HIGH ENERGY PHYSICS ADVISORY PANEL

C. Denise Caldwell
Division Director, Division of Physics, Mathematical and Physical Science Directorate
National Science Foundation
December 8, 2022

MPS Organization

Senior Facilities Advisor
Chris Smith

Senior Strategy Advisor
Saul Gonzalez

Office of Multidisciplinary Activities (OMA)
Dean Evasius

Staff Associate
Michelle Bushey

Assistant Director
Sean L. Jones

Deputy AD
Tie Luo

Astronomical Sciences Division Director
Debra Fischer

Chemistry Division Director
David Berkowitz

Materials Research Division Director
Linda Sapochak

Mathematical Sciences Division Director
David Manderscheid

Physics Division Director
Denise Caldwell

Deputy DD
James Neff

Deputy DD
Lin He

Deputy DD
Alex Klironomos

Deputy DD
Junping Wang

Deputy DD
Jean Allen

Biden Administration

Clean Energy

Climate Change

Equity

Emerging Industries

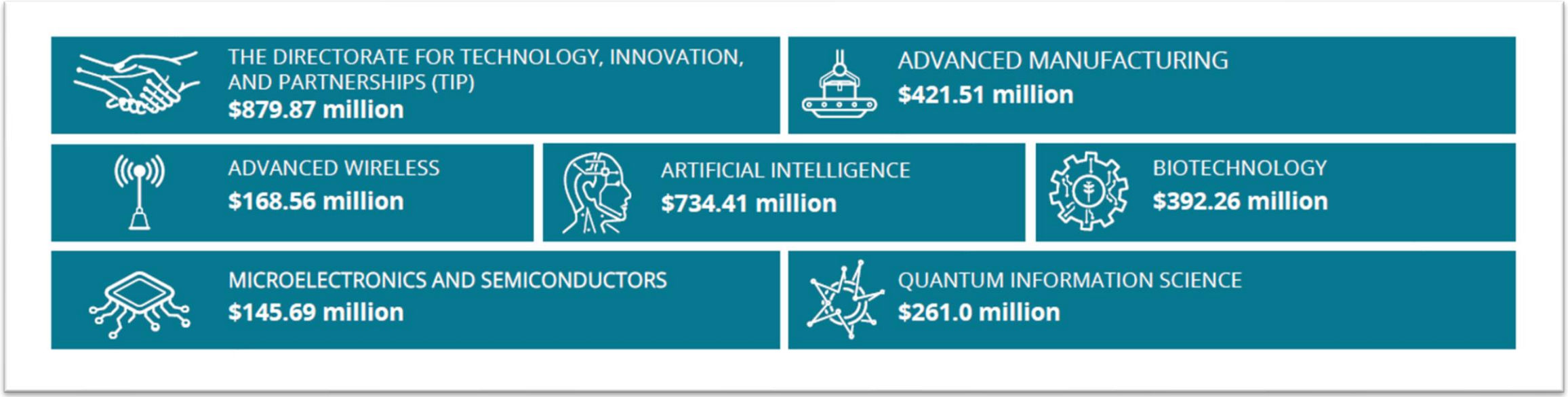
NSF Global Priorities

Total Alignment between NSF, Administration, and Congressional priorities in:

ADVANCING SCIENCE AND TECH TO ADDRESS NATIONAL NEEDS	ENABLING OPPORTUNITY EVERYWHERE	GLOBAL LEADERSHIP AND COMPETITIVENESS

FY 2023 President's Budget Request

- $10.5B for NSF, a 24% increase
- $1.75B for MPS, a 9.6% increase
- New Strategic Plan released (2022 – 2026)
- Accelerate R&D in Climate Change & Clean Energy $1.5 billion
- Advance Equity in STEM $393M
- Continue construction & procurement of research infrastructure and instrumentation
- Expedite technology development in emerging technologies



NSF Emerging Industries and Biden Administration , FY 2021 – FY 2023

	Emerging Industries - NSF	FY 2021 Actuals	FY 2022 Estimate	FY 2023 Request
★	Advanced Manufacturing	$452.11	$364.89	$421.51
	Advanced Wireless	$131.03	$131.76	$168.56
★	Artificial Intelligence	$701.78	$679.23	$734.41
★	Biotechnology	$336.47	$315.22	$392.26
★	Microelectronics & Semiconductors	$131.11	$106.46	$145.69
★	Quantum Information Science	$255.06	$252.48	$261.00
★	Clean Energy Technology	$381.89	-	$500.00
	Climate Change	$568.19	-	$913.40

★ MPS leads in investments

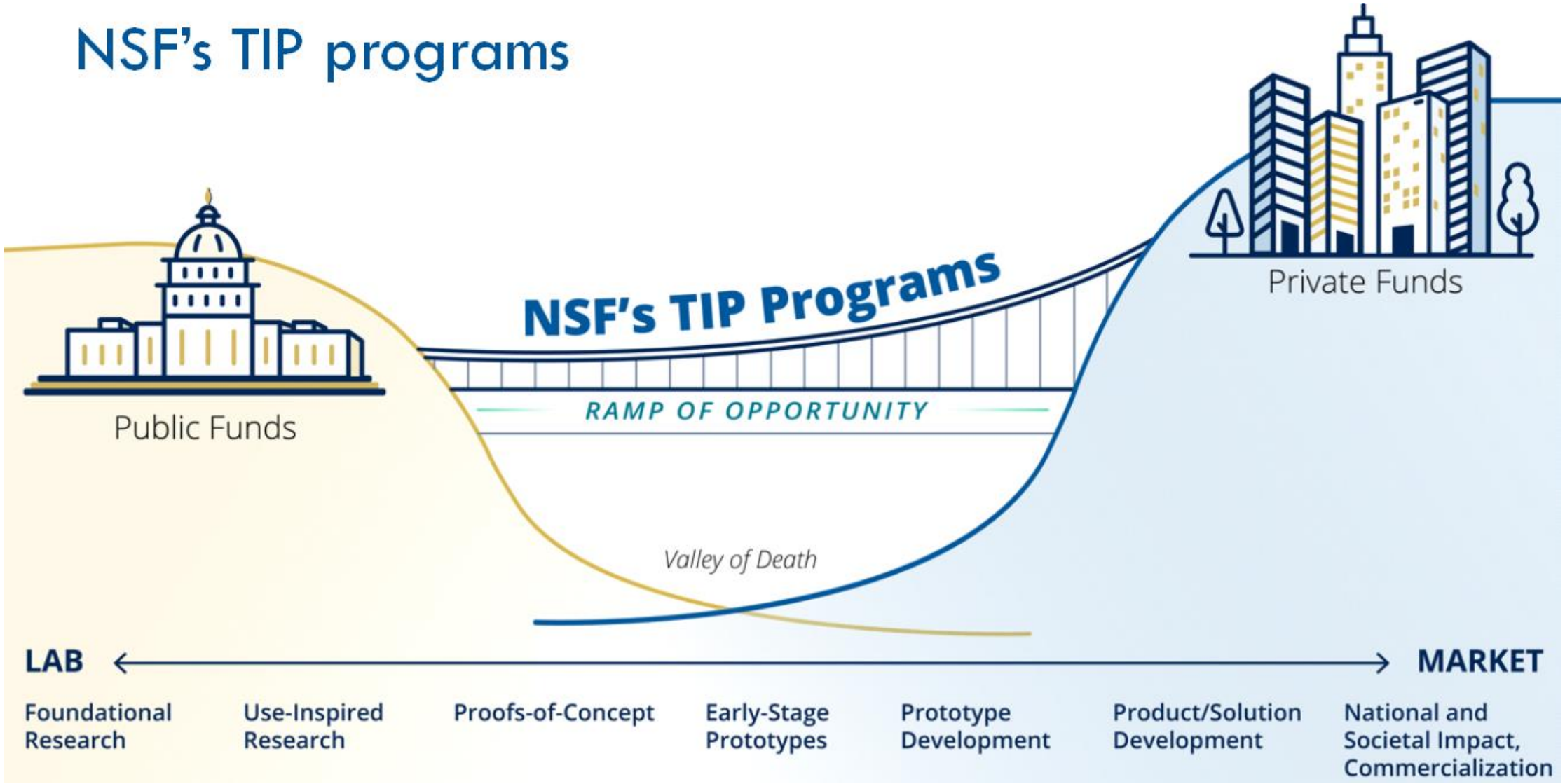
★ MPS within top 3 NSF Directorates for investments

