Assessment of the Low Contrast Detectability of Multi-slice CT Scanners

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Clinical importance of LCD in CT

- Studies where soft tissue differentiation is important are common in CT

•Abdomen, Pelvis	26 %
•Cerebrum	22 %
•Spine	20 %
•Mediastinum	7 %
•Lung parenchyma	6 %
•Trauma	5 %
•Interventions	4 %
•Base of skull	3 %
•Pediatrics	3 %
•Orthopedics	3 %
•Inner ear	1 %

Contrast resolution more important in ~90 %

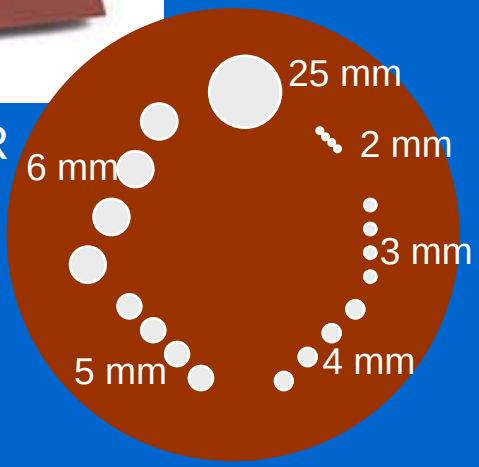
Spatial resolution more important in ~10 %

Figures of a typical clinical workload courtesy of Mario Scolari, Philips Medical Systems

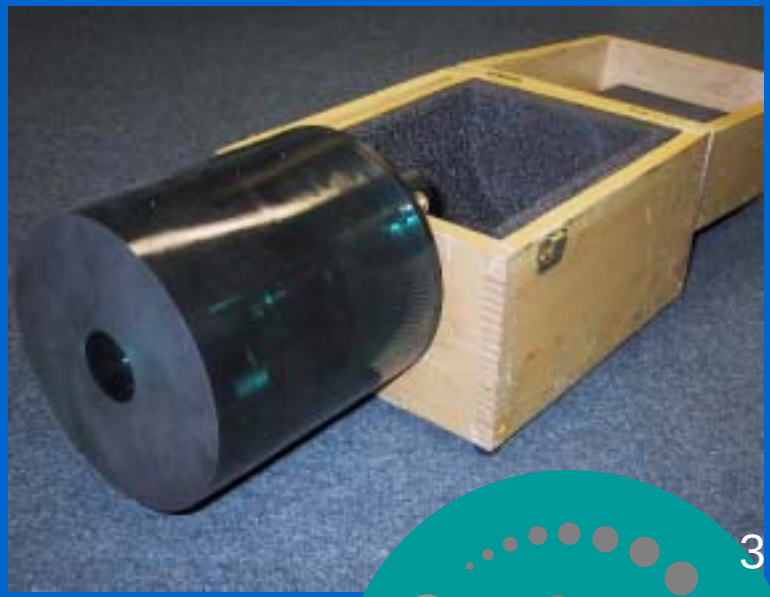
Assessment of LCD

- Generally use uniform phantoms with variable size low contrast inserts

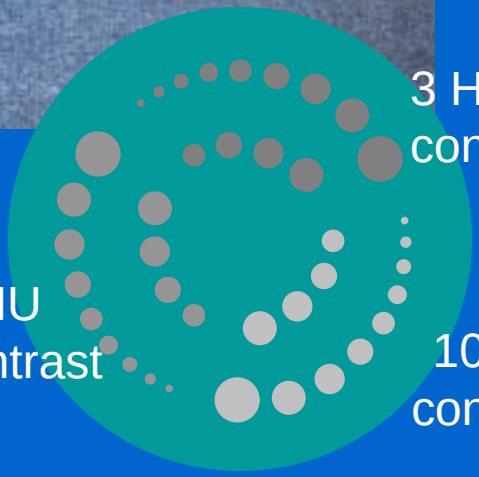
Gammex 464 ACR CT Accreditation Phantom



All 6 HU contrast



Catphan 500



2-15 mm diameter

Why use the Catphan?

