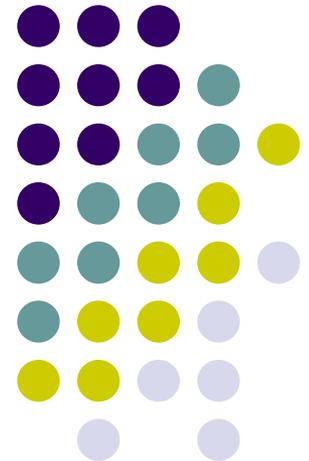
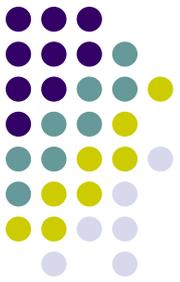


# A tale of three (identical) scanners

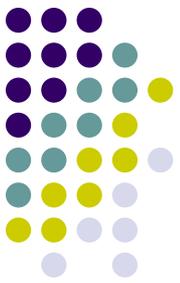
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**Gareth Iball, Lizzy Crawford, Samir Dawoud**  
Leeds Teaching Hospitals NHS Trust



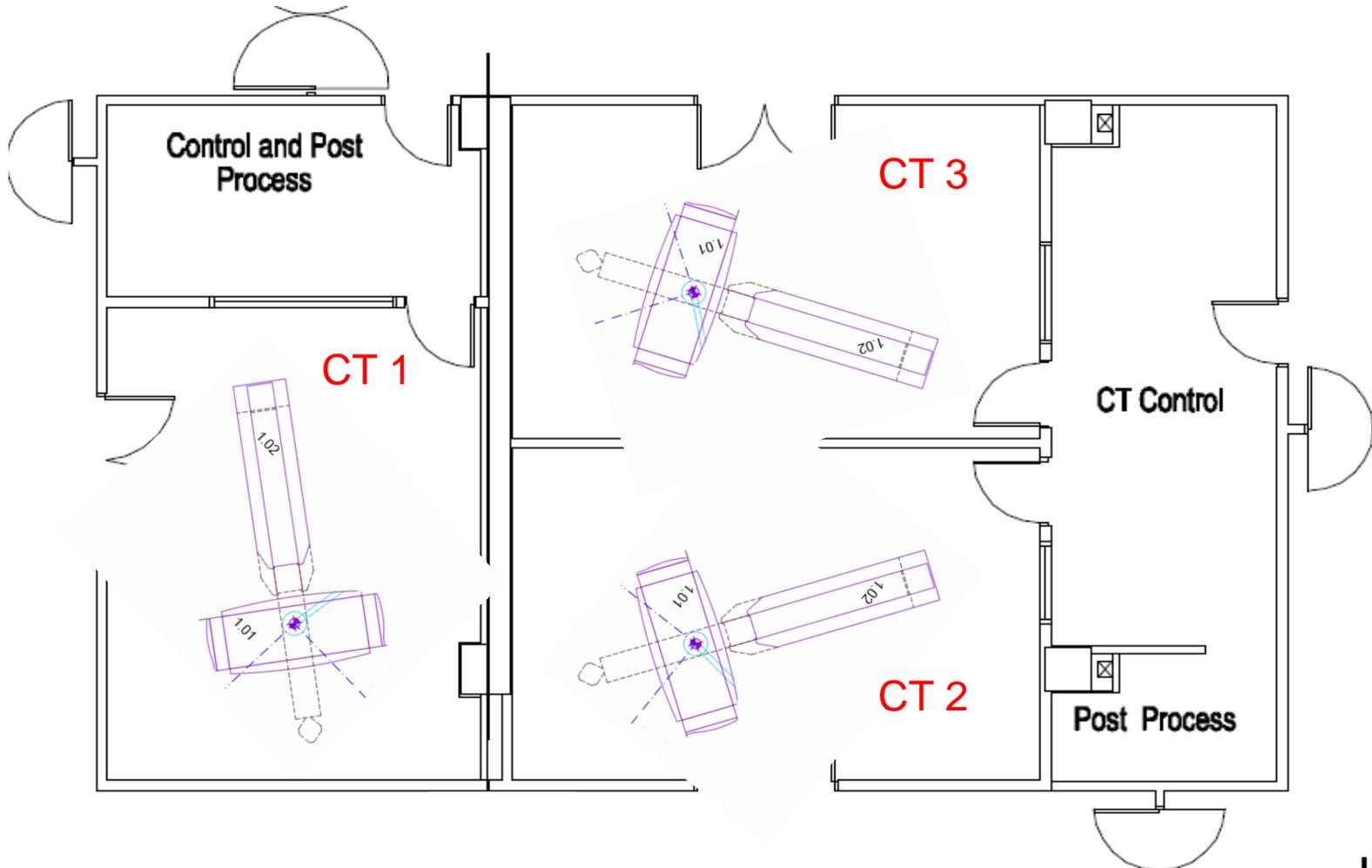
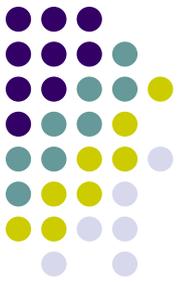
This is an edited version of the presentation  
that was given at the CT Users Group  
meeting.



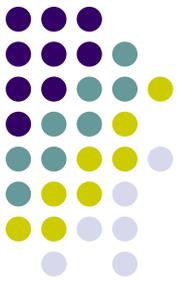
# Background

- October 2007: three Siemens Sensation 64 systems installed in new hospital wing
  - Serial numbers: 55220, 55224, 55226
- Commissioned by MPE – all results very comparable
- Protocols set up by Siemens on one scanner, copied across to other two systems
- Into clinical use January 2008

# Department layout

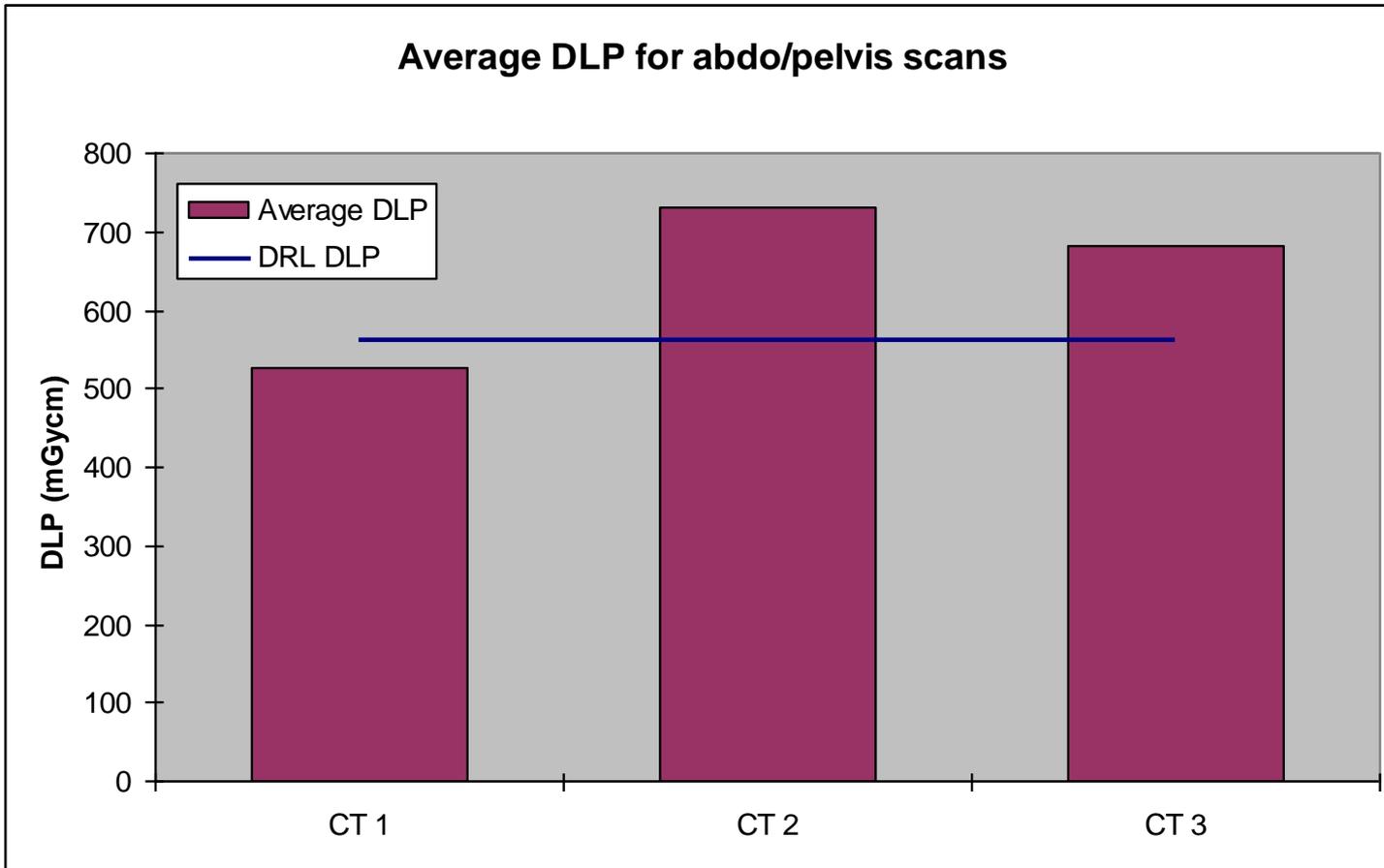
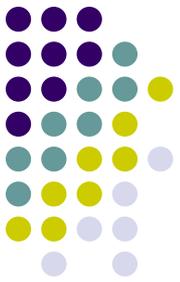


