



NSF/MPS
Division of Astronomical Sciences
AAAC September 2023

R. Chris Smith, Division Director (Interim)

NSF Staffing Changes

AST Division Director

- Debra Fischer rotated out Jul 31, 2023
- Chris Smith named Interim Division Director as of Aug 1, 2023

Thank you Debra!

MPS Assistant Director

- Sean Jones rotating out Oct 3, 2023
- Denise Caldwell named Acting Assistant Director as of mid-Oct 2023
- Saul Gonzalez named Acting MPS Senior Advisor for Facilities

Thank you Sean!



Directorate for Mathematical and Physical Sciences (MPS)
CURRENT ORGANIZATIONAL STRUCTURE

Office of the Assistant Director

Assistant Director

Deputy Assistant Director

Communications

Office of
Multidisciplinary
Activities

Senior Advisor for
Facilities

Senior Advisor for
Strategy and
Engagement

Astronomy

Disciplinary
Programs

Midscale /
Instrumentation

Major Facilities

Chemistry

Disciplinary
Programs

Centers

Instrumentation

Materials
Research

Disciplinary
Programs

Centers

Groups

Major Facilities

Mathematics

Disciplinary
Programs

Institutes

Partnerships

Physics

Disciplinary
Programs

Centers

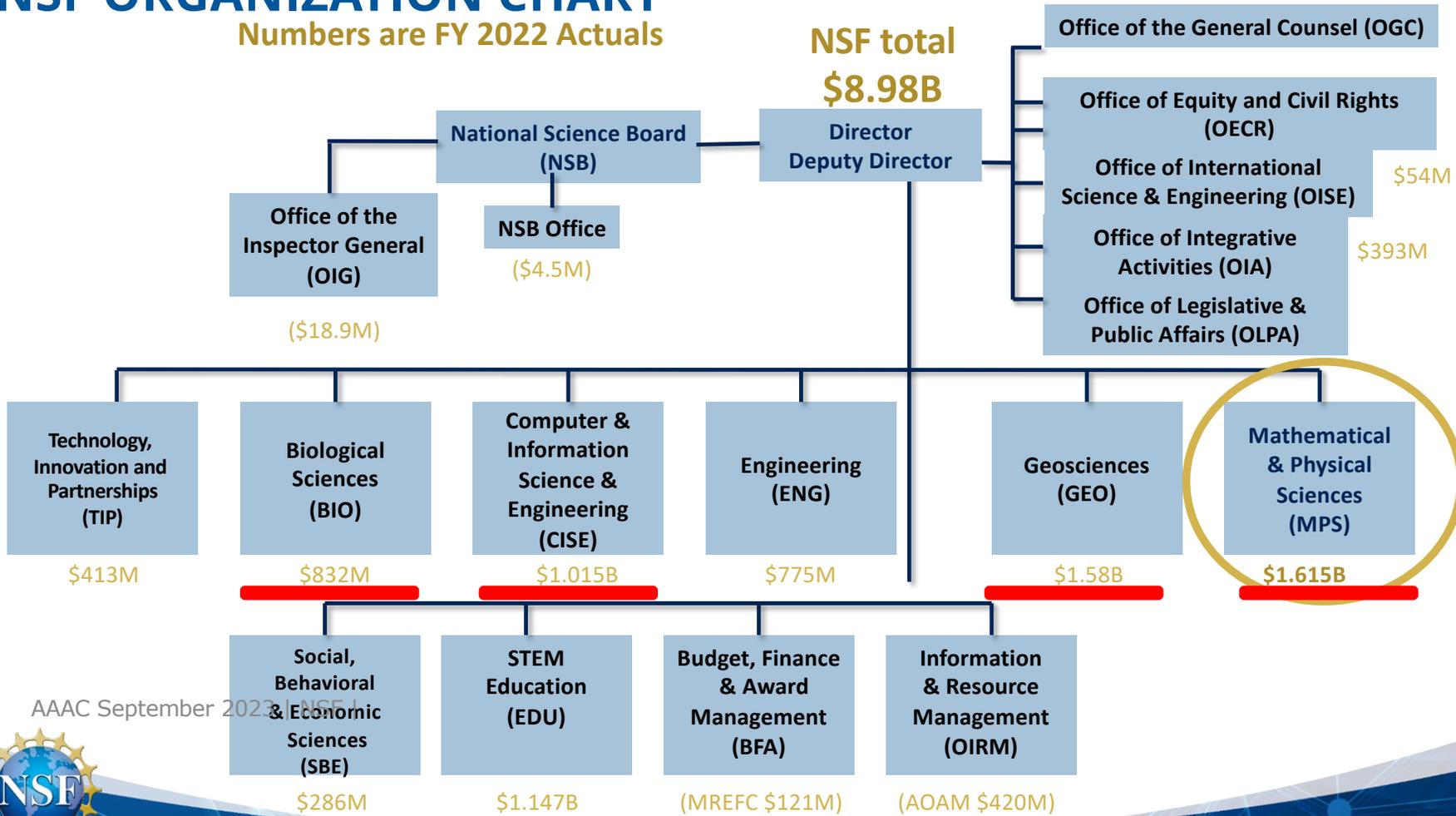
Midscale /
Instrumentation

Major Facilities

NSF ORGANIZATION CHART

Numbers are FY 2022 Actuals

NSF total
\$8.98B

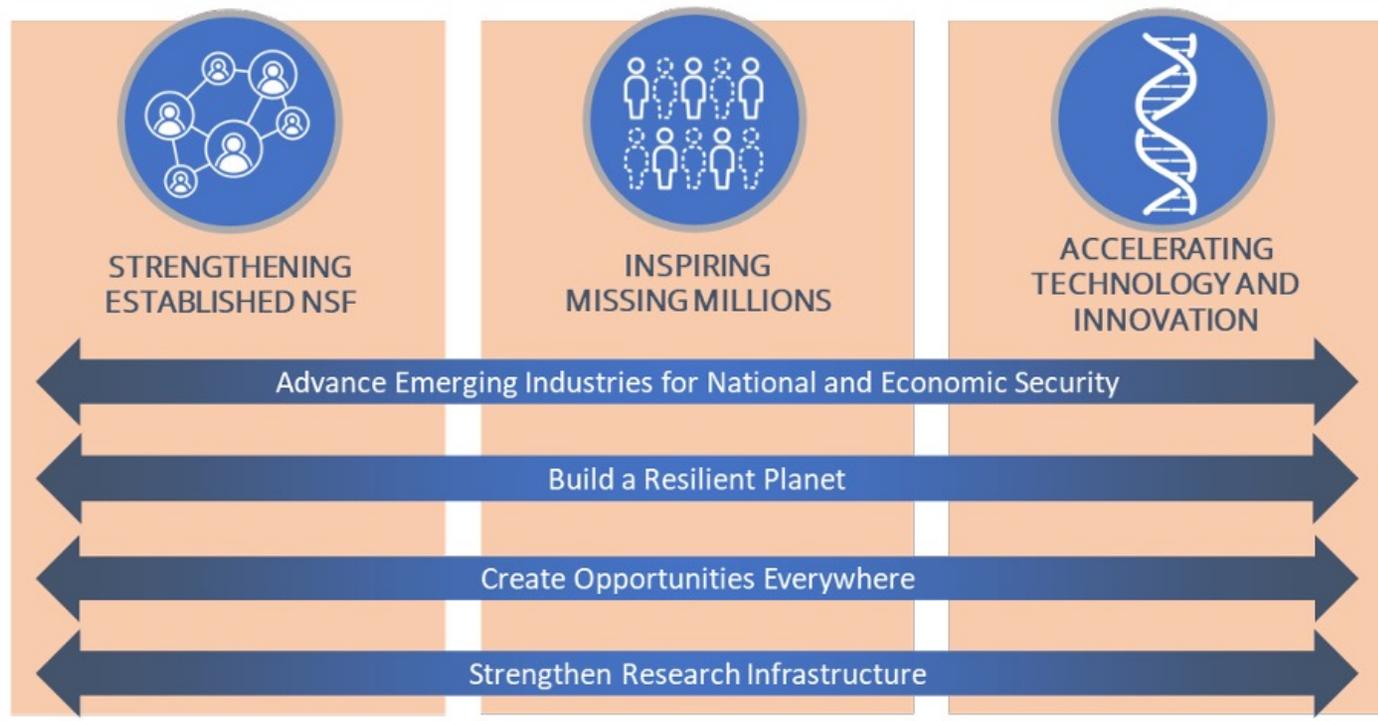


AAAC September 2023 - NSF



NSF Pillars and Priorities

These pillars and cross-cutting themes drive NSF investments and shape the President's Budget Request



NSF's Division of Astronomical Sciences (AST) supports:

- Forefront research in astronomy
- Access to world-class ground-based Research Facilities
- Development of new instrumentation and next-generation facilities; and
- Broadening participation in the astronomical sciences by a Diverse Population of scientists, policy makers, educators, and the public at large

The Division supports research in **all areas** of astronomy and astrophysics as well as related multidisciplinary studies, with evaluation based on two “simple” criteria: Intellectual Merit and Broader Impacts.



AST Division Programs



Individual Investigators

Mid-scale

Facilities

MREFC

Research

AAG

CAREER

AAPF

ATI

MRI

REU Sites & Supplements

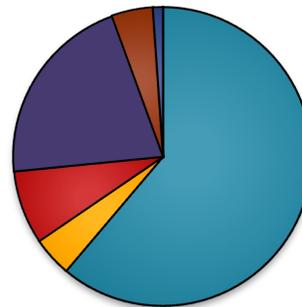
MPS LEAPS & ASCEND

PAARE

MSIP

* MSRI 1

* MSRI 2



ESM Host

NRAO

ALMA

GBO

Arecibo

NSO

DKIST

NOIR Lab

MidScale Obs

Gemini N & S

Rubin Operations

* Rubin

Technology/ Instrumentation *

Education and Special Programs *

* Outside AST budget



SCIENCE

Workhorse Program: AAG

- Four general areas
 - Extragalactic Astronomy
 - Galactic Astronomy
 - Planetary Astronomy
 - Stellar astronomy and astrophysics
- ~\$50M annually, highly competitive



[← Search for more funding opportunities](#)

i Important information for proposers

