P5 Process, Activities, Timetable and Rollout

Hitoshi Murayama

HEPAP meeting, virtual, Aug 7, 2023

U.S. DEPARTMENT OF ENERGY | Office of Science

NSF National Science Foundation

Background

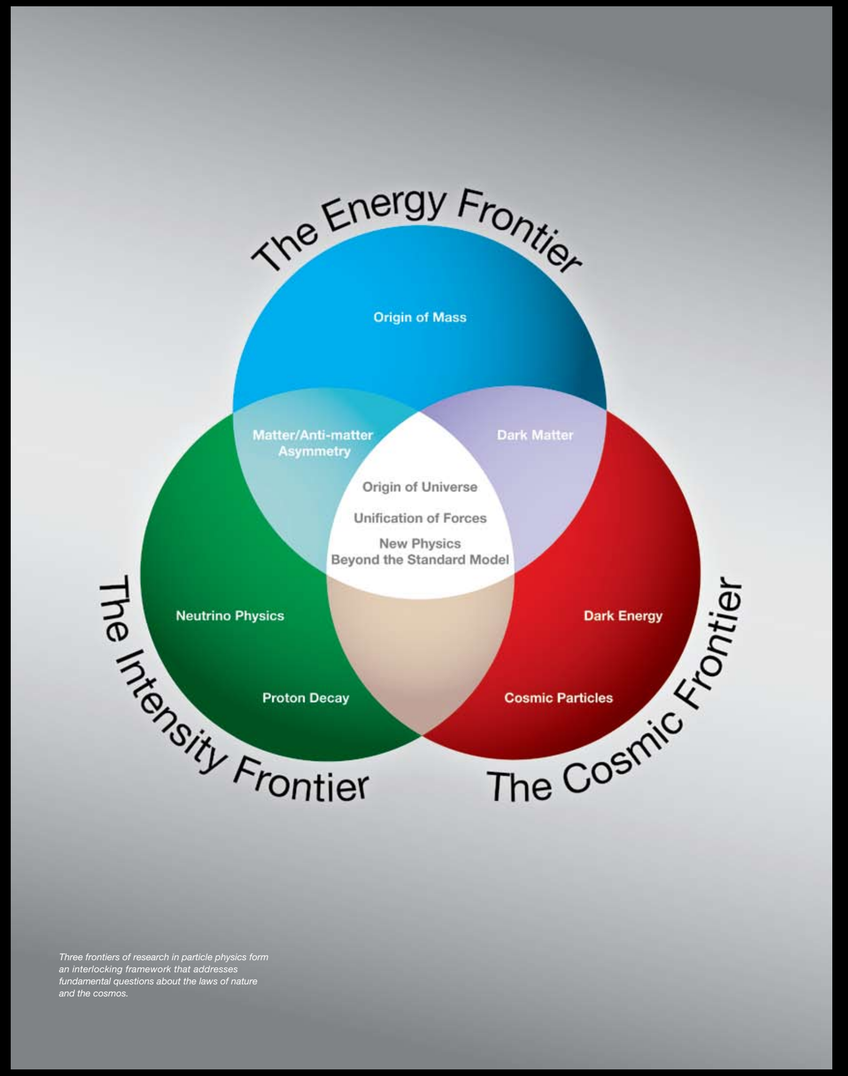
- HEPAP advises DOE OHEP and NSF PHY
  - Current chair: Sally Seidel
  - Sunshine law requires such advisory panels are open
  - Impossible to discuss sensitive issues such as prioritization!
- But HEPAP can create a “subpanel” whose meetings can be closed
  - HEPAP subpanels existed for a long time, discussed “big things”
- Individual projects used to be purview of lab PACs
- Around 2000, it was becoming increasingly clear that “projects” have become too big to be handled by lab PACs
- Natalie Roe: “national PAC” (Snowmass 2001)
  - A standing committee that handles decisions of mid-size and big projects in particle physics
  - Made it into the recommendation by Bagger & Barish subpanel 2001

2003-2007 P5 (Abe Seiden)

- 2003 P5 reviewed
  - CDF/D0 Run II upgrades
  - CKM
  - BTeV
  - Terminated CKM
- 2004 P5 reviewed
  - BTeV
  - Recommended staging of BTeV
- 2007 P5
  - Tevatron beyond FY09?
  - Deferred decision

2008 P5

- 2008 P5 (Charles Baltay)
  - First “modern” P5 for the whole program with budget scenarios
  - 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*
- Coined Energy, Intensity, Cosmic Frontiers
- Followed by specific 2010 P5 on Tevatron that recommended additional 2-3 years



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.
- Embraced CMB in HEP
- Finally “got it right”
  - Well received in Washington
  - “*Made many hard choices*”

Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context 18

Figure 1
Construction and Physics Timeline

Buil

Strategic

Project	2015	2020	2025	2030	2035
Currently operating					
Large Projects					
Mu2e					
LHC: Phase 1 upgrade					
HL-LHC					
LBNF					
ILC					
Medium and Small Projects					
LSST					
DESI					
DM G2					
DM G3					
CMB S4					

FIGURE 1 Approximate construction (blue; above line) and expected physics (green; below line) profiles for the recommended major projects, grouped by size (Large [>$200M] in the upper section, Medium and Small [<$200M] in the lower section), shown for Scenario B. The LHC: Phase 1 upgrade is a Medium project, but shown next to the HL-LHC for context. The figure does not show the suite of small experiments that will be built and produce new results regularly.

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

US Process for Future Planning

Community

“Snowmass”
Community Study

Organized by
APS / DPF

Snowmass 2021

Particle Physics Project
Prioritization Panel (P5)

Organized by
HEPAP

Charge
Budget scenario

DOE HEP
NSF PHYS

DOE HEP
NSF PHYS

OMB
OSTP
Congress

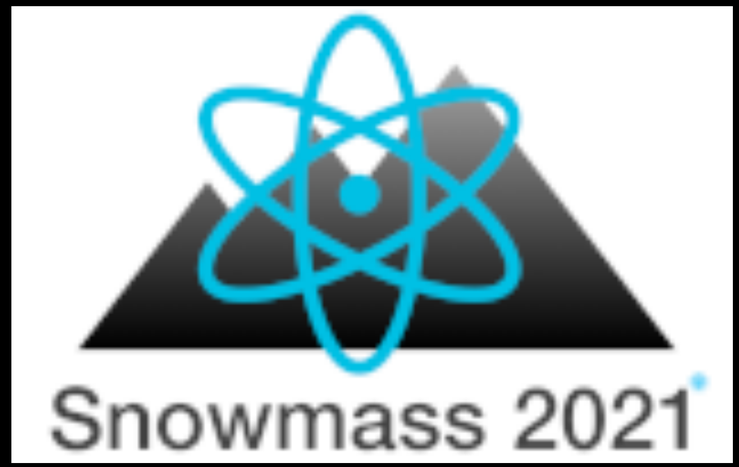
Key Elements of a Successful P5

- 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
Then interim director of HEP
Now deputy director for Science Programs

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
  - “search wide, aim high, delve deep”
- 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
- Field is more global than ever, yet geopolitical challenges, climate change



Current Portfolio of medium to large projects

- Energy frontier
  - HL-LHC (AUP, ATLAS & CMS), LHCb
- Intensity frontier
  - Neutrinos: NOvA, SBND+Icarus, DUNE + PIP-II
  - Precision: Muon g-2
  - Flavor: Mu2e, Belle II
- Cosmic frontier
  - Galaxy surveys: DESI, Rubin
  - Dark matter: LZ, SuperCDMS, ADMX
  - CMB: Simons Observatory & BICEP/Keck

My takeaway from Snowmass

- We have an exciting program lined up
  - Thanks to Steve Ritz, previous P5, agencies!
- Our scientific interests 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 was very scared of the tasks ahead
  - Reading Snowmass reports!

