



NSF Physics Division: Particle Physics Perspective

Saúl González
NSF/PHY

HEPAP Meeting
29 November 2018



Particle Physics @ NSF

- Status of EPP/PA/THY Programs
- NSF Funding Opportunities, FY 2019
 - MRI, MREFC, Midscale
 - MPS AGEP/GRS Supplements, NSF Grad Fellows, CAREER awards
- Research Infrastructure
- Program Highlights





Particle Physics Programs



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. González, R. Ruchti



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. Cottam-Allen, J. Whitmore



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



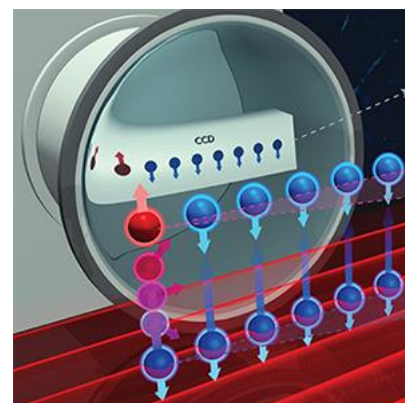
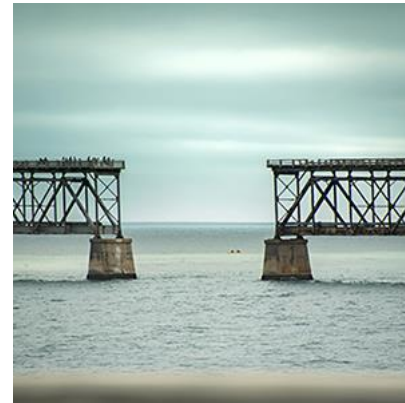
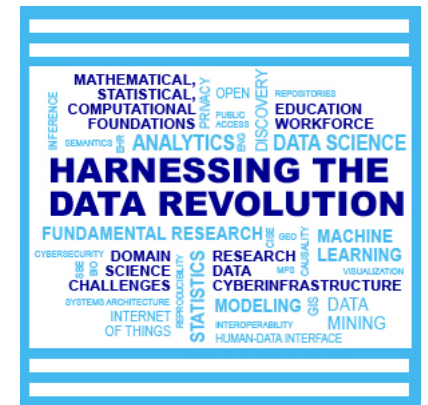
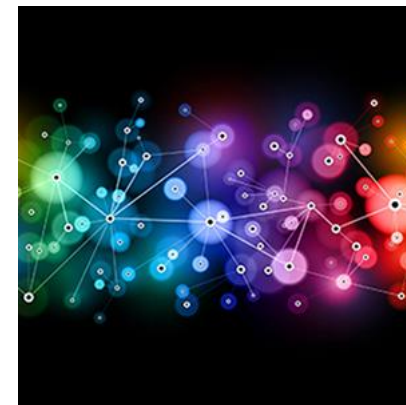
FY 2019 Solicitation / Funding Opportunities



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





Physics Solicitation NSF 18-564

Division of Physics: Investigator-Initiated Research Projects (PHY)

PROGRAM SOLICITATION NSF 18-564

REPLACES DOCUMENT(S): NSF 17-561



National Science Foundation

Directorate for Mathematical & Physical Sciences
Division of Physics

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

November 28, 2018

Fourth Wednesday in November, Annually Thereafter

AMO - Theory and Experiment; Gravitational Physics - Theory and Experiment; LIGO Research Support; Integrative Activities in Physics

December 04, 2018

First Tuesday in December, Annually Thereafter

Nuclear Physics - Theory and Experiment; Elementary Particle Physics - Experiment; Particle Astrophysics - Experiment [Computational Physics: starting December 2019]

December 11, 2018

Second Tuesday in December, Annually Thereafter

Elementary Particle Physics - Theory; Particle Astrophysics and Cosmology – Theory; Physics of Living Systems; Quantum Information Science

Deadlines

Experiment: Elementary Particle Physics

Proposal Deadline: **Dec 4, 2018**

Program Directors: S. Gonzalez, R. Ruchti

Experiment: Particle Astrophysics

Proposal Deadline: **Dec 4, 2018**

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

Theory: Elementary Particle Physics, Particle Astrophysics/Cosmology

Proposal Deadline: **Dec 11, 2018**

Program Director: Keith R. Dienes

Current submissions must follow *Proposal & Award and Procedures Guide* (NSF 18-001)



NSF 18-564: Reviews of Long-Duration Activities

The Physics Division solicitation (NSF 18-564) states:

“NSF anticipates conducting comparative reviews of selected long-duration efforts on an as-needed basis. The intent of the review is primarily a strategic evaluation aimed at setting long-term scientific priorities... A long-duration effort review report will also provide context for reviews of future proposals from individuals and groups who wish to use associated instrumentation.”

