Pilot experiment on laser-plasma ion generation at HiLASE

L. Giuffrida[1*], H. Zulic[1], A. Velyhan[1], A. Picciotto[2], M. Barozzi[2], P. Bellutti[2], R. Dell`Anna[2], M. Divoky[3], A. Fajstavr[1], D. Giubertoni[2], M. Hanus[3], C. Lazzarini[1], A. Lucianetti[3], P. Navratil[3], G. Pepponi[2], J. Pilar[3], D. Rostohar[3] F. Schillaci[1], T. Mocek[3], G. Korn and D. Margarone[1]

[1] *Institute of Physics ASCR, v.v.i (FZU), ELI-Beamlines project, Prague, Czech Republic*
[2] *Micro-Nano Facility, Fondazione Bruno Kessler, Trento, Italy*
[3] *Institute of Physics ASCR, v.v.i (FZU), HILASE centre, Prague, Czech Republic*

[*]Corresponding author: Lorenzo.Giuffrida@eli-beams.eu

Abstract

An experimental campaign on ion generation was recently performed in HiLASE (Czech Rep.) by using the Bivoj laser system with a laser energy on target of 6 J, pulse duration between 5 and 10 ns, and repetition rates up to 10Hz.

This laser system, focused on a solid target, was used to generate an ion beam propagating mainly along the target-normal (backward direction), aiming at its further use for applications. The laser was tightly focused on a solid target (around 5 μm FWHM), thus a maximum intensity of $2*10^{15}$ W/cm^2 was achieved, allowing to obtain up to 20 keV protons and 150 keV Al ions. The ion beam was characterized by using various Ion Collectors (IC), and an ion energy spectrometer, Thomson Parabola (TP). These diagnostics allowed to determine the delivered ion dose and corresponding energy. Moreover, a detailed investigation of ion/proton energy vs laser energy was carried out using various targets (semiconductors and metals).

The generated ion beams have been explored for potential applications in various fields, such as material science and nuclear Physics. So far, a first attempt to demonstrate the feasibility of the produced ion beam for implantations was carried out. At this aim, Si substrates were irradiated with Al laser-plasma ions, integrating over few hundreds of laser shots. The implanted Si sample revealed the presence of Al atoms at a depth of a few hundred nanometers. This preliminary result might be promising for applications in microelectronics.

A detailed description of the experimental setup will be provided, together with an analysis and interpretation of the achieved results. Finally, a perspective of future steps for possible applications in various applicative fields is given.