

P1.2009 Physics of the chromatic focusing and post-acceleration of laser-driven protons by the target discharge current

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See the full abstract here:

<http://ocs.ciemat.es/EPS2019ABS/pdf/P1.2009.pdf>

The production of laser driven protons has attracted a large number of studies thanks to their potential applications such as isochoric heating, proton radiography, isotope production or proton therapy [1]. The Target Normal Sheath Acceleration (TNSA) is the most robust and well-known generating process but it produces proton bunches suffering from a broad energy spectrum and large beam divergence. To optimize the properties of the proton beam, a new scheme of post-acceleration and chromatic focusing of TNSA-produced protons [2,3] proposes to add a helical coil connected at the rear side of the target foil. After the laserplasma interaction, the discharge current induced by the electron charge ejection propagates through this helix and generates an electromagnetic pulse which collimates, post-accelerates and energy selects the protons emitted from the rear side of the target. A highly collimated, propagating along the helix axis and quasi-monoenergetic proton bunch is then produced.

We present the results of the experimental campaign carried out at the LULI 2000 facility where 100 TW laser pulses were irradiating gold foils attached to helices of different diameters, lengths or pitches. The goal of the campaign was to demonstrate how the control of the propagation of the discharge current through the helical coil can influence the proton chromatic focusing. The experimental data will be compared to the results of numerical simulations carried out with the home-made code SOPHIE. This massively parallelized Particle-In-Cell code models the generation and propagation of the discharge current through the helix by using realistic boundary conditions as well as the proton energy selection, focusing and acceleration, in a self-consistent manner between fields and particles.

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[1] A. Macchi et al., Rev. Mod. Phys. 85, 751 (2013)

[2] S. Kar et al., Nature Com. 7, 10792 (2016)

[3] H. Ahmed et al., Scientific Reports 7, 10891 (2017)

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