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The ATLAS Level-1 Trigger System with 13TeV nominal LHC collisions

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The Level-1 (L1) Trigger system of the ATLAS experiment at CERN's Large Hadron Collider (LHC) plays a key role in the ATLAS detector data-taking. It is a hardware system that selects in real time events containing physics-motivated signatures. Selection is purely based on calorimetry energy depositions and hits in the muon chambers consistent with muon candidates. The L1 Trigger system has been upgraded to cope with the more challenging run-II LHC beam conditions, including increased centre-of-mass energy, increased instantaneous luminosity and higher levels of pileup. This talk summarises the improvements, commissioning and performance of the L1 ATLAS Trigger for the LHC run-II data period.

The acceptance of muon triggers has been improved by increasing the hermiticity of the muon spectrometer. New strategies to obtain a better muon trigger signal purity were designed for certain geometrically difficult transition regions by using the ATLAS hadronic calorimeter. Algorithms to reduce noise spikes in muon trigger rates were also deployed. L1 Calorimeter Trigger underwent various major upgrades. At the pre-prosessing stage, more than 1700 FPGA-based daughter boards were exchanged which replace the previous ASIC-based modules. The new modules enable significantly improved pile-up control, such as dynamic bunch-by-bunch pedestal correction as well as an enhanced signal-to-noise ratio by the use of digital auto-correlation Finite Impulse Response filters. Furthermore the digitisation speed was doubled to 80 MHz which allows for improved treatment of saturated signals and refined input timing. The firmware of the subsequent object finding hardware components was modified to add extra selectivity, such as energy-dependent electromagnetic isolation criteria in the cluster processor. In addition, the transmission bandwidths were enlarged, as well as new merger modules introduced that provided flexibility for the integration of a brand new system: the ATLAS L1 Topological Trigger. The ATLAS L1 Topological trigger uses physically motivated kinematic quantities of triggered candidates to reject undesired background processes extending the reach of the ATLAS physics program.

The Central Trigger Processor, heart of the ATLAS L1 Trigger system, was also upgraded. Its hardware, firmware and software architectures were redesigned. It now allows twice as many trigger channels, a much more flexible handling of detector dead-times, the possibility of concurrent independent triggering of up to 3 different sub-detector combinations and the handling interface to the new topological trigger system.

Summary

To be added soon

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