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Laser-driven positron sources for applications

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Positron annihilation lifetime spectroscopy (PALS) is one of the methods for the non-invasive inspection of materials and identification of small-scale defects. PALS presents several unique advantages when compared to other inspection techniques: it works virtually with any type of material (crystalline and amorphous, organic and inorganic) and it can identify even sub-nanometer defects with concentrations as low as less than a part per million. Laser-generated high-charge electrons can be used with a high-Z converter target to generate positron beams that are suitable for PALS. Unlike the conventional positron sources, these laser-driven positrons can be intrinsically of short duration and can have tuneable energies in the MeV range, which is suitable for high-resolution scanning of a material. Based on our preliminary experimental work at a lower repetition rate and extensive numerical modelling using FLUKA, it is observed that laser-wakefield driven electron beams, produced at a high repetition rate (~ 1kHz) by 10s of mJ laser system, have the potential to drive a high average flux positron source (>10^6 e^+/s) suitable for industrial applications and material science. Positron sources with high average flux, tuneable energy, and a beam duration in the range of 30 -50 ps can be obtained.

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