

Update from DOE-HEP

Regina Rameika
Associate Director of Science
for High Energy Physics

HEPAP Meeting
May 9-10, 2024



U.S. DEPARTMENT OF
ENERGY

Office of
Science

[Energy.gov/science](https://www.energy.gov/science)

Outline

- ◆ Office of High Energy Physics Organization
 - Introducing the Accelerator and Technology Division (ATD)
- ◆ Highlights from the Frontiers
 - Energy, Intensity, Cosmic, and Theory
- ◆ Highlights from Projects
 - HL-LHC, LBNF/DUNE, Mu2e
- ◆ Update on Fermilab Operations
- ◆ Broadening Engagements and Outreach
- ◆ Current Budget Situation
- ◆ Recent Events and Reviews
- ◆ Sneak peak at the DOE P5 response

Office of High Energy Physics at a Glance

FY 2024 Enacted: \$1.2B



Largest Supporter (~85%)
of Particle Physics in the
U.S.



Funding at >180
Institutions, including 12
DOE Labs



[Snowmass, July 2022, Seattle]
Over 1,120 Ph.D. Scientists
and 515 Grad Students
Supported



[Fermilab Accelerator Complex]
Over 2,345 Users at
2 SC Scientific Facilities



~30% of Research to
Universities



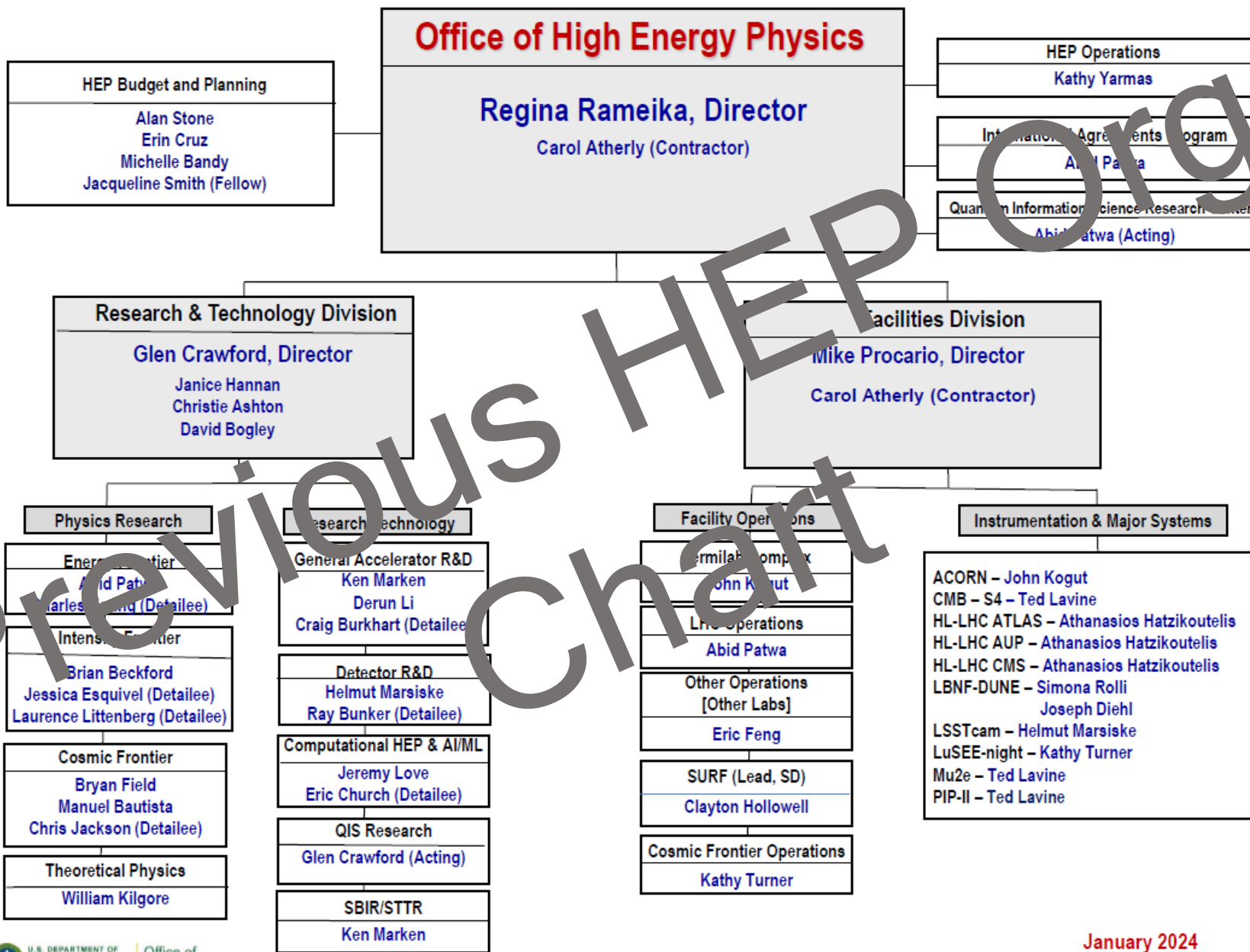
Research:
36%, \$426.3M



[Vera Rubin Observatory, Chile]
Facility Operations:
29%, \$348.5M



[LBNF/DUNE Cavern, SURF,
SD]
Projects:
35%, \$425.2M



Office of High Energy Physics

Regina Rameika, Director
 Eric Colby, Sr. Technical Advisor
 Carol Atherly, Administrative Support (CONTR)
 Janice Hannan, Administrative Support

HEP Budget and Planning

Michelle Bandy
 Erin Cruz
 Alan Stone

International Cooperation

Abid Patwa

HEP Support

Christie Ashton
 David Bogley
 Kathy Yarmas

Broadening Engagement

Alan Stone
Jacqueline Smith (AAAS Fellow)

Accelerator and Technology Division
 Regina Rameika, Acting Director

Research Division
 Glen Crawford, Director

Facilities and Projects Division
 Michael Procaro, Director

Accelerator Programs

Camille Ginsburg
 Derun Li
 Ken Marken
Craig Burkhart (Detailee)
Christine Clarke (Detailee)
Roark Marsh (Detailee)

Instrumentation and Detector R&D

Helmut Marsiske
Ray Bunker (Detailee)

QIS, AI/ML, Computational HEP

Jeremy Love
 Vacant PM (Acting: *Glen Crawford & Abid Patwa*)
Eric Church (Detailee)

Energy Frontier

Abid Patwa
Charles Young (Detailee)

Intensity Frontier

Brian Beckford
Jessica Esquivel (Detailee)
Laurence Littenberg (Detailee)

Cosmic Frontier

Manuel Bautista
 Bryan Field
 Kathy Turner
Chris Jackson (Detailee)

Theory

William Kilgore

AGILE

Glen Crawford

Facility Lab Operations

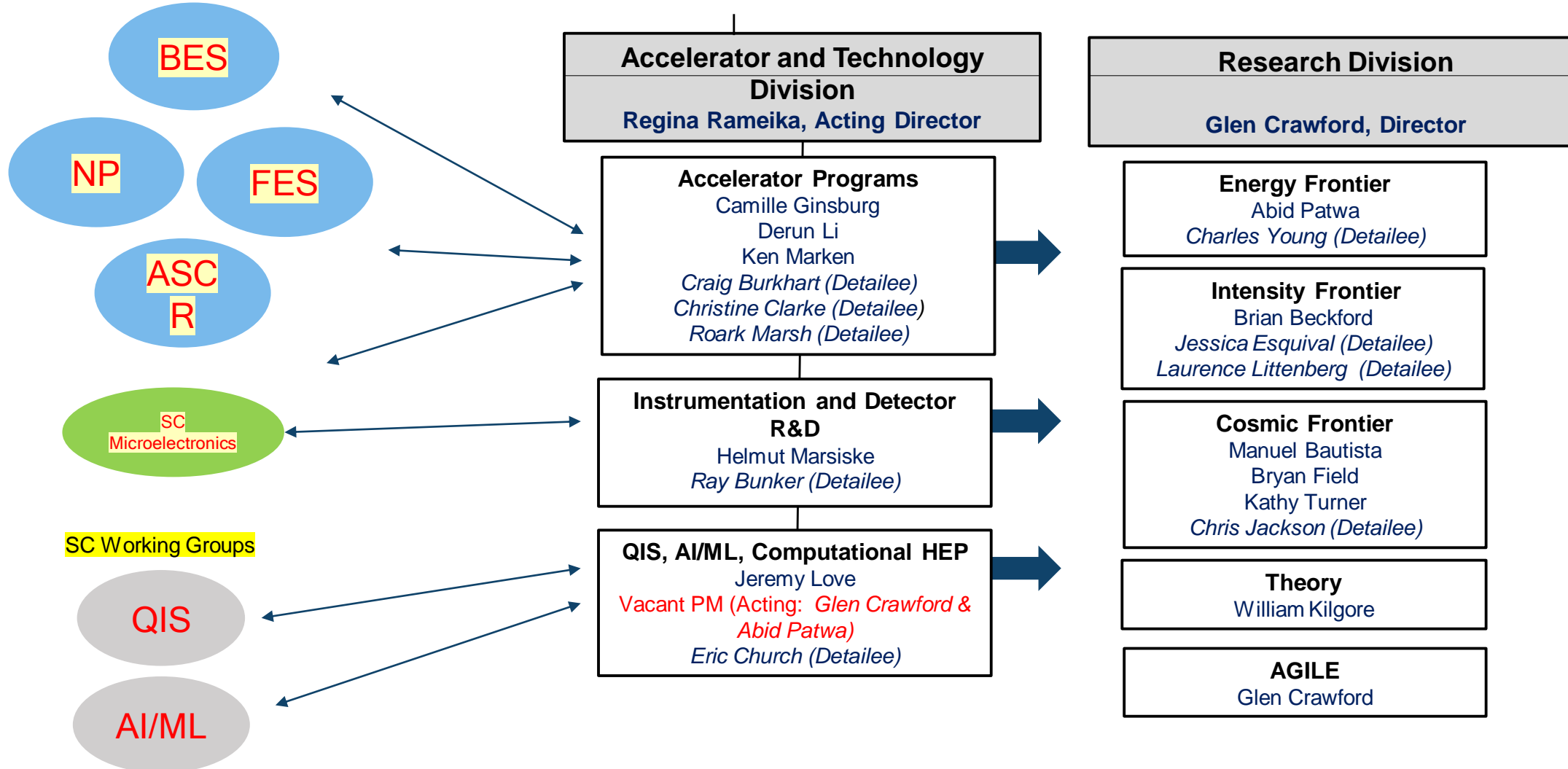
Eric Feng (FACET-II, DUNE, NERSC)
 Clayton Hallowell (SURF)
 John Kogut (FNAL, BNL, SLAC, LBNL)
 Abid Patwa (LHC, ANL)
 Kathy Turner (Cosmic Experiments)

Projects

Joseph Diehl (LBNF/DUNE)
 Athans Hatzikoutelis (HL LHC)
 John Kogut (ACORN)
 Ted Lavine (mu2e, CMB-S4)
 Simona Rolli (LBNF/DUNE)
 Kathy Turner (LuSEE night, DMNI)

Introducing the Accelerator and Technology Division (ATD)

SC Program Offices



Accelerator R&D and Production (ARDAP)*

an investment to ensure the U.S. remains a world-leader in the accelerator technologies needed for science and industry

