NSF/MPS
Division of Astronomical Sciences
CAA Update: October 2023

R. Chris Smith, Division Director (Interim)

Jim Neff, Deputy Division Director

NSF Staffing Changes

AST Division Director

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

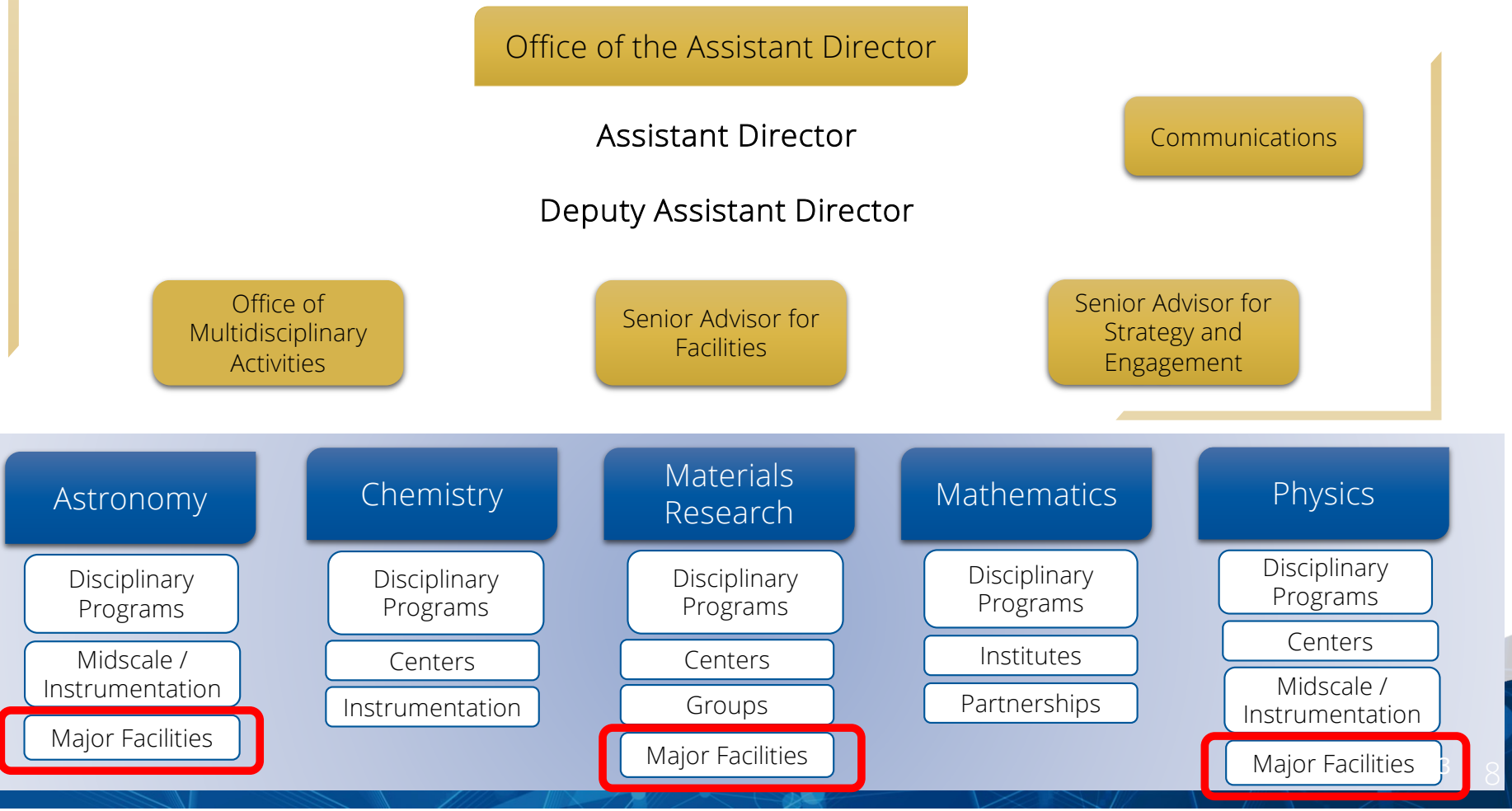
Thank you Debra!

MPS Assistant Director

- Sean Jones moved out Oct 3, 2023
- Denise Caldwell named Acting Assistant Director as of Oct 9, 2023
- Saul Gonzalez named Acting MPS Senior Advisor for Facilities

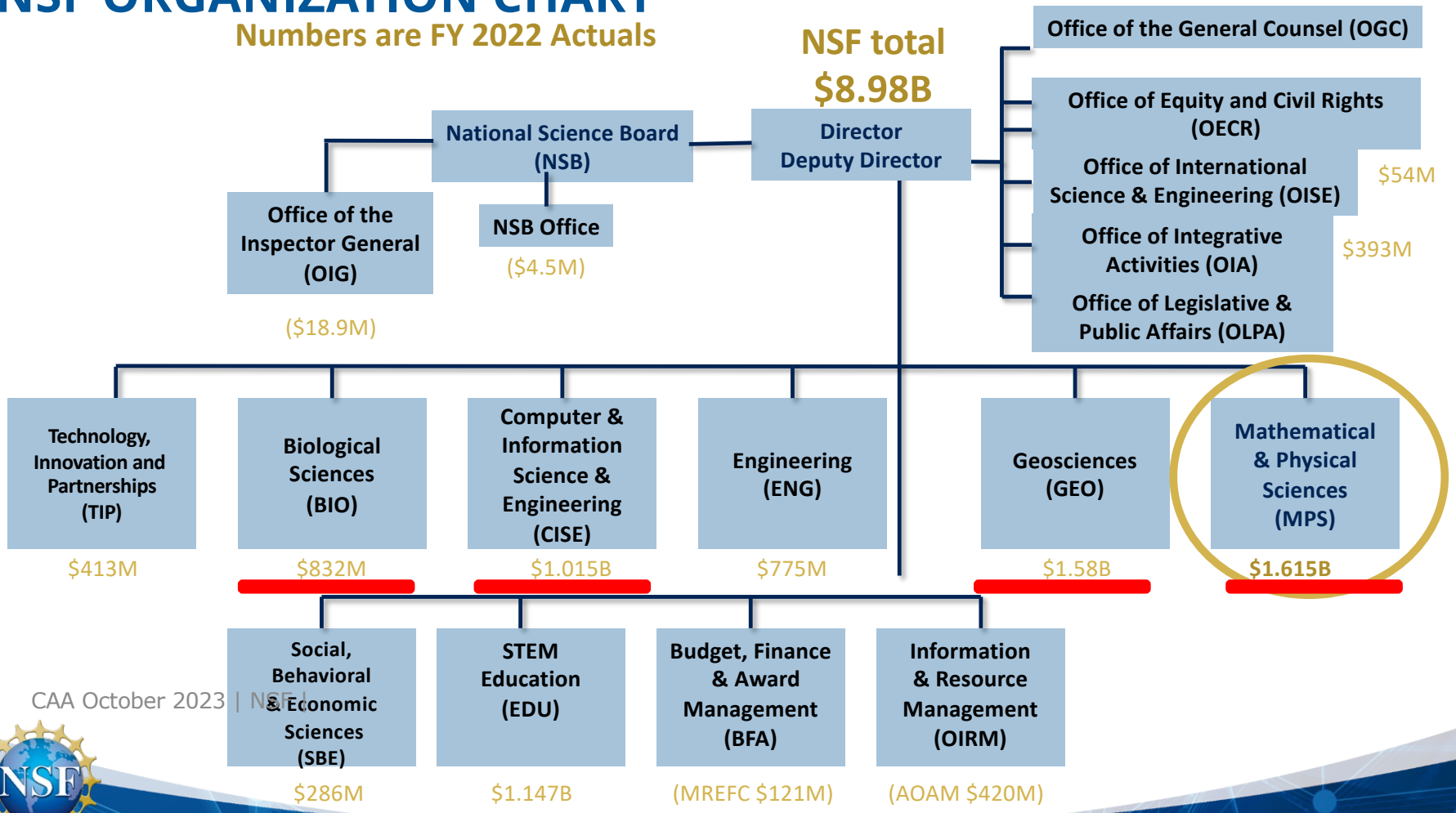
Thank you Sean!

