Perspectives from NSF's Directorate for Mathematical and Physical Sciences

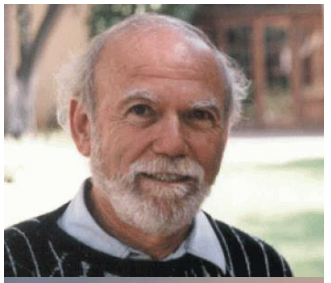
Anne Kinney

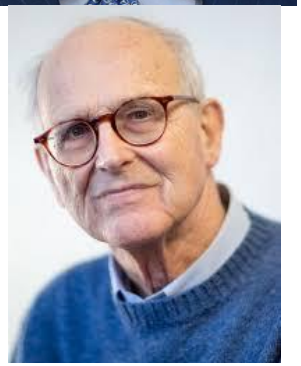
Assistant Director

Mathematical and Physical Sciences

HEPAP Meeting
May 14, 2018

LIGO Pioneers Win 2017 Nobel Prize in Physics for Detecting Gravitational Waves

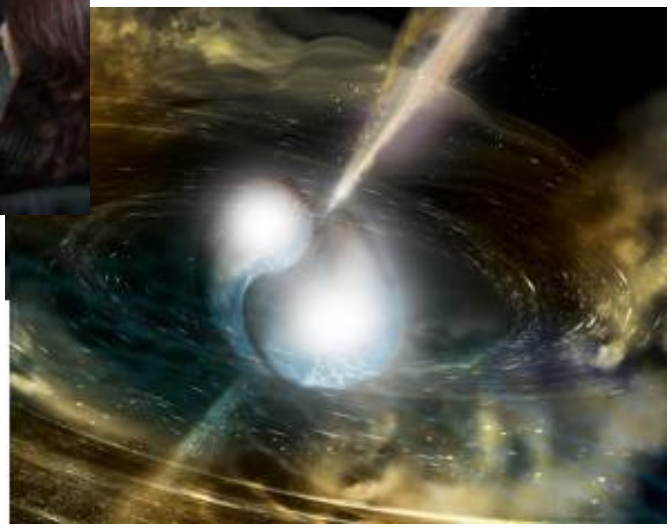




Getting the Word Out

NSF Director France Córdova at press conference in October 2017 at the National Press Club

Detections Continue: In August 2017, LIGO and Virgo make first detection of gravitational waves produced by colliding neutron stars



MPS Transitions

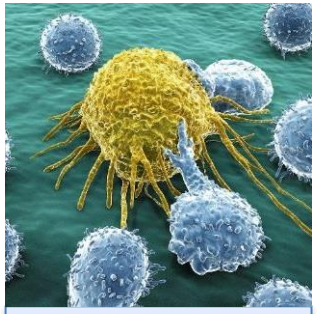
- Anne Kinney began as Assistant Director on January 2, 2018
- Jim Ulvestad, former Acting Assistant Director, is now NSF's Chief Officer for Research Facilities

NSF's Sexual Harassment Reporting Policy

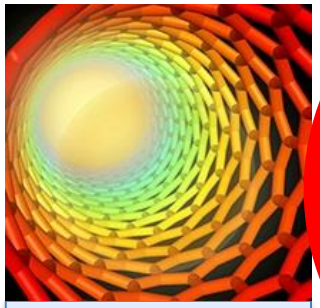
The National Science Foundation (NSF) **does not tolerate sexual harassment, or any kind of harassment, at grantee organizations, field sites, or anywhere NSF-funded science and education are conducted**. NSF is committed to promoting safe, productive research environments for current and future scientists and engineers.

Funded institutions must comply with Title IX of the Education Amendments of 1972 which **prohibits discrimination on the basis of sex in educational programs and activities that receive Federal financial assistance**, including NSF grants and cooperative agreements.

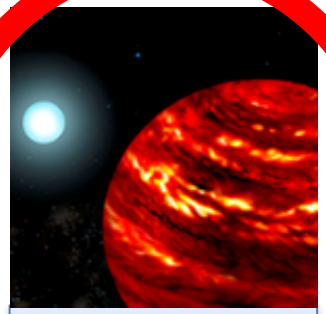
NSF Funds Research and Education across All Fields of Science and Engineering



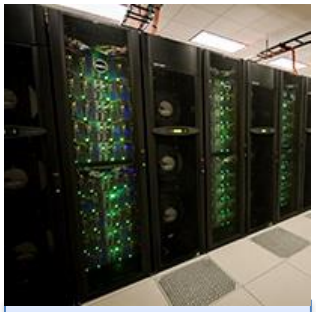
Biological Sciences



Engineering



Mathematical & Physical Sciences



Computer & Information Science & Engineering

Geosciences (including Polar Programs)

