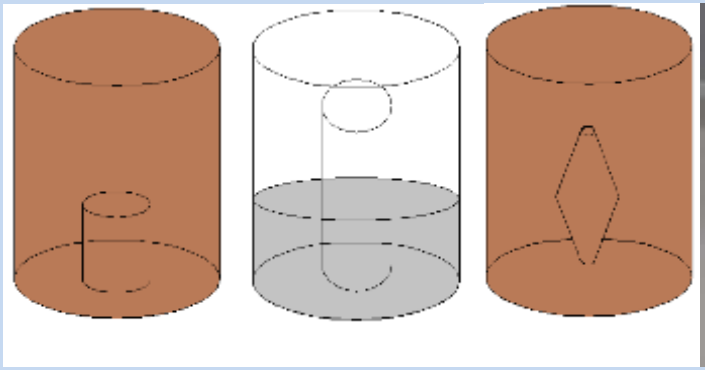

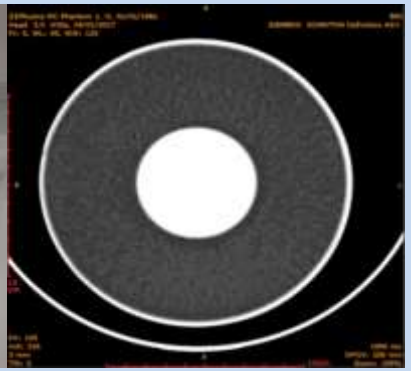

Factors affecting the task specific modulation transfer function in computed tomography

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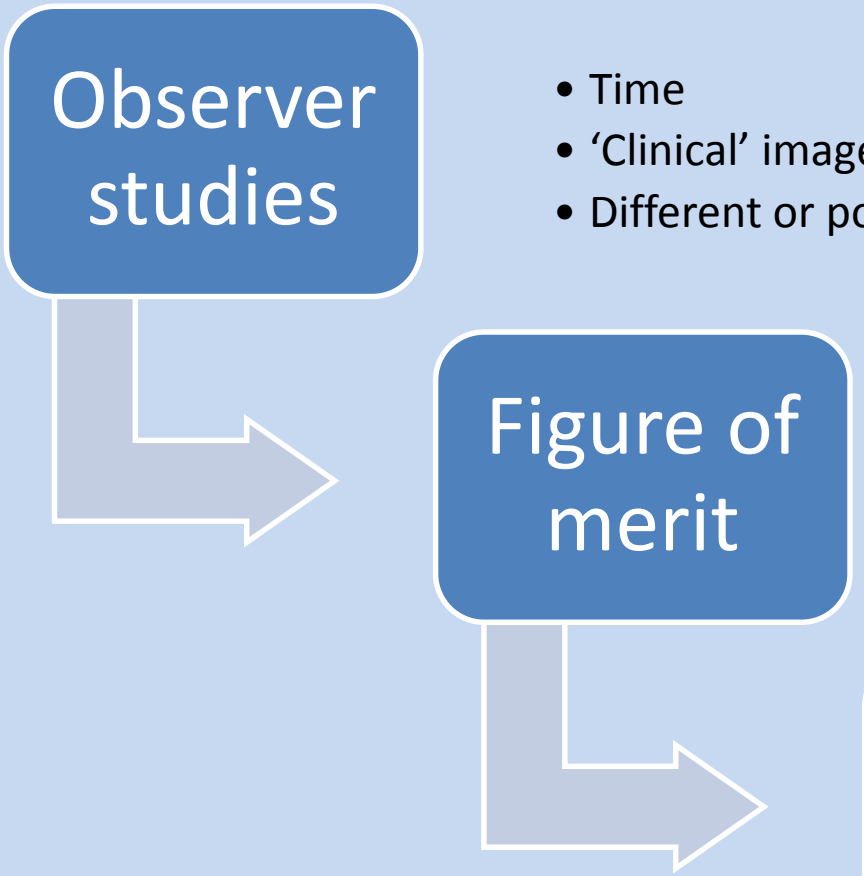
The problem

- Optimisation
  - The balance between image quality and dose
  - Particularly important in CT
- Image quality testing
  - But is image quality testing really representative of clinical image detectability?

A solution?



- Time
- 'Clinical' images or test object
- Different or poor?

