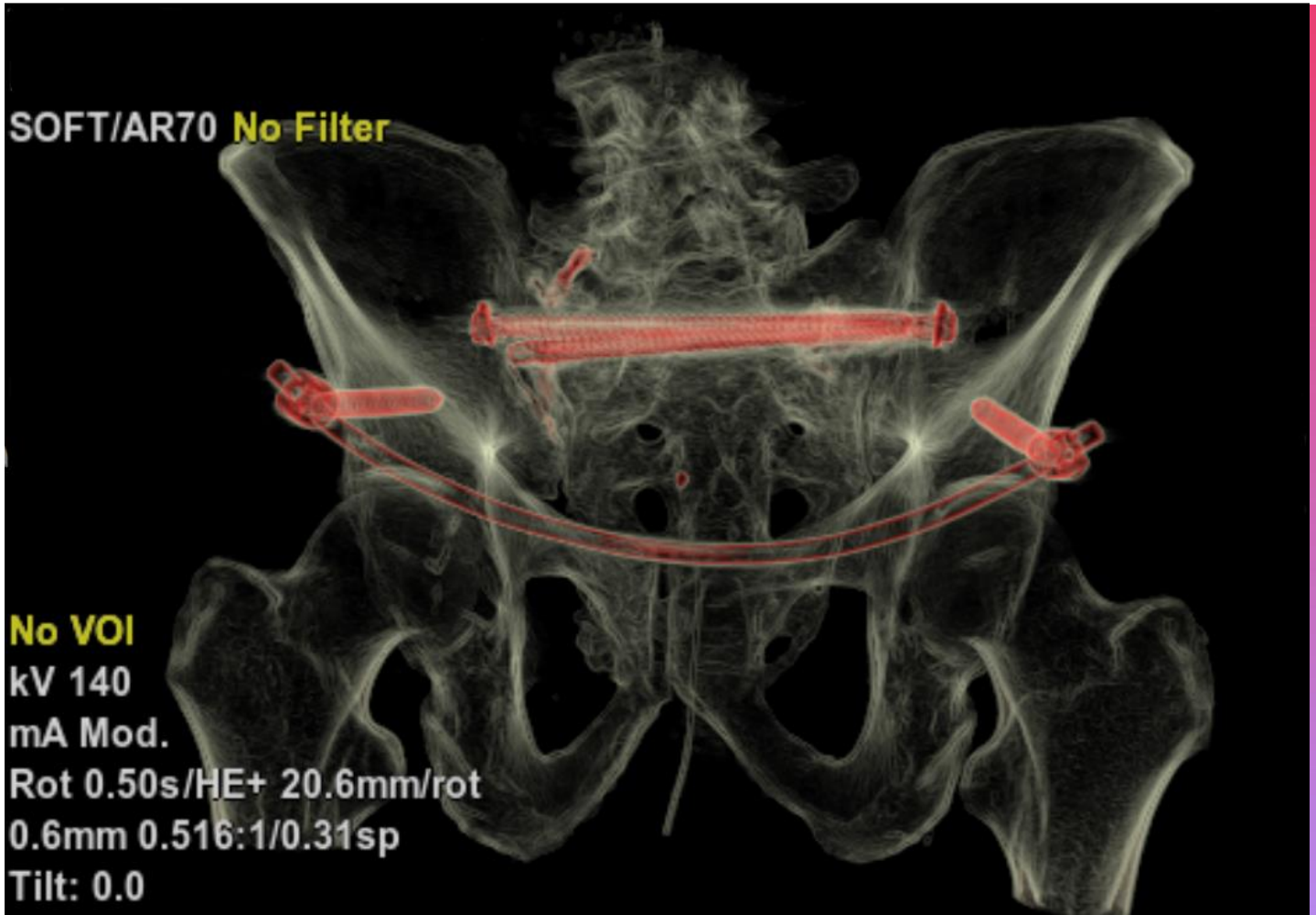
Outstanding care every time

St George's University Hospitals NHS Foundation Trust

Development of an optimal protocol for low dose CT imaging of metallic pelvic fixation devices



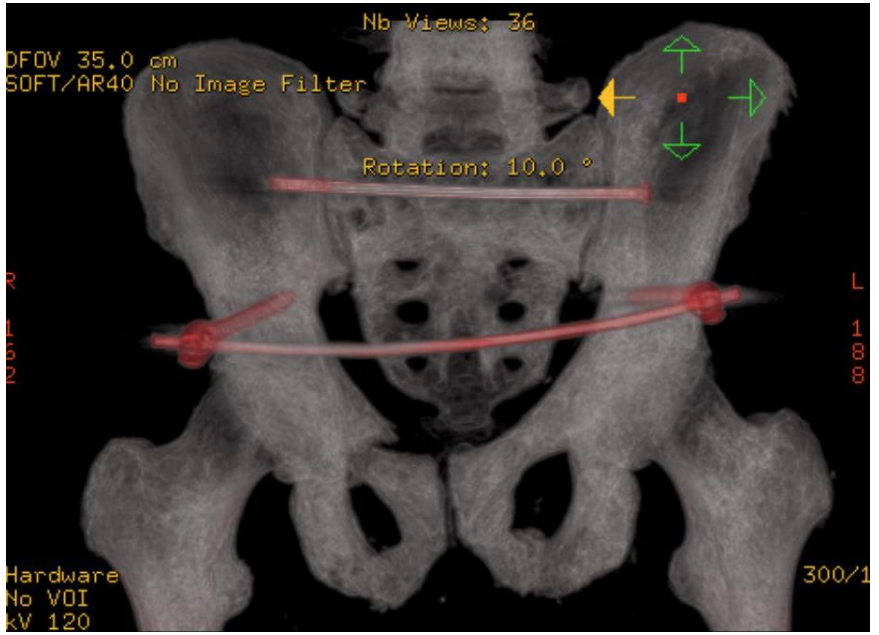
Ruby Callister and Jennifer Robinson
Medical Physics

21st October 2021

Background

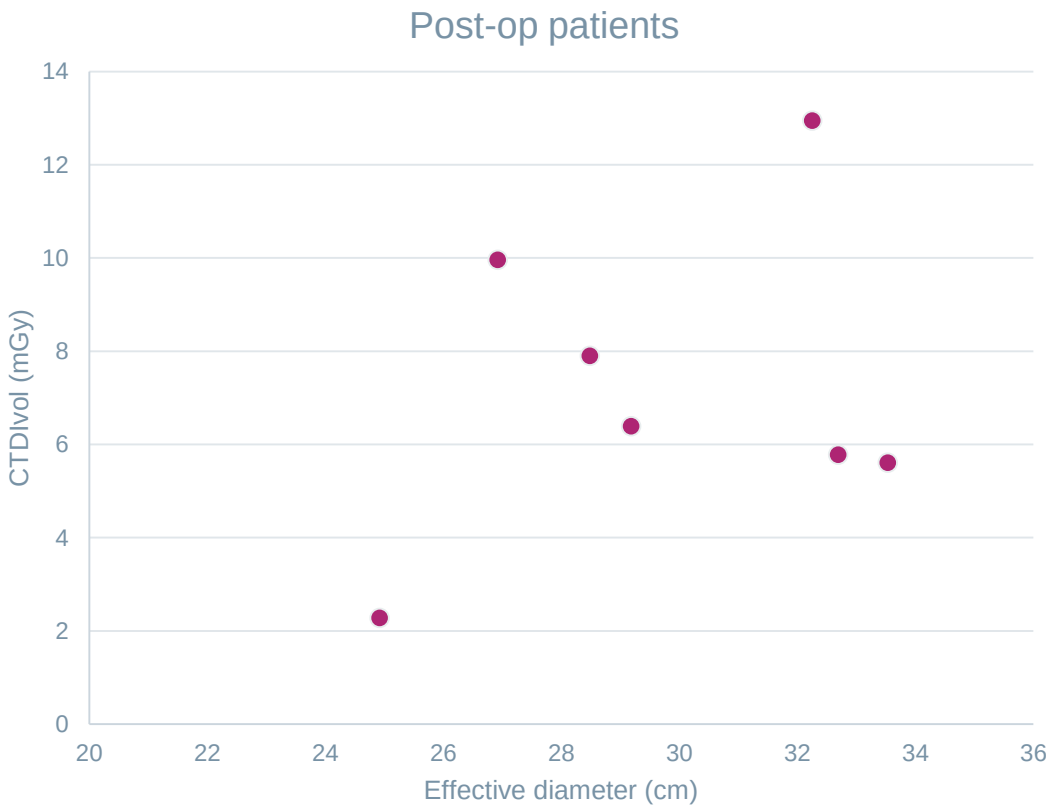
The story…..

