Three methods for measuring irradiated slice width

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The issue…

- How should we be measuring irradiated slice thickness?
- What are our options?
- Which is best?

Our ideal…

- Something we have ownership of
- Instant result
- Simple and compact

Overview

- IPEM 2003 recommendation
- Czajka et al 1994
- Therapy film
- Fuji CR Plate
- Gafchromic film

IPEM 2003

Basic measurement method

- Detector placed at isocentre
- Expose to full and half dose
- Measure width of full dose exposure at points corresponding to half dose -FWHM

No one method or medium suggested

Tolerance is +/-1mm or 20% whichever is greater?

Czajka et al 1994

- Use of self-developing dental film or TLD
- Need special jig plus dental film

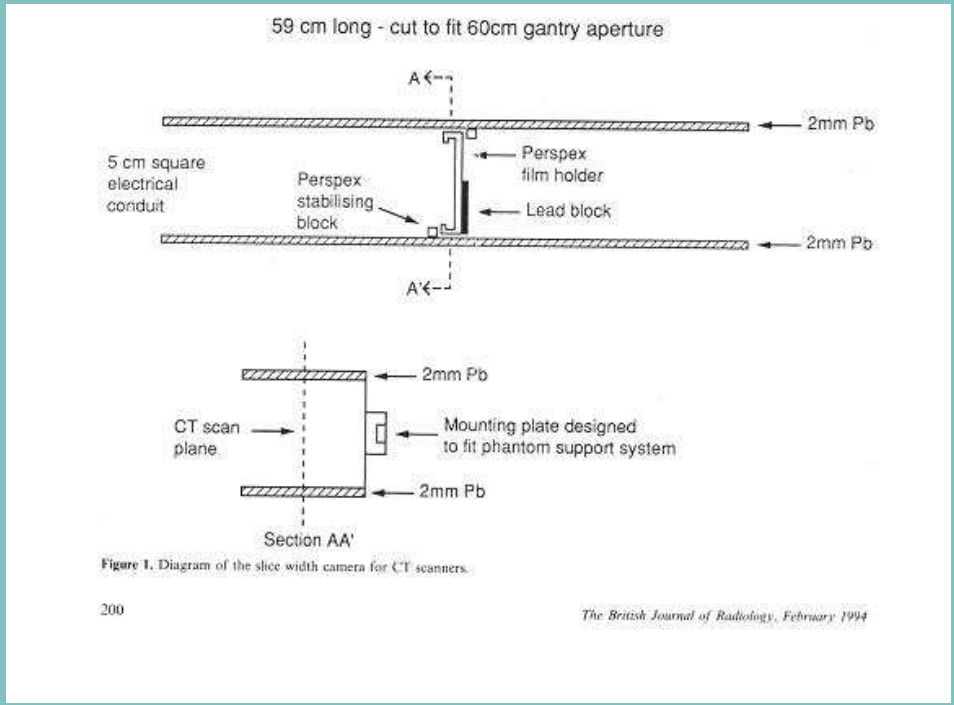
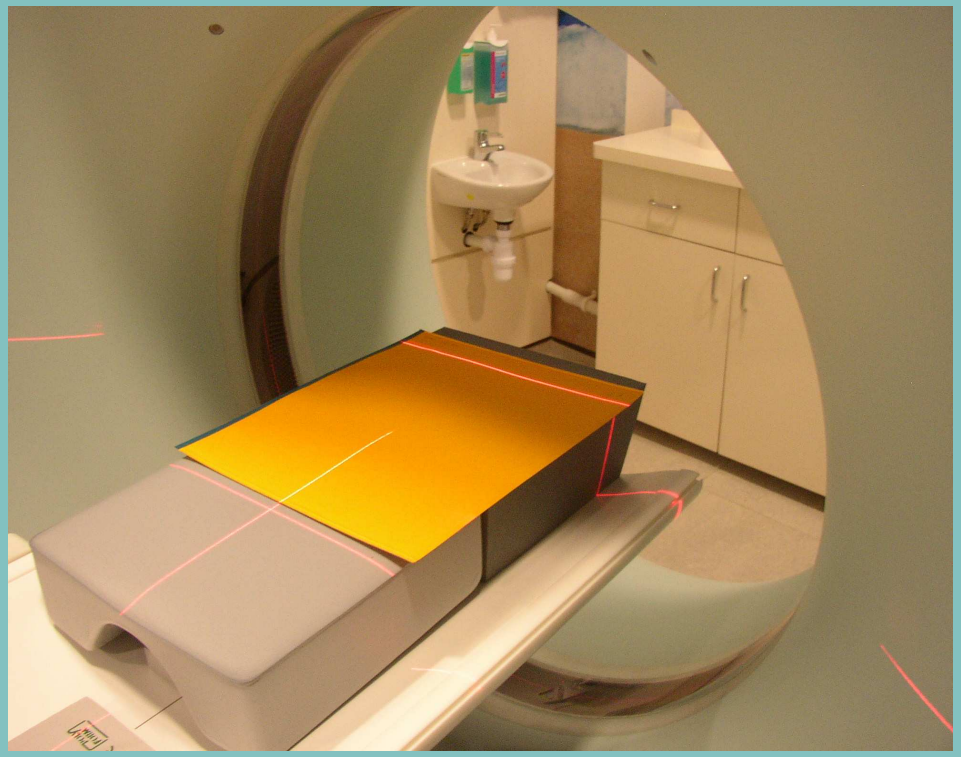


