Purpose: This project is aimed at developing a practical laser-particle radiation therapy system as an alternative to conventional accelerators for particle therapy.

Method and Materials: A significant effort has been made through federal, industrial and institutional funding to develop cost-effective alternatives to conventional accelerator-based particle therapy. We have established a laser-ion acceleration facility that consists of a commercial 150 TW laser, custom-made laser-pulse compression and target chambers, particle selection and beam collimating devices, dosimetry monitoring systems and shielding constructions. We have performed initial laser-proton acceleration experiments with thin aluminum and plastic foils as target materials. The maximum proton energy was measured using CR-39 film and a Thomson parabola ion analyzer. Particle-in-cell (PIC) simulations were carried out to investigate the optimal laser parameters and target configurations to facilitate laser-proton acceleration and dosimetric studies.

Results: The primary particles resulting from the laser-target interaction are positive ions and electrons. Our initial testing with a 10^{18} W/cm^2 laser intensity (at 20 TW) produced up to 4 MeV protons with a broad energy spectrum. PIC simulations confirmed these results demonstraing a scalability of the maximum ion energy and laser intensity. A compact shielding designed was investigated using Monte carlo simulations that allows for the installation of the particle therapy head on a small rotating gantry.

Conclusion: An experimental laser-ion accelerator has been established for radiation therapy studies and for future applications. Initial experimental studies have demonstrated proton acceleration at low laser power levels. Further studies with laser intensities up to 2 x 10^{20} W/cm^2 are being conducted with different target materials and configurations.