University Hospitals Coventry and Warwickshire NHS Trust

Assessing AEC performance of CT scanners using a custom-designed phantom

Focus on positioning and centering of the patient

By
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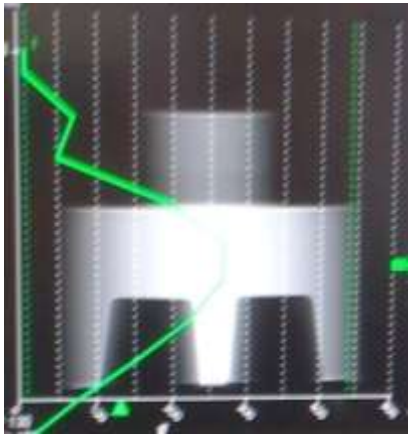
Talk Outline

- The Use of AEC on CT scanners
- Existing AEC phantoms
- AEC testing
- Design of UHCW phantom “Bertie”
- Preliminary results: GE Lightspeed and Discovery
- Preliminary results: Toshiba Aquillion
- Conclusions and Future Work

Methods of tube current modulation

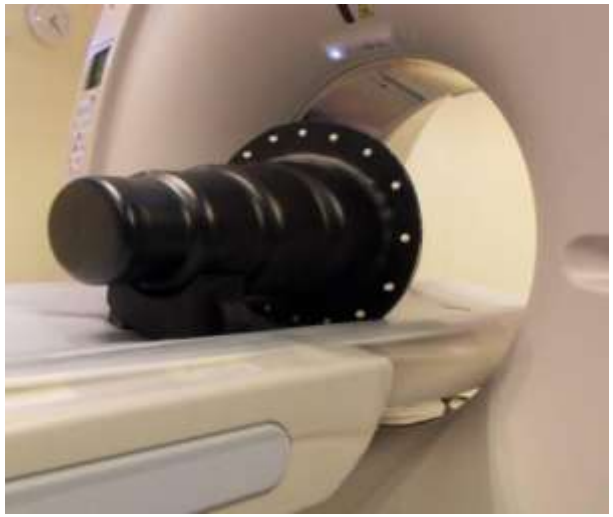
- Patient size: tube current is fixed as a function of patient size



- Z-axis AEC: current varies for each rotation as a function of patient size and material density

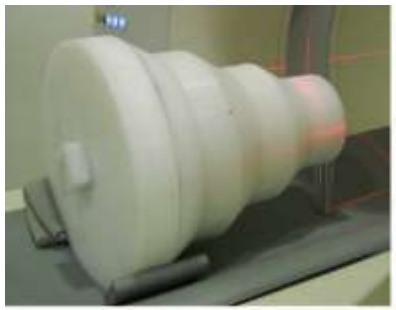
- Rotational AEC: current varies over a rotation (accounts for elliptical shape of human body and anatomy)

Some Existing AEC phantoms



BOD phantom and CeLT phantom (North Wales Medical Physics)

ImPACT phantom (Keat *et al*)



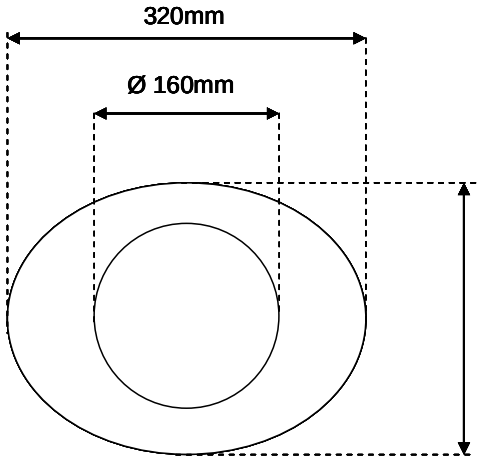
Polyethylene phantom (Wilson *et al* – US)

