

# Eye Doses in Head CT; Sequential Vs Spiral

CT Users Group October 2010

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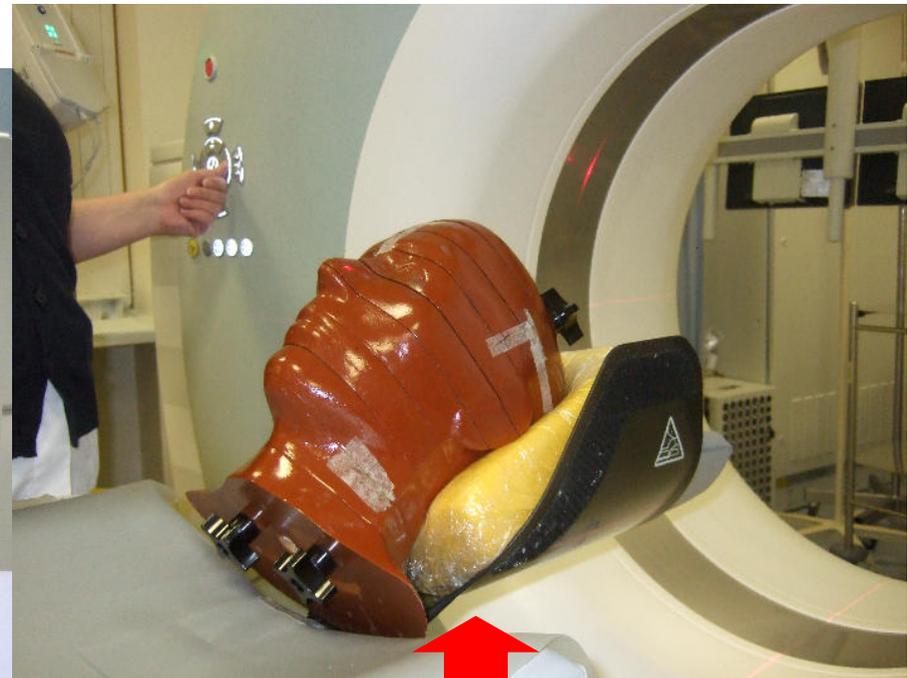
## Synopses

- CT head scanning at Portsmouth
- Why look at eye doses in head CT?
- Why choose Spiral over Sequential?
- ImPACT assessment of eye doses
- TLD assessment of eye doses
- Topogram Eye doses
- Review of patient images (scan positions)
- Individual patients receiving multiple head scans

## Routine Head Scans

- Clinical Preference is to change from routine head sequential scans to Routine Spiral scan
- Lead radiographer in CT has produced scan protocol for spiral scans, but sought Medical Physics advice on eye doses before change was fully implemented
  - PHT historically had two 4 slice VZ scanners – almost all head scans were sequential
  - PFI has introduced additional scanners to QAH site (one 40 slice, one 128 slice in addition to one of the old 4 slice scanners) this has come with a move towards increasing spiral scanning
  - Old 4 slice rarely used for Routine heads (occasional use if volume needs arise), these are done routinely on the 40 and 128 slice

## Siemens Sensation 40



Siemens Definition AS+  
128

Portsmouth Hospitals NHS Trust

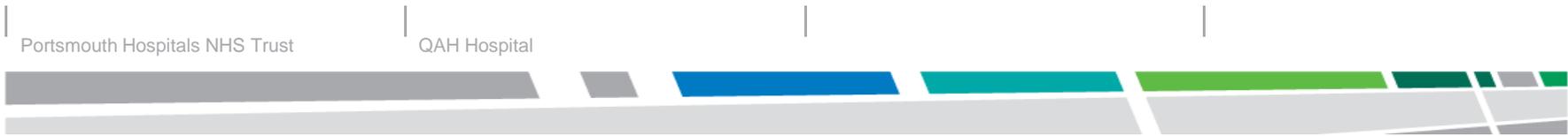
QAH Hospital



Why look at eye doses in head CT.....

## Importance of Eye doses

- Lens of the eye is known to be radiosensitive (ICRP 103 data)
  - Detectable opacities form with chronic exposure  $>5\text{Gy}$ , or  $>100\text{mGy/yr}$
  - Acute exposure  $>500\text{mGy}$
- NICE guidelines suggest that CT should be used instead of skull x-ray for head injuries
- Increase in use of CT scanners for head exams – 50% increase in last 5 years
- Recent papers suggest that lens damage could be without a threshold and so doses should therefore be ALARP

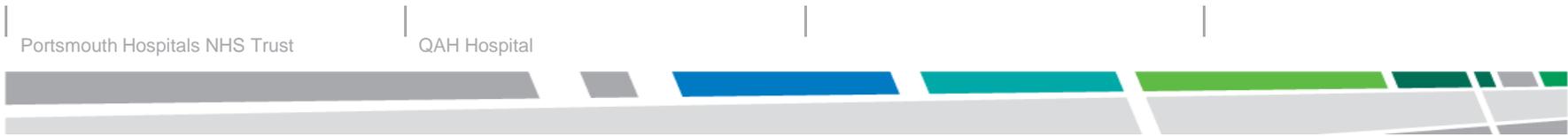


Why choose Spiral over Sequential.....

## Sequential Vs Spiral scanning

- Why scan sequentially?
  - Potential for significantly lower eye doses.....The scanner can be tilted to avoid the eye. Together with tilting the patients head should allow the eye to be excluded from the scan in the majority of cases (with good radiographic practice)
  - Useful for stroke patients
- Why scan spiral?
  - Spiral scans can be reconstructed in any orientation giving valuable clinical information not available with sequential scans
  - Greater flexibility with straightening up scans if patient is not properly aligned
  - Useful for dementia diagnosis (reconstruct along the line of the silvian fissure – shows temporal lobe abnormality)

