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Vertex and tracker research and development for CLIC

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The requirements for high precision measurements at the CLIC e+e− collider impose tight performance criteria on the vertex detector and tracking system. A single point resolution of 3µm in the vertex and 7µm in the tracker needs to be achieved. Moreover, the vertex and tracker have to be ultra-low mass detectors with a material budget of ~0.2% X0 per layer in the vertex and ~1% X0 per layer in the tracker, leading to the adoption of a forced air-flow cooling in the vertex detector. To further reduce power consumption, power pulsing of the front end electronics is investigated. In addition, the high rate of beam-beam interactions requires fast time-stamping of ~10ns.
An all-silicon vertex and tracking system is currently being investigated for CLIC, addressing the above criteria. Highly granular hybrid pixel detectors with analogue readout are under evaluation for the vertex detector. The CLICpix readout ASIC, produced in 65nm technology with a pixel pitch of 25µm, has been fabricated and tested. Prototypes of the CLICpix readout ASIC have been bump bonded to planar sensors and capacitatively coupled to active High-Voltage-CMOS sensors. Moreover, Timepix3 ASICs have been bump bonded to thin edgeless planar sensors. The achieved resolution and timing results from test-beam data are compared to the detector needs at CLIC. In addition, pulsed power operation has been tested using Timepix3 assemblies. Simulations of the different technologies have been set up and are compared to the results of the test-beam studies. For the tracker fully integrated readout technologies are considered. To study the feasibility of a 180nm CMOS process, an investigator chip from the ALICE collaboration has been characterised in the CLIC test-beam setup and the analogue performance has been assessed. Engineering studies have also been performed, addressing the construction of a low material support structure for both vertex and tracking detectors and air-flow cooling of the vertex detector.

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