NSF FY 2017 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; to secure the national defense..."***

*The National Science Foundation Strategic Plan for 2014-2018, "Investing in Science, Engineering, and Education for the Nation's Future," defines our vision: "**A Nation that creates and exploits new concepts in science and engineering and provides global leadership in research and education."***

This FY 2017 Budget Request for the National Science Foundation (NSF) continues NSF's longstanding commitment to supporting research that drives scientific discovery, maintains America's global competitiveness, and builds the modern workforce that is critical for addressing the complex challenges that face the Nation. NSF is vital because we invest in basic research and people who make the discoveries that transform our future. Those discoveries are a primary driver of the U.S. economy, enhance our Nation's security, and give the country the competitive edge to remain a global leader.

NSF's FY 2017 Budget Request is $7.964 billion, an increase of $500.53 million (6.7 percent) over the FY 2016 Estimate. This includes $7.56 billion in discretionary budget authority and $400 million in new mandatory budget authority. The FY 2017 Budget Request reflects a carefully chosen portfolio that supports the fundamental research that is NSF's hallmark and creates and sustains key partnerships with other federal agencies, industry, and international entities. Through sustained, longstanding investments in all areas of science, engineering, and education, this submission ensures a robust return on investment for all American citizens.

FY 2017 Budget Request

Total:	$7.964 billion
Increase:	$500.53 million

6.7% over FY 2016

NSF's broad portfolio positions the agency to contribute productively and rapidly to important national challenges. For example, the Computer Science for All initiative, announced by the President on January 30, 2016, builds on ongoing NSF activities that foster rigorous and engaging computer science education in schools across the Nation. Similarly, a range of NSF-supported advances and innovations will help to launch the Administration's cancer "moonshot." These include fundamental research in biology, biochemistry, biophysics; data-driven discovery enabled by machine learning techniques and leveraging NSF-cyberinfrastructure; and engineered systems in nanotechnology, imaging, material science and robotics.

FY 2017 Major Emphases

NSF's FY 2017 Budget Request includes two areas of major emphasis: Clean Energy R&D and strengthening support for core activities, with a special focus on support for early career investigators.

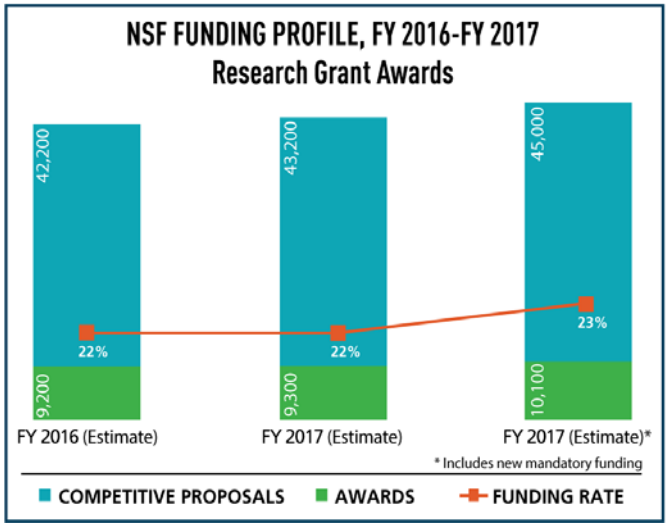
The President joined other world leaders at the recent Paris climate negotiations to launch Mission Innovation, a landmark commitment to dramatically accelerate public and private global clean energy innovation, by investing in new technologies that will define a clean, affordable, and reliable global power mix. Through this initiative, the U.S. and 19 other countries have committed to doubling their governmental clean energy research and development investment over five years. Successful innovation in clean energy requires broad participation, including nontraditional approaches and innovators close to stakeholders that will benefit from clean energy solutions. Mission Innovation provides a robust framework to expand and better integrate clean energy research across agencies. The Budget for NSF includes $512.22 million for investments in Clean Energy R&D. NSF's clean energy portfolio supports research and education in innovative renewable and alternative energy sources for electricity (solar, wind, wave, geothermal) and fuels (chemical and biofuels). NSF funding also addresses the collection, conversion, storage, and distribution of energy from diverse power sources, including smart grids; the science and engineering of energy materials; and energy use and efficiency, including for computing systems. Clean energy research addresses our advancement toward reliable and sustainable energy resources and systems that preserve essential ecosystems and environmental services, promote positive social and economic outcomes, and prepare society to responsibly adopt them.

Funding for FY 2017 Clean Energy R&D

(Dollars in Millions)

	FY 2015 Actual	FY 2016 Estimate	FY 2017 Request	FY 2017 Request Change Over FY 2016 Estimate Amount	Percent
Clean Energy R&D	$356.02	$371.45	$512.22	$140.77	37.9%

New one-year mandatory funding totaling $400 million will support the fundamental, curiosity-driven research that is NSF's principal contribution to the Nation's science and technology enterprise. In particular, this funding will support more scientists and engineers at the early stages of their careers – who bring particular expertise in data- and computationally-intensive activities – to quicken the pace of discovery and advance the leading edge of research and education. This funding will allow for an estimated 800 additional research grants to be made from a pool of highly-rated proposals that would otherwise be declined for lack of funding. This additional funding would bring NSF's FY 2017 funding rate to an estimated 23 percent.



FY 2017 Cross-Foundation Investments

NSF continues to bring together researchers from all fields of science and engineering to address today's cross-disciplinary questions and challenges through Foundation-wide activities. In FY 2017, NSF continues to support its four FY 2016 cross-foundation investments.

