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Geometric Optimization Simulation of the CEPC Vertex Detector

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The identification of heavy-flavored quarks and τ leptons is an important physics goal of the Circular Electron Positron Collider(CEPC). The vertex detector of the CEPC is capable of obtaining precise track parameters of charged particles in the vicinity of the Interaction Point to reconstruct the decay vertex of short-lived particles. The CEPC vertex detector adopts the CEPC-MOST2 structure, which is a cylindrical barrel structure consisting of three layers from the inside to the outside with the ladder as the detection unit. The two sides of the ladder are affixed with a pixel-type sensor, TaichuPix-3, which has a single-point resolution of $5\mu m$, and the center is supported by carbon fiber. The carbon fiber, along with flexible circuit boards affixed to both sides as a support structure. To achieve low material mass, the ladder of layers at different radii covering $\theta = 8.1°$ adopts varying thicknesses of flexible circuit boards and support structures. The impact parameter is used to characterize the performance of the vertex detector. Currently, based on the radius of the beam pipe of $10\ mm$ in the CEPC-TDR, the position of the first layer of the CEPC vertex detector has reduced to $12.5\ mm$, and the radius of the outermost layer of the vertex detector is set at $44.5\ mm$. The average material budget for the beam pipe, the first layer of the vertex detector, and the second layer of the vertex detector are $0.162\%\ X_0$, $0.565\%\ X_0$, and $0.676\%\ X_0$, respectively. The outgoing particles μ^- momentum is greater than $15\ \mathrm{GeV/c}$, the resolution of the impact parameter resolution is less than $3\ \mu m$, and the performance exceeds that of the CDR-full simulation.

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