

Implementing Siemens IR techniques in routine CT protocols

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CT Users Group meeting
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Context: The Royal Marsden Hospital



- Three sites:
 - Chelsea
 - Sutton
 - Private clinic in Central London (Cavendish Square)
- Siemens scanners
 - Flash
 - Edge
 - Drive

➤ Flash and Edge: SAFIRE

➤ Drive: ADMIRE



Context: IR vs FBP at the RMH

- Most of the routine CT protocols in the main sites use FBP
- SAFIRE is applied to some protocols at the Flash in Sutton
 - Reduce image noise, consequence of the old detector
- Somatom Drive: first in the Trust with ADMIRE capabilities
 - Use IR instead of FBP
- Chelsea and Sutton: use SAFIRE without dose reduction and introduce it gradually over time



Context: optimisation

- Optimisation task group: physicists, radiographers, and consultants. Main goals:
 1. Evaluate the effect of IR algorithms and compare them to FBP
 2. Set up routine CT protocols on the Siemens Drive with ADMIRE
 - Reduce patient dose
 - Ensure image quality is consistent across the Trust



Context: optimisation

ADMIRE, SAFIRE, and FBP compared to each other:

Objectively, with IQ parameters such as MTF, NPS, and CNR.

Qualitatively, by a consultant radiologist.

	A	B	C	D	E
1		SAFIRE 3		ADMIRE 3	
2	Frequency (cm-1)	mean NPS	2xsem	mean NPS	2xsem
3	0	21.24	0.00	11.87	0.00
4	0.08	10.71	1.09	13.46	0.73
5	0.16	11.90	1.29	11.21	1.01
6	0.24	10.25	0.90	13.34	1.40
7	0.32	11.52	1.89	13.34	2.21
8	0.4	15.67	2.14	14.66	1.80
9	0.48	19.38	2.73	17.34	3.15
10	0.56	23.32	3.26	22.17	2.71



Materials and methods



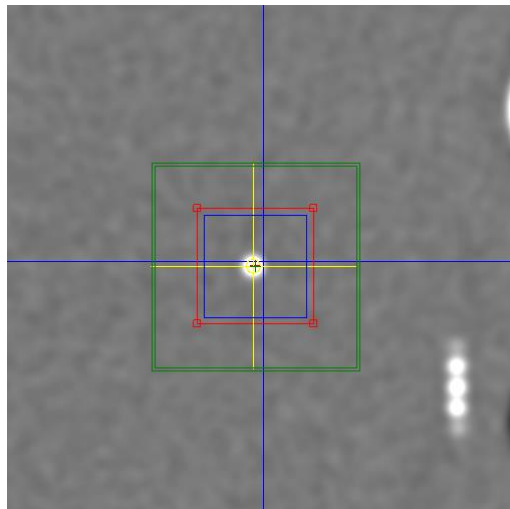
Materials

- Siemens Somatom Drive (with ADMIRE) and Siemens Definition Edge (with SAFIRE)
- CATPHAN 700
- Upper body of the Kyoto Kagaku PBU-60 anthropomorphic phantom
- Siemens QA phantom (water section)
 - Reconstruction kernels applied: normally used clinically (soft tissue and sharp kernels)



MTF

- CATPHAN 700, sensitometry section (CTP682)
- Axial mode
- Images reconstructed with FBP, and low, medium and high IR strength levels (soft tissue and sharp kernels)
- Analysis carried out on the 0.05 mm Tungsten wire



NPS

- Water section of the Siemens phantom
- Axial mode
- Variable mA: 20, 100, 200, 400, and 800.
- Images reconstructed with FBP, and low, medium and high IR strength levels
- In addition to the NPS: analysis of the inverse of the image variance
 - Inform us about the linearity of the noise behavior
 - Establish what mAs to get the same noise in IR images as in FBP



CNR and IQ assessment

- Upper body of Kyoto
- Thorax and abdomen protocol used with various mAs
- Images reconstructed with FBP and IR strength 3
- ROI placed on features and featureless regions of the liver



- Difference images (FBP minus IR): more effective approach to better visualize differences between algorithms