Funding for FY 2017 Cross-Foundation Investments

(Dollars in Millions)

	FY 2015 Actual	FY 2016 Estimate	FY 2017 Request	FY 2017 Request Change Over FY 2016 Estimate Amount	Percent
Understanding The Brain (UtB)	$109.39	$146.93	$141.62	-$5.31	-3.6%
Risk and Resilience	19.34	41.15	43.15	2.00	4.9%
Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS)	-	48.68	62.18	13.50	27.7%
Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES)	-	15.50	16.00	0.50	3.2%

Understanding the Brain (UtB) encompasses ongoing cognitive science and neuroscience research and NSF's contributions to the Administration's Brain Research through Advancing Innovation and Neurotechnologies (BRAIN) Initiative. The goal of UtB is to enable scientific understanding of the full complexity of the brain in action and in context. Priorities include: brain-inspired concepts and designs; development of innovative technologies, tools and instrumentation, computational infrastructure, theory, and models to understand the brain; identification of the fundamental relationships among neural activity, cognition, and behavior; understanding how the brain responds and adapts to changing environments and recovers from lost functionality; and BRAIN workforce development and training for the next generation of neuroscientists and neuroengineers. Improved understanding of the brain will promote brain health; enable engineered solutions that enhance, replace or compensate for lost function; improve the effectiveness of formal and informal educational approaches; and lead to brain-inspired smarter technologies for improved quality of life. Basic research in these areas will also offer novel insights into how cognitive abilities develop and can be maintained and improved throughout the lifespan.

NSF In Action

NSF has already helped lay the groundwork for BRAIN by supporting innovations in brain research, including the development of optogenetics, a bioengineering technique that enables scientists to selectively turn on and off particular neurons and neuronal circuits in living organisms; the resulting behavioral changes can be observed in real time. Researchers are using optogenetics to help identify the functions of neurons and neuronal circuits and appropriate targets for drugs or technologies that address brain dysfunction related to conditions such as Parkinson's disease. A crucial prerequisite to the development of optogenetics was a discovery of light-sensitive algae proteins. This pivotal application of algae research to neuroscience underscores the importance to BRAIN of NSF-funded research — including basic research in seemingly far-flung disciplines.

Risk and Resilience investments aim to improve predictability and risk assessment and increase preparedness for extreme natural and man-made events in order to reduce their impact on quality of life, society, and the economy. NSF is uniquely positioned to support such improvements that require multidisciplinary expertise in science, engineering, and education, such as understanding the dynamic processes that produce extreme events, how people respond to extreme events, and how to engineer resilient infrastructure, including in the context of smart and connected communities. One supporting program is Critical Resilient Interdependent Infrastructure Systems and Processes, which directly addresses the need for the resilient and reliable infrastructure that is critical to U.S. economic competitiveness and national security. Another is Prediction of and Resilience against Extreme Events, which aims to enhance the understanding and prediction of, as well as resilience and sustainable responses to, extreme events and geohazards, and their impact on natural and human systems.

NSF In Action

A team of engineers from across the country designed and carried out a series of large-scale tests to better understand exactly what happens when debris carried by tsunamis strikes buildings and other structures. The research ultimately seeks to improve building designs so structures can withstand the force of fast-moving tsunami debris, which can include large objects such as telephone poles or even other buildings. The ambitious project was a collaboration of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) large-scale structures test facility at Lehigh University, the NEES Tsunami Research Facility at Oregon State University, and researchers at the University of Hawaii.

Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) is an NSF-wide investment that aims to understand, design, and model the interconnected food, energy, and water system through an interdisciplinary research effort that incorporates all areas of science and engineering and addresses the natural, social, and human-built factors involved. Throughout NSF, activities address food, energy, or water, such as Water Sustainability and Climate and Hazards; Coupled Natural and Human Systems; and Basic Research to Enable Agricultural Development. INFEWS, however, is the first program to study the interconnected food-energy-water nexus. The need for this program is increasingly urgent, as growing U.S. and global populations, changes in land use, and increasing geographic and seasonal variability in precipitation patterns are placing an ever-increasing stress on these critical resources. NSF, through INFEWS, is uniquely poised to focus not only on the fundamental science and engineering questions at this nexus, but to train the next generation of researchers in this interdisciplinary area.

NSF In Action

In arid New Mexico, NSF EPSCoR researchers are modelling different scenarios to demonstrate the impact that water pricing, population growth, education, and drought have on the groundwater aquifer for the Albuquerque, Santa Fe, and Rio Rancho areas. They showed that price incentives impact indoor and outdoor water use and lower water use by more than 15 percent per capita. Their research also indicated that as more droughts occur in tandem with population increases, the aquifer has a lower chance of recovery. Such findings can assist city planners, officials, and citizens with plans to slow aquifer depletion.

This activity is an example of the type of water research that INFEWS will build upon to address the larger food-energy-water nexus.

NSF INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science), is an integrated, national initiative to increase the preparation, participation, advancement, and potential contributions of those who have been traditionally underserved and/or under-represented in the science, technology, engineering, and mathematics (STEM) enterprise. In FY 2017, NSF investment in this key priority is $16.0 million. Building on activities underway in FY 2015 and FY 2016, NSF will proceed to full implementation of NSF INCLUDES in FY 2017. Investments aim to produce, through alliances organized within a national network, rapid progress on changing the balance of diversity in science and engineering, have significant national impact for the participation of underrepresented groups, stimulate the community, forge new partnerships, and catalyze new approaches. NSF INCLUDES will build on and amplify other NSF investments in broadening participation.

NSF in Action

One groundbreaking NSF-supported project introduces girls from under-resourced areas to the emerging field of co-robotics. The girls, aged 8 to 12, learn to program co-robots — humanoid bots that work collaboratively with people. The girls tackle problems such as how robots should interact with people and how they might express emotion. The project expands the NSF-funded COMPUGIRLS, which was founded by social scientist and White House Champion of Change Kimberly Scott. COMPUGIRLS offers informal-learning programs in which girls explore the latest technologies in digital media, game development, and virtual worlds. Girls should know they belong in computer science, said Marquette University's Andrew Williams, who conceived of "Co-Robots for COMPUGIRLS." "They can have a vision of computer science or robotics and can someday apply it at a place like Google."