◆ Accelerator Research

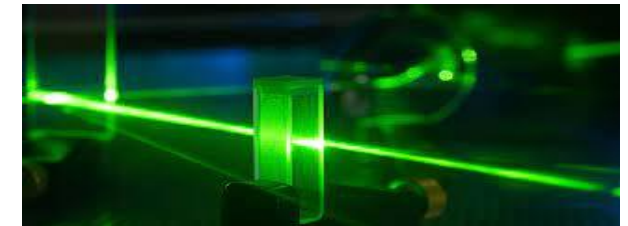
- **Accelerator Stewardship:** developing cross-cutting transformative accelerator technology for future scientific facilities, medicine, industry, security, and defense
- **Technology Maturation:** readying technologies for production and use in scientific facilities, broader USG, and commercial applications
- **Workforce Development:** supporting R&D capacity building and workforce training at MSIs and ERIs
- **Accelerator User Facilities:** Brookhaven Accelerator Test Facility supports technology R&D and industrial access to DOE capabilities

◆ Accelerator Development

- **Domestic Supplier Development:** collaborative early-stage R&D partnerships to develop new domestic sources for critical accelerator technologies

◆ Coordination for effective technology transfer

- Through interagency cooperation, research collaborations, public-private partnerships, and workshops aimed at identifying common R&D needs and forming research networks



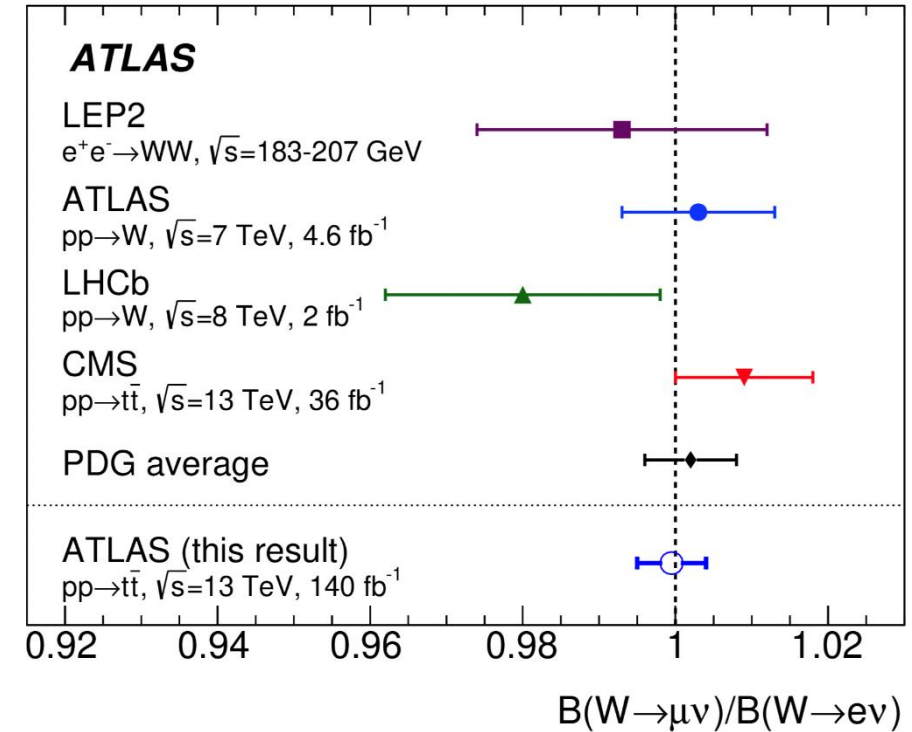
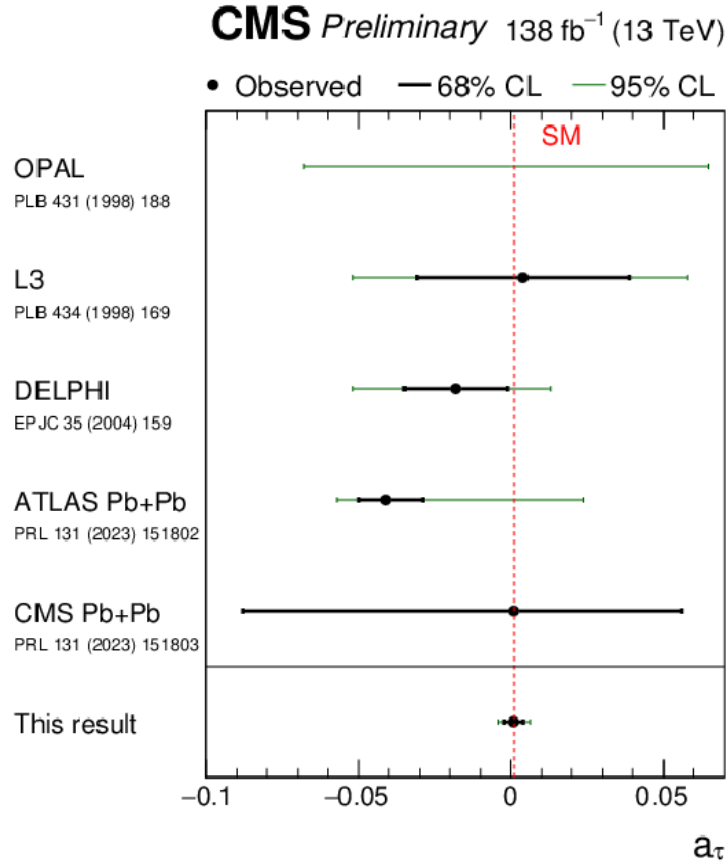
*These programs merge back into Office of High Energy Physics in FY 2026

Energy Frontier Program: LHC Physics Highlights

Obs. of photo-production of tau pairs ($\gamma\gamma \rightarrow \tau\tau$)

- First obs. in pp (was seen in PbPb collisions)

New ATLAS result on lepton universality in W-boson decays ([arXiv:2403:02133](https://arxiv.org/abs/2403.02133))

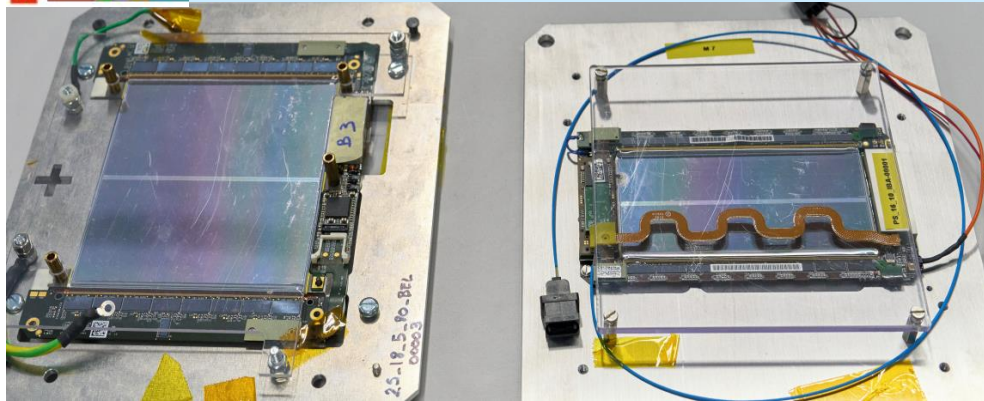


Run 3 for calendar year 2024 has resumed ... more results expected for summer conferences!

High-Luminosity LHC Upgrade Projects



CMS Silicon sensors and onboard electronics assembled for production qualification testing

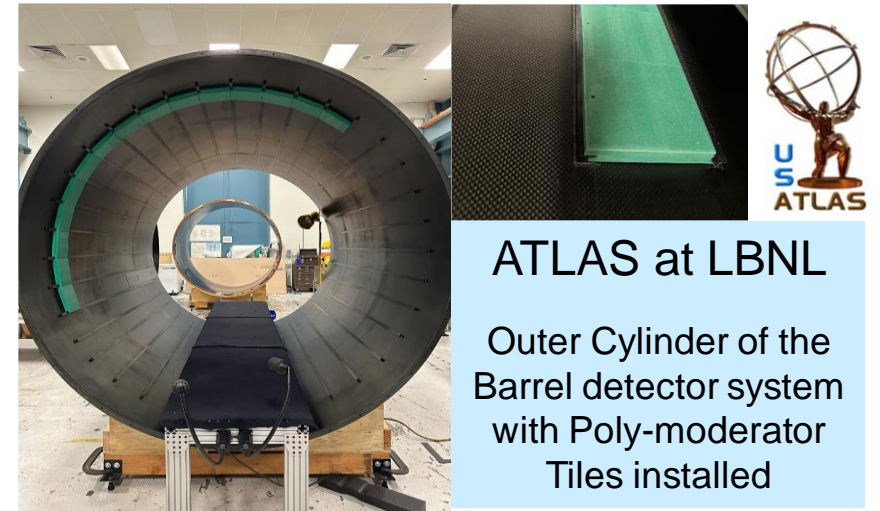


All U.S. HL-LHC projects are in their fabrication stage

- Detector upgrade sites for ATLAS and CMS are ready to qualify the thousands of sensor assemblies
- Accelerator upgrade project (AUP) team has delivered the 1st of 10 quadrupole magnet assemblies to CERN
 - 2nd assembly being tested at Fermilab. Shipment planned for this Fall



The AUP group delivered the first quadrupole magnet assembly to CERN for the HL-LHC



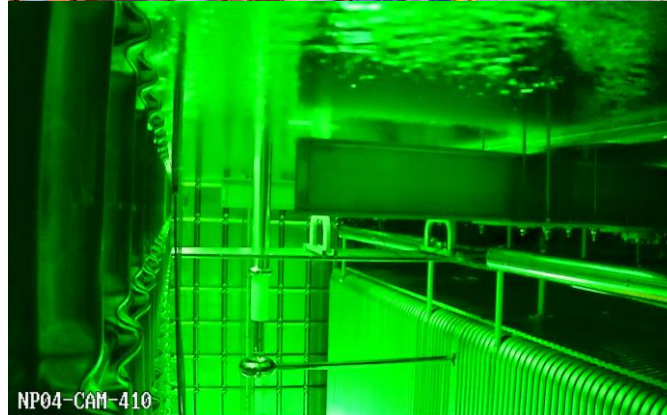
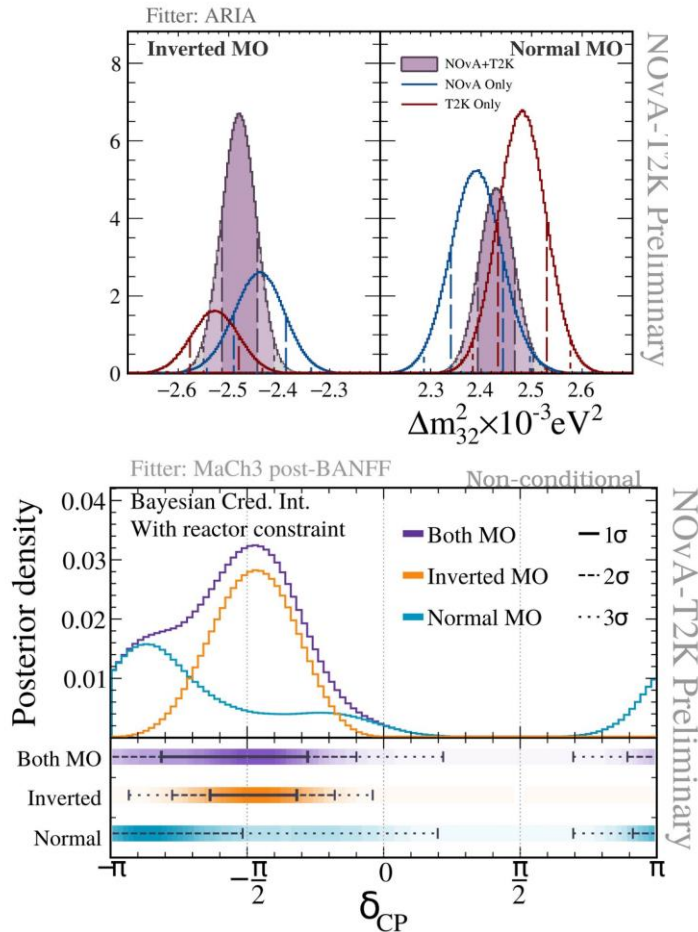
ATLAS at LBNL

