

NATIONAL SOLAR OBSERVATORY (NSO)

<https://nso.edu/>

National Solar Observatory Funding

(Dollars in Millions)

FY 2023		FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan	
Base Plan				Amount	Percent
\$26.56		-	\$34.24	\$7.68	28.9%

Brief Description

As a Federally Funded Research and Development Center, NSO is NSF's central institution for support of ground-based solar astronomy. Headquartered on the campus of the University of Colorado, Boulder, NSO provides leadership to the global solar astronomy community through operations of the Daniel K. Inouye Solar Telescope (also known as DKIST or Inouye Telescope). This is the largest and most advanced solar telescope on the planet, poised to answer fundamental questions in solar physics by providing transformative improvements over other ground-based facilities.

NSO also operates the NSO Integrated Synoptic Program (NISP), which consists of the Global Oscillations Network Group (GONG) facility and the Synoptic Long-term Investigations of the Sun (SOLIS) telescope. GONG is a coordinated worldwide network of six telescopes specifically designed to study solar oscillations and, more recently, to provide critical data products for the prediction of space weather. SOLIS, which was recently moved to a site co-located with Big Bear Observatory, adds complementary capabilities, including vector spectromagnetograms. NSO routinely provides detailed synoptic solar data from NISP for use by individual researchers and other government agencies through the NSO Digital Library.

Meeting Scientific Community Needs

The mission of NSO is to advance our knowledge of the Sun, both as an astronomical object and as the dominant external influence on the Earth, by providing forefront observational capabilities to the scientific research community. NSO operates a suite of ground-based optical and infrared solar telescopes and auxiliary instrumentation, allowing solar physicists to probe all aspects of the Sun, from the deep solar interior to its interface with the interplanetary medium.

NSO's flagship telescope, Inouye, enables the study of magnetic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and coronal mass ejections and their impact on Earth and other planets. Solar activity can affect life on Earth through phenomena generally described as space weather and may have impacts on the terrestrial climate.

Other NSO assets provide data to space weather researchers in their efforts to understand solar eruptions and their effect on the Earth, and to apply that knowledge to the protection of satellites, astronauts, land-based power systems, and Earth's climate. GONG is critical infrastructure for

operational space weather prediction and provides data necessary for refinement of solar forecasting models.

Status of the Facility

Although delayed due to impacts of the COVID-19 pandemic, construction of the Inouye Telescope at the summit of Haleakalā on Maui, Hawai'i was completed in November 2021. The operations commissioning phase began in December of the same year. Commissioning science observations from the first peer-reviewed proposal cycle were made through CY 2022, including coordinated campaigns with other observatories. The second call for proposals was issued in the summer of CY 2022 for observations from late CY 2022 into CY 2023. From 2022 through 2024, there was considerable time for the development, testing, and verification of instrument configurations and combinations on the telescope as the first generation of instruments was delivered and brought online.

The Inouye Telescope Data Center is located in Boulder, Colorado at the NSO headquarters, where observational data will be curated and made publicly available after an initial proprietary period. NSO data, including GONG data, are made available to the user community via the Virtual Solar Observatory.

The importance of the science supported by the Inouye Telescope has been reaffirmed by the National Academies of Sciences, Engineering, and Medicine in multiple decadal surveys for Astronomy¹ and for Solar and Space Physics.² The 2020 Decadal Survey for Astronomy and Astrophysics, *Pathways to Discovery* (Astro2020)³ noted the importance of both global observations of our Sun, such as those provided by NSO's GONG facility, and detailed observations enabled by the Inouye Telescope, which it stated, "will revolutionize observations of the Sun's atmosphere."

NSO has been in the process of transitioning away from its user facilities at Kitt Peak, Arizona and Sacramento Peak, New Mexico, which began operations in 1962 and 1969, respectively. Although both sites were once the best ground-based facilities available to the entire U.S. solar research community, there are currently better ground-based facilities both inside and outside the United States. NSO provides limited site infrastructure support at the Sunspot Solar Observatory (formerly Sacramento Peak Observatory) to New Mexico State University (NMSU), which is responsible for the science operations of the Dunn Solar Telescope. The McMath Pearce Solar Telescope on Kitt Peak was transitioned to NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab) as an astronomy outreach center. NISP's SOLIS telescope was removed from Kitt Peak National Observatory and is now co-located with one of NSO's GONG shelters on the grounds of Big Bear Solar Observatory, which is operated by New Jersey Institute of Technology with support from multiple agencies, including NSF and the National Aeronautics and Space Administration (NASA). SOLIS has been installed in a new telescope enclosure and is in a commissioning phase. Operations and maintenance will continue to be supported by NSO.

