NSF Astrophysics Update

Committee on Astronomy and Astrophysics

November 7, 2024

R. Chris Smith, Division Director (Interim)

NSF/MPS/AST

Who we are…

Division of Astronomical Sciences (AST)
Last updated October 2024

Indicates IPA

Management Team

R. Chris Smith
Division Director (Interim)

James Neff
Deputy Division Director

Craig McClure
Program Support Manager

Daphne Marshall
Financial Operations Specialist

Ashley VanderLey
Senior Advisor for Facilities

Administration

PENDING
Program Analyst

Matthew Viau
Facilities Management and Program Analyst

Allison Farrow
Business Operations Analyst

Valerie Maizel
Business Operations Specialist

PENDING
Program Analyst Pathways Student

Tiana Faulcon
Executive Administrative Support Analyst, Contractor

Individual Investigator Programs (IIP)

Hans Krimm
Program Director

IIP Coordinator

Nigel Sharp
Program Director

Lead: Extragalactic & Cosmology; cross-NSF programs

Glen Langston
Program Director

Lead: Galactic Astronomy

Harshal Gupta
Program Director

AAG, Lab Astro

Louise Edwards
Program Director

Lead: Postdoctoral Fellowships

Gioia Rau
Program Director

Lead: SAA, AI Institutes; NASA Liaison

Matthew Bershady
Program Director

Lead: Advanced Technology & Instrumentation; AAG

Dan Fabrycky
Program Director

Lead: CAREER; AAG

Juan Madrid
Program Director

Lead: REU; EXC

Matthew Benacquista
Program Director

Expert

Alison Peck
Program Director

Instrumentation

Andreas Berlind
Program Director

Lead: Extragalactic & Cosmology; AI Institutes; cross-NSF programs

Jacqueline Keane
Program Director

Lead: PLA

Facilities, Mid-Scale, & MREFC Projects

Nigel Sharp
Program Director

MSIP; MSRI

Luca Rizzi
Program Director

Rubin Observatory; US ELT

Christopher Davis
Program Director

NOIRLab; US ELT

Edward Ajhar
Program Director

Rubin Observatory; US ELT

Joe Pesce
Program Director

NRAO; ALMA

Harshal Gupta
Program Director

GBO

Martin Still
Program Director

Gemini

Carrie Black
Program Director

NSO/DKIST

Megan Johnson
Program Director

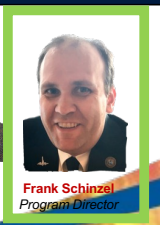
Facilities

Electromagnetic Spectrum Management (ESM)

Jonathan Williams
ESM Coordinator

John Chapin
Special Advisor for Spectrum

Josh Reding
AAAS Fellow



Frank Schinzel
Program Director

What we do…

We have roughly $300M per year to support the U.S. astronomical community. With that funding, we must:

- Support current generation and develop next-generation tools, including telescopes and instrumentation, that can support forefront astronomical research (**TOOLS**)
- Provide support for people to do that research now (**SCIENCE**)
- Support the development of the next-generation diverse workforce to do new science with next-generation tools (**PEOPLE**)

AND

- Develop and steward a sustainable ground-based observing ecosystem while protecting our ability to observe the universe from the ground in optical and radio

Recent Highlights

https://new.nsf.gov/news/nsf-simons-foundation-launch-2-ai-institutes-help

View image credit & caption

NSF News

NSF and Simons Foundation launch 2 AI Institutes to help astronomers understand the cosmos

Researchers will build a new breed of AI-powered tools to find the needles of discovery lurking in vast haystacks of astronomical data

September 18, 2024

Share

Related stories

Two New AI Institutes for Astronomy

- Each institute will receive $20M over 5 years
  - $10M from NSF and
  - $10M from Simons Foundation

Photo by Bettymaya Foott/NSF NRAO/AUI, composition by U.S. National Science Foundation

- Each institute is a multi-institutional partnership
- Research consists of both foundational AI and astronomy applications, carried out by interdisciplinary teams
- Institutes will also carry out significant programs of education/training and public outreach
- AI research themes include: trustworthy/explainable AI, physics-informed AI, multi-modal foundation models

NSF-Simons AI Institute for Cosmic Origins (CosmicAI)

PI: Stella Offner
University of Texas

Lead Institutions

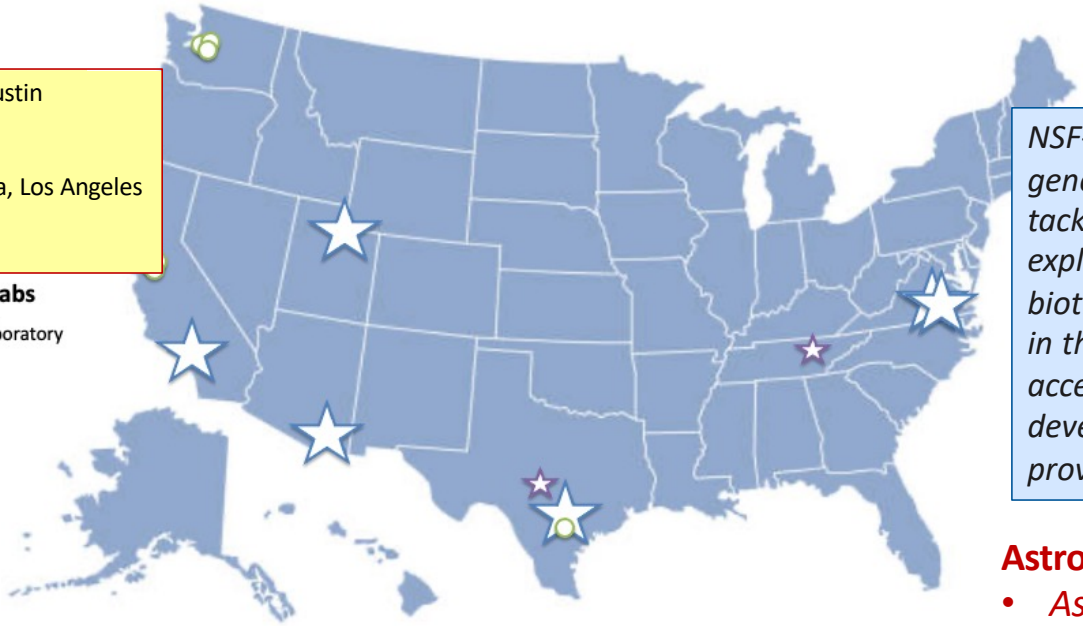
- University of Texas, Austin
- University of Virginia
- University of Utah
- University of California, Los Angeles
- NRAO
- NOIRLab

Academic Parters & Labs

- SLAC National Accelerator Laboratory
- University of Texas Arlington
- University of Tennessee