Qualitative IQ assessment

- Upper body of Kyoto
- Thorax and abdomen protocol used with various mAs
- Images reconstructed with FBP and IR strength 3
- Images clinically appraised by a consultant radiologist
 - ADMIRE: consultant radiologist looked at the images for each mAs and gave his opinion;
 - SAFIRE: blinded to the mAs; scored images from “good” to “unacceptable”



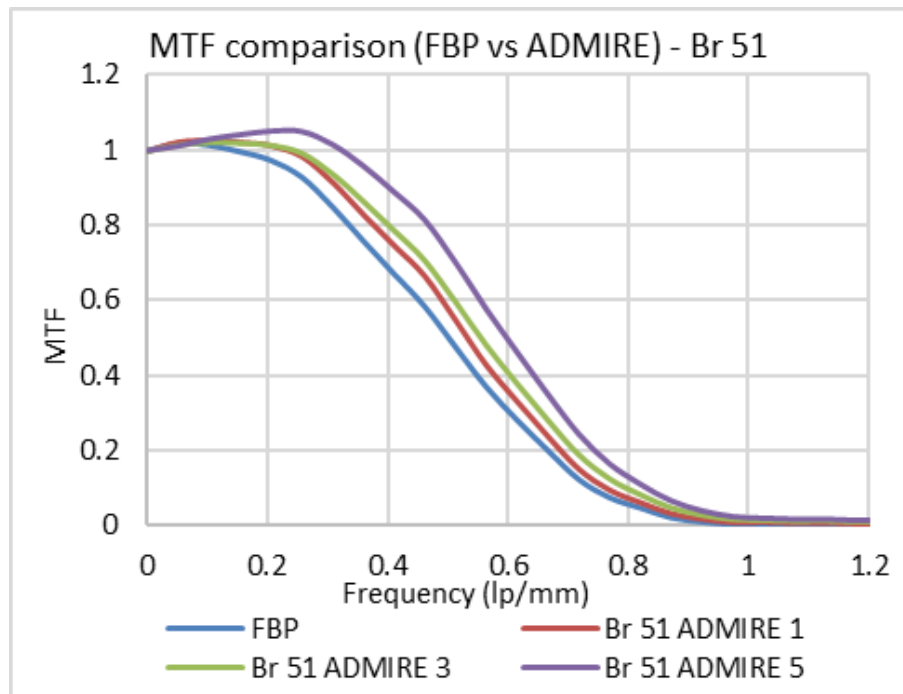
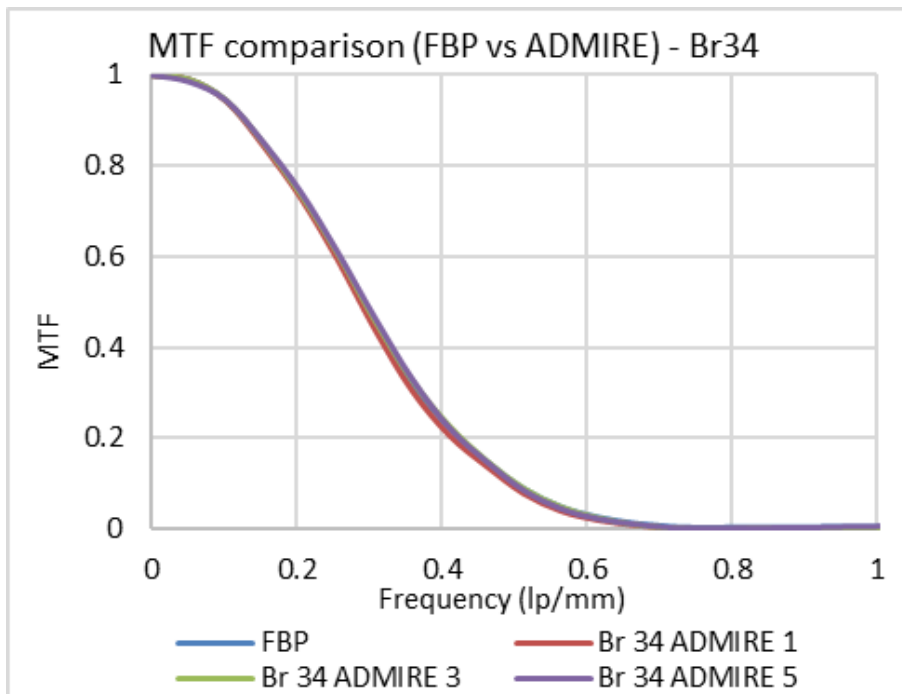
Results



