The P5 Vision

subtitle: things I learned from 600 hours of P5 deliberations

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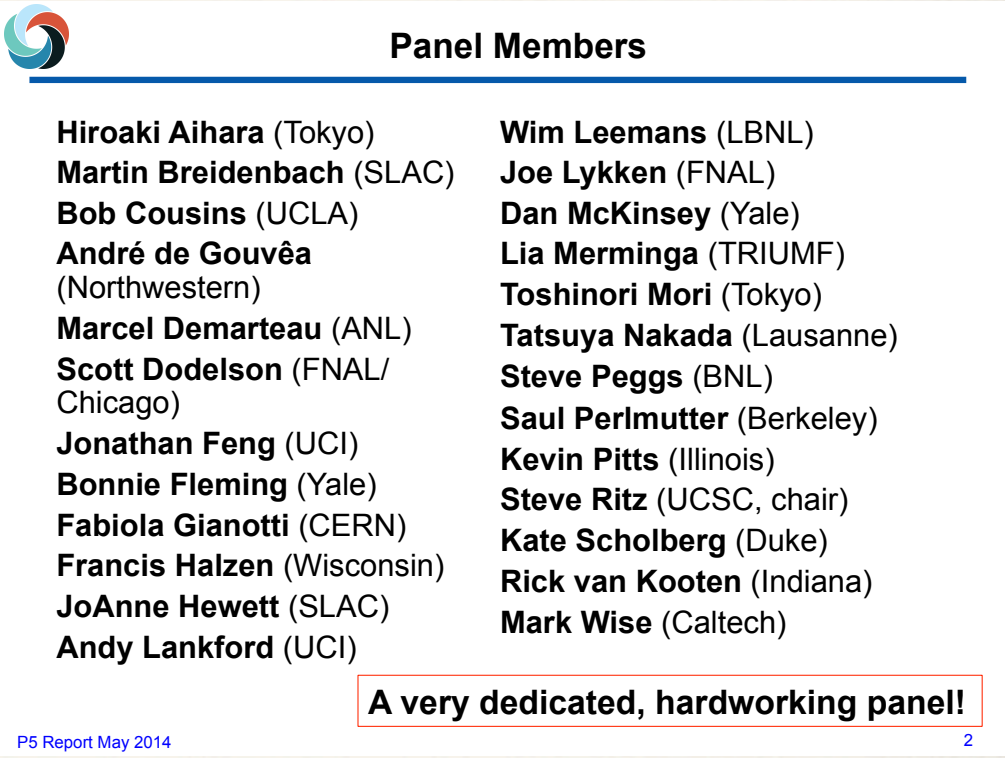
Consensus!

- 23 days of face-to-face meetings, 200 hours of telecons, plus subgroup meetings
- strongly guided by both Snowmass and the "Gina Report" of the FNAL scientists
- all of the "factions" of our field represented, but the consensus rose above this



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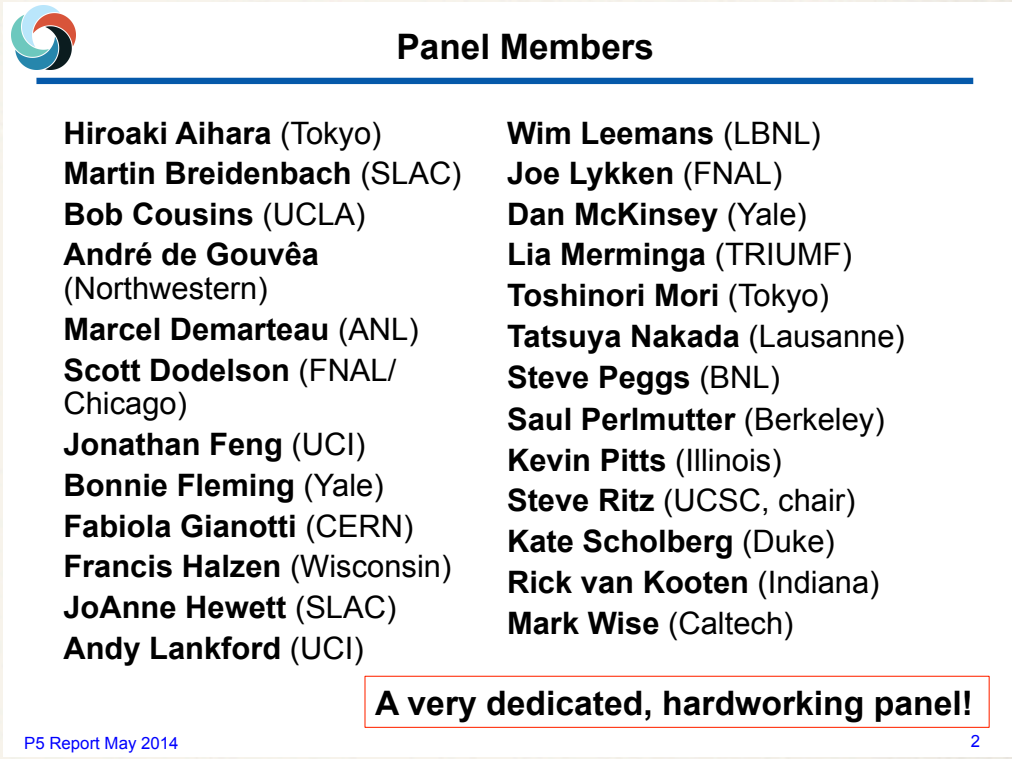