This augments the existing NSF review process with reviews that are conducted on long-duration activities. They are intended to establish priorities for continued investments within the context of a individual program and taking into account the program’s resource constraints. As a result of these reviews, NSF support for projects may be phased-out.

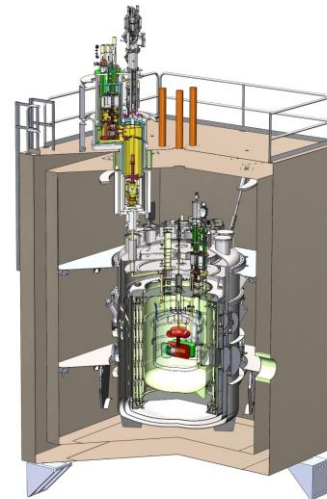


NSF 18-564: Physics Midscale

- It funds design and construction *or* acquisition of instrumentation
 - Competed within Physics
 - Pre-award R&D and post-award O&M costs must be covered by the originating program
- Midscale proposals come through the Division solicitation to individual programs and are competitively reviewed
 - Intellectual merit, broader impacts
 - Additional technical reviews for project feasibility, soundness, readiness
 - Availability of funding / opportunity costs to research program (including O&M impacts)

We currently have 8 Midscale projects in four programs (EPP, NP, Gravitational Physics, and PA)

Invested about \$60M in the last 5 years



nEDM @ ORNL



LHCb@CERN Upstream Tracker upgrade (credit: CERN)



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 a research-excellence prize—instead depends on interplay of research and education
 - Not intended as a default proposal mechanism for new Assistant Professors
 - Has a specialized purpose which may not be suitable for all PI's
- 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 FY19 is past.
 - FY19 Proposals are now currently in merit review.
 - Next deadline will be in 19 July 2019 for the FY20 program year.



NSF Graduate Research Fellowship Program(GRFP)

- Program Solicitation: NSF 18-573
- <https://www.nsf.gov/pubs/2018/nsf18573/nsf18573.htm>
 - The purpose of the GRFP is to help ensure the vitality and diversity of the scientific and engineering workforce of the United States. The program recognizes and supports outstanding graduate students who are pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) or in STEM education.
 - The GRFP provides three years of support for the graduate education of individuals who have demonstrated their potential for significant research achievements in STEM or STEM education.
 - NSF especially encourages women, members of underrepresented minority groups, persons with disabilities, veterans, and undergraduate seniors to apply
- **Next proposal deadline is October 25, 2019.**



AGEP Fellowships in the MPS Directorate

Alliances for Graduate Education and the Professoriate (AGEP)

- Dear Colleague Letter: NSF 16-125, https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf16125
- AGEP Program Solicitation: NSF 16-522, https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5474
- MPS has long promoted efforts to recruit and retain students from underrepresented groups in all areas of the mathematical and physical sciences. AGEP-GRS introduces a new 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. Contact program directors below for information as to whether your institute satisfies this requirement.
- The goal is to create an opportunity to engage additional students in research, to develop a positive learning environment for students, and to improve diversity and retention at the doctoral level within the mathematical and physical sciences.
- 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.
- Supplement requests may be submitted at any time.
- Cognizant program directors: Kathleen McCloud (kmcccloud@nsf.gov) and EPP/PA/THY program directors.



