

Integration of the CMS regional calorimeter Trigger hardware into the CMS level-1 Trigger

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The electronics for the Regional Calorimeter Trigger (RCT) of the Compact Muon Solenoid Experiment (CMS) have been produced and tested. The RCT hardware consists of 18 double-sided crates containing custom boards, ASICs, and backplanes. The RCT receives 8 bit energies and a data quality bit from the HCAL and ECAL Trigger Primitive Generators (TPGs) and sends it to the CMS Global Calorimeter Trigger after processing.

Before installation, integration tests were performed. Data was successfully received from the TPG electronics and read out with a RCT Jet Capture Card. These tests, other tests involving more trigger subsystems, their results, and the RCT installation will be described.

Summary

The electronics for the Regional Calorimeter Trigger (RCT) of the Compact Muon Solenoid (CMS) Experiment have been produced and the individual boards and crates validated. The RCT hardware consists of 18 9Ux680mm double-sided crates containing custom boards with custom ASICs and backplane. Including spares, almost 1800 boards of 6 different types have been produced. Included are a backplane, Clock and Control Card (CCC), Receiver Mezzanine Card (RMC), Receiver Card (RC), Electron Identification Card (EIC), and Jet/Summary Card (JSC). This system will receive 8 bit transverse energies (ET) and a characterization bit from over 8000 hadronic and electromagnetic calorimeter towers via 4 GBaud copper links and sum these ET's over 4x4 tower regions for jet-finding, missing ET, and total ET. Additionally, the individual tower energies and characterization bit are used to find electron candidates. These quantities are then forwarded to the Global Calorimeter Trigger (GCT) for further processing and sorting.

After the production and validation of the system, and before integration with the other trigger sub-systems, two special test boards were developed to verify the input and output of the RCT. The Serial Test Card mimics the input

from the calorimeter Trigger Primitive Generators (TPGs). This card was used to validate the links and to check all routes on the board that could not be validated without active links. The Jet Capture Card (JCC) was developed to capture the output of the JSC and if needed, generate an external trigger. Using the ability of the RCT to repeatedly cycle through its LookUp Tables (LUTs), it was possible to validate the data paths with changing patterns for an extended period of time.

Before the JCC long-term tests were performed, small-scale integration had already begun. The HCAL and ECAL TPGs were each integrated separately, providing input data to the RCT. Data was received successfully at the RCT from the TPGs on up to 24 links simultaneously. The RCT JCC was used to verify that the data was aligned in time. Additionally, the RCT LUTs were used to send data patterns from a single crate to the GCT for verification.

Currently, integration tests are performed in a purpose-built aboveground facility, with a row of racks identical to what exists underground at CMS. At this facility integration of multiple trigger sub-systems can be performed at once. The ECAL and HCAL TPG's have now sent data simultaneously to the RCT. This was performed with a real CMS clocking system. In this facility the RCT sent pattern data from two crates to the GCT. After the GCT in the trigger chain is the Global Trigger (GT), where data was seen using the JCC trigger output, using patterns generated by the RCT.

Tests to be reported on include long term tests using patterns with the HCAL and ECAL TPGs, integrating with the HCAL TPG's in the Magnet Test and Cosmic Challenge, and using real cosmic ray data from the detectors. The RCT will also send activity triggers from the JCC to the GT.

Details of past and forthcoming tests and their results will be described. In addition, the installation and integration for CMS trigger will have begun underground, and this will be covered as well.

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