

NSF Physics Division Report

Jim Shank presenting for
Program Directors for Particle Physics:
Keith Dienes, Darren Grant, Jim Shank, Kaushik De,
William Wester
National Science Foundation
Division of Physics



Overview

- NSF Physics Division
 - New personnel
- Overview of EPP, PA programs
- Funding Opportunities
 - DEI



Division of Physics – Core Research Programs

Atomic, Molecular, & Optical Physics

Experiment: John Gillaspay; Kevin Jones,
Theory: Robert Forrey

Plasma Physics

Slava Lukin, Jose Lopez

Elementary Particle Physics

Experiment: Jim Shank , Kaushik De
Theory: Keith Dienes

Particle Astrophysics

Experiment: Darren Grant, William Wester
Theory (+cosmology): Keith Dienes

Gravitational Physics + LIGO research

Pedro Marronetti

Nuclear Physics

Experiment: Allena Opper;
Alfredo Galindo-Uribarri
Theory: Bogdan Mihaila

Physics of Living Systems

Krastan Blagoev, Angel Garcia

Quantum Information Science

Alex Cronin;

Newest faces:
Kaushik De
Mike Cavagnero

Physics at the Information Frontier
Bogdan Mihaila

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

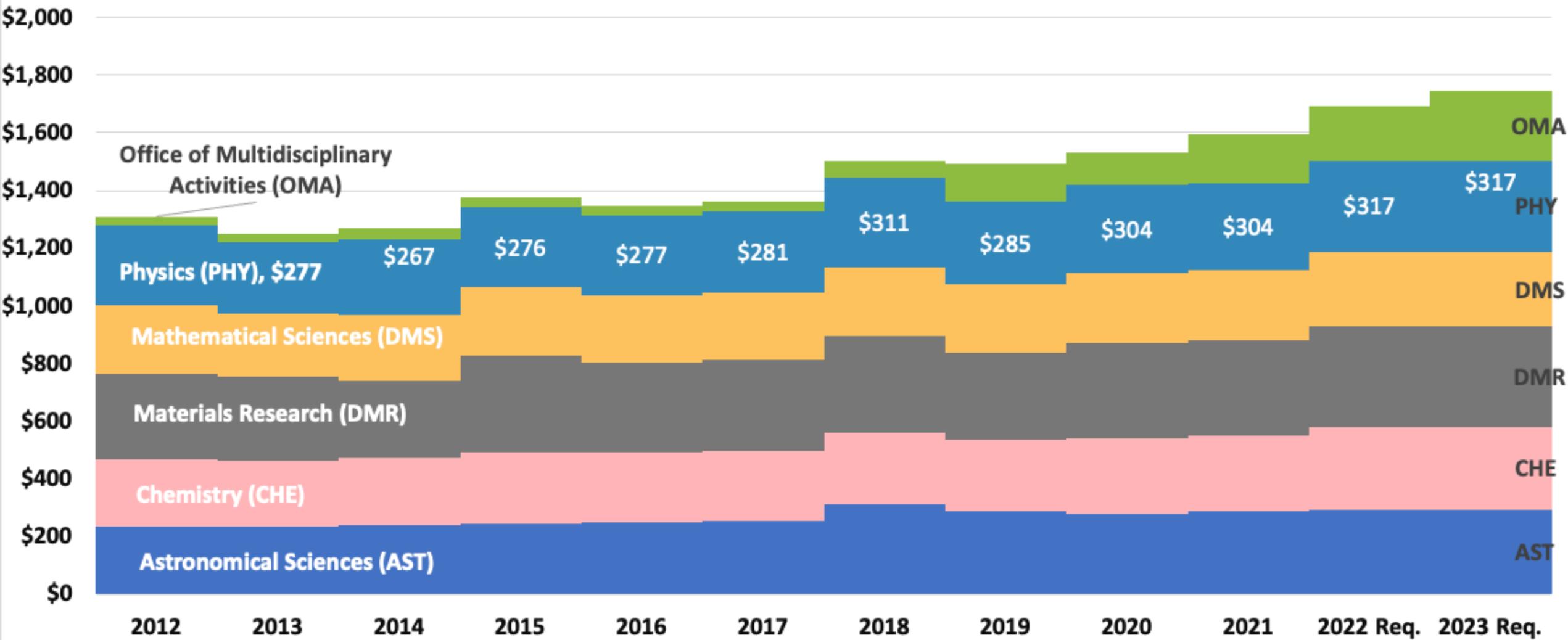
Physics Frontiers Centers
Mike Cavagnero, Kathy McCloud