2014 P5 Table 1 Summary of Scenarios

Project/Activity	Scenarios			Science Drivers					Technique (Frontier)
	Scenario A	Scenario B	Scenario C	Higgs	Neutrinos	Dark Matter	Cosm. Accel.	The Unknown	
Large Projects									
Muon program: Mu2e, Muon g-2	Y, Mu2e small reprofile needed	Y	Y					✓	I
HL-LHC	Y	Y	Y	✓		✓		✓	E
LBNF + PIP-II	Y, LBNF components delayed relative to Scenario B.	Y	Y, enhanced		✓			✓	I,C
ILC	R&D only	R&D, possibly small hardware contri-butions. See text.	Y	✓		✓		✓	E
No “Y”									
Medium Projects									
LSST	Y	Y	Y		✓		✓		C
DM G2	Y	Y	Y			✓			C
Small Projects Portfolio	Y	Y	Y		✓	✓	✓	✓	All
Accelerator R&D and Test Facilities	Y, reduced	Y, some reductions with redirection to PIP-II development	Y, enhanced	✓	✓	✓		✓	E,I
CMB-S4	Y	Y	Y		✓		✓		C
DM G3	Y, reduced	Y	Y			✓			C
No “Y”									
Additional Small Projects (beyond the Small Projects Portfolio above)									
DESI	N	Y	Y		✓		✓		C
Short Baseline Neutrino Portfolio	Y	Y	Y		✓				I

Muon g-2 finished data taking, Mu2e getting ready

Moving ahead full steam

Under construction

No word from Japanese government

Start data taking soon

LZ, SuperCDMS, ADMX

Not happening as envisioned

Not happening as envisioned

CD-0 but issue with South Pole

Not yet

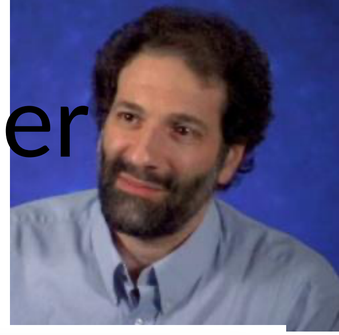
Data taking

MicroBooNE finished, SBND+Icarus soon

The Importance of Program Balance

- A subfield (aka “Frontier”) isn’t defined by one large project. A facility isn’t a vision.
- **What are the questions that can be answered, and how can they best be addressed with a mix of small, medium, and large experiments?**
- The 2014 P5 made a portfolio of smaller experiments a high priority
  - We can help the next P5 make a similar case
  - Again, the international context and connections to other subfields essential

And then, after P5, it's important to work together for the whole program in a unified manner.



- https://www.usparticlephysics.org
- https://www.usparticlephysics.org/wp-content/uploads/2022/03/Particle-Physics-Progress-and-Priorities-2022.pdf

- Every year, working with DPF, and Users Groups, and others, materials about the whole field are developed and updated for interactions with decision makers in Washington and elsewhere.

Building for Discovery

Strategic Plan for U.S. Particle Physics in the Global Context

usparticlephysics.org

The P5 Report provides the strategy and priorities for U.S. investments in particle physics for the coming decade.

The top three priorities in 2022

Strengthen support for particle physics research at universities and national laboratories, which includes data analysis, R&D, design of new experiments, and a vibrant theory program. As emphasized in the P5 Report, these activities are essential for the success of the field. They are crucial for extracting scientific knowledge from all the great new data, developing new methods and ideas, maintaining U.S. leadership, and training the next generation of scientists and innovators.

Advance the High-Luminosity Large Hadron Collider (HL-LHC) accelerator and ATLAS and CMS detector upgrade projects on schedule, continuing the highly successful LHC program and bilateral partnership with CERN.

Advance the Long-Baseline Neutrino Facility (LBNF), Deep Underground Neutrino Experiment (DUNE), and Proton Improvement Plan-II (PIP-II), working with international partners on the design, prototypes, initial site construction, and long-lead procurements.

These carefully chosen investments will enable a steady stream of exciting new results for many years to come and will maintain U.S. leadership in key areas.

Particle physics is both global and local. Scientists, engineers, and technicians at more than 180 universities, institutes, and laboratories throughout the U.S. are working in partnership with their international colleagues to build high-tech tools and components, conduct scientific research, and train and educate the next generation of innovators. Valuing equity, diversity, and inclusion, the field is committed to increasing participation of underrepresented groups. Particle physics activities in the U.S. attract some of the best scientists from around the world.

The P5 strategy has been very successful. Even with extraordinary challenges due to COVID-19, there was great progress.

Recent results

The LHC experiments reported many important and precise results. The remarkably productive ATLAS and CMS experiments have each produced more than 1,000 refereed publications. The advances in precision are represented well by the new measurement of fundamental symmetry properties of **Higgs boson** decays that test the foundations of the underlying theory. The LHCb experiment also published many new results that are sensitive to **new physics**.

The Muon g-2 fundamental parameter was measured to much greater precision, which represents another success in the program recommended in the P5 report. Remarkably, the value differs significantly from the theoretical prediction, pointing the way to more scientific progress.

Using the high-temperature superconductor, YBCO, researchers at **Fermilab set a new record for a fast-cycling accelerator magnet.**

The **Dark Energy Survey (DES)** announced many results using data from its first three years of operation.

Theoretical physicists have discovered new connections between particle production at **colliders** and fundamental concepts in **quantum field theory**, offering new, more incisive tests. They have also discovered new ways to search for candidate **dark matter** particles.

Intriguing first results from the **MicroBooNE** neutrino experiment, which is a proof-of-principle application of liquid argon for neutrino detectors, tested hypotheses about anomalies from previous neutrino experiments.

Program advances in 2021

Building upon the historic 2015 and 2017 bilateral U.S.–CERN agreements, U.S. and CERN scientists successfully continued their cooperative partnership at the LHC and the international neutrino program hosted by Fermilab. So far, government-to-government agreements with 10 countries have been signed for LBNF/DUNE, PIP-II, and the Short Baseline Neutrino program at Fermilab, with more in progress.

The **Vera C. Rubin/LSST Camera** successfully passed its CD-4 construction completion milestone. The **Dark Energy Spectroscopic Instrument (DESI)**, the world's premiere multi-object spectrometer, began its 5-year survey in May 2021, enabling major advances in the study of the nature of **dark energy** using methods complementary to those of Rubin Observatory's upcoming imaging survey.

The next-generation cosmic microwave background facility, CMB-S4, was ranked highly in the NAS Decadal Survey of Astronomy & Astrophysics, opening the path for a partnership in this interdisciplinary science that was also a priority in the P5 report. CMB measurements uniquely probe **physics of the inflationary era in the early Universe** at energies well beyond those of earth-bound accelerators and can also reveal **neutrino properties.**

Looking forward

All eyes are on the LHC, as its sensitivity to new physics will continue to improve through vastly greater data volumes and new deep-learning data analysis methods. The experiments will extend their discovery reach and probe the Higgs boson's properties with ever greater precision for many years to come. Despite COVID and funding constraints, the HL-LHC upgrade projects are progressing.

Eagerly anticipated new data from operating experiments will advance the understanding of the Intertwined Science Drivers identified in the P5 Report. At the LHC, the accelerator is on track to resume operations this spring for data-taking by the successfully upgraded experiments.

Particle physicists are expanding efforts to develop and apply artificial intelligence (AI) techniques to the operation of accelerators and experiments, data analysis, and simulations, opening new avenues for scientific discovery.

Theoretical and experimental particle physicists are advancing Quantum Information Science (QIS), providing solutions to problems in computation, data analysis, sensors, and simulations.

The particle physics theory community will continue to play key roles in interpreting results from current experiments, motivating future experiments, and pursuing answers to the deepest questions.

Looking beyond the current P5 horizon, and guided by new results, the U.S. is currently engaged in the Snowmass community planning process, in which opportunities in all areas of the field are discussed in depth. To inform choices, the U.S. is also working with partners worldwide on the development of concepts for facilities that could be hosted in the U.S. and abroad.

U.S. researchers are pursuing R&D on advanced technologies to enable future generations of accelerators and detectors with a wide variety of applications in science, medicine, and industry.

