

# CT tube current modulation

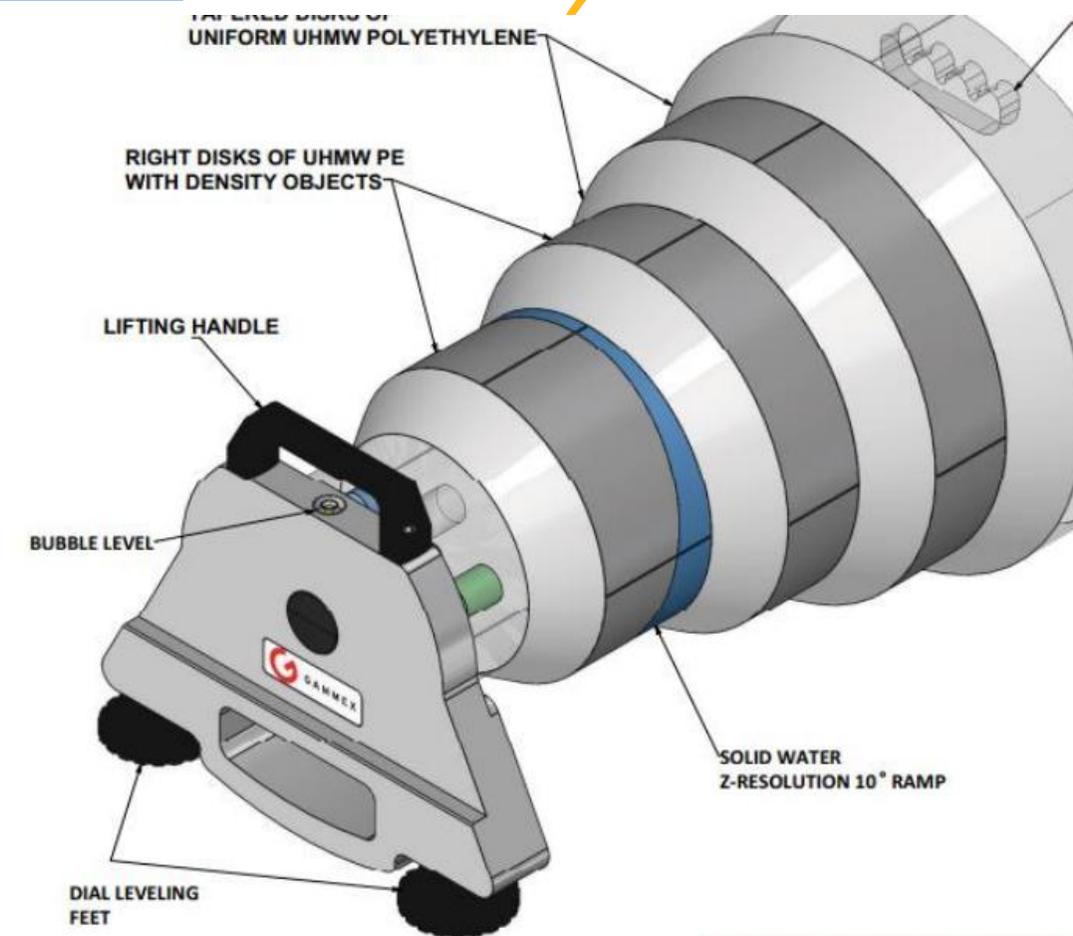
Addendum to October 2024  
presentation

Laurence King

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# Previous talk: 2024 CTUG meeting, Exeter

