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Proton acceleration in the interaction of high power laser and cryogenic hydrogen targets ROHINI MISHRA, Stanford Linear Accelerator Center, FREDERICO FIUZA, Lawrence Livermore National Lab, SIEGFRIED GLENZER, Stanford Linear Accelerator Center — High intensity laser driven ion acceleration has attracted great interest due to many prospective applications ranging from inertial confinement fusion, cancer therapy, particle accelerators. Particle-in-Cell (PIC) simulations are performed to model and design experiments at MEC for high power laser interaction with cryogenic hydrogen targets of tunable density and thickness. Preliminary 1D and 2D simulations, using fully relativistic particle-in-cell code PICLS, show a unique regime of proton acceleration, e.g. $\sim$ 300 MeV peak energy protons are observed in the 1D run for interaction of $\sim 10^{20}$ W/cm^2, 110fs intense laser with 6n_c dense ($n_c = 10^{21}$ cm^{-3}) and 2 micron thin target. The target is relativistically under-dense for the laser and we observe that a strong (multi-terawatt) shock electric field is produced and protons are reflected to high velocities by this field. Further, the shock field and the laser field keep propagating through the hydrogen target and meets up with target normal sheath acceleration (TNSA) electric field produced at the target rear edge and vacuum interface and this superposition amplifies the TNSA fields resulting in higher proton energy. In addition, the electrons present at the rear edge of the target continue to gain energy via strong interaction with laser that crosses the target and these accelerated electrons maintains higher electric sheath fields which further provides acceleration to protons. We will also present detailed investigation with 2D PICLS simulations to gain a better insight of such physical processes to characterize multidimensional effects and establish analytical scaling between laser and target conditions for the optimization of proton acceleration.

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