

MAJOR MULTI-USER RESEARCH FACILITIES**\$1,185,120,000**
+\$109,070,000 / +10.1%**Major Multi-User Research Facilities Funding**

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Facilities	\$954.21	\$361.00	\$880.46	\$982.41	\$101.95	11.6%
Federally Funded R&D Centers	199.41	-	195.59	202.71	7.12	3.6%
Total, Major Multi-User Research Facilities	\$1,153.62	\$361.00	\$1,076.05	\$1,185.12	\$109.07	10.1%

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 the construction projects funded through NSF's MREFC account is provided in the MREFC chapter.

Major Multi-User Research Facilities

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted	
					Amount	Percent
Engineering						
National Nanotechnology Infrastructure Network (NNIN)	\$16.71	-	\$16.26	\$15.56	-\$0.70	-4.3%
Network for Earthquake Engineering Simulation	23.46	-	22.00	20.50	-1.50	-6.8%
Geosciences						
Academic Research Fleet	78.04	-	80.00	69.35	-10.65	-13.3%
EarthScope: USArray, SAFOD, PBO	25.25	-	25.05	26.00	0.95	3.8%
Incorporated Research Institutions for Seismology	12.36	-	12.36	12.36	-	-
Integrated Ocean Drilling Program	50.80	-	43.40	45.40	2.00	4.6%
Mathematical and Physical Sciences						
Cornell High Energy Synchrotron Source (CHESS) / Cornell Electron Storage Ring (CESR)	9.51	-	9.00	15.47	6.47	71.9%
Gemini Observatory	19.10	-	19.10	20.07	0.97	5.1%
Large Hadron Collider	18.00	-	18.00	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	28.50	-	28.50	30.40	1.90	6.7%
National Astronomy & Ionosphere Center ¹	10.75	-	10.60	8.70	-1.90	-17.9%
National High Magnetic Field Laboratory	40.53	15.00	35.56	33.30	-2.26	-6.4%
National Solar Observatory	9.10	-	9.10	9.79	0.69	7.6%
National Superconducting Cyclotron Laboratory	21.00	-	21.00	21.50	0.50	2.4%
Polar Programs						
Polar Facilities and Logistics ²	307.18	-	312.27	327.30	15.03	4.8%
Other						
MREFC Projects ³	220.55	146.00	163.54	292.21	128.67	78.7%
Other Facilities ⁴	6.93	200.00	7.02	3.90	-3.12	-44.4%
Pre-construction Planning ^{5,7}	56.44	-	47.70	12.60	-35.10	-73.6%
Federally Funded Research and Development Centers⁶						
Geosciences						
National Center for Atmospheric Research	96.29	-	97.00	100.00	3.00	3.1%
Mathematical and Physical Sciences						
National Optical Astronomy Observatories ⁷	35.40	-	31.50	29.17	-2.33	-7.4%
National Radio Astronomy Observatories ⁸	67.73	-	67.09	73.54	6.45	9.6%
Total	\$1,153.62	\$361.00	\$1,076.05	\$1,185.12	\$109.07	10.1%

Totals may not add due to rounding.

¹ NSF will decertify NAIC as an FFRDC upon award of the next cooperative agreement for its management and operation in FY 2011.

² Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM are included on the MREFC Projects line. In FY 2010, Polar Facilities and Logistics excludes a one-time appropriation transfer of \$54.0 million to U.S. Coast Guard per P.L. 111-117.

³ 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) construction implementation support provided through the MREFC account. Final MREFC support for SPSM is also included in this line.

⁴ Other Facilities includes support for other physics and materials research facilities, and Academic Research Infrastructure funded through ARRA.

⁵ Pre-construction planning includes funding for potential next-generation major multi-user facilities. Not included on this line is \$1.73 million in FY 2010 Actual pre-construction planning funds for the Large-Aperture Synoptic Survey Telescope included under NOAO.

⁶ Federally Funded R&D Centers does not include support for the Science and Technology Policy Institute, which is an FFRDC but not a research platform.

⁷ Funding for the National Optical Astronomy Observatories (NOAO) includes \$1.73 million in pre-construction planning funds for the Large-Aperture Synoptic Survey Telescope.

⁸ Funding for the National Radio Astronomy Observatories (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC projects line.

NSF's Facilities Investments in FY 2012:

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Academic Research Fleet

\$69,350,000
-\$10.65 / -13.3%

Academic Research Fleet

(Dollars in Millions)

	FY 2010	FY 2010	FY 2012	Change over	
	Actual	Enacted/ Annualized	Request	FY 2010 Enacted	
		FY 2011 CR		Amount	Percent
Academic Research Fleet	\$78.04	\$80.00	\$69.35	-\$10.65	-13.3%

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 an inter-agency fleet renewal status plan.

Total Obligations for the Academic Research Fleet

(Dollars in Millions)

	FY 2010	FY 2010	FY 2012	ESTIMATES¹				
	Actual	Enacted/ Annualized	Request	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
		FY 2011 CR						
Operations and Maintenance	\$78.04	\$73.00	\$67.35	\$70.00	\$72.50	\$75.00	\$78.00	\$81.00
Fleet Renewal:								
Human Occupied Vehicle		5.00	-					
Regional Class Research Vessel		2.00	2.00					
Total, Academic Research Fleet	\$78.04	\$80.00	\$69.35	\$70.00	\$72.50	\$75.00	\$78.00	\$81.00

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 oceans. Scientists contribute to advances in areas such as 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 National Oceanic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR) 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 state and federal agencies. Within NSF, science is supported via competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Division of Earth Sciences (EAR) and the Division of Atmospheric and Geospace Sciences (AGS), and also through the Office of Polar Programs (OPP) and the Directorate for Biological Sciences (BIO). Approximately 30 percent of the GEO 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 2012 is the result of the retirement of the *R/V OCEANUS*. The FY 2012 Request of \$67.23 million will support approximately 2,300 ship operating days.

Project 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. A Business Systems Review (BSR) was conducted in April 2010; none are scheduled for 2011 or 2012.
- **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. The most 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, as well as the October 2009 report by the National Research Council (NRC), *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet*. In coordination with the other federal agencies with ocean research investments and UNOLS, the Interagency Working Group for Facilities (IWG-F) published a *Federal Oceanographic Fleet Status Report* in December 2007 reviewing the status and describing plans for renewal of 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 Renewal

- Oversight: The NSF coordinator for fleet renewal 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 planning and development activities for potential new Regional Class Research Vessels. A panel of experts, in October 2009, conducted a technical evaluation of two alternative designs and made a recommendation to NSF using a rigorous down-select process. NSF worked with UNOLS in FY 2010 to identify areas in the ship design that will need additional inputs. In FY 2011, NSF is soliciting proposals using a phased approach beginning with the conceptual design phase of preconstruction development. Decisions on proceeding to further development stages will be based upon NSF, National Science Board, and interagency reviews. A major purpose of these reviews will be to integrate this potential investment with other needs across the government for research vessel support, including consideration of several acquisition models.
- Research Vessel *SIKULIAQ* (formerly known as the Alaska Region Research Vessel (ARRV)): This project represents NSF's first major contribution to fleet renewal in over twenty years. Construction of the *SIKULIAQ* was funded completely through the MREFC account and American Reinvestment and Recovery Act (ARRA) funds, and is described separately in the MREFC chapter. Shipyard construction will begin in CY 2011 and science operations are anticipated to begin in mid-calendar year 2014 at which time operational funding will be supported by OCE.

Other Ongoing Activities

- Development and construction of a deep submergence capability to replace the submersible human occupied vehicle (HOV) *ALVIN* continues in FY 2012. 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 WHOI team is supporting this effort.

The re-scoped *ALVIN* Upgrade Project would be accomplished in two phases. Phase I is integration of a new titanium 6,500 meter-capable personnel sphere with existing *ALVIN* vehicle components. Initial Phase I operations are anticipated in 2012 with 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 could follow in three to five years, pending availability of funds and science priority evaluations. 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.

Renewal/Recompetition/Termination:

Ships supported by NSF are operated by academic institutions, each having a cooperative agreement with NSF. These awards are reviewed using the NSB-approved criteria and awardees are subject to additional oversight measures, including Business System reviews conducted by NSF.

