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Application of the Kalman Alignment Algorithm to the CMS Tracker

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One of the main components of the CMS experiment is the Inner Tracker. This device, designed to measure the trajectories of charged particles, is composed of approximately 16,000 planar silicon detector modules, which makes it the biggest of its kind. However, systematical measurement errors, caused by unavoidable inaccuracies in the construction and assembly phase, reduce the precision of the measurements drastically. The geometrical corrections that are therefore required should be known to an accuracy that is better than the intrinsic resolution of the detector modules, such that special alignment algorithms have to be utilized.

The Kalman Alignment Algorithm (KAA) is a novel approach to extract a set of alignment constants from a sufficiently large collection of recorded particle tracks, suited even for a system as big as the CMS Inner Tracker. To show that the method is functional and well understood, and thus expedient for the data-taking period of the CMS experiment, two significant case studies are discussed. Results from detailed simulation studies demonstrate that the KAA is able to align the CMS Inner Tracker under the conditions expected during the LHC start-up phase. Moreover, it has been shown that the associated computational effort can be kept at a reasonable level by deploying the available CMS computing resources to process the data in parallel. Furthermore, an analysis of the first experimental data from cosmic particle tracks, recorded directly after the assembly of the CMS Inner Tracker, shows that the KAA is at least competitive to existing algorithms when applied to real data.

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