Estimation of track reconstruction efficiency in the PHENIX drift chamber in Run7 Au+Au collisions: normal and double hit/track density

Technical note 441

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1. Introduction

This note summarizes results of the study of track reconstruction efficiency in the PHENIX drift chamber at normal and double hit/track density. Two cases under study correspond to original design of the anode nets and alternative design where the sense wires are not cut in the center but still attached to the central support.

2. Method

The study was performed for the east drift chamber (DCE). It has slightly different design comparing to the DCW. The difference is in equidistant spacing of B-G wires that simplifies production of the nets and requires lower gas gains to reach the same efficiencies as in the DCW. The design of the DCE proved to be satisfying all requirements.

The analysis is based on embedding of tracks in the real events and estimation of track reconstruction efficiency vs centrality. The real data events were taken from Run7 Au+Au data at 200 GeV, run 228411.

Since neither fast nor slow simulators properly reproduce signal width distributions we decided to embed real tracks. Preselected tracks were stored and randomly embedded in Run7 events, one track per event. All preselected tracks belonged to the south side of the DCE. Embedding procedure included merging of the overlapping hits.

To simulate double track density for the case when sense wires are not cut in the center we moved all hits from the north side of the DCE to the south side. As before all overlapping hits were merged to emulate real detector performance.

2.1 Selection of tracks for embedding

Single tracks for embedding were selected from ultra peripheral events with the number of hits measured in the south side of the DCE less then 40. What we really embedded were not tracks but groups of hits which belonged to a single well isolated track. To make sure that the hits belong to a single isolated track all such events were checked using “noise” program. Example of one such group of hits is shown in Fig.1. We did not require specific number of hits in X1 and X2 layers; we did not require all hits to be associated with a track by track reconstruction algorithm.

We preselected 100 groups of hits originating from single tracks. Then these groups one by one were embedded in empty events with zero number of hits. All preselected groups of hits resulted in reconstructed tracks of high quality with X1 and X2 information. Alpha (α_{REF}) and phi (φ_{REF}) variables for the reconstructed tracks were recoded and assigned to corresponding groups of hits.

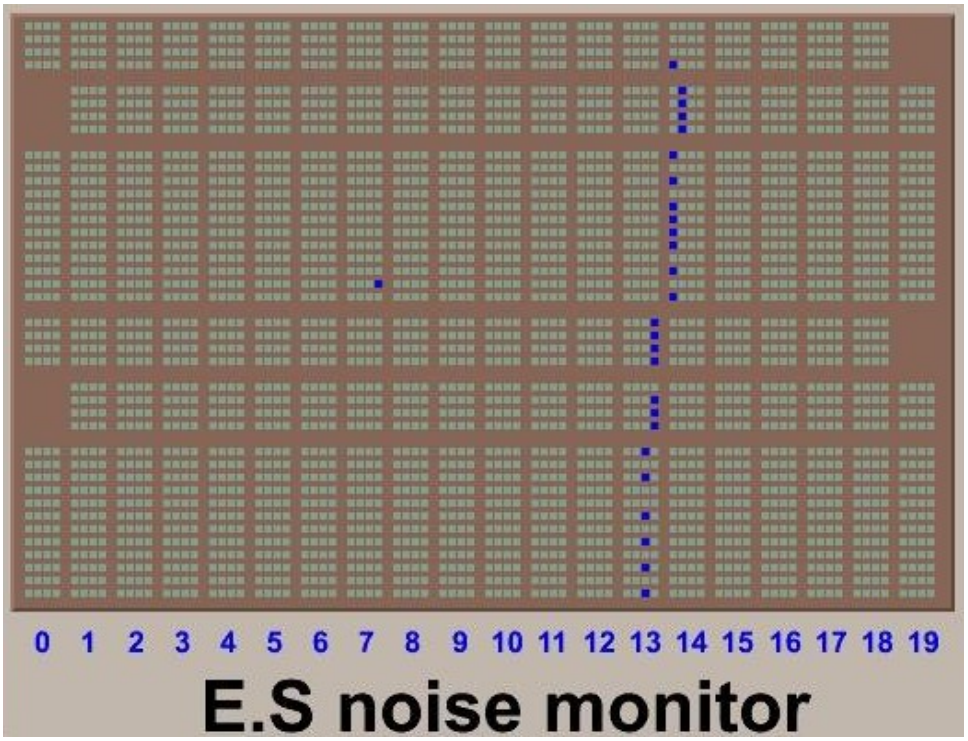

Fig. 1. Typical group of hits reconstructed in the south side of the DCE.
Such groups are embedded in real events.