**Cornell High Energy Synchrotron Source
and Cornell Electron Storage Ring**

**\$15,470,000
+\$6,470,000 / 71.9%**

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring

(Dollars in Millions)

	FY 2010		Change over		
	Enacted/ FY 2010	Annualized FY 2011 CR	FY 2012 Request	FY 2010 Enacted Amount	Percent
	Actual	FY 2011 CR	Request	Amount	Percent
Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring ¹	\$9.51	\$9.00	\$15.47	\$6.47	71.9%

Totals may not add due to rounding.

¹ The combined reporting of CHESS and CESR began in FY 2009.

The Cornell High Energy Synchrotron Source (CHESS) is a 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 state-of-the-art 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. The mission of CHESS also includes X-ray technology development. Support and oversight of CHESS is provided through the NSF Division of Materials Research (DMR) within the Directorate for Mathematical and Physical Sciences (MPS).

The significant increase in FY 2012 reflects one-time action in FY 2010: Forwarding funding of some CHESS activities in late FY 2009 using dollars provided by the American Recovery and Reinvestment Act of 2009 (ARRA). The FY 2012 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. A separate award will support a program of X-ray technology development.

Total Obligations for CHESS/CESR

(Dollars in Millions)

	FY 2010		FY 2012 Request	ESTIMATES ¹				
	Enacted/ FY 2010	Annualized FY 2011 CR		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Actual	FY 2011 CR						
Operations and Maintenance	\$9.51	\$9.00	\$15.47	\$21.43	\$21.43	\$21.43	\$21.43	\$21.43

Totals may not add due to rounding.

¹ Outyear funding is shown through the end of the current cooperative agreement in March, 2014. Years beyond FY 2013 are shown for planning purposes only. NSF support for future light sources will be within the framework of a developing MPS/DMR strategic plan for instrumentation for materials research.

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. Accelerator research and development conducted at CHESS is helping to create the world's most advanced future storage rings and accelerators. For more information on coherent light sources, please see the narrative for the Division of Materials Research in the Directorate for Mathematical and Physical Sciences chapter.

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 Eastman Kodak, 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 partnerships 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 about 100 Ph.D. thesis projects result in more than 25 degrees granted. 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 many CHESS students and postdoctorates going to staff or lead other X-ray facilities in the U.S. and around the world.

Project 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 cooperative agreements 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:
 - Site visit review of CHESS operations, November 2010.
 - Business Systems Review by NSF Large Facilities Office, FY 2010 – FY 2011.
 - Next operations review, planned for fall 2011.

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 from April 2010 until March 2014.

EarthScope

\$26,000,000
+\$950,000 / 3.8%

EarthScope

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	FY 2010	Enacted/ Annualized		FY 2010	Enacted
	Actual	FY 2011 CR		Amount	Percent
EarthScope	\$25.25	\$25.05	\$26.00	\$0.95	3.8%

The EarthScope facility is a distributed, multi-purpose geophysical instrument array that is making 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 2010		FY 2012 Request	ESTIMATES¹				
	FY 2010	Enacted/ Annualized		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Actual	FY 2011 CR						
Operations & Maintenance	\$25.25	\$25.05	\$26.00	\$27.25	\$42.68	\$43.49	\$44.34	\$45.20

Totals may not add due to rounding.

¹ Outyear funding estimates are for planning purposes. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, there is a significant increase in EarthScope support beyond 2013.

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. SAFOD also includes a long-term observatory intended to continuously monitor the physical condition within an active earthquake nucleation zone. 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 \$6.50 million.

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, currently located at Oregon 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.

Current Project Status

The SAFOD observatory ceased operating in late 2008 and is currently undergoing examination by an independent panel of experts to understand how the instruments ceased operating and what appropriate restoration methods may be. The EarthScope seismic and geodetic instruments consistently exceed 90 percent uptime, and have provided over 67 terabytes of data for 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. At the 2010

American Geophysical Union (AGU) Fall Meeting, more than 35 papers presented results from studies of SAFOD core, including insights into the roles of different minerals and fault fluids in earthquake and faulting processes. 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 great Sumatra earthquake and tsunami of December 2004. 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.

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 science plan for EarthScope that was developed through an extensive community process and released in February 2010.

EarthScope has engaged a broad and steadily growing community of scientists. More than 120 unique investigators have received NSF funding through the EarthScope science program, including eleven early career scientists in just FY 2009 through FY 2010; at the same time, success rate has remained fairly steady at about 30 percent. About 300 scientists came together for the May 2009 EarthScope National Meeting in Boise, ID, and during the 2009 and 2010 AGU meetings, there were more than 50 special sessions relevant to EarthScope science, covering thirteen different areas of AGU, and including two Union sessions focused on EarthScope. 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. Budget estimates shown for FY 2014 and beyond reflect the combined EarthScope, IRIS and UNAVCO facility budgets.

Gemini Observatory

\$20,070,000
+\$970,000 / 5.1%

Gemini Observatory
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over		
	Enacted/			FY 2010	Enacted	
	FY 2010 Actual	Annualized FY 2011 CR			FY 2010 Amount	Percent
Gemini Observatory	\$19.10	\$19.10	\$20.07	\$0.97	5.1%	

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. They 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 2010		FY 2012 Request	ESTIMATES ¹				
	Enacted/			FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	FY 2010 Actual	Annualized FY 2011 CR						
Operations and Maintenance	\$19.10	\$19.10	\$20.07	\$20.07	\$20.07	\$20.07	\$20.07	\$20.07

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.

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.

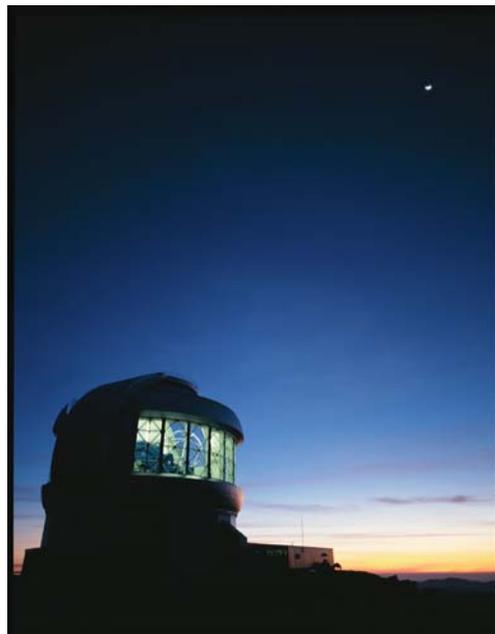
Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are available for both telescopes, with the laser on Gemini North in routine use. Late 2010 saw the installation and beginning of commissioning of an advanced "multi-conjugate" adaptive optics 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.

Budget projections for FY 2013 and beyond represent a level of effort adopted by the Gemini Board and NSF for planning purposes.

Facility Report

Management and Oversight

- **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. An independent visiting committee, established by the Gemini Board, advises on the operation of the Observatory and meets bi-annually. 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



The Gemini South telescope on Cerro Pachon in Chile prepares for the beginning of observation. The telescope is visible through the three-storey-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.*

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

The current International Gemini Agreement will expire at the end of calendar year 2012. The Gemini Board is developing the process and schedule for renegotiation of the agreement. At the November 2009 meeting of the Gemini Board, all partners with the exception of the United Kingdom expressed their intention to remain in the partnership in 2013 and beyond. In late December 2009, the United Kingdom officially announced its intention to withdraw from the partnership post-2012, guaranteeing that there will be changes in the partner shares and attendant budgetary impact in the years following 2012. The Board is now considering contingency plans proposed by the Observatory for reduced operations scope in response to a potential budget reduction of 20 percent. Negotiations for the international agreement and the Gemini management scheme may require a number of years to complete, thus requiring extensions of the current agreements.

The current NSF cooperative agreement covered calendar years 2006-2010. On the basis of the mid-term management review of AURA's performance as the Gemini managing organization in November 2008, the Gemini Board recommended not to compete the management of the Observatory when the current cooperative agreement expired. Furthermore, due to uncertainties in the international financial climate that make it difficult for some of the Gemini partners to commit to long-term funding, the current cooperative agreement has been extended through mid-calendar year 2012 in order to provide a stable operations and management environment throughout the negotiations with the Gemini partners on their future involvement in the partnership. A proposal from AURA for a new cooperative agreement covering the mid-2012-2015 timeframe is expected in January 2011, with review scheduled for March 2011. A key recommendation of the National Research Council-commissioned Astro2010 Decadal Survey suggests that the Gemini Observatory and National Optical Astronomy Observatories (NOAO), which operates smaller aperture telescopes in both hemispheres and is also managed by AURA, be considered for some type of consolidation under a single operational structure, for the purposes of cost-effectiveness and better response to scientific needs. That recommendation is being actively explored.