FY 2017 Ongoing NSF-Wide Priorities

NSF invests in a number of ongoing Foundation-wide programs that focus on addressing the most pressing challenges that face our Nation today. Foundation-wide programs and priorities bring together researchers from all fields of science and engineering to work on projects no one field can address on its own. These interdisciplinary investments are carefully balanced with a longstanding commitment to the fundamental research that addresses grand challenges and furthers basic scientific knowledge.

FY 2017 Funding for Ongoing NSF-Wide Investments

(Dollars in Millions)

	FY 2015 Actual	FY 2016 Estimate	FY 2017 Request	FY 2017 Request Change Over FY 2016 Estimate Amount	Percent
Cyber-Enabled Materials, Manufacturing and Smart Systems (CEMMSS)	$269.83	$256.30	$257.12	$0.82	0.3%
Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21)	157.04	132.42	100.07	-32.35	-24.4%
NSF Innovation Corps (I-Corps™)	26.19	30.00	30.00	-	-
Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS)	35.47	31.31	29.81	-1.50	-4.8%
Science, Engineering, and Education for Sustainability (SEES)	183.01	74.73	52.48	-22.25	-29.8%
Secure and Trustworthy Cyberspace (SaTC)	124.71	129.75	149.75	20.00	15.4%

- **Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS)** ($257.12 million) aims to integrate a number of science and engineering activities across the Foundation – breakthrough materials, advanced manufacturing, and smart systems, which includes robotic, cyber-physical, and autonomous systems. It will address pressing technological challenges facing the Nation and promote U.S. economic competitiveness in a variety of sectors. In FY 2017, CEMMSS continues to leverage key interagency activities, including the Administration's Materials Genome Initiative, Advanced Manufacturing Partnership, and the National Robotics Initiative. Through CEMMSS, NSF also invests in Advanced Manufacturing ($175.74 million) to advance cutting-edge manufacturing, as described in the *National Strategic Plan for Advanced Manufacturing.*

- **Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21)** ($100.07 million) accelerates and transforms the process of scientific discovery and innovation by providing advanced cyberinfrastructure that enables new functional capabilities in computational and data-enabled science and engineering across all disciplines. CIF21 has a planned sunset at the end of FY 2017, but efforts will inform a subsequent, focused set of activities for FY 2018 as a part of the Administration's new National Strategic Computing Initiative (NSCI).

- **NSF Innovation Corps (I-Corps™)** ($30.0 million) improves NSF-funded researchers' access to resources that can assist in bridging the gap between discoveries and speed knowledge transfer to downstream technological applications and use at scale. In FY 2017, NSF will continue to support I-Corps™ Nodes and I-Corps™ Sites to further build, utilize, and sustain a national innovation ecosystem

that helps researchers effectively identify viable market opportunities and augments the development of technologies, products, and processes that benefit the Nation.

- **Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS)** ($29.81 million) involves the Directorates for Biological Sciences and Mathematical and Physical Sciences, and it seeks to advance discovery at the intersections of these established disciplines. Research includes activities such as development of models, informed by statistical physics that establish the mechanisms linking the biological function of chromosomes to their cellular structure.

- **Science, Engineering, and Education for Sustainability (SEES)** ($52.48 million) supports investments to increase understanding of the integrated system of supply chains, society, the natural world, and alterations humans bring to Earth, in order to create a sustainable world. FY 2017 is the last year in which funding will be formally associated with the SEES portfolio; however, through the planned sunsetting, SEES continues to support important scientific contributions and will make significant progress towards achieving programmatic goals through projects currently underway. Several SEES components with significant community interest will be continued through core programs and other aspects will be folded into the INFEWS and Risk and Resilience investments.

- The **Secure and Trustworthy Cyberspace (SaTC)** ($149.75 million) investment aims to build the knowledge base in cybersecurity that enables discovery, learning and innovation, and leads to a more secure and trustworthy cyberspace. Through a focus on long-term, foundational research, SaTC will develop the scientific foundations for cybersecurity research for years to come. SaTC also focuses on the training of the next generation cybersecurity workforce, especially for government. SaTC aligns NSF's cybersecurity investments with the national cybersecurity strategy.

Additional Highlights

NSF continues to emphasize investments in important or emerging areas that have been developed in recent years, including:

- NSF aims to increase the operational efficiency of **U.S. activities in the Antarctic** ($23.50 million) by continuing progress on a multi-year commitment toward more efficient and cost-effective science support as recommended by the U.S. Antarctic Program Blue Ribbon Panel report, *More and Better Science in Antarctica through Increased Logistical Effectiveness*. Emphases include investing in cargo-carrying capabilities for the South Pole heavy traverse, adding to its ability to deliver fuel, as well as continued investment in vehicle fleet and lifecycle capital equipment purchases to modernize Antarctic inventories and ensure facilities efficiency. This includes targeted investment in information technology infrastructure upgrades such as network management hardware, as well as design work for a new satellite earth station to move the primary communications facility from Black Island to McMurdo Station. Included in the total investment for FY 2017 is $5.0 million for the Antarctic Infrastructure Modernization for Science (AIMS) preconstruction planning project.

- In FY 2017, support for several of NSF's **astronomy and astrophysics** facilities investments reaches a decision point. A 2012 portfolio review was conducted under the auspices of the Advisory Committee for the Directorate for Mathematical and Physical Sciences in order to align budget realities with the 2010 National Research Council decadal survey, "*New Worlds, New Horizons in Astronomy and Astrophysics.*" Based on these recommendations, NSF is developing potential divestment options for several facilities.