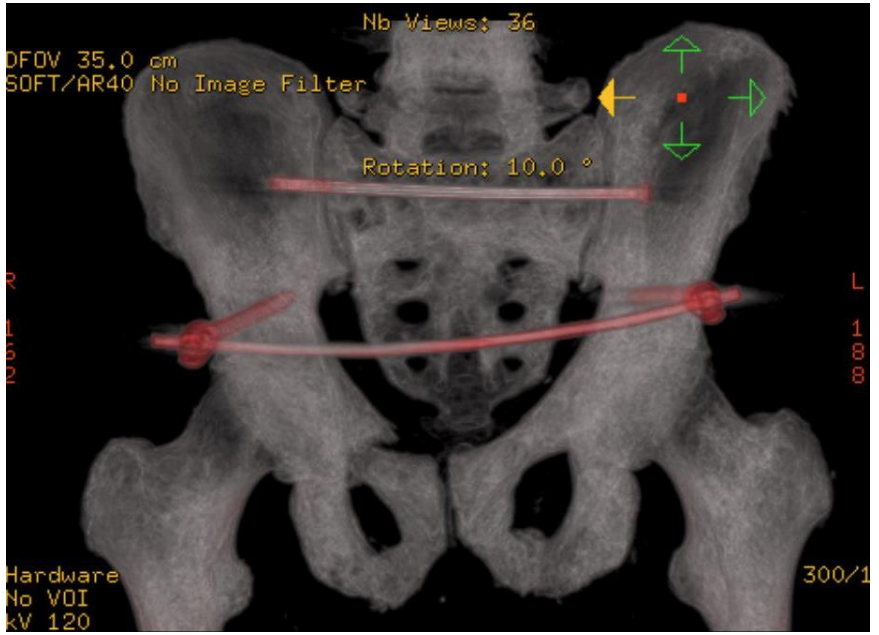
- Patients having surgery for pelvic fractures
- Post-op CT scan to look at location of fixation devices
- Asked to set up a low dose protocol



Background

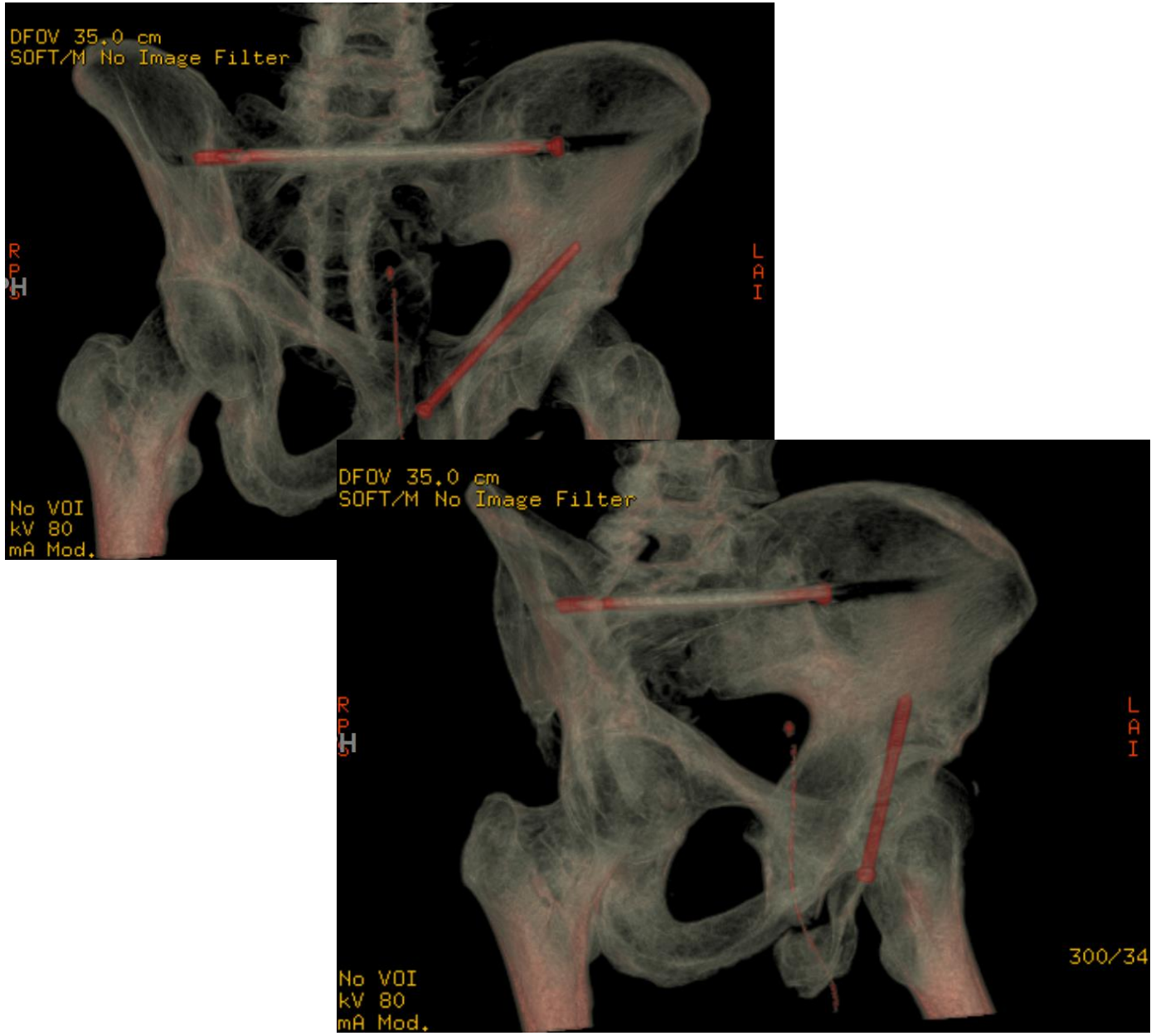
The story…..





