# Challenge to distinguish between signal and background using 3 bit ADC of sPHENIX-INTT detector

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The sPHENIX experiment started in 2023 using the relativistic heavy ion collider (RHIC) in BNL to study the properties of the quark gluon plasma, QGP. We measured particles generated in Au-Au collisions at $\sqrt{s_{NN}} = 200$ GeV at the collision point. The intermediate track detector (INTT) introduced in this experiment is a silicon strip barrel detector, covering $\pm 23$ cm along the beam axis and full azimuth. The INTT consists of 56 INTT ladders,[1)] has an inner and outer layer located 7 and 10 cm respectively in radius and plays an important role in reconstructing particle tracking. We applied $-100$ V bias voltage to INTT.

To achieve a good signal-to-noise ratio in this experiment, it is crucial to evaluate the energy deposit of passing charged particles (Minimally Ionized Particles (MIP)) and noise contamination in the MIP region. Although ADC has only 3 bits, it is possible to measure the distribution of the energy deposit with higher accuracy by spanning narrow range of DAC value at a time, but different ranges in multiple runs. The DAC value is an 8-bit threshold corresponding to a 3-bit ADC. We will then be able to reconstruct full energy deposit distribution in high resolution by concatenating these multilple runs offline. In this experiment, we performed five narrow range measurements shown in Fig. 1 covering the MIP peak range and scanned the energy deposit spectrum in the range of DAC values 68–176. The theoretical value of the MIP peak calculated using the Bethe-Bloch equation is expected to be 0.086 MeV for a parpendicular trajectory.

To improve the signal-to-noise ratio, we applied an event selection and a track selection. In the event selection, we removed strips with extremely large number of hits, and clusters which contain a hit with ADC = 7 that were likely to be overflow value. In a track selection, we selected clusters which are incident perpendicular to the sensor and which often pass through only one strip to find the MIP peak more accurately.

| | Setting the DAC value (corresponding to ADC threshold) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DAC0 (ADC=0) | DAC1 (ADC=1) | DAC2 (ADC=2) | DAC3 (ADC=3) | DAC4 (ADC=4) | DAC5 (ADC=5) | DAC6 (ADC=6) | DAC7 (ADC=7) |
| $\mathrm{Run}_{68-96}$ | 68 | 72 | 76 | 80 | 84 | 88 | 92 | 96 |
| $\mathrm{Run}_{88-116}$ | 88 | 92 | 96 | 100 | 104 | 108 | 112 | 116 |
| $\mathrm{Run}_{108-136}$ | 108 | 112 | 116 | 120 | 124 | 128 | 132 | 136 |
| $\mathrm{Run}_{128-156}$ | 128 | 132 | 136 | 140 | 144 | 148 | 152 | 156 |
| $\mathrm{Run}_{148-176}$ | 148 | 152 | 156 | 160 | 164 | 168 | 172 | 176 |

Fig. 1. The table which shows setting the DAC values corresponding to ADC threshold in each measument.

Figure 2(a) shows ADC distributions measured in the five DAC value settings corresponding to each color. We overlapped the five distibutions and combined them into one energy deposit curve, as in Fig. 2(b).

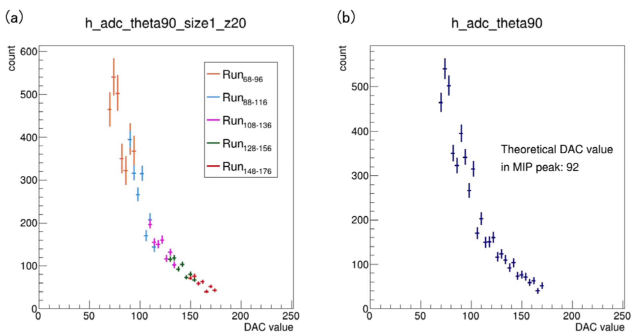


Fig. 2. (a) The ADC distribution obtained from 5 runs after normalization. (b) The energy deposit spectrum.

It is theoretically predicted that the MIP peak appears at a DAC value of 92, but the ADC distribution from data had too much background and no clear MIP peak was seen. To see a clear MIP peak, we need to reduce the background. We plan to continue investigating the causes of the background and evaluating MIP peaks and noise contamination. Finally, we aim to confirm the sufficient ability of INTT to achieve a good signal-to-noise ratio in energy deposit measurements for the sPHENIX experiment.

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DOI:10.34448/RIKEN.APR.57-185