AbstractID: 9243 Title: Angular Distribution of Neutron Fluence and Its Effect on Shielding for a Passively-Scattered Proton Therapy Unit

Purpose:

Neutron production is of principal concern in shielding of proton therapy units. Conventionally, neutron calculations are based on the analytical methods, which do not take the actual beam shaping components and the nozzle shielding into account. The goal of this study was to calculate neutron spectral fluence produced at a passive scattering proton treatment unit with detailed Monte Carlo modeling and to estimate the corresponding neutron dose equivalent and shielding requirements at various angles relative to the beam direction.

Method and Materials:

We modeled all key components in the nozzle including a range modulator, scatter, range shifter and aperture for a passive scattering proton therapy unit with MCNPX. We simulated the spectral neutron fluences at different angles and distances around the nozzle. The neutron spectral fluences were then converted to neutron dose equivalent using conversion factors from International Committee of Radiological Protection (ICRP) Publication 74. Based on the neutron dose equivalent and spectral fluence, the shielding requirements for walls facing the beam and parallel to the beam were assessed.

Results:

The spectral neutron fluence varied significantly with angle relative to the beam. High energy neutrons were forward peaked and decreased with increasing angle. Low energy neutrons did not change much with angle. Neutron dose equivalent in treatment room did not change significantly with angle, but more shielding was required for the wall facing the beam than other walls because the high energy neutrons were greatest at zero degrees.

Conclusion:

The neutron spectral fluence from proton therapy units changes significantly with angle relative to the beam direction. Compared to the analytical methods, Monte Carlo simulated results provided a more accurate estimation of the neutron angular distribution for shielding design.

Conflict of Interest (only if applicable):