Life demands excellence

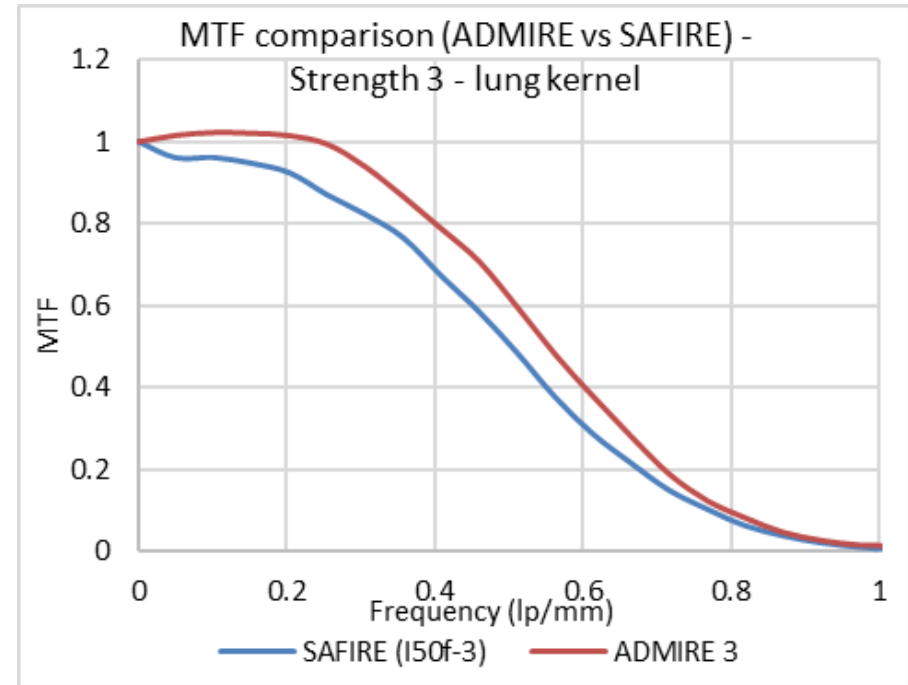
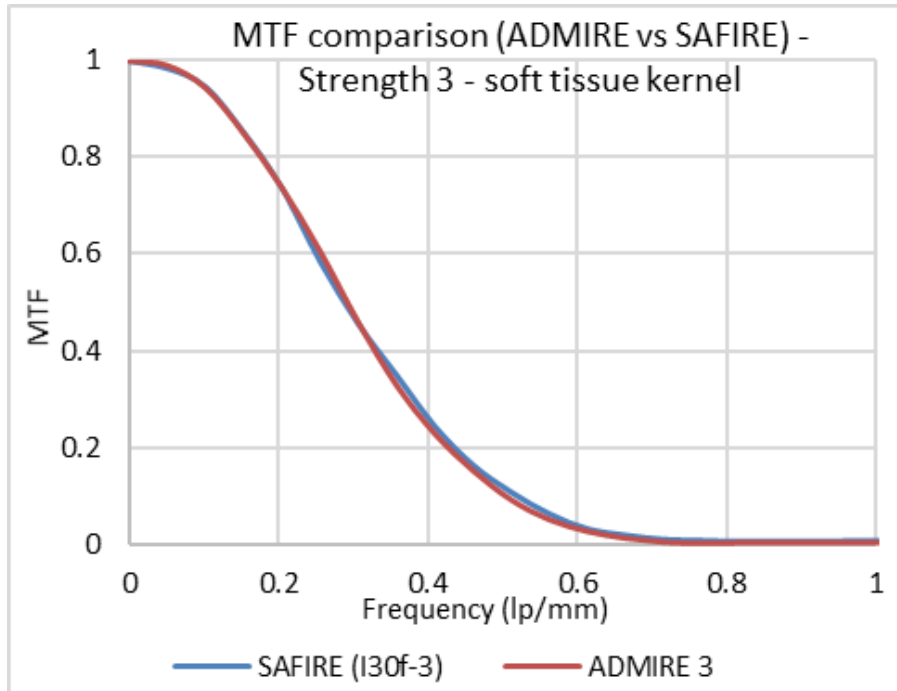
MTF