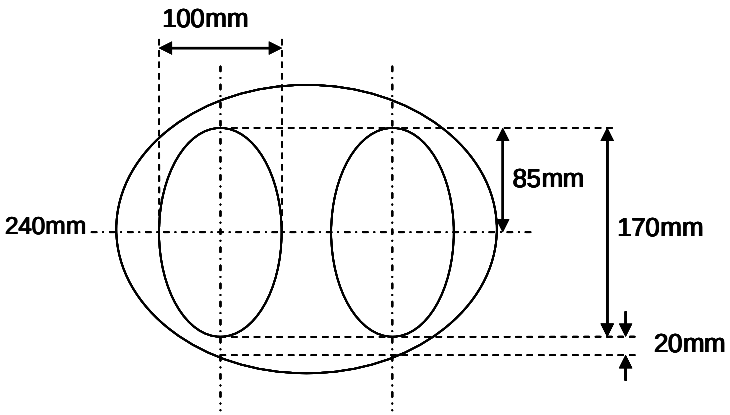
Current AEC testing

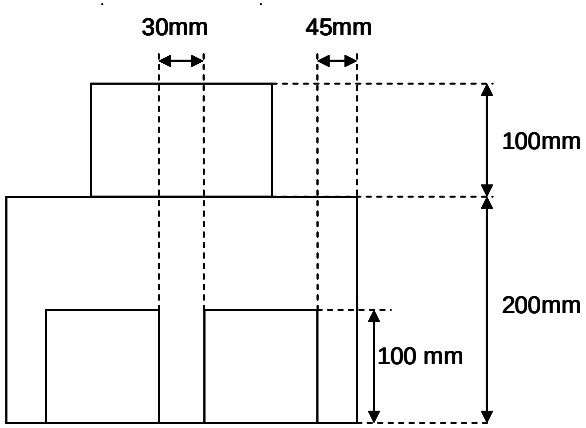
- **Examine current modulation across scan**
- **Verify image quality consistency by looking at noise variations**
- Dose measurements
- MTF assessment

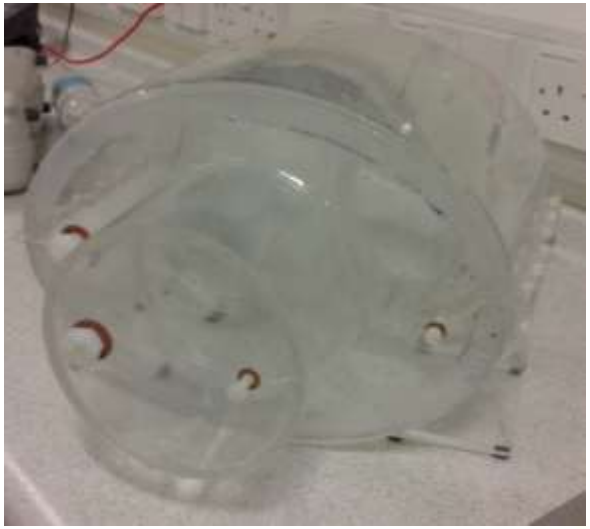
AEC testing at UHCW

- Currently no CT-AEC testing performed
- Design phantom for robust, repeatable QC measurements. Use phantom to set baselines and tolerances.
- Phantom can be used to investigate specific problems: effect on AEC of patient positioning
- Biggest issue is bed height









Design based on CT anatomical dimensions (Kramer *et al* 2012 and Ogden *et al* 2004 – Health Physics)

"Bertie"

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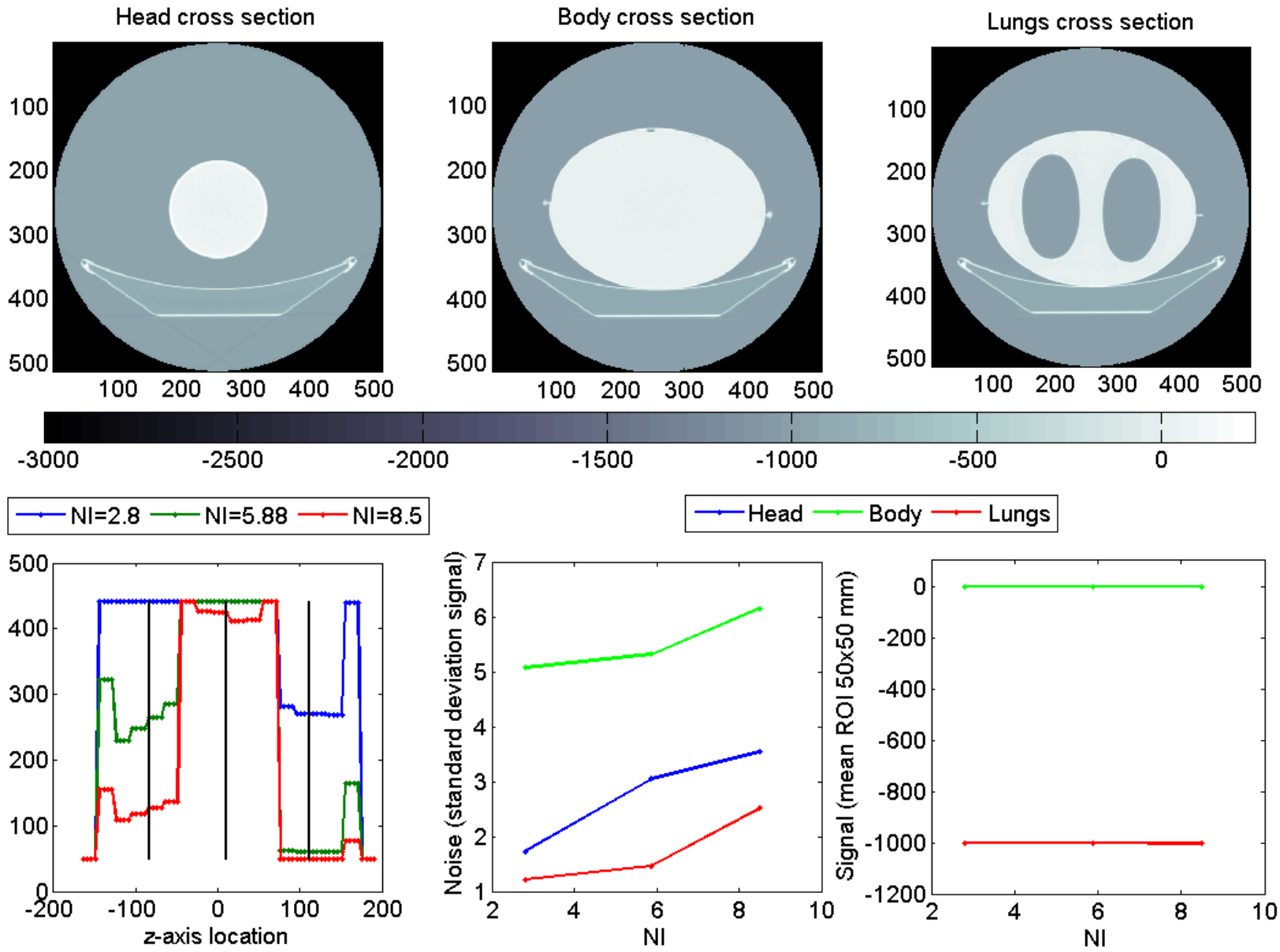
CT test parameters

