

NSF Report: Division of Physics Particle Physics

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National Science Foundation

Division of Physics

HEPAP Meeting

July 9, 2020



NSF Particle Physics Programs & Funding Opportunities

- Transitions in Physics Division (PHY)
- COVID-19 Impacts
- Status of EPP/PA/THY Programs
- Funding Opportunities
- Research Infrastructure



Division of Physics – Individual Investigator Programs

Atomic, Molecular, & Optical Physics

Experiment: John Gillaspay; Kevin Jones
Theory: Robert Forrey

Plasma Physics

Slava Lukin

Elementary Particle Physics

Experiment: Jim Shank; Saul Gonzalez
Theory: Keith Dienes

Particle Astrophysics

Experiment: Jim Whitmore; Nigel Sharp
Theory (+cosmology): Keith Dienes

Gravitational Physics + LIGO research

Pedro Marronetti

Nuclear Physics

Experiment: Allena Opper; Jim Thomas
Theory: Bogdan Mihaila

Physics of Living Systems

Krstan Blagoev

Quantum Information Science

(Alex Cronin); Julio Gea-Banacloche

Notable transitions:

- Randy Ruchti is back at Notre Dame
- Jim Shank is back at NSF
- Jean Cottam is now permanent Deputy Division Director
- Nigel Sharp (AST) added detail to PHY

Physics at the Information Frontier
Bogdan Mihaila

Integrative Activities in Physics
REU Sites, MRI, CAREER, BP (Kathy McCloud)

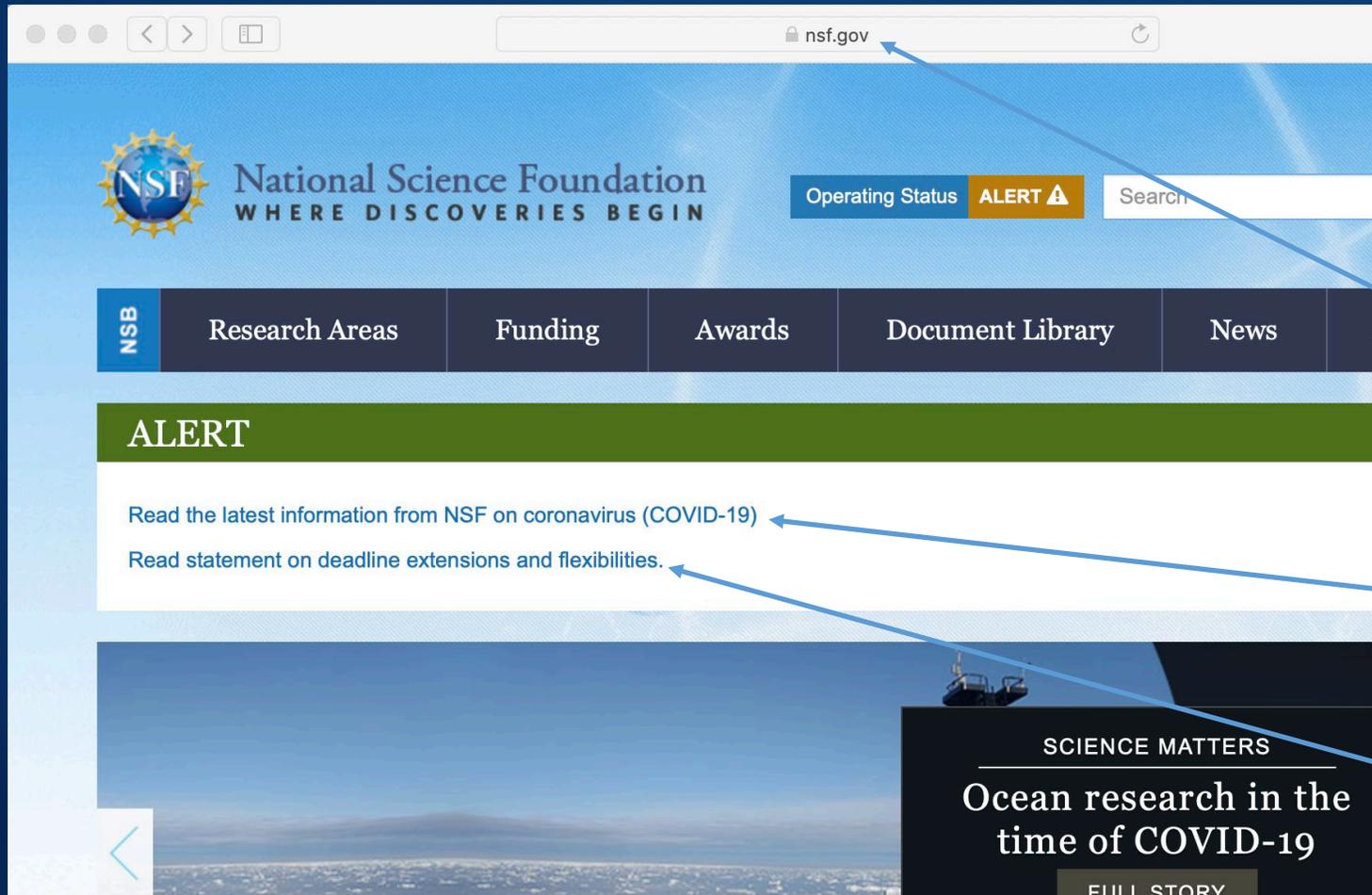
Physics Frontiers Centers
(Jean Cottam); (Kathy McCloud)