Outer Cylinder of the Barrel detector system with Poly-moderator Tiles installed



◆ NOvA & T2K Joint Results

- Good agreement on allowed values for Inverted Ordering
- Doubles total statistics
- Joint result slightly disfavors Normal Ordering compared to individual experiments



◆ MicroBooNE

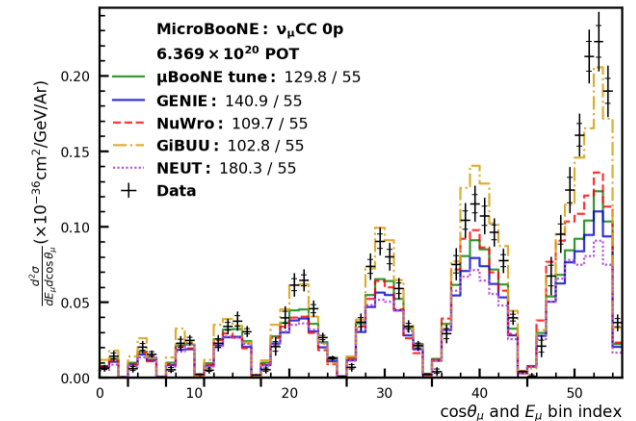
- First simultaneous measurement of ν_μ CC XP

◆ SBND

- Cryogenics commissioning completed
- Cryostat filled with LAr

◆ DUNE

- DUNE ND LAr 2x2 installed in NUMI
- NP04 Protodune filled with LAr



Cosmic Acceleration:

NSF-DOE Vera C. Rubin Observatory, Legacy Survey of Space and Time (LSST) Camera



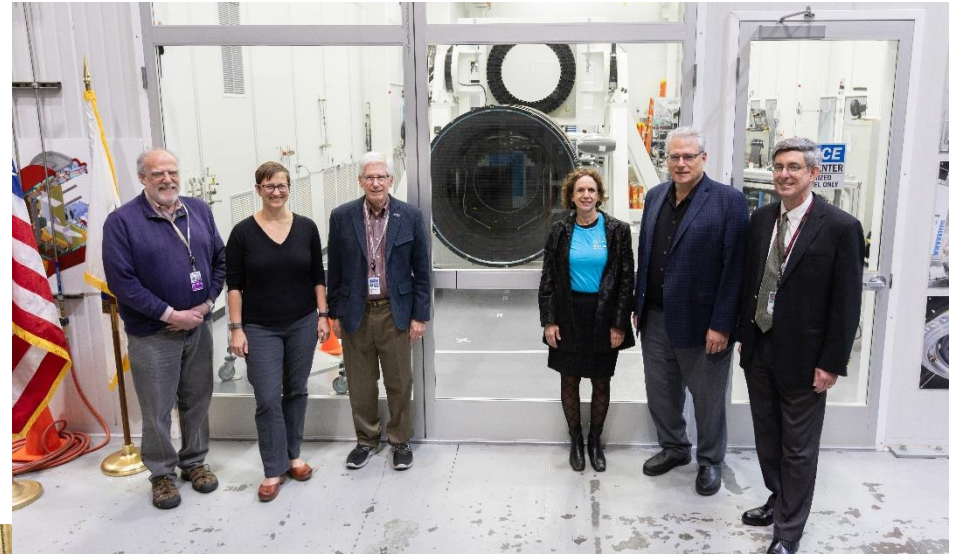
LSSTCam for NSF-DOE Vera C. Rubin Observatory completed; being shipped to Chile later this month!

Media coverage: 1,040 articles; 87 broadcast clips; 13 news outlets showed for media day

LSSTCam Bon Voyage event at SLAC 4/15/24.



LSSTCam integrated at SLAC



LSSTCam Bon Voyage event at SLAC 4/15/24.

Packed up & into shipping container



US Data Facility is ramping up; realistic data transfers from summit; data processing with simulated, LSSTCam and the auxiliary telescope (AuxTel) is ongoing.

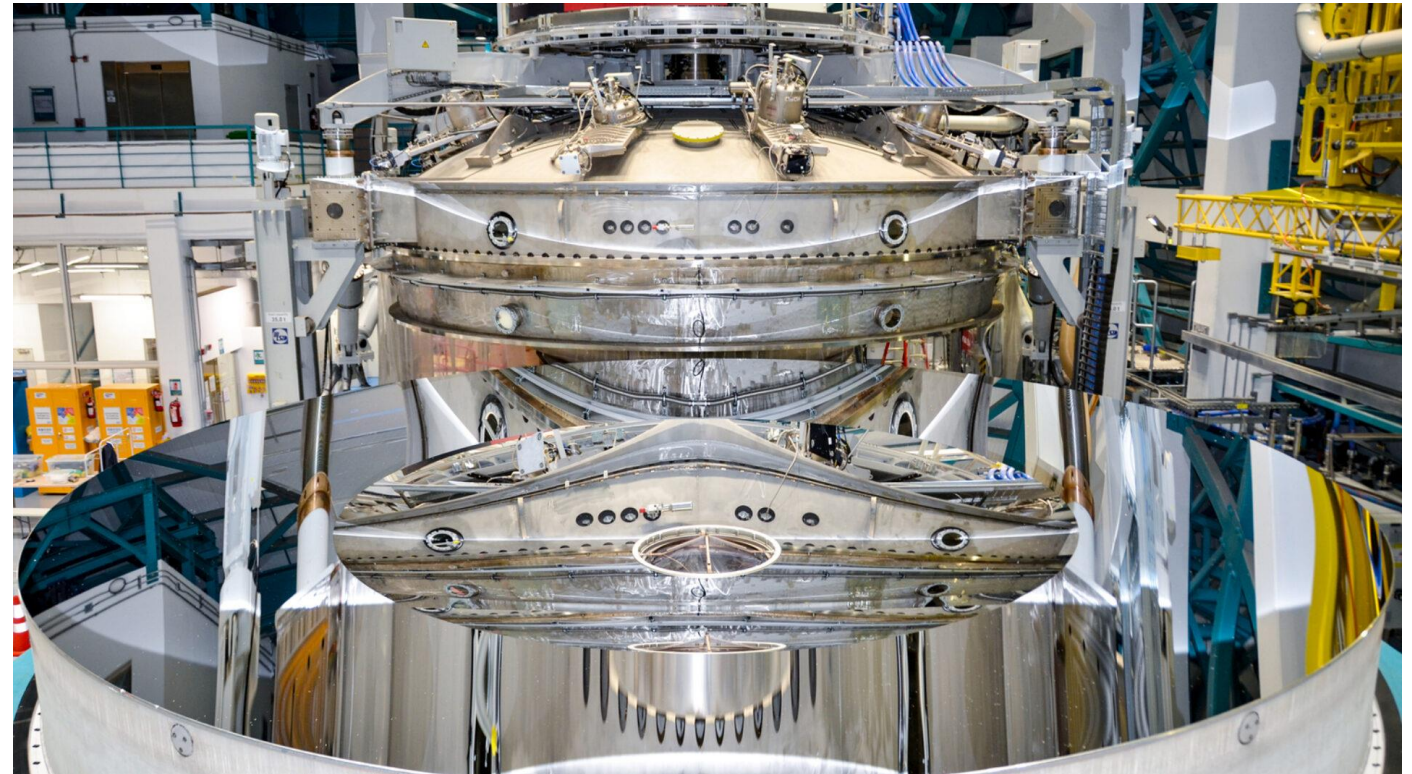
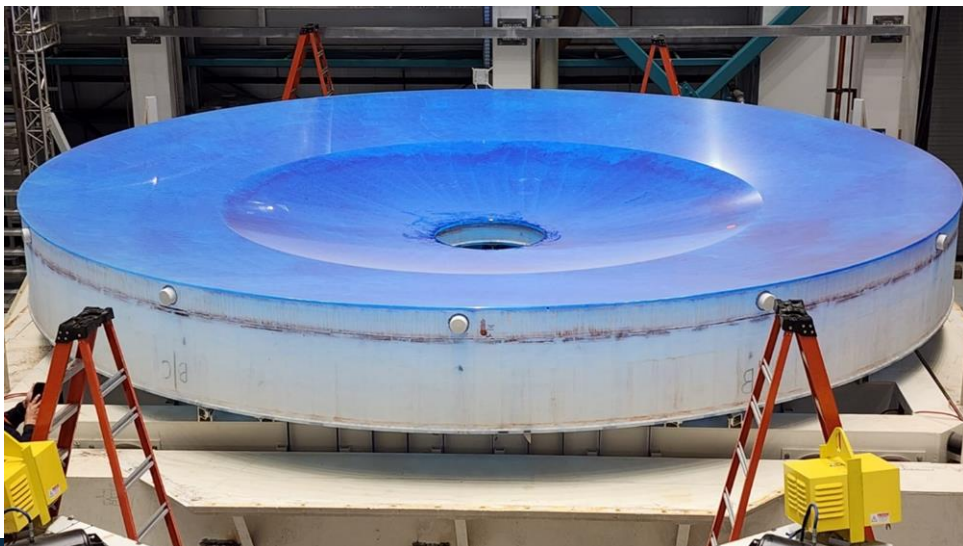
Cosmic Acceleration:

NSF-DOE Vera C. Rubin Observatory, Legacy Survey of Space and Time (LSST) Camera



News from NSF's MREFC:

The M1M3 mirror was moved to summit, unpacked and coated!



Direct Detection Dark Matter - DM-G2's & DMNI's

Dark Matter Generation 2 (DM-G2) suite of projects with multiple technologies, mass ranges, and particle types was recommended by 2014 P5

- ◆ ADMX-G2 axion search is operating at U. Washington. 2021, 2024 results exclude axionlike signals for the 2.66-2.81 μeV mass range at the 90% confidence limit. The experiment continues systematic scanning towards higher axion masses.
- ◆ LZ WIMP search at SURF: First results (from 60 live days) found no WIMP action with masses above 9 GeV (PRL July 2023). Run 3 is underway (1 year of data)
- ◆ SuperCDMS-SNOLAB is in integration/installation phase. Data-taking with all 4 towers expected late 2025.



