

# Installation and Commissioning 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, 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 (GCT) after processing. Integration tests with the TPG and GCT subsystems have been successful.

Installation is complete and commissioning of the final system is underway. During installation, pattern tests were used to validate 1026 TPG links and 108 GCT cables. Additionally, the RCT was part of several successive Global Runs, where an increasingly larger fraction of the full chain of the final Level-1 trigger system was tested. These tests, 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 has been integrated with the ECAL and HCAL Trigger Primitive Generators (TPGs) responsible for RCT input and the Global Calorimeter Trigger (GCT) that receives the RCT output. The hardware of the RCT consists of eighteen 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 receives 8000 calorimeter trigger tower transverse energies (ETs) and characterization bits from the ECAL and HCAL TPGs via 4 GBaud copper links. These ETs are summed over 4x4 tower regions for jet-finding, missing ET, and total ET. Additionally, the individual tower energies and characterization bits are used to find electron candidates. These quantities are then forwarded to the GCT via their source cards for further processing and sorting.

The RCT crates, cables and associated hardware have been installed underground and the commissioning of the final system is underway. RCT integration tests started with a subset of the Trigger Timing and Control (TTC) hardware for clocking and control and a portion of the ECAL and HCAL TPG hardware as input. At first, simple patterns were sent to validate timing between systems and link operation, and were captured with a RCT custom test board, the Jet Capture Card (JCC) in lieu of the GCT Source Cards. When the GCT Source Cards became available, the testing chain was extended and the JCC used to verify the patterns seen at the GCT and predicted by the trigger emulation software. These patterns included simulated electron and jet triggers to validate the system. As more crates were installed and the cabling finished up, these patterns became more complex and testing was automated.

Additionally, monthly Global Runs were started at the end of May 2007, each lasting for one full week. The purpose of these runs was to validate the system in parts, gradually working up to the final system. The RCT joined these runs in June 2007, when a slice of the full calorimeter trigger chain was available. Timing in the subsystems, using software to automate the configuration and monitoring, and the previous integration were all crucial to the success of these runs.

Details of the installation, integration, and commissioning for CMS trigger will be described, as well as the results from participating in the monthly Global Runs.

**Primary author:** KLABBERS, Pamela Renee (University of Wisconsin - Madison)

**Co-authors:** LEONARD, Jessica (University of Wisconsin - Madison); LACKEY, Joseph (University of Wisconsin - Madison); JAWORSKI, Mathew (University of Wisconsin - Madison); GROTHE, Monika (University of

Wisconsin - Madison); ROBL, Phillip (University of Wisconsin - Madison); DASU, Sridhara (University of Wisconsin - Madison); GORSKI, Thomas (University of Wisconsin - Madison); SMITH, Wesley H. (University of Wisconsin - Madison)

**Presenter:** KLABBERS, Pamela Renee (University of Wisconsin - Madison)

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