# Patient dose survey - 2008

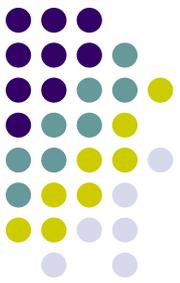


- Audit against current national DRLs
  - Head, abdo/pelvis, CAP, chest/liver, HRCT
  - No patient size information
  - Some comments on large/small patients

# Abdomen/pelvis scans



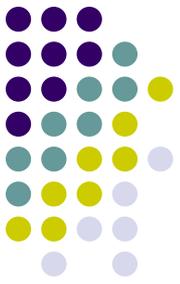
120kV, 200 Q.Ref mAs, 24x1.2mm, 5mm images, pitch = 1.4, CARE Dose 4D on



# Follow up

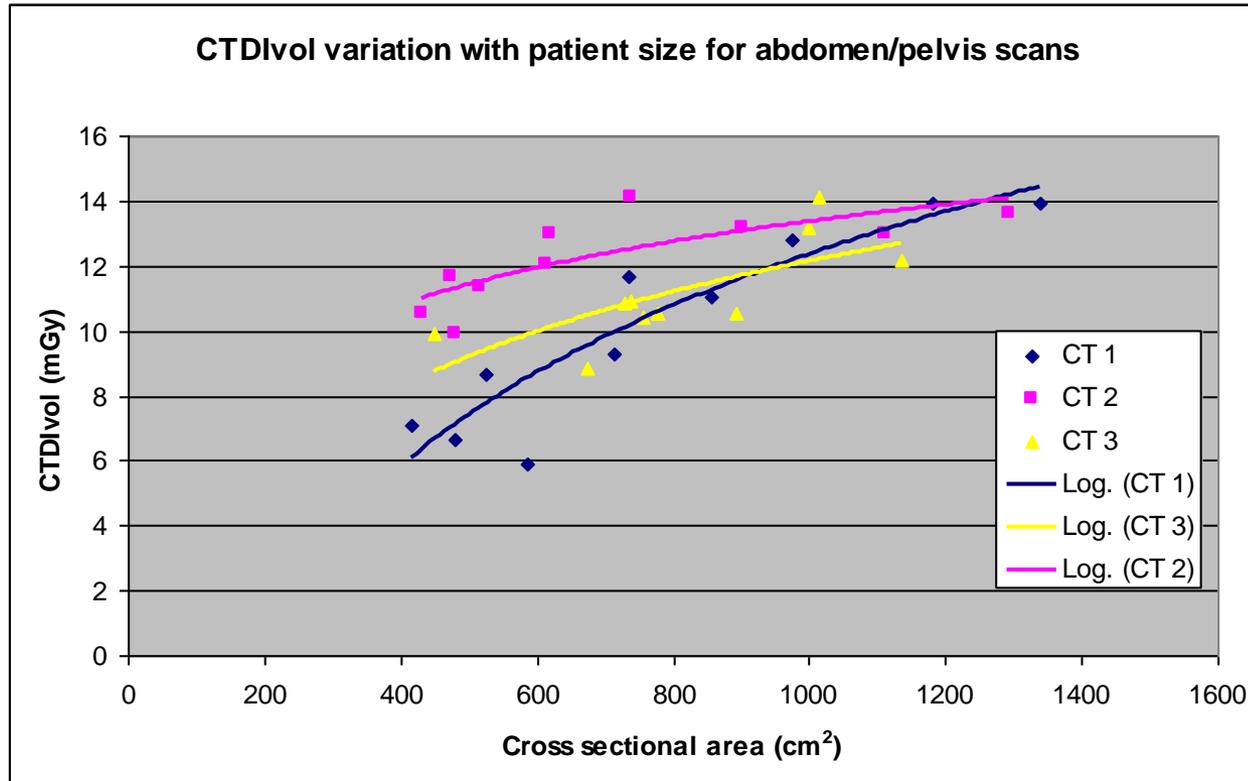
- Why the difference?
  - CT 2 – used for all ICU/HDU patients
    - Many scanned with arms down → higher doses
  - CT 3 – quite a few large patients in the sample
- Suggested lowering mAs to 180 Q.Ref mAs
- No subsequent image quality issues reported

# 3<sup>rd</sup> UK CT Dose Survey



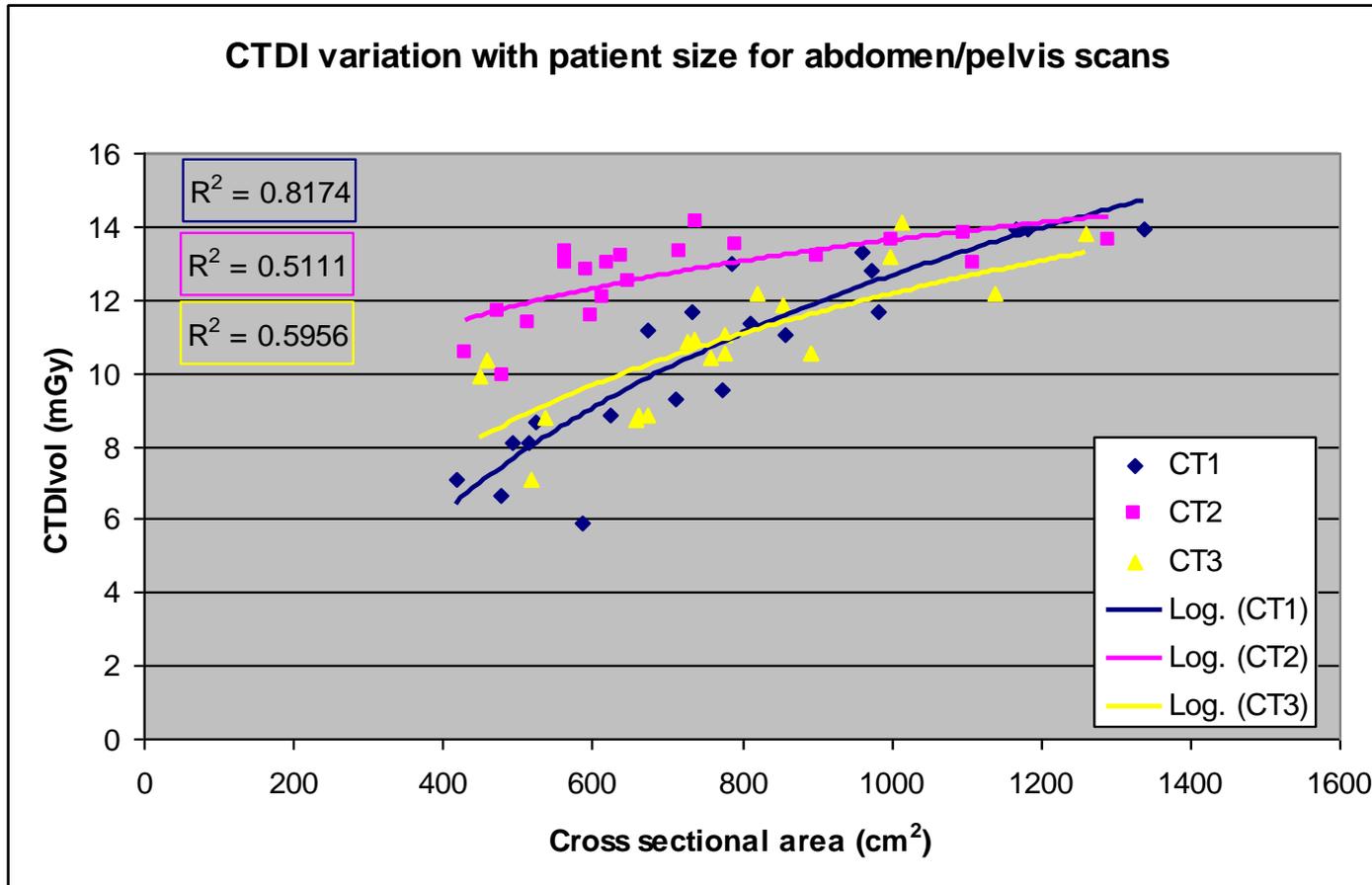
- Set trainees on abdomen/pelvis dose surveys from PACS
  - CT DIvol, DLP, AP & lateral sizes
- 30 patients from across the 3 scanners
  - Chose 10 patients from each scanner in order to compare
  - Found something strange...

