AbstractID: 3821 Title: Comparison between proton and neutron dose distributions from single-scattering and dual-scattering systems in ocular proton therapy

Purpose: Typically, ocular proton treatment nozzles use a single-scattering (SS) flattening filter design to achieve lateral spreading of a raw pencil-beam to create a flat field. This approach has the advantage of simplicity but at the cost of proton efficiency, η. It is expected, though never demonstrated, that a more efficient, dual-scattering (DS) flattening filter design may possess several advantages.

Methods and Materials: A proton nozzle with the SS filter design was modeled in Monte Carlo (MC) radiation transport software. Simulations of this nozzle provided in-field proton absorbed dose distributions in water, *D*, and the neutron dose equivalent values, *H*, outside of the field, which were subsequently benchmarked to published measurements. Then, a proposed nozzle was modeled that uses a DS filter design. Simulations of the SS and DS nozzles were conducted to investigate differences in several figures-of-merit including the distal 80%-20% falloff $l_{D80\text{-}20}$ and neutron dose equivalence per therapy Gray (*H/D*) distributions. Other figures-of-merit presented will include the field uniformity *U*, therapeutic dose rate *D*dot, and the 80-20% lateral penumbral width $l_{L80\text{-}20}$.

Results: The simulations and measurements of the proton absorbed dose distributions from the SS nozzle agreed to within 2% or 0.1 mm. The shape of the measured and simulated *H/D* values as a function of distance from isocenter perpendicular to the beam agreed within 3%. The distal falloff width was expectedly narrower from the DS nozzle by 2.5 mm. The simulations revealed that the DS design yields substantially lower *H/D* values (between 0.3-0.6 times the SS values). This is partially attributed to the DS design's increased peak dose per proton.

Conclusion: The DS flattening filter design may offer clinical advantages when compared to the SS filter design, including a sharper distal falloff, *D*dot, and decreased *H/D* values.