



# NSF Physics Division: Particle Physics Perspective

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NSF/PHY

USLUA Meeting

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# NSF Physics Particle Physics

- EPP/PA/THY Base Programs
- FY18 Merit Review Synopsis
- Agency Program Planning
  - NSF's 10 Big Ideas
- NSF Funding Mechanisms, FY19
  - MRI, MREFC, Midscale
  - MPS AGEP/GRS Supplements, NSF Grad Fellows, Early CAREER
- Some Program Highlights





# Experimental EPP Program

- Elementary Particle Physics (EPP) Program, which 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 expts)

- Solicitation: NSF18-564

<https://www.nsf.gov/pubs/2018/nsf18564/nsf18564.htm>

[https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505433&org=PHY](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505433&org=PHY)

Proposal Deadline: Dec 4, 2018

Program Directors: S. Gonzalez, R. Ruchti



# Experimental PA Programs

- Particle Astrophysics (PA) Program, which supports non-accelerator experiments.
- 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
- 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
- Solicitation: NSF18-564  
<https://www.nsf.gov/pubs/2018/nsf18564/nsf18564.htm>  
[https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505442&org=PHY](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505442&org=PHY)  
Proposal Deadline: Dec 4, 2018  
Program Directors: J. Cottam-Allen, J. Whitmore



# FY18 Synopsis of the Merit Reviews (EPP/PA)

Physics Program Awards	Base Program Proposals	Career Proposals	MRI Proposals	Mid-scale or Mid-scale Planning	Advanced Computing	MREFC Status	AGEP/GRS Supplement Requests
<b>EPP</b>	<b>18</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>Passed PDR</b>	<b>3</b>
<b>PA Cosmic Phenomena</b>	<b>8</b>	<b>1</b>	<b>1</b>				
<b>PA Underground</b>	<b>16</b>	<b>0</b>	<b>1</b>	<b>1</b>			



# Theory Program for Particle Physics

- Vibrant, intellectually diverse Theory programs are vital to the success of the entire Particle Physics mission. We capitalize on the talents and creativity of the Theory community by supporting the best, most cutting-edge investigator-driven research in two programs:
  - **Theoretical High-Energy Physics**
  - **Theoretical Particle Astrophysics and Cosmology**
- These two theory programs interface regularly with many other programs at NSF (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.)
- Solicitation: NSF18-564
  - <https://www.nsf.gov/pubs/2018/nsf18564/nsf18564.htm>
  - [https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505438&org=PHY](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505438&org=PHY)
  - [https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505444&org=PHY](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505444&org=PHY)
  - Proposal Deadline: Dec 11, 2018**
  - Program Director: Keith R. Dienes**



# Theory Trends

- FY15-18: absorption of string-theoretic portion of former Mathematical Physics program. Now nearly complete.
- FY16: NSF renews Aspen Center for Physics grant for next five years, expands support and scope into Atomic Physics
- Numbers of proposals received is currently twice what it was only 3-4 years ago.
- Increasing numbers of RUI proposals, particularly in FY17 and FY18.
- One major challenge affecting Theory is the entrance of significant non-traditional (private philanthropic) funding sources. NSF has developed new procedures for evaluating overlapping sources of funding and introducing such evaluations into the proposal review process. See NSF 18-564.



# Synopsis of the Merit Reviews FY15-18 (THY)

<b>THEORY PROGRAMS</b>	<b>FY 2015</b>	<b>FY 2016</b>	<b>FY 2017</b>	<b>FY 2018</b>
<b>Proposals receiving awards</b>	<b>28</b>	<b>30</b>	<b>26</b>	<b>32</b>
<b>CAREER awards</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>



