AbstractID: 14247 Title: Parameterization of Scatter Dependent Artifacts in Cone-Beam CT

Purpose: X-ray scatter limits image quality in cone-beam CT (CBCT), resulting in shading/cupping and skin-line artifacts, lack of CT number accuracy and reduction in contrast-to-noise ratio. In this manuscript, seven metrics of image performance are defined and used to quantify the influence of x-ray scatter on image quality in a commercial kV CBCT unit used in image-guided radiation therapy. The dependence on axial FOVz (SI), bowtie compensation, and object shape are examined. The results provide a quantitative framework for assessing physical and computational methods of improving CBCT image quality.

Method: Catphan-600 with and without NEMA-shaped jacket was imaged at five different FOVz (2-27 cm, SI) to examine the scatter influence on a CBCT equipped radiotherapy unit. CBCT images were acquired with and without the bowtie filter and all scatter corrections were disabled. Seven metrics were examined: (i) $m_{shading,}$ (ii) $m_{skinline}$, (iii) m_{lag}, (iv) m_{noise}, (v) m_{CNR}, (vi) $m_{CT\#}$, and (vii) $m_{linearity}$. These were quantitatively analyzed using Matlab-2008.

Results: Increasing the FOVz from 2 to 27 cm significantly reduces image quality in all 7 metrics. $m_{shading}$ exceeded 30%; $m_{skinline}$ (10 mm depth) was increased from 15 to 26% (without bowtie) and was more stable (-5.9% and 6.5%) with the use of the bowtie. m_{lag} was 10.5% and m_{CNR} was reduced by a factor of ~2 between 2 and 27 cm FOVz. CT numbers ($m_{CT\#}$) improved in accuracy as FOV was decreased.

Conclusion: Quantitative evaluation in phantoms demonstrates significant artifacts with increasing FOV. Bowtie study's led to reduction in shading/cupping and skin-line, as well as improvement in CNR and CT number accuracy. These improvements will lead to benefits in detection low contrast accuracy, and support initiatives in online and adaptive radiotherapy. Cone-beam CT can be applied for adaptive planning with improved image quality using proper scatter correction.