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Aligning the CMS muon chambers with the muon alignment system during an extended cosmic ray run

CMS Collaboration

ABSTRACT: The alignment system for the muon spectrometer of the CMS detector comprises three independent subsystems of optical and analog position sensors. It aligns muon chambers with respect to each other and to the central silicon tracker. System commissioning at full magnetic field began in 2008 during an extended cosmic ray run. The system succeeded in tracking muon detector movements of up to 18 mm and rotations of several milliradians under magnetic forces. Depending on coordinate and subsystem, the system achieved chamber alignment precisions of 140–350 μm and 30–200 μrad, close to the precision requirements of the experiment. Systematic errors on absolute positions are estimated to be 340–590 μm based on comparisons with independent photogrammetry measurements.

KEYWORDS: Muon spectrometers; Large detector systems for particle and astroparticle physics

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Table 4. Typical precisions obtained for DT and CSC chamber alignment. Dashes in the table indicate degrees of freedom not yet measured by the system. Of the reconstructed degrees of freedom, the most relevant for momentum measurement is $r\phi_{CMS}$, the remaining affecting the momentum reconstruction as a higher-order correction.

Chamber	$r\phi_{CMS}$ [μm]	z_{CMS} [μm]	$\phi_{x_{\text{local}}}$ [μrad]
DT	200	–	–
CSC ME1	–	220–340	–
CSC ME2,3,4	–	280–320	200

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