Implementing the P5 Recommendations: Report of the Subcommittee of the NSF MPS Advisory Committee

MPS AC meeting, January 23, 2015

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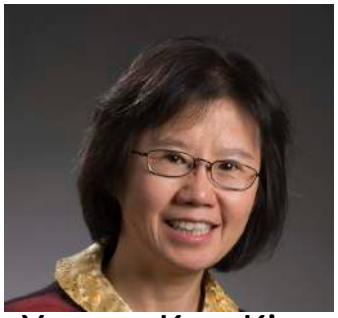

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Young-Kee Kim (Chair)	The University of Chicago
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Structure of the report and this presentation

- Introduction
- Process
- Addressing Charge 1
- Addressing Charge 3
- Addressing Charge 2, and parts of Charges 4 and 5
- Addressing Charge 2, and parts of Charges 4 and 5 concerning the LHC phase-2 upgrades
- Addressing Charge 2, and parts of Charges 4 and 5 concerning other large projects
- Conclusions and Prospects
- Acknowledgement

Introduction: strategic plan for U.S. particle physics

- Fall 2012 – Summer 2013
  - Particle physics community-wide study to develop the long-term physics aspirations
- Summer 2013 – May 2014
  - NSF MPS Directorate / DOE Office of Science charged HEPAP (High Energy Physics Advisory Panel) to form a subpanel to develop an executable strategic plan
  - P5 (Particle Physics Project Prioritization Panel) process
- May 2014
  - P5 Report “Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context”
  - 10-year plan within the context of a 20-year global vision

Introduction: P5 report

- Recommends a global program
  - with projects at all scales
  - from the largest international projects to mid- and small-scale projects

- Lists as the highest priority for large projects
  - LHC Phase 2 Upgrades in the near term
  - LBNF (Long Baseline Neutrino Facility) in its timeframe

Charge to the subcommittee (1/2)

1. Based on the science drivers identified in the P5 report, how should the NSF target its investments in such a way that they maximize the NSF impact and visibility? Should the Physics Division target specific areas or should it invest broadly?

2. What criteria should the Physics Division use to balance support between small-scale, mid-scale and large projects?

3. How should the Division of Physics define a unique role in areas of common interest with DOE?

The committee is not expected to revisit the P5 charge, priorities, or conclusions, but to focus on the balance of NSF investments.

Charge to the subcommittee (2/2)

NSF is considering an investment in LHC Phase 2 Upgrades, ranging from the Midscale to the MREFC level, and Midscale investments in other scientific priority areas identified by P5. For this scenario:

4. Would proposed investments of this type best capture the strengths of NSF and result in NSF funding having a significant and identifiable impact in the field? What criteria should be used to determine whether or not the Physics Division should pursue this scenario?

5. What are the opportunity costs of such an investment strategy? Would required investments outside the MREFC budget line before, during, and after a construction project allow enough flexibility to respond to new, unforeseen particle physics opportunities? Is the balance between facility investments (pre-construction, construction, and operations and maintenance) and PI-driven research awards appropriate for particle physics at the NSF?

Introduction: particle physics at NSF

- Program offices
  - Elementary Particle Physics
  - Particle Astrophysics
  - Elementary Particle Theory
- NSF has already been successfully executing a number of projects and programs that are aligned with the P5 recommendations, including
  - LHC phase-1 upgrades (ATLAS, CMS, LHCb)
  - neutrinos, muons, …
  - dark matter, dark energy, cosmic microwave background, …

Process: subcommittee

- Announcement of the subcommittee
  - September 28, 2014
    - Denise Caldwell's presentation at the HEPAP meeting
  - September 30, 2014
    - Subcommittee chair's message to APS Divisions
      - Particles & Fields
      - Physics of Beams
      - Astrophysics

Process: meetings

- Meetings:
  - Weekly teleconference calls
  - Two face-to-face meetings in DC: November 1-2, 2014 and January 5, 2015

- Participants
  - Subcommittee members
  - NSF staff
    - Denise Caldwell, Bradley Keister
    - Jean Allen, Mark Coles, Vyacheslav Lukin, Brian Meadows, James Shank, Marc Sher, James Whitmore
  - MPS AC liaison since early November
    - William Zajc

Process: input from the community

- Mechanisms
  - Web portal: http://p5response.uchicago.edu/
    - options: open to the public, subcommittee only
  - Email messages
  - Phone calls
  - Others: HEPAP meetings, U.S. LHC Users meeting, hallway conversations, …
- Input from P5 chair and HEPAP chair
- Brief documents solicited by the subcommittee
  - Future mid- and large-scale projects identified by P5

Process: mid- and large-scale projects

- Potential for major discovery in particle physics depends on
  - mid- and large-scale projects
  - scientists who perform their research on the resulting facilities ("PI driven research awards")

- Support models considered under two budget scenarios
  - Mid-Scale Instrumentation Fund (MSIF)
  - Major Research Equipment & Facilities Construction (MREFC)

- Investments of R&D and operating funds required by projects (outside of MSIF or MREFC) – carefully considered for
  - balance between such investments and the full range of PI-driven research awards
  - opportunity costs of such investments

Addressing Charge 1

- The major role of NSF is to support a broad range of first-class scientific research and to assist in the education of the next generation of scientific leaders. This should remain the top overall research priority of the Division of Physics.

