



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Discussion of Charge and Expectations for EPP2024

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Associate Director

Office of High Energy Physics

November 29, 2022

Introduction

- ▶ I am new to this role in the Department of Energy, Office of Science (SC), Office of High Energy Physics (OHEP); started on November 7
- ▶ Prior to this role, I have been 40 years as a research scientist at Fermilab
 - ▶ Early work on hyperons
 - ▶ Since 1993 work has been on neutrinos, most recently, DUNE
- ▶ Since April 2022, OHEP has been led by Dr. Harriet Kung, assisted by the entire team – my thanks to all of them for keeping the office progressing and welcoming me
- ▶ Any errors or misunderstandings in my remarks today, are entirely mine...

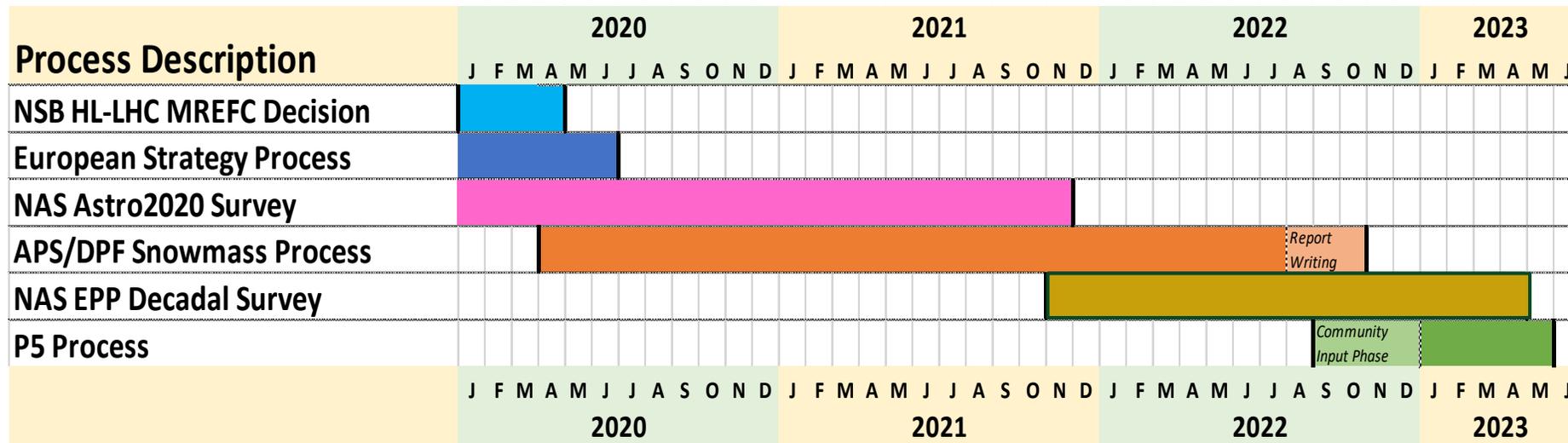


Context

HEP community-wide “Snowmass” study process organized by the American Physical Society (APS) Division of Particles and Fields (DPF) & Division of Particles and Beams held July 2022. <https://snowmass21.org/start>

- Identify science questions & directions & options to address these for the coming decade.

National Academy of Sciences (NAS) Elementary Particle Physics (EPP) Decadal Survey will complement the P5 process. (JoAnne and Hitoshi will address details)