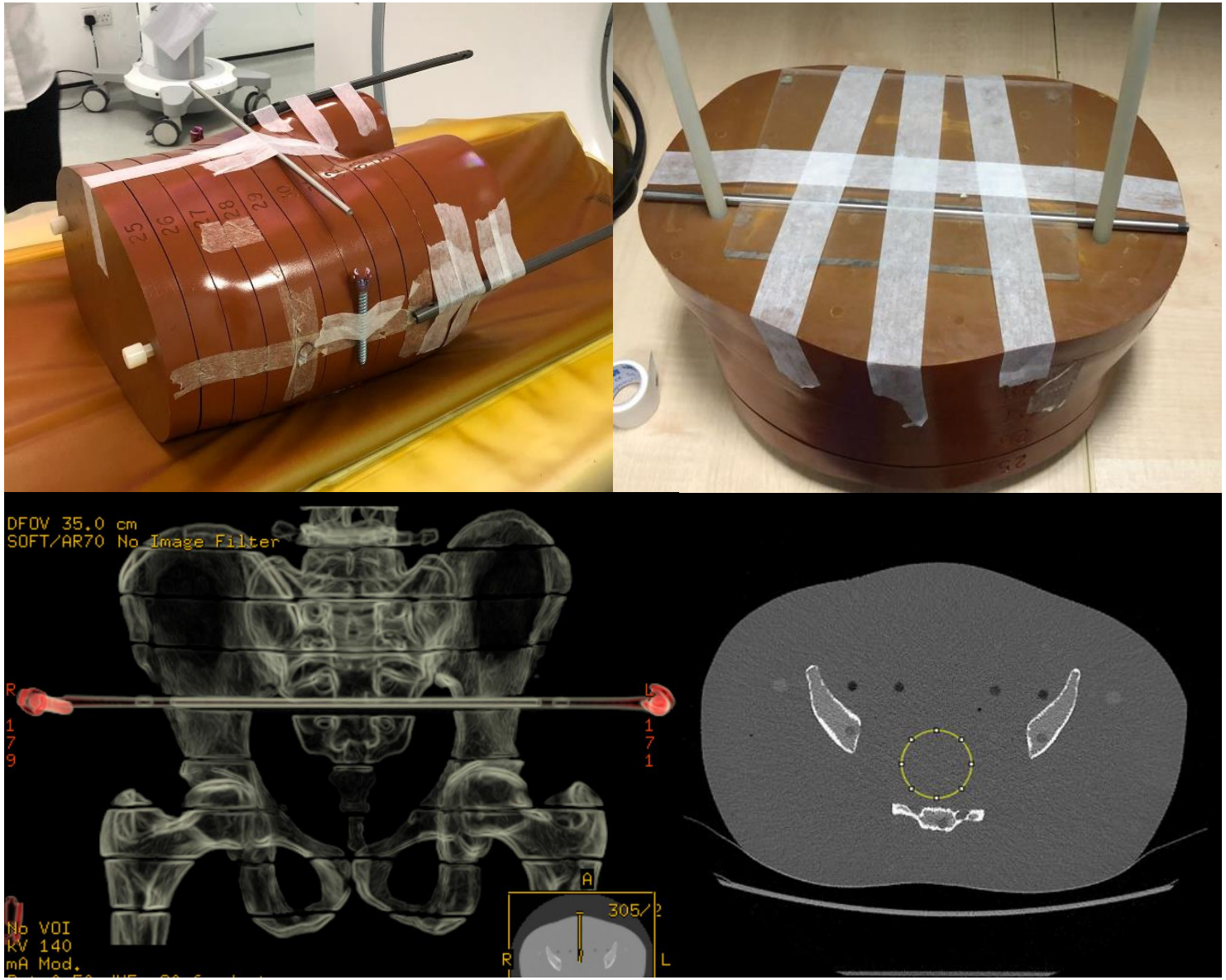
Initial ideas

- High kV
- Tube current modulation
- Smart Metal Artefact Reduction (MAR)
- Low pitch
- Horizontal bar issue
- We needed an appropriate test object...



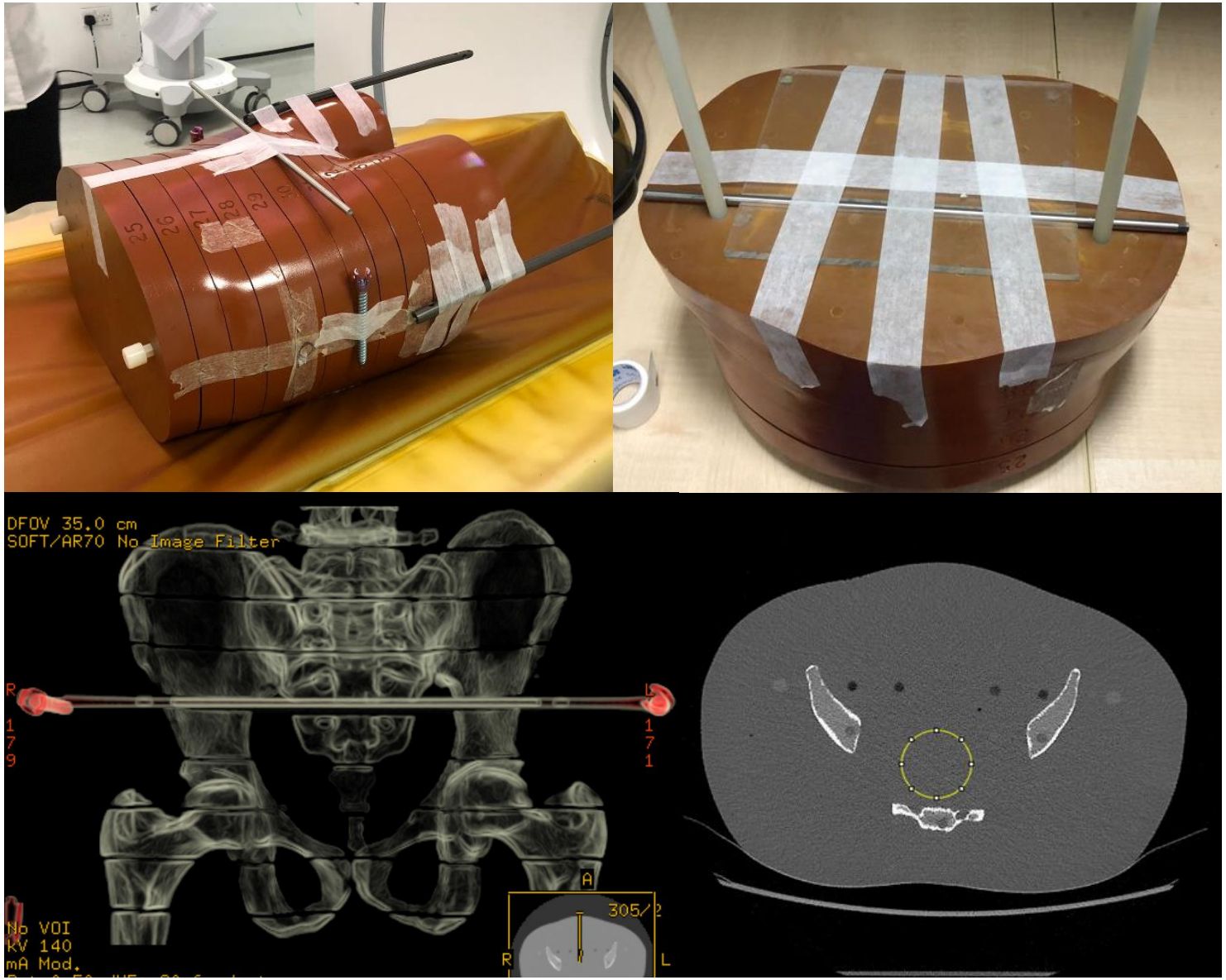
Methods

- RANDO phantom
- Metal on outside and between slices
- 2x GE scanners: Revolution and Revolution GSI
- Scanned lots of times



Methods

- Qualitative analysis of image quality
- Image noise measurements
- Dose comparisons



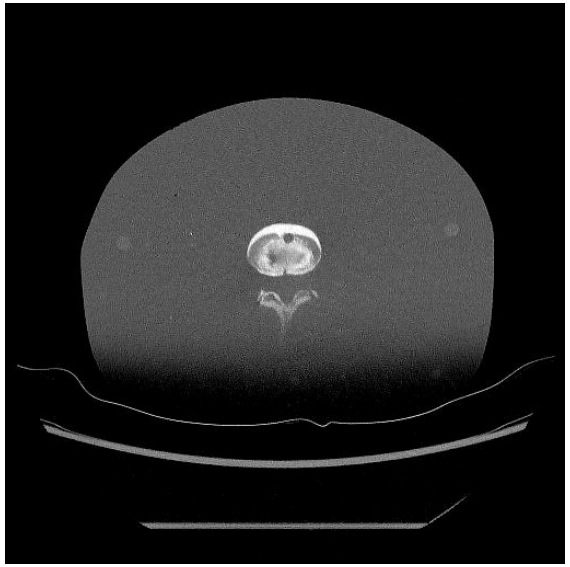
Methods

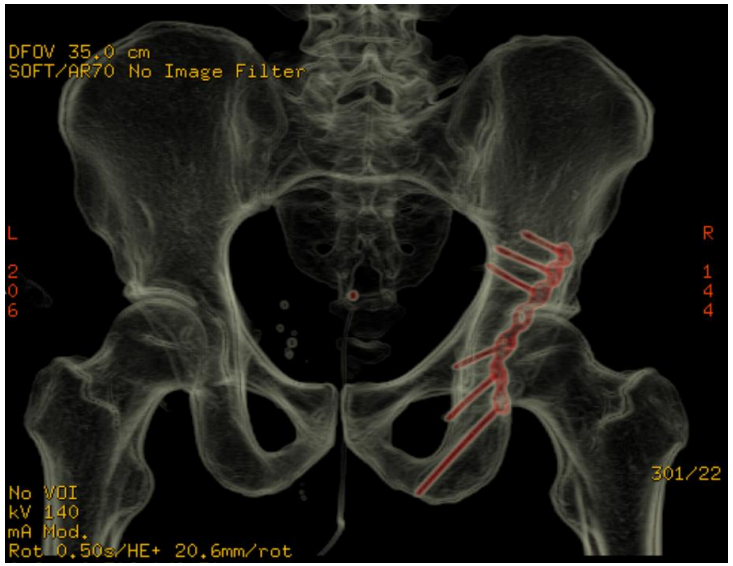
Image sets

- Bone reconstruction
- Soft tissue reconstruction

} With MAR?

