



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

# High Energy Physics Research Program Status

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High Energy Physics Advisory Panel

November 2021

*Glen Crawford*

*Research & Technology Division Director*

*Office of High Energy Physics*

*Office of Science, U.S. Department of Energy*

# U.S. Secretary of Energy's Excellence Award

**Dr. Abid Patwa** was recognized for his efforts to make the United States High Energy Physics (HEP) program a world leader through international cooperation.

*Dr. Patwa's patience, expertise, leadership, and problem-solving abilities have made international cooperation possible through the development of international agreements that support U.S. researchers around the world and bring researchers from other countries to work in the United States. Dr. Patwa's understanding of Departmental requirements for international agreements and his diplomatic skills in working with our international partners have helped fulfill the HEP strategic plan for an international program in particle physics.*

*For his contributions to the Department of Energy and the Nation, Dr. Abid Patwa is awarded the Secretary of Energy's Excellence Award.*



# 2021 Gruber Cosmology Prize

*For the introduction of "numerous techniques for the study of the large-scale structure of the universe as well as the properties of its first instant of existence. Their work includes a mathematical means for studying the early universe that not only has allowed both theorists and observers to test and ultimately embrace a standard cosmological model but, in the coming decade, will allow researchers to probe the existence of gravitational waves in the so-called inflationary era, when the age of the universe was  $10^{-35}$  seconds"*

- ▶ Marc Kamionkowski (JHU)
- ▶ Uros Seljak (LBNL)
- ▶ Matias Zaldarriaga (IAS)

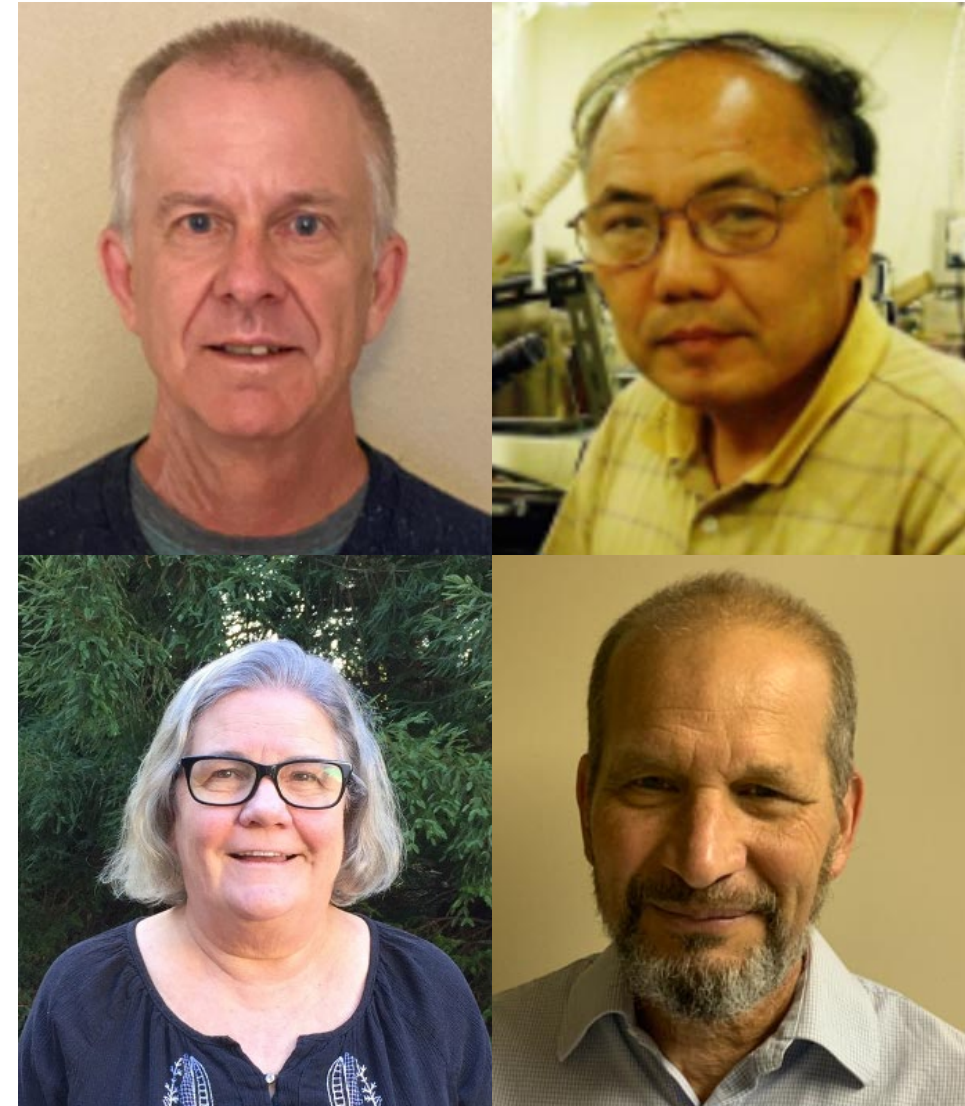




# APS 2022 W.K.H. Panofsky Prize in Experimental Particle Physics

*For the first direct observation of the tau neutrino through its charged-current interactions in an emulsion detector.*

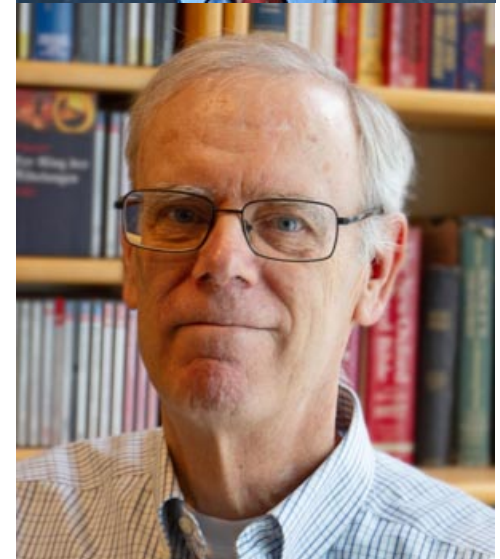
- ▶ Byron G Lundberg, Fermilab
- ▶ Kimio Niwa, Nagoya University
- ▶ Regina Abby Rameika, Fermilab
- ▶ Vittorio Paolone, University of Pittsburgh



# APS 2022 Robert R. Wilson Prize for Achievement in the Physics of Particle Accelerators

*For leadership in developing the modern accelerator complex at Fermilab, enabling the success of the Tevatron program that supports rich programs in neutrino and precision physics.*

