Optimisation of Standard Protocols on a MultiSlice CT Scanner

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Contents

- Comparison of single slice and 4 slice spiral scanners
- Work to optimise exposure factors
- Comparative dose data from axial, spiral and 4-slice scanners from around the SW
- Discussion of optimisation

A New CT Scanner !

- Marconi Mx8000 4-slice scanner installed December 2001
- Standard protocols use thinner reconstructed slices than existing single slice spiral Siemens Somatom Plus4
- What effect is this having on patient dose / Image Quality?

Workload of Single Slice Spiral CT (Patient Numbers)

Abdomen	4892	Neck	203
Pelvis	3411	HRCT	144
Thorax	2235	C Spine	77
Head	974	3D Renal	65
Abdo BP	257	CTAPA3	52

Workload on Siemens : Dec 2000 – Nov 2001
Ten most frequent exams account for 94% of total

Noise / Dose Comparison

	Siemens Plus 4				Marconi Mx8000			
	Pitch	T (mm)	Noise (St Dev)	CTDI Vol (mGy)	Pitch	T (mm)	Noise (St Dev)	CTDI Vol (mGy)
Abdo / Pelvis	1.5	10	10	**9**	0.88	6.5	8	**17**
Chest	1.5	10	15	**5.6**	1.25	6.5	14	**10**
3D Renal	1.5	3	14	**17**	1.25	1.3	16	**25**
3D PE	1.5	3	19	**7**	1.25	3.2	17	**15**

Noise / Dose Comparison 2

	Siemens Plus 4				Marconi Mx8000			
	Pitch	T (mm)	Noise (St Dev)	CTDI Vol (mGy)	Pitch	T (mm)	Noise (St Dev)	CTDI Vol (mGy)
C Spine	1.5	5	11	**9.5**	0.88	3.2	16	**17**
L Spine	1.5	5	33	**14.4**	0.63	3.2	13	**25**
Brain 5	Cont	5	3	**59**	Cont	5	3	**56**
HRCT	Inc 20	1	102	**1.3**	Inc 20	1	57	**2**

IR(ME)R

JUSTIFICATION

OPTIMISATION

Variation of Noise with mAs and Slice Width

$$Noise \propto \frac{1}{\sqrt{mAs}}$$

or

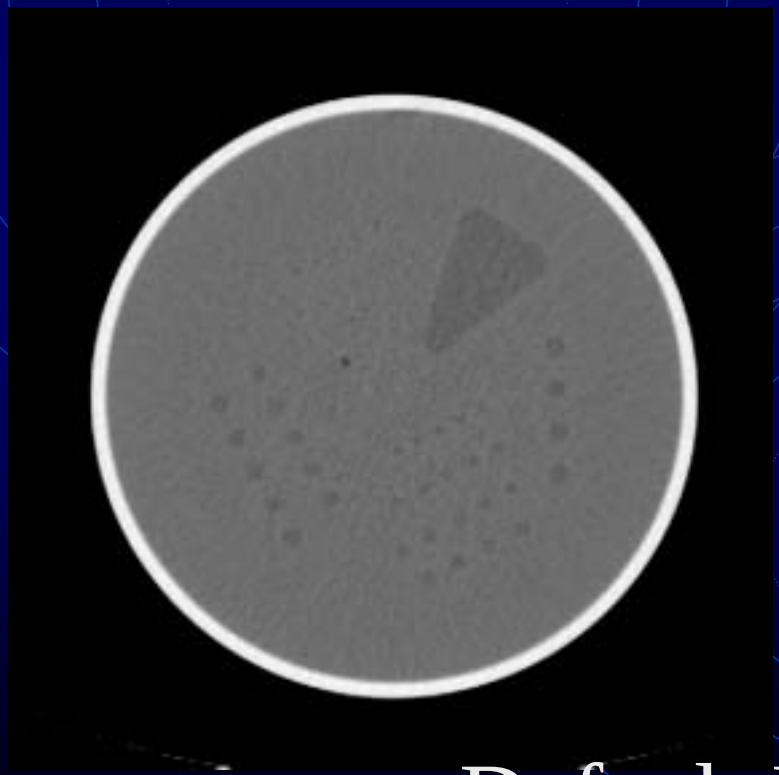
$$Noise \propto \frac{1}{\sqrt{recon\ slice\ width}}$$

