Experiences commissioning the Toshiba Aquilion ONE 320 detector row CT scanner

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CTUG 2009 Belfast

The Clinical Research Imaging Centre (CRIC), Edinburgh

- 320 MDCT: Toshiba Aquilion ONE
- 3T MRI: Siemens Verio
- PET-CT: Siemens Biograph mCT X (128 slice CT)

The Clinical Research Imaging Centre (CRIC), Edinburgh

Toshiba Aquilion ONE: Scanner Stats

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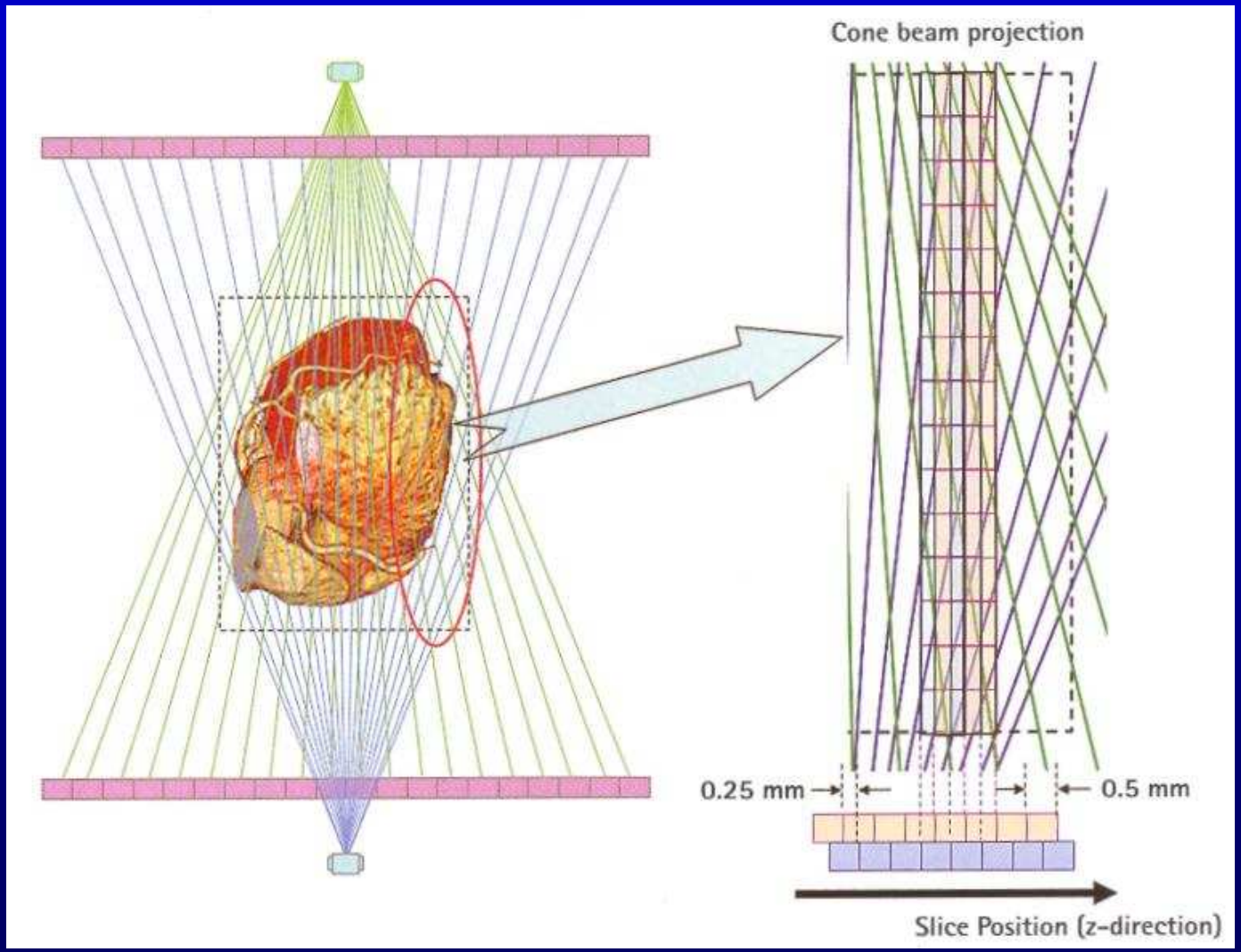
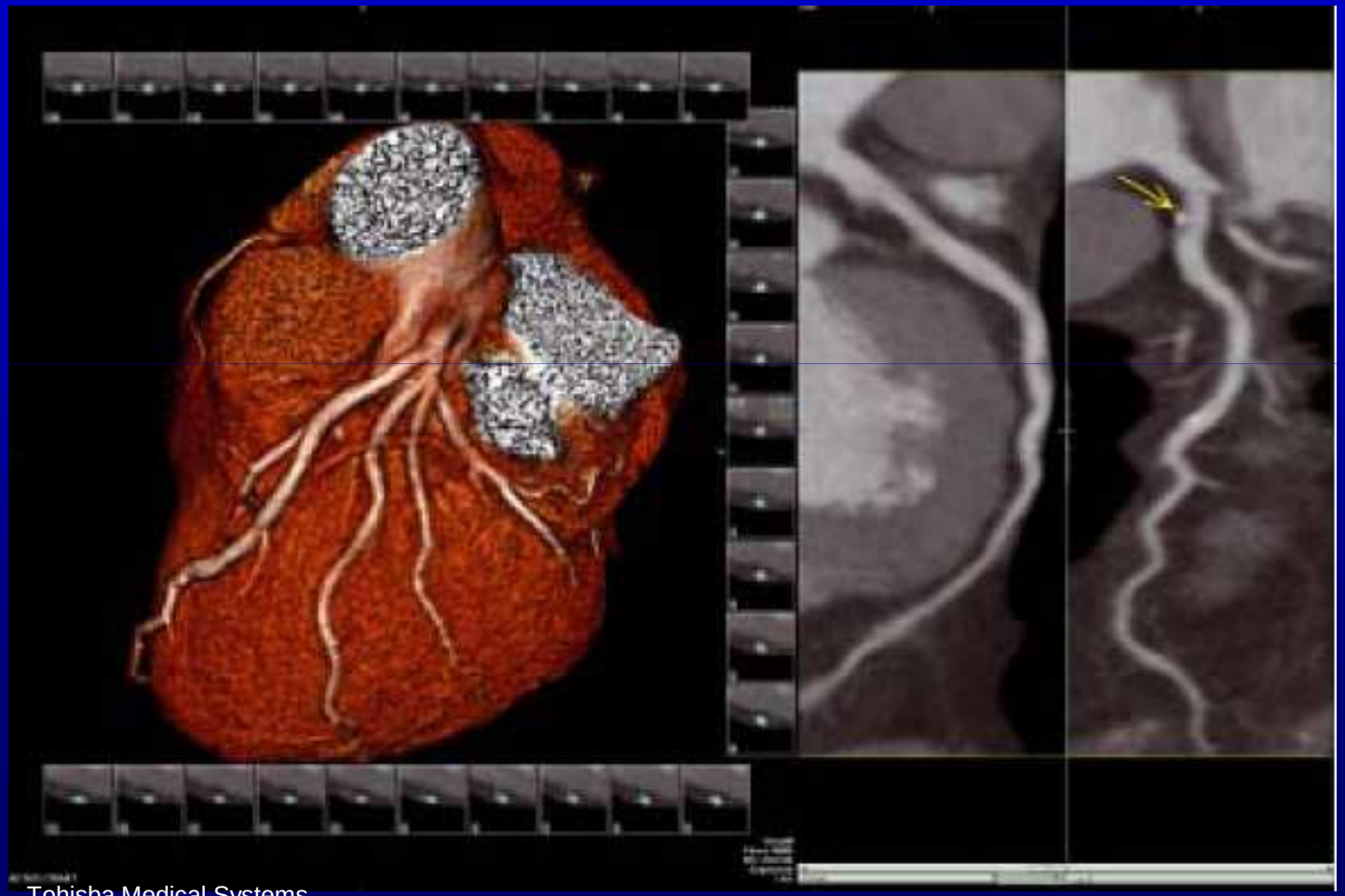
Detector rows	320x0.5mm
Total detector width (z) at isocentre	16 cm
Min rot time	0.35s
Dose reduction	SureExposure3D and QDS
Scan modes	Sequence, spiral, volume, dynamic volume
Spiral mode	64x0.5mm or 32x0.5mm, no gantry tilt
Volume mode	Static or stepped table, 80-320 detector rows selectable 640 slice mode (0.5mm@0.25mm) possible
3 beam shaping filters	Small: <= 240 mm Medium: > 240 mm, <= 400 mm Large: > 400 mm