2.2 Embedding of tracks

For every real event we randomly embedded one of the preselected tracks (groups of hits). Overlapping hits were merged resulting in one hit with:

- leading edge: the smallest leading time from overlapping hits;
- trailing edge: the largest trailing time from overlapping hits.

To emulate double track density (case of sense wires not cut in the center) we moved all hits from the north side to the south side of the DCE. Overlapping hits were merged following the same procedure.

2.3 Reconstruction of embedded tracks

We run track reconstruction chain for ~8,000 Au+Au events embedding one of the preselected tracks in each one of them. To understand whether or not we had embedded track reconstructed we compared (alpha, phi) variables for the reconstructed tracks with (α_{REF}, φ_{REF}) for the embedded tracks.

Fig.2 shows (alpha-α_{REF}) and (phi-φ_{REF}) distributions measured in embedded events. Peaks centered around zero correspond to reconstructed embedded tracks. Final widths of the distributions are explained by the absence of event-by-event T_0 correction for the embedded hits. The base level outside the peaks is negligible even in most central events.

The embedded track was assumed to be reconstructed if at least one track in the event had (alpha-α_{REF}) and (phi-φ_{REF}) within the limits shown with vertical lines in Fig.2. Contribution of combinatorial background was estimated to be negligible.

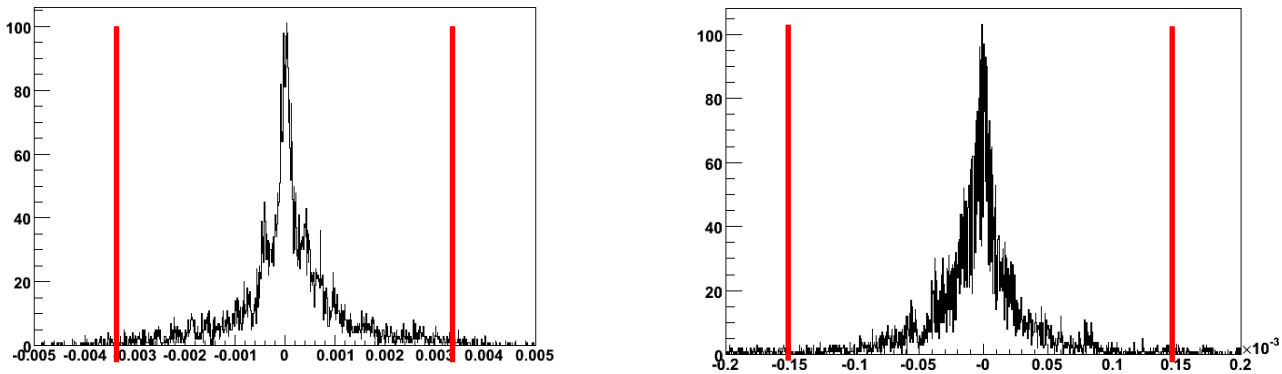

Fig. 2. Distributions of alpha-α_{REF} (left) and phi-φ_{REF} (right) measured in embedded events. Peaks correspond to reconstructed embedded tracks.

3. Results

The total number of processed events is 8173.

Table 1 shows results obtained for tracks embedded in Run7 Au+Au events vs centrality bin. Column on the left shows centrality bin and the column on the right shows probability to reconstruct embedded tracks.

Table 2 shows similar results obtained in case of double track/hit density.

Fig.3 shows the track reconstruction efficiency for two considered cases vs centrality.

Table 1. Results for tracks embedded in real Run7 Au+Au events.

Centrality, %	**Number of events with reconstructed embedded tracks**	**Total number of processed events**	**Probability to reconstruct embedded track, %**
0-10	775	877	88.4
10-20	754	829	90.9
20-30	813	868	93.7
30-40	841	872	96.5
40-50	870	896	97.1
50-60	899	918	97.9
60-70	897	907	98.9
70-80	894	902	99.1
80-92	1096	1104	99.3
0-92	**7839**	**8173**	**95.9**

Table 2. Results for tracks embedded in real Run7 Au+Au events with double track/hit density.

