

**MAJOR RESEARCH EQUIPMENT
AND FACILITIES CONSTRUCTION (MREFC)**

**\$249,000,000
+\$8,000,000 / 3.3%**

Major Research Equipment and Facilities Construction Funding

(Dollars in Millions)

| FY 2020 Actual | FY 2021 Estimate | FY 2022 Request | Change over FY 2021 Estimate | |
|-------------------|---------------------|--------------------|---------------------------------|---------|
| | | | Amount | Percent |
| \$154.84 | \$241.00 | \$249.00 | \$8.00 | 3.3% |

Overview

The Major Research Equipment and Facilities Construction account supports the acquisition, construction, and commissioning of major facilities and larger mid-scale research infrastructure that provide unique capabilities at the frontiers of science and engineering. Initial development, design, and post-construction operations and maintenance are funded through the R&RA account.

MREFC Account Funding, by Project

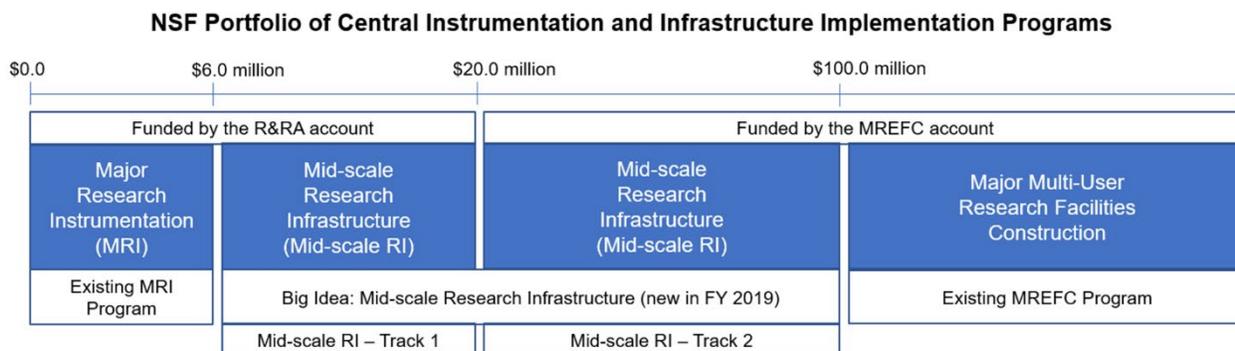
(Dollars in Millions)

| | FY 2020 Actual | FY 2021 Estimate ¹ | FY 2022 Request | FY 2023 Estimate | FY 2024 Estimate | FY 2025 Estimate | FY 2026 Estimate | FY 2027 Estimate |
|--|-------------------|----------------------------------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Antarctic Infrastructure Recapitalization | \$48.78 | \$90.00 | \$90.00 | \$60.00 | \$60.00 | TBD | TBD | TBD |
| DKIST | - | - | - | - | - | - | - | - |
| HL-LHC Upgrade | 33.00 | 33.00 | 36.00 | 33.00 | 18.00 | - | - | - |
| Mid-scale Research Infrastructure ² | - | 76.25 | 76.25 | 76.25 | 76.25 | 76.25 | 76.25 | 76.25 |
| NEON | 0.74 | - | - | - | - | - | - | - |
| RCRV | 25.00 | - | 5.00 | 15.00 | - | - | - | - |
| Vera C. Rubin Observatory | 46.35 | 40.75 | 40.75 | 15.00 | - | - | - | - |
| Dedicated Construction Oversight | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Total | \$154.84 | \$241.00 | \$249.00 | \$200.25 | \$155.25 | \$77.25 | \$77.25 | \$77.25 |

¹ A total of \$129.35 million was carried forward from FY 2020 into FY 2021: \$29.71 million for AIMS, \$9.40 million for DKIST, \$65.0 million for Mid-scale RI, \$10.97 million for RCRV, \$10.07 million for the Rubin Observatory, and \$780,000 for Dedicated Construction Oversight.

² Outyear amounts are for planning purposes only. NSF will evaluate Mid-Scale Research Infrastructure in the context of agency priorities for future budget submissions.

Modern and effective research infrastructure is critical to maintaining U.S. international leadership in science and engineering. The future success of entire fields of research depends upon access to new generations of powerful research tools. Over time, these tools are becoming larger and more technically complex and have a significant information technology or cyber-infrastructure component. To be considered for MREFC funding, NSF requires that a major multi-user research facility (major facility) project represent an exceptional opportunity to enable research and education. The project should be transformative in nature, with the potential to shift the paradigm in scientific understanding. The major facility projects included in this budget request meet these criteria based on NSF and National Science Board review and approval. The mid-scale research infrastructure projects funded through this budget line are evaluated separately as described in a distinct section below.