- As the CIF21 investment sunsets in FY 2017, NSF will develop a subsequent, focused set of activities aligned with the Administration's new **National Strategic Computing Initiative (NSCI)** ($33.20

million) in order to focus efforts on advancing the Nation's computational infrastructure for science and engineering research. The rich topic of data, encompassing data science, data assimilation, data management, data policy, community building, and workforce development, will remain a strategic focus under the new NSF Data for Scientific Discovery and Action (D4SDA) activity, which will span research and research infrastructure.

Education and STEM Workforce

NSF's education and STEM workforce investment, centered in the Directorate for Education and Human Resources (EHR), funds activities that support students, teachers, researchers, and the public. The EHR investment in core STEM education research is critical to building the Nation's knowledge base for improving STEM learning. In keeping with the Administration's priorities and the strategic goals for STEM education as described in the Federal STEM Education Strategic Plan,[1] NSF's investments for FY 2017 focus on the following priorities:

- The **CyberCorps®: Scholarship for Service (SFS)** program ($70.0 million) supports cybersecurity education and research at higher education institutions. SFS also focuses on workforce development by increasing the number of qualified students entering the fields of information assurance and cybersecurity, which enhances the capacity of the United States higher education enterprise to continue to produce professionals in these fields to secure the Nation's cyberinfrastructure. In FY 2017, $25.0 million of the total funding will lay the groundwork for SFS alumni to be available over the course of their careers to serve the federal government to help respond rapidly to cybersecurity challenges.

- **Computer Science for All (CS for All)** ($20.0 million) will build on ongoing efforts to enable rigorous and engaging computer science education in schools across the Nation. Funds will support the development and assessment of prototype instructional materials, scalable and sustainable professional development models, approaches to preservice preparation for computer science teachers, and teacher resources. CS for All will also fund research that will add to knowledge of effective approaches to the teaching and learning of computer science across grades K-12.

- The **Improving Undergraduate STEM Education (IUSE)** ($109.0 million) initiative supports the development of the STEM and STEM-capable workforce by investing in the improvement of undergraduate STEM education, with focus both on attracting and retaining students, and on degree completion.**.**

- Through the **Advanced Technological Education (ATE)** ($66.00 million) program, NSF is able to reach technicians in undergraduate programs preparing for the high-technology fields that drive our Nation's economy. The ATE program is actively engaged in connecting community college educators funded by the program to the Institutes for Manufacturing Innovation within the National Network for Manufacturing Innovation.

- The **Graduate Research Fellowship (GRF)** ($332.16 million) program recognizes students with high potential in STEM research and innovation and provides support for them to pursue multidisciplinary research. GRF fellows may participate in Graduate Research Opportunities Worldwide (GROW), which provides opportunities to conduct research with international partner countries and organizations, and Graduate Research Internship Program (GRIP), which provides professional development through research internships at federal agencies. An NSF-wide strategic plan for investment in graduate education will be released in FY 2016.

[1] National Science and Technology Council. Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf

- **The NSF Research Traineeship (NRT)** ($58.63 million) program invests directly in the development of the STEM workforce, and in the improvement of the education of tomorrow's STEM workforce. NRT funds proposals to test, develop, and implement innovative and effective STEM graduate education models, to promote interdisciplinary and broad professional training of graduate students, and to foster fundamental research advances in support of national priorities. NRT thus provides a mechanism for developing a knowledge base about the implementation and impact of innovative graduate traineeship programs and graduate education policies.

Major Research Equipment and Facilities Construction

In FY 2017, NSF requests funding to begin construction of one new project, the Regional Class Research Vessel (RCRV), and to continue construction of two projects, the Daniel K. Inouye Solar Telescope (DKIST) and the Large Synoptic Survey Telescope (LSST).

- The **Regional Class Research Vessel** (RCRV) ($106.0 million) project will initiate construction of two ships to meet anticipated ocean science requirements for the U.S. East Coast, West Coast, and Gulf of Mexico consistent with the recent report, *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences*.[2] The RCRV project is a major component in the plan for modernizing the U.S. Academic Research Fleet (ARF).[3]

- The **Daniel K. Inouye Solar Telescope** ($20.0 million) will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona at unprecedented spatial, temporal, and wavelength resolution to gain information on the creation, interaction, and ultimate annihilation of solar magnetic fields. 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. FY 2017 is year nine of an eleven year construction process. In FY 2017, the Coudé rotator platform will be commissioned and accepted. The installation of the Telescope Mount Assembly (TMA) electrical systems will be completed, and commissioning and acceptance testing of the TMA will begin. The Coudé lab room will be complete and various components of the Coudé optics system installed. The first of the five first-light instruments, the visible broadband imager (VBI), will be delivered, assembled and will begin initial checkout.

- The **Large Synoptic Survey Telescope** ($67.12 million) will be an 8-meter-class wide-field optical telescope designed to carry out surveys of the entire sky available from its site. LSST will collect nearly 40 terabytes of multi-color imaging data every night and will produce the deepest, widest-field sky image ever. It will image the entire visible sky twice per week, as well as issue alerts for moving and transient objects within 60 seconds of their discovery. The LSST surveys will result in a comprehensive data set that will enable hundreds of other fundamental astrophysical studies by the entire research community. FY 2017 is year four of a nine year construction process. In FY 2017, work on the summit facility will be completed with the installation of the dome. The telescope structure will be factory tested and shipped to the site for installation. Integration of the innovative primary-tertiary mirror into its support cell will begin, and polishing of the secondary mirror will be finished. The camera cryostat will be made, the first sensor raft will be completed, and the camera's active support structure will be delivered. The data management project expects to deliver its initial archive and finalize the interface to the dedicated education and public outreach system.