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



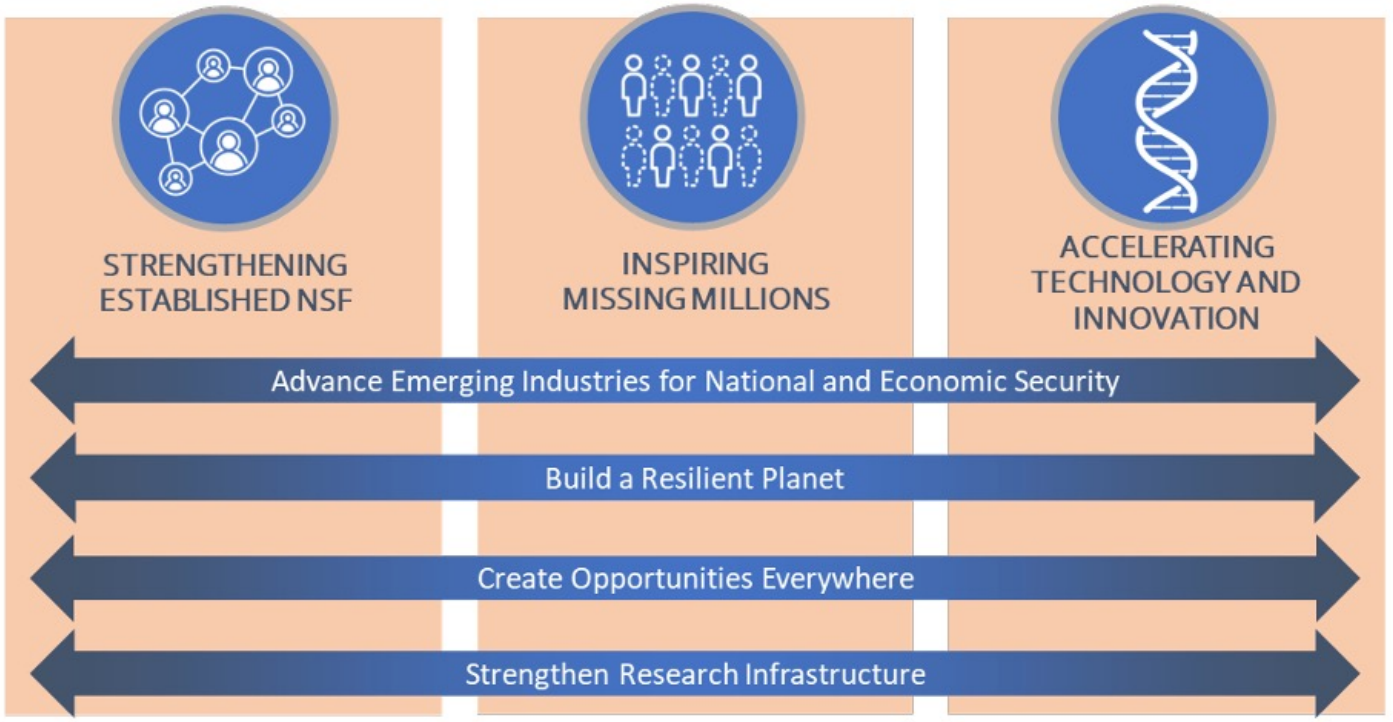
NSF ORGANIZATION CHART

Numbers are FY 2022 Actuals



NSF Pillars and Priorities

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

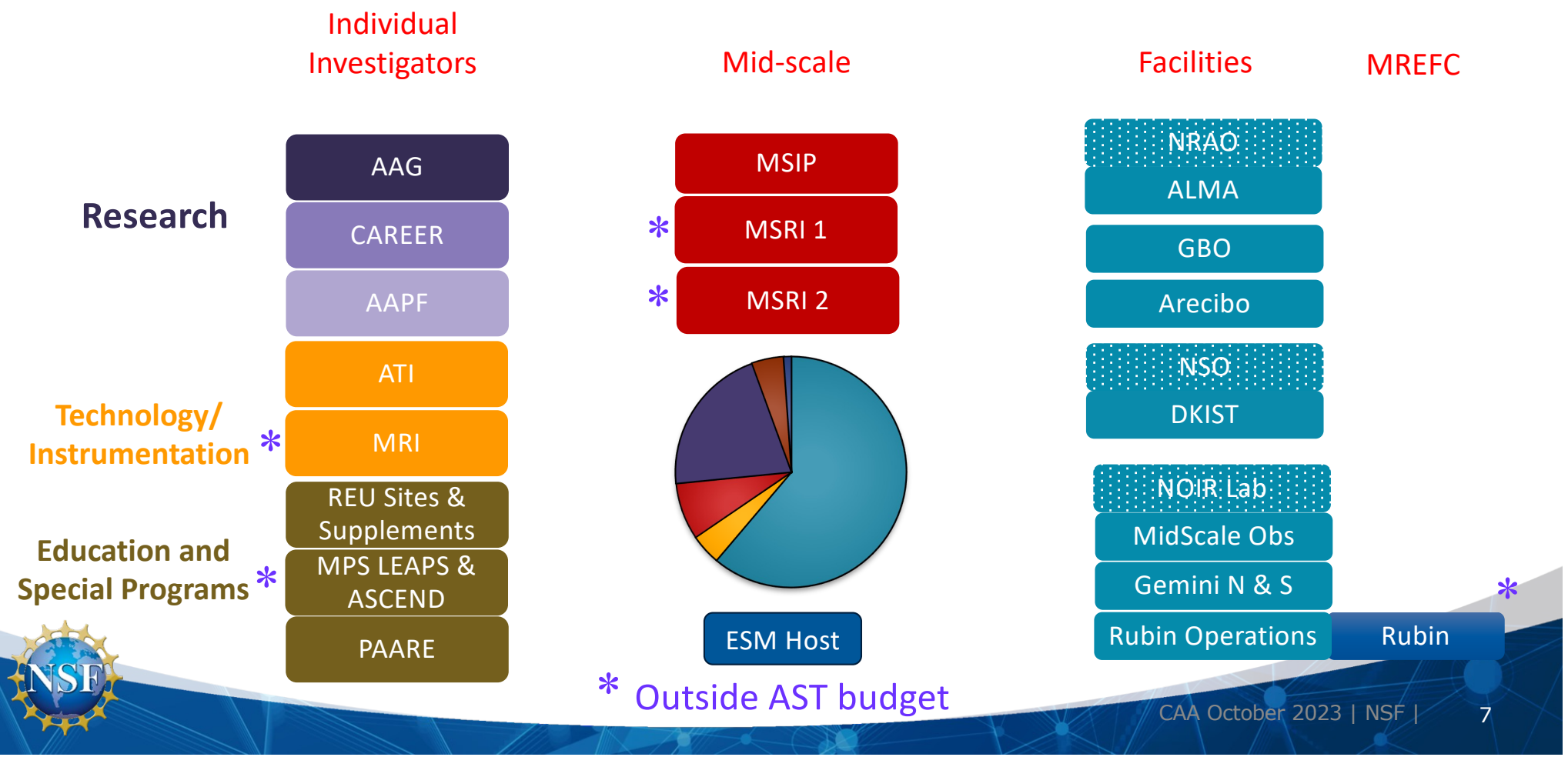


NSF's Division of Astronomical Sciences (AST) supports:

- 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, policymakers, 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



SCIENCE
Workhorse Program: AAG

- Four general areas
  - Extragalactic Astronomy
  - Galactic Astronomy
  - Planetary Astronomy
  - Stellar astronomy and astrophysics
- But **everything** fits!
- ~$50M annually, highly competitive

← 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 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 a 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 contributions
- *Doubling the impact* of AST investments 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 Institutes: $16-20M each for 4-5yrs
- Funded in collaboration with Simons Foundation *doubling the impact* of AST investments

← 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 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.

* Outside AST budget

2nd Gen: 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
- *Next year's solicitation soon…*

← 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 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

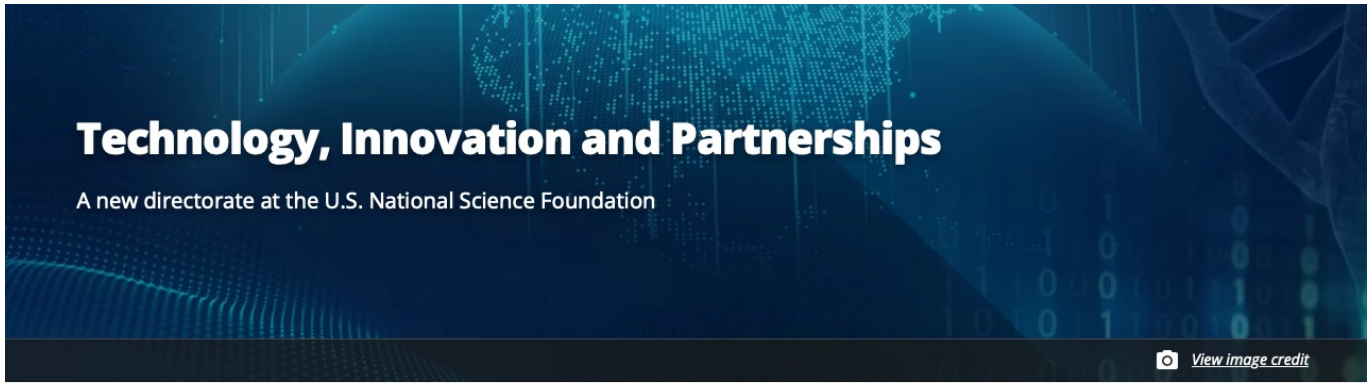
AST Advanced Technologies & Instrumentation (ATI)	
NSF Major Research Instrumentation (MRI)	*
AST MSIP	
NSF MidScale Research Infrastructure 1	*
NSF MidScale Research Infrastructure 2	*

- Broad portfolio of technology development and innovation
- ALL heavily oversubscribed

* Outside AST budget

Technology, Innovation, and Partnerships

- NEW Directorate
- Incorporates some existing programs, like I-Corps & SBIR
- Partnerships for Innovation
- Other programs



Home / Directorate for Technology, Innovation and Partnerships (TIP) / Latest

One year ago, under the leadership of Director Sethuraman Panchanathan, the U.S. National Science Foundation announced the establishment of the Directorate for Technology, Innovation and Partnerships, or TIP, the agency's first new directorate in more than 30 years.