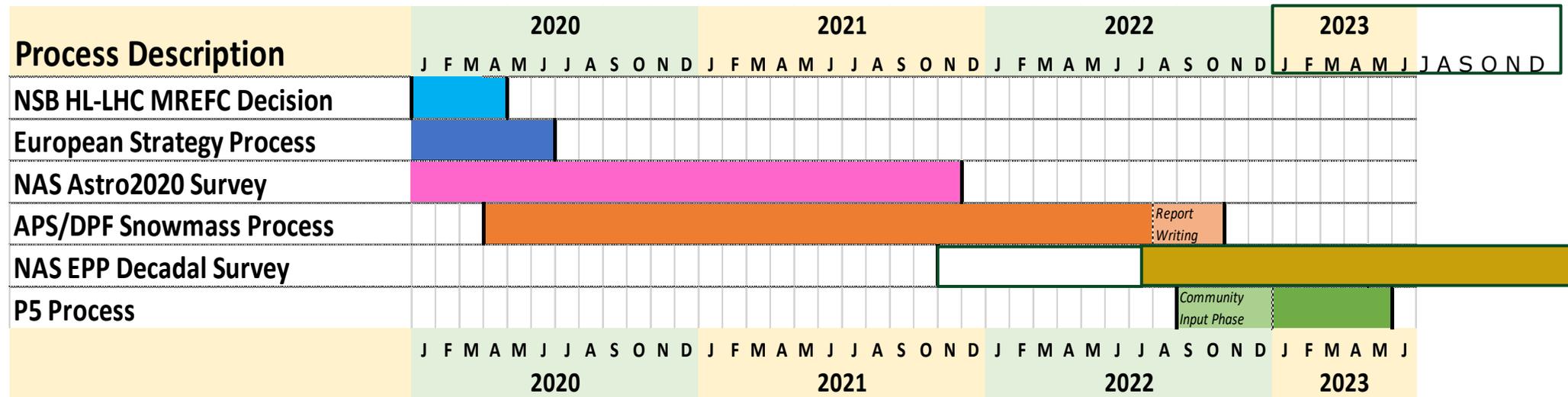


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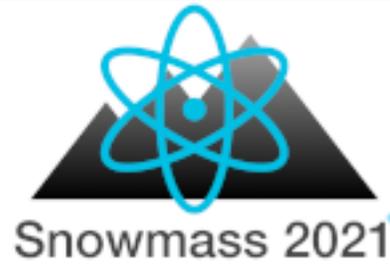
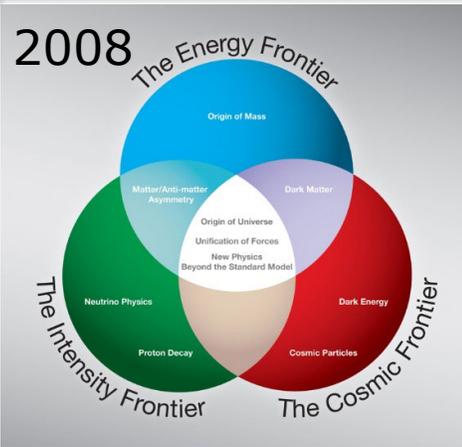
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Expanding Frontiers



- ▶ Energy Frontier
- ▶ Neutrino Physics Frontier
- ▶ Rare Processes and Precision
- ▶ Cosmic Frontier
- ▶ Theory Frontier
- ▶ Accelerator Frontier
- ▶ Computational Frontier
- ▶ Underground Facilities
- ▶ Community Engagement

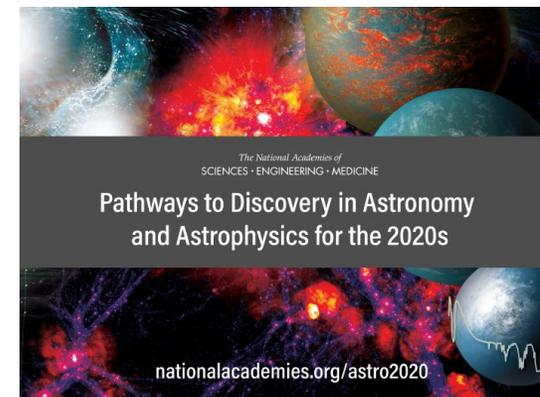
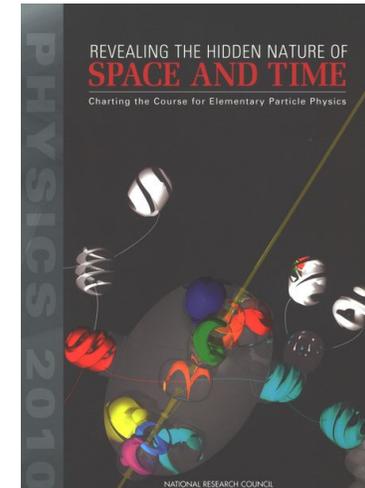
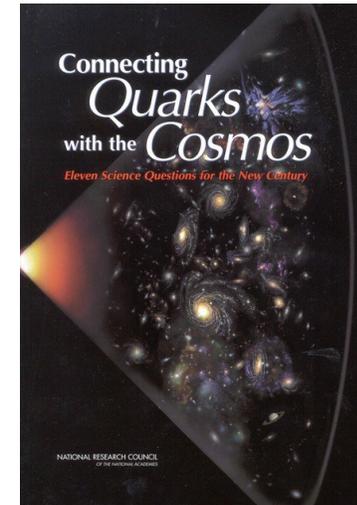
2014

| Research Frontiers | | | | |
|----------------------------------|---|-----------------|--------------------|-----------------|
| Particle Physics Science Drivers |  | Energy Frontier | Intensity Frontier | Cosmic Frontier |
| | Higgs Boson | ● | | |
| | Neutrino Mass | | ● | ● |
| | Dark Matter | ● | | ● |
| | Cosmic Acceleration | | | ● |
| | Explore the Unknown | ● | ● | ● |



Why are we asking you to do this?

- Overall goal is a community-led and externally vetted **strategic plan for HEP science for next 2-3 decades**
- Snowmass is largely HEP community view, and provides updated input to P5
 - P5 will look at specific projects within specific budget guidance, and related topics
- We look to NAS to bring in other viewpoints, other fields of science, “outside the box” thinking
 - i. Past successful example of this would include *Quantum Universe* and *Quarks to Cosmos* studies



Overview of the EPP2024 Charge Elements

1. Identify the **fundamental questions** in particle physics that could motivate research in the **next decade and beyond**, **irrespective of the tools and techniques** to address them.
2. Distinguish **which** of these questions **could be addressed with available experimental and theoretical tools** in the coming decade and which could require new techniques or approaches.
3. **Suggest** technical research areas that could provide particle physics with **new tools** needed to enable new techniques and approaches.
4. Suggest **different ways of thinking and alternative approaches** from other areas of science that could be incorporated into and benefit the overall particle physics enterprise.



What have we accomplished and what have we learned?

We are here.



- ▶ A lot has been accomplished since 2014 P5
- ▶ We (you) can evaluate how much, and how much is left to do
- ▶ Importantly, what have we learned, what questions have we answered, what questions remain – be honest!
- ▶ Have we answered any of our BIG questions?
- ▶ Have new questions emerged?

Finding answers to BIG questions

- ▶ What will be DATA driven?
- ▶ What will test theories?
- ▶ How do we make sure we are addressing both approaches?



