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The ALICE EMCal L1 trigger first year of operation experience

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The ALICE experiment at the LHC is equipped with an electromagnetic calorimeter (EMCal) designed to enhance its capabilities for jet measurement. In addition, the EMCal enables fast triggering on high energy jets and high pt photons with a multiplicity dependent threshold. After its commissioning in 2010, the EMCal L1 trigger has been officially approved for physics data taking in 2011.
After describing the original Level 1 hardware and trigger algorithms, the commissioning and the first year of running experience, both in proton and heavy ion beams, are reviewed. Additionally, the needed upgrades to the original L1 trigger design are detailed.

Summary

The ALICE experiment at the LHC is equipped with a large acceptance ElectroMagnetic Calorimeter (EMCal) involved in the L1 trigger decision. The L1 calorimeter trigger, consisting of 12288 layered Pb-scintillator towers, selects both electromagnetic objects and jets from coarsely segmented data obtained from 2x2 tower analog sums. These being fed through shapers and digitized by 32 Trigger Region Unit (TRU) at the machine bunch crossing rate (40MHz).
In each TRU, the 12 bit ADC values, associated to the 96 analog sums are integrated over a 5 samples time-sliding window and stored in a circular buffer. Upon reception of a confirmed L0 from the Central Trigger Processor, all TRUs send the appropriate 96 time summed data to the Summary Trigger Unit (STU) via custom high speed LVDS links.
The data are transferred via 12m cat7 Ethernet type cables. Out of the 4 available differential pairs, one is dedicated to the transfer of a clean machine clock from STU to the TRUs, 2 to serially transfer the data to the STU at 2x240Mbps, and the last one to provide the local L0 to the STU which is locally ORed to provide the global L0 candidate trigger to the CTP.
The level-1 (L1) algorithm is subdivided in 2 stages. First, for each region, the 2x2 towers time-integrated values are space summed in order to build 8x8 towers sub-regions. Then the L1 jet trigger is generated whenever the integrated energy over a sliding window of 4x4 sub-region is above a multiplicity corrected threshold. The data transfer and processing is achieved in less than 6.2μs after interaction.
The STU can also insert the primitive triggering data in the data stream via the ALICE optical Dedicated Data Link upon reception of a L2 accept trigger. This last feature is extensively used to check the STU/TRU data correlation and to perform routine verifications on the trigger quality, i.e. adequateness of the hardware and off-line computed trigger.
During the first years of running experience, several STU firmware improvements were done. Initially, thanks to the additional L1 processing time offered by CTP, the custom serial link speed was decreased and the synchronization protocol modified to increase reliability. Then, the possibility to load and "replay" up to 8 events in the STU by mimicking TRU received data, revealed to be a powerful tool to recheck the triggering algorithm in online conditions, but without beam.
STU has a second order programmable centrality dependent threshold capability offering a unique possibility to keep the rejection factor constant versus centrality while taking full benefit of the allocated recording bandwidth. For simplicity, a first order threshold was finally used during 2011 Pb+Pb data taking. It performed as expected and revealed to be great asset in event selection.
A foreseen 2012 EMCal L1 upgrade, consisting in providing an additional set of lower threshold trigger outputs, will be presented. It aims at collecting a triggered data sample substantially overlapping with the minimum bias one.

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