Centrality, %	**Number of events with reconstructed embedded tracks**	**Total number of processed events**	**Probability to reconstruct embedded track, %**
0-10	617	877	70.3535
10-20	701	829	84.5597
20-30	783	868	90.2074
30-40	804	872	92.2018
40-50	861	896	96.0938
50-60	894	918	97.3856
60-70	889	907	98.0154
70-80	892	902	98.8913
80-92	1094	1104	99.0942
0-92	**7535**	**8173**	**92.1938**

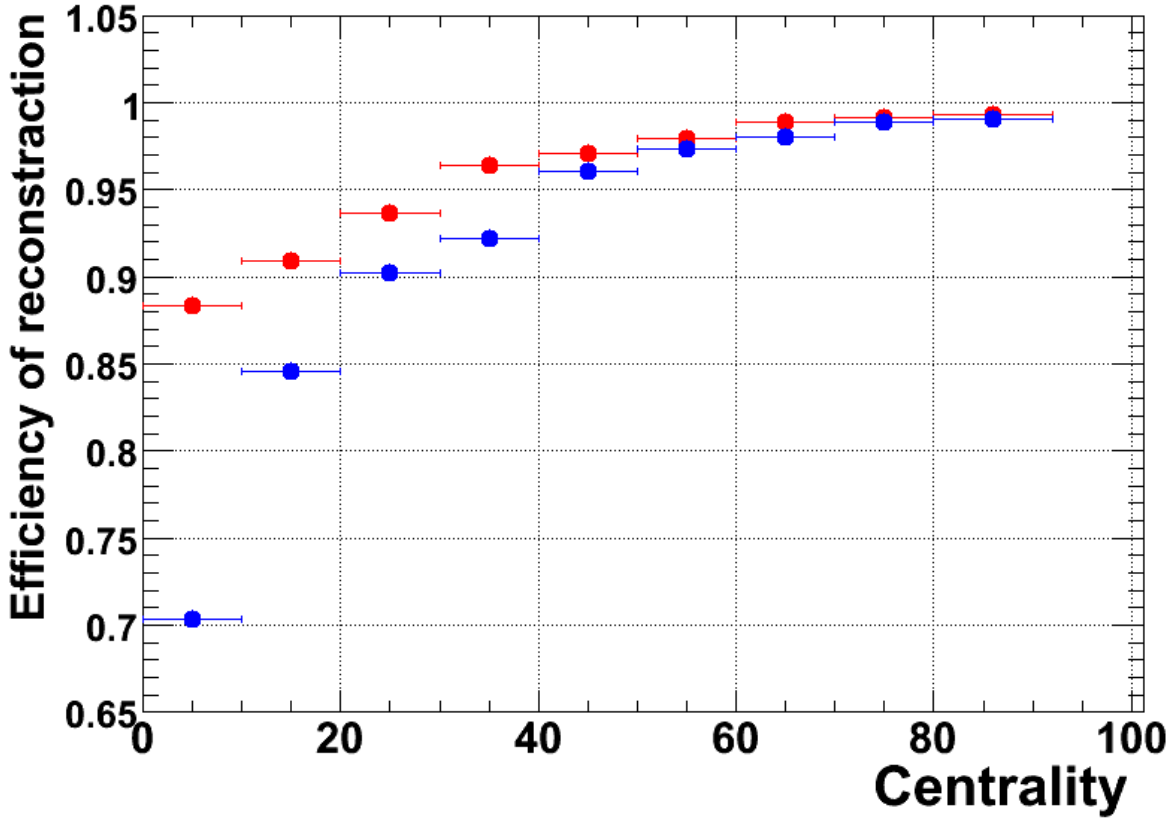

Fig. 3. Track reconstruction efficiency for the case of normal hit density (red) and double hit density (blue) vs centrality.

4. Conclusion

Double hit density result in 15-20% additional loss of track reconstruction efficiency in most central Au+Au collisions at 200 GeV. There is no difference in most peripheral events as expected. Discussion of how much additional loss of tracks affects physical capabilities of the detector are beyond the scope of this note.