**Physics Driver:** Operation of Collider Experiments at High Luminosity

**Time Frame:** Intermediate (2025)

**Physics Justification:** Experiments running at the HL-LHC will need to operate at a luminosity of 5x1034 corresponding to ~140 interactions per 25 ns crossing. These experiments hope to integrate 3000 fb-1 of luminosity. Physics goals include a set of precise measurements of the Higgs branching ratios, search for new physics including supersymmetry and extra dimensions, and measurement of WW scattering. Experiments hope to maintain at least the current values of resolution for tracking and calorimetry and maintain the ability of the triggers to select physics events.

**Technical limitations:** There are a number of technical challenges to maintaining experimental capabilities at high luminosity. 1) Detectors for forward calorimetry, tracking, and vertexing are not currently sufficiently radiation hard. 2) Level 1 triggers will require information from the trackers based either on region of interest or stand-alone tracking to reduce the trigger rate to acceptable levels. 3) Forward detectors with ~100ps time resolution are required to isolate the primary vertex Z region. 4) Support structures and associated power delivery and cooling systems are currently too massive. This problem will increase with the increasing power density due to pixelization of the tracker and higher data bandwidth. 5) Triggers must be much more selective. This will require increasing L1 latency and data bandwidth.

**Technical Capabilities:** 1) Study of new detector materials and processes such as diamond and 3D sensors. 2) Develop electronics based on Through-Silicon-Via technology (TSV) to allow the development of trigger layers capable of momentum filtering 3) Study radiation hard detectors and electronics capable of fast timing. 4) Studies of low mass mechanics, CO2 cooling, foamed materials, and high efficiency DC-DC conversion. 5) Development of new DAQ technologies based on ATCA and uTCA, development of low power high speed radiation hard data transmission. 6) Continued development of ASIC technologies.

**Key R&D Directions:** The US has had a leading role in the construction and physics analysis of the LHC experiments. It has pioneered 3D and diamond detectors, TSV based electronics, triggering technologies, ASIC development, mechanics and radiation hard silicon technology. Suggested key areas of R&D with broad impact are:

* Radiation hard crystal calorimetry
* ATCA-based novel data acquisition structures
* 3D silicon technology
* Low-mass tracking and vertex detectors