Cone beam reconstruction: ConeXact



Tohisba Medical Systems

Clinical imaging at 320slice



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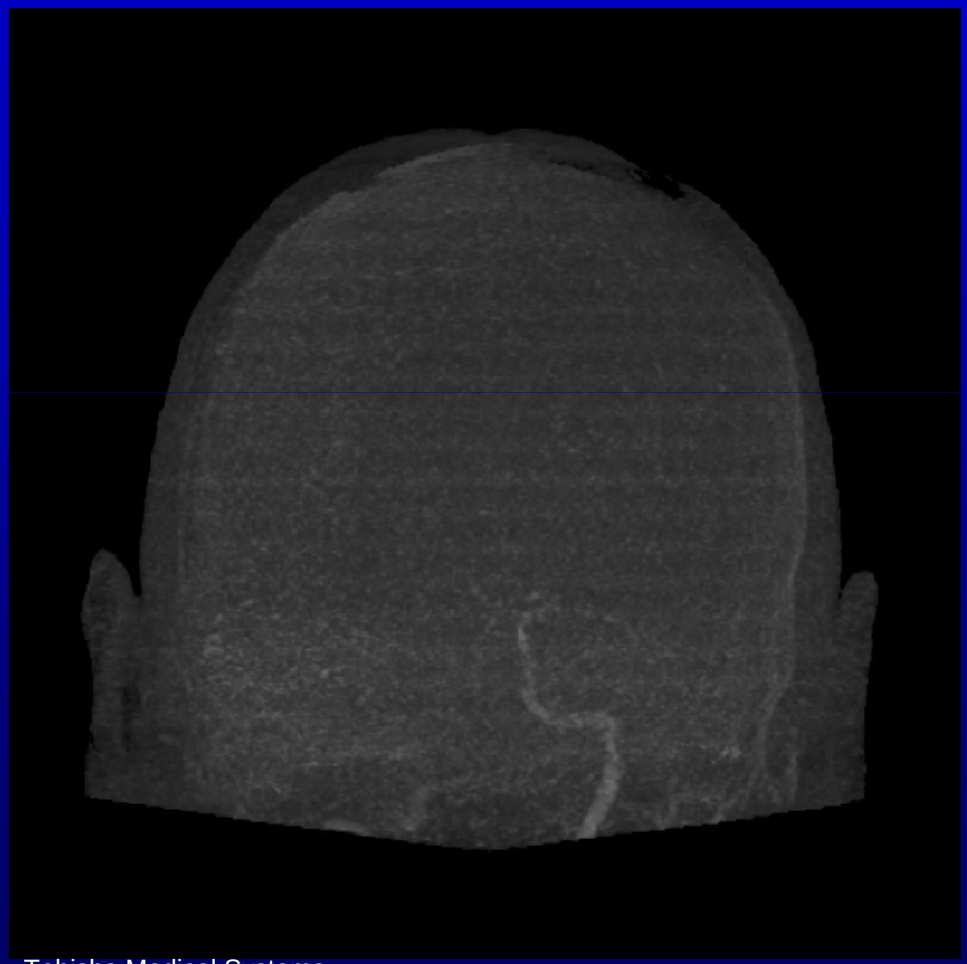
Clinical imaging at 320slice