Industry Partners

- AI2
- Microsoft
- Intel
- NVIDIA
- Sony AI
- Amazon
- SparkCognition

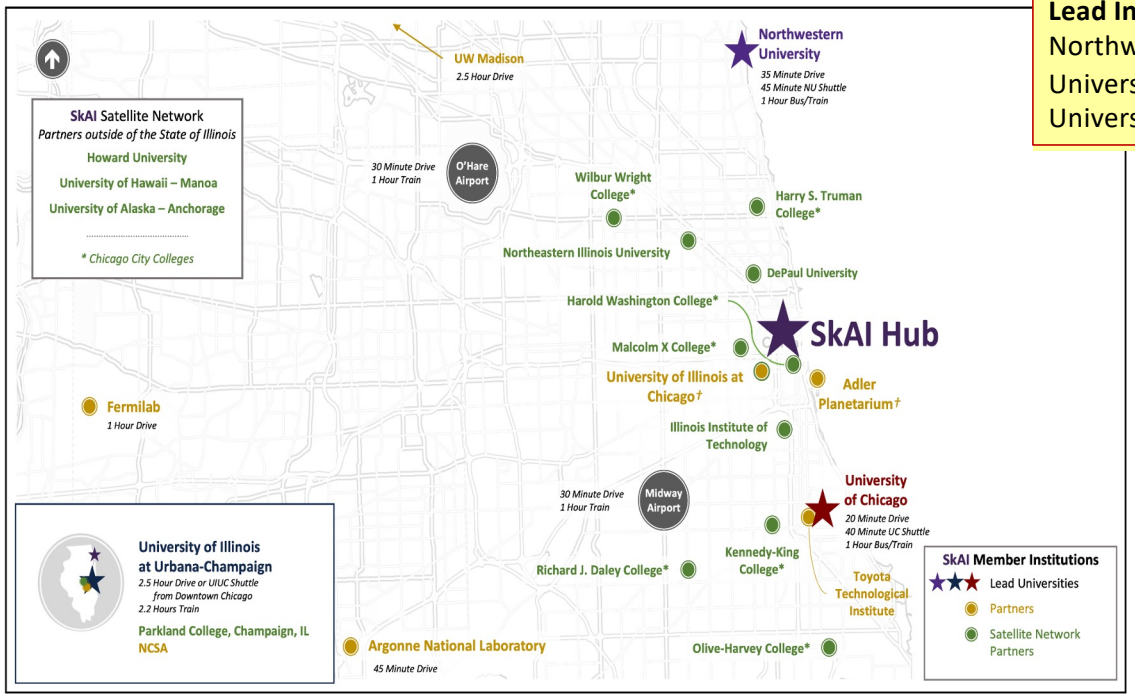


NSF-Simons CosmicAI aims to create next-generation AI tools to accelerate discoveries, tackle the analysis of large astronomical datasets, explore the nature of dark matter, and model pre-biotic molecules that are key to understanding life in the Universe. The institute plans to democratize access to astronomical data and analysis by developing a powerful AI-based assistant that provides accurate responses to scientific queries.

Astronomy research themes

- *AstroCopilot* and Data Platform
- Analysis of radio data
- Dark matter
- Astrochemistry simulations

NSF-Simons AI Institute for the Sky (SkAI)



Lead Institutions:
Northwestern University
University of Chicago
University of Illinois at Urbana-Champaign

PI: Vicky Kalogera
Northwestern University

NSF-Simons SkAI will tackle exceptionally complex problems in astrophysics and astronomy across a broad range of cosmic scales, from the physics of exotic objects like neutron stars and black holes to the formation of galaxies and the role that dark matter and dark energy play across the entire universe.

Astronomy research themes

- LSST: Transients and low surface brightness objects
- Precision cosmology
- AI-Accelerated simulations
- Survey and Instrument design

Two New AI Institutes for the Astronomical Community

- Institutes will serve the whole astronomical community,
  - providing data, models, tools
- Institutes will also carry out programs of education/training and public outreach

Photo by Bettymaya Foott/NSF NRAO/AUI, composition by U.S. National Science Foundation

Science & People: Workforce Development

		Description
AST	**AAG**	**General Astronomy and Astrophysics Grants program**
	REU	Research Experience for Undergraduates
	AAPF	Astronomy & Astrophysics Postdoctoral Fellows
	PAARE	Partnerships in Astronomy & Astrophysics Research and Education (institutional)
MPS	**ASCEND**	Postdocs with potential to broaden participation
	LEAPS	Early career faculty at institutions with little NSF STEM funding
NSF	**GRFP**	Graduate Student Research Fellowships Program
	CAREER	Faculty early career development for leadership
	GRANTED	Growing Research Access (institutional)

Throughout careers, NSF supports individual investigators with grant funding.

We want your proposals!

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

Important information about NSF's implementation of the revised 2 CFR
NSF Financial Assistance awards (grants and cooperative agreements) made on or after October 1, 2024, will be subject to the applicable set of award conditions, dated October 1, 2024, available on...

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.

Upcoming due dates

Full proposal

2024

October 1 2024 - November 15, 2024 - Window

October 1 - November 15, Annually Thereafter

Due by 5pm submitting organization's local time

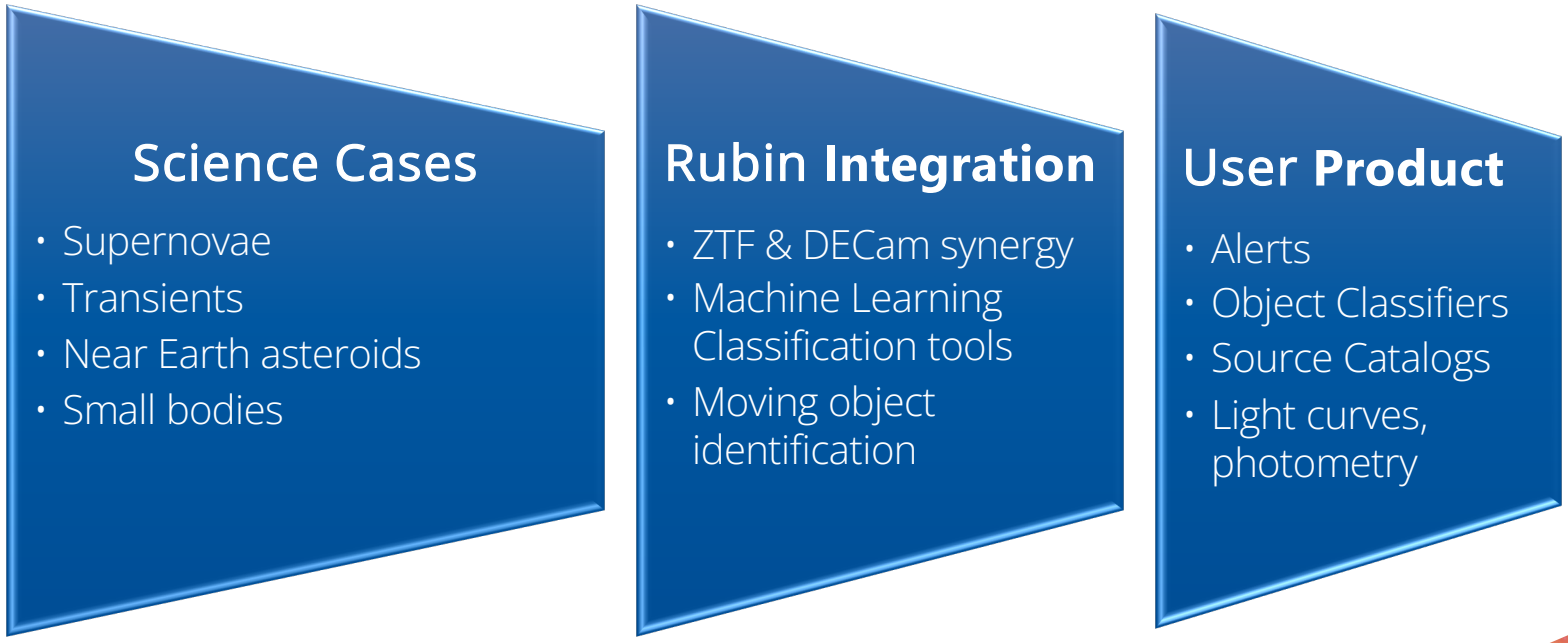
Due by 5 pm proposer's local time on the last day of the full proposal window.

Simonyi/NSF Fellowship Funds

Partnership between Charles Simonyi and NSF to support early career scientists in their contribution to Vera C. Rubin Observatory's Legacy Survey of Space and time.