Non-Academic Research Internships for Graduate Students (INTERN)

- Supplemental Funding Opportunity: **NSF 18-102**
 - Provide graduate students with the opportunity to augment their research assistantships with non-academic research internship activities and training opportunities that will complement their academic research training;
 - Allow graduate students to pursue new activities aimed at acquiring professional development experience that will enhance their preparation for multiple career pathways after graduation; and
 - Encourage the participation of graduate students from groups that have traditionally been underrepresented and underserved in the STEM enterprise
- Supports students at for-profit industry laboratories or industry research and development groups; Start-ups, Government agencies (all levels), National Laboratories, Policy think-tanks, and Non-profit organizations



Research Infrastructure

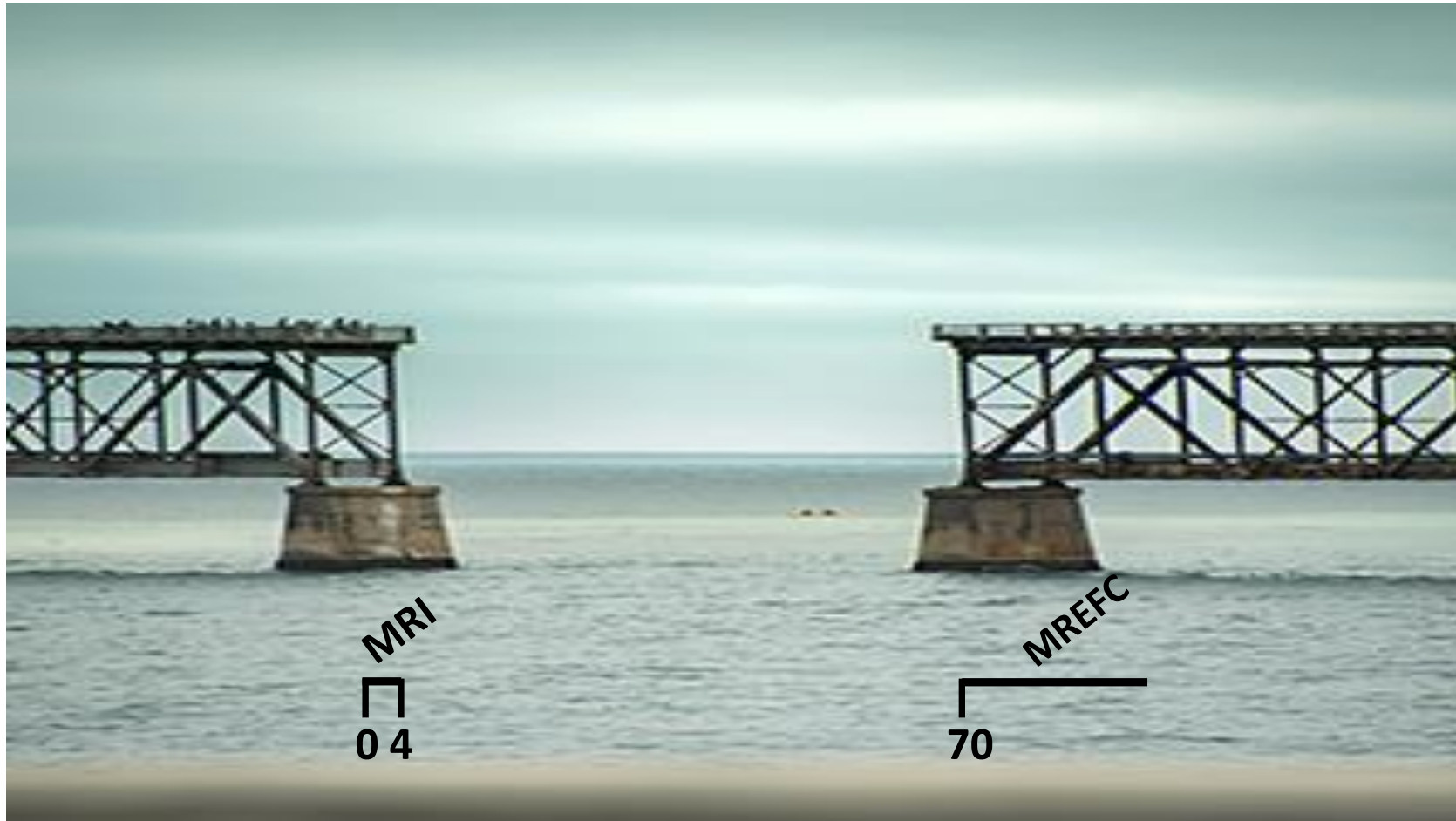


MRI - Major Research Instrumentation

- 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).
- **Present solicitation NSF 18-513:**
 - 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 Window: January 1-22, 2019**
 - Proposers need to read the solicitation carefully.
 - Program Contacts: kmcccloud@nsf.gov, rphelps@nsf.gov

