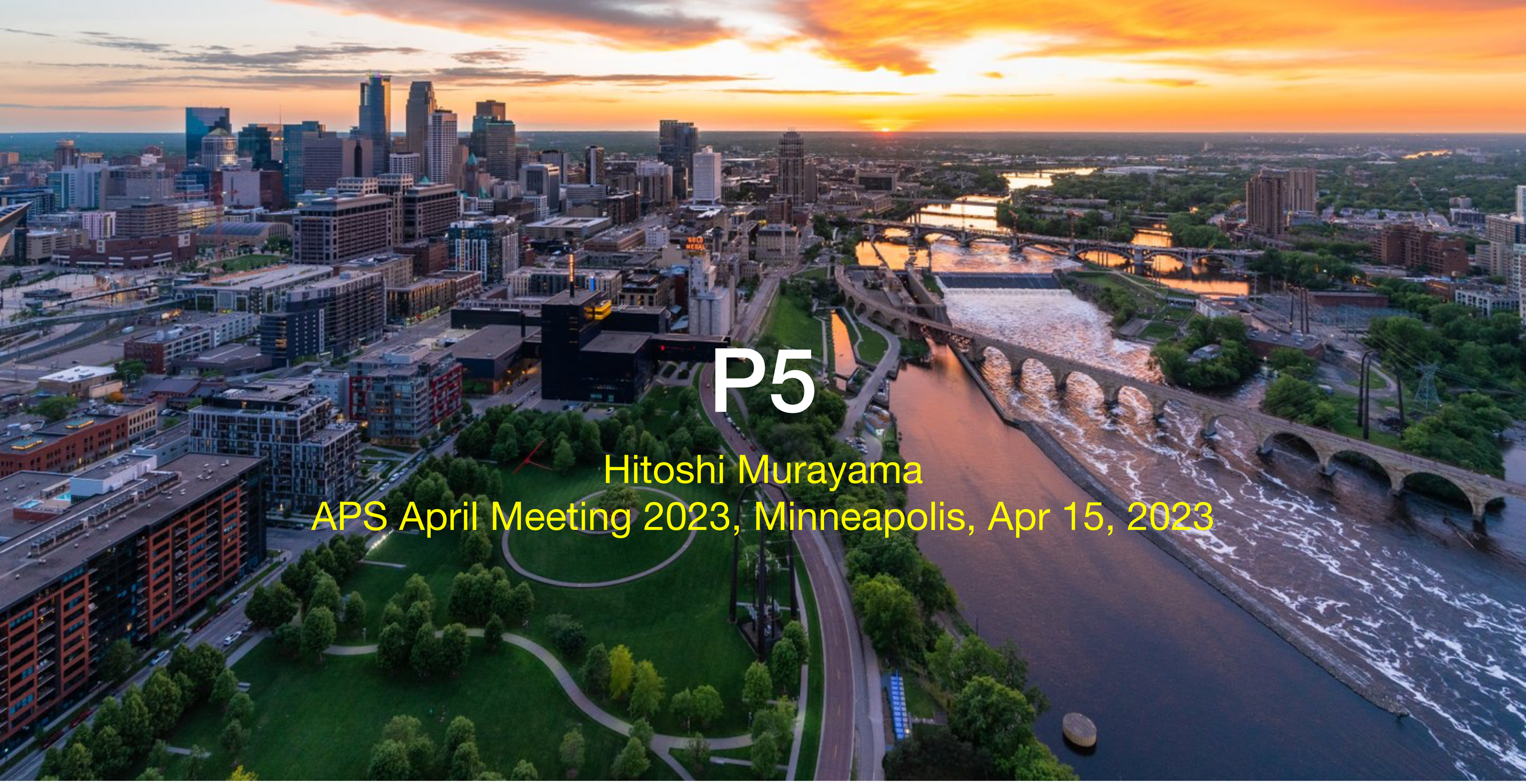


P5

Hitoshi Murayama

APS April Meeting 2023, Minneapolis, Apr 15, 2023

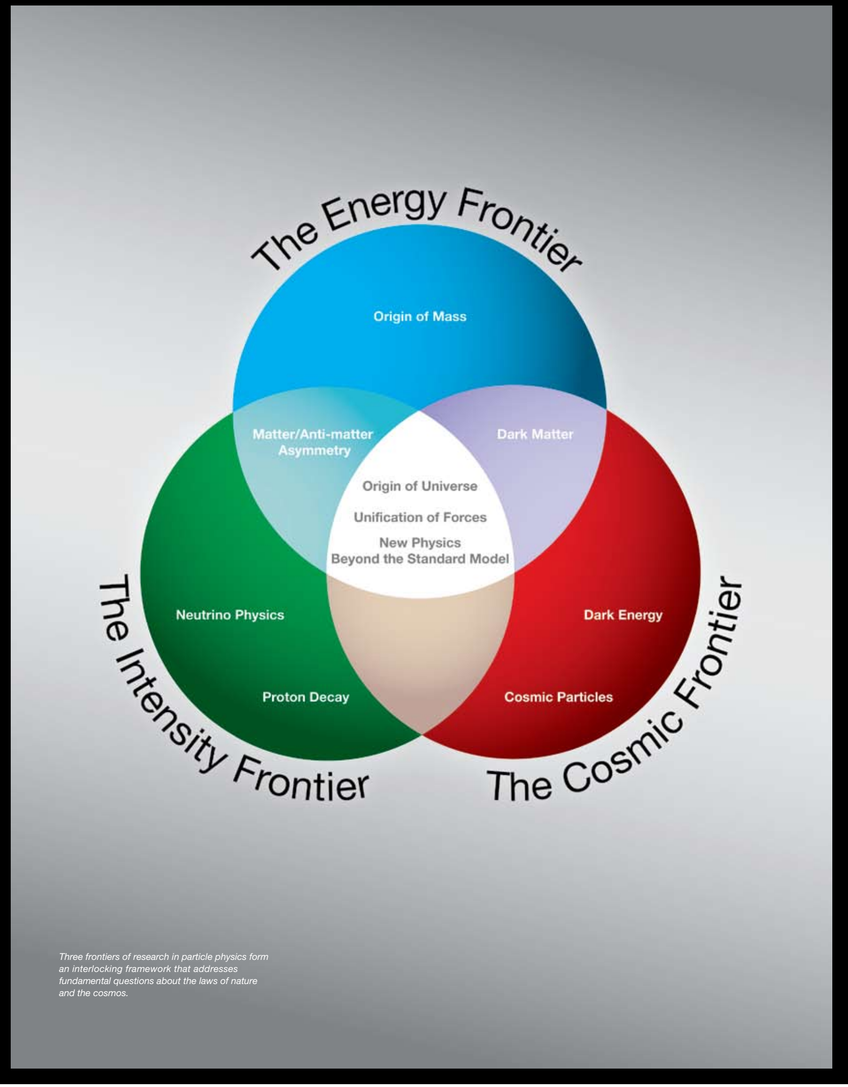
Key Elements of a Successful P5

- Well informed by the science community
- Set a grand long-range vision for U.S. particle physics
- Faced budget constraints realistically
  - "Community made tough choices."
- Balanced portfolio
  - Domestic and international
  - Small, mid-scale, and large projects
