AbstractID: 3160 Title: Simulation of organ specific secondary neutron dose in proton beam treatments.

Purpose: To determine the effective secondary neutron dose to patients undergoing proton therapy. Goal was to separate the secondary radiation generated from the proton treatment nozzle from the one generated inside the patient. Further, the secondary dose should be calculated for specific organs independently.

Method and Materials: GEANT4 based Monte Carlo methods were used to study the neutron induced secondary dose deposited to healthy organs/tissues during proton therapy. A whole-body patient model, VIP-Man, was implemented as patient model. Two proton treatment plans for tumor in the lung tumor and paranasal sinus were applied to VIP-Man. Internal (generated inside the patient body) and external (generated in the treatment nozzle) neutrons were studied separately. The averaged absorbed dose and neutron quality factor were deduced for each organ. The ICRP-60 tissue weighting factors were used to calculate the whole body effective dose.

Results: The magnitude of secondary dose in organs/tissues depends on the distance to the primarily irradiated volume. In general, the averaged secondary dose is at least three orders of magnitudes lower than the planned dose in GTV. The neutron quality factor is calculated as to be ~6 since the neutron fluence includes a large fraction of thermal and low energy neutrons. Neutrons are mainly generated in the treatment nozzle. Results show that the whole body effective dose for the two proton plans is 0.162 Sv and 0.027 Sv, respectively. The statistic error of the estimated effective dose is better than 0.5% and 2% for internal and external neutrons, respectively.

Conclusion: Our VIP-Man Monte Carlo method is an effective tool for secondary dose calculations in patient geometry. Secondary dose can be calculated organ specific. Our method can be used for any treatment modality and is planned to serve as basis for more quantitative evaluation of secondary cancer risk following radiation therapy.