Building for Discovery

Strategic Plan for U.S. Particle Physics in the Global Context

usparticlephysics.org

Finally, the Importance of Positive, Clear, and Actionable Messages

- Snowmass can provide clear questions and viable options. Nothing should be off the table for consideration.
- Realism is important, but so are well-motivated, big aspirations. Snowmass can provide these, too. From the 2014 P5 Report:
  - *As work proceeds worldwide on long-term future-generation accelerator concepts, the U.S. should be counted among the potential host nations.*
  - *We had the responsibility to make the tough choices for a world-class program under each of these scenarios, which we have done. At the same time, we felt the responsibility to aspire to an even bolder future. These are not contradictory responsibilities: an annual budget is a balance sheet, but investment in fundamental research is a powerful expression that our culture and economy have greater potential in the long run. Our society's capacity to grow is limited only by our collective imagination and resolve to make long-term investments that can lead to fundamental, game-changing discoveries, even in the context of constrained budgets.*
- Diversity, Equity, and Inclusion are also areas of necessary attention and different thinking.
- Cutting across "Frontiers" is important
  - Suggest how to think about activities in a given area and how they connect to everything else.
- The evolving international context remains essential.

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	
	US role? Higgs Factory	Scope? Technology? Complementarity?
Neutrino Frontier	LBNF/DUNE Phase I & PIP- II	DUNE Phase II (incl. proton injector)
Cosmic Frontier	South Pole? Cosmic Microwave Background - S4	Next Gen. Grav. Wave Observatory*
	Spectroscopic Survey - S5* Scope?	Line Intensity Mapping* Do we embrace them?
	Big, small, new? Multi-Scale Dark Matter Program (incl. Gen-3 WIMP searches)	
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.*

NSF 23-117

Dear Colleague Letter: 2023 Update on Science Support and Infrastructure in Antarctica

June 12, 2023

Dear Colleagues:

This letter provides information on the status and future of science support and infrastructure recapitalization in Antarctica. Since the last NSF update <https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf22078> in April 2022, the COVID-19 pandemic has continued to severely impact the Office of Polar Program's (OPP) ability to support science on the continent, and those impacts have been exacerbated by increasing constraints on resources arising from inflation and the need for facility renewal.

South Pole Station is saturated with already-funded projects and required critical infrastructure and maintenance activities that cannot be deferred until late in the decade. South Pole Station will continue to host the current suite of large-scale science projects; however, proposers seeking support for new projects at South Pole Station should consult the cognizant program officer to discuss alternative locations to accomplish science goals.

Master planning begins for the future of the South Pole Station

June 20, 2023

The United States Antarctic Program <https://www.usap.gov/> (USAP) has begun work on a Master Plan for the Amundsen-Scott South Pole Station <https://www.nsf.gov/geo/opp/support/southp.jsp> .

Master Plans are a common tool used across research campuses and universities to ensure infrastructure projects are guided by a clear and consistent vision of the future. The South Pole Station Master Plan will inform investments planned under the Antarctic Infrastructure Recapitalization program and ensure that the future state will achieve USAP's mission and priorities.

Community and public input on the South Pole Station Master Plan will be sought through postings to the federal register and a planning charrette open to all stakeholders in August 2023. Additional information, including how to participate in the master planning process, will be posted on the Office of Polar Programs <https://www.nsf.gov/news/announcements.jsp?org=OPP> website.

There are currently Master Plans in place for Palmer Station <https://future.usap.gov/master-plan/palmer-master-plan/> and McMurdo Station <https://future.usap.gov/master-plan/mcmurdo-master-plan-page/> .

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

Balance

- Project vs research (Previous P5 recommended Research > 40%, not there)
- Large (>$200M), medium ($50-200M), small (<$50M) (previous P5)
- Investments in future
  - Instrumentation, computing, theory
- National initiatives
  - AI/ML, microelectronics, QIS
  - How do we capitalize on it? How do we contribute to justify it?
- DEI
  - Many cultural, community, institutional issues
  - What can agencies do?

HEPAP Assessment of Progress on 2014 P5 Report

In 2019, halfway through the 10-year strategic plan for U.S. particle physics presented in the 2014 report of the Particle Physics Project Prioritization Panel (P5), the High Energy Physics Advisory Panel (HEPAP) evaluated the plan's implementation. The review concluded that the U.S. Department of Energy (DOE) and National Science Foundation (NSF) have successfully carried out the first five years of the plan, which focused on construction of experimental facilities. Going forward, reviewers said, it will be important to fully support plans for operating those facilities and provide adequate research support to the particle physics community for carrying out the remainder of the plan and achieving its scientific goals.

The 2014 P5 report, "Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context," presented a 10-year strategic plan for U.S. High Energy Physics (HEP). The plan emphasized the global nature of particle physics and recommended construction of projects both large and small, including a new international facility in the U.S. to study the nature of neutrinos. These projects would push the field forward by advancing discovery science in five intertwined areas of science that drive progress in the field.

Last year, HEPAP evaluated the implementation of this report to date. The panel heard presentations on the current High Energy Physics science landscape, including developments in each of the P5 science drivers; the status of each project; and how the agencies have been executing the plan.

The assessment concluded that:

- The five P5 science drivers continue to describe the most urgent questions in our field.
- The DOE and NSF have closely followed the advice given in the P5 Report and have been successfully executing the plan. All the projects in the plan are underway, with some projects nearing completion and the rest proceeding in a timely fashion. This suite of projects is expected to yield exciting discovery science for the next decade.
- Thanks to generous DOE Office of Science budgets, construction of the Long-Baseline Neutrino Facility and Deep Underground Neutrino Detector is farther along than envisioned by P5. Timely construction of this international facility is critical to achieving our national priorities.
- While investments over the past 5 years have focused on project construction, it will be fundamentally important to balance the components of the HEP budget to continue successful execution of the P5 plan. Operations of the newly constructed experiments require full support to reap their scientific goals. The HEP research program also needs strong support to fully execute the plan, throughout the construction, operations, and data analysis phases of the experiments, and to lay a foundation for the future.

