Development of FVTX High-Multiplicity Trigger System for the RHIC-PHENIX experiment in Run15

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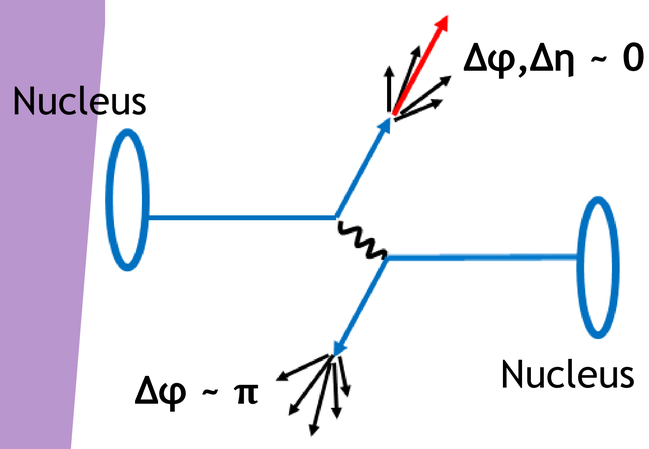
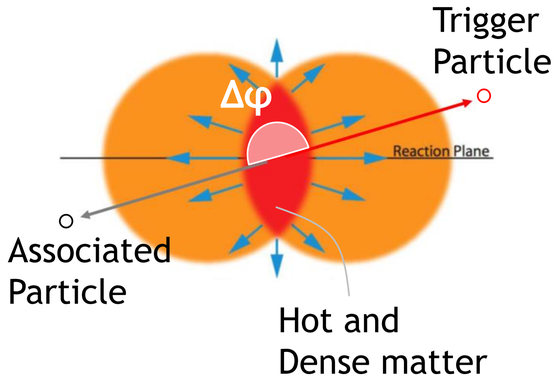
Abstract

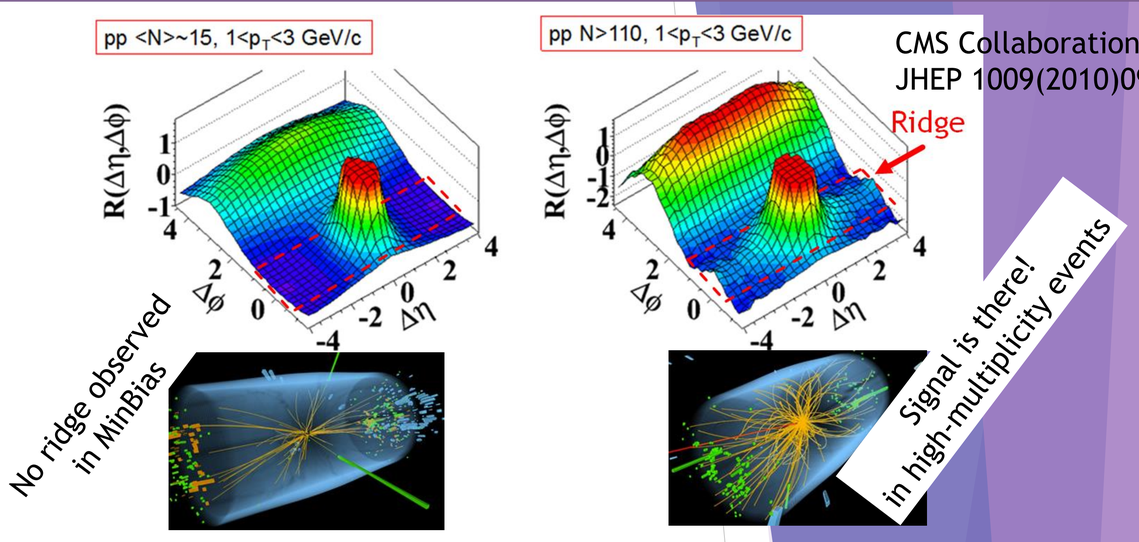
Particle angular correlation measurements in small colliding systems, such as p+Pb, d+Au and 3He+Au at RHIC and the LHC have recently attracted significant interest. In particular, high multiplicity events from such collisions exhibit azimuthal correlations between rapidity separated hadrons, so called ridge. To investigate the ridge phenomena in small colliding systems at RHIC, a new high multiplicity trigger system was developed using the forward silicon vertex detector (FVTX) in the PHENIX experiment.