Integrative Activities

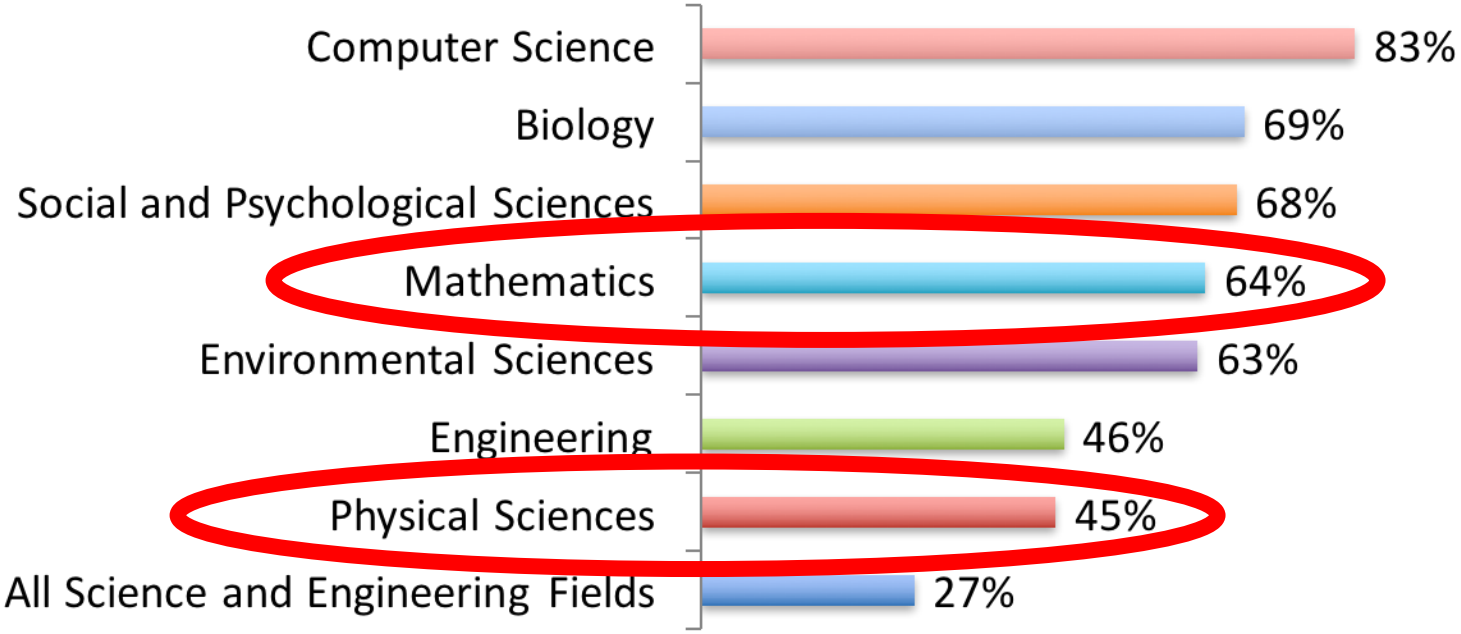
Education & Human Resources

Social, Behavioral & Economic Sciences

International Science & Engineering

NSF Support of Academic Basic Research in Selected Fields

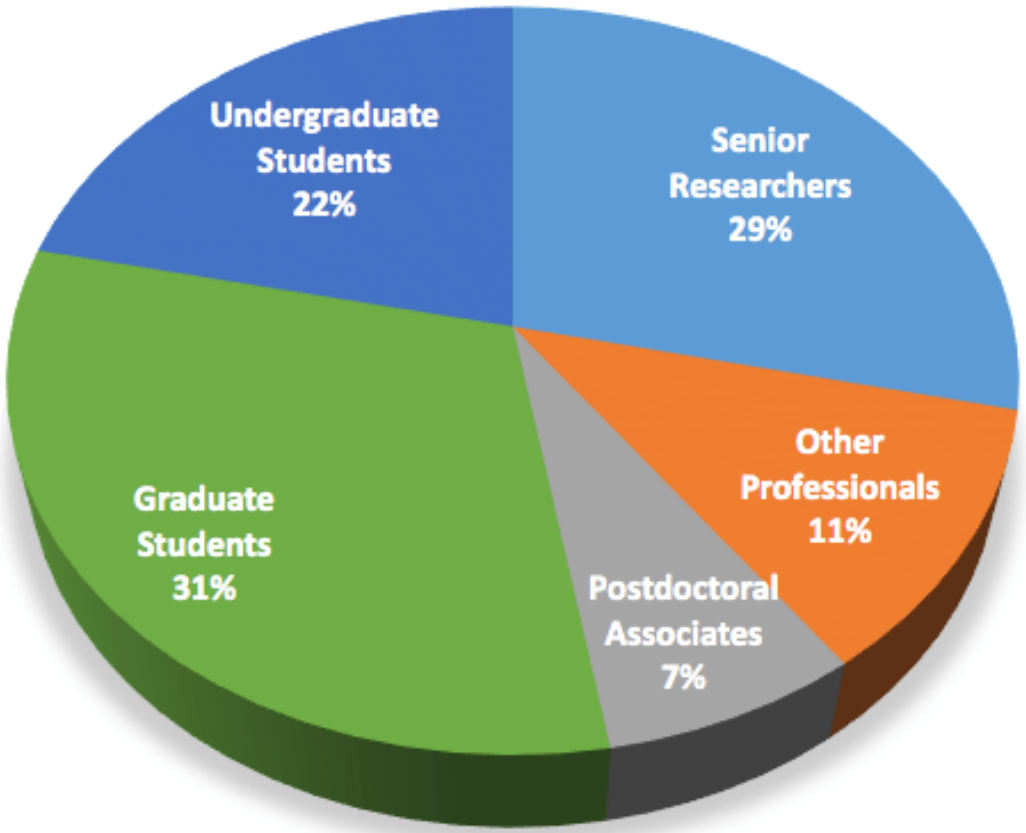
(as a percentage of total federal support)