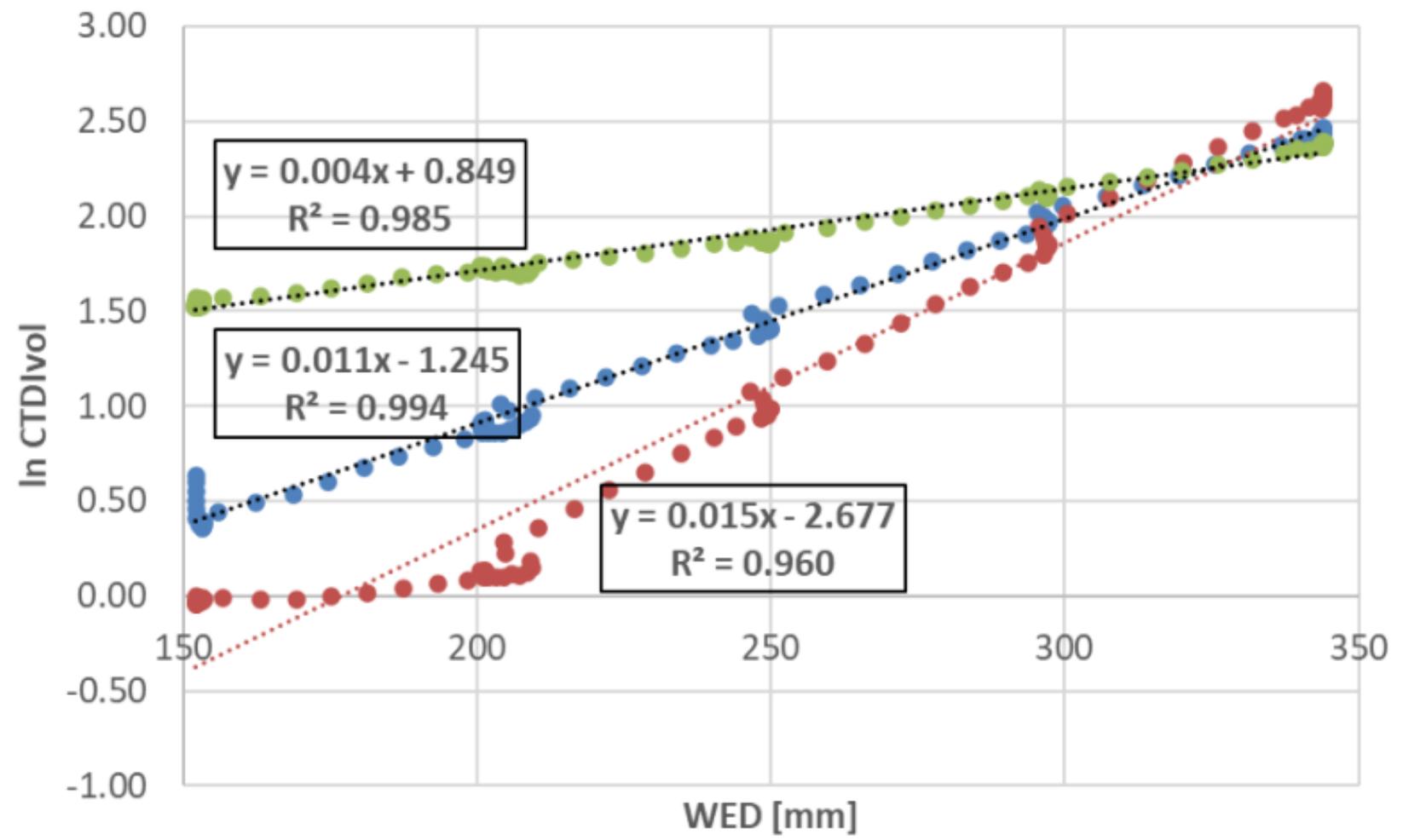
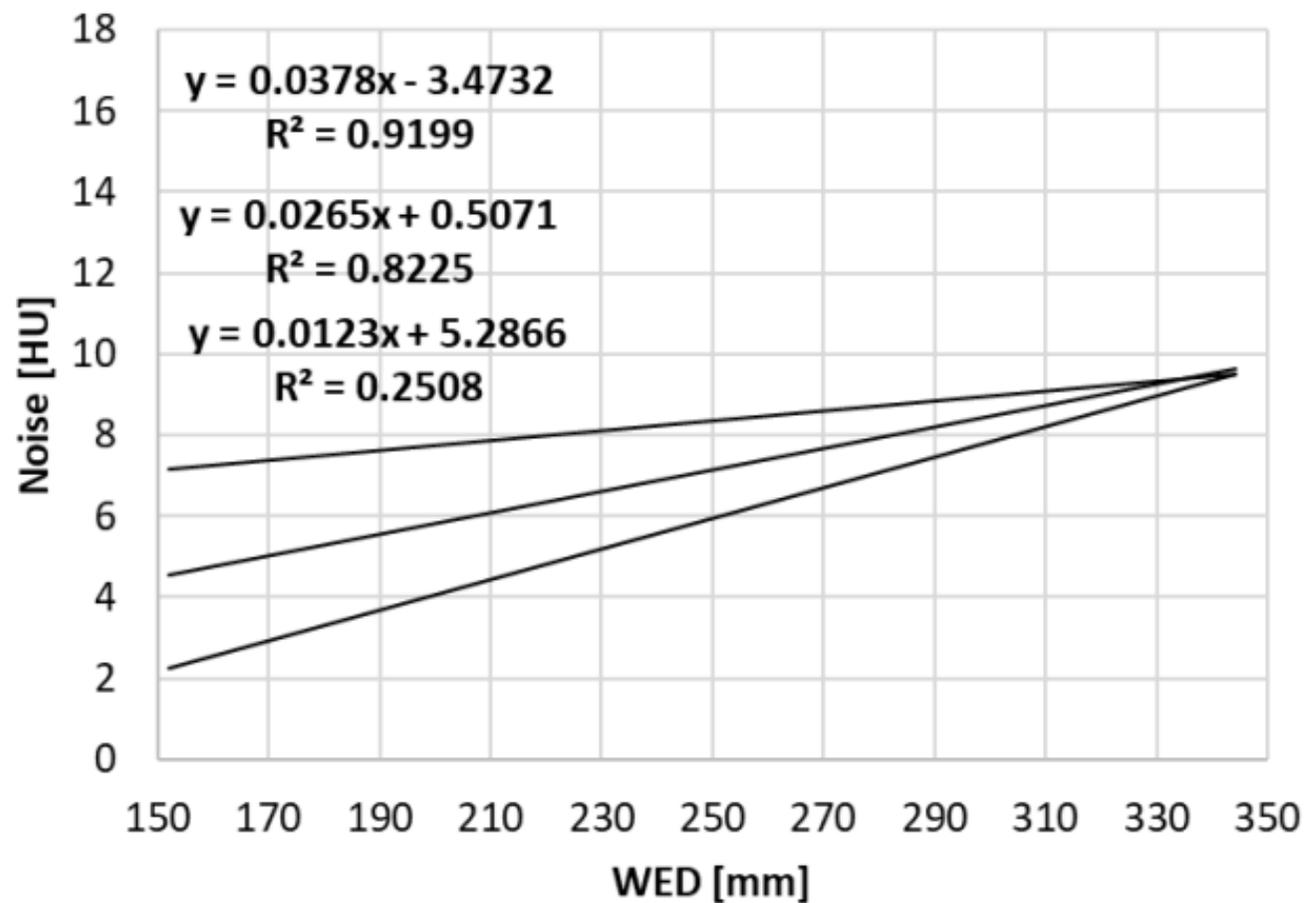
- [26th CT users group meeting](#): talk title [Experiences of CT tube current modulation testing](#)
- Experience of using the AAPM task group 233 report-recommended analysis of tube current modulation scans of a phantom
- Mercury phantom scanned with tube current modulation, using default clinical protocols (thorax and abdomen)
- Noise and natural log of tube current (or CTDIvol) plotted against water equivalent diameter of phantom for each slice.



