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A multi-shot wheel-target assembly for laser-plasma proton acceleration

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A multi-shot target assembly for laser-plasma proton acceleration has been commissioned at the Laser Laboratory for Acceleration and Applications (L2A2), at the University of Santiago de Compostela. The assembly consists of a multi-target wheel holding plain target foils for around 1000 –2000 shots. Two linear stages and one rotating stage hold the target wheel and move it to replenish the target material, and to position it at the laser focus. For this purpose, we have developed a procedure for the shot-to-shot correction of the target position, capable of functioning at the L2A2 laser nominal repetition rate of 10 Hz. This procedure is based on a detailed 3D mapping of the impact positions at the targets, obtained by measuring the deformation of the target surface with an optical position sensor prior to the irradiation. The map is then programmed into the stages which automatically correct the laser focal position on the target shot-to-shot with micrometric resolution.
The reliability of this procedure was tested by performing an online mapping of the target surface during the correction, in synchronization with the positioning of the impact points at repetition rates of 10 and 15 Hz. The obtained stability in the positioning resulted to be about 4 μm standard deviation over 2016 points.
As a second validation, protons up to 1.7 MeV were successfully accelerated in the Target Normal Sheath Acceleration (TNSA) regime by irradiating Al foils of 12 μm-thickness with 1.2 J, 40 fs (3.6·1018 W/cm2) laser pulses at the L2A2. We have performed series of 24 shots at 10 Hz reaching a stability in proton maximum energy of about 13%, and of about 16% in the spectral temperature.

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