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Clinical imaging at 320slice

Volume mode dosimetry: What to measure?

- Mori et al., Med Phys, 32, 2005:

Integration length at least 300 mm required to represent >90% of integral dose within beams up to 138mm

- Scan through small detector (e.g. Farmer / RTI) ?

Volume mode dosimetry: What to measure?

IOP Publishing — Physics in Medicine and Biology

Phys. Med. Biol. **54** (2009) 3141–3159 — doi:10.1088/0031-9155/54/10/012

Computed tomography dose assessment for a 160 mm wide, 320 detector row, cone beam CT scanner

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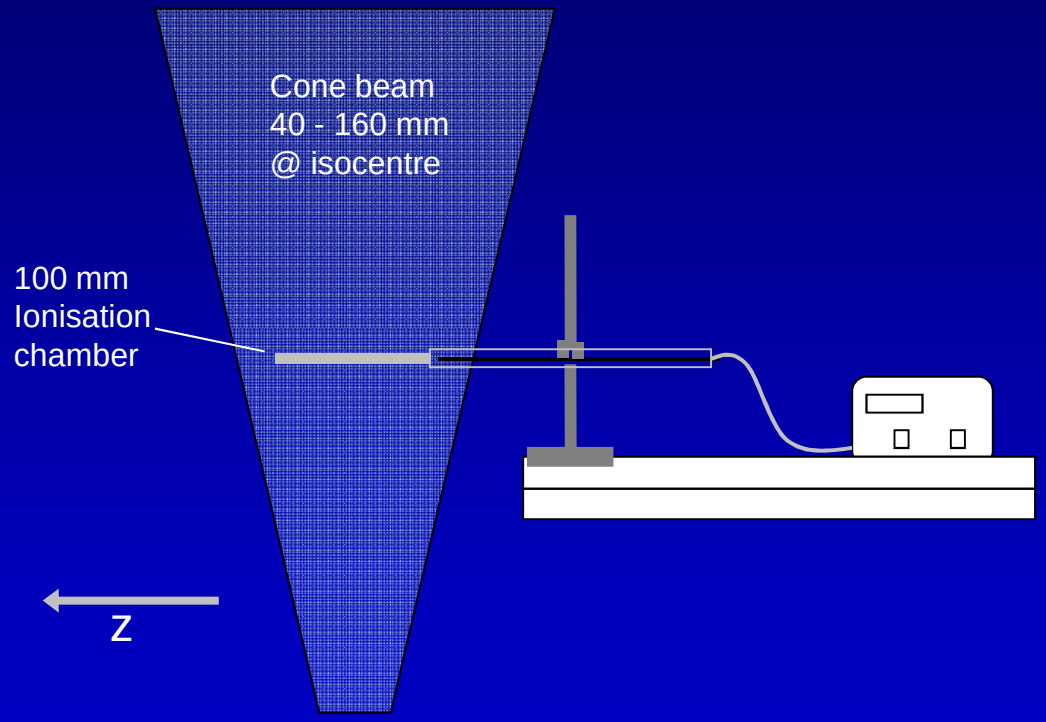
- Good agreement between CTDI300w, CTDI600w
- D100w numerically ≈ CTDI300w

