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Alignment of the ATLAS Inner Detector

CERN's Large Hadron Collider (LHC) is the world's largest particle accelerator. It will make two proton beams collide at an unprecedented centre-of-mass energy of 14 TeV. ATLAS is a general purpose detector which will record the products of the LHC proton-proton collisions. At the inner radii, the detector is equipped with a charged-particle tracking system built on two technologies: silicon and drift-tube based detectors, comprising the ATLAS Inner Detector (ID). The performance of this detector will be optimized in order to enable ATLAS to achieve its physics goals.

The alignment of this tracking system poses a real challenge as one needs to determine almost 36000 degrees of freedom. The precision one needs to attain for the alignment of the most sensitive coordinates of the silicon sensors is just few microns. This limit comes from the requirement that the misalignment should not worsen significantly the track parameter determination far beyond that due the intrinsic sensor resolution. Therefore the alignment of the ATLAS ID requires the application of complex algorithms which demand extensive CPU and memory usage, as large matrix inversion and many iterations of the algorithms are required. So far, the proposed alignment algorithms have been exercised already in several situations, such as: a Combined Test Beam, Cosmic Ray runs and a large-scale computing simulation of physics samples mimicking the ATLAS operation. For the later samples, the trigger of the experiment has been simulated and the event filters applied in order to produce an alignment stream. The full alignment chain has been tested on that stream and alignment constants have been produced and validated within 24 hours, providing a complete test of the first-pass reconstruction of physics events.

The ATLAS ID commissioning is being finalized currently and many thousands of cosmic-ray tracks have already been reconstructed with the final operating system. These cosmic ray data served to produce an early alignment of the real ATLAS Inner Detector even before the LHC start-up.

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Track Classification: Data Analysis - Algorithms and Tools