Just a few months later, Congress passed the "CHIPS and Science Act," authorizing the establishment of the directorate and charging it with the critical mission of advancing U.S. competitiveness through investments that accelerate the development of key technologies and address pressing societal and economic challenges.

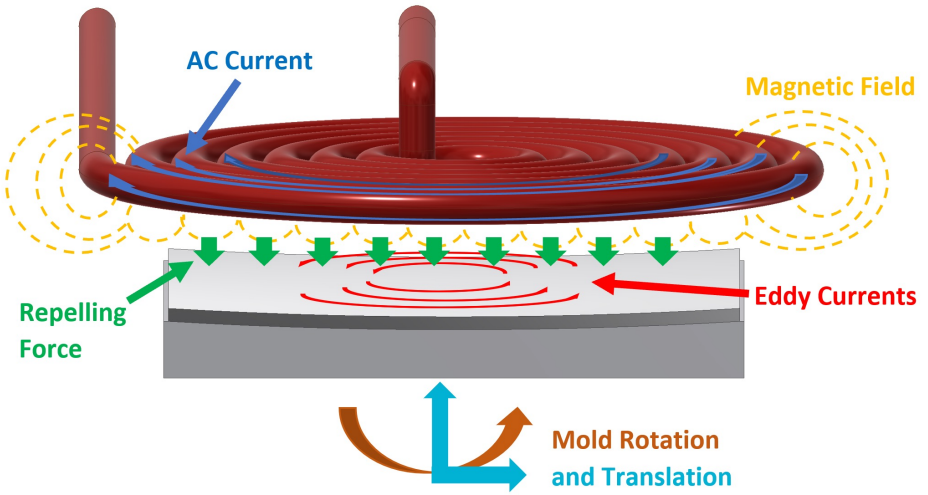
Learn More About TIP

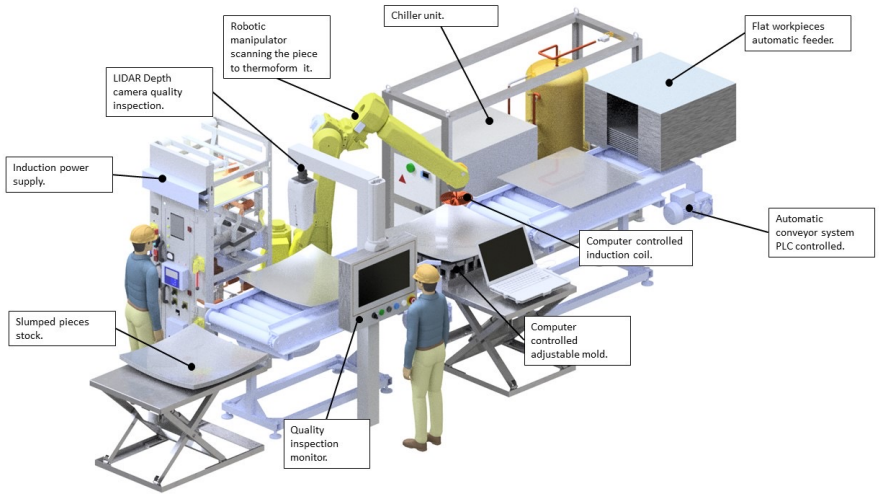
- More About TIP
- TIP Resources
- Funding Opportunities
- Broad Agency Announcements
- TIP Leadership

ATI Example: Hyatt @ UArizona

- Paramium Technology is an offshoot.
- Company started by PI and UA collaborators.
- https://paramium.com/
- This patent pending electromagnetic thermoforming technology is a highly energy efficient adaptable method of shaping precision metal panels creating a hybrid effect of localized induction heating (Joule effect) and electromagnetic force (Lorentz effect) to heat and press the panel at the same time along the non-contact "tool" path controlled by a Computer Numerical Control (CNC) machine as depicted.

- Awarded NSF SBIR and NSF I-Corps (2242729)





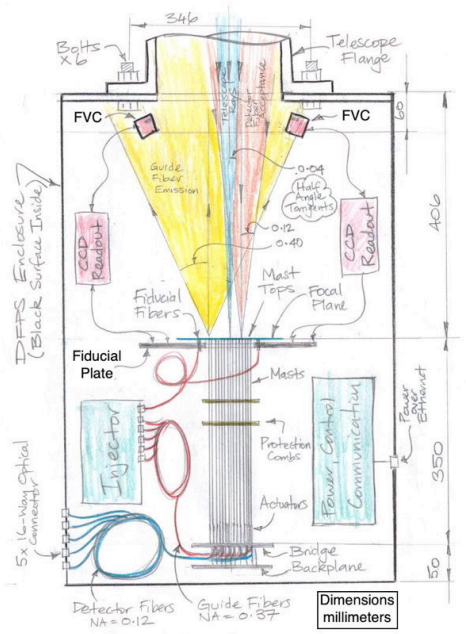
ATI Example: Marshall @ Texas A&M

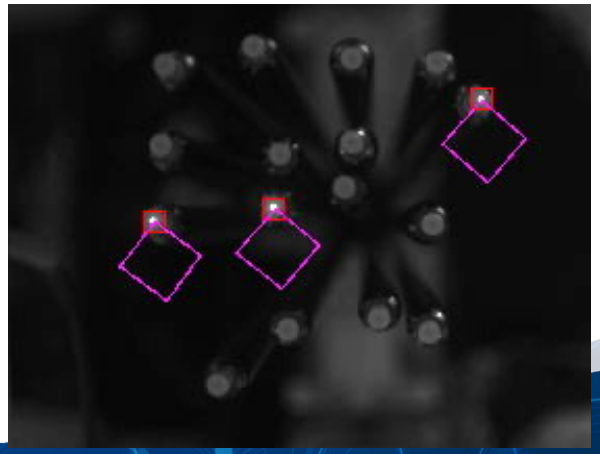
- hQphotonics is an offshoot.

- Collaboration between ATI funded TAMU group and small company Open Source Instruments (K. Hashemi) to develop dense fiber array positioner.

- https://www.opensourceinstruments.com/

- Funded by SBIR Phase I (2111936).





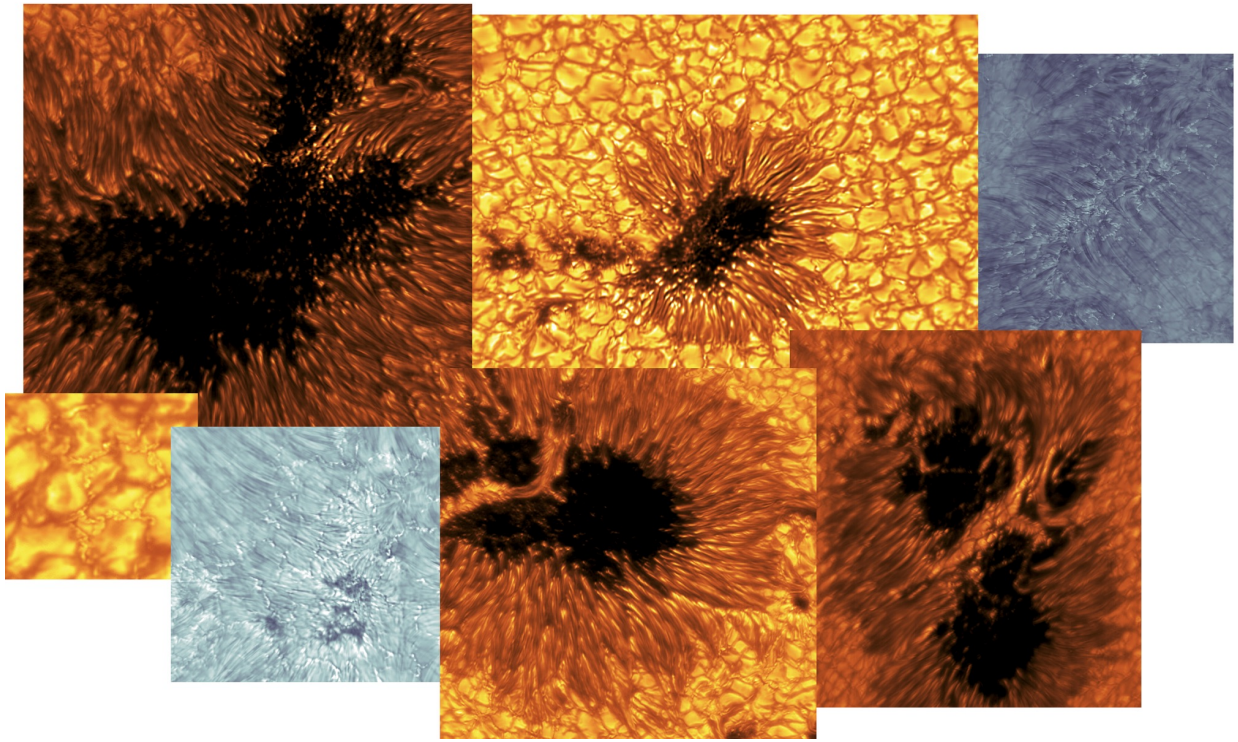
TOOLS: Major Research Facilities

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

- National Solar **Observatory** (DKIST, NISP program including GONG+SOLIS)
- 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.