Suggested Protocols - Abdo

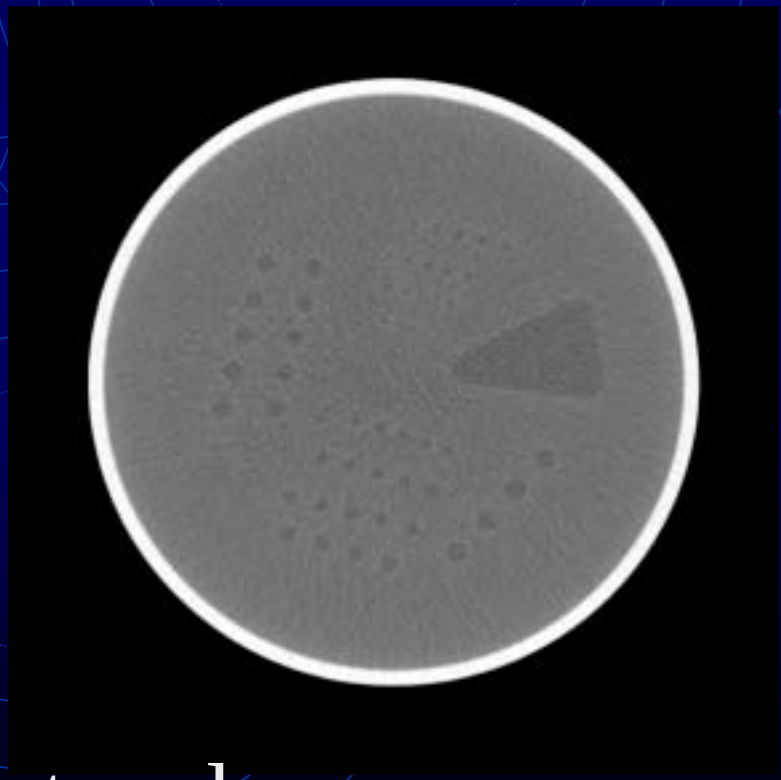
	mAs *(/slice)*	Pitch	Noise (St Dev)	CTDI vol	Relative Dose
Siemens	170	1.5	10	9	1
Marconi Default	*250*	0.875	8	17	1.9
Equal Dose	***135***	0.875	11	9	1
Equal Noise	***150***	0.875	10	10	1.1
Equal Dose, smoother Alg'm	***135***	0.875	8	9	1