Note: Biology includes Biological Science and Environmental Science. Biology and Psychological Sciences exclude National Institutes of Health funding from the total amount of federal support.

Source: NSF/National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development

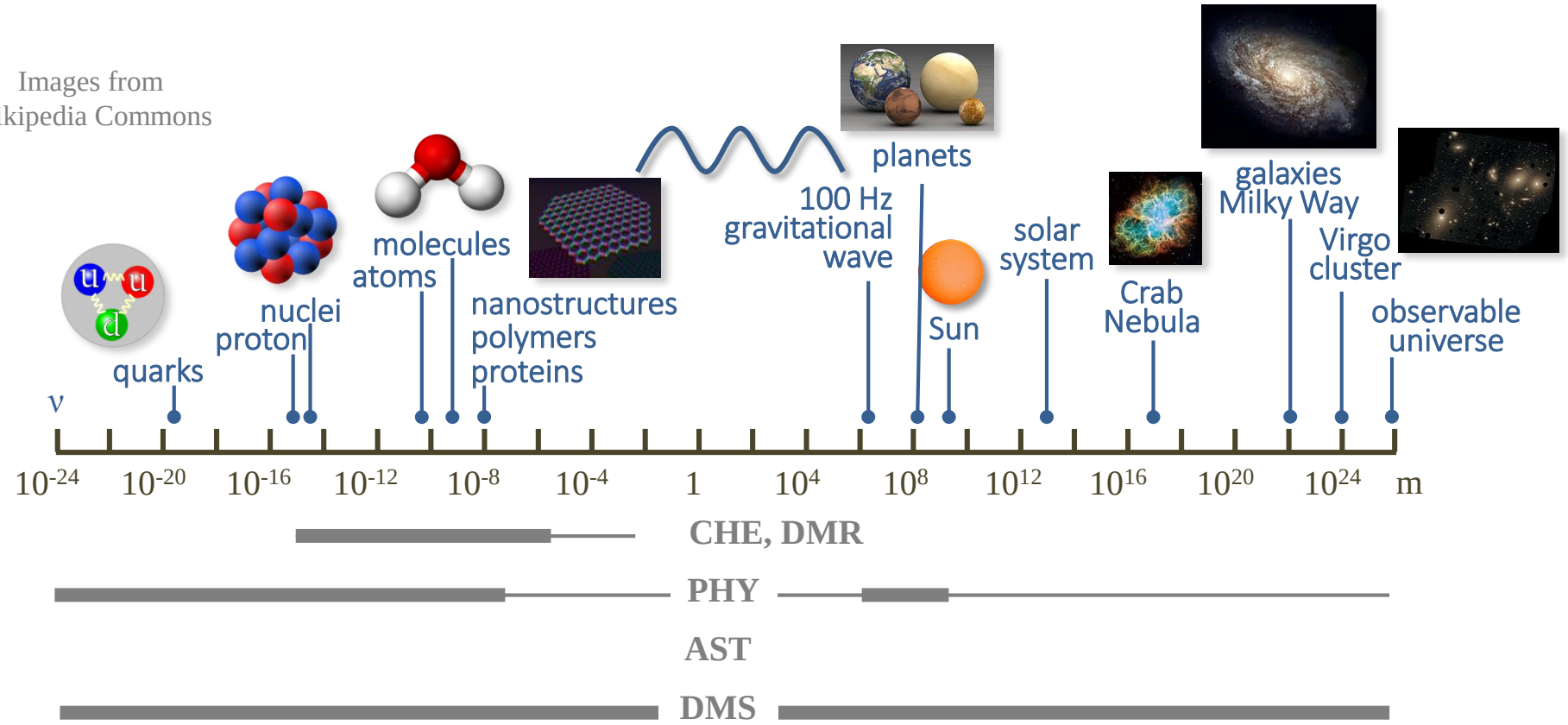
People Do Science: 28,400 People in MPS Activities