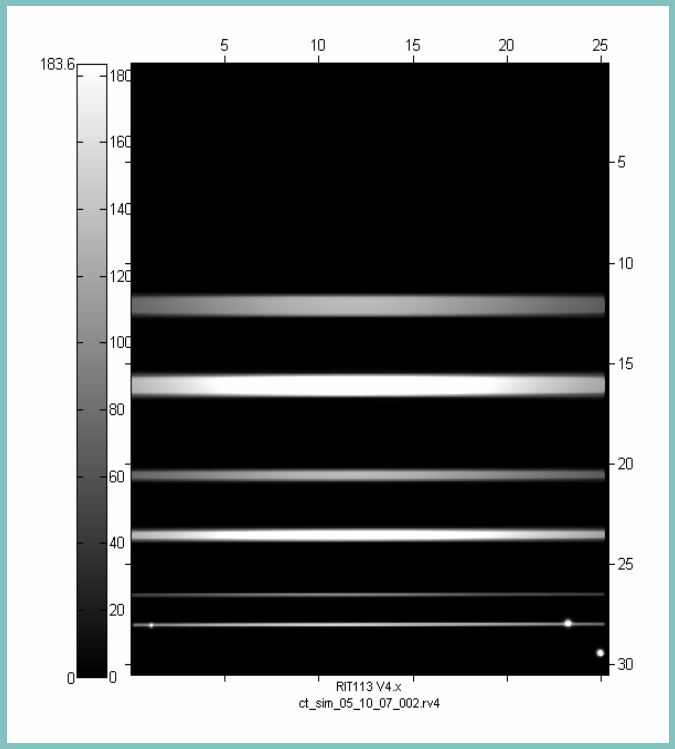
Figure 1. Diagram of the slice width camera for CT scanners.

Therapy film

- Available from friendly radiotherapy colleagues
- Measurement by ruler and eye or use film digitiser and image processing software e.g. ImageJ
- Expose – process – digitise –export – import – calibrate - measure (6 steps)