# Physics Division Proposal Preparation & Submission for FY19

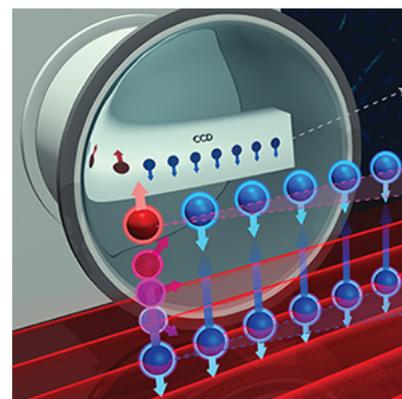
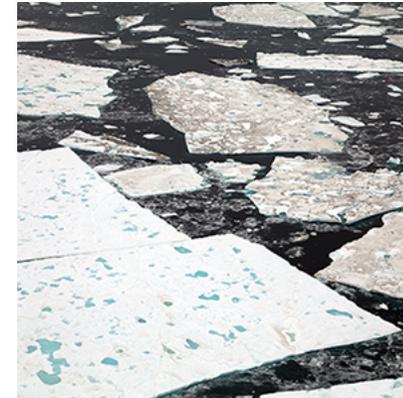
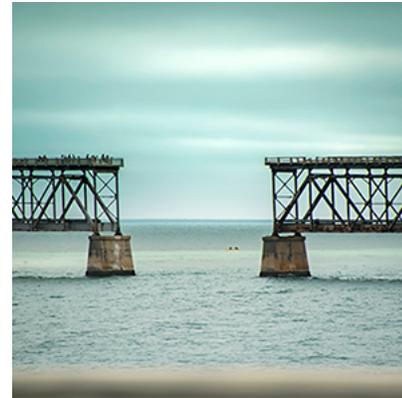
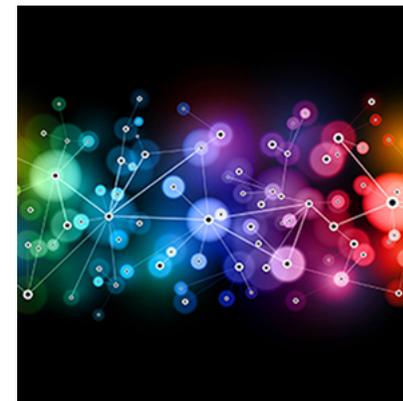
- All NSF proposals must conform to the NSF Proposal & Award and Procedures Guide:
  - Current submissions must follow PAPPG (NSF18001)
  - [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=nsf18001](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18001)
  - Questions can be referred to cognizant program directors.
- Proposals to other directorates – please refer to the NSF website: [www.nsf.gov](http://www.nsf.gov)
- **Intellectual Merit and Broader Impacts - All proposals to NSF PHY must address these two NSF Merit Criteria.**



# NSF's 10 Big Ideas...

[https://www.nsf.gov/news/special\\_reports/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





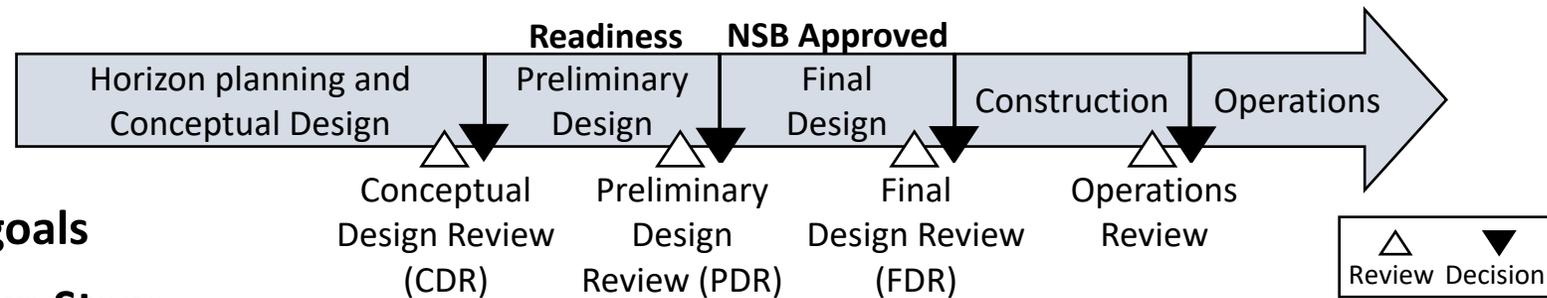
# MRI - Major Research Instrumentation

- 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 NSF18-513:**
  - [https://www.nsf.gov/publications/pub\\_summ.jsp?WT.z\\_pims\\_id=5260&ods\\_key=nsf18513](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](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](mailto:kmcccloud@nsf.gov), [rphelps@nsf.gov](mailto:rphelps@nsf.gov)