FY 2017 numbers

Science at the Scales of the Universe

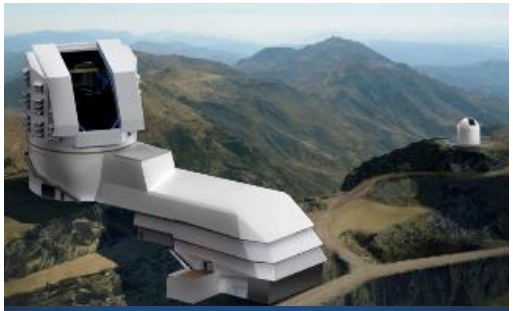
Images from
Wikipedia Commons



Continued Investment in MPS Research Facilities

Sample of 18 Funded Facilities

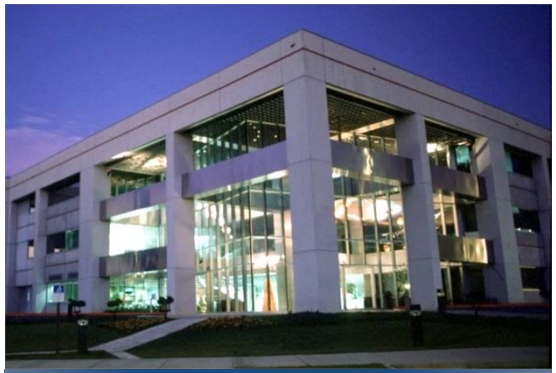

LIGO


LSST

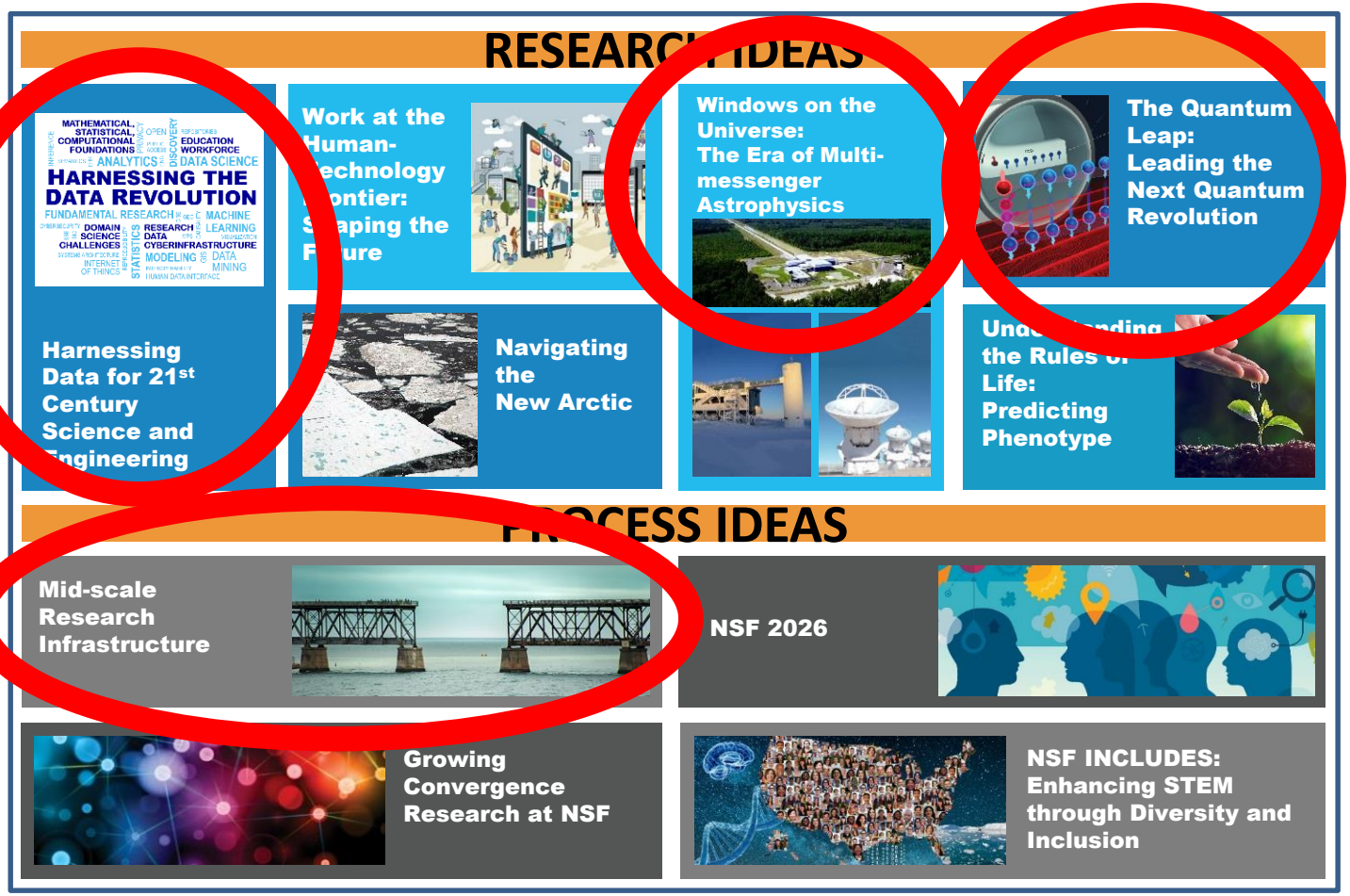

ALMA


Daniel K. Inouye Solar Telescope


NSCL


National High Magnetic Field Laboratory

NSF's 10 Big Ideas



The Quantum Leap

Can we go fully quantum?

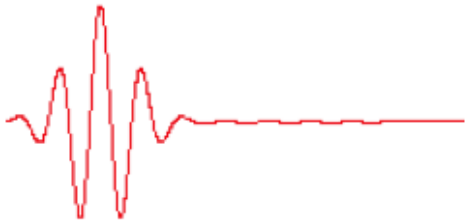
