Laser driven proton acceleration with solid and gas targets

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Experiments for laser driven proton acceleration were carried out by using the femtosecond petawatt laser system at Shanghai Institute of Optics and Fine Mechanics (SIOM), Chinese Academy of Sciences (CAS). With an overdense plasma produced by the laser prepulse ionizing an initially ultrathin plastic foil, proton beams with narrow spectral peaks at energies up to 9 MeV, and with fluxes of as high as $\sim 3\times 10^{12}$ protons/MeV/sr which is increased by two orders of magnitude compared with previous experimental results, were observed. Two-dimensional particle-in-cell simulations reveal that collisionless shocks are efficiently launched by circularly polarized lasers in exploded plasmas, resulting in a narrow energy spectrum. [1] A highly-collimated argon ion beam with narrow energy spread is produced by irradiating a 45-fs fully-relativistic laser pulse onto an argon cluster target. The argon ions get pre-accelerated from Coulomb explosion and then the laser-driven intense plasma wakefield has a strong modulation on the ion beam in a way that the low energy part is cut off. [2] The optimum and controllable two-stage proton acceleration was realized for the first time by a novel double beam image (DBI) technique in experiment. Two laser pulses are successfully tuned on two separated foils with both spatial collineation and time synchronizing, resulting in spectrum tailoring and an energy increase at the same time. [3] A strong electromagnetic pulse (EMP) is generated on a copper mesh which is irradiated by a laser pulse and propagates on it, forming an EMP mesh. After flying through the copper mesh, a laser driven proton beam is divided into several beamlets and each beamlet was separately focused due to the electric force of the EMP. The area density of proton beamlet focused by the EMP is 25 times as many as the initial density of the proton beam. [4]

References

[1] Hui Zhang, Baifei Shen et al., to be submittd.
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