CHIPS and Science Act

- Creates Directorate for Technology, Innovation and Partnerships (TIP)
  - Authorization of $1.85 billion in FY 2023
- Increases overall NSF authorization (not including TIP) to $10 billion in FY 2023
- Supports research and workforce development related to:
  - Biotechnology
  - Climate change and clean energy
  - Manufacturing
  - Semiconductors and microelectronics
  - Research and infrastructure
  - Other emerging technology areas

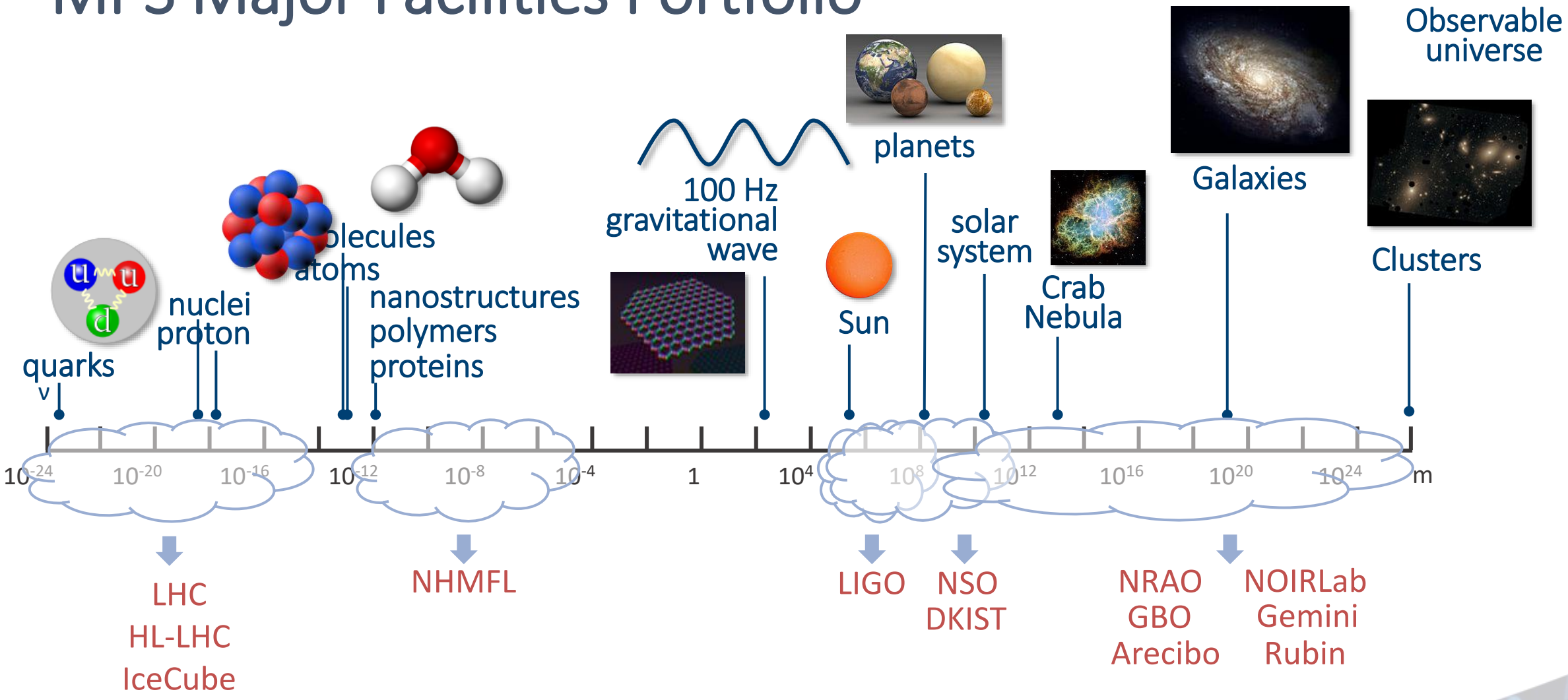
- Puts NSF on a path to increase investments in EPSCoR jurisdictions

Technology, Innovation and Partnership (TIP)



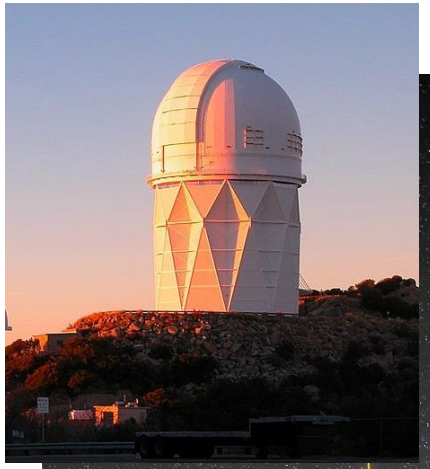
- MPS Facilities
- Broadening Participation

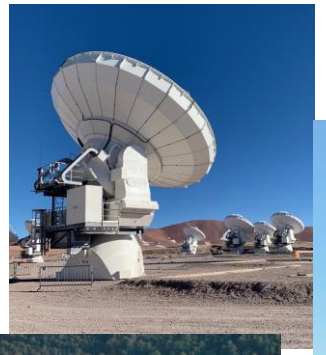
MPS Major Facilities Portfolio

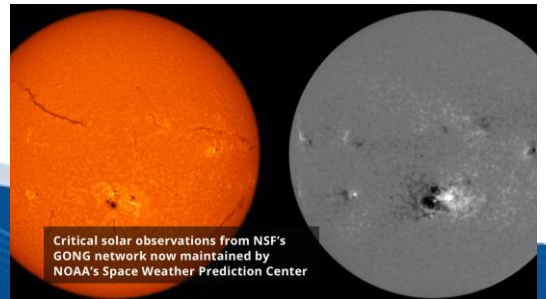


Astronomy

- **AST is the Federal steward for ground-based astronomy**
- Optical: National Optical-Infrared Astronomy Research Laboratory (NOIRLab)
  - Examples: Kitt Peak (AZ), Gemini (HI+Chile), Rubin Observatory (Chile)
- Radio: National Radio Astronomy Observatory (NRAO)
  - Examples: Very Large Array (New Mexico), ALMA (Chile)
  - Also Green Bank Observatory
  - And Arecibo
- Solar: National Solar Observatory (NSO)
  - DKIST, Global Oscillation Network Group (GONG)



