Optimization Study of Laser Triggered Ion Acceleration for Radiation Sources of Socially Significant Applications

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The recent trend in laser acceleration of ions is to use an advanced modern technology for target design to increase efficiency of the laser based ion sources. The effects of utilization of ultra-thin foils, micro-structured targets or targets with micro-structured front side surface, and low dense targets on ion acceleration are widely studied elsewhere.

In this paper, by using 3D PIC code MANDOR we have performed optimization of proton and deuteron acceleration from ultrathin foils, low dense substance, and surface-microstructured targets irradiated by short relativistically strong laser pulses. The laser energy was varying from several mJ to hundred joules. We came to conclusion on a universal dependence of the maximum proton energy on laser energy for the optimum laser-target interaction, corresponding to semi-transparent targets. The obtained dependence shows that for a wide range of laser intensities the energy of accelerated protons from the plane targets with high concentration of hydrogen scales as the laser energy to the 0.7 power. It has been shown that utilization of low dense target results in increase of maximum proton energy as compared to the case of optimal thickness foil. It has also been demonstrated that for moderate laser energies (several joules) there can be some increase in the ion energy with using of surface-structured targets.

We have applied our study to estimation of feasibility for laser based SPECT isotope, PET isotope, and neutron production for medical applications.

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