Low Contrast Phantom Images Abdomen Protocol

Spiral 170 mAs



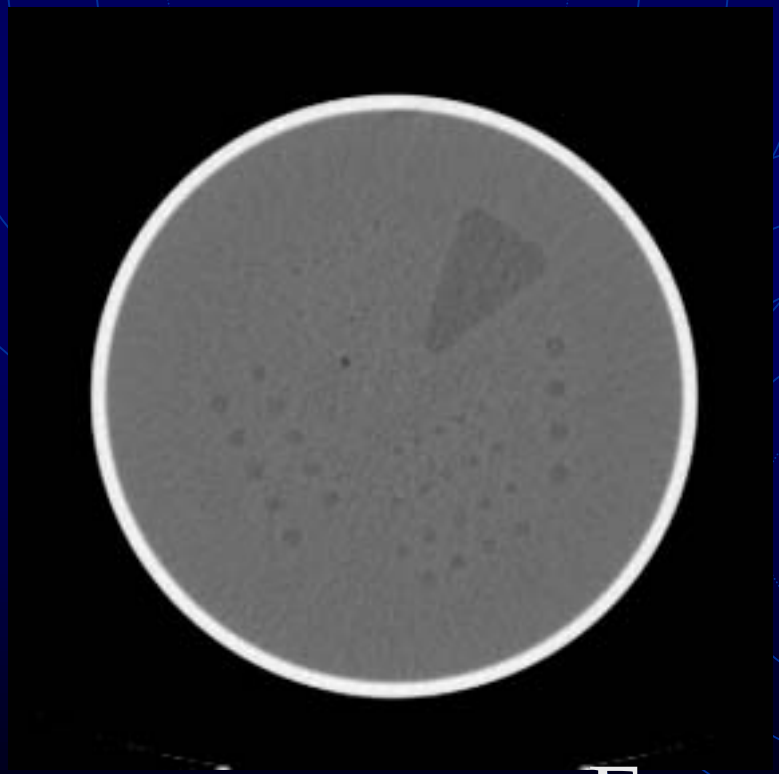
Quad 250 mAs



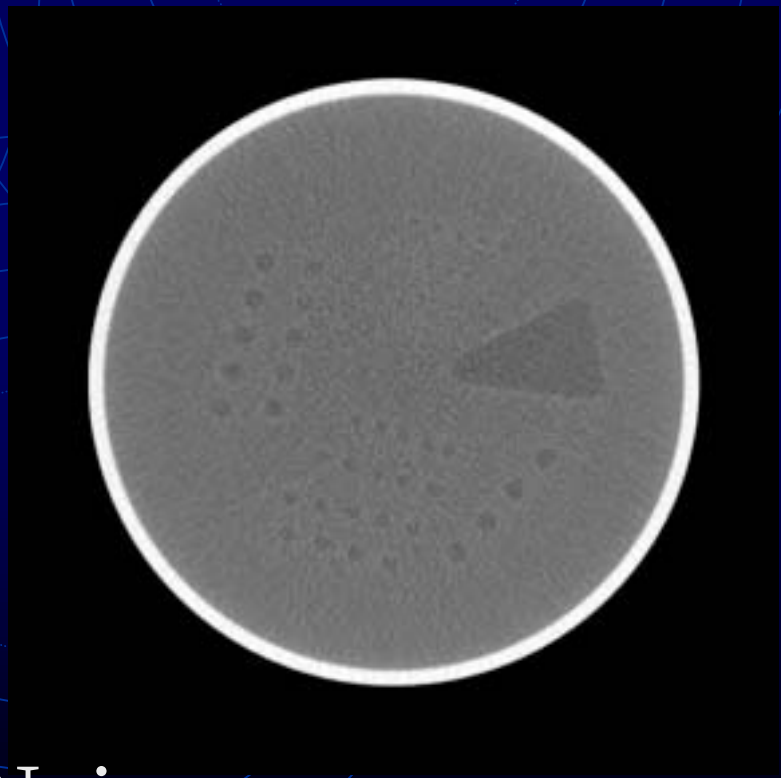
Default Protocols

Low Contrast Phantom Images Abdomen Protocol

Spiral 170 mAs



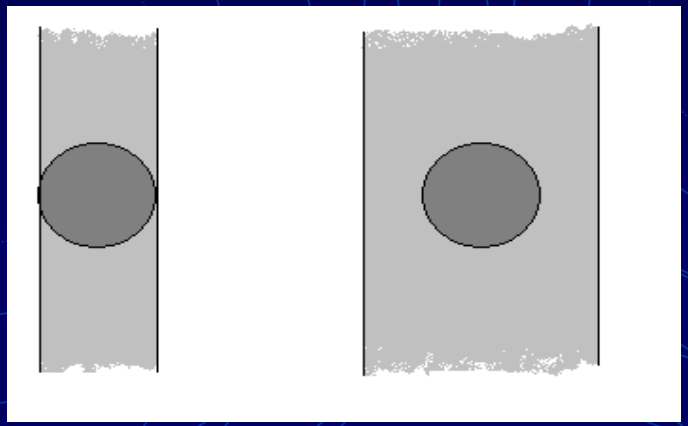
Quad 150 mAs