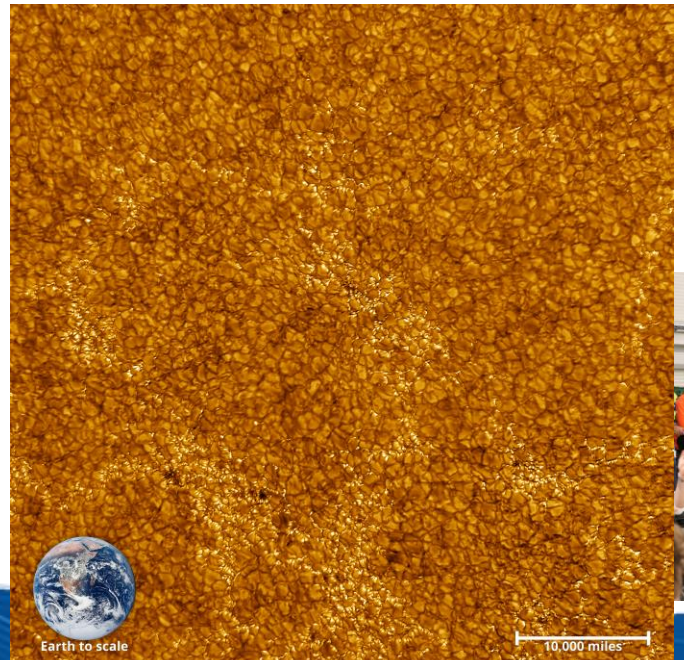




Construction to Operations: Inauguration of the Daniel K. Inouye Solar Telescope

On August 31, 2022, a delegation of NSF leaders, congressional dignitaries, and members of both the scientific and Native Hawaiian communities gathered near the summit of Haleakalā, Maui to commemorate the inauguration of the world's most powerful solar telescope.

If a picture is worth a thousand words, the images and data produced by Inouye Solar Telescope will write the next chapters of solar physics research

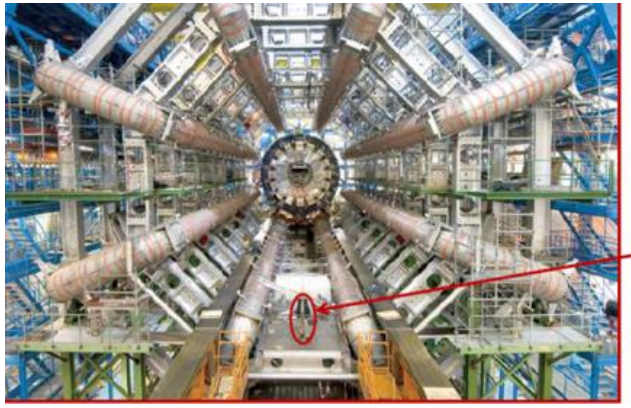


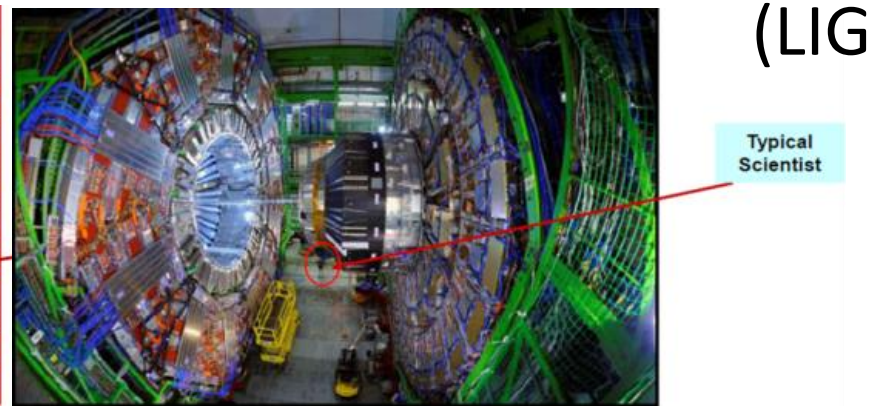
Transitions: Arecibo Observatory
Arecibo Center for STEM Education & Research

- NSF issued a solicitation Oct. 13 for a new multidisciplinary, world-class educational center at the Arecibo Observatory site in Puerto Rico that aims to serve as a hub for STEM education and outreach.
  - Eligibility focused on Hispanic Serving Institution (HSI) involvement
  - Link to solicitation: Arecibo Center for STEM Education and Research (ACSER) (nsf23505) | NSF - National Science Foundation

- Site management structure flexible to allow support of some ongoing and other new NSF-funded activities
  - Funding to be determined through standard NSF merit review processes

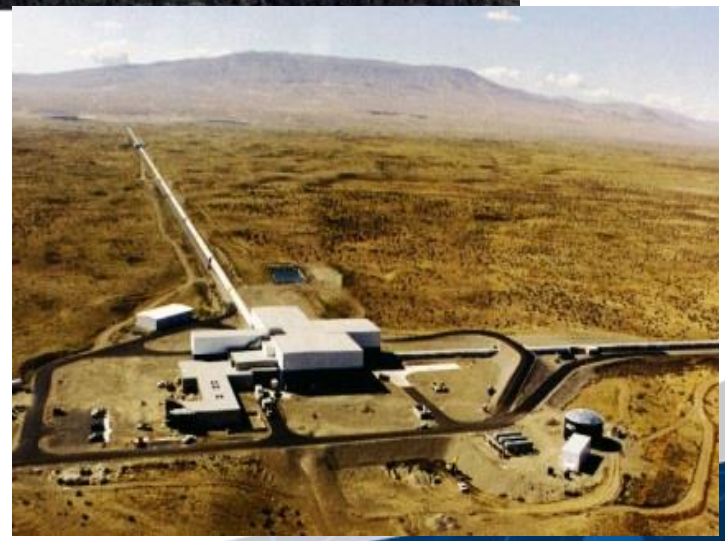
Physics



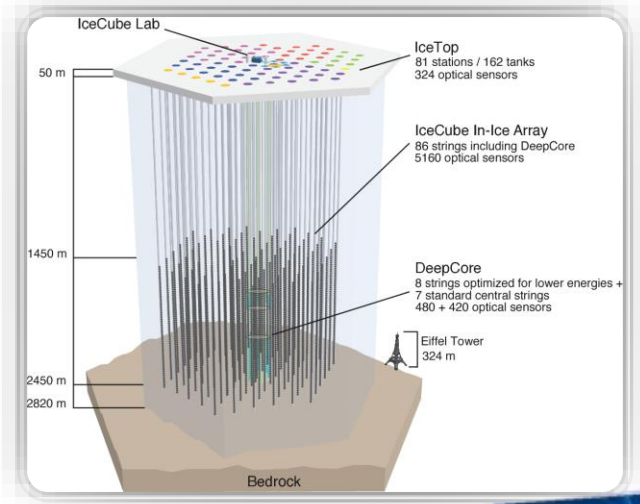


ATLAS and CMS Detectors at the Large Hadron Collider (LHC)

