

**NATIONAL SUPERCONDUCTING CYCLOTRON
LABORATORY (NSCL)**

\$15,500,000
-\$13,000,000 / -45.6%

National Superconducting Cyclotron Laboratory Funding
(Dollars in Millions)

FY 2019 Actual ¹	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
			Amount	Percent
\$28.50	-	\$15.50	-\$13.00	-45.6%

¹ Includes \$4.50 million for continuity of operations into FY 2020.

The National Superconducting Cyclotron Laboratory Funding is a national user facility based at Michigan State University (MSU). With two linked superconducting cyclotrons, K500 and K1200, it is the leading rare isotope research facility in the United States and is a world leader in nuclear physics with the unique capability of producing radioactive beams at energies relevant to nuclear astrophysics. Funding for NSCL also supports the research program of the MSU nuclear science faculty. NSF’s stewardship of NSCL will come to a close at the end of FY 2021, when NSCL transitions into Department of Energy’s (DOE) Facility for Rare Isotope Beams (FRIB) at MSU.

Scientists at NSCL work at the forefront of rare isotope research. They create 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 understanding 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. NSCL is a leader in the era of multi-messenger astrophysics in that it provides data that is directly related to the origin of the elements in the Universe and the physical processes that drive quiescent stellar burning, core collapse supernovae and neutron star mergers. In addition, research is carried out in accelerator physics.

NSCL scientists employ a range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Applications of research conducted at NSCL benefit society in numerous areas, including studies on the effects of ionizing radiation on DNA, tests of detectors to be used in space missions, development of data acquisition systems and software, and homeland security. 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 Coupled Cyclotron Facility, heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities. The laboratory operates an MSU-funded reaccelerator facility (ReA3) that enables experiments at very low energies—a domain of particular interest to nuclear astrophysics. NSCL is the only facility in the world to provide radioactive beams in this energy regime. Nearly one third of recently proposed experiments will use the ReA3. The mix of experiments is determined by proposals for beam use. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent, with constraints on beam availability. The science output of NSCL is driven by these experiments, with most running five to fifteen days.



Undergraduate students reconfigure the MoNA detector for a new experiment. Credit: NSCL and MSU

Total Obligations for NSCL

(Dollars in Millions)

	FY 2019	FY 2020	FY 2021	ESTIMATES ²				
	Actual ¹	(TBD)	Request	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Operations & Maintenance	\$28.50	-	\$15.50	-	-	-	-	-

¹ Includes \$4.50 million for continuity of operations into FY 2020.

² The current cooperative agreement ends in FY 2021, after which the NSF-managed NSCL will transition to the DOE-managed Facility for Rare Isotope Beams.

For information on continuity of operations funding, see the opening narrative of this chapter.

Funding for NSCL has always had two components: operations and maintenance of the lab and the research activity of the MSU nuclear scientists whose research is based at NSCL. In FY 2019, the operations and maintenance support totaled \$18.0 million and research support totaled \$6.0 million, with an additional \$4.50 million in advanced obligations to partially cover operations costs in FY 2020. The reduction in FY 2021 reflects the transfer of a portion of the NSCL research support to the MPS Division of Physics (PHY) core program, Nuclear Physics, as part of the planned transfer of NSCL operations and maintenance to the Department of Energy in FY 2022. The FY 2021 Budget Request reflects an additional reduction of \$4.50 million in response to prior advanced obligations.

NSCL supports and enhances doctorate-level graduate education and post-doctoral research experiences. About 10 percent of all doctorates granted in nuclear physics in the United States are based on research at NSCL. The lab also provides research experiences for undergraduate students, K-12 students, and K-12 teachers. In a typical year about 800 users conduct research at NSCL; approximately 70 percent of those users are U.S. scientists.

Management and Oversight

- **NSF Structure:** MSU operates NSCL under a cooperative agreement with NSF. NSF oversight is provided through annual site visits by the cognizant program officer in PHY and other staff, accompanied by external experts. NSF uses the annual site reviews to assess the user program, operations, maintenance, facility efficiency, national and international research developments, and in-house research programs. The NSF program officer monitors lab operations and plans through monthly phone conferences with the NSCL director. The program officer consults regularly with the NSF Large Facilities Office and the NSF Division of Acquisition and Cooperative Support in BFA. The MPS Facilities team, together with the NSF Chief Officer for Research Facilities, also provide high-level guidance, support, and oversight.
- **External Structure:** MSU provides added support for NSCL, which is managed by a director and three associate directors (experimental research, education and outreach, and operations) as well as a chief scientist. The director has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSCL’s research program is guided by a program advisory committee of external experts as well as an in-house expert and the chairperson of the NSCL user group. Opportunities for proposal submission occur once a year and the beam hour backlog is no longer than two years. Optimally the laboratory can provide about 5,000 beam hours to the scientific community each year, with actual output depending upon facility reliability factors and available funds.
- **Reviews:** An in-depth review in FY 2016 looked at results and achievements related to intellectual merit and broader impacts for the prior four years (FY 2012-FY 2015) as well as a review of proposed research, operations, and maintenance funding for the next five years (FY 2017-FY 2021). The most recent annual review took place in August 2019 and included review of NSCL’s proposed research program, operations plan for that program, and maintenance plan for the last year of the cooperative

agreement (FY 2021). The report expressed overwhelming support for the management and operations of NSCL and endorsed NSCL's plan for the last year of the cooperative agreement. The next review is planned for Summer 2020.

Renewal/Recompetition/Termination

NSCL currently operates under a cooperative agreement with MSU, which is due to expire at the end of FY 2021. After that time, NSCL will transition to the new Facility for Rare Isotope Beams (FRIB),¹ which is being built by the DOE on the NSCL site. FRIB is scheduled to become operational in FY 2022 and will use much of the NSCL beamlines, instrumentation, and general infrastructure. MSU will be the performing institution under a cooperative agreement with DOE for the future FRIB. To facilitate interagency planning and coordinate the transition from the NSF-funded NSCL to the DOE-funded FRIB, a Joint Oversight Group of DOE and NSF personnel has been meeting regularly since 2010. DOE and NSF will coordinate transfer of facility stewardship as it transitions from NSCL to FRIB.

¹ <https://frib.msu.edu/>