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# Previous talk: results for different tube current modulation strengths (Siemens scanners)

noise vs WED - abdomen region - lines of best fit

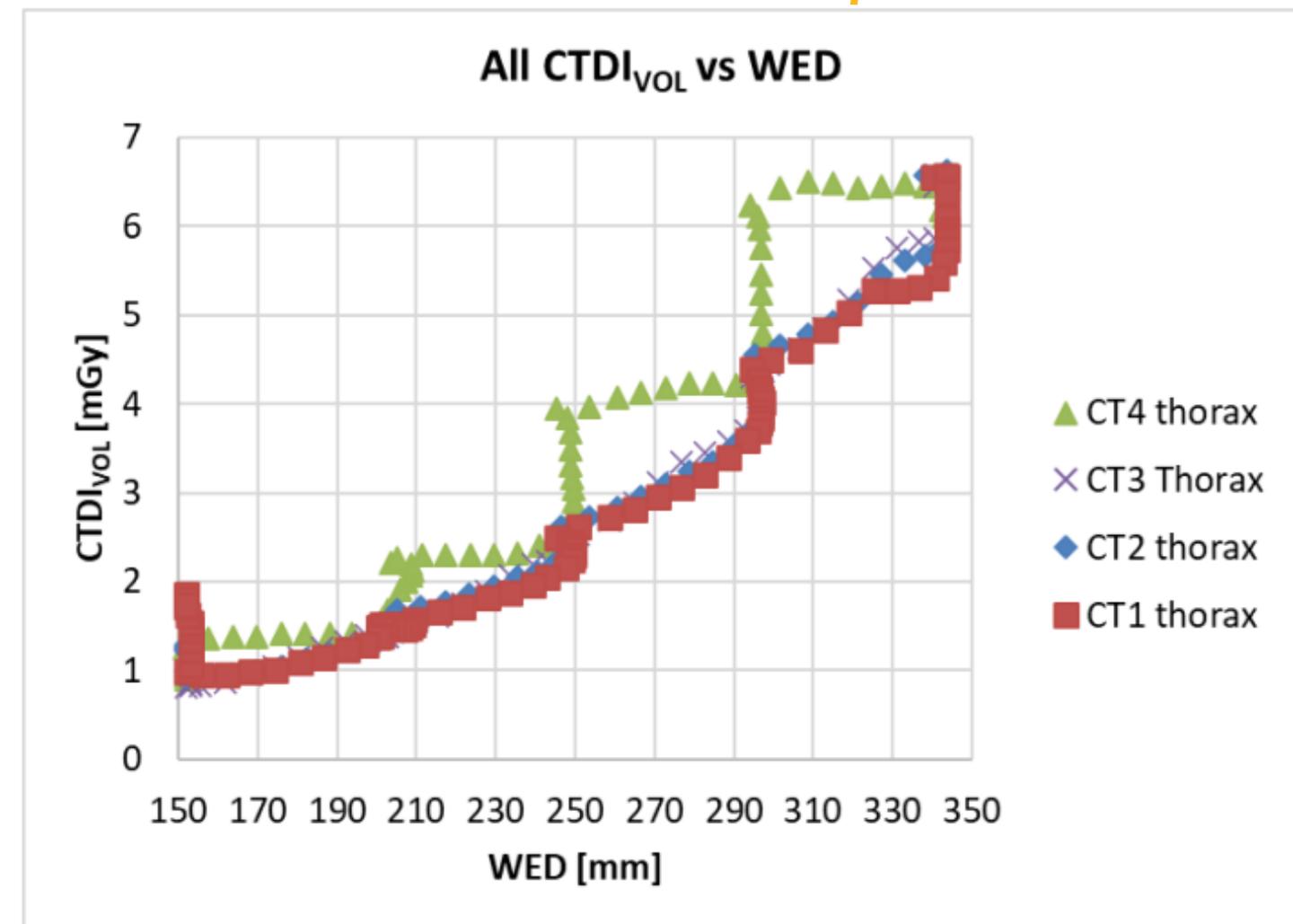


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# Previous talk:

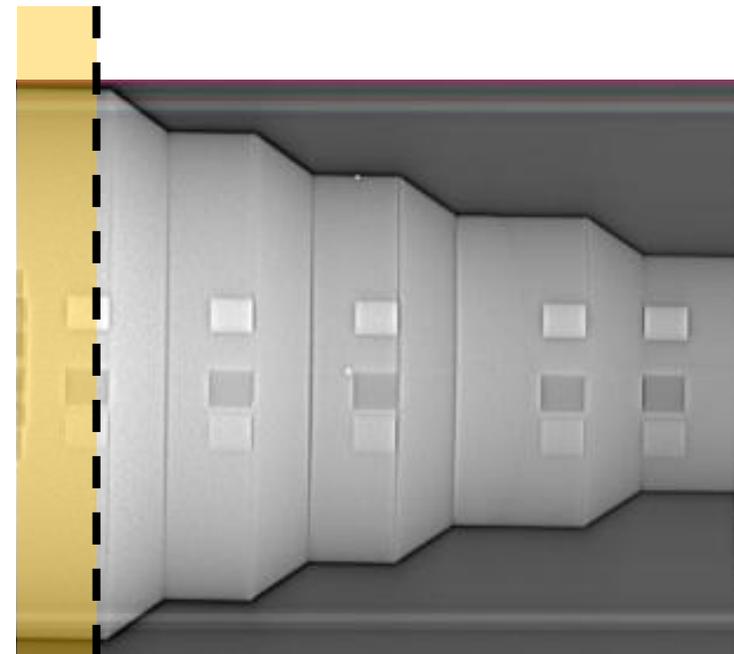
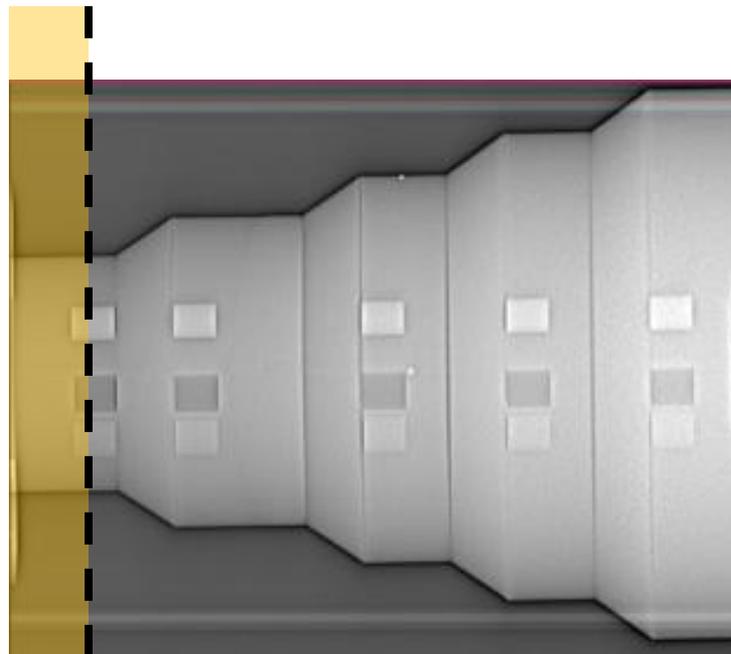
- The change in gradient of linear fits to these plots was a more sensitive metric than the percent change in overall scan CTDI<sub>vol</sub> or DLP.
- However: one result stood out as strange
- Scanner 'CT4' CTDI<sub>vol</sub> response to water-equivalent diameter did not match the other scanners.
- All Siemens Edge or Drive scanners, same software versions, 38.4 mm detector widths.
- Phantom had been placed in the opposite orientation on CT4 compared to the other scanners.

