U.S. DEPARTMENT OF ENERGY | Office of Science

Office of High Energy Physics (HEP) Program and Budget Report

Astronomy & Astrophysics Advisory Committee (AAAC)

January 26, 2021

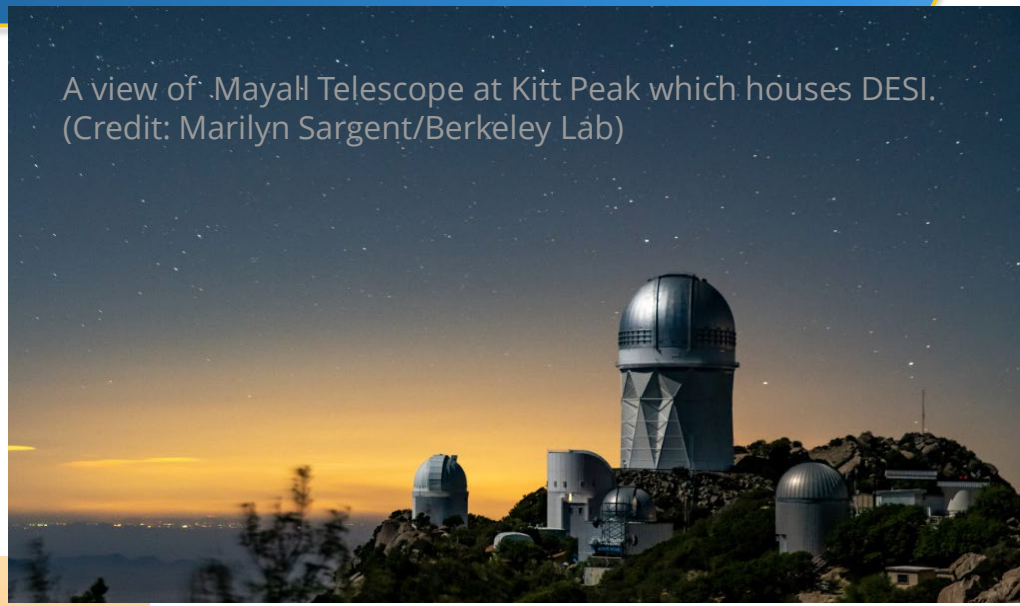
Kathy Turner, Cosmic Frontier Program Manager

Cosmic Frontier group members:

- *Current: Karen Byrum (Detailee), Drew Baden (IPA),*
- *Term recently ended: Eric Linder (IPA)*

OUTLINE

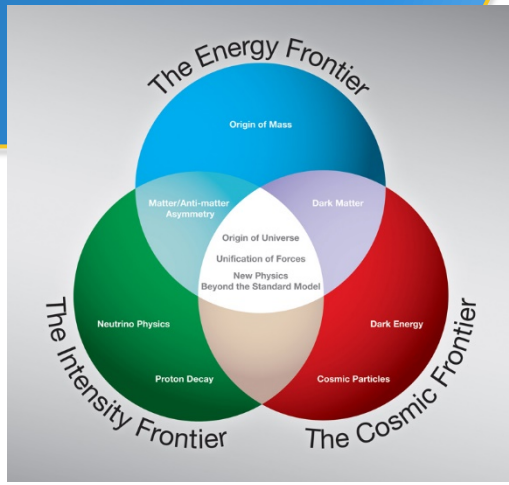
- Budget
- Project/Experiment status
- New Opportunities
- Planning for the future
- Research support



A view of Mayall Telescope at Kitt Peak which houses DESI. (Credit: Marilyn Sargent/Berkeley Lab)

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, using data from natural sources is an increasingly important area for discovery.

Guidance & Community Input from:
- **FACA panels: HEPAP, AAAC**
- Natl. Academy of Sciences, other community studies

→HEP continues to follow HEPAP's **2014 "P5" strategic plan**.

Many interagency and international partnerships.

Other HEP and Office of Science areas to fully carry out the program:
- Theoretical research
- High Performance Computing → Exascale
- State-of-the-Art Detector and Accelerator technology development
- Quantum Information Science (QIS) is a quickly-growing area.
- Artificial Intelligence/Machine Learning efforts are a growing area.

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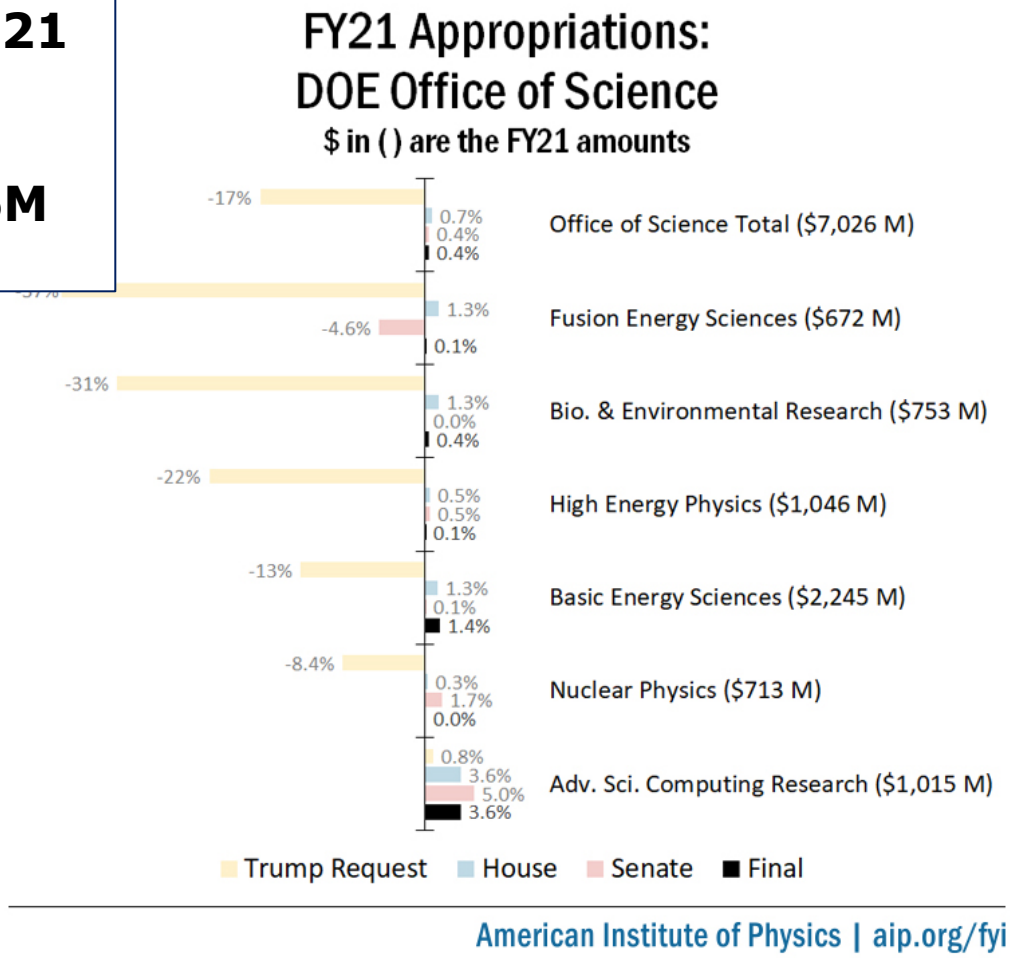
Budget

