Characterization of a Commercial Photodiode Based Plastic Scintillation Detector Prototype

Innovation/Impact: This new plastic scintillation detector (PSD) uses a photo-diode to convert scintillation light to an electric signal that can be measured with an electrometer. This constitutes a significant step towards widespread use of the PSD outside of the research environment. Other PSD systems require specialized light detection equipment not commonly available in a clinical setting such as CCD cameras or photo-multiplier tubes. However, due to the widespread use of ion chambers, electrometers are commonplace in most clinics and nearly all physicists are familiar with their use. A clinically accessible PSD is desirable because of the PSD’s unique set of characteristics including water-equivalency; pressure, temperature, energy, dose rate, and angular independence; high spatial resolution; and excellent dosimetric accuracy (<1%).

To test the reproducibility of the detector we made ten measurements in a cobalt beam on a daily basis over the span of ten days. The detector was placed between two 1cm thick slabs of acrylic situated on a tray attached to the head of the cobalt unit at 80cm SSD to reproducibly position the detector. A 10x10 field was used with the sensitive volume of the detector (i.e. the plastic scintillating fiber) on the central axis. The dose to the detector was approximately 100cGy. Using this setup we observed a very high degree of day-to-day reproducibility as displayed in Figure 1.

To test the accuracy we obtained percent depth dose (PDD) curves. PDD curves in water were obtained using IBA Dosimetry's mechanized 'Blue Phantom' for precise positioning on a Varian Clinac. Three measurements were taken and averaged together to produce each data point. We obtained very good results for photons and electrons (measurements were compared to machine data obtained with ion chambers at commissioning). These results are displayed in Figure 2.

Figure 1. Each data point represents the average of ten individual measurements ($\pm 1\sigma$) on one of ten days. The data points are normalized to the average dose measured over all ten days. No measurement is observed to deviate more than 0.5% from the total average response.

Figure 2. Percent depth dose curves for 6MV and 18MV photons; and 9MeV and 16MeV photons. A slight systematic discrepancy is observed for the electron curves, likely due to positioning error.