[2] www.nap.edu/catalog/21655/sea-change-2015-2025-decadal-survey-of-ocean-sciences
[3] National Ocean Council. Federal Oceanographic Fleet Status Report, 2013
www.whitehouse.gov/sites/default/files/federal_oceanographic_fleet_status_report.pdf

Major Research Equipment and Facilities Construction Funding

(Dollars in Millions)

	FY 2015 Enacted	FY 2016 Estimate	FY 2017 Request
Ongoing Projects:			
Daniel K. Inouye Solar Telescope (DKIST)	$25.12	$20.00	$20.00
Large Synoptic Survey Telescope (LSST)	79.64	99.67	67.12
National Ecological Observatory Network (NEON)	96.00	80.64	-
Regional Class Research Vessel (RCRV)	-	-	106.00
Total, MREFC	**$200.76**	**$200.31**	**$193.12**

Totals may not add due to rounding.

Organizational Excellence

NSF seeks to integrate mission, vision, and core values to efficiently and effectively execute our activities and provide the flexibility and agility required for all aspects of its operations. This goal incorporates a culture of continuous improvement to ensure effective, inclusive, and accountable programs and merit review processes that provide the greatest value for taxpayer dollars.

Staffing

In FY 2017, NSF will work towards full utilization of its established FTE allocations, which are consistent with the FY 2016 Estimate of 1,442. The Foundation recognizes that maintaining staffing levels is vital for managing increasing numbers of proposals and the subsequent increase in workload.

FY 2017 Priorities

In FY 2017, the primary drivers of the increase for the Agency Operations and Award Management (AOAM) account are the headquarters relocation, the 1.6 percent cost-of-living adjustment and related salary and benefit increases, and information technology investments supporting DATA Act requirements, implementation of electronic invoicing, system updates, and increased security. AOAM also supports operational activities to ensure the Foundation has sufficient resources to fully fund ongoing operational requirements and maintain essential services as we approach the transition to the new NSF headquarters. These include strengthening capabilities in administrative services and human resource management.

Organizational Excellence by Appropriation

(Dollars in Millions)

	FY 2015 Actual	FY 2016 Estimate	FY 2017 Request	Change over FY 2016 Estimate Amount	Percent
Agency Operations & Award Management (AOAM)	$306.56	$330.00	$373.02	$43.02	13.0%
National Science Board (NSB)	4.15	4.37	4.38	0.01	0.2%
Office of Inspector General (OIG)	14.60	15.16	15.20	0.04	0.3%
Program Support:					
Research and Related Activities	107.30	110.74	128.75	18.01	16.3%
Education and Human Resources	16.21	17.28	20.18	2.90	16.8%
Subtotal, Program Support	*$123.52*	*$128.01*	*$148.94*	*$20.93*	*16.4%*
Total	**$448.83**	**$477.54**	**$541.53**	**$63.99**	**13.4%**

Total may not add due to rounding.

2014-2018 Strategic Plan and Performance

2014-2018 Strategic Plan

Integral to this submission is the NSF Strategic Plan for 2014-2018: *Investing in Science, Engineering, and Education for the Nation's Future*. The goals and strategies outlined in the plan build on lessons learned from NSF's past successes and continue to uphold NSF's mission: "To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...."

The plan presents the following goals, which guide the FY 2017 Budget Request:

- "Transform the Frontiers of Science and Engineering" aims to expand and explore the frontiers of human knowledge to enhance the power of the Nation to meet its challenges, and to create new paradigms and capabilities for scientific, technological, and economic leadership in an increasingly fast-paced, competitive world.

- "Stimulate Innovation and Address Societal Needs through Research and Education" strives to focus NSF's research communities on opening up new avenues to address high priority national challenges, as well as encourages formation of partnerships with industry, other agencies, and international counterparts to leverage resources and build capacity.

- "Excel as a Federal Science Agency" focuses on efficiently and effectively executing the agency's responsibilities and achieving the flexibility and agility required to meet the quickly evolving challenges associated with the first two strategic goals.

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 strategic objectives for each strategic goal.

Performance Plan

NSF embraces the use of goals to drive performance improvements. For FY 2017, NSF has set nine performance goals so that NSF can strategically monitor and oversee progress being made towards its larger aims. NSF also assesses progress through an annual process of strategic reviews of the objectives in its Strategic Plan.

In FY 2017, NSF will monitor the following annual goals:

- **Agency Priority Goal – Improve Graduate Student Preparedness:** Improve STEM graduate student preparedness for entering the workforce.

- **Agency Priority Goal – Invest Strategically in Public Participation in STEM Research (PPSR):** Build the capacity of the Nation to solve research challenges and improve learning by investing strategically in crowdsourcing and other forms of public participation in science, technology, engineering, and mathematics (STEM) research.

- **Ensure that Key Program Investments are on Track:** NSF will monitor progress on four investments using a set of common milestones and indicators: 1) Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES), 2) Innovations at the Nexus of Food, Energy, Water, and Social Systems (INFEWS), 3) Risk and Resilience, and 4) Understanding the Brain (UtB).

- **Ensure that Infrastructure Investments are on Track:** Ensure program integrity and responsible stewardship of major research facilities at varying stages of their lifecycle. In FY 2017, this involves monitoring the performance of construction projects.

- **Use Evidence to Guide Decisions:** NSF will use evidence-based reviews to guide management investments.

- **Make Timely Award Decisions:** NSF aims to inform applicants whether their proposals have been declined or recommended for funding within 182 days, or six months of deadline, target, or receipt date, whichever is later.

- **Foster a Culture of Inclusion:** NSF seeks to foster a culture of inclusion through change management efforts resulting in change leadership and accountability.