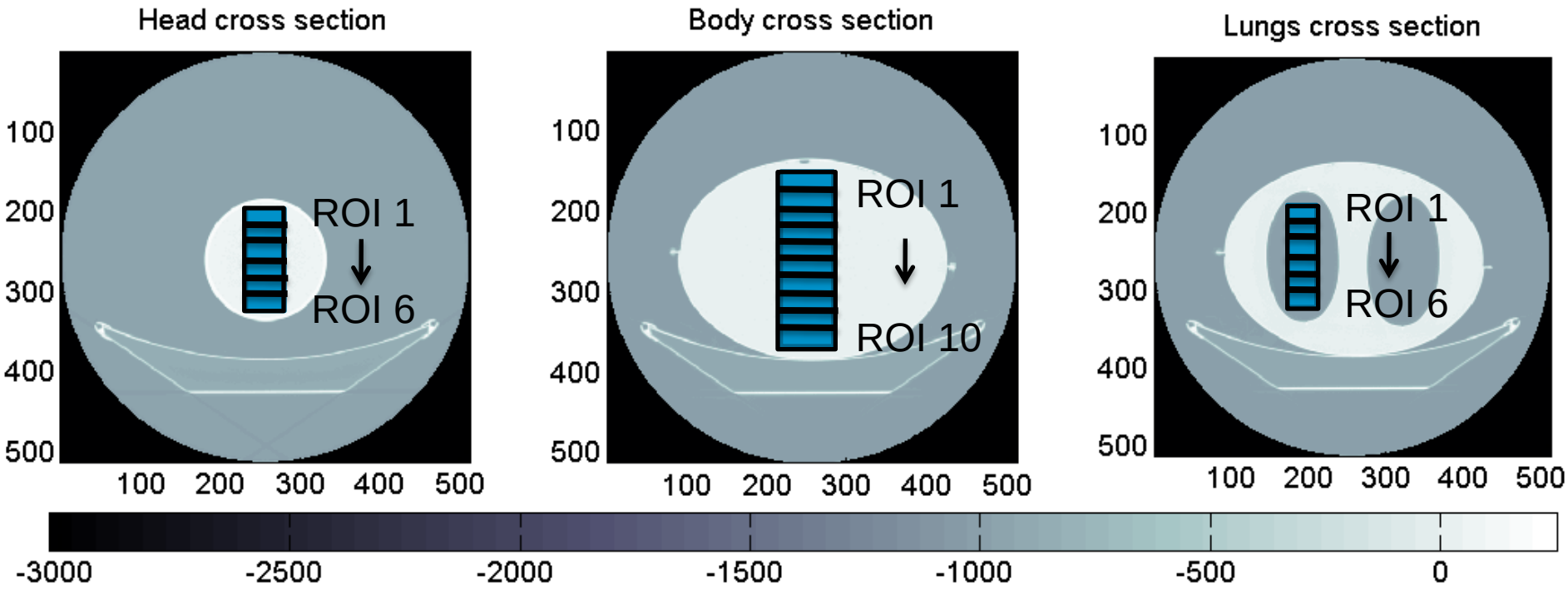
GE Lightspeed 4 slice/Discovery 750 CT	Toshiba Aquillion
120 kV	120 kV
Axial/helical	Helical
1.25 mm slice width	1 mm slice width
10/20 mm collimation	32 mm collimation
1s rotation time	1s rotation time
Large FOV	Large FOV
10-440 mAs	10-440 mAs
automA/smartmA (noise index=10)	Noise standard deviation = 10

