Purpose: To perform a sensitivity analysis of the parameters that define beam quality for a kilovoltage (kV) x-ray source

Methods: Using a previously developed hybrid approach to calculate radiation dose deposited by x-ray beams of energies <150 kVp, we computed dose inside a simulated heterogeneous phantom for varying beam spectra to evaluate the sensitivity of calculated dose to half-value layer (HVL). The approach involves computing the primary photon component deterministically and scattered component stochastically, accounting for the real micro cross sections of the materials involved.

We characterized the spectrum of the Varian® On-Board Imaging® units at our institution by HVL measurements made using of a Farmer-type Capintec ion chamber (0.06cc) in air. We compared doses computed with our characterized source spectrum with measurements inside water-equivalent Gammex® Solid Water® phantom. Measurements were done using a 10x10 cm2 field at 100 cm SSD at every centimeter for depths 1 to 12 cm.

Results: We found that measuring kV and HVL gives us sufficient beam quality information for accurate [>0.5%] x-ray dose calculations. We also showed that HVL varies by less than 0.1 mm Al for field sizes over 5x5 cm2, allowing us to use one HVL irrespective of field size. Agreement between calculations and experimental measurements was better than 2% for a transverse profile and the central axis depth dose. This implies that our approach to characterizing the beam quality of a kV source is suitable for ensuring accurate results.

Conclusions: We have determined the parameters we need to characterize the source in order to obtain good agreement between theoretical calculations and experimental measurements. This is a crucial step in developing an independent tool to calculate patient dose from kV beams such as cone-beam CT and brings us closer to our goal of calculating patient-specific dose from imaging procedures.