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Beam test of a baseline vertex detector for the CEPC

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The proposed Circular Electron Positron Collider (CEPC) imposes new challenges for the vertex detector in terms of pixel size and material budget. A Monolithic Active Pixel Sensor (MAPS) prototype, TaichuPix, based on a column drain readout architecture, has been implemented to achieve high spatial resolution and fast readout. A 6-layer telescope made by TaichuPix-3 chips and baseline vertex detector were tested at the DESY II TB21 beamline. This presentation proposes to show the architecture and beam test results of the baseline vertex detector prototype.

Summary (500 words)

The baseline vertex detector is proposed with a three-ladder architecture which will be double-sided with TaichuPix sensors. Thus, it can provide 6 precise reconstruction points. The key elements of the baseline vertex detector are the pixel sensors, a test system made by TaichuPix-3 sensors was set up in DESY II TB21 in December 2022. Two detectors under test (DUT) were characterized, the analysis results indicate the spatial resolution is better than $5\ \mu\text{m}$ and the detection efficiency is better than 98% under the set threshold. The experimental setup included 6 planes with the same test modules and one test module was configured as a DUT and the rest of the 5 test modules were set as a reference telescope. The distance between neighboring planes is 4 cm. The main beam energy used is 4 GeV, which is running at a data rate of 67.4 KB/s per plane to the system.

For the verification of the baseline vertex detector prototype, the double-sided structure is adopted to reduce the multiple scattering of particles and improve the impact parameter. That means the silicon pixel sensors and cables are installed on both sides of the support structure. Therefore, a ladder was made by common support together with two layers of silicon detectors. For this prototype, one side of a ladder is proposed to assemble 10 TaichuPix sensors on a flexible printed circuit board (PCB). Two flexible boards will be installed on the front and back sides of the lightweight carbon fiber support structure.

A preliminary baseline vertex detector was made by 2 TaichuPix-3 chips on each flexible PCB, and it was tested in DESY beamline in April 2023, which kept the main structure of the proposed design but fewer chips. The offline results of this prototype are under analysis and will be shown in the presentation.

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