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Novel Approach to Positron Production for the FCC-ee Using Lattice Coherent Effects in Oriented Crystals

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The high-luminosity requirement in future lepton colliders imposes a need for a high-intensity positron source. In the conventional scheme, positron beams are obtained by bremsstrahlung and electron-positron pair through the interaction between a high-energy electron beam and a high-Z amorphous target. In the conventional positron generation system, one way to increase positron intensity is by boosting the incident electron beam power. However, the target's allowable heat load and thermo-mechanical stresses severely limit the beam power of the incident electrons. To overcome these limitations, an innovative approach using lattice coherent effects in oriented crystals appears promising.
Two configurations were investigated in application to the Future Circular Collider (FCC-ee) positron injector as alternatives to the conventional scheme. One configuration splits the production into two stages: a thin crystal as a radiator followed by an amorphous target for positron production. The other configuration uses a single thick crystal that simultaneously acts as a radiator and converter. Simulations were conducted from the positron production phase to the entrance of the damping ring to estimate the accepted positron yield. The results show significant advantages of the crystal-based positron source: thinner targets than the conventional scheme, resulting in lower deposited power, achieve a comparable accepted positron yield.

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