- Catphan is probably closest to a ‘standard’ phantom for LCD assessment
- Manufacturers’ published LCD data is usually on the Catphan
  - Smallest visible detail size (mm) for 3 HU (0.3%) contrast
  - Dose given by CTDI measured on the Catphan surface

Manufacturers' LCD performance data

	GE	Philips	Siemens	Toshiba
Scanner	LightSpeed +	Mx8000	Volume Zoom	Aquilion Multi
Phantom	Catphan	Catphan	Catphan	Catphan
Contrast	0.3%	0.3%	0.3%	0.3%
Slice width	2 x 10 mm	10 mm	1 x 10 mm	10 mm
Surface Dose	18 mGy	27 mGy	21 mGy	120 kV, 150 mAs*
Detail Size	5 mm	4 mm	5 mm	4 mm
Detail visibility criteria	?	?	?	?

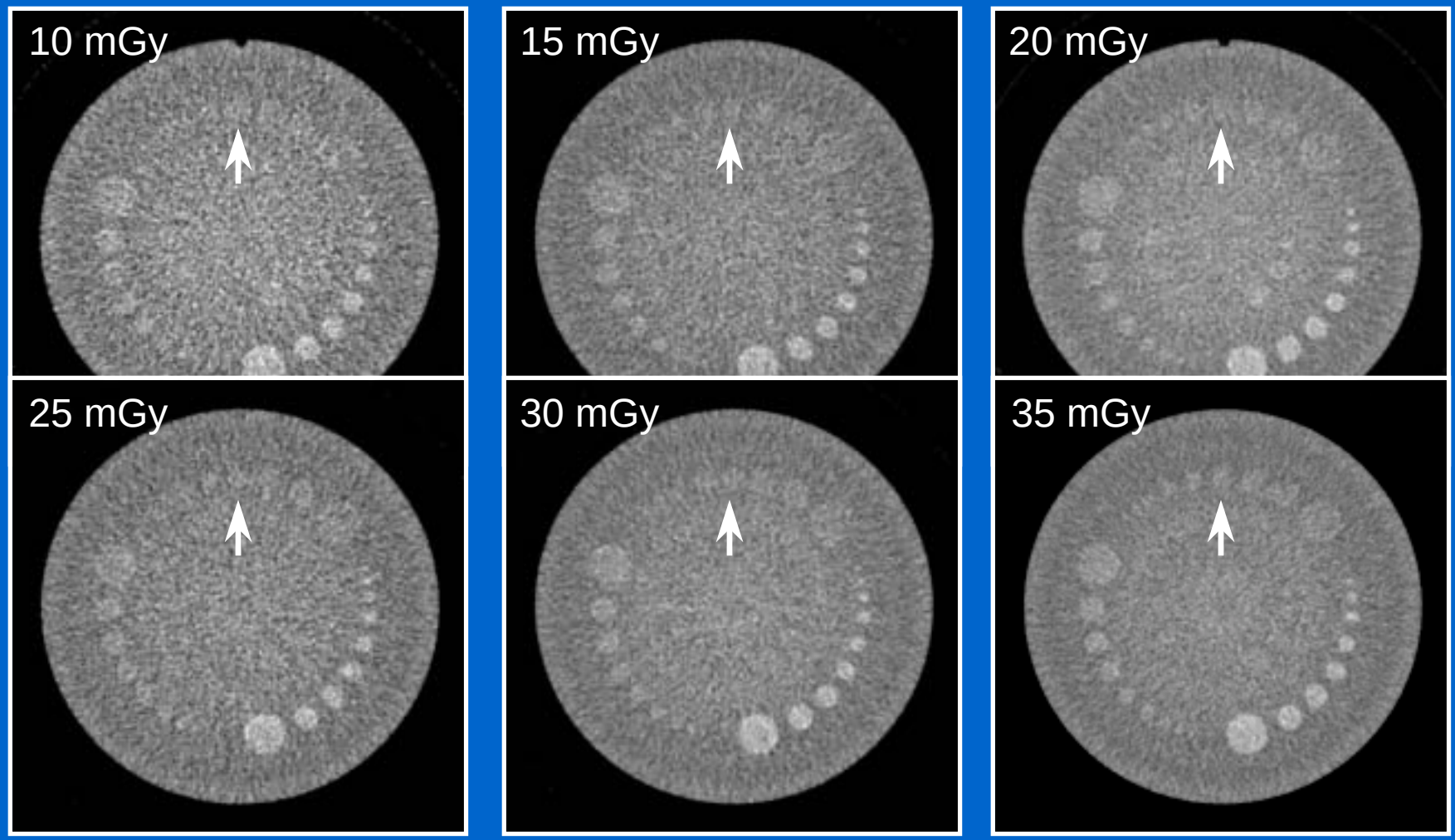
*ImPACT estimated CTDI: 24 mGy

- Data not directly comparable
- Variable visibility criteria will always be a problem

Source: ImPACT Four Slice CT Scanner Comparison Report, V5

Visibility Criteria

- When does a detail become visible?



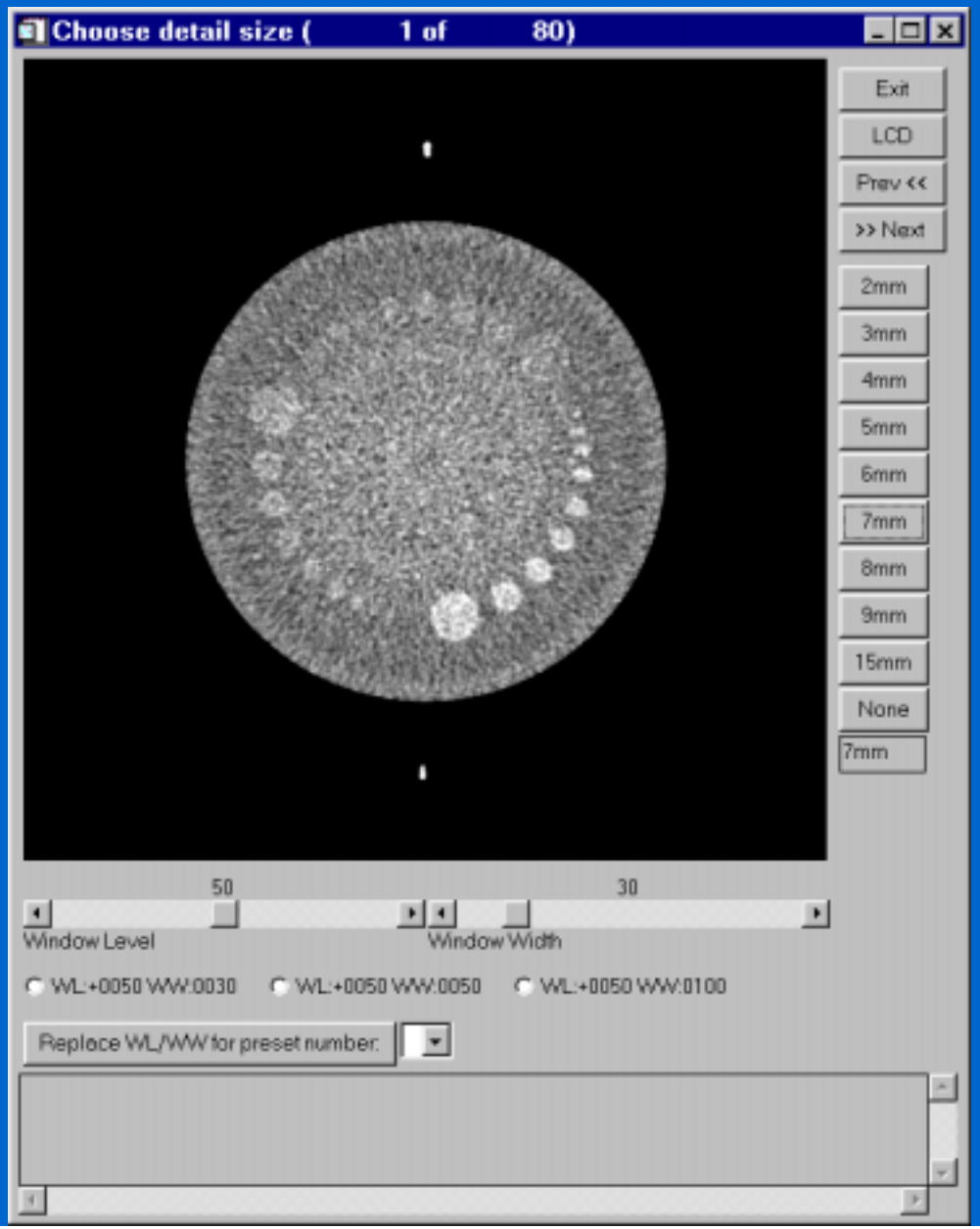
Doses given are CTDI measured at surface of Catphan