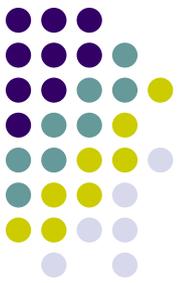
# His original data



- CTDIvol noticeably higher for small patients on CT 2
- All 'arms down' patients excluded from the data set

# With extra data

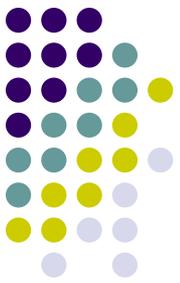




# Average CTDIvol figures

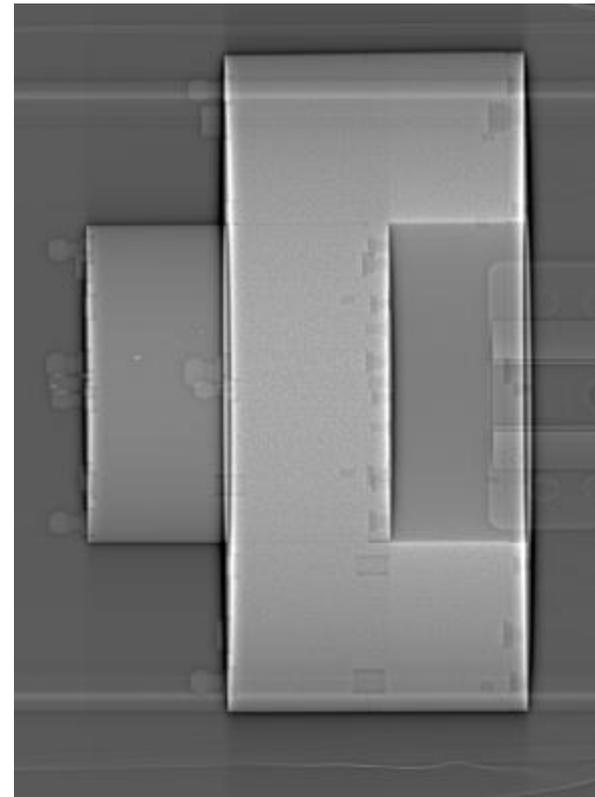
CTDIvol (mGy)	“Small”	“Average”	“Large”
CT 1	7.4	10.6	12.0
CT 2	11.8	13.1	13.4
CT 3	9.0	10.0	11.7

- Definitely something strange with CT 2
  - Suspect CARE Dose not functioning properly

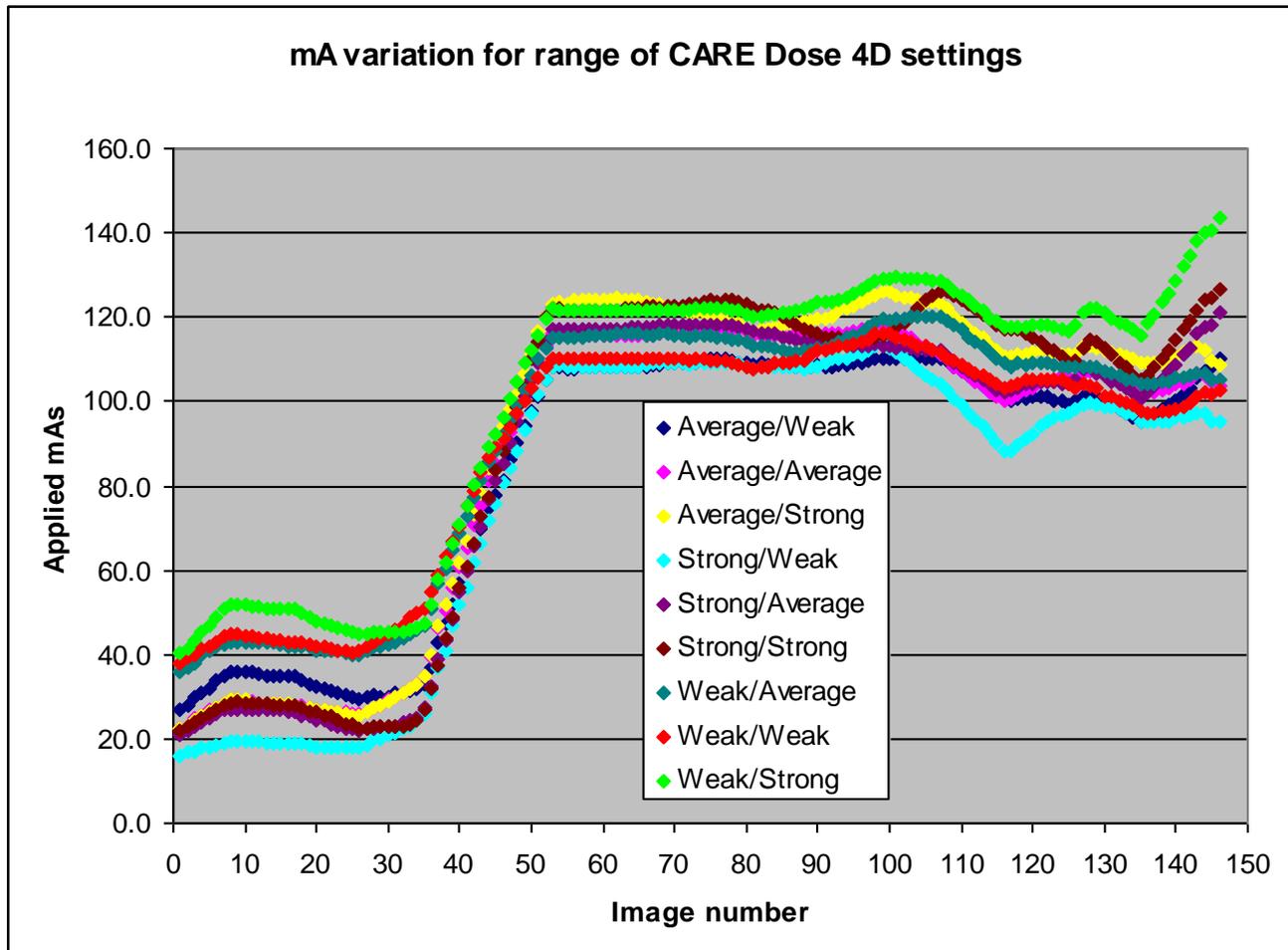
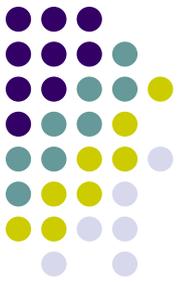


# Attempt at CT AEC testing

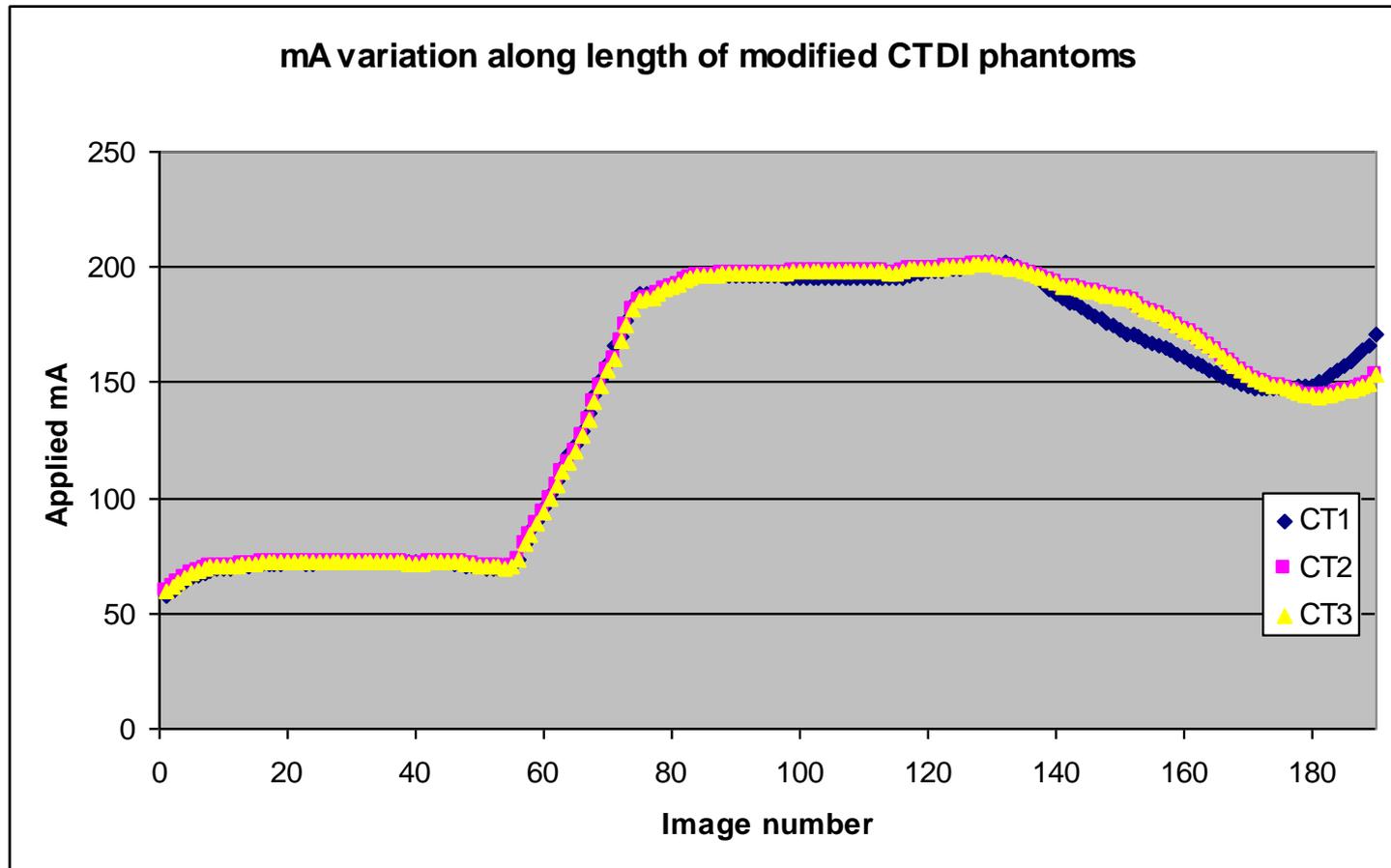
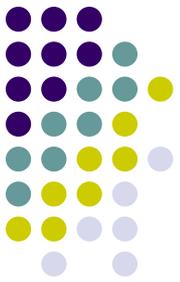
- Other trainees looking at method of routine AEC testing
- Modified CTDI phantoms
- mA values obtained using DICOM Info Extractor software