- Community engagement critical to success
  - "Bickering scientists get nothing."

Harriet Kung, Snowmass in Seattle

2008 P5

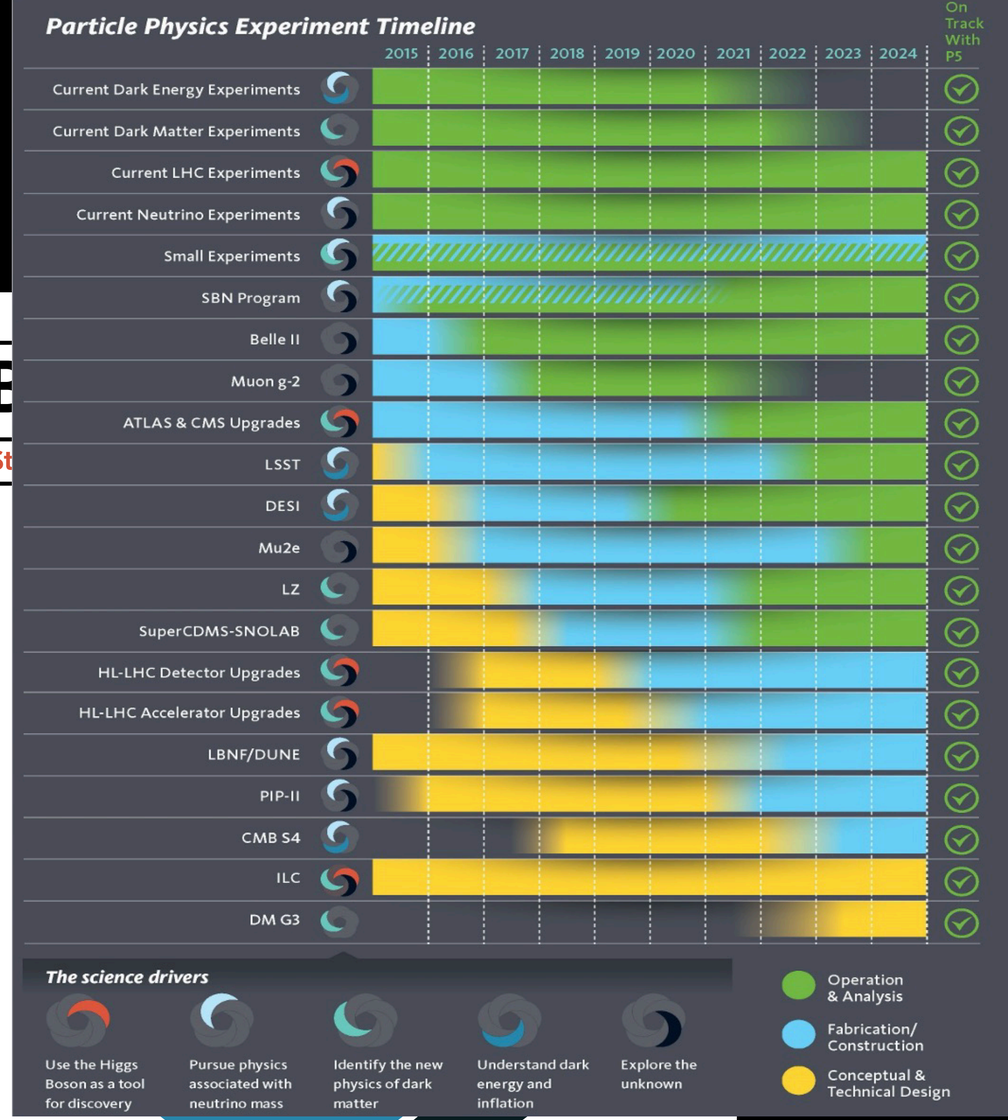
- 2008 P5 (Charlie Baltay)
  - First “modern” P5 with budget scenarios and long-term vision
  - Energy, Intensity, Cosmic Frontiers
  - Tevatron for one to two more years
  - World-class neutrino program
  - Dark matter & dark energy, LSST
- *US Particle Physics: Scientific Opportunities A Strategic Plan for the Next Ten Years*