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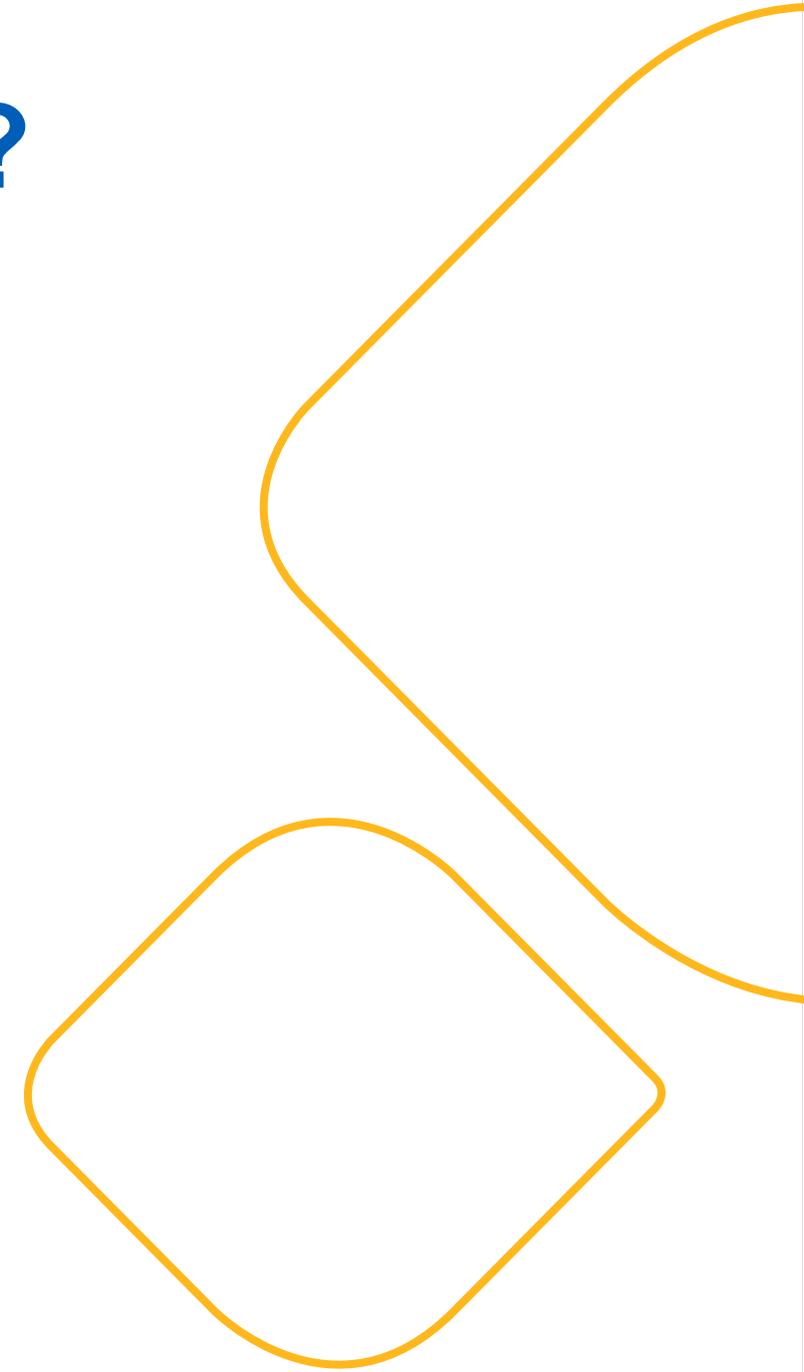


# Why does phantom orientation matter?

- I theorised that by scanning in the opposite direction, using approx. 40 mm collimation, there was a different relationship in detected Water Equivalent Diameter compared to WED at central detector row position – resulting in different mA response with WED
- Probably because real-time transmission is measured by a reference detector element or row at one end of the detector array.