- **Evaluate NSF Investments:** Enable consistent evaluation of the impact of NSF investments with a high degree of rigor and independence.

- **Increase the Percentage of Panelists Participating in Merit Review Virtually:** Increase the percentage of proposal review panelists that participate virtually while maintaining the quality of the merit review process.

Please refer to performance.gov for information on NSF's Agency Priority Goals and NSF's contributions to the federal Cross-Agency Priority (CAP) goals.

Cuts, Consolidations, Savings, and Lower Priority Programs

NSF's FY 2017 Request follows a thorough examination of programs and investments across NSF to determine where the potential exists for more innovative investments. This Request includes two proposed terminations, one reduction, and two administrative savings, totaling $46.10 million.

Enhancing Access to the Radio Spectrum (EARS) (-$16.0 million) is a cross-cutting program initiated in FY 2012 whose purpose was to fund interdisciplinary research that enhances the efficiency with which radio spectrum is used and/or leads to greater access to wireless services for all Americans. EARS was a partnership of the Directorates for Computer and Information Science and Engineering (CISE), Engineering (ENG), Mathematical and Physical Science (MPS), and Social, Behavioral, and Economic Sciences (SBE) to support research in new wireless communications and spectrum sharing architectures and services. In FY 2017, CISE, ENG, and MPS will terminate investment in EARS, but will continue ongoing support of research for wireless communication, spectrum sharing, and mobile computing as well as the development of wireless and spectrum testbeds. SBE's support concluded in FY 2014.

Integrated NSF Support Promoting Interdisciplinary Research & Education (INSPIRE) (-$25.35 million) was established to address the myriad scientific challenges that lie at the intersections of traditional disciplines. It was aimed at strengthening NSF's support of interdisciplinary, potentially transformative research within the directorates by complementing existing efforts with a suite of innovative Foundation-wide activities and funding opportunities. Based on initial analysis of the INSPIRE portfolio, NSF has determined that dedicated funding is not necessary to encourage the kinds of projects supported through INSPIRE. Starting in FY 2017, each directorate will continue support for INSPIRE-like interdisciplinary research through core and cross-cutting programs, coordinating with other directorates and divisions, as necessary, for internal review of these projects. NSF anticipates developing a new funding mechanism that will manifest many of the principles of INSPIRE.

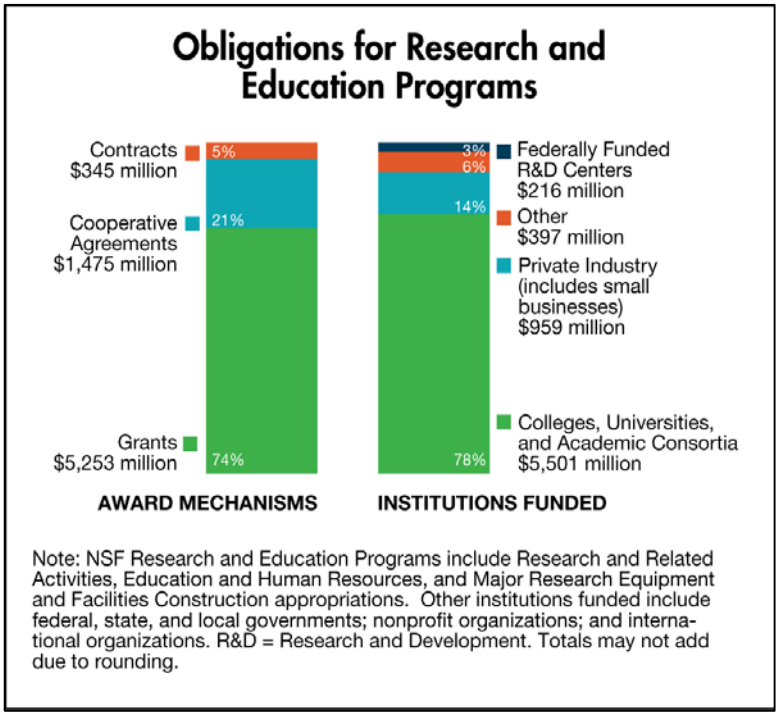
National Solar Observatory (NSO) (-$3.50 million) is reduced as part of the planned transition away from existing NSO facilities (NSO Integrated Synoptic Program, Dunn Solar Telescope, and McMath-Pierce Solar Telescope) and toward the Daniel K. Inouye Solar Telescope (DKIST).

Strategic Human Capital Support Contracts (-$810,000) funding is decreased due to NSF's planned investment in business intelligence and other tools, supported in the FY 2016 Request, which are anticipated to reduce the cost of contract support.

Information Dissemination (-$440,000) costs associated with maintenance and support of the NSF website are decreased due to a recent retirement of dated infrastructure and the conversion of content to modern platforms.

NSF by the Numbers

NSF by The Numbers: In FY 2017, NSF expects to evaluate over 52,000 proposals through a competitive merit review process and make over 12,000 new awards. This will require over 230,000 proposal reviews, engaging on the order of 35,000 members of the science and engineering community participating as panelists and proposal reviewers. In a given year, NSF awards reach over 1,800 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. In FY 2017, NSF support is expected to reach approximately 377,000 researchers, postdoctoral fellows, trainees, teachers, and students.



