AbstractID: 7299 Title: Investigation of the impact of leaf design on the radiation leakage through a multileaf collimator for use in proton radiotherapy

Purpose: To investigate the impact of leaf design on the radiation leakage through a multileaf collimator (MLC) for use in proton radiotherapy.

Method and Materials: Using the Geant4 toolkit, a simulation program was developed to study the dose inadvertently administered to patients undergoing proton radiotherapy as a result of radiation leakage through the closed leaves of a MLC. In the model, the MLC comprised two opposing banks of tungsten-alloy leaves, arranged perpendicularly to the beam axis. Each leaf was composed from a cuboid base, together with a step along the beam direction—in order to cover the gaps that would otherwise exist between neighbors—in both of the sides that abut leaves in the same bank, and in the end that faces the opposing bank. A simplified beam nozzle was modeled to provide a uniform fluence of protons over the upstream face of the MLC. Energy deposits were recorded in a voxelized water phantom adjoining the downstream face of the MLC. The radiation leakage was assessed as a function of gap and step size, leaf material and beam properties.

Results: For a 5×5 cm^2 field of 230 MeV protons incident on the MLC in the absence of interleaf gaps, the mean dose deposited in a $40 \times 40 \times 40$ cm^3 water phantom is 0.66 % of that when the field impinges directly on the phantom ("intraleaf leakage"). With realistic gaps of width 0.125 mm, this increases by a further 0.38 % if no steps are added, reducible to 0.04 % with steps of size 0.2 mm ("interleaf leakage"). The interleaf leakage dose distribution correlates highly with leaf design.

Conclusion: Interleaf leakage through a proton MLC can be effectively removed by incorporating steps into the leaf design. Intraleaf leakage can be minimized by appropriate choice of leaf material.