Comparison of LCD on different scanners

- ImPACT have compared LCD for four slice scanners using equivalent scan parameters
  - 120 kV, 2 x 10 mm slice thickness, 25 mGy surface CTDI, 20 images per scanner
  - Reconstructed using 250 mm FOV, and standard brain reconstruction algorithm (no bone correction)

Image scoring

- Custom program written in IDL to allow user to score all 80 images, presented in a random order

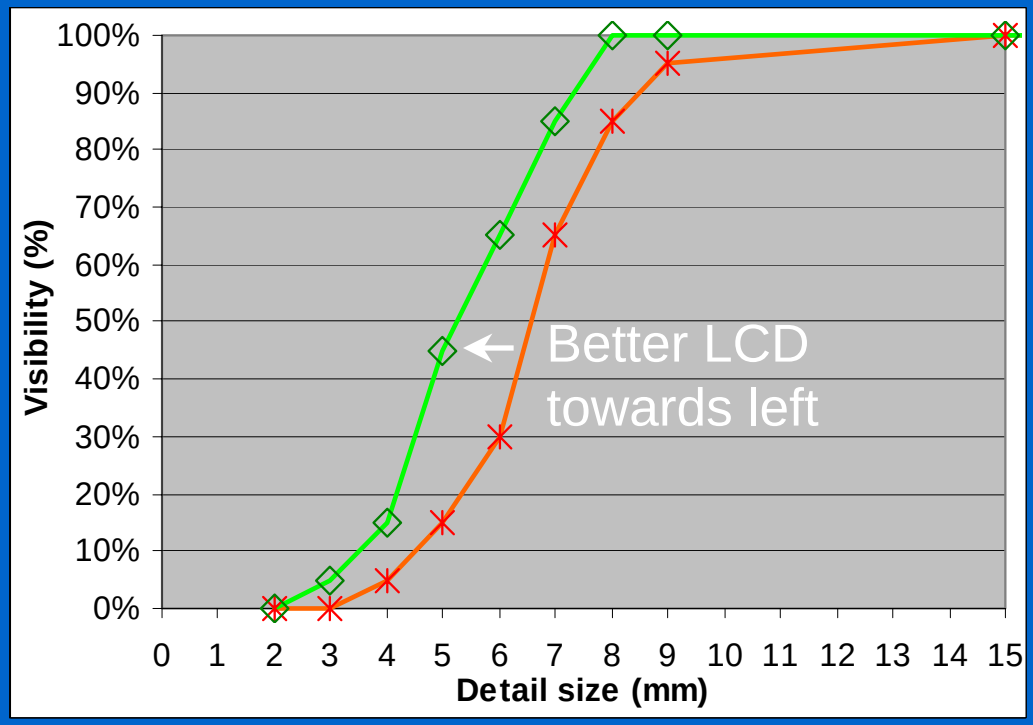


Reading images

- 20 images presented for each scanner, and the 0.3% contrast details scored for visibility
- Users allowed to select window level and width
- Written criteria for visibility of objects
  - ‘The criteria for visibility of a detail is whether the observer is sure that there is an object visible against the background. This does not mean that they need to be able to see a circle, but it must be plain that what they are seeing is not just image noise patterns.’
- Lighting and monitor set up controlled

