AbstractID: 13113 Title: Monte Carlo study of neutron dose equivalent for a compact proton therapy unit

Purpose:
A compact proton therapy unit (Still River Systems, Littleton, MA) is under development. This will be the first such unit in the world and neutron exposure for this machine is unknown. Our purpose is, using Monte Carlo methods, to model the detailed beam line, simulate neutron fluence, and estimate neutron dose equivalent for this proton therapy unit.

Method and Materials:
The compact proton therapy unit utilizes a synchrocyclotron, which will be aligned together with the beam shaping system (BSS) in a single room. We modeled the proton source coming out of the cyclotron as a Gaussian distribution with a mean energy of 250 MeV. The BSS uses passive scattering techniques to spread out the beam laterally and in depth. We modeled each BSS component in detail according to the design data provided by the manufacturer. The MCNPX code (Version 2.5.0) system was used. The neutron spectral fluence in air was simulated with a closed aperture and without range modulation. Neutron dose equivalents were then calculated using the neutron fluence to dose equivalent conversion factors based on ICRP publication 74. Up to 10^8 proton histories were tracked per simulation.

Results:
Fourteen options (combinations of modulator wheel and scatterer) were modeled. Neutron spectral fluence was simulated and analyzed. The neutron dose equivalent per therapeutic proton dose (*H/D*) at isocenter ranged from 0.82 mSv/Gy for a shallow range and small field size option, and up to 17.4 mSv Gy^{-1} for a deep penetrating, and large field size option.

Conclusion:
The *H/D* values from this compact unit are comparable to those from conventional multi-room proton therapy units employing passive scattering techniques. The *H/D* values decrease with decreasing maximum treatment depth (range), but are relatively higher for very shallow range options, compared with existing passive scattering units.

Conflict of Interest (only if applicable):