Three frontiers of research in particle physics form an interlocking framework that addresses fundamental questions about the laws of nature and the cosmos.

2014 P5

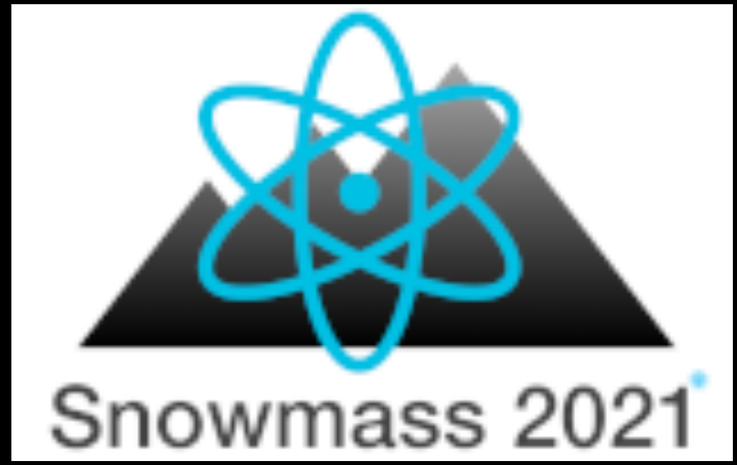
- 2014 P5 (Steve Ritz)
  - Use the Higgs boson as a new tool for discovery
  - Pursue the physics associated with neutrino mass
  - Identify the new physics of dark matter
  - Understand cosmic acceleration: dark energy and inflation
  - Explore the unknown: new particles, interactions, and physical principles.
- Finally “got it right”
  - Well received in Washington
  - Embraced CMB (inflation)
- *Building for Discovery*



Report of the Particle Physics Project Prioritization Panel (P5) May 2014

Changing landscape

- 125 GeV Higgs does look like standard model
  - Previous P5: “Higgs as a new tool for discovery”
- Recognition that dark matter parameter space is *big*
  - Growing in interest in low-energy weakly coupled sector
- ΛCDM + inflation is the new Standard Model
  - But H_0, σ_8 tension
  - Inflation, cosmological constant vs swampland?
- DUNE moving ahead
  - Now Hyper-Kamiokande is also happening
- Lattice vs g-2?
- Interesting anomalies in flavor physics
- Gravitational wave! High-energy neutrinos!
- Now 10 frontiers (+costing frontier?)
- National Initiatives: Quantum, AI/ML, microelectronics



My take away from Snowmass

- We have an exciting program lined up
  - HL-LHC, DUNE, SBND, g-2, Mu2e, Belle II, DESI, LZ, CMB-S4
  - Thanks to Steve Ritz, previous P5, agencies!
- We are broader than the current program
  - Where is the boundary of our field?
- We are a forward-looking community
  - We need program beyond what the previous P5 outlined
  - We also need more freedom
  - better balance big, medium, small; projects vs research
- We deeply care about our community
  - Diversity, equity, inclusion, outreach, engagement
- Visited both DOE & NSF in early September
  - I'm still scared of the tasks ahead.
  - Reading Snowmass reports!

Decadal Overview of Future Large-Scale Projects		
Frontier/Decade	How do we develop enabling technology for long-term vision in a fashion executable in 20 years?	
Energy Frontier	U.S. Initiative for the Targeted Development of Future Colliders and their Detectors	
		Higgs Factory US role?
Neutrino Frontier	LBNF/DUNE Phase I & PIP- II	DUNE Phase II Scope? Technology? Complementarity?
Cosmic Fron Logistics? Scope?	Cosmic Microwave Background - S4	Next Gen. Grav. Wave Observatory*
	Spectroscopic Survey - S5*	Line Intensity Mapping* Do we embrace them?
	Multi-Scale Dark Matter Program (incl. Gen-3 WIMP searches) Big, small, new?	
Rare Process Frontier		Advanced Muon Facility Scope? Other science?

