

AbstractID: 13483 Title: Study of the magnitude of detector size effect in the measured lateral profiles of proton pencil beam spots

Purpose: Lateral profiles of therapeutic radiation beams measured by ionization chambers are known to be affected by their sizes. The purpose of this study is to quantify the detector size effect on the measurements of lateral profiles of the proton pencil beam spots (PPBS) of the scanning beam nozzle of the Proton Therapy Center at Houston.

Methods and Materials: In-air and in-water lateral profiles of 72.5, 163.9 and 221.8 MeV energy PPBS were measured by a PTW 31014 Pinpoint ionization chamber (IC) (radius of 0.1 cm). The measured profiles were fitted to a sum of multiple Gaussians and were deconvolved with a Gaussian detector response kernel, $K(x) = A \cdot \exp(-x^2/2\sigma_k^2)$ with σ_k taken as the radius of the IC. The deconvolved profiles are also given by the sum of Gaussians with modified $\sigma^2 = \sigma_m^2 - \sigma_k^2$, where σ_m is the sigma of a Gaussian in the fitted measured profiles. The full width at half maxima (FWHM) and full width at 0.9 and 0.01 of the maxima, (FW0.9M, FW0.01M) of the profiles with and without the detector size corrections were compared to quantify the effect of the IC size on the in-air and in-water lateral profiles of PPBS.

Results: The maximum differences between the uncorrected and corrected FWHM, FW0.9M and FW0.01M for the PPBS of all the three energies in this study, were found to be less than 0.3, 0.1, 0.5 mm for in-air and 0.2, 0.1, 0.3 mm for in-water lateral profiles respectively. The detector size corrected and the measured lateral profiles were found to be very close to each other.

Conclusion: The analytical deconvolution method with a Gaussian detector response kernel indicates that the detector size has a rather small effect on the Gaussian like lateral profiles of PPBS measured with small ionization chambers.