MAJOR MULTI-USER RESEARCH FACILITIES $1,201,100,000
$125,050,000 / 11.6%

Major Multi-User Research Facilities Funding
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Facilities	$930.27	$378.55	$880.46	$991.90	$111.44	12.7%
Federally Funded R&D Centers	198.06	24.20	195.59	209.20	13.61	7.0%
Total, Major Multi-User Research Facilities	**$1,128.33**	**$402.75**	**$1,076.05**	**$1,201.10**	**$125.05**	**11.6%**

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 Funding

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Engineering						
National Nanotechnology Infrastructure Network	16.67	10.27	16.26	16.26	-	-
Network for Earthquake Engineering Simulation	20.98	-	22.00	22.50	0.50	2.3%
Geosciences						
Academic Research Fleet	$88.95	$18.00	$80.00	$77.00	-$3.00	-3.8%
EarthScope	24.29	9.00	25.05	26.00	0.95	3.8%
Incorporated Research Institutes for Seismology	12.00	-	12.36	12.73	0.37	3.0%
Integrated Ocean Drilling Program	47.95	25.00	43.40	46.41	3.01	6.9%
Mathematical and Physical Sciences						
Cornell High Energy Synchrotron Source/ Cornell Electron Storage Ring	13.60	14.99	9.00	13.45	4.45	49.4%
Gemini Observatory	18.71	-	19.10	19.58	0.48	2.5%
Large Hadron Collider	18.00	-	18.00	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	30.30	-	28.50	30.30	1.80	6.3%
National Astronomy and Ionosphere Center[1]	9.60	3.10	10.60	9.00	-1.60	-15.1%
National High Magnetic Field Laboratory	26.50	5.00	35.56	34.00	-1.56	-4.4%
National Solar Observatory	7.83	1.40	9.10	9.51	0.41	4.5%
National Superconducting Cyclotron Laboratory	20.50	2.00	21.00	21.50	0.50	2.4%
Polar Programs						
Polar Facilities and Logistics[2]	341.38	22.50	312.27	381.38	69.11	22.1%
Other						
MREFC Projects[3]	199.75	257.10	163.54	214.69	51.15	31.3%
Other Facilities[4]	5.60	4.99	7.02	7.65	0.63	9.0%
Preconstruction Planning[5]	27.67	5.20	47.70	31.94	-15.76	-33.0%
Federally Funded Research and Development Centers[6]						
Geosciences						
National Center for Atmospheric Research	106.79	13.20	97.00	108.00	11.00	11.3%
Mathematical and Physical Sciences						
National Optical Astronomy Observatory	30.48	5.60	31.50	33.33	1.83	5.8%
National Radio Astronomy Observatory[7]	60.79	5.40	67.09	67.87	0.78	1.2%
Total	**$1,128.34**	**$402.75**	**$1,076.05**	**$1,201.10**	**$125.05**	**11.6%**

[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, totaling $1.10 million in FY 2009, 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, OOI and ATST; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) implementation support provided through the MREFC account. Final MREFC support for SPSM is also included in this line.

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

[5] Preconstruction Planning includes funding for next generation physics and astronomy facilities, including: an underground physics laboratory, high intensity synchrotron radiation x-ray sources; large aperture optical telescopes; fast, wide-field telescopes; and meter/centimeter wavelength radio telescopes.

[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 Radio Astronomy Observatory includes operations and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC Projects line above.

NSF's Facilities Investments in FY 2011:

The following pages contain information on NSF's ongoing facilities in FY 2011, organized by sponsoring directorate. These are:

ENGINEERING

National Nanotechnology Infrastructure Network **$16,260,000**
+$0 / 0%

The National Nanotechnology Infrastructure Network
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
The National Nanotechnology Infrastructure Network	$16.67	$10.27	$16.26	$16.26	-	-

The National Nanotechnology Infrastructure Network (NNIN) is now in the 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 2009	FY 2010	FY 2011	ESTIMATES				
	Actual	Estimate	Request	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$16.67	$16.26	$16.26	$16.26	$16.26	$16.26	$16.26	$16.26
ARRA Actual	10.27	-	-	-	-	-	-	-
Total, NNIN	**$26.94**	**$16.26**	**$16.26**	**$16.26**	**$16.26**	**$16.26**	**$16.26**	**$16.26**

Totals may not add due to rounding.

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.

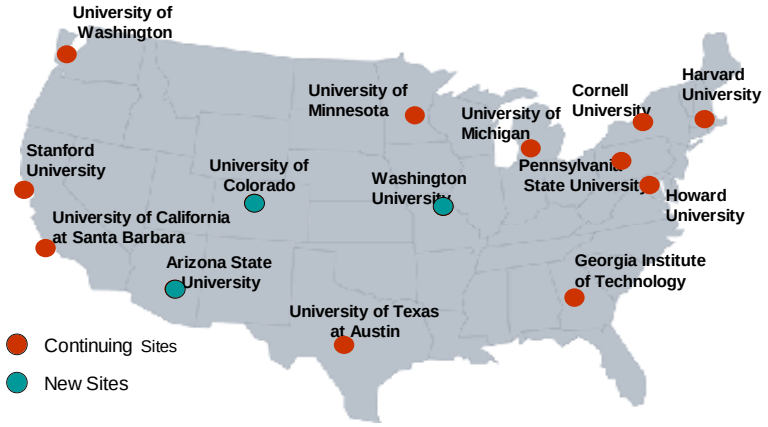
NNIN undertakes on a national scale a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis is placed on education and training of a diverse science and engineering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

In its fifth year of operation encompassing 2008-2009, NNIN served approximately 5,100 unique users from 180 institutions, resulting in over 3,100 attributed publications. During the first 6 months of 2009, approximately 4,000 unique users have been served, of whom 3,200 were Ph.D students. NNIN affords a major avenue for affordable development and commercialization for small companies in nascent application areas. Some 590 industrial users including over 270 small companies also used NNIN facilities during this 6-month period. Over the period of a year, NNIN estimates that it has enabled in excess of 1,000 PhD awards and leveraged over $500 million in research investments through use of its facilities. NNIN continues strong education outreach and diversity-oriented efforts, which include its network-wide Research Experience for Undergraduates (REU) program, Nanotechnology Showcase for Students, and Laboratory Experience for Faculty from underrepresented institutions.



Facility Report:

Management and oversight:

- NSF structure: NSF provides oversight of the NNIN under a cooperative agreement. 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 2009-2113. A mid-year informational review was held at NSF in October 2009.
  - Upcoming reviews: A fifth annual review will be held in Spring 2010.

NNIN was awarded $10,000,000 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.

Network for Earthquake Engineering Simulation

$22,500,000
+$500,000 / 2.3%

Network for Earthquake Engineering Simulation
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Network for Earthquake Engineering Simulation	$20.98	-	$22.00	$22.50	$0.50	2.3%

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 U.S., 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 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$20.98	$22.00	$22.50	$22.50	$23.00	$23.00	$23.00	$23.00

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. NEES operates under an education, outreach, and training strategic plan to develop 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. NEES 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 the NSF support research 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 is leveraging and complementing 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), 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. Planning meetings were held at NSF in January 2009 and at E-Defense in September 2009 to explore research topics for a second five-year NEES/E-Defense collaboration. Two NSF-supported research projects used the E-Defense facility during FY 2009 to test new seismic design methodologies for mid-rise wood frame buildings and steel frame structures.

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 NEES cyberinfrastructure 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 $12.5 million in FY 2010. 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.

Slab-column subassembly being tested as part of a NSF-supported NEES research award at the NEES Multi-Axial Subassemblage Testing (MAST) Laboratory at the University of Minnesota. *Courtesy of the MAST Laboratory at the University of Minnesota.*

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 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 Center Director. A Governance Board meets several times a year and provides independent advice and guidance to the Center 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 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 NEES cyberinfrastructure for network coordination. The NEES cyberinfrastructure provides telepresence, data, 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: Spring of FY 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 made the decision to recompete 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., is supported by NSF to provide continuity of operations and help transition software, documents, and other inventory to Purdue University and to complete its own award close-out. In FY 2010, NSF will fund an assessment of the NEES experimental facilities, NEES cyberinfrastructure, and earthquake engineering experimental facilities available worldwide. This assessment is expected to be completed in FY 2012 and will form the basis for determination by NSF of whether to recompete or scale back NEES operations at the end of FY 2014.

GEOSCIENCES

Academic Research Fleet **$77,000,000**
-$3,000,000 / -3.8%

Academic Research Fleet
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Academic Research Fleet	$88.95	$18.00	$80.00	$77.00	-$3.00	-3.8%

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 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$87.07	$18.00	$73.00	$73.00	$74.00	$74.00	$75.00	$77.00	$77.00
Fleet Renewal:									
Human Occupied Vehicle	-	-	5.00	2.00	-				
R/V Langseth (Seismic Ship)	1.00	-	-	-	-				
Regional Class Research Vessel	0.88	-	2.00	2.00	20.00	20.00	20.00	20.00	20.00
Total, Academic Research Fleet	**$88.95**	**$18.00**	**$80.00**	**$77.00**	**$94.00**	**$94.00**	**$95.00**	**$97.00**	**$97.00**

Totals may not add due to rounding.