Incorporated Research Institutions for Seismology

\$12,360,000
+\$0.00 / 0.0%

Incorporated Research Institutions for Seismology

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	Enacted/	Annualized		FY 2010	Enacted
	FY 2010 Actual	FY 2011 CR		Amount	Percent
Incorporated Research Institutes for Seismology	\$12.36	\$12.36	\$12.36	-	-

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 2010		FY 2012 Request	ESTIMATES ¹				
	Enacted/	Annualized		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	FY 2010 Actual	FY 2011 CR						
Operations and Maintenance	\$12.36	\$12.36	\$12.36	\$12.36	-	-	-	-

¹Outyear 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 in four major core program elements:

- The Global Seismographic Network (GSN), which currently 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), which manages a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies;
- The IRIS Data Management System (DMS), which provides the national and international seismic research community with timely access to data from the GSN and PASSCAL (130 terabyte archive);
- The IRIS Education and Outreach (E&O) Program, which 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.

In addition, IRIS operates the USArray component of EarthScope. The 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.

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), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

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.



Polar engineer Guy Tytgat installing a seismographic station in Antarctica's Gamburtsev Province. *Credit: IRIS.*

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.

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 (four standing committees for each of the four IRIS programs 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.

Renewal/Recompetition/Termination

A five-year cooperative agreement with the IRIS Consortium for the continued management of the IRIS core facilities (2006-2011) was approved by the NSB in May 2006 and finalized in September 2006. A proposal from IRIS for a 27-month renewal of support was submitted in August 2010; if awarded, this would synchronize the IRIS award with the complementary EarthScope activity. 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**

**\$45,400,000
+\$2,000,000 / 4.6%**

The Integrated Ocean Drilling Program

(Dollars in Millions)

	FY 2010 Enacted/ FY 2010 Actual	FY 2010 Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Integrated Ocean Drilling Program	\$50.80	\$43.40	\$45.40	\$2.00	4.6%

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 24 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 2010 Enacted/ FY 2010 Actual	FY 2010 Annualized FY 2011 CR	FY 2012 Request	ESTIMATES¹				
				FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	\$50.80	\$43.40	\$45.40	\$46.40	\$46.40	\$46.40	\$46.40	\$46.40

Totals may not add due to rounding.

¹ Outyear funding estimates are for planning purposes only. Funding for FY 2014, FY 2015, FY 2016, and FY 2017 is estimated assuming renewal of the program.

Annual operations and maintenance support for IODP includes the costs of operating the platform itself and is based on NSF experience in management of the ODP and the contract with the SODV operator. 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.

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 help become future leaders themselves. 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 2,300 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including approximately 1,050 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 Scientific Ocean Drilling Vessel 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.

Facility Report

Management and Oversight

- **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. SIC, 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). The SAS consists of a Science Advisory Structure Executive Committee (SASEC) and a series of committees, panels, and groups headed by the Science Planning Committee (SPC). The CMO is responsible for coordinating the SAS committees, panels, and groups; and for integrating the advice from the SAS into drilling and operational guidance for IODP. Representation in the SAS is proportional to IODP member's financial contribution.

- **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 http://www.iodp-usio.org/Publications/IODP_OA_2010.pdf and <http://www.iodp.org/triennium-review/>. 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, are expected to commence in FY 2011. 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. 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 nine 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, in Spring, 2010 the ship completed a pole-to-pole investigation of Earth's past climate history. It was discovered that in the Pliocene Epoch (the last warm period before the Pleistocene "Ice Ages"), the Bering Sea was ice-free year-round and at least 5 degrees C warmer than it is presently, where sea ice is absent only during summer months. Additionally, a 10,000 year-long marine climate record of unprecedented annual resolution was cored offshore of Wilkesland, Antarctica, showing apparent seasonal variations within each 1cm-thick annual deposition. This sediment core allows precise study of Antarctic climate since the last Ice Age glaciation, tying in the marine sedimentary record to the annual climate record shown in Antarctic ice cores.

Large Hadron Collider

\$18,000,000
+\$0.00 / 0.0%

Large Hadron Collider
(Dollars in Millions)

	FY 2010			Change over	
	FY 2010	Enacted/ Annualized	FY 2012	FY 2010	Enacted
	Actual	FY 2011 CR	Request	Amount	Percent
Large Hadron Collider	\$18.00	\$18.00	\$18.00	\$0.00	0.0%

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=10¹² 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. To be prudent, it was decided that the beam energy would be slowly increased in stages. Since the accelerator and the detectors performed very well in the 2010 run, the decision has been made that the run will be extended through 2012 before a shut-down for planned accelerator upgrade work is implemented.

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 will 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 43 international funding agencies participate in the ATLAS detector project and 41 in the CMS detector project. NSF and the Department of Energy (DOE) are providing U.S. support. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors are expected to 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 is enabling 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 2010			ESTIMATES¹				
	FY 2010	Enacted/ Annualized	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Actual	FY 2011 CR	Request					
Operations and Maintenance	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00	\$18.00

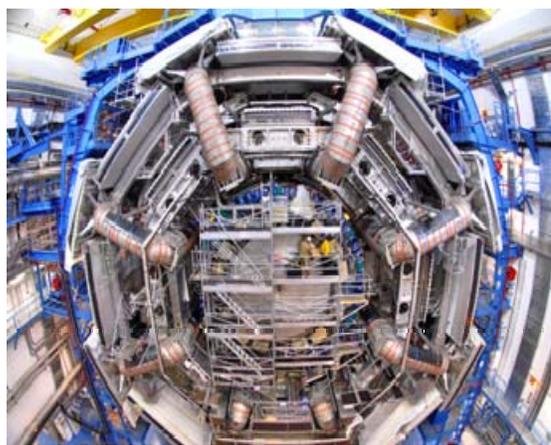
¹ The current cooperative agreement ends in FY 2011. FY 2012 funding is the subject of current negotiations. Outyear funding estimates are for planning purposes only.

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 four known forces 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 2012 the estimate for material procurements is approximately \$5.0 million, which is included within the \$18.0 million operating costs.

Because of the delay in the start-up schedule of the accelerator due to failure in September 2008 of a high current line that caused arcing and destructive failure of a liquid helium cryogenic system, the U.S. LHC collaboration did extensive commissioning of the detectors and the data analysis systems using cosmic rays while the accelerator was being repaired. As a result, with the advent of colliding beams in the Spring of 2010, the detectors began immediately taking data at very near design performance levels, which was unprecedented for the start-up of such complex instruments. Since then, the collaborations have been actively engaged in keeping the detectors operating smoothly and adapting quickly to the significant increases in beam intensities, which will be an ongoing challenge.



The ATLAS detector in February 2007. Credit: CERN.

Facility Report

Management and Oversight

- **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 2011. 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. As the present award ends at the close of calendar year 2011, a new cooperative agreement will be negotiated with the ATLAS and CMS collaborations to extend funding for an additional five years to support their role in the international collaboration of which they are members. This process comes at a critical time due to the fact that the detectors are only just beginning to collect data. All participating scientists want to maximize use of the first phase of the machine operation, which has been extended to compensate for the downtime induced by a mechanical accident shortly after start-up. Therefore, NSF will review proposals from the U.S. ATLAS and U.S. CMS collaborations for an additional five years of funding to cover this critical period.

Laser Interferometer Gravitational-Wave Observatory

\$30,400,000
+\$190,000 / 6.7%

Laser Interferometer Gravitational-Wave Observatory

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	Enacted/			FY 2010	Enacted
	FY 2010	Annualized			
	Actual	FY 2011 CR		Amount	Percent
Laser Interferometer Gravitational-Wave Obs.	\$28.50	\$28.50	\$30.40	\$1.90	6.7%

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 both fundamental physics and astrophysics. 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 test masses 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 in the apparent 4-km length is only on the order of 4×10^{-18} , 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.

In April 2008 construction began on the Advanced LIGO 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 2010		FY 2012 Request	ESTIMATES ¹				
	Enacted/			FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	FY 2010	Annualized						
	Actual	FY 2011 CR						
Operations and Maintenance	\$28.50	\$28.50	\$30.40	\$30.50	\$30.50	\$30.50	\$30.50	\$30.50

¹ Outyear funding estimates are for planning purposes only.