Table 1-1. *An overview, binned by decade, of future large-scale projects or programs (total projected costs of $500M or larger) endorsed by one or more of the Snowmass Frontiers to address the essential scientific goals of the next two decades. This table is not a timeline, rather large projects are listed by the decade in which the preponderance of their activity is projected to occur. Projects may start sooner than indicated or may take longer to complete, as described in the frontier reports. Projects were not prioritized, nor examined in the context of budgetary scenarios. In the observational Cosmic program, project funding may come from sources other than HEP, as denoted by an asterisk.*

Leadership team

JoAnne Hewett
HEPAP chair

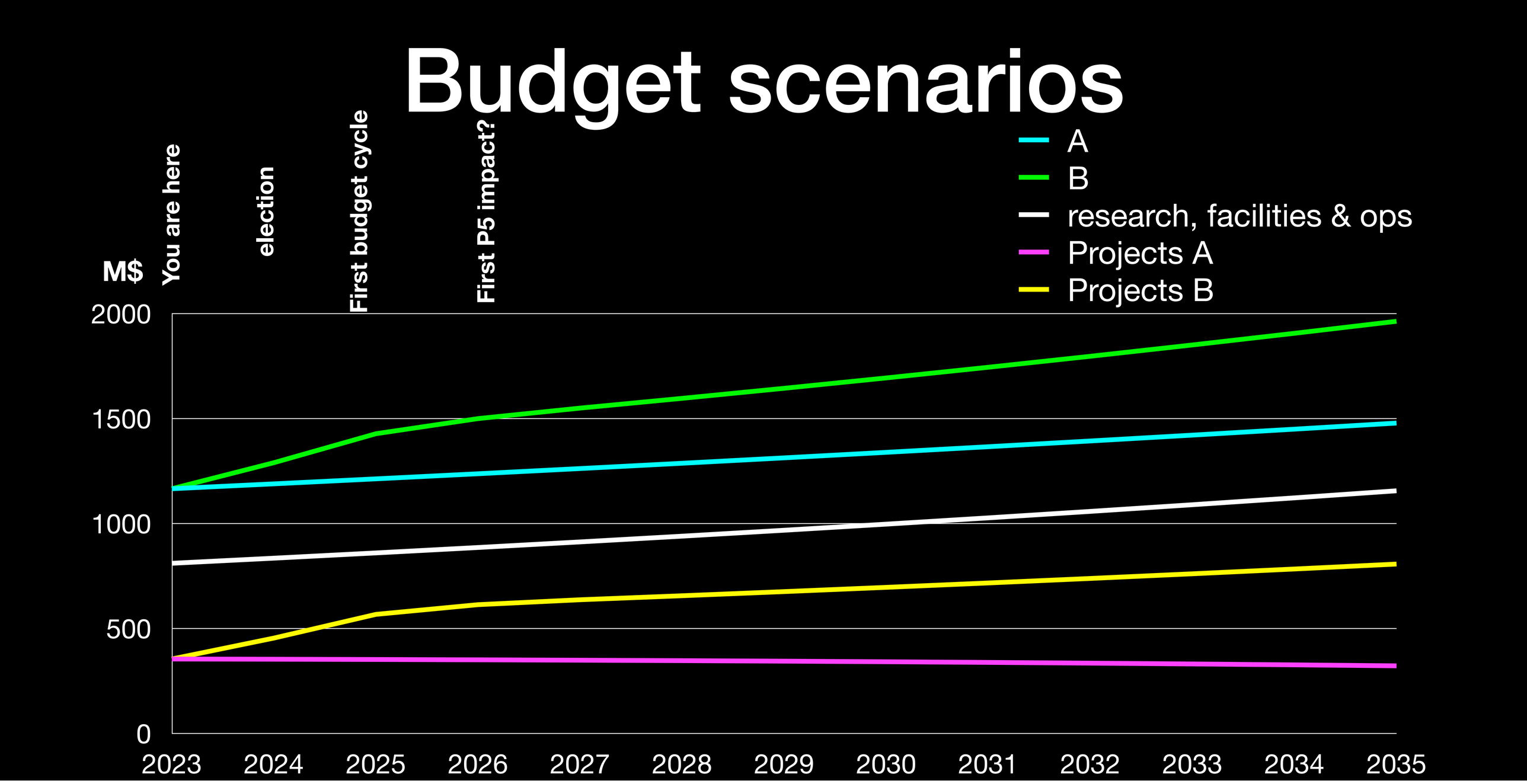
Hitoshi Murayama
P5 chair

Karsten Heeger
P5 Deputy chair


It is a great panel!

