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Fast TPC online tracking on GPUs and asynchronous data-processing in the ALICE HLT to enable online calibration

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ALICE (A Large Heavy Ion Experiment) is one of the four major experiments at the Large Hadron Collider (LHC) at CERN, which is today the most powerful particle accelerator worldwide. The High Level Trigger (HLT) is an online compute farm of about 200 nodes, which reconstructs events measured by the ALICE detector in real-time. The HLT uses a custom online data-transport framework to distribute the data and the workload among the compute nodes.

ALICE employs several subdetectors that are sensitive to calibration, e.g. the TPC (Time Projection Chamber). For a precise reconstruction, the HLT has to perform the calibration online. Online-calibration can make certain offline calibration steps obsolete and can thus speed up offline analysis. In ALICE Run 3 starting in 2020, online calibration becomes a necessity. The main detector used for track reconstruction is the TPC. Reconstructing the trajectories in the TPC is the most compute-intense step during event reconstruction. Therefore, a fast tracking implementation is of great importance. Reconstructed TPC tracks build the basis for the calibration making a fast online-tracking mandatory.

We present several components developed for the ALICE High Level Trigger to perform fast event reconstruction and to provide features required for online calibration.

As first topic, we present our TPC tracker, which employs GPUs to speed up the processing, and which bases on a Cellular Automaton and on the Kalman filter. Our TPC tracking algorithm has been successfully used in 2011 and 2012 in the lead-lead and the proton-lead runs. We have improved it to leverage features of newer GPUs and we have ported it to support OpenCL, CUDA, and CPUs with a single common source code. This makes us vendor independent.

As second topic, we present framework extensions, which are required for online calibration. The extensions, however, are generic and can be used for other purposes as well. We have extended the framework to allow asynchronous compute chains, which are required for long-running tasks e.g. for online calibration. And we describe our method to feed in custom data sources in the data flow. This can be external parameters like environmental temperature required for calibration and this can also be used to feed back calibration results in the processing chain.

Overall, the work presented in this contribution makes the ALICE HLT ready for online reconstruction and calibration for the LHC Run 2 starting in 2015.

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