All proposals must be submitted in accordance with the requirements specified in this funding opportunity and in the NSF [Proposal & Award Policies & Procedures Guide \(PAPPG\)](#) that is in effect...

Supports observational, theoretical, laboratory and archival data research in astronomy and astrophysics.

Synopsis

The Astronomy and Astrophysics Research Grants (AAG) Program is an inclusive and flexible funding opportunity to support research in the astronomical sciences. The Program provides individual investigator and collaborative research grants for observational, theoretical, laboratory, and archival data studies in astronomy and astrophysics. The Program also considers proposals for projects and tools that enable or enhance astronomical research. Proposals may span multiple disciplines and/or areas of study and may utilize multiple techniques.

NEW: NSF-Simonyi Scholars

Partially funded with contribution from Charles Simonyi, supporting early career astronomers with *research that supports Rubin science*.

- Proposals (e.g., AAG, CAREER) are evaluated through regular merit review process.
- Research connected to Rubin Observatory (theory or observation) will be identified as eligible by program officers and will receive 50:50 support by regular NSF funds and Simonyi contribution.
- Up to \$2M awards / year for up to 10 years, *doubling the impact* of AST in supporting research related to Rubin science.



NEW: AI for Astronomical Sciences

- Awards anticipated in FY2024
- Proposal Deadlines
 - Preliminary: Oct 31, 2023
 - Full proposal: Feb 16, 2024
- Expecting to fund 2 Awards:
\$16-20M for 4-5yrs
- Funded in collaboration with
Simons Foundation



[← Search for more funding opportunities](#)

i Important information for proposers

All proposals must be submitted in accordance with the requirements specified in this funding opportunity and in the NSF [Proposal & Award Policies & Procedures Guide \(PAPPG\)](#) that is in effect...

Supports the development of new AI Institutes that focus on one of the following themes: astronomical sciences, materials research and new methods for strengthening AI.

PEOPLE: Workforce Development

		Description
AST	PAARE	AST: Partnerships in Astronomy & Astrophysics Research and Education
	REU	AST: Research Experience for Undergraduates
	AAPF	Astronomy & Astrophysics Postdoctoral Fellows
MPS	ASCEND	MPS: postdocs with potential to broaden participation
	LEAPS	MPS: early career faculty at institutions with little NSF STEM funding
NSF	GRFP	NSF: Graduate Student Research Fellowships Program
	CAREER	NSF: faculty early career development for leadership
	GRANTED	NSF: Growing Research Access

Main AST/MPS/NSF programs devoted to training a diverse workforce and enhancing early careers.



