Characterisation of laser-driven positron beams for injection in secondary stages

A. Alejo[1], G. Sarri[1]

[1] *Centre for Plasma Physics, Queen's University Belfast, United Kingdom*

The generation of high-quality relativistic positron beams has gained significant attention in experimental physics, due to their potential relevance in a wide range of scientific and engineering areas, ranging from fundamental science to practical applications.

Optimising the spectral and spatial quality of these beams is crucial not only for these applications, but also for the possibility of using these laser-driven sources as injectors for further stages of acceleration, being them plasma-based or radio-frequency.

Here we report on experimental and numerical results on determining and optimising the emittance of these beams, whilst preserving high peak current. This work is justified by the necessity of generating small-scale and rather inexpensive positron beam accelerators with superior spatial and spectral qualities. For instance, these results indicate that ultra-relativistic and high-current positron beams with geometrical emittance below 0.1mm·mrad can be generated using already existing technology. This value is already comparable to the emittance in more conventional radio-frequency positron accelerators, such as the LEP injector (0.2 mm·mrad), indicating the possibility of direct injection without the necessity of beam manipulation and storage.

These results are of central importance for the development of laser-driven particle sources and, in perspective, for the construction of an all-optical electron-positron collider, main interest of several national and international projects world-wide, such as the European-funded EuPRAXIA.

References:

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