

ARECIBO OBSERVATORY

\$7,720,000
-\$1,180,000 / -13.3%

Arecibo Observatory

(Dollars in Millions)

FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request	Change over FY 2016 Actual	
			Amount	Percent
\$8.90	-	\$7.72	-\$1.18	-13.3%

The Arecibo Observatory (Arecibo) is a center for multidisciplinary research and education with world-class observational facilities. The observatory’s principal facility is one of the world’s largest single-dish radio/radar telescopes, a 305-meter diameter reflector located near the town of Arecibo in western Puerto Rico on 120 acres of U.S. Government-owned land. Arecibo is currently operated and managed by SRI International and subrecipients Universities Space Research Association (USRA) and Universidad Metropolitana (UMET) under a cooperative agreement with NSF that initially ran from October 1, 2011 to September 30, 2016, and was extended by 18 months to March 31, 2018. The observatory serves over 350 users annually with a wide range of research and observing instrumentation in passive radio astronomy, solar system radar astronomy, and space and atmospheric sciences. A peer-review telescope allocation committee provides merit-based telescope time to users. The committee is common to the three fields, but specific subject matter experts from outside the observatory are consulted for reviews. NSF does not provide awards targeted specifically for use of Arecibo, although some Arecibo users are supported through NSF or NASA grants to pursue scientific programs that require use of the facility.

Currently, Arecibo is staffed at approximately 120 full-time equivalent (FTE) employees, of which about 100 are funded by NSF. The remaining FTEs are supported by a grant from NASA, by the Angel Ramos Foundation Visitor Center, and by other funding sources. Staff include approximately 20 scientists who, along with engineers, technicians, and operators, are available to help visiting investigators with observing programs. In addition, there are management, administrative, and clerical positions, as well as maintenance staff, and several postdoctoral scholars and students.

Total Obligations for the Arecibo Observatory

(Dollars in Millions)

	FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request	ESTIMATES ¹				
				FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Operations & Maintenance (MPS)	\$4.80	-	\$3.90	\$3.05	\$2.13	\$1.50	\$1.13	\$1.00
Operations & Maintenance (GEO)	4.10	-	3.82	3.03	2.13	1.50	1.13	1.00
Total, Arecibo	\$8.90	-	\$7.72	\$6.08	\$4.25	\$3.00	\$2.25	\$2.00

¹ Outyear funding estimates are for planning purposes only. The current cooperative agreement, initially scheduled to end in FY 2016, has been extended through 31 March 2018.

Arecibo is jointly supported by the NSF Directorate for Mathematical and Physical Sciences (MPS), Division of Astronomical Sciences (AST) and the NSF Directorate for Geosciences (GEO), Division of Atmospheric and Geospace Sciences (AGS). Planned AST support through FY 2018 is based on the 2006 AST Senior Review recommendations, an external review of the AST portfolio conducted in 2012, and guidance from a third-party cost review of AST facilities.

In 2012, the AST Portfolio Review Committee recommended “continued AST involvement in Arecibo...be

re-evaluated later in the decade in light of the science opportunities and budget forecasts at that time.”⁹ The *New Worlds, New Horizons: Midterm Assessment* (August 15, 2016) reinforced this, with Recommendation 3.1 noting: “The NSF should proceed with divestment from ground-based facilities that have a lower scientific impact....”¹⁰

The Geospace Section (GS) Portfolio Review Committee was charged by the NSF Advisory Committee for Geosciences to review the most promising Geospace science strategies and critical capabilities and to reconcile these with the science goals described by the 2013 Decadal Survey for Solar and Space Physics. The GS is associated with AGS and its portfolio includes grant programs in upper-atmospheric sciences, space science and space weather. This GS portfolio review was carried out using the assumption of an inflation-adjusted, flat budget for GS over the next decade to FY 2026. The GS Portfolio Review Committee recommendations include the reduction of annual AGS Arecibo Observatory funding from \$4.10 million to \$1.10 million by 2020.

GEO commissioned a review from a second panel assembled by the National Academy of Science that assessed the process by which the GS Portfolio Review Committee reached their findings and recommendations. The panel published the results of this review in early 2017 and, for Arecibo, reiterated the recommendations GS Portfolio Review Committee.

Because of these potential changes, NSF is currently preparing an Environmental Impact Statement (EIS) to evaluate proposed operational changes at Arecibo due to funding constraints, pursuant to the National Environmental Policy Act (NEPA). NSF is also completing its compliance obligations with the National Historic Preservation Act (NHPA), and the Endangered Species Act (ESA). A draft version of the EIS (Draft EIS) was released on October 28, 2016.¹¹ In the Draft EIS, NSF evaluated the anticipated environmental impacts stemming from implementation of several proposed alternatives, including: (1) No-Action Alternative; (2) *Alternative 1* - Collaboration with interested parties for continued science-focused operations at Arecibo Observatory (identified in the Draft EIS as the Agency Preferred Alternative); (3) *Alternative 2* - Collaboration with interested parties for continued education-focused operations at Arecibo Observatory; (4) *Alternative 3* - Mothballing of facilities (suspension of operations in a manner such that operations could resume efficiently at some future date); (5) *Alternative 4* - Partial deconstruction and site restoration; and (6) *Alternative 5* - Full deconstruction and site restoration.

Following the 45-day public comment period that ended on December 12, 2016, NSF is preparing a Final EIS. Concurrent with the EIS process, NSF is working with consulting parties under Section 106 of the NHPA to find ways to avoid, minimize, or mitigate any adverse effects on nationally significant historic properties at Arecibo as a result of implementation of any of the proposed alternatives. Likewise, NSF is working with the U.S. Fish and Wildlife Service to evaluate the anticipated impacts from implementation of the proposed alternatives on threatened/endangered species and their habitats.