Equal Noise

Limitations of AAPM Phantom

Small object in thin slice



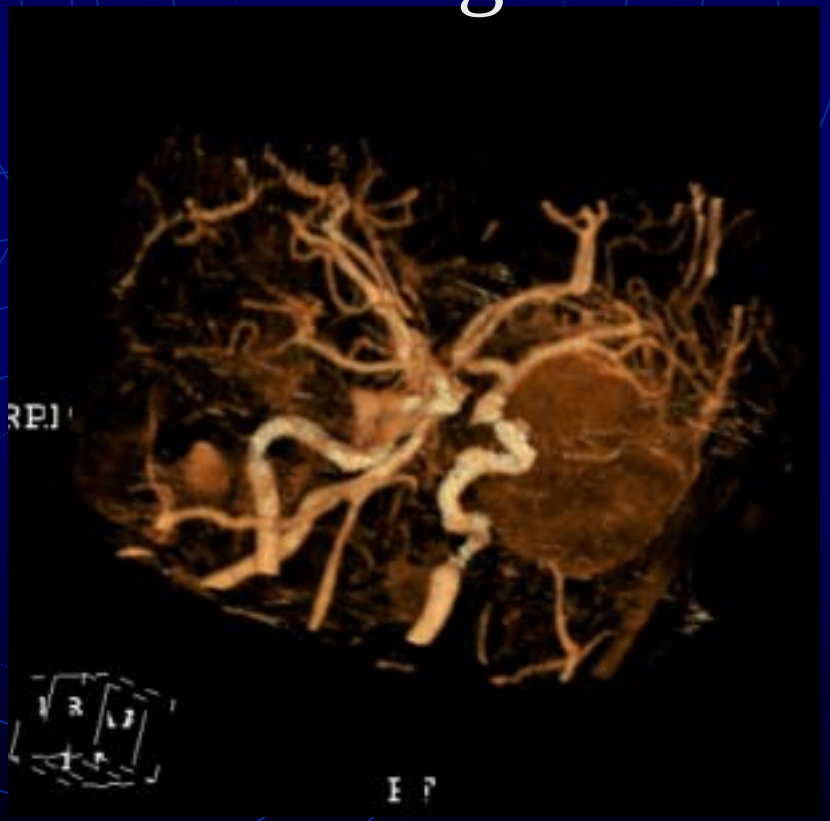
Small object in thick slice gives lower contrast

- Phantom does not reflect increased contrast of small details with thinner slices
- A phantom with 3D details should be used

