

Testing the performance of adaptive iterative image reconstruction on a Toshiba CX 64-slice CT scanner

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CT Scanner

A Toshiba Aquilion CX 64-slice scanner
(Milton Keynes General Hospital)





CT scanner specifications

- Data channels – 64×0.5
(# \times mm)
- Total z-axis detector length – 32 mm
- Max gantry rotation speed – 0.4 s
- Toshiba claim that by using iterative reconstruction that dose to patient can be reduced by up to 70%

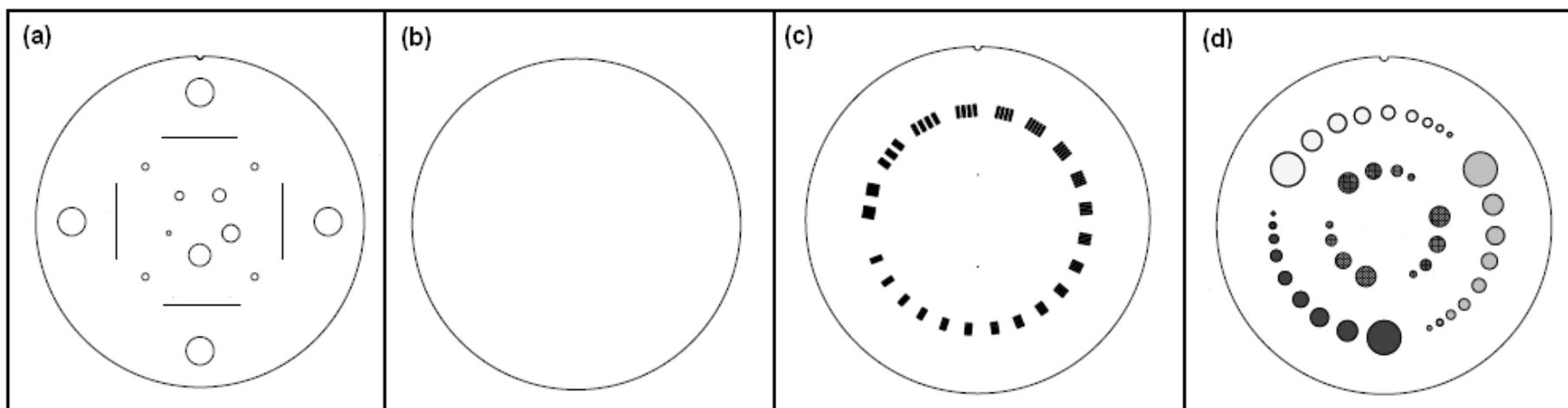


Dose from CT scans - present situation

- HPA-CRCE-012 - A report on the frequency and collective dose for Medical and Dental X-ray Examinations in the UK, 2008; (Hart *et al*, 2010)
- CT accounts for 68% of the collective dose of all medical and dental X-ray examinations
- 11% of hospital examinations
- CT examinations doubled in the previous 10 years

Phantom (Catphan 500)

- (a) Alignment module
- (b) Uniformity/Noise module
- (c) Spatial Resolution module
- (d) Low contrast module





Testing parameters

- Detector configuration – 32×1 (# \times mm)
 - Abdomen scan
 - Rotational Time – 0.5 s
 - 120 kV
 - Helical scan → HP - 27 (0.844 Pitch)
 - Pixel size - 0.488 mm (512 \times 512)
- $f_N = 1.026 \text{ mm}^{-1}$



Noise

- The greater the amount of noise, the harder it becomes to visualise an object as noise competes with signal
- To reduce image noise, use:
 - Quantum Denoising Software (QDS+)
 - uses a combination of smoothing and enhancing filters



Adaptive Iterative Dose Reduction (AIDR)

- Iterative reconstruction technique that can be used as an alternative to FBP.
- It works by comparing an initial estimation of the image with the raw data from the projections to create a new set of data which is again compared to the raw data and so on...
- Promise of improved image quality with **less noise**
- ?