Large Facilities
Mark Coles

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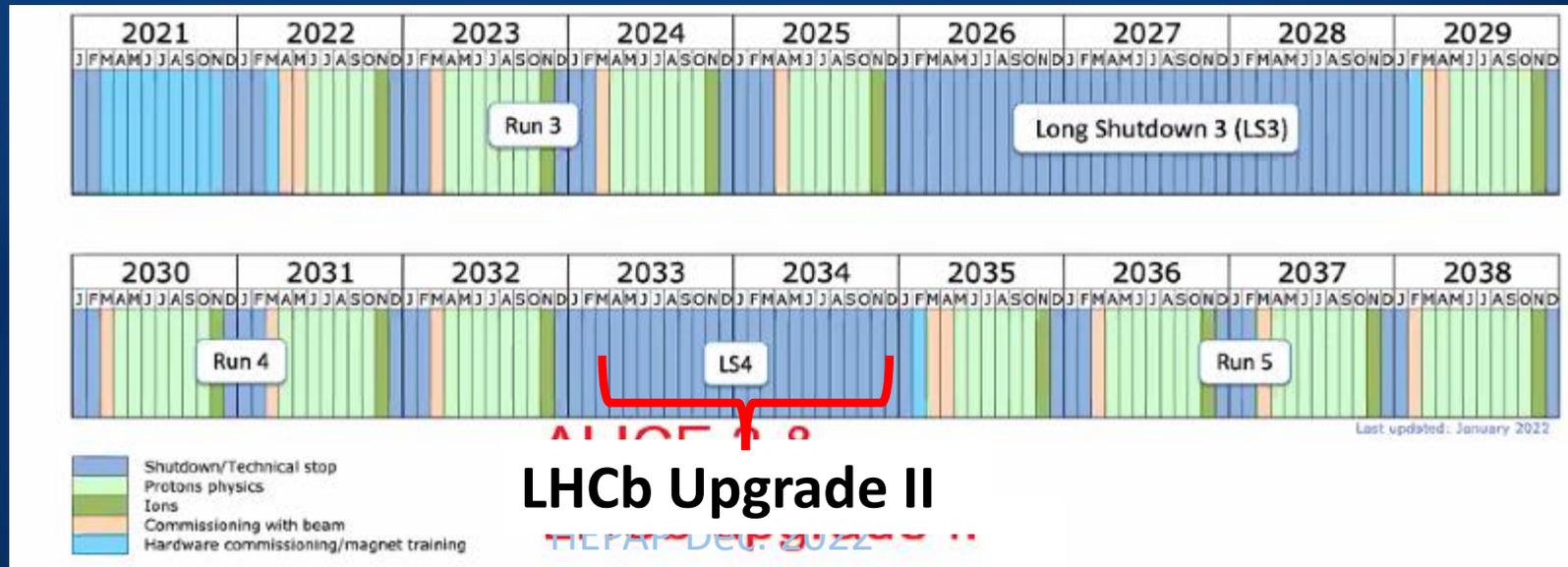


Directorate of Mathematical and Physical Sciences by Fiscal Year (Actual or Pres. Req.) \$M



The LHC

- ATLAS and CMS operations are all in good shape with respect to funding at the beginning of FY 2023, with full funding available for CMS operations through March 31, 2022, and for ATLAS operations through April 30, 2023.
 - NSF will hold a technical progress and rebaselining review of the ATLAS high luminosity upgrade the week of April 17, 2023. The review will be held at Columbia's Nevis Laboratory.
 - NSF will hold a technical progress and rebaselining review of the CMS high luminosity upgrade the week of March 20, 2022. The review will be held at Cornell University.
- Supply chain issues, and particularly the global lack of availability of some commercial electronics components, continue to be problematic and are delaying certain activities.



