Contribution ID: **214** Type: **Oral**

Parallel 4-Dimensional Cellular Automaton Track Finder for the CBM Experiment

Monday 18 January 2016 14:50 (25 minutes)

The future heavy-ion experiment CBM (FAIR/GSI, Darmstadt, Germany) will focus on measurement of very rare probes at interaction rates up to 10 MHz with data flow of up to 1 TB/s. The beam will provide free stream of beam particles without bunch structure. That requires full online event reconstruction and selection not only in space, but also in time, so-called 4D event building and selection. This is a task of the First-Level Event Selection (FLES). The main module of the FLES reconstruction and selection package is the Cellular Automaton (CA) based track finder.

The CA algorithm consists of several logical parts. First, a short (2% of the total execution time) initialization, when we prepare the hit information for tracking, takes place. The main and the most time consuming part of the triplet construction takes 90.4% of the sequential execution time. Out of triplets we construct tracks, that takes about 4%, and in addition 3.4%, when we prepare the information for the next iteration.

All steps of the algorithm were parallelized inside the time-slice, using different sources of parallelism at each step. In the initialization part hits are processed in parallel, split in portions and stored to the grid data structure. For the triplet construction part portions of hits are processed in order to obtain triplets, as well as their neighboring relations. These triplets in the next part of the track candidate construction serve as a source of parallelism, giving as a result a track-candidate for each triplet with a high level. In the track competition part the candidates are processed in parallel to reveal common hits and choose the best ones according to their chi^2-value. For the final stage portions of hits are checked in parallel in order to remove hits tagged as used from the grid structure and to prepare the input for the next track set search iteration.

We describe in details all stages of the CA track finder and present results of tests on a many-core computer.

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Session Classification: Track 2

Track Classification: Data Analysis - Algorithms and Tools