Axial scans: GE Lightspeed 4 slice

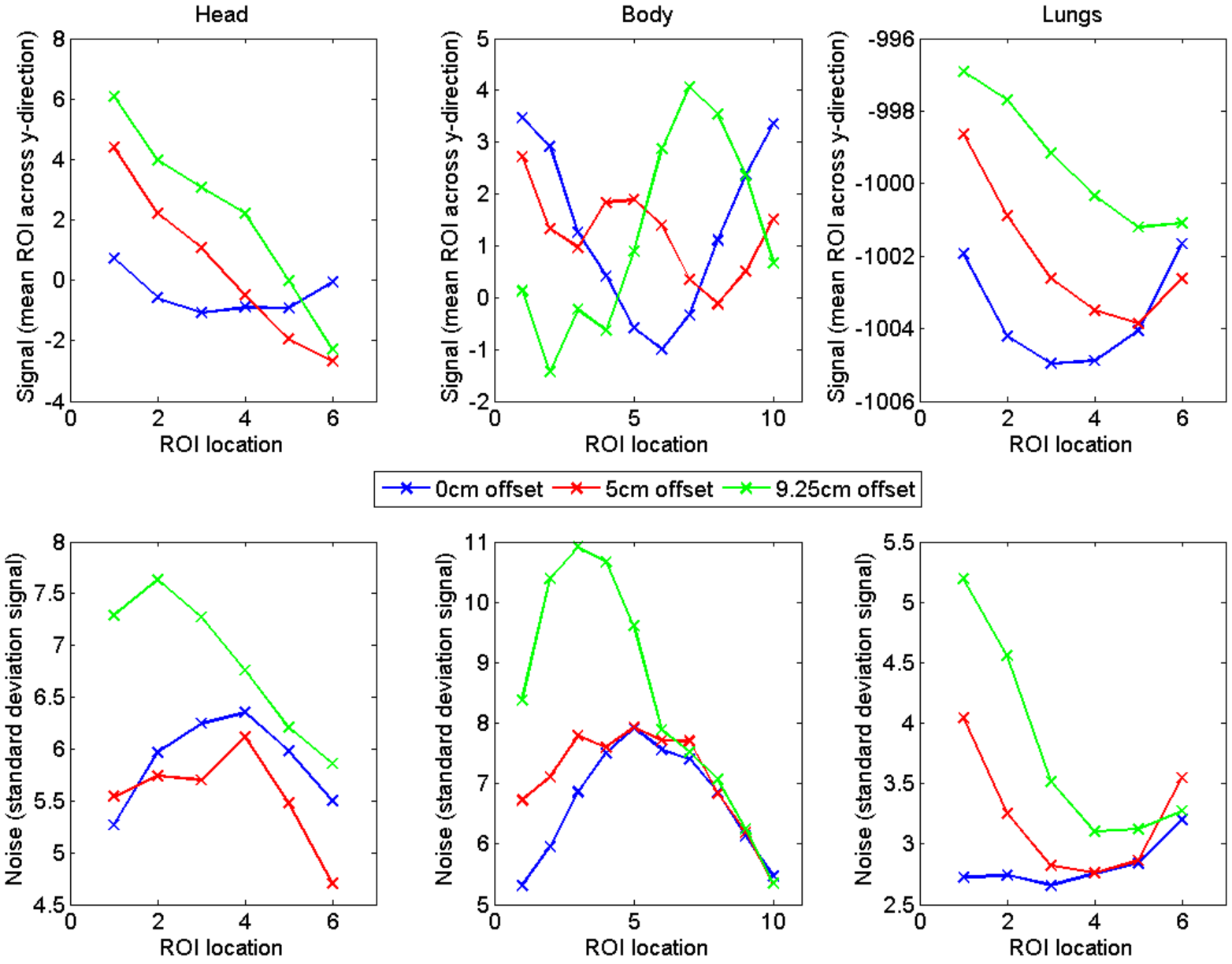


Axial scans: GE Lightspeed 4 slice

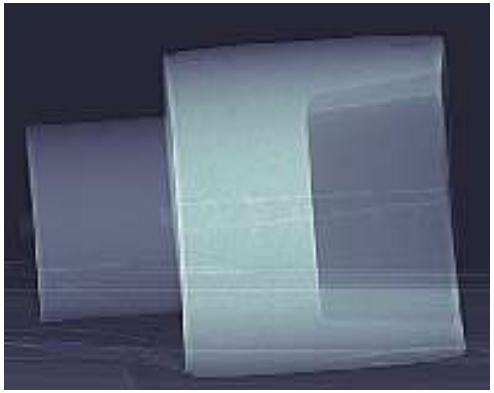
- Look at Signal and Noise in Regions of Interest along y-axis of scans