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 made 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 significant temporary increase in funding for support of ship operations in FY 2009 reflects the large number of awards that NSF funded through ARRA that require ship support. This temporary increase reflects approximately 600 additional ship days for a total of 3,300 days. The FY 2011 Request of $77.0 million will support approximately 2,500 ship 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 the Large Facilities Office via the Business Systems Review (BSR) of selected operating institutions, site visits, ship inspections, and participation at UNOLS Council and Subcommittee meetings by NSF program directors. Several program directors within OCE at NSF, at NOAA, and at ONR are involved in the activities and overall oversight of the Academic Research Fleet. NSF reviewed two large Academic Research Fleet operating institutions through the Large Facilities office via a BSR in CY 2008. A third BSR will be conducted on another operating institution in CY 2010.

- 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 document stating this need is an 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. In addition to these plans, several activities are

underway to support the upgrade of the Academic Research Fleet using FY 2009 ARRA funding. 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.

- The Hybrid-ROV Nereus successfully completed sea trials to the deepest part of the world's ocean, the Challenger Deep in May and June 2009. The Nereus can operate either autonomously or tethered to a tender ship via a hair-thin fiber optic cable. The Nereus is now conducting research for scientists supported by NSF and other agencies.

- Regional Class Research Vessel (RCRV): NSF and the Navy's Program Executive Office Ships (PEO Ships) ended a MOU for the acquisition of the RCRV in January 2009. The process produced two designs by late 2008 but was halted before a down-select to a single design was made because adequate construction funds could not be identified. To move the replacement effort forward, NSF convened a Panel of Experts in October 2009 to conduct a technical evaluation of the two designs and make a recommendation to NSF using a rigorous down-select process. NSF expects to begin working with UNOLS to identify needed enhancements to the ship design. Funds in FY 2011 will support design refresh activities needed to comply with any regulation changes and, potentially, to issue a shipyard RFP, with construction anticipated to begin in FY 2012.

- Alaska Regional Research Vessel (ARRV): This project represents NSF's first major contribution to fleet renewal in over twenty years. Construction of the ARRV was funded completely through the MREFC account and ARRA, and is described separately in the MREFC chapter. Shipyard selection will be complete in early FY 2010 with construction beginning shortly thereafter. 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 2010. This project, begun in FY 2004, experienced significant cost over-runs in 2008 and was subsequently re-scoped and placed on a revised review path, which includes a Preliminary Design Review (PDR) in December 2009 with a Final Design Review (FDR) planned in May 2010. Following a successful FDR, NSF will authorize continued expenditures on the project.

  Integration of a new titanium 6,500 meter-capable personnel sphere with existing ALVIN vehicle components is planned during FY 2011. Initial Phase I operations are anticipated in 2012 with a depth capability of 4,500 meters, the limit of the current ALVIN and the infrastructure components to be shared across both platforms. Upgrades to permit operations at a depth of 6,500 meters could follow in three to five years, pending availability of funds and priority evaluations. The cost increase

over previous estimates is due to delays in schedule, increases in labor costs and levels of effort, and a rise in titanium costs. Approximately $5 million remains unspent of the original $22.90 million awarded. Additional increases will be shared by the awardee.

- The NRC report, *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet* made several recommendations on fleet renewal, including the "Recommendation: The future academic research fleet requires investment in larger, more capable general purpose Global and Regional class ships to support interdisciplinary, multi-investigator research and advances in ocean technology". NSF will consider this recommendation, along with those from the RCRV Design Down-select panel report and the current U.S. Navy efforts to replace two aging Global class ships with Ocean class vessels, in determining the way ahead for construction of the RCRV. Funds in FY 2010 will allow coordination with the UNOLS community to make any required refinements to the RCRV requirements documentation and to prepare a solicitation for selection of an academic institution to design/build the RCRV. NSF plans to use the same process currently being used for the design and construction of the Alaska Region Research Vessel, which is proving to be highly successful.

EarthScope

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

EarthScope
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
EarthScope	$24.29	$9.00	$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 10 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.

Total Obligations for EarthScope
(Dollars in Millions)

	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations & Maintance	$51.39	$24.29	$25.05	$26.00	$26.65	$27.25	$28.05	$28.86	$29.70
ARRA Actual		9.00							
Total, EarthScope	**$51.39**	**$33.29**	**$25.05**	**$26.00**	**$26.65**	**$27.25**	**$28.05**	**$28.86**	**$29.70**

Totals may not add due to rounding.

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 Programme 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.

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 $6.20 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:

EarthScope completed its construction phase on-time and on-budget on September 30, 2008 and is now fully operational. 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 specific experiments, 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, to collect rocks and fluids from the fault zone for laboratory study, and to continuously monitor the physical condition within an active earthquake nucleation zone. The EarthScope seismic and geodetic instruments consistently exceed 90 percent uptime, and have provided nearly 30 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.

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. While the unique SAFOD core from the San Andreas Fault is just beginning to be analyzed, early mineralogical analysis has already answered key questions about why sections of the fault exhibit slip in the form of creep. 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 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 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, including the use of EarthScope GPS measurements to understand the distribution of soil moisture, a key input to climate models, across the western U.S. These new results are being incorporated in an updated science plan for EarthScope under development through an extensive community process.

EarthScope has engaged a broad and steadily growing community of scientists. More than 110 unique investigators have received NSF funding through the EarthScope science program, including eight early career scientists in FY 2009; 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 American Geophysical Union meeting, there were more than 30 special sessions relevant to EarthScope science, covering eight different areas of AGU, and including a Union session focused on EarthScope. Scientific results utilizing data collected by the EarthScope facility have already been presented at national meetings and in professional publications.

Operations costs:

Annual operations costs for EarthScope are anticipated to remain approximately steady, with annual adjustments for inflation. EarthScope received $9.0 million in ARRA funds in FY 2009. Of those, $4.0 million were allocated to fill a budget shortfall caused by smaller than anticipated growth of the EarthScope operations budget in FY 2008. The ARRA funds allowed the full EarthScope facility to operate throughout FY 2009, avoiding a potential reduction in operations staff and loss of scientific data. The remaining $5.0 million funded facility enhancements to support onshore/offshore experiments of interest to EarthScope and MARGINS, with the first deployment in the Cascadia region.

Incorporated Research Institutions for Seismology

$12,730,000
$370,000 / 3.0%

Incorporated Research Institutions for Seismology
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Incorporated Research Institutes for Seismology	$12.00	-	$12.36	$12.73	$0.37	3.0%

The Incorporated Research Institutes for Seismology (IRIS) operates a distributed national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research 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 113 U.S. universities and non-profit institutions with research and teaching programs in seismology. 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 2009 Omnibus Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$12.00	$12.36	$12.73	$13.09	$13.48	$13.89	$14.31	$14.75

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 (105 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, museum exhibits, educational materials, 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.

Global Seismic Station SPA at South Pole, Antarctica. Shown is a prototype borehole sensor package being tested in a shallow vault. This prototype was eventually deployed at the new South Pole seismic station QSPA, located 5 miles from SPA. *Credit: IRIS*

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.

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 for NSF-sponsored research making use of the IRIS facilities, totaling approximately $15.0 million per year. 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 scientific and administrative performance of IRIS.

- External Structure: IRIS is incorporated as a non-profit consortium representing 113 U.S. university and non-profit organizations with research and teaching programs in seismology. Each member institution appoints a representative. However, all IRIS program and budget decisions are made by a nine-member Board of Directors. 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 two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.

Reviews & Renewal:

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. 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 an extremely 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 will be considered by the seismological community as it prepares a new Strategic Plan for this program in 2010. A proposal from IRIS for renewed support is anticipated, however of approximately two years duration to synchronize the IRIS award with the complementary EarthScope activity.

The Integrated Ocean Drilling Program **$46,410,000**
and the Scientific Ocean Drilling Vessel **+$3,010,000 / 6.9%**

The Integrated Ocean Drilling Program

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Integrated Ocean Drilling Program	$47.95	$25.00	$43.40	$46.41	$3.01	6.9%

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 seafloor.

SODV Underway for Initial Science Expedition, March 10, 2009. *Credit: NSF*

Total Obligations for IODP

(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$47.95	$43.40	$46.41	$46.41	$46.41	$47.00	$47.00	$47.00
ARRA Actual	25.00	-						
Total, IODP	**$72.95**	**$43.40**	**$46.41**	**$46.41**	**$46.41**	**$47.00**	**$47.00**	**$47.00**

Totals may not add due to rounding.

Operations and maintenance funds support the operation and maintenance of the Scientific Ocean Drilling Vessel (SODV).

NOTE: The IODP program officially ends in 2013 but may be renewed. NSF activities regarding 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. Funding for FY 2014, FY 2015, and FY 2016 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 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 2,200 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including approximately 1,000 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 the light drillship 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 the light drillship through contract with the U.S. SIC, an alliance formed by the Consortium for Ocean Leadership, Inc. (COL) together with subcontractors 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 will undergo external review in FY 2010. 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 independent panel every several years.

