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Development and firmware implementation of a Machine Learning based hadronic Tau lepton Level-1 Trigger algorithm in CMS for the HL-LHC

The High-Luminosity LHC will open an unprecedented window on the weak-scale nature of the universe, providing high-precision measurements of the Standard Model (SM) as well as searches for new physics beyond the SM. The CMS Collaboration is planning to replace entirely its trigger and data acquisition systems to match this ambitious physics program. Efficiently collecting datasets in Phase 2 will be a challenging task, given the harsh environment of 200 proton-proton interactions per LHC bunch crossing. The already challenging implementation of an efficient tau lepton trigger will become, in such conditions, an even crucial and harder task; especially interesting will be the case of hadronically decaying taus. To this end, the highly upgraded capabilities of the Phase 2 Level-1 (L1) triggering system can be exploited to design new complex machine learning based triggering algorithms that are not yet implementable in the current Phase 1 L1 system. Moreover, the foreseen high-granularity endcap calorimeter (HGCAL), and the astonishing amount of information it will provide, play a key role in the design of novel tau lepton triggering methods. In this poster, the development of an L1 trigger, with consistent barrel and endcap treatment, for hadronically decaying taus based on the calorimetric information from the ECAL, HCAL, and HGCAL detectors will be presented. A completely new and innovative design for an L1 trigger based on machine learning techniques (neural networks and boosted decision trees), as well as its preliminary FPGA firmware implementation, will be shown. The L1 trigger latency and resource availability constraints will also be discussed, and their role in the algorithm design will be highlighted.

Collaboration / Activity

CMS / Level-1 Trigger

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