NSO: DKIST News



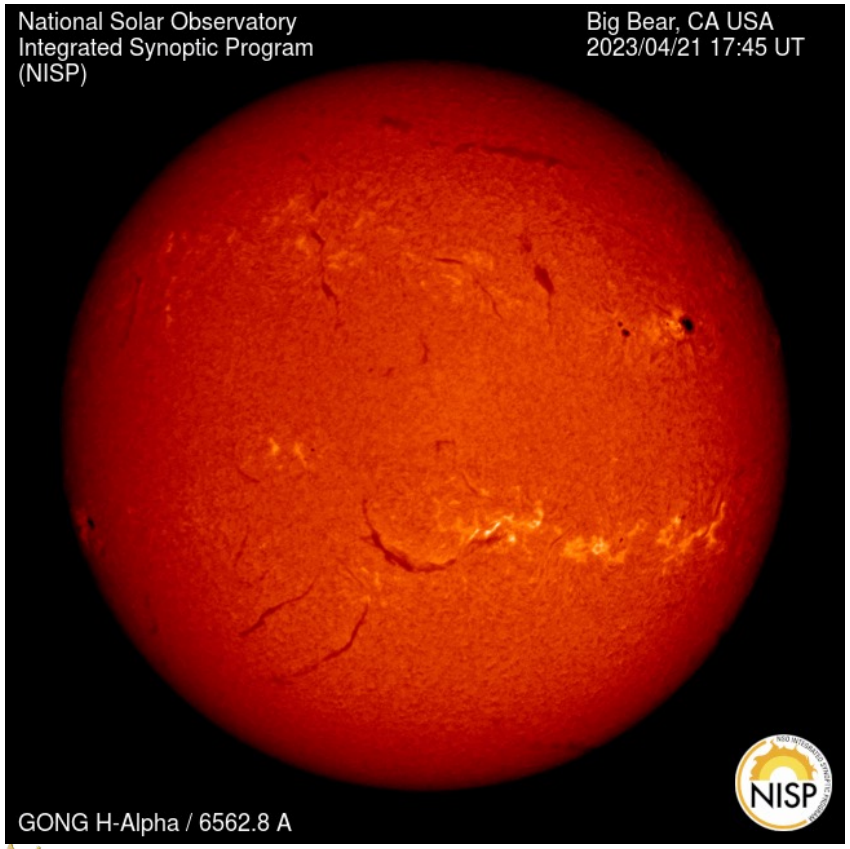
DKIST

- DKIST released first data sets to the public in December of 2022
- Still in Science Operations Commissioning phase, as instruments are brought online, pipelines worked out, and observational strategies optimized

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

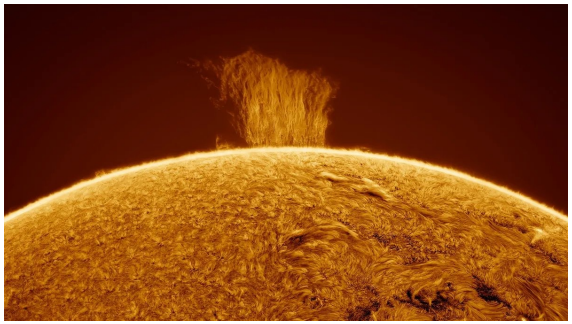
Image credit: NSO/AURA/NSF

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.

Solar eclipse 2023-2024:

An opportunity to excite interest in STEM. Developing educational packets with protective filters and gratings.

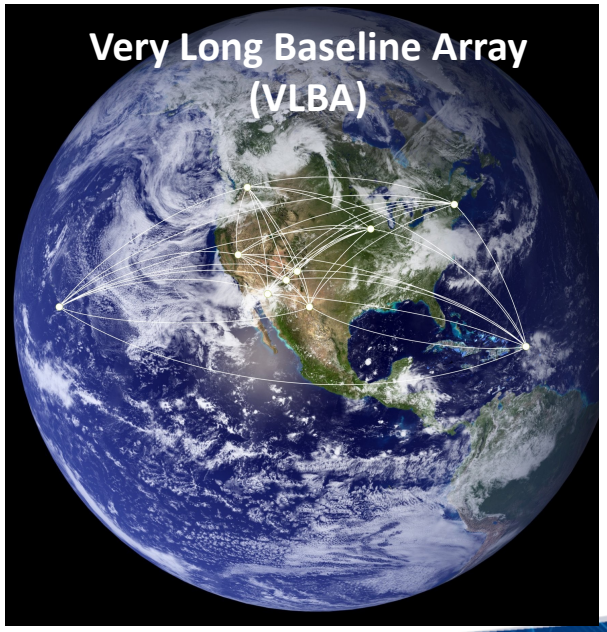
NSF, NSO, NOAA, NCAR, AAS, ASP, coordinating with philanthropic groups (Simons Foundation and others).

AAS Call: Jay M. Pasachoff Solar Eclipse Mini-Grants Program Invites Proposals

Citizen CATE 2024 (Citizen Continental-America Telescope Eclipse)

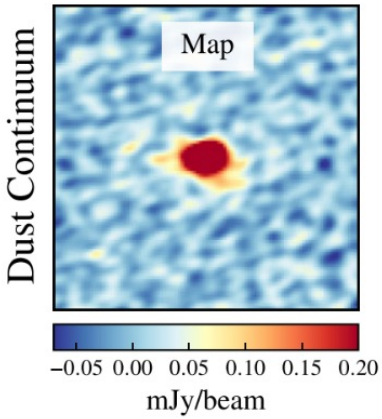
NRAO

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

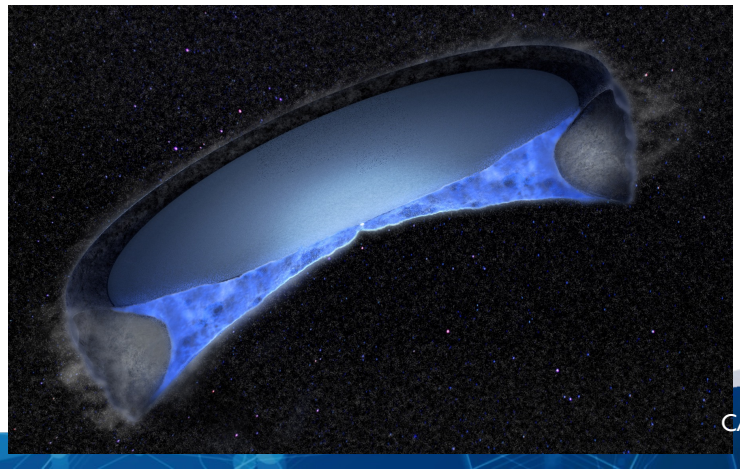


ALMA

- 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,

ALMA Cycle 9/10 Observing Highlights

Cycle 9

- Observed hours at/exceeded record levels (in spite of losing 641 hrs due to cyberattack)
- No power outages throughout the entire Cycle; a first in ALMA's operational history

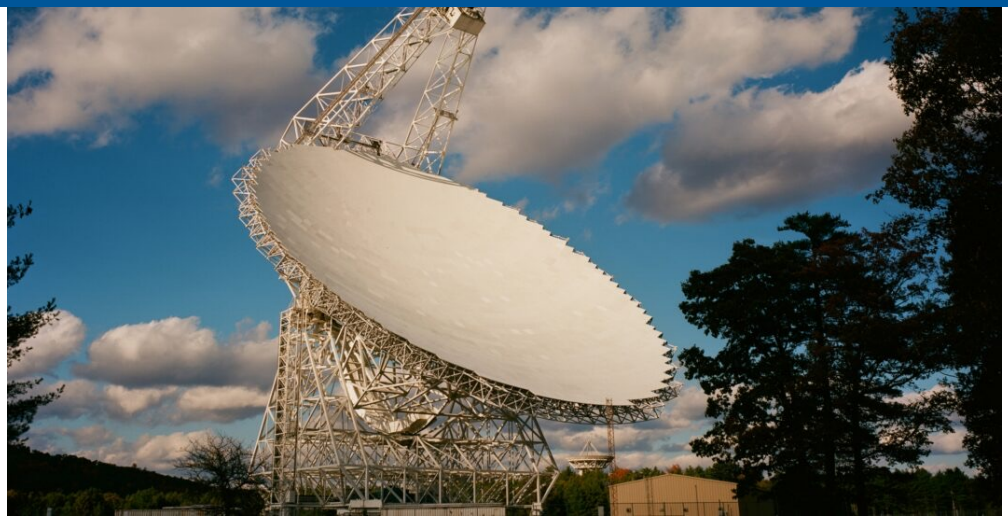
Cycle 10 (observations began 1 Oct 2023)

