Date: **March 11th, 2019**

To: Bob Tschirhart, Chief Project Officer

From: Nigel Lockyer, Director

Re: Director's Progress and CD-1 Readiness Review of the CMS HL-LHC Project

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Message:

In May 2014 the U.S. HEP program completed its long-term strategic plan through the Particle Physics Project Prioritization Panel (P5), a subpanel of the High Energy Physics Advisory Panel (HEPAP). The P5 plan for the Energy Frontier recommended that the U.S. actively continue its participation in the Large Hadron Collider (LHC) program at CERN, and specifically, in the planned High Luminosity (HL) upgrade of the LHC, designating it as the "highest-priority near-term large project". A shutdown of the LHC accelerator complex is planned to begin in 2024, which will result in the LHC delivering much higher luminosities than the current running conditions in the period from 2026-2035. The new operating conditions require upgrades to the aging CMS tracker system, the barrel and the end-cap calorimeters and associated readout electronics, the muon system readout electronics and the trigger and data acquisition system, as well as the installation of a new timing detector.

The U.S. CMS HL-LHC upgrade comprises both NSF and DOE projects. The NSF project is reviewed separately. The DOE project was comprehensively reviewed in June 2018, and the Tracker, Endcap Calorimeter and Trigger/DAQ subsystems were deemed to be at a CD-1 level of maturity. However, the MIP Timing Detector was considered not mature enough to proceed to CD-1. The DOE review committee further pointed out some of the project documentation needed to be updated, especially in the ESH and QA areas.

This Director's Review on March 19th – 21st, 2019 will assess the project's readiness to proceed to CD-1 and address the following specific questions for CD1:

1. Does the acquisition strategy document a carefully considered analysis of alternatives that support the preferred alternative?
2. Does the conceptual design satisfy the performance requirements?
3. Does the conceptual design report and supporting documentation adequately justify the stated cost range and project duration?
4. Do the project's plans to execute the work make the most efficient use of the financial, human, and technical resources available to them at the

participating national labs and universities when they are the most efficient choice?

5. Does the proposed project team have adequate management experience, design skills, and laboratory support to produce a credible technical, cost, and schedule baseline?
6. Are the ESH&Q aspects of the project being properly addressed and is the ESH&Q planning currently sufficient for this stage of the project?
7. Is the documentation required by DOE O413.b for CD-1 approval complete and in good order?
8. Has the project satisfactorily responded to the recommendations from previous reviews?

The committee is asked to present a draft of their report at the review closeout and to issue the final report within three weeks of the review's conclusion.

Nigel S. Lockyer
Director of Fermilab