# MREFC Process

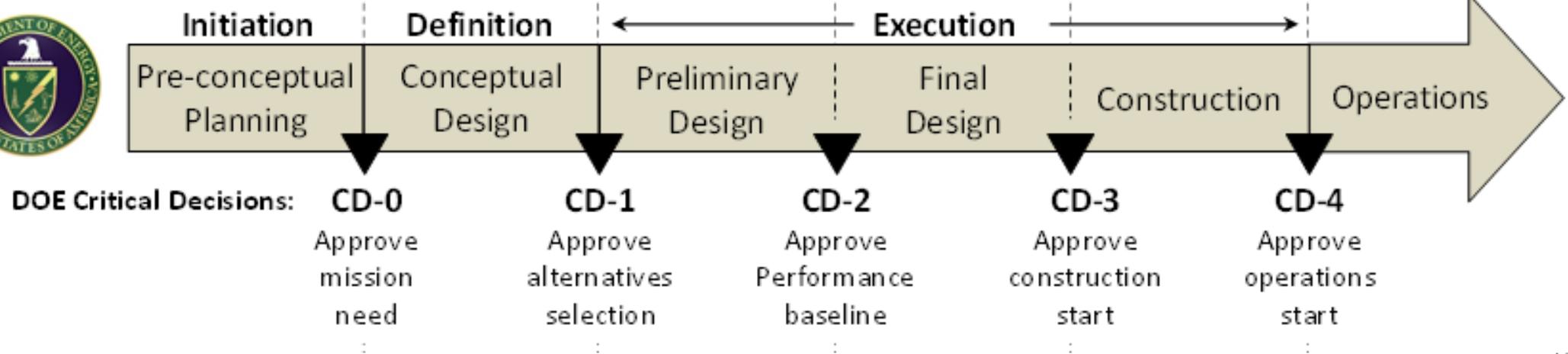
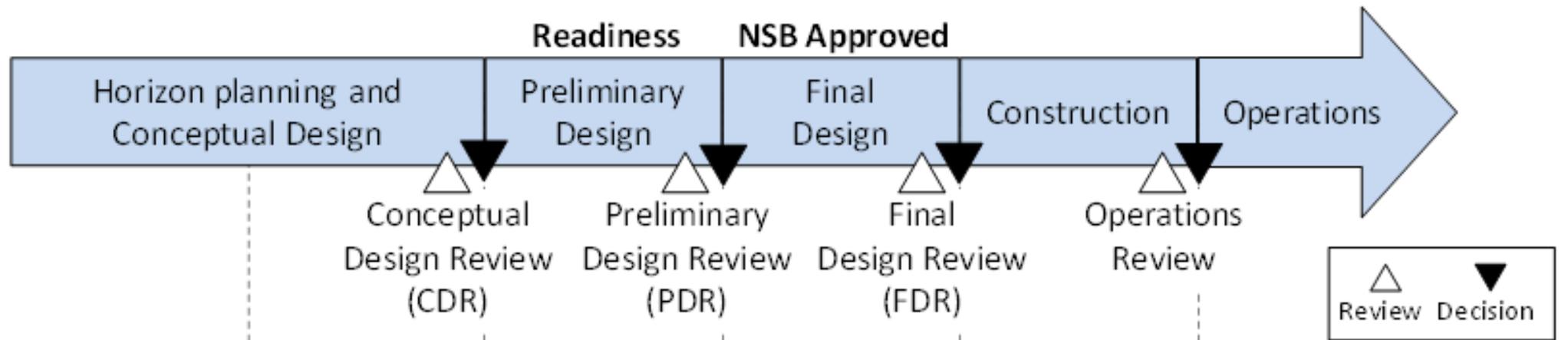
- Process underway for the HL-LHC Upgrades for ATLAS and CMS.
- Total request of \$150M, with \$75M for each experiment.
- Program Director: M. Coles with support from EPP program