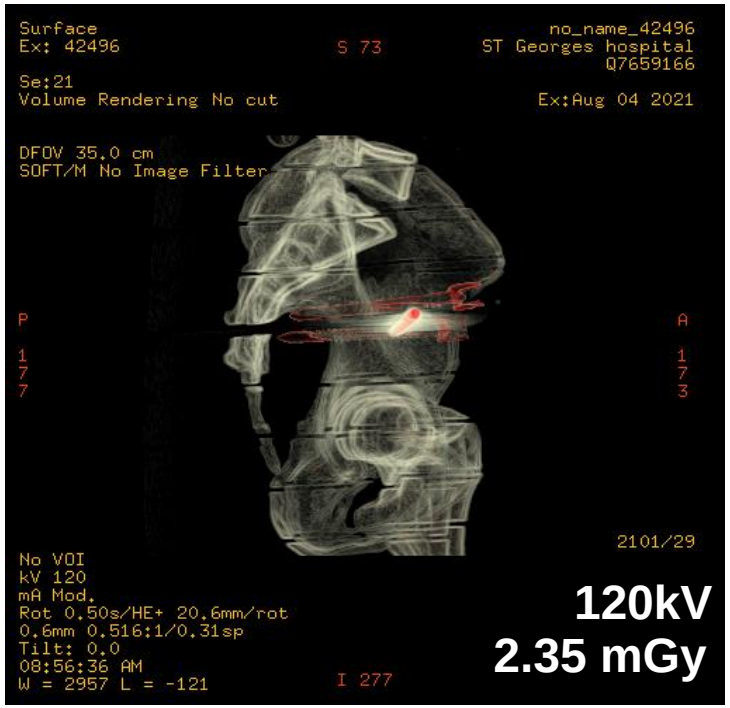
- Volume rendering (from soft tissue recon)

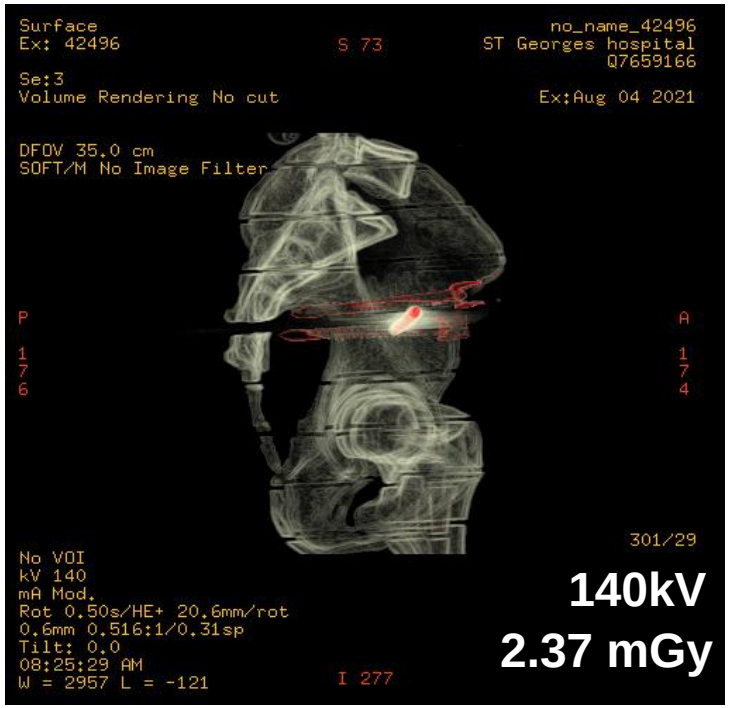




Results: Tube Voltage

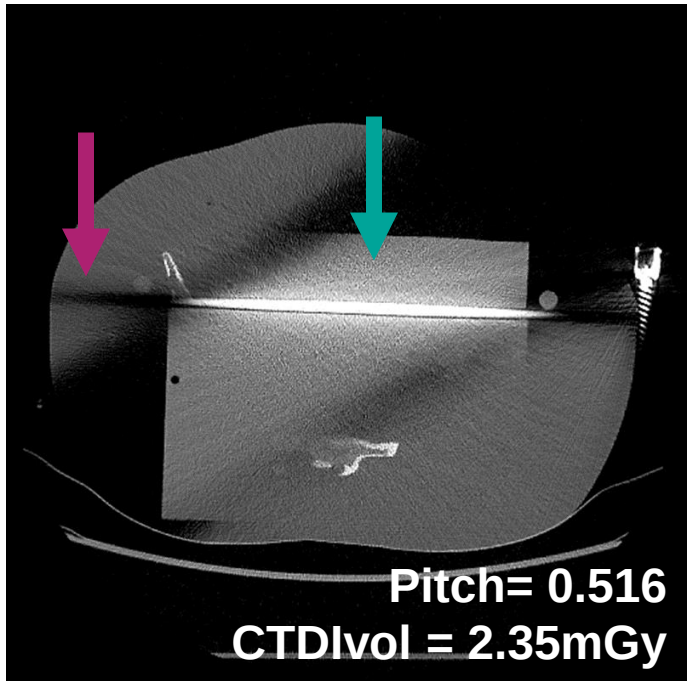
- High tube voltage for visualising metal
- Small difference in CTDIvol
- Reduced beam hardening and photon starvation artefacts

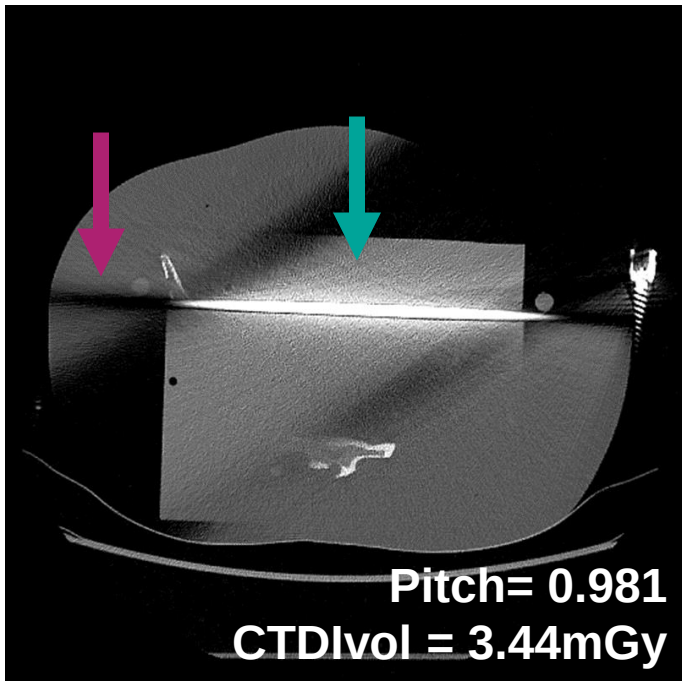


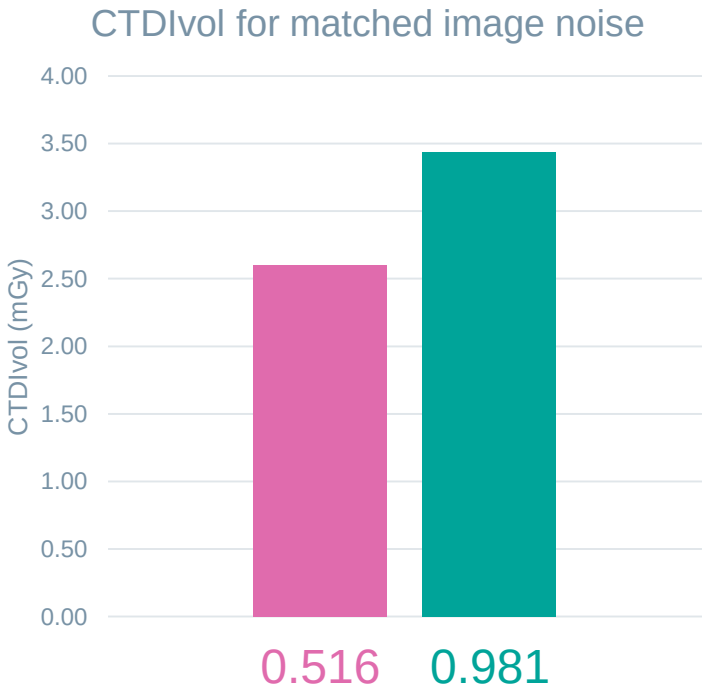


Results: Pitch

- Improved image quality
- Dose efficiency: 20% more dose efficient to use lower pitch
- Longer scan times not an issue