- Received the charge in November
  - Formed by panel by end of December
  - Started work in January
- Town halls based on Snowmass Community Study
  - But costs & schedule as much as possible
- Berkeley: February 22-23
  - Cosmic frontier
  - 513 registrants, 157 in person attendees
- Fermilab/Argonne: March 21-23
  - Neutrino, Intensity & precision frontiers
  - 809 registrants, 318 in person attendees
- Brookhaven: April 12-13
  - Energy, Computing, Instrumentation frontiers
  - 666 registrants, 253 in person attendees
- Short remarks oversubscribed x3
- SLAC: May 3-5
  - Accelerator, Underground, Theory Frontiers
  - Community Engagement
- All with ASL interpretation and closed captioning

Budget scenarios



Interface to EPP2024


- EPP2024 looks into long-term vision, dreams
  - unconstrained by budget scenarios
- I was on EPP2024 until I was appointed as the P5 chair
- We make sure to get the same inputs from the community
  - We invite EPP2024 members to P5 town halls
  - JoAnne and I participated in their November & December meetings
  - Karsten and I tuned in to their CERN town hall
  - P5 and EPP2020 overlapped at Fermilab
- What we recommend should smoothly connect to their longer-term vision

Costs/Risks/Schedule Subcommittee

- One lesson from the previous P5 was some of the costs were off by a factor of ~π
- Need to understand maturity of cost estimates better
- Jay Marx (Caltech) started working as of April 10
- Now membership is there (+one or two)
  - Gil Gilchriese & Matthaeus Leitner (LBNL)
  - Giorgio Apollinari & one more (Fermilab)
  - Mark Reichanandter & Nadine Kurita (SLAC)
  - Jon Kotcher & Srini Rajagopalan (BNL)
  - Allison Lung (JLab)
  - Harry Weerts (Argonne)

Jay Marx

Charge to P5 cost committee (Draft - 3/1/2023)

The cost/schedule/risk subcommittee to P5 is asked to obtain and clarify the cost/schedule/risk information from the proponents of high cost (>250M FY23$) HEP projects funded or being considered for funding by the DOE and/or NSF. The subcommittee will not prepare its own estimates. The committee should assess this information at a high level, noting key assumptions, risks and cost and schedule uncertainties including the risk from non-DOE/NSF funding sources, international partners making in-kind contributions and collaborations and missing costly items, if any. The committee is also asked to comment on the operation costs for projects for during commissioning and when the resulting facilities are in steady-state operation. This committee will provide P5 with the expert opinions on the uncertainty ranges for the projects that P5 needs to develop a strategy for the field within assumed budgetary constraints. The subcommittee will submit their preliminary report to P5 in early summer.

Requests to “big” projects out
Will also ask for information from medium and small

P5

This web site was only tentative. Go to the official site instead.

P5 (Particle Physics Project Prioritization Panel) reports to HEPAP (High-Energy Physics Advisory Panel) that advises High-Energy Physics of DOE Office of Science and Division of Physics of NSF. We will build on the "Snowmass" community study to hash out priorities for the next 10 years within 20-year context.

This is a tentative bare-bones web site for information and annnouncements. More professional web site is in the works.

There is some misinformation out there about P5. We are now just entering the information gathering mode and no discussions or decisions took place. Please be careful!

Charge

The charge to P5 was issued by Dr. Asmeret Asefaw Berhe, Director of Office of Science, Department of Energy, and Dr. Sean L. Jones, Assistant Director, Directorate for Mathematical and Physical Sciences, National Science Foundation, to the HEPAP chair JoAnne Hewett on November 2, 2022

Town Halls

We will have four town hall meetings with people in the community to give short presentations on issues, visions, science, projects of interest to the field, including an open-mic session. If people want to speak privately with the panel, we will try to accommodate the request as much as we can, especially for early career scientists. They are not tied to any specific Snowmass frontiers.

In addition, we will have a set of invited talks at the meetings cenetered around some of the Snowmass frontiers, on the visions of the communities and specific set of projects. This is an important part of the information gathering mode for the panel.

We plan for additional virtual town halls to receive more input from the community. Details are still subject to change. I'm sorry that registration pages are slow to open. There are forces beyond our control.

- Lawrence Berkeley National Laboratory, Cosmic Frontier (except for High-Energy Astrophysics and Gravitational Wave), open sessions on February 22 and 23, followed by a closed session for the panel in the morning on 24 (confirmed)
- Fermilab/Argonne, Neutrino, Rare Processes and Precision Frontier, High-Energy Astrophysics, Mar 21, 22, 24 (Fermilab), 23 (Argonne) (confirmed)
- Brookhaven, Energy, Instrumentation, Computational Frontiers, Gravitational Wave, Apr 12, 13, 14 (confirmed)
- SLAC, Underground, Accelerator, Theory Frontiers, Community Engagement, May 3 to 5 (confirmed)

Virtual Town Halls

We make some of them specific to early career scientists in closed settings. Details TBD.