LZ direct dark matter search experiment at SURF

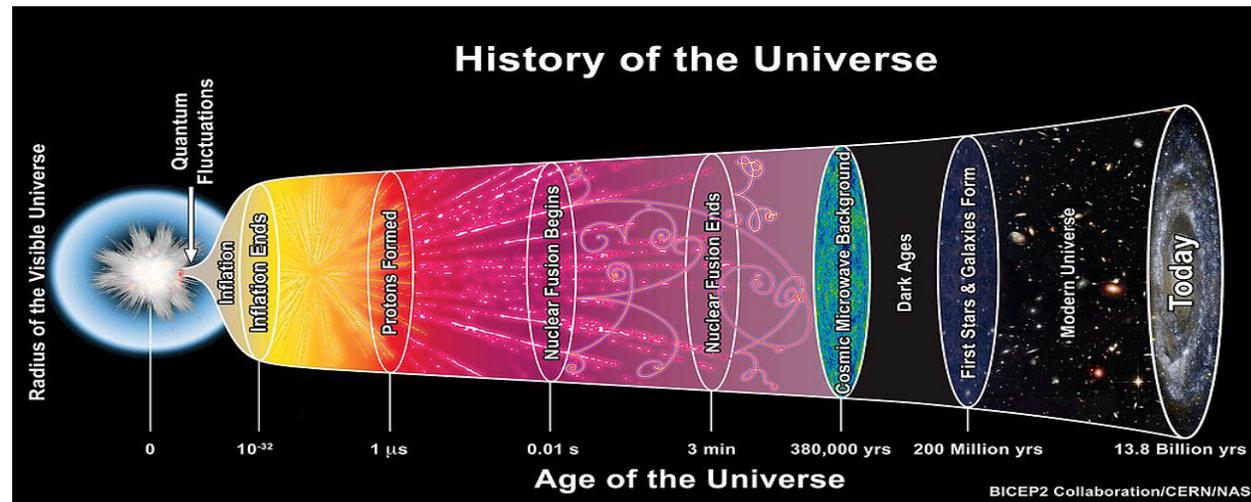
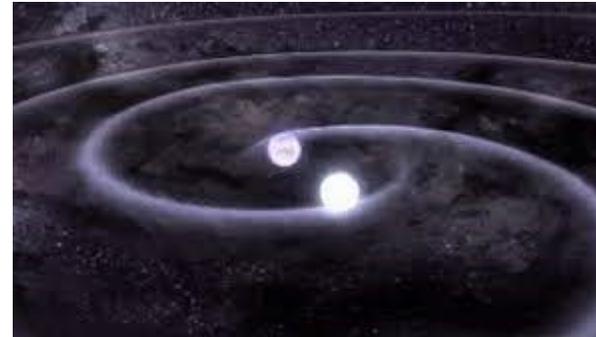
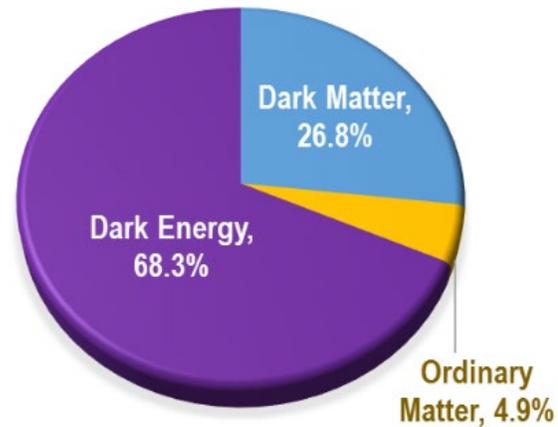
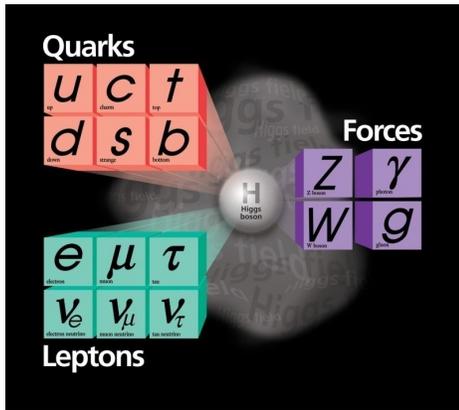


Short-Baseline Neutrino Detector at Fermilab



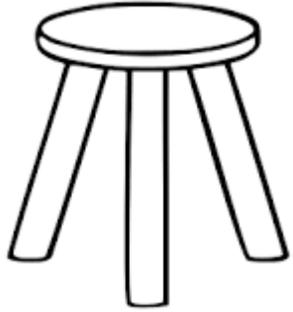
CMS Detector at LHC in CERN

Questions don't come with agency labels



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

• Consider what drives us



- ▶ **University Community :**
 - ▶ Curiosity driven
 - ▶ Empowered to teach and train
 - ▶ Offers opportunity and has broad reach
- ▶ **Research Funding Agencies :**
 - ▶ Proposal driven or Mission driven
 - ▶ Accountable to Congress and taxpayers
 - ▶ Major support from international partners
- ▶ **Laboratories**
 - ▶ Proposal, mission and curiosity driven
 - ▶ Synergistic environments where the all can come together and partner to deliver more than each alone could do



