behavior; to encourage research that addresses important societal questions and problems; to work with other scientific disciplines to ensure that basic research and solutions to problems build upon the best multidisciplinary science; and to provide mission-critical statistical information about science and engineering (S&E) in the U.S. and the world through the National Center for Science and Engineering Statistics. SBE supports long-term research across a diverse range of sciences that includes economics, psychology, sociology, geography, neuroscience, anthropology, archaeology, statistics, linguistics, and political science. SBE combines these sciences in a dynamic suite of interdisciplinary activities that link these fields to each other and to other science and engineering fields. Thus, SBE is a significant partner in cross-directorate programs that connect the social and behavioral sciences to priority investments across the agency, including OneNSF investments.

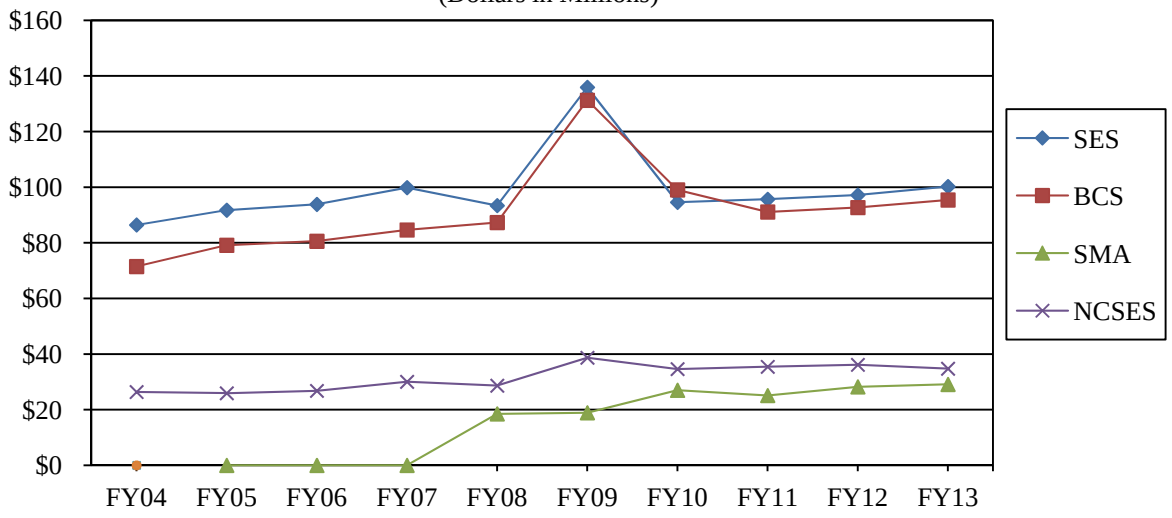
In FY 2013, SBE continues to strategically transform its scientific direction. These changes build on NSF's strategic plan, *Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years 2011-2016;* and on SBE's own SBE 2020 visioning activity, which led to a report entitled *Rebuilding the Mosaic*, which was published by NSF in November 2011. SBE proposes significant investments in many NSF areas of emphasis for FY 2013, such as: sustainability (via the Science, Engineering, and Education for Sustainability (SEES) investment); cyberinfrastructure (via the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) investment); access to data for science teachers (via Expeditions in Education ($E^2$) investments); national security (via the Comprehensive National Cybersecurity Initiative (CNCI)); international leadership through a variety of international partnerships; innovation (via the NSF Innovation-Corps (I-Corps)) investment and support to Enhancing Access to the Radio Spectrum (EARS)); and interdisciplinary research and training (via INSPIRE and full implementation of the SBE Transformed Portfolio, SBE 2020). These investments reflect both newly requested funds and a significant redeployment of resources previously committed to other areas.

The SBE portfolio also includes major surveys that provide broad-based infrastructure for the research community while providing policy makers with needed information. The National Center for Science and

Engineering Statistics (NCSES) is the designated federal statistical entity with responsibility for statistics about the S&E enterprise, and its data collections and analyses are important for evaluating overall U.S. competitiveness in science and engineering.

SBE provides 62 percent of the federal funding for basic research at academic institutions in the SBE sciences.

**SBE Subactivity Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary by Division

- SES's FY 2013 request reflects its strong contribution to the unifying themes in the FY 2013 NSF Budget Request. This includes support for SEES, through investments in understanding energy use and decision making and the Sustainable Energy Pathways, SEES Fellows, Water Sustainability and Climate, and Sustainability Research Networks activities; support for Secure and Trustworthy Cyberspace (SaTC) through the Cyber Economic Incentives theme within CNCI; and support for CIF21 through community research networks and research on virtual organizations. SES will also maintain its commitment to existing programs and continue its support for surveys that provide unique insights into U.S. social, economic, and political life, while providing support for new research that has the potential to transform the social and economic sciences and contribute to effective policy development. SES will also enhance support for the CAREER program. SES will partner with the Directorate for Computer and Information Science and Engineering (CISE) in exploring the emerging interface between computer science and economics. To further transform SBE by increasing interdisciplinary research, training, and integration with other parts of NSF, SES will increase its investment in SBE 2020, creating more SBE Fellows. As part of a broadly interdisciplinary activity that spans SBE, to enhance interdisciplinary research and training, SES will increase teachers' access to science data through: support for the Expeditions in Education ($E^2$) investment; expand its role in international activities with increased investments in the European Open Research Area (ORA) and Science Across Virtual Institutes (SAVI) programs; and continue support for an activity designed to understand the implications of a changing population shaped by aging and migration, and to develop new approaches to ensuring social well-being in this emerging population.

- In FY 2013, BCS will be a major partner in NSF-wide interdisciplinary activities such as SEES, CIF21, $E^2$, EARS, neuroscience research, and CNCI. BCS will expand support for behavioral and cognitive research that informs our understanding of critical issues facing the Nation such as terrorism, pandemics, and sustainability. Increased SEES funding will support research with SBE-specific emphases, such as investments in understanding human behavior and decision making about energy use, interactions among natural and human systems, vulnerability and resilience, and participation in Sustainable Energy Pathways and Sustainability Research Networks. In its ongoing programs, BCS will operate in an interdisciplinary context; providing additional support for research on the complex ways people interact with climate and other natural systems; and research and methodological development on learning and adaptive systems. BCS support for CNCI will enable research on cognitive and behavioral aspects of threats to cybersecurity. Increased funding for the SBE 2020 activity will enable BCS to partner with other NSF directorates, increasing interdisciplinary research and training for behavioral and cognitive scientists. BCS will expand its role in international activities by participating in SAVI, ORA and other international partnerships, and will also support the Science of Learning Centers (SLC) program and the science of broadening participation. It will also continue investments in support of integrative interdisciplinary approaches to the understanding of human cultural and biological evolution over long time scales. BCS will also continue to support basic research that advances understanding of the brain, cognition, and behavior through various research mechanisms.

- SMA provides a focal point for programmatic activities that cut across NSF and SBE boundaries. In addition, SMA assists with seeding both multidisciplinary and interdisciplinary activities for the future. In FY 2013, SMA will play a critical role in the expansion of an interdisciplinary program as part of SBE 2020. SMA will provide overall management and support for the program with funding provided through the SES and BCS divisions. SMA will support interdisciplinary activities associated with CIF21; the Science of Science and Innovation Policy activity (SciSIP); the interagency STAR METRICS pilot project; and SEES, including Sustainable Energy Pathways and Sustainability Research Networks. SMA will participate in I-Corps, INSPIRE, and SaTC (through the Cyber Economic Incentives theme within CNCI, a multi-agency priority). SMA will also partner with the BCS and SES divisions in supporting research on understanding population change in the 21st century, a new SBE investment with emphasis on migration and aging and their impact on job creation and human development. SMA will continue to manage and support the agency-wide Science of Learning Centers (SLCs) program.

- The National Center for Science and Engineering Statistics (NCSES), formerly the Division of Science Resources Statistics (SRS), was established within the National Science Foundation by Section 505 of the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). The Act not only provides a new name but also provides NCSES with the legislative mission to "…serve as the central Federal clearinghouse for the collection, interpretation, analysis, and dissemination of objective data on science, engineering, technology, and research and development." For FY 2013, NCSES will accelerate efforts to rely more heavily on data from the National Survey of College Graduates, built from the American Community Survey, which will reduce overall survey costs while still continuing to meet the needs of policy makers, researchers, and the general public for data on the overall science and engineering workforce. NCSES will develop plans for a project to utilize federal agency administrative records to measure research and development activity and to explore new methods to enhance data collection, analysis and data sharing capabilities to better serve all its customers interested in the science and engineering enterprise.

## Major Investments

**SBE Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| CAREER | $8.88 | $5.54 | $5.87 | $0.33 | 6.0% |
| CIF21 | - | 5.50 | 6.00 | 0.50 | 9.1% |
| CTE | 1.01 | 1.00 | 1.00 | - | - |
| CNCI | - | 6.00 | 6.00 | - | - |
| $E^2$ | - | - | 1.00 | 1.00 | N/A |
| EARS | - | 1.00 | 0.50 | -0.50 | -50.0% |
| I-Corps | 0.05 | 0.50 | 0.50 | - | - |
| INSPIRE | - | 0.50 | 1.00 | 0.50 | 100.0% |
| SaTC | - | 4.00 | 4.00 | - | - |
| SEES | 6.25 | 7.75 | 8.75 | 1.00 | 12.9% |
| Science of Learning Centers (SLC) | 16.39 | 13.67 | 13.67 | - | - |
| SciSIP | 13.05 | 13.50 | 11.05 | -2.45 | -18.1% |

Major investments may have funding overlap and thus should not be summed.

- CAREER: SBE supports CAREER (an increase of $330,000 to a total of $5.87 million) with awards to young investigators in social and behavioral sciences who exemplify the role of teacher-scholar through the integration of education and research. SBE estimates that it will make approximately 5 CAREER awards in FY 2013.

- CIF21: Support for this NSF-wide investment ($6.0 million total, $500,000 above the FY 2012 Estimate level) will support awards for data and cyberinfrastructure investments that create new opportunities for SBE researchers to understand human behavior and cognition and the effectiveness of virtual organizations in the context of the 21st century networked society. CIF21 is supported by three SBE divisions: SES, BCS, and SMA.

- CTE: SBE's participation in Cyberlearning Transforming Education (CTE) remains at $1.0 million in FY 2013 for research on the development of technologies for cyberlearning, and for studying the impact of technologies on learning.

- Comprehensive National Cybersecurity Initiative (CNCI): In partnership with CISE and the Office of Cyberinfrastructure (OCI), SBE will support multidisciplinary research in the science of cybersecurity, moving target defense, tailored trustworthy spaces, and cyber economic incentives. SBE's investment in this national priority is maintained at $6.0 million in FY 2013. SBE will devote resources to SaTC through support for the Cyber Economic Incentives theme within CNCI. In addition, SBE's broad scientific base in the behavioral, social, and decision making sciences provides a wealth of opportunities to contribute to this national priority. SES, BCS, and SMA support CNCI.

- Expeditions in Education ($E^2$): SBE's investment ($1.0 million) will make targeted research data available for educational uses and will give scientists better access to scientific data for learning and instructional purposes. This funding is provided through the budgets of SES and BCS.

- Enhancing Access to the Radio Spectrum (EARS): In partnership with MPS, ENG, and CISE, SBE will provide $500,000 ($500,000 below the FY 2012 Estimate level) for the basic research that underlies EARS in FY 2013, especially research about market and non-market-based mechanisms for spectrum access, and opportunities for all Americans to benefit from current and future wireless-enabled goods and services.

- I-Corps: With a sustained investment of $500,000, SBE will continue a multi-year effort to strengthen collaboration between social scientists and practitioners and improve social science students' understanding of innovation.

- INSPIRE: SBE support for this NSF priority is aligned with SBE Transformed Portfolio, SBE 2020. This support increases in FY 2013 (+$500,000 to a total of $1.0 million) to support interdisciplinary research and training.

- SEES: In FY 2013 SBE will continue its commitment to sustainability research by making significant investments across a variety of SEES activities, such as Water Sustainability and Climate (WSC), Coupled-Natural and Human Systems (CNH), Research Coordination Networks (RCN), SEES Fellows, Sustainability Research Networks (SRN), and Sustainable Energy Pathways (SEP). These investments further integrate the SBE sciences into research on energy and sustainability, while strengthening SBE's existing investments, and making new investments in decision making, coastal communities, and vulnerability and resilience. Funding increases by $1.0 million (to a total of $8.75 million) and is provided through the budgets of three SBE divisions; SES, BCS, and SMA.

- Science of Learning Centers (SLC) program: SBE will continue funding for the centers. In FY 2013, SBE's investment remains constant with the FY 2012 Estimate level, $13.67 million.

- Science of Science and Innovation Policy (SciSIP): decreases in FY 2013 (-$2.45 million to a total of $11.05 million), as a result of SBE decreasing investments in disciplinary research programs across the directorate and and a decrease to NCSES' SciSIP related projects. SciSIP will continue to support research and data collections related to innovation and R&D spending. SciSIP is supported by two of four SBE divisions; NCSES and SMA.

## SBE Funding for Centers Programs and Facilities

**SBE Funding for Centers Programs**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$17.46** | **$14.27** | **$14.27** | **-** | **-** |
| Nanoscale Science & Engineering Centers (SES & BCS) | 1.07 | 0.60 | 0.60 | - | - |
| Science of Learning Centers (SMA & BCS) | 16.39 | 13.67 | 13.67 | - | - |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Funding for the Nanoscale Science & Engineering Centers will continue at $600,000 in FY 2013.

- The Science of Learning Centers (SLC) program funding remains constant with the FY 2012 Estimate level of $13.67 million. Support includes annual increments to all six centers: the Center of Excellence for Learning in Education, Science, and Technology (CELEST); the Center for Learning in Informal and Formal Environments (LIFE); the Pittsburgh Science of Learning Center for Robust Learning (PSLC); the Spatial Intelligence and Learning Center (SILC); the Temporal Dynamics of Learning Center (TDLC); and the Visual Language and Visual Learning Center (VL2). Support is also included for SLC evaluation activities in FY 2013. Funding for Cohort 1 centers will end in FY 2014, and funding for Cohort 2 centers, approved for an additional five-year renewal by the National Science Board in February 2011, will end in FY 2015.

**SBE Funding for Facilities**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Facilities (Total)** | **$0.40** | **$0.40** | **$0.40** | **-** | **-** |
| National Nanotechnology Infrastructure Network (SES) | 0.40 | 0.40 | 0.40 | - | - |

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

SBE will continue to support the National Nanotechnology Infrastructure Network (NNIN) at a level of $400,000 in FY 2013.

## Summary and Funding Profile

SBE supports investment in core research and education as well as research infrastructure.

In FY 2013, the number of research grant proposals is expected to increase by 100 compared to the FY 2012 Estimate level. SBE expects to award approximately 590 research grants in FY 2013. Average

annualized award size will increase by $1,000 and duration will be held constant at the FY 2012 Estimate level.

In FY 2013, funding for the centers accounts for 5.5 percent of SBE's Request. Center funding remains constant with the FY 2012 Estimate level with the SLC program supporting six centers and support to the Centers for Nanotechnology in Society.

**SBE Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 5,111 | 5,300 | 5,500 |
| Number of New Awards | 997 | 1,190 | 1,220 |
| Funding Rate | 20% | 22% | 22% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 3,539 | 3,600 | 3,700 |
| Number of Research Grants | 555 | 570 | 590 |
| Funding Rate | 16% | 16% | 16% |
| Median Annualized Award Size | $99,351 | $100,351 | $101,351 |
| Average Annualized Award Size | $113,229 | $115,429 | $116,429 |
| Average Award Duration, in years | 2.6 | 2.6 | 2.6 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and Directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):

- In FY 2012, one COV convened on December 15-16, 2012 and reviewed programs under the Office of Multidisciplinary Activities (SMA): Research Experiences for Undergraduates (REU) Sites, SBE Minority Postdoctoral Research Fellowships (MPRF), and the Science of Science and Innovation Policy (SciSIP). The SMA COV recommends SBE management review the current placement of the multidisciplinary programs in the directorate, as well as the question of how many submissions a year are appropriate. The COV also recommends taking actions to broaden participation and increase capacity for research related to the Science of Science and Innovation Policy (SciSIP) program. The SMA COV will present their report to the SBE Advisory Committee on May 17-18, 2012.
- A COV to review the BCS division will convene on October 10-12, 2012.
- A COV to review the SES division will convene late in FY 2013.
- All SBE divisions are responding to and implementing recommendations from recent COVs.

Workshops and Reports:

- A recent report by the SBE directorate, *Rebuilding the Mosaic; Fostering Research in Social, Behavioral, and Economic Sciences at the National Science Foundation in the Next Decade* (issued November, 2011), sets forth a next generation model of research that is collaborative, data-intensive,

and multi- or interdisciplinary. Based on 252 white papers from more than 500 individuals, together with consultation with professional associations and societies and campus visits, the report explores the programmatic implications of this model of research for the directorate's programs and has been influential in setting priorities and framing discussions within the directorate, across the Foundation, and with other public and private agencies and organizations. Key areas of interest are interdisciplinary training and support for graduate students and young faculty; programs to foster interdisciplinary investigations; and efforts, within the directorate and in cooperation with OCI and other entities, to catalyze research communities around new data and computational infrastructures.

**Number of People Involved in SBE Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 3,042 | 3,100 | 3,130 |
| Other Professionals | 674 | 680 | 685 |
| Postdoctorates | 333 | 340 | 345 |
| Graduate Students | 2,236 | 2,275 | 2,295 |
| Undergraduate Students | 789 | 805 | 815 |
| **Total Number of People** | **7,074** | **7,200** | **7,270** |

## DIVISION OF SOCIAL AND ECONOMIC SCIENCES (SES) $100,250,000
**+$3,070,000 / 3.2%**

**SES Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, SES** | **$95.68** | **$97.18** | **$100.25** | **$3.07** | **3.2%** |
| **Research** | **83.92** | **87.83** | **90.90** | **3.07** | **3.5%** |
| *CAREER* | *2.44* | *2.82* | *3.05* | *0.23* | *8.2%* |
| *Centers Funding (total)* | *0.89* | *0.42* | *0.42* | - | - |
| *Nanoscale Science & Engineering Centers* | *0.89* | *0.42* | *0.42* | - | - |
| **Education** | **6.19** | **3.79** | **3.79** | **-** | **-** |
| **Infrastructure** | **5.57** | **5.56** | **5.56** | - | - |
| *Nat'l Nanotechnology Infrastructure Network(NNIN)* | *0.40* | *0.40* | *0.40* | - | - |
| *Research Resources* | *5.17* | *5.16* | *5.16* | - | - |

Totals may not add due to rounding.

SES supports research and related activities, conducted within the U.S. and globally, that improve our understanding of economic, political, and social institutions and how individuals and organizations behave within them. SES also supports activities investigating risk assessment and decision-making by individuals and groups; the nature and development of science and technology and their impact on society; methods and statistics applicable across the social, economic, and behavioral sciences; scholarly career development; and broadening participation in the social, behavioral, and economic sciences. Its discipline-based programs include sociology, economics, and political science, while interdisciplinary programs support fields such as decision-making and risk; methods, measurement and statistics; science of organizations; law and social science; and science and technology studies. In many of its programs, SES is the major, if not only, source of federal funding for fundamental research, making important investments in the data resources and methodological advances that produce transformative research.

SES also coordinates the Ethics Education in Science and Engineering program, supporting (with other NSF directorates) the Online Ethics Center for Engineering and Science, and manages the Centers for Nanotechnology in Society. SES is a participant in a number of Nanoscale Science and Engineering Centers and the National Nanotechnology Infrastructure Network (NNIN). In addition, SES plays a major role in managing the Decision Making Under Uncertainty collaborative projects.

In general, 58 percent of the total SES portfolio is available for new research grants. The remaining 42 percent funds continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate. In the FY 2013 Request there is a general reduction for core programs to provide resources for enhancement and implementation of other programs related to directorate priorities.

**Research**

Overall, support for SES disciplinary and interdisciplinary research increases (+$3.07 million to a total of $90.90 million). Disciplinary research funding was redeployed to establish or increase funding for new NSF and SBE priorities.

- Increased support (+$6.0 million to a total of $7.60 million) for SBE 2020 to support interdisciplinary research, training, and integration opportunities for social scientists. Increasing funding in this investment will require a reduction in core disciplinary research programs.
- CAREER funding in FY 2013 increases by $230,000, to a total of $3.05 million. This investment is consistent with SES's emphasis on supporting early career researchers.
- An increase of $2.0 million will expand SBE's international leadership role through participation in SAVI, the European Open Research Area program, and other international partnerships.
- SES continues its investments in ethics in science via an equivalent $400,000 investment in the Ethics Education in Science and Engineering (EESE) cross-directorate program.
- Support for CIF21 continues in FY 2013. Of particular interest to SES is how researchers can enhance the effectiveness of virtual organizations. Support of $2.90 million (an increase of $250,000) will support planning awards for future data and cyberinfrastructure investments that create new opportunities for SBE researchers to understand human behavior and cognition and the effectiveness of virtual organizations in the context of the 21st century networked society.
- Increased funding (+$700,000, to a total of $4.35 million) for SEES will support research in expanded SEES activities through SBE-specific emphases, such as investments in understanding energy use and in decision making, coastal communities, and vulnerability and resilience, through the enhancement of existing programs and new solicitations; funding will also support Sustainable Energy Pathways, Sustainability Research Networks, RCN-SEES, SEES Fellows, and Water Sustainability and Climate.
- Continued support of $2.0 million for SaTC (level with the FY 2012 Estimate) through support for the Cyber Economic Incentives theme within CNCI; ; additional continued support of $1.0 million for multidisciplinary research in three other CNCI themes; The Science of Cybersecurity, Moving Target Defense, and Tailored Trustworthy Spaces.
- $500,000 supports the Expedition in Education ($E^2$) investment (to a total of $500,000), enabling SBE scientists to make targeted research data available for educational uses and give scientists better access to substantive science data.
- $250,000 (a decrease of $250,000 from the FY 2012 Estimate) supports the Enhancing Access to the Radio Spectrum (EARS) program, a partnership with NSF's Directorates for Engineering, Mathematical and Physical Sciences, and Computer and Information Science and Engineering. EARS addresses the need for research on new and innovative ways to use the spectrum more efficiently.
- Continued support of $1.50 million for research on understanding population change in the 21st century, an SBE interdisciplinary investment with emphasis on migration and aging and their impact on job creation.

**Education**

- FY 2013 support for ADVANCE ($790,000), IGERT ($2.50 million), and REU supplements ($500,000) will remain at the FY 2012 Estimate level.

**Infrastructure**

- FY 2013 support for NNIN ($400,000) and Research Resources activities ($5.16 million) will remain at the FY 2012 Estimate level. Funding supports multi-million dollar survey awards such as the American National Election Studies (ANES), the Panel Study of Income Dynamics (PSID), and the General Social Survey (GSS). These surveys are national resources for research, teaching, and decision-making and have become models for similar undertakings in other fields.

## DIVISION OF BEHAVIORAL AND COGNITIVE SCIENCE (BCS) $95,430,000
**+$2,740,000 / 3.0%**

**BCS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, BCS** | **$91.11** | **$92.69** | **$95.43** | **$2.74** | **3.0%** |
| **Research** | **85.75** | **89.73** | **92.47** | **2.74** | **3.1%** |
| *CAREER* | *5.72* | *2.72* | *2.82* | *0.10* | *3.7%* |
| *Centers Funding (total)* | *4.88* | *5.78* | *5.78* | - | - |
| *Nanoscale Science & Engineering Centers* | *0.18* | *0.18* | *0.18* | - | - |
| *Science of Learning Centers* | *4.70* | *5.60* | *5.60* | - | - |
| **Education** | **5.32** | **2.92** | **2.92** | **-** | **-** |
| **Infrastructure** | **0.04** | **0.04** | **0.04** | - | - |
| *Research Resources* | *0.04* | *0.04* | *0.04* | - | - |

Totals may not add due to rounding.

BCS supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. Strong core programs are complemented by active involvement in competitions that support collaborative and cross-disciplinary projects. The division seeks to advance scientific knowledge and methods focusing on human cognition and behavior, including perception, thought processes, language, learning, and social behavior across neural, individual, family, and group levels. BCS also supports activities focusing on human variation at the scales of society, culture, and biology, and how these variations and related patterns develop and change across time and space. The division aims to increase basic understanding of geographic distributions and relationships as well as the capabilities to explore them, with an emphasis on interactions among human and natural systems on the Earth's surface. BCS research is helping us prepare for and mitigate the effects of natural and human-initiated disasters, predict and address how people respond to stressors, improve methods for effective learning, enhance the quality of social interaction, and respond to issues such as globalization, terrorism, and climate change. BCS investments in SEES advance our understanding of sustainability, and contribute to energy research.

In general, 51 percent of the BCS portfolio is available for new research grants. The remaining 49 percent funds continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate. In the FY 2013 Request there is a general reduction for core programs to provide resources for enhancement and implementation of other programs related to directorate priorities.

**Research**
Overall, support for BCS disciplinary and interdisciplinary research increases (+$2.74 million to a total of $92.47 million). Disciplinary research funding was redeployed to establish or increase funding for new NSF and SBE priorities.

- Increased support (+$4.0 million, to a total of $6.40 million) for SBE 2020 to support interdisciplinary research, training, and integration opportunities for behavioral and cognitive scientists. Increasing funding in this investment will require a reduction in core disciplinary research programs.
- CAREER funding will increase by $100,000, to a total of $2.82 million. This investment is consistent with BCS' emphasis on supporting early-career researchers.
- Funding for neuroscience totals approximately $2.0 million in FY 2013. BCS research will contribute to NSF's participation in upcoming Office of Science and Technology Policy (OSTP) efforts towards coordination of federal research in this emerging field. BCS and other NSF programs work together informally through co-review of interdisciplinary proposals and formally through special solicitations, such as Collaborative Research in Computational Neuroscience. Starting in FY 2012, a Dear Colleague Letter (DCL) will be issued supporting research on neuroscience and cognitive science. In FY 2013, SBE, ENG, BIO, MPS, and the Directorate for Education and Human Resources (EHR) will continue to leverage existing investments in neuroscience, informed by the results of the DCL activity, and come together to call for a broad-based focus on understanding the brain and learning how to deploy that understanding.
- An increase of $1.0 million will expand SBE's international leadership role through participation in SAVI, the European Open Research Area program, and other international partnerships.
- Increased funding (+$300,000, to a total of $3.55 million) for SEES to support research with SBE-specific emphases, such as investments in understanding human behavior and decision making about energy use, interactions among natural and human systems, vulnerability and resilience, and to participate in Sustainable Energy Pathways, Sustainability Research Networks, RCN-SEES, SEES Fellows, and Water Sustainability and Climate (WSC).
- Increased support (+$250,000, to a total of $2.10 million) for CIF21 will create new opportunities for BCS researchers to understand human behavior and cognition.
- Continued support of $1.20 million for SaTC through support for the Cyber Economic Incentives theme within CNCI. Additional continued support for CNCI ($1.0 million) is provided for multidisciplinary research in three other CNCI themes; The Science of Cybersecurity, Moving Target Defense, and Tailored Trustworthy Spaces.
- Support for the Enhancing Access to the Radio Spectrum (EARS) program is halved (-$250,000 to a total of $250,000). These funds will support a partnership with NSF's Directorates for Engineering, Mathematical and Physical Sciences, and Computer and Information Science and Engineering to address the need for research on new and innovative ways to use the spectrum more efficiently.
- $500,000 supports the Expedition in Education ($E^2$) investment (for a total of $500,000) enabling SBE scientists to make targeted research data available for educational uses and give scientists better access to substantive science data.
- As planned, support for the SLC program remains constant with the FY 2012 Estimate level of $5.60 million. A gradual phase down of the SLC program will continue as the centers reach their endpoints.
- $1.50 million is aimed at understanding population change in the 21st century, a new SBE interdisciplinary investment, with emphasis on migration and human development as they pertain to learning, cognition, language, group dynamics, culture change, and the use of natural resources.
- Continued investment in the science of broadening participation in order to better understand the mechanisms and processes that result in the under-representation of women and minorities in STEM.
- Continued investment in support of integrative and interdisciplinary approaches to the understanding of human cultural and biological evolution over long time scales.

**Education**

- FY 2013 support for ADVANCE ($680,000), REU Supplements ($440,000) and IGERT ($1.80 million) will remain level with the FY 2012 Estimate level.

**Infrastructure**

- FY 2013 support for infrastructure activities will remain at the FY 2012 Estimate level. Funding supports multi-million dollar survey awards such as the Panel Study of Income Dynamics (PSID) and the General Social Survey (GSS). These surveys are national resources for research, teaching, and decision-making and have become models for similar undertakings in other fields.

## SBE OFFICE OF MULTIDISCIPLINARY ACTIVITIES (SMA)

**$29,110,000**
**+$880,000 / 3.1%**

**SMA Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, SMA** | **$25.10** | **$28.23** | **$29.11** | **$0.88** | **3.1%** |
| **Research** | **19.08** | **22.56** | **23.26** | **0.70** | **3.1%** |
| *CAREER* | *0.72* | - | - | - | *N/A* |
| *Centers Funding (total)* | *11.69* | *8.07* | *8.07* | - | - |
| *Science of Learning Centers* | *11.69* | *8.07* | *8.07* | - | - |
| **Education** | **3.72** | **3.38** | **3.56** | **0.18** | **5.3%** |
| **Infrastructure** | **2.29** | **2.29** | **2.29** | - | - |
| *Research Resources* | *2.29* | *2.29* | *2.29* | - | - |

Totals may not add due to rounding.

SMA provides a focal point for programmatic activities that cut across SBE disciplinary boundaries, including the agency-wide Science of Learning Centers (SLCs). SMA also funds the Science of Science and Innovation Policy (SciSIP) program, Research Experiences for Undergraduates (REU) Sites, and Minority Postdoctoral Research Fellowships (MPRF). SMA will play a critical role in several NSF areas of emphasis for FY 2013, such as clean energy and sustainability (via the SEES investment); cyberinfrastructure and computer science (via the CIF21 investment); national security (via the CNCI investment); international leadership and interaction (via support to the Digging Into Data (DiD) Initiative); innovation (via the Innovation Corps (I-Corps) investment); and interdisciplinary research and training (via the INSPIRE/CREATIV investment and full implementation of the SBE Transformed Portfolio, SBE 2020). These investments reflect both newly requested funds and a significant redeployment of resources previously committed to other social, behavioral and economics science disciplines within SBE. Co-funding with other divisions in SBE and with other directorates is typical for SMA, as is participation in interagency activities. While all SBE divisions pursue interdisciplinary work, SMA assists with seeding multidisciplinary activities for the future. All areas of SBE sciences are represented in the SMA portfolio.

In general, 36 percent of the SMA portfolio is available for new research grants. The remaining 64 percent funds continuing awards made in previous years, including funding for the SLCs.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate. In the FY 2013 Request there is a general reduction for core programs to provide resources for enhancement and implementation of other programs related to directorate priorities.

**Research**

- Overall, support increases for basic research activities (+$700,000 above the FY 2012 Estimate to a total of $23.26 million).

- $500,000 (to a total of $500,000) supports the I-Corps investment, strengthening collaboration between social scientists and academe and improving social science students' understanding of innovation.
- $1.0 million (an increase of $500,000) supports the OneNSF theme INSPIRE/CREATIV, an NSF priority aligned with SBE 2020.
- In FY 2013, SMA will continue to support six active Science of Learning Centers and funding will remain at the FY 2012 Estimate level, $8.07 million. A gradual phase down of the program continues as centers reach their endpoints in FY 2014 and FY 2015.
- Continued investment in SEES (a total of $850,000) to support research with SBE-specific emphases, such as investments in understanding human behavior and decision making about energy use, interactions among natural and human systems, and vulnerability and resilience. SMA will participate in Sustainable Energy Pathways, Sustainability Research Networks, RCN-SEES, and SEES Fellows.
- Support of $1.0 million, level with the FY 2012 Estimate, for Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) continues in FY 2013. Of particular interest to SMA are new opportunities for SBE researchers to understand the 21st century networked society.
- Funding for the SciSIP program decreases by $1.45 million, to a total of $6.10 million as a result of SBE decreasing investments in disciplinary research programs across the directorate.
- With an investment of $800,000, level with FY 2012, SMA will partner with CISE and OCI in devoting resources to the Secure and Trustworthy Cyberspace (SaTC) initiative through support for the Cyber Economic Incentives theme within CNCI. This investment will support research at the interstices of the economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior.
- Continued investment in support of research on understanding population change in the 21st century, an interdisciplinary SBE investment with emphasis on migration and aging and their impact on job creation and human development as they pertain to learning, cognition, language, group dynamics, culture change and the use of natural resources.

**Education**

Overall, support for Education activities in SMA increases by $180,000, to a total of $3.56 million.

- Support for Research Experiences for Undergraduates (REU) Sites increases by $80,000, to a total of $2.40 million.
- Funding for the SBE Minority Postdoctoral Research Fellowships (MPRF) increases by $100,000, to a total of $1.10 million.

**Infrastructure**

- FY 2013 support for infrastructure activities will remain at the FY 2012 Estimate level. Funding is primarily for data and tool development. Data development includes such databases as: the National Bureau of Economic Research/Harvard patent database; the University of California, Davis database on initial public offerings; and two surveys, "Management and Organizational Practices Across the U.S.", and the "Division of Innovative Labor." Tool developments include such projects as Open Researcher and Contributor ID (ORCID) unique researcher identifiers and Publication Harvester: An Open-Source Software Tool for Science Policy Research.

## NATIONAL CENTER FOR SCIENCE AND ENGINEERING STATISTICS (NCSES)

**$34,760,000**
**-$1,390,000 / -3.8%**

**NCSES Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, NCSES[1]** | **$35.44** | **$36.15** | **$34.76** | **-$1.39** | **-3.8%** |
| **Research** | **0.53** | **0.55** | **0.50** | **-0.05** | **-9.1%** |
| **Infrastructure** | **34.91** | **35.60** | **34.26** | **-1.34** | -3.8% |

Totals may not add due to rounding.

[1]The Division of Science Resources Statistics (SRS) was renamed the National Center for Science and Engineering Statistics (NCSES) in FY 2011.

The National Center for Science and Engineering Statistics (NCSES), formerly the Division of Science Resources Statistics (SRS), was established within the National Science Foundation by Section 505 of the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). The Act not only provides a new name but also provides NCSES with the legislative mission to "…serve as the central Federal clearinghouse for the collection, interpretation, analysis, and dissemination of objective data on science, engineering, technology, and research and development." NCSES is also called on to support the collection of statistical data on the condition and progress of United States STEM education; to support research using the data it collects and on methodologies in areas related to the work of the Center; and to support the education and training of researchers in the use of large-scale, nationally representative data sets. This change broadens the responsibilities of NCSES and formally supports a number of activities currently underway in the former SRS division. NCSES will refine its priorities to ensure they are in line with the Act and will continue to identify and implement efficiencies in its data collection operations.
As one of the thirteen principal federal statistical agencies, NCSES has responsibility for statistics about the science and engineering enterprise. NCSES designs, supports, and directs a coordinated collection of periodic national surveys and performs a variety of other data collections and research, providing policymakers, researchers, and other decision makers with high quality data and analysis on R&D, innovation, the education of scientists and engineers, and the S&E workforce. The work of NCSES involves survey development, methodological and quality improvement efforts, data collection, analysis, information compilation, dissemination, web access, and customer service to meet the statistical and analytical needs of a diverse user community. It also prepares two congressionally mandated biennial reports — *Science and Engineering Indicators (SEI)* and *Women, Minorities, and Persons with Disabilities in Science and Engineering*. The data collected by NCSES also serve as important tools for researchers in SBE's Science of Science and Innovation Policy (SciSIP) program.

The funding portfolio for NCSES includes ongoing, cyclical surveys; reports and other products; and projects accomplished primarily through contracts and also a few standard grants.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Infrastructure**

- FY 2013 support for core NCSES infrastructure activities decreases by $1.34 million to an overall total of $34.26 million.

- As a cost saving measure, NCSES will accelerate efforts to rely more heavily on data from the National Survey of College Graduates built from the American Community Survey (ACS) to meet its needs for data on the overall science and engineering workforce. As a result, funding for the National Survey of College Graduates will increase by $2.22 million and funding for the National Survey of Recent College Graduates will decrease by $4.50 million, for an overall net decrease of $2.28 million.
- FY 2013 support for NCSES' exploration of new methods to enhance data collection, analysis, and sharing capabilities, which would help NCSES better serve its role of providing information on the science and engineering enterprise, will be reduced by $150,000. NCSES will proceed with a pilot project establishing collaboration between several federal agencies and NCSES to test the feasibility of tagging and extracting agencies' administrative records to measure research and development activity. If feasible, the use of such administrative records should reduce the cost of conducting R&D surveys of Federal agencies.
- Funding for NCSES SciSIP activities decreases by $1.0 million, to a total of $4.95 million. Current SciSIP funding is used to support the Business R&D and Innovation Survey, the federal statistical system's primary survey on business domestic and global R&D expenditures and workforce, and the National Survey of College Graduates, the federal statistical system's primary survey of the nation's science and engineering workforce.

## OFFICE OF CYBERINFRASTRUCTURE (OCI) $218,270,000
## +$6,630,000 / 3.1%

**OCI Funding**

(Dollars in Millions)

| | FY 2011 Actual[1] | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Research** | **$68.01** | **$87.48** | **$94.87** | **$7.39** | **8.4%** |
| CAREER | $3.89 | $3.97 | $4.16 | $0.19 | 4.8% |
| Software | 8.60 | 25.43 | 25.90 | 0.47 | 1.8% |
| Data | 24.02 | 24.85 | 28.33 | 3.48 | 14.0% |
| Virtual Organizations | 4.78 | 5.00 | 5.50 | 0.50 | 10.0% |
| Other Disciplinary and Interdisciplinary Research | 26.72 | 28.23 | 30.98 | 2.75 | 9.7% |
| **Education** | **$11.39** | **$7.60** | **$6.40** | **-$1.20** | **-15.8%** |
| **Infrastructure** | **221.35** | **116.56** | **117.00** | **0.44** | **0.4%** |
| High Performance Computing (HPC) | 187.91 | 88.31 | 82.00 | -6.31 | -7.1% |
| Other Networking and Computational Programs | 33.44 | 28.25 | 35.00 | 6.75 | 23.9% |
| **Total, OCI** | **$300.75** | **$211.64** | **$218.27** | **$6.63** | **3.1%** |

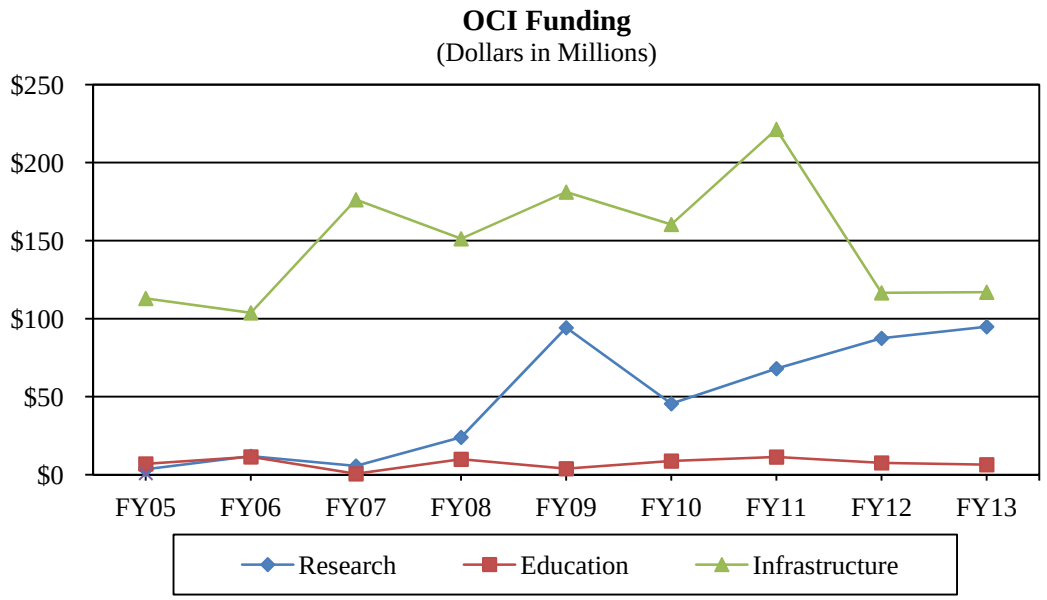
Totals may not add due to rounding.

[1] FY 2011 Actual includes $90.50 million in funds that were obligated in FY 2010, de-obligated in FY 2011 and then obligated to other projects in the OCI portfolio.

## About OCI

OCI enables science and engineering research and education by creating secure, advanced, global cyberinfrastructure (CI). OCI supports research and development activities on cyberinfrastructure components as well as acquisition and operation of advanced CI. CI is used to transform data into knowledge and to develop a better understanding of complexity through simulation, prediction, and multidisciplinary collaboration.

Due to the continuing rapid change in High Performance Computing and related technologies, coupled with the exponential growth and complexity of data for the science, engineering, and education enterprise, NSF has created a new vision and strategy towards Advanced Computing Infrastructure (ACI). This new NSF-wide strategy will focus on a complementary, comprehensive, and balanced portfolio that will address foundational research issues in algorithms, software, parallel systems, data analytics, visualization, simulation, computational and data enabled science, future workforce issues, and hardware acquisition.




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary

All funding decreases/increases represent changes over the FY 2012 Estimate.

**Research**

Scientific communities are being inundated by a deluge of data. Miniaturization and commoditization of computer chips and sensors, as well as the lower cost of computing and storage, contribute to large amounts of data being generated by scientific instruments and facilities. The OCI FY 2013 Request reflects the continued and growing need to support sharing of large data sets and connections among scientific communities.

- Software funding is supported at $25.90 million, an increase of $470,000 over the FY 2012 Estimate. The software program supports sustainability and extensibility of software to ensure robustness so that tools may be used across scientific communities. In FY 2013, in conjunction with the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) NSF-wide investment, the software program will fund new software institutes designed to help researchers extend and maintain their software.
- Data support increases by $3.48 million from the FY 2012 Estimate to a total of $28.33 million for data-enabled science, including long-term data support and infrastructure, a data life-cycle program focus (access, curation, mining, security, and management), data tools, data interoperability, data repositories, and a multi-disciplinary focus on data services, data science, and data-intensive science in conjunction with the CIF21 portfolio.
- The Virtual Organizations program increases by $500,000 to $5.50 million. Efforts in FY 2012 focus on understanding and developing new research community networks (RCNs). This includes the support of workshops and a study to understand how scientists collaborate using technology and to identify gaps in what is known. In FY 2013 efforts will be expanded in building and supporting multidisciplinary community research networks.
- Other disciplinary and interdisciplinary research funding increases by $2.75 million to a total of $30.98 million. This includes an increase of $1.50 million, to a total of $3.0 million, for Science,

Engineering, and Education for Sustainability (SEES), an increase of $750,000 to a total of $1.0 million for NSF Innovation Corps (I-Corps), and an additional $500,000 to a total of $1.0 million for INSPIRE.

**Education**

Support for education decreases by $1.20 million to a total of $6.40 million.

- Funding for the Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM) program is eliminated (-$4.0 million) as more support is provided to NSF Fellowships for Transformative Computational Science using CyberInfrastructure (CI-TraCS) and to education through co-funding of awards with other directorates in conjunction with CIF21 activities.
- Funding for the CI-TRaCS program is increased by $2.90 million to $4.90 million to support 4 new post-doctoral researchers in their training in cyberinfrastructure. The CI-TraCS program is undergoing an evolution in FY 2013. When this evolution is complete in FY 2014, the program will more broadly support education at different levels (graduate, post-doctoral, mid-career) across the spectrum of OCI program areas and in scientific domains supported by CIF21 activities.
- OCI support for the CISE-led Computing Education for the 21st Century (CE21) program ends, for a reduction of $500,000. OCI support for this program is being eliminated to allow OCI to increase support for Research Experiences for Undergraduates (REU).
- REU site funding increases by $300,000 to $1.30 million and REU supplement funding increases by $100,000 to $200,000. OCI is committed to the support of undergraduates and to connecting smaller undergraduate institutions with larger research universities.

**Infrastructure**

Support for High Performance Computing decreases by $6.31 million to a total of $82.0 million.

- The Blue Waters (Track One) program is expected to be operational by the end of FY 2012. This program transitions from acquisition to operations and maintenance in FY 2013 at a funding level of $30.0 million. This is a decrease of $80.50 million from FY 2012 (including FY 2011 funds that will be obligated in FY 2012), when funds were provided for the final phase of acquisition.
- Innovative HPC funding decreases by $23.90 million to a total of $25.0 million. FY 2013 funding will support the acquisition of a single system or multiple smaller systems via a competitive process. In FY 2013, funding for operations and maintenance (O&M) is not required, as FY 2012 funds will support multiple years of O&M on several systems.
- Funding for eXtreme Digital will be $27.0 million to support ongoing commitments to these resources and services.

Support for other networking and computational programs increases by $6.75 million to $35.0 million.

- Total OCI funding for cybersecurity in FY 2013 is unchanged from FY 2012 at $21.0 million. Decreases of $1.50 million for the Comprehensive National Cybersecurity Initiative (CNCI) and of $500,000 in other cybersecurity efforts in core HPC programs are offset by an increase of $2.0 million for the OneNSF Secure and Trustworthy Cyberspace (SaTC) investment. OCI's support of SaTC, which will focus on the transition to practice perspective, is part of OCI's support for CNCI. Additional funding under CNCI supports awards for testing of new and innovative cybersecurity prototypes.
- An increase of $2.50 million will fund networking and connectivity support for components of the EarthCube project with GEO and CIF21 infrastructure projects with other directorates.
- An increase of $3.25 million to a total of $13.0 million will support the International Research Network Connections (IRNC) program to enable high-speed connections to compute facilities and NSF-supported Major Research Equipment and Facilities Construction (MREFC) projects.
- An increase of $1.0 million to a total of $6.50 million will support broadband efforts, some in conjunction with CIF21 programs.

## Major Investments

**OCI Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| CAREER | $3.89 | $3.97 | $4.16 | $0.19 | 4.8% |
| CEMMSS | - | 0.50 | 1.00 | 0.50 | 100.0% |
| CIF21 | - | 23.00 | 32.03 | 9.03 | 39.3% |
| CNCI | - | 8.00 | 6.50 | -1.50 | -18.8% |
| $E^2$ | - | - | 1.50 | 1.50 | N/A |
| I-Corps | - | 0.25 | 1.00 | 0.75 | 300.0% |
| INSPIRE | - | 0.50 | 1.00 | 0.50 | 100.0% |
| SEES | 5.61 | 1.50 | 3.00 | 1.50 | 100.0% |
| SaTC | - | 4.00 | 6.00 | 2.00 | 50.0% |
| EarthCube | - | 1.50 | 4.50 | 3.00 | 200.0% |

Major investments may have funding overlap and thus should not be summed.

- CAREER: OCI's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organization. OCI estimates that it will make approximately 5 CAREER awards in FY 2013.

- Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS): OCI support will fund awards related to computing algorithms and infrastructure, and data systems for the Materials Genome Initiative.

- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21): OCI support focuses on the extension of OCI core programs in data, software, networking, and virtual organizations across NSF communities to serve as resources for enhancing scientific collaboration and discovery.

- Comprehensive National Cybersecurity Initiative (CNCI): OCI continues support of CNCI with awards focused on game-changing security prototypes and experimental approaches.

- Expeditions in Education ($E^2$): Through the $E^2$ program, OCI will participate in efforts across NSF to assure that scientists and engineers have the training and skills to realize the potential of new cyberinfrastructure tools.

- Innovation Corps (I-Corps): OCI support for I-Corps will fund awards for mentoring researchers or providing additional support for projects that have been previously funded to transition them into practical cyberinfrastructure tools.

- Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE): OCI support of INSPIRE will support Creative Research Awards for Transformative Interdisciplinary Ventures (CREATIV) that help further the OCI goals of creating integrated cyberinfrastructure across

multiple disciplines. OCI will also participate in additional award mechanisms that might be issued as part of the INSPIRE investment.

- Science, Engineering, and Education for Sustainability (SEES): OCI will support computational approaches in climate modeling, system dynamics, and fuel research. OCI supports Research Coordination Networks in the SEES-RCN track to bring different communities together through digital environments to address sustainability problems.

- Secure and Trustworthy Cyberspace (SaTC): OCI support of SaTC is focused on the transition to practice perspective, which leverages successful results from previous and current research and focuses on later stage activities in the research and development lifecycle.

- EarthCube: EarthCube is a partnership between GEO and OCI to create integrated data management infrastructures across the geosciences. OCI funding supports multiple applied areas of cyberinfrastructure development, leveraging OCI core programs, with emphasis on data sharing and archiving, networking, and community building.

## Summary and Funding Profile

OCI invests in core research and education, as well as research infrastructure, such as high performance computing resources, software, data, and networking infrastructure. In FY 2013, the number of research grant proposals is expected to increase by 10 from the FY 2012 Estimate as OCI initiates programs to award smaller grants in conjunction with CIF21. The average annualized award size decreases in FY 2013 relative to the FY 2012 Estimate also for this reason. In addition, due to a large acquisition in FY 2012 for the Track 1 HPC program, the average and, to a lesser extent, the median award size in FY 2012 will be larger than in FY 2013.

**OCI Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 706 | 680 | 690 |
| Number of New Awards | 151 | 135 | 145 |
| Funding Rate | 21% | 20% | 21% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 642 | 670 | 680 |
| Number of Research Grants | 115 | 125 | 135 |
| Funding Rate | 18% | 19% | 20% |
| Median Annualized Award Size | $127,707 | $175,000 | $160,000 |
| Average Annualized Award Size | $159,221 | $250,000 | $225,000 |
| Average Award Duration, in years | 2.7 | 2.5 | 2.6 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):

- In 2011 a COV reviewed OCI. The COV presented its report to the Advisory Committee for Cyberinfrastructure in November 2011. The COV generally found the integrity and efficiency of OCI's processes and management to be high. The COV found the merit review process and portfolio of awards to be excellent. The COV recommended a change to the DataNet program, which is being implemented with a new solicitation in FY 2012. The COV also found that OCI faces unique challenges in creating long-term infrastructure programs with rotating program directors and in developing new communities around data-intensive science while maintaining support for its existing science and engineering computing community.

**Number of People Involved in OCI Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 1,004 | 775 | 800 |
| Other Professionals | 426 | 320 | 330 |
| Postdoctorates | 78 | 85 | 90 |
| Graduate Students | 324 | 325 | 320 |
| Undergraduate Students | 197 | 155 | 155 |
| **Total Number of People** | **2,029** | **1,660** | **1,695** |

## Office of Cyberinfrastructure High Performance Computing Portfolio

**OCI High Performance Computing Funding**

(Dollars in Millions)

| | Prior Years[1] | FY 2011 Actual | FY 2012 Estimate[2] | FY 2013 Request |
|---|---|---|---|---|
| Track 1 | 329.49 | 92.13 | 39.41 | 30.00 |
| Innovative HPC Program | 171.52 | 4.97 | 48.90 | 25.00 |
| Teragrid - Phase III (XD) | 23.82 | 90.81 | - | 27.00 |
| **Total** | **$524.83** | **$187.91** | **$88.31** | **$82.00** |

Totals may not add due to rounding.

[1] Prior Years includes $17.0 million of ARRA funding in FY 2009 and support for Teragrid (included on the Track 1 funding line) through FY 2010.

[2] FY 2012 Estimate excludes $71.10 million of FY 2011 funds that will be provided for Track 1 in FY 2012. The FY 2011 funds were originally obligated in FY 2011 to fund FY 2013 – FY 2015 of another OCI award (XD) but they were deobligated in FY 2012 in order to complete the Blue Waters funding. No funding is needed for XD in FY 2012 due to forward funding provided in FY 2011.

NSF has been a leader in High Performance Computing (HPC) for almost four decades. Due to the continuing rapid change in computing and related technologies, coupled with the exponential growth and complexity of data for the science, engineering, and education enterprise, NSF has created a new vision and strategy towards Advanced Computing Infrastructure (ACI) which will expand NSF's leadership role in science and engineering. This new coordinated NSF-wide strategy, which is a key component of the CIF21 framework, seeks to position and support the entire spectrum of NSF-funded communities at the cutting edge of advanced computing technologies, hardware, and software. It also aims to promote a more complementary, comprehensive, and balanced portfolio of advanced computing infrastructure and programs for research and education to support multidisciplinary computational and data-enabled science and engineering that supports the entire scientific, engineering, and education community. This shift away from a focus on procurement is consistent with the recommendations of a recent review[1] of the Federal Networking and Information Technology R&D (NITRD) program by the President's Council of Advisors on Science and Technology.

### TRACK 1 (PETASCALE COMPUTING) – BLUE WATERS

**Description**

The National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign has provided the capability for researchers to tackle much larger and more complex research challenges than previously possible, by acquiring, deploying, and operating a sustained petascale leadership class high-performance computational resource known as Blue Waters. This investment complements the Department of Energy (DOE) Office of Science program on computing hardware, which focuses on peak petascale performance, with Blue Waters providing sustained petascale performance. This system, which is located at the University of Illinois at Urbana-Champaign, will be delivered in FY 2012. It is operated by NCSA and its partners in the Great Lakes Consortium for Petascale Computing (GLC).

[1] *Designing a Digital Future: Federally Funded Research and Development Networking and Information Technology,* President's Council of Advisors on Science and Technology, December, 2010.

The Blue Waters project also includes education and outreach programs that will target pre-college, undergraduate, graduate, and post-graduate levels. A Virtual School of Computational Science and Engineering has been established to create courses that focus on petascale computing and petascale-enabled science and engineering. The Virtual School is exploring new instructional technologies and creating courses, curricula, and certificate programs tailored to science and engineering students. It has also sponsored workshops, conferences, summer schools, and seminars.

The project includes an annual series of workshops targeted at the developers of simulation packages and aspiring application developers. In addition, the project includes two industrial partnership activities: the Industry Partners in Petascale Engagement (IPIPE) program will provide industrial partners with a first look at the technological and scientific developments that flow from the petascale program. The Independent Software Vendor Application Scalability Forum will promote collaborations among consortium members, independent software vendors, and the industrial end-user community.

The broader impacts of this award include: provisioning of unique infrastructure for research and education; extensive efforts accelerating education and training in the use of high-performance computation in science; training in petascale computing techniques; promoting an exchange of information between academia and industry about the applications of petascale computing; and broadening participation in computational science through NCSA's Girls Engaged in Mathematics and Science (GEMS) program. GEMS is designed to encourage middle-school girls to consider mathematics-oriented and science-oriented careers.

**Current Status**

In late FY 2010 UIUC was notified by the vendor, IBM, that FY 2011 sub-award milestones would be delayed. UIUC submitted a request to NSF to extend the project end date by approximately nine months, and an external review panel at NSF approved a change in schedule. Under a dispute resolution procedure in the contract, UIUC and IBM attempted to reach agreement regarding project timeline and scope. The parties were unable to reach agreement, and in August 2011, per the terms of their agreement, IBM terminated its contract with UIUC. UIUC submitted a change to the Project Execution Plan (PEP) that was reviewed by an external panel and approved in late September 2011. UIUC selected a new vendor, Cray, for the project, which is expected to be complete by the end of FY 2012.

**Science and engineering research and education activities enabled by Blue Waters**

This award permits investigators across the country to conduct innovative research demanding petascale capabilities. Allocations have been requested for research on: complex biological behavior in fluctuating environments, the electronic properties of strongly correlated systems, the properties of hydrogen and hydrogen-helium mixtures in astrophysically relevant conditions, the electronic and magnetic structures of transition metal compounds, the molecular dynamics responsible for the properties of liquid water, and the propagation of seismic energy through a detailed structural model of Southern California together with the predicting of ground motion and the modeling of the response of buildings and other structures. Other allocations address testing hypotheses about the role of cloud processes and ocean mesoscale eddy mixing in the dynamics of climate and improving climate models, the formation of the first galaxies, turbulent stellar hydrodynamics, binary black hole and neutron star systems as sources of gamma ray bursts, and other intense radiation phenomena, contagion, and particle physics.

**Management and Oversight**

**NSF Structure:** The project is managed and overseen by OCI program staff and a grants officer from the Division of Grants and Agreements (DGA). These NSF staff members receive strategic advice from NSF's CIF21 Strategy and Leadership group, which includes representatives from the various directorates and offices. Advice from the Office of General Counsel (OGC) is sought as necessary.

**External Structure:** During the development and acquisition phase of this project, UIUC oversees work by a number of sub-awardees, conducts software development, and assists competitively selected research groups to prepare to use the Blue Waters system. The primary sub-awardee is responsible for implementation of the hardware, system software, and main program development tools. Other sub-awardees will work on performance modeling, the evaluation of an astrophysical modeling framework, the engagement of applications groups, scalable performance tools, undergraduate training, and broadening the participation of underrepresented groups in high-performance computing. Following system testing and acceptance in 2012, the Blue Waters project will enter a five-year operations phase. A proposal from UIUC for operations is anticipated in FY 2012. The project team is advised by a Petascale Executive Advisory Committee composed of senior personnel with technical and management expertise in high-performance scientific computing, the management of acquisition contracts for leading-edge computing systems, and the operation of large computing centers.

**Risks:** Any activity of this nature, and at this scale, comes with a certain element of risk. The extensive review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 1 award required that risks be identified and analyzed, and that a mitigation plan be created and followed. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register. Discussion of risks is part of the weekly discussions between UIUC and NSF. Periodic closed session updates to the National Science Board (NSB) identify any major changes in risk assessment.

**Reviews:** The project was selected through a competitive review in 2007. An external panel of experts, selected by NSF, reviews the progress of the project including project management, risk management, hardware and software development, and the provision of advanced user support to research groups receiving provisional resource allocations on the Blue Waters system. One of the important roles of this external review panel is to analyze the awardee's assessments of the deliverables from its sub-awardees, together with the awardee's and sub-awardees' plans for remedial action when necessary, and to provide NSF with advice on whether these assessments and plans are reasonable. At the time of writing, these external reviews had been conducted in February 2008, April 2008, October 2008, April 2009, July 2009, December 2009, April 2010, September 2010, December 2010, February 2011, and May 2011, and September 2011.

## INNOVATIVE HPC

Using lessons learned during the execution of the HPC Track 2 program and informed by the NSF Advisory Committee for Cyberinfrastructure's (ACCI) High Performance Computing task force, the HPC Track 2 program was renamed Innovative HPC in 2011. Innovative HPC awards will be made in the context of the eXtreme Digital (XD) services program (described below). While the Track 1 (Petascale Computing) system is targeted to provide sustained petascale performance, the Innovative HPC systems provide, at most, petascale peak performance. Each system is capable of supporting hundreds of researchers (over the course of a year) doing leading-edge science and engineering.

There is a direct relationship between the Innovative HPC awards and the XD activity. Several systems are currently serving as allocatable resources within XD. Initially, Innovative HPC awards were generally made as two parts: a) an acquisition component and associated funding, and b) an operations and maintenance component and associated funding. More recent awards in the Innovative HPC program (including FutureGrid, Gordon, and Keeneland) did not separate these components due to the experimental nature of the systems. When an award was made, funding was provided to the institution, which issued sub-awards to vendors for acquisitions as necessary. Once the system has passed the

acceptance process, vendors receive final payment for the system. Once the system has been fully tested, it becomes an XD resource and the institution becomes an XD resource provider and has access to the operations and maintenance funding component of the award.

Beginning with the FY 2011 solicitation, based on feedback from the scientific and engineering community, a more sustained approach to core HPC services was initiated. This provides a longer time horizon for funding of HPC providers in recognition of the value and time required for building and retaining staff skilled in interdisciplinary computational science. Thus, an eight to ten year horizon is envisioned for a core HPC provider. This timeline begins with an acquisition award, which allows for the possibility of a renewal acquisition award four years after the original award. In addition to the acquisition awards, accompanying operations and maintenance (O&M) awards are planned.

**Science and engineering research and education activities enabled by Innovative HPC**

- The complete spectrum of scientific research is supported, including: climate and weather modeling, economics, cosmology and astrophysics, geosciences, physics, chemistry, biology and medicine, earthquake engineering, and mechanical engineering.

- Innovative HPC will enable world leading transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by underrepresented groups; by providing researchers and educators with usable access to computational resources, beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.

- Through the unifying XD framework and services, Innovative HPC will enable researchers to manipulate extremely large amounts of digital information from simulation, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.

- Outreach and training critical to reducing the barriers to the use of HPC systems by the research and education community will be provided by engaging research universities and foundations. Innovative HPC will incorporate new computational technologies and new approaches to software and data management, together with the expertise to enable researchers and students to complement theory and experiment with an equal emphasis in computation.

**Management and Oversight for Innovative HPC**

**NSF Structure:** OCI program officers provide direct oversight during both the acquisition and operations phase. Formal reporting consists of quarterly and annual reports, which are reviewed by the program officer. There are also bi-weekly teleconferences with NSF program officers.

**Risks:** Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The awards are experimental, by nature, and therefore encompass high-risk, high-reward scenarios. The award process requires that risks be identified and analyzed, and that a mitigation plan be created and followed. One of the activities of the periodic NSF external reviews, conducted by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

**Reviews:** Annual reviews will be performed as part of the XD review. Semi-annual reviews will be performed as part of the acquisition phase. The reviews are arranged by the NSF program officer. The reviewers' backgrounds include scientific research, project management, and large-scale systems acquisitions and operations, and include familiarity with projects funded by NSF as well as other federal agencies. To the extent possible, continuity through the series of reviews will be provided by using the same set of reviewers.

**External Structure:** Each Innovative HPC award is managed under a cooperative agreement. Each awardee is responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress is evaluated by the review process and the NSF program officer.

Each project has a detailed management plan in place. Each cooperative agreement includes the management structure, milestones, spending authorization levels, and review schedule.

**Current Status:** Machines and facilities that are currently operational in the Innovative HPC program include Blacklight, Forge, Kraken, Lonestar, Longhorn, Ranger, and Trestles. FutureGrid, Gordon, Keeneland are new highly innovative experimental systems that are becoming fully operational in FY 2012. An award for $27.50 million was made in September 2011 to the University of Texas at Austin for the development of a new system called Stampede. Stampede will be a comprehensive computing, data analysis, and visualization system. It is expected to come online in January 2013 and will be the most powerful system in the NSF XD environment.

The largest resource in the NSF portfolio designed for capacity computing, Kraken, located at the National Institute for Computational Sciences at the University of Tennessee, has reached the end of its useful lifetime. The intent is to provide an additional year of funding to Kraken in FY 2012 while the new solicitation and review process proceeds during late FY 2012 through early FY 2013. New award(s) are expected in FY 2013 to provide the capacity level computational needs of the Open Science community.

**FutureGrid Experimental High Performance Grid Testbed at Indiana University (IU)**

**Description**

- The project team, led by Indiana University, has provided a significant new experimental computing grid and cloud test-bed, named FutureGrid, to the research community, together with user support for third-party researchers conducting experiments on FutureGrid. This will enable them to tackle complex research challenges in computer science related to the use and security of grids and clouds.

- The test-bed includes a geographically distributed set of heterogeneous computing systems, a data management system that will hold both metadata and a growing library of software images, and a dedicated network allowing isolatable, secure experiments.

- The test-bed will support virtual machine-based environments, as well as native operating systems for experiments aimed at minimizing overhead and maximizing performance.

- The project partners will integrate existing open-source software packages to create an easy-to-use software environment that supports the instantiation, execution, and recording of grid and cloud computing experiments.

- The FutureGrid system is being integrated into XD in FY 2012 as an operational system.

**Gordon Data-Intensive Computing at San Diego Supercomputer Center (SDSC)**

**Description**

- The University of California at San Diego (UCSD) has provided a ground-breaking new computing facility, Gordon, which will be made available to the research community together with advanced user support for researchers with data-intensive problems that may not parallelize well or will require access to very large amounts of memory.

- The distinguishing features are the integration of solid state disks (SSDs) and very large shared memory. This system will be optimized to support research with very large data-sets or very large input-output requirements. It will provide a step-up in capability for data-intensive applications that scale poorly on current large-scale architectures, providing a resource that will enable transformative research in many research domains.

- As a result of the change in the processor timeline, the system will become fully operational as part of the NSF XD environment in FY 2012.

**Keeneland Experimental High Performance Computing at Georgia Institute of Technology**

**Description**

- Keeneland, provided by the Georgia Tech Research Corporation (GTRC), is a new experimental high performance computing facility with unconventional computing architectures. The system will allow scientific and engineering researchers to evaluate the relative merit of these new architectures.

- The distinguishing feature of Keeneland is the inclusion of General-Purpose computation on Graphics Processing Units processors (GPGPU) as a general purpose technique for computational acceleration in large systems. The goal is to address computational problems that are challenging to more conventional supercomputing architectures. Productivity is of particular interest in using Open Computing Language (OpenCL) as a mechanism to program the GPGPUs.

- Applications will require additional development and testing to be appropriately prepared to effectively use this new type of architecture.

- An initial system for prototype software and applications development was installed in FY 2010. A full-scale system is being installed in FY 2012 and will become an XD resource.

**Stampede – Enabling, Enhancing and Extending Petascale Computing for Science and Engineering at University of Texas at Austin**

**Description**

- The Stampede project at the University of Texas at Austin will deliver a new system to NSF XD cyberinfrastructure services in FY 2013, replacing a previous system that was developed from an award in FY 2007.

- The new resource and accompanying services target science and engineering researchers using both advanced computational methods and emerging data-intensive approaches.

- The new system will boost XD resources to nearly twice their current capacity. It provides researchers with early access to a potentially transformative new approach to performance via Intel Many Integrated Core (MIC) processors. An addition of the second generation of the MIC processors is planned in late FY 2015.

## TERAGRID PHASE III: EXTREME DIGITAL (XD)

**Description:**

- XD, successor to the TeraGrid program, is an advanced, nationally distributed, open cyberinfrastructure comprised of shared user and management services (XSEDE, eXtreme Science and Engineering Discovery Environment), supercomputing, storage, analysis, and visualization systems, data services, and science gateways, connected by high-bandwidth networks, integrated by coordinated policies and operations, and supported by computing and technology experts.

- XD enables and supports leading-edge scientific discovery and promotes science and technology education.

- XD has taken a significant step forward by encouraging innovation in the design and implementation of an effective, efficient, increasingly virtualized approach to the provision of high-end digital services – extreme digital services – while ensuring that the infrastructure continues to deliver high-quality access for the many researchers and educators that use it in their work.

**Science and engineering research and education activities enabled by XD**

- XD services will enable transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering to under-represented groups, by providing researchers and educators with coherent and highly usable access to extreme-scale digital resources beyond those typically available on most campuses, together with the interfaces, consulting, advanced user support, and training necessary to facilitate their use.

- XD provides high-performance computing services, enables researchers to manipulate extremely large amounts of digital information from simulations, sensors, and experiments, and adds needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.

- XD is developing tools and services that not only link users to national facilities but that enable scientific collaboration within and across university campuses, government laboratories, and experimental facilities.

- The project includes outreach and training critical to reducing the barriers to the use of advanced digital systems by the research and education communities. XD incorporates new ideas and technologies to enable researchers and students to move transparently between local and national resources, substantially lowering the barriers to effective use of cyberinfrastructure and promoting enhanced productivity.

**Management and Oversight**

**NSF Structure:**

- XD shared services consist of several inter-related parts – High-Performance Remote Visualization Service (HPRVS); Technology Audit Service (TAS); Technology Insertion Service (TIS); Coordination and Management Service (CMS); Advanced User Support Service (AUSS); and Training, Education and Outreach Service (TEOS). The last three elements constitute the XSEDE project that manages shared services in the XD program.

- These elements are designed and implemented in a way that is consistent with sound system engineering principles, clearly tied to the user requirements of the science and engineering research

community using a flexible methodology that permits the architecture to evolve in response to changing user needs and presents the individual user with a common user environment regardless of where the resources or user is located.

- The HPRVS was reviewed in FY 2009 and two awards were made, one to the University of Texas at Austin ($7.0 million) and one to the University of Tennessee-Knoxville ($10.0 million).

- The TAS and TIS components of XD were reviewed in FY 2010 and two awards were made; one award to the University of Buffalo for the TAS and one award to the University of Illinois at Urbana-Champaign for the TIS. These two awards have facilitated the TeraGrid to XD transition and are already functioning successfully in the new environment.

- The final component of XD, called XSEDE, for CMS, AUSS and TEOS, has been awarded to the University of Illinois Urbana-Champaign (UIUC) as of July 1, 2011. This is a five-year award for $121.0 million and involves four other major partners. They are the University of Pittsburgh, University of Texas at Austin, University of California San Diego (UCSD) and the University of Tennessee at Knoxville. XSEDE also involves twelve other institutions.

- Similar to TG, XD will be managed by OCI, informed by the ACCI and its task forces, with ongoing strategic guidance from the NSF cross-directorate CIF21 Strategy and Leadership Group. The project has an external advisory board, a user board, and a service providers board to ensure that all stakeholders can provide project input. These boards provide substantial ongoing community input to the XD project.

- OCI participates in the management of XSEDE via weekly teleconferences with the senior XSEDE personnel.

**External Structure:** The final configuration of XD consists of an access and accompanying services component, and compute, visualization, and storage resources at a number of sites. The sites contain a range of high-performance computing platforms, large disk storage devices, computational platforms specifically tailored for remote visualization, high-bandwidth networks, a broad set of user services and an education, outreach, and training component designed to fulfill the needs of current users of high-performance computing, as well as to broaden participation to new communities and under-represented groups in science and engineering. The composition of these sites will change in time as new resources become part of the XD family and other resources are retired. University partners may be part of XSEDE services either by providing and receiving services to the project or by simply using the digital products being developed by XSEDE in their own local environment.

**Current Status:** Two planning grants, one to UCSD ($1.60 million) and one to UIUC ($1.62 million), were made in FY 2009 to obtain community input and engagement in order to develop the ideas and expanded horizons that will be required to deploy the advanced infrastructure required for XD. The planning grants were reviewed in February 2010 and the two teams submitted their full proposals in July 2010. The full proposals were reviewed by an external panel of experts in the fourth quarter of FY 2010. A recommendation for an award, entitled XSEDE, was approved by the NSB and awarded July 1, 2011.

## OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING (OISE)

**$51,280,000**
**+$1,430,000 / 2.9%**

**OISE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **OISE** | **$49.03** | **$49.85** | **$51.28** | **$1.43** | **2.9%** |

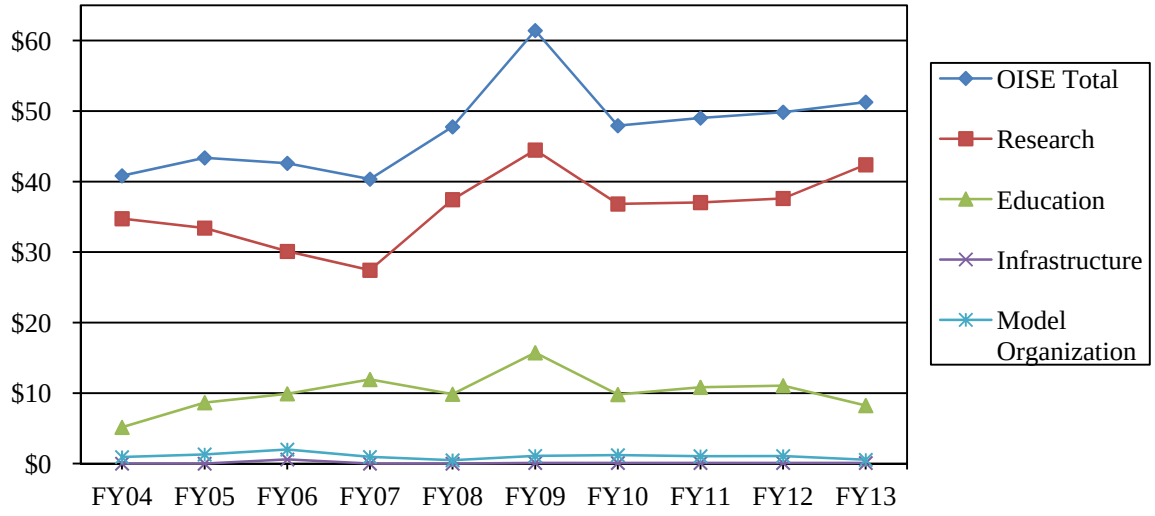
## About OISE

The Office of International Science and Engineering (OISE) serves as the NSF focal point for international science and engineering activities. In support of the OneNSF framework, OISE's goal is to promote an integrated, Foundation-wide international strategy and manage internationally-focused programs that are innovative, catalytic, and responsive to a broad range of NSF and national interests. In FY 2013, OISE will emphasize support of activities that augment and further integrate international engagement of research and education programs across NSF. OISE supports co-funding with NSF directorates and offices through two activities – Science Across Virtual Institutes (SAVI) and the Global Venture Fund (GVF). In addition, OISE manages and funds the Partnerships for International Research and Education (PIRE) program, the International Research Fellowship Program (IRFP), and the International Research Experience for Students (IRES), that support U.S. scientists, engineers, and students engaged in international research and education activities in all NSF-supported disciplines involving any region of the world. OISE's programs and activities are designed to complement and enhance the Foundation's broad research and education portfolio and to overcome barriers to international collaboration. America's next generation of scientists and engineers must be able to work effectively in the global arena and marketplace. OISE supports programs that enable students and researchers to engage in international research and educational activities across such areas as cyberinfrastructure, complex biological systems, natural hazards prediction and mitigation, nanotechnology, water resources, climate, and energy sustainability.

In addition, OISE manages NSF's offices in Beijing, Paris, and Tokyo that report on and analyze in-country and regional science and technology developments and policies, promote greater collaboration between U.S. and foreign researchers, liaise with foreign counterpart agencies and research institutes, and facilitate coordination and implementation of NSF research and education programs.

OISE also coordinates much of NSF's engagement with international organizations across diverse disciplines and initiatives and coordinates NSF efforts to strengthen collaborations with Muslim Majority and developing countries, which are increasingly important partners in addressing critical global issues. NSF supports these activities by funding proposals that meet NSF's high standards of merit review and involve true intellectual collaboration and mutually beneficial activities with researchers and educators in Muslim-Majority and developing countries. Examples of NSF and OISE managed programs that advance U.S. research interests and encourage research collaborations in both developing countries and Muslim-Majority Countries include PIRE, Advanced Studies Institutes, IRES, IRFP, and Partnerships for Enhanced Engagement in Research (PEER).

**OISE Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

**OISE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **OISE** | **$49.03** | **$49.85** | **$51.28** | **$1.43** | **2.9%** |
| Research | 38.10 | 38.70 | 42.93 | 4.23 | 10.9% |
| Education | 10.84 | 11.05 | 8.25 | -2.80 | -25.3% |
| Infrastructure | 0.10 | 0.10 | 0.10 | - | - |

Totals may not add due to rounding.

## FY 2013 Summary

### Research

OISE works closely with the other NSF directorates and offices to support and leverage international opportunities between U.S. and foreign researchers. The OISE FY 2013 request will, in part, co-fund international disciplinary and interdisciplinary activities with other NSF organizational units as driven by proposal pressure from the research community. OISE's existing funding mechanisms, together with the potential for involving new funding partners both domestic and foreign, will enable more and stronger international research collaborations.

### Education

OISE supports international research and education activities for U.S. undergraduate and graduate students and post-doctoral fellows through programs managed by OISE and through supplemental funding associated with NSF disciplinary programs.

**Infrastructure**
In FY 2013 OISE will continue support of the National Nanotechnology Infrastructure Network (NNIN) to leverage connections and collaborations with foreign institutions. For information about NNIN, please refer to the Facilities chapter.

## Major Investments

**OISE Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| CIF21 | - | - | 1.00 | 1.00 | N/A |
| Clean Energy Technology | 2.85 | 13.21 | 13.07 | -0.14 | -1.1% |
| $E^2$ | - | - | 0.50 | 0.50 | N/A |
| INSPIRE | - | - | 1.00 | 1.00 | N/A |
| SEES | 1.33 | 12.00 | 11.55 | -0.45 | -3.7% |
| PIRE | 18.71 | 19.00 | 19.00 | - | - |
| GVF | - | 3.00 | 7.00 | 4.00 | 133.3% |
| SAVI | - | 2.00 | 5.00 | 3.00 | 150.0% |
| International Programs for students and early career researchers | 10.63 | 11.05 | 8.25 | -2.80 | -25.3% |
| U.S. participation in Global Organizations | 7.76 | 7.76 | 7.76 | - | - |

Major investments may have funding overlap and thus should not be summed.

- OISE funding of $1.0 million in the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) will support the international components of NSF programs in data, software, networking, and virtual organizations that enhance scientific collaboration and discovery.

- OISE support of $13.07 million for clean energy technology will enhance research and innovations in such areas as solar energy technologies, biofuels and bioenergy, wind energy generation, sustainability, and renewable energy storage. The OISE Clean Energy investment includes its support of the Science, Engineering, and Education for Sustainability (SEES) activity.

- Initial funding of $500,000 in FY 2013 will support international components of the new Expeditions in Education ($E^2$) OneNSF investment area.

- OISE participation in Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) will strengthen NSF's long-standing investments in globally focused interdisciplinary, potentially transformative research. OISE's FY 2013 Request for INSPIRE is $1.0 million.

- OISE will support the NSF-wide SEES investment ($11.55 million) by funding international collaborations that focus on research and technologies to mitigate and adapt to, environmental change that threatens sustainability. OISE's greatest share of SEES support consists of its funding for the existing 2012-2016 PIRE cohort.

- Partnerships for International Research and Education (PIRE) is an NSF and OISE funding priority in FY 2013. The PIRE program makes multi-year and multi-million dollar awards to U.S. institutions that build strong international research and education partnerships. Each PIRE award supports U.S. faculty to lead projects designed to achieve research excellence through the added-value gained by international collaboration including, access to essential intellectual expertise, research facilities, and/or unique phenomena outside the U.S. In FY 2013, OISE plans to invest $10.0 million for the second-year PIRE funding of the 2012-2016 cohort, and $9.0 million for continuation funding of the 2010-2014 PIRE cohort. No new PIRE competition will be conducted during FY 2013 as PIRE competitions are biannual. Total FY 2013 Request funding for PIRE is $19.0 million and is unchanged from the FY 2012 Estimate.

- The Global Venture Fund (GVF) formalizes, streamlines, and standardizes OISE's long-standing practice of co-funding new awards and supplements to existing awards that enhance research excellence through international collaboration and promote the development of globally engaged U.S. scientists and engineers. OISE will invest $7.0 million in GVF co-funding in FY 2013.

- Science Across Virtual Institutes (SAVI) is an NSF-wide activity designed to provide a mechanism for U.S. research communities and their international partners to develop long-term collaboration in STEM, building on relationships initiated via NSF-supported teams of researchers, research institutes and universities. OISE will support SAVI projects across NSF through co-funding at $5.0 million.

- OISE manages three programs that support students and early career researchers in international activities:
  - IRFP supports U.S. postdoctoral-level scientists and engineers for international collaborative research, with the objective of furthering their research capacity and global perspective, and forging long-term relationships with researchers abroad. In FY 2013, IRFP funding will be $3.60 million, which is $900,000 less than the FY 2012 Estimate in order to increase OISE support of GVF. In FY 2013, at least $1.0 million will be provided through GVF to support disciplinary NSF postdoctoral fellows who wish to spend part of their tenure in foreign institutions.

  - East Asia and Pacific Summer Institutes (EAPSI) introduces U.S. graduate students to science and engineering research in the East Asia and Pacific region, and initiates scientific relationships that will enable future collaboration with foreign counterparts. Seven locations currently partner with NSF in the program: Australia, China, Japan, Korea, New Zealand, Singapore, and Taiwan. In FY 2013, EAPSI funding will be $2.40 million, which is unchanged from the FY 2012 Estimate.

  - IRES supports groups of U.S. undergraduate and/or graduate students conducting research in collaboration with foreign investigators at an international site. In FY 2013, IRES funding will be $2.25 million, which is $900,000 less than the FY 2012 Estimate primarily to increase OISE support of SAVI in FY 2013. In addition, it is expected that at least $1.0 million will be used to support U.S. graduate students' international research experience in European Union (EU) countries through SAVI in partnership with the EU. Approximately $500,000 will be spent to co-fund disciplinary programs support of international research experience for students via GVF.

- In FY 2013, OISE will continue to provide $7.76 million in support of U.S. participation in domestic and foreign organizations that facilitate international activities for U.S. researchers and educators.

## OISE Funding for Facilities

**OISE Funding for Facilities**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Facilities** | $0.10 | $0.10 | $0.10 | - | - |
| National Nanotechnology Infrastructure Network (NNIN) | 0.10 | 0.10 | 0.10 | - | - |

For detailed information on individual facilities, please see the Facilities chapter.

### Facilities

OISE will continue to provide $100,000 in support of the National Nanotechnology Infrastructure Network (NNIN). This contribution will leverage connections and collaborations among U.S. and foreign institutions.

## Summary and Funding Profile

The average and median award size for OISE decreases in FY 2013 from the FY 2012 Estimate since no PIRE competition will be conducted during FY 2013. PIRE competitions are biannual with multi-year and multi-million dollar awards to U.S. institutions.

**OISE Funding Profile**

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 1,215 | 1,235 | 1,270 |
| Number of New Awards | 405 | 410 | 425 |
| Funding Rate | 33% | 33% | 33% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 897 | 910 | 940 |
| Number of Research Grants | 104 | 105 | 110 |
| Funding Rate | 12% | 12% | 12% |
| Median Annualized Award Size | $49,542 | $70,000 | $50,000 |
| Average Annualized Award Size | $60,136 | $270,000 | $60,000 |
| Average Award Duration, in years | 1.9 | 2.4 | 2.0 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see that chapter for additional information.

External independent evaluations of the IRFP and EAPSI programs will be completed in FY 2012. Funding was provided in FY 2011. These evaluations will focus on four tasks: (1) a study of the IRFP and EAPSI fellows' experiences in applying for and participating in the programs; (2) a comparative data analysis of professional outcomes (educational and occupational) for IRFP and EAPSI awardees and other applicants; (3) an analysis of the impact IRFP and EAPSI have on U.S. academic institutions and on the foreign institutions that host IRFP and EAPSI fellows; and (4) the bringing together of an advisory group to ensure the quality of the evaluation process.

An evaluation of the PIRE program will be initiated during FY 2012 and is expected to be completed in FY 2014. The FY 2012 PIRE competition will be the fourth competition and an evaluation and assessment is timely and appropriate.

A review of the three overseas offices (Paris, Tokyo, and Beijing) will be conducted in FY 2012 to examine lower-cost options for NSF to maintain an effective and efficient international presence.

**Number of People Involved in OISE Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 1,590 | 1,615 | 1,660 |
| Other Professionals | 70 | 70 | 70 |
| Postdoctorates | 550 | 560 | 575 |
| Graduate Students | 1,800 | 1,830 | 1,880 |
| Undergraduate Students | 1,170 | 1,190 | 1,225 |
| **Total Number of People** | **5,180** | **5,265** | **5,410** |

## OFFICE OF POLAR PROGRAMS (OPP) $449,740,000
## +$13,870,000 / 3.2%

**OPP Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Arctic Sciences (ARC) | $105.86 | $102.76 | $108.51 | $5.75 | 5.6% |
| Antarctic Sciences (ANT) | 69.07 | 69.75 | 75.80 | $6.05 | 8.7% |
| Antarctic Infrastructure & Logistics (AIL) | 259.41 | 256.74 | 258.33 | $1.59 | 0.6% |
| *U.S. Antarctic Logistical Support* | [67.52] | [67.52] | [67.52] | - | - |
| Polar Environment, Health & Safety (PEHS) | 6.36 | 6.62 | 7.10 | $0.48 | 7.3% |
| **Total, OPP** | **$440.70** | **$435.87** | **$449.74** | **$13.87** | **3.2%** |

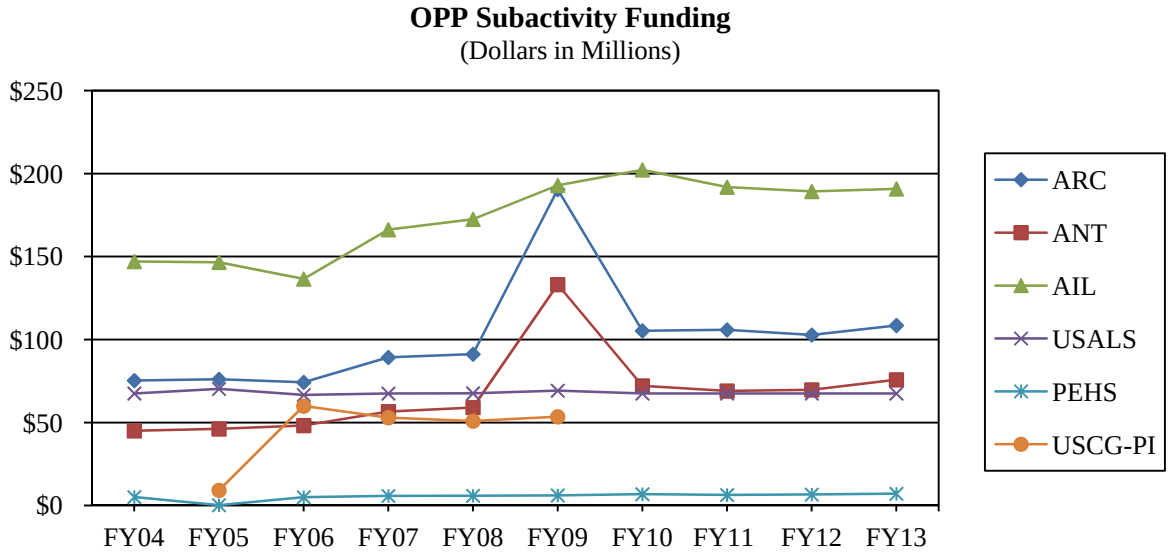
Totals may not add due to rounding.

### About OPP

The Office of Polar Programs (OPP) is the primary U.S. supporter of fundamental research in the polar regions. In addition, NSF provides interagency leadership for U.S. activities in polar regions. In the Arctic, NSF helps coordinate research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee created for this purpose, which is now a component of the President's National Science and Technology Council. In the Antarctic, per Presidential Memorandum 6646, NSF manages all U.S. activities as a single, integrated program, making Antarctic research possible for scientists supported by NSF and by other U.S. agencies. The latter include the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the Smithsonian Institution, and the Department of Energy. The U.S. Antarctic Program research activity supported by NSF also supports leadership by the U.S. Department of State in the governance of the continent and Southern Ocean under the aegis of the Antarctic Treaty.

OPP's FY 2013 Budget Request is influenced by four key priorities: (1) maintaining strong disciplinary programs that provide a base for our investments in cross-disciplinary system science programs; (2) strengthening U.S. research community activities in polar system science; (3) supporting critical facilities that enable research in the Earth's polar regions; and (4) enabling scientific leadership in research in polar regions that is aligned with the NSF-wide investments in Science, Engineering, and Education for Sustainability (SEES) and Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21). These priorities reflect opportunities for fundamental scientific discovery uniquely available in polar regions, as well as studies to investigate the causes and future trajectory of changes now being observed at the poles that could impact global systems. This work will implement the Foundation's lead-agency role in facilitating the Nation's investment in polar science, where environmental change in parts of the Arctic and Antarctic is occurring faster than anywhere else in the world, and has a wide variety of regional and global impacts. Research supported by OPP will elucidate the causes and likely impacts of these changes, thus providing a sound basis for future policy decisions.

In FY 2013 OPP will also provide support for NSF-wide efforts, such as Integrating NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) and NSF Innovation Corps (I-Corps).




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

OPP funding in FY 2010 and FY 2011 excludes appropriation transfers to the U.S. Coast Guard for Polar Icebreaking activities per Congressional mandates.

## FY 2013 Summary by Division

- ARC's FY 2013 Request is focused on fundamental research and the science needed by policy-makers to support decision-making regarding sound and sustainable economic and social development. A common theme in these activities is that they support NSF-funded research in the broader context of both interagency and international scientific studies.

- ANT's FY 2013 Request is focused on enabling fundamental discovery in fields as diverse as space weather, microbiology, and astrophysics, as well as on providing the fundamental science needed to reduce uncertainty in projections of future climate change. A common theme in these activities is that they have been identified as important directions in numerous community reports and discussions including the National Research Council's "Future Science Opportunities in Antarctica and the Southern Ocean."

- In FY 2013, AIL support includes providing increased logistical support for scientific studies that will further quantify ice-mass loss and sea level rise, atmosphere-ocean exchange rates, and how associated chemical changes will affect the marine ecosystem. Additional investments are focused on energy efficiency improvements and building the McMurdo fuel supply to a level that allows resiliency in the resupply schedule.

- In FY 2013, the Office of Polar Environment, Safety and Health continues its emphasis on environmental stewardship of the Arctic and the Antarctic, and on protecting the health and safety of researchers and others supporting research in polar regions. A priority for the office is the establishment of an electronic medical records system, using information technology to lower the cost of health care and improve delivery of health care services.

## Major Investments

**OPP Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| CIF21 | - | $4.00 | $4.50 | $0.50 | 12.5% |
| $E^2$ | - | - | 1.50 | 1.50 | N/A |
| I-Corps | - | - | 0.75 | 0.75 | N/A |
| INSPIRE | - | - | 1.00 | 1.00 | N/A |
| SEES | 7.00 | 14.50 | 14.50 | - | - |

Major investments may have funding overlap and thus should not be summed.

- CIF21: OPP support ($4.50 million, an increase of $500,000 over the FY 2012 Estimate) for the NSF-wide CIF21 investment will focus on continued support for the creation of robust data management approaches that support access to research community data, archive requirements, and interoperability among different databases; and to build science community networks in order to advance data-enabled science.

- Expeditions in Education ($E^2$): In FY 2013 OPP redirects its Climate Change Education Program investments of $1.50 million to participate in the $E^2$ program to advance the partnership between the science of learning and polar science communities. OPP expects to build on experience from the Climate Change Education program, as well as the International Polar Year education and outreach portfolio in order to capitalize on and encourage polar science perspectives for advancing the Expeditions in Education focus areas. The continuing partnership with the Directorate for Education and Human Resources (EHR) will ensure best practices are applied to rigorous assessment of funded activities.

- Innovation Corps (I-Corps): OPP will invest $750,000 in I-Corps in FY 2013, with the goal of advancing technologies for research, such as robotics and remote sensing technologies in support of polar observations, and for creating pathways for exporting technological advances, such as the innovative radars and radar data processing that have been developed by the OPP-supported Science & Technology Center for the Remote Sensing of Ice Sheets (CReSIS).

- Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE): OPP's existing system science programs were established expressly to encourage communities to innovate across disciplinary lines to address societally-compelling issues, such as polar contributions to sea level rise, impacts of change for the coupled Arctic-human system, and cryospheric feedbacks in the global climate system. OPP will strengthen these programs in FY 2013 by contributing $1.0 million to NSF efforts to identify and improve ways to review and support the most compelling interdisciplinary science.

- SEES: OPP will continue investments (totaling $14.50 million) to advance understanding of ice-mass loss and sea level rise; effects of change on Arctic social structures; ecosystem changes associated with warming permafrost, oceanographic processes, and marine ecosystem impacts associated with

ocean acidification; and building the intellectual capacity to address complex problems through support of interdisciplinary science networks.

## OPP Funding for Centers Programs and Facilities

**OPP Funding for Centers Programs**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$4.45** | **$4.45** | **$3.77** | **-$0.68** | **-15.3%** |
| STC: Center for the Remote Sensing of Ice Sheets (ANT) | 4.45 | 4.45 | 3.77 | -0.68 | -15.3% |

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- Funding for CReSIS is reduced in FY 2013, the ninth year of operation, in accordance with NSF policy for the phase-out of sunsetting Science and Technology Centers.

**OPP Funding for Facilities**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Facilities (Total)** | **$300.98** | **$299.24** | **$300.96** | **$1.72** | **0.6%** |
| Arctic Research Support & Logistics (ARC) | 44.29 | 43.54 | 43.54 | - | - |
| IceCube Neutrino Observatory[1] | 3.45 | 3.45 | 3.45 | - | - |
| U.S. Antarctic Facilities & Logistics | 185.72 | 184.73 | 186.45 | 1.72 | 0.9% |
| U.S. Antarctic Logistical Support | 67.52 | 67.52 | 67.52 | - | - |

[1]MPS (PHY) provides an equal amount for operation of IceCube

For detailed information on individual facilities, please see the Facilities chapter.

- Funding for U.S. Antarctic Facilities & Logistics increases in FY 2013 to support new research programs that are aligned with OneNSF framework investments and identified by ANT as high-priority scientific studies.

## Summary and Funding Profile

OPP supports investments in core research and education and provides research support and infrastructure, such as permanent stations and temporary field camps in the Antarctic and the Arctic.

In FY 2013, the number of research grant proposals is expected to increase by 112 compared to the FY 2012 Estimate and OPP expects to award about 305 research grants. Average annual award size and duration increase from FY 2011 through FY 2013. Funding for facilities accounts for approximately 68 percent of OPP's budget.

**OPP Funding Profile**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| **Statistics for Competitive Awards:** | | | |
| Number of Proposals | 680 | 674 | 786 |
| Number of New Awards | 297 | 288 | 336 |
| Funding Rate | 44% | 43% | 43% |
| **Statistics for Research Grants:** | | | |
| Number of Research Grant Proposals | 646 | 640 | 762 |
| Number of Research Grants | 267 | 260 | 305 |
| Funding Rate | 41% | 41% | 40% |
| Median Annualized Award Size | $149,125 | $146,500 | $157,500 |
| Average Annualized Award Size | $184,184 | $182,200 | $192,500 |
| Average Award Duration, in years | 2.5 | 2.5 | 2.8 |

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory Committees (ACs). Please see this chapter for additional information.

OPP plans to conduct COVs of its research and research support activities in late FY 2012/early FY 2013. The OPP AC met twice in FY 2011.

Aspects of the Office of Polar Environment, Health, and Safety requiring medical input are reviewed annually by a medical panel. Specialized reviews, such as that of the scientific diving program, are conducted as needed.

Indicators such as funding rates, award size and duration, and numbers of people supported on research and education grants also factor into OPP's internal program evaluation and performance improvement process.

In FY 2010, OSTP and NSF – which manages the U.S. Antarctic Program on behalf of the U.S. Government – tasked an independent review of the program that will continue into FY 2012. The review is being conducted in two phases: the first involved a National Research Council committee that examined and identified scientific drivers over the next two decades (see, *Future Science Opportunities in Antarctica and the Southern Ocean*, National Research Council, 2011); the second, a Blue Ribbon Panel, will analyze and report on the associated logistics and infrastructure needed to implement the science of the future effectively and efficiently. The Blue Ribbon Panel's report is expected in FY 2012.

**Number of People Involved in OPP Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 1,439 | 1,425 | 1,540 |
| Other Professionals | 874 | 860 | 940 |
| Postdoctorates | 123 | 110 | 125 |
| Graduate Students | 400 | 390 | 430 |
| Undergraduate Students | 261 | 245 | 290 |
| K-12 Teachers | - | - | - |
| K-12 Students | - | - | - |
| **Total Number of People** | **3,097** | **3,030** | **3,325** |

## DIVISION OF ARCTIC SCIENCES (ARC) $108,510,000
**+$5,750,000 / 5.6%**

**ARC Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, ARC** | **$105.86** | **$102.76** | **$108.51** | **$5.75** | **5.6%** |
| **Research** | **60.65** | **57.94** | **63.55** | **5.61** | **9.7%** |
| **Education** | **0.92** | **1.28** | **1.42** | **0.14** | **10.9%** |
| **Infrastructure** | **44.29** | **43.54** | **43.54** | **-** | **-** |
| *Arctic Research Support & Logistics* | *44.29* | *43.54* | *43.54* | - | - |

Totals may not add due to rounding.

Arctic Sciences is organized into several programs that support research in social science, earth system science, and a broad range of natural sciences. Educational projects are also supported. The Research Support and Logistics program assists researchers with access to the Arctic, improves safety and environmental stewardship, and increases the ability of researchers to share plans and results with local Arctic communities. The Arctic is experiencing rapid climate change, with scientific observations recording an estimated 14 percent per decade reduction in sea ice extent in the Arctic over the past 30 years, and significant summer melting of the Greenland Ice Sheet. At the same time the changes vary from region to region and, in addition, are tightly coupled to climate variability, which is also regional. These and other phenomena are forcing change and uncertainty in traditional Arctic populations, presenting challenges and opportunities for industry and commerce, and have the potential to affect the global population through changes in sea level and changed weather patterns. Arctic Sciences funds a broad range of activities to provide an integrated understanding of environmental change in the Arctic, including the study of significant, system-scale environmental change and its human dimension.

The Research Support and Logistics program is driven by and responds to research and education funded by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic support and logistics. Emphasis will be placed on improving access to and the energy security of the remote facilities used by Arctic researchers and educators.

In general, 40 percent of the Arctic Science division's portfolio is available for new research grants, with 20 percent for continuing grants made in previous years and 40 percent for research support and logistics.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Commitments to ongoing research programs are maintained; support for new grants is focused on disciplinary programs that are aligned with OneNSF framework investments. These programs include awards to advance understanding of the Chukchi-Beaufort Seas, building on new syntheses of historical data and the recent successes of interagency studies of the Bering Sea ecosystem; of the connection of land-ice and sea level and the mechanism(s) for ice-loss; and of the changing seasonality of sea ice that may have profound consequences at a variety of spatial scales – local,

regional, circumpolar Arctic, and global. Approximately $38.0 million is available for new grants in FY 2013.

