U.S. DEPARTMENT OF ENERGY | Office of Science

Office of High Energy Physics (HEP) Cosmic Frontier

Astronomy & Astrophysics Advisory Committee

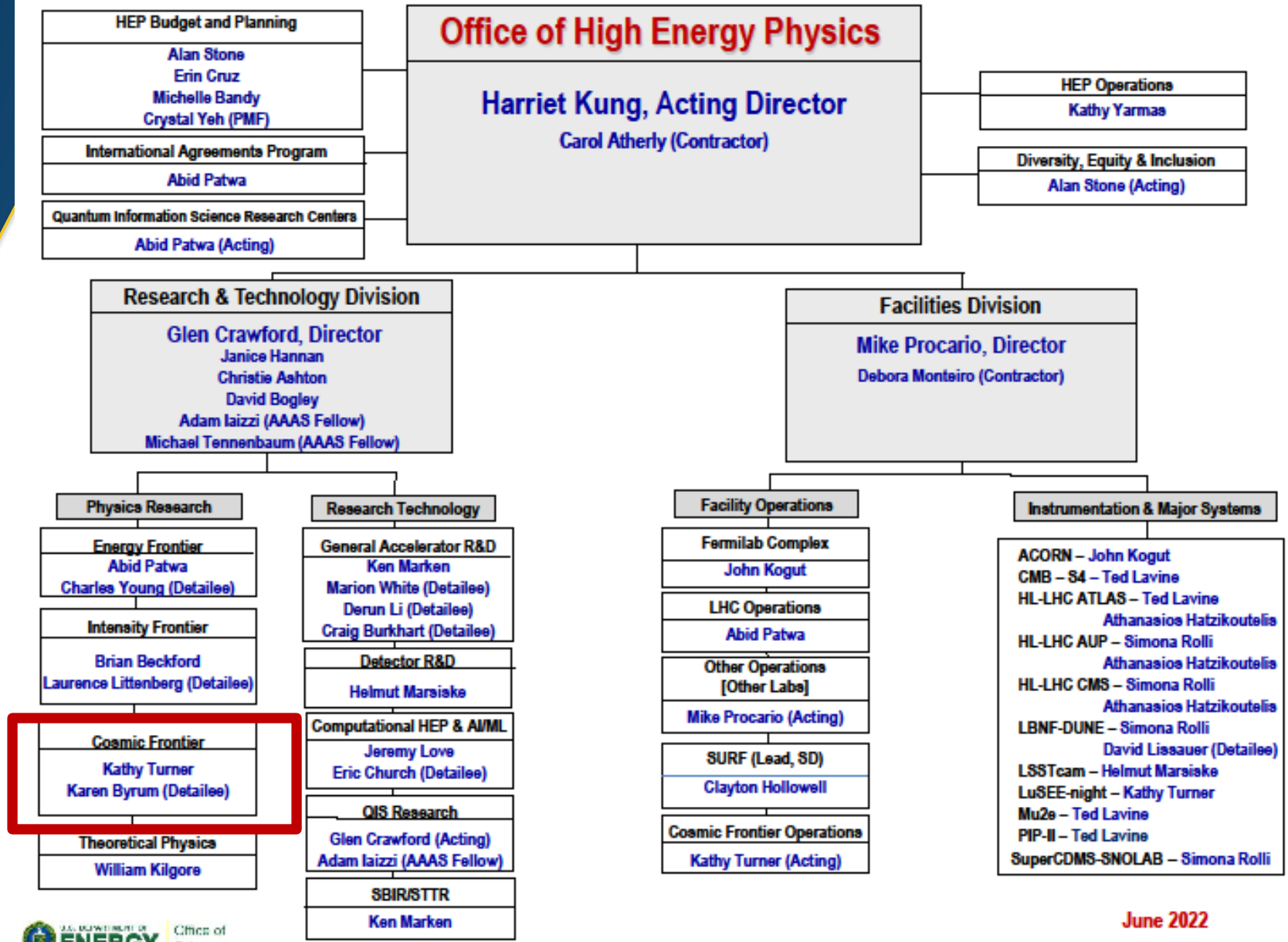
June 6, 2022

Kathy Turner

Experimental Research at the Cosmic Frontier
Office of High Energy Physics, Office of Science (SC)

OUTLINE

- HEP Program: Intro, Guidance, Budget
- Cosmic Frontier Program Details
- Astro2020 & AAAC Recommendation & DOE comments



HEP Cosmic Frontier group also includes:
Elgin Leary (DOE scholar, summer intern)

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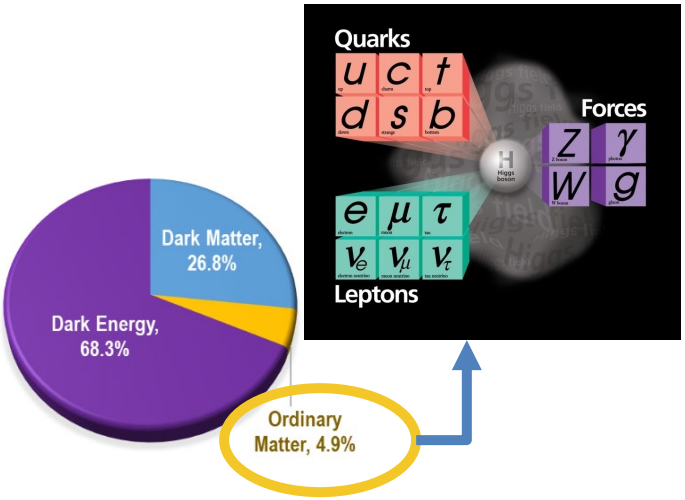
HEP Program:
Intro, Guidance, Budget

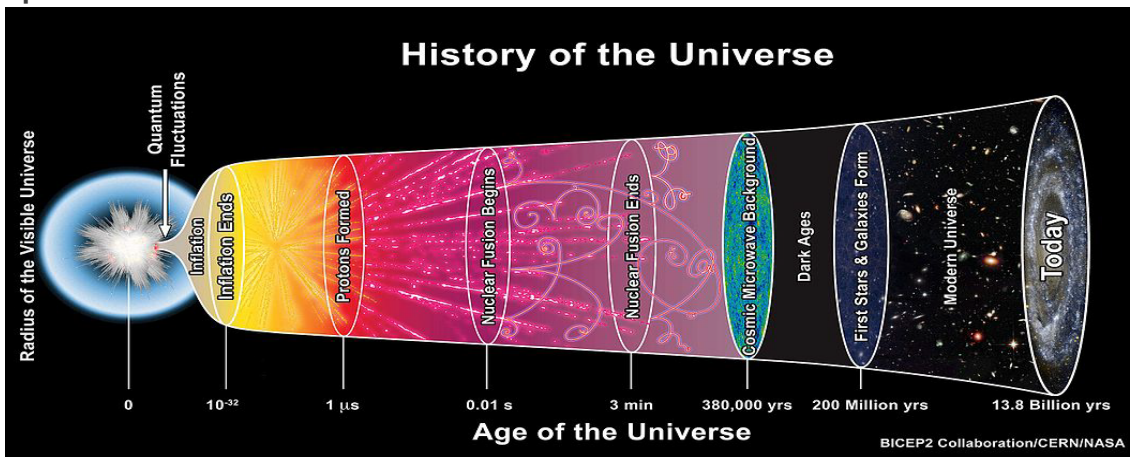
The Office of High Energy Physics (HEP) Program Mission

DOE is a mission-oriented agency → mission includes **maintaining a vibrant U.S. effort in science and engineering as a cornerstone of our economic prosperity with clear leadership in strategic areas.**

HEP's mission is to understand the universe at the most fundamental level:

- Discover the elementary constituents of matter and energy
- Probe the interactions between them
- Explore the basic nature of space and time

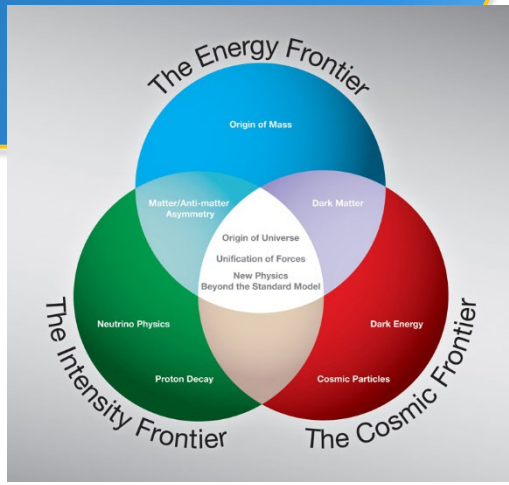




➔Scientific Areas are intertwined: High Energy/Particle Physics, Cosmology, Astrophysics, and Astronomy.

DOE supports ~ 85% of the U.S. HEP effort (in $) at Universities + National Labs

HEP Program Layout



HEP is carried out along 3 Frontiers:
Advancements at all 3 frontiers are needed to achieve the long-term goals of the field.
→HEP is primarily a Particle Accelerator based program: **Energy & Intensity Frontiers**

→Cosmic Frontier is an increasingly important area for discovery. Experiments use naturally occurring data to provide additional input to the Standard Model picture: Cosmic Acceleration (Dark Energy, Inflation), search for Dark Matter particles, Neutrino properties, New Physics (e.g. relic particles, etc)

Crosscutting HEP subprograms:

- Theoretical research, High Performance Computing & Computational HEP, Advanced Detector R&D, Quantum Information Science (QIS).