- Need clinical input to decide acceptable detectability
- NPS and MTF and dose

- Physicist only
- Possible within normal QC

Factors affecting MTF in CT

- Iterative reconstruction
  - Different manufacturers have shown differences in MTF of between 0% and 12%

- Task specific contrast levels
  - Papers disagree on the effect on MTF

Project Aim

- Method of task specific MTF measurement
  - Manufacture of a suitable phantom
  - Development of analysis software

- Greater understanding of Siemens Somatom Definition AS+ algorithms used at UHBristol.

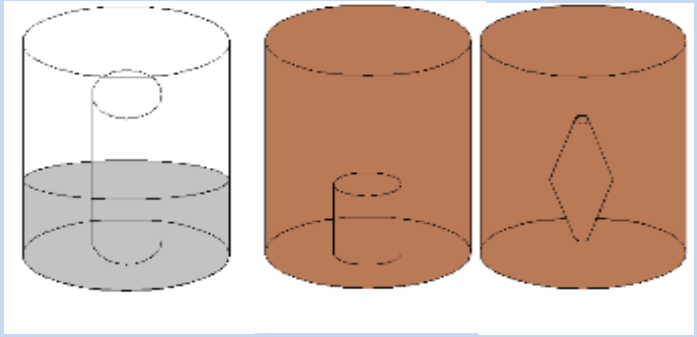
Phantom planning

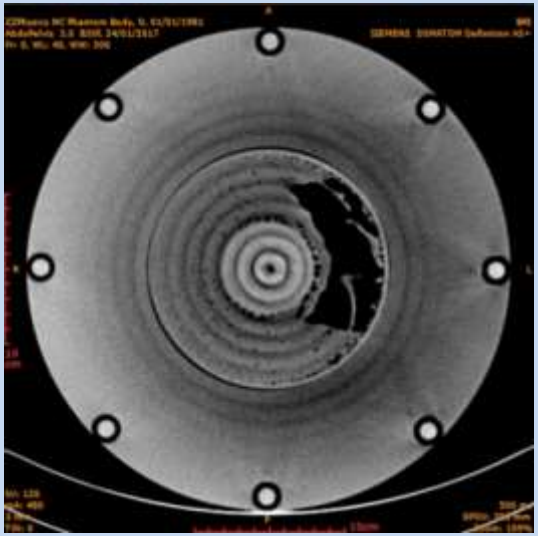
- MTF by circular edge method
  - PMMA rods (120HU)
- Multiple contrast levels