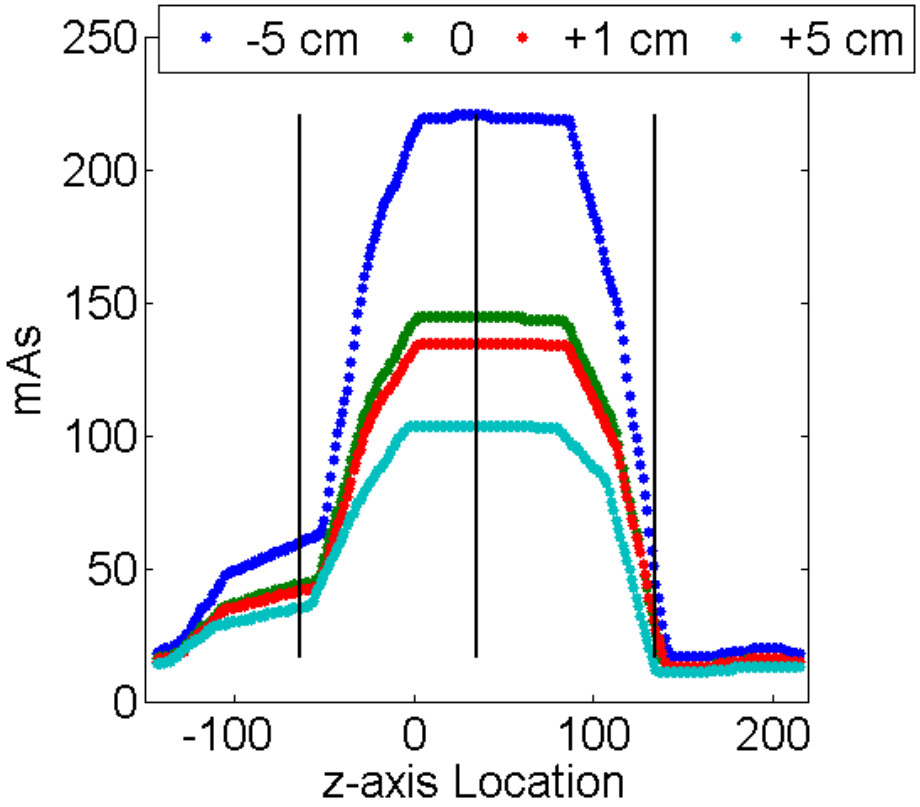


Axial scans: GE Lightspeed 4 slice

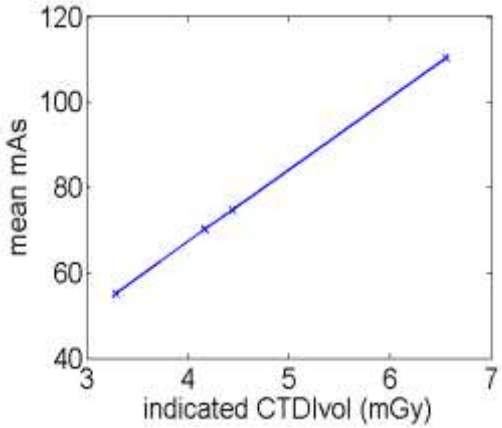


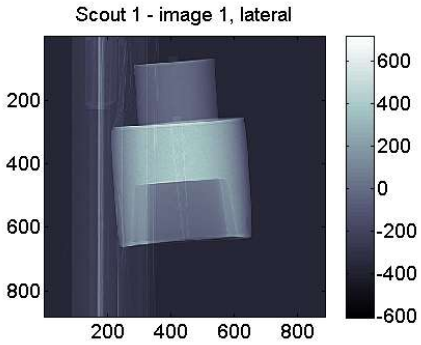
Helical scans: GE Discovery 750 (NI=10)

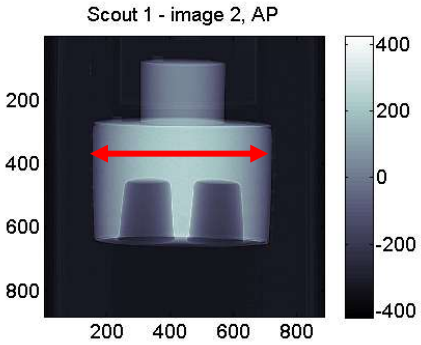




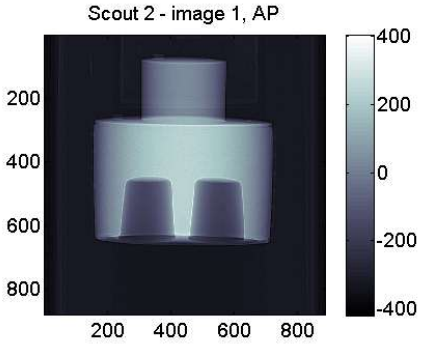
- mAs varies as function of table height
- much less variation is seen through the lung region than the abdomen and head regions
- mean mAs is linear with indicated CTDIvol on scanner