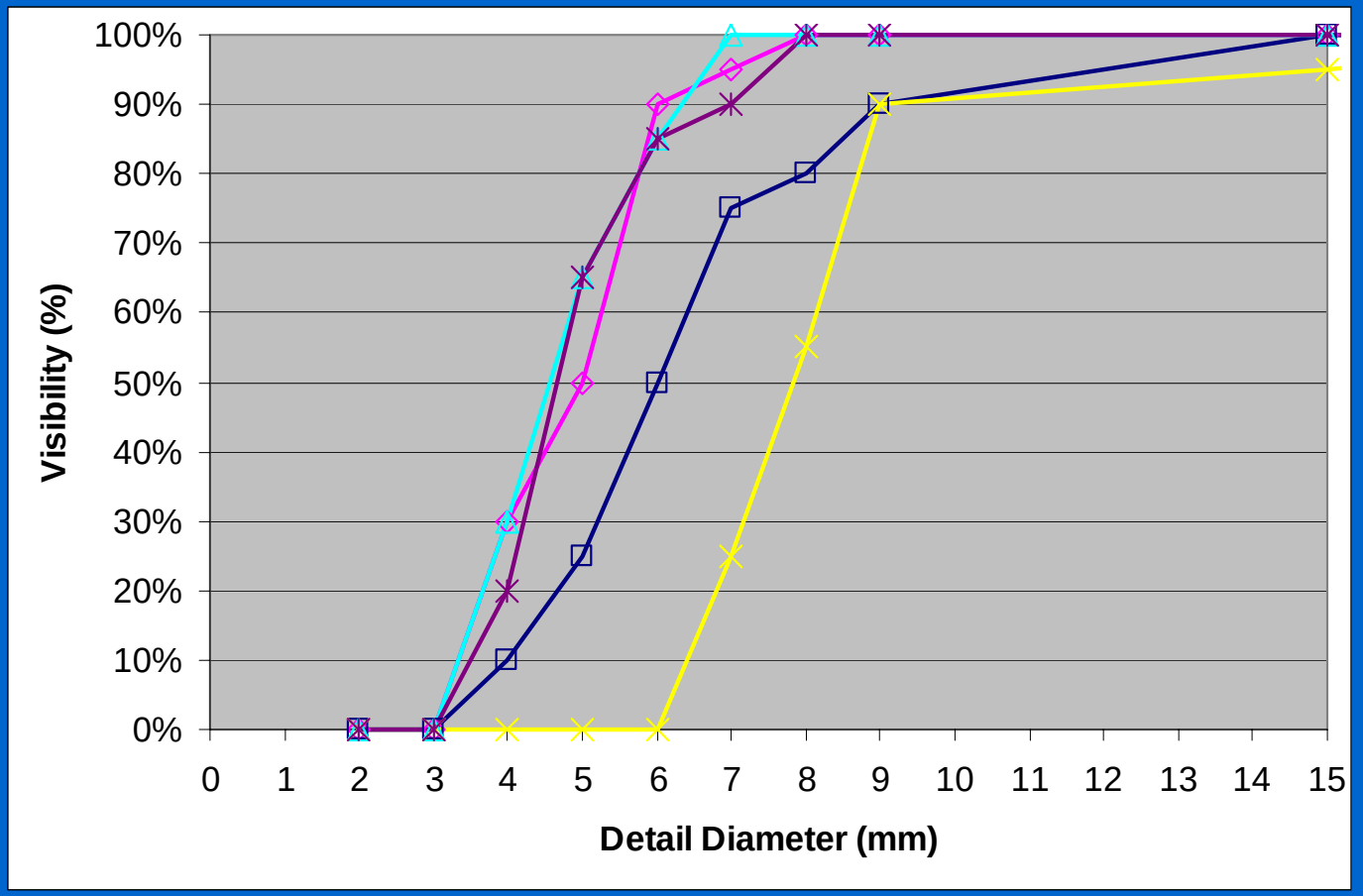
Presentation of results

- e.g. from 20 images:
  - 15 mm detail is visible in all 20: 100 % visibility
  - 7 mm detail visible in 13 images: 65 % visibility
- etc...



