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Tunable laser positron source

A tunable laser positron source as originally described in [1] is being prototyped using the collocated LWIR CO2 laser and electron beam at BNL-ATF. Unlike LPA, this work deals with interaction of three distinct entities, a laser, a pair-plasma, and laser-driven electron density structures.

This work relies on the advantages of larger size of electron density structures excited by the CO2 laser relative to NIR lasers at a given electron density, allowing more effective overlap with the pair-plasma in real space. Additionally, CO2 laser driven structures have a lower velocity for the same electron density, making possible longer interaction and greater energy exchange with the density structures.

The ATF electron beam that has mean particle energy of 55MeV, waist-size of 50-microns, bunch length 100fs with a high-Z metal target photo-produces the pair-plasma in a metal target of 15-25 mm length. The CO2 laser pulse which is collinear with the electron beam is focused onto a gas jet and the laser energy that propagates around the target excites electron density structures in the plasma. These electron density structures trap and exchange energy with the electron-positron pairs.

A positron source with nearly monoenergetic characteristics and pC charge has only been available at large accelerator complexes. Moreover, on-demand tunability of such positrons is only possible using the technique that we pursue. A compact, tunable laser positron source will open new possibilities in antimatter research [2].

[1] PRAB 21, 081301 (2018)
[2] US Patent 16,770,943

Working group

WG1 : Laser-driven plasma wakefield acceleration

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