- Studies on advancing understanding of societally-pressing areas, such as the effects of change on Arctic social structures and ecosystems changes associated with warming permafrost, are a continuing priority under SEES, as is building the intellectual capacity to address such complex problems through support of interdisciplinary science networks. Some of the resources previously directed to SEES are redistributed to other investment areas. (-$1.50 million to $7.75 million)
- Investments in CIF21 are focused on advancing data systems to enable science for the Arctic Observing Network to achieve the objectives of understanding the coupled human-natural Arctic system and for development of models that better represent the dynamic processes involved in this system. NSF funds primarily terrestrial and ocean-based observations through peer-reviewed research proposals. Data becomes immediately available after quality control, and most datasets are stored at the NCAR Earth Observing Laboratory.[1] CIF21 funds would allow improvements in areas of data interoperability and potentially building new systems for data discovery and access with interagency and international partners, again through peer-reviewed proposals. (+$1.0 million to $3.50 million)

**Education**

- Arctic Sciences redirects its $750,000 investment from the Climate Change Education program and will use these funds to participate in the Expeditions in Education program to advance the partnership between the science of learning and polar science communities. Arctic Sciences expects to build on experience from the Climate Change Education program, as well as the International Polar Year education and outreach portfolio in order to capitalize on and encourage polar science perspectives for advancing the Expeditions in Education focus areas. The continuing partnership with the Directorate for Education and Human Resources (EHR) will ensure best practices are applied to rigorous assessment of funded activities.
- Arctic Sciences will continue its investment in the Polar Postdoctoral Program, designed to broaden the community of polar researchers. ($500,000).

**Infrastructure**

- Funds are provided for logistics support to new research programs that are aligned with OneNSF framework investments and high-priority scientific studies that are needed to advance understanding of societally-pressing areas, such as the effects of change on Arctic social structures and ecosystems changes associated with warming permafrost, and building the intellectual capacity to address such complex problems through support of interdisciplinary science networks.
- Adjustments made to accommodate the above priorities include reducing costs by conservation of fuel through increased reliance on tractor-pulled sleds in lieu of aircraft to move fuel and equipment in support of studies at and near Summit Station, Greenland.

[1] http://data.eol.ucar.edu/codiac/projs?A-CADIS

## DIVISION OF ANTARCTIC SCIENCES (ANT) $75,800,000
**+$6,050,000 / 8.7%**

**ANT Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, ANT** | **$69.07** | **$69.75** | **$75.80** | **$6.05** | **8.7%** |
| **Research** | **64.20** | **65.03** | **70.93** | **5.90** | **9.1%** |
| Centers Funding (total) | 4.45 | 4.45 | 3.77 | -0.68 | -15.3% |
| *Center for Remote Sensing of Ice Sheets* | *4.45* | *4.45* | *3.77* | *-0.68* | *-15.3%* |
| **Education** | **1.38** | **1.27** | **1.42** | **0.15** | **11.8%** |
| **Infrastructure** | **3.49** | **3.45** | **3.45** | **-** | **-** |
| *IceCube Neutrino Observatory* | *3.45* | *3.45* | *3.45* | - | - |

Totals may not add due to rounding.

Antarctic Sciences funds research on high priority scientific topics for which access to Antarctica is essential to advancing the scientific frontiers. This includes research on physical, biological, geological, glaciological, oceanographic, and atmospheric processes in Antarctica, as well as on interactions of the ice sheets with the underlying continent, the surrounding ocean, and the overlying atmosphere. These studies also elucidate the Antarctic environment's role in the global Earth system. In particular, a new programmatic emphasis on system science fosters linkages across the disciplines in order to better advance understanding of Antarctica as an integrated system. Antarctic Sciences also provides instrumentation and supports research in astronomy and astrophysics that takes advantage of the polar environment to study the origin of super-high-energy neutrinos and the nature of dark energy and dark matter in the universe.

In general, 65 percent of the Antarctic Sciences portfolio is available for new research grants. The remaining 35 percent is used primarily to fund continuing grants made in previous years.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Research**

- Support for new grants is provided, increasing the capability to support research in more remote and unstudied regions of Antarctica. Investments will be informed by the report of the National Research Council committee on future science in Antarctica and on the Southern Ocean, as well as by the companion Blue Ribbon Panel's findings and recommendations related to support of that science. Approximately $35.0 million is available for new research grants in FY 2013.
- Priorities under SEES include studies on advancing understanding of societally-pressing areas, such as studies of ice-mass loss and sea level rise, quantifying atmosphere-ocean exchange rates and how these chemical changes will affect the marine ecosystem. An overall focus is building the intellectual capacity to address such complex problems through support of interdisciplinary science networks. (+$1.50 million to a total of $6.75 million)
- Investments in CIF21 are focused on improving in the interoperability of databases and tools for access and use of large geo- and bioscience spatially-based data sets by building on investments in the

Antarctic and Southern Ocean Data Portal, which makes diverse geospatial data sets accessible for analysis and modeling efforts. (-$500,000 to a total of $1.0 million)

Center for Remote Sensing of Ice Sheets (CReSIS):

- Funding continues to support research and education programs at CReSIS, a science and technology center devoted to developing innovative radars for determining ice sheet thickness and the nature of the lithosphere/ice sheet interface that are critical to developing models of ice sheet behavior and to make the expertise developed at CReSIS available to other researchers. Funding for CReSIS is reduced in FY 2013, the ninth year of operation, in accordance with NSF policy for the phase-out of sunsetting Science and Technology Centers.

**Education**

- Antarctic Sciences redirects its $750,000 investment from the Climate Change Education program and will use these funds to participate in the Expeditions in Education program to advance the partnership between the science of learning and polar science communities. Antarctic Sciences expects to build on experience from the Climate Change Education program, as well as the International Polar Year education and outreach portfolio in order to capitalize on and encourage polar science perspectives for advancing the Expeditions in Education focus areas. The continuing partnership with the Directorate for Education and Human Resources (EHR) will ensure best practices are applied to rigorous assessment of funded activities.
- Antarctic Sciences will continue its investment in the Polar Postdoctoral Program, designed to broaden the community of polar researchers. ($500,000).

**Infrastructure**

- Funds support operation and maintenance of IceCube, the world's only neutrino observatory designed to discover astrophysical sources of super-high-energy neutrinos. IceCube is expected to make discoveries about fundamental physical processes that occur in high-energy astrophysical phenomena such as supernovae or gamma-ray bursters. This funding maintains full operations of IceCube during its third year of data collection following completion of the Observatory construction. Antarctic Sciences and the Division of Physics in the Directorate for Mathematical and Physical Sciences contribute equally to IceCube operations.

## DIVISION OF ANTARCTIC INFRASTRUCTURE AND LOGISTICS (AIL)

**$258,330,000**
**+$1,590,000 / 0.6%**

**AIL Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, AIL** | **$259.41** | **$256.74** | **$258.33** | **$1.59** | **0.6%** |
| **Infrastructure** | **259.41** | **256.74** | **258.33** | **1.59** | **0.6%** |
| *U.S. Antarctic Facilities & Logistics* | *191.89* | *189.22* | *190.81* | *1.59* | *0.8%* |
| *U.S. Antarctic Logistical Support* | *67.52* | *67.52* | *67.52* | - | - |

Totals may not add due to rounding.

Antarctic Infrastructure and Logistics supports research through a network of stations, labs, equipment, and logistical resources that enables research activities in Antarctica. This includes operation of a year-round inland research station at the South Pole and two year-round coastal research stations (McMurdo and Palmer) with extensive laboratory, transportation, housing, communication, and computing capabilities (approximately $85.0 million); summer camps as required for research (approximately $5.0 million); icebreaking research ships—the *Laurence M. Gould* and the *Nathaniel B. Palmer* (approximately $32.0 million); small fixed-wing aircraft and helicopters (approximately $9.0 million); icebreakers for channel-breaking and ship escort and an annual fuel tanker and cargo ship at McMurdo Station (approximately $40.0 million for ship charters and fuel). The division uses a mix of government and civilian contract service providers for research support activities in Antarctica.

The U.S. Antarctic Logistical Support budget line funds support provided by the U.S. Department of Defense (DoD). DoD operates as a logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations and maintenance support through the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the resupply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Infrastructure**

- The AIL budget funds logistics support to research projects funded by ANT, including those that are aligned with OneNSF framework investments and high-priority scientific studies that are needed to advance understanding of societally-pressing areas, such as studies of ice-mass loss and sea level rise, quantifying atmosphere-ocean exchange rates, and how these chemical changes will affect the marine ecosystem. Direct support to science projects comprises approximately 21 percent of the annual budget. The AIL budget also funds infrastructure and operations at all operating locations (including operation of the permanent stations (11 percent), facilities maintenance (10 percent), communications and information technology (12 percent), and materials (13 percent)).

- Reimbursable support provided by the Department of Defense includes inter- and intracontinental airlift ($10.0 and $36.0 million, respectively) as well as weather forecasting and airfield services ($19.0 million).
- In order to better utilize the resources provided to AIL to accommodate the above referenced priorities, adjustments may be implemented, including reducing costs and conserving fuel through increased reliance on tractor-pulled sleds, in lieu of aircraft, to move fuel and equipment in support of studies at South Pole Station, Antarctica.
- Investments continue to implement local smart-grid technology and alternative renewable energy systems at all Antarctic stations through planning, design and limited procurements. These activities include installation of additional metering and power distribution monitoring equipment, as well as design and engineering studies for installation of wind/solar power to augment station power production at South Pole Station, and for replacement of the hybrid wind/solar power system for the Black Island telecommunications facility. (Total of $1.0 million)
- A priority for the division is to build the McMurdo fuel supply to a level that allows resiliency in the resupply schedule, fully ensuring the nationally-mandated operation of continental stations in Antarctica. With two full years of fuel in storage, the U.S. Antarctic Program (USAP) could plan for resupply every two years, allowing funds used to charter the fuel tanker to be redirected to other logistics and infrastructure priorities. Investments in FY 2013 will include construction of additional fuel tanks, energy improvements to facilities and waste-to-energy (WTE) technologies that reduce fuel usage, and additional fuel to increase on-station supplies. (Total of $5.75 million)
- Funds are requested for the design and procurement of materials to support Palmer Station facility upgrades, including improvements to the pier, fuel storage, and fuel distribution systems. Palmer Station is the only station on the peninsula operated by the U.S. and national policy, as expressed in Presidential Memorandum 6646, demands its continuous operation. (Total of $3.0 million)

## OFFICE OF POLAR ENVIRONMENT, HEALTH & SAFETY (PEHS) — $7,100,000 / +$480,000 / 7.3%

**PEHS Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, PEHS** | **$6.36** | **$6.62** | **$7.10** | **$0.48** | **7.3%** |
| **Infrastructure** | **6.36** | **6.62** | **7.10** | **0.48** | **7.3%** |
| *Polar Environment, Health & Safety* | *6.36* | *6.62* | *7.10* | *0.48* | *7.3%* |

Totals may not add due to rounding.

The Office of Polar Environment, Health, & Safety within OPP manages and oversees the environmental, health, and safety aspects of research and operations conducted in polar regions. It ensures compliance with environmental, safety, and health related regulatory, statutory, and international treaty requirements. The office has overall responsibility for guiding the implementation of both environmental protection and environmental stewardship to minimize the environmental impact of OPP-supported activities in polar regions. The office also develops and oversees programs to ensure the safety and health of all participants in the polar research enterprise.

### FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Infrastructure**

- Increased funding for Polar Environment, Health & Safety in FY 2013 (+$480,000 to a total of $7.10 million) will enable continued emphasis on environmental stewardship of the Arctic and the Antarctic, and measures to protect the health and safety of grantees and others conducting and supporting research in the polar regions, including, for example, field safety programs and access to on-site health care. A priority for the office is establishment of an electronic medical records system, using information technology to lower health care costs and improve delivery of health care services.

## INTEGRATIVE ACTIVITIES (IA)

**$431,520,000**
**+$81,930,000 / 23.4%**

**IA Funding**
(Dollars in Millions)

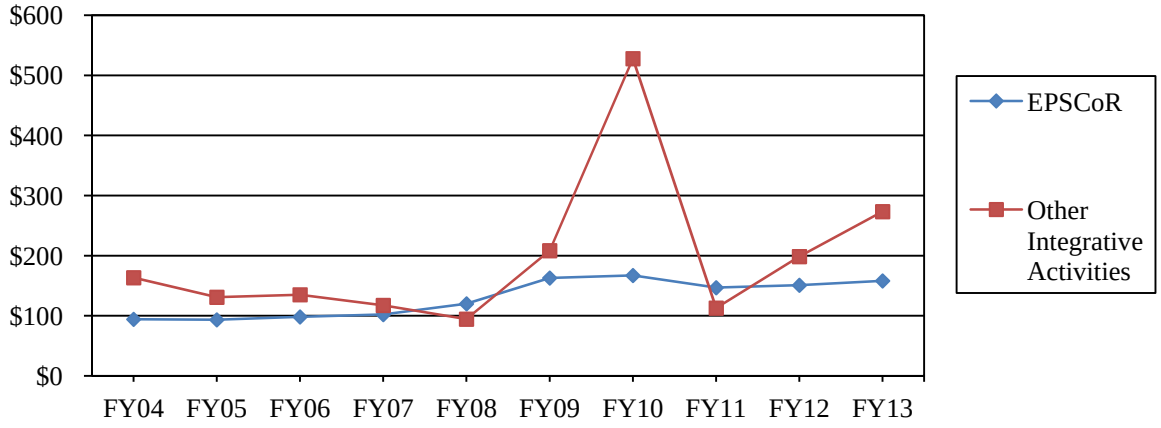
| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Communicating Science Broadly | $3.38 | $2.00 | - | -$2.00 | -100.0% |
| EPSCoR | 146.82 | 150.90 | 158.19 | 7.29 | 4.8% |
| Graduate Research Fellowship | 15.09 | 88.50 | 121.49 | 32.99 | 37.3% |
| INSPIRE | - | 12.35 | 31.00 | 18.65 | 151.0% |
| Major Research Instrumentation | 89.99 | 90.00 | 90.00 | - | - |
| Science & Technology Centers Admin | 0.88 | 1.30 | 1.30 | - | - |
| Science & Technology Centers Class of 2013 | - | - | 25.00 | 25.00 | N/A |
| Science and Technology Policy Institute | 3.04 | 3.14 | 3.14 | - | - |
| STAR Metrics | 0.40 | 1.40 | 1.40 | - | - |
| **Total, IA** | **$259.60** | **$349.59** | **$431.52** | **$81.93** | **23.4%** |

Totals may not add due to rounding.

### About IA

IA includes a diverse array of Foundation-wide activities. Through IA, funding is provided for high priority, well-established activities such as the Science and Technology Centers (STCs), Experimental Program to Stimulate Competitive Research (EPSCoR), Major Research Instrumentation (MRI), and Graduate Research Fellowship (GRF) programs. IA also invests in new activities, such as Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE), that will have a significant impact on the way NSF supports novel science and engineering research at the intersection of traditional disciplines. Other IA activities, such as piloting enhancements in the merit review process and developing new tools and approaches to evaluation and assessment, will influence how NSF conducts its core business functions.

**IA Subactivity Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

## FY 2013 Summary/Major Investments

All funding decreases/increases represent change over the FY 2012 Estimate.

- In FY 2013, there is no request for funding to support the Communicating Science Broadly activity. This reflects a decrease of $2.0 million from the FY 2012 Estimate. FY 2012 is the final year of this activity. Related peer-reviewed activities will continue to be supported through the Advancing Informal STEM Learning (AISL) program – formerly known as the Informal Science Education program – in the Directorate for Education and Human Resources.

- The Experimental Program to Stimulate Competitive Research (EPSCoR) assists the Foundation in its mandate to promote scientific progress nationwide. EPSCoR investments attempt to bring about lasting improvements in the research capacity of institutions in participating states and promote broader engagement at the frontiers of discovery and innovation in science and engineering. EPSCoR's FY 2013 $158.19 million budget request is an increase of $7.29 million over the FY 2012 Estimate.

- The Graduate Research Fellowship (GRF) program builds the critical human capital base required for future STEM investigation and innovation. Research and Related Activities (R&RA) investments in GRF, funded within the IA budget line, will increase by $32.99 million above the FY 2012 Estimate to a total of $121.49 million. This constitutes 50 percent of total GRF funding. In FY 2013, total NSF investments in GRF will support 2,000 new graduate research fellows and 4,900 fellows overall.

- Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) was established in FY 2012 to address some of the most complicated and pressing scientific problems that lie at the intersections of traditional disciplines, in keeping with NSF's strategic goal of *Transform the Frontiers*. INSPIRE will continue to strengthen NSF's support of interdisciplinary, potentially transformative research by complementing existing efforts with a suite of new, highly innovative Foundation-wide activities and funding opportunities. In FY 2013, IA will invest $31.0 million in INSPIRE, representing an increase of $18.65 million above the FY 2012 of level of $12.35 million.

- Advanced research instrumentation is essential for breakthrough discoveries. In addition, state-of-the-art research instrumentation motivates and enables researchers at all career levels. In FY 2013, the Major Research Instrumentation (MRI) program investments will support awards that strengthen the Nation's research instrumentation capacity and modern research infrastructure. Funding for MRI is unchanged from the FY 2012 Estimate of $90.0 million.

- The Science and Technology Policy Institute (STPI), a Federally Funded Research and Development Center sponsored by the NSF on behalf of the White House Office of Science and Technology Policy (OSTP), provides analysis on significant domestic and international science and technology policies and developments for OSTP and other federal agencies. STPI funding is unchanged in FY 2013 from the FY 2012 Estimate of $3.14 million.

- Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness and Science (STAR METRICS) is an interagency pilot activity that represents a new approach to developing information on how NSF and other federal R&D investments affect the innovation ecosystem. STAR METRICS' FY 2013 funding of $1.40 million is unchanged from the FY 2012 Estimate. This funding will enable NSF to meet commitments to the interagency STAR METRICS partnership, promote the integration of elements of STAR METRICS

into a developing assessment and evaluation information system linked to NSF management information systems, and support assessment and evaluation pilots in NSF programs using STAR METRICS tools. The project supports the assessment and evaluation plans described in the FY 2011-FY 2016 NSF Strategic Plan. There are ongoing interagency conversations about the future of the STAR METRICS effort.

## IA Support for OneNSF and Other Major Investments

**IA Major Investments**

(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| Clean Energy Technology | $12.00 | $12.00 | $10.50 | -$1.50 | -12.5% |
| INSPIRE | - | 12.35 | 31.00 | 18.65 | 151.0% |

Major investments may have funding overlap and thus should not be summed.

- IA's support of $10.50 million for clean energy will enhance research on solar energy technologies and biomass energy generation. The IA clean energy investments represent existing RII awards within the EPSCoR program.

- The NSF Office of Integrative Activities (OIA) serves as the organizational lead for INSPIRE. During FY 2013, improvements will be made in how NSF supports science and engineering that fall outside the scope of existing NSF programs. In addition, INSPIRE will support the development of new funding opportunities to better enable investigators to propose and NSF to support innovative, potentially transformative, interdisciplinary research projects. In FY 2013, IA will invest $31.0 million in INSPIRE, which is an increase of $18.65 million above the FY 2012 Estimate level of $12.35 million.

## IA Funding for Centers Programs

**IA Funding for Centers Programs**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Centers Programs Total** | **$0.88** | **$1.30** | **$26.30** | **$25.00** | **1923.1%** |
| Science & Techology Admin | 0.88 | 1.30 | 1.30 | - | - |
| Science & Techology Centers Class of 2013 | - | - | 25.00 | 25.00 | N/A |

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- NSF's investments in Science and Technology Centers (STCs) create platforms to support interdisciplinary discovery. The STC Integrative Partnerships program — which in FY 2013 will fund a total of 16 centers (11 existing centers and five new centers) nationwide — supports innovative, potentially transformative, complex research and education projects that require large-

scale, long-term efforts. STCs engage the Nation's intellectual talent through partnerships between academia and other sectors including industry, national laboratories, and government. These collaborations attempt to enhance innovation and the timely transfer of knowledge and technology from the laboratory to industry and policymakers; they support the training of the next generation of scientists, engineers and educators; and they regularly foster the launch of spin-off companies and the creation of job opportunities. In FY 2013, the increase of $25.0 million for IA STC funding is to support five new centers. The remaining $1.30 million will support administrative costs associated with post-award management for the existing 11 centers.

## Program Monitoring and Assessment

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

A number of program reviews and performance improvement activities are underway or planned for FY 2012-2013.

Committee of Visitors (COV):

- In FY 2012, a COV review will take place for EPSCoR.

Report by the National Academy of Science (NAS):

- In FY 2011, the NAS was charged with conducting a study of the EPSCoR and EPSCoR-like programs as directed in, Section 517 of P.L. 111-358: the America COMPETES Reauthorization Act of 2010. Agencies with active programs are the Department of Energy (DOE), the Environmental Protection Agency (EPA), the National Aeronautics and Space Administration (NASA), the National Institute of Health (NIH), NSF, and the United States Department of Agriculture (USDA). The output for this evaluation will provide recommendations that may have policy implications for federal agencies that have EPSCoR and EPSCoR-like programs. The anticipated completion date for this evaluation is August 2013.

Science and Technology Policy Institute (STPI) Evaluation:

- In FY 2011, EPSCoR contracted STPI to perform an in-depth, life-of-program assessment of NSF EPSCoR activities and their outputs and outcomes and, based on this assessment, provide recommendations for better targeting funds to those jurisdictions for which the EPSCoR investment can result in the largest incremental benefit to their research capacity. This evaluation focuses on progress in research competitiveness, infrastructure development, broadening participation in science and engineering, and STEM workforce development within EPSCoR jurisdictions. The completed report is due December 2013.

## EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

**$158,190,000**
**+$7,290,000 / 4.8%**

**EPSCoR Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, EPSCoR** | **$146.82** | **$150.90** | **$158.19** | **$7.29** | **4.8%** |
| Research Infrastructure Improvement (RII) | 106.20 | 110.00 | 116.19 | 6.19 | 5.6% |
| Co-Funding | 39.44 | 39.40 | 40.00 | 0.60 | 1.5% |
| Outreach and Workshops | 1.18 | 1.50 | 2.00 | 0.50 | 33.3% |

Totals may not add due to rounding.

The Experimental Program to Stimulate Competitive Research (EPSCoR) assists the National Science Foundation (NSF) in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." EPSCoR goals are: 1) to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity competitiveness; and 2) to advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

EPSCoR's FY 2013 $158.19 million budget request is an increase of $7.29 million over the FY 2012 Estimate. It is focused on three strategic investment tools: Research Infrastructure Improvement (RII) awards, co-funding, and outreach. RII awards support development of physical, human, and cyber-based research infrastructure in EPSCoR jurisdictions with emphasis on collaborations among academic researchers, the private sector, and state and local governments to effect sustainable improvements in research infrastructure.

**Research Infrastructure Improvement (RII)**

- RII awards are designed to improve the research competitiveness of jurisdictions by strengthening their academic research infrastructure in areas of science and engineering supported by NSF and critical to the particular jurisdiction's science and technology initiative or plan. These areas are identified by the jurisdiction's EPSCoR governing committee as having the best potential to improve the jurisdiction's future R&D competitiveness. RII awards also enable broader regional and topical collaborations among jurisdictions and facilitate the enhancement of discovery, learning, and economic development of EPSCoR. The FY 2013 Request for RII increases by $6.19 million to a total of $116.19 million over the FY 2012 Estimate of $110.0 million.

**Co-Funding of Disciplinary and Multidisciplinary Research**

- EPSCoR co-invests (co-funds) with NSF directorates and offices on meritorious proposals from individual investigators, groups, and centers in EPSCoR jurisdictions that are submitted to the Foundation's research and education programs, and to crosscutting initiatives. These proposals are merit reviewed in NSF disciplinary programs and recommended for award, but cannot be funded without the combined, leveraged support of EPSCoR. The FY 2013 Request for co-funding increases by $600,000 to a total of $40.0 million over the FY 2012 Estimate of $39.40 million.

**Outreach**

- The EPSCoR Office solicits requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other capacity-building areas of importance to EPSCoR jurisdictions.

In general, about 40 percent of the EPSCoR portfolio is available for new research awards. The remaining 60 percent funds continuing awards made in prior years.

**Number of People Involved in EPSCoR Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 734 | 755 | 790 |
| Other Professionals | 229 | 235 | 245 |
| Postdoctorates | 73 | 75 | 80 |
| Graduate Students | 462 | 475 | 495 |
| Undergraduate Students | 599 | 615 | 645 |
| K-12 Teachers | 500 | 515 | 540 |
| K-12 Students | 1,750 | 1,800 | 1,885 |
| **Total Number of People** | **4,347** | **4,470** | **4,680** |

Totals may not add due to rounding.

## UNITED STATES ARCTIC RESEARCH COMMISSION (USARC)

**$1,390,000**
**-$60,000 / -4.1%**

**USARC Funding**
(Dollars in Millions)

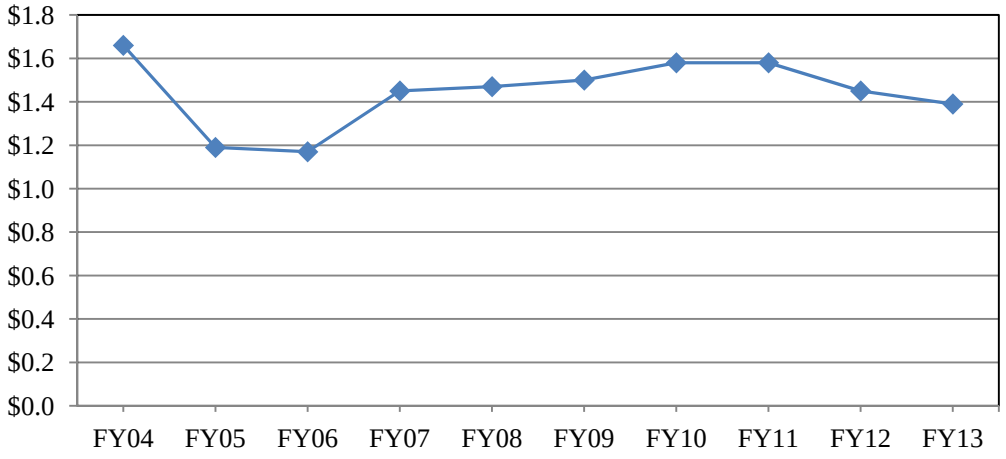
| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, USARC** | **$1.58** | **$1.45** | **$1.39** | **-$0.06** | **-4.1%** |

### About USARC

USARC was created by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences. This request provides funds to promote Arctic research, to recommend Arctic research policy, and to communicate research and policy recommendations to the rest of the Administration and the Congress, as well as supporting close collaboration with the National Science Foundation (NSF) as the lead agency responsible for implementing Arctic research policy and supporting cooperation and collaboration throughout the federal government. In addition, USARC gives guidance to the Interagency Arctic Research Policy Committee (IARPC) to develop national Arctic research projects and a five-year plan to implement those projects. USARC also supports interaction with Arctic residents, international Arctic research programs and organizations, and local institutions, including regional governments, in order to obtain the broadest possible view of Arctic research needs. USARC is an independent federal agency, funded through NSF's appropriations, specifically as an activity in the Research and Related Activities account.

The USARC is requesting $1.39 million, a decrease of $60,000 below the FY 2012 Estimate. Currently, there are three FTE funded at the USARC, with two additional IPAs. A total of seven compensated personnel are authorized in P.L. 101-609.

**USARC Funding**
**(Dollars in Millions)**




Note: Funding in FY 2004 reflects a one-time recovery of $370,000.

## DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES (EHR)

**$875,610,000**
**+$46,610,000 / 5.6%**

**EHR Funding**
(Dollars in Millions)

| | FY 2011 Actual[1] | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Division of Research on Learning in Formal and Informal Settings (DRL) | $322.47 | $290.43 | $309.51 | $19.08 | 6.6% |
| Division of Undergraduate Education (DUE) | 217.28 | 235.65 | 246.65 | 11.00 | 4.7% |
| Division of Human Resource Development (HRD) | 144.71 | 129.63 | 134.63 | 5.00 | 3.9% |
| Division of Graduate Education (DGE) | 176.58 | 173.29 | 184.82 | 11.53 | 6.7% |
| **Total, EHR** | **$861.04** | **$829.00** | **$875.61** | **$46.61** | **5.6%** |

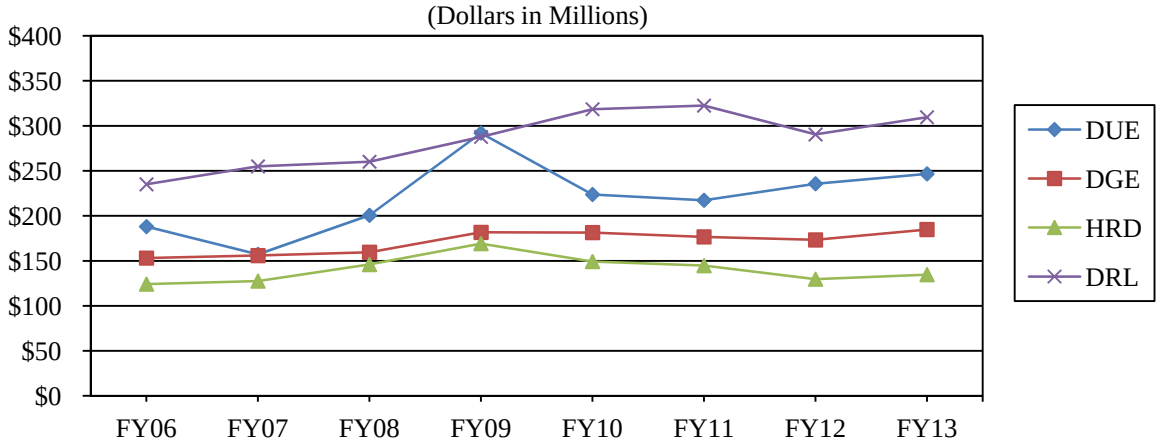
Totals may not add due to rounding.

[1] In FY 2013, Climate Change Education and Excellence Awards in Science and Engineering funding responsibilities are transferred from DUE to DGE and HRD, respectively. The Math and Science Partnership funding responsibility is transferred from DUE to DRL. Funding for all years is shown in the FY 2013 structure for comparability.

## About EHR

The mission of the Directorate for Education and Human Resources (EHR) is to achieve excellence in U.S. science, technology, engineering and mathematics (STEM) education in order to support the development of a diverse and well-prepared workforce of scientists, engineers, and educators and a scientifically literate citizenry. The priorities in the FY 2013 Budget Request for EHR are driven by the critical importance to the Nation of a coherent and growing STEM education research and development Research and Development (R&D) knowledge base. This knowledge base forms the foundation required to advance strategic investment priorities – inside EHR, within OneNSF, and in partnership with other agencies – to reestablish U.S. preeminence in STEM education and STEM workforce development. NSF and EHR play a unique and crucial role in this endeavor. For more than 60 years NSF has been the lead federal agency supporting R&D innovations to improve the Nation's STEM education systems and to prepare the STEM workforce.

**EHR Subactivity Funding**
(Dollars in Millions)




FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

NSF is collaborating with the White House Office of Science and Technology Policy, federal science mission agencies, and the Department of Education (ED) to address national priorities in STEM education through a coordinated STEM education investment strategy. NSF Director Subra Suresh co-chairs the National Science and Technology Council's Committee on Science, Technology, Engineering, and Mathematics Education that is developing a five-year strategic plan for federal STEM investment. EHR is centrally involved in the design and implementation of this plan, and in FY 2013 will collaborate with ED in three areas: 1) investments in the NSF Math and Science Partnership (MSP) program will be aligned with ED's Effective Teaching and Learning: STEM initiative, to build and use the evidence base for improving STEM education at the state and local level; 2) $30.0 million in EHR FY 2013 funds from the Discovery Research K-12 (DR K-12), and Transforming Undergraduate Education in STEM (TUES) programs will be directed towards a new evidence-based grant competition focused on developing, evaluating, and scaling proven practices that can help increase student learning in mathematics K-16 to be jointly administered with ED. This competition will use a tiered-evidence model similar to that used ED's Investing in Innovation program and NSF's TUES program, but will be targeted to making significant advancements in mathematics learning; 3) efforts to establish joint standards of evidence for STEM education innovations and research are underway between EHR and ED's Institute of Education Sciences (IES), to improve the evidence base for STEM education programs across government..

## Appropriations Language

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel, and rental of conference rooms in the District of Columbia, ~~$829,000,000~~$875,610,000, to remain available until September 30, ~~2013: Provided, That not less than $54,000,000 shall be available until expended for activities authorized by section 7030 of Public Law 110-69~~2014.

**Education and Human Resources**
**FY 2013 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Rescission | Carryover/ Recoveries | Expired | Total Resources | Obligations Incurred/Est. |
|---|---|---|---|---|---|---|
| FY 2011 Appropriation | $862.76 | -$1.73 | $0.23 | | $861.26 | $861.04 |
| FY 2012 Estimate | 829.00 | | 0.22 | | 829.22 | 829.22 |
| FY 2013 Request | 875.61 | | | | 875.61 | 875.61 |
| $ Change from FY 2012 Estimate | | | | | | $46.39 |
| % Change from FY 2012 Estimate | | | | | | 5.6% |

Totals may not add due to rounding.

## Explanation of Carryover

Within the **Education and Human Resources (EHR)** appropriation, NSF carried over $221,000 (i.e., 2-year: $181,000; and no-year: $40,000) into FY 2012 for awards and contracts that were not ready for obligation in FY 2011. Obligation of these funds is expected by the second quarter of FY 2012.

**Reframing EHR Investments**

This Request provides a new framing of the EHR investment portfolio into three categories: Core R&D, Leadership, and Expeditions. A description of each EHR investment category follows.

*Core R&D Investments.* Four core areas of STEM R&D are proposed:

- STEM Learning
- STEM Learning Environments
- Broadening Participation and Institutional Capacity in STEM
- STEM Professional Workforce Preparation

These core areas were developed based on national studies and reports[1] and through consultations with the community. R&D in these core areas will continue to build the knowledge base and evidence needed to achieve excellence in STEM education and workforce development. Each EHR division will take responsibility for the intellectual definition, direction, and coherence of one core R&D area. Resources are requested to create a new $5.0 million "Core Launch Fund" in each division, to allow for a first round of grant awards that will give shape to the core R&D areas, provide synthesis of existing work, identify future needs, and highlight important trends and challenges. In FY 2013 EHR will engage in a year of dialogue with key stakeholders and communities concerned with STEM learning to seek response to the early definition of the core foci. In FY 2014 the four core R&D areas will be clarified and additional program realignment and combinations will be proposed. The divisional core R&D emphases are based on depth of staff experience within the divisions and the readiness of the respective research communities to rapidly develop strategic responses.

*Leadership Investments.* Leadership investments accelerate the development of the next generation of diverse and well qualified STEM researchers and educators. These include direct recognition awards, fellowships, and scholarships or grants to students, teachers, and beginning researchers.

*Expedition Investments*. Expeditions will be strategic investments that target opportunities through leveraging, partnering, and innovating to take on specific challenges over defined periods. Expeditions will be a key vehicle for EHR partnerships with other NSF directorates and offices and with the U.S. Department of Education (ED).

**FY 2013 Summary by Division**

In FY2013, three EHR programs will be assigned to divisions different from their current placement, in each case in the interest of providing appropriate balance with EHR's R&D Core, Leadership, and Expedition framework; to ensure alignment of staff expertise; and to better balance the EHR workload. The Math and Science Partnership (MSP) program (part of the STEM Learning Core) will be transferred from DUE to DRL, to center the majority of EHR's investment in K-12 STEM education in DRL and build on the report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*. The Excellence Awards in Science and Engineering (EASE) program, part of the Leadership Portfolio, will be based in the Division of Human Resource Development

[1] See for example, National Research Council. (2007) *Taking science to school: Learning and teaching science in grades K-8*. Washington, DC: The National Academies Press; and U.S. Department of Education. (2008) *Foundations for success: Final report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education; The National Research Council. (2011) *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics. Washington, DC: The National Academies Press*; and The President's Council of Advisors on Science and Technology (2010) *Prepare and inspire: K-12 education in STEM for America's future*. Washington, DC.

(HRD) in order to ensure that broadening participation is a central focus in the awards programs. And finally, the Climate Change Education Program (CCE) will be managed in the Division of Graduate Education, and will be associated with the $E^2$ Sustainability.

EHR continues to define and expand its R&D core to improve STEM learning for all learners, in all settings, and at all levels. In the FY 2013 Budget Request, each division's funding includes $5.0 million for "Core Launch" to initiate activities in the division's designated Core R&D area. Explicit focus on this foundation is necessary to systematically improve the impact of NSF investments in STEM learning and workforce development and to define NSF's complementary role in R&D in the partnerships and collaborations EHR is building across NSF, and with ED, other agencies, and the private sector.

The Division of Research on Learning in Formal and Informal Settings (DRL) will continue to support the development of innovative resources, models, and tools for K-12 STEM education; fundamental research on learning; engaging experiences that support lifelong STEM learning, teacher learning, and research on national STEM priorities; and evaluation studies and activities. DRL is the NSF lead in building knowledge and evidence through research on STEM learning and will lead the Core R&D area of STEM Learning. The MSP program will be based in DRL. In addition, $15.0 million has been added to the Discovery Research K-12 (DR-K12) program in DRL to develop, validate and scale up evidence-based approaches to improve student learning at the K-12 and undergraduate levels.

The Division of Undergraduate Education (DUE) serves as the NSF focal point for transforming undergraduate STEM education to meet the needs of the 21st century. DUE will lead the Core R&D area of STEM Learning Environments, a portfolio of programs that will build and expand a coherent body of knowledge on innovative and effective STEM learning environments at all education levels. In FY 2013, the Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) program will fund research and demonstration projects exploring how to achieve widespread sustainable implementation of evidence-based undergraduate instructional practices to improve student outcomes. In addition, the Transforming Undergraduate Education in STEM (TUES) program will fund a number of projects responsive to the President's Council of Advisors on Science and Technology (PCAST) draft report on strengthening early undergraduate education as well as $15.0 million to develop, validate and scale up evidence-based approaches to improve student learning at the K-12 and undergraduate levels, which is jointly funded with ED.

The Division of Human Resource Development (HRD) focuses on building a diverse and well-qualified S&E workforce through Broadening Participation. HRD investments in Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and other minority-serving institutions, as well as institutions with strong missions to support broadening participation, remain critically important to the EHR mission. In FY 2013, HRD will lead the Core R&D area of Broadening Participation and Institutional Capacity in STEM to build a coherent body of knowledge about successful approaches and models for broadening STEM participation for all groups traditionally underrepresented in STEM, including women and persons with disabilities. This Core work also includes building the required institutional capacity to ensure that all students have access to the highest quality STEM programs and instruction. The Excellence Awards in Science and Engineering (EASE) program will move into HRD from DUE, to enable strong alignment with the broadening participation commitment.

The Division of Graduate Education (DGE) invests in U.S. graduate students and innovative graduate programs to prepare tomorrow's leaders in STEM. DGE will lead the Core R&D area of STEM Professional Workforce Development, a portfolio that will build and expand a coherent body of knowledge about successful approaches, practices, and models for STEM professional workforce preparation. The Climate Change Education (CCE) program will move into DGE from DUE, for better programmatic alignment with workforce readiness and the sustainability focus in $E^2$.

## Major Investments

**EHR Major Investments**
(Dollars in Millions)

| Area of Investment | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| $E^2$ | - | - | 20.50 | 20.50 | N/A |
| I-Corps | 0.10 | - | 0.30 | 0.30 | N/A |
| INSPIRE | - | - | 2.00 | 2.00 | N/A |
| SaTC | - | 45.00 | 25.00 | -20.00 | -44.4% |
| SEES | 6.08 | 6.00 | 0.50 | -5.50 | -91.7% |

Major investments may have funding overlap and thus should not be summed.

- Expeditions in Education ($E^2$): The resources committed to the OneNSF $E^2$ ($20.50 million) will formalize a series of partnership activities among EHR and other directorates and offices to engage, empower, and energize learners in STEM. See the $E^2$ narrative in the OneNSF Portfolios for further detail.

- NSF Innovation Corps (I-Corps): For FY 2013, DGE will lead EHR's participation to promote this OneNSF activity.

- Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE): The FY 2013 resources committed to INSPIRE ($2.0 million) will promote the development of STEM professionals in the INSPIRE-supported research areas led by EHR, with DRL as the lead division.

- Secure and Trustworthy Cyberspace (SaTC): The Division of Undergraduate Education (DUE) will be responsible for funding SaTC activities, totaling $25.0 million in FY 2013, through the Federal Cyber Service: Scholarships for Service/Cybercorps (SFS) program.

- Science, Engineering, and Education for Sustainability (SEES): The Division of Human Resource Development (HRD) will be responsible for funding of SEES activities totaling $500,000, through the Centers of Research Excellence in Science and Technology (CREST) program.

## Program Monitoring and Assessment

The Performance chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees.

Program Evaluation:

- EHR conducts program evaluations to assess the quality and impact of its programs. These evaluation activities are essential to the continued shaping of program and portfolio directions and emphases. EHR currently has 24 evaluation studies and activities underway. In FY 2012, findings will be available from the Math and Science Partnership program (MSP), the ADVANCE program, and the Alliances for Graduate Education and the Profession (AGEP) program.
- In FY 2012, EHR's cross-directorate evaluation group is exploring the feasibility of how best to evaluate themes that cross NSF STEM education programs. EHR anticipates initiating evaluation studies around cyberlearning, preK-5 education, Research Experiences for Undergraduate (REU)

sites, and broadening participation. In addition, two longitudinal studies will be initiated, one to examine the long-term impact of REU site experiences on student participants, and the other to study impact of Graduate Research Fellowships (GRF) on recipients. The Promoting Research and Innovation in Methodologies for Evaluation (PRIME) activity continues to fund proposals to develop new methods, measures, and tools for conducting innovative evaluations of STEM education programs**.**

- In FY 2013, EHR will systematize project-level evaluation, allowing better aggregation of data from its projects.

Committees of Visitors (COV):

- In 2012, COVs are scheduled for the following programs: Research on Education and Learning (REAL) (formerly Research and Evaluation on Education in Science and Engineering (REESE)); Discovery Research K-12 (DR-K12); Research in Disabilities Education (RDE) and Research on Gender in Science and Engineering (GSE) in DRL/HRD; Advanced Technological Education (ATE); STEM Talent Extension Program (STEP); the Robert Noyce Scholarship Program (NOYCE) in DUE; and the Graduate Research Fellowship Program (GRF) in DGE.
- In 2013, COVs will review Centers for Research Excellence in Science and Technology (CREST), AGEP; Louis Stokes Alliances for Minority Participation (LSAMP); Tribal Colleges and Universities Program (TCUP); the Historically Black Colleges and Universities Program (HBCU-UP) in HRD; and Transforming Undergraduate Education in STEM (TUES) in DUE.

Workshop on Successful STEM Schools:

- NSF funded a recent workshop convened by the National Research Council which produced a report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*. The workshop report provides information that leaders at the school, district, state, and national levels can use to make strategic decisions about improving STEM education. A summary of this workshop is available via the National Academies Press webpage at www.nap.edu\\catalog.php?record_id=13158. Several follow-up regional workshops and dissemination activities are underway, and report results are being used to inform funding plans in EHR.

**Number of People Involved in EHR Activities**

| | FY 2011 Actual Estimate | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|
| Senior Researchers | 6,310 | 6,210 | 6,410 |
| Other Professionals | 2,620 | 2,620 | 2,660 |
| Postdoctorates | 245 | 245 | 250 |
| Graduate Students | 8,549 | 8,550 | 8,680 |
| Undergraduate Students | 5,495 | 5,500 | 5,580 |
| K-12 Teachers | 47,586 | 47,600 | 48,310 |
| K-12 Students | 84,475 | 84,510 | 85,760 |
| **Total Number of People** | **155,280** | **155,235** | **157,650** |

## DIVISION OF RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS (DRL)

**$309,510,000**
**+$19,080,000 / 6.6 %**

**DRL Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DRL** | **$322.47** | **$290.43** | **$309.51** | **$19.08** | **6.6%** |
| **Core R&D Programs** | **303.87** | **272.43** | **281.23** | **8.80** | **3.2%** |
| Core Launch: STEM Learning | - | - | 5.00 | 5.00 | N/A |
| Discovery Research K-12 (DR-K12) | 120.00 | 99.23 | 109.90 | 10.67 | 10.8% |
| Advancing Informal STEM Learning (AISL)[1] [formerly Informal Science Education (ISE)] | 64.21 | 61.40 | 47.82 | -13.58 | -22.1% |
| INSPIRE | - | - | 2.00 | 2.00 | N/A |
| Math and Science Partnership (MSP) | 57.12 | 57.08 | 57.08 | - | - |
| Research on Education and Learning (REAL)[2] [formerly Research and Evaluation on Education in Science & Engineering (REESE)] | 62.53 | 54.72 | 59.43 | 4.71 | 8.6% |
| *Research in Disabilities Education (RDE)* | *[6.53]* | *[6.50]* | *[6.50]* | - | - |
| *Research on Gender in Science and Engineering (GSE)* | *[10.42]* | *[10.50]* | *[10.50]* | - | - |
| **Expeditions** | **-** | **-** | **4.33** | **4.33** | **N/A** |
| DR-K12/E[2]: Cyberlearning, Data, and Observations for STEM Education | - | - | 4.33 | 4.33 | N/A |
| **Leadership Programs** | **18.60** | **18.00** | **23.95** | **5.95** | **33.1%** |
| Project and Program Evaluation (PPE) | 18.60 | 18.00 | 23.95 | 5.95 | 33.1% |

Totals may not add due to rounding.

[1] EHR proposes renaming Informal Science Education (ISE) beginning in FY 2013.

[2] EHR proposes renaming Research and Evaluation on Education in Science & Engineering (REESE) beginning in FY 2013.

The Division of Research on Learning in Formal and Informal Settings (DRL) will lead the Core R&D area of STEM Learning**,** where investments from several DRL-based programs (DR-K12, AISL (formerly ISE), MSP, and REAL (formerly REESE) will be treated as a portfolio that contributes to a coherent body of knowledge and evidence about STEM learning. This foundation will be part of the basis for innovations in STEM education and learning environments, for broadening participation, for workforce development, and for partnerships with other directorates and offices as they invest in discipline-based approaches to STEM education. While DRL-funded research is likely to be situated in physical and social settings, and may involve development of learning resources and tools, the principal goal is to characterize the STEM learning process in all its forms, by the full range of learners, in a full range of settings. This includes development of innovative and effective approaches and instruments for promoting and assessing learning. A particular focus is on understanding how to improve STEM learning and education opportunities for all learners, including those from groups traditionally underrepresented in STEM, especially women, minorities, persons with disabilities, English language learners, and veterans.

Within this Core R&D area, DRL will collaborate across the directorate in FY 2013 to emphasize:

- understanding STEM learning in the context of emerging cyberinfrastructure, which is transforming STEM practices, STEM learning, and assessment;
- understanding learning by underrepresented STEM learners, including women and persons with disabilities;
- understanding STEM learning across settings, including homes, formal institutions, informal institutions, and mobile or cross-setting forms;
- advancing assessment of STEM learning using a variety of approaches and resources, especially with the advent of common core state standards in K-12 education; and
- understanding STEM learning at the undergraduate level, by building on the knowledge base generated by the REAL program (formerly REESE), the TUES program, the WIDER program, a forthcoming National Academies report on discipline-based education research, the PCAST report on undergraduate education, and numerous activities underway within and outside of NSF, including funded synthesis projects, workshops, and seminars.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Core R&D Programs**

- Core Launch, initiated at $5.0 million in FY 2013, will provide grant awards to document what is known about STEM learning to date and develop plans for coordination and synthesis among STEM learning programs.
- DR-K12 (+$10.67 million to a total of $109.90 million) funds awards that focus on R&D models and tools for K-12 education projects. Additionally, in conjunction with TUES in DUE, DR-K12 invests $15.0 million to develop, validate and scale up evidence-based approaches to improve student learning at the K-12 and undergraduate levels, which will be jointly administered by NSF and ED.
- AISL (formerly ISE) (-$13.58 million to a total of $47.82 million) will support fewer awards, focusing on the research and model-building contributions of the program to better understand effective means and innovative models for engaging today's young people and adults in science outside of school settings. Additionally, this reduction helps support the Core Launch area, which will include an emphasis on learning outside of school.
- INSPIRE (+$2.0 million), an OneNSF activity, EHR's leadership to come from DRL.
- MSP remains at the FY 2012 Estimate.
- REAL (formerly REESE) (+$4.71 million to a total of $59.43 million) will support awards that focus on EHR's CORE R&D as described above.

**Expeditions**

- $E^2$: Cyberlearning, Data, and Observations for STEM Education (+$4.33 million), an OneNSF activity, will be coordinated by DRL in partnership with other directorates and offices. It will build on the current Cyberlearning Transforming Education (CTE) activity as well as other EHR investments in cyberlearning.

  An external expedition project with ED will be initiated in FY 2013 building on the partnership model developed between ED and NSF's MSP programs. The expedition will explore ways to improve STEM-based initiatives within states, regions, or districts based on the lessons learned in NSF's MSP program, with a focus on mathematics in a tiered-evidence approach. This activity will be based in DRL, with funding in the DRK-12 program.

**Leadership Programs**

- PPE (+$5.95 million to a total of $23.95 million) will be managed by DRL on behalf of all of EHR. The focus in FY 2013, with increased resources, will be on common metrics across workforce and undergraduate programs, monitoring systems to better shape leadership investments over time, and assessment of instruction and outcomes in undergraduate education.

## DIVISION OF UNDERGRADUATE EDUCATION (DUE) $246,650,000
**+$11,000,000 / 4.7 %**

**DUE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DUE** | **$217.28** | **$235.65** | **$246.65** | **$11.00** | **4.7%** |
| **Core R&D Programs** | **147.59** | **127.76** | **146.76** | **19.00** | **14.9%** |
| Core Launch: STEM Learning Environments | - | - | 5.00 | 5.00 | N/A |
| Advanced Technological Education (ATE) | 64.35 | 64.00 | 64.00 | - | - |
| STEM Talent Extension Program (STEP) | 32.23 | 24.30 | 16.30 | -8.00 | -32.9% |
| National STEM Education Distributed Learning (NSDL) | 9.75 | - | - | - | N/A |
| Transforming Undergraduate Education in STEM (TUES) | 41.25 | 39.46 | 61.46 | 22.00 | 55.8% |
| **Expeditions** | **-** | **8.00** | **20.00** | **12.00** | **150.0%** |
| Widening Implementation and Demonstration of Evidenced-based Reforms (WIDER)/$E^2$: Transforming Undergraduate STEM Learning | - | 8.00 | 20.00 | 12.00 | 150.0% |
| **Leadership Programs** | **69.69** | **99.89** | **79.89** | **-20.00** | **-20.0%** |
| Robert Noyce Scholarship Program (NOYCE) | 54.90 | 54.89 | 54.89 | - | - |
| Federal Cyber Service: Scholarship for Service/Cybercorps (SFS) | 14.79 | 45.00 | 25.00 | -20.00 | -44.4% |

Totals may not add due to rounding.

The Division of Undergraduate Education (DUE) will lead the Core R&D area of STEM Learning Environments, where investments from several DUE programs (ATE, STEP, and TUES) will be developed as a portfolio to anchor a coherent body of knowledge on innovative and effective STEM learning environments. This Core R&D area will eventually encompass all levels, including such critical transitions as the high school to undergraduate or community college to four-year institution shifts, and will address the anytime, anywhere nature of education and learning today. Investments will support research about the design, implementation, scale-up, dissemination, and institutionalization of STEM instructional practices, tools, models, and materials that can bring learners to the frontiers of science.

While the TUES program is the intellectual base of DUE's Core R&D, the STEM Talent Expansion Program (STEP) has a complementary portfolio in the development, study, and broad implementation of best practices in the recruitment and retention of students in STEM disciplines. Particular R&D emphases within DUE's core in FY 2013 will be:

- designing STEM learning environments and tools aimed at increasing and tapping the diversity of the STEM workforce for broadening participation;
- assessing the nature and impact of evidence-based undergraduate STEM instructional practices;
- understanding how successful, evidence-based instructional practices can be broadly diffused and adopted/adapted;
- building innovative curricular, pedagogical, and technological approaches to disciplinary and interdisciplinary STEM learning; and preparing tomorrow's STEM leaders; and

- using scientific content and emphases in STEM learning environments to reflect the changing nature and practice of science, particularly data-driven and computationally enabled science, as a way to engage, retain, and prepare STEM learners.

Beginning in FY 2013, EHR proposes to move three programs from DUE to other EHR divisions, to enable better alignment and investment synergies. Refer to the table EHR Realignment of Programs Between Divisions on page 17 for a complete list of changes. These are:

- The MSP program moves into DRL.
- CCE program moves into DGE.
- The Excellence Awards in Science and Engineering (EASE) program moves into the Division of Human Resources (HRD).

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Core R&D Programs**

- Core Launch, initiated at $5.0 million in FY 2013, will provide grant awards to document what is known about STEM learning environments to date and develop plans for coordination and synthesis among STEM learning environment R&D programs in the directorate.
- ATE remains at the FY 2012 Estimate at $64.0 million.
- STEP (-$8.0 million to a total of $16.30 million) is decreased in part to support the Core Launch activities, which will include focus on institutional change in STEM education.
- TUES (+$22.0 million to a total of $61.46 million) will invest in the undergraduate component of the joint mathematics tiered evidence program with the Department of Education as well as some of the specific recommendations related to evidence-based instruction proposed in the PCAST report on undergraduate education. Additionally, in conjunction with DR-K12 in DRL, TUES invests $15.0 million to develop, validate and scale up evidence-based approaches to improve student learning at the K-12 and undergraduate levels, which will be jointly administered by NSF and ED.

**Expeditions**

- WIDER (+$12.0 million to a total of $20.0 million) invests in institutional change in colleges and universities to bring evidence-based instructional practices to scale.
- $E^2$: Transforming Undergraduate STEM Learning: DUE will coordinate the OneNSF Expeditions in Education ($E^2$) activity in partnership with a number of the other directorates and offices. We anticipate this activity will advance undergraduate learning across disciplinary boundaries, take advantage of the available assets in NSF-funded science facilities and centers, and expand research on undergraduate STEM instructional practice and impact. This activity will be closely connected to the NSF-wide Priority Goal for undergraduate education. See the Performance Information chapter for specific information.

**Leadership Programs**

- NOYCE remains at the FY 2012 Estimate.
- SFS (-$20.0 million to a total of $25.0 million) is decreased below FY 2012 but increased $10.21 million over FY 2011. This program is EHR's principal contribution to the Secure and Trustworthy Cyberspace (SaTC) OneNSF initiative.

## DIVISION OF HUMAN RESOURCE DEVELOPMENT (HRD) $134,630,000
**+$5,000,000 / 3.9%**

**HRD Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, HRD** | **$144.71** | **$129.63** | **$134.63** | **$5.00** | **3.9%** |
| **Core R&D Programs** | **139.53** | **124.48** | **129.48** | **5.00** | **4.0%** |
| Core Launch: Broadening Participation and Institutional Capacity in STEM | - | - | 5.00 | 5.00 | N/A |
| ADVANCE | 1.52 | 1.53 | 1.53 | - | - |
| Alliances for Graduate Education and the Profession (AGEP)[1] | 16.69 | 7.84 | 7.84 | - | - |
| Historically Black Colleges and Universities Program (HBCU-UP) | 31.93 | 31.94 | 31.94 | - | - |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 45.63 | 45.62 | 45.62 | - | - |
| Tribal Colleges & Universities Program (TCUP) | 13.33 | 13.31 | 13.31 | - | - |
| Centers for Research Excellence in Science and Technology (CREST) | 30.43 | 24.24 | 24.24 | - | - |
| **Leadership Programs** | **5.18** | **5.15** | **5.15** | **-** | **-** |
| Excellence Awards in Science and Engineering (EASE) | 5.18 | 5.15 | 5.15 | - | - |

Totals may not add due to rounding.

[1] Alliances for Graduate Education and the Professoriate has been changed to Alliances for Graduate Education and the Profession.

The Division of Human Resource Development (HRD) aims to grow the U.S. science, technology, engineering and mathematics (STEM) workforce by supporting the broader participation and success of individuals currently underrepresented in STEM, building the capacity of the institutions that serve them, and conducting research on effective mechanisms and models for achieving both of these goals. HRD takes the NSF-wide lead in advancing understanding of issues specific to participation of underrepresented minorities in STEM fields, including women and persons with disabilities, and of institutional capacity.

HRD will lead the Core R&D area of Broadening Participation and Institutional Capacity in STEM, where investments from several HRD programs (ADVANCE, AGEP, HBCU-UP, LSAMP and TCUP). The division is committed to knowledge building and application, including investing in the creation of new knowledge, innovations, and models for broadening participation in the STEM enterprise and translating these for use by stakeholders**.** The expansion of stakeholder institutional capacity to support and engage diverse populations in high-quality STEM education and research programs is critical and will be advanced through this Core R&D. Emphases will include:

- institutional capacity building models and strategies;
- research to examine the particular STEM student and institutional capacity needs in Hispanic-serving institutions;
- examination of model practices and their relationships to particular institution types; and

- the role of community colleges in attracting and retaining underrepresented minority students, women, and persons with disabilities in STEM.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Core R&D Programs**

- Core Launch, initiated at $5.0 million, in FY 2013, will provide grant awards to document what is known about building and expanding a coherent body of knowledge about successful approaches and models for broadening STEM participation and building institutional capacity.
- CREST will remain at the FY 2012 Estimate. Funding will allow for both continuing and new awards that support the transformation of institutional academic and research infrastructure to expand opportunities for underrepresented groups in STEM disciplines at the graduate, post-doctorate, and professoriate levels.

**Leadership Programs**

- EASE will remain at the FY 2012 Estimate. In FY 2013, HRD will assume full leadership from the Division of Undergraduate Education (DUE) for EASE. This program will be the signature Leadership program of HRD to promote broader participation and success in Presidential awards programs.

## DIVISION OF GRADUATE EDUCATION (DGE) $184,820,000
**+$11,530,000 / 6.7%**

**DGE Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **Total, DGE** | **$176.58** | **$173.29** | **$184.82** | **$11.53** | **6.7%** |
| **Core R&D Programs** | **29.70** | **31.20** | **28.16** | **-3.04** | **-9.7%** |
| Core Launch: STEM Professional Workforce Preparation | - | - | 5.00 | 5.00 | N/A |
| Integrative Graduate Education and Research Traineeship Program (IGERT) | 29.60 | 31.20 | 22.86 | -8.34 | -26.7% |
| I-Corps | 0.10 | - | 0.30 | 0.30 | N/A |
| **Expeditions** | **5.43** | **5.50** | **8.17** | **2.67** | **48.5%** |
| Integrative Graduate Education and Research | - | - | 3.41 | 3.41 | N/A |
| Traineeship Program (IGERT)/ $E^2$: Learning and Understanding Sustainability | | | | | |
| Climate Change Education (CCE)/$E^2$: Learning and Understanding Sustainability | 5.43 | 5.50 | 4.76 | -0.74 | -13.5% |
| **Leadership Programs** | **141.44** | **136.59** | **148.49** | **11.90** | **8.7%** |
| Graduate STEM Fellows in K-12 Education (GK-12) | 48.18 | 26.95 | 27.00 | 0.05 | 0.2% |
| Graduate Research Fellowship (GRF) | 93.27 | 109.64 | 121.49 | 11.85 | 10.8% |

Totals may not add due to rounding.

The Division of Graduate Education (DGE) supports U.S. graduate students and innovative graduate programs to prepare tomorrow's leaders in science, technology, engineering, and mathematics (STEM). DGE will lead the Core R&D area of STEM Professional Workforce Preparation, where investment from the DGE-based IGERT program will serve as the foundation. The focus of this core extends beyond the graduate level and includes the development of a range of STEM professionals, such as technicians, STEM teachers, undergraduate-level entrants to the STEM workforce, and others. This body of R&D will be treated as a portfolio that supports implementation of successful approaches, practices, and models for STEM professional workforce preparation. The FY 2013 emphases will include:

- program and project evaluation to determine the impacts of innovative and varied approaches to graduate education developed through NSF support (including research assistantships, traineeships, fellowships, etc.);
- strategies for monitoring and tracking NSF's investments in human capital and workforce preparation; and
- preparation of a STEM professional workforce prepared to lead in data-intensive, cyber-enabled science, and in interdisciplinary science.

DGE will support the development of curricular, experiential, and instructional models at the graduate level to prepare members of the S&E workforce to be innovators. The following are potential activities that will increase integration with other directorates and offices, and other divisions within EHR.

*Research and Curriculum Development*

- Because of its size, the DGE portfolio, consisting of a traineeship and a fellowship program, is limited in its potential impact on innovation in graduate education as a whole. However, in FY 2012, DGE is working with other EHR divisions to provide support for research in graduate education, curriculum development, and other activities to promote improvements in S&E graduate education.

*Increase NSF Impact in Graduate Education*

- In partnership with other groups in EHR and across NSF, DGE will initiate efforts to evaluate current mechanisms for supporting graduate students (for example, RAs, fellowships, traineeships, centers, research training groups) with the goal of developing a comprehensive strategy to increase the impact of NSF's support for graduate students and graduate education.

*Leverage NSF Support of Graduate Students*

- In FY 2013, DGE will develop a pilot effort that leverages existing NSF support of graduate students (RAs, GRF Fellows, Trainees, etc.) at an institution to help ensure these students benefit from effective practices in graduate education. In FY 2012, GRF is initiating and conducting a phase-one evaluation framing study. In FY 2013, a GRF full-scale longitudinal study will be initiated.

## FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

**Core R&D Programs**

- Core Launch, initiated at $5.0 million in FY 2013, will provide grant awards to document what is known about STEM Professional Workforce Preparation and develop plans for coordination and synthesis among NSF STEM workforce development programs., The workforce preparation focus, extends beyond the graduate level and includes the development of a range of STEM professionals, such as technicians, STEM teachers, and undergraduate-level entrants to the STEM workforce.
- IGERT (-$4.93 million to a total of $26.27 million) will decrease the number/amount of awards to support comprehensive Ph.D. programs that are innovative models for interdisciplinary education and research and that prepare students for academic and non-academic careers. Additionally, this decrease supports the DGE Core Launch on STEM Professional Workforce Preparation. EHR's contribution to the IGERT program also will support the Learning and Understanding Sustainability focus area of the $E^2$ activity.
- I-Corps ($300,000 in FY 2013) will promote the development of STEM professionals in the I-Corps-supported research areas.

**Expeditions**

- EHR's involvement in the $E^2$ activity on Learning and Understanding Sustainability (+$3.41 million) will be led through the IGERT program.
- CCE (-$740,000 to a total of $4.76 million) will be transferred from the DUE to DGE and will contribute to $E^2$ Learning and Understanding Sustainability activities.

**Leadership Program**

- GRF (+$11.85 million to a total of $121.49 million) continues as NSF's signature graduate research fellowship program, led by DGE. The requested amount will allow for the addition of 2,000 new fellows in FY2013 and support a stipend increase from $30,000 to $32,000. The remainder of funding for the GRF program is shown in the Integrative Activities budget line within the R&RA account.
- GK-12 (+$50,000 to a total of $27.0 million) is increased slightly to support continuing grant increments. This aligns with the approved plan for termination of the program. FY 2013 funding will provide final support for an estimated 800 GK-12 graduate fellows.

**EHR Realignment of Programs Between Divisions**

(Dollars in Millions)

| FY 2012 Structure | FY 2013 Request | FY 2013 Structue | FY 2013 Request |
|---|---|---|---|
| **Undergraduate Education** | **$308.64** | **Undergraduate Education** | **$246.65** |
| Climate Change Education | 4.76 | Core Launch:STEM Learning Environments | 5.00 |
| Transforming Undergraduate Education in STEM (TUES) | 61.46 | Transforming Undergraduate Education in STEM (TUES) | 61.46 |
| National STEM Education Distributed Learning (NSDL) | - | National STEM Education Distributed Learning (NSDL) | - |
| Advanced Technological Education (ATE) | 64.00 | Advanced Technological Education (ATE) | 64.00 |
| STEM Talent Expansion Program (STEP) | 16.30 | STEM Talent Expansion Program (STEP) | 16.30 |
| Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) | 20.00 | Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) | 20.00 |
| Robert Noyce Scholarship Program (NOYCE) | 54.89 | Robert Noyce Scholarship Program (NOYCE) | 54.89 |
| Federal Cyber Service: Scholarship for Service/Cybercorps (SFS) | 25.00 | Federal Cyber Service: Scholarship for Service/Cybercorps (SFS) | 25.00 |
| Excellence Awards in Science and Engineering (EASE) | 5.15 | | |
| Math and Science Partnership (MSP) | 57.08 | | |
| **Graduate Education** | **$174.76** | **Graduate Education** | **$184.82** |
| | | Core Launch: STEM Professional | 5.00 |
| | | NSF Innovation Corps (I-Corps) | 0.30 |
| Graduate Research Fellowship (GRF) | 121.49 | Graduate Research Fellowship (GRF) | 121.49 |
| Graduate STEM Fellows in K-12 Education (GK-12) | 27.00 | Graduate STEM Fellows in K-12 Education (GK-12) | 27.00 |
| Integrative Graduate Education and Research Traineeship (IGERT) | 26.27 | Integrative Graduate Education and Research Traineeship (IGERT) | 26.27 |
| | | Climate Change Education (CCE) | 4.76 |
| **Human Resource Development** | **$124.48** | **Human Resource Development** | **$134.63** |
| | | Core Launch: Broadening Participation and Institutional Capacity in STEM | 5.00 |
| Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) | 31.94 | Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) | 31.94 |
| Louis Stokes Alliances for Minority Participation (LSAMP) | 45.62 | Louis Stokes Alliances for Minority Participation (LSAMP) | 45.62 |
| Tribal Colleges and Universities Program (TCUP) | 13.31 | Tribal Colleges & Universities Program (TCUP) | 13.31 |
| Alliances for Graduate Education and the Profession (AGEP) | 7.84 | Alliances for Graduate Education and the Profession (AGEP) | 7.84 |
| Centers of Research Excellence in Science and Technology (CREST) | 24.24 | Centers for Research Excellence in Science and Technology (CREST) | 24.24 |
| ADVANCE | 1.53 | ADVANCE | 1.53 |
| | | Excellence Awards in Science and Engineering (EASE) | 5.15 |
| **Research on Learning in Formal and Informal Settings** | **$245.43** | **Research on Learning in Formal and Informal Settings** | **$309.51** |
| | | Core Launch: STEM Learning | 5.00 |
| | | INSPIRE | 2.00 |
| Discovery Research K-12 (DR-K12) | 114.23 | Discovery Research K-12 (DR-K12) | 114.23 |
| Advancing Informal STEM Learning (AISL) [formerly Informal Science Education (ISE)] | 47.82 | Advancing Informal STEM Learning (AISL) [formerly Informal Science Education (ISE)] | 47.82 |
| Project and Program Evaluation (PPE) | 23.95 | Project and Program Evaluation (PPE) | 23.95 |
| Research on Education and Learning (REAL) [formerly Research and Evaluation on Education in Science & Engineering (REESE)/ Research on Gender in Science and Engineering (GSE)/Research in Disabilities Education (RDE)] | 59.43 | Research on Education and Learning (REAL) [formerly Research and Evaluation on Education in Science & Engineering (REESE)/ Research on Gender in Science and Engineering (GSE)/Research in Disabilities Education (RDE)] | 59.43 |
| | | Math and Science Partnership (MSP) | 57.08 |
| Core Launch | 20.00 | | |
| INSPIRE | 2.00 | | |
| I-Corps | 0.30 | | |
| **TOTAL, EHR** | **$875.61** | **TOTAL, EHR** | **$875.61** |

Totals may not add due to rounding.

Totals may not add due to rounding.

## H-1B NONIMMIGRANT PETITIONER FEES **$100,000,000**

**+$0 / 0%**

In FY 2013, H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equal to the FY 2012 projection.

**H-1B Nonimmigrant Petitioner Fees Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Estimate | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| H-1B Nonimmigrant Petitioner Fees Funding | $96.30 | $100.00 | $100.00 | - | - |

In FY 2005, Public Law 108-447 reauthorized H-1B funding. NSF was provided with 40 percent of the total H-1B receipts collected. Thirty percent of H-1B receipts (75 percent of the receipts that NSF receives) are to be used for the Low-income Scholarship Program, which has now been renamed Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM). Ten percent of receipts (25 percent of the receipts that NSF receives) are designated for support of the Grants for Mathematics, Science, or Engineering Enrichment Courses, through Information Technology Experiences for Students and Teachers (ITEST).

- **Low-income Scholarship Program: S-STEM.** Eligibility for the scholarships was expanded in 2006 from the original fields of computer science, engineering, and mathematics to include "other technology and science programs designated by the Director." The maximum annual scholarship award amount was raised from $3,125 to $10,000. NSF may use up to 50 percent of funds "for undergraduate programs for curriculum development, professional and workforce development, and to advance technological education." Because of the changes, the program was renamed in 2006 from CSEMS to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

  Since its inception the low-income scholarship program has received approximately 5,000 proposals from all types of colleges and universities and has made awards for 1,195 projects. Approximately 63,800 students have received scholarships ranging from one to four years, and many new grants have yet to award all their scholarships. In addition to scholarships, projects include student support activities featuring close involvement of faculty, student mentoring, academic support, curriculum development, and recognition of the students. Such activities are important in recruiting and retaining students in high-technology fields through graduation and into employment. S-STEM projects report much higher retention and graduation rates among scholarship students than among other STEM majors. Approximately 90 awards are anticipated in FY 2013, with an emphasis on increasing involvement of community colleges.

- **Mathematics, Science, or Engineering Enrichment Courses: ITEST**. The ITEST program invests in K-12 activities that address the current concern about shortages of STEM professionals and information technology workers in the U.S. and seeks solutions to help ensure the breadth and depth of the STEM workforce. ITEST funds activities for students and teachers that emphasize mathematics, science, and engineering careers, and emphasizes the importance of evaluation and research to understand the impact of such activities. The program supports the development, implementation, testing, and scale-up of models, STEM robotic projects, and research studies to improve the STEM workforce and build student's capacity to participate in the STEM workforce.

The solicitation places emphasis on capturing and establishing a reliable knowledge base about the dispositions toward and knowledge about STEM workforce skills in U.S. students.

Since its inception, the ITEST program has received 1,949 proposals and funded over 200 projects that allow students and teachers to work closely with scientists and engineers on extended research projects, ranging from biotechnology to environmental resource management to programming and problem-solving. Projects draw on a wide mix of local resources, including universities, industry, museums, science and technology centers, and school districts in order to identify the characteristics that engage a wide range of young people in STEM, especially those not successful in traditional school settings. Through a projected $191 million federal investment, ITEST impacts an estimated 216,000 students (grades K-12), 7,700 educators, and 2,300 parents and caregivers. In FY 2011, ITEST received 408 full proposals and funded 15 awards.

**H-1B Financial Activities from FY 2000 - FY 2011**

(Dollars in Millions)

| | FY 2001 | FY 2002 | FY 2003 | FY 2004 | FY 2005 | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | FY 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Receipts** | **$88.34** | **$61.04** | **$65.34** | **$0.57** | **$83.68** | **$105.32** | **$107.36** | **$104.43** | **$88.66** | **$91.22** | **$106.11** |
| **Unobligated Balance start of year** | **$48.89** | **$59.72** | **$63.45** | **$83.90** | **$29.10** | **$89.58** | **$98.19** | **$63.37** | **$50.83** | **$52.62** | **$50.15** |
| Obligations incurred: | | | | | | | | | | | |
| Computer Science, Engineering, and Mathematics Scholarships | 68.37 | 34.69 | 25.30 | 33.91 | 0.54 | 80.95 | 100.04 | 92.40 | 61.22 | 75.96 | 77.67 |
| Grants for Mathematics, Engineering or Science Enrichment Courses | 4.22 | 5.83 | 16.27 | - | - | - | - | - | - | | - |
| Systemic Reform Activities | 3.70 | 3.97 | 5.00 | 2.50 | 2.72 | - | - | - | - | | - |
| Private-Public Partnership in K-12[1/] | 2.22 | 12.82 | - | 20.87 | 22.69 | 18.45 | 45.90 | 28.72 | 27.86 | 20.85 | 18.62 |
| **Total Obligations** | **$78.51** | **$57.31** | **$46.57** | **$57.28** | **$25.95** | **$99.40** | **$145.94** | **$121.12** | **$89.08** | **$96.81** | **$96.29** |
| Unallocated Recoveries | | | | | | | | | 2.20 | 3.12 | 0.96 |
| **Unobligated Balance end of year** | **$59.72** | **$63.45** | **$83.90** | **$29.10** | **$89.58** | **$98.19** | **$63.37** | **$50.83** | **$52.62** | **$50.15** | **$60.93** |

Totals may not add due to rounding.

[1/] P.L 106-313 directs that 15 percent of the H-1B Petitioner funds go toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established an H-1B Nonimmigrant Petitioner Account in the general fund of the U.S. Treasury for fees collected for each petition for alien nonimmigrant status. That law required that a prescribed percentage of funds in the account be made available to NSF for the following activities:

- **Computer Science, Engineering, and Mathematics Scholarships (CSEMS)**. The program supported grants for scholarships to academically-talented, financially needy students pursuing associate, baccalaureate, or graduate degrees in computer science, computer technology, engineering, engineering technology, or mathematics. Grantee institutions awarded scholarships of up to $2,500 per year for two years to eligible students.

- **Grants for Mathematics, Engineering, or Science Enrichment Courses.** These funds provided opportunities to students for enrollment in year-round academic enrichment courses in mathematics, engineering, or science.
- **Systemic Reform Activities.** These funds supplemented the rural systemic reform efforts administered under the former EHR Division of Educational System Reform (ESR).

In FY 2001, Public Law 106-311 increased the funds available by increasing the petitioner fees. Also, the American Competitiveness in the 21st Century Act (P.L. 106-313) amended P.L. 105-277 and changed the way petitioner fees were to be expended.

- The CSEMS activity continued under P.L. 106-313 with a prescribed percentage of H-1B receipts. The maximum scholarship duration was four years and the annual stipend was $3,125. Funds for this scholarship program totaled 59.5 percent of the total H-1B funding for NSF.
- Private-Public Partnerships in K-12: P.L. 106-313 directed the remaining 40.5 percent of receipts toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development.
- The Information Technology Experiences for Students and Teachers (ITEST) program was developed as a partnership activity in K-12 to increase opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including information technology (IT) courses.

**Explanation of Carryover**

Within the H-1B Nonimmigrant Petitioner account (Mandatory), $60.93 million was carried over into FY 2012, which consisted of $17.41 million in ITEST and $43.52 million in S-STEM and includes third quarter H-1B receipts (received in July 2011) and $32.5 million in fourth quarter receipts (received in October 2011). Since NSF receives the largest quarterly payment of H-1B visa fees in July, there is insufficient time to obligate the receipts on awards before the end of the fiscal year. These resources will allow for both I-TEST and S-STEM to support awards in the third quarter of FY 2012.

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

**$196,170,000**
**-$890,000 / -0.5%**

### Major Research Equipment and Facilities Construction Funding

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| Major Research Equipment and Facilities Construction | $125.37 | $197.06 | $196.17 | -$0.89 | -0.5% |

The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and post-construction operations and maintenance of the facilities are funded through the Research and Related Activities (R&RA) account.

### MREFC Account Funding, by Project

(Dollars in Millions)

| | FY 2011 Actual | FY 2012[1] Estimate | FY 2013 Request | FY 2014 Estimate | FY 2015 Estimate | FY 2016 Estimate | FY 2017 Estimate | FY 2018 Estimate |
|---|---|---|---|---|---|---|---|---|
| AdvLIGO | $23.58 | $20.96 | $15.17 | $14.92 | - | - | - | - |
| ALMA | 13.92 | 3.00 | - | - | - | - | - | - |
| ATST | 5.00 | 10.00 | 25.00 | 42.00 | 20.00 | 20.00 | 9.93 | - |
| IceCube[2] | 5.29 | - | - | - | - | - | - | - |
| NEON | 12.58 | 60.30 | 91.00 | 98.20 | 91.00 | 80.66 | - | - |
| OOI | 65.00 | 102.80 | 65.00 | 27.50 | - | - | - | - |
| MREFC Total | $125.37 | $197.06 | $196.17 | $182.62 | $111.00 | $100.66 | $9.93 | - |

Totals may not add due to rounding.

[1]In FY 2012, $30.0 million was transferred from the Research and Related Activities (R&RA) account to the Major Research Equipment and Facilities Construction (MREFC) account, as provided by the Science Appropriations Act, 2012, P.L. 112-55.

[2] IceCube and South Pole Station Modernization are expected to report FY 2012 Actual funding from FY 2011 carryover.

Modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

NSF requires that a project represent an exceptional opportunity to enable research and education to be considered for MREFC funding. The project should be transformative in nature, with the potential to shift the paradigm in scientific understanding. The projects included in this budget request meet these criteria based on NSF and National Science Board (NSB) review.

In FY 2013, NSF requests funding to continue construction of four projects: Advanced LIGO (AdvLIGO), Advanced Technology Solar Telescope (ATST), Ocean Observatories Initiative (OOI), and the National Ecological Observatory Network (NEON). No additional funding is required in FY 2013 for Atacama Large Millimeter Array (ALMA).

NSF maintains a "no cost overrun" policy: it requires that (1) the total cost estimate for each project at the preliminary design stage include adequate contingency to cover all foreseeable risks, and (2) any total project cost increases not covered by contingency be accommodated by reductions in scope, provided that the actual enacted funding levels have been consistent with the established project profiles.

NSF agency-wide procedures are designed to ensure that cost and contingency tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective. If total costs for a project are revised during construction for reasons other than inadequate funding, NSF will identify mechanisms for offsetting any cost increases in accordance with the no overrun policy. In addition, all of the projects funded through the MREFC account undergo major cost and schedule reviews as required by NSF guidelines.

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

### Appropriations Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, ~~$167,055,000~~*$196,170,000*, to remain available until expended~~: *Provided*, That none of the funds may be used to reimburse the Judgment Fund~~.

**Major Research Equipment and Facilities Construction**
**FY 2013 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Rescission | Carryover/ Recoveries | Transfers[1] | Total Resources | Obligations Incurred/Est. |
|---|---|---|---|---|---|---|
| FY 2011 Appropriation | $117.29 | -$0.23 | $9.19 | | $126.25 | $125.37 |
| FY 2012 Estimate | 167.06 | | 0.88 | 30.00 | 197.94 | 197.94 |
| FY 2013 Request | 196.17 | | | | 196.17 | 196.17 |
| $ Change from FY 2012 Estimate | | | | | | -$1.77 |
| % Change from FY 2012 Estimate | | | | | | -0.9% |

Totals may not add due to rounding.

[1]In FY 2012, $30.0 million was transferred from the Research and Related Activities (R&RA) account to the Major Research Equipment and Facilities Construction (MREFC) account, as provided by the Science Appropriations Act, 2012, P.L. 112-55.

### Explanation of Carryover

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, $878,000 was carried over into FY 2012. This includes:

- $694,000 for IceCube Neutrino Observatory (IceCube): Project closure activities and associated costs are currently being finalized.

- $164,000 for South Pole Station Modernization (SPSM): Final project costs are being reconciled and will be concluded in FY 2012. If any of the remaining funds are required, they will be obligated in the second quarter of FY 2012.

- NSF recovered $20,000 in FY 2011 following the conclusion of the Earthscope and NEES construction projects. These funds were carried over and are being applied to ongoing projects.

**The MREFC Account in FY 2013**

The following pages contain information on NSF's ongoing projects in FY 2013, grouped by sponsoring organization. These are:

Advanced LIGO, AdvLIGO (MPS).....MREFC – 4
Advanced Technology Solar Telescope, ATST (MPS).....MREFC – 8
Atacama Large Millimeter Array, ALMA (MPS).....MREFC – 13
National Ecological Observatory Network, NEON (BIO).....MREFC – 18
Ocean Observatories Initiative, OOI (GEO).....MREFC – 25

## Advanced Laser Interferometer Gravitational-Wave Observatory $15,170,000

The FY 2013 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $15.17 million, which represents the sixth year of a seven-year project totaling an estimated $205.12 million.

**Appropriated and Requested MREFC Funds for the Advanced Laser Interferometer Gravitational-Wave Observatory**

(Dollars in Millions)

| FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 Estimate | FY 2013 Request | FY 2014 Estimate | FY 2015 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|
| $32.75 | $51.43 | $46.30 | $23.58 | $20.96 | $15.17 | $14.92 | - | $205.12 |

Totals may not add due to rounding.

### Baseline History

NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal, received in 2003, estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review held in June 2007 confirmed this cost, subject to changes in inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites 3,000 km apart: Hanford, WA and Livingston, LA. These interferometers measure minute changes in arm lengths resulting from the passing of wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one one-thousandth the diameter of a proton over the 4-km arm length; AdvLIGO is expected to be at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered and led the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

Assembly and testing of AdvLIGO optical suspension components for use in high vacuum. *Credit:* LIGO Laboratory.

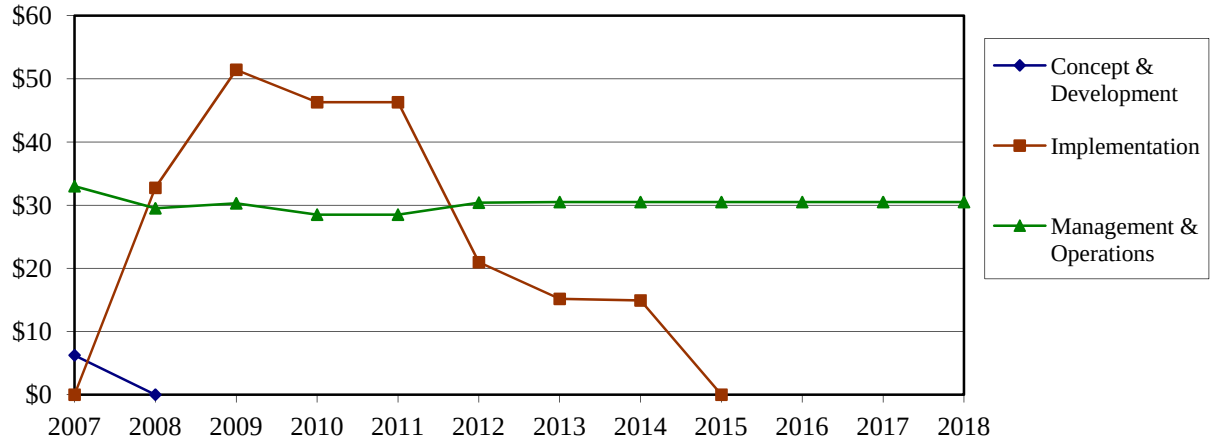
**Total Obligations for AdvLIGO**
(Dollars in Millions)

| | Prior Years[1] | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $40.74 | - | - | - | - | - | - | - | - |
| Management & Operations | 28.50 | 30.30 | 30.40 | 30.50 | 30.50 | 30.50 | 30.50 | 30.50 | 30.50 |
| Subtotal, R&RA Obligations | $69.24 | $30.30 | $30.40 | $30.50 | $30.50 | $30.50 | $30.50 | $30.50 | $30.50 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 130.49 | 23.58 | 20.96 | 15.17 | 14.92 | - | - | - | - |
| Subtotal, MREFC Obligations | $130.49 | $23.58 | $20.96 | $15.17 | $14.92 | - | - | - | - |
| **TOTAL Obligations** | **$199.73** | **$53.88** | **$51.36** | **$45.67** | **$45.42** | **$30.50** | **$30.50** | **$30.50** | **$30.50** |

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

**AdvLIGO Funding, by Stage**
(Dollars in Millions)




Note: Management & Operations refers to the continued operations of LIGO during the construction phase and the onset of operations for the newly constructed AdvLIGO planned for FY 2015.

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects, with some partnerships leading to the development of new products and techniques. Areas of involvement include novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products), the development of new low-noise optical coatings, the development of new ultra-fine optics polishing techniques, and the development of new optical inspection equipment (new product).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration of some 870 members that has formal ties with at least 77 institutions in 15 countries. Close collaboration is maintained with three other gravitational-wave observatories: GEO, a UK-German collaboration; Virgo, a French-Italian collaboration; and LCGT, a nascent Japanese project. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and

developed by the Max Planck Gesellschaft; the mirror/test mass suspension systems, funded and developed by the GEO collaboration; and auxiliary optical components, developed by the Australian National University and Adelaide University.

## Project Report

**Management and Oversight**

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY) in the Directorate for Mathematics and Physical Sciences (MPS), who also participates in the LIGO Advisory Team (LIGO PAT). The LIGO PAT includes staff from the Offices of Budget, Finance, and Award Management (BFA), General Counsel (OGC), and Legislative and Public Affairs (OLPA). Formal reporting consists of submitted quarterly and annual reports and brief monthly status reports to the LIGO program officer, who in turn reviews, edits, comments, and submits the reports to the Deputy Director for Large Facility Projects.

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement with NSF. An Executive Director has overall responsibility for the LIGO Laboratory. A Deputy Director is responsible for executing the LIGO program and for organizing and directing the Laboratory team. A LIGO Scientific Collaboration (LSC) spokesperson is responsible for assuring that the efforts of the LSC and LIGO Laboratory are well aligned. (The LSC carries out the LIGO research and development program, the analysis of data, and the publication of scientific results, and it enables participation by collaborating groups in appropriate LIGO activities). The Advanced LIGO construction project has its own management structure, which reports directly to the LIGO Executive Directorate. Advanced LIGO management consists of a Project Leader, who is responsible for the overall management of the project, a Project Manager, who oversees construction activities, and the Systems Engineer, who is responsible for all engineering for the project.

- Reviews:
  - Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers, participates in meetings of the LIGO Scientific Collaboration (LSC), and conducts site visits to the Hanford, WA and Livingston, LA interferometers.
  - Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June 2006; (2) second baseline review in June 2007; (3) final readiness review in November 2007.
  - Project Reviews: (1) First review of the active project in November 2008; (2) first annual review in April 2009; (3) interim review in December 2009; (4) second annual review in April 2010; (5) interim review in December 2010; (6) third annual review in April 2011; (7) interim review in November 2011. The fourth annual review is scheduled for April 2012.
  - Continuing annual reviews will be conducted by external panels throughout construction. As part of the constant monitoring of progress, these reviews will be supplemented by smaller interim reviews held concurrently with the LIGO facility annual reviews, which are held in the October to December timeframe each year.

**Current Project Status**

The National Science Board approved funding for AdvLIGO in March 2008, and the project began in April 2008. On October 20, 2010, the final LIGO science run ended and the facility was turned over to the AdvLIGO project for the installation of the advanced components. The project has pushed back two milestone dates, completion of installation at Livingston and at Hanford, by three months due to procurement difficulties; no effect on the project completion date is expected. The removal of initial LIGO instruments is nearing completion with the end of a highly successful quantum-squeezing

experiment and the decommissioning of the final initial LIGO interferometer. The major current project activity is the assembly and installation of large subsystem components; testing of major subsystems will begin in 2012. The current project performance is consistent with ending on time and on budget. Total project contingency usage as of November 2011 is $23.0 million of an initial $39.10 million, or 59 percent of initial contingency for 64 percent of the project completed.

**Cost and Schedule**

The projected length of the project is seven years, with an 11-month schedule contingency. The risk-adjusted cost of $205.12 million included a contingency budget of 23.7 percent (at the time of the award).

**Risks**

The AdvLIGO project underwent a comprehensive external annual review in April 2011 and an interim review in December 2011. The annual review panel reported: "Overall the project team has been extremely effective at keeping the project on schedule and within budget. This is due to constant vigilance and the skilled exploitation of schedule float to enable early testing and to respond to changes in parts delivery schedules and various other circumstances to keep the major milestones in place." This assessment was confirmed by the interim review. NSF program staff are confident that risk is being managed effectively but are monitoring progress, maintaining frequent communications with the project managers, and conducting frequent reviews.

Technical risks include uncertainties about such topics as eliminating parametric acoustooptic instabilities in the interferometers, minimizing thermal noise in the mirror optical coatings, and mitigating possible electrical charge on optical elements. The LIGO Laboratory has been conducting research to minimize these and other risks, and an internal risk management team oversees these efforts. Risk management and its results are topics of internal and biannual external reviews.

Management risks include the planned decommissioning and installation procedures as well as risks involving adherence to the project timelines and budget. NSF staff conduct weekly meetings with the project management to oversee the progress of the project; monthly, quarterly, and annual reports, as well as annual reviews (supplemented by interim reviews), are also important project monitoring instruments. The project status is tracked with earned value management parameters.

Environmental risk is being effectively mitigated. The freely-suspended optical elements at the core of the observatory are carefully protected from earthquakes. Anthropogenic noise at the Livingston site due to logging and oil exploration has been mitigated by communication with local industry and by the early adoption of AdvLIGO seismic noise isolation technology.

Safety is maintained by strict adherence to institutional guidelines and to published LIGO Laboratory safety practices, overseen by dedicated safety officers at both sites. Hazard analysis is conducted before work is begun and mitigation is performed. External reviews have found safety procedures to be satisfactory.

**Future Operations Costs**

Future operations and maintenance costs will be approximately $39.0 million per year funded through NSF's Division of Physics in the Directorate for Mathematical and Physical Sciences.

## Advanced Technology Solar Telescope $25,000,000

The FY 2013 Budget Request for the Advanced Technology Solar Telescope (ATST) is $25.0 million. The total project cost to NSF, $297.93 million, was finalized after a Final Design Review (FDR) in May 2009. The National Science Board approved an award for this amount at the NSF Director's discretion, contingent upon completion of compliance with relevant environmental and cultural/historic statutes. The environmental compliance requirements were completed on November 20, 2009, and the Record of Decision authorizing the construction was signed by the NSF Director on December 3, 2009. The Board on Land and Natural Resources (BLNR) approved the project's application for a Conservation District Use Permit (CDUP) on December 1, 2010. Site preparation awaits resolution of a challenge to the CDUP by a Native Hawaiian organization.

**Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope**
(Dollars in Millions)

| | FY 2009 | FY 2010 | FY 2011 | FY 2012 Estimate | FY 2013 Request | FY 2014 Estimate | FY 2015 Estimate | FY 2016 Estimate | FY 2017 Estimate | FY 2018 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MREFC Appropriation | $7.00 | $13.00 | $5.00 | $10.00 | $25.00 | $42.00 | $20.00 | $20.00 | $9.93 | - | $151.93 |
| ARRA MREFC Approp. | 146.00 | - | - | - | - | - | - | - | - | - | 146.00 |
| **Total, ATST** | **$153.00** | **$13.00** | **$5.00** | **$10.00** | **$25.00** | **$42.00** | **$20.00** | **$20.00** | **$9.93** | **-** | **$297.93** |

### Baseline History

ATST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and coronal mass ejections. These can affect civil life on Earth through the phenomena generally described as "space weather" and may have impact on the terrestrial climate. The relevance of ATST's science drivers was reaffirmed by the National Academy of Sciences 2010 Astronomy and Astrophysics Decadal Survey, *New Worlds, New Horizons.*

Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences (AGS, formerly ATM). The current design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review (PDR) in October-November 2006. The FDR held in May 2009 determined that the project was fully-prepared to begin construction.

In FY 2009, $6.67 million was provided through the Research and Related Activities (R&RA) account. Of this total, $3.57 million in regular R&RA funds supported design activities to complete a construction-ready design, and $3.10 million through the American Recovery and Reinvestment Act of 2009 (ARRA) supported risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. Funding also provided for several new positions to complete preparation for the start of construction. Also in FY 2009, $153.0 million was provided through the Major Research Equipment and Facilities Construction (MREFC) account to initiate construction. Of these MREFC funds, $146.0 million was appropriated through ARRA. Given the timing of the receipt of budget authority and the complexity of project contracting, the entire $153.0 million was carried over from FY 2009 and subsequently obligated in FY 2010. Since then, the primary mirror blank has been purchased and contracts for the mirror's figuring and polishing have been let. Detailed design and fabrication contracts for the ATST major subsystems and instruments have been issued. A Habitat Conservation Plan (HCP) that is designed to protect and rehabilitate habitats of the endangered Hawaiian

petrel and Hawaiian goose that could potentially be affected by the construction of the ATST has been approved by the Hawaii Board on Land and Natural Resources. Formal consultation with the U.S. Fish and Wildlife Service (USF&WS) with regard to the endangered petrel was completed in calendar year 2011.

**Total Obligations for ATST**

(Dollars in Millions)

| | Prior Years[1] | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $20.41 | - | - | - | - | - | - | - | - |
| Management & Operations[2] | - | 2.00 | 2.00 | 2.00 | 7.00 | 11.00 | 13.00 | 16.00 | 18.00 |
| ARRA | 3.10 | - | - | - | - | - | - | - | - |
| Subtotal, R&RA Obligations | $23.51 | $2.00 | $2.00 | $2.00 | $7.00 | $11.00 | $13.00 | $16.00 | $18.00 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 20.00 | 5.00 | 10.00 | 25.00 | 42.00 | 20.00 | 20.00 | 9.93 | - |
| ARRA | 146.00 | - | - | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $166.00 | $5.00 | $10.00 | $25.00 | $42.00 | $20.00 | $20.00 | $9.93 | - |
| **TOTAL Obligations** | **$189.51** | **$7.00** | **$12.00** | **$27.00** | **$49.00** | **$31.00** | **$33.00** | **$25.93** | **$18.00** |

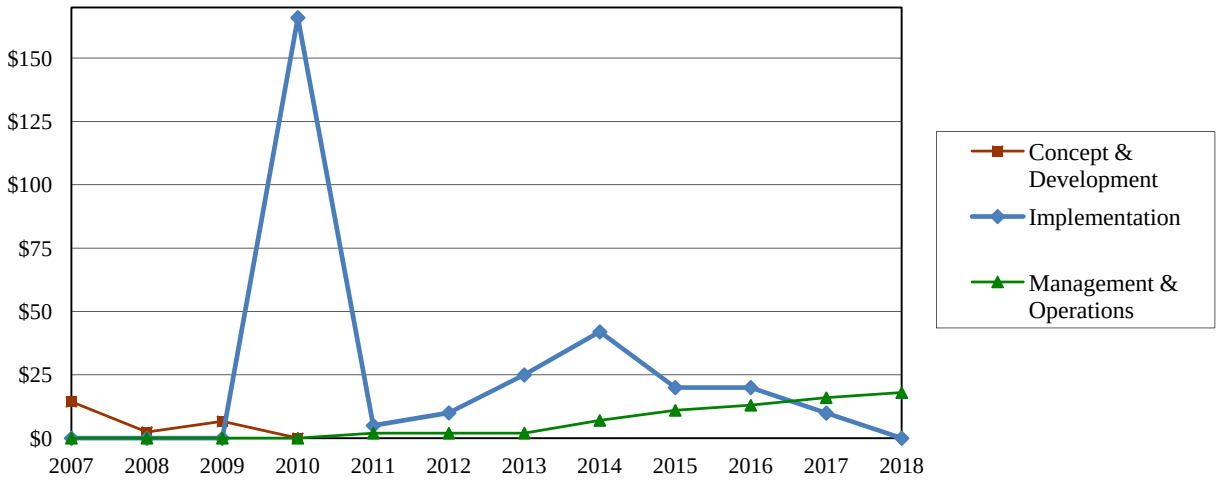
Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years.

[2] Of the total Management & Operations funding, $2.0 million per year for FY 2011 through FY 2020 is for cultural mitigation activities as agreed to during the compliance process.

**ATST Funding, by Stage**

(Dollars in Millions)




The project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Other potential partners include the Air Force Office of Scientific Research and international groups in Germany, the United Kingdom, and Italy. Now that there is firm funding for construction, details of these partnerships are being discussed. These include the following activities:

- The US Air Force has replaced the aluminizing chamber at their Advanced Electro-Optical System telescope on Maui and sized it to accommodate the ATST mirror. This obviates the need to build a chamber for the ATST primary.
- Kiepenheuer-Institut fuer Sonnenphysik (Freiburg, Germany) is constructing a narrow-band visible tunable filter, a first-light instrument.

- Queens University Belfast is considering contributing high speed cameras for ATST instrumentation.
- Arcetri Observatory (Italy) is considering the design and construction of an adaptive secondary (an upgrade to the current plans), as well as an infrared tunable filter.

Discussions of other possible contributions for second-generation instruments are continuing. Partner share of observing time on the facility will be calculated according to the value of their contributions.

## Project Report

**Management and Oversight**

- NSF Structure: Oversight from NSF is handled by a program manager in the AST Division working with staff from the Directorate of Mathematical and Physical Sciences, Offices of Budget, Finance and Award Management, General Counsel, Legislative and Public Affairs, and the Division of Atmospheric and Geospace Sciences in the Directorate for Geosciences. The Deputy Director for Large Facilities also provides advice and assistance.

- External Structure: The project is managed by NSO. NSF funds NSO operation and maintenance and ATST design and development via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc. (AURA). The ATST Director is a senior NSO scientist who was a leader in the development of the science case. The newly-appointed Project Manager has experience in several other NSF-funded large projects including ALMA and the Expanded Very Large Array. Several councils and working groups provide input from the solar and space physics communities.