Air	Axson F18 fast cast	DSM6060 Polyester
-1000HU	20HU	115HU
1120HU	100HU	5HU

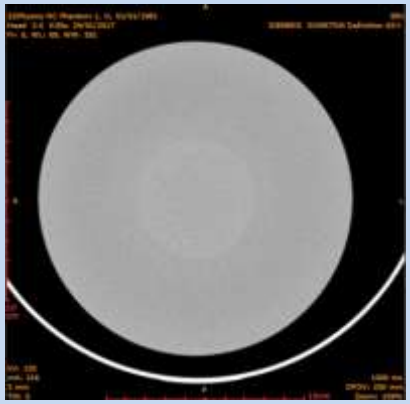
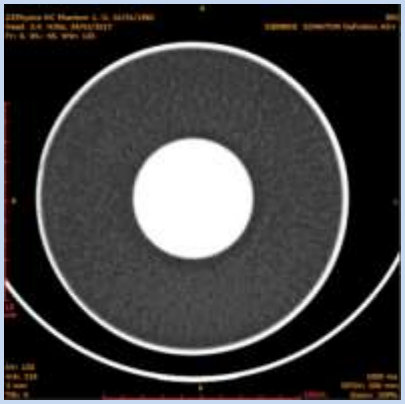
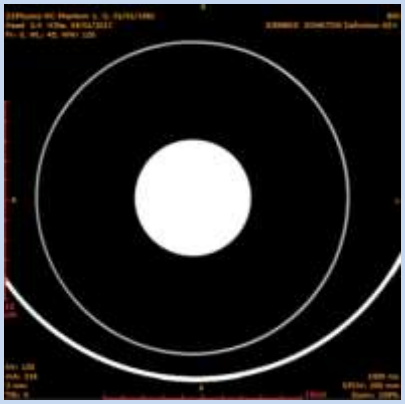
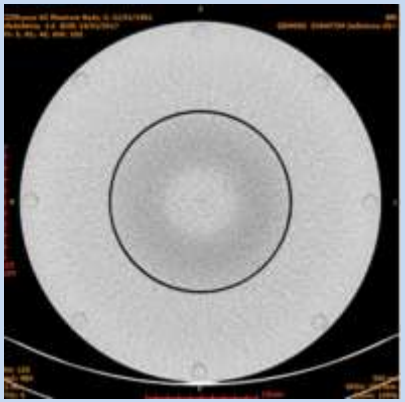
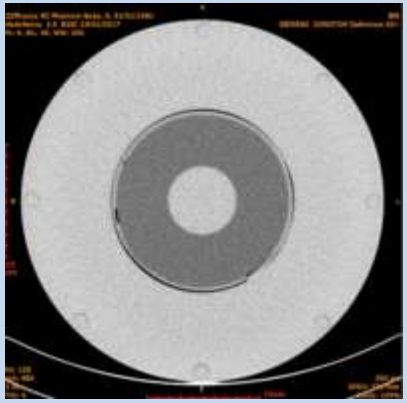
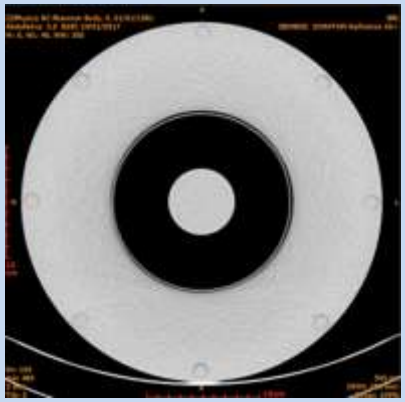
- Inside CTDI phantom for “body”