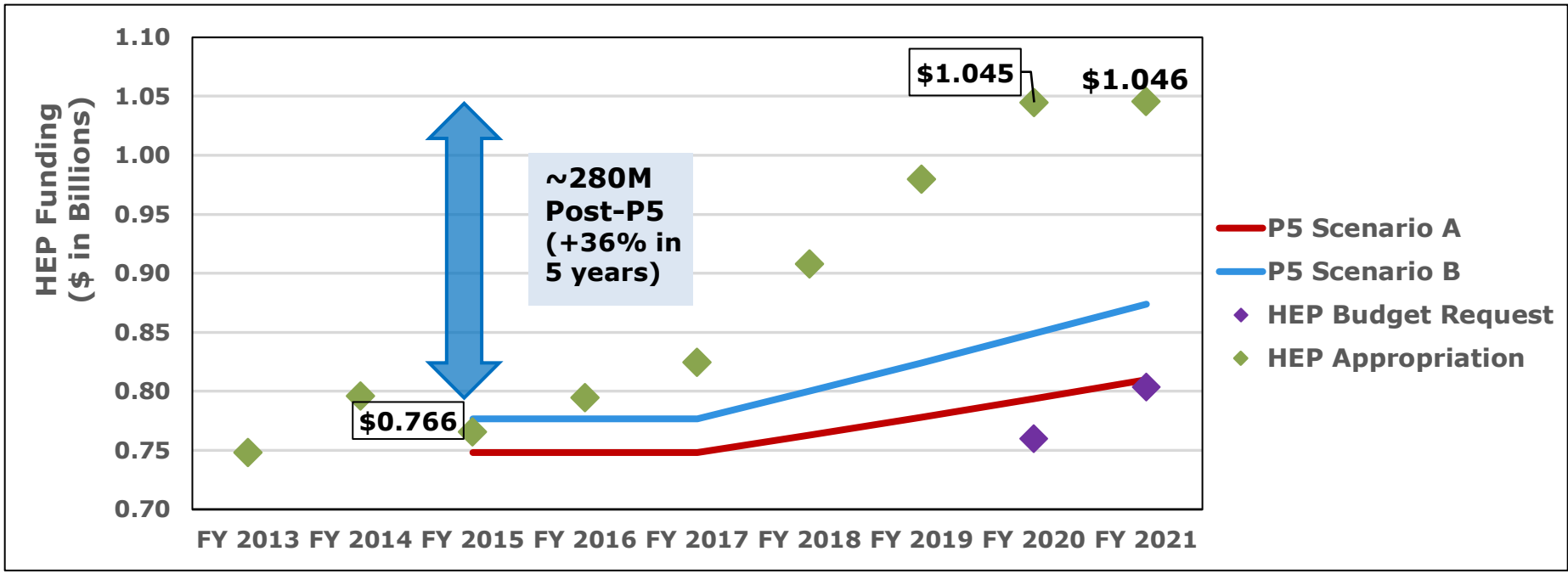
FY2021 Appropriation – SC, HEP

- **SC increase 0.4% from $7,000M in FY2020 to $7,026M in FY2021**
- **HEP increase of +0.1% from $1,045M in FY 2020 to $1,046M in FY 2021**

- Strong support in QIS and Artificial intelligence Research.
- Flat construction funding for LBNF/DUNE and PIP-II.
- Appropriations specified budget amounts in a number of areas.
- Increased support, up $4M, from $2M to $6M for Cosmic Microwave Background-Stage 4.



HEP Budget: U.S. Congress Supports P5 Strategy



- U.S. Congress continues to show strong support for executing the P5 strategy, and for accelerating the pace of projects

FY 2021 Appropriation - HEP

HEP Funding Category ($ in K)	FY 2019 Actual	FY 2020 Actual	FY2021 Request	FY2021 House	FY2021 Senate	FY 2021 Appropriation	FY 2021 Appropriation - FY 2020 Actual
Research	384,286	389,577	328,906	397,259	385,685	409,370	+19,793
Facilities/ Operations	258,364	317,929	285,725	313,702	325,315	303,130	-14,799
Projects	337,350	337,494	203,500	339,039	339,000	333,500	-3,994
Total	**980,000**	**1,045,000**	**818,131**	**1,050,000**	**1,050,000**	**1,046,000**	**+1,000**

FY 2021 Appropriations supports the SC and P5 priorities

- SC: Interagency & international partnerships, national labs, R&D initiatives
- HEP's P5: preserve vision, modifications as needed to progress

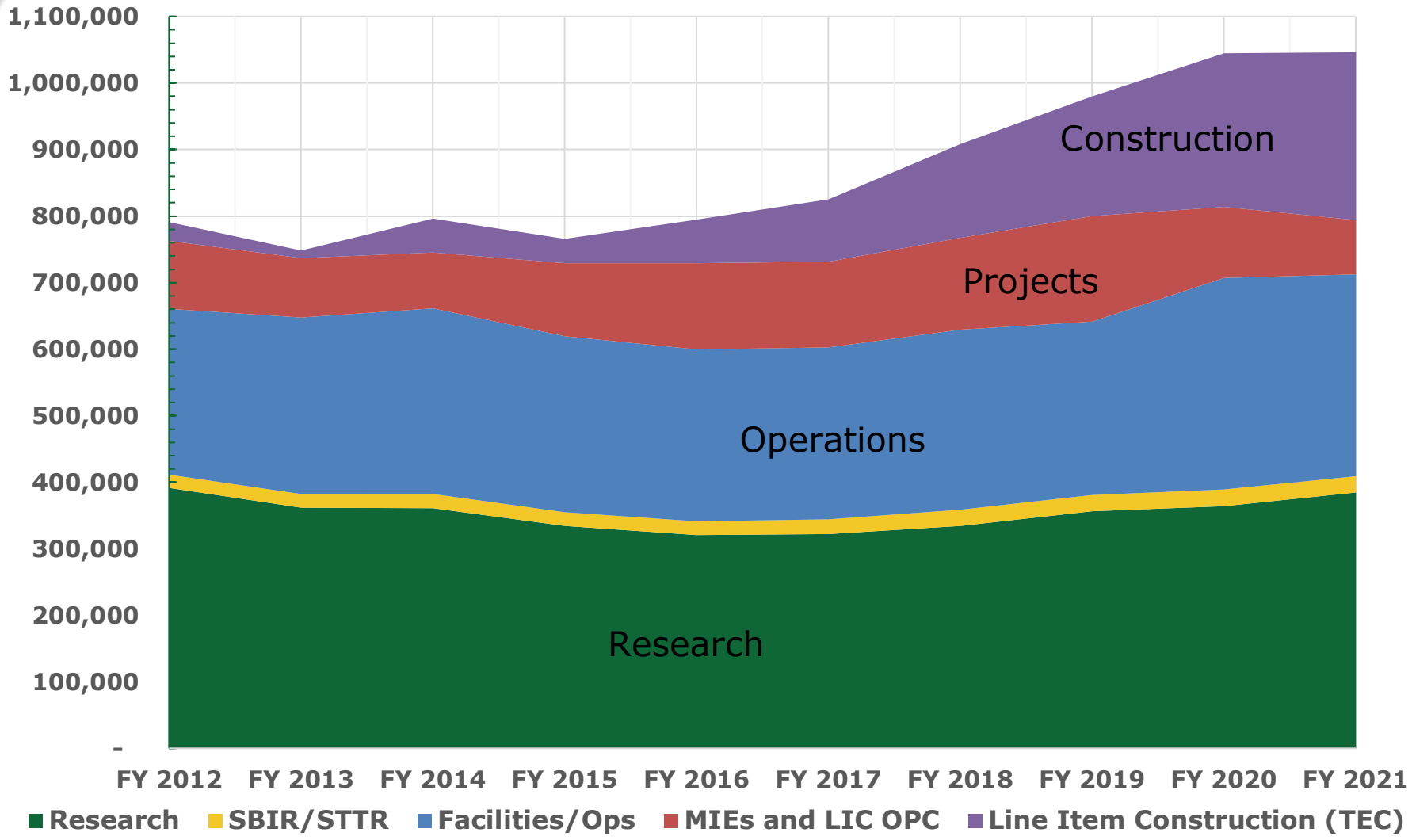
- Strong support in QIS and Artificial Intelligence/Machine Learning Research.
- Flat construction funding for LBNF/DUNE and PIP-II. Strong support for HL-LHC projects.
- Appropriations specified budget amounts in a number of areas.
- Increased support, up $4M, from $2M to $6M for Cosmic Microwave Background-Stage 4.

FY 2021 Appropriation Language for HEP, related to Cosmic Frontier

- not less than $30M for the Sanford Underground Research Facility
- not less than $6M for Cosmic Microwave Background-Stage 4
- $12M for the Dark Energy Spectroscope Instrument; 6M for LZ
- not less than $18.5M for Vera C. Rubin Observatory operations

- The agreement supports activities toward the completion of the Large Synoptic Survey Telescope and Super Cryogenic Dark Matter Search projects.
- The agreement notes the longstanding planning and contributions of resources by partner organizations with respect to data management on the Vera C. Rubin Observatory.
- The Department is directed to employ the computational expertise and existing capabilities in data management of the Vera C. Rubin Observatory, potentially in partnership with the national laboratories, to ensure the successful operation of this project and access for the broad research community.
- The Department is directed to brief the Committees on Appropriations of both Houses of Congress not later than 30 days after enactment of this Act on the status of the project, including plans for management of the data facility.
- The Department is strongly urged to maintain a balanced portfolio of small-, medium-, and large scale experiments and to ensure adequate funding for research performed at universities and the national laboratories. The Department is encouraged to fund facility operations at levels for optimal operations.