- Reviews:
  - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in the NSF-conducted Conceptual Design Review in March 2005 and Preliminary Design Review in October-November 2006. The project has completed a comprehensive set of system-level design reviews for all major sub-systems.
  - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design and Final Design Reviews.
  - The Final Design Review: The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the ATST project was fully prepared to begin construction. A number of specific panel recommendations on contracting strategy, contingency estimating, and other items, were subsequently included in the project execution plan.
  - Upcoming Reviews: A baseline review will be conducted in early calendar year 2012, after final approval to begin construction is received from the State of Hawaii.

**Current Project Status**

Current activities include finalizing the detailed designs and beginning fabrication of all ATST subsystems and instruments, resolving the remaining permitting issue, and preparing for site preparation and construction. Haleakala High Altitude Observatory on the island of Maui was chosen as the ATST site. The Final Environmental Impact Statement was submitted to the Environmental Protection Agency on July 24, 2009. Consultation with Native Hawaiian stakeholders has resulted in a fully-executed Programmatic Agreement that details steps to minimize impacts on the traditional cultural assets on Haleakala, thereby completing compliance with the National Historic Preservation Act. The record of decision authorizing the commencement of construction in FY 2010 was signed by the NSF Director and published in the Federal Register on December 9, 2009. All federal environmental compliance requirements are now complete. Application for the CDUP, which is required for construction at the ATST site, was completed in June 2010. BLNR approved the issuance of the CDUP in December 2010. This permit has been challenged by a Native Hawaiian group via an administrative contested case. The

project postponed site preparation until this case is resolved. A contested case hearing was held in July 2011, and the report from the hearing officer and the ruling by the BLNR as to whether the CDUP will stand have not been issued. Assuming that the validity of the CDUP is upheld, groundbreaking at the site and the subsequent commencement of construction should occur in early calendar year 2012. The project is completing work with the Haleakala National Park to obtain the Special Use Permit required for construction traffic to traverse the park road to access the site. The project has established an office in Pukalani, Maui.

**Costs and Schedule**

The baseline not-to-exceed cost was established following the FDR. Funding is derived from ARRA ($146.0 million) and annual appropriations in the MREFC account ($151.93 million). In order to clearly separate funds from the two sources, the project developed two statements of work, dividing their resource-loaded Work Breakdown Structure between large contracts to be funded early in the project by ARRA, and smaller procurements and project costs, such as labor and rent, to be funded by future annual MREFC appropriations. In January 2010, the project submitted a revised budget for the construction proposal for use of MREFC funds, along with a revised statement of work and budget justification for funds from ARRA. Initial awards of $146.0 million of ARRA and $20.0 million of MREFC funds were made via separate Cooperative Support Agreements under the NSO management and operations cooperative agreement. The project is currently revising its baseline as a result of the delay imposed by the above mentioned challenge to the CDUP and in response will accelerate the expenditure of ARRA funds, in keeping with Administration policy. The new baseline will undergo a comprehensive review in the spring of 2012.

**Risks**

Cost and contingency have been validated and essentially all technical risks have been retired. Project management control, interface control, and change control, are all in place. The delay in obtaining full access to the site and the changes to the project funding profile since NSB approval may impact the total project cost and schedule. This will be assessed during the current re-baselining activity and treated in accordance with the policies described at the beginning of the MREFC section

*Technical:* The remaining technical risk is very low as a result of the long design and development phase.

*Environmental and Cultural Compliance:* Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, delay in obtaining permission to begin construction was anticipated. The Division of Astronomical Sciences, NSF's Office of the General Counsel, and the ATST project have worked carefully through the processes of the applicable statutes. The remaining issue at this time is the resolution of the challenge to the CDUP. Additionally, it was previously assumed that heavy construction could not be carried out during the brooding season of the Hawaiian petrels that nest in the cliffs adjacent to the site; however acceptance of the HCP and completion of formal consultation with USF&WS have enabled year-round construction activity.

*Environmental Health and Safety:* NSO has a well-developed safety program engendered in the ATST project. However, it is imperative that a culture of safety be imposed on site contractors. The ATST project has developed a site safety plan and conducted a thorough construction readiness review in 2011. Safety reviews will be held annually following the commencement of construction.

**Future Operations Costs**

The estimated annual operations cost is $18.0 million in FY 2018, including $2.0 million annually for cultural mitigation. Since ATST will become the flagship solar telescope of NSO and will render some telescopes obsolete, about $5.0 to $7.0 million per year of NSO costs will be recovered from the closure or divestment of redundant facilities. NSO has a preliminary transition plan that will be revised and

externally reviewed after construction begins. Cultural mitigation commitments have been made pursuant to terms of ATST environmental and cultural compliance as described in the final environmental impact study and the subsequent Record of Decision, and the Programmatic Agreement. These include $2.0 million of R&RA funding to be provided annually for 10 years for programs on Maui, supporting science, technology, engineering, and mathematics education and workforce development with an emphasis towards Native Hawaiian students. A ten-year award to develop and administer these programs was made to the University of Hawaii Maui College (UHMC) in 2011.

Artist's rendition of the ATST facility, looking south. *Credit: NSO/AURA*.

## Atacama Large Millimeter Array **$0.00**

No MREFC funds are requested for the Atacama Large Millimeter Array (ALMA) in the FY 2013 Budget Request. The FY 2012 appropriation provided $3.0 million, which represents the final amount necessary to complete funding for the eleven-year project, totaling $499.26 million.

**Appropriated and Requested MREFC Funds for the Atacama Large Millimeter Array**
(Dollars in Millions)

| FY 2007 & Earlier[1] | FY 2008 | FY 2009 | FY 2010 | FY 2011 | FY 2012 Estimate | FY 2013 Request | Total Project Cost |
|---|---|---|---|---|---|---|---|
| $255.27 | $102.07 | $82.25 | $42.76 | $13.92 | $3.00 | - | $499.27 |

[1]An additional $31.99 million was appropriated through the MREFC account prior to FY 2005 for concept and development.

The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 mm to 0.4 mm. ALMA will be the world's most sensitive, highest resolution millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer is under construction at 5,000 meters altitude near San Pedro de Atacama in the Antofagasta (II) Region of Chile, the ALMA host country.

### Baseline History

A $26.0 million, three-year design and development phase was originally planned for a U.S.-only project, the Millimeter Array. NSF first requested funding for design and development of this project in FY 1998. In June 1999, the U.S. entered into a partnership via a Memorandum of Understanding (MOU) with the European Southern Observatory (ESO), a consortium of European funding agencies and institutions. The MOU committed the partners to construct a 64 element array of 12-meter antennas. NSF received $26.0 million in appropriations between FY 1998 and FY 2000. Because of the expanded managerial and technical complexity of the joint US/ESO project, now called ALMA, Congress provided $5.99 million in FY 2001 for an additional year of design and development. In FY 2002, $12.50 million was appropriated to initiate construction; the U.S. share of the cost was estimated to be $344.0 million. The National Research Council (NRC) of Canada joined ALMA as a partner in 2003. In 2004, Japan entered under the provisions of a MOU between NSF, ESO, and the National Institute of Natural Sciences of Japan.

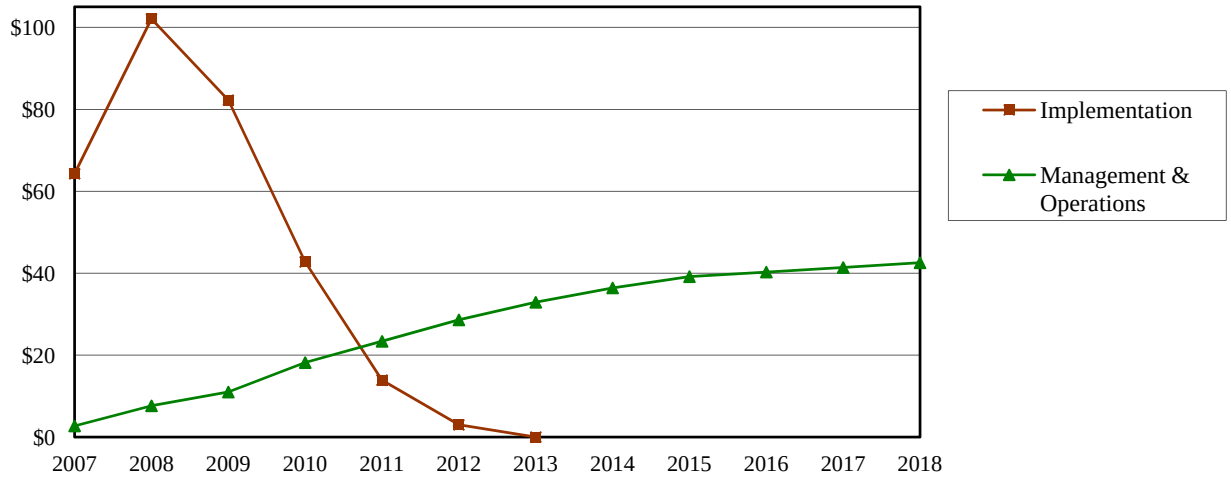
The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. At that point, the project was sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the rebaselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in the FY 2011 Budget Request.

**Total Obligations for ALMA**
(Dollars in Millions)

| | Prior Years[1] | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $6.50 | - | - | - | - | - | - | - | - |
| Management & Operations | 18.20 | 23.38 | 28.61 | 32.92 | 36.41 | 39.17 | 39.95 | 40.79 | 41.65 |
| Subtotal, R&RA Obligations | $24.70 | $23.38 | $28.61 | $32.92 | $36.41 | $39.17 | $39.95 | $40.79 | $41.65 |
| *MREFC Obligations:* | | | | | | | | | |
| Concept & Development | 31.99 | - | - | - | - | - | - | - | - |
| Implementation | 482.35 | 13.92 | 3.00 | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $514.34 | $13.92 | $3.00 | - | - | - | - | - | - |
| **TOTAL Obligations** | **$539.04** | **$37.30** | **$31.61** | **$32.92** | **$36.41** | **$39.17** | **$39.95** | **$40.79** | **$41.65** |

Totals may not add due to rounding.
[1] Concept & Development funding and Implementation funding are cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

**ALMA Funding, by Stage**
(Dollars in Millions)




Once completed, ALMA will be the most capable imaging radio telescope ever built and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet, and x-ray astronomical instruments of the 21st century.

ALMA will help educate and train U.S. astronomy and engineering students; at least 15 percent of ALMA's approximately 1,000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program, providing an opportunity to broaden participation in science and engineering by members of underrepresented groups.

Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. ALMA education and public outreach (EPO) programs are funded regionally, through the Associated Universities Incorporated/National Radio

Astronomy Observatory (AUI/NRAO), ESO, and the National Astronomical Observatory of Japan (NAOJ), and jointly by the ALMA partnership in Chile. AUI/NRAO's request for NSF funding (including partnership activities) was critically evaluated as a component of a proposal review in mid-2010 and assessment will continue as part of the annual external reviews. NRAO's EPO activities are included in their annual program plan and the status, performance, and issues are assessed by program staff through regular quarterly reports. ESO and NAOJ will follow their own processes for review of their contributions. These reviews include consideration of plans for evaluation and measurement of all programs. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social, and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

North America and Europe are equal partners in the core ALMA instrument. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project (including Taiwan) is led by AUI/NRAO. Funding and execution of the project in Europe is carried out through the ESO. Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the NAOJ.

From an industrial perspective, ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and is expected to stimulate commercial device and communication technologies development.

Peer-review telescope allocation committees will provide merit-based telescope time but no financial support. NSF will not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or National Aeronautics and Space Administration (NASA) grants to pursue research programs that require use of ALMA.

Construction progress continues in FY 2012, both at the site in Chile and within the ALMA partner countries. In FY 2011, delivery of North American production antennas continued at the planned rate of one every two months, and a total of twenty antennas were accepted or assembled and tested in Chile. Following assembly and testing, antennas were transported to the final, high-altitude site and science commissioning has begun. Early science operations commenced in late FY 2011 and completion of the construction project and the start of full science operations are forecast to occur in FY 2013.

## Project Report

**Management and Oversight**

- NSF Structure: Programmatic management is the responsibility of the ALMA program manager in the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, the Office of International Science and Engineering, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy Director for Large Facility Projects (DDLFP) is a member of the PAT and provides advice and assistance.

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA

Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, project manager, and systems engineer.

- Reviews:
  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the schedule, risks and cost to complete was held in October 2009, March 2010 and March 2011. A review of the science operations implementation plan was held in September 2009 and further science readiness reviews were held in October and November 2010. A function of the AMAC is to conduct project-wide annual external reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad project and in targeted areas. A review of the operations plan was conducted in July 2010. Project-wide annual reviews, last held in October 2010 and October 2011, assessed management, cost, and schedule performance, status, issues, and risks. A performance review of the labor management and practices at the Chilean sites was held in September 2010.
  - Upcoming reviews: The next annual external review will occur in October 2012.

**Current Project Status**

- Major milestones attained in FY 2011 included:
  - Continued delivery of North American antennas at a rate of one every two months
  - Acceptance of the tenth through sixteenth North American antennas
  - Acceptance of the last two Japanese 12-meter antennas, for a total of four, and the first four 7-meter antennas
  - Acceptance of the first two European antennas
  - Transport of a total of 17 accepted antennas to the high-altitude site in Chile
  - Installation and acceptance of the third quadrant of the correlator
  - Installation and acceptance of the remainder of the central local oscillator (will serve all 66 ALMA antennas)
  - Call for proposals for early science made in March 2011
  - Cycle 0 early science operations started in September 2011

- Major milestones for FY 2012 are expected to include:
  - Acceptance of the remaining nine North American antennas
  - Installation and acceptance of the fourth quadrant of the correlator
  - Acceptance of the remaining Japanese eight 7-meter antennas
  - Completion of delivery of all receiving systems from North America and East Asia
  - Continued delivery of European antennas at a rate of one every four to six weeks
  - Continued commissioning of accepted antenna and integration into the science array
  - Call for Cycle 1 early science proposals

- Major milestones for FY 2013 are expected to include:
  - Acceptance of the remaining 11 European antennas
  - Completion of delivery of European receiving systems
  - Continued commissioning of accepted antenna and integration into the science array
  - Inauguration of 50 antennas in the array
  - Start Cycle 1 early science

**Cost and Schedule**

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of receivers and European antennas. Consequently, the major milestone of full-science is forecast to be delayed by nine to twelve months when compared to the baseline plan. However, early science commenced in September 2011 as predicted a year ago. Cost performance is good at this stage — cost variance is on track with the reference baseline and schedule variance is -6 percent relative to the reference — with about 25 percent contingency remaining in the uncommitted budget. Significant expenditure of budgeted contingency is foreseen during the remainder of the project.

**Risks**

- The receiver systems and European antennas are the schedule pacing items. Fabrication of North American antennas is at the planned rate and testing and handover are catching up with delivery.
- Fabrication of individual receiver components is now at the production rate and the implementation of parallel integration and testing lines has improved receiver delivery overall so that receiver delivery can stay ahead of antenna delivery in the longer term.
- The production of the remaining receivers and European antennas will be required to hold the forecast schedule for completion. Integration of the final antennas and receivers into the science array is projected to continue well into 2013.

**Future Operations Costs**

Operations and maintenance funds phase-in as initial site construction is completed and antennas are delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early-science (FY 2012) and eventually full-science operations, as well as support ALMA observations by the U.S. science community. Full ALMA science operations are forecast to begin in 2013. An operations plan and a proposal for North American operations were externally reviewed in FY 2007 and again in July 2010. A funding profile through FY 2011 was authorized by the National Science Board in December 2007. A renewal through FY 2015 was authorized by the National Science Board in FY 2011. The process of a competition for the management and operation of ALMA/NRAO for a subsequent award in 2016 is expected to begin in FY 2012 provided that ALMA construction is completed as forecast and operations in Chile continue on their path to become sustainable. The operations estimates for FY 2013 and beyond are based on current cost projections. The anticipated operational lifespan of this project is at least 30 years.

Twenty antennas undergoing science commissioning at the ALMA high altitude site in Chile. *Credit: ALMA/ESO/ NRAO/NAOJ.*

## The National Ecological Observatory Network $91,000,000

The FY 2013 Budget Request for the National Ecological Observatory Network (NEON) is $91.00 million, which represents the third year of a 6-year project and totals an estimated $433.72 million.

**Appropriated and Requested Funding for the National Ecological Observatory Network**

(Dollars in Millions)

| Prior Years[1] | FY 2010 | FY 2011 | FY 2012 Estimate | FY 2013 Request | FY 2014 Estimate | FY 2015 Estimate | FY 2016 Estimate | FY 2017 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|---|
| $3.02 | - | $9.57 | $60.30 | $91.00 | $98.20 | $91.00 | $80.66 | - | $433.73 |

[1]Per P.L. 110-161, $4.0 million was rescinded from prior year unobligated balances, leaving $3,015,121 available for future obligations.

NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

### Baseline History

In 2004, the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the Major Research Equipment and Facilities Construction (MREFC) account for NEON in FY 2007 and FY 2008, $4.0 million of which was rescinded in FY 2008. A Preliminary Design Review (PDR) was completed in June 2009 and a Final Design Review (FDR) was completed in November 2009. Project planning continued through FY 2011 until construction began in August 2011. The FDR also included a formal construction baseline review and cost review; an additional baseline review was conducted in April 2011 prior to initiation of construction that confirmed the scope, cost, and schedule baselines.

**Total Obligations for NEON**
(Dollars in Millions)

| | Prior Years [1] | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $79.15 | $9.67 | $7.00 | $3.00 | - | - | - | - | - |
| Management and Operations[2] | - | - | 15.93 | 30.39 | 38.18 | 45.51 | 65.00 | 65.00 | 65.00 |
| ARRA | 9.96 | - | - | - | - | - | - | - | - |
| Subtotal, R&RA Obligations | $89.11 | $9.67 | $22.93 | $33.39 | $38.18 | $45.51 | $65.00 | $65.00 | $65.00 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation[3] | | $12.58 | $60.30 | 91.00 | 98.20 | 91.00 | 80.66 | - | - |
| Subtotal, MREFC Obligations | - | $12.58 | $60.30 | $91.00 | $98.20 | $91.00 | $80.66 | - | - |
| **TOTAL Obligations** | **$89.11** | **$22.25** | **$83.23** | **$124.39** | **$136.38** | **$136.51** | **$145.66** | **$65.00** | **$65.00** |

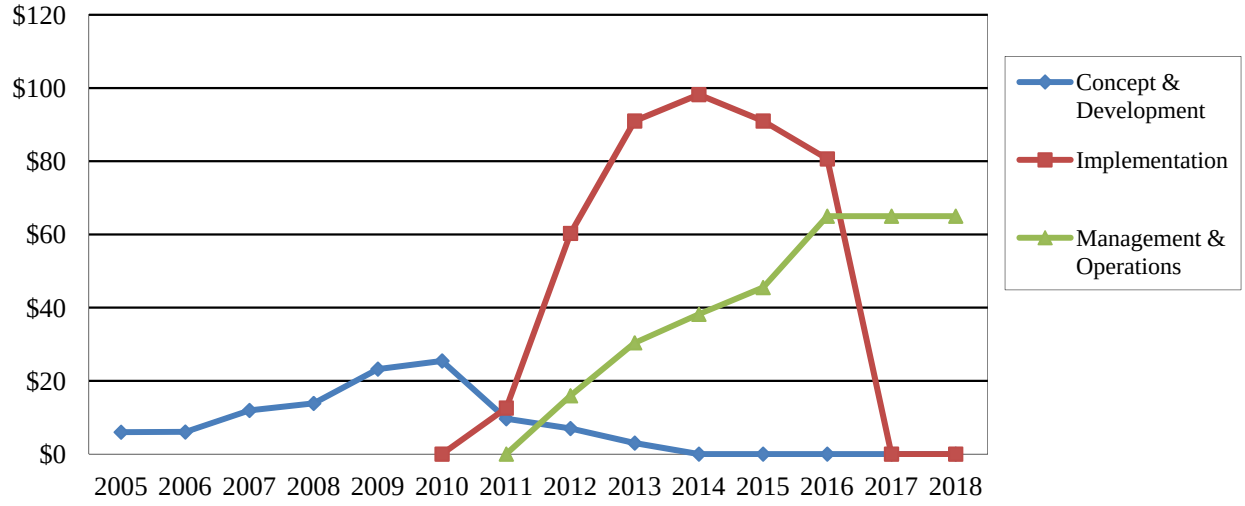
Totals may not add due to rounding.

[1] For the Prior Year column, the Concept & Development and Implementation funding lines are cumulative for all prior years.

[2] Funding for Maintenance and Operations (M&O) in outyears has been capped at now-year dollars in anticipation of an initial three year funding to test and model M&O in later years.

[3] FY 2011 obligations include $15,121 allocated to NEON using funds remaining in the MREFC account following financial closeout of other completed construction projects.

**NEON Funding, by Stage**
(Dollars in Millions)



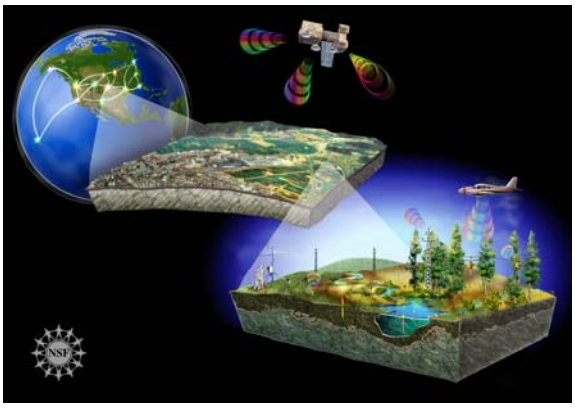

Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. For the first time, NEON will enable scientists and researchers to address the complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. NEON's technical and design requirements were informed

by knowledge acquired from previous NSF investments in research through the Long Term Ecological Research (LTER) program, and the Ecosystem, Ecology, and Long Term Research in Environmental Biology Programs. NEON is a user facility that will enable research at regional to continental scales. NEON infrastructure will be deployed at 60 sites; eleven of them being LTER sites. When operational, NEON will allow researchers to expand the scale of their research to understand large scale dynamics affecting ecosystems. As a continent-wide research instrument, NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will use NEON infrastructure in their research and educational programs. A NEON cyberinfrastructure gateway will provide resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. Data from standard measurements made using NEON will be available in "near real time." The basic NEON data streams will be open-access via web portals and available as soon as possible, once basic quality assurance and quality control procedures have been applied.

Recent United States Global Change Research Program (USGCRP) assessments (Karl, Melillo, and Peterson 2009) indicate that U.S. ecosystems will experience abrupt and unpredictable changes from a suite of human-driven processes in the near future. The Administration has identified these environmental issues as among the most important, demanding, and urgent global problems of our time, and scientific discovery and science-based decision making are critical to selecting mitigation and adaptation policies and strategies. NEON will provide an unprecedented opportunity to detect environmental signals as early as FY 2013.

NEON will enable research on the impacts of climate and land use change, water use, and invasive species on the Nation's living ecosystems at temporal and spatial scales that are relevant to human well-being. NEON will be the first research platform and the only national experimental facility specifically designed to enable basic research in these areas. All prior basic research infrastructure was designed and deployed on an *ad hoc*, question-, mission-, or site basis.

NEON's unique statistically-determined, continental-scale design, with data products, data management, and standardization will support research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON anticipates providing. For example, federal operational agencies, such as the Environmental Protection Agency (EPA), provide comprehensive, sustained, and dependable observations in real time on a broad geographic basis, similar to the observations supporting the forecasts of the National Weather Service; these observations support information needs and forecasts for resource management. In contrast, NEON will provide infrastructure to enable hypothesis-driven basic biological and ecological research, with data and high-level data products available in close to real-time. NEON scientists will develop and use the latest technologies and sensors to push the envelope of knowledge. Just as NEON researchers will benefit from access to data from federal agency networks that provide spatial and temporal coverage of the U.S., so will federal agencies benefit as the techniques, sensors and knowledge gained through NEON-enabled activities migrate from research to societal applications and inform management decisions.



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

NSF and NEON, Inc. coordinate with other federal agencies through the NEON Federal Agency Coordinating Committee, Memoranda of Understanding (MOU), Memoranda of Agreements, and Cooperating Agency Agreements. Areas of coordination include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling. In addition, NSF will continue to seek opportunities for new interagency and international partnerships. Examples of current partnerships include:

- Design: The Jet Propulsion Laboratory (JPL) at the National Aeronautics and Space Agency (NASA) designed and is building the hyperspectral sensor for the NEON airborne observation platform. NASA and NEON, Inc. are involved in joint instrument calibration and primary algorithm development.
- NEON infrastructure deployment sites: U.S. Department of Agriculture Forest Service, USDA Agricultural Research Service, Bureau of Land Management, Department of Energy (DOE), and National Park Service.
- Sharing of geospatial data, in-situ verification, and archival of NEON aerial remote sensing data with the U.S. Geological Survey (USGS).
- Partners in research, modeling, data exchange, standards, and protocols: NASA, the National Oceanic and Atmospheric Administration (NOAA), USGS, and EPA.
- International: Discussions between NEON, Inc. and Mexican and Canadian scientists to broaden linkages with NEON and expand the research capability to the North American continent are underway. Global partnerships with the European Union and Australia are developing.

Private organizations including the Heinz Center, National Geographic Society, Nature Serve, and the Science and Engineering Alliance, participated in NEON design and development activities. The Science and Engineering Alliance and the Ecological Society of America are assisting NEON, Inc. with education and inclusion of minority serving institutions in NEON science and education. Building enhanced accessibility for all institutions into the design will broaden the impact of NEON science and education to the next generation of scientists and educators. While the bulk of NEON's infrastructure and instrumentation will be "commercial off-the-shelf," NEON's scientific and networking design required certain technological innovations. Consequently, the Directorate for Biological Sciences (BIO) has provided Research and Related Activities (R&RA) funds for advanced research and development (R&D) activities in the areas of sensors, cyberinfrastructure, and remote sensing technology.

## Project Report

**Management and Oversight**

- NSF Structure: The NEON program is managed in the Directorate for Biological Sciences (BIO) Office of the Assistant Director (OAD/BIO) as part of Emerging Frontiers. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in Emerging Frontiers (EF) within BIO fosters its broader biological and interdisciplinary science connections. The NEON program is managed by a dedicated program officer, and an NSF/NEON project manager was added in FY 2011 to oversee construction and participate in planning, development, and oversight of management and operations. A business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) and a cross-NSF Program Advisory Team (PAT), formulates program planning for NEON. The NEON program officer served as the contracting officer's technical representative (COTR) for the NEON environmental assessment completed in FY 2010. A NEON Environmental Assessment Team (EA) provides ongoing technical advice on the National Environmental Policy Act (NEPA) compliance and NSF environmental policy.

- External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium, established to oversee the design, construction, management, and operation of NEON for the scientific community. Within that organization, the CEO provides overall leadership and management; the project manager oversees all aspects of the project design, review, construction, and deployment; the chief science officer provides scientific leadership; and the director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. A Board of Directors and a Science, Technology, and Education Advisory Committee (STEAC) composed of members of the NEON user community, each provide oversight and guidance to the project and help ensure that NEON will enable frontier research and education. A Program Advisory Committee (PAC) will be formed once the first sites are commissioned.

- Reviews:
  - Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
  - Management, Cost, and Schedule reviews:
  - The Conceptual Design Review was held in November 2006.
  - A combined PDR/FDR of the airborne observation platform was successfully completed in February 2009.
  - A PDR for the entire project was successfully completed in June 2009.
  - An FDR was successfully completed in November 2009, including construction and cost reviews.
  - National Science Board (NSB) Review: The Board reviewed and authorized NEON construction subject to final appropriation of funds in May 2010.
  - An additional baseline review, to ascertain readiness to begin construction, was conducted in April 2011 prior to construction.
  - NSF conducted a Business Systems Review (BSR) and issued a final report in November 2011.
  - An operations review of the project's operating plan and anticipated budget was held in January 2012.
  - An annual construction review will be scheduled for summer 2012 and 2013.

**Current Project Status**

In November 2009, the final design, scope, schedule, and risk-adjusted costs were reviewed and the project's baseline scope, budget, and schedule were found to be credible. The review panel endorsed the pre-construction planning activities in 2011 that enabled the project to commence construction in FY 2011. Contingency was increased to cover known risks, per panel recommendations. The NEON, Inc. project office completed the final design and NEON project execution plan (PEP). The site selection and associated deployment plan were merit reviewed during the preliminary design review. The NEPA environmental assessment was also completed in November 2009. A "Finding of No Significant Impact" was signed by NSF in December 2009; the U.S. Fish and Wildlife Service concurred with this finding, as well as with NSF's compliance with the Endangered Species Act. In April 2010, a NEON-led operations review was completed; NSF staff participated as observers. In July 2011, the NSF Record of Decision was signed, which allowed construction to commence in August 2011. The first NSF-led operations review, covering the operating plan and associated budget, was conducted in January 2012.

In FY 2012, funding for Concept and Development is provided through BIO's Emerging Frontiers division within the R&RA account. These funds are used to used to retire risk, complete detailed construction-ready design documents, and scale up final project activities, including: the airborne spectrometer; establishment of the NEON Calibration/Validation Laboratory for sensors and instrumentation; advanced design for the first six NEON domains and all NEON core sites; and

permitting for the first six domains. Funds will continue to be provided through the R&RA account for innovation and advanced development of new technologies, new capabilities, observatory improvements and performance upgrades, collaborative partnerships with PI-led experiments involving observatory infrastructure that require engineering innovation, and sensors to reduce human-mediated measurements of biology. Funds will support innovative approaches for training, education, and outreach.

**Cost and Schedule**

The projected length of the project is six fiscal years, with a six-month schedule contingency. The risk-adjusted cost of $433.72 million includes a contingency budget of 19 percent.

In 2011, NEON obligated $12.58 million in MREFC funds to initiate construction. These funds supported hardware and software development for cyberinfrastructure, tower boom assemblies for production, engineering technical facility, project management and systems engineering, and contracts and procurements for some long-lead instruments, communications, civil infrastructure, and field equipment.

In FY 2012, $60.30 million is provided for construction. These funds support: civil and facilities construction in four domains; instrument procurement and calibration for five domains, with deployment in three domains; biological site characterization in three domains; and aquatic site characterization in all domains. Construction activities include production engineering and ongoing equipment procurement for the associated calibration/validation and instrument integration laboratories. These funds also include support for the Data Center infrastructure and will initiate the data products application implementation. Construction will begin on the NEON Airborne Observatory, including spectrometer and Light Detection and Ranging (LIDAR) procurements.

In FY 2013, $91.0 million from the MREFC account is requested for construction. These funds will support: continuation of civil and facility construction and instrumentation deployment in the next six domains in the construction schedule. Commissioning of the three domains constructed in FY 2012 will occur. Biological sampling and analysis activities will commence in all constructed and accepted Observatory sites. Stream Experimental and Observatory Network (STREON) site construction will begin and pre-manipulation sensing and measurements will begin. Funds will also support continuation of the NEON cyberinfrastructure hardware and software development and implementation. The Level I-III ecological data products, a key cyberinfrastructure deliverable, will be made available to the research community. The first NEON Airborne Observatory platform is expected to be completed, fully instrumented, and flight-tested in preparation for delivery to Observatory operations in FY 2014.

In FY 2013, management and operations funding will commence. $30.39 million is requested from the R&RA account for maintenance and operations of the five domains commissioned, including related management and technical support, seasonal biological sampling, and domain facilities costs. Funds will also support headquarters functions, including the Airborne Observatory and Calibration & Validation Laboratories.

**Risks**

Technical: Dependence on commercial off-the-shelf technology will be mitigated by long-lead purchase orders and alternative vendors. Production quality, embedded and system-level cyberinfrastructure will be addressed by a combination of “in-house” design, commercial, contracts, and targeted research (e.g., cyber-dashboard).

Deployment: Environmental assessment and permitting may impact schedule and costs. These risks have been and continue to be addressed through multiple means, including: the direct contracting of the environmental assessment by NSF; the hiring of two national firms by NEON, Inc. for engineering and

permitting; the identification of alternative sites if the primary sites are determined to have significant risk; and the allocation of two full-time equivalents (FTE) by the U.S. Forest Service to assist with environmental compliance issues on Forest Service lands.

Geospatial Data Acquisition: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS Earth Resources Observation and Science (EROS) Data Center, which has the federal responsibility for curation and management of LANDSAT and MODIS images and having alternative satellite sensor sources to purchase images (e.g., SPOT - France, AWIFS – India, Terra and Aqua – U.S.). The proposed NEON airborne observatory platform (AOP) sensor system design and aircraft availability are also sources of technical and implementation risk. To minimize this risk, the AOP is being developed by JPL; similar instrument packages are being prototyped by NASA and Carnegie Institution at Stanford University. The sensor system fits multiple aircraft, including commercial aircraft. Experienced flight design engineers were contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could potentially support NEON flight operations, and experienced research aircraft pilots serve on the design team.

**Future Operations Costs**

NEON will be the first research observatory that will maintain and operate in-situ instrumentation and conduct biological sampling in twenty domains (106 locations); three airborne observatories; a central operating facility; and a cyberinfrastructure center. Support will be provided to monitor the sensors, and receive, process, and archive the data from all measurement systems. NEON operations include significant labor costs due to the labor-intensive processes required for biological sampling and data collection as part of the Fundamental Sentinel Unit (FSU), which is a major component of each domain. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle, so operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. Due to the complexity of operating the facility, NSF provided funds to prototype, test, simulate, and evaluate the major cost drivers.

NEON, Inc. developed an operations and maintenance plan for review that included scope, schedule, and costs for the first eight years of operations. NSF convened an operations and cost review in January 2012 to evaluate the plan, schedule, and costs. The panel concluded that the Operations and Maintenance Plan's scope, costs, schedules, staffing, and transition to operations were thorough and accurate, and that NEON has done an exemplary job of using prototyping to gain operational experience. The panel indicated that the budgetary estimates are based on the best analyses of extant information and modeling, and any improvement in efficiencies or costs will require actual operating experience. Given the high degree of complexity planned for NEON, and its large, distributed nature, it was recommended that NEON gain operations experience and explore the potential for efficiencies through a three year initial operations funding.

The current request incorporates a three year initial operations request to allow NEON to gain operational experience and explore opportunities for schedule and cost efficiencies. For the outyears the costs are held constant at the projected operations ceiling reviewed at both the Preliminary Design and Final Design Reviews. After gaining operational experience, NEON, Inc. will submit a plan for the remaining five years.

## Ocean Observatories Initiative **$65,000,000**

The FY 2013 Budget Request for the Ocean Observatories Initiative (OOI) is $65.0 million, which represents the fourth year of a six-year construction project totaling $386.42 million.

**Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative**
(Dollars in Millions)

| | Prior Years[1] | FY 2009 | FY 2010 | FY 2011 | FY 2012 Estimate | FY 2013 Request | FY 2014 Estimate | FY 2015 Estimate | Total Project Cost |
|---|---|---|---|---|---|---|---|---|---|
| Regular Approps | $5.91 | - | $14.28 | $65.00 | $102.80 | $65.00 | $27.50 | | $280.49 |
| ARRA | - | 105.93 | - | - | - | - | - | - | 105.93 |
| **Total, OOI** | **$5.91** | **$105.93** | **$14.28** | **$65.00** | **$102.80** | **$65.00** | **$27.50** | **-** | **$386.42** |

[1] Per P.L. 110-161, $5.12 million was rescinded from prior year unobligated balances.

OOI will provide the oceanographic research and education communities with continuous, interactive access to the ocean through an integrated network of observatories. Deployed in critical parts of the global and U.S. coastal ocean, OOI's 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales at which they occur. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability and ocean circulation, coastal ocean dynamics and ecosystem response, and the interplay of tectonically-driven fluid flow on the carbon cycle, deep ocean ecosystems, and earthquakes.

The OOI has three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) regional cabled nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observatories. A cutting-edge, user-enabling cyberinfrastructure will link the three components of OOI and facilitate experimentation using assets from the entire network. Data from the network will be made publicly available via the Internet.

### Baseline History

NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received an initial appropriation of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction, assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling, and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. An additional Science Review Panel and Cost/Schedule Review Panel convened by NSF in March 2009 supported proceeding with the Variant Design and the project was approved at the May 2009 National Science Board meeting.

**Total Obligations for OOI**

(Dollars in Millions)

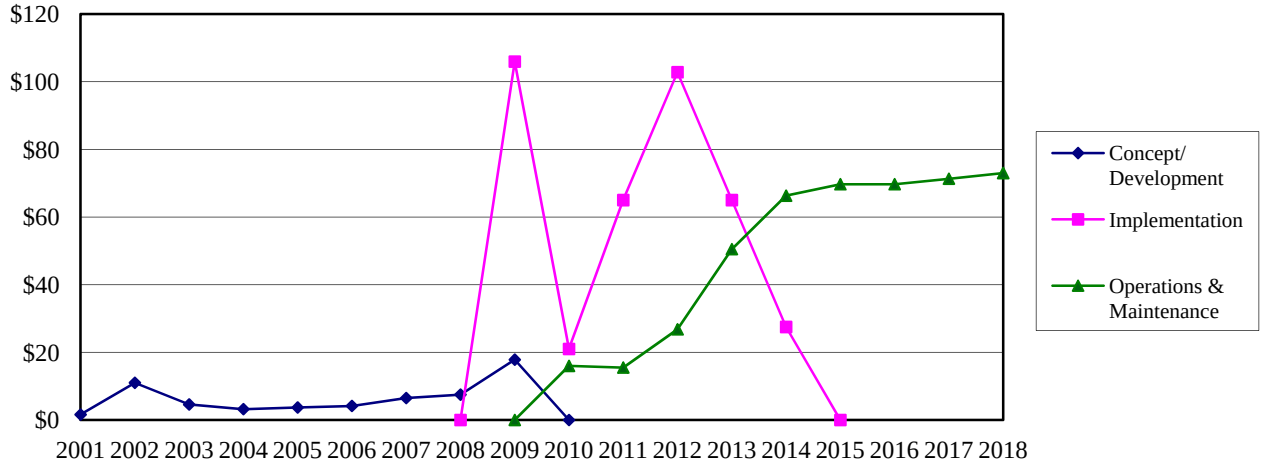
| | Prior Years | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $74.90 | - | - | - | - | - | - | - | - |
| Management and Operations | 15.99 | 15.49 | 26.80 | 40.10 | 52.81 | 58.80 | 61.80 | 64.80 | 67.80 |
| Subtotal, R&RA Obligations | $90.89 | $15.49 | $26.80 | $40.10 | $52.81 | $58.80 | $61.80 | $64.80 | $67.80 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 20.99 | 65.00 | 102.80 | 65.00 | 27.50 | - | - | - | - |
| ARRA | 105.93 | - | - | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $126.92 | $65.00 | $102.80 | $65.00 | $27.50 | - | - | - | - |
| **TOTAL Obligations** | **$217.81** | **$80.49** | **$129.60** | **$105.10** | **$80.31** | **$58.80** | **$61.80** | **$64.80** | **$67.80** |

Totals may not add due to rounding.

[1] Concept & Development and Implementation funding is cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

**OOI Funding, by Stage**

(Dollars in Millions)




NOTE: FY 2009 implementation funding includes $105.93 million provided through the American Recovery and Reinvestment Act.

## Project Report

### Management and Oversight

- NSF Structure: The project is managed and overseen by a program director in OCE in the Directorate for Geosciences (GEO). The program director receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance. NSF has established an Ocean Observing Science Committee (OOSC) via the University National Oceanographic Laboratory System (UNOLS). The committee is made up of ocean science

community representatives. The OOSC is charged with providing guidance on decisions and plans from the science perspective related to all NSF observing systems. The OOSC will be an essential element in the process of communicating the science use perspective to NSF and project teams involved in deploying and operating ocean observatories.

- External Structure: NSF established a cooperative agreement with the Consortium for Ocean Leadership (Ocean Leadership) for the construction and initial operation of the OOI in September 2009. The program director at Ocean Leadership is responsible for designing, building, deploying, testing, commissioning, and conducting initial operations and maintenance for the OOI. The Ocean Leadership program director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs will deliver the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego), education (led by Rutgers, The State University of New Jersey) and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to Ocean Leadership, which ensures integration, cooperation, and coordination between the IOs.
- NSF Oversight: NSF conducts a weekly meeting, attends weekly calls, convenes external panels and reviews monthly Earned Value Management reports from the project team. NSF attends internal project reviews; critical design reviews and conducts vendor site visits as required.

- Reviews:

  <u>Preconstruction Phase Reviews of OOI</u>
  - Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design (CND) would provide the capabilities for the ocean researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These science reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the existing network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

  <u>Management, Cost, and Schedule Reviews</u>
  - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system-level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
  - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
  - The FDR in November 2008 assessed whether OOI's project plans were fully ready for

construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.

- A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
- A Business Systems Review (BSR) is scheduled to be conducted in FY 2012.
- A comprehensive construction review will be held during the summer of 2012.

Construction Phase and Initial Operations Reviews of OOI

- Construction Reviews: NSF conducted the first Operations and Maintenance (O&M) review of OOI on August 17-18, 2010, using an external panel of experts. The panel recommended that the project have tighter linkages between the construction schedule and O&M ramp up plans.
- A second O&M review was conducted in December 2011. The project presented an O&M plan with an integrated construction/O&M schedule. The panel provided praise for the specific plans for the FY 2012 glider operations transition and recommended improvements to the remaining elements of the O&M plan in the areas of cost estimation, safety and maintenance. The panel also recommended a study of alternative management structures to ensure that the observatory uses resources effectively across the various oceanographic institutions involved in the OOI.

**Current Project Status**

The project is in year three of the construction and transition to O&M effort. Major construction milestones were achieved on time and within budget. NSF signed a Site-specific Environmental Assessment Finding of No Significant Impact (FONSI) in January 2011 (www.nsf.gov/geo/oce/envcomp/ooi/ooi-final-fonsi-31jan11.pdf), which enabled the build phase of the project to commence. The ocean cable was successfully deployed in July 2011 and landed on shore in Pacific City, Oregon. University of Washington and L3 Maripro were the major subawardees involved. Woods Hole Oceanographic Institution and their academic partners, Oregon State University and Scripps Institution for Oceanography, coordinated major at-sea tests of moorings that were deployed in summer and fall 2011. Unique instruments, observing platforms and mooring designs are being tested in order to conduct critical design reviews this year and enter the build phase for the coastal and global moorings. With respect to cyberinfrastructure, University of California completed software release 1 of 4 and engaged their cyberinfrastructure project team via subcontracts and subawards. Other major activities include the award of subcontracts for instrumentation as well as for autonomous underwater vehicles (AUVs) and gliders. Based in part on the May 2011 Construction and Transition to Operations review of OOI, the Consortium for Ocean Leadership proposed to NSF a realignment of the construction and deployment of the Endurance Array to capitalize on the relative strengths across the OOI subawardee institutions.

OOI transition to operations and maintenance was funded in FY 2011 and FY 2012. This funded the initial spare parts purchases for the network, initial hiring of operations personnel, and production of a more mature O&M plan. Gliders are mobile, buoyancy-driven underwater vehicles that carry instruments that measure attributes of the ocean environment and send data to shore via satellite telemetry. Glider operations are planned to commence in early summer of 2012 as the first element of the network to transition to operations. An external panel review of these efforts occurred in December 2011.

The request for O&M funding for FY 2013 is $40.10 million. This funding will support initial glider operations and maintenance for the OOI Endurance and Pioneer Arrays. The O&M request also supports the regional cable shore station operations, cyberinfrastructure network performance monitoring, data management, integrated logistics support, ship operations for glider redeployments, quality, safety and

operations management. Finally, this request will also support acquisition of supplies required for mooring redeployments in 2014 and 2015, which occur after the initial construction deployments. Full operations and maintenance is planned for FY 2015.

**Cost and Schedule**

The project is working to an integrated construction and O&M schedule that is resource-loaded. Costs are tracked at work breakdown structure levels and reported in a detailed monthly report. To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs are closely monitored by the OOI Program Manager for deviations from established baselines using Earned Value Management. Contingency is tightly managed via change control and specific guidelines in the Cooperative Agreement. In 2011 the schedule for the project was updated.

## Risks

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. A detailed project tracking system has been developed to assure that the scope, schedule and budget are continuously monitored.
- Scope contingency: The Project Team has provided an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project. There have been no reductions in scope to date for the project.
- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at all of the OOI reviews. The testing and design process will allow for real users to be involved in the final acceptance of the cyberinfrastructure. The review process will assess progress and results.

**Future Operations Costs**

The project is designed to ensure a smooth transition from construction to operations and maintenance. Staff, spare parts, integrated logistics and facility readiness will ramp up as the construction elements are completed and accepted for operations. The funding profile presented shows an FY 2013 budget of $40.10 million and FY 2014 budget of $52.81 million. Full operations costs in FY 2015 are estimated at $58.80 million. The expected operational lifespan of this project is 25 years. Operations cost reviews will be conducted prior to and throughout the operations phase to assess the project and inform future budget requests. Upon completion of construction, high quality ocean data will be delivered to the scientific community, educators and the public.

# MODEL ORGANIZATION

"Perform as a Model Organization" (or "Model Organization") is one of three strategic goals outlined in *Empowering the Nation through Discovery and Innovation: NSF's Strategic Plan for Fiscal Years (FY) 2011-2016.* Model Organization is an internally-focused goal that emphasizes the agency's desired outcome of attaining excellence in all aspects of its operations. Excellence in NSF's performance as a model organization is essential to carrying out and achieving NSF's mission and accomplishing the agency's other strategic goals of "Transform the Frontiers" and "Innovate for Society." Model Organization underpins NSF programmatic activities and encompasses all the agency's management activities. It also includes support for the activities of the Office of Inspector General (OIG) and the National Science Board (NSB), which are provided in separate appropriations.

This summary provides an overview of the FY 2013 Request for the portfolio of activities directly associated with the Model Organization goal. Detailed information about the various components/activities of Model Organization is included in the four sub-sections that follow this discussion. The chart below and Table 1 show the major components of Model Organization: Human Capital, Information Technology, Other Administrative Support, Future NSF, and support for the NSB and OIG. Table 1 also shows the funding sources for the major components/activities, as several are funded through multiple appropriation accounts.

The FY 2013 Request for Model Organization is $428.27 million, a $720,000 or 0.2 percent increase from the FY 2012 Estimate of $427.55 million. NSF's FY 2013 Request for Model Organization responds to Executive Order 13589, *Promoting Efficient Spending*, which requires agencies to achieve their mission in the most efficient, cost effective way and to reduce administrative costs. NSF's FY 2013 Request reflects efficiency savings in several areas such as travel, information technology devices, printing, and contractual services.

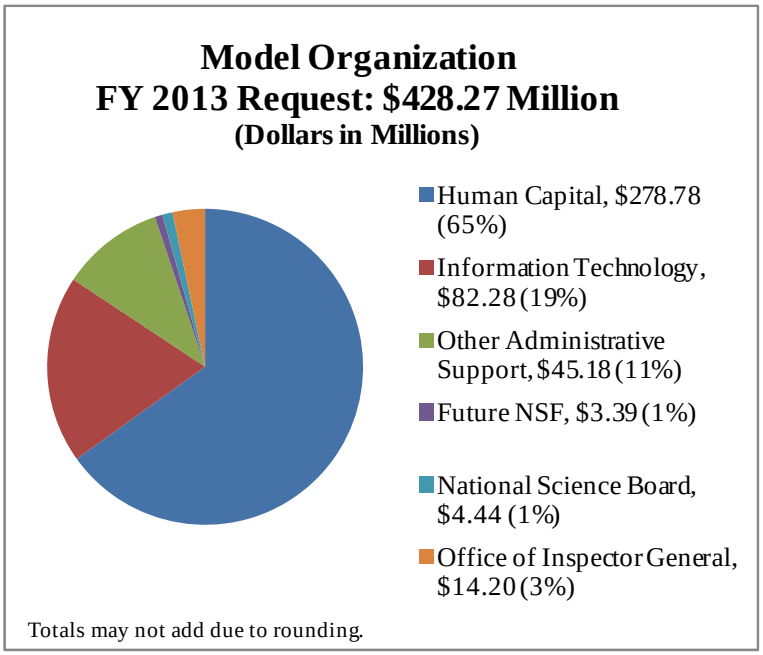


**Table 1. Model Organization**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent | Funding Source | Details Available on Page |
|---|---|---|---|---|---|---|---|
| Human Capital | $269.66 | $278.12 | $278.78 | $0.66 | 0.2% | | |
| Human Capital | *226.96* | *233.61* | *236.73* | 3.12 | 1.3% | | |
| Personnel Compensation & Benefits | 202.73 | 202.91 | 209.47 | 6.56 | 3.2% | AOAM | AOAM-3 |
| Management of Human Capital | 8.22 | 9.40 | 8.20 | -1.20 | -12.8% | AOAM | AOAM-5 |
| Operating Expenses[1] | 9.97 | 15.26 | 13.32 | -1.94 | -12.7% | AOAM | AOAM-6 |
| Travel | 6.04 | 6.04 | 5.74 | -0.30 | -5.0% | AOAM | AOAM-7 |
| IPA Appointments | *42.70* | *44.51* | *42.05* | -2.46 | -5.5% | | |
| Compensation | 35.66 | 37.90 | 35.91 | -1.99 | -5.3% | R&RA/EHR | R&RA/EHR-1 |
| Lost Consultant & Per Diem | 4.01 | 4.29 | 3.89 | -0.40 | -9.3% | R&RA/EHR | R&RA/EHR-1 |
| Travel | 3.03 | 2.32 | 2.25 | -0.07 | -3.0% | R&RA/EHR | R&RA/EHR-1 |
| Information Technology | 84.42 | 84.10 | 82.28 | -1.82 | -2.2% | | |
| Agency Operations Information Technology | *28.42* | *26.10* | *22.00* | -4.10 | -15.7% | AOAM | AOAM-7 |
| Administrative Applications Services and Support | 12.65 | 11.81 | 7.71 | -4.10 | -34.7% | AOAM | AOAM-8 |
| Associated Infrastructure Services and Support | 12.98 | 11.50 | 11.50 | - | - | AOAM | AOAM-9 |
| Security and Privacy Services and Support | 2.79 | 2.79 | 2.79 | - | - | AOAM | AOAM-9 |
| Program Related Technology (PRT) | *56.00* | *58.00* | *60.28* | 2.28 | 3.9% | | |
| Mission-Support Applications Services | 39.13 | 41.13 | 43.41 | 2.28 | 5.5% | R&RA/EHR | R&RA/EHR-3 |
| Associated IT Operations & Infrastructure | 13.91 | 13.91 | 13.91 | - | - | R&RA/EHR | R&RA/EHR-4 |
| Related Security and Privacy Services | 2.96 | 2.96 | 2.96 | - | - | R&RA/EHR | R&RA/EHR-4 |
| Other Administrative Support | 46.50 | 44.08 | 45.18 | 1.10 | 2.5% | | |
| Space Rental | 26.11 | 26.39 | 27.22 | 0.83 | 3.1% | AOAM | AOAM-10 |
| Other Infrastructure | *14.71* | *10.69* | *10.06* | -0.63 | -5.9% | AOAM | AOAM-10 |
| Administrative Contracts | 8.23 | 5.22 | 4.72 | -0.50 | -9.6% | | |
| Government Goods and Services | 2.17 | 1.61 | 1.61 | - | - | | |
| Adminstrative Services, Equipment & Supplies | 4.31 | 3.86 | 3.73 | -0.13 | -3.4% | | |
| Other Program Related Administration[2] | 5.68 | 7.00 | 7.90 | 0.90 | 12.9% | R&RA/EHR | R&RA/EHR-4 |
| Future NSF | 3.10 | 2.61 | 3.39 | 0.78 | 29.9% | AOAM | AOAM-11 |
| National Science Board (NSB) | 4.47 | 4.44 | 4.44 | - | - | NSB | NSB-1 |
| Office of Inspector General (OIG)[3] | 14.00 | 14.20 | 14.20 | - | - | OIG | OIG-1 |
| **Total, Model Organization** | **$422.14** | **$427.55** | **$428.27** | **$0.72** | **0.2%** | | |

Notes: Totals may not add due to rounding.

AOAM: Agency Operations and Awards Management; R&RA: Research & Related Activities; MO: Model Organization; IPA: Intergovernmental Personnel Act. FY 2012 and FY 2013 funding estimates for NSF-supported E-Government Initiatives can be found on pages Model Organization-7 and 8.

[1] Operating exenses include funding for suppplies and equipment, contracts, and other costs necessary to enable accomplishment of NSF's mission.

[2] Includes funding for certain NSF-wide activities such as major studies, evaluation, outreach efforts, NSF contributions to interagency E-Government activities, and grants management applications that benefit the research community.

[3] FY 2011 includes $82,946 in Office of Inspector General obligations associated with FY 2009 ARRA funding carried over into FY 2011.

## Model Organization by Major Component

1. **Human Capital**: Support for NSF's human capital activities is the largest component of Model Organization, accounting for nearly two-thirds of the portfolio. The FY 2013 Request for Human Capital is $278.78 million, a $660,000 or 0.2 percent increase over the FY 2012 Estimate. The Human Capital component includes NSF's federal employees and temporary employees hired through authority provided by the Intergovernmental Personnel Act, known as "IPAs." NSF's federal employee FTE (full-time equivalents) is funded through the Agency Operations and Award Management (AOAM) appropriation account and IPAs are funded through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) appropriation accounts. In addition to these workforce costs, the Human Capital component also provides support for:

   - Personnel-related services such as recruiting, classification and staffing, workforce planning, and learning and development activities;
   - Financial management and post-award monitoring services;
   - Outreach, diversity and inclusion, legislative and public affairs, and legal services;
   - Agency-wide operating expenses for supplies and office equipment; and
   - Travel for outreach activities, post-award oversight and monitoring, site visits, and training.

Detailed information about each of the Human Capital activities can be found in the AOAM section, pages AOAM-3 through AOAM-7. Detailed information about IPAs can be found in the R&RA/EHR section.

2. **Information Technology (IT)**: IT investments are the second largest component of Model Organization, accounting for 19 percent.

   - Agency operations IT investments include routine administrative IT efforts that support the agency's basic administrative operations such as human resources management, the preparation of the agency's financial statements, a portion of NSF's financial system modernization project (iTRAK), and procurement activities. These efforts are funded through the AOAM appropriation and are discussed on page AOAM-7.
   - Program Related Technology (PRT) investments directly support NSF's programmatic activities and associated services, such as Research.gov, eJacket, FastLane, and a portion of iTRAK. PRT supports the NSF grants management process, and is funded through the R&RA and EHR appropriations. These efforts are discussed on page 2 of the R&RA/EHR sub-chapter.

   Table 2 shows NSF's total investments in the IT portfolio by appropriation. NSF's FY 2013 Request for IT investments is $82.28 million, a $1.82 million or 2.2 percent decrease from the FY 2012 Estimate of $84.10 million.

**Table 2. Information Technology (IT) Investments by Appropriation**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Agency Operations and Award Management (AOAM) | $28.42 | $26.10 | $22.00 | -$4.10 | -15.7% |
| Program Related Technology | 56.00 | 58.00 | 60.28 | 2.28 | 3.9% |
| *R&RA* | *48.72* | *50.46* | *52.44* | *3.72* | *7.6%* |
| *EHR* | *7.28* | *7.54* | *7.84* | *0.56* | *7.7%* |
| **Total** | **$84.42** | **$84.10** | **$82.28** | **-$1.82** | **-2.2%** |

Totals may not add due to rounding.

3. **Other Administrative Support:** The FY 2013 Request of $45.18 million accounts for 11 percent of the Model Organization portfolio, and is a $1.10 million or 2.5 percent increase from the FY 2012 Estimate. NSF funding for Other Administrative Support covers three activities:

   - Space Rental, which includes rent, utilities, and physical security costs;
   - Infrastructure goods and services such as travel management, conference room and meeting support, security guards, building services, library services (including subscriptions), office furnishings, and building improvements; and
   - Other Program Related Administration, which funds NSF-wide activities such as major studies, evaluations, outreach efforts, E-government efforts, and certain fellowship programs.

   Space Rental and infrastructure activities are funded by the AOAM appropriation. Detailed information about these activities can be found in the AOAM section, beginning on page AOAM-10. Other Program Related Administration (PRA) is funded by the R&RA and EHR appropriations. Detailed information on the PRA activities can be found on page 4 of the R&RA/EHR section which follows this discussion.

4. **Future NSF:** NSF's current leases for the headquarters' facility expire in 2013. NSF has been working collaboratively with the GSA on the replacement long-term lease, which is expected to be awarded by 2013. The FY 2013 Request for Future NSF is $3.39 million, a $780,000 or 29.9 percent increase over the FY 2012 Estimate. Details of the FY 2013 Future NSF request, which is funded through AOAM, can be found on page AOAM-11.

5. **National Science Board** (NSB): The staffing and operations of the NSB office are supported through a separate NSB appropriation. Details about the NSB FY 2013 Request can be found in the NSB section.

6. **Office of Inspector General** (OIG): The staffing and operations of the OIG are supported through a separate OIG appropriation. Details about the OIG FY 2013 Request can be found in the OIG sub-chapter.

## Model Organization by Appropriation

Table 3 shows the appropriation accounts that support Model Organization activities.

- In FY 2013, 70 percent ($299.4 million) of Model Organization is funded through AOAM.
- The R&RA and EHR appropriation accounts fund program support costs — $94.75 million (22 percent) through the R&RA account and $15.48 million (4 percent) through the EHR account.
- The activities of the OIG and NSB are each funded by separate appropriations. The FY 2013 Request for the OIG of $14.20 million accounts for 3 percent of the Model Organization portfolio. The NSB FY 2013 Request of $4.44 million accounts for 1 percent of the Model Organization portfolio.

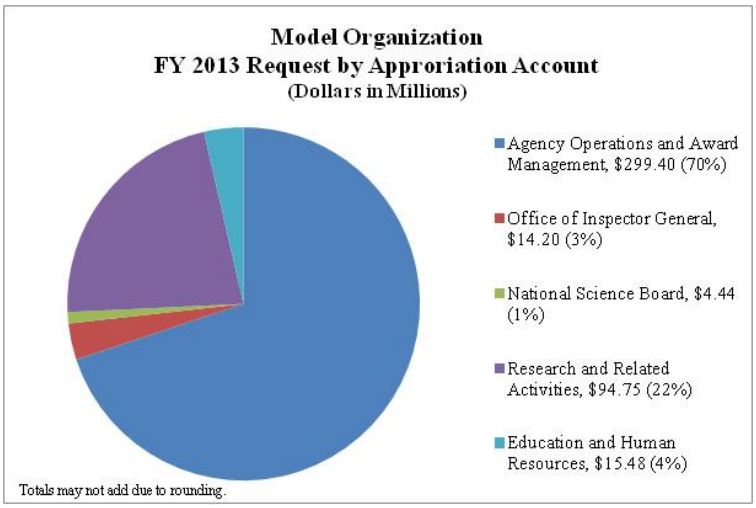



**Table 3. Model Organization by Appropriation**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Agency Operations and Award Management | $299.29 | $299.40 | $299.40 | - | - |
| Office of Inspector General[1] | 14.00 | 14.20 | 14.20 | - | - |
| National Science Board | 4.47 | 4.44 | 4.44 | - | - |
| Research & Related Activities | 89.19 | 94.12 | 94.75 | 0.63 | 0.7% |
| Education and Human Resources | 15.19 | 15.39 | 15.48 | 0.09 | 0.6% |
| Subtotal, Program Support | 104.39 | 109.51 | 110.23 | 0.72 | 0.7% |
| **Total** | **$422.14** | **$427.55** | **$428.27** | **$0.72** | **0.2%** |

Totals may not add due to rounding.

[1] FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

## NSF Workforce

Table 4 shows the agency's total staffing allocation and usage for the FY 2013 Request, including the Arctic Research Commission and contractor staffing not funded as part of the Model Organization portfolio.

**Table 4. NSF Workforce**
Full-Time Equivalents (FTE)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| *AOAM FTE Allocation* | | | | | |
| *Regular* | *1,310* | *1,310* | *1,310* | - | - |
| *Student* | *40* | *42* | *42* | - | - |
| *Subtotal, AOAM FTE Allocation* | *1,350* | *1,352* | *1,352* | - | - |
| AOAM FTE Usage (Actual/Projected) | | | | | |
| NSF Regular | 1,282 | 1,285 | 1,310 | 25 | 1.9% |
| NSF Student | 42 | 42 | 42 | - | - |
| Subtotal, AOAM FTE[1] | 1,324 | 1,327 | 1,352 | 25 | 1.9% |
| Office of the Inspector General[2] | 74 | 78 | 78 | - | - |
| Regular | 70 | 73 | 73 | - | - |
| Student | 4 | 5 | 5 | - | - |
| National Science Board[3] | 18 | 18 | 18 | - | - |
| Arctic Research Commission[4] | 3 | 3 | 3 | - | - |
| Total, Federal Employees (FTE) | 1,419 | 1,426 | 1,451 | 25 | 1.8% |
| IPAs (FTE) | 175 | 183 | 183 | - | - |
| Detailees to NSF | 3 | 6 | 6 | - | - |
| Contractors (est.) | 449 | 449 | 449 | - | - |
| **Total, Workforce** | **2,046** | **2,064** | **2,089** | **25** | **1.2%** |

Totals may not add due to rounding.

[1]Additional information about FTEs funded through the AOAM appropriation are available in the AOAM section.

[2]The Office of Inspector General is discussed in a separate chapter and is funded through a separate appropriation.

[3]The National Science Board is discussed in a separate chapter and is funded through a separate appropriation.

[4]The U.S. Arctic Research Commission is discussed in a separate chapter and is funded through the R&RA appropriation.

In FY 2013, NSF's federal employee FTE utilization will increase by 25 FTE over the FY 2012 Estimate. The staffing profile in the table above shows that a small but significant percentage of the NSF workforce included in the FY 2013 Request—183 FTE or about 9 percent—consists of temporary employees hired through the authority provided by the Intergovernmental Personnel Act (IPA). IPAs do not count as federal FTE. A smaller number of visiting staff—roughly 40 people annually—are employed through NSF's own Visiting Scientist, Engineer, and Educator Program (VSEE). VSEEs count as federal FTE and are included in the Federal Employee FTE total. The use of IPAs and VSEEs, commonly referred to as rotators, has been a defining characteristic of NSF since its inception in 1950, as it gives NSF a direct connection to the researchers and educators working at the frontiers of science and engineering. Additional information about the agency's FY 2013 FTE allocation and usage can be found on page AOAM-3.

## NSF FY 2012 and FY 2013 Funding For E-Government Initiatives

The following two tables show NSF contributions and service fees for various E-governments initiatives.

**Table 5. NSF FY 2012 Funding for E-Government Initiatives**

| Initiative | FY 2012 Agency Contributions | FY 2012 Agency Svc. Fees | NSF Total | Appropriations Account | | |
|---|---|---|---|---|---|---|
| | | | | AOAM | R&RA | EHR |
| Grants.gov | - | 481,957 | **$481,957** | - | $419,303 | $62,654 |
| E-Travel | - | 215,163 | **215,163** | 215,163 | - | - |
| Geospatial LoB | - | - | **-** | - | - | - |
| E-Training | - | 370,000 | **370,000** | 370,000 | - | - |
| E-Rulemaking | - | 10,500 | **10,500** | 10,500 | - | - |
| Recruitment One-Stop (USA Jobs) | - | 7,522 | **7,522** | 7,522 | - | - |
| E-HRI | - | 26,237 | **26,237** | 26,237 | - | - |
| Integrated Acquisition Environment (IAE) | - | 18,511 | **18,511** | 18,511 | - | - |
| IAE- Loans and Grants | - | 89,973 | **89,973** | 89,973 | - | - |
| Human Resources Management LoB | 65,217 | - | **65,217** | - | 56,739 | 8,478 |
| Financial Management LoB | 44,444 | - | **44,444** | - | 38,666 | 5,778 |
| Budget Formulation/Execution LoB | 105,000 | - | **105,000** | - | 91,350 | 13,650 |
| Performance Management LoB | - | - | **-** | - | - | - |
| E-Payroll (includes Shared Services) | - | 314,640 | **314,640** | 314,640 | - | - |
| **Total** | $214,661 | $1,534,503 | **$1,749,164** | $1,052,546 | $606,058 | $90,560 |

LoB: Line of Business; Totals may not add due to rounding.

In NSF's FY 2012 Congressional Budget Justification, the portfolio of E-Gov initiatives also included the Grants Management Line of Business (GMLoB) – for which previously NSF was the managing partner. NSF's FY 2012 contribution to the GMLoB had been anticipated to be $107,000, and OMB is currently working with partner agencies on future frameworks for integrated efforts related to grants management.

**Table 6. NSF FY 2013 Funding for E-Government Initiatives**

| Initiative | FY 2013 Agency Contributions | FY 2013 Agency Svc. Fees | NSF Total | Appropriations Account | | |
|---|---|---|---|---|---|---|
| | | | | AOAM | R&RA | EHR |
| Grants.gov | - | $370,923 | **$370,923** | - | $322,703 | $48,220 |
| E-Travel | - | 257,684 | **257,684** | 257,684 | - | - |
| Geospatial LoB | 15,000 | - | **15,000** | - | 13,050 | 1,950 |
| E-Training | - | 370,000 | **370,000** | 370,000 | - | - |
| E-Rulemaking | - | 10,000 | **10,000** | 10,000 | - | - |
| Recruitment One-Stop (USA Jobs) | - | 8,312 | **8,312** | 8,312 | - | - |
| E-HRI | - | 32,427 | **32,427** | 32,427 | - | - |
| Integrated Acquisition Environment (IAE) | - | 15,406 | **15,406** | 15,406 | - | - |
| IAE - Loans and Grants | | 89,973 | **89,973** | 89,973 | - | - |
| Human Resources Management LoB | 65,217 | - | **65,217** | - | 56,739 | 8,478 |
| Financial Management LoB | 44,444 | - | **44,444** | - | 38,666 | 5,778 |
| Budget Formulation/Execution LoB | 105,000 | - | **105,000** | - | 91,350 | 13,650 |
| Performance Management LoB | 34,000 | - | **34,000** | - | 29,580 | 4,420 |
| E-Payroll (incl. Shared Services) | - | 314,640 | **314,640** | 314,640 | - | - |
| **Total** | $263,661 | $1,469,365 | **$1,733,026** | $1,098,442 | $552,088 | $82,496 |

LoB: Line of Business; Totals may not add due to rounding.

Benefits realized through the use of these activities are:

- *Geospatial Line of Business*
  NSF supports basic research at the frontiers of discovery across all fields of science through competitive proposals that are evaluated using merit-based peer review. To advance its mission, NSF actively participates in activities that shape and enhance the scientific enterprise. Although NSF is not currently a provider of geospatial data, it does consider proposals for support of fundamental research that utilizes or enhances the value of geospatial information. NSF recognizes the importance of the Geospatial Line of Business in establishing a more collaborative and performance-oriented culture within the federal geospatial arena that optimizes investments in data and technology and yield many long-term benefits to the Nation.

- *Human Resources Line of Business (HRLoB)*
  Through the usage of one of the HRLoB's approved service providers—Department of Interior's National Business Center—NSF is able to leverage economies of scale, reduce costs, and increase the quality and consistency of services provided. Utilizing this service delivery model frees up NSF HR resources to provide valuable strategic and consultative support to the Foundation's mission.

- *Financial Management LoB (FMLoB)*
  NSF benefits from its participation in FMLoB due to the initiative's focus on financial systems improvements in coordination with the Chief Financial Officers Council (CFOC). In FY 2011, FMLoB added and expanded upon the functionality offered during its Verifypayment.gov initiative, which has been rebranded the GOVerify Business Center and is expected to be in production in early 2012. Once GOVerify is in production, it could assist the grants and contracting communities verify eligibility to receive a grant or award.

- *Budget Formulation and Execution Line of Business (BFELoB)*
  The BFELoB provides significant benefits to NSF by encouraging best practices crossing all aspects of federal budgeting. NSF uses the MAX Federal Community to share budget information with the Office of Management and Budget (OMB) and other federal agencies, collaborate on internally- and externally-facing initiatives, and hold on-line meetings with remote participants. The BFELoB also provides NSF with increased analytical and reporting capabilities through the ongoing systems development, such as MAX Analytics. In addition, the Budgeting Capabilities Self-Assessment Tool (BCSAT) was published, and has provided NSF with a simple survey-like method to assess and gain perspective on how our current operations and processes compare against best practices in a broad range of budgeting capability categories. NSF has already begun using the BCSAT to assess organizational practices, presented the results of its self-assessment to the BFELoB Task Force, and is developing plans to address areas of need.

- *Performance Management Line of Business (BFELoB)*
  NSF will participate in the Performance Management Line of Business (PMLoB), an interagency effort to develop government-wide performance management capabilities and meet the transparency requirements of the GPRA Modernization Act. Starting at the end of 2012, NSF's performance information will be reported through a federal website which includes advanced data display and reporting capabilities, the ability to extract raw data, and, over time, will integrate other government-wide data, such as program, human capital, and spending information. All information currently provided publicly will be updated more frequently and will be provided in user-friendly formats that the public can more easily access and analyze.

## PROGRAM ACCOUNTS: R&RA and EHR

R&RA and EHR funding accounts for about a quarter of the total Model Organization portfolio. There are two activities that comprise Program-Funded Model Organization – Intergovernmental Personnel Act (IPA) costs and Program Related Administration.

**Summary of R&RA and EHR-Funded Model Organization**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| IPA Costs | $42.70 | $44.51 | $42.05 | -$2.46 | -5.5% |
| Program Related Administration | 61.68 | 65.00 | 68.18 | 3.18 | 4.9% |
| *Program Related Technology* | *56.00* | *58.00* | *60.28* | *2.28* | *3.9%* |
| *Other Program Related Administration* | *5.68* | *7.00* | *7.90* | *0.90* | *12.9%* |
| **Total, R&RA and EHR Funded Model Organization** | **$104.38** | **$109.51** | **$110.23** | **$0.72** | **0.7%** |

Totals may not add due to rounding.

## IPA Costs

**IPA Costs by Appropriation**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Number of IPAs | 175 | 183 | 183 | - | - |
| R&RA | | | | | |
| IPA Compensation | $30.30 | $32.54 | $30.95 | -$1.59 | -4.9% |
| IPA Lost Consultant & Per Diem | 3.26 | 3.54 | 3.15 | -0.39 | -11.0% |
| IPA Travel | 2.69 | 2.14 | 2.02 | -0.12 | -5.6% |
| Subtotal, R&RA Costs | 36.25 | 38.22 | 36.12 | -2.10 | -5.5% |
| EHR | | | | - | |
| IPA Compensation | 5.36 | 5.36 | 4.96 | -0.40 | -7.5% |
| IPA Lost Consultant & Per Diem | 0.75 | 0.75 | 0.74 | -0.01 | -1.3% |
| IPA Travel | 0.34 | 0.18 | 0.23 | 0.05 | 27.8% |
| Subtotal, EHR Costs | 6.45 | 6.29 | 5.93 | -0.36 | -5.7% |
| **Total, IPA Costs** | **$42.70** | **$44.51** | **$42.05** | **-$2.46** | **-5.5%** |

Totals may not add due to rounding.

A portion of NSF's workforce consists of temporary employees hired through the authority provided by the Intergovernmental Personnel Act (IPA). IPAs remain employees of their home institution while serving alongside NSF employees during their temporary assignment. They are not paid directly by NSF and are not subject to federal pay and benefits limitations. NSF reimburses the home institution directly for salary and benefits using the traditional grant mechanism. IPAs are eligible to receive relocation

expenses or an allowance in lieu of an NSF-arranged household goods move, and reimbursement for a portion of income foregone because of their assignment at NSF (i.e., lost consulting fees).

The FY 2013 Request of $42.05 million represents a decrease of $2.46 million, or 5.5 percent, from the FY 2012 Estimate of $44.51 million. FY 2013 funding for IPA compensation is $35.91 million, a reduction of $1.99 million from FY 2012. While NSF anticipates no change in the number of IPAs in FY 2013, current projections indicate lower per IPA costs.

FY 2013 funding for IPA travel is $2.25 million, which represents a reduction of 3.0 percent over the FY 2012 Estimate. IPA travel cost decreases reflect implementation of Executive Order 13589, *Promoting Efficient Spending.* In FY 2013, IPA travel is reduced by 14 percent from FY 2010 IPA travel levels to reflect the agency's travel efficiency reduction target. Savings will be achieved by improving IPA travel tracking, reporting and monitoring, and by potentially expanding the usage of efficiencies in place for NSF staff travel, such as the use of non-refundable airline tickets under certain conditions.

## Program Related Administration

Program Related Administration (PRA) includes two categories of activities that support the Perform as a Model Organization Goal and that are directly funded from NSF's program accounts.

- Program Related Technology
- Other Program Related Administration

**Program Related Administration**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Program Related Technology | $56.00 | $58.00 | $60.28 | $2.28 | 3.9% |
| Other Program Related Administration | 5.68 | 7.00 | 7.90 | 0.90 | 12.9% |
| **Total, Program Related Administration** | **$61.68** | **$65.00** | **$68.18** | **$3.18** | **4.9%** |

Totals may not add due to rounding.

### Program Related Technology

Program Related Technology (PRT) activities that relate directly to NSF's programmatic investments are funded through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts. NSF's FY 2013 total information technology (IT) investment is $82.28 million. A total of $60.28 million, or 73 percent of the total cost, is funded by the R&RA and EHR appropriations as these investments relate directly to NSF's programmatic activities. The remaining portion of the IT requirement is funded in AOAM.

**FY 2013 Program Related Technology Investments**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| PRT (R&RA and EHR) | | | | | |
| Mission-Support Applications Services | $39.13 | $41.13 | $43.41 | $2.28 | 5.5% |
| Associated IT Operations and Infrastructure | 13.91 | 13.91 | 13.91 | - | - |
| Related Security and Privacy Services | 2.96 | 2.96 | 2.96 | - | - |
| **Total, Program Related Technology** | **$56.00** | **$58.00** | **$60.28** | **$2.28** | **3.9%** |

Totals may not add due to rounding.

For FY 2013, NSF's information technology priorities for PRT include:

- Support the acquisition and implementation of iTRAK, the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial management system to a fully integrated financial management solution; and
- Maintain mission-related applications and services and the operations, infrastructure, and security that support these applications at requisite service levels.

The FY 2013 Request of $60.28 million for PRT represents an increase of $2.28 million over the FY 2012 Estimate and will be used for the following activities and initiatives:

*Mission-related Applications and Services (+$2.28 million, to a total of $43.41 million)*
Investments in this category directly support NSF program activities: including pre-award planning and activities; the receipt, processing, and review of proposals; award decisions, documentation, and notification; funding awards; post-award oversight; dissemination of award results; and award close-out. Mission-related applications and services include investments such as Research.gov, eJacket, and FastLane.

- iTRAK is the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial management system to a fully integrated financial management solution. In FY 2013, the total request for iTRAK increases to $11.70 million from $5.57 million in the FY 2012 Estimate. Consistent with the FY 2012 Estimate, 70 percent of the projected cost will be funded by PRT and 30 percent will be funded by AOAM. For FY 2013, the PRT portion of the iTRAK request is $8.19 million, which is an increase of $4.26 million over the FY 2012 Estimate funding amount of $3.93 million.
- Legacy mission applications, including FastLane and eJacket, provide comprehensive services for NSF staff, applicants, and awardees to manage the grants life cycle. These legacy applications support NSF business processes, providing effective mission-support technology solutions for NSF's ongoing grants management needs. For FY 2013, the total request for Legacy Mission Applications is $23.92 million. This reflects a $1.72 million increase in Mission-related Applications and Services for activities necessary to prepare legacy mission applications, including FastLane and eJacket, for integration with iTRAK.

  In order to fully support the $4.26 million increase for iTRAK and the $1.72 increase in funding legacy mission applications for activities to prepare these applications to integrate with iTRAK, $3.70 million will be deferred from Research.gov in FY 2013.
-

- Research.gov is a community driven solution, led by NSF, that gives the general public, the science, engineering, research, and education community, and Congressional staff easy access to key information and services in one location (www.research.gov). Research.gov also provides services to help NSF staff plan and manage their programs and portfolios of proposals and awards. For FY 2013, the Research.gov request is $11.30 million, which represents a decrease of $3.70 million from the FY 2012 Estimate. The impact of this decrease will be to defer new and modernized merit review tools (e.g. eJacket and FastLane) for program staff and reviewers.

*Associated IT Operations and Infrastructure (no change, to a total of $13.91 million)*
Investments in this category provide basic maintenance and operations levels for ongoing operations. NSF's IT-enabled business infrastructure supports the operation of mission-essential IT applications and office automation activities, including its network and telecommunications requirements. This includes NSF's data centers, network, hosting, phone, email, and remote access services. Network services include NSF's primary network for NSF staff, external network for NSF visitors, and connection to Internet2 for scientific purposes. Additionally, this category includes NSF's call center and customer care services. NSF provides customer care support for internal users (NSF staff) and external users (the research community including institutions, principal investigators, panelists, and other NSF visitors) 14-hours per day, five days per week. The call center assists NSF's research community of institutions and principal investigators with functions such as preparing and submitting proposals, financial reports, and progress reports to NSF. A call center, desktop support, and a walk-in center offer technical assistance to NSF staff and visitors. In FY 2011, NSF serviced over 100,000 requests. Also included in this category are activities to continue to transition onsite operations to an offsite commercial data center facility and the cloud.

*Related IT Security and Privacy Services (No change, to a total of $2.96 million)*
Investments in this category include automated configuration management tools that manage security patches and provide proactive protection from viruses, spyware, and other threats. Critical investments include network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services.

**Other Program Related Administration (+$900,000, to a total of $7.90 million)**

Other Program Related Administration includes funding for Foundation-wide activities such as major studies, evaluations, and NSF's costs associated with interagency E-Government activities. These activities include verification and validation of performance information; surveys of scientists, engineers, and educators who submit proposals for NSF awards; the Waterman Award which recognizes an outstanding young researcher in any field of science or engineering supported by NSF; some American Association for the Advancement of Science (AAAS) fellowship program and internships; and external evaluations of cross-foundational programs. The FY 2013 funding estimate, representing an increase of $900,000 from the FY 2012 Estimate, is based on the level of Other PRA activities and projects anticipated in FY 2013 including additional activities that focus on evidence- and performance-based evaluation of NSF's programs. Potential activities may include developing a data collection mechanism for gathering information about broader impacts; surveys to provide a measurement baseline for the INSPIRE program; and/or surveys to collect data on the Foundation's merit review processes for use by NSF's Merit Review Working Group.

# AGENCY OPERATIONS AND AWARD MANAGEMENT

**Summary of Agency Operations and Award Management by Function**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Human Capital | | | | | |
| Personnel Compensation & Benefits | $202.73 | $202.91 | $209.47 | $6.56 | 3.2% |
| Management of Human Capital | 8.22 | 9.40 | 8.20 | -1.20 | -12.8% |
| Operating Expenses | 9.97 | 15.26 | 13.32 | -1.94 | -12.7% |
| Travel | 6.04 | 6.04 | 5.74 | -0.30 | -5.0% |
| Subtotal, Human Capital | 226.96 | 233.61 | 236.73 | 3.12 | 1.3% |
| Technology and Tools | | | | | |
| Information Technology | 28.42 | 26.10 | 22.00 | -4.10 | -15.7% |
| Space Rental | 26.11 | 26.39 | 27.22 | 0.83 | 3.1% |
| Other Infrastructure | 14.71 | 10.69 | 10.06 | -0.63 | -5.9% |
| Subtotal, Technology and Tools | 69.23 | 63.18 | 59.28 | -3.90 | -6.2% |
| Future NSF | 3.10 | 2.61 | 3.39 | 0.78 | 29.9% |
| **Total, AOAM** | **$299.29** | **$299.40** | **$299.40** | **-** | **-** |

Totals may not add due to rounding.

Investments in the Agency Operations and Award Management (AOAM) account, contained within NSF's *Perform as a Model Organization* strategic goal, continue to be an NSF priority. This activity provides the fundamental framework through which the Foundation's science and engineering research and education programs are administered. Additionally, many of the administrative areas that NSF plans to streamline in an effort to bolster efficiency in response to Executive Order 13589, *Promoting Efficient Spending*, are funded through AOAM. Therefore, although the FY 2013 Request for AOAM is flat with FY 2011 and FY 2012 funding levels, investments in AOAM will continue to be of high priority to the Foundation.

AOAM's priorities are framed by three performance goals:

- Achieving management excellence through leadership, accountability, and personal responsibility;
- Infusing learning as an essential element of the NSF culture with emphasis on professional development and personal growth; and
- Encouraging and sustaining a culture of creativity and innovation across the agency to ensure efficiency and effectiveness in achieving high levels of customer service.

## HUMAN CAPITAL

**Human Capital Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Human Capital | | | | | |
| Personnel Compensation & Benefits | $202.73 | $202.91 | $209.47 | $6.56 | 3.2% |
| Management of Human Capital | 8.22 | 9.40 | 8.20 | -1.20 | -12.8% |
| Operating Expenses | 9.97 | 15.26 | 13.32 | -1.94 | -12.7% |
| Travel | 6.04 | 6.04 | 5.74 | -$0.30 | -5.0% |
| **Total, Human Capital** | **$226.96** | **$233.61** | **$236.73** | **$3.12** | **1.3%** |

Totals may not add due to rounding.

**AOAM NSF Workforce**
(Full-Time Equivalent (FTE) and Other Staff)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| NSF AOAM -- Regular | 1,310 | 1,310 | 1,310 | - | - |
| NSF AOAM -- Student | 40 | 42 | 42 | - | - |
| Subtotal, FTE Allocation | 1,350 | 1,352 | 1,352 | - | - |
| | | | | | |
| NSF AOAM -- Regular | 1,282 | 1,285 | 1,310 | 25 | 1.9% |
| NSF AOAM -- Student | 42 | 42 | 42 | - | - |
| Subtotal, FTE Usage | 1,324 | 1,327 | 1,352 | 25 | 1.9% |
| Detailees to NSF | 3 | 6 | 6 | - | - |
| **Total, Workforce (Usage)** | **1,327** | **1,333** | **1,358** | **25** | **1.9%** |

Totals may not add due to rounding.

NSF funding for Human Capital covers four general areas:

- Personnel Compensation and Benefits funds the salaries and benefits of NSF's federal employees and students;
- Management of Human Capital includes personnel-related services such as recruiting, classification and staffing, hiring and on-boarding, workforce planning, learning and development activities, employee relations, and other services to ensure the agency retains highly qualified and motivated staff to enable mission accomplishment;
- Operating Expenses includes funding for supplies and equipment, as well as contracts for post-award monitoring and financial services consulting; and
- Travel funds outreach activities, post-award oversight and monitoring, site visits, as well as travel for training.

## Personnel Compensation and Benefits (+$6.56 million to a total of $209.47 million)

**Personnel Compensation & Benefits**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount[3] | Percent[4] |
|---|---|---|---|---|---|
| Regular FTE Allocation | 1,310 | 1,310 | 1,310 | - | - |
| *Regular FTE Usage (actual/projected)* | *1,282* | *1,285* | *1,310* | 25 | *1.9%* |
| Regular Salary | | | | | |
| Base Salary | $154.06 | $155.38 | $155.90 | $0.52 | 0.3% |
| Salary Cost of Additional FTE | - | 0.36 | 3.00 | 2.64 | 733.3% |
| COLA & Locality Pay[1] | - | - | 0.59 | 0.59 | N/A |
| Subtotal, Regular FTE Salary | 154.06 | 155.74 | 159.49 | 3.75 | 2.4% |
| *Student FTEs* | *42* | *42* | *42* | - | - |
| Student Salary | 1.46 | 1.44 | 1.54 | 0.10 | 6.9% |
| *Total, FTEs* | *1,324* | *1,327* | *1,352* | *25* | *1.9%* |
| Subtotal, FTE Pay | 155.52 | 157.18 | 161.03 | 3.85 | 2.4% |
| Benefits and Other Compensation[2] | 47.21 | 45.73 | 48.44 | 2.71 | 5.9% |
| **Total, PC&B** | **$202.73** | **$202.91** | **$209.47** | **$6.56** | **3.2%** |

Totals may not add due to rounding.

[1] The pay increase includes nine months of the projected FY 2013 pay raise of 0.5 percent, as well as anticipated within grades and promotion increases.

[2] This category includes employee benefits, terminal leave, awards, and other benefits.

[3] The increase in the FY 2013 base salary reflects the full annual cost of employees hired throughout FY 2012.

[4] The percent change in the FY 2013 salary cost of additional FTE over the FY 2012 Estimate reflects the cost of 25 additional FTE in FY 2013 compared to an increase of only three FTE in FY 2012 over the FY 2011 Actual.

The FY 2013 Request for Personnel Compensation and Benefits (PC&B) of $209.47 million represents an increase of $6.56 million over NSF's FY 2012 Estimate of $202.91 million. The PC&B cost estimate includes a projected allocation and year-end usage of 1,310 regular full-time equivalent (FTE) employees, a projected FY 2013 pay raise of 0.5 percent, associated cost of benefits, general workforce performance awards (GWFPA) funded at 2 percent of the aggregate salary pool, and SES bonuses funded at 5 percent of the aggregate SES salary pool.

The FTE allocation of 1,310 FTE represents no change from the FY 2012 Estimate. FY 2013 usage of 1,310 represents an increase of 25 FTE from the projected FY 2012 year-end usage of 1,285 FTE to fully utilize the FTE allocation. Of this increase, nine FTE will be used to support acquisition and financial management activities across the Foundation, areas that have been identified as workforce priorities by the Administration, and that address issues raised in recent audits and other reports from the NSF Office of the Inspector General. Specifically, NSF will allocate the resources necessary to continue a strong focus on strengthening the acquisition workforce consistent with the agency acquisition workforce human capital plan. Internal staffing planning activities for FY 2013 identified a strong need for business operations positions within both the administrative offices and the science and engineering directorates. It is therefore a priority to recruit and fill these additional positions.

As NSF's program funding increases by 4.8 percent in FY 2013 over the FY 2012 estimate, NSF will face increased responsibilities in program monitoring and award oversight. At a minimum, seven of the additional positions would support these areas.

Finally, NSF will seek to better address its workload issues and other administration initiatives regarding workforce management. Since 2002, NSF has seen a decline of almost 20 percent in positive responses to the question "My workload is reasonable" in the OPM-administered Employee Viewpoint Survey. In FY 2011, NSF was a full 14 percent below the government wide average in this area. To fully maximize utilization, NSF will employ aggressive recruiting efforts and more assertive management of staffing levels within its directorates and offices.

## Management of Human Capital (-$1.20 million to a total of $8.20 million)

**Management of Human Capital**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $8.22 | $9.40 | $8.20 | -$1.20 | -12.8% |

The FY 2013 Request for Management of Human Capital of $8.20 million represents a decrease of $1.20 million from the FY 2012 Estimate. The decrease from the FY 2012 Estimate reflects a $1.1 million reduction achieved by eliminating almost 70 percent of contractual support for strategic human capital initiatives, with the remaining $100,000 attributable to achieving administrative efficiencies in the delivery of training.

Collectively, the $8.20 million will support human capital activities and ongoing operations and maintenance of existing systems as follows:

- Maintaining funding for NSF's basic HR systems accessed through shared service providers, such as the Federal Personnel Payroll System, the time and attendance system (WebTA), which NSF will begin using in FY 2012, eRecruit capabilities using USAJobs, and security investigations for incoming staff. FY 2013 funding for these activities will be $950,000.
- Providing the day-to-day operational support for recruiting, hiring and on-boarding of permanent and rotating staff and executives, as well as processing support of pay and benefits and incentive and other awards. Total FY 2013 funding for these support service contracts total $4.0 million.
- Continuing workplace and work life support for employees through NSF health and family-friendly activities, including the Health Unit, the Employee Assistance Program and the child care subsidy. FY 2013 funding for these activities will be $800,000.
- Maintaining contracts in support of training and development programs such as the Learning Management System, LearnNSF, and related on-line training capabilities, as well as support for training and networking activities such as the Executive Leadership Retreat and Program Management Seminar. FY 2013 funding for these activities will be $1.95 million, a reduction of $100,000 from FY 2012, reflecting efficiencies from the reduction of off-site training activities.
- Continuing the highest priority contractual support for strategic human capital initiatives. Management support contracts, which NSF has relied on in the past for assistance in developing new approaches to critical human resource needs including recruitment (particularly in areas such as veterans, underrepresented minorities, and persons with disabilities), hiring reform, workforce planning, executive coaching, and new training and development initiatives, will be funded at $500,000, a reduction of $1.1 million from the FY 2012 Estimate. The primary impacts resulting from the FY 2013 reduction will be a delay in reshaping performance management processes and developing the full spectrum of internal training offerings appropriate for NSF's workforce. The focus will be on assessing past initiatives, consolidating effective practices in ongoing human capital management programs, and laying the groundwork for the next phases of activity.

## Operating Expenses (-$1.94 million to a total of $13.32 million)

**Operating Expenses**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $9.97 | $15.26 | $13.32 | -$1.94 | -12.7% |

Operating Expenses includes funding for supplies and equipment, contracts, and other costs necessary to enable accomplishment of NSF's research and education mission and to support a wide variety of financial and award management, leadership, and other activities.

The FY 2013 Request of $13.32 million for Operating Expenses represents a decrease of $1.94 million over the FY 2012 estimate. The key activities funded in this budget are described below.

- FY 2013 funding of $5.42 million, a reduction of $1.71 million from the FY 2012 Estimate, for training, equipment, communications devices, printing, and supplies for NSF's directorates and offices. Savings to be achieved from efficiencies implemented in response to Executive Order 13589, *Promoting Efficient Spending*, will help to mitigate this reduction.
- FY 2013 funding of $3.43 million for award management and oversight support services (AMOSS), a decrease of $170,000 from FY 2012. AMOSS provides support services in the areas of post award monitoring, contract closeout activities, large facility oversight, ARRA reporting, and grantee outreach.
- FY 2013 funding of $1.5 million, a $100,000 decrease from FY 2012, for financial management support including financial statement reporting, NSF property reporting, audit resolutions, and Access database development associated with the existing financial system; in addition to internal control quality assurance.
- FY 2013 funding of $370,000 for the Congressionally-mandated Committee on Equal Opportunities in Science and Engineering (CEOSE) activity. This funding level provides for an increase of $140,000 over FY 2012, to publish the CEOSE Biennial Report
- FY 2013 funding of $350,000 for Enterprise Information System (EIS) and the Budget Internet Information System (BIIS) data analysis associated with providing accurate, consistent information on funding rate, award size, and other statistics for NSF staff and the public.
- FY 2013 funding of $360,000 million to support on-going licensing, subscription, and infrastructure support for Automated Acquisition Management System – NSF's E-procurement system.
- FY 2013 funding of $190,000 to support the review of grant payments and grantee expenditures of those payments as reported on the quarterly Federal Financial Reports (FFR) in order to comply with the Improper Payments Information Act (IPIA).
- FY 2013 funding of $270,000 for reasonable accommodations to persons with disabilities, including NSF employees, applicants, and those conducting business at NSF.
- FY 2013 funding of $400,000 for an inter-agency agreement with the Department of Interior National Business Center to negotiate indirect rate agreements on behalf of NSF with organizations where NSF has rate cognizance.

## Travel (-$300,000, to a total of $5.74 million)

**Travel**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $6.04 | $6.04 | $5.74 | -$0.30 | -5.0% |

The FY 2013 Request of $5.74 million for Travel represents a 5.0 percent decrease from the FY 2012 Estimate. This level of funding allows NSF to fund travel associated with the level of program activities and FTE usage contained in the FY 2013 Request. Travel within NSF is used to meet programmatic needs and to carry out the necessary level of site reviews, post-award monitoring and oversight, training-related travel and outreach activities.

The decrease in the FY 2013 Request reflects the agency's efforts to reduce administrative and programmatic travel costs in response to Executive Order (EO) 13589, *Promoting Efficient Spending*. By the end of FY 2013, NSF plans to reduce travel costs by a total of 14 percent from actual FY 2010 levels.

## TECHNOLOGY AND TOOLS

**Technology and Tools Funding**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Information Technology | $28.42 | $26.10 | $22.00 | -$4.10 | -15.7% |
| Space Rental | 26.11 | 26.39 | 27.22 | 0.83 | 3.1% |
| Other Infrastructure | 14.71 | 10.69 | 10.06 | -0.63 | -5.9% |
| **Total, Technology and Tools** | **$69.23** | **$63.18** | **$59.28** | **-$3.90** | **-6.2%** |

Totals may not add due to rounding.

The Technology and Tools activities encompass the information and physical infrastructure for NSF's working environment.

### Information Technology (-$4.10 million, to a total of $22.0 million)

NSF funds administrative applications from the Agency Operations and Award Management (AOAM) account while mission-related information technology (IT) investments that are directly associated with NSF programs are funded from program accounts. Resources to support mission-related IT investments are discussed in the Program Related Technology (PRT) section; see page R&RA and EHR-3.

Administrative applications and associated IT operations and infrastructure and IT security and privacy services and support funded by Agency Operations and Award Management are discussed below.

**Agency Operations Information Technology (IT)**

(Dollars in Millions)

| Agency Operations IT | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Administrative Applications Services and Support | $12.65 | $11.81 | $7.71 | -$4.10 | -34.7% |
| Associated Infrastructure Services and Support | 12.98 | 11.50 | 11.50 | - | - |
| Security and Privacy Services and Support | 2.79 | 2.79 | 2.79 | - | - |
| **Total, Information Technology** | **$28.42** | **$26.10** | **$22.00** | **-$4.10** | **-15.7%** |

Totals may not add due to rounding.

Information technology for agency operations ensures high quality, reliable, and secure administrative applications and associated IT infrastructure support and services to meet the needs of the Foundation.

For FY 2013, NSF's information technology priorities for AOAM include:

- Support the acquisition and implementation of iTRAK, the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial management system to a fully integrated financial management solution.
- Maintain administrative applications and services and the operations, infrastructure, and security that support these applications at current service levels.

The FY 2013 Request of $22.0 million represents a decrease of $4.10 million, or 15.7 percent below the FY 2012 Estimate. These resources will be used for the following activities and initiatives:

*Administrative Applications Services and Support (-$4.10 million, to a total of $7.71 million)*
Investments in this category support administrative applications, such as maintenance of NSF's legacy financial and accounting system and related functions, NSF's human resources management systems, the NSF website, and property and procurement applications.

iTRAK is the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial management system to a fully integrated financial management solution. In FY 2013, the total request for iTRAK is $11.70 million. Consistent with the FY 2012 Estimate, 70 percent of this request will be funded by Program Related Technology (PRT) and 30 percent will be funded by AOAM. In FY 2013, the AOAM portion of the iTRAK request is $3.51 million, an increase of $1.84 million over the FY 2012 Estimate.

Total funding for human resources systems is $1.50 million, which represents a decrease of $3.0 million from the FY 2012 estimate. The $1.50 million will be used for ongoing maintenance of the systems that support the strategic management of NSF human capital, including those to enable the effective recruitment, retention, development, and use of NSF staff. Non-routine maintenance and integrated, end-to-end automation of human capital functions, such as a fully automated performance management system, will be deferred.

For FY 2013, $1.50 million will be used for ongoing operations of the legacy financial and accounting system (FAS), which represents a decrease of $1.80 million from the FY 2012 Estimate. FAS is the primary system currently used by NSF to monitor, control, and execute the management and financial accountability of active awards. FAS is also the financial system of record for the Foundation, managing

all funding allocations, financial transaction processing, accounts maintenance, and rules processing. FAS activities in FY 2013 will be limited to critical maintenance and activities.
In FY 2013, $1.20 million will support ongoing operations and routine maintenance of collaboration services, such as SharePoint. This represents a decrease of $940,000 from the FY 2012 Estimate. FY 2013 activities for collaboration services will be limited to ongoing maintenance.

*Associated IT Operations and Infrastructure (no change, to a total of $11.50 million)*
Investments in this category provide basic maintenance and operations for ongoing operations that support administrative applications and services.

In addition to its primary purpose of supporting mission-related applications and services, NSF's IT-enabled business infrastructure supports the operation of administrative applications and office automation activities, including its network and telecommunications requirements. This includes NSF's data centers, network, hosting, phone, email, and remote access services. Additionally, this category includes NSF's call center and customer care services. NSF provides 14-hours per day, five days per week customer care support for internal users (NSF staff) and external users (the research community, including institutions, principal investigators, panelists, and other NSF visitors). The call center assists NSF's research community of institutions and principal investigators with functions such as preparing and submitting proposals, financial reports, and progress reports to NSF. The FY 2013 Request includes $9.25 million for these activities.

Also included in this category is $2.25 million in funding to continue to transition onsite operations to an offsite commercial data center facility and the "cloud."

*Security and Privacy Services and Support (no change, to a total of $2.79 million)*
Investments in this category include automated configuration management tools that manage security patches and provide proactive protection from viruses, spyware, and other threats. This includes the portion of NSF's network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services related to administrative applications.

**Summary of Space Rental and Other Infrastructure by Function**

(Dollars in Millions)

| | | | | FY 2013 Request Change Over FY 2012 Estimate | |
|---|---|---|---|---|---|
| **Space Rental and Other Infrastructure** | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Amount | Percent |
| Space Rental | $26.11 | $26.39 | $27.22 | $0.83 | 3.1% |
| Other Infrastructure | 14.71 | 10.69 | 10.06 | -0.63 | -5.9% |
| *- Administrative Contracts* | *8.23* | *5.22* | *4.72* | *-0.50* | *-9.6%* |
| *- Government Goods and Services* | *2.17* | *1.61* | *1.61* | - | - |
| *- Administrative Services Equipment & Supplies* | *4.31* | *3.86* | *3.73* | *-0.13* | *-3.4%* |
| **Total, Other Admin. Support** | **$40.82** | **$37.08** | **$37.28** | **$0.20** | **0.5%** |

Totals may not add due to rounding.

