P5 Plan Hitoshi Murayama wn Hall at LBNL, Feb 22, 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

Snowmass 2022 at University of Washington Seattle





2008 25

- 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



e frontiers of research in particle physic menocking framework that addresses damental questions about the laws of natu the occurrence

- 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

Buil

Strategic

ling for Discovery: Strategic Plan for U.S. Particle Physics in the Global Contex

Figure 1 **Construction and Physics Timeline**

Project	2015	2020	2025	2030	203
Currently operating					
Large Projects					
Mu2e					
LHC: Phase 1 upgrade					
HL-LHC					
LBNF					
ILC					
Medium and Small Projects					
LSST		_			
DESI					
DM G2					
DM G3					

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)



My take away from Snowmass

We have an exciting program lined up • Thanks to Steve Ritz, previous P5, agencies! • We are broader than the current program energy, intensity, cosmic • 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!**





Last P5 science drivers

- 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.
- Still very much true
- Main aim: physics beyond the standard model



Five evidences for physics beyond SM

- at least five missing pieces in the SM
 - dark matter
 - neutrino mass
 - dark energy
 - apparently acausal density fluctuations
 - baryon asymmetry

also anomalies (H_0 , σ_{8} , flavor, g-2)

Where is the next energy scale?



Unusual in science: the problems are clear!

- theoretical problems:
 - hierarchy problem
 - origin of flavor
 - unification of matter and forces
 - quantum gravity



w/Zoltan Ligeti for 2008 P5 (Baltay panel)

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
- ACDM + 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



Leadership team



JoAnne Hewett HEPAP chair

Karsten Heeger













Summary	of	\mathbf{th}
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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				
Energy Frontier	U.S. Initiative for the Targeted Development of Future Colliders and their Detectors			
Lifer y rionon	US role?	Higgs Factory Scope? Technology? Compleme		
Neutrino Frontier	LBNF/DUNE Phase I & PIP- II	DUNE Phase II (incl. proton injector)		
	Cosmic Microwave Background - S4	Next Gen. Grav. Wave Observatory [*]		
Cosmic Frontier	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.

10

ne 2021-22 U.S. HEP Community Planning Exercise



Necium & small

- axion, emerging dark matter experiments
- IceCube Gen2, AugerPrime, CTA, Southern Wide-field Gamma Ray Observatory
- New detectors @ LHC: Faserv, Mathusla, CODEX-b, FACET
- dark sector beam dump
- Short-baseline ν , ν cross sections, astrophysical ν
- Hadrons, lepton flavor violation & non-universality, i.e. Mu2e-II
- Galaxy surveys beyond dark energy?
- CMB beyond inflation? (*i.e.* N_{eff})
- Gravitational wave?
- Line Intensity Mapping? (i.e. high-z 21cm)
- Cosmic v background? $0v\beta\beta$ with DUNE far detector?

- Project vs research
- Large (>\$200M), medium (\$50-200M), small (<\$50M) (previous P5) Collection of small may be medium
- Science vs R&D
 - Instrumentation, computing, theory
- National initiatives
 - AI/ML, microelectronics, QIS
 - How do we capitalize on it? How do we contribute to justify it?
- DEI
 - What can agencies do?
 - Example: blind reviews for Hubble Space Telescope (not for us)



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
- We invite all EPP2024 members to P5 town halls to make sure we get the same inputs from the community
 - We will overlap at Fermilab in March
- Will keep informing EPP2024 about our progress and vice versa
- Hopefully what we recommend will smoothly connect to their longer-term vision



- One lesson from the previous P5 was some of the costs were off by a factor of $\sim \pi$
- Need to understand maturity of cost estimates better
- We are putting together another expert panel to look into costs, risks, schedule
- Chair: Jay Marx (STAR, LIGO)
- That panel will ask for inputs from collaborations in March
- We will receive their assessment by May

COSIS





Jay Marx

Community interest

- >440 participants!
 - Including 157 in-person registra
- Short remarks oversubscribed x3
 - 24 accepted
 - Sorry for rejected ones
 - Please try again at later town halls!

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	11.00	Solid-state based direct detection & G3	1	Matt Pyl
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		Axion direct detection (haloscope & helioscope) & G3	Gary F	₹ybka
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- Open Town Halls
 - LBNL: today and tomorrow.

 - Fermilab/Argonne: March 21, 22, 23 Brookhaven: April 12, 13, 14 (just before DPF in Minnesota)
 - SLAC: May 3, 4, 5
 - Sign up for making short remarks! (This time x3 oversubscription)
- DPF session on P5 (April 15?)
- Jay Marx committee running in parallel
- Virtual Town Halls
- Closed meetings
- Preliminary recommendations August
- Final report due October

Coming meetings

P5 tentative logo



Apologies to Antarctica! CMB and IceCube

	5. Did you
Survey on the LBNL Town Hall	◯ Yes
* 1. Have you attended the town hall in-person or remote?	⊖ Somet
⊖ in-person	O No Please desc
⊖ remote	
2. Was the ASL interpretation useful to you?	6. Was the
⊖ Yes	⊖ Yes
◯ No	◯ No
Please comment on the quality of the interpretation.] 7. How use
3. Was the live captioning useful for you?	◯ Extrem
• Yes	🔿 Very u
◯ No	○ Somev
Please comment on the quality of the captioning.	○ Not so ○ Not at
4. Any issues with physical access?	Add any cor

🔿 No

🔿 Yes

If any, please describe the problems you encountered.

have problems reading the slides?

times

cribe the nature of the problems, e.g., choice of colors, size of fonts, speed of network

link to day care centers useful for you?

eful was the Town Hall overall?

mely useful

useful

what useful

useful

all useful

mments you may have about the Town Hall



I ask you to fill out the survey on Thursday https://www.surveymonkey.com/r/5WZ5785