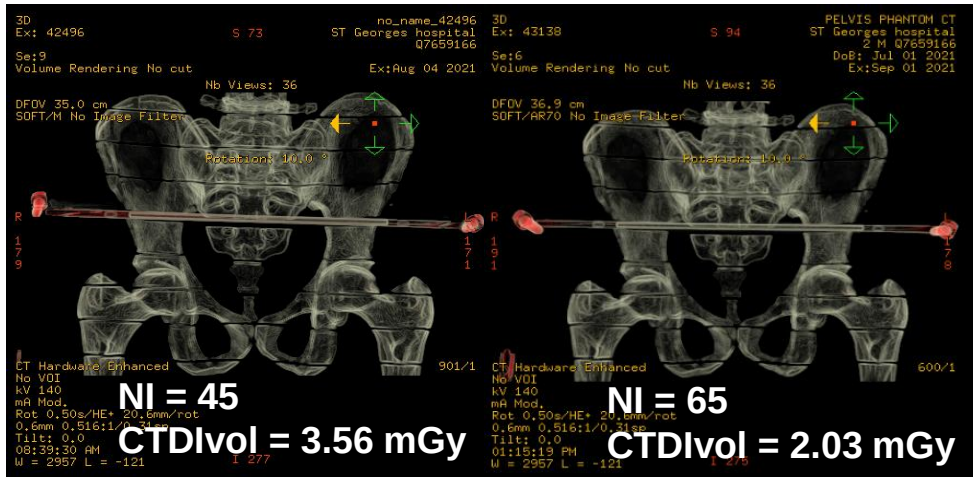


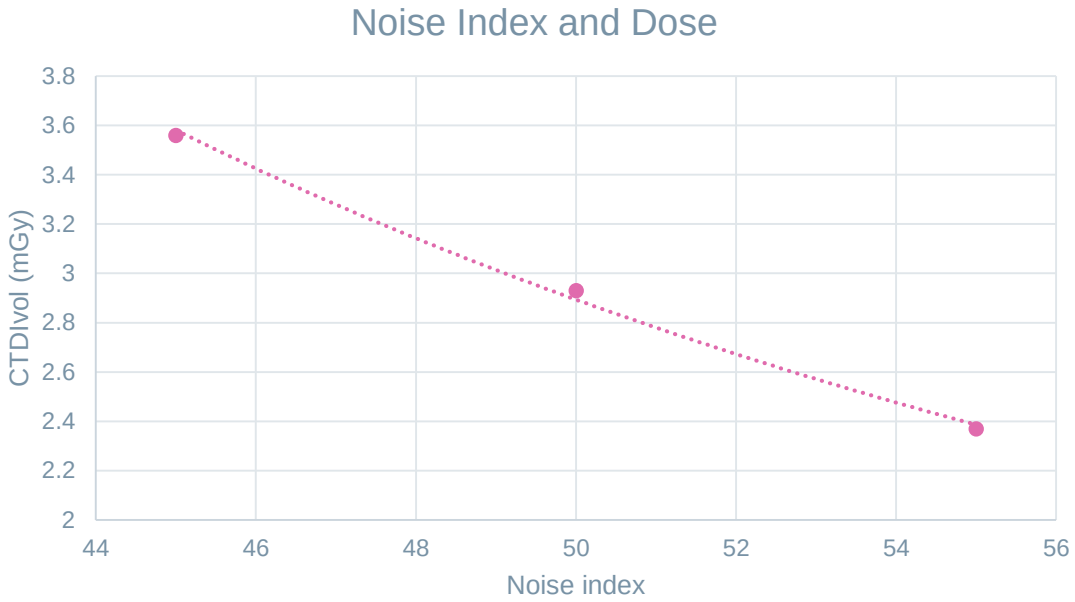


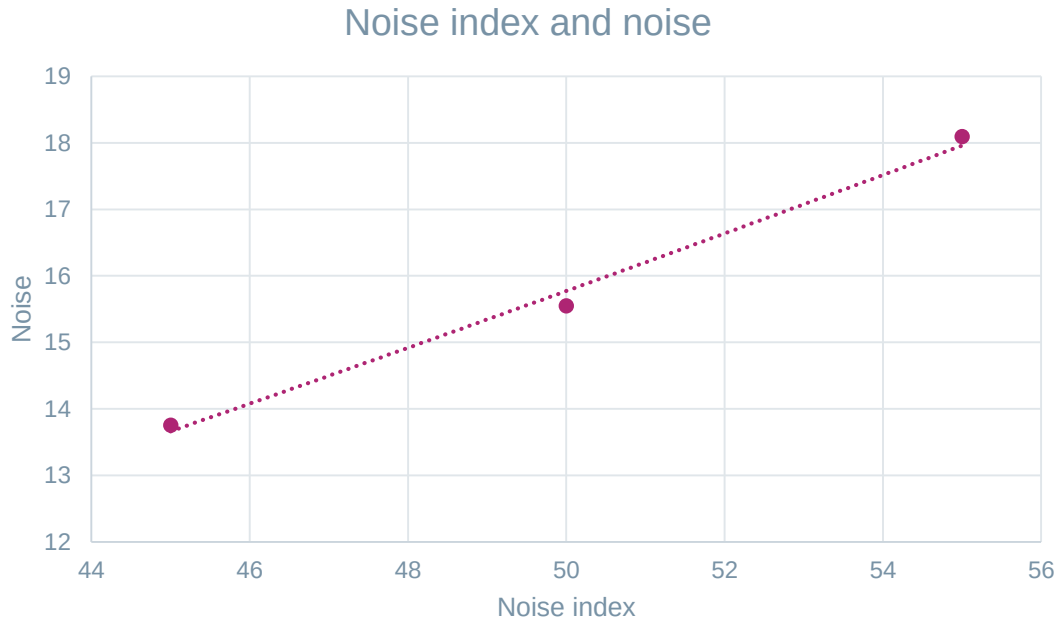


Results: Noise Index

Revolution GSI:

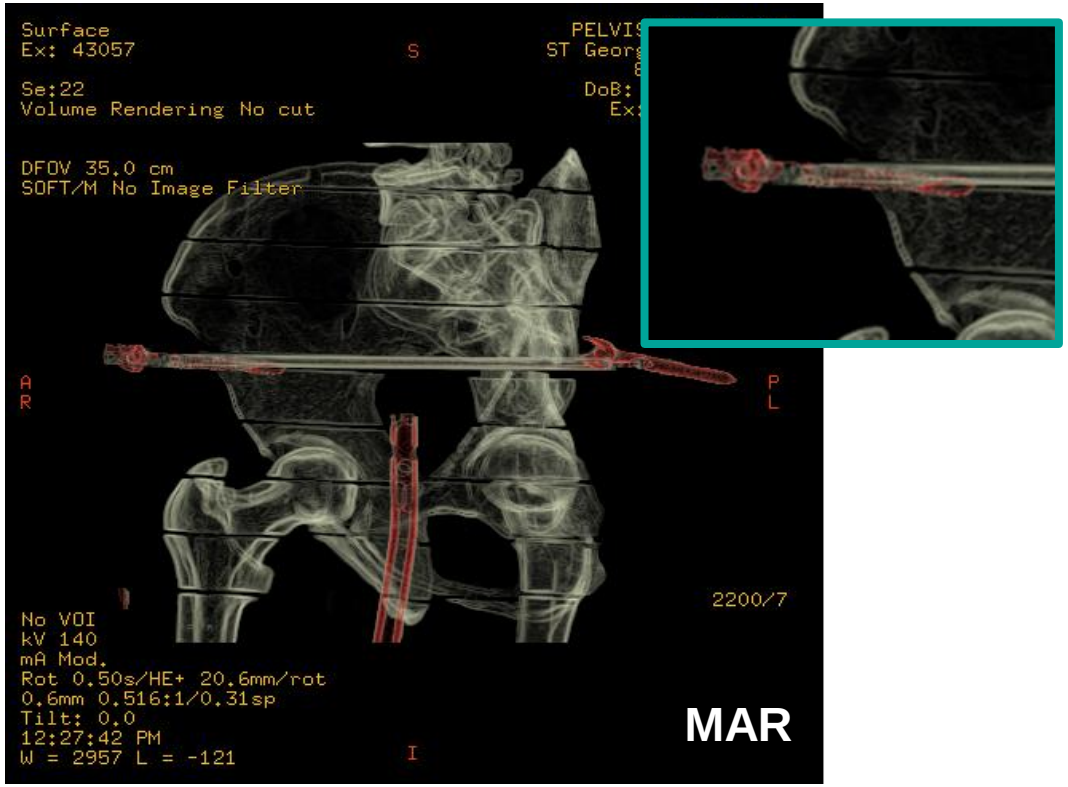


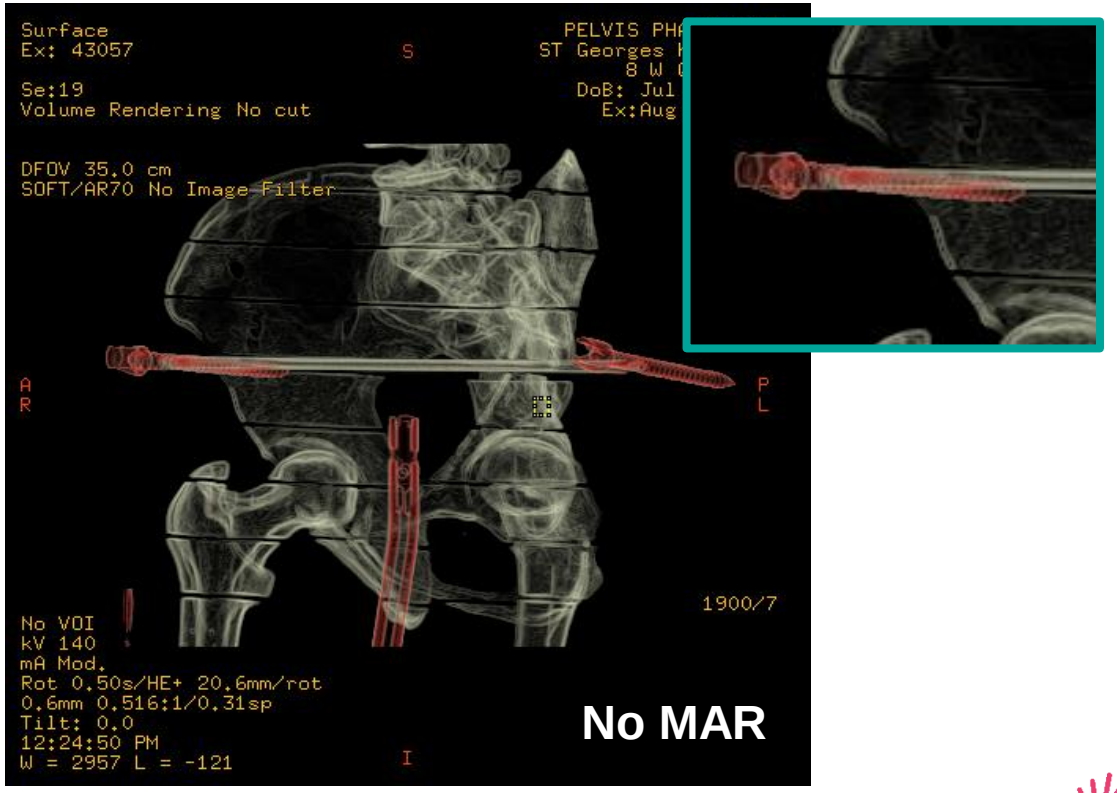




Results: Metal Artefact Reduction

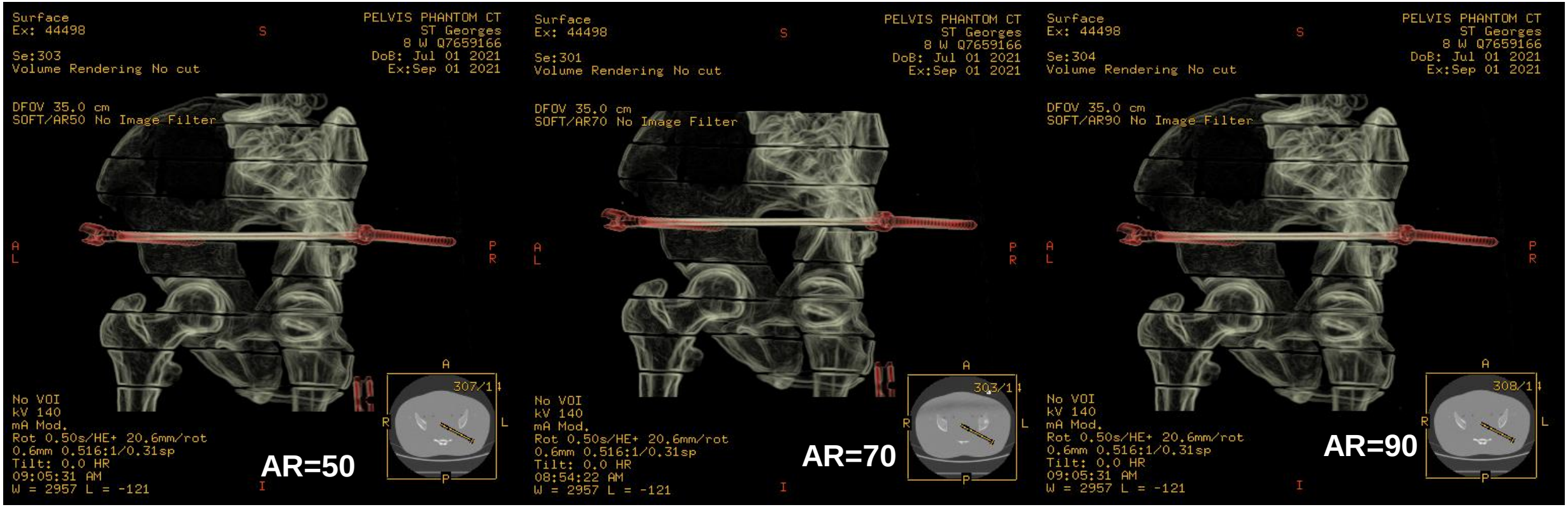
- Metal is clearer without MAR on





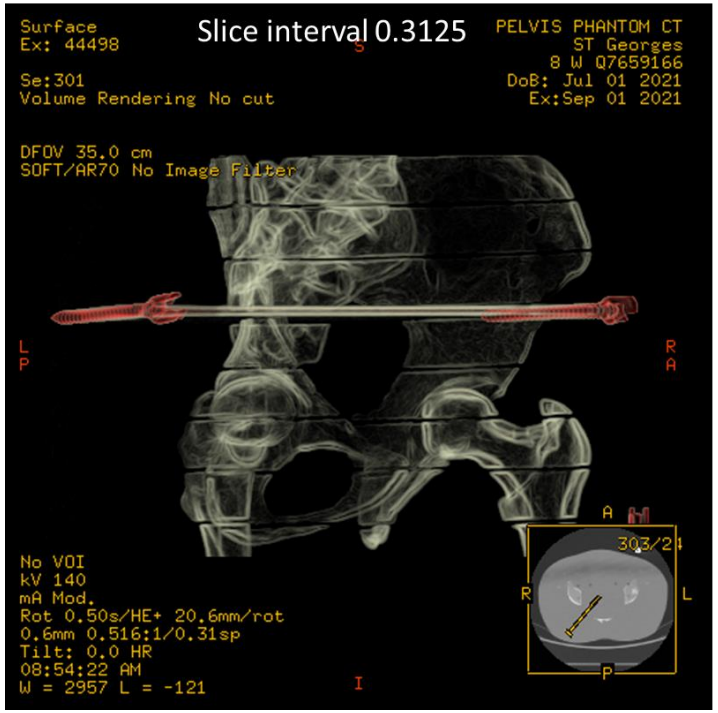
Results: Reconstruction Settings

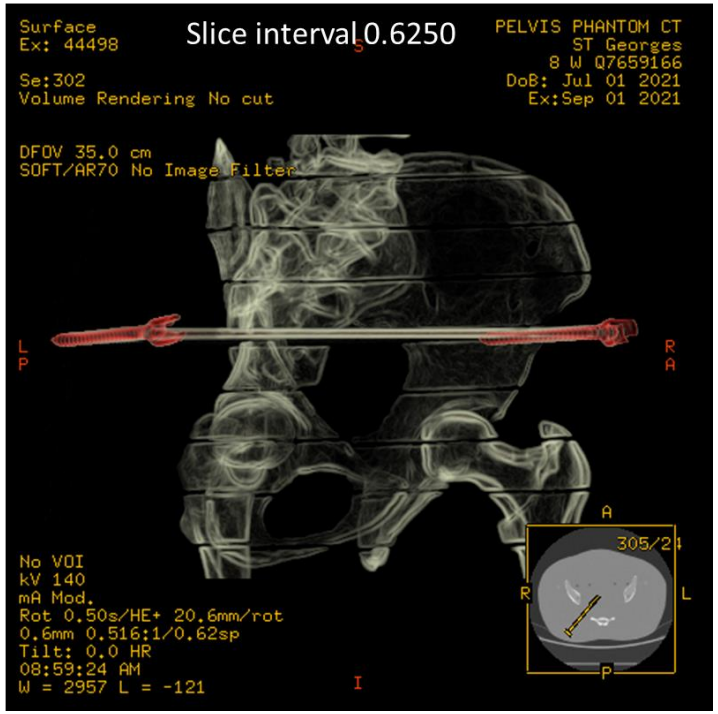
- Based on image quality, it was decided that AR70 was the best



Results: Reconstruction Settings Volume Rendered image

- We used the soft tissue reconstruction to produce the volume rendered images
- Volume rendered images looked best with overlapping slice interval – no dose penalty but longer reconstruction times. As this protocol is used infrequently that's ok.