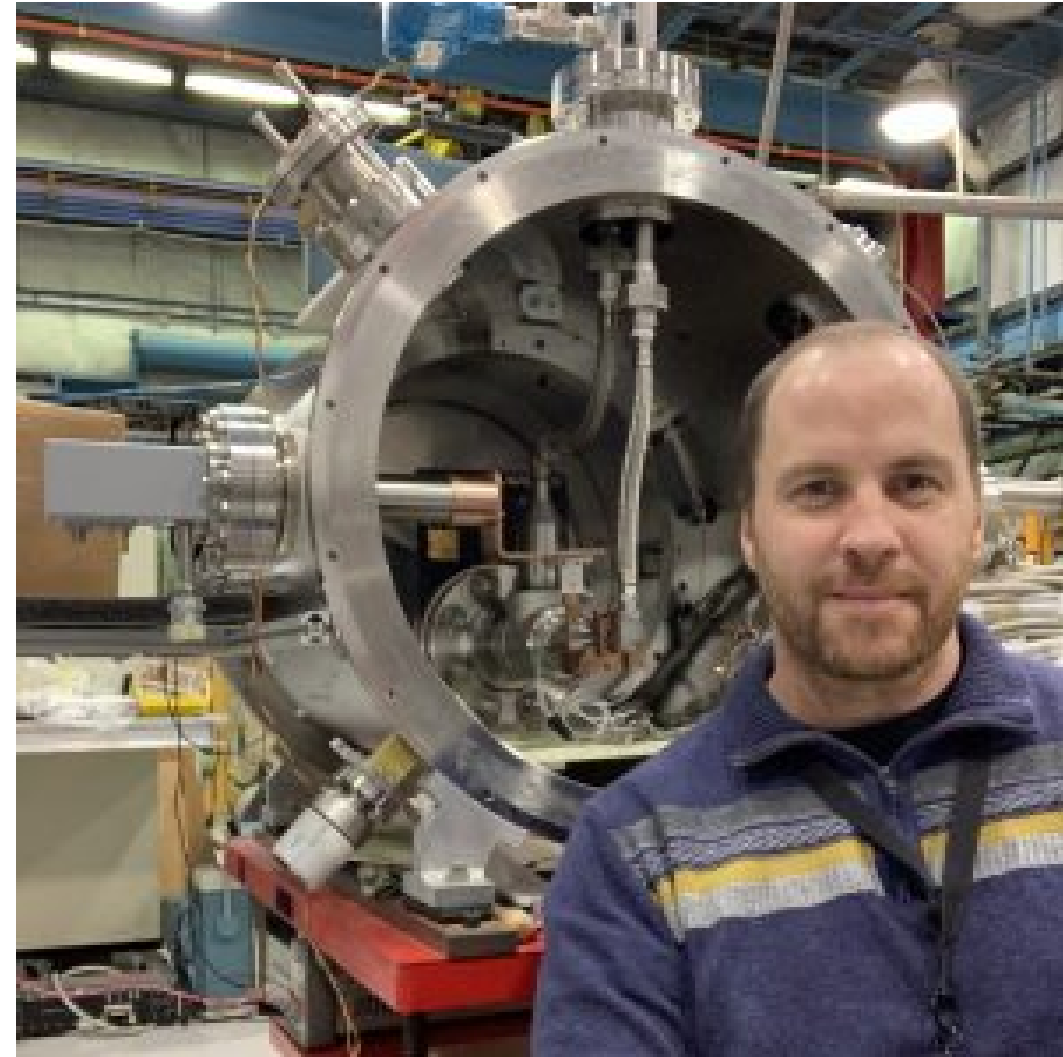
- ▶ G. William Foster, Fermilab (Retired) and U.S. Congress
- ▶ Stephen D. Holmes, Fermilab



# APS DPF Instrumentation Award 2020

*For his creation and development of novel applications for CCD technology that probe wide-ranging areas of particle physics including cosmology, dark matter, neutrino detection and quantum imaging*

▶ Juan Estrada (Fermilab)



# APS 2022 Excellence in Physics Education Award

*For groundbreaking analysis revealing sources of persistent underrepresentation of African-Americans in physics and astronomy; recommendation of data-driven, systemic strategies to increase the number of African-American physics bachelor's degree recipients; and ways to catalyze cultural change.*

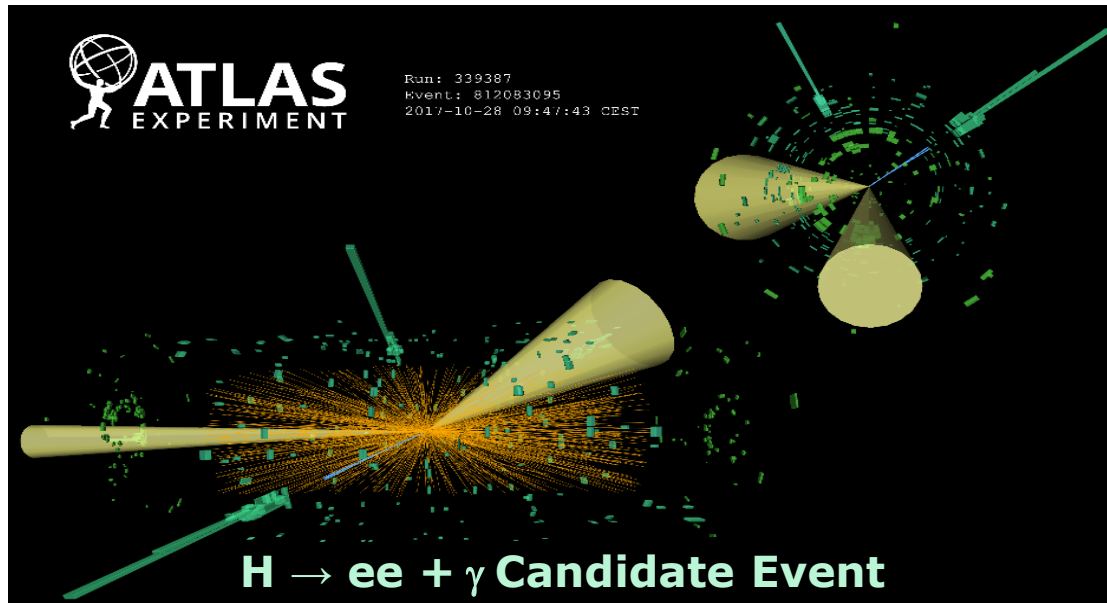
- ▶ TEAM-UP Task Force,  
American Institute of Physics
- ▶ Mary James, Ed Bertschinger, Brian Beckford, Tabbetha Dobbins, Sharon Fries-Britt, Sylvester James Gates, Jedidah Isler, Maria Ong, Quinton Williams, Arlisa Richardson, Arlene Modeste Knowles, Philip "Bo" Hammer