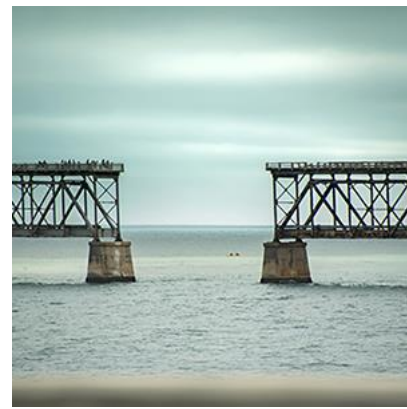


Prior to Mid-scale Research Infrastructure Opportunities





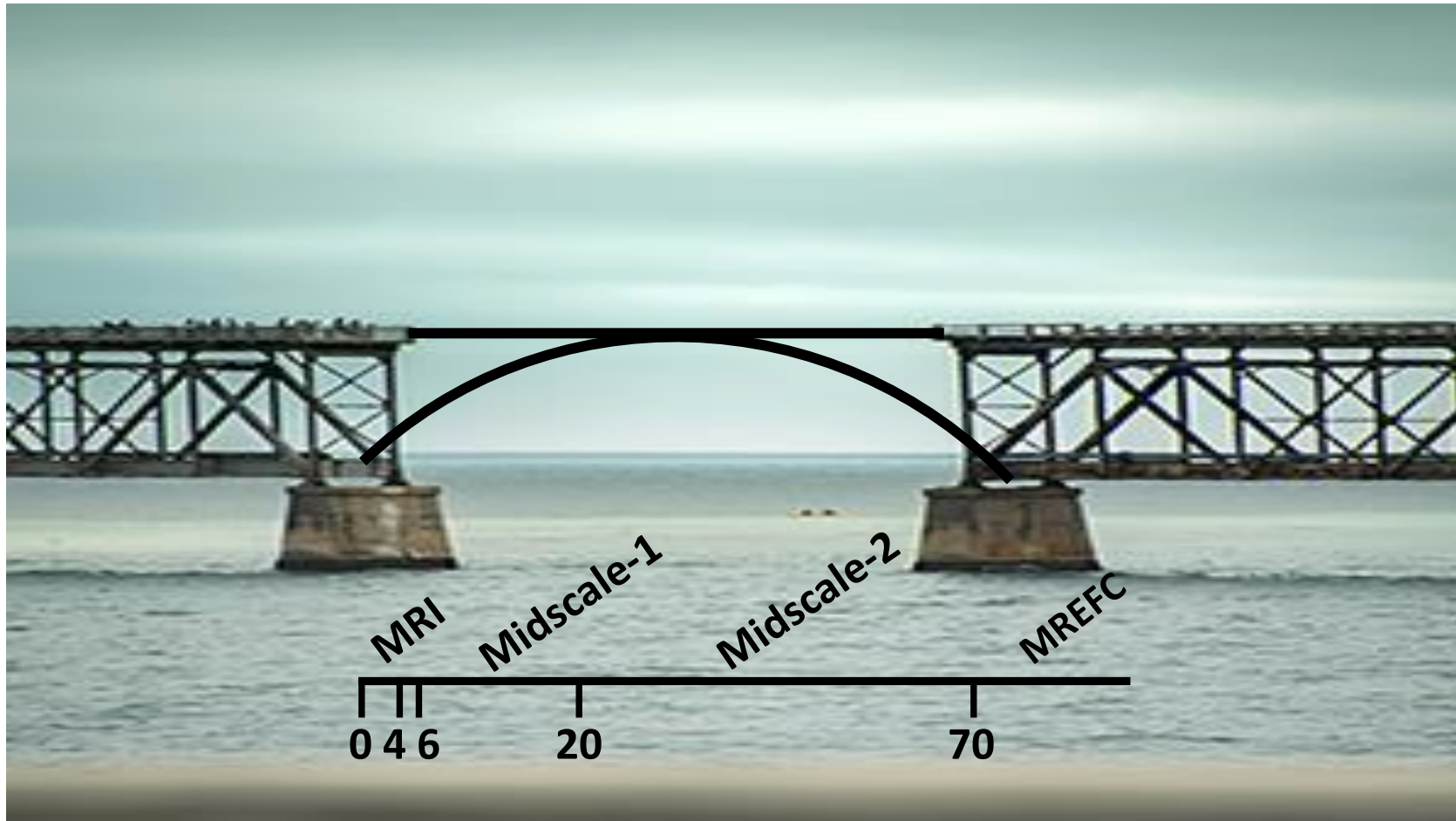
Mid-Scale Research Infrastructure



- 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 will be two solicitations: one for \$6M-\$20M, another for \$20M-\$70M
- 2017 *Request For Information* identified up to \$10B in midscale projects
- Program Contacts: Program Directors