Dark Matter New Initiatives (DMNI)

- ◆ Concept development continues. These will be folded into the Advancing Science and Technology through Agile Experiments (ASTAE) program as recommended by the 2023 P5. (More in P5 talk)



Theory Highlight

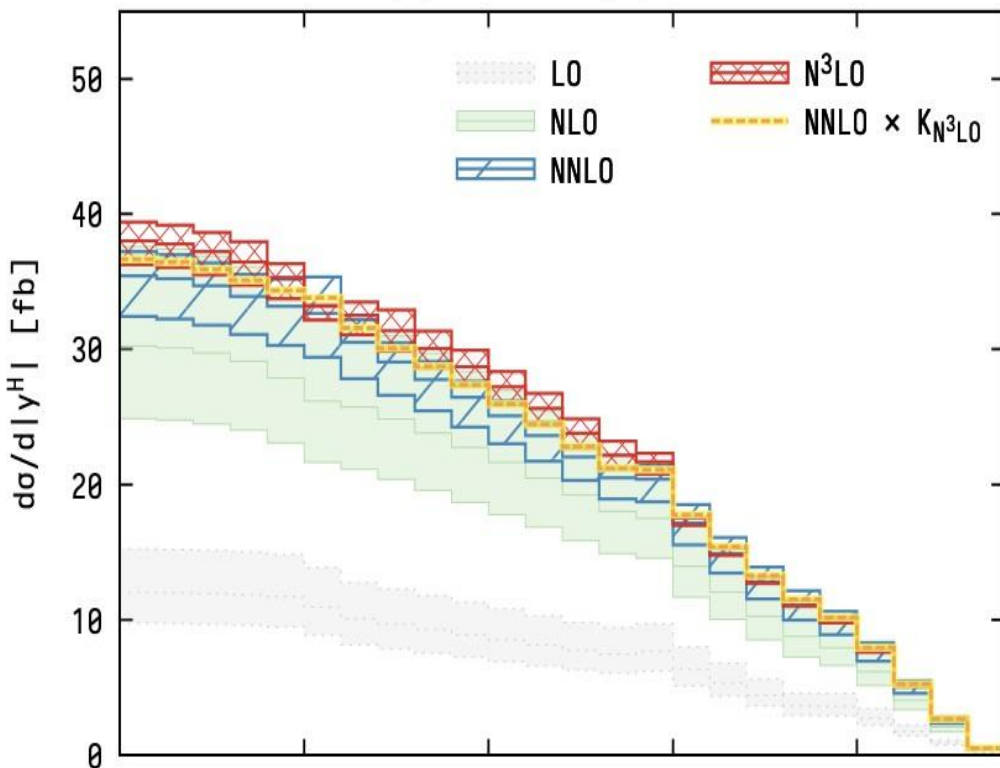
Pushing the Boundaries of Precision: N3LO Predictions for the LHC

2023 Office of Science Early Career Award: Bernhard Mistlberger, SLAC

Goal: Establish N3LO technology to achieve one-percent precision phenomenology at the LHC



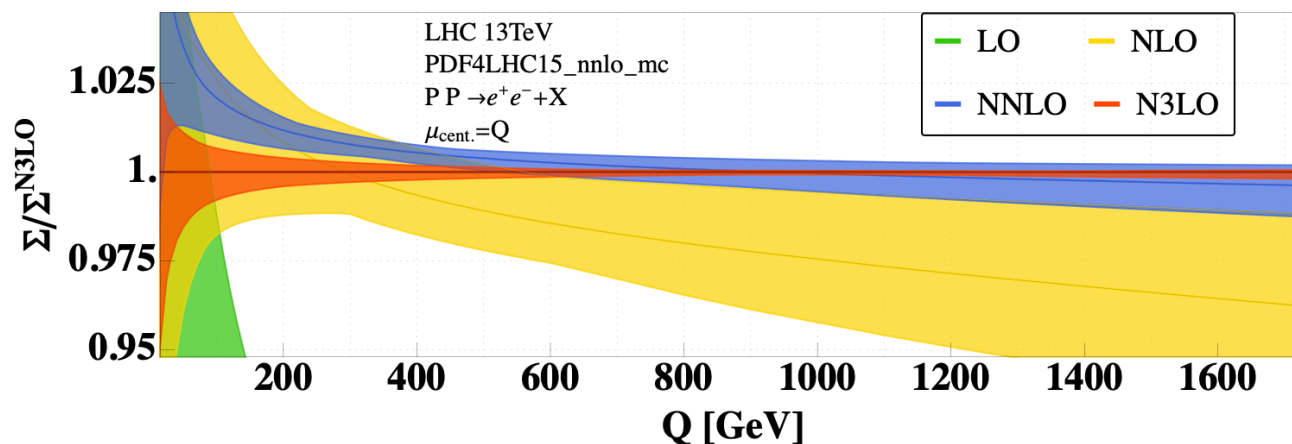
NNLOJET + RapidIX $p p \rightarrow H (\rightarrow \gamma \gamma) + X$ $\sqrt{s} = 13$ TeV



[Chen, Mistlberger, et al. 21]

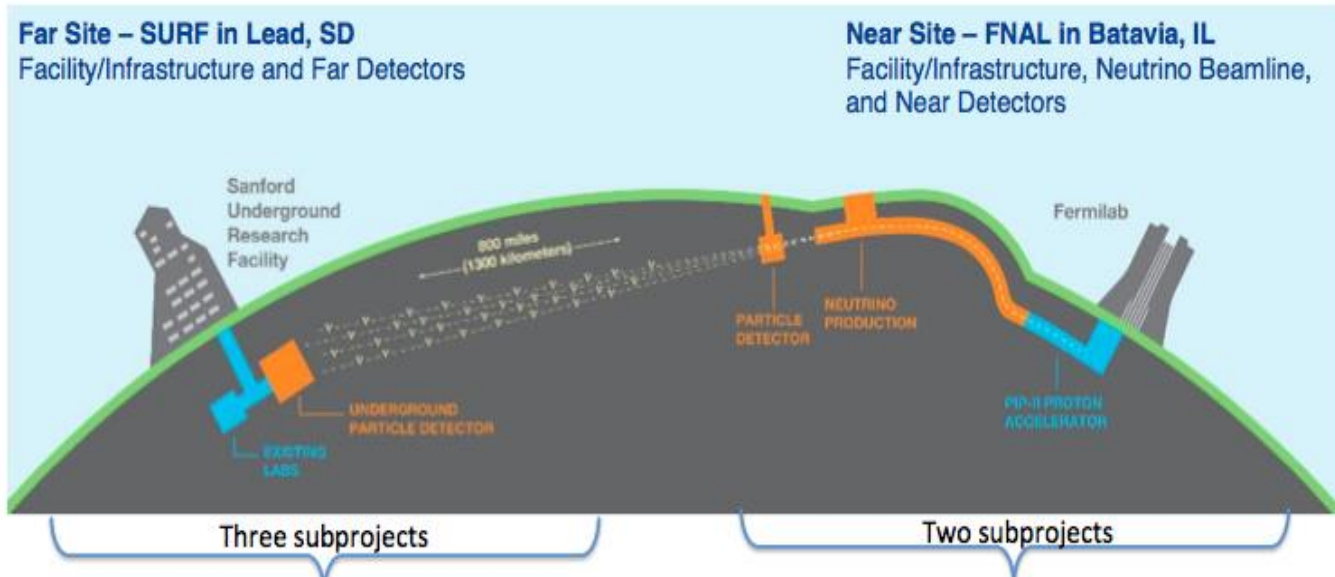
- Develop algorithm for fully differential N3LO computations of generic LHC processes
- Improve techniques for perturbative computations to facilitate three (and higher) loop calculations
- Apply to key LHC observables like Higgs boson / Drell-Yan production in association with a jet

Drell Yan Production



[Duhr, Mistlberger 21]

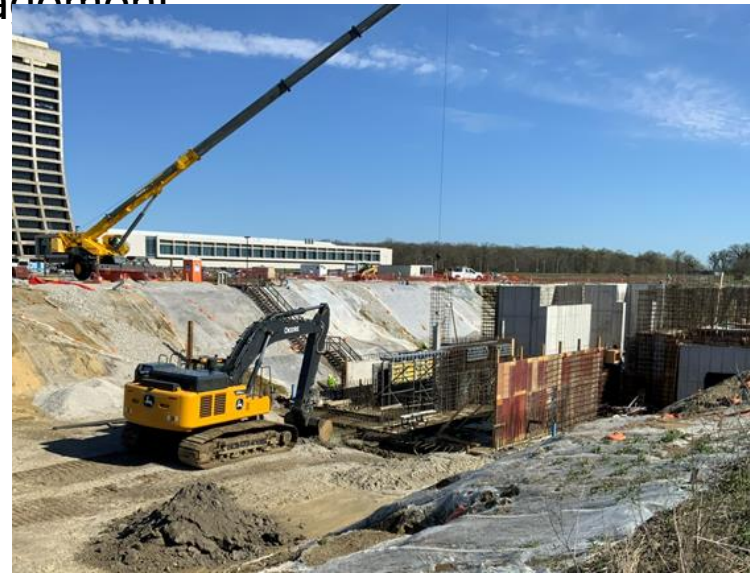
LBNF/DUNE-US Project



Subproject	Cost	Scope	Critical Decision Status
FSCF-EXC	\$644M	Excavation to support up to 4 far detector modules	CD-2/3 approved 08/2022
FSCF-BSI	\$211M	Utilities and outfitting to support up to 4 far detector modules	CD-2/3 approved 03/2023
FDC	\$1,119M	Fabricate and install 2 far detector modules and cryogenic systems (includes international contributions)	Preparing for CD-2/3
NSCF+B	\$1,103M	1.2 MW upgradeable beam, facilities for beam and near detector (includes international contributions to the beam)	Preparing for CD-2/3 approval in first half of FY25
ND	\$200M	Fabricate and install near detector and cryogenic systems (includes international contributions)	Optimizing given DOE cost cap and expect CD-2/3 in FY25

PIP-II Project Highlights

- Fermilab capability modernization
 - 1.2 MW proton beam for LBNF
 - Upgradable to 2.4 MW
 - CW compatible
 - Beams customizable for multiple users
- First US accelerator project to incorporate significant international contributions
- Partner laboratories in France, Italy, Poland, and UK bring experience from XFEL, ESS, etc.
- Project Early Finish Q1FY30
- Project Completion Baseline is 1Q FY 2033.
- Major accomplishments since May 2023
 - Recovery from May 25, 2023 construction injury accident. Full work restarted by January 5, 2024 with augmented processes for construction safety, work planning and authorization.
 - Rebuilt Project Management Office staff following turn-overs of key positions in accelerator physics, project, engineering, procurement, and technical management



Mu2e Project Highlights

Transport Solenoid Magnets are in final position in the experimental area.

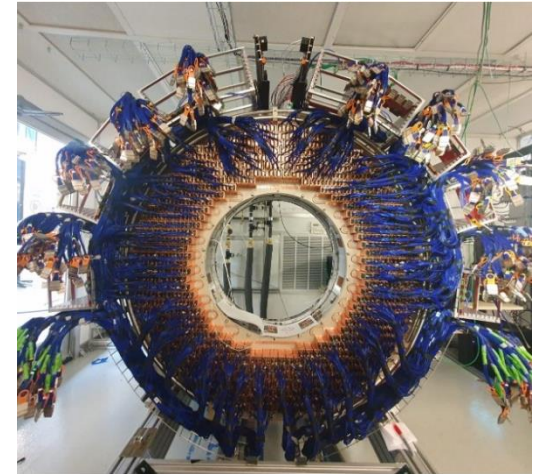


Delivery of the Production Solenoid and Detector Solenoid are expected from General Atomics in late 2024 and early 2025.



