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Impact of the laser spatio-temporal shape on Breit-Wheeler pair production

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The forthcoming generation of multi PetaWatt lasers opens the way to the possibility of abundant electron-positron pair production by the nonlinear Breit-Wheeler process. A possible configuration that can be tested in the laboratory will involve the interaction of a flash of high energy gamma photons colliding with an intense laser pulse. Such a photon flash can be created either from the interaction of an ultra-relativistic electron beam with the laser itself, or by an external source. In the presented work, a simple model for the case of so-called soft shower, is derived considering the situation of an interaction with a plane wave. This approach provides us with a semi analytical model for more complex situations with either Gaussian or Laguerre-Gauss beams. Our results match very well with 3D Particle-In-Cell (PIC) simulations performed with the code SMILEI [1]. The role of the laser peak intensity versus the focal spot size and shape is examined in this respect and we explore the influence of the order of the LG laser beams on pair creation. Finally we obtain the counter-intuitive result that, for some laser intensities, a larger spot size (or a higher order in the case of LG laser beams) is more favorable than a higher peak intensity to increase pair production.

References

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