Modeling of High Energy Photon Production and Collisions in High Intensity Laser Plasma Interaction for Linear Breit-Wheeler Experiments

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The creation of an electron-positron pair in the collision of two real photons, namely the linear Breit-Wheeler process, has never been detected directly in the laboratory since its prediction in 1934 despite its fundamental importance in quantum electrodynamics and astrophysics. In the last few years, several experimental setups have been proposed to observe this process in the laboratory, relying either on thermal radiation, Bremsstrahlung, linear or multiphoton inverse Compton scattering photons sources created by lasers or by the mean of a lepton collider coupled with lasers. Indeed, the advent of ultra high-intensity lasers has led to the production of unique sources of high energy photons with high brightness and high energy with promising applications as radiography sources or to study fundamental processes like the linear Breit-Wheeler process. We have performed an optimization study on collimated gamma sources generation with high-intensity lasers interacting with various types of targets using numerical simulations with QED effects. We have also developed a general and original, semi-analytical model to estimate the influence of the photons energy distribution on the total number of pairs produced by the collision of two such photon beams and give optimum energy parameters for some of the proposed experimental configurations. Our results show that the production of optimum Bremsstrahlung and linear inverse Compton sources are, only from energy distribution considerations, already reachable in today's facilities. These results give important insights for designing experiments intended to detect linear Breit-Wheeler produced positrons in the laboratory for the first time.

Acknowledgements: We acknowledge the financial support from the French National Research Agency (ANR-17-CE30-0033-01) - TULIMA Project and AFOSR (Grant No. FA9550-17-1-0382).