Renewal/Recompetition/Termination:

IODP international agreements and contracts cover activities through FY 2013. NSF activities regarding 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 operator, Overseas Drilling Limited (ODL), is covering certain construction costs in exchange for a higher day rate charge during the operations phase. Construction activities have been completed and the ship commenced international scientific operations on March 5, 2009. 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.

Project Report:

Management and Oversight:

- NSF Structure: The project was overseen by a program director in the OCE in GEO with advice and oversight support from a NSF Project Advisory Team (PAT), including representatives from GEO, the Office of Polar Programs, the Office of Budget, Finance and Award Management (BFA), and the Office of General Counsel. The BFA Deputy Director for Large Facility Projects participated as a member of the PAT, providing advice and assistance.

- External Structure: A SODV Independent Oversight Committee provided technical, financial and scheduling recommendations and advice for the SODV project to top-level management. A Program Advisory Committee (PAC), comprised of members of the science and drilling communities, provided ongoing assessment of the design plans for the on-board science and drilling capabilities, to assure that the converted vessel reflects the needs of the scientific communities.

- Reviews:
  - A two-phase independent readiness assessment of the SODV science systems was completed in February and March 2009 by a group of ocean drilling veteran scientists.

Current Project Status:

Shipyard conversion of the vessel was completed in early January 2009. Initial load-out and shakedown activities were conducted and the SODV commenced IODP scientific operations on March 5, 2009. The ship has since completed 5 IODP expeditions with exceptional reliability and demonstrably superior coring capability (the global piston coring depth record – with virtually 100% recovery – has been broken three times since commencement of operations, to a depth of over 458 meters below sea floor).

Cost and Schedule:

Refitting of the ship is completed. Due to the enormous worldwide demand for shipyard services during the SODV refit period, actual shipyard work lagged planned progress, resulting in significant delay in return of the vessel to science operations. Various project costs are still under review but current indications are that the NSF portion of the SODV refit has been completed within the MREFC project funding profile established in early FY 2005.

Risks:

None remaining.

Future Operations Costs:

Future operations costs are described in the obligations table above.

MATHEMATICAL AND PHYSICAL SCIENCES

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring **$13,450,000**
+$4,450,000 / 49.4%

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Cornell High Enegry Synchrotron Source/ Cornell Electron Storage Ring (CHESS/CESR)[1]	$13.60	$14.99	$9.00	$13.45	$4.45	49.4%

Totals may not add due to rounding.

[1] The combined reporting of CHESS/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 Division of Materials Research (DMR) within the Directorate for Mathematical and Physical Sciences (MPS).

CESR was constructed and operated for many years to support elementary particle physics research, serving a dual role by also providing the electrons and positrons for the operation of CHESS. Over the last few years, elementary particle physics research at CESR was phased out and a larger fraction of CESR operations was dedicated to support CHESS. As of FY 2010, this is CESR's primary function. Concomitant with this transition, funding and oversight of CESR is transferred from the Division of Physics (PHY) in MPS to DMR. Because some of the FY 2010 obligations were met using FY 2009 ARRA funds, the FY 2010 request is less than originally planned.

Total Obligations for CHESS/CESR
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
CHESS/CESR-Ops & Maintenance	$13.60	$13.69	$9.00	$13.45	$18.45	$20.93	$22.19	$22.54	$23.81
CHESS/CESR-R&D	-	$1.30	-	-	-	-	-	-	-
Total, CHESS/CESR	**$13.60**	**$14.99**	**$9.00**	**$13.45**	**$18.45**	**$20.93**	**$22.19**	**$22.54**	**$23.81**

Totals may not add due to rounding.

In FY 2011, $13.45 million will allow for expanded operation of the facilities in support of synchrotron light users as well as in X-ray technology development.

CHESS/CESR staff assists in transferring Superconducting Radio Frequency (SRF) 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 the 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.

Project Report:

Management and Oversight:

- NSF Structure: Through FY 2008, NSF oversight of CESR was provided through PHY and involved panel evaluation of the CESR continuation proposal as well as a site visit by NSF staff and external reviewers. As CESR transitioned from supporting elementary particle physics research to a dedicated source of electrons for CHESS, oversight and funding of CESR shifted from PHY to DMR in FY 2010. CHESS is supported by DMR and by NIH. CHESS also hosts MacCHESS, a NIH-funded macromolecular crystallography program at Cornell. NSF and NIH provide management oversight for 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 facilities.

- 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:
  - Recent reviews conducted (CESR):
    - Review for phase-out of facility particle physics operations, FY 2008.
  - Recent reviews conducted (CHESS):
    - Proposal review including site visit review with panel of external experts, FY 2008.
    - Review of combined CHESS/CESR with panel of experts, May 2009.
  - Upcoming reviews:
    - Review of CHESS operations, planned in fall 2010.

Renewal/Recompetition/Termination:

CESR is currently funded through a five-year cooperative agreement initiated in 2003 and extended in 2008 to allow time to implement the transition of CESR from a high energy physics facility to a facility fully dedicated to support photon science. Use of CESR as a facility for particle physics concluded with final phase out during FY 2008 and FY 2009. As of FY 2010, CESR is dedicated entirely to support the CHESS operation. CHESS is currently funded through a cooperative agreement also initiated in 2003. In FY 2009, NSF completed the review of a proposal for the continued operation of CESR/CHESS in support of X-ray photon science. In December 2009, the National Science Board authorized NSF to make a four-year award for CHESS/CESR starting on April 1, 2010.

Gemini Observatory

$19,580,000
+$480,000 / 2.5%

Gemini Observatory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Gemini Observatory	$18.71	-	$19.10	$19.58	$0.48	2.5%

The Gemini Observatory consists of two 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope, Gemini North, is optimized for infrared observations and is located on Mauna Kea at an altitude of 4,200 meters. The telescope in Chile, Gemini South, is located on Cerro Pachon, also an outstanding photometric site, 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. It provides 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 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$18.71	$19.10	$19.58	$20.07	$20.57	$21.08	$21.61	$22.15

Astronomers need to resolve important questions about the age and rate of expansion of the universe, its overall topology, 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 significantly larger aperture (8-meter diameter) than previous instruments provides better 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, and compensate for the blurring effects of the Earth's atmosphere.

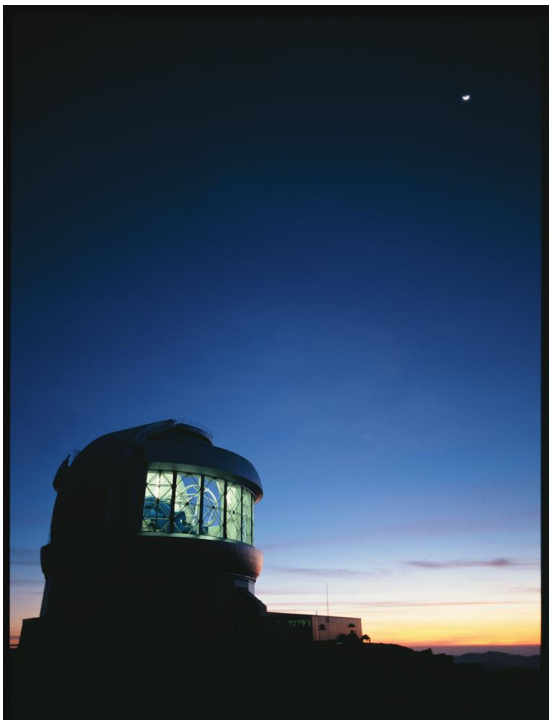
The Gemini telescopes help educate and train U.S. astronomy and engineering students. An estimated 10 percent of the roughly 500 U.S. users per year are students. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including "sister city" arrangements between Hilo, Hawaii and La Serena, Chile involving students and teachers at high school and elementary school levels. Gemini staff 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 industries, 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 being developed for both telescopes, with the laser on Gemini North in routine operation and integration of the system on Gemini South underway. An advanced "multi-conjugate" adaptive optics system, which will yield crisp images over a larger field of view, is in development on Gemini South and will start integration, commissioning on the telescope, and early-scientific operation in FY 2010. Several new instruments are in various states of development. These include a high-performance infrared spectrometer that was delivered to Gemini South in FY 2009 and is currently beginning early-science observations; and the Gemini Planet Imager, an advanced camera, currently under construction, that is designed to directly detect planets around nearby stars.

Budget projections for FY 2012 and beyond represent a fixed level of effort as approved by the Gemini Board and NSF.



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. This late twilight shot also shows the crescent moon in the western evening sky. *Credit: Gemini Observatory/Association of Universities for Research in Astronomy*

Facility Report:

Management and Oversight:

- NSF Structure: NSF has one seat on the Gemini Board and an additional NSF staff members 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

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 partnership with attendant budgetary impact in the years following 2012. The Board has directed the observatory to prepare contingency plans 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 covers FY 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 expires. 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, it may be necessary to extend the current cooperative agreement through at least 2012 in order to provide stable ongoing operations and management through the negotiations with the Gemini partners on their future involvement in the partnership.