- **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



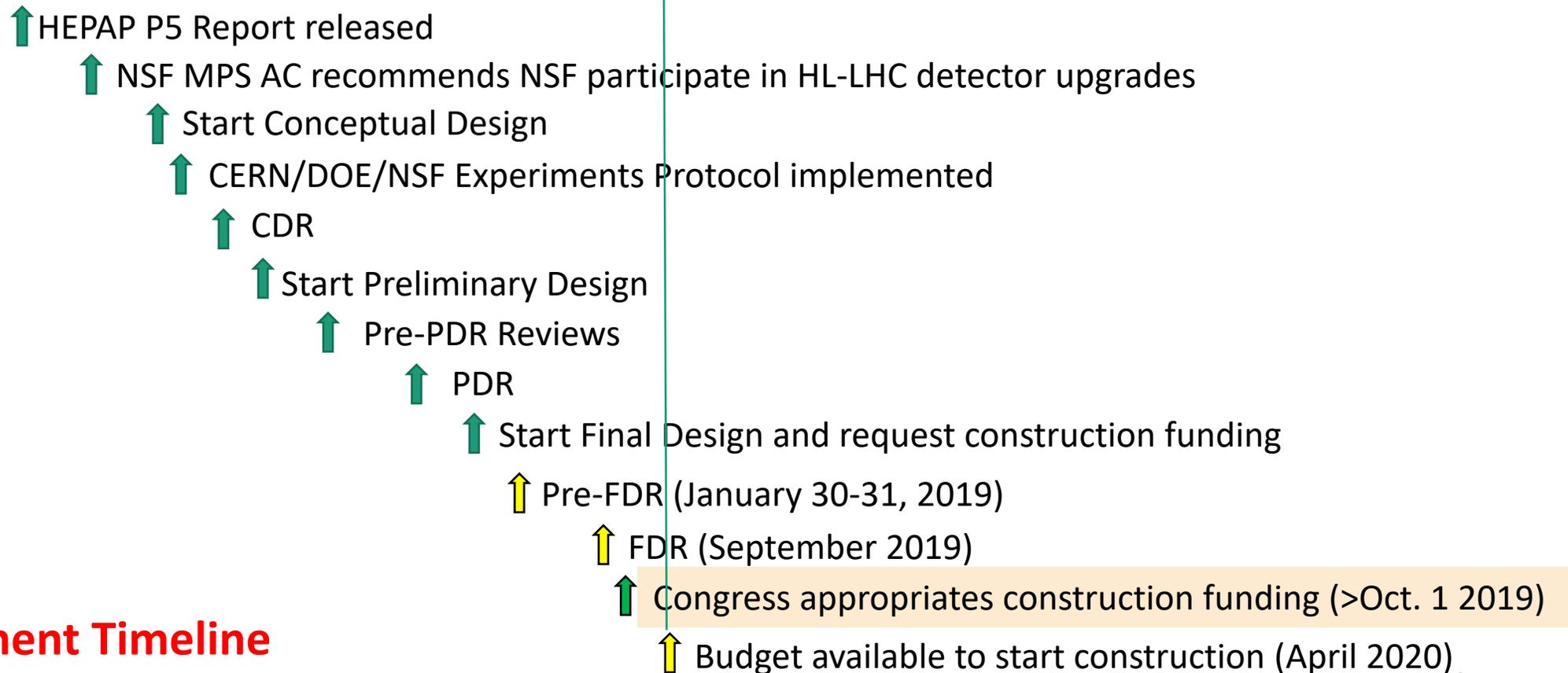
# Comparison of agency planning processes





