P5 Preliminary Comments

HEPAP
13-14 March 2014

S. Ritz

Topics

- Review of the key elements of the charge; summary of P5 processes and activities since September
- Context:
  - The evolution of our field since the previous P5 report
  - Big scientific questions and drivers
  - The global nature of our field
- Key elements of strategic planning:
  - Opportunities to address the big scientific questions and how they fit together
  - Budgetary constraints compared with proposed programs
  - National planning in the global context
  - Balancing investments
- Discussion of prioritization criteria
- Steps to completion, and communication planning

Key Aspects of the Charge

- Updated strategic plan for the U.S. that can be executed over a 10 year timescale, in the context of a 20 year global vision for the field.
- Appropriate balance of small, mid-scale, and large experiments.
- Technical readiness and feasibility. Estimate time and resources needed.
- Maintain healthy and flexible domestic infrastructure…maintain leadership position….a healthy balance that preserves essential roles and contributions for national laboratories and universities and enables opportunities for global coordination of large initiatives.
- Three budget scenarios. Not literal guidance, but an opportunity to identify priorities and make high-level recommendations.
- Articulate opportunities that can and cannot be pursued, and approximate overall level of support needed in core research and advanced technology R&D.
- A detailed perspective on whether and how the pursuit of major international partnerships might fit into the program in each of the scenarios.
- Effective communications about the excitement, impact, and vitality of particle physics for non-scientific audiences.
- Preliminary comments by March 1, final report by May 1.

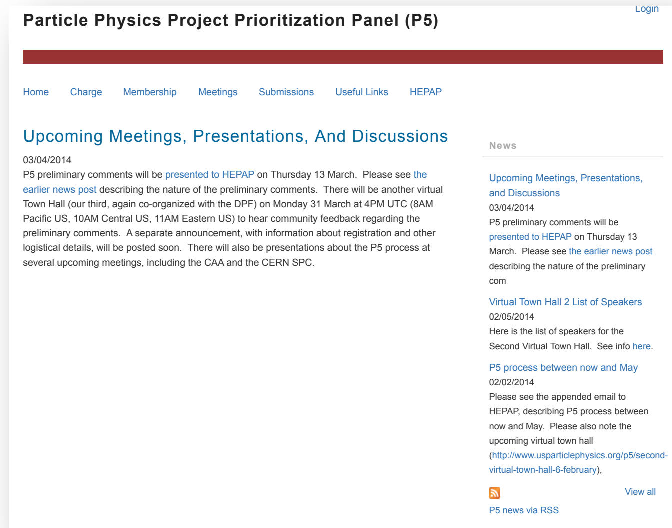
Members

Hiroaki Aihara (Tokyo)
Marty Breidenbach (SLAC)
Bob Cousins (UCLA)
André de Gouvea (Northwestern)
Marcel Demarteau (ANL)
Scott Dodelson (FNAL/Chicago)
Jonathan Feng (UCI)
Bonnie Fleming (Yale)
Fabiola Gianotti (CERN)
Francis Halzen (Wisconsin)
JoAnne Hewett (SLAC)
Andy Lankford (UCI)
Wim Leemans (LBNL)
Joe Lykken (FNAL)
Dan McKinsey (Yale)
Lia Merminga (TRIUMF)
Toshinori Mori (Tokyo)
Tatsuya Nakada (Lausanne)
Steve Peggs (BNL)
Saul Perlmutter (Berkeley)
Kevin Pitts (Illinois)
Steve Ritz (UCSC, chair)
Kate Scholberg (Duke)
Rick van Kooten (Indiana)
Mark Wise (Caltech)

A very dedicated, hardworking panel!

Summary of P5 Process

- All info available on P5 website, frequently updated with News (RSS and Twitter feeds)
- Meetings:
  - Face-to-face
    - Three big, open, topical meetings: 2-4 Nov, 2-4 Dec, 15-18 Dec
    - Plus 12-14 Jan, 21-24 Feb, 5-8 April
  - Frequent phone calls since September. Continuous work between meetings.
- Large Project/Activity worksheets to help ensure uniformity, data quality.
- Meetings include P5 alone time. Separate site for discussions, text development, etc.
- Ongoing effort to maximize community interactions, including:
  - Numerous emails, outreach to younger physicists
  - Town halls at all 3 big meetings
  - Virtual town halls (with DPF) 8 Jan & 6 Feb. Next one is on 31 March.
  - Public submissions portal
  - Many ongoing discussions and consultations



http://interactions.org/p5

Community engagement and community support of the report are essential.