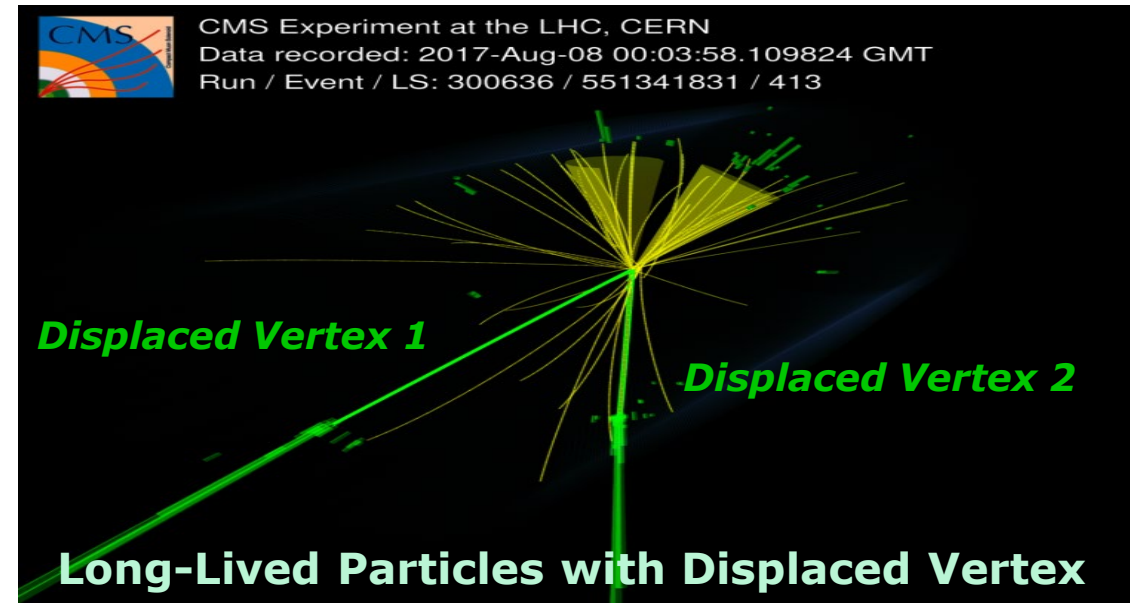


# Energy Frontier: LHC Highlights

- ▶ 2021: first  $3.2\sigma$  evidence for a new Higgs decay mode at LHC
  - ▶ Dalitz decays of the Higgs where a pair of oppositely charged electrons or muons accompany the photon decay of the Higgs
  - ▶ Process is 5-10 times rarer than the original Higgs  $\rightarrow \gamma\gamma$  discovery mode
  - ▶ AI/ML tools and techniques used by ATLAS to enhance the sensitivity for this challenging decay process
- ▶ CMS experiment probing new and more exotic decays of the Higgs, ones that are long-lived  $\Rightarrow$  travel longer distances in the detector
  - ▶ AI/ML algorithms applied at early data selection phase to identify signatures



November 2021

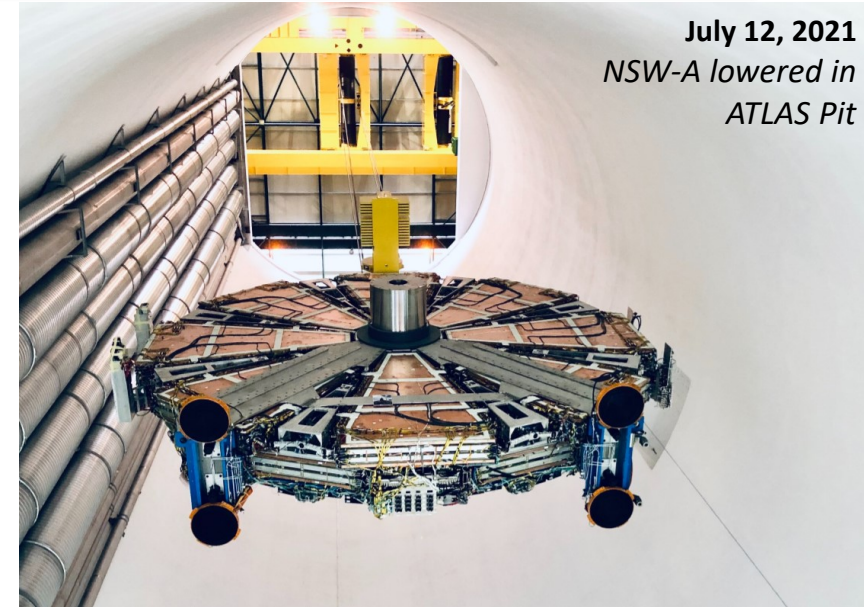


HEP Research Program - HEPAP



# LHC: ATLAS and CMS Detectors Operations

- ▶ US ATLAS and US CMS objectives for detector maintenance and consolidation activities during the current ongoing LHC Long-Shutdown 2 have been achieved
  - ▶ Includes the ATLAS Muon New Small Wheel installation
  - ▶ CMS successfully completed HCAL upgrades, electronics upgrade of the endcap muon chambers, and fully-refurbished pixel detector, one with better radiation tolerance
- ▶ LHC “pilot” beams began circulating ~2 weeks ago
- ▶ Both experiments expected to be ready for the Feb 2022 LHC start with Run 3 physics data-taking by early June 2022



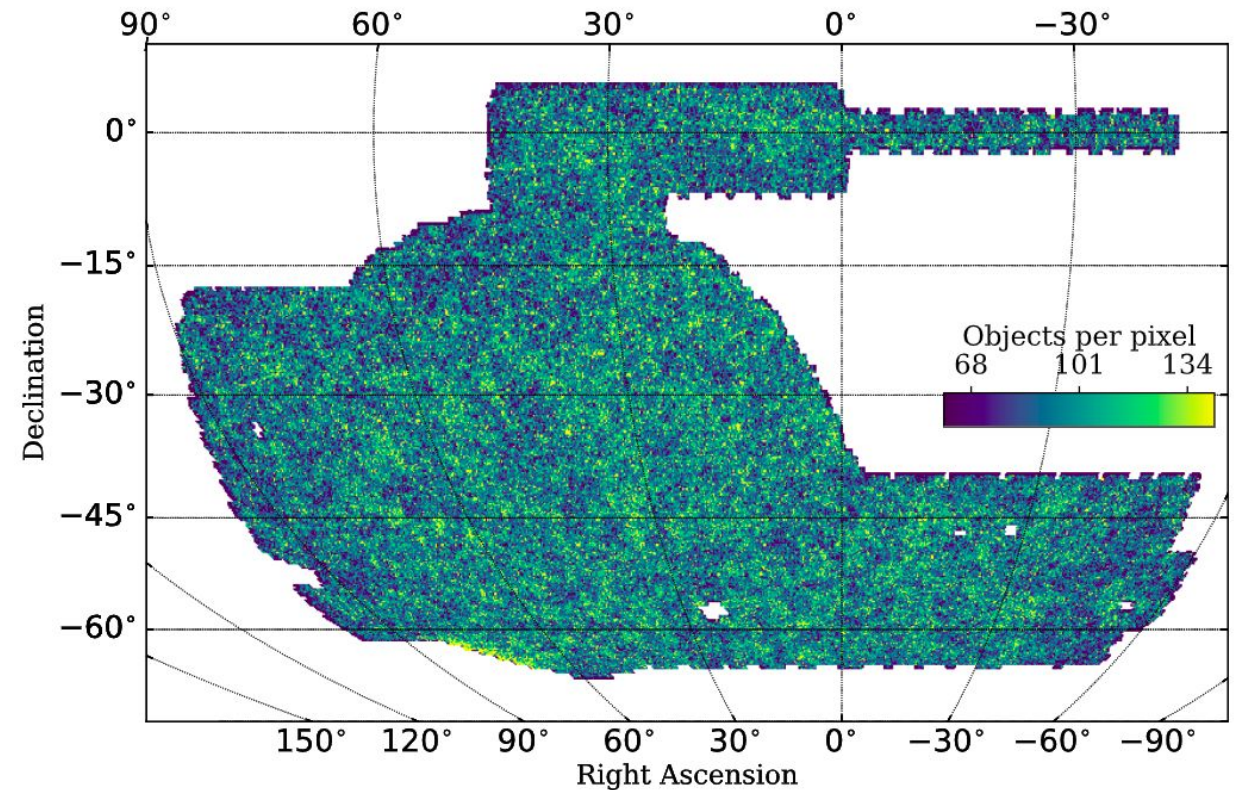
July 12, 2021  
NSW-A lowered in  
ATLAS Pit



June 29, 2021:  
CMS FPix installation

# Cosmic Frontier: Dark Energy Survey (DES) Highlights

- ▶ DOE and NSF partnership
  - ▶ 6-year imaging survey of 5,100 square-degrees, completed Jan 2019
- ▶ Jan. 2021: Public Data Release 2, 6 years of data
  - ▶ 690 million objects with unprecedented photometric, astrometric precision & uniformity