Expanded PAARE

- Encouraging new partnerships, expanding opportunity to a wider range of institutions
- Fully developed partnership concepts funded up to 5 years
- Shorter term proposals (1 to 2 years) available to develop new partnerships



[← Search for more funding opportunities](#)

i Important information for proposers

All proposals must be submitted in accordance with the requirements specified in this funding opportunity and in the NSF [Proposal & Award Policies & Procedures Guide \(PAPPG\)](#) that is in effect...

Supports partnerships between institutions that provide pathways into research and broaden the participation of individuals from groups underrepresented in astronomy.

Synopsis

The objective of PAARE is to improve the quality and environment of astronomy and astrophysics research and education by stimulating the development of formal, long-term partnerships that provide authentic pathways into the research enterprise and broaden the participation of individuals from groups underrepresented in astronomy. Partnerships must substantially involve institutions seeking to create opportunities for student and faculty research that will increase the recruitment, retention, and success of these individuals. It is expected that the partnerships will build or strengthen research capacity, as well as foster a diverse, inclusive, and equitable environment for astronomy and astrophysics research and education at the partnering institutions.

TOOLS: Technology & Instrumentation

AST Advanced Technologies
& Instrumentation (ATI)

NSF Major Research
Instrumentation (MRI)

AST MSIP

NSF MidScale Research
Infrastructure 1

NSF MidScale Research
Infrastructure 2

- Broad portfolio of technology development and innovation
- Heavily oversubscribed

Workshop: Future of Astronomical Instrumentation

- Develop a sustainable plan to support the design, development, and construction of the next generation of astronomical instrumentation.
- Themes:
 - Critical technologies such as photonics, detectors, adaptive optics.
 - The “centers of excellence” model (a distributed network of instrument development centers supported on an ongoing base)
 - How can we better enable and nurture more nationally dispersed university-university and university-industry partnerships.
 - Strategic approach to instrument and funding landscape.
 - Workforce development



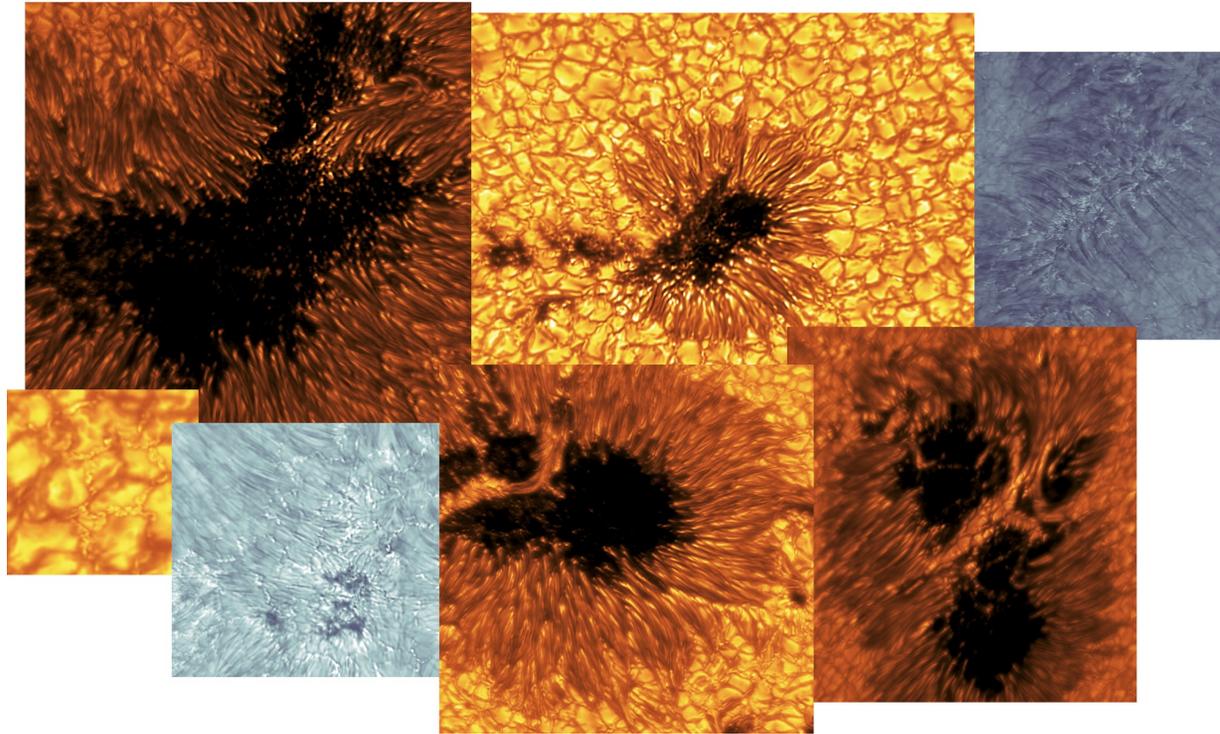
TOOLS: Major Research Facilities

Facilities operated as Federally Funded Research Development Centers (FFRDCs):

- National Solar **Observatory** (DKIST, NISP program including GONG)
- NOIRLab **Observatories**: (Gemini-N, Gemini-S, Mayall, WIYN and tenant telescopes at Kitt Peak, Blanco, SOAR, SMARTS, and tenant telescopes at CTIO, and soon: Rubin Observatory operations)
- National Radio Astronomy **Observatory** (VLA, VLBA, ALMA)
- Green Bank **Observatory**

These facilities give public access to any astronomer with a strong proposal, broadening participation.