NSF issued a solicitation on January 25, 2017 requesting proposals to provide continued operations and management of Arecibo for five years, but at reduced funding. After the conclusion of NSF’s compliance with federal statutes for the EIS, and review of responses to the solicitation, NSF will prepare a Record of Decision documenting its chosen course of action with regard to Arecibo Observatory.

Partnerships and Other Funding Sources: Arecibo leverages NSF support with funding from other federal and non-federal sources. Since FY 2010, the NASA Near Earth Object Observation Program has committed \$2.0 million annually to Arecibo in support of the planetary radar program; this increased to \$3.60 million

⁹ www.nsf.gov/mps/ast/ast_portfolio_review.jsp

¹⁰ www.nap.edu/read/23560/chapter/1

¹¹ www.nsf.gov/mps/ast/env_impact_reviews/arecibo/arecibo_drafteis.jsp

Major Multi-User Research Facilities

for FY 2013, with more observing time allocated to the NASA program. NASA support is expected to continue at approximately \$3.60 million in FY 2018.

Education and Public Outreach (EPO): Arecibo hosts a Research Experiences for Undergraduates (REU) site, and Ph.D. students receive training through the use of the facility. Over 350 students have participated in REU programs at Arecibo. In collaboration with the National Radio Astronomy Observatory (NRAO), Arecibo holds a summer school on single-dish radio astronomy techniques. Arecibo also sponsors a major outreach program in Puerto Rico via the Angel Ramos Foundation Visitor Center as well as summer workshops for K-12 teachers. This center attracts more than 80,000 visitors each year; over 1.4 million people have visited since its opening in 1997. Approximately 25 percent of these visitors are K-12 students. Exhibits at the visitor center were updated, and physical renovations to the visitor center building were completed in FY 2016. These improvements were funded by the Angel Ramos Foundation and the Ana G. Méndez University System, and were formally approved by the NSF. With funds received from the Puerto Rico Department of Education, Arecibo has hosted numerous teacher workshops and has trained approximately 500 teachers. This program integrates formal activities at the Angel Ramos Foundation Visitor Center into the STEM curriculum in Puerto Rico. Arecibo also hosts several meetings each year within a wide variety of scientific disciplines.



An image of the Arecibo Radio Telescope in Puerto Rico. The platform suspension structure, including the Gregorian dome that houses the main suite of research instruments, is visible over the 305-meter primary reflector dish below. *Credit: Arecibo Observatory/NSF.*

Operations and Maintenance: Arecibo administers observing time to the astronomy and aeronomy communities via competitive observing proposals, and conducts educational and public outreach programs at all levels. Observing hours among science programs are based on the quality of the observing proposals. The telescope is currently oversubscribed, counting ongoing astronomy surveys, new astronomy projects, solar system observations, and atmospheric sciences programs. About 75 percent of astronomy users conduct their observing remotely via networked control software, while radar observations typically employ on-site users.

Management and Oversight

- AST, \$3.90 million: AST funding will maintain basic operations costs and science programs in passive radio astronomy. As recommended by the 2006 AST Senior Review, AST funding for Arecibo has been gradually reduced. The reduction will continue in FY18.
- AGS, \$3.82 million: AGS funding will support basic operations costs and science programs in aeronomy and space physics, including space weather.
- NSF Structure: Ongoing oversight is provided by the lead NSF program officer in AST, in close cooperation with a program officer in AGS, and in consultation with community representatives. The program officers make use of detailed annual program plans, long-range plans, quarterly technical and financial reports, and annual reports submitted to NSF by SRI. They also attend SRI governance committee meetings, as appropriate. To address issues that arise, program officers work closely with other NSF offices. This includes the Division of Acquisition and Cooperative Support and the Large Facilities Office, both within the Office of Budget, Finance, and Award Management; and the Office of General Counsel. The AST and AGS program officers conduct periodic site visits and frequent,

- regular, teleconferences.
- External Structure: Management is via a cooperative agreement with SRI and its sub-awardees, USRA and UMET. The awardees provide management and oversight through their own advisory and visiting committees, including an Arecibo Observatory Users Committee, a Scientific Management Advisory Committee, a Council of Puerto Rican Chancellors and Stakeholders, and an Executive Governing Committee. The principal investigator of the operations award resides at SRI headquarters in Menlo Park, CA, but makes frequent site visits to Puerto Rico. The principal on-site management staff include the Arecibo site director, resident at the telescope site, a deputy director in the areas of Radio Astronomy and Planetary Radar, and a deputy director for Education and Public Outreach.
 - Reviews:
 - A proposal review for the management and operations of Arecibo occurred 2010, resulting in an award to SRI (see above) from October 2011 to September 2016, extended by 18 months to March 31, 2018.
 - AST and AGS jointly conduct annual external reviews of Arecibo program plans; the most recent such review was held in January 2017.

Renewal/Competition/Termination

The current cooperative agreement with SRI for the management of Arecibo was awarded on October 1, 2011, when SRI succeeded the previous managing organization, Cornell University. This followed a competitive process for a new five-year cooperative agreement, consistent with National Science Board policy. This agreement was in effect through September 30, 2016, and was extended through March 31, 2018. As discussed previously, the direction beyond that time will be determined after carrying out the EIS process and evaluating the responses to the solicitation for management and operations beyond March 31, 2018. As can be seen in the obligations table above, outyear funding estimates are reduced from recent levels and are consistent with the NSF funding profile provided in the FY 2017 management competition solicitation.