Sub-system assembly and testing are progressing at Fermilab

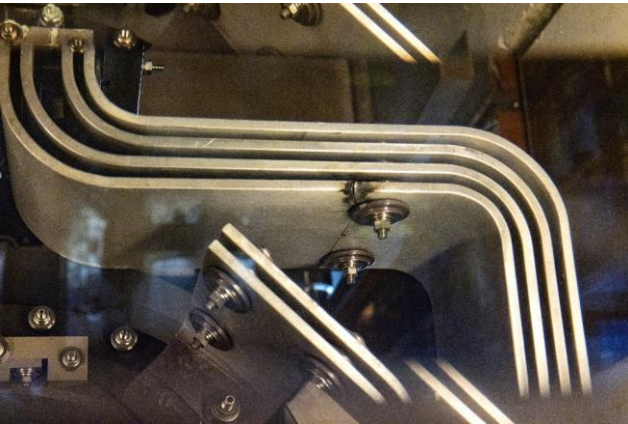
- Straw-tube Tracker
- Cs-I Calorimeter (INFN)
- Cosmic-ray Veto (UVa)
- Triggering & DAQ System
- Electrostatic septa
- AC-dipoles for beam extinction
- Next IPR in June 2024
- Project completion baseline is January 2025



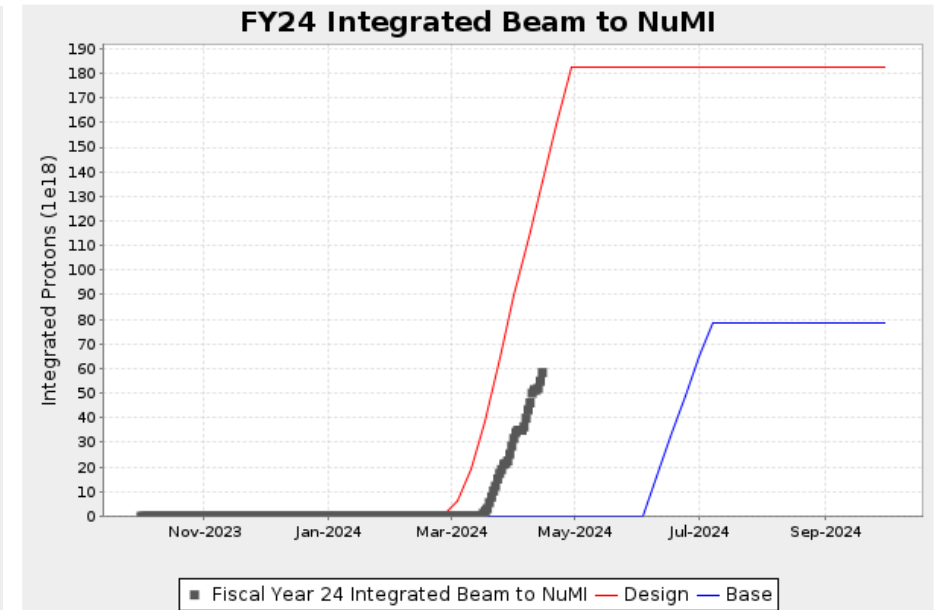
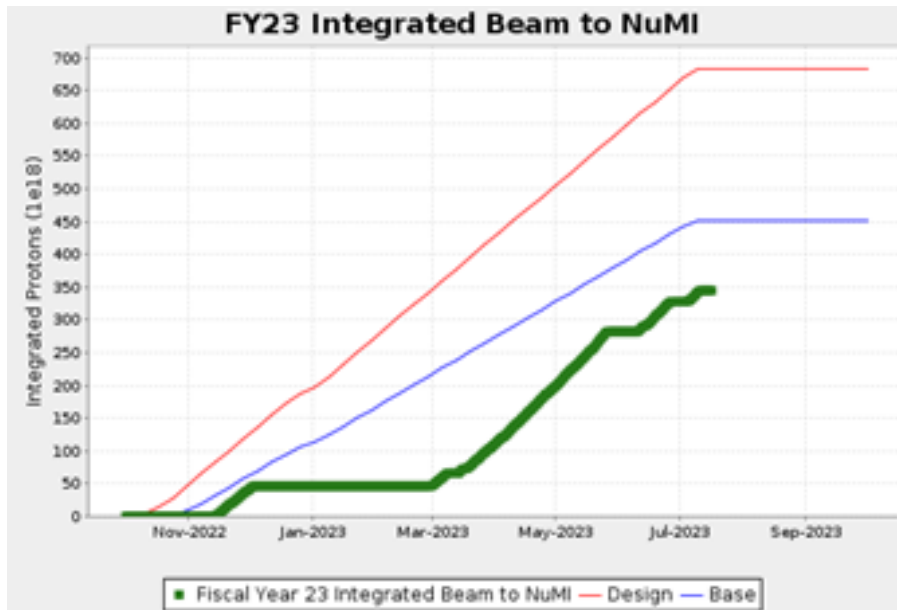
Fermilab is planning initial run of the Mu2e experiment in 2027, prior to the two-year Booster shut-down for construction of the PIP-II beam transfer line.

Fermilab Accelerator Complex 2023-24

- The Fermilab Accelerator Complex achieved 2486 run hours in FY2023 which fell short of its originally scheduled goal for FY2023 of 5320 hours.
- The reason for the shortfall was a stripline failure in the NuMI horn power supply which took over 2 ½ months to repair.
- FY2024 goal is 2240 hours of operations (Half of a typical year). NuMI uptime 50.5%. Frequent failures of auxiliary equipment (sump pumps and lines, electrical switches, cables, etc. reduces physics output)
- Power goal is 1MW for this run. Power gain can be achieved without increase in beam intensity via faster beam acceleration cycle in Main Injector. Main Injector started this year's operations at 1.067 s cycle.
- No Beam delivery until mid March. Laboratory was working on Safety Assessment Documents (SADs) and Accelerator Safety Envelope (ASE) documents to conform with DOE O420.2D.



**Crack in Stripe-line.
No Spares. One vendor in US.**



Delayed Start. Reduced Goals

HEP Budget (\$K): Research, Facilities/Ops, Projects

FY 2014 – FY 2024

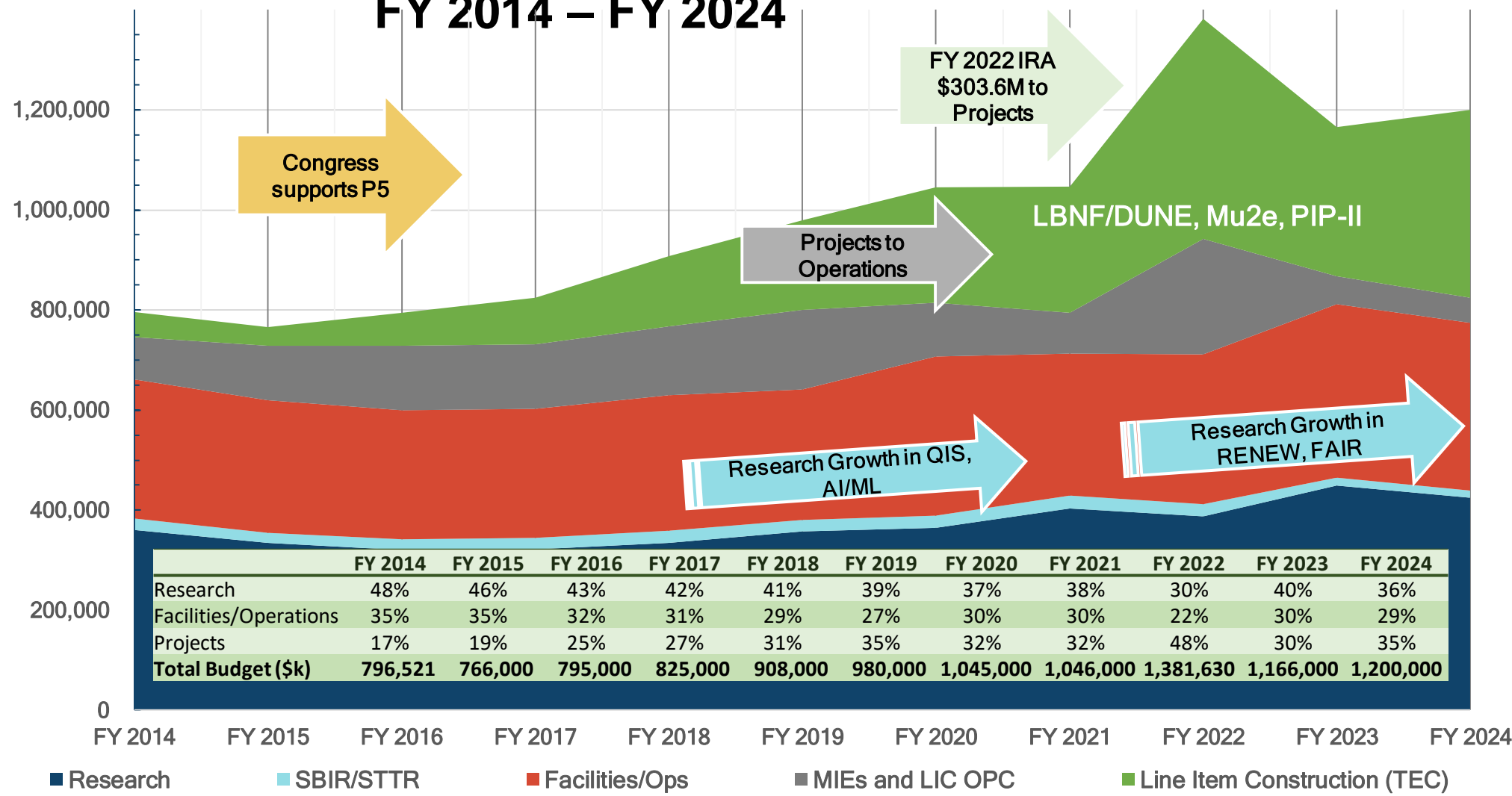


Strategic Plan for U.S. Particle Physics next 10 years

Particle physics is global

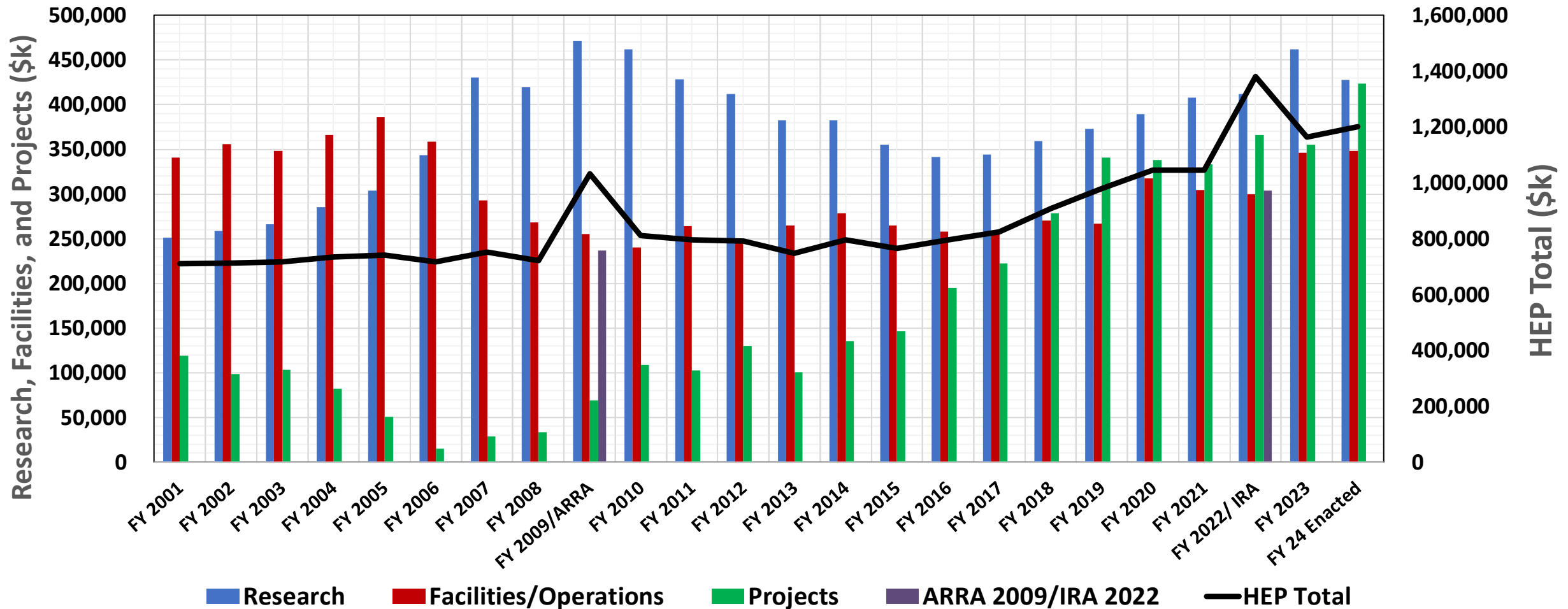
Community made difficult choices

Increase investment in construction



HEP Budget (\$K): Research, Facilities & Projects

FY 2001 – FY 2024



ARRA 2009 funds supported Research, Facilities, and Projects
 IRA 2022 funds supported Projects only