## Space Rental (+$830,000, to a total of $27.22 million)

**Space Rental**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Actual Amount | Percent |
|---|---|---|---|---|
| $26.11 | $26.39 | $27.22 | $0.83 | 3.1% |

Space Rental includes services provided by General Services Administration (GSA) related to rent, utilities, taxes, and security.

The FY 2013 Request for Space Rental is $27.22 million, an increase of $830,000, or 3.1 percent, over the FY 2012 Estimate. NSF currently occupies 660,000 square feet of space, primarily in two adjoining, leased office buildings located in Arlington, Virginia. The GSA procurement process for a new long term headquarters lease (see "Future NSF" below) is ongoing. The current lease at Stafford Place II expires on April 30, 2013, and an interim occupancy agreement at current market rates may be required pending completion of a new long term lease agreement by GSA. The additional $830,000 reflects fixed cost increases for Rent, Utilities and Homeland Security; annualized costs associated with space acquired in 2010 and 2011; and the potential increased GSA rental costs at Stafford Place II should an interim occupancy agreement be necessary through the end of FY 2013.

## Other Infrastructure (-$630,000, to a total of $10.06 million)

**Other Infrastructure**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $14.71 | $10.69 | $10.06 | -$0.63 | -5.9% |

The FY 2013 Request for Other Infrastructure of $10.06 represents a decrease of $630,000 from the FY 2012 Estimate. This funding level will support three sets of activities:

*Administrative Contracts* (-$500,000, to a total of $4.72 million)
Investments in this category fund core activities that support NSF's facilities and business operations, including the mail center, loading dock, shipping and receiving, and supply and warehouse management; conference room and merit review panel support, including audio visual and virtual meeting support; printing and digital scanning and imaging; travel management support; NSF intranet operations and maintenance; and the visitor information center.

NSF welcomes 40,000 visitors a year and supports approximately 1,800 panels. Plans to increase the number of virtual panels in FY 2013 are expected to lower infrastructure costs, but these savings will likely be reapplied to offset the increased IT and technology costs associated with virtual panels. In supplying the building services that support 2,100 NSF staff, on site contractors, IPAs and up to 14,000

panelists per year, NSF continually evaluates the highest priorities for the Foundation and seeks to identify efficiencies to reduce the cost of services while still supporting the most critical aspects of its Mission.

The $500,000 reduction will be achieved by reducing and streamlining contractual support for activities as projects and initiatives are completed.

*Government Goods and Services* (no change, to a total of $1.61 million)
Investments in this category provide core business activities such as building cleaning services, building improvements, records storage, warehouse cleaning and utilities, relocation and transit subsidy. These services will be maintained at the current FY 2012 Estimate funding level.

*Administrative Services, Equipment and Supplies* (-$130,000, to a total of $3.73 million)
Investments in this category provide a full range of business activities supporting NSF's infrastructure, including the security system maintenance, badge office (ID issuance), Public Announcement (PA) system maintenance, NSF Alert System, Continuity of Operations support services, Emergency Management Services, Data Center Uninterrupted Power Supply (UPS) maintenance, office reconfigurations, furniture purchase/cleaning /refinishing, carpet cleaning and installation, library services, equipment leases and maintenance, copier paper for all of NSF, metered mail postage, printing of publications, and Federal Register notices for panels and advisory committees.

The reduction in resources requested would be mitigated by reductions in contracts supporting some of these activities as efficiencies are achieved in response to Executive Order 13589, *Promoting Efficient Spending* in printing and/or copying activities, among others.

**FUTURE NSF (+$780,000 to a total of $3.39 million)**

**Future NSF**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $3.10 | $2.61 | $3.39 | $0.78 | 29.9% |

The FY 2013 Request for Future NSF of $3.39 million represents an increase of $780,000 over the FY 2012 Estimate. This increase provides support for technical evaluations of the reusability of existing furniture and equipment and pilot projects to test new furniture and equipment in cases where it is not feasible or cost effective to utilize, over the long-term, existing furniture and equipment.

NSF staff has been housed in Stafford Place I in Arlington VA since 1993. As NSF's mission, operations and staff have grown over the past eighteen years, NSF expanded its footprint into the nearby Stafford II facility. Both leases for NSF space will expire by the end of Calendar Year 2013. In anticipation of this event, in December 2010, the General Services Administration (GSA) submitted a prospectus to Congress requesting authorization to enter into a new 15-year operating lease for the Foundation.

During FY 2012, GSA intends to procure, award and sign a new replacement long-term lease for the NSF headquarters. Accordingly, in FY 2013, NSF will support the requisite activities necessary to facilitate

and respond to any lease acquisition scenario GSA pursues, thus minimizing risk and cost to the government.

In FY 2013, the requested funds will be used to provide the technical expertise required to prepare NSF for the new HQ long-term lease and related technology and operational requirements including:

- NSF management support to the GSA lease procurement, real estate and development evaluations, design issues, and architecture/engineering and construction review and oversight.
- Studies, proposals and coordination with GSA for the space plans, design integration and oversight, furniture and equipment pilot projects and acquisition strategies, procurement support, and new or modified functional and program operation recommendations.
- Planning, design, execution and oversight for NSF's new leased space will be required to meet Federal mandates such as energy efficiency, data center reduction and consolidation, and space utilization rate goals. This work will be performed by the building owner and funded through allowances and/or credits provided as typically negotiated into a GSA lease. NSF will be responsible for conceptual designs, as well as for oversight and acceptance of work, and coordinating associated activities and other NSF work that may be required as a result, including NSF communications cabling and furniture reconfigurations.

## AGENCY OPERATIONS AND AWARD MANAGEMENT BY OBJECT CLASS

The following table shows the planned distribution of obligations by object class. A brief explanation of each category follows.

**AOAM by Object Class**

(Dollars in Thousands)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | FY 2013 Request Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Personnel Compensation | $162,574 | $161,128 | $166,432 | $5,304 | 3.3% |
| Personnel Benefits | 40,155 | 41,782 | 43,042 | 1,260 | 3.0% |
| Travel and Transportation of Persons | 6,039 | 6,039 | 5,740 | -299 | -5.0% |
| Transportation of Things | 806 | 545 | 485 | -60 | -11.0% |
| Rental Payments to GSA | 25,160 | 26,390 | 27,220 | 830 | 3.1% |
| Rent to Others | 1,035 | 1,015 | 903 | -112 | -11.0% |
| Communications, Utilities and Misc. Charges | 1,941 | 1,902 | 1,691 | -211 | -11.1% |
| Printing and Reproduction | 432 | 432 | 384 | -48 | -11.1% |
| Advisory and Assistance Services | 43,950 | 43,311 | 38,513 | -4,798 | -11.1% |
| Other Services | 7,336 | 7,190 | 6,394 | -796 | -11.1% |
| Purchases of Goods & Srvcs from Gov't. Accts | 1,952 | 1,914 | 1,702 | -212 | -11.1% |
| Operations and Maintenance of Equipment | 131 | 128 | 114 | -14 | -10.9% |
| Supplies and Materials | 3,945 | 3,866 | 3,438 | -428 | -11.1% |
| Equipment | 3,834 | 3,758 | 3,342 | -416 | -11.1% |
| **Total, AOAM** | **$299,289** | **$299,400** | **$299,400** | **-** | **-** |

Totals may not add due to rounding.

FY 2013 Request object class code estimates reflect NSF's response to Executive Order 13589, *Promoting Efficient Spending.* The FY 2013 Request for Travel and Transportation of Persons represents a 5 percent reduction from the FY 2012 Estimate to meet the agency's FY 2013 travel efficiency reduction goal. Additionally, FY 2013 funding estimates in other object classes such as Advisory and Assistance Services, Other Services, and Supplies and Materials, have been reduced by 11.1 percent over FY 2012 estimated spending to promote efficient spending in categories highlighted in the Executive Order.

**Personnel Compensation and Benefits:** Personnel compensation funds pay, awards/bonuses, reimbursable details to NSF, overtime, and terminal leave. Personnel Benefits include the Government's contribution towards retirement systems, health and life insurance, thrift saving plans, special overseas allowances, and unemployment insurance. Personnel Compensation and Personnel Benefits increase by 3 percent over the FY 2012 Estimate as a result of the increase of 25 FTE in FY 2013 from the projected FY 2012 year-end estimate of 1,285 FTE; the increase in the general workforce performance awards pool from 1 percent of aggregate salaries in FY 2012 to 2 percent of aggregate salaries in FY 2013; and the 0.5 percent pay raise.

**Travel and Transportation of Persons:** These resources fund travel required for planning, outreach, and increased oversight of existing awards, as recommended by the agency's Inspector General.

**Transportation of Things:** This category consists of household moves associated with bringing new staff to NSF.

**Rental Payments to GSA:** This category includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and additional floors currently leased in an adjacent building.

**Rental Payments to Others:** This category includes rent paid to a non-Federal source for rental of space, land, and structures.

**Communications, Utilities, and Miscellaneous Charges:** This category includes all costs for telephone and other communication lines and services, both local and long distance, and postage.

**Printing and Reproduction:** This category includes contract costs of composition and printing of NSF's publications, announcements, and forms, as well as printing of stationery and specialty items.

**Advisory and Assistance Services:** This category includes development, learning, and career enhancement opportunities offered through the NSF Academy; contracts for human capital operational activities, work life initiatives, outreach, and related services; assistance in award oversight and monitoring; and support for OMB Circular A-123 reviews.

**Other Services:** This category includes warehousing and supply services, mail handling, proposal processing, equipment repair and maintenance, building-related costs, furniture repair, contract support for conference room services, security investigations, and miscellaneous administrative contracts.

**Purchases of Goods and Services from Government Accounts:** This category includes reimbursable services purchased from other government agencies. Examples include GSA for security guard services, some electrical upgrades, and modest renovation services, and Department of the Interior for payroll services.

**Operation and Maintenance of Equipment:** This category includes management and operation of the central computer facility 24x7 year-round; operation of the customer service center and FastLane help desk; maintenance of database server hardware and related peripherals; software licensing fees; data communications infrastructure and network systems support; electronic mail support; and remote access (e.g., internet and World Wide Web).

**Supplies and Materials:** This category includes office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies.

**Equipment:** This category includes new and replacement computing equipment, desktop computers, data communications equipment, video-teleconferencing equipment, office furniture, file cabinets, and support equipment such as audio-visual equipment.

## Appropriations Language

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $8,280 for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; $299,400,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2013 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

**Agency Operations and Award Management**
**FY 2013 Summary Statement**
(Dollars in Millions)

| | Enacted/ Request | Rescission | Carryover/ Recoveries | Transfers | Expired | Total Resources | Obligations Incurred/Est. |
|---|---|---|---|---|---|---|---|
| FY 2011 Appropriations | $300.00 | -$0.60 | | | -0.11 | $299.29 | $299.29 |
| FY 2012 Estimate | 299.40 | | | | | 299.40 | 299.40 |
| FY 2013 Request | 299.40 | | | | | 299.40 | 299.40 |
| $ Change from FY 2012 Estimate | | | | | | | - |
| % Change from FY 2012 Estimate | | | | | | | - |

Totals may not add due to rounding.

## NATIONAL SCIENCE BOARD (NSB) $4,440,000

The FY 2013 Request for the National Science Board is $4.44 million, level with the FY 2012 Estimate of $4.44 million. The FY 2013 Budget Request will enable the Board to fulfill its policy-making responsibilities for NSF. This funding will allow the Board to continue its responsibilities related to the American Recovery and Reinvestment Act of 2009 (ARRA) and the America COMPETES Reauthorization Act of 2010, and to perform activities related to the review of major research facilities projects. These resources will also be used to develop and submit to the President and Congress *Science and Engineering Indicators 2014* and related products.

**NSB Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Personnel Compensation and Benefits | $2.73 | $2.97 | $3.01 | $0.04 | 1.3% |
| Other Operating Expenses | 1.74 | 1.47 | 1.43 | -0.04 | -2.7% |
| **Total, NSB** | **$4.47** | **$4.44** | **$4.44** | **-** | **-** |
| Full-Time Equivalents (FTEs) | 18 | 18 | 18 | - | - |

Totals may not add due to rounding.

## Appropriations Language

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,440,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

**National Science Board**

**FY 2013 Summary Statement**

(Dollars in Millions)

| | Enacted/ Request | Rescission | Expired | Total Resources | Obligations Incurred/Est. |
|---|---|---|---|---|---|
| FY 2011 Appropriation | $4.54 | -$0.01 | -$0.06 | $4.47 | $4.47 |
| FY 2011 Estimate | 4.44 | | | 4.44 | 4.44 |
| FY 2013 Request | 4.44 | | | 4.44 | 4.44 |
| $ Change from FY 2012 Estimate | | | | | - |
| % Change from FY 2012 Estimate | | | | | - |

Totals may not add due to rounding.

## National Science Board in Context

The Board, established by the NSF Act of 1950, has dual responsibilities to: a) provide national science policy advice to the President and Congress; and b) establish policies for NSF. The Board is composed of 25 presidentially-appointed, Senate-confirmed members, including the NSF Director, representing the broad U.S. science and engineering (S&E) community. Board Members, who serve 6-year terms on staggered appointments, are drawn from industry, academe, non-profit organizations and professional scientific societies, and represent the breadth of S&E disciplines supported by NSF. They are selected for their eminence in research, education, or public service.

The Board currently meets five times a year to review and approve major NSF awards and new programs, oversee and provide policy direction to NSF, and address significant science and engineering related national policy issues. It initiates and conducts studies and reports on a range of policy topics and reviews NSF's priorities both to ensure progress and consistency along the strategic direction set for NSF and to ensure balance among new investments and core programs.

## Policy Responsibilities

Issues of importance to the science, engineering, and education communities in general and to the NSF in particular are often examined by the Board. Topics for exploration are determined through consultation with the science community and NSF management. Recent reports have examined topics such as merit review, mid-scale instrumentation, cost sharing, science and engineering education, and the globalization of science and engineering research.

Currently, the Board is finalizing two studies critical to the functioning of the agency. The Board is developing a report on data policies to determine best practices for data collected through NSF-sponsored research so that they remain available to the broad science, engineering, and education communities. Another report studies the support structure for potentially transformative and interdisciplinary mid-scale research. Identification of Board items for study in FY 2013 will be determined at a later date.

In addition to those special studies, the Board has several standing committees to assist with its responsibilities. The Committee on Audit and Oversight provides general supervision for the NSF Inspector General; oversight of major agency administrative processes and principal administrative systems; and review of the agency's Government, Performance, and Results Act (GPRA) requirements.

The Committee on Strategy and Budget (CSB) focuses on strategic planning and new investments for NSF; analyzes the Foundation's budget to ensure progress and consistency against strategic direction for the Foundation; and identifies strategic, typically long-term, issues that are critical to NSF's future. Within CSB, the Subcommittee on Facilities (SCF) provides guidance and review of the NSF-funded research equipment and facilities portfolio, including both Major Research Equipment and Facilities Construction (MREFC) account-funded and Research and Related Activities (R&RA)-funded facilities.

The Committee on Education and Human Resources (CEH) provides guidance and advice on major policy issues related to the NSF education, informal science, and training portfolio; and reviews proposals representing a significant expenditure of National Science Foundation resources. It also provides advice on major national policy issues in science, technology, engineering and mathematics (STEM) education, human resource needs and employment, and human resource development.

The Committee on Science and Engineering Indicators (SEI) offers guidance on content, organization, and presentation of data in the Board’s biennial report, *Science and Engineering Indicators*, and other

related products; and keeps the Board informed on trends and other data with significant policy implications identified during the production of *Indicators*. The Board's publication, *Science and Engineering Indicators (SEI)*, is a statutory responsibility. Over the past several years, the Board has heightened its efforts to expand the audience for Indicators, implementing enhancements such as the on-line *Digest of Key Science and Engineering Indicators* that encourage audiences outside the normal community of users to become familiar with the data resources in Indicators and to facilitate the use of Indicators data in policy decisions and analyses. Release of the 2014 edition of SEI to Congress is scheduled for January, 2014. The Board has indicated an interest in developing additional policy statements based on the SEI data to assist policymakers in their deliberations on science and technology issues.

The Board is responsible for direct review and approval of the Foundation's largest awards, and is responsible for the review and approval of MREFC projects at all stages of development, including budget planning, review of proposals and management effectiveness, and approval of awards. The Committee on Programs and Plans (CPP) provides guidance and advice on major policy issues related to the NSF research and related activities portfolio, reviews proposals representing a significant expenditure of agency resources, and makes informal recommendations, as appropriate, to the full Board for its consideration and action. The Subcommittee on Polar Issues (SOPI), reporting to CPP, provides oversight, guidance, and advice on major policy and operational issues related to the NSF polar research portfolio.

The Board's Executive Committee (EC) is required by the National Science Foundation Act of 1950, as amended (42 U.S.C. Section 1865). It consists of the NSF Director, who chairs the Committee, and four other elected members from the Board. The Board may delegate to the Executive Committee or to the Director or both such of the powers and functions granted to the Board by the NSF Act as it deems appropriate.

The Board expects to continue to be significantly engaged with assisting the agency in its responsibilities stemming from the American Recovery and Reinvestment Act of 2009 and the America COMPETES Reauthorization Act of 2010.

On-going activities of the Board include reviews of the following:

- NSF's Office of Inspector General (OIG) Semi-annual Reports to Congress and NSF management responses;
- The NSF Budget Submission for transmittal to the Office of Management and Budget (OMB);
- NSF's research infrastructure portfolio;
- NSF's annual Merit Review Report; and
- Large awards, MREFC projects, or proposal funding requests and other proposals as needed.

**National Science Board**

**Personnel Compensation and Benefits and General Operating Expenses**

(Dollars in Thousands)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Amount | Change Over Estimate Percent |
|---|---|---|---|---|---|
| Personnel Compensation and Benefits | $2,727 | $2,973 | $3,014 | $41 | 1.4% |
| Staff Development & Training | 29 | 36 | 36 | - | - |
| Advisory & Assistance Services | 1,160 | 903 | 877 | -$26 | -2.9% |
| Travel & Transportation of Persons | 418 | 365 | 350 | -$15 | -4.1% |
| Communications, Supplies and Equipment | 133 | 160 | 160 | - | - |
| Representation Costs | 3 | 3 | 3 | - | - |
| **Total, NSB** | **$4,470** | **$4,440** | **$4,440** | - | - |
| Full-Time Equivalent | 18 | 18 | 18 | - | - |

Totals may not add due to rounding.

## Personnel Compensation and Benefits

The Board's FY 2013 Budget Request supports a small core of full-time policy, administrative, legal, and operations staff. About 67 percent of the 2013 request is for Board member and staff salaries and benefits. The Board Office staff provides both the independent resources and capabilities for coordinating and implementing science and education policy analyses and development, and the operational support that is essential for the Board to fulfill its mission. The FY 2013 Request funds a 0.5 percent Cost of Living Adjustment (COLA) effective January 2013.

### Other Operating Expenses

NSB's Advisory and Assistance Services includes the resources needed to produce policy reports. Most of these reports require expert analysis from organizations such as the agency's dedicated Federally Funded Research and Development Center (FFRDC) and the Science and Technology Policy Institute (STPI). Another major expense in the Advisory and Assistance Services line is the development and implementation of an electronic architecture to search, identify, and retrieve relevant documents, in a common format, for use by stakeholders. This electronic records center houses substantive Board materials, such as discussions, decisions, and minutes. Other costs within the Advisory and Assistance Services line are associated with the Open Government initiative including the webcasting and archiving of all open Board meetings, as well as transcription services, and report printing and dissemination. The FY 2013 reduction of $41,000 reflects savings to be achieved in response to Executive Order 13589, "Promoting Efficient Spending."

NSB's Travel and Transportation of Persons account primarily covers Board member travel costs to NSF headquarters for four meetings, and to one off-site meeting, as well as travel for invited speakers and participants in Board activities. The Communications, Supplies, and Equipment line funds the range of electronic purchases, upgrades and installations, such as copiers and computers.

## OFFICE OF INSPECTOR GENERAL (OIG) $14,200,000

The Appropriations Act that funds the National Science Foundation provides for a separate appropriation for NSF's Office of Inspector General (OIG). Accordingly, the FY 2013 Request level identifies the resources needed to support OIG, including amounts for personnel compensation and benefits (PC&B), contract services, training, travel, supplies, materials, and equipment.

The FY 2013 Budget Request for OIG is $14.20 million, which is identical to the FY 2012 Estimate. In accordance with the Inspector General Act of 1978, as amended (5 U.S.C. App.), it should be noted that this request is $800,000 less than the $15 million initially submitted to, and approved by, the National Science Board (NSB).

**OIG Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|
| Personnel Compensation and Benefits | $10.82 | $0.07 | $11.38 | $11.54 | $0.16 | 1.4% |
| Other Operating Expenses | 3.10 | 0.01 | 2.82 | 2.66 | -0.16 | -5.7% |
| **Total, OIG** | **$13.92** | **$0.08** | **$14.20** | **$14.20** | **-** | **-** |
| Full-Time Equivalent Employment | 74 | | 78 | 78 | - | - |

Totals may not add due to rounding.

### Appropriations Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $14,200,000, *to remain available until September 30, 2014*.

**Office of Inspector General**
**FY 2013 Summary Statement**

(Dollars in Millions)

| | Enacted/ Request | Rescission | Carryover/ Recoveries | Expired | Total Resources | Obligations Incurred/Est. | Carryover/ Recoveries |
|---|---|---|---|---|---|---|---|
| FY 2011 Appropriations | $14.00 | -$0.03 | | -$0.05 | $13.92 | $13.92 | |
| FY 2011 ARRA[1] | - | | 1.92 | - | 1.92 | 0.08 | 1.84 |
| FY 2012 Estimate | 14.20 | | | - | 14.20 | 14.20 | |
| FY 2013 Request | 14.20 | | | - | 14.20 | 14.20 | |
| $ Change from FY 2012 | | | | | | - | |
| % Change from FY 2012 | | | | | | - | |

Totals may not add due to rounding.

[1]$1.92 million in unobligated FY 2009 ARRA funds were carried over into FY 2011. The remaining unobligated balance of $1.84 million was subsequently carried over into FY 2012.

**Explanation of Carryover**

Within the **Office of Inspector General** appropriation, $1.84 million was carried over. These multi-year funds are intended explicitly for ARRA oversight. Obligation of these funds will occur over the period of availability, which was revised under P.L. 111-203 to be through December 31, 2012. In January 2012, the Council of the Inspectors General for Integrity and Efficiency (CIGIE) submitted a formal request to the President, on behalf of NSF and other OIGs, for a waiver that would extend the availability of these funds. The response to that request has not yet been received.

**OIG Responsibilities**

In February 1989, the National Science Board established OIG pursuant to the Inspector General Act Amendments of 1988. The statute confers on OIG the responsibility and authority to:

- Conduct and supervise audits of NSF programs and operations, including organizations that receive NSF funding;
- Conduct investigations concerning NSF programs and operations, including organizations that receive NSF funding;
- Evaluate allegations of research misconduct, such as fabrication, falsification, or plagiarism, involving individuals who participate in NSF-funded activities;
- Provide leadership, coordination, and policy recommendations for:
  - Promoting economy, efficiency, and effectiveness in the administration of NSF programs and operations, and
  - Preventing and detecting fraud and abuse in NSF programs and operations;
- Issue semiannual reports to the National Science Board and Congress to keep them informed about problems, recommended corrective actions, and progress being made in improving the management and conduct of NSF programs.

OIG performs audits of grants, contracts, and cooperative agreements funded by NSF's programs. The office also conducts audits and reviews of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with agency and federal requirements. OIG is also responsible for overseeing the audit of NSF's annual financial statements, which are required for all NSF accounts and activities by the Government Management Reform Act of 1994. Since FY 2006, funds to cover the complete cost of the financial audit have been requested in this appropriation. OIG also audits financial, budgetary, and data processing systems used by NSF to develop the financial statements. In addition, the office performs multi-disciplinary reviews – involving auditors, attorneys, management analysts, investigators, and others as needed – of financial, management, and program operations to identify broader problems and highlight best practices.

OIG investigates possible wrongdoing by organizations and individuals who seek or receive NSF funds such as those who submit proposals to, receive awards from, conduct business with, or work for NSF. Allegations of research misconduct are also investigated. OIG assesses the validity and seriousness of all the allegations it receives and recommends proportionate action. When appropriate, the office refers the results of these investigations to the Department of Justice or other authorities for criminal prosecution, civil litigation, or resolution via settlement agreements and institutional compliance plans. OIG refers other cases to NSF for administrative resolution and when needed will recommend modifications to agency policies and procedures to ensure the integrity of NSF's business systems. The office works closely with institutions on the conduct of their internal investigations and performs outreach activities aimed at preventing and detecting fraud, waste, and abuse; and at raising the awareness of funded

researchers, institutional administrators, and agency employees about OIG's role and NSF's rules and expectations.

Because diverse skills, training, and experience are necessary to oversee NSF's many programs, the OIG staff includes scientists, attorneys, certified public accountants, investigators, evaluators, and information technology specialists. The subjects of investigations, audits, and other reviews are also varied and may include: an individual grant recipient or institution; a broad program or functional area of NSF; or a project involving multiple disciplines or entities. OIG also utilizes contractors to perform work when it is cost effective, or when OIG lacks the necessary expertise in-house, as in the case of the annual review of the agency's financial systems controls and their compliance with FISMA. In FY 2013, the office will also continue to be involved in audits and investigations of NSF programs, grants, contracts, and other activities associated with funding provided by the American Recovery and Reinvestment Act of 2009 (ARRA). Nearly all these grants and contracts involve multi-year awards that in FY 2013 will reach the point at which many allegations and other indicators will be peaking, but because the special appropriation the office received in 2009 to oversee NSF's ARRA funds will expire at the end of CY 2012[1] unless the President approves our previously-noted waiver request, our ARRA work will have to be funded instead from OIG's regular appropriation.

**Office of Inspector General**
**Personnel Compensation and Benefits and General Operating Expenses**

(Dollars in Thousands)

| | FY 2011 Actual | FY 2011 ARRA | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|---|
| Personnel Compensation and Benefits | $10,816 | $77 | $11,375 | $11,543 | $168 | 1.5% |
| Travel & Transportation of Persons | 297 | 6 | 335 | 345 | 10 | 3.0% |
| Advisory & Assistance Services[1] | 2,483 | | 2,130 | 1,952 | -178 | -8.4% |
| Communications, Supplies and Equipment, and Other Services | 319 | | 360 | 360 | - | - |
| *Training* | *111* | | *160* | *160* | - | - |
| *Other* | *208* | | *200* | *200* | - | - |
| **Total, OIG** | **$13,915** | **$83** | **$14,200** | **$14,200** | - | - |
| Full-Time Equivalent | 74 | | 78 | 78 | - | - |

Totals may not add due to rounding.

[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

The FY 2013 request level of $14.20 million will enable OIG to maintain the same number of FTEs it expects to achieve in FY 2012, by using funds that in previous years were allocated to contractor support, and provide adequate oversight of NSF's core programs, largest contracts, and riskiest grant awards. Some planned initiatives will be deferred. The FY 2013 Request funds a 0.5 percent Cost of Living Adjustment (COLA) effective January 2013. In FY 2013, $178,000, an 8.4 percent reduction in Advisory and Assistance Services reflects savings to be achieved in response to Executive Order 13589, "Promoting Efficient Spending." OIG will undertake a few modest but necessary systems and equipment

[1] P.L. 111-203 specifies that the availability of these funds for obligation expires on December 31, 2012. Previously, these funds were available until the end of FY 2013.

upgrades, including the improvement of Audit's data analytics capability, and the acquisition of investigative case management software.

This funding level would enable OIG to keep pace with NSF's increased financial exposure in awarding billions of dollars in grants and contracts each year. The agency obligated almost $3.0 billion in American Recovery and Reinvestment Act (ARRA) funds in 2009 in addition to its regular annual appropriation of approximately $7.0 billion. As many of the projects funded by ARRA wind down through 2012 and 2013, the need for audits and investigations is likely to rise, as fraudulent and other unallowable behavior does not usually surface until the later stages of an award. Since the $2.0 million appropriation NSF OIG received to oversee ARRA is scheduled to expire at the end of December 2012, these costs will be primarily borne by our regular appropriation in FY 2013 unless the President grants our pending waiver request. If a waiver is approved, the ARRA funds would enable the commitment of more of our FY 2013 appropriation to the oversight of non-ARRA programs, including the research and education programs slated for growth in FY 2013.[2]

*Audits.* Due to the declining quality and economy of contractor-performed audits, OIG is planning to conduct more audits of NSF contracts and grants with its own staff, reducing the number of audits performed by CPA firms under contract. OIG also plans to add an in-house information technology audit capability that was formerly lacking. This change should enable us to achieve greater control over the audit process, resulting in better quality and more timely audits at a lower price. OIG also expects to gain greater institutional knowledge and familiarity by sending its own staff, rather than contractors, into the field to personally observe and report on awardees financial issues, resulting in better program oversight and integrity. The average cost of a contracted audit has risen from approximately $100,000 in FY 2004 to about $130,000 in FY 2010, while the need for staff oversight of contractors and the rework associated with their audits further add to their cost.

Our audit unit is investing in enhanced technical capabilities and data analytics that will allow us to improve oversight of NSF funds by better targeting our audits toward the riskiest awardees and by more efficient screening and analysis of large volumes of data. Improvements in the staffing and coordination of our external audits will allow OIG to increase the number of risk-based audits by 33 percent to approximately 20 institutions annually. Plans for technical architecture enhancements to servers, software, and interfaces would be limited to available funding, and deferred if necessary. Once completed, these advancements will provide a strong risk-based framework for identifying high risk awardees for review. At the current funding level, audits of NSF's IT infrastructure will be phased in as funds allow as the agency moves applications and resources into cloud computing and internet service into the Trusted Internet Connection (TIC).

The requested funds would continue to support performance and information technology audits that reflect important federal and OIG priorities, including assessments of the effectiveness of: 1) NSF's acquisition program and its ability to meet existing and newly implemented federal requirements, 2) NSF oversight of contingency costs for construction projects and 3) NSF's financial accountability and oversight responsibilities. Funds would also be used for a series of audits of the adequacy of NSF's cooperative agreements to manage and oversee its large facility awards, and to improve our oversight of IT security at NSF. Finally, funds would be committed to audits that are mandated by law, including the annual Financial Statement Audit, the related Federal Information Security Management Act independent evaluation report, and the triennial audit of the National Science Board's compliance with the Government in the Sunshine Act.

[2] NSF OIG has requested that the President extend the period of availability of its ARRA appropriation to its original expiration date of September 30, 2013.

*Investigations*. The appropriation requested would enable OIG to keep pace with an expanding workload driven by NSF's increase in number of awards and ARRA expenditures, a vigorous proactive review and investigative program, the increasing complexity of the financial fraud and internal cases being investigated, and the dramatic increase in Small Business Innovation Research (SBIR) program investigations. Over the past two years, we have responded to Congressional concerns over the growth of SBIR fraud by organizing a working group of OIGs to improve federal law enforcement efforts in this key area. During that period we have opened 52 new SBIR cases, and we expect this upward trend to continue. Many of these investigations are conducted jointly with other agencies, requiring extensive coordination and nation-wide travel. The increased SBIR caseload has also prompted OIG to seek statutory law enforcement authority from the Department of Justice. If this request is approved, OIG special agents will be required to meet specific requirements under the US Attorney General Guidelines, which include quarterly firearms qualifications as well as other tactical training that will increase costs.

Past investments in OIG's investigative program have yielded an excellent return for the government. Our civil and criminal cases frequently produce both financial settlements for institutional fraud and compliance agreements for correcting the underlying systemic problems, thus providing greater protection for future federal funding. Although time-consuming, monitoring institutions' efforts to meet the terms of their five-year compliance plans is vital to preventing fraud from recurring, and it sends a strong message to the community. The systemic problems that have allowed fraud to occur take time to rectify, and ongoing oversight is required to ensure that vulnerabilities in the systems are not further exploited.

OIG's investigative workload is growing rapidly in the research misconduct area as well. Over the past few years, there has been an increase in serious data fabrication and falsification cases. Rising concerns about research integrity led NSF in 2010 to implement a responsible conduct of research (RCR) requirement for NSF awards. OIG is responsible for oversight of institutional RCR plans to ensure that they effectively address risk. Unfortunately, some institutions are implementing RCR programs that are significantly flawed, reflecting a lack of serious commitment to institutional oversight of research awards. Addressing research integrity and misconduct issues requires a highly-skilled staff, equipped with the necessary technological and other resources, to effectively determine their scope and complexity, perform the intricate investigations, and develop meaningful recommendations.

OIG also has a robust outreach program to fulfill its core mission to prevent fraud, waste, and abuse. Drawing on OIG's extensive experience in dealing with grant fraud and research misconduct, our staff plays a key role in educating NSF's and OIG's stakeholders. Our proactive efforts are consistent with the emphasis on transparency and accountability mandated by the administration and the Congress, and they help us assure the integrity of federally funded research and conduct effective oversight of ARRA funds. From an investigative perspective, the requested funds would enable OIG to perform sufficient outreach activities to address: 1) growing concerns regarding the erosion of research integrity, as evidenced by a threefold increase in allegations in the past decade and studies indicating that 25 to 30 percent of scientists engage in questionable research practices; 2) the issues underlying the increasing number of egregious allegations that we are investigating, many of which are related to the employment of scientists from other countries who may not fully understand U.S. rules and procedures; 3) misconduct related to ARRA funds; and 4) the growth of SBIR program fraud. Our ability to continue a vigorous preventative program of proactive review and outreach depends on whether our staffing and travel resources provide sufficient support, especially in light of our other urgent investigative priorities, as set out above.

The appropriated funds would enable us to provide an adequate level of oversight, while limiting some elements of our investigations program. OIG would have to absorb the unique training, equipment and related costs involved in maintaining statutory law enforcement authority. The forensic accounting support that is so vital to investigations involving complex financial systems would be continued, although at a reduced level. Our emphasis on major investigations involving sophisticated financial

issues may have to be cut back to ensure coverage of new investigative efforts related to such high priorities as SBIR fraud and ARRA-supported grants. We would also continue, albeit at a reduced level, our efforts to educate the federal community about issues such as fraud, suspension and debarment, and research misconduct. Other reductions in training and support functions would be needed to preserve funds that are necessary to travel, which is critical to our work.

We would also make a few modest but necessary systems and equipment upgrades, including the acquisition of investigative case management software. We would be able to perform a smaller number of the proactive reviews that guide our investigative efforts, but priority reviews, including an important analysis of fraud and duplicative funding within the SBIR program, and an analysis of research integrity programs would be preserved. These proactive investigative reviews have proven to be an efficient means of uncovering fraud, research misconduct, and other systemic wrongdoing by NSF awardees.

# MAJOR MULTI-USER RESEARCH FACILITIES

**Major Multi-User Research Facilities Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Change Over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Total, Research and Related Activities** | **$913.54** | **$909.70** | **$923.30** | **$13.60** | **1.5%** |
| *Operations and Maintenance of Existing Facilities* | *673.63* | *655.37* | *647.35* | *-8.02* | *-1.2%* |
| *Federally Funded R&D Centers* | *195.25* | *195.85* | *191.71* | *-4.14* | *-2.1%* |
| *Operations and Maintenance of Facilities under Construction* | *17.49* | *44.73* | *72.49* | *27.76* | *62.1%* |
| *R&RA Planning and Concept Development* | *27.17* | *13.75* | *11.75* | *-2.00* | *-14.5%* |
| **Major Research Equipment and Facilities Construction** | **$125.37** | **$197.06** | **$196.17** | **-$0.89** | **-0.5%** |
| **Total, Major Multi-User Research Facilities** | **$1,038.91** | **$1,106.76** | **$1,119.47** | **$12.71** | **1.1%** |

Totals may not add due to rounding.

NSF investments provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based and distributed user facilities are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies, and countries to ensure complementarity and integration. Planning, and operations and maintenance of multi-user facilities are funded through the Research and Related Activities (R&RA) account, and most major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) account.

This chapter provides descriptions of each major multi-user research facility supported through the R&RA account and provides funding information by life cycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for large facility projects. Information on projects under construction funded through NSF's MREFC account is provided in the MREFC chapter.

## Major Multi-User Research Facilities Funding

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Change over FY 2012 Estimate Percent |
|---|---|---|---|---|---|
| **Operations and Maintenance of Existing Facilities** | **$673.63** | **$655.37** | **$647.35** | **-$8.02** | **-1.2%** |
| ***Engineering*** | | | | | |
| *National Nanotechnology Infrastructure Network (NNIN)* | *16.36* | *15.86* | *15.36* | *-0.50* | *-3.2%* |
| *Network for Earthquake Engineering Simulation* | *20.10* | *20.50* | *20.50* | *0.00* | *0.0%* |
| ***Geosciences*** | | | | | |
| *Academic Research Fleet* [1] | *81.67* | *76.75* | *72.00* | *-4.75* | *-6.2%* |
| *EarthScope: USArray, SAFOD, PBO* | *26.02* | *25.05* | *26.17* | *1.12* | *4.5%* |
| *Incorporated Research Institutions for Seismology* | *12.37* | *12.36* | *11.25* | *-1.11* | *-9.0%* |
| *Integrated Ocean Drilling Program* | *53.35* | *44.40* | *38.90* | *-5.50* | *-12.4%* |
| ***Mathematical and Physical Sciences*** | | | | | |
| *Arecibo Observatory (formerly NAIC)* [2] | *9.26* | *8.70* | *8.20* | *-0.50* | *-5.7%* |
| *Cornell High Energy Synchrotron Source (CHESS) / Cornell Electron Storage Ring (CESR)* | *14.12* | *19.67* | *20.00* | *0.33* | *1.7%* |
| *Gemini Observatory* | *19.50* | *22.07* | *18.15* | *-3.92* | *-17.8%* |
| *IceCube* | *6.90* | *6.90* | *6.90* | *0.00* | *0.0%* |
| *Large Hadron Collider* | *18.00* | *18.00* | *18.00* | *0.00* | *0.0%* |
| *Laser Interferometer Gravitational Wave Observatory* | *30.30* | *30.40* | *30.50* | *0.10* | *0.3%* |
| *National High Magnetic Field Laboratory* | *32.68* | *25.80* | *31.75* | *5.95* | *23.1%* |
| *National Solar Observatory* | *9.10* | *9.10* | *8.00* | *-1.10* | *-12.1%* |
| *National Superconducting Cyclotron Laboratory* | *21.50* | *21.50* | *21.50* | *0.00* | *0.0%* |
| *Other Facilities* [3] | *4.86* | *2.52* | *2.66* | *0.14* | *5.6%* |
| ***Polar Programs*** | | | | | |
| *Polar Facilities and Logistics* [4] | *297.54* | *295.79* | *297.51* | *1.72* | *0.6%* |
| **Federally Funded Research and Development Centers** [5] | **$195.25** | **$195.85** | **$191.71** | **-$4.14** | **-2.1%** |
| *National Center for Atmospheric Research* | *98.10* | *98.60* | *92.29* | *-6.31* | *-6.4%* |
| *National Optical Astronomy Observatory* | *29.50* | *25.50* | *25.50* | *0.00* | *0.0%* |
| *National Radio Astronomy Observatory* [6] | *67.65* | *71.75* | *73.92* | *2.17* | *3.0%* |
| **Operations and Maintenance of Facilities under Construction** | **$17.49** | **$44.73** | **$72.49** | **$27.76** | **62.1%** |
| *Advanced Technology Solar Telescope (ATST)* | *2.00* | *2.00* | *2.00* | *0.00* | *0.0%* |
| *National Ecological Observatory Network (NEON)* | | *15.93* | *30.39* | *14.46* | *90.8%* |
| *Ocean Observatories Initiative(OOI)* | *15.49* | *26.80* | *40.10* | *13.30* | *49.6%* |
| **R&RA Planning and Concept Development** | **$27.17** | **$13.75** | **$11.75** | **-$2.00** | **-14.5%** |
| *Pre-construction Planning* [7] | *17.50* | *6.75* | *8.75* | *2.00* | *29.6%* |
| *Concept and Development for MREFC projects* | *9.67* | *7.00* | *3.00* | *-4.00* | *-57.1%* |
| **Major Research Equipment and Facilities Construction** | **$125.37** | **$197.06** | **$196.17** | **-$0.89** | **-0.5%** |
| **Total, Major Multi-User Research Facilities** | **$1,038.91** | **$1,106.76** | **$1,119.47** | **$12.71** | **1.1%** |

Totals may not add due to rounding.

[1] An additional $2.0 million in FY 2012 and $1.0 million in FY 2013 for Regional Class Research Vessels is included in pre-construction planning.

[2] The National Astronomy and Ionosphere Center (NAIC) was decertified as an FFRDC in FY 2011 and renamed Arecibo Observatory.

[3] Other Facilities includes support for other physics and materials research facilities.

[4] In FY 2011, Polar Facilities and Logistics excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 112-10.

[5] Federally Funded R&D Centers does not include support for the Science and Technology Policy Institute, which is an FFRDC but not a multi-user research facility

[6] Operations and Maintenance of ALMA are included in NRAO.

[7] Pre-construction planning includes R&RA funding for potential next-generation major multi-user facilities.

## NSF's Facilities Investments in FY 2013

The following pages contain information on NSF's ongoing facilities in FY 2013.

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## Academic Research Fleet

**$73,000,000**
**-$5,750,000 / -7.3%**

**Academic Research Fleet**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $81.67 | $78.75 | $73.00 | -$5.75 | -7.3% |

The Academic Research Fleet consists of 21 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, enabling NSF and other federally-funded scientists with the means to conduct ocean science research with a diverse fleet capable of operating in coastal and open ocean waters. Funding for the Academic Research Fleet includes investments in ship operations; shipboard scientific support equipment; oceanographic instrumentation and technical services; and submersible support. Funding levels reported here reflect investments in the Directorate of Geosciences (GEO) by the Division of Ocean Sciences (OCE) and the Division of Innovative and Collaborative Education and Research (ICER). In addition to operations, OCE has undertaken selected construction projects based on inter-agency planning and coordination as discussed in the Federal Oceanographic Fleet Status Report published in 2007.

**Total Obligations for the Academic Research Fleet**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $73.67 | $74.35 | $72.00 | $72.30 | $73.60 | $76.00 | $77.40 | $78.80 |
| Fleet Renewal: | | | | | | | | |
| Human Occupied Vehicle | 8.00 | 2.40 | - | - | - | - | - | - |
| Regional Class Research Vessel | - | 2.00 | 1.00 | 1.00 | 1.00 | - | - | - |
| **Total, Academic Research Fleet** | **$81.67** | **$78.75** | **$73.00** | **$73.30** | **$74.60** | **$76.00** | **$77.40** | **$78.80** |

Totals may not add due to rounding.
[1] Outyear funding estimates are for planning purposes only.

The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses about the structure and dynamics of the ocean. Scientists contribute to advances in many areas including climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis through use of these facilities. Vessels in the Academic Research Fleet provide about 62,000 scientist days at sea and permit shipboard training of future oceanographers, with students forming about 25 percent of the sea-going science parties. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Increasingly, technological innovations allow research conducted at sea to be transmitted via satellite back to the classroom, broadening the educational impact of the vessels to a wider audience, including K-12 students.

The Academic Research Fleet is supported through an interagency partnership, principally with the Office of Naval Research (ONR) and the National Oceanic and Atmospheric Administration (NOAA) via a Memorandum of Understanding (MOU). The operating costs for the Fleet are divided proportionally

among the vessel users based on usage; NSF supports approximately 70 percent of the total. NSF also coordinates with ship-operating and ship-user academic institutions through UNOLS.

Support for scientists using the Fleet is provided by both NSF and other federal and state agencies. Within NSF, science is supported through competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Division of Earth Sciences (EAR), the Division of Atmospheric and Geospace Sciences (AGS), the Office of Polar Programs (OPP) and the Directorate for Biological Sciences (BIO). Approximately 30 percent of the OCE proposals request ship time; GEO-funded shipboard science has ranged from about $35.0 million to $45.0 million per year over the last five years. Not reflected in this number is the science that utilizes samples or data collected on prior cruises, scientists piggy-backing on scheduled cruises to accomplish additional science, international scientists sailing with the U.S. Academic Research Fleet, and science funded by other agencies.

The reduction in ship operation and upgrade costs in FY 2013 is the result of reduced ship demand and the completion of support for the replacement human occupied vehicle *ALVIN*. The FY 2013 Request of $73.0 million will support approximately 2,400 ship operating days.

**Facility Report**

Fleet Operations

- Oversight: NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and through a separate cooperative agreement with the UNOLS Office. In addition, NSF oversees the Fleet through site visits, ship inspections, and participation at UNOLS Council and Subcommittee meetings by NSF program directors. Several program directors within OCE at NSF, at NOAA, and at ONR are involved in the activities and overall oversight of the Academic Research Fleet. NSF conducted a Business Systems Review (BSR) of the R/V *Langseth*, and issued a final report in September 2010. No BSRs are scheduled for 2012 or 2013.
- Management: Management of an operating institution's ship-operating facilities varies with the scale of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship's Captain (for at-sea operations). For larger multi-ship-operating institutions, a Chief of Marine Technicians, schedulers, and finance administrators may also be involved in facility management.
- Reviews: Based on projected science requirements identified in recent reports and workshops, a fleet of vessels supporting ocean science research will be needed far into the future. Recent documents supporting this need include the *National Ocean Policy* and the *Final Recommendations of the Interagency Ocean Policy Task Force* of July 19, 2010. Two applicable reports by the National Research Council (NRC) include *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet* published in 2009, and *Critical Infrastructure for Ocean Research and Societal Needs in 2030* published in 2011. In coordination with UNOLS and the other federal agencies which invest in ocean research, the Interagency Working Group on Facilities (IWG-F), which has been renamed as the Interagency Working Group on Facilities and Infrastructure (IWG-FI) under the National Ocean Policy, published a *Federal Oceanographic Fleet Status Report* in December 2007 reviewing the status and describing plans for modernizing the federal and academic oceanographic research and survey fleet. Ship operations and technical services activities are reviewed internally on the basis of detailed annual reports provided by the operating institutions. Ship operations proposals are exempt from external review by peers, and budgets are negotiated yearly since they are dependent on the number of days the ships will be at sea in support of NSF-funded research programs. Technical services awards are reviewed every three years and negotiated annually.

Fleet Modernization

- Oversight: The NSF coordinator for fleet modernization activities is the Program Director for Ship Acquisitions and Upgrades, within the Integrative Programs Section (IPS) in OCE, with additional IPS staff providing project management assistance as required.
- Regional Class Research Vessel (RCRV): NSF is continuing analysis, planning, and development activities for potential new Regional Class Research Vessels. NSF has held several discussions with the NOAA Office of Marine and Aviation Operations to explore the potential for collaboration between the two agencies on the design of the RCRV and the modernization efforts being considered for the NOAA mid-size vessels. In addition, NSF is an active participant in the IWG-FI Ship Subcommittee, which is developing the first draft of an update to the 2007 Federal Oceanographic Fleet Status Report, an action in the draft National Ocean Policy Implementation Plan. The role of the RCRV in meeting the needs across the government agencies for research vessels in support of ocean science research is an integral aspect of the Fleet Status Report Update. Decisions on proceeding to further development stages will be based upon NSF, National Science Board, and interagency reviews.

Other Ongoing Activities

- Development and construction of a deep submergence capability to replace the submersible human occupied vehicle *(HOV) ALVIN* continues in FY 2012 and will complete in FY 2013. This project, begun in FY 2004, to design and build an all-new submersible, experienced significant cost over-runs in 2008 and was subsequently re-scoped and placed on a revised review path, which included a Preliminary Design Review (PDR) in December 2009, and a Final Design Review (FDR) in September 2010. The FDR Panel recommended the project continue and felt the budget was adequately defined. The Panel also recommended NSF partner with the Navy, specifically Naval Sea Systems Command (NAVSEA), to certify the operational capability and safety of *ALVIN*. NSF subsequently entered into an interagency agreement with NAVSEA to do so, and the Woods Hole Oceanographic Institution (WHOI) team is supporting this effort.

  The re-scoped *ALVIN* Upgrade Project would potentially be accomplished in two phases. Phase I is the integration of a new titanium 6,500-meter-capable personnel sphere with existing *ALVIN* vehicle components. Initial Phase I operations will provide a depth capability of 4,500 meters, the limit of the current *ALVIN* components to be retained during Phase I. A potential Phase II would provide upgrades to permit operations to a depth of 6,500 meters, but there has been no implicit or explicit commitment to proceed with Phase II at this time. The cost increase over previous estimates was due to delays in schedule, increases in labor costs and levels of effort, and a rise in titanium prices. Certification for operation of the Phase I vehicle is scheduled for fall 2012, with an anticipated return to normal science operations in early 2013.

Renewal/Recompetition/Termination:

Ships supported by NSF are operated by academic institutions, each having a cooperative agreement with NSF. All ship cooperative agreements will be renewed in 2012 using the NSB-approved criteria and review by an external panel. Awardees are subject to additional oversight measures, including Business System reviews conducted by NSF. In FY 2012, NSF announced the retirement of the *R/V Oceanus*. Subsequent review revealed that the Oceanus was better suited to anticipated needs on the West Coast than a similar vessel, the *R/V Wecoma*. Thus, to better and more cost effectively serve the needs of the ocean research community, the *R/V Oceanus* is being transferred to the West Coast and will be operated by Oregon State University and the *R/V Wecoma* will be removed from service.

## Alaska Region Research Vessel (R/V *SIKULIAQ*)

The Research Vessel *SIKULIAQ* (formerly known as the Alaska Region Research Vessel) represents NSF's first major contribution to fleet renewal in over twenty years. Construction of the *SIKULIAQ* was funded completely through the MREFC account, partially with American Reinvestment and Recovery Act (ARRA) funds. Shipyard construction began in early CY 2011, and science operations are anticipated to begin in early CY 2014 at which time operational funding will be supported by OCE.

### Baseline History

NSF first requested construction funding for the *SIKULIAQ* through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year, followed by an additional appropriation of $42.0 million in FY 2008. $148.07 million was provided through the American Recovery and Reinvestment Act of 2009. In early 2010, the vessel was officially named the R/V *SIKULIAQ*, which means "First year ice able to be walked on" in a native Inuit dialect.

The project is led by the University of Alaska, Fairbanks (UAF) with engineering support from design through construction provided by UAF's naval architect, The Glosten Associates, Inc. The final project baseline (against which the project is now being monitored) incorporates an up-dated technical scope to meet regulatory and science requirements, proper administrative support by UAF, a realistic construction schedule, and an independent, risk-adjusted cost/contingency estimate for construction. The baseline was finalized in late 2010 following selection of Marinette Marine Corporation as the shipyard for construction.

**Total Obligations for the ARRV**

(Dollars in Millions)

| | Prior Years[1] | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | | |
| Concept & Development | $2.24 | - | - | - | - | - | - | - | - |
| Management & Operations | - | - | - | - | 4.17 | 8.34 | 8.50 | 8.50 | 8.50 |
| Subtotal, R&RA Obligations | $2.24 | - | - | - | $4.17 | $8.34 | $8.50 | $8.50 | $8.50 |
| *MREFC Obligations:* | | | | | | | | | |
| Implementation | 51.42 | - | - | - | - | - | - | - | - |
| ARRA | 148.07 | - | - | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $199.49 | - | - | - | - | - | - | - | - |
| **TOTAL Obligations** | **$201.73** | **-** | **-** | **-** | **$4.17** | **$8.34** | **$8.50** | **$8.50** | **$8.50** |

Totals may not add due to rounding.

[1] Concept & Development funding and Implementation funding are cumulative of all prior years; Management & Operations funding reflects the FY 2010 Actual only.

Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of nine percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research, to natural hazards and cultural anthropology. The *SIKULIAQ* will provide a sophisticated and significantly larger platform for scientists as well as graduate and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. The *SIKULIAQ* is expected to greatly expand research capabilities in the Arctic with up to 270-300 science days at sea annually. An ice-strengthened hull will allow the vessel to operate in seasonal ice up to one meter thick and an anti-roll tank will permit it to operate effectively in the open waters of the Bering Sea, Gulf of Alaska and North Atlantic as well.

Due to its size and projected operating area, the *SIKULIAQ* will operate as a Global Class vessel within the U.S. academic research vessel fleet.

The increased capabilities of the *SIKULIAQ* are expected to dramatically increase the number of proposals addressed to NSF for Arctic science. UAF conducted an initial science planning workshop in May 2011, with a second planned for February 2012, to alert the US science community to the vessel's capabilities and availability to support science beginning in 2014. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in research would be supported annually.

**Management and Oversight**

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within the Integrative Programs Section (IPS) of the Division of Ocean Sciences (OCE), Directorate for Geosciences (GEO). Periodic oversight is provided by a Project Advisory Team (PAT), which includes staff from GEO and OPP, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and the Office of Legislative Public Affairs (OLPA). Additional staff from IPS, LFO, and DACS, as well as external consultants, help provide the Program Officer with routine project management and technical assistance. To ensure effective management and oversight, monthly and annual reports provided by the UAF project office are closely monitored by the SIKULIAQ Program Officer for deviations from the established baseline using Earned Value Management. NSF conducted a Business Systems Review (BSR) and issued a final report in July 2011.
- External Structure: UAF maintains project management offices in both Fairbanks and Seward, AK. UAF management also includes an experienced on-site team in Marinette, Wisconsin that will remain at the shipyard until delivery. The *SIKULIAQ* Oversight Committee (SOC), which includes community experts in research vessel design, construction, and operations, convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.
- Reviews: With construction now well underway, NSF will conduct annual project reviews as follows:
  - July 2012: Construction and Trials Review
  - July 2013: Trials and Operational Readiness Review

**Current Project Status**

Construction began in January 2011 after Design Verification and Transfer (DVT) uncovered a weight issue that had to be corrected by adding six additional feet to the hull and changing the superstructure to aluminum. Launch is now scheduled for October 2012, with final delivery to UAF in July 2013. There appears to be adequate schedule float in Phase IV (Transition to Operations) to complete science trials and still begin science operations in early 2014 as originally planned. With the contract modifications for the weight mitigation changes now in place, a significant level of project risk has been retired. Panel reviews in July and November 2011 indicate a high level of confidence that the project will now be completed within budget and on schedule.

**Cost and Schedule**

The total project cost approved by NSF and NSB following FDR is $199.50 million. The majority of this total, $138.0 million, or 70 percent, is the fixed price contract with the shipyard which includes the changes associated with vessel weight. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $34.70 million (17 percent). Final outfitting, science trials, and delivery

are $11.20 million (6 percent). Uncommitted project contingency for the shipyard contract is approximately $14.50 million (7 percent).

Delivery of the *SIKULIAQ* to UAF is scheduled for July 2013. This will be followed by a period of science, final outfitting, and transit to the first science operational area. Science operations are projected to begin in early 2014 with transition to the OCE Ship Operation Program for funding support. With the delay in delivery, ice trials and a warranty shipyard will now be conducted in 2014 using MREFC funds; both of which were within the original project scope.

**Risks**

The project risk register is formally up-dated monthly by UAF and reviewed by NSF on a routine basis. Risks at this stage of the project now include:

- Technical Risk: Any component of the vessel not meeting technical requirements of the specifications resulting in loss of capability or increased costs to correct after installation or delivery. With DVT complete and all weight mitigation changes fully incorporated into the shipyard contract, this risk is now considered low.
- Change Risk: Shipyard cost claim potential associated with design development due to changing regulatory body requirements, Buy American and owner-initiated design changes during design and/or construction (Change Orders). This risk is now considered moderate.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation, shipyard liquidated damages, and UAF standing army costs. This risk is now considered low.

Mitigation strategies have been employed by UAF, and the risk analyses reviewed by the panel in both July 2011 and November 2011 indicate that sufficient contingency is currently in place to handle these remaining project risks. The panel also was satisfied that proper change and contingency management control processes are in place to facilitate the project coming on time and within budget.

**Future Operations Costs**

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within OCE/IPS. Daily rate estimates for both the ship and technical services will be updated in 2012. It is anticipated that OCE will utilize at least 65 percent of the annual vessel availability based on historical data from other global ships within the academic research vessel fleet. Up to 35 percent of the *SIKULIAQ's* schedule is expected to be available to the Office of Polar Programs (OPP) and other federal agencies. In short, the *SIKULIAQ* will fold into an already well-established framework for operating the academic research vessel fleet.

## Arecibo Observatory

**$8,200,000**
**-$500,000 / -5.7%**

**Arecibo Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $9.26 | $8.70 | $8.20 | -$0.50 | -5.7% |

Totals may not add due to rounding.

The Arecibo Observatory (Arecibo), formerly the National Astronomy and Ionosphere Center, is a center for multidisciplinary research and education enabled by world-class observational facilities. The observatory's principal observing facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector located near the town of Arecibo in western Puerto Rico on 120 acres of U.S. Government-owned land. Arecibo Observatory is currently operated and managed by SRI International and subawardees USRA and Universidad Metropolitana under a cooperative agreement with NSF that began October 1, 2011. It serves over 300 users annually with a wide range of research and observing instrumentation in passive radio astronomy, solar system radar astronomy, and space and atmospheric sciences.

Including the Angel Ramos Foundation Visitor Center, Arecibo has a staff of about 120 full-time-equivalent positions, of which approximately 90 are supported by NSF funds. A permanent staff of 17 scientists and 34 engineers, technicians, and operators is available to help visiting investigators with observing programs. The remainder includes 26 management, administrative, and clerical positions, 37 maintenance staff, and several postdoctoral scholars and students.

**Total Obligations for the Arecibo Observatory**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $9.26 | $8.70 | $8.20 | $8.00 | $8.00 | $8.20 | $8.20 | $8.20 |
| *Astronomical Sciences (MPS)* | *6.19* | *5.50* | *5.00* | *4.50* | *4.00* | *4.10* | *4.10* | *4.10* |
| *Atmospheric & Geospace Sciences (GEO)* | *3.07* | *3.20* | *3.20* | *3.50* | *4.00* | *4.10* | *4.10* | *4.10* |
| **Total, Arecibo** | **$9.26** | **$8.70** | **$8.20** | **$8.00** | **$8.00** | **$8.20** | **$8.20** | **$8.20** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Arecibo is jointly supported by the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS) and the Division of Atmospheric and Geospace Sciences (AGS) in the Directorate for Geosciences (GEO). In 2006 the AST Senior Review recommended a reduction in AST support for Arecibo to $8.0 million (FY 2006 dollars) by 2010. In response, the managing organization, then Cornell University, reduced the Arecibo staff by 30 FTEs, modified the operating mode for astronomy observations, and limited the observing time for astronomy and planetary radar projects.

AST support for Arecibo in FY 2008–2010 reflected a planned ramp down in response to the 2006 Senior Review recommendations. The Review also recommended that sufficient external financial or personnel contributions be found to operate Arecibo with competitive scientific productivity after 2011 with an AST

contribution not to exceed half of the expected operational costs, estimated in FY 2006 at $8.0 million. AST support for FY 2011–2017 is based upon the Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of Arecibo's non-scientific costs.

As AST has ramped down support for Arecibo, AGS has significantly increased support and, in FY 2011 and beyond, will contribute substantively to general facility operations. In the past, AGS funding has primarily supported a research staff in the space and atmospheric sciences program and contributed only incrementally for basic operations costs. Outyear estimates for planned AGS support of Arecibo ramp up to parity with AST support.

Partnerships and Other Funding Sources: Arecibo leverages NSF support with funding from other federal and non-federal sources. Since FY 2010, the NASA Near Earth Object Observation Program has committed $2.0 million to Arecibo in support of the planetary radar program. NASA support is expected to continue at this level, subject to availability of appropriated funds. In association with the new cooperative agreement for Arecibo management and operation, NSF will negotiate a memorandum of understanding with NASA in early spring 2012 to establish appropriate oversight procedures for multi-agency support of Arecibo. In FY 2010, observatory management finalized an assistance agreement with the Puerto Rico Infrastructure Financing Authority to receive $3.0 million for major infrastructure improvements at Arecibo Observatory. In FY 2009, the observatory contracted with the Puerto Rico Department of Education for up to $2.35 million to provide student enhancement and teacher professional development programs at Arecibo through the site's Angel Ramos Foundation Visitor Center and Learning Center. Recent sources of external funding have also included $942,000 from the Defense University Research Instrumentation program at the Air Force Office of Scientific Research (AFOSR/DURIP) and the Office of Naval Research (ONR), and approximately $500,000 from other non-federal and private sources.

An aerial image of the Arecibo Radio Telescope in Puerto Rico. The platform suspension structure, including the Gregorian dome that houses the main suite of research instruments, is visible over the 305-meter primary reflector dish below. *Credit: Arecibo Observatory/NSF.*

A peer-review telescope allocation committee provides merit-based telescope time to users. NSF does not provide awards targeted specifically for use of Arecibo Observatory, although many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facility.

Education and Public Outreach (EPO): A primary education goal for Arecibo is to support and enhance the experiences of student researchers. Arecibo hosts a Research Experiences for Undergraduates (REU) site, and Ph.D. students receive training through use of the facility. In collaboration with the National Radio Astronomy Observatory (NRAO), Arecibo holds a summer school on single-dish radio astronomy techniques. Arecibo also sponsors a major outreach program in Puerto Rico via the modern Angel Ramos Foundation Visitor Center and Learning Center, as well as summer workshops for K-12 teachers. This center attracts roughly 100,000 visitors each year; over 1.3 million people have visited since its opening in 1997. With funds from the Puerto Rico Department of Education, Arecibo recently hosted 25,000 K–12 school children through the *Inspiration for Science* program that provided transportation to the Observatory and science enrichment activities at no cost to participants.

Operations and Maintenance, $8.20 million: Arecibo administers observing time to the astronomy and aeronomy communities via competitive observing proposals and conducts educational and public outreach programs at all levels. Observing hours among science programs are based on the quality of observing proposals; the current average oversubscription rate of the telescope is approximately 3.5. This metric accounts for the number of current astronomical surveys requesting time for a given area of sky, plus the time request in the program year for small radio astronomy projects, solar system observations, and atmospheric sciences programs. About 80 percent of astronomy users conduct their observing remotely via networked control software, while radar observations typically employ on-site users.

- Division of Astronomical Sciences, $5.0 million: AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Funding for the Astronomy program continues to decrease in FY 2013, in response to recommendations of the AST Senior Review. Operational scope changes are anticipated in response to decreased AST funding, as part of the next five-year award for Arecibo management and operations. Beginning in program year 2011, substantial support for planetary radar astronomy will be supplied by NASA (see below).

  Radio astronomers use the Arecibo facility to study diverse areas such as interstellar gas, galactic structure formation and evolution, pulsars and fundamental physics; topics in solar system astronomy include the physical properties of asteroids, planetary surfaces and moons, and the post-discovery characterization and orbital refinement of near-Earth asteroids. Approximately 50 to 60 percent of the astronomy observing time is dedicated to ongoing survey programs, most of which use the Arecibo L-band Feed Array (ALFA) receiver that was commissioned in 2005–2006. The installation and commissioning of wide-band spectrometers in FY 2008 allow up to three survey programs to be conducted simultaneously on each sky pointing.
- Division of Atmospheric and Geospace Sciences, $3.20 million: AGS supports a research staff in the space and atmospheric sciences program and has historically contributed only incrementally for basic operations costs. As stated above, in FY 2011 and beyond, AGS funding will contribute substantively to general operations. The incoherent scatter radar at Arecibo is part of an NSF-supported network of radars strategically distributed to observe the transport of radiative energy and charged particles, from their origins at the sun to their deposition in Earth's upper atmosphere. The unique sensitivity of the Arecibo incoherent scatter radar system allows it to measure the density, temperature, and motion of plasma in Earth's ionosphere with unrivaled time and spatial resolution. Arecibo is also the only aeronomy observatory located at tropical mid-latitudes, where many important ionospheric processes take place. An ionospheric high-frequency heating facility is currently under construction at Arecibo with completion anticipated in FY 2012.

**Facility Report**

Management and Oversight

- NSF Structure: Ongoing oversight is provided by an assigned NSF program director in AST, in close cooperation with AGS and in consultation with community representatives. The program director makes use of detailed annual program plans, long range plans, quarterly technical and financial reports, and annual reports submitted to NSF by SRI, as well as attending SRI governance committee meetings as appropriate. To address issues as they arise, AST program managers work closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office. The NSF program director and AGS program manager conduct periodic site visits and frequent teleconferences.
- External Structure: Management is via a cooperative agreement with SRI and its subawardees, USRA and Universidad Metropolitana. The awardees provide management and oversight through their own advisory and visiting committees. The Arecibo Director, resident at the telescope site, is the Principal Investigator of the operations award for the facility. Three deputy directors in the areas

of Atmospheric Sciences, Planetary Radar, and Puerto Rican EPO report to the Arecibo Director. A new a new five-year cooperative agreement is beginning in FY 2012.

- Reviews: Management reviews by external panels are held midway into each 5-year cooperative agreement. The last management review was held in March 2007; a follow up assessment of Cornell's response to the AST Senior Review recommendations was completed in March 2008. AST and AGS jointly conduct annual external reviews of Arecibo program plans; the most recent review was held in December 2010. Future annual reviews will continue after review and recommendation of proposals received in response to the competition for Arecibo management and operations (see below). A Business Systems Review (BSR) is planned for 2013.

Renewal/Competition/Termination

The current cooperative agreement with SRI for the management of Arecibo was awarded on schedule on October 1, 2011, replacing Cornell in a competitive process for a new five-year cooperative agreement, consistent with National Science Board policy. This agreement is in effect through September 30, 2016.

NSF decertified Arecibo as a Federally Funded Research and Development Center (FFRDC) upon award of the new cooperative agreement for its management and operation. This decision was made after careful consideration of the advantages and disadvantages such a designation carries. Without restrictions imposed by the FFRDC designation, the Arecibo managing organization will have greater freedom to establish partnerships beyond those permitted by government regulations applicable to FFRDCs.

## Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring

**$20,000,000**
**+$330,000 / 1.7%**

**Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring**

(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $14.12 | $19.67 | $20.00 | $0.33 | 1.7% |

Totals may not add due to rounding.

The Cornell High Energy Synchrotron Source (CHESS) is a first generation, high-intensity, high-energy X-ray facility supported by NSF with partial interagency support from the National Institutes of Health (NIH). It uses synchrotron light given off by charged particles, both electrons and positrons, as they circulate at nearly the speed of light around the Cornell Electron Storage Ring (CESR). CHESS provides capabilities for X-ray research in physics, chemistry, biology, materials, and environmental sciences. Areas of emphasis include soft matter and thin film studies, solution scattering, nanomaterials, high-pressure science, structural biology, time-resolved studies of materials, and X-ray studies of items of art and archaeology. Stewardship and oversight of CHESS is provided through the NSF Division of Materials Research (DMR) within the Directorate for Mathematical and Physical Sciences (MPS), though the majority of CHESS users come from disciplines outside of materials science..

The FY 2013 Request supports operations of CHESS/CESR as a user facility and is consistent with funding levels in previous years. Funding will allow continued operation of the facilities in support of synchrotron light users.

**Total Obligations for CHESS/CESR**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $14.12 | $19.67 | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 |

[1]Years beyond FY 2013 are shown for planning purposes only. The current cooperative agreement ends in March 2014.

The CHESS user program supports work in cancer research, new materials for electronics, aircraft and biotechnology, batteries, fuel cells, solar cells and other energy applications. X-ray detectors developed at CHESS are now in use at 3rd and 4th Generation X-ray sources around the world, including the world's first hard X-ray laser, the Department of Energy (DOE) Linac Coherent Light Source.

CHESS/CESR staff assists in transferring Superconducting Radio Frequency technology to industry. Several CHESS/CESR users are from industry, including pharmaceutical corporations (such as Rib-x Pharmaceuticals) and the research arms of Xerox, and General Motors. Some medical institutions also make use of CHESS/CESR (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute). CHESS/CESR also has collaborations with DOE-supported synchrotron facilities such as the Advanced Photon Source and National Synchrotron Light Source.

CHESS/CESR supports and enhances Ph.D. level graduate education, postdoctoral research, and research experiences for undergraduates and for K-12 science teachers. Each year there are about 25 Ph.D.

degrees granted as a result of CHESS research. More than 60 undergraduates participate in research at the facility during the academic year; about 16 undergraduates and 10 pre-college teachers participate during the summer. In this educational role, CHESS plays a key role as a training ground for X-ray science and accelerator physics with CHESS students and postdoctorates going to staff other X-ray facilities in the U.S. and around the world.

**Facility Report**

Management and Oversight

- NSF Structure: CHESS is supported by DMR and by the National Institutes of Health (NIH). CHESS also hosts MacCHESS, a NIH-funded macromolecular crystallography program at Cornell. NSF and NIH provide oversight of CHESS through regular site visits by external reviewers.
- External structure: Both CESR and CHESS are administered by the Cornell Laboratory of Accelerator-based Sciences and Education (CLASSE), which reports to Cornell's Vice-Provost for Research. CHESS/CESR is operated by Cornell University in accordance with a cooperative agreement with NSF that set goals and objectives for the facility.
- CHESS is a national user facility accessed on the basis of competitive proposal review. The primary function of the CHESS staff is to maintain and operate the facility and to assist users. A policy and advisory board, appointed by the Cornell Vice President for Research, provides advice to the director of CHESS on policies related to the use and development of CHESS facilities and equipment for user experiments. A users committee appointed by the users of CHESS advises the director on matters of facilities operations and priorities for the users. An annual users meeting and several workshops help disseminate results from the facility.
- Reviews:
  - Annual site visit review of CHESS operations, November 2011.
  - Business Systems Review (BSR), final report issued in September 2011.
  - Next operations review, planned for fall 2012.

Renewal/Recompetition/Termination

In FY 2009, NSF completed the review of a proposal for the continued operation of CHESS/CESR in support of X-ray photon science. In December 2009, the National Science Board authorized NSF to make a four-year award. The cooperative agreement between NSF and Cornell University funds operations until March 2014. Future support will be determined through interagency discussions on the stewardship of CHESS as a national multidisciplinary user facility.

## EarthScope

**$26,170,000**
**+$1,120,000 / 4.5%**

**EarthScope**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $26.02 | $25.05 | $26.17 | $1.12 | 4.5% |

The EarthScope facility is a distributed, multi-purpose geophysical instrument array that is helping researchers make major advances in our knowledge and understanding of the structure and dynamics of the North American continent. EarthScope instrumentation is expected to be located in nearly every county within the U.S. over the 15-year life span of the program. Construction of EarthScope was completed September 30, 2008. FY 2009 was the first year of operation of the full EarthScope facility.

**Total Obligations for EarthScope**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| *EarthScope* | $26.02 | $25.05 | $26.17 | $42.51 | $43.28 | $44.05 | $44.85 | $45.65 |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. FY 2013 is the final year of the current cooperative agreement; funding beyond FY 2013 assumes continued operation of the EarthScope infrastructure by IRIS and UNAVCO under new awards which integrate the previous activities of these organizations.

EarthScope seeks to enhance our understanding of the structure and evolution of the North American continent, including earthquakes and seismic hazards, magmatic systems and volcanic hazards, lithospheric dynamics, regional tectonics, continental structure and evolution, fluids in the crust, and associated educational aspects. Science and non-science students will be engaged in geosciences discovery through the use of technology in real-time or retrospectively with the aim of integrating research and education.

The U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the International Continental Scientific Drilling Program are partners with NSF in EarthScope. Project partners also include state and local governments, geological and engineering firms, and Canadian and Mexican agencies. Over 3,000 Earth scientists and students are expected to use the facility annually. Geotechnical and engineering firms directly use data and models that are enabled by EarthScope. Instrumentation firms are collaborating on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision GPS antenna designs.

The USArray component of EarthScope is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales. USArray consists of four major components: (1) a Reference Network of permanent seismic stations, (2) a Transportable Array of ~400 seismic stations, (3) a Flexible Array pool of seismic instruments for use in experiments proposed by individual scientists, and (4) a Magnetotelluric Array with permanent and transportable instruments. The Plate Boundary Observatory (PBO) component of EarthScope is a geodetic observatory designed to study the three-dimensional strain field resulting

from deformation across the active boundary zone between the Pacific and North American plates in the western United States. PBO includes 1,200 geodetic and 79 strain meter/seismic stations. The San Andreas Fault Observatory at Depth (SAFOD) is a 3-kilometer deep hole drilled directly into the San Andreas Fault midway between San Francisco and Los Angeles, near Parkfield, CA. Located in an area that has ruptured six times since 1857, the hole is providing the first opportunity to observe directly the conditions under which earthquakes occur and to collect rocks and fluids from the fault zone for laboratory study.

Along with direct operations and maintenance support for EarthScope, NSF will support research performed utilizing the facility through ongoing research and education programs. The annual support for such activities is approximately $6.42 million. Increased support for EarthScope will enable the capital acquisition, long-term siting and operation of up to 250 EarthScope Transportable Array (TA) stations to be left in the central and eastern United States after the TA's proposed move to Alaska beginning in 2014.

Beginning in FY 2014, the separate seismic and geodetic facilities operated by the Incorporated Research Institutions for Seismology (IRIS), UNAVCO and EarthScope will be integrated into two facilities: (1) Seismological Facilities for the Advancement of Geosciences and EarthScope (SAGE) operated by IRIS and, (2) Geodesy for the Advancement of Geoscience and EarthScope (GAGE) operated by UNAVCO. SAGE will integrate IRIS core programs with the management and operation of EarthScope's Transportable, Flexible and Magnetotelluric arrays. GAGE will integrate UNAVCO's core activities with the management and operation of EarthScope's Plate Boundary Observatory.

**Facility Report**

Management and Oversight

- NSF Structure: The EarthScope Program Director, located in the Division of Earth Sciences (EAR) in the Directorate for Geosciences (GEO), provides NSF oversight. The Deep Earth Processes section head and division director in EAR provide other internal oversight.
- External Structure: The external management structure includes the community-based EarthScope National Office, which recently moved from Oregon State University to Arizona State University; an independent steering committee consisting of scientists from the EarthScope community, including two subcommittees, one devoted to education and outreach and one devoted to cyberinfrastructure; and external management oversight committees for each of the EarthScope facility components.
- Reviews: Each year, NSF convenes a panel of external experts to review project management, cost, schedule, and technical status of the EarthScope facilities and to provide advice for the EarthScope managers and NSF. NSF conducted a Business Systems Review (BSR) and issued a final report in July 2010.

Current Project Status

The EarthScope seismic and geodetic instruments consistently exceed 90 percent uptime, and have provided over 92 terabytes of data to the scientific community. EarthScope's open access data policy is having an impact on how experiments are planned and carried out, and is resulting in more scientists making data available to the community in real-time. As just one example, following the March 2010 magnitude 8.8 Chile earthquake, scientists from the United States, Chile, France, Germany, and elsewhere worked together to record critical data using EarthScope and other equipment, and in an unprecedented international partnership, all agreed to share all data collected through the IRIS Data Management Center, which hosts EarthScope data.

Although it became fully operational only during FY 2009, EarthScope has already led to a number of important scientific advances. EarthScope is aiding in the development of predictive models for

earthquakes by unraveling the dynamic processes along faults, from stress build-up to catastrophic rock failure. Analysis of the unique SAFOD core from the San Andreas Fault is well underway, with more than 550 samples being analyzed by more than 20 research groups worldwide; in just the past two years, more than two dozen research papers using SAFOD samples have been published. The planned long-term SAFOD observatory has not been as successful, but an independent engineering panel convened through the Advisory Committee for Geosciences has reviewed the observatory and recommended possible paths forward, which have been incorporated along with community input into a new plan announced to the community in November 2011 through an NSF Dear Colleague Letter.

The combined use of PBO geodetic and strain data, and USArray seismic data, has documented a wide range of seismic and aseismic signals associated with different modes of fault slip along the Cascadia subduction zone and San Andreas Fault and provided unique new insight into spatial and temporal relationships between earthquakes (large and small), tremor, and slow slip. These exciting new results may have important implications for assessing seismic risk along a plate boundary that is capable of a magnitude 9+ earthquake similar to the disastrous Tohoku, Japan, earthquake and tsunami of March 2011. PBO's regional-scale geodetic network has also provided surprising new information on the Pacific-North American plate boundary, showing for example that extension in the Basin and Range province is not uniform as was once widely believed, but instead focused near its western and eastern edges. Seismic data from the EarthScope Transportable Array, coupled with individual research projects using the Flexible Array, have provided images of the structure of the North American continent with unprecedented detail and scope.

New advances are also being made in joint modeling of EarthScope seismic and strain data with other data types such as those used in geochemistry and structural geology. EarthScope data have been used to develop a revolutionary new tomographic technique for imaging crust and upper mantle structure in western North America that utilizes seismic signals previously considered to be noise. Finally, EarthScope data are being used for unexpected discoveries with potentially transformative impact. Among these are use of EarthScope GPS measurements to understand the distribution of soil moisture and snow depth, key inputs to climate models across the western U.S., and vegetation greenness, a measure of the health of the environment and response to drought. Another example is the incorporation of atmospheric pressure sensors at the USArray Transportable Array stations, which is providing improved understanding of atmospheric structure and enhanced coverage of severe storms, along with better recordings of the seismic data that are the main focus of USArray. These new results have been incorporated in an updated EarthScope solicitation that was released in March 2011.

EarthScope has engaged a broad and steadily growing community of scientists. More than 150 unique investigators have received NSF funding through the EarthScope science program. Over 300 scientists came together for the May 2011 EarthScope National Meeting in Austin, TX, and during the 2011 American Geophysical Union (AGU) meeting, there were 75 presentations related to EarthScope in 46 special sessions spanning 11 different areas of AGU. Scientific results utilizing data collected by the EarthScope facility have already been presented at numerous national meetings and in professional publications.

Operations costs

Annual operations costs for EarthScope are anticipated to remain approximately steady, with annual adjustments for inflation.

Renewals/Recompetition/Terminations

In FY 2013, NSF will begin the phased integration of IRIS and UNAVCO core facilities with the EarthScope facilities operated by these organizations under two awards, one to IRIS and one to UNAVCO. In 2017 and 2018, NSF will recompete the operation of the two integrated facilities.

## Gemini Observatory

**$18,150,000**
**-$3,920,000 / -17.8%**

**Gemini Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $19.50 | $22.07 | $18.15 | -$3.92 | -17.8% |

Totals may not add due to rounding.

The Gemini Observatory consists of two infrared-optimized 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope, Gemini North, is situated on Mauna Kea at an altitude of 4,200 meters, while the Chilean telescope, Gemini South, is located at the outstanding photometric site of Cerro Pachon, at an altitude of 2,700 meters. This siting of the two telescopes assures complete coverage of the sky and complements the observations from space-based observatories. The Gemini telescopes provide access to the center of our own Galaxy as well as the Magellanic Clouds, our nearest galactic neighbors. Both telescopes are designed to produce superb image quality and both use sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere.

**Total Obligations for the Gemini Observatory**
(Dollars in Millions)

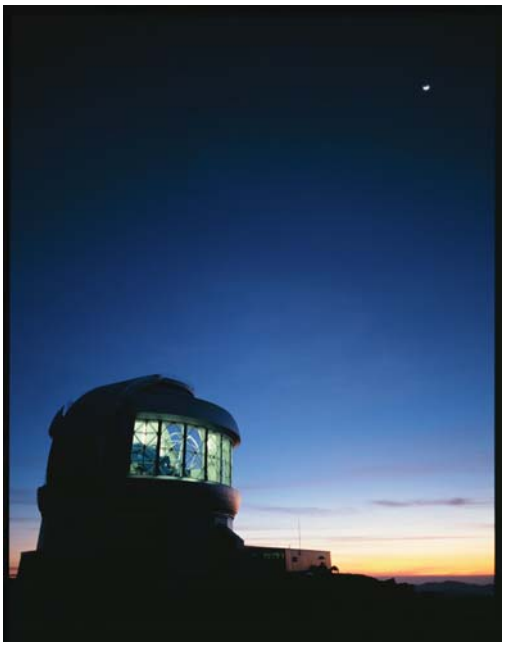
| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $19.50 | $22.07 | $18.15 | $21.09 | $21.61 | $21.61 | $21.61 | $21.61 |

[1] Outyear funding estimates are for planning purposes only.

Astronomers are working to resolve important questions about the age and rate of expansion of the universe, its overall topology, the amount and nature of non-luminous matter, the epoch of galaxy formation, the evolution of galaxies (including our own) once they are formed, and the formation of stars and planetary systems. The current generation of optical/infrared telescopes with large aperture (8-meter diameter and above) provides unsurpassed sensitivity and spectral and spatial resolution. Technological advances in a number of key areas of telescope construction and design optimize the telescopes' imaging capabilities and infrared performance, as well as the ability to rapidly reconfigure the attached instrumentation in response to changing atmospheric conditions.

The Gemini telescopes help educate and train U.S. astronomy and engineering students. An estimated 10 percent of the roughly 500 U.S. users per year are students. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including "sister city" arrangements between Hilo, Hawaii and La Serena, Chile, involving students and teachers at high school and elementary school levels. Gemini staff members also provide guidance and support to the Imiloa Science Center, a public astronomy and cultural center in Hilo.

Gemini is an international partnership with the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil. Construction of the telescopes and their instrumentation has involved a large number of industrial entities in several partner and non-partner countries. These industrial entities have involved firms specializing in large and/or complex optical systems, aerospace, electronics, and engineering, etc. Continued involvement of such industries is part of the instrumentation and facilities renewal activities included in the operating budget of the Gemini Observatory.



The Gemini South telescope on Cerro Pachon in Chile prepares for the beginning of observation. The telescope is visible through the three-story-high vents on the rotating dome, which allow a strong air flow across the telescope to provide good image quality. *Credit: Gemini Observatory/Association of Universities for Research in Astronomy.*

Peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Gemini. Many U.S. users are supported through separate NSF or NASA grants to pursue scientific programs that require use of Gemini.

Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are available for both telescopes, with the laser on Gemini North in routine use. In 2011 first light on the sky was achieved and technical commissioning continued for an advanced "multi-conjugate" adaptive optics system, which will yield crisp images over a substantially larger field of view than previous laser systems. Several new instruments are in various states of development. A high-performance infrared spectrometer is now available for science observations; and the Gemini Planet Imager, an advanced camera for the southern telescope designed to directly detect planets around nearby stars, is undergoing subsystem acceptance testing.

The budget request for FY 2013 includes the full contribution to general operations committed in the Gemini international agreement, with a reduced contribution to the instrument development fund. This represents an offset for a contribution in FY 2012 that was above the international commitment. Budget projections for FY 2014 and beyond represent a level of effort adopted by the Gemini Board and NSF for planning purposes.

**Facility Report**

<u>Management and Oversight</u>

- NSF Structure: NSF has one seat on the Gemini Board and an additional NSF staff member serves as the executive secretary to the board. Programmatic management is the responsibility of an assigned NSF program manager for Gemini in the Division of Astronomical Sciences in the Directorate for Mathematical and Physical Sciences. The program manager approves funding actions, reports, and contracts, and conducts reviews on behalf of the Gemini partnership.
- External Structure: The Observatory is governed by the Gemini Board, established by the International Gemini Agreement signed by the participating agencies. NSF serves as the executive agency for the seven-nation partnership, carrying out the project on their behalf. Gemini is managed by Associated Universities for Research in Astronomy (AURA), Inc., on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees.

- Reviews: In addition to a review held mid-way through the cooperative agreement, NSF conducts periodic reviews of AURA management and Observatory programs as requested by the Gemini Board. The mid-term management review was held in Hilo on September 23-26, 2008. In addition, NSF conducted a Business System Review of the Observatory in March 2009.

Renewal/Recompetition/Termination

In late December 2009, the United Kingdom officially announced its intention to withdraw from the partnership post-2012. Following extensive discussions of the Gemini Board, the remaining partner countries decided to not increase their financial contributions nor to pursue a replacement partner, but rather to adjust the operations model of the Observatory to accommodate the approximately 24 percent reduction in operations budget. All partners with the exception of the U.K. then certified their commitment to this objective by renewing the International Agreement through the end of 2015.

The current NSF cooperative agreement to AURA for management of the Gemini Observatory originally covered calendar years 2006-2010 but was extended through June 30, 2012 to accommodate the partnership decisions described in the previous paragraph. A proposal from AURA to renew the cooperative agreement for the mid-2012-2015 timeframe was received in January 2011 and reviewed in March 2011. The review endorsed the Observatory's plan for the transition to the new operations model, which reduces the instrument complement available at each telescope, reduces the manpower requirements for the scheduling queue, reduces the development and outreach activities of the Observatory, and focuses the operation more on serving the partner user communities and less on internal scientific research activities. The funding recommendation for the renewal proposal was approved by the National Science Board in February 2012.

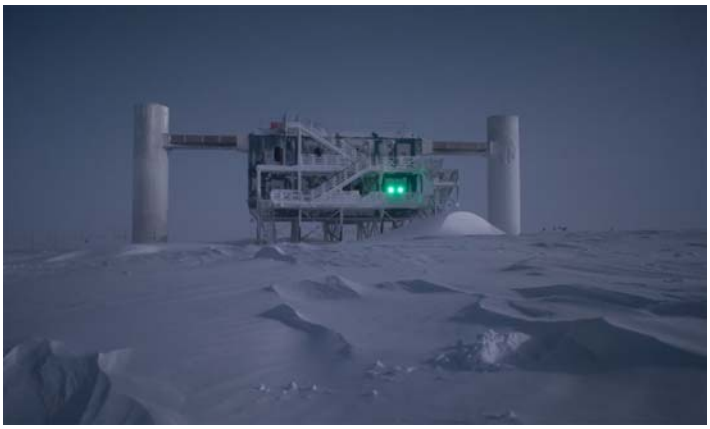
## IceCube Neutrino Observatory

**$6,900,000**
**+$0.00 / 0.0%**

**IceCube Neutrino Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $12.19 | $6.90 | $6.90 | - | - |

IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high-energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of Digital Optical Modules (DOMs), each containing a PM and associated electronics, is distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. The energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV ($10^{11}$ electron Volts [eV]) to 10 PeV ($10^{16}$ eV) are derived from the IceCube data stream.



The IceCube project has transformed one kilometer cubed of natural Antarctic ice into a particle detector. The sensors keep watch for momentary flashes of blue light made by subatomic particles called muons; some are produced in collisions of neutrinos with atomic nuclei inside or near the detector. With the last hole instrumented on December 14, 2010, the IceCube detector has been taking data in its final configuration since May 16, 2011 with an up-time of well over 99 percent. IceCube detects one neutrino every 6 minutes in a background of 2700 cosmic ray muons per second. To handle the high rates, first analysis of the data is performed by a cluster of computers housed in a two-story building placed on top of the array. The filtered data is sent over satellite to the IceCube Research Center at the University of Wisconsin. *Credit: IceCube Collaboration.*

The Observatory includes a Deep Core Array (DCA), situated within the lower part of the center of the overall array. The DCA is composed of eight strings with the DOMs concentrated in the lower-middle part of the array. The tighter spacing of the DOMs allows the Observatory to detect lower energy neutrinos (down to about 10 GeV), thus opening the door to studies of neutrino oscillation measurements and studies of Weakly Interacting Massive Particles (WIMPs) below 250 GeV. In essence, the DCA closes the energy gap between the IceCube Neutrino Observatory and the Super-Kamiokande detector in Japan, and also allows effective observations of high-energy neutrinos entering from the sky of the southern hemisphere.

**Total Obligations for IceCube**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| *R&RA Obligations:* | | | | | | | | |
| Operations & Maintenance (MPS) | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 | $3.45 |
| Operations & Maintenance (OPP) | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 | 3.45 |
| Subtotal, R&RA Obligations | $6.90 | $6.90 | $6.90 | $6.90 | $6.90 | $6.90 | $6.90 | $6.90 |
| *MREFC Obligations:* | | | | | | | | |
| Implementation | 5.29 | - | - | - | - | - | - | - |
| Subtotal, MREFC Obligations | $5.29 | - | - | - | - | - | - | - |
| **TOTAL Obligations** | **$12.19** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** | **$6.90** |

Totals may not add due to rounding.
[1] Outyear funding estimates are for planning purposes only. FY 2015 is the final year of the current cooperative agreement. Funding beyond FY 2015 assumes continued operation of the facility.

IceCube is led by the University of Wisconsin (UW) and was constructed with support from four countries (U.S., Belgium, Germany, and Sweden). The science collaboration is much broader, consisting of 16 U.S. institutions and 23 institutions in 10 other countries (Germany, Belgium, Sweden, New Zealand, Australia, Canada, Barbados, Japan, Switzerland, and the UK). NSF's foreign partners contribute a pro rata share of operations and maintenance costs based on the number of PhD-level researchers involved. IceCube construction was successfully completed at the South Pole on December 18, 2010, New Zealand Time.

## Facility Report

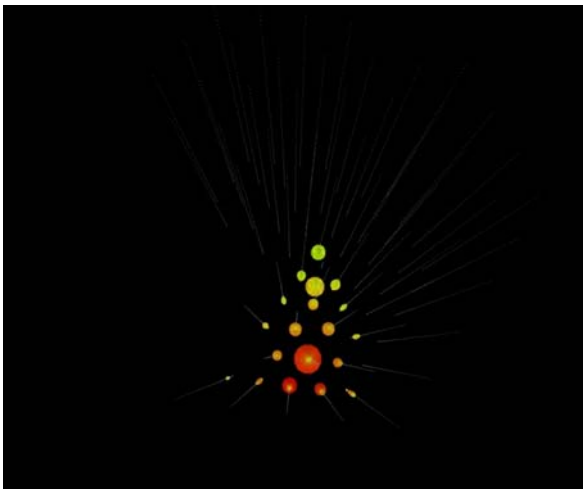
Management and Oversight

- NSF Structure: Oversight responsibility for IceCube is the responsibility of the Office of Polar Programs (OPP). Support for operations and maintenance, research, and education and outreach is shared by OPP and the Directorate for Mathematical and Physical Sciences (MPS), as well as other organizations and international partners. NSF provides oversight of IceCube through regular site visits by external reviewers.
- External Structure: The UW management structure for IceCube includes leadership by a project director and a project manager. At lower levels, project management includes international participation, as well as participation by staff at collaborating U.S. institutions. This framework was put in place during the start-up phase of IceCube and provided a sound basis for initiation of full construction with FY 2004 funding as soon as the project was baselined. UW has in place an external Scientific Advisory Committee and a Software and Computing Advisory Panel that meet annually and provide written advice to the project. UW leadership, including the Chancellor, provides additional awardee-level oversight.
- Reviews: NSF will conduct a review mid-way through the cooperative agreement in approximately October 2013. NSF conducted a Business Systems Review (BSR) and issued a final report in November 2007.

Operations Costs

Full operations and maintenance in support of scientific research began in FY 2011. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – proportional to the number of PhD researchers involved (currently about 55:45). Since total annual costs are $12.50 million, the U.S. share of full science operations and maintenance is $6.90 million.

Support for U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades is provided through the Research and Related Activities (R&RA) account in response to merit-reviewed proposals.



This image shows IceCube's display of the response of the lattice of light sensors to the shockwave of light produced by a muon passing through IceCube at the speed of light. One can recognize the muon track by its geometry as well as by the trail of sensors recording multiple photons (large colored dots—the smallest dots indicate sensors detecting a single photon). *Credit: IceCube Collaboration.*

The general operations of South Pole Station, reported in the Polar Facilities and Logistics narrative, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. The expected operational lifespan of the IceCube Neutrino Observatory is 25 years beginning in FY 2011.

Education and Outreach

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased opportunity for involvement of students in international collaborations; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. NSF supports evaluation and measurement-based education and outreach programs under separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Renewal/Recompetition/Termination

The current IceCube Maintenance & Operations award expires in September 2015. Prior to expiration, the award will be re-competed in accordance with NSF policy.

## Incorporated Research Institutions for Seismology

**$11,250,000**
**-$1,110,000 / -9.0%**

**Incorporated Research Institutions for Seismology**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $12.37 | $12.36 | $11.25 | -$1.11 | -9.0% |

The Incorporated Research Institutes for Seismology (IRIS) operates a distributed, multi-user, national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research and education in the Earth sciences, in earthquake research, global real-time earthquake monitoring, and in nuclear test ban verification. It is managed via a consortium of 114 U.S. universities and non-profit institutions with research and teaching programs in seismology, 22 educational affiliates, and 108 foreign affiliates. IRIS led the construction of the USArray component of the EarthScope project and it is now operating USArray as part of the EarthScope Facility.

**Total Obligations for IRIS**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $12.37 | $12.36 | $11.25 | - | - | - | - | - |

[1]Outyear funding estimates are for planning purposes only. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, separate budget estimates for IRIS are not made beyond FY 2013.

The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission, and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. To serve the research needs of the broad national and international seismology community, IRIS is organized under three Service Areas, which include five major core programs, and two Special Emphasis Areas:

- **Instrumentation Services**
  - The Global Seismographic Network (GSN) consists of a global deployment of over 150 permanently-installed broadband digital seismic stations, most of which have real-time data access;
  - The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) includes a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies;
  - USArray is the seismological component of the EarthScope facility, operated by IRIS under separate funding from the NSF EarthScope Program. USArray is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales.
- **Data Services**
  - The IRIS Data Management System (DMS) provides the national and international seismic research community with timely access to data from the GSN and PASSCAL (130 terabyte archive);

- **Education and Public Outreach**
  - The IRIS Education and Outreach (E&O) Program enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, lectureships, museum exhibits, educational materials, school seismographs, and programs for under-resourced schools.
- **Special Emphasis Areas**
  - IRIS Polar Services, with supplemental funding from the NSF Office of Polar Programs, supports the development of specialized seismic equipment for use in harsh polar environments and provides instrumentation, training and field support for experiments in the Arctic and Antarctic.
  - International Development Seismology leverages the core IRIS Service Areas to provide capacity building and training for earthquake hazard mitigation in developing countries, through technical assistance and research collaborations with scientists at US academic institutions.

Besides its role in providing the observational data essential for basic research in geophysics and earthquake dynamics, IRIS also plays a significant role providing real-time seismic data to the U.S. Geological Survey and the National Oceanic and Atmospheric Administration for global earthquake and tsunami monitoring, in seismic monitoring of the Comprehensive Test Ban Treaty, and in bringing seismology to students and the public through the activities of its education and outreach program.

IRIS is heavily involved in partnership activities, many international in nature. Installation and operation of the GSN has put IRIS in contact with scientists as well as government and non-government organizations from around the world. Many international IRIS GSN stations are designated as the official stations for nuclear test-ban monitoring in their host countries. The IRIS facilities also are multi-use resources for other government agencies that have responsibilities for development of a nuclear test-ban monitoring capability and for monitoring global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support to IRIS for accelerated development of the GSN (Department of Defense, Department of Energy, and State Department), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

*A student volunteer prepares to deploy a sensor on a wind farm near Palm Springs, California, that will record high-frequency seismic waves for the Salton Sea Imaging Project. Principal Investigators: John Hole, Virginia Tech, Joann Stock, Caltech, and Gary Fuis, USGS. Credit: IRIS.*

The use of IRIS PASSCAL instruments for investigations of the shallow crust provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to collaborate closely with industry in development of seismic instrumentation and software.

The Geophysics, Tectonics, and Continental Dynamics Programs in the Division of Earth Sciences (EAR); the Marine Geology and Geophysics Program in the Division of Ocean Sciences (OCE); and the Geology and Geophysics, and Glaciology Programs in the Antarctic Research Section of the Office of Polar Programs (OPP) provide most of the funds, totaling approximately $15.0

million per year, for NSF-sponsored research making use of the IRIS facilities. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major Earth science problems. Overall, support of IRIS is reduced $1.11 million, to a total of $11.25 million in FY 2013, reflecting increasing efficiency and streamlining of operations with their new integrated management structure.

**Facility Report**

Management and Oversight

- NSF Structure: EAR, through its Instrumentation & Facilities Program (IF), provides IRIS with general oversight to help assure effective performance and administration. The program also facilitates coordination of IRIS programs and projects with other NSF-supported facilities and projects and with other federal agencies, and evaluates and reviews the operational and administrative performance of IRIS.
- External Structure: IRIS is incorporated as a non-profit consortium representing 114 U.S. university and non-profit organizations with research and teaching programs in seismology. Each voting Member Institution of the Consortium appoints a Member Representative. However, all IRIS program and budget decisions are made by a nine-member Board of Directors, elected to three-year terms by the Member Representatives. These decisions are made after consultation with the IRIS advisory committees (seven committees for each of the major IRIS program areas and additional *ad hoc* working groups appointed for special tasks). The Board of Directors appoints a president of IRIS to a renewable two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.
- Reviews: All major ongoing geoscience facilities routinely undergo mid-award reviews of their management in addition to peer review of proposals for new or continued support. A management review of IRIS took place in April 2009. Although a number of specific recommendations were made by the review committee, overall the committee found that IRIS is a well-managed and effective organization that has, through its commitment to the collection and open dissemination of the highest quality seismological data, transformed the discipline of seismology. A review of the IRIS Education and Outreach (E&O) Program also took place during 2009. The review panel found the E&O Program to be healthy but made a number of recommendations that are being considered by the seismological community as it prepares a new Strategic Plan for this program. NSF conducted a Business Systems Review (BSR) and issued a final report in January 2010.

