

AbstractID: 14050 Title: Observation of quasi-monoenergetic laser accelerated proton and carbon beams

Purpose: To perform preliminary experiments to achieve the Directed Coulomb Explosion (DCE) regime of proton acceleration to therapeutic energies in high-intensity laser-matter interactions. **Method and Materials:** Particle-in-Cell (PIC) simulations of the planned experiments at HERCULES laser at the University of Michigan have predicted a new regime of attainable laser-target interactions for proton acceleration. The laser was recently upgraded to 300 TW with Amplified Spontaneous Emission (ASE) intensity contrast ratio of 10^{-11} , allowing intensities of 2×10^{22} W/cm² to be achieved in a near diffraction limited, 1.3 micron, focal spot. Dual plasma mirrors have been installed and characterized to reduce the prepulse at < 30 ps (from the uncompensated dispersion of optical elements during the pulse compression) before the main pulse providing 3 orders of magnitude contrast improvement. This allowed experiments on thin foil membranes (50 nm) with 50TW temporally clean pulses without compromising the target. **Results:** We found for the first time that for all target thicknesses proton spectra exhibit quasi-monoenergetic features, which are more pronounced for ultra-thin (50 nm Si₃N₄) targets resulted in $\Delta E/E \sim 30\%$. Moreover for these Si₃N₄ targets spectra for all the charge states of carbon ions C³⁺-C⁶⁺ are also found to be quasi-monoenergetic. Maximum proton energy drops from 6 MeV for 1 μ m Mylar foil to 4 MeV for 50 nm Si₃N₄ membranes. **Conclusion:** Implementation of dual plasma mirrors substantially improved laser contrast and created more favorable proton and carbon flux-energy distributions. Further improvements to the plasma mirrors are required, using better antireflection coatings on glass substrates, to achieve the DCE regime of proton acceleration.