Therapy film

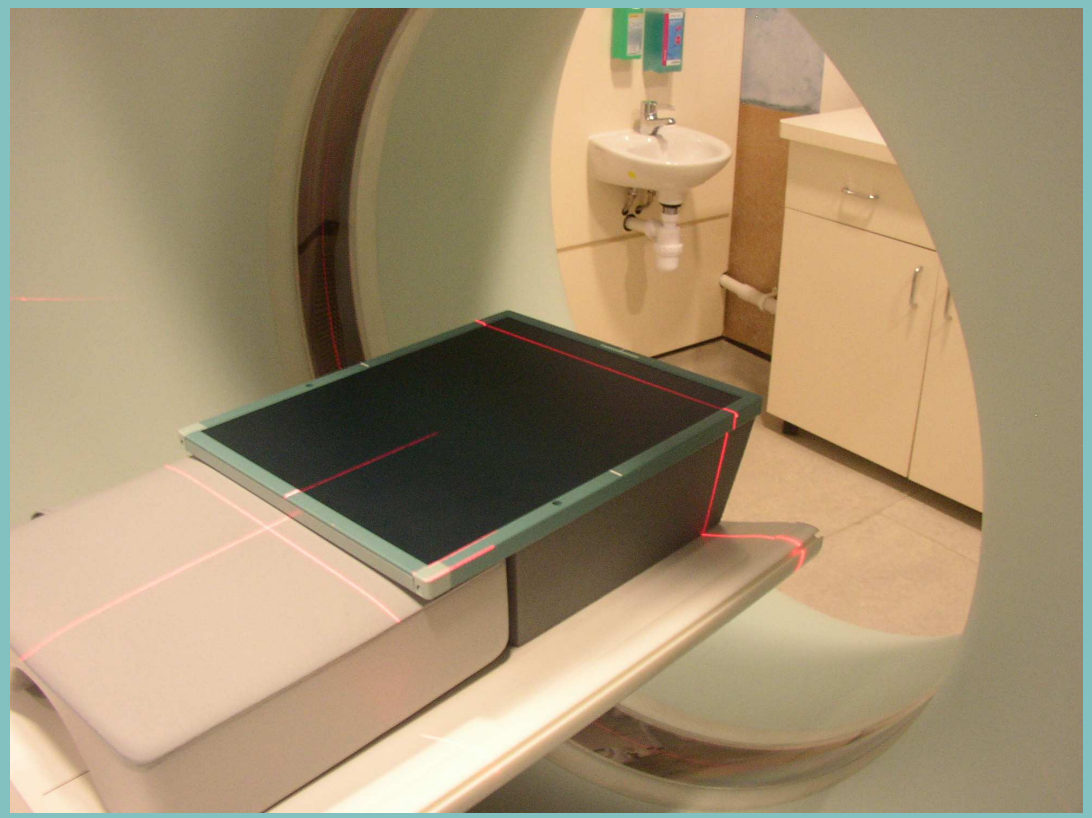




Fuji CR Plate

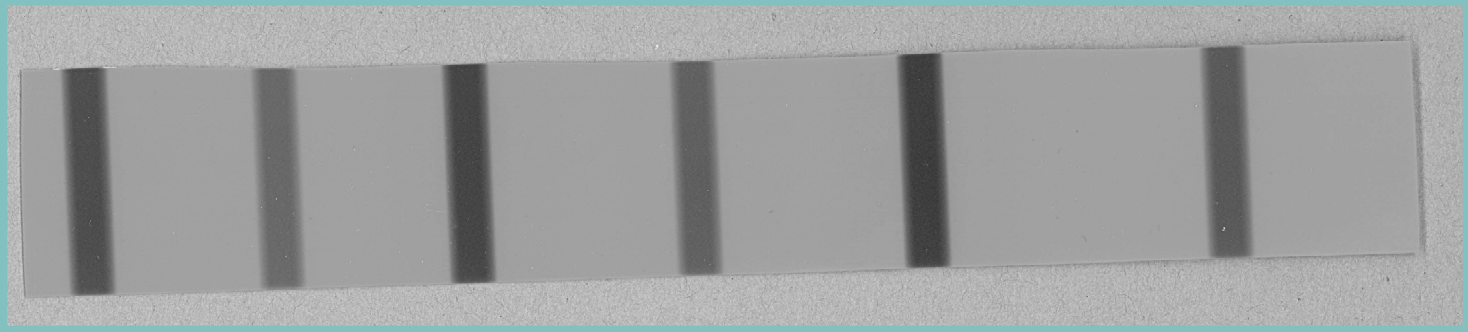
- Available where Fuji CR is used
- Need lowest possible scan parameters
- No instant “ruler” analysis possible
- Fuji reader allows image to be exported in DICOM format
- Expose – read – export – import - measure (5 steps)