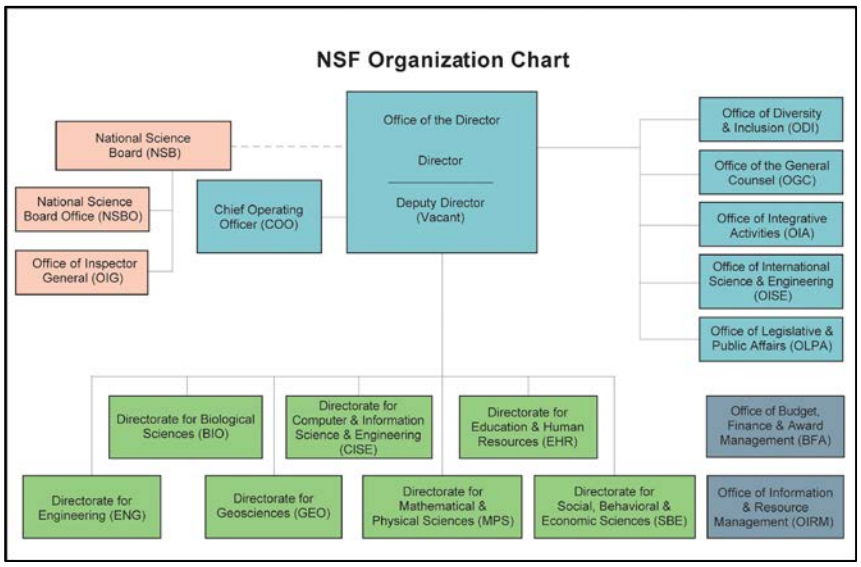
The chart on the right shows the distribution of NSF's obligations by institution type and funding mechanism. While the data are based on FY 2015, the relative shares should provide a good indication of the FY 2017 distribution. As shown on the graph, 95 percent of NSF's FY 2015 projects were funded 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.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

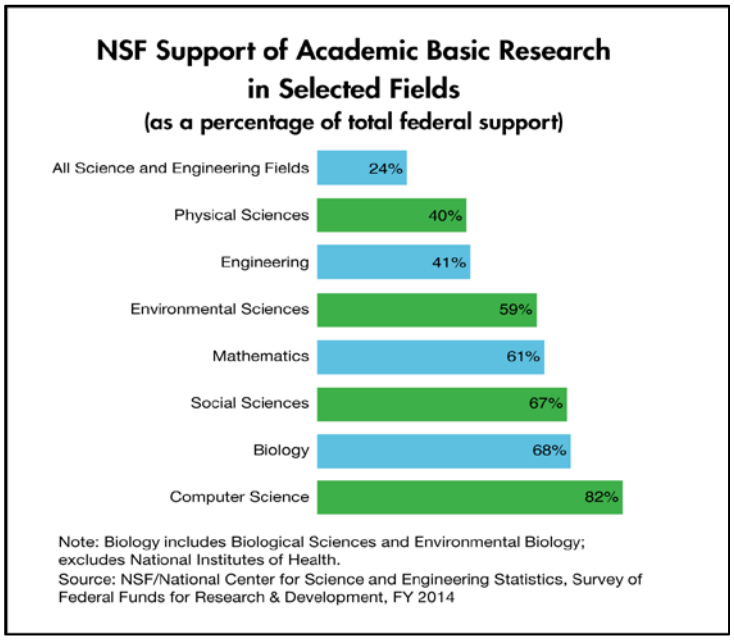
Most NSF awards are to academic institutions. As shown in the chart, 78 percent of support for research and education programs ($5,501 million) was to colleges, universities, and academic consortia. Private industry, including small businesses, accounted for 14 percent ($959 million), and support to Federally Funded Research and Development Centers (FFRDCs) accounted for 3 percent ($216 million). Other recipients included federal, state, and local governments; nonprofit organizations; and international organizations. A small number of awards fund research in collaboration with other countries, which adds value to the U.S. scientific enterprise and maintains U.S. leadership in the global scientific enterprise.

Organization and Role in the Federal Research Enterprise

NSF's comprehensive and flexible support of meritorious projects enables the Foundation to identify and foster both fundamental and transformative discoveries and broader impacts 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 creates – 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, integrative activities, and international science and engineering. The 25-member National Science Board sets the overall policies of the Foundation.





NSF's annual budget represents 24 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to nearly 60 percent when medical research supported by the National Institutes of Health is excluded. In many science and engineering fields NSF is the primary source of federal academic support.

Highlights

For over 60 years, NSF has pursued investments in fundamental research and education to fulfill its mission of promoting the progress of science and engineering. In doing so, NSF-supported research has connected the discovery and advancement of knowledge with the potential societal, economic, and educational benefits that are critical for continued U.S. prosperity. Below are just a few of the important recent advances that NSF funding continues to enable.

Supercomputer Cybersecurity

The Bro Network Security Monitor protects many scientific computing networks.

Credit: Bro Center of Expertise

Computer networks at national labs, scientific computing facilities, universities, and large companies identify and block hundreds of thousands of hostile intrusions every month, thanks to a freely available cybersecurity software advanced by NSF-funded computer scientists at the University of California, Berkeley. The programmable "Bro" code analyzes a network's unique data traffic patterns and tailors its defenses as needed, depending on the anomalies detected. The code played a critical role in identifying hackers trying to sell access to federal supercomputers. The NSF-funded Bro Center of Expertise provides resources for users to protect their cyberinfrastructure.

Hunting for Gravitational Waves

NSF, in May 2015, helped dedicate the Advanced Laser Interferometer Gravitational-Wave Observatories (LIGO) in Washington State. Researchers using the facilities seek to observe and record gravitational waves for the first time. Those discoveries would allow us to learn more about the phenomena that generate the waves, such as supernovae and colliding black holes. The Advanced LIGO project represents a major upgrade expected to enhance the sensitivity of LIGO's instruments by a factor of at least 10 and can see a volume of space more than 1,000 times greater than the initial LIGO. The existence of gravitational waves is a crucial prediction of the General Theory of Relativity.

Image of the LIGO observatory in Hanford, Washington, where astronomers completed a major upgrade in a quest to understand the extraordinary mysteries of our universe.

Credit: *Cfoellmi via Wikimedia Commons*.