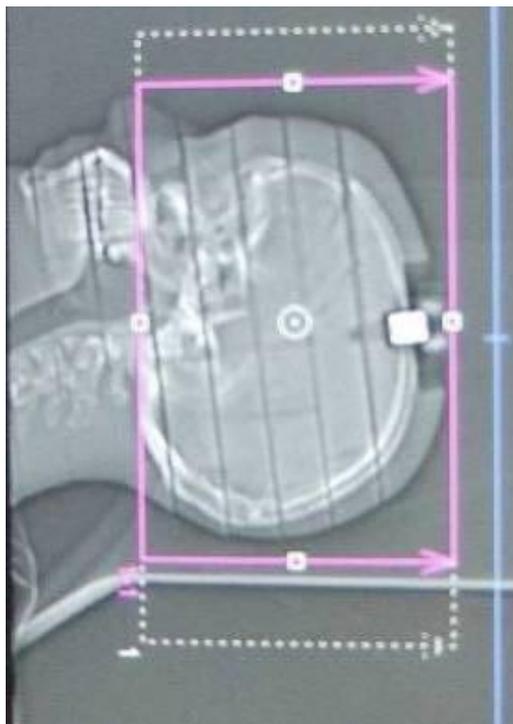
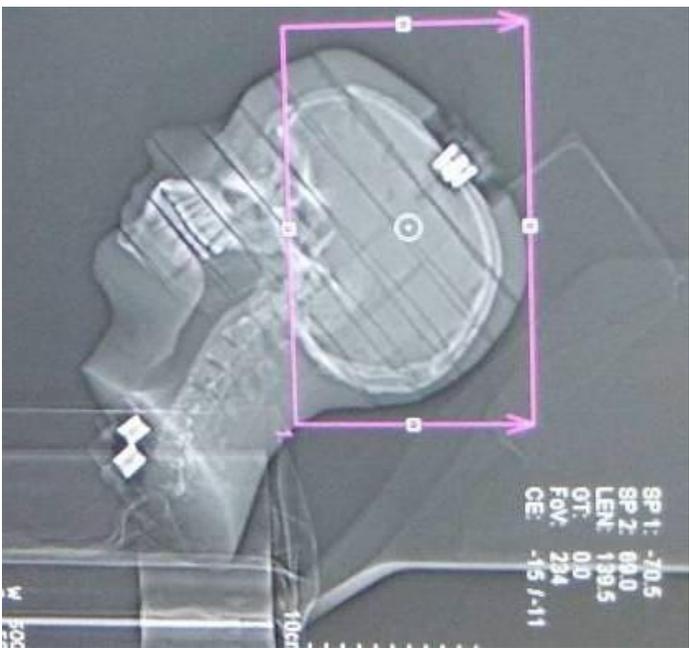
The image displays a medical CT scan software interface. At the top, three axial CT slices of a head are shown. The left slice is labeled 'HPL', the middle 'AHR', and the right 'HRA'. Each slice includes patient information: '10.05.27-18:10:55-DST-Specl... 18/11/1958, O, 151Y' and the date '27/05/2010'. The slices are overlaid with a 3D wireframe box and a 10cm scale bar. The middle slice is highlighted with a pink border. Below the slices is a control panel with various icons for navigation and reconstruction. The panel includes a 'Resolution' dropdown set to '512 square', a 'Planning base' dropdown set to 'HEAD ACQUISITION AXIAL H', and a 'Total mAs' value of '5069'. The main control area is titled '1A\_SPIRAL\_BRAIN (Adult)' and contains a 'Topogram' section with a 'Head' button. Below this, there are several settings: 'Recon job' (1-8), 'Series description' (TRUE AXIAL H41s), 'Recon job type' (axial, 3D), 'Recon axis' (oblique), 'Image order' (Feet to head), 'Position increment' (4.0 mm), 'No. of images' (39), and 'Comments'. At the bottom, there are buttons for 'Recon' and 'Auto Tasking'.

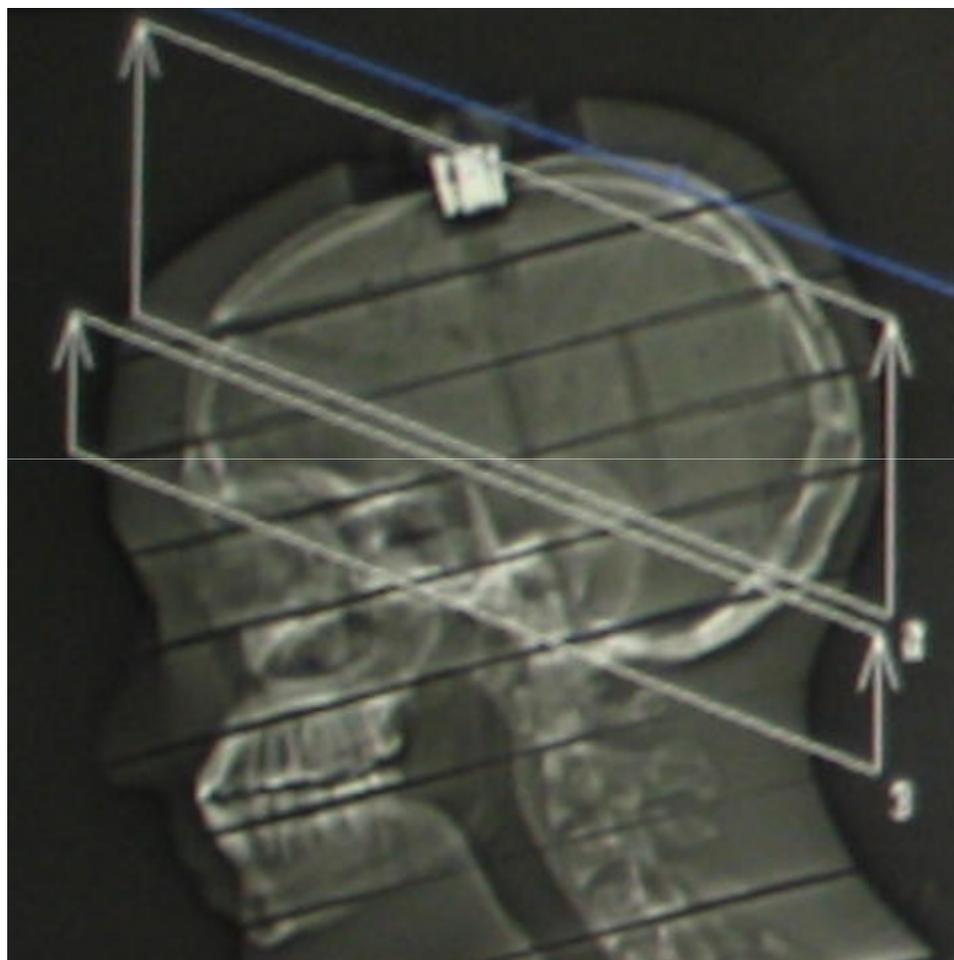


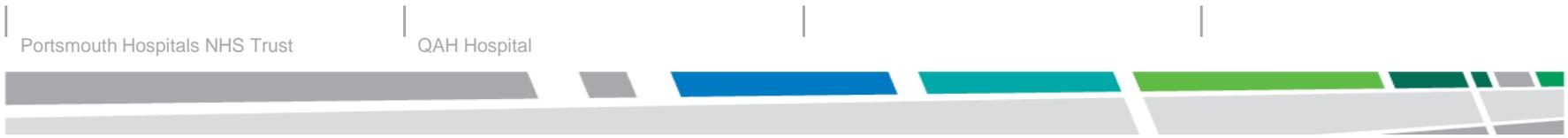
The ideal scan position.....

