

**OTHER ASTRONOMICAL FACILITIES**

**\$8,420,000**  
**-\$3,490,000 / -29.3%**

**Other Astronomical Facilities Funding**

(Dollars in Millions)

FY 2018 <sup>1</sup> Actual	FY 2019 (TBD)	FY 2020 Request	Change over	
			FY 2018 Actual Amount	Percent
\$11.91	-	\$8.42	-\$3.49	-29.3%

<sup>1</sup> FY 2018 Actual includes both GBO and LBO/VLBA, while the FY 2020 Request only includes GBO funding.

For FY 2020, Other Astronomical Facilities consists of the Green Bank Observatory (GBO), which was separated from the National Radio Astronomy Observatory (NRAO) beginning in FY 2017. The Long Baseline Observatory (LBO), which was separated from NRAO at the same time as GBO and was previously in “Other Astronomical Facilities,” has been reintegrated as the Very Long Baseline Array (VLBA) into NRAO effective October 1, 2018. The reassignment of that share of the funding request accounts for the significant difference in the requested FY 2020 total. Associated Universities, Inc. (AUI) remains the managing organization for GBO through a cooperative agreement with NSF. This narrative presents the FY 2020 Budget Request for GBO.

GBO provides ground-based radio-wavelength research facilities for the U.S. national community, while carrying out a program in education for public visitors and students. The Green Bank Telescope (GBT) is the world’s largest fully steerable single-dish radio telescope and is GBO’s flagship research instrument. The GBO contributes to a broad area of scientific research, including fundamental physics, astronomy, and the search for intelligent life beyond the Earth. GBO is the administrative site of the 13,000-square-mile National Radio Quiet Zone, where all radio transmissions are limited. Having telescopes within this quiet zone allows for detection of faint scientific signals that would otherwise be drowned out by human-made signals.

In 2010, the National Academies of Science, Engineering, and Medicine conducted their sixth decadal survey in astronomy and astrophysics. In their report, *New Worlds, New Horizons in Astronomy and Astrophysics*,<sup>1</sup> the committee recommended that “NSF-Astronomy should complete its next senior review before the mid-decade independent review that is recommended in this report, so as to determine which, if any, facilities NSF-AST should cease to support in order to release funds for (1) the construction and ongoing operation of new telescopes and instruments and (2) the science analysis needed to capitalize on the results from existing and future facilities.” In response to this recommendation, the MPS Division of Astronomical Sciences (AST) conducted a community-based review of its portfolio. The resulting Portfolio Review Committee report, *Advancing Astronomy in the Coming Decade: Opportunities and Challenges*,<sup>2</sup> was released in August 2012 and included recommendations about all major AST telescope facilities.

In 2012, the Portfolio Review Committee recommended divestment of GBT and VLBA from AST funding because of a less compelling mapping to the science questions of the 2010 decadal survey compared to other facilities. As announced in a Dear Colleague Letter, NSF 13-074,<sup>3</sup> NSF partitioned GBT and VLBA from the competition for NRAO management and operations, which increased flexibility for exploring cost-efficient operational models and sustainable partnerships for GBO (comprising GBT and the Green Bank site and facilities) and VLBA/LBO. Existing partnerships are described below, and additional partner

<sup>1</sup> [www.nap.edu/catalog.php?record\\_id=12951](http://www.nap.edu/catalog.php?record_id=12951)

<sup>2</sup> [www.nsf.gov/mps/ast/ast\\_portfolio\\_review.jsp](http://www.nsf.gov/mps/ast/ast_portfolio_review.jsp)

<sup>3</sup> [www.nsf.gov/pubs/2013/nsf13074/nsf13074.jsp](http://www.nsf.gov/pubs/2013/nsf13074/nsf13074.jsp)

discussions with governmental and non-governmental entities are ongoing.