Highlights

Researchers Look to Fill a Critical Cybersecurity Gap

Cybersecurity experts have for years called the insider threat – someone within an institution or agency who can, intentionally or not, gain access to a system and create dangerous vulnerabilities – one of the most serious problems in the digital world. To address that challenge, researchers at the University of Texas at Arlington and the State University of New York at Buffalo are working with a major financial institution to study the insider threat. By studying behavior logs for that institution's computer networks, the research team has been able to assess risk levels for different types of information and identify potential vulnerabilities that cyberattackers could exploit. The research, designed to help build future network access controls, is one of a group of NSF-funded projects focusing on solving cybersecurity problems with behavioral science.

Researchers partnered with a financial institution to obtain anonymized access records for every interaction with their computer networks by several thousand internal users

Credit: © iStock.com/KevinAlexanderGeorge

PBS Series Engages Latino Children in Math and Science

Animation still from *Peep and the Big Wide World*

Credit: WGBH Education Foundation

Peep and the Big Wide World, an NSF-funded Emmy award-winning Public Broadcasting Service series, developed an outreach campaign to encourage greater family involvement, particularly among Latino families, in children's exploration of math and science. A Spanish-speaking character, "Splendid Bird from Paradise," was added to the animated cast, and parents, including Spanish speakers, are now featured in the live-action videos. A multipronged study found that Spanish-speaking parents who used Peep resources with their preschool-age children were better equipped to facilitate science and math exploration. The parents reported feeling more inclined to do math and science activities with their preschoolers and said the resources are easy to understand, fun, and help them learn science alongside their children.

Highlights

Control of Soot Formation in Flames

Environmental soot, which is associated with respiratory illness and cancer, is a deadly pollutant and a leading man-made contributor to global warming. A ternary flame system developed to study soot oxidation could save thousands of lives and contribute to a cleaner environment. This novel flame system, developed by NSF-funded researchers at the University of Maryland, College Park, allows complicated flame processes to be separated and controlled. In ordinary flames, soot formation and oxidation regions overlap, preventing either process from being studied independently. The ternary system will allow soot oxidation to be studied in a region without soot formation, which could lead to more accurate computer models used in the design of engines and other combustors.

Soot oxidation will be studied in the yellow flame at the top of the ternary flame system seen in this image.

Credit: Haiqing Guo and Peter B. Sunderland, University of Maryland, College Park

Cosmic Confirmation

Photo of IceCube, a neutrino observatory whose detectors are buried more than 1 mile below the surface of the South Pole.

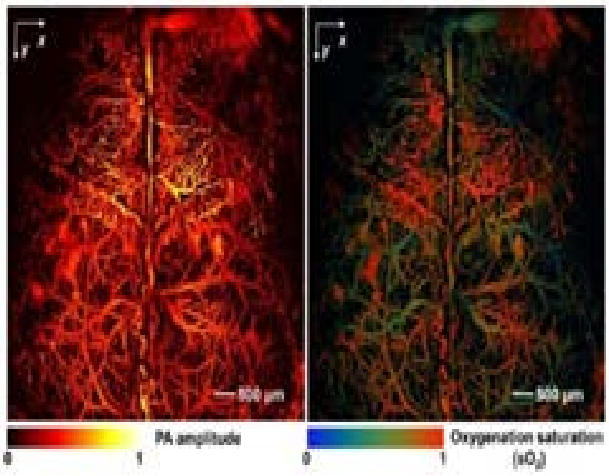
Credit: Emanuel Jacobi, National Science Foundation

Researchers using a massive, NSF-funded instrument buried deep in the ice at the South Pole observed high-energy neutrinos from beyond our solar system—and beyond our galaxy. Billions of the subatomic particles known as neutrinos pass through Earth every day but are difficult to detect. The IceCube Neutrino Observatory, a cubic-kilometer-sized detector sunk into the South Pole ice sheet, allows researchers to see byproducts of neutrino interaction with ice. A 2015 observation confirmed the discovery of high-energy neutrinos IceCube made in 2013. "Cosmic neutrinos are the key to yet unexplored parts of our universe and might be able to finally reveal the origins of the highest energy cosmic rays, including the rare 'Oh-My-God' particles," said IceCube Collaboration spokesperson Olga Botner.

Highlights

Imaging the Brain in Real Time

Overcoming the light-scattering effects of tissue, NSF-funded researchers at Washington University in St. Louis (WUSTL) use laser light to peer into the brain to unprecedented depths (nearly 3 inches). The approach they pioneered, termed photoacoustic imaging, combines laser light and sound waves. The technique allows the study of biological material, from cells to tissues and organs, in its natural environment, free of imaging agents. It detects single red blood cells as well as fats and proteins. The researchers are integrating the technique into a system to capture images every 1/1,000th of a second—fast enough to image action potentials (changes in electrical potential along a nerve fiber when a nerve impulse is transmitted.



The mouse brain was visualized using label-free photoacoustic microscopy.

Credit: Junjie Yao and Lihong Wang, WUSTL

Energy Savings through Wind Power

This image shows turbines on the Cedar Creek wind farm with plowed fields beneath.

Credit: © University Corporation for Atmospheric Research

Xcel Energy, the leading wind energy producer in the U.S., relies on a highly detailed wind forecasting system developed through a partnership with the NSF-funded National Center for Atmospheric Research (NCAR). Since 2009, the forecasting system has saved Xcel customers about $49 million. Accurate predictions of wind timing and intensity at turbine sites allow the company to decide when to switch from costly coal and natural gas to wind power to generate electricity. Global Weather Corporation (GWC), an NCAR spinoff company, now markets the forecasting system along with several other forecast modeling technologies. GWC forecasts have a 99.9 percent accuracy.