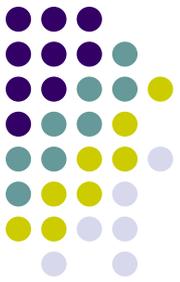
# Initial CARE Dose 4D tests



# CARE Dose 4D test



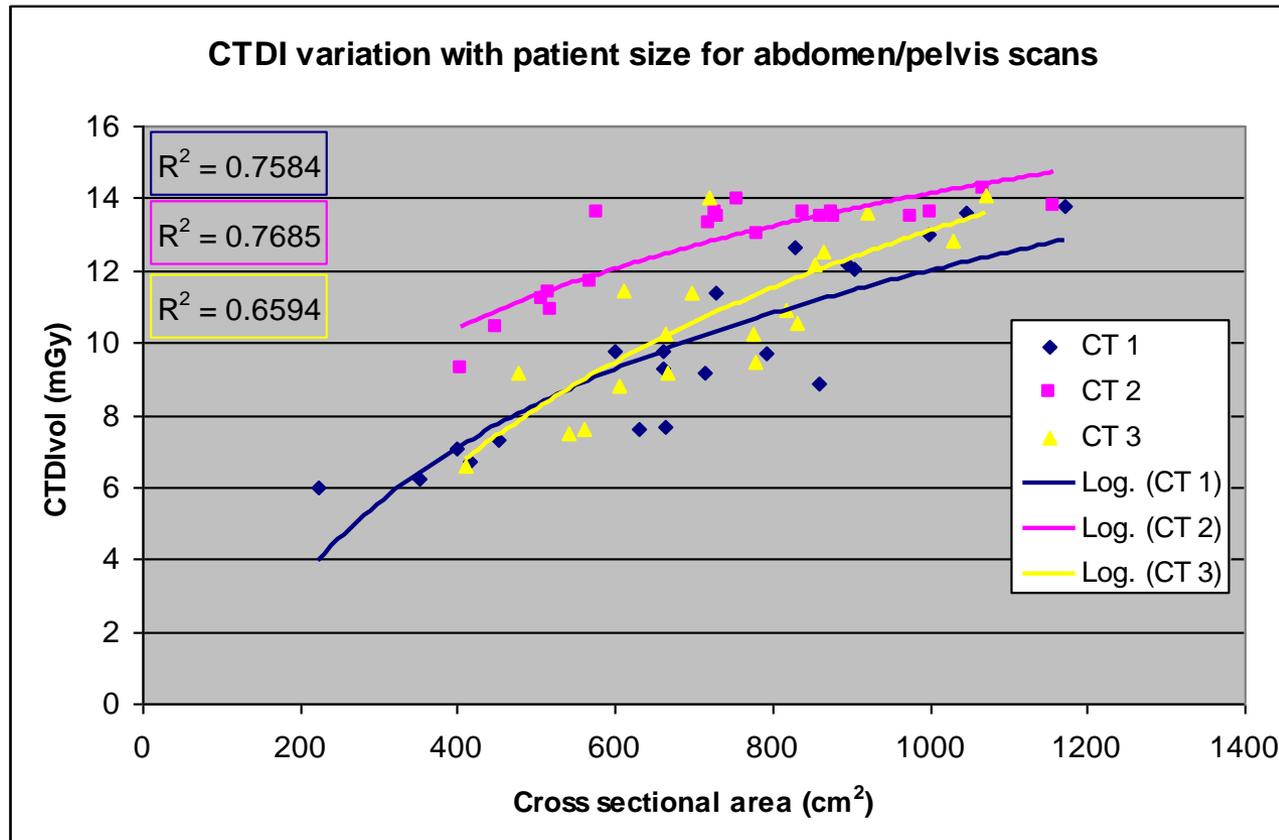
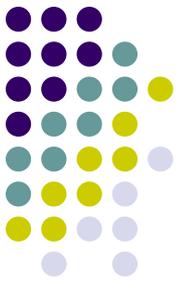
We'd used a chest protocol, but all seemed ok now?



# Check protocols

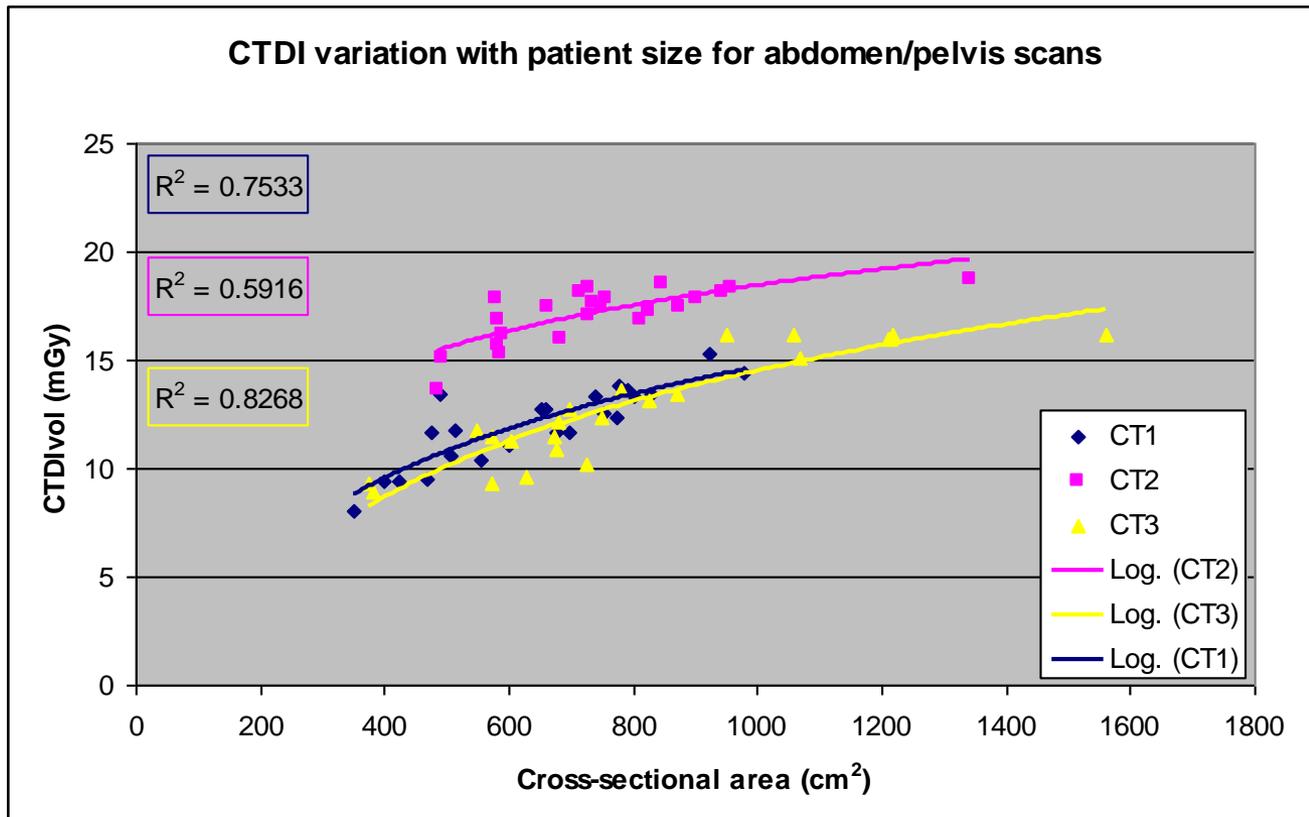
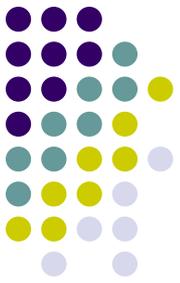
- Routine abdomen/pelvis:
  - 120kV, 180 Q.Ref mAs, 24x1.2mm, 1 & 5mm images, pitch = 1.4
  - CARE Dose 4D settings: Weak/Strong
  - Same on all the scanners

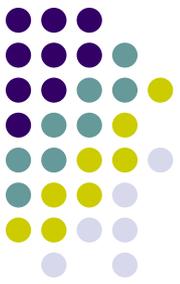
# Repeat dose survey



Data from the same week as we performed the CARE Dose 4D tests

# Retrospective doses – June '08



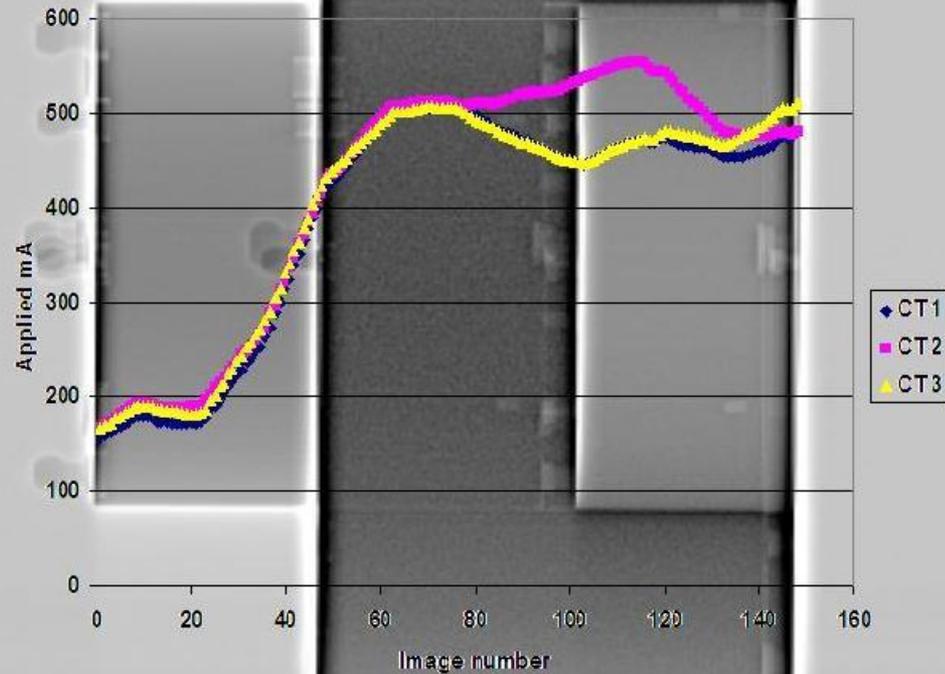
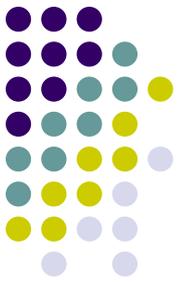