Laser-Interferometry Gravitational Wave Observatory (LIGO)

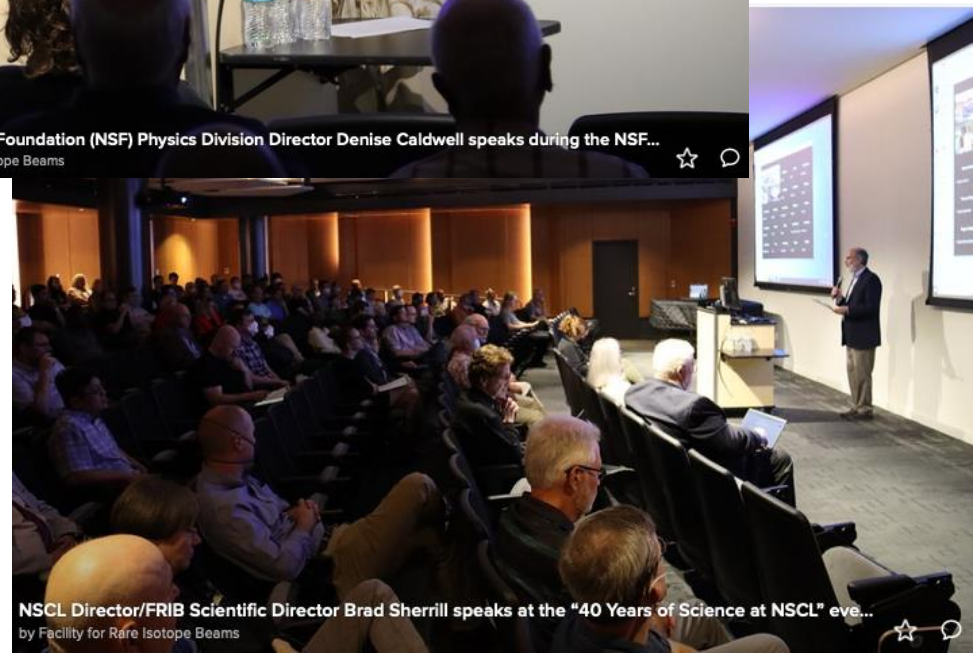


Ice-Cube Neutrino Observatory (ICNO)



Transitions:
NSF's NSCL to DOE's FRIB

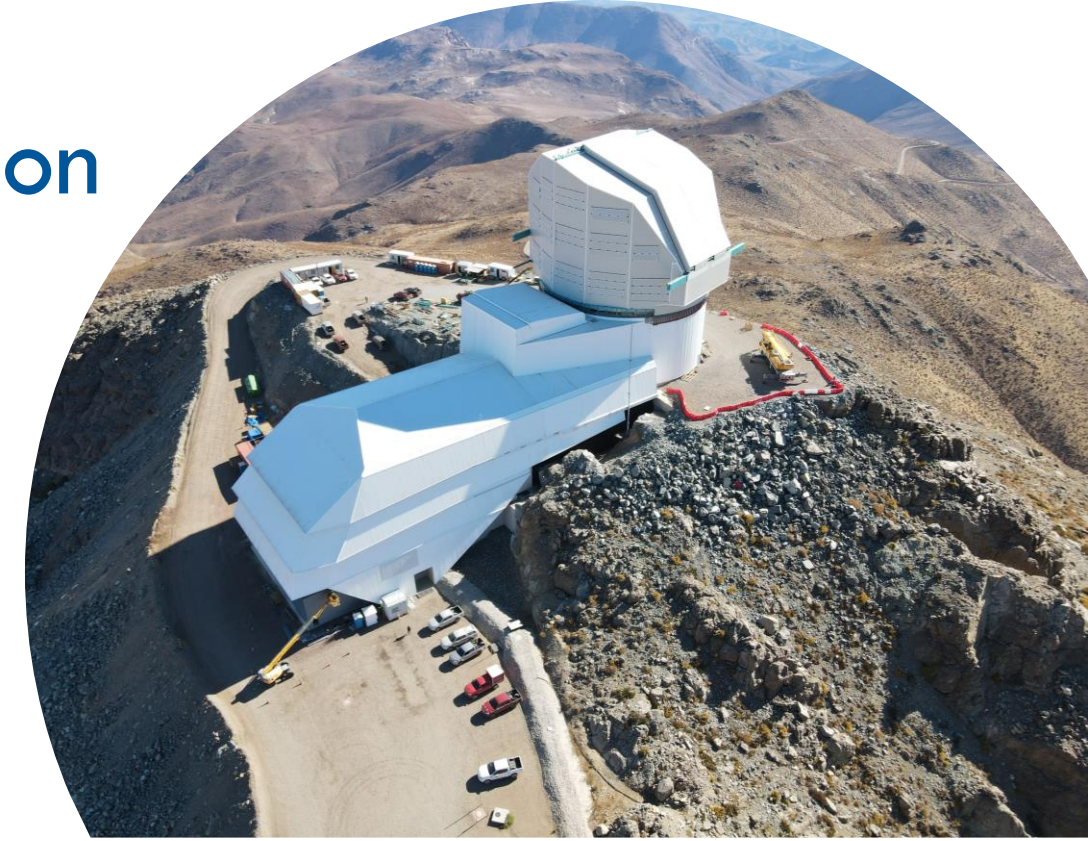
- NSCL (NSF): National Superconducting Cyclotron Laboratory
  - Based at Michigan State University campus
  - First NSCL experiment September 1982, FINAL experiment formally May 2022
  - August 2022: "40 Years of Science at NSCL"
- FRIB (DOE): Facility for Rare Isotope Beams
  - Built upon the success of NSCL
  - Elements of NSCL incorporated into construction of FRIB; completed and now operational



LIGO Exploration Center

New LIGO Exploration Center opened in Hanford, Washington on June 2, 2022. The center will house 50 interactive exhibits and is expected to host 10,000 visitors a year.

