Tracking performance simulation for INTT at sPHENIX

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The sPHENIX tracking system comprises, from the inside to outside, i) the Monolithic-Active-Pixel-Sensor-based Vertex Detector (MVTX),[1)] ii) the Intermediate Silicon Strip Tracker (INTT),[2)] and iii) the Time Projection Chamber (TPC).[2)] MVTX measures the distance of closest approach for heavy-flavour physics. TPC aims at a momentum resolution of 1.2% for different Υ state separations. INTT has a narrow timing window of 100 ns, which is orders smaller than those of MVTX (4000 ns) and TPC (26400 ns), which provides rejection powers on pile-up events and tracks.

The INTT tracking performance and its optimal layer configuration are evaluated via 1) pile-up event rejections, 2) pile-up track rejections, and 3) MVTX cluster association efficiency to TPC track seeds. For these studies, GEANT4 simulations with PYTHIA8 p+p events at $\sqrt{s}$ = 200 GeV, embedded at realistic collision rates at sPHENIX, are employed. Tracks are reconstructed only with MVTX hit triplets and a cluster in one of the INTT layers for the (1), while tracks are seeded in TPC and interpolated to INTT and MVTX hits with the Hough transformation for the (2) and (3).

Figure 1 Left (Right) shows the event vertex tagging (rejection) efficiency in (out of) the INTT time window as a function of PYTHIA event multiplicity at the collision rate of 12 MHz. The integrated in-time vertex tagging efficiency is 98.4 ± 0.3%, and the integrated out-of-time, *i.e.* pile-up, vertex rejection efficiency is 99%. This indicates 1 INTT cluster provides a good rejection of pile-up tracks.

Figure 2 shows the numbers of tracks per p_T bin width from in-time and pile-up events as a function of p_T at the collision rate of 10 MHz. The blue and red lines are the generated tracks in in-time and pile-up events.

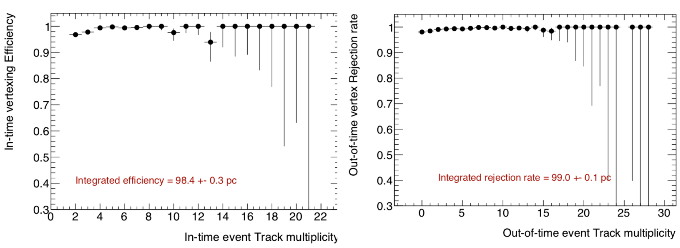

Fig. 1. (Left) In-time vertex tagging and (Right) out-of-time vertex tagging efficiency versus event multiplicity.

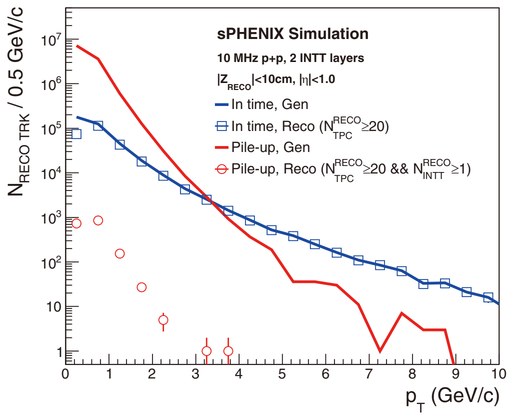

Fig. 2. Number of tracks from in-time and pile-up events as a function of p_T with different tracking requirements.

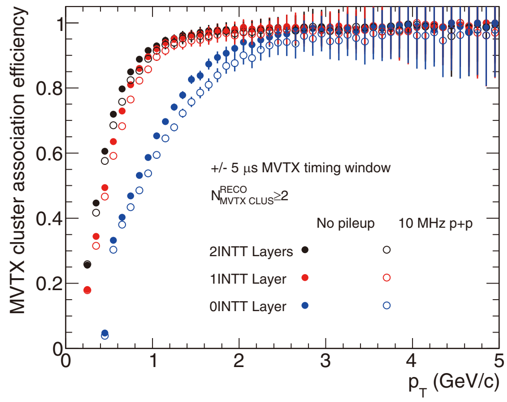

Fig. 3. MVTX cluster association efficiency to TPC track seeds as a function of p_T with different number of INTT layers.

The red circles show that the pile-up contribution in the reconstructed tracks becomes two orders smaller than that from the in-time events (blue squares) by requiring 1 INTT cluster in addition to 20 TPC clusters in tracking. This also indicates 1 INTT cluster provides a good rejection of pile-up tracks.

Figure 3 shows MVTX cluster association efficiency to TPC track seeds as a function of p_T at no pile-up (0 Hz) and 10 MHz collision rates. The worst efficiency is obtained without INTT (0INTT Layer) because of the large distance between MVTX and TPC. INTT hits in the association reduce the uncertainty in searching MVTX hits, resulting in better efficiency. The efficiency is the best with 2 INTT layers. These studies show that a two-layer INTT detector is optimal for obtaining the best tracking performance at sPHENIX.

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References
1) MVTX proposal submitted to the DOE Office of Science
2) sPHENIX proposal, arXiv:1501.06197