To date:

- **12 Early Career PIs**
- ~$3 million Simonyi
- ~$3 million NSF

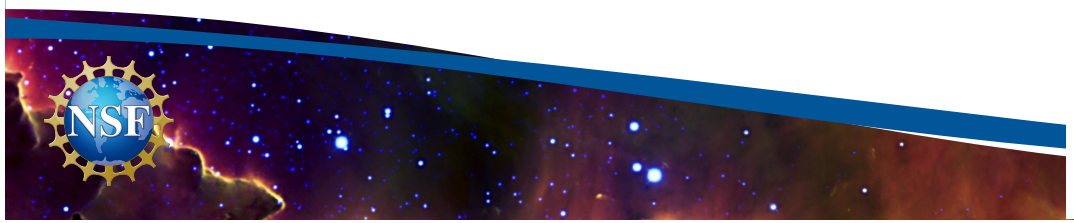


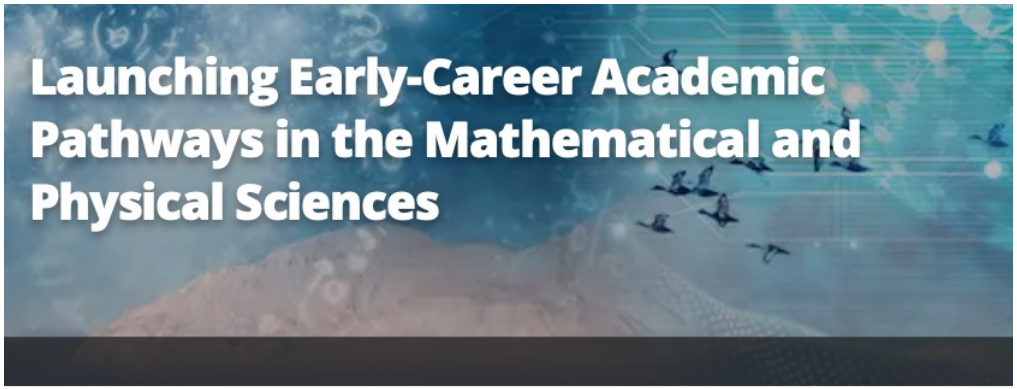
LEAPS

- Support for pre-tenure faculty
- 24 months
- Up to $250,000 total costs
- Meant to be a springboard to launch research careers

- DEADLINE: January 23, 2025

https://new.nsf.gov/funding/opportunities/launching-early-career-academic-pathways





← Search for more funding opportunities

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 research of pre-tenure faculty in mathematical and physical sciences, with an emphasis on those at institutions that traditionally do not receive significant NSF funding, such as minority-serving, predominantly undergraduate or R2 institutions.

Synopsis

The Launching Early-Career Academic Pathways in the Mathematical and Physical Sciences (LEAPS-MPS) call has an emphasis to help launch the careers of pre-tenure faculty in Mathematical and Physical Sciences (MPS) fields at institutions that do not traditionally receive significant amounts of NSF-MPS funding, such as some minority-serving institutions (MSIs), predominantly undergraduate institutions (PUIs), and Carnegie Research 2 (R2) universities. LEAPS-MPS has the additional goal of achieving excellence through diversity and aims to broaden participation to include members from groups historically excluded and currently underrepresented in the Mathematical and Physical Sciences, including Blacks and African Americans, Hispanics, Latinos, Native Americans, Alaska Natives, Native Hawaiians, and other Native Pacific Islanders.

PAARE: Partnerships in Astronomy & Astrophysics Research and Education

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

FY25 deadline: February 18, 2025

FY24 was another very successful year: 5 awards made

- Large partnership that had been supported by earlier PAARE awards
- Renewal of PAARE pilot awarded two years ago
- Existing partnership that will be significantly expanded through PAARE
- New pilot awards to EPSCoR states

Windows on the Universe and TDAMM

- Series of Joint NSF- and NASA-sponsored workshops
  - Identify science and community needs
  - Identify agency partnership potential
- #2 Oct 2023 Tucson (NSF-AST/NSF-PHY/NASA-APD)
  - What are the main challenges to perform successful MMA campaigns and to maximize their scientific potential?
  - How should we coordinate MMA follow-up to reduce operational redundancy across the network of ground and space-based observatories?
  - How should we foster collaboration in the MMA community?
  - How can we ensure that the MMA field reaches its full potential over the next decade?
  - **Outcome: $8M FY24 NSF WoU solicitation to develop follow-up coordination**
- #3 Sep 2024 Baton Rouge (NSF-AST/NSF-PHY/NASA-APD/DOE-NNSA/DOE-NP)
  - Key measurements leveraging current and forthcoming facilities? Do we need new ones?
  - How can multidisciplinary research be fostered?
  - What advances are relevant for other fields of physics and national strategic priorities?

Report out: Dec/Jan?

MMC-WoU

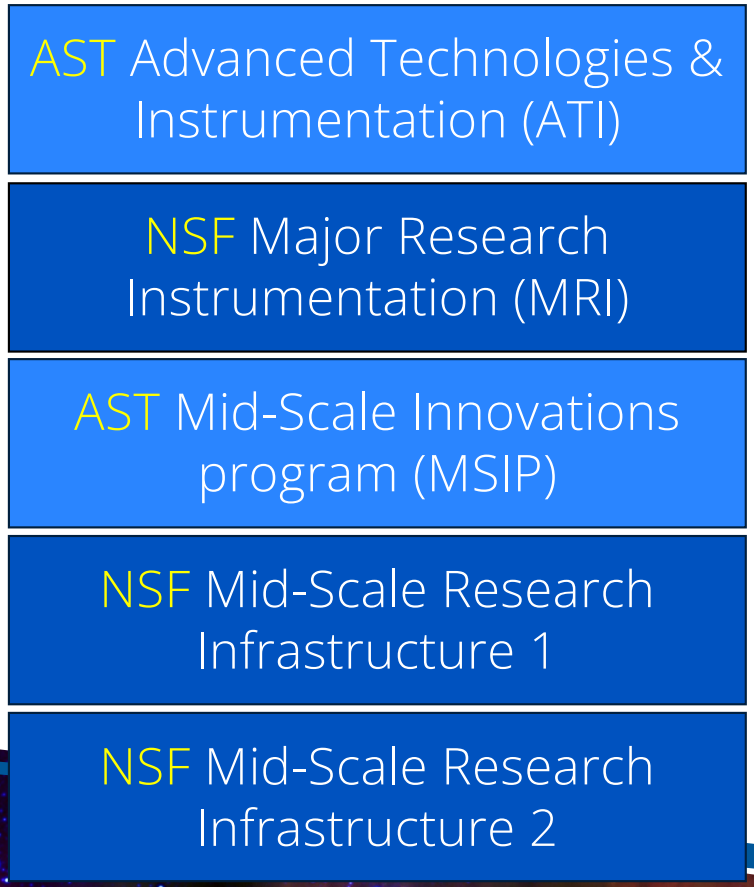
- Outcome of community discussions & recommendations
  - Posted Feb 2024, Deadline was May 2024
- The astrophysics community has available a diverse and powerful network of ground- and space-based instruments and facilities to enable observers to identify the electromagnetic signatures of Multi-Messenger Astrophysics (MMA) events, and then monitor and characterize their evolution. There also exists a rich set of software packages to track, schedule and support these observations. The community has identified the need to better harmonize these resources and interconnect users. The Multi-Messenger Coordination for Windows on the Universe (MMC-WoU) program will support the development of pathways or networks to increase the coordination and optimization of follow-up observations for MMA campaigns.

MMC-WoU

Four Awards, totaling almost $8.2M

- **CalTech (PI Kasliwal):** Deliver three open and accessible software infrastructure projects that will boost discoveries for the entire multi-messenger community.
- **Illinois (PI Narayan):** HEROIC will provide the entire astrophysics community a single destination to quickly see what facility can point to a multi-messenger source, what observations are currently being scheduled or undertaken with them, and which groups to coordinate with.
- **Arizona/Northwestern (PI Sand+Kilpatrick):** The team will build the Treasure TROVE (a Tool for Rapid Object Vetting and Examination), which will use the vast stores of information in astronomical archives and real-time searches for supernovae to help multi-messenger astronomers assess and prioritize incoming candidate counterparts to gravitational wave events and neutrinos.
- **Las Cumbres Observatory (PI Street):** AEON+: Enabling time-domain and multi-messenger follow-up at all wavelengths

Tools: Technology & Instrumentation



- Broad portfolio of technology development and innovation
- Heavily oversubscribed but critical to keep pressure on!

