Performance evaluation and mass production status for sPHENIX intermediate silicon tracker

Genki Nukazuka
(RIKEN BNL Research Center)
on behalf of the sPHENIX collaboration
sPHENIX at RHIC in BNL will start data taking from 2023 for QGP and cold QCD physics:
- **QGP:** γ-jet, b-quark tagged jet, Y (1S, 2S, 3S), …
- **Cold QCD:** transverse single spin asymmetry (direct γ, D⁰, and inclusive jet in mid-rapidity), …

The sPHENIX detector covering full azimuthal angle in $|\eta| < 1.1$ and $|z_{vtx}| < 10$ cm is under construction.

The tracking system consists of 3 tracking detectors:
- **MVTX** ($r < 4$ cm) : vertexing
- **INTT** ($r < 10$ cm) : hit position&timing matching
- **TPC** ($r < 80$ cm) : good momentum resolution
**INTermediate Tracker (INTT)**

**Cross-section**
- Inner ladders: $12 \times 2$
- Outer ladders: $16 \times 2$
- Total: 56

128 $\times$ 26 $\times$ 2 = 6,656 ch/ladder
6,656 $\times$ 56 $\sim$ 370k ch

**ReadOut Card (ROC)**
- BUS extender
- Conversion Cable
- FPHX chips
- Silicon sensors
- HDI

**Status of Barrels**
- Assembly May 25th, 2021: Very Successful

2 types of silicon modules made by Hamamatsu:
- strip: 128
- strip width: 78 $\mu$m
- strip length: 16 mm or 20 mm
- thickness: 320 $\mu$m

**Active area**

**QuarkMatter2022, Performance evaluation and mass production status for sPHENIX intermediate silicon tracker, G. Nukazuka (RBRC)**
Ladder Mass Production: Smoothly done

56 ladders are needed AT LEAST!

Ladder mass production was almost finished. QA showed that most of them are in quite good condition.

56 ladders are needed AT LEAST!

Gluing HDI to stave

Gluing FPHX chips on a stave

CFC stave HDI

FPHX chips

silicon strip sensor

QA tests

Encapsulation

Wire bonding

QA results

<table>
<thead>
<tr>
<th>Class</th>
<th>BNL</th>
<th>Taiwan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>71</td>
<td>11</td>
<td>82</td>
</tr>
<tr>
<td>Class 2</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Class 3</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Class 4</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

( #bad ch ≦ 0.5%)

(0.5% < bad ≦ 1%)

(1% < bad ≦ 2%)

(2% < bad ≦ 3%)

ADC linearity

width

ampl.

BNL

Taiwan

Total

ADC
### Performance: Test beam experiment in 2021

#### Fingertip scintillator
- (not trigger)
- e+ beam
- 1 GeV

#### Trigger scintillator
- Newly developed extension cable (1.3 m)

#### Readout
- INTT ladder 1
- ROC extension cable (1.3 m)
- INTT ladder 2

#### Beam Detection e

<table>
<thead>
<tr>
<th>Channel</th>
<th>2E+07</th>
<th>6E+07</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### My analysis

<table>
<thead>
<tr>
<th>Ladder</th>
<th>ε</th>
<th>Ladder 1</th>
<th>ε</th>
<th>Ladder 2</th>
<th>ε</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ</td>
<td>0.994</td>
<td>0.996</td>
<td>0.992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.992</td>
<td>0.998</td>
<td>0.991</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC</td>
<td>0.995</td>
<td>0.996</td>
<td>0.998</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More than 99% efficiency even with the new extension cable confirmed!

### Residual distribution of ladder0 chip10

- Entries: 41326
- Mean: 0.03801
- Std Dev: 0.1951
- Underflow: 173
- Overflow: 0

#### Detection efficiency:

\[ \varepsilon_i \equiv \frac{N(h_i \cap h_j \cap h_k)}{N(h_j \cap h_k)}, \quad (i \neq j \neq k) \]