- week of May 15
- week of June 5
- week of June 26

http://hitoshi.berkeley.edu/P5/

U.S. Particle Physics

Change the design soon

2023 P5

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https://www.usparticlephysics.org/p5/

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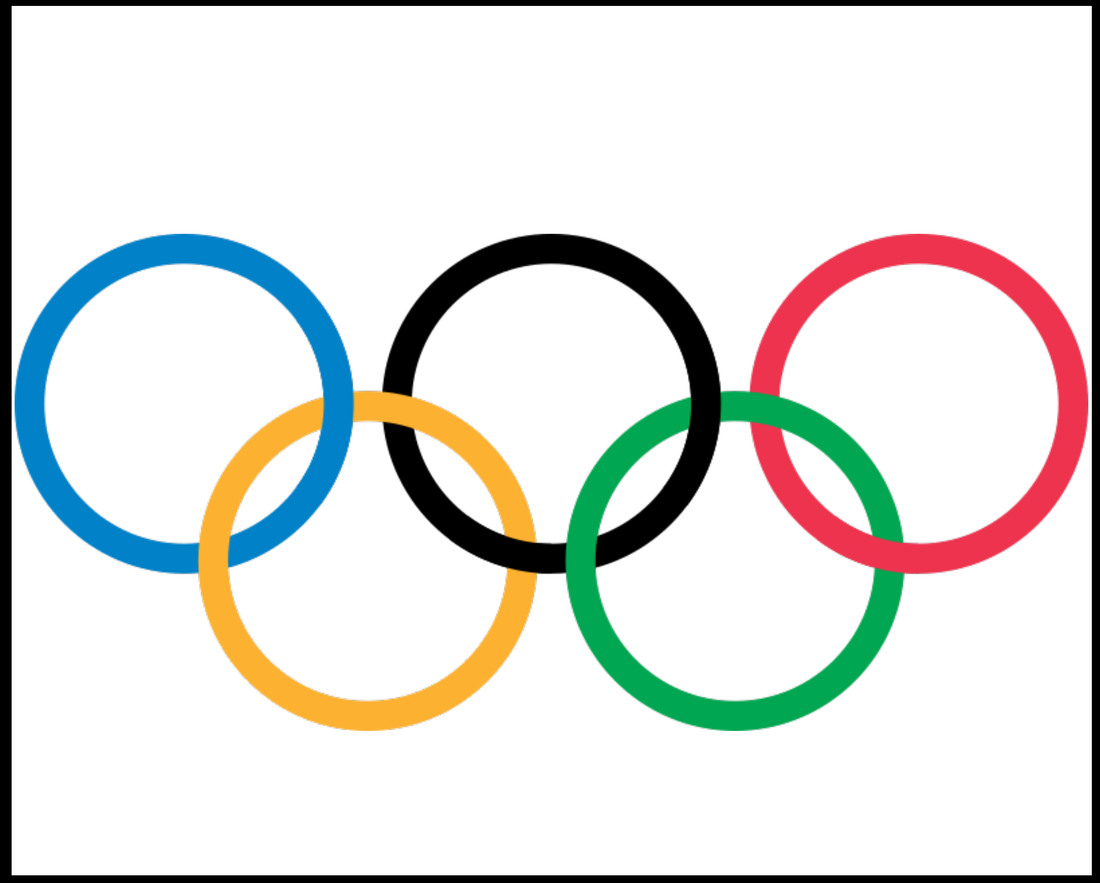
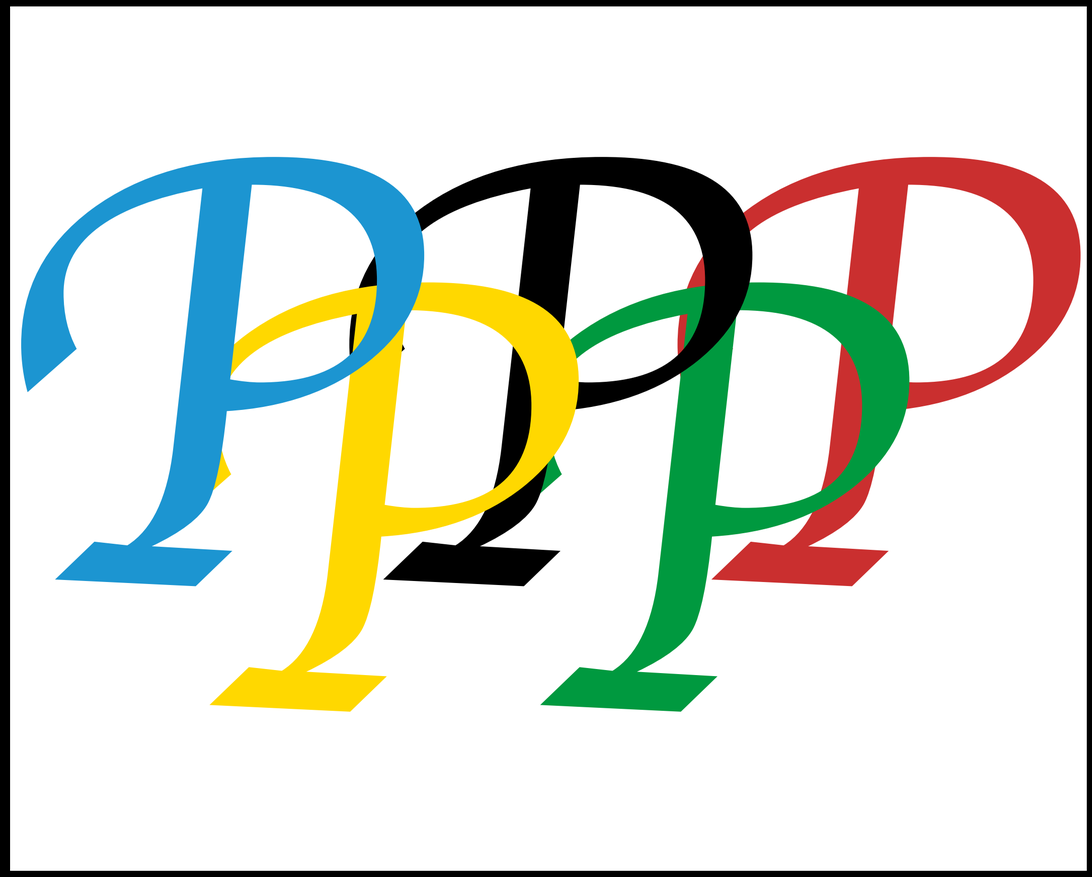
P5 tentative logo





