

**MID-SCALE RESEARCH INFRASTRUCTURE TRACK 2
(MID-SCALE RI-2)**

\$85,000,000

**Appropriated and Requested MREFC Funds for the Mid-Scale Research Infrastructure
Track 2 Program¹
(Dollars in Millions)**

	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
FY 2023	Request	Request	Estimate	Estimate	Estimate	Estimate	Estimate
	\$76.25	\$105.06	\$85.00	\$90.00	\$100.00	\$100.00	\$100.00

¹ Outyear estimates are for planning purposes only. NSF will evaluate mid-scale in the context of agency priorities for each future budget submission.

Scientific Purpose

The Mid-scale Research Infrastructure program is an NSF-wide effort to meet the research community's needs for modern research infrastructure to support priority science and engineering research. Here, we describe Track 2 (Mid-scale RI-2), covering projects with individual implementation costs between \$20.0 million and \$100.0 million, with funding provided from the MREFC account.

Baseline History

The scientific importance of mid-scale research infrastructure is reflected in the 2017 American Innovation and Competitiveness Act (AICA), which directed NSF to “evaluate the existing and future needs, across all disciplines supported by the Foundation, for mid-scale projects.” NSF issued a Request for Information in late 2017 that resulted in nearly 200 ideas for research infrastructure with project costs in the \$20.0 million to \$100.0 million range, amounting to a prospective demand for approximately \$10 billion in funding. The Mid-scale RI-2 track is intended to respond directly to that demand.

In the 2018 appropriation for NSF, report language from the House of Representatives encouraged the NSB “to consider further changes that would bridge the gap between the Major Research Instrumentation program and the MREFC account while also developing processes appropriate for mid-scale infrastructure, cyberinfrastructure, and instrument upgrades to be funded through the MREFC account.” The NSB issued a report (NSB-2018-40)¹ that made several recommendations, including “a long-term *agency-level* commitment to mid-scale research infrastructure.”

NSF’s response to the NSB recommendations and the AICA mandate to develop a strategy was the creation of a targeted Mid-scale RI program. As part of that program, funding for projects with implementation costs greater than \$20.0 million was requested in the MREFC account as Track 2 of an NSF-wide mid-scale program, and funding was appropriated in that account beginning in FY 2020. NSF issued its first solicitation for Mid-scale RI-2 in December 2018,² requesting proposals with total implementation costs between \$20.0 million and \$70.0 million. A second solicitation³ with a new upper

¹ www.nsf.gov/nsb/publications/2018/NSB-2018-40-Midscale-Research-Infrastructure-Report-to-Congress-Oct2018.pdf

² www.nsf.gov/pubs/2019/nsf19542/nsf19542.htm

³ www.nsf.gov/pubs/2021/nsf21537/nsf21537.pdf

limit of \$100.0 million was issued in December 2020 and full proposals were received in September 2021. These proposals have undergone a series of reviews, including scientific and technical panels, site visits, and reverse site visits focused on project management. The award portfolio was approved in February 2023, resulting in three awards in FY 2023. The third solicitation⁴ for Mid-scale RI-2 was released in March 2023 and, following the review of preliminary proposals, invitations for full proposals were extended in September 2023. Full proposals were received in December 2023 and are currently under review.

Since Mid-scale RI-2 is a portfolio of implementation awards that span all NSF research communities, it does not have a single set of *a priori* scientific goals. Rather, the solicitations define research infrastructure as “any combination of facilities, equipment, instrumentation, or computational hardware or software, and the necessary human capital in support of the same” and, consequently, generate proposal submissions over a wide range of disciplines. In the 2020 solicitation, NSF stated that “[t]he Mid-scale Research Infrastructure programs are aimed at transforming scientific and engineering research fields as well as science, technology, engineering, and mathematics education research by making available new capabilities, while simultaneously training early-career researchers in the development, design, and construction of cutting-edge infrastructure.” This intent has remained in all subsequent solicitations. Past examples of mid-scale-size awards in individual directorates have included items such as: mid-size telescopes or telescope systems; replacement of the Palmer Pier in Antarctica; next-generation computer networking testbeds; and higher-sensitivity instrumentation at LIGO. Results from the two prior NSF-wide-program solicitations are discussed below.

