Diploma thesis abstract

Front surface bulk target high-ionized ion acceleration in relativistic laser-plasma interactions

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The experimental results on the interaction of relativistic ($2-4\times10^{18}\mathrm{W/cm^2}$) femtosecond laser pulse with the front surface of bulk teflon, molybdenum, silicon, polyethylene and deuterated polyethylene are presented in the diploma thesis work. The ions were registered with the use Time-of-flight spectrometer with charge-to-mass (Z/M) separation in the presence of magnetic field, which was preliminary theoretically modeled and calibrated.

It was demonstrated, that the efficiency of protons and high charge ions acceleration (as well as their charge state composition) is mainly defined by the contrast of the laser radiation. At contrast level about 10^{-8} the high charge ions up to C^{6+}, Si^{12+} and Mo^{14+} with maximal energy from 0.5 to 1 MeV were registered from polyethylene, teflon, silicon and molybdenum, respectively. The main process leading to generation of high charge ions is the electron impact ionization at plasma plume expansion. In the case of metal target the appreciable drop in acceleration efficiency of protons from the thin organic surface layer was observed, which is the evidence of the cleaning effect of the target surface by the action of prepulse. The measurements with high contrast ($< 10^{-10}$) laser radiation have shown the presence of fast protons (up to $300-700$ keV) on every target and decrease of energies and charge state of high charge ions simultaneously.

In the experiments on irradiation of deuterated polyethylene the deuterons with maximal energy exceeding 300 keV were detected, which allowed to initiate synthesis reaction $D+D\rightarrow n+{}^3He+3.27\,\mathrm{MeV}$ with the neutron yield around 700 particles per laser shot.