- Start of proposal call only delayed 2 weeks (despite disruptions due to cyber attack)
- Record 29,000 hrs requested; 6.9-to-1 over subscription
- Record number of Large Programs (44, requesting 5,000 hrs)
- First joint JWST/ALMA proposals this Cycle: 42 Joint Proposals requesting 1,200 hrs (out of 115 hrs available)

Radio Facility Updates

ALMA

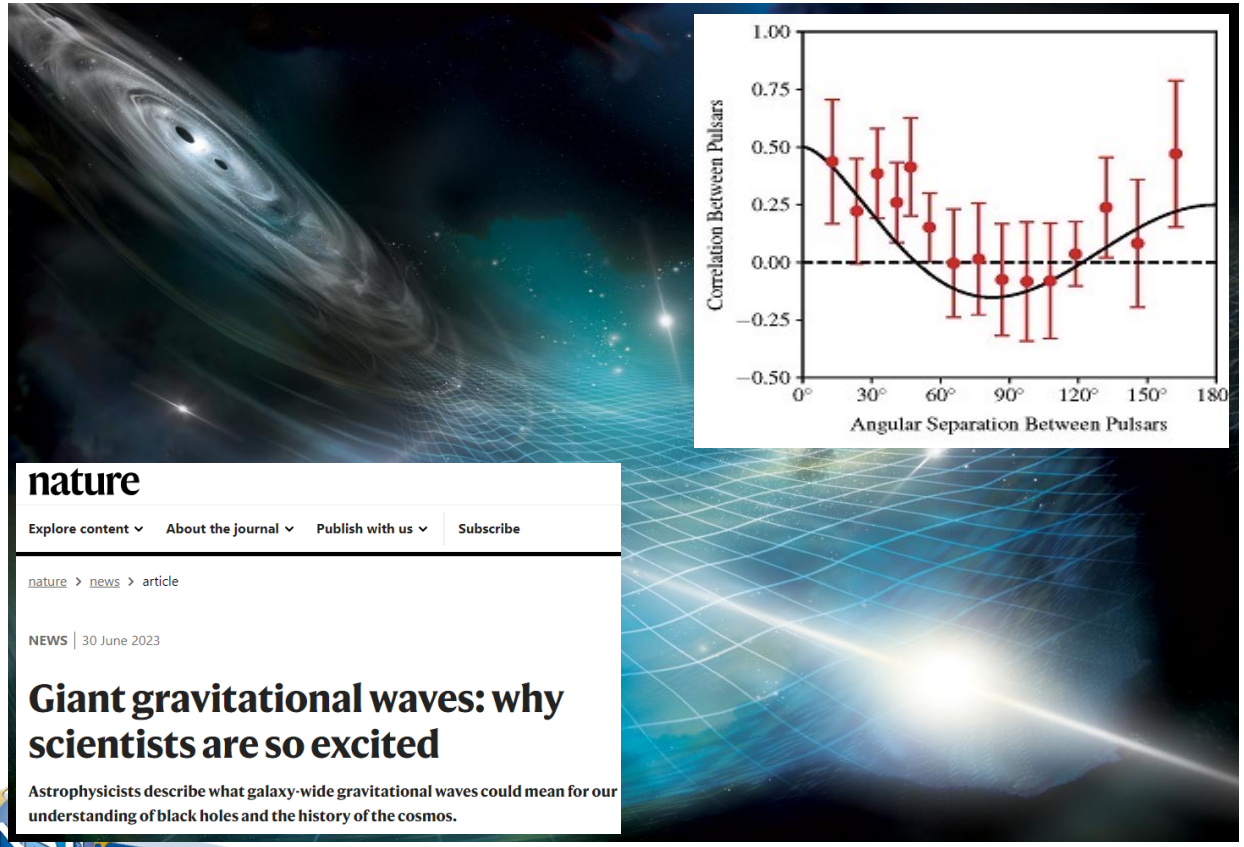
- Fully recovered from cyber attack last Fall. No science data or antennas compromised. ALMA operations resumed in December 2022 (2-month shutdown).



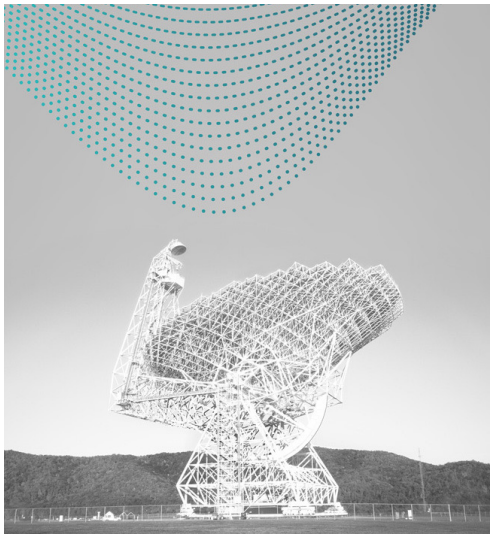
Green Bank

- Damaged wheel replaced and work completed on bad areas of foundation.
- GBT resumed operations Apr 12,
- All 16 wheels being replaced with FY23 supplement funding

Science Highlight: NANOGrav discovery of the Long Wavelength Gravitational Wave Background



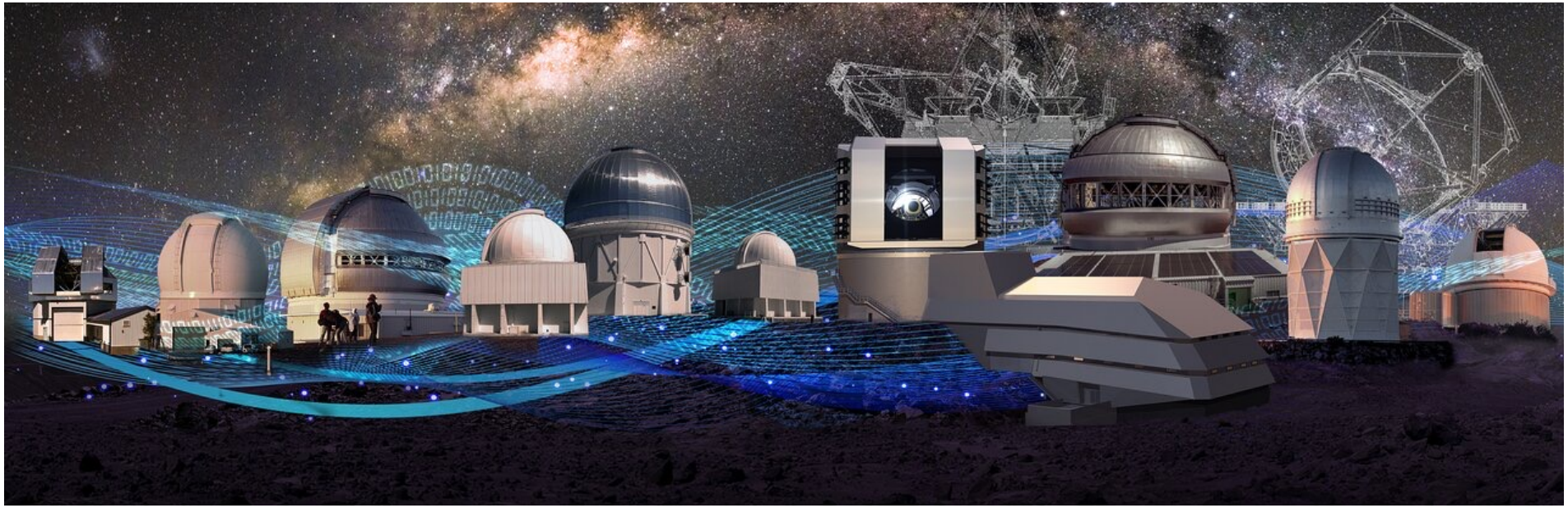
(Credit: NANOGrav)



100-m Green Bank Telescope (GBT)