# Further investigations...

- All scans performed with clinical abdomen/pelvis scan protocol
  - Modified CTDI phantoms
  - Offset modified CTDI phantoms
  - CIRS virtually human pelvis phantom
  - mA variation
  - Noise measurements



# Modified CTDI phantoms



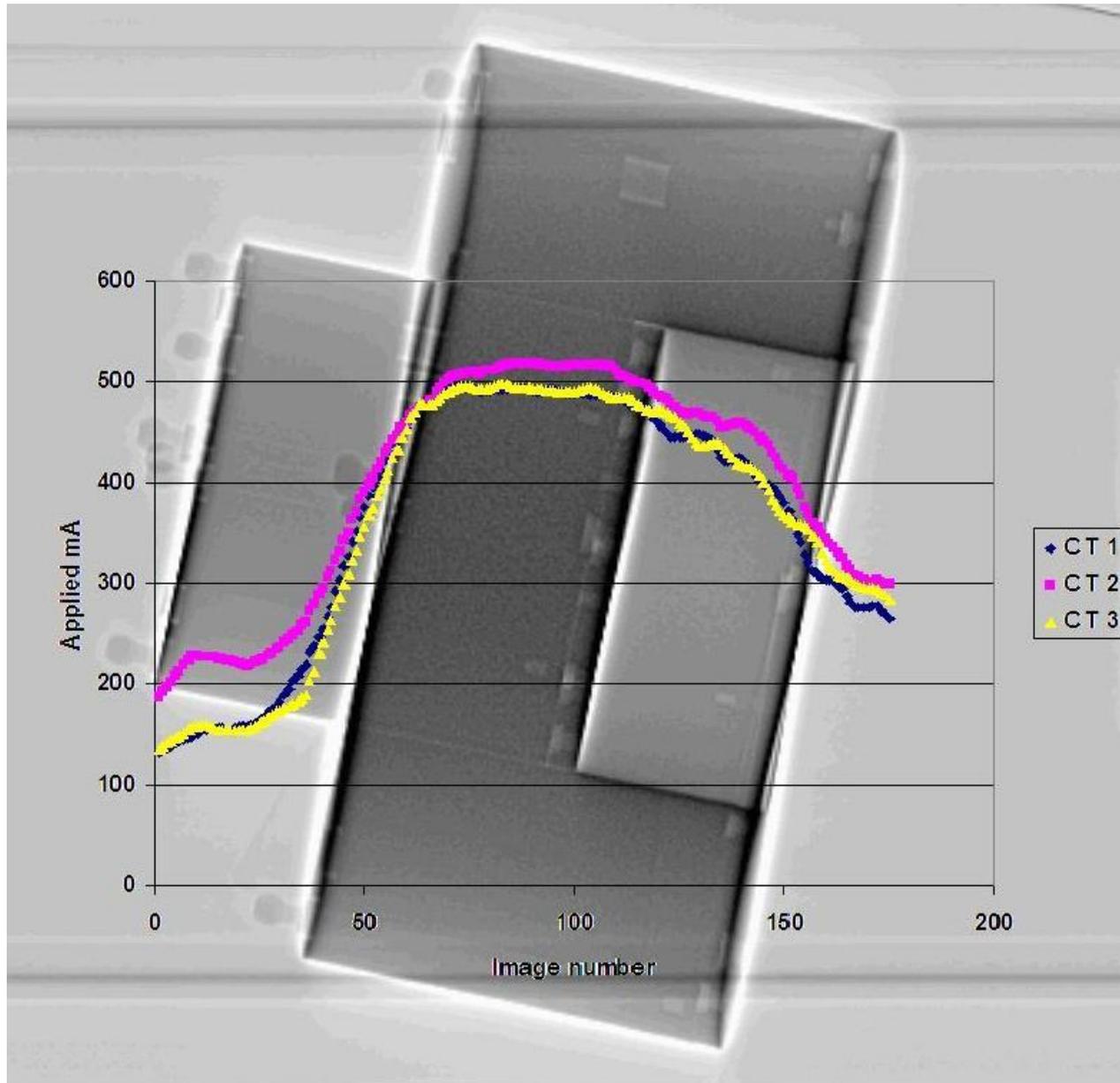
DLP (mGycm):

CT1: 263

CT2: 283

CT3: 276

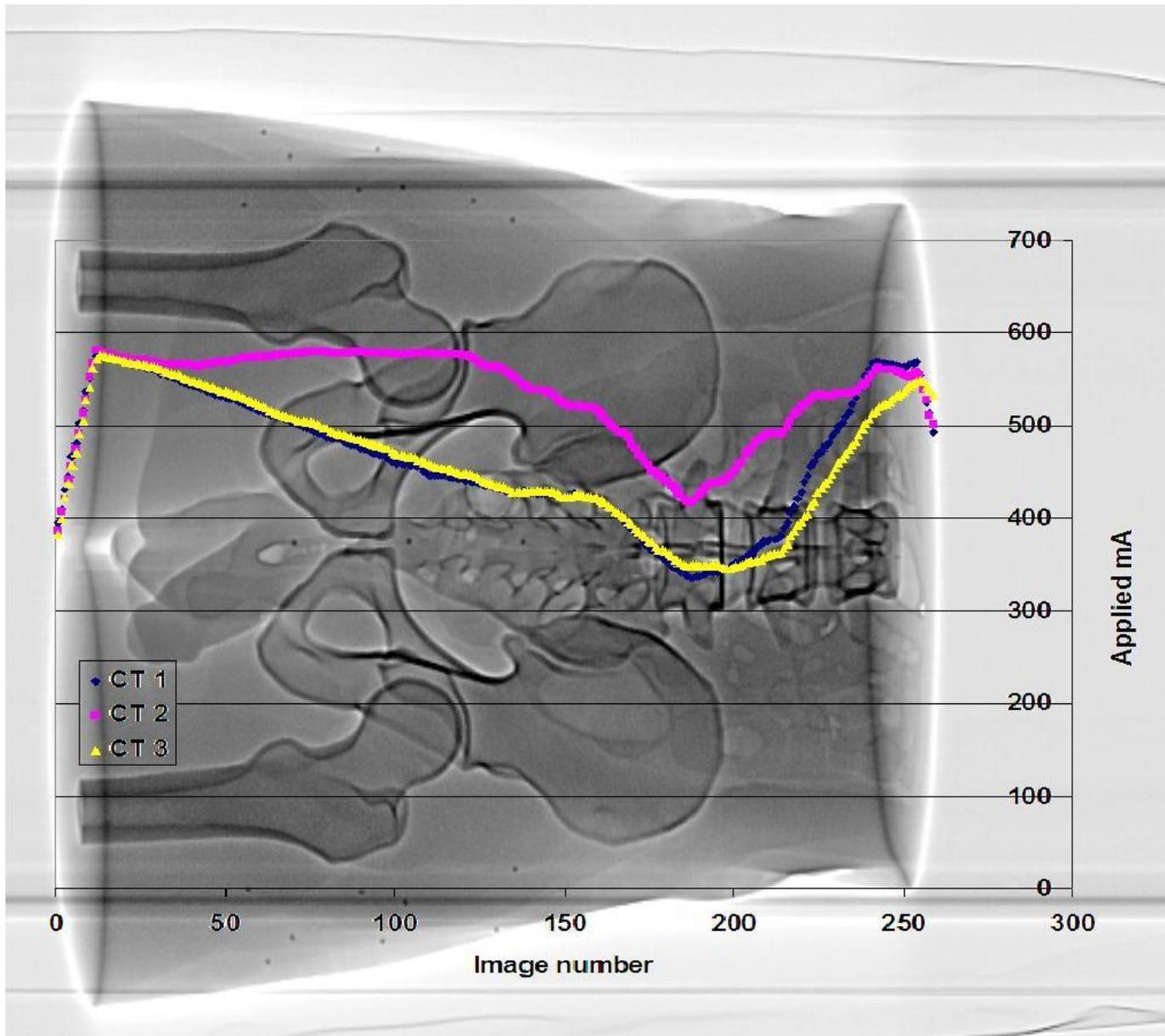
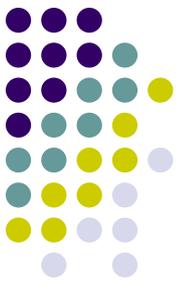
# Offset, modified CTDI phantoms