Considerations for a 3D CT Phantom

Thorax

Neuro Angio



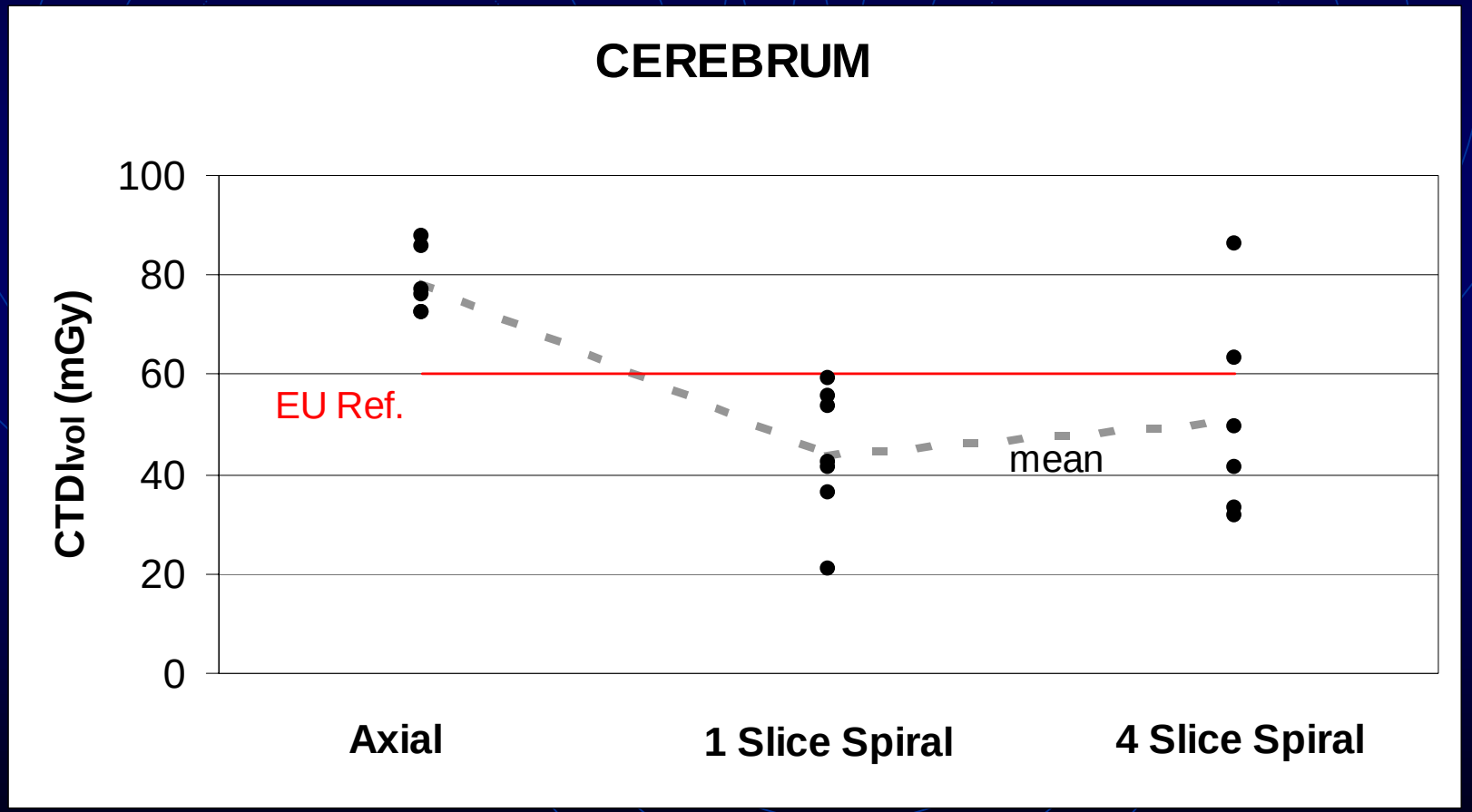
Progress and Further Work

- Some dose reduction on Marconi 4 slice scanner (Abdo down 20%)
- Construction of 3D detail phantom
- Resin spheres / polystyrene rods in water

