

NSF Report: Division of Physics Particle Physics

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NSF/PHY/EPP

HEPAP Meeting
November 21-22, 2019



Comments on Particle Physics Programs & Funding Opportunities



- Status of EPP/PA/THY Programs
- NSF FY20 Base Program and Related Funding Opportunities
- Research Infrastructure
- New Funding Opportunity – AI Research Institutes



Experimental EPP Program

- Elementary Particle Physics (EPP) Program, which primarily supports particle physics at accelerators and advances in detector development.
- Range of program coverage:
 - Hadron Collider Experiments (ATLAS, CMS, LHCb)
 - Intensity Frontier Experiments (Neutrinos, accelerator-based)
 - Precision Measurements (Belle-II, Rare K, cross disciplinary experiments)

EPP PROGRAM	FY 2015	FY 2016	FY 2017	FY 2018
Funding (in \$k)	\$19,913	\$19,183	\$18,973	\$20,522
Awards issued	19	12	7	18
CAREER awards	1	2	1	1



Program Directors: S. Gonzalez, R. Ruchti

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Experimental Particle Astrophysics Programs

- Underground Physics (PA): This area supports university research that generally locates experiments in low background environments:
 - IceCube Science Program
 - Underground experiments, reactor neutrinos
 - Neutrino mass measurements
 - Searches for the direct detection of Dark Matter
- Cosmic Phenomena (PA): This area supports university research that uses astrophysical sources and particle physics techniques to study fundamental physics:
 - Astrophysical sources of cosmic rays, gamma rays, neutrinos

Particle Astrophysics	FY 2015	FY 2016	FY 2017	FY 2018
Funding (in \$k)	\$19,665	\$18,253	\$18,142	\$18,717
Awards issued	26	16	17	25
CAREER awards	2	3	1	1



Program Directors: J. Whitmore, J. Cottam-Allen

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Theory Program for Particle Physics

- Particle Theory is essential to the success of the entire Particle Physics mission. We support cutting-edge investigator-driven research in two programs:
 - Theoretical High-Energy Physics
 - Theoretical Particle Astrophysics and Cosmology
- Regular interactions with EPP, PA, Gravity Theory, Nuclear Theory, Astronomy, Materials Research, Mathematical Sciences, etc.
- Supporting individuals, RUI's, and special facilities or initiatives (Aspen Center for Physics, TASI summer school, LHC Theory Initiative, etc.)
- Trend: Dramatic increase in number of proposals—factor of two in last 5 years

THEORY PROGRAMS	FY 2015	FY 2016	FY 2017	FY 2018
Funding (in \$k)	\$13,751	\$13,232	\$13,388	\$13,427
Awards issued	28	30	26	32
CAREER awards	2	1	2	1

Program Director: K. Dienes

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Physics Division Proposal Preparation & Submission for FY2020

- All NSF proposals must conform to the NSF Proposal & Award and Procedures Guide:
 - Current submissions must follow PAPPG (NSF19001)
 - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf19001
 - Questions can be referred to cognizant program directors.
- Proposals to other directorates – please refer to the NSF website: www.nsf.gov
- **Intellectual Merit and Broader Impacts** - All proposals to NSF PHY must address these two NSF Merit Criteria.



Physics Solicitation NSF 18-564

Programmatic Information and Deadlines for FY20

https://www.nsf.gov/publications/pub_summ.jsp?org=NSF&ods_key=nsf18564

Experiment: Elementary Particle Physics

Proposal Deadline: Dec 3, 2019

Program Directors: S. Gonzalez, R. Ruchti

Experiment: Particle Astrophysics

Proposal Deadline: Dec 3, 2019

Program Directors: J. Cottam-Allen, J. Whitmore

Theory: Elementary Particle Physics, Particle Astrophysics/Cosmology

Proposal Deadline: Dec 10, 2019

Program Director: K. Dienes



RUI: Research at Undergraduate Institutions

ROA: Research Opportunity Awards

(NSF 14-579) <https://www.nsf.gov/pubs/2014/nsf14579/nsf14579.htm>

- The Research in Undergraduate Institutions (RUI) and Research Opportunity Awards (ROA) funding opportunities support research by faculty members at predominantly undergraduate institutions (PUIs).
 - **RUI proposals** support PUI faculty in research that engages them in their professional field(s), builds capacity for research at their home institution, and supports the integration of research and undergraduate education.
 - **ROA proposals** support PUI faculty research, but these awards typically allow faculty to work as visiting scientists at research-intensive organizations where they collaborate with other NSF-supported investigators.
- **Proposal deadlines are the same as EPP, PA and THY proposals (see previous slide).**
- Contact the EPP, PA and THY program directors for information.