COVID-19 Impacts



COVID-19 Impacts



We recognize how disruptive the pandemic has been to everyone's personal and professional lives.

The best source of latest NSF information on COVID-19 impacts is <https://nsf.gov>

FAQs, OMB Guidance, NSF Guidance, Funding Opportunities & impacts

Deadline extensions



COVID-19 Impacts

- Immediate NSF actions
 - Flexibilities for current awards, including facilities, while mindful of Federal, State, local, and institutional guidelines
 - Implemented deadline extensions for solicitations
 - COVID-19 “RAPID” funding opportunities
- NSF has been fully operational through the pandemic
 - Everyone teleworking
 - All panels (review, advisory, etc.) have been virtual
 - Business processes proceeding
- Longer term impacts



NSF 20-052: Dear Colleague Letter on the Coronavirus Disease 2019 (COVID-19)

Rapid Response Research (RAPID) funding mechanism allows NSF to fund proposals as quick-response research on natural or anthropogenic disasters and similar unanticipated events.

Awards within Physics Division “mission space”:

- **2026657:** *Physics of Coronavirus SARS-COV-2 Survival Outside a Host and Implications for Seasonal Dependence of COVID-19 Outbreaks*
- **2026995:** *Immunogenicity of SARS-CoV2 to Human T Cells*
- **2031756:** *Mathematical Models for Understanding Key Epidemiological Parameters and Transmission of SARS-CoV-2*
- **2033046:** *Identifying the Role of Mucus in COVID-19 Pathogenesis*
- **2031509:** *Open Research Infrastructure for COVID-19 Ventilator Data*