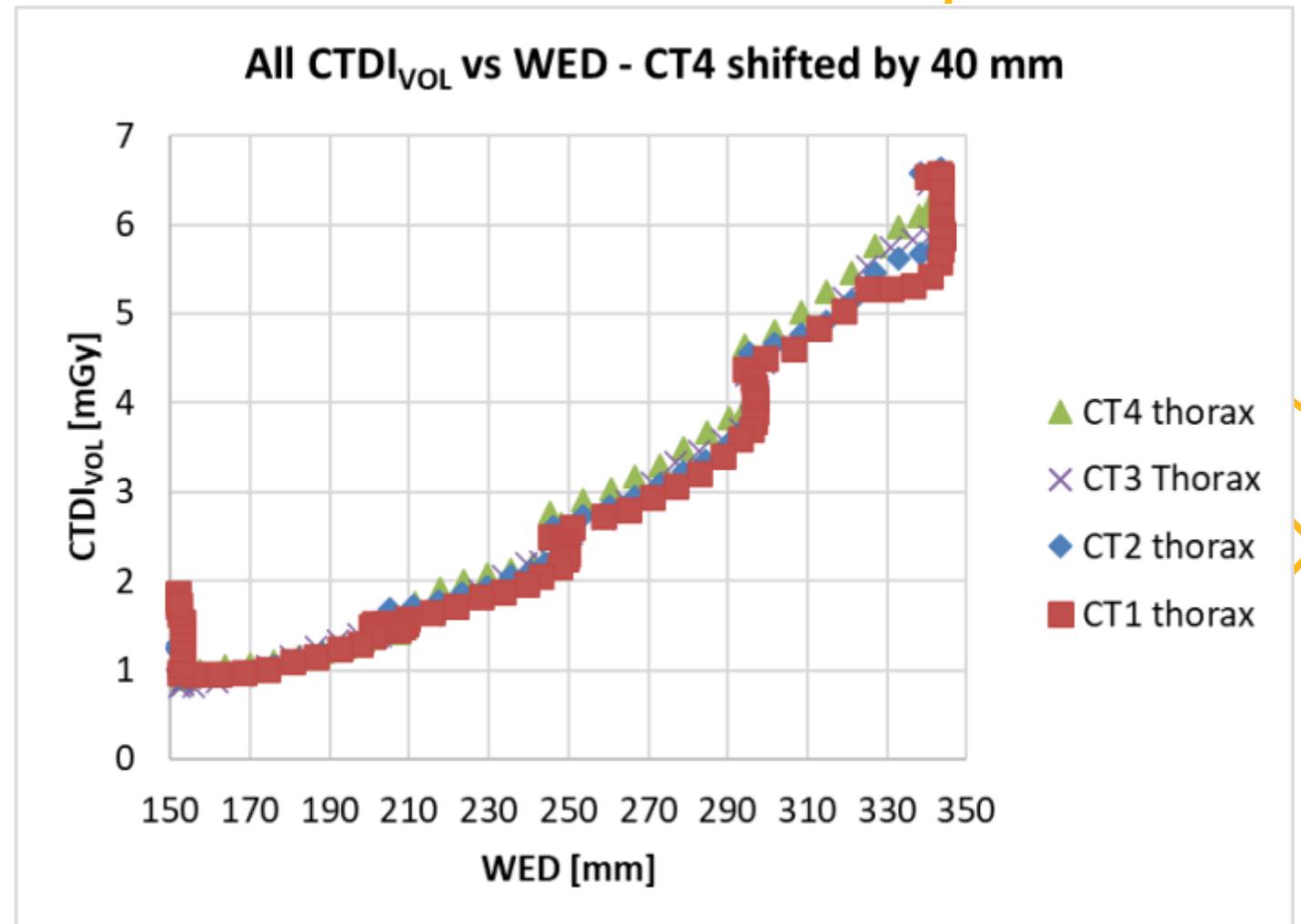
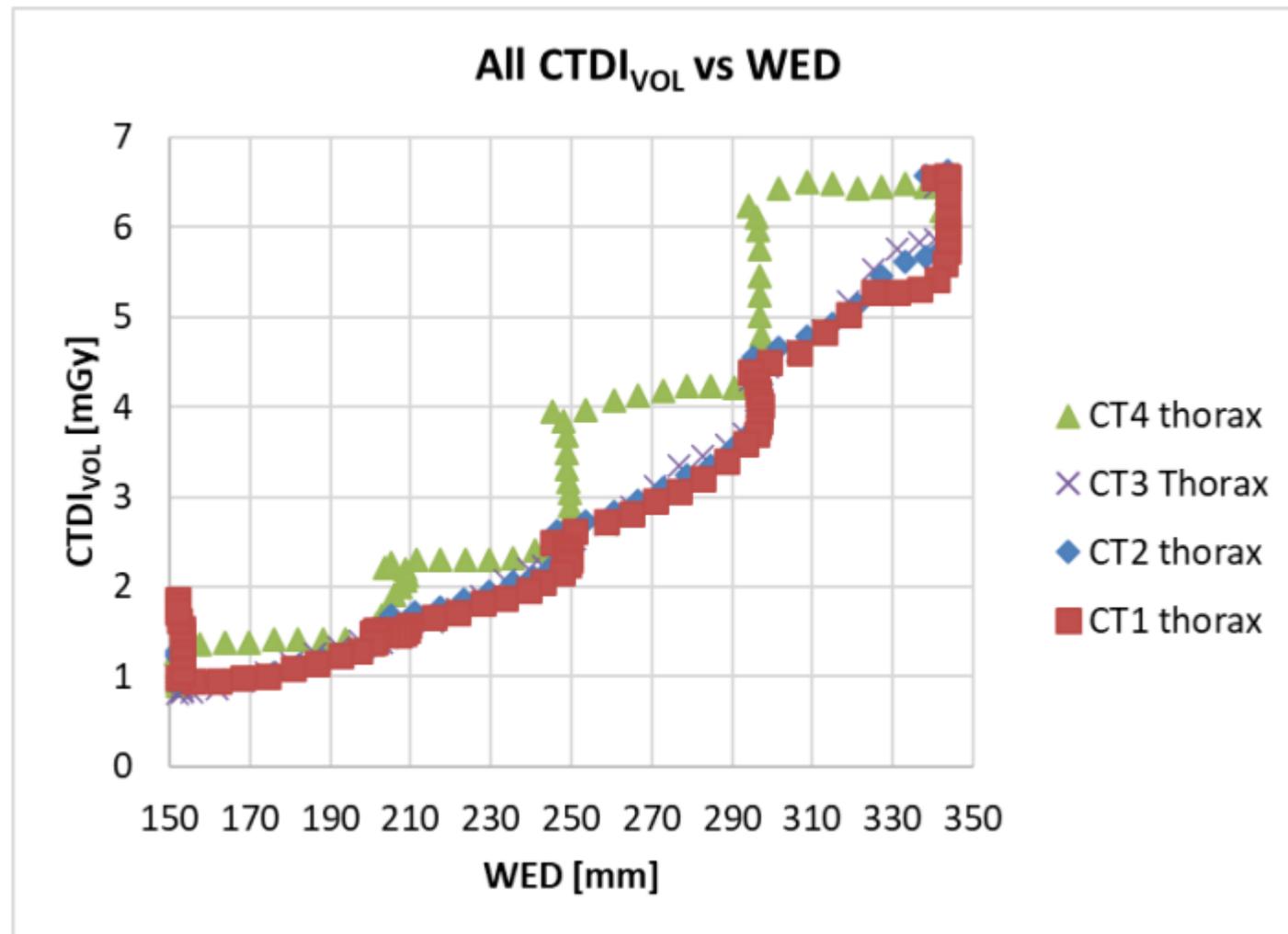


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# What went wrong?

