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Subject: Just Released: DOE Basic Research Needs for High Energy Physics Detector Research and Development Report
Date: September 25, 2020 at 12:05 PM
To: dune-collab dune-collab@listserv.fnal.gov

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Please see the message below:

Dear Colleagues,

"Transformative discovery in science is driven by innovation in technology. Our boldest undertakings in particle physics have at their foundation precision instrumentation. To reveal the profound connections underlying everything we see from the smallest scales to the largest distances in the Universe, to understand its fundamental constituents, and to reveal what is still unknown, we must invent, develop, and deploy advanced instrumentation."

The above words are the opening paragraph of the DOE Basic Research Needs for High Energy Physics Detector R&D Report which has has just been released.

The goal of the BRN study was to assess the present status of the HEP physics and technology landscape, and to identify strategic technology areas, aligned with the strengths of the US community, that future long-term R&D efforts should focus on in pursuit of the HEP science drivers identified in the P5 report. The BRN structure consisted of five Physics Panels one for each of the five P5 Science Drivers: the Higgs as a tool for discovery, the physics of neutrino mass, the new physics of dark matter, cosmic acceleration: inflation and dark energy, and exploring the unknown: new particles, new interactions and physical principles; and seven Technology Panels in alphabetical order: Calorimetry, Nobel Liquids, Photodetectors, Quantum Sensors, Readout and ASICs, Solid State (including vertexing and tracking), and Trigger and Data Acquisition (including Machine Learning). Each Physics Panel identified the physics objectives associated with the current status of the Science Driver and the Technical Requirements to meet them. Each Technology Panel determined Priority Research Directions to meet the Technical Requirements together with research plans and infrastructure needs, to push the technology well beyond the current state of the art, i.e. high-risk high-reward ("Blue Sky") R&D, potentially leading to transformative advances with broad-ranging applicability in HEP as well as to other fields of science, medicine, and national security, and taking full advantage of the major advances happening in materials science, photonics, nanotechnology, and QIS, as well as innovations in the commercial sector such as in microelectronics and telecommunications. A Cross-cut Panel identified connections and synergies between and across the physics and technology areas as well as foundational issues for the field. Furthermore, the study identified a small set of high-impact instrumentation "Grand Challenges" where technological breakthroughs could lead to game-changing experimental capabilities in pursuit of HEP science goals.

Executing the research plans outlined in the report will only be possible on the foundation of a diverse, highly trained, and advanced workforce, access to unique capabilities and facilities, deep connections to the programs of other offices in DOE, other federal agencies, commercial partners, and global collaborations.

The Basic Research Needs (BRN) Study on HEP Detector Research and Development (R&D) was announced by DOE HEP at the American Physical Society Division of Particles and Fields meeting in Boston, July 29-August 2, 2019. In September regular telecons began to conduct the ground work for a productive and conclusive workshop in December that would lead to a report that is an articulation of the essential enabling power of instrumentation to deliver the U.S. High Energy Physics program in a global context over the next twenty years.

A hallmark of the BRN Study was the very close interaction with the HEP community. The initial community input to the BRN Study was the DPF Coordinating Panel on Advanced Detectors (CPAD) 2018 Report "New Technologies for Discovery". During the fall BRN Panels engaged in outreach to the relevant communities. This led in some cases to small targeted workshops. A BRN website provided email addresses of the conveners and co-Chairs and we encouraged the community to contact any convener or the co-Chairs with comments, ideas, suggestions or questions. The website also had portals to communicate with the BRN Study. In addition, many BRN Study members attended the CPAD Workshop in Madison, Wisconsin December 8-10, 2019 where each BRN Panel gave a plenary status report and there were town halls and other fora for community input and dialog with the BRN process.

The report took its final shape at a BRN Workshop in December 11-14, 2019 in the Washington D.C. area. The workshop was attended by all 66 BRN Study members and a number of observers: Program Managers from DOE HEP and related programs, and from NSF. The plenary talks on the first day were live-streamed to the community.

After the workshop BRN Study members continued to work on the report. A draft was circulated to designated readers and feedback was incorporated before transmission to HEPAP in July, 2020.

Many people contributed at various stages of the Basics Research Needs study that led to this report. We are grateful to those who played roles beyond the report authors. We acknowledge with gratitude the 142 additional contributors - members of the particle physics community who contributed their time and ideas to the BRN study in the months leading up to the BRN workshop. Their names appear at the end of this email. The Report's designated readers gave us critical feedback and provided fact checking during the final stages of preparation. Many thanks for this to Dan Akerib (SLAC National Laboratory), Myron Campbell (University of Michigan), Andy Lankford (University of California Irvine), Ritchie Patterson (Cornell University), Steve Ritz (University of California Santa Cruz) and Heidi Schellman (University of Oregon). Our report benefited enormously from professional editing assistance by Tiffani Conner, (Oak Ridge Associated Universities). DOE staff and contractors were always responsive to logistical requests. We especially thank Christie Ashton and Donna Nevels who provided outstandingly professional support at the workshop and contributed importantly to the immensely positive and constructive atmosphere that was highly conducive to productivity.

The P5 program pushes the frontiers of science into new territory. To explore this territory HEP will soon embark on planning the next generation of experiments. Realizing these experiments will require giant leaps in capabilities beyond the instrumentation of today. Accordingly, now is a pivotal moment to invest in the accelerated development of cost-effective instrumentation with greatly improved sensitivity and performance that will make measurable the unmeasurable, enabling a tool-driven revolution to open the door to future discoveries. Historic scientific opportunities await us, enabled by executing the instrumentation research plans outlined in this report.

Onward and upward!

The Basic Research Needs for High Energy Physics Detector R&D Study Panels

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Cross-Cut Panel
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