Spatial Resolution of a Plastic Scintillator Sheet Dosimetry System for Brachytherapy: Measurement and Effect on Dose Linearity

Plastic scintillator (PS) is a promising 2D dosimeter for brachy-therapy since it possesses a high sensitivity and approximate tissue equivalence. Our 2D dosimetry system consists of a 1 mm thick PS sheet placed near the brachytherapy source, producing a 2D optical scintillation image which is captured by a liquid nitrogen-cooled CCD camera with a 512x512 pixels array. The purpose of this study is to evaluate the 2D spatial resolution of our system by measuring its point-spread function (PSF). PS light profile, produced by a low energy X-ray beam collimated to a 1 cm wide slit, was deconvolved from radiographic film (RGF) data in order to obtain the line spread function (LSF). The rotationally symmetric PSF was analytically derived from the LSF. The FWHM of the PSF is 4 mm with slowly decaying tails and is caused by transport, scattering and internal reflection of scintillation photons within the sheet. To assess its dosimetric significance, we convolved the PSF with simulated dose distributions ($D \sim 1/r^2$) in the PS plane as a function of source-to-sheet distance. The transverse-axis PS signal deviates from relative dose by as much as 50% due to imaging of light photons arising from ionizing radiation interactions occurring far from the measurement point. Accordingly, deconvolution of the light distributions, measured with the PS, is needed in order to obtain accurate dose measurements.

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