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# Benchmark between OSIRIS and GUINEA-PIG for the simulation study on high-energy electron-positron collisions

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The beam-beam effects, including collective beam motion (disruption) and strong-field quantum electrodynamics (SF-QED) processes (beamstrahlung and coherent pair production) [1,2], are investigated for collisions between high-energy flat electron and positron beams with parameters close to those designed at Compact Linear Collider (CLIC).
Particle-in-cell (PIC) simulations using the OSIRIS framework are performed, and the PIC results are benchmarked against those from the specialized beam-beam code GUINEA-PIG [3]. The GUINEA-PIG simulations fully agree with the PIC results when the disruption effect is low. However, when significant disruption occurs, the beam pinch, field enhancement, beamstrahlung, and pair production are stronger in GUINEA-PIG simulations, compared with the OSIRIS simulations. The collision luminosity, photon emission, and field enhancement in GUINEA-PIG can be orders of magnitude higher than those in OSIRIS. These remarkable differences are attributed to the different field advancement employed in GUINEA-PIG and OSIRIS. Our study indicates that the PIC framework is better suited for exploring the collisions with both prominent disruptions and SF-QED processes.

## Footnotes

*W. Zhang, T. Grismayer, and L. O. Silva, "Signatures for strong-field QED in the quantum limit of beamstrahlung" , Phys. Rev. A 108, 042816 (2023).W. Zhang, T. Grismayer, and L. O. Silva, "Anomalous pinch in electron-electron beam collision", arXiv:2412.09398 (2024).**D. Schulte, "Study of Electromagnetic and Hadronic Background in the Interaction Region of the TESLA Collider", Ph.D. thesis, University of Hamburg, (1996).

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