HEP Program Guidance

FACA panels & subpanels provide official advice:

- **High Energy Physics Advisory Panel (HEPAP)**
  - Advises **DOE & NSF: Provides the primary advice for the HEP program**
  - Subpanels: **The Particle Physics Project Prioritization Panel ("P5") provides the Strategic Plan for HEP**
- **Astronomy and Astrophysics Advisory Committee (AAAC)**
  - Advises **DOE, NASA, & NSF** on issues of overlap, mutual interest and concern
  - Subpanels: CMB-S4 Concept Definition Taskforce (2017), Gemini-Blanco-SOAR Telescopes roles (2019)

Advice Also Provided by: National Academy of Sciences (NAS)

- **Decadal Surveys in Astronomy & Astrophysics (Astro2010 → Astro2020)**
- Decadal Survey of Elementary Particle Physics being planned
- Board on Physics & Astronomy (BPA), Committee on Astronomy & Astrophysics (CAA)

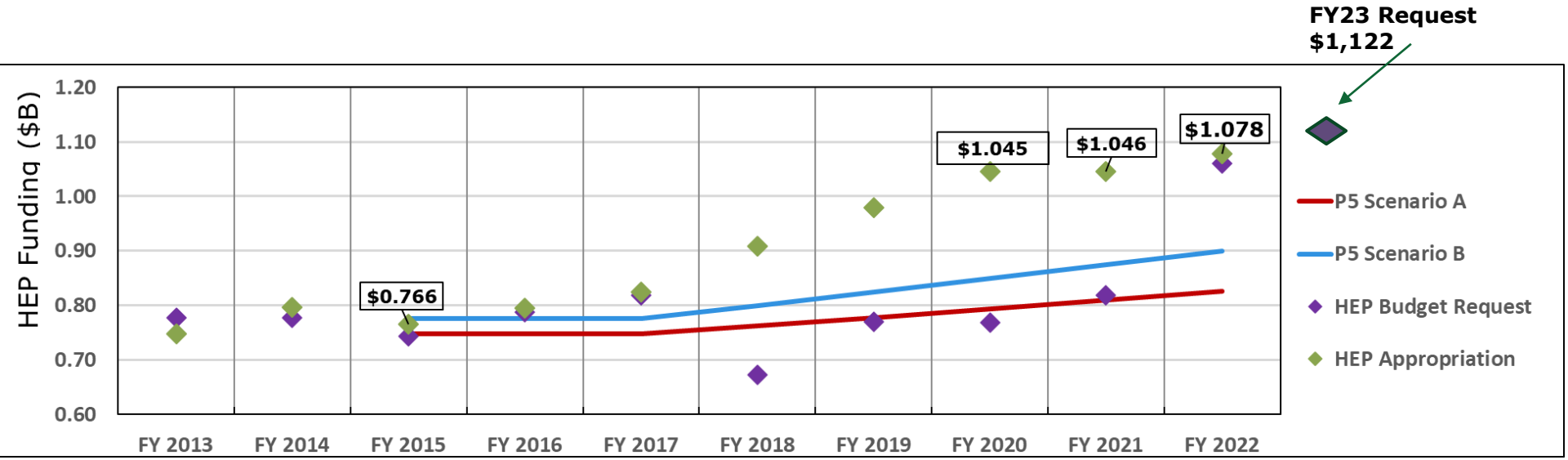
Other Input & Coordination

- Community studies & input, e.g. Snowmass, APS/DPF
  - Basic Research Needs (BRN) studies to start development of new HEP initiatives

HEP is continuing to carry out the 2014 P5 Strategic Plan

- The **projects** selected for the P5 strategic plan make significant leaps in addressing HEP science goals.
- U.S. Congress continues to show strong support for executing the P5 strategy, and for accelerating the pace of projects
- When the P5 report was released in May 2014, the FY 2015 budget was already in Congress and the FY 2016 budget was being formulated
- Arguably the first impact (success!) of the P5 strategic was not seen until FY 2016, and continues today…

- The **FY2023 President's Request** continues strong support of the P5 plan.



HEP Budget: FY2022 Enacted, FY2023 Request

HEP Funding Category ($K)	FY 2020 Actual	FY 2021 Request	FY 2021 Enacted	FY 2021 Actual	FY 2022 Request	FY2022 Enacted	FY2023 Request
Research	389,646	328,906	398,203	408,163	419,605	416,605	418,646
Facilities, Exp. Operations	317,310	285,725	314,297	304,337	309,395	290,395	313,374
Projects	338,044	203,500	333,500	333,500	332,000	371,000	390,000
Total	**1,045,000**	**818,131**	**1,046,000**	**1,046,000**	**1,061,000**	**1,078,000**	**1,122,020**

FY2022 Enacted

- HEP received $1,078M in the FY 2022 Congressional Appropriation, +$17M above the FY 2022 President's Budget Request, and +$32M above FY 2021 Appropriations
- Congressional direction fixed LBNF/DUNE, PIP-II, and Mu2e at 176M, 90M, and 2M respectively, which is +$16M over FY 2021 funding levels
- Additional direction provided floor and ceiling limits for SURF, **CMB-S4**, HL-LHC Upgrade projects and LBNF/DUNE OPC and approved **LuSEE-Night** (new project with NASA)
- Congressional direction at the SC level for QIS and AI/ML propagated down to HEP
  - AI/ML $35.8M, and QIS & QIS Center $51.6M → +$8.8M over FY 2021 funding levels

FY 2022 Budget Enacted – Guidance to HEP

The agreement provides not less than $30,000,000 for the Sanford Underground Research Facility, up to $20,000,000 for Cosmic Microwave Background-Stage 4, and not less than $40,000,000 for the HL-LHC Upgrade projects.

The agreement supports activities for the LuSEE-Night project.

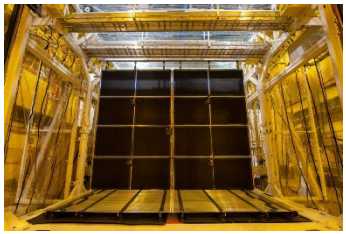
The agreement provides up to $13,000,000 for other project costs for the Long Baseline Neutrino Facility / Deep Underground Neutrino Experiment. Further, if the Department deems it necessary to provide further funding for this project, it is encouraged to seek a reprogramming, but these funds shall come from other research activities and projects currently funded at Fermi National Laboratory.

FY 2023 HEP Budget Request Highlights

FY 2023 Request for ~$1,122M focuses resources on the highest priorities in fundamental research, operation and maintenance of scientific user facilities, facility upgrades, and projects identified in the 2014 Particle Physics Project Prioritization Panel (P5) report.

- **Experimental HEP** is "mission-driven":
  - Develops and supports a specific portfolio of projects. Emphasis is placed on supporting science collaborations in all stages, conducting experiments, and seeking the best possible science results.
  - Makes significant, coherent contributions to facilities & experiments selected for the program, including project management.
  - Supports R&D that will advance the state-of-the-art in particle accelerators & detectors, which will lead to new, more capable facilities.
  - Supports R&D to enable new and transformative capabilities in QIS, AI/ML, and crosscutting technology areas.
- **Theory** funding supports activities that provide the vision and the mathematical framework for understanding and extending our knowledge of particles, forces, space-time, and the universe.

Main Injector at the Fermilab Accelerator Complex



Short-Baseline Neutrino Detector at Fermi National Accelerator Laboratory

LZ direct dark matter search experiment at SURF

CMS Detector at LHC in CERN

HEP supports ~85% of U.S. particle physics (in $), including ~all national labs.

Office of Science & HEP -- [New] Initiatives in Research funding

HEP budget (in $K)	FY20 Enacted	FY21 Enacted	FY22 Enacted	FY23 Request
Artificial Intelligence & Machine Learning (AI/ML)	15.0	33.5	35.8	40.0
Integrated Computational & Data Infrastructure (renamed to Advanced Computing in FY23 Request)			4.1	5.146
Microelectronics		5.0	7.0	7
Quantum Information Science (QIS)	23.5	20.1	26.6	25.566
Quantum Center	15.0	25.0	25.0	25
Reaching a New Energy Sciences Workforce	0.0	0.0	4.0	8
Accelerate Innovations in Emerging Technologies				4
Accelerator Science and Technology Initiative (ASTI)	0	6.3	17.4	10
Funding for Accelerated, Inclusive Research (FAIR)				2

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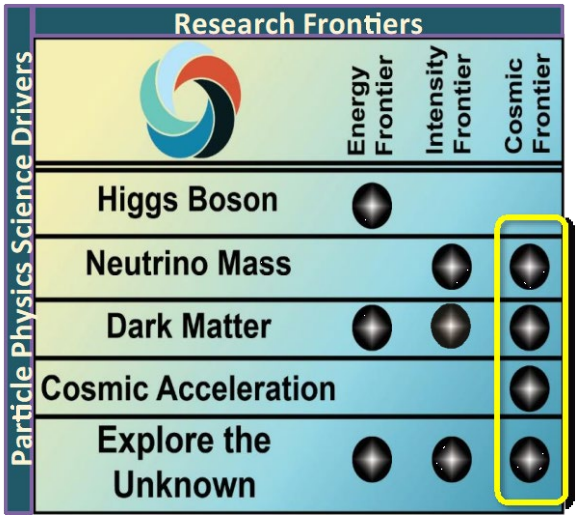
Cosmic Frontier – Intro, Budget, Guidance

Cosmic Frontier Experimental Research Program

Cosmic Frontier researchers use naturally occurring cosmic particles and phenomena to reveal the nature of dark energy and dark matter, comprising ~95% of the universe, understand the cosmic acceleration caused by dark energy and inflation, infer neutrino properties, and explore the unknown.

→Carrying out program with specific projects recommended by P5:



Cosmic Acceleration:

- Study the nature of **Dark Energy** using imaging & spectroscopic surveys
- Use the **CMB** to study the Inflation
- Search for the Dark Ages signal

Dark Matter

- Direct Detection searches for **Dark Matter** particles using a variety of methods and technologies

Neutrinos - Constrain properties using dark energy & CMB measurements

Exploring the Unknown - Always interested in New Physics!

- Partnerships w/NSF-PHY, NSF-AST, NSF-OPP, NASA, and/or International
- Significant contributions & support from other HEP areas (e.g. Theory, Advanced Detector Development, Computational HEP, QIS, AI/ML) and other SC areas (e.g. ASCR Supercomputing resources)

Cosmic Frontier – Program Planning & Execution

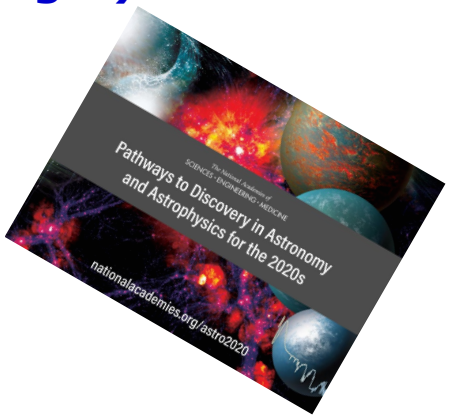
Astro2010 recommended DOE/NSF partnership on LSST (Rubin)

P5 (2014) strategic plan recommended science & project priorities in Dark Energy, Dark Matter (direct detection) & CMB

- Cosmic Acceleration
  - Dark Energy: build **LSST (Rubin) & DESI**
  - CMB: support as part of the core program within multi-agency context; carry out multi-agency **CMB-S4** project later in the decade
- Dark Matter: suite of "generation 2" direct detection experiments – **ADMX-G2, LZ, SuperCDMS SNOLAB**
- Maintain a portfolio of small projects: e.g. we are carrying out **ADMX-G2, SPT-3G, (**carrying out **Dark Matter New Initiatives, LuSEE-Night)**