Large Hadron Collider

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

Large Hadron Collider
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
Large Hadron Collider	$18.00	-	18.00	$18.00	-	-

The Large Hadron Collider (LHC), an international project at the CERN laboratory in Geneva, Switzerland, is nearing completion of construction and will be 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, each beam to have an energy up to 7 TeV ($1TeV=10^{12}$ electron volts). 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. 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 has been a leader in the development of Grid-based computing. The Grid will enable 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 the LHC
(Dollars in Millions)

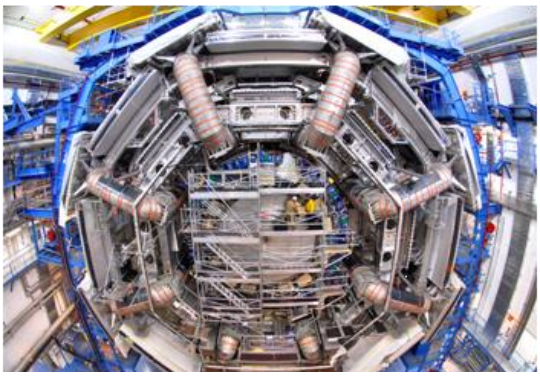
	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$18.00	$18.00	$18.00	$20.00	$20.00	$20.00	$20.00	$20.00

[1] The current cooperative agreement ends in FY 2011. Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

The LHC will enable 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 will also enable a search 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 2011 the estimate for material procurements is approximately $4.50 million, which is included within the $18.0 million operating costs.



The ATLAS detector in February 2007. *Credit: CERN.*

The U.S. LHC collaboration has completed installation of detector components in the experimental areas and has been actively engaged in the integration of these components with the rest of the detectors and the commissioning of the detectors using cosmic rays. This effort is proceeding on schedule and budget. However, the accelerator start-up schedule had been delayed due to failure in September 2008 of a high current line that caused arcing and destructive failure of a liquid helium cryogenic system. While the accelerator has been undergoing repairs for the past year, the collaboration did intensive commissioning of the detectors and the data analysis systems using cosmic rays with extended runs of several weeks at a time, 24 hours a day. First beams were delivered in December 2009; further detector commissioning is proceeding using the particle beams and will continue into early 2010. Data-taking is expected to begin when the beam performance stabilizes.

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 May 2010. 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. Since the present award extends to the end of calendar year 2011, it will require a renewal. The U.S. LHC collaboration is part of an international collaboration in which the U.S. contribution to the detector construction and operations is intimately connected to that of its international collaborators. Under these circumstances it would be difficult, if not unrealistic, to consider recompeting the U.S. role in the international collaboration when the present award ends.

Laser Interferometer Gravitational-Wave Observatory — $30,300,000
+$1,800,000 / 6.3%

Laser Interferometer Gravitational-Wave Observatory
(Dollars in Millions)

	FY 2009 Actual	FY 2009 ARRA Actual	FY 2010 Request	FY 2011 Request	Change over FY 2010 Request Amount	Change over FY 2010 Request Percent
Laser Interfer. Gravitational-Wave Observatory	$30.30	-	$28.50	$30.30	$1.80	6.3%

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe 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; Hanford has a second 2-km interferometer in the same housing. 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 type of 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.

LIGO's current and projected operations and maintenance requests for FY 2009 – FY 2013 are less than the funding levels during the previous cooperative agreement for FY 2002 – FY 2008, since some employees and resources are being diverted to the Advanced LIGO (AdvLIGO) project funded through the Major Research Equipment and Facilities Construction (MREFC) account. LIGO operations will, however, continue to analyze data taken during the current and earlier runs and will also plan for, conduct, and analyze scientific runs from FY 2009 until a temporary shutdown of the detectors in FY 2011. LIGO operations will also include research and development for AdvLIGO during this period.

Total Obligations for LIGO
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$30.30	$28.50	$30.30	$30.40	$30.50	$36.00	$39.00	$39.00

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, LIGO has a diverse set of educational activities at its different sites, activities that involve a large number of undergraduates (including those from minority-serving institutions), hands-on activities for K-12 classes and teachers at all levels, and informal education and outreach activities for the public. A visitors' center at the Livingston site, dedicated in November 2006, houses Exploratorium exhibits and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systemic Initiative program, originally funded by NSF.

LIGO Laboratories at Livingston LA (upper) and Hanford WA (lower). *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), development of new ultra-fine optics polishing techniques, and optical inspection equipment (new product). LIGO has recently cooperated with the Defense Intelligence Agency on research investigating the use of LIGO interferometers as impulse seismic event detectors.

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 60 collaborating institutions with more than 740 participating scientists and LSC membership is growing at a rate of approximately 10 percent per year. A Memorandum of Understanding between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating institution. The LSC plays a major role in many aspects of the LIGO effort including: R&D for detector improvements, R&D for AdvLIGO, data analysis and validation of scientific results, and setting priorities for instrumental improvements at the LIGO facilities. Annual NSF support for science and engineering research directly related to LIGO activities through ongoing research and education programs is about $5.50 million.

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 is testing technologies that will become part of AdvLIGO, began in July 2009. The detector sensitivity is higher than that during the previous S5 run, making the S6 science run a valuable testbed for AdvLIGO.

LIGO's operations during the AdvLIGO construction era will concentrate on:

- Planning for and operation of "enhanced" LIGO and the corresponding S6 science run at a sensitivity about twice that of initial LIGO in FY 2009 – FY 2011;
- Research and development to reduce risk for the AdvLIGO project, to enhance performance post-construction and to enable future enhancements;
- Data analysis and other science activities by staff of the LIGO Laboratory
- Education and outreach activities;
- Ramp-up of AdvLIGO commissioning activities.

For more information on AdvLIGO, see the MREFC chapter.

Facility Report:

Management and Oversight:

- NSF Structure: NSF oversight is coordinated internally by the LIGO program director in the Division of Physics (PHY), who also participates in the PHY AdvLIGO Project Advisory Team, comprising staff from the NSF Offices of General Counsel, Legislative and Public Affairs, International Science and Engineering , as well as the the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management,. .

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the 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, November 2010; and
  - AdvLIGO Annual Review, April 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

$9,000,000
-$1,600,000/ - 15.1%

National Astronomy and Ionosphere Center
(Dollars in Millions)

	FY 2009 Omnibus Actual[1]	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Astronomy and Ionosphere Center	$9.60	$3.10	$10.60	$9.00	-$1.60	-15.1%

[1]A planned FY 2009 contribution of $2.10 million from AGS (formerly ATM) was obligated in FY 2008.

The National Astronomy and Ionosphere Center (NAIC) is a national research center focusing on radio and radar astronomy and atmospheric sciences. The center's principal observing facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector in western Puerto Rico. Located near the town of Arecibo on 120 acres of U.S. Government-owned land, the facility is known as Arecibo Observatory. NAIC is currently operated and managed by Cornell University under a cooperative agreement with NSF. NAIC provides telescope users with a wide range of research and observing instrumentation and serves over 400 users annually.

NAIC has a staff of about 120 full-time-equivalent positions, including those who support the Angel Ramos Visitor Center and Learning Center. A permanent staff of 17 scientists and 34 engineers/ technicians are available to help visiting investigators with their observation programs. The remainder includes 26 management, administrative and clerical positions, 37 maintenance staff, and several postdoctoral scholars and graduate students.

Total Obligations for NAIC
(Dollars in Millions)

	FY 2009 Actual[1]	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$9.60	$10.60	$9.00	$8.70	$8.30	$8.00	$8.00	$8.20
Astronomical Sciences (MPS)	*9.60*	*8.40*	*6.00*	*5.50*	*5.00*	*4.50*	*4.00*	*4.10*
Atmospheric & Geospace Sciences (GEO)	-	*2.20*	*3.00*	*3.20*	*3.30*	*3.50*	*4.00*	*4.10*
ARRA Actual (MPS)	3.10	-	-	-	-	-	-	-
Total, NAIC	**$12.70**	**$10.60**	**$9.00**	**$8.70**	**$8.30**	**$8.00**	**$8.00**	**$8.20**

Totals may not add due to rounding.

[1]A planned FY 2009 contribution of $2.10 million from AGS (formerly ATM) was obligated in FY 2008.

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). The AST Senior Review recommended an emphasis on observations in support of large astronomical surveys and a reduction in funding through AST to $8.0 million (FY 2006 dollars) for NAIC by 2010. In response, the managing organization, Cornell University, has modified the operating mode for astronomy observations and limited the observing time for astronomy projects. These changes also resulted in a reduction in force of 30 FTEs in FY 2007. In addition, availability of the S-band planetary radar system was reduced in FY 2008. The FY 2010 Budget Request reflected the planned ramp-down to meet the Senior Review recommendations. As AST ramps down support for NAIC in response to the Senior Review, in FY 2011 and beyond AGS funding will contribute substantively to general 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.

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 costs, estimated in FY 2006 at $8.0 million. AST support for FY 2011–2015 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.