Construction: Facilities coming soon



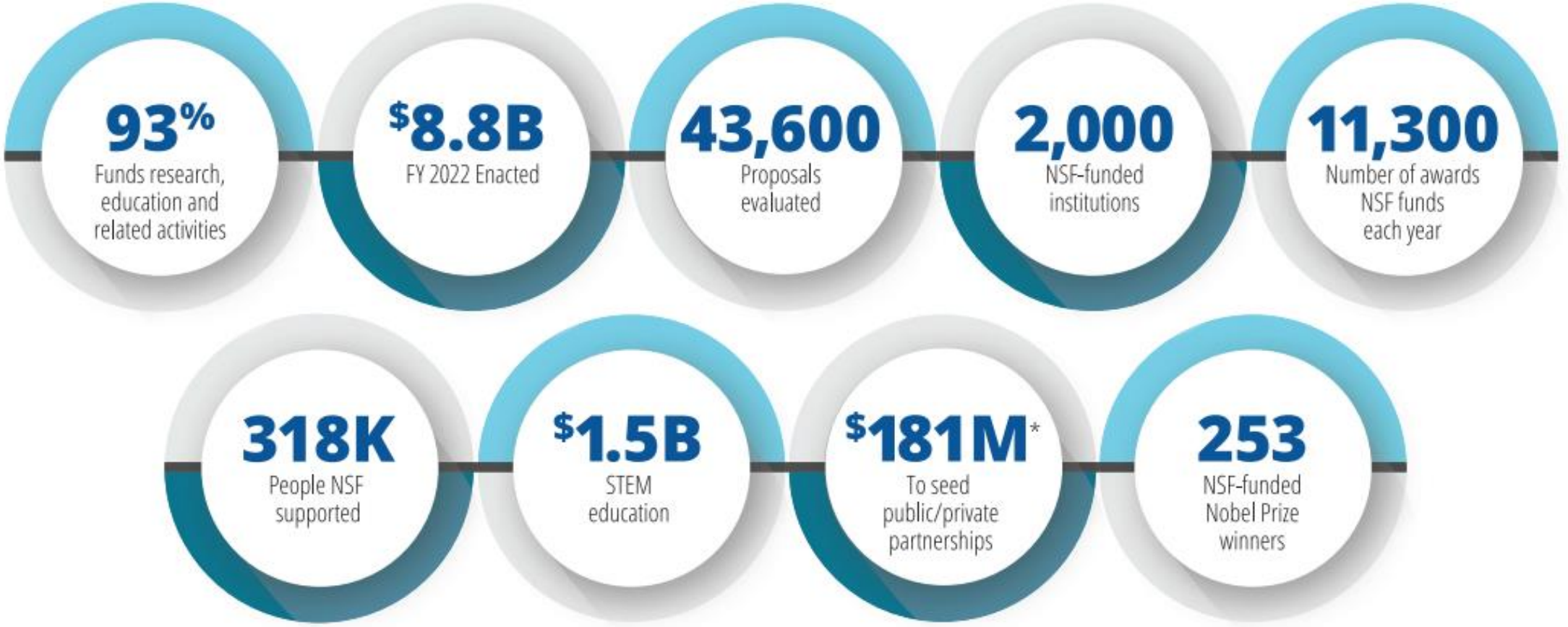
- Rubin Observatory
  - Construction started in 2014
  - Significant COVID-19 impacts
    - Rebaselined in Spring 2022
  - ETA: Operations in mid/late-2024

- High-luminosity LHC Detector Upgrades: ATLAS and CMS
  - Started in April 2020
  - Impacts due to COVID-19, CERN Schedule delay, Ukraine (loss of Russian contribution)
    - Rebaseline in Spring 2023
  - ETA: New CERN schedule = installation in January 2026 (+1yr)

Development: Facilities on the Horizon

- AST: Astro2020
  - Several Major Facility recommendations critical to advances in the field
- PHY: What is next in Gravitational Wave observations?
  - Cosmic Explorer “Horizon Study”
  - AC Subcommittee on next-generation facility concepts
- DMR: What is next in high magnetic field instrumentation?
  - National Academies Study

NSF By The Numbers



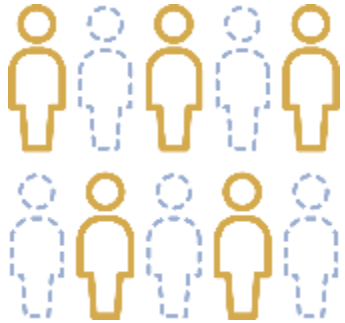
Data represents FY 2021 Actuals unless otherwise indicated.
**Corresponds to NSF investments initiated in FY 2021 and spanning multiple years.*

Partnerships for Research and Education in MPS

GOALS

- **Increase recruitment, retention and degree attainment** by members of those groups most underrepresented in Mathematical and Physical Sciences research
- **Support excellent research and education endeavors** that strengthen such partnership

Expanding Geography of Innovation



Missing Millions

Partnerships

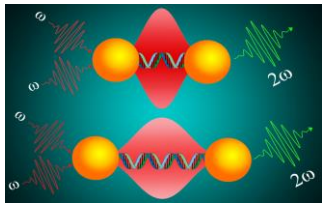
Partnerships for Research and Education in Materials (PREM)

Goal: Enhance diversity in materials research and education *through long-term, collaborative research and education partnerships between Minority Serving Institutions and DMR-supported Centers, Facilities or Platforms*

Minority-Serving Colleges & Universities ⇔ DMR-Supported Centers & Facilities

- Hispanic Serving/High Hispanic Enrollment Institutions (HSI/HHE)
- Historically Black Colleges and Universities (HBCUs)
- Minority Serving Institutions (MSI)
- Alaska Native Serving Institutions (ANSI)
- Native American-serving non-Tribal Institutions and Tribal Colleges and Universities (TCU)
- Native Hawaiian Serving Institutions (NHSI)

- Materials Research Science and Engineering Centers (MRSECs)
- DMR supported Science and Technology Centers (STCs)
- DMR supported Materials Innovation Platforms (MIP)
- National High Magnetic Field Laboratory (NHMFL)
- Cornell High Energy Synchrotron Source (CHESS)
- Center for High Resolution Neutron Scattering (CHRNS)



Partnerships for Research and Education in MPS

Over $12.5 million invested total in FY22

PREP: Partnerships for Research and Education in Physics

- **Partners:** 11 Physics Frontiers Centers
- **Awards made:** 6 awards

Includes: 3 HSIs, 2 HBCUs, 1 AANAPSI, 3 R2 institutions

PREC: Partnerships for Research and Education in Chemistry

- **Partners:** 8 Centers for Chemical Innovation, Facilities, and Institutes
- **Awards made:** 3 awards

Includes: 2 HSIs, 1 AANAPSI, 1 R2 institution

PAARE: Partnerships in Astronomy & Astrophysics Research and Education

- **Awards made:** 11 awards

Includes: 5 HSIs, 3 AANAPSIs, 1 HBCU, 1 PBI , 4 R2 institutions

MPS Ascend Postdoctoral Fellows

12 to 36 Months, $100,000 per year

- A monthly stipend of $5,833 (up to $70,000 annually)

- An annual allowance of $30,000 for:

  a) expenses directly related to the conduct of the research and/or

  b) support of fringe benefits, dependent care, and moving expenses.