HEP Budget ($k) FY 2012-2021

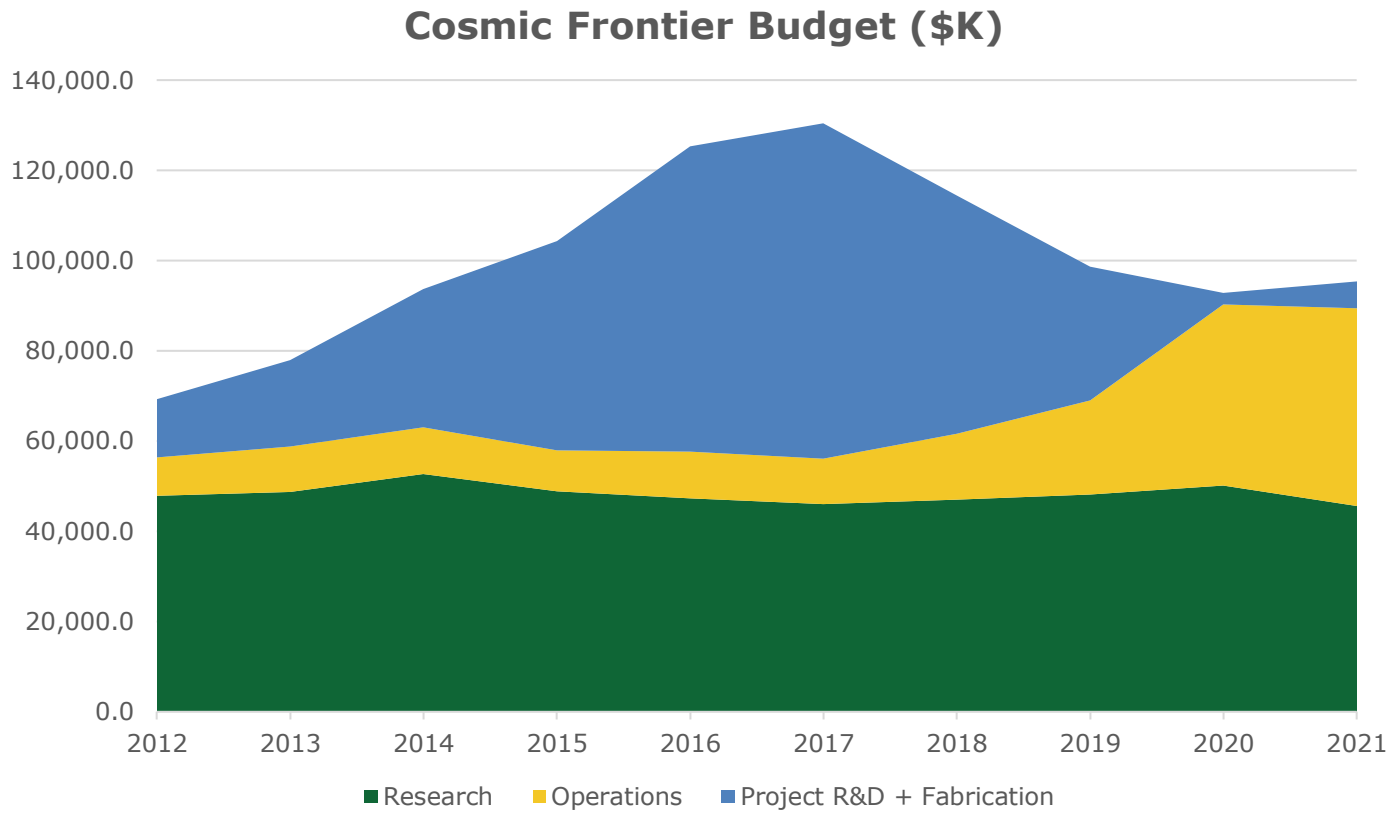


FY 2021 Funding – Cosmic Frontier

Cosmic Frontier ($K)	FY2019 Actual	FY2020 Actual	FY2021 Approp.
Research (Univ+Lab)	48,053	44,264	39,634
Research AI/ML		3,351	3,920
Future R&D	3,265	2,480	2,000
Facility Operations	20,957	40,235	43,897
Projects	26,350	2,450	6,000
DESI	*9,350*	*0*	*0*
LZ	*14,450*	*0*	*0*
SuperCDMS	*2,550*	*0*	*0*
CMB-S4	-	*2,450*	*6,000*
Office support	3,667	4,181	4,436
SBIR/STTR	2,869	3,524	
Total	**105,161**	**100,485**	**99,887**

- **Research:** World-leading research efforts in support of design and optimization on dark matter and dark energy experiments in their fabrication and commissioning phases, R&D and planning for CMB-S4, planning for future experiments.
- **Operations:** Commissioning and facility operations planning for LSST/Rubin, commissioning and operations for LZ, operations for DESI, pre-operations activities for SuperCDMS-SNOLAB. Support for the currently operating experiments will continue.
- **Projects:** CMB-S4

Cosmic Frontier Budget History (FY12-21)



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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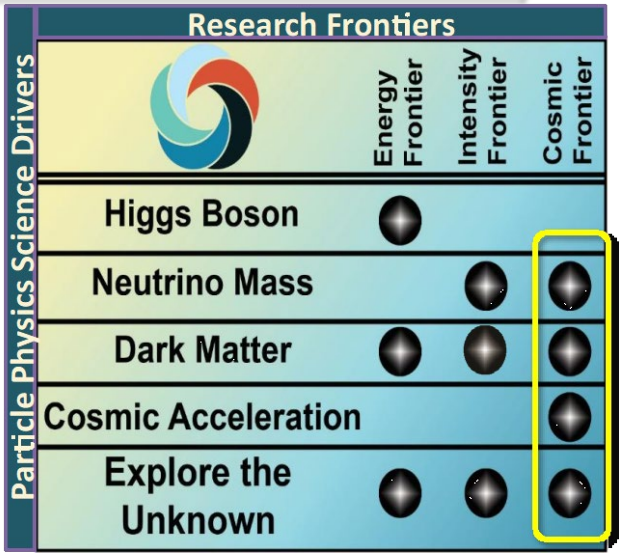
Cosmic Frontier

Cosmic Frontier Experimental Research Program

Address 2014 "P5" strategic plan science drivers using naturally occurring cosmic phenomena via ground-based telescopes & arrays, space missions, and deep underground detectors



Cosmic Acceleration:

- Imaging & Spectroscopic surveys to determine the nature of **Dark Energy**
- Study the Inflationary era using its imprint on the cosmic microwave background (**CMB**) at energies near the Planck scale (with NSF)

Dark Matter: Primary efforts are direct-detection searches for particle dark matter (WIMPs; axions) through deep underground experiments

- Also indirect searches using cosmic-ray & gamma-ray data

Neutrino Mass: Unique constraints from Dark Energy and CMB experiments

Explore the unknown: search for New Physics, e.g. relic particles

Most projects have partnerships with NSF-PHY, NSF-AST, NSF-OPP, NASA, and international.

Dark Energy Survey (DOE/NSF)

DARK ENERGY SURVEY

6-year imaging survey of 5100 sq-deg completed 2019

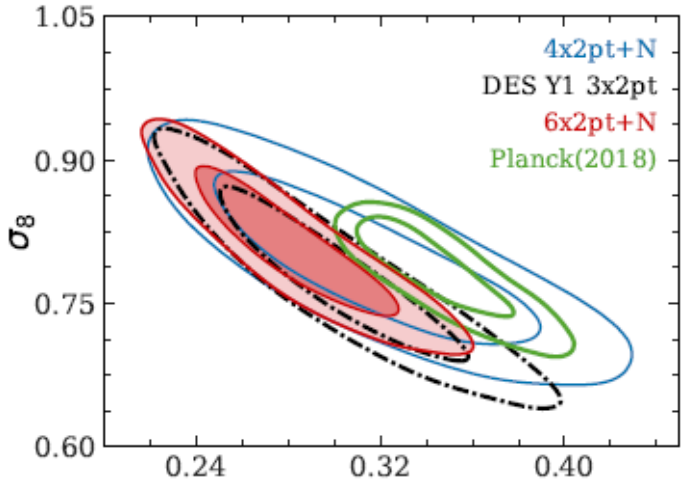
- DOE/Fermilab 570Mpix Dark Energy Camera (DECam) operated on NSF's Blanco telescope at CTIO in Chile.
  - Over 320 science publications with world-leading constraints on dark energy (including submitted) (see plot upper right)
  - 84+ PhD's awarded through 2020