AGEP/GRS Fellowships in the MPS Directorate

- Dear Colleague Letter: NSF16-125, https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf16125
- AGEP Program Solicitation: NSF16-522, https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5474
- **AGEP-GRS provides a mechanism by which a current MPS research awardee is able to support one (additional) Ph.D. student in an ongoing MPS-funded research project. Such supplement requests are possible for Institutions that are current AGEP members or legacy AGEP members.**
- The only allowable expenses in the AGEP-GRS request are: student stipend and fringe benefits, consistent with academic institutional practices, tuition support, and any allowed institutional overhead on these costs.
- Cognizant program directors: Kathleen McCloud (kmcccloud@nsf.gov) and EPP/PA/THY program directors.
- **Supplement requests may be submitted at any time. Interested PIs should contact the cognizant program director before submitting an AGEP request**



Faculty Early Career Development Program (CAREER)

- **CAREER awards are aimed at early-career faculty who seek to integrate research and education.** NSF encourages submission of CAREER proposals from early-career faculty at all CAREER-eligible organizations and especially encourages women, members of underrepresented minority groups, and persons with disabilities to apply.
- Important points to bear in mind....
 - Not intended as a default proposal mechanism for new Assistant Professors
 - Has a specialized purpose which may not be suitable for all PI's--“build a firm foundation for a lifetime of leadership in integrating education and research”
- Solicitation: NSF 17-537
 - <https://www.nsf.gov/pubs/2017/nsf17537/nsf17537.htm>
 - Program Contacts: Kathleen McCloud and EPP/PA/THY program directors
- Proposal Deadline for FY20 is past.
 - Proposals are now currently in merit review.
- **Next deadline will be Friday 17 July 2020 for the FY21 program year.**



Research Infrastructure



MRI - Major Research Instrumentation

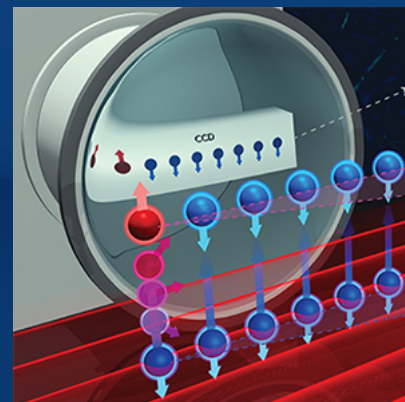
- Increase access to shared scientific and engineering instruments for research and research training
- Improve the quality and expand the scope of research and research training in science and engineering
- Two types of MRI proposals
 - **Track 1: Request for Funds in the range:** $\$100k \leq \text{request} < \$1M$
 - **Track 2: Request for funds in the range:** $\$1M \leq \text{request} \leq \$4M$
 - There is a limit to the number of submissions from a given institution (up to two of Type 1 and only one of Type 2).
- **There is no commitment made by NSF to provide either R&D or operations support for the equipment.**
- **Present solicitation NSF18-513:**
 - https://www.nsf.gov/publications/pub_summ.jsp?WT.z_pims_id=5260&ods_key=nsf18513
 - https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5260
 - **Proposal submission window: January 1-21, 2020**
 - Proposers need to read the solicitation carefully.
 - Program Contacts: kmcccloud@nsf.gov, rphelps@nsf.gov



