DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS) $1,746,847,000
+$153,540,000 / 9.6%

MPS Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2021 ARP Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Astronomical Sciences (AST)[1]	$289.27	-	-	$294.05	$4.78	1.7%
Chemistry (CHE)	259.60	-	-	284.14	24.54	9.5%
Materials Research (DMR)	330.07	-	-	349.92	19.85	6.0%
Mathematical Sciences (DMS)	243.66	-	-	259.47	15.81	6.5%
Physics (PHY)	304.42	-	-	316.59	12.17	4.0%
Office of Multidiscplinary Activities (OMA)	166.29	20.33	-	242.677	76.39	45.9%
Total	**$1,593.31**	**$20.33**	**-**	**$1,746.847**	**$153.54**	**9.6%**

[1] AST FY 2021 Actual funding includes $12.30 million from FY 2020 Appropriations.

About MPS

Research in the foundational physical sciences is the central theme of work supported by MPS. The core areas of MPS science (astronomical sciences, chemistry, materials research, mathematical sciences, and physics) continue to advance and transform knowledge and support the development of the next generation of scientists. Science funded by MPS spans an enormous range: from the smallest objects and shortest timescales studied to distances and timescales that are the size and age of the universe. MPS continues to foster and support interdisciplinary scientific programs that span in scope and complexity, ranging from individual investigator awards to large, multi-user facilities. Individual investigators and small teams receive most awards, but centers, institutes, and facilities are all integral to MPS-funded research. This convergence of disciplines and various ways to organize researchers allows MPS to invest in compelling basic science that will underpin and enable advances in the technologies of the future, enabling collaborations such as with the TIP Directorate, and help to support a strong U.S. economy for decades to come.

Through its Centers and Institutes programs, MPS will continue to support leading-edge science and the development of the next generation of scientists engaged in research ranging from fundamental through translational science. The MPS Centers and Institutes span a broad range, from addressing challenges in fundamental mathematics to the development of new materials.

Research tools and infrastructure are key priorities that MPS will continue funding. Mid-scale Research Infrastructure in astronomical sciences, chemistry, materials research, and physics continue to be important to the advancement of these disciplines. Large scale research infrastructure is also highly important and provides opportunities for partnerships with international entities, other federal agencies, and private foundations, as is evidenced by facilities such as the Atacama Large Millimeter/submillimeter Array, the Gemini Observatory, the Large Hadron Collider (LHC), and the National High Magnetic Field Laboratory. Construction activities began in April 2020 to upgrade the two primary LHC detectors, A Toroidal LHC Apparatus and the Compact Muon Solenoid, in preparation for high luminosity operation of the LHC. The Vera C. Rubin Observatory Project is advancing the physical infrastructure on the summit of Cerro Pachón in Chile as well as a state-of-the-art data management system and the largest digital camera ever constructed. The construction of Daniel K.

Inouye Solar Telescope, the world's most powerful solar observatory, was completed and entered operations near the end of 2021, atop Haleakalā on Maui, Hawaii. Since its first detection of gravitational waves in 2015, the Laser Interferometer Gravitational-Wave Observatory (LIGO) has been reporting event alerts on a regular basis, including a neutron star-neutron star merger and a collision of heavy and light black holes. LIGO researchers are working to further enhance the sensitivity of the apparatus in preparation for a planned fourth observational run that is expected to begin as early as the Fall of 2022.

MPS' FY 2023 Request builds on past efforts and aligns with NSF's priorities articulated for FY 2023. There are exciting new opportunities emerging, research efforts that are maturing, and established programs and activities that continue to meet important goals and support science that will transform the Nation's future. MPS investments are driven by the following key priorities: (a) sustaining core research programs, (b) supporting the highest priority centers, institutes, and facilities, (c) supporting early-career investigators, (d) providing funding for targeted basic research in NSF-wide investments including the NSF Big Ideas, (e) advancing support for Emerging Industries, such as QIS, advanced manufacturing, biotechnology, microelectronics, the spectrum innovation initiative (SII), and AI, (f) increasing support for clean energy and climate research, and (g) increasing support to promote equity and broadening participation in STEM research.