LIGO has been a significant source of highly trained Ph.D. graduates for the country’s workforce. The number of graduate students has grown from the beginning of LIGO’s science runs in FY 2002 and will continue to do so. In addition, active outreach programs have been developed at both the Hanford and

Livingston sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include

participation in the Research Experiences for Teachers (RET) program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/REU) programs for college students. Both sites have developed web-based resources for teachers that include information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. The LIGO Science Education Center at the Livingston site contains many exhibits from the Exploratorium@ Museum of Science in San Francisco and 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. In FY 2010, each site has made more than 10,000 on- or off-site outreach contacts. The LIGO Scientific Collaboration has developed a traveling exhibit, which has appeared at the New York City World Science Festival, the Science and Engineering Expo in Washington, DC, and at several science centers across the country.



An aerial view of the Hanford, WA observatory. *Credit: LIGO Laboratory.*

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in LIGO projects with some 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), new ultra-fine optics polishing techniques, and optical inspection equipment (new product).

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 61 collaborating institutions in 13 countries with more than 830 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



A view of the high-vacuum vertex chambers at the Livingston, LA site (bottom). *Credit: LIGO Laboratory.*

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 mission-defining scientific run (S5), in which a year's accumulation of data was taken at its design sensitivity with all three interferometers operating in coincidence, in October 2007. These data were taken at a detector sensitivity in excess of the defined goal sensitivity outlined in the design specifications. The S6 science run, which, in addition to the acquisition of science data, also tested technologies that will become part of AdvLIGO, began in July 2009 and ended in October 2010. The detector sensitivity was higher than that during the previous S5 run, making the S6 science run a valuable testbed for AdvLIGO.

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 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 LIGO Scientific Collaboration (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 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, October 2011

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 Astronomy and Ionosphere Center

\$8,700,000
-\$1,900,000/ -17.9%

National Astronomy and Ionosphere Center

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	Enacted/			FY 2010 Enacted	
	FY 2010 Actual	Annualized FY 2011 CR		FY 2010 Amount	Percent
National Astronomy and Ionosphere Center	\$10.75	\$10.60	\$8.70	-\$1.90	-17.9%

The National Astronomy and Ionosphere Center (NAIC) is a national center for multidisciplinary research and education, as enabled by the world-class observational facilities of the Arecibo Observatory. The center’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. Currently operated and managed by Cornell University under a cooperative agreement with NSF, NAIC 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, NAIC 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 are 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 NAIC

(Dollars in Millions)

	FY 2010		FY 2012 Request	ESTIMATES ¹				
	Enacted/			FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	FY 2010 Actual	Annualized FY 2011 CR						
Operations and Maintenance	\$10.75	\$10.60	\$8.70	\$8.30	\$8.00	\$8.00	\$8.00	\$8.00
<i>Astronomical Sciences (MPS)</i>	8.40	8.40	5.50	5.00	4.50	4.00	4.00	4.00
<i>Atmospheric & Geospace Sciences (GEO)</i>	2.35	2.20	3.20	3.30	3.50	4.00	4.00	4.00
Total, NAIC	\$10.75	\$10.60	\$8.70	\$8.30	\$8.00	\$8.00	\$8.00	\$8.00

Totals may not add due to rounding.

¹ Outyear funding estimates are for planning purposes only.

NAIC 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 NAIC to \$8 million (FY 2006 dollars) by 2010. In response, the managing organization reduced the NAIC 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 NAIC in FY 2008–2010 reflected a planned ramp down in response to the Senior Review recommendations. The AST Senior Review also recommended that sufficient external financial or personnel contributions be found to operate NAIC 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 Senior Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of NAIC's non-scientific costs.

As AST has ramped down support for NAIC, 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 AGS support of NAIC ramp up to parity with AST support by FY 2015.

Partnerships and Other Funding Sources: NAIC leverages NSF support with funding from other federal and non-federal sources. In FY 2010, the NASA Near Earth Object Observation Program committed \$2.0 million to NAIC in support of the Arecibo planetary radar program. NASA support is expected to continue at this level, subject to availability of appropriated funds. In FY 2010, Cornell 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 Cornell 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 also include \$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 but no financial support. 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 NAIC.

Education and Public Outreach: A primary education goal for NAIC 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, NAIC holds a summer school on single-dish radio astronomy techniques. NAIC 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, NAIC 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, \$8.70 million: NAIC 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, \$5.50 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 2012, in response to recommendations of the AST Senior Review. Operational scope changes are anticipated in response to decreased AST funding, pending merit review of proposals received in response to an open competition for the next five-year award for NAIC management and operations. Beginning in program year 2011, support for planetary radar astronomy will shift to 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 allows 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 2011.

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 Cornell, as well as attending Cornell 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.

- **External Structure:** Management is via a cooperative agreement with Cornell University. Cornell provides management and oversight through its own advisory and visiting committees. The NAIC Director is resident at Cornell and reports to the Vice Provost for Research in Physical Sciences and Engineering. The Arecibo Observatory Site Director reports to the NAIC Director.
- **Reviews:** Management reviews by external review 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. NAIC underwent an NSF Business Systems Review in FY 2005. AST and AGS jointly conduct annual external reviews of NAIC 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 NAIC management and operations (see below).

Renewal/Competition/Termination

The current cooperative agreement with Cornell for the management of NAIC is in effect through September 30, 2011. Consistent with National Science Board policy, NSF has solicited proposals through a competitive process for a new, five-year cooperative agreement for NAIC management and operations. The program solicitation (NSF 10-562) was published in April 2010 with a proposal submission deadline of October 1, 2010. Proposals are currently under review. Following recommendation and negotiation of an award and, if applicable, an appropriate transition plan, the new cooperative agreement is planned for award in early FY 2012.

The program solicitation for the management and operation of NAIC provided five-year budget guidance at a level significantly reduced relative to current operations, as reflected in out-year estimates for NSF support. To sustain NAIC as a competitive scientific and educational facility that is responsive to its stakeholders in the scientific community and in the Commonwealth of Puerto Rico, proposing organizations were encouraged to consider novel models of operations and governance, revisions to programmatic scope, and/or sources of additional funding. Within available resources and as consistent with the expectations and criteria identified in the program solicitation, the successful proposal is expected to present a compelling, sustainable vision for NAIC that supports an optimal suite of user-driven research and education activities through effective structures for management and operations.

In FY 2010, NASA established support of \$2.0 million to NAIC expressly for planetary radar capabilities and in support of the agency's Congressional mandate to identify potentially hazardous near-earth objects. NASA has communicated the intent to continue this level of support, increased at inflation rates and subject to availability of appropriated funds, and that any institution awarded the cooperative agreement for NAIC management and operations may propose to NASA for this planetary radar supplement under the Near Earth Object Observation Program. In association with the next cooperative agreement for NAIC management and operation, NSF will negotiate a memorandum of understanding with NASA to establish appropriate oversight procedures for multi-agency support of NAIC.

NSF will decertify NAIC as a Federally Funded Research and Development Center (FFRDC) upon award of the next cooperative agreement for its management and operation. The decision to remove NAIC from the list of FFRDCs was made after careful consideration of the advantages and disadvantages this

designation carries with it. Without restrictions imposed by the FFRDC designation, the NAIC managing organization will have greater freedom to establish partnerships beyond those permitted by government regulations applicable to FFRDCs.

National High Magnetic Field Laboratory

\$33, 300,000
-\$2, 260,000 / -6.4%

National High Magnetic Field Laboratory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted	
					Amount	Percent
National High Magnetic Field Lab	\$40.53	\$15.00	\$35.56	\$33.30	-\$2.26	-6.4%

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 physics, biology, bioengineering, chemistry, geochemistry, biochemistry, materials science, medicine, and engineering. It is the world’s premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems. The principal scientific goals of NHMFL are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process.

In addition, the lab is an internationally recognized leader in magnet design, development, and construction. Many of the unique magnet systems were designed, developed, and built by the Magnet Science and Technology (MS&T) Division of NHMFL. MS&T has broad responsibility to develop high field magnets as well as conducting and superconducting materials for future generation magnet components in response to national needs. 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 2012 Request will allow the facility to continue operations, focus on magnet development, and strengthen education, training, user support, and in-house research.

