Quantum vs. classical radiation reaction

Marija Vranic[1*] , Thomas Grismayer[1], Ricardo A. Fonseca[1,2] and Luis O. Silva[1]

[1]*GoLP/Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, 1049-001 Lisbon, Portugal*
[2]*DCTI/ISCTE—Instituto Universitário de Lisboa, 1649-026 Lisboa, Portugal*
** marija.vranic@tecnico.ulisboa.pt*

New generation of laser facilities will provide intense laser fields that will alow us to explore the radiation reaction dominated regime. It will be possible to measure signatures of both, quantum and classical radiation reaction in the laboratory. In our particle-in-cell code OSIRIS, we have incorporated continuous classical radiation reaction through Landau & Lifshitz equation of motion, and high-energy photon emission via nonlinear Compton scattering. One can use this tool to identify quantum radiation reaction signatures for future all-optical experiments where GeV electrons obtained through Laser Wakefield acceleration collide with intense laser pulses. The most pronounced QED signatures are reflected on the electron beam energy distribution function: classical radiation reaction always tends to decrease the energy spread [1], but the inherent stochasticity of quantum emission tends to increase it. We have identified an upper limit to such an increase. Based on this conclusion, we will present a theoretical estimate for the final width of the electron energy distribution function after the interaction with laser pulses of different durations, supported by QED PIC simulations [2]. We will also discuss how the increase of the enregy spread is related with the beam divergence. QED radiation reaction is illustrated in Fig. 1.

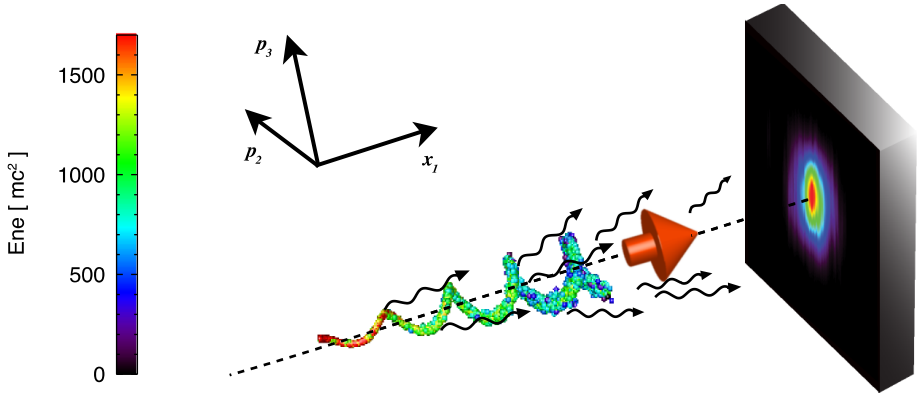

Figure 1. QED radiation reaction and photon detection.

References

[1] M. Vranic, J. L Martins et. al, Phys. Rev. Lett. 113, 134801 (2014).
[2] M. Vranic, T. Grismayer et. al, New J. Phys, 18, 073035 (2016).