## Correct positioning for a routine CT head









# Assessment of Eye doses.....

# Calculated doses - ImPACT

**ImPACT CT Patient Dosimetry Calculator**  
Version 0.99z 20/10/06

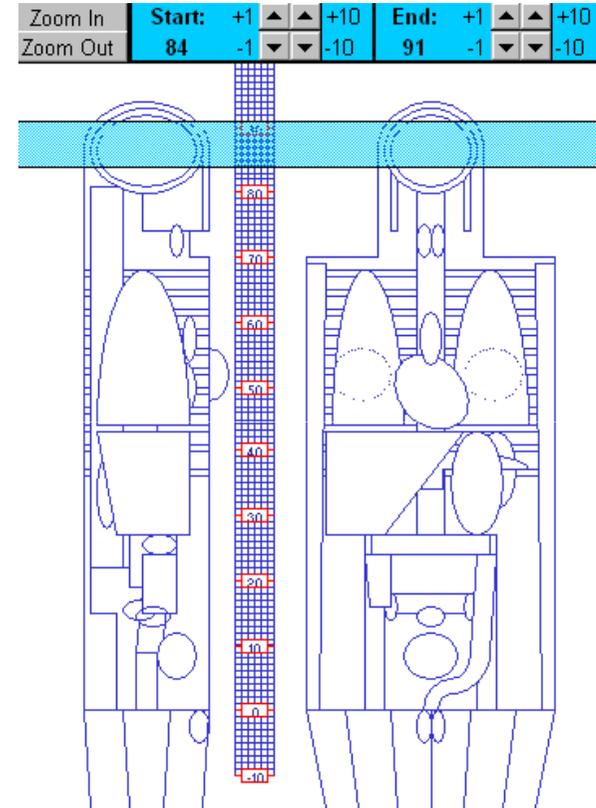
<b>Scanner Model:</b>				<b>Acquisition Parameters:</b>				
Manufacture	Siemens	Tube current	174	mA	Rotation time	0.75	s	
Scanner	Siemens Volume Zoom, Accort	mAs / Rotation	130.5	mAs	Collimation	1(Zoom)	mm	
kV	120	Slice Width	4	mm	Pitch	0.87		
Scan Region	Body	Rel. CTDI	Look up	2.08	at selected collimation			
Data Set	MCSET16	CTDI (air)	Look up	36.4	mGy/100mAs			
Current Data	MCSET16	CTDI (soft tissue)	Look up	38.9	mGy/100mAs			
<b>Scan range</b>				<b>Remainder Organs</b>				
Start Position	84	cm	Adrenals				0.0031	
End Position	91	cm	Brain				25	
Patient Sex	m		Upper Large Intestine				0.00021	
				Small Intestine				0.00018
				Kidney				0.00032
				Pancreas				0.0016
				Spleen				0.0021
				Thymus				0.024
				Uterus				0.0002
				Muscle				0.26
				CTDI <sub>w</sub> (mGy)				21.7
				CDTI <sub>w,air</sub> (mGy)				24.9
				DLP (mGy.cm)				175
				<b>Total Effective Dose (mSv)</b>				<b>0.86</b>

Organ	w <sub>r</sub>	H <sub>r</sub>	w <sub>r</sub> .H <sub>r</sub>
Gonads	0.2	0	0
Bone Marrow (red)	0.12	1.2	0.14
Colon	0.12	0.00011	1.3E-05
Lung	0.12	0.029	0.0035
Stomach	0.12	0.0013	0.00016
Bladder	0.05	0	0
Breast	0.05	0.011	0.00053
Liver	0.05	0.0022	0.00011
Desophagus (Thymus)	0.05	0.024	0.0012
Thyroid	0.05	0.44	0.022
Skin	0.01	1.1	0.011
Bone Surface	0.01	4.9	0.049
Brain	0.025	25	0.63
Remainder 2	0.025	0.24	0.0061