Timeframes

- ▶ Past : What have we decided, started and need to finish or continue
- ▶ Present : What are we doing right now? What challenges are we facing?
 - ▶ Aftermath of a pandemic
 - ▶ Global unrest and aggression
 - ▶ These have led to supply chain issues and inflation
 - ▶ Recognition/acknowledgement of climate issues in the community

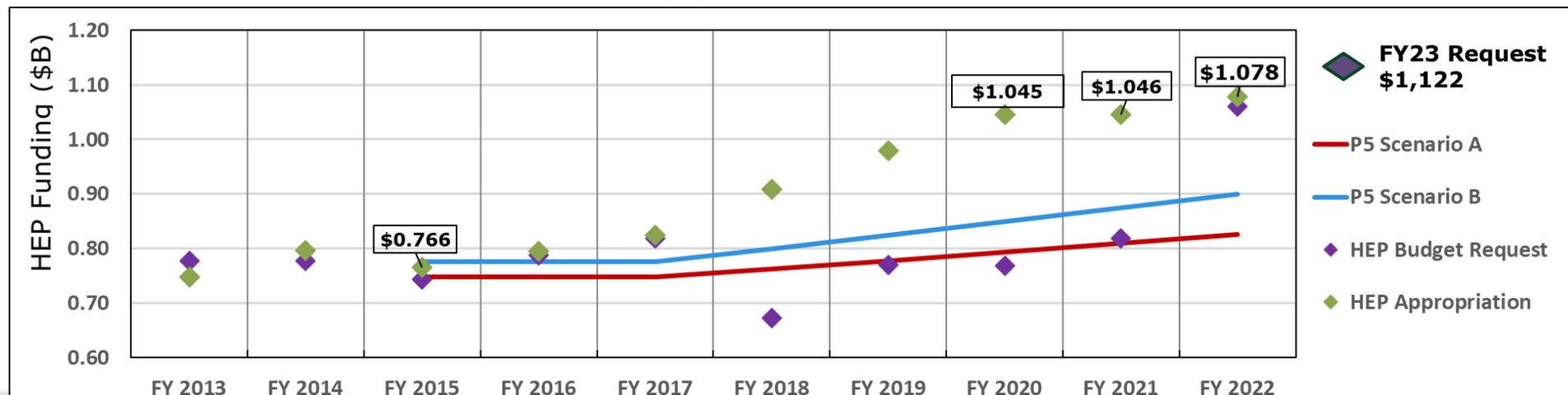
Timeframes (con't)

- ▶ Near future (2023 – 203?)
 - ▶ P5 process should influence
 - ▶ Budget outlook is important (and possibly predictable)
- ▶ Longer term future (2030+)
 - ▶ EPP2024 has the opportunity to shape
 - ▶ EPP2024 needs to work with P5 to agree on the near term groundwork which will enable the longer term future

