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Detailed Performance Study of ATLAS Endcap Muon Trigger with Beam Collision Data

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In 2009 the first beam collision was occurred at LHC and the ATLAS detector has started data taking with beam collision at 7TeV since May 2010.
Thanks to the eagerest commissioning works with test pulses, cosmic rays and single beams, the Level-1 endcap muon trigger system can successfully provide trigger signals on proper timing for the ATLAS detector. The phase adjustment of the gate timing, optimization of the gate width and others have been done using real muons from the beam collision in the commissioning phase. Insufficient immunity of the system against the frequency change during LHC ramping-up and beam chromaticity was found. After the detailed investigation into such unexpected feature, we could optimized data taking procedure eventually by minimizing error occurrence. We report results of detailed studies on the performance of Level-1 endcap muon trigger with beam collision data.

Summary

The Level-1 endcap muon trigger system is a part of the first stage among the three level of ATLAS trigger system. It selects events containing muons with transverse momentum (pT) greater than 6 GeV/c.
The coverage of the Level-1 endcap muon trigger system is from η = 1.05 to 2.4.
The Thin Gap Chambers (TGCs) are installed in three stations with seven layers in each ATLAS endcap region. A muon is identified with three station coincidence and course pT with six level thresholds is measured in r-φ space.

We have been taking the data using cosmic rays and single beams since 2008. And we have developed the system to keep the best trigger performance as much as possible through precise timing adjustment, fixing of cable connection bugs, recovery of noisy or dead channels, and measurements on chamber efficiencies.

The Level-1 endcap muon trigger has so far provided on good timing in beam collision. However, some TGCs have the time jitter over than 25 ns (repletion time of bunch crossing). We need finer adjustments on the gate timing and gate width in order to give more reliable trigger signals.
In commissioning with beam, we have also found that our electronics system is sensitive to clock phase shifts. Frequency and phase of LHC clock are slightly changed during the beam ramp up, and some optical links lose the synchronization and it causes problems on data read out. In addition when the system clock source is changed, our system fails to find bunch identification for events. We will introduce new features on our timing and trigger control system to recover synchronization.
In this report we will discuss various problems encountered and overcome in the system development stage and report the first results of systematic study of the performance of Level-1 endcap muon trigger with beam collision data.

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