**Data Release 2 survey map**

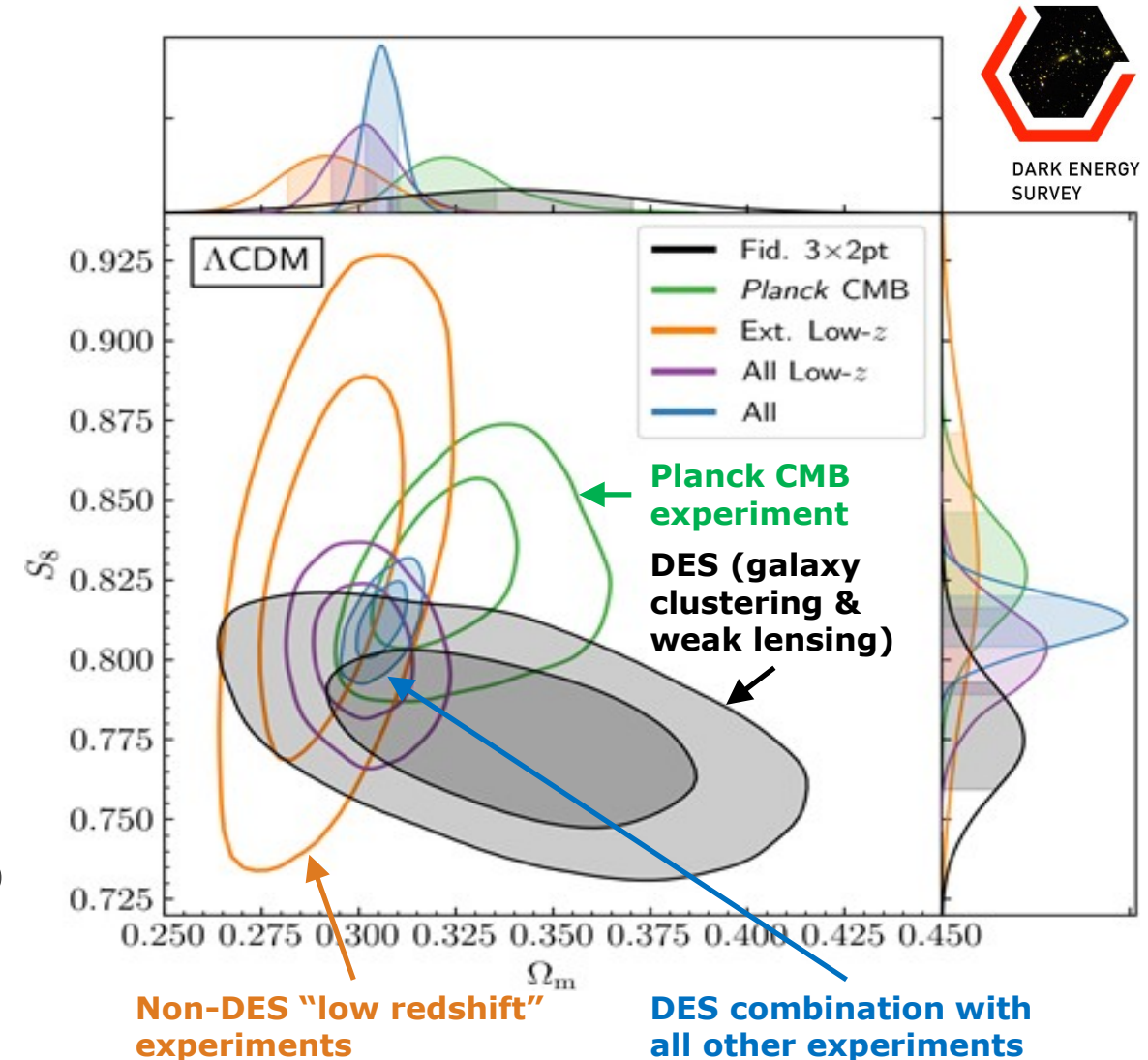


DARK ENERGY  
SURVEY



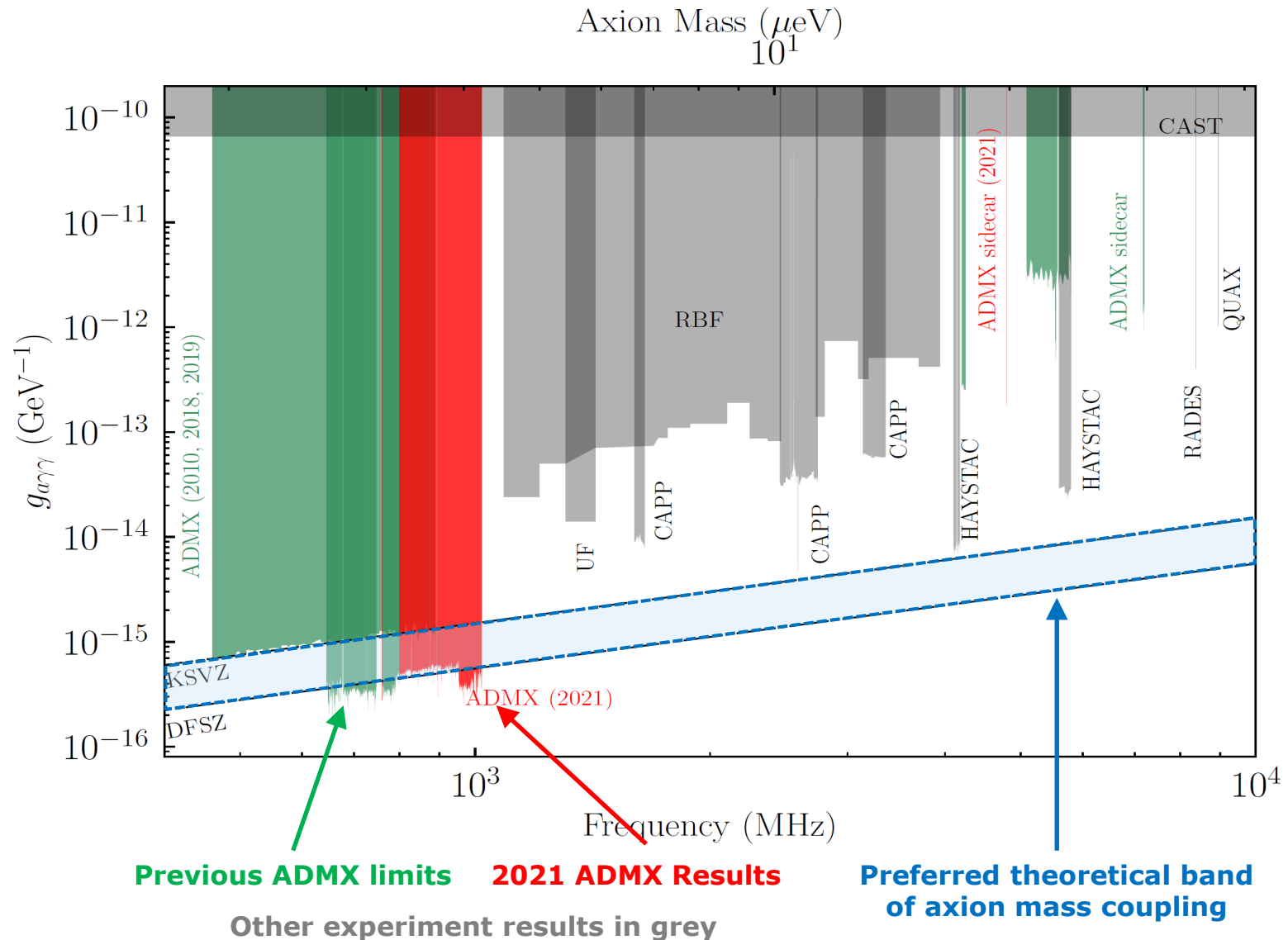
# Cosmic Frontier: Dark Energy Survey (DES) Highlights

