

## MAJOR MULTI-USER RESEARCH FACILITIES

### Major Multi-User Research Facilities Funding (Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
<b>Total Research and Related Activities</b>	<b>\$1,026.38</b>	-	<b>\$867.42</b>	<b>-\$158.96</b>	<b>-15.5%</b>
Operations and Maintenance of Existing Facilities	684.44	-	598.38	-86.06	-12.6%
Federally Funded Research and Development Centers	331.44	-	264.04	-67.40	-20.3%
Operations and Maintenance of Facilities under Construction	8.50	-	5.00	-3.50	-41.2%
R&RA Design Stage Activities	2.00	-	-	-2.00	-100.0%
<b>Major Research Equipment and Facilities Construction</b>	<b>\$284.95</b>	-	<b>\$228.75</b>	<b>-\$56.20</b>	<b>-19.7%</b>
<b>Total, Major Multi-User Research Facilities</b>	<b>\$1,311.33</b>	-	<b>\$1,096.17</b>	<b>-\$215.16</b>	<b>-16.4%</b>

NSF investments in major multi-user research facilities (major facilities) provide large, state-of-the-art tools for research and education. These can include instrumentation networks, observatories, accelerators, telescopes, research vessels, aircraft, and simulators. In addition, scientific utilization of cyber-enabled and geographically distributed facilities continues to increase as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, federal agencies, and international partners to ensure they are complementary and well-integrated. Planning, operations, and maintenance of major facilities are funded through the R&RA account. Most construction is funded through the MREFC account.

In FY 2018, NSF created the position of Chief Officer for Research Facilities in the Office of the Director, to enhance oversight of major facilities throughout their complete lifecycle. The individual in that position serves as the senior agency official whose responsibility is oversight of the development, construction, and operations of major facilities across the Foundation, as required by Section 110 of the American Innovation and Competitiveness Act (P.L. 114-329).

The Program Management Improvement and Accountability Act requires an annual NSF portfolio review integrated with an agency Strategic Review. In FY 2019, the NSF Strategic Review evaluated practices in funding NSF's Major Facilities and lessons learned from the FY 2019 lapse in appropriations. One of the two areas of improvement identified was "[t]he implementation of agency-wide practices regarding funding increments that promote financial continuity and stability for the Major Facilities throughout the fiscal year." The key outcome of funding-continuity discussions surrounding the Strategic Review was that NSF Major Facilities should have at least three months of funding obligated to execute the NSF mission across any recognized boundaries of funding discontinuity or other potential shortfalls. NSF allocated funds in its FY 2019 spending plan to assist directorates and offices in the implementation of this new agency-wide practice to provide more robust "continuity of operations" for its Major Facilities.

The Facility Operation Transition activity proposed in the Integrative Activities (IA) section is the second year of a pilot program that reflects NSF's strategic commitment to successful operations and maintenance (O&M) of new major facilities as well as balancing portfolio funding between facilities and investigator research, both of which were emphasized in the NSF's Congressionally requested 2018 report entitled

## *Major Multi-User Research Facilities*

“Study of Operations and Maintenance Costs for NSF Facilities” (NSB-2018-17).<sup>1</sup> NSB suggested a more flexible MREFC account as one way to achieve these goals. Owing to the challenges that would be introduced by maintaining separate construction and operations funding in the MREFC account, as well as the desire to maintain MREFC as a self-contained “capital” account, the recommended strategic funding is requested in the R&RA account instead. The funds in this activity will be used to (1) partially support initial O&M of new facilities so that the full O&M costs can be gradually absorbed into the managing division or directorate, and (2) partially support divestment of lower-priority facilities, the full cost of which may significantly impact individual division or directorate funding.

A total of \$10.0 million is requested in FY 2021 for the Facility Operation Transition activity. Of this amount, \$8.0 million will support O&M for NSF facilities that are in the pre-operations phase within the first five years of their operational life—the National Ecological Observatory Network (NEON), the Daniel K. Inouye Solar Telescope (DKIST), and the Vera C. Rubin Observatory. This funding will be divided among these three facilities in approximate proportion to their total O&M requirements. The requested amount is less than 10 percent of the O&M costs of these three facilities, so that most of the funding remains the responsibility of the managing directorates. The Facility Operation Transition funds will assist the research directorates in sustaining the core research needed to take advantage of the new facility capabilities. The remaining \$2.0 million for this activity will support investments in facility divestment activities. The distribution of IA support between facilities O&M and divestment will be re-evaluated annually as new facilities come online and lower-priority facilities are removed from NSF’s portfolio. This program will be reevaluated after FY 2022 to determine whether it should be modified, continued, or ended.

This chapter provides descriptions of each major facility supported through the R&RA account and provides funding information by lifecycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for major facility projects. Information on projects under construction and funded through NSF’s MREFC account is provided in the MREFC chapter. The following pages contain information on the budget requests for NSF’s major facilities in FY 2021.

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<sup>1</sup> National Science Board, *Study of Operations and Maintenance Costs for NSF Facilities* (NSB-2018-17), May 2018, [www.nsf.gov/pubs/2018/nsb201817/nsb201817.pdf](http://www.nsf.gov/pubs/2018/nsb201817/nsb201817.pdf).