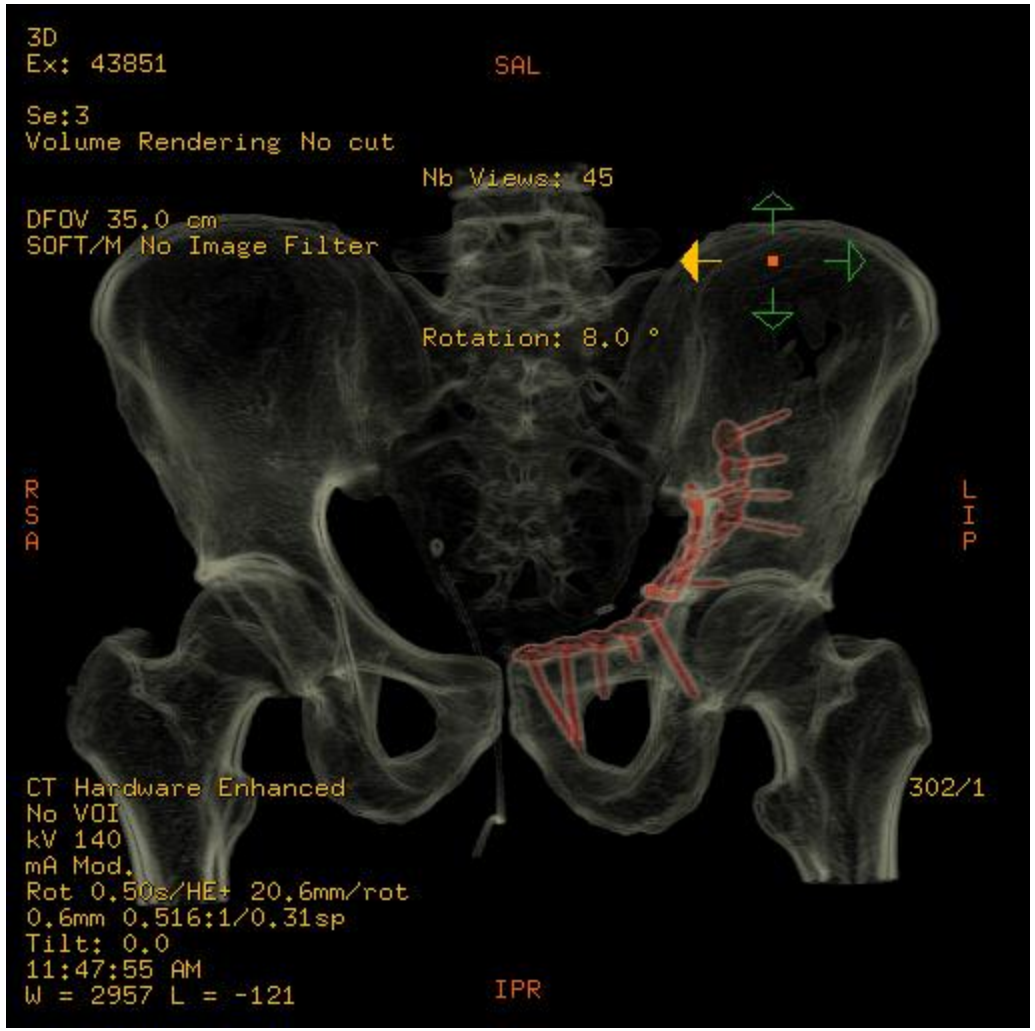




Interim Results

- Based on this, we had a reasonable idea of our protocol for the Revolution GSI

Parameter	Value
Tube Voltage	140kV
Pitch	0.516
Noise index	65
MAR	OFF
Slice interval	0.325
Recon percentage	70



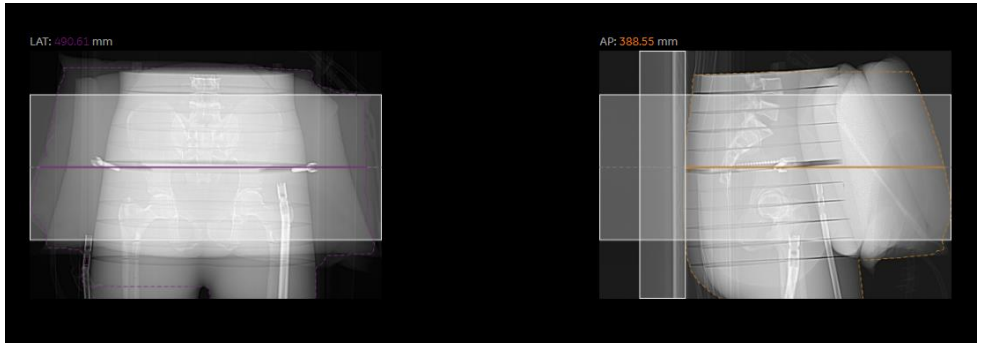
- Most of this is easy to replicate on the Revolution scanner, except the noise index

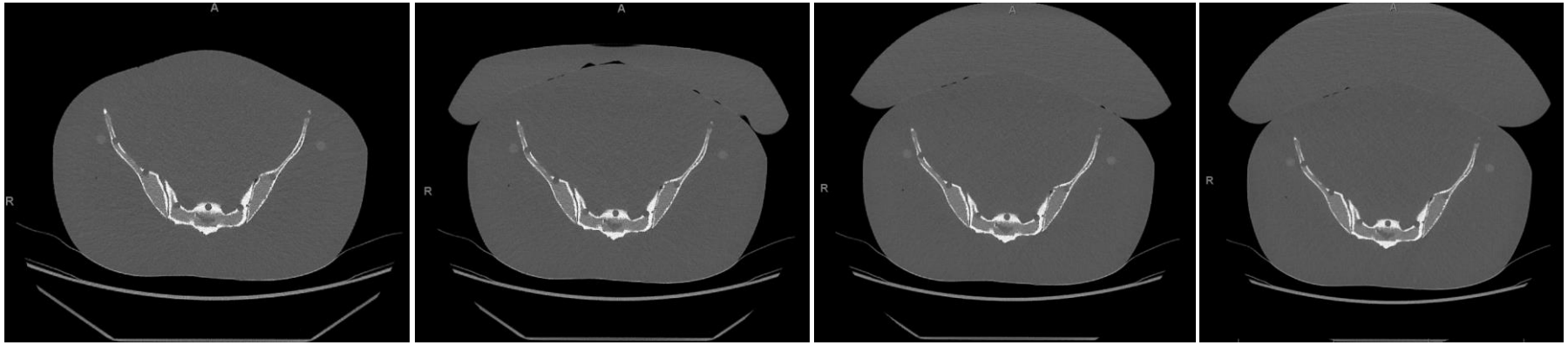
Tube Current Modulation Check

- Need to ensure mA upper and lower thresholds are appropriate
- Need to ensure tube current is modulating appropriately for different patient sizes

Method: Tube Current Modulation Check

- Addition of water sacks to phantom to provide different levels of attenuation.