Total Obligations for NHMFL

(Dollars in Millions)

	FY 2010		FY 2012 Request	ESTIMATES ²				
	FY 2010 ¹ Actual	Annualized FY 2011 CR ¹		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Enacted/							
Operations and Maintenance	\$40.53	\$35.56	\$33.30	\$33.30	\$33.30	\$33.30	\$33.30	\$33.30
ARRA ³	15.00	15.00	-	-	-	-	-	-
Total, NHMFL	\$55.53	\$50.56	\$33.30	\$33.30	\$33.30	\$33.30	\$33.30	\$33.30

Totals may not add due to rounding.

¹ FY 2010 funding reflects one-time support for the design and development of the 21 Tesla magnet.

² Outyear funding estimates are for planning purposes only.

³ \$15.0 million in ARRA funding was carried over from FY 2009 and obligated in FY 2010.

Current magnet development at NHMFL focuses on new energy-saving, high-field magnet technologies, including the design 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, 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. Its annual K-12 outreach engages more than 9,000 students from Florida and Georgia in hands-on activities in their classrooms and tours of the lab. In addition, NHMFL conducts a College Outreach-Workforce Initiative program to increase diversity in lab programs. This has included outreach to approximately 200 undergraduates at historically-black colleges and universities. Summer researchers include 13 high school teachers, 21 undergraduates, and 7 high school and 14 middle school students. Thirty-two middle school girls attend the SciGirls summer camp per year. The annual one-day open house features 80 science demonstrations and hosts more than 5600 visitors, aged 3 to 83.

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). 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 NSF Directorates for Engineering and 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:
 - Annual Review by external panel of site visitors, November 2010.
 - National Research Council study on the future of high field magnetic science, to be started in FY 2011.

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 proposal will be reviewed in summer 2011 for a potential renewal beginning in FY 2013. In FY 2011, NSF will seek 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

\$15,560,000
-\$700,000 / -4.3%

National Nanotechnology Infrastructure Network

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over FY 2010 Enacted		
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2012 Request	FY 2010 Enacted Amount	Percent
	National Nanotechnology Infrastructure Network	\$16.71		\$16.26	\$15.56	-\$0.70

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 capabilities 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 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Operations and Maintenance	\$16.71		\$16.26	\$15.56	\$17.10	\$17.10	\$17.10

¹ Outyear funding estimates are for planning purposes only. The current award receives final funding in FY 2013.

NNIN's broad-based national user facilities enable the Nation's researchers from academia, small and large industry, and government to pursue transformative research, to seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and to 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.

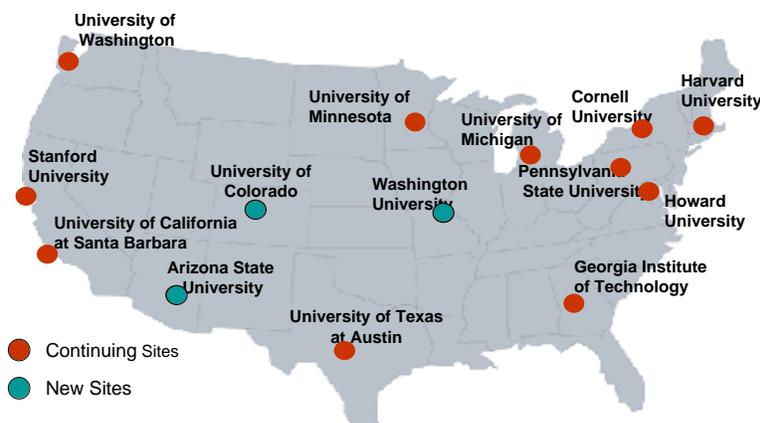
NNIN undertakes, on a national scale, a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis is placed on education and training of a diverse science and engineering 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: 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 geosciences community and the nanotechnology sensor community.

In its seventh year of operation for the 10 month period encompassing March 2010 through December 2010, NNIN served 5,352 unique users (an increase of 10 percent over the previous year 10 month period) who performed a significant part of their experimental work at NNIN facilities. Of these, 4,446 were academic users, most of whom were graduate students, 818 industrial users (653 from small companies), 57 from U.S., state, and federal laboratories, and 31 from foreign institutions. Nearly 2,500 publications, several of them the 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 United States, where there is a continuous and significant turnover. During the 10 month period, 1,883 new (first time) users were trained across the network's vast instrument set. The results of NNIN enabled research are presented in over 3,100 attributed publications in high quality journals and at conferences worldwide. 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.



Facility Report

Management and oversight

- NSF structure: NSF provides oversight of the 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 network director, is from the lead institution, Cornell University, and provides intellectual leadership for the network, is 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 Stanford University 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.
 - Upcoming reviews: The seventh annual review will be held at the University of Colorado in Boulder in May 2011.

NNIN was awarded \$10 million in ARRA funds in FY 2009 to acquire advanced nanofabrication and characterization instrumentation and tools at each of its network sites to enable users to accomplish state-of-the-art research projects. Availability of these funds helped address challenges the network has faced in maintaining its capital equipment base through acquisition of new instrumentation and replacement of old or high-demand equipment.

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. In FY 2011, the third year of this final award period, NSF plans to convene a panel of recognized national experts to evaluate the needs of, and appropriate future investments in, the national infrastructure for nanotechnology.

National Solar Observatory

\$9,790,000
+\$690,000 / 7.6%

National Solar Observatory

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	FY 2010	Enacted/ Annualized		FY 2010	FY 2010
	Actual	FY 2011 CR		Amount	Percent
National Solar Observatory	\$9.10	\$9.10	\$9.79	\$0.69	7.6%

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 2010, 68 unique observing programs from 12 U.S. and 13 foreign institutions were carried out using NSO facilities. Thirty three per cent of these programs were carried out by students, and they included 11 Ph.D. thesis programs. Nearly six terabytes of NSO synoptic data were downloaded from the NSO digital archives.

Total Obligations for NSO

(Dollars in Millions)

	FY 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010	Enacted/ Annualized		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Actual	FY 2011 CR						
NSO-Operations	\$7.25	\$7.25	\$7.81	\$8.02	\$8.26	\$7.80	\$5.74	\$2.69
NSO-Development	1.50	1.50	1.61	1.67	1.72	1.75	1.80	0.84
NSO-Research & Education	0.35	0.35	0.37	0.40	0.41	0.45	0.46	0.47
Total, NSO	\$9.10	\$9.10	\$9.79	\$10.09	\$10.39	\$10.00	\$8.00	\$4.00

Totals may not add due to rounding.

¹ Outyear funding estimates are for planning purposes only.

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 subawards 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, \$7.81 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. The ATST will replace several of the NSO telescopes at SPO and on Kitt Peak. These will be divested or removed as ATST approaches full operation. The reductions in operations costs in the 2015-2017 timeframe reflect the savings from the decommissioning of these redundant facilities. Increasing support through FY 2012 is intended to offset the impact of reduced FY 2009 funding, including deferred merit pay.

NSO-Development, \$1.61 million: NSO reporting now includes only work apart from ATST, notably for the SOLIS telescope. Small increases in FY 2012 and beyond will help maintain the scientific productivity of existing facilities as ATST enters construction and moves toward operations.

NSO-Research & Education, \$370,000: 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, \$0.00 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 expected to begin in FY 2011. This support 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

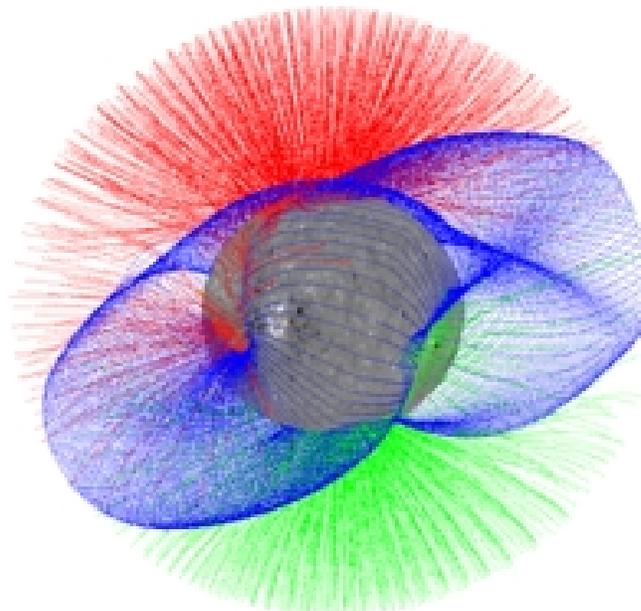
- **NSF Structure**: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program director makes use of detailed annual program plans, annual long-range plans, quarterly technical and 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 which led to the award of a new cooperative agreement at the beginning of FY 2010. The last review of major NSO activities was conducted during the final design review of the ATST project in May 2009. Annual reviews are anticipated for both NSO program plans and the ATST project, beginning in spring 2011.