Scan Description / Comments	
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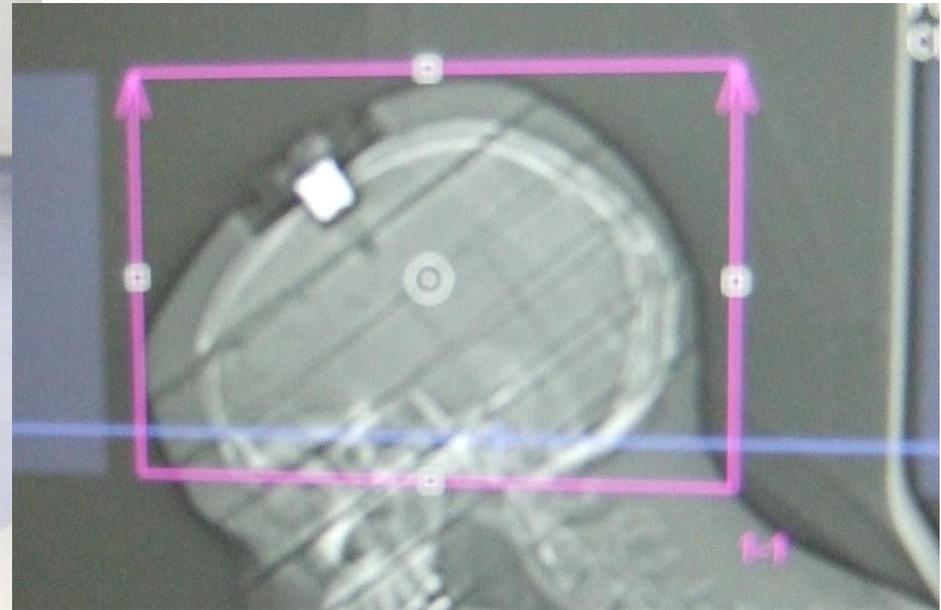
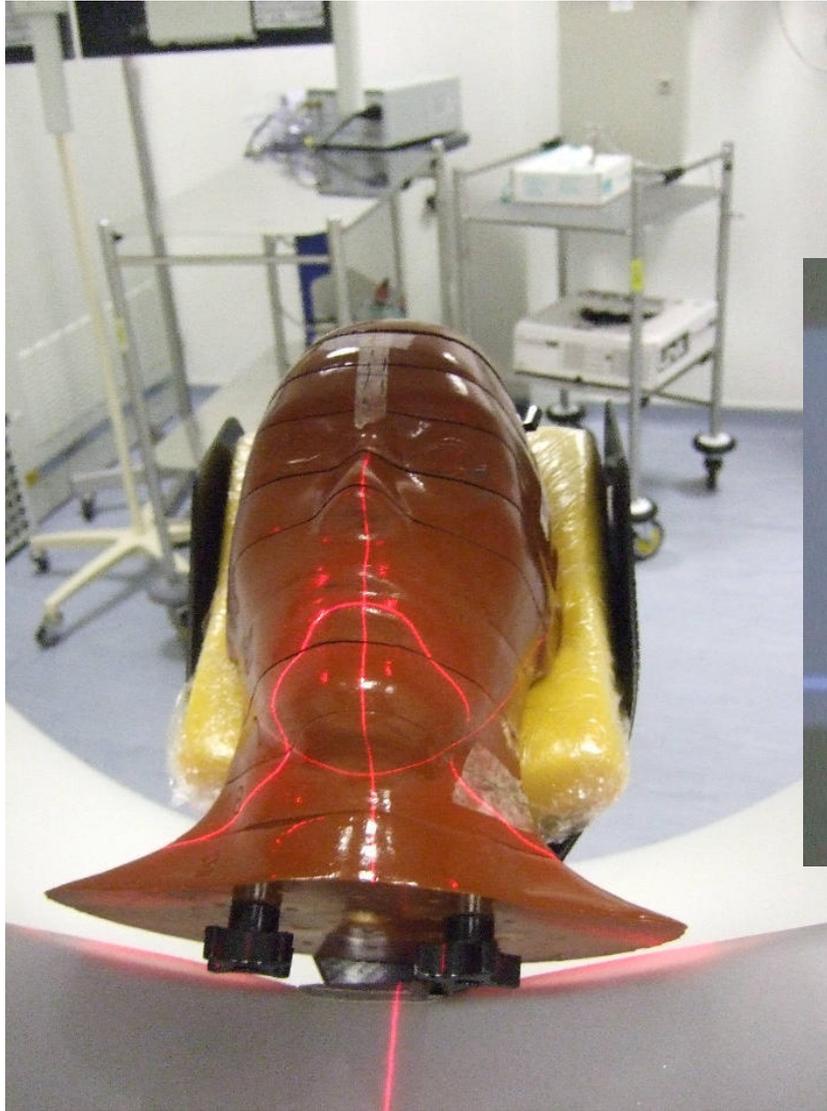
## Scan parameters....

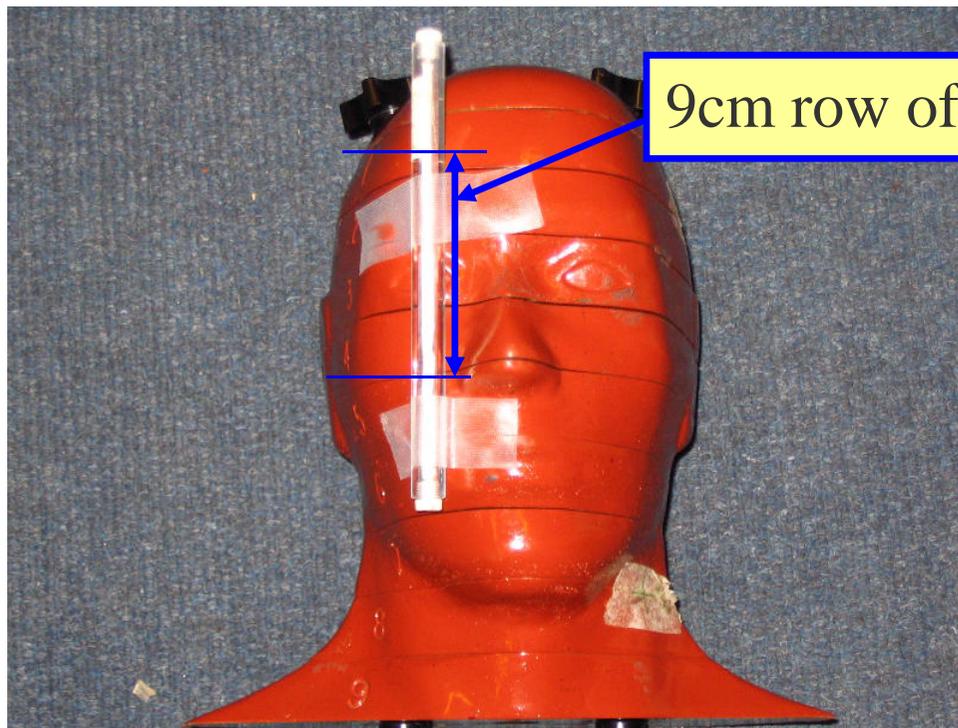
	Sensation		Definition	
	Spiral	Sequential	Spiral	Sequential
Effective mAs	360	380	350	420
kV	120	120	120	120
Slice thickness, mm	4.0mm	3.0 mm	4.0mm	4.8 mm
Collimation	24 x 1.2mm	20 x 0.6 mm	40 x 0.6mm	32 x 1.2 mm
Pitch	0.8	1	0.65	1
Rotation time, sec	1	1	0.5	2
CTDI (air), mGy/100mAs	17.8	17.8	22	22

## Practical measurements

- Rando phantom used as patient to give realistic set-up
- Radiographers assisted with setting rando up on the scanner, and defining fields of view that they would aim to achieve
- TLDs used to establish eye doses

