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Calibration of the CMS drift tube chambers and measurement of the drift velocity with cosmic rays

CMS Collaboration

ABSTRACT: This paper describes the calibration procedure for the drift tubes of the CMS barrel muon system and reports the main results obtained with data collected during a high statistics cosmic ray data-taking period. The main goal of the calibration is to determine, for each drift cell, the minimum time delay for signals relative to the trigger, accounting for the drift velocity within the cell. The accuracy of the calibration procedure is influenced by the random arrival time of the cosmic muons relative to the LHC clock cycle. A more refined analysis of the drift velocity was performed during the offline reconstruction phase, which takes into account this feature of cosmic ray events.

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

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The drift velocity calibration results show an approximately constant value of 54.3 μm/ns for all the chambers of the DT system, with a relative systematic uncertainty of 2.5 %. This uncertainty originates from the measured drift time, used in the mean-time method, which is limited by the uncertainty of the arrival time of cosmic ray muons. This explains why the obtained spatial resolution is worse than would be expected with collision data.

A more refined analysis of the drift velocity has been performed, exploiting the full potential of the CMS offline software for data reconstruction. It uses a track fitting procedure which leaves as free parameters the drift velocity and the time of passage of the muons through the chambers. Cosmic ray data with and without magnetic field have been studied. Without magnetic field, a constant average value of 54.5 μm/ns has been observed, with an error of 0.2 %; when the field strength is 3.8 T, the innermost chambers of the external barrel wheels measure a lower value, as expected, of about 53.6 μm/ns. These results confirm what was observed in an analysis performed on simulated collision data and provide a spatial resolution that is close to the design performance.

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References

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

[2] L. Evans and P. Bryant eds., *LHC Machine*, 2008 *JINST* **3** S08001.

[3] CMS collaboration, *The Muon Project Technical Design Report*, CERN-LHCC-97-032 (1997).

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

[5] CMS collaboration, *Performance of the CMS drift-tube chamber local trigger with cosmic rays*, 2010 *JINST* **5** T03003.

[6] J. Christiansen, *High Performance Time to Digital Converter*, Version 2.1 CERN-EP-MIC (2002).

[7] G. Altenhoefer, *Development of a Drift Chamber for Drift Velocity Monitoring in the CMS Barrel Muon System*, Diploma Thesis, III Phys. Inst. A, RWTH Aachen (2006).

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