Laser-driven positron sources for fundamental science and industrial applications

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We present here recent developments in the generation, characterization, and manipulation of laser-driven positron beams for their application in both fundamental science and industry. We will focus on three different regimes: generation of high-density, MeV-scale positron beams for material characterization [1], generation of high-quality, GeV-scale positron beams for fundamental science [2-4], and generation of high-density and neutral electron-positron pair beams for laboratory astrophysics studies [5,6].

For the first regime, we will show recent experimental and numerical results confirming the possibility of generating ps-scale positron beams with an energy tuneable from 0.5 to 2 MeV and a number of positrons per second, in a 50 keV energy slice, exceeding 10^6 [1]. These positron beams will allow for ultra-high resolution volumetric scanning of materials [7,8], greatly advancing what currently possible with conventional Positron Annihilation Lifetime Spectroscopy (PALS) machines.

For the second regime, we will show extensive numerical work, validated by recent experimental results, demonstrating the possibility of generating fs-scale GeV positron beams with high spatial quality, which would provide an ideal witness beam for experimental studies of plasma wakefield acceleration of positrons.

Finally, we will show that, by using sufficiently thick converter targets, one can generate neutral electron-positron pair beams of sufficient density to allow for collective behaviour and the onset of instabilities.

References

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