Climate change and its impacts clearly represents one of the greatest challenges facing civilization today. MPS will support research in providing scientific modeling tools needed to advance our understanding of the physical basis of climate change and develop mitigation and adaptation solutions. MPS-supported research will also significantly contribute to innovation in clean and sustainable energy resources, addressing problems that require fundamentally new ideas.

MPS will continue to explore ways to identify and address barriers to equity and broaden participation after the successful launch of several programs in FY 2021 and FY 2022, including those enhancing the support of early-career researchers from less resourceful institutions and postdoctoral fellows who will broaden the participation of groups that are underrepresented in MPS fields.

As the lead directorate, MPS is the steward of funds for the Big Idea, WoU. For more information about the Big Ideas, see the narrative in the Cross Theme Topic section of the NSF-Wide Investments chapter.

MPS provides 44 percent of the federal funding for basic research at academic institutions in the mathematical and physical sciences.

Major Investments

MPS Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Advanced Manufacturing	$193.42	-	$123.13	-$70.29	-36.3%
Advanced Wireless Research	17.00	-	17.00	-	-
Artificial Intelligence	110.63	-	71.67	-38.96	-35.2%
Biotechnology	91.88	-	62.20	-29.68	-32.3%
Climate: Clean Energy Technology[3]	132.07	-	128.56	-3.51	-2.7%
Climate: USGCRP[3]	9.83	-	34.63	24.80	252.3%
Microelectronics/Semiconductors	57.31	-	26.00	-31.31	-54.6%
MPS Postdoctoral Fellowships	20.21	-	40.55	20.34	100.6%
Quantum Information Science	154.03	-	156.13	2.10	1.4%
Secure & Trustworthy Cyberspace	1.26	-	1.25	-0.01	-0.8%

[1] Major investments may have funding overlap and thus should not be summed.

[2] This table reflects this directorate's support for selected areas of investment. In other directorate narratives, areas of investment displayed in this table may differ and thus should not be summed across narratives.

[3] Funding includes resources for agency-wide initiatives.

- Advanced Manufacturing: MPS will invest in activities that develop new methods, processes, analyses, tools, or equipment for new or existing manufacturing products, supply chain components, or materials. These will yield advantages such as reduced time to market, new performance attributes, improved small-batch production, cost and energy savings, and reduced environmental impact.
- Advanced Wireless—SII: As the steward of this initiative, MPS will coordinate agency-wide investments that catalyze research and development in spectrum research, addressing key challenges related to an increasingly congested radio frequency environment and outdated approaches to spectrum allocation. The funding will primarily continue the support of three cross-cutting initiatives: (1) the most innovative approaches to dynamic spectrum sharing in specialized geographic regions - "National Radio Dynamic Zones"; (2) the national center for wireless SII-Center; and (3) education and workforce development specifically related to spectrum research.
- AI: Together with other NSF directorates/offices, MPS will continue its support for AI research, with a focus on supporting basic research in machine learning and deep learning and development of tools and techniques driven by the physical sciences.
- Biotechnology: MPS, together with other NSF directorates/offices, will invest in fundamental research, infrastructure, and education that advance foundational knowledge needed to understand and harness biological processes for societal benefit.
- Climate Research and Clean Energy Technology: MPS, together with other NSF directorates/offices, will increase investment in activities that focus on research in developing mitigation and adaptation solutions for climate change and innovation in clean and sustainable energy resources.
- Equity and Broadening participation: MPS will enhance the support of Mathematical and Physical Sciences Ascending Postdoctoral Research Fellowship (MPS-Ascend) program with an additional

$10 million and continue its investment in early career researchers from less resourceful institutions.