NSF Mid-Scale Research Infrastructure

The Foundation-wide Mid-scale Research Infrastructure opportunity is intended to provide NSF with an agile, Foundation-wide process to fund experimental research capabilities in the mid-scale range between MRI and Major Multi-user Facilities.

NSF defines Research Infrastructure (RI) as any combination of facilities, equipment, instrumentation, or computational hardware or software, and the necessary human capital in support of the same. Major facilities and mid-scale projects are subsets of research infrastructure.

NSF MidScale Research Infrastructure MidScale RI-1

Track 1: Supports the **design** and/or **implementation** of research infrastructure — including equipment, cyberinfrastructure, large-scale datasets and personnel — whose total project costs are under $20 million.

- Design track: $400,000 to <$20M
- Implementation track: $4M to <$20M
- FY2025/26 call: anticipating $100M, 5-10 awards, subject to appropriations
  - **Preliminary proposals required, Due November 18, 2024**
- FY2027/28 call anticipated, subject to appropriations

ASTRO RESULTS TO DATE: 2019 = CMB-S4*, ngEHT; 2021=none; 2023=none

Distribution: MPS 6.5, GEO 4.5, ENG 4, BIO 3, CSE 3, SBE 1

NSF MidScale Research Infrastructure MidScale RI-2

Track 2: Supports the implementation of research infrastructure — including equipment, cyberinfrastructure, large-scale datasets and personnel — whose total project costs fall between $20 million and $100 million.

- Funded from MREFC line
- Last call FY2023: anticipated $150M-200M, 2-5 awards, subject to appropriations
  - Pending awards

ASTRO RESULTS TO DATE: 2019 = none; 2021 = ASO; 2023 = pending

Distribution: GEO 3, BIO 2, MPS 2, ENG 1, EDU 1

Tools: Major Research Facilities

Operated as Federally Funded Research and Development Centers (FFRDCs):

- **National Solar Observatory:** DKIST, NISP program including GONG
- **NOIRLab**: Gemini-N, Gemini-S; Mayall, WIYN and tenant telescopes at Kitt Peak; Blanco, SOAR, and tenant telescopes at CTIO; and soon Rubin Observatory operations!
- **National Radio Astronomy Observatory:** VLA, VLBA, ALMA, CDL
  - Green Bank Observatory integrated back into NRAO as of Oct 1, 2024

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

FFRDCs

Federally Funded Research and Development Center

A broad concept used in different ways across the government (& in NSF)

NSF Scientific FFRDCs (currently we have 4)

Facility management: keep an existing set of instrumentation producing best science, finding best ways to serve community with the facility

FFRDC management: in partnership with NSF, optimally serve a community by providing the tools necessary to advance the science, including an evolving **portfolio of facilities**

Somewhat along the lines of DOE's National Laboratories

FFRDCs & Cooperative Agreements

- AST's FFRDCs are managed under "cooperative agreements"
  - Neither standard grants nor contracts (services to NSF)
  - Operate with "substantial involvement" in planning and implementation
  - Proposals (usually 5-year) define anticipated scope, detail activities budgeted; are codified in a "cooperative agreement" for the period
- Budgets vary, pending appropriations
  - Cooperative Agreement sets expectations, roadmap
  - Funding varies with appropriations and other planning
    - Can be held flat for various years; cuts have happened in tight years
  - Deferred maintenance is a real issue
  - Supplements provide opportunities, e.g., ARRA, emergency repairs, etc.

AST's Three FFRDCs

National Solar Observatory

Daniel K. Inouye Solar Telescope

NSO Integrated Synoptic Program (NISP), including SOLIS + GONG (Global Oscillation Network Group)

Sacramento Peak Observatory

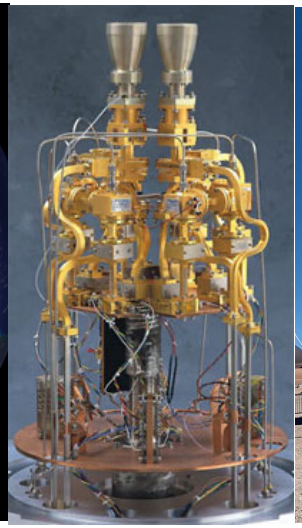
Inouye Solar Telescope

- NSO Acting Associate Director for Inouye –
  - Dr. David Boboltz
  - Thank you Dr. Thomas Rimmele (on sabbatical)
- Ongoing Operations Commissioning Phase
- Cycle 3 call for proposals closed June 12, 2024
- Final instrument – the Visible Tunable Filter has been integrated and is undergoing commissioning

National Radio Astronomy Observatory

Karl G. Jansky Very Large Array (VLA)

Very Long Baseline Array (VLBA)



Central Development Lab

Atacama Large Millimeter/sub-millimeter Array (ALMA)

Green Bank Observatory*

Programs with individual Cooperative Support Agreements, under one Cooperative Agreement

Entering its 2nd Decade, ALMA continues to set records

- Just starting Cycle 11
- A record ~1700 proposals

- Cycle 10: record observing time of over 4000 hours of quality observations

- Wide-band Sensitivity Upgrade underway

TBA/ODS

ODS = Operational Data Sharing

- Autonomously informs Starlink satellites about current observations

TBA = Telescope Boresight Avoidance

- Satellites ensure downlinks do not emit signals that would disrupt observations

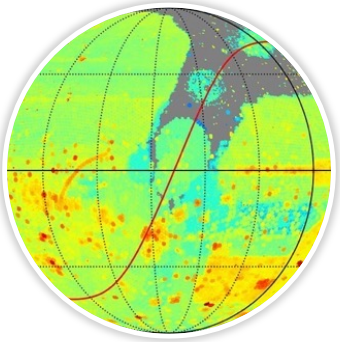
System in testing phase

NSF National Optical-Infrared Astronomy Research Laboratory (NOIRLab)

Mid-Scale Observatories

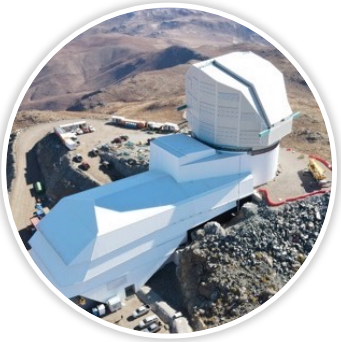
Cerro Tololo Inter-American Observatory, Chile