Can we overcome decoherence?

If you are not completely confused by quantum mechanics, you do not understand it. -John Wheeler

I do not like it, and I am sorry I ever had anything to do with it. -Erwin Schrödinger

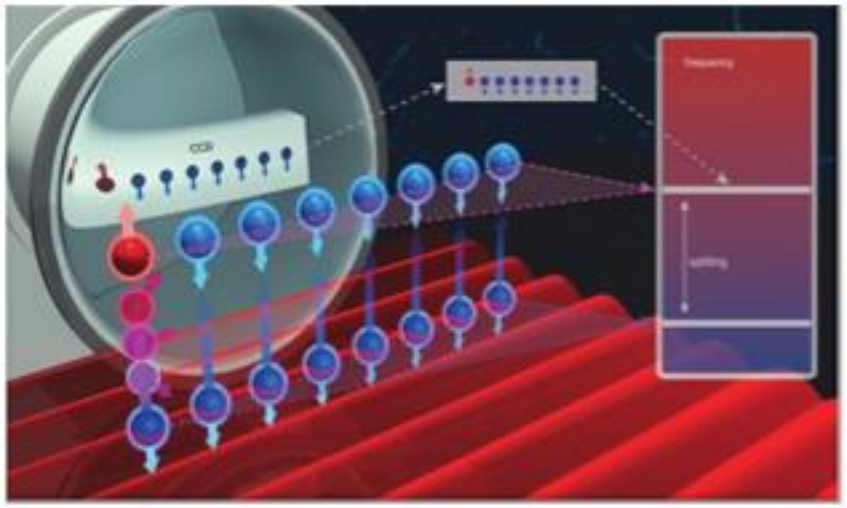
Spooky action at a distance. -Albert Einstein

It is safe to say that nobody understands quantum mechanics. -Richard Feynman



$$i\hbar\frac{\partial}{\partial t}|\Psi(\mathbf{r},t)\rangle = \hat{H}|\Psi(\mathbf{r},t)\rangle$$