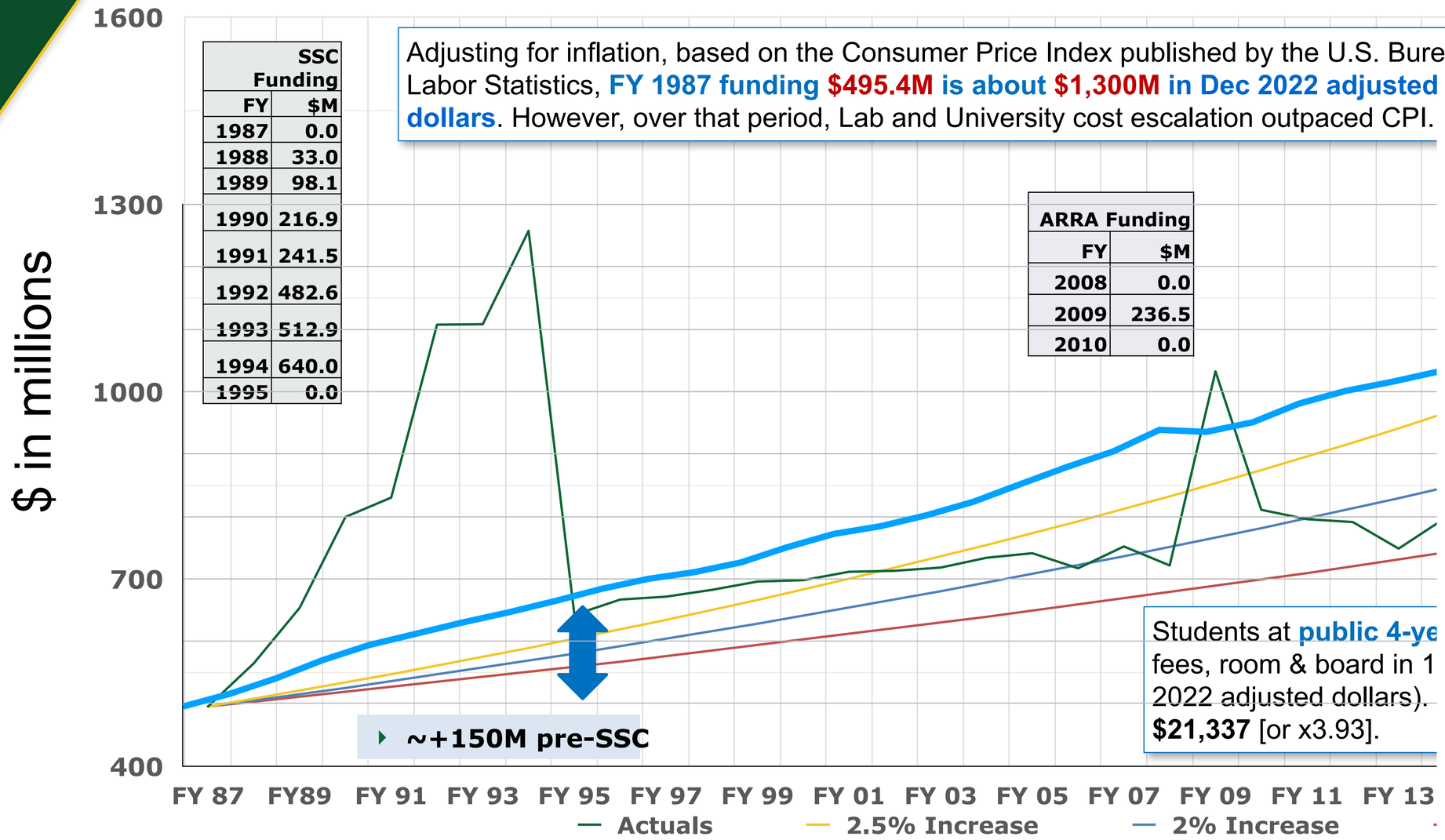
JoAnne L Hewett

JoAnne Hewett
Chair, High Energy Physics Advisory Panel

On behalf of the members of HEPAP:

—Timothy Alan Bolton
—Janet Conrad
—Priscilla Cushman
—Rohini Godbole
—Jordan Goodman
—Michael Hildreth
—Kent Irwin
—Donatella Lucchesi
—Alysia Marino
—Meenakshi Narain
—Fulvia Pilat
—Soren Prestemon
—Patrizia Rossi
—Michael Syphers

HEP Funding in Historical Context: 1987 to Present



SSC Funding	
FY	$M
1987	0.0
1988	33.0
1989	98.1
1990	216.9
1991	241.5
1992	482.6
1993	512.9
1994	640.0
1995	0.0

Adjusting for inflation, based on the Consumer Price Index published by the U.S. Bureau of Labor Statistics, **FY 1987 funding $495.4M is about $1,300M in Dec 2022 adjusted dollars**. However, over that period, Lab and University cost escalation outpaced CPI.

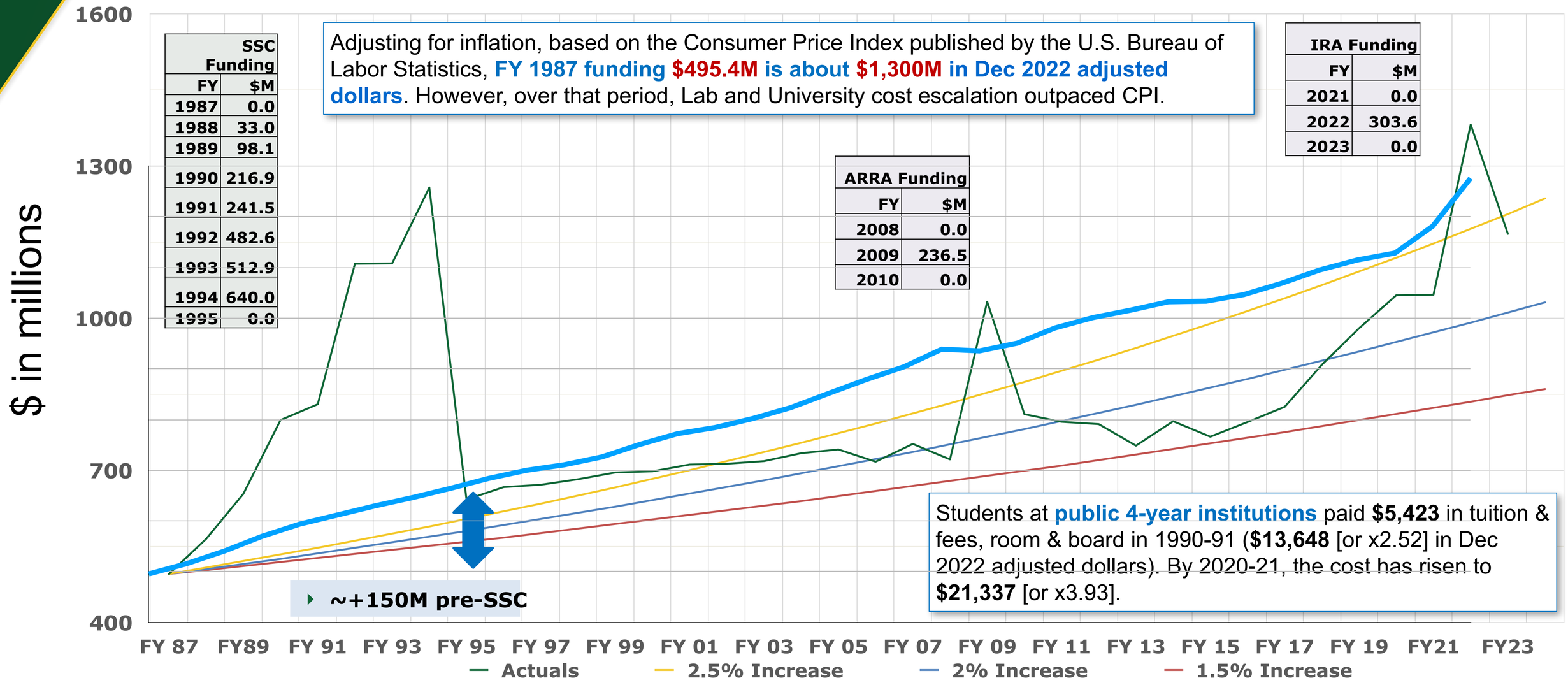
ARRA Funding	
FY	$M
2008	0.0
2009	236.5
2010	0.0

IRA Funding	
FY	$M
2021	0.0

Students at **public 4-ye**
fees, room & board in 1
2022 adjusted dollars).
$21,337 [or x3.93].

Before the previous P5

HEP Funding in Historical Context: 1987 to Present



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ARRA Funding	
FY	$M
2008	0.0
2009	236.5
2010	0.0