Kitt Peak National Observatory, Arizona



Community Science & Data Center, Arizona

International Gemini Observatory, Hawai'i & Chile



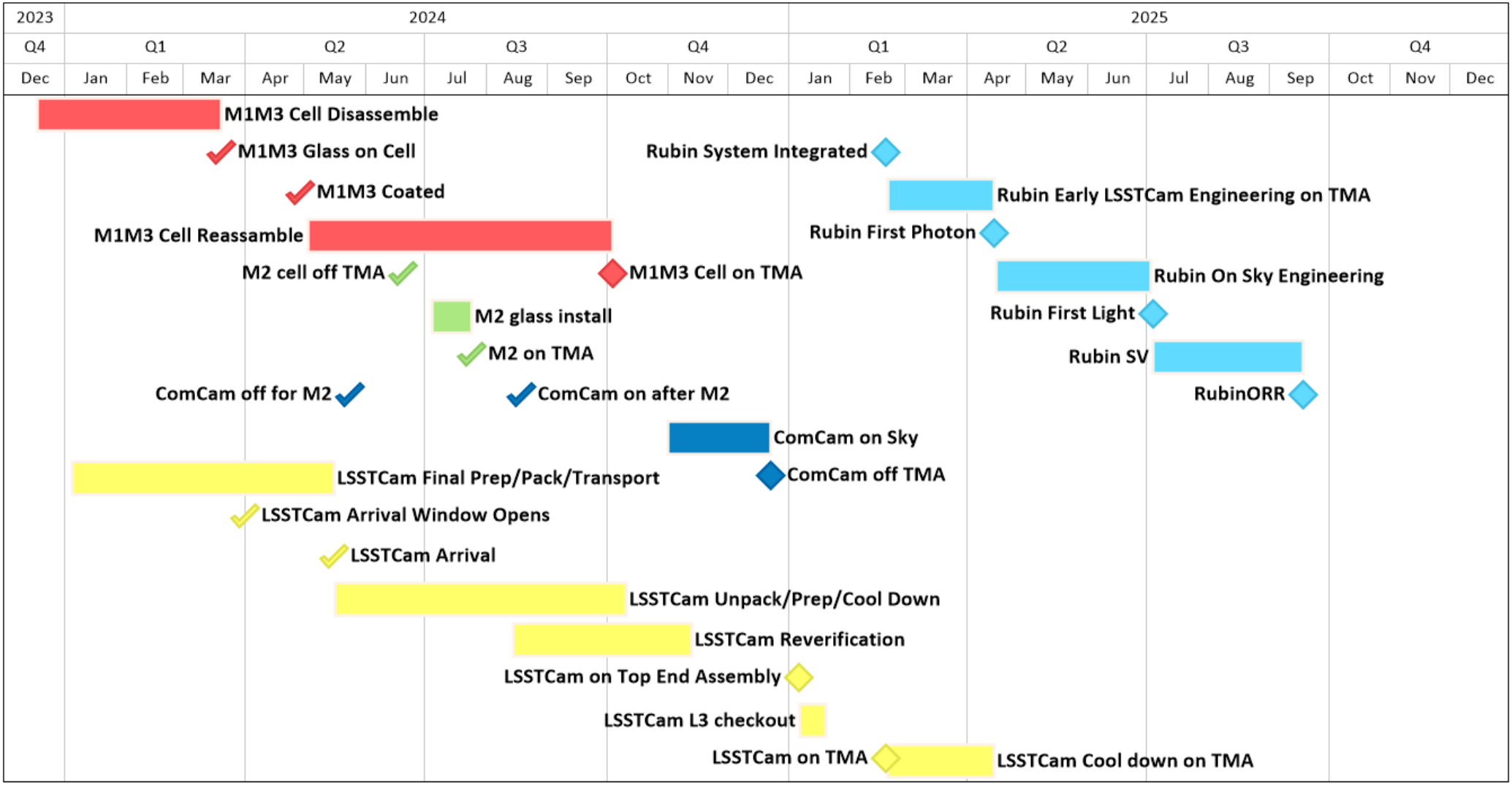
NSF-DOE Vera C. Rubin Observatory, Chile

Programs with individual Cooperative Support Agreements, under one Cooperative Agreement

NSF-DOE Vera C. Rubin Observatory: Marching toward Operations

- M2 and Commissioning Camera (ComCam) installed on telescope
- M1M3 installation successful
- **Engineering light “first photons” October 2024 with ComCam**
- DOE LSSTCam on summit, cold with CCDs working
- LSSTCam installation Q1 2025
- **Official First Light mid-2025**
- Operations late 2025

Rubin Key Activities September 2024



Rubin Data Policy

Full data policy available at

ls.st/rdo-013

All data products generated by Rubin Observatory will have a two-year proprietary period EXCEPT the contents of the alert packets and the catalogs produced by Prompt Processing (real-time image differencing; catalogs of transient, variable, and moving objects), which are public and can be shared with anyone, anywhere.

VERA C. RUBIN OBSERVATORY

Data Policy

RDO-13 (rel 1.2.2)

Latest Revision Date: January 03, 2024

Rubin Science Productivity

First and foremost:

- Over $150M from NSF in construction for the Data Management System
- About HALF of the operations budget will be for Data Management, Analysis, and Scientific Support
- DOE is investing heavily in support and optimization of the operations of the data management through SLAC

Additionally,

- Rubin engagement with community through annual meetings, training, etc.
- “Data preview” releases, first of simulated data & later commissioning data
- Investments in time-domain follow-up (MMA-WoU and TDA at facilities)
  - Investments through AAG; *complementary investments, e.g., Simonyi Scholar Program*

Ask Kathy: DESC ! Inter-agency coordination

Looking forward…

~~AST~~ NSF Challenge: 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 (in era of BILLION dollar projects)

Development & Design	Construction	O&M
$150 to 250 million	$1.5 Billion	~$50-150 million **per year**

Initial O&M supported by central "Facilities Operations Transition" funding

Facilities Operations: Current & Future

Discussions of Operations funding continue at all levels within NSF (Director's Office/CORF, Directorate, Division)

- Widely understood problem, from NSB down
- All working toward NSF-wide resolution

Can't assume NSF will resolve future AST facilities operations funding dilemma

Have to take a HARD look at prioritization

- Current facilities operations (WITHIN three FFRDCs)
  - Telescopes and user support
  - Archives, data products, and user support
- Full lifecycle of new facilities
  - Inouye Concept of Operations review
  - Ongoing review of 10yr LSST at NSF-DOE Vera C. Rubin Observatory
  - Understanding how US ELT and ngVLA operations fit within the respective FFRDCs
- AST is exploring the best way to move forward with community engagement

Portfolio Prioritization Process (P3)

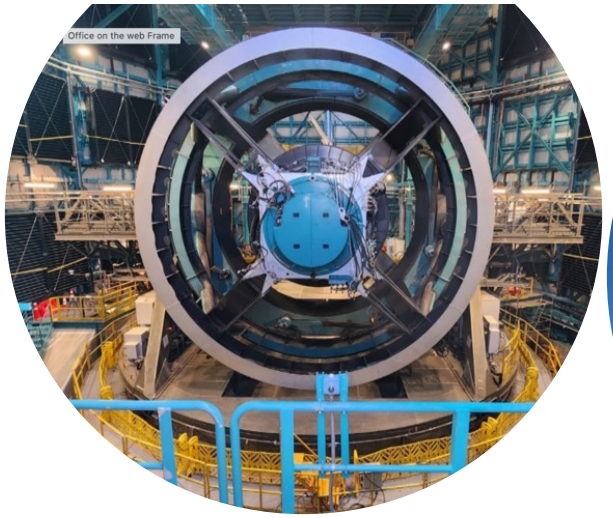
To strategically plan for an evolving AST portfolio in the 2030s and beyond, we must understand and document the existing AST portfolio of facilities, and look at upcoming opportunities.

Process:

- Prioritize existing facilities, so that we can make room for new facilities if needed
- Understand the investments needed to maintain and develop current facilities
- Prioritize emerging research opportunities and technologies
- Understand current and future partnership opportunities
- Quantify future NSF budget needs
- Explore and justify (if necessary) options for future divestments

We want our Federally Funded Research & Development Centers (FFRDCs) and the community to be part of this Portfolio Prioritization Process

Portfolio Prioritization Process (P3)



We have agreed upon a three-phase approach with out FFRDCs:

Phase 1 – FFRDC-led prioritization (2025)

- ***Task each FFRDC*** with developing a "Plan for the 2030s" that prioritizes its facilities and services and includes future opportunities
- The process must be ***broad in scope, transparent, and inclusive – community input is essential***

Phase 2 – External assessment of plans (2026)