Major Research Equipment Account

FY2023 President's budget request

MREFC Account Funding, by Project

(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate ¹	FY 2022 Request	FY 2023 Request	FY 2024 Estimate	FY 2025 Estimate	FY 2026 Estimate	FY 2027 Estimate
Antarctic Infrastructure Recapitalization	\$48.78	\$90.00	\$90.00	\$60.00	\$60.00	TBD	TBD	TBD
DKIST	-	-	-	-	-	-	-	-
HL-LHC Upgrade	33.00	33.00	36.00	33.00	38.00*	-	-	-
Mid-scale Research Infrastructure ²	-	76.25	76.25	76.25	76.25	76.25	76.25	76.25
RCRV	25.00	-	5.00	1.98	-	-	-	-
Vera C. Rubin Observatory	46.35	40.75	40.75	15.00	-	-	-	-
Dedicated Construction Oversight	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total	\$154.84	\$241.00	\$249.00	\$187.23	\$155.25	\$77.25	\$77.25	\$77.25

*Not-to-exceed placeholder, pending outcome of rebaselining reviews



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: K. De, J. Shank								
EPP Program	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Awards issued	19	12	7	18	15	15	20	18
CAREER awards	1	2	1	1	0	3	0	0

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The EPP experiment FY2022 Portfolio:

Science Thrust	No. of Sr. Pers.	No. Awards	FY22 Amount
CMS	45	18	39.75%
ATLAS	35	18	31.25%
Neutrino	17	10	15.50%
LHCb	10	5	8.51%
Computing	6	2	1.98%
FASER	4	3	0.00%
Precision	3	3	1.06%
Workshop	2	1	0.09%
Neutrino: Design/Production TPC Wire Planes	1	1	0.00%
Precision MoEDAL	1	1	0.00%
Precision: NA62	1	1	0.00%
NASEM	1	1	0.00%
DarkMatter	1	1	1.87%
Precision: Belle II	1	1	0.00%
Precision: strong QED	1	1	0.00%
LHCb Ops & Comp.	1	1	0.00%
AI	1	1	0.00%
MUonE	1	1	0.00%
Grand Total	132	70	100.00%



Theoretical HEP and Particle Astro/Cosmology Programs

- 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 numbers of proposals, also huge numbers of new PIs applying