Total Funding Requirements for Mid-scale RI-2¹

(Dollars in Millions)

	Prior Years	FY 2023	FY 2024 Request	FY 2025 Request	ESTIMATES ²				
					FY 2026	FY 2026	FY 2028	FY 2029	FY 2030
<i>R&RA:</i>									
Development & Design	-	-	-	-	-	-	-	-	-
Subtotal, R&RA	-	-	-	-	-	-	-	-	-
<i>MREFC:</i>									
Implementation	\$110.71	\$76.25	\$105.06	\$85.00	\$90.00	\$100.00	\$100.00	\$100.00	\$100.00
Subtotal, MREFC	\$110.71	\$76.25	\$105.06	\$85.00	\$90.00	\$100.00	\$100.00	\$100.00	\$100.00
TOTAL REQUIREMENTS	\$110.71	\$76.25	\$105.06	\$85.00	\$90.00	\$100.00	\$100.00	\$100.00	\$100.00

¹ Operations costs to be borne by the lead disciplinary directorates are not included in this table but are discussed below in the section on Future Operations Costs.

² Outyear numbers are for planning purposes only. NSF will evaluate mid-scale in the context of agency priorities for each future budget submission.

Management and Oversight

Mid-scale RI-2 proposals have been received from all scientific disciplines covered by NSF, as noted above. Management and oversight processes for Mid-scale RI have been codified in the NSF Research Infrastructure Guide (NSF 21-107).⁵ Because of the varied nature of potential Mid-scale RI-2 awards, the Research Infrastructure Guide states the following:

“Mid-scale project oversight requirements are to be tailored based on each project’s unique characteristics such as the technical scope, the type and mix of work performed (e.g., standard procurement by the Recipient, software development, or

⁴ www.nsf.gov/pubs/2023/nsf23570/nsf23570.pdf

⁵ www.nsf.gov/pubs/2021/nsf21107/nsf21107.pdf

civil construction), and an assessment of the associated technical and programmatic risks. However, NSF is committed to the principle that this flexibility does not preclude the requirement for appropriate rigor on the part of NSF or the Recipient. Appropriate use of NSF major facility oversight practices will be determined on a case-by-case basis..."

Each mid-scale project is overseen by a program officer from a relevant research directorate as well as a grants and agreements officer from BFA. Additionally, within BFA, the Research Infrastructure Office has designated a liaison for the mid-scale award portfolio to assure a consistent and effective approach to project management oversight for these awards. To enable appropriate oversight, all Mid-scale RI-2 proposals are required to include a detailed Project Execution Plan. This plan establishes management requirements for the Awardee as referenced by individual award's Terms and Conditions and helps NSF assess project risk and complexity to tailor the oversight needs prior to award issuance.

Oversight requirements for individual awards are detailed in the grant or cooperative agreement terms and conditions. Portfolio-wide oversight, ensuring that the Mid-scale RI-2 program meets its overall objectives, is led by the Deputy Chief Officer for Research Facilities in the Office of the Director.

Mid-scale RI Track 2 Status

Authorization for the first and second suites of Mid-scale RI-2 awards was given in May 2020 and February 2023, respectively. The authorized awards underwent full cost analyses and final award negotiations, including Independent Cost Estimates (as appropriate) required under AICA. The first three Mid-scale RI-2 awards, made from the MREFC account in October 2020, are listed below and described further in an NSF special report:⁶

- "High Magnetic Field Beamline," Cornell University, \$32.69 million.
- "Global Ocean Biogeochemistry Array," Monterey Bay Aquarium Research Institute, \$52.94 million.
- "Grid-Connected Testing Infrastructure for Networked Control of Distributed Energy Resources," University of California at San Diego, \$39.47 million.
- Mitigation of impacts from COVID-19, \$2.40 million in ARPA funds

Additional awards for proposals from the first solicitation were authorized in February 2021. The fourth award was made in June 2021, and a fifth award was announced in February 2022:

- "Network for Advanced NMR [Nuclear Magnetic Resonance]," University of Connecticut, \$39.70 million.⁷
- "Research Data Ecosystem: A National Resource for Reproducible, Robust, and Transparent Social Science Research in the 21st Century," University of Michigan, \$38.36 million.⁸

In FY 2023 the following three projects were added to the award portfolio.

- "Airborne Phased Array Radar," University Corporation for Atmospheric Research, \$91.80 million.⁹

⁶ www.nsf.gov/news/special_reports/announcements/102920.jsp

⁷ www.nsf.gov/news/special_reports/announcements/061621.jsp

⁸ www.nsf.gov/news/special_reports/announcements/020422.jsp

⁹ www.new.nsf.gov/news/nsf-announces-investment-research-infrastructure

- “Advanced Simons Observatory,” University of Pennsylvania, \$52.70 million.¹⁰
- “Compact X-ray Free-Electron Laser,” Arizona State University, \$90.80 million.¹¹

A solicitation for a third round of proposals for Mid-scale RI-2 was released in March 2023. NSF anticipates making new awards from that competition in mid-CY 2025.