Astro2020 recommended:

- DOE/NSF partnership on CMB-S4
- Efforts on diversity, equity, inclusion, demographics, data, etc. (joint with NSF & NASA)



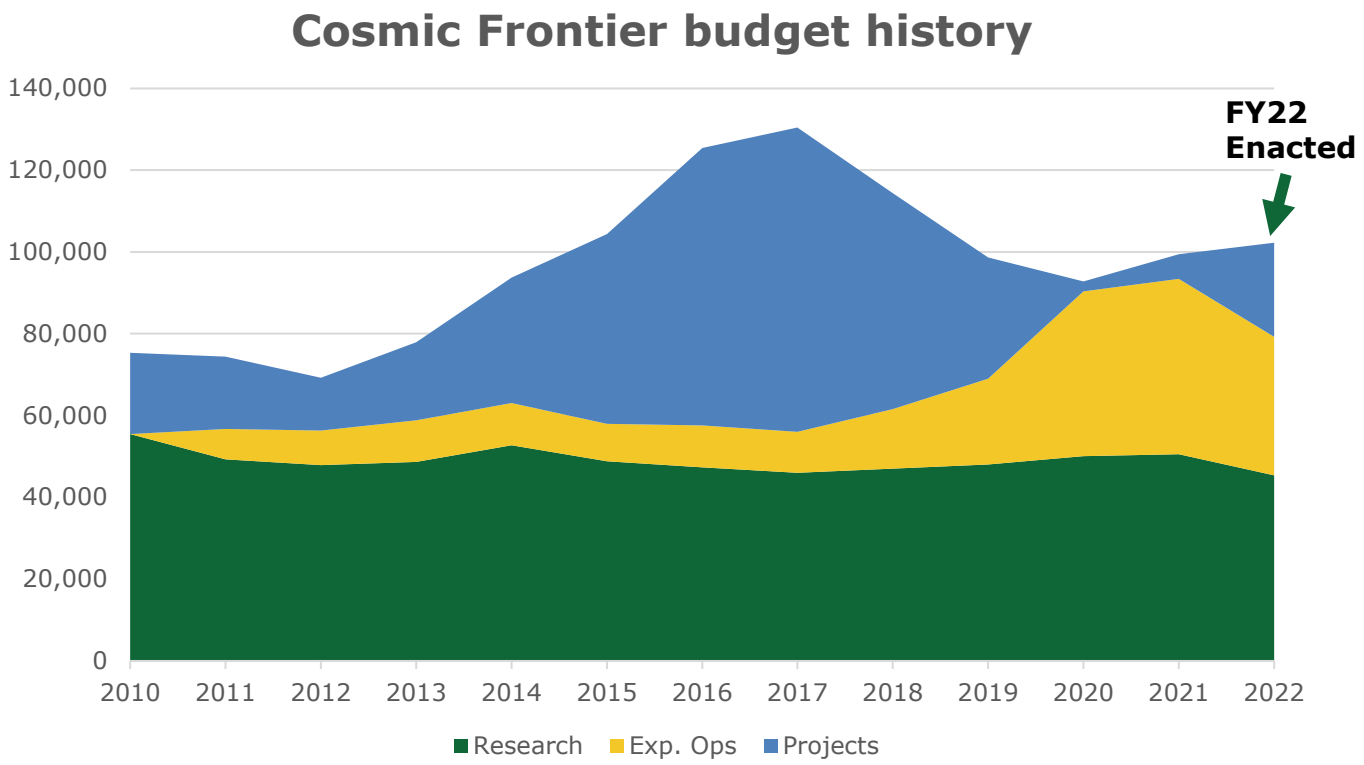
Cosmic Frontier Budget

Cosmic Frontier ($K)	FY2019 Actual	FY2020 Actual	FY2021 Actual	FY2022 Enacted	FY2022 Current	FY2023 Request
Research (Univ+Lab)	*48,053*	*44,264*	*43,901*	*38,552*	*39,939*	*42,213*
Future R&D	*3,265*	*2,480*	*1,700*	*1,926*	*1,475*	*0*
AI/ML Research for CF		3,351	4,920	4,920	4,900	4,817
Experimental Ops.	20,957	40,235	42,880	33,829	44,350	45,851
Projects	26,350	2,450	6,000	23,000	23,000	1,000
DESI	*9,350*	*0*	*0*			*0*
LZ	*14,450*	*0*	*0*			*0*
SuperCDMS	*2,550*	*0*	*0*			*0*
CMB-S4	*-*	*2,450*	*6,000*	*8,000*	*8,000*	*1,000*
LuSEE-Night				*15,000*	*15,000*	
Total	**98,625**	**92,780**	**99,401**	**102,227**	**113,664**	**93,881**

The FY2022 Enacted is the starting budget, without additional distributions and changes through the year.

- Research: Scientist support for world-leading efforts in design and optimization in their planning, fabrication, commissioning, operations and data production/analysis.
- **Operations:** Commissioning and facility operations planning for LSST/Rubin; operations of FGST/LAT, SPT-3G, ADMX-G2, DESI, LZ; pre-operations activities for SuperCDMS-SNOLAB.
- **Projects:** CMB-S4, LuSEE-Night

Cosmic Frontier Budget History



Projections:

- **Experimental Operations**: As the current Projects complete, estimated needs ramps up to ~ $55M to $60M by FY2024; levels to ~ $40M by FY2030.
- **Future opportunities**: Compelling Cosmic Frontier Projects will be considered and supported within available overall HEP Project funds. Guidance from Astro2020, next P5

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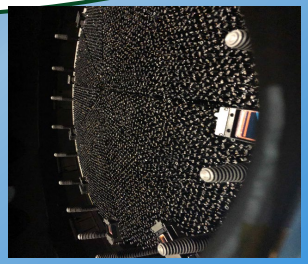
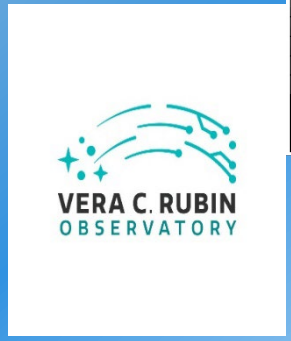
Cosmic Frontier Program & Project Details

- **Cosmic Acceleration**
  - **Dark Energy: DESI, Rubin/LSST**
  - **CMB: SPT-3G, CMB-S4**
  - **Dark Ages: LuSEE-Night**
- **Dark Matter**

HEP Cosmic Frontier: Cosmic Acceleration

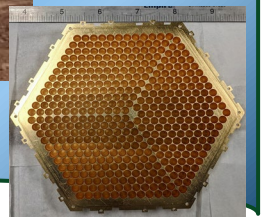
Dark Energy





Pinhole camera 3.2Gpixel image of Vera C. Rubin

CMB



Dark Ages

Dark Energy Spectroscopic Instrument (DESI) Experiment

DOE's DESI started its 2nd year of operations in May.

- World's premier multi-object spectrograph w/5,000 fibers, positioned robotically

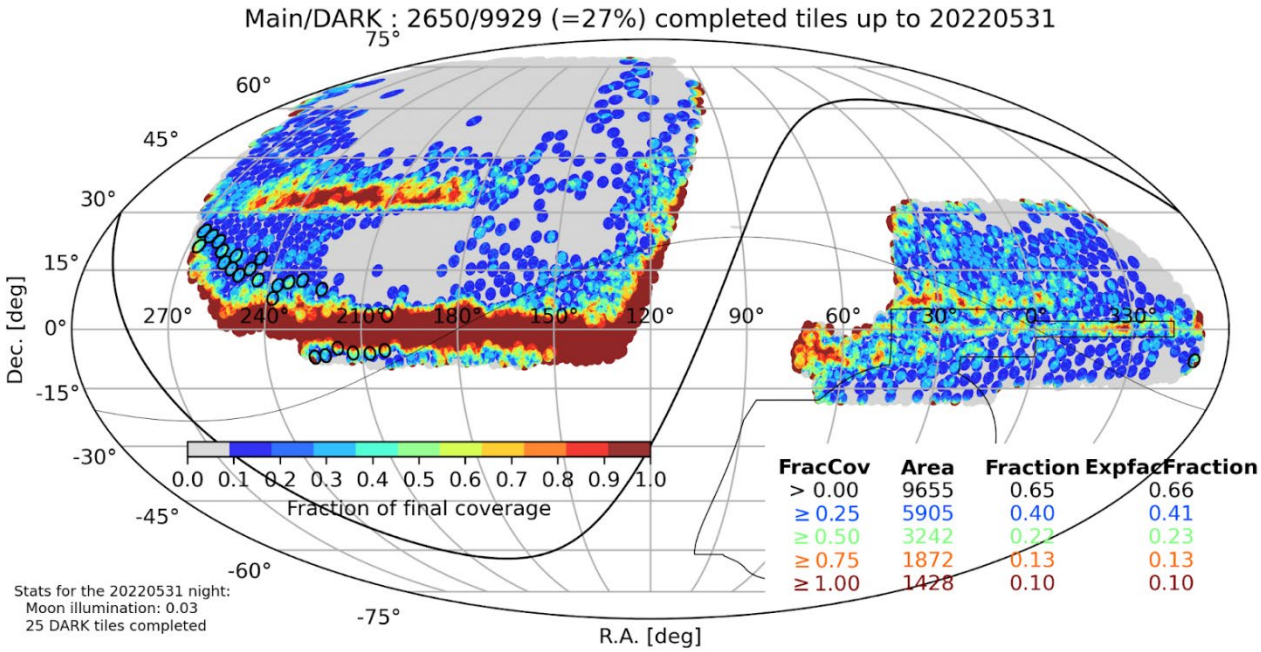
First **Stage IV dark energy** ☐ Will measure spectra of > 40 million galaxies

Running at full steam →

- **Continues successful data-taking: 10 Million extra-galactic redshifts recorded (more than all other surveys combined)**
- **Dark time survey > 27% complete; Bright time survey ~ 40% complete.**

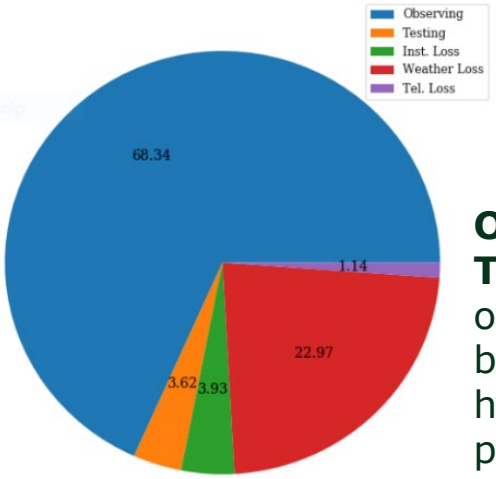
DOE/LBNL Project: Instrumentation, Data Management System, & Upgrades of NSF's Kitt Peak Mayall telescope (including MOSAIC camera).