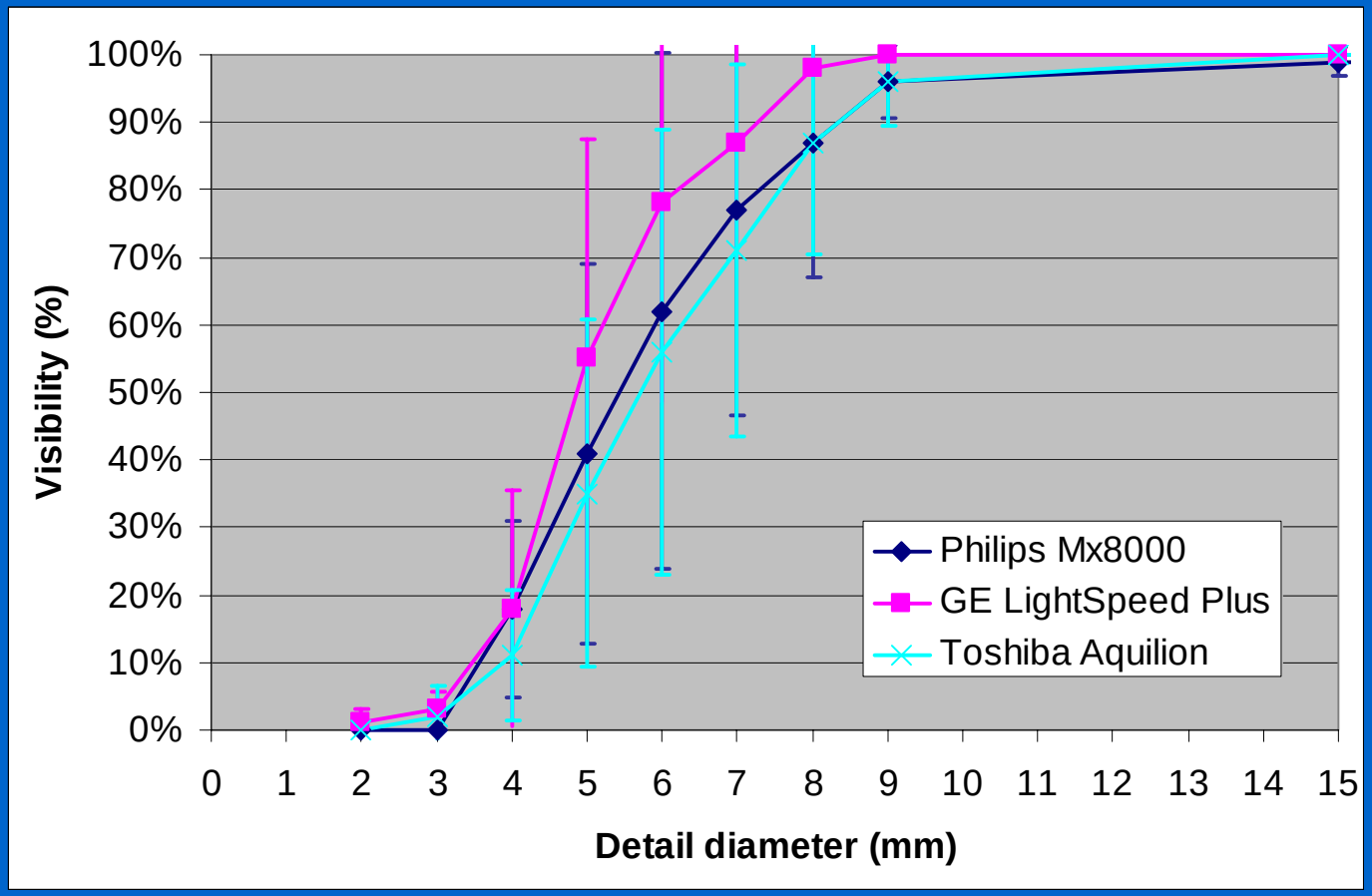
Results

- Results from 5 viewers for 1 scanner



LCD for different scanners