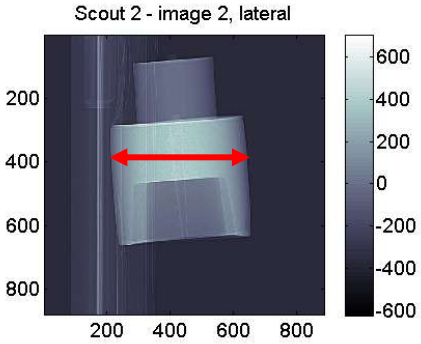


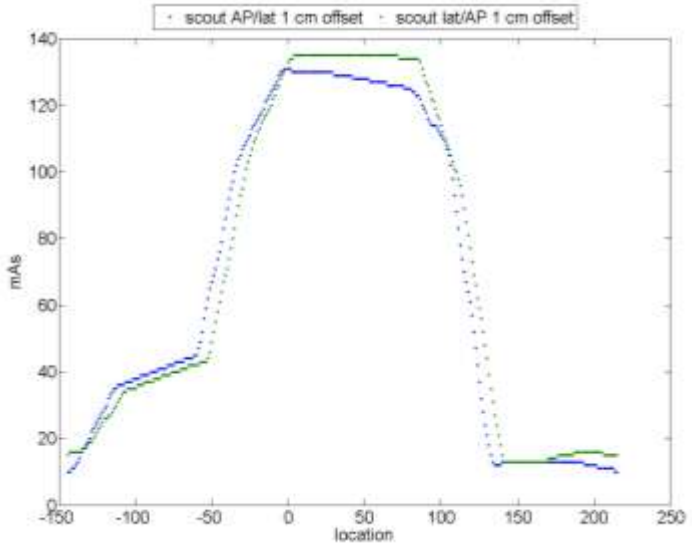




GE scanners use **last** scout image to determine patient size (oval ratio).