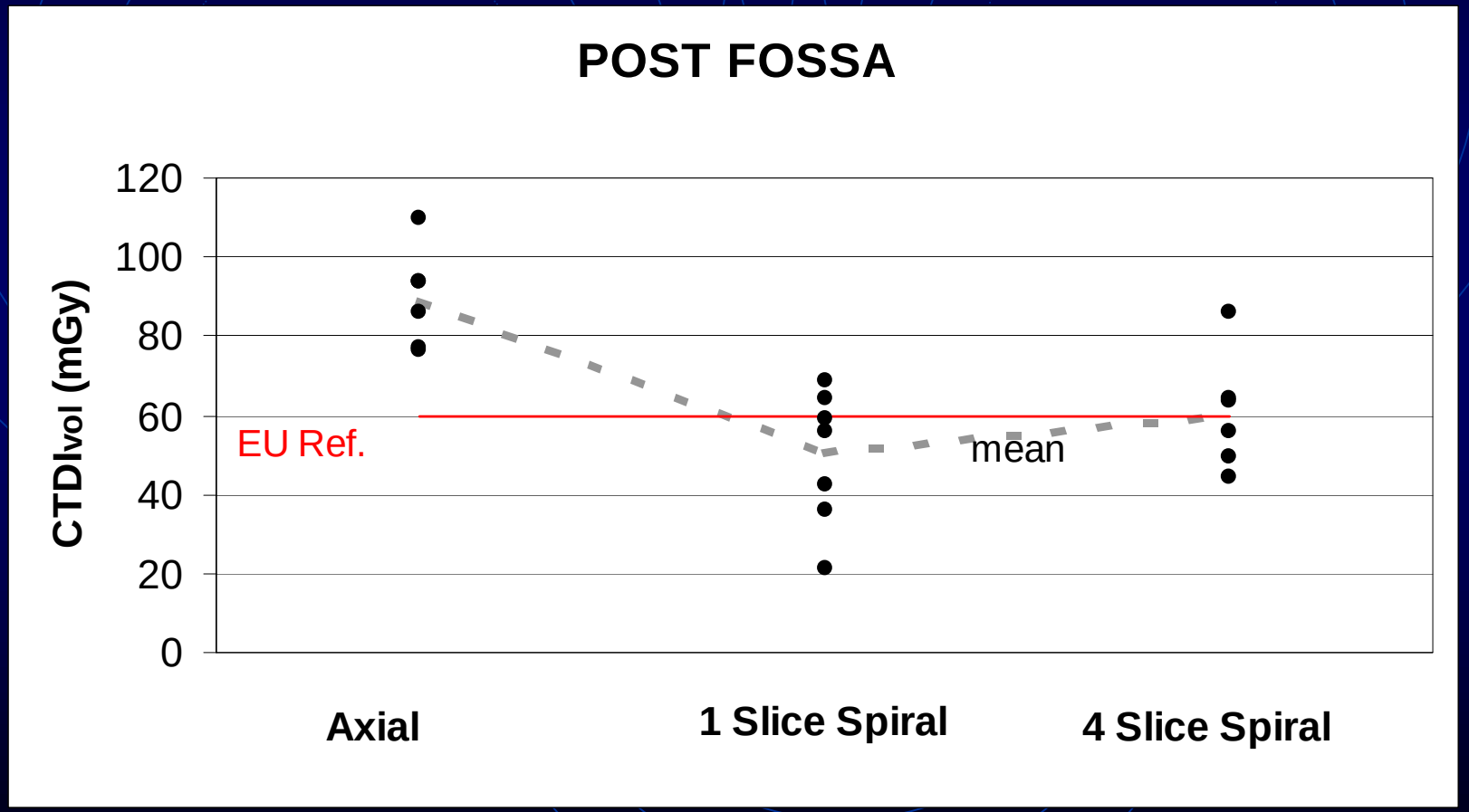
South West Region CT Dose Survey

- CTDIw measured on a range of scanners since 1999
- Intercomparison of CT chambers
- Radiographers asked for standard exposure factors for Head, Chest, Abdo, Pelvis

