Transversely polarized proton-proton collision measurements at a center of mass energy of 200 GeV with sPHENIX

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The sPHENIX experiment at the relativistic heavy ion collider (RHIC) in Brookhaven National Laboratory started its operation in 2023 to study of quark-gluon-plasma (QGP) and the proton spin structure. The sPHENIX detector covers the midrapidity region ($|\eta| < 1.1$) using both the calorimeter and tracking systems. The tracking system includes three detectors: MAPS-based VerTeX (MVTX), intermediate silicon tracker (INTT), and the time projection chamber (TPC). The tracking system achieves high-precision vertex reconstruction and high momentum resolution, and therefore, the three states of upsilon can be separated. The calorimeter system consists of electromagnetic and hadronic calorimeters for reconstructing jets even without the tracking system.

In 2024, transversely polarized proton-proton ($p^{\uparrow}p^{\uparrow}$) collisions at a center-of-mass energy of 200 GeV were performed. The maintenance of the tracking system was conducted after the end of the commissioning run with gold-gold collisions in 2023 and before collecting data; the system was restored in March 2024. The detector shakedown with $p^{\uparrow}p^{\uparrow}$started in April and successfully finished in June. Since the TPC required more time to find a voltage and gas mixture working point, the physics data was collected without TPC on June 25. In this Phase 1, the beam-beam crossing angle was set to 0 mrad.

The sPHENIX TPC received the safety approval to operate with a 5% admixture of isobutane in Argon in late July. This gas mixture allowed the TPC to operate in a stable manner with full physics capability. Thus, we started Phase 2 of collecting physics data using all detectors. In Phase 2, the crossing angle was set to 1.5 mrad, and therefore, most of the collisions occurred at the center region of the sPHENIX detector as designed. Further, the tracking system achieved a streaming readout in this period, and it collected data up to 30% of all $p^{\uparrow}p^{\uparrow}$ collisions while the triggered data corresponds to about 0.2% of all collisions. The study of heavy flavor physics can be accomplished using the streaming tracker data given its high statistics.

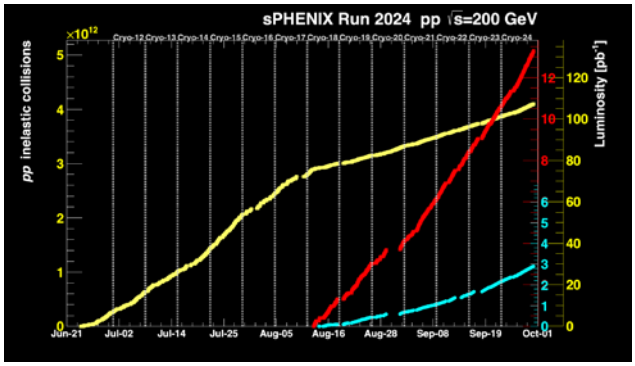

Fig. 1. Integrated luminosity accumulated with 200 GeV $p^{\uparrow}p^{\uparrow}$ collisions by sPHENIX in 2024. The yellow, red, and blue points indicate the calorimeter data, all detector data, and tracker streaming data, respectively.

Figure 1 shows the luminosity recorded by sPHENIX during this run as a function of date. The calorimeter data shown in yellow was collected from Phase 1 and reached 107.4 pb^{-1}, which corresponds to 240% of the proposed goal.[1)] Data from all detectors (red) reached 13.28 pb^{-1}, reaching 30% of the goal. The streaming readout data (blue) from the tracking detectors reached 2.9 pb^{-1}, which is 65% of the goal, and they will be used to study open-heavy flavor physics.

sPHENIX acquired enough statistics with all detectors in operation with transversely polarized proton-proton collisions in 2024 although sPHENIX-TPC came up late. The data will be used for the base-line of QGP studies and the transverse structure of polarized proton.

Reference

1) sPHENIX collaboration, sPHENX Beam Use Proposal (2023).

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