Department of Energy
Office of Science
Washington, DC 20585

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MEMORANDUM FOR HELMUT MARSISKE

FROM: GLEN CRAWFORD
DIRECTOR, RESEARCH AND TECHNOLOGY DIVISION
OFFICE OF HIGH ENERGY PHYSICS (HEP)

SUBJECT: Basic Research Needs Study on HEP Detector Research and Development

I request that you organize and carry out a Basic Research Needs (BRN) study to assess the present status of the HEP technology landscape, and to identify strategic technology areas, aligned with the strengths of the US community, that future long-term research and development (R&D) efforts should focus on in pursuit of the HEP science drivers identified in the P5 report. For each of these areas, the study should articulate and justify a set of Priority Research Directions (PRDs) to push the technology well beyond the current state of the art, potentially leading to transformative advances with broad-ranging applicability in HEP and beyond. Furthermore, the study should identify a small set of high-impact instrumentation "Key Challenges" where technological breakthroughs could lead to game-changing experimental capabilities in pursuit of HEP science goals.

You should select co-chairs to lead the study and work with them to select the core group of working group leads to carry it out. The study encompasses responses to the specific charge elements elucidated below and is expected to take several months to complete. A focal point of the study should include a workshop, with attendance beyond the core group, expected to be held in December 2019 time frame in the Washington, DC area. The study participants are to serve by invitation only.

The HEP Detector R&D program aims to develop cutting-edge, novel instrumentation to enable scientific leadership in a worldwide experimental program that is broadening into new research areas with ever increasing demands in sensitivity, scale, and cost. To meet this challenge, HEP aims to execute a program appropriately balanced between incremental, near-term, low-risk detector R&D and transformative, long-term, high-risk detector R&D.

With the near-term technical challenges of current high-priority P5 projects subsiding, the HEP Detector R&D program aims to shift more emphasis towards building a long-term, high-risk high-reward ("Blue Sky") R&D portfolio that holds the promise of transformative advances with broad-ranging applications across HEP as well as other fields of science, medicine, and national security. Crucially, the program must take full advantage of the major advances happening in other scientific disciplines such as materials science, photonics, nanotechnology, and QIS, as

well as innovations in the commercial sector such as in microelectronics and telecommunications. In light of constrained budgets, the Detector R&D program must optimize the use of human and technical resources through collaboration and equipment sharing.

Following the 2013 Snowmass Community Planning Exercise, the P5 Report emphasized the importance of instrumentation development for the long-term advancement of the field. In response, the DPF's Coordinating Panel for Advanced Detectors (CPAD) has organized since 2015 a series of "New Technologies for Discovery" annual community workshops that aim to "...explore and evaluate detector R&D opportunities, the critical needs of the field, and the challenges that lie ahead for HEP in the US within the context of the P5 plan and beyond". These workshops provide a broad survey of the detector technologies the US community is currently engaged in. Moreover, CPAD is using them to conduct a study to identify "research directions in instrumentation in support of the HEP science mission within the twenty-year P5 vision" where the US community can play a leadership role. The results of the CPAD study are summarized in a report available at https://anl.app.box.com/v/CPADReport2016. For this BRN study, the 2016 CPAD report together with any near-term updates and other workshop materials will provide the primary input for the assessment of the present state of the technology landscape relevant for HEP, summarized in a Technology Perspectives Factual Document.

In carrying out the BRN study, the following specific charge elements should be addressed:

- Survey the present state of the HEP technology landscape.
- Identify key enabling capabilities and associated performance requirements.
- Identify technologies to provide/enhance such capabilities.
- Articulate PRDs to push well beyond the current state of the art, potentially leading to transformative technological advances with broad-ranging applicability. Flesh out the required R&D efforts with deliverables with notional timelines and key technical milestones along the way. Elucidate the technical infrastructure required to support these efforts.
- Formulate a small set of instrumentation Key Challenges that could result in game-changing experimental capabilities.

The study results should be described in a report delivered within two months following the completion of the workshop. DOE will use the study results to inform Detector R&D program planning, which may include a call for proposals to support new technology developments and capabilities that address the study priorities.

cc: James Siegrist, SC-25
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