Phantom building





Imaging

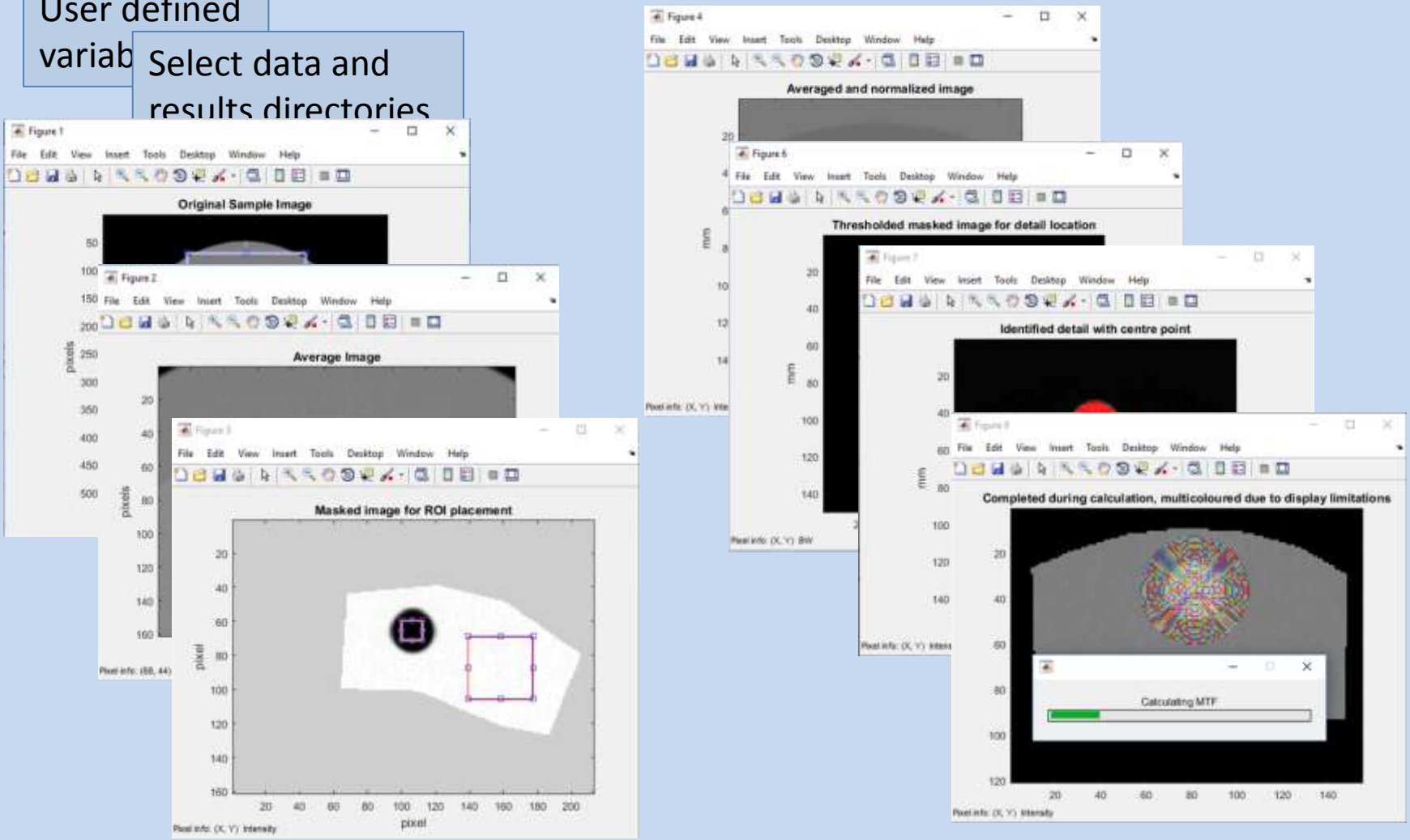
Code writing

- Original MATLAB code published by Friedman et.al. MedPhys 2013
- Limitations to adapt
  - Used full ACR phantom edge with air
    - Need to be able to select region and remove artefacts/other details
  - Generates two text files with the axis and MTF data
    - Excel output for easier manipulation

MATLAB Code

User defined variab

Select data and results directories



MATLAB Code

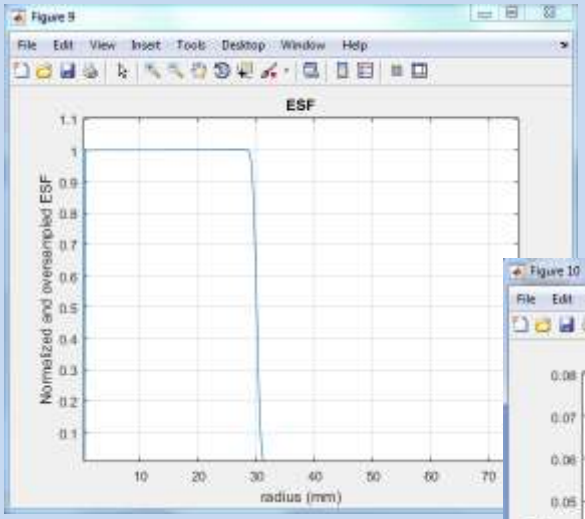


Figure 9
File Edit View Insert Tools Desktop Window Help
ESF
Normalized and oversampled ESF
radius (mm)

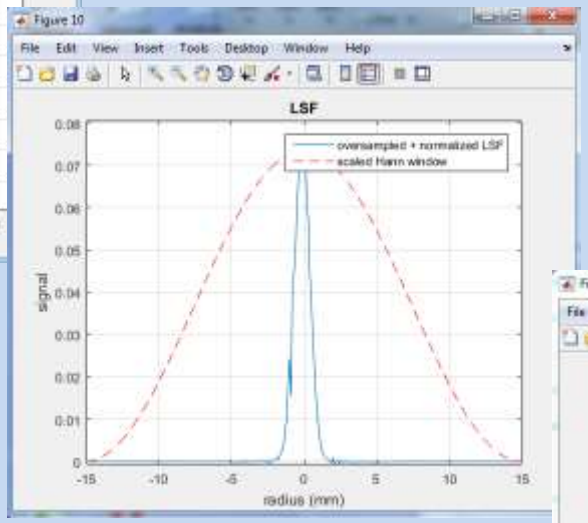


Figure 10
File Edit View Insert Tools Desktop Window Help
LSF
oversampled + normalized LSF
scaled Hann window
signal
radius (mm)