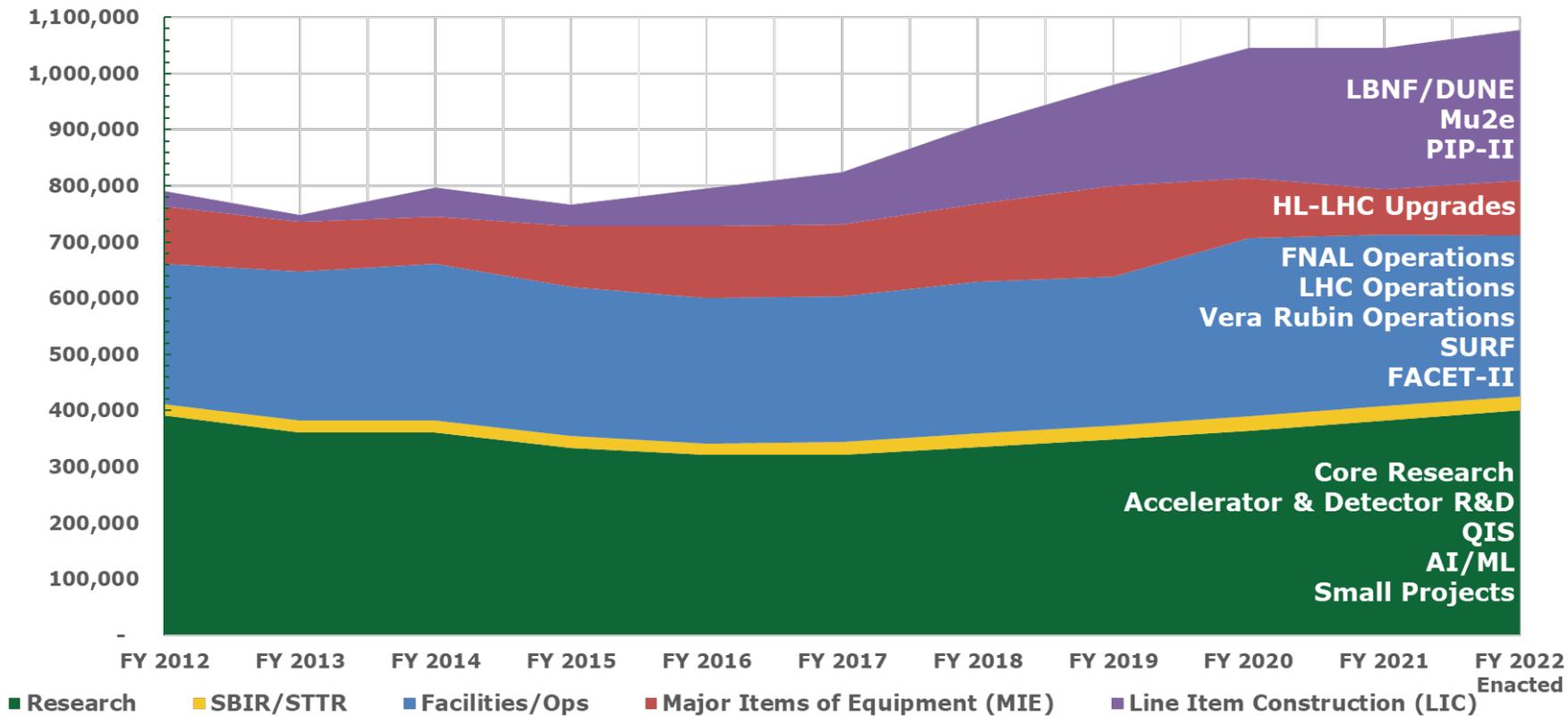


Perspective on budgets

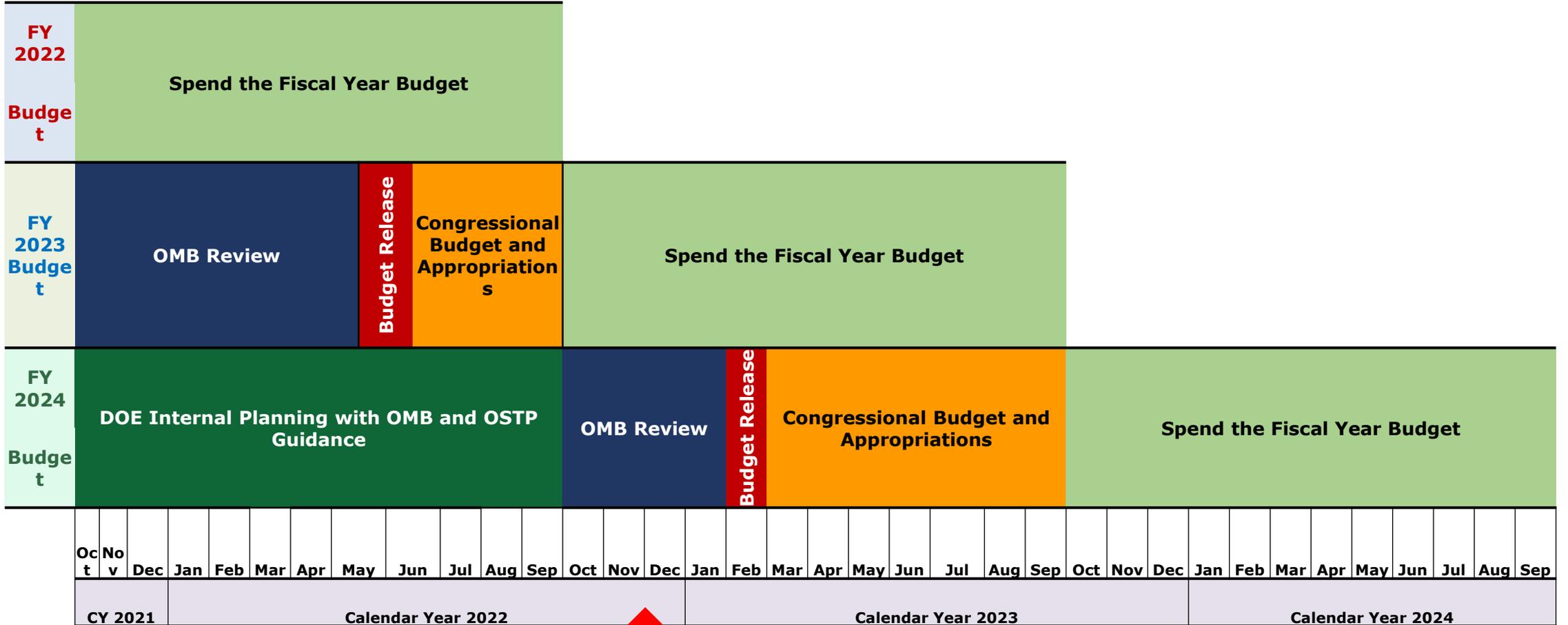
- ▶ HEP is continuing to carry out the 2014 P5 Strategic Plan
- ▶ The Projects selected for this P5 strategic plan offer significant leaps in addressing the HEP science goals identified by P5 and other strategic planning studies
- ▶ This plan was well received by Congress and the budget in the years 2015 onward reflects this support