Operations: DOE provides full support for NSF's Mayall telescope.



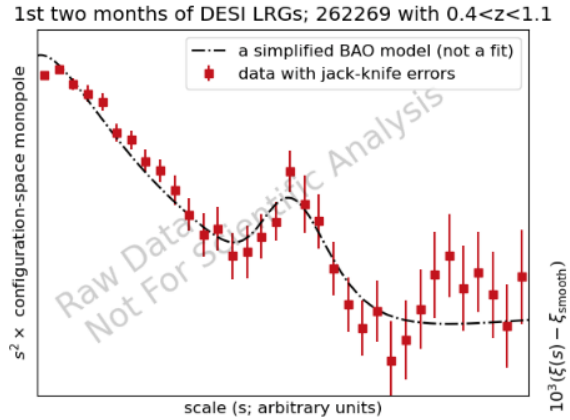
DESI Collaboration - First Year Progress

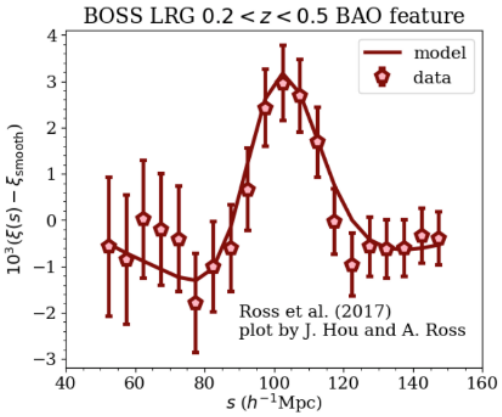
DESI Highlights

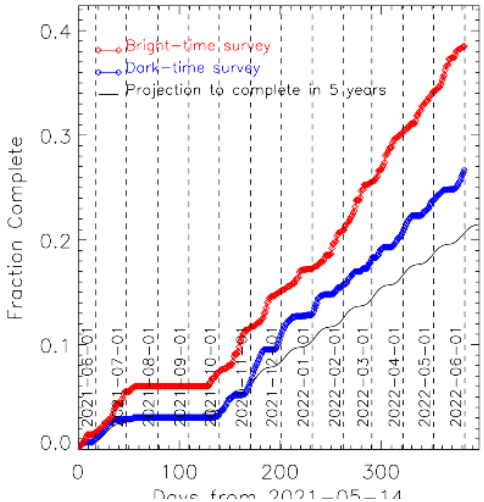


Observing Time – optimal & better than historical predictions

May – July 2021 data of 370k Luminous Red Galaxies. **Raw data shown here as a comparison to BOSS 2008-2014 data.**







Schedule: ahead of projected timelines

1st year of main survey observations concluded May 14, 2022.

Outreach & Education
The team presented at the Smithsonian National Museum of American History in April 2022 on Making the Largest Map of our Universe

Vera C. Rubin Observatory

A next-generation, ground-based facility, providing time-lapse imaging of faint astronomical objects across the entire visible sky every few nights.

NSF (AURA) and DOE (SLAC) partnership, with private, international contributions

- Project: DOE responsible for the LSST Camera fabrication & commissioning

LSST Camera project completed Sept. 2021.

HEP Commissioning roles

- LSST Camera assembly and verification at SLAC; Ready to ship to Chile (~ spring 2023) & then installation & commissioning on telescope (~ fall 2023)

Facility Operations: 50/50 DOE & NSF split; DOE responsible primarily for camera maintenance and operations, US Data Facility

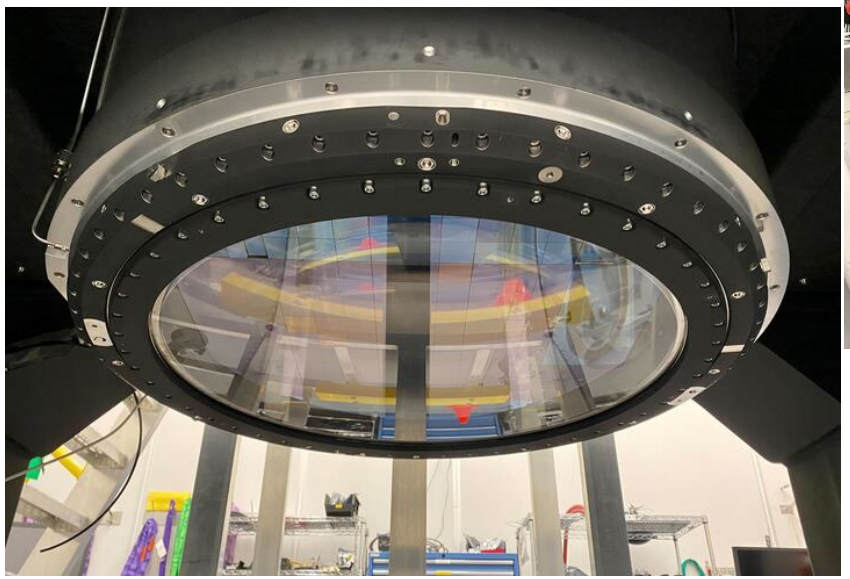
- **Successful joint NSF/DOE review in Feb. 2022.**

LSST Camera Commissioning

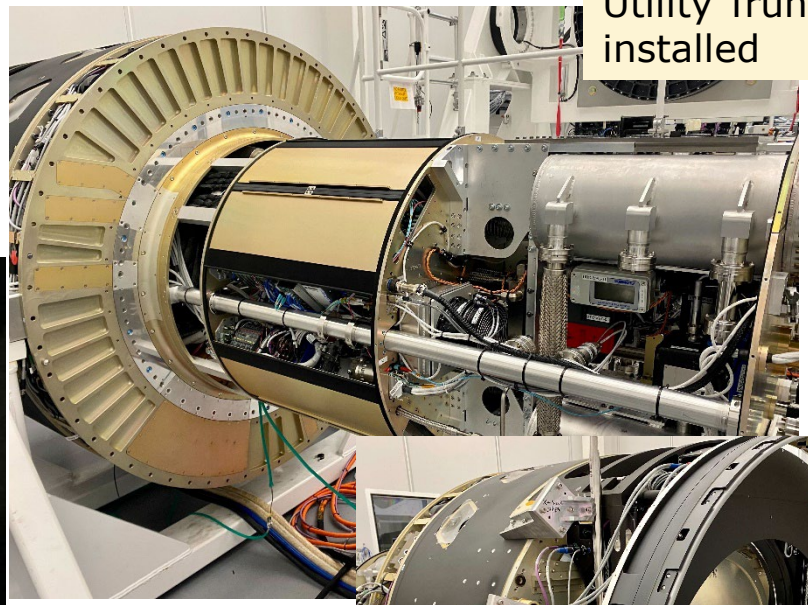
HEP Commissioning roles – LSST Camera

- Assembly and verification at SLAC + preparations in Chile
- Ready to ship to Chile (~ Spring 2023)

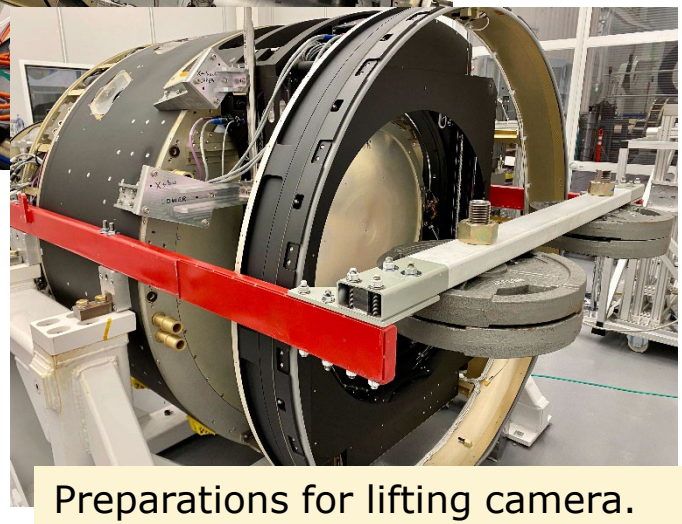
Final lens, L3, installed on the cryostat. L1 and L2 installation planned for June w/alignment through July.



In June: preparations for shutter installation



Utility Trunk door installed



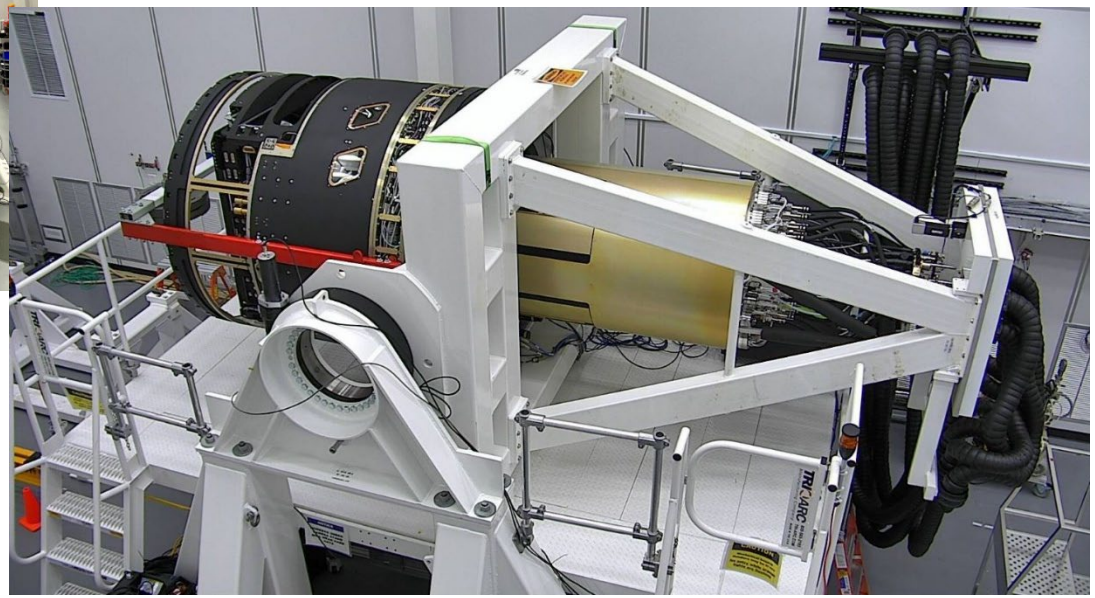
Preparations for lifting camera.