- ▶ DOE and NSF partnership
  - ▶ 6-year imaging survey of 5,100 square-degrees, completed Jan 2019
- ▶ May 2021: Years 1-3 data Weak Lensing Cosmology results
  - ▶ Largest ever sample of 226 million galaxies over an enormous piece of the sky used to produce the most precise measurements of the universe's composition and growth to date



# Cosmic Frontier: ADMX-G2

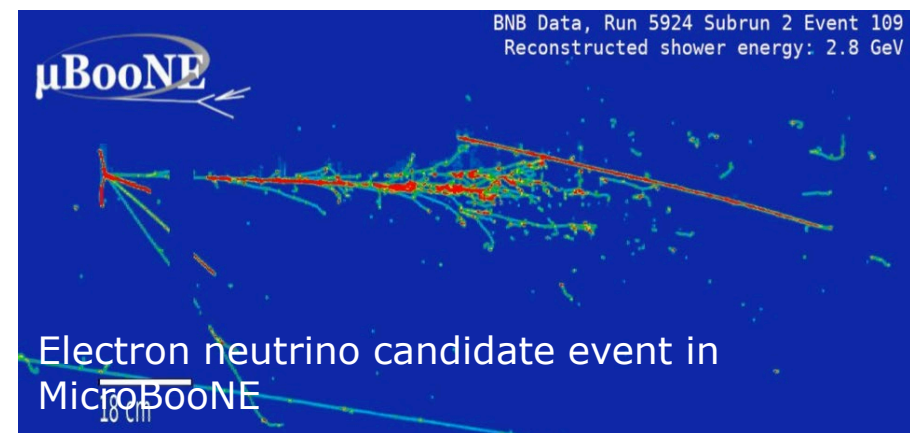
- ▶ Axions are a theoretical candidate particle to explain dark matter
  - ▶ Ten-trillionth of the mass of an electron, an axion would convert to a photon in the presence of a strong magnetic field
- ▶ Axion Dark Matter eXperiment Generation 2 (ADMX-G2) currently operating at U. Washington
  - ▶ 2021 results are 5-orders of magnitude better than previous limits, ruling out axion DM hypothesis in this mass-coupling range
  - ▶ Planned upgrades enable continuing search





# Intensity Frontier: MicroBooNE

- ▶ MicroBooNE is the longest-running liquid argon neutrino detector to date
  - ▶ MicroBooNE is producing a lot of firsts & critical work for FNAL Short-Baseline Neutrino Program, Deep Underground Neutrino Experiment (DUNE) → training the next generation
- ▶ Investigating excess of low energy electron-neutrino ( $\nu_e$ ) events observed by the MiniBooNE experiment's
  - ▶ Fourth type of "sterile" neutrino is one proposed explanation
- ▶ Results from first three years of MicroBooNE data are consistent with the nominal  $\nu_e$  rate expectations from the Booster Neutrino Beam
  - ▶ No excess of photon-producing events that would suggest MiniBooNE excess due to enhanced photon backgrounds
  - ▶ No excess of  $\nu_e$  events that would explain MiniBooNE excess from electron interactions alone
- ▶ Analysis underway using more MicroBooNE data, additional candidate interactions, improved analysis tools



# Summary of FY 2021 FOA Outcomes

- ▶ Funding Opportunity Announcements (FOAs) and National Laboratory Announcements (LABs) in FY21:
  - ▶ Continuation of Solicitation for the Office of Science Financial Assistance Program (“Open call” FOA)
  - ▶ Research Opportunities in High Energy Physics (“Comparative Review” FOA)
  - ▶ SC Early Career Research Program (FOA/LAB)
  - ▶ Instrumentation Traineeship (FOA)
  - ▶ Accelerator Science and Engineering Traineeship (FOA)
  - ▶ U.S.-Japan S&T Cooperation Program in HEP (LAB)
  - ▶ Microelectronics Co-Design Research (LAB)
  - ▶ SBIR/STTR (FOA)

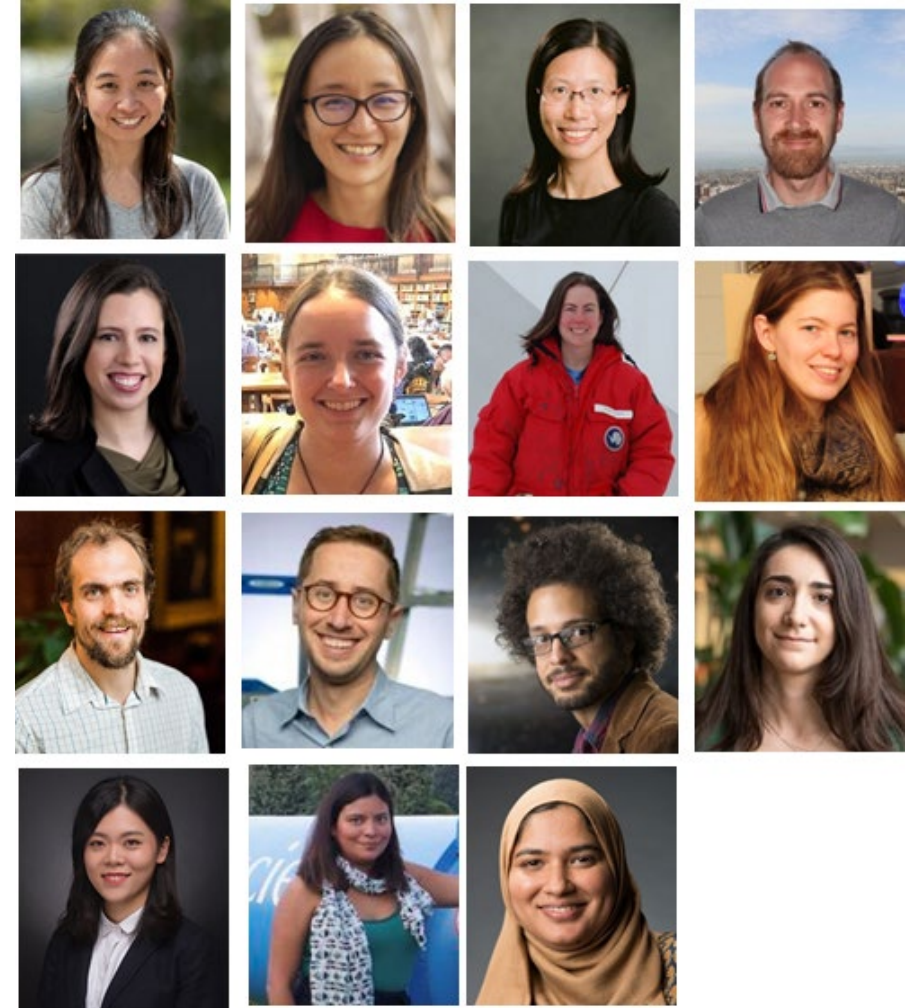
# FY21 Comparative Review

- ▶ FY 2021 Research Opportunities in High Energy Physics [DE-FOA-0002424] closed on 1/26/2021
  - ▶ 151 proposals submitted, 145 reviewed
    - ▶ 3 non-compliant, 3 duplicates
  - ▶ 93 proposals funded through 86 awards
    - ▶ Includes 7 merged into other awards and 15 funded in FY 2022
    - ▶ 52 declined; 64% success rate
  - ▶ Additional award statistics:
    - ▶ 28 new awards
    - ▶ 21 multi-thrust (umbrella) awards
    - ▶ 61 different institutions in 31 states
    - ▶ 15% of award PIs are women
  - ▶ Numbers of funded research thrusts (by sub program):
    - ▶ 19 Cosmic, 16 Energy, 24 Intensity, 11 GARD, 14 Detector, 32 Theory
    - ▶ PI counts of individual research thrusts range from 1-9
  - ▶ Total funding: \$97M, including \$33M in FY 2021