Motivation

Under extreme density and temperature, nuclear matter is expected to undergo a phase transition to a Quark Gluon Plasma(QGP) which is best described as a liquid. One of the characteristic behaviors exhibited by the QGP is the near side ridge structure in the 2 particle correlation. In nucleus+nucleus collisions, the ridge phenomena is interpreted as a reflection of a collective motion of the matter generated by the collision.



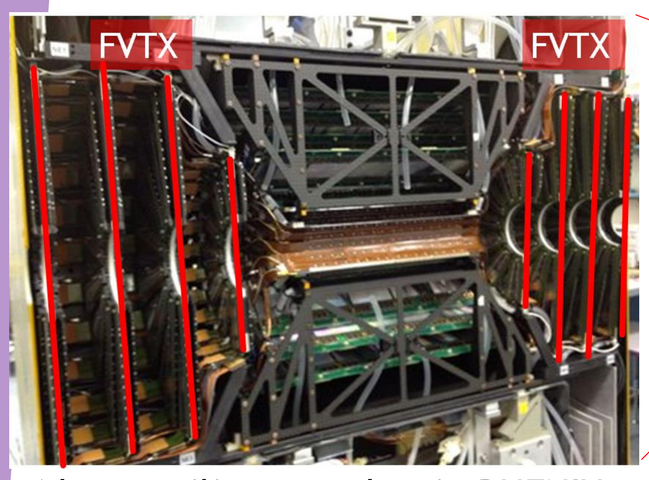


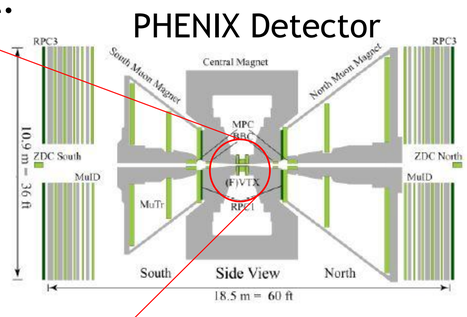


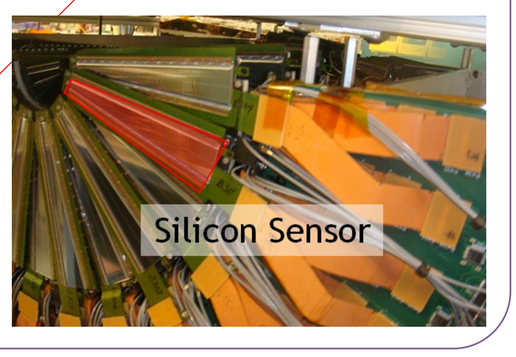
Although the ridge phenomenon had been considered to be unique in nucleus + nucleus collisions, similar structure was recently observed in small colliding systems such as proton+proton. However, since the ridge signal in small colliding systems is far smaller than that in nucleus+ nucleus collisions, a system to effectively collect high multiplicity events is needed to observe the signal.

Forward Silicon Vertex Detector (FVTX)

New high multiplicity trigger system was installed in the RHIC-PHENIX experiment, using Forward Silicon Vertex Detector (FVTX). FVTX is suitable to select high-multiplicity events since it is one of the closest tracker to the vertex point.