- Recent release of 8 new images from DKIST's Visible Broadband Imager
- Images have reached over 500 Million Viewers

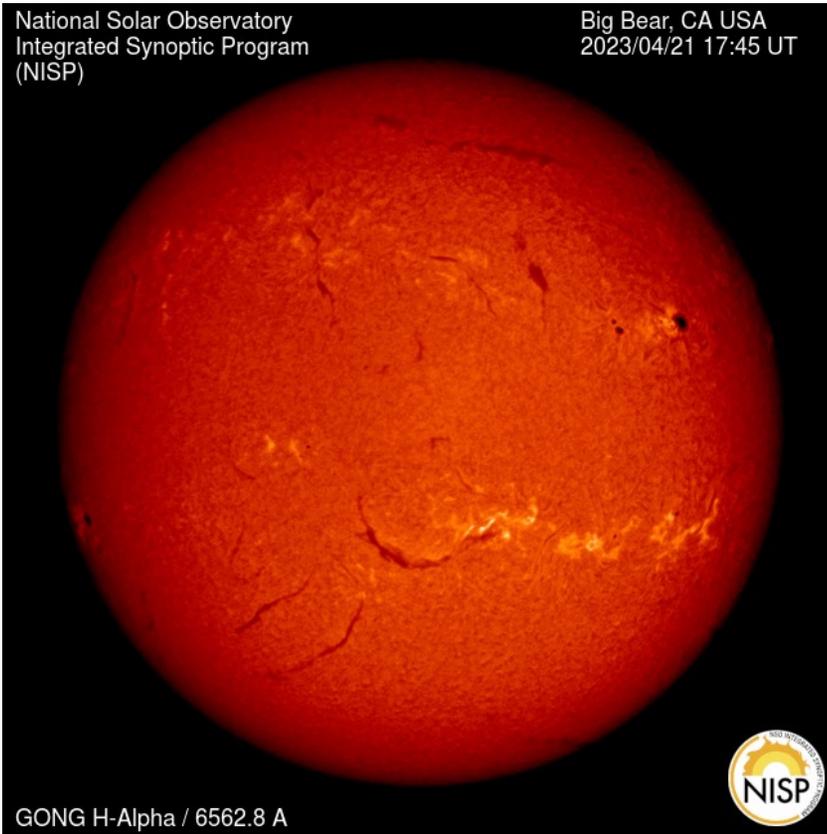
Image credit: NSO/AURA/NSF



DKIST

- DKIST released first data sets to the public in December of 2022
- Brinson Foundation Postdoctoral Fellow, Ryan French, published on the detection of umbral flashes in the solar chromosphere using science verification data from the DKIST's Visible SpectroPolarimeter (ViSP).
- This result provides a tantalizing high-resolution peek at the magnetic structures we expect to see from DKIST.

NSO GONG: Making waves



GONG

A severe geomagnetic storm hit Earth on Sunday, April 23. The storm was rated G4 (4 out of 5) by NOAA's Space Weather Prediction Center. The eruption was captured by GONG at Big Bear Solar Observatory. Aurora from the storm were seen as far south as Arizona.



Data from the [@NatSolarObs](#)'s GONG network of solar telescopes alerted astrophotographer Eduardo Schaberger Poupeau to this polar crown prominence on the Sun.



N. Oien

NRAO facilities

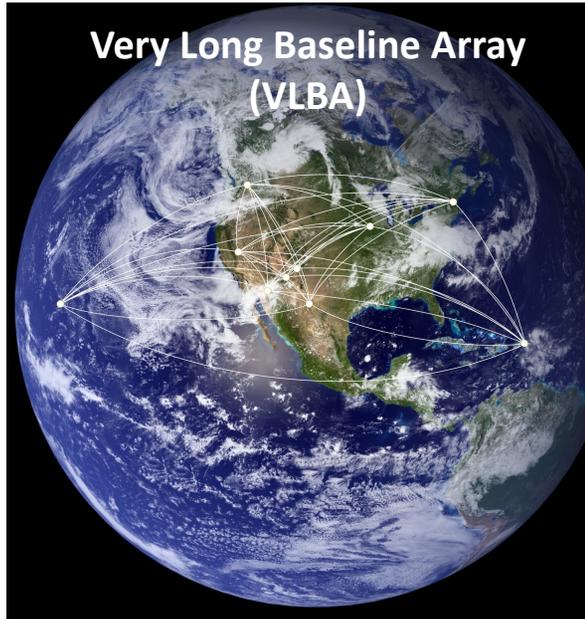
NRAO

- VLA Sky Survey continues
- VLBA provides celestial reference frame measurements – critical to GPS
- CDL advances technology for radio instrumentation - ngVLA

Karl G. Jansky Very
Large Array (VLA)



Very Long Baseline Array
(VLBA)



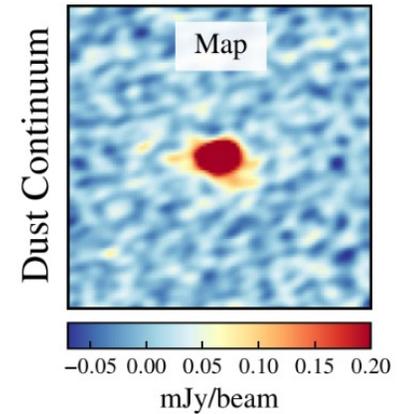
Central
Development Lab



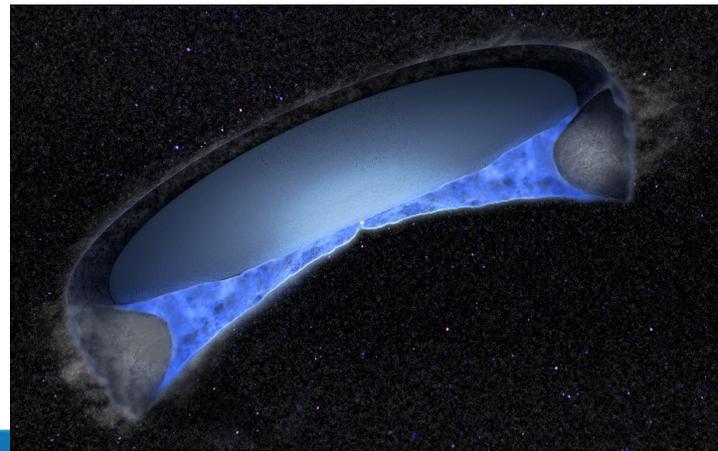
ALMA



- 10th anniversary of ALMA Operations
- Continues to break records for proposals and time requested



Top: Dust continuum of early galaxy COS-87259 12.7 Bly away



Left: V883 Ori is a unique protostar whose temperature is just hot enough that the water in its circumstellar disk has turned to gas,



Radio Facility Updates



ALMA

- Fully recovered from cyber attack last Fall. No science data or antennas compromised. ALMA operations resumed in December (2-month shutdown).