LSST Camera Commissioning

- Moving forward with new "pumped coolant" refrigeration system due to stability issues in the current system; Final Design Review being held Aug. 2022

Camera being lifted.

Camera in its integration stand.



LSST Camera Commissioning

The LSSTCamera team has conducted successfully the removal of the filter auto-changer from the camera. This is needed to allow installation of the shutter.

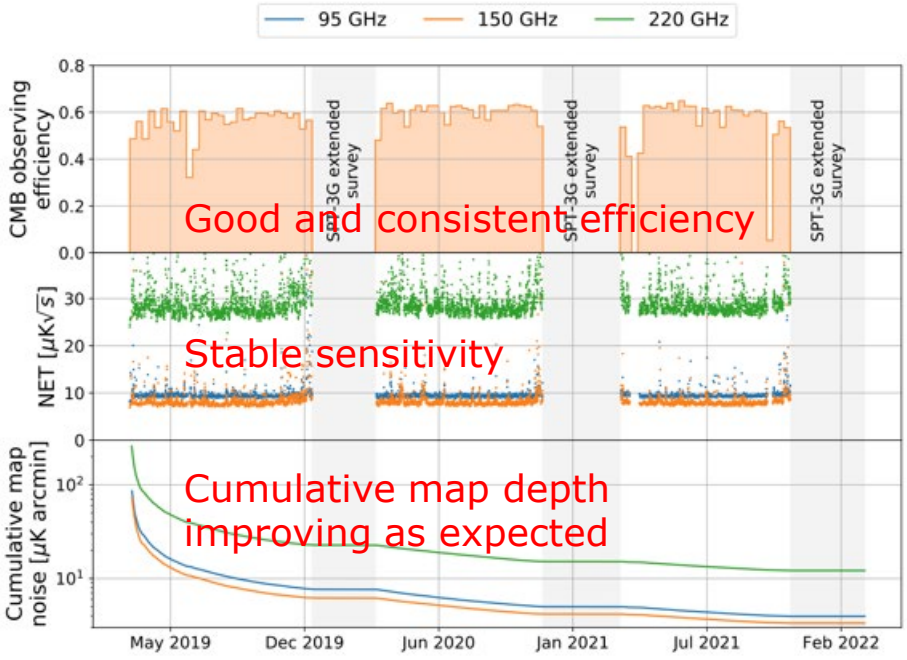
South Pole Telescope (SPT-3G)

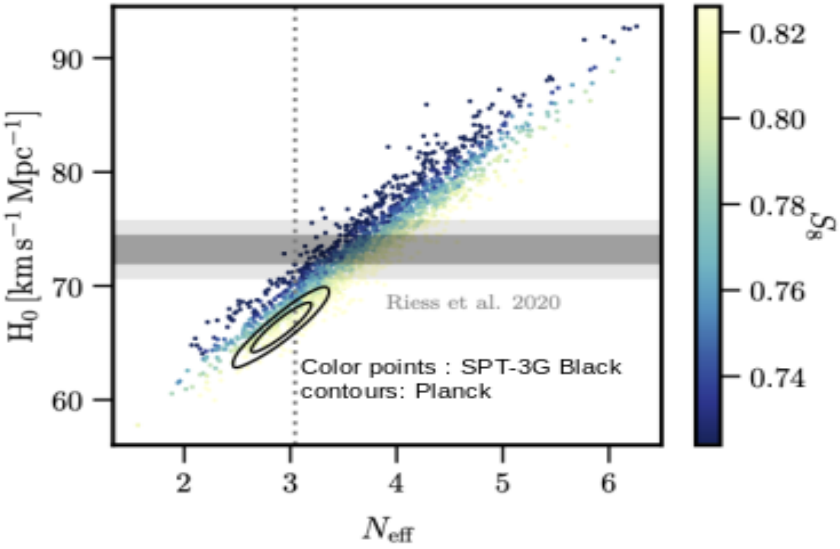
Gain insight into inflationary epoch at the beginning of the universe, dark energy & neutrino properties by studying oldest visible light.

- **P5 recommended DOE should support CMB experiments in the core program.**
- **P5 recommended CMB- S4; planned to be the next flagship HEP project**

NSF & DOE partnership

HEP supported major upgrade: fabrication of the 16,000-detector focal plane, greatly increasing sensitivity; in operations since 2018





SPT-3G science publication

- EE/TE Parameter Constraints
- Better confining the value of H_0

Balkenhol et al. DOI:10.1103/PhysRevD.104.083509
Submitted to Physical Review D

Survey started 2018; continues to operate smoothly with high observing efficiency. From 2019/2020 data a galaxy cluster catalog is being made

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Astro2020 Science/Project Recommendations

Astro2020 Science Theme:
New Messengers and New Physics ➔ CMB

Priority Area: New Windows on the Dynamic Universe

Capabilities include:

- Discover and characterize the brightness and spectra of transient sources
- Ground-based ELTs to see light coincident with mergers
- Radio observatory to detect the relativistic jets from neutron stars & black holes
- **Next generation CMB telescopes to search for the polarization produced by gravitational waves in the infant universe**
- Upgrades to current ground-based gravitational wave detectors & technology development
- Improvements in the sensitivity and angular resolution of high energy neutrino observatories

Recommendation(p. 7-26): DOE/NSF partnership on CMB-S4

NSF & DOE should jointly pursue the design & implementation of the next generation ground-based cosmic microwave background experiment.

Key Attributes

Balanced program between DOE (60%) and NSF (40%) for all phases
Brings wide range of technical & scientific expertise from community & national labs
Total design, development and construction cost: $660M; First observations ~ 2030

"An important requirement for our strong endorsement is that the project broadly engage astronomers beyond the traditional CMB community.

CMB-S4

CMB-S4 builds on the foundation of decades of CMB measurements to take a major leap, pushing CMB science to the next level, with scientific goals:

- B-mode CMB polarization signatures of primordial gravitational waves & inflation
- Maps 50% sky, every other day from 0.1-1 cm with unprecedented sensitivity
- Broad science including systematic time domain science

Goal: cross critical science thresholds, including definitive tests of Inflation

Project plan sent to Astro2020

21 telescopes, in 2 aperture scales, at 2 sites:

- 2 large aperture (6m) in **Chile;** Deep & wide N_{eff} & Legacy Survey ~60% of sky
- 1 large (5m), 18 small (0.5m) at **South Pole;** Ultra-deep survey ≥ 3% of sky + delensing

Total 500,000 cryogenic sensors, superconducting readout; scale up of over x10 from all stage 3.

2014 HEPAP/P5 strategic plan recommended CMB-S4 as a joint DOE/NSF project

2016-2017 AAAC subpanel: CMB-S4 Concept Definition Taskforce study

2019 – DOE approved CD-0

2020 – LBNL chosen as DOE's lead lab

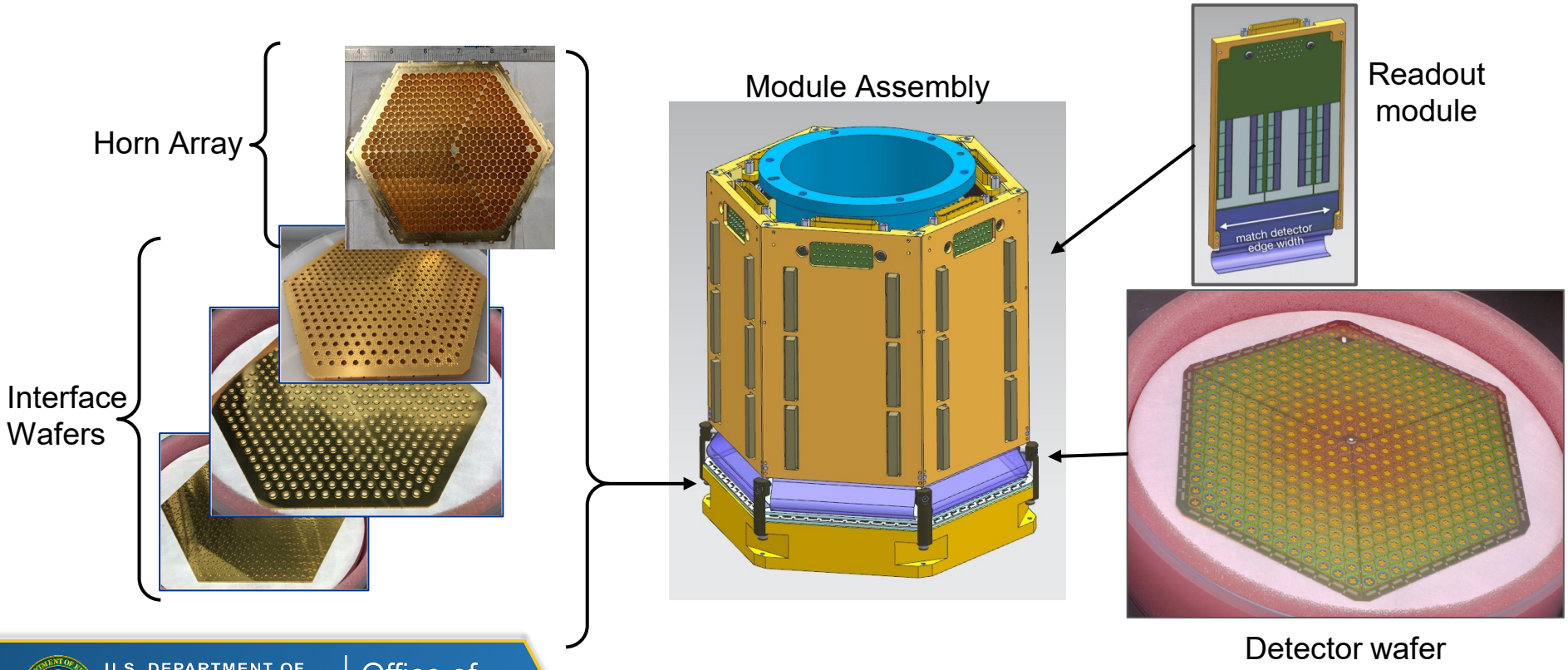
FY2021 - Congress approved DOE **Major Item of Equipment "project start"**

FY2022 - **Astro2020 recommended DOE/NSF partnership** on CMB-S4

CMB-S4 Planning & Status

DOE & NSF have been meeting regularly for a few years. Following Astro2020, meetings were held to consider potential paths forward.