# MREFC Process for ATLAS and CMS Phase 2 Upgrades

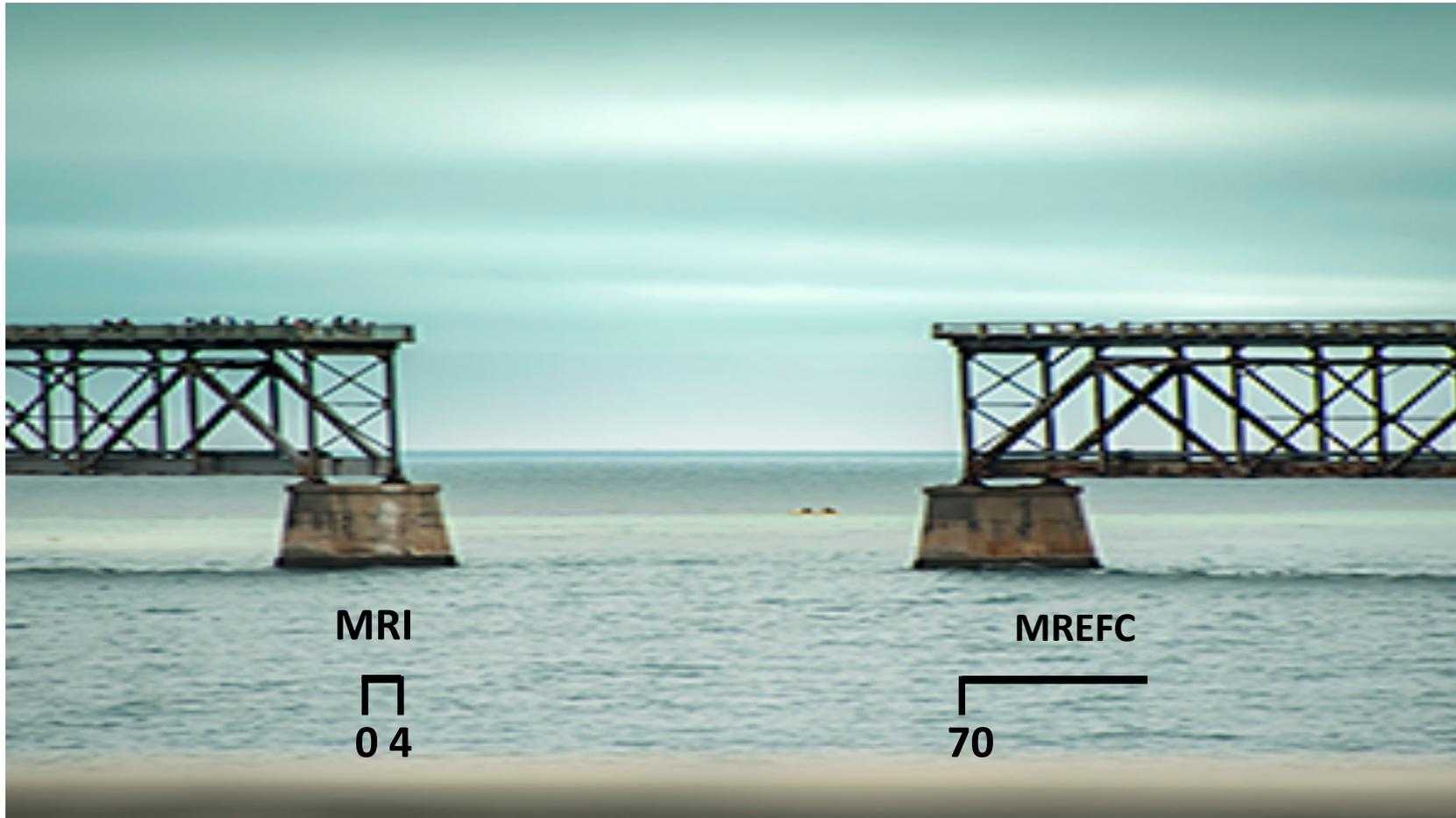
LHC											HL-LHC			
LS12		Run 2			LS2		Run 3			LS3		Run 4		
2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027