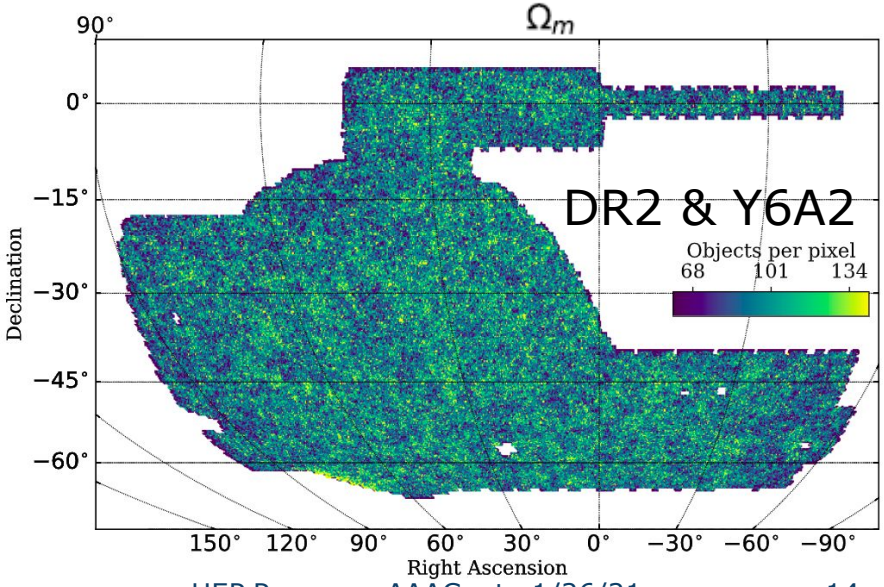
January 2021 at AAS: Public Data Release 2 (Y1-Y6 data). 690M objects with unprecedented photometric & astro-metric precision and uniformity.

Coming soon: Cosmology from 2000+ SN1a and Y1-Y3 data Weak Lensing analysis.

- Proceeding with cosmology from Y1-Y6 data (Y6A2)

Y1 3x2pt WL & Y1 Galaxy Clusters





Dark Energy Spectroscopic Instrument (DESI)

DOE's DESI is taking data!

- World's premier multi-object spectrograph and the first **Stage IV dark energy** project to start operations

DOE/LBNL-led project: instrumentation, data management system, upgrades of NSF's Kitt Peak Mayall telescope; Completed March 2020, Cost $56M.

- Designed and built by large international collaboration w/160 grad students!
- Partners: STFC, Heising-Simons, Gordon & Betty Moore, France, Mexico, Spain, NSF
  - **Thank you to strong support by NSF, NOIRLab and KPNO**

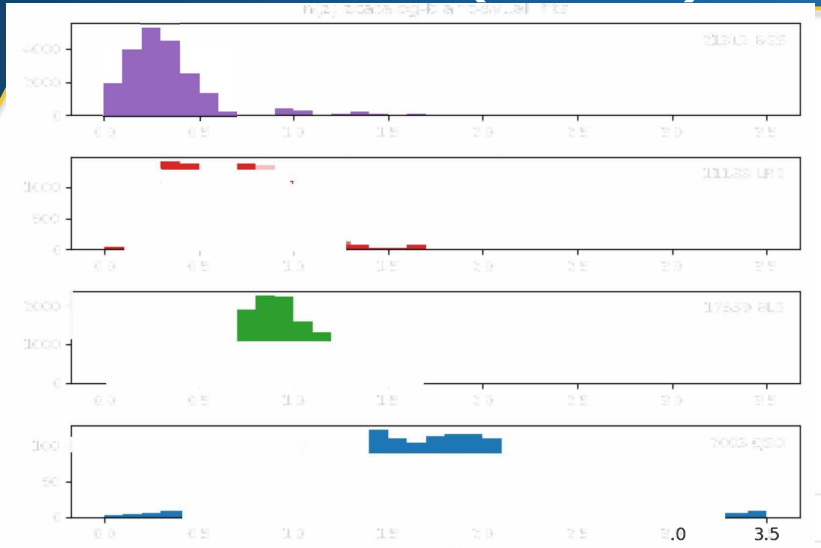
LBNL continues to lead in Operations Phase & Scientific Collaboration

- Data collection started Dec. 14, 2020
  - 23 nights recorded so far; 716 science exposures

- Covid-19 era observing now includes only one on-site lead observing scientist, with remote observing & data quality scientists.

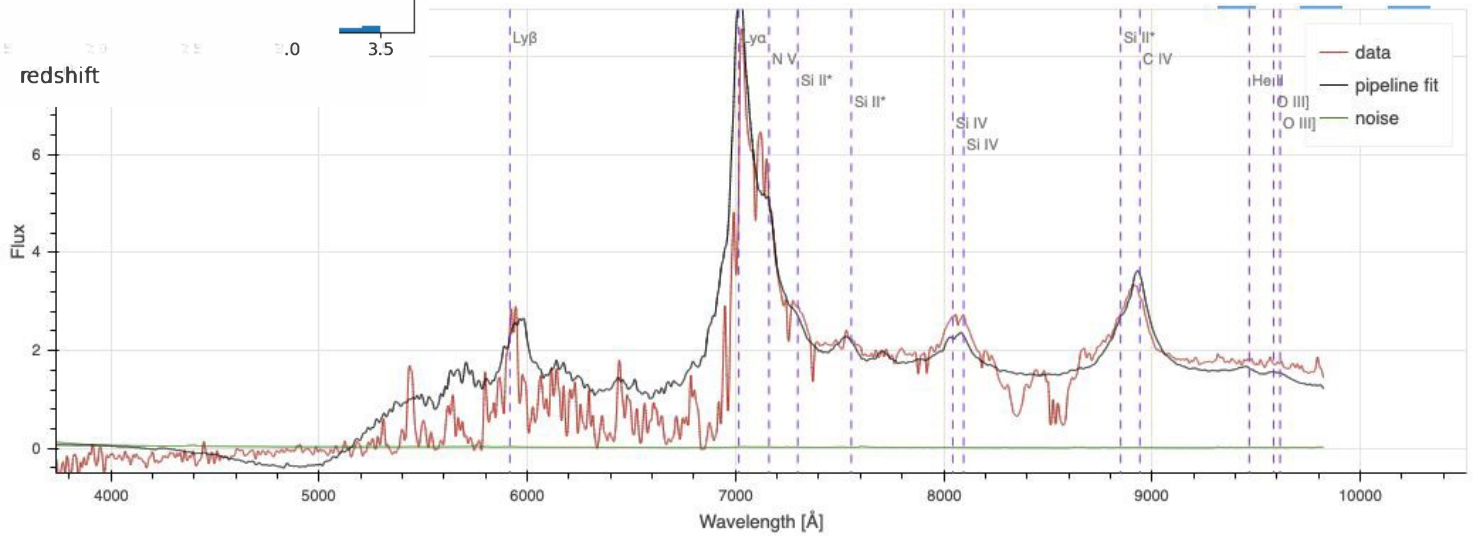
- Throughput measured from stars within 5% of technical design expectation!

Dark Energy Spectroscopic Instrument (DESI)



Redshift Distributions of the 4 principal target classes (December Data only)