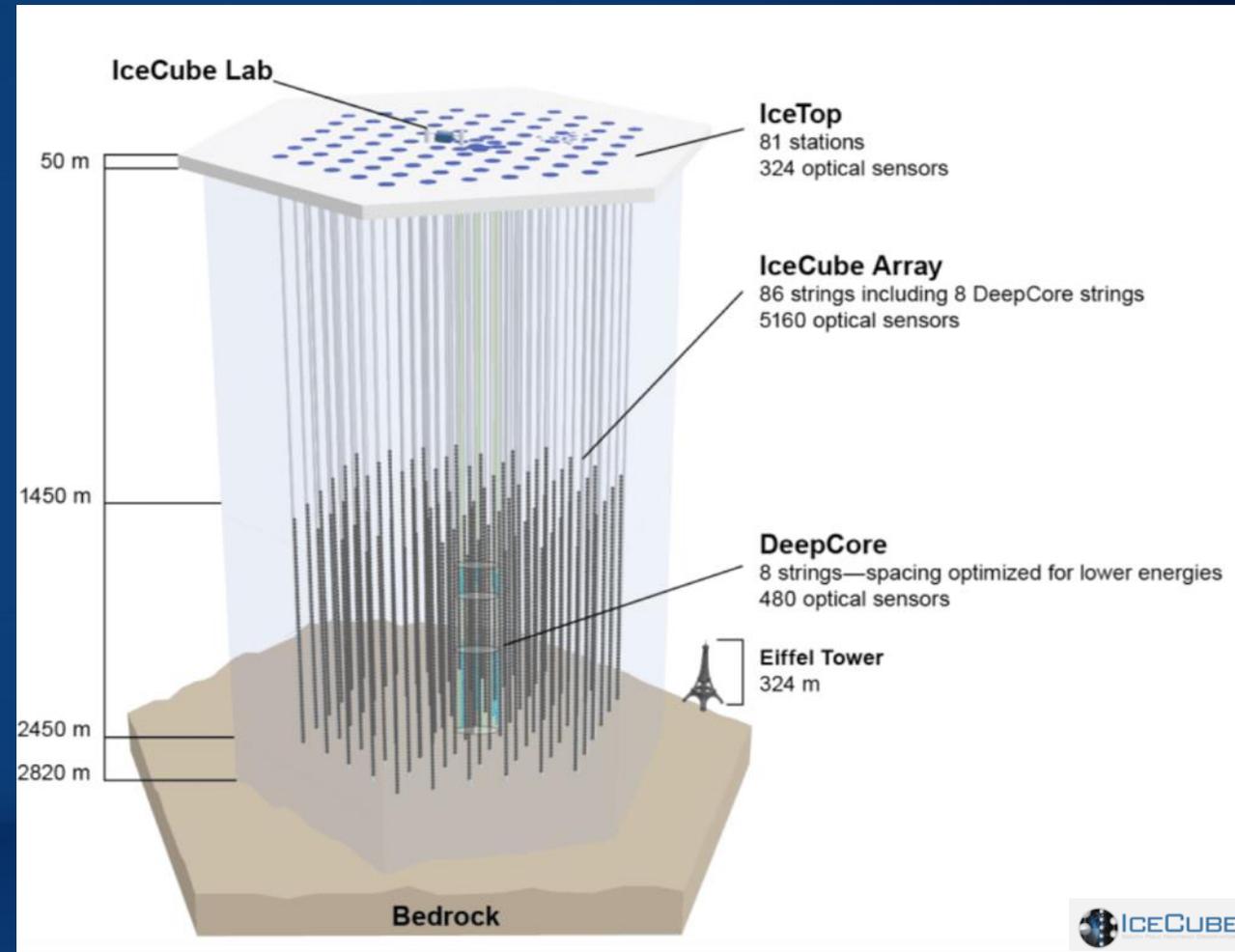
Program Director: K. Dienes

Theory Programs	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Awards issued	28	30	26	32	23	32	30	30
CAREER awards	2	1	2	1	1	1	1	0