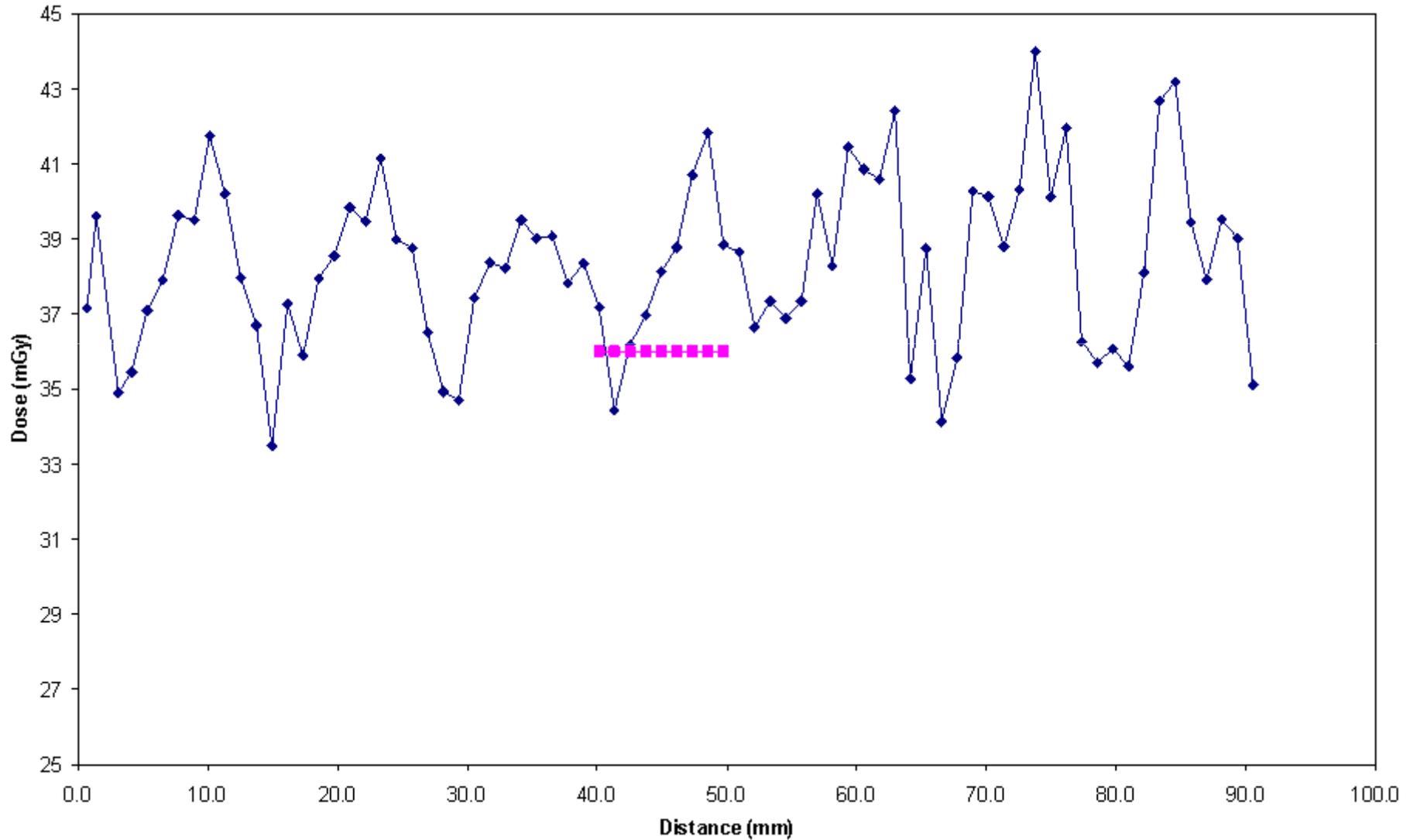




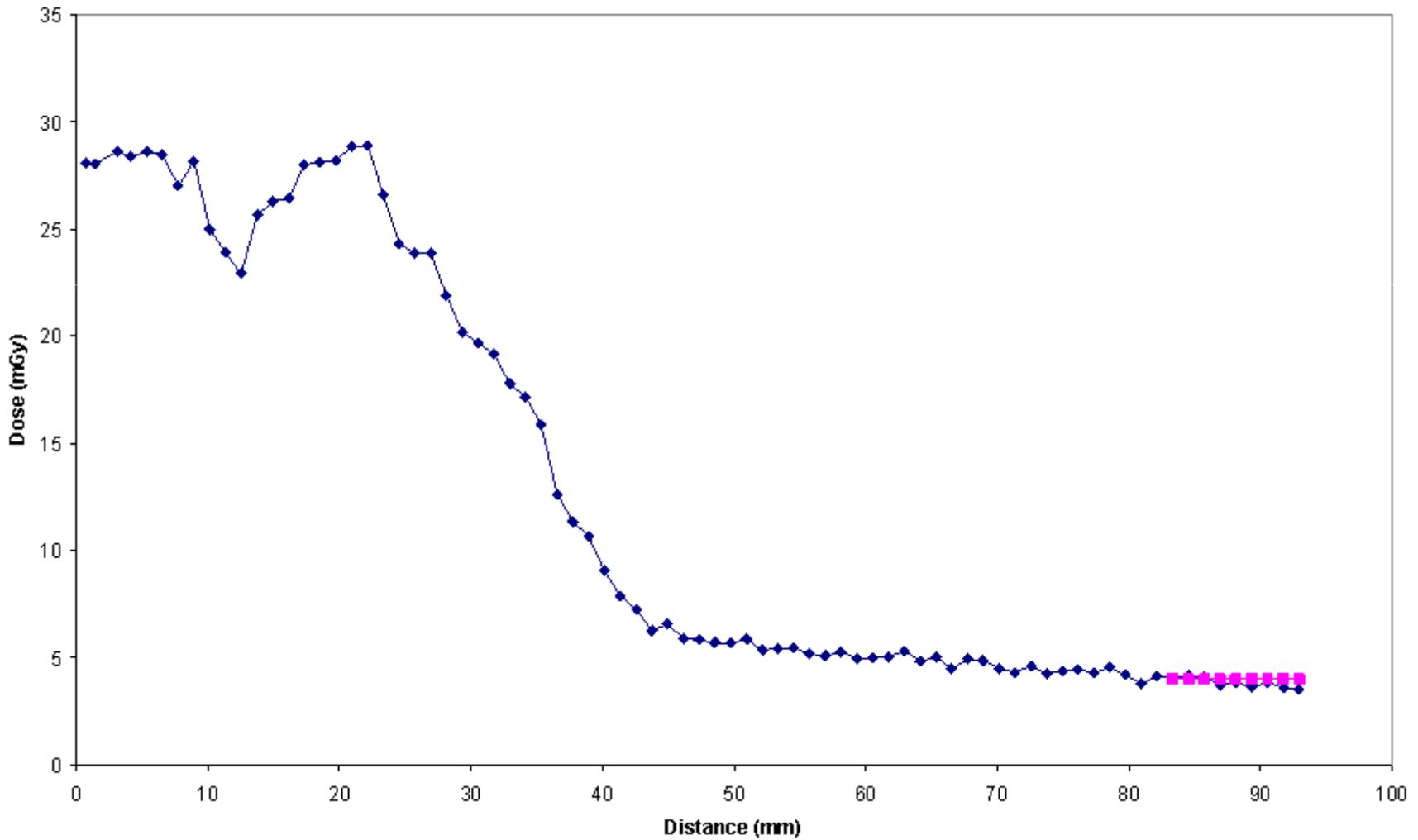


9cm row of TLDS

# Definition AS+ Spiral scan including the eye

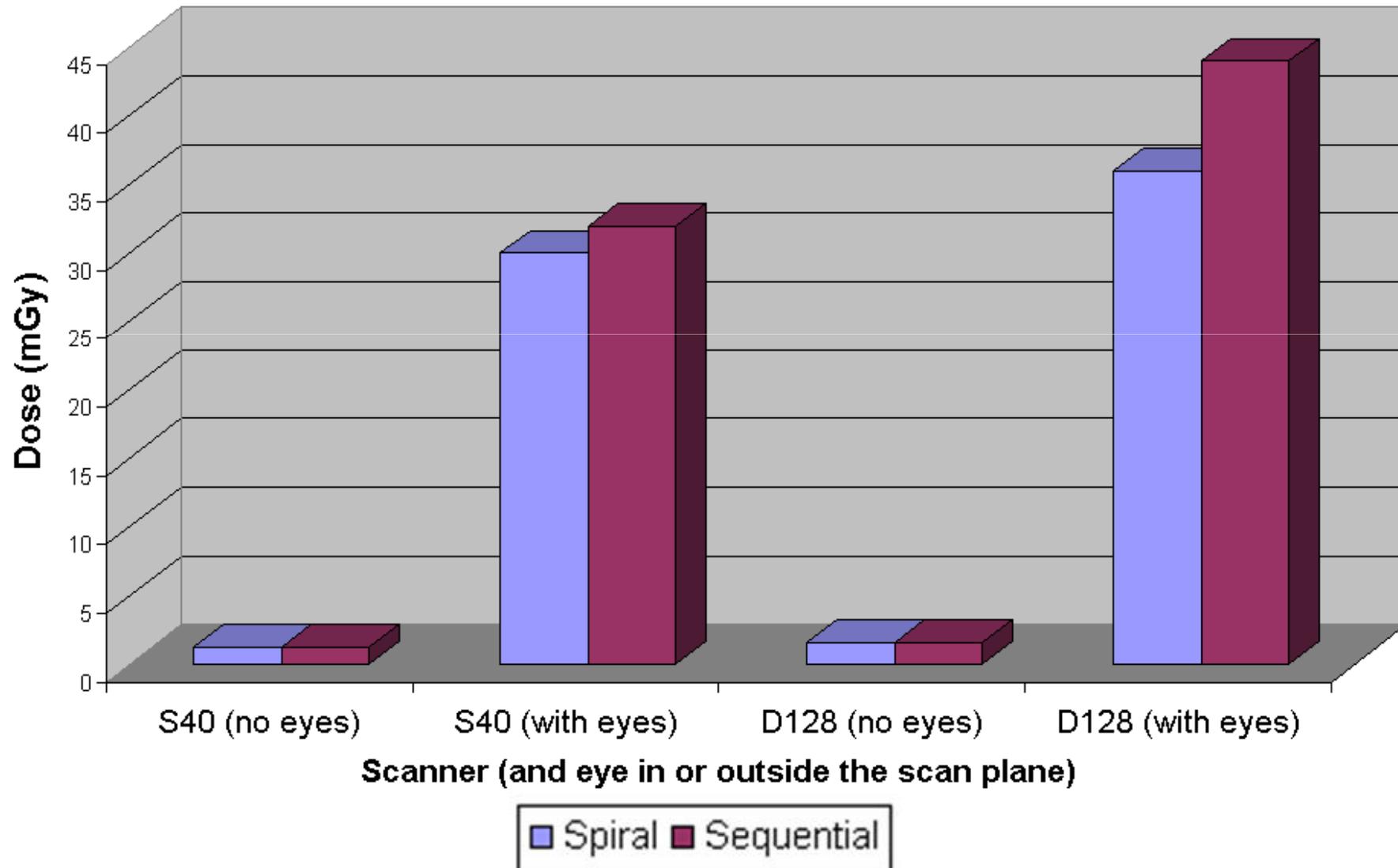


# Definition AS+ Spiral scan excluding