Development of a prototype silicon tracking detector for the sPHENIX experiment

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Quark Gluon Plasma (QGP) is an extreme hot and dense QCD matter where quarks and gluons are released from confinement inside hadrons and it is believed to have existed in the early universe. The study of QGP gives a rich knowledge on not only how our universe has been formed but fundamental features of QCD in a high dense and high temperature environment.

The sPHENIX experiment is scheduled to start data taking from 2021 at the Relativistic Heavy Ion Collider (RHIC) to reveal the medium properties of QGP, and the tracking system of the sPHENIX detector consists of the monolithic active pixel sensors (MAPS), the intermediate silicon tracking detector (INTT), and the time projection chamber (TPC) from the inside to the outside. We have a responsibility for construction of INTT which has an important role to realize good capabilities on:

- track reconstruction by association of MAPS and TPC hit information
- single collision vertex finding with a high collision rate

We have inherited the readout system and basic idea of the module structure for the forward vertex detector (FVTX)[1] as a subsystem of the PHENIX detector to minimize R&D efforts of INTT so that INTT construction can be completed in time for start-up of the sPHENIX experiment. Therefore, we need to understand how a whole readout system of INTT including the inherited devices works using a prototype module. In this report, the current status of development of a prototype module is reported.

The first prototype modules of INTT have been assembled at BNL. Si sensors[2] with thickness of 240 and 320 μm from HAMAMATSU Photonics K.K. are used for the prototype modules. Figure 1 shows the prototype module with 320 μm-thick Si sensors. High density interconnect circuits (HDIs) are connected on either side of the Si sensors and 10 FPHX chips are mounted on each HDI. The FPHX chip is originally designed as a pre-amplifier for FVTX and contains 128 channels. The Si sensors are mechanically separated at the middle and the FPHX chips are wire-bonded to the Si sensors.

Tests of the prototype modules have been made using calibration pulses. The test result for a single FVTX chip on the HDI is shown in Fig. 2. A clear correlation between calibration pulse amplitude and ADC values can be seen and all channels look working. It has been confirmed that the Si sensors and FPHX chips can be assembled successfully on a HDI and a whole readout system works well with the prototype modules.

Fig. 1. A prototype module of INTT with 320 μm-thick Si sensors.

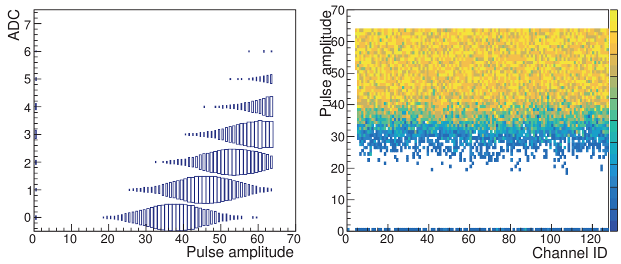

Fig. 2. The correlation between calibration pulse amplitude and ADC values (Left) and reactions with the calibration pulses for all channels on a chip (Right).

New HDIs will be produced with an improved design to match an updated detector position configuration soon and further tests with prototype modules are scheduled including cosmic ray measurements.

References
1) C. Aidala *et al.*, NIM A **755**, 44-61 (2014).
2) Y. Akiba *et al.*, in this report.

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