Searching for mini-QGP in p+p collisions using a high multiplicity trigger with the FVTX

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There have been many reports via RHIC and LHC experiments about the collective behavior of matter formed in high-energy heavy-ion collisions such as Au+Au and Pb+Pb. This non-zero elliptic flow has been considered to indicate strong evidence of the formation of the quark gluon plasma (QGP). On the other hand, it has been believed no QGP formation exist in small systems such as $p+p$ or p+A collisions because the system is too small to attain a thermal equilibrium. However, recent LHC results have shown collective behaviors from high-multiplicity events (when the total number of tracks is larger than 110) in $p+p$ collisions both at $\sqrt{s}$ =7 and 13 TeV[1)], and in p+Pb collisions at $\sqrt{s_{NN}}$ =5.02 TeV[2)]. A ridge structure on the near-side of two-particle correlations was observed where the near side corresponds to the region of small azimuthal angular difference between the particles. Inspired by these results, PHENIX also studied collective behaviors in small systems such as p+Au, d+Au, and ^{3}He+Au[3)] collisions.

In order to explore the possible collective behavior in the smallest system, i.e., $p+p$ collisions at RHIC energies, we implemented a high-multiplicity trigger to the existing readout system of the forward vertex detector (FVTX) before RHIC Run-15 to tag events of multiple tracks at forward rapidity. The FVTX is a new silicon strip detector that was installed before starting RHIC Run-12 to measure the precise event vertex position and trajectory of charged particles at the rapidity range of $1.2 < |\eta| < 2.2$. The FVTX has four stations per arm, which consist of 48 number of mini-strip silicon sensors. A previous study showed that there is a very weak correlation between tracks measured at central arms (CNT, $|\eta| < 0.35$) and the beam beam counter (BBC, $3.4 < |\eta| < 3.8$) in $p+p$ collisions. We decided to use the FVTX to trigger high-multiplicity events in $p+p$ collisions. That is because the FVTX detector is closer to mid-rapidity than the BBC, so we could expect a stronger correlation between CNT-FVTX than that between CNT-BBC.

The logic of the FVTX trigger system relies on the basic unit of the FVTX reconstruction, the wedge. The wedge consists of two silicon strip sensors, readout chips, and high-density interconnect. Each station contains 24 wedges. In the FVTX trigger system, the number of online tracks simply indicates the number of the fired wedges according to the logic of the threshold, so the number of online tracks cannot be larger than 24. More over, the number of offline tracks indicates reconstructed roads from the PHENIX raw data files according to the road reconstruction logic. Fig. 1 shows correlations between the number of offline tracks and online tracks. The number of offline tracks is supposed to show a linear correlation with the number of online tracks. In our trigger, we can clearly observe a correlation between the number of online tracks and the number of offline tracks. However, when comparing Fig. 2 with Fig. 1, there seems to be a larger off-diagonal component with more online tracks than offline tracks.

We still need to find a way how to remove the off-diagonal part in the correlation between online and offline track numbers, particularly on the $p+p$ collisions. A data analysis of two-particle correlations in $p+p$ collisions at $\sqrt{s}$ =200 GeV is ongoing.

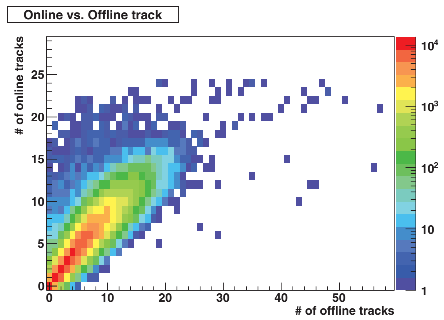

Fig. 1. Correlation of number of tracks between online and offline reconstructions at p-going side in p+Au collisions.

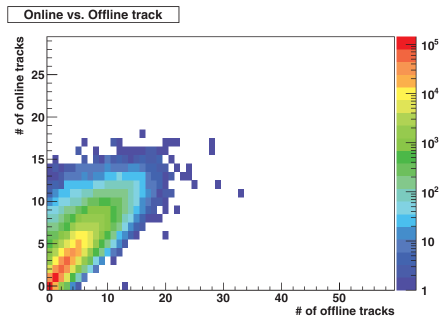

Fig. 2. Correlation of number of tracks between online and offline reconstructions in p+p collisions.

References

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