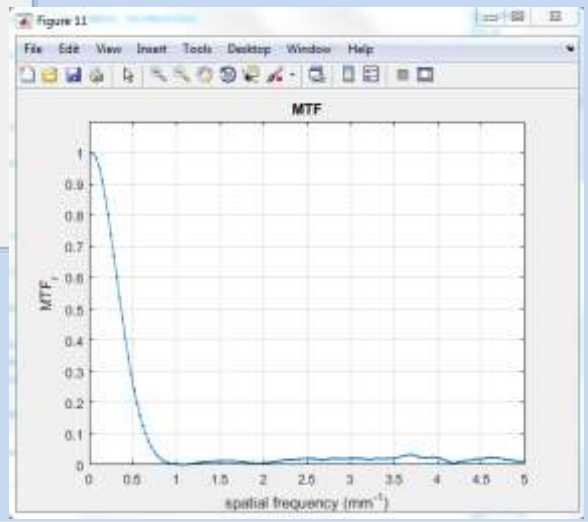
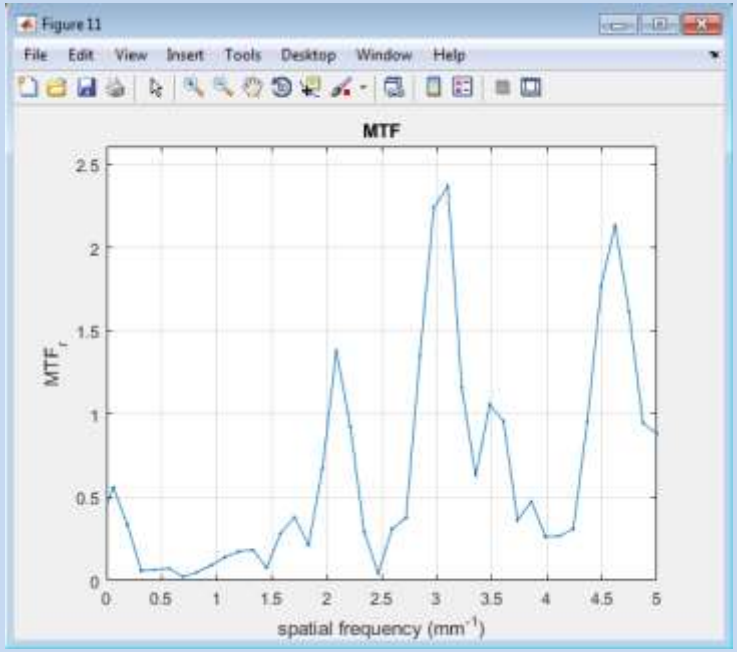


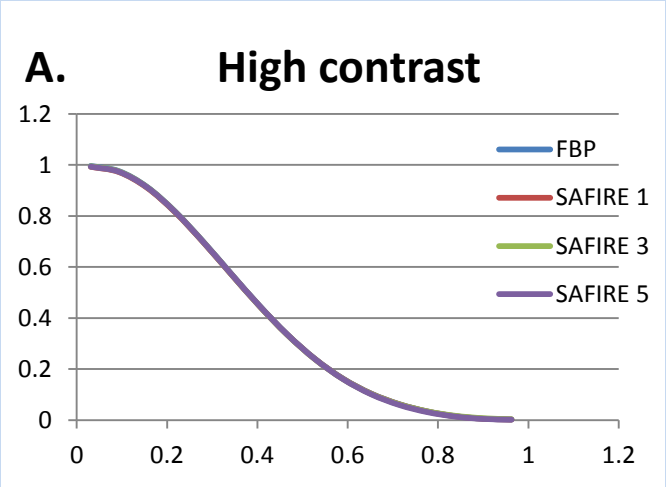
Figure 11
File Edit View Insert Tools Desktop Window Help
MTF
MTF
spatial frequency (mm⁻¹)

