Small field aperture validation of the RayStation proton pencil beam scanning Monte Carlo algorithm.

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PURPOSE:

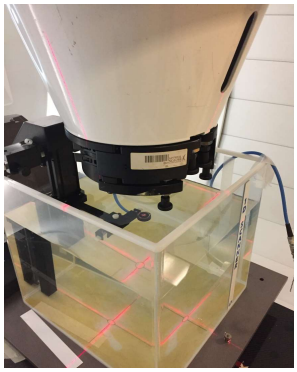
The RayStation 6 TPS provides proton PBS users the ability to optimize with an aperture. Previous work at the Northwestern Proton Center validated the algorithm down to an aperture field size of 4x4cm^2. This study aims to validate the algorithm down to a 1cm diameter aperture. Ion chamber measurements became the focus of this validation testing as radiochromic film experiences significant quenching in proton fields.

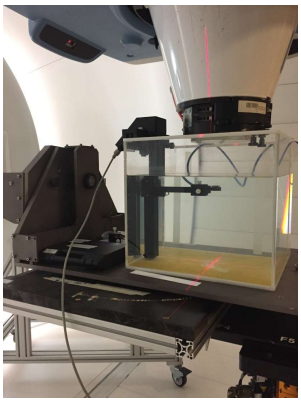
METHOD:

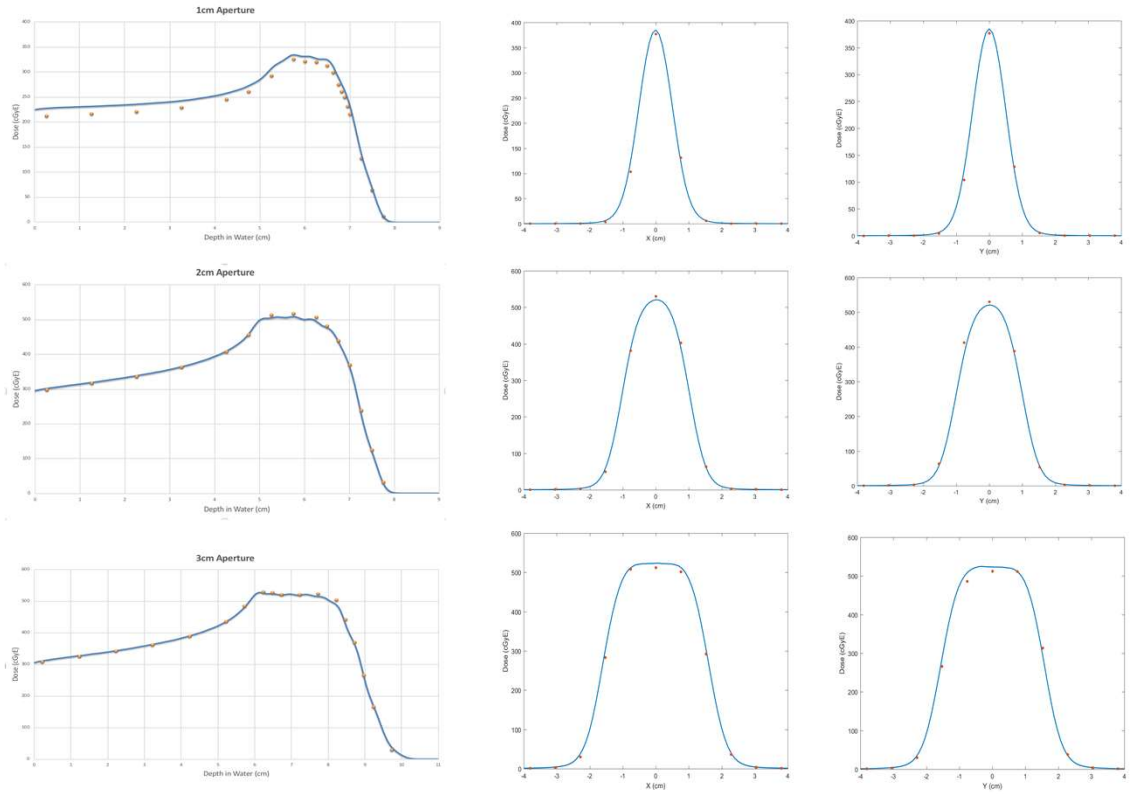
Three plans with 1cm, 2cm, and 3cm diameter apertures, including a 4.0cm WET range shifter were created in the RayStation TPS. Provision's standard beam model was used (reference field = 10x10cm^2 with no range shifter or aperture present). Longitudinal profiles were measured in a 1D water tank using the IBA PPC05 (sensitive area = 76.9mm^2). Transverse profiles were measured at mid-SOBP using the MatriXX PT (sensitive area = 15.9mm^2) in solid water. The measured depth doses and lateral profiles were then compared to the predicted doses from RayStation, considering the lateral extension of the PPC05 and MatriXX ionization chambers.

RESULTS:

Comparing the calculated depth dose profiles to PPC05 measurements, an average SOBP dose difference (computed-measured) for the 1cm, 2cm, and 3cm diameter apertures was 2.8%, -2.0% and -1.0%, respectively. The range discrepancy between calculated and measured was less than 1mm. The measured transverse profiles at mid-SOBP were in excellent agreement to the calculated profiles, with dose differences of +2.1%, -1.7%, and +2.1% for the 1cm, 2cm, and 3cm apertures, as evaluated for the MatriXX chamber aligned with the central axis.







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