Leading the Next Quantum Revolution



Quantum Leap Summer School: Students learned to program the IBM Quantum Experience computer

"A cross-NSF approach to identifying and supporting research that ***answers deep questions about quantum behavior and develops the means of accessing and manipulating quantum systems*** *… couple together experiment, computation, and theory to attack fundamental questions"*

Windows on the Universe:
The Era of Multi-Messenger Astrophysics

The goal of "Windows on the Universe" is to bring ***electromagnetic waves, high-energy particles,*** *and* ***gravitational waves*** *together to study the universe and probe events in real time in a way that was previously impossible.*

Windows on the Universe: Science Questions

- How did the universe begin?
- Why is the universe accelerating?
- What is the unseen matter that constitutes much of the universe?
- How does gravity work under the most extreme conditions?
- What are the properties of the most exotic objects in the universe?
- How do matter and energy evolve to produce the universe around us?

National Science Foundation

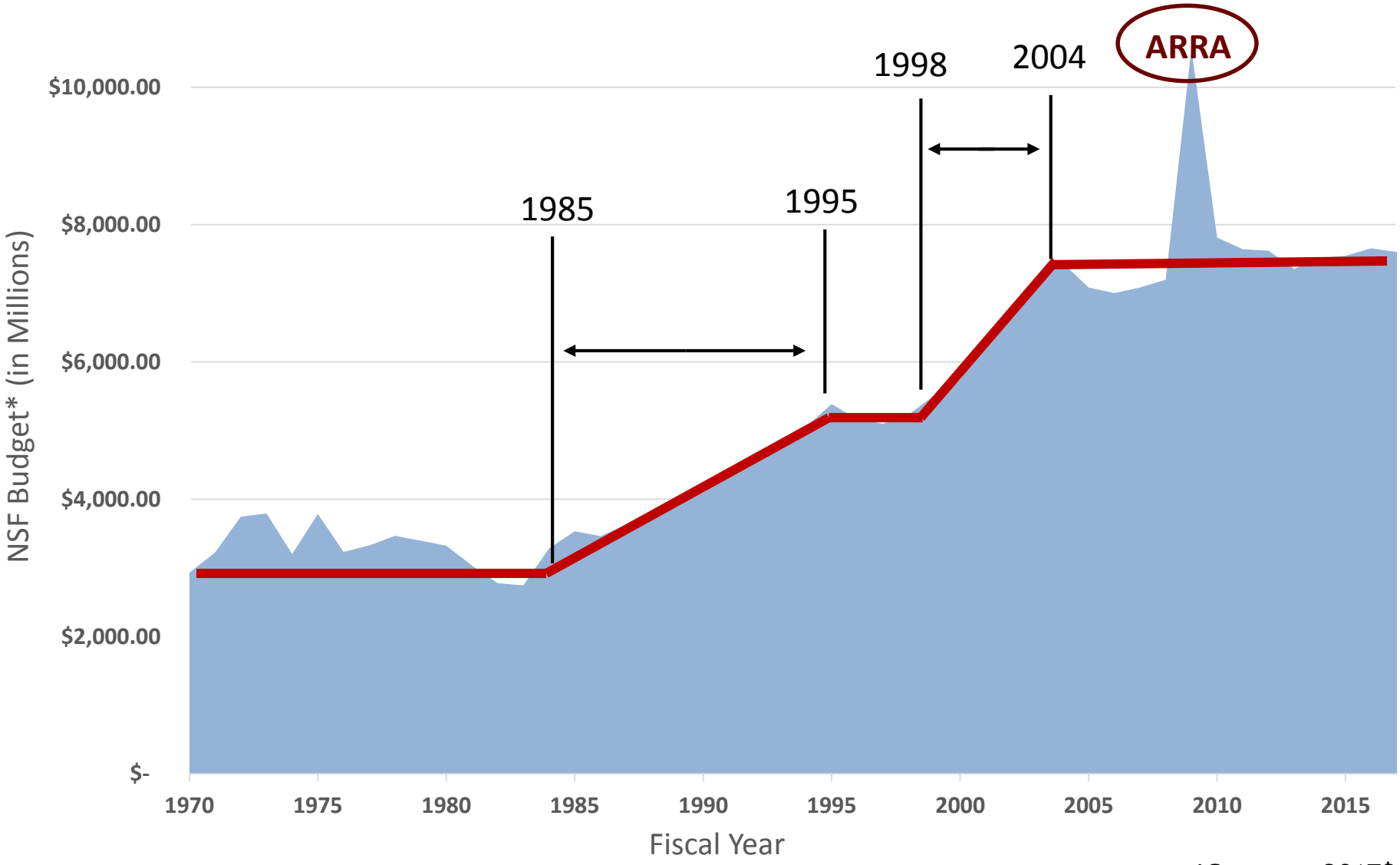
THE NSF 2026 IDEA MACHINE

- **Entrants suggest new "Big Ideas" for future investment**
- **Open to all**
- **Public comments; blue-ribbon panel**
- **Best ideas receive public recognition, cash prizes, and other awards**

