Quality Assurance for the ATLAS Muon Spectrometer Drift Tubes ◇

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1. Motivation

A high precision momentum measurement for muons in the range of 5 GeV/c into the TeV/c region is vital for the exploration of the physics potential of future hadron colliders. Extending the concept of magnetic spectrometry into the above momentum range requires large volume detectors with stringent demands on the precision of the individual active cells and their relative alignment. The muon spectrometer of the ATLAS experiment [1] is described in detail in [2]. The basic detection elements are pressurized drift tubes which are combined into chambers of suitable geometry. Once implemented into larger structures, repair or even replacement of these drift tubes is virtually impossible. Therefore a fast and efficient quality control of individual tubes is a mandatory part of the production chain. We have designed such a quality assurance facility, which up to now has served as a feedback to the production of prototype tubes and as check-out for smaller mass productions of tubes which are combined into prototype chambers to establish the assembly procedure. With further optimizations such a quality assurance facility will be part of the production sites which will produce a total of 300 000 drift tubes for the ATLAS detector.

2. Sense wire location

The tight specifications for the location of the central sense wire relative to the tube outer diameter require a precision of 10 μm in order to have intrinsic reference points for later calibration procedures which are sensitive to the relative alignment of tubes and local changes in the operating conditions. This demand is verified using the set-up shown in Fig. 1.

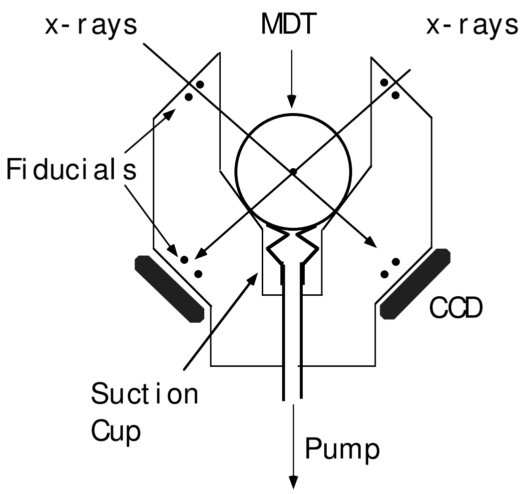

Fig. 1: Schematic illustration of the wire location measurement setup

The drift tube is positioned rigidly into two V-groves. Once positioned the location of the wire in the transverse plane can be calculated from the projected wire images of two X-ray sources relative to the image of precisely positioned fiducial wires. The images are recorded by CCD arrays (768x512 pixel format, 9x9 μm pixel size) and analyzed. The reproducability of the wire location of a single tube which is subject repeatedly to the measurement procedure amounts to 2 μm. The wire location test gives a very sensitive response to small changes of the drift tube fabrication process and also provides important input for the present transition phase from the prototyping to the production of individual tubes. Fig. 2 shows the distribution of wire locations for a recent test sample of tubes which matches the specifications.

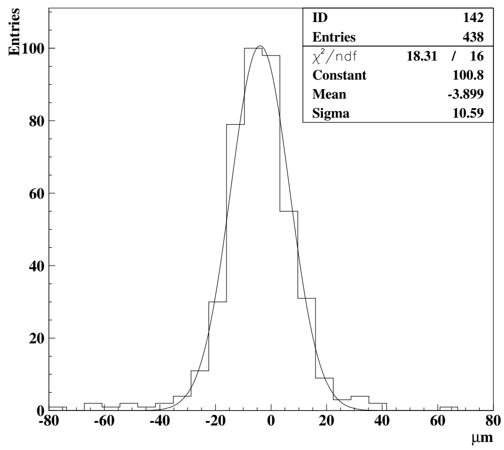

Fig. 2: Measured sense wire locations of the drift tubes for a recent prototype chamber.

3. Further Tests

The wire tension is an important parameter, which determines the stability of the tube operation and the corrections to the drift time measurement along the wire length. In our set-up the wire tension is determined by measuring the ground mode frequency of magnetically excited vibrations of the wire. In a set-up to measure the leak rate (required $< 10^{-8}$ bar l/s) a small vacuum volume is mounted around each endplug region separately. The pressure increase in the small volume is a measure of the drift tube's leak rate. Finally the response of the drift tubes to a radioactive source is recorded to test the high voltage stability and noise properties of the tube. The tubes are operated with a gas mixture (Ar(90%)CH_4(10%)) at an operating point which was optimized in extensive beam tests. We monitor the signal pulse height and the counting rate with and without source.

References

[1] The ATLAS Collaboration; ATLAS, technical proposal for a general purpose pp experiment at the Large Hadron Collider at CERN; CERN/LHCC/P2, 1994
[2] The ATLAS Muon Collaboration, ATLAS Muon Spectrometer, Technical Design Report, CERN/LHCC/97-22, 1997

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