Calibration of the Wire Positions of the Atlas Muon Spectrometer

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One of the first full scale prototypes of the Monitored Drift Tube(MDT) chambers for the ATLAS Muon Spectrometer [1] was built in 1998 at the Max Planck Institute in Munich in collaboration with the LMU and Freiburg University. This chamber consists of two triple layers(multilayers) of MDT aluminum tubes. The chamber was scanned by an X-Ray Tomograph at CERN, a very precise device(5 μm) made for the special purpose of scanning ATLAS MDT chambers. Later the prototype was placed in a high energy muon beam at CERN for testing and studying its performance.

In order that the required momentum resolution at high momenta can be achieved in the ATLAS detector, the sense wires of the drift tubes which form the MDT chambers should be positioned to better than 10 μm inside a drift tube and better than 20 μm inside a chamber. The prototype MDT chamber mentioned above fulfills these requirements: the standard deviations of the residual distributions of the X-Ray Tomograph measurements of the positions of the wires on both multilayers with respect to the ideal wire grid for the whole chamber are below the required 20 μm RMS.

A precise method for determining the wire positions of the chamber relative to each other using no external reference system has been developed. As the chamber was placed vertically to the muon beam, the position of each wire is defined by two coordinates: the so called z coordinate along the direction of the muon beam and the so called y coordinate along the direction perpendicular to the beam direction. In order to reconstruct the tracks of the muons passing through the chamber, straight lines have to be fitted to the impact circles defined by the drift times of those ionization electrons which arrive earliest at the drift tubes' anode wires. Then the difference between the fitted track and the radius of the impact circle of the tube is defined as 'residual'. When the wire of a tube is displaced, the distribution of the residuals versus the drift distance, for tracks which traverse the tube RIGHT from its wire is not symmetric with the distribution of the residuals versus again the drift distance for tracks which traverse the tube LEFT from its wire. According to the method, the positions of two tubes(one on each multilayer) are kept fixed, while the y coordinates of the twelve surounding tubes are moved till the distributions of their residuals left and right from their wires become symmetric that is till the resolution of these tubes becomes minimal.

For regions which were irradiated by the beam, the method was applied successfully to groups of 14 tubes in the chamber. The results obtained with this method were compared with those of the X-Ray Tomograph revealing a very nice correlation (fig.1) and an accuracy of the method of better than 10 μm (fig.2).

Simulation studies will show the statistical and systematic effects of the method. The completion of the method will be its application for determining also the z coordinate of the wire positions.

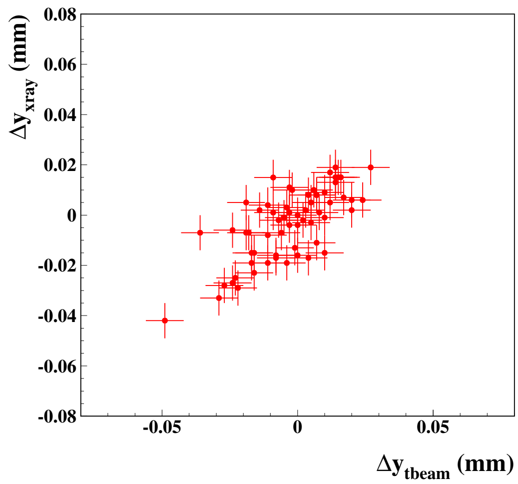

Fig. 1: The displacements of the y coordinates of the wire positions from their nominal positions for 62 tubes measured by the X-Ray Tomograph(Δy_{xray}) versus the corresponding displacements Δy_{tbeam} found with the method discussed.

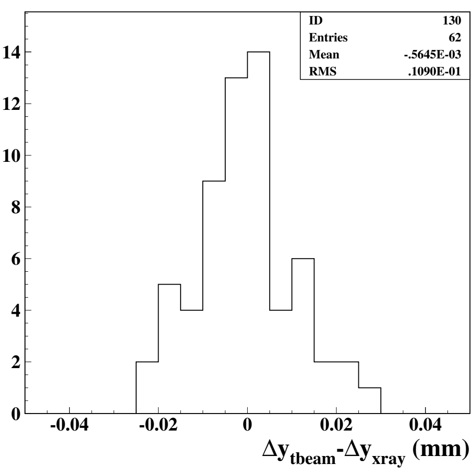

Fig. 2: The RMS of 10 μm of the distribution of the difference Δy_{xray}-Δy_{tbeam} shows that the accuracy of the method is better than 10 μm.

References

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