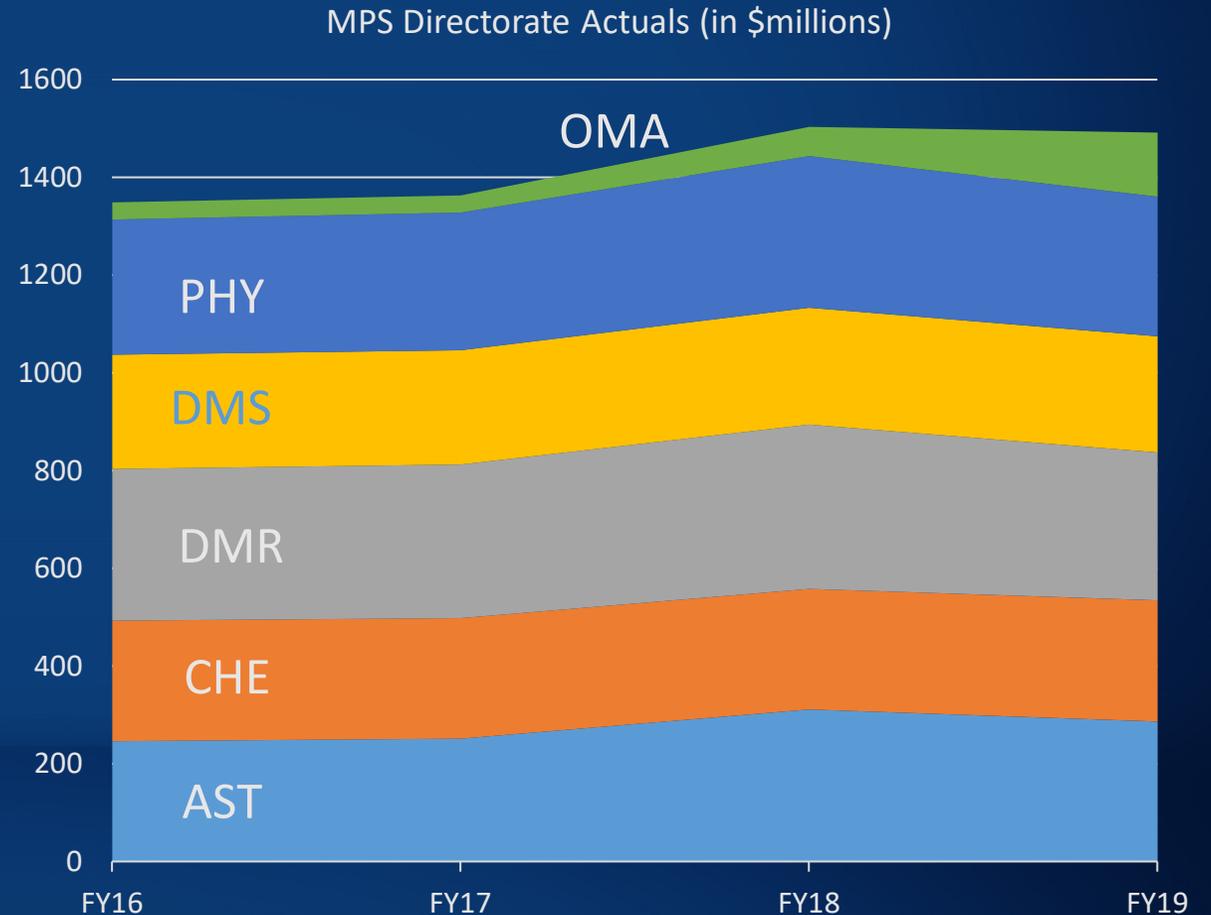


Particle Physics Research Programs



Physics Funding @ NSF

- FY20 Actuals not yet available
 - Overall, FY20 enacted is ~3% *above* FY19 Actual for NSF
 - PHY FY21 Request is 9.6% *below* FY19 Actual
- Individual program budgets have tracked PHY budgets
- Significant increase in NSF-wide “Big Ideas” (\$ held in OMA)
- FY19 was 8% lower than FY18 for PHY



Experimental EPP Program

- Elementary Particle Physics (EPP) Program, which primarily supports particle physics at accelerators and advances in detector development.
- Range of program coverage:
 - High Energy Physics (ATLAS, CMS,...)
 - Precision Experiments (Neutrinos, LHCb, Rare-K, EDMs, ...), LHCb M&O
 - Tools for Particle Physics (Artificial Intelligence, Instrumentation,...)

Program Directors: S. Gonzalez, J. Shank

EPP Program	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Funding (in \$k)	\$19,913	\$19,183	\$19,133	\$20,522	\$17,325
Awards issued	19	12	7	18	15
CAREER awards	1	2	1	1	0



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

Program Directors: J. Whitmore, N. Sharp

Particle Astrophysics	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Funding (in \$k)	\$19,665	\$18,253	\$18,142	\$18,717	\$16,632
Awards issued	26	16	17	25	18
CAREER awards	2	3	1	1	1



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, +20% last year

Program Director: K. Dienes

Theory Programs	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Funding (in \$k)	\$13,751	\$13,232	\$13,388	\$13,427	\$12,029
Awards issued	28	30	26	32	23
CAREER awards	2	1	2	1	1



Funding Opportunities



NSF Proposal Preparation for FY2021

- All NSF proposals must conform to the NSF Proposal & Award and Procedures Guide:
 - Current submissions must follow PAPPG (NSF20001)
 - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf20001
 - 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 20-580

Programmatic Information and Deadlines for FY20

<https://www.nsf.gov/pubs/2020/nsf20580/nsf20580.htm>

Experiment: Elementary Particle Physics

Proposal Deadline: **Dec 1, 2020**

Program Directors: Saul Gonzalez, Jim Shank

Experiment: Particle Astrophysics

Proposal Deadline: **Dec 1, 2020**

Program Directors: Nigel Sharp, Jim Whitmore

Theory: Elementary Particle Physics, Particle Astrophysics/Cosmology

Proposal Deadline: **Dec 8, 2020**

Program Director: Keith Dienes



New EPP program description for FY2021

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505433:

“The Experimental Particle Physics (EPP) program explores the fundamental building blocks of matter and their forces by probing, directly or indirectly, particle interactions in a laboratory setting. Major focus areas include direct observation of new phenomena at the highest achievable energies and indirect discovery via precision measurements of known processes. The program provides support for university research at high energy accelerator facilities, development of novel instrumentation and analysis paradigms, and techniques that provide alternate pathways to discovery of new physics beyond the Standard Model.

