Commissioning of the intermediate silicon tracker in sPHENIX

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The sPHENIX collaboration[1] studies Quark-Gluon Plasma and Cold-QCD at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. There are four trackers in the sPHENIX detector: a MAPS-based Vertex Detector (MVTX), Intermediate Silicon Tracker (INTT), Time Projection Chamber (TPC), and TPC Outer Tracker (TPOT).

The INTT is a two-layer barrel detector using silicon strip sensors, covering full azimuth angles and pseudo-rapidity within ±1.1. The barrel was constructed using 56 ladders equipped with silicon sensors with a sensitive area of approximately 40 cm × 2 cm. The strips are 78 µm × 320 µm × 16 mm or 20 mm in size, and a single FPHX chip[2] reads 128 strips. The INTT is located between the MVTX and TPC, and is responsible for hit position and timing measurements for tracking. The detector was installed in March 2023, and the construction of the sPHENIX detector was completed in April 2023. The commissioning started in May and was conducted with Au-Au collisions with center-of-mass energy $\sqrt{s}$ = 200 GeV triggered by a Minimum Bias Detector (MBD) located at the forward region. In order to measure particles in the collisions, the timing of the signal readout must be appropriately adjusted. Figure 1 shows the number of hits per event measured in the 1/16 region of the INTT barrel as a function of one of the delay parameters for the readout timing. The peak at the center of the plot indicates that the timing of the Au-Au collision has been matched, while the region outside the peak is considered the background, such as detector noise.

Figure 2 shows a positive correlation between the number of hit clusters per event for the inner (x-axis) and the outer (y-axis) barrels. The correlation can be explained by a simple picture: particles originating from the collision inside the INTT barrels pass through the outer barrel if they pass the inner barrel. Validation of such a simple concept is evidence of the healthy operation of the detector. Other correlations, such as the number of hits of INTT and other detectors, and the collision points reconstructed in the beam axis by INTT and by MBD, also showed reasonable results, *i.e.*, INTT behaved as expected. The chip-by-chip analysis of FPHX also confirmed that approximately 99% of the chips were in good condition.

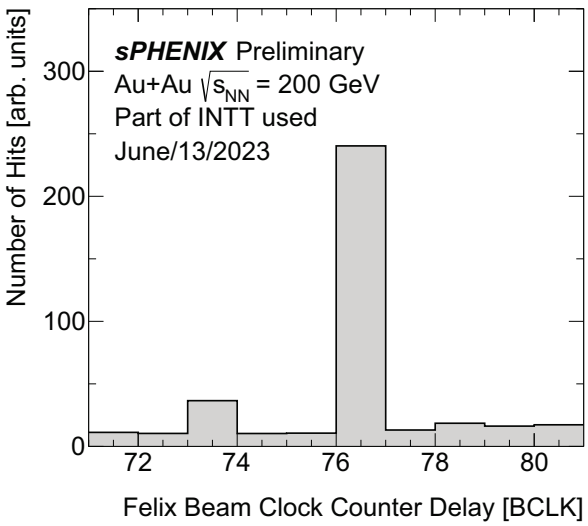

Fig. 1. Number of hits on the INTT barrel as a function of a delay parameter in the system.

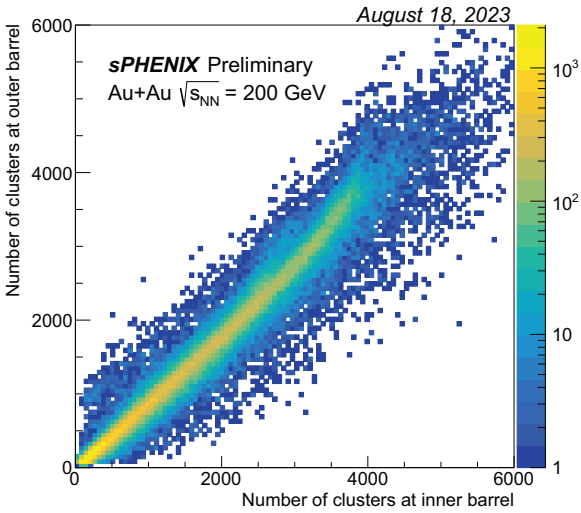

Fig. 2. Correlation between the number of hit clusters in the INTT inner barrel and the outer barrel.

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The beam commissioning was stopped earlier than planned owing to a severe issue with the RHIC magnet. Commissioning by cosmic ray measurement was then employed. The tracking of cosmic rays is discussed in Ref. 3). Almost all test procedures of the INTT were completed during the commissioning in 2023, and it was found to be in good condition.

References

1) sPHENIX collaboration, sPHENX Beam Use Proposal (2020).
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3) C. W. Shih, *et al.*, in this report.