Beam background analysis with the sPHENIX-INTT detector

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The sPHENIX experiment at Brookhaven National Laboratory launched in 2023 with Au + Au collisions at $\sqrt{s_{\rm NN}}$ = 200 GeV, following successful detector commissioning. Three most inner detectors, MVTX, INTT,[1] and TPC forming the tracking system of sPHENIX frequently observed some trajectories along the beam direction (z-axis) during the commissioning as well as throughout production run of $p+p$ in 2024. This disrupts the stable operation for all trackers.[2] These trajectories appear as the series of hits (cluster) connected in z-axis maintaining overlapping hits in azimuthal (ϕ) direction from one z segment to the next, as shown in Fig. 1.

The INTT strip-type silicon sensor comprises of strip width of 78 μm in ϕ and either 16 or 20 mm length in z-direction. It is oriented towards the collision point in the barrel shaped configuration. The trajectory from the ideal collision point near $z = 0$ should traverse the sensor nearly perpendiculary, preventing formation of multiple hit cluster in z-direction, unlike the hit pattern shown in Fig. 1. These true hits from collision can possibly form a multiple z-cluster size by the accidental coincidence between adjacent hits in z-segment, as shown in Fig. 2 (top). The accidental effect was estimated by the full Monte-Carlo (MC) based on the GEANT for the INTT and the HIJING[3] models as an event generator. As the z-size of the cluster increases, the probability decreases by an order of magnitude, as shown in red histogram.

However, the observed data (green) shows distinctively thicker tail towards the larger z-cluster size, which cannot be reproduced by the simple accidental MC. To identify the origin of the thick tail in data, the correlation plot between the z-cluster size and the collision vertex of the event is presented in Fig. 2 (bottom). As can be observed, the population of large-z-size clusters is significantly smaller in the region where

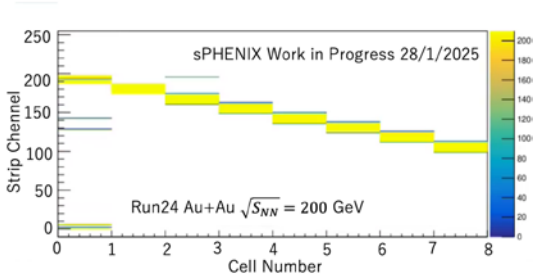

Fig. 1. INTT hit map of of a given event in particular acceptance of the INTT detector observed in Run24 Au + Au collision. The vertical and horizontal axis depict hit channels in ϕ and segmentation cells in z direction. The color coordinate of hits represents energy loss of a hit.

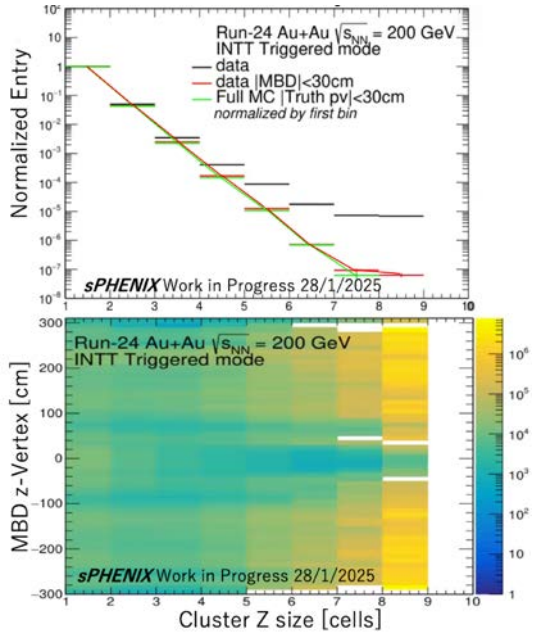

Fig. 2. (Top) z-cluster size distribution for the MC (red), the data (green), the data with z-vertex cut (black). (Botttom) The collision z-vertex position (horizontal axis) dependence of the z-cluster size (vertical axis).

the vertex z is within 30 cm. When the event selection of $|z_{\rm vertex}| < 30$ cm is applied, the data histogram (black) was accurately reproduced by the MC in Fig. 2 (top). This study provides insights for better operation of other trackers.

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