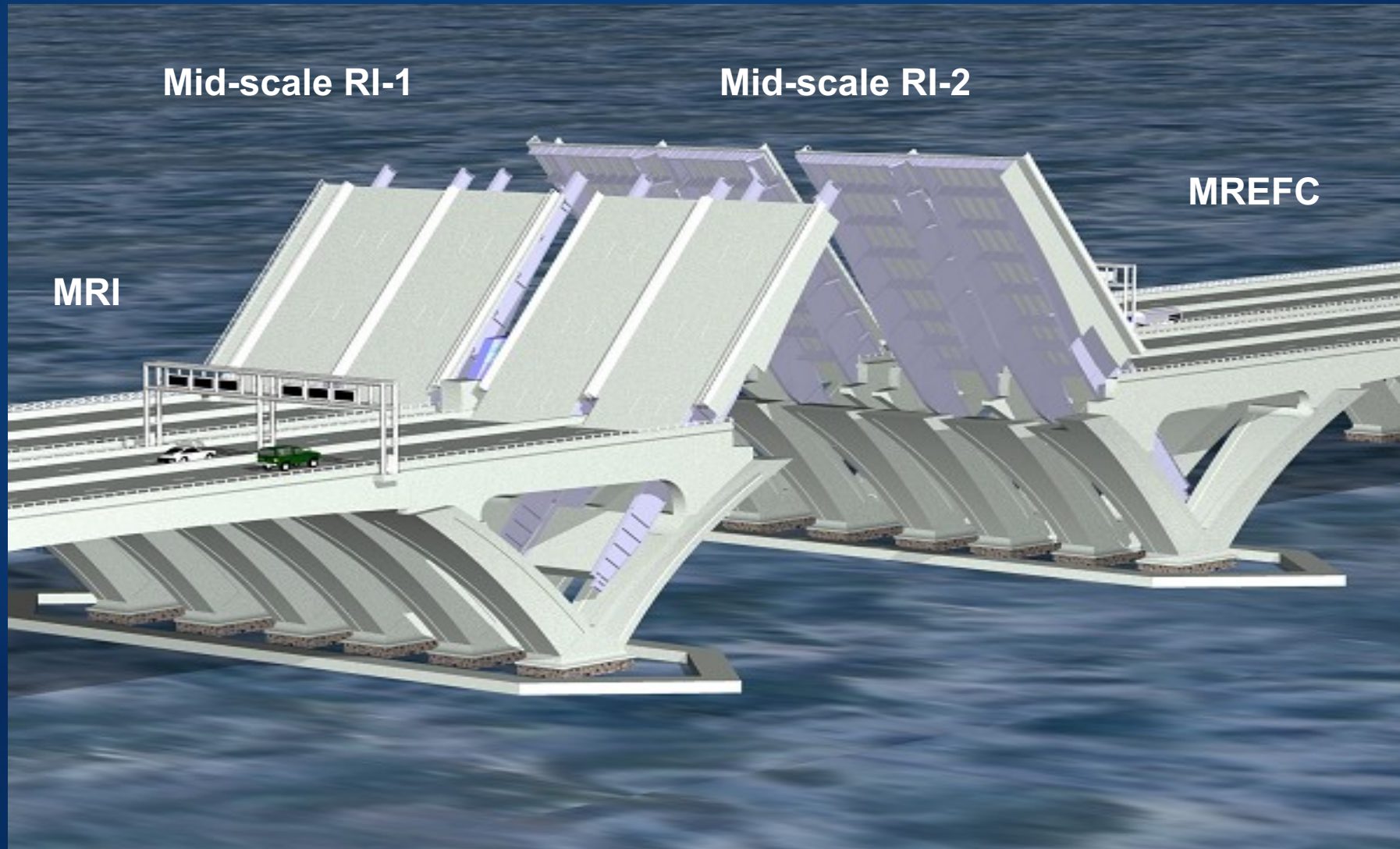
NSF's 10 Big Ideas...

https://www.nsf.gov/news/special_reports/big_ideas/

- Future of Work
- Growing Convergence Research
- Harnessing the Data Revolution
- Mid-scale Research Infrastructure
- Navigating the Arctic
- NSF2026
- NSF INCLUDES
- Quantum Leap
- Understanding the Rules of Life
- Windows on the Universe



Now with Mid-scale Research Infrastructure Opportunities A new span...



