Production of collimated $\gamma$ ray beams for $e^-e^+$ pair creation.

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Despite being one of the most basic process of quantum electrodynamics (QED), and being responsible of the universe opacity to high energy photons [1], the electron-positron pair production by two photons collision ($\gamma\gamma \rightarrow e^-e^+$, linear Breit-Wheeler [2] process, LBW) has never been observed directly in the laboratory.

However, increasing available intensity at laser facilities make possible to create high brilliance $\sim$MeV $\gamma$ ray sources that could be used to observe this process for the first time [3].

We propose [4] to detect $e^+$ produced by LBW using two crossing $\gamma$ ray beams (see Fig. 1). Those sources could be created in typical laser-solid experiments: some target $e^-$ are accelerated from laser field and their propagation near a high $Z$ atomic nuclei in the material can produce $\gamma$ rays through the Bremsstrahlung process. However, $e^-$ and $\gamma$ propagation in a high $Z$ material can also produce background $e^-e^+$ pairs through the Trident ($e^-Z \rightarrow e^-Ze^-e^+$) and Bethe-Heitler ($\gamma Z \rightarrow Ze^-e^+$) processes.

In this work, a semi-analytical model to estimate LBW pair production, and a complete simulation setup (using hydrodynamics, Particle-In-Cell and Monte Carlo codes) have been developed to simulate LBW and background $e^+$ production.

These tools could be used to investigate pair plasma jets in Active Galactic Nuclei [5], and further developments could help to test more advanced theoretical predictions [6] or measure the LBW cross section (widely used in QED) for the first time.

References