Calibrating Cut-Out Chambers at the Cosmic-Ray Measurement-Facility

O. Biebel, G. Duckeck, J. Elmsheuser, M. Erlebach, F. Fiedler, R. Hertenberger, J. Kennedy, G. Krobath, R. Mameghani, D. Merkl, T. Nunnemann, F. Rauscher, B. Ruckert, D. Schaile, C. Serfon, M. Schott, and R. Ströhmer

1. Introduction

The drift-tube chambers which perform the precision tracking in the ATLAS Muon Spectrometer consist of two multilayers containing three layers of drift tubes each. The multilayers are glued to a spacer with two long beams parallel to the tubes and three cross-plates perpendicular to the tubes. An optical alignment system monitors the deformation of the spacer and the position of the middle cross-plate with respect to the outer ones. The outer cross plates are close to the end plugs of the tubes, where the wires are fixed. Tere is no intermediate support of the wires in between the end plugs, and therefore they show a gravitational sag of 200 μm if the chamber is in horizontal position. The vertical position of the middle cross plate, and with it the sag of the tube walls, can be adjusted so that the wires are centered along the tubes. A sag adjustment with a precision of 100 μm makes the drift-time to radius relation independent of the track angle.

The outermost chambers of each sector of the barrel muon-spectrometer have a cut-out which allows an optical alignment system to look at the end-cap muon-spectrometer. This is formed by using shorter tubes in one region per multilayer (see figure 1). The endplugs of these shorter tubes are fixed at the middle cross plate. Here the sag adjustment directly affects the vertical wire position of the shorter tubes and has therefore to be done with a precision of 20 μm.

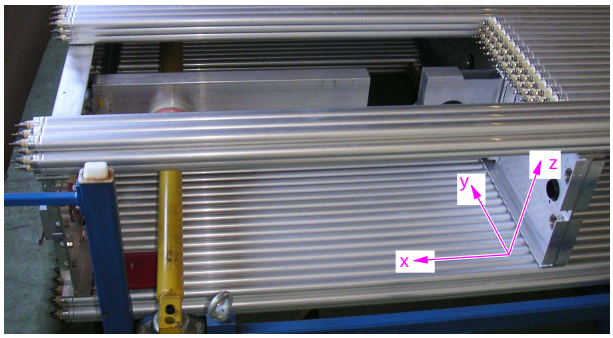

Fig. 1: Cut-out region region of a special MDT-chamber. Indicated is the coordinate frame, which will be used furtherly.

Two methods of verifying the sag adjustment at the Cosmic Ray Test Facility were investigated.

2. Verifying the Wire Centricity with the Maximum Drift Time

Tracks with a slope $|m| > 0.4$ which pass the middle meter of the tubes are selected. Drift time spectra are filled for tracks above and below the wire separately (see figure 2). The lengths of these spectra, $t_{max,\,above/below}$, are determined by fitting Fermi-functions to their trailing edges (see [1]). If the wire is not in the centre of the tube these lenghts will differ as the maximum drift difference differs. The deviation of a wire position from the centre of the tube is approximated by

$$\Delta z \;=\; v_{drift}\;(t_{max,\;above}\;-\;t_{max,\;below})\;/\sqrt{1\;-\;\langle|m|\rangle}, \tag{1}$$

where v_{drift} is the drift velocity near the tube wall and $\langle|m|\rangle$ is the mean slope of the selected tracks. The wire centricity averaged over the whole chamber can be determined with a precision of 50 μm.

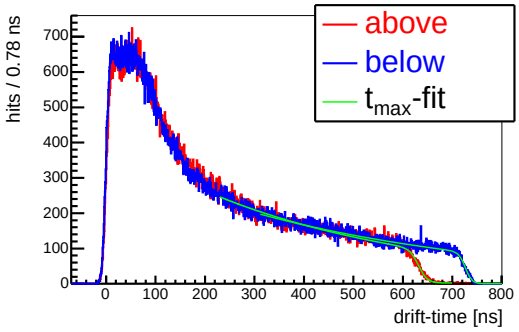

Fig. 2: Drift time spectra for tracks passing above and below the wire for an extremely wrong sag setting.

3. Vertical Wire Positions

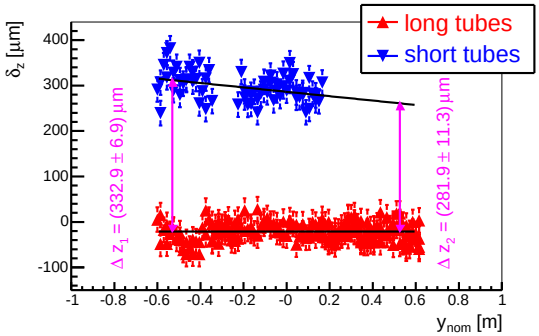

Fig. 3: Wire displacement for a chamber with an extremely wrong sag setting

At the cut-out chambers, the wires of the shorter tubes are fixed at the middle cross plate. Therefore the vertical wire positions of these tubes are determined by the sag compensation.

To calibrate the sag setting of the cut-out chambers the vertical wire position is measured at an x-position corresponding to the end of the shorter tubes. A straight line is fitted to the distribution of the deviation of the measured z-position from the nominal versus the nominal y-position for both, the shorter and the long tubes. The distance of these lines at the longbeam position constitutes the correction to the sag setting.

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