Partnerships and Other Funding Sources: NAIC leverages NSF support with funding from other federal and non-federal sources. In FY 2008 – FY 2010, NAIC received $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 $100,000 from other non-federal and private sources. In FY 2009 Cornell contracted for $2.35 million with the Puerto Rico Department of Education to provide student enhancement and teacher professional development programs at Arecibo through the site's Angel Ramos Visitor Center and Learning Center. In FY 2010, Cornell finalized an assistance agreement with the Puerto Rico Infrastructure Financing Authority to receive $3.0 million in support of major infrastructure improvements at Arecibo Observatory.

An image of the Arecibo Radio Telescope in Puerto Rico. The gregorian dome, which houses the main suite of research instruments, and its suspension structure are visible over the main reflector below. *Credit: Arecibo Observatory/NSF*.

A peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Arecibo. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of NAIC.

Education and Public Outreach: NAIC's primary education goal 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 Visitor Center and Learning Center, as well as summer workshops for K-12 teachers. The Angel Ramos Visitor Center attracts roughly 100,000 visitors each year, and with funds from the Puerto Rico Department of Education, NAIC has hosted up to 40,000 school children each year for science enrichment programs.

Operations and Maintenance, $9.0 million ($1.60 million below the FY 2010 Estimate of $10.60 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 three to four. 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.

- Division of Astronomical Sciences, $6.0 million ($2.40 million below the FY 2010 Estimate of $8.40 million): AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Radio astronomers and planetary scientists use the Arecibo facility to study diverse areas such as interstellar gas, galactic structure formation and evolution, pulsars and fundamental physics, the dynamic variations in Earth's ionosphere, and topics in solar system astronomy, such as the physical properties of asteroids, planetary surfaces and moons and the post-discovery characterization and orbital refinement of near-Earth asteroids. Funding for the Astronomy program decreases by $2.40 million from FY 2010 to FY 2011, following the 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 operation.

- Division of Atmospheric and Geospace Sciences, $3.0 million (+$800,000 over FY 2010 Estimate of $2.20 million): AGS primarily funds 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.

- Approximately 60 percent of the astronomy observing time is dedicated to ongoing survey programs, most of which utilize the Arecibo L-band Feed Array (ALFA) receiver that was commissioned in 2005–2006. The installation and commissioning of new, wide-band spectrometers in FY 2008 allows up to three survey programs to be conducted simultaneously on each sky pointing, a capability unique to Arecibo Observatory. About 75 percent of astronomy users conduct their observing programs remotely via networked control software, while radar observations typically employ on-site users.

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 November 2009. Future annual reviews will continue after review and recommendation of proposals received in response to the new management competition (see below).

Renewal/Recompetition/Termination:

The current cooperative agreement with Cornell for the management of Arecibo is in effect through September 30, 2010. Consistent with National Science Board policy, NSF will solicit proposals for a new, five-year cooperative agreement for the management and operation of NAIC through a competitive process. The program solicitation is under development with publication anticipated in the first quarter of calendar year 2010.

The Astronomy Senior Review report 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. In response, AGS has increased support in FY 2011 and beyond, including support for general operations.

The program solicitation for the management and operation of NAIC will identify five-year budget guidance at a significantly reduced level relative to current operations. To sustain NAIC as a competitive scientific and educational facility that is responsive to its stakeholders in the scientific community and the Commonwealth of Puerto Rico, potential managing organizations will be encouraged to consider novel models of operations and governance, revisions to programmatic scope, and/or sources of additional funding.

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

$34,000,000
-$1,560,000 / -4.4%

National High Magnetic Field Laboratory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National High Magnetic Field Laboratory	$26.50	$5.00	$35.56	$34.00	-$1.56	-4.4%

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). The 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. Many of the unique magnet systems were designed, developed, and built by the magnet engineering and design team at the NHMFL in collaboration with industry. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process. A FY 2009 ARRA award ($15.0 million) made in the first quarter of FY 2010 will enable the NHMFL to develop and build a world-record-holding advanced mass spectrometer 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 molecular biology and heavy petroleum analysis.

Total Obligations for NHMFL
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations and Maintenance	$26.50	$35.56	$34.00	$34.00	$37.50	$38.50	$39.50	$40.50
ARRA	5.00	15.00		-	-	-	-	-
Total, NHMFL	**$31.50**	**$50.56**	**$34.00**	**$34.00**	**$37.50**	**$38.50**	**$39.50**	**$40.50**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

The FY 2010 includes a one-time award of $2.56 million for development of a magnet purchased with ARRA funds during the first quarter of FY 2010. Thus, the FY 2011 Request appears to be a decrease, but is actually an increase of $1.0 million with respect to the base NHMFL funding. This base increase will allow the facility to strengthen user support and in-house research, education, and training. Funding will allow completion of the planned split-magnet development, meet operations needs, such as electricity and cryogenics cost increases, and support technical staff, education, and training efforts.

The principal scientific goals of NHMFL are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research conducted by users from a range of science and engineering disciplines. In addition, the lab is an internationally recognized leader in magnet design, development, and construction. The Magnet Science and Technology (MS&T) Division of NHMFL has broad responsibility to develop high field magnets, as well as conducting and superconducting materials for future generation magnet wires 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.

Current magnet development at NHMFL is focusing on design and construction of new energy-saving, high-field magnet technologies, including the design and construction of new, all-superconducting magnets based on high-temperature superconductor technology, and high field magnets for the Spallation Neutron Source at Oak Ridge National Laboratory, the nation's premier neutron facility. The NHMFL has collaborated 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. International collaboration includes magnet development with the Hahn-Meitner Institute in Berlin, the International Thermonuclear Experimental Reactor (ITER) in Switzerland, and the Korea Basic Science Institute.

NHMFL provides a unique interdisciplinary learning environment. Its annual K-12 outreach engages more than 7,000 students from Florida and Georgia in hands-on activities 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. NHMFL hosts an annual one-day open house as well as tours in which about 10,000 college and pre-college students participate each year.

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 Directorates for Engineering and Biological Sciences. Site visit reviews are conducted annually. Representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) are invited to observe.

- External Structure: A consortium of the three universities (FSU, UF, and LANL) operates the 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, 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 reviews include:

  - Renewal Review, January 9-11, 2007;
  - Annual Review by external panel, December 2008;
  - Business System Review, conducted spring 2009;

- Annual Review by external panel, conducted October 2009;
- Mid-Term Review by NSF program directors planned Spring 2010; and
- Annual Review by external review planned October 2010.

Renewal/Recompetition/Termination:

A comprehensive renewal review was conducted in FY 2007. On August 8, 2007 the National Science Board approved NSF's recommendation for a five-year renewal award not to exceed $162.0 million for FY 2008-2012. This award allows NHMFL to increase its user program, continue development of new magnet systems, and support the strongest aspects of its in-house research efforts. The award ensures that the laboratory will remain the international leader in magnet research operations and development. NSF is currently examining options to recompete or renew the award in FY 2012.

National Solar Observatory

$9,510,000
+$410,000 / 4.5 %

National Solar Observatory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Solar Observatory	$7.83	$1.40	$9.10	$9.51	$0.41	4.5%

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 provides routine, 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. They serve over 1,000 scientists annually. In FY 2009, NSO employed approximately 17 support scientists, 29 technical staff and 43 other personnel within the operating budget. In FY 2010, NSO will reduce staff by approximately three FTEs.

Total Obligations for NSO
(Dollars in Millions)

	FY 2009 Omnibus Actual	2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
NSO-Operations	$6.75	$1.40	$7.25	$7.58	$7.81	$8.02	$8.26	$8.51	$8.77
NSO-Development	0.78	-	1.50	1.57	1.61	1.67	1.72	1.75	1.80
NSO-Research & Ed.	0.30	-	0.35	0.36	0.37	0.40	0.41	0.45	0.46
ATST infrastructure	-	-	-	2.00	2.00	2.00	2.00	2.00	2.00
Total, NSO	**$7.83**	**$1.40**	**$9.10**	**$11.51**	**$11.79**	**$12.09**	**$12.39**	**$12.71**	**$13.03**

Totals may not add due to rounding.

[1] Funding levels displayed for FY 2012 through FY 2016 are planning estimates only.

Partnerships and Other Funding Sources: Thirty-four 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. Starting in FY 2011 and continuing for ten years, $2.0 million will be funded for education and workforce development programs on Maui, Hawaii in partnership with Maui Community College. This program is part of the mitigation of the impacts of the ATST construction.

NSO-Operations, $7.58 million (+$330,000 above FY 2010 Estimate of $7.25 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. In FY 2009 this amount was reduced below the originally presented plan, partly due to separating out ATST funding. This reduction also required operational cuts, including freezing unfilled positions and postponing merit increases (FY 2009 ARRA funding was restricted to urgent repairs and upgrades that would reduce future operations and maintenance costs). Increasing support in FY 2010 and further in FY 2011 is intended to offset some of the impact of the reduced FY 2009 funding.

The SOLIS (Synoptic Optical Long-term Investigations of the Sun) facility for solar observations over a long time frame.
Credit: National Solar Observatory/NSF

NSO-Development, $1.57 million (+$70,000 above FY 2010 Estimate of $1.50 million): In the FY 2009 estimate, this item included design and development of ATST, as well as development of new instrumentation for telescopes at KPNO and SPO. FY 2009 actual funding for ATST at $3.57 million has been separated out from the NSO base budget and is reported within the ATST narrative in the MREFC chapter. As discussed in the FY 2010 Request, NSO reporting now includes only work apart from ATST, notably for the SOLIS telescope (see picture). Small increases in FY 2011 and beyond will help maintain the scientific productivity of existing facilities as ATST enters construction and moves toward operations.