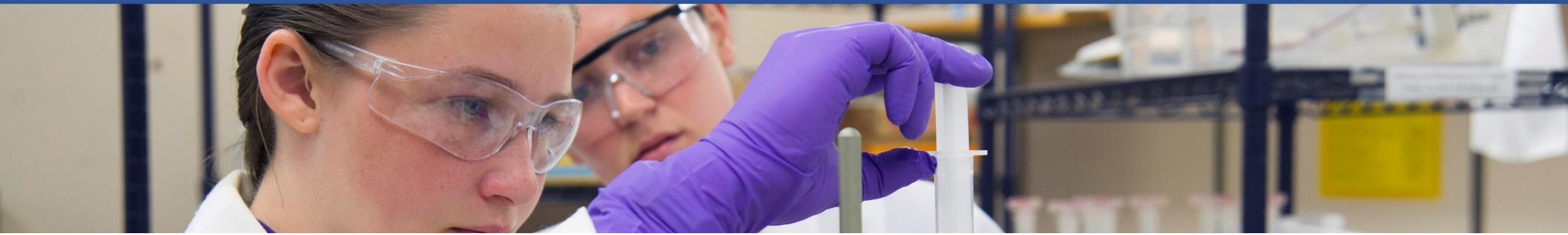
31 MPS Ascend Awards Made in FY22

NSF 23-501 MPS-Ascend (Deadline Jan. 25, 2023)
Anticipating 20-50 awards

Launching Early-Career Academic Pathways in the Mathematical and Physical Sciences (LEAPS-MPS) FY22

- **A discussion of how activities will facilitate development of a subsequent research proposal.**
- **A specific plan on broadening participation activities will increase (1) the participation of scientists from underrepresented groups and (2) the numbers of such individuals that serve as role models for the scientific workforce of the future.**
- **LEAPS Impact Statement (3 pages): (1) impact on institutional research environment, (2) impact on career of PI and department's ability to prepare students to enter STEM careers, including provisions for increasing broader participation.**
- 58 LEAPS- MPS Awards Made

NSF 22-604 LEAPS-MPS (DEADLINE JAN. 26TH, 2023)
ANTICIPATING 32-48 AWARDS



DCL: MPS-High

High School Student Research Assistantships Funding to Broaden Participation in the Mathematical and Physical Sciences (NSF 22-041)

PURPOSE

Broaden participation of high school students who are in groups that have been traditionally underrepresented and under-served in STEM fields.

INTENT

Invite requests which foster interest in the pursuit of studies in the Mathematical and Physical Sciences.

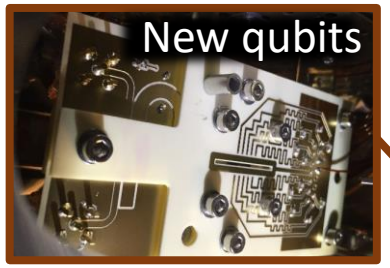
GOAL

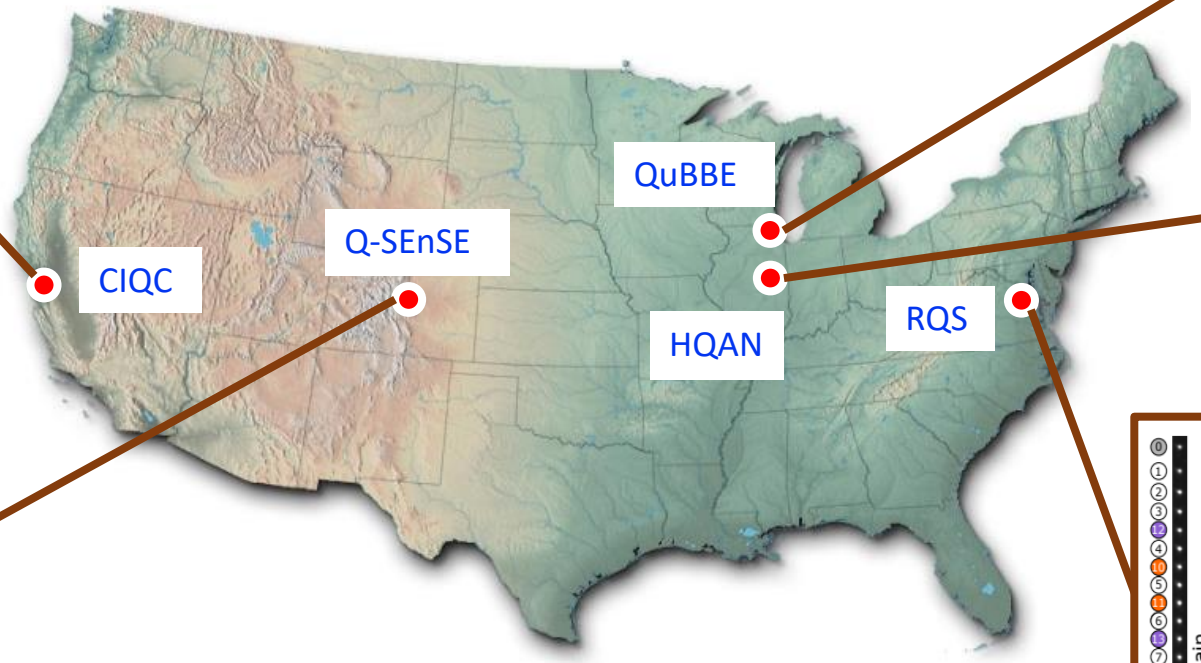
Provide supplemental funding to expand number of research and mentoring opportunities for underrepresented high schoolers.

NSF Quantum Leap Challenge Institutes

5 National Quantum Initiative Centers – NSF Quantum Leap Institutes

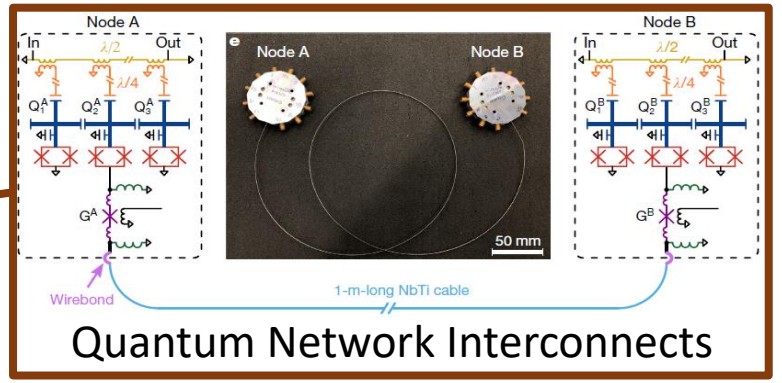
- CIQC: Challenge Institute for Quantum Computation
- Q-SEnSE: Quantum Systems through Entangled Science and Engineering
- HQAN: Hybrid Quantum Architectures and Networks
- QuBBE: Quantum Sensing for Biophysics and Bioengineering
- RQS: Institute for Robust Quantum Simulation

