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Performance of the CMS drift tube chambers with cosmic rays

CMS Collaboration

ABSTRACT: Studies of the performance of the CMS drift tube barrel muon system are described, with results based on data collected during the CMS Cosmic Run at Four Tesla. For most of these data, the solenoidal magnet was operated with a central field of 3.8 T. The analysis of data from 246 out of a total of 250 chambers indicates a very good muon reconstruction capability, with a coordinate resolution for a single hit of about 260 μm, and a nearly 100% efficiency for the drift tube cells. The resolution of the track direction measured in the bending plane is about 1.8 mrad, and the efficiency to reconstruct a segment in a single chamber is higher than 99%. The CMS simulation of cosmic rays reproduces well the performance of the barrel muon detector.

KEYWORDS: Large detector systems for particle and astroparticle physics; Particle tracking detectors (Gaseous detectors)

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has been measured to be about 99% in all chambers. The comparison between measurements of the track segment positions and directions in the different chambers shows a behaviour compatible with the expectations from the multiple scattering of the muons in the steel yoke. The spread in the measurement of the track direction in the bending plane of CMS was about 6 mrad, averaged over the whole momentum spectrum of cosmic muons with $p_T > 10\,\text{GeV/c}$. The bending power in the steel return yoke between the innermost and outermost station has been measured to be about 3 mrad for $p_T = 200\,\text{GeV/c}$ muons. The relative misalignments of the chambers, as measured by the data collected at $B = 0$ T, are well within the mechanical tolerances (a few mm) for the insertion of the chambers into their cradles inside the magnet yoke structure.

The chamber performance is in good agreement with the simulation; it provides a good starting point that assures fully efficient operation of the muon DT trigger and eventual achievement of the original design criteria of the DT system. The criteria specify robust and efficient muon identification, and the capability of measuring the muon position in each station with a precision of about 100 μm, in order to provide good momentum resolution for highly energetic muons. The above results are very encouraging and allow the anticipation of a good performance of the DT barrel muon detector during early phases of LHC operation and data taking, which would provide efficient identification and reconstruction of muons.

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References

[1] CMS collaboration, *The CMS experiment at the CERN LHC*, 2008 *JINST* **3** S08004.

[2] CMS collaboration, *Commissioning of the CMS experiment and the cosmic run at four tesla*, 2010 *JINST* **5** T03001.

[3] T. Christiansen, *The CMS magnet test and cosmic challenge*, CMS-NOTE-2006-076 (2006).

[4] M. Fouz et al., *Measurement of the Drift Velocity in the CMS Barrel Muon Chambers During CMS magnet test and cosmic challenge*, CMS-NOTE-2008-003 (2008).

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