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Alignment of the CMS Silicon Tracker using MillePede II

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The CMS silicon tracker comprises about 17000 silicon modules. Its radius and length of 120 cm and 560 cm, respectively, make it the largest silicon tracker ever built. To fully exploit the precise hit measurements, it is necessary to determine the positions and orientations of the silicon modules to the level of μm and mrad , respectively.

Among other track based alignment algorithms, the CMS collaboration studied MillePede II, developed by V. Blobel. This experiment independent program offers several methods to solve the large system of linear equations which arises from a global χ^2 -minimisation.

Studies show that MillePede II is indeed capable to align the about 45000 degrees of freedom of the CMS silicon tracker that have sensible influence on track reconstruction. This result is achieved utilising complementary data sets like muons from Z- or W-decays and cosmic rays, vertex and mass constraints. A hierarchical parametrisation allows to make full use of survey measurements accomplished during construction.

In a realistic case study, all elements of the tracker have been aligned simultaneously. The precision reached is close to 1 μm for the pixel detector and about 20 μm in the endcaps of the strip detector. Remarkably, using the GMRES method to solve the matrix equation takes less than 2 hours on a standard 64-bit PC and requires only 2 GB of memory.

Submitted on behalf of Collaboration (ex, BaBar, ATLAS)

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