NEAR-100 MEV PROTONS VIA A HYBRID ACCELERATION SCHEME IN AN ULTRATHIN FOIL

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The range of potential applications of compact laser-plasma ion sources motivates the development of new acceleration schemes, such as those involving ultrathin foils, to increase achievable ion energies and to control the spectral and divergence properties of the ion beam. The fast evolving nature of the interaction means that typically more than one acceleration mechanism occurs during the interaction with a thin foil target.

Here, experimental and numerical results on the interaction of linearly polarized, picosecond-duration, ultra-intense laser pulse interactions with ultrathin foils, in which proton energies close to 100 MeV are achieved [1], are presented. It is shown that record high energies are produced via a hybrid scheme involving both radiation pressure and sheath acceleration, and that the acceleration field is boosted by the onset of relativistic self-induced transparency in the expanding foil. This takes place due to the formation of a relativistic plasma jet [2,3], supported by a self-generated, azimuthal magnetic field. Electrons within this jet experience direct acceleration to super-thermal energies by the portion of the laser pulse transmitted through the target. The resultant streaming of electrons into the layers of expanded sheath-accelerated ions enhances their energy in the vicinity of the jet, leading to the acceleration of protons to high energies [4].

New experimental measurements of the properties of these jets, including measurements the self-generated, azimuthal magnetic field supporting the jet, and the range of laser and target parameters over which the hybrid acceleration scheme works are presented.

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