AbstractID: 4885 Title: Laser-accelerated proton therapy: target chamber design and shielding requirements

Purpose: Recent advances in laser technology have facilitated proton (light ion) acceleration using laser-induced plasmas. In this work, we investigate target chamber designs and their shielding requirements for a laser-proton therapy system.

Method and Materials: This new therapy system employs laser-accelerated protons. If successfully developed, it may provide a compact and cost-effective solution to energy- and intensity-modulated proton therapy (EIMPT). Since laser-accelerated protons have broad energy and angular distributions, which are not suitable for radiotherapy applications directly, we have designed a compact particle selection and beam collimating system for EIMPT beam delivery. The target chamber contains the laser focusing and target assembles and is connected to the proton beam collimation and particle selection device. Monte Carlo simulations using MCNPX and FLUKA have been performed to verify the shielding walls for the experimental setup, which consist of stainless steel, polystyrene and lead.

Results: The primary particles resulting from the laser-target interaction are protons and electrons. Our particle in cell simulation predicted energy spectra with 300 MeV maximum energy for protons and 20 MeV for electrons for a laser intensity of 10^{21} W/cm^2. The maximum number was 10^{11} and 10^{12} per pulse for protons and electron, respectively. Our Monte Carlo simulations showed that a combination of 1/4” 304 stainless steel, 6” polystyrene and 3” lead will reduce the combined leakage dose equivalent to 0.32 μSv (0.032 mrem) per laser pulse at 1 m from the chamber, which included the effect of all primary and secondary particles.

Conclusion: We have designed an experimental setup to accommodate the laser focusing mirror, the target assemblies, the beam collimator and the particle selection system. Different shielding walls are designed to ensure the leakage dose equivalent to within 20 μSv (2 mrem)/week.