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Construction and Test of a Prototype Chamber for the Upgrade of the ATLAS Muon Spectrometer

Bernhard Bittner, Jörg Dubbert, Hubert Kroha,
Jörg v. Loeben, Philipp Schwegler

Abstract

The muon spectrometer of the ATLAS detector at the Large Hadron Collider (LHC) is exposed to high background rates of neutrons and γ-rays. Upgrading the LHC towards up to five times the design luminosity of $1 \times 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ necessitates the replacement of muon tracking and trigger detectors in the region with the highest radiation background in order to avoid deterioration of the muon detection efficiency and momentum resolution.

Based on the standard ATLAS muon precision (MDT) chambers, consisting of 6 or 8 layers of aluminum drift tubes with 30 mm outer diameter, faster tracking chambers using drift tubes with 15 mm diameter have been developed for the critical end-cap regions of the spectrometer. With the shorter maximum drift time of 200 ns, compared to about 700 ns now and the smaller tube cross section, the background occupancy is reduced by a factor of 7. At the same time the excellent spatial resolution of 40 μm per chamber is retained up to very high counting rates. A larger number of drift tube layers in the same detector volume offers improved redundancy and pattern recognition efficiency.

A full-sized prototype chamber consisting of 1152 tubes arranged in 2×8 layers and covering an area of $1\,\mathrm{m}^2$ has been built to validate the assembly procedure and to test the detector performance. We present results of measurements at high γ radiation rates at the CERN Gamma Irradiation Facility (GIF) and with high momentum muons at the H8 beam line at CERN. Measurements of the response of the drift tubes to highly ionizing particles (neutrons and protons) will also be discussed.