Mid-Scale Research Infrastructure



- The overall objective of Mid-Scale RI is to transform scientific and engineering research fields by making available new capabilities, while simultaneously training researchers in the acquisition, implementation, development, design, and/or construction of cutting-edge infrastructure.
- Mid-Scale RI will fund the implementation of experimental research capabilities in the range between MRI and MREFC (Total project costs between \$6 million and \$70 million).
- **There have been two solicitations: one for \$0.6M/6M-\$20M, another for \$20M-\$70M**
- **Solicitations: (MsRI-1) NSF19-537 and (MsRI-2) NSF19-542**
- **FY19 MsRI-1 merit review is completed. Summary information is on the next slide. Solicitation for next round will be in FY21/22.**
- **FY19 MsRI-2 merit review is currently underway. ~50 preproposals were received. Solicitation for the next round will be in FY21/22.**
- Program Contacts: Program Directors



Mid-Scale Research (NSF 19-537): Programmatic Outcome

247 Preproposals Received (\$2.6B)
42 Full Proposals Invited
10 Awards (\$121 million)

Funded Projects FY 2019

1. Next-generation Event Horizon Telescope design
2. Consortium proposal for CMB-S4 design development
3. Compact X-ray Free-Electron Laser project (CXFEL)
4. Next-generation Wyoming King Air atmospheric research aircraft
5. 1.2 GHz NMR spectrometer for National Gateway Ultrahigh Field NMR Center
6. World-class neutron spin echo spectrometer for the nation
7. FABRIC: Adaptive programmable networked Research Infrastructure for Computer science
8. Zettawatt-Equivalent Ultrashort pulse laser System (ZEUS)
9. Light source for advancing national research interests in quantum materials and energy conversion
10. SAGE: A software-defined sensor network

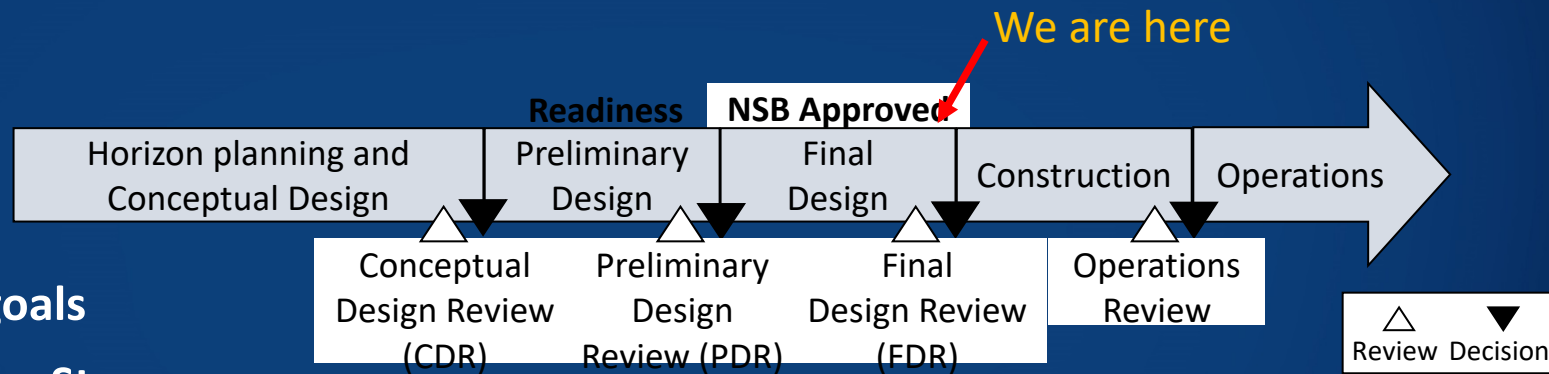
Development
Proposals

Implementation
Proposals



High Luminosity LHC MREFC

- Process underway for the HL-LHC Upgrades for ATLAS and CMS.
- Total request of \$150M, with \$75M for each experiment.