- The project's planned scope for the South Pole is not possible at this time.
- The agencies have asked the project team to do an Analysis of Alternatives (AoA) with different configuration(s), that could include a much smaller footprint at the Pole.
- Project activities in the near term will center on this AoA.
- DOE project funding availability in FY2022 is $9M, an increase of $4M from FY2021.



Astro2020: Science Panel on Cosmology → Dark Ages

The **Panel on Cosmology** identified **4 Questions**:

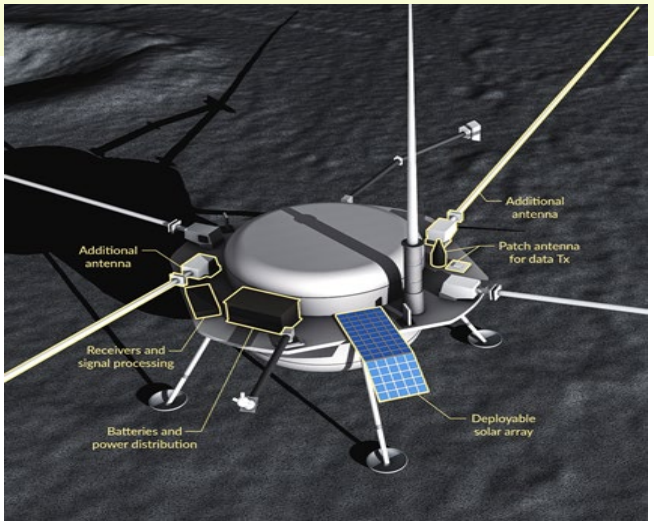
- What set the hot Big Bang in motion?
- What are the properties of dark matter and the dark sector?
- What physics drives the cosmic expansion & large-scale evolution of the universe?
- How will measurements of gravitational waves reshape our cosmological view?

The **Panel on Cosmology** identified as a **Discovery Area** using the **Dark Ages as a cosmological probe with great potential.**

"The panel sees 21 cm and molecular line intensity mapping of the Dark Ages and reionization era as both the discovery area for the next decade and as the likely future technique for measuring the initial conditions of the universe in the decades to follow."

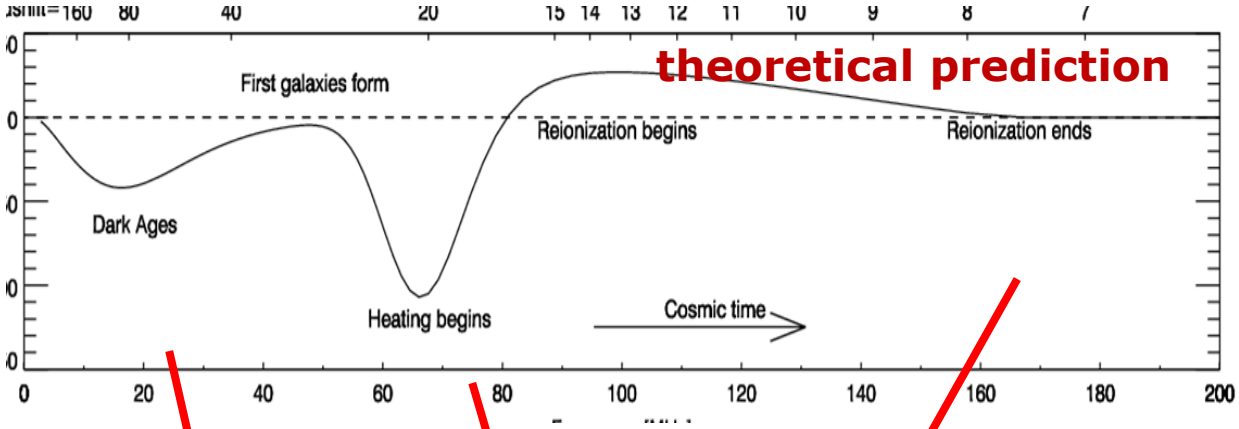
➔The Dark Ages signal has never been observed. A first discovery would be a significant step in understanding this phase of the universe.

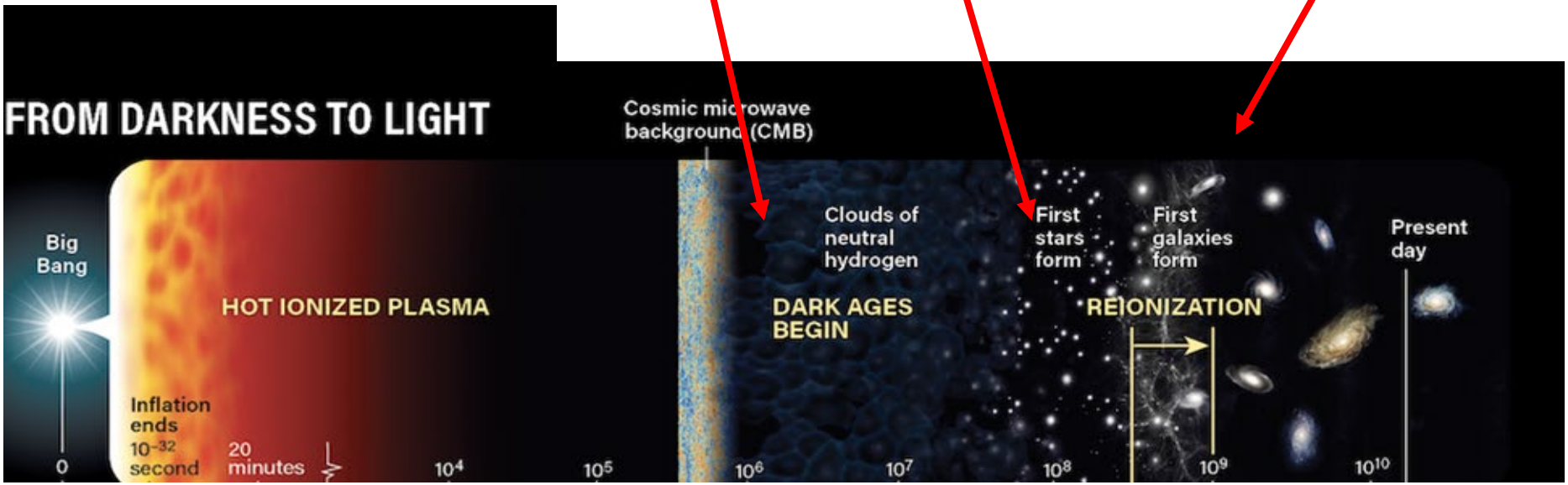
- Detecting and characterizing the Dark Ages monopole dip in the 21cm radiation is the first step in the exciting program to explore Dark Ages



Discovery of the Dark Ages

Measurements of the low-frequency (<50MHz) radio sky are sensitive to 21cm emission from neutral hydrogen at high redshift (z>30)"



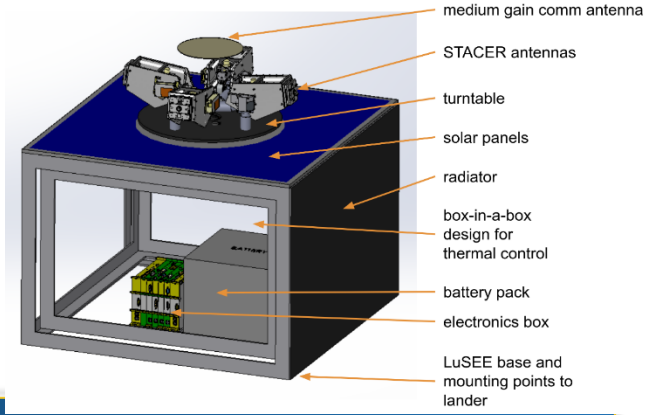


DOE/NASA Partnership on LuSEE-Night → Pathfinder to the Dark Ages

DOE/NASA high level MOU to continue partnerships signed in Oct. 2020

- Opportunity to partner on Lunar Surface Electromagnetics Experiment at Night
  - Pathfinder mission to place the most sensitive constraints to date on the **Dark Ages signal** & potentially discover the Dark Ages signal.
  - Capability to measure the radio environment and observe the long-wavelength radio signal through the lunar night (launch early 2025).

- **DOE/NASA partnership**: high level initiative & opportunity for great science. LuSEE-Night is optimally done in a DOE/NASA collaboration, bringing our synergistic expertise to enable new scientific directions.
  - Aligned with the DOE/HEP **2014 P5 strategic plan** science drivers. DOE/HEP has significant interest in Dark Ages science as it is uniquely sensitive to fundamental physics.
  - **Astro2020** Discovery Area with great potential



Milestones/Schedule

- **Nov. 2021**: DOE approval of Critical Decision 0; DOE lead is Brookhaven Lab
- **March 15, 2022** approved as a DOE Major Item of Equipment (MIE) Project by the FY 2022 omnibus appropriations bill; Full funds provided.
  - Project starts in FY 2022 and is delivered to the UCB/SSL project office by early 2024
  - Launch in early 2025 by NASA's Commercial Lunar Payload Service (CLPS) mission.