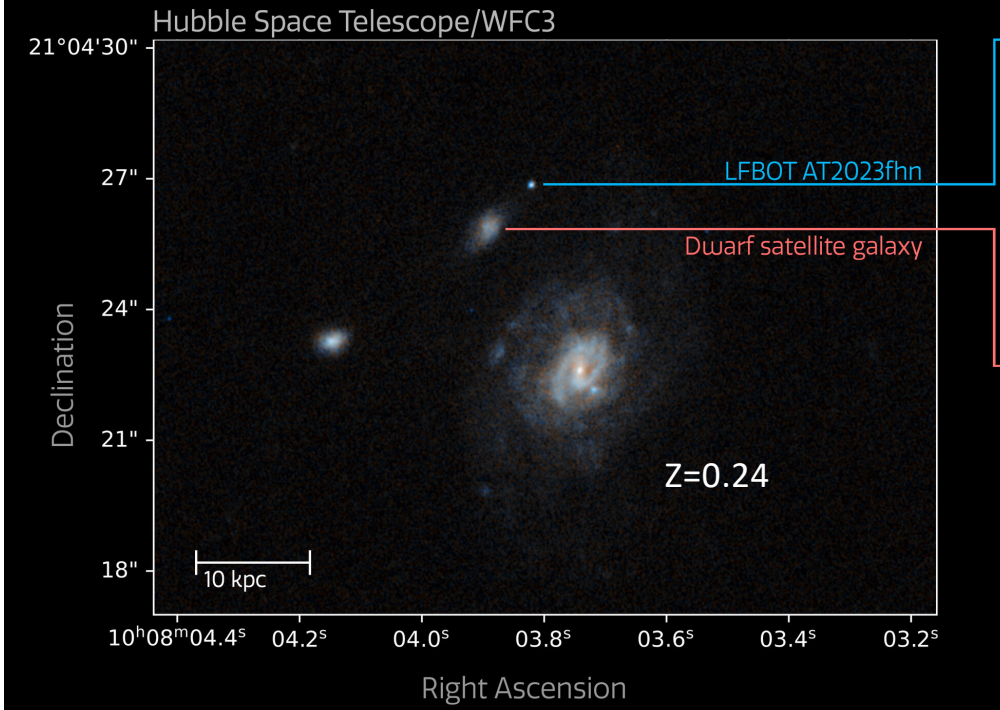
(Credit: West Virginia U)

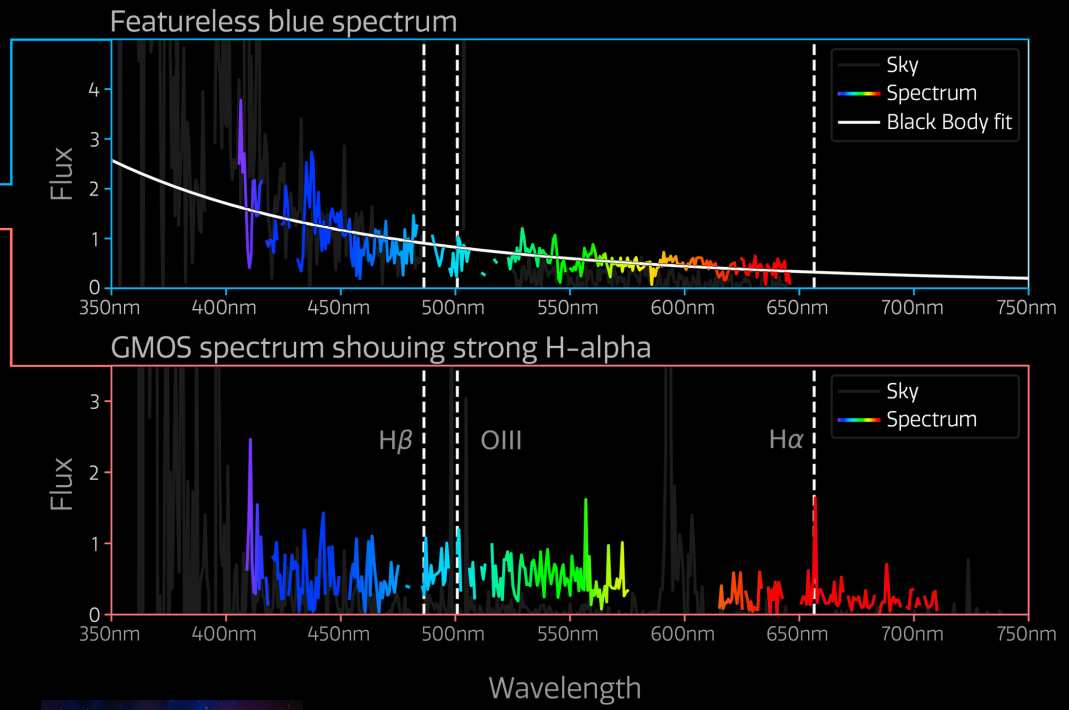
NOIRLab: the OIR ecosystem



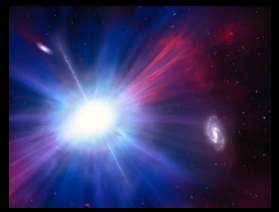
The Finch – A Luminous Fast Blue Optical Transient far from home

Discovered by ZFT - Spectra from Gemini/GMOS - Follow-up with the VLA, Chandra

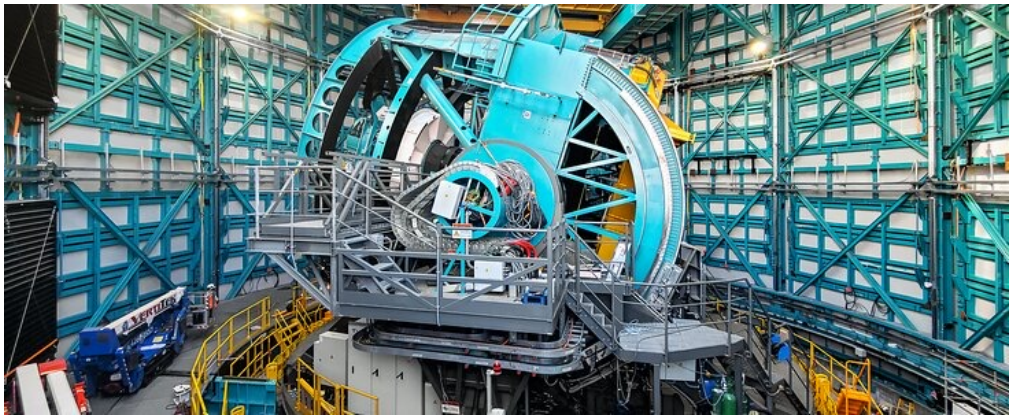




The "Finch" lies > 3.5 half-light radii from its host galaxy – a first for Luminous Fast Blue Optical Transients



How does a massive core-collapse object get 16 Kpc from its host in less than 100 Myr?



Credit: Rubin Observatory/AURA/DOE/NSF

AuxTel being used to test some data management processes

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 mid-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
- KP reopened to public (made local news!)

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

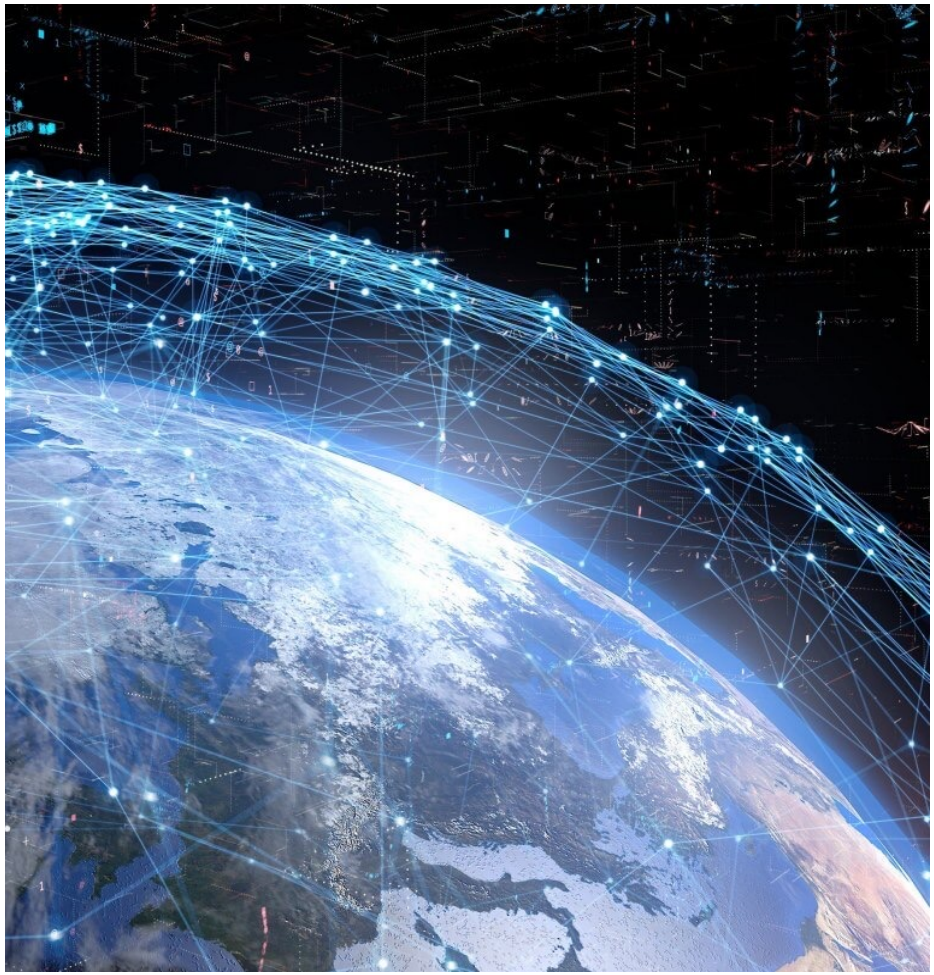
What is coming?