## NSF Development Timeline

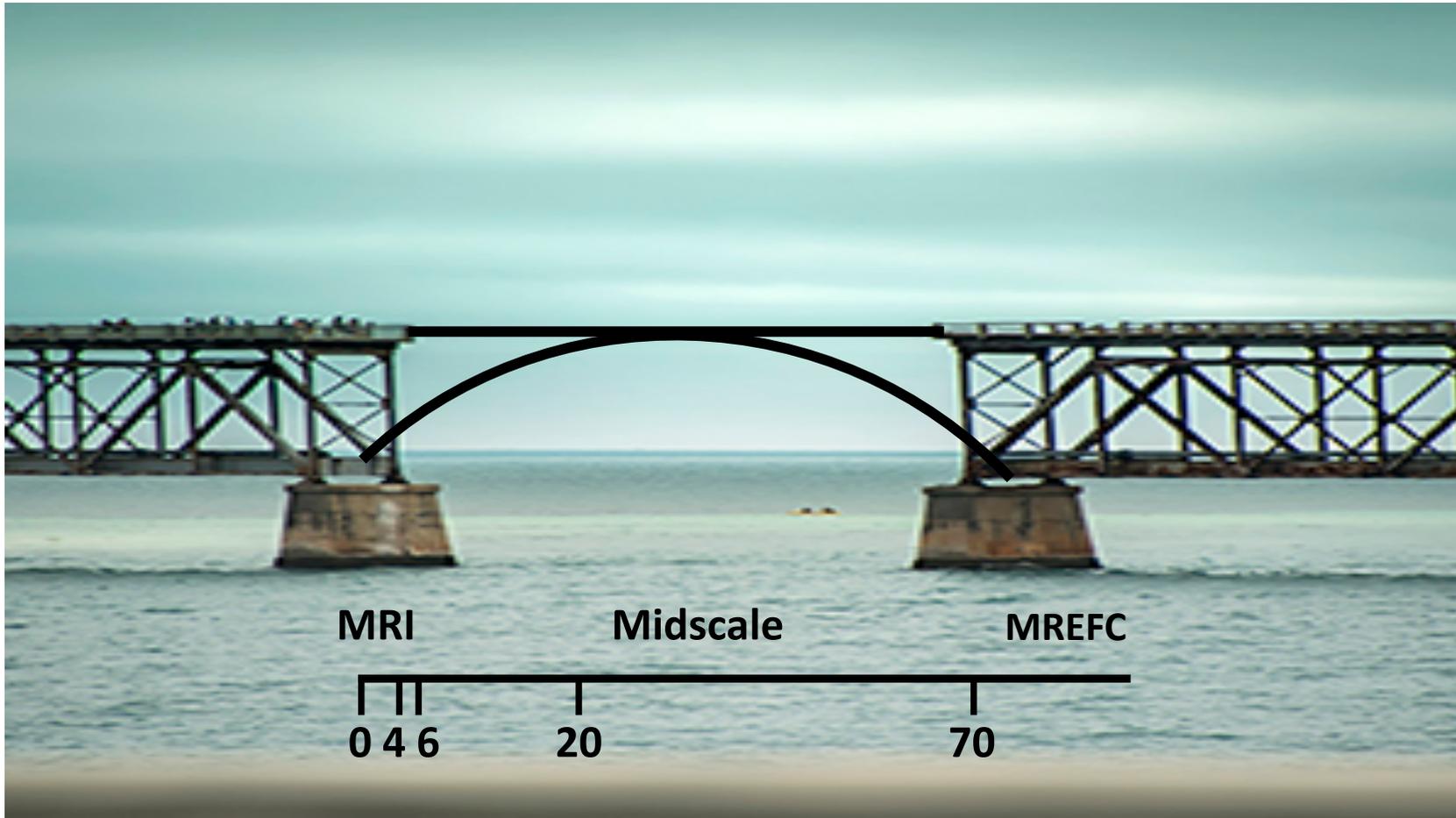


# Prior to Mid-scale Research Infrastructure Opportunities





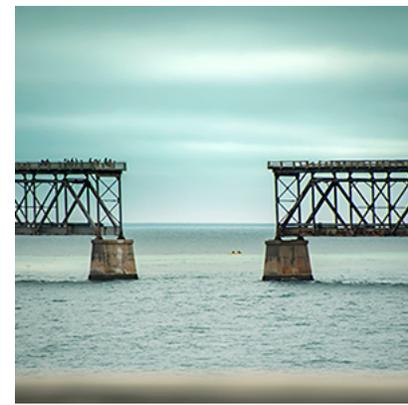
# Now with Mid-scale Research Infrastructure Opportunities A new span...





# 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 will be two solicitations: one for \$6M-\$20M, another for \$20M-\$70M
- DCL just released this month
  - <https://www.nsf.gov/pubs/2019/nsf19013/nsf19013.jsp>
  - Program Contacts: EPP/PA Program Directors





# Advanced computation



- **Institute for Research and Innovation in Software for High Energy Physics (IRIS-HEP)**
- The Institute for Research and Innovation in Software for High Energy Physics (IRIS-HEP) addresses key elements of the international "Roadmap for HEP Software and Computing R&D for the 2020s" and implements the "Strategic Plan for a Scientific Software Innovation Institute (S2I2) for High Energy Physics" submitted to the NSF in December 2017.
- IRIS-HEP will advance R&D in three high-impact areas:
  - (1) **development of innovative algorithms for data reconstruction and triggering**
  - (2) **development of highly performant analysis systems that reduce 'time-to-insight' and maximize the HL-LHC physics potential**
  - (3) **development of data organization, management and access (DOMA) systems for the community's upcoming Exabyte era. IRIS-HEP will sustain investments in today's distributed high-throughput computing (DHTC) and build an integration path to deliver its R&D activities into the distributed production infrastructure**
- As an intellectual hub, IRIS-HEP will lead efforts to:
  - (1) **build convergence research between HEP and the Cyberinfrastructure, Data Science and Computer Science communities for novel approaches to address the compelling software and computing challenges of HL-LHC era HEP experiments**
  - (2) **engage broadly with researchers and students from U.S. Universities and labs emphasizing professional development and training**
  - (3) **sustain HEP software and underlying knowledge related to the algorithms and their implementations over the two decades required**