Important Changes Since the Previous P5

- Scientific:
  - Higgs discovered! The Higgs mass is relatively low, pointing the way for next steps and informing choices for long-term planning.
  - The neutrino mixing parameter $\sin^2(2\theta_{13})$ measured! The value is relatively large, enabling a program of measurements of fundamental properties.
  - Three Nobel Prizes: CKM, Higgs boson, and dark energy.
  - Demonstrates importance of diversity of topic and scale.

- Programmatic:
  - DUSEL did not proceed, SURF continued. JDEM did not proceed.
  - Tevatron collider operations ended.
  - PEP-II/B-factory operations ended.
  - Budgets lower than anticipated.
  - International cooperation continues to be extremely productive, enabling many of the big discoveries driving the field. A model for international science projects.

- These developments play central roles in most of our planning.

- The Snowmass process was very helpful for collecting, assessing, and disseminating the great scientific challenges and opportunities for the field. An expanding sense of unity emerged.

Snowmass Questions

1. How do we understand the Higgs boson? What principle determines its couplings to quarks and leptons? Why does it condense and acquire a vacuum value throughout the Universe? Is there one Higgs particle or many? Is the Higgs particle elementary or composite?
2. What principle determines the masses and mixings of quarks and leptons? Why is the mixing pattern apparently different for quarks and leptons? Why is there CP violation in quark mixing? Do leptons violate CP?
3. Why are neutrinos so light compared to other matter particles? Are neutrinos their own antiparticles? Are their small masses connected to the presence of a very high mass scale? Are there new interactions that are invisible except through their role in neutrino physics?
4. What mechanism produced the excess of matter over anti-matter that we see in the Universe? Why are the interactions of particles and antiparticles not exactly mirror opposites?
5. Dark matter is the dominant component of mass in the Universe. What is the dark matter made of? Is it composed of one type of new particle or several? What principle determined the current density of dark matter in the Universe? Are the dark matter particles connected to the particles of the Standard Model, or are they part of an entirely new dark sector of particles?
6. What is dark energy? Is it a static energy per unit volume of the vacuum, or is it dynamical and evolving with the Universe? What principle determines its value?
7. What did the Universe look like in its earliest moments, and how did it evolve to contain the structures we observe today? The inflationary Universe model requires new fields active in the early Universe. Where did these come from, and how can we probe them today?
8. Are there additional forces that we have not yet observed? Are there additional quantum numbers associated with new fundamental symmetries? Are the four known forces unified at very short distances? What principles are involved in this unification?
9. Are there new particles at the TeV energy scale? Such particles are motivated by the problem of the Higgs boson, and by ideas about space-time symmetry such as supersymmetry and extra dimensions. If they exist, how do they acquire mass, and what is their mass spectrum? Do they provide new sources of quark and lepton mixing and CP violation?
10. Are there new particles that are light and extremely weakly interacting? Such particles are motivated by many issues, including the strong CP problem, dark matter, dark energy, inflation, and attempts to unify the microscopic forces with gravity. What experiments can be used to find evidence for these particles?
11. Are there extremely massive particles to which we can only couple indirectly at currently accessible energies? Examples of such particles are seesaw heavy neutrinos or grand unified scale particles mediating proton decay. How can we demonstrate that these particles exist?

P5 Identified Scientific Drivers for the Field

"Driver" = a compelling line of inquiry that shows great promise for major progress over the next 10-20 years. Each has the potential to be transformative. Expect surprises.

- Use the Higgs as a new tool for discovery.
- Explore the physics associated with neutrino mass.
- Identify the new physics of Dark Matter.
- Test the nature of Dark Energy in detail, and probe the physics of the highest energy scales that governed the very early Universe.
- Search for new particles and interactions; new physical principles.

These drivers are intertwined, possibly even more deeply than we currently understand. A selected set of different experimental approaches, which reinforce each other, is required. This effort also opens important discovery space beyond the drivers.