Green Bank

- Damaged wheel replaced and work completed on bad area of foundation.
- GBT resumed operations Apr 12, operating at slower azimuth speeds while wheel breaks in.

AAAC September 2013 | NSF |





Credit:International Gemini Observatory/NOIRLab/NSF/AURA/M. Garlick/M. Zamani

NOIRLab / Gemini-S

Gemini-S used to observe the first evidence of a dying Sun-like star engulfing an exoplanet.

The “smoking gun” of this event was seen in a long and low-energy outburst from the star — the telltale signature of a planet skimming along a star’s surface.

This never-before-seen process may herald the ultimate fate of Earth when our own Sun nears the end of its life in about five billion years.



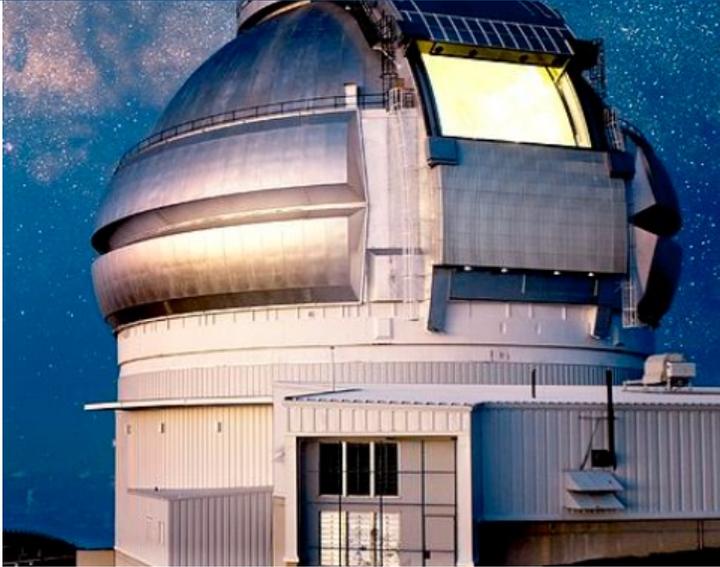
Credit:Rubin Observatory/AURA/DOE/NSF

Rubin

- Vera C. Rubin Observatory passed a major construction milestone: the telescope structure is being outfitted with a full-size replica of its 8.4-meter mirror and stand-ins for its 3200-megapixel LSST Camera (DOE) and other critical optical components.
 - Re-baseline of construction project costs complete.
 - Current forecast completion in early 2025.
 - Expect operations to begin some months after that.



NOIRLab: Facility Updates



Gemini-N

- Repairs to the damaged area of the mirror and re-coating of primary mirror completed
- Gemini-N now returned to science operations (until...)



Kitt Peak

- Main power reinstated, fiber installation underway, road open to staff; some visitor access.
- Mayall 4.0-m and WIYN 3.5m and other telescopes operating.



More Recent Events

- Maui Fires
 - Severe impacts on DKIST community: staff, families, friends, and neighbors
 - Science Support Center: Smoke Damage
 - DKIST: no direct impact, back online sooner than expected due to the amazingly dedicated staff

- NOIRLab/Gemini Cyberattack
 - Initially impacted Gemini-N and Gemini-S
 - broader impacts across NOIRLab system, shutdowns out of abundance of caution
 - NOIRLab systems coming back online slowly, as all are thoroughly reviewed



Astro2020 & Major Facilities Recommendations



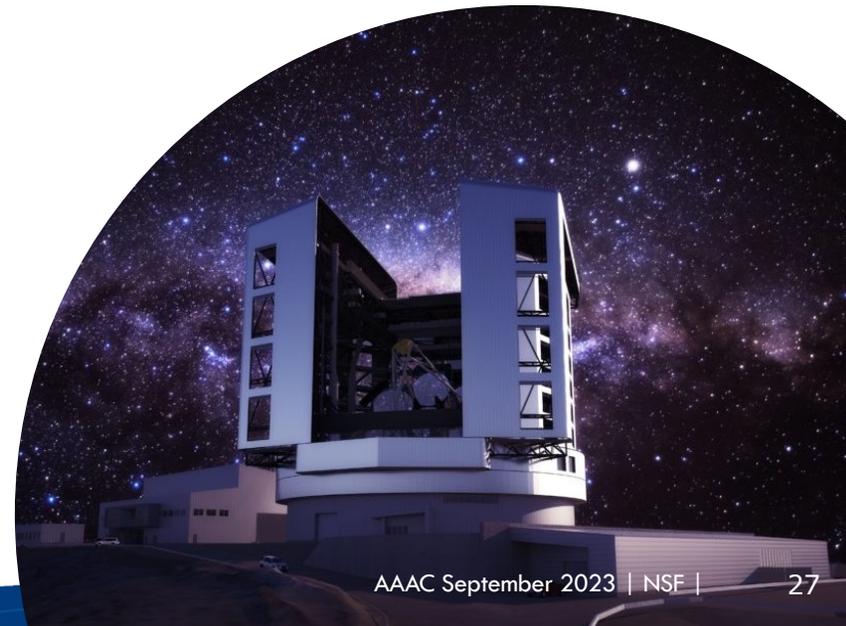
Sustainability efforts

- Supplements provided for a photo-voltaic system and battery storage at Cerro Pachón, with goal of making Gemini-South carbon neutral!
- Exploring options to extend systems, phasing in renewable energy for Rubin and then all of Cerro Pachón.
- Working with all facility directors to get estimates of energy use, carbon emissions, etc.
- Funded initial investments in electric vehicles with FY23 appropriations.
- Solar panels funded for NRAO Science Operations Center in Socorro



US-ELT Program

- **US-ELT entered NSF's Major Facility Design Stage (in Preliminary Design Phase) in Dec 2022**
- TMT and GMT both successfully completed NSF's PDR
 - Two-stages – Dec. 2022 and Jan. 2023
 - Final report – Mar. 3, 2023
- MPS Blue Ribbon Panel supported AST plan for moving projects forward
- NSF formally started the TMT environmental review process – Aug. 2022



Status of Maunakea and TMT

- Maunakea Stewardship and Oversight Authority (MKSOA) established: 11 members representing a broad range of interests and expertise including the traditions and culture of Native Hawaiians (NH).
- NSF is committed to working closely and respectfully with the MKSOA
 - On the future management of existing facilities on MK
 - On the potential installation of TMT
- No matter what happens with a TMT partnership, NSF looks forward to finding ways to improve STEM opportunities for Native Hawaiians.



