AbstractID: 9597 Title: Role of the laser pulse duration on maximum proton energy for future accelerators

Purpose: Laser-accelerated protons have a great potential for radiation therapy. This work investigates the dependency of the maximum proton energy on the laser pulse duration. The results will demonstrate the relative importance of the laser intensity and energy to the characteristics of laser accelerated protons.

Method and Materials: Ti:Sa laser of 30 TW (2J, 30fs, 10^6 contrast ratio) was focalized on thick aluminum targets (20 microns) to generate polyenergetic proton beams with energies up to 4 MeV. The laser pulse duration was changed by increasing the distance between the two gratings (using a triplet offner compressor configuration) from 30 fs to 1.2 ps. The target thickness was chosen to avoid contrast ratio effect. Protons were detected using a real time detector (combination of Micro Channel Plate + scintillator + Photomultiplier tube). Particle in Cell (PIC) simulations were performed to confirm the experimental results. The laser energy was tuned by decreasing the pumping energy of the third amplifier stage.

Results: Both experimental and PIC simulation results show that the maximal proton energy decreases from 4 to 2 MeV with the increasing pulse duration from 30 to 1200 fs. A decrease of a factor 40 on the laser intensity results in a decrease on the proton energy of just a factor of 2. Further experiments with the same pulse duration and variable laser energy show a clear decrease of the maximum proton energy with the laser energy.

Conclusion:
Our results indicate that under certain experimental conditions the laser pulse energy is a more important factor than the laser peak intensity. Small variations in laser intensity should not affect the proton maximum energy that is crucial to radiation therapy. Both the laser peak intensity and the pulse energy should be optimized to achieve therapeutic proton beams.