AbstractID: 3757 Title: Monte-Carlo Investigation of Proton-Generated Radioactivity in a Multileaf Collimator for a Proton Therapy Facility

Purpose: The requirements for a multi-leaf collimator (MLC) for a proton therapy facility include the neutrons and radioactive products generated by proton interactions in the collimator material. The range of protons decreases with increasing density of the leaf material, which suggests fabricating the MLC with a high density material to keep the length short. However, the rate of nuclear spallation events whereby particles such as n, ^{2}H, ^{3}H and α are ejected depends on the target nucleus.

Material and Methods: The GEANT4 Monte-Code code was used to determine, per incident proton, the rate of these reactions as a function of proton energy in tungsten, iron and brass. In addition, the radioactive daughter products resulting from these interactions were evaluated.

Results: Neutron production per incident 250 MeV proton on a leaf 1 cm^2 in cross-sectional area and 10 cm in length was found to be 0.94, 1.27 and 1.75 for iron, brass and tungsten respectively. Decreasing the leaf thickness of W from 10 cm to 5 cm, which is still greater than the range of a 250 MeV proton in W, did not change the neutron production significantly (<3%) suggesting that the majority of neutrons were produced by the proton interaction and not by the interactions of the secondary neutrons. The mean neutron energy was between 15-17 MeV in all three materials, and 95% of the neutrons produced had energy less than 60 MeV. The yield of ^{2}H and ^{3}H particles, generated per incident 250 MeV proton was 0.178 and 0.096 respectively for all three metals. Alpha particles generated per incident 250 MeV proton were 0.08, 0.092 and 0.124 for Fe, brass, and W respectively.

Conclusion: The production rates of secondary particles and radioactive isotopes within the MLC, and the associated radiation safety concerns, have been explored using GEANT4.