Budget growth has enabled the 2014 P5 projects

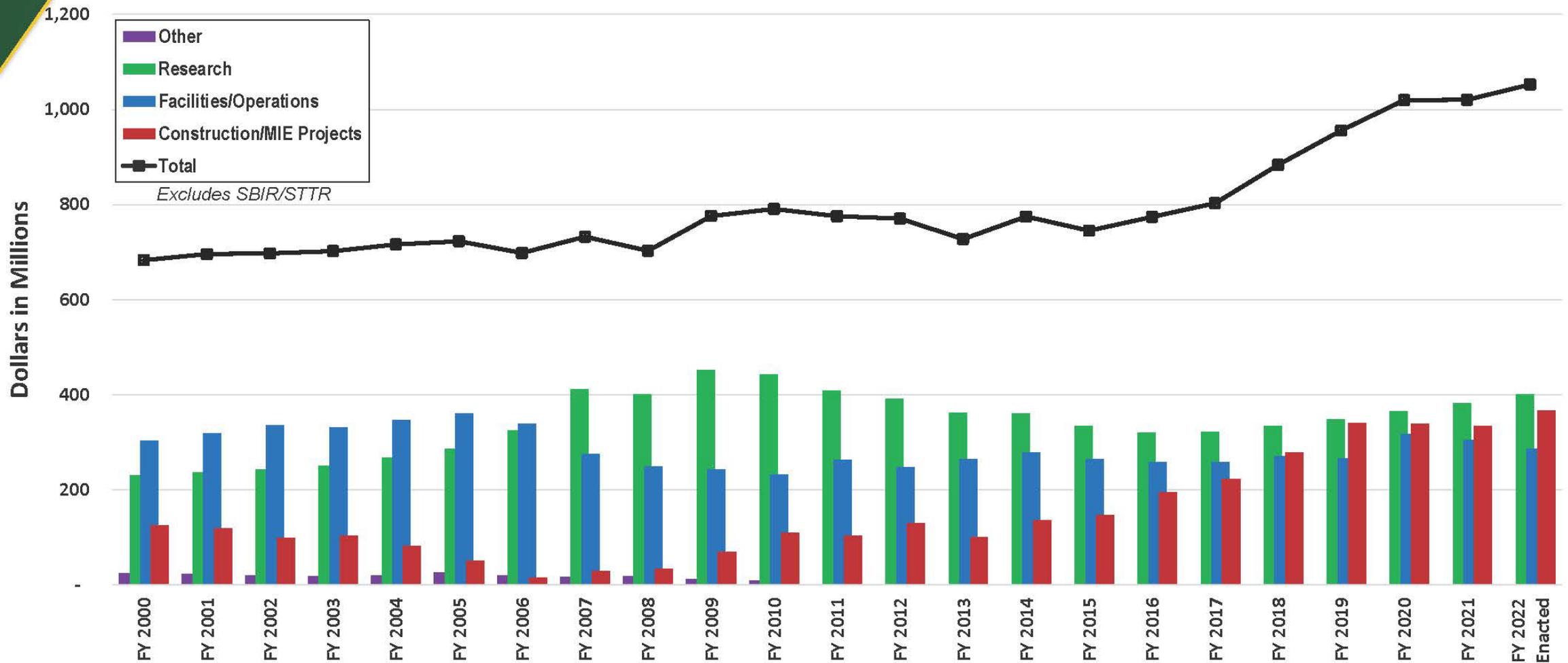


The Federal Budget Cycle



 *We are here*

HEP Budget by Component FY 2000-2022



FY 2023 SC President's Budget Request

(Dollars in thousands)

| | FY 2021 Enacted | FY 2022 Enacted | FY 2023 Request | FY 2023 Request vs FY 2022 Enacted | | FY 2023 Request vs FY 2021 Enacted | |
|--|--------------------|--------------------|--------------------|---------------------------------------|----------------|---------------------------------------|---------------|
| Advanced Scientific Computing Research (ASCR) | 1,015,000 | 1,035,000 | 1,068,741 | 33,741 | 3.26% | 53,741 | 5.29% |
| Basic Energy Sciences (BES) | 2,245,000 | 2,308,000 | 2,420,439 | 112,439 | 4.87% | 175,439 | 7.81% |
| Biological and Environmental Research (BER) | 753,000 | 815,000 | 903,685 | 88,685 | 10.88% | 150,685 | 20.01% |
| Fusion Energy Sciences Research (FES) | 672,000 | 713,000 | 723,222 | 10,222 | 1.43% | 51,222 | 7.62% |
| High Energy Physics (HEP) | 1,046,000 | 1,078,000 | 1,122,020 | 44,020 | 4.08% | 76,020 | 7.27% |
| Nuclear Physics (NP) | 713,000 | 728,000 | 739,196 | 11,196 | 1.54% | 26,196 | 3.67% |
| Isotope R&D and Production (IRP) | ... | 82,000 | 97,451 | 15,451 | 18.84% | 97,451 | ... |
| Accelerator R&D and Production (ARP) | ... | 18,000 | 27,436 | 9,436 | 52.42% | 27,436 | ... |
| Workforce Development for Teachers and Scientists (WDTS) | 29,000 | 35,000 | 41,300 | 6,300 | 18.00% | 12,300 | 42.41% |
| Science Laboratories Infrastructure (SLI) | 240,000 | 291,000 | 255,000 | -36,000 | -12.37% | 15,000 | 6.25% |
| Safeguards and Security (S&S) | 121,000 | 170,000 | 189,510 | 19,510 | 11.48% | 68,510 | 56.62% |
| Program Direction (PD) | 192,000 | 202,000 | 211,211 | 9,211 | 4.56% | 19,211 | 10.01% |
| Office of Science | 7,026,000 | 7,475,000 | 7,799,211 | 324,211 | 4.34% | 773,211 | 11.00% |