- Microelectronics and Semiconductors: MPS will support research that addresses fundamental science questions on the concepts, materials, devices, circuits, and platforms necessary to sustain progress in semiconductor-microelectronic technologies. This research is critical to future advances and security in information technology, communications, sensing, smart electric grid, transportation, health, advanced manufacturing, and other areas.
- MPS Postdoctoral Fellowships: Postdoctoral research is a critical stage in preparation for professional careers. The MPS-Ascend, the Mathematical Sciences Postdoctoral Research Fellowships, and the Astronomy and Astrophysics Postdoctoral Fellowship programs will significantly increase their investment to support an additional 80 fellows.
- QIS: As the steward for QIS, MPS will work together with other NSF directorates and offices to continue support for QIS research and development. These investments align with the National Quantum Initiative to coordinate and expand the United States' world-leading position in fundamental quantum research. QIS investments will deliver proof-of-concept devices, applications, tools, or systems with a demonstrable quantum advantage over their classical counterparts. Research in QIS examines uniquely quantum phenomena that can be harnessed to advance information processing transmission, measurement, and fundamental understanding in ways that classical approaches can only do much less efficiently, or not at all. Current and future QIS applications differ from prior applications of quantum mechanics, such as lasers, transistors, and magnetic resonance imaging, by using distinct quantum phenomena—superposition and entanglement—that do not have classical counterparts. MPS will increase the investment in QIS workforce development and in the newly launched Expanding Capacity in Quantum Information Science and Engineering program.
- SaTC: MPS will continue to invest in fundamental research in cybersecurity.
- WoU: MPS is the steward for WoU, and together with GEO/OPP, will support research in the "windows"—electromagnetic waves, high-energy particles, and gravitational waves—of multi-messenger astrophysics. Through WoU investments, NSF will also grow the workforce not only for multi-messenger astrophysics but also for engineering and data science. For more information about the Big Ideas, see the narrative in the Cross Theme Topics section of the NSF-Wide Investments chapter.

MPS Funding for Centers Programs and Major Facilities

MPS Funding for Centers Programs

(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Artificial Intelligence Research Institutes (AST, CHE, PHY)	$4.36	-	$5.00	$0.64	14.7%
Centers for Chemical Innovation (CHE)	27.64	-	27.70	0.06	0.2%
Materials Centers (DMR)	50.08	-	56.80	6.72	13.4%
Quantum Leap Challenge Institutes (OMA)[1]	32.05	-	32.00	-0.05	-0.2%
STC: Center for Integrated Quantum Materials (DMR)[2]	4.15	-	-	-4.15	-100.0%
STC: STC on Real-Time Functional Imaging (DMR)	5.00	-	5.00	-	-
STC: Center for Integration of Modern Optoelectronic Materials on Demand (DMR)[3]	-	-	5.00	5.00	N/A
STC: Center for Bright Beams (PHY)	4.84	-	5.00	0.16	3.3%
Spectrum Innovation Initiative Center (DIV or Multiple)	7.79	-	5.00	-2.79	-35.8%
Total	**$135.91**	**-**	**$141.50**	**$5.59**	**4.1%**

[1] Since FY 2020, Quantum Leap Challenge Institutes (QLCI) funding has been a vital part of NSF's overall $50 million investment in multidiscplinary centers for quantum research and education.

[2] All Class of 2013 STCs were sunsetted in FY2021.

[3] The IMOD STC was selected as part of the new STC Class of 2021.

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

MPS Funding for Major Facilities

(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Arecibo Observatory[1]	$38.18	-	$3.00	-$35.18	-92.1%
Green Bank Observatory[2]	8.90	-	10.83	1.93	21.7%
IceCube Neutrino Observatory (IceCube)	3.53	-	3.83	0.30	8.5%
Large Hadron Collider (LHC)	20.00	-	20.50	0.50	2.5%
Laser Interferometer Gravitional-Wave Observatory (LIGO)	45.00	-	45.00	0.00	-
National High Magnetic Field Laboratory (NHMFL)[3]	26.13	-	40.49	14.36	55.0%
National Radio Astronomy Observatory (NRAO)	98.21	-	98.11	-0.10	-0.1%
NRAO O&M[4]	*49.53*	-	*44.45*	*-5.08*	*-10.3%*
Atacama Large Millimeter Array (ALMA) O&M[5]	*48.68*	-	*53.66*	*4.98*	*10.2%*
National Solar Observatory (NSO)	24.19	-	27.74	3.55	14.7%
NSO O&M[6]	*4.65*	-	*7.06*	*2.41*	*51.8%*
Daniel K. Inouye Solar Telescope (DKIST) O&M[7]	*19.54*	-	*20.68*	*1.14*	*5.8%*
National Superconducting Cyclotron Laboratory (NSCL)[8]	15.50	-	-	-15.50	-100.0%
NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab)	60.32	-	70.90	10.58	17.5%
NOIRLab O&M (Mid-Scale Observatories & Community Science and Data Center)[9]	*29.95*	-	*25.99*	*-3.96*	*-13.2%*
Gemini Observatory O&M[10]	*24.27*	-	*24.61*	*0.34*	*1.4%*
Vera C. Rubin Observatory O&M	*6.09*	-	*20.30*	*14.21*	*233.4%*
Total	**$339.96**	**-**	**$320.40**	**-$19.56**	**-5.8%**

[1] FY 2021 Actual includes $34.92 million for emergency cleanup of the Arecibo site following the collapse of the platform above the 305-meter telescope in December 2020. FY 2021 Actual excludes $0.53 million of O&M funding obligated in FY 2020.