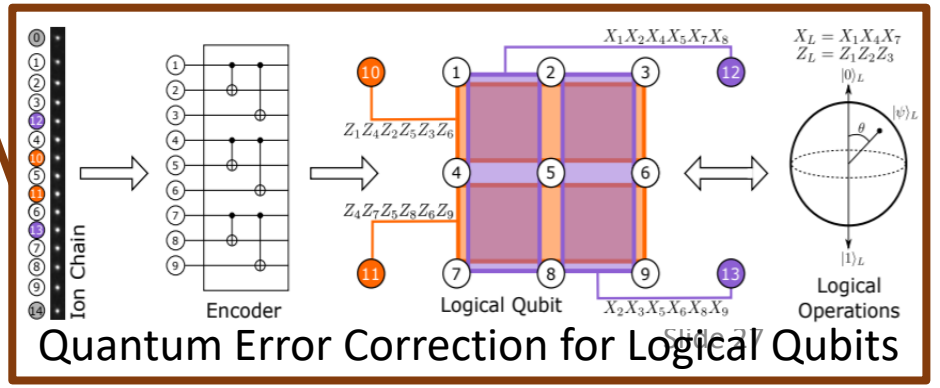




$125M over 5 years

www.nsf.gov/quantum





Quantum Leap Challenge Institutes - Education

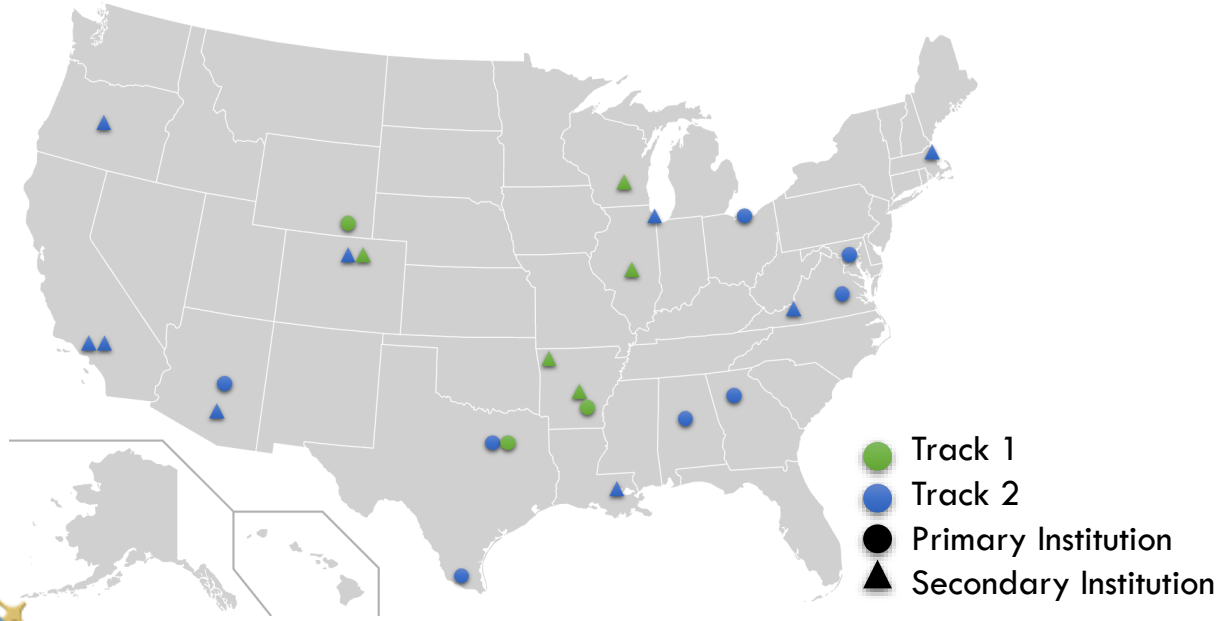
Broad Array of Educational, Workforce Development, and Outreach Activities

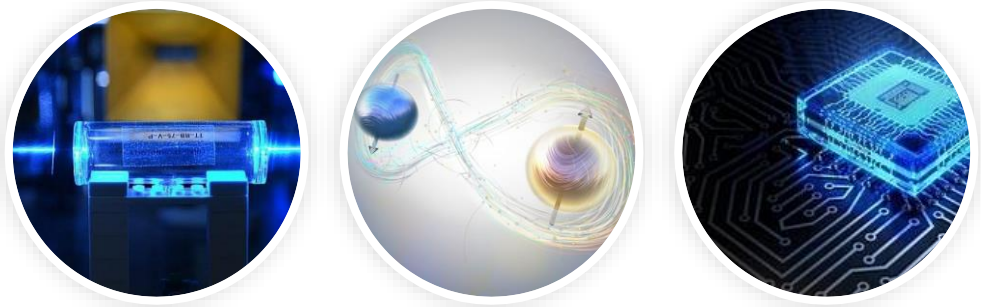
	CIQC	Q-SenSE	HQAN	QuBBE	RQS
K-8 Students			X		X
K-8 Teachers			X		
High School Students			X	X	X
High School Teachers			X	X	X
2-Year College Students		X			
Undergraduate Students	X	X	X	X	X
Master's Students	X	X			
PhD Students	X		X	X	X
Postdoctoral Researchers	X		X	X	X
STEM Professional Development		X	X	X	
Public	X		X		
Minority-Serving Institutions		X	X	X	X
Industry / National Lab Involvement	X	X	X	X	

- CIQC: Challenge Institute for Quantum Computation
- Q-SEnSE: Quantum Systems through Entangled Science and Engineering
- HQAN: Hybrid Quantum Architectures and Networks
- QuBBE: Quantum Sensing for Biophysics and Bioengineering
- RQS: Institute for Robust Quantum Simulation

ExpandQISE

- Build connections between new and existing efforts
- Create critical mass at institutions not yet fully involved in QISE
- Fund Institutions of Higher Education **received <$5M** in federal funding for QISE research as described in Focus areas 1-3, in the most recent five calendar years.