Research Initiatives

(B/A in thousands)

| | FY 2021 Enacted | FY 2022 Enacted | FY 2023 Request | FY 2023 Request vs FY 2022 Enacted | FY 2023 Request vs FY 2021 Enacted |
|---|--------------------|--------------------|--------------------|---------------------------------------|---------------------------------------|
| New Research Initiatives | | | | | |
| SC Energy Earthshot | ... | ... | 204,250 | 204,250 | ... |
| Funding for Accelerated, Inclusive Research (FAIR) | ... | ... | 35,508 | 35,508 | ... |
| Accelerate Innovations in Emerging Technologies | ... | ... | 40,051 | 40,051 | ... |
| Ongoing Research Initiatives | | | | | |
| Climate and Clean Energy <i>(includes funding scored to other initiatives)</i> | 2,472,842 | 2,716,570 | 3,009,849 | 293,278 | 10.80% |
| Reaching a New Energy Sciences Workforce (RENEW) | ... | 30,000 | 60,000 | 30,000 | 100.00% |
| Fundamental Science to Transform Advanced Manufacturing | ... | 25,353 | 27,000 | 1,647 | 6.50% |
| Biopreparedness Research Virtual Environment (BRaVE) | ... | 21,756 | 51,756 | 30,000 | 137.89% |
| Urban Integrated Field Laboratory | ... | 17,000 | 22,000 | 5,000 | 29.41% |
| National Virtual Climate Laboratory (NVCL) | ... | 3,000 | 3,000 | ... | ... |
| Climate Resilience Centers | ... | 5,000 | 5,000 | ... | ... |
| Microelectronics | 30,182 | 47,701 | 47,701 | ... | 17,519 |
| Critical Materials/Minerals | 17,000 | 25,000 | 25,000 | ... | 8,000 |
| Quantum Information Science | 270,391 | 293,075 | 293,426 | 351 | 0.12% |
| Artificial Intelligence and Machine Learning | 124,354 | 129,837 | 169,000 | 39,163 | 30.16% |
| Exascale Computing | 479,945 | 445,000 | 268,000 | -177,000 | -39.78% |
| Revolutionizing Polymers Upcycling | 14,500 | 14,500 | 14,500 | ... | ... |
| Accelerator Science and Technology Initiative | 11,411 | 34,725 | 28,872 | -5,853 | -16.86% |
| Advanced Computing <i>(formerly Integrated Computational & Data Infrastructure)</i> | 11,974 | 34,657 | 37,661 | 3,004 | 8.67% |
| Total, Research Initiatives | 3,432,599 | 3,843,174 | 4,342,574 | 499,399 | 12.99% |

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Reaching a New Energy Sciences Workforce (RENEW)

FY 2023 \$60M Request, $\Delta = +\$30M$

Building foundations through undergraduate and graduate training opportunities for students and institutions historically underrepresented in the SC research portfolio



- SC conducted outreach and listening sessions in FY 2022 on barriers to participation in SC opportunities to inform FY 2022 FOAs



- FY 2022 FOAs piloting models of support that directly address barriers to participation in SC supported fields of research
 - Models will be evaluated
- November 29, 2022



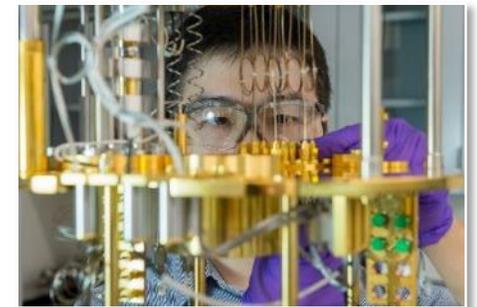
- FY 2023 doubles investment and commitment to advance discovery and innovation by increasing the diversity of individuals and institutions supported

Funding to Accelerate Inclusive Research (FAIR)

FY 2023 \$36M Request

FAIR will enhance research on clean energy, climate, and related topics at minority serving institutions (MSIs), including underserved and environmental justice regions

- ▶ Builds research capacity, infrastructure, and expertise at MSIs
- ▶ Develops mutually beneficial relationships between MSIs and DOE national laboratories and user facilities
- ▶ Complements the RENEW initiative (internships at national laboratories for workforce development)
- ▶ Provides support of single PI or research teams, and includes an equipment or infrastructure element
- ▶ Majority of funds will go directly to HBCUs/MSIs, a portion will fund the partnering institution (Lab, university)



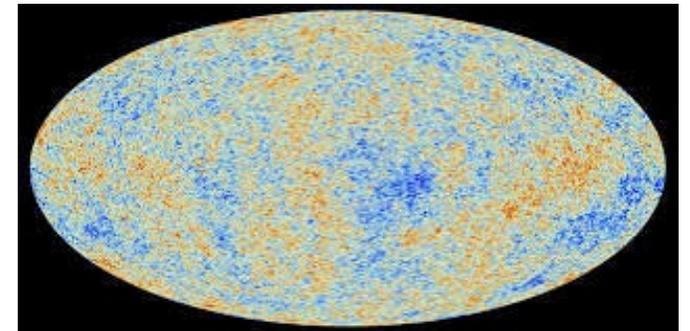
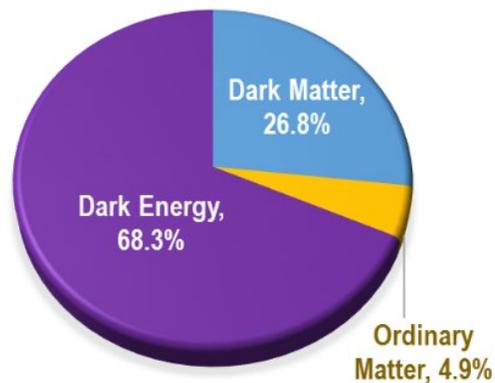
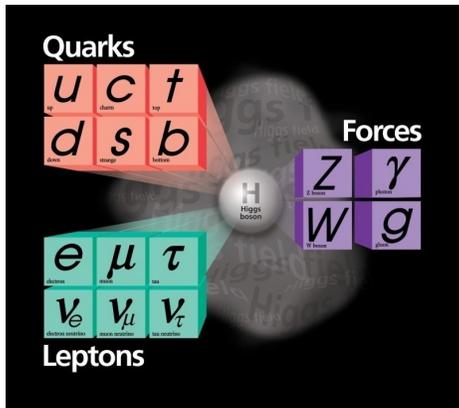
New initiatives in research funding for HEP