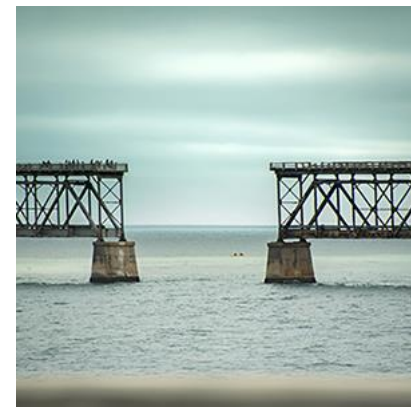


Now with Mid-scale Research Infrastructure Opportunities A new span...





Mid-Scale Research Infrastructure



Mid-scale Research Infrastructure-1 (Mid-scale RI-1)

PROGRAM SOLICITATION NSF 19-537



National Science Foundation

Preliminary Proposal Due Date(s) (*required*) (due by 5 p.m. submitter's local time):

February 19, 2019



Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

May 20, 2019



By invitation only.

Two tracks:
(1) Design (\$600k-\$20M)
(2) Implementation (\$6M-\$20M)

\$20M+ → coming soon



Research Infrastructure (summary)

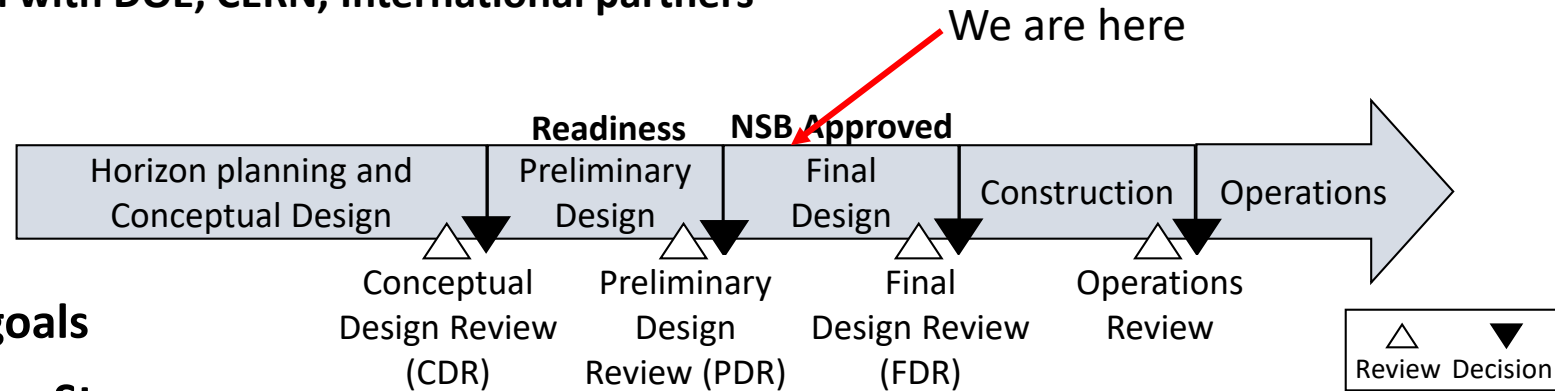
Project Cost (~\$million)		Funding Source				Scope of Competition	Funding Opportunity
From	To	R&D/Planning	Construction	Operations			
0	1.0	EPP or PA	EPP or PA	EPP or PA	EPP or PA	NSF 18-564	
0.2	5.7	n/a	MRI (70%); University (30%)	n/a	PHY (<1.0) NSF (>1.0)	NSF 18-513	
4.0	15	EPP or PA	PHY Midscale	EPP or PA	PHY	NSF 18-564	
0.6-6.0	20	Midscale RI-1	Midscale RI-1	EPP or PA	NSF	NSF 18-537	
20	70	TBD	TBD	TBD	TBD	TBD (soon)	
70	--	EPP or PA	MREFC	EPP or PA	NSF	N/A	

