Calibration and Performance of the precision chambers of the ATLAS muon spectrometer

Elena Solfaroli Camillocci
(on behalf of the ATLAS Collaboration)
Università degli Studi di Roma "La Sapienza" and INFN Roma, ITALY

1 MDT Calibration and Data Quality Assessment

The precision Monitored Drift Tube (MDT) [1] chambers of the ATLAS muon spectrometer [2] measure the track sagitta up to a pseudo-rapidity of 2.7 with a 40μm uncertainty, yielding a design muon transverse momentum resolution of 10% at 1TeV. To ensure a 80μm resolution on single hit, continuous MDT calibration [3] is necessary. It consists of computation of single tube drift time offset (t_0), and determination of the space vs time (r-t) relation of each chamber [3]. High statistics is required: $2 \cdot 10^8$ muon tracks over the entire spectrometer in less than one week. To this purpose a dedicated Stream of muon data, the Muon Calibration Stream [4], is extracted from the second level trigger, requiring a track in the MDTs pointing to the collision vertex (10kHz muon rate in 2010 obtained with an instantaneous luminosity of $\sim 10^{32}\text{cm}^{-2}\text{s}^{-1}$). Data are streamlined and processed in three Calibration Centres (sited in Ann Arbor, Munich and Rome). The full chain, from the data extraction to the assessment of the data quality (DQA) and the calibration computation, requires one day latency.

The DQA at the Calibration Centers takes advantage of the large statistics of muon tracks to monitor the MDT performances looking at detector level. Also the muon track reconstruction is monitored, providing high level quality assessment on current reconstruction with latest calibration constants.

The MDT calibration constants are uploaded in the Condition database at CERN, whenever significant variations are observed.

2 Performance measured with first LHC data

During the first year (2010) of LHC collisions, the Calibration Centres were fully operative. The short-term reproducibility and stability of the calibration constants were tested, comparing results obtained in different high statistics runs taken few days apart (October 2010). The results are shown in figure 1. For the t_0 distributions on the left, the mean values show a very small overall shift of -0.2ns and the RMSs

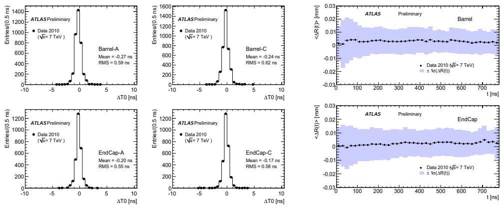

Figure 1: Short-term reproducibility and stability of t_0 (left) and r-t (right). The t_0s are obtained with a fit to the drift time spectrum of all the tubes in the same front-end electronics card (24 tubes). The r-t relations are evaluated per chamber for each run. In each time bin, the distribution of the differences between the two r-t relations is fitted with a gauss function, the resulted mean values are reported (black dots). The colored bands represent $\pm 1\sigma$ in the spread of the r-t differences around the mean value.

are all compatible with the statistics uncertainty of each measurement. The stability of the r-t determination, shown on the right, is within $\pm 10\mu m$ all over the detector, ensuring a good short-term reproducibility.

We also estimated the systematics of the calibration constant determination, comparing results obtained using different muon samples: calibration stream muon tracks and muons selected and reconstructed offline ($p_T > 4GeV$), for the same collision data. Figure 2 on the left shows the distribution of the differences in the t_0 determination for the Barrel-C. Similar results are obtained for the other regions: the RMS differences are between 1.4 and 1.7ns and an overall difference of about 1ns is observed. On the right, the differences in the r-t computation are shown, they are well below $30\mu m$ for most of the tube radii all over the detector.

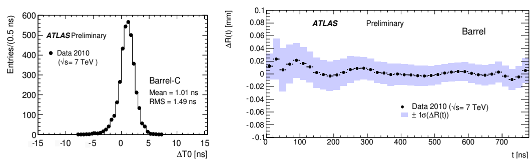

Figure 2: Estimate of the systematics due to muon selection in the t_0 (left) and r-t (right) determination, comparing results obtained using different muon samples. For the right plot the black dots are the mean values resulted fitting with a gauss function the r-t difference in that bin. The colored bands represent the $\pm 1\sigma$ regions.

References

[1] M.Livan "Monitored drift tubes in ATLAS", Nucl. Instrum. Meth. A384:214-218 (1996).

[2] ATLAS Muon Collaboration "ATLAS Muon Spectrometer Technical Design Report" CERN/LHCC/97-022 (1997).

[3] D.Orestano et al. "Calibration model for the MDT chambers of the ATLAS Muon Spectrometer" ATL-MUON-PUB-2008-004 (2008).

[4] E.Pasqualucci et al. "Muon detector calibration in the ATLAS experiment: data extraction and distribution" Nuclear Science Symposium Conference Record, 2005 IEEE, 830-833 (2006).