AbstractID: 9110 Title: Cellular radiosensitivity of laser accelerated protons: a feasibility study

Purpose: Protons accelerated by high intensity laser pulses result in high-current, short-pulses beams, which are different from conventional proton beams. Lesions generated by laser-accelerated protons emerge at almost the same time leading to much higher average sublethal lesion concentration than conventional protons. Therefore, the chance of sublethal-to-lethal conversion could be much higher. The purpose of this study is to investigate the dependence of the cellular radiosensitivity on the intensity and frequency of the laser-proton beam.

Method and Materials: A revised microdosimetric-kinetic model is developed in this research. This model specifies that ionizing radiation may cause two types of lesions in DNA that can disable the cell. A type I lesion is lethal that cannot be repaired. A type II lesion may either be repaired or become lethal. A type II lesion may undergo 2 transformations: (1) It may be repaired; (2) It may combine with another type II lesion to form a lethal lesion that becomes unrepairable. The combination probability is a function of sublethal lesion concentration. The lesion repair and combination take place at the same time until all the lesions are repaired or the cell becomes apoptotic.

Results: Simulations show that the highest sublethal-to-lethal conversion will occur if a 2-Gy dose can be delivered with one laser pulse. The lethal lesions under this condition are four times higher than that when the beam is delivered continuously. However, the sublethal-to-lethal conversion decreases quickly with the dose per pulse and it reaches a minimum at about 0.2 Gy/pulse.

Conclusions: Results of this study show that the laser-proton beam may generate different cellular damages compared to conventional proton beams for the same physical dose. It can be explained by the increase repairable lesion concentration among subnuclear volumes that causes pairwise repairable lesions to form a lesion lethal to the cell.