New! {



High Luminosity LHC MREFC

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

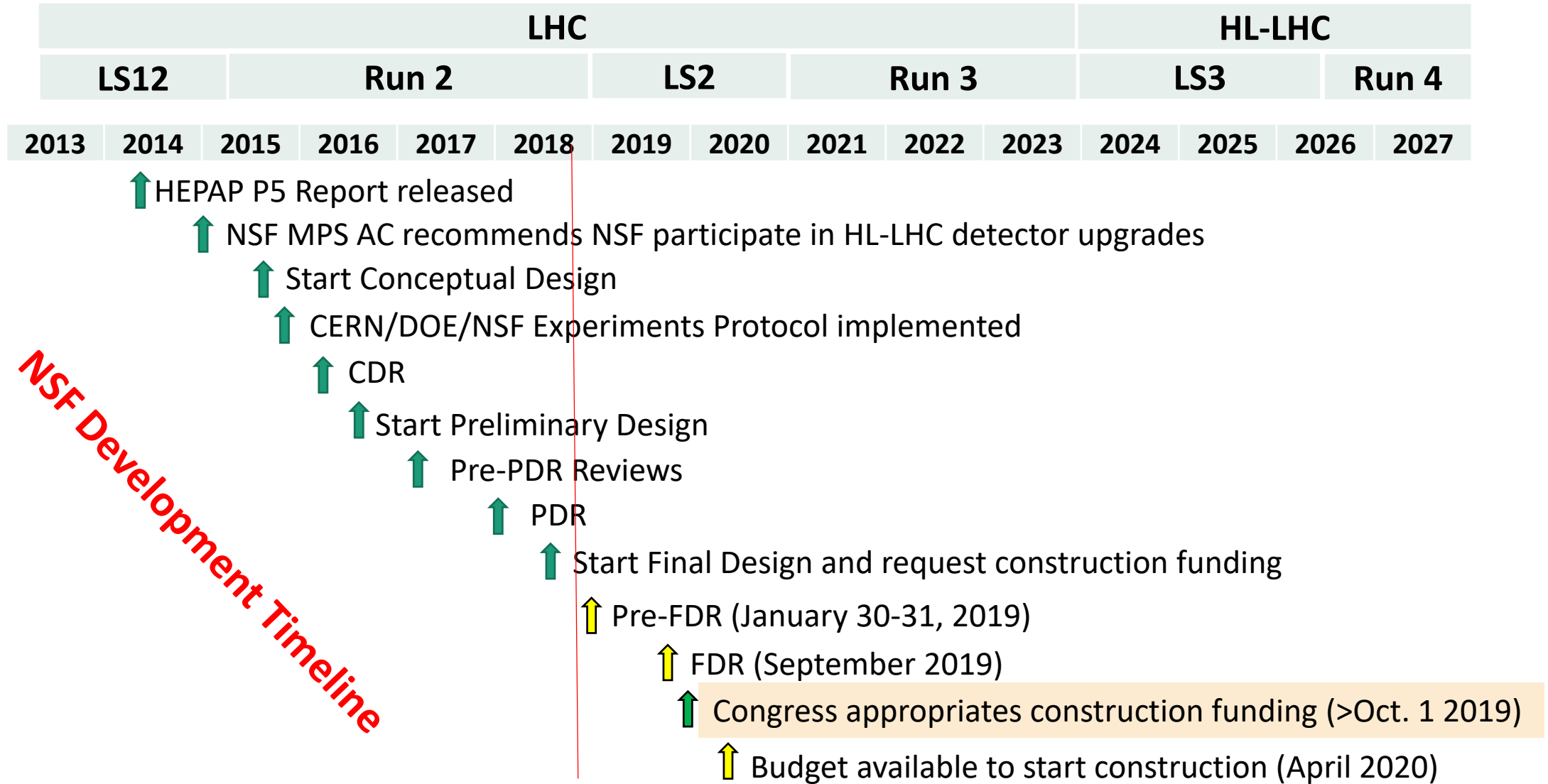


- **Review science goals**
- **Conceptual Design Stage**
 - Requirements, initial estimates of cost (including operations), risk and schedule
- **Preliminary Design Stage**
 - Definition and design of major elements, detailed estimates of cost, risk and schedule, partnerships, siting
- **Final Design 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 Phase 2 Upgrades





