AbstractID: 8458 Title: Optimizing the laser parameters in a simulated laser-proton accelerator

Purpose: To identify new ways of increasing the proton energy from a laser driven accelerator without increasing the laser power. To design an optimized interaction geometry regarding target positioning and laser energy delivery, that will result in more energetic protons.

Method and Materials: Fully relativistic 2D3V particle-in-cell (PIC) simulations are used in this study. The initial conditions are chosen to correspond to a real experiment with a 40fs laser pulse (λ=800nm) and energy in the pulse in the range 4J–7J, focused to 2.8–3.4μm. The loading of the laser pulse in the simulation is adequately controlled in order to study the influence of angle of incidence and wave-front curvature on the proton acceleration. The target is Cu with thickness of 400nm and width of 10μm. A thin proton layer attached to its back surface.

Results: When the laser beam is focused on the target optimum incidence angle is found at ~30^o angle for a 21% gain in proton energy compared to normal incidence. When the laser pulse is split in two and both sub-pulses are focused on the target at opposite angles (+30^o and -30^o) the proton energy is increased and reaches maximum for equal splitting for a total energy gain of 42%. Positioning the target exactly one Rayleigh range behind the beam's waist is found to be beneficial as well. This position of the target corresponds to a wave-front with the lowest positive radius of curvature.

Conclusion: The combined optimization of angle of incidence, pulse splitting, and wave-front curvature leads to energy gain between 65% and 140% compared to normal incidence for two realistic experimental situations. Increasing the proton energy by such a significant amount without increasing the energy in the laser pulse can prove to be the way to reach the therapeutic range of proton energies.