Fuji CR Plate

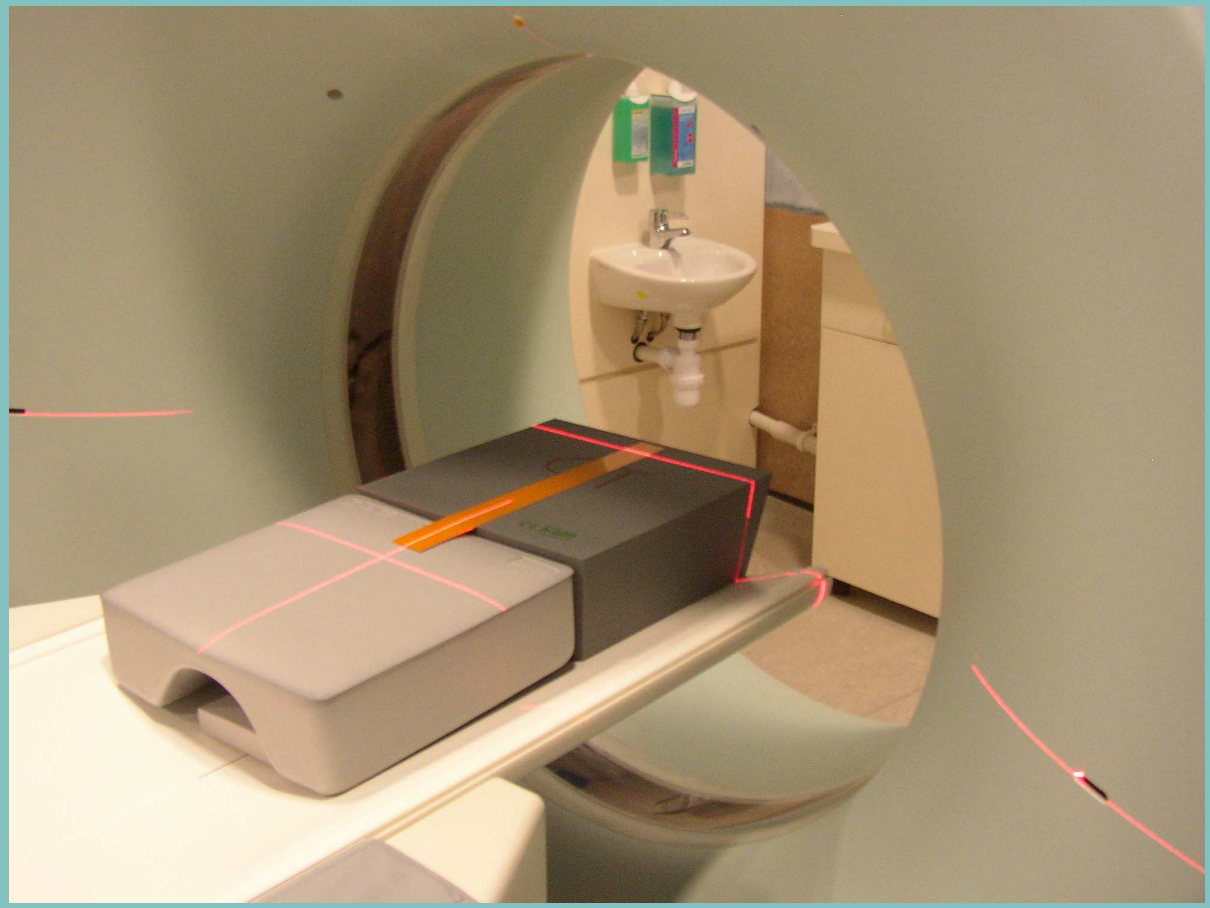


Gafchromic film

- Owned by Med Phys
- Expose – digitise – measure (3steps)
- Immediate response – can check with ruler then digitise for more accurate result

