

AbstractID: 5300 Title: Prepulse effect and maximum energy of protons accelerated by high-power lasers

Purpose: In recent years there has been an explosion of research work concerning the topic of charged ion acceleration using high-power lasers. The maximum particle energy and the shape of the distribution function are the two main parameters influencing the potential utilization of the new technology in radiation therapy. The energy spectrum depends on the quality of the laser beam as well as the geometric shape of the interaction target. Recent experiments have shown that it is possible to generate quasi-monoenergetic protons using a double target system. However, influence of the laser prepulse has not yet been fully quantified. The purpose of this study is to find how the laser prepulse changes the property of the target and under which conditions can one expect the highest proton energy.

Method and Materials: A radiation-magnetodynamics code with inline atomic kinetic modeling was used to simulate interaction of the laser prepulse with initially cold double-layer target. The simulated target system consists of an aluminum substrate on which a thin layer of hydrogen is located. Different initial substrate thicknesses and laser contrast ratios were simulated to find an optimal interaction conditions. Results of hydrodynamic simulations were used as initial conditions for the simulation of the main pulse interaction with the altered target.

Results: It is shown that interaction of the prepulse with the target leads to its partial ionization with subsequent formation of a shock wave. Propagating shock wave destroys initial configuration of matter in a substrate, greatly expanding it in laser's propagation direction. Results of simulations suggest that maximal proton energy is achieved using lasers with smallest contrasts, incident on targets of thicknesses 1-2 μm .

Conclusions: Presence of laser prepulse impedes acceleration efficiency of protons. Minimizing the contrast ratio or shortening the duration of the prepulse should result in higher maximal proton energies.