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P4.2010 On the role of non-equilibrium relativistic hot electron populations in Target Normal Sheath Acceleration

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Laser-driven ion acceleration is a long-standing topic of great appeal in the field of laserplasma interaction, both because of the rich physics at play and the foreseen applications [1]. Various laser-ion acceleration mechanisms have been identified in the literature. Among them, Target Normal Sheath Acceleration (TNSA) has emerged as the most robust and reliable one, being active in a wide range of experimental conditions, including advanced target configurations [2]. Considerable theoretical effort has been put into understanding the role played by several key parameters in TNSA experiments, as for the case of static models that feature a self-consistent electrostatic potential, which have been proven to be a simple, yet effective approximate tool to describe the physics of TNSA [3,4]. In this work, we overcome a number of severe limitations affecting such approach, by proposing a fully relativistic, self-consistent model that includes non-thermal features in the theoretical description of TNSA. By means of an analytical investigation we show how the presence of non-equilibrium features in the relativistic electron population affect the ion acceleration process. In addition, complementary 3D PIC simulations demonstrate that nonthermal processes are particularly relevant, especially in the case of advanced target configurations involving a nanostructured, near-critical plasma layer. Therefore, besides its fundamental interest, the model hereby proposed can serve as a predictive tool to design future experiments investigating enhanced TNSA scenarios.

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Presenter: MAFFINI, A. (EPS 2019)

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