Series Calibration and Commissioning of ATLAS-MDT-Chamber at the Cosmic-Ray Test-Facility

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Since end of the year 2003 the test, commissioning, and calibration of ATLAS monitored drift-tube (MDT-) chambers is done in series and at a rate of one chamber per week. The 88 drift tube chambers to be processed at LMU's cosmic-ray test-facility are built in collaboration with the Max-Planck-Institut für Physik (MPI) in and the JINR at Dubna. These chambers are the second largest (BOS) of the 1200 drift-tube chambers which provide precision tracking in the ATLAS Muon-Spectrometer [2]. BOS-chambers consist of 432 drift tube of about four meters in length and three centimetres in diameter. They are arranged in two multi-layers, each containing three layers of tubes. 48 out of 88 chambers have been tested up to now in the facility at LMU [1].

After measuring the wire-resistance to check for broken wires and bad electrical contacts, the gas connections on the chamber are inspected for tightness. By close collaboration and exchange of experience with the production team of the MPI, who mount the on-chamber gas-system, the number of leakages could be reduced to a minimum. On average only about 4 leakages per chamber, whose gas system contains 3500 o-ring seals, have to be repaired. After these repairs the chambers fulfilled the stringent ATLAS requirement for gas tightness, which was asserted by monitoring pressure and temperature of the chambers over several days (see figure 1) [3].

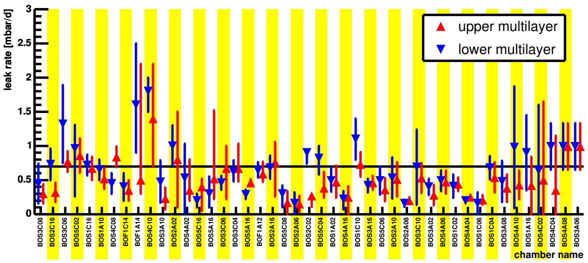

Fig. 1: The pressure loss per day corrected for temperature changes. The horizontal line marks the ATLAS requirement.

Afterwards, the on-chamber electronics is mounted, and the chamber is tested for high-voltage stability and basic funtionality of the read-out. By autumn, the final version of the mezzanine read-out cards became available. These cards contain the complete signal processing, and are mounted directly on the chambers. Like this the chambers now are tested together with the final electronics. The basic functionality and the noise rate in each channel is checked before the chamber is installed in the test-facility.

During two days 13 million events are recorded. Analytic functions are fitted to the edges of the drift-time spectrum of each tube, which results in a set of parameters describing the response of the tube. The equality of these parameters for all tubes asserts the homogeneity of the chamber response to muons. The length of the drift time spectrum is especially sensitive to the drift properties of the tubes. In figure 2 the difference of this quantity between the two multi-layers of the chamber shows no systematic deviation. Using the position of the rising edge of the spectra, the variations of the on-chamber signal processing times between tubes can be determined, which are important calibration constants of the chamber.

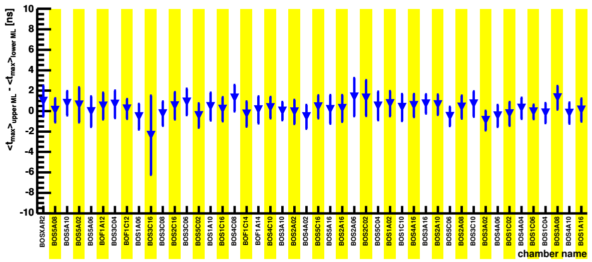

Fig. 2: Difference between the mean maximum drift times of the upper multilayer and the lower multilayer. The error bars denote the spread of maximum drift times in the chambers.

The positions of the individual anode-wires are determined by comparing the measured drift radius of the tubes in the tested chamber with the predictions derived from the extrapolated tracks of the reference chambers. Thus the wire positions can be derived with a precision of 8 μm in the chamber plane and 25 μm perpendicular to it. Averaging over layers and multilayers results in the calibration parameters like layer displacements, tilt angles and grid constants. As an example the deviation of the multi-layer distance from the nominal value is shown for each chamber in figure 3.

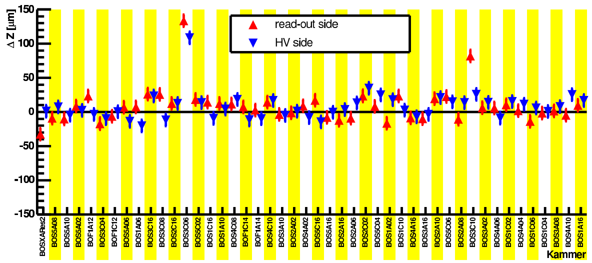

Fig. 3: Deviation of the multi-layer distance from the nominal distance for all measured chambers. Data points for both ends of the chambers, where the wire positions are fixed, are shown. The two chambers with larger deviations were known to have production errors.

All MDT chambers tested so far are gastight, show a homogeneous response and have a geometrical precision within the allowed tolerances. Two chambers showing larger deviations due to production errors, can be used without restrictions by applying the calibration parameters derived from the measurements at the cosmic-ray test-facility.

References

[1] O. Biebel *et al.*, physics/0307147, LMU-ETP-01 (2003)
[2] ATLAS Muon Technical Design Report, 1997, CERN-LHCC-97-22
[3] R. Hertenberger *et al.*, Annual report 2003