ngVLA

- **ngVLA project entered NSF's Major Facility Design Stage (in Conceptual Design Phase) in July 2023**
- NRAO design and development program office funded for FY23+FY24
- Work on antenna prototype progressing
- MOU between NRAO and UNAM for ngVLA activities (Nov 2022)



CMB-S4

- Moving project toward entry into NSF's Major Facility Design Stage, Conceptual Design
- Team is developing alternative possible designs with different infrastructure footprints at South Pole (in response to OPP DCL: <https://www.nsf.gov/pubs/2022/nsf22078/nsf22078.jsp>)
- Both short-term and long-term planning for South Pole activities still evolving, impacting potential plans for CMB-S4



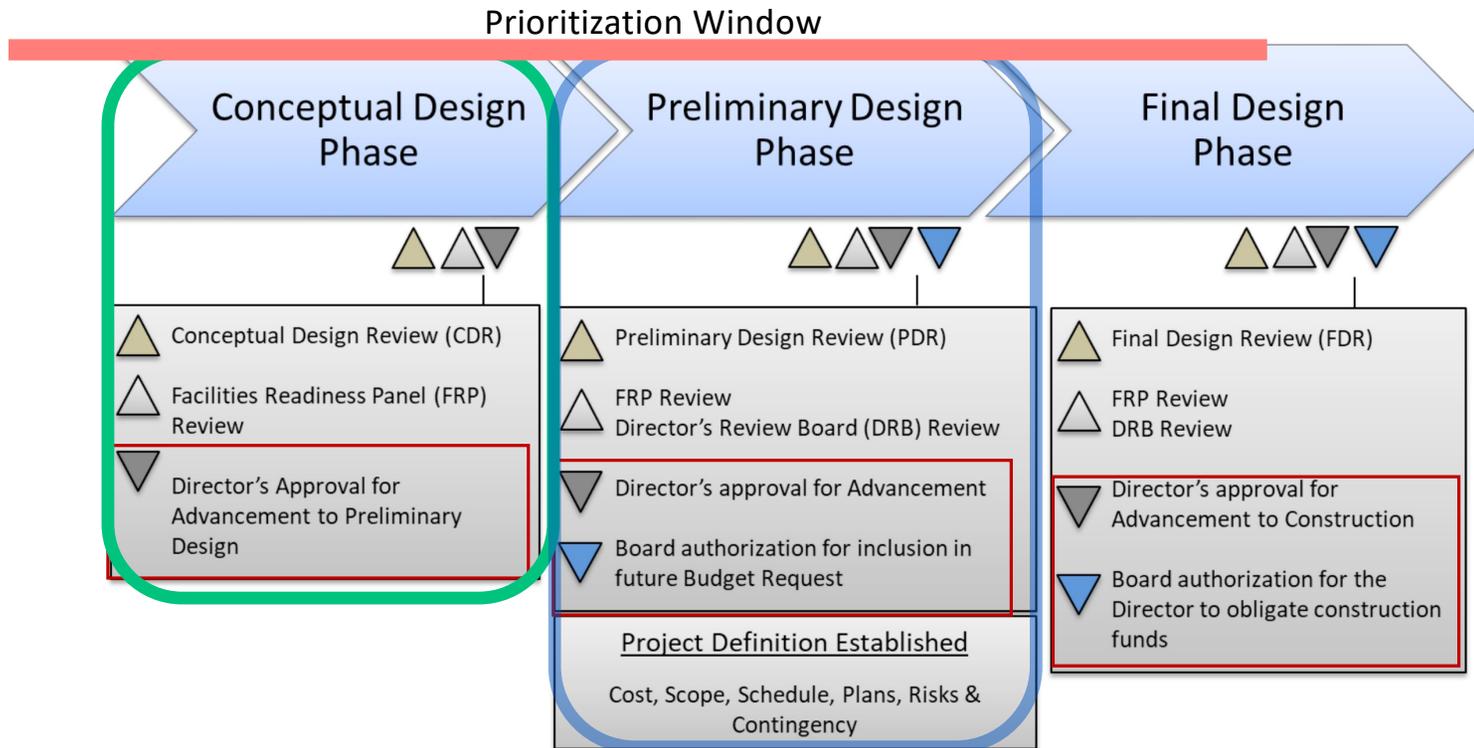
Facilities Lifecycle Context



Source: NSF Major Facilities Guide (Sep. 2019), Figure 2.1.3-1.



NSF's Major Facilities Design Stage



- Projects can enter at any point before PDR
- **Entry into Design Stage does NOT imply commitment to fund construction**

Source: NSF Major Facilities Guide (Sep. 2019), Figure 2.1.3-2.

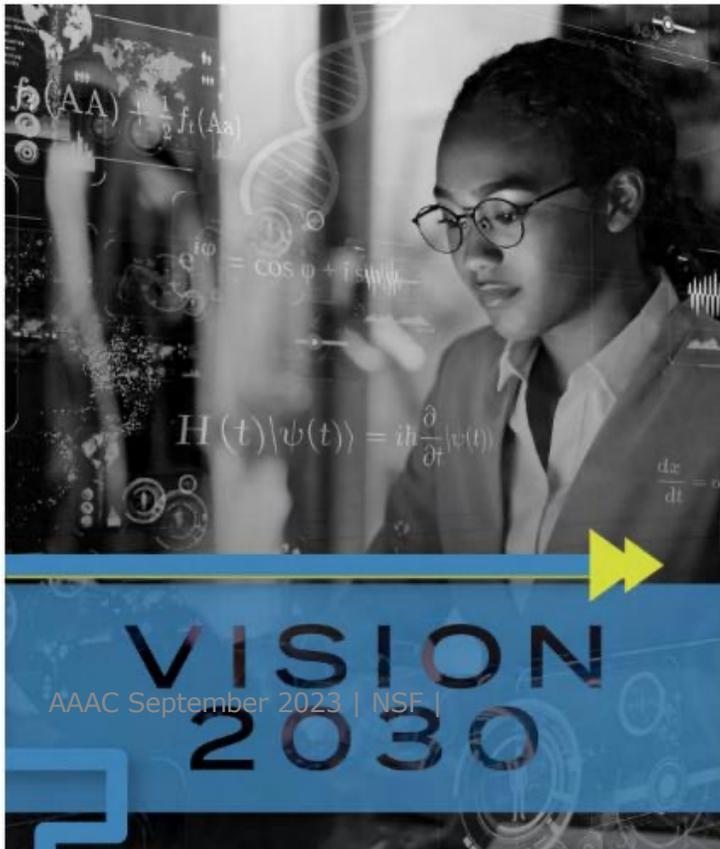


Future MREFC Candidates: MPS Facilities on the Horizon?

