Hybrid Pixels for the Micro-Vertex Detector of the PANDA Experiment

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Spatial Resolution < 100 μm
- Momentum Resolution δp/p ~ 1%
- Time Resolution ≤10 ns
- PID by dE/dx
- High Rate Capability
- No Hardware trigger
- Radiation tolerance ~10^{-14} n_{1MeVeq} cm^{-2}
(10 years 50% duty cycle)
- Low Material Budget

Readout Channels:
- ~ 11·10^6 Hybrid Pixels
- ~ 2·10^5 Double Side Microstrips

Sensor R&D

Behaviour of the full depletion voltages as a function of the annealing time (60°C) for the diodes irradiated to 1.5 \times 10^{14} n_{1MeVeq} cm^{-2}. Bias voltage normalised to the 50 μm.

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Full Dep. Voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epi-50 HR</td>
<td>4.4</td>
</tr>
<tr>
<td>Epi-75 HR</td>
<td>5.6</td>
</tr>
<tr>
<td>Epi-100 HR</td>
<td>5.9</td>
</tr>
<tr>
<td>Epi-50 MR</td>
<td>4.9</td>
</tr>
<tr>
<td>Epi-75 MR</td>
<td>8.2</td>
</tr>
<tr>
<td>Epi-100 MR</td>
<td>10.4</td>
</tr>
<tr>
<td>Epi-75 LR</td>
<td>42.8</td>
</tr>
</tbody>
</table>

Epitaxial Silicon Wafer for PANDA

Partial view of a sensor made with 100 μm × 100 μm pixels. White circles are the pads for the bonding.

Readout ASIC in CMOS 130 nm: ToPix

- Pixel Size: 100 μm x 100 μm
- Self Trigger Capability
- Chip Size: 11.6 mm x 14.8 mm (11.4 x 11.6 mm² Active Area)
- dE/dx Measurement: ToT Technique (12 bits resolution)
- Input Range: up to 50 fC
- Noise Floor: ≤ 0.032 fC
- Clock Frequency: 155.52 MHz
- Time Resolution: 6.45 ns
- Power Budget: < 1 W/cm^2
- Max Event Rate cm^{-2}: 6 \times 10^6 Hits/s
- TID: ≤ 100 kGy
- Serial Output

ToPix 3

- 4.5 x 4 mm die area
- 130 nm CMOS technology
- End of column logic
- Triple redundancy-based SEU protection
- 160 Mb/s SLVS serial output
- Pad for bump bonding
- 2x32 & 2x128 double columns → 640 pixels

4 Assemblies with ToPix 3 & Epi Sensor

Pixel Tracking Station

Map of 1 Board with p @ 2.7 GeV/c

Reconstructed signal shapes with threshold scan for different input charge values.

Baseline distribution before and after correction.

Baseline as a function of the Total Ionising Dose.

ToT linearity.