The EPP program is organized in the following subareas (Program Elements):

- High Energy Particle Physics (1221): This area supports university research focused primarily on direct discovery using the highest achievable energies. It includes research support for the ATLAS and CMS experiments at the Large Hadron Collider and studies of discovery reach at current and future collider facilities.
- Precision Particle Physics (156Y): This area supports university research focused on precision measurements of known and often rare processes to discover or constrain deviations from Standard Model expectations. It includes research support for experiments at accelerator facilities, such as the LHCb experiment and neutrino experiments, and non-accelerator experiments using AMO or other techniques.
- Tools for Particle Physics (157Y): This area supports university research efforts to significantly improve or transform current particle physics experimental techniques. It includes early concept research into new particle detection technologies and development of novel data collection, processing, and analysis capabilities. Advances in this area are expected from connections to other domains such as AMO, QIS, and AI.”



Research at Undergraduate Institutions and 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**
- Contact the EPP, PA and THY program directors for information.



AGEP/GRS Fellowships in the MPS Directorate

- MPS Dear Colleague Letter: NSF20-083, https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf20083
- 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.
- These supplements are designed to promote increased participation in all fields of MPS research, with an emphasis placed on increasing the participation of members of underrepresented groups--a key goal of the AGEP Program.
- Supplement requests may be submitted at any time. Interested PIs should contact the cognizant program director before submitting an AGEP request
- Cognizant program directors: Kathleen McCloud and EPP/PA/THY program directors.



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”
- New Solicitation: NSF 20-525
 - <https://www.nsf.gov/pubs/2020/nsf20525/nsf20525.htm>
 - Program Contacts: Kathleen McCloud and EPP/PA/THY program directors
- More information at: <https://www.nsf.gov/career>
- Proposal Deadline for FY21 was extended to August 11, 2020.
 - CAREER eligibility must still be met by July 27, 2020 (original deadline)



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

- 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. 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. 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**

Results to be announced soon – stay tuned!

