AbstractID: 6983 Title: Stray radiation exposure during proton radiotherapy of the prostate: the influence of the patient on scatter and production

Purpose: To characterize the scatter, production, and attenuation of secondary radiation in patients receiving passively-scattered proton radiotherapy for prostate cancer.

Methods and Materials: A proton therapy treatment was simulated using a Monte Carlo model of a double-scattering treatment machine. Whole body effective dose (*E*) from secondary radiation was estimated from a weighted sum of doses to the major organs in an anthropomorphic phantom. The effect of the patient on secondary dose was quantified by comparing *E* with ambient dose equivalent, *H*(10)*, which was based on free-in-air spectral fluence calculations at isocenter. Various treatment parameters (proton beam energy, range modulation width, field size, and snout position) were varied in order to study their influence on *E* and *H*(10)*.

Results: The calculated *E* for the simulated treatment was 7.8 mSv/Gy, while the calculated *H*(10)* at isocenter was 16 mSv/Gy. Both *E* and *H*(10)* approximately doubled over the range of modulation widths and energies studied. As field size increased from 0×0 to 15×15, *E* doubled, while *H*(10) decreased* by 30%. When the snout position was changed from 30 cm to 48 cm, *E* decreased by less than 20%, while *H*(10)* decreased by 44% over the same interval.
Simulations revealed that, while *E* is predominated by neutrons generated in the nozzle, neutrons produced in the patient contributed significantly (up to 40%) to dose equivalent in near-field organs. In most cases, *H*(10)* provided a conservative estimate of *E*. However – because *H*(10)* does not account for neutrons created in the patient – it did not conservatively estimate *E* for large field sizes, where neutron production in the patient becomes significant.

Conclusions: Neutrons generated in the patient contribute significantly to exposures to organs near the irradiated volume. When evaluating stray radiation exposure, production, scatter, and attenuation in the patient should be taken into consideration.