[2] FY 2023 Request contains $1.71 million for research infrastructure and O&M costs, including additional costs for repairs and maintenance.

[3] FY 2021 Actual excludes $12.00 million obligated in FY 2020 for FY 2021 operations. FY 2023 Request contains $2.21 million for additional research infrastructure and O&M costs, including costs for repairs and maintenance.

[4] FY 2021 Actual includes funding for the ngVLA program office. FY 2023 Request contains $3.92 million in additional research infrastructure and O&M costs, including additional costs for repairs and maintenance.

[5] FY 2023 Request includes $3.03 million in additional research infrastructure and O&M costs, including additional costs for repairs and maintenance.

[6] FY 2023 Request includes $1.18 million in additional research infrastructure funding for transition activities at Sacramento Peak Observatory.

[7] FY 2023 Request includes $1.10 million in research infrastructure to optimize community access.

[8] FY 2021 was the final year of NSF stewardship of NSCL, after which NSCL transitioned into the Department of Energy's Facility for Rare Isotope Beam

[9] FY 2021 Actual includes special projects funding of $9.44 million. FY 2023 Request contains $4.86 million in additional research infrastructure and O&M costs, including additional costs for repairs and maintenance.

[10] FY 2023 Request contains $1.63 million for additional research infrastructure and O&M, including costs for repairs and maintenance.

For detailed information on individual facilities, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

Funding Profile

MPS Funding Profile

	FY 2021 Actual Estimate	FY 2022 (TBD)	FY 2023 Estimate
Statistics for Competitive Awards:			
Number of Proposals	8,114	-	9,500
Number of New Awards	2,422	-	3,000
Regular Appropriation	2,366		3,000
ARP	56		
Funding Rate	30%	-	32%
Statistics for Research Grants:			
Number of Research Grant Proposals	7,258	-	8,350
Number of Research Grants	2,117	-	2,400
Regular Appropriation	2,065		2,400
ARP	52		
Funding Rate	29%	-	29%
Median Annualized Award Size	$136,964	-	$135,000
Average Annualized Award Size	$164,267	-	$169,000
Average Award Duration, in years	3.2	-	3.1

In FY 2023, the number of research grant proposals is expected to increase by 1,400 compared to the FY 2021 Actual, and MPS expects to award about 3,000 research grants. Average annual award size and duration are not expected to materially fluctuate in FY 2021 through FY 2023. O&M funding for MPS-supported user facilities comprises 23 percent of MPS' FY 2023 Request.

People Involved in MPS Activities

Number of People Involved in MPS Activities

	FY 2021 Actual Estimate	FY 2021 ARP Actual Estimate	FY 2022 (TBD)	FY 2023 Estimate
Senior Researchers	9,651	227	-	10,200
Other Professionals	2,569	8	-	2,500
Postdoctoral Associates	2,478	29	-	2,200
Graduate Students	9,867	136	-	10,300
Undergraduate Students	5,044	171	-	7,000
Total Number of People	**29,609**	**571**	**-**	**32,200**