**MAJOR MULTI-USER RESEARCH FACILITIES FUNDING, BY PROJECT**

(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Actual Percent
<b>Operations and Maintenance of Major Facilities</b>	<b>\$1,024.38</b>	-	<b>\$867.42</b>	<b>-\$156.96</b>	<b>-15.3%</b>
<b>Biological Sciences</b>	<b>\$73.93</b>	-	<b>\$65.00</b>	<b>-\$8.93</b>	<b>-12.1%</b>
National Ecological Observatory Network (NEON) <sup>1</sup>	73.93	-	65.00	-8.93	-12.1%
<b>Engineering</b>	<b>\$11.57</b>	-	<b>\$10.95</b>	<b>-\$0.62</b>	<b>-5.4%</b>
Natural Hazards Engineering Research Infrastructure (NHERI) <sup>2</sup>	11.57	-	10.95	-0.62	-5.4%
<b>Geosciences</b>	<b>\$357.37</b>	-	<b>\$307.75</b>	<b>-\$49.62</b>	<b>-13.9%</b>
Academic Research Fleet <sup>3</sup>	85.32	-	80.00	-5.32	-6.2%
Geodesy Advancing Geosciences and EarthScope (GAGE) <sup>4</sup>	6.92	-	12.05	5.13	74.1%
International Ocean Discovery Program (IODP) <sup>5</sup>	53.00	-	47.00	-6.00	-11.3%
National Center for Atmospheric Research (NCAR) FFRDC <sup>6</sup>	152.44	-	103.70	-48.74	-32.0%
Ocean Observatories Initiative (OOI)	44.01	-	43.00	-1.01	-2.3%
Seismological Facilities for the Advancement of Geoscience & EarthScope (SAGE) <sup>4</sup>	15.68	-	22.00	6.32	40.3%
<b>Mathematical and Physical Sciences</b>	<b>\$363.56</b>	-	<b>\$286.58</b>	<b>-\$76.98</b>	<b>-21.2%</b>
Arecibo Observatory <sup>7</sup>	19.22	-	3.00	-16.22	-84.4%
Cornell High Energy Synchrotron Source (CHESS) <sup>8</sup>	5.00	-	-	-5.00	-100.0%
Green Bank Observatory (GBO) FFRDC <sup>9</sup>	10.26	-	7.30	-2.96	-28.8%
Large Hadron Collider (LHC) - ATLAS and CMS	16.00	-	20.00	4.00	25.0%
Laser Interferometer Gravitational Wave Observatory (LIGO) <sup>10</sup>	66.72	-	45.00	-21.72	-32.6%
National High Magnetic Field Laboratory (NHMFL) <sup>11</sup>	40.62	-	37.74	-2.88	-7.1%
National Radio Astronomy Observatory (NRAO) FFRDC	95.04	-	88.13	-6.91	-7.3%
NRAO O&M <sup>12</sup>	49.83	-	39.45	-10.38	-20.8%
Atacama Large Millimeter Array (ALMA) O&M	45.21	-	48.68	3.47	7.7%
National Solar Observatory (NSO) FFRDC	18.39	-	21.79	3.40	18.5%
NSO O&M <sup>13</sup>	7.89	-	4.25	-3.64	-46.1%
Daniel K. Inouye Solar Telescope (DKIST) <sup>14</sup>	10.50	-	17.54	7.04	67.0%
National Superconducting Cyclotron Laboratory (NSCL) <sup>15</sup>	28.50	-	15.50	-13.00	-45.6%
NSF's National Optical-Infrared Astronomy Research Laboratory FFRDC <sup>16</sup>	63.81	-	48.12	-15.69	-24.6%
NSF's National Optical-Infrared Astronomy Research Laboratory O&M (formerly the National Optical Astronomy Observatory (NOAO)) <sup>17</sup>	29.16	-	22.23	-6.93	-23.8%
GEMINI Observatory O&M <sup>18</sup>	34.65	-	20.89	-13.76	-39.7%
Vera C. Rubin Observatory O&M (formerly the Large Synoptic Survey Telescope) <sup>19</sup>	-	-	5.00	5.00	N/A
<b>Office of Polar Programs</b>	<b>\$217.95</b>	-	<b>\$197.14</b>	<b>-\$20.81</b>	<b>-9.5%</b>
Antarctic Facilities and Operations (AFO) <sup>20</sup>	210.94	-	190.14	-20.80	-9.9%
IceCube Neutrino Observatory (ICNO)	7.01	-	7.00	-0.01	-0.00
<b>Major Research Facilities Construction Investments</b>	<b>\$286.95</b>	-	<b>\$228.75</b>	<b>-\$58.20</b>	<b>-20.3%</b>
<b>R&amp;RA Design Stage Activities<sup>21</sup></b>	<b>\$2.00</b>	-	-	<b>-\$2.00</b>	<b>-100.0%</b>
<b>Major Research Equipment and Facilities Construction</b>	<b>\$284.95</b>	-	<b>\$228.75</b>	<b>-\$56.20</b>	<b>-19.7%</b>
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FFRDC is an acronym for Federally-Funded Research and Development Center.