The graphic above summarizes NSF’s centralized instrumentation and infrastructure programs. Information presented in this chapter focuses on the items funded at levels above \$20.0 million, through the MREFC account. All Mid-scale Research Infrastructure (RI) – Track 2 (Mid-scale RI-2) investments are managed as a single portfolio, with individual projects selected from submissions to a dedicated program solicitation and NSF’s merit review process. The NSF-established thresholds for Mid-scale RI – Track 2 projects and major facilities construction projects have been updated from initial presentations to provide for greater consistency with definitions in the 2017 American Innovation and Competitiveness Act (AICA), as amended by the National Defense Authorization Act for FY 2021. Information on the complete Mid-scale RI program (Tracks 1 and 2) can be found in the Mid-scale narrative in the NSF-wide Priorities chapter. Information on the MRI program can be found in the Integrative Activities narrative in the R&RA chapter.

In FY 2022, NSF requests a total of \$249.00 million to support mid-scale research infrastructure and continued construction on four ongoing major facility projects; Antarctic Infrastructure Recapitalization (AIR),¹ the High Luminosity-Large Hadron Collider (HL-LHC) Upgrade, the Vera C. Rubin Observatory, and Regional Class Research Vessels (RCRV). For more information on each major facility project, see the individual narratives later in this chapter.

Major Facilities

Since FY 2009, major facility projects funded through the MREFC account have been subject to NSF’s “no cost overrun” policy. As a result, NSF processes and procedures must assure the development of realistic and well-supported total project cost estimates such that approved budgets for the award recipient are sufficient to accomplish the scientific objectives. The current policy as published in NSF’s Major Facilities Guide (MFG) requires that: (1) the total project cost estimate when exiting the preliminary design phase includes adequate contingency to cover foreseeable risks manageable by the recipient; (2) any cost increases not covered by contingency be accommodated first by reductions in scope with any significant scope reductions reviewed by the agency prior to implementation; and (3) if the project is approved to continue and further scope reductions become too detrimental to science, then the first 10 percent of any cost increase must be covered by the sponsoring directorate through R&RA funding. NSF holds the risk to total project cost for unforeseen events that are beyond the recipient’s control. The COVID-19 pandemic constitutes such an unforeseen event for all major facility construction projects, and mitigation of this risk falls outside the “no cost overrun policy” and the use of contingency. NSF policy allows for both authorization of management reserve and re-baselining, and a subsequent increase in total project cost, to address the consequences of unforeseen events. The overall NSF response to COVID-19 for its major facilities is described at the end of this section.

¹ “Antarctic Infrastructure Recapitalization (AIR)” replaces the item called Antarctic Infrastructure Modernization for Science (AIMS) in previous budget requests. Appropriated funds from FY 2021 and a fraction of the funds requested from FY 2022 will be used to complete a re-scoped AIMS project, caused by the need to revise the nature of Antarctic infrastructure investments in light of the impacts of COVID-19.

Mid-scale Research Infrastructure

AICA required the agency to develop a strategy for supporting research infrastructure with a total project cost above the upper limit for the Major Research Instrumentation (MRI) program, which is \$6.0 million including cost sharing, and below the lower threshold for the MREFC account, which was then at \$70.0 million. NSF evaluated community demand that resulted in the submission of approximately \$10 billion in ideas for projects in the NSF cost range of \$20–\$100 million. After evaluating that community input, existing mechanisms, and implementation options, NSF included a dedicated funding line within the MREFC account beginning in FY 2020 for research infrastructure projects in the \$20–\$70 million range. The upper limit has been increased to \$100 million in the second Mid-scale RI-2 solicitation to align with the lower threshold defining a major facility project as given in the FY 2021 National Defense Authorization Act which amended the original AICA definition. This funding line supports upgrades to major facilities as well as stand-alone projects. Projects between \$6.0 million and \$20.0 million in total project cost are addressed by individual directorates and an NSF-wide program (Mid-scale RI-1) drawing its heritage from the NSF-wide MRI program. NSF’s overall central Mid-scale Research Infrastructure program is described in the NSF-wide Priorities chapter of this budget submission.

Dedicated Construction Oversight

All major facility projects funded through the MREFC account undergo periodic cost, schedule, and risk reviews as required by the MFG and the terms and conditions of the cooperative agreements or contracts governing the projects. NSF policies and routine reporting are designed to ensure timely and reliable tracking of progress including the use of Earned Value Management, project spending, and use of contingency, and that program managers and recipients each have sufficient oversight and management authority (respectively) to meet project objectives.

Enhanced oversight of the construction stage includes mandatory incurred cost audits, Earned Value Management System surveillance, and re-baseline independent cost estimates, as well as other audits and reviews based on NSF’s annual major facility portfolio risk assessment. These efforts are conducted by NSF and are generally not attributable to a specific project at the time of budget formulation, nor are they part of the total project cost developed and managed by the recipient. To properly support and transparently account for these efforts, actual costs and future estimates for Dedicated Construction Oversight are shown separately from each project in the MREFC account table.

