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Alignment of the CMS Muon System

The CMS Muon system consists of 250 drift tube chambers in central region and 468 cathode strip chambers in forward region complimented by trigger system consisting of 480 resistive plate chambers distributed in both regions. The muon system provides fast muon trigger, muon identification, and muon trajectory measurements. The performance of the muon system depends on a precise knowledge of the positions and orientations of all its elements within the CMS detector. We present two alignment techniques, track-based and hardware-based. The track-based technique uses tracks from pp collision data at the LHC to align the muon system elements relative to the CMS inner silicon tracker. An iterative algorithm for the track-based alignment has been designed and implemented in the overall simulation, reconstruction, and analysis software of CMS. The complimentary hardware-based technique consists of two separate optical systems in central and forward regions linked with another subsystem to the inner tracker. The hardware systems are specifically designed to perform well in environment of large radiation flux and high magnetic field. We discuss the alignment results of the several years of CMS operation, achieved precision of the alignment techniques and improved muon momentum resolution. We also present plans for upgrade and future development.

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