Timeline of FY 2024 Budget Headlines

Request	Markup	Markup	Enacted	Request			
 <p>9 Mar 2023</p> <p>President's 2024 \$1.73T discretionary budget request submitted to Congress</p> <p>Would increase non-defense appropriations by about \$96B (5.9%) over the 2023 enacted level</p> <p>1.226B HEP</p>	 <p>3 Jun 2023</p> <p>HR. 3786, Fiscal Responsibility Act, signed into law</p> <p>Suspends debt limit through Jan 1, 2025.</p> <p>Sets statutory caps on non-defense appropriations for FY 2024 (flat) and FY 2025 (+1%). No adjustments for inflation.</p>	 <p>23 Jun 2023</p> <p>House Appropriations Subcommittee for Energy and Water Development, and Related Agencies released a summary for the FY 2024 House Mark</p> <p>1.192 HEP</p>	 <p>28 Jun 2023</p> <p>Senate Appropriations Subcommittee for Energy and Water Development, and Related Agencies released a summary for the FY 2024 Senate Mark</p> <p>1.226B HEP</p>	 <p>30 Sep 2023</p> <p>HR. 5860, Continuing Appropriations Act, 2024 and Other Extensions Act, signed into law</p> <p>Continuing resolution temporarily extends fiscal year 2023 spending levels until Nov 17, 2023.</p>	 <p>Nov 2023 - Mar 2024</p> <p>Congress passed three additional Continuing Resolutions.</p> <ol style="list-style-type: none"> 1) Nov 18 - Jan 19 2) Jan 20 - Mar 1 3) Mar 2 - Mar 8 	 <p>9 Mar 2024</p> <p>HR. 4366, Consolidated Appropriations Act, 2024, signed into law</p> <p>Office of Science increases 1.7% from to 8.24B</p> <p>•Office of High Energy Physics increases 2.9%</p> <p>•1.2B HEP</p>	 <p>11 Mar 2024</p> <p>President's 2025 \$1.67T discretionary budget request submitted to Congress</p> <p>Would decrease non-defense appropriations by about \$60B (3.4%) over the 2024 Request</p> <p>1.231B HEP</p>

FY 2024 HEP Budget

- Office of Science increased 1.7% from 8.1B in FY 2023 to 8.24B in FY 2024
- Office of High Energy Physics increased 2.9% (+34M) from 1.166B in FY 2023 to 1.2B in FY 2024
- Congressional direction set LBNF/DUNE and PIP-II at 255M and 125M, which is **+\$80M over FY 2023 funding levels**
- Additional direction provided floor/ceiling limits for SURF, CMB-S4, ACORN, HL-LHC Upgrade projects, and LBNF/DUNE OPC.
- Congressional directional at the SC level for QIS and AI/ML propagated down to HEP and holds FAIR and RENEW at FY 2023 levels
- Overarching language included a note stating House and Senate marks carry same weight as the final appropriation language

	FY 2023 Enacted	FY 2024 Request	FY 2024 House	FY 2024 Senate	FY 2024 Approp
High Energy Physics	868,000	850,334	842,334	850,000	824,000
Construction					
LBNF/DUNE	176,000	251,000	225,000	251,000	251,000
PIP-II	120,000	125,000	125,000	125,000	125,000
Mu2e	2,000	-	-	-	-
HEP Total	1,166,000	1,226,334	1,192,334	1,226,000	1,200,000



The agreement provides not less than \$35,000,000 for the Sanford Underground Research Facility and not less than \$5,000,000 for the Accelerator Controls Operations Research Network.

Funding for HEP Research and Operations, which supports all Research, Facilities/Operations, and MIE Projects, **decreased 5% from 868M in FY 2023 to 824M in FY 2024.**

High Energy Physics	FY 2023	FY 2024**
Research	446,037	424,561
SBIR/STTR	15,867	15,267
Facilities/Ops	349,096	334,972
Projects (excl LIC TEC)	57,000	49,200
Total	868,000	824,000

**Final year distributions may be adjusted (~± 0.2%)

FY 2025 Request Highlights




Research \$395.8M (-\$30.4M, -7.1% from FY 2024 Enacted)

- **\$24M increase** for AI/ML. **\$8M increase** for RENEW and FAIR
- **\$4M decrease** as Accelerate Innovations in Emerging Technologies concludes
- QIS, Microelectronics, Advanced Computing, and Accelerator Science and Technology continue at the FY 2024 Enacted Level
- **\$59.9M decrease** to Core Research. Focus support on high-profile research topics and early research results; key contributions and critical U.S. commitments to experiments & projects; University research & training; other priority cross-cutting initiatives



Facilities Operations \$381.7M (+\$33.2M, +9.5% above FY 2024 Enacted)

- **Fermilab Accelerator Complex** \$166.9M (+\$25.3M, +17.9% above FY 2024 Enacted): 5,180 hours
- **SLAC FACET-II** \$17.6M (+\$1.1M, +6.9% above FY 2024 Enacted): 3,120 hours
- U.S. LHC Detector Operations \$57.3M (+\$4.5M, +8.5% above FY 2024 Enacted)
- Vera Rubin Operations \$33M (+\$2.1M, +6.7% above FY 2024 Enacted)
- Sanford Underground Research Facility \$35M (No change from FY 2024 Enacted)



Projects \$453.2M (+\$28.0M, +6.6% above FY 2024 Enacted)

- **LBNF/DUNE** \$280M (+\$25M, +10% above FY 2024 Enacted to support LBNF/DUNE's five subprojects)
- **ACORN** \$10M (+\$5M, +100% above FY 2024 Enacted)
- **CMB-S4** \$4.5M (level funding from FY 2024 Enacted)
- **ATLAS and CMS Detectors** \$33.7M (-\$2M, -6% below FY 2024 Enacted): as per the baselined profiles
- **PIP-II** \$125M (level from FY 2024 Enacted): continue support for baseline profile

Early Comments on FY 2026

- ◆ FY 2026 comes with a unique set of opportunities, challenges, and unknowns
- ◆ Opportunities
 - HEP will begin the implementation of 2023 P5 guidance during the FY 2026 Formulation phase of the budget process
- ◆ Challenges
 - 2024 is a Presidential election year. Being competed: 435 seats in the House, 1/3 seats in the Senate, and 1 seat in White House
 - The debt ceiling limit authority expires Jan 1, 2025
- ◆ Unknowns
 - Transition to a new Administration would come with new political appointees and S&T priorities
 - Change in leadership in House and/or Senate may change the level of support for Basic Research

FY 2024 Budget	Spend the Fiscal Year Budget																																			
FY 2025 Budget	OMB Review			Budget Release	Congressional Budget and Appropriations				Spend the Fiscal Year Budget																											
FY 2026 Budget	DOE Internal Planning with OMB and OSTP Guidance												OMB Review			Budget Release	Congressional Budget and Appropriations					Spend the Fiscal Year Budget														
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	CY 2023			Calendar Year 2024									Calendar Year 2025									Calendar Year 2026														

Recent Events and Reviews

- ◆ Committee of Visitors (COV) reviewed DOE Facilities divisions, March 11-13, (YKK and MP talks)
- ◆ HEPAP sub-panel on Facilities met, March 5-6 and delivered report for this meeting (N. Roe will report)
- ◆ Report from Users Organizations annual visit to Congress, April 12
- ◆ Lab Budget Briefings in GTN (many days in April)
- ◆ Comparative Reviews (Feb, Mar) (G. Crawford talk)

International HEP: DOE-Italy Cooperation

- ◆ Two bilateral cooperation agreements signed in Washington on April 9th by DOE and the Italian Ministry of Universities and Research (MUR):
 - One that establishes the framework of MUR and INFN's cooperation in the DUNE program at LBNF, including Italy's expertise and in-kind contributions to DUNE
 - 2nd agreement for DOE and INFN to collaborate in the R&D of advanced computing techniques (for the HL-LHC; DUNE) and in QIS, including Italy's partnership at the SQMS QIS Research Center



U.S.-CERN Statement of Intent



The text of the following statement was released by the Government of the United States of America and the European Organization for Nuclear Research (CERN), an Intergovernmental Organization having its seat at Geneva, Switzerland. White House Office of Science and Technology Policy Principal Deputy U.S. Chief Technology Officer Deirdre Mulligan signed for the United States while Director-General Fabiola Gianotti signed for CERN.

- ◆ Text available at: [U.S. Department of State Remarks & Releases site](#)
- ◆ Among the topics in the Statement,
 - Expresses intentions by the U.S. and CERN to continue collaborating in the FCC Higgs Factory feasibility study
 - Subject to appropriate processes, the intention for the U.S. to collaborate on the FCC-ee, should the CERN Member States determine the FCC-ee is likely to be CERN's next research facility following the HL-LHC
- ◆ Statement aligned with P5: should FCC-ee receive a “green-light” following the next update of the European Strategy, U.S. intends to collaborate; and nature of the contributions to be discussed by the panel prescribed in 6.1.

Upcoming Events

- ◆ DPF Meeting - @Pittsburgh, May 13 - 17; includes PI meetings with HEP Program Managers (more detail from Glen)
- ◆ US-Japan Joint Cooperation Meeting - @KEK May 29 - 30, 2024
- ◆ FCC Week in San Francisco, June 10 - 14, 2024
- ◆ LCWS in Tokyo, July 8 - 11, 2024

- ◆ SC Office Hours

HEP Office Hours

Join us on the third Tuesday of each month, 2-3 pm Eastern Time, for virtual office hours to learn about our programs and ask questions. Researchers, educators, and research administrators from all institutional types are encouraged to join. A primary goal of the virtual office hours is to broaden awareness of our programs; no prior history of funding from DOE is required to join. Program managers will be available to answer questions. Registration is required for attendance. Please use an institutional email address to complete the registration process. A confirmation email containing information about joining the Office Hours session will be sent to the email address provided. Future virtual office hour topics and past office hours recordings and slides will be posted here (<https://science.osti.gov/hep/officehours>). Closed captioning will be available.

Upcoming Office Hour and Topic

- Tuesday, May 21, 2024 – Technology Initiatives and HEP Core Research.

Past Office Hours – Recordings and Slides are posted

- Tuesday, April 16, 2024 – Funding Opportunities for Early Career Researchers.
- Tuesday, March 19, 2024 – Introduction to HEP and Program Mission.

