Fast Cellular Automaton tracker for the ALICE High Level Trigger

S. Gorbunov[1,2], M. Kretz[2], D. Rohr[2] for the ALICE collaboration
[1]FIAS, Frankfurt, Germany; [2]KIP, Heidelberg, Germany

The core of the event reconstruction in ALICE is the reconstruction of particle trajectories (tracking) in TPC detector, the main tracking detector of the experiment. For this propose a fast on-line algorithm has been developed. It reconstructs all types of data including physics events, cosmics and special calibration events.

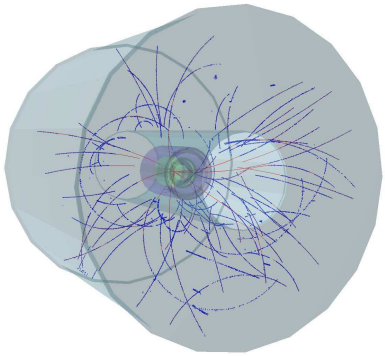

Figure 1: Real proton-proton event, reconstructed in HLT

The algorithm combines a Cellular Automaton method [1], which is used for a fast pattern recognition, and the Kalman filter method [2], which performs a fit of found trajectories and the final track selection. The algorithm has proved its high performance (99.9% for the proton-proton events and 95.8% for the central Pb-Pb collisions) in comparison with the off-line reconstruction (99.9% and 98.5% correspondingly). In addition to the the high efficiency, the on-line reconstruction is an order of magnitude faster than the off-line analysis: 19.6ms (pp) or 17.6s (PbPb central) in comparison with 66.0ms or 160.1s for the off-line.

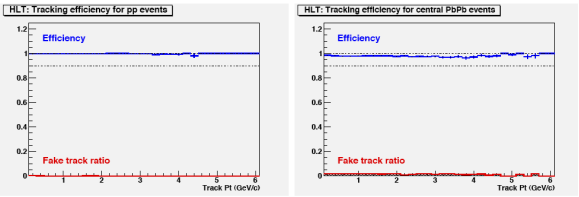

Figure 2: Reconstruction performance for p-p (left) and central Pb-Pb (right) events

Due to the large combinatorial background the key issue is the dependence of the reconstruction time on the number of tracks to be reconstructed. Figure 3 shows that the HLT tracker requires 130 us per track independent of the detector occupancy.

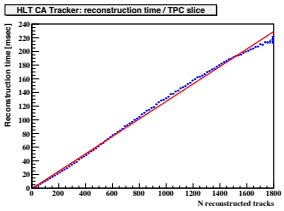

Figure 3: Reconstruction time on CPU

An important feature of the algorithm is an ability to use GPU hardware accelerators, giving another order of magnitude speed-up for the on-line data processing. The GPU accelerators allow to perform a fast reconstruction of heavy ion collisions where a track density is very high.

The first GPU implementation of the algorithm was developed for the NVIDIA graphic card. In addition, the algorithm was adopted for the upcoming Intel Larrabee graphic card. For this propose the code has been vectorized [3] , implying a detailed investigation of the SIMD instructions and development of general vector classes.

The GPU tracker is integrated to the High Level Trigger framework and will be used for the on-line data processing in the ALICE experiment.

References

[1] I. Kisel, V. Kovalenko, F. Laplanche et al. (NEMO Collaboration), Cellular automaton and elastic net for event reconstruction in the NEMO-2 experiment. Nucl. Instr. and Meth. A387 (1997) 433-442.

[2] R. Frühwirth et al., Data analysis techniques for high-energy physics. Second edition, Cambridge Univ. Press (2000).

[3] S. Gorbunov, U. Kebschull, I. Kisel, V. Lindenstruth and W. F. J. Mller, Fast SIMDized Kalman filter based track fit. Comp. Phys. Comm. 178 (2008) 374-383.