Generation of Energetic Particles in Intense Laser Matter Interaction

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The acceleration of high energy ion beams (up to several tens of MeV per nucleon) following the interaction of an ultra-short ($t < 50$ fs), intense ($I\lambda^2 > 10^{18}$ W.cm^{-2}.μm^{-2}) laser pulse with solid targets, is one of the burgeoning fields of research in the last few years. Mechanisms leading to forward-accelerated, high quality ion beams, operating at currently accessible laser intensities (up to 10^{21} W/cm^2) in laser-matter interactions, are mainly associated with large electric fields set up at the target rear interface by the laser-accelerated electrons leaving the target. The emitted ion pulses, and in particular, the proton pulses contain a large number of particles (up to 10^{13}) with energies in excess of several MeV, having a pulse duration ~ ps, and a source size of tens to hundreds of μm [1-2]. Conversion efficiencies (laser energy to proton energy) up to 7 percent have been reported [3]. However, the emitted proton beam has a large divergence, which restricts its applications in ion cancer therapy and inertial confinement fusion (ICF) [4-5].

In this paper, we present our recent experimental results on MeV ion generation by mildly relativistic (10^{18} W/cm^{-2}) short-pulse (45 fs) laser interaction with foil targets of varying thicknesses, structured / uniform targets (e.g. nano structures on thin metallic foils, sandwich targets). Spectral modification / bunching, and divergence from structured targets will be discussed. Observation of energetic negative hydrogen ions from ultra-short laser pulse interaction with thin foil targets will also be discussed.

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