Goal was an ***actionable plan*** for US HEP as a whole

Key elements of the P5 Plan

- Global is new! A big change, e.g. from the 2008 P5 report
- We use LHC and the Higgs discovery as our model for success
- Emphasize the 2-way street
- Emphasize where U.S. has leading capabilities

Particle Physics is Global

- The United States and major players in other regions can together address the full breadth of the field's most urgent scientific questions if each hosts a unique world-class facility at home and partners in high-priority facilities hosted elsewhere.
  - Hosting world-class facilities and joining partnerships in facilities hosted elsewhere are both essential components of a global vision.

- Strong foundations of international cooperation exist, with the Large Hadron Collider (LHC) at CERN serving as an example of a successful large international science project. Reliable partnerships are essential for the success of international projects. This global perspective is finding worldwide resonance in an intensely competitive field.
  - The 2013 *European Strategy for Particle Physics* report focuses at CERN on the Large Hadron Collider (LHC) program and envisions substantial participation at facilities in other regions.
  - Japan, following its 2012 *Report of the Subcommittee on Future Projects of High Energy Physics*, expresses interest in hosting the International Linear Collider (ILC), pursuing the Hyper-Kamiokande experiment, and collaborating on several other domestic and international projects.

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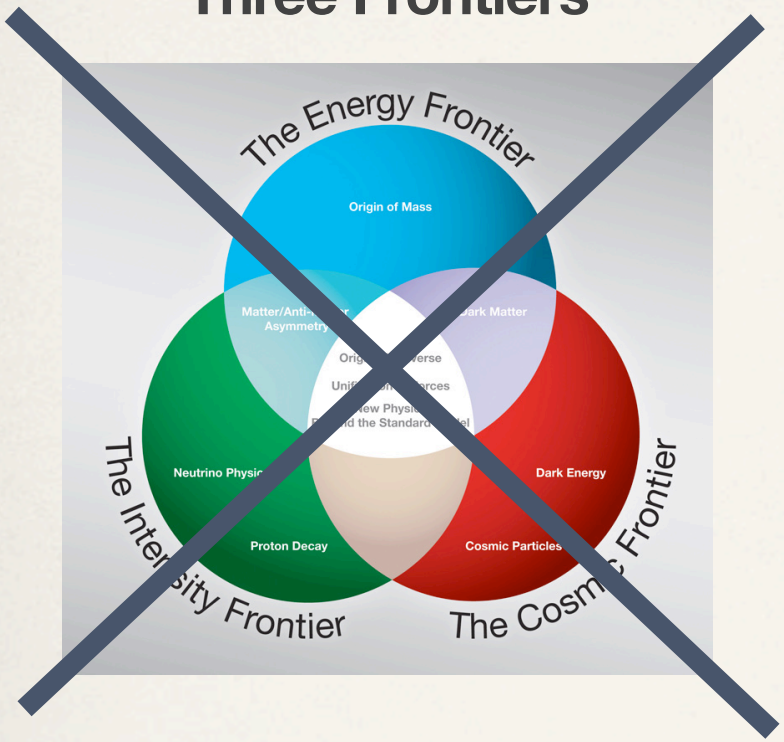
Key elements of the P5 Plan

Three Frontiers



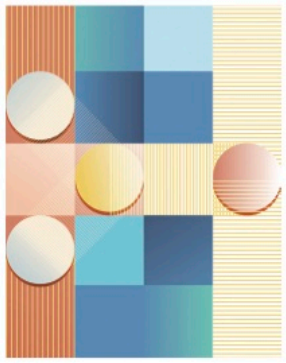
Five Science Drivers

- The Frontiers were approaches, not Science Drivers
- In particle physics you should lead with the science

