AbstractID: 8950 Title: The contribution of nuclear products on the lateral profile of the pencil scanning proton beams from the MD Anderson Proton Therapy Center Houston nozzle: The halo effect

Purpose: Secondary particles created by nuclear interactions produce a halo of low secondary dose that extends far beyond the center of primary pencil beams. This work investigates this "halo effect" in the MD Anderson Proton Therapy Center Houston (PTCH) pencil beam nozzle. **Method and Materials:** A model of the PTCH pencil beam nozzle was implemented using the Monte Carlo code MCNPX. Upstream of the nozzle a water phantom was placed to score: i) the energy deposited as a function of depth for cylindrical tallies with increasing radii; and ii) the lateral profile of the beam as a function of depth. **Results**: Lateral profiles at the Bragg peak depth for three beam energies (72.50 MeV 159.52 MeV, and 221.83 MeV) show that dose is deposited far beyond the center of the PTCH pencil beam. Although this halo dose is very low for a single pencil beam (0.01 % of the maximum at 15 cm from the center of the 221.83 MeV beam), for a large number of beams it accumulates, which causes the dose deposition to increase, a fact that is not properly accounted for in treatment planning dose models. Furthermore, the energy deposited as a function of depth shows differences of up to 8 % when comparing 4 cm with 10 cm tally radii for the 221.83 MeV beam. This result suggests that percent depth dose (PDD) measurements should be performed with ion chambers (ICs) large enough to cover not only the central part of the beam, but also the halo region of small doses. **Conclusion:** The halo dose can be deposited far beyond the center of the primary PTCH pencil beam and PDD measurements should be performed with ICs large enough to cover the halo region of small doses.