the eyes

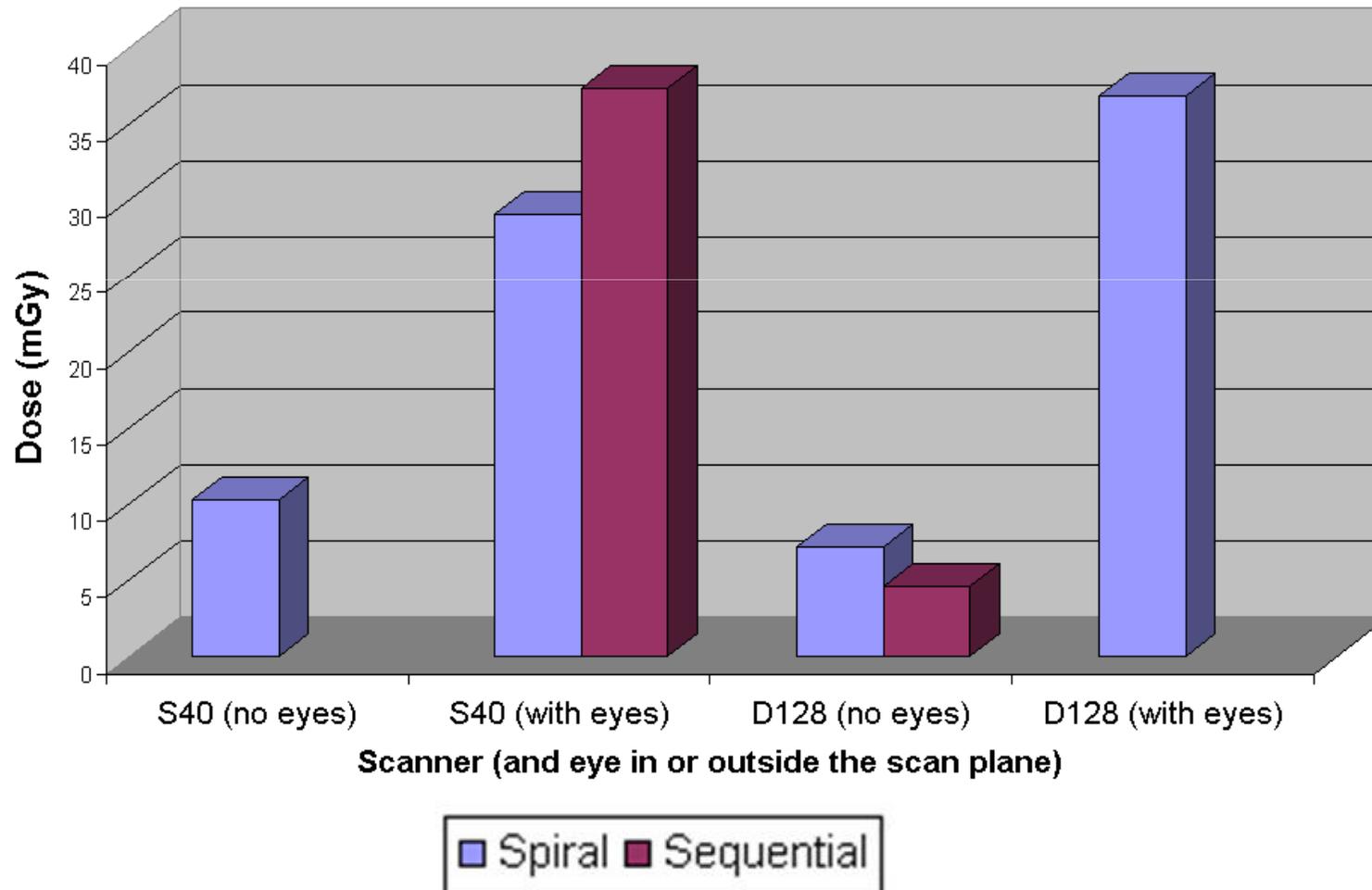




## Comparison of Spiral Vs Sequential calculated eye doses



## Comparison of Spiral Vs Sequential measured eye doses



## Topogram doses....

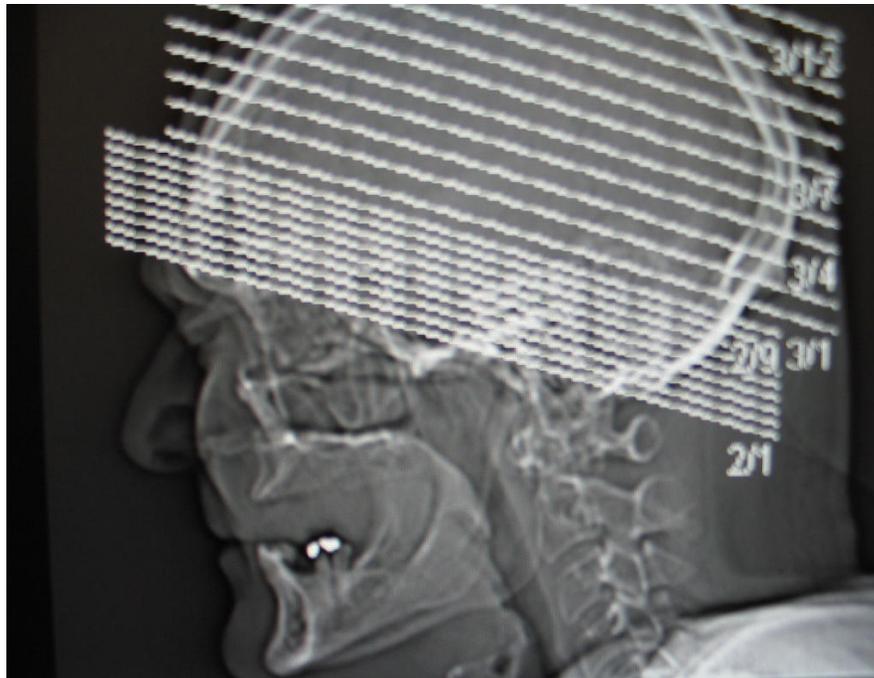