Method & Measurements

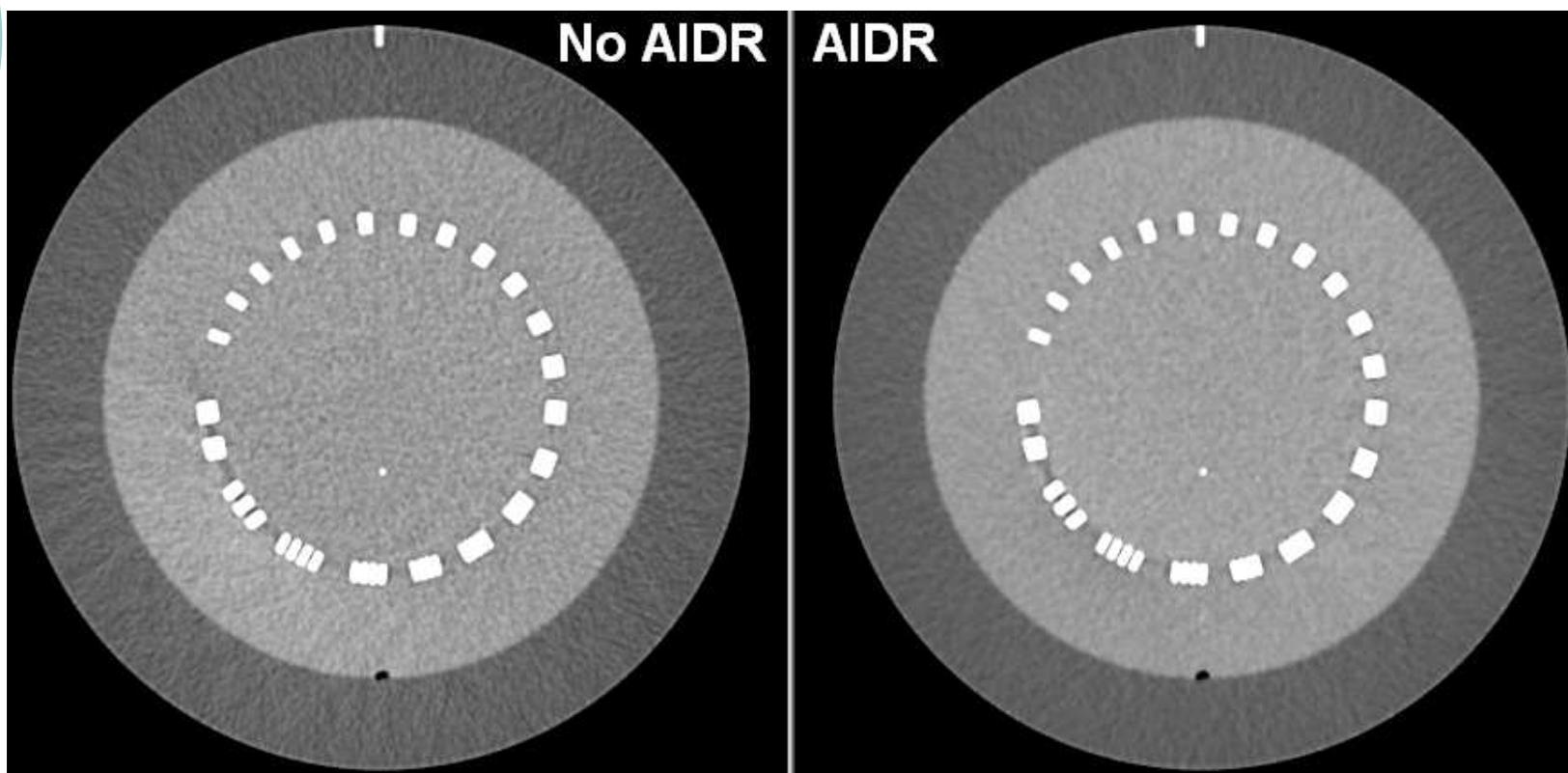
- Phantom was scanned 10 times @ 100, 50 & 25 mA, with images obtained using the FC08 reconstruction algorithm kernel. QDS+ was switched off
- These images were reconstructed again from the raw data using iterative reconstruction
- The phantom was scanned a further 10 times at 100 mA with QDS+ switched on (Clinical setting)