MTF curves for soft tissue and lung kernels with FBP and ADMIRE



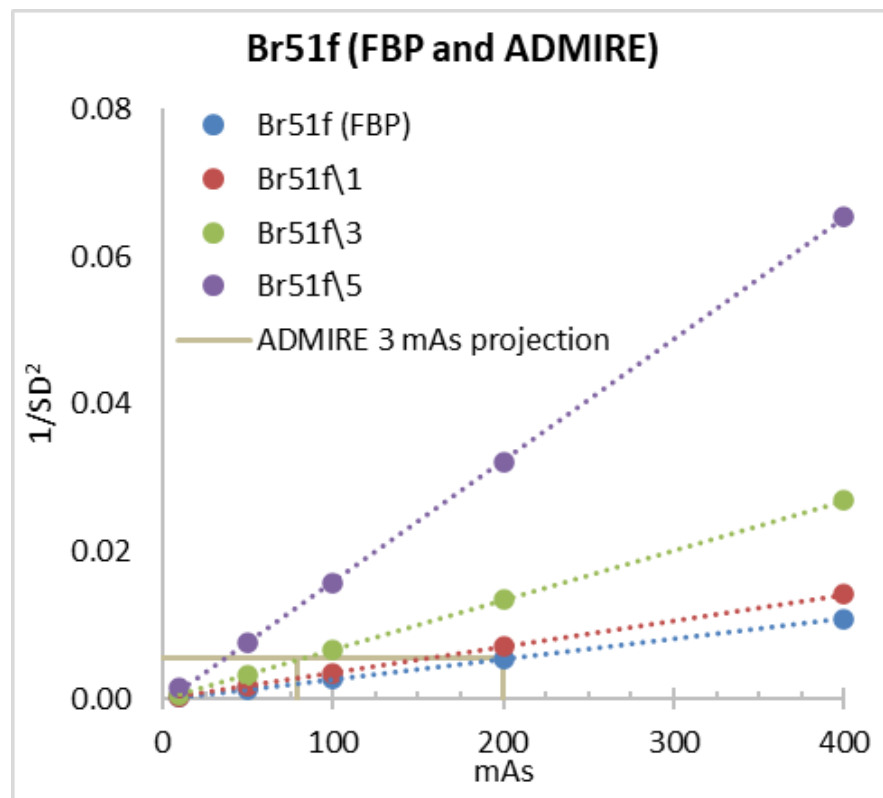
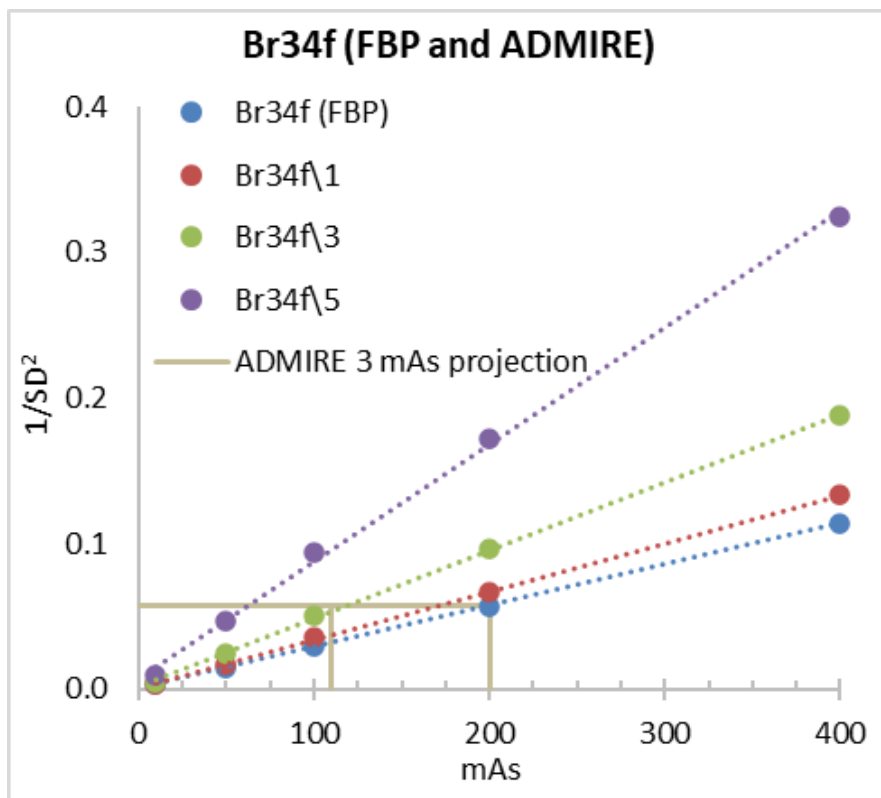
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MTF curves for soft tissue and lung kernels with ADMIRE and SAFIRE