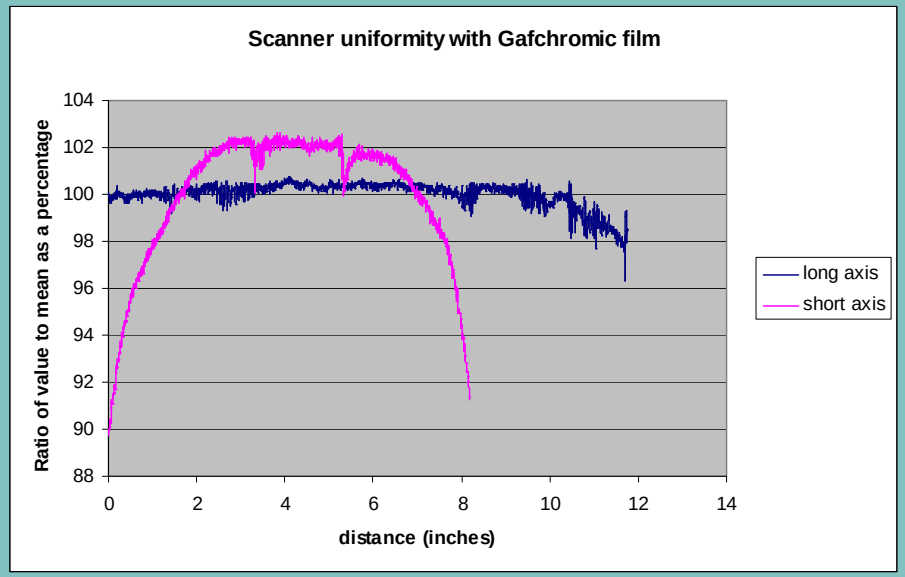


Gafchromic film



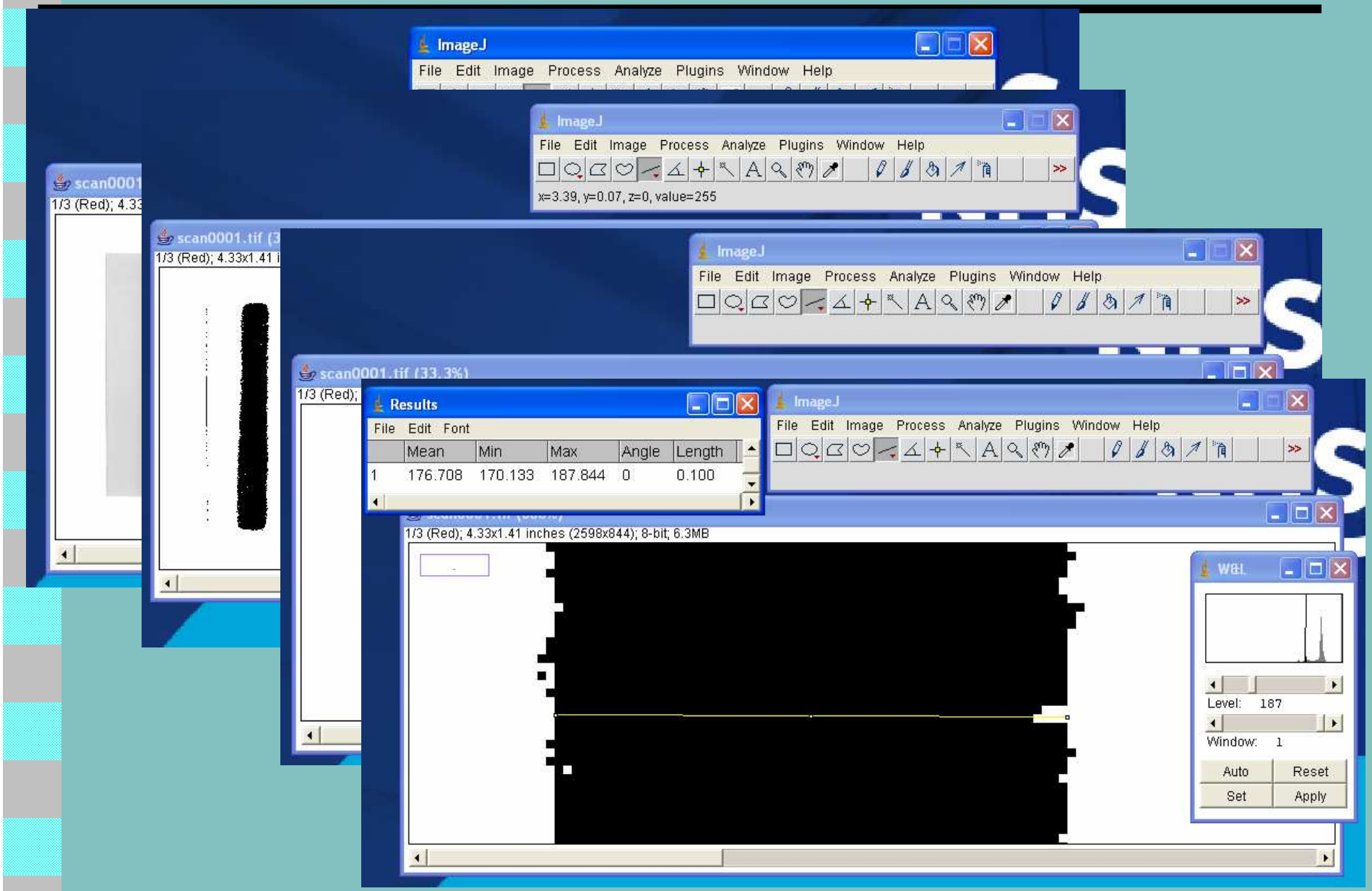
Scanning the Gafchromic film

- Normal desktop scanner HP Scanjet 4850
- Scanned as colour document - 600ppi
- Strips ~3cm wide scanned lengthways for <1% variation



