**Requirements**

<table>
<thead>
<tr>
<th>Single point resolution</th>
<th>Pixel size</th>
<th>Material budget per layer</th>
<th>Timing resolution</th>
<th>Hit efficiency</th>
<th>Average power dissipation (using power pulsing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertex</td>
<td>3μm</td>
<td>≤ 25μm x 25μm</td>
<td>0.2% X&lt;sub&gt;0&lt;/sub&gt;</td>
<td>5ns</td>
<td>99.7 - 99.9% &lt; 50mWcm&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tracking</td>
<td>7μm</td>
<td>30 - 50μm x 1 - 10mm</td>
<td>1 - 2% X&lt;sub&gt;0&lt;/sub&gt;</td>
<td>5ns</td>
<td>99.7 - 99.9% &lt; 150mWcm&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

- None of the available detector technologies can fulfill all vertex/tracking requirements.
- Therefore new sensors & readout technologies are under study.

**Compact Linear Collider (CLIC):** concept for future high-luminosity, high-energy linear e+e- collider at CERN. Physics programme puts strict requirements on the vertex & tracking detectors.

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**CLICpix2**

CLICpix2 readout ASICs:
- 65nm CMOS process
- Part of Timepix/Medipix family
- Bump-bonded at IZM to planar silicon sensors of thicknesses 50μm-200μm

- Initial laboratory tests carried out on assemblies
- High quality CLICpix2 assemblies produced, 99.7% interconnect yield
- Low assembly yield due to challenging bonding process
- Efficiencies of ~97%
- Optimal voltage for charge sharing~25V
- Depletion voltage = -24V

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**ELADs**

- High quality ELADs assemblies produced, 99.7% interconnect yield
- Low assembly yield due to challenging bonding process

- ELAD design enhances lateral drift to increase charge sharing using sensors with deep ion implants
- Electric field shape modified by implants
- More charge shared & low field regions are minimised
- Charge sharing near theoretical optimum
- Improves positional resolution for same pitch & thickness

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**ATLASPix**

HV Monolithic Active Pixel Sensor:
- 180nm HV-CMOS processing
- Fully integrated readout
- Fast charge collection via drift
- Low material budget

ATLASpix Simple:
- 25 x 400 pixels
- Pitch 130μm x 40μm
- 10bit ToA, 6bit ToT

Assemblies:
- Sensor resistivities from 20 to 10000cm
- 100μm & 62μm thickness
- Tested in laboratory & test-beam

Test-beam results:
- Bias voltage down to -95V
- Results show expected dependence of performance on resistivity & sensor thickness

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**Developed tools:**

- Caribou: Flexible pixel detector readout system
- ap²: Pixel detector simulation framework
- Corryvrekan: Test-beam data reconstruction software

**15th Topical Seminar on Innovative Particle & Radiation Detectors (IPRD19)**

On behalf of the CLICdp collaboration
Reference: D. Dannheim et al., Detector Technologies for CLIC, CERN, 2018
DOI: 10.23731/CYRM-2019-001