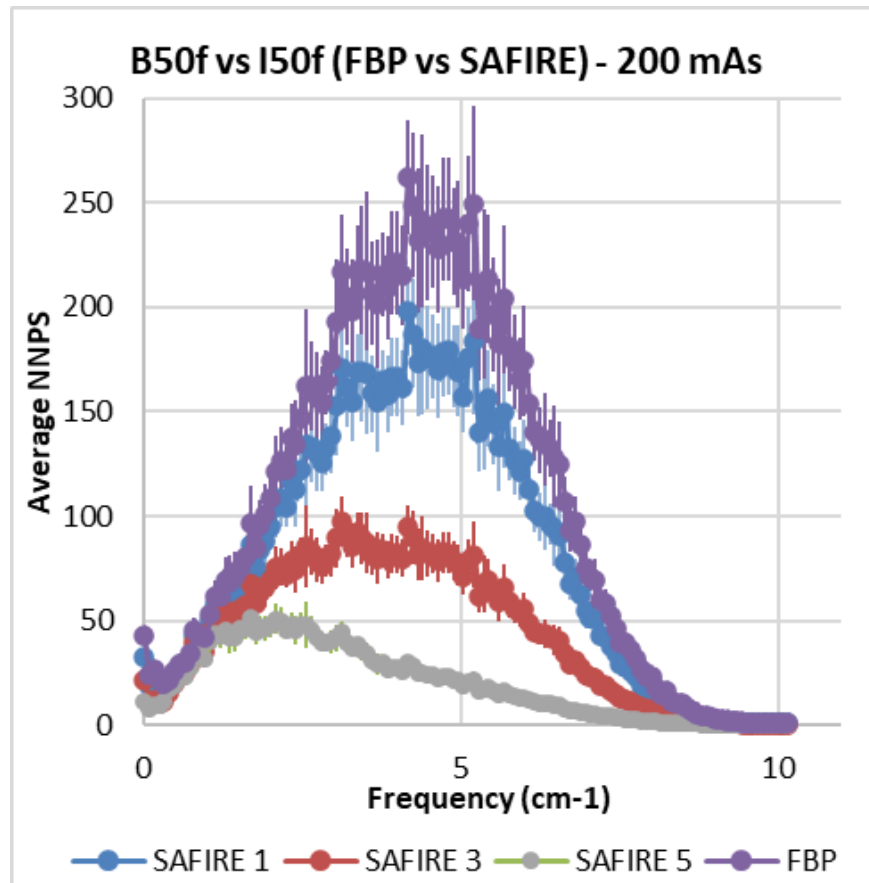
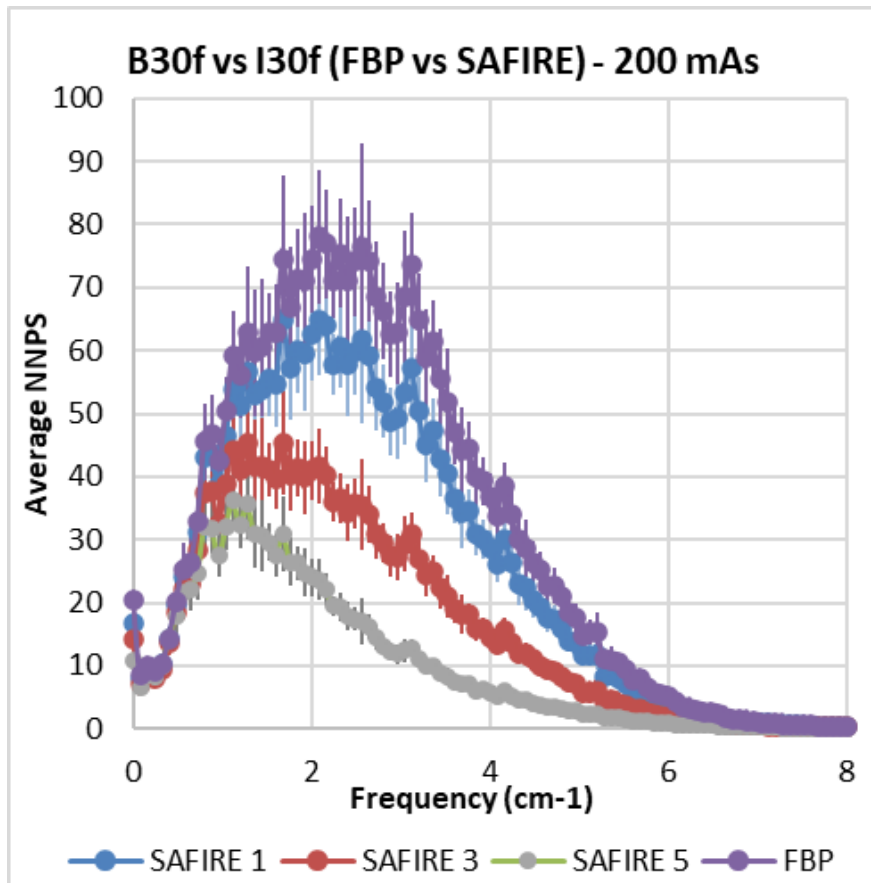
Noise matching