Broadening Engagements and Outreach Frequent observations

- ◆ AAAS Science & Technology Policy Fellow Dr. Jacqueline Smith joined HEP in Sep 2023 [mentor, Dr. Alan Stone]
 - Prior to the fellowship, Jacqueline worked both as a professor and as an advisor to international policing executives to train officers in evidence-based policing programs and policies.
- ◆ Outreach (in-person) campaign in 8 months: 3 conferences, 5 DOE Labs, and >30 Universities
 - Meeting people where they are forging trustworthy and longstanding relationships between SC/HEP and Emerging Research Institutions and Minority Serving Institutions
 - Visiting campuses, touring facilities, conversations with faculty, students, and administration
 - Important to visit both Labs/R1s and ERIs/MSIs on trips. SC initiatives emphasize partnerships between former & latter
 - Follow up after visit, encouraging further communication

Strengths

- ▲ Resilience
- ▲ Strong work ethics
- ▲ Sense of community
- ▲ Small research enterprises with out-sized impact
- ▲ Relationship builders

Deficiencies

- ▲ Do not know about FOA, are eligible to apply, etc.
- ▲ Research grant infrastructure
- ▲ Faculty overburden
- ▲ Outdated equipment



Georgia State, Oct 2023



Virginia State, Feb 2024



Coppin State, Mar 2024

Sneak peak at DOE response to P5

- ◆ The 2023 P5 Report provides a vision of an exciting path into the future for high energy/particle physics
- ◆ It provides us in DOE with actionable recommendations that will keep us on that path
- ◆ The vision is long-term and will take long-term planning

- ◆ We couldn't agree more with Recommendation #1 to continue to execute and complete the on-going projects resulting from the 2014 report.
- ◆ We have been able to determine and initiate a number of responses to priorities given in Recommendations 2, 3 and 6

Extra Slides



Cosmic Acceleration: Dark Energy Spectroscopic Instrument (DESI)



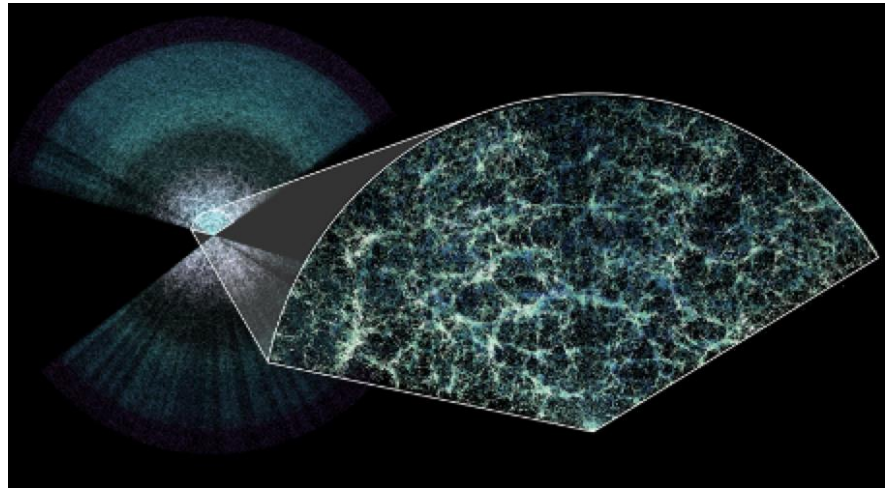
DOE's DESI – Stage IV spectroscopic dark energy results; has completed 3 years of data-taking
 Collaboration of 1000 scientists; about 1/3 are grad students; > 182 publications to date

Cosmology results from first year of data released at APS on 4/4/24 (fully blinded result).

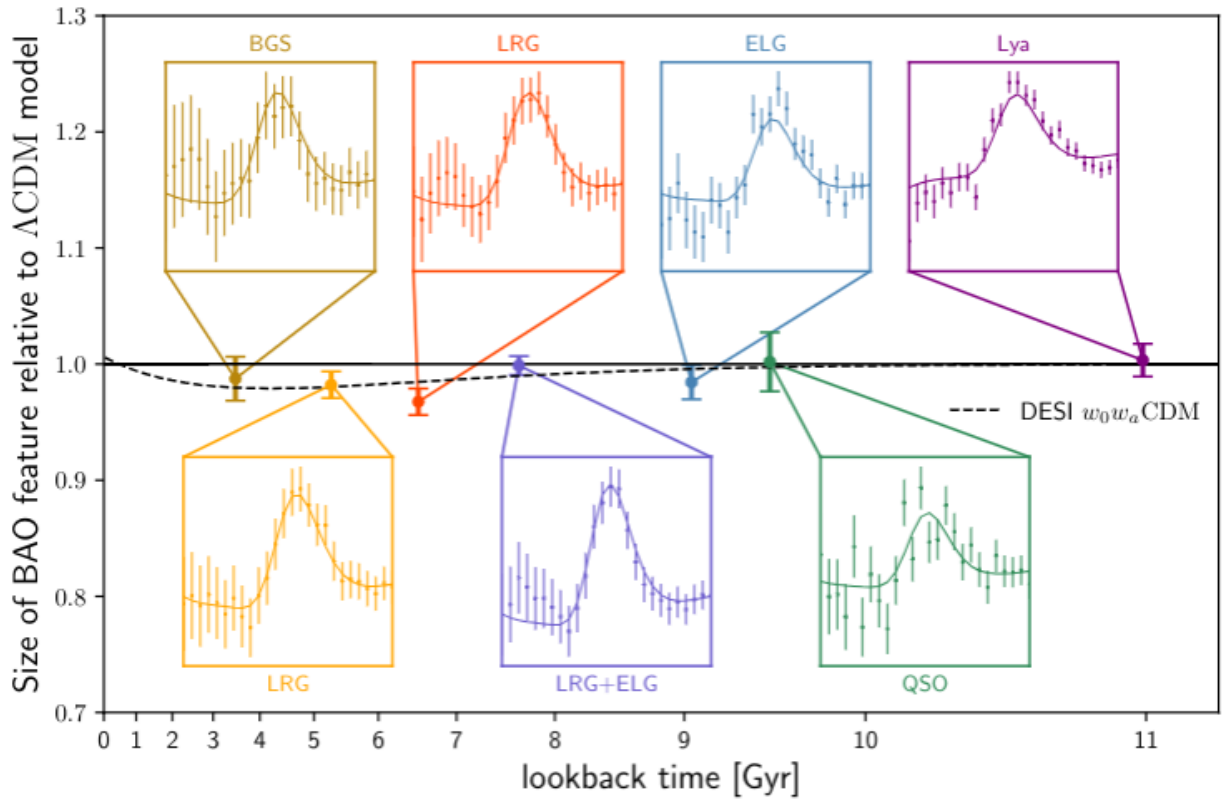
- 1,229 popular articles in 33 languages in first week!

Baryon Acoustic Oscillation (BAO) analysis using a variety of object types from $0.1 < z < 4.2$; record setting BAO precision of 0.5%

- o Data consistent with Λ CDM model with cosmological constant but ... a 2.6σ preference for time-variable dark energy
- o Sum of neutrino masses $\Sigma m\nu < 0.072$ eV



Map shows underlying matter in the universe (Earth at bottom center)



HEP Mission and Support at DOE National Laboratories



Fermi National Accelerator Laboratory

\$692.3M Total

- Quantum Information Science
- Superconducting Quantum Materials and Systems Center
- Artificial Intelligence and Machine Learning
- Energy, Intensity, and Cosmic Frontier particle physics research
- Theoretical and Computational Physics
- Advanced Technology R&D and Microelectronics
- Fermilab Accelerator Complex (*SC User Facility*)
- LHC Operations
- Cosmic Frontier Experimental Operations
- Acc. and Det. Infrastructure and Test Facilities
- LBNF/DUNE, PIP-II, Mu2e Construction Projects
- HL-LHC Accelerator, CMS Detector Upgrade, and ACORN MIE



Argonne National Laboratory

\$20.3M Total

- Quantum Information Science
- Artificial Intelligence and Machine Learning
- Energy, Intensity, and Cosmic Frontier particle physics research
- Theoretical and Computational Physics
- Advanced Technology R&D
- LHC Operations
- Cosmic Frontier Experimental Operations



Brookhaven National Laboratory

\$75.9M Total

- Quantum Information Science
- Artificial Intelligence and Machine Learning
- Energy, Intensity, and Cosmic Frontier particle physics research
- Theoretical and Computational Physics
- Advanced Technology R&D and Microelectronics
- LHC Operations
- Intensity Experimental Operations (Belle-II)
- Cosmic Frontier Experimental Operations, including Vera C. Rubin Observatory
- LBNF/DUNE Construction Project
- HL-LHC Accelerator and ATLAS Detector Upgrade MIEs
- Lunar Surface Electromagnetic Experiment (LuSEE)-Night



Lawrence Berkeley National Laboratory

\$80.2M Total

- Quantum Information Science
- Artificial Intelligence and Machine Learning
- Energy, Intensity, and Cosmic Frontier particle physics research
- Theoretical and Computational Physics
- Advanced Technology R&D and Microelectronics
- LHC Operations
- Cosmic Frontier Experimental Operations, including DESI and LZ
- Accelerator and Detector Infrastructure and Test Facilities (BELLA)
- CMB-S4 MIE (lead lab)
- HL-LHC Accelerator and ATLAS Detector Upgrade MIEs



SLAC National Accelerator Laboratory

\$106.7M Total

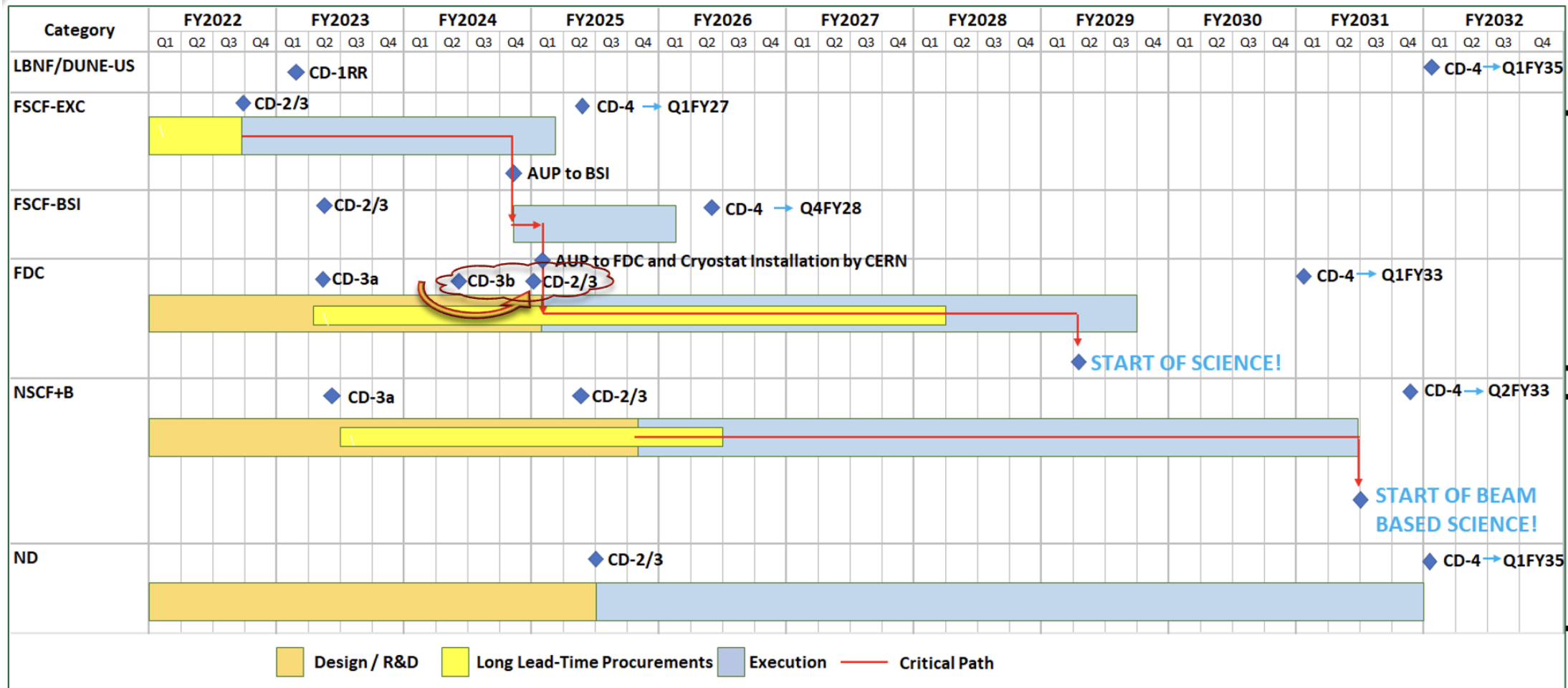
- Quantum Information Science
- Artificial Intelligence and Machine Learning
- Energy, Intensity, and Cosmic Frontier particle physics research
- Theoretical and Computational Physics
- Advanced Technology R&D and Microelectronics
- FACET Operations (*Scientific User Facility*)
- Cosmic Frontier Experimental Operations, including Vera C. Rubin Observatory, SuperCDMS-SNOLAB
- Accelerator Infrastructure and Test Facilities

