

Theoretical and experimental neutron dose determination for proton therapy delivery techniques

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In recent years the use of high energy protons in radiotherapy has increased dramatically. The clinical advantages are apparent, but there is some controversy regarding the secondary neutrons produced during treatment. This work presents a study of neutron production in proton therapy. We examined the neutron production due to materials typically present in a treatment nozzle. In addition, the neutron field characteristics, fluence, energy spectra and absorbed dose were investigated for a contemporary passive system. Microdosimetric measurements were performed to quantify the neutron field characteristics for a passive beam delivery system.

The neutron absorbed dose is dependent on the type of material with which the primary proton beam interacts. Lower atomic number materials produce fewer neutrons, although they are forward directed and have energies close to the primary proton beam. Higher atomic number materials produce a larger number of evaporation neutrons emitted nearly isotropically, although there is some forward directed production. This behavior was confirmed by microdosimetric measurements for thick targets. In addition, from our studies and measurements, we determined that the treatment snout is in fact the maximum neutron dose contributor to the dose that a patient will receive during proton therapy. Other beam shaping devices, such as the range modulation wheel (RMW), produce a greater neutron fluence within the nozzle but do not dominate the neutron dose receive by the patient.