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A 40 MHz Level-1 trigger scouting system for the CMS Phase-2 upgrade

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The CMS Phase-2 upgrade for the HL-LHC aims at preserving and expanding the current physics capability of the experiment under extreme pileup conditions. A new tracking system incorporates a track finder processor, providing tracks to the Level-1 (L1) trigger. A new high-granularity calorimeter provides fine-grained energy deposition information in the endcap region. New front-end and back-end electronics feed the L1 trigger with high-resolution information from the barrel calorimeter and the muon systems. The upgraded L1 will be based primarily on the Xilinx Ultrascale Plus series of FPGAs, capable of sophisticated feature searches with resolution often similar to the offline reconstruction. The L1 Data Scouting system (L1DS) will capture L1 intermediate data produced by the trigger processors at the beam-crossing rate of 40 MHz, and carry out online analyses based on these limited-resolution data. The L1DS will provide fast and virtually unlimited statistics for detector diagnostics, alternative luminosity measurements, and, in some cases, calibrations. It also has the potential to enable the study of otherwise inaccessible signatures, either too common to fit in the L1 trigger accept budget or with requirements that are orthogonal to "mainstream"physics. The requirements and architecture of the L1DS system are presented, as well as some of the potential physics opportunities under study. The first results from the assembly and commissioning of a demonstrator currently being installed for LHC Run-3 are also presented. The demonstrator collects data from the Global Muon Trigger, the Layer-2 Calorimeter Trigger, the Barrel Muon Track Finder, and the Global Trigger systems of the current CMS L1. This demonstrator, as a data acquisition system operating at the LHC bunch-crossing rate, faces many of the challenges of the Phase-2 system, albeit with scaled-down connectivity, reduced data throughput and physics capabilities, providing a testing ground for new techniques of online data reduction and processing.

Collaboration

CMS

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