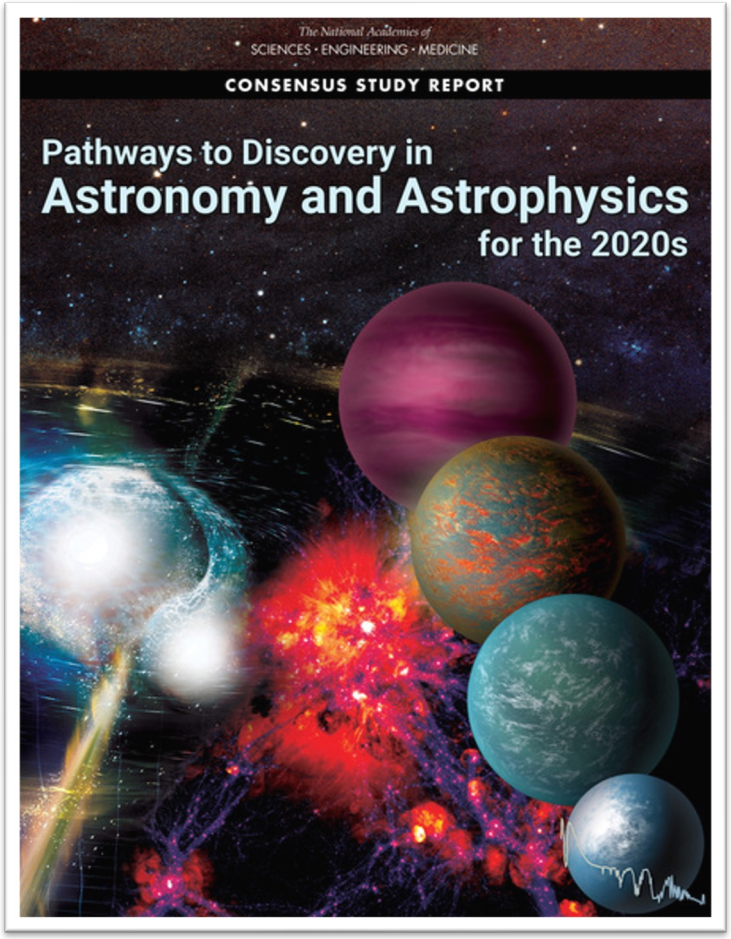
- Ensure process is ***robust*** and ***plans are sound***
- A ***platform for engagement*** between the FFRDC, NSF, and the external panel

Phase 3 – Long-term portfolio planning (2026+)

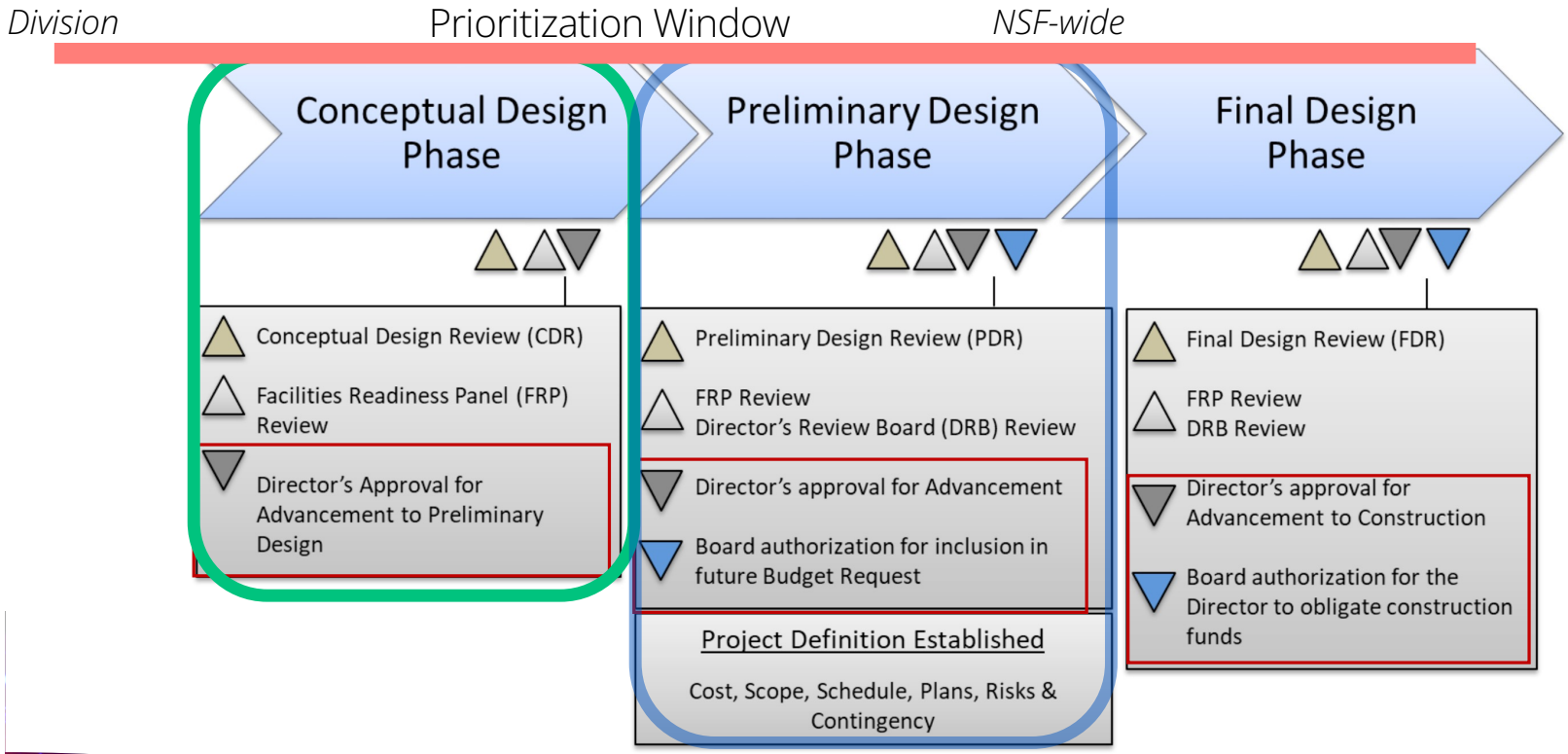
- Plans and Review Feedback fold into AST long-term strategic planning *(alongside other inputs)*
- Plans not written in stone – revise every ~5 yrs

Looking towards Tools of the future: Astro2020 Facilities Recommendations

Updates



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.

US ELT Program

Goal of "Program": Provide access to 30-m-class telescope time for the U.S. astronomical community, including pre- and post-observing support to maximize scientific productivity.

Milestones:

- Nov 2021: Ranked highest priority in ground-based next-generation facilities
- Nov 2022: Moved into MF Design Stage in **Preliminary Design Phase**
- Dec 2022-Feb 2023: Preliminary Design Review
- Jun 2023: **MPS Blue Ribbon Panel** evaluating AST plan to move forward
- Oct 2023: Facilities Readiness Panel requesting entry into Final Design
- Jul 2024: Director's **Reverse Site Visit** Panel → Move to Final Design?

NSF FY25 Budget Request (Mar 2024)

Design of Potential New Major Facility Construction Projects.

The FY 2025 Request supports the continued design of a single telescope within the U.S. Extremely Large Telescope (U.S. ELT) program. Consistent with a recent statement by the National Science Board to fund one telescope in the ELT program, **NSF will initiate an external expert panel to conduct a review of the two U.S. ELT projects** that will inform NSF's decision of which project will remain in the Major Facility Design Stage. A future decision remains about whether to advance that project to Construction, pending completion of the Final Design Phase.

NSF Statement at NSB (May 2024)

NSF Director decided to convene an external panel to provide input to him as he considers whether to advance either of the two candidate projects (GMT and TMT) into the Final Design Stage.

Panel asked to comment on topics including:

- Progress since the Preliminary Design Reviews
- Partnerships and Resources
- Risk and Risk mitigation
- Governance Models
- Scientific complementarity to the European ELT
- Opportunities for Early Career Scientist Access
- Engagement of the Public

Timeline: Report by end of FY24 (Sep 2024) to inform budget process

Also consider impact of supporting a project on Agency resources in Design, Construction, and Operation phases

Status of Reverse Site Visit

The panel is working on its report to the Director, which is anticipated by the end of the fiscal year.

The Director has indicated that he will engage with many stakeholders, including Congress, before making any decisions, so the timing of any decisions about entry to FDP is uncertain.

In the meantime, we'll continue to work with the Projects under the current award structures to advance the maturity and readiness of the projects.

