Investigation of ion beam instabilities in intense laser plasma and applications

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The interaction of intense laser pulses with matter is opening up new frontiers in physics via the production of extreme pressures, temperatures and intense electric and magnetic fields. This is leading to the use of high-power laser radiation for exploring the properties of hot dense matter, the production of high-energy particles and radiation and the development of schemes for "tabletop ion acceleration". These advances are driven by rapid developments in ultrashort pulse laser technology, which have enabled new regimes in laser power and intensity to be reached.

Mechanisms leading to forward accelerated, high quality ion beams, operating at currently accessible laser intensities 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 with energies in excess of several MeV, having a pulse duration ps, and a source size of tens to hundreds of micrometers [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 with filamentary structures, which restricts its applications [4, 5]. In this talk, we present our recent experimental results on MeV ion generation by relativistic 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). Controlling the filamentary structures and instabilities in plasmas will be presented. This talk will also emphasize on the usefulness of employing laser driven ion beams for "cancer therapy" - a regime of laser-plasma interactions not previously addressed - and to harness predicted promising new ion acceleration schemes achievable with ultrahigh intensity laser pulses.

References
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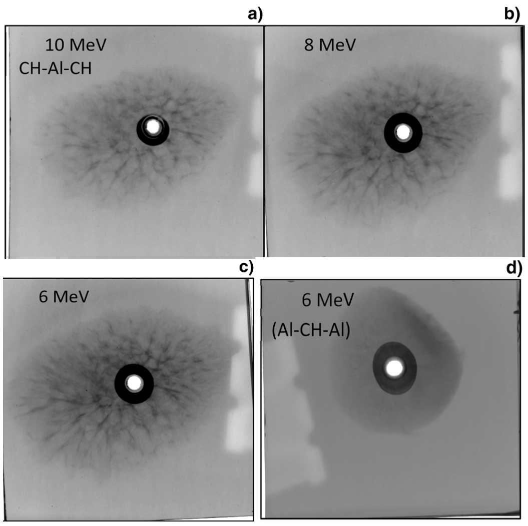

Fig. 1.: Proton beam profiles (a) 10 MeV, (b) 8 MeV, and (c) 6 MeV recorded on RCF from the target rear surface CH–Al–CH (2.5 μm); (d) shows a smooth beam recorded on RCF from the target rear surface of Al–CH–Al (2.5 μm).

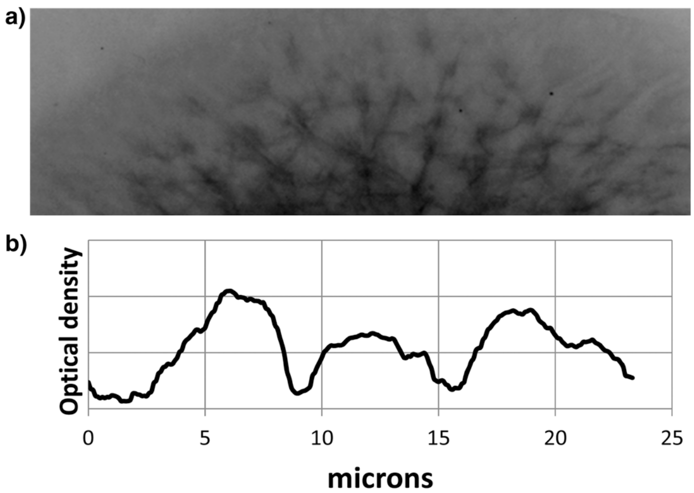

Fig.2. (a) A zoom in the profile depicting a net-like pattern in the proton beam imprint. (b) A line out of the pattern shows periodicity in the net pattern.