A Cosmic Ray Telescope for Chamber Calibration, Hardware Progress and Simulation

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With the MPI in Munich we will build 88 MDT BOS chambers during the next four years for the ATLAS experiment at CERN [1]. The initial geometry survey and the study of calibration procedures to reduce the systematic effects of operation will be performed in a detector laboratory in Garching. Apart from determination of gas leak rates and leakage currents we plan to equip the chambers with readout electronics and run them as position detectors for a few days in the cosmic ray test stand. Efficiency, noise and drift-time spectra will be measured for each tube. We furthermore plan to measure the position of the anode wires relative to those in permanently installed reference MDT chambers.

The cosmic ray muon test stand (see Figure 1 and [2]) has a permanent part and chambers to be tested. The permanent part consists of two MDT reference chambers, measured at the X-ray tomograph. Below the lower MDT reference chamber is an absorber consisting of a layer of solid iron, 34 cm thick. Below that iron absorber is a hodoscope with a time resolution better than 800 ps with the counters oriented perpendicular to the MDT tube. Below the hodoscope are two layers of streamer tubes, giving a spatial resolution of about 1.5 mm with tubes oriented parallel to the MDT tubes and placed about 1 m below the absorber. Above the top MDT reference chamber is another layer of streamer tubes. The chamber to be tested is positioned in between the two chambers. The permanent part of the teststand would provide:

- A trigger on cosmic ray muon with more than 500 MeV energy.
- From the two MDT reference chambers the position of the hit perpendicular to the MDT wires in the horizontal plane.
- From the streamer tubes above the iron and the hodoscope below it, the position of the hit along the MDT wires with a precision of a few cm.
- From the MDT reference chamber immediately above the iron and the streamer tubes below it information on multiple scattering in the iron. Tracks with large multiple scattering stem most probably from low energy muons and will be discarded.

Between the two reference MDT chambers the MDT chamber(s) to be tested are installed. We have foreseen three different scenarios for test and calibration:

- Chambers in operating positions at 0, 22.5 and 67.5°.
- Determination of the anode wire coordinate in the multilayer planes in 0° set-up.
- Determination of the coordinate orthogonal to the multilayer planes in vertical set-up.

For both scenarios we calculated the precision to determine wire positions. Multiple scattering is the main limiting factor. All our calculations are done for an accumulation time of 10 hours, i.e. 20000 events per 1 m length of tube in the middle of the teststand. At the borders of the teststand the event rate is zero because of vanishing angular acceptance. The plan is to run 10 hours with the chamber not centered in the teststand but shifted by one third of the chamber width in the -z-direction and a second measurement (10 hours) with the chamber shifted by one third of the chamber width in the +z-direction. The average number of events per tube with the two data sets combined would be at least 13000 per meter of tube. A detailed Monte Carlo study with GEANT3/GEANT4 shows that in the cosmic ray teststand a determination of wire positions in the z-coordinate should be possible within 10 - 15 μm precision for chamber lying flat and 10 - 30 μm precision for tilted chambers. Systematic errors should not spoil the measurement. Because of the small stereo-angle we expect to measure the wire position relative to the reference chambers in the y-coordinate with a much lower precision (50 μm for the center of the teststand where the stereo-angle is $\pm\pi/6$).

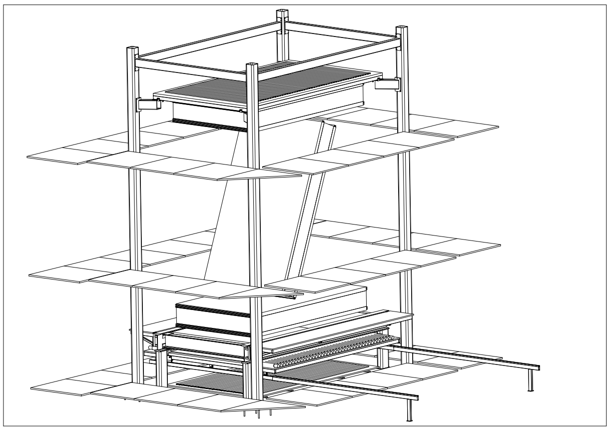

Fig. 1: Schematic of the cosmic ray teststand.

It is foreseen to measure the first MDT chamber in July this year. The frame of the teststand and the iron absorber are in place, the streamer tubes and the scintillation counters for the hodoscope are tested and will be installed during the next weeks. For the data acquisition we will use MAR$_{\mathrm{a}}$BOU [3], which has been recently developed at the BL.

References

[1] The ATLAS Muon Collaboration, ATLAS Muon Spectrometer Technical Design Report, CERN/LHCC/97-22, 1997.
[2] N. Hessey, A. Staude, T. Trefzger, Cosmic Ray test stand at the LMU Munich, ATLAS-MUON-98-266, 1998.
[3] R. Lutter, O. Schaile, K. Schöffel, K. Steinberger, P. G. Thirolf, C. Broude, MARABOU - A MBS and ROOT Based Online/Offline Utility, Proceedings of the IEEE Realtime Conference, 1999