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Design and Performance of the Phase I Upgrade of the CMS Global Trigger

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The Global Trigger is the final decision stage of the Level-1 Trigger of the CMS Experiment at the LHC. Previously implemented in VME, it has been redesigned and completely rebuilt in microTCA technology, using the Virtex-7 FPGA chip family. This allows implementing trigger algorithms close to the final analysis selection, combining different physical objects. The flexible and compact new system is presented, together with performance tests at a proton-proton centre-of-mass energy of 13 TeV. Firmware and software developments for the operation and validation of the Global Trigger will also be discussed.

Summary

The Global Trigger is the final decision stage of the Level-1 Trigger of the CMS Experiment at the LHC. Previously implemented in VME, it has been redesigned and completely rebuilt in microTCA technology, using the Virtex-7 FPGA chip family. This allows implementing trigger algorithms close to the final analysis selection, combining different physical objects received from the calorimeters and muon detectors. Electrons or photons, muons, jets, taus, as well as energy sums can be combined. Topological conditions and invariant mass triggers may be applied. The number and complexity of the algorithms making up the trigger menu are substantially increased compared to the legacy design. The new system, much more compact and flexible than the previous one, is presented. It is based on a single principal type of board, called MP7, which performs the logic calculations and which has initially been developed for the CMS calorimeter trigger at Imperial College, University of Bristol and Rutherford Appleton Laboratory. Auxiliary boards, developed at HEPHY Vienna, are used to receive external signals from other subdetectors and to manage the simultaneous operation of several MP7 boards in case of trigger menus with a large number of complex algorithms. Performance evaluations undertaken in parallel operation with the legacy system during the initial months of Run II of the LHC and during data taking in 2016 at a proton-proton centre-of-mass energy of 13 TeV will be presented. Details on the use of chip resources and link operation will be given. Firmware and software developments necessary for the setup, control, monitoring and validation of the Global Trigger will also be discussed.

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