Design of the innermost layer module of the silicon tracking detector for the sPHENIX experiment

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High energy heavy ion collisions are the most suitable tool to study the properties of Quark Gluon Plasma (QGP), which is an extreme hot and dense QCD matter where quarks and gluons are free from confinement inside hadrons. The Relativistic Heavy Ion Collider (RHIC) can provide heavy ion collisions with an enough energy to create QGP experimentally. sPHENIX is a new RHIC experiment for QGP study and is scheduled to start data taking from 2021. We are in charge of construction of the intermediate silicon tracking detector (INTT)[1] which plays an important role on charged particle tracking together with the monolithic active pixel sensors (MAPS) and the time projection chamber (TPC). INTT makes a good tracking together with MAPS and TPC and also helps to resolve pile-up events by its excellent timing resolution.

We have designed the innermost INTT layer (L0) sensitive to z-position while the other three layers are ϕ-sensitive. Figure 1 shows the drawings of an L0 single cell and a module consisting of ten cells on one high density interconnect circuit (HDI). One L0 sensor

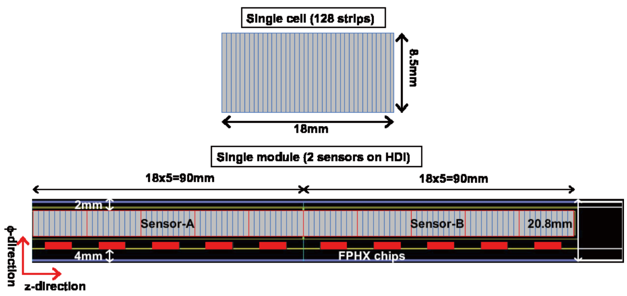

Fig. 1. The drawings of an L0 single cell and a module consisting of ten cells on HDI.

has 5 cells and a FPHX readout chip is wire-bonded to each cell. The z-length of a single cell is 18 mm and it is divided into 128 strips. The width of the cell is optimized through the Geant4 based simulation. Figure 2 shows the simulated L0 acceptance with different ϕ-widths. 1M electron events are simulated within the L0 coverage assuming all electrons are emitted at $z = 0$. Unavoidable 3.2% loss of the acceptance comes from the 2 mm-gap in the z-direction between two modules. 8.5 mm of ϕ-width keeps the maximum acceptance with the minimum occupancy. 48 L0 modules are integrated into one barrel like rotor blades as shown in Fig. 3. The tilt angle of each module is set to 15° with a 1 mm-gap between neighboring modules for realistic engineering.

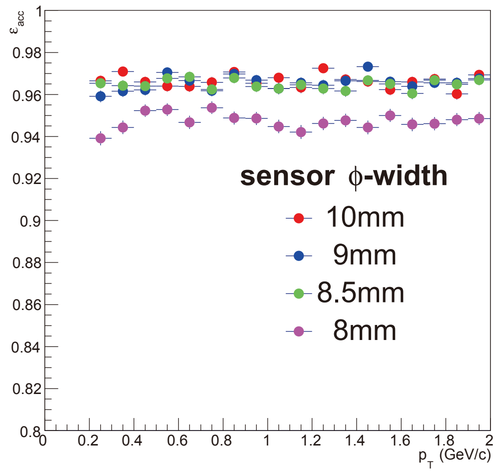

Fig. 2. The simulated L0 acceptance with different ϕ-widths.

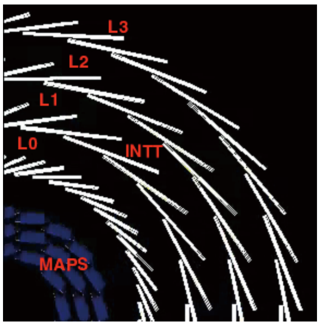

Fig. 3. L0 module alignment from the beam view.

The first prototype sensors and HDIs are being manufactured by HAMAMATSU Photonics K.K. and Yamashita Material Co.+REPIC, respectively. They will be assembled into the first L0 module.

Reference
1) I. Nakagawa *et al.*, in this report.

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