

## FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCS)

### GREEN BANK OBSERVATORY (GBO)

[www.greenbankobservatory.org](http://www.greenbankobservatory.org)

#### Green Bank Observatory Funding

(Dollars in Millions)

FY 2023		Change over		
Base	FY 2024	FY 2025	FY 2023 Base Plan	
Plan	(TBD)	Request	Amount	Percent
\$10.83	-	\$9.68	-\$1.15	-10.6%

#### Brief Description

GBO is a major NSF research facility and FFRDC located in Green Bank, West Virginia. It is operated by Associated Universities, Inc. (AUI) under a cooperative agreement with NSF. GBO enables leading ground-based research at radio wavelengths by offering access to telescopes, facilities, and advanced instrumentation to the U.S. scientific community, and it conducts an active program of education and public outreach. GBO is located within the 13,000-square-mile National Radio Quiet Zone, where radio transmissions are restricted by law. Having telescopes within this quiet zone allows detection of faint astronomical signals that would otherwise be overwhelmed by anthropogenic radio signals.

#### Meeting Scientific Community Needs

The main scientific instrument at GBO is the 100-meter Robert C. Byrd Green Bank Telescope (GBT), which is the world's largest fully steerable single-dish radio telescope, operating at frequencies from 0.2 GHz to 116 GHz. Its large sky coverage, very high sensitivity, and extensive suite of instruments make it a powerful and versatile telescope that continues to enable important advances in virtually all areas of modern astrophysics, including solar system and planetary astronomy; star formation and evolution; interstellar physics and chemistry; pulsar studies of long-wavelength gravitational waves; physics of black holes, neutron stars, and other compact objects; and galaxy formation and evolution. GBT is complementary to and synergistic with interferometric arrays that are part of the National Radio Astronomy Observatory (NRAO). It also plays a critical supporting role as a highly sensitive element of very long baseline interferometry as well as a bistatic radar receiver for rapid and sensitive imaging of near-Earth objects and asteroids. GBT's focal plane is ideal for rapid, wide-field imaging using multi-pixel cameras.

Approximately 500 scientists use GBT each year for research that spans virtually every field of modern astrophysics. Graduate students using GBT gain vital hands-on experience with a major telescope, an increasingly rare opportunity but critical for their training. Further, there are opportunities for university groups to build and install new instruments (e.g., receivers and backends) on GBT, as well as on prototype telescopes on the GBO site.

GBO also conducts a variety of education and public outreach programs and activities that have impact regionally and across North America. The Green Bank Science Center enables these programs and activities with its auditorium, classrooms, and large exhibit hall, visited by nearly 50,000 people

## *Major Facilities*

every year. Thousands of K-12 teachers and students participate in educational programs using the variety of radio telescopes available at GBO.

### **Status of the Facility**

GBT is currently used for observations approximately 6,500 hours per year. Of these, approximately 4,500 hours are available as Open Skies, or NSF-sponsored observing time, and are allocated through community-based peer review. The “oversubscription rate”, or the ratio of the Open Skies time requested to the time granted, has been in the range of 2 to 3 since FY 2015. Non-open-skies time (about 2,000 hours) on GBT is provided exclusively to GBO partners (see Partnerships section below) who make significant financial contributions to facility operations.

GBO conducts regular inspections of and maintenance on numerous components of its telescopes and site infrastructure. The last full structural inspection of GBT by an independent engineering firm was completed in FY 2021. The report from that inspection identified key areas for future maintenance work and upgrades. Additional inspections are scheduled in late 2024. Significant maintenance is already underway, including repairs to the track and foundation as well as the replacement of damaged azimuth wheels of GBT. AUI has developed a comprehensive plan to address major necessary maintenance due to GBT’s aging infrastructure that is under consideration by NSF.

The scientific direction and operations of the Observatory are assessed through regular NSF reviews, input from various community workshops, and AUI governance and external advisory committee meetings. Development and upgrade efforts are driven by community needs and priorities, address certain key recommendations of the NSF external merit review panel that evaluated the most recent renewal proposal, and align with strategic initiatives such as NSF’s Windows on the Universe. Thus, GBO is poised to address community needs and enable important advances in astronomy in the coming years.