DIVISION OF ASTRONOMICAL SCIENCES (AST) $294,050,000
+$4,780,000 / 1.7%

AST Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Percent
Total	**$289.27**	**-**	**$294.05**	**$4.78**	**1.7%**
Research	**52.61**	**-**	**73.74**	**21.13**	**40.2%**
CAREER	3.60	-	4.81	1.21	33.6%
Centers Funding (total)	0.30	-	0.30	-	-
Artificial Intelligence Research Institutes	0.30	-	0.30	-	-
Education	**3.54**	**-**	**6.10**	**2.56**	**72.3%**
Infrastructure	**233.12**	**-**	**214.21**	**-18.91**	**-8.1%**
Arecibo Observatory[1]	13.83	-	3.00	-10.83	-78.3%
Green Bank Observatory	8.90	-	9.12	0.22	2.5%
Mid-scale Research Infrastructure	19.17	-	19.50	0.33	1.7%
National Radio Astronomy Observatory (NRAO)	98.21	-	91.16	-7.05	-7.2%
NRAO O&M[2]	*49.53*	*-*	*40.53*	*-9.00*	*-18.2%*
Atacama Large Millimeter Array (ALMA) O&M	*48.68*	*-*	*50.63*	*1.95*	*4.0%*
National Solar Observatory (NSO)	24.19	-	25.46	1.27	5.3%
NSO O&M	*4.65*	*-*	*5.88*	*1.23*	*26.5%*
Daniel K. Inouye Solar Telescope (DKIST) O&M	*19.54*	*-*	*19.58*	*0.04*	*0.2%*
NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab)	60.32	-	58.97	-1.35	-2.2%
NOIRLab O&M (Mid-Scale Observatories & Community Science and Data Center)[3]	*29.95*	*-*	*25.99*	*-3.96*	*-13.2%*
Gemini Observatory O&M	*24.27*	*-*	*22.98*	*-1.29*	*-5.3%*
Vera C. Rubin Observatory O&M	*6.09*	*-*	*10.00*	*3.91*	*64.2%*
Research Resources	7.94	-	7.00	-0.94	-11.8%

[1] FY 2021 Actual includes $10.57 million for emergency cleanup of the Arecibo site following the collapse of the platform above the 305-meter telescope in December 2020. FY 2021 Actual excludes $0.53 million of O&M funding obligated in FY 2020.

[2] FY 2021 Actual includes funding for the ngVLA program office.

[3] FY 2021 Actual includes special projects funding of $9.44 million. FY 2023 Request contains $4.86 million in additional research infrastructure and O&M costs, including additional costs for repairs and maintenance.

About AST

AST is the federal steward for ground-based astronomy in the United States, and funds awards to individual investigators and small research groups as well as provide access to world-leading astronomical laboratories via cooperative agreements. These state-of-the-art telescope facilities enable scientific advances by providing observational capabilities on a competitive basis to thousands of astronomers each year. AST supports the development of advanced technologies and instrumentation and manages the electromagnetic spectrum for scientific use by the entire NSF community.

The AST portfolio includes research on the nature of planets, stars, and galaxies and the structure of the universe. This leads to a deeper understanding of the composition and evolution of the cosmos and the nature of the mysterious dark matter and dark energy that comprise more than 95 percent of the universe. AST facilities and research programs have enabled the detection of planets orbiting other stars and are beginning to search for life on these other worlds. AST research probes the universe through three distinct “windows”—electromagnetic waves, high-energy particles, and gravitational waves.

An estimated 20 percent of the AST portfolio is available for new research grants to individual investigators and about 80 percent of the AST budget supports the instrumentation and facilities needed for international leadership and advances at the frontiers of observational astronomy. Through the MREFC appropriation, AST oversight is provided for the construction of the Vera C. Rubin Observatory. For detailed information on AST's individual facilities and the construction of the Vera C. Rubin Observatory, see the Research Infrastructure section of the NSF-Wide Investments chapter.

DIVISION OF CHEMISTRY (CHE)

$284,140,000
+$24,540,000 / 9.5%

CHE Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Total	**$259.60**	**-**	**$284.14**	**$24.54**	**9.5%**
Research	**245.09**	**-**	**270.97**	**25.88**	**10.6%**
CAREER	29.37	-	26.00	-3.37	-11.5%
Centers Funding (total)	26.00	-	29.70	3.70	14.2%
Artificial Intelligence Research Institutes	0.36	-	2.00	1.64	455.6%
Centers for Chemical Innovation	25.64	-	27.70	2.06	8.0%
Education	**4.92**	**-**	**4.52**	**-0.40**	**-8.1%**
Infrastructure	**9.59**	**-**	**8.65**	**-0.94**	**-9.8%**
Midscale Research Infrastructure	0.60	-	0.60	-	-
NHMFL	1.88	-	2.10	0.22	11.7%
National Nanotechnology Coordinated Infrastructure (NNCI	0.30	-	0.30	-	-
Research Resources	6.81	-	5.65	-1.16	-17.0%