DLP (mGycm):  
CT1: 261  
CT2: 291  
CT3: 266

◆ CT 1  
■ CT 2  
▲ CT 3

# Pelvis phantom



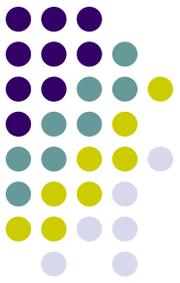
DLP (mGycm):

CT1: 482

CT2: 588

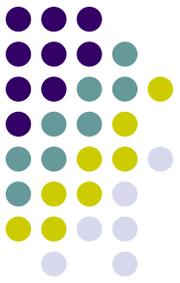
CT3: 504

# Noise measurements



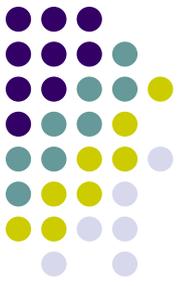
	CT number	Noise (s.d.)
CT 1	40.77	23.93
CT 2	41.98	19.73
CT 3	44.12	24.84

# Investigations with Siemens



- Day 1:
  - MPE AEC tests performed again – same results
  - Siemens performed their CARE Dose 4D – all ok
  - Still no clearer

# Suggestion from Siemens

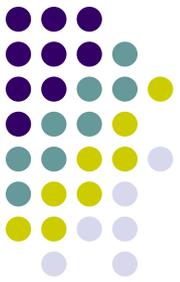


“One possibility for the observed behaviour is, that the scan protocols used at the three scanners, although having the same scan parameter settings, may originate from different Siemens protocols.

The mAs adaptation of CARE Dose 4D is based on the ref. mAs and the **related reference attenuation**. The latter is stored in the system and depends on the body part for which the original Siemens protocol was built.

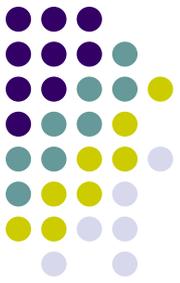
If for instance the protocol at scanner 2 is based on a thorax protocol, while the protocols at scanners 1 and 3 are based on a pelvis protocol, the dose at scanner 2 will be higher, because the ref. mAs at scanner 2 is related to the typical attenuation of a thorax, while the ref. mAs of scanner 1 and 3 is related to the (higher) attenuation of a typical pelvis.”

# Recommended test



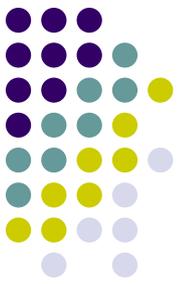
“Use for a test the same original Siemens protocol (e.g. Pelvis Routine) for all three scanners and scan the pelvis phantom (accurate phantom positioning is essential) - is the dose now identical?”

# Investigations with Siemens

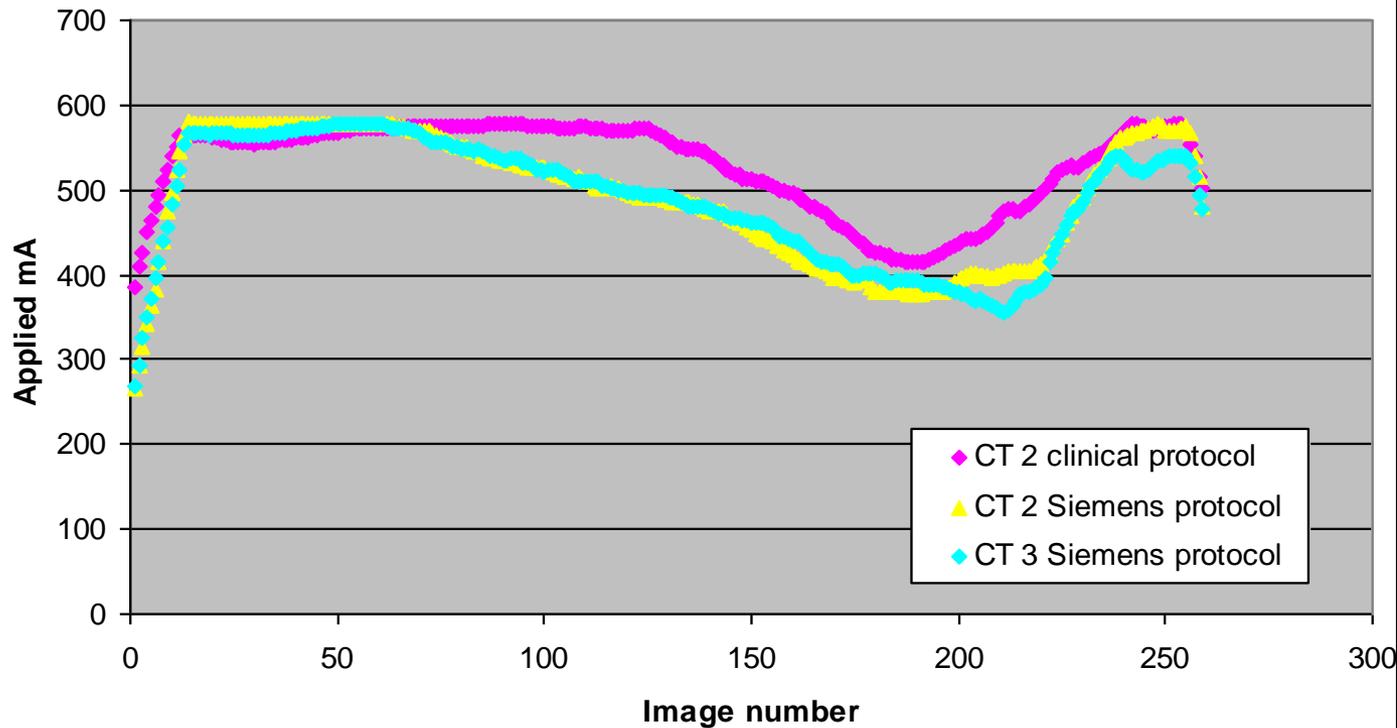


- Day 2:
  - Scan pelvis phantom on clinical and Siemens standard protocols

# Protocol comparison



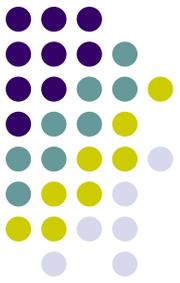
mA variation along the length of the CIRS pelvis phantom



DLP (mGycm):  
CT2 clinical: 588  
CT2 Siemens: 551  
CT3 Siemens: 551

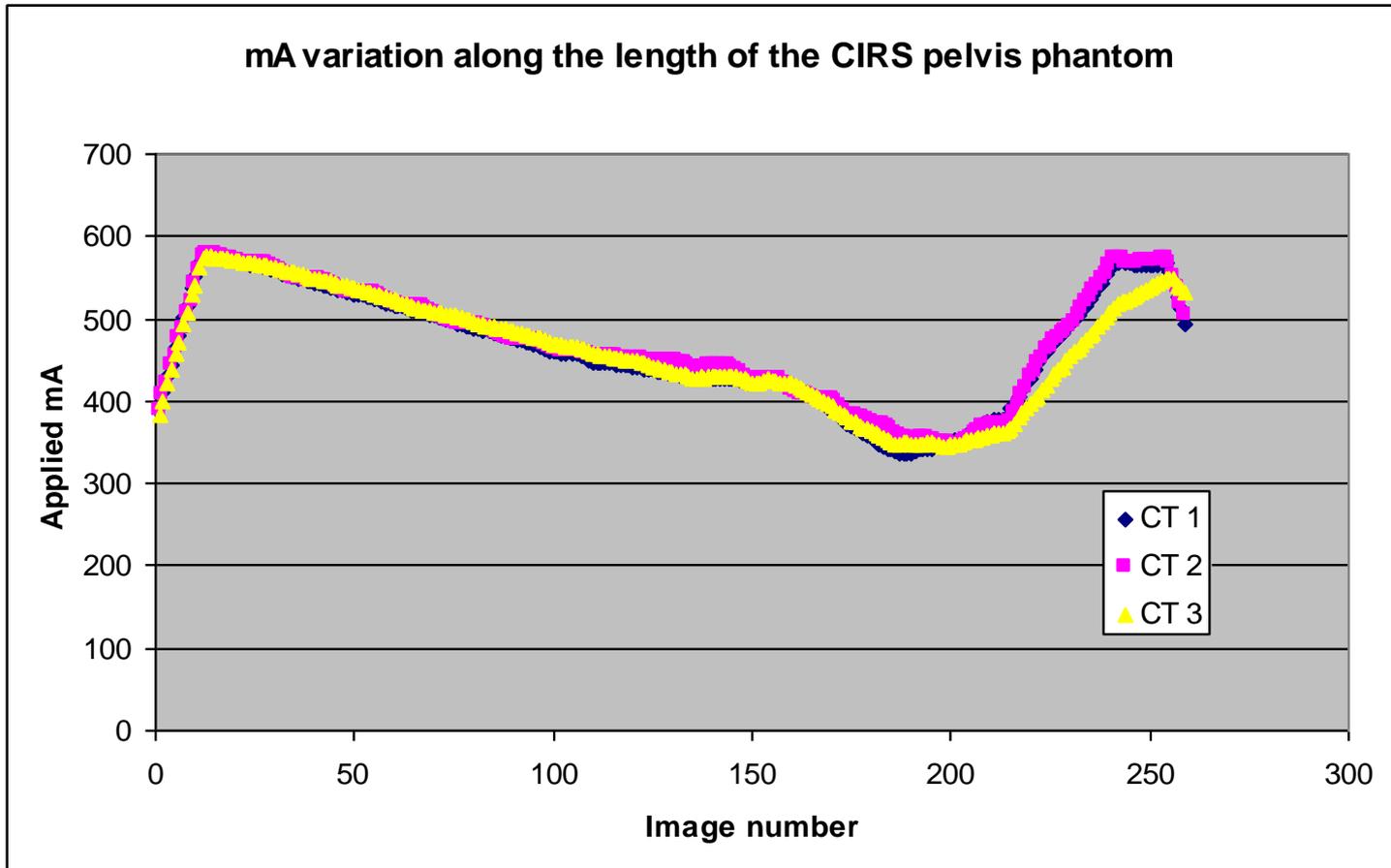
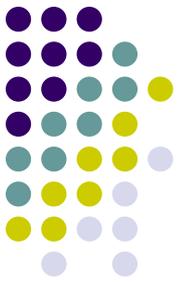
Shows no problem with CARE Dose but a protocol problem. Siemens were correct

# Investigations with Siemens



- Day 3:
  - Delete all scan protocols from CT 2 and replace with scan protocols from CT 3 (hoping that there were no other protocol errors on CT 3...)