Renewal/Recompetition/Termination

A proposal from IRIS for a 27-month renewal of support was submitted in August 2010; this will synchronize the IRIS award with the complementary EarthScope activity. A 27-month cooperative agreement with the IRIS Consortium for the continued management of the IRIS core facilities (2011-2013) was approved by the NSB in May 2011 and finalized in September 2011. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, separate budget estimates for IRIS are not made beyond FY 2013.

## The Integrated Ocean Drilling Program and the Scientific Ocean Drilling Vessel

**$38,900,000**
**-$5,500,000 / -12.4%**

**Integrated Ocean Drilling Program**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $53.35 | $44.40 | $38.90 | -$5.50 | -12.4% |

The Integrated Ocean Drilling Program (IODP), which began in FY 2004, is an expanded successor program to the Ocean Drilling Program (ODP) and represents an international partnership of the scientists, research institutions, and funding organizations of 25 nations to explore the evolution and structure of Earth as recorded in the ocean basins. The IODP is co-led by NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. IODP platforms provide sediment and rock samples (cores), in-situ monitoring, sampling, and measurement from borehole observatories, shipboard and shorebased descriptive and analytical facilities, downhole geophysical and geochemical measurements (logging), and opportunities to conduct experiments to determine in-situ conditions beneath the sea floor.

SODV Underway for Initial Science Expedition, March 10, 2009. *Credit: NSF*

**Total Obligations for IODP**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $53.35 | $44.40 | $38.90 | $40.00 | $40.00 | $40.00 | $40.00 | $40.00 |

Totals may not add due to rounding.
[1] Outyear funding estimates are for planning purposes only. Funding for FY 2014 through FY 2018 is estimated assuming renewal of the program.

Annual operations and maintenance support for IODP includes the costs of operating the *Joides Resolution*, the primary platform of IODP. Maintaining databases, preparing scientific publications emerging from IODP expeditions, and management of the international program are additional IODP science integration costs, made minimal to NSF because of international contributions to the IODP program. In addition, NSF provides support for U.S. scientists to sail on IODP drilling platforms and to participate in the IODP Science Advisory Structure through an associated grants program. The annual costs for the associated science integration and science support (not included in the table above) are estimated to be about $12.0 million. Operations support is reduced in 2013. This reduction may result in fewer expeditions, however, the addition of new international members may mitigate this impact.

The IODP Scientific program includes emphasis on the following research themes:

- Deep Biosphere and the Sub-seafloor Ocean;
- Processes and Effects of Environmental Change; and
- Solid Earth Cycles and Geodynamics, including study of tsunami-producing seismogenic zones and other geohazards.

Undergraduate and graduate students participate in drilling expeditions, working with leading scientists to aid in their development as future leaders. Other students and the public are engaged in geoscience discovery through distance learning initiatives (including remote broadcasts from the drillship), classroom teaching modules on IODP research initiatives, outreach displays for museums and educational/teaching institutions, and lecture programs. During each fiscal year, an estimated 180,000 K-12, 10,000 undergraduate and 10,500 graduate students, and 35,000 teachers are engaged in or supported by IODP education and outreach efforts.

MEXT and NSF are equal partners in IODP and contribute approximately equally to program operation costs. The European Consortium for Ocean Research Drilling (ECORD; representing 16 European countries and Canada), the People's Republic of China, Korea, India, Australia, and New Zealand have also officially joined IODP and provide financial contributions. IODP partners, including NSF, support IODP integrative activities including science planning, review, data management, drilling science-related engineering development, core and sample archiving, publishing, and international outreach.

Over 2,400 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including approximately 1,080 U.S. scientists from over 150 universities, government agencies, and industrial research laboratories. Samples and data have been distributed to more than 800 additional U.S. scientists.

NSF is contracting the services of a light drillship (see the SODV discussion below) from a leading offshore drilling contractor. A commercial contractor provides downhole-logging services. In addition, scientists from industrial research laboratories propose and participate in IODP cruises, are members of the program's scientific and technical advisory committees, and supply data for planning expeditions and interpretation of drilling results. Reduction in NSF support for operations will be offset with new sources of revenue from international partners and/or industry.

**Facility Report**

<u>Management and Oversight</u>

- NSF Structure: The Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO) manages the SODV and the IODP under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is located within the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers serves as the contracting officer's technical representative for the Central Management Office (CMO) contract and the System Integration Contractor (SIC) contract.
- External Structure: NSF and MEXT have signed a Memorandum of Cooperation, which identifies procedures for joint management of a contract to an IODP CMO. A non-profit corporation of U.S., Japanese, and other international institutions (IODP Management International, Inc.) has been contracted by NSF for the CMO activity. The CMO coordinates and supports scientific planning, drilling platform activity, data and sample distribution, and publication and outreach activities through its management of commingled international science funds, collected and provided by NSF. Drillship providers are responsible for platform operational management and costs. NSF provides a light drillship through a contract with the U.S. systems integration contractor, an alliance formed by

the Consortium for Ocean Leadership, Inc. (COL) together with subcontractors at Texas A&M University and Lamont-Doherty Earth Observatory, Columbia University. MEXT manages its drillship through the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), while the British Geological Survey manages ECORD drilling contributions.

- Scientific advice and guidance for IODP is provided through the science advisory structure (SAS), recently streamlined and made more efficient in response to independent, contractual management review. The SAS now consists of a Science Implementation and Policy Committee (SIPCOM), a Proposal Evaluation Panel (PEP), and a series of service panels. The CMO is responsible for coordinating the SAS committee and panels, and for integrating the advice from the SAS into drilling and operational guidance for IODP. Representation in the SAS is proportional to IODP member financial contributions.
- Reviews: Both the CMO and SIC contracts call for management reviews every three years by independent, external panels. Both the SIC and CMO contracts underwent external review in FY 2010, and are available at www.iodp-usio.org/Publications/IODP_OA_2010.pdf and www.iodp.org/triennium-review/. Performance under both contracts will be reviewed again in FY 2013. Reviews for each expedition are carried out on a regular basis to evaluate operational and scientific performance, with review of scientific progress in broader thematic areas conducted by an independent panel every several years.

Renewal/Recompetition/Termination

The current IODP program officially ends in 2013, with IODP international agreements and contracts covering activities through FY 2013. NSF activities regarding a possible IODP renewal, including overall program review, commenced in FY 2010. IODP scientific community planning efforts for a possible post-FY 2013 science program commenced in FY 2009.

**Scientific Ocean Drilling Vessel (SODV)**

The SODV project was funded through the Major Research Equipment and Facilities Construction (MREFC) account and supported the contracting, conversion, outfitting, and acceptance trials of a deep-sea drilling vessel for long-term use in the IODP. The total NSF cost of the project was $115.0 million, appropriated through the MREFC account over three years, with FY 2007 representing the final year of appropriations. The ship owner and operator, Overseas Drilling Limited (ODL), covered an additional $15.0 million in construction costs in exchange for a higher day-rate charge during operations. This higher day-rate charge will expire at the end of FY 2013, with reversion to the lower base day-rate for a contractually guaranteed ten years if IODP is renewed. Construction activities have been completed and the ship commenced international scientific operations on March 5, 2009. It has since proved highly reliable, with a facility efficiency rating approximating 100 percent. As well, the drillship and crew have broken numerous scientific coring depth records, with recovered core being of extremely high quality. The outfitted drillship is capable of operating in nearly all ocean environments (subject to limitations regarding minimum water depth and surface ice coverage), and accommodates a scientific and technical staff of up to 60 persons.

Assessment of the SODV science facilities, with emphasis on its data management systems, was conducted during summer 2010 by an independent, international group of ocean drilling geoscientists. The ship has completed fifteen IODP expeditions with exceptional reliability and demonstrably superior coring capability (both the single bit rotary coring and global piston coring depth records have been broken).

Notably, the ship recently completed two expeditions assessing the presence and abundance of subseafloor life in both Pacific and Atlantic Ocean crust. Specialized downhole logging tools were deployed to detect microbial presence and abundance, and sophisticated long-term borehole observatories

were left in place to sample and culture subseafloor microbes in an effort to better assess the abundance and diversity of life in this extreme but globally widespread environment.

## Large Hadron Collider

**$18,000,000**
**$0.00 / 0.0%**

**Large Hadron Collider**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $18.00 | $18.00 | $18.00 | - | - |

Totals may not add due to rounding.

The Large Hadron Collider (LHC), an international project at the CERN laboratory in Geneva, Switzerland, is the premier facility in the world for research in elementary particle physics. The facility consists of a superconducting particle accelerator providing two counter-rotating beams of protons, approximately 16.5 miles in circumference, with each beam to have an energy up to 7 TeV (1TeV=$10^{12}$ electron volts). It can also provide colliding beams of heavy ions, such as lead. Because of start-up difficulties encountered with the accelerator in 2008, data-taking with colliding proton beams was delayed until the Spring 2010, beginning at a lower beam energy of 3.5 TeV. Starting in 2013, the LHC will undergo repairs and upgrades that will enable it to operate at the design energy of 7 TeV per beam. During this period the detectors will undergo a series of repairs and maintenance to prepare them for higher-energy operations. The accelerator, the detectors, and the LHC computing grid (described below) performed very well during the 2010 and 2011 running periods, successfully collecting five times more data than originally planned.

The U.S. is involved in the maintenance and operation of two particle detectors, a Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). These have been built to characterize the different reaction products produced in the very high-energy proton-proton collisions that occur in intersection regions where the two beams are brought together. They are also being used to study the reaction products from heavy ion beam collisions. A total of 44 international funding agencies participate in the ATLAS detector project and 40 in the CMS detector project. NSF and the Department of Energy (DOE) provide U.S. support to both experiments. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors take data approximately 200 days per year. The remaining time is to be used for maintenance and testing.

The U.S. LHC collaboration continues to be a leader in the development of grid-based computing. The grid enables the enhanced participation of U.S. universities, and thus the training of students, in both state of the art science and computational techniques, in a project that is centered overseas. The grid is expected to have broad application throughout the scientific and engineering communities.

**Total Obligations for LHC**
(Dollars in Millions)

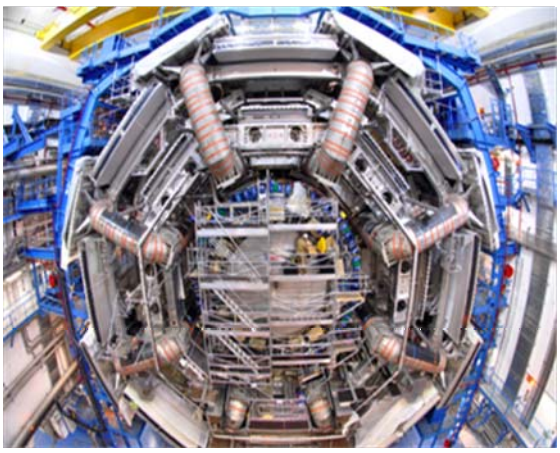
| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $18.00 | $18.00 | $18.00 | $20.00 | $20.00 | $20.00 | $20.00 | $20.00 |

[1] The current cooperative agreement ends in FY 2016. Funding estimates beyond FY 2016 are for planning purposes only.

The LHC is enabling a search for the Higgs particle, the existence and properties of which will provide a deeper understanding of the origin of mass of known elementary particles. The LHC program also

includes searches for particles predicted by a powerful theoretical framework known as supersymmetry, which may provide clues as to how the known forces, weak, strong, electromagnetic, and gravitational, evolved from different aspects of the same "unified" force in the early universe, and can investigate the possibility that there are extra dimensions in the structure of the universe. Through the participation of young investigators, graduate students, undergraduates, and minority institutions in this international project, LHC serves the goal of helping to produce a diverse, globally-oriented workforce of scientists and engineers. Further, innovative education and outreach activities, such as the QuarkNet project, allow high school teachers and students to participate in this project (see http://quarknet.fnal.gov).

Major procurements of components of both warm and superconducting magnets, as well as high-speed electronics, are performed through U.S. industries. Major developments in grid computing are also valuable outcomes. In the construction phase, approximately $45.0 million was devoted to materials procurements from industry. In FY 2013 the estimate for material procurements is approximately $5.0 million, which is included within the $18.0 million detector operating costs.



The ATLAS detector in February 2007. *Credit: CERN.*

Both U.S. LHC collaborations did extensive commissioning of the detectors and the data analysis systems using cosmic rays, while the accelerator was being repaired after the failure of one of the superconducting magnets in 2008. As a result, with the advent of colliding beams in the Spring of 2010, the detectors began immediately collecting data at very near design performance levels, which was unprecedented for the start-up of such complex instruments. Both collaborations continue to operate the detectors smoothly and to analyze the collected data efficiently using world-wide grid resources. The LHC experiments are also adapting quickly to the significant increases in beam intensities. While challenging, these increases in intensity significantly enhance the chances of ground-breaking discoveries at the LHC. During the accelerator shut-down period in 2013, the collaborations will carry out needed maintenance on the detectors while continuing to analyze the many Petabytes of data collected in the previous two years.

**Facility Report**

<u>Management and Oversight</u>

- NSF Structure: A program director in the Division of Physics (PHY) is responsible for day-to-day project oversight. The NSF program director participates in an internal Project Advisory Team, including staff from the NSF Offices of Budget, Finance, and Award Management, General Counsel, Legislative and Public Affairs, and International Science and Engineering, as well as the Office of the Assistant Director for the Directorate of Mathematical and Physical Sciences (MPS).
- External Structure: U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE. The JOG has the responsibility to see that the U.S. LHC program is effectively managed and executed to meet commitments made under the LHC international agreement and its protocols.
- Reviews: There is one major management/technical review each year with a panel of external, international experts, as well as bi-weekly telephone reviews by NSF/DOE program directors to monitor progress. The next major management/technical review is scheduled for March 2012. Two JOG review meetings per year monitor overall program management.

Renewal/Recompetition/Termination

The LHC project is expected to continue at least through the end of the next decade. In December 2011, a new cooperative agreement was negotiated with the ATLAS and CMS collaborations to extend funding for an additional five years to support their role in the international collaborations of which they are members.

## Laser Interferometer Gravitational-Wave Observatory

**$30,500,000**
**+$100,000 / 0.3%**

**Laser Interferomter Gravitational-Wave Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $30.30 | $30.40 | $30.50 | $0.10 | 0.3% |

Totals may not add due to rounding.

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe, such as the collision and merger of two neutron stars or black holes, will produce gravitational radiation. Detection of these gravitational waves is of great importance for fundamental physics, astrophysics, and astronomy. The Laser Interferometer Gravitational-Wave Observatory (LIGO), the most sensitive gravitational-wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber with two 4-km arms joined at right angles houses one or more optical interferometers; the Hanford chamber contains a second 2-km interferometer. The interferometers are used to measure minute changes in the distances between mirrors at the ends of the arms caused by a passing gravitational wave. The predicted distortion of space caused by a gravitational wave from a likely source is on the order of one part in $10^{21}$, meaning that the expected change over the apparent 4-km length is only on the order of $4 \times 10^{-18}$ meters, or about 1/1000th the diameter of a proton. The 4-km length for LIGO, the largest for any optical interferometer, was chosen to make the expected signal as large as possible within terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection.

An aerial view of the Livingston, LA LIGO site. *Credit: Caltech/MIT LIGO Laboratory.*

In April 2008 construction began on the Advanced LIGO MREFC project (AdvLIGO), which is designed to increase the sensitivity of LIGO tenfold. AdvLIGO is being built within the existing LIGO laboratory. LIGO's current and projected operations and maintenance expenses are designed to sustain operation of the LIGO laboratory during the time that the construction is underway. These include support for the basic infrastructure costs not directly related to the AdvLIGO construction project, support for data analysis for the S5 and S6 science runs, maintenance of computational resources for data storage and analysis, support for R&D for any pre-design costs and risk reduction related to AdvLIGO that are outside the scope of the AdvLIGO project, and support for the education and outreach projects associated with the laboratory.

**Total Obligations for LIGO**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $30.30 | $30.40 | $30.50 | $30.50 | $30.50 | $30.50 | $30.50 | $30.50 |

[1] Outyear funding estimates are for planning purposes only.

The LIGO Science Education Center at the Livingston site is the focal point for augmenting teacher education at Southern University and other student teacher activities state wide through the Louisiana Systematic Initiative Program. The LIGO Science Education Center's programs include funding for an external evaluation firm that provides both assistance in aligning future activities with proposed goals and evaluating outcomes.

Substantial connections with industry have been required for the state-of-the-art construction and measurement involved in LIGO projects, with some innovations leading to new products. Interactions with industry include exploring novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product), high optical power electrooptic components (new products), new ultra-fine optics polishing techniques, and optical inspection equipment (new product).

Installation of a quantum-mechanical squeezing experiment at LIGO in 2011. The temporary experiment allowed LIGO to increase its sensitivity by more than 20% over most of its frequency range. Such research is conducted by LIGO Laboratory and the LIGO Scientific Collaboration to reduce risk in the Advanced LIGO construction project. *Credit: Caltech/MIT LIGO Laboratory.*

In 1997 LIGO founded the LIGO Scientific Collaboration (LSC), an open collaboration that organizes the major international groups doing research supportive of LIGO. The LSC now has more than 77 collaborating institutions in 15 countries with more than 870 participating scientists, and LSC membership is growing at a rate of approximately 10 percent per year. A Memorandum of Understanding between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating institution. The LSC plays a major role in many aspects of the LIGO effort, including R&D for detector improvements, R&D for AdvLIGO, data analysis and validation of scientific results, and setting priorities for instrumental improvements at the LIGO facilities. Annual NSF support for science and engineering research directly related to LIGO activities through ongoing research and education programs is about $5.50 million, provided through the disciplinary programs.

LIGO concluded its initial phase of existence with the S6 science run, which, in addition to the acquisition of science data, also tested technologies that will become part of AdvLIGO. This run began in July 2009 and ended in October 2010. The detector sensitivity was about 30% higher than that during the previous S5 run, making the S6 science run both a scientific success and a valuable testbed for AdvLIGO. At the end of this run the LIGO instruments were turned over to the AdvLIGO project for decommissioning and for the installation of advanced components. LIGO and the LSC are currently analyzing the data from the S6 run.

For more information on AdvLIGO, see the MREFC chapter.

**Facility Report**

Management and Oversight

- NSF Structure: NSF oversight is coordinated internally by the LIGO Program Director in the Division of Physics (PHY), who also participates in the PHY AdvLIGO Project Advisory Team, comprising staff from the NSF Offices of General Counsel, Legislative and Public Affairs, International Science and Engineering , as well as the the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management .
- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LSC, and collaboration with the other major gravitational-wave detector activities in Asia, Europe, and Australia. External peer-review committees organized by NSF help provide oversight through an annual review.
- Reviews:
  - AdvLIGO Baseline Review, May-June 2006
  - LIGO Annual Review, November 2006
  - AdvLIGO Baseline Update Review, June 2007
  - LIGO Annual Review and LIGO FY 2009-2013 Operations Proposal Review, November 2007
  - LIGO Business Systems Review (BSR), final report issued March 2008.
  - LIGO Annual Review, November 2008
  - AdvLIGO Annual Review, April 2009
  - LIGO Annual Review and AdvLIGO Interim Review, December 2009
  - AdvLIGO Annual Review, April 2010
  - LIGO Annual Review and AdvLIGO Interim Review, December 2010
  - AdvLIGO Annual Review, April 2011
  - LIGO Annual Review and AdvLIGO Interim Review, November 2011
  - LIGO Annual Review and AdvLIGO Interim Review, November 2012

Renewal/Recompetition/Termination

LIGO began operating under a new five-year cooperative agreement at the beginning of FY 2009. As a condition of approval of this award (and a possible future award), the National Science Board stipulated that the operation of LIGO be recompeted no later than 2018. The projected lifetime of the LIGO facility is 20 years.

## National High Magnetic Field Laboratory

**$31,750,000**
**+$5,950,000 / 23.1%**

**National High Magnetic Field Laboratory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $32.68 | $25.80 | $31.75 | $5.95 | 23.1% |

Totals may not add due to rounding.

The National High Magnetic Field Laboratory (NHMFL) is operated by Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL). NHMFL develops and operates high magnetic field facilities that scientists and engineers use for research in core areas of condensed matter and material physics, materials science and engineering, solid state chemistry and various areas of the biological and biochemical sciences, as well as work on energy and the environment. It is the world's premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems and extensive support services. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process; external users number about 1,100 per year as well as faculty and staff at the three collaborating institutions.

The lab is an internationally recognized leader in magnet design, development, and construction, including the development of conducting and superconducting materials. Many of the unique magnet systems were designed, developed, and built by the Magnet Science and Technology (MS&T) Division of NHMFL. In 2011, the lab set the world's record for the highest nondestructive pulsed magnetic field reaching 97.4 tesla. The 45 tesla hybrid magnet currently provides the highest steady state magnetic fields in the world. Both magnets enable scientists to get new insights on the electronic structure of novel materials such as graphene, topological insulators, high temperature superconductors and more. The 45 tesla magnet supports experiments that require longer time whereas experiments on the 97.4 tesla pulsed magnet can be done in a fraction of a millisecond.) MS&T works with industry and other international magnet laboratories on a variety of technology projects. These include analysis, design, component development and testing, coil fabrication, cryogenics, system integration, and testing.

Two FY 2010 actions -- a $15.0 million award funded by the American Recovery and Reinvestment Act of 2009 (ARRA) and a $2.56 million award funded by regular appropriated dollars -- are supporting design and development of a 21 tesla magnet and world-record-holding advanced mass spectrometer. This equipment will be capable of analyzing chemical samples of unprecedented complexity, such as biological fluids and biofuels, and with unprecedented speed. This new capability will have high impact in several areas including chemistry, molecular biology, and heavy petroleum analysis.

The FY 2013 Request will allow the facility to continue operations, focus on magnet development, and strengthen education, training, user support, and in-house research. It is consistent with prior levels for this activity. The FY 2012 level, by contrast, reflects advanced funding provided from earlier appropriations.

**Total Obligations for NHMFL**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $32.68 | $25.80 | $31.75 | $31.75 | $31.75 | $31.75 | $31.75 | $31.75 |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Current magnet development at NHMFL focuses on new energy-saving, high-field magnet technologies, including the design, development and construction of all-superconducting magnets based on high-temperature superconductor technology. The goal is to develop high-field magnets for the NHMFL user program that double current energy-efficiency. NHMFL collaborates with more than 60 private sector companies, including Cryomagnetics, Pfizer, SuperPower, and Oxford Superconductor Technologies, and national laboratories and federal centers, including those supported by the Department of Energy (DOE) such as the Spallation Neutron Source and the Advanced Photon Source at Argonne National Laboratory. International collaboration includes magnet development with the Helmholtz-Zentrum Berlin (HZB) (previously known as the Hahn-Meitner-Institute Berlin), the International Thermonuclear Experimental Reactor (ITER) in France, and national magnet labs in France, the Netherlands, Germany, and China.

NHMFL provides a unique interdisciplinary learning environment. The Center for Integrating Research and Learning at NHMFL conducts education and outreach activities, which include a Research Experience for Undergraduates, summer programs for teachers, and a summer camp for young girls in middle schools, including programs to raise the scientific awareness of the general public.

**Facility Report**

Management and Oversight

- NSF Structure: NHMFL is supported by the Division of Materials Research (DMR) and the Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences (MPS). DMR is the steward supporting the broad mission of the facility, providing 95 percent of the funds. CHE supports the Fourier Transform Ion Cyclotron Resonance Laboratory and provides about 5 percent. Primary responsibility for NSF oversight is with the national facilities program director in DMR, with guidance from an *ad hoc* working group with members from CHE and the Directorate for Biological Sciences. Site visit reviews are conducted annually. In addition to a panel of experts from the community, representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) attend these site visits.
- External Structure: A consortium of the three institutions (FSU, UF, and LANL) operates NHMFL under a cooperative agreement. FSU, as the signatory of the agreement, has the responsibility for appropriate administrative and financial oversight and for ensuring that operations of the laboratory are of high quality and consistent with the objectives of the cooperative agreement. The principal investigator serves as the NHMFL director. Four senior faculty members are co-principal investigators. The NHMFL director receives guidance and recommendations from an external advisory committee, the NHMFL executive committee, the NHMFL science council, the NHMFL diversity committee, participating institutions, and the users' executive committee.
- Reviews: NSF conducts annual external reviews, which assess user programs, in-house research, long-term plans to contribute significant research developments both nationally and internationally, and operations, maintenance, and new facility development. Annual reviews also assess the status of education training and outreach, operations and management efficiency, and diversity plans. Recent and upcoming reviews include:

- Business Systems Review (BSR), final report issued in September 2009.
- Renewal Review by external panel of site visitors, December 2011.
- National Research Council study on the future of high field magnetic science, started in FY 2012.

Renewal/Recompetition/Termination

A comprehensive renewal review was conducted in FY 2007. On August 8, 2007 the National Science Board approved a five-year renewal award not to exceed $162.0 million for FY 2008-2012. A 5-year renewal proposal for the operation of the NHMFL from FY 2013 through FY 2017 was submitted to NSF in summer 2011 and is currently under review, with results expected in summer 2012. NSF has initiated broad-based community input through the National Research Council to plan for the Nation's long-term investment in high magnetic field research.

## National Nanotechnology Infrastructure Network

**$15,360,000**
**-$500,000 / -3.2%**

**National Nanotechnology Infrastructure Network**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $16.36 | $15.86 | $15.36 | -$0.50 | -3.2% |

Totals may not add due to rounding.

The National Nanotechnology Infrastructure Network (NNIN) is in the second and final five-year funding period from FY 2009-2013. NNIN comprises 14 university sites that form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN provides users across the Nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and expertise for fabrication, synthesis, characterization, design, simulation, and integration. The broad scope of NNIN coverage includes areas of physics, chemistry, materials, mechanical systems, geosciences, biology, life sciences, electronics, optics, molecular synthesis, and molecular scale devices, among others.

**Total Obligations for NNIN**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $16.36 | $15.86 | $15.36 | $15.36 | $15.36 | $15.36 | $15.36 | $15.36 |

[1] Outyear funding estimates are for planning purposes only. FY 2013 is the final year of the current cooperative agreement. Funding beyond FY 2013 assumes continued operation of the facility.

NNIN's broad-based national user facilities enable the Nation's researchers from academia, small and large industry, and government to pursue transformative research, seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and stimulate technological innovation. The network also develops the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology, including issues of environment, health, and safety. The NNIN user facilities promote interdisciplinary research by bridging the gap between materials, mechanics, electronics, photonics, biology and diverse fields, and enabling longitudinal pathways from fundamental studies to devices and systems.

NNIN undertakes, on a national scale, a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis is placed on education and training of a diverse science and engineering workforce that involves non-traditional users and under-represented groups, including women and minorities.

NNIN seeks to leverage its capabilities through connections and collaborations with national and industrial laboratories and with foreign institutions. Through such partnerships, joint meetings, and workshops, the network shares expertise and perspectives, provides specialized training opportunities, coordinates access to unique instrumentation, and transfers newly developed technologies.

NNIN leverages research strengths of the university to bring them to the external community. The institutions comprising the NNIN have strong underlying internal research programs that provide the knowledge base for developing new processes, methodologies, and instrumentation, as well as much of the capital infrastructure. NSF and other agencies independently award research grants to principal investigators who use the NNIN facilities to carry out some aspects of their research projects.

Three institutions joined the network in the renewal period, each bringing new capabilities and broadening the user base: the University of Colorado, which focuses on research in energy-related problems and in precision sciences that include measurements, standards, and systems; Arizona State University, which focuses on organic/inorganic interfaces in electronics, biodesign, implantable devices, flexible electronics, sensors., and outreach to underrepresented communities in the Southwest; and Washington University in St. Louis, whose research focuses on nanomaterials and nanosciences for environment, health, and safety. NNIN, through lead efforts at the University of Washington and University of Michigan, is also serving as a technology source to facilitate collaboration between the ocean sensing infrastructure geoscienses community and the nanotechnology sensor community.

During its eighth year of operation encompassing the 10 month period from March 2011 through December 2011, 5,626 unique users (an increase of 5 percent over the previous year 10 month period) performed a significant part of their experimental work at NNIN facilities. Of these, 4,700 were academic users, mostly graduate students, 865 industrial users, 29 users from State and Federal laboratories, and 32 users from foreign institutions. Included in the above are 644 users from more than 300 small companies who used NNIN facilities during this period. Over 2,700 publications, several of them significant scientific and engineering highlights of the year, resulted from the work of the user community. A major task of staff of NNIN is in training of this user community, particularly graduate students from across the United States, where there is a continuous and significant turnover. A total of 1,925 new users were trained in the vast instrument set, large and small, at the network's facilities.

**Facility Report**

Management and Oversight

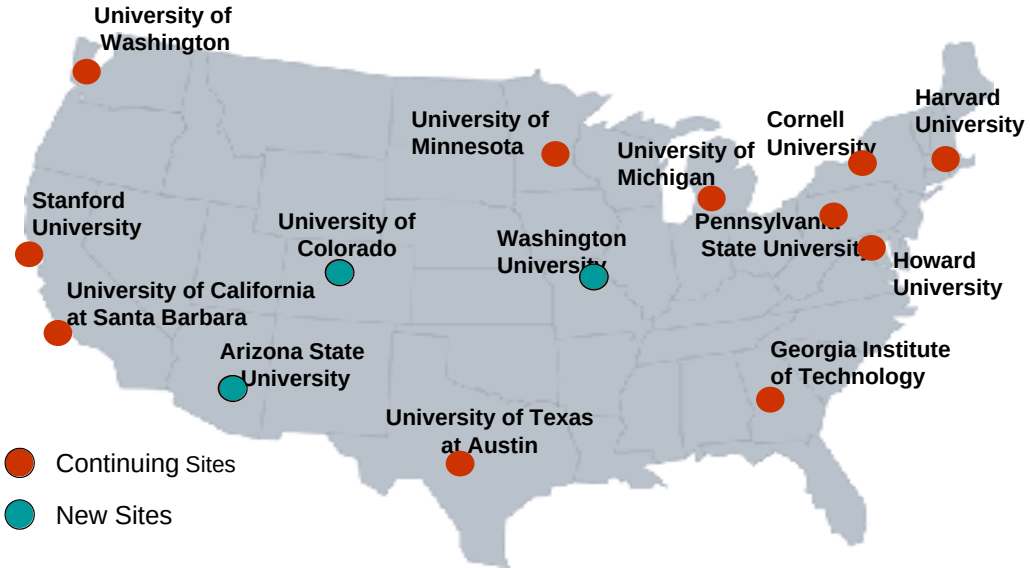
- NSF structure: NSF provides oversight of NNIN under a cooperative agreement with Cornell University, the lead institution. The program officer for the NNIN activity resides in the Division of Electrical, Communications and Cyber Systems (ECCS) in the Directorate for Engineering (ENG). The program officer coordinates NNIN oversight with the NNIN working group comprised of representatives from all NSF research and education directorates. NNIN is reviewed annually through site reviews held at one of the network sites. These reviews involve an external team of experts selected by NSF staff. In addition to the annual site reviews, semi-annual briefings of NSF staff are held at the NSF attended by the NNIN network director, site directors, and area coordinators.
- External structure: NNIN is managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual site directors, and the Education/Outreach and Society/Ethics coordinators. The position of Network Director, which has previously resided with Professor Sandip Tiwari at the lead institution, Cornell University, has at his request and NSF concurrence now been transferred to Professor Roger Howe, director of the Stanford University site. The Network Director provides intellectual leadership for the network and is also responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network, and serves as the principal contact on behalf of the network with the NSF. An external Network Advisory Board meets at least annually and provides independent advice and guidance to the network director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board shares its major recommendations with the NSF. The site directors are responsible for local

management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

- Reviews:
  - The first comprehensive annual review of the NNIN was held following an initial 9 months of operation at the Georgia Institute of Technology site in December 2004. The second annual review was held at the University of Texas-Austin site in February 2006. The third annual review was held at the University of Michigan site in May 2007. The fourth annual review was held at the Stanford University site in May 2008. This review also served to evaluate the NNIN renewal proposal for the five-year period FY 2009-2013. A mid-year informational review was held at NSF in October 2009. The sixth annual review was held at the University of Washington site in May 2010. The seventh annual review was held at the University of Colorado-Boulder site in May 2011
  - Upcoming reviews: The eighth annual review will be held at the Georgia Institute of Technology site in May 2012.

Renewal/Recompetition/Termination

The National Science Board approved NSF's review-based recommendation in December 2008 and authorized renewal of the NNIN award for a final five-year period from FY 2009-2013. NSF plans to convene a panel of recognized national experts in 2012 to evaluate the needs of, and appropriate future investments in, the national infrastructure for nanotechnology. This evaluation would be followed by an open recompetition process for the period FY 2014 and beyond.



## National Solar Observatory

**$8,000,000**
**-$1,100,000 / -12.1%**

**National Solar Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $9.10 | $9.10 | $8.00 | -$1.10 | -12.1% |

Totals may not add due to rounding.

The National Solar Observatory (NSO) operates facilities in New Mexico and Arizona as well as a coordinated worldwide network of six telescopes specifically designed to study solar oscillations. NSO leads the community in design and development of the Advanced Technology Solar Telescope (ATST). (More information on this project may be found in the Major Research Equipment and Facilities Construction chapter). NSO makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. NSO also provides routine and detailed, synoptic solar data used by many researchers and other agencies through its online archive and data delivery system.

NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. In 2011, 84 unique observing programs from 15 U.S. and 17 foreign institutions were carried out using NSO facilities. Students carried out twenty six per cent of these programs, which included 28 Ph.D. thesis programs. Nearly nine terabytes of NSO synoptic data were downloaded from the NSO digital archives.

The Division of Astronomical Sciences (AST) is carrying out a community-based review of its entire portfolio and it is expected that this review will be completed during FY 2012. Its output will inform future budget allocation and planning activities.

**Total Obligations for NSO**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| NSO-Operations | $7.25 | $7.25 | $6.70 | $6.70 | $6.70 | $6.70 | $6.70 | $6.70 |
| NSO-Development | 1.50 | 1.50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| NSO-Research & Education | 0.35 | 0.35 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| **Total, NSO** | **$9.10** | **$9.10** | **$8.00** | **$8.00** | **$8.00** | **$8.00** | **$8.00** | **$8.00** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only and do not include ATST operations.

Partnerships and Other Funding Sources: Thirty-seven U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NSO. Other partners include the U.S. Air Force Office of Scientific Research, U.S. Air Force Weather Agency, NASA, and industrial entities. Many universities and institutes collaborate with NSO on solar instrumentation development and on the design and development of ATST. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with industry through sub-awards to aerospace, optical fabrication, and information technology

companies. Observing time on NSO telescopes is assigned on the basis of merit-based review. No financial support accompanies telescope time allocation.

Education and Public Outreach: NSO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. NSO introduces undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate students (REU) program. NSO has diverse education programs, including teacher training and curriculum development, visitor centers, and a web-based information portal at www.nso.edu.

NSO-Operations, $6.70 million: NSO Operations include facility operations at Sacramento Peak Observatory (SPO) in New Mexico, the world-wide Global Oscillations Network Group (GONG), and solar facilities based on Kitt Peak, Arizona. ATST will replace several of the NSO telescopes at SPO and on Kitt Peak.

NSO-Development, $1.0 million: NSO reporting now includes only work apart from ATST, notably for the synoptic program consisting of the GONG array and the SOLIS telescope.

NSO-Research & Education, $300,000: NSO supports public education in solar physics through its education and public outreach office at SPO. This office provides science community outreach, a visitors' center, news and public information, and the activities on Maui in collaboration with University of Hawaii Maui Campus.

ATST infrastructure, $0.0 million in this narrative ($2.0 million in the ATST narrative): In its Record of Decision authorizing ATST construction, NSF agreed to mitigation activities of $2.0 million per year for ten years. This support, which began in FY 2011, is provided through the ATST budget in the Research and Related Activities account, not the MREFC construction project account. Please see the ATST narrative in the MREFC chapter for more information.

**Facility Report**

Management and Oversight

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program director makes use of detailed annual program plans, annual long-range plans, quarterly technical and financial reports, and annual reports submitted by NSO as well as attending AURA Solar Observatory Council meetings. The latter committee is formed from the national solar physics community and provides a window into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office in the Office of Budget, Finance, and Award Management.
- External Structure: AURA is the managing organization for NSO. The NSO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from its Solar Observatory Council, composed of members of its scientific and management communities. NSO employs visiting and users' committees for the purposes of self-evaluation and prioritization. The visiting committee, composed of nationally prominent individuals in science, management, and broadening participation, reviews for AURA all aspects of the management and operations of NSO. The users committee, composed of scientists with considerable experience with the observatory, reviews for the Director all aspects of NSO that affect user experiences at the observatory.

Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc reviews of AURA management, as needed, by external committees. The last extensive review for NSO was in FY 2008 that led to the award of a new cooperative agreement at the beginning of FY 2010. Annual reviews are anticipated for both NSO program plans and the ATST project, beginning in spring 2011. A Business Systems Review is scheduled for spring 2012.

Renewal/Recompetition/Termination

A management review of AURA's performance was carried out in August 2006. In response to the favorable review, the National Science Board extended the current cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for management and operation of NSO for the period October 1, 2009, through March 31, 2014. Since NSO is the home for the ATST project, which is expected to begin operation in 2018, it is anticipated that the current cooperative agreement will be renewed without competition upon its expiration in 2014.

The NSO's SOLIS (Synoptic Optical Long-term Investigations of the Sun) instrument on Kitt Peak, Arizona. SOLIS provides detailed image, spectral, and magnetic data of the sun that is distributed in near real-time by the web. *Credit: NSO/AURA.*

## National Superconducting Cyclotron Laboratory

**$21,500,000**
**+$0.00/ 0.0%**

**National Superconducting Cyclotron Laboratory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $21.50 | $21.50 | $21.50 | - | - |

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a university-based national user facility. With two linked superconducting cyclotrons, K500 and K1200, it is the leading rare isotope research facility in the U.S. and is among the world leaders in heavy ion nuclear physics and nuclear physics with radioactive beams. Funding for NSCL also supports the MSU faculty and staff research program.

**Total Obligations for NSCL**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $21.50 | $21.50 | $21.50 | $21.50 | $21.50 | $20.00 | $15.00 | $10.00 |

[1]Outyear funding estimates are for planning purposes only.

NSCL scientists employ a range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Applications of the research conducted at the NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. Through the Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities. The laboratory is completing construction and commissioning of an MSU-funded reaccelerator facility (ReA3) that will enable experiments at very low energies – a domain of particular interest to nuclear astrophysics.

Scientists at NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on Earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

NSCL supports and enhances doctorate graduate education and post-doctoral research experiences. About 10 percent of all doctorates granted in nuclear physics in the U.S. are based on research at NSCL. The lab also provides research experiences for undergraduate students, K-12 students, and K-12 teachers.

The coupled cyclotron facility supports a broad experimental program. The mix of experiments is determined by beam use proposals. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments – 4,000-4,500 beam hours each year, with most running one to three days.

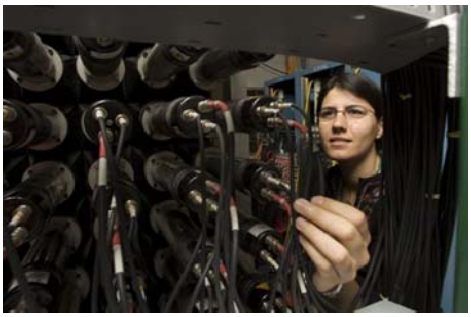
**Facility Report**

Management and Oversight

- NSF Structure: MSU operates NSCL under a cooperative agreement with NSF. The laboratory director is the key officer, who has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSF oversight is provided through annual site visits by the cognizant program officer of the Division of Physics and other staff, accompanied by external experts.
- External Structure: NSCL is managed by its director and four associate directors for research, education, operations, and new initiatives. NSCL's research program is guided by a program advisory committee of external experts as well as an in-house expert, and includes the chairperson of the full NSCL user group. The procedure for users includes writing and submitting proposals to the NSCL director and oral presentations. There are two proposal submission opportunities each year. About 5,000 beam hours are provided for experiments annually, with a backlog of at least a year.
- Reviews:
  - Total Business Systems Review (TBSR), report issued in January 2008.
  - Latest Review: A 5-year review in FY 2011 covered results and achievements related to intellectual merit and broader impacts for the past five year period (FY 2007 – FY 2011), and future funding for the next five year period (FY 2012 – FY 2016).
  - Next Review: An annual review is planned for May 2012. Review topics include science, operations, and future funding.

Renewal/Recompetition/Termination

In December 2008 the Department of Energy (DOE) announced that it had selected Michigan State University as the site for a new world-class rare isotope Facility for Rare Isotope Beams (FRIB). FRIB will be built on the site of the present NSCL and will make use of much of the NSCL beamlines and general infrastructure. Michigan State University will be the performing institution under a cooperative agreement with DOE for the future FRIB, which is now in the preliminary design stage. A recent National Science Board (NSB) resolution approved a new 5-year renewal of the present Cooperative Agreement, which expires at the close of FY 2016. The FRIB cooperative agreement between DOE and MSU was signed in 2009. To facilitate interagency planning and allow for a smooth transition from the NSF-funded NSCL to the DOE-funded FRIB, a Joint Oversight Group (JOG) of DOE and NSF personnel has been established.



An NSCL research associate adjusts a cabling on a detector. *Credit: NSCL.*

## Network for Earthquake Engineering Simulation

**$20,500,000**
**+$0.00 / 0.0%**

**Network for Earthquake Engineering Simulation**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $20.10 | $20.50 | $20.50 | - | - |

The Network for Earthquake Engineering Simulation (NEES) is a national, networked simulation resource of 14 advanced, geographically distributed, multi-user earthquake engineering research experimental facilities with telepresence capabilities. NEES provides a national infrastructure to advance earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation to improve the seismic design and performance of U.S. civil infrastructure systems. Experimental facilities include shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and mobile and permanently installed field equipment. NEES facilities are located at academic institutions (or at off-campus field sites) throughout the United States, networked together through a high performance Internet2 cyberinfrastructure system (NEEShub). NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES was operated during FY 2005-FY 2009 by NEES Consortium, Inc., located in Davis, CA. During FY 2008 and FY 2009, NSF recompeted NEES operations using program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. The outcome of that competition was an award to Purdue University to operate NEES from FY 2010-FY 2014. Through a five-year cooperative agreement with NSF (FY 2010-FY 2014), Purdue University operates the NEES experimental facilities and cyberinfrastructure; coordinates education, outreach, and training; and develops national and international partnerships.

**Total Obligations for NEES**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $20.10 | $20.50 | $20.50 | $20.50 | $20.50 | $20.50 | $20.50 | $20.50 |

[1] Outyear funding estimates are for planning purposes only. FY 2014 is the final year of the current cooperative agreement. Funding beyond FY 2014 assumes continued operation of the facility.

NEES' broad-based national research facilities and cyberinfrastructure enables new discovery and knowledge through capabilities to test more comprehensive, complete, and accurate models of how civil infrastructure systems respond to earthquake loading and tsunamis. This enables the design of new methodologies, modeling techniques, and technologies for earthquake and tsunami hazard mitigation. NEES engages students in earthquake engineering discovery through on-site use of experimental facilities, telepresence technology, archival experimental and analytical data, and computational resources with the aim of integrating research and education. Purdue University operates NEES under a strategic plan and develops a broad spectrum of education and human resource development activities with special emphasis on non-traditional users and underrepresented groups through its Research Experiences for Undergraduates (REU) program. Purdue also organizes an annual meeting for NEES users/researchers and facility operators.

Through the National Earthquake Hazards Reduction Program (NEHRP), which includes the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), and NSF, NEES supports research and outreach related to earthquake hazard mitigation. Connections to industry include private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES. NEES leverages and complements its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF has developed a partnership to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), located in Miki City, Japan, built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED), and operational in 2005. To facilitate NEES/E-Defense collaboration, in September 2005, NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed a Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. The annual planning meeting was held at the E-Defense facility in August 2011 to continue to develop research topics and experiments for NEES/E-Defense collaboration. Two NSF-supported research projects conducted tests at the E-Defense facility during FY 2009 to investigate new seismic design methodologies for mid-rise wood frame buildings and steel frame structures, and collaborative testing on reinforced concrete structures was conducted during December 2010. In August 2011, two NSF-supported research projects used a full-scale, five-story steel frame structure at the E-Defense facility to test new seismic base isolation concepts and the response of non-structural systems during strong seismic motion.

Using a unique landslide tsunami generator, researchers at the Georgia Institute of Technology in cooperation with faculty at University of Alaska at Fairbanks are investigating a methodology for improved assessment and mitigation of landslide and tsunami hazards. Field data from landslide-generated tsunamis events are limited to very few cases with marginal data that are generally missing the most important information related to tsunami generation characteristics. Researchers are compensating for this lack of field data by creating physical models of three-dimensional tsunami generation by deformable landslides and source run-up in the NEES Tsunami Wave Basin at Oregon State University. *Credit: Devin K. Daniel, California Polytechnic State University, San Luis Obispo, NEES summer 2010 REU student.*

Along with direct operations and maintenance support for NEES, NSF separately provides support for research to be conducted at the NEES experimental facilities through ongoing research and education programs. The NEEShub also provides a platform for the earthquake engineering and tsunami communities, as well as other communities, to develop new tools for shared cyberinfrastructure. The annual support for such activities, funded through annual NEES research program solicitations, is estimated to be up to $9.0 million in FY 2013. These awards support basic research in multi-hazard engineering involving experimental and computational simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research. ENG support for NEES Operations in FY 2013 will continue to support core research conducted at the 14 network sites through FY 2014.

**Facility Report**

<u>Management and Oversight</u>

- NSF structure: NSF provides oversight to NEES operations through a cooperative agreement with Purdue University during FY 2010-FY 2014. NEES operations are reviewed through annual site

visits and through periodic site visits to the individual NEES facilities. The annual site reviews are held at either the headquarters or at one of the network facilities. All reviews involve an external team of experts selected by NSF staff. The NSF program manager for NEES is located in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) in the Directorate for Engineering (ENG). The Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) provides advice and assistance.

- External structure: Purdue University provides the headquarters and staffing to coordinate network-wide operation of the NEES experimental facilities, cyberinfrastructure, and education, outreach, and training activities as well as develop national and international partnerships. Day-to-day operations of the network are overseen by the headquarters staff led by a director. A governance board meets several times a year and provides independent advice and guidance to the director concerning the network's programs, activities, vision, funding allocations, and new directions. The governance board shares its major recommendations with the NSF. Each of the 14 experimental facilities has an on-site director responsible for local day-to-day equipment management, operations, and interface with Purdue, other NEES facilities, users, and the NEEShub for network coordination. The NEEShub provides telepresence, the NEES Project Warehouse data repository, and collaborative, simulation, and other related services for the entire NEES network.
- Reviews:
  - Management reviews: NSF BFA Business Systems Review: May 2006
  - Mid-award operations reviews: NSF Annual Merit Reviews: June 2005, April 2006, July 2007
  - Experimental facility reviews: NSF Periodic Merit Reviews: FY 2006-FY 2008
  - Transition review: April 2010
  - Management reviews: NSF BFA Business Systems Review: March 2011
  - Mid-award operations reviews: NSF Annual Merit Reviews: FY 2010-FY 2013
  - Experimental facility reviews: Up to three annually: FY 2010-FY 2013

Renewal/Recompetition/Termination

In FY 2008, NSF recompeted NEES operations for a second five-year period from FY 2010-FY 2014. The competition was announced in program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. As an outcome of that competition, the National Science Board, at its August 5-6, 2009 meeting, approved NSF's recommendation for a five-year cooperative agreement (FY 2010-FY 2014) to Purdue University. Annual funding to Purdue University for NEES operations is based upon satisfactory progress and availability of funding. During FY 2010, the prior NEES operations awardee, NEES Consortium, Inc., was supported by NSF to provide continuity of operations and to help transition software, documents, and other inventory to Purdue University. During FY 2010, NEES Consortium, Inc., also closed out its support for NEES operations. In FY 2010, NSF supported two studies for the assessment of the need for earthquake engineering experimental and cyberinfrastructure facilities beyond 2014, as described in the Dear Colleague Letter NSF 10-071 (http://nsf.gov/pubs/2010/nsf10071/nsf10071.jsp). One study, a workshop held by the National Research Council on the Grand Challenges in Earthquake Engineering Research, was completed in FY 2011 and the second study will be completed in FY 2012. These studies will provide input to NSF for the determination of support for future earthquake engineering research infrastructure beyond 2014.

## Polar Facilities and Logistics

**$297,510,000**
**+$1,720,000 / 0.9%**

**Polar Facilities and Logistics**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| Polar Facilities[1] | $185.72 | $184.73 | $186.45 | $1.72 | 0.9% |
| Polar Logistics | 111.82 | 111.06 | 111.06 | - | - |
| **Total, Polar Facilities and Logistics** | **$297.54** | **$295.79** | **$297.51** | **$1.72** | **0.6%** |

Totals may not add due to rounding.

[1]Funding for Polar Facilities for FY 2011 excludes a one-time appropriation transfer of $53.892 million ($54.0 million less the 0.2% rescission) to U.S. Coast Guard, per P.L.112-10.

### Polar Facilities

The Office of Polar Programs (OPP) within NSF provides the infrastructure needed to support U.S. research conducted in Antarctica, including research funded by U.S. mission agencies, for year-round work at three U.S. stations, two research ships, and a variety of remote field camps. One example of support to other agencies includes mission-essential satellite communications support at McMurdo Station for the Joint Polar Satellite System (JPSS), the National Aeronautics and Space Administration's (NASA) Ground Networks for the relay of data. In addition, OPP enables important climate monitoring activities for the National Oceanic and Atmospheric Administration (NOAA) at the Clean Air Facility at South Pole Station, one of only five such sites around the globe. OPP also provides support for NASA's Long Duration Balloon program that enables research in fields ranging from astrophysics to cosmic radiation to solar astronomy. OPP also provides support to the U.S. Geological Survey's (USGS) South Pole Remote Earth Science and Seismological Observatory (SPRESSO), the most seismically-quiet station on earth, and access to its Global Navigation Satellite System (GNSS).

All support for these activities is provided by OPP, including transportation, facilities, communications, utilities (water and power), health and safety infrastructure, and environmental stewardship. The U.S. Antarctic Program (USAP) maintains the U.S. presence in Antarctica in accordance with U.S. policy, and supports Antarctic Treaty administration under State Department leadership.

**Total Obligations for Polar Facilities**
(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Antarctic Infrastructure & Logistics | $185.72 | $184.73 | $186.45 | $191.53 | $191.53 | $191.53 | $191.53 | $191.53 |
| U.S. Coast Guard Icebreaker Support | [53.892] | - | - | | | | | |
| **Total, Polar Facilities** | **$185.72** | **$184.73** | **$186.45** | **$191.53** | **$191.53** | **$191.53** | **$191.53** | **$191.53** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

NOTE: FY 2011 funding for U.S. Coast Guard Icebreaker Support excludes a one-time appropriation transfer of $53.892 million, $54.0 million less the 0.2% rescission, to USCG, per P.L. 112-10.

OPP contracts with a prime contractor for science support, operations, the leasing of research vessels, and the maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile. The contractor is selected through a competitive bidding process. Rotary- and fixed-wing aircraft used in support of research are also provided through separate competitively awarded contracts. Other agencies and contractors provide technical support in areas of expertise such as engineering, construction, and communications.

**Project Report**

Management and Oversight

- NSF Structure: OPP has overall responsibility for funding and managing Polar Facilities. This includes planning all activities, and overseeing contractors.
- External Structure: A new Antarctic support contract was competed and awarded to Lockheed Martin Corporation in December 2011. There are many separate subcontractors for supplies and technical services, and other services are procured through separate competitively bid contracts.
- Reviews: OPP evaluates the performance of the Antarctic support contractor annually via an Award Fee Plan, which involves multiple tiers of review, including a Performance Evaluation Board (PEB) composed of representatives from OPP and the Office of Budget, Finance, and Award Management (BFA). In addition, OPP's performance is reviewed externally by Committees of Visitors and the OPP Advisory Committee.

Helicopters provide support to field parties in the McMurdo Dry Valleys in southern Victoria Land and at remote field camps. *Credit: Kristan Hutchison, RPSC.*

Current Status

- All facilities (stations, research vessels, and field camps), including the newly-constructed South Pole Station, are currently operating normally.
- South Pole Station Modernization (SPSM) project was funded through NSF's Major Research Equipment and Facilities Construction (MREFC) account. The new station was dedicated in January 2008 and construction was completed in January 2011. The new station replaces the previous U.S. station at the South Pole, built 30 years ago and inadequate in terms of capacity, efficiency, and safety. The new station is an elevated complex with two connected buildings, supporting 150 people in the summer and 50 people in the winter. The completed South Pole Station provides a platform for the conduct of science at the South Pole and fulfills NSF's mandate to maintain a continuous U.S. presence at the South Pole in accordance with U.S. policy. FY 2008 represented the final year of MREFC appropriations for SPSM. Operations and maintenance of South Pole Station is consolidated within the requested budget funding for polar facilities.

Recompetition

- NSF recently concluded an effort to recompete the Antarctic support contract. Lockheed Martin Corporation was awarded a 13.5 year contract, consisting of a five-year base period and four option periods exercised on the basis of performance and totaling an additional 8.5 years.
- U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. The research emphases at the three stations change as the scientific forefronts addressed there evolve with time, as does the infrastructure needed to support it.

**Polar Logistics**

Polar Logistics consists of two activities: the U.S. Antarctic Logistical Support program within the Division of Antarctic Infrastructure and Logistics, and the Research Support and Logistics program within the Arctic Sciences Division.

**Total Obligations for Polar Logistics**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| U.S. Antarctic Logistical Support | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 | $67.52 |
| Research Support and Logistics | 44.29 | 43.54 | 43.54 | 44.85 | 44.85 | 44.85 | 44.85 | 44.85 |
| **Total, Polar Logistics** | **$111.82** | **$111.06** | **$111.06** | **$112.37** | **$112.37** | **$112.37** | **$112.37** | **$112.37** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The U.S. Antarctic Logistical Support program funds support activities provided by the U.S. Department of Defense (DoD). DoD operates as a logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations and maintenance support through the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and ground electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the re-supply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

The Research Support and Logistics program in the Arctic Sciences Division is driven by and responds to science supported by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. A contractor provides research support and logistics services for NSF-sponsored activities in the Arctic. Additional major support components include: access to U.S. Coast Guard and other icebreakers, University-National Oceanographic Laboratory (UNOLS) vessels and coastal boats; access to fixed- and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts; global satellite telephones for emergency response and improved logistics coordination; and development of a network of strategically placed U.S. Long-Term Ecological Research observatories linked to similar efforts in Europe and Canada.

**Project Report**

Management and Oversight

- NSF Structure: OPP has overall responsibility for U.S. Antarctic Logistical Support and Arctic Research Support & Logistics. DoD operates as a logistical support provider on a cost-reimbursable basis. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling and sets forth the terms and conditions for reimbursement to DoD by NSF.
- External Structure: The current Arctic support contract was recompeted and recently awarded to the incumbent, CH2M Hill, in September 2011. There are many separate subcontractors for supplies and technical services, and other services are procured through separate competitively bid contracts.
- Reviews: OPP evaluates the performance of the Arctic support contractor using feedback from the research community they support, and by conducting site visits that include representatives from OPP and BFA. OPP's performance is externally reviewed by Committees of Visitors and the OPP Advisory Committee.

Current Status

- All facilities (stations, research vessels, and field camps) are currently operating as normal.

Renewal/Recompetition/Termination

- U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. As discussed above, the research emphases at the three stations and at Arctic research sites change as the scientific forefronts addressed there evolve with time, as does the logistics support for these activities. NSF recently recompeted the Arctic support contract and made an award to the incumbent contractor, CH2M Hill, in September 2011. The contract has an initial term of four years and the possibility of two, two-year extensions exercised on the basis of performance.

## FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCs)

### National Center For Atmospheric Research

**$92,290,000**
**-$6,310,000/ -6.4%**

**National Center for Atmospheric Research**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $98.10 | $98.60 | $92.29 | -$6.31 | -6.4% |

The Mesa Laboratory, designed by architect I.M. Pei, in Boulder, CO. *Credit: NCAR.*

The National Center for Atmospheric Research (NCAR) is a Federally Funded Research and Development Center (FFRDC) serving a broad research community, including atmospheric scientists and researchers in complementary areas of the environmental and geosciences. NCAR is managed under a cooperative agreement with NSF by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprising 77 Ph.D. granting academic institutions.

As of November 2011, NCAR employed a total of 964 FTEs, of which 392 are funded under the NSF primary award to UCAR.

**Number of FTEs Supported at NCAR**

| FTEs | Primary Award[1] | All Funding |
|---|---|---|
| Career Scientists | 98 | 127 |
| Scientific Support[2] | 276 | 673 |
| Other Staff[3] | 18 | 164 |
| **Total** | **392** | **964** |

[1]The primary award supports substantial facility infrastructure that does not include staff costs.

[2]Scientific Support includes Associate Scientists, Project Scientists, Post Docs, Software Engineers, Engineers, System Support and Technicians.

[3]Other Staff includes Administrative positions, Managers, Paid Visitors, Pilots and Mechanics.

In addition to performing fundamental research, NCAR provides facilities, including world-class supercomputing services, research aircraft, airborne and portable ground-based radar systems, atmospheric sounding, and other surface sensing systems for atmospheric research, to university, NCAR, and other atmospheric researchers. In addition, NCAR operates several facilities dedicated to the study of the Sun, solar phenomena, space weather, and the responses of the upper atmosphere to the sun's output. As an NSF sponsored facility, NCAR is committed to the dissemination of newly discovered knowledge in all the above areas.

**Total Obligations for NCAR**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Aircraft Support | $9.93 | $9.93 | $9.00 | $9.20 | $9.41 | $9.62 | $9.84 | $10.06 |
| Computational Infrastructure | 22.00 | 22.59 | 25.59 | $26.17 | $26.75 | $27.36 | $27.97 | $28.60 |
| Other Facility Support | 23.42 | 23.42 | 19.00 | $19.43 | $19.86 | $20.31 | $20.77 | $21.24 |
| Research & Education Support | 42.75 | 42.66 | 38.70 | $39.57 | $40.46 | $41.37 | $42.30 | $43.25 |
| **Total, NCAR** | **$98.10** | **$98.60** | **$92.29** | **$94.37** | **$96.48** | **$98.66** | **$100.88** | **$103.15** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2011, NCAR received approximately $45.30 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Federal Aviation Administration, and $15.90 million from non-federal sources.

Major Investments in FY 2013: In FY 2013, investments at NCAR will focus on issues of societal importance in the areas of atmospheric chemistry, climate, including climate models, cloud physics, severe storms, weather hazards to aviation, and interactions between the Sun and Earth. In all of these areas, NCAR scientists will work with their university colleagues to look closely at the role of humans in both creating climate change, responding to severe weather occurrences, and to better understand the characteristics of the Sun and Sun-Earth connections. Example investments are an increased emphasis on research efforts that combine ecological, hydrological, biogeochemical and social science expertise with core atmospheric disciplines to address challenging and multifaceted Earth system science problems. This includes the continued development and improvement of community climate and weather numerical models.

Aircraft Support: NCAR operates a C-130 and a Gulfstream-V (G-V, also known as the High Altitude Instrumented Airborne Platform for Experimental Research, or HIAPER), both of which are highly modified and equipped with specialized instrumentation, to enable the support of research activities designed to understand complex environmental processes. These aircraft will continue to support several community-originated projects deemed by peer review to be of exceptional scientific merit. These campaigns occur not only in the United States but overseas as well.

Computational Infrastructure: NCAR's computational facility supports high-end modeling and simulation of climate, weather and other Earth Systems processes. Additionally, this facility supports the development and application Interagency U.S. Global Changes Research Program (USGCRP) Community Climate System Model (CCSM), which uses mathematical formulas to simulate and better understand the chemical and physical processes that drive Earth's climate system. CCSM results are to be used as a major US contribution to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report scheduled for release in 2013.

In FY 2013, NCAR will oversee the transition to operations of a new computational facility near Cheyenne, Wyoming. This new facility is a joint effort between NCAR and the University of Wyoming and other Wyoming partners. The NCAR/Wyoming Supercomputing Center will provide physical infrastructure needed to expand NCAR's computational capability to better meet the high-end computational needs of the atmospheric and related sciences and to allow the development of

supercomputing research and educational activities of specific interest to the University of Wyoming and the state.

Other Facility Support: In addition to the C-130 and G-V aircraft, NCAR also provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including a large transportable Doppler radar, a unique aircraft mounted radar, upper atmosphere observing capabilities, and other unique experimental systems. NCAR operates a coronagraph as a community resource, and supports community weather and climate models as well as other infrastructure. NCAR collaborates with universities in development and operation of instrumentation for use by the broad community. These facilities are used by both NCAR and community researchers to undertake cutting edge research projects.

Research and Education Support: Funding for research and education support at NCAR totals $41.0 million in FY 2013. NCAR operates scientific research programs that include the following areas:

- studies of large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change;
- global and regional atmospheric chemistry, including atmospheric connections to geochemical and biogeochemical cycles;
- the variable nature of the sun and the physics of the corona and their interaction with the Earth's magnetic field;
- the physics of clouds, thunderstorms, precipitation formation, and their interactions and effects on local and regional weather; and
- the examination of human society's impact on and response to global environmental change.

Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and serve as a focus and meeting point for the broader atmospheric and related sciences community. Further, NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning, and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer-term economic consideration of climate change issues.

Educational activities at NCAR are noteworthy, in particular the SOARS (Significant Opportunities in Atmospheric Research and Science) program is an undergraduate-to-graduate bridge program designed to broaden participation in the atmospheric and related sciences, which integrates research, education, and mentoring.

In addition, NCAR further supports the scientific community by providing fellowships, internships, workshops, and colloquia for students and visiting scientists, and disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, undergraduate and graduate institutions, postdoctoral and career scientists and researchers, as well as to policy and decision makers. Professional training courses, innovative and award-winning science education websites, as well as the directed activities of NCAR's Office of Education and Outreach are further examples of how NSF's goal of integrating research and education is attained through NCAR activities. Total support for education and outreach is $3.44 million.

Management and Oversight

- NSF Structure: NSF's Division of Atmospheric and Geospace Sciences (AGS), along with the Division of Acquisitions and Cooperative Support (DACS), provide oversight of NCAR and the cooperative agreement with the University Corporation for Atmospheric Research (UCAR) for NCAR's management. The cooperative agreement between UCAR and NSF encourages interactions between NCAR scientists and AGS staff and ensures close coordination between AGS and NCAR

management. The agreement contains requirements necessary for AGS's oversight of the NCAR program and UCAR management activities that affect NCAR. These include a provision that UCAR submit an annual program plan for AGS approval that provides details on how resources will be used in that fiscal year. In addition, NCAR summarizes its past year's accomplishments in an annual scientific report. Over the course of a year, several strategic planning sessions are held between AGS, UCAR, and NCAR to ensure that scientific and facility priorities remain consistent with those of NSF. Previous Committee of Visitors (COV) reports offered positive and constructive comments on NSF's oversight of UCAR/NCAR.

- External Structure: UCAR works in partnership with NSF and the university community to ensure the effective implementation of the strategic mission of NCAR to the benefit of the research community. In addition, other research sponsors, such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), the Department of Defense (DOD), the Environmental Protection Agency (EPA), and the Federal Aviation Administration (FAA) support research collaboration wherever it enhances NCAR's basic NSF-supported research goals or facilities missions.
- Reviews:
  - As required by the cooperative agreement between NSF and UCAR, a major review of the science, facilities and management of NCAR was conducted between mid-FY 2011 and early FY 2012. Review results were very positive with NCAR receiving high marks in all areas. Some issues were identified and appropriate actions to these issues are being pursued with UCAR and NCAR management.
  - NSF conducted a Business Systems Review (BSR) and issued a final report in March 2011.

Renewal/Recompetition/Termination:

In May 2008, UCAR competed successfully for the management and operation of NCAR. The term of the award is for a period of five years, extensible for an additional five years subject to appropriate and successful review. After satisfactory resolution of the minor issues identified in the review process, AGS will formulate a recommendation to the National Science Board to either recompete or renew the current cooperative agreement.

## National Optical Astronomy Observatory

**$25,500,000**
**+$0.00 / 0.0%**

**National Optical Astronomy Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $29.50 | $25.50 | $25.50 | - | - |

Totals may not add due to rounding.

The National Optical Astronomy Observatory (NOAO) was established in 1982 by uniting operations of the Kitt Peak National Observatory (KPNO) in Arizona and the Cerro Tololo Inter-American Observatory (CTIO) in Chile. NOAO is a Federally Funded Research and Development Center (FFRDC) for research in ground-based, nighttime, optical, and infrared (OIR) astronomy. NOAO also is the gateway for the U.S. astronomical community to the International Gemini Observatory and to the "System" of federally-funded and non-federally-funded OIR telescopes through the Telescope System Instrumentation Program (TSIP) and the Renewing Small Telescopes for Astronomical Research (ReSTAR) program. For all NOAO and "System" telescopes, peer-review telescope allocation committees provide merit-based telescope time but no financial support. NOAO manages national community involvement in the development of potential future infrastructure projects and is closely involved in the design, development, and potential construction and operations of the Large Synoptic Survey Telescope (LSST). This project was the highest priority recommendation for "New Ground-Based Activities – Large Projects" of the 2010 Decadal Survey (*Astro2010*) conducted by the National Research Council's Astronomy and Astrophysics Survey Committee.

NOAO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve nearly 1,400 U.S. and foreign scientists annually. In FY 2011, 80 thesis students and an additional 106 non-thesis graduate students from U.S. institutions used NOAO telescopes for their research. In FY 2011 NOAO employed nearly 380 personnel in Arizona and Chile, including 46 support scientists and 12 postdoctoral fellows.

The NSF Directorate for Mathematical and Physical Sciences Division of Astronomical Sciences (MPS/AST) is carrying out a community-based review of its entire portfolio and it is expected that this review will be completed during FY 2012. Its output will inform future budget allocation and planning activities.

Partnerships and Other Funding Sources: Thirty-seven U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NOAO. Other partners include NASA and industrial entities. A large number of U.S. universities support their own astronomical facilities at KPNO and CTIO with reimbursed services provided by NOAO. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with universities and with industry through subawards to aerospace, optical fabrication, and information technology companies. NOAO leverages NSF support with funding from other federal agencies and non-federal sources. In FY 2011, NOAO received $15.77 million for reimbursed services from partnerships and tenant observatory support, from the Kitt Peak Visitors' Center, grants from other federal agencies, and NSF supplemental funding for LSST and for the Research Experiences for Undergraduates (REU) program.

Education and Public Outreach: NOAO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. Over 200 graduate students observe on NOAO telescopes yearly and a significant fraction of the observations contribute to PhD dissertations. The observatories introduce undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate Students (REU) program. NOAO has a diverse education program, visitor centers, and a web-based information portal at www.noao.edu.

**Total Obligations for NOAO**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| NOAO-Operations | $21.40 | $20.10 | $20.10 | $20.50 | $20.50 | $20.50 | $20.50 | $20.50 |
| NOAO-Development | 5.60 | 4.90 | 4.90 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| NOAO-Research & Education | 0.50 | 0.50 | 0.50 | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 |
| TSIP[2] | 2.00 | - | - | - | - | - | - | - |
| **Total, NOAO** | **$29.50** | **$25.50** | **$25.50** | **$26.01** | **$26.01** | **$26.01** | **$26.01** | **$26.01** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

[2] TSIP is the Telescope System Instrumentation Program.

NOAO-Operations: $20.10 million: NOAO-Operations support covers the operation of facilities at KPNO, CTIO, and the headquarters, offices, laboratories, and workshops in Tucson, Arizona and La Serena, Chile.

NOAO-Development: $4.90 million: Development support includes $1.50 million for the share of LSST design and development funded from NOAO's base budget, as well as the development of new instrumentation for telescopes at KPNO and CTIO. The Senior Review recommended that the instrumentation at KPNO and CTIO urgently be modernized. In FY 2010 NOAO began a multi-year effort to introduce new capabilities to the U.S. community.

NOAO-Research and Education: $500,000: NOAO links the research conducted at its facilities to education of the public through its education and public outreach office in Tucson.

Telescope System Instrumentation Program (TSIP): $0.0 million: The TSIP program has been used to enhance instrumentation at non-federal observatories in exchange for open-access time for the U.S. community at those observatories. The TSIP competition and this open-access time have been administered by NOAO and have resulted in U.S. community access to unique assets such as the Keck and Magellan telescopes. The FY 2012 Budget Request proposed to eliminate TSIP as a standalone program and reallocate funding to a broader, more competitive activity outside NOAO. In FY 2013, proposals for TSIP-like activities will be considered within the Disciplinary and Interdisciplinary Research portfolio of the MPS Division of Astronomical Sciences.

**Facility Report**

Management and Oversight

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program

director reviews detailed annual program plans, annual long range plans, quarterly technical and financial reports, and annual reports submitted by NOAO, and attends AURA governance committee meetings. Governance committees are formed from the national astronomical community and provide additional windows into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Office of General Counsel, the Division of Acquisition and Cooperative Support, and the Large Facilities Office in the Office of Budget, Finance, and Award Management.

- External Structure: AURA is the managing organization for NOAO. The NOAO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from an observatory council composed of members of its scientific and management communities. NOAO employs separate visiting and users committees for the purposes of self-evaluation and prioritization. The visiting committees, composed of nationally prominent individuals in science, management, and broadening participation, review for AURA all aspects of the management and operations of the observatories. The user committees, composed of scientists with considerable experience with the observatories, review for the NOAO Director all aspects of user experiences at the observatory.
- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc external reviews of AURA management. A Business Systems Review (BSR) to evaluate the restructuring of NOAO's business services began in FY 2012. A mid-term management review is scheduled for FY 2012. A full BSR will be conducted in FY 2013.

Renewal/Recompetition/Termination

A management review of AURA's performance was carried out in August 2006. In response to the review, the National Science Board extended the previous cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for the management and operation of NOAO for the period October 1, 2009, through March 31, 2014. A solicitation is being developed and will be promulgated in late 2012 for the management of NOAO under a new cooperative agreement to begin April 1, 2014.

The Cerro Tololo Inter-American Observatory 4-meter telescope dome. *Credit: M. Urzua Zuniga/Gemini Observatory.*

## National Radio Astronomy Observatory

**$73,920,000**
**+$2,170,000 / 3.0%**

**National Radio Astronomy Observatory**
(Dollars in Millions)

| FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|
| $67.65 | $71.75 | $73.92 | $2.17 | 3.0% |

Totals may not add due to rounding.

The National Radio Astronomy Observatory (NRAO) provides state-of-the-art radio telescope facilities for scientific users. NRAO conceives, designs, builds, operates, and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away.

As a Federally Funded Research and Development Center (FFRDC), NRAO operates major radio telescopes in Green Bank, West Virginia, near Socorro, New Mexico, and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. Headquartered in Charlottesville, Virginia, NRAO is the North American implementing organization for the international Atacama Large Millimeter Array (ALMA) project. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals, and annually serve over 1,500 users worldwide. The Observatory allocates telescope time on the basis of merit but provides no financial support. NSF does not provide individual investigator awards targeted specifically for use of NRAO facilities. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facilities.

In FY 2011, NRAO concluded an organizational realignment across its multiple observatory sites. Including the ALMA operations staff located at NRAO, Observatory staff consists of 495 FTEs in the operations and maintenance components of the Observatory: 80 in Observatory Science Operations, 302 in Observatory Telescope Operations, 26 in Observatory Development Programs, 52 in Observatory Administrative Services, and 35 in the Director's Office.

The Division of Astronomical Sciences (AST) is carrying out a community-based review of its entire portfolio and expects that this review will be completed during FY 2012. Findings from this review will inform future budget allocation and planning activities.

In FY 2013 the Karl G. Jansky Very Large Array (VLA) will begin full science operations. Transformed by upgrades in the hardware, electronics and computing of the existing VLA infrastructure, the Jansky VLA will provide order-of-magnitude improvements in observing sensitivity, spectral coverage, and resolution. *Credit:NRAO/AUI*

**Total Obligations for NRAO**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | ESTIMATES[1] FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Operations and Maintenance | $43.14 | $43.14 | $41.00 | $41.82 | $42.66 | $42.66 | $42.66 | $42.66 |
| *Observatory Management* | *6.03* | *6.03* | *5.73* | *5.85* | *5.97* | *5.97* | *5.97* | *5.97* |
| *Observatory Operations* | *31.77* | *31.77* | *30.20* | *30.80* | *31.41* | *31.41* | *31.41* | *31.41* |
| *Science, Academic Affairs, EPO* | *3.62* | *3.62* | *3.44* | *3.51* | *3.58* | *3.58* | *3.58* | *3.58* |
| *Central Development Lab* | *1.72* | *1.72* | *1.63* | *1.66* | *1.70* | *1.70* | *1.70* | *1.70* |
| Implementation of EVLA | 1.13 | - | - | - | - | - | - | - |
| ALMA Operations | 23.38 | 28.61 | 32.92 | 36.41 | 39.17 | 39.17 | 39.17 | 39.17 |
| **Total, NRAO** | **$67.65** | **$71.75** | **$73.92** | **$78.23** | **$81.83** | **$81.83** | **$81.83** | **$81.83** |

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The primary area of increased funding in FY 2013 is in ALMA operations. Base funding for NRAO operations decreases in FY 2013 as part of the budget realignment plan to support increases in ALMA operations. The amounts presented here may be adjusted based on the outcome of the astronomy portfolio review currently in progress. Funding for the implementation of the Expanded Very Large Array (EVLA), recently renamed the Karl G. Jansky Very Large Array (Jansky VLA), concluded in FY 2011.

Partnerships and Other Funding Sources: NRAO supplements Division of Astronomical Sciences (AST) support with funding provided by other NSF sources, other federal agencies, and non-federal sources. In FY 2011, NRAO received approximately $1.10 million from non-AST sources at NSF, $1.30 million from other federal agencies, and $530,000 from U.S. universities, foreign scientific and technical institutes, and other non-federal and industrial sources. The development of new telescopes, instrumentation, and sensor techniques is conducted in partnership with relevant industries through competitive subawards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer hardware and software companies.

Education and Public Outreach: NRAO supports a comprehensive outreach program that makes information about radio astronomy available to the public (see www.nrao.edu/index.php/learn). With over 150 students involved per year, NRAO facilities are also used by graduate students carrying out dissertation research and work experience programs and by undergraduate students participating in the Research Experiences for Undergraduates (REU) program. NRAO sites also support visitor and education centers and conduct active educational and public outreach programs. The Green Bank Science Center and the visitor center at the Jansky VLA together attract about 62,000 public visitors each year.

Observatory Management, $5.73 million: Observatory Management includes the director's office, administrative services, and the New Initiatives Office.

Observatory Operations, $30.20 million: The Observatory Operations programmatic area includes support for operating facilities at Green Bank, West Virginia and in New Mexico, and the computer and information services that support the facilities.

Science & Academic Affairs and EPO, $3.44 million: This area includes staff research, science training and education, science centers, the library, science community outreach, and news and public information.

Central Development Laboratory (CDL), $1.63 million: The CDL is developing next generation electronics and detectors for radio astronomy, making fundamental contributions to materials science, the physics of quantum detectors, electromagnetics, photonics, and radio propagation.

Implementation of EVLA, $0.00: As planned, support for the construction phase of EVLA was last obligated in FY 2011.

ALMA Operations, $32.92 million: NRAO is engaged in construction of the international ALMA, which in FY 2013 will be in the final stages of construction, funded through the Major Research Equipment and Facilities Construction (MREFC) account. Early operations funding for ALMA began in FY 2005 and ramps up sharply from FY 2008 to FY 2015. A funding profile through FY 2015 was authorized by the National Science Board in February 2011. Please see the MREFC chapter for additional information on ALMA construction.

In 2006 NRAO created the North American ALMA Science Center (NAASC) to support the broad user community in fully realizing the scientific capabilities of ALMA. The NAASC is increasing its activity in conjunction with the ramp up in ALMA operations. The NAASC serves two key functions: (1) supporting basic ALMA operations as an ALMA Regional Center (ARC), providing day-to-day support for ALMA operations carried out in Chile, and (2) providing easy access and strong support to the broad astronomical community that will be using ALMA. The NAASC organizes summer schools, workshops, and courses in the techniques of millimeter and submillimeter astronomy.

**Facility Report**

Management and Oversight

- NSF Structure: Continuing oversight and assessment is carried out for NRAO and ALMA by dedicated AST program officers and in consultation with community representatives making use of detailed annual program plans, long-range plans, quarterly technical and financial reports, and annual reports submitted to NSF, as well as by attendance by the AST program officers and AST management at triannual governance committee meetings of the managing organization, Associated Universities, Inc., (AUI). To address issues as they arise, AST works closely with other NSF offices, such as the Office of General Counsel and the Division of Acquisition and Cooperative Support and the Large Facilities Office in the Office of Budget, Finance, and Award Management.
- External Structure: Management is through a cooperative agreement with AUI. AUI manages the observatory through its own community-based oversight and users' committees. The NRAO director reports to the president of AUI.
- Reviews: NSF conducts annual reviews of the NRAO Program Operating Plan, the Long Range Plan, and the AUI Management Report. A Business Systems Review and mid-term Management Review are scheduled to be conducted in FY 2012.

Renewal/Recompetition/Termination

The current cooperative agreement is in place for the years FY 2010 through FY 2015. Preparations are underway for a solicitation for the management and operation of NRAO that will be promulgated in FY 2013 for a new cooperative agreement to begin October 1, 2015.

## OTHER FACILITIES FUNDING

### Major Research Equipment and Facilities Construction Account Projects

The MREFC account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts.

For information on projects funded through this account, refer to the MREFC chapter of this Budget Request.

### Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction planning activities for prospective large facility projects. This funding generally supports such activities as design, cost estimates, and other actions that prepare potential projects for oversight review, agency decisions milestones, and potential implementation.

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# OneNSF INVESTMENTS
# CYBER-ENABLED MATERIALS, MANUFACTURING, AND SMART SYSTEMS (CEMMSS)

## OVERVIEW

In the spirit of OneNSF and in response to the President's Materials Genome Initiative and Advanced Manufacturing Partnership, the Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) framework includes a number of related science and engineering activities – breakthrough materials, advanced manufacturing, and smart systems – across the Foundation. NSF recognizes that substantive advances in the next generation of discoveries in any single CEMMSS domain are entirely dependent upon complementary advances in the other two domains. CEMMSS is a new investment framework that will pursue solutions to three major questions:

1) What is the scientific basis for designing, manufacturing, and deploying cyber-enabled smart systems and the new materials from which they will need to be composed?
2) Who will have the multidisciplinary skills to design, build, and implement these materials and systems? and
3) What gives us confidence that these materials and future systems will predictably perform as designed once transitioned into practice?

Materials science, advanced manufacturing, robotics, cyber-physical systems, and innovation are not new research topics for NSF. Over the years, elements of these areas of research have been included in core and cross-cutting programs in the Directorates for Computer and Information Science and Engineering (CISE), Engineering (ENG), Mathematical and Physical Sciences (MPS), Biological Sciences (BIO), and the Office of Cyberinfrastructure (OCI). Bringing these investments together under one umbrella emphasizes the important interdisciplinary research to be undertaken and the potential for interaction among various research ideas, boosting scientific discovery and the economic future of the Nation. The research needed to make progress includes the following three areas:

*1. Breakthrough materials.* New integrated computational, experimental, and data informatics tools are needed to create advanced materials; seamlessly integrate improved predictive modeling algorithms of materials behavior into product design tools; and design frameworks that enable rapid and holistic design engineering. Research areas include:

- Discovery and development of materials with multi-functional capabilities;
- Predictive algorithms that have the ability to model behavior and properties across multiple spatial and temporal scales;
- Computational mining of the genomic data from diverse biological systems to identify inspirations for the design and synthesis of new materials with defined properties and capabilities;
- Predictive synthetic biology to design new nanomaterials, particularly based on photosynthesis and other biological processes;
- Improved physics-based models that can be used in advanced techniques, such as high-throughput combinatorial processing;
- New synergies between experimental and computational methods; and
- Cyberinfrastructure for materials to facilitate multi-disciplinary communication, to accelerate the rate of innovation by sharing materials properties data, and to develop modeling and simulation tools that enable the creation of advanced materials with specific parameters.

*2. Advanced manufacturing.* This area focuses on product and process design, including novel features, functions and desirable attributes, increased quality and reliability, greater customization, production speed, productivity, reconfigurability, resource optimization, and sustainability. Research areas include:

- Robotics, autonomous systems, the role of simulation and modeling, and the role of big data from multiple sources to assist in computer-integrated and cyber-based manufacturing;
- Dynamic behavior of manufacturing and supply chain operations for more efficient and responsive production and distribution;
- Improved flexibility in interface protocols, interoperable applications and service architectures for advanced manufacturing;
- Novel paradigms for reconfigurable, evolvable, adaptive nano-hardware architectures, and the use of heterogeneous systems that can dynamically change via software mechanisms capable of combating error-prone devices at the nano-scale;
- More adaptive, responsive applications that are made possible by intelligent computation and communications; and
- Optimizations of low-power, self-calibrating, and inexpensive cyber systems.

*3. Smart systems*. New algorithms, materials, control schemes, user interfaces, communication protocols, and devices will be required to produce the physical world transducers and autonomous actuation devices needed for engineered systems to perform smartly in dynamic environments. Research areas include:

- Systems technology frameworks to support networked cyber-physical systems with built-in assurance of their critical properties, including safety and security, and correct, timely performance of their intended functions;
- Rigorous, systematic, scalable, and repeatable design, development, verification, and validation methods, particularly to integrate design, evolution, and certification and reduce the cost of including (or modifying) new Information Technology (IT)-based capabilities in products for public use;
- Development of the next generation of robotics to advance the capability and usability of such systems and artifacts and to encourage existing and new communities to focus on innovative application areas;
- Advances in extracting information from diverse inputs, including the continuous streams of data generated by embedded physical and chemical sensors, to provide timely and critical input into control loops that must make decisions and take actions in real time; and
- Fundamental cognitive and behavioral science needed to make devices that are trustworthy and will be effectively used by people in the U.S. and in markets around the world, as well as the economic, social, and decision science needed to understand adoption and deployment.

*Why NSF?* NSF is unique among federal agencies because it supports foundational academic research in computer science, engineering, the physical and biological sciences, and education; has long experience in developing and implementing interdisciplinary programs across these fields; and invests in innovation and transition of discoveries into practice. To accomplish the vision of cyber-enabled smart systems and the new materials from which they are composed, increasingly complementary and interdisciplinary research challenges need to be addressed. Each system conceived and developed at the intersection of these domains must evolve under both the constraints and degrees of freedom that each one contributes. Interdisciplinary advances are necessary to make progress in scientific and engineering foundations and for the emergence of novel smart systems application solutions.

## Goals

The CEMMSS framework will focus on activities in three tracks – science and engineering, education and workforce, and cyberinfrastructure. The goals of the three tracks include:

1. *Science and engineering*: Establish a scientific basis, a codified knowledge base, and shared principles for designing, manufacturing, and deploying cyber-enabled, smart engineered systems.
2. *Education and workforce*: Educate a cadre of high caliber disciplinary and interdisciplinary researchers and develop a vibrant workforce so as to ensure a pipeline of talent and a growing community in this critical area.
3. *Cyberinfrastructure:* Develop the infrastructure that can be used to discover, test, refine, validate, and approve materials, designs, and manufacturing and development methods for smart engineered systems.

**Approach**

The interaction of research ideas that is promoted by CEMMSS multiplies their impact across multiple research communities. Bringing together researchers focused on breakthrough materials, advanced manufacturing, and smart systems will increase collaboration and communication among these research communities leading to enhanced disciplinary research, as well as more interdisciplinary research. These efforts will transform static systems, processes, and edifices into adaptive, pervasive "smart" systems with embedded computational intelligence that can sense, adapt, and react. While hints of what is possible are already apparent, the smart systems of tomorrow and the materials from which they will be composed will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, usability, recoverability, and recyclability.

*Programmatic.* To generate new capabilities with meaningful impact, NSF must develop a portfolio that coordinates and synchronizes activities across the three main areas – breakthrough materials, advanced manufacturing, and smart systems – and allows interdependencies and common research elements to surface and be exploited in each subsequent stage of the evolution of the program.

*Organizational.* An internal working group (WG) will be charged in FY 2012 to develop CEMMSS activities and implement the suite of activities over the next four years. The WG will also be asked to develop a set of metrics by which program progress can be evaluated over time.

*Scope.* Pair-wise connections already exist at NSF, e.g., between robotics and manufacturing; materials and manufacturing; cyber-physical systems and robotics; and robotics and the biological sciences. Activities that aim to bring together all of these research areas will be critical if this ambitious program is to succeed. NSF will hold workshops and request white papers for the associated research areas to contribute to the development and evolution of CEMMSS program solicitations and dear colleague letters. In addition, NSF will develop partnerships with other agencies and with industry to leverage CEMMSS investments.

## INVESTMENT FRAMEWORK

### FY 2012

This initiative aligns well with the President's commitment "to winning the future through investments in innovation, education, and infrastructure," which he launched in June 2011 through the Advanced Manufacturing Partnership[1], National Robotics Initiative[2], and Materials Genome Initiative[3], all activities in which NSF participates. The President's Council of Advisors on Science and Technology (PCAST)

[1] http://www1.eere.energy.gov/industry/amp/
[2] http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503641&org=CISE
[3] http://www.whitehouse.gov/sites/default/files/microsites/ostp/materials_genome_initiative-final.pdf

recently focused on these national priorities in the "Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology"[4] report.

To make progress across the three tracks, in FY 2012, the CEMMSS WG will leverage existing research and education programs, as well as initiate community development activities, as described in more detail below.

*Science and engineering track.* In the first year, the CEMMSS WG will start by developing a baseline derived from portfolio and gap analysis. The analysis will provide a better understanding of the state of the research and will identify the areas that need increased emphasis. The CEMMSS WG will also summarize the recommendations made in recent reports from the PCAST and National Academy of Sciences (NAS) on materials, advanced manufacturing, cyber-physical systems, and robotics. Based on the recommendations in these reports and the portfolio analysis carried out by the WG, it will develop a multi-year plan for CEMMSS with associated milestones and performance measures.

In FY 2012, CEMMSS support includes the NSF investments in Cyber-Physical Systems (CPS) ($31.5 million), the National Robotics Initiative (NRI) ($20.83 million), as well as activities in core research related to advanced manufacturing, robotics, and materials. NRI will provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, conceived as co-robots that work beside, or cooperatively with people, increasing their productivity, performance, and safety, especially in manufacturing, while support for basic research in robotics will enable new functionalities and provide the next-generation of products and services for various industries. A number of pilot programs in materials and engineering will also start in FY 2012, including Designing Materials to Revolutionize and Engineer the Future (DMREF), involving MPS and ENG ($10.0 million).

To jumpstart the CEMMSS activity within the research communities, white papers will be requested, webinars and workshops will be held, and Early-Concept Grants for Exploratory Research (EAGER) awards will be made. A communications plan will also be developed and will include a website with links to relevant programs, information, and activities. During the year, the CEMMSS WG will present their recommendations for the plan to relevant NSF senior management as well as to directorate advisory committees to solicit their input.

*Education and workforce track.* Science and engineering education needs to be transformed to embrace the data- and computationally- intensive components of smart systems. In particular, changes in undergraduate and graduate education will be necessary to ensure a pipeline of a talented and vibrant workforce. In FY 2012, the CEMMSS WG will engage in portfolio and gap analysis; develop a logic model and an appropriately rigorous evaluation methodology; and begin to collect baseline data. NSF will support community workshops specifically focused on the educational aspects of materials, manufacturing, and smart systems. The CEMMSS WG will also partner with existing NSF education working groups, for example, CAREER, Integrative Graduate Education and Research Traineeships (IGERT), Computing Education for the 21st Century (CE21), and Cyberlearning Transforming Education (CTE), to further emphasize smart systems research and education throughout the Foundation.

*Cyberinfrastructure track.* Many reports on cyber-enabled materials, manufacturing, and smart systems establish the need for cyberinfrastructure to accelerate discovery and innovation. The CEMMSS WG will focus on developing partnerships with other NSF working groups, including Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21), to better align with their activities and to better understand how CEMMSS discoveries, materials, and systems might be transitioned into practice.

[4] http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-nitrd-report-2010.pdf

**FY 2013 Request**

Focusing on the knowledge base developed in FY 2012, the CEMMSS WG will create a coordinated set of solicitations and dear colleague letters that cross over two or more areas, expanding on what has been accomplished to date. For example, one new activity will include a focus on the science and engineering foundations of 21st century smart systems and materials. This new program will emphasize, mid-scale team-based interdisciplinary research, building the knowledge base needed to make progress in cyber-enabled materials, manufacturing, and smart systems, with opportunities for transitioning discoveries into practice. In addition, the DMREF program piloted in FY 2012 will evolve to new interdisciplinary areas of cyber-enabled materials ($32.0 million). In FY 2013, CEMMSS will continue to support investments in NRI ($27.50 million) and CPS ($43.0 million).

To make progress across the three tracks, CEMMSS WG activities in FY 2013 will include:

- Workshops that bring together researchers from the different communities to develop grand challenge research problems in the overarching CEMMSS areas with clear outcome goals and performance measures. In addition, the associated big data and cyberinfrastructure components necessary for making advances in cyber-enabled materials, manufacturing, and smart systems will be identified.
- The first CEMMSS Principal Investigator (PI) meeting will be held to provide opportunities for building new interdisciplinary research communities.
- CEMMSS summer schools and new curricula for undergraduate and graduate students in engineering, computer science, materials, and biological sciences will be developed and deployed. To measure the impact of these efforts, the working group will continue the rigorous evaluation methodology started in FY 2012.
- Industry partnership development, interagency activities, and joint programs will be increasingly emphasized in order to leverage NSF investments.

**FY 2014 – FY 2016**

As the CEMMSS investment matures, the focus will be on evolving a comprehensive, integrated program across the focus areas to encourage new connections, discoveries, and/or emerging fields of science and engineering. The CEMMSS WG will develop a coordinated set of integrated innovative solicitations that include all three focus areas and that encourage foundational and interdisciplinary research across them. For example, in FY 2014, CISE and ENG, working together with BIO, MPS, and OCI, will replace the Cyber-Physical Systems solicitation with one on CEMMSS to discover commonalities, leverage new knowledge, and transform fields. Starting in FY 2014, NSF plans to invest in center-scale multidisciplinary research across the CEMMSS activities.

NSF has worked with other agencies, such as the National Institute of Standards and Technology (NIST), the National Institutes of Health (NIH), the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Agriculture (USDA), and the Departments of Transportation and Defense, which are currently building and deploying smart systems of all kinds (e.g., underwater sensor networks; autonomous vehicles that swim, fly, crawl up walls; portable energy efficient storage devices, etc.). Combining mission agency investments with the basic science and engineering funded by NSF could have a significant impact on future U.S. critical infrastructure by embedding computational intelligence in the underlying systems and the materials from which they are composed. By developing partnerships with other agencies, NSF will pave the way to an interagency CEMMSS program starting in FY 2014 or FY 2015.

**CEMMSS Funding**

(Dollars in Millions)

| Directorate/Office | FY 2012 Estimate | FY 2013 Request |
|---|---|---|
| BIO | $3.00 | $5.00 |
| CISE | 50.00 | 91.00 |
| ENG | 56.00 | 110.42 |
| MPS | 32.15 | 50.00 |
| OCI | 0.50 | 1.00 |
| **Total, NSF** | **$141.65** | **$257.42** |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

Using portfolio analysis tools, a baseline of NSF research and education activities in CEMMSS will be established. Metrics will be identified to measure progress across the three tracks. Possible indicators include:

- For science and engineering – increase in breakthrough discoveries; the emergence of new fields; increasing agency, industry and international partnerships; and increasing transition of discoveries into practice (i.e., patents, start-ups, new products);
- For education – increases in the number of smart systems courses offered, faculty recruited and students graduating from academic programs; and
- For cyberinfrastructure – the development of de facto standards for interoperability, increased use of shared data analytic, simulation and modeling tools and common software platforms, and the growth of computer-integrated and cyber-based manufacturing across the U.S.

Based on the program goals and associated metrics, a plan will be developed by the start of FY 2013 for the following four years (FY 2013 through FY 2016) with milestones, subgoals, and evaluation plans at each stage. Yearly program assessments will be carried out by the CEMMSS WG and presented to NSF senior management.

# OneNSF INVESTMENTS
# CYBERINFRASTRUCTURE FRAMEWORK FOR 21ST CENTURY SCIENCE AND ENGINEERING (CIF21)

## OVERVIEW

NSF has a long history of investments in cyberinfrastructure. Since the 1960s, NSF has sought to develop the foundational cyberinfrastructure technologies needed to maintain U.S. prominence in science and engineering (S&E). The shaping of CIF21, a new approach to managing and investing in cyberinfrastructure development and deployment, began in 2007 when NSF formed the Advisory Committee for Cyberinfrastructure (ACCI). Through its six task forces, the ACCI developed recommendations for future directions in the areas of bridging campuses, data and visualization, grand challenges, high-performance computing, learning and workforce development, and software. The recommendations, which are contained in task force final reports formally accepted in 2011, serve as a basis for CIF21 activities.

### Goals

CIF21 will promote new research opportunities and partnerships across all S&E fields by providing integrated and scalable cyberinfrastructure that will leverage existing and new components. This includes identifying common methods and approaches in software, data, networking, cybersecurity, and advanced computing infrastructure, and leveraging the substantial existing cyberinfrastructure activities and efforts underway across NSF. CIF21 will ensure long-term sustainability for cyberinfrastructure by creating communities of users and providers and will also promote the development of a scientific workforce that has appropriate skills and training to develop, deploy, and use cyberinfrastructure. This will result in a greater number of scientific communities that can effectively use cyberinfrastructure to conduct research and education.

A new coordinated NSF-wide strategy for Advanced Computing Infrastructure (ACI) was developed in early FY 2012 as a key component of the CIF21 framework. This strategy seeks to position and support the entire spectrum of NSF-funded communities at the cutting edge of advanced computing technologies, hardware, and software. It also aims to move away from an approach centered on procurement and promote a more complementary, comprehensive, and balanced portfolio of advanced computing infrastructure and programs for research and education to support multidisciplinary computational and data-enabled science and engineering that supports the entire scientific, engineering, and education community. This approach is consistent with the recent PCAST review of NITRD (*PCAST, December 2010, "Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology.")*

### Approach

CIF21 is governed by a steering committee, consisting of NSF assistant directors, which provides strategic direction for CIF21 activities. In FY 2012 this committee established a CIF21 Strategy and Leadership Group (SLG), with representation from each directorate and office; OCI provides both technical and administrative support. The SLG provides guidance for a portfolio of programs, including cross-directorate (common) and single directorate (unique) programs. It has four major areas of responsibility: 1) Development of solicitation guidance for common CIF21 programs; 2) coordination of common and unique CIF21 activities; 3) convening and charging of writing groups for common CIF21 programs; and 4) programmatic planning and budgeting for CIF21. The SLG has chartered initial writing groups in software development, data services, and computational and data-enabled science and

engineering (CDS&E). These groups will coordinate existing and new NSF programs, perform gap analyses, and develop new programs to fill the gaps.

## INVESTMENT FRAMEWORK

### FY 2012

FY 2012 is the first year of CIF21. Investments in FY 2012 begin to build the CIF21 portfolio by focusing on building new communities of developers and users of digital environments and beginning to make awards that develop core data and computational technologies to bridge scientific communities. This will position NSF to specify requirements for data systems and computational requirements and to further develop and integrate robust software resources in FY 2013.

Community Building

- The EarthCube program, involving GEO and OCI, is a multi-year initiative to support earth-system science. Early-Concept Grants for Exploratory Research (EAGER) and supplement awards are being used to develop concepts. A community-building event will be held mid-year and additional awards will be made in summer/fall 2012. OCI is providing $2.0 million and GEO is providing $4.0 million in support for FY 2012.
- The existing Research Coordination Networks (RCN) solicitation, supported by BIO, EHR, GEO, MPS, SBE, OPP, OISE, and OCI, has been expanded to involve two additional directorates, CISE and ENG.

Integration

- The Software Infrastructure for Sustained Innovation ($SI^2$) program involves BIO, ENG, MPS, and OCI. Its goal is to support the further development of existing scientific software to create tools that can be useful to broader communities. A new component of $SI^2$ is initiation of an Institutes track to establish center-scale awards of approximately $5.0 million per year, each, that bring together tools, data, and computational resources to advance grand challenge science goals. A novel, multi-stage process is being developed that will be science driven, risk-managed, and promote cross-disciplinary collaboration.
- The SLG is forging partnerships with other cyberinfrastructure efforts at the Foundation, including those involving construction of large facilities and the cyberinfrastructure track of the Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) OneNSF investment.

Data and Computational Technologies

- The BigData Senior Steering Group (BDSSG) of the Networking and Information Technology Research and Development (NITRD) program, will launch a Core Techniques and Technologies for Advancing Science and Engineering (BIGDATA) solicitation involving CISE, MPS, and OCI at NSF, as well as other agencies, including several institutes at NIH. The program aims to develop new approaches and tools to address the challenges of managing, analyzing, visualizing, and extracting useful knowledge from large, diverse, distributed, and heterogeneous data sets. This includes the development of data analytics, algorithms, and statistical and mathematical methods.
- A new program in computational and data-enabled science and engineering in Mathematical and Statistical Sciences (CDS&E-MSS) is established jointly with OCI and the Division of Mathematical Sciences (DMS). Workforce development and community needs workshops are planned in order to determine unmet needs in the mathematics and statistical science communities with respect to computational resources.
- Multiple efforts have been initiated in the area of data cyberinfrastructure. A joint effort between MPS and OCI addresses long term data storage, management, and access issues. SBE and OCI have

a joint program in the area of metadata for long-standing large scale social science surveys META-SSS) that seeks to enhance data access and usability, and to facilitate interdisciplinary analyses. OCI, MPS, GEO, and the European Union (EU) are coordinating on a call for international data cyberinfrastructure proposals. The new OCI DataNet solicitation addresses the data cyberinfrastructure needs of multidisciplinary data-intensive researchers.