| 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 | 5.1 |
| Microelectronics | | 5.0 | 7.0 | 7 |
| Quantum Information Science (QIS) | 23.5 | 20.1 | 26.6 | 25.6 |
| Quantum Center | 15.0 | 25.0 | 25.0 | 25 |
| Reaching a New Energy Sciences Workforce (RENEW) | 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 |

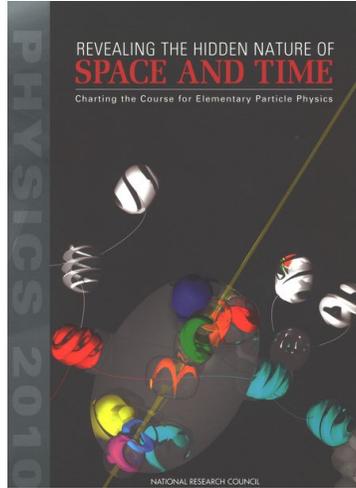


Elementary Particles and High Energy Physics

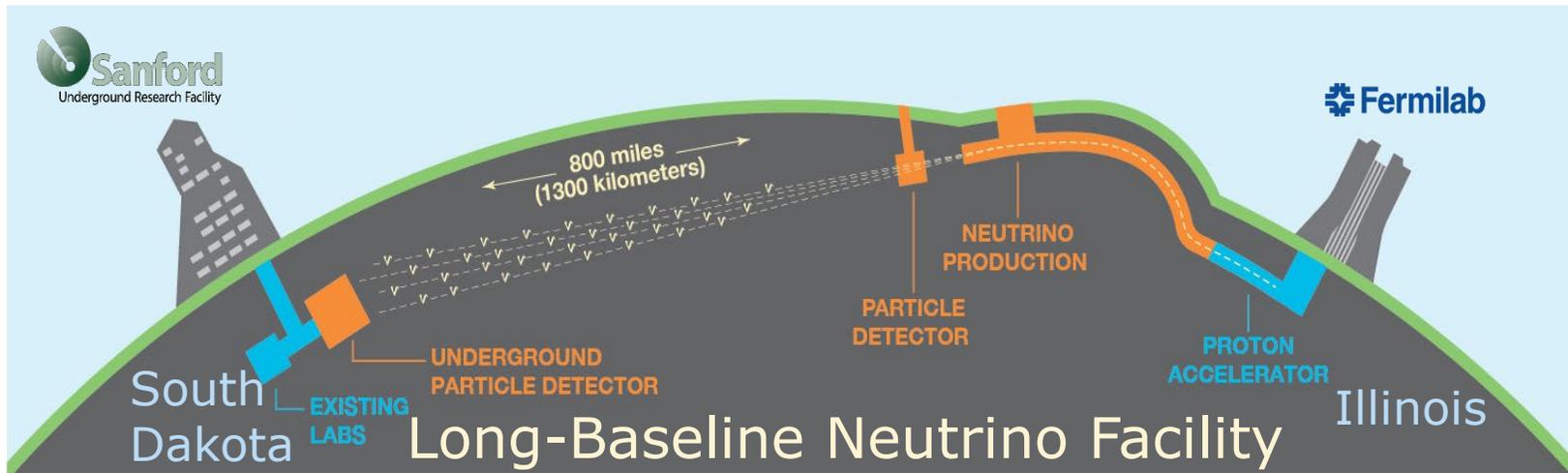
- ▶ Our goal, and hence mission, is to understand the nature of matter, energy, space and time
- ▶ The science crosses the boundaries set by agencies; the agencies have constraints; the science doesn't
- ▶ We ask for you to think outside of the box, and in particular outside of stovepipes, so that we can identify the most important questions that need to be answered
- ▶ Agencies need to coordinate and work together to bring resources together to maximize what we can accomplish



Curiosity, vision, strategy, tactics



| Research Frontiers | | | | |
|----------------------------------|---|-----------------|--------------------|-----------------|
| Particle Physics Science Drivers |  | Energy Frontier | Intensity Frontier | Cosmic Frontier |
| | Higgs Boson | ● | | |
| | Neutrino Mass | | ● | ● |
| | Dark Matter | ● | | ● |
| | Cosmic Acceleration | | | ● |
| | Explore the Unknown | ● | ● | ● |



The key is to understand navigation ...

- ▶ First, we need a general idea of where we are going (roadmap)
- ▶ We should acknowledge, there is more than one way to reach a destination
- ▶ We should conserve resources on the journey
- ▶ Sometimes we can stray from under the lamppost



In conclusion

- ▶ Thank you for agreeing to this important job!
- ▶ Good luck!
- ▶ We look forward to your report!



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