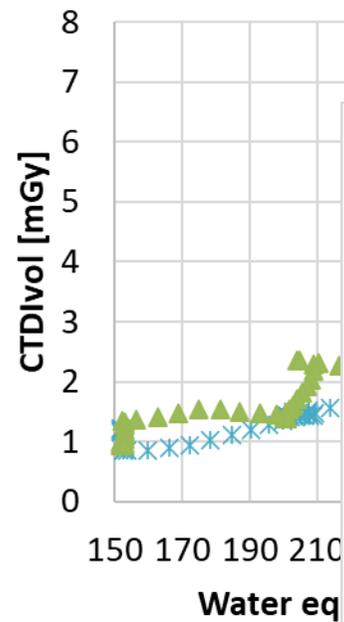
- By shifting this outlying plot of scan CTDI<sub>vol</sub> versus WED by approximately a whole-detector width: all measured plots now match.



# Repeat measurements

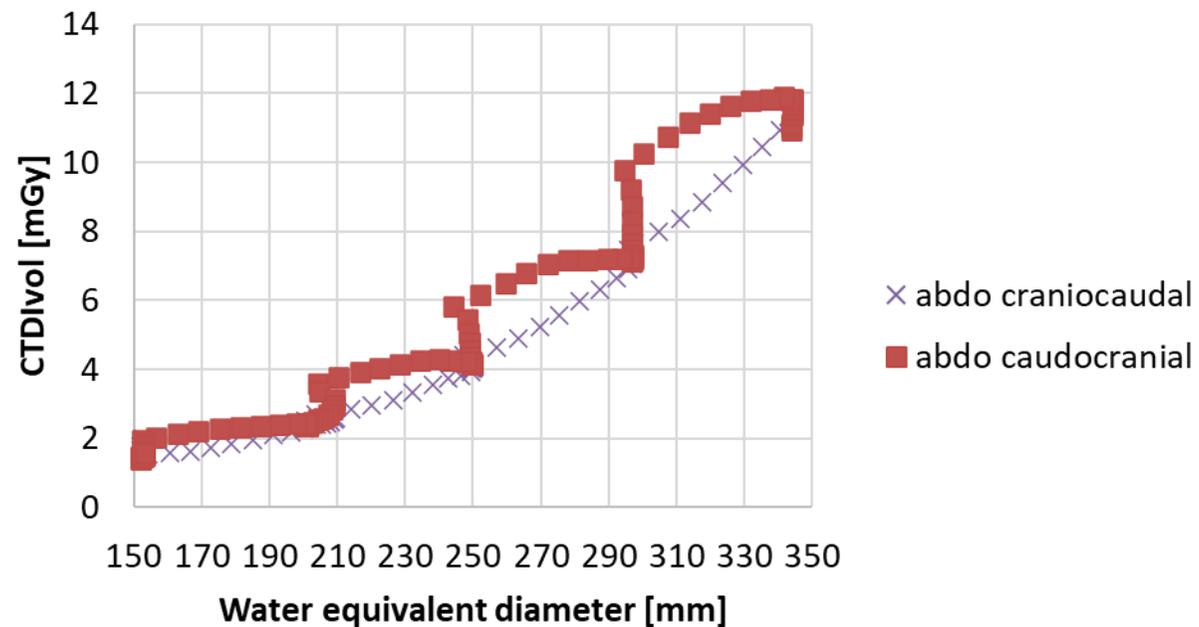
- I returned to the suspect scanner
- Repeated scans of phantom, scanning with phantom in different orientations.
- Measurements were consistent with my suspicions