### **Governance Structure and Partnerships**

#### NSF Governance Structure

Oversight from NSF is led by a program officer in the Division of Astronomical Sciences (AST) who works cooperatively with staff from BFA’s Research Infrastructure Office and Division of Acquisition and Cooperative Support, the Office of the General Counsel, and the Office of Legislative and Public Affairs. The MPS facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

#### External Governance Structure

GBO is managed and operated through a cooperative agreement with AUI, a non-profit research management organization consisting of an Executive Office overseen by a Board of Trustees, with input from several internal and external committees. AUI manages GBO through its own community-based oversight and user committees. The GBO Director reports directly to the AUI Vice President for Radio Astronomy.

#### Partnerships and Other Funding Sources

External contributions represent approximately 30-35 percent of the total operations budget of GBO.

These contributions come mostly from non-federal partners, including Breakthrough Listen (BL),<sup>1</sup> the Gordon and Betty Moore Foundation,<sup>2</sup> and individual contracts for GBT observing time. The NSF-funded North American Nanohertz Observatory for Gravitational Waves (NANOGrav) Physics Frontiers Center also contributes to annual operations costs. Partnerships with BL and NANOGrav are anticipated to continue through FY 2025. Many of the GBO partnerships involve guaranteed allocations of observing time on GBT in exchange for operations funding. Other partnership development efforts are continuing.

## Funding

Total Obligations for GBO								
(Dollars in Millions)								
	FY 2023	FY 2024 Plan	FY 2025 Request	ESTIMATES <sup>1</sup>				
	Base			(TBD)	FY 2026	FY 2027	FY 2028	FY 2029
Operations & Maintenance	\$9.12	-	\$9.68	\$9.68	\$9.68	\$9.68	\$9.68	\$9.68
Special Projects <sup>2</sup>	1.71	-	-	-	-	-	-	-
<b>TOTAL</b>	<b>\$10.83</b>	<b>-</b>	<b>\$9.68</b>	<b>\$9.68</b>	<b>\$9.68</b>	<b>\$9.68</b>	<b>\$9.68</b>	<b>\$9.68</b>

<sup>1</sup> Outyear estimates are for planning purposes only. The current cooperative agreement ends on September 30, 2024.

<sup>2</sup> FY 2023 Special projects reflects funding for repairs and maintenance beyond regular O&M.

The FY 2025 operations and maintenance (O&M) request 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. Additional funding for major maintenance identified as part of a midterm review of the GBT infrastructure is displayed under special projects, and funding for deferred maintenance may be provided by MPS' Office of Strategic Initiatives.

## Reviews and Reports

In November 2021, the Decadal Survey of Astronomy and Astrophysics, "Pathways to Discovery (Astro2020),"<sup>3</sup> identified the need for three key capabilities to advance radio astronomy: long-term timing of pulsars, development of new instrumentation, and mitigation of radio-frequency interference. GBT is involved in each of these activities and is poised to play a key role in all three. The report recommended continuing operations of GBT, particularly for pulsar-timing observations, as well as the development of radio cameras. GBT played a prominent role in the recent discovery of low-frequency gravitational waves as part of the NANOGrav project and is anticipated to continue providing vital opportunities to address key scientific questions in radio astronomy. Activities at GBO are particularly important to achieving the scientific objectives laid out in the Astro2020 report.

NSF conducts annual reviews of the program operating plan and reports, including external advice from community representatives. Recommendations from these reviews are used to inform GBO's operations planning and NSF's oversight.

<sup>1</sup> [www.breakthroughinitiatives.org/initiative/1](http://www.breakthroughinitiatives.org/initiative/1)

<sup>2</sup> [www.moore.org/](http://www.moore.org/)

<sup>3</sup> [www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020](http://www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020)

### Renewal/Recompetition/Disposition

NSF's current cooperative agreement with AUI for O&M of GBO spans the five-year period October 1, 2019 – September 30, 2024. In accordance with standard procedures, NSF decided to renew the O&M award to AUI to manage GBO for a two-year period, from FY 2025 through FY 2026. In addition, after splitting GBO out from NRAO in FY 2017 to better understand costs and explore potential divestment, NSF will reintegrate GBO into NRAO as of FY 2025 to allow for unified support of and coherent planning for the U.S. radio astronomy community. The future direction and focus of GBO will be considered as part of the integrated whole of NRAO in the decision process regarding renewal, competition, or disposition beyond FY 2026. Thus, FY 2025 will be the final year with a separate NSF budget request for GBO; subsequent budget requests will be incorporated into the budget request for NRAO. The decision for renewal and reintegration was based on key input from external reviews, as well as important scientific, strategic, and administrative considerations by NSF.



Views showing the Green Bank Telescope in the Fall (left) as well as the unblocked aperture and fully steerable structure (right). *Credit: GBO/AUI.*