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Revised CMS Global Calorimeter Trigger Functionality & Algorithms

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A revised design of Global Calorimeter Trigger (GCT) has been implemented. The primary function of the GCT is to process the Regional Calorimeter Trigger (RCT) data and transmit a summary to the Global Trigger (GT) which computes the First Level Trigger Accept (L1A) decision. The GCT must also transmit a copy of the RCT and GCT data to the CMS DAQ. This paper presents an overview of the revised design, concentrating on the firmware structure and algorithms. A separate paper presented in this conference details the hardware design.

Summary

The Global Calorimeter Trigger (GCT) is the last stage of the calorimeter trigger chain. The primary purpose of the GCT is to reduce the number of calorimeter trigger objects that need to be considered by the Global Trigger (GT) for a First Level Trigger Accept (L1A) decision. The pipeline memories that store event information prior to a L1A request have only limited depth and thus data transmission and processing time must be kept to a short, critical time period.

The trigger objects sent to the GT are listed below. The "rank" of an electron or jet is at present its transverse energy, however in principle it could also be derived from jet location and energy. The jet transverse energy is the sum of both the hadronic and electromagnetic calorimeter.

- 4 isolated and 4 non-isolated electrons of highest rank
- 4 central, 4 forward and 4 tau clustered jets of highest rank
- total transverse energy: sum of all jet transverse energy (magnitude)
- missing transverse energy (magnitude and angle)
- jet transverse energy: sum of found clustered jets (magnitude)
- 12 jet counters based on rank and position criteria

These trigger objects are calculated/extracted by the GCT from information supplied by the Regional Calorimeter Trigger (RCT). The original task of the GCT was to sort electron and jet trigger objects received from the RCT using rank. Jets are subdivided into and for central, forward and tau jets based

on a tau veto bit and
eta. The task of the GCT has now been extended to
perform jet cluster finding and
subsequent conversion of jet energy to rank to create
trigger objects before
performing the sort.

The electron sort operation must determine the 4 highest
rank objects from 72
candidates for both isolated and non-isolated electrons from
a significant data
volume (29Gb/s per electron type).
The jet cluster finding and subsequent sort is more
challenging because of the
larger data volume (172.8 Gb/s) and the need to share data
between processing
regions to perform cluster finding. The latter can require
data flows of a similar
magnitude to the incoming data volume depending on the
cluster algorithm used. The
baseline algorithm of a 3x3 sliding window requires
substantial data sharing, making
the system more complex. An alternative algorithm is
presented and compared to the
original.

In addition to these tasks the GCT: (a) acts as a readout
device for both itself and
the RCT by storing information until receipt of a L1A and
then sending the
information the DAQ via a SLINK64 interface (b) extracts
trigger information for the
muon system from the calorimeter data stream (c) monitors
the LHC luminosity.

The revised design is discussed, although the hardware
details are kept to a minimum
as they are presented in a separate talk at this conference.
The data processing
firmware, in particular the algorithms, data flow and
associated latency within the
revised GCT are presented.

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