High quality spectrum of a z=4.8 quasar observed in December

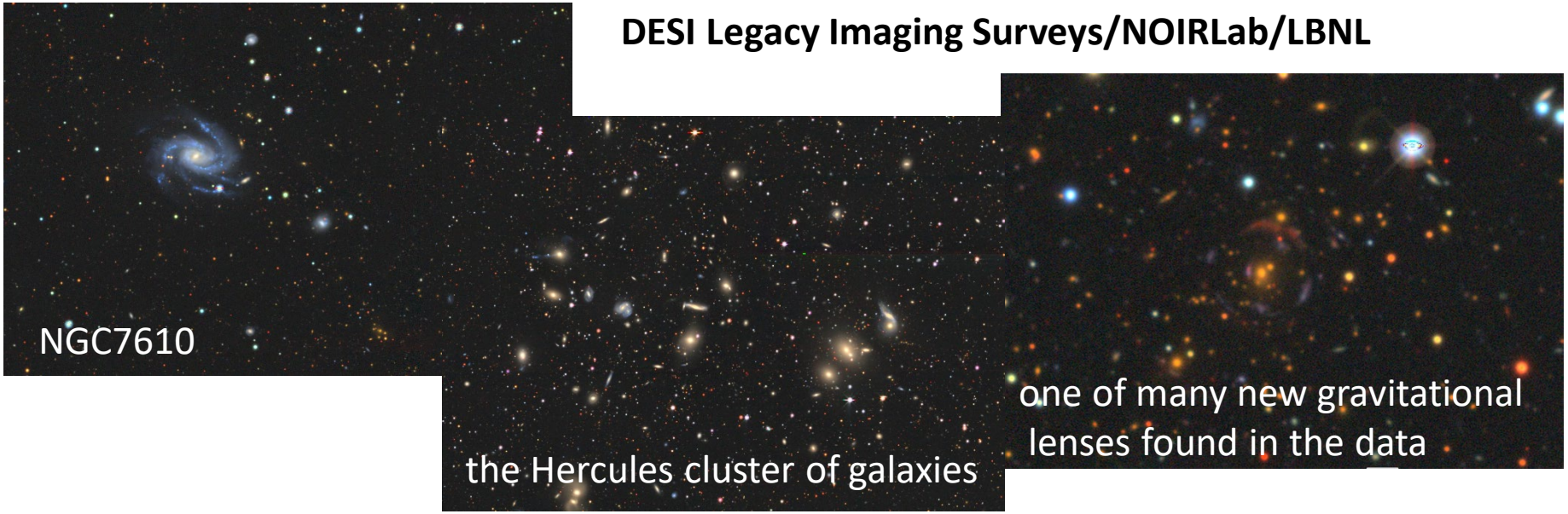


Jan.2021 AAS DESI Special Session: *status of the instrument, performance during commissioning and survey validation early data results, and DESI's legacy imaging surveys.*

Dark Energy Spectroscopic Instrument (DESI)

DESI is delivering data!

- Imaging survey public data release DR9
  - 2B objects from 3 public surveys which mapped 20,000 deg^2
  - for DESI target selection with many other studies possible
- See: legacysurvey.org/viewer
- HEP contributions included upgrade of MOSAIC camera on the Mayall and data processing at NERSC



Vera C. Rubin Observatory

NSF (AURA) and DOE (SLAC) partnership

- Project: DOE responsible for the Camera fabrication & commissioning
- Facility Operations: 50/50 DOE & NSF split

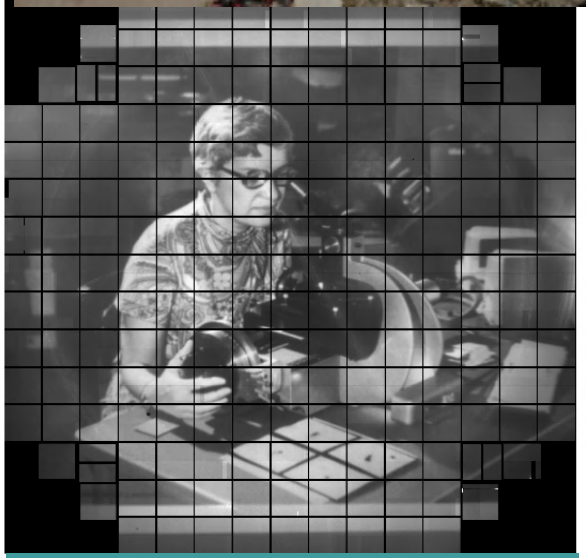
Camera Fabrication:

- Due to covid-19 delays, uncertainties, the Major Item of Equipment (MIE) Project has been restructured to complete at the subsystem level (~ May 2021)
- Full assembly and verification has been transferred to commissioning.
- Only remaining scope is filter completion

Commissioning (on HEP program funds):

- assembly and verification at SLAC
- ship to Chile, I&T; commissioning with overall observatory systems

Delay due to covid-19 expected to be about a year.



Pinhole camera 3.2Gpixel image of Vera C. Rubin

LSST Camera MIE Status: all hardware has been fabricated at the subsystem level except filters


22 science raft

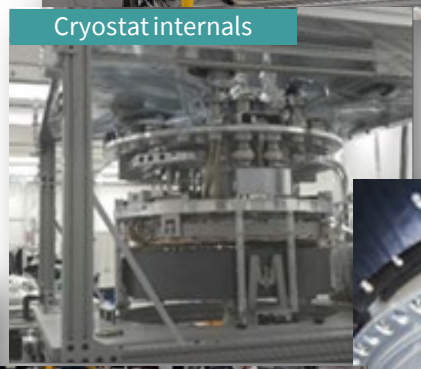

L1 and L2 lenses in their assembly

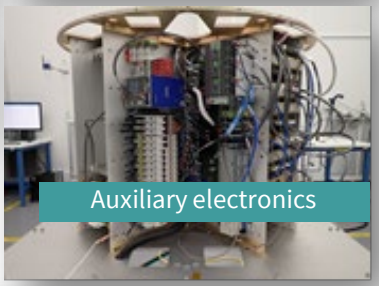

Filter exchange system

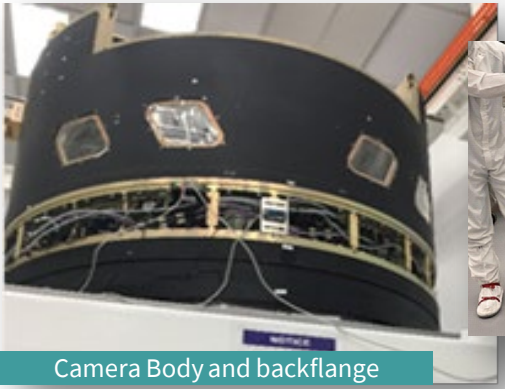

Data Acquisition system

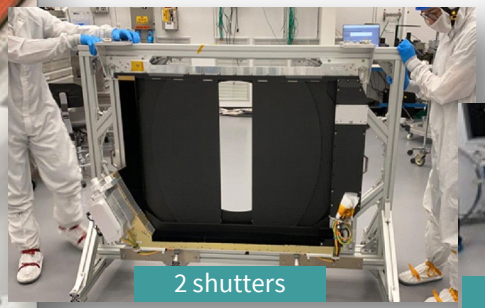

5 corner rafts


L3 lens in its mount


Cryostat internals


Auxiliary electronics


Camera Body and backflange

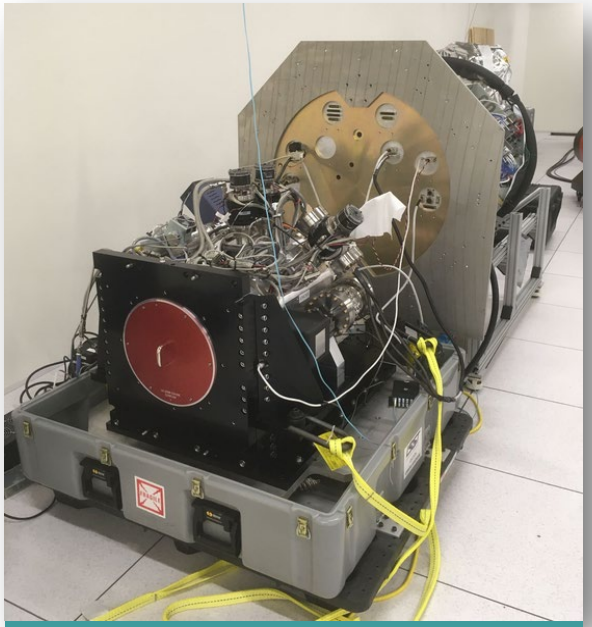

2 shutters


Utility trunk


3.2 Giga Pixel Focal Plane

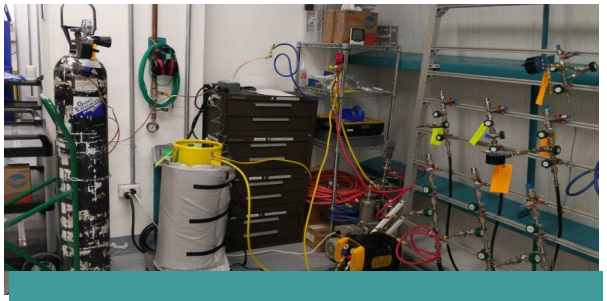
Camera Commissioning Hardware & Camera Delivery

Installation of the MIE delivered refrigeration cabinets on the summit (Jan 2020)



Commissioning camera in Chile delivered by MIE and MREFC and being re-verified with SIT-Com prior to installation on the summit (Apr 2020)

Refrigeration pathfinder unit built at SLAC and delivered to the summit (Feb 2020)

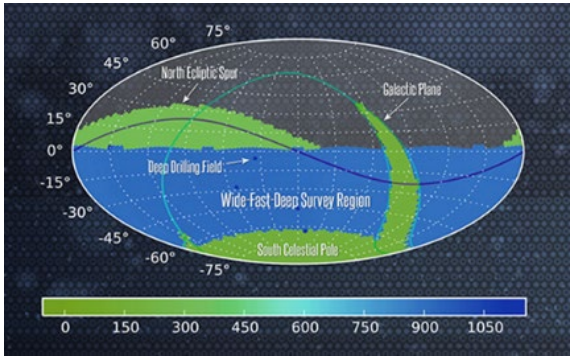


Installation and flushing of the refrigeration lines (Oct 2019)

- All Camera Commissioning hardware is on site in Chile, in the summit building.
- Camera is expected to ship to Chile in Feb. 2022 and be ready for installation on telescope ~ July 2022.

