Operational Test of the Prototype ATLAS BOS Chamber ◇

O. Kortner, S. Chouridou, M. Deile, M. Hartmann, N.P. Hessey, D. Schaile, A. Staude, R. Ströhmer, and T. Trefzger

Studies in the H8 Muon Beam at CERN

In the barrel region of the ATLAS detector monitored drift tubes (MDT) will be the sensitive components of the muon spectrometer. LMU and MPI Munich will build and put into operation 90 short MDT chambers (out of 378 cm long tubes) for the outer barrel region of the ATLAS detector, so-called BOS chambers [1]. A BOS chamber consists of two triple layers of MDT tubes. The wires will have to be within ± 10 μm at their nominal position. To prove that this mechanical requirement can be fullfilled, a prototype BOS chamber was produced at MPI Munich and tested in the H8 muon beam at CERN in summer 1998.

A silicon tracker consisting of six silicon microstrip detectors with 7 μm resolution per plane was installed in front of the BOS chamber as very precise reference system. It allows to check the track reconstruction in BOS.

Mechanical Precision

As the silicon tracker gives the distance r from the tube wire, it is possible to precisely determine the r-t relation of a single tube by plotting its drift time versus r. Once the r-t relation is known one can determine the spatial resolution of a single tube as a function of r. This yields an important input for the Monte-Carlo simulation.

With the silicon tracker as external reference it is possible to measure the position of the signal wires relative to each other. This was done for a small region of the BOS chamber. The results show that the wires are within ± 20 μm at the nominal position. This is in agreement with X-ray measurements of the wire positions for the entire chamber. From these observations one can conclude that the tubes were glued with the required mechanical precision. This is also confirmed by the residual distributions of track fits, which are centered at 0 within a few μm.

Study of the Influence of Matter in the Muon Beam on the Tracking Efficiency

The muons produced at LHC will pass through a huge amount of matter – the inner detector, the calorimeter, and support structures – before they enter the muon chambers. High-energetic muons passing through matter can produce electromagnetic showers; the shower production increases with increasing muon energies. For former experiments at muon energies up to 470 GeV only phenomenological parametrizations were available. In the mean time detailed calculations have been implemented into GEANT, but multiplicity distributions at high energy have not yet been tested with high precision muon spectrometers. When the shower particles enter the muon chambers, they give rise to hits in the chamber in addition to the muon hits and hence spoil the tracking efficiency. Obviously, this has to be taken into account when tuning the track finding and track reconstruction algorithms.

To study the influence of shower production on the performance of the muon chambers, a 5 cm thick iron absorber of 11×11 cm^2 cross section was put into the 180 GeV H8 muon beam 47 cm in front of BOS chamber. In about 10% of the events the absorber causes extra hits in the chamber. The distribution of extra hits is present in figure 1. The tracking efficiency is reduced by 1% compared to no-absorber runs.

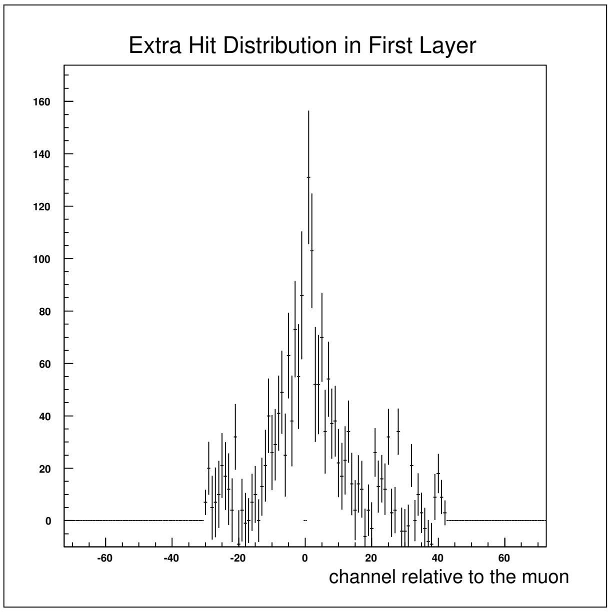

Fig. 1: Extra hit distribution in the first layer.

Since the effect of the shower production is much stronger at LHC energies which are currently unavailable for test beam studies, Monte-Carlo simulations are required to estimate the tracking efficiency at these energies. A full detector Monte-Carlo simulation (based on CERN's detector simulation package GEANT) was developed at LMU and compared with the test beam measurements. At present Monte-Carlo and experimental data show agreement within the uncertainties of the measurement. After this first experimental test, further studies are foreseen to show that the muon simulation is suited to estimate tracking efficiencies at LHC energies.

References

[1] The ATLAS Muon Collaboration, ATLAS Muon Spectrometer, Technical Design Report, CERN/LHCC/97-22, 1997

◇ supported by BMBF