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 will begin operation in 2018, it is anticipated that the current cooperative agreement will be renewed without competition upon its expiration in 2014.



The magnetic field in the corona of the sun derived from GONG data. Magnetic field lines that are closed on the Sun are shown in blue, those that are open to interplanetary space are shown in red (negative inward pointing field polarity) and green (positive polarity). *Credit: NSO/AURA.*

National Superconducting Cyclotron Laboratory

\$21,500,000
+\$500,000 / 2.4%

National Superconducting Cyclotron Laboratory

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	FY 2010 Actual	Enacted/ Annualized		FY 2010 Enacted	Percent
		FY 2011 CR			
National Superconducting Cyclotron Laboratory	\$21.00	\$21.00	\$21.50	\$0.50	2.4%

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 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010 Actual	Enacted/ Annualized		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
		FY 2011 CR						
Operations and Maintenance	\$21.00	\$21.00	\$21.50	\$21.50	\$21.50	\$21.50	\$21.50	-

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.

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.

NSCL occasionally enters into license agreements for cyclotron technology or nuclear electronics. An agreement with Accel Corporation exists for compact cyclotrons based on superconducting technology. 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 – many per year, with most running one to three days. The FY 2012 funding level is the first of an overall five-year plan developed in response to recommendations from an external operations review committee in 2011. The committee recommended providing support such that NSCL runs at close to optimal operation, which includes new capabilities that have been provided by MSU, with “optimal” defined as the maximum amount of added beam time per extra dollar spent.

Facility Report

Management and Oversight

- **NSF Structure:** MSU operates NSCL under a cooperative agreement with NSF. The lab 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 the laboratory 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:**
 - **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 February 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 allows a new 5-year renewal of the present Cooperative Agreement, which expires at the close of FY 2011. New funding will permit NSCL to continue to operate as a user facility up to and through the initial phases of FRIB construction activities and will facilitate the transfer of operations to DOE when construction is complete. The FRIB cooperative agreement between DOE and MSU was signed in 2009 and start of FRIB operations is expected to occur in 2019. To facilitate NSCL termination and interagency planning, and to allow for a



An NSCL research associate adjusts a cabling on a detector. *Credit: NSCL.*

smooth transition from NSF-funded NSCL user operations to DOE-funded FRIB user operations, a Joint Oversight Group (JOG) of DOE and NSF personnel has been formed and has begun to meet regularly.

Network for Earthquake Engineering Simulation

\$20,500,000
-\$1,500,000 / -6.8%

Network for Earthquake Engineering Simulation

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Network for Earthquake Engineering Simulation	\$23.46	\$22.00	\$20.50	-\$1.50	-6.8%

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 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES¹				
				FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	\$23.46	\$22.00	\$20.50	\$23.00	\$23.00	\$23.00	\$23.00	\$23.00

¹ Outyear funding estimates are for planning purposes only. The current award receives final funding in FY 2014.

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), 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 September 2010 to develop research topics and experiments for continuing 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.

As an outreach and education component of a NEES research (NEESR) project, Researcher and Project Investigator Dan Cox, Oregon State University, helped the Museum of Science and Industry, Chicago develop content for “Science Storms”, which includes this 30-foot tsunami wave tank exhibit and a large-scale video presentation that relates the basic concepts demonstrated in the wave tank to the research that is being conducted to make coastlines safer. *Courtesy of J.B. Spector, Museum of Science and Industry, Chicago, IL*

As a part of the NEES education and outreach program, the NEES tsunami facility at Oregon State University developed the 30-Foot Science Storms Tsunami Wave Tank exhibit at the Museum of Science and Industry in Chicago, Illinois.

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 \$12.0 million in FY 2012, a reduction of \$500,000 from the FY 2010 Enacted level. 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 2012 will be reduced by \$1.50 million to a total of \$20.50 million in line with an overall reduction in core research supported at the network sites.

Facility Report

Management and Oversight

- 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, and to 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: FY 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://128.150.4.107/pubs/2010/nsf10071/nsf10071.jsp>). These two

studies are to be completed in FY 2012 and will form the basis for determination by NSF for support for future earthquake engineering research infrastructure beyond 2014.

Polar Facilities And Logistics **\$327,030,000**
and the South Pole Station Modernization Project **\$15,030,000 / 4.8%**

Polar Facilities and Logistics
(Dollars in Millions)

	FY 2010 Actual	FY 2010 ARRA Actual	FY 2010	FY 2012 Request	Change over	
			Enacted/ Annualized FY 2011 CR Estimate		FY 2010 Enacted Amount	Percent
Polar Facilities ¹	\$195.16	-	\$199.24	\$213.03	\$13.79	6.9%
Transfer to U.S. Coast Guard per P.L. 111-117	[54.00]	-	-	-	-	N/A
Polar Logistics	112.02	-	113.03	114.27	1.24	1.1%
Total, Polar Facilities and Logistics	\$307.18	-	\$312.27	\$327.30	\$15.03	4.8%

Totals may not add due to rounding.

¹Funding for Polar Facilities for FY 2010 excludes a one-time appropriation transfer to U.S. Coast Guard per P.L.111-117.

Polar Facilities

The Office of Polar Programs (OPP) within NSF provides the infrastructure needed to support U.S. research conducted in Antarctica, including that 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. Examples of support to other agencies include mission essential satellite communications support at McMurdo Station for the National Polar-Orbiting Operational and Environmental Satellite System (NPOESS) and NASA's Ground Networks for the relay of data. In addition, OPP enables important climate monitoring activities for NOAA at the Clean Air Facility at South Pole Station, one of only five such sites around the globe, and OPP provides support for NASA's Long Duration Balloon program that enables research in fields ranging from astrophysics to cosmic radiation to solar astronomy.

All life support 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 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010 Actual	Enacted/ Annualized FY 2011 CR		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Antarctic Infrastructure & Logistics	\$195.16	\$199.24	\$213.03	\$213.03	\$213.03	\$213.03	\$213.03	\$213.03
<i>South Pole Station Modernization Project</i>	<i>15.93</i>	<i>16.15</i>	<i>16.33</i>	<i>16.33</i>	<i>16.33</i>	<i>16.33</i>	<i>16.33</i>	<i>16.33</i>
U.S. Coast Guard Icebreaker Support	-	54.00	-	-	-	-	-	-
Total, Polar Facilities	\$195.16	\$199.24	\$213.03	\$213.03	\$213.03	\$213.03	\$213.03	\$213.03

Totals may not add due to rounding.

¹ Outyear funding estimates are for planning purposes only.

NOTE: Funding for the South Pole Station Modernization (SPSM) Project in this table is for the operation of the South Pole Station and is included in the amounts shown for Antarctic Infrastructure and Logistics. FY 2010 funding for U.S. Coast Guard Icebreaker Support excludes a one-time appropriation transfer of \$54.0 million to USCG per P.L. 111-117.

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 competitively awarded contracts. Other agencies and contractors provide technical support in areas of expertise such as engineering, construction, and communications.

Facility 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: The current Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. There are many separate subcontractors for supplies and technical services.
- Reviews: OPP evaluates the performance of RPSC every year via a Performance Evaluation Committee and an Award Fee Board that includes 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) are currently operating normally.

Evolution

- 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.

Recompetition

- NSF is currently engaged in an effort to recompetete the Antarctic support contract. The most recent Antarctic support contract was recompeteted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. After a five-month phase-in period, RPSC assumed responsibility for operations in March 2000. The contract's ten-year performance period is segregated into a five-year initial period and a five-year option period. NSF exercised its option to extend the performance period through March 31, 2010, and extended the contract through March 2011. NSF is in the process of extending the contract for a second year, through March 2012. An award for the new support contract is expected to be made in Fall 2011.

