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Design Studies of the ATLAS Muon Level-1 Trigger based on the MDT Detector for the LHC Upgrade

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The present muon Level-1 trigger of the ATLAS is given by dedicated detectors for the trigger; RPC and TGC chambers in barrel and endcap regions, respectively. The monitored drift tube (MDT) chambers and the CSC are used for precision measurements of muon tracks. The performance of the muon Level-1 trigger is limited by the momentum resolution of the trigger chambers. In order to improve the trigger performance, the muon track finding scheme based on the MDT signals is envisaged. The studies of the algorithm and the estimation of the trigger latency will be presented.

Summary

The present ATLAS muon spectrometer system consists of two types of chambers, which are for the purpose of either the precision momentum measurements of the tracks or the fast track finding for the Level-1 trigger. The monitored drift tube (MDT) chambers and the cathode strip chambers (CSC) in the inner-most endcap region are used as precision-tracking chambers. The resistive plate chambers (RPC) in the barrel and the thin gap chambers (TGC) in the endcap region are dedicated for the triggering. The muon trigger system provides the flag of the muon track with the pT (transverse momentum) thresholds in range 6-35 GeV. According to the simulation studies of the muon trigger rate, the sharpness of the pT threshold curve is a dominant contributor of the trigger rate. The long tail of the threshold curve towards the lower momentum region makes the background rate worse. The present trigger chambers and their trigger circuits satisfy the requirements of the L=1034 cm-2s-1 operation. In the luminosity upgrade of the LHC, the improvement of the trigger performance would be foreseen for the potential requirement of the additional robustness against the background. The simulation studies show that the detectors having higher momentum resolution for the trigger are desired to sharpen the pT threshold curve. Additional detectors for the trigger in the inner most regions also contribute the reduction of the muon trigger rate. The replacement of the existing trigger chambers is not a realistic solution. The replacement of the existing trigger electronics does not help the reduction of the muon trigger rate. We propose the muon level-1 trigger based on the MDT detectors. The leading edges of signals from the MDT ASD chips are bunch identified (BCID) with the 40 MHz LHC clock and transmitted from the cavern to the counting room via high speed serial links. The data are processed by FPGA based modules in standard crates. The BCID signal is equivalent with data from a TDC having 25 nsec time resolution, which corresponds to 0.1 mm drift length of the MDT. Processing the BCID signals from multi-layers MDT detectors, one can find muon tracks having high pT momentum. The algorithm of the track finding will be shown. The estimated the trigger latency is approximately 3 □sec, which satisfies the constraint from the present frontend system of the ATLAS.

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