Contribution ID: **39** Type: **Oral**

Analysis of the initial performance of the ATLAS Level-1 Calorimeter Trigger

Tuesday 16 September 2008 11:50 (25 minutes)

The ATLAS first-level calorimeter trigger is a hardware-based system designed to identify high-pT jets, electron/photon and tau candidates and to measure total and missing ET in the calorimeters. The installation of the full system of custom modules, crates and cables was completed in late 2007, but, even before the completion, it was being used as a trigger during ATLAS commissioning and integration. During 2008, the performance of the full system has been tuned during further commissioning and cosmic runs, leading to its use in initial LHC data taking. Results and analysis of the trigger performance in these runs will be presented.

Summary

The ATLAS first-level calorimeter trigger (L1Calo) is a hardware-based system with a high degree of adaptability provided by widespread use of FPGAs. The real-time path of the trigger is subdivided into a Preprocessor, which takes analogue signals from the calorimeters and digitizes them, followed by two digital processor systems working in parallel: the Jet/Energy-sum processor and the Cluster Processor. It provides all the calorimeter based trigger information used by the Central Trigger Processor to make the final Level-1 trigger decision, and as such provides the majority of the individual inputs to this decision.

Along with the trigger decision path, L1Calo also provides read-out data and 'region-of-interest'(RoI) data on events accepted for further processing. The read-out data is used to monitor and understand the trigger decision, but the RoI data is used at a more fundamental level to guide the second level trigger. The correct operation of all these streams is necessary in order for ATLAS to be operational from the first day of LHC beam. Much of the functionality of the system can be verified via calorimeter calibration systems and rare high-energy cosmic events. However, the final tuning of timing and signal processing requires LHC beam with the correct beam-interaction timing.

The full system has been installed since the end of 2007, and has now been tested both stand-alone and in integrated runs with the rest of ATLAS over a long period. Even before the end of 2007, a partial system was being used to form triggers on high-energy cosmic events in ATLAS. During 2008, these integration and cosmic runs became increasingly sophisticated, allowing the correct performance of many aspects of the system to be thoroughly tested. Events with significant energy could be used to cross-check the trigger decision against the data read-out from the calorimeters themselves. The integration with the ATLAS data-acquisition and high level trigger systems could also be checked using this data.

It is hoped that LHC will start to produce beams during the summer of 2008. This will precipitate a great deal of analysis of beam and signal timing in order to optimize the performance of the calorimeter trigger. This will have to be executed quickly and efficiently to ensure that the trigger is properly timed for first collisions. When proton-proton collisions are achieved, it will then be necessary to measure the efficiency of the trigger and decide on suitable thresholds to maximize the potential for LHC physics.

The architecture of the L1Calo system will be presented, along with results from data taking in 2008, showing how the trigger achieved its goals in all areas –namely, calorimeter integration, algorithm implementation, trigger formation and RoI provision.

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Session Classification: Parallel session B1 - Trigger 1