Program Directors: S. Gonzalez, J. Shank, N. Sharp

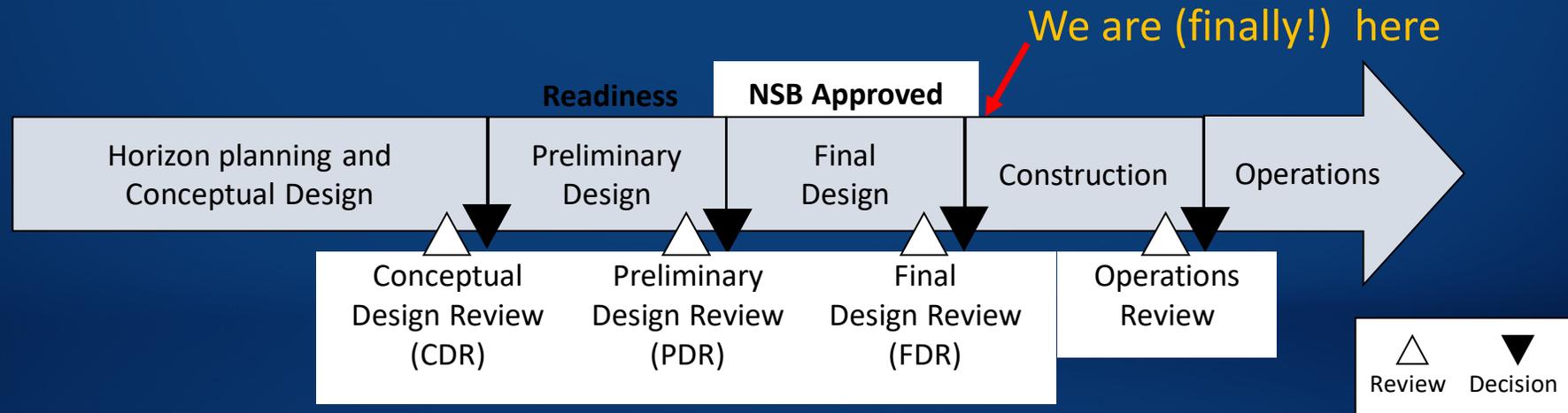


Research Infrastructure



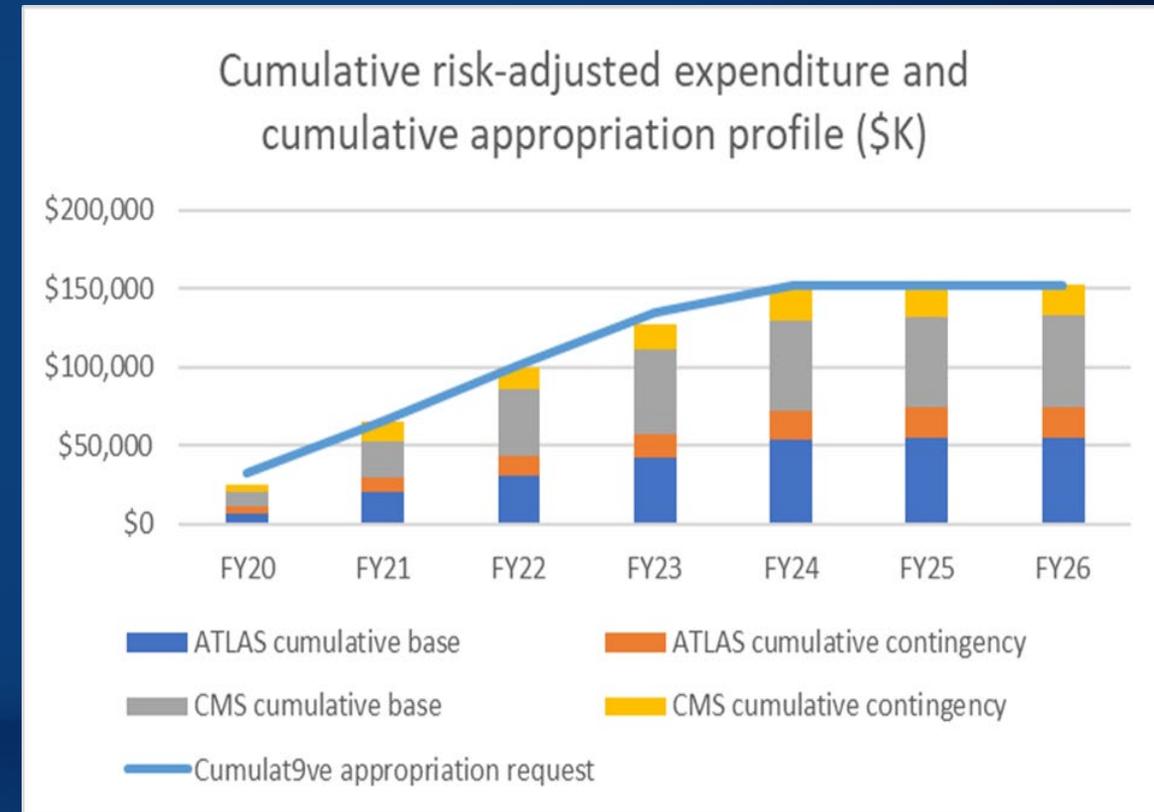
High Luminosity LHC MREFC

- NSF Contributions to HL LHC Detector Upgrades
- Made possible by:
 - 2013 Snowmass
 - 2014 P5 Plan
 - MPS Advisory Committee Report (Jan 2015)
 - U.S. CERN Agreement (May 2015)



NSF awarded MREFC construction funding to ATLAS and CMS Upgrades on April 1, 2020

- ATLAS: Award 1948993 (Columbia U)
 - \$75.0M total (\$8.45M in FY 2020)
- CMS: Award 1946735 (Cornell U)
 - \$77.2M total (\$13.27M in FY 2020)
- Nearly flat appropriation request profile mitigates risk from future CR
- Evolving understanding of COVID impacts on upgrades
 - Pandemic impacts are “unknown unknown” not in project risk plan



