Abstract ID: 15431 Title: Application of a Plastic Scintillation Detector in Measuring Depth-Dose Curves for Passive-Scattering Proton Beams

Purpose: The plastic scintillation detector (PSD) has many advantages over other detectors in small field dosimetry due to its high spatial resolution, excellent water equivalency and instantaneous readout. However, in proton beams, the PSDs will undergo a quenching effect which makes the signal level reduced significantly when the detector is close to Bragg peak where the linear energy transfer (LET) for protons is very high. This study investigates the feasibility of using PSDs in depth-dose measurements for clinical passive-scattering proton beams.

Methods: A polystyrene based PSD (BCF-12, 0.5mm diameter and 4mm length) was used to measure the depth-dose curves in a water phantom for pristine proton beams of nominal energies 100, 180, and 250 MeV. A Markus plane-parallel ion chamber was also used to get the dose distributions for the same proton beams. From these results, the quenching correction factor (QCF) as a function of depth was derived for these proton beams. Next, the LET depth distributions for these proton beams were calculated by using the MCNPX Monte Carlo code, based on the experimentally validated nozzle models for these passive-scattering proton beams. Then the relationship between the QCF and the proton LET could be derived as an empirical formula. Finally, the obtained empirical formula was applied to the PSD measurements to get the corrected depth-dose curves and they were compared to the ion chamber measurements.

Results: A linear relationship between QCF and LET, i.e. Birk's formula, was obtained for the proton beams studied. The PSD measurements after the quenching corrections agree with ion chamber measurements within 5%.

Conclusions: PSDs are good dosimeters for proton beam measurement if the quenching effect is corrected appropriately.