Oversight of the mid-scale research infrastructure projects is more flexible and tailored to the technical nature of the project. All mid-scale research infrastructure projects funded through the MREFC account are required to provide a detailed Project Execution Plan for review. The MFG, Section 5, notes that the detailed oversight requirements, and application of major facility oversight practices, depend on characteristics such as the technical scope, type and mix of work performed, and assessment of the technical and programmatic risks.

COVID-19 Impacts on MREFC Projects

As noted above, the COVID-19 pandemic constitutes an unforeseen event that was not within the control of the recipients managing the ongoing major facility construction projects. NSF expects most or all these projects to cost more than their originally authorized total project costs, which only included sufficient contingency to cover the known risks that were within the recipient’s control. NSF had policies for responding to unforeseen events that were established in advance of the COVID-19 pandemic, which subsequently have been further refined to support the current situation.

In FY 2020, with the approval of Congress, NSF re-programmed \$19.40 million in appropriated MREFC

Major Research Equipment and Facilities Construction

funds from the AIMS project to the Daniel K. Inouye Solar Telescope (DKIST, \$9.40 million) and to the Vera C. Rubin Observatory (\$10.0 million). These funds have been allocated to management reserve for the two projects. The funds for DKIST have been fully obligated to cover costs incurred due to COVID-19, while the funds for Rubin Observatory will be obligated as needed to cover substantiated project needs that are likewise attributable to the pandemic. Funding requests for FY 2022 and out-year forecasts for all projects have been adjusted from previous estimates based on NSF’s current assessment. As appropriate, re-baselining of several projects will take place during FY 2021, once the cost and schedule impacts become better known.² Further details for each project can be found in the individual narratives later in this chapter.

Appropriations Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950 (42 U.S.C. 1861 et seq.), including authorized travel, ~~\$241,000,000~~\$249,000,000, to remain available until expended.

**Major Research Equipment and Facilities Construction
FY 2022 Summary Statement
(Dollars in Millions)**

| | Enacted/ Request | Unobligated Balance Available Start of Year | Unobligated Balance Available End of Year | Adjustments to Prior Year Accounts | Transfers | Obligations Actual/ Estimates |
|----------------------------------|---------------------|---|---|--|-----------|-------------------------------------|
| FY 2020 Appropriation | \$243.23 | \$38.95 | -\$129.35 | \$2.01 | - | \$154.84 |
| FY 2021 Estimated | 241.00 | 129.35 | | | | 370.35 |
| FY 2022 Request | 249.00 | | | | | 249.00 |
| \$ Change from FY 2021 Estimated | | | | | | -\$121.35 |
| % Change from FY 2021 Estimated | | | | | | -32.8% |

Explanation of Carryover

Within the MREFC account, \$129.35 million (including \$3.42 million in no-year recoveries) was carried over into FY 2021.

Mid-scale Research Infrastructure Track 2 (Mid-scale RI-2)

- Amount: \$65.0 million
- Purpose: Funding for Mid-scale Track 2 awards. Awards pending independent cost estimates required by Congress in the American Innovation and Competitiveness Act (AICA), and then to complete the NSF cost analysis on the new projects prior to award.

Obligation: FY 2021 Quarter 1 and Anticipated FY 2021 Quarter 3

Antarctic Infrastructure Modernization for Science (AIMS)

- Amount: \$29.71 million
- Purpose: Baseline and budget contingency funding not obligated in FY 2020.
- Obligation: Anticipated FY 2021 Quarter 3 to support FY 2022 fabrications and FY 2023 construction

² NSF currently plans to allocate up to \$53.55 million from the American Rescue Plan to fund documented COVID-19 impacts to several of the major facility construction projects.

Regional Class Research Vessel (RCRV)

- Amount: \$10.97 million
- Purpose: Budget contingency funding not obligated in FY 2020.
- Obligation: Anticipated FY 2021 Quarter 3

Vera C. Rubin Observatory

- Amount: \$10.07 million
- Purpose: Management reserve funding not obligated in FY 2020.
- Obligation: Anticipated FY 2021 Quarter 4 as the cost impacts of COVID-19 become better known

Daniel K. Inouye Solar Telescope (DKIST)

- Amount: \$9.40 million
- Purpose: Management reserve funding not obligated in FY 2020.
- Obligation: Awarded towards mitigating impact of COVID-19 final construction in FY 2021 Quarter 1.

Dedicated Construction Oversight

- Amount: \$780,000
- Purpose: Support for major facility construction oversight required under AICA and NSF policy, National Ecological Observatory Network construction close-out, and additional management reserve for DKIST, if needed.
- Obligation: Anticipated FY 2021 Quarter 4