

AbstractID: 5076 Title: Effects of choice of the MLC material on neutron dose equivalent outside of the treatment field in proton therapy

**Purpose:** To determine the effects of choice of MLC material on neutron dose equivalent outside of the treatment field in proton therapy.

**Method and Materials:** A four-dimensional GEANT4 Monte Carlo simulation of a commercially available proton therapy nozzle has been used to calculate the ratio of neutron dose equivalent to therapeutic proton absorbed dose ( $H_N/D_P$ ).  $H_N/D_P$  varies significantly with proton beam energy, materials used in the nozzle, treatment technique, and range modulation. Technical specifications of the nozzle have been provided by the vendor. Lateral beam spreading is achieved primarily by binary pre-scatterer foils and a double contoured scatterer. Modulation is generated by a stepped propeller positioned at nozzle entrance, and pre-collimation is done by nickel inserts. A preliminary design of a multi-leaf collimator has been added to the simulation, providing final collimation. Four different data sets have been generated, each one corresponding to a different MLC composition: tungsten, brass, iron and stainless steel.

**Results:** A 200 MeV proton beam is used in order to produce a large circular treatment field with a 10 cm radius, a depth of penetration of approximately 22 cm, and an SOBP width of 10 cm. Neutron dose equivalents are calculated outside the treatment field at three distances from isocenter: 15 cm, 25 cm, and 47 cm (along beam direction). The highest  $H_N/D_P$  ratios are calculated for tungsten, and vary from 10 mSv/Gy at a distance of 15 cm off axis, to 0.7 mSv/Gy at 47.5cm off axis. Corresponding  $H_N/D_P$  ratios for stainless steel are 6.93 mSv/Gy and 0.46 mSv/Gy, representing the lowest calculated values.

**Conclusion:** A steel MLC produces, on average, 45% less secondary neutron dose deposit compared to a tungsten MLC. The result indicates potential for dose reduction in proton therapy when a steel collimator is used instead of a tungsten collimator.