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A compact laser-plasma based setup for positron production and collection

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Development of compact, Laser Plasma Acceleration (LPA)-based sources for positrons is a key step in the R&D effort towards development of a TeV collider. The conventional production and collection schemes of positron beams cannot be easily transferred to an LPA setup. This is mainly due to the large distance required to transport particles from the production to the acceleration point and the inherently small transverse acceptance of the LPA stage. For such reasons, positron production schemes compatible with a plasma-based accelerator are still lacking. In this work, we present a compact, laser-based scheme for the production of positron beams. Positrons are produced via pair decay of the Bremsstrahlung radiation generated when a multi-GeV, laser-plasma accelerated electron beam interacts with a high-Z solid target. We explore the possibility of using the back of the target itself as a plasma mirror for an incoming laser, in order to generate a plasma wave able to trap and accelerate positrons as soon as they leave the target. A realistic phase-space distribution for the positrons is obtained by modeling the electron beam interaction with the solid target using the Monte Carlo code Geant4. We then study the trapping and acceleration efficiency of the subsequent plasma stage in order to find an optimum working point.

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