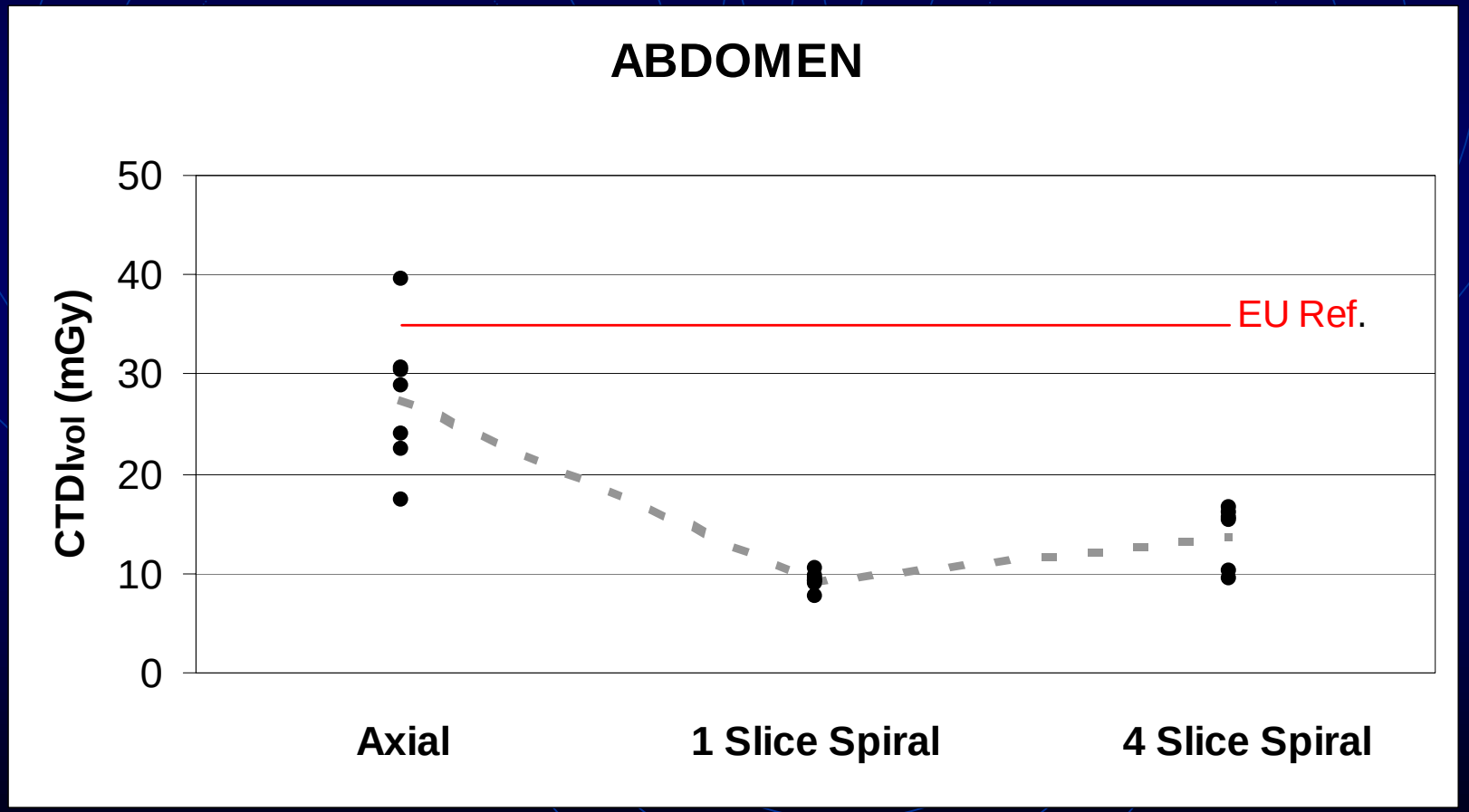
SW Regional Survey
$CTDI_{vol}$ for Standard protocols (1)