Rubin Observatory: Facility Operations Planning

The Rubin Observatory will conduct a 10-year deep, wide, fast, optical imaging Legacy Survey of Space and Time (LSST) using DOE's LSST Camera & the Simonyi Survey Telescope



Planning is well underway

- Funding ramp-up started FY2019
- DOE & NSF will provide 50/50 support
- DOE-supported efforts are primarily:
  - Camera maintenance and operations
  - US Data Facility (USDF) → SLAC was selected to be the managing organization in Oct. 2020.
- Google has been selected for the cloud-based Interim Data Facility (IDF)

In the coming year the team plans to

- Prepare for Dec. 2021 NOIRLab proposal including the Detailed Ops plan
- Deploy the Dark Energy Science Collaboration (DESC) data challenge 2 (DC2) simulated data in the IDF as "Data Preview 0". DP1 & DP2 will use commissioning data
- Carry out the USDF planning
- Finalize the international in-kind contribution planning

Rubin Observatory – International Contributions

International in-kind contributions to Operations are being considered in exchange for early access to data. Types of contributions:

- Priority is offsets to US Ops costs (or Project, Commissioning costs)
- Enhancements to US Science, e.g.
  - Contribution to science collaboration software, simulations, data analysis tools
  - Contributing telescope time to US scientists
  - Contributing other data sets or appointments to collaborations that the US otherwise doesn't have access to

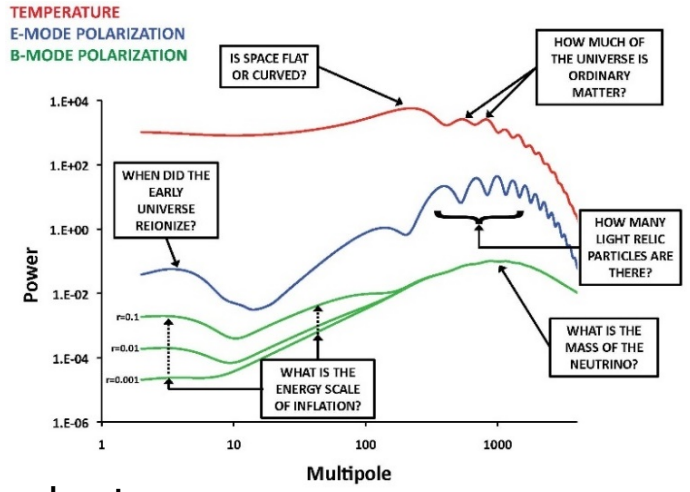
Rubin Operations Team is working with contributors to carry out the planning

- Fall 2020 – Detailed proposals submitted.
  - Received 33 proposals with 831 PI's (each PI gets to bring 4 junior people).
- Contribution Evaluation Committee is currently carrying out assessments.
- Following needed modifications and approval by the Management Board, the team will present the plan to DOE & NSF for approval ~ April 2021.
- Working towards signing agreements by the end of 2021.
- Annual International Resource Board will assess and update contributions

Cosmic Microwave Background – Stage 4 (CMB-S4)

CMB-S4 recommended by P5 in all scenarios
- Intended as HEP/Cosmic Frontier's next flagship project

Goal: cross critical science thresholds



Highlights: 2 sites, Chile & South Pole

- Chile: 2 large aperture (6m) telescopes
  - Deep & wide N_{eff} & Legacy Survey ~60% of sky
- South Pole: 1 large (5m), 18 small (0.5m)
  - Ultra-deep survey ≥ 3% of sky + delensing
- Total 500,000 cryogenic sensors, superconducting readout
  - Scale-up > x10 of current CMB ground based efforts

The Science

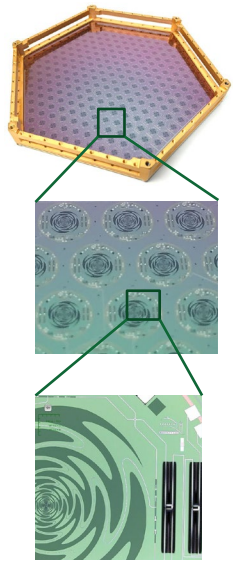
Science	Stage 2	Stage 3	Stage 4	Top Level goal for CMB-S4
Inflation "r"	≤0.1	≤0.01	**≤0.001**	Detect/rule out classes of inflationary models
s(Neff)	0.14	0.06	**0.03**	Detect/rule out light relic particles w/ spin
s(Mn)	0.15eV	0.06eV	**0.02eV**	3s detection
# detectors	~1000	~10,000	**~500,000**	Deployed on multiple telescopes
Sensitivity (mK^{-2})	10^5	10^8	**10^8**	2° to 1' angular scales

CMB-S4 Status at DOE

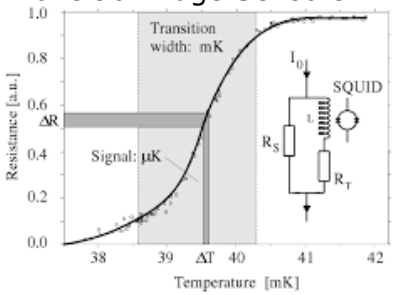
- Huge discovery potential recognized by 2014 P5 as a community priority
  - Envisioned as a DOE-NSF project, DOE/HEP joint with 3 NSF divisions: MPS/PHYS, MPS/ASTRO, GEO/OPP
- **Aug.2019** Project received CD-0

- **Aug.2020**, LBNL chosen as DOE Lead lab
  - Will manage DOE/HEP roles & responsibilities
    - Currently developing project management, personnel, R&D plan, cost, & schedule in association with Univ. of Chicago 2019 NSF MSRI-1 award
- **Dec.2020, FY21** budget appropriation provides $6M for R&D and project management
  - Congress approved it as a Major Item of Equipment (MIE) "project start" by providing $1M (of the $6M) in equipment "EQU" funding.

Detector wafers
~1000 pixels per waver



Transition Edge Sensors



Short term challenge: slow ramp up of funding compared to Project's request; limits the planned R&D, especially on detectors and readout

Longer term challenge: Synchronizing the NSF and DOE parts; Experience with partnerships on LSST and HL-LHC will prove useful

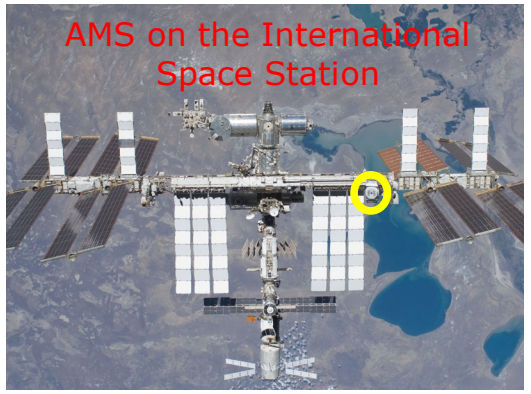
Exploring the Unknown

Use ground-based arrays, space telescopes, & an experiment on the International Space Station to explore the unknown, e.g. indirect searches for dark matter

Operations continuing – no major covid-19 impacts

Fermi/GLAST - Large Area Telescope (LAT) (w/NASA)

- HEP continues to support critical efforts at the LAT Instrument Science Ops Center at SLAC
- Results shown at AAS (Jan.2021): study of galactic center excess based on 11 years of LAT data and models for Milky Way diffuse emissions – consistent with the dark matter annihilation model, though hints of other explanations remain.



AMS *(w/NASA)*

- Cosmic rays, antimatter studies on the ISS

HAWC *(w/NSF)*

Gamma rays and cosmic rays between 100 GeV and 100 TeV

- HEP operations support completed at end of 2020.
- 2020 results of proof of the existence of g-rays >285 TeV provides ~ 2 orders of magnitude better constraints on superluminal Lorentz Invariance

Alpha Magnetic Spectrometer (AMS-02)

Physics: Search for antimatter, dark matter annihilations & new particle phenomena on International Space Station (ISS).

