The Cellular Automaton track finder at high track multiplicities for CBM*

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The CBM experiment at FAIR is being designed to study heavy-ion collisions at extremely high interaction rates (up to 10 MHz) and high track multiplicities (up to 1000). Since the beam in the CBM experiment will have no bunch structure, but continuous, the groups of events may be close or overlapped in time. Measurements in this case will be 4D (x, y, z, t). Thus, the reconstruction of time slices rather than events will be needed. In addition to such high input rate and complicated event topology, the full event reconstruction and selection will be done at the First Level Even Selection (FLES) stage. In this respect, both the speed of the reconstruction algorithms and their efficiency are crucial.

The Cellular Automaton (CA) [1] track finder is fast and robust and thereby is used both for the online and offline track reconstruction in the CBM experiment. The algorithm creates short track segments in each three neighbouring stations, then combines them into track-candidates and selects the best tracks according to the maximum length and minimum χ^2 criteria. The algorithm was further optimized for the case of high track multiplicity with respect to time: additional sorting of found hits according to 2-dimensional (y, z) grid was introduced in order to speed up the search for the next hit. The standalone FLES package [2] was used to investigate the stability of the CA track reconstruction with respect to a track multiplicity per event. For the study 1000 of minimun bias Au+Au UrQMD events at 25 AGeV was simulated. As the first step towards 4D tracking a number of minimum bias events (up to 100) were packed into one group with no time measurement taken into account. The group was treated by the CA track finder as a single event and the regular reconstruction procedure was performed (Figure 1).

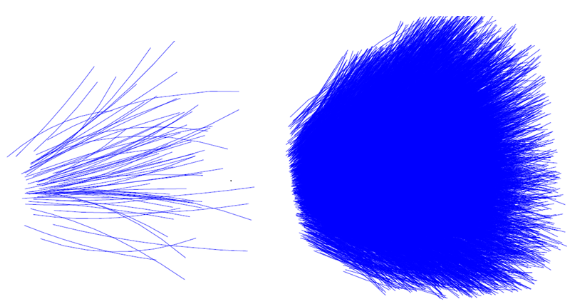

Figure 1: Reconstructed tracks in minimum bias event (left) and packed group of 100 minimum bias events (right), 109 and 10 340 tracks in average respectively.

The dependence of the track reconstruction efficiency on the track multiplicity is stable (Figure 2). In particular, the efficiency of the algorithm decreases only by 4% for 100 minimum bias events in one group, comparing to the case of a single minimum bias event. The efficiencies for the reference tracks ($p > 1$ GeV/c), which include tracks of particular physics interest, remains high for all range of track multiplicities. The efficiencies for extra (100 MeV/c $< p <$ 1 GeV/c) and secondary tracks are also stable. The level of ghost tracks is less than 10%. Thus, the study has shown that the CA track finder is stable with respect to the track multiplicity.

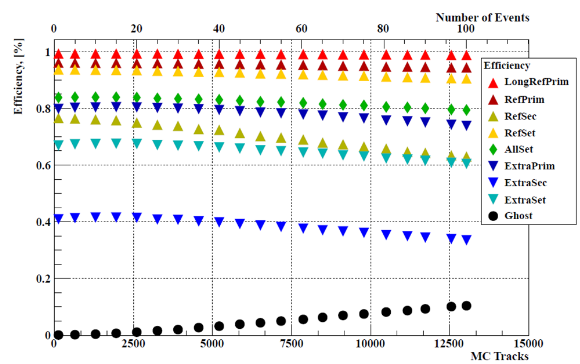

Figure 2: Track reconstruction efficiencies and ghost rate for different sets of tracks versus track multiplicity.

The speed of the algorithm was studied as a function of track multiplicity. The time, which algorithm needs to proceed a grouped event, behaves as a second order polynomial with respect to a number events in the group. Due to this fact, the CA track finder needs less than 2 seconds in order to reconstruct a grouped event combined of 100 minimum bias events, that corresponds to about 10 000 reconstructed tracks.

Summarizing, the CA track finder reconstruction algorithm shows high speed performance and stability with respect to the track multiplicities, up to the extreme case of about 10 000 reconstructed tracks per event.

References

[1] I. Kisel, Nucl. Instr. and Meth. A566 (2006) 85-88.

[2] V. Akishina, I. Kisel, I. Kulakov, M. Zyzak, *FLES: Standalone First Level Event Selection Package for the CBM experiment*, this report.

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