Measurement comparison - Method

- Used a Siemens 64 slice scanner @ RHSC
- Exposed therapy film, Fuji CR plate and Gafchromic film on same day using 2mm and 10mm slice thicknesses
- Exposed full and half dose slices three times at each width
- Window image until half dose slice just vanishes
- Calculate average width for each method


ImageJ
File Edit Image Process Analyze Plugins Window Help
ImageJ
File Edit Image Process Analyze Plugins Window Help
x=3.39, y=0.07, z=0, value=255
scan0001.tif (3
1/3 (Red); 4.33x1.41 i
ImageJ
File Edit Image Process Analyze Plugins Window Help
scan0001.tif (33.3%)
1/3 (Red);
Results
File Edit Font
Mean Min Max Angle Length
1 176.708 170.133 187.844 0 0.100
ImageJ
File Edit Image Process Analyze Plugins Window Help
1/3 (Red); 4.33x1.41 inches (2598x844); 8-bit; 6.3MB
W&L
Level: 187
Window: 1
Auto Reset
Set Apply

Measurement comparison - Results

Method	Nominal 2mm collimation	Nominal 10mm collimation
Gafchromic film	2.46 ± 0.03	9.54 ± 0.06
Fuji CR	2.23 ± 0.04	9.75 ± 0.07
Therapy film	2.46 ± 0.12	9.73 ± 0.32

Pros and cons

Method	Therapy Film	Fuji CR Plate	Gafchromic Film
Access to equipment	Wet processing not available in all hospitals	Not available in all hospitals	Available within physics – no external resources needed
Exposure factors	120kV, 100mAs, 50mAs	80kV, 38mAs, 19mAs – not available everywhere	120kV, 200mAs, 100mAs
Resolution (pixel size)	0.26mm	0.1mm	0.04mm
No. steps from exposure to measure	6	5	3

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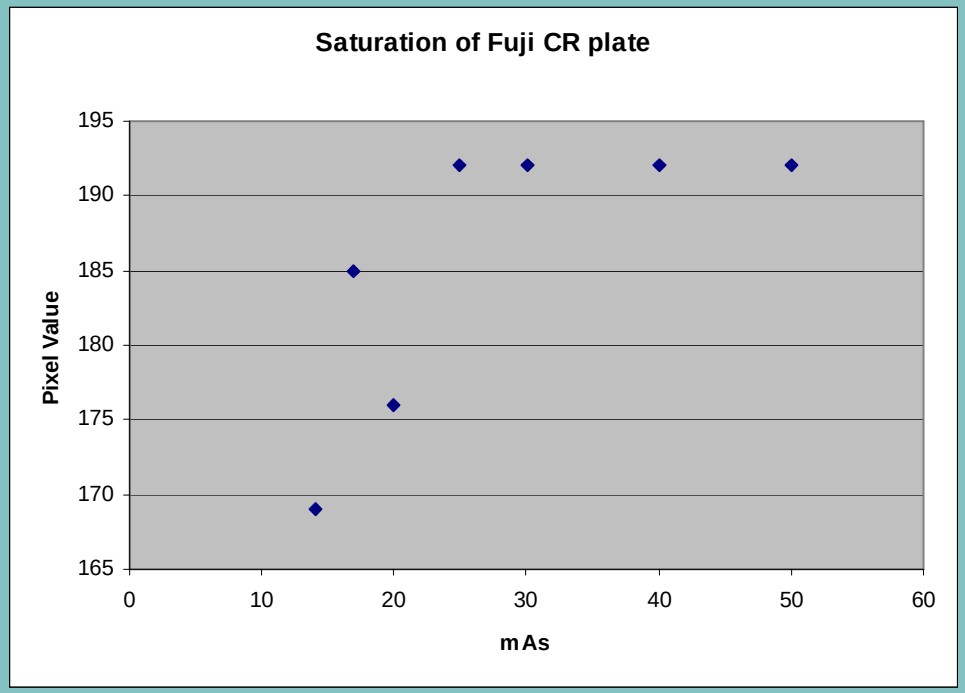
Fuji CR plate saturation