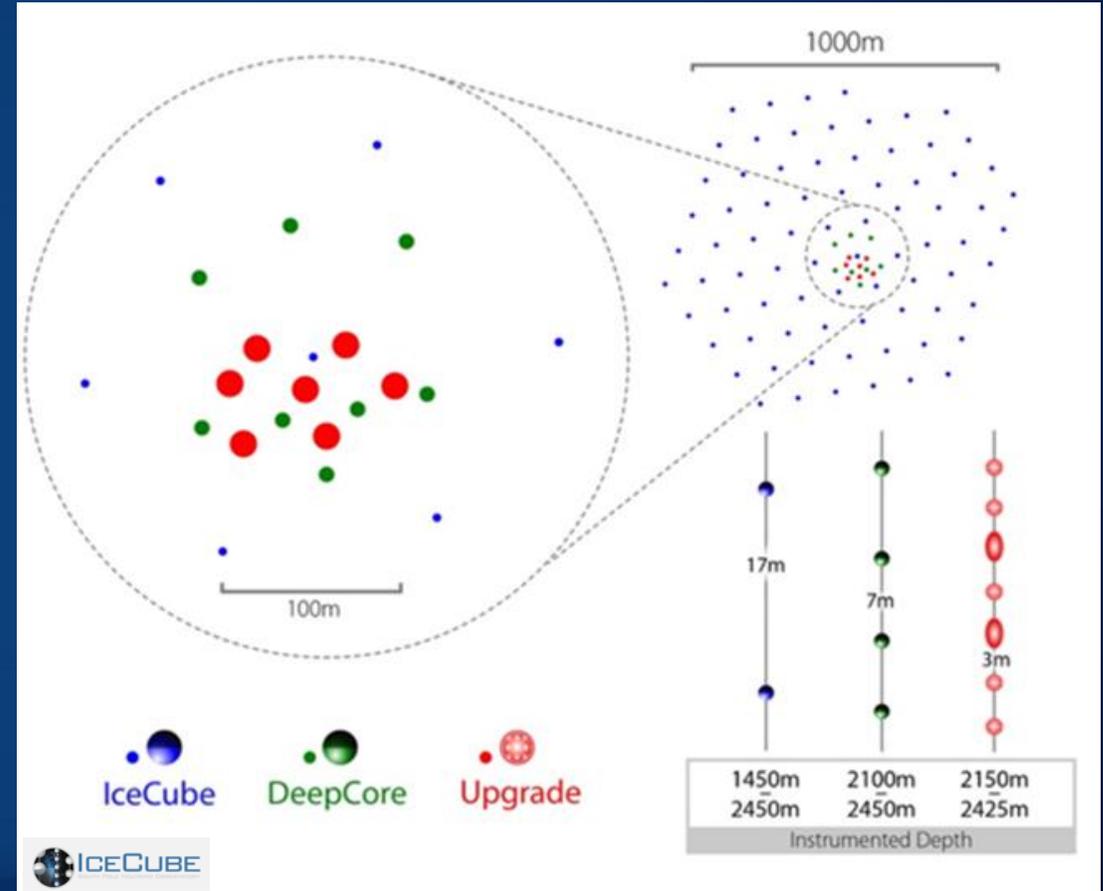
IceCube Neutrino Observatory

- 2011-2021: 10 years of IceCube
- 1 cubic kilometer of instrumented clear ice beneath the South Pole to capture the highest energy cosmic neutrino interactions
 - 86 strings of optical sensors
 - Additional stations with sensors
- International IceCube Collaboration
 - 320 Scientists, 28 U.S. institutions and 28 from other countries
 - In the U.S. / Non-U.S.
 - 47 / 45 faculty members
 - 45 / 33 postdocs / young scientists
 - 63 / 86 graduate students



IceCube upgrade

- Funded in 2018 to add seven (7) additional strings of sensors
- Exciting science to connect with
 - Lower energy cosmic neutrinos
 - Fundamental neutrino properties
 - Improved calibration to apply to new and 10+ yrs of archival data
- COVID impacts for work at the South Pole has added 3 years delay and the project has recently been re-baselined



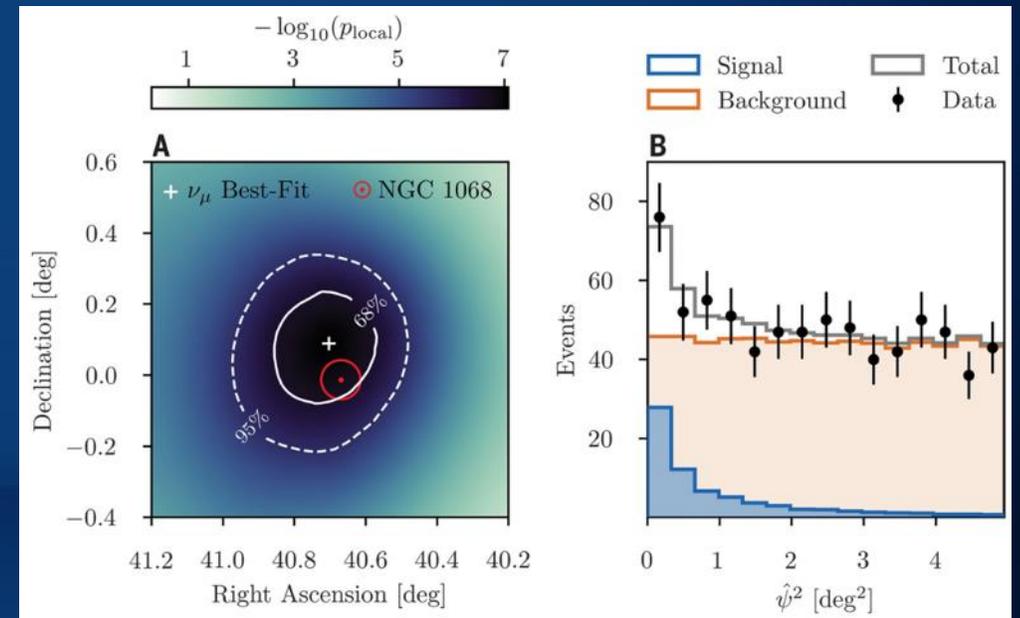
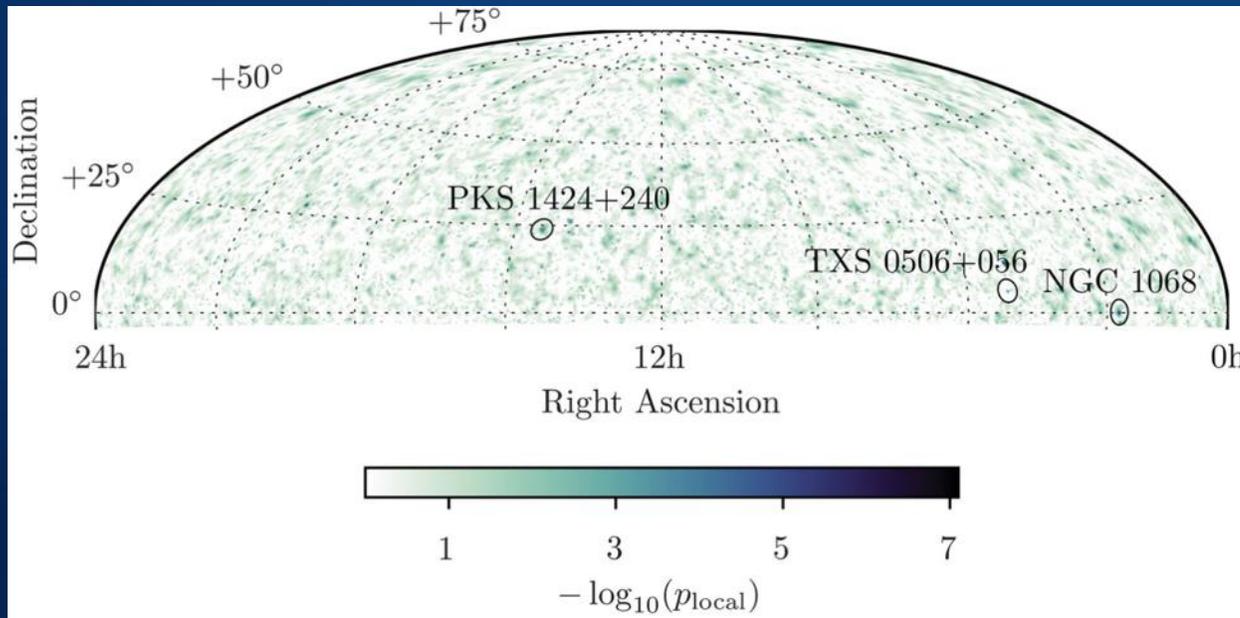
New string positions of the IceCube Upgrade