A Few Highlights

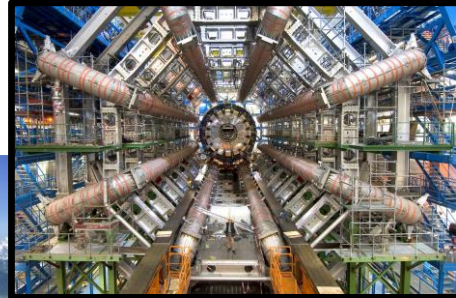


IRIS-HEP: Institute for Research and Innovation in Software for High-Energy Physics

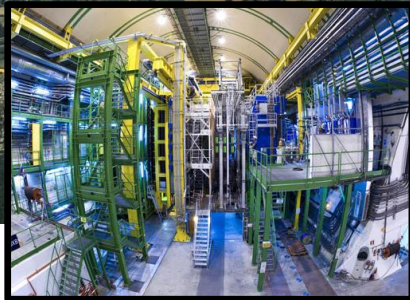
CMS



ATLAS



LHCb



High-Luminosity Large Hadron Collider (HL-LHC) upgrade :

- order of magnitude increase in data analysis complexity
- order of magnitude increase in store and compute cycles
- solutions needed by : HL-LHC : 2025/2026

- Convergence : HPC/HTC/Data
- Many stakeholders: Collaborations, Agencies, CERN...

IRIS-HEP mission :

- Intellectual hub for community-wide software R&D
- Transform the operational services and computing model
- Address engagement, workforce, education/training

Note: Complements the NSF MREFC for HL-LHC upgrade

\$5M/year—PHY co-funding with CISE/OAC

Program Director: B. Mihaila

Award 1836650; PI: P. Elmer (Princeton)

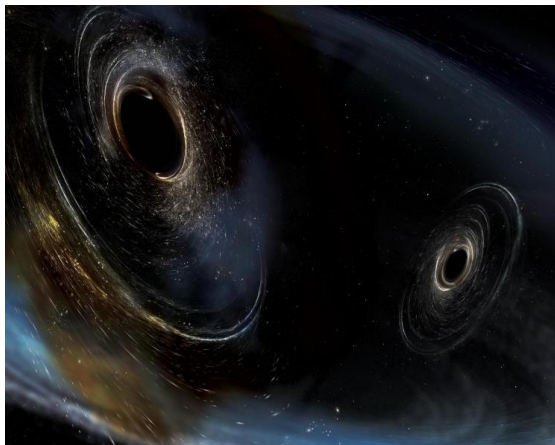


Scalable Cyberinfrastructure for Multi-Messenger Astrophysics

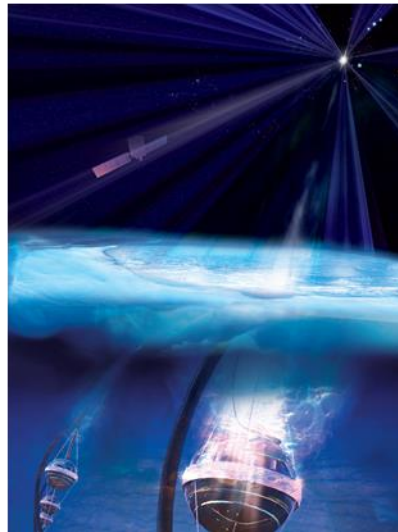
GW170817



GW150914



IceCube-170922A



MMA Challenge:

- Detection, Source Identification, Observation, Simulation
- Time lost is Science Lost!

Community building:

- [CiMMA Workshop](#), UMD, May 2018
- White Paper : MMA - HDR, [arXiv:1807.04780](#) [astro-ph]
- Community Planning for Scalable CiMMA
- Convergence: astrophysics, computer science, mathematics, and software engineering
- Stakeholders: NSF, NASA, DOE, +International, collaborations
- Solutions needed by:
 - LSST : 2023
 - Advanced (A) LIGO : 2020
 - A+ LIGO : 2022/2023
 - IceCube Gen2-Phase 1 : 2023
 - +Many others...



