AbstractID: 12769 Title: Experimental characterization of the low-dose envelope of spot scanning proton beams

Purpose: To measure the low-dose envelope of spot scanning proton pencil beams. **Method and Materials:** Measurements were performed in the spot scanning proton pencil beam nozzle at M. D. Anderson Cancer Center. We directly measured the low-dose envelope by measuring single pencil beams' lateral profiles at central axis to relative dose levels that were a factor of 10^{-4} lower than the central axis dose. We also indirectly measure the low-dose envelope by measuring the effect of the filed size on central axis point doses using a plane parallel ionization chamber. **Results:** For lowest (72.5 MeV) and highest (221.8 MeV) energy beams in-air at isocenter plane, the full width (FW) at half maximum ranged from 1.26 ± 0.02 cm to 3.43 ± 0.02 cm; the FW at 1% maximum ranged from 3.99 ± 0.25 cm to 11.41± 0.25 cm; and the FW at 0.1% maximum ranged from 6.6 ± 0.5 cm to 17.9 ± 0.5 cm, respectively. The effect of the field size on central axis point doses showed strong dependence with energy and depth. **Conclusion:** We showed that it is possible to accurately measure the low-dose envelope down to a dose level of 10^{-4} of the central axis dose using standard dosimetric equipment. Because of the large lateral extent of the beams, care should be taken when measuring integral depth doses, which are input parameters for analytical dose calculation algorithms. Additionally, we observed that the in-air fluence of the pencil beams has various components due to scattering in the beam line and cannot be accurately described by a single Gaussian function. Finally, we showed that because of the low-dose envelope, the dose output's dependence on field size can vary for fields as large as 20 cm × 20 cm.