Performance evaluation of sensor module for INTT at sPHENIX

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Intermediate silicon strip tracker (INTT) is one of the tracking detectors of sPHENIX.[1)] As shown in Fig. 1, INTT ladder consists of high-density interconnect (HDI) FVTX chips for PHENIX (FPHX) and silicon strip sensor.[2)] HDI is a flexible PC board to provide input and output for FPHX. The power to FPHX and silicon strip sensor are supplied through HDI. FPHX is a readout LSI chip used for PHENIX. 26 FPHX are implemented into the INTT ladder. One FPHX readouts 128 strip channels. Each channel is equipped with a shaping amplifier and 3-bit ADC. There are two different sizes of the silicon strip sensor. One of them is 78 $\times$ 16 mm for A (20 mm for B). It is sensitive in ϕ direction.

We built a test bench to evaluate the sensor module performance at Nara Women's University as shown in Fig. 2. The read-out system of the bench is described below. First, the hit data is sent from FPHX to read-out card (ROC) through a flexible cable, and are read-out at ROC. Data are sent from ROC to the front-end module (FEM) through an optical fiber and to be formatted. Finally the data from the FEM in the PC is recorded. Figure 3 shows the schematic drawing of the read-out system.

To check the functionality of the read-out system, we input a test pulse from ROC to FPHX with changing pulse height and measure ADC. Figure 4 (a) shows the correlation between input pulse height and output ADC in a chip. Every chip responded linearly as expected. There were some strange signals in ADC 7 of a chip. Figure 4 (b) shows the number of hits (z-axis) as a function of pulse height (y-axis) in different strip channels (x-axis). All channels responded correctly and the hit efficiency improved at the threshold (pulse heights are near 30). The read-out system operated properly.

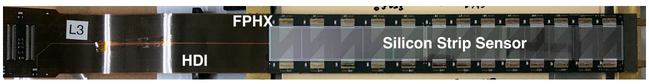

Fig. 1. INTT ladder.

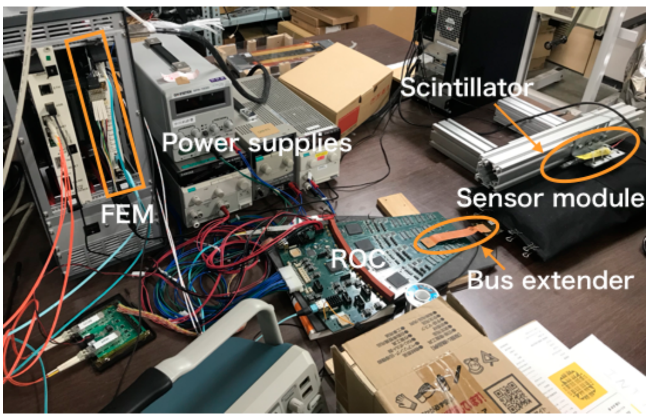

Fig. 2. Test bench setup.

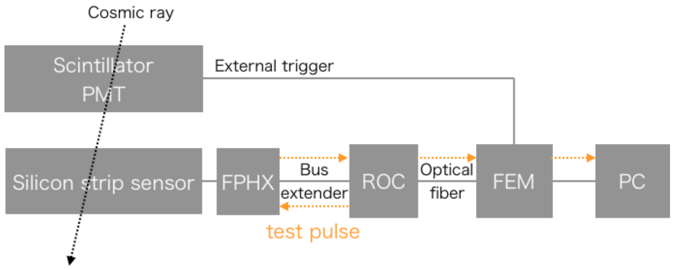

Fig. 3. The schematic drawing of the readout system.

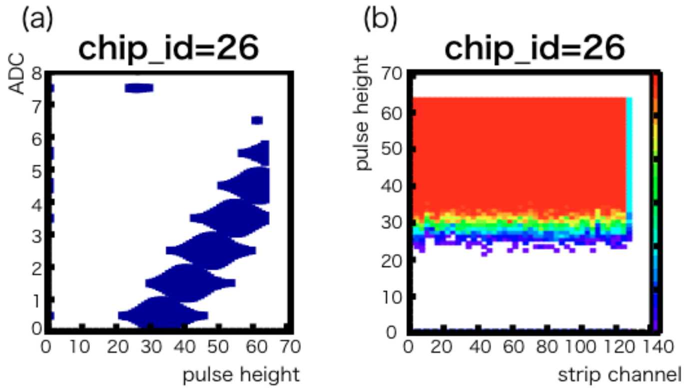

Fig. 4. (a) ADC vs pulse height (b) Pulse height vs strip channel.

We measured the cosmic ray with an external trigger to study the response of minimum ionizing particle (MIP). As shown in Fig. 3, the sensor module and external trigger overlap each other, and the coincidence of both sensor module and external trigger decreases the noise. We are in the progress of accumulating data.

In the next step we will qualitatively evaluate the noise and efficiency by measuring the radiation source and cosmic ray. We plan to conduct the beam test at Fermi lab. in 2019 to evaluate the sensor modules.

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References

1) I. Nakagawa *et al.*, in this report.
2) C. Aidata *et al.*, Nucl. Instrum. Methods Phys. Res. A **755**, 44–61 (2014).