Breaking news: *FY24 awards of $6.5M for GMT and $6.5M of TMT made in September 2024, continuing support for NOIRLab effort planned*

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ngVLA

- July 2023: Entered NSF's Major Facility Design Stage
  - in Conceptual Design Phase
- Informational Presentation to NSB in November 2023
- **NSF CDR held September 2024**
- NRAO Design/Development program office funded FY23+FY24+
- Continuing discussions with international and domestic organizations/agencies

Antenna prototype – rollout event in Germany in September 2023

ngVLA – Prototype Antenna at VLA Site

Prototype antenna construction progressing at VLA Site. Prototype antenna will be assembled and tested interferometrically with the Jansky Very Large Array

CMB-S4 and CMB Program

Importance of CMB science was highlighted in both Astro2020 and P5

CMB-S4 ranked #2 (tied) in Astro2020, #1 for new construction in P5

After extensive analysis, the NSF has made the decision not to move the CMB-S4 project in its current form into the NSF Major Facility Design Stage at this time.

The agency **must prioritize the recapitalization of critical infrastructure** at the South Pole so that the groundbreaking research it enables can continue to thrive. The South Pole Master Plan will outline proposed infrastructure investments and will be placed in the federal register and open for public comment later this month. NSF is committed to cosmic microwave background science and will continue to support current CMB activities at the South Pole and in Chile.

CMB-S4 and CMB Program

Ongoing Support CMB Science @ NSF

- South Pole Telescope (SPT-3G)
- BICEP
- CLASS

Midscale RI-2 Project: Advanced Simons Observatory

- 30,000 new detectors and associated optics for the SO Large Aperture Telescope, doubling its mapping speed and enabling the detection of transient objects;
- an end-to-end data pipeline to produce and validate maps of all SO data, and generate daily light curves of variable sources concurrent with other surveys such as those from the Rubin Observatory
- a photovoltaic power system that directly increases system sensitivity while reducing operating costs and environmental impact.

CMB-S4: NSF continuing to work closely with DOE & Project Team

- Refocus on Chile with configuration to meet CMB-S4 science goals, including

1. Survey the Landscape of CMB experiments collecting data over next 10 years
2. Optimize an all-Chile design

Budget

FY25 NSF Budget Realities

- FY23 enacted **= $9.87B***
  - *Including supplements, +11.7% over FY22

- FY24 Budget Request = $11.31B
- FY24 Appropriation **= $9.06B**

- FY25 Budget Request = $10.18B
  - *House Mark* = *$ 9.26B*
  - *Senate Mark* = *$ 9.55B*
- FY25 Appropriation **= ?.??B**

FY25 Request Top Line

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS) **$1,681,630,000**

MPS Funding

(Dollars in Millions)

	FY 2023 Base Plan[1]	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Astronomical Sciences (AST)	$288.21	-	$318.53	$30.32	10.5%
Chemistry (CHE)	264.99	-	264.99	-	-
Materials Research (DMR)	334.50	-	345.72	11.22	3.4%
Mathematical Sciences (DMS)	248.40	-	248.40	-	-
Physics (PHY)	308.65	-	312.90	4.25	1.4%
Office of Strategic Initiatives (OSI)	215.20	-	191.09	-24.11	-11.2%
Total	**$1,659.95**	**-**	**$1,681.63**	**$21.68**	**1.3%**

[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

FY25 Request: AST Breakdown

- Significant changes over FY23 Base plan

But

- Some instrumentation grant funding moved into Research
- Some funding from OSI that was used for AST Facilities previously moved to AST Infrastructure
- And remember, this is the request…

MPS Divisions

MPS Division Funding by Category[1]

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
AST	**$288.21**	**-**	**$318.53**	**$30.32**	**10.5%**
Research	68.40	-	78.89	10.49	15.3%
Education	4.60	-	4.60	-	-
Infrastructure	215.21	-	235.04	19.83	9.2%
CHE	**$264.99**	**-**	**$264.99**	**-**	**-**
Research	251.05	-	251.05	-	-
Education	4.04	-	4.54	0.50	12.4%
Infrastructure	9.90	-	9.40	-0.50	-5.1%
DMR	**$334.50**	**-**	**$345.72**	**$11.22**	**3.4%**
Research	282.11	-	275.61	-6.50	-2.3%
Education	3.00	-	3.00	-	-
Infrastructure	49.39	-	67.11	17.72	35.9%
DMS	**$248.40**	**-**	**$248.40**	**-**	**-**
Research	235.04	-	235.40	0.36	0.2%
Education	13.36	-	13.00	-0.36	-2.7%
PHY	**$308.65**	**-**	**$312.90**	**$4.25**	**1.4%**
Research	212.32	-	212.80	0.48	0.2%
Education	5.02	-	5.02	-	-
Infrastructure	91.31	-	95.08	3.77	4.1%
OSI	**$215.20**	**-**	**$191.09**	**-$24.11**	**-11.2%**
Research	146.75	-	132.70	-14.05	-9.6%
Education	10.00	-	10.62	0.62	6.2%
Infrastructure	58.45	-	47.77	-10.68	-18.3%

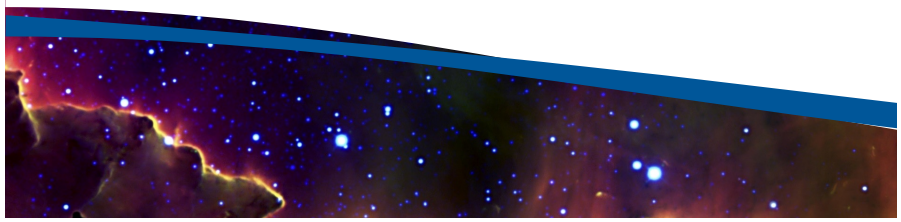
[1] For comparability with FY 2025, the FY 2023 levels do not include this organization's share of Mission Support Services that were funded through the R&RA and EDU directorates and offices.