**FY 2013 Request**

Community Building

- The EarthCube program will develop additional community efforts and prototype systems for integrating scientific communities with respect to data, modeling, and analysis. New areas of common interest and joint solicitations will be developed with BIO, CISE, ENG, MPS, and OPP to create components of EarthCube. OCI will provide $5.0 million and GEO will provide $12.0 million to support EarthCube in FY 2013.
- The RCN will continue to build digital communities with new scientific communities, including OPP. Some of the evolving prototypes may transition to operational RCNs. International collaboration on data curation, standards, and access will be explored.

Integration

- Under the $SI^2$ program, it is expected that the first software institute will be established. This center will serve as a resource for software development to scientific communities. GEO and some of the large facility construction projects are expected to participate. Likely collaborators include the large telescopes, the High Energy Physics Center, the National Ecological Observatory Network, and the Ocean Observatories Initiative. A joint effort on exascale software development with the Department of Energy is being explored.
- NSF's large facilities are in many cases developers and users of significant cyberinfrastructure resources. A well attended breakout session at the spring 2011 Annual Large Facilities Operations workshop highlighted the concerns related to data and cybersecurity. A CIF21 WG consisting of program directors of large facilities is being considered. This will focus on common cyberinfrastructure needs of the major facilities.
- Efforts will continue to support cyberinfrastructure development for materials research in collaboration with the CEMMSS investment.

Data and Computational Technologies

- The Core Techniques and Technologies for Advancing Big Data Science & Engineering (BIGDATA) program will be expanded to involve BIO, ENG, and SBE at NSF, as well as additional NITRD agencies. The initiative will expand to include education and workforce development activities, as well as competitions and prizes in areas relevant to big data challenges.
- OCI data cyberinfrastructure programs will include additional solicitations on data interoperability, storage, policy, and integration with increased international coordination.
- Large facility data requirements will be considered in the data storage, management, and access efforts. Joint solicitations to include BIO, ENG, and GEO, in addition to MPS and OCI, are planned.

Sustainability

- Efforts in programs across the portfolio of CIF21 programs will ensure development of the workforce required to sustain the Nation's cyberinfrastructure.

**FY 2014 – FY 2016**

In FY 2014 through FY 2016, it is expected that many of the development efforts will begin to produce practical tools for deployment and use by research communities. Relying on a spiral development approach, promising areas for additional investment will be considered by the Strategy and Leadership Group and AD Steering Committee for further development. Also, programs will begin to experiment with different funding approaches, including grand challenge prizes.

EarthCube is expected to develop a suite of tools to integrate the geoscience communities, and many are expected to become available and adapted for use by other scientific communities outside the geosciences.

The $SI^2$ program will mature by supporting a total of 2-3 institutes that will serve as a resource to software developers in academic communities, as well as a number of smaller software projects. These combined efforts will expand the network and library of accessible and useable software tools.

The Core Techniques and Technologies for Advancing Big Data Science & Engineering (BIGDATA) solicitation will include education and workforce development activities, as well as competitions and prizes in areas relevant to big data challenges.

OCI data cyberinfrastructure programs will provide increasing levels of access to federally funded scientific data for national and international scientific and engineering collaborations.

Research to understand and solve issues of cyberinfrastructure sustainability, including shared governance, succession, and management of technological trajectories will be supported. The transition to practice focus and efforts in OCI help bridge the gap from idea to deployment. Awards will ensure that tools are created for scientists and that scientists develop skills and relationships with industry to create a full cycle of innovation for cyberinfrastructure.

**CIF21 Funding**

(Dollars in Millions)

| Directorate/Office | FY 2012 Estimate | FY 2013 Request |
|---|---|---|
| BIO | $2.00 | $4.00 |
| CISE | 12.00 | 16.00 |
| ENG | 5.00 | 11.00 |
| GEO | 4.00 | 12.00 |
| MPS | 11.50 | 19.55 |
| SBE | 5.50 | 6.00 |
| OCI | 23.00 | 32.03 |
| OISE | - | 1.00 |
| OPP | 4.00 | 4.50 |
| IA | 11.00 | - |
| EHR | - | - |
| **Total, NSF** | **$78.00** | **$106.08** |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

The CIF21 investment will be evaluated by the Strategy and Leadership Group (SLG) in the short term and by an independent contractor in the long term.

In the short term (FY 2012 – FY 2013) the SLG, in concert with its writing groups, will be performing assessments to inform decision making at the close of each fiscal year. The writing groups will be evaluating directorate and office efforts and solicitations that support ongoing discipline-driven cyberinfrastructure to assess how these efforts can be coordinated with existing and planned CIF21 programs. These assessments will inform decisions concerning the overall CIF21 portfolio balance as well as provide a basis for suggested changes to other directorate and office programs involving cyberinfrastructure to focus on common approaches and leverage CIF21-specific programs.

Prior to the end of FY 2013, the investment-wide assessment will be shared with both the AD steering committee as well as the external advisory committee, ACCI, in order to gain insight in strategic directions. Adjustments to existing programs and formulation of plans will result. A proposal for an independent evaluation by an outside party may be initiated before the end of FY 2013 to help further define data needs with respect to overall portfolio evaluation.

In FY 2014 or FY 2015 a summative evaluation will be carried out through an outside party. The evaluation will examine outcomes of awards to establish the degree to which the goals of scalability, integration, and sustainability have been achieved, as well as the degree to which the cyberinfrastructure has supported new scientific discoveries. Specific metrics might include the value of CI tools associated with new discoveries, the level of use of new coupled systems, the degree of coupling of existing systems, disciplinary diversity of system users, and perceptions of the level of CI support in various communities. The impact of CIF21 in computing and cyberinfrastructure programs will extend beyond the programs directly affiliated with CIF21, so it will not be appropriate to compare programs under the CIF21 framework with those outside it.

# OneNSF INVESTMENTS
# $E^2$: EXPEDITIONS IN EDUCATION

## OVERVIEW

Expeditions in Education ($E^2$) is an NSF initiative to infuse cutting-edge science, engineering, and innovation into the preparation of a world-class scientific workforce for the twenty-first century, and to ensure that all of NSF's education and workforce investments are drawing on the latest educational theory, research, and evidence. The initiative will draw in new ideas on the best and most exciting of NSF-supported scientific advances and knowledge.

The resources committed to $E^2$ in FY 2013 will be used to develop pilot activities among all NSF directorates and offices to engage, empower, and energize learners in science, technology, engineering, and mathematics (STEM). This initiative is planned to last five years with planning beginning in FY 2012; pilot activities will be launched in FY 2013; and further shaping and definition will occur in FYs 2014-2017. Additional focus areas may emerge over time.

### Goals

$E^2$ activities will integrate STEM education research and development to improve learning in science and engineering disciplines and capitalize on the scientific assets across NSF to bring engaging new evidence-based practices, content, knowledge, and real-world applications to more learners.

*Scope*
The $E^2$ initiative brings the educational and research missions of NSF together to consolidate, leverage, and focus efforts to "move the dial" towards achieving important national goals in STEM education and human capital development. $E^2$ encompasses all of the science and engineering fields that NSF funds to develop approaches to engaging all citizens in STEM in both formal and informal settings. As such it involves multiple directorates and offices in each of the three focus areas: Transforming Undergraduate STEM Learning through Science and Engineering, Learning and Understanding Sustainability and Cyberlearning, Data and Observations of STEM Education. $E^2$ is a research-intensive activity and the goal for all components must be to address a challenge in STEM learning or education using current or emerging areas of science. This will require disciplinary and interdisciplinary collaboration among cognitive scientists, STEM education researchers, and disciplinary researchers.

*Organizational Structure*
The $E^2$ initiative will be managed jointly, with the research directorates/offices leading areas in their disciplines and EHR providing coordination, evidence-based practices, and evaluation expertise. Research directorates and offices will participate in $E^2$ by providing funds to jointly support the R&D projects and by re-defining ongoing R&RA-based education efforts to fit within $E^2$ and consolidating efforts where appropriate and advantageous. To facilitate its coordination and evaluation role, EHR will make available expert staff liaisons to link to other directorates, divisions, and offices.

A Dear Colleague Letter will be issued in FY 2013 to invite proposals for each of the three focus areas, calling attention to the programs across NSF that are part of the portfolio. Within each program announcement for this set, the $E^2$-specific expectations and language will be included. Review and award decisions will be undertaken as a joint effort among all participating directorates and offices. EHR will match financial and staffing commitments made by the other directorates and offices for FY 2013 $E^2$ activities. All projects funded across the Foundation within the $E^2$ initiative in FY 2013 will become part of a phase-one $E^2$ portfolio that will be managed jointly.

This portfolio will be subject to a set of common metrics, common data collection and reporting standards, and a comprehensive rigorous evaluation. A set of $E^2$ draft guiding principles is under development in FY 2012 to define what will constitute an $E^2$ activity. These principles will be refined over time as the $E^2$ activity matures, and will be central to the Dear Colleague Letter.

**Approach**

The Nation's capacity for innovation and global competitiveness depends on a science and engineering workforce well prepared for the twenty-first century and a citizenry that is science-literate. This means ensuring that learners have access to current science and opportunities to glimpse the frontiers. $E^2$ investments will leverage two important assets of NSF:

- Research that is transforming the frontiers of science and engineering and leading to innovation for society; and
- Research and development to improve STEM teaching and learning for the twenty-first century.

The $E^2$ vision is to *engage*, *empower*, and *energize* America's populace with STEM and to help create tomorrow's STEM leaders. *Engagement*, in part through the exciting content of NSF-funded research programs, will bring learners at all levels, in both formal and informal settings, into evidence-driven educational environments and settings. There they can be *empowered* through evidence-based instruction, and innovative curricular offerings. NSF-wide educational programs will provide tested models for potential national-scale transformation to *energize* tomorrow's STEM workforce, creating deeper levels of knowledge and more dynamic pathways to economic innovation across U.S. society.

Over time, $E^2$ will transform NSF's education portfolio into a coordinated and strategic set of investments spanning: basic research and theory about STEM learning; design, implementation, and assessment of models for STEM learning and workforce development; evidence-based models for building institutional and human capacity; and innovative approaches to adaptation and scale-up. Collaboration and coordination among all directorates and offices will lead to a systemic and coherent NSF approach to improved learning in the science and engineering disciplines that capitalizes on the scientific assets across NSF. In addition to the programmatic activity of $E^2$, the re-envisioning of the EHR Directorate proposed for FY 2013 is intended to provide a full set of core investments in STEM education R&D.

The $E^2$ approach will evolve in three stages: conceptualization and planning (underway in FY 2012); pilot effort in three focus areas (FY 2013); longer-term structure, evaluation, and expansion to enhance NSF encouragement of cross-disciplinary science in STEM education and learning (FYs 2013-2017).

## INVESTMENT FRAMEWORK

### FY 2012

In FY 2012 planning efforts are underway, beginning with establishing the baseline portfolio of NSF investment in the three $E^2$ focus areas (undergraduate STEM education, sustainability, and cyberlearning/data). Town hall meetings, focus groups, and webinars will be held internally and with the PI community to determine interest and capacity in the field and the agency to sharpen the focus areas. An investment framework and operational roadmap for $E^2$ in FY 2013 will be developed by a committee of program officers.

Evaluation planning also will begin in FY 2012.

**FY 2013 Request**

In FY 2013, $E^2$ will comprise three initial focus areas:

1. ***Transforming Undergraduate STEM Learning through Science and Engineering***
   This focus area will bring evidence-based practices in teaching, learning, assessment, and research to undergraduate science and engineering education across disciplines, and will enrich the undergraduate curriculum so that all students can have access to inspiring and authentic science learning opportunities. Goals include actively engaging students in the science and engineering enterprise to prepare them either as practitioners or science-savvy citizens, and the initiative will emphasize undergraduate student research and preparation for graduate studies in STEM. As solicitations are developed, principal investigators (PIs) will be asked to frame a major question that they will pursue through their research, such as "How can introductory courses in the physical sciences (both disciplinary and interdisciplinary) be effectively re-imagined and re-designed to put undergraduate research experiences at the center, as a means of enabling more students to continue in STEM and perhaps consider graduate school?" Parallel efforts by STEM education researchers will build theory and knowledge about the impact of such experiences on learners and faculty. An emphasis will be placed on programs that have the potential to be scaled up nationally and potentially affect national statistics for STEM student retention and other important outcome indicators. This will build on several core programs in EHR, such as Transforming Undergraduate Education in STEM (TUES), STEM Talent Expansion Program (STEP), and other learning programs across the agency. For example, the Directorate for Biological Sciences (BIO) will develop a portfolio of investments to catalyze and support the implementation of improvements in undergraduate biology education through the Transforming Undergraduate Biology Education (TUBE) program.

2. ***Learning and Understanding Sustainability***
   In this focus area we will build on current investments in Science, Engineering and Education for Sustainability (SEES) about sustainability. SEES programs, including the Sustainability Research Network (SRNs), are creating new interdisciplinary learning experiences for graduate and undergraduate students as well as literacy programs. The ongoing Climate Change Education program (CCE) that is directed toward K-12 levels will be included in this portfolio beginning in FY 2013. Within this $E^2$ focus we will draw in new ways on the assets and science underway in NSF facilities and centers to bring meaningful data and current scientific practice to learners. Participating programs will reframe solicitations to ask PIs to identify a major learning question that they will pursue in the area of sustainability education (e.g., How do students develop systems thinking skills? Does undergraduate student participation in sustainability research lead to greater interest in STEM careers? Can research centers that focus on sustainability effectively integrate education and public outreach components and demonstrate impact on learning?). This element will place particular emphasis on the role of interdisciplinary science and engineering in transforming learning outcomes at the national scale, with strong partnership between EHR and participating research directorates and offices.

3. ***Cyberlearning, Data, and Observations for STEM Education***
   Modern research in science and engineering generates substantial volumes of data. Increasingly, these data are dynamic and are delivered in real-time through observatories, such as the Ocean Observatories Initiative (OOI) and the National Ecological Observatory Network (NEON), and many other large facilities and major research centers supported by NSF. Most of these facilities and centers invest in education and outreach, but the activities are not always fully integrated into NSF education efforts. NSF-funded Research in cyberlearning, funded in several NSF directorates, is advancing learning using tools for networking, visualization, and other capabilities. For example,

BIO will likely support this focus area to increase its investment in education/workforce development activities at its Centers for Analysis and Synthesis, NEON and in major Advances in Biological Informatics (ABI) investments. Leveraging the data generated by major facilities and centers with the advancements being made in cyberlearning research has the potential to greatly enhance the STEM learning experience. For example, cyber-enabled simulation and data-intensive virtual labs at the secondary and undergraduate level could be developed with the integration of data from major NSF facilities. Additionally, mechanisms could be developed for the submission of samples gathered in K-12 or informal science education settings by scientists with the data processed using instruments based at NSF-funded facilities and university labs. The overall goal of this activity is to address the many questions associated with how STEM learning can be enhanced and how new content can be introduced using these new cyberlearning resources and tools. For example, "what are the premier approaches to pedagogy and faculty development for the "connected" age, and how can these technologies be used to advance a diverse workforce for science and engineering, build a science-savvy populace, or derive value from citizen science?

The first phase of investments, totaling $49.0 million, within the $E^2$ frame will begin in FY 2013.

**FY 2014 – FY 2017**

By FY 2017, as a result of increasing scope and experience with $E^2$, the following specific outcomes are anticipated:

- As noted in the EHR chapter, the EHR portfolio is being reframed to have clear emphasis on a set of core research and development (R&D) activities that provide the intellectual foundation for STEM learning and a set of highly-successful and strongly-leveraged $E^2$ partnerships with the research directorates and offices.
- EHR's STEM education and workforce development portfolio is distinguished from that of other agencies, particularly the U.S. Department of Education, by an emphasis on the learning opportunities in frontier science and the emerging practice of science for the twenty-first century. The STEM education and workforce programs across NSF are conceptualized and managed in partnership with EHR.
- NSF's scientific staff includes a set of individuals, based both in EHR and in other parts of the agency, with formal expertise, training, or experience at the national level in STEM education learning research.
- The $E^2$ initiative will become the agency's signature vehicle for presenting a coherent and exciting set of opportunities in STEM learning investments with an emphasis on well-evaluated learning outcomes for programs that have the potential to operate at the national scale. .

EHR, over the next five fiscal years, will include a stronger and more deliberate infusion of cutting-edge science, engineering, and innovation in all programs designed to prepare a world-class scientific workforce for the twenty-first century. $E^2$ also will lead to changes in the education investments made within NSF's research directorates and offices by enabling much stronger connections to the existing base of research and theory about STEM learning and stronger evaluation of STEM education activities lead by EHR.

**Expeditions in Education ($E^2$) Funding**

(Dollars in Millions)

| Directorate/ Office | FY 2011 Actuals | FY 2012 Estimate | FY 2013 Request | Focus Area |
|---|---|---|---|---|
| BIO | - | - | $2.00 | Transforming Undergraduate STEM Learning through Science and Engineering |
| CISE | - | - | 4.00 | Cyberlearning, Data, and Observations for STEM Education |
| ENG | - | - | 1.00 | Cyberlearning, Data, and Observations for STEM Education |
| GEO | - | - | 12.00 | $6M- Transforming Undergraduate STEM Learning through Science and Engineering, $6M- Learning and Understanding Sustainability |
| MPS | - | - | 5.00 | $2M- Transforming Undergraduate STEM Learning through Science and Engineering, $3M- Cyberlearning, Data, and Observations for STEM Education |
| SBE | - | - | 1.00 | Cyberlearning, Data, and Observations for STEM Education |
| OCI | - | - | 1.50 | Cyberlearning, Data, and Observations for STEM Education |
| OISE | - | - | 0.50 | Cyberlearning, Data, and Observations for STEM Education |
| OPP | - | - | 1.50 | Learning and Understanding Sustainability |
| IA | - | - | - | |
| EHR | - | - | 20.50 | $8M- Transforming Undergraduate STEM Learning through Science and Engineering, $8.17M- Learning and Understanding Sustainability, $4.33M- Cyberlearning, Data, and Observations for STEM Education |
| **Total, NSF** | **-** | **-** | **$49.00** | |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

A single evaluation and monitoring framework will be developed for the $E^2$ activity, with customization as appropriate underneath each focus area. The following are additional details about what activities will be undertaken each year.

### FY 2012

- Establish the unifying goal and framework and clarify sub-goals within each focus area;
- Develop roadmaps and a logic model for each focus under the unifying framework;
- Identify metrics to be used in common across focus areas;

- Develop indices to estimate interdisciplinary scope;
- Align evaluation and monitoring processes with $E^2$ metrics; and
- Undertake feasibility studies for evaluation planning in **$E^2$ *Cyberlearning, Data, and Observations for STEM Education*** focus area.

**FY 2013**

- Use roadmaps and logic models to determine implementation plans and activities;
- Establish evaluation contract for all $E^2$ activity;
- Assure that baseline data is collected for **$E^2$ *Transforming Undergraduate STEM Learning through Science and Engineering*** focus area;
- Incorporate $E^2$ focus on undergraduate transformation in planning for FY 2013 NSF priority goal on undergraduate instruction as the evaluation baseline;
- Determine longer-term goals for $E^2$ impact on EHR and R&RA programs;
- Develop baseline data gathering plan for **$E^2$*Learning and Understanding Sustainability*** focus area; and
- Launch evaluation studies of **$E^2$ *Cyberlearning, Data, and Observations for STEM Education*** focus area.

**FY 2014 – 2017**

- Launch a comprehensive evaluation of impacts on NSF's undergraduate education investments;
- Continue long-term monitoring and focus area evaluations;
- Create a plan and begin implementation for studying impact on EHR programs and R&RA programs; and
- Refine $E^2$ investments based on data; and
- Launch evaluation of **$E^2$*Learning and Understanding Sustainability*** focus area.

# OneNSF INVESTMENTS
# INTEGRATED NSF SUPPORT PROMOTING INTERDISCIPLINARY RESEARCH AND EDUCATION (INSPIRE)

## OVERVIEW

INSPIRE was established to address some of the most complicated and pressing scientific problems that lie at the intersections of traditional disciplines and to advance the NSF's strategic goal of *Transform the Frontiers*.[1] INSPIRE will strengthen NSF's support of interdisciplinary, potentially transformative research by complementing existing efforts with a suite of new, highly innovative Foundation-wide activities and funding opportunities.

### Background

INSPIRE was announced in February 2011 in the NSF FY 2012 Budget Request to Congress, which included funding of $12.35 million in the Integrative Activities (IA) budget for new funding opportunities, to be augmented by co-funding from directorates and offices. It responds to issues raised in a variety of external and internal publications, including a National Academies report[2] that identified barriers to interdisciplinary research (IDR), documents relating to the reauthorization of the America COMPETES Act, the report of the NSF Facilitating Transformative and Interdisciplinary Research (FacTIR) Working Group,[3] and to perceptions in the research community that NSF does not always provide good opportunities for comprehensive review and support of unsolicited IDR proposals that cross traditional boundaries. INSPIRE directly supports NSF's strategic goal of *Transform the Frontiers* and performance goal T-1 (make investments that lead to emerging new fields of science and engineering and shifts in existing fields).

### Goals

**Goal 1:** NSF program officers will have the necessary tools and management support to empower cross-cutting collaboration and risk-taking in developing and managing their awards portfolio.

> INSPIRE seeks to empower program officers to encourage and support bold, interdisciplinary projects. Program officers report that a variety of factors create pressure toward funding of lower risk, more conventional disciplinary choices. INSPIRE will provide financial incentives through co-funding and establish an expectation that NSF management will promote a bolder interdisciplinary and potentially transformative vision. INSPIRE will identify changes to NSF systems and training practices to enable and facilitate interdisciplinary activities.

**Goal 2:** Researchers will submit and NSF will support a greater proportion of unusually novel, creative interdisciplinary proposals.

> Existing NSF programs support potentially transformative interdisciplinary research through the agency's highly-regarded merit review process. INSPIRE seeks to increase NSF's support of

[1] Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011-2016, www.nsf.gov/news/strategicplan/index.jsp (2011).
[2] Committee on Facilitating Interdisciplinary Research, Committee on Science, Engineering, and Public Policy (2004). *Facilitating interdisciplinary research.* National Academies. Washington: National Academy Press.
[3] Final Report, *Facilitating Transformative and Interdisciplinary Research (FacTIR),* www.inside.nsf.gov/od/factir/FacTIRFinalReport_091221.pdf (2009).

bold high-risk interdisciplinary projects that transcend typical programmatic scope, through novel funding and merit review mechanisms. These mechanisms are intended to increase the community's submissions of such proposals and will provide additional funding for their support.

**Approach**

**Programmatic structure:** INSPIRE will address its two goals through two programmatic tracks. Goal 1 will be addressed through Track 1, which focuses on how NSF supports science that may fall outside of the scope of existing NSF programs. In particular, Track 1 activities will encompass improvements in business practices, funding culture, training, and evaluation. Goal 2 will be addressed through Track 2, which will support the development of new funding opportunities and mechanisms that encourage the pursuit of novel, creative projects. New INSPIRE funding mechanisms will demonstrate to research communities the priority that NSF places on interdisciplinary and potentially transformative research.

**Organizational structure:** The NSF Office of Integrative Activities (OIA) will serve as the organizational lead for INSPIRE. The INSPIRE Working Group (IWG) has been established to guide INSPIRE's activities and is co-chaired by members from OIA and one of the research directorates. All research directorates and programmatic offices are represented. The IWG reports to the NSF Director through NSF's Senior Management Roundtable.

**Scope:** By design, the scope of INSPIRE is broad. For Track 1 activities, all research directorates and offices will be engaged. In addition, the Office of Information and Resource Management (OIRM) and the Office of Budget, Finance, and Award Management (BFA) will be called on to address issues, e.g., business systems, performance plans, and novel forms of evaluation. For Track 2, each research directorate and office will participate by providing co-funds to support research projects. OIA will also provide matching support. Program officers from every research directorate and office will be engaged in communicating the goals of INSPIRE to their communities and facilitating cross-Foundational partnering in the review and support of individual proposals. INSPIRE proposals can be in any field of science and engineering supported by NSF.

## INVESTMENT FRAMEWORK

### FY 2011-FY 2012

- **(Track 1)** Based on report recommendations, input from NSF advisory committees, and feedback from NSF scientists and the research community, a detailed implementation plan for INSPIRE will be developed. Also in this timeframe, baseline data on NSF-supported IDR will be gathered for use in subsequent evaluation of the impact of INSPIRE funding mechanisms. Adjustments to NSF's eBusiness systems will be made to enable principal investigators (PIs) to identify multiple NSF programs of interest and to enable program officers to more easily collaborate on review of proposals shared across programs. Tracking of co-funded proposals and training of program officers on IDR review processes will also be enhanced.
- **(Track 2)** In November 2011, Dear Colleague Letter NSF 12-011[4] announced the pilot CREATIV (Creative Research Awards for Transformative Interdisciplinary Ventures) award mechanism, which will award the INSPIRE funds for FY 2012. CREATIV awards, with a maximum award size of $1.0 million, will generally be internally reviewed and will support bold high-risk IDR projects. In general terms, the new CREATIV funding mechanism will:

[4] www.nsf.gov/pubs/2012/nsf12011/nsf12011.jsp

  - Provide $12.35 million in FY 2012 in new centralized integrative activities (IA) funds, matched by directorates and offices, for approximately 30 new awards;
  - Target individuals and small groups of investigators;
  - Be open to potentially transformative ideas on any NSF-supported topic;
  - Use primarily internal NSF Program Officer merit review; and
  - Have aggressive outreach to the research community.
- **(Track 2)** Work will include planning and piloting an expansion of NSF INSPIRE to support awards up to the range of $2.5-$3.0 million for open, untargeted interdisciplinary research efforts that are larger in scale than CREATIV.
- **(Track 2)** Baseline data gathering for recipients and declined applicants of CREATIV awards and their institutions as part of INSPIRE evaluation will be initiated.

**FY 2013 Request**

- **(Track 1)** For the internal practices, systems, and evaluation, the INSPIRE IWG will continue to oversee implementation and gathering of data, with attendant AOAM budgetary needs, such as IT systems development and support, contract evaluations, and staffing.
- **(Track 2)** The INSPIRE activities will continue, supporting the second year of the CREATIV pilot and expanding to include larger "mid-scale" awards up to the range of $2.5-$3.0 million. Directorates and offices will co-fund INSPIRE awards funded through the integrated activities centralized funding source for a total INSPIRE FY 2013 budget of $63.0 million. In general, the new pilot INSPIRE "mid-scale" mechanism will be open to interdisciplinary proposals on any NSF-supported topic and use novel merit review mechanisms involving both internal and external review.

**FY 2014 – FY 2016**

The program will continue with the CREATIV and INSPIRE mid-scale award activities, and in FY 2014 will potentially introduce annual honorific Director's INSPIRE Awards. These are envisioned as highly prestigious awards for potentially transformative future research. Implementation of Track 1 activities will continue and broaden with time.

**INSPIRE Funding**

(Dollars in Millions)

| Directorate/Office | FY 2011 Actuals | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| BIO | - | $2.00 | $4.00 |
| CISE | - | - | 4.00 |
| ENG | - | - | 6.00 |
| GEO | - | 2.00 | 5.00 |
| MPS | - | 3.00 | 7.00 |
| SBE | - | 0.50 | 1.00 |
| OCI | - | 0.50 | 1.00 |
| OISE | - | - | 1.00 |
| OPP | - | - | 1.00 |
| IA | - | 12.35 | 31.00 |
| EHR | - | - | 2.00 |
| **Total, NSF** | **-** | **$20.35** | **$63.00** |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

### FY 2011-2012

The primary tasks for evaluation in these years are to:

- Develop a logic model for the INSPIRE funding mechanism, identify metrics, develop indices to estimate interdisciplinarity, and determine failure targets for high-risk research. Refresh the baseline of data that was collected in the 2007 Booz Allen Hamilton (BAH) proposer survey that was done as part of the IPAMM (Impact of Proposal and Award Management Mechanisms) study.[5] Conduct a feasibility study to do: (1) a short-term portfolio analysis, (2) a medium-term collection of data on outcomes from awards funded by INSPIRE and non-INSPIRE mechanisms, and (3) a long-term study plan for a possible impact study.

### FY 2013

Baseline results from previous years will make it possible to:

- Analyze the INSPIRE portfolio of awards to determine whether the new mechanism is resulting in types of awards that were not being funded with previous mechanisms. Case studies and qualitative assessments of the review process for projects with transformative results are expected to provide helpful information.
- Analyze the results from program monitoring to determine whether results suggest that a rigorous impact evaluation is feasible.

[5] www.nsf.gov/od/ipamm/ipamm_2007 survey.jsp

# OneNSF INVESTMENTS
# NSF INNOVATION CORPS (I-Corps)

## OVERVIEW

The National Science Foundation (NSF) seeks to develop and nurture a national innovation ecosystem that builds upon fundamental research to guide the output of scientific research toward the development of technologies, products, and processes that benefit society.

In order to help jumpstart a national innovation ecosystem, NSF has established the NSF Innovation Corps (I-Corps). The NSF I-Corps' purpose is to support NSF-funded researchers who, with teams, are interested in transitioning their research out of the lab. I-Corps awards are based the on maturity of the effort (i.e. is the research ready to leave the lab), strength of the team, and anticipated market value. The teams selected for I-Corps awards will receive additional support – in the form of mentoring and funding – to accelerate innovation that can attract subsequent third-party funding.

The purpose of the I-Corps grant is to give the project team access to resources to help determine the readiness to commercialize technology developed by previously-funded or currently-funded NSF projects. The outcome of the I-Corps projects will be threefold: 1) a clear go/no go decision regarding viability of products and services, 2) should the decision be to move the effort forward, a transition plan to do so, and 3) a technology demonstration for potential partners.

I-Corps has its genesis in many of the long standing innovation ecosystem programs. Most closely related to I-Corps is the Accelerating Innovation Research (AIR) program in the Directorate for Engineering (ENG), started in FY 2011. The AIR program:

- encourages the translation of the numerous, technologically-promising, fundamental discoveries made by NSF researchers, while drawing upon and building the entrepreneurial spirit of the researchers and students; and
- fosters connections between existing NSF innovation research alliances.

Those existing NSF innovation research alliances include consortia such as Engineering Research Centers (ERC), Industry University Cooperative Research Centers (I/UCRC), Partnerships for Innovation (PFI), Science and Technology Centers (STC), Nanoscale Science and Engineering Centers (NSEC), Materials Research Science and Engineering Centers (MRSEC) grantees and other institutions. Their complementary focus will spur the development of discoveries into innovative technologies through collaboration.

Both I-Corps and AIR are designed to strengthen the U.S. innovation ecosystem.

### Goals

The goals of the I-Corps program are:

- to build on NSF's investment in fundamental research;
- to offer academic researchers and students an opportunity to learn firsthand about technological innovation and entrepreneurship, and thereby fulfill the promise of their discoveries; and
- to prepare students for real-world experience through curricular enhancements, and provide them with opportunities to learn about and participate in the process of transforming scientific and engineering discoveries to meet societal needs.

**Approach**

NSF's core mission is to fund basic research in all fields of science and engineering. I-Corps supports this mission by helping to transform scientific output into technological innovation. I-Corps will leverage existing funding for programs like PFI, AIR, ERCs, STCs and SBIR/STTR, and will utilize additional support from NSF's private-sector and regional partners, including universities, industries, venture capitalists, and nonprofits. The partnership with universities will also contribute to the development of novel pedagogical tools. This support will be used to support entrepreneurship and innovation costs not normally supported by NSF.

The I-Corps program will also help create a new network that will strategically connect NSF-funded scientists and innovators to the national innovation ecosystem, including direct connections with mentors and potential future investors.

*Scope*

The Deshpande Foundation and the Kauffman Foundation have joined with NSF as founding members of the I-Corps public-private partnership. The Deshpande Foundation has been a strong supporter of innovation as a catalyst for positive change. Their support of I-Corps is their first partnership with NSF. The Kauffman Foundation has a history devoted to the support of entrepreneurship and entrepreneurship education, and their participation in I-Corps continues a rich relationship with NSF. For example, Kauffman provided invaluable advice and structure to our Innovation Fellows Post-Doctoral program, carried out in partnership with the American Society for Engineering Education (ASEE), in 2009 - 2010. Donations to the I-Corps program, which will leverage NSF appropriated funds, are currently estimated to be $1.20 million over the first two years.

*Organizational Structure*

NSF participation includes every directorate and NSF's Offices of Cyberinfrastructure and Polar Programs. The structure of I-Corps mirrors the NSF Director's vision of OneNSF, working together seamlessly in well-integrated and efficient ways across organizational and disciplinary boundaries. The internal review structure for the program involves a core of cognizant program officers in partnership with topic-specific program officers in each of the seven directorates and the Offices of Cyberinfrastructure and Polar Programs.

The I-Corps award mechanism includes funding, mentorship, and focused instruction in a hypothesis-driven approach to evaluating potential commercial viability. The I-Corps execution model will involve, at least initially, only a single solicitation. As NSF learns more about the community response to this program, NSF may modify the structure. Modifications might include award size, award duration, education, and mentorship requirements, just to suggest a few possibilities. For example, I-Corps awards could be increased to $75,000 from the current $50,000 to provide the team additional resources.

## INVESTMENT FRAMEWORK

### FY 2011-FY 2012

The Innovation Corps program is a key element in a series of NSF-supported programs concentrating on the innovation ecosystem. As explained in the Overview, I-Corps has its genesis in a number of long-standing programs within the NSF that support the innovation ecosystem. In FY 2011 and FY 2012, investments in the inaugural year for I-Corps complemented these long-standing investments in programs, such as ERC, I/UCRC, PFI, STC, NSEC, and MRSEC. Of course, all of these programs are built on the backbone of support for core research, primarily to individual investigators, found in every directorate at NSF.

The I-Corps program is comprised of three elements, namely:

- Financial support to the team for the development of a prototype or a proof of concept;
- A specific structure for the I-Corps team, comprised of a principal investigator, an entrepreneurial lead, and an innovation/entrepreneurial mentor; and
- A strong educational component focusing on a hypothesis driven approach to developing a methodology for evaluating both the technical merits and the marketability of the concept being proposed.

In FY 2012, the I-Corps program will initially support up to 150 projects annually, at $50,000 each, for up to six months. The projects are submitted to NSF in response to NSF solicitation 11-560 and are reviewed under NSF's standard Grants for Rapid Response Research (RAPID) mechanism.

### FY 2013 Request

The FY 2013 Request begins with the basic I-Corps structure developed in 2011-2012, the elements of which will not change substantively in 2013. In FY 2013, NSF anticipates supporting up to 375 awards at $50,000 each or 250 awards at $75,000 each. However, based on lessons we will learn in the execution of I-Corps in 2012, we may make some adjustments to the program. Potential adjustments include:

- The size and duration of the award;
- The extent to which all I-Corps team members are required to participate in all aspects of the educational elements of the program; and
- The specific providers of the educational content of the program.

Today, a hypothesis driven approach to evaluating technical and market viability is offered to all principal investigators. This approach has proven to be very successful and experience to date indicates it provides significant "value added" to the principal investigator (PI). While this curriculum is currently offered to the PIs by one university, the expectation is that other universities will be able to leverage this curriculum and integrate it into similarly productive curricula. We anticipate, in FY 2013, to offer opportunities to other universities to develop the curriculum, using the lessons learned in the execution of the I-Corps program in FY 2011 and FY 2012. We also anticipate the establishment of regional I-Corps nodes, wherein the hypothesis driven innovation educational offerings for PIs and their teams would be developed and provided by the universities involved in these nodes.

### FY 2014 – FY 2016

In the next three to five years following FY 2013, full-scale integration and dissemination of this program throughout the country, utilizing a regional hub model, is anticipated. The Foundation has purposely

restricted opportunities for providing the educational content of I-Corps to one institution for the first full year of the program (FY 2012), so that we can collect data from the FY 2011 and FY 2012 awardees and learn the advantages and disadvantages of that particular approach. The intention, from the outset, has been to solicit participation of universities throughout the country in offering these dynamic and powerful curricula for innovation. NSF also anticipates that, in the outyears, a substantial cohort of SBIR proposers and winners will develop from successful I-Corps recipients. NSF has already seen, in just the short time since launching this program in July of 2011, a significant number of SBIR proposals from among the I-Corps cohort.

**I-Corps Funding**

(Dollars in Millions)

| Directorate/Office | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| BIO | $0.05 | $0.50 | $2.00 |
| CISE | 0.20 | 2.50 | 6.00 |
| ENG | 0.45 | 2.50 | 6.00 |
| GEO | - | 0.25 | 1.00 |
| MPS | 0.20 | 1.00 | 1.30 |
| SBE | 0.05 | 0.50 | 0.50 |
| OCI | - | 0.25 | 1.00 |
| OPP | - | - | 0.75 |
| EHR | 0.10 | - | 0.30 |
| **Total, NSF** | **$1.06** | **$7.50** | **$18.85** |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

I-Corps is the focus of one of NSF's three Priority Goals for FY 2012 and FY 2013. Progress towards Priority Goals is assessed quarterly by agency senior management and reported on the website *Performance.gov*. The relevant priority goal is to increase the number of entrepreneurs emerging from university laboratories. Specifically, the Priority Goal states that by September 30, 2013, 80 percent of teams participating in the Innovation Corps program will have tested the commercial viability of their product or service.

Additional primary outcomes and milestones for the I-Corps program center on those tangible measures that relate directly to the societal application realized from NSF's investments in basic research. For example, successful completion of the I-Corps grant would be expected to contribute to one or more of the following:

- New start-up businesses, 25-30 percent of I-Corps recipients;
- Licensing, 5 percent of recipients;
- SBIR proposals, 10-15 percent of recipients;
- A business plan suitable for review by third-party investors, 10-15 percent of recipients;
- Students prepared to be entrepreneurially competitive, 80 percent of recipients; and
- New curriculum development or improvement in current curricula focusing on entrepreneurship and innovation.

While the expectation is that the I-Corps program will have a positive impact on all these measures, establishing a realistic *timeline* over which these measures will change is more challenging. Because of the high visibility and high community interest in I-Corps, there is naturally going to be close examination almost immediately of the impact of this program on metrics such as these. It may take more than a one-year cycle to see real and substantive changes in these measures. For this reason, quantifiable *measures of progress* that indicate NSF is indeed likely to see improvements in the above metrics as a result of I-Corps investments need to be used**.**

With the exception of the performance target established in the priority goal, at this early stage in the development and evolution of I-Corps, it is difficult to assign specific numerical targets around the metrics listed above. However, there is the expectation that numerical growth in all these areas will take place as a result of NSF's I-Corps investments. Initial evaluations will focus on process measures primarily, such as level of interest and number of proposals, and the ability to expand the mentor network. More substantive indicators such as start-ups, SBIR submissions, and third party investment will become critical as the program matures. Being very analytical, but also realistic, about the measures of success and when it will be appropriate to use each particular metric, a projected timeline is:

FY 2011: 21 awards at $50,000 each – Primary evaluation, conducted by NSF staff, done on operations and process only; make procedural adjustments as necessary.

FY 2012: Up to 150 awards at $50,000 each – The Foundation will establish baseline activities "Pre I-Corps" and begin data collection of the metrics described above.

FY 2013: Up to 375 at $50,000 each or 250 awards at $75,000 each – The Foundation will initiate evaluations utilizing the baseline metrics developed in FY 2012.

FY 2014-FY 2016: NSF will continue with regular evaluations of the previously described metrics, developing a chronological database that allows for more detailed historical analysis of program success. The approach will be similar to that taken with the very successful Engineering Research Centers and Industry/University Cooperative Research Centers programs since 1985.

# OneNSF INVESTMENTS
# SCIENCE, ENGINEERING, AND EDUCATION FOR SUSTAINABILITY

## OVERVIEW

A sustainable world is one in which human needs are met without harm to the environment, and without sacrificing the ability of future generations to meet their needs. Meeting this formidable challenge requires a substantial increase in our understanding of the integrated system of resource and supply chains, society, the natural world, and the alterations humans bring to Earth. Given the pressing national and global need to realize a sustainable human future, the National Science Foundation (NSF) has developed a coordinated research portfolio spanning the entire range of scientific domains at NSF: the Science, Engineering, and Education for Sustainability (SEES) program.

SEES is a broad investment in the scientific underpinnings of sustainability at numerous temporal and spatial scales. Multiple perspectives and areas of expertise are required to increase our understanding of integrated systems of human society and the natural world. Thematic programs are aimed at building the knowledge base, while simultaneously encouraging interdisciplinary linkages, new partnerships, and education and outreach efforts.

### Goals

SEES has three main goals to advance sustainability:

1. Support interdisciplinary research and education to facilitate the move towards global sustainability (Research and Education);
2. Build linkages among existing projects and partners and add new participants in the sustainability research enterprise (Collaboration); and
3. Develop a workforce trained in the interdisciplinary scholarship needed to understand and address the complex issues of sustainability (Workforce).

### Approach

SEES is planned to be a decade long effort across NSF to coordinate and grow research and education associated with the environment, energy, and sustainability. NSF's work under SEES will be a blend of activities – formal solicitations and informational announcements of interest (e.g., Dear Colleague Letters) that span across scientific disciplines and require input and oversight from multiple NSF directorates. Research in such areas as complex environmental and climate-system responses and pathways will continue to be supported and emphasized across NSF and will be matched by increased emphasis on activities focused on sustainable materials and clean energy technologies. NSF will also work with other federal agencies and national and international stakeholder groups whose function and mission complement NSF's role to ensure that sustainability goals are carried forward.

The portfolio approach – as opposed to a large single program – facilitates coordination, monitoring, and impact across the major investment areas and also across NSF, as SEES activities are complex and highly interdisciplinary. The SEES organizational structure includes:

- A senior leadership committee composed of assistant directors/office heads to provide long-term planning and provide overall guidance;
- A cross-agency integration group composed of division directors and lead program directors, who develop consistent guidelines, provide internal and external communication, and shape evaluation plans; and

- Working groups of program directors, each overseen by assistant directors/office heads/division directors who are most relevant to the specific activity to manage programs or activities. When interagency or international partnerships, such as with the European Union (EU), have been established, then members of those entities may also be members of the working group to facilitate preparation of joint solicitations, establishment of MOUs/MOAs, or other arrangements for collaboration.

## INVESTMENT FRAMEWORK

### FY 2010-FY 2012

In FY 2010, NSF developed SEES in response to numerous major community reports, including the August 2009 National Science Board (NSB) report *Building a Sustainable Energy Future*, which emphasized the need for a coordinated program. Initial efforts focused on developing and coordinating a suite of research and education programs at the intersection of climate and environment, with specific attention to human behavior. These solicitations (Dimensions of Biodiversity; Regional and Decadal Earth System Modeling; Ocean Acidification; Water Sustainability and Climate; and the Climate Change Education program) resulted in awards totaling approximately $70.0 million.

In FY 2011, NSF requested an increment of $105.0 million for new SEES activities. Facing budgetary uncertainties, NSF maintained momentum in the SEES investment area by augmenting existing interdisciplinary programs (Coupled Natural and Human Systems, Research Coordination Networks) and issuing a Dear Colleague Letter (DCL) that advanced the research and education activities proposed for 2011 and laid the groundwork for programs proposed for continuance and expansion in FY 2012. An additional approximately $24.0 million in SEES activities was supported from existing 2011 resources through these activities.

In its FY 2012 Budget Request, NSF proposed to expand SEES by $233.0 million above the FY 2011 Request, through significant investments in programs related to energy and collaborative networks. During FY 2011, interdisciplinary working groups drafted and NSF released solicitations consistent with those plans, although at reduced scope and funding levels, for four new activities totaling approximately $60.0 million. The four new activities initiated in FY 2012 were: the NSF SEES Fellows program, at the postdoctoral level; Sustainability Research Networks (SRN), that include existing and new centers of collaboration; Sustainable Energy Pathways (SEP) focused on integrated energy resource utilization; and SEES-focused Partnerships for International Research and Education (PIRE), which advances international networks.

### FY 2013 Request

In FY 2013, NSF plans to initiate five SEES programs that complement existing programs, including those recently developed for FY 2012. In addition, the five programs are consistent with long-term planning for the SEES investment area, and focus on environmental, technological, and societal resilience; dissemination of results; responsiveness to societal needs; and workforce development. These five programs are:

Two programs related to complex interactions in rapidly changing geographic areas:

- *Coastal SEES* is designed to enable place-based system-level understanding of vulnerable coastal systems; yield outcomes with quantitative predictive value; identify pathways to enhance coastal resilience; and communicate outcomes and develop international connections.

- *Arctic Regions (ArcSEES)* seeks fundamental research that improves our ability to evaluate the sustainability of the Arctic human-environmental system as well as integrated efforts that will provide community-relevant sustainability pathways and engineering solutions.

Two programs related to environmental and societal resilience:

- *Creating a More Disaster-Resilient America (CaMRA)* aims to catalyze basic research and education efforts in hazard-related science, engineering, risk assessment and decision making in order to improve forecasting and prediction of natural and technological hazards, mitigate their effects, and prepare communities to respond to, and recover from disasters.
- *Sustainable Chemistry, Engineering and Materials (SusCHEM)* responds to the America COMPETES Reauthorization Act of 2010 (P.L. 111-358 Section 509), which called for NSF to establish a Green Chemistry Basic Research program that embraces concepts such as renewable feed stocks, atom economy, less hazardous chemical syntheses, life cycle planning and designing safer chemicals. Consistent with the goals of SEES, SusCHEM aims to enable the basic science and engineering discoveries that will reduce dependence on non-renewable resources and improve the efficiency of industrial processes. Example research goals are to utilize new (non-petroleum based) sources of important raw materials; replace toxic chemicals and materials with benign alternatives; economically recycle chemicals that cannot be replaced, such as phosphorus; and devise chemical reactions and processes that require little energy, water and organic solvents, and minimize undesirable by-products.

One program related to energy conservation:

- *Role of Information Sciences and Engineering in SEES (RISES)* addresses the goal of decreasing energy consumption, which can be advanced by information technologies through improved hardware and software, increased use of renewable energy sources, and optimization strategies that minimize energy usage and reduce impacts on the environment. Along with many other efforts, SEES research and communication that is computationally intensive will benefit directly from the efficiencies discovered.

These five programs will total $76.70 million in FY 2013, and are primarily responsible for the $45.50 million increase over the FY 2012 Estimate. Funding for the five programs is partially offset by the Sustainable Energy Pathways (SEP) solicitation, which is released in alternate years (FY 2012 and FY 2014). The FY 2013 programs have strong support throughout all of NSF's directorates and offices. The remaining $125.80 million, which brings SEES to a total of $202.50 million in FY 2013, supports SEES programs that were initiated in prior years.

**FY 2014 – FY 2019**

In FY 2014 and beyond, it is anticipated that SEES will focus on further development and refinement of the investments that were established in FY 2011, 2012, and 2013. Additional focused five-year emphasis areas may be initiated in FY 2014 and FY 2015. Future years will emphasize consolidation and coordination of existing activities; incorporation of any new emphasis areas; dissemination of information from the rapidly growing SEES knowledge base to the scientific community, policy-makers, and the public; and the workforce development critical for producing the next generation of sustainability scientists and engineers.

At the conclusion of SEES, NSF, in collaboration with its partners across government, academia, and industry, expects to have made significant progress towards a sustainable human future. With respect to the three over-arching SEES goals, NSF expects to achieve the following three outcomes:

1. Goal 1, Research and Education: the sustainability science and engineering knowledge base is available and accessible to scientists, decision-makers, and society at large;
2. Goal 2, Collaboration: the private sector will be able to more rapidly identify and deploy technologies and methods to address sustainability issues; and
3. Goal 3, Workforce: transdisciplinary approaches to sustainability education are common practice; the U.S. has a robust and appropriately sized cadre of early career scientists and engineers to address sustainability issues.

As programs have been phased into SEES each year, it is expected that the various programs will not necessarily end simultaneously. Based on the results of rolling assessments, programs will have variable lifetimes, and successful programs of continued relevance will be folded into core research in directorates and offices. Thus, while the SEES portfolio has a planned conclusion, the critical research, engineering, and education on sustainability that has been catalyzed by the initiative will continue to have impact throughout NSF.

**SEES Funding**

(Dollars in Millions)

| Directorate/Office | FY 2011 Actuals | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| BIO | $24.59 | $27.25 | $34.75 |
| CISE | 2.25 | 8.00 | 11.50 |
| ENG | 3.28 | 19.25 | 20.00 |
| GEO | 28.85 | 44.25 | 70.75 |
| MPS | 2.72 | 16.50 | 27.20 |
| SBE | 6.25 | 7.75 | 8.75 |
| OCI | 5.61 | 1.50 | 3.00 |
| OISE | 1.33 | 12.00 | 11.55 |
| OPP | 7.00 | 14.50 | 14.50 |
| EHR | 6.08 | 6.00 | 0.50 |
| **Total, NSF** | **$87.96** | **$157.00** | **$202.50** |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

NSF will employ a variety of tools to evaluate the scientific impact and progress of the various programs in the SEES portfolio. The senior leadership will consider a matrix of assessment methods and measures that captures a range of outcomes and impacts. Planned evaluation activities include, by main SEES goal:

**Goal 1: Research and Education**

- *Short-term:* Conduct a portfolio analysis to examine the representation of multiple disciplines in proposals, and project reports. Use the portfolio analysis to identify gaps.
- *Long-term:* Engage an external group to conduct an independent assessment of the legacy of funding through SEES.

**Goal 2: Collaboration**

- *Short-term:* Monitor indicators of collaboration such as the number of new international collaborations, private and public sector participants in networks, papers in publications, or fora applicable to private and public sector concerns.
- *Long-term:* Use a network analysis to measure changes in nodes and links through time.

**Goal 3: Workforce**

- *Short-term:* Develop and baseline a monitoring system to collect metrics associated with the goals of SEES workforce development programs (such as SEES Fellows)
- *Long-term:* Use monitoring data to determine if a formal impact evaluation for large investments is indicated.

As solicitations are a key component of the SEES portfolio, NSF program directors will be looking for success indicators such as increased number of highly-rated proposals received, representation of multiple disciplines in proposals, and development of new international collaborations. NSF is particularly interested in measuring results in terms of new and productive connections made between researchers in a range of disciplines; development of new knowledge and concepts that advance the over-arching goal of a sustainable human future; and development of a workforce capable of meeting sustainability challenges.

# OneNSF INVESTMENTS
# SECURE AND TRUSTWORTHY CYBERSPACE (SaTC)

## OVERVIEW

The Secure and Trustworthy Cyberspace (SaTC) investment is aimed at building a cybersecure society and providing a strong competitive edge in the Nation's ability to produce high-quality digital systems and a well-trained workforce. Achieving a cybersecure society is a critical challenge in today's world, as corporations, agencies, national infrastructure, and individuals have been victims of cyber-attacks. These attacks exploit weaknesses in technical infrastructures and human behavior. Understanding the motivations and incentives of individuals and institutions, both as attackers and defenders, can aid in creating a more secure and trustworthy cyberspace. Addressing this problem requires multi-disciplinary expertise in statistical, mathematical, computational, economic, and computer sciences, and ultimately the transition of new concepts and technologies to practice.

Fundamental research in algorithms, models, probability theory, reliability, statistical theory and analysis, cryptanalysis, system structures, and secure computing is needed to stay ahead of new threats enabled by new technologies. The increasing power of computers implies that in the next era of computing many existing algorithms used to secure transmissions will no longer be robust or adequate. Research is needed in market mechanisms that can align incentives, hedge risks, and reduce the frequency and severity of attacks and that provides a deeper understanding of the social and behavioral factors that affect cybersecurity. Development and deployment of innovative cybersecurity models and practices throughout scientific environments, including research and education communities, to embed innovative curricula within these models and practice is also required. This research and development requires a well-trained professional workforce with new skills and knowledge, necessitating creative and innovative approaches to the education and preparation of tomorrow's cybersecurity researchers.

The 2010 President's Council of Advisors on Science and Technology (PCAST) report on Networking and Information Technology R&D (NITRD) and several National Academy of Sciences reports[1] have argued strongly for the need to increase U.S. cybersecurity research and development. The NITRD *Strategic Plan for the Federal Cybersecurity Research and Development Program* (released in December 2011) details four thrusts that together cover a set of interrelated priorities for the federal agencies that conduct or sponsor research and development in cybersecurity. These four thrusts are: (1) inducing change, which provides four game-changing research themes to direct efforts towards understanding the root causes of current threats, namely designed-in security, moving target defense, tailored trustworthy space, and cyber economic and behavioral incentives; (2) developing scientific foundations, which calls for the development of an organized, cohesive scientific foundation for the body of knowledge that informs the field of cybersecurity; (3) maximizing research impact, which aims to catalyze integration across the research themes, to increase cooperation between governmental and private-sector communities, to increase collaboration across international borders, and to protect critical infrastructure, such as Health IT and Smart Grid; and (4) accelerating transition to practice, which calls for focusing efforts on ensuring adoption and implementation of the new technologies that emerge from the research themes and scientific foundations, so as to create measureable improvements in the cybersecurity landscape.

Specific objectives of NSF's SaTC program, and how they relate to the four thrusts of the Federal Cybersecurity Strategic Plan, include:

[1] Reports available from http://sites.nationalacademies.org/CSTB/CSTB_059144

*Inducing Change*

- Focus the direction of research on four game-changing research topics – designed-in security, moving target defense, tailored trustworthy space, and cyber economic and behavioral incentives – to better understand the motivations, incentives, and behaviors of users, attackers, and defenders. For example, study how information flows within and between these groups, how organizations or policies can be developed to align individual and societal incentives, or how targets are selected and defended.
- Provide the foundations and tools for privacy, confidentiality, accountability, and anonymity, as well as extraction of knowledge from massive datasets without compromising societal values.
- Advance the design and implementation of software that exhibits resiliency in the face of an attack; the design and composition of software components into large-scale systems with known security properties; the design, including attention to behavior and human factors, of reliable systems that can function dependably even if some subset of components do not function as intended; and support transition of novel software into shared cyberinfrastructure.

*Developing Scientific Foundations*

- Develop the scientific foundations for digital systems that can resist attacks, including a range of cryptographic algorithms and statistical tools that can withstand attacks from novel computing engines, such as quantum computers, and that support operation in environments with restricted computational resources.
- Develop the mathematical and statistical theory and methodologies required to model and predict the behavior of large-scale, complex systems; assure that the large-scale computations in many fields of research are not vulnerable to manipulation or compromise; and develop and implement improved cybersecurity defenses for scientific environments and cyberinfrastructure.
- Develop the scientific foundations to understand how individuals, groups, organizations, and other actors make decisions in the realm of cybersecurity; develop market-based approaches to align incentives for investments, efficiently share risks, and internalize externalities.

*Maximizing Research Impact*

- Ensure that the Nation's populace understands the security and privacy characteristics and limitations of the digital systems on which they rely daily.
- Coordinate with the NSF Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) investment to support foundational research in cybersecurity issues arising in advanced manufacturing, robotics, and critical infrastructure such as Smart Grids.
- Investigate opportunities and challenges in organizational alliances around cybersecurity; examine alternative governance mechanisms, for example, private-public partnerships and international agreements.

*Accelerating Transition to Practice*

- Provide insight and incentives into the process for innovation diffusion and adoption at the organizational, group, and individual levels.
- Drive innovation through applied research, development, and experimental deployment. Transition successful basic research results and commercial innovations into early adoption and use tailored for NSF communities and learning environments. Enable NSF cyberinfrastructure as a premier proving ground and state-of-the-art environment for advancing cybersecurity solutions and moving them into technical and organizational practice.

In addition, SaTC will address the pivotal issues in the education and preparation of tomorrow's cybersecurity researchers. Specific objectives are:

- Promote innovation and development of new curricula and learning opportunities to create and sustain an unrivaled cybersecurity workforce capable of developing sound and secure cyberinfrastructure components and systems.
- Study new approaches to training and education in cybersecurity to understand their impact and provide a basis for continual refinement and improvement.

**Goals**

The long-term goal of the SaTC program is to build the knowledge base in cybersecurity that enables discovery, learning, and innovation in this critical area, and ultimately leads to a more secure and trustworthy cyberspace. The program aligns with the President's *Strategic Plan for the Federal Cybersecurity Research and Development Program* (released in December 2011), which details four subgoals that together cover a set of interrelated priorities for the federal agencies that conduct or sponsor research and development in cybersecurity. These four goals are: (1) inducing change, (2) developing scientific foundations, (3) maximizing research impact, and (4) accelerating transition to practice. In order to achieve these goals, a coordinated, interdisciplinary program is needed.

**Approach**

The Directorates for Computer and Information Science and Engineering (CISE); Education and Human Resources (EHR); Engineering (ENG); Mathematical and Physical Sciences (MPS); Social, Behavioral, and Economic Sciences (SBE); and the Office of Cyberinfrastructure (OCI) will participate in this program. Each of these organizations supports a research community whose abilities are needed to build the envisioned cybersecure and trustworthy environment and to prepare the scientists and supporting workforce needed to sustain and improve that environment. The SaTC program is managed by a Working Group (WG) made up of program directors from the participating directorates and offices.

Under the OneNSF umbrella, the SaTC working group will coordinate with the EHR Scholarship for Service (SFS) program to help align opportunities for cybersecurity education and workforce development. SFS, which focuses on cybersecurity education and workforce development, has funded more than 1,500 students. Over 1,100 of these students have been successfully placed in internships and full-time positions in more than 120 federal agencies and departments. Furthermore, SFS capacity building grants have increased the capacity of the higher education enterprise in cybersecurity education and research.

NSF is uniquely positioned to support the broad, open, long-term, foundational research and education needed to establish a sound basis for progress in this critical area. There are currently about 500 active projects in the CISE cybersecurity programs that pre-date the FY 2012 SaTC program. This research portfolio includes projects addressing security from the microscopic level (e.g., detecting whether a silicon chip may contain a malicious circuit) to the macroscopic level (e.g., determining strategies for securing the next generation electrical power grid). The portfolio also ranges from mathematical algorithms and statistical tools – cryptography, cryptographic protocol analysis, formal specification and verification techniques, reliability, probabilistic modeling, risk analysis, data and text-mining, static and dynamic program analysis, and security testing methods – to human-centric systems that include web applications, smart phones, medical devices, and automotive systems. Through the interagency NITRD program, NSF plays a number of key roles in cross-agency coordination of the federal government's cybersecurity research investments. NSF is active in the NITRD Cyber Security and Information Assurance Interagency Working Group (CSIA IWG), which has a leadership role in executing and coordinating the *Strategic Plan for the Federal Cybersecurity Research and Development Program* across the thirteen member agencies. In addition with its co-chair role on the Senior Steering Group (SSG) for

Cybersecurity R&D, NSF helps define, coordinate, and recommend strategic federal R&D objectives in cybersecurity, and to communicate research needs and proposed budget priorities to policy makers and budget officials, including recommendations to OSTP, OMB, and the Joint Inter-Agency Cyber Task Force (JIACTF).

## INVESTMENT FRAMEWORK

### FY 2012

In FY 2012, CISE, MPS, SBE, and OCI issued a joint solicitation for the new Secure and Trustworthy Cyberspace (SaTC) program that called for proposals that build teams across these different research communities. To help develop this community, the directorates are planning community-building workshops and a PI meeting with interagency representation that will be held in 2012.

SFS will continue its focus on increasing the number of qualified students entering the fields of information assurance and cybersecurity and enhancing the capacity of the United States higher education enterprise to continue to produce professionals in these fields to meet the needs of our increasingly technological society.

### FY 2013 Request

The following activities are planned for FY 2013:

- Expand the number of large, multi-institution projects that provide high-level visibility to grand challenge research areas.
- Expand the research portfolio to include more cross-disciplinary projects and broaden the portfolio to both cover a broader set of research topics and to increase transition to practice.
- Coordinate SaTC efforts with Cyber-enabled Materials, Manufacturing, and Smart Systems, which supports foundational research in cybersecurity issues arising in advanced manufacturing, critical infrastructure, and robotics.
- Continue to facilitate the development of a National Virtual Lab for Cybersecurity Education to promote collaboration and resource sharing.
- Hold a PI meeting that brings together SaTC funded PIs with interested parties from industry and government agencies in support of the NITRD *Strategic Plan for the Federal Cybersecurity Research and Development Program* thrust of accelerating transition to practice.
- Support efforts to define a cybersecurity body of knowledge and to establish curricula recommendations for new courses, degree programs, and educational pathways.
- Through SFS, continue to support efforts to define the knowledge base in cybersecurity education and work with the community to develop recommendations for new courses, degree programs, and educational pathways based on evidence of effective practice. SFS supports innovative and creative projects, which lead to an increase in the ability of the United States higher education enterprise to produce information assurance and cybersecurity professionals.

### FY 2014 – FY 2016

Building on the knowledge base developed during the previous years, SaTC will continue to focus on game-changing research and education; the development of digital systems that are resistant to attacks; coordination with the CEMMSS WG to secure advanced manufacturing systems, robotics, and critical infrastructure; and transition to practice of the research results ready for experimental deployment, early adoption, commercial innovation, or implementation in cyberinfrastructure. To more effectively achieve

its long-term goals, SaTC will develop partnerships with other agencies, industry, and international organizations. The cybersecurity research community is also expected to grow to include more researchers who cross the boundaries between computer science, engineering, economics, social and behavioral sciences, statistics, and mathematics, creating a flourishing cybersecurity research and development ecosystem.

**SaTC Funding**
(Dollars in Millions)

| Directorate/Office | FY 2012 Estimate | FY 2013 Request |
|---|---|---|
| CISE | 55.00 | 69.00 |
| ENG | 3.25 | 4.25 |
| MPS | 0.50 | 2.00 |
| SBE | 4.00 | 4.00 |
| OCI | 4.00 | 6.00 |
| EHR | 45.00 | 25.00 |
| **Total, NSF** | **$111.75** | **$110.25** |

Totals may not add due to rounding.

## EVALUATION FRAMEWORK

Using information collected by the SaTC WG and the recommendations in the recent national strategic plan on cybersecurity, the WG will conduct gap and portfolio analysis to develop a shared understanding of program goals, milestones, and outcomes over the next four years. Each year, the program will conduct an annual review based on those assessments and report its results to NSF senior management as well as to the NITRD CSIA Senior Steering Group for feedback and recommendations.

Based on the four subgoals of SaTC, the outcomes will include: for inducing change – discovery of the root causes of threats and attacks and continuous investment in transformational approaches that improve the security of cyberspace; for developing scientific foundations – development of a systematic scientific approach to cybersecurity, including discovery of laws and principles; for maximizing research impact – partnerships with other agencies, industry, and international collaborators as well as linkages to national priorities, such as health IT or Smart Grid; and for accelerating transition to practice – new patents, products, services, companies, and research that can be transitioned into cyberinfrastructure.

The SaTC program will convene biennial PI meetings to monitor progress in this area of research. In addition, a trend analysis based on the annual reviews will be presented to the CISE Committee of Visitors, which is held every three years.

The SFS program will be evaluated by the Office of Personnel Management's Human Resources Solution (HRS) group with input from the NSF SFS program directors and the OPM SFS Program Office. An evaluation plan and design that links SFS program objectives with measures, data sources, and expected and unexpected outcomes will be submitted and agreed upon in January/February of 2012. The mixed method evaluation is designed to provide information to the program for purposes of program improvement, accountability, and learning, and builds on the previous evaluation that was released in January 2008 by the Assessment Services Branch of the Division for Human Resources Products and Services, U.S. Office of Personnel Management (OPM). As the current evaluation proceeds, HRS will continue to consult with NSF in the design and execution of the evaluation of the SFS program. The evaluation is expected to be completed in FY 2013.

# NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

NSF's contribution to the multiagency National Nanotechnology Initiative (NNI) encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. Novel materials, devices, and systems – with their building blocks designed on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and manipulate matter at this scale, science, engineering, and technology are realizing revolutionary advances in areas such as catalysts for industry, individualized pharmaceuticals, new drug delivery systems, order-of-magnitude faster computer chips, more resilient materials and fabrics, and sustainable development for water and energy resources utilization.

**NNI by Program Component Area**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| 1. Fundamental Nanoscale Phenomena & Processes | $182.13 | $146.29 | $146.29 |
| 2. Nanomaterials | 98.53 | 78.80 | 81.30 |
| 3. Nanoscale Devices & Systems | 55.77 | 52.43 | 53.93 |
| 4. Instr. Research, Metrology, & Standards for Nanotech | 12.89 | 12.05 | 12.05 |
| 5. Nanomanufacturing | 44.83 | 47.77 | 52.77 |
| 6. Major Research Facilities & Instrumentation Acquisition | 35.11 | 28.53 | 28.53 |
| 7. Environmental Health & Safety | 22.42 | 30.01 | 29.91 |
| 8a. Education | 29.31 | 24.79 | 24.79 |
| 8b. Societal Dimensions (ELSI) | 4.09 | 5.33 | 5.33 |
| **Total, National Nanotechnology Initiative** | **$485.08** | **$426.00** | **$434.90** |

Totals may not add due to rounding.

**FY 2013 NNI Funding**

NSF supports nanoscale science and engineering throughout all the research and education directorates as a means to advance discovery and innovation and integrate various fields of research. NNI enables increased interdisciplinarity at atomic and molecular levels for about 5,000 active awards with full or partial contents on nanoscale science and engineering (NSE). About 10,000 students and teachers will be educated and trained in nanoscale science and engineering in FY 2013. NSF contributes to the goals and eight program component areas (PCAs) outlined in the NNI Strategic Plan (www.nano.gov). Increases of $5.0 million in the Nanomanufacturing PCA and $2.50 million in the Nanomaterials PCA will be dedicated to research on breakthrough materials and advanced manufacturing as part of the Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) OneNSF investment, which coordinates and synchronizes activities across three main areas – breakthrough materials, advanced manufacturing, and smart systems – and allows interdependencies and common research elements to surface. Three Nanosystems Engineering Research Centers (NERC), with a total estimated budget of approximately $10.0 million, will be established in the summer of 2012 and start to fully operate in FY 2013. Partnerships of new NERCs with small businesses in the areas of nanomanufacturing and commercialization will be strengthened while maintaining about the same level of NSF investment. In 2013 the agency continues its contributions to translational innovation programs, including GOALI (Grant Opportunities for Academic Liaison with Industry), I/UCRC (Industry/University Cooperative Research Centers), the Innovation-Corps program, AIR (Accelerating Innovation Research), PFI (Partnerships for Innovation), and PFI's Building Innovation Capacity (BIC) component. The NSF Small Business Innovation Research (SBIR) program has an ongoing nanotechnology topic with subtopics for

nanomaterials, nanomanufacturing, nanoelectronics and active nanostructures, nanotechnology for biological and medical applications, and instrumentation for nanotechnology. Overall, NNI funding in the FY 2013 Request will increase by $8.90 million, or 2.1 percent, over the FY 2012 Estimate.

A portion of NSF's FY 2013 NNI funding is for the NNI Signature Initiatives. FY 2013 funding for the Nanoelectronics for 2020 and Beyond Signature Initiative is $45.0 million, which is distributed in the Fundamental Nanoscale Phenomena and Processes, Nanomaterials, and Nanoscale Devices PCAs. These three PCAs also include FY 2013 funding of $31.67 million for the Nanotechnology for Solar Energy Collection and Conversion Signature Initiative. In addition, FY 2013 funding of $23.40 million for Sustainable Nanomanufacturing is contained within the Nanomanufacturing PCA.

In FY 2013, NSF will continue its funding for the Environmental, Health and Safety (EHS) PCA at $29.91 million, representing about seven percent of its overall NNI budget. Requests for research are primarily directed at environmental, health, and safety implications and methods for reducing the respective risks of nanotechnology development.

NSF sponsored an international study on long-term research entitled "Nanotechnology Research Directions for Societal Needs in 2020" (NSF/WTEC 2010, Springer, available on www.nsf.gov/nano and www.wtec.org/nano2/). It provides assessment of nanotechnology development in the last ten years (2000-2010) and a long-term vision of the field in the next decade (2010-2020). This study evaluates the outcomes as recommended by the first report "Nanotechnology Research Directions: A vision for the next decade" (1999), adopted as an official document of the National Science and Technology Council (NSTC).

**Fundamental Nanoscale Phenomena and Processes**

The FY 2013 Request includes $146.29 million, unchanged from the FY 2012 Estimate, for fundamental research and education. Special emphasis will be on:

- *Novel phenomena, quantum control, selfassembling, and basic engineering processes at the nanoscale* – to discover and understand phenomena and design processes specific at the nanoscale, including new phenomena in materials, mechanics, chemistry, biology, electronics, and optics. Potential applications include quantum information systems, novel products by multiscale selfassembling, and new devices and sensors for industry and environmental monitoring. A new focus will be on understanding complex and emerging behavior of nanosystems, and creating nanomaterials and nanosystems by computational design.
- *Biosystems at the nanoscale* – to support study of biologically-based or -inspired systems that exhibit novel properties and potential applications. Potential applications include improved drug delivery, biocompatible nanostructured materials for implantation, exploiting of functions of cellular organelles, devices for research in genomics, proteomics, and cell biology, food and plant systems, and nanoscale sensory systems, such as miniature sensors for early detection of cancer. A focus will be on the understanding of structure and function and simulation of cells, tissues, and nervous systems.
- *Converging science and engineering at the nanoscale* – to support the convergence of nanotechnology with information technology, modern biology, and social sciences – potentially reinvigorating discoveries and innovation in almost all areas of the economy. Examples are the nano-biology interface, the nano-information interface, and nano-neurosciences.
- *Multi-scale, multi-phenomena theory, modeling, and simulation at the nanoscale* – to support theory, modeling, large-scale computer simulation and new design tools, and infrastructure in order to understand, control, and accelerate development in new nanoscale regimes and systems. A special

focus will be on simulations with atomic precision, time resolution of chemical reactions, and for domains of engineering and biological relevance.

- *NNI Signature Initiatives* – to support the NNI Signature Initiatives, as well as planning for Nanotechnology for Regenerating the Human Body and Nanostructured Catalysts for Green Manufacturing.
- *Advanced Manufacturing Technologies* – to support research in the Directorate for Engineering (ENG) and the Directorate for Computer and Information Science and Engineering (CISE) on advanced manufacturing technologies. A portion of this funding supports CISE's participation in the Nanoelectronics for 2020 and Beyond Signature Initiative.

**Nanomaterials**

The FY 2013 Request includes $81.30 million, an increase $2.50 million over the FY 2012 Estimate, for discovery of novel nanoscale and nanostructured materials, and improving the comprehensive understanding of the properties of nanomaterials (ranging across length scales and including interface interactions). A special focus will be design and synthesis, in a controlled manner, of nanostructured materials with targeted properties. Research on the discovery, understanding, and control of materials at the nanoscale will be critical to the development and success of innovative technologies, including advances in electronics in science and engineering beyond Moore's Law, catalysts, energy, healthcare, and manufacturing.

**Nanoscale Devices and Systems**

The FY 2013 Request includes $53.93 million, an increase of $1.50 million from the FY 2012 Estimate, for R&D that applies the principles of nanoscale science and engineering to create novel, or to improve existing, devices and systems. The increase is for nanoscale engineering design in ENG. A portion of support is for CISE's participation in the Nanoelectronics for 2020 and Beyond Signature Initiative. A research focus will be on the architecture and emerging behavior of nanosystems, and on nanomanufacturing of active nanostructures and nanosystems. Nanoelectronics beyond silicon nanotechnology and complementary metal-oxide superconductors (CMOS) research will explore the ultimate limits to scaling of features and alternative physical principles for devices employed in sensing, storage, communication, and computation. The research activity in this area will help develop innovative technologies, including replacing electron charge as information carrier, bottom-up device assembly technologies at the atomic and molecular levels, and new system architectures using nanoscale components. Another focus will be on building biosystems and to regenerate the human body. An additional area of emphasis will be nano-informatics for better communication and nanosystem design.

**Instrumentation Research, Metrology, and Standards for Nanotechnology**

The FY 2013 Request includes $12.05 million – unchanged from the FY 2012 Estimate – for R&D to create new tools needed to advance nanotechnology research and commercialization. Special challenges are developing tools for measuring and restructuring matter with atomic precision, for time resolution of chemical reactions, and for domains of biological and engineering relevance. Another focus is on developing on-line process instrumentation for nanoscale characteristics.

**Nanomanufacturing**

The FY 2013 Request includes an increase of $5.0 million above the FY 2012 Estimate, to $52.77 million, to support new concepts for high-rate synthesis and processing of nanostructures, nanostructured catalysts, nanobiotechnology methods, fabrication methods for devices, and assembling them into nanosystems and then into larger scale structures of relevance to industry and to the medical field. R&D is aimed at enabling scaled-up, reliable, cost effective manufacturing of nanoscale materials, structures, devices, and systems. Advanced semiconductor and optical device design, fabrication and processing, for

application in biomedical, alternative energy, communications, computing and sensing systems, will be pursued both through support of the centers and the core programs. The NNI Signature Initiative on Sustainable Nanomanufacturing will support processes and techniques for continuous and scalable nanomanufacturing with a focus on three classes of sustainable materials—high-performance structural carbon-based nanomaterials, optical metamaterials, and cellulosic nanomaterials. CISE will support fabrication of new reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error-prone devices at the nanoscale. The Foundation will continue to support four NSECs (Nanoscale Science and Engineering Centers) that focus on manufacturing at the nanoscale. Those centers and the National Nanotechnology Infrastructure Network (NNIN) have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies. The NSECs with a focus on nanomanufacturing are: the Center for Hierarchical Manufacturing (CHM); the Center for Scalable and Integrated Nanomanufacturing (SINAM); (c) the Center for High-rate Nanomanufacturing (CHN); and the Center for Nano-Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS). NSF also supports the National Nanomanufacturing Network (NNN), which includes the NSF NSECs and non-NSF centers in collaboration with the Department of Defense (DOD), National Institute of Standards and Technology (NIST), and industry partners in an alliance to advance nanomanufacturing strength in the U.S. The FY 2013 Request increase is primarily associated with $5.0 million for sustainable nanomanufacturing.

**Major Research Facilities and Instrumentation Acquisition**

The FY 2013 Request includes $28.53 million for user facilities, acquisition of major instrumentation, and other activities that develop, support, or enhance the scientific infrastructure required for the conduct of nanoscale science, engineering, and technology research and development. It also supports ongoing operations of the National Nanotechnology Infrastructure Network (NNIN), the Network for Computational Nanotechnology (NCN), the National Network for Nanomanufacturing (NNN), and the National High Magnetic Field Laboratory (NHMFL). The networks had about 190,000 users in FY 2012. The investment will support facilities for ongoing NSECs. In addition, the FY 2013 Request will support planned growth supplements to the first class of three new NERCs funded in FY 2012.

**Environmental, Health, and Safety**

The FY 2013 Estimate includes $29.91 million for research primarily directed at environmental, health, and safety (EHS) implications and methods for reducing the prospective risks of nanotechnology development. NSF, the Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), and the European Union (EU) will continue collaboration on development of a joint solicitation for nanotechnology EHS. A focus will be on implications of the next generation of nanotechnology products and productive processes, as well as public participation in nanotechnology-related activities. Research on both implications and applications of nanotechnology will address the sources of nanoparticles and nanostructured materials in the environment (in air, water, soil, biosystems, and working environments), as well as the non-clinical biological implications. Research on the safety of manufacturing nanoparticles is included in seven NSECs and NNIN. Environmental implications of nanotechnology, including development of new measurement methods for nanoparticle characterization and toxicity of nanomaterials will be investigated in two dedicated multidisciplinary centers (Centers for Environmental Implications of Nanotechnology at UCLA and Duke University). These centers aim to conduct fundamental research on the interactions between nano-particles and -materials and the living world at all scales. An essential element of this will be research on methods and instrumentation for nano-particle detection, characterization, and monitoring, including interactions of nano-materials with

cellular constituents, metabolic networks and living tissues, bioaccumulation and its effects on living systems, and the impacts of nanostructures dispersed in the environment.

**Education and Societal Dimensions**

The FY 2013 Request includes $30.12 million for research and other activities that address the broad implications of nanotechnology for society, including education and social aspects, such as:

- Education-related activities, such as development of materials for schools, curriculum development for nanoscience and engineering, development of new teaching tools, undergraduate programs, technical training, and public outreach ($24.79 million). Two networks for nanotechnology education with national outreach will be supported.
- Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, workforce, educational, ethical, and legal implications ($5.33 million). The application of nanoscale technologies will stimulate far-reaching changes in the design, production, and use of many goods and services. NSF also supports a project to embed humanists and social scientists for greater collaboration in nanoscience around the world, providing a model for future integration of ethicists and social scientists into nanotechnology R & D laboratories.

**Coordination with Other Agencies**

The NSF program is coordinated with 25 departments and agencies through the NSTCs subcommittee on Nanoscale Science, Engineering and Technology (NSET). Examples of specific coordination efforts are: Sustainable Nanomanufacturing (with NIST, Department of Energy (DOE), EPA, Intelligence Community (IC), National Institutes of Health (NIH), National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Department of Agriculture USDA/FS); Nanoelectronics (with NIST, DOD, DOE, IC/DNI, NASA) Environmental issues (with EPA, USDA/NIFA, Consumer Product Safety Commission (CPSC)); Solar energy conversion (with DOE, , IC/DNI, National Aeronautics and Space Administration (NASA), NIST, NSF, USDA/NIFA); NSECs, NNIN and NCN centers and networks (DOD/ NASA/ DOE/ NIH); simulations in nanoelectronics (DOD/NASA); research and training activities (DOD/NIH); NSF awards supplements for student participation in the Sandia National Lab "National Institute for Nano-Engineering" Summer Scholars Program.

**NNI Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| Biological Sciences | $56.36 | $56.10 | $57.10 |
| Computer and Information Science and Engineering | 17.45 | 17.75 | 17.75 |
| Engineering | 181.59 | 166.37 | 174.37 |
| Geosciences | 0.85 | 0.85 | 0.75 |
| Mathematical and Physical Sciences | 224.56 | 183.16 | 183.16 |
| Social, Behavioral and Economic Sciences | 1.67 | 1.67 | 1.67 |
| Office of International Science and Engineering | 0.10 | 0.10 | 0.10 |
| Subtotal, Research and Related Activities | 482.58 | 426.00 | 434.90 |
| Education and Human Resources | 2.50 | - | - |
| **Total, National Nanotechnology Initiative** | **$485.08** | **$426.00** | **$434.90** |

Totals may not add due to rounding.

# NETWORKING AND INFORMATION TECHNOLOGY R&D

The National Science Foundation is a primary federal agency supporting the Networking and Information Technology Research and Development (NITRD) program. NSF's NITRD portfolio includes all funding in the Directorate for Computer and Information Science and Engineering (CISE) and the Office of Cyberinfrastructure (OCI), and contributions from all of the agency's other directorates. NSF makes research, education, or research infrastructure investments in every NITRD Program Component Area (PCA). NSF's Assistant Director for CISE is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology, and OCI provides NSF representation to the subcommittee. In addition, NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in five of the seven PCA Coordinating Groups and all of the Senior Steering Groups.

NSF's FY 2013 Request continues strong support for NITRD at a level of $1.207 billion, a 6.1 percent increase over the FY 2012 Estimate. NITRD activities represent approximately 16 percent of NSF's FY 2013 budget. CISE and OCI's combined support comprises 77 percent of NSF's NITRD activities.

Several NSF-wide investments, both new and continuing, are reflected in various NITRD PCAs:

- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21), designed to develop and deploy comprehensive, integrated, sustainable, and secure cyberinfrastructure to accelerate research and new functional capabilities in computational and data-intensive science and engineering, primarily supports investments in six program component areas: Large Scale Networking; High End Computing Research and Development (R&D); High End Computing Infrastructure and Applications; Human-Computer Interaction and Information Management; Software Design and Productivity; and Social/Economic/Workforce Implications of IT and IT Workforce Development.
- The Science, Engineering, and Education for Sustainability (SEES) cross-Foundation investment supports activities in Large Scale Networking as well as in Software Design and Productivity, High End Computing R&D, and Social/Economic/Workforce Implications of IT and IT Workforce Development.
- The National Robotics Initiative (NRI), a cross-agency initiative engaging four U.S. agencies (NSF, NASA, NIH and USDA) in a concerted program to provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, supports activities in Human-Computer Interaction and Information Management, High Confidence Software and Systems, and Social/Economic/Workforce Implications of IT and IT Workforce Development.
- Advanced Manufacturing investments encompass research in nanotechnology, cyber-physical systems, and robotics, as well as expanded industry/university cooperation. Activities are supported in High End Computing R&D, High End Computing Infrastructure and Applications, and High Confidence Software and Systems.
- Enhancing Access to the Radio Spectrum (EARS), which supports research in wireless communication, spectrum sharing, and mobile computing, as well as the development of wireless testbeds, supports activities in Large Scale Networking, High End Computing R&D, and High End Computing Infrastructure and Applications.
- Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS), expands the Cyber-Physical Systems (CPS) program to accelerate advances in 21st century smart engineered systems. CEMMSS will begin to establish a scientific basis for engineered systems interdependent with the physical world and social systems; synthesize multi-disciplinary knowledge to model and simulate systems in their full complexity and dynamics; and develop a smart systems technology framework. CEMMSS includes investments in the National Robotics Initiative (NRI), an important multi-agency activity. CEMMSS supports activities in High End Computing R&D, High Confidence Software and

Systems, Human-Computer Interaction and Information Management, Software Design and Productivity, and Social/Economic/Workforce Implications of IT and IT Workforce Development.

- The Comprehensive National Cybersecurity Initiative (CNCI) supports activities in Cybersecurity and Information Assurance.
- Secure and Trustworthy Cyberspace (SaTC) aligns NSF cybersecurity investments (including investments from CISE, OCI, SBE, MPS, and ENG) with the President's national cybersecurity strategy, Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program. SaTC supports scientific foundations, induces change, maximizes research impact, and accelerates transitions to practice. SaTC supports activities in Cybersecurity and Information Assurance.
- Expeditions in Education ($E^2$) aims to generate a stronger and more deliberate infusion of cutting-edge science, engineering, and innovation into programs that focus on preparing a world-class scientific workforce for the twenty-first century, and to ensure that all of NSF's education and workforce investments are drawing on the latest educational theory, research, and evidence. $E^2$ supports activities in Social/Economic/Workforce Implications of IT and IT Workforce Development.

**Networking and Information Technology Research and Development Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| Biological Sciences | $93.00 | $99.00 | $99.00 |
| Computer and Information Science and Engineering | 636.06 | 653.59 | 709.72 |
| Engineering | 21.00 | 18.30 | 19.80 |
| Geosciences | 22.98 | 22.98 | 26.98 |
| Mathematical and Physical Sciences | 83.88 | 93.75 | 94.75 |
| Social, Behavioral, and Economic Sciences | 22.21 | 29.51 | 29.20 |
| Office of Cyberinfrastructure [1] | 300.75 | 211.64 | 218.27 |
| Subtotal, Research and Related Activities | $1,179.88 | $1,128.77 | $1,197.72 |
| Education and Human Resources | 9.50 | 9.50 | 9.50 |
| **Total, NITRD** | **$1,189.38** | **$1,138.27** | **$1,207.22** |

Totals may not add due to rounding.

[1] FY 2011 Actual includes $90.50 million in funds that were obligated in FY 2010, de-obligated in FY 2011, and then obligated to other projects in the OCI portfolio.

**FY 2013 NSF Investments by Program Component Area**

The following information focuses on FY 2013 NSF investments, both new and continuing, by PCA.

Large Scale Networking (LSN) ($131.39 million) CISE and ENG will support research in new wireless communications and spectrum sharing architectures and services as part of Enhancing Access to the Radio Spectrum (EARS). A portion of NSF's investment in CIF21 will address broadband applications and research on end-to-end performance from the desktop to major scientific and computational facilities.

Cybersecurity and Information Assurance (CSIA) ($114.12 million) CSIA includes support for the Comprehensive National Cybersecurity Initiative (CNCI) at $57.0 million and for NSF's Secure and Trustworthy Cyberspace (SaTC) program. CISE investments in SaTC, in partnership with EHR, ENG, MPS, OCI, and SBE, include developing scientific foundations; inducing change through designed-in security, moving target defense, tailored trustworthy space, and cyber economic and behavioral incentives; and accelerating transition to practice.

High-End Computing R&D (HEC R&D) ($109.85 million) Support is provided for CISE's nanotechnology research, including participation in the National Nanotechnology Initiative Signature Initiative. HEC R&D also includes support for NSF's investment in SEES, focusing on research that will develop the theory and design principles to effectively tackle energy versus computation and communication tradeoffs and the development of new theory, algorithms, and design principles to optimize energy-computational performance in computing and communications systems. HEC R&D also includes support for CIF21to develop new functional capabilities in support of highly parallel computing and for research on technical and economic models for flexible spectrum access, real-time auctions, and on-demand spectrum services as part of EARS. MPS, through the Division of Materials Research, will support research on quantum effects and their use for information science, potentially leading to new paradigms for high-end computing.

High-End Computing Infrastructure and Applications (HEC I&A) ($255.62 million) HEC I&A includes increased efforts by OCI to develop software and algorithms for high-end computing systems. It also includes MPS and ENG investment in new computational methods, algorithms, robust software and other computational tools to support researchers in the mathematical and physical sciences and engineering. The CISE investment in computational infrastructure as part of CIF21 is reflected here, as well as the development of wireless testbeds that support experimentation with new wireless technology services as part of EARS. HEC I&A also includes investments in innovative partnerships and collaborations between universities and industries, including the Industry/University Cooperative Research Centers program (I/UCRC); GEO support for operations and maintenance for the new NCAR Wyoming Supercomputer facility; and BIO's support for development of pioneering informatics tools and resources that have the potential to transform research in biology.

High Confidence Software and Systems (HCSS) ($97.64 million) CISE and ENG will increase investments in the National Robotics Initiative and in Cyber-Physical Systems as part of CEMMSS as well as continue investments in smart health and wellbeing. As development of the next generation of robotics proceeds, complete confidence in the systems supporting robots that work beside, or cooperatively with, people in areas such as manufacturing, space, and undersea exploration must be assured. High confidence surgical robots and medical devices are central to high quality healthcare and building trust in robotic aids. CISE and ENG will support advanced manufacturing technologies research in cyber-physical systems such as smart infrastructure that will blend traditional concrete-and-steel physical infrastructure systems with cyber-infrastructure systems such as computers, networks, and sensors. BIO support for HCSS will expand and enhance access to the national resource of digital biological and paleontological data, and the Bio/computation Evolution in Action CONsortium (BEACON) Center established to study the power of evolutionary processes and to transfer those discoveries from biology into computer science and engineering design.

Human Computer Interaction and Information Management (HCI&IM) ($297.24) HCI&IM includes CISE support for the National Robotics Initiative, part of CEMMSS, as well as support for smart health and wellbeing. As part of the next generation of robotics, co-robot systems will be characterized by their flexibility and resourcefulness. They will use a variety of modeling or reasoning approaches, and use real-world data in real-time, demonstrating a level of intelligence and adaptability seen in humans and animals. Research in smart health and wellbeing will focus on human-centered intelligent information systems and tools that collect, mine, synthesize, protect and share appropriate data and knowledge with healthcare organizations, practitioners, caregivers, and individuals to enable effective, safe, and well-informed decision-making by all stakeholders. HCI&IM also includes NSF investments in CIF21 related to big data, data analytics, and visualization tools and a focus on expanding the national data infrastructure through the DataNet and Virtual Organizations programs in OCI. BIO investments in HCI&IM will facilitate discovery through tools that integrate the published literature with the expanding universe of digital data collections, expand capacity for understanding through virtual environments, and

make it practical for scientists to search vast collections of biological images simply and quickly. MPS investments will focus on the provision of new automated data-analysis pipelines that will provide initial reference images for the data-rich radio interferometers that are just coming on line, with analysis tools and guidance for those scientists who need to interact with the data in order to achieve image fidelities beyond those that can be delivered using automated processing techniques. SBE will continue investments to increase the benefit of computer technologies to scientists as well as non-science users.

Software Design and Productivity (SDP) ($83.69 million) SDP support reflects increased investment in CIF21 with a focus on software sustainability, and new research on smart systems as part of CEMMSS. OCI support for SDP includes increasing investment in the Software Institutes for Sustainable Innovation (SI2) program to support efforts to create and maintain usable software. The program supports both individual software development efforts and centers of excellence that will become long-term resources to ensure sustainable software infrastructure within scientific communities. BIO support for SDP includes support for the interagency and international Collaborative Research in Computational Neuroscience program (CR-CNS). BIO funds research involving the development of software and other computational tools to advance biological knowledge as well as computational innovations. SDP also includes support for SBE's National Center for Science and Engineering Statistics to continue exploration of new methods to enhance data collections, analysis, and sharing capabilities, which will help NCSES better serve its role of providing information on the science and engineering enterprise. In addition, SBE will partner with CISE in exploring the emerging interface between computer science and economics.

Social, Economic and Workforce (SEW) Implications of IT and IT Workforce Development ($117.67 million) As part of the National Robotics Initiative, SEW research in CISE will focus on human-robot interaction, a critical component in achieving effective human robot partnerships in manufacturing, education, space exploration, etc. In addition, CISE's continued emphasis on smart health and wellbeing focuses on, for example, assistive technologies and quality of life aids. This also reflects CISE support for big data and e-science collaboration tools as part of CIF21 and support for $E^2$ through the Cyberlearning Transforming Education program. EHR will continue to study the impact of information and communication technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, the effects of technology of learning, and efforts that advance teaching and learning opportunities utilizing cyberinfrastructure. These efforts also will support science, technology, engineering and mathematics education for the cyber-workforce through workforce programs and research and development in learning sciences. OCI increases support for the study of virtual organizations to better understand how research communities use cyberinfrastructure to improve collaboration. BIO support for SEW focuses on advancing the nation's ability to incorporate and apply biological knowledge to economic development and other issues of societal importance. SBE will continue to support the social, economic and workforce aspects of information technology, focusing on the nature and dynamics of IT impacts on technical and social systems.

**NITRD by Program Component Area**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| Large Scale Networking | $128.14 | $121.76 | $131.39 |
| Cybersecurity and Information Assurance | 76.51 | 98.49 | 114.12 |
| High End Computing R&D | 103.36 | 102.98 | 109.85 |
| High End Computing Infrastructure and Applications | 357.00 | 249.96 | 255.62 |
| High Confidence Software and Systems | 78.01 | 84.67 | 97.64 |
| Human-Computer Interaction and Info Management | 283.25 | 291.98 | 297.24 |
| Software Design and Productivity | 54.72 | 78.26 | 83.69 |
| Social/Economic/Workforce | 108.399 | 110.17 | 117.67 |
| **Total, NITRD** | **$1,189.38** | **$1,138.27** | **$1,207.22** |

Totals may not add due to rounding.

[1] FY 2011 Actual includes $90.5 million in funds that were obligated in FY 2010, de-obligated in FY 2011, and then obligated to other projects in the OCI portfolio.

# U.S. GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)

Climate and global change have pervasive effects on the U.S. through their impacts on the environment, natural resources, and the economy. Global change encompasses a wide range of planetary-scale changes in the Earth's natural and human systems. These changes involve atmospheric and ocean circulation and composition, the water cycle, biogeochemical cycles, land and sea ice, biological diversity, marine and terrestrial ecosystem health, resource and land use, urbanization, economic development, and more. The U.S. Global Change Research Program (USGCRP) provides the Nation and the world with the scientific knowledge necessary for understanding and predicting climate change and environmental responses, managing risk, and anticipating opportunities that may result from changes in climate and climate variability. Research conducted through the USGCRP (www.globalchange.gov) builds on the scientific advances of recent decades and deepens our understanding of how the interplay between human and natural systems affects the climate system, and of the impacts of a changing climate on those systems. The USGCRP involves thirteen U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. NSF provides support for a broad range of fundamental research activities that provide a sound scientific basis for climate-related policy and decisions.

The Earth's climate is determined by highly complex interactions among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere – all significantly influenced by human activities. NSF programs address these components by investing in: fundamental discovery that utilizes the full range of intellectual resources of the scientific community; research infrastructure that provides advanced capabilities; and innovative educational activities. NSF strongly encourages interdisciplinary approaches, and focuses particularly on fundamental Earth system processes and the consequences of change. High priorities for the agency include: data acquisition and information management activities necessary for global change research; the enhancement of models designed to improve our understanding of Earth system processes and of feedbacks between ecosystems and the physical climate; the development of new, innovative Earth observing instruments and networks; the development of advanced analytic research methods; and preparation of a scientific workforce equipped to deal with the complexities of global change. NSF also supports fundamental research on the processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions. NSF-supported research on the science of impacts, vulnerability and resilience as well as the enhancement and development of a range of climate and process models will be key contributions to the National Climate Assessment. A new strategic plan, developed under NSF leadership, will be released in early 2012.

**U.S. Global Change Research Program Funding**

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|
| Biological Sciences | $81.00 | $89.00 | $91.00 |
| Geosciences | 194.00 | 194.00 | 194.00 |
| Mathematical and Physical Sciences | 3.32 | 5.03 | 8.03 |
| Social, Behavioral and Economic Sciences | 20.73 | 22.23 | 23.23 |
| Office of Polar Programs | 18.52 | 23.10 | 16.65 |
| **Total, U.S. Global Change Research Program** | **$317.57** | **$333.36** | **$332.91** |

Totals may not add due to rounding.

## FY 2013 Areas of Emphasis

NSF's FY 2013 investment in USGCRP decreases by $450,000, or 0.13 percent, relative to the FY 2012 Current Plan. NSF's USGCRP investments continue to reflect two major integrated NSF activities, the Science, Engineering, and Education for Sustainability (SEES) and the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21). The major USGCRP foci in FY 2013 include:

**Improving our knowledge of Earth's past and present climate variability and change –** NSF investments include activities to document and understand long-term climate cycles across the globe, as well as to better understand the natural variability of climate and the processes responsible for climate changes using a range of paleoclimate and instrumental data and modeling approaches. NSF also supports activities to improve our understanding of the frequency and intensity of extreme climate events in the past and how those may be manifested in the future. Upgrading and expanding critical environmental observing systems and ensuring data quality and access are integral parts of NSF's investments that will be supported under the CIF21 Data and Access to Cyberinfrastructure components.

**Improving our understanding of natural and human forces of climate change –** NSF activities in this area span a broad range of disciplines and topics that seek to better understand the physical, geological, chemical, biological, and human components of the Earth system and their interactions. Examples of major foci include fundamental research on all aspects of the carbon cycle, the water cycle, atmospheric composition and greenhouse gas processes, marine and terrestrial ecosystems, and ocean and atmospheric circulations that both drive and respond to climate and global change. Human drivers of change include urbanization, population growth, and economic development. NSF has a strong commitment to fostering new interdisciplinary research approaches that allow exploration of the interdependencies across these areas. Such efforts will be enhanced with the sustainability focus under the SEES Integrated Science and Engineering thrust.

**Improving our capability to model and predict future conditions and impacts** – NSF-supported research will examine major feedback processes between the climate and natural and human systems and will incorporate these into the next generation Community Earth System Model (CESM). High priority will be given to developing more complete representations of coupled interactive atmospheric chemistry, terrestrial and marine ecosystems, biogeochemical cycling, and middle atmospheric processes. NSF will continue to devote significant resources to advancing climate modeling capabilities from global and centennial to regional and decadal scales. In addition, NSF is encouraging the development of ecosystem and water models at regional scales, as well as models that integrate human system components such as risk, vulnerability, and decision-making. These efforts will depend on new computational resources and tools that will be developed through the CIF21 efforts in computational infrastructure.

**Assessing the Nation's vulnerability to current and anticipated impacts of climate change –** A key focus of the USGCRP is developing better means of assessing the impacts of climate change and the vulnerability and resilience of both human and natural systems to those changes. NSF supports the basic research that underpins the National Climate Assessment, including developing models that can be used for these assessments. For example, NSF-supported researchers are developing integrated river-basin models to address often competing water management issues that affect stream flow, such as protecting endangered species, meeting agricultural needs, and honoring transboundary water rights agreements. NSF will support fundamental research regarding the science of adaptation, from developing the theoretical framework for evaluating adaptation options (and avoiding unintended consequences of adaptation choices) to risk assessment and decision making. Under the SEES Integrated Science and Engineering Research on Environmental, Economic, and Engineering systems, NSF will continue interdisciplinary research (including human factors) in water sustainability, biodiversity, and ocean

acidification and initiate new efforts in particularly vulnerable areas such as the Arctic and coastal regions.

**Providing climate information and decision support tools** – NSF supports basic research on how humans impact climate and other natural systems, how people respond to changing natural conditions, and how human and natural systems engage in complex interactions across multiple spatial, temporal, and organizational scales. Support will continue for basic research on decision making under uncertainty associated with climate change, as well as for developing and testing decision-support tools that can be used by stakeholders to improve their decision making processes.

# NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research program or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principle means by which NSF fosters interdisciplinary research.