# Advanced Computation

- IRIS-HEP Broader Impacts

- In addition to enabling the best possible HL-LHC science, **IRIS-HEP will bring together the larger Cyberinfrastructure and HEP communities** to address the complex issues at the intersection of Exascale high-throughput computing and Exabyte-scale datasets in ways broadly relevant to many research domains with emerging data-intensive needs.
- The **education and training provided by the Institute** in the form of summer schools and a fellows program will contribute to a highly qualified STEM workforce as most students and even most post-docs move into the private sector taking their skills with them.
- Co-funding between CISE/OAC and PHY. PHY Program Director: B. Mihaila





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



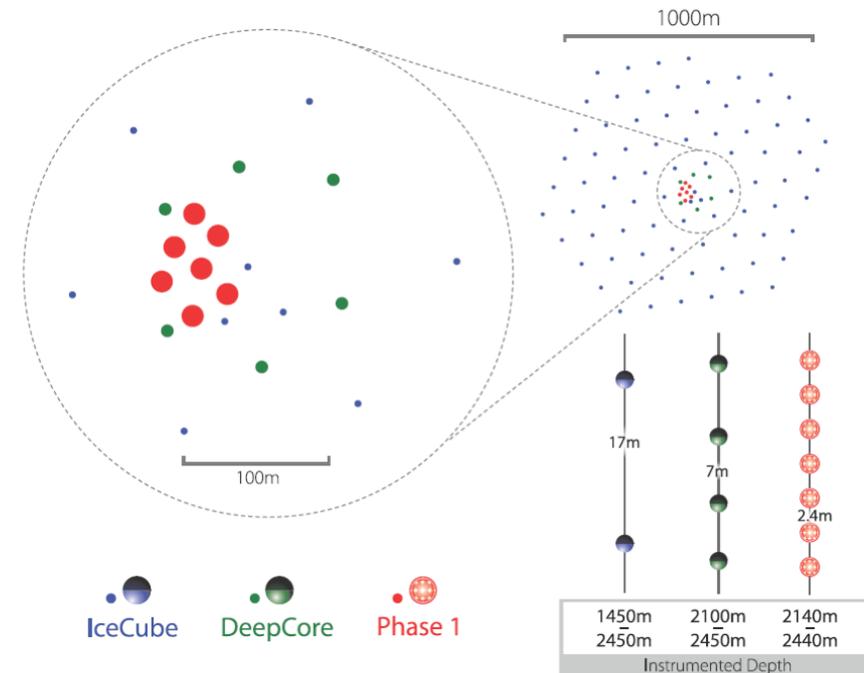
Deploying an additional 7 strings (each 100+ multi-PMT DOMs) in the center of the IceCube Deep Core array

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 ( ~ factor of 4)
  - Tau neutrino appearance on cosmic baselines
  - Neutrino astronomy with high-energy cascades





# AGEP/GRS Fellowships in the MPS Directorate

- Dear Colleague Letter: NSF16-125, [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=nsf16125](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](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](mailto:kmcccloud@nsf.gov)) and EPP/PA/THY program directors.



# NSF Graduate Research Fellowship Program(GRFP)

- Program Solicitation: NSF18-573
- <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
- **Proposal Deadline: October 26, 2018 (today!) next one October 25, 2019.**



# NSF 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!
  - 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.



# Some Program Highlights

**EPP:**

ATLAS and CMS pass PDR phase of the MREFC process for the Phase 2 Upgrade.

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

**LHCb has made strong progress on its Upgrade and US groups have leadership on the UT.**

**Physics: CP studies ... Rare decays ... B ->  $\mu\mu$  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 director A. Cronin.

**IRIS-HEP Software Institute Project awarded and initiated. Co-funding with CISE/OAC.**

**Program director B. Mihaila.**

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.

**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).**

**Visit by USLUA and other User Groups to NSF in March. Thank you for a very informative visit!**