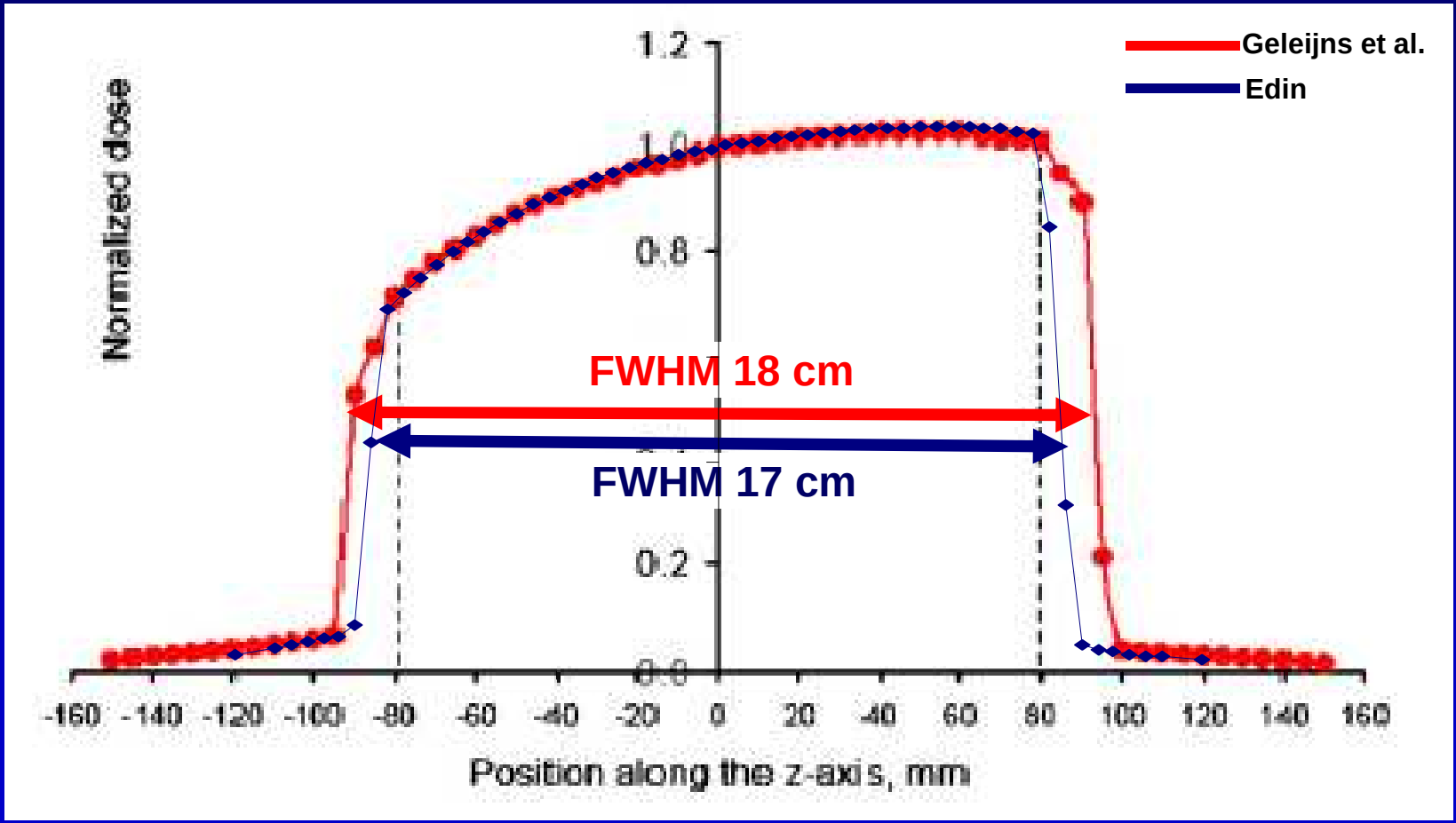
Volume mode dosimetry: D_{100}



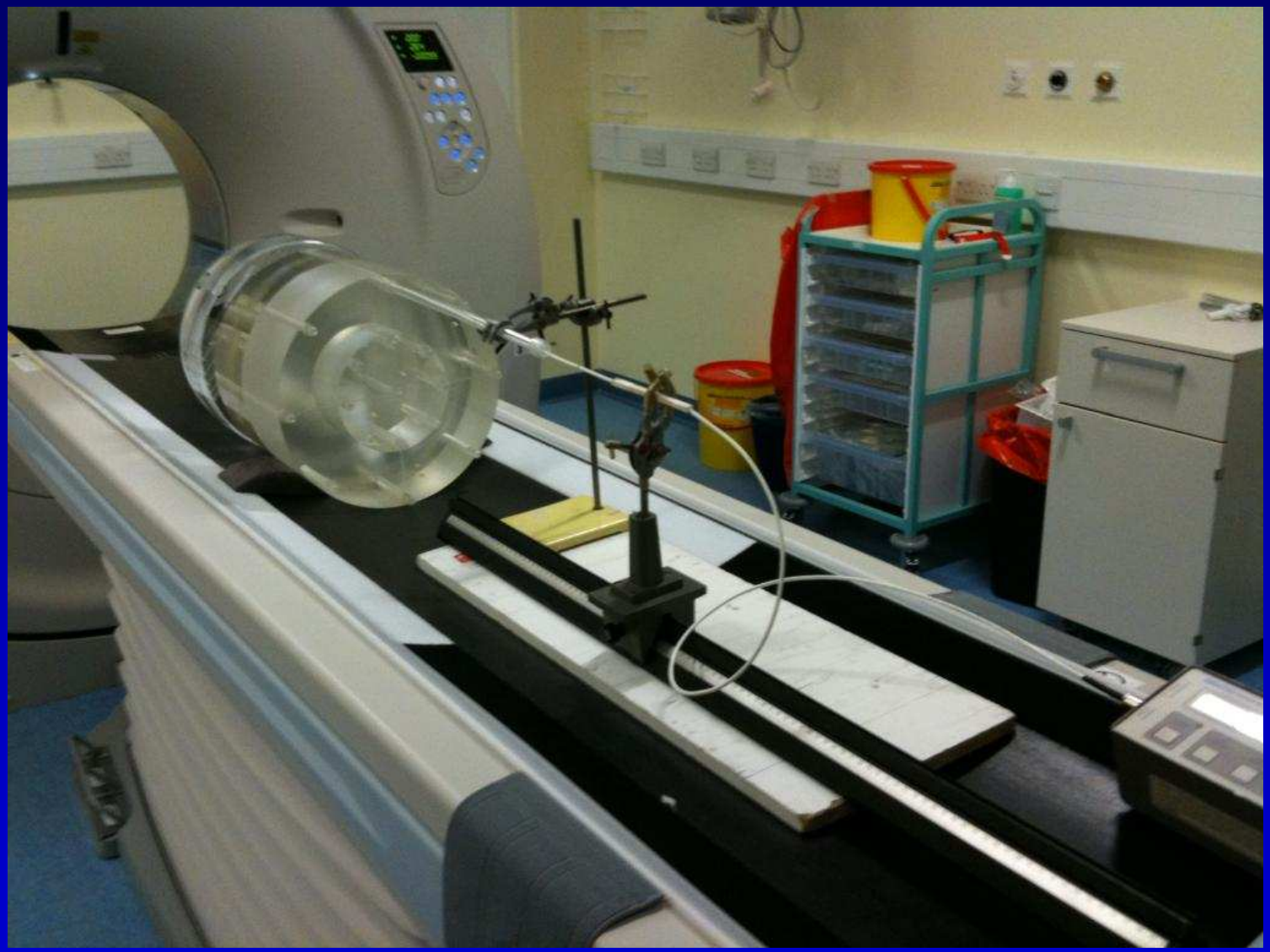
Volume mode dosimetry: D_{100} results

	Filter	kV	D100	CF	CTDI300 Edin (calc)	CTDI300 Geleijns et al	%diff
Air	L	80	9.2	1.02	**9.4**	**10.1**	-7.3
	L	100	15.8	1.04	**16.4**	**17.8**	-7.7
	L	120	23.7	1.05	**24.9**	**26.9**	-7.5
	L	135	30.4	1.05	**32.0**	**34.7**	-7.9
	M	120	23.3	1.05	**24.5**	**26.8**	-8.7
	S	120	26.7	1.05	**28.0**	**29.5**	-5.0
Body	L	80	3.0	1.02	**3.0**	**3.3**	-7.6
	L	100	6.0	1.04	**6.2**	**6.6**	-5.6
	L	120	9.7	1.08	**10.4**	**11.1**	-6.0
	L	135	13.0	1.06	**13.8**	**14.9**	-7.5
	M	80	2.7	0.98	**2.6**	**2.9**	-10.3
	M	100	5.2	1.02	**5.3**	**5.9**	-9.7
	M	120	8.6	1.04	**9.0**	**9.8**	-8.5
	M	135	11.7	1.06	**12.4**	**13.2**	-6.4
Head	S	80	6.4	1.08	**6.9**	**7.2**	-3.7
	S	100	11.8	1.10	**13.0**	**13.6**	-4.8
	S	120	18.5	1.11	**20.5**	**21.5**	-4.5
	S	135	23.9	1.10	**26.3**	**28.1**	-6.3

Volume mode dosimetry: Beam profile



Measuring $CTDI_{300}$



$CTDI_{300}$ measurements: Results

	Filter	kV	CTDI300 Edin (meas)	CTDI300 Geleijns et al	%diff
Air	L	80	**9.9**	**10.1**	-2.4
	L	100	**17.0**	**17.8**	-4.7
	L	120	**25.4**	**26.9**	-5.4
	L	135	**32.7**	**34.7**	-5.6
