AbstractID: 7126 Title: Study of neutron exposure during passively scattered proton therapy

Purpose:
Stray radiation exposures are of concern for patients receiving proton radiotherapy and vary strongly with several treatment factors such as proton energy, field size and modulation width. The purposes of this study were to conservatively estimate neutron exposures for a contemporary passive scattering proton treatment unit and to understand how they vary with treatment factors.

Method and Materials:
We simulated all 24 options (each range modulator and second scatterer combination is accounted for one option) for a passive scattering proton therapy unit with MCNPX. Spectral neutron fluence from simulations was then converted to neutron dose equivalent using corresponding dose conversion factors. We studied the neutron dose equivalent per therapeutic absorbed dose (*H/D*) as a function of treatment factors including proton energy, location in the treatment room, treatment field size, and spread-out Bragg peak (SOBP) width using Monte Carlo simulation.

Results:
The *H/D* value at isocenter for a 250-MeV medium field size option was estimated to be 20 mSv Gy^{-1}. *H/D* decreased to about 20% from 250 Mev to 160 MeV. *H/D* fell off sharply with distance from the treatment unit, approximately following a power law; *H/D* was about 10% higher for a large field option than a medium field option for the same energy. *H//D* almost doubled when SOBP width was increased from a pristine peak to 16 cm. An analytical model was developed, which predicted *H/D* values within 28% of those obtained in simulations; this value is within typical neutron measurement uncertainties.

Conclusion:
The results quantified how treatment factors influence *H/D* values. The in-air method with a closed aperture presented here provides a simple and straightforward approach that could be adopted for facility inter-comparisons. In addition, an analytical model was developed to quickly estimate *H/D* values.

Conflict of Interest (only if applicable):