In FY 2016, AST received a proposal from AUI to continue management and operation of GBO and LBO in FY 2017 and FY 2018, separate from the management and operation of NRAO. Previously, the obligations for GBO and VLBA/LBO were heavily matrixed and not separable from the overall obligation for NRAO. Hence, GBO and VLBA/LBO, which were previously included in the NRAO narrative, were first presented as a separate entry in the FY 2017 Budget Request. Through the development of (primarily) federal government partnerships, NSF was able to decrease its funding commitment to VLBA/LBO operations to a satisfactory level that ensures the future of the facility and enabled the reintegration back into NRAO at the beginning of FY 2019 while maintaining the overall facility top-level funding line.

Pursuant to the National Environmental Policy Act, NSF has conducted a formal environmental review of GBO and developed an Environmental Impact Statement (EIS), which considers the environmental impact of various future alternatives for GBO. The final EIS was published in February 2019, and the process is anticipated to conclude in FY 2019 with a decision on the way forward for GBO, which will be memorialized in a Record of Decision published by NSF.

**Total Obligations for Other Astronomical Facilities**

(Dollars in Millions)

	FY 2018	FY 2019	FY 2020	ESTIMATES <sup>1</sup>				
	Actual	(TBD)	Request	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
GBO Operations & Maintenance	\$8.42	-	\$8.42	\$8.42	\$8.42	\$8.42	\$8.42	\$8.42
LBO Operations & Maintenance <sup>2</sup>	3.49	-	-	-	-	-	-	-
<b>Total</b>	<b>\$11.91</b>	<b>-</b>	<b>\$8.42</b>	<b>\$8.42</b>	<b>\$8.42</b>	<b>\$8.42</b>	<b>\$8.42</b>	<b>\$8.42</b>

<sup>1</sup> Outyear funding estimates are for planning purposes only. The current cooperative agreement for GBO has been extended through September 2019.

<sup>2</sup> Funding for LBO was reintegrated into NRAO as VLBA effective October 1, 2018.

GBO Operations and Maintenance: The FY 2020 Request of \$8.42 million encompasses support for direct telescope operations at GBO, including maintenance, infrastructure upgrades, and telescope management, as well as funds allocated for Education and Public Outreach.

Partnerships and Other Funding Sources: In FY 2017, GBO received approximately \$4.3 million from other sources, mostly from non-federal partners. External (non-NSF) contributions represented approximately 35 percent of the total operations budget of GBO. Many of the GBO partnerships involve guaranteed allocations of observing time on the GBT.

In FY 2016, GBO began a 10-year partnership with Breakthrough Listen and had funding partnerships with West Virginia University and the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) consortium that are expected to continue through FY 2020. (The NANOGrav funding comes from the NSF award to the NANOGrav Physics Frontiers Center.) In addition, the GBO partnership with the RadioAstron space mission continued into FY 2019. Other partnership development efforts are continuing.

**Management and Oversight**

- **NSF Structure**: In consultation with community representatives, a dedicated AST program officer carries out continuing oversight and assessment for GBO by making use of detailed annual program plans, technical and financial reports, and annual reports submitted to NSF. The AST program officer attends AUI governance and advisory committee meetings. To address issues as they arise, AST has a dedicated Integrated Project Team for GBO, which includes representatives from other NSF offices,

## *Major Multi-User Research Facilities*

such as the Office of General Counsel, OISE, and the Division of Acquisition and Cooperative Support and the Large Facilities Office in BFA. The MPS Facilities team, together with the NSF Chief Officer for Research Facilities (CORF), also provide high-level guidance, support, and oversight.

- **External Structure:** Management is through a cooperative agreement with AUI. AUI manages the observatories through its own community-based oversight and users committees. The GBO director reports directly to the AUI Vice President for Radio Astronomy.
- **Reviews:** NSF conducts annual reviews of the Program Operating Plan and reports, including external advice from community representatives. The last annual review took place in June 2018, and the next one is scheduled for April 2019.

### **Renewal/Recompetition/Termination**

GBO is currently supported through a cooperative agreement, which ends on September 30, 2019. NSF expects to receive a proposal from AUI that will help to identify the future structure and operational support required for GBO beyond FY 2019.