**NSF Centers**
(Dollars in Millions)

| | Program Initiation | Number of Centers in FY 2011 | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|---|---|
| Centers for Analysis & Synthesis | 1995 | 4 | $23.04 | $26.32 | $26.40 | $0.08 | 0.3% |
| Centers for Chemical Innovation | 1998 | 14 | 26.28 | 24.00 | 29.25 | 5.25 | 21.9% |
| Engineering Research Centers | 1985 | 17 | 59.06 | 70.00 | 69.00 | -1.00 | -1.4% |
| Materials Centers[1] | 1994 | 30 | 61.33 | 44.35 | 51.20 | 6.85 | 15.4% |
| Nanoscale Science & Engineering Centers | 2001 | 19 | 39.13 | 31.48 | 26.50 | -4.98 | -15.8% |
| Science & Technology Centers | 1987 | 17 | 66.10 | 50.75 | 74.39 | 23.64 | 46.6% |
| Science of Learning Centers | 2003 | 6 | 23.08 | 20.37 | 20.02 | -0.35 | -1.7% |
| **Totals** | | **107** | **$298.02** | **$267.27** | **$296.76** | **$29.49** | **11.0%** |

Totals may not add due to rounding.

[1] In FY 2011, funding includes $2.66 million for Materials Interdisciplinary Research Teams, which are not formal NSF Centers. In FY 2012 and FY 2013, support for these teams is captured in core research programs, outside the NSF Centers portfolio.

## Description of Major Changes

### Centers for Analysis and Synthesis - BIO

The Socio-Environmental Synthesis Center (SESynC) is the newest (funding initiated in FY 2011) BIO Center for Analysis and Synthesis. SESynC uses a variety of approaches to synthesize scientific information, data, and knowledge to advance the frontiers of scientific understanding of environmental complexity through the active involvement of environmental and social scientists in order to anticipate and manage emerging environmental challenges. These approaches include discussions between scientists and policy makers, working groups from the broad socio-environmental community, and an array of computational and technical service providers. SESynC is expected to be funded at $6.0 million in FY 2013, which is flat with FY 2012.

The iPlant Collaborative provides cyberinfrastructure to enable new conceptual advances in plant sciences through integrative, computational thinking. iPlant focuses on grand challenge questions in the plant sciences, including innovative approaches to education, outreach, and the study of social networks. Pending a successful outcome from the FY 2012 site review, center funding could be renewed or a recompetition held for an additional five years of funding. iPlant is expected to be funded at $12.0 million in FY 2013, which is flat with FY 2012.

The National Evolutionary Synthesis Center (NESCent) promotes the synthesis of information, concepts and knowledge to address significant, emerging, or novel questions in evolutionary science and its applications. NESCent funds graduate students engaged in center synthesis activities; supports activities to expand the conceptual reach of the center; and initiates a formalized, three-tiered assessment of the center that includes milestones for reporting on the impact of center activities. Support for this Center

decreases by $540,000 to a total of $4.78 in FY 2013 as NSF funding ramps down; FY 2014 is expected to be the final year of funding for NESCent.

The National Institute for Mathematical and Biological Synthesis (NIMBioS) supports creative solutions to complex problems at the interface between mathematics and biology. The center is designing education programs aimed at the mathematics/biology interface, thereby building the capacity of mathematically competent, biologically knowledgeable, and computationally adept researchers needed to address the vast array of challenging questions in this century of biology. NSF support for NIMBioS increases by $1.0 million in FY 2013 to $3.62 million because prior co-funding from the Department of Homeland Security is expected to be withdrawn.

**Centers for Chemical Innovation (CCI) – MPS**

The Centers for Chemical Innovation (CCI) are designed to support research on strategic, transformative "big questions" in basic chemical research. The program is stimulating the chemical sciences community to perform work that is high-risk and of potential high scientific and societal impact. CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of the work. CCIs are expected to be agile, responding to scientific opportunities as they arise, and to creatively engage the public. Grand challenges include emulating and even surpassing the efficiency of the natural process of photosynthesis to capture the sun's energy; activating strong bonds as a means to store and use chemical energy and to lower energy costs in chemical processing; and designing self-assembling, complex structures, such as molecular computers, with emergent and useful functions not yet known or foreseen.

The CCI program is designed as a staged competition. Phase I centers, which are supported for three years, may then compete for larger Phase II awards, which are for five years. Phase I centers initiated in FY 2010 may compete for Phase II awards in FY 2013. In FY 2013, the MPS Division of Chemistry expects to support eight Phase I awards, five continuing and three new, and six Phase II awards, three continuing and three new and/or renewals. Funding levels per center have not changed over FY 2012. However, the requested change (+$5.25 million to a total of $29.25 million) will allow the Division of Chemistry to increase support for renewing Phase I awards, from $1.50 million to $1.75 million per year. The renewal of the Phase II "Center for Enabling Technologies through Catalysis" is currently pending, and the Phase II Center on "POWERING THE PLANET: A Chemical Bonding Center in the Direct Conversion of Sunlight into Chemical Fuel" will be seeking renewal in FY 2013.

The CCI program began collecting qualitative (e.g., list of partnering companies) data and quantitative data (e.g., the amount of funding leveraged from other sources) in FY 2012 to inform an external programmatic evaluation scheduled for FY 2017. A Leadership Network of CCI managing directors and staff has formed to plan meetings to discuss topics of common interest and build collaborations between the CCIs. The first Leadership Network meeting is scheduled for spring 2012.

**Engineering Research Centers (ERC) – ENG**

NSF Engineering Research Centers (ERCs) enable innovation through partnerships, bridging the intellectual curiosity of discovery-focused university research and the engineered systems and technology opportunities of industry research. The centers also educate a technology-enabled workforce with hands-on, real-world experience. These characteristics catalyze the development of marketable technologies to generate wealth and address grand challenges. ERCs are investigating intelligent electric power grid systems to provide electricity from renewable sources, devising healthcare innovations through tissue engineering and microelectronics research, creating sensing systems that improve the prediction of tornados, and demonstrating intelligent robotic systems to assist people who are elderly or disabled in daily tasks.

ERCs face two renewal reviews, one in year three to determine if they are structured effectively to deliver on ERC program goals, and another in year six to determine if they are making an impact, delivering on goals, and positioning themselves for more challenging tasks to warrant further support. The ERC program periodically commissions program-level evaluations by external evaluators such as SRI International; the Science and Technology Policy Institute (STPI); and ABT Associates to determine the effectiveness of ERC graduates in industry and the benefits of ERC membership to industry and others. A recent update of a past survey of the 35 ERCs that have graduated from NSF support after 10 years finds that 29 (83 percent) are self-sustaining with strong financial support and most ERC features in place.

In FY 2013, funding for ERCs will decrease by $1.0 million, below the FY 2012 Estimate, to a total of $69.0 million. Building on the long-standing ERC program model, NSF will maintain funding for the existing portfolio of ERCs and provide planned growth supplements to the first class of three Nanosystems ERCs (NERCs) funded in FY 2012. This investment will transition the nano-devices created at graduating NSECs to the systems level and commercialization. This will support the first class of three Nanoscale Engineering Research Centers (Nanoscale ERCs) initially funded in FY 2012, maintaining the number of traditional ERCs and Nanoscale ERCs at 17.

**Materials Centers - MPS**

The Materials Center program is an interdisciplinary vehicle for increasing materials research and educating students, including global experiences. These centers address fundamental research problems of intellectual and strategic importance that will advance U.S. competitiveness and the development of new technologies.

In FY 2011 the Materials Centers program was divided into centers and teams, or Centers for Materials Research and Innovation (CEMRIs) and Materials Interdisciplinary Research Teams (MIRTs). However, based on comments from the Committee of Visitors for the MPS Division of Materials Research in February 2011 and a request from the community, the CEMRIs are reverting to their original name, or Materials Research Science and Engineering Centers (MRSEC). "MRSEC" has been used since 1994 and is a recognized brand of excellence in the materials community. NSF agreed that it would be beneficial to continue using the MRSEC name in place of the newer CEMRI name. This change does not require any programmatic or funding adjustments. The materials teams, or MIRTs, will remain in place as planned. Due to their smaller size, MIRTs do not meet the criteria as formal NSF centers. Therefore, beginning in FY 2012, MIRT funding has been integrated with core research programs. $2.66 million of the funding decrease from FY 2011 to FY 2012 is due to this reallocation of MIRT funding to core programs.

The FY 2013 Request will support 23 MRSECs at $51.20 million (+$6.85 million over the FY 2012 Estimate). The number of centers is equal to FY 2012, with 14 from the 2008 competition and 9 from the 2011 competition. Funding supports continuing grant increments as outlined in existing cooperative agreements. The Materials Centers program holds triennial competitions; the last competition was in FY 2011 and the next is planned for FY 2014.

**Nanoscale Science and Engineering Centers (NSEC) - multi-directorate**

Nanotechnology, which addresses the smallest of scales, is projected to be one of the largest drivers of technological innovation for the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale, through NSF-funded Nanoscale Science and Engineering Centers (NSECs), aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. Each center has an extended vision for research. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education and also address the social and ethical implications of such research. NSEC funding supports education and

outreach programs from K-12 to the graduate level, which is designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. These centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies.

The FY 2013 Request of $26.50 million, representing a decrease of $4.98 million below the FY 2012 Estimate, will support 11 continuing NSECs. The decrease from the FY 2012 Estimate level is primarily associated with two centers receiving final funding in FY 2012. The first class of six NSECs, initiated in 2001, received their final year of support in FY 2010 and completed their associated research programs in FY 2011.

**Science and Technology Centers: Integrative Partnerships (STCs) - multi-directorate**

The Science and Technology Centers: Integrative Partnerships (STC) program advances interdisciplinary discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse workforce. The STC portfolio reflects NSF-supported disciplines. Examples of investment include: engineering of biological systems; energy-efficient electronics; global and regional environmental systems − sustainability and change; new ways of handling the extraction, manipulation, and exchange of information; cyber security; and new materials for optical and electronic applications. STCs engage the Nation's intellectual talent and collaborate with partners in academia, industry, national labs, and government. STCs strengthen the caliber of the Nation's science, technology, engineering, and mathematics (STEM) workforce through intellectually challenging research experiences for students, postdoctoral fellows, researchers, and educators and advance public scientific understanding through partnerships with K-12 and informal education communities.

A recent review, released in December 2010, by the American Association for the Advancement of Science (AAAS) concluded that the STC program is an effective and distinctive mode of Foundation support for addressing grand challenges and emerging opportunities in science and technology. STCs serve as NSF's major funding instrument for supporting emerging fields of science and technology that do not fit within its existing organizational and programmatic structures – including its other existing center programs. See http://php.aaas.org/programs/centers/capacity/documents/stc_aaas_full_report.pdf.

The FY 2013 Request funding of $74.39 million will support the continuation of 11 existing STCs ($48.09 million), the start up of five new centers ($25.0 million), and the administrative costs ($1.30 million) associated with running the competition and overseeing the program. The change over the FY 2012 Estimate is primarily associated with the funding of five new STCs in FY 2013.

**Science of Learning Centers (SLC) - multi-directorate**

The Science of Learning Centers (SLC) program supports six large-scale, long-term centers that create the intellectual, organizational, and physical infrastructure needed for the advancement of Science of Learning research. It supports research that harnesses and integrates knowledge across multiple disciplines to create a common groundwork of conceptualization, experimentation, and explanation that anchor new lines of thinking and inquiry towards a deeper understanding of learning. The SLC program goal is to advance the frontiers of all the sciences of learning through integrated research; to connect the research to specific scientific, technological, educational, and workforce challenges; to enable research communities to capitalize on new opportunities and discoveries; and to respond to new challenges. The SLC portfolio represents synergistic, exciting research efforts that address many different dimensions of learning.

In FY 2013, $20.02 million (-$350,000 below the FY 2012 Estimate) will fund six SLCs. SBE will continue to oversee management of all six centers, with co-funding from the NSF Directorates for Biological Sciences (BIO), Computer and Information Science and Engineering (CISE), and Engineering (ENG).

Four awards for the first cohort of SLCs were made in FY 2004. One center was decommissioned in its second year due to its failure to develop cohesively as a center. The remaining three centers, Pittsburgh Science of Learning Center (PSLC), Learning in Formal and Informal Environments (LIFE), and the Center of Excellence for Learning in Education, Science and Technology (CELEST), have been approved for renewal through FY 2014, with a ramp down in funding beginning in FY 2012. Three awards for a second cohort were made in FY 2006 and renewed in February 2011. Two of the three centers in Cohort 2, Temporal Dynamics of Learning Center (TDLC) and the Spatial Intelligence and Learning Center (SILC), were renewed for an additional five years, ending in FY 2015. The third, Visual Language and Visual Learning Center (VL2), was renewed for four years, ending in FY 2014.

Each SLC award requires an annual, external evaluation of the center. Annual meetings of the SLC evaluators contribute to consistency across these evaluations and its usefulness for program managers. A Committee of Visitors (COV) review for the SLCs was held in 2009, and an external, program-level evaluation of the SLC program is being planned for FY 2012.

SBE initiated external discussion on the future of the SLC program and the science it supports at its May 2010 Advisory Committee meeting. The consensus was that NSF should evaluate the program as funding for individual centers comes to a close, with consideration of shifting resources wherever possible to enhance support for the science of learning through non-center mechanisms. In FY 2012 there will be a workshop to explore future directions for the Science of Learning, including diversifying the program's funding mechanisms to include non-center opportunities. NSF started ramping down its funding for the SLC Program in FY 2012.

**NSF Estimates for Centers Participation in 2011**

(Dollars in Millions)

| | Number of Participating Institutions | Number of Partners | Total FY 2011 NSF Support | Total Leveraged Support | Number of Participants |
|---|---|---|---|---|---|
| Centers for Analysis & Synthesis | 385 | 62 | $23 | $8 | 2,369 |
| Centers for Chemical Innovation | 74 | 62 | $26 | $3 | 505 |
| Engineering Research Centers | 472 | 299 | $59 | $101 | 2,720 |
| Materials Centers | 388 | 344 | $61 | $54 | 4,000 |
| Nanoscale Science & Engineering Centers | 648 | 622 | $39 | $47 | 6,553 |
| Science & Technology Centers | 177 | 460 | $66 | $46 | 3,129 |
| Science of Learning Centers | 44 | 73 | $23 | $17 | 1,120 |

No. of Participating Institutions: All academic institutions participating in activities at the centers.

No. of Partners: The total number of non-academic participants, including industry, states, and other federal agencies at the centers.

Total Leveraged Support: Funding for centers from sources other than NSF.

No. of Participants: The total number of people who use center facilities, not just persons directly supported by NSF.

## Centers Supported by NSF in FY 2011

| Center | Institution | State |
|---|---|---|
| **Centers for Analysis and Synthesis** | | |
| National Evolutionary Synthesis Center | Duke, NC State U, U of N. Carolina | NC |
| National Institute for Mathematical & Biological Synthesis | U of Tennessee- Knoxville | TN |
| Plant Science Cyberinfrastructure Collaborative | U of Arizona | AZ |
| SocioEnvironmental Synthesis Center | U of Maryland | MD |
| **Centers for Chemical Innovation** | | |
| Chemistry at the Space-Time Limit (phase II) | U of California-Irvine | CA |
| Center for Aerosol Impacts on Climate and Environment (phase I) | U of California-San Diego | VA |
| Center for Chemical Evolution (phase II) | Georgia Institute of Technology | GA |
| Center for Enabling New Technologies through Catalysis (phase II) | U of Washington | WA |
| Center for Energetic Non-Equilibrium Chem. at Interfaces (phase I) | U of Chicago | IL |
| Center for Molecular Spintronics (phase I) | North Carolina State U | NC |
| Center for Molecular Optimization of Electronic Plastics (phase I) | U of Texas Austin | TX |
| Center for Multiscale Theory and Simulation (phase I) | U Chicago | IL |
| Center for Nanostructured Electronic Materials (phase I) | University of Florida | FL |
| Center for Stereoselective C-H Functionalization (phase I) | Emory U | GA |
| Center for Sustainable Materials Chemistry (phase II) | Oregon State U | OH |
| Center for Sustainable Polymers (phase I) | U of Minnesota-Twin Cities | MN |
| Powering the Planet (phase II) | California Institute of Tech | CA |
| Quantum Information Center for Quantum Chemistry (phase I) | Purdue U | IN |
| **Engineering Research Centers** | | |
| Biomimetic Microelectronic Systems | U of Southern California | CA |
| Biorenewable Chemicals | Iowa State U | IA |
| Center for Ultra-wide-area Resilient Electric Energy Transmission Network (CURENT) | U of Tennessee Knoxville | TN |
| Collaborative Adaptive Sensing of the Atmosphere | U of Mass-Amherst | MA |
| Compact and Efficient Fluid Power | U of Minnesota | MN |
| Extreme Ultraviolet Science and Technology | Colorado State | CO |
| Future Renewable Electric Energy Delivery & Mgmt. Systems | North Carolina State U | NC |
| Integrated Access Networks | U of Arizona | AZ |
| Mid-IR Tech for Health and the Environment | Princeton | NJ |
| Quality of Life Technology | Carnegie Mellon/U of Pittsburgh | PA |
| Quantum Energy and Sustainable Solar Technologies (QESST) | Arizona State U | AZ |
| Re-inventing the Nation's Urban Water Infrastructure | Stanford University | CA |
| Revolutionizing Metallic Biomaterials | North Carolina A&T U | NC |
| Sensorimotor Neural Engineering | U of Washington | WA |
| Smart Lighting | Rensselaer Polytechnic Institute | NY |
| Structured Organic Composites | Rutgers | NJ |
| Synthetic Biology | U of California-Berkeley | CA |
| **Materials Centers** | | |
| Brandeis Materials Research Science and Engineering Center | Brandeis U | MA |
| Princeton Center for Complex Materials | Princeton | NJ |
| Center for Emergent Materials | Ohio State U | OH |
| Cornell Center for Materials Research | Cornell | NY |
| Center for Materials Science and Engineering | Massachusetts Institute of Tech | MA |
| Center for Micro- and Nanomechanics of Materials | Brown | RI |
| Center for Multifunctional Nanoscale Materials Structures | Northwestern | IL |
| Quantum and Spin Phenomena in Nanomagnetic Structures | U of Nebraska | NE |
| Center for Nanoscale Science | Pennsylvania State | PA |
| Center for Nanostructured Interfaces | U of Wisconsin | WI |
| Center for Interface Structures and Phenomena | Yale | CT |
| Center for Photonics and Multiscale Nanomaterials | U. Michigan | MI |

| | | |
|---|---|---|
| Center for Science and Engineering of Materials | California Institute of Tech | CA |
| Center for Semiconductor Physics in Nanostructures | U of Oklahoma, U of Arkansas | OK, AR |
| Liquid Crystals Materials Research Center | U of Colorado-Boulder | CO |
| Genetically Engineered Materials Science and Engineering Center | U of Washington | WA |
| Laboratory for Research on the Structure of Matter | U of Pennsylvania | PA |
| Materials Research Center | U of Chicago | IL |
| Materials Research Science and Engineering Center | Carnegie Mellon | PA |
| Materials Research Science and Engineering Center | Johns Hopkins | MD |
| Materials Research Science and Engineering Center | Harvard | MA |
| Materials Research Science and Engineering Center | Georgia Institute of Tech | GA |
| Materials Research Science and Engineering Center | New York U | NY |
| Materials Research Science and Engineering Center | U of California-Santa Barbara | CA |
| Materials Research Science and Engineering Center | U of Maryland | MD |
| Materials Research Science and Engineering Center | U of Minnesota | MN |
| Materials Research Science and Engineering Center | U. Utah | UT |
| Materials Research Science and Engineering Center on Polymers | U of Massachusetts | MA |
| Renewable Energy Materials Science and Engineering Center | Colorado School of Mines | CO |
| Triangle Materials Research Science and Engineering Center | Duke U. | NC |
| **Nanoscale Science and Engineering Centers** | | |
| Affordable Nanoengineering of Polymer Biomedical Devices | Ohio State | OH |
| Center for Environmental Implications of Nanotechnology (CEIN) | Duke | NC |
| Center for Integrated and Scalable Nanomanufacturing | U of California-Los Angeles | CA |
| Directed Assembly of Nanostructures | Rensselaer Polytechnic Institute | NY |
| Electronic Transport in Molecular Nanostructures | Columbia | NY |
| High Rate Nanomanufacturing | Northeastern, U of New Hampshire, U of Mass-Lowell | MA, NH |
| Integrated Nanomechanical Systems | U of California-Berkeley, Cal Tech, Stanford, U of California-Merced | CA |
| Integrated Nanopatterning and Detection Technologies | Northwestern | IL |
| Molecular Function at the Nano/Bio Interface | U of Pennsylvania | PA |
| Nanotechnology in Society Network: Center at ASU | Arizona State U | AZ |
| Nanotechnology in Society Network: Center at UCSB | U of California-Berkeley | CA |
| Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems | U of Illinois-Urbana Champaign | IL |
| Nanoscale Systems in Information Technologies | Cornell | NY |
| Nanoscience in Biological and Environmental Engineering | Rice | TX |
| National Nanomanufacturing Network: Center for Hierarchical Manufacturing | U of Massachusetts-Amherst | MA |
| Predictive Toxicology Assessment & Safe Implementation of Nanotechnology in the Environment (CEIN) | U of California-Los Angeles | CA |
| Probing the Nanoscale | Stanford, IBM | CA |
| Science of Nanoscale Systems and their Device Applications | Harvard | MA |
| Templated Synthesis and Assembly at the Nanoscale | U of Wisconsin-Madison | WI |
| **Science and Technology Centers** | | |
| An NSF Center for the Study of Evolution in Action | Michigan State U | MI |
| Center of Adv. Materials for the Purification of H2O with Systems | U of Illinois-Urbana Champaign | IL |
| Center for Biophotonics Science and Technology | U of California-Davis | CA |
| Center for Coastal Margin Observation and Prediction | Oregon Health and Science U | OR |
| Center for Dark Energy Biosphere Investigations | U of Southern California | CA |
| Center for Energy Efficient Electronics Science | U of California-Berkeley | CA |
| Center for Embedded Networked Sensing | U of California-Los Angeles | CA |
| Center for Integrated Space Weather Modeling | Boston U | MA |
| Center for Layered Polymeric Systems | Case Western Reserve U | OH |
| Center for Microbial Oceanography: Research and Education | U of Hawaii-Manoa | HI |
| Center for Multi-Scale Modeling of Atmospheric Processes | Colorado State U | CO |
| Center for Remote Sensing of Ice Sheets | U of Kansas | KS |
| Emergent Behaviors of Integrated Cellular Systems | MIT | MA |

| | | |
|---|---|---|
| Emerging Frontiers of Science Information | Purdue U | IN |
| National Center for Earth Surface Dynamics | U of Minnesota-Twin Cities | MN |
| Center on Materials and Devices for Info. Technology Research | U of Washington | WA |
| Team for Research in Ubiquitous Secure Technology | U of California-Berkeley | CA |
| **Science of Learning Centers** | | |
| Center for Excellence for Learning in Education, Science, & Tech. | Boston U | MA |
| Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms | Carnegie Mellon | PA |
| LIFE Center - Learning in Formal and Informal Environments | U of Washington | WA |
| Spatial Intelligence and Learning Center | Temple | PA |
| The Temporal Dynamics of Learning Center | U of California-San Diego | CA |
| Visual Language and Visual Learning | Gallaudet | DC |

# SELECTED CROSSCUTTING PROGRAMS

NSF crosscutting programs include interdisciplinary programs and programs that are supported by multiple directorates. Examples of major crosscutting activities include the following:

**ADVANCE**

In FY 2013, ADVANCE will fund transformative efforts to address the systemic barriers to women's full participation in academic science, technology, engineering, and mathematics (STEM) with funding of $17.06 million, a decrease of $890,000 below the FY 2012 Estimate of $17.95. This decrease reflects a reprioritization of funding pending the results of an evaluation currently underway. A major focus will be broadening the spectrum of institutions participating in the program. The IT-Catalyst program component, which provides support to institutions to undertake institutional self-assessment activities, will be used to support predominantly undergraduate institutions, teaching-intensive colleges, community colleges, minority-serving institutions, and women's colleges. The funding will also support new awards under the Institutional Transformation (IT) program component as well as data collection to capture the impact of prior ADVANCE awards and as part of an overall program evaluation.

ADVANCE is in the process of completing a retrospective evaluation of the first two cohorts of the program. The evaluation is examining such questions as:

- What is the impact of ADVANCE on institutional transformation?
- What is the impact of ADVANCE beyond the initially funded institutions (e.g., publications, new collaborations)?
- How and why have successful programs worked in specific institutional contexts?

The evaluation methodology includes an analysis of project documents and data, survey results, interviews, and comparative data from the Survey of Earned Doctorates (SED). The evaluation will be completed in early FY 2013. Results are expected to inform future program budgets.

**Climate Change Education Program**

The FY 2013 Request provides $6.26 million for the Climate Change Education (CCE) program, a decrease of $3.74 million below the FY 2012 Estimate level of $10.00 million. The Directorates for Education and Human Resources, and Geosciences, will continue to support this activity. In FY 2013, CCE, formerly part of the Science, Engineering, and Education for Sustainability (SEES) portfolio, is refocused to support the Learning and Understanding Sustainability focus area of the Expeditions in Education ($E^2$) activity. The Directorate of Biological Sciences and the Office of Polar Program concludes its participation in CCE in FY 2013 as a result of this refocusing of activities. CCE is a multi-disciplinary, multi-faceted climate change education program that is enabling a variety of partnerships within formal and informal settings, including partnerships among K-12 education, higher education, the private sector, related non-profit organizations, and relevant education and/or climate-related policymakers. It will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those with a local, regional, and/or global scope.

FY 2013 investments continue support for Phase II Climate Change Education Partnership (CCEP-II) projects initiated in FY 2012. Climate scientists, learning scientists, and education practitioners from formal or informal settings are engaged in efforts to foster a deeper understanding of, and engagement with, the complex processes of the climate system and the potential impacts of a changing climate, through activities that lead to development, evaluation, dissemination, and increased adoption of effective, high quality educational programs and resources. Development and implementation of a strategy for program-wide evaluation of the combined CCEP-II projects is a priority for FY 2013. In addition, NSF continues collaboration with NASA and NOAA to support annual tri-agency principal

investigator meetings for climate change-education related awards and to develop common evaluation approaches. CCE program activities continue to be informed by discussions with the National Research Council, through the auspices of its Climate Change Education Roundtable.

**Enhancing Access to the Radio Spectrum (EARS)**

NSF's FY 2013 Request provides $50.50 million for EARS, an increase of $35.50 million above the FY 2012 Estimate level of $15.0 million. EARS' purpose is to fund interdisciplinary research that can enhance the efficiency with which radio spectrum is used, and/or lead to improved access to wireless services for all Americans. The increased support for EARS in FY 2013 is consistent with the recent NSF supported workshop report, *Enhanced Access to the Radio Spectrum: A Path Forward*[1], which highlighted the need for research on new and innovative ways to utilize the spectrum more efficiently. EARS is a collaboration among the Directorates for Computer and Information Science and Engineering (CISE), Engineering (ENG), Mathematical and Physical Sciences (MPS), and Social, Behavioral, and Economic Sciences (SBE). It will fund innovative collaborative research that transcends the traditional boundaries of existing disciplinary programs.

**Faculty Early Career Development (CAREER)**

The FY 2013 Request provides $216.49 million for the CAREER program, an increase of $10.14 million over the FY 2012 Estimate level of $206.35 million. This will result in approximately 40 more CAREER awards than in FY 2012. CAREER awards support exceptionally promising college and university junior faculty who are committed to the integration of research and education and who are most likely to become the leaders in their fields. A Committee of Visitors will review the CAREER program in 2012, and its report is expected to be available in 2013.

**Graduate Fellowships and Traineeships**

The FY 2013 Request provides $321.67 million for NSF's flagship graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 6,950 graduate students, including 2,000 new Graduate Research Fellows in FY 2013.

- $242.98 million for the Graduate Research Fellowship (GRF) program, an increase of $44.84 million over the FY 2012 Estimate of $198.14 million. As indicated below, the Budget Request increase is needed primarily to support the increased number of fellows, and also the proposed increases in the cost of education allowance and stipend. The fellowship provides up to 3 years of support over a 5-year period to graduate students in all STEM fields. In FY 2013, 2,000 new fellows will be supported maintaining the doubling of new fellowships awarded as achieved in FY 2010. In order to maintain the competitiveness and appeal of the GRF program, NSF increased the cost of education (COE) allowance in FY 2012 from $10,500 to $12,000. The COE allowance level is consistent with the America COMPETES Reauthorization Act of 2010. NSF will address inflationary pressures on the long-stagnant GRF stipend level implementing a stipend increase to $32,000 in FY 2013. In FY 2013, GRF funding will be drawn equally between the R&RA and Education and Human Resources (EHR) accounts. In FY 2012, GRF is initiating and conducting a phase-one evaluation framing study. In FY 2013, a GRF full-scale longitudinal study will be initiated.

[1] www.nsf.gov/mps/ast/nsf_ears_workshop_2010_final_report.pdf

**NSF Graduate Research Fellowship Program**

| | Total Number of Fellows | Number of New Fellows | Projected Fellows on Tenure[1] |
|---|---|---|---|
| FY 2012 Estimate | 7,800 | 2,000 | 4,200 |
| FY 2013 Estimate | 8,900 | 2,000 | 4,900 |

[1]Fellowship tenure status is the period of time during which fellows actively utilize the fellowship award to pursue an advanced degree in the science, technology, engineering, or mathematics fields supported by the National Science Foundation.

- $51.69 million for the Integrative Graduate Education and Research Traineeship (IGERT) program, a decrease of $8.13 million from the FY 2012 Estimate of $59.82 million. CISE and EHR have reduced funding support of IGERT to direct resources to other activities in FY 2013. IGERT will support comprehensive Ph.D. programs that are innovative models for interdisciplinary education and research and that prepare students for academic and non-academic careers. This reduced funding will support approximately 1,250 IGERT trainees, which is about 200 less than the number in FY 2012.
- $27.00 million for the NSF Graduate STEM Fellows in K-12 Education (GK-12) program, an increase of $50,000 from the FY 2012 Estimate of $26.95 million. The GK-12 program was initiated in 1999, and during the subsequent years more than 300 projects have been funded throughout the Nation. The GK-12 program did not hold a new competition in FY 2011 and will not hold future competitions because it has been terminated. The program has achieved its goal of providing models for other organizations to consider, along with evaluation data, in developing their efforts. The FY 2013 amount will be used to cover commitments to grants made in prior years, and it will support an estimated 800 GK-12 graduate fellows.

**Long-Term Ecological Research (LTER)**

The FY 2013 Request provides $27.97 million, an increase of $570,000 above the FY 2012 Estimate level of $27.40 million. LTER supports fundamental ecological research that requires long time periods and large spatial scales. This program supports a coordinated network of more than two dozen field sites that focus on: 1) understanding ecological phenomena that occur over long temporal and broad spatial scales; 2) creating a legacy of well-designed and documented ecological experiments; 3) conducting major syntheses and theoretical efforts; and 4) providing information necessary for the identification and solution of environmental problems. LTER field sites represent a diversity of habitats in continental North America, the Caribbean, Pacific Ocean, and the Antarctic, including coral reefs, deserts, estuaries, lakes, prairies, various forests, alpine and Arctic tundra, urban areas, and production agriculture. Beginning in FY 2012, NEON infrastructure will be co-located at eleven LTER sites, as the LTER network and NEON are complementary networks that enhance ecological research in different ways. NEON is a continental-scale infrastructure facility providing standardized physical and data resources to researchers and educators. LTER is a network of long-term research projects aimed at understanding processes in a wide range of ecosystems. The co-location of NEON infrastructure at LTER sites will enable innovative research building on the long history of LTER research with the new capabilities to quantitatively scale the site-based knowledge to regional and continental scales. The increased support for LTER in FY 2013 covers planned periodic increases to cover higher costs as sites are renewed.

**Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS)**

The FY 2013 Request provides $30.17 million, an increase of $10.17 million above the FY 2012 Estimate of $20.00 million for the BioMaPS program, an interdisciplinary partnership between the Directorates for Biological Sciences, Mathematical and Physical Sciences, and Engineering. Support for BioMaPS is

consistent with the recommendations of the National Academies of Science study, Research at the Intersection of the Physical and Life Sciences.[2] BioMaPS seeks to discover fundamental new knowledge at the intersections of the biological, mathematical and physical sciences, and engineering in order to enable innovation in national priorities such as clean energy, climate science, and advanced manufacturing that are essential to the Nation's prosperity, economic competitiveness, and quality of life. The increases funding in FY 2013 reflects the overall alignment with these funding priorities.

**Research Experiences for Teachers (RET)**

The FY 2013 Request for NSF's RET program totals $5.47 million, a decrease of $1.51 million below the FY 2012 Estimate level of $6.98 million. Funding will provide pre-service and in-service K-12 teachers, and community college faculty with discovery-based learning experiences. The professional development gained by the participants through this unique experience has enriched their performance in the classroom and their guidance of students toward engineering. A formal evaluation by SRI International was completed in 2007, which documented achievements of the RET program from 2001 to 2006.[3] As a result, some minor adjustments were made to the program, for example, extending the minimum duration of the program from four weeks to six weeks.

**Research in Undergraduate Institutions (RUI)**

The FY 2013 Request for NSF's RUI program totals $40.15 million, equal to the FY 2012 Estimate. The RUI activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions.

**Research Experiences for Undergraduates (REU)**

The FY 2013 Request for NSF's REU program totals $68.40 million, an increase of $2.41 million from the FY 2012 Estimate of $65.99 million. The request for FY 2013 reflects the importance of undergraduate research experiences in building students' interest and competence in STEM disciplines, and aligns with the Administration's focus on improving undergraduate STEM education. The increase is consistent with the external evaluation of REU conducted between 2003 and 2006, and also with a survey of former REU participants conducted in 2009 by SRI International, which found that undergraduate students who participate in hands-on research are more likely to pursue advanced degrees and careers in STEM. REU grants involve students at all stages of undergraduate education, including the freshman and sophomore levels, which enhances retention and graduation rates in STEM. REU Supplements allow students to join research projects that are supported by NSF research grants. REU Sites support cohorts of students to conduct research within STEM disciplines or on topics that cut across disciplines. Most of the students in an REU Site come from outside the host institution. This feature enables the program to involve students in research who might not otherwise have the opportunity, particularly students from institutions where research activities are limited. The REU program encourages partnerships between community colleges and baccalaureate degree-granting institutions to provide research opportunities for community college STEM students and faculty. This emphasis will continue in FY 2013 as a means of broadening participation in STEM and fostering educational pathways and transfer opportunities for students in STEM programs. In FY 2012, EHR's evaluation group is exploring the feasibility of how best to evaluate themes, such as research experience that cross NSF's STEM education programs. REU is included in the FY 2012-FY 2013 Agency Priority Goal focusing on undergraduate programs.

[2] www.nap.edu/catalog.php?record_id=12809

[3] http://csted.sri.com/content/evaluation-national-science-foundations-research-experiences-teachers-ret-program-2001-2006

**Science and Technology Centers (STCs)**

The FY 2013 Request for the Science and Technology Centers program totals $74.39 million, an increase of $23.64 million over the FY 2012 Estimate level of $50.75 million. The funding increase in FY 2013 includes support for a new class of STCs. For additional information, see the NSF Centers Programs section of this chapter.

# PERFORMANCE

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## NSF'S PERFORMANCE CONTEXT

The following information on NSF's mission statement, organizational structure, and strategic goals is required to be included in the agency's Annual Performance Plan and Annual Performance Report by the GPRA Modernization Act of 2010 (P.L.111-352).

**Mission Statement**

The NSF Act of 1950 (Public Law 81-507) states the Foundation's mission: "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes."

**Strategic Plan and Performance Goals**

NSF's Strategic Plan, *Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011-2016*[1], lays out three strategic goals—Transform the Frontiers, Innovate for Society, and Perform as a Model Organization—that relate directly to this mission. This goal structure enables NSF to link its investments to longer-term outcomes. To bridge the gap between these strategic goals and measurable outputs, the Strategic Plan establishes a set of performance goals (also called strategic objectives) for each strategic goal:

| Strategic Goal | Strategic Objectives / Performance Goals |
|---|---|
| *Transform the Frontiers (T)* emphasizes the seamless integration of research and education as well as the close coupling of research infrastructure and discovery. | T-1: Make investments that lead to emerging new fields of science and engineering and shifts in existing fields.<br>T-2: Prepare and engage a diverse science, technology, engineering, and mathematics (STEM) workforce motivated to participate at the frontiers.<br>T-3: Keep the United States globally competitive at the frontiers of knowledge by increasing international partnerships and collaborations.<br>T-4: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers. |
| *Innovate for Society (I)* points to the tight linkage between NSF programs and societal needs, and it highlights the role that new knowledge and creativity play in economic prosperity and society's general welfare. | I-1: Make investments that lead to results and resources that are useful to society.<br>I-2: Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering.<br>I-3: Support the development of innovative learning systems. |
| *Perform as a Model Organization (M)* emphasizes the importance to NSF of attaining excellence and inclusion in all operational aspects. | M-1: Achieve management excellence through leadership, accountability, and personal responsibility.<br>M-2: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth.<br>M-3: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service. |

[1] http://www.nsf.gov/about/performance

Under each of these performance goals are one or more strategic targets, 14 in all. In FY 2011, each strategic target was monitored through one or more annual performance goals, 16 in all. The NSF set 18 performance goals for FY 2012-FY 2013.

**GPRA Modernization Act of 2010**

The GPRA Modernization Act of 2010 (P.L.111-352, 31 U.S.C. 1115(b)(10)) revises the federal government's performance management framework, retaining and amplifying certain aspects of the Government Performance and Results Act of 1993 (GPRA). The Act shifts the focus of its predecessor from the production of plans and reports to the use of goals and performance data to improve outcomes. Among other changes, it strengthens leadership engagement in setting ambitious goals, reviewing progress, and clearly communicating results.

The GPRA Modernization Act (GPRA-MA) institutes important changes to existing strategic planning, performance planning, and reporting requirements. GPRA-MA serves as a foundation for helping agencies to focus on their highest priorities and creating a culture where data and empirical evidence plays a greater role in policy, budget, and management decisions.

As required in the GPRA Modernization Act, this FY 2013 Congressional Budget Request includes the following reports on NSF's performance framework:

- FY 2012 - 2013 Agency Priority Goals. This section also includes a report on the FY 2010-2011 Priority Goal.
- FY 2012 - 2013 Annual Performance Plan, Goals and Priorities section
- FY 2011 Annual Performance Report, including information about the program evaluations completed in FY 2011
- FY 2011-2016 Strategic Plan Addendum
- Supporting Information, including discussion of the strategies and supporting analyses used in development of the FY 2012-2013 Plan and the methods used to verify and validate performance data.

# AGENCY PRIORITY GOALS

## FY 2012-FY 2013 Agency Priority Goals

NSF has set three priority goals for accomplishment in FY 2012 and FY 2013. These goals cover the range of programmatic activities that NSF supports, from basic research to training of the science and engineering workforce to education of the general public. The goals will require cross-agency coordination to make progress, and NSF is leveraging its experiences with FY 2010-FY 2011 Priority Goal achievement towards this end.

The information on the following pages about the FY 2012-2013 Goals is also available on NSF's Performance.gov page. NSF also participates in cross-agency Federal Priority Goals. Please refer to Performance.gov for information on these Federal Priority Goals and NSF's contributions to them.

| **FY 2012-FY 2013 NSF Agency Priority Goals** | | |
|---|---|---|
| **Goal Short Title** | **Impact Statement** | **Goal Statement** |
| Access to Digital Products of NSF-Funded Research | Increase opportunities for research and education through public access to high-value digital products of NSF-funded research. | By September 30, 2013, NSF will have established policies for public access to high-value data and software in at least two data-intensive scientific domains. |
| Undergraduate Programs | Develop a diverse and highly qualified science and technology workforce. | By September 30, 2013, 80 percent of institutions funded through NSF undergraduate programs document the extent of use of proven instructional practices. |
| NSF Innovation Corps | Increase the number of entrepreneurs emerging from university laboratories. | By September 30, 2013, 80 percent of teams participating in the NSF Innovation Corps program will have tested the commercial viability of their product or service. |

## FY 2012-FY 2013 Priority Goal: Access to Digital Products of NSF-Funded Research

**Impact Statement**
Increase opportunities for research and education through public access to high-value digital products of NSF-funded research.

**Goal Statement**
By September 30, 2013, NSF will have established policies for public access to high-value data and software in at least two data-intensive scientific domains.

**Lead Organization**
Directorate for Mathematical and Physical Sciences

**Relevant Strategic Objective/Performance Goal**
Under the "Transform the Frontiers" strategic goal, Objective T-4, "Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and enable transformation at the frontiers."

**Description**
Digital data are increasingly one of the primary products of scientific research. As advanced by the National Science Board, open data sharing is closely linked to public access to scholarly publications resulting from federally funded unclassified research, and they should be considered in concert. The digital data underlying figures and the key findings in the literature should be accessible and linked to one another so that scientists can verify and reproduce major findings in the literature and repurpose the data to enable new discoveries. Simultaneously, access to digital products of research enhances openness and transparency in the scientific enterprise and enables new types of multi-disciplinary research and education. Therefore, it is increasingly important for NSF to facilitate and encourage access to data and research results. The priority goal supports this vision of increasingly collaborative and multi-disciplinary science by assuring that knowledge and data can flow easily across traditional disciplinary boundaries.

This goal is also linked to the National Science Foundation's concept for "OneNSF", which promotes collaboration in well-integrated and efficient ways across organizational and disciplinary boundaries.

**Contributing Programs**
The effort is led by the Assistant Director of the Mathematical and Physical Sciences Directorate. All programmatic directorates and offices will provide appropriate program staff for working groups. The NSF will help staff and liaise to related activities of the National Science Board. Personnel from the NSF Policy Office (Office of Budget and Finance and Award Management, Division of Institutional and Award Support) and NSF Information Systems (Office of Information and Resource Management, Division of Information Systems) will be required for working groups and implementation.

Other research agencies, such as the National Institutes of Health (NIH) and the Department of Energy (DOE), face similar challenges with regard to products of federally funded scientific research. NSF staff communicate with representatives of other agencies to identify best practices for facilitating access to data. Prototyping and implementation will engage a variety of external stakeholders.

## FY 2012-FY 2013 Priority Goal: Undergraduate Programs

**Impact Statement**
Develop a diverse and highly qualified science and technology workforce.

**Goal Statement**
By September 30, 2013, 80 percent of institutions funded through NSF undergraduate programs document the extent of use of proven instructional practices.

**Lead Organization**
Directorate for Education and Human Resources (EHR).

**Relevant Strategic Objective/Performance Goal**
Under "Transform the Frontiers" strategic goal, T-2: "Prepare and engage a diverse STEM workforce motivated to participate at the frontiers."

**Description**
NSF's Strategic Plan emphasizes the pressing need for science and engineering workforce development and emphasizes diversity and innovation as aspects of high quality preparation and engagement. The current priority goal addresses NSF's long-term core commitment to using undergraduate education to engage and prepare a diverse and highly qualified science and engineering workforce. Research shows that evidence-based instructional practices lead to improved student learning, and thus are a useful metric for assessing impact on a well-prepared workforce. Therefore, one way that NSF can advance its efforts to invest in the preparation of a strong science and engineering workforce is by encouraging and facilitating the use of empirically-based instructional practices in undergraduate science, technology, engineering, and mathematics (STEM) education. To do this first means establishing a baseline about the use of such practices.

Implementation of this goal will include the design, piloting, and testing of a suite of methods to gather information about the nature of undergraduate STEM instructional practice in institutions. These methods will enable academic institutions to benchmark their instructional practices in STEM fields.

By September 30, 2013, 80 percent of the institutions funded through NSF undergraduate programs will be expected to document the extent of their use of evidence-based instructional practices.

**Contributing Programs**
All NSF programs that support undergraduate science, technology, engineering, and mathematics (STEM) education.

## FY 2012-FY 2013 Priority Goal: NSF Innovation Corps

**Impact Statement**
Increase the number of entrepreneurs emerging from university laboratories.

**Goal Statement**
By September 30, 2013, 80 percent of teams participating in the NSF Innovation Corps program will have tested the commercial viability of their product or service.

**Lead Organization**
Directorate for Engineering

**Relevant Strategic Objective/Performance Goal**
Under "Innovate for Society" strategic goal, Objective I-1, "Make investments that lead to results and resources that are useful to society," and Objective I-2, "Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering."

**Description**
Through the NSF Innovation Corps (I-Corps) program, NSF seeks to accelerate the development of new technologies, products and processes that arise from fundamental research. The goals of I-Corps are to spur translation of fundamental research, to encourage collaboration between academia and industry, and to train students to understand innovation and entrepreneurship. With I-Corps, NSF supports NSF-funded researchers whose efforts will be augmented - in the form of mentoring and funding - to accelerate the translation of knowledge derived from fundamental research into emerging products and services that can attract subsequent third party funding. NSF investments will strategically strengthen the innovation ecosystem (http://www.nsf.gov/eng/iip/innovation.pdf) by addressing the challenges inherent in the early stages of the innovation process.

Implementation of this goal will require the development of mechanisms and partnerships to support I-Corps teams. The teams will consist of three people and will include an NSF Principal Investigator (PI), an Entrepreneurial Lead (typically a graduate student) and a mentor from the private sector. Teams will propose a specific service or product concept for six months of I-Corps-funded development and testing. The concepts will have arisen from basic research led by the PI and funded by NSF within the previous five years. The selected teams will proceed through an intensive prescribed curriculum designed to develop their entrepreneurial skills and to ensure that the critical assumptions underpinning their perceived opportunities are tested. At the end of the six months, teams will decide whether or not to proceed with development of their concept.

**Contributing Programs**
NSF Innovation Corps, http://www.nsf.gov/news/special_reports/i-corps/

## FY 2010-FY 2011 Priority Goal Report

NSF had one priority goal for accomplishment in FY 2010 and FY 2011. A summary of this priority goal, including the goal's achievements, is provided below.

**FY 2010-FY2011 Priority Goal: Science, Technology, Engineering and Mathematics (STEM) Workforce Development**

**Goal Statement**
By the end of 2011, at least six major NSF science, technology, engineering and mathematics (STEM) workforce development programs at the graduate, postdoctoral, or early career level have evaluation and assessment systems providing findings enabling program re-design or consolidation for more strategic impact.

**Lead Organization**
Directorate for Education and Human Resources

**Relevant Strategic Objective/Performance Goal**
Transform the Frontiers strategic goal, subgoal T-2: "Prepare and engage a diverse STEM workforce motivated to participate at the frontiers."

**Result: Achieved. Twelve programs reached the target.**
NSF's goal aimed to strengthen NSF's internal culture and practices to rely more heavily on assessment and evaluation for decision-making and grants program improvement. The NSF Priority Goal (PG) target was for six of the twenty-five participating grants programs to have evaluation and assessment systems capable of providing enough information for program re-design or consolidation. A theoretical model of program design and evaluation was developed to help provide a framework for assessment and measurement.

At the close of the performance period, September 30, 2011, materials from each of the twenty-five programs were rated by an expert against the theoretical model. Twelve of the twenty-five programs in the target program universe reached the goal, identified below by NSF managing directorate or office and program focus:

| Program | Directorate | Focus |
|---|---|---|
| Alliances for Graduate Education and the Professoriate (AGEP) | EHR/SBE | Graduate |
| Faculty Early Career Development Program (CAREER) | EHR | Early Career |
| Fellowships for Transformative Computational Science using Cyberinfrastructure (CI-TraCS) | OCI | Postdoctoral |
| Earth Sciences Postdoctoral Fellowship (EAR-PF) | GEO | Postdoctoral |
| Graduate Research Fellowship Program (GRF) | EHR | Graduate |
| Integrative Graduate Education and Research Traineeship Program (IGERT) | EHR | Graduate |
| International Research Fellowship Program (IRFP) | OISE | Postdoctoral |
| Mathematical Sciences Postdoctoral Research Fellowships (MSPRF) | MPS | Postdoctoral |
| Robert Noyce Teacher Scholarship Program (NOYCE) | EHR | Postdoctoral |
| Opportunities for Enhancing Diversity in the Geosciences (OEDG) | GEO | Graduate |

| Program | Directorate | Focus |
|---|---|---|
| Postdoctoral Research Fellowship in Biology (PRFB) | BIO | Postdoctoral |
| Scholarship for Service/Cybercorps (SFS) | EHR | Graduate |

All twenty-five programs made progress towards achieving the goal. Of the thirteen programs that did not achieve the goal, four have not been active long enough to meet all the criteria of the theoretical model.

A more comprehensive report is available for download at http://www.nsf.gov/about/budget/fy2013. Posting of this report addresses concerns about transparency and accountability, which were raised by an Office of the Inspector General audit in FY 2011 of NSF's process for achieving Priority Goals. The audit found that "the detail and documentation provided to support milestone accomplishment was inadequate and did not provide for the transparency and accountability intended of priority goal processes." However, it also stated:

> *NSF has taken steps consistent with OMB guidance related to coordinating, measuring, monitoring, and communicating progress towards achieving its priority goal. Through the priority goal process, NSF appears to be moving towards a foundation of increased performance data-driven program evaluation and assessment, as evidenced by improvements in both the quantity and quality of the performance information included in its budget requests to Congress.*[1]

**Lessons Learned and Future Directions**

NSF will not continue this Priority Goal in FY 2012-2013, but will continue efforts to bring a stronger orientation toward evidence as a basis for program improvement. Changing culture is a slow process, but, as a direct result of undertaking this Priority Goal, a culture of evaluation and performance assessment is gaining momentum across the Foundation. Agency-wide collaborations will continue.

Unanticipated positive impacts of the Priority Goal process include:

- As a result of their involvement in the Priority Goal activities, staff leaders of the twelve postdoctoral and early career programs increased their level of collaboration. One major activity undertaken, for example, was the development of a common logic model for postdoctoral programs which could serve as an umbrella for individual programs. And, the programs collectively convened a group of postdoctoral grantees to discuss how to best improve postdoctoral programming. In the future, this effort could help the programs make maximal use of limited resources, improve assessment, and share best practices to improve effectiveness.
- Partially in response to needs of program staff working on the Priority Goal activities, in FY 2011 NSF's Office of Integrative Activities (OIA) began developing capabilities for NSF-wide data mining and analysis of available program information. The office collaborated with a number of Priority Goal programs to attempt to address specific questions formulated by the programs as part of the Priority Goal process. This new capacity for improved data mining of existing program documents provided substantial evidence for evaluative analysis of the programs participating in the PG activity. Given NSF's commitment to developing Foundation-wide evaluation capability, the OIA participation in this component of the Priority Goal was critical in helping to build needed resources.
- Ongoing discussion of metrics and monitoring systems for STEM education and workforce development, in programs across the agency, has benefitted from the Priority Goal activity, and there are new efforts for a range of programs to work with logic models and goal development.

[1] http://www.nsf.gov/oig/11-2-008.pdf

## FY 2012-FY 2013 PERFORMANCE PLAN

This Annual Performance Plan, together with other sections of this chapter, addresses the topics specified in the GPRA Modernization Act. One exception however, is the topic of Federal Priority Goals. Per the GPRA Modernization Act, P.L. 111-352, requirement to address Federal Goals in the agency Strategic Plan and Annual Performance Plan, please refer to Performance.gov for information on Federal Priority Goals and NSF's contributions to those goals, where applicable.

NSF's FY 2012 and FY 2013 performance goals are presented in the table below in context with their associated strategic goal. As in FY 2011, all program activities within the agency are covered, and all longer-term objectives under each strategic goal are covered.

| **Strategic Goal** | **FY 2012-FY 2013 Performance Goal** | | **New or continuing activity?** |
|---|---|---|---|
| Transform the Frontiers | T-1.1 | INSPIRE* | Continuing |
| | T-2.1 | Priority Goal, Undergraduate Programs | New |
| | T-2.2 | Career-Life Balance | New |
| | T-3.1 | International Implications | Continuing |
| | T-4.1 | Construction Project Monitoring | Continuing |
| | T-4.2 | Priority Goal, Access to Digital Products | New |
| Innovate for Society | I-1.1 | Priority Goal, Innovation Corps | New |
| | I-1.2 | Industrial and Innovation Partnerships | Continuing |
| | I-2.1 | Public Understanding and Communication | Continuing |
| | I-2.2 | K-12 Scale-up | Continuing |
| | I-3.1 | Innovative Learning Systems | Continuing |
| Perform as a Model Organization | M-1.1 | Model EEO* Agency | Continuing |
| | M-1.2 | IPA* Performance Plans | Continuing |
| | M-1.3 | Performance Management System | New |
| | M-2.1 | Assess Developmental Needs | Continuing |
| | M-3.1 | Financial System Modernization | Continuing |
| | M-3.2 | Time To Decision | Continuing |
| | M-3.3 | Virtual Panels | New |

*Acronyms:
INSPIRE: Integrated NSF Support Promoting Interdisciplinary Research and Education
EEO: Equal Employment Opportunity
IPA: Intergovernmental Personnel Act

This FY 2012-FY 2013 Plan builds on NSF's FY 2011 Performance Plan, which was the first under a new set of Strategic Goals introduced by NSF's FY 2011-FY 2016 Strategic Plan, *Empowering the Nation Through Discovery and Innovation*. Almost all FY 2011 goals continue into FYs 2012 and 2013, and several activities with no FY 2011 precedents have been added as performance goals, including goals to advance the OneNSF framework (INSPIRE, Expeditions in Education, Innovation Corps) and the Career-Life Balance Initiative. NSF's three Priority Goals for FY 2012 and FY 2013 are also included in this Plan.

In FY 2012 and FY 2013, NSF expects to continue refining its implementation of the GPRA Modernization Act. This will involve internal process modifications to integrate lessons learned from past experience with ideas from the growing performance management community of practice in the Federal government.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-1:** Make investments that lead to emerging new fields of science and engineering and shifts in existing fields.

**Strategic Target**: The NSF portfolio fully incorporates emerging areas with transformative potential, including those forming at disciplinary boundaries.

**Goal T-1.1 INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education)**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Strengthen support of unusually novel, potentially transformative, interdisciplinary research (IDR), through new funding mechanisms, systems, and incentives that facilitate and encourage IDR. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012,<br>• Track 1: Gather baseline data on NSF-supported IDR.<br>• Track 2: Make 25 awards via the pilot CREATIV (Creative REsearch Awards for Transformative Interdisciplinary Ventures) mechanism. | By September 30, 2013,<br>• Track 1: Modify NSF's eBusiness systems to facilitate co-review and management of proposals by multiple divisions, and to ease tracking of co-funded IDR.<br>• Track 2: Award up to one-third of FY 2013 INSPIRE funds via the CREATIV mechanism.<br>• Track 2: Establish a second pilot award mechanism for funding mid-scale IDR (up to $3 million), and make first round of awards. |
| **Explanation** | INSPIRE was established to address some of the most complicated and pressing scientific problems that lie at the intersections of traditional disciplines. INSPIRE will strengthen NSF's support of interdisciplinary, potentially transformative research by complementing existing efforts with a suite of new, highly innovative Foundation-wide activities and funding opportunities.<br><br>The INSPIRE program has two goals. The first goal is to provide NSF program officers with the necessary tools and management support to empower cross-cutting collaboration and risk-taking in developing and managing their awards portfolio. The second goal is for researchers to submit, and NSF to support, a greater proportion of unusually novel, creative interdisciplinary proposals.<br><br>For more information about INSPIRE's background, goals, design, and investment and evaluation framework, refer to the NSF-Wide Investments tab. | |

| | |
|---|---|
| **Potential Methods and Processes** | Track 1 of INSPIRE seeks to make changes to NSF systems and practices that will facilitate identification, review, support, management, and tracking of IDR. Activities will encompass improvements in business practices, funding culture, training, and evaluation.<br><br>The pilot CREATIV (Creative Research Awards for Transformative Interdisciplinary Ventures) award mechanism will invest all of the INSPIRE funds for FY 2012. CREATIV awards, with a maximum award size of $1.0 million, will generally be internally reviewed and will support bold high-risk IDR projects that investigators may be reluctant to submit to a conventional review process. The CREATIV funding mechanism will be open to ideas on any NSF-supported topic as long as they are interdisciplinary and potentially transformative.<br><br>To facilitate later evaluation of INSPIRE, baseline data on NSF-supported IDR will be gathered, and internal and external surveys about support of IDR and potentially transformative research (PTR) will be conducted. In FY 2013, the 2012 portfolio of CREATIV awards will be analyzed to determine whether the new mechanism is resulting in types of awards that were not being funded with previous mechanisms. Case studies and qualitative assessments of the review process for projects with transformative results are expected to provide helpful information.<br><br>In FY 2013, the INSPIRE awards activities will continue, supporting the second year of the CREATIV pilot and expanding to include larger "mid-scale" awards up to the range of $2.5-3.0 million. This second pilot INSPIRE mechanism will be open to IDR proposals on any NSF-supported topic and will utilize novel merit review mechanisms involving both internal and external review. Directorates and offices will co-fund CREATIV and mid-scale awards, together with centralized funds from the Office of Integrative Activities.<br><br>This and future reports on this activity to support fundamental, high-risk, and potentially transformative research is provided also per Section 1008 of the 2007 America COMPETES Act. |
| **Trend information** | INSPIRE is a new activity in FY 2012. Its centralized IA funds and interdisciplinary aspects have no clear precedent at NSF. Baseline data is yet to be gathered.<br><br>NSF has been experimenting with how to support potentially transformative research (PTR) for several years. The EAGER (Early-concept Grants for Exploratory Research) mechanism, first used in FY 2009, is designed to support small-scale PTR (two years, <$300,000). In FY 2010, the directorates funded by the Research and Related Activities appropriations account allocated a total of $138.44 million to explore different methodologies to support PTR, which created a set of awards that are collectively considered case studies for the various methodologies used. The tracking of this activity was a GPRA performance goal in FY 2010 and FY 2011. |
| **Lead Organization** | Office of Integrative Activities |

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-2:** Prepare and engage a diverse science, technology, engineering, and mathematics (STEM) workforce motivated to participate at the frontiers.

**Strategic Target**: NSF STEM workforce development programs, models, or strategies have rigorous evidence about the impact on diversity and innovation in the workforce.

**Goal T-2.1 PRIORITY GOAL: Undergraduate Programs**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Develop a diverse and highly qualified science and technology workforce. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2013, 80 percent of institutions funded through NSF undergraduate programs document the extent of use of proven instructional practices. | |
| **Explanation** | NSF's Strategic Plan emphasizes the pressing need for science and engineering workforce development and emphasizes diversity and innovation as aspects of high quality preparation and engagement. The current priority goal addresses NSF's long-term core commitment to using undergraduate education to engage and prepare a diverse and highly qualified science and engineering workforce. Research shows that evidence-based instructional practices lead to improved student learning, and thus are a useful metric for assessing impact on a well-prepared workforce. Therefore, one way that NSF can advance its efforts to invest in the preparation of a strong science and engineering workforce is by encouraging and facilitating the use of empirically-based instructional practices in undergraduate science, technology, engineering, and mathematics (STEM) education. To do this first means establishing a baseline about the use of such practices.<br><br>Implementation of this goal will include the design, piloting, and testing of a suite of methods to gather information about the nature of undergraduate STEM instructional practice in institutions. These methods will enable academic institutions to benchmark their instructional practices in STEM fields.<br><br>By September 30, 2013, 80 percent of the institutions funded through NSF undergraduate programs will be expected to document the extent of their use of evidence-based instructional practices. | |
| **Potential Methods and Processes** | Action Plan will be posted on performance.gov in Summer 2012. | |
| **Trend information** | NA. This Priority Goal is a newly developed activity for FY 2012-FY 2013. | |
| **Lead Organization** | Directorate for Education and Human Resources | |

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**Goal T-2.2 Career-Life Balance**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Promote Career-Life Balance policies and practices that support more fully utilizing the talents of individuals in all sectors of the American population – principally women, underrepresented minorities and persons with disabilities. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012, establish the FY 2012 baseline for number and value of award support provided to CAREER awardees and postdoctoral fellows intended to fund research technicians. | By September 30, 2013,<br>• Establish the FY 2013 baseline for number and value of awards provided to ADVANCE institutions intended to fund dual career supports.<br>• Increase the number and value of research technician award support provided to CAREER awardees and postdoctoral fellows by 10 percent over FY 2012. |
| **Explanation** | Although women comprise a significant and growing fraction of the U.S. STEM talent pool, recent studies demonstrate the challenges that they face when attempting to balance the often extreme demands of career and life without adequate institutional support. Utilizing women's talent and potential in STEM fields is critical to the nation's future success in science and technology and to economic prosperity.<br><br>To address this challenge, NSF's Career-Life Balance (CLB) Initiative, a set of forward-looking policies and practices, will help to increase the placement, advancement, and retention of women in STEM disciplines, particularly women who are seeking tenure in academe. NSF aims to enhance existing – and implement new – gender-neutral, family-friendly policies, as it is important that our nation's colleges and universities accommodate the needs of the largest-growing segment of our science and engineering workforce. The Foundation is pursuing an agency-level pathway approach across higher education and career levels (i.e., graduate students, postdoctoral students, and early-career scientists, and engineers). CLB seeks new and innovative ways in which NSF can partner with U.S. universities, colleges, and research institutions to help attract, nurture, and retain a much greater fraction of women engineers and scientists in the nation's STEM workforce.<br><br>In FY 2012 and FY 2013, NSF will introduce CLB supports for technicians for awardees (CAREER and postdoctoral fellows) who need temporary help to continue research while facing the demands of child and/or elder dependent care. In FY 2013, the NSF will introduce a support through the ADVANCE Institutional Transformation award for hiring dual-career spouses. Achievement of the FY 2012 and FY 2013 | |

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| | targets will signify significant new CLB supports for postdoctoral students and early-career scientists and engineers. |
| **Potential Methods and Processes** | The following methods will be used:<br>• A Working Group with representation from across the agency to coordinate activities.<br>• Communications strategy to raise awareness around the Foundation and in the S&E community about the CLB initiative (e.g. dedicated dynamic webpage, email announcements, town hall meetings, conferences, and activity fairs).<br>• Training of NSF staff in opportunities and resources, and award management provided through CLB.<br>• Establishment of unique accounting codes to facilitate financial reporting of CLB supports.<br>• Individual program officers to work with grantees to identify opportunities to use the supports.<br>• Development of an integrated documentation, assessment and evaluation approach to guide and determine the added value of the CLB initiative. |
| **Trend information** | NA. The CLB Initiative is new in FY 2012. Such support provided in past years was not trackable. |
| **Lead Organization** | Office of the Director |

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-3**: Keep the United States globally competitive at the frontiers of knowledge by increasing international partnerships and collaborations.

**Strategic Target**: NSF programs increasingly establish international partnerships that advance the frontiers of knowledge.

**Goal T-3.1 International Implications**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications. | |
| **Target Measure, Milestone, or Deliverable** | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications by 10 percent over FY 2011. | Increase proportion of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications by 10 percent over FY 2012. |
| **Explanation** | As science and engineering expertise and infrastructure advance across the globe, it is expected that the United States will increasingly benefit from international collaborations and a globally engaged workforce leading to transformational science and engineering breakthroughs. To this end, NSF promotes cooperation among scientists and engineers from all nations and encourages funding of international collaborative activities through all of our programs. By supporting institutions that collaborate on research, education and related activities with international colleagues, U.S. scientists and engineers gain access to unique facilities and research sites and to partnerships with the global research community. In these ways, they are able to augment what might otherwise be purely domestic activities and resources in their field and have an opportunity to better understand the increasingly global character of science and engineering.<br><br>In NSF's internal document clearance process, program officers have the opportunity to indicate whether a given solicitation, announcement, or Dear Colleague Letter has international implications. For example, study of earthquakes may require international travel or collaboration, so a solicitation on the topic may have implications for international activity. OISE will work with NSF directorates and offices to identify opportunities to expand international engagements among NSF activities and incorporate them into these proposal-generating documents. | |
| **Potential Methods and Processes** | The number of new NSF solicitations, announcements, and Dear Colleague Letters that have international implications will be compared to the total number of such documents issued by NSF in each year. | |
| **Trend information** | This was a new goal in FY 2011 under NSF's new strategic plan framework. OISE conducted a count of these materials in FY 2011 and established a baseline of 23 solicitations, announcements, and Dear Colleague Letters.<br><br>FY 2011 baseline: 20 percent (23 of 116 solicitations, announcements, and Dear Colleague Letters issued in FY 2011.) | |

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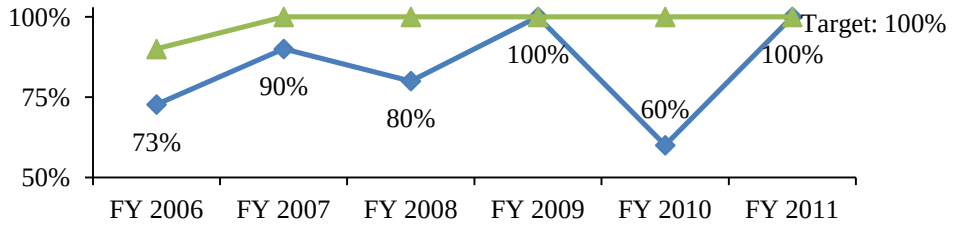
| | FY 2012 target: 22 percent of solicitations, announcements, and Dear Colleague Letters issued in FY 2012.<br>FY 2013 target: 24 percent of solicitations, announcements, and Dear Colleague Letters issued in FY 2013. |
| **Lead Organization** | Office of International Science and Engineering |

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-4**: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers.

**Strategic Target**: NSF prioritizes and manages facility investments throughout their life-cycle in a transparent and effective way.

**Goal T-4.1 Construction Project Monitoring**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | For all MREFC facilities under construction, keep negative cost and schedule variance at or below 10 percent. | |
| **Target Measure, Milestone, or Deliverable** | 100 percent of construction projects that are over 10 percent complete. | |
| **Explanation** | The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. This goal provides a monitoring component for NSF's "no cost overrun" policy, discussed on page 2 of the MREFC chapter. The 10 percent target is consistent with OMB and Congressional guidelines for large projects. | |
| **Potential Methods and Processes** | Performance of construction projects funded by the MREFC account is monitored using the Earned Value Management (EVM) system. EVM is an integrated management control system for assessing, understanding, and quantifying what a contractor or field activity is achieving with program dollars. Monitoring cost and schedule is a standard measure of performance for construction projects.<br><br>Projects that are under ten percent complete are not considered eligible for this goal because EVM data is less meaningful statistically in the very early stages of a project. Early in a project, the actual costs of the work, and the total values of the work scheduled and performed, are small compared to the total project cost and schedule. Consequently, their ratios - the reported cost and schedule variances - can change by large amounts even though the real values of their differences are small. | |
| **Trend information** | Monitoring construction projects using the EVM method is an ongoing practice at NSF.<br><br>**Construction Project Monitoring performance trends, FY 2006-FY 2011**<br>  <br> | |
| **Lead Organization** | Large Facilities Office, Office of Budget, Finance, and Award Management | |

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-4**: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers.

**Strategic Target**: Ensure data generated by NSF's major multi-user facilities are widely accessible to the research community.

**Goal T-4.2 PRIORITY GOAL: Access to Digital Products of NSF-Funded Research**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Increase opportunities for research and education through public access to high-value digital products of NSF-funded research. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2013, NSF will have established policies for public access to high-value data and software in at least two data-intensive scientific domains. | |
| **Explanation** | Digital data are increasingly one of the primary products of scientific research. As advanced by the National Science Board, open data sharing is closely linked to public access to scholarly publications resulting from federally-funded unclassified research, and they should be considered in concert. The digital data underlying figures and the key findings in the literature should be accessible and linked to one another so that scientists can verify and reproduce major findings in the literature and repurpose the data to enable new discoveries. Simultaneously, access to digital products of research enhances openness and transparency in the scientific enterprise and enables new types of multi-disciplinary research and education. Therefore, it is increasingly important for NSF to facilitate and encourage access to data and research results. The priority goal supports this vision of increasingly collaborative and multi-disciplinary science by assuring that knowledge and data can flow easily across traditional disciplinary boundaries.<br><br>This goal is also linked to the National Science Foundation's concept for "OneNSF", which promotes collaboration in well-integrated and efficient ways across organizational and disciplinary boundaries.<br><br>The effort is led by the Assistant Director of the Mathematical and Physical Sciences Directorate. All programmatic directorates and offices will provide appropriate program staff for working groups. The NSF will help staff and liaise to related activities of the National Science Board. Personnel from the NSF Policy Office (Office of Budget and Finance and Award Management, Division of Institutional and Award Support) and NSF Information Systems (Office of Information and Resource Management, Division of Information Systems) will be required for working groups and implementation. Other research agencies, such as the National Institutes of Health (NIH) and the Department of Energy (DOE), face similar challenges with regard to products of federally-funded scientific research. NSF staff communicate with representatives of other agencies to identify best practices for facilitating access to data. Prototyping and implementation will engage a variety of external stakeholders. | |
| **Potential Methods and** | Action Plan will be posted on performance.gov in Summer 2012. | |

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| **Processes** | The National Science Foundation (NSF) has aligned its Priority Goal on Access to Digital Products with the open data policy process being led by OSTP. NSF participates in OSTP's Open Data Policy initiative by serving on the National Science and Technology Council (NSTC)'s Interagency Working Group on Digital Data (IWGDD). The IWGDD is tasked with identifying the specific objectives and public interests that need to be addressed by any policies in this area. The working group includes representatives from the Department of Energy, the National Institutes of Health, and other science funding agencies as well as NSF. The group is assessing the varying missions, types of data, standards, and dissemination models associated with the range of Federal science agencies and scientific disciplines, and will help OSTP address other public access requirements in the COMPETES Act. The two NSF representatives on the IWGDD also serve on the NSF-wide group on data and access, and facilitate regular communications among these two groups, NSF leadership, and the National Science Board (particularly the Task Force on Data Policies) in order to ensure that the Foundation's activities to facilitate increased accessed to digital products of federally funded research are aligned with those led by OSTP. NSF's activities for the Priority Goal will take into account the processes and short-term and intermediate-term outcomes of the IWGDD. |
| **Trend Information** | NA. This Priority Goal is a newly developed activity for FY 2012-FY 2013. |
| **Lead Organization** | Directorate for Mathematics and Physical Sciences |

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-1:** Make investments that lead to results and resources that are useful to society.

**Strategic Target**: NSF investments underpin long-term solutions to societal challenges such as economic development, climate change, energy, and cyber-security.

**Goal I-1.1 PRIORITY GOAL: Innovation Corps**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Increase the number of entrepreneurs emerging from university laboratories. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2013, 80 percent of teams participating in the Innovation Corps program will have tested the commercial viability of their product or service. | |
| **Explanation** | Through the Innovation Corps (I-Corps) program, NSF seeks to accelerate the development of new technologies, products and processes that arise from fundamental research. The goals of I-Corps are to spur translation of fundamental research, to encourage collaboration between academia and industry, and to train students to understand innovation and entrepreneurship. With I-Corps, NSF supports NSF-funded researchers whose efforts will be augmented - in the form of mentoring and funding - to accelerate the translation of knowledge derived from fundamental research into emerging products and services that can attract subsequent third party funding. NSF investments will strategically strengthen the innovation ecosystem (http://www.nsf.gov/eng/iip/innovation.pdf) by addressing the challenges inherent in the early stages of the innovation process.<br><br>Implementation of this goal will require the development of mechanisms and partnerships to support I-Corps teams. The teams will consist of three people and will include an NSF Principal Investigator (PI), an Entrepreneurial Lead (typically a graduate student) and a mentor from the private sector. Teams will propose a specific service or product concept for six months of I-Corps-funded development and testing. The concepts will have arisen from basic research led by the PI and funded by NSF within the previous five years. The selected teams will proceed through an intensive prescribed curriculum designed to develop their entrepreneurial skills and to ensure that the critical assumptions underpinning their perceived opportunities are tested. At the end of the six months, teams will decide whether or not to proceed with development of their concept. | |
| **Potential Methods and Processes** | Action Plan will be posted on performance.gov in Summer 2012. | |
| **Trend information** | NA. The Innovation Corps program began in the fourth quarter of FY 2011. | |
| **Lead Organizations** | Office of Integrative Activities and Directorate for Engineering | |

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-1:** Make investments that lead to results and resources that are useful to society.

**Strategic Target**: NSF investments underpin long-term solutions to societal challenges such as economic development, climate change, energy, and cyber-security.

**Goal I-1.2 Industrial and Innovation Partnerships**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Identify the number and types of partnerships entered into by Industrial & Innovation Partnerships (IIP) Division grantees. | |
| **Target Measure, Milestone, or Deliverable** | • Count number of financial partnerships in FY 2010 and FY 2011 made by IIP program grantees.<br>• Evaluate the potential to collect other types of partnership data in the future. (e.g. strategic, people partnerships, in-kind partnerships, lab sharing, acquisitions, etc.) | • Count number of financial partnerships in FY 2012 made by IIP program grantees. |
| **Explanation** | The IIP programs are:<br>• Small Business Innovation Research (SBIR)<br>• Small Business Technology Transfer (STTR)<br>• Industry/University Cooperative Research Centers (I/UCRC)<br>• Partnerships for Innovation (PFI)<br>• Grant Opportunities for Academic Liaison with Industry (GOALI)<br><br>“Partnership” here includes only "financial investments" for the purpose of baselining all IIP Programs. Examples of a financial investment would include:<br>• Subcontractor in SBIR Award<br>• Executed third party investment package in SBIR supplement (required for award)<br>• Partnership condition in award (e.g. GOALI, PFI, STTR, SBIR: Phase IICC, Phase IIA, TECP)<br>• I/UCRC Industrial Advisory Board Member<br>• I/UCRC Interagency Agreement and Military Interdepartmental Purchase Requests (MIPRs) | |
| **Potential Methods and Processes** | Development of a sound methodology and collection mechanism that if approved (e.g. a final report template) would be used starting with FY 2013 awards. | |
| **Trend information** | This was a new goal in FY 2011 under NSF’s new strategic plan framework. A baseline of FY 2010 partnerships (1,567) was determined in FY 2011 in three of the IIP division’s five programs: SBIR/STTR, PFI and I/UCRC. However, due to changes in data collection systems and clarification of the “partnership” definition, FY 2010 will be re-baselined in FY 2012. | |
| **Lead Organization** | Industrial & Innovation Partnerships Division, Directorate for Engineering | |

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-2:** Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering.

**Strategic Target**: NSF's scientific literacy and public engagement programs are supported by rigorous evidence about learning outcomes

**Goal I-2.1 Public Understanding and Communication of Science and Engineering**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Establish a common set of evidentiary standards for programs and activities across the agency that fund public understanding and communication of science and engineering activities. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012,<br>• Deliver an internal report defining standards of evidence for the models used by the 16 programs identified in FY 2011 that fund public understanding and communication of science and engineering.<br>• Identify all programs across the agency that employ the models and strategies. | By September 30, 2013, utilize report to inform the revision of solicitation language in one-half of programs identified in FY 2012 to reflect evidence standards |
| **Explanation** | Certain programs in EHR's Division of Research and Learning (DRL) aim to address public understanding and communication of science and engineering, but other NSF activities also work towards this aim. This Goal's intent is to identify all such activities across the Foundation and provide them with evidence-based criteria for evaluation of such projects. This can lead to more consistent expectations across NSF for use of and production of evidence.<br><br>Three-year trajectory: search NSF core programs to identify programs that explicitly address Public Understanding and Communication; extract models and evidence strategies used by those programs and reassess NSF's investments to identify those that implicitly address Public Understanding and Communication; use this list of programs to establish common criteria for Public Understanding and Communication activities in general across programs. | |
| **Potential Methods and Processes** | EHR staff will collect, search, and analyze NSF data and information; NSF-wide group of program staff to be convened and solicitations revised. This effort will also include collaboration with the Office of Legislative and Public Affairs (OLPA). | |
| **Trend information** | This was a new goal in FY 2011 under NSF's new strategic plan framework. In FY 2011, a keyword search of NSF program solicitations using the term "public understanding" was used to generate a baseline. Sixteen programs had this phrase in their solicitations. Searches performed using awarded project descriptions and abstracts identified a number of projects that include the focus in ways other than specifically mentioned as part of a formal program solicitation. Consequently, a baseline based on those numbers was not used because the context and definition of the phrase "public understanding" in funded project descriptions varied. | |
| **Lead Organization** | Division of Research on Learning in Formal and Informal Settings (DRL), EHR | |

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-2:** Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering.

**Strategic Target**: NSF's K-12 STEM education investments are designed and tested for scale-up.

**Goal I-2.2 K-12 Components**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Establish a common set of evidentiary standards for programs across the agency that fund activities with K-12 components. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012,<br>• Identify the number of programs that fund activities with K-12 components in FY 2012.<br>• Develop common standards of evidence for inclusion in future solicitations of the identified programs. | By September 30, 2013,<br>• 100 percent of programs identified in FY 2012 ("the portfolio") will include the common standards in their solicitations.<br>• A baseline count will be taken of the projects in the portfolio that already meet these standards. |
| **Explanation** | There is increasing interest across the federal government not just to count the number of programs addressing K-12 education, but to examine the potential of projects for "going to scale": moving beyond the initial project site to be adapted and implemented successfully under more representative conditions and with appropriate population groups.<br><br>There are multiple sets of standards for identifying a project's readiness for scale-up. Sources for standards of evidence that will be examined in FY 2012 include those under development at the Department of Education and NSF, individual NSF programs (e.g. Arctic Sciences rigor standards; DRK-12 Horizon Research Standards), and National Academies of Science reports. | |
| **Potential Methods and Processes** | NSF expert staff will review standards of evidence in the literature, repeat and revise the FY 2011 analysis, update solicitations, and write reports.<br><br>A baseline count of the number of projects that meet the standards will be conducted in FY 2013. It is estimated that approximately 15 percent of the projects in the portfolio will already meet the standards. | |
| **Trend information** | This was a new goal in FY 2011 under NSF's new strategic plan framework. A baseline of NSF's K-12 programs (FY 2011 baseline: 16) was established as the first step in a three-year trajectory to establish a set of standards in common across NSF to articulate a pathway toward readiness to scale up. | |
| **Lead Organization** | Directorate for Education and Human Resources | |

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-3**: Support the development of innovative learning systems.

**Strategic Target**: NSF invests in innovative learning tools and structures that use emerging technologies and are tested for effectiveness and scalability.

**Goal I-3.1 Innovative Learning Systems**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Integrate common language about, or goals for, innovative learning research into the Cyberlearning, Data and Observation for STEM Education focus area of the Expeditions in Education (E2) investment, and into other programs across the agency that fund innovative learning tools, structures, and systems. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012, write a synthesis report on NSF support of Innovative Learning Systems supporting common language for solicitations. | By September 30, 2013,<br>• Programs with significant innovative learning system research will update their solicitations with the language developed in FY 2012 to include common language or goals about innovative learning systems.<br>• At least 50 percent of new projects funded in the innovative learning systems portfolio have in place research and evaluation mechanisms that will provide high quality evidence about the nature of student learning. |
| **Explanation** | Networked computing and communications technologies that support learning, teaching, and education are already opening up access for all learners, in all age groups, in all settings. Innovative learning systems can bring authentic scientific data immediately to learners, which enable learners to experience science through modeling, simulation, sensor networks, digital telescopes and remote instruments.<br><br>Expeditions in Education ($E^2$) is an NSF initiative to infuse cutting-edge science, engineering, and innovation into the preparation of a world-class scientific workforce for the twenty-first century, and to ensure that all of NSF's education and workforce investments are drawing on the latest educational theory, research, and evidence.<br><br>$E^2$ activities will integrate, leverage, and expand STEM education research and development to improve learning in science and engineering (S&E) disciplines and capitalize on the scientific assets across NSF to bring engaging new science content, knowledge, and real-world applications to more learners.<br><br>The "Cyberlearning, Data, and Observations for STEM Education" focus area of $E^2$ aims to address the many questions associated with how STEM learning can be enhanced and how new content can be introduced using cyberlearning resources and tools. | |
| **Potential Methods and Processes** | NSF staff will review standards of evidence in the literature, confer with experts in other agencies and the field, repeat and revise the FY 2011 analysis, update solicitations, and write reports. | |

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| **Trend information** | This was a new goal in FY 2011 under NSF's new strategic plan framework. Its intent was to identify activities across the Foundation that contribute to development of innovative learning systems, which are not funded by any one program. In FY 2011, a latent semantic analysis tool was used to find awards made in FY 2011 that fit into the general category of Research-Based Innovative learning Systems (ILS). 150 awards were identified, 95 percent of which were made by eight divisions within the EHR, CISE, and ENG directorates. The awards corresponded to 28 distinct programs. |
| **Lead Organization** | Directorate for Education and Human Resources |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.1 Model EEO Agency**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Perform activities necessary to attain essential elements of a model EEO agency, as defined by the Equal Employment Opportunity Commission (EEOC). | |
| | Collaborate with the Chief Human Capital Officer (CHCO) in drafting the Office of Diversity and Inclusion's responsibilities within NSF's first Diversity and Inclusion (D&I) Strategic Plan for submission to the Office of Personnel Management (OPM). | |
| **Target Measure, Milestone, or Deliverable** | • Attain four of six essential elements.<br>• Submit D&I Strategic Plan to OPM by March 30, 2012. | • Attain five of six essential elements. |
| **Explanation** | For NSF to achieve model EEO agency status, it must meet and maintain each of the six criteria established by the EEOC. The EEOC refers to these criteria as the "Essential Elements" of a Model Agency, which are:<br><br>A. Demonstrated commitment from agency leadership;<br>B. Integration of EEO into the agency's strategic mission;<br>C. Management and program accountability;<br>D. Proactive prevention of unlawful discrimination;<br>E. Efficiency; and<br>F. Responsiveness and legal compliance.<br><br>Per Executive Order 13583, which establishes a coordinated government-wide initiative to promote diversity and inclusion in the federal workforce, NSF will submit a D&I Strategic Plan to OPM in FY 2012.<br><br>Specifically, the Office of Diversity and Inclusion's (ODI's) focus in the D&I plan will include, after review of the required barrier analysis, action plans to eliminate any identified barriers and implementation progress for at least two NSF directorates. | |
| **Potential Methods and Processes** | To evaluate NSF's progress towards meeting measures in the essential elements of a model EEO agency, ODI will conduct an annual self assessment, as required by the EEOC. Such assessment is certified for accuracy by both the ODI and NSF Director. At the end of each fiscal year, ODI will provide to the verifiers a narrative illustrating NSF's progress, based on the certified self assessment, as well as provide data, such as training, and any supporting documentation that is not protected under privacy laws.<br><br>In evaluating targets regarding NSF's D&I Strategic Plan, the following will be measured:<br>1. Whether the D&I Plan was timely submitted to OPM.<br>2. Whether ODI, upon review of its annual barrier analysis, identified any potential | |

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| | barriers to EEO, worked with applicable senior leaders in at least two directorates in devising plans to eliminate any barriers, and provided an assessment of the plan for effectiveness. |
| **Trend information** | In FY 2011, the first year of this performance goal, model EEO agency criteria A (Demonstrated commitment from agency leadership), B (Integration of EEO into the agency's strategic mission), and E (Efficiency) were achieved. |
| **Lead Organization** | Office of Diversity and Inclusion, Office of the Director. |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.2 IPA Performance Plans**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Include assignees on temporary appointment to NSF under the Intergovernmental Personnel Act (IPAs) under an NSF performance management system. | |
| **Target Measure, Milestone, or Deliverable** | By March 31, 2012, 95 percent of executive-level IPAs whose assignments have at least 90 days remaining will have performance plans in place.<br><br>By September 30, 2012, 90 percent of non-executive IPAs whose assignments have at least 90 days remaining will have performance plans in place. | By March 31, 2013, 100 percent of executive IPAs with appointments exceeding 90 days will have performance plans in place.<br><br>By September 30, 2013, 95 percent of all non executive IPAs whose assignments have at least 90 days remaining will have performance plans in place.<br><br>By October 1, 2013, an evaluation of the effectiveness of executive and non-executive IPA performance plans in setting and communicating expectations will be completed.<br><br>By October 31, 2013, best practices for managing executive and non-executive IPA performance will be identified and shared. |
| **Explanation** | This goal addresses human resource management challenges specific to NSF that were identified by Congress, the Office of Personnel Management, and NSF's Office of the Inspector General.<br><br>The Intergovernmental Personnel Act (IPA) mobility program (5 CFR part 334) provides the authority for NSF to bring in scientific staff for limited periods of time. IPA assignees are on detail to NSF and remain on the payroll of their home institution. Using the IPA authority to recruit active researchers infuses new talent and expertise into NSF and provides scientists and engineers with valuable information and knowledge to bring back to their home institutions. NSF's use of the IPA helps to maintain the Foundation's close association with the nation's colleges and universities and the contributions made by NSF's IPA scientists furthers the agency's mission of supporting the entire spectrum of science and engineering research and education. | |
| **Potential Methods and Processes** | In order to facilitate tracking and documentation, HRM will seek to develop an electronic process for submitting and tracking IPA performance plans and appraisals. HRM will conduct interviews, focus groups, and/or surveys with IPAs and their | |

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| | supervisors to determine the impact of these performance plans on IPAs' understandings of what is expected of them and their ability to support NSF's mission. |
| **Trend information** | Before FY 2011, IPAs were not required to submit performance plans. In FY 2011, a performance goal to expand the coverage of NSF's performance management framework to include IPAs was set. In the first year, 92 percent of all non-executive IPAs (target: 80 percent) and 90 percent of executive-level IPAs (target: 90 percent) had performance plans on file. |
| **Lead Organization** | Division of Human Resources Management (HRM), Office of Information and Resource Management (OIRM) |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.3 Performance Management System**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Use findings from assessments to guide improvement of NSF's employee performance management systems.<br><br>Acronyms:<br>• CHCO: Chief Human Capital Officer<br>• EVS: Employee View Point Survey<br>• GWF: General Workforce<br>• PAAT: Performance Appraisal Assessment Tool<br>• SES: Senior Executive Service | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012, deliver an action strategy for improvement of one to three areas noted in NSF's SES or GWF PAAT or identified in NSF's EVS results to the NSF CHCO. | By July 31, 2013,<br>• Submit 2013 NSF SES PAAT to OPM.<br>• Put in place the needed supporting materials for full implementation of the government-wide SES Performance Plan and Appraisal Process.<br><br>By September 30, 2013, achieve a 65 percent positive response rate on the 2012 EVS to the question: "In my most recent performance appraisal, I understood what I had to do to be rated at different performance levels (for example, Fully Successful, Outstanding)." |
| **Explanation** | NSF has two primary performance management systems for NSF employees, one that covers members of the Senior Executive Service (SES) and one that covers the General Workforce (GWF). In 2011 NSF added a third performance system to cover staff on assignment to NSF through the Intergovernmental Personnel Act (IPA) mobility program. Staff under this third system are covered by goal M-1.2.<br><br>In 2011, NSF administered OPM's Performance Appraisal Assessment Tool (PAAT) for both the SES and GWF performance management systems. The SES PAAT was submitted to OPM in September 2011, and NSF's SES performance management system was certified in January 2012. NSF can use the OPM review materials and internal review to identify potential areas of weakness and to develop a strategy for improving the SES performance management system in conjunction with a new government-wide approach to SES performance management. The GWF PAAT was submitted to OPM in December 2011. It is still under review at OPM. Feedback | |

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| | from OPM will be incorporated with related internal review processes to develop a strategy for improving the GWF performance management system.<br><br>The Federal EVS is a tool that measures employees' perceptions of whether, and to what extent, the conditions that characterize successful organizations are present in their agencies. The EVS includes questions related to performance appraisal.<br><br>This goal addresses human resource management challenges specific to NSF that were identified by Congress, the Office of Personnel Management, and NSF's Office of the Inspector General. |
| **Potential Methods and Processes** | HRM will:<br>• Analyze the findings of SES PAAT, the GWF PAAT, and the EVS.<br>• Partner with others to benchmark against and identify promising practices in other organizations to assist NSF in addressing priority areas.<br>• Develop action strategy for implementation in FY 2013. |
| **Trend information** | The NSF's most recent SES-PAAT Assessment Report (released in December of 2011) identified a need for the NSF to establish guidelines about how organizational performance should be considered when deciding ratings and awards and to develop a plan for setting and adjusting SES rate of basic pay.<br>• On the question related to organizational assessment guidelines, the NSF scored 4 out of 6 because the NSF did not provide written guidelines about how organizational performance should be considered when deciding ratings and awards.<br>• On the question related to pay policy, the NSF scored 3 out of 5 because some criteria outlined in 5 CFR 534.404(g) were missing.<br><br>NSF is still awaiting OPM's review of the GWF PAAT.<br><br>The 2011 EVS found that the percentage of NSF employees who understood what they had to do to be rated at different performance levels was lower than in previous years. For the EVS question "In my most recent performance appraisal, I understood what I had to do to be rated at different performance levels (for example, Fully Successful, Outstanding)":<br>2010 EVS positive response rate: 68 percent.<br>2011 EVS positive response rate: 63 percent.<br>2012 EVS target: 65 percent.<br>2013 EVS target: 68 percent.<br><br>A given year's EVS results are made available approximately six months following the survey. Thus, the 2012 EVS results will be available in late FY 2012 or early FY 2013, and the 2013 results will be available in late FY 2013 or early FY 2014. |
| **Lead Organization** | Division of Human Resources Management (HRM), Office of Information and Resource Management (OIRM) |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-2**: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth.

**Strategic Target**: NSF emphasizes learning for personal and professional development for all staff.

**Goal M-2.1 Assess Developmental Needs**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Enhance NSF capabilities to provide training of staff for their current positions. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012, design a structured curriculum which meets assessed needs for at least two types of NSF staff roles (e.g. leaders, program officers, administrative professionals, technical professionals). | • By September 30, 2013, identify gaps between desired curricula and current course offerings and recommend approaches to filling identified gaps.<br>• Attain a 60 percent positive response rate on the 2013 Employee Viewpoint Survey (EVS) on the question "How satisfied are you with the training you receive for your present job?" (results available in FY 2014) |
| **Explanation** | NSF core values and strategic goals place a high priority on learning and development for its staff. NSF stresses personal learning and development to enhance performance, further our knowledge base on all aspects of NSF activity, and continue to build for the future. This directly reflects the specific action identified in the Strategic Plan: "review current NSF learning opportunities and develop a plan for addressing gaps." | |
| **Potential Methods and Processes** | HRM will continue to evaluate data from the 2011 and 2012 needs assessments to determine gaps between identified needs and current curricula and course offerings. Needs assessments will be designed to reflect the needs of key elements of the NSF workforce. They will use a combination of survey and focus group methods. Once identified, the gaps will be assigned a priority status and the Academy will recommend options for filling those gaps. Note that training around implementation of performance management systems will be important components of both this goal and the goals regarding improvement in performance management systems. | |
| **Trend information** | In FY 2011, HRM developed and launched targeted needs analysis questionnaires designed to generate new learning needs data. Questionnaires asked NSF administrative professional staff to rate the performance of specific skills necessary to complete their work, and rated the importance of creating additional skill-based learning and development opportunities to help them successfully complete their work. Approximately 38% of administrative support staff participated in the survey. In September 2011, contract support for assessment of the broader spectrum of NSF staff was obtained.<br><br>The 2010 and 2011 Employee Viewpoint Surveys found that the number of employees satisfied with the training they received had decreased. For the EVS question "How satisfied are you with the training you receive for your present job?":<br>2008 EVS positive response rate: 66 percent.<br>2010 EVS positive response rate: 61 percent.<br>2011 EVS positive response rate: 57 percent.<br>2012 EVS target: 60 percent. | |

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| | 2013 EVS target: 63 percent.<br><br>A given year's EVS results are made available approximately six months following the survey. Thus, the 2012 EVS results will be available in late FY 2012 or early FY 2013, and the 2013 results will be available in late FY 2013 or early FY 2014. |
| **Lead Organization** | Division of Human Resources Management (HRM), Office of Information and Resource Management (OIRM) |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Strategic Target**: NSF uses the innovation and creativity of our staff to improve agency processes and systems on a continuing basis.

**Goal M-3.1 Financial System Modernization**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Upgrade NSF's financial system. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012, to support the iTRAK initiative, the Division of Financial Management (DFM) and the Division of Acquisition and Cooperative Agreements (DACS) will award a contract for the iTRAK financial system implementation and integration services. | By September 30, 2013, to support the transition to the grant-by-grant payment process known as the Award Cash Management $ervice (ACM$), DFM will reconcile 100 percent of the grantee's reported cash on hand balances as of December 31, 2012 with NSF's general ledger. |
| **Explanation** | "iTRAK" is the Foundation-wide effort to transition NSF from its legacy financial support systems to a fully integrated, commercial-off-the-shelf (COTS) financial management shared services solution.<br>In FY 2012, NSF will select a system integration contractor to implement the COTS solution. | NSF is transitioning its financial processing of grants from a pooled system (quarterly reporting of expenditures by institution) to a grant-by-grant payment process where grant funds are requested and reported on an individual grant level. |
| **Potential Methods and Processes** | The iTRAK Technical Evaluation Panel (TEP) reviews and rates the proposals submitted by vendors. Upon award, a memo from the Contracting Officer Technical Representative (COTR) will be given to the CFO stating that this goal has been met. | DFM will reconcile each grantee's award balance with NSF's Financial Accounting System (FAS). Upon completion of the reconciliation process, a memo from the Cash Management Branch Chief will be given to the DCFO stating that this goal has been met. |
| **Trend information** | Financial system modernization efforts have been underway at NSF for several years. The iTRAK effort–a Foundation-wide effort to transition NSF from its legacy financial support systems to a fully integrated, commercial-off-the-shelf (COTS) financial management shared services solution—is central, but other modernization steps are required as prerequisites. GPRA performance goals related to the activities were first developed in FY 2011 to measure one of these prerequisites, when functional requirements were gathered for changes in current system processes that will accommodate the transition to a grant-by-grant payment method. This payment method is a prerequisite for the transition to a COTS financial management shared services solution.<br><br>The FY 2011 target for this goal was the documentation of functional requirements to transition to a real-time payment method. Documentation detailing business rules and | |

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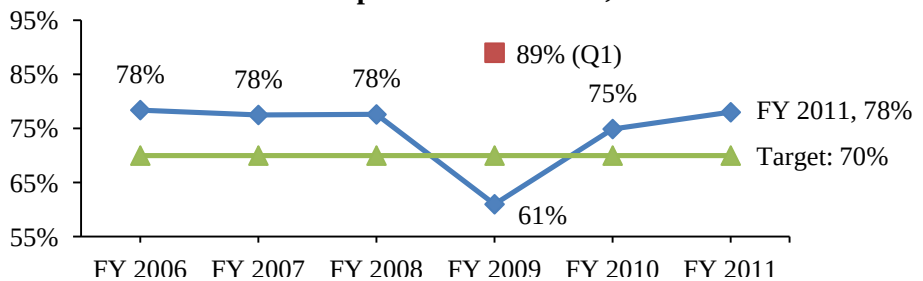
| | functional requirements was prepared by the Office of Budget, Finance, and Award Management in FY 2011. However, during cross-agency working group meetings, additional requirements were raised that needed to be addressed. Consequently, this target was not met in FY 2011. In fulfillment of the goal, the requirements were delivered in December 2011.<br><br>Establishing the capability to monitor expenditures at the award level is an essential aspect of NSF's financial system modernization. NSF is committed to transition its financial processing of grants from a pooled system (quarterly reporting of expenditures by institution) to grant-by-grant (near real-time reporting of expenditures by award) by FY 2013. This change will result in more timely financial data and stronger monitoring programs. This initiative is per the Administration and CFO directive to increase efficiency and transparency in the agency. |
| **Lead Organizations** | Divisions of Acquisition and Cooperative Agreements (DACS) and Financial Management (DFM), Office of Budget, Finance, and Award Management (BFA). |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Strategic Target**: NSF organizations achieve high levels of customer satisfaction

**Goal M-3.2 Time-to-Decision**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Inform applicants whether their proposals have been declined or recommended for funding within six months of deadline, target date, or receipt date, whichever is later. | |
| **Target Measure, Milestone, or Deliverable** | 70 percent. | |
| **Explanation** | Time-to-decision or "dwell time" is the amount of time that passes between receipt of a proposal and notification to the principal investigator about the funding decision. One of the most significant issues raised in customer satisfaction surveys is the time it takes NSF to process proposals. Too long a time period inhibits the progress of research as it delays the funding process, but too short a time period may inhibit the merit review process. The six-month target seeks to strike a balance between the need of the investigator for timely action and the need of NSF for a credible and efficient merit review system. | |
| **Potential Methods and Processes** | NSF automates the collection of data and calculation of result for this goal, thereby ensuring the quality of the data. The NSF databases used (FastLane and eJacket) have internal controls that ensure data quality. | |
| **Trend information** | Monitoring the merit review process with the time-to-decision metric is an ongoing practice at NSF.<br><br>The most relevant recent variations in performance took place in FY 2009 and FY 2010. In the second quarter of FY 2009, the American Recovery and Reinvestment Act (ARRA) was passed. This goal was suspended for the second, third, and fourth quarters of that year to allow for a greater number of proposals to be processed with additional funds from ARRA. The goal was reinstated in FY 2010, when NSF exceeded this goal despite a significant increase in workload. Overall, staffing levels increased by 5.5 percent between FY 2008 and FY 2011, while proposal pressure increased by 17.4 percent.<br><br>**Time to decision performance trends, FY 2006-FY 2011**<br>  <br> | |
| **Lead Organization** | Office of the Director | |

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Strategic Target**: NSF organizations achieve high levels of customer satisfaction

**Goal M-3.3 Virtual Merit Review Panels**

| **Fiscal Year** | **2012** | **2013** |
|---|---|---|
| **Statement** | Expand the use of virtual merit review panels. | |
| **Target Measure, Milestone, or Deliverable** | By September 30, 2012, develop guidelines and training modules for NSF staff on the use of virtual merit review panels. | In FY 2013, as a pilot activity, five percent of merit review panels will be virtual panels. |
| **Explanation** | This goal will test ways to make NSF's merit review process more innovative, sustainable and family-friendly to encourage greater participation and the best use of resources.<br><br>NSF makes extensive use of panels of reviewers to evaluate proposals. The predominant practice is for the panelists to travel to a single location, usually NSF, and meet face-to-face for one to five days. In FY 2010, approximately 1,800 review panels were held. Of these, just over one quarter involved six or fewer panelists. Face-to-face panels impose a significant time burden on the reviewers, making some potential reviewers reluctant to participate. For example, panelists with young children may not be able to obtain two continuous days of childcare, or panelists in remote locations or foreign countries may find the amount of travel required prohibitive. It also causes NSF to incur significant travel costs. | |
| **Potential Methods and Processes** | As used here, the term "virtual panel" refers to a panel meeting in which the reviewers do not travel to a common location but instead participate via teleconference, videoconference or an online meeting technology.<br><br>In FY 2012, administrative offices and program staff will collaborate to develop:<br>• An internal web-site that provides guidance to NSF staff on when to choose a virtual panel and how best to implement such panels; and<br>• Training opportunities for NSF staff and reviewers.<br><br>During the FY 2013 pilot, several different technologies to support virtual panels will be made available to programs experimenting with virtual panels. After the pilot has been completed, an evaluation of the effectiveness and efficiency of different approaches will be made and used to inform development of future policies on the use of virtual panels. | |
| **Trend information** | NSF has experimented with virtual panels at a small scale for several years. In FY 2011, approximately one percent of panels were virtual panels. | |
| **Lead Organization** | Office of Integrative Activities | |

## Other Goals, Priorities, and Activities

This section provides information required by the GPRA Modernization Act on discontinued goals, lower-priority programs, unnecessary reports to Congress, and management challenges.