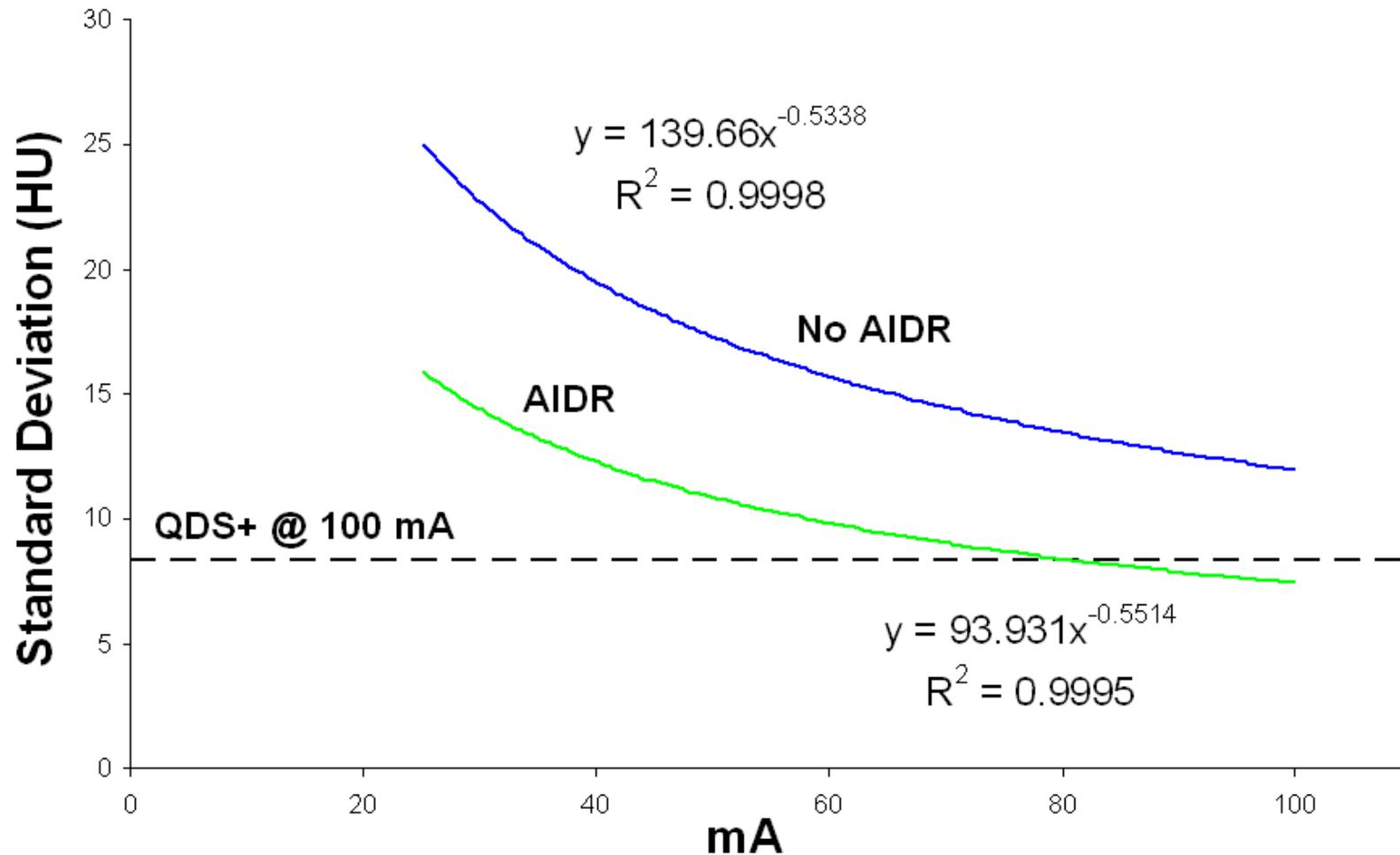
Method & Measurements

- 1. Noise** - Standard Deviation
- Noise Power Spectrum
- 2. Spatial Resolution** -
Modulation Transfer Function
(MTF)
- 3. Low contrast** - Subjective test