IceCube also has future aspirations for a GEN2 upgrade - approx. x10 in area with possible large radio array
Astro2020 Decadal has “endorsed” the facility



IceCube Science Highlight

- Multi-messenger observation of neutrinos from the AGN NGC 1068
 - Conclusive 4.2σ extra-galactic source detected with ~ 80 ν 's above background
 - Illuminating the environment around a super-massive black hole



Science (Vol 378, Issue 6619, pp 538-543 (2022))

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Press coverage by a large number of media outlets

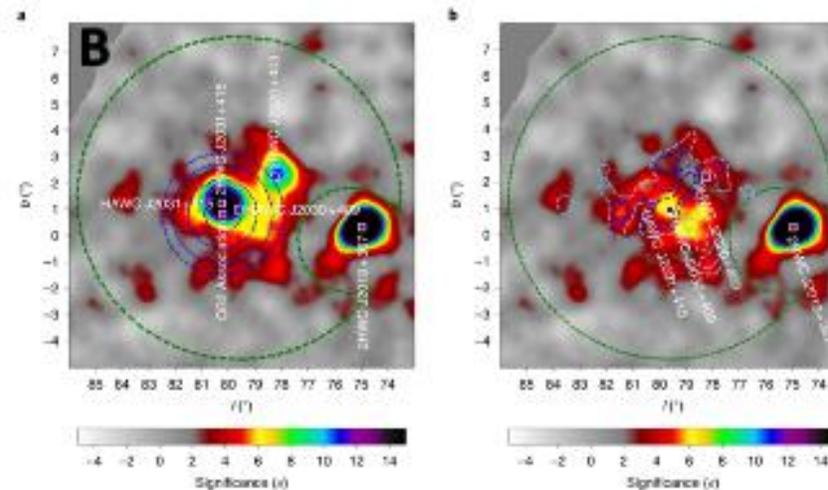
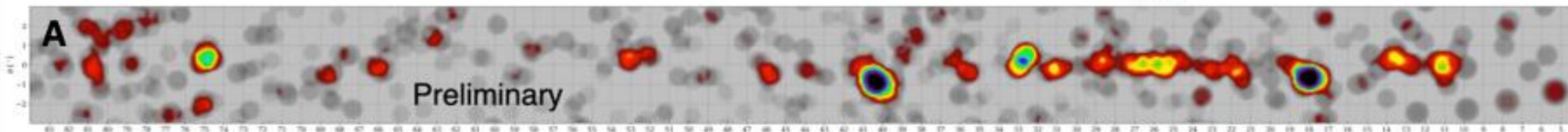