Apologies to Antarctica! CMB and IceCube

Plan

- Information gathering mode
  - Four hybrid town halls
  - DPF session on P5 (April 15)
  - Virtual Town Halls: weeks of May 15, June 5, June 26 (at least one for early career only)
  - Recommendations from Jay's subcommittee ~June
- Deliberations / Decisions
  - Closed meetings from May to July
    - Including one visit to NSF
  - Preliminary recommendations to agencies August
  - Final report due October


APS
DPF/DPB
HEP community
Snowmass
Reports
P5
US government
Executive Branch
Congress
Charge
DOE / NSF
Maximize science!

P5 Charge (dated November 2, 2022)  1/8

Dear Dr. Hewett:

The 2014 report of the Particle Physics Project Prioritization Panel (P5), developed under the auspices of the High Energy Physics Advisory Panel (HEPAP), successfully laid out a compelling scientific program that recommended world-leading facilities with exciting new capabilities, as well as a robust scientific research program. That report was well received by the community, the U.S. Department of Energy (DOE) and the National Science Foundation (NSF), and Congress as a well-thought-out and strategic plan that could be successfully implemented. HEPAP's 2019 review of the implementation of this plan demonstrated that many of the report's recommendations are being realized, and the community has made excellent progress on the P5 science drivers.

- The 2014 report was successful
- 2019 implementation review by HEPAP showed progress on the plan

As the landscape of high-energy physics continues to evolve and the decadal timeframe addressed in the 2014 P5 report nears its end, we believe it is timely to initiate the next long-range planning guidance to the DOE and NSF. To that end, we ask that you constitute a new P5 panel to develop an updated strategic plan for U.S. high-energy physics that can be executed over a 10-year timeframe in the context of a 20-year, globally aware strategy for the field.

- 2023 P5 to update strategic plan over 10-yr timeframe in 20-yr context

P5 Charge  2/8

A critical element of this charge is to assess the continued importance of the science drivers identified by the 2014 P5 report and, if necessary, to identify new science drivers that have the potential to enable compelling new avenues of pursuit for particle physics. Specifically, we request that HEPAP 1) evaluate ongoing projects and identify potential new projects to address these science drivers; 2) make the science case for new facilities and capabilities that will advance the field and enhance U.S. leadership and global partnership roles; and 3) recommend a program portfolio that the agencies should pursue in this timeframe, along with any other strategic actions needed to ensure the broad success of the program in the coming decades.

In developing the plan, we would like the panel to take into consideration several particularly relevant aspects of constructing a compelling and well-balanced portfolio:

- Re-evaluate the 2014 science drivers
- Evaluate ongoing projects
- Identify new projects
- Make science case for new facilities and capabilities
- Recommend program portfolio

P5 Charge  3/8

- A core tenet of the 2014 P5 Report is that particle physics is fundamentally a global enterprise. Thus far, the U.S. program has achieved high impact through U.S. researchers participating in the programs at world-class facilities outside the U.S. and international researchers working at world-class U.S. facilities. The recommendations developed for this report should carefully consider the current and future international landscape for particle physics. The panel's report should include an explicit discussion of the choices made in this context, including the extent to which it is necessary to construct, maintain, and/or upgrade leading U.S.hosted high-energy physics facilities so that our leadership position in the global scientific arena continues, while at the same time preserving the essential roles of, and contributions by, the National Laboratories and universities to global collaboration on large-scale initiatives.

- Remember HEP is a global field
- Support decisions to retain US leadership as a global parter
- Preserve essential roles of Universities and National Labs

- A number of the projects recommended by the 2014 P5 report are still being built, and the agencies take their commitments to complete them very seriously. Understanding the continued strength of the science case for these projects is quite valuable, and the panel should provide its assessment of these projects in this context.

