Double layer target with interface modulations for laser acceleration of collimated ion beams

M. Matys[1;2], K. Nishihara[1;3;4], M. Danielova[1], J. Psikal[1;2], G. Korn[1] and S. V. Bulanov[1;5]

[1] Institute of Physics of the ASCR, ELI-Beamlines project, Prague, Czech Republic

[2] FNSPE, Czech Technical University in Prague, Prague, Czech Republic

[3]Graduate School of Engineering, Osaka City University, Osaka, Japan

[4]Institute of Laser Engineering, Osaka University, Osaka, Japan

[5]Kansai Photon Science Institute-QST, Kizugawa, Kyoto, Japan

With the advent of multi-petawatt laser systems like the ELI-Beamlines (Czech Republic), APOLLON (France) and SEL (China) the laser-driven ion accelerators will enter the acceleration regimes dominated by radiation pressure [1]. High quality ion beams with low emittance and narrow energy spectrum will be generated when these lasers irradiate tailored targets.

Below we present the results of studying the effects of the interface modulations in double layer targets. The numerical particle-in-cell simulations with the code EPOCH [2] are used. We show that the pre-modulated targets can undergo relativistic Rayleigh-Taylor [3] and Richtmyer-Meshkov instabilities. Their use can improve the properties of generated ion beams [4].

It is shown that small perturbations originated from the interface modulation grow during the laser-target interaction. This leads to the formation of low-density regions and high-density ion bunches between them at the positions determined by the pre-modulation geometry. The ion bunches are then accelerated by the laser radiation pressure. The collimated central bunch of proton beam has the average energy in the multi-GeV range with narrow energy spread. The laser accelerated ion beams from composite targets will find applications in nuclear physics research [5].

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