Semi-Analytical Model for Pair Production *Via* Laser and Electron/Photon Beam Interaction in the Shower Regime

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Upcoming multi-petawatt lasers provide us with new opportunities for electron-positron pair production. A high- energy photon in an intense laser field can decay into an electronpositron pair, a process known as non-linear Breit-Wheeler. The resulting electron and positron can in turn emit new photons via non-linear Compton Scattering which may decay into new pairs, driving a so-called QED cascade. The interaction of an electron beam or a photon flash with an intense laser can drive a cascade in the so-called shower regime via multiple subsequent steps of pair production: we define each of the steps a 'generation'. In this work we present a model that allows to predict the number of pairs created in a shower by considering a finite number of generations. This allows to extend previous analytical works where i) either electron-seeded cascades at small pair-production rate were considered [1] ii) or photon-seeded cascades with only one generation was considered (soft shower regime) [2]. A semi-analytic model with a broad range of validity is derived that allows to predict the number of produced pairs. A systematic study using the particle-in-cell code SMILEI [3] shows an excellent agreement with our model predictions and demonstrates that, for the conditions available at laser facilities that will start operating within this decade, QED cascades develop over only two generations at most. A comparison of the efficiency of electron or photon seeding is also performed.

References

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