ALICE HLT TPC GPU Tracker*

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The Alice High Level Trigger

The Large Hadron Collider (LHC) at the European Center for Particle Physics (CERN) is today's most powerful particle collider built to search for rare particles such as the Higgs boson and to study properties of dense hot medium. Alice is one of its four major detectors designed specifically for the second purpose. The ALICE High Level Trigger (HLT) is a compute farm of about 250 nodes and it is the first point where all data from the various subdetectors are available together. The HLT is capable of a full online event reconstruction and uses data compression techniques in order to reduce the data rate stored to the tapes to a feasible level.

The Alice HLT TPC Tracker

Reconstruction of the trajectories (tracking) of particles measured in the Time Projection Chamber (TPC) is one critical part of event reconstruction and requires significant compute resources. The HLT implements a parallel tracking algorithm that can make use of GPUs. It is based on the cellular automation and the Kalman filter [1]. The tracker employs a pipeline which ensures continuous GPU utilization. Results of the GPU and the CPU version of the tracker match exactly except for artifacts caused by different rounding due to non-associative floating point arithmetic [5] [2] [3]. A direct comparison of the GPU tracker to a hexa-core CPU demonstrates a speedup factor of about three [4].

The HLT compute nodes are not exclusively used for tracking but also for other tasks such as cluster transformation and vertexing. Hence, not all CPU cores are available for tracking. The below figure shows the speedup of both the GPU and the CPU implementation of the HLT tracker running on four CPU cores and, in the case of the GPU tracker, also on the GPU. The HLT tracker is 12 to 15 times faster than the offline version and the GPU tracker is faster by another order of magnitude [2] (see figure 1).

If the CPU tracker employs all available cores of one node, tracking takes about as long as tracking on the GPU. Hence, plugging a GPU in an existing node saves an entire node - and the required additional infrastructure. Overall, the GPU tracker enables TPC tracking with only about one tenth the investment which would be required otherwise.

During the Pb-Pb run in 2010 the GPU tracker was first tested under real conditions. This led to some minor improvements, e.g. with respect to memory consumption. Some other improvements coped with irreproducible results caused by concurrency, which - even though they

* Work supported by GSI, BMBF, HGS-HIRe

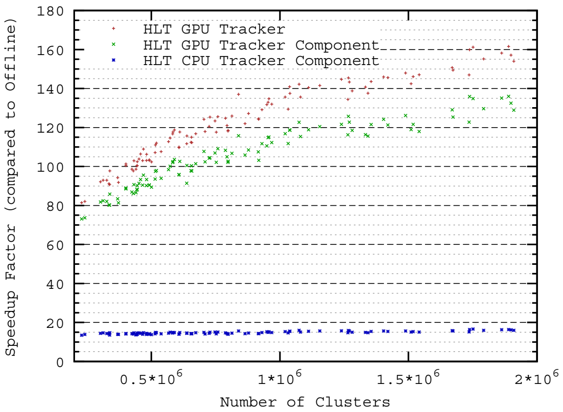

Figure 1: HLT Tracker Speedup.

did not affect physical observables - complicated QA efforts. Later on, the GPU tracker was operated during the lead run in 2011, and it ran stably in 24/7 operation during the full proton phase of 2012. For the current proton-lead run the HLT was upgraded with more GPUs to cope with the increased rate.

At the moment, the HLT is equipped with about 60 Fermi GPUs achieving a maximum data rate of more than 200 Hz in central lead-lead collisions.

References

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