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Parallel approach to online event reconstruction in the CBM experiment

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Future many-core CPU and GPU architectures require relevant changes in the traditional approach to data analysis. Massive hardware parallelism at the levels of cores, threads and vectors has to be adequately reflected in mathematical, numerical and programming optimization of the algorithms used for event reconstruction and analysis.
An investigation of the Kalman filter, which is the core of the reconstruction algorithms in modern HEP experiments, has demonstrated a potential several orders of magnitude increase of the speed of the algorithms, if properly optimized and parallelized. The Kalman filter based track fit is used as a benchmark for monitoring the performance of novel CPU and GPU architectures, as well as for investigating modern parallel programming languages.
In the CBM experiment at FAIR/GSI all basic reconstruction algorithms have been parallelized. For maximum performance all algorithms use variables in single precision only. In addition, a significant speed-up is provided by localizing data in a high-speed cache memory. Portability of the parallel reconstruction algorithms with respect to different CPU and GPU architectures is supported by the special headers and vector classes, which have been developed for using SIMD instruction sets. The reconstruction quality is monitored at each stage in order to keep it at the same level as for the initial scalar versions of the algorithms.
Different reconstruction methods, implemented in CBM, show different degrees of intrinsic parallelism, thus the speed-up varies up to few orders of magnitude. The speed-up factors for each stage of the algorithms parallelization are presented and discussed.

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