Particle Astrophysics – Cosmic Phenomena

High-Altitude Water Cherenkov Observatory (HAWC)

A: First evidence of the highest energy gamma-ray galactic sources measured to date; 9 sources with spectrum extending beyond 100 TeV

B: First observation of gamma-rays up to 100 TeV in the “Cygnus Cocoon,” a superbubble surrounding a massive star formation region. New evidence these regions are producing PeV-scale cosmic rays.



Experimental Particle Astrophysics Programs

- Underground Physics (PA-UG): This area supports university research that generally locates experiments in low background environments:
 - Underground experiments, reactor neutrinos, coherent scattering (with ENP)
 - Neutrino mass measurements
 - Searches for the direct detection of Dark Matter
- IceCube Science Program (PA-IC): This area supports university research making use of data collected by IceCube for neutrino, cosmic ray, and particle physics
- Cosmic Phenomena (PA-CP): 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: D. Grant, W. Wester

Particle Astrophysics	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY2020	FY2021	FY2022
Awards issued	26	16	17	25	18	28	27	16
CAREER awards	2	3	1	1	1	0	1	2



Funding Opportunities



Primary NSF Physics Funding Opportunities

(relevant for high-energy physics, particle astrophysics, and cosmology)



- <https://www.nsf.gov/pubs/2021/nsf21593/nsf21593.htm>: **Our general, all-purpose Solicitation for our regular base grants. Use this as your default.** Deadlines now, depending on specific program (see online).
- <https://www.nsf.gov/pubs/2014/nsf14579/nsf14579.htm>. (“RUI”) Same as above, but for applicants from primarily undergraduate institutions. Check eligibility with your SRO
- <https://www.nsf.gov/pubs/2022/nsf22586/nsf22586.htm>: (“CAREER”) An alternative funding track for those junior (untenured) faculty who, at this point in their careers, wish to undertake a *significant education/outreach activity* in addition to their research. **Not simply a research-excellence prize, and not intended as a default for junior faculty unless you plan a major mix of research and education/outreach.** Next deadline: July 26, 2023.
- https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf22604 (“LEAPS-MPS”) Grants designed to “*launch*” the careers of pre-tenure faculty... at minority-serving institutions (MSIs), predominantly undergraduate institutions (PUIs), and Carnegie Research 2 (R2) universities ... with the goal of achieving excellence through diversity.” *Launch* = you have no prior or current NSF grants (see special exceptions). Next deadline: January 26, 2023.
- Supplements to *existing* NSF grants to fund a *new* graduate student. Emphasis placed on “increasing the involvement by members of underrepresented groups”. Apply anytime, fall preferred.
 - <https://www.nsf.gov/pubs/2020/nsf20083/nsf20083.jsp>: “MPS AGEP-GRS” (only for allowed institutions).
 - <https://www.nsf.gov/pubs/2021/nsf21065/nsf21065.jsp>: “PHY-GRS” (similar, but for remaining institutions).
- <https://www.nsf.gov/pubs/2023/nsf23501/nsf23501.htm>: (“MPS-Ascend”) Fellowships to “support postdoctoral Fellows who will broaden the participation of under-represented groups”. Postdocs or graduating PhDs apply on their own after identifying a potential postdoctoral mentor. See [webinar](#)). **Next deadline: Jan 25, 2023**
- Other Divisions, such as Division of Astronomy, Math... Contact relevant Program Directors in both Divisions.

Proposal & Award
Policies & Procedures
Guide:

**New PAPPG
in effect in
Jan 2023!**

<https://beta.nsf.gov/policies/pappg/23-1>

PHY Contacts:

- **Jim Shank** (jshank@nsf.gov) **Kaushik De** (kde@nsf.gov) -- HEP Experiment
- **Keith Dienes** (kdienes@nsf.gov) -- HEP Theory & Particle Astro/Cosmo Theory
- **Darren Grant / William Wester** (dgrant@nsf.gov / wwester@nsf.gov) -- Particle Astro Experiment
- **Kathy McCloud** (kmcccloud@nsf.gov) -- for LEAPS-MPS and MPS-Ascend

