Overview of software development for sPHENIX INTT detector

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In May 2023, the sPHENIX experiment began at Relativistic Heavy Ion Collider at Brookhaven National Laboratory. The sPHENIX is a second-generation heavy-ion experiment and its primary goal is to understand properties of quark-gluon plasma created in high-energy heavy-ion collisions. The sPHENIX experiment comprises a tracking system, electromagnetic, and hadron calorimeters. INtermediate Tracker (INTT) is a silicon strip barrel detector with two layers covering psuedorapidity $|\eta| < 1.1$ and a full azimuth. The purpose of the INTT is to measure charged particle trajectories and identify a single beam crossing where the collision takes place. During the experimental period, all sPHENIX detectors were commissioned with Au + Au collision, which confirmed that all the basic functions of INTT were properly worked.[1] This article describes the first version of the INTT software for the data analyses.

INTT has approximately 370,000 channels of 78 μm $\times$ 1.6 or 2.0 mm strip sensors. The hits of particles generated by Au + Au collisions are detected, aggregated by eight data-collection circuits, named FELIX, and stored in 8 different files. Each hit has the channel number corresponding to the hit position, ADC value for dE/dx measurement, a time information to identify the beam crossing.

The data is reconstructed to physical location by the following procedure: 1) The data collected at 8 FELIXes are synchronized into one using the time information of each hit. The sPHENIX tracking detectors take data with a free streaming mode for high-speed data acquisition. Therefore, the time information is also used to synchronize among the tracking detectors. 2) The data is converted to the sPHENIX standard data format by the unpacker.[2] The unpacker also removes hot, cold, and dead channels.[3] 3) Adjacent hits are grouped into single cluster, and its cluster is converted to physical 3D positions using the detector geometry. Here, the geometry is obtained by a survey.[4]

The locations of the reconstructed clusters are visualized by the INTT event display[5] to verify the conversion. By combining the INTT clusters with other tracking detectors, the charged particle trajectory is reconstructed. The successful reconstruction of the cosmic ray in the sPHENIX detector is demonstrated in the Ref. 6).

A software for INTT stand-alone track reconstruction and collision point determination is also being developed.[7] Figure 1 shows the correlation of the z-coordinate of the collision vertex measured by MBD and INTT. MBD, minimum bias detector, is a pair of the Cherenkov timing detectors and provides z-vertex positions. A positive correlation indicates that the INTT successfully measured the collision vertex. Additionaly, the measurements of charged particle multiplicity in Au + Au collisions using INTT clusters and tracks are also in progress.[8]

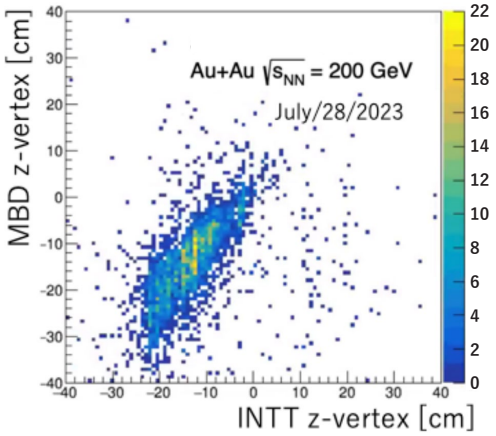

Fig. 1. A correlation of z-vertex measured by MBD and INTT.

In summary, the first version of the software development has been completed to convert the collected data to 3D positions. The integration of the software into the sPHENIX framework is underway. Using this software, the tracks and the collision vertex will be reconstructed by INTT immediately after the start of the proton-proton experiment in the spring of 2024.

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