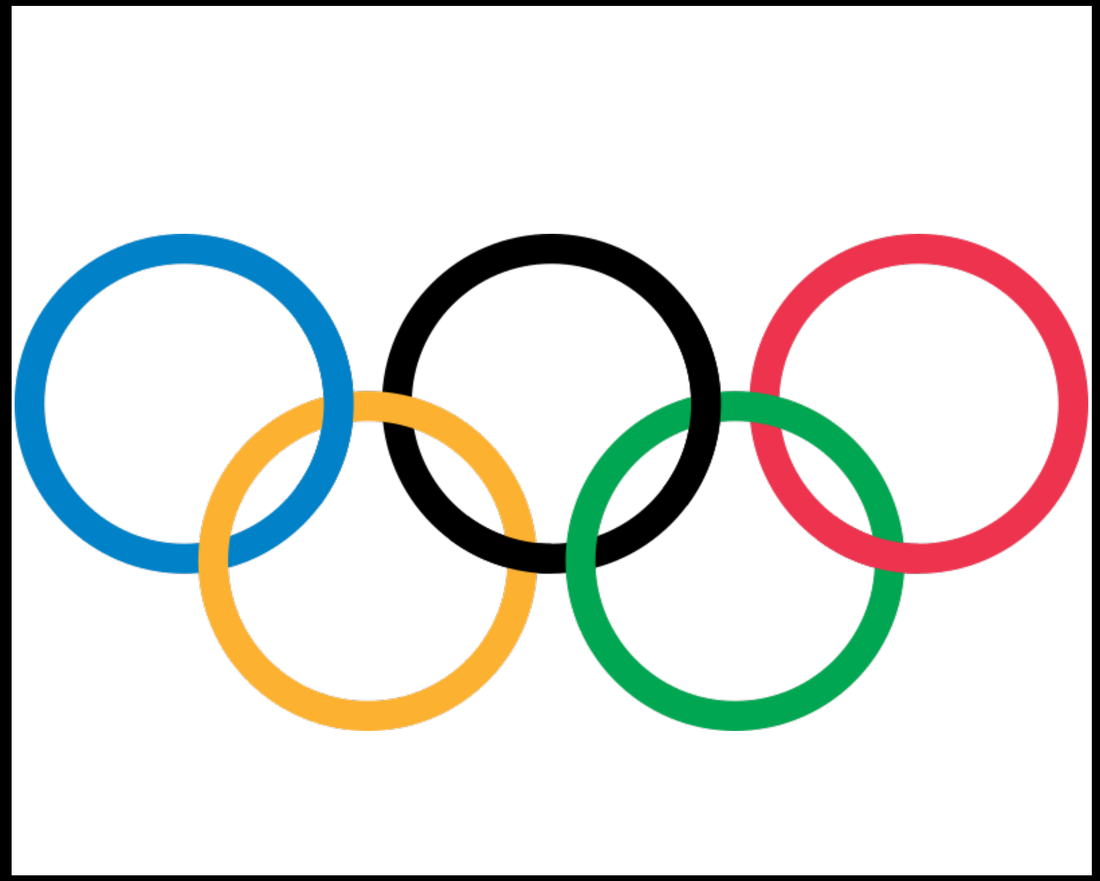
IRA Funding	
FY	$M
2021	0.0
2022	303.6
2023	0.0

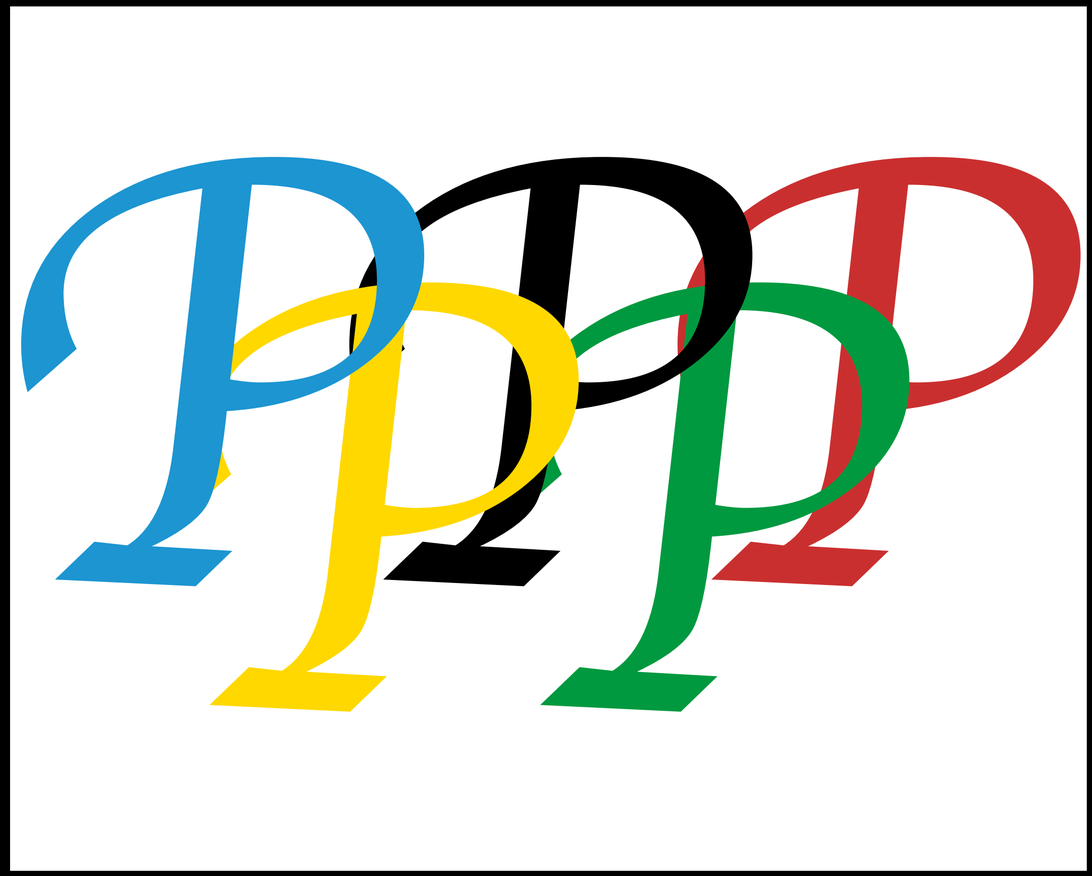
Students at **public 4-year institutions** paid **$5,423** in tuition & fees, room & board in 1990-91 (**$13,648** [or x2.52] in Dec 2022 adjusted dollars). By 2020-21, the cost has risen to **$21,337** [or x3.93].

Getting P5 off the ground

- 7/26/22 JoAnne announced P5 chair on the last day of “Snowmass in Seattle”
- 9/7,8/22 HM Visited DOE and NSF
- JoAnne and I discussed membership intensively and waited for the charge
- 11/2/22 Charge issued
- 11/3/22 HM contacted Karsten
- Consulted agencies about the composition
- By end of 2022 panel was assembled
- 1/31/23 Amalia Ballarino added
- 2/6/23 Kickoff meeting with DOE and NSF

P5 tentative logo



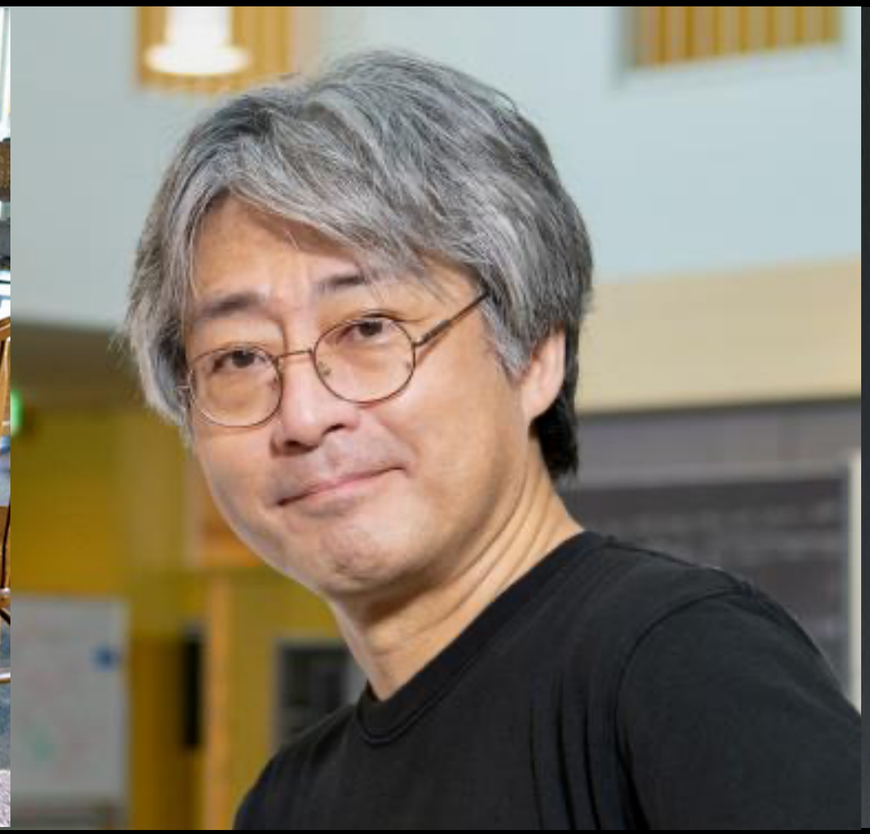


Apologies to Antarctica! CMB and IceCube

Leadership team

Sally Seidel
Interim HEPAP chair, ex officio

JoAnne Hewett
HEPAP chair, ex officio



Hitoshi Murayama
P5 chair

Karsten Heeger
P5 Deputy chair


It is a great panel!