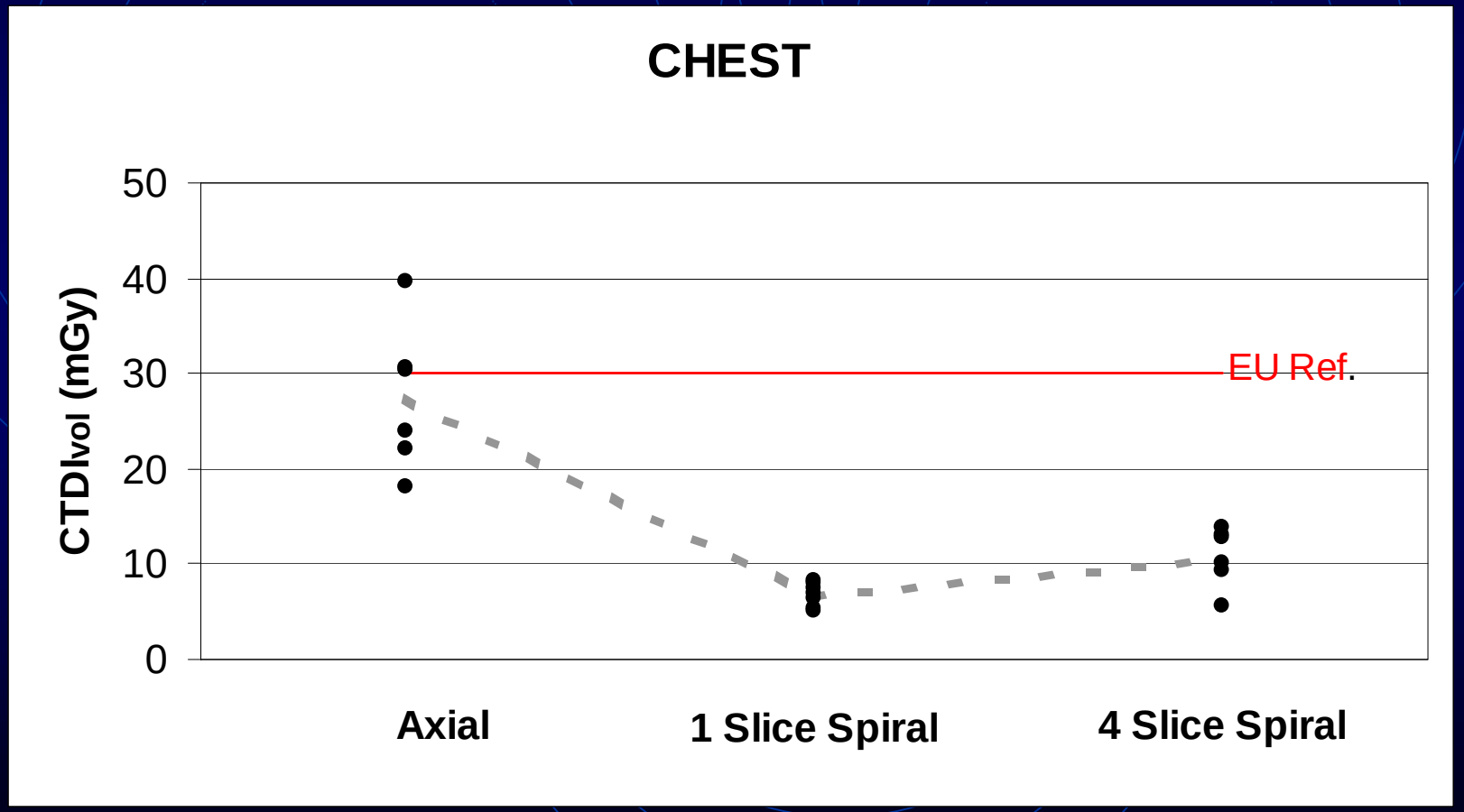
SW Regional Survey
$CTDI_{vol}$ for Standard protocols (2)



SW Regional Survey
$CTDI_{vol}$ for Standard protocols (3)



SW Regional Survey
$CTDI_{vol}$ for Standard protocols (4)



Conclusions 1

- Multislice CT typically uses thinner slices than existing single slice scanners
- This can give significantly higher doses which may not be justified for routine exams
- Multislice doses are, in general, lower than on older axial scanners

Conclusions 2

- Protocols should be optimised to reduce dose
- Image noise provides a simple method of assessing image quality
- Use of a 3D phantom may be required

Conclusions 3

- Multislice CT enables new / improved investigations which may justify the use of higher doses
- e.g. angiography, virtual colonoscopy
  major trauma, cardiology
- These protocols must still be optimised
- More sophisticated phantoms required ?

Discussion

(These comments are meant as discussion points, and do not necessarily represent the views of the presenter!)

"Good images sell scanners"

"What if the radiologist misses something?"

Discussion 2

"10mm slices, with an image noise of 'X' have been good enough for years, so there is no need for thinner slices and lower noise (and higher dose)"

"We have always needed thinner slices, but couldn't use them because the scanner was too slow"

Discussion 3

"The (body) doses are much lower than EU reference levels, so what's the problem?"

"Exposures must be optimised. By law."

"EU reference doses are out of date"

Discussion 4

“Phantoms must be used to test visibility of 3D objects, as this is the most relevant indicator of image quality”

“All exposures must be optimised. A simple technique is required (and 3D phantoms cost ££££s or lots of time)”

Discussion 5

“This is all too complicated. Just turn down the dose until the radiologist squeaks”