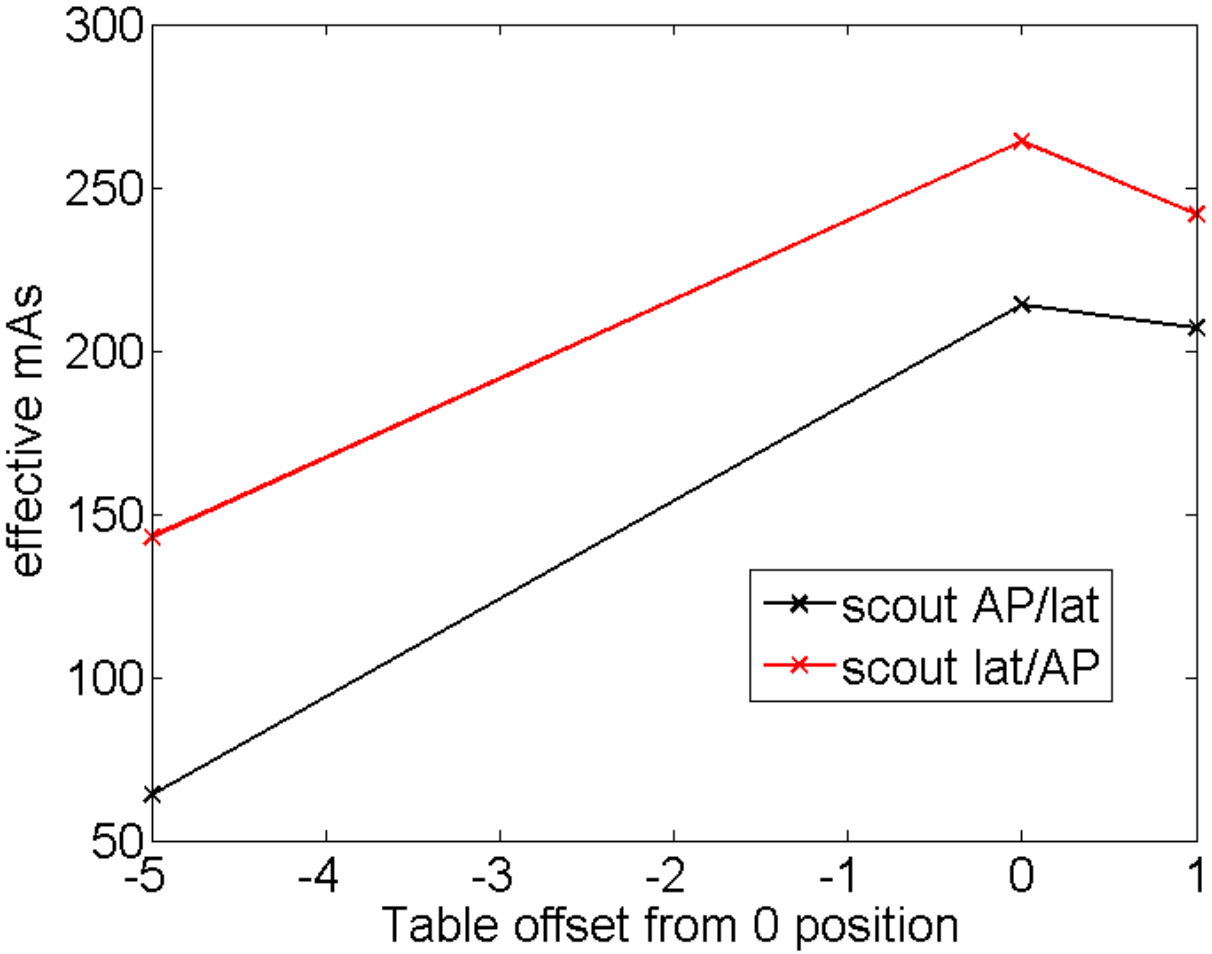






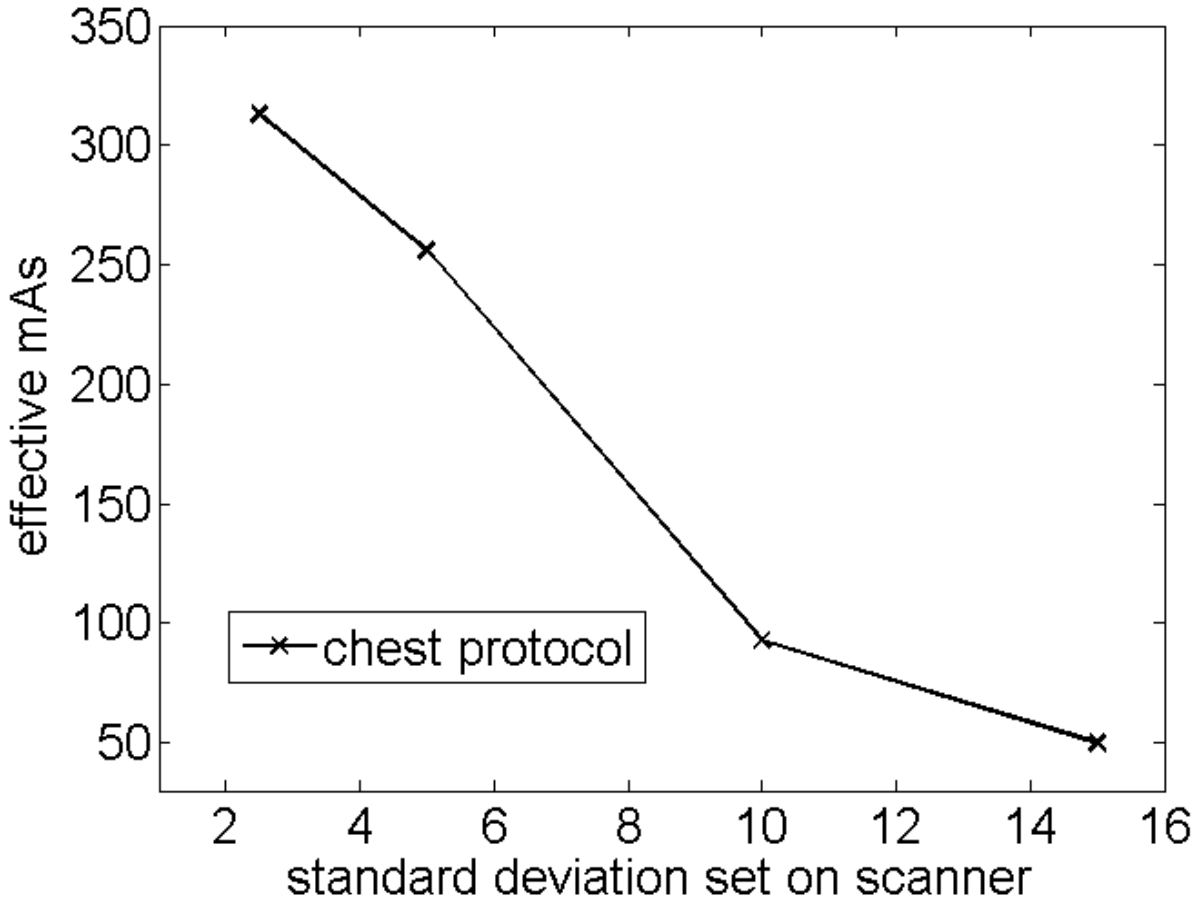
Order in which scouts are performed combined with small offset does affect AEC

