Ultra-high-intensity lasers for channel acceleration of positrons

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Experiments have already shown that positron wakefield acceleration is possible when the wake structure is driven by a single positron beam [1], and numerical investigations indicate that it is also achievable either using a Laguerre-Gaussian laser pulse driver [2] or a hollow plasma channel [3]. Multi-Petawatt lasers are now expected to be able to both, create and accelerate positrons [4]. This is predicted for a 90 degree collision between a multi-PW laser and a GeV-class electron beam, where positrons are created via the multi-photon Breit-Wheeler process and are then accelerated on a short distance by the laser in vacuum.

In this work, we suggest a new scheme based on the propagation of a multi PW pulse in a preformed plasma channel. It stands out from previous attempts since it addresses the three key steps of creation, injection and acceleration of the positrons within a single 3D self-consistent numerical framework. In this setup, positrons generation takes place at the focus of a multi-PW laser and is stimulated by a perpendicularly propagating electron beam via the inverse Compton and Breit-Wheeler processes. The positron acceleration takes place in the plasma channel over a distance of 400 μm. The fields focusing positrons on the channel axis are mediated by a large electron beam loading, formed self-consistently along the pulse propagation [5, 6].

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