TRACKS

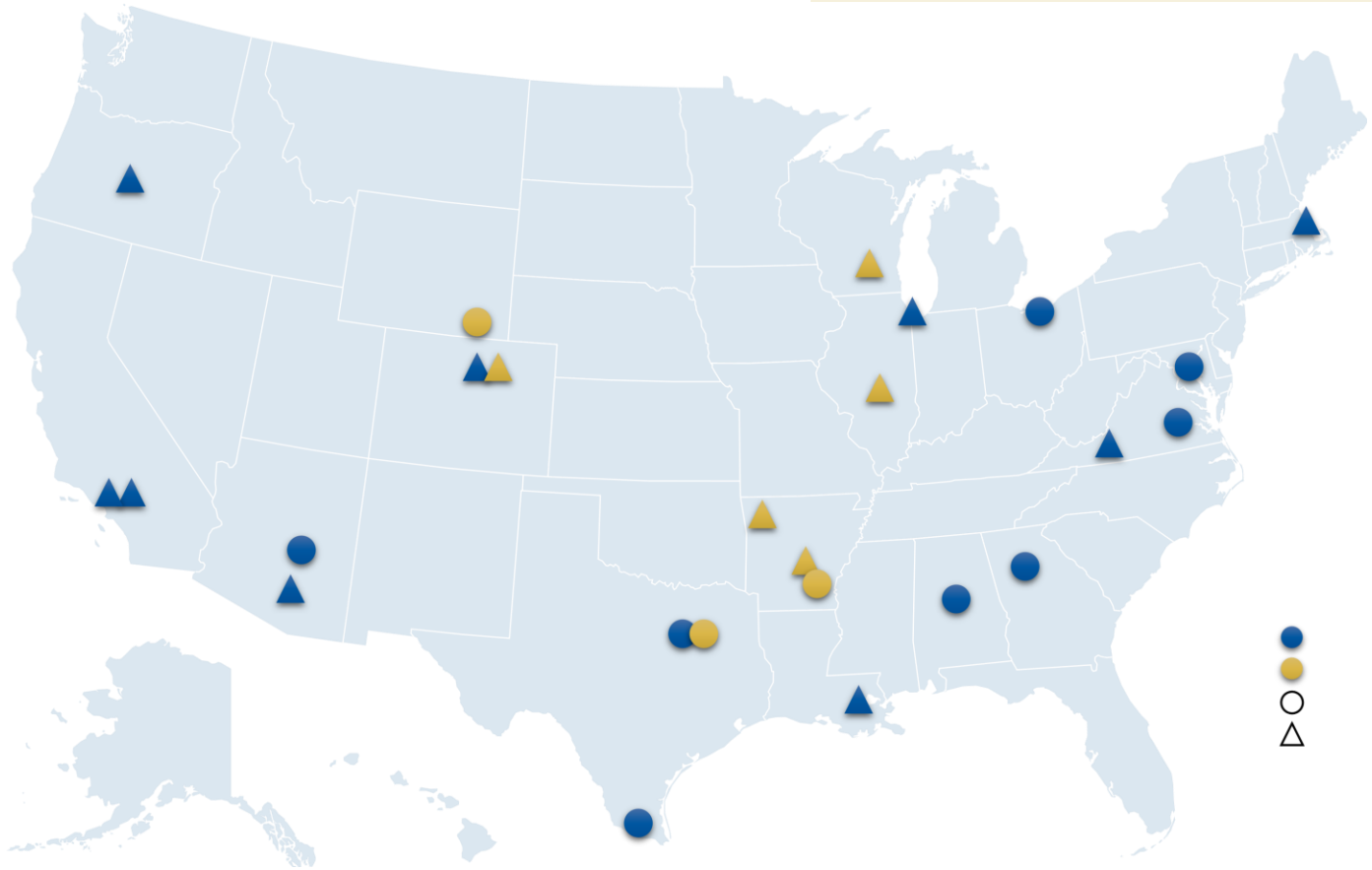
1. Individual PIs paired with an external co-PI. Up to **$800,000** per award for up to **3 yrs**.
2. Small-to-medium teams of 2-5 collaborators, paired with one or more external co-PIs. Up to **$5,000,000** per award for up to **5 yrs**.

FOCUS AREAS

- Quantum Fundamentals
- Quantum Metrology and Control
- Co-Design and Quantum Systems
- **Education and Workforce Development (mandatory for all)**

ExpandQISE

Purpose: Broaden participation of institutions contributing to QISE IHEs that in the last 5 calendar received **not more than $5,000,000** from all federal funding sources for broad QISE research.

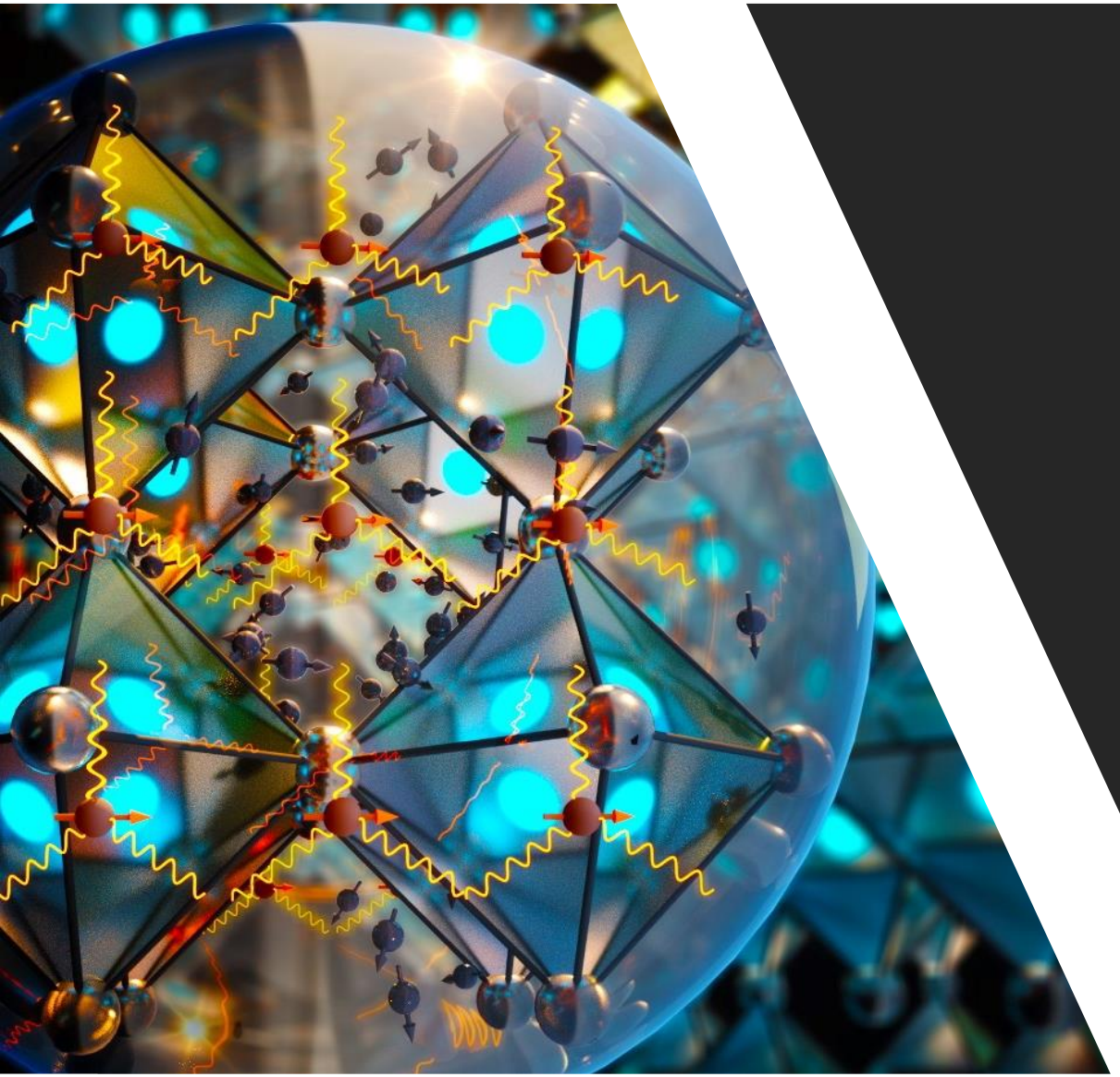


$21,397,566 made to 11 awards in 2022, including:

3 HBCUs, 3 HSIs, 3 EPSCOR states

In All Focus Areas:

- Quantum Fundamentals,
- Quantum Metrology and Control
- Co-Design and Quantum Systems
- Education and Workforce Development



Thank you!
Questions?