Development of a L1 tau lepton trigger algorithm for the HL-LHC using the CMS high-granularity calorimeter information

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HL-LHC will integrate 10 times the LHC luminosity, and have an instantaneous luminosity 3 times the Run 2 peak value. This will result in unprecedented levels of radiation and high pileup (PU) collision rate.

The CMS Collaboration will replace:
- the tracking detectors
- the barrel barrier electronics
- the muon detectors
- the endcap calorimeter

The many L1 trigger upgrades permit a better knowledge of the

main hardware improvements for the L1 Phase-2 system, w.r.t. the current system, will be:
- the extensive use of state-of-the-art FPGA boards
- the use of high-speed optical links
- the implementation of a highly modular architecture

The main features of the L1 Phase-2 system will be:
- the implementation of the correlator trigger
- the first ever inclusion of tracker information
- the inclusion of HGCAL information in the form of 3D-clusters (HGCAL trigger primitives)

The Phase-2 trigger system implements the well-established two-level trigger architecture with Level-1 (L1) and High-Level-Trigger (HLT).

The HLT will operate at software level using as input the CMS detector full-granularity information and more sophisticated algorithms.

The efficiency of the L1 algorithm is evaluated with simulated collisions with the Run 2 peak value.

The Phase-2 trigger system will be:
- the inclusion of 
- the tracking detectors
- the barrel barrier electronics
- the muon detectors
- the endcap calorimeter

The underlying developments of the discussed algorithm are:
- the calculation and exploitation of isolation variables
- the inclusion of QCD-jet rejection
- the exploitation of the L1 track trigger information
- the firmware implementation

PERFORMANCES

The efficiency of the L1 algorithm is evaluated with simulated collisions with 200 average PU events. The efficiency as a function of the generated visible \( \tau \) lepton \( p_T \) shows a sharp turn-on, both for the aggregated and split decay modes cases, that reaches 100% at plateau. The single-\( \tau \) rate corresponding to different L1 threshold shows a large reduction for \( p_T \geq 30 \text{ GeV} \).

OUTLOOK

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HGCAL the High-Granularity CALorimeter, will be a 5D \((x, y, z, E, t)\) sampling calorimeter with:
- silicon-based + scintillator tiles hadronic compartment
- silicon-based - electromagnetic compartment

REFERENCES:
The Phase-2 Upgrade of the CMS endcap calorimeter (CMS-TDR-019)
The Phase-2 Upgrade of the CMS Level-1 Trigger (CMS-TDR-021)