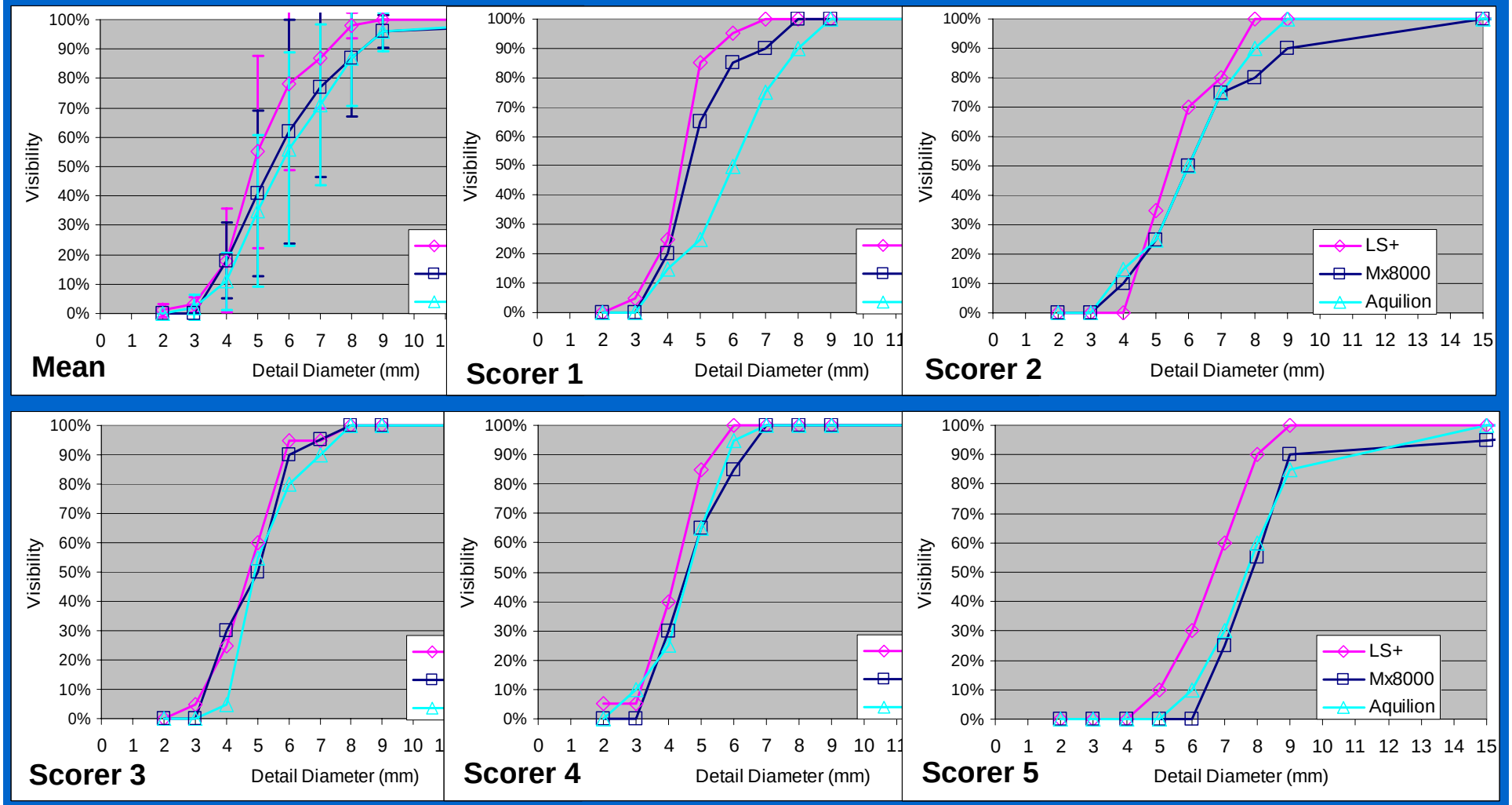
- Average scores of 5 viewers for 3 scanners



- Standard deviation of scores very high!