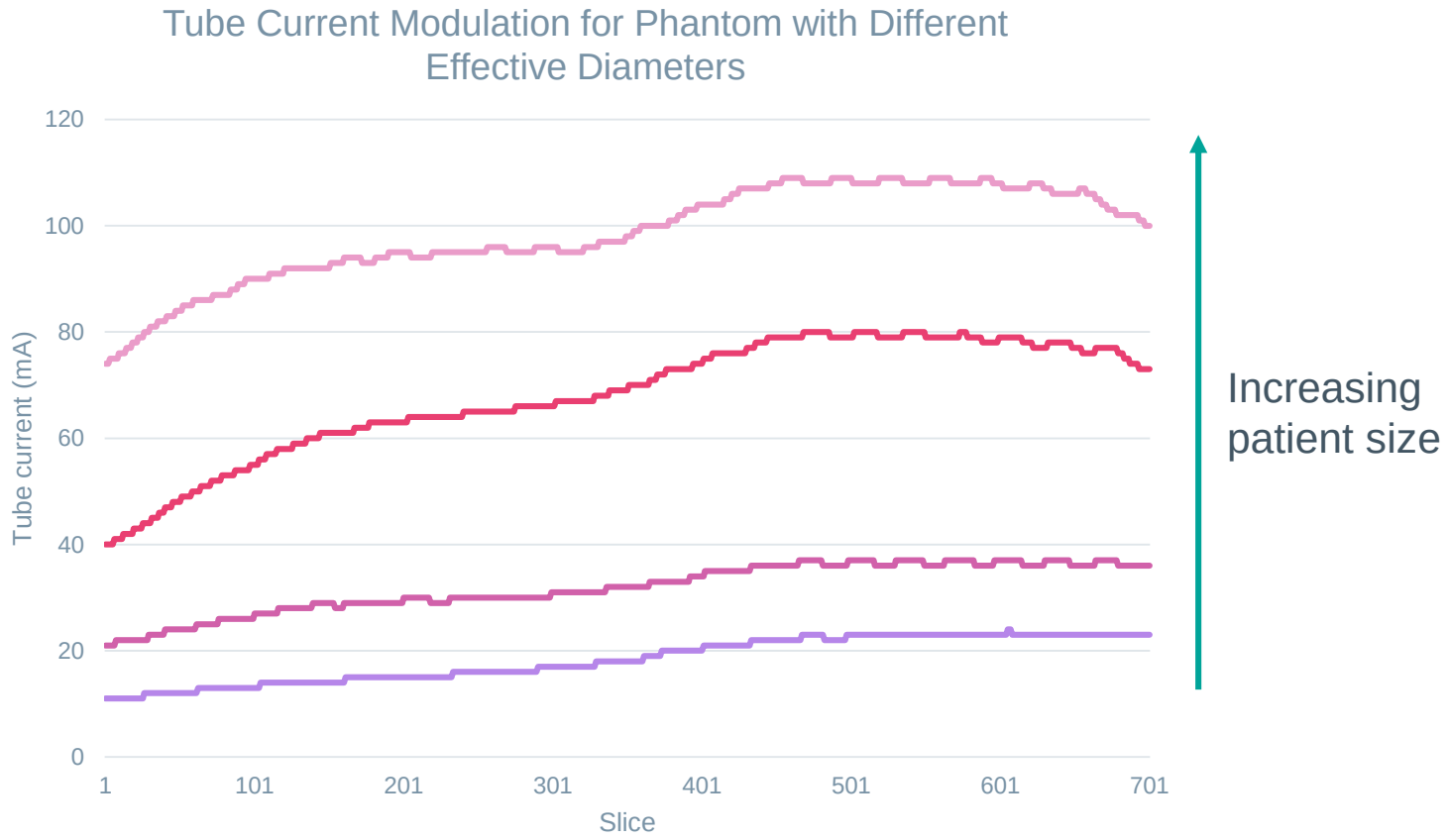
Effective diameter:	27.5 cm	33.2 cm	38.3 cm	43.7 cm

Method: Tube Current Modulation Check

- mA slice analysis
- Compare CTDIvol vs effective diameter curve for new protocol versus standard diagnostic protocol

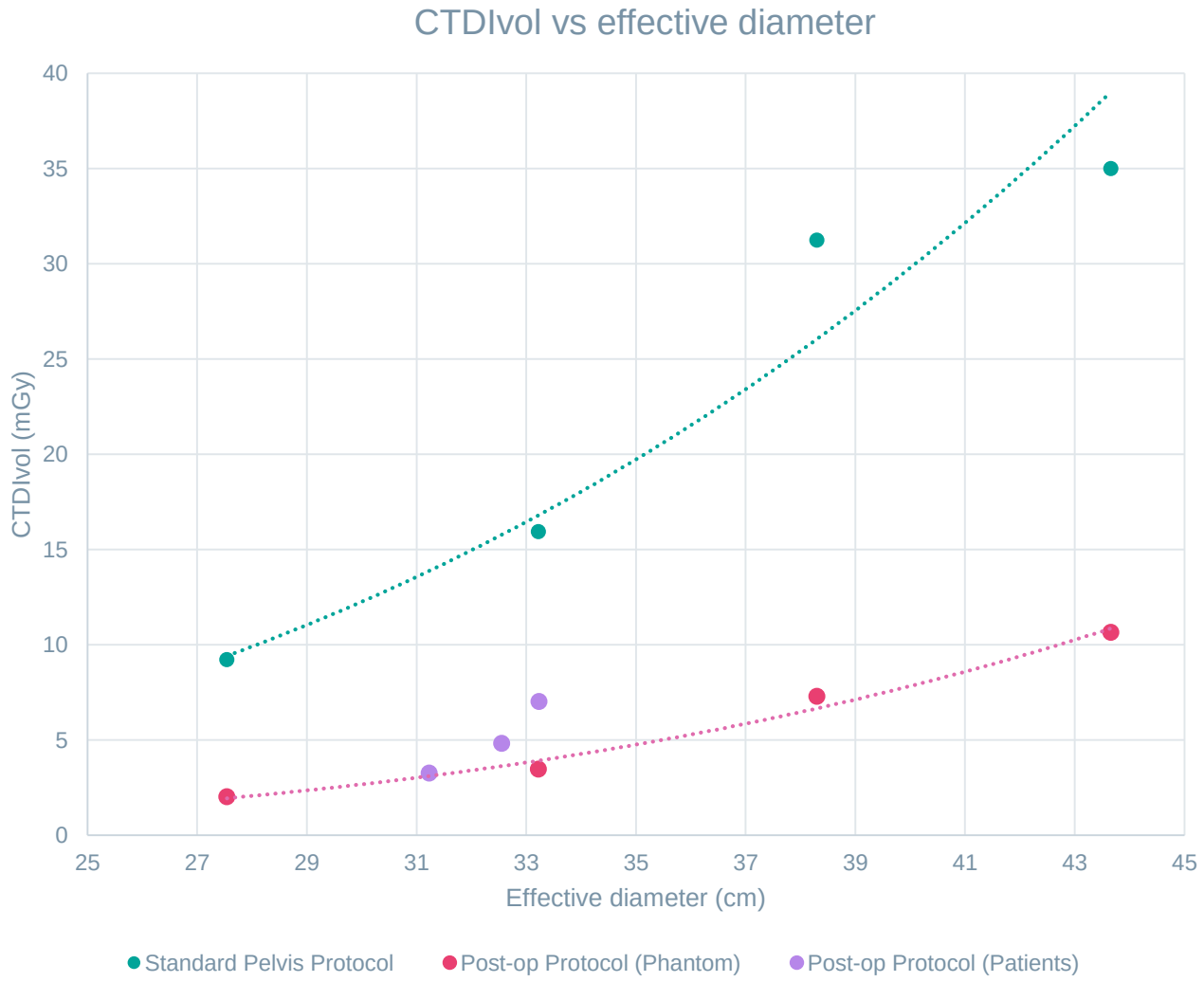
Results: Tube Current Modulation Check

- mA per slice analysis for different phantom sizes
- Previous limits: 80-250mA
- New limits: 10-250mA



Results: Tube Current Modulation Dose Comparison

- Tested the new parameters and compared with standard pelvis protocol
- Doses as low as 25% the standard
- Continuing to monitor this trend as more patient cases become available
- Continuing to ask for image quality feedback from clinicians – so far so good



Next steps

- Protocol for routine post-op evaluation
- AP, inlet and outlet X-ray technically difficult to perform particularly for larger patients
- Effective dose calculations for comparison with 3-view plain film x-ray
- Is CT justified?

	X-ray		Post-op CT	
Patient	Effective dose	Cancer risk	Effective dose	Cancer risk
#1	0.6 mSv	1 in 27,000	0.9 mSv	1 in 18,000
#2	0.5 mSv	1 in 22,000	1.3 mSv	1 in 8,800

Lessons learned…

- Get on the scanner whenever you can
- Know your individual scanner
- Plan ahead of time
- Test the things you are recommended by apps
- Communicate properly with radiographers and radiologists
- Be creative with your test objects
- Get trainees involved in optimisation work

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Acknowledgements

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Outstanding care every time

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