About CHE

CHE supports discovery research and workforce development in chemistry that have the potential to transform major commercial sectors of the U.S. economy: energy, pharmaceuticals, medical applications, plastics, electronics, food, agriculture, and transportation. CHE investments also support highly competitive and rapidly evolving fields that include advanced manufacturing, quantum information sciences, data mining and artificial intelligence, sensor and instrument development, biotechnology, clean energy, and climate research. Experimental, computational, and theoretical chemical research is integrated into core programs focused on new synthetic and catalytic methods; measurement/imaging tool and technique development; understanding the structure, dynamics and mechanistic relationships between function and reactivity; environmental chemical sciences; the chemistry of biological processes; and macromolecular, supramolecular and nanochemistry leading to higher ordered structures and materials. CHE programs have a strong emphasis on sustainability and the protection of natural resources. The division uses multiple funding mechanisms to support individuals and team science as well as interdisciplinary user facilities.

CHE encourages researchers to apply chemical understanding and tools to other fields, including biology, engineering, materials research, geosciences, mathematics/statistics, computing, and social sciences. Investments across fields not only expedite chemical understanding, invention, and innovation, but also have significant impact on the training and deployment of the future STEM workforce.

In general, about 70 percent of the CHE portfolio is available to support new research grants. The remaining 30 percent supports research grants made in prior years and the research infrastructure needed by the chemistry community.

DIVISION OF MATERIALS RESEARCH (DMR)

$349,920,000
+$19,850,000 / 6.0%

DMR Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over Amount	Change over Percent
Total	**$330.07**	**-**	**$349.92**	**$19.85**	**6.0%**
Research	**267.51**	**-**	**280.24**	**12.73**	**4.8%**
CAREER	33.45	-	25.00	-8.45	-25.3%
Centers Funding (total)	59.23	-	66.80	7.57	12.8%
Materials Centers	50.08	-	56.80	6.72	13.4%
STC: Center for Integrated Quantum Materials (DMR)[1]	4.15	-	-	-4.15	-100.0%
STC: STC on Real-Time Functional Imaging (DMR)	5.00	-	5.00	-	-
STC: Center for Integration of Modern Optoelectronic Materials on Demand (DMR)[2]	-	-	5.00	5.00	N/A
Education	**5.63**	**-**	**2.50**	**-3.13**	**-55.6%**
Infrastructure	**56.93**	**-**	**67.18**	**10.25**	**18.0%**
Center for High Energy X-ray Science (CHEXS)	9.50	-	7.00	-2.50	-26.3%
Midscale Research Infrastructure	18.47	-	15.34	-3.13	-16.9%
National High-Magnetic Field Laboratory (NHMFL)[3]	24.25	-	37.81	13.56	55.9%
National Nanotechnology Coordinated Infrastructure (NNCI)	2.58	-	2.58	-	-
Other MPS Facilities	1.50	-	3.00	1.50	100.0%
Research Resources	0.45	-	1.45	1.00	222.2%

[1] All Class of 2013 STCs were sunsetted in FY 2021.

[2] The IMOD STC was selected as part of the new STC Class of 2021.

[3] FY 2021 Actual excludes $12.00 million obligated in FY 2020 for FY 2021 operations. FY 2023 Request contains $1.63 million for additional research infrastructure and O&M costs, including costs for repairs and maintenance.

About DMR

Materials research is defined by the broad intersection of many disciplines with materials science & engineering (MS&E), including chemistry, physics, biology, mathematics, and other engineering disciplines that naturally converge in the pursuit of understanding the properties of materials and the phenomena they host. Materials are ubiquitous and pervasive, serving as critical building blocks in technology and innovation. Materials research directly and fundamentally impacts life and society, as it shapes our understanding of the world and enables significant advances in electronics, communications, transportation, and health-related fields. The development and deployment of advanced materials are major drivers of U.S. economic growth.