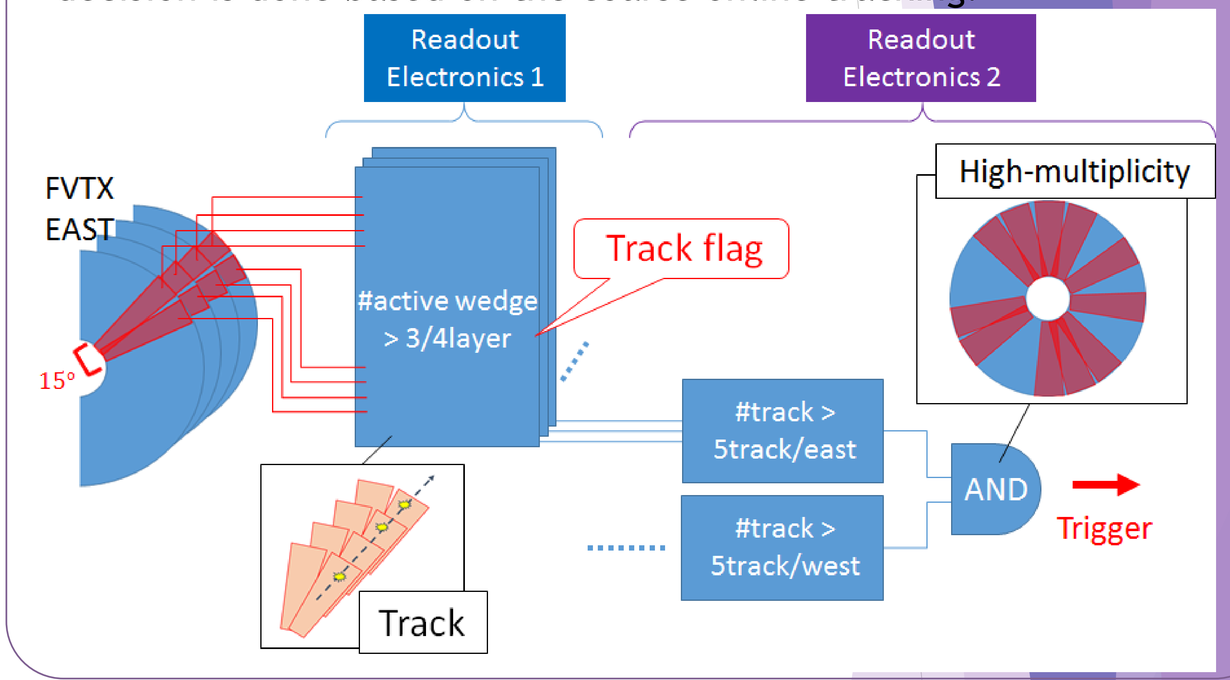




- 4 layers silicon tracker in PHENIX muon arm
- Each layer is composed of 24 φ column
- Coverage : 0<φ<2π, 1.2<|η|<2.2

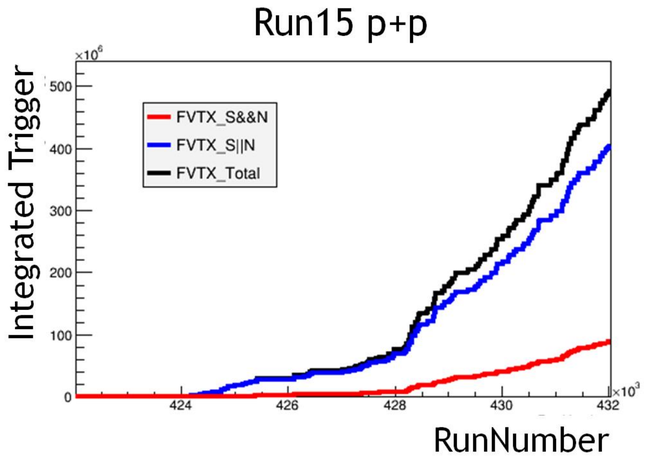
Trigger Design

The trigger signal is generated in FPGAs implemented on FVTX readout electronics. Using the feature that the hit information in FVTX is sent to front end electronics without any event cut, trigger decision is done based on the coarse online tracking.