Should a topogram be repeated if the patient moves?

	<b>R eye</b>	<b>L eye</b>	
Definition	0.13 mGy	0.25 mGy	128 slice scanner
Sensation	0.44 mGy	0.17 mGy	40 slice scanner

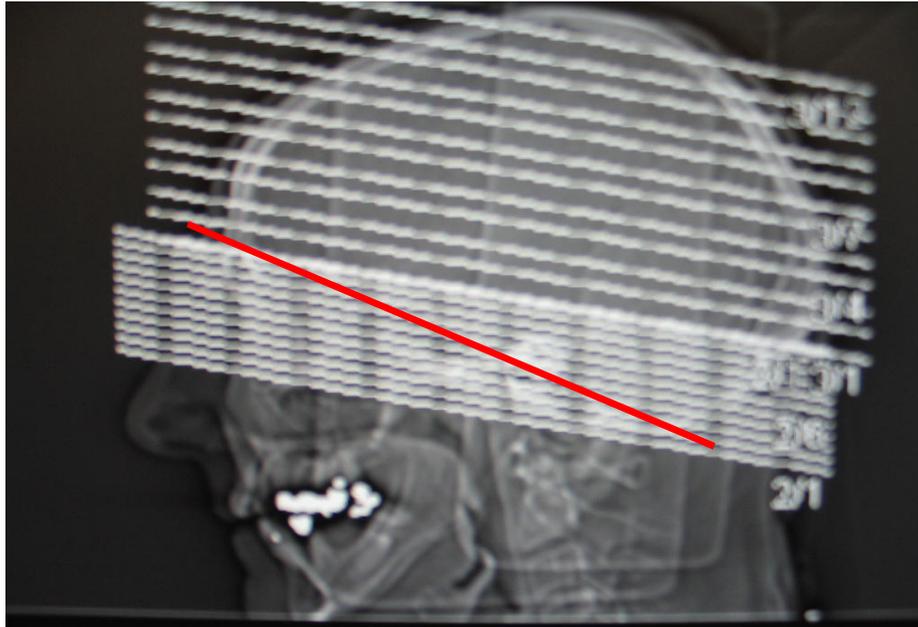
Yes !!