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 2010	FY 2010	FY 2012	ESTIMATES ¹				
	Enacted/	Annualized	Request	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Actual	FY 2011						
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	44.50	45.51	46.75	46.75	46.75	46.75	46.75	46.75
Total, Polar Logistics	\$112.02	\$113.03	\$114.27	\$114.27	\$114.27	\$114.27	\$114.27	\$114.27

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 provided by the U.S. Department of Defense (DoD). The 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.

Facility 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 awarded to CH2M Hill (previously, VECO USA) in January 2005. There are many separate subcontractors for supplies and technical services.
- Reviews: 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 is currently engaged in an effort to recompeted the Arctic support contract. The most recent Arctic support contract was recompeted and awarded to CH2M Hill in January 2005. The contract has an initial term of four years and the possibility of three one-year extensions exercised on the basis of performance. All options have been exercised for this contract. An award for the new support contract is expected to be made in October 2011, with the phase-out completed in May 2012.

South Pole Station Modernization (SPSM)

The SPSM project was funded through NSF’s Major Research Equipment and Facilities Construction (MREFC) account, and supported procurement, construction, and commissioning. SPSM provides a new station to replace 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 will provide 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. Construction continues through the 2010/2011 operating season.

The prime contractor for the U.S. Antarctic Program is responsible for constructing the South Pole Station. In addition, there are many separate subcontractors for supplies and technical services.

NSF also supports education associated with the research projects at the South Pole. Along with direct operations and maintenance support for South Pole Station, NSF supports science and engineering research through ongoing programs. The annual support for such activities is currently estimated to be approximately \$9.50 million.

Total Obligations for SPSM
(Dollars in Millions)

	FY 2010 Enacted/ Prior FY 2010 Years	FY 2010 Actual	FY 2011 Annualized FY 2011 CR	FY 2012 Request	ESTIMATES ¹					
					FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	
<i>R&RA Obligations</i>										
Concept & Development	\$16.40									
Management & Operations		15.93	16.15	16.33	16.33	16.33	16.33	16.33	16.33	16.33
Subtotal, R&RA Obligations	16.40	15.93	16.15	16.33	16.33	16.33	16.33	16.33	16.33	16.33
<i>MREFC Obligations</i>										
Implementation	148.09	1.03	0.17	-						
Subtotal, MREFC Obligations	148.09	1.03	0.17	-	-	-	-	-	-	-
Total, SPSM Obligations	\$164.49	\$16.96	\$16.32	\$16.33	\$16.33	\$16.33	\$16.33	\$16.33	\$16.33	\$16.33

Totals may not add due to rounding.

¹ A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized levels provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is \$16.15 million; \$0.0 million for MREFC, and \$16.15 million for R&RA. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

² Outyear funding estimates are for planning purposes only.

NOTE: Funding for the operation of South Pole Station is provided through Antarctic Infrastructure and Logistics.

Project Report

Management and Oversight

- NSF Structure: OPP has overall responsibility for SPSM, including development of the basic requirements, design, procurement, and construction. The project status, including cost expenditures and cost projections, is monitored closely by the OPP Facilities Engineer and other OPP staff, and on a periodic basis by the project's Project Advisory Team, a group of experts drawn from all relevant NSF directorates and offices.
- External Structure: NSF contracted for procurement and construction management for all phases of the project, including design reviews of all drawings and specifications; conformance of the designs and procurements with established standardization criteria; assistance in establishing functional interfaces; transition from the existing to the new facilities; and systems integration. Naval Facilities Engineering Command, Pacific Division (PACDIV) selects, monitors, and manages architectural and engineering firms for design, construction inspection for the project, and post-construction services.
- Reviews: Design, development, planning, and closely related activities in support of this project included preparation of more than 40 engineering studies and reports. The documents ranged widely in subject matter including subjects such as snowdrift minimization modeling, detailed analysis of power and heating requirements, preparation of a draft Environmental Impact Statement, energy conservation measures, efficiency and maintainability of diesel generators, fuel storage support system evaluation, design code criteria matrix, concept for signal/communication systems, gray-water system evaluation, minimization of ventilation requirements, control of diesel engine exhaust emissions, and jacking plan and concept.



The newly completed South Pole Station, January 2010. Credit: Vladimir Papitashvili, NSF

The OPP Facilities Engineer, other OPP and NSF staff, and subject matter experts attend quarterly reviews at the contractor's facility for the purpose of reviewing all aspects of the project including cost, schedule, and plans. In September 2006, an external panel of experts reviewed the scope, cost, schedule, and effectiveness of management processes to complete the final 10 percent of the project. As a result, the project's baseline was increased to \$149.29 million. A subsequent review of the cost and schedule for the final year of the project was completed early in FY 2010; this review confirmed the project would complete on schedule and on budget.

Current Project Status

- The project is on schedule to complete all tasking by the end of the 2010/2011 operating season.

Cost and Schedule

- SPSM scope is approximately 99.9 percent complete and within budget. All science facilities are in full use.

Risks

Project performance could be affected by equipment failure, damaged materials, unforeseen downtime from power failures, inclement weather, and widespread illness – all of which have occurred to varying degrees. Risk management is ongoing and has produced multiple sets of back-up strategies to employ in the face of identified concerns.

Future Operations Costs

Operational costs of the modernized station are expected to be higher than those of the previous station due to increased station size and increases in science support and information systems. The FY 2012 level (\$16.0 million) for operational costs of the modernized station is anticipated to represent the steady state for future years (before inflation). The expected lifetime of the modernized station is 25 years, through FY 2031.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

National Center For Atmospheric Research

\$100,000,000
\$3,000,000 / 3.1%

National Center for Atmospheric Research

(Dollars in Millions)

	FY 2010 Enacted/ FY 2010 Actual	Annualized FY 2011	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Center for Atmospheric Research	\$96.29	\$97.00	\$100.00	\$3.00	3.1%

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 75 Ph.D. granting academic institutions.



The Mesa Laboratory, designed by architect I.M. Pei, in Boulder, CO. Credit: NCAR.

As of November 2010, NCAR employed a total of 833 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	134
Scientific Support ²	249	572
Other Staff ³	15	127
Total	362	833

¹The primary award supports substantial facility infrastructure that does not include staff costs.

²Scientific Support includes Associate Scientists, Project Scientists, Post Docs, Software Engineers, Engineers, System Support and Technicians.

³Other Staff includes Administrative positions, Managers, Paid Visitors, Pilots and Mechanics.

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 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010 Actual	Enacted/ Annualized FY 2011 CR		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Aircraft Support	\$9.93		\$9.93	\$9.93	\$10.43	\$10.95	\$11.50
Computational Infrastructure	22.00	22.00	26.00	\$27.30	\$28.67	\$30.10	\$31.60	\$33.18
Other Facility Support	23.42	23.42	23.42	\$24.59	\$25.82	\$27.11	\$28.47	\$29.89
Research & Education Support	41.65	41.65	40.65	\$43.21	\$45.37	\$47.64	\$50.02	\$52.52
Total, NCAR	\$97.00	\$97.00	\$100.00	\$105.53	\$110.80	\$116.34	\$122.16	\$128.27

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 2010, NCAR received approximately \$48.0 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Federal Aviation Administration, and \$28.0 million from non-federal sources.

Major Investments in FY 2012: In FY 2012, 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 models, 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 preparing input for the next Intergovernmental Panel on Climate Change (IPCC) assessment and research into significantly enhancing our ability to understand and predict changes in hurricane intensity.

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 to enable the support of research activities designed to understand complex environmental processes. The two aircraft will support several community-originated projects deemed by peer review to be of exceptional scientific merit.

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 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. The 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 2012, NCAR will oversee the completion of construction and 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, NCAR also provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including transportable Doppler radars, upper atmosphere observing capabilities, and other experimental systems. As well as the operation of a coronagraph as a community resource, NCAR also supports community models and other infrastructure facilities. 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 \$40.65 million in FY 2012. 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 into an effective program.

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 \$3.34 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. Annual strategic planning sessions between AGS, UCAR, and NCAR are held 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. The most recent COV found that AGS's management of the NCAR program was "good to excellent."¹

- 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:
 - Approximately mid-way through the current award (in FY 2012), AGS will conduct comprehensive reviews of science, facilities, and management. The results of these reviews will inform future decisions regarding recompetition of the facility.

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 60 months, extensible for an additional 60 months subject to appropriate and successful review.