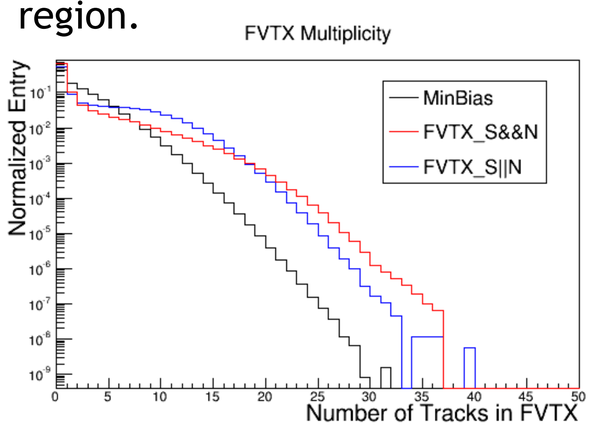
Trigger Performance

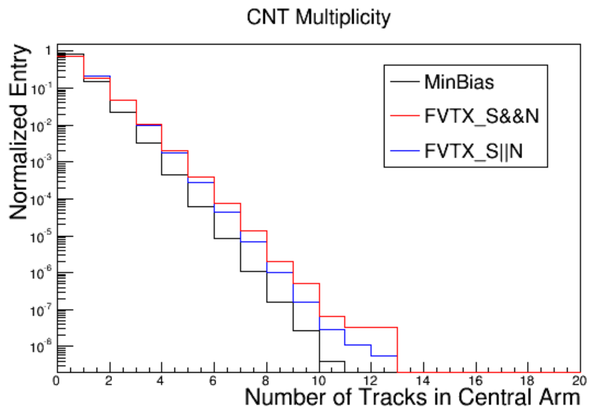
Run15 p+p



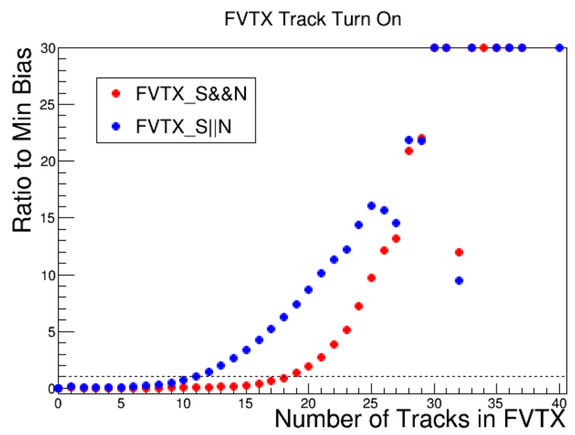
FVTX high-multiplicity trigger system has operated during physics data taking in p+p, p+Au and p+Al in PHENIX Run15. Integrated trigger scaler counts for p+p are shown in the left figure. In p+p, the FVTX trigger had operated using AND/OR of south and north trigger signal. Total number of triggered event is 500M events in p+p, 300M in p+Au and 180M in p+Al.

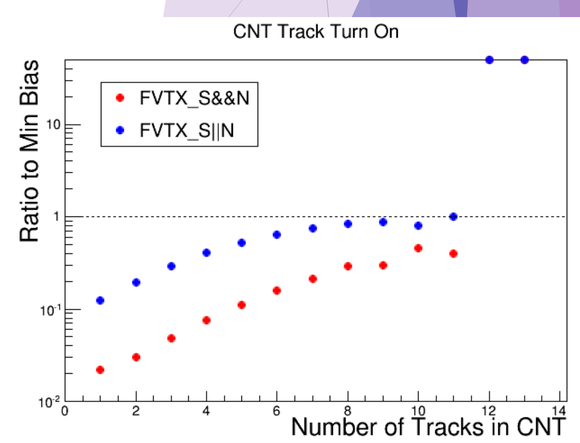
Trigger performance plot are shown below. Compared to the minimum bias trigger, the FVTX trigger has a better sensitivity to high multiplicity events not only in FVTX, but also in central arm region.





Following plots show the ratio of the actual triggered events taken by minimum bias and FVTX triggers as a function of multiplicity. Clear turn on curve is seen at higher multiplicity region in the forward rapidity. In the central region, even though assigned bandwidths of the FVTX trigger is narrower than MB, number of triggered event is close in the high multiplicity region.





Summary and Future Outlook

- FVTX high-multiplicity trigger system has installed in the PHENIX experiment and operated during physics data taking in Run15.
- The trigger performance shows a good sensitivity in high multiplicity region especially in the forward rapidity.
- Performance analysis for p+Au and p+Al is ongoing.
- 2 particle correlation analysis in small colliding systems, especially in p+p, will be done using the FVTX triggered data set.