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New development in the CMS ECAL Level-1 trigger system to meet the challenges of LHC Run 2

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To face the harsh environmental conditions in high energy physics, the systems have to find the right balance between high availability and fault tolerance. In response to the new failures during the runs, the graceful degradation has to be adaptive, with the minimum of impact on the data acquisition chain. To improve the Trigger Concentrator Cards, during the CMS Level-1 trigger upgrade, the approach of an hardware/software co-design has been used to benefit from the performances and flexibility of these respective areas.

Summary

The CMS Electromagnetic Calorimeter (ECAL) provides energy sums to the Level-1 calorimeter trigger at a rate of 40 MHz. The processing of these trigger primitives (TPs) is performed by dedicated trigger concentrator cards (TCCs) located in the CMS service cavern. The TCCs transmit approximately 4000 TPs every LHC bunch crossing to the Level-1 trigger to form electron/photon, tau and jet candidates, as well as calorimeter energy sums.
Updates to the functionality of the TCCs are required to respond to the challenging experimental conditions of LHC Run 2, where the centre-of mass of proton-proton collision energy was 13 TeV and the peak instantaneous luminosity of the proton beams reached 2x10ˆ34 cmˆ-2 sˆ-1.
New features have been added during Run 2, to improve the robustness of the TCCs to Single Event Upsets (SEUs), and to the presence of noisy signals from the ECAL on-detector electronics, which would otherwise affect the triggering performance of CMS at high luminosities.
A key element of this is a new algorithm to automatically detect and mask noisy or problematic TPs via configurable thresholds. This allows the detector to trigger efficiently without direct expert intervention, and the thresholds can evolve with changing LHC conditions. This algorithm, termed the Cumulative Overflow Killing Engine (COKE), has been developed and implemented via software and firmware updates to the TCCs.
In this presentation, we will describe the algorithm in detail, outline the strategies employed to deploy and commission it without impacting data integrity, and present the algorithm performance on LHC collisions data from Run 2.

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