Commissioning of intermediate silicon tracker at sPHENIX with transversely polarized proton-proton collisions at $\sqrt{s} = 200$ GeV

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The sPHENIX experiment at the relativistic heavy ion collider (RHIC) in Brookhaven National Laboratory began operation in 2023 for the study of quark-gluon-plasma (QGP) and proton spin structure. The operation in 2023 commissioned a detector with gold-gold collisions at a center-of-mass energy of 200 GeV per nucleon; however it was terminated one month earlier than planned because of issues with the accelerator. In 2024, RHIC provided transversely polarized proton-proton collisions ($p^{\uparrow}p^{\uparrow}$) at a center-of-mass energy of 200 GeV. The first one and half months were devoted to detector optimization.

The intermediate silicon tracker (INTT) is a two-layer barrel detector that uses silicon strip sensors. It is located in the second-to-innermost layer of the sPHENIX detector. Determining the timing is the main mission of INTT because it is the only tracking detector that has a sufficient timing resolution to identify bunch crossings every 106 ns.

In the commissioning run in 2023, the timing parameter of INTT was adjusted to collect data at the timing of collision as reported in the previous report,[1] and it was confirmed that the detector operated as expected. The required accuracy of the timing tuning is significantly different for $p^{\uparrow}p^{\uparrow}$ from the Au-Au collision because of two reasons. One reason is is the direction of proton beam polarization being different for each beam bunch, which reduces the systematic error drastically in the measurement dependent on the beam polarization. Thus, bunch-crossing identification is crucial to avoid mixing different polarizations. Another reason is that the collision rate is different by two orders of magnitude.

Figure 1 shows the results of the timing adjustment

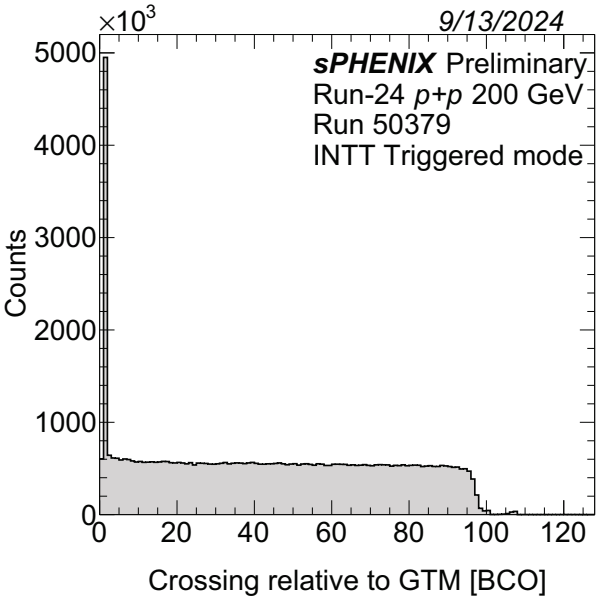

Fig. 1. Number of hits of INTT as a function of bunch-crossing timing.

of the INTT. The horizontal axis represents time in the units of the time difference of bunch crossing of 106 ns (Beam ClOck, BCO). The vertical axis represents the number of hits measured by the INTT in this run. The timing is $x = 1$ when the minimum bias detectors located at the forward and backward regions are triggered by $p^{\uparrow}p^{\uparrow}$ collisions, and a single-bin peak is at that timing. This indicates that the INTT detects hits at the timing of the trigger, and the timing parameters are optimized. INTT continues collecting data for about 10 µs from the trigger timing so that the data can be used in a streaming readout, without triggering. The flat region next to the peak corresponds to this data. Stable data collection continued for about 10 µs. The commissioning of INTT with $p^{\uparrow}p^{\uparrow}$ was successfully completed, and the physical data collection was conducted without any problems and is discussed elsewhere.[2]

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References

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DOI:10.34448/RIKEN.APR.58-087