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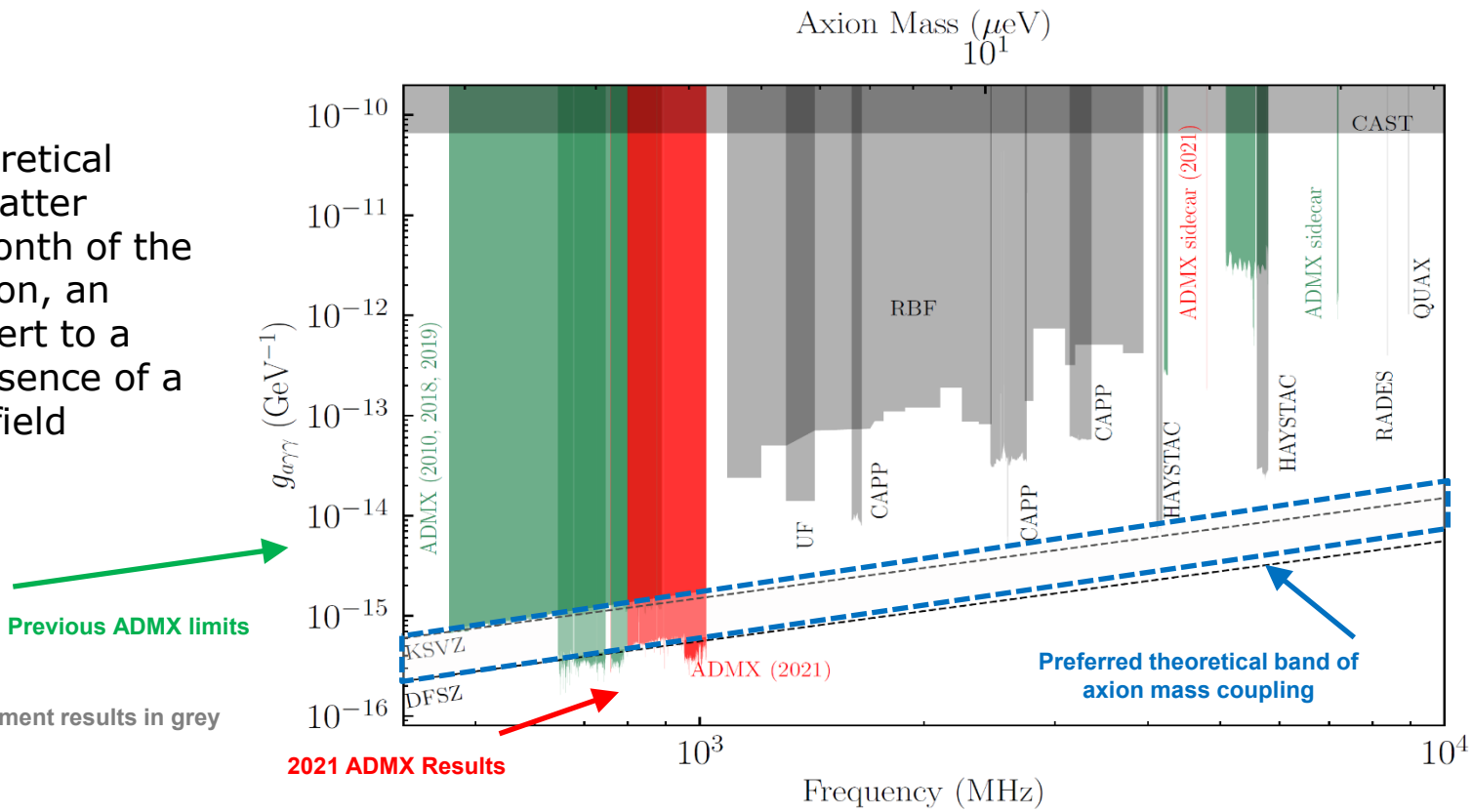
Dark Matter Searches

Suite of 3 “gen-2” direct detection search experiments following the 2014 P5 recommendation; variety of particle types and technologies over a wide mass range.

ADMX-G2: Direct Detection Dark Matter 2nd Generation project

Axions are a theoretical candidate dark matter particle. Ten-trillionth of the mass of an electron, an axion would convert to a photon in the presence of a strong magnetic field



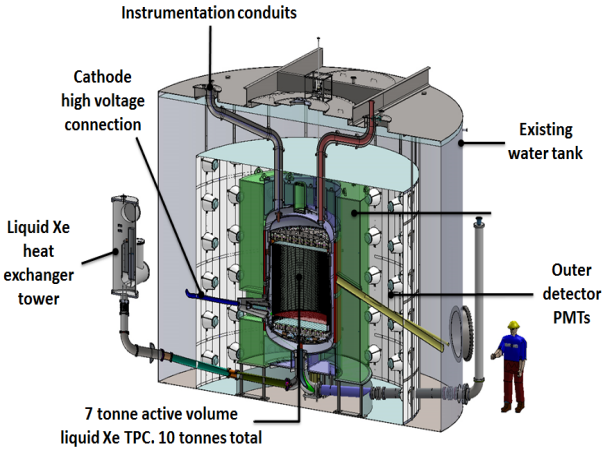
Axion Dark Matter eXperiment Generation 2 continues operations at U. Washington

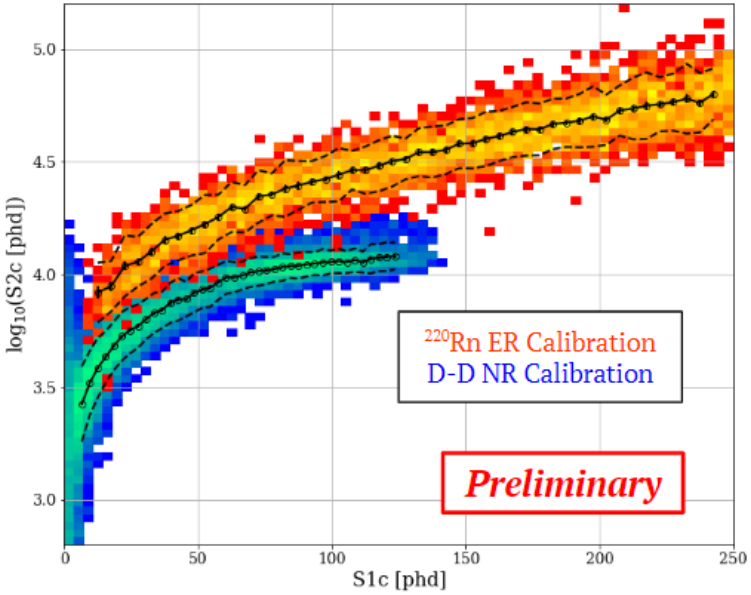
- 2021 results are 5-orders of magnitude better than previous limits, ruling out axion DM hypothesis in this mass-coupling range
- Planned upgrades enable continuing search

LZ: Direct Detection Dark Matter 2nd Generation project

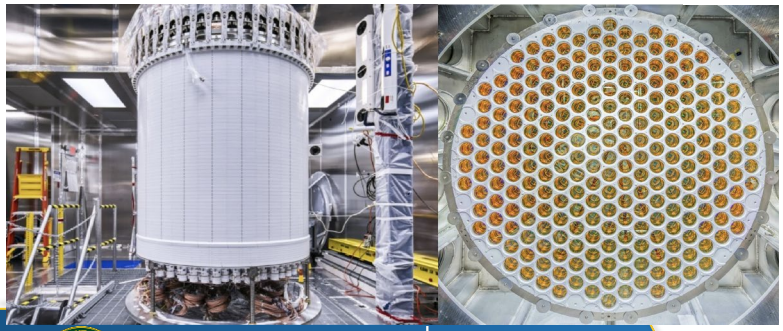
LZ at Homestake Mine in South Dakota – 1 mile underground

- Dual phase liquid Xenon Weakly Interacting Massive Particle (WIMP) search; ~10-1000 GeV mass





LZ Calibration plots during commissioning: D-D neutrons for nuclear recoils (NR) and ^{220}Rn injection electronic recoils (ER). **The plot shows well defined bands as expected**.



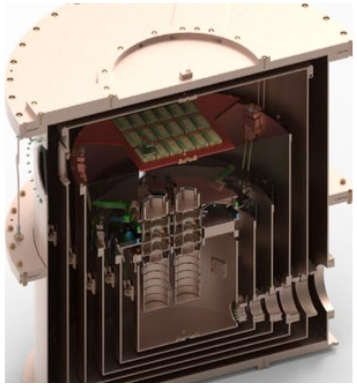
- Project completed in Sept. 2020
- Installation & Commissioning through Dec. 2021; Currently carrying out engineering runs.

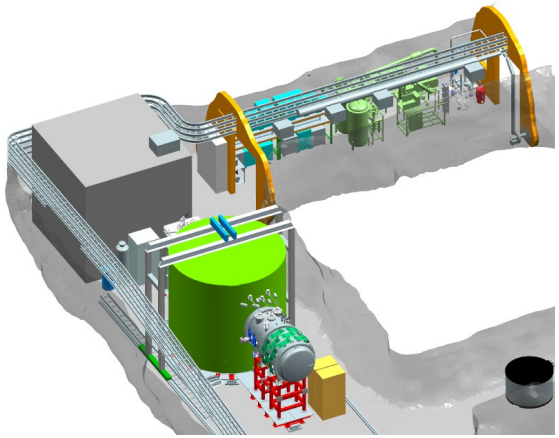
SuperCDMS SNOLAB: Direct Detection Dark Matter 2nd Generation project

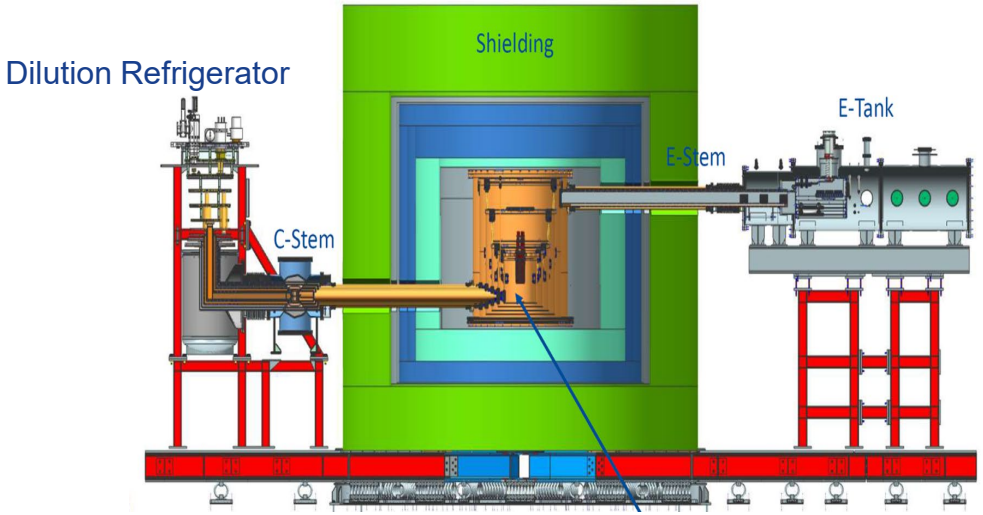
SuperCDMS SNOLAB in Canada at the Creighton nickel mine (HEP+NSF partnership)

Cryogenic solid-state crystal WIMP search; ~1-10 GeV mass

Project fabrication was restructured due to issues with cryostat procurement & covid-19; Rebaselined end of FY2021.







- Expect full fabrication completion in 2023; full science operations start in 2024; Start operating with partial detector beforehand.

