Cosmic track reconstruction toward alignment for the INTT

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The sPHENIX experiment is a new detector constructed at the Relativistic Heavy Ion Collider at the Brookhaven National Laboratory and aims to study quark-gluon plasma and cold quantum chromodynamics.[1] The intermediate tracker (INTT) is one of tracking detectors in the sPHENIX. The INTT is a silicon strip detector composed of 56 ladders, forming two layers: an inner layer and an outer layer. It is essential to align the detector geometry. The residual distribution of the good cosmic tracks are useful to perform the alignment. This report presents the cosmic track reconstruction toward alignment for the INTT.

This study uses cosmic data taken in 2024 without magnetic field. To ensure noise-free cosmic data, hot channel masking and a good cluster cut are applied. If an event has 4 or more clusters, combinations of clusters need to be considered based on $C(n,k) = n!/k!(n-k)!$, where n is the total number of clusters in the event, and k is the number of clusters used for track reconstruction. The value of k ranges from 4 to 7 because a minimum of 4 clusters is required to construct a cosmic track in the INTT. The selected clusters are fitted their position with a straight line in both the X-Y plane and the Z-Radius plane for each combination, and the reduced residuals (the least distance from the hit point to the fitting line) are calculated for both planes. There are two requirements to be classified as a good track. The first one is that the reduced residual in X-Y plane needs to be smaller than 0.02 cm. The cluster combination satisfies 1st requirement suppose to have a good fitting in Z-Radius plane, so whether the hit is within the range of a ladder in Z axis is considered as the 2nd requirement. And if a certain event has tracks with 4, 5, 6, and 7 clusters that all meet the requirement, the one with 7 clusters is chosen as shown in Fig. 1.

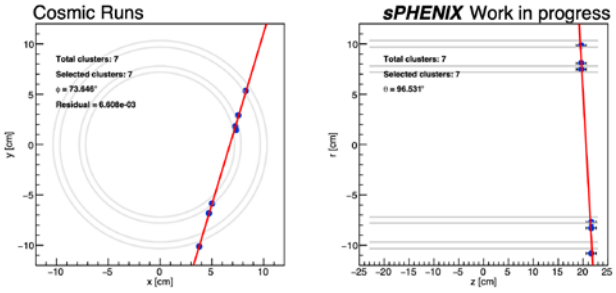

Fig. 1. A good reconstructed cosmic track event display with 7 clusters in X-Y plane (left) and Z-Radius plane (right).

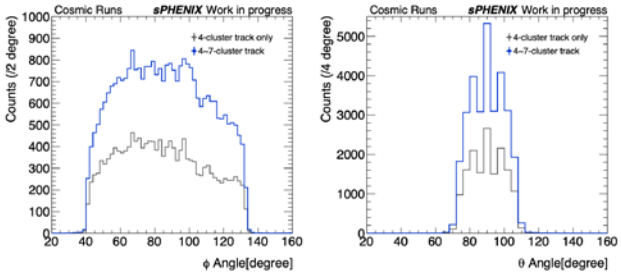

Fig. 2. (Left) The angle distribution of the ϕ (X-Y plane). (Right) The angle distribution of the θ (Z-Radius plane).

The tracks with total clusters equal to 4 are the majority. However, we could still find some events with more clusters included. The angle distribution of cosmic tracks in ϕ (X-Y plane) and in θ (Z-Radius plane) are shown in Fig. 2. The number of the tracks whose total clusters only equal to 4 is around 1.6×10^4, on the other hand, the number of the tracks whose total clusters include from 4 to 7 is around 3×10^4. This shows the statistic can increase by the factor of 2 through the tracks reconstruction algorithm.

The result shows that the cosmic tracks could be well reconstructed through the requirements of cosmic track in both X-Y and Z-Radius planes. The well reconstructed cosmic tracks can be used as a cosmic data set and contributed to the detector alignment check.

Reference

1) sPHENIX collaboration, sPHENX Beam Use Proposal (2020).

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