- NSF should invest broadly while also targeting a few specific resource-intensive projects using the Major Research Instrumentation (MRI), MSIF, and MREFC funding processes for small-, mid-, and large-scale projects.

- MSIF (~$10M) and MREFC (> ~$130M): The MPS should continue to explore options to bridge the gap.

Addressing Charge 3

- The Physics Division has been doing an excellent job of coordinating its efforts with DOE.

- NSF should contribute to areas of common interest with DOE when the NSF investment:

  - significantly enhances scientific value;
  - enables NSF-supported groups to play distinctive and visible roles;
  - results in the training of the next generation of scientists; and
  - results in significant broader impacts.

Addressing Charge 2, and parts of Charges 4 and 5

- To balance support among projects of different scales, the Physics Division should consider the following criteria:
  - scientific impact;
  - feasibility of project execution within the proposed budget;
  - training of the next generation of scientists;
  - visibility and importance of the NSF investment;
  - broader impacts; and
  - budgetary impact on PI-driven research awards.

- The total investment in R&D for future projects and operations for ongoing facilities is currently about 1/3 of the particle physics budget. This fraction, distributed among projects of different scales, is a reasonable level going forward.

Addressing Charge 2, and parts of Charges 4 and 5

- LHC phase-2 upgrades
  - The P5 report lists the LHC phase-2 upgrades as the highest priority near-term large project.
  - Based on the criteria described on slides 14-15, the subcommittee strongly supports the NSF investment in the LHC phase-2 upgrades as a way to enable and participate in fundamental discoveries.
  - Funding level
    - Funding at the MREFC level is required for NSF to play significant and visible leadership roles.
    - One or more mid-scale investments would be insufficient to allow NSF to play significant and visible roles.
  - Note: the subcommittee also considered no participation in the LHC detector upgrades, but found that the opportunity cost of this option is too high.

Addressing Charge 2, and parts of Charges 4 and 5

- LHC phase-2 upgrades (cont.)
  - R&D and operating funds
    - NSF has been supporting operating costs through sub-awards to university PIs under the Cooperative Agreements. They include:
      - detector maintenance and operations;
      - software and computing including Tier-2 centers at U.S. universities; and
      - R&D for the phase-2 upgrades, much of which has been carried out at U.S. universities
    - The potential R&D and operating costs for the LHC phase-2 upgrades are consistent with the budgetary criteria described on slide 15.
  - The project team is well positioned to undertake the work needed.

Addressing Charge 2, and parts of Charges 4 and 5

- LHC phase-2 upgrades (cont.)
  - Challenges
    - The time scale could be appropriate as current MREFC projects approach completion, although there is a challenge to match the MREFC pre-construction planning and approval process to CERN's proposed LHC upgrade schedule.
    - Acquiring support through the MREFC program is a significant challenge: success cannot be assumed. It is critical
      - for the LHC's extraordinary science case to be transmitted to the broader scientific community, and
      - for the science case and an in-depth technical design, cost, schedule, and risk of the projects to be communicated to the Physics Division as soon as possible.

Addressing Charge 2, and parts of Charges 4 and 5

- LBNF (Long-Baseline Neutrino Facility)
  - P5 lists LBNF hosted by the U.S. as the highest-priority large project in its timeframe.
  - When the project is better defined and the shape of the international contribution begins to emerge, NSF should evaluate its participation in the LBNF following the criteria described on slides 14-15.
- IceCube upgrade
  - The role of NSF in support of an exploratory science program with a multidisciplinary nature is important for science in the U.S. IceCube is a great example.
  - P5 encouraged further development of the PINGU portion of the IceCube upgrade. The Division of Physics should evaluate its participation in the IceCube upgrade following the criteria described on slide 15 if approached by the Division of Polar Programs.

Conclusions and Prospects

- Particle physics addresses profound questions, inspires and invigorates scientists far beyond the field, and lays foundations for future technologies. Historic opportunities await us, enabled by decades of hard work and support.

- Many opportunities will go unrealized without strong NSF participation in a broad range of research programs including a few specific projects with mid- and large-scale investments.

- The universities supported by NSF
  - are crucial to the field of particle physics.
  - train graduate students – the next generation of scientists for the field of particle physics and for a wide range of professions that are key to future American competitiveness.

- NSF's strong partnerships with the community and DOE are well appreciated and crucial for advancing the field.

Acknowledgement

The subcommittee appreciates the thoughtful input that it has received from the MPS Directorate and staff of the Division of Physics and from the community.