Same effect observed on Toshiba Aquillion scanner:



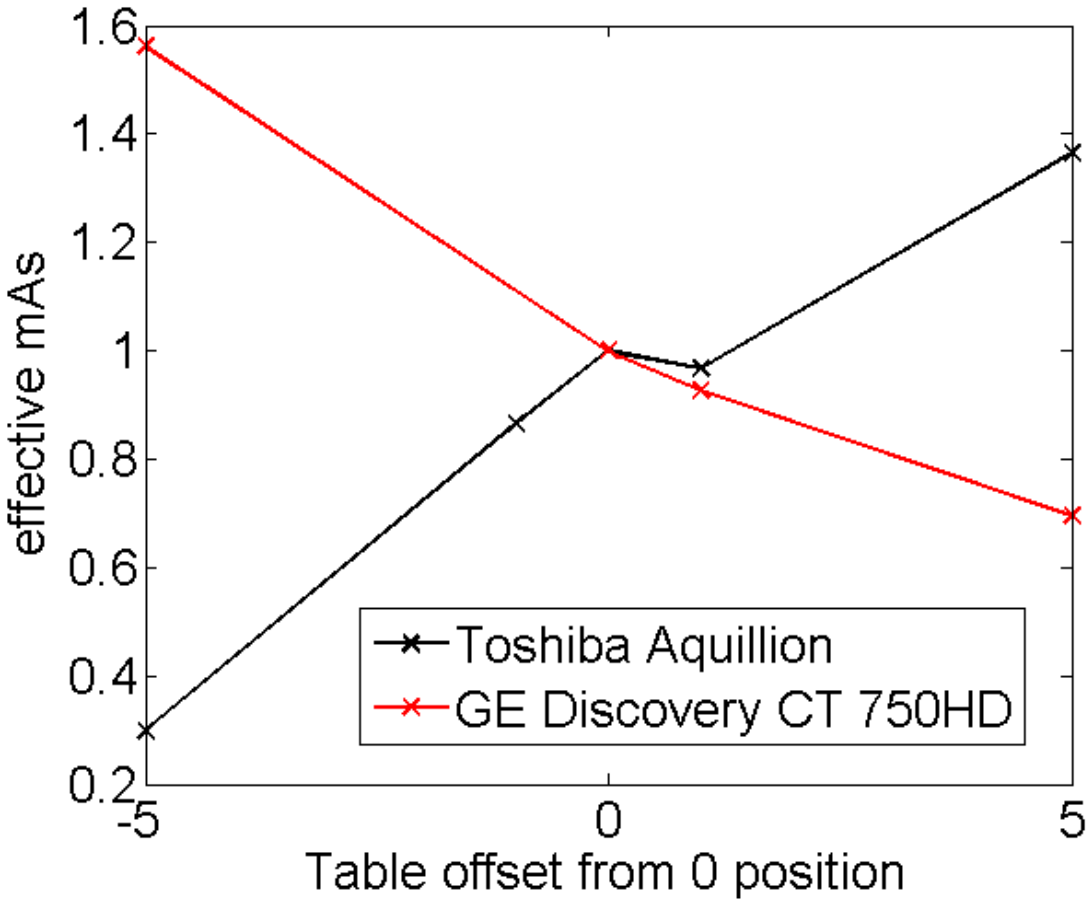
- For this phantom, using AP increases the mAs

Variation in effective mAs with set noise standard deviation (equivalent to GE Noise Index)



- Similar to NI, noise doubles if mAs divided by four

Comparison Toshiba/GE mAs variation



Toshiba: AP scout set at 0° orientation
Standard dev.=10

GE: AP scout set at 180° orientation
NI=10

Conclusions

- The design of Bertie allows us to estimate current modulation using AEC and perform noise analysis.
- Variations in positioning combined with order in which scouts are performed can lead to up to 50% variations in delivered mAs and dose.
- See a corresponding effect on image quality and uniformity.
- Image quality (as measured using noise) is not consistent across scans performed at different heights.

Further work

- Investigate further effect of scouts: Test AP in different positions (0 and 180°) as well as order lateral/AP, and effect of only using one scout.

- Variations in scout mA (10/20 mA on GE compared to 50/100 mA on Toshiba) were observed. The effect of scout mA and kV on the AEC should be examined.

- Look at other CT scanners: Philips, Siemens…

Thanks for your attention!

Many thanks to the Radiotherapy workshop for building Bertie, the CT staff at Warwick Hospital and UHCW and Andrew Bridges for coming to work on Saturdays.

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