Program Director: M. Coles



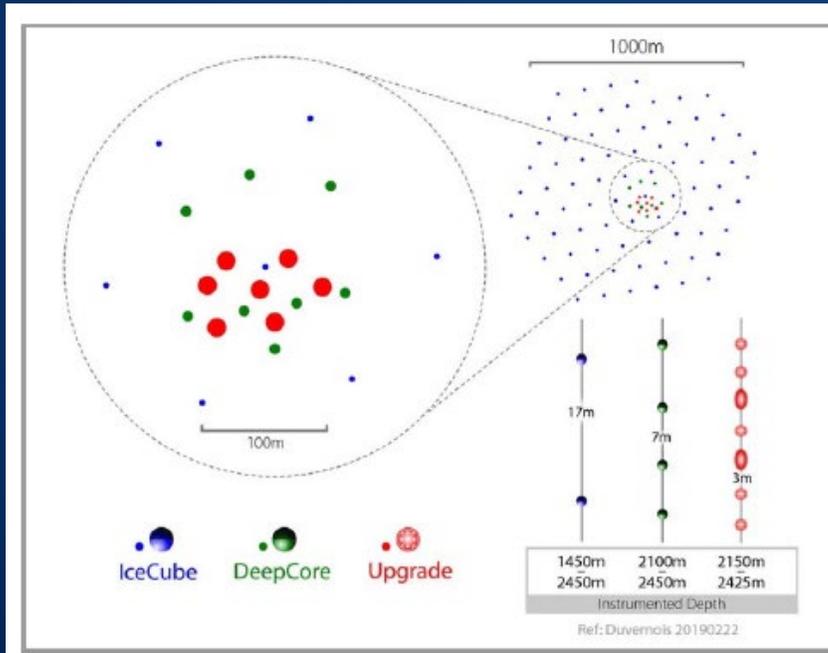
Next Phase of LHC Operations

- NSF awards supporting operation expire near the end of Calendar Year 2021
 - ATLAS: PHY-1624739 (Stony Brook U), expires Jan. 31, 2022
 - CMS: PHY-1624356 (Princeton U), expires Dec. 31, 2021
- Overall schedule for issuing new NSF operating awards:
 - Fall 2020 – community selection of NSF lead institutions and PIs for 2022-26 awards
 - ATLAS and CMS collaborations prepare operating proposals to NSF
 - Feb. 2021 – proposals received, NSF conducts ad hoc reviews and internal cost analyses
 - July 2021 – external panel review of proposals, internal review assessment, completion of cost analyses
 - ~November 2021 – Cooperative Agreements negotiated to award NSF funding

Program Director: M. Coles

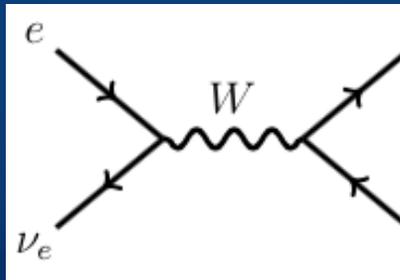
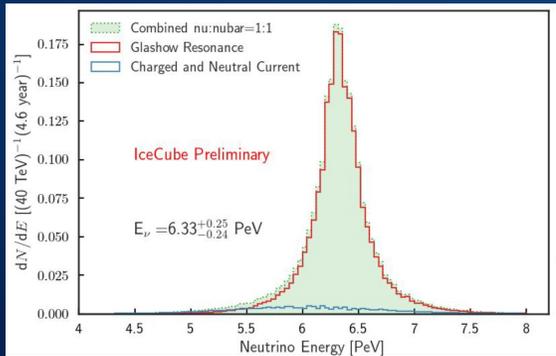
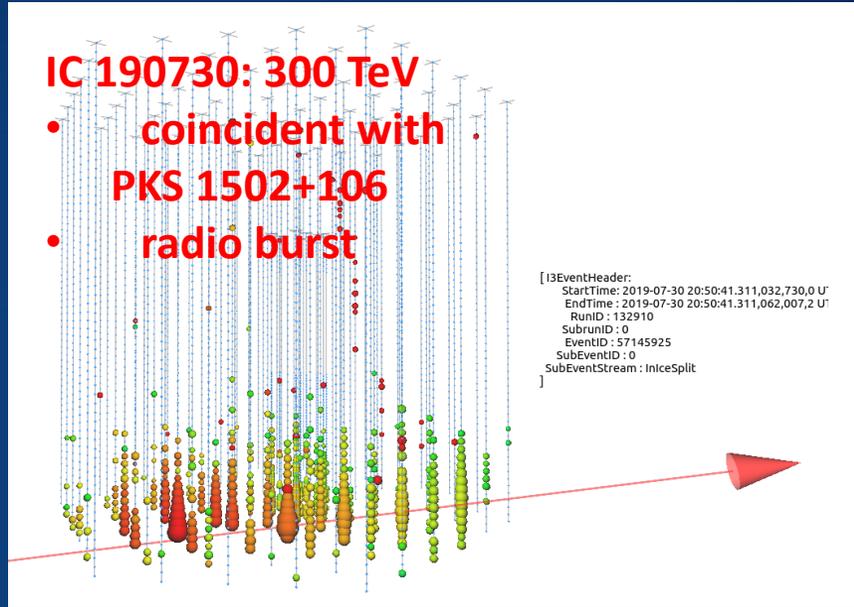
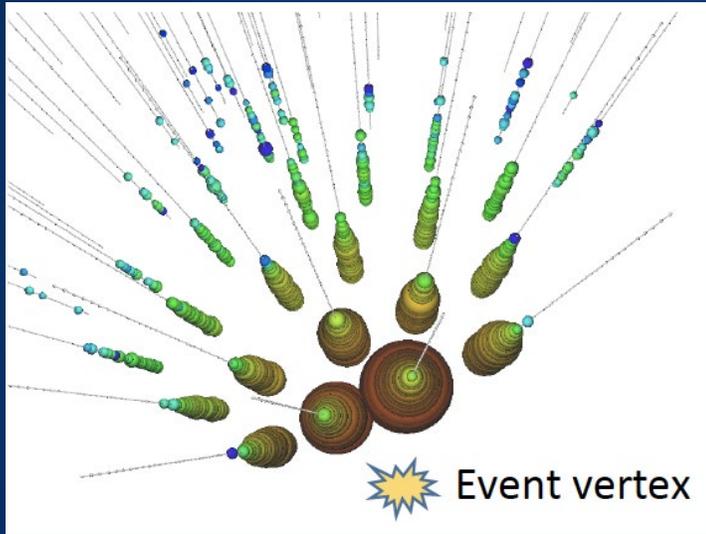


