Commissioning of the Jet/Energy-sum and Cluster Processors for the ATLAS Level-1 Calorimeter Trigger System

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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. The trigger consists of a preprocessor system which digitises 7200 analogue inputs, and two digital multi-crate processor systems which find jets, measure energy sums, and identify localised energy deposits (electron/photon and tau candidates). In order to provide a trigger quickly enough, the hardware is parallel and pipelined.

Experience so far of the jet/energy-sum and cluster processor system production, commissioning, and integration into ATLAS will be described.

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 (PPr) which takes analogue signals from the calorimeters and digitises them, followed by two digital processor systems working in parallel: the jet/energy-sum processor (JEP) and the cluster processor (CP). This contribution discusses the digital processor systems and their commissioning: the PPr is discussed in a separate contribution.

The input to both CP and JEP systems are 8-bit digitised transverse energy deposits covering either 0.1x0.1 (CP) or 0.2x0.2 (JEP) in eta-phi space. These signals are transmitted to the CP and JEP systems over high-speed serial LVDS cables. The CP and JEP systems are each comprised of two parts: a parallel set of high-density processor modules - the CPMs and JEMs respectively - and a common merger module (CMM) which collates results and sends them to the ATLAS central trigger processor (CTP), which in turn makes the overall first-level trigger decision. Both CP and JEP systems take events at the bunch-crossing rate of 40 MHz, and are heavily pipelined. The CP and JEP processors are allocated about 400ns processing time (in parallel), as their share of the overall trigger latency. The CP occupies four 9U VME crates, the JEP two.

One of the principal challenges of the processor systems is the connectivity over the large eta-phi array of trigger towers, required in order to avoid double-counting of energy deposits. The main component that ensures this is a dense custom backplane with approximately 22 000 pins per crate.

The output from the CP system passed to the CTP consists of a set of multiplicities of electromagnetic (EM) objects passing flexible Et thresholds on shower energy as well as limits on activity in surrounding cells, and in the hadronic samplings behind the EM cells. A simple alteration of how hadronic samplings are used also allows triggering on isolated hadrons from tau decays. Co-ordinates and classifications

of these candidates are also made available to the second-level trigger system via regions-of-interest (RoIs).

The output from the JEP system includes information about hadronic jets passing Et thresholds, in a similar scheme to that of the CP system. In addition, the total Et deposited in the calorimetry is found, as well as a vector sum of Et deposits; these are compared to thresholds and the results are passed to the CTP.

Production of the modules for the full-scale calorimeter trigger system has taken place during 2006-7, and installation and commissioning of the full system is taking place during the spring and summer of 2007. The installation of the processor systems into the ATLAS counting rooms is outlined, together with results of commissioning tests, and lessons learnt. Integration with the CTP, ATLAS DAQ systems and higher-level trigger systems is also in progress and will be discussed.

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