→ Multi-purpose particle-physics spectrometer detects cosmic-rays up to multi-TeV; uses permanent magnet

→ 95% of construction costs from Europe and Asia

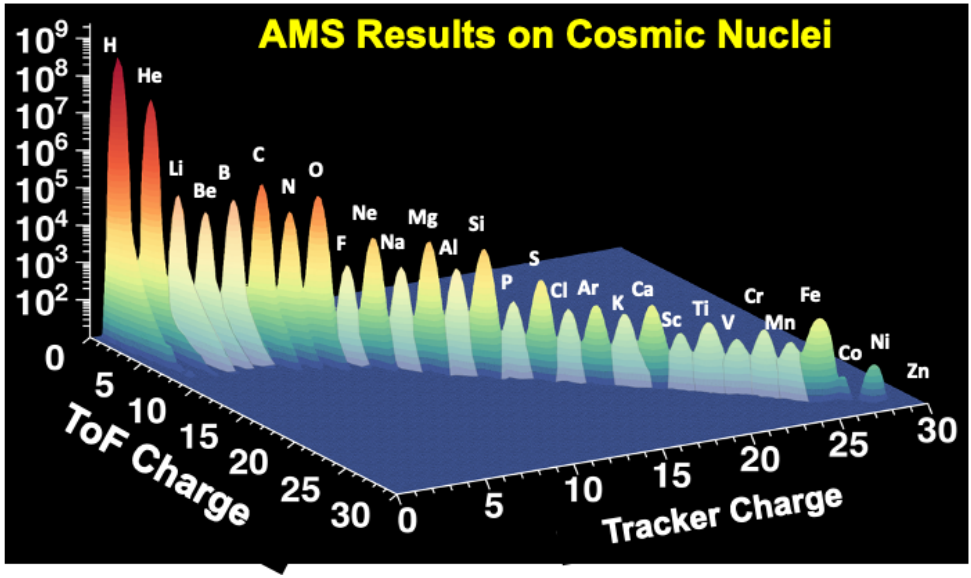
International Collaboration, with DOE/HEP leading US roles

- **DOE-HEP is responsible for management of the science program, led by Prof. Sam Ting (MIT) and has roles in operations**
- NASA provides the use of the ISS power, data, and mission management
- CERN hosts the Operations Control Center

Recent Highlights

~150 billion cosmic rays collected.

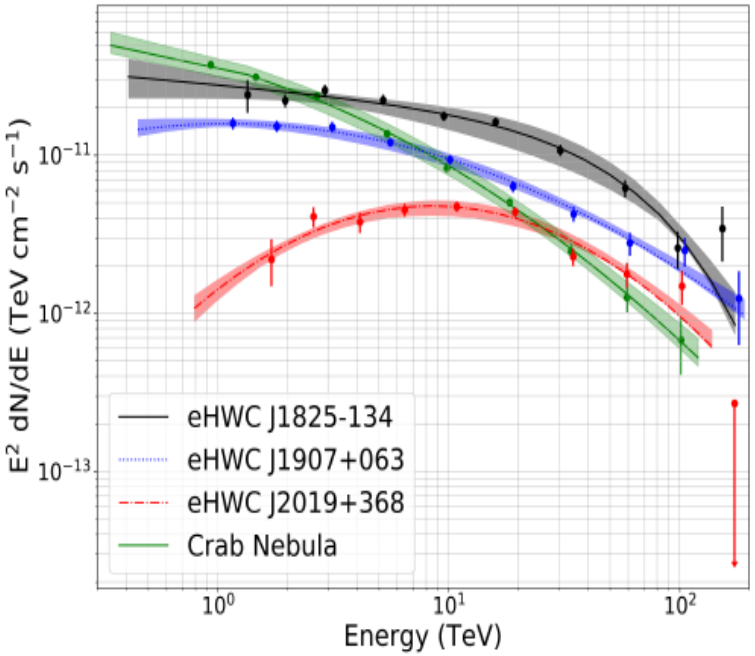
- **Recent EVAs (Fall 2019) by NASA to replace cooling system enables AMS to operate beyond 2028.**
- **High precision results on cosmic-ray elementary particle and nuclei fluxes, search for heavy antimatter and the origin of dark matter.**



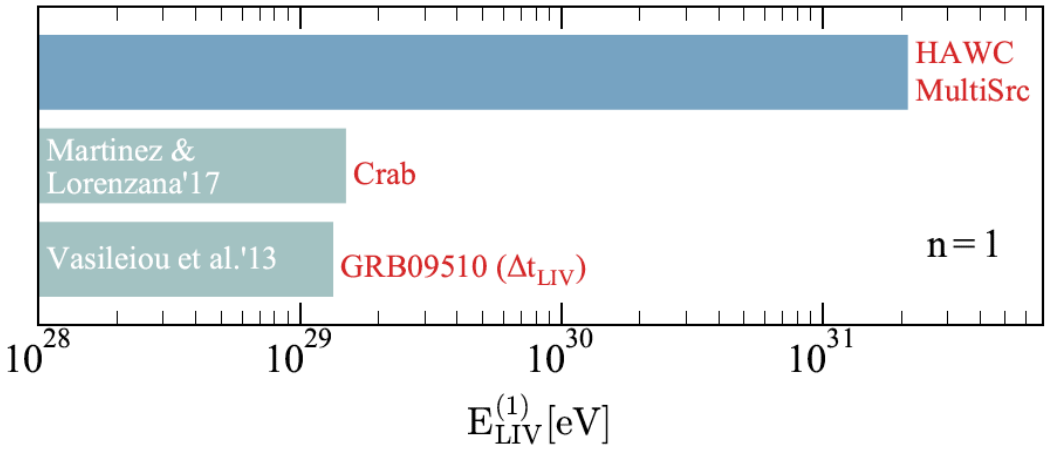
HAWC - Testing Lorentz Invariance

HAWC detects g-rays to >285 TeV which puts strongest constraints on Lorentz Invariance

- If Lorentz Invariance is violated, then g-rays above an energy threshold rapidly decay into e^+e^- pairs.
- HAWC's proof of the existence of g-rays >285 TeV provides ~ 2 orders of magnitude better constraints on superluminal Lorentz Invariance



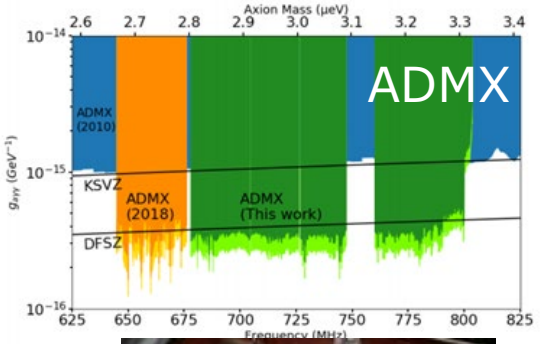
PRL (Jan 2020)
K. Malone (LANL) corresponding author



PRL (Apr 2020)
P. Harding (LANL) corresponding author

Direct Detection of Dark Matter

Staged suite of complementary direct detection experiments with multiple technologies to search for dark matter particles



3 Dark Matter 2nd Generation (DM-G2) projects

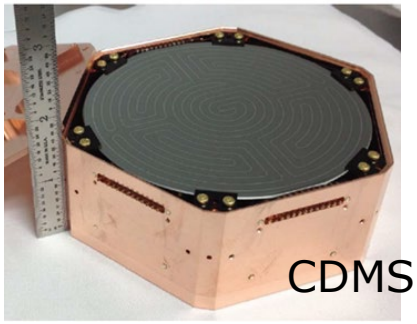
ADMX-G2 axion search (μeV-meV mass) operating at UW

LZ at Homestake Mine in South Dakota

- Dual phase liquid Xe WIMP search; ~10-1000 GeV mass
- Project fabrication complete; Now in commissioning; Physics data-taking starts summer 2021.

SuperCDMS-SNOLab in Canada (HEP+NSF partnership)

- Cryogenic solid-state crystal WIMP search; ~1-10 GeV mass
- Project fabrication delays due to cryostat procurement & covid-19; Rebaseline review in Feb. 2021 planned leading to fabrication complete at end of 2021.



Dark Matter New Initiative - Future Planning: Supporting technology R&D and concept studies for small projects in new areas of phase space: 4 Cosmic Frontier studies & 2 Intensity Frontier (accelerator-based) Future planning: Dark Matter New Initiatives (DMNI) small project concept development

Opportunity: Joint DOE-NASA RFI

On January 21, DOE Office of Science, jointly with NASA Science Mission Directorate, released a **Request for Information (RFI) related to high energy physics and space-based astrophysics.**

- The RFI is to gather information from the community in **3 specific, focused areas aligned with the science goals of both of the program offices**
  - including the scientific and technology benefits and obstacles, how it will make use of each agency's capabilities, infrastructure and resources, and other pertinent information.
- The information received will inform DOE and NASA regarding the potential development of mutually beneficial partnerships and collaborative activities.