Finding "Big Ideas 2.0": Identifying new directions for research

STEP 01	STEP 02	STEP 03	STEP 04	STEP 05	STEP 06	STEP 07	STEP 08	STEP 09	STEP 10
Competition opens/ entries accepted	NSF staff select 30 competitive entries	Videos invited & posted online	Public comments collected; NSF analysis added	Blue-Ribbon Panel picks 12 entries for remote interviews	Blue-Ribbon Panel recommends 6 entries to NSF	NSF staff add analysis/ recom-mendations	NSF Leadership selects 2-4 winning entries	Prizes awarded for winning ideas	New Big Idea funding opportunities developed

NSF Funding History



*Constant 2017$

FY 2019 President's Budget Request
NSF Overall Funding: $7.47 B

Principles Applied to FY 2019 Request

- MPS Budget Request: **$1.345 B** (1.3% below FY 17 level)

- **Emphasis on Big Ideas**
  - MPS stewardship: Quantum Leap & Windows on the Universe
  - Joining: Harnessing the Data Revolution, Mid-Scale & Rules of Life

- **Strategic investments** in:
  - Fundamental research in all MPS disciplines
  - MPS research facilities
  - Next generation researchers and workforce
  - External partnerships
  - Includes absorbing long-term programs into MPS disciplines

FY 2019 President's Budget Request: MPS Overall Funding: $1.345 B

MPS Funding
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over FY 2017 Actual Amount	Percent
Astronomical Sciences (AST)	$252.05	-	$230.69	-$21.36	-8.5%
Chemistry (CHE)	246.24	-	230.58	-15.66	-6.4%
Materials Research (DMR)	314.31	-	295.05	-19.26	-6.1%
Mathematical Sciences (DMS)	233.54	-	218.82	-14.72	-6.3%
Physics (PHY)	281.43	-	266.73	-14.70	-5.2%
Office of Multidisciplinary Activities (OMA)	34.86	-	103.45	68.59	196.8%
Total	**$1,362.43**	**-**	**$1,345.32**	**-$17.11**	**-1.3%**

- OMA delta reflects MPS Coordination of Big Ideas: $60M

Our Mission from the Beginning

"To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes."

Picture Credits

- Slide 2:
  - Black holes: Geoffrey Lovelace, the Simulating eXtreme Spacetimes Collaboration
  - Thorne: http://mashable.com/2014/11/11/interstellar-kip-thornes-book/#wOchnwdw0iq6
  - Barish: Caltech
  - Weiss: Physics Today
- Slide 3:
  - Press conference: NSF
  - Neutron stars: NSF/LIGO/Sonoma State University/A. Simonnet
- Slide 4:
  - Ulvestad: NSF
  - Kinney: NSF/Sandy Schaeffer Photography
- Slide 6: NSF
- Slide 9: Wikipedia Commons
- Slide 10:
  - DKIST: Tom Kekona, K.C. Environmental, Inc
  - LSST: https://www.lsst.org/gallery/lsst-and-calypso
  - LIGO: LIGO Scientific Collaboration
  - ALMA: ALMA
  - NSCL: Gary Westfall, Michigan State, NSCL
  - MagLab: National High Magnetic Field Laboratory
- Slide 11: NSF
- Slide 13:
  - Left: Joint Quantum Institute, University of Maryland
  - Right: Joseph Checkelsky, Materials Research Lab, MIT
- Slide 14:
  - Left: F. Fleming Crim, NSF
  - Center: LIGO Scientific Collaboration
  - Right: F. Fleming Crim, NSF
- Slide 16: NSF
- Slide 21: Nicole R. Fuller/NSF

Backup slides follow

MPS Partnerships

Almost 30 partnerships with other federal agencies, international partners, and private foundations

