Electron beam and photon distribution functions after a laser-electron scattering: analytical model accounting for 3D focusing geometry and non-ideal spatio-temporal synchronization

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Upcoming experiments using PW optical lasers will be able to measure energy losses of electrons arising from the emission of radiation, as well as emit photons in nonlinear Compton scattering regime and generate electron-positron pairs.
While several studies have already addressed these processes assuming a scattering with a transversely plane wavepacket, it is challenging to describe a more realistic setup where not all particles will interact with the same peak laser field due to finite beam sizes and spatio-temporal synchronization. Assigning an effective laser intensity to each interacting particle allows for generalization of scaling laws previously derived in the context of a Plane Wave to more realistic geometries including 3D effects. In our recent work [1], we have shown that the positron yield in focused laser-electron scattering can indeed be estimated by extending a scaling law derived for Plane-Wave scattering.
In this work we develop a semi-analytical model to predict the final electron and photon spectra for both Classical and Quantum Radiation Reaction, including several non-ideal features such as offsets of the interaction point from the laser focus. We also address the collision between high-energy photons and a focused laser. This model may be used to support experiments in the future, namely when searching for specific signatures of Quantum Radiation Reaction.

References

[1] O.Amaro, M.Vranic, New Journal of Physics 23, 115001 (2021)