	M	120	**25.3**	**26.8**	-5.5
	S	120	**29.1**	**29.5**	-1.4
Body	L	80	**3.2**	**3.3**	-3.8
	L	100	**6.4**	**6.6**	-3.1
	L	120	**10.5**	**11.1**	-5.7
	L	135	**14.1**	**14.9**	-5.2
	M	120	**9.4**	**2.9**	-3.8

$CTDI_{300}$ measurements: Results

Perisinakis et al. PMB 52, 2007:
"The ratio of (CTDIw / CTDIair) determined using the optimum [chamber] length was found to be independent of beam collimation"

$CTDI_{300}$ measurements: Results

	Filter	kV	CTDI300 Edin (meas)	CTDI300 Geleijns et al	%diff	$(CTDI_{air})_{Edin}$ *$(CTDI_w/CTDI_{air})_{Geleijns}$	%diff
Air	L	80	**9.9**	**10.1**	-2.4	**3.2**	1.4
	L	100	**17.0**	**17.8**	-4.7	**6.3**	-1.6
	L	120	**25.4**	**26.9**	-5.4	**10.5**	0.3
	L	135	**32.7**	**34.7**	-5.6	**14.1**	-0.5
	M	120	**25.3**	**26.8**	-5.5	**9.3**	-1.8
	S	120	**29.1**	**29.5**	-1.4		
Body	L	80	**3.2**	**3.3**	-3.8		
	L	100	**6.4**	**6.6**	-3.1		
	L	120	**10.5**	**11.1**	-5.7		
	L	135	**14.1**	**14.9**	-5.2		
	M	120	**9.4**	**2.9**	-3.8		

Volume mode dosimetry: Scanner displayed values

On Aquilion ONE, Toshiba define:

- Extended CTDIvol -> $CTDI_{vol}$.e
- Extended DLP -> DLP.e

$$CTDI_{vol}.e = CTDI_{w}' \times R \qquad (R = \text{no rotations})$$

Where $CTDI_{w}'$ uses:

$$CTDI_{100}' = \int_{-50}^{+50} D(z) / \min\{NxT, 100mm\}\, dz$$

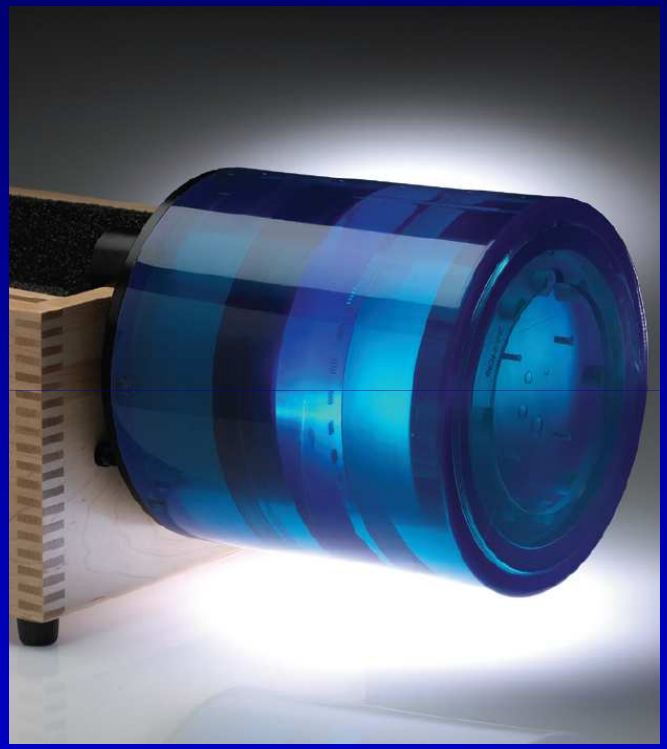
i.e. for a volume scan with collimation ≥ 100 mm

$$CTDI_{100}' \equiv D100$$

and,

$$DLP.e = CTDIvol.e \times N \times T$$

Image quality - Phantoms



24,000 images….

