MDT Chamber Alignment Studies within the ATLAS Software Framework

M. Obermaier, O. Biebel, T. Christiansen, J. Dubbert, G. Duckeck, J. Elmsheuser, M. Erlebach, F. Fiedler, R. Hertenberger, J. Kennedy, R. Mameghani, D. Merkl, T. Nunnemann, F. Rauscher, D. Schaile, M. Schott, A. Staude, H. Steffens, R. Ströhmer, A. Varga, F. Vollmer, and C. Zupancic

The MCT package [1] is a software collection for simulation and reconstruction of muons in the Cosmic Ray Measurement Facility in Garching [2]. Aimed at providing calibration and alignment procedures for the ATLAS Monitored Drift Tube (MDT) Chambers, the MCT package has been fully integrated into the ATLAS software framework Athena. The Athena framework, which was realized exclusively in C++, strongly emphasizes reusability and provides generic algorithms and tools which define experiment-wide policies on simulation and reconstruction tasks.

Additionally, Athena components provide useful features for high-energy physics computing. Among those are a unified detector description concept, the Athena "GeoModel", and a memory management system, which separates between transient and persistent stores, depending on the particular type of data. Another key feature is interactivity and dynamic library loading. Starting from a generic Athena executable, algorithms, data structures, converters and other components are specified via a job-options configuration file in order to be instantiated at run-time.

The MCT package realizes each reconstruction task as an Athena algorithm. The raw data, as obtained from the Measurement Facility setup, is processed several times in order to obtain calibration data which is needed to perform precise reconstruction of muon events. The first calibration run concerns corrections to the measured drift times. Tube-specific time parameters of the drift time spectra are calculated and applied in the next step in order to get correct drift-time to radius conversions. The drift-radius information is used in the pattern finding process which associates sets of drift radii with muon trajectories, to be further processed in track fitting. Subsequently, track information for each muon event is stored in ROOT N-Tuples.

Event reconstruction depends on precise calibration. The correct alignment of the MDT chambers is particularly important. The experiment setup in Garching relies on two well-known MDT chambers acting as "reference chambers" which enclose a third MDT chamber, the "test chamber". Muon trajectories can be reconstructed independently in each of these chambers. By comparing these trajectories a relative alignment of the chambers can be determined. Originally the test chamber has been used as a reference frame for the chamber alignment. However, internal deformations of the test chamber can generate various subtle effects which possibly bias the results. Therefore, the alignment process has been changed: only the reference chambers, for which the internal alignment is well known from other measurements, are aligned with respect to each other while the test chamber is not aligned.

In the new procedure one can then investigate step-by-step the alignment parameters of the chamber at different levels: taking the chamber as a whole, then each multi-layer, each single-layer and finally the position of individual tubes. In addition, it is possible to study chamber distortions beyond the assumption of a rigid body. One such effect has been found, the two ends of the test chamber are slightly twisted with respect to each other, see figure 1. At the extreme positions this twist causes a deformation of about 100 μm.

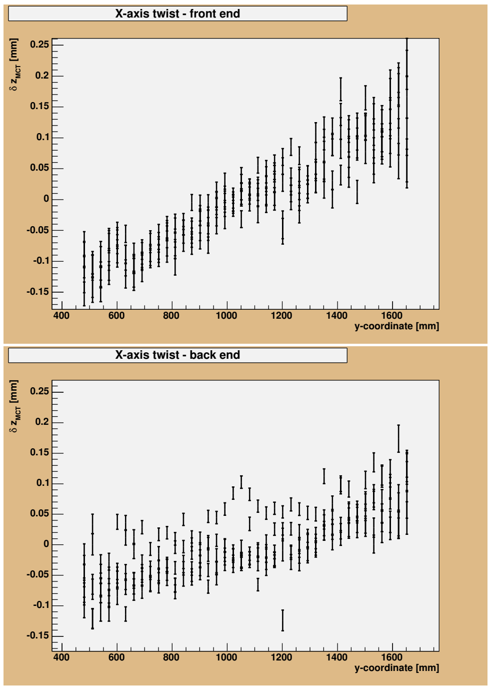

Fig. 1: Vertical wire displacements vs horizontal wire position for front side and back side. The difference in slope corresponds to an MDT chamber twist.

Other deformations were investigated but found to be not significant. We also compared the individual wire displacements with wire position measurements using an X-ray tomograph [2] and with the existing reconstruction software MTOffline [3]; in both cases we found good agreement.

References

[1] Alexander Brandt, diploma thesis, LMU München, 2003
[2] LMU-ETP-2003-01.
[3] O. Kortner, Ph.D. thesis, LMU München, 2002