THE GRADUATE COLLEGE OF THE
UNIVERSITY OF OKLAHOMA HEALTH SCIENCES CENTER

ANNOUNCES THE FINAL EXAMINATION OF

Michael T. Prusator

FOR THE DEFENSE OF THE DOCTOR OF PHILOSOPHY DEGREE
GRADUATE COLLEGE

Department of Radiological Sciences

Tuesday, May 1, 2018 | 2:00 p.m. | Stephenson Oklahoma Cancer Center, Room 6039

Monte Carlo Simulation for the Mevion S250 Proton Therapy System: A TOPAS Study

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ABSTRACT: Proton therapy is becoming increasingly popular as a cancer treatment modality due to its high conformity of dose delivery. The Mevion S250 proton therapy system operated at the Stephenson Cancer Center offers a unique single-room design where the cyclotron is located in the treatment room with the patient. This study is the first to conduct a full characterization of the Mevion proton system including general dosimetry, neutron production and patient specific studies using Monte Carlo simulation toolkits.

All 24 beam-line configurations were constructed

according to manufacturer provided blueprints and a series of beam data were simulated and compared to the analogous commissioning data, including pristine Bragg peaks, spread out Bragg peaks and lateral profiles at various delivery conditions. The simulated and commissioning data matched exceptionally well, with agreements being well within the specific tolerances. Using the simulation model, an in-room neutron production study was carried out by irradiating a water phantom with various field sizes for three selected beam configurations (deepest, smallest and largest). Neutron ambient dose equivalents at distances up to 150 cm from isocenter and at angles up to 135 degrees relative to the central beam path were calculated and then compared to measured doses using the SWENDI-II neutron detector. Simulated neutron dose equivalents ranged from 8 mSv/Gy to less than 1 mSv/Gy. Measured neutron doses were lower, in some cases by an order of magnitude. Lastly, a clinical workflow was developed to compare simulated patient specific dose to the 3D dose distributions produced by the treatment planning system. Using this workflow, a patient specific study was conducted to explore the effects of patient anatomy and range compensator on the dose per monitor unit calibration. Patient scatter factors (PSF), and compensator scatter factors (CSF) were calculated for four target sites including brain, lung, pancreas and prostate using both treatment planning system and simulation techniques. Linear relationships were found between the quantity of specific tissues in the treatment field and PSF values for lung and prostate cases. The impact of compensator shape on the CSF values was also evaluated.