- AST: Astro2020
 - Several Major Facility recommendations critical to advances in the field and U.S. Leadership: US ELT Program, CMB-S4, ngVLA
- PHY: Astro2020, P5 coming
 - Astro2020: What is next in Gravitational Wave observations?
 - Cosmic Explorer “Horizon Study”, ngLIGO
 - AC Subcommittee on next-generation facility concepts
 - Astro2020: IceCube Gen 2?
- DMR: What is next in high magnetic field instrumentation?
 - National Academies Study underway; recommendations for Next-gen High-field Magnets
 - Potential alignment with TIP



Infrastructure: Vitally Important to Advance Science



"For the U.S. to remain a global leader in innovation, America's researchers must have access to scientific facilities that will astonish the world – **tools that let them see further, faster, and deeper.**"

"This infrastructure is critical for fundamental research, empowering U.S. businesses and entrepreneurs, and developing and attracting STEM talent."

NSB sees three infrastructure imperatives:

- The U.S. must invest in infrastructure, including data, software, computation, and networking capabilities, **across all S&E disciplines.**
- To catalyze **regional** scientific and innovation networks, America must strategically build S&E infrastructure and capacity in the **nation's underserved areas and institutions**, while retaining excellence and capacity where it already exists.
- For the most complex and costly facilities, for which **only one or two of a kind are needed worldwide, the U.S. must cooperate with other countries**, such that U.S. researchers can participate fully, help set the agenda, and share equitably in the results.

Vital, Yes – Community Vision Requires Prioritization

MPS Advisory Committee (AC) Subcommittee on Facilities and Major Research Infrastructure
Long term (5-yr) Charge

- **Assess potential contributions of new Major and Mid-scale infrastructure projects in the context of the MPS portfolio**
- Provide recommendations for (required) MPSAC endorsements of Major Facility projects
- Provide strategic advice on elements of, and the balance of, the evolving MPS research infrastructure portfolio, including Major Facilities and Mid-scale investments
- **Provide guidance on the structure for decisions that will lead to a robust 10-year program of strategic investments in the development, construction, operations, and divestment of MPS major research infrastructure**



Study 1: Establish Critical Need

- Provide a summary for MPSAC consideration articulating the importance of major and mid-scale facilities to NSF's scientific leadership and MPS's role in ensuring that its scientific research infrastructure enables the current and future cutting-edge science of the Directorate.
- Report 1:
 - ***The science and technology that will define our future, and power our economy, will only flourish in the U.S. if we sustain a strong scientific ecosystem that includes leading-edge research instruments.***



Study 2: Prioritization of NEW Major Facility Projects

- Provide to MPS a set of considerations for prioritization of major facility projects across the competing needs of the communities served by the Directorate that incorporate the financial and societal realities of the scientific enterprise in the 2020s and the current and future needs of MPS communities, in order to ensure a vibrant infrastructure portfolio that delivers the scientific mission of MPS, specifically, and NSF, overall.
- Including
 - Multi-level strategic considerations (Directorate, Agency, Federal priorities)
 - Partnerships and discipline context
 - Current investments in new facilities vs future investments
 - Societal realities; holistic view of broader impacts and broadening participation
 - Balance of risk and reward



Foundation for Prioritization: Brinkman Report & NSB response

- Brinkman 2004: Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation
- National Science Board 2005: Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation

These represent our (almost 20 year old) starting point. Much is still relevant, and we should not rewrite these, but update them and (most importantly) provide advice on the best ways to implement them in the current and future MPS context.