$\frac{1}{SD^2}$ vs mAs for FBP and for the IR images for both kernels



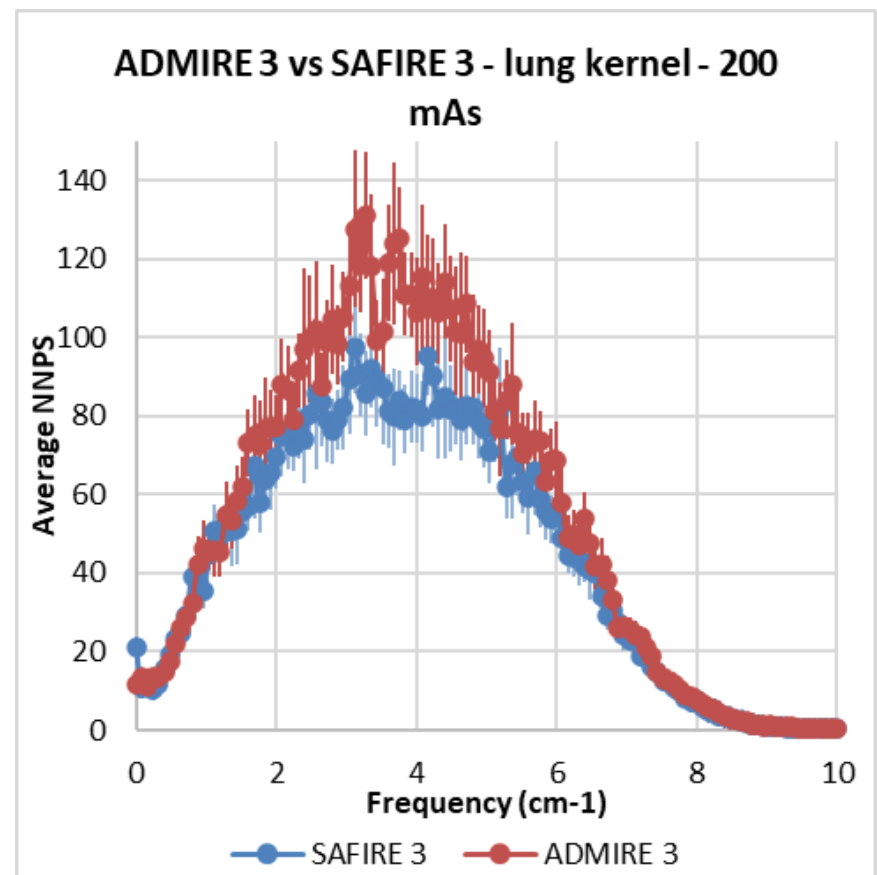
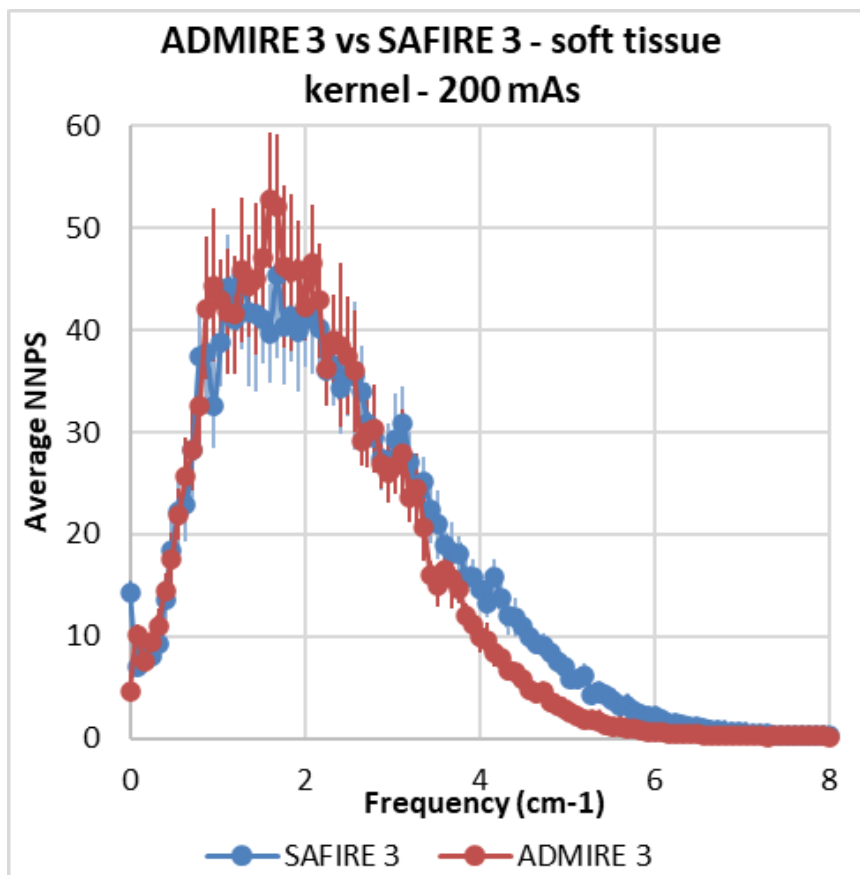
NPS