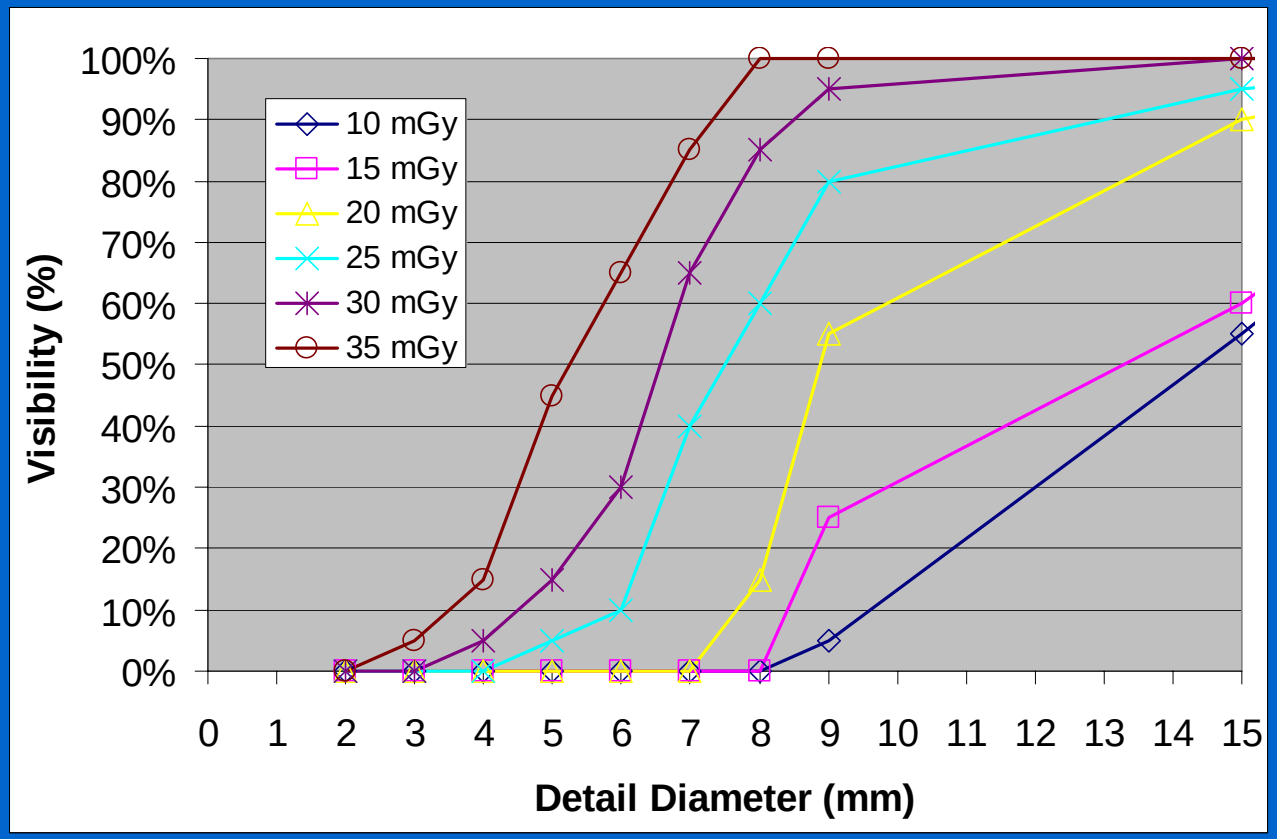
Are all scanners the same?

- Individual scores show similar general trends



LCD and dose

- 20 images at each of 6 dose levels, single viewer



Conclusions

- Very difficult to establish definitive LCD figures
  - comparisons of LCD should only occur when images are viewed at the same time, by the same viewers
- It is possible to establish relative LCD values under controlled conditions
  - Results suggest that fundamental differences in LCD for four slice scanners are not huge, when using Catphan

Conclusions (continued)

- It is important to bear in mind that:
- LCD details in phantom do not represent clinical situation
  - details within patients are not always round, with sharp edges in a predefined position!
- Results are not a ‘definitive’ assessment of LCD - there is no right or wrong answer!

Thank you

- Colleagues in ImPACT who read the images
- Scanner manufacturers for their cooperation
- Hospitals who allowed their scanners to be used for testing

- Slides from this talk are available at www.impactscan.org