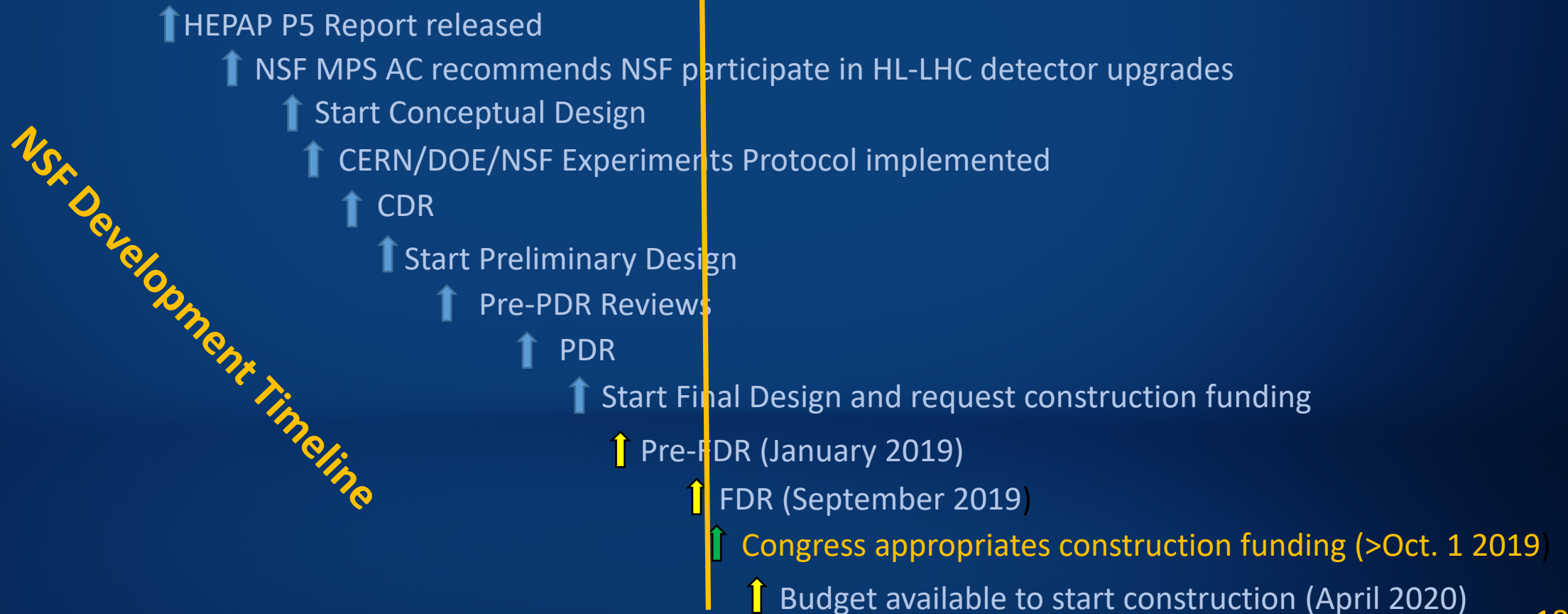
- **Review science goals**
- **Conceptual Design Stage**
 - Requirements, initial estimates of cost (including operations), risk and schedule
- **Preliminary Design Stage**
 - Definition and design of major elements, detailed estimates of cost, risk and schedule, partnerships, siting
- **Final Design Stage**
 - Interconnections and fit-ups of functional elements, refined cost estimates based substantially on vendor quotes, construction team substantially in place

Program Director: M. Coles



MREFC Process for ATLAS and CMS HL-LHC Upgrades

LHC											HL-LHC			
LS12		Run 2			LS2		Run 3			LS3		Run 4		
2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027



Research Infrastructure (Summary)

Project Cost (approx. in \$million)		Funding Source				
From	To	R&D/Planning	Construction	Operations	Scope of Competition	
0	1.0	EPP or PA	EPP or PA	EPP or PA	Program (within EPP or PA)	
0.2	5.7	n/a	MRI (70%); University (30%)	n/a	PHY (<1.0) NSF (>1.0)	
4.0	15	EPP or PA	PHY Research	EPP or PA	PHY	
0.6-6.0	20	EPP or PA or Midscale RI-1	Midscale RI-1	EPP or PA	NSF	
20	70	EPP or PA or Midscale RI-1	Midscale RI-2	EPP or PA	NSF	
70	--	EPP or PA	MREFC	EPP or PA	NSF	

New in FY19 >

New in FY19 >



Harnessing the Data Revolution



- The National Science Foundation's (NSF) *Harnessing the Data Revolution (HDR) Big Idea* is a national-scale activity to enable new modes of data-driven discovery that will allow new fundamental questions to be asked and answered at the frontiers of science and engineering. Through this NSF-wide activity, HDR will generate new knowledge and understanding, and accelerate discovery and innovation. The HDR vision is realized through an interrelated set of efforts in:
 - The foundation of data science;
 - Algorithms and systems for data science;
 - Data-intensive science and engineering;
 - Data cyberinfrastructure; and
 - Education and workforce development.
- Each of these efforts is designed to amplify the intrinsically multidisciplinary nature of the emerging field of data science. The HDR Big Idea will establish theoretical, technical, and ethical frameworks that will be applied to tackle data-intensive problems in science and engineering, contributing to data-driven decision-making that impacts society.