Resolution Slices



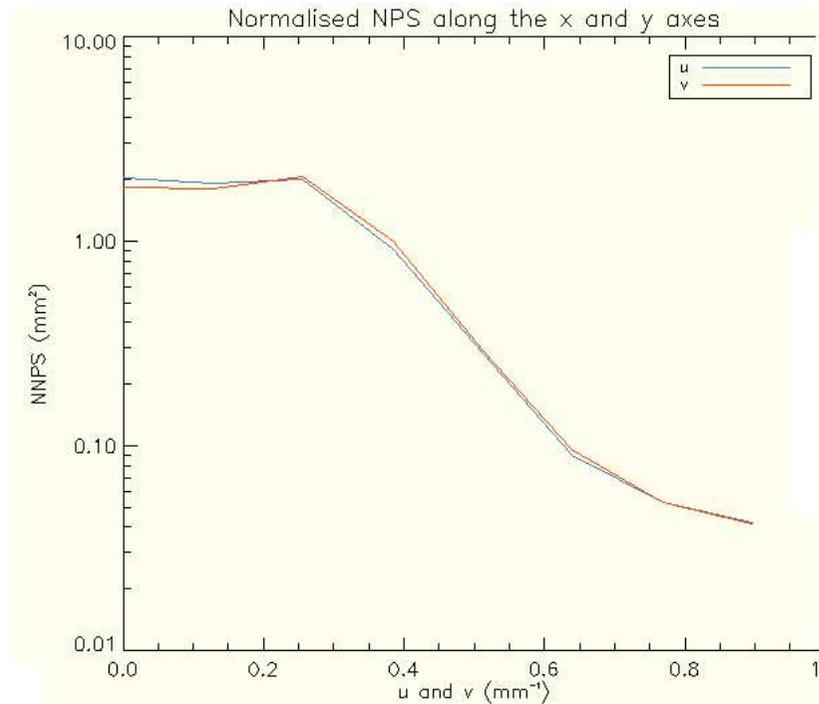
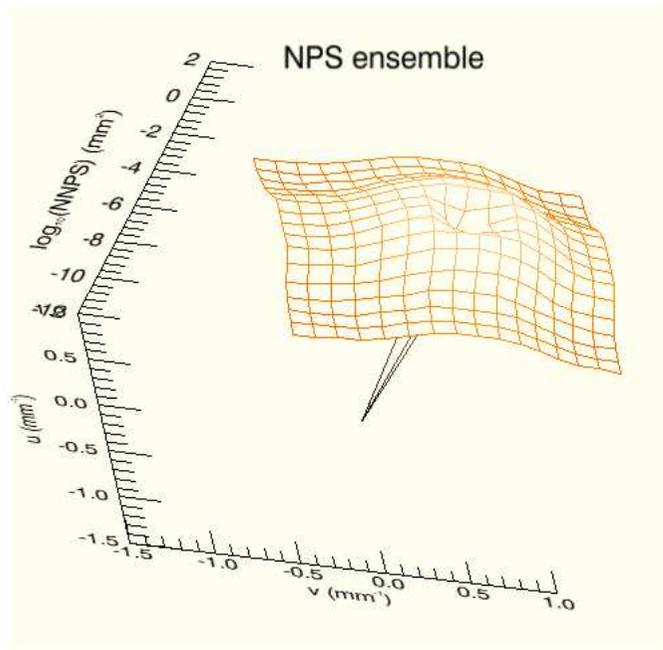
Change in Noise with mA (SD)



Change in Noise with mA (SD)

