Scaling laws for positron production in laser—electron-beam collisions

T. G. Blackburn[1*], A. I. Ilderton[2], C. D. Murphy[3] and M. Marklund[1]

[1]*Department of Physics, Chalmers University of Technology, SE-41296 Gothenburg, Sweden*
[2]*Centre for Mathematical Sciences, University of Plymouth, PL4 8AA, UK*
[3]*York Plasma Institute, Department of Physics, University of York, York, YO10 5DD, UK*
**tom.blackburn@chalmers.se*

Showers of gamma rays and positrons are produced when a multi-GeV electron beam collides with a super-intense laser pulse [1]. All-optical realisation of this geometry, where the electron beam is generated by laser-wakefield acceleration [2], is currently attracting much experimental interest as a probe of radiation reaction and QED effects. These interactions may be modelled theoretically in the framework of strong-field QED [3] or numerically by large-scale PIC simulation [4]. To complement these, we present analytical scaling laws for the electron beam energy loss, gamma ray spectrum, and the positron yield and energy that are valid in the radiation-reaction—dominated regime. These indicate that by employing the collision of a 2 GeV electron beam with a laser pulse of intensity 5×1021 W/cm2, it is possible to produce 10,000 positrons in a single shot at currently available laser facilities.

References

[1] D. L. Burke et al., Phys. Rev. Lett. 79, 1626 (1997).
[2] G. Sarri et al., Phys. Rev. Lett. 113, 224801 (2014).
[3] A. Di Piazza, Phys Rev. Lett. 117, 213201 (2016).
[4] M. Lobet, X. Davoine, E. d'Humieres and L. Gremillet, Phys. Rev. Accel. Beams 20, 043401 (2017).