Constellations of thousands of NGSO satellites (10-50+ GHz transmitters) such that from any location you would always “see” at least one and up to 3 or 4 satellites or more!

Credit: University of Southampton

Also:

- Large numbers of smaller satellites
- Mobile telecommunications, including direct-to-cell from satellites and high-altitude platform systems



Addressing the impact of satellite constellations:

1. New solicitation (ENG CISE MPS GEO): Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT) includes stream of funding R&D for astronomy and satellite constellations.
2. Work in developing U.S. statement on dark and Quiet Skies at U.N. COPUOS
3. Support of SpectrumX (spectrum innovation center, Notre Dame)
4. IAU SKAO / NOIRLab leadership: Center for Protection of Dark and Quiet Skies

- ESM Unit staff updates

Jonathan Willams
NSF ESM Coordination Group Chair, Program Director

John Chapin
Special Advisor for Spectrum, Program Director

Joshua Reding
AAAS Science and Technology Policy Fellow

Ashley VanderLey
Acting Senior Science Advisor, MPS

Additional IPA

NSF activities related to satellite constellations

Optical and Infrared

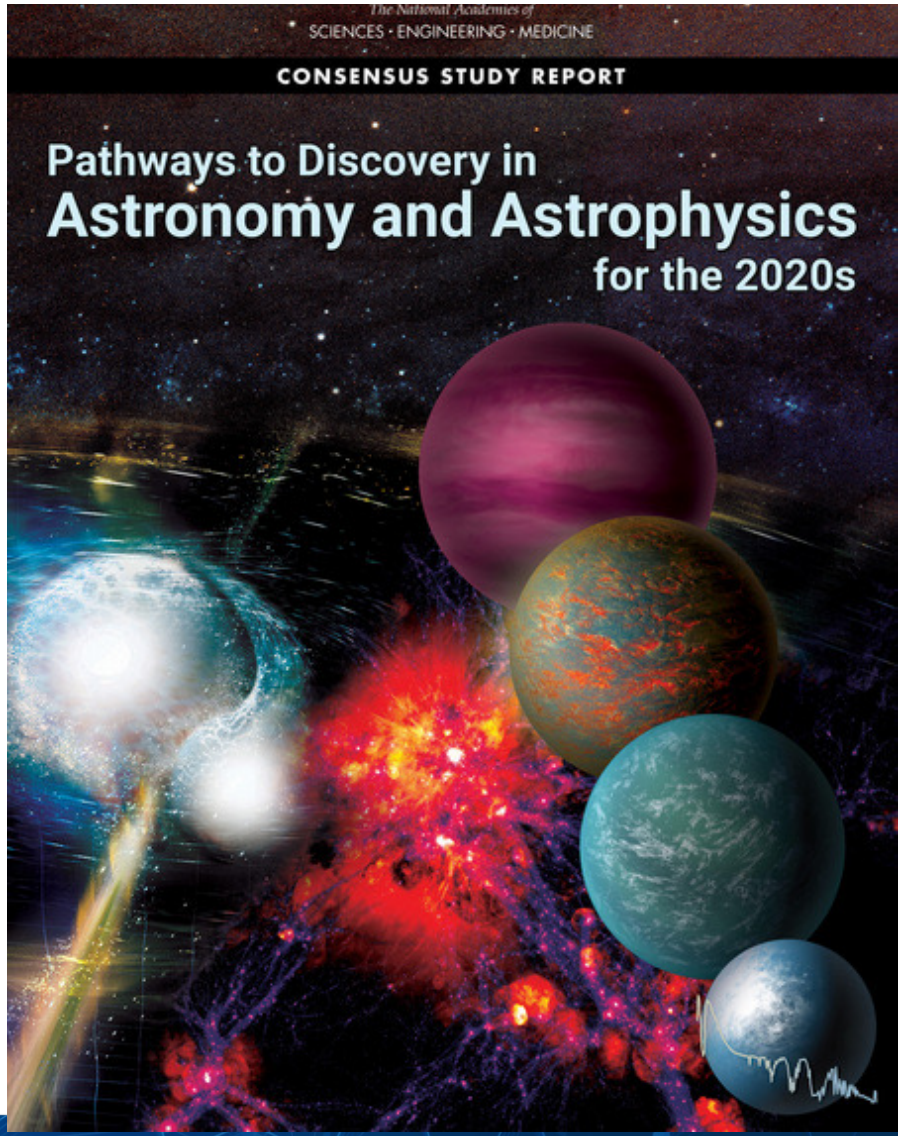
- 3 NSF-funded or supported workshops: NOIRLab + AAS
  - SATCON1 – July 2020
  - SATCON2 – July 2021
  - Laser Clearinghouse – April 2023
- NSF's NOIRLab + Rubin Observatory working closely with satellite operators
- NSF/Satellite Industry Association joint technical presentation for the USA to UN Committee on the Peaceful Uses of Outer Space (COPUOS), SME for COPUOS STSC
- NSF's NOIRLab jointly runs IAU Centre for the Protection of Dark and Quiet Skies with SKAO (launch date 1 April 2022); next meeting October 2023 La Palma

Radio Frequency

- Spectrum coordination agreements
  - SpaceX (signed 2019, updated 2022)
  - OneWeb (signed 2023)
  - Other US-licensed operators to come – including Kuiper
- R&D on satellite interference mitigation/coexistence
  - Spectrum Innovation Initiative
    - SpectrumX: An NSF Spectrum Innovation Center
  - SWIFT program: includes a stream for satellite and astronomy impacts
- Active engagement in "traditional" satellite spectrum management (domestic and international): WRC-23
- NRAO working closely with satellite operators

- NSF-supported JASON study (July 2021)
  - Optical impacts on NSF/Rubin Observatory
  - Mitigation opportunities
  - Good practices for satellite vendors
- Analytic study of radio interference, including
  - Single-dish telescopes
  - Interferometers
  - Cosmic Microwave Background-Stage 4

Astro2020 & Major Facilities Recommendations



Sustainability efforts

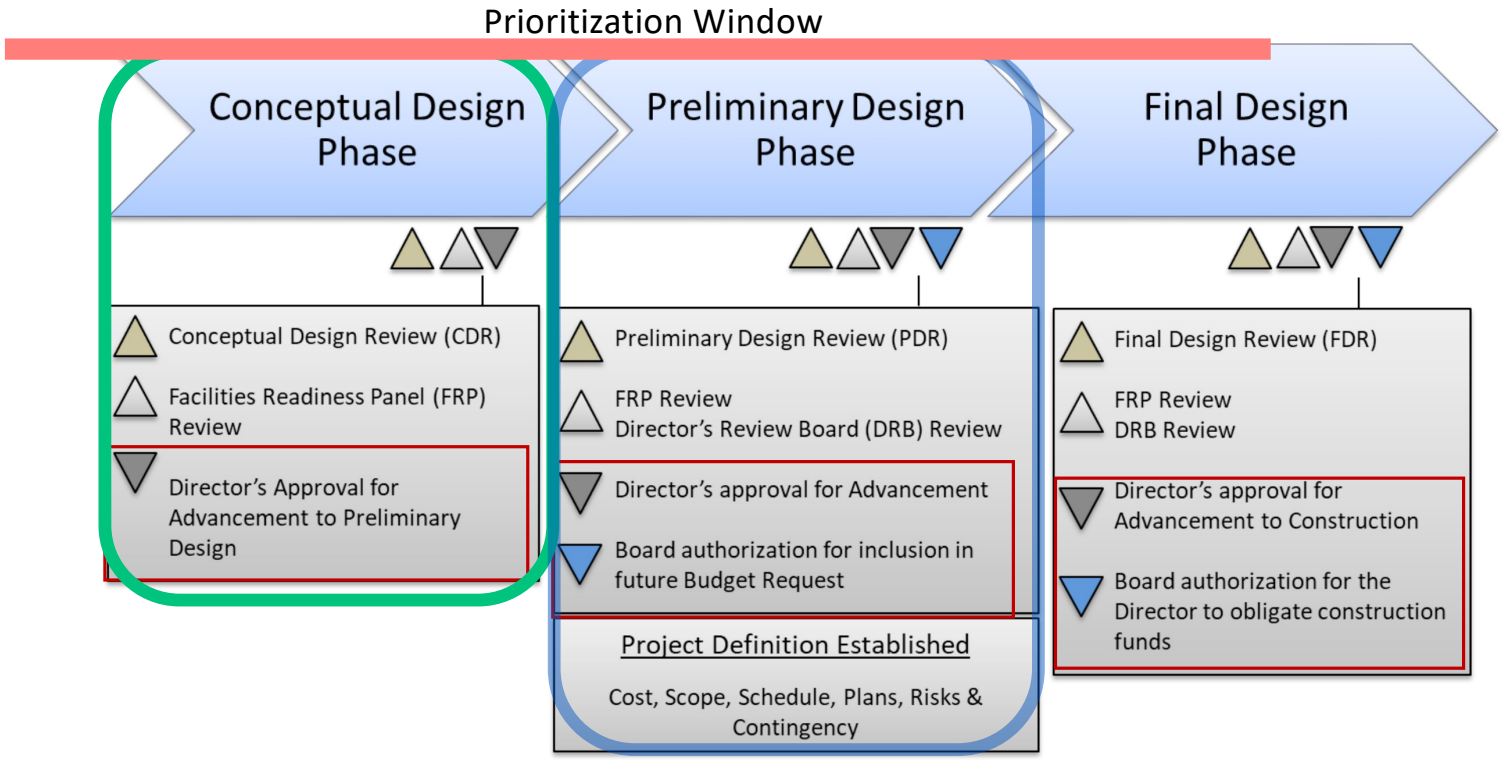
- Supplements provided for a photo-voltaic system and battery storage at Cerro Pachón, with goal of making Gemini-South carbon neutral!
- Renewable energy for Rubin (PV panels to provide up to ~40% of power)
- GOAL all of Cerro Pachón, then beyond...