¹ www.nap.edu/catalog/12951/new-worlds-new-horizons-in-astronomy-and-astrophysics

² www.nap.edu/catalog/13060/solar-and-space-physics-a-science-for-a-technological-society

³ www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is led by a program officer in the MPS Division of Astronomical Sciences, 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

NSO is managed by the Association of Universities for Research in Astronomy Inc. (AURA), through a cooperative agreement with NSF. The NSO director reports to the president of AURA. AURA receives advice from its Solar Observatory Council, composed of scientific and management experts. The NSO director receives advice on all aspects of user experiences from a User Committee, composed of scientists with considerable experience with the observatory. The NSF program officer for NSO has frequent discussions with NSO management and carries out reviews of the facility, attends meetings of the Solar Observatory Council and the Users Committee as an *ex officio* observer, conducts periodic site visits, and attends community science meetings to stay current with the solar community.

Partnerships and Other Funding Sources

NSO's partners include the National Oceanic and Atmospheric Administration (NOAA), NASA, and industrial entities, as well as academic institutions on solar instrumentation development. NOAA contributes approximately \$1 million per year to GONG operations under an interagency agreement with NSF. NMSU operates the Dunn Solar Telescope at Sunspot Solar Observatory through a consortium of universities, while NSO continues to maintain the site infrastructure. NSO has partnered with Big Bear Solar Observatory to operate the SOLIS facility.

Funding

Total Obligations for NSO

(Dollars in Millions)

	FY 2023	FY 2024 (TBD)	FY 2025 Request	ESTIMATES ¹				
	Base Plan			FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
NSO	\$5.88	-	\$6.24	\$6.24	\$6.24	\$6.24	\$6.24	\$6.24
<u>DKIST</u>	<u>20.68</u>	-	<u>28.00</u>	<u>28.00</u>	<u>28.00</u>	<u>28.00</u>	<u>28.00</u>	<u>28.00</u>
<i>Operations and Maintenance</i>	19.58	-	28.00	28.00	28.00	28.00	28.00	28.00
<i>Special Projects</i>	\$1.10	-	-	-	-	-	-	-
TOTAL	\$26.56	-	\$34.24	\$34.24	\$34.24	\$34.24	\$34.24	\$34.24

¹ Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 30, 2024.

The budget request for FY 2025 supports NSO operations, including NISP and Inouye Telescope operations. Base NSO operations do not include the costs associated with the transition of NSO facilities on Sacramento Peak and Kitt Peak. Total funding for Inouye Telescope increases in FY 2025 as the new telescope continues to transition into full operations. Additional funding for deferred maintenance may be provided by MPS' Office of Strategic Initiatives.

Reviews and Reports

In July 2019, a comprehensive midterm review of NSO's progress and long-range plan for the second five years of the cooperative agreement was conducted. The results of this review were presented to the National Science Board (NSB) in February 2020. NSF conducts regular reviews of NSO's Annual Progress Report and Program Plan (APRPP). A review of the FY 2021-FY 2022 APRPP was held onsite at NSO headquarters on June 1-3, 2022. The FY 2022 – FY 2023 APRPP review was held on April 27, 2023.

Renewal/Recompetition/Disposition

The NSB approved the renewal of the NSO/Inouye Telescope cooperative agreement in August 2014; the award began June 1, 2015, and will run through September 30, 2024. NSF is assessing the options regarding renewal, competition, or disposition of the facilities operated by NSO beyond FY 2024, in accordance with NSF policy. The NSF-NSO-NMSU partnership has resulted in partial operation of the Dunn Solar Telescope and the Visitor Center at NSO's Sacramento Peak Observatory in Sunspot, New Mexico as part of the divestment of operations costs of that facility. This partnership is being evaluated in coordination with the assessment of the options for NSO beyond FY 2024.