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Testing and calibrating analogue inputs to the ATLAS Level-1 Calorimeter Trigger

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The ATLAS Level-1 Calorimeter trigger is a hardware-based system which aims to identify high-pt objects within an overall latency of 2.5us. It is composed of a Preprocessor system which digitises 7200 analogue input channels, determines the bunch crossing of the interaction, and provides a fine calibration; and two subsequent digital processors.

The Preprocessor system needs various channel dependent parameters to be set in order to provide digital signals which are aligned in time and have proper energy calibration. The different techniques which are used to derive these parameters are described along with the quality tests of the analogue input signals.

Results from first collision data are expected.

Summary

The high luminosity and bunch-crossing rate of the LHC poses an immense challenge for triggering. The ATLAS Level-1 calorimeter trigger processes 7200 trigger towers within a fixed latency of 2.5 us, reducing the event rate from 40 MHz to below 100 kHz. It is realised completely in hardware, including ASICs and FPGAs, in a VME-based system.

The Preprocessor of the Level-1 calorimeter trigger is a compact system which digitizes the detector signals, determines the bunch crossing number of the interaction and provides a fine energy calibration. The results are sent to two digital processors, the Cluster Processor (CP) and the Jet/Energy Processor (JEP). The CP searches for electron/photon and tau candidates. The JEP identifies jets and computes total and missing transverse energy sums. Both digital processors provide the information to the Central Trigger Processor which makes the overall Level-1 decision.

The Preprocessor is a highly modular system consisting of eight crates hosting a total of 124 preprocessor modules (PPMs). Each of these modules handles 64 channels in parallel. The main signal processing is done by the custom-built Preprocessor ASIC. It is placed on the multichip modules (MCMs) hosted on a PPM. Each MCM handles four input channels.

The Preprocessor system needs various channel dependent parameters to be set in order to provide digital output data which are aligned in time and have proper energy calibration. The analogue cables from the detector frontend have length differences which amount to channel-to-channel timing differences of up to 10 bunch crossings which is corrected for by means of input shift registers. In addition to this, the fine timing of the FADC clock needs to be set with ns accuracy in order to sample the analogue pulses on their maximum which guarantuees proper signal reconstruction and the maximum dynamic range. The energy of the pulses is determined by means of a FIR filter in combination with a look up table for which the corresponding coefficients and values have to be determined in order to increase the signal to noise ratio and to achieve proper calibration.

During the commissioning phase of the experiment the Preprocessor system is also used to test the signal quality of the analogue input signals since it provides independent readout for all trigger towers in parallel.

This talk gives an introduction to the Level-1 Calorimeter Trigger with a focus on the preprocessor system. The different calibration methods are described along with the quality tests of the analogue input signals. Results from cosmic muon data are presented and if possible first results from proton collisions.

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