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
- JoAnne and I participated in their November & December meetings
- Karsten took part of the panel discussion in their July meeting
- We invited all EPP2024 members to P5 town halls to make sure we get the same inputs from the community
  - We overlapped at Fermilab in March
- Will keep informing EPP2024 about our progress and vice versa
- What P5 recommends should smoothly connect to their longer-term vision

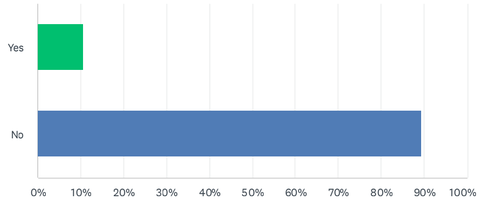
Time Table

- Information Gathering phase
  - Open Town Halls
    - LBNL: Feb 22, 23. 513 registrants
    - Fermilab/Argonne: March 21, 22, 23. 797 registrants, overlapped with EPP
    - Brookhaven: April 12, 13. 666 registrants
    - SLAC: May 3, 4. 512 registrants
    - All with short remarks (x3 oversubscription), talks on international programs
  - Virtual Town Halls
    - UT Austin: June 5. 159 registrants, exclusive session for early career
    - Virginia Tech, June 27. 119 registrants
  - All town halls offered live captioning and ASL
- Keeping the community informed
  - DPF session on P5 (April 15), Early Career Network Workshop (June 8,9), ACE Science Workshop (June 14, 15), CEPC Workshop (July 6), ICFA (July 15)
  - DPF & DPB mailing list, Snowmass mailing list

Survey on the Fermilab Town Hall

Q2 Was the ASL interpretation useful to you?

Answered: 168 Skipped: 11

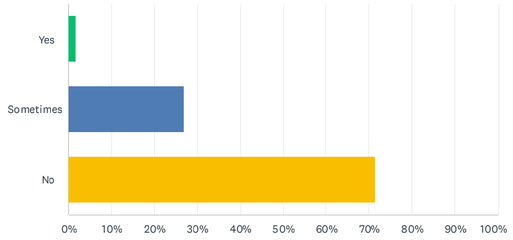


ANSWER CHOICES	RESPONSES	
Yes	10.71%	18
No	89.29%	150
TOTAL		168

Survey on the Fermilab Town Hall

Q5 Did you have problems reading the slides?

Answered: 178 Skipped: 1



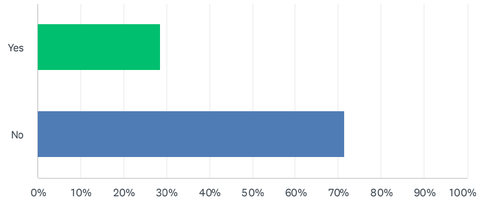
ANSWER CHOICES	RESPONSES	
Yes	1.69%	3
Sometimes	26.97%	48
No	71.35%	127
TOTAL		178

Response rate: 168 out of 797 registrants

Survey on the Fermilab Town Hall

Q3 Was the live captioning useful for you?

Answered: 175 Skipped: 4

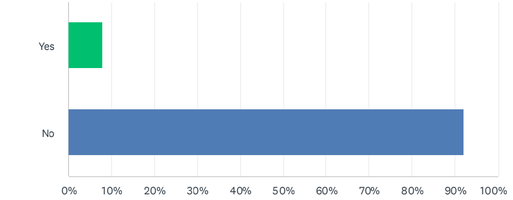


ANSWER CHOICES	RESPONSES	
Yes	28.57%	50
No	71.43%	125
TOTAL		175

Survey on the Fermilab Town Hall

Q6 Was the link to day care centers useful for you?

Answered: 164 Skipped: 15



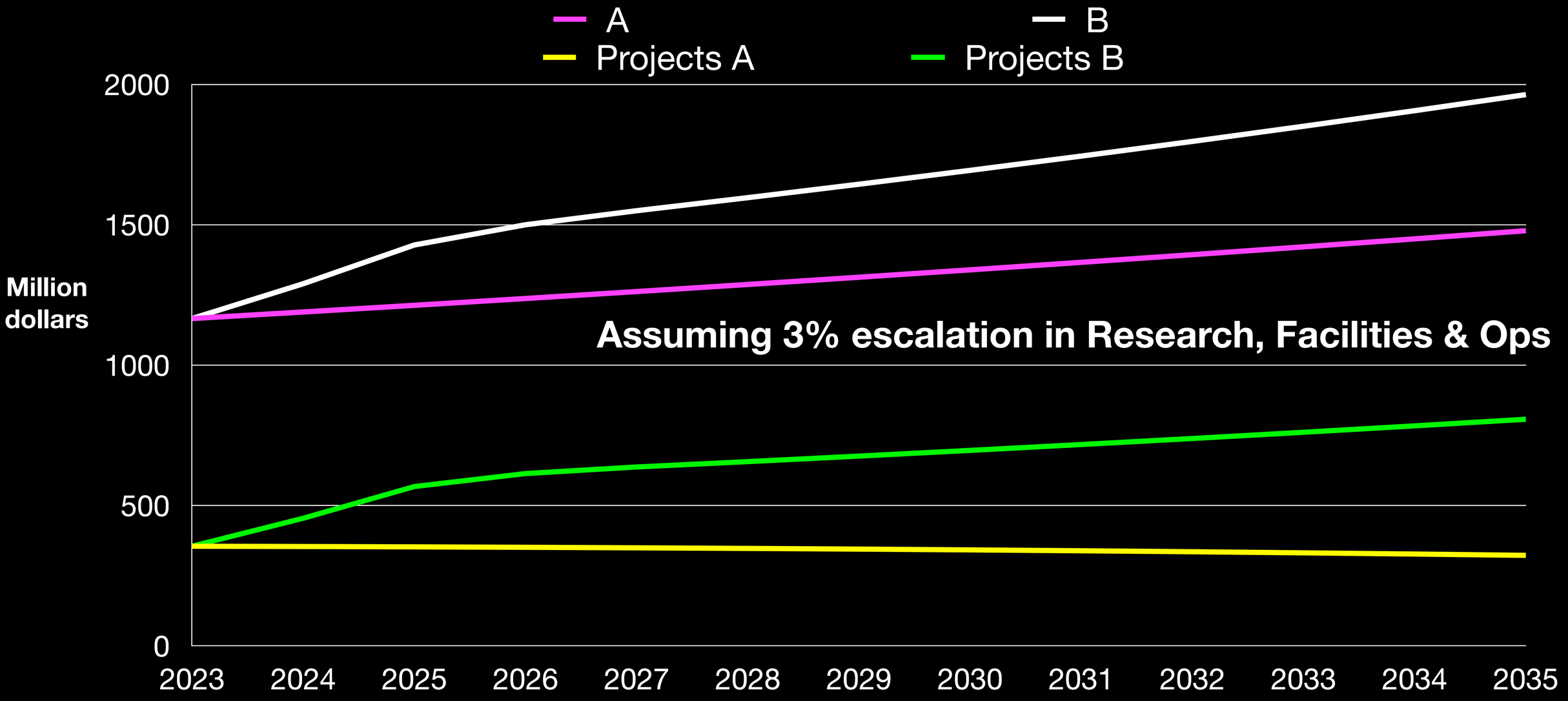
ANSWER CHOICES	RESPONSES	
Yes	7.93%	13
No	92.07%	151
TOTAL		164