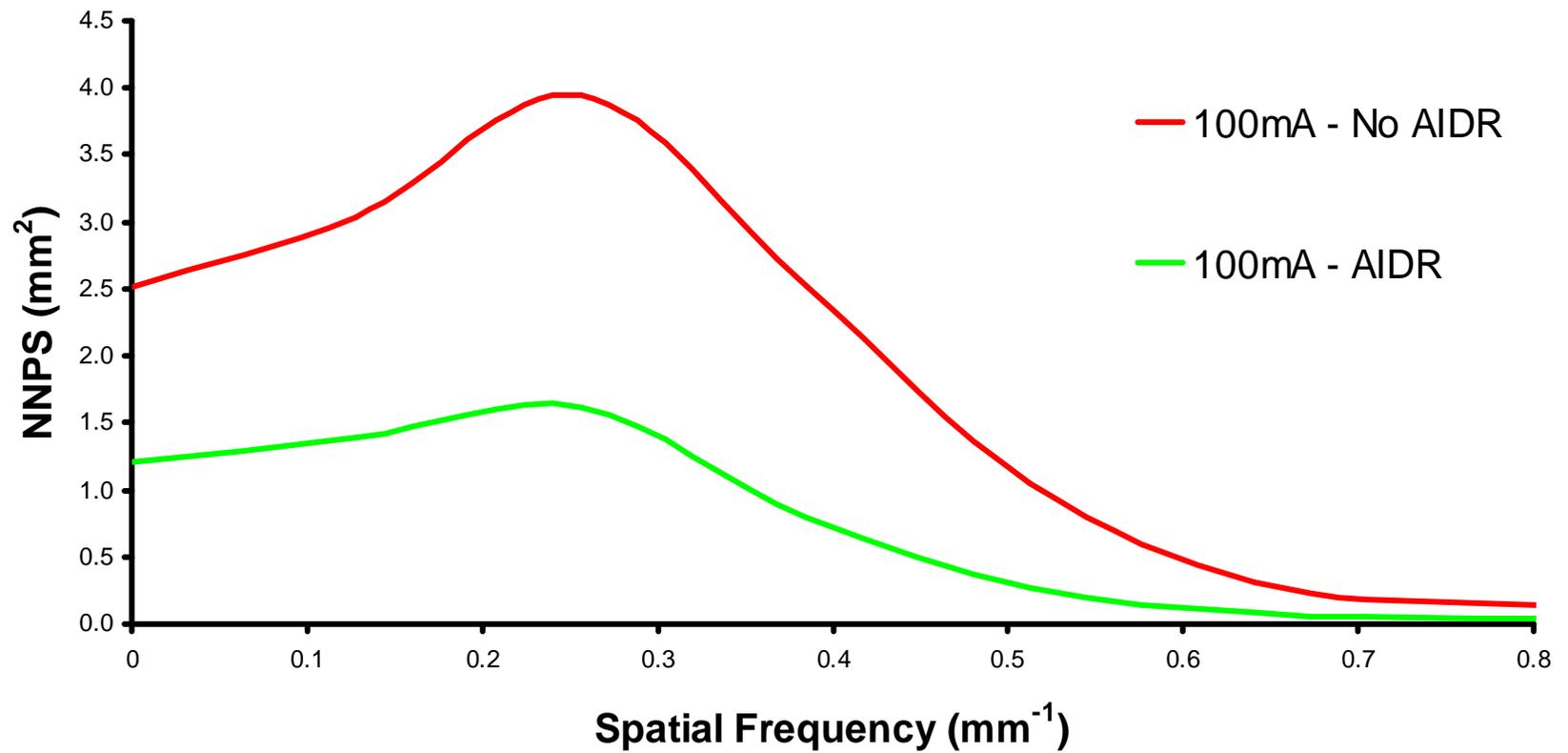
- For AIDR: $y = 93.931x^{-0.5514}$
 $y = 8.36$ (SD of QDS+ @ 100 mA)
 $\therefore x \sim 80mA$
- Note: Noise (y) $\propto 1/\sqrt{\text{Dose (x)}}$