DMR invests in the discovery, prediction and design of new materials; the discovery, explanation and harnessing of materials phenomena; as well as the development of the next generation of materials scientists, which includes increasing the pathways for participation by underrepresented group. DMR supports fundamental experimental, computational, and theoretical materials research and education via programs focused on condensed matter physics, solid-state and materials chemistry, and the science of materials that are ceramic, metallic, polymeric, nanostructured, biological, electronic, photonic, and multifunctional. This broad enterprise is dependent on investments across scales, including single investigators, teams, and centers; singularly focused research and areas requiring interdisciplinarity; and infrastructure ranging from small instruments to national mid- and large-scale user facilities. Specifically, DMR investments have contributed to U.S. leadership in high-field magnet science and further aim at democratizing national access to high-magnetic fields. DMR also supports materials-relevant instrumentation and technique development broadly in x-ray and neutron science, nanofabrication, as well in automated and autonomous tools coupled to AI.

In general, about 43 percent of the DMR portfolio is available to support new research grants. The remaining 57 percent supports research grants made in prior years and the research infrastructure needed by the materials research community.

DIVISION OF MATHEMATICAL SCIENCES (DMS) $259,470,000
+$15,810,000 / 6.5%

DMS Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Total	**$243.66**	**-**	**$259.47**	**$15.81**	**6.5%**
Research	**229.36**	**-**	**245.32**	**15.96**	**7.0%**
CAREER	16.48	-	15.00	-1.48	-9.0%
Education	**14.30**	**-**	**14.15**	**-0.15**	**-1.0%**

About DMS

DMS provides the major U.S. federal support for fundamental research in the mathematical sciences, leading to accelerated discovery and innovation in all science and engineering fields. Modern computing and communication systems, medicine, manufacturing, energy, transportation, finance, and national security all rely on advances in the mathematical sciences. DMS investments support research at the forefront of fundamental, applied, and computational mathematics, and statistics that accelerates discovery and innovation. DMS partnerships with science and engineering in turn inspire development of effective mathematical and statistical theories and methodologies applicable to current and future national priority areas such as artificial intelligence, quantum information science, biotechnology, and climate science. Another DMS priority is the development and advancement of future researchers in the mathematical sciences, through dedicated workforce and development programs.

DMS also provides leadership in emerging research fields through its support of the Mathematical Sciences Research Institutes program, which advances mathematics and statistics research through thematic programs and workshops on current and emerging trends.

DMS continues to develop strong partnerships to expand the impact of its research investments. Examples of partnerships within NSF include the Transdisciplinary Research in Principles of Data Science program with CISE and a program for developing new models for uncovering phenomena in biology with BIO. DMS also forms partnerships with other federal agencies including: a program in biosciences with NIH, the Joint DMS/National Institute of General Medical Sciences Initiative to Support Research at the Interface of the Biological and Mathematical Sciences; a program with the National Geospatial Intelligence Agency to develop the next generation of mathematical and statistical algorithms for threat analysis; and a program on algorithms for modern power systems with DOE. Finally, DMS partners with private foundations such as the Simons Foundation on programs that support research centers on the Mathematics of Complex Biological Systems and on the mathematical foundations of deep learning.

In general, about 58 percent of the DMS portfolio is available to support new research grants each year. The remaining 42 percent supports research grants made in prior years.

DIVISION OF PHYSICS (PHY)

$316,590,000
+$12,170,000 / 4.0%

PHY Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Total	**$304.42**	**-**	**$316.59**	**$12.17**	**4.0%**
Research	**210.56**	**-**	**222.84**	**12.28**	**5.8%**
CAREER	11.99	-	7.30	-4.69	-39.1%
Centers Funding (total)	7.54	-	7.70	0.16	2.1%
Artificial Intelligence Research Institutes	2.70	-	2.70	-	-
STC: Center for Bright Beams (PHY)	4.84	-	5.00	0.16	3.3%
Education	**5.02**	**-**	**4.92**	**-0.10**	**-2.0%**
Infrastructure	**88.84**	**-**	**88.83**	**-0.01**	**-0.0%**
IceCube	3.53	-	3.83	0.30	8.6%
LHC	20.00	-	20.50	0.50	2.5%
LIGO	45.00	-	45.00	-	-
Midscale Research Infrastructure	1.69	-	18.50	16.81	993.4%
NSCL[1]	15.50	-	-	-15.50	-100.0%
Research Resources	2.75	-	1.00	-1.75	-63.7%

[1] FY 2021 was the final year of NSF stewardship of NSCL, after which NSCL transitioned into the Department of Energy's Facility for Rare Isotope Beams.

