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# The CMS calorimeter trigger upgrade for the LHC Run II

The CMS experiment implements a sophisticated two-level online selection system that achieves a rejection factor of nearly 10e5. The first level (L1) is based on coarse information coming from the calorimeters and the muon detectors while the High-Level Trigger combines fine-grain information from all sub-detectors. During Run II, the LHC will increase its centre of mass energy up to 13 TeV and progressively reach an instantaneous luminosity of 2e34 cm-2s-1. In order to guarantee a successful and ambitious physics program under this intense environment, the CMS Trigger and Data acquisition system must be consolidated. In particular the L1 calorimeter Trigger hardware and architecture will be modified. The goal is to maintain the current thresholds (e.g., for electrons and photons) and improve the performance for the selection of tau leptons. This can only be achieved by designing an updated trigger architecture based on the recent microTCA technology. Racks can be equipped with fast optical links and latest generation FPGAs can be used. Sophisticated object reconstruction algorithms as well as online pile-up corrections can thus be envisaged. The plan to consolidate the CMS trigger system will be presented as well as the recent hardware and firmware developments. Algorithms to select efficiently electrons, photons, tau leptons or jets will also be presented along with the expected performance.

## Summary

The presentation will cover details of the CMS data acquisition and trigger upgrade planned for the next run at the LHC, concentrating on the replacement of the Level-1 calorimeter trigger. As the LHC restarts and delivers higher luminosity collisions, exceeding the design parameters, the current CMS trigger system will not be capable of maintaining the high efficiency required for the CMS physics programme. The replacement of the trigger system is also a good opportunity to consider even more efficient ways of selecting electrons, photons, tau leptons, reconstructing jets and performing energy sums. In these intense conditions, the implementation of pile-up mitigation techniques is required to reach acceptable performance.

Modern technologies offer an effective solution to achieve these goals. The trigger primitives generated by the detector will be transmitted by newly installed optical link boards (4.5 to 6.4 Gb/s) replacing the existing copper cables (1.2 Gb/s), to a new system based on the microTCA electronics standard. The system is based on custom designed AMC (Advanced Mezzanine Boards) with Xilinx Virtex 7 FPGAs. These FPGAs use 10Gb/s MGTs to gather information from the entire calorimeter for each event in one FPGA, where sophisticated algorithms may be implemented. The complete view of the calorimeter will allow the trigger to compute global quantities such as the average energy density that can be used to estimate the pile-up level. The resulting increase in rejection power will permit the experiment keep low trigger thresholds on physics objects.

The talk will cover the design, development and testing of the components of the new trigger system, including results from recent demonstrator systems at CERN and elsewhere. The talk will also detail the algorithms under study, and put in perspective the CMS physics goals for the next LHC run. The new system will allow the experiment to efficiently select low momentum leptons to pursue the full characterisation of the Higgs sector, in particular including VBF production modes, as well as searching for cascades initiated by SUSY particles.

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