Image quality results – Interslice noise

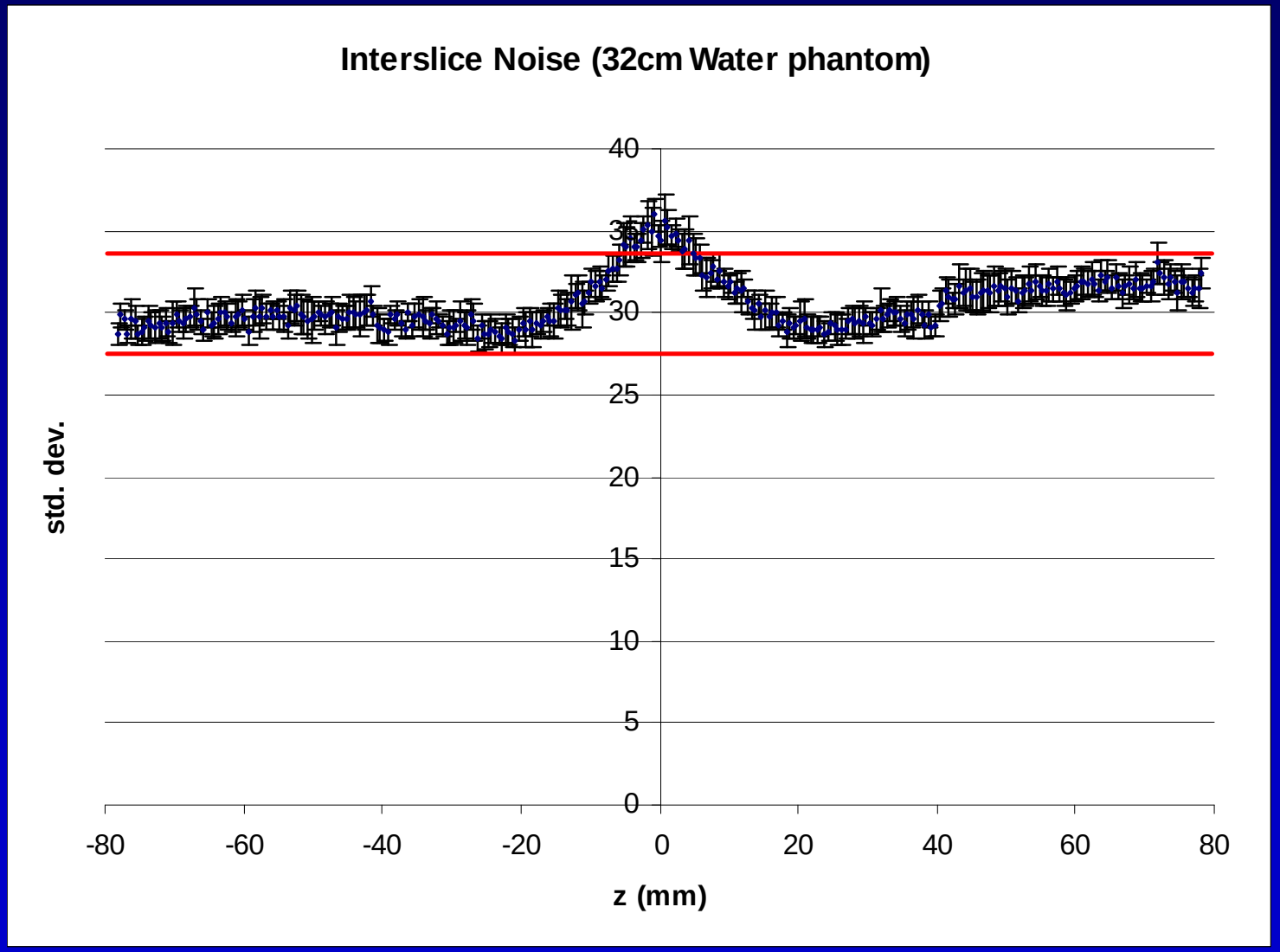


Image quality results –Uniformity through volume: Body phantom

Image quality results – Body phantom: Uniformity in z

Image quality results – Spatial resolution

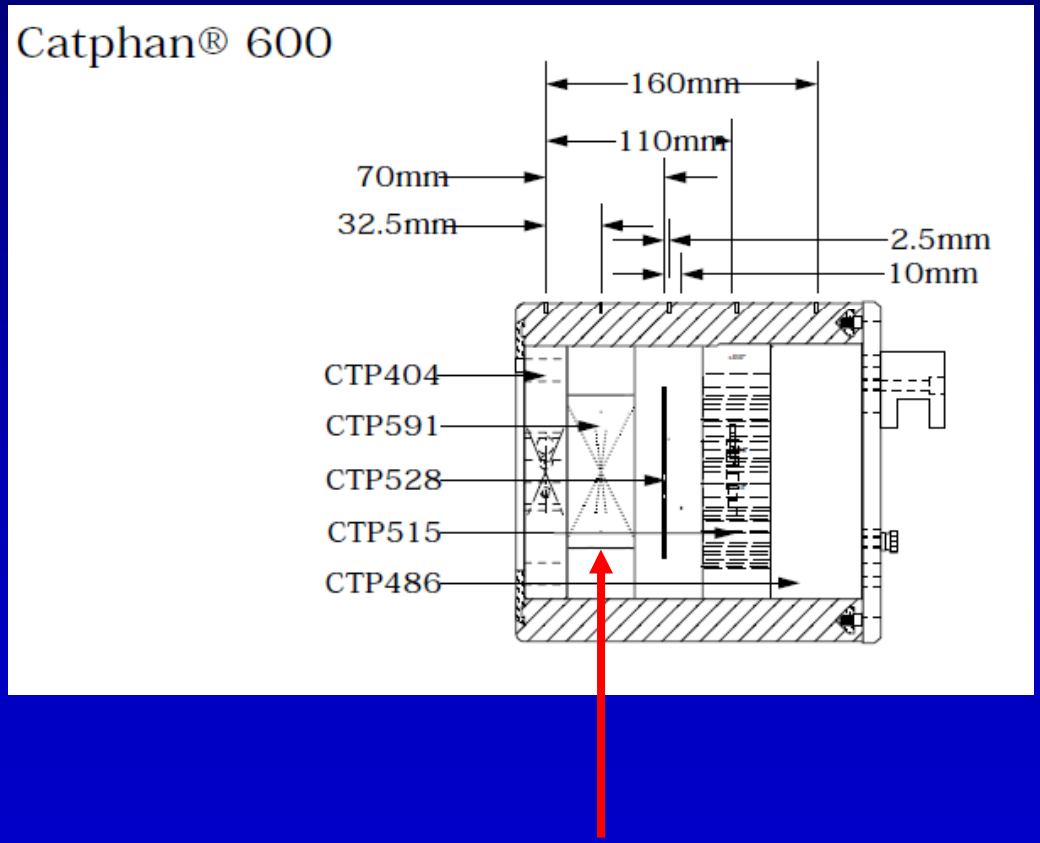


Image quality results – Spatial resolution

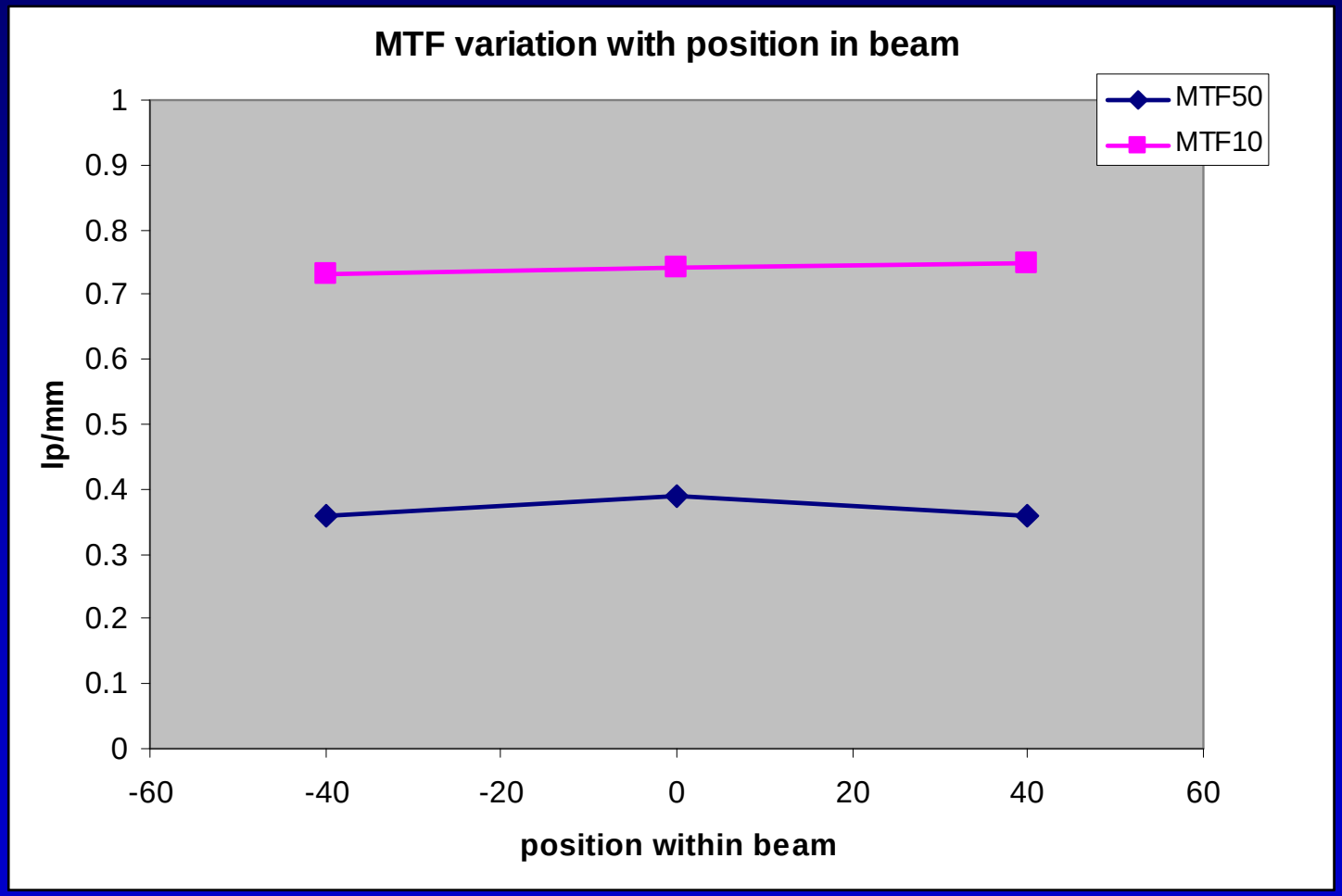
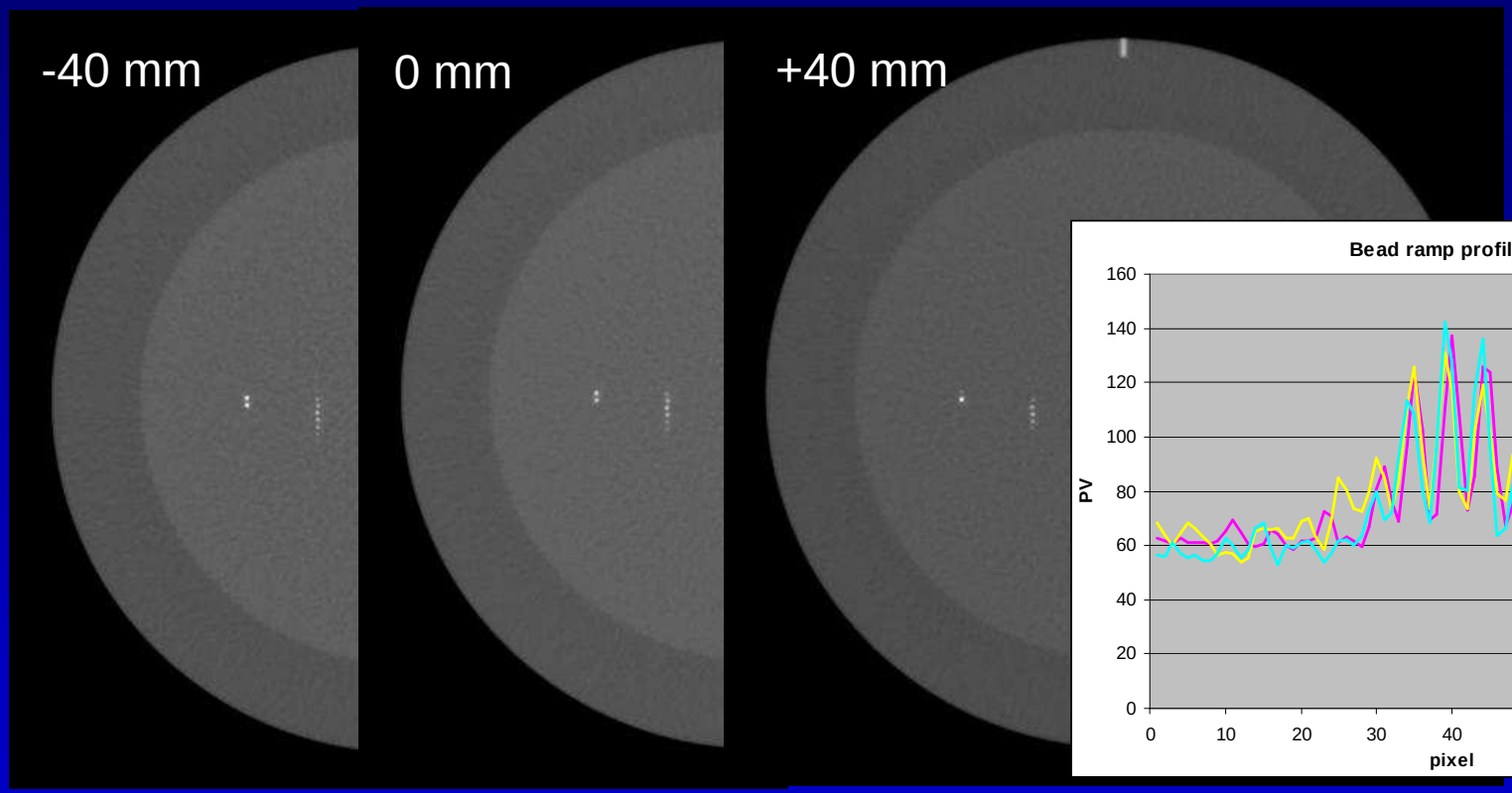


Image quality results – Slice thickness thro’ volume



Conclusions

- Modified methodology for dosimetry and image quality testing required for wide beam system
- Largely possible with existing equipment, manufacturer supplied phantoms
- Automated image analysis essential

Acknowledgements

- Toshiba Medical Systems
- IQWorks Project
- CRIC CT Radiographers: David Brian, Tessa Smith
- Dundee Medical Physics Department


Bye!