CTDI<sub>vol</sub> vs WED - thorax protocol

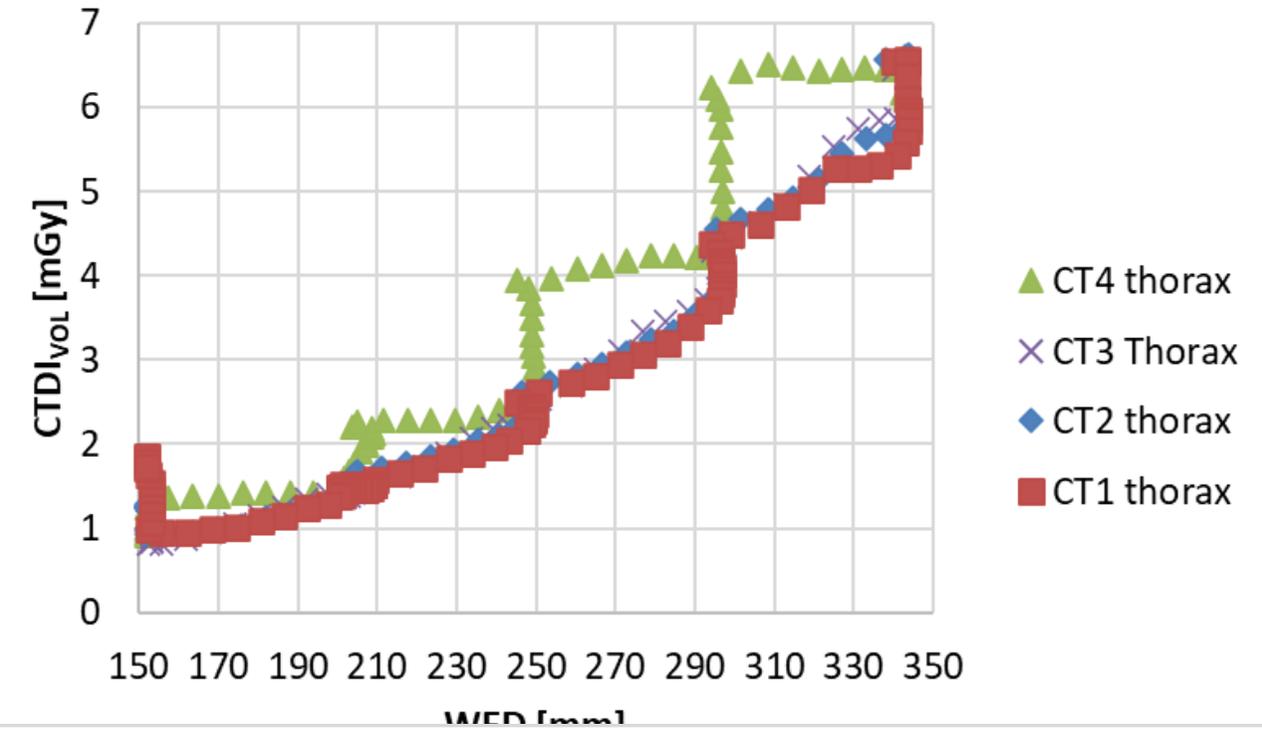


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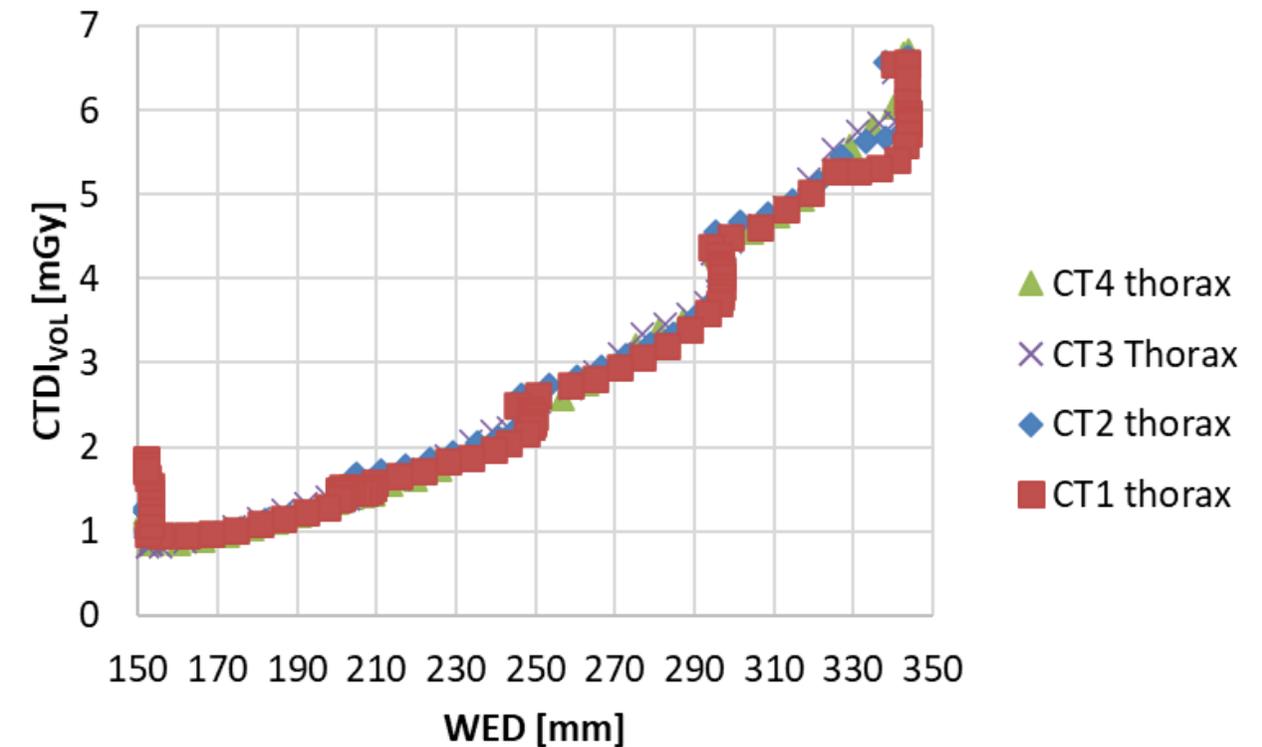
CTDI<sub>vol</sub> vs WED - abdomen protocol



