Abstract

Organic plastic scintillation detectors (PSDs) are growing in popularity for relative dosimetry measurements in megavoltage (MV) photon beams. However, a potential limitation of these detectors is that they are subject to an unwanted noise or stem-effect signal composed of Čerenkov radiation and fluorescence. This stem-effect signal can skew the response of the PSD if not properly removed and result in an incorrect determination of dose. This dissertation explores the properties of this stem-effect signal in various light guides used in PSD dosimetry as functions of measurement geometry and magnetic field strength.

The first part of this work focused on performing spectra measurements of the stem-effect in various irradiation geometries in a 6 MV photon beam from a Varian Clinac® 21EX linear accelerator. The spectral response and shape of the stem-effect was observed to vary as a function of measurement geometry. The change in spectral response and shape were unique to each light guide based on the optical properties of that fiber. The variations in spectral shape were attributed to changes in the fluorescent signal contribution to the stem-effect as a function of measurement geometry.

A Monte Carlo model of the optical properties of a light guide was developed to simulate the spectral response of the light guide in a magnetic field. Spectral measurements of the stem-effect were performed as functions of magnetic field strength and measurement geometry in collaboration with the German primary standards laboratory. The stem-effect response significantly varied in the presence of a magnetic field due to the directional nature

of Čerenkov light emission. Variations in the spectral shape of the stem-effect were also observed in the magnetic field. Good agreement was obtained between the simulated and measured data for the positive magnetic field strengths where all differences were within two standard deviations of the measured data. These variations in spectral response and shape of the stem-effect were found to have a significant impact on the response of a PSD in a magnetic field.