NPS curves for soft tissue and lung kernels with FBP and SAFIRE



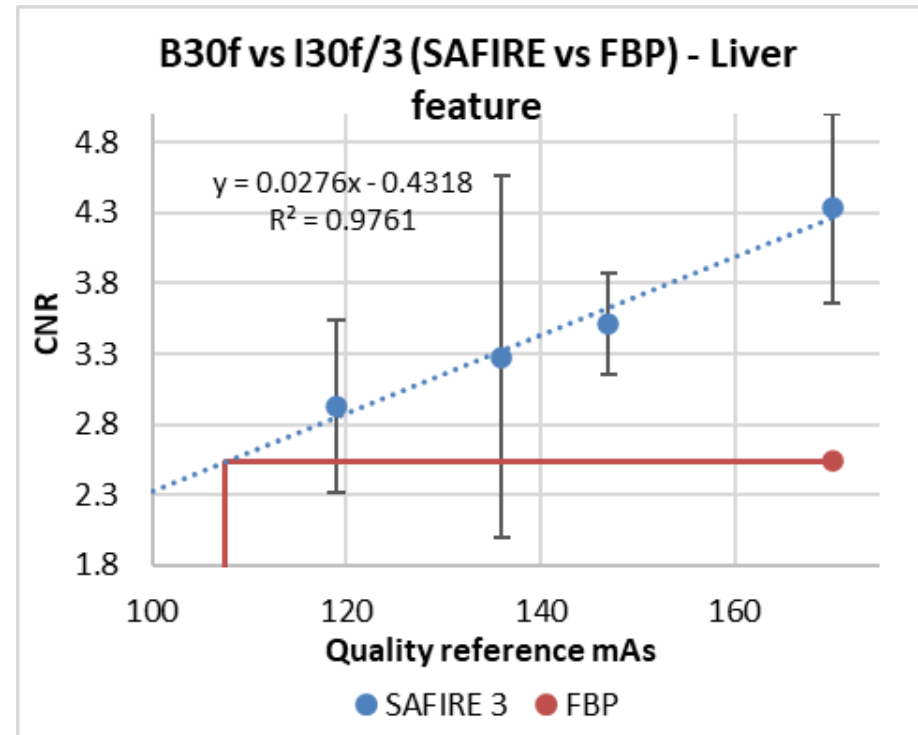
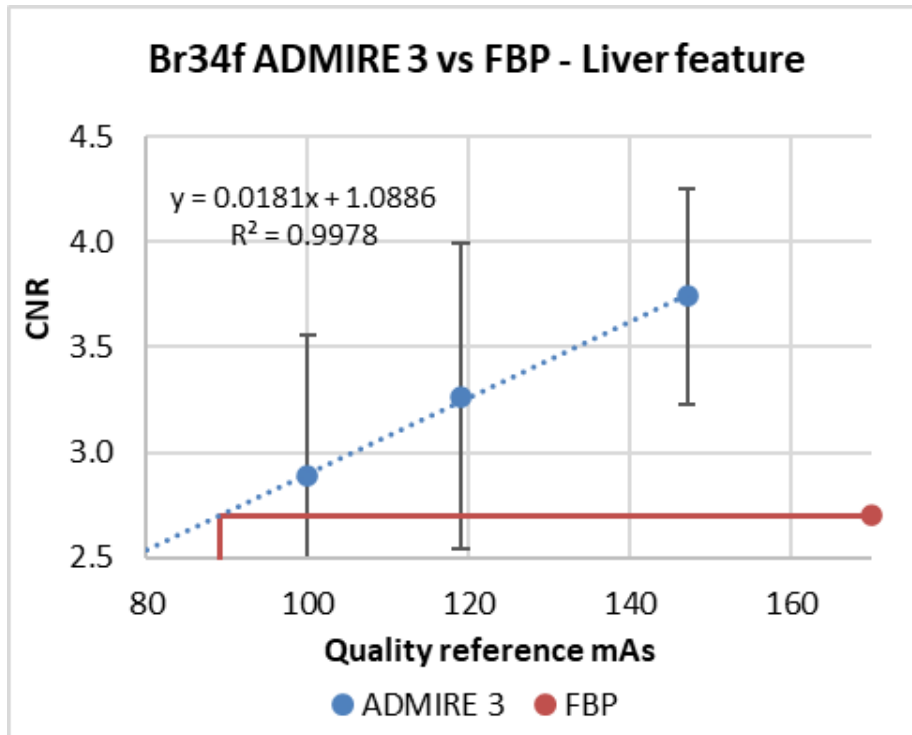
NPS

NPS curves for soft tissue and lung kernels with ADMIRE and SAFIRE