New Award: “IceCube Gen2 Phase 1: an IceCube extension for precision neutrino physics and astrophysics”



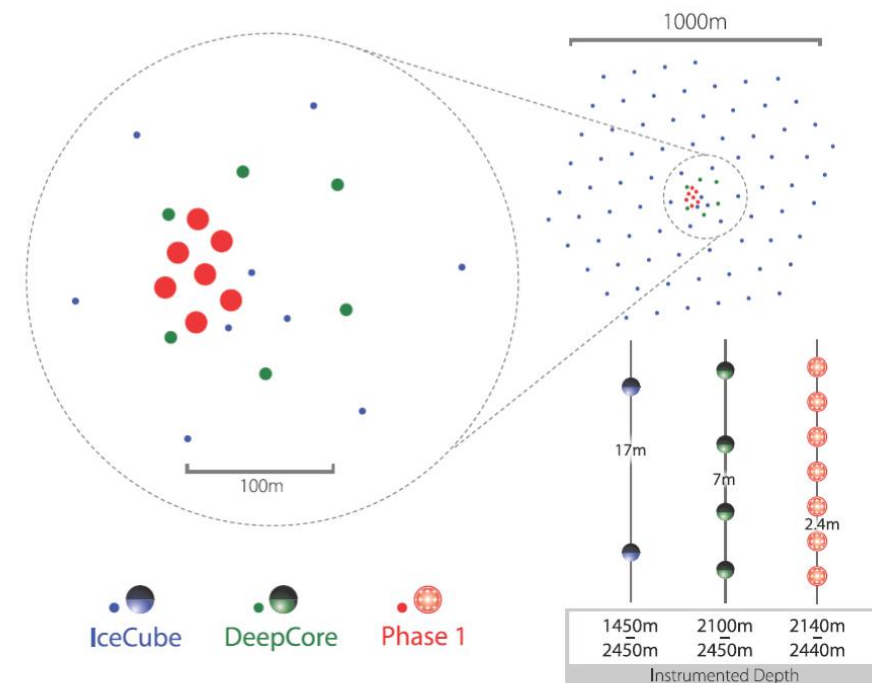
Deploying an additional 7 strings (each 100+ multi-PMT DOMs) in the center of the IceCube Deep Core array

Main Science Objective: **Multi Messenger Astrophysics: A new Window on the PeV Universe**

It will enhance scientific capabilities of IceCube at both high (> 10 TeV) and low (< 100 GeV) energy

Science Topics:

- Tau neutrino appearance and tests of SM and the unitarity of the PMNS matrix
- Neutrino oscillations, sterile neutrinos, and indirect dark matter (lower threshold to $O(5)$ GeV)
- Improving IceCube’s capabilities for neutrino astronomy by inserting additional calibration devices (apply to 10 years of data):
 - Better tracking angular resolution (\sim factor of 4)
 - Tau neutrino appearance on cosmic baselines
 - Neutrino astronomy with high-energy cascades





Additional Program Highlights

EPP:

ATLAS and CMS pass PDR phase of the MREFC process for the HL LHC Upgrade.

Physics: ttH ... VH->bb ... Higgs couplings to Gen3 ...

LHCb has made strong progress on its Upgrade and U.S. groups have leadership on the UT.

Physics: CP studies ... Rare decays ... B -> μμ Exotic Hadrons ...

New results from ACME (Adv. Cold Mol. Electron Electric Dipole Moment Search) – revealing spherical shape to the electron’s charge. Cross disciplinary and complementary to LHC experiments. Co-funding with AMO, (Program Directors: A. Cronin, J. Gillaspay)

Planning grant awarded for DUNE/APA Engineering and Fabrication Planning.

APS W. K. H. Panofsky Prize for 2019 – awarded to Prof. Sheldon Stone (Syracuse).

PA:

IceCube Phase 1 Upgrade awarded. Midscale Award under Windows on the Universe. Multi Messenger Astrophysics.

Astro2020 Decadal underway

THY:

TASI Summer School (now exclusively supported by NSF) renewed for next 5 years

APS J. J. Sakurai Prize for 2019 – awarded to Profs. Lisa Randall (Harvard) and Raman Sundrum (Maryland).

ALL:

Committee of Visitors!