InSitu: Beamlines for Structural Materials

The Physics of Cancer

DOE/EERE Fuel Cell Technologies

NSF-Simons Research Centers for Mathematics of Complex Biological Systems

Beamlines at the Center for High Resolution Neutron Scattering

MPS Funding Profile

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Estimate
Statistics for Competitive Awards:			
Number of Proposals	8,849	-	9,000
Number of New Awards	2,335	-	2,300
Funding Rate	26%	-	26%
Statistics for Research Grants:			
Number of Research Grant Proposals	7,754	-	8,000
Number of Research Grants	1,853	-	1,800
Funding Rate	24%	-	23%
Median Annualized Award Size	$120,000	-	$120,000
Average Annualized Award Size	$139,127	-	$140,000
Average Award Duration, in years	3.2	-	3.2

- Absorbing long-term, cross-cutting programs into MPS disciplines
- Addition of the Big Ideas (QL and WoU): $60M

MPS Major Investments
(Dollars in Millions)

Area of Investment	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over FY 2017 Actual Amount	Change over FY 2017 Actual Percent
CAREER	$90.32	-	$70.94	-$19.38	-21.5%
INFEWS[1]	8.78	-	-	-8.78	-100.0%
NSF I-Corps™	1.69	-	1.70	0.01	0.6%
NSF Research Traineeship[2]	4.54	-	-	-4.54	-100.0%
SaTC	1.03	-	1.00	-0.03	-2.9%
UtB	25.46	-	13.30	-12.16	-47.8%
BRAIN Initiative	*25.46*	-	*13.30*	*-12.16*	*-47.8%*
NSF's Big Ideas					
NSF INCLUDES[3]	*2.22*	-	-	*-2.22*	*-100.0%*
Quantum Leap	-	-	*30.00*	*30.00*	*N/A*
Windows on the Universe	-	-	*30.00*	*30.00*	*N/A*

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

[1]In FY 2019, INFEWS funding declined due to other priorities.

[2]In FY 2019, NRT funding is provided through CISE and EHR.

[3]In FY 2019, NSF INCLUDES funding is provided through the EHR account.

MPS Funding for Facilities
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over FY 2017 Actual Amount	Change over FY 2017 Actual Percent
Total	**$289.17**	**-**	**$298.37**	**$9.20**	**3.2%**
Arecibo Observatory	3.90	-	3.05	-0.85	-21.8%
Atacama Large Millimeter Array (ALMA)	44.98	-	40.28	-4.70	-10.4%
Cornell High Energy Synchrotron (CHESS)[1]	16.20	-	10.00	-6.20	-38.3%
Daniel K. Inouye Solar Telescope (DKIST)[2]	13.50	-	18.50	5.00	37.0%
Gemini Observatory	24.24	-	21.66	-2.58	-10.6%
IceCube Neutrino Observatory (IceCube)	3.50	-	3.50	-	-
Large Hadron Collider (LHC)[3]	16.00	-	16.00	-	-
Large Synoptic Survey Telescope (LSST)	-	-	0.50	0.50	N/A
Laser Interferometer Gravitational Wave Observatory (LIGO)[4]	41.93	-	45.00	3.07	7.3%
National High-Magnetic Field Laboratory (NHMFL)[5]	23.15	-	35.76	12.61	54.5%
National Nanotechnology Coordinated Infrastructure (NNCI)	2.88	-	2.50	-0.38	-13.2%
National Optical Astronomy Observatories (NOAO)	22.99	-	20.13	-2.86	-12.4%
National Radio Astronomy Observatories (NRAO)	31.67	-	38.85	7.18	22.7%
National Solar Observatory (NSO)[6]	6.00	-	4.00	-2.00	-33.3%
National Superconducting Cyclotron Laboratory (NSCL)	24.00	-	24.00	-	-
Other MPS Facilities:	14.23	-	14.64	0.41	2.9%
Center for High Resolution Neutron Scattering (CHRNS)	2.78	-	2.79	0.01	0.4%
Other Astronomical Facilities (LBO, GBO)	11.45	-	11.85	0.40	3.5%

[1]Includes forward funding of $8.20 million in FY 2017.

[2]Includes $2.0 million per year for cultural mitigation activities as required by the compliance process.

[3]Excludes $5.71 million in FY 2017 and $6.30 million in FY 2019 for High-Lumosity LHC Upgrade planning.

[4]Includes one-time supplemental funding of $2.50 million in FY 2017 for a critical vacuum repair.

[5]CHE and DMR forward funded NHMFL by $1.92 million and $10.73 million respectively in FY 2016. This reduced the FY 2017 total needed by $12.65 million.

[6]Excludes $11.50 million in FY 2017 and $16.50 million in FY 2019 for operations and maintenance support for the DKIST construction project. This funding is included in the DKIST total presented above.