Principles in deliberations

- Optimization of science within the boundary conditions
  - Everything is on the table, nothing is off the table
- Attention to balance among
  - Different areas
  - Different sizes
  - Domestic vs international
  - Project and Research
- Actionable recommendations on DEI
- Decisions based on consensus
  - Never relied on voting

DOE only

Budget Scenarios

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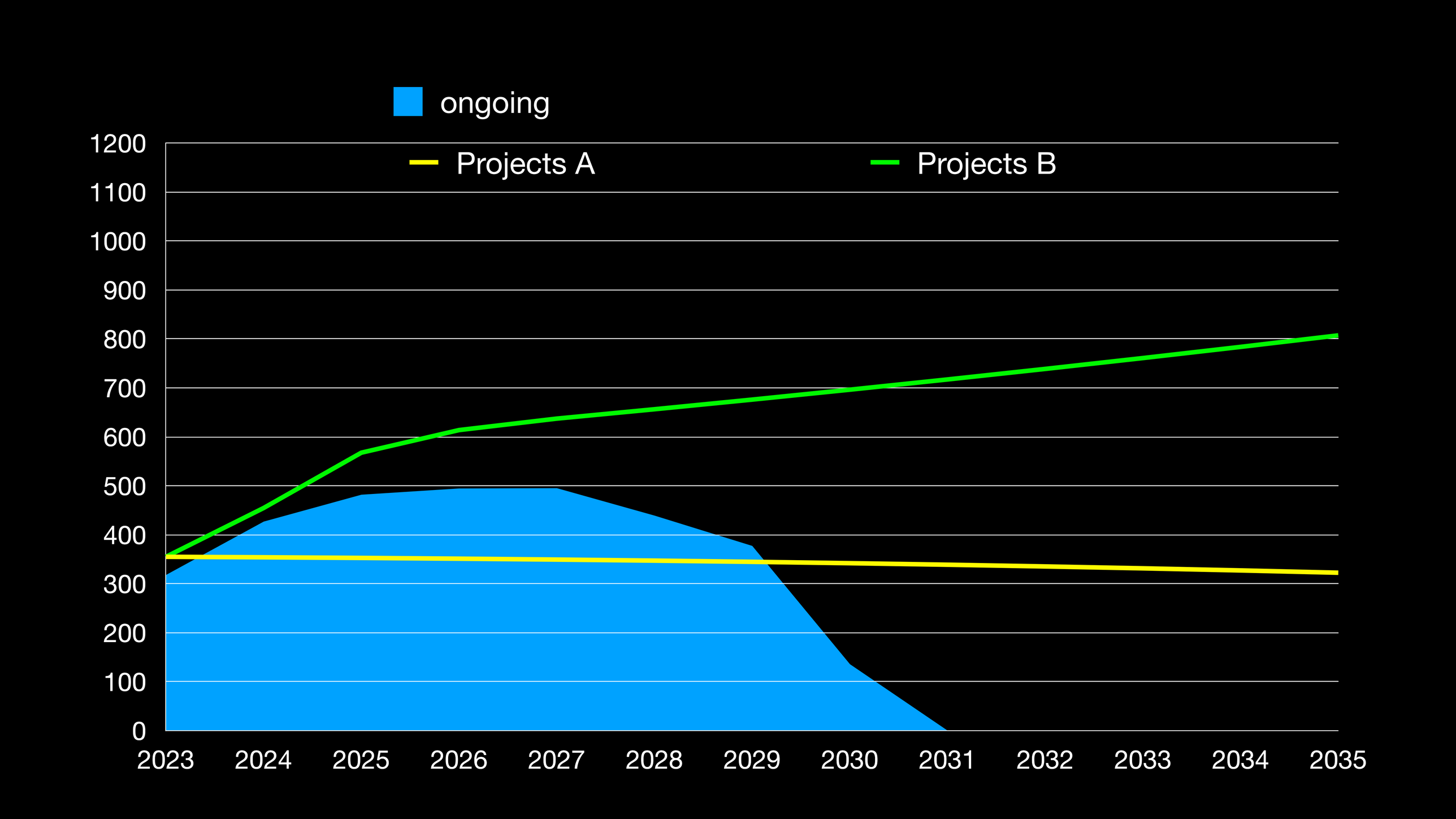
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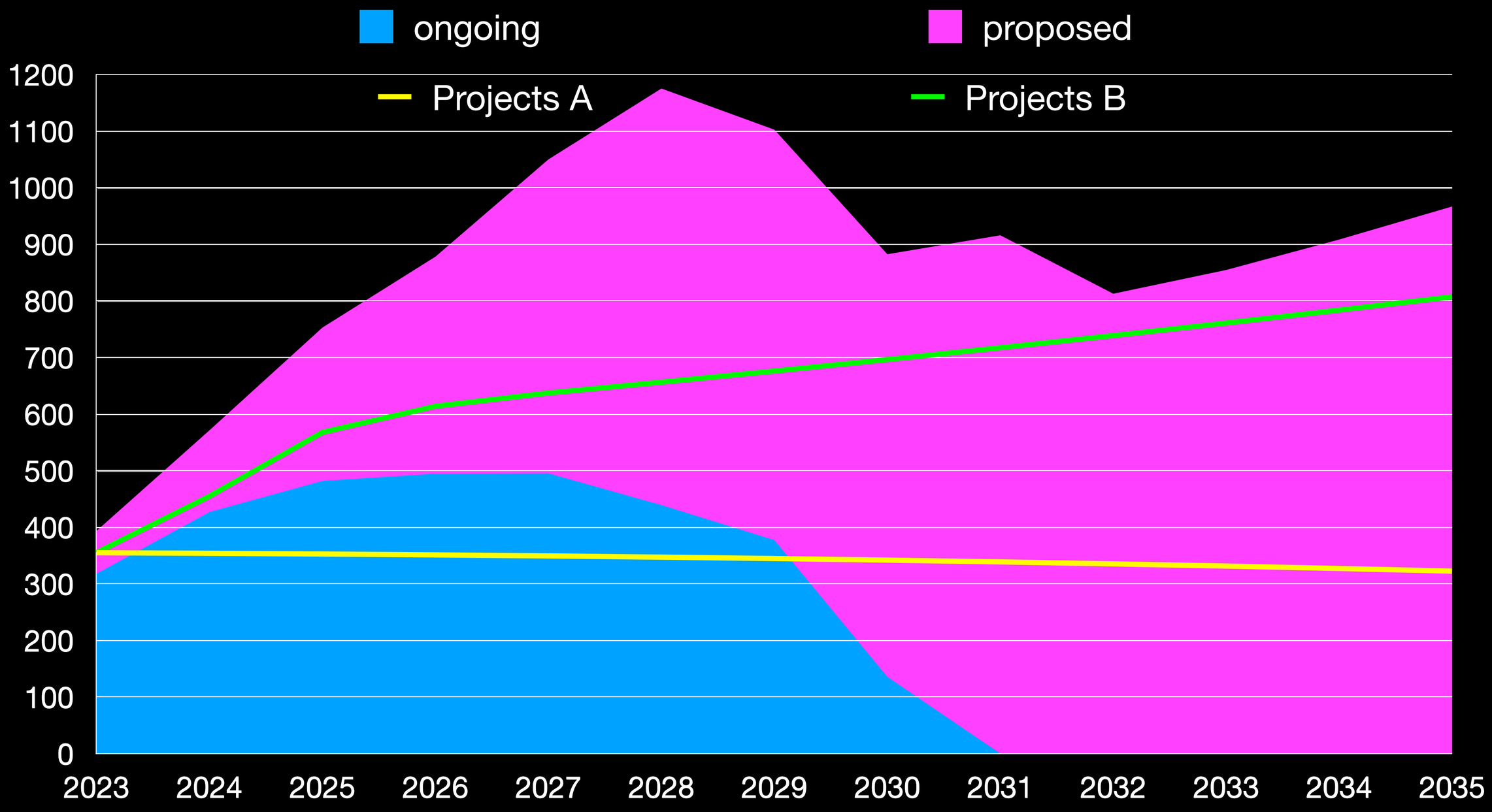
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Costs/Risks/Schedule

- 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), Chair
  - Gil Gilchriese, Matthaeus Leitner (LBNL)
  - Giorgio Apollinari, Doug Glenzinski (Fermilab)
  - Norbert Holtkamp, 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.