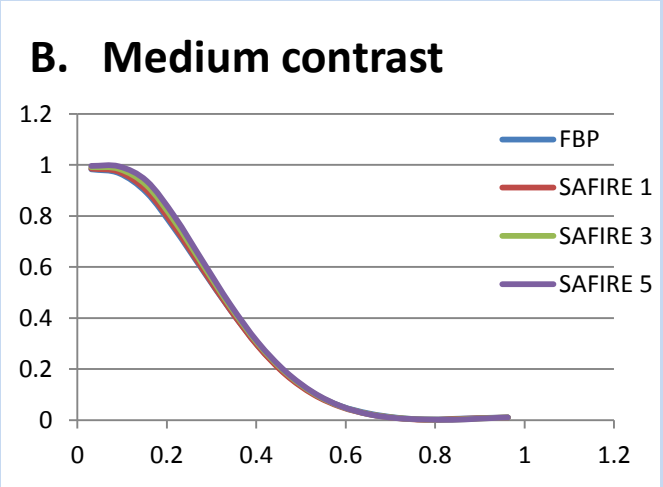


- Low contrast region too noisy – unusable
- Very careful user region definition required
  - Any tiny artefacts/CATPHAN detail changes the peak in the LSF
- Removal of noisy tails of LSF required in med/low contrast regions
  - Leads to reduction in MTF through loss of data

