AbstractID: 8463 Title: Improved proton yield from a laser-proton accelerator

Purpose: To improve the energy output of the laser proton accelerator. To investigate how target position and thickness influence the final proton energy. To identify which set of laser parameters are most crucial to obtaining higher proton energies.

Method and Materials: The experimental set-up for generation of laser-accelerated protons has been redesigned. The laser system is a chain of amplifiers capable of delivering up to 25TW in a 40fs pulse. The high-power laser pulses are delivered to a thin (7μm – 20μm) Al or 7.5μm polyamide $(C_{22}H_{10}O_4N_2)_n$ target in a shielded vacuum chamber. When the laser beam is focused by an off-axis parabolic mirror of focal length of 15 cm, the light intensity on the target exceeds $2x10^{19}$ W/cm^2. All experiments are conducted at oblique (45^o) incidence with p-polarized light. The energy of the generated protons is sampled by a range filter and the transmitted beam is registered on a CR39 track detector.

Results: The proton spectra from targets with varying thickness and composition have been recorded. The maximum proton energy in excess of 2MeV was obtained for a 15μm Al target situated 50μm behind the focal plane of the laser beam. Comparison study in 7μm Al and 7.5μm polyamide targets has been conducted, resulting in slightly higher proton flux from the aluminum target and no measurable energy difference. Applying a simplified heat-transfer model of target destruction we estimated that the laser pre-pulse is at a level sufficient to destroy Al target of thickness below 14.5μm.

Conclusion: The acceleration of protons using 25TW ultra-short laser pulses to energies in excess of 2MeV has been experimentally demonstrated. The influence of various interaction parameters on the final proton energy has been evaluated. These experimental results are a new step toward the generation of therapeutic proton beams with controlled characteristics using lasers.