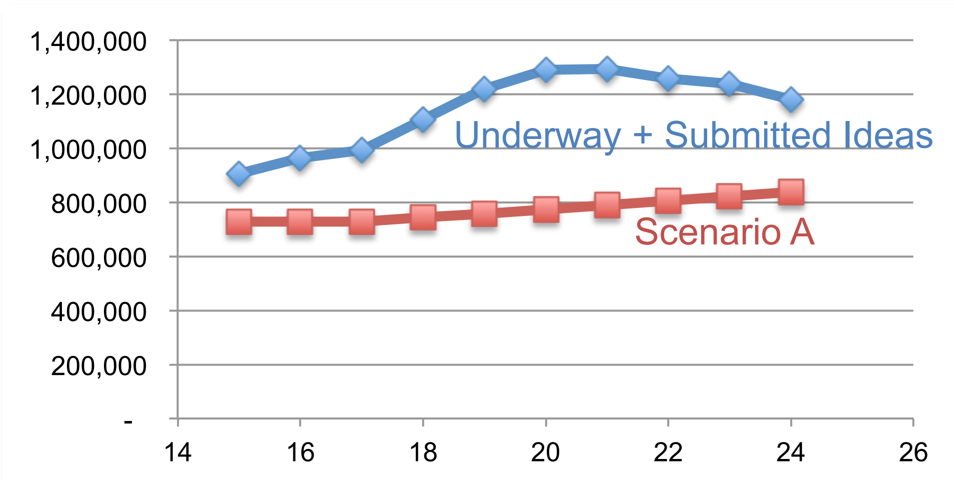
Particle Physics is Global

- World-leading countries pursue particle physics:
  - A very successful field of discovery and exploration
  - The questions are profound and exciting, and the techniques are beautiful and useful
  - Attracts great minds, talent, and dedication to a common purpose
- Cooperation and competition are both needed for continued success
  - Large projects require cooperation for technical know-how and the required resources.
  - Competition spurs innovation, speed, and efficiency.
  - The U.S. has leadership roles in both modes.
- Global optimization and cooperation are now critical for progress in several key areas
  - Strong foundations exist (LHC is a model, *e.g.*). Building further international cooperation is an important theme.

Key Elements of Strategic Planning

- Assess the opportunities to address the big scientific drivers and how they fit together.
- Budgetary constraints compared with ideas presented to P5:

DOE-funded component, for illustration:



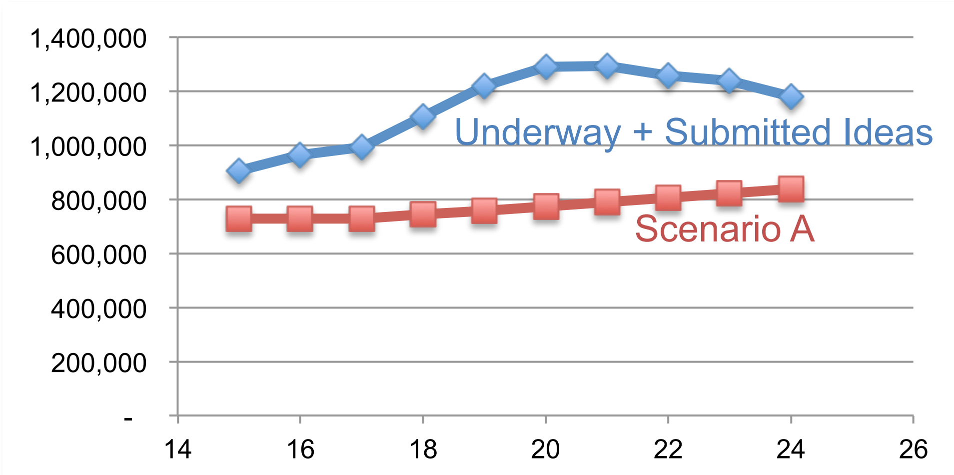
- Integrated Difference ~$4B
- Ideas already cost-constrained (and many are pre-CD-0)!
- scenario B ~$0.5B above A

