Alignment of the ATLAS Muon Spectrometer with Tracks

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Abstract

The muon spectrometer of the ATLAS experiment at the Large Hadron Collider is designed to measure momenta of highly energetic muons up to 1 TeV with a resolution of better than 10% in a toroidal magnetic field of superconducting air-core magnets. This requires alignment of the precision muon tracking chambers with an accuracy of better then 30 μm in the track bending plane. An optical alignment system monitors movements of the muon chambers with a precision of few microns. In order to determine the chamber positions in the spectrometer, the initial chamber positions have to be measured with 30 μm accuracy using straight muon tracks from proton-proton collisions in a dedicated run of the ATLAS detector with the toroid magnets turned off. A global χ^2 minimization algorithm determining the misalignment parameters of each azimuthal sector of the barrel muon spectrometer has been developed and tested with straight cosmic muon tracks during the commissioning of the ATLAS experiment. Simulations show that the required alignment accuracy of a sector is reached with only 10^5 muons of $p_T > 10$ GeV from the interaction point. Several barrel sectors have already been aligned with better than 30 μm accuracy using the cosmic muons tracks. In addition, a new method based on curved tracks has been developed as an alignment monitoring tool during normal operation of the experiment. The method uses a muon momentum determination from the angular deflection of the muon tracks between the inner and outer chamber layer which is independent of the standard track sagitta measurement.