# FY 2021 SC Early Career Awardees

## HEP made 15 awards to the DOE Office of Science Early Career Research Program:

- ▶ Chiway Chang, University of Chicago
- ▶ Netta Engelhardt, MIT
- ▶ Philip Harris, MIT
- ▶ Xeuying Lu, Northern Illinois University
- ▶ Tongyan Lin, UC San Diego
- ▶ Diana Parno, Carnegie Mellon University
- ▶ Daniel Scolnic, Duke University
- ▶ Indara Suarez, Boston University
- ▶ Hai-Ye (Heidi) Wu, Boise State University
- ▶ Lindsay Bleem, Argonne National Laboratory
- ▶ Brian Nord, Fermi National Accelerator Laboratory
- ▶ Farah Fahim, Fermi National Accelerator Laboratory
- ▶ Simone Pagan Griso, Lawrence Berkeley National Laboratory
- ▶ Kiersten Ruisard, Oak Ridge National Laboratory
- ▶ Caterina Vernieri, SLAC National Accelerator Laboratory



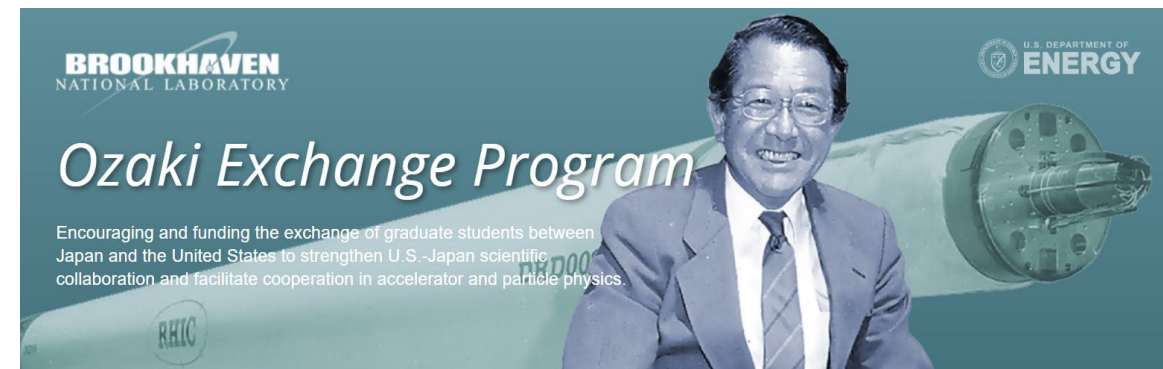


# FY21 HEP Traineeship Outcomes

- ▶ FY 2021 DOE Traineeships in Accelerator Science and Engineering [DE-FOA-0002489] and HEP Instrumentation [DE-FOA-0002496]
  - ▶ 17 proposals submitted, all reviewed, 5 proposals funded
    - ▶ Includes 1 funded in FY 2022
  - ▶ Total Funding: \$13.4M over 5 years
  - ▶ Awardees: Old Dominion U., *Graduate Traineeship in Accelerator Engineering and Science*. Consortium proposal with Hampton U., Norfolk State and Jefferson Lab
  - ▶ UC Davis, *HEP Consortium for Advanced Instrumentation Training*. Consortium with multiple UC campuses, Stanford and Caltech.
  - ▶ Michigan State U., *HEP Instrumentation Traineeship*. Jointly funded with NP.
  - ▶ Stanford U., *HEP IC Design Apprenticeship Program*. Consortium proposal.
  - ▶ Brown U., *Traineeship in Silicon Detectors, Quantum Sensors, and Electronics for HEP*. Consortium proposal. Jointly funded with QIS. (FY22)

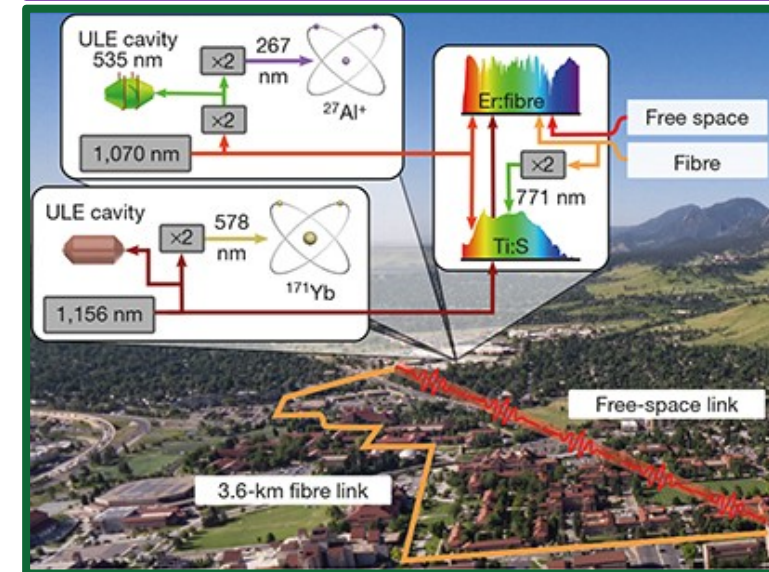
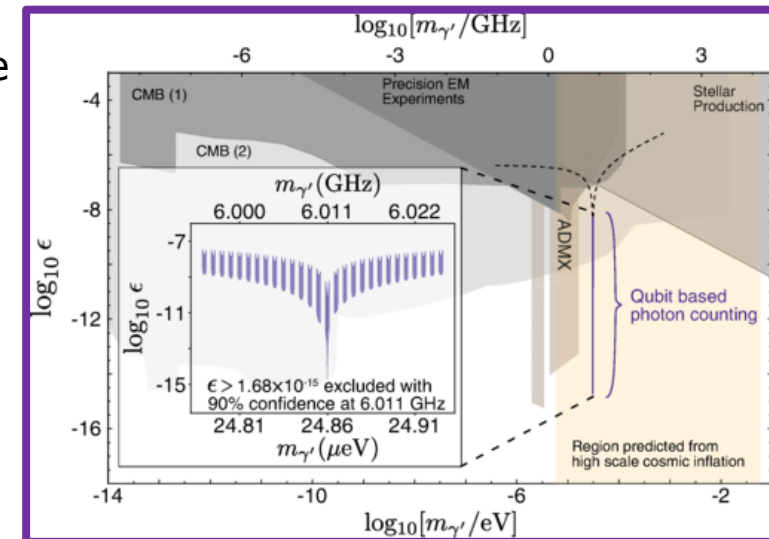
# U.S.-Japan Program Activities

- ▶ **U.S.-Japan Science and Technology Cooperation Program in HEP**
  - ▶ Started in FY 2017 to support bilateral cooperative research activities as part of the U.S.-Japan Science and Technology Cooperation Program in High Energy Physics
  - ▶ FY 2017 U.S.-side call issued through FOA and LAB
  - ▶ Since FY 2018, U.S.-side call issued through LAB only, universities participate via subawards in laboratory-led proposals
  - ▶ In FY 2021, began accepting multi-year proposals (up to 3 years)
  - ▶ FY 2022 LAB posted October 29, 2021, closes **December 15, 2021 @ 5 PM Eastern**
- ▶ **Ozaki Exchange Program**
  - ▶ Began in 2019 to encourage exchange of graduate students between Japan and U.S.
  - ▶ Strengthens U.S.-Japan scientific collaboration and facilitates cooperation in accelerator and particle physics
  - ▶ <https://www.bnl.gov/ozaki/>