DEI

- Making progress on Diversity, Equity, and Inclusion has been an NSF priority for a long time. Over the past few years we have taken additional steps in order to enhance our goals in these areas.
- NSF now offers a large number of funding opportunities aimed at broadening participation in our field (new PIs, new institutions). Some of these have been in existence for a while, others are new.
 - **New Investigator Workshops**: learn about grant writing, meet Program Directors, etc.
 - **MPS-ASCEND**: postdoctoral fellowships, cohort-building across MPS subdisciplines
 - **LEAPS-MPS**: entry grants for faculty to initiate research, to provide alternate entry portal into the funding stream
 - **MPS-HIGH**: for current NSF PIs, bring targeted high-schoolers into your research
 - **AGEP-GRS** and **PHY-GRS**: for current NSF PIs, Supplements to bring extra grad students into your group
 - **PREP**: partnerships between MSIs and our Physics Frontier Centers
 - Likewise with AI Institutes: [ExpandAI](#)
 - Physics Division also has special **Broadening Participation (BP) funds**
 - New additional programs being formulated....
- Also new MPS-wide and NSF-wide initiatives are coming!



Precision Measurements

- NSF 20-127
- Dear Colleague Letter: Searching for New Physics Beyond the Standard Model of Particle Physics Using Precision Atomic, Molecular, and Optical Techniques
- This DCL encourages interdisciplinary research across the domains of AMO and EPP physics aimed at developing new small-scale experiments and techniques that could complement large EPP facilities.
- From 2021:
 - PM: Electron and Positron Magnetic Moments from a Quantum Cyclotron
 - PM: CeNTREX, A Search for Nuclear Time-Reversal Symmetry Violation with Quantum-State-Controlled TIF Molecules
 - PM: Precision Low-Energy Quantum Electrodynamics Theory and Fundamental Processes
- 2022:
 - PI: Collar, Juan. Inst: University of Chicago Title: PM: Search for a Cosmologically Relevant Boson in Antimuon Decay



New Limited Opportunity in EPP-exp Program

- **NSF 22-097** Dear Colleague Letter: Partnership in Experimental Elementary Particle Physics and STEM Education Research to Promote Broadening Research Participation
 - Partnership between PHY and Division of Undergraduate Education (DUE)
 - With this Dear Colleague Letter (DCL), PHY and DUE encourage proposals that involve collaboration between an experimental physicist(s) involved in research with the ATLAS or CMS detector and an educator(s) conducting research in STEM education. This partnership between the investigators should enable them to concurrently carry out research in experimental elementary particle physics (EPP) and advance educational practice and education research at the undergraduate (college/university) level within state-of-the-art research environments in physics. NSF is especially interested in receiving proposals from collaborations that have these goals and expected outcomes:
 - Exhibit strong intellectual merit for both the experimental particle physics research and the STEM education research at the undergraduate (college/university) level,
 - Strengthen diverse participation in physics research, and
 - Increase the diversity, quantity, and quality of the next generation of STEM professionals.
 - This is a pilot initiative. It is anticipated that no more than two projects will be funded in FY 2023.



Research Infrastructure



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; No cost sharing	~0.2	5.7	n/a	n/a	PHY (<1.0 M) NSF (>1.0 M)
<u>Midscale RI-1</u>	0.6-6.0	20	EPP or PA or Midscale RI-1	EPP or PA	NSF
Midscale RI-2	20	70	EPP or PA or Midscale RI-1	EPP or PA	NSF
MREFC	70	Now 100	EPP or PA	EPP or PA	NSF

First Awards in FY19 →

Four awards in FY21 →



Mid-Scale Research Infrastructure

- Webinar from July 2022: [weblink](#)
- Mid-Scale RI-1 Solicitation: [22-637](#)
- Preliminary Proposal Deadline Date: January 5, 2021
- **Full Proposal Deadline Date: May 5, 2023 (By Invitation Only)**
- Mid-Scale RI-1 Implementation projects Total cost: \$6M - \$20M
- Mid-Scale RI-1 Design projects Total cost: \$400k - \$20M
- Mid-Scale RI-2 Solicitation: [21-537](#) (not updated)
- Mid-Scale RI-2 Projects Total cost: \$20M - \$100M
- Consult the Research Infrastructure Guide [NSF 21-107](#)



Backup...