**Changes from FY 2011**

Most FY 2011 goals continued into FY 2012 and FY 2013. Several had modified goal statements but are logical follow-ons to former activities. A few were discontinued as GPRA goals, although activities towards the objectives continue. For more about these goals see the FY 2011 Performance Report.

| Strategic Goal | FY 2011 Annual Performance Goal | | Status in FY 2012-FY 2013 Performance Plan |
|---|---|---|---|
| Transform the Frontiers | T-1.1 | Potentially Transformative Research | Modified |
| | T-2.1 | STEM Workforce Priority Goal | Modified--new Priority Goal |
| | T-3.1 | International Implications | Continuing |
| | T-4.1 | Construction Project Monitoring | Continuing |
| | T-4.2 | Data Management Practices at Large Facilities | Modified--new Priority Goal |
| Innovate for Society | I-1.1 | IIP Grantees' Partnerships | Continuing |
| | I-2.1 | Public Understanding and Communication | Continuing |
| | I-2.2 | K-12 Components | Continuing |
| | I-3.1 | Innovative Learning Systems | Continuing |
| | I-3.2 | Partnerships for Learning Technologies | Discontinued |
| Perform as a Model Organization | M-1.1 | Model EEO Agency | Continuing |
| | M-1.2 | IPA Performance Plans | Continuing |
| | M-1.3 | 360 Degree Evaluation Instrument | Discontinued |
| | M-2.1 | Staff Developmental Needs | Continuing |
| | M-3.1 | Grant-By-Grant Payments | Continuing |
| | M-3.2 | Time to Decision | Continuing |

**Lower-Priority Programs**

The 2013 Cuts, Consolidations, and Savings (CCS) Volume of the President's Budget identifies the lower-priority program activities under the GPRA Modernization Act (31 U.S.C. 1115(b)(10)). The public can access the CCS volume at: http://www.whitehouse.gov/omb/budget.

**Burden Reduction/Unnecessary Plans and Reports to Congress**

The GPRA Modernization Act 2010 requires that agencies identify which of the plans and reports they provide to Congress are outdated or duplicative of other required plans and reports. The complete list of reports that NSF suggested for consolidation or elimination can be found in the President's Budget: http://www.whitehouse.gov/omb/budget.

**Management Challenges**

A discussion of agency management challenges can be found in the FY 2011 Agency Financial Report, http://www.nsf.gov/pubs/2012/nsf12001/.

## FY 2011 ANNUAL PERFORMANCE REPORT

In FY 2011, NSF set 16 performance goals, which between them cover all program activities within the agency. 13 were achieved in FY 2011; achievement for the remaining three was delayed, but all were achieved by the time of publication of this Report. Below is a tabular overview.

| Strategic Goal | Annual Goal | | FY 2011 Result |
|---|---|---|---|
| Transform the Frontiers | T-1.1 | Potentially Transformative Research | Achieved |
| | T-2.1 | STEM Workforce Priority Goal | Achieved |
| | T-3.1 | International Implications | Achieved |
| | T-4.1 | Construction Project Monitoring | Achieved |
| | T-4.2 | Data Management Practices at Large Facilities | Achieved |
| Innovate for Society | I-1.1 | IIP Grantees' Partnerships | Achieved |
| | I-2.1 | Public Understanding and Communication | Achieved |
| | I-2.2 | K-12 Components | Achieved |
| | I-3.1 | Innovative Learning Systems | Achieved |
| | I-3.2 | Partnerships for Learning Technologies | Achieved |
| Perform as a Model Organization | M-1.1 | Model EEO Agency | Achieved |
| | M-1.2 | IPA Performance Plans | Achieved |
| | M-1.3 | 360 Degree Evaluation Instrument | Not met (achieved 10/2011) |
| | M-2.1 | Staff Developmental Needs | Achieved after deadline |
| | M-3.1 | Grant-By-Grant Payments | Not met (achieved 12/2011) |
| | M-3.2 | Time to Decision | Achieved |

The following pages present the results for each goal individually. Goals are presented in their strategic context, with reference to strategic goals, objectives, and targets from NSF's FY 2011-FY 2016 Strategic Plan (see the first section of this chapter). The majority of FY 2011 goals were new because NSF's Strategic Plan introduced impact-oriented goals that could not be measured with existing measures or techniques. Therefore, multiple years of trend data are available only for NSF's long-standing quantitative performance measures, time to decision (M-3.2) and construction cost and schedule variance (T-4.1). A few goals monitor activities begun in recent years and therefore have limited historical or trend data (e.g. T-1.1, T-2.1, M-1.2).

A statement by the NSF Director verifying the reliability and completeness of the performance data in this report can be found in the FY 2011 Performance and Financial Highlights report at http://www.nsf.gov/about/history/annual-reports.jsp.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-1:** Make investments that lead to emerging new fields of science and engineering and shifts in existing fields.

**Strategic Target**: The NSF portfolio fully incorporates emerging areas with transformative potential, including those forming at disciplinary boundaries.

**Goal T-1.1 Potentially Transformative Research (PTR)**
Lead Organization: Office of the Director.

| Fiscal Year | Goal Statement and Target | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2010 (new goal) | Each directorate in the Research and Related Activities account will invest a minimum of $2.0 million per research division to leverage and facilitate activities that foster PTR. | $94.0 million | Achieved: $138.44 million |
| 2011 | Produce an analysis of NSF's FY 2010 investments in activities undertaken to foster potentially transformative research. | Deliverable: One analysis. | Achieved: Report delivered in fourth quarter. |

**Discussion**
NSF identifies PTR as work that may lead to:

- Dramatically new ways of conceptualizing or addressing major scientific and technological challenges, or
- New methods or analytical techniques that could put a discipline on a new scientific pathway, provide tools that allow unprecedented insights, or radically increase the rate of data collection.

In FY 2010, each Research and Related Activities (R&RA) directorate allocated a minimum of $2.0 million per research division ($94.0 million Foundation-wide) to explore methodologies that help support PTR. Each directorate devised its own methods to distribute the funds.

In FY 2011, using information collected from NSF directorates and offices, an analysis of the methods used to identify and/or facilitate potentially transformative research was performed. Challenges to these processes were also assessed. This analysis was drafted into an internal report including recommendations on how NSF can continue to promote PTR in the future.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-2**: Prepare and engage a diverse science, technology, engineering, and mathematics (STEM) workforce motivated to participate at the frontiers.

**Strategic Target**: NSF STEM workforce development programs, models, or strategies have rigorous evidence about the impact on diversity and innovation in the workforce.

**Goal T-2.1 STEM Workforce Priority Goal**
Lead Organization: Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2010 | Develop goals and metrics for NSF's programmatic investments in its FY 2010 Learning portfolio. | 100 percent of programs (baseline: 80 percent) | Achieved: 100 percent of programs that received funding in FY 2010. |
| 2011 | NSF science, technology, engineering, and mathematics (STEM) workforce development programs at the graduate, professional, or early career level participate in evaluation and assessment systems. (Priority Goal) | Six programs. | Achieved: 12 programs. |

**Discussion**
NSF's Learning portfolio includes activities funded by the Education and Human Resources (EHR) and R&RA accounts. In FY 2009, an EHR working group developed performance metrics for all EHR programs. In FY 2010, efforts continued: EHR expanded and refined these goals and metrics, goals and metrics were developed for R&RA account programs, and all programs submitted evaluation plans. These can be found at http://nsf.gov/about/budget/fy2012.

NSF's FY 2010-2011 Priority Goal built on the learning portfolio metrics activities. Achieving the Priority Goal in FY 2011 also achieved Goal T-2.1. The following programs met the target:

- Alliances for Graduate Education and the Professoriate (AGEP)
- Faculty Early Career Development Program (CAREER)
- Fellowships for Transformative Computational Science using Cyberinfrastructure (CI-TraCs)
- Earth Sciences Postdoctoral Fellowship (EAR-PF)
- Graduate Research Fellowship Program (GRF)
- Integrative Graduate Education and Research Traineeship Program (IGERT¬)
- International Research Fellowship Program (IRFP)
- Mathematical Sciences Postdoctoral Research Fellowships (MSPRF)
- Robert Noyce Teacher Scholarship Program (NOYCE)
- Opportunities for Enhancing Diversity in the Geosciences (OEDG)
- Postdoctoral Research Fellowship in Biology (PRFB)
- Scholarship for Service/Cybercorps (SFS)

For more information on the achievement of the Priority Goal, see the Priority Goal section of this chapter or the Additional Performance Information at http://www.nsf.gov/about/budget/fy2013.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-3:** Keep the United States globally competitive at the frontiers of knowledge by increasing international partnerships and collaborations.

**Strategic Target**: NSF programs increasingly establish international partnerships that advance the frontiers of knowledge.

**Goal T-3.1 International Implications**

Lead Organization: Office of International Science and Engineering (OISE).

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Identify number of new NSF program solicitations, announcements, and Dear Colleague Letters with international implications. | Establish baseline. | Achieved. Baseline: 23 solicitations, announcements, and Dear Colleague Letters |

**Discussion**

NSF has a system for program officers to indicate which solicitations, announcements, and Dear Colleague Letters have international implications in the internal clearance stages. OISE conducted a baseline count of these materials. The solicitation numbers are listed in parentheses below.

- Wiki for Enabling International Partnerships for the BREAD (Basic Research to Enable Agricultural Development) Program (11-017)
- US-China Collaborative Research in Advanced Sensors and Bio-Inspired Technologies (11-024)
- Japan/New Zealand Earthquakes/Tsunami (11-045)
- NSF-Deutsche Forschungsgemeinschaft (DFG) Collaborative Research (11-053)
- The "Earth Cube" - Towards a National Data Infrastructure for Earth System Science (11-065)
- G8 Multilateral Funding Initiative "Interdisciplinary Program on Material Efficiency - A first step towards sustainable manufacturing" (11-068)
- Dear Colleague Letter: United States and Ireland (11-070)
- Catalyzing New International Collaborations (11-508)
- Network for Earthquake Engineering Simulation Research (11-512)
- Ethics Education in Science and Engineering (11-514)
- Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM) (11-515)
- Dimensions of Biodiversity (11-518)
- Science and Technology Centers: Integrative Partnerships (11-522)
- Metabolomics for a Low Carbon Society (11-527)
- Research Coordination Networks (RCN) (11-531)
- Software Infrastructure for Sustained Innovation (SI2) (11-589)
- Centers for Chemical Innovation (CCI) (11-552)
- Partnerships for International Research and Education (PIRE) (11-564)
- Faculty Early Career Development (CAREER) (11-690)
- Sustainability Research Networks Competition (SRN) (11-574)
- NSF Graduate Research Fellowship Program (GRFP) (11-582)
- International Collaboration in Chemistry between US Investigators and their Counterparts Abroad (ICC) (11-585)
- Materials World Network: Cooperative Activity in Materials Research between US Investigators and their Counterparts Abroad (MWN) (11-568)

## Strategic Goal 1: Transform the Frontiers

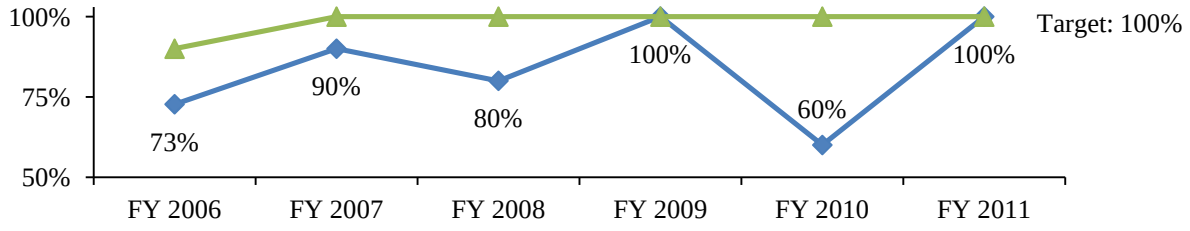
**Strategic Objective/Performance Goal T-4**: Enhance research infrastructure and promote data access to enable transformation at the frontiers.

**Strategic Target**: NSF prioritizes and manages facility investments throughout their life-cycle in a transparent and effective way.

**Goal T-4.1 Construction Project Monitoring**
Lead Organization: Large Facilities Office.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| Ongoing | For all MREFC facilities under construction, keep negative cost and schedule variance at or below 10 percent. | 100 percent of construction projects that are over 10 percent complete | Achieved: 100 percent |

**Construction Project Monitoring Performance Trends, FY 2006-FY 2011**




Four facilities under construction were over 10 percent complete at the end of FY 2011. Of those four, all had cost and schedule variances under 10 percent. One of the projects, the Ocean Observatories Initiative, was rebaselined in FY 2011 which resulted in revised earned value variance bases.

The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Performance of construction projects funded by the MREFC account is monitored using the Earned Value Management (EVM) system. EVM is an integrated management control system for assessing, understanding, and quantifying what a contractor or field activity is achieving with program dollars. Monitoring cost and schedule is a standard measure of performance for construction projects.

Projects that are under 10 percent complete are not considered eligible for this goal because EVM data is less meaningful statistically in the very early stages of a project. Early in a project, the actual cost of the work, and the total value of the work scheduled and performed, are small compared to the total project cost and schedule. Consequently, their ratios—the reported cost and schedule variances—can change by large amounts even though the real values of their differences are small.

## Strategic Goal 1: Transform the Frontiers

**Strategic Objective/Performance Goal T-4**: Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and to enable transformation at the frontiers.

**Strategic Target**: Ensure data generated by NSF's major multi-user facilities are widely accessible to the research community.

**Goal T-4.2 Data Management Practices at Large Facilities**
Lead Organization: Directorate for Mathematics and Physical Sciences.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Determine current data management practices at NSF-funded facilities. | Current data management practices documented for 100 percent of NSF-funded facilities. | Achieved: 17 of 17 facilities. |

The universe of facilities was defined as those appearing by name on the "Major Multi-User Research Facilities Funding" table in NSF's FY 2011 Budget Request's Facilities chapter:

- Academic Research Fleet
- Cornell High Energy Synchrotron Source/Cornell Electron Storage Ring
- EarthScope
- Gemini Observatory
- Incorporated Research Institutes for Seismology
- Integrated Ocean Drilling Program
- Large Hadron Collider
- Laser Interferometer Gravitational Wave Observatory
- National Astronomy and Ionosphere Center
- National Center for Atmospheric Research
- National High Magnetic Field Laboratory
- National Nanotechnology Infrastructure Network
- National Optical Astronomy Observatory
- National Radio Astronomy Observatory
- National Solar Observatory
- National Superconducting Cyclotron Laboratory
- Network for Earthquake Engineering Simulation

During FY 2011, these facilities provided documentation of their data management plans that contained the following elements:

- Types: Types of data, samples, physical collections, software, curriculum materials, and other materials that are managed and shared;
- Standards: The standards used for data and metadata format and content (where existing standards are absent or deemed inadequate, this should be documented as well);
- Access Policies: Policies for access and sharing including provisions for appropriate protection of privacy, confidentiality, security, intellectual property, or other rights or requirements;
- Re-use Policies: Policies and provisions for re-use, re-distribution, and the production of derivatives; and
- Archival: Plans for archiving data, samples, and other research products, and for preservation of access to them.

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-1:** Make investments that lead to results and resources that are useful to society.

**Strategic Target**: NSF investments underpin long-term solutions to societal challenges such as economic development, climate change, energy, and cyber-security.

**Goal I-1.1 IIP Grantees' Partnerships**
Lead Organization: Directorate for Engineering (ENG).

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Industrial and Innovation Partnerships (IIP): Identify the number and types of grantee's partnerships. | Establish baseline. | Achieved. Baseline: 1,567 partnerships. |

Using ENG's IIP division as the model to start the process of collecting data on diverse types of partnerships is intended as the beginning of a process to identify how the links between science, industry, and innovation mediate the long term impacts of NSF investments.

The baseline for all SBIR/STTR, PFI and I/UCRC partnerships from FY 2010 is in the following table.

| PARTNER TYPE | TOTAL | SUB-TYPE | COUNT |
|---|---|---|---|
| For Profit | 929 | < 500 Employees | 453 |
| | | > 500 Employees | 476 |
| | | Corporate Ventures | 0 |
| Not For Profit | 95 | Foundations | 14 |
| | | 501C3s | 14 |
| | | Consortia/Associations | 67 |
| Government | 205 | State | 41 |
| | | Local | 30 |
| | | Federal | 125 |
| | | Foreign | 9 |
| Academic | 296 | Community Colleges | 6 |
| | | Colleges | 7 |
| | | Universities | 283 |
| Investors | 42 | Angels | 29 |
| | | Venture Capitalists | 13 |
| Unknown/Undisclosed | 445 | | 445 |
| **Total Number of Partnerships** | | | **1,567** |

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-2:** Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering.

**Strategic Target**: NSF's scientific literacy and public engagement programs are supported by rigorous evidence about learning outcomes.

**Goal I-2.1 Public Understanding and Communication**
Lead Organization: Division of Research on Learning in Formal and Informal Settings (DRL), EHR.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Identify number of programs that fund activities that address public understanding and communication of science and engineering. | Establish baseline. | Achieved. Baseline: 16 programs |

Certain DRL programs explicitly aim to address public understanding and communication of science and engineering, but other NSF activities may also work towards this aim. This Goal's intent was to identify all such activities across the Foundation. A keyword search of NSF program solicitations using the term "public understanding" was used to generate the baseline. As of September 27, 2011, 16 programs had this phrase in their solicitations. The solicitation numbers are listed in parentheses below.

- OPP: Antarctic Artists and Writers Program (11-549)
- OPP: Antarctic Research (11-532)
- GEO: Centers for Ocean Sciences Education Excellence (10-527)
- BIO: Collections in Support of Biological Research (11-558)
- OIA/Cross-Cutting: Experimental Program to Stimulate Competitive Research: Workshop Opportunities (EPS) (06-583)
- OIA/Cross-Cutting: EPSCoR Research Infrastructure Improvement Program: Track-1 (11-565)
- GEO: Geoscience Education (10-512)
- GEO: Opportunities for Enhancing Diversity in the Geosciences (OEDG) (10-599)
- Cross-Cutting: Climate Change Education (CCE): Climate Change Education Partnership (CCEP) Program, Phase I (10-542)
- Cross-Cutting: Nanoscale Science and Engineering Education (05-543)
- Cross-Cutting: Science and Technology Centers: Integrative Partnerships (11-522)
- Cross-Cutting: Sustainable Energy Pathways (11-590)
- EHR: Informal Science Education (11-546)
- EHR: Innovative Technology Experiences for Students and Teachers (11-525)
- EHR: Research and Evaluation on Education in Science and Engineering (10-586)
- EHR: Research on Gender in Science and Engineering FY 2010 (10-516)

Searches performed using awarded project descriptions and abstracts identified a number of programs that include the focus in ways other than specifically mentioned as part of a formal program solicitation, but a baseline based on those numbers was not used because the context in which the phrase "public understanding" is used in funded project descriptions varies.

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-2**: Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering.

**Strategic Target**: NSF's K-12 STEM education investments are designed and tested for scale-up.

**Goal I-2.2 K-12 Components**
Lead Organization: Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Identify number of programs that fund activities with K-12 components. | Establish baseline. | Achieved. Baseline: 16 programs. |

There is increasing interest across the federal government not just to count the number of programs addressing K-12 education, but to examine the potential of projects for going to scale and moving beyond the initial site to be implemented successfully under typical conditions and with population groups that are broadly reflective of that intended for the scale-up setting (Draft Evidence Standards). A more accurate and complete list of NSF's K-12 programs is the first step in identifying the programs that have the capacity to identify the conditions that enable projects to go to scale.

The websites of all NSF directorates and divisions were searched for evidence of an explicitly stated K-12 programmatic mission or a programmatic component directed explicitly at K-12 education. Sixteen programs were identified:

- CISE: Research Assistantships for High School Students (RAHSS)
- CISE: Computing Education for the 21st Century (CE21)
- CISE: Research Experiences for Teachers (RET) Supplement
- CISE/EHR/SBE: Cyberlearning: Transforming Education
- EHR: Discovery Research K-12
- EHR: Innovative Technology Experiences for Students and Teachers (ITEST)
- EHR: Math and Science Partnership (MSP)
- EHR: Research & Evaluation on Education in S&E (REESE)
- EHR: Transforming STEM Learning (TSL) (Combines with DRK-12 in FY 2012)
- EHR: Advanced Technological Education (ATE)
- ENG: Research Experiences for Teachers (RET) Sites
- GEO: Geoscience Education (GeoEd)
- GEO: Opportunities for Enhancing Diversity in the Geosciences (OEDG)
- GEO: GEO Teach
- SBE: Science of Learning Centers (SLC)
- Multiple: Climate Change Education (CCE) Phase II (Not yet implemented)

The National STEM Digital Library (NSDL) program was originally on the list, but was last funded in FY 2011. The Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) is a K-12 program, but since it is a teacher recognition program, has no potential for going to scale, and was not included.

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-3**: Support the development of innovative learning systems.

**Strategic Target**: NSF invests in innovative learning tools and structures that use emerging technologies and are tested for effectiveness and scalability.

**Goal I-3.1 Innovative Learning Systems**
Lead Organization: Directorate for Education and Human Resources (EHR).

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Identify number of programs that fund the development of research-based innovative learning systems. | Establish baseline. | Achieved. Baseline: 150 awards within 28 program elements. |

This Goal's intent was to identify activities across the Foundation that contribute to development of innovative learning systems. Such activities are not funded by any one program within NSF. After determining NSF's baseline for this area of research, targets for subsequent years can be designed.

A latent semantic analysis tool was used to find awards made in FY 2011 that fit into the general category of Research-Based Innovative learning Systems (ILS). 150 awards were identified, 95 percent of which were made by eight divisions within the EHR, Computer and Information Science (CISE), and Engineering (ENG) directorates. The awards corresponded to 28 distinct programs.

## Strategic Goal 2: Innovate for Society

**Strategic Objective/Performance Goal I-3**: Support the development of innovative learning systems.

**Strategic Target**: New partnerships among scientists, engineers, and educators (both theorists and practitioners) take innovations from development to practice.

**Goal I-3.2 Partnerships for Learning Technologies**
Lead Organization: Directorate for Education and Human Resources.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Identify number of programs that fund activities that promote partnerships that support development of learning technologies. | Establish baseline. | Achieved. Baseline: 14 programs. |

Interdisciplinary partnerships that support development of learning technologies are funded by organizational units across the Foundation. This Goal's intent is to identify all such activities so an NSF-wide baseline can be determined. 14 core programs with capacity to fund partnerships for learning technologies were identified. The solicitation numbers are listed in parentheses below.

- CISE: Computing Education for the 21st Century (CE21) (10-619)
- OIA: Cyber-Enabled Discovery and Innovation (CDI) (11-502)
- OCI: Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM) (11-515)
- CISE: Cyberlearning: Transforming Education (11-587)
- EHR: Discovery Research K-12 (DR K-12) (11-588)
- CISE: Human-Centered Computing (HCC) (11-556)
- CISE: Human-Robot (and/or Agents) Interaction (HRI) (11-556)
- EHR: Informal Science Education (ISE) (11-546)
- EHR: Innovative Technology Experiences for Students and Teachers (ITEST) (11-525)
- EHR: Math and Science Partnership (MSP) (10-556)
- EHR: Research and Evaluation on Education in Science and Engineering (REESE) (10-586)
- SBE: Science of Learning Centers (SLC)
- EHR: Transforming STEM Learning (TSL) (10-602)
- EHR: Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) (10-544)

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.1 Intergovernmental Personnel Agreement (IPA) Performance Plans**
Lead Organization: Division of Human Resources Management (HRM).

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Include temporary staff appointed under the Intergovernmental Personnel Act (IPAs) under NSF's performance management system. | 80 percent of all IPAs have performance plans as of July 1, 2011. | Achieved: 92 percent of all IPAs had performance plans as of July 1, 2011. |
| | | 90 percent of IPAs in executive-level positions have performance plans as of July 1, 2011. | Achieved: 90 percent of executive IPAs had performance plans as of July 1, 2011. |

This goal is designed to establish agency-wide guidance for assessing IPAs' performance and to ensure consistent implementation. It was formulated to address specific human resource management challenges identified by Congress, the Office of Personnel Management, and NSF's Office of the Inspector General.

The Intergovernmental Personnel Act (IPA) Mobility Program allows the temporary assignment of personnel between Federal agencies and other governmental, academic, tribal, and eligible non-profit organizations. IPA assignments can strengthen management, assist in the transfer and implementation of new technology, involve officials of other organizations in developing and implementing Federal policies and programs, and enhance the professional abilities of the participants. IPA assignments are management-initiated and are made for the benefit of Federal agencies and non-Federal organizations.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.2 360 Degree Evaluation Instrument**
Lead Organization: Division of Human Resources Management.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Pilot use of OPM's 360 degree evaluation instrument to provide feedback to NSF leaders and managers on skills and abilities. | By July 1, 2011, at least 20 NSF managers use OPM's 360 instrument. | Achieved: 27 managers by 7/1/11 |
| | | By September 30, 2011, at least 20 NSF managers who used OPM's 360 instrument establish a plan for improving performance. | Achieved late: six managers by 9/30/2011, 29 managers by 10/15/2011 |

This aim of this goal is to provide managers "structured feedback about leadership skills from their supervisors, peers, subordinates, and themselves." The feedback is intended to be developmental in nature and help managers "identify leadership strengths and developmental opportunities." It was formulated to address specific human resource management challenges identified by Congress, the Office of Personnel Management, and NSF's Office of the Inspector General.

In FY 2011, a number of executive-level managers were invited to participate in the OPM 360 assessment process. Twenty-seven NSF managers completed the OPM 360 Leadership Assessment by the target date of July 1 2011, exceeding the target of 20 managers.

**Information on delayed achievement**

Only six of the managers who participated in the OPM 360 Assessment submitted an Executive Level Development Plan (EDP) for improving performance by 9/30/2011. NSF EDPs are not traditionally due until October 15. Twenty-nine managers who used the OPM 360 Evaluation Instrument had submitted updated performance plans by the 10/15/2011 standard submission date.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-1**: Achieve management excellence through leadership, accountability, and personal responsibility.

**Strategic Target**: More effective management enables all staff to understand how their duties support the mission of the Foundation.

**Goal M-1.3 Model EEO Agency**
Lead Organization: Office of Diversity and Inclusion.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Attain essential elements of a model Equal Employment Opportunity (EEO) program, as defined in Equal Employment Opportunity Commission (EEOC) requirements. | Three elements. | Achieved: Three elements obtained. |

For NSF to achieve model EEO agency status, it must meet and maintain each of the six criteria established by the Equal Employment Opportunity Commission (EEOC). The EEOC refers to these criteria as the "Essential Elements" of a Model Agency, which are:

A. Demonstrated commitment from agency leadership;
B. Integration of EEO into the agency's strategic mission;
C. Management and program accountability;
D. Proactive prevention of unlawful discrimination;
E. Efficiency; and
F. Responsiveness and legal compliance.

The target of three is based on the progress reported in FY 2010 as compared to resource-responsive expectations for FY 2011. NSF took the following actions to achieve measures that were unmet in FY 2010 as related to essential elements A, B, and E:

A. Demonstrated commitment from agency leadership
   - Training that included Alternative Dispute Resolution was offered to all managers and supervisors in which there was 100 percent participation.
   - Training that included a module on religious accommodations was offered to all managers and supervisors to ensure they have clear understanding of their roles and responsibilities, in which there was 100 percent participation.

B. Integration of EEO into the agency's strategic mission
   - In FY 2011, ODI's Director conducted NSF's first "State of the Agency" briefing, covering all components of the EEO annual report to the EEOC, to NSF senior officials.

E. Efficiency
   - ODI worked closely with the Office of the General Counsel (OGC), which represents the agency on EEO matters, to ensure impartiality in EEO matters processed within ODI.

Additionally, in conducting its annual barrier analysis, ODI accomplished the following:

- Worked with senior managers in three directorates in identifying potential barriers to EEO.
- Worked with these senior managers in devising plans to eliminate barriers, implementing such plans, and ensuring that ODI plays a role in assessing the effectiveness of such plans.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-2**: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth.

**Strategic Target**: NSF emphasizes learning for personal and professional development for all staff.

**Goal M-2.1 Assess Developmental Needs**
Lead Organization: Division of Human Resources Management.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Pilot process for assessing developmental needs and addressing them. | By March 31, 2011 commence survey of administrative support staff. | Achieved. |
| | | By September 20, 2011, obtain contract support for assessment of non-administrative-support staff. | Achieved late: Contract support obtained September 23, 2011. |

NSF stresses personal learning and development to enhance performance, further our knowledge base on all aspects of NSF activity, and continue to build for the future. This directly reflects the specific action identified in the Strategic Plan: "review current NSF learning opportunities and develop a plan for addressing gaps."

In FY 2011, the Division of Human Resource Management (HRM) developed and launched targeted needs analysis questionnaires designed to generate new learning needs data. Questionnaires asked NSF administrative professional staff to rate the performance of specific skills necessary to complete their work, and rated the importance of creating additional skill-based learning and development opportunities to help them successfully complete their work. Approximately 38 percent of administrative support staff participated in the survey.

**Information on delayed achievement**

In support of the target "to obtain contract support for assessment of non-administrative-support staff", in the Third Quarter of FY 2011, OPM issued a contract solicitation for this work. The results of NSF's evaluation were sent to OPM on 8/8/11. OPM issued a Notice to Proceed to NSF for this contract on 9/23/11. While this notice to proceed fell beyond the target agreement date of 9/20/11, NSF had minimal control of the contract procurement effort following the contract solicitation issuance in Third Quarter FY 2011.

## Strategic Goal 3: Perform as a Model Organization

**Strategic Objective/Performance Goal M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Strategic Target**: NSF uses the innovation and creativity of our staff to improve agency processes and systems on a continuing basis.

**Goal M-3.1 Grant-By-Grant Payments**
Lead Organization: Division of Financial Management, Office of Budget, Finance, and Award Management (BFA).

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| 2011 | Gather functional requirements for changes in current system processes that will accommodate the transition to a grant by grant payment method. | Documentation of functional requirements. | Achieved late: Functional requirements delivered first quarter of FY 2012 |

Establishing the capability to monitor expenditures at the award level is an essential aspect of NSF's financial system modernization. NSF is committed to transition its financial processing of grants from a pooled system (quarterly reporting of expenditures by institution) to grant-by-grant (near real-time reporting of expenditures by award) by FY 2013. This change will have many advantages for both NSF and its grantees, such as better and more timely financial data and stronger monitoring programs. This initiative is per the Administration and CFO directive to increase efficiency and transparency in the agency.

**Information on delayed achievement**

The FY 2011 target for this goal was the documentation of functional requirements that will accommodate transition to a real-time payment method. Documentation detailing final business requirements and draft functional requirements was prepared by BFA in FY 2011. However, during cross-agency working group meetings, additional requirements were raised that needed to be addressed. Consequently, this target was not met in FY 2011. In fulfillment of the goal, the requirements were delivered in December 2011.

## Strategic Goal 3: Perform as a Model Organization

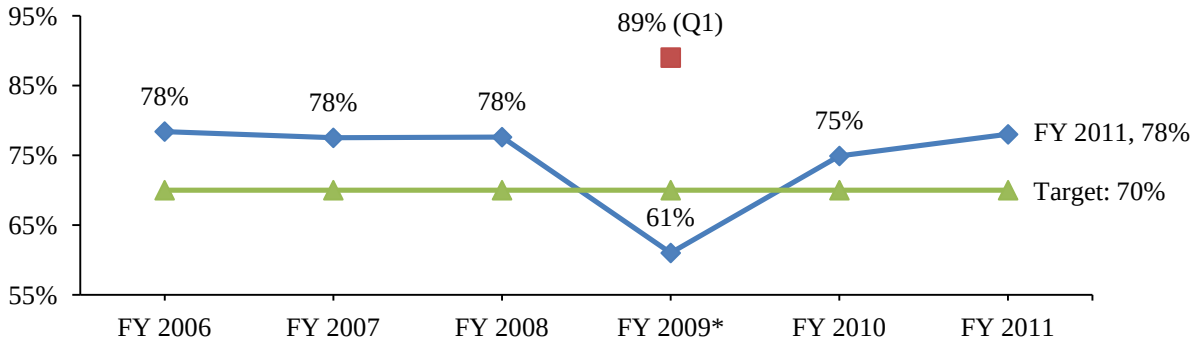
**Strategic Objective/Performance Goal M-3**: Encourage and sustain a culture of creativity and innovation across the agency to ensure continuous improvement and achieve high levels of customer service.

**Strategic Target**: NSF organizations achieve high levels of customer satisfaction.

**Goal M-3.2 Time to Decision**
Lead Organization: Office of the Director.

| Fiscal Year | Goal Statement | Target Measure, Milestone, or Deliverable | Result |
|---|---|---|---|
| Ongoing | Inform applicants whether their proposals have been declined or recommended for funding within six months of deadline, target date, or receipt date, whichever is later. | 70 percent. | 78 percent. |

**Time to Decision Performance Trends, FY 2006-FY 2011**




* In FY 2009, this goal was in effect only for the period October 1 through December 31, 2008 (Quarter 1, FY 2009). The goal was suspended for all actions taking place between January 1, 2009 and September 30, 2009 to allow for a greater number of proposals to be processed with the additional funds from the American Recovery and Reinvestment Act of 2009 (ARRA).

Time to decision or "dwell time" is the amount of time that passes between receipt of a proposal and notification of the principal investigator about the funding decision made about the proposal. One of the most significant issues raised in customer satisfaction surveys is the time it takes NSF to process proposals. Too long a time period inhibits the progress of research as it delays the funding process, but too short a time period may inhibit the merit review process. The six-month target seeks to strike a balance between the need of the investigator for timely action and the need of NSF for a credible and efficient merit review system.

The most relevant recent variations in performance took place in FY 2009 and FY 2010. In FY 2009, the goal was suspended after the first quarter to allow for a greater number of proposals to be processed with additional funds from ARRA. The goal was reinstated in FY 2010, when NSF exceeded this goal despite a significant increase in workload. Overall, staffing levels increased by 5.5 percent between FY 2008 and FY 2011, while proposal pressure increased by 17.4 percent.

## FY 2011 PROGRAM EVALUATIONS

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. NSF obtains this feedback through periodic scheduled reviews such as external evaluations, Committees of Visitors, directorate Advisory Committees, and facilities reviews.

### External Evaluations Conducted by Contractors

NSF directorates, divisions, and programs use the recommendations of external experts in their decision-making. During FY 2011, seven external evaluations of NSF's existing programs and strategic investments were published. These evaluations include the results of studies, reports, and workshops commissioned by various programmatic offices within the National Science Foundation.

- ENG: Research Experiences For Undergraduates in the Directorate For Engineering (ENG): Follow-up of FY 2006 Student Participants
- ENG: External education evaluations conducted by Engineering Research Center (ERC) Lead Universities
- ENG: Assessment of the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) Program
- ENG: Grand Challenges in Earthquake Engineering Research: A Community Workshop Report
- MPS: Feasibility Study for Evaluation of the Mathematical Science Research Institutes
- MPS: Findings of the Feasibility Study for Evaluation of the Phased Approach Used to Implement the Centers for Chemical Innovation
- OPP: Future Science Opportunities in Antarctica and the Southern Ocean

Descriptions of these evaluations can be found on the following pages.

| **DIRECTORATE FOR ENGINEERING**<br>**Division of Engineering Education and Centers (EEC)** | |
|---|---|
| Evaluation Name | Research Experiences For Undergraduates (REU) in the Directorate for Engineering: Follow-Up of FY 2006 Student Participants |
| Contractor | SRI International |
| Program Name | Research Experiences for Undergraduates (REU) in Engineering |
| Completion date | October 2010 |

**Program Description**
Chief among the programs intended to increase graduate-degree production in fields covered by the National Science Foundation (NSF) is the Research Experiences for Undergraduates (REU) program, which has been in existence for more than 20 years. ENG has two major award types for REUs—Site and Supplement awards.

**Evaluation Description**
This is the second phase of a study of the REU in Engineering Program. It was conducted through a follow-up survey of the 1,248 FY 2006 REU students who responded to the student survey administered in the first phase of the study. The purpose of the second data collection was to measure the longer-term outcomes of the ENG REU and other undergraduate research experiences. The follow-up survey focused on the totality of undergraduate research experiences (rather than the FY 2006 ENG REU experience), and the effects of those experiences on academic and career decisions that former REU students had made by December 2009.

The evaluation report describes the major outcomes and other findings from the 2009 follow-up survey. The summary begins with the major outcomes, continues with other overall findings, and ends with the differences by sex, race/ethnicity, and REU award type.

**Findings**
Key findings include the following:

- Most respondents had earned their undergraduate degree and gone on to graduate school.
- The majority of respondents considered their undergraduate research experiences to be a factor in their decisions about whether to go to graduate school, what field to study, and where to apply, and in being accepted into their graduate institution.
- Most undergraduate engineering students stayed in engineering for graduate school.
- Most respondents raised their highest degree expectations over time. Today few expect to stop at a bachelor's degree.
- For more than one-half of respondents, undergraduate research led to increased interest in engineering and/or research as potential careers. One-fourth of respondents reported that undergraduate research introduced them to a career they had not known existed. More than 4 in 5 respondents considered their undergraduate research experiences to have been extremely or fairly important to their career decision.
- About 3 in 10 respondents became less interested in a research career once they had a better understanding of what was involved.
- About 37% of respondents were employed and not in school at the time of the survey. A substantial majority of these workers had jobs that involved engineering and were employed in the for-profit sector.
- More than 7 in 10 non-student workers were using their research skills at least somewhat in their jobs.

**Recommendations**
By far the most frequent recommendation for how to improve undergraduate research experiences was to increase the involvement of mentors and faculty members.

**Agency response to recommendations**
The survey has been disseminated to all ENG REU Site Directors. Plans are to discuss recommendations with REU Site Directors during the March 2011 annual PI meeting to gain feedback from the PIs on how involvement of mentors and faculty members with undergraduate participants may be increased and improved.

**Publications**
Publications are located at http://csted.sri.com/content/research-experiences-undergraduates-reu-directorate-engineering-eng-follow-fy-2006-student-p

**Actual Cost**:
Pending

| **DIRECTORATE FOR ENGINEERING**<br>**Division of Engineering Education and Centers (EEC)** | |
|---|---|
| Evaluation Name | External education evaluations conducted by Engineering Research Center (ERC) Lead Universities |
| Contractor | Various organizations, please see narrative below |
| Program Name | Engineering Research Centers (ERC) Program of the Division of Engineering Education and Centers |
| Completion date | *Evaluations are ongoing in each separate ERC over a ten-year period* |

**Program Description**
There are currently seventeen (17) active, NSF-funded ERCs. Each ERC provides an environment in which academe and industry can collaborate in pursuing innovations in research and education that can impact curricula at all levels, from pre-college to life-long learning. These education programs are required to carry out evaluations/assessment of progress and outcomes. To accomplish this, the ERC lead university employs staff, faculty, or contractors.

During FY 2011, program evaluations of three ERCs were conducted:
- Center for Collaborative, Adaptive, Sensing of the Atmosphere – University of Massachusetts;
- Mid-IR Tech. for Health & the Environment – Princeton University; and
- Synthetic Biology ERC – UC-Berkeley.

**Recommendations**
None of these programs provides direct recommendations to NSF. They provide feedback to the ERCs' education program leaders and the Center Directors and the results are assessed by annual site visit review teams managed by the ERC Program.

**Agency response to recommendations**
N/A

**Publications**
N/A

**Actual Cost**:
- FY 2011: N/A since the evaluation costs are borne by the ERC.
- FY 2010: N/A since the evaluation costs are borne by the ERC.

| **DIRECTORATE FOR ENGINEERING**<br>**Emerging Frontiers in Research and Innovation (EFRI) Office** | |
|---|---|
| Evaluation Name | Assessment of the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) Program |
| Contractor | Science and Technology Policy Institute (STPI) |
| Program Name | Emerging Frontiers in Research and Innovation (EFRI) program |
| Completion date | March 2011 |

**Program Description**
The Emerging Frontiers in Research and Innovation (EFRI) program was created in October 2006 after a reorganization of the Directorate for Engineering (ENG) within the National Science Foundation (NSF). The overall goal of the program is to fund higher risk opportunities for research that will lead to "new research areas for NSF, ENG, and other agencies; new industries or capabilities that result in a leadership position for the country; and/or significant progress on a recognized national need or grand challenge." The program achieves this through funding interdisciplinary teams to conduct potentially transformative research. The first EFRI solicitation was announced in FY 2007. Since then, EFRI has supported 44 projects through grant funding totaling about $90 million.

**Evaluation Description**
In FY 2010–2011, ENG funded STPI to perform a formative assessment and evaluation of the processes by which topic areas and potentially transformative projects are selected by EFRI, and to design a protocol for future outcome evaluation of EFRI research projects.

**Findings**
The findings clustered in three areas: process related findings (related to program design and implementation); distinctiveness of the EFRI program within the Engineering Directorate (ENG), in particular that of its PIs, topics and proposals; and methodological findings.

**Recommendations**
The following recommendations were made:

- Consider using just the Grand Challenge criterion for topics.
- Use Web 2.0 and other collective intelligence tools for voting on topics.
- Have a definition of potentially transformative research that is easier to operationalize and standardize.
- Consider defining and specifying "cognitive integration" as a criterion rather than focusing on requiring PIs from multiple disciplines.
- Recruit non-traditional reviewers such as maverick researchers or entrepreneurs, among others.
- Provide standardized training regarding the criteria to ensure all panelists have the same understanding of what the EFRI program is seeking.
- EFRI should consider a more descriptive approach to an outcome evaluation.
- Test the emerging concept of calculating "integration scores" and data visualization tools on larger data sets to assess interdisciplinarity in the science and engineering policy community.

**Agency response to recommendations**
In response to this report and 2011 COV recommendations, the directorate substantially revised the research topic selection process and instituted several internal process innovations in FY 2011–2012.

**Publications**

Balakrishnan, A., M. B. Hughes, V. Peña, D. Roessner, B Lal. 2011. *Assessment of the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) Program*. Science and Technology Policy Institute, Washington, DC.

**Actual Cost**: $304,892

| **DIRECTORATE FOR ENGINEERING**<br>**Division of Civil, Mechanical and Manufacturing Innovation (CMMI)** | |
|---|---|
| Evaluation Name | Grand Challenges in Earthquake Engineering Research: A Community Workshop Report |
| Contractor | National Research Council |
| Program Name | George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) |
| Completion date | 2011 |

**Program Description**
The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), supported by the National Science Foundation (NSF), is an important component of the National Earthquake Hazards Reductions Program (NEHRP). NEHRP is a coordinated effort across four federal agencies to address earthquake risk in the United States. Since 2004, NEES researchers have produced significant advances in the science and technology for earthquake loss reduction that would not have been possible without the network's experimental facilities and cyberinfrastructure. By FY 2014, NSF will have supported 10 years of NEES operations and research.

**Evaluation Description**
As part of NSF's preparation of plans for FY 2014 and beyond, NSF sought an evaluation of next-generation U.S. needs for earthquake engineering research beyond 2014. At the request of NSF, the National Research Council (NRC) hosted a two-day workshop to give members of the community an opportunity to address two major questions:

- What are the high-priority Grand Challenges in basic earthquake engineering research that require a network of earthquake engineering experimental facilities and cyberinfrastructure?
- What networked earthquake engineering experimental capabilities and cyberinfrastructure tools are required to address these Grand Challenges?

The workshop featured invited presentations and discussion. Workshop participants were asked to describe the experimental infrastructure capabilities and cyberinfrastructure tools in terms of requirements, rather than by reference to any existing or specifically located future facilities. In responding to the foregoing questions, workshop participants were also asked to consider future technical and conceptual advances with the potential to influence future earthquake hazard research, such as early warning systems, new materials, sustainability, high-performance computing and networking, modeling, sensor and monitoring technologies, and other factors identified by the committee. The committee prepared a report summarizing discussions at the workshop.

**Findings**
The report did not include findings.

**Recommendations**
The report did not include recommendations.

**Agency response to recommendations**
The NSF response is under development as outlined in the NSF 10-071 Dear Colleague Letter (http://nsf.gov/pubs/2010/nsf10071/nsf10071.jsp). The response is anticipated to be final by fall 2012.

**Publications**

Committee for the Workshop on Grand Challenges in Earthquake Engineering Research--A Vision for NEES Experimental Facilities and Cyberinfrastructure Tools; Committee on Seismology and Geodynamics; National Research Council. 2011. *Grand Challenges in Earthquake Engineering Research: A Community Workshop Report*. The National Academies Press. http://www.nap.edu/catalog.php?record_id=13167.

**Actual Cost**: $251,052

| **DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES**<br>**Division of Mathematical Sciences (DMS)** | |
|---|---|
| Evaluation Name | Feasibility Study for Evaluation of the Mathematical Science Research Institutes |
| Contractor | Science and Technology Policy Institute (STPI) |
| Program Name | Mathematical Science Research Institutes |
| Completion date | December 2010 |

**Program Description**
Eight Mathematical Science Research Institutes ("Institutes") are currently supported by DMS. In recent years, DMS supervision of the Institutes awards has evolved from management of individual Institute awards to management of the suite of awards as a portfolio. This shift in management philosophy has generated interest in evaluation at the level of the portfolio to supplement regular NSF processes for peer review of individual Institutes.

**Evaluation Description**
DMS requested a study to assess the need for and feasibility of evaluation of the Institutes at the portfolio level. If formal program evaluation was determined to be warranted and feasible, an additional objective was to recommend an evaluation approach and strategy.

**Findings and Recommendations**
The study's key findings are as follows:

- A separate evaluation approach and design would be required for Institutes using each of the three convening models.
- Evaluation of Institute for Advanced Study (IAS) and American Institute of Mathematics (AIM) as individual Institutes is feasible, but it does not appear to be warranted.
- Evaluation of the long program convening model as implemented by Mathematical Sciences Research Institute (MSRI), Statistical and Applied Mathematical Sciences Institute (SAMSI), Institute for Pure and Applied Mathematics (IPAM), Mathematical Biosciences Institute (MBI), and Institute for Mathematics and Its Applications (IMA) is warranted.
- Systematic evaluation of long program outcomes at the Institute level is not feasible in the short term, but it may be feasible in the long term if NSF standardizes key data collection processes.
- Evaluation of the long-program-convening-model is feasible using primarily qualitative methods to examine individual long programs.
- Evaluation of outcomes associated with additional education, training, and outreach activities at the various Institutes is neither feasible nor warranted.
- Formal evaluation of outcomes associated with coordination among the Institutes is neither feasible nor warranted, but opportunities and best practices could be explored informally.

**Agency response to recommendations**
N/A

**Publications**
Zuckerman, B., C. V. Srivastava, P. C. Boardman, C. Weber, and S. Jonas. 2010. *Feasibility Study for Evaluation of the Mathematical Science Research Institutes*. Science and Technology Policy Institute, Washington, DC.

**Actual Cost**: $63,406

| **DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES**<br>**Division of Chemistry (CHE)** | |
|---|---|
| Evaluation Name | Findings of the Feasibility Study for Evaluation of the Phased Approach Used to Implement the Centers for Chemical Innovation |
| Contractor | Science and Technology Policy Institute (STPI) |
| Program Name | Centers for Chemical Innovation (CCI) program |
| Completion date | June 2011 |

**Program Description**
The CCI program of CHE appears to be unique among NSF Centers programs in that it has been implemented using a phased approach. The program competitively awards up to $1.5M over three years for "Phase I" activities prior to accepting "Phase II" applications for full Center awards at the beginning of the third year.

**Evaluation Description**
In August 2009, NSF tasked the Science and Technology Policy Institute (STPI) of the Institute for Defense Analyses (IDA) to assess the feasibility of evaluating the phased implementation of the CCI program. The goals of the feasibility study were to identify potential research questions of interest to NSF, assess existing and potential sources of evidence about the program, and determine whether those questions can be answered. Potential research questions were identified through two sources: (1) in-depth discussions with NSF leadership about the program and priorities for evaluation; and (2) analysis of program logic. The assessment of available evidence included a thorough review of available program documents, including program announcements and applications for funding. Published literature on science policy and research evaluation was also consulted as appropriate.

**Findings and Recommendations**
The study's key findings are as follows:
- Evaluation of the phased implementation of the CCI program is warranted.
- There are serious concerns about the feasibility of assessing whether the phased approach encouraged experimentation while mitigating the Foundation's exposure to undesirable risk.
- Comparative assessment of return on investment in Phase I Centers is likely feasible.
- There are serious concerns about the feasibility of assessing changes in level of ambition or creativity from Phase I to Phase II.

**Agency response to recommendations**
The CCI Program accepted the STPI findings that several of the questions posed by the phased implementation of CCIs are not amenable to a program evaluation at this time. The NSF continues to develop the program, informed by multiple sources including the STPI study on evaluation design.

**Publications**
B. Zuckerman, C. V. Srivastava, and M. E. Hughes. 2011. *Findings of the Feasibility Study for Evaluation of the Phased Approach Used to Implement the Centers for Chemical Innovation*. Science and Technology Policy Institute, Washington, DC.

**Actual Cost**: $62,743

| **OFFICE OF POLAR PROGRAMS** | |
|---|---|
| Evaluation Name | Future Science Opportunities in Antarctica and the Southern Ocean |
| Contractor | National Research Council |
| Program Name | U.S. Antarctic Program (USAP) |
| Completion date | September 2011 |

**Program Description**
The U.S. Antarctic Program (USAP) within the National Science Foundation (NSF) is the primary U.S. agency responsible for supporting science in Antarctica and the Southern Ocean.

**Evaluation Description**
In 2010, the NSF Office of Polar Programs, in coordination with the Office of Science Technology Policy, initiated two activities to provide guidance to the USAP program. In 2011, the National Research Council's Committee on Future Science Opportunities in Antarctica and the Southern Ocean released the first report in support of this activity. The committee's task was to identify and summarize the changes to important science conducted on Antarctica and the surrounding Southern Ocean that will demand attention over the next two decades. The second activity, an NSF-organized Blue Ribbon Panel intended to assist in making strategic decisions to improve the logistical support of the U.S. science program in Antarctica and the Southern Ocean over the next two decades, will take place in 2012.

**Findings**
In response to its charge, the committee highlighted important areas of research by encapsulating each into a single, overarching question. The questions fall into two broad themes: (1) those related to global change and (2) those related to fundamental discoveries. In addition, the committee identified several opportunities to be leveraged to sustain and improve the science program in Antarctica and the Southern Ocean in the coming two decades.

**Recommendations**
The committee made the following recommendations:
- Lead the development of a large-scale, interdisciplinary observing network and support a new generation of robust Earth system models.
- Continue to support a wide variety of basic scientific research in Antarctica and the Southern Ocean, which will yield a new generation of discoveries.
- Design and implement improved mechanisms for international collaboration.
- Exploit the host of emerging technologies.
- Coordinate an integrated polar educational program.
- Continue strong logistical support for Antarctic science.

**Agency response to recommendations**
N/A

**Publications**
Committee on Future Science Opportunities in Antarctica and the Southern Ocean. 2011. *Future Science Opportunities in Antarctica and the Southern Ocean*. The National Academies Press.

**Actual Cost**: $465,000

## Committees of Visitors (COVs)

During FY 2011, seven Directorates convened 21 Committees of Visitors in FY 2011.

Committee of Visitors (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the outputs and outcomes generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals. COV reviews are conducted at regular intervals of approximately three years for programs and offices that recommend or award grants, cooperative agreements, and/or contracts and whose main focus is the conduct or support of NSF research and education in science and engineering. Approximately one-third of NSF's divisions are assessed each year.

A COV typically consists of up to 20 external experts, selected to ensure independence, programmatic coverage, and geographic balance, and they represent academia, industry, government, and the public sector. They meet for two or three days to review and assess program priorities, program management, and award accomplishments or outcomes. Each COV prepares a report and the division or program that is being reviewed must prepare a response. These reports and responses are submitted to the parent advisory committee and to the Director of NSF. COV recommendations must be addressed by the division director, and appropriate actions must be taken to comply. All reports and responses are public and posted on NSF's website at: www.nsf.gov/od/oia/activities/cov/covs.jsp.

Committees of Visitors for the following divisions and programs were convened in FY 2011:

- BIO: Integrative Organismal Biology
- BIO: Molecular and Cellular Biosciences
- EHR: Research on Learning in Formal and Informal Settings
- EHR: Informal Science Education
- EHR: Information Technology Experiences for Students and Teachers (ITEST)
- EHR: Noyce Scholarships
- EHR: Math and Science Partnership (MSP)
- EHR: Scholarship for Service, Scholarships (S-STEM in FY 2007)
- EHR: GK-12 Fellows
- EHR: Integrative Graduate Education and Research Traineeship (IGERT)
- EHR: ADVANCE
- ENG: Electrical, Communications and Cyber Systems(ECCS)
- ENG: Emerging Frontiers in Research and Innovation (EFRI)
- GEO: GeoSpace Section
- GEO: Surface Earth Processes Section
- GEO: Deep Earth Processes Section
- GEO: Integrative Projects Section
- MPS: Astronomical Sciences
- MPS: Materials Research
- Office of Cyberinfrastructure
- Office of International Science and Engineering

# NATIONAL SCIENCE FOUNDATION
# FY 2011 – 2016 STRATEGIC PLAN ADDENDUM

This addendum to the NSF Strategic Plan for FY 2011-2016 includes three new sections required by the GPRA Modernization Act: Agency Priority Goals, Federal Priority Goals, and Congressional Consultation.

## FY 2012-FY 2013 Agency Priority Goals

### Access to Digital Products of NSF-Funded Research

| | |
|---|---|
| Impact Statement | Increase opportunities for research and education through public access to high-value digital products of NSF-funded research. |
| Goal Statement | By September 30, 2013, NSF will have established policies for public access to high-value data and software in at least two data-intensive scientific domains. |
| Relevant Strategic Goal | Transform the Frontiers |
| Relevant Strategic Objective | T-4, "Enhance research infrastructure and promote data access to support researchers' and educators' capabilities and enable transformation at the frontiers." |

### Undergraduate Programs

| | |
|---|---|
| Impact Statement | Develop a diverse and highly qualified science and technology workforce. |
| Goal Statement | By September 30, 2013, 80 percent of institutions funded through NSF undergraduate programs document the extent of use of proven instructional practices. |
| Relevant Strategic Goal | Transform the Frontiers |
| Relevant Strategic Objective | T-2: "Prepare and engage a diverse STEM workforce motivated to participate at the frontiers." |

### Innovation Corps

| | |
|---|---|
| Impact Statement | Increase the number of entrepreneurs emerging from university laboratories. |
| Goal Statement | By September 30, 2013, 80 percent of teams participating in the Innovation Corps program will have tested the commercial viability of their product or service. |
| Relevant Strategic Goal | Innovate for Society |
| Relevant Strategic Objectives | I-1, "Make investments that lead to results and resources that are useful to society."<br>I-2, "Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering." |

## FY 2012-FY 2013 Federal Priority Goals

Per the GPRA Modernization Act, P.L. 111-352, requirement to address Federal Goals in the agency Strategic Plan and Annual Performance Plan, please refer to Performance.gov for information on Federal Priority Goals and the agency's contributions to those goals, where applicable.

## Congressional Consultations

Members of the House Science Committee and Senate Commerce Committee were briefed on the content of this Plan during its development and given the opportunity for comment.

# SUPPORTING INFORMATION

## Annual Performance Plan

This section provides information required by the GPRA Modernization Act on "Strategies and Supporting Analysis." The required information includes 1) a description of how agency goals will be achieved with the reason for choosing strategies and 2) a description of how human capital programs are used to advance agency performance goals. This required information follows.

### Strategies and Supporting Analysis

No one standard strategy is used across NSF for achievement of goals. Goal leaders at NSF choose strategies tailored to their stakeholders' needs and their institutional capabilities. In general, NSF goals involve testing the impacts of new activities or new approaches to existing activities, so feedback mechanisms are built in. Use of analysis, evidence, and evaluation findings is also at the discretion of each individual goal leader. Performance at NSF is reviewed quarterly by NSF's Performance Improvement Officer, who reports on goal progress to NSF senior management.

NSF employs a balanced set of performance indicators, milestones, and measures. Due to the nature of NSF investments, the two mission-oriented goals, *Transform the Frontiers* and *Innovate for Society*, tend to be output- or outcome-based. The management-oriented goal, *Perform as a Model Organization*, contains efficiency and customer-service measures, but also output and outcome measures relating to long-term activities such as financial system modernization and strategic human capital management.

### Strategic Human Capital Management at NSF

NSF's Human Capital Strategic Plan constitutes the framework for managing NSF's human capital system through 2012 and builds upon the strength and commitment of NSF's workforce to fulfill the Foundation's mission. This Plan identifies internal and external factors that shape human capital planning and creates an integrated framework of policies and practices that will guide the Foundation in meeting our workforce needs and enable NSF to perform as a model organization. The Plan, which seeks to inform NSF managers and staff alike, takes a strategic approach—both in terms of identifying the human capital challenges facing the Foundation as well as how best to maximize the vitality and capabilities of NSF's workforce at all levels. Drawing from the Plan's interdependent goals and the more focused workforce and succession planning action strategies, NSF's individual directorates and offices will be able to develop organizationally-specific human capital implementation strategies. The Plan is intended as a "living" document—one that accommodates changing environments and needs as they arise. This strategic plan works in concert with NSF's annual Human Capital Accountability Plan to define clear lines of responsibility and identify specific goals for each area in OPM's Human Capital Accountability and Assessment Framework.

The next Human Capital Strategic Plan will be developed concurrently with the next NSF Strategic Plan, to be issued February 2014.

## Annual Performance Report

This section provides information required by the GPRA Modernization Act on the completeness and reliability of performance data. The required information includes 1) a discussion of the agency's verification and validation (V&V) practices and 2) a description of data sources and known data limitations. This required information follows.

**Verification and Validation of Performance Goals**

It is NSF's practice to follow Government Accountability Office (GAO) guidance and engage external contractors to conduct an independent validation and verification (V&V) review of its annual performance information, data, and processes. The guidance from GAO indicates that agencies should "…describe the means the agency will use to verify its performance data…" and "…provide confidence that [their] performance information will be credible." [1] NSF will continue this process in FY 2012 and FY 2013.

In FY 2011, IBM Global Business Services (IBM) assessed the validity of NSF data and verified the reliability of the methods used to collect, process, maintain, and report that data, and reviewed NSF's information systems based on GAO standards for application controls. IBM's FY 2011 report concluded:

> *Overall, we verify that NSF relies on sound business practices, internal controls, and manual checks of system queries to ensure accurate performance reporting. NSF maintains adequate documentation of its processes and data to allow for an effective V&V review. Based on our assessment, IBM has confidence in the systems, policies, and procedures used by NSF to calculate results for its performance measures and targets. NSF continues to take concerted steps to improve the quality of their systems and data. We confirm NSF's commitment to ensuring the accuracy of its reported GPRA results, and the reliability of its processes for collecting, processing, maintaining, and reporting data for its performance goals*[2].

**Data Sources, Limitations, and Intended Use**

The data and information required to measure progress towards NSF's performance goals in FY 2011 and later years fall into three broad categories.

- NSF automated administrative systems. Performance monitoring can be a valuable secondary function of such systems. In FY 2011, reporting included data from systems that:
  - store and approve publications such as solicitations announcements, and Dear Colleague letters;
  - collect transactional data about proposal and award management;
  - perform financial transactions;
  - store human resources data; and
  - permit keyword search of abstract or full texts of proposals and awards.

  The data were used either directly or for achieving milestones that involve the writing of a report. While not all goals require a high level of accuracy, data from these systems are highly reliable.
- Reports on internal activities. Milestone achievement is often determined from review of records of certain activities and events. Records of this sort tend to be compiled from review of the evidence provided by goal leaders.
- Data requests of external parties. Qualitative or quantitative information is solicited directly from awardees.

## Other parts of the Annual Performance Report required by the GPRA Modernization Act:

Use of non-federal parties in preparation of this report: None

Classified appendices not available to the public: None

[1] GAO, The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans, GAO/GGD-10.1.20 (Washington, D.C.: April 1998), pp. 40-41.

[2] IBM Global Business Services, *National Science Foundation Performance Measurement Verification and Validation Report, Fiscal Year 2011*. October 25, 2011

# TECHNICAL INFORMATION

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## FY 2013 Appropriations Language

## National Science Foundation

## RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; $5,983,280,000, to remain available until September 30, 2014, of which not to exceed $500,000,000 shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program: *Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

## EDUCATION AND HUMAN RESOURCES

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel, and rental of conference rooms in the District of Columbia, $875,610,000, to remain available until September 30, 2014.

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, $196,170,000, to remain available until expended.

## AGENCY OPERATIONS AND AWARD MANAGEMENT

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $8,280 for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; $299,400,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2013 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

## OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $14,200,000, to remain available until September 30, 2014.

## OFFICE OF THE NATIONAL SCIENCE BOARD

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,440,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

## ADMINISTRATIVE PROVISION

Not to exceed 5 percent of any appropriation made available for the current fiscal year for the National Science Foundation in this Act may be transferred between such appropriations, but no such appropriation shall be increased by more than 15 percent by any such transfers. Any transfer pursuant to this section shall be treated as a reprogramming of funds under section 505 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

## SUMMARY OF FY 2013 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| ***RESEARCH AND RELATED ACTIVITIES*** | | | | | |
| Appropriation | $5,575.03 | $5,719.00 | $5,983.28 | $264.28 | 4.6% |
| Unobligated Balance Available Start of Year | 1.37 | 2.38 | | -$2.38 | |
| Unobligated Balance Available End of Year | -2.38 | | | | |
| Adjustments to Prior Year Accounts[1] | 99.40 | | | | |
| Rescission Pursuant P.L. 112-10 | -11.15 | | | | |
| **Subtotal, R&RA** | 5,662.27 | 5,721.38 | $5,983.28 | $261.90 | 4.6% |
| Transferred to/from other funds | -53.89 | -30.00 | - | 30.00 | |
| **Total Budgetary Resources** | $5,608.38 | $5,691.38 | $5,983.28 | $291.90 | 5.1% |
| ***EDUCATION AND HUMAN RESOURCES*** | | | | | |
| Appropriation | $862.76 | $829.00 | $875.61 | $46.61 | 5.6% |
| Unobligated Balance Available Start of Year | 0.04 | 0.22 | | -$0.22 | |
| Unobligated Balance Available End of Year | -0.22 | | | | |
| Adjustments to Prior Year Accounts[1] | 0.19 | | | | |
| Rescission Pursuant P.L. 112-10 | -1.73 | | | | |
| **Total Budgetary Resources** | $861.04 | $829.22 | $875.61 | $46.39 | 5.6% |
| ***MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION*** | | | | | |
| Appropriation | $117.29 | $167.06 | $196.17 | $29.12 | 17.4% |
| Unobligated Balance Available Start of Year | 9.17 | 0.88 | | -$0.88 | |
| Unobligated Balance Available End of Year | -0.88 | | | | |
| Adjustments to Prior Year Accounts[1] | 0.02 | | | | |
| Rescission Pursuant P.L. 112-10 | -0.23 | | | | |
| **Subtotal, MREFC** | $125.37 | $167.94 | $196.17 | $28.24 | 16.8% |
| Transferred to/from other funds | - | 30.00 | - | -30.00 | |
| **Total Budgetary Resources** | $125.37 | $197.94 | $196.17 | -$1.77 | -0.9% |
| ***AGENCY OPERATIONS AND AWARD MANAGEMENT*** | | | | | |
| Appropriation | $300.00 | $299.40 | $299.40 | $0.00 | |
| Unobligated Balance - Expired | -0.11 | | | | |
| Rescission Pursuant P.L. 112-10 | -0.60 | | | | |
| **Total Budgetary Resources** | $299.29 | $299.40 | $299.40 | - | |

Totals may not add due to rounding.

[1]Adjustments include upward and downward adjustments to prior year obligations.

## SUMMARY OF FY 2013 BUDGETARY RESOURCES BY ACCOUNT

(Dollars in Millions)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| ***NATIONAL SCIENCE BOARD*** | | | | | |
| Appropriation | $4.54 | $4.44 | $4.44 | $0.00 | |
| Unobligated Balance - Expired | -0.06 | | | | |
| Rescission Pursuant P.L. 112-10 | -0.01 | | | | |
| **Total Budgetary Resources** | $4.47 | $4.44 | $4.44 | - | |
| ***OFFICE OF INSPECTOR GENERAL*** | | | | | |
| Appropriation | $14.00 | $14.20 | $14.20 | $0.00 | |
| Unobligated Balance Available Start of Year - ARRA | 1.93 | 1.84 | | -$1.84 | |
| Unobligated Balance - Expired | -0.06 | | | | |
| Unobligated Balance Available End of Year - ARRA | -1.84 | | | | |
| Rescission Pursuant P.L. 112-10 | -0.03 | | | | |
| **Total Budgetary Resources** | $14.00 | $16.04 | $14.20 | -$1.84 | -11.5% |
| ***TOTAL DISCRETIONARY, NATIONAL SCIENCE FOUNDATION*** | $6,912.55 | $7,038.42 | $7,373.10 | $334.68 | 4.8% |
| ***EDUCATION AND HUMAN RESOURCES, H-1B*** | | | | | |
| Appropriation, Mandatory (H1-B Non-Immigrant Petitioner Fees) | $104.78 | $100.00 | $100.00 | $0.00 | |
| Unobligated Balance Available Start of Year | 50.15 | 60.93 | | -$60.93 | |
| Unobligated Balance Available End of Year | -60.93 | | | | |
| Adjustments to Prior Year Accounts[1] | 2.29 | | | | |
| **Total Budgetary Resources** | $96.29 | $160.93 | $100.00 | -$60.93 | -37.9% |
| ***DONATIONS*** | | | | | |
| Mandatory Programs (Special or Trust Fund) | $53.15 | $25.00 | $25.00 | $0.00 | |
| Unobligated Balance Available Start of Year | 45.63 | 52.34 | | -$52.34 | |
| Unobligated Balance Available End of Year | -52.34 | | | | |
| Adjustments to Prior Year Accounts[1] | 0.10 | | | | |
| **Total Budgetary Resources** | $46.54 | $77.34 | $25.00 | -$52.34 | -67.7% |
| ***TOTAL, NATIONAL SCIENCE FOUNDATION*** | $7,055.38 | $7,276.69 | $7,498.10 | $273.75 | 3.8% |

Totals may not add due to rounding.

[1]Adjustments include upward and downward adjustments to prior year obligations.

**NSF FY 2013 FUNDING BY PROGRAM**
(Dollars in Millions)

| PROGRAM | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **BIOLOGICAL SCIENCES** | | | | | |
| MOLECULAR AND CELLULAR BIOSCIENCES | $123.93 | $125.79 | $132.68 | $6.89 | 5.5% |
| INTEGRATIVE ORGANISMAL SYSTEMS | 212.55 | 212.33 | 220.52 | 8.19 | 3.9% |
| ENVIRONMENTAL BIOLOGY | 142.72 | 142.56 | 139.73 | -2.83 | -2.0% |
| BIOLOGICAL INFRASTRUCTURE | 129.28 | 126.18 | 129.68 | 3.50 | 2.8% |
| EMERGING FRONTIERS | 103.79 | 105.52 | 111.25 | 5.73 | 5.4% |
| **Total, BIO** | $712.27 | $712.38 | $733.86 | $21.48 | 3.0% |
| **COMPUTER AND INFORMATION SCIENCE AND ENGINEERING** | | | | | |
| COMPUTING & COMMUNICATION FOUNDATIONS | $175.93 | $179.13 | $195.00 | $15.87 | 8.9% |
| COMPUTER & NETWORK SYSTEMS | 210.26 | 212.50 | 233.50 | 21.00 | 9.9% |
| INFORMATION & INTELLIGENT SYSTEMS | 169.14 | 176.50 | 193.00 | 16.50 | 9.3% |
| INFORMATION TECHNOLOGY RESEARCH | 80.73 | 85.46 | 88.22 | $2.76 | 3.2% |
| **Total, CISE** | $636.06 | $653.59 | $709.72 | $56.13 | 8.6% |
| **ENGINEERING** | | | | | |
| CHEMICAL, BIOENGINEERING, ENVIRONMENTAL & TRANSPORT SYSTEMS | $158.82 | $171.45 | $179.40 | $7.95 | 4.6% |
| CIVIL, MECHANICAL & MANUFACTURING INNOVATION | 189.62 | 203.58 | $217.06 | 13.48 | 6.6% |
| ELECTRICAL, COMMUNICATIONS & CYBER SYSTEMS | 97.54 | 106.73 | $114.30 | 7.57 | 7.1% |
| INDUSTRIAL INNOVATION & PARTNERSHIPS | 162.64 | 193.41 | $210.30 | 16.89 | 8.7% |
| SBIR/STTR | [126.47] | [152.76] | [165.20] | [12.44] | [8.1%] |
| ENGINEERING EDUCATION & CENTERS | 125.76 | 120.00 | $123.27 | 3.27 | 2.7% |
| EMERGING FRONTIERS IN RESEARCH & INNOVATION | 28.95 | 31.00 | $32.00 | 1.00 | 3.2% |
| **Total, ENG** | $763.33 | $826.17 | $876.33 | $50.16 | 6.1% |

[1]Formerly known as Division of Science Resources Statistics

[2]Excludes $96.29 million in obligations in FY 2011 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2012 and

[3]Beginning in FY 2013, EHR proposes to move several programs from DUE to other EHR divisions. The Math Science Partnership (MSP) program moves into the Division of Research on Learning in Formal and Informal Settings (DRL). The Climate Change Education (CCE) program moves into the Division of Graduate Education (DGE). The Excellence Awards in Science and Engineering (EASE) program moves into the Division of Human Resources (HRD). Funding for all years is shown in the FY 2013 structure for comparability.

[4]FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

**NSF FY 2013 FUNDING BY PROGRAM**
(Dollars in Millions)

| PROGRAM | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **GEOSCIENCES** | | | | | |
| ATMOSPHERIC & GEOSPACE SCIENCES | $257.66 | $258.66 | $264.06 | $5.40 | 2.1% |
| EARTH SCIENCES | 183.83 | 183.50 | $189.20 | 5.70 | 3.1% |
| INTEGRATIVE & COLLABORATIVE EDUCATION AND RESEARCH | 91.62 | 91.21 | 91.21 | 0.00 | - |
| OCEAN SCIENCES | 352.21 | 351.90 | $361.97 | 10.07 | 2.9% |
| **Total, GEO** | $885.32 | $885.27 | $906.44 | $21.17 | 2.4% |
| **MATHEMATICAL AND PHYSICAL SCIENCES** | | | | | |
| ASTRONOMICAL SCIENCES | $236.78 | $234.55 | $244.55 | $10.00 | 4.3% |
| CHEMISTRY | 233.55 | 234.06 | 243.85 | 9.79 | 4.2% |
| MATERIALS RESEARCH | 294.90 | 294.55 | 302.63 | 8.08 | 2.7% |
| MATHEMATICAL SCIENCES | 239.79 | 237.77 | 245.00 | 7.23 | 3.0% |
| PHYSICS | 280.34 | 277.37 | 280.08 | 2.71 | 1.0% |
| MULTIDISCIPLINARY ACTIVITIES | 27.06 | 30.64 | 29.07 | -1.57 | -5.1% |
| **Total, MPS** | $1,312.42 | $1,308.94 | $1,345.18 | $36.24 | 2.8% |
| **SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES** | | | | | |
| SOCIAL AND ECONOMIC SCIENCES | $95.68 | $97.18 | $100.25 | $3.07 | 3.2% |
| BEHAVIORAL AND COGNITIVE SCIENCES | 91.11 | 92.69 | 95.43 | 2.74 | 3.0% |
| MULTIDISCIPLINARY ACTIVITIES | 25.10 | 28.23 | 29.11 | 0.88 | 3.1% |
| NATIONAL CENTER FOR SCIENCE AND ENGINEERING STATISTICS[1] | 35.44 | 36.15 | 34.76 | -1.39 | -3.8% |
| **Total, SBE** | $247.33 | $254.25 | $259.55 | $5.30 | 2.1% |

[1]Formerly known as Division of Science Resources Statistics
[2]Excludes $96.29 million in obligations in FY 2011 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2012 and
[3]Beginning in FY 2013, EHR proposes to move several programs from DUE to other EHR divisions. The Math Science Partnership (MSP) program moves into the Division of Research on Learning in Formal and Informal Settings (DRL). The Climate Change Education (CCE) program moves into the Division of Graduate Education (DGE). The Excellence Awards in Science and Engineering (EASE) program moves into the Division of Human Resources (HRD). Funding for all years is shown in the FY 2013 structure for comparability.
[4]FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

**NSF FY 2013 FUNDING BY PROGRAM**
(Dollars in Millions)

| PROGRAM | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING** | $49.03 | $49.85 | $51.28 | $1.43 | 2.9% |
| **OFFICE OF CYBERINFRASTRUCTURE** | $300.75 | $211.64 | $218.27 | $6.63 | 3.1% |
| **OFFICE OF POLAR PROGRAMS** | | | | | |
| ARCTIC SCIENCES | $105.86 | $102.76 | $108.51 | $5.75 | 5.6% |
| ANTARCTIC SCIENCES | 69.07 | 69.75 | 75.80 | 6.05 | 8.7% |
| ANTARCTIC INFRASTRUCTURE & LOGISTICS | 259.42 | 256.74 | 258.33 | 1.59 | 0.6% |
| U.S. Antarctic Logistical Support Activities | [67.52] | [67.52] | [67.52] | - | - |
| POLAR ENVIROMENT, HEALTH & SAFETY | 6.35 | 6.62 | 7.10 | 0.48 | 7.3% |
| **Total, OPP** | $440.70 | $435.87 | $449.74 | $13.87 | 3.2% |
| **INTEGRATIVE ACTIVITIES** | | | | | |
| EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR) | 146.82 | 150.90 | 158.19 | $7.29 | 4.8% |
| OTHER INTEGRATIVE ACTIVITIES | 112.78 | 198.69 | 273.33 | $74.64 | 37.6% |
| MAJOR RESEARCH INSTRUMENTATION (MRI) | [89.987] | [90.00] | [90.00] | - | - |
| **Total, IA** | $259.60 | $349.59 | $431.52 | $81.93 | 23.4% |
| **U.S. ARCTIC RESEARCH COMMISSION** | $1.58 | $1.45 | $1.39 | -$0.06 | -4.1% |
| **Total, RESEARCH AND RELATED ACTIVITIES** | $5,608.39 | $5,689.00 | $5,983.28 | $294.28 | 5.2% |
| **EDUCATION AND HUMAN RESOURCES** | | | | | |
| RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS | $322.47 | $290.43 | $309.51 | $19.08 | 6.6% |
| UNDERGRADUATE EDUCATION | 217.28 | 235.65 | 246.65 | 11.00 | 4.7% |
| GRADUATE EDUCATION | 176.58 | 173.29 | 184.82 | 11.53 | 6.7% |
| HUMAN RESOURCE DEVELOPMENT | 144.71 | 129.63 | 134.63 | 5.00 | 3.9% |
| **Total, EHR[2,3]** | $861.04 | $829.00 | $875.61 | $46.61 | 5.6% |

[1]Formerly known as Division of Science Resources Statistics

[2]Excludes $96.29 million in obligations in FY 2011 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2012 and

[3]Beginning in FY 2013, EHR proposes to move several programs from DUE to other EHR divisions. The Math Science Partnership (MSP) program moves into the Division of Research on Learning in Formal and Informal Settings (DRL). The Climate Change Education (CCE) program moves into the Division of Graduate Education (DGE). The Excellence Awards in Science and Engineering (EASE) program moves into the Division of Human Resources (HRD). Funding for all years is shown in the FY 2013 structure for comparability.

[4]FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

**NSF FY 2013 FUNDING BY PROGRAM**
(Dollars in Millions)

| PROGRAM | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request | Change Over FY 2012 Estimate Amount | Percent |
|---|---|---|---|---|---|
| **MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION** | $125.37 | $197.06 | $196.17 | -$0.89 | -0.4% |
| **MANAGEMENT** | $299.29 | $299.40 | $299.40 | - | - |
| **NATIONAL SCIENCE BOARD** | $4.47 | $4.44 | $4.44 | - | - |
| **OFFICE OF INSPECTOR GENERAL**[4] | $14.00 | $14.20 | $14.20 | - | - |
| **NATIONAL SCIENCE FOUNDATION** | $6,912.56 | $7,033.10 | $7,373.10 | $340.00 | 4.8% |

Totals may not add due to rounding.

[1]Formerly known as Division of Science Resources Statistics

[2]Excludes $96.29 million in obligations in FY 2011 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2012 and

[3]Beginning in FY 2013, EHR proposes to move several programs from DUE to other EHR divisions. The Math Science Partnership (MSP) program moves into the Division of Research on Learning in Formal and Informal Settings (DRL). The Climate Change Education (CCE) program moves into the Division of Graduate Education (DGE). The Excellence Awards in Science and Engineering (EASE) program moves into the Division of Human Resources (HRD). Funding for all years is shown in the FY 2013 structure for comparability.

[4] FY 2011 Actual includes $82,946 of obligations funded through the American Recovery and Reinvestment Act of 2009 (ARRA).

# OBJECT CLASSIFICATION

## NSF Consolidated Obligations

(Dollars in Millions)

| Object Class Code | Standard Title | FY 2011 Actual | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|---|
| **11.1** | Full-time permanent | $156 | $160 | $164 |
| **11.3** | Other than fulltime permanent | 12 | 13 | 14 |
| **11.5** | Other personnel compensation | 8 | 3 | 4 |
| **11.8** | Special personal service payment | 2 | 1 | 1 |
| | Total personnel compensation | 178 | 177 | 183 |
| **12.1** | Civilian personnel benefits | 40 | 42 | 43 |
| **21.0** | Travel and transportation of persons | 32 | 29 | 27 |
| **23.1** | Rental payments | 26 | 27 | 28 |
| **23.3** | Communications, utilities, and miscellaneous charges | 2 | 2 | 2 |
| **24.0** | Printing and Reproduction | - | - | - |
| **25.1** | Advisory and assistance services | 180 | 180 | 172 |
| **25.2** | Other services | 20 | 22 | 18 |
| **25.3** | Purchases of goods and services from Government accounts | 34 | 34 | 34 |
| **25.4** | Operation and maintenance of facilities | 359 | 359 | 359 |
| **25.5** | Research and development contracts | 12 | 12 | 12 |
| **26.0** | Supplies and materials | 6 | 6 | 6 |
| **31.0** | Equipment | 6 | 6 | 6 |
| **32.0** | Land and Structures | - | - | - |
| **41.0** | Grants, subsidies, and contributions | 6,160 | 6,381 | 6,608 |
| | **Total, Direct obligations [1]** | **$7,055** | **$7,277** | **$7,498** |

Totals may not add due to rounding.

[1]Includes mandatory obligations, but excludes obligations for reimbursable accounts.

## REIMBURSABLE ACTIVITY

Reimbursements for the Research and Related Activities Appropriation and the Education and Human Resources Appropriation are realized from other federal agencies that have entered into interagency agreements with the Foundation. NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. These activities can include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

**Reimbursements by Agency**

(Dollars in Millions)

| DEPARTMENT/AGENCY | FY 2011 Actual |
|---|---|
| DEFENSE | |
| *Air Force* | $11.0 |
| *Army* | $5.2 |
| *Other DOD (DARPA, NSA & Intelligence)* | $13.4 |
| Subtotal, DOD | $29.6 |
| Agriculture | $1.1 |
| Commerce (Including Census, NOAA, & NIST) | $25.7 |
| Education | $0.9 |
| Energy | $14.5 |
| Environmental Protection Agency | $1.1 |
| Health & Human Services | $17.5 |
| Homeland Security | $7.7 |
| Justice | $0.8 |
| NASA | $11.9 |
| National Archives | $1.0 |
| State | $2.3 |
| Transportation | $9.0 |
| OTHER (less than $500,000) | $3.5 |
| **TOTAL REIMBURSEMENTS** | **$126.6** |

Totals may not add due to rounding

Consistent with applicable legislation and GAO decisions, agreements include reimbursement for costs that are incurred in the management and administration of these awards.

In FY 2011, the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (23.4 percent), Department of Commerce (including Census, NOAA, & NIST) (20.3 percent), the Department of Health and Human Services (13.8 percent), the Department of Energy (11.5 percent), National Aeronautics and Space Administration (9.4 percent), the Department of Transportation (7.1 percent), and the Department of Homeland Security (6.1 percent). Reimbursable activities with the Department of Defense were largely for the management of the National Center for Atmospheric Research (NCAR). Reimbursable activities with the Department of Health and Human Services are for non-medical biological research such as the Human Frontiers Science Program and the Macromolecular Structure Database (MSD) program.

**NSF Personnel Summary of Permanent Appointments**

| Statutory Pay Systems | FY 2011 Actual Appointments |
|---|---|
| ES | 73 |
| AD | 343 |
| GS/GM-15 | 92 |
| GS/GM-14 | 139 |
| GS/GM-13 | 128 |
| GS-12 | 118 |
| GS-11 | 86 |
| GS-10 | 15 |
| GS-9 | 74 |
| GS-8 | 28 |
| GS-7 | 78 |
| GS-6 | 4 |
| GS-5 | 3 |
| GS-4 | - |
| Subtotal, GS/GM | 765 |
| Total, Permanent Appointments | 1,181 |
| Average Salary | $116,758 |

All data are for permanent appointments.

## FY 2011 CARRYOVER INTO FY 2012 BY ACCOUNT

The National Science Foundation's (NSF) total unobligated balance of $127.52 million from the FY 2011 Discretionary appropriation, the American Recovery and Reinvestment Act of FY 2009 (ARRA) appropriation, Incoming Interagency Reimbursable Agreements, and Mandatory accounts consist of amounts described below.

### DISCRETIONARY

Within the **Research and Related Activities (R&RA)** appropriation, NSF carried over $2.38 million (i.e., 2-year: $1.31 million; and no-year: $1.07 million) into FY 2012. The major items include awards and contracts from various programs throughout NSF that were not ready for obligation in FY 2011. Obligation of these funds is expected by the second quarter of FY 2012.

Within the **Education and Human Resources (EHR)** appropriation, NSF carried over $221,000 (i.e., 2-year: $181,000; and no-year: $40,000) into FY 2012 for awards and contracts that were not ready for obligation in FY 2011. Obligation of these funds is expected by the second quarter of FY 2012.

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, $878,000 was carried over into FY 2012. This includes:

- $694,000 for IceCube Neutrino Observatory (IceCube): Project closure activities and associated costs are currently being finalized.

- $164,000 for South Pole Station Modernization (SPSM): Final project costs are being reconciled and will be concluded in FY 2012. If any of the remaining funds are required, they will be obligated in the second quarter of FY 2012.

- NSF recovered $20,000 in FY 2011 following the conclusion of the Earthscope and NEES construction projects. These funds were carried over and are being applied to ongoing projects.

## AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 (ARRA)

Within the **Office of Inspector General ARRA** appropriation, $1.84 million was carried over from FY 2011 into FY 2012. These multi-year funds are intended explicitly for ARRA oversight. Obligation of these funds will occur over the period of availability, which was revised under P.L. 111-203 to be through December 31, 2012 pending a waiver process which could extend availability back to September 30, 2013.

### INCOMING INTERAGENCY REIMBURSABLE AGREEMENTS

- R&RA: Incoming two-year interagency funds were carried over into FY 2012 in the amount of $4.73 million. Obligation of these funds is expected by the second quarter of FY 2012.

- EHR: Incoming two-year interagency funds were carried over into FY 2012 in the amount of $4.20 million. Obligation of these funds is expected by the second quarter of FY 2012.

**MANDATORY**

Within the **H-1B Nonimmigrant Petitioner** account (Mandatory), $60.93 million was carried over into FY 2012, which consisted of $17.41 million in ITEST and $43.52 million in S-STEM and includes third quarter H-1B receipts (received in July 2011) and $32.5 million in fourth quarter receipts (received in October 2011). Since NSF receives the largest quarterly payment of H-1B visa fees in July, there is insufficient time to obligate the receipts on awards before the end of the fiscal year. These resources will allow for both I-TEST and S-STEM to support awards in the third quarter of FY 2012.

Within the **Donations** account, $52.34 million was carried over into FY 2012. Donations were received from foreign governments, organizations, and individuals to fund various cooperative efforts in science, research, and education. This includes donations from the Bill and Melinda Gates Foundation (BMGF), which provided substantial funding ahead of schedule that enabled forward funding on several awards. NSF is currently ahead on spending the BMGF portion of funds.

**Discretionary and ARRA Appropriations, Incoming Interagency Reimbursable Agreements, Donations, and Mandatory Account**

**Distribution of FY 2011 Carryover into FY 2012**

(Dollars in Millions)

| | FY 2012 Carryover from FY 2011 | ARRA FY 2012 Carryover from FY 2011 | Incoming Interagency Reimbursables | Total FY 2012 Carryover |
|---|---|---|---|---|
| Research and Related Activities (R&RA) | $2.38 | - | - | $2.38 |
| R&RA Incoming Reimbursables | | | 4.73 | 4.73 |
| Education and Human Resources (EHR) | 0.22 | - | | 0.22 |
| EHR Incoming Reimbursables (EHR) | | | 4.20 | 4.20 |
| Major Research Equipment and Facilities Construction (MREFC) | 0.88 | - | - | 0.88 |
| Office of Inspector General (OIG) | - | 1.84 | - | 1.84 |
| **Subtotal** | **3.48** | **1.84** | **8.93** | **14.25** |
| **Mandatory** | | | | |
| Mandatory (H-1B Non-Immigrant Petitioner) | 60.93 | - | - | 60.93 |
| Donations (Special or Trust Fund) | 52.34 | - | - | 52.34 |
| **Subtotal** | **113.27** | **-** | **-** | **113.27** |
| **Total** | **$116.75** | **$1.84** | **$8.93** | **$127.52** |

Totals may not add due to rounding.

## Physicians' Comparability Allowance (PCA) Worksheet

## Department: National Science Foundation

## Table 1

| | | PY 2011 (Actual) | CY 2012 (Estimates) | BY 2013* (Estimates) |
|---|---|---|---|---|
| 1) Number of Physicians Receiving PCAs | | 0 | 1* | 1 |
| 2) Number of Physicians with One-Year PCA Agreements | | 0 | 1* | 1 |
| 3) Number of Physicians with Multi-Year PCA Agreements | | 0 | 0 | 0 |
| 4) Average Annual PCA Physician Pay (without PCA payment) | | 0 | $176,547 | $176,547 |
| 5) Average Annual PCA Payment | | 0 | $21,588 (prorated) | $23,000 |
| 6) Number of Physicians Receiving PCAs by Category (non-add) | Category I Clinical Position | 0 | 0 | 0 |
| | Category II Research Position | 0 | 0 | 0 |
| | Category III Occupational Health | 0 | 1* | 1 |
| | Category IV-A Disability Evaluation | 0 | 0 | 0 |
| | Category IV-B Health and Medical Admin. | 0 | 0 | 0 |

*FY 2013 data will be approved during the FY 2014 Budget cycle.
*Upon return from LWOP-US

7) If applicable, list and explain the necessity of any additional physician categories designated by your agency (for categories other than I through IV-B). Provide the number of PCA agreements per additional category for the PY, CY and BY.

N/A

8) Provide the maximum annual PCA amount paid to each category of physician in your agency and explain the reasoning for these amounts by category.

NSF employs one physician in the occupational health category. This position has been covered by a PCA agreement since November 2006. The incumbent was placed in Leave Without Pay status for active duty military service beginning in August 2009. Under NSF's PCA Plan, a PCA is not paid during LWOP. NSF intends to resume PCA coverage of this position upon his expected return in September 2012. The maximum PCA amount previously paid was $21,588. The 2009 PCA amount represented a modest increase from the previous year and balanced the combined PCA and salary of competing organizations utilizing physicians with comparable qualifications.

9) Explain the recruitment and retention problem(s) for each category of physician in your agency (this should demonstrate that a current need continues to persist).

NSF's one PCA covered position is Head of the Polar Environment, Health and Safety Office in the Office of Polar Programs. The OPP physician serves as the chief medical officer of the U.S. Antarctic Program which NSF manages on behalf of the nation pursuant to Presidential Memorandum 6646. The responsibilities of this physician include overseeing medical practices and facilities at three land-based medical clinics in Antarctica and Arctic Ocean waters, and at remote field stations in Antarctica and Greenland. The OPP physician is also responsible for workplace safety at these locations and for developing sound environmental, safety, and medical aspects of research and operations supported by NSF and conducted in the polar regions. These duties require the attention of a physician with outstanding management ability and extensive operational experience. Offering a physicians' comparability allowance is essential to attracting and retaining a qualified individual. Prior to obtaining PCA authority, OPP experienced considerable difficulty hiring a high quality candidate possessing the unique qualifications for this position.

10) Explain the degree to which recruitment and retention problems were alleviated in your agency through the use of PCAs in the prior fiscal year.

NSF's use of a PCA allowed the agency to offer compensation commensurate with the experience, background, and salary requirements of the best qualified pool of applicants. NSF was able to attract and retain a physician who previously received a PCA at another Federal agency.

11) Provide any additional information that may be useful in planning PCA staffing levels and amounts in your agency.

NSF has no plans to increase the use of PCA beyond the current level of one.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

December 5, 2011

Pam Hammett
Chief, Executive and Visiting Personnel Branch
Division of Human Resource Management
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Ms. Hammett,

This is to advise you that the proposed FY 2012 Physicians' Comparability Allowance (PCA) plan for the National Science Foundation is consistent with the policy on comparability based on data presented. The National Science Foundation's plan will be effective through September 30, 2012.

We appreciate the effort you and your staff have taken to prepare this PCA plan.

Sincerely,

Richard A. Mertens
Deputy Associate Director
Energy, Science, and Water Division
Office of Management and Budget

# QUANTITATIVE DATA TABLE

## NATIONAL SCIENCE FOUNDATION

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | $4,690.62 | - | $4,690.62 | $4,726.61 | $4,965.31 |
| Applied Research | 454.97 | - | 454.97 | 450.38 | 458.04 |
| Subtotal, Conduct of R&D | 5,145.59 | - | 5,145.59 | 5,176.99 | 5,423.35 |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | 44.48 | - | 44.48 | 22.98 | 23.66 |
| Major Equipment | 346.53 | - | 346.53 | 414.36 | 424.99 |
| Subtotal, R&D Facilities & Major Equipment | 391.01 | - | 391.01 | 437.34 | 448.65 |
| Total, Support of R&D | 5,536.60 | - | 5,536.60 | 5,614.33 | 5,872.00 |
| Non-Investment Activities | 575.51 | 0.08 | 575.59 | 580.50 | 587.40 |
| Education and Training | 800.36 | - | 800.36 | 838.27 | 913.70 |
| TOTAL | $6,912.47 | $0.08 | $6,912.55 | $7,033.10 | $7,373.10 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## RESEARCH AND RELATED ACTIVITIES

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | $4,606.09 | - | $4,606.09 | $4,645.22 | $4,865.17 |
| Applied Research | 317.73 | - | 317.73 | 318.24 | 336.62 |
| Subtotal, Conduct of R&D | 4,923.82 | - | 4,923.82 | 4,963.46 | 5,201.79 |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | 44.22 | - | 44.22 | 22.98 | 23.66 |
| Major Equipment | 223.37 | - | 223.37 | 216.50 | 227.95 |
| Subtotal, R&D Facilities & Major Equipment | 267.59 | - | 267.59 | 239.48 | 251.61 |
| Total, Support of R&D | 5,191.41 | - | 5,191.41 | 5,202.94 | 5,453.40 |
| Non-Investment Activities | 209.81 | - | 209.81 | 218.91 | 222.14 |
| Education and Training | 207.17 | - | 207.17 | 267.15 | 307.74 |
| TOTAL | $5,608.39 | - | $5,608.39 | $5,689.00 | $5,983.28 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## EDUCATION AND HUMAN RESOURCES

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | FY 2013 Estimate |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | $84.53 | - | $84.53 | $81.38 | $100.14 |
| Applied Research | 137.24 | - | 137.24 | 132.13 | 121.42 |
| Subtotal, Conduct of R&D | 221.77 | - | 221.77 | 213.51 | 221.56 |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | 0.83 | - | 0.83 | 0.80 | 0.87 |
| Subtotal, R&D Facilities & Major Equipment | 0.83 | - | 0.83 | 0.80 | 0.87 |
| Total, Support of R&D | 222.60 | - | 222.60 | 214.31 | 222.43 |
| Non-Investment Activities | 45.25 | - | 45.25 | 43.57 | 47.22 |
| Education and Training | 593.19 | - | 593.19 | 571.12 | 605.96 |
| TOTAL | $861.04 | - | $861.04 | $829.00 | $875.61 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | 0.26 | - | 0.26 | - | - |
| Major Equipment | 122.33 | - | 122.33 | 197.06 | 196.17 |
| Subtotal, R&D Facilities & Major Equipment | 122.59 | - | 122.59 | 197.06 | 196.17 |
| Total, Support of R&D | 122.59 | - | 122.59 | 197.06 | 196.17 |
| Non-Investment Activities | 2.78 | - | 2.78 | - | - |
| Education and Training | - | - | - | - | - |
| TOTAL | $125.37 | - | $125.37 | $197.06 | $196.17 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## AGENCY OPERATIONS AND AWARD MANAGEMENT

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | Y 2013 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research..... | - | - | - | - | - |
| Applied Research..... | - | - | - | - | - |
| Subtotal, Conduct of R&D..... | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment..... | - | - | - | - | - |
| Major Equipment..... | - | - | - | - | - |
| Subtotal, R&D Facilities & Major Equipment... | - | - | - | - | - |
| Total, Support of R&D..... | - | - | - | - | - |
| Non-Investment Activities..... | $299.29 | - | 299.29 | $299.40 | $299.40 |
| Education and Training..... | - | - | - | - | - |
| TOTAL..... | $299.29 | - | $299.29 | $299.40 | $299.40 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## OFFICE OF INSPECTOR GENERAL

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | - | - | - | - | - |
| Subtotal, R&D Facilities & Major Equipment | - | - | - | - | - |
| Total, Support of R&D | - | - | - | - | - |
| Non-Investment Activities | $13.92 | 0.08 | 14.00 | $14.20 | $14.20 |
| Education and Training | - | - | - | - | - |
| TOTAL | $13.92 | $0.08 | $14.00 | $14.20 | $14.20 |

Totals may not add due to rounding.

# QUANTITATIVE DATA TABLE

## NATIONAL SCIENCE BOARD

**Research and Development Special Analysis**

(Dollars in Millions)

| | FY 2011 Actual | FY 2011 ARRA | FY 2011 Total | FY 2012 Estimate | FY 2013 Request |
|---|---|---|---|---|---|
| Support of R&D | | | | | |
| Conduct of Research and Development | | | | | |
| Basic Research | - | - | - | - | - |
| Applied Research | - | - | - | - | - |
| Subtotal, Conduct of R&D | - | - | - | - | - |
| R&D Facilities | | | | | |
| Land, Building and Fixed Equipment | - | - | - | - | - |
| Major Equipment | - | - | - | - | - |
| Subtotal, R&D Facilities & Major Equipment | - | - | - | - | - |
| Total, Support of R&D | - | - | - | - | - |
| Non-Investment Activities | $4.47 | - | 4.47 | $4.44 | $4.44 |
| Education and Training | - | - | - | - | - |
| TOTAL | $4.47 | - | $4.47 | $4.44 | $4.44 |

Totals may not add due to rounding.