FY25 Request

In the fine print…

FY23 Design Stage
- $12.43 for ARV
- $15M for US ELT
- $3.0M for ngVLA

FY25 Request Design Stage
- $22.0 for ARV
- $17.0M for US ELT
- $7.0M for ngVLA



MAJOR FACILITIES FUNDING, BY PROJECT
(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request	Change over FY 2023 Base Plan Amount	Change over FY 2023 Base Plan Percent
Operations and Maintenance of Major Facilities	**$996.74**	**-**	**$1,120.33**	**$123.59**	**12.4%**
National Ecological Observatory Network (NEON)	71.71	-	82.02	10.31	14.4%
Biological Sciences	***$71.71***	***-***	***$82.02***	***$10.31***	***14.4%***
Academic Research Fleet[1]	136.09	-	151.33	15.24	11.2%
National Center for Atmospheric Research (NCAR) FFRDC	116.20	-	124.59	8.39	7.2%
National Geophysical Facility (NGF)[2]	37.92	-	45.29	7.37	19.4%
Geodetic Facility for the Advancement of GEoscience (GAGE)[2]	*14.55*	-	*8.55*	*-6.00*	*-41.2%*
Seismological Facility for the Advancement of GEoscience (SAGE)[2]	*23.37*	-	*13.25*	*-10.12*	*-43.3%*
NGF O&M[2]	-	-	23.49	23.49	N/A
Ocean Observatories Initiative (OOI)[1]	42.02	-	47.76	5.74	13.7%
U.S. Sub-seafloor Sampling (S3P) (Formerly IODP)	50.40	-	55.51	5.11	10.1%
Geosciences	***$382.63***	***-***	***$424.48***	***$41.85***	***10.9%***
Green Bank Observatory (GBO) FFRDC[3]	10.83	-	9.68	-1.15	-10.6%
Large Hadron Collider (LHC) - ATLAS and CMS	20.50	-	20.50	-	-
Laser Interferometer Gravitational Wave Observatory (LIGO)	45.00	-	49.00	4.00	8.9%
National High Magnetic Field Laboratory (NHMFL)[3]	39.91	-	39.13	-0.78	-2.0%
National Radio Astronomy Observatory (NRAO) FFRDC[3]	93.66	-	96.71	3.05	3.3%
NRAO O&M[3,4]	*43.03*	-	*43.00*	*-0.03*	*-0.1%*
Atacama Large Millimeter Array (ALMA) O&M	*50.63*	-	*53.71*	*3.08*	*6.1%*
National Solar Observatory (NSO) FFRDC[3]	26.56	-	34.24	7.68	28.9%
NSO O&M	*5.88*	-	*6.24*	*0.36*	*6.1%*
Daniel K. Inouye Solar Telescope (DKIST)[3]	*20.68*	-	*28.00*	*7.32*	*35.4%*
NSF's National Optical-Infrared Astronomy Research Laboratory FFRDC[3]	73.57	-	86.40	12.83	17.4%
NOIRLab O&M (Mid-Scale Observatories & Community Science and Data Center)[3,5]	*28.49*	-	*24.82*	*-3.67*	*-12.9%*
GEMINI Observatory O&M	*22.98*	-	*25.49*	*2.51*	*10.9%*
Vera C. Rubin Observatory O&M	*22.10*	-	*36.09*	*13.99*	*63.3%*
Mathematical and Physical Sciences	***$310.03***	***-***	***$335.66***	***$25.63***	***8.3%***
Antarctic Facilities and Operations (AFO)	224.71	-	269.94	45.23	20.1%
IceCube Neutrino Observatory (ICNO)	7.66	-	8.23	0.57	7.4%
Office of Polar Programs	***$232.37***	***-***	***$278.17***	***$45.80***	***19.7%***
Major Research Facilities Construction Investments	**$216.66**	**-**	**$345.00**	**$128.34**	**59.2%**
R&RA Design Stage Activities[6]	**$30.43**	**-**	**$46.00**	**$15.57**	**51.2%**
Major Research Equipment and Facilities Construction (MREFC)	**$186.23**	**-**	**$299.00**	**$112.77**	**60.6%**
Total, Major Research Facilities	**$1,213.40**	**-**	**$1,465.33**	**$251.93**	**20.8%**

FFRDC is an acronym for Federally-Funded Research and Development Center.

[1] FY 2023 reflects the transfer of ship-time costs, estimated at $8.98 million, from the Ocean Observatories Initiative (OOI) to the Academic Research Fleet (ARF). These costs are reflected within ARF for the FY 2025 Request.

[2] GAGE and SAGE will be consolidated into a single facility during FY 2025. Budget Year and outyear estimates for the consolidated facility are shown under a new line represented as the "National Geophysical Facility (NGF)".

[3] FY 2023 includes funding for repairs and maintenance beyond regular O&M.

[4] Includes funding for VLBA ($3.43 million per year), as well as funding for the ngVLA program office.

[5] Includes support for the Windows on the Universe Center for Astronomy Outreach, ongoing activities at the WIYN telescope, and potential future participation in the U.S. Extremely Large Telescope program.

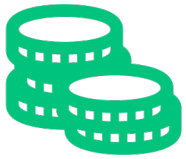
[6] Design Stage Activities include support for potential next generation major facilities. This line reflects FY 2023 funding amounts of $12.43 million for the Antarctic Research Vessel (ARV), $3.0 million for the Next Generation Very Large Array (ngVLA), and $15.0 million for Extremely Large Telescopes (ELT), and FY 2025 funding amounts of $22.0 million for the ARV, $7.0 million for the ngVLA, and $17.0 million for ELT.

Astro2020 Funding: Major Facilities Initiatives

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

Over half of this is dedicated to development and design work on the US ELTs, including GMT, TMT, and NOIRLab

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 implementation

US ELT: Includes $6.5M for GMT, $6.5M for TMT, support for NOIRLab Program Office

$7M for ngVLA

Funding for the continued development of CMB-S4 and next-generation Gravitational Wave facility

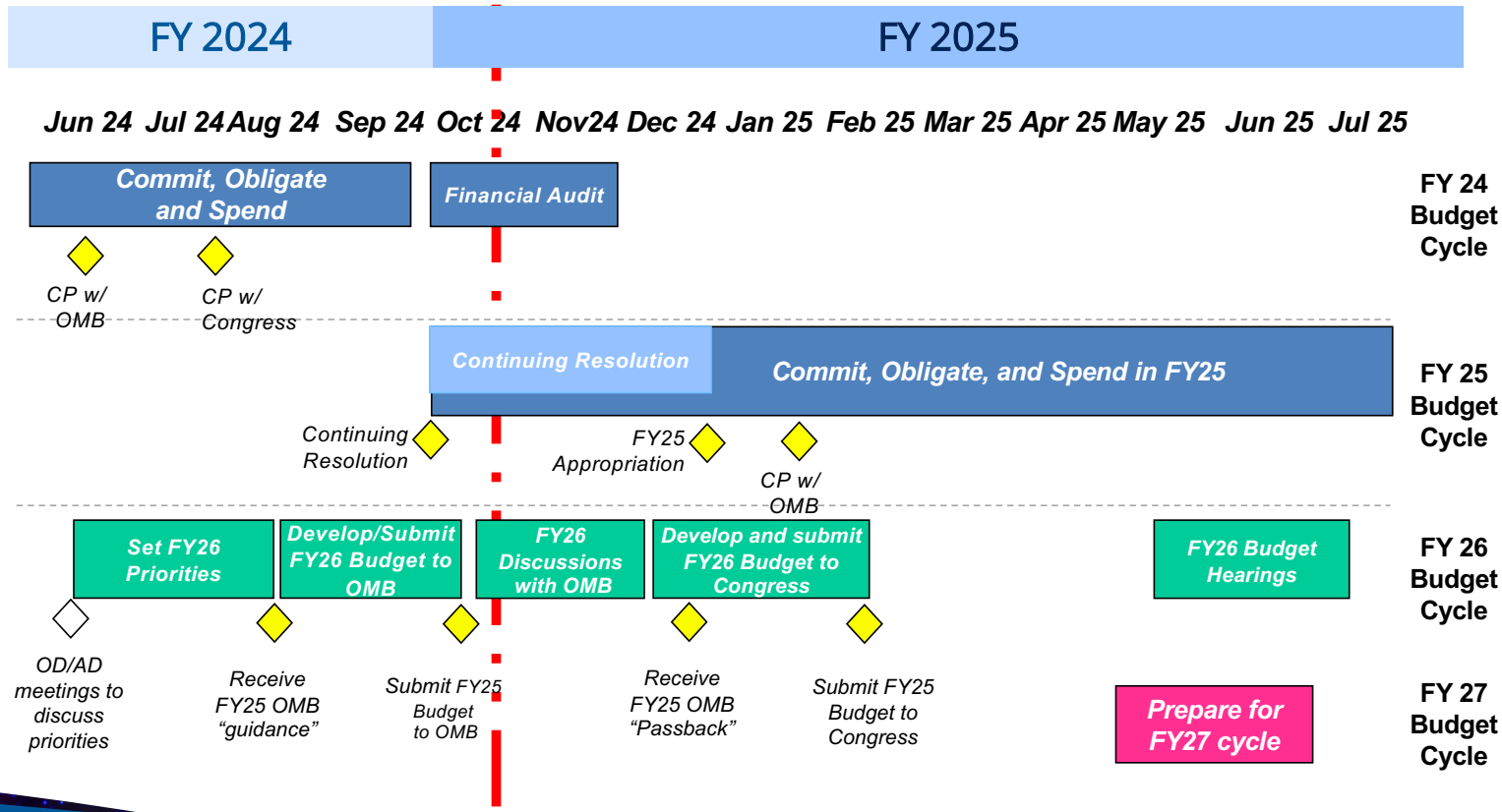
FY25 Budget Request

Includes

- $17M request for US ELT,
- $7M for ngVLA

along with continued development and design of other Major Facilities prioritized in Astro2020.

Typical NSF Budget Activity Timeline - Update



Questions/Discussion