- Assess science case for on-going projects

P5 Charge  4/8

- A successful plan should maintain a balance of large, medium, and small projects that can deliver scientific results throughout the decadal timeframe. We do not expect the panel to consider the large number of possible small-scale projects individually, but advice on research areas where focused investments in smallscale projects can have a significant impact is welcome.
- There are elements of DOE HEP-operated infrastructure that are a stewardship responsibility for HEP. Investments to maintain that infrastructure in a safe and reliable condition are an HEP responsibility and are outside the scope of the panel. Major infrastructure upgrades that create new science capabilities are within the scope of the charge and should be considered by the panel.
- Successfully exploiting a newly built project requires funding for the commissioning and operation of the project and to support the researchers who will use these new capabilities to do world-leading science. Funding is also needed for research and development (R&D) that develops new technologies for future projects. Scientists and technical personnel working in experimental particle physics often contribute to all these project phases, while theoretical physics provides both the framework to evolve our fundamental understanding of the known universe as well as the innovative concepts that will expand our knowledge into new frontiers. The panel should deliver a research portfolio that will balance all these factors and consider related issues such as training and workforce development.

- Maintain balance of large, medium & small projects
- Advise on science topics to focus small projects

- Assess infrastructure upgrades that create new science capabilities

- Remember costs of R&D, commissioning, and operations for future projects
- Remember that a balanced core research budget is paramount to producing science from current projects and developing ideas for new ones

P5 Charge  5/8

- Both NSF and DOE are deeply committed to diversity, equity, inclusion, and accessibility principles in all the scientific communities they support. Creating a more diverse and inclusive workforce in particle physics will be necessary to implement the plan that this panel recommends, and the panel may further recommend strategic actions that could be taken to address or mitigate barriers to achieving these goals.
- Broad national initiatives relevant to the science and technology of particle physics have been developed by the administration and are being implemented by the funding agencies. These include, but are not limited to, investments in advanced electronics and instrumentation, artificial intelligence and machine learning, and quantum information science. Potential synergies between these initiatives and elements of the recommended portfolio should be considered.

- Remember that a diverse workforce results in improved science
- Address synergies with broad national initiatives

P5 Charge - budget scenarios  6/8

We request that the panel include these considerations in their deliberations and discuss how they affect their recommendations in the report narrative.

The panel's report should identify priorities and make recommendations for an optimized particle physics program over 10 years, FY 2024–FY 2033, under the following budget scenarios:

1) Increases of 2.0 percent per year during fiscal years 2024 to 2033 with the FY 2024 level calculated from the FY 2023 President's Budget Request for HEP.
2) Budget levels for HEP for fiscal years 2023 to 2027 specified in the Creating Helpful Incentives to Produce Semiconductors and Science Act of 2022, followed by increases of 3.0 percent per year from fiscal years 2028 to 2033.

The recommended projects and initiatives should be implementable under reasonable assumptions and be based on generally accepted estimates of science reach and capability. Estimated costs for future projects and facility operations should be given particular scrutiny and may be adjusted if the panel finds it prudent to do so. Given the long timescales for realizing these initiatives, we expect the funding required to enable the priorities the panel identifies may extend well past the 10-year budget profile, but any recommendation should be technically and fiscally plausible to execute in a 20-year timeframe.

- Scenario A: 2% increase per year
- Scenario B: Budgets in Chips and Science Act, followed by 3% increase per year

- Evaluate projected project costs
- Plan should be executable in 20-yr timeframe

P5 Charge  7/8

In addition to articulating the scientific opportunities that can and cannot be pursued in the various scenarios, the panel may provide their opinions on the approximate overall level of support that is needed for core particle physics research and advanced technology R&D programs to be successful in the context of the science goals of the recommended plan.

We expect the "Snowmass" community planning reports and HEPAP's 2022 study on international benchmarking of scientific resources and capabilities will be useful inputs and that the panel will make efforts to maximize community input and participation in the overall process. Coordination and congruence with the National Academies of Sciences, Engineering, and Medicine's recent and ongoing decadal studies in astronomy, astrophysics, and particle physics are also important considerations.

- Evaluate level of core research budget and technology R&D programs

- Include Snowmass report and Benchmarking subpanel report in deliberations
- Strive towards coordination and congruence with EPP2024

P5 Charge 8/8

Finally, effective communication about the excitement, impact, and vitality of particle physics that can be shared with a general audience and other disciplines continues to be critical when advocating the strategic plan. It would be particularly valuable if the panel could re-state the key scientific questions that drive the field so that they are accessible to non-specialists and crisply articulate the value of basic research and the broader benefits of particle physics on other sciences and society.

We would appreciate the panel's preliminary comments by August 2023 and a final report by October 2023. We recognize that this is a challenging task; nevertheless, your assessments will be an essential input to planning at both the DOE and NSF.

Sincerely,

Asmeret Asefaw Berhe
Director, Office of Science
U.S. Department of Energy

Sean L. Jones
Assistant Director
Directorate for Mathematical and Physical Sciences
National Science Foundation

- Effectively communicate the 2023 P5 plan once it's finished

- Preliminary comments in August 2023
- Report due by October 2023