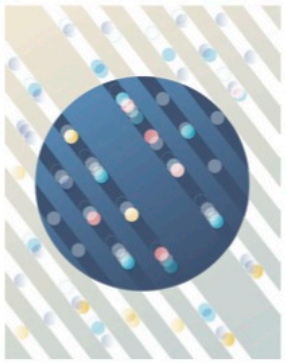
Key elements of the P5 Plan

Five intertwined scientific Drivers were distilled from the results of a yearlong community-wide study:

- 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

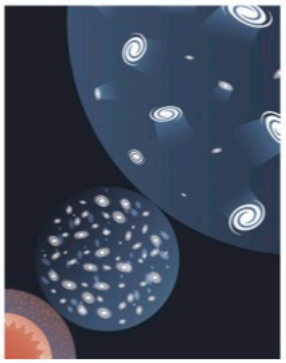


Higgs boson

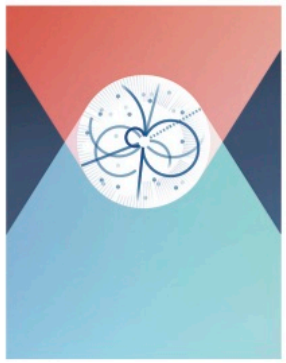


Neutrino mass

Dark matter



Cosmic acceleration



Explore the unknown

- Drivers are not prioritized. We pursue all five. They are intertwined
- A new way of thinking:
  - ➡ Driver #5 maps to Mu2e and g-2, but also to LHC searches
  - ➡ Driver #2 maps to LBNF, but also to cosmic surveys and CMB

Particle physics evolves

Significant Developments Since the 2008 P5 Report

- Physics!
  - Higgs boson discovered at a relatively low mass, pointing the way to the next steps and informing choices for long-term planning.
  - Three Nobel Prizes related to particle physics: Quark Mixing and Symmetries, Dark Energy, Higgs Boson.
  - A key neutrino mixing parameter, $\sin^2(2\theta_{13})$, was measured to be relatively large, enabling the next steps in a campaign to understand the implications of the tiny, but non-zero, neutrino masses.
- These successes demonstrate the deep value of diversity of topic and project scale.
- New technology and innovative approaches are creating fresh opportunities that promise an even brighter future.

- Discoveries drive the field -> Higgs, neutrinos, dark energy are Science Drivers now because of recent discoveries
- Technology and innovative approaches provide new opportunities -> dark matter searches, CMB, exploring the unknown with Mu2e, LHC upgrades, new accelerators!

P5 physics vision

- On the big over-arching questions particle physicists are groping in the dark
- But many concrete questions are strongly addressed by the P5 plan
- And everything seems to be connected

Neutrinos!

Big question: What is the origin of neutrino mass?

Questions directly addressed by the P5 plan:

- How are the neutrino masses ordered?
- What are the neutrino masses?
- Do neutrinos violate CP?
- Are there additional types of neutrinos or neutrino interactions?
- Are neutrinos their own antiparticles?

As usual in particle physics (and especially neutrino physics), powerful experimental probes of concrete questions may produce surprises

Neutrino Factories

- The P5 plan launches the U.S. toward a long term comprehensive neutrino program
- This program should include a home for people thinking about neutrino factories
- The ICFA neutrino study provides an opportunity to build some momentum for this

The P5 MAP recommendation

- This was a programmatic recommendation about the advisibility of carving out MAP as a directed R&D program, versus supporting MAP activities within GARD
- P5 recognized the first class achievements, leadership, and coherence of the MAP program
- P5 was specifically concerned that the excellent people currently working in MAP can migrate as smoothly as possible
- The new HEPAP subcommittee is charged to help work this out, and has institutional memory of P5 in the form of co-chair Marty Breidenbach

physics strategy in a nutshell

- We focus on studying the Higgs boson and neutrinos because they are the least-understood, least-measured of the known particles, seemingly connected to many big questions. Linked together in P5 plan by a global approach.
- Dark matter may be a game changer in the next few years, and we have leadership in all three kinds of DM searches
- Dark energy and inflation are exciting parts of the intellectual property of our field, and we have leadership in cosmic surveys and CMB
- Regardless of whether any current BSM thinking is correct, we expect discoveries from exploring the unknown - always a major driver of our field
- We prepare for success by pursuing new technologies for accelerators and detectors, and then building them

Moving Forward

- To me, the P5 plan encompasses hugely exciting science
- If we can pull it off, U.S. HEP will be golden for 20 years, with the foundations for a great future beyond
- I admire what you have already accomplished with MAP, and I'm sure you will do great things, individually and collectively, as we all move forward.