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Construction and test of high precision drift-tube (sMDT) chambers for the ATLAS muon spectrometer

For the upgrade of the ATLAS muon spectrometer in March 2014 new muon tracking chambers (sMDT) with drift-tubes of 15 mm diameter, half of the value of the standard ATLAS Monitored Drift-Tubes (MDT) chambers, and 10 μm positioning accuracy of the sense wires have been constructed.
The new chambers are designed to be fully compatible with the present ATLAS services but, with respect to the previously installed ATLAS MDT chambers, they are assembled in a more compact geometry and they deploy two additional tube layers that provide redundant track information.
The chambers are composed of 8 layers of in total 624 aluminium drift-tubes.
The assembly of a chamber is completed within a week.
A semi-automatised production line is used for the assembly of the drift-tubes prior to the chamber assembly.
The production procedures and the quality control tests of the single components and of the complete chambers will be discussed.
The wire position in the completed chambers have been measured by using a coordinate measuring machine and cosmic ray muons tracks in a test stand with two MDT reference chambers.

Summary

New high precision drift-tube chambers with a tube diameter of 15 mm, a factor of two smaller than the standard Monitored Drift-Tube (MDT) chambers, have been developed for the upgrade of the ATLAS muon spectrometer in the 2013-2014 shutdown of the Large Hadron Collider at CERN.
The new chambers consist of 624, 2.2 m long, aluminium drift tubes deployed in 8 layers, for a total with a width of 1.2 m, and an accuracy of 10 μm in the positioning of the sense wires.
The new chambers operate with the same Ar:CO_2 (93:7) gas mixture at 3 bar pressure and the same read-out electronics as the present chambers.

The tube layers with 78 drift tubes each are arranged in two multi-layers of 4 tube layers separated by a spacer frame containing an optical alignment system which monitors deformation with few micron precision. The smaller tube diameter allows for more tube layers and, therefore, more tracking redundancy and for about a factor 10 higher rate capability in the neutron and gamma ray environment of the ATLAS muon spectrometer.

Extensive quality control tests are employed to ensure the high reliability of the detector.
The drift tubes are assembled and tested prior to the chamber construction using semi-automated wiring and testing stations where the wire tension, HV leakage current and gas leak rate of each drift tube are measured, quality controlled, and stored in a database. The chamber is then assembled with a procedure that allows to complete a 4 layer sub-section of the chamber in less than two working days.

After the assembly the geometry of the chamber is tested using a precision 3D-position measurement machine and a cosmic ray test facility with two MDT reference chambers with precisely known wire position and geometry.

Primary authors: SFORZA, Federico (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); KROHA, Hubert (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); KORTNER, Oliver (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); SCHWEGLER, Philipp (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Presenter: SFORZA, Federico (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Track Classification: Sensors: 1c) Gaseous Detectors