¹www.nsf.gov/geo/adgeo/advcomm/fy2009_cov/atm_ulafos_cov_report_2009.pdf

National Optical Astronomy Observatory

\$29,170,000
-\$2,330,000 / -7.4%

National Optical Astronomy Observatory
(Dollars in Millions)

	FY 2010			Change over	
	FY 2010	Enacted/ Annualized	FY 2012	FY 2010 Enacted	
	Actual	FY 2011 CR	Request	Amount	Percent
National Optical Astronomy Observatory	\$35.40	\$31.50	\$29.17	-\$2.33	-7.4%

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 such as the Giant Segmented Mirror Telescope (GSMT) and is closely involved in the design, development, and potential construction of the Large Synoptic Survey Telescope (LSST). Both of these projects are high ranking recommendations 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 1,000 scientists annually. In FY 2010, 95 thesis students and an additional 81 non-thesis graduate students from U.S. institutions used NOAO telescopes for their research. In FY 2010 NOAO employed nearly 360 personnel in Arizona and Chile, including 46 support scientists and 11 postdoctoral fellows.

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 2010, NOAO received \$12.49 million for reimbursed services from partnerships and tenant observatory support, and from the Kitt Peak Visitors’ Center, grants from other federal agencies, and NSF supplemental funding for the Research Experiences for Undergraduates (REU) program, GSMT, and LSST.

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. Typically, a quarter of all doctorates awarded annually in astronomy in the U.S. involve use of NOAO facilities. 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 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010 Actual	Enacted/ Annualized/ FY 2011 CR		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
NOAO-Operations	\$20.00	\$20.00	\$20.84	\$21.36	\$21.89	\$21.89	\$21.89	\$21.89
NOAO-Development	10.90	7.00	7.78	8.12	8.47	8.47	8.47	8.47
NOAO-Research & Education	0.50	0.50	0.55	0.57	0.59	0.59	0.59	0.59
TSIP ²	4.00	4.00	-	-	-	-	-	-
Total, NOAO	\$35.40	\$31.50	\$29.17	\$30.05	\$30.95	\$30.95	\$30.95	\$30.95

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: \$20.84 million: NOAO-Operations cover the operation of facilities at KPNO, CTIO, and the headquarters, offices, laboratories, and workshops in Tucson, Arizona and La Serena, Chile. The majority of these funds will be used for the retention of key personnel.

NOAO-Development: \$7.78 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. This investment in new instrumentation at KPNO, CTIO, and, possibly Gemini will continue with modest increases in this component. In FY 2010, \$3.90 million in supplemental funding was awarded to NOAO as the second award in response to an unsolicited 3-yr proposal for "Renewing Small Telescopes for Astronomical Research (ReSTAR)"; this supplemental funding is included in the NOAO Development line. The goal of ReSTAR awards is to improve the instrument capabilities and increase the availability to the community of telescope time on "small" NOAO and non-federally-funded telescopes. In this context, "small" telescopes are from two to five meters in aperture. There are no current commitments to ReSTAR awards in FY 2011 and beyond.

NOAO-Research and Education: \$550,000: NOAO links the research conducted at its facilities to education of the public through its education and public outreach office in Tucson. Although this has historically been supported at a higher level, some programs are ending as planned, and other priorities currently preclude full exploitation of NOAO's many opportunities in education and public outreach.

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 has been administered by NOAO and has resulted in U.S. community access to unique assets such as the Keck and Magellan telescopes. While TSIP has been somewhat successful in achieving its original goals, the budget request proposes to eliminate it as a standalone program and reallocate funding to a broader, more competitive activity outside the NOAO budget: the Mid-Scale Innovations Program, which was a top recommendation of the *Astro2010* decadal survey in astronomy. Proposals for TSIP-like activities will

still be entertained within the Disciplinary and Interdisciplinary Research portfolio of the 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 and the Division of Acquisition and Cooperative Support and the Large Facilities Project 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 is scheduled for FY 2012.

Renewal/Recompetition/Termination

A management review of AURA's performance was carried out in August 2006. In response to the



The Cerro Tololo Inter-American Observatory 4-meter telescope dome. Credit: M. Urzua Zuniga/Gemini Observatory.

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. When this current cooperative agreement nears expiration, a solicitation will be promulgated for the management of NOAO under a new cooperative agreement to begin April 1, 2014. As recommended by the *Astro2010* decadal survey, consolidation of the management of NOAO and Gemini as part of this solicitation is under consideration.

National Radio Astronomy Observatory

\$73,540,000
+\$6,450,000 / 9.6%

National Radio Astronomy Observatory
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change over	
	FY 2010 Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	FY 2010 Enacted Percent
National Radio Astronomy Observatory	\$67.72	\$67.09	\$73.54	\$6.45	9.6%

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 2010 the Very Large Array (VLA) telescope, located about 80 km west of Socorro, NM, transformed into the Expanded Very Large Array (EVLA). Like the VLA the EVLA is composed of 27 individual antennas arranged in a "Y" pattern. In their closest configuration (about 1 km wide), the EVLA is able to image large portions of the sky. In its largest configuration (about 36 km wide) the EVLA is able to home in on the fine details of astronomical objects. *Credit: Andrew Clegg, National Science Foundation.*

NRAO staff includes 432 FTEs in the operations and maintenance component of the Observatory: 35 in Observatory Management, 344 in Observatory Operations, 33 in Science & Academic Affairs and Education and Public Outreach (EPO), and 20 in the Central Development Laboratory.

Total Obligations for NRAO

(Dollars in Millions)

	FY 2010		FY 2012 Request	ESTIMATES ¹				
	FY 2010 Actual	Enacted/ Annualized FY 2011 CR		FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	\$43.14	\$43.14	\$42.89	\$44.33	\$46.95	\$49.25	\$49.25	\$49.25
<i>Observatory Management</i>	6.03	6.03	7.10	7.25	7.30	7.40	7.40	7.40
<i>Observatory Operations</i>	31.77	31.77	30.64	31.33	33.15	35.00	35.00	35.00
<i>Science, Academic Affairs, EPO</i>	3.62	3.62	3.65	4.00	4.50	4.60	4.60	4.60
<i>Central Development Lab</i>	1.72	1.72	1.50	1.75	2.00	2.25	2.25	2.25
Implementation of EVLA	6.38	1.13	-	-	-	-	-	-
ALMA Operations	18.20	22.82	30.65	33.92	36.41	39.17	39.17	39.17
Total, NRAO	\$67.72	\$67.09	\$73.54	\$78.25	\$83.36	\$88.42	\$88.42	\$88.42

Totals may not add due to rounding.

¹ Outyear funding estimates are for planning purposes only.

The major area of increased funding in FY 2012 is in ALMA operations. Base funding for NRAO operations decreases in FY 2012 as part of the budget realignment plan to support increases in ALMA operations. Funding for the implementation of the Expanded Very Large Array (EVLA) is scheduled to conclude 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 2010, NRAO received approximately \$300,000 from non-AST sources at NSF, \$400,000 from other federal agencies, and about \$500,000 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 completed 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). 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, with over 150 students involved per year. 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 Very Large Array (VLA) together attract about 68,000 public visitors each year.

Observatory Management, \$7.10 million: Observatory Management includes the director's office, administrative services, the end-to-end data management initiative, and the New Initiatives Office.

Observatory Operations, \$30.64 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, \$3.65 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), \$1.50 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: FY 2011 is scheduled to be the last year of support for the construction phase of EVLA, so there is no funding in FY 2012.

ALMA Operations, \$30.65 million: NRAO is engaged in construction of the international ALMA, which in FY 2012 will be entering the eleventh year of its eleven year construction phase, 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 2011 was authorized by the National Science Board in December 2007. The operations funding plan for FY 2012 through FY 2015 is the subject of National Science Board action in 2011. Please see the MREFC chapter for additional information on the ALMA project.

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 in AST 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 by NRAO, as well as by attendance at governance committee meetings of the managing organization, Associated Universities, Inc., (AUI). 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, to address issues as they arise.
- **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.

Renewal/Recompetition/Termination

The current cooperative agreement is in place for the years FY 2010 through FY 2015. When this current cooperative agreement nears expiration, a solicitation will be promulgated for the management of NRAO under a new cooperative agreement to begin September 30, 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 estimations, and other activities that prepare potential projects for oversight review, agency decision milestones, and potential implementation.