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Parallelized Kalman-Filter-Based Reconstruction of Particle Tracks on Many-Core Architectures with the CMS Detector

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In the High-Luminosity Large Hadron Collider (HL-LHC), one of the most challenging computational problems is expected to be finding and fitting charged-particle tracks during event reconstruction. The methods currently in use at the LHC are based on the Kalman filter. Such methods have shown to be robust and to provide good physics performance, both in the trigger and offline. In order to improve computational performance, we explored Kalman-filter-based methods for track finding and fitting, adapted for many-core SIMD and SIMT architectures. Our adapted Kalman-filter-based software has obtained significant parallel speedups using such processors, e.g., Intel Xeon Phi, Intel Xeon SP (Scalable Processors) and (to a limited degree) NVIDIA GPUs.
Recently, an effort has started towards the integration of our software into the CMS software framework, in view of its exploitation for the Run III of the LHC. Prior reports have shown that our software allows in fact for some significant improvements over the existing framework in terms of computational performance with comparable physics performance, even when applied to realistic detector configurations and event complexity. Here, we demonstrate that in such conditions physics performance can be further improved with respect to our prior reports, while retaining the improvements in computational performance, by making use of the knowledge of the detector and its geometry.

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