# QuantISED Technical Progress Highlights

- ▶ **Successful readout of resonant cavities for dark matter detection with superconducting qubits**, achieving noise reduction 15.7 dB below the Standard Quantum Limit ( $\sim$ ties world record). A. V. Dixit, et al., *Phys.Rev.Lett.* 126 (2021) 141302
- ▶ **First bounds on ultralight dark matter based on optical atomic clock frequency ratios**. Beloy et al., *Nature* 591, 564 (2021) (ANL-NIST team – with BACON Collaboration)
- ▶ Sustained high-fidelity quantum teleportation system. R. Valivarthi et al *PRX Quantum* 1, 020317 – 2020; Caltech, FNAL JPL, AT&T, U. Calgary and Harvard
- ▶ Progress towards quantum models of the Big Bang and cosmology and their simulations on quantum Simulators; S. Antonini-B. Swingle *Nat. Phys.* (1907.06667); *Phys. Rev. D* (2105.02912)
- ▶ Discovered a new mechanism for many-body quantum teleportation, which generalizes previous traversable wormhole approaches. Potential experimental implementations on quantum simulators; Schuster et al arXiv:2102.00010 & Many-Body Chaos in the Sachdev-Ye-Kitaev Model Kobrin et al *Phys. Rev. Lett.* 126, 030602 (2021)
- ▶ Demonstrated quantum machine learning algorithm competitive with leading classical AI when applied to a real-world science problem (supernovae image classification) on a noisy quantum processor. E. Peters et al <https://arxiv.org/abs/2105.08161> (Fermilab – Google collaboration)

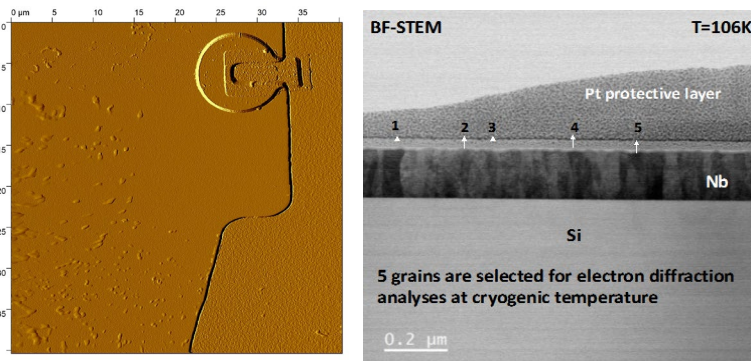




# HEP-led National QIS Research Center: Superconducting Quantum Materials and Systems (SQMS)

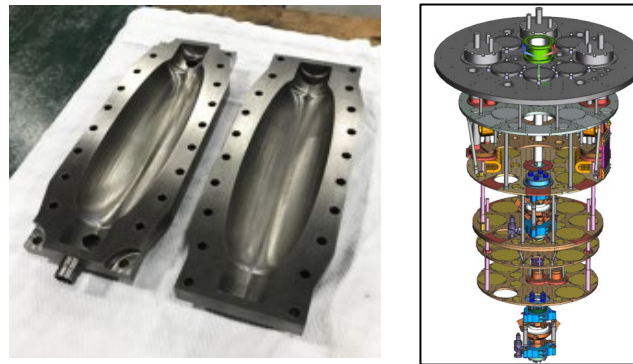
- ▶ HEP is the lead program for SQMS, one of five National Quantum Information Science Research Centers launched by DOE SC in September 2020
- ▶ SQMS is led by Fermilab, and involves more than 275 collaborators across 20 institutions (Federal labs, academia, and industry)
- ▶ A few areas of initial effort and technical progress:

Cryogenic materials analysis  
of superconducting qubits



Identification of previously unrecognized precipitants and interfacial phases limiting qubit performance

Development of new axion & dark photon search platforms



New measurements in Tesla magnetic fields and optimized cavity geometry; completed design for DarkSRF experiment in mK fridge at FNAL

Round robin measurements  
of quantum coherence



Standardization and cross-institutional benchmarking of performance enables common baseline to be established across numerous partners



# COVID-19 Mitigations

- ▶ Maximum flexibility for changes in current/new research awards, e.g.:
  - ▶ Extending student and postdoc terms, reducing travel
  - ▶ “switching” thesis experiments due to delays in data
  - ▶ *Please check with your program manager/point of contact if any questions.*
- ▶ No specific COVID relief funding has been provided to DOE to-date, so no additional funds available for direct mitigations
- ▶ Instead, we prioritized ongoing support for existing personnel, particularly GS and PD on Grants (i.e., Renewal proposals, some supplements) and lab awards. Proposals for new efforts were given a lower priority.
- ▶ We continue to monitor the situation going forward for FY22.

# COVID-19 Impacts

- ▶ All formerly in-person reviews, meetings are now remote via video conferencing
  - ▶ Not clear when we will be able to move to even partial in-person meetings
  - ▶ Pros: easier accessibility, greater flexibility, reduced travel
  - ▶ Cons: highly structured, little opportunity for informal interactions, Zoom fatigue/stress, technology issues
- ▶ We do rely on peer-reviewers being generous with their time, but it is *always* ok to decline review requests due to other commitments or work
  - ▶ To recognize reviewers' effort and time commitment, we piloted a modest "thank-you" via honoraria for some FY21 FOA reviews, which was well-received
  - ▶ If there are other ways we can support you to make your Research and related activities easier, please let us know

# FY22 Funding Opportunities

- ▶ **Current/planned HEP Solicitations for FY22:**
  - ▶ Continuation of Solicitation for the Office of Science Financial Assistance Program (“Open call” FOA)
  - ▶ Research Opportunities in High Energy Physics (“Comparative Review” FOA)
    - ▶ Closed Oct 5
  - ▶ Early Career Research Program
    - ▶ Pre-applications were due Oct 21, submission deadline **Jan 20, 2022**
  - ▶ **U.S.-Japan S&T Cooperation Program in HEP**
    - ▶ Closes **December 15, 2021, at 5 PM Eastern**
  - ▶ **HEP Traineeships (new topic)**
  - ▶ **Scientific Discovery through Advanced Computing (SCiDAC) for HEP**
  - ▶ **Artificial Intelligence and Machine Learning (AI/ML) R&D in HEP**
  - ▶ **REaching a New Energy Sciences Workforce (RENEW)**

# HEP Traineeships in FY22

- ▶ **Scope:** Call supports graduate traineeship programs in selected specialized topical areas:
  - ▶ **Accelerator Physics and Technology** (3<sup>rd</sup> call for proposals in FY21)
  - ▶ **HEP Instrumentation** (new in FY21)
  - ▶ **Computational HEP** (planned in FY22)
- ▶ **Program Planning/Context:**
  - ▶ These FOAs are planned to be issued every 1-2 years with rotating topical areas
  - ▶ Recommendations are based on mail-in reviews
- ▶ **Program Coordination:**
  - ▶ Review process will be coordinated with other SC programs that have overlapping technical requirements and interests, particularly Nuclear Physics
  - ▶ Awards may also be coordinated with RENEW program as appropriate
- ▶ **Application requirements:**
  - ▶ Eligible Institutions: Universities only (single or collaboration); must include DOE lab partnership(s)
  - ▶ Demonstrated history of success in graduate training/mentorship in technical areas; and/or research infrastructure in targeted areas desirable