## Patient positioning audit

- Local protocol is that the patient should be positioned such that the eye is avoided from the scan plane



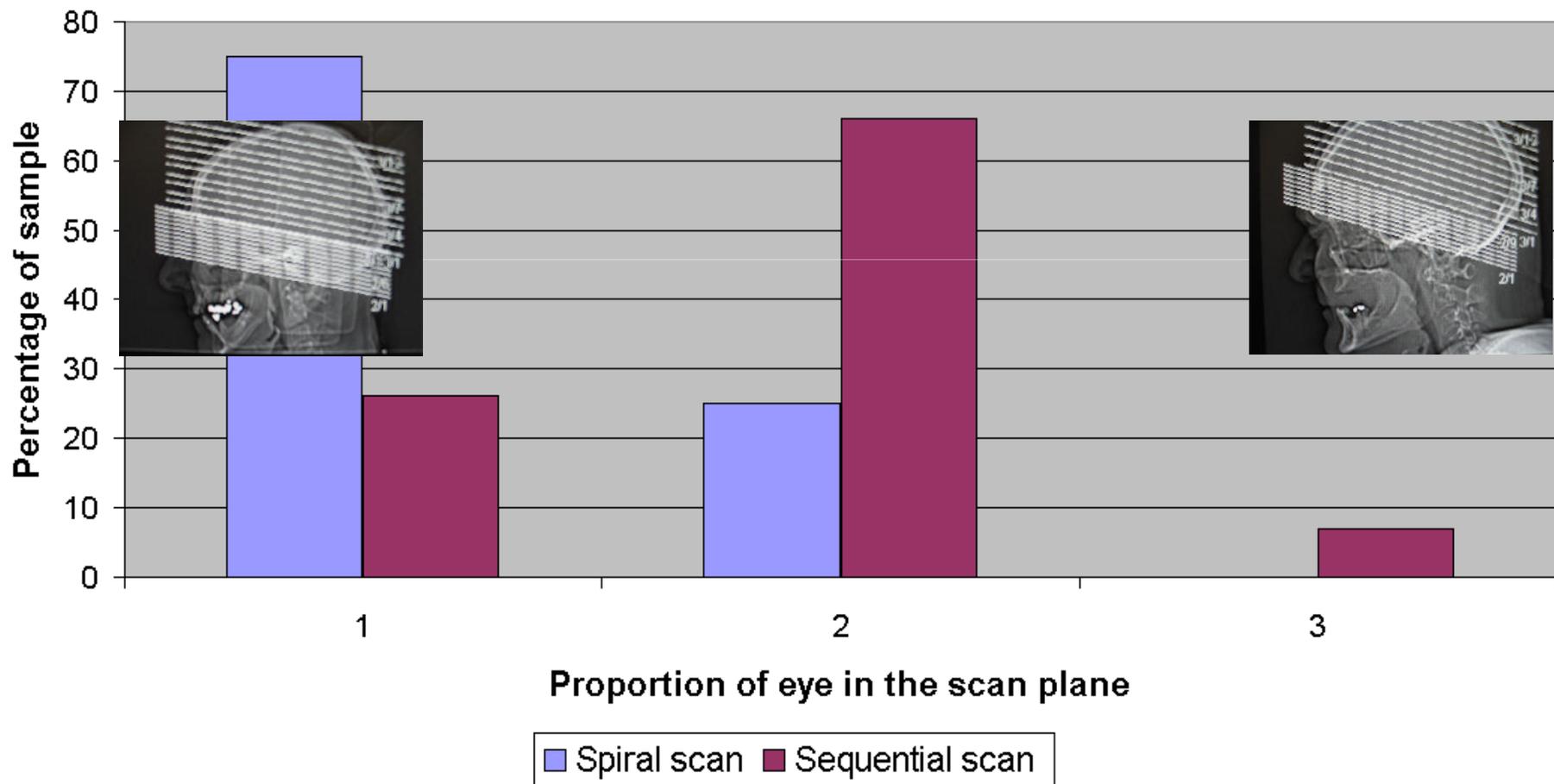
- However, a significant number of patients have eyes included in the scan plane



- Reasons :
  - Cannot tilt patients head
  - Cannot tilt scanner in spiral scanning
  - Miscellaneous



## Percentage of patients that are scanned with eyes included in the scan plane



## Patients with multiple scans

- Using the Radiology Information System (RIS) system, the rates at which head scans are repeated were analysed

### Number of exams for a 25 month period

Total Routine head sequential scans undertaken 6849

### Repeat Rates - total for a 25 month period

*(Sample of ~7000 patients)*

Total patients with 1 scan	90.2 %
Total patients with 2 scans	8.3 %
Total patients with 3 scans	1.1 %
Total patients with 4 scans	0.2 %
Total patients with 5 scans	0.1 %
Total patients with 6 scans	0.1 %

## Conclusions

- With ideal practice eyes are more likely to be excluded from the scan plane with sequential scanning
- When eyes are included in the scan plane (either compromised [time issues or insufficient training] practice or lack of patient mobility) sequential scanning results in doses 7-22% higher than spiral scanning
- Practice could potentially be improved if an additional topogram is taken prior to the scan, if this is more likely to allow the eyes to be excluded
- Sequential scanning should be used where there is adequate patient mobility to fully exclude the eyes, and sufficient clinical information will be gained
- Spiral scanning should be used for patients with poor mobility that would mean that eyes cannot be excluded or if reconstructing in additional planes will be useful
- Patients receiving 3 or more scans per year could be accumulating doses of concern (ICRP). All patients with eyes included in the scan field unnecessarily could be of concern if there is no (or a lower) threshold

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Any Questions ?