Noise Power Spectrum

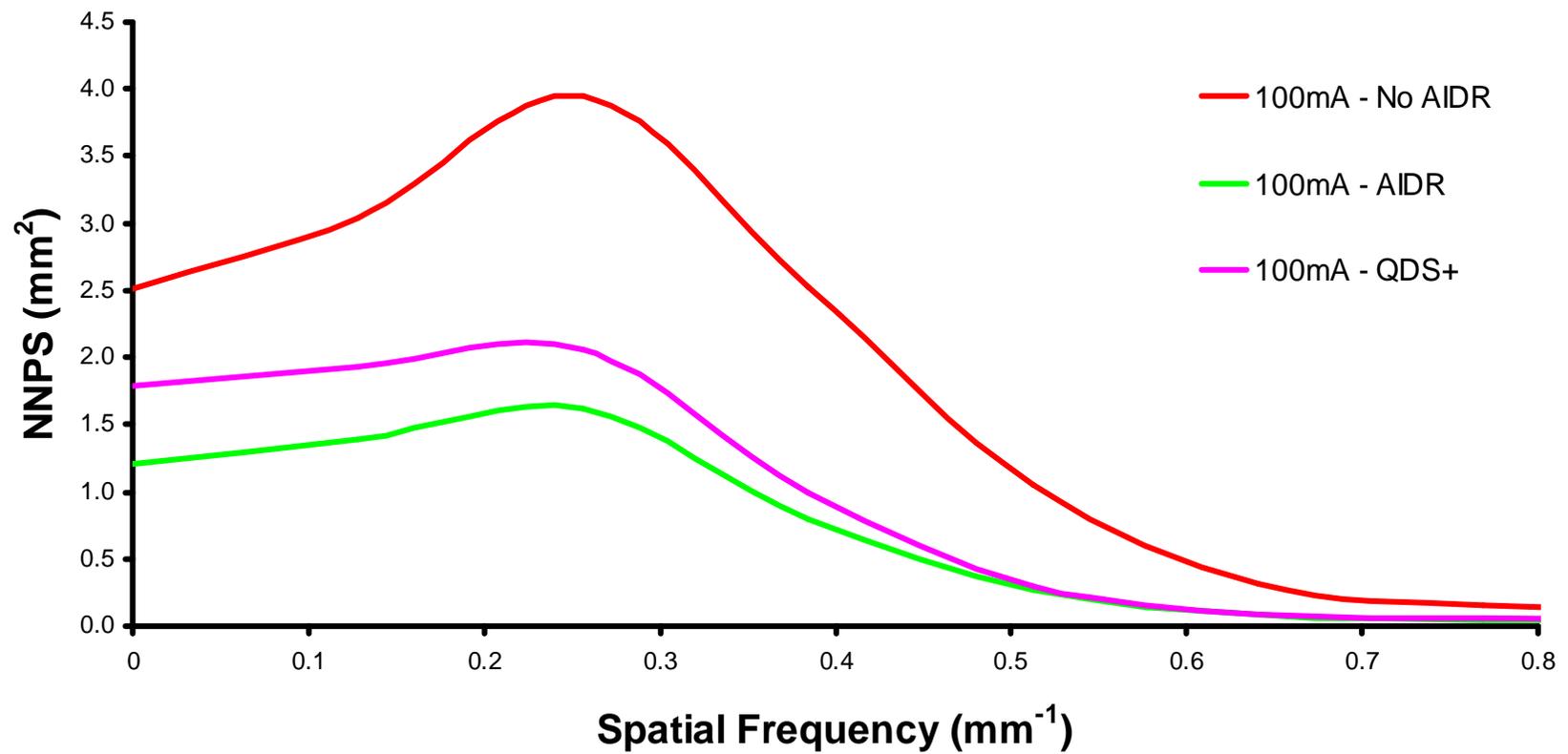


- u and v were averaged over 10 images with very little variation. There was also little variation between u and v.