- Plate saturates above 25mAs
- Liu et al carried out similar investigations

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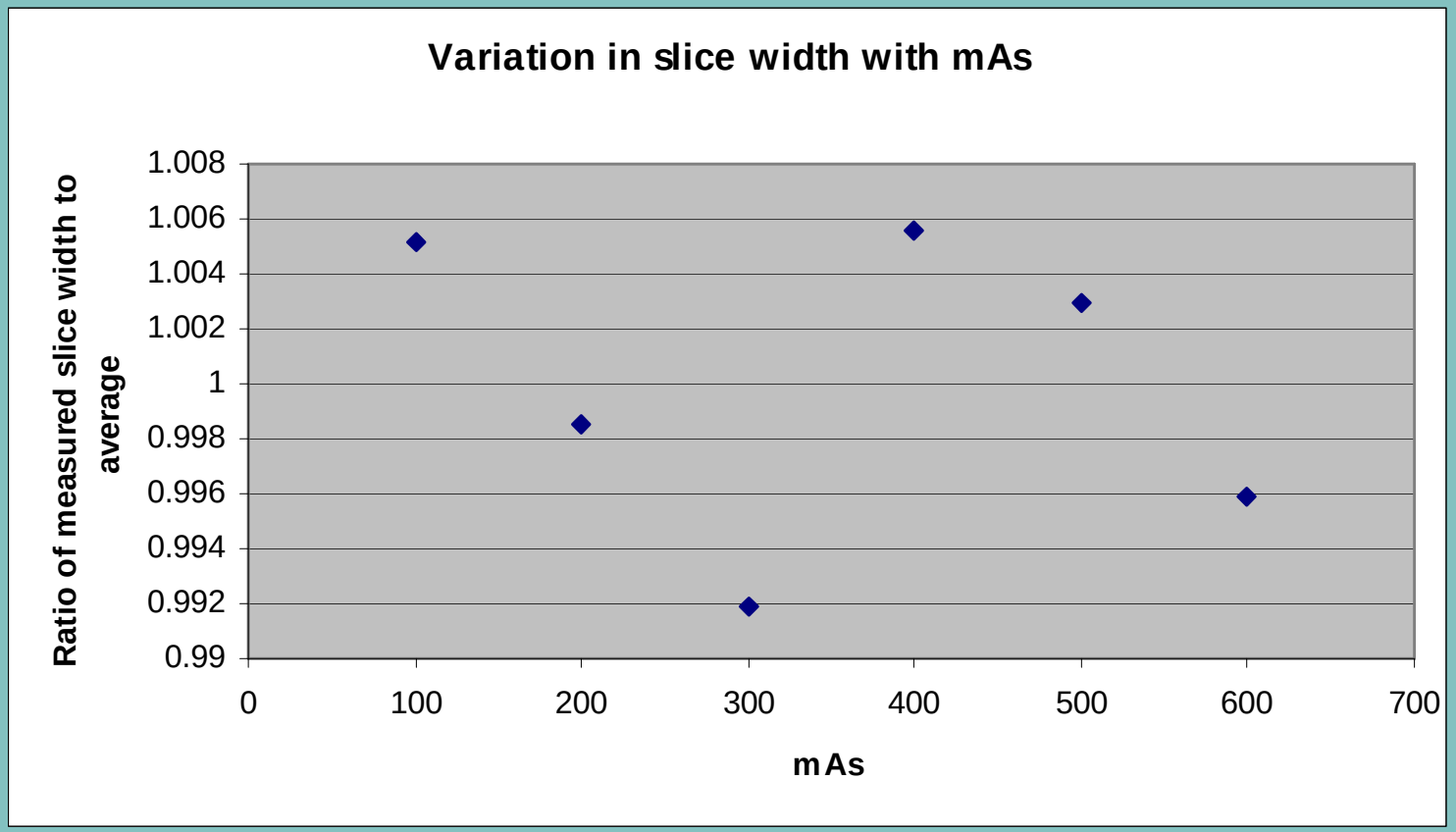
Response of Gafchromic film to changes in mAs



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Conclusions

- Gafchromic film best method to use
  - Owned by Medical Physics
  - Highest resolution of all 3 methods
  - Usable on all CT scanners
  - Simple and portable
  - Instant result visible

References

- IPEM Report 91
- Czajka et al *"Technical Note: Measurement of computed tomography scanner slice widths"* 1994 BJR [67] 20-202
- IPEM Report 32 *"Part III Computed Tomography X-ray Scanners"*
- Liu et al *"Measurement of CT profile width using CR imaging plates"* 2005 Med.Phys 32(9)

Thanks…

- Nick Weir – CT/MR physicist
- Radiography staff at Royal Hospital for Sick Children
- Physics staff in Oncology physics at the Western General Hospital