All CTDI<sub>vol</sub> vs WED

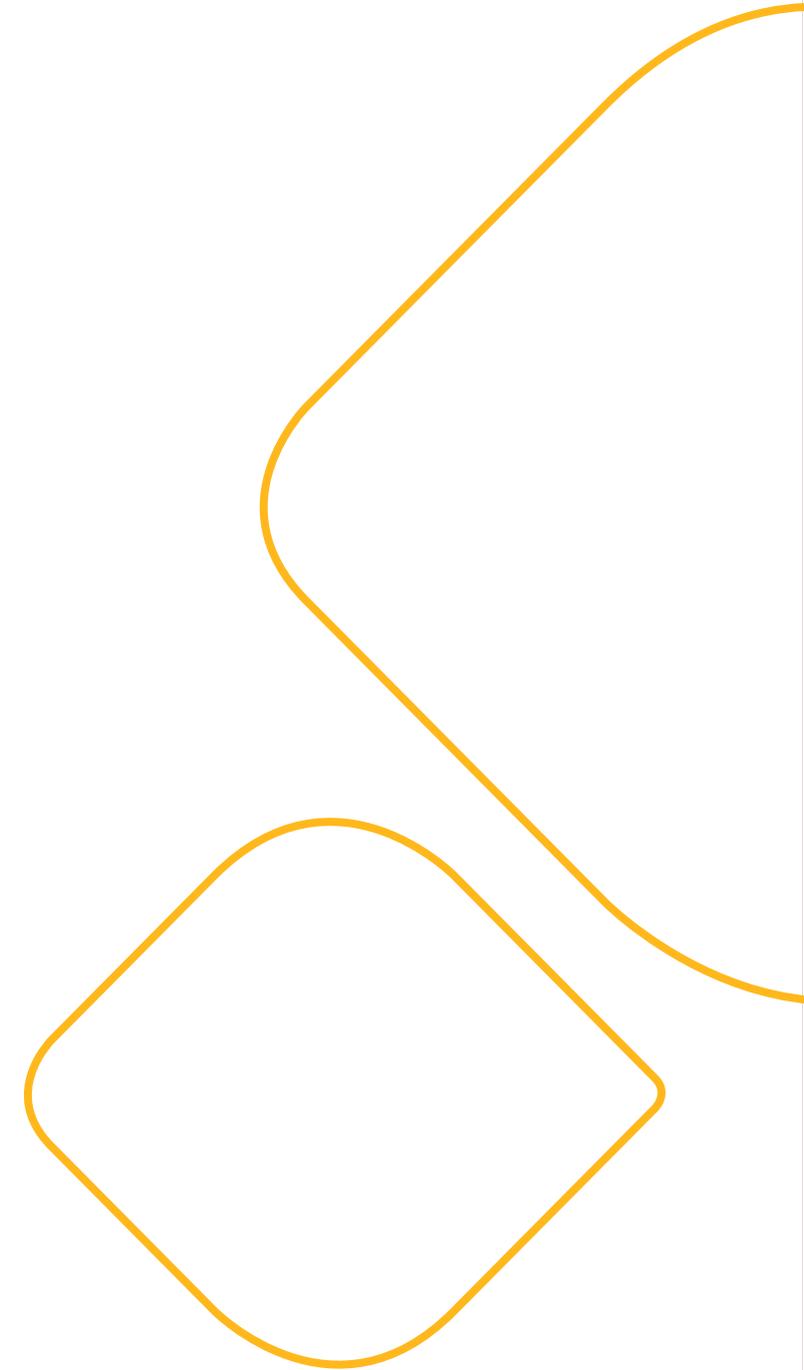


All CTDI<sub>vol</sub> vs WED



# Lessons learnt

- QC measurements must be reproducible!
- Departmental CT QC Work instructions now updated with more specific instructions on phantom orientation and scan direction.
- **Phantom positioning** and **scan direction** have an effect on reproducibility of tube current modulation testing, as well as protocol kV, pitch, effective mAs, collimation settings, etc.



# More reproducible tube current modulation

- See the recent IAEA videos on CT scanner quality control (published July 2025):

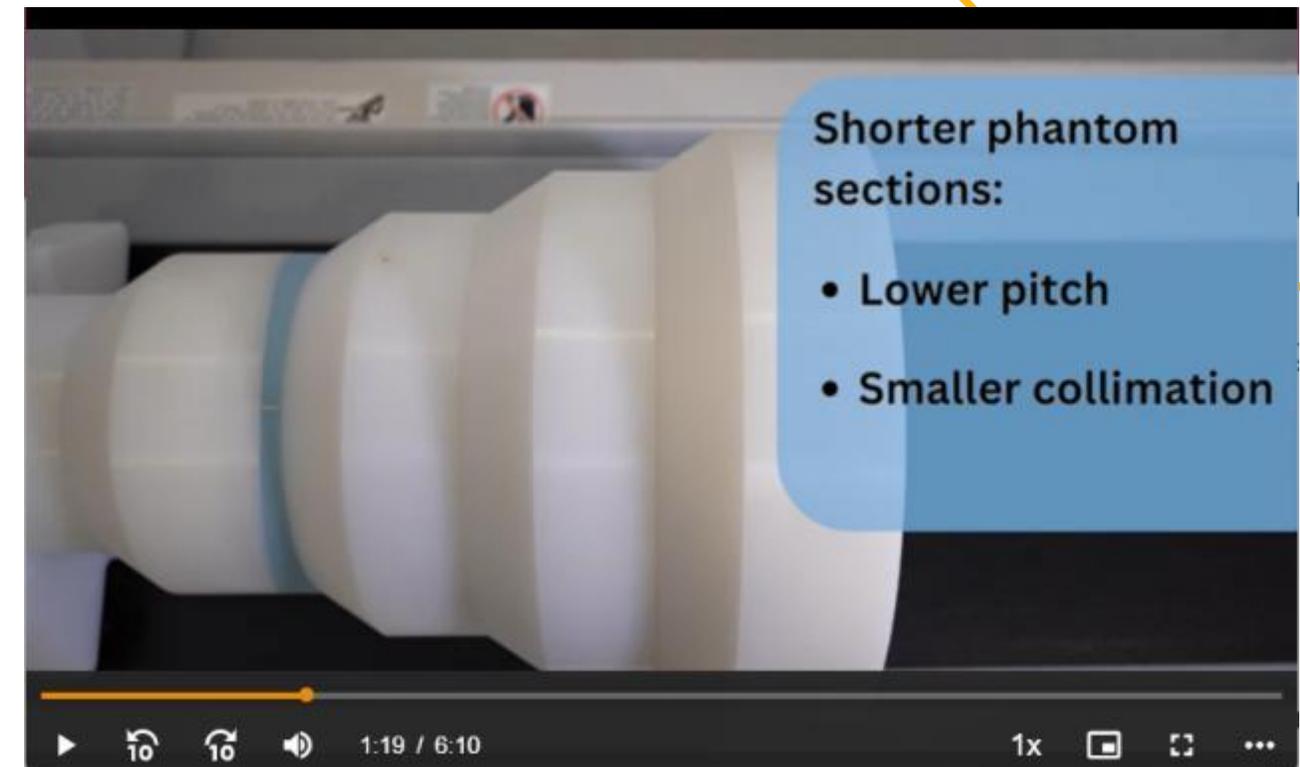
<https://www.iaea.org/resources/video/ct-optimization-series-for-medical-physicists>

(David Platten, Emily Smith and others)

Video 3 – Quality assurance of the Automatic Exposure Control

- This tutorial recommends a low helical pitch, and narrow collimation for routine QC.
- This means the scanner can more accurately adapt to changes in phantom diameter – and would have avoided the issues I encountered!
- Less clinical perhaps – but more reproducible and importantly still testing the underlying functionality of the tube modulation system.

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# Question for the audience

- I've only spotted the effect of scan direction on this phantom by chance on our Siemens scanners –
- Does scan direction affect tube current modulation in a similar way for other manufacturers?

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**Thank you**

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