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Astro2020 – Other Recommendations & DOE Comments

DOE's SC and HEP already have efforts addressing a number of the Astro2020 recommendations

The DOE **Office of Science (SC)** is fully committed to fostering safe, diverse, equitable, and inclusive work, research, and funding environments that value mutual respect and personal integrity.
https://www.energy.gov/science/diversity-equity-inclusion

There is a DOE **SC**-wide effort to implement the DEI 2019 Report Recommendations. See report to Nov. 2021 HEPAP by Dr. Julie Carruthers, head of DOE SC Office of Diversity, Inclusion & Research Integrity.
https://science.osti.gov/-/media/hep/hepap/pdf/202111/SC_DEI_Initiatives-Carruthers_HEPAP_202111.pdf

Astro2020 Chapter 3: The Profession & its Societal Impacts

- **Recommendations - Relating to Diversity, Equity, Inclusion**

Recommendation (p. 3-14)(p 4-1B AAAC): Funding agencies should increase incentives for improving diversity among the college/university astronomy and astrophysics faculty, for example by increasing the number of awards that invest in the development and retention of early-career faculty and other activities for members of under-represented groups.

Recommendation (p. 3-22)(p 6-3 AAAC): NASA, NSF, and DOE should reinvest in professional workforce diversity programs at the division/directorate levels with purview over astronomy and astrophysics. Because academic pipeline transitions are loss points in general, supporting the creation and continued operation of "bridge" type programs across junctures in the higher-education pipeline and into the professional ranks appear especially promising.

Recommendation (p. 3-23)(p. 6-4 AAAC): NSF, DOE and NASA should implement undergraduate and graduate "traineeship" funding, akin to the NIH MARC and NIH "T" training grant programs, to incentivize department/institution-level commitment to professional workforce development, and prioritize interdisciplinary training, diversity, and preparation for a variety of career outcomes.

Recommendation (p. 3-30)(p. 6-2 AAAC): NASA, DOE, and NSF should consider including diversity—of project teams and participants—in the evaluation of funding awards to individual investigators, project and mission teams, and third-party organizations that manage facilities. Approaches would be agency specific, and appropriate to the scale of the projects.

Other DEI Recommendations →from the AAAC Report

Recommendation (p. 4-1): There should exist a living document between NASA, The Department of Energy, and The National Science Foundation that links each agency's effort to the 2020 Decadal recommendations.

Recommendation (p. 5-1): NASA, NSF, and DOE should implement a cross-agency committee or working group tasked with establishing a consistent format and policy for regularly collecting, evaluating, and publicly reporting demographic data and indicators pertaining at a minimum to outcomes of proposal competitions.

Recommendation (p. 7-6): The National Science Foundation, NASA, and the Department of Energy should release data on proposal success rates on an annual basis and should track metrics that allow them to analyze statistically what is being supported.

Astro2020 Chapter 3: The Profession & its Societal Impacts - DOE Efforts/Comments - Relating to Diversity, Equity, Inclusion

SC now includes **diversity-promoting program policy factors** in all of its Funding Opportunity Announcement's (FOA) which allows the selection official to make award decisions based on other factors when all other things such as merit are considered equal, including e.g. promoting diversity of PI's, institutions, etc.

SC **Early Career Program** continues to promote diversity of PI's & Institutions and supports over 80 PI's/year. The 2022 FOA strengthened review criteria consideration of promotion of diversity of PI's and Institutions.

HEP Research FOA for FY2022 required a specific appendix describing the PI's Recruitment and Mentoring Plan
➔ A new merit criterion was added as part of the proposal evaluation.

HEP has **graduate student traineeships** in Instrumentation, Accelerator R&D and Computing, e.g. see
https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002496.pdf

HEP specifically considers diversity when **setting up review panels** for proposals as well as projects, experimental operations and facilities.

Astro2020 Chapter 3: The Profession & its Societal Impacts - DOE Efforts/Comments - Relating to Diversity, Equity, Inclusion

RENEW FOA is out!

DOE has announced $40 million to provide research opportunities to historically underrepresented groups in STEM and diversify American leadership in the physical and climate sciences through internships, training programs, and mentor opportunities.

The REACHING A NEW ENERGY SCIENCES WORKFORCE for HIGH ENERGY PHYSICS (HEP-RENEW) FOA will support training and research experiences in particle physics for members of underserved communities**, with the goals of supporting investigators and building research infrastructure at institutions which have not traditionally been part of the portfolio and encouraging underrepresented populations to pursue STEM careers**.

- The HEP FOA can be found **here.**
- **A webinar will be held on June 15, 14:00 ET** to introduce this new opportunity and answer questions for investigators who may be interested in applying. Information on the Webinar and HEP involvement in the RENEW Initiative can be found **here**.
- Proposals are due August 15, 2022 at 11:59 PM ET.

The FOA's, sponsored by the respective programs within the Department's Office of Science, as well as information about each associated webinar, **can be found here**.

Astro2020 Chapter 3: The Profession & its Societal Impacts - DOE Efforts/Comments - Relating to Diversity, Equity, Inclusion

SC **Office of Workforce Development for Teachers and Scientists** (WDTS) programs (see https://science.osti.gov/wdts). These include:

Community College Internships (CCI)
- Supports students to work at a DOE laboratory, encouraging STEM careers

Science Undergraduate Laboratory Internships (SULI)
- Supports undergraduate research at a DOE lab, 10 to 16 weeks

SC Graduate Student Research fellowships (SCSGR)
- Supports grad student research at a DOE lab, 3 to 12 months

Visiting Faculty Program
- Summer research support for faculty/students from historically underrepresented institutions

Albert Einstein Distinguished Educator Program
- K-12 educators in STEM fields work in Federal agencies or US Congressional Offices; applying their knowledge to the national education program.

DOE Scholars Program https://orise.orau.gov/doescholars/

Available funds for these programs have been increasing!

Astro2020 Chapter 3: The Profession & its Societal Impacts - DOE Efforts/Comments - Relating to Diversity, Equity, Inclusion

Our labs have active efforts on community outreach and workforce development, e.g.

Fermilab Office of Education and Public Engagement
https://ed.fnal.gov/office/index.shtml

LBNL K-12 STEM Education & Outreach
https://k12education.lbl.gov/

SLAC – Education & Internships
https://careers.slac.stanford.edu/jobs-slac/educational-and-outreach-programs
SLAC Outreach
https://www6.slac.stanford.edu/outreach

* Astro2020 Chapter 3: The Profession & its Societal Impacts - Relating to Harassment Issues

Recommendation (p. 3-27)(p. 7-7 AAAC): NASA, NSF, DOE, and professional societies should ensure that their scientific integrity policies address harassment and discrimination by individuals as forms of research/scientific misconduct.

DOE Efforts/Comments:

SC has added language to its FOA's to remind the community of **prohibition of harassment & discrimination** by awardees and recipient institutions.

Most of the HEP Cosmic Frontier projects and collaborations have developed **Codes-of-Conduct** and have an **Ombudsperson**. This is a promising practice within the community.

Astro2020 Chapter 3: The Profession & its Societal Impacts - Relating to Local Community Engagement

Recommendation (p. 3-35)(p. 7-1 AAAC): The astronomy community should, through the American Astronomical Society in partnership with other major professional societies (e.g., American Physical Society, American Geophysical Union, International Astronomical Union), work with experts from other experienced disciplines (such as archaeology and social sciences) and representatives from local communities to define a Community Astronomy model of engagement that advances scientific research while respecting, empowering and benefiting local communities.

DOE Efforts/Comments:

- We have local efforts by labs and experiments, e.g. DESI at Kitt Peak
- The Sanford Underground Research Lab (SURF) in S. Dakota has an extensive outreach program, with a focus on the Lakota community. They regularly organize events and activities around the native heritage. e.g.:
  - https://www.sanfordlab.org/garden
  - https://www.sanfordlab.org/article/celebrate-our-regions-rich-heritage-during-virtual-neutrino-day
  - https://www.sanfordlab.org/article/one-sky-many-worlds-annette-s-lee-keynote-neutrino-day-2021

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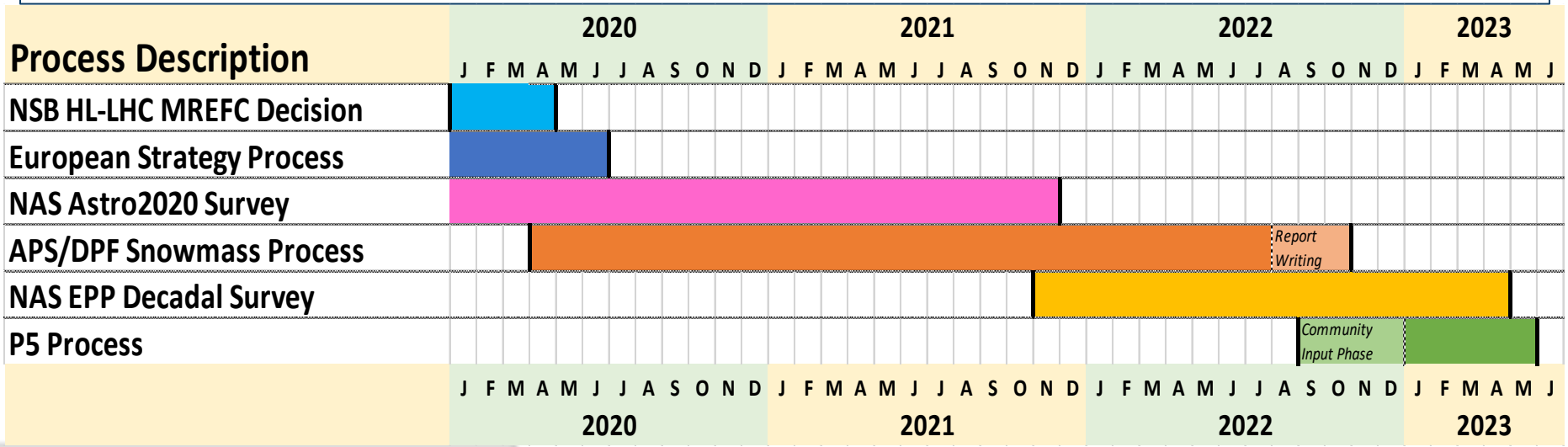
Planning, Summary

HEP Next Strategic Planning Timeline

HEP community-wide "Snowmass" study process organized by the American Physical Society (APS) Division of Particles and Fields (DPF) & Division of Particles and Beams is in full swing. https://snowmass21.org/start

National Academy of Sciences (NAS) Elementary Particle Physics (EPP) Decadal Survey will run concurrently with and complement the community-driven Snowmass process.

Next P5 process to begin after Snowmass and NAS Decadal Survey, circa late 2022: P5 report by May 2023 will inform FY 2024 Congressional actions & FY 2025 U.S. budget formulation



HEP Cosmic Frontier – Summary & Future Planning

- **HEP continues to carry out the 2014 P5 strategic plan**
- **Complete execution of the FY 2022 budget**
  - **Planning for FY 2023**
    - **Develop FY2024**
- **Future Planning** – Astro2020, Snowmass → P5

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