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GPU-based tracking with Acts

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At future hadron colliders such as the High-Luminosity LHC(HL-LHC), tens of thousands of particles can be produced in a single event, which results in a very challenging tracking environment. The estimated CPU resources required by the event processing at the HL-LHC could well exceed the available resources. To mitigate this problem, modern tracking software tends to gain performance by taking advantage of modern computing techniques on hardware such as multi-core CPUs or GPUs with the capability to process many threads in parallel.

The Acts (A Common Tracking Software) project encapsulates the current ATLAS tracking software into an experiment-independent toolkit designed for modern computing architectures. It provides a set of high-level track reconstruction tools agnostic to the details of the detector and magnetic field configuration. Particular emphasis is placed on thread-safety of the code in order to support concurrent event processing with context-dependent detector conditions, such as detector alignments or calibrations. Acts also aims to be a research and development platform for studying innovative tracking techniques and exploiting modern hardware architectures. The multi-threaded event processing on multi-core is supported by using the Intel Thread Building Block (TBB) library. It also provides plugins for heterogeneous computing, such as CUDA and SYCL/oneAPI, and contains example code that could be offloaded to a GPUs, for instance, the Acts seed finder.

In this talk, I will present a summary of the R&D activities to explore parallelism and acceleration of elements of track reconstruction using GPUs, such as the GPU-based seed finding, geometry navigation and Kalman fitting, based on the Acts software. The strategies of GPUs implementation will be shown. Both the achieved performance and the encountered difficulties will be discussed.

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