IceCube Upgrade



- Latest upgrade adds 7 new strings to the existing DeepCore array, boosting performance at the 5 – 10 GeV range, yielding over an order of magnitude more statistics and enabling a world's best measurement of **tau neutrino appearance**.
- The new strings will increase the light collection in the DeepCore infill array with vertical and horizontal spacings that are three times smaller than DeepCore, which will enhance **the pointing resolution of astrophysical neutrinos**.
- Status: Drilling initially scheduled for 2022/2023 season; due to COVID-19, likely delayed by one year

IceCube Highlights



**the first Glashow resonance event:
anti- ν_e + atomic electron \rightarrow real W at 6.3 PeV**

Neutrino candidate source FSRQ PKS 1502+106 at highest flux density at 15 GHz

ATel #12996; *S. Kiehlmann (IoA FORTH, OVRO), T. Hovatta (FINCA), M. Kadler (Univ. W rzburg), W. Max-Moerbeck (Univ. de Chile), A. C.S. Readhead (OVRO)*
on 7 Aug 2019; 12:31 UT
Credential Certification: Sebastian Kiehlmann (skiehlmann@mail.de)

Subjects: Radio, Neutrinos, AGN, Blazar, Quasar



On 2019/07/30.86853 UT IceCube detected a high-energy astrophysical neutrino candidate (Ate #12967). The FSRQ PKS 1502+106 is located within the 50% uncertainty region of the event. We report that the flux density at 15 GHz measured with the OVRO 40m Telescope shows a long-term outburst that started in 2014, which is currently reaching an all-time high of about 4 Jy, since the beginning of the OVRO measurements in 2008. A similar 15 GHz long-term outburst was seen in TXS 0506+056 during the neutrino event [IceCube-170922A](#).



Research Infrastructure Opportunities

Solicitation	Project Cost (approx. in \$million)		Funding Source		Scope of Competition
	From	To	R&D/Planning	Operations	
Individual program	0	~1.0	EPP or PA	EPP or PA	Program (within EPP or PA)
MRI (70%); University (30%)	~0.2	5.7	n/a	n/a	PHY (<1.0) NSF (>1.0)
First Awards in FY19 → Midscale RI-1	0.6-6.0	20	EPP or PA or Midscale RI-1	EPP or PA	NSF
First Awards soon → Midscale RI-2	20	70	EPP or PA or Midscale RI-1	EPP or PA	NSF
MREFC	70	--	EPP or PA	EPP or PA	NSF

First Awards in FY19 →

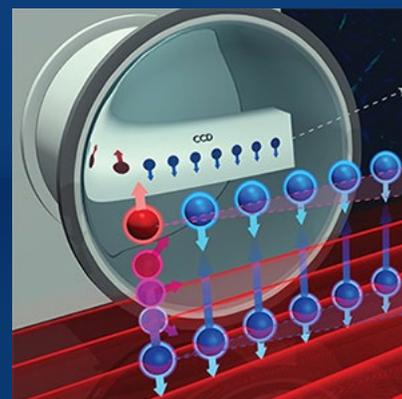
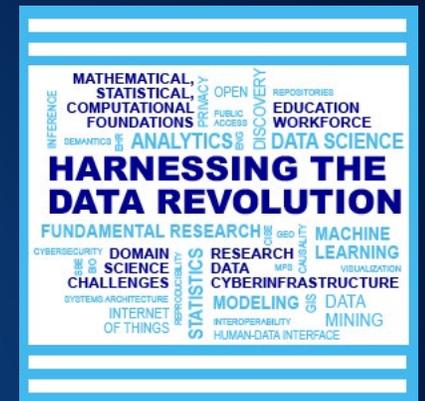
First Awards soon →



NSF's 10 Big Ideas...