The 3 focused areas are:

1. Sensitive radio telescopes or sensors on the Moon's far side to explore the early eras of the universe or test the standard cosmological model
2. Small experiments to carry out space-based probes of fundamental physics in a microgravity environment of the International Space Station
3. Enhance or extend the dark energy science reach of data from the Vera C. Rubin Observatory, the Nancy Grace Roman Space Telescope and the Euclid observatory when considered together, including development of a common library of simulations, &/or capabilities to enable joint data processing & analysis.

Opportunity: Joint DOE-NASA RFI

RFI* link is:
https://www.federalregister.gov/documents/2021/01/21/2021-01236/request-for-information-related-to-high-energy-physics-and-space-based-astrophysics

→ ***Formal responses to the RFI are due before March 8th***

→Requests for additional information may be submitted to Kathy Turner at *HEP-APD-BPS-RFI2021@science.doe.gov*

*Note that this is an RFI for both agencies though it says it's only from DOE on the RFI. HEP will collect the info for discussion within both agencies.

This RFI is part of a wider DOE/NASA effort to investigate collaborative activities as part of an MOU signed in Oct. 2020
See https://www.energy.gov/articles/department-energy-and-nasa-sign-memorandum-understanding

Cosmic Frontier – Future Planning

Astronomy & Astrophysics "Astro2020" Decadal Survey

- Identify the most compelling science challenges and frontiers
- Develop a comprehensive strategy for 2022-2032.

-

DOE & NSF are charging the NAS to carry out an **Elementary Particle Physics (EPP) decadal survey**; starts in 2021

- Assess the current state of the field, identify the fundamental questions that motivate research and tools necessary to answer these questions in context of international landscape; consider cross-disciplinary aspects and societal benefits

"Snowmass" process led by APS/DPF, DPB for High Energy/Particle Physics community to identify science questions and directions for the coming decade. Process started summer 2019 and culminates in a workshop in summer 2022 (moved out a year due to covid-19 to ensure broad engagement and the fullest possible participation of the HEP community).

The multi-year community-driven processes culminates in the HEPAP **Particle Physics Project Prioritization Panel (P5)** to lay out a strategic plan.

- Input includes: Astro2020, European Strategy for Particle Physics, Japanese planning, "Snowmass" community workshops, NAS EPP, etc.

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Research Support

Cosmic Frontier - HEP Research "Comparative Review" (Universities)

PASAG criteria applied to Research; priority for critical HEP roles & science goals.

- Work as part of an HEP-style collaboration w/leadership & critical contributions to project, operations and data planning & analysis.

HEP uses merit review and then folds in programmatic factors of priorities for support, funding availability: Ensure PI's with near-term, critical roles/responsibilities are supported; Support all phases of project, operations, and data analysis.

	FY 2016		FY 2017		FY 2018		FY 2019		FY 2020	
Y1 request, available	$7.8/$4.3M		$7.6/$4.7M		$14.3/$5.4M		$5.2/$3.4M		$9.1/$4.9M	
	# Prop.	# PI's	# Prop.	# PI's	# Prop.	# PI's	# Prop.	# PI's	# Prop.	# PI's
# Received	43	62	31	49	30	49	23	36	30	51
Reviewed	36	55	26	43	28	47	20	33	30	51
Funded	21	25	18	26	23	33	18	26	23	36
Success Rate (%)	58%	45%	69%	60%	82%	70%	90%	79%	77%	71%

Cosmic Frontier
➔ Early Career Awards (Univ + Lab)

Cosmic Frontier - Early Career awards	FY16	FY17	FY18	FY19	FY20
#Proposals Received	**13**	**13**	**16**	**17**	**16**
Proposals Reviewed Univ	7	8	11	13	11
Proposals Reviewed Lab	6	5	5	4	5
Funded Univ	**1**	**1**	**2**	**3**	**3**
Funded Lab	**0**	**1**	**0**	**0**	**0**

FY16:

Eduardo Rozo
Dark Energy

Anja von der Linden
Dark Energy

FY17:

Michael Schneider
Dark Energy

FY18:

Alexie Leauthaud
Dark Energy

Hee-Jong Seo
Dark Energy

FY19:

Tim Eifler
Dark Energy

Scott Hertel
Dark Matter

Elisabeth Krause
Dark Energy

FY20:

Hugh Lippincott
Dark Matter

Lado Samushia
Dark Energy

Michael Troxel
Dark Energy

Research Funding Opportunities

Workforce Development (WDTS) programs:
https://science.osti.gov/wdts

- **Office of Science Graduate Student Research fellowships (SCSGR)**
  - Supports grad student research at a DOE lab, 3 to 12 months, 2 calls per year
- **Science Undergraduate Laboratory Internships (SULI)**
  - Supports undergraduate research at a DOE lab, 10 to 16 weeks; 3 calls per year
- **Visiting Faculty Program (VFP)**
  - Summer research support for faculty/students from historically underrepresented institutions
- **Community College Internships (CCI)**
- **Albert Einstein Distinguished Educator Fellowship (AEF)**
- **National Science Bowl (NSB)**

HEP funding opportunities, plus from other Office of Science programs:

- **Research Opportunities in HEP (closes 1/26/21)**

https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002424.pdf

- **Early Career Research (closes 2/16/21)** https://science.osti.gov/early-career
- **SC "Open Call"** [DE-FOA-0002181]
  - HEP uses this primarily for conferences and supplements

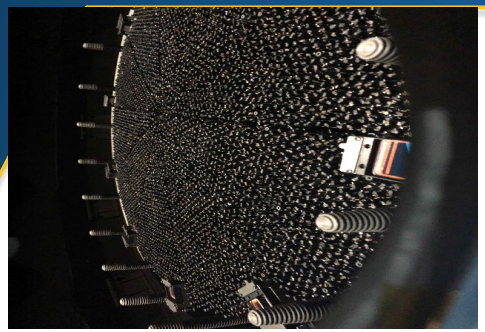
Research Support during covid-19

- PI's have been notified that they have significant flexibility within existing grant awards to re-plan their scope of work to accommodate research tasks that have been cut short or delayed by the pandemic, including extending support for junior scientists, which is one of our highest priorities.

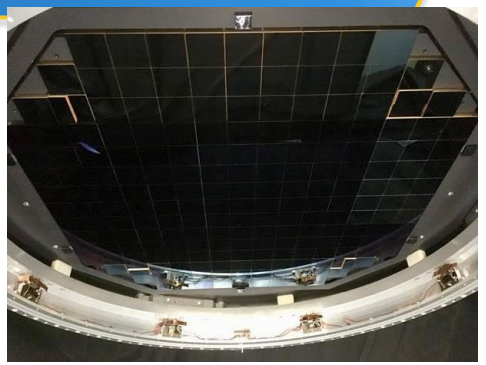
- We have been working with PIs on a case-by-case basis to address these issues as needed.

- The need to continue support for existing students and postdocs may impact the availability of funds for new proposals and/or new personnel on renewal proposals.

Summary

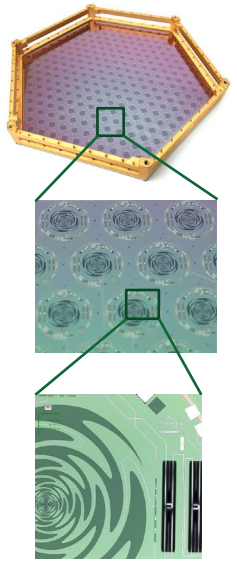


HEP continues to carry out the 2014 P5 strategic plan.
→ Many important interagency and international partnerships.



Cosmic Frontier:

- Continues to produce excellent, world-leading science results
- **DESI** has started it science survey operations
- **LZ** (dark matter) fabrication complete, now in commissioning
- **LSST Camera** nearly complete, Commissioning ongoing
- **Rubin Observatory** Facility Ops planning is ramping up: Google Interim Data Facility, SLAC US Data Facility, International in-kind contributions
- **CMB-S4** – LBNL selected as lead DOE lab; Approved as a fabrication project for DOE in the FY2021 budget; working towards planning for next decision points.
- **DOE/NASA RFI** to collect information on focused, potentially collaborative areas.
- **Future Planning** – Astro2020 and beyond



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