Effect of radiation exposure on MIP peak position during the 2024 $p+p$ running of sPHENIX-INTT

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The sPHENIX[1] experiment started in 2023 using the relativistic heavy ion collider at the Brookhaven National Laboratory (BNL). The study primarily targets the properties of quark-gluon-plasma by measuring jet phenomena and upsilon particles generated by 200 GeV Au-Au and p-p collisions.

The intermediate silicon tracker (INTT) is a silicon strip barrel detector, covering ±23 cm along the beam axis and full azimuth. INTT consists of 56 ladders, half of which have 26 readout FPHX chips.

Radiation exposure is known to damage silicon sensors and increase leakage current, possibly exacerbating the response to the energy deposition of charged particles. In this research, energy deposition of minimal ionizing particles (MIP) is analyzed with $p+p$ collision data taken from May to August in 2024. Energy deposition in the sensor is measured by 3-bit analog-to-digital converter (ADC). Adjacent hits are clustered in the first step of analysis. After reconstruction of the collision point using INTT cluster pairs, tracklet reconstruction is optimized for INTT.[2] Figure 1 shows ADC distribution of clusters associated with reconstructed tracklets. The tracklets are required to be incident to the sensor perpendicularly for the variation of the energy deposit to be minimized. To quantify the MIP peak, the distribution was fitted with a convolution function of Landau and Gaussian distributions.[3] The red line represents the fitting function. The MIP peak position, which is the most probable value of Landau distribution, was found to be 83.0 ± 0.5.

Figure 2 shows MIP peak positions as a function of run number. The run numbers correspond to the data acquisition periods. The MIP peak positions appear to be mostly spread among ADC of 80 and 85. After Run 46000, the average peak seems to have shifted to slightly lower. Although its performance is expected to get worse due to radiation damage, the result shows no drastic change of MIP peak positions in INTT. This suggests that the radiation damage does not have a significant effect on particle measurements by INTT. For further investigation, noise reduction analysis is ongoing.

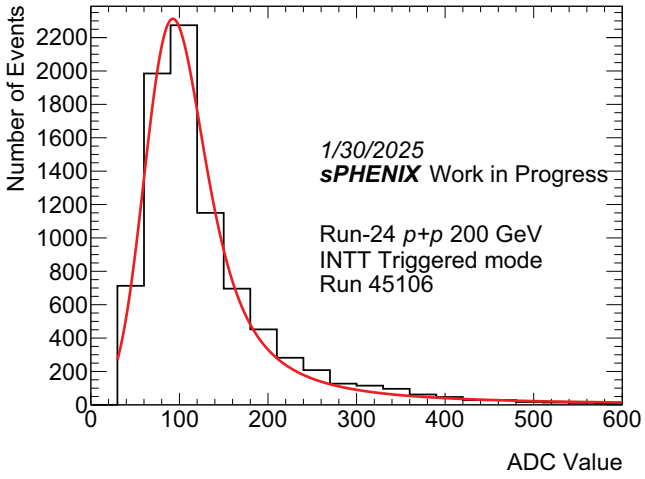

Fig. 1. ADC distribution (black) fitted with a convolution of Landau and Gaussian distributions (red).

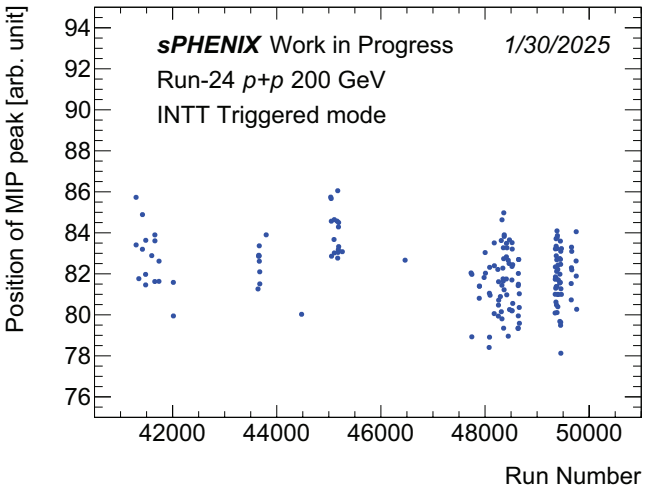

Fig. 2. MIP peak position as a function of run number.

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