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

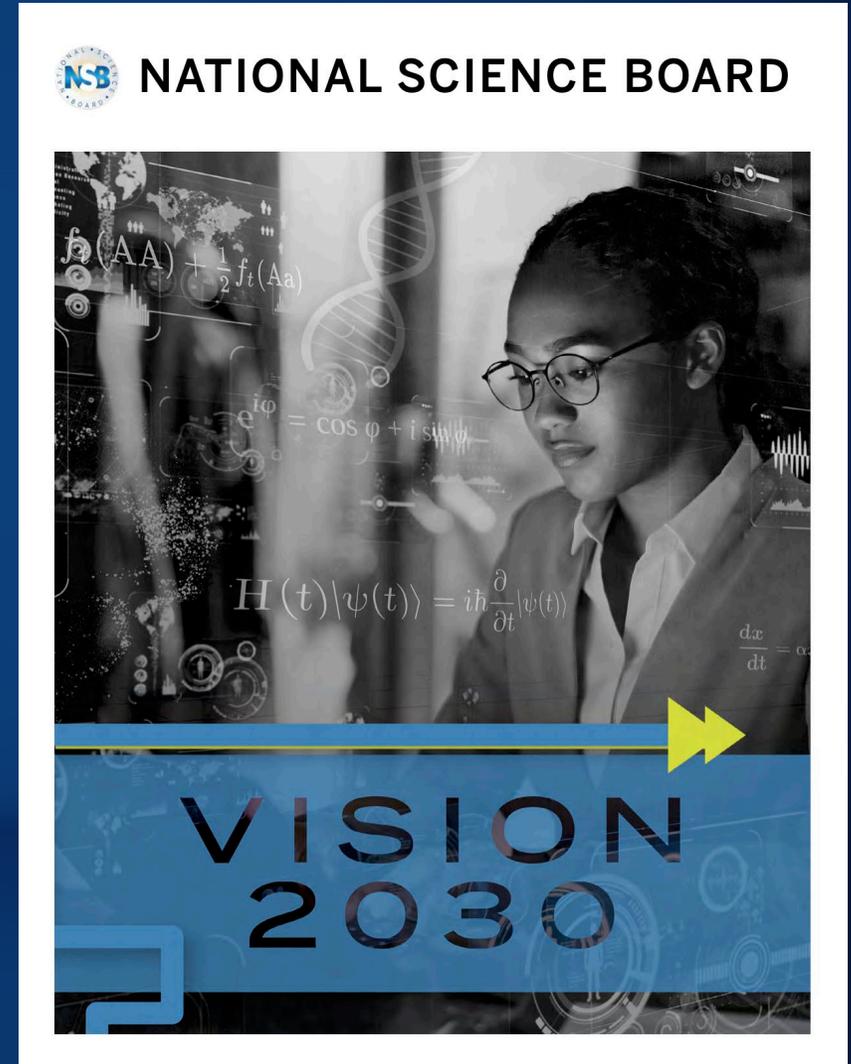
- Future of Work
- Growing Convergence Research
- Harnessing the Data Revolution
- Mid-scale Research Infrastructure
- Navigating the Arctic
- NSF2026
- NSF INCLUDES
- Quantum Leap
- Understanding the Rules of Life
- Windows on the Universe



National Science Board: Vision 2030 Report

<https://www.nsf.gov/nsb/publications/2020/nsb202015.pdf>

- A “Vision for the Future”
- “This report lays out what the National Science Board believes the U.S. must do to achieve this vision and remain the world innovation leader in 2030.”
- Roadmap Elements:
 - Deliver benefits from research
 - Develop STEM talent for America
 - Expand the geography of innovation
 - Foster a global S&E community
- Watch this space!



NSF/PHY: Summary/Comments

- The recent fiscal years have been challenging, but the Physics is compelling.
- We are working to understand and mitigate the full impact of the pandemic
- NSF-wide priorities offer opportunities to add value to the field.
 - Midscale Programs (NSF wide and PHY specific)
 - Windows on the Universe
 - AI Institutes
- We continue to work on Programmatic Balance
 - Demographic and Geographic
 - Larger Scale and Smaller Scale Programs
- The HL LHC MREFC is underway
- We look forward with great interest to the Snowmass process

