Channel classification of intermediate silicon tracker at sPHENIX

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sPHENIX[1] is a novel detector system at Relativistic Heavy Ion Collider designed to advance our understanding of Quark Gluon Plasma and Cold-QCD. The tracking system comprises four subdetectors: Monolithic Active Pixel Sensor-based Vertex Detector, Intermediate Silicon Tracker (INTT), Time Projection Chamber, and TPC Outer Tracker.

The INTT, based on silicon strip sensors, consists of a group of 56 silicon ladders assembled in a two-layer barrel configuration. Each half-ladder has 26 readout chips called FPHX, and each chip has 128 readout channels, resulting in a total of approximately 370,000 channels for the entire INTT. The strip size is 78 μm $\times$ 16 mm or 20 mm, with a thickness of 320 μm, providing high spatial resolution in the ϕ angle. Owing to the large number of channels in the INTT, channel classification is essential for systematic analysis. The classification method is being studied using data from Au-Au collisions at a center-of-mass energy of $\sqrt{s_{NN}}$ = 200 GeV.

Figure 1 shows the hit rate of all channels on the one half-ladder, normalized by the number of events. Owing to two strip lengths of the INTT (16 mm and 20 mm) and the non-negligible difference in the radii of the inner and outer barrels, these factors are accounted for in the normalization process. As the number of events increases, the hit rate of chips on the same ladder gradually approximates a Gaussian distribution, following the central limit theorem. Both differences are taken into account in normalization. As the number of events increases, the hit rate of chips on the same ladder gradually follows the form of Gaussian distribution according to the central limit theorem. Figure 2 shows the hit rate distribution.

The"COLD" channels have a hit rate less than $\mu - 3\sigma$, while the HOT channels have a hit rate greater than $\mu + 3\sigma$. The channels without hits are tagged as"DEAD." This method clearly depends on the σ cut used to define both "HOT" and "COLD" channels.

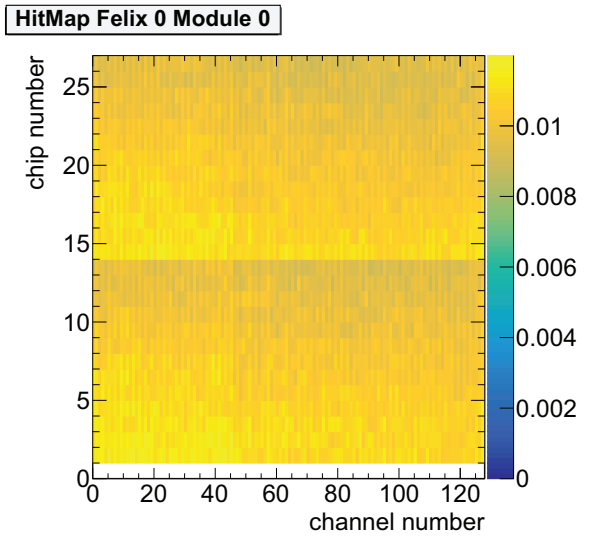

Fig. 1. Normalized hit rate of all channels on the one half-ladder. Channels with chip numbers ranging from 6 to 13 and 20 to 26 have a size of 78 μm $\times$ 16 mm, while others have a size of 78 μm $\times$ 20 mm.

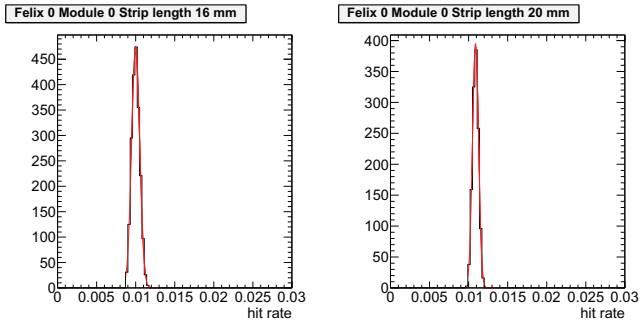

Fig. 2. The hit rate distributions from Fig. 1 with the fitted Gaussian functions. The figure on the left corresponds to chips with a strip length of 16 mm, and the figure on the right corresponds to chips with a strip length of 20 mm.

Table 1 shows the fraction of channels with $\mu \pm N\sigma$ cut. Through this classification, we achieved approximately 93% strips tagged as "GOOD" channels. We expect that adjustments to the DAQ system, particularly in the threshold settings, will increase the fraction of "GOOD" channels before Run 2024.

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Table 1. Fraction of classified channels depending on the σ cut.

Tag	3σ	3.5σ	4σ	4.5σ	5σ
GOOD	92.94%	93.25%	93.38%	93.49%	93.61%
COLD	5.43%	5.25%	5.16%	5.07%	4.96%
HOT	0.27%	0.14%	0.10%	0.08%	0.07%
DEAD	1.36%	1.36%	1.36%	1.36%	1.36%

References

1) sPHENIX collaboration, sPHENX Beam Use Proposal (2020).
2) G. Nukazuka *et al.*, in this report.