# After protocol replacement



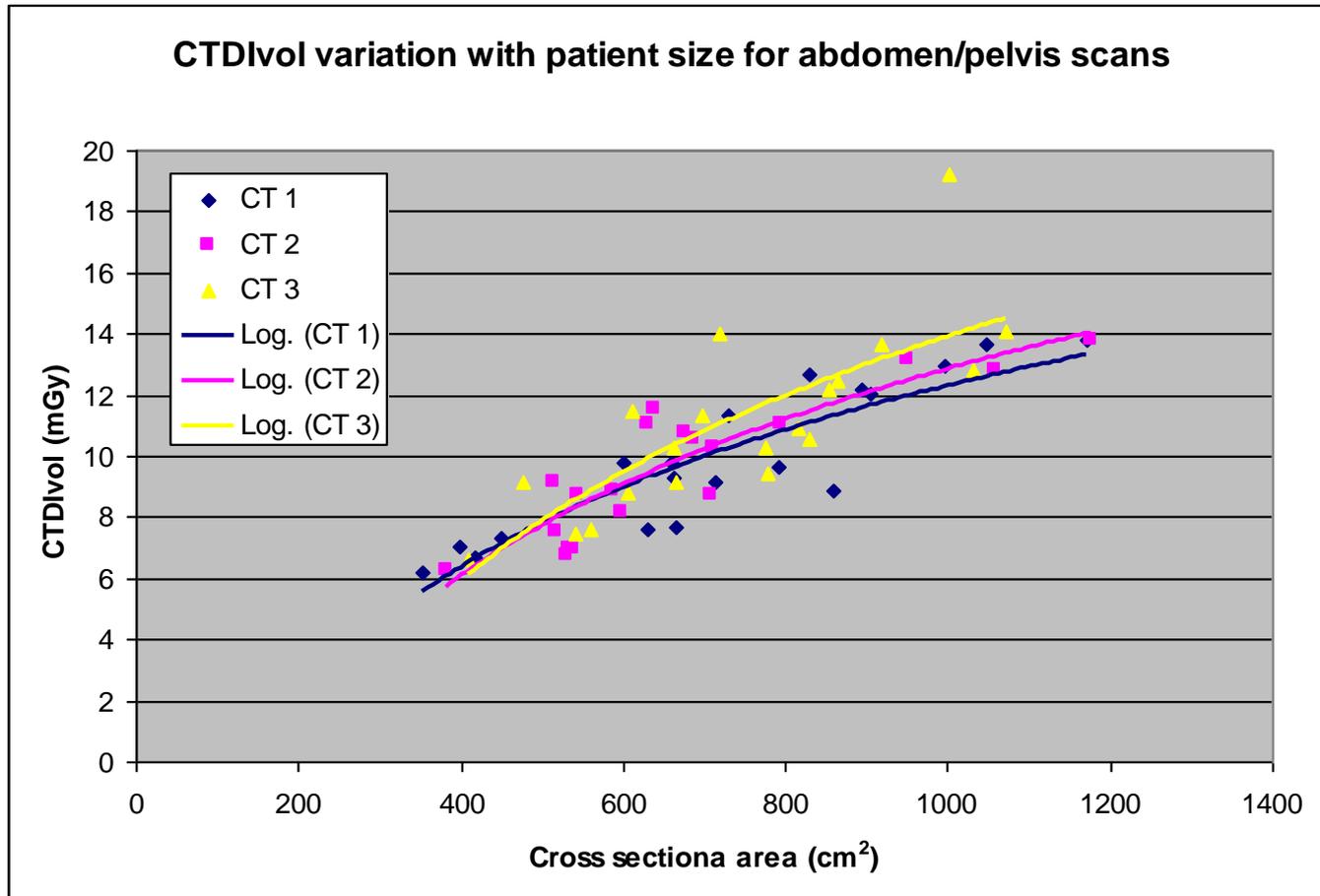
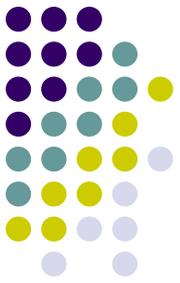
DLP (mGycm):

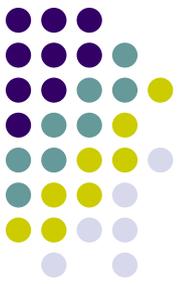
CT1: 482

CT2: 493

CT3: 504

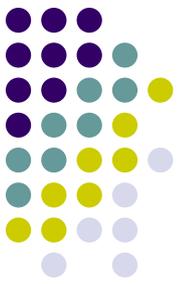
# Follow up dose survey





# Summary

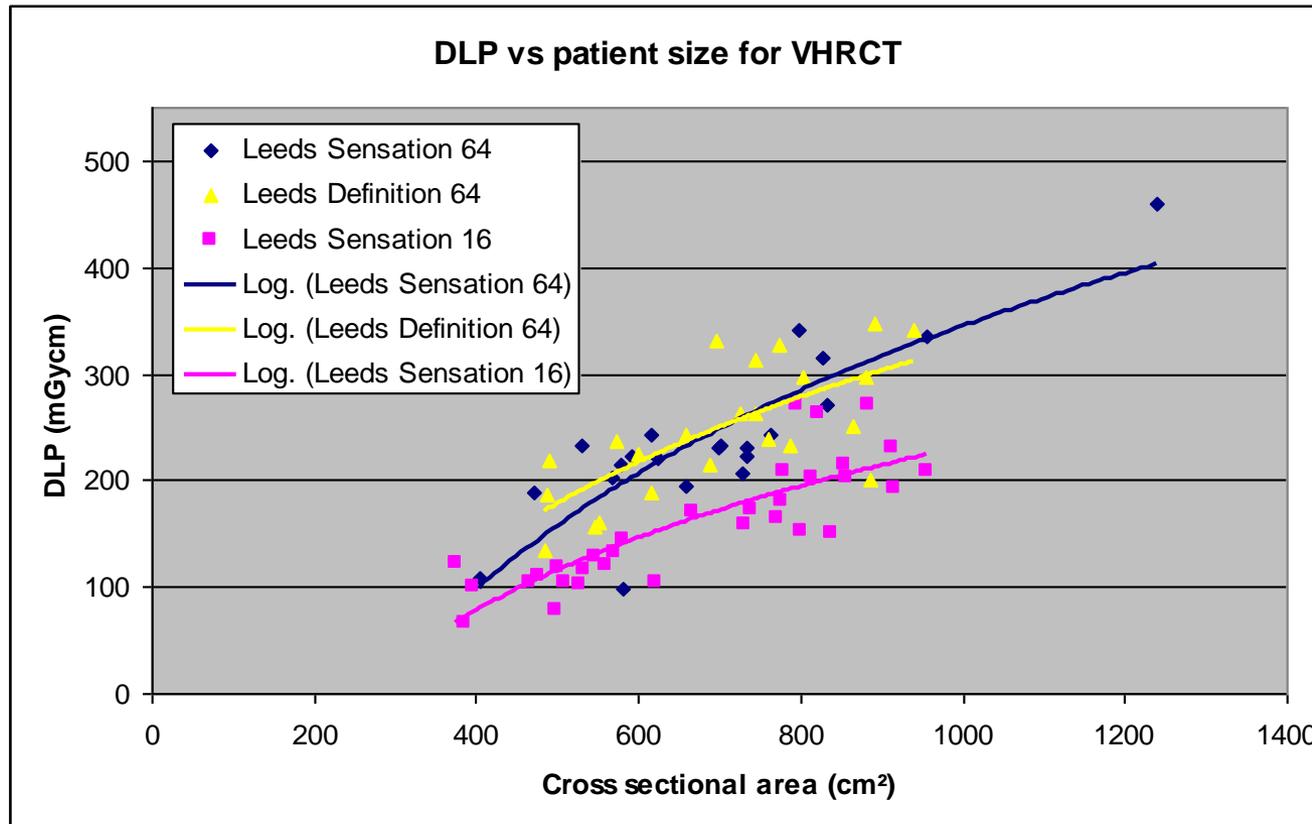
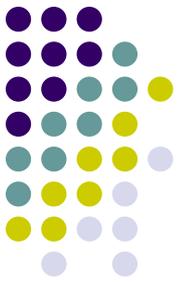
- Even though the protocols appeared identical they were very different!
- Reference attenuation is different for each body part and affects dose significantly
- No display of the body part on which a protocol is based
- Problem only identified because we have 3 identical scanners



# Implications for Leeds

- Protocols to only be created/amended by CT Team Leaders
- More regular & robust patient dose audit programme
- Need a system for regularly auditing scan protocols – IR(ME)R requirement
  - How?? We have 13 scanners in Leeds Trust alone, maybe 50-100 protocols per scanner...