We have received their report

Time Table

- Deliberation Phase
  - Four closed meetings
    - May 1 to June 2, Austin
    - June 21 to 23, Gaithersburg
    - July 11 to 14, Santa Monica
    - August 1 to 4, Denver
    - Many meetings between them by various working groups
  - Agencies: Asmeret Berhe, Harriet Kung, Sean Jones, Saúl Gonzalez, DOE/HEP, NSF/PHY, NSF/AST (Debra Fisher, Nigel Sharp), NSF/OPP (Jim Ulvestad)
  - Government: Cole Donovan (State, OSTP)
  - Community: International Benchmarking Panel, computing frontier, DPF leadership, previous P5 (Steve Ritz, Andy Lankford), CoV reports (Ritchie Patterson, Dmitry Denisov)
- Writing Phase (Now)
  - Weekly zoom meetings
  - Professional editor, graphic design artists already on board
  - Preliminary recommendations to agencies in September
  - Peer reviews
- Final report due October, subject to approval by HEPAP, Roll-out (DPF)


Exciting Future!

Community Letter

- In support of P5 Report
- Sent to Energy Secretary Moniz & to NSF Director Cordova
- 2095 signatures gathered in 1st week and sent with letter
- 2331 signatures collected in total

Drafted and assembled by the "HEP Community P5 Rollout Committee",
a joint committee of:

- **APS Division of Particles and Fields**
- **Users organizations of Fermilab, SLAC, and US LHC**

The letter was effective at communicating the broad support in the US particle physics community for the P5 report
- an important message in light of our reputation as a "fractious" community

Many thanks to community members for their support of the P5 report,
& thank you for initiative to HEP Community P5 Rollout Organizing Committee*

* The HEP Community P5 Rollout Organizing Committee consisted of: Daniel Akerib, Robert Bernstein, Pushpa Bhat (Co-Chair), Edward Blucher, James Brau, Raymond Brock, Sally Dawson, Robin Erbacher, Yuri Gershtein, Howard Haber, Nick Hadley, JoAnne Hewett, Harvey Newman, Nicola Omodei, Laura Reina, B. Lee Roberts, Jonathan Rosner, Sally Seidel, Ian Shipsey (Co-Chair), Michael Tuts, Breese Quinn, Michael Sokoloff, Nikos Varelas, Hendrik Weerts

P5 Briefings & Presentations

22 May: Approval of P5 report by HEPAP.

Week 1

27 May: 90-minute briefing at the **Executive Office of the President** (**OSTP/OMB**, including the examiners for NSF and DOE and agency representatives). They were very engaged and interested.

28 May: **Secretary Moniz** briefing (30 minutes)

29 May: briefing and discussion with the **APS Physics Policy Council**. Speakers were Ritz, Lankford, and Lockyer. ***APS President Mac Beasley sent testimony in support of HEP for our hearing on 10 June*** (see below).

Week 2

2 June: **Community online presentation**, followed by **further discussions in various venues**.

5 June: **Senate Energy and Natural Resources** briefing. Pushpa Bhat wrote summary. There were also statements of support read by Jonathan Bagger, Drew Baden, and Bob Wilson. Joe Lykken was also there and talked with staffers and others.

6 June: **LHCP panel and presentations**. Fabiola Gianotti gave a great talk on future colliders. Dennis Overbye moderated a panel discussion (Ritz, Arkani-Hamed, Blazey, Bertolucci, Muryama, Roe). Andy Lankford and Jim Siegrist then summed up.

Week 3

8 June: **CMS** at meeting in Tahoe.

10 June: **House Energy subcommittee hearing**. Nigel Lockyer, Natalie Roe, Persis Drell, and Steve Ritz were invited to testify.

11 June: **FNAL Users meeting**: presentation & panel discussion

12 June: **U. Chicago Physics Department presentation**, as well as additional meetings

P5 Briefings & Presentations - 2

Week 4

16 June: **DOE PI meeting** presentation and discussion

16 June: **Scientific Policy Committee, CERN**

Week 5

23 June: **APPEC international neutrino infrastructure meeting** in Paris

Week 6

30 June: **Nuclear Science Advisory Committee (NSAC)**

Week 7

7 July: Discussion with **HEPAP Accelerator R&D Panel**

8 July: as part of American program report to **ICHEP**, Valencia (Shipsey)

9 July Discussion with **Fermilab PAC**

Week 8

14 July: **Advanced Accelerator Concepts 2014 Workshop** presentation & discussion

Week 9

25 July: **ECFA Plenary**, DESY

Future:

27 October: Lankford – **ICFA Seminar, Beijing**

2 November: Ritz – National Academy of Science **Board of Physics & Astronomy**

- In addition, many consultations and discussions with community members and leaders of projects and activities in other regions
- There are also strong letters of support from community, from APS President Beasley and other community organizations. Op-Ed by APS President Beasley

U.S. Particle Physics

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

2023 P5 Process

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

Charge

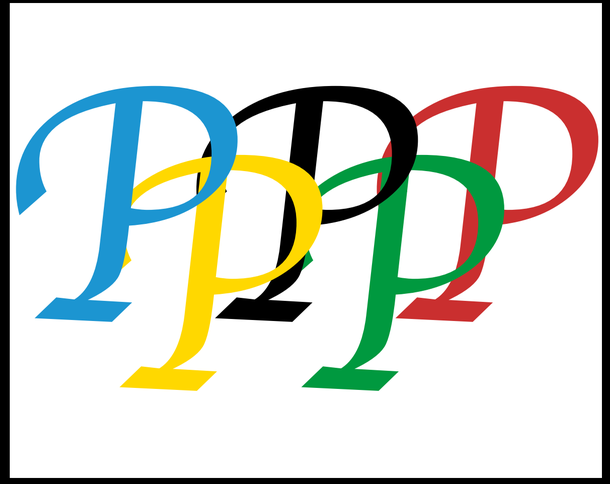
The charge to P5 was issued by Dr. Asmeret Asefaw Berhe, Director of Office of Science, Department of Energy, and Dr. Sean L. Jones, Assistant Director, Directorate for Mathematical and Physical Sciences, National Science Foundation, to the HEPAP chair JoAnne Hewett on November 2, 2022. The P5 report is expected to be released in October 2023.

Contact

P5 is chaired by Hitoshi Muryama and deputy chair Karsten Heeger.

P5 News

- 8/1-4: On Aug1, Dr. Asmeret Berhe, the Director of the Office of Science, joined the P5 meeting and presented her view on workforce and DEI issues. In addition, Dr. Harriet Kung, the Deputy Director for Science Programs in the Office of Science, came to join the panel in person and discusses far-reaching issues about the role of HEP in the Office of Science. She also keenly listened to our concerns about the site access issues at the national labs. On the following days, the panel had intense discussions throughout the week to formulate the recommendations. The whole panel worked very constructively and collegially. We also listened to the conveners of the Snowmass computing frontier.
- 7/11-14/2023: The third closed session in Santa Monica, CA. Sally Seidel is the interim HEPAP chair and attended the P5 meeting for the first time. We heard reports from Committees of Visitors, both from DOE and NSF, and from Jlab and Oak Ridge about their visions.
- Many meetings of the working groups.
- 6/21-23/2023: The second closed session in Gaithersburg, MD. The first day was intended to be at NSF in Alexandria, but the visit by the Indian



Maximize science!

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NSF National Science Foundation