# REaching a New Energy Sciences Workforce (RENEW)



- ▶ Outreach
- ▶ Listening tours & round tables to:
  - ▶ Gain understanding about challenges
  - ▶ Develop evidence-based solutions



- ▶ Identify unique SC Lab opportunities
- ▶ Partner with MSIs & professional societies
- ▶ Implement action plan

- ▶ Competitively support new traineeship awards resulting in:
  - ▶ “Hands on” experiences, mentoring, enhanced workforce DEI
  - ▶ Tracking of post-traineeship outcomes
  - ▶ Assessing program effectiveness



# FY22 Comparative Review

- ▶ FY 2022 Research Opportunities in High Energy Physics [DE-FOA-0002546] closed on 10/05/2021
- ▶ 143 proposals submitted, including 11(!) duplicates
- ▶ **Many changes implemented including:**
  - ▶ New Merit Review Criterion on the Quality and Efficacy of Recruitment and Mentoring Plans
  - ▶ A new Appendix to provide content describing Recruitment and Retention plans
  - ▶ A new (required!) format for reporting collaborators, advisors, and others who should probably not review the proposal due to possible conflicts of interest.
  - ▶ Required formats for Biosketches and reporting Current and Pending awards
  - ▶ A new (currently optional) budget format for multi-thrust proposals
- ▶ **Proposals are currently under review**

# Notes on DOE/SC FOAs

**Applicants should note some specific changes to DOE/SC FOAs for FY 2022. As always, please read the FOA carefully for details of specific requirements and consult the FAQ for common questions.**

- ▶ Identification of potential Conflicts of Interest among prospective reviewers:
  - ▶ Identify Ph.D. advisors, postdoctoral supervisors, advisees, recent co-authors and close collaborators.
  - ▶ SC provides an (optional) Excel template. The list must be included in tabular form in all SC proposals, required pre-proposals, etc.

**Several changes were implemented in FY 2021 that will be new to many applicants:**

- ▶ Biosketches and Current & Pending Support:
  - ▶ Applicants must use the NSF-approved formats available from Science Experts Network Curriculum Vita (SciENCv).
  - ▶ Part of an effort to reduce administrative burden by standardizing forms across agencies.
  - ▶ The new format is machine readable and (in future) searchable within the PAMS database.
  - ▶ All foreign government-sponsored talent recruitment programs must be identified in Current and Pending support.
- ▶ Reporting requirements
  - ▶ DOE is implementing (as-yet unspecified) enhanced reporting requirements for applications and awards.
  - ▶ Changes may be implemented before the award date or upon award modification (continuation, renewal, etc.)
- ▶ Early Career Research Program
  - ▶ Eligibility extensions for “major life events”. See FOA and FAQ for details.
  - ▶ Lab proposals will respond to the same ECRP FOA as university proposals and will be submitted through grants.gov

**Also note that DOE Orders (such as Foreign Visits and Assignments) do NOT generally apply to DOE/SC grants, unless specifically included in the terms of the award.**

# Small Projects

- ▶ In DOE HEP parlance, “small projects” are those which:
  - ▶ Do not fall under DOE Order 413.3 (<\$20M Total Project Cost or TPC)
  - ▶ Are generally aligned with P5 science drivers but not specifically called out in P5 Report
  - ▶ Are managed in the Research programs using Order 413.3 principles
  - ▶ Recent examples: Dark Matter New Initiatives (DMNI) - several under development; Intermediate Neutrino Program (→ ANNIE, COHERENT, PROSPECT)
- ▶ Now that Snowmass/P5 process is re-starting, we are not considering new project proposals at this time for projects >\$10M TPC
  - ▶ Physics studies and directed R&D for new projects is OK
- ▶ Anything above this cost level that is not already in-process (such as DMNI) will need to go through Snowmass/P5 for science vetting
  - ▶ There may be exceptions for strategic projects



# HEP Research Reviews in FY21

- ▶ Review process largely restarted (all-virtual)
- ▶ This table shows some highlights, but does not include many of the “usual” activities (eg, budget, lab plans) or Project (OPA) Reviews. **Most Lab Comparative Reviews moved to FY22, may be in-person or hybrid.** Others Delayed from FY20/rescheduled to FY2021

Date	Activity
Oct/Nov-20	Belle-II Ops, GARD Roadmap Review (Magnets)
Feb-21	SBIR Phase I
Mar-21	HEP Comparative Review
Apr-21	SBIR Phase II, US-Japan lab call, Early Career
May-21	Lattice QCD
Jun-21	Dark Matter New Initiatives, Cosmic Frontier Lab Review, Accel Stewardship
Jul-21	LANL Institutional Review
Aug-21	ANL Institutional Review
Oct-21	AMS Review, Rubin Observatory Joint DOE/NSF Review

# Planned Research Reviews in FY22

- ▶ Review process on “normal” schedule
  - ▶ We are actively adjusting to load-balance. Dates subject to change.
  - ▶ Same caveats as previous slide. **No in-person reviews** until at least Jan 2022; if allowed, TBD whether they will be in-person or hybrid.

Target Date	Activity
Nov-21	HEP Comparative Review
Jan-22	Rubin Facility Operations
Feb-22	SBIR Phase I
Mar-22	Detector R&D Lab Review, Early Career
Apr-22	SBIR Phase II, US-Japan lab call
May-22	Energy Frontier Lab Review, Cosmic Ops, FNAL Accel Ops
Jun-22	Dark Matter New Initiatives, FACET II Ops
Jul-22	SURF Ops, [Snowmass (Seattle)]
Aug-22	SLAC Institutional Review
Sep-22	Rubin Observatory Joint DOE/NSF Review

# Summary

- ▶ There has been a lot going on in the past year in HEP Research:
  - ▶ Awards
  - ▶ Science Highlights
  - ▶ FY21 Proposals and Reviews march on
    - ▶ Including New topics : HEP Instrumentation Traineeships and Microelectronics
- ▶ We expect a busy year in FY22:
  - ▶ Of course, more great science
  - ▶ FY22 Review process on ~normal schedule but evolving remote v. in-person balance
  - ▶ Several new calls/topics: Traineeships, SciDAC, AI/ML, RENEW



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# HEP QIS Core Research: QuantISED

## Quantum Information Science Enabled Discovery (QuantISED) began in FY18

- ▶ Synthesizes **QIS for HEP** and **HEP for QIS** in alignment with SC
- ▶ Intersects all the HEP frontiers and thrusts (via PIs and connected topics)
- ▶ Some interagency partnerships (with DOD & NIST) and one formal UK collaboration (via FNAL)
- ▶ Lab-University partnerships for Lab program
- ▶ University consortia for University Program
- ▶ Workforce development embedded due to interdisciplinary collaborations
- ▶ QuantISED has made significant progress and impact including publications and citations in these topical areas (aligned to national QIS Categories):
  1. **Cosmos and Qubits** – connecting cosmic physics to qubit protocols and lab simulations
  2. **Foundational Theory** – formulations of gauge theories targeting quantum computing
  3. **Quantum Computing & Communication** – quantum ML, computing, communications including QN
  4. **Quantum Sensors** – developing quantum sensors beyond SQL using QIS techniques (for HEP & QIS)
  5. **QuantISED Experiments** – exploring BSM/new physics using quantum sensors including MAGIS
  6. **QIST/QISE** – research technology applying HEP technology and tools for QIST