Enhancement of laser-driven proton acceleration and gamma-ray production due to preplasma on the surface of solid targets

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Plasma created at irradiation of solid targets by ultra-intense laser pulses is considered as a perspective source of X-rays, relativistic electrons, protons for different applications like radiography, diffractometry, cancer therapy and others. Efforts of scientific community are aimed at enhancement of laser-plasma sources (LPS) efficiency. Extensive research is dedicated to optimization of laser targets: low density foams, targets with micro-structures on the surface, ultra-thin targets, reduced-mass targets etc. But usually, production of such sophisticated specimens is a highly labor-consuming task. So these targets can't be used for applications where operation at repetition rate is required.

More convenient way to enhance LPS efficiency is modification of interaction region by prepulses of different duration and intensity. Here we present a simple method based on positioning of the target so that laser focus is inside the preplasma from ASE prepulse. On Ti:Sa femtosecond laser at focused intensities of up to 4×10^{20} W/cm^2 (5 ns ASE prepulse contrast is 10^{10}), the highest LPS efficiency is reached after we placed target at 40 um from tight focus. Using this method in experiments on laser-driven proton acceleration with 6 um Al foils, there was obtained 2-fold cut-off energy increase (up to 9 MeV). In experiments with 0.5 mm tungsten targets there was detected 4-fold increase of gamma-rays yield.