<sup>1</sup> NEON: FY 2019 Actual includes \$8.93 million for continuity of operations into FY 2020.

<sup>2</sup> NHERI: FY 2019 Actual includes \$8.50 million to upgrade the LHPOST facility. Excluded is \$8.93 million of FY 2019 O&M costs obligated in FY 2018.

<sup>3</sup> ARF: Includes ship operations and upgrade support. FY 2019 Actual includes \$3.0 million for continuity of operations into FY 2020. Regional Class Research Vessels (RCRV) began construction in FY 2017 and the final year of MREFC funding is FY 2019, included in the MREFC line below. Operations and maintenance of RCRV is not anticipated to begin until FY 2022.

<sup>4</sup> GAGE and SAGE: FY 2019 Actual reflects part of an operating year as funding for these cooperative agreements were re-phased for continuity of operations into FY 2020.

<sup>5</sup> IODP: FY 2019 Actual includes \$5.0 million for continuity of operations into FY 2020.

<sup>6</sup> NCAR: FY 2019 Actual includes \$17.80 million for continuity of operations into FY 2020 as well as \$30.94 million in funds re-obligated from prior award.

<sup>7</sup> ARECIBO: FY 2019 Actual includes \$12.30 million in carryover funds from the FY 2018 emergency supplemental appropriation -- Further Additional Supplemental Appropriations for Disaster Relief Requirements Act of 2018 (P.L. 115-123) -- for hurricane damage repairs and \$2.03 million for continuity of operations into FY 2020. It excludes \$2.69 million of FY 2019 O&M costs obligated in FY 2018.

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<sup>8</sup> CHESS: In FY 2019, NSF stewardship of CHESS ended as NSF transitioned to funding the Center for High Energy X-Ray Sciences (CHEXS), a sub-facility at CHESS operated in partnership with Cornell University. This table does not include CHEXS as it is not a major facility.

<sup>9</sup> GBO: Previously under "Other AST Facilities". FY 2019 Actual includes \$2.17 million for continuity of operations into FY 2020.

<sup>10</sup> LIGO: FY 2019 Actual includes \$10.47 million for Advanced LIGO Plus enhancement and \$11.25 million for continuity of operations into FY 2020.

<sup>11</sup> NHMFL: FY 2019 Actual includes \$14.20 million for continuity of operations into FY 2020. Excluded is \$9.34 million of FY 2019 O&M costs obligated in FY 2018.

<sup>12</sup> NRAO: As of Oct. 1, 2018, the Long Baseline Observatory (LBO) was reintegrated into NRAO as the Very Long Baseline Array (VLBA) at \$3.82 million in FY 2019 and \$3.43 million in FY 2021. Also included in FY 2019 is \$8.09 million for continuity of operations into FY 2020 and \$4.0 million for development of a next generation Very Large Array (ngVLA).

<sup>13</sup> NSO: FY 2019 Actual includes \$3.50 million for development of DKIST level 2 (advanced) data products.

<sup>14</sup> DKIST: FY 2019 Actual includes \$2.0 million to another awardee for cultural mitigation activities as agreed to during the DKIST environmental compliance process. Excluded is \$8.0 million of FY 2019 O&M costs for DKIST obligated in FY 2018.

<sup>15</sup> NSCL: FY 2019 Actual includes \$4.50 million for continuity of operations into FY 2020. FY 2021 is the final year of NSF stewardship of NSCL, after which NSCL will transition into the Department of Energy's Facility for Rare Isotope Beams.

<sup>16</sup> NSF's National Optical-Infrared Astronomy Research Laboratory was established at the start of FY 2020. The Lab encompasses operations of the Mid-Scale Observatories (MSO) and Community Science & Data Center (CSDC), which formerly comprised NOAO, together with operations of the Gemini Observatory and the Vera C. Rubin Observatory.

<sup>17</sup> NSF's National Optical-Infrared Astronomy Research Laboratory: FY 2019 Actual includes \$5.73 million for continuity of operations into FY 2020, \$2.50 million to support NSF transition activities associated with the creation of the Lab, approximately \$412,000 in supplemental funding for U.S. Extremely Large Telescope program planning, and \$1.18 million for other special projects.

<sup>18</sup> GEMINI: FY 2019 Actual includes \$12.99 million to enhance Gemini's adaptive optics system, software capabilities, and public information and outreach activities in the era of multi-messenger astronomy.

<sup>19</sup> Vera C. Rubin Observatory: Excluded is \$11.10 million in FY 2019 - FY 2021 pre-operations ramp up costs obligated in FY 2018.

<sup>20</sup> AFO: FY 2019 Actual includes additional funding to replace the aging pier at Palmer Station and to replace or refurbish other equipment and facilities.

<sup>21</sup> Design Stage Activities include support for potential next generation multi-user facilities. This line reflects FY 2019 funding of \$2.0 million for the potential Leadership Class Computing Facility.