Contribution ID: **34** Type: **Poster**

Fast tracking for the CBM experiment

Typical central Au-Au collision in the CBM experiment (GSI, Germany) will produce up to 700 tracks in the inner tracker. Large track multiplicity together with presence of non-homogeneous magnetic field make reconstruction of events complicated.

A cellular automaton method is used to reconstruct tracks in the inner tracker. The cellular automaton algorithm creates short tracklets in neighboured detector planes and links them into tracks. Being essentially local and parallel the cellular automaton avoids exhaustive combinatorial search, even when implemented on conventional computers. Since the cellular automaton operates with highly structured information, the amount of data to be processed in the course of the track search is significantly reduced. The method employs a very simple track model which leads to utmost computational simplicity and fast algorithm.

Track and vertex fitting is done using the Kalman filter technique.
A special analytic formula has been derived for fast track extrapolation in an inhomogeneous magnetic field.

Results of tests of the reconstruction procedure are presented.

Summary

In order to test the quality of the reconstruction procedure we used 1000 events of central Au+Au collisions at 25 AGeV in the asymmetric inhomogeneous magnetic field of the CBM magnet. The Monte Carlo simulated tracks were transported trough the inner tracker and their positions were smeared with sigma of 10 μm in order to emulate detector measurements.

Total track finding efficiency is about 97%, providing very clean reconstructed tracks with practically no ghost tracks (0.6%).

Three procedures for the propagation of track parameters have been implemented in the Kalman filter track fitting routine: a linear extrapolator for fast propagation in field free regions, a fourth order Runge-Kutta extrapolator and an extrapolator based on the analytic formula for propagation in the inhomogeneous magnetic field.

A measure of the reliability of the fit is the pull distributions of the fitted track parameters. The reconstructed track parameters and covariance matrix at the vertex where the track originates are obtained by propagating the track parameters at the measurement position closest to the vertex, taking into account the remaining material traversed.

All pulls are centred at zero indicating that there is no systematic shift in the reconstructed track parameter values. The distributions are well fitted using Gaussian functions with small tails caused by the various non-Gaussian contributions to the fit. The average relative momentum resolution is 0.73%.

The primary vertex fitting algorithm provides a very high accuracy: the residuals of the xv and yv positions of the primary vertex are about 1 μm and the zv position is reconstructed with an accuracy of 5 μm. The normalized residuals (pulls) are close to unity. The average relative momentum resolution of primary tracks is 0.63%.

The fit of secondary vertices is implemented with three options: geometrical without constraints and with mass and topological constraints. The pull of the secondary vertex position shows that the vertex parameters are well estimated. The longitudinal resolution of the vertex of D0 decay is 61 μm. The relative momentum resolution of pi+ and K- secondary tracks are 0.43% and 0.54% respectively.

A possible hardware (FPGA) implementation of the reconstruction algorithms for the Level-1 trigger is discussed.

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Track Classification: Triggering