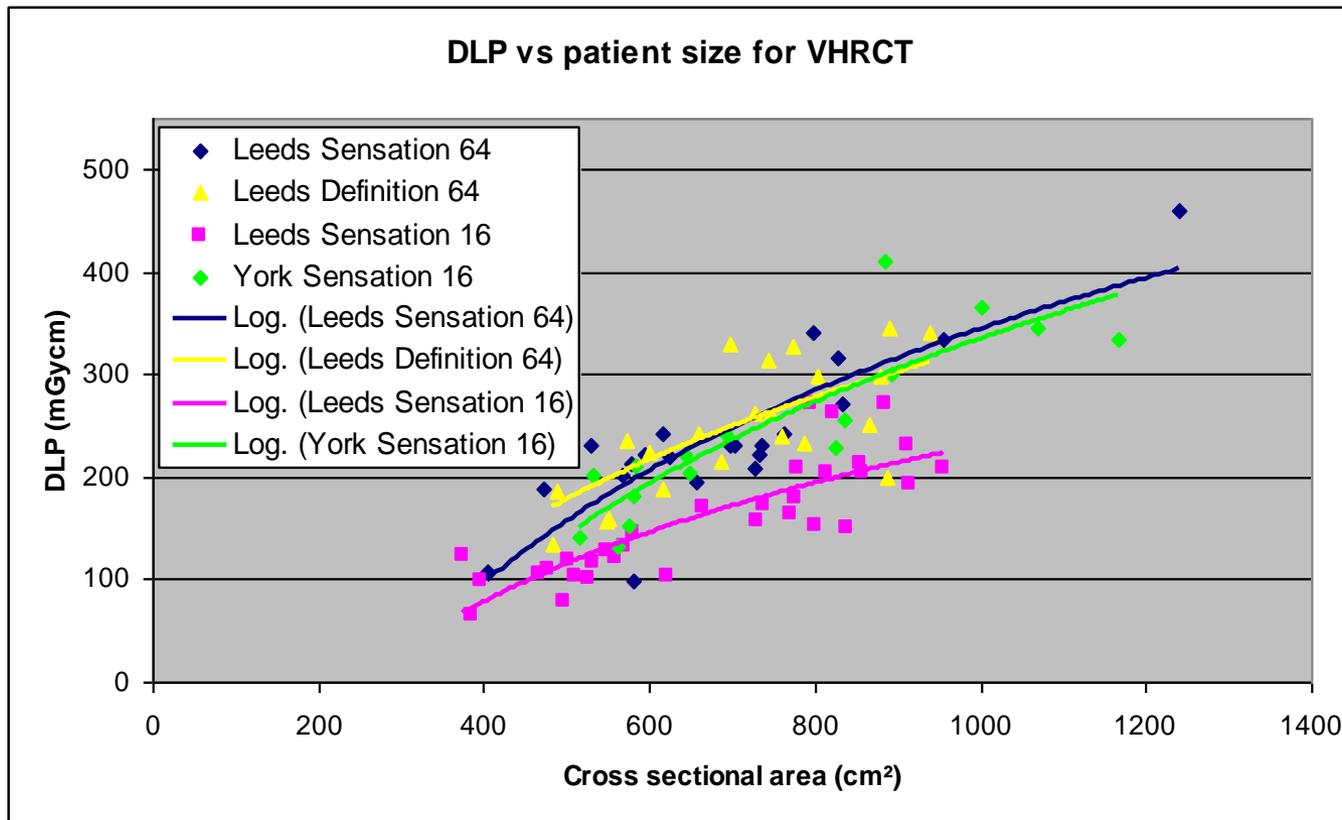
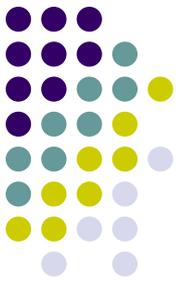
# Could it happen elsewhere?



64 slice: 120kV, 100 Q.Ref mAs, 64x0.6mm, pitch=1.2, CD4D: Weak/Strong

16 slice: 120kV, 100 Q.Ref mAs, 16x0.75mm, pitch=0.85, CD4D: Average/Average

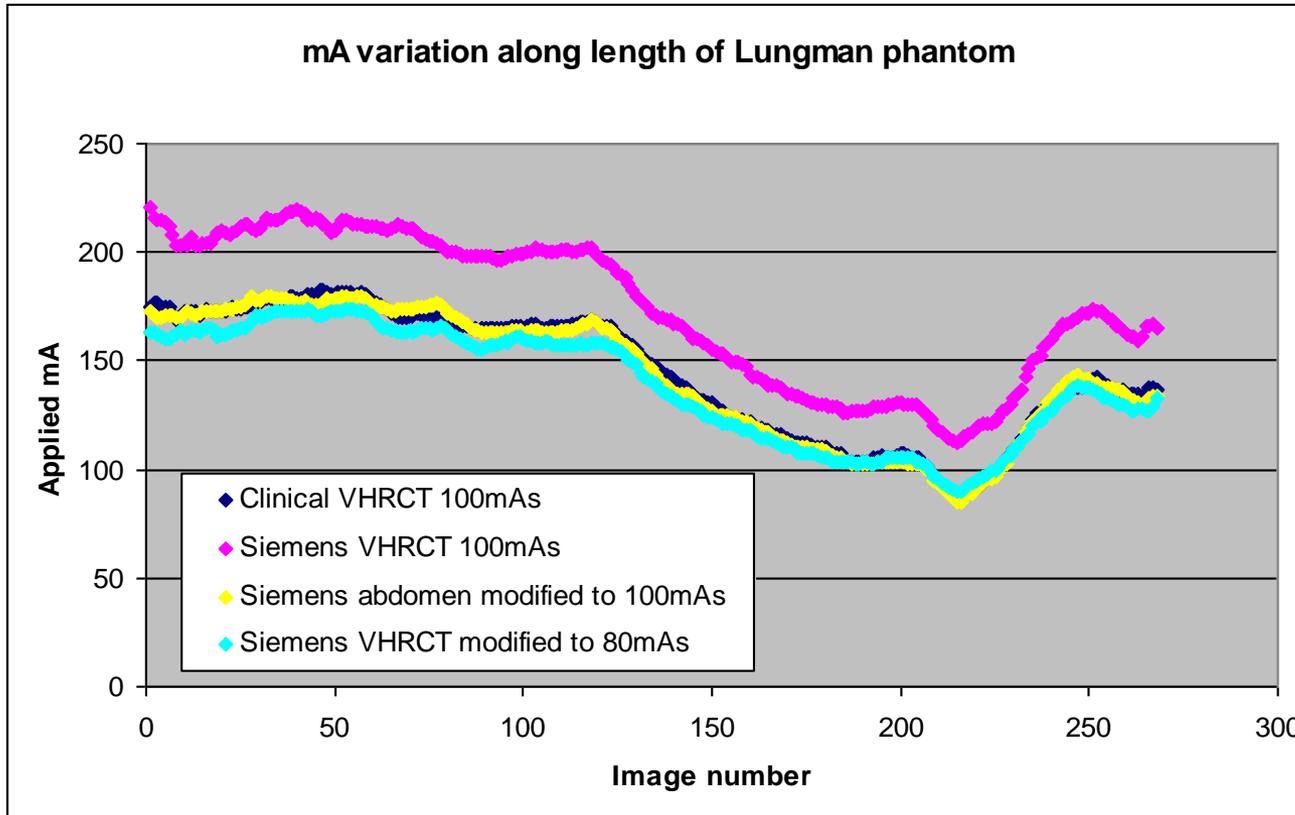
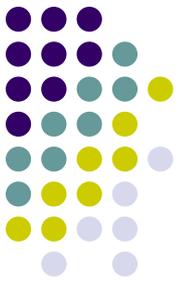
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64 slice: 120kV, 100 Q.Ref mAs, 64x0.6mm, pitch=1.2, CD4D: Weak/Strong

16 slice: 120kV, 100 Q.Ref mAs, 16x0.75mm, pitch=0.85, CD4D: Average/Average

# Scan Lungman phantom

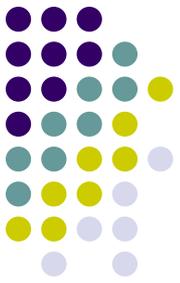


DLP Clinical = 203  
DLP Siemens = 250  
DLP Abdomen = 203  
DLP Siemens 80mAs = 197



No complaints from Radiologists about the image quality on this scanner.

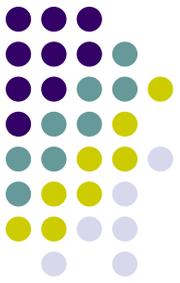
All Siemens scanners in Trust using 100 Q.Ref mAs for VHRCT. Can we now reduce them all to 80mAs to match the dose on the 16 slice machine?



# Conclusions

- Siemens protocols built for specific body parts & shouldn't be used for anything else
- Raised a lot of issues for ourselves and Siemens
- Working through how to address them all
- It could be happening to you

# Thanks to



Gillian Ward, Becky Artschan, Dan Shaw  
(Medical Physics, LTH)

Altan Senvar, Paul Playford, Anna Sedgwick  
(Siemens Healthcare UK)