AMES	\$1.59M
LANL	\$2.93M
LLNL	\$2.08M
ORNL	\$2.85M
PNNL	\$2.98M
SNL	\$0.12M
TJNAF	\$0.02M



FY 2024 HEP Funding to Labs

Schedule

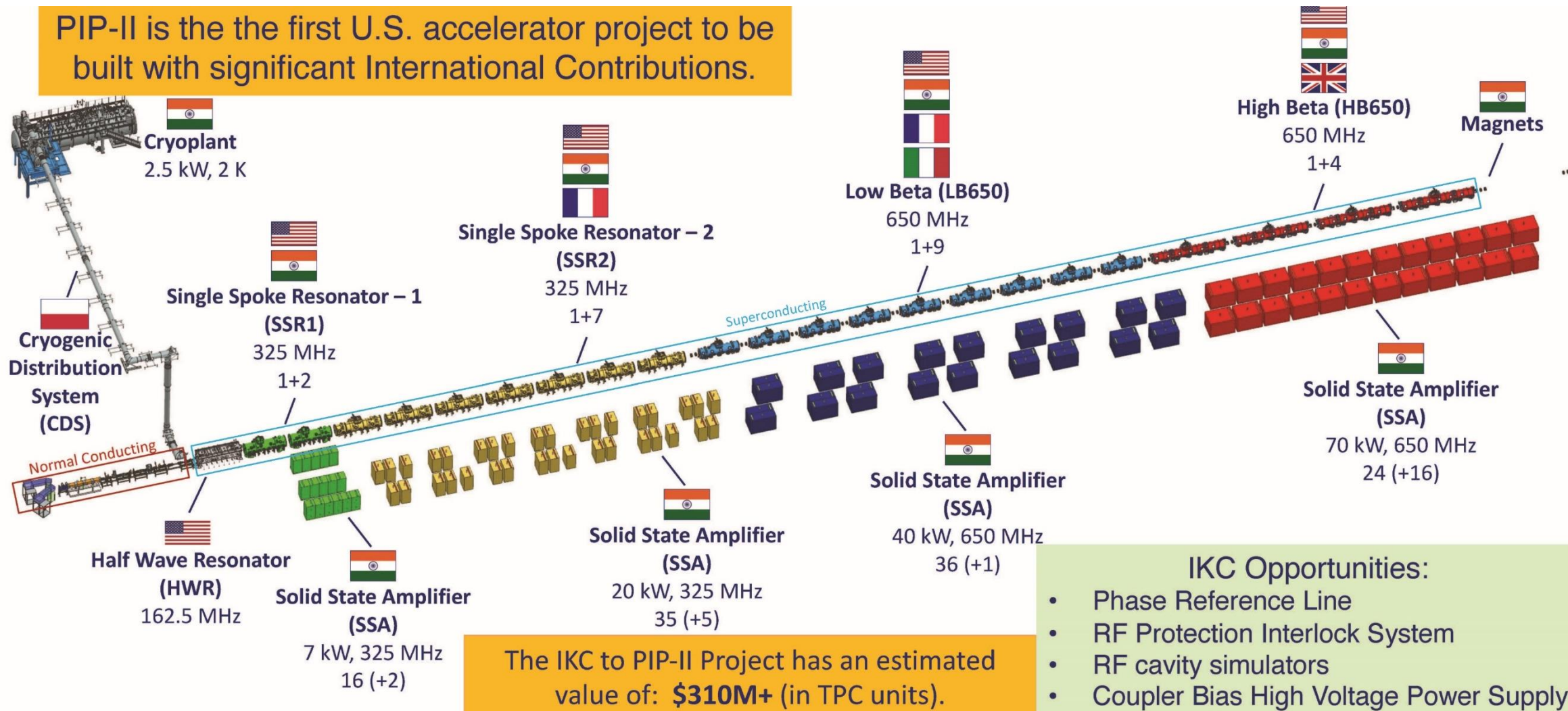


Far Site
Technically Driven

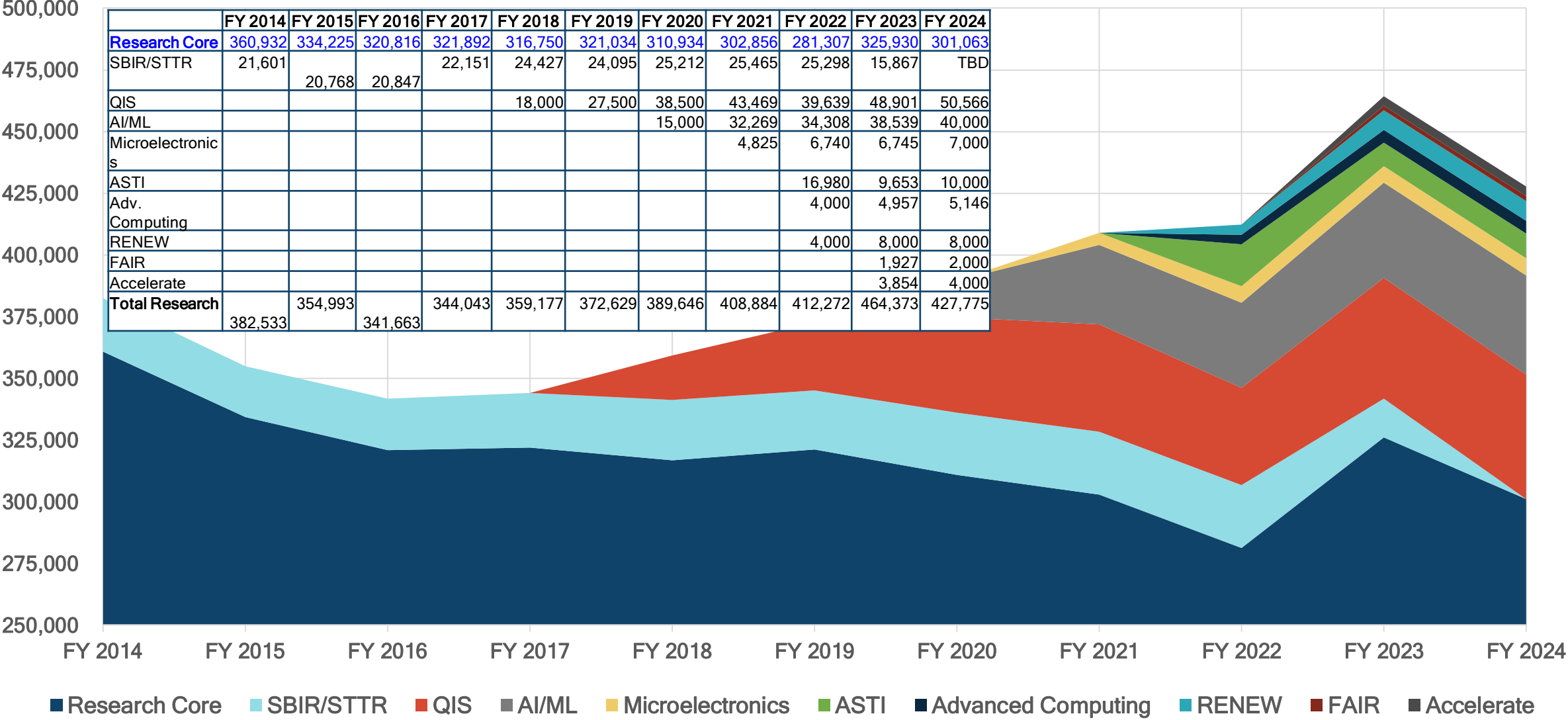
Near Site
Funding Limited

PIP-II Project In-kind Contributions

PIP-II is the the first U.S. accelerator project to be built with significant International Contributions.

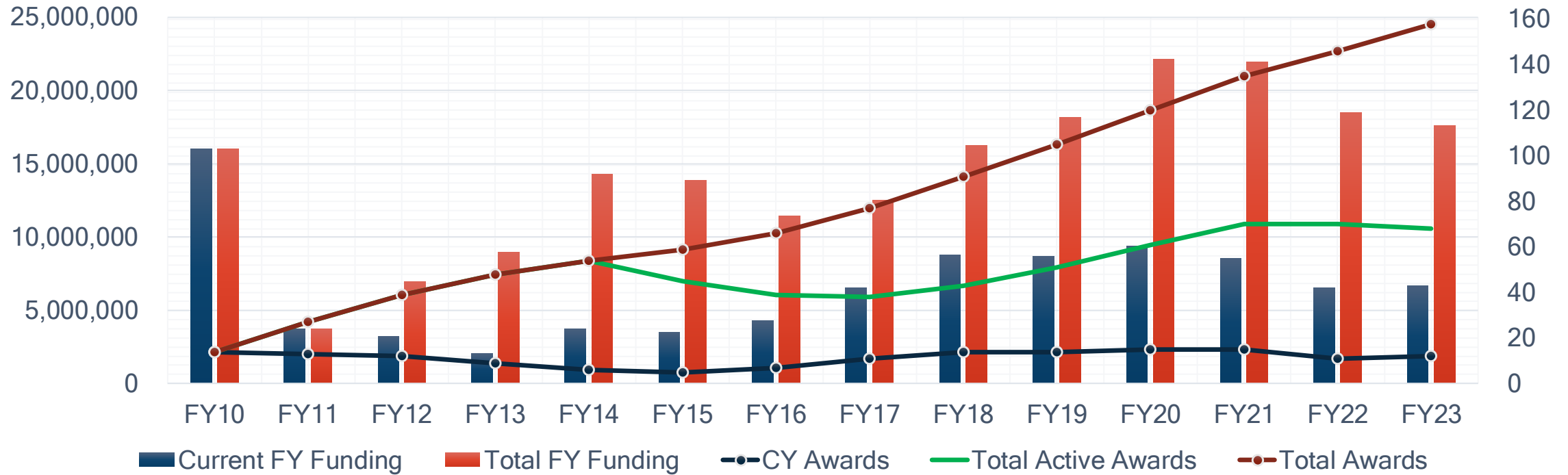


HEP Research Breakdown (\$k) FY 2014-2024



Increasing HEP Investments to Early Career Research Program

HEP ECA funding & awards/year



Start Date	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
Current FY Funding (\$k)	16,000	3,717	3,251	2,012	3,750	3,500	4,250	6,500	8,750	8,675	9,400	8,550	6,500	6,700
Total FY Funding (\$k)	16,000	3,717	6,966	8,993	14,253	13,866	11,458	12,497	16,250	18,175	22,100	21,950	18,500	17,575
CY Awards	14	13	12	9	6	5	7	11	14	14	15	15	11	12
Total Active Awards	14	27	39	48	54	45	39	38	43	51	61	70	70	68
Total Awards	14	27	39	48	54	59	66	77	91	105	120	135	146	158