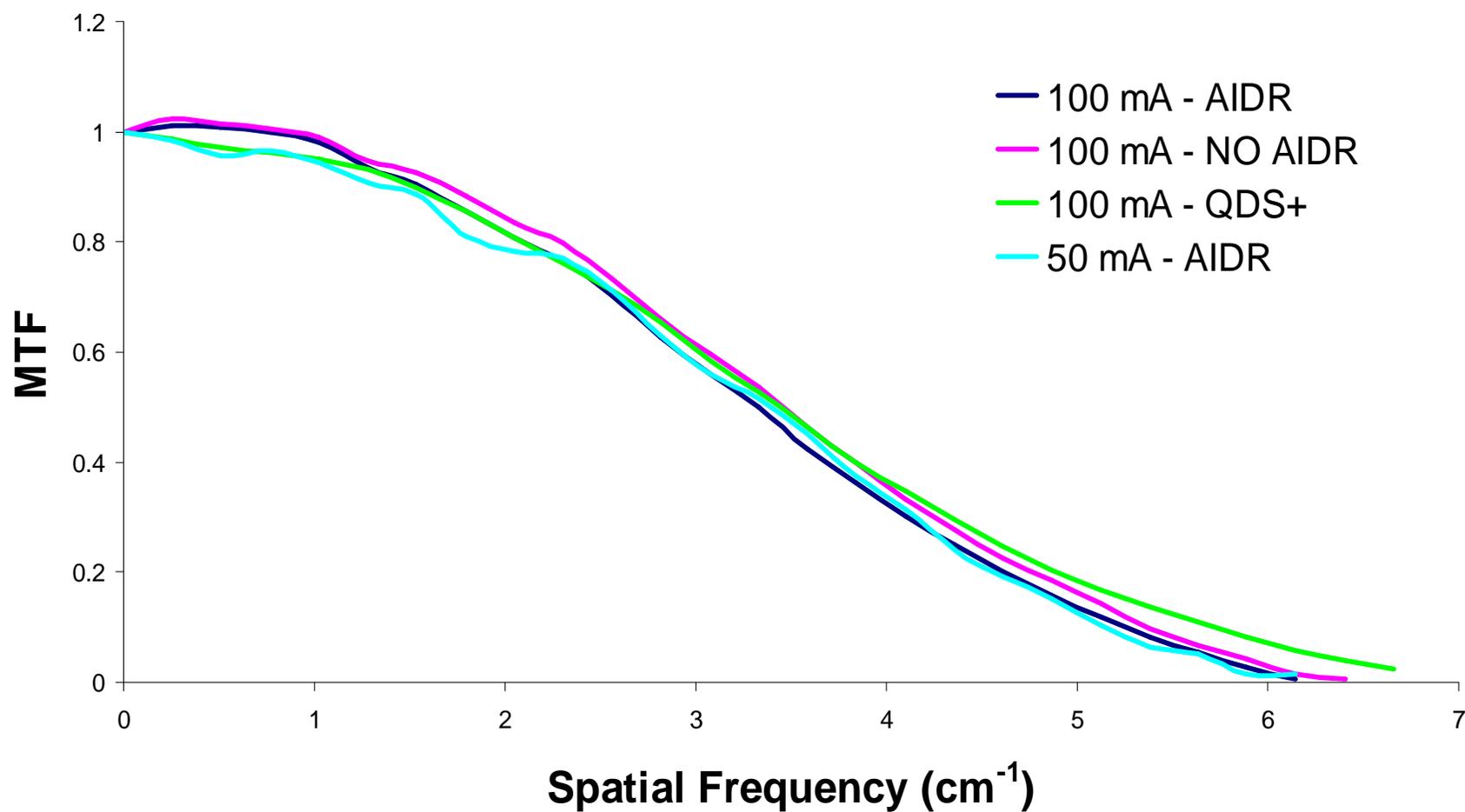
Noise Power Spectra



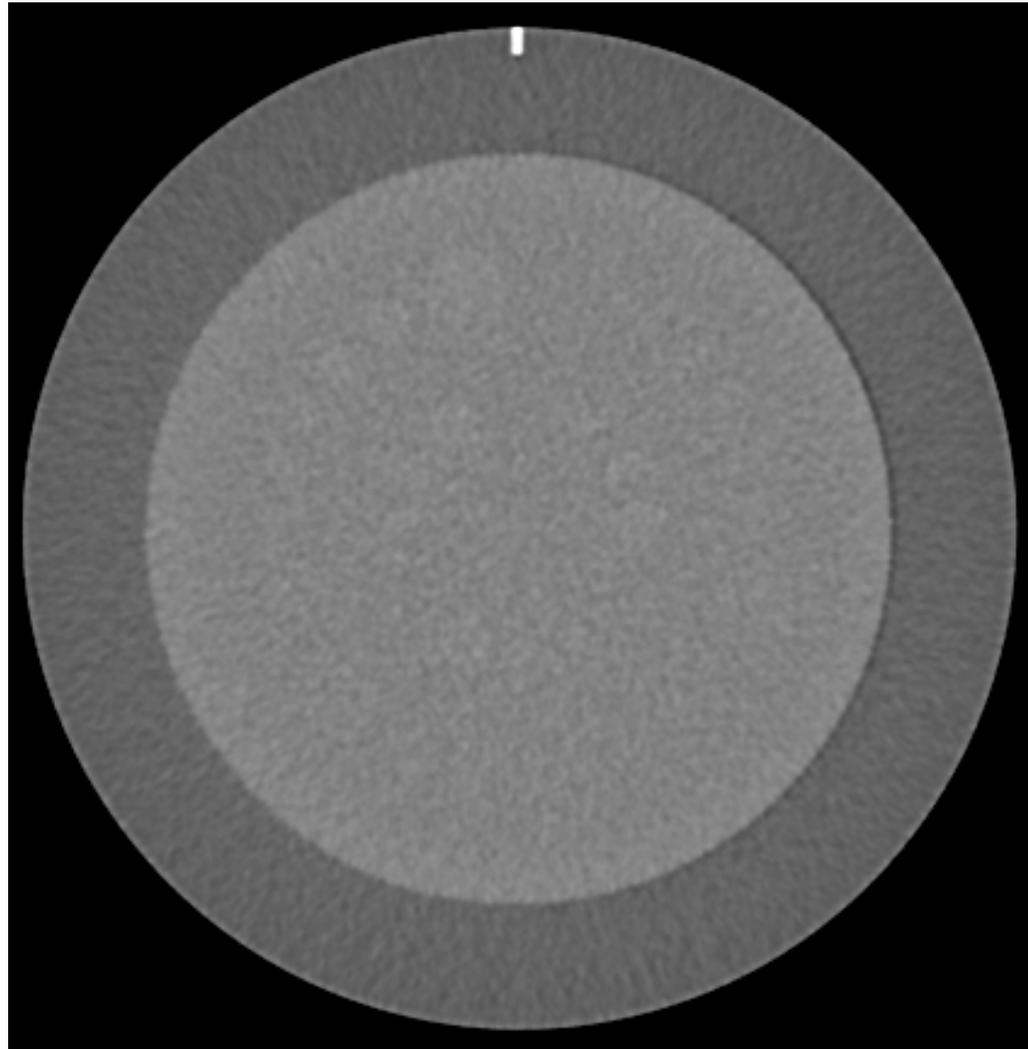
Noise Power Spectra



Spatial Resolution

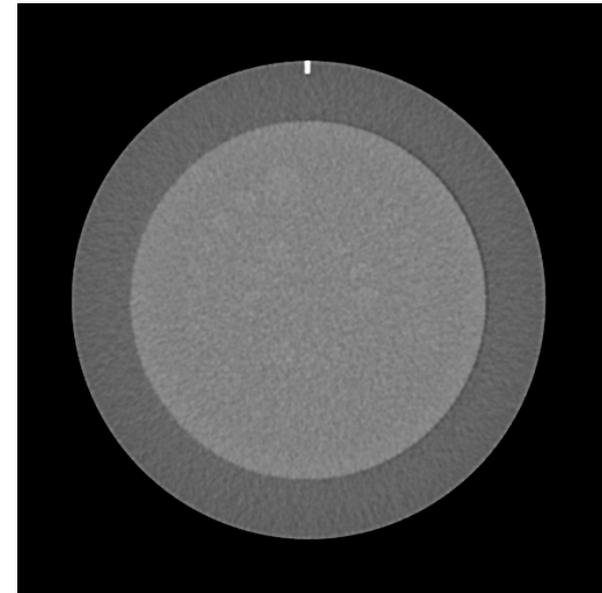


Low Contrast



Low Contrast

- Four observers judged images presented at random
- 15, 9, 8, 7, 6, 5, 4, 3, 2, 1 mm target diameters



| | | A | B | C | D | MEAN |
|-------|------|----|----|----|----|------|
| 100mA | ORG | 7 | 9 | 8 | 7 | 7 |
| | AIDR | 6 | 7 | 7 | 6 | 6 |
| | QDS | 6 | 7 | 8 | 6 | 6 |
| 50mA | ORG | 15 | 15 | 15 | 15 | 15 |
| | AIDR | 15 | 8 | 9 | 9 | 9 |



Conclusions

- AIDR did reduce noise without affecting image quality negatively and worked better than QDS+, currently used clinically
- Potential to reduce dose to patients while still retaining adequate diagnostic images
- Further discussion with staff at MK needed to see of possibility of implementation



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Questions