NSO-Research & Education, $360,000 (+$10,000 above FY 2010 Estimate of $350,000): NSO supports education of the public 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 Maui Community College.

ATST infrastructure, $2.00 million (+$2.00 million above FY 2010 Estimate of $0): NSO has agreed to mitigation activities related to ATST construction. The $2.0 million requested in FY 2011 is for education and workforce development programs on Maui in partnership with Maui Community College. Funding for these activities is not included in the MREFC construction project. This amount is therefore added over and above NSO's basic operations and maintenance support.

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 and independent cooperative agreement, separate from the NOAO award, 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 summer 2010.

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.

National Superconducting Cyclotron Laboratory

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

National Superconducting Cyclotron Laboratory
(Dollars in Millions)

	Fy 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Superconducting Cyclotron Laboratory	$20.50	$2.00	$21.00	$21.50	$0.50	2.4%

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a national user facility. With two 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 research program.

Total Obligations for NSCL
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations & Maintenance	$20.50	$21.00	$21.50	$21.50	$21.50	$23.50	$23.50	$23.50
ARRA Actual	2.00	-	-	-	-	-	-	-
Total, NSCL	**$22.50**	**$21.00**	**$21.50**	**$21.50**	**$21.50**	**$23.50**	**$23.50**	**$23.50**

Totals may not add due to rounding.

[1]The current cooperative agreement expires in FY 2011. Outyear funding estimates are for planning purposes only and do not reflect policy decisions.

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 recently completed 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. Also, the site provides research experiences for undergraduate 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.

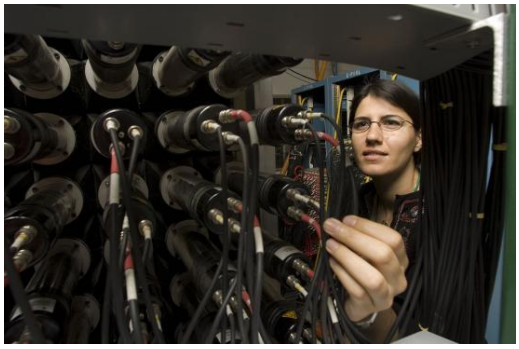
An experimental program using the coupled cyclotron facility is also underway. This effort is determined by beam use proposals. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments – many per year, with most running one to three days. The FY 2011 funding level is part of an overall five-year plan developed in response to recommendations from an external operations review committee in 2006. The committee recommended ramping up support such that NSCL runs at close to optimal operation, which is defined as the maximum amount of added beam time per extra dollar spent. FY 2011 marks the final year of the five-year plan and optimal operations will be achieved with the FY 2011 Request.

Facility Report:

Management and Oversight:

- NSF Structure: MSU operates NSCL under a cooperative agreement with NSF. The laboratory director is the key officer, who has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSF oversight is provided through annual site visits by the cognizant program officer of the Division of Physics and other staff, accompanied by external experts.

- External Structure: NSCL is managed by 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 opportunities for proposal submission each year. About 5,000 beam hours are provided for experiments each year, with a backlog of at least a year.



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

- Reviews:
  - Latest Review: An annual review in FY 2009 covered results and achievements related to intellectual merit and broader impacts.
  - Next Review: An annual review is planned for February 2010. Review topics include science, operations, and future funding.

Renewal/Recompetition/Termination:

NSCL is funded through a cooperative agreement that was renewed in FY 2007 and will expire in FY 2011. NSF will address the appropriateness of recompetition for the facility as a part of the FY 2010 review. If it is determined that renewal is appropriate, NSF anticipates that MSU will submit a renewal proposal in FY 2011. Funding for FY 2012 and beyond will be determined by the outcome of the review process.

POLAR PROGRAMS

Polar Facilities And Logistics **$381,380,000**
and the South Pole Station Modernization Project **+$69,110,000 / 22.1%**

Polar Facilities and Logistics
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Percent
Polar Facilities[1]	$228.72	$15.50	$199.24	$266.66	$67.42	33.8%
Transfer to U.S. Coast Guard per P.L. 111-117	-	-	[54.00]	-	N/A	N/A
Polar Logistics	112.66	7.00	113.03	114.72	1.69	1.5%
Total, Polar Facilities and Logistics	**$341.38**	**$22.50**	**$312.27**	**$381.38**	**$69.11**	**22.1%**

Totals may not add due to rounding.

[1]Funding 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 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Antarctic Infrastructure & Logistics	$175.20	$15.50	$199.24	$212.66	$216.70	$221.03	$225.46	$229.96	$234.56
South Pole Station Modernization Project	*15.76*	-	*15.93*	*16.15*	*16.46*	*16.79*	*17.12*	*17.47*	*17.82*
U.S. Coast Guard Icebreaker Support	53.52	-	[54.00]	54.00	54.00	54.00	54.00	54.00	54.00
Total, Polar Facilities	**$228.72**	**$15.50**	**$199.24**	**$266.66**	**$270.70**	**$275.03**	**$279.46**	**$283.96**	**$288.56**

Totals may not add due to rounding.

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, and maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile, and leasing of research vessels. 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 Polar Facilities. This line item also funds the operation and maintenance of the *Polar Sea* and the *Healy* in support of NSF science and, on a reimbursable basis, the needs of other federal agencies. The U.S. Coast Guard estimates that $54.0 million will be needed to fund operation and maintenance of the two vessels in FY 2011, which includes significant funding for a triennial dry dock for each vessel.

- 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. The relatively poor condition of the USCG polar icebreaker *Polar Sea*, due to its age and the uncertainty regarding its future availability, prompted OPP and its Advisory Committee to identify and study options for reducing demands on the ship-based logistics system. OPP is implementing several projects as contingencies against a possible failure of that system.

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. However, the research emphases at the three stations changes 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 recompete the Antarctic support contract. The most recent Antarctic support contract was recompeted 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 is in the process of extending the contract for an additional year. An award for the new support contract is expected to be made in FY 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 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
U.S. Antarctic Logistical Support	$69.24	-	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52
Research Support and Logistics	43.42	7.00	45.51	47.20	48.10	49.06	50.04	51.04	52.06
Total, Polar Logistics	**$112.66**	**$7.00**	**$113.03**	**$114.72**	**$115.62**	**$116.58**	**$117.56**	**$118.56**	**$119.58**

Totals may not add due to rounding.

The U.S. Antarctic Logistical Support program funds support provided by the U.S. Department of Defense (DoD). The DoD operates as a primary logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations, maintenance, and facilities support of 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. The current contract with CH2M HILL (previously, VECO USA) to provide research support and logistics services for NSF-sponsored activities in the Arctic was recompeted and awarded 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. 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 primary 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: 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. However, 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. Support contracts are recompeted as noted earlier.

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 FY 2010.

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)

					ESTIMATES				
	Prior Years	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
R&RA Obligations									
Concept & Development	$16.40								
Management & Operations		15.76	15.93	16.15	16.46	16.79	17.12	17.47	17.82
Subtotal, R&RA Obligations	16.40	15.76	15.93	16.15	16.46	16.79	17.12	17.47	17.82
MREFC Obligations									
Implementation	147.23	1.10	0.96	-					
Subtotal, MREFC Obligations	147.23	1.10	0.96	-	-	-	-	-	-
Total, SPSM Obligations	**$163.63**	**$16.86**	**$16.89**	**$16.15**	**$16.46**	**$16.79**	**$17.12**	**$17.47**	**$17.82**

Totals may not add due to rounding.

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 has 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, post-construction services, and construction inspection for the project.

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

- 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 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 review of the cost and schedule for the final year of the project is planned for early FY 2010.

Current Project Status:

- Tasking Completed in FY 2009:
  - Conditional Occupancy of the Logistics Facility and the Aircraft Fueling Module, the last major technical milestones

Cost and Schedule:

SPSM scope is approximately 96.5 percent complete, with the elevated station and all science facilities in full use. Project cost performance index (CPI) and schedule performance index (SPI) are presently ranked green, indicating variances are within 10 percent, and current forecasts show the project completing on schedule and within budget. Available contingency is approximately 4 percent of remaining costs

- Tasking Scheduled for FY 2010:
  - Complete Dome Demolition;
  - Retrograde Demolition Materials;
  - Install Logistics Facility Racks;
  - Complete Siding of the Elevated Station; and
  - Complete Punch List Items.

Risks:

Project performance could be affected if a full construction crew cannot be maintained for the remaining scope. Additional high impact risk elements to project completion include 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. A steady state of operational support is anticipated at $16.0 million, excluding inflation. The expected lifetime of the modernized station is 25 years, through FY 2031.

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, please see the MREFC chapter in this document.

Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction planning activities for prospective large facility projects. The funding generally supports such activities as design, cost estimations, and other activities that prepare projects for oversight review and potential implementation. For FY 2011, these funds support next generation physics and astronomy facilities, including: an underground physics laboratory, high intensity synchrotron radiation x-ray sources; large aperture optical telescopes; fast, wide-field telescopes; and meter/centimeter wavelength radio telescopes.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

GEOSCIENCES

National Center For Atmospheric Research **$108,000,000**

$11,000,000 / 11.3%

National Center for Atmospheric Research
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Center for Atmospheric Research	$106.79	$13.20	$97.00	$108.00	$11.00	11.3%

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 2009, there are a total of 783 FTEs in NCAR of which 354 are funded under the NSF primary award to UCAR.

Number of FTEs Supported at NCAR

FTEs	Primary Award[1]	All Funding
Career Scientists	95	135
Scientific Support[2]	235	519
Other Staff[3]	24	129
Total	**354**	**783**

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

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

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

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 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Aircraft Support[1]	$10.56	$10.70	$9.93	$10.23	$10.63	$11.06	$11.50	$11.96	$12.44
Computational Infrastructure[2]	21.17	2.50	22.00	24.25	25.22	26.22	27.27	28.36	29.50
Other Facility Support	27.55		23.42	26.88	27.95	29.06	30.23	31.43	32.69
Research & Education Support	47.51		41.65	46.64	48.50	50.44	52.46	54.56	56.74
Total, NCAR	**$106.79**	**$13.20**	**$97.00**	**$108.00**	**$112.30**	**$116.78**	**$121.46**	**$126.31**	**$131.37**

Totals may not add due to rounding.

[1]Includes about $150,000 for scientific research in areas such as biogeosciences and aerosols.

[2]Does not contain research funds

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2009, NCAR received approximately $46.0 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR), and $26.0 million from non-federal sources, such as universities.

Major Investments in FY 2011: In FY 2011, 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. In addition, UCAR will continue to invest NSF funds to refurbish NSF-owned infrastructure such as replacing the Mesa Lab access road and parking lot, which are beyond their designed life expectancy.

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 complex research measurements. The two aircraft will support several community-originated projects deemed by peer review to be of exceptional scientific merit. In 2011, aircraft support totals approximately $10.23 million.

Scheduled projects in FY 2010:

- The Bio-hydro-atmosphere interactions of Energy, Aerosols, Carbon, H2O, Organics & Nitrogen (BEACHON) program will study boundary layer evolution over the Manitou Experimental Forest in Woodland Park, Colorado. Two events will be targeted: a wet environment immediately following rainfall, and a drier period approximately one week after heavy rain. The principal investigators (PIs) plan to involve students from Colorado College and to conduct public outreach activities. The cost of this project is $78,000.
- Continued missions of the HIAPER Pole to Pole Observations (HIPPO) experiment, which measures cross sections of atmospheric concentrations of carbon cycle and greenhouse gases from the north to

the south polar areas four different times over a two year period. This experiment provides a comprehensive global survey of atmospheric trace gases covering the full troposphere in all seasons and multiple years. Conducted in Colorado, Alaska, Hawaii, American Samoa, New Zealand, Tahiti, Easter Island, and Costa Rica, HIPPO totals $2.96 million.

- The Inhibition of Snowfall by Pollution Aerosols (ISPA) project examines the link between riming of snow and aerosols. The study is centered around the Desert Research Institute's Storm Peak Laboratory (SPL) on Mt. Warner near Steamboat Springs, Colorado. SPL will operate a range of equipment (e.g., aerosol and cloud droplet samplers), while balloon-borne sounding systems will operate near the base of the mountain providing thermodynamic profiles through the clouds. Students will be involved in the project, and outreach activities are planned with local schools. The NCAR cost of ISPA is $200,000.
- The Profiling of Winter Storms (PLOWS) experiment is a study of the microphysical structures within banded features and their relation to mesoscale storm dynamics in mid-western snow storms. The goal of the proposed research is to improve our understanding of precipitation, thermodynamic, and kinematic sub-structures in the northwest and warm frontal quadrants of these storms. This project costs $2.22 million, which includes $1.55 million for C-130 operations.
- The HIAPER Equipment Flight Test for FY 2010 (HEFT-4) will provide extended flight testing of new research instruments on the G-V aircraft. The payload for HEFT-4 includes: HIAPER Atmospheric Radiation Package (HARP); Airborne Multi-AXis Differential Optical Absorption Spectroscopy (AMAX-DOAS) instrument; Laser Air Motion Sensor (LAMS); Holographic Detector for Clouds 2 (HOLODEC-2); Small Ice Detector, Version 2 (SID-2H); and the High Spectral Resolution Lidar (HSRL). Twenty-five flight hours are planned at a cost of $102,000.

Projects scheduled or under consideration for FY 2011:

- Genesis and Rapid Intensification Processes (GRIP) is a cost-recovery, NASA-funded field experiment to investigate tropical cyclones. NASA will use NCAR's Airborne Vertical Atmospheric Profiling System (AVAPS) GPS Dropsonde system on its DC-8 aircraft to study intensification of tropical cyclones in the western Atlantic, Caribbean, and Gulf of Mexico. The cost is $73,000.
- The Persistent Cold Air Pool Study (PCAPS) is designed to investigate the processes leading to the formation, maintenance, and destruction of persistent, multi-day, mid-winter temperature inversions or cold-air pools that form in the Salt Lake basin. This experiment will cost $534,000.
- The PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) is a field experiment designed to improve our understanding of the dynamics of tropical cyclone formation and to dramatically improve the spatial and temporal sampling of tropical disturbances prior to, and during, genesis. The project will be located in St. Croix and totals about $3.0 million, including $1.76 million to support costs associated with HIAPER.
- The Western Airborne Mercury Observations (WAMO) experiment will measure gaseous elemental mercury (GEM) and reactive gaseous mercury (RGM) with high time (and spatial) resolution from the NSF/NCAR C-130. This experiment will cost $354,000.
- The HIAPER Equipment Flight Test for FY 2011 (HEFT-5) will test the performance of new research instruments on the G-V aircraft, specifically the HIAPER Cloud Radar (HCR) and the Time of Flight Aerosol Mass Spectrometer (ToF-AMS), and should cost approximately $100,000.

Computational Infrastructure: NCAR's computational facility is recognized as world-class. The latest addition to the facility, BlueFire, installed in November 2008, was ranked as the 43rd most powerful computer in the world by the top 500 Supercomputer Centers project.

Computational Infrastructure by Subcategory, FY 2011
(Dollars in Millions)

Operations Staff and Staff Related Costs	$11.19
IT and Facility Infrastructure, Utilities, Data Analysis, Mass Storage Equipment	5.40
Supercomputing Capital Equipment	4.25
Total	**$20.84**

BlueFire supports the Community Climate System Model (CCSM) which uses mathematical formulas to recreate the chemical and physical processes that drive Earth's climate, and was used by the Intergovernmental Panel on Climate Change (IPCC) to forecast future climate under a number of scenarios.

In FY 2011, NCAR will continue to oversee construction of a new computational facility. This activity is expected to receive $25.0 million in Research and Related Activities (R&RA) account funding in FY 2010, with $19.2 million and $6.0 million anticipated in 2011 and 2012 respectively. Although NCAR is overseeing the construction of this facility, construction funds are budgeted separately from NCAR's other activities and are not included in NCAR's budget. For this effort, NCAR is working with the University of Wyoming and other partners in the state. The Wyoming partners are providing the land, $20.0 million for the construction of the facility, and will also contribute $1.0 million annually toward the supercomputer and mass storage procurements. This 3-year effort would provide the physical infrastructure needed to expand NCAR's computational capability, and the building and computational resources are planned to be available to the community in FY 2012. Planning activities currently underway include a project development plan, an architectural and engineering study, an environmental assessment study, and a thorough external review of the proposed enhancement to NCAR facilities.

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 (see table below). These facilities are used by both NCAR and community researchers to undertake cutting edge research projects. Funding for other facilities at NCAR totals $26.88 million in FY 2011.

Other Facility Support by Subcategory, FY 2011
(Dollars in Millions)

Observing Platforms and Technology	
EOL Infrastructure (including Equipment)	$2.90
Field Proj. and Data Management	1.05
Design and Fabrication Services	1.24
CDS Systems Infrastructure	2.25
Dropsonde/Driftsonde	0.85
SPOL	1.08
Technology Developments	0.92
ISFS	1.43
ELDORA	0.53
ISS/GAUS	1.15
Subtotal, Observing Platforms and Technology	13.40
Community Models	
Community Climate System Model	$8.19
Weather Research and Forecasting model	2.00
Whole Atmosphere Community Climate Model	0.79
Subtotal, Community Models	10.98
Other Infrastructure	
Upper atmospheric observing facilities	$1.58
Chemistry instrumentation (ACD)	0.92
Subtotal, Other Infrastructure	2.50
Total, Other Facility Support	**$26.88**

Totals may not add due to rounding.

Research and Education Support: Funding for research and education support at NCAR totals $46.64 million in FY 2011. As an internationally recognized center of excellence, 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 larger-scale weather; and
- the examination of human society's impact on and response to global environmental change.

