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Cooling of relativistic electron beams in intense laser pulses

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The next few years will see next-generation high-power laser facilities (such as the Extreme Light Infrastructure) become operational, for which it is important to understand how interaction with intense laser pulses affects the bulk properties of a relativistic electron beam. As we move to higher laser intensities, we expect both radiation reaction and quantum effects to play a significant role in the beam dynamics.

At the upcoming field strengths, quantum effects can no longer be neglected and it is expected that the resulting reduction in relative energy spread (beam cooling) at the expense of mean beam energy predicted by classical theories of radiation reaction will not be observed. Unlike classical predictions, the final properties of a particle beam colliding with a high-intensity laser predicted by semi-classical and quantum theories of radiation reaction are highly sensitive to the distribution of energy in the laser pulse. This offers potential opportunities to modify or control final beam properties. In addition, longitudinal and transverse contributions to cooling are no longer equal [1].

[1] S. R. Yoffe, Y. Kravets, A. Noble, D. A. Jaroszynski, New J. Phys. 17: (2015) <10.1088/1367-2630/17/5/053025>

Primary author: Dr YOFFE, Samuel (University of Strathclyde)

Co-authors: Dr NOBLE, Adam (University of Strathclyde); Prof. JAROSZYNSKI, Dino (University of Strathclyde)

Presenter: Dr YOFFE, Samuel (University of Strathclyde)

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