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Speeding up the CMS track reconstruction with a parallelized and vectorized Kalman-filter-based algorithm during the LHC Run 3

Wednesday, 26 October 2022 11:00 (30 minutes)

One of the most challenging computational problems in the Run 3 of the Large Hadron Collider (LHC) and more so in the High-Luminosity LHC (HL-LHC) is expected to be finding and fitting charged-particle tracks during event reconstruction. The methods used so far at the LHC and in particular at the CMS experiment are based on the Kalman filter technique. 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 architectures. This adapted Kalman-filter-based software, called "mkFit", was shown to provide a significant speedup compared to the traditional algorithm, thanks to its parallelized and vectorized implementation. The mkFit software was recently integrated into the offline CMS software framework, in view of its exploitation during the Run 3 of the LHC. At the start of the LHC Run 3, mkFit will be used for track finding in a subset of the CMS offline track reconstruction iterations, allowing for significant improvements over the existing framework in terms of computational performance, while retaining comparable physics performance. The performance of the CMS track reconstruction using mkFit at the start of the LHC Run 3 is presented, together with prospects of further improvement in the upcoming years of data taking.

Significance

The deployment of a novel parallel Kalman-filter-based algorithm (called "mkFit") for the charged track reconstruction of the CMS experiment for the LHC Run 3 allows for a very significant improvement of the CMS reconstruction computational performance, while retaining comparable physics performance with respect to the traditional tracking algorithm in use during the LHC Run 2, with clear prospects of further improvement.

References

Speeding up particle track reconstruction using a parallel Kalman filter algorithm, Steven Lantz (Cornell U.), Kevin McDermott (Cornell U.), Michael Reid (Cornell U.), Daniel Riley (Cornell U.), Peter Wittich (Cornell U.) et al., e-Print: 2006.00071 [physics.ins-det], DOI: 10.1088/1748-0221/15/09/P09030, Published in: JINST 15 (2020) 09, P09030.

Experiment context, if any

CMS

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