Management at NCAR uses the NSF merit review criteria to allocate resources within NCAR. These allocations are subject to review and approval by the Division of Atmospheric and Geospace Sciences.

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. This research is performed in the Research Application Laboratory and currently receives $3.33 million in support.

Educational activities at NCAR are recognized as outstanding in their field, 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, which includes the Advanced Study Program.

Facility Report:

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 requirement 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 COV reports offered positive and constructive comments on NSF's oversight of UCAR/NCAR. The most recent Committee of Visitors 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.

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

- Reviews:
  - Approximately mid-way through the current award (in FY 2012), AGS will conduct comprehensive reviews of science, facilities, and management.

Renewal/Recompetition/Termination Issues:

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.

MATHEMATICAL AND PHYSICAL SCIENCES

National Optical Astronomy Observatory

$33,330,000
+$1,830,000 / 5.8%

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Optical Astronomy Observatory[1]	$30.48	$5.60	$31.50	$33.33	$1.83	5.8%

Totals may not add due to rounding.

[1] Includes the Telescope System Instrumentation Program (TSIP)

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 the Large Synoptic Survey Telescope (LSST), both of which are high priority recommendations of the 2000 Decadal Survey 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 2009, 85 thesis students and an additional 64 non-thesis graduate students used NOAO telescopes for their research. In FY 2010 NOAO employs nearly 360 personnel in Arizona and Chile, including 45 support scientists and 11 postdoctoral fellows.

Total Obligations for NOAO

(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Plan	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
NOAO-Operations	$19.86	$5.60	$20.00	$20.33	$20.84	$21.36	$21.89	$22.44	$23.00
NOAO-Development	5.94	-	7.00	7.50	7.78	8.12	8.47	8.83	9.19
NOAO-Research & Ed.	0.68	-	0.50	0.50	0.55	0.57	0.59	0.61	0.65
TSIP[2]	4.00	-	4.00	5.00	5.00	5.00	5.00	5.00	5.00
Total, NOAO	**$30.48**	**$5.60**	**$31.50**	**$33.33**	**$34.17**	**$35.05**	**$35.95**	**$36.88**	**$37.84**

Totals may not add due to rounding.

[1] Funding levels displayed for FY 2012 through FY 2016 are planning estimates only.

[2] TSIP is the Telescope System Instrumentation Program.

Partnerships and Other Funding Sources: Thirty-four U.S. member institutions and six 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 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 2009, NOAO received about $5.11 million from partnerships, tenant observatory support, the Kitt Peak Visitors' Center, grants from other federal agencies, and NSF supplemental funding for GSMT, LSST, and ReSTAR. An additional $5.60 million of FY 2009 ARRA funds supported infrastructure improvements.

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.

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

NOAO-Operations: $20.33 million (+$330,000 over FY 2010 Estimate of $20.0 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: $7.50 million (+$500,000 over FY 2010 Estimate of $7.0 million): Development support covers NOAO's share of the design and development of the LSST and 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, perhaps, Gemini will continue with modest increases in this component. Design and development contributions to the LSST will also continue.

NOAO-Research & Education: $500,000 (equal to the FY 2010 Estimate): 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 the EPO area.

Telescope System Instrumentation Program (TSIP): $5.0 million (+$1.0 million over FY 2010 Estimate of $4.0 million): NOAO manages TSIP on behalf of NSF. This program supports the development and fabrication of instrumentation at non-federal observatories in return for competitively reviewed observing time for the national community. A recommendation of the 2000 Decadal Survey in astronomy, TSIP has proved extremely effective in gaining access for the Nation's community of researchers to non-federal

observatories.. This program was funded at the $4.0 million level through FY 2010, and the FY 2011 request increases this to $5.0 million (roughly, 20 extra nights).

In FY 2009, $3.0 million was added to the NOAO budget for the award "Renewing Small Telescopes for Astronomical Research (ReSTAR)". The goal of this award is to improve the instrument capabilities and increase the availability to the community of telescope time on "small" non-federally-funded telescopes. In this context, "small" telescopes are from two to five meter size.

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 as.

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 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.

National Radio Astronomy Observatory

$67,870,000
+$780,000 / 1.2%

National Radio Astronomy Observatory
(Dollars in Millions)

	FY 2009 Omnibus Actual	FY 2009 ARRA Actual	FY 2010 Estimate	FY 2011 Request	Change over FY 2010 Estimate Amount	Change over FY 2010 Estimate Percent
National Radio Astronomy Observatory	$60.79	$5.40	$67.09	$67.87	$0.78	1.2%

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

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.

NRAO staff includes 420 FTEs in the operations and maintenance component of the Observatory: 62 in Observatory Management, 316 in Observatory Operations, 28 in Science & Academic Affairs and Education and Public Outreach (EPO), and 14 in the Central Development Laboratory.

Total Obligations for NRAO
(Dollars in Millions)

	FY 2009 Actual	FY 2010 Estimate	FY 2011 Request	ESTIMATES[1] FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Operations & Maintenance	$43.60	$43.14	$43.24	$42.89	$44.33	$46.95	$49.25	$51.71
Observatory Management	*7.30*	*6.03*	*7.10*	*7.10*	*7.25*	*7.30*	*7.40*	*7.75*
Observatory Operations	*30.35*	*31.77*	*31.02*	*30.04*	*30.93*	*33.15*	*35.00*	*36.71*
Science, Academic Affairs, EPO	*4.26*	*3.62*	*3.62*	*4.25*	*4.40*	*4.50*	*4.60*	*4.75*
Central Development Lab	*1.69*	*1.72*	*1.50*	*1.50*	*1.75*	*2.00*	*2.25*	*2.50*
ARRA Actual	5.40	-						
Implementation of EVLA	6.19	6.38	1.13					
ALMA Operations	11.00	17.57	23.50	30.65	33.92	36.41	39.17	42.10
Total, NRAO	**$66.19**	**$67.09**	**$67.87**	**$73.54**	**$78.25**	**$83.36**	**$88.42**	**$93.81**

Totals may not add due to rounding.

[1]Funding levels under Operations and Maintenance in FY 2012 to FY 2016 are planning estimates only.

The major area of increased funding in FY 2011 is ALMA operations (+$5.93 million to $23.50 million). Base operations funding increased by $100,000 to $43.24 million. Funding for the implementation of the Expanded Very Large Array (EVLA), concludes in FY 2011 (decrease of $5.25 million to $1.13 million).

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 2009, NRAO received approximately $1.0 million from non-AST sources at NSF, $250,000 from other federal agencies, and about $300,000 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 (now in full operation) and the redesigned visitor center at the Very Large Array (VLA) together attract about 68,000 public visitors each year.

Observatory Management, $7.10 million (+$1.07 million over FY 2010 Estimate of $6.03 million): Observatory Management includes the director's office, administrative services, the end-to-end data management initiative, and the New Initiatives Office. The FY 2010 Estimate is decreased due to a lower than anticipated outlay rate at the facility in FY 2009. The FY 2011 Request restores funding to the required obligation level.

Observatory Operations, $31.02 million ($750,000 decrease over FY 2010 Estimate of $31.77 million): The Observatory Operations programmatic area includes the support for operating facilities at Green Bank, West Virginia and in New Mexico, and the computer and information services that support the facilities. Decreased funding is part of the budget realignment plan to support ALMA operations.

Science & Academic Affairs and EPO, $3.62 million (equal to the FY 2010 Estimate): This area includes staff research, science training and education, science centers, the library, science community outreach, and news and public information. Funding is held constant to partially accommodate the ramp up in ALMA operations.

Central Development Laboratory (CDL), $1.50 million ($220,000 decrease below FY 2010 Estimate of $1.72 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. Decreased funding is part of the budget realignment plan to support ALMA operations.

Implementation of EVLA, $1.13 million (-$5.25 million decrease below the FY 2010 Estimate of $6.38 million): FY 2011 funding includes a planned decrease as the construction phase ends. The Very Large Array (VLA) is undergoing an upgrade of electronics and communications systems, referred to as the Expanded Very Large Array (EVLA), to significantly enhance capabilities. Total project cost is $87.0 million. Construction of the EVLA began in FY 2001 and is proceeding on budget and on schedule according to original plans, for completion in calendar year 2012. The EVLA will provide a factor of ten improvement in capability in several areas over the VLA. More than half of the VLA antennas have been converted to EVLA standards and all remaining antennas will be retrofitted by the end of 2010. Canada is responsible for the correlator for processing EVLA data, and the first sections of the correlator arrived in the third quarter of 2008. Early scientific observations will begin in 2010, with full science operations by 2013. The transformation of the VLA into the EVLA has proceeded with little interruption to the regular VLA observing schedule.

ALMA Operations, $23.50 million (+$5.93 million over the FY 2010 Estimate of $17.57 million): NRAO is also engaged in construction of the international ALMA, which in FY 2011 will be entering the tenth 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 in FY 2008 to FY 2015. A funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations estimates for FY 2012 and beyond are based on current cost projections. Additional information on the ALMA project is available in the MREFC chapter.

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 ramping up its activity level 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 Large Facilities Project Office in 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:

A new cooperative agreement is in place for the years FY 2010 through FY 2015.