JULY 12–16 2020 VIRTUAL
JOINT AAPM | COMP MEETING
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The Effect of Dose Calculation Accuracy for HU to Electron Density Calibration For Iterative CBCT Reconstruction

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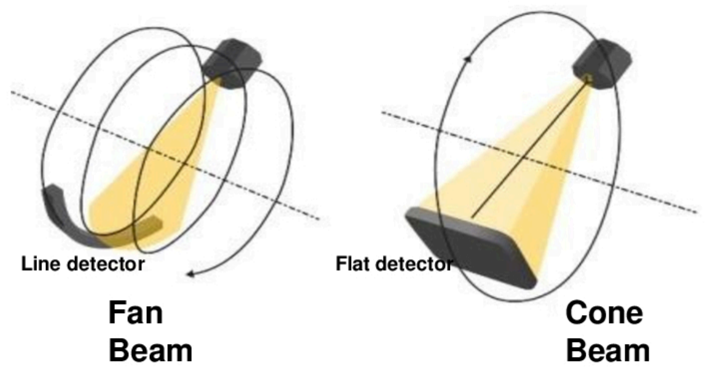
RETHINKING MEDICAL PHYSICS

INTRODUCTION

- Adaptive radiotherapy aims to incorporate deviations in the planned dose distribution due to systematic patient anatomy changes over the course of treatment
- Many approaches to adaptive planning require calculating dose on a Cone Beam Computed Tomography (CBCT) (1).



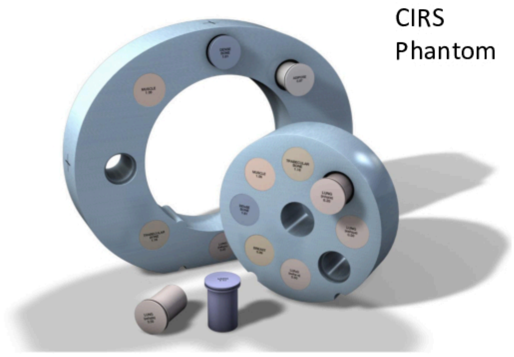
- CBCT Scans contain more scatter than fan CT scans which causes inaccurate Hounsfield units conversion which limits the use of CBCT for dose calculation (2).
- Varian's new iterative reconstruction algorithm removes the scatter component for the CBCT improving soft tissue contrast.

AIM

- Investigate Varian's new iterative cone beam reconstruction which may provide more accurate HU conversion for dose calculations for adaptive planning.

METHOD

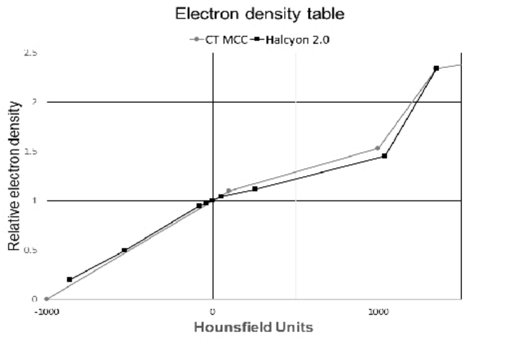
- Investigate the performance of the iCBCT on the Varian Halcyon compared to the non-iterative reconstruction on a True Beam.
- A CIRS electron density phantom was scanned with iCBCT and non-iterative CBCT pelvis protocol



- Bolus sheets were added to the CIRS phantom to create different phantom diameters:
  - 18, 20, 24, 25 and 32 cm
- At each thickness the The HU values of different tissues inserts were found.
- HU to electron density curves were calculated from the 18 and 32 cm diameter phantoms.
- The calibration curves were used to calculate dose on CBCT scans of the CIRS thorax phantom (MU's fixed). Which contains lung and bone equivalent tissue.
- Dose was compared to plans calculated using a ED to HU calibration from a CT.

RESULTS

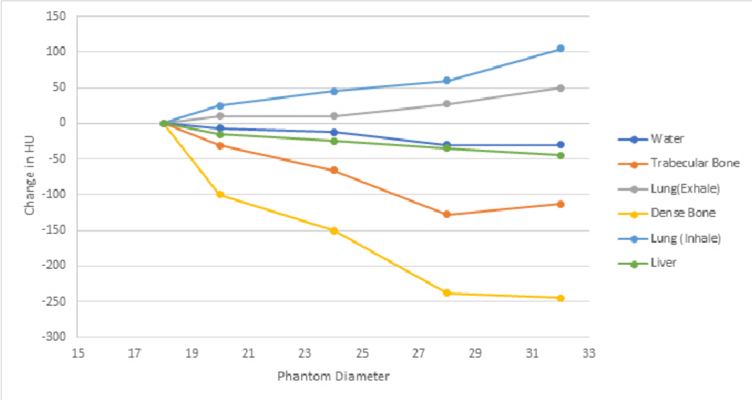
For a phantom diameter of 18 cm the HU values from the iCBCT reconstruction (Halcyon 2.0) matched closely with the HU for our CT scanner.



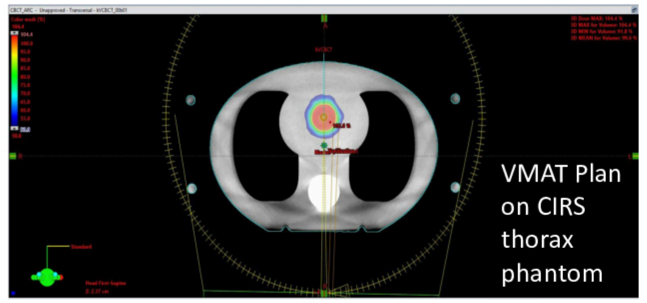
Electron density of calibration curve for CT scanner and iCBCT using a phantom of 18 cm diameter

RESULTS

- For the both the iCBCT and non-iterative reconstruction algorithms the measured HU values varied as more bolus was added to increase the diameter of the phantom. The figure below showing the change in HU value when making the phantom larger for the iCBCT reconstruction.



- For the non-iterative reconstruction the change in HU was larger for phantoms with a larger diameter (On average 100 HU larger than iCBCT).
- Using the CIRS thorax phantom the dose for a full ARC VMAT plan calculated using the CT ED to HU calibration curve was compared to the dose calculated using the ED to HU calibration curve from the different CBCT reconstruction methods.
- Using the 18 cm phantom to generate the ED to HU calibration curves the mean target dose was 0.8% hotter than the CT calculation for both iCBCT and non-iterative CBCT.
- Using the 32 cm phantom to generate the ED to HU calibration curve the mean target dose was 1.3% hotter for the iCBCT and 2.0% hotter for the non-iterative CBCT.



CONCLUSIONS

- Increasing the radial diameter of a phantom has less of an impact on the HU values for the new Varian iCBCT reconstruction compared to the non-iterative reconstruction.
- When calculating dose, a smaller error was introduced when using a ED to HU calibration curve from a iCBCT scan when compared to a similar scan using a non-iterative CBCT reconstruction.

REFERENCES

1. Webster GJ, Stratford J, Rodgers J, Livsey JE, Macintosh D, Choudhury A. Comparison of adaptive radiotherapy techniques for the treatment of bladder cancer. *Br J Radiol*. 2013;86(1021):20120433.
2. Hatton J, McCurdy B, Greer PB. Cone beam computerized tomography: the effect of calibration of the Hounsfield unit number to electron density on dose calculation accuracy for adaptive radiation therapy. *Phys Med Biol*. 2009;54(15):N329-N346. doi:10.1088/0031-9155/54/15/N01

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