Other Studies & Reports for AST & MPS

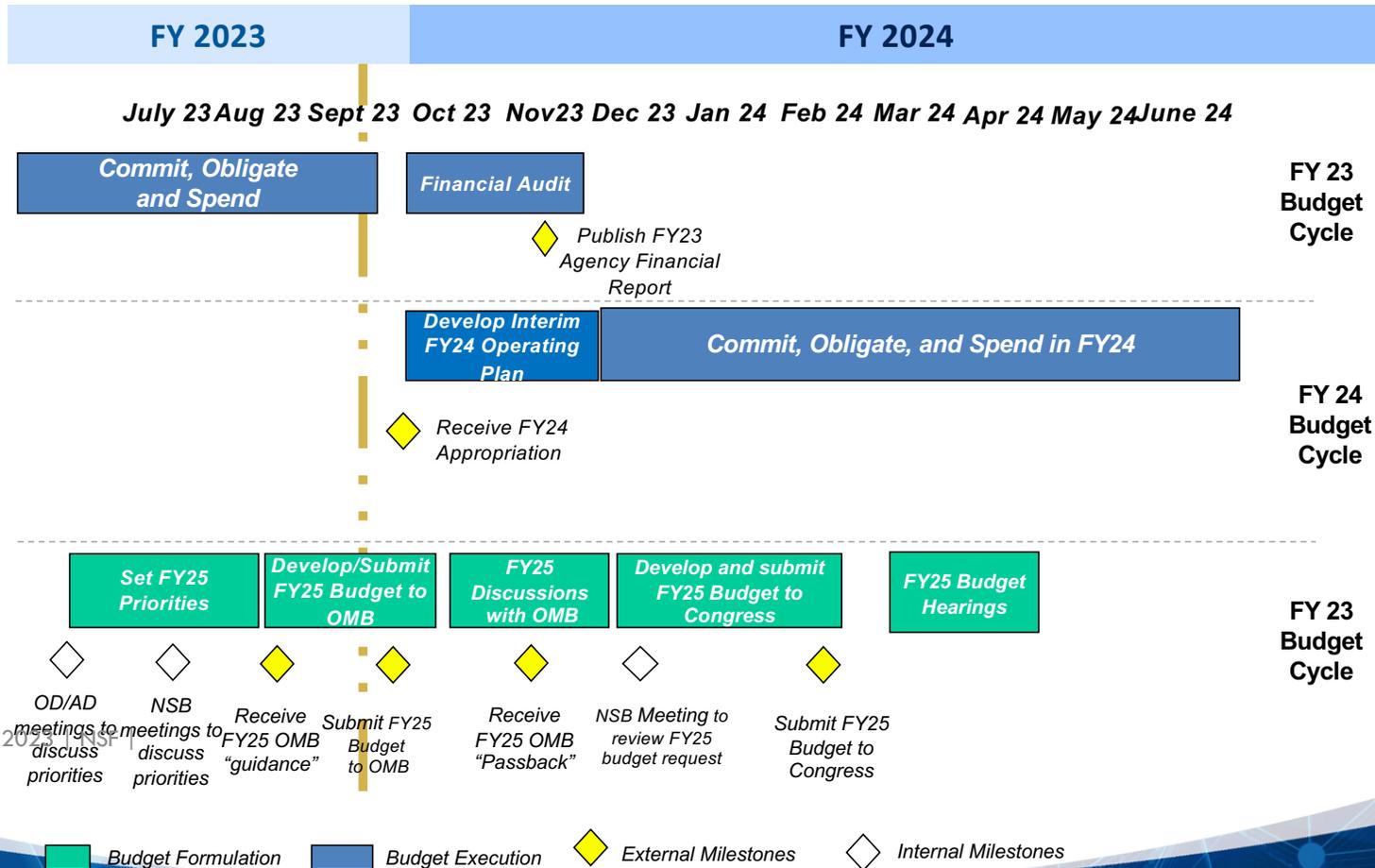
- Decadal Surveys in addition to ASTRO2020
 - Planetary Science & Astrobiology; released in April 2022
 - Solar & Space Physics underway
 - Biological & Physical Science Research in Space underway
 - HEPAP/P5 underway
- Committee of Visitors met August 2023; report pending
- Senior Review/Facilities Portfolio Review planning underway
- MPS Advisory Committee; esp Subcommittee on Future Facilities
- AST Community workshops on 1) Data Infrastructure (Feb 2023) and 2) Instrumentation and Technology (planning underway)



Budgets



Typical NSF Budget Activity Timeline



AAAC September 2023 NSF

NSF Budgets

- Budget allocations typically flow from NSF Director, Administration, and Congressional priorities
 - August planning guided by OSTP/OMB R&D Memo
 - Baseline often from previous year; increases/decreases depending on priorities
 - Results in President's Budget Request
- Appropriations set final planning
 - NSF budget remains highly flexible to respond to Congressional language as well as Director's priorities



FY24 President's Budget Request

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

\$1,835,790,000

MPS Funding (Dollars in Millions)

	FY 2022 Actual ¹	Disaster Relief Supplemental			FY 2023 Estimate Total	FY 2024 Request	Change over FY 2023 Base Total ²	
		FY 2023 Estimate Base	RI Damage Base	Mitigation			FY 2024 Request	FY 2023 Base Total ² Amount
Astronomical Sciences (AST)	\$283.61	\$283.57	\$8.76	-	\$292.33	\$303.33	\$11.00	3.8%
Chemistry (CHE)	265.19	264.46	4.37	-	268.83	279.83	11.00	4.1%
Materials Research (DMR)	338.75	338.78	0.63	-	339.41	350.41	11.00	3.2%
Mathematical Sciences (DMS)	248.32	247.99	4.00	-	251.99	262.99	11.00	4.4%
Physics (PHY)	309.89	308.90	4.23	-	313.13	324.13	11.00	3.5%
Office of Strategic Initiatives (OSI) ³	169.50	169.20	48.45	2.50	220.15	315.10	97.45	44.8%
Total	\$1,615.26	\$1,612.90	\$70.44	\$2.50	\$1,685.84	\$1,835.79	\$152.45	9.1%

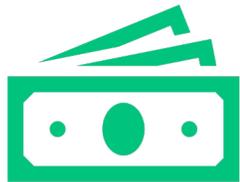
¹ Excludes \$80.70 million in American Rescue Plan supplemental funding.

² Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

³ Formerly titled Office of Multi-Disciplinary Activities (OMA)



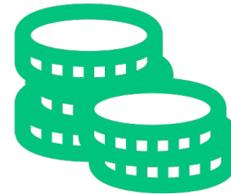
Astro2020 Funding: Major Facilities



NSF dedicated \$30M in FY23 to Astro2020 Major Facilities

Over half of this is going to be dedicated to development and design work on the US ELTs.

The balance put towards continued development of other major facilities prioritized in Astro2020, including CMB-S4, ngVLA, and initial next-gen Gravitational Wave definition.



FY24 appropriations under consideration by Congress



FY24 NSF Realities

- President's Request = \$11.31B
- House mark = \$9.63B
- Senate mark = \$9.50B
- Conference = ?



AST Challenge: Major Facilities Full Lifecycle Costs

- Development & Design: Division funding
 - ROM 10-20% of Construction cost
 - Over 5-10 years, sometimes as part of previous facility
- Construction: **MREFC funding**
- Operations & Maintenance: Division funding
 - ROM 5-10% of Construction cost **per year**
 - 10-50 year commitment
- EXAMPLE for **next generation** facility...

Development & Design	Construction	O&M
\$150 to 250 million	\$1.5 Billion	~\$100-150 million per year



AST Challenge: Balancing needs

- Immediate need = Facilities Design & Development, with help from MPS+OD
- Plan for construction = MREFC Funding (not AST, but NSF-wide prioritization)
- Future need = Managing growing Facilities operations costs of existing facilities while bringing new facilities online



AST Challenge: Aspirational planning, but Execution within Allocations

- Strategic planning: plan for best case
 - Research Infrastructure prioritization alongside modest growth in “base” for grants
 - Still need to understand/resolve operations costs!
- Strategic planning: prepare for difficult decisions
 - Phasing projects, balancing needs, prioritizing funding lines



Further information

- AST host of Electromagnetic Spectrum Management (ESM) group; more on that in Dark & Quiet Skies session
- Data archiving, data management, and more generally Data-to-Science efforts to be covered in Data session
- AST's Time Domain Astronomy and Multi-Messenger Astrophysics covered in TDA/MMA session