- Funded initial investments in electric vehicles with FY23 appropriations.
- Solar panels funded for NRAO Science Operations Center in Socorro
- PV system at Adv. Simons Observatory

Facilities Lifecycle Context

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

NSF's Major Facilities Design Stage



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

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

US ELT Pathway through NSF's Design Stage

- Currently being treated as TWO projects under ONE umbrella
  - NSF's US ELT Program
- AST requested entry directly into NSF's Design Stage at the Preliminary Design Phase
  - Approved by Office of the Director in November 2022
- AST + LFO ran Preliminary Design Reviews (PDRs): Dec 2022-Jan 2023
  - Review of TECHNICAL aspects of two projects
- AST Recommends advancement to MPS*
  - Blue Ribbon Panel (BRP) Review of AST Recommendation and Implementation Plan; advice to MPS Assistant Director and NSF
- AST preparing for review by NSF's Facilities Readiness Panel (FRP) for possible entry into NSF's Final Design Phase

Status of Maunakea and TMT

- NSF formally started the TMT environmental review process – Aug. 2022
- 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
- MOU between NRAO and UNAM for ngVLA activities (Nov 2022)

Credit: mtex

Work on antenna prototype progressing – recent rollout event in Germany

CMB-S4

- NSF considering entry into NSF's Major Facility Design Stage, Conceptual Design
  - *Development funding provided*
- CMB-S4 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

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

Community Vision Requires Prioritization

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

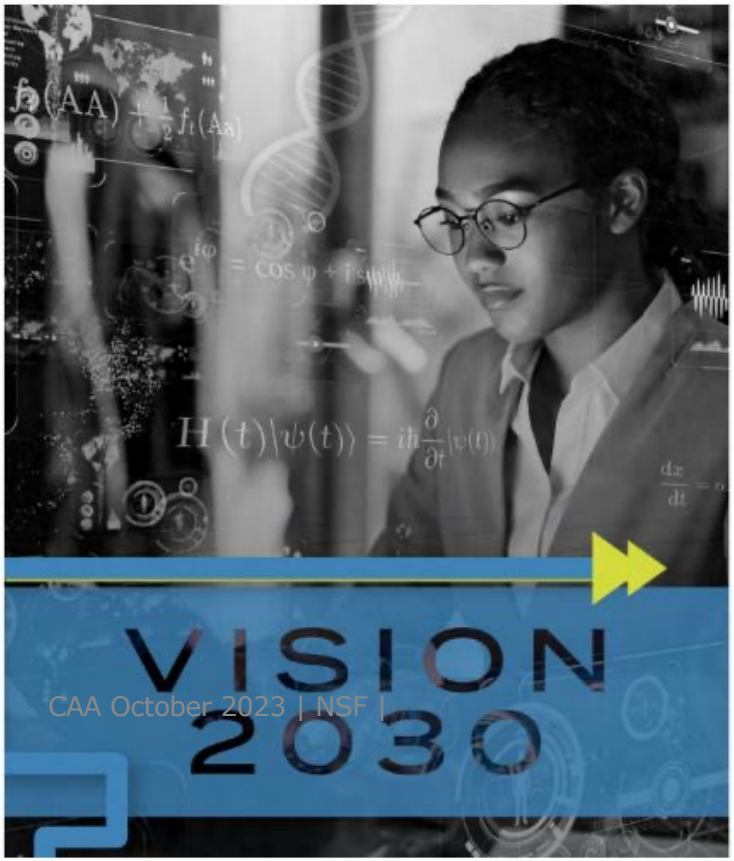
- **Assess potential contributions of new Major and Mid-scale infrastructure projects in the context of the MPS portfolio**
- Provide recommendations for (required) MPSAC endorsements of Major Facility projects
- Provide strategic advice on elements of, and the balance of, the evolving MPS research infrastructure 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.***

Infrastructure: Vitally Important to Advance Science

NATIONAL SCIENCE BOARD



"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.

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**

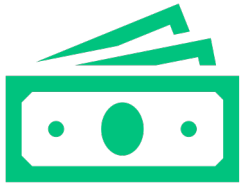
Foundation for Prioritization: Brinkman Report & NSB response

- 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.

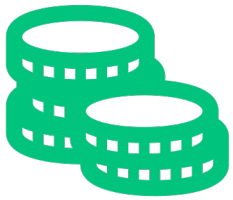
Astro2020 Funding: Major Facilities Initiatives



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

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

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

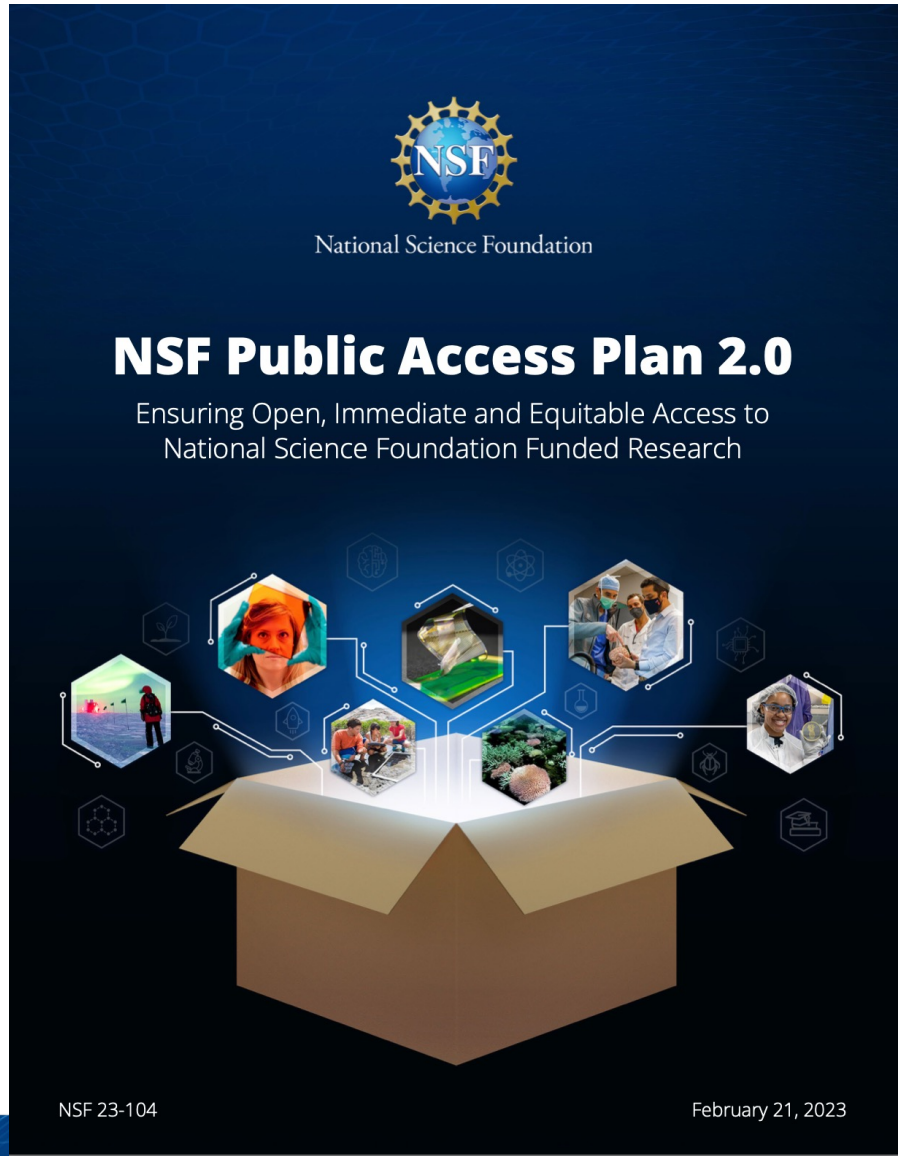
AST Challenge: Aspirational planning, but Execution within Allocations

- 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

Open Access Policies and Initiatives

- Initial Response
- https://www.nsf.gov/pubs/2023/nsf23104/nsf23104.pdf

- Work ongoing on Policy updates to PAPPG

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