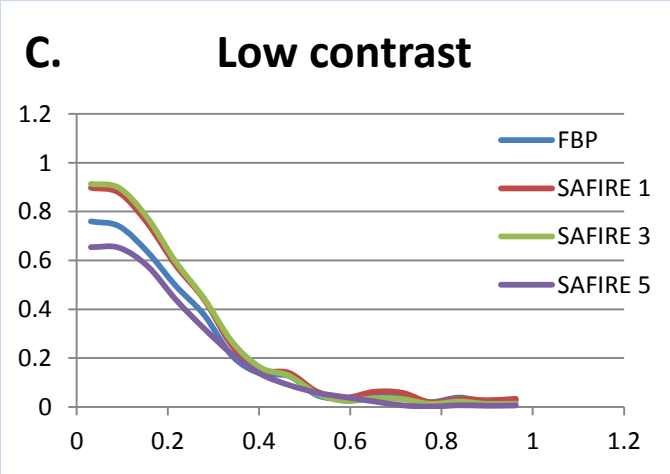
Iterative Reconstruction Results

0.1%



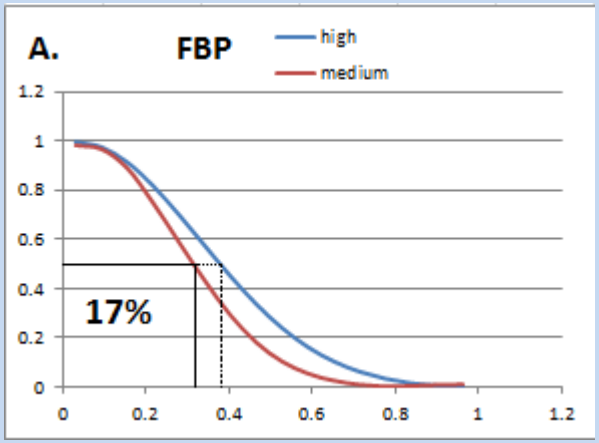


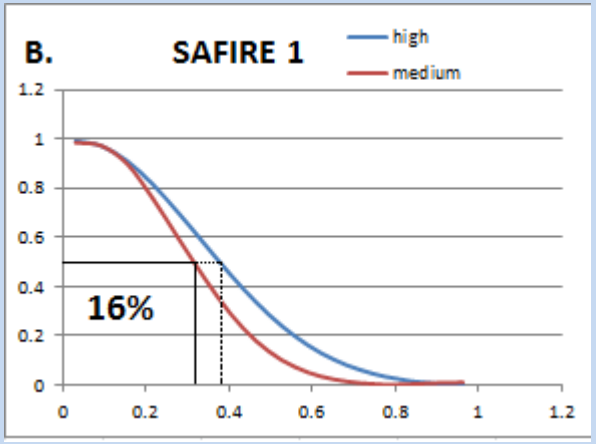
3%

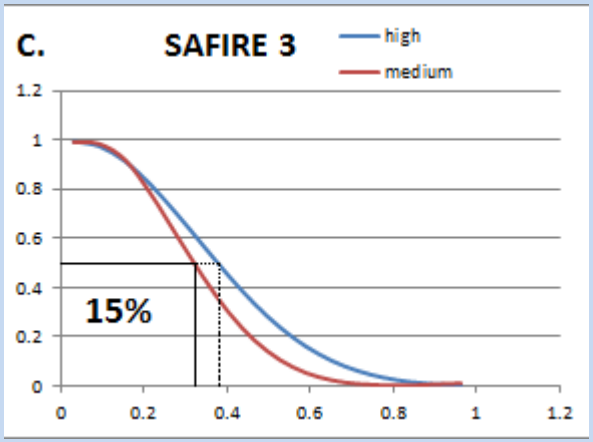


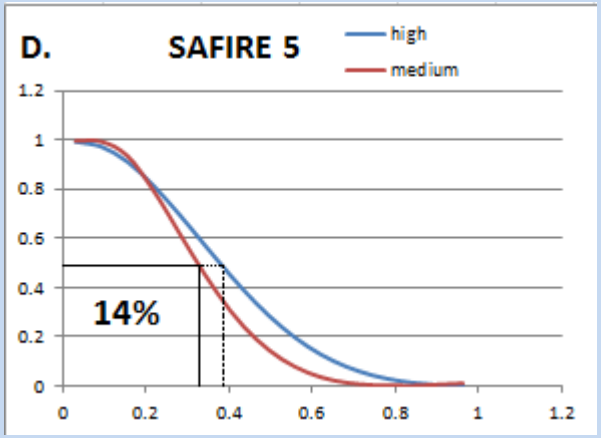
- Very little effect on MTF due to the use of iterative reconstruction

Detail contrast results



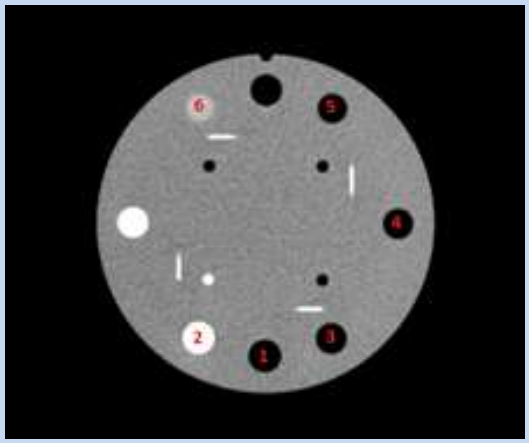






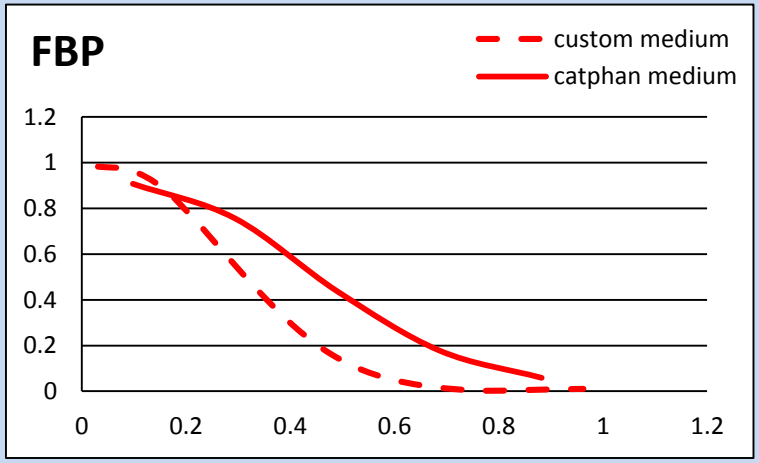
- The contrast of the detail used does affect the 0.5MTF by up to 17%

CATPHAN



Detail number	Material	Expected CT no.	Measured CT no.	Contrast	Comparable to custom phantom
1	Air	-1000	-994	1089	High (1120)
2	Teflon	990	910	815	
3	PMP	-200	-183	278	
4	LDPE	-100	-92	187	
5	Polystyrene	-35	-35	130	Medium (100)
6	PMMA	120	115	20	Low (5)

- Very different shape from custom phantom.
- Size of detail causing the drop from 1 at f=0.
  - Try decreasing the radius increment of calculation.



Conclusions

- Phantom manufacture is very difficult!
- The Siemens Somatom iterative reconstruction algorithms did not affect MTF (across all contrasts tested)
- For the custom phantom there was a 17% difference in MTF (max) between high and medium contrast details (for FBP and IR)

Further work

- Look at other manufacturers scanners within UHBristol
  - No effect of iterative recon in Philips
  - Toshiba and GE to go
- Further discussion needed to find of ways to look at low contrast
  - Fillable phantom?
- Converting MATLAB code to ImageJ for wider use.

Thank you!

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NHS Foundation Trust

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