Commissioning of the ATLAS Muon Trigger System With Early Data

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1. – ATLAS Muon Trigger

The ATLAS trigger system has been designed on three levels in order to reduce the high rate of collision events, about 1 GHz if we consider the LHC instantaneous luminosity of 10^{34} cm^{-2}s^{-1}, to the maximum rate we can afford to write on disk, about 200 Hz. The goal is to have a selection that gives the highest efficiency on the physics events studied and an elevated rejection on background events. In this section we present the three levels of the muon Trigger.

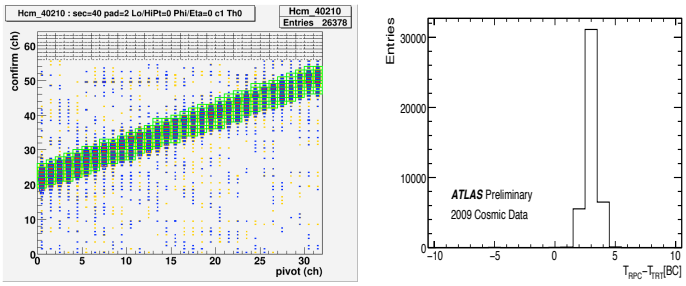

Fig. 1. – *Left:* In green we have the trigger roads, while all other colours are for muon hits. *Right:* Calibration of RPC Timing is performed with cosmic muons using the Inner Detector TRT timing as a reference, here the difference between the two is given in units of Bunch Crossing (BC)

1˙1. *Muon Level One Trigger.* – The first level muon trigger is hardware based. Its aim is to select muons giving a first estimate of their parameters: p_T, η, ϕ. This is done using the trigger chambers: RPC (*Resistive Plate Chambers*) in the central region of the detector, $|\eta| < 1.05$, and the TGC (*Thin Gas Chambers*) in the forward region, $1.05 < |\eta| < 2.7$.

1˙2. *Muon Level Two Trigger.* – The Level Two (L2) trigger uses software algorithms to reconstruct the muon and applies a selection:

- μFast - Uses both the trigger chambers and the precision chambers to perform a more accurate measurement of the muon p_T using the sagitta method, η and ϕ in the spectrometer.

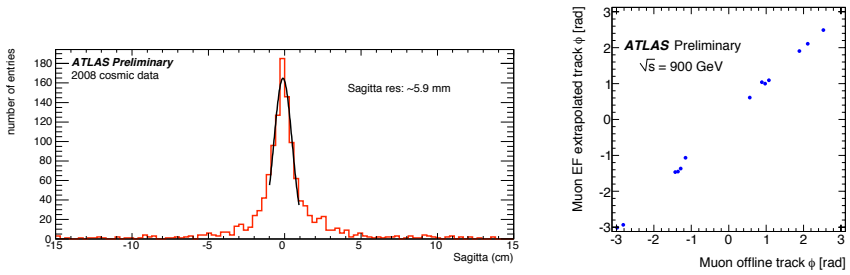

Fig. 2. – *Left:* μFast sagitta reconstruction with cosmic data. *Right:* Comparison between the ϕ coordinate as reconstructed by the EF and the offline muon's one performed using 900 GeV collision data.

- μComb - Combines μFast measurement with the corresponding Inner Detector track, improving the resolution on the muon parameters reconstruction.
- μIso - Requires the muon to be isolated using the Inner Detector and Calorimeters information.
- μTile - Identifies muons by their energy deposit in the Tile Hadronic Calorimeter.

1˙3. *Muon Event Filter Trigger*. – Having about 2 seconds of time to reconstruct the event and apply a selection, the Event Filter is able to use the offline muon reconstruction algorithms. In analogy to the L2 algorithms, here too the muon is first reconstructed in the muon spectrometer, then combined with an Inner Detector track.

2. – Commissioning of the Muon Trigger with Early Data

In this section we present some preliminary results on the commissioning of the muon trigger system presented in the previous section. Those results have been obtained using either the cosmic-ray data collected in 2009, or the LHC collision data collected in November-December 2009 at $sqrt(s) = 900$ GeV.

The commissioning of the L1 muon trigger has been focused on two main aspects:

- the roads: the spatial correlation between the hits of the muons left on different RPC (TGC) chambers (figure 1 on the left);
- the timing alignment: the trigger devices and the readout devices have to be synchronized between them and with respect to the other ATLAS sub-detectors in order to perform a coherent measurement on data (figure 1 on the right).

Validation of the L2 and EF algorithms has been also performed using both cosmic and colliosion data. In figure 2, on the right, the sagitta measurement performed by μFast with cosmic data is shown. In figure 2 on the left the muon's ϕ parameter as measured by the EF algorithms is compared with the one reconstructed by the offline algorithms for early LHC collision data.