About PHY

PHY supports fundamental research addressing frontier areas of physics that lead to the understanding of the make-up of the universe, from the formation of stars and galaxies to the principles of life processes on Earth. This research covers a range of physics subfields: atomic, molecular, and optical physics, elementary particle physics, gravitational physics, nuclear physics, particle astrophysics and cosmology, physics of living systems, plasma physics, and quantum information science.

PHY is the primary supporter of all U.S. research in gravitational physics and the leading supporter of fundamental research in atomic, molecular, and optical physics in the United States. PHY is a major partner with DOE in support of elementary particle physics, nuclear physics, and plasma physics. PHY also has the only U.S. program designed for the support of physics research in living systems. The development of the most advanced cutting-edge computational resources, innovative technology, and new instrumentation is a key part of physics research. Tools developed by the physics community continuously have major impacts in other scientific and engineering fields, allowing PHY to contribute in major ways to emerging new frontiers such as quantum information science and artificial intelligence.

In general, about 29 percent of the PHY portfolio is available for new research grants. The remaining 71 percent is used primarily to fund continuing grants made in previous years and to support operations and maintenance for three facilities that are a key part of the division portfolio. Through

the MREFC appropriation, PHY also oversees the construction of HL-LHC. For detailed information on PHY's individual facilities and the construction of HL-LHC, see the Research Infrastructure section of the NSF-Wide Investments chapter.

OFFICE OF MULTIDISCIPLINARY ACTIVITIES (OMA) $242,680,000
+$76,390,000 / 45.9%

OMA Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Change over FY 2021 Actual Percent
Total	**$166.29**	**-**	**$242.68**	**$76.39**	**45.9%**
Research	**124.97**	**-**	**190.23**	**65.26**	**52.2%**
CAREER	1.04	-	-	-1.04	-100.0%
Centers Funding (total)	39.84	-	37.00	-2.84	-7.1%
Quantum Leap Challenge Institutes	32.05	-	32.00	-0.05	-0.2%
Spectrum Innovation Initiative Center	7.79	-	5.00	-2.79	-35.8%
Education	**9.67**	**-**	**29.00**	**19.33**	**199.9%**
Infrastructure[1]	**31.65**	**-**	**23.45**	**-8.20**	**-25.9%**

[1] FY 2021 Actual includes $24.35 million for emergency cleanup of the Arecibo site following the collapse of the platform above the 305-meter telescope in December 2020. FY 2023 Request contains additional research infrastructure and O&M for MPS Major Facilities, including additional costs for repairs and maintenance.

About OMA

In partnership with MPS divisions and programs, OMA strategically invests in research and education to support novel, challenging, and multidisciplinary projects of varying scale that are not readily accommodated by traditional organizational structures and procedures.

OMA funding will focus on priority areas relevant to MPS: QIS, WoU, AI, SII, and Climate Research. As the steward for QIS, OMA will work with all MPS divisions, BIO, ENG, CISE and OISE that engage several relevant disciplines in a convergent and interdependent manner to advance quantum science and technology. Societal benefits of this science and technology are expected to be significant, as it is poised to include proof-of-concept devices, applications, tools, or systems with a demonstrable quantum advantage over their classical counterparts. MPS is also the steward for WoU, supporting AST, PHY, and GEO/OPP in activities that bring together fundamental research in electromagnetic waves, high-energy particles, and gravitational waves; advance the study of the universe; and grow the nation's multi-messenger astrophysics, engineering, and data science workforce. OMA will collaborate with all MPS divisions to support their investments in AI for sciences and the science of AI, clean energy, and climate science research. OMA is the steward for SII, which promotes transformative use and management of the electromagnetic spectrum with a focus on dynamic and agile spectrum utilization, benefiting multiple research areas. OMA will foster broadening participation through the new MPS-Ascend program and the Launching Early-Career Academic Pathways in the Mathematical and Physical Sciences and continue to place high priority on the Alliances for Graduate Education and the Professoriate Graduate Research Supplement program and the MPS Graduate Research Supplements to Veterans program.

In general, about 32 percent of the OMA portfolio is available to support new research grants. The remaining 68 percent supports multidisciplinary research infrastructure and education activities needed by the MPS community.