On-line Calibration of MDT Chambers in the ATLAS Muon-Spectrometer

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The precision tracking in the ATLAS-Muonspectrometer is performed by 1200 drift-tube chambers (MDT). They consist of two multi-layers on a support structure. The multi-layers themselves are built out of three to four layers of drift tubes in a tight package (see figure 1). The tubes have a diameter of 3 cm and are filled with a gas mixture of Argon and CO_2 at a pressure of 3 bar. A voltage of 3080 V leads to a gas amplification of $2 \cdot 10^4$. A single tube resolution of better than 80 μm is demanded.

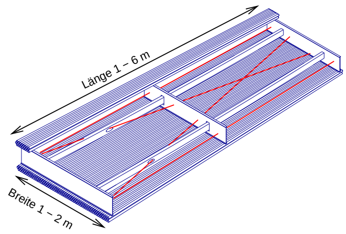

Fig. 1: The MDT chambers consist of two multi-layers glued to a support structure.

In the on-line calibration the conversion from the measured TDC digits to the drift radii is calculated with the data from the detector. In order to reach the single tube resolution, the conversion function has to be known with a precision better than 20 μm. As the reconstruction of the data cannot start before the calibration is provided, the calibration must be done within 24 hours after the data taking.

The calibration is strongly dependent on the background irradiation in the cavern, and therewith on the instantaneous luminosity. Therefore the calibration will be done for 10 minute intervals. To get sufficient statistics, a dedicated calibration stream is extracted after the level 2 muon trigger (2 kHz, 300 GB/day) and transfered to the calibration centers. The calibration stream was successfully created and transfered to the centers during commissioning runs with cosmics. The full chain is to be commissioned in 2008.

The first step in the calibration is the determination of the start of the drift-time spectrum (t_0-fit) for each tube, in order to compensate for signal processing and propagation times. This is done by fitting the edges of the drift-time spectra with Fermi-functions (see figure 2). The position of the leading edge yields t_0. An automatic procedure using a pattern recognition to determine fit ranges allows a reliable fit, which is needed because of the large number of tubes ([1]).

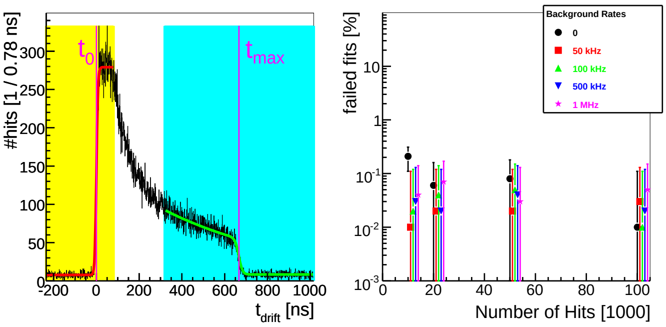

Fig. 2: The fit regions are selected automatically. The stability is tested for different number of hits, and different background rates. The fits are reliable with more than 20000 hits per fit.

In a second step the conversion function between drift times and radii (r-t-relation) is calculated using the overconstraints of fitting a straight track to up to eight hits. The analytic method described in [2] reliably converges to the right r-t-relation also in regions with an adverse angular distribution of the tracks, and provides the precision needed with 2000 tracks per muon chamber (see figure 3).

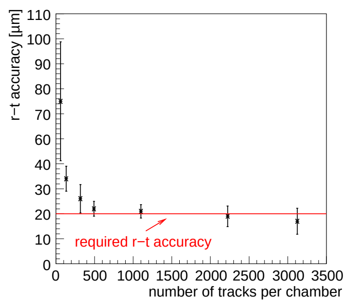

Fig. 3: The precision of the r-t-relation is determined depending on the number of segments per chamber.

Before the calibration is used it has to be validated. Therefore several control histograms are created (drift-time, residual distributions). They also provide vital information to check for proper operation conditions of the muon spectrometer. An automatic procedure to analyze these histograms for the large amount of chambers is under development.

References

[1] O. Kortner, F. Rauscher; Automatic Synchronization of Drift-Time Spectra and Maximum Drift-Time Measurement of an MDT; ATLAS note ATL -MUON-2005-012

[2] Mario Deile, Ph.D. thesis, LMU München, 2000, Optimization and Calibration of the Drift-Tube Chambers for the ATLAS Muon Spectrometer