Abstract ID: 17594    Title: Reproducibility of CVD Diamond Detectors for Radiotherapy Dosimetry

Purpose: Three diamond x-ray detectors fabricated in-house using films from the same batch of commercially-available chemical vapor deposition (CVD) diamond were investigated for performance inter-comparability under clinically relevant conditions.

Methods: Detectors were based on single-crystal CVD diamond films (0.5 x 3 x 3 mm^3) with 0.4 mm^3 sensitive volumes, which were encapsulated with PMMA. Detectors were placed in a (30 x 30 x 30 cm^3) PTW water phantom. Six-MV photons from an Elekta Synergy linac were measured using an SSD of 90 cm and 10 cm phantom depth with a 10 x 10 cm^2 field size in the central axis of the beam. Data acquisition was performed using a PTW UNIDOS E electrometer. Leakage current, priming dose, response dynamics, dose linearity, dependence on dose rate and angular dependence were used to evaluate differences between diamond detectors.

Results: Differences were seen in leakage currents before (< 1.5 pA) and after (< 12 pA) irradiation. A priming dose of ~7 Gy and rise and fall times of 2 s were found for all three detectors. Sensitivities differed by up to 10%. Dependence on dose rate was similar (Fowler fitting parameter, delta = 0.92-0.94). Angular dependence was minimal (97-102% average). Differences in detector performance appeared to be primarily due to film thickness, which can significantly change sensitivities and applied fields for detectors with small sensitive volumes.

Conclusions: Although films were sourced from the same manufactured batch, small deviations were seen between detectors such that correction factors may be required much like natural diamonds used in existing commercial detectors. Differences in sensitivity and dependence on dose rate most likely originate from variation in film thickness due to manufactured tolerances. Preselecting films by thickness is important to help eliminate variability in detector response where small sensitive volumes are used.