NSF 19-549 (FY19): Planning/Conceptualization Awards.

Upcoming in FY21: Institute Awards.

Program Director: V. Lukin
vlukin@nsf.gov

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Harnessing the Data Revolution FY19

2-year Planning/Conceptualization Awards

- **Collaborative Research: Advancing Science with Accelerated Machine Learning**
 - PI: P. Harris, MIT
 - https://nsf.gov/awardsearch/showAward?AWD_ID=1934700&HistoricalAwards=false
- **Collaborative Research: Science-Aware Computational Methods for Accelerating Data-Intensive Discovery: Astroparticle Physics as a Test Case**
 - PI: C. Tunnell, Rice U
 - https://nsf.gov/awardsearch/showAward?AWD_ID=1940209&HistoricalAwards=false
- **A framework for Data Intensive Discovery in Multimessenger Astrophysics**
 - PI: P. Brady, UW Milwaukee
 - https://nsf.gov/awardsearch/showAward?AWD_ID=1934752&HistoricalAwards=false



New funding opportunity

National Artificial Intelligence (AI) Research Institutes (NSF20-503)

- Artificial Intelligence (AI) has advanced tremendously and today promises personalized healthcare; enhanced national security; improved transportation; and more effective education, to name just a few benefits. Increased computing power, the availability of large datasets and streaming data, and algorithmic advances in machine learning (ML) have made it possible for AI development to create new sectors of the economy and revitalize industries. Continued advancement, enabled by sustained federal investment and channeled toward issues of national importance, holds the potential for further economic impact and quality-of-life improvements.
- **This program solicitation describes two tracks:**
- **Planning track. (Proposal Deadline: January 30, 2020)** Submissions to the **Planning** track are encouraged in any areas of foundational and use-inspired research appropriate to NSF and its partner organizations.
- **Institute tracks. (Proposal Deadline: January 28, 2020)** Submissions to the **Institute** track must have a principal focus in one or more of the following themes
 - Theme 1: Trustworthy AI
 - **Theme 2: Foundations of Machine Learning**
 - Theme 3: AI-Driven Innovation in Agriculture and the Food System
 - Theme 4: AI-Augmented Learning
 - Theme 5: AI for Accelerating Molecular Synthesis and Manufacturing
 - **Theme 6: AI for Discovery in Physics**

Program Director: S. Gonzalez



National Artificial Intelligence (AI) Research Institutes (NSF 20-503)

Theme 6: AI for Discovery in Physics

Example Topics

1. Improving and optimizing operations, real-time event selection, classification, feature extraction, reconstruction, and analysis at dataflow-intensive facilities
2. Accelerating multi-scale, multi-physics simulations for multi-messenger astrophysics, quantum chromodynamics, cosmology, and plasma physics
3. Exploring the very large space of potentially viable string theories ("string landscape")
4. Developing and validating predictive dynamical models of complex, far-from-equilibrium systems
5. Improving the understanding of the physics principles behind genome packing and the resulting genome architecture and dynamics
6. Co-developing improved physical models of brain function and new AI architectures



NSF/PHY: Summary/Comments

- The recent fiscal years have been challenging, but the Physics is compelling.
- NSF Big Ideas offer new opportunities to add value to the field.
 - Midscale Programs (NSF wide and PHY specific)
 - Windows on the Universe
 - AI Institutes
- COV for the Physics Division held 2019. Committee Report is available.
 - https://www.nsf.gov/mps/advisory/PHY_2019_COV_final_report.pdf
- We continue to work on Programmatic Balance
 - Demographic and Geographic
 - Larger Scale and Smaller Scale Programs
- MREFC Process Continues
- **Position Opening:** Program Director (IPA) for the EPP program, to replace R. Ruchti
 - Contact S. Gonzalez if interested: sgonzale@nsf.gov
- We are following with interest the community developments through the Snowmass process
- It should be another exciting year...!