Future Operations Costs

The Mid-scale RI-2 solicitations specifically prohibited inclusion of operations costs in the individual project budgets, but proposers are required to present operations and utilization plans as well as estimates of full lifecycle costs. For each individual proposal considered for inclusion in the award portfolio, the lead directorate is required to estimate and commit to any additional operations costs necessary to reap the scientific benefits of an award. At the current award level of \$438.46 million from the first two solicitations and an estimated upper limit to the operations cost of 10 percent of the capital costs per project per year,¹² the total operations cost impact from the current portfolio of Mid-scale RI-2 awards could potentially ramp up to a steady state of about \$44.0 million per year when implementation is complete. Given the variety of operational models for the funded infrastructure, this cost would only be partially borne by NSF,¹³ and such costs within NSF are spread across multiple directorates and divisions. Some of the first projects funded by the Mid-scale RI-2 program will transition to operations in FY 2025. Operations costs of projects funded from the second and third solicitations, released in FY 2021 and FY 2023, respectively, and from subsequent solicitations, would not begin until well after FY 2025.

Reviews

The Mid-scale RI-2 program only considers projects that have reached a high state of readiness for implementation through previous investments in development. As a result, the multi-phase Design Stage and accompanying reviews, which are typical of major facility projects, are not used. Instead, the program has been designed to include a two-step, pre-proposal/full-proposal process to limit the burden on the research community of both preparing and reviewing full proposals. Lead NSF directorates are identified to review each pre-proposal and full proposal. Pre-proposals are reviewed externally according to the standard NSF merit review criteria and solicitation-specific review criteria, with a subset of teams invited to submit full proposals. Those full proposals are also reviewed externally, with a subset selected for a Site Visit. Based on the results of the site visit, a further subset of proposals is invited to a Reverse Site Visit at NSF (or held virtually) for detailed assessment of the Project Execution Plans.

Based on the extensive input from external merit review, the most meritorious proposals are identified by the lead directorates and submitted to the Mid-scale RI-2 Working Group. That working group prepares sample portfolios of those proposals at different levels of total funding and forwards

¹⁰ www.new.nsf.gov/news/detecting-faint-traces-universes-explosive-birth

¹¹ www.new.nsf.gov/news/nsf-announces-infrastructure-investment

¹² www.nsf.gov/nsb/publications/2018/NSB-2018-17-Operations-and-Maintenance-Report-to-Congress.pdf

¹³ An annual operations cost of 10 percent of the total capital costs is a typical “high-end” estimate for a major infrastructure project. Since some of the Mid-scale RI-2 awards being made by NSF are additions to existing facilities or infrastructure, the predicted increments to the operations costs are less than that high-end estimate for several projects.

them to the Office of the Director for further consideration. The Deputy Chief Officer for Research Facilities convenes an independent Portfolio Recommendation Group to evaluate the portfolios from the working group and develop one or more final recommended portfolios that consider agency strategy, technical and programmatic risk, projected funding availability, and overall portfolio balance. During the portfolio construction process, NSF also conducts a rigorous cost analysis of each candidate project to ensure compliance with the Government Accountability Office good practices, as required by the solicitation and the Research Infrastructure Guide. That analysis may inform modifications to the award portfolio if it reveals substantial deficiencies in the proposed cost of a project.

Risks

Technical risks and risk management approaches are described in each project's Project Execution Plan and are evaluated rigorously by an external panel of project management experts. The construction of the final portfolio also relies significantly on an evaluation of agency risks. These include, for example, a constraint that not all the projects should have very high or very low technical risk,¹⁴ potential cost risks identified during the review process, assessment of any partnership risks, the risk that events out of the control of an awardee might significantly impact an individual project, and/or the risk of overcommitting future budgets such that the next solicitation might be significantly delayed.

¹⁴ NSF does not want all projects to have very high technical risk because of the desire for a high probability of very successful projects coming out of the Mid-scale program. On the other hand, NSF does not want all projects to be "safe" projects with very low technical risk because a portfolio consisting only of such projects might have less potential for dramatic increases in scientific knowledge.