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Parallelized Kalman-Filter-Based Reconstruction of Particle Tracks on Many-Core Architectures

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Faced with physical and energy density limitations on clock speed, contemporary microprocessor designers have increasingly turned to on-chip parallelism for performance gains. Examples include the Intel Xeon Phi, GPGPUs, and similar technologies. Algorithms should accordingly be designed with ample amounts of fine-grained parallelism if they are to realize the full performance of the hardware. This requirement can be challenging for algorithms that are naturally expressed as a sequence of small-matrix operations, such as the Kalman filter methods widely in use in high-energy physics experiments. In the High-Luminosity Large Hadron Collider (HL-LHC), for example, one of the dominant computational problems is expected to be finding and fitting charged-particle tracks during event reconstruction; today, the most common track-finding methods are those based on the Kalman filter. Experience at the LHC, both in the trigger and offline, has shown that these methods are robust and provide high physics performance. Previously we reported the significant parallel speedups that resulted from our efforts to adapt Kalman-filter-based tracking to many-core architectures such as Intel Xeon Phi. Here we report on how effectively those techniques can be applied to more realistic detector configurations and event complexity.

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