- National planning in the global context.
- Balancing investments
  - Projects, Facilities, R&D, Research (including Theory)
  - Host large, world-leading facilities
  - Small projects bookkept and prioritized as groups
  - Goal-oriented and blue-sky R&D
  - Check timeframes for project results, avoid long gaps

Key Elements of Strategic Planning

- Assess the opportunities to address the big scientific drivers and how they fit together.
- Budgetary constraints compared with ideas presented to P5:

DOE-funded component, for illustration:



- Integrated Difference ~$4B
- Ideas already cost-constrained (and many are pre-CD-0)!
- scenario B ~$0.5B above A
- **Scenario A is especially difficult:** near a tipping point beyond which historic balance is not possible.

- National planning in the global context.
- Balancing investments
  - Projects, Facilities, R&D, Research (including Theory)
  - Host large, world-leading facilities
  - Small projects bookkept and prioritized as groups
  - Goal-oriented and blue-sky R&D
  - Check timeframes for project results, avoid long gaps
- Criteria

Criteria (I): Overall Program Optimization

- Science-driven big picture: where we want to go and how to get there.
- Prioritized portfolio for discovery and exploration.
- International context and optimization:
  - Pursue the most important opportunities wherever they are, and host world-leading facilities that attract the worldwide scientific community.
  - Reliable partnerships are essential.
  - Duplication only when significant value added or when competition helps propel us in important directions. When competing, be clearly leading in key ways.
- Health of the field, sustained productivity:
  - Maintain a stream of results while investing in facilities and future capabilities => a balance of project scales.
  - Maintain and develop critical technical and scientific expertise and infrastructure to enable future discoveries.
  - a guideline: total expenditures on projects around 20-25% of total budget; research fraction >~40% for both project data analysis and blue-sky research to explore unplanned new directions.

Criteria (II): Projects

- Science first: how does it address key questions in particle physics?
- Discovery space. How might it change the direction of the field, and what is the value of null results?
- When is it absolutely needed, and how does it fit into the larger picture? What does the experiment add that is unique, is it definitive, and/or where might it lead? Are there alternatives?
- Cost vs value.
  - Is the scope well defined and does it match the physics case? For multi-disciplinary/agency projects, does the support match the distribution of science?
  - One main measurement or a preponderance of interesting possible results? Solid result(s) expected or possibly marginal?
  - At what cost/schedule/capability changes does the priority change?
- Take into account previous prioritization and existing commitments. What are the impacts of changes in direction?
- Is the project feasible as proposed? Technical, cost, schedule risks.
- Is U.S.particle physics leadership, or participation, critical, and how?
- What are the other benefits of the project?

Steps to Completion, Communication Planning

- Current plan:
  - Internal draft report to HEPAP members ~3 weeks prior to 22 May meeting
    - Aiming for a short report
      - More effective
      - Plenty of great text from Snowmass already!
    - One-week turnaround for comments by peer reviewers
  - Final draft report to HEPAP members in advance of 22 May meeting discussion. Public release upon acceptance by HEPAP.
- Communication
  - At the time of the May HEPAP meeting:
    - International partner consultations
    - Draft versions of 1-page overview and talking points
    - Press release and web features ready to go
  - Followed quickly by
    - **Community: Virtual Town Hall, emails, news items, briefings by phone and talks/discussions at universities and labs, and conferences.**
    - Briefing decision makers as requested
    - Additional options under discussion, including Op-Eds, informational events,… Suggestions welcome!
  - Continued talks/discussions at community meetings, universities, and labs

From September Presentation…

Community

- Snowmass output is essential input to P5.
- Most meetings will have public components, geographically distributed.
- In addition to all the other work to set up P5, we have been talking extensively with community members about P5, the process, and the issues. This will continue.
- P5 website under construction. Will be updated frequently with news and information. In addition, an input portal is being set up.
- Community buy-in is critical to our success.
  - Process as it develops will be inclusive and clear
  - Rationale for the choices must be articulated
  - Note that it is possible to support a plan even if it doesn't match one's specific taste in physics.
  - Work will continue after the report is complete.
- HEPAP has very important roles throughout this process.

5 September 2013 S. Ritz P5 9

A huge amount of work done by the community and by the panel for P5.
THANK YOU!

Discussion