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Upgrade of the ATLAS Muon Trigger for the SLHC

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The upgrade of the LHC towards luminosity beyond the design value requires improved L1 trigger selectivity in order to keep the maximum total trigger rate at 100 kHz. In the ATLAS L1 muon trigger system this necessitates an increase of the pT threshold for single muons. Due to the limited spatial resolution of the trigger chambers, however, the selectivity for tracks above ~20 GeV/c is insufficient for an effective reduction of the L1 rate. We propose to used the precise track coordinates of the Monitored Drift Tube chambers of the ATLAS muon spectrometer for a decisive improvement of the pT determination and thus of the selectivity of the L1 muon trigger. Requirements on the trigger latency will also be discussed.

Summary

The SLHC project at CERN foresees an increase of the peak luminosity of the LHC by a factor of 4-10 beyond the nominal value of 10^34 cm-2 s-1. As the total L1 trigger rate of the ATLAS experiment cannot be significantly increased beyond 100 kHz, a higher selectivity of the L1 trigger for high-pT event signatures is required. One of the main inputs to the ATLAS L1 trigger are high-pT tracks identified in the muon spectrometer. As the muon rate decreases strongly with pT, the trigger rate is highly sensitive to the selected pT threshold. To keep the trigger rate for single muons at an acceptable level of about 10 kHz, a minimum pT threshold of 20-30 GeV/c is required. Due to the limited spatial resolution of the trigger chambers and the corresponding pT error, however, a large fraction of tracks with pT below the selected threshold will be accepted, inflating the L1 rate.

We present a concept for using the much higher spatial resolution of the Monitored Drift Tube (MDT) chambers for a precise track momentum determination for the L1 trigger and a decisive improvement of the rejection of muons below threshold. This scheme requires a communication path between the trigger and MDT chambers to be established within each trigger tower. The coordinates of the high-pT track as determined by the trigger chambers are communicated to a newly implemented local processor ("TowerMaster") which determines the search path for MDT tubes to be read out (using a LUT) and sends this information to the front-end boards of the MDT chambers. At the front-end, a system of scalers (one scaler per tube) is added to the existing readout logic, determining the drift time with the relaxed time resolution of 25 ns. At this clock frequency the word size of the drift time information is reduced to 6 bit, yet providing a spatial resolution of about 0,5 mm. This is more than a factor 10 better than the resolution of the trigger chambers. The scalers are started by the signals on the MDT wires and stopped by the L1 muon trigger signal. This signal is timed to arrive a fixed number of beam crossings following the passage of the muon. The scaler readings thus correspond directly to the drift times of the primary electrons and to the distances of the muons from the MDT wires. The drift-time readings of six tubes along the track in a MDT chamber contain redundancy and provide a robust measurement of the track coordinate. The track coordinates measured by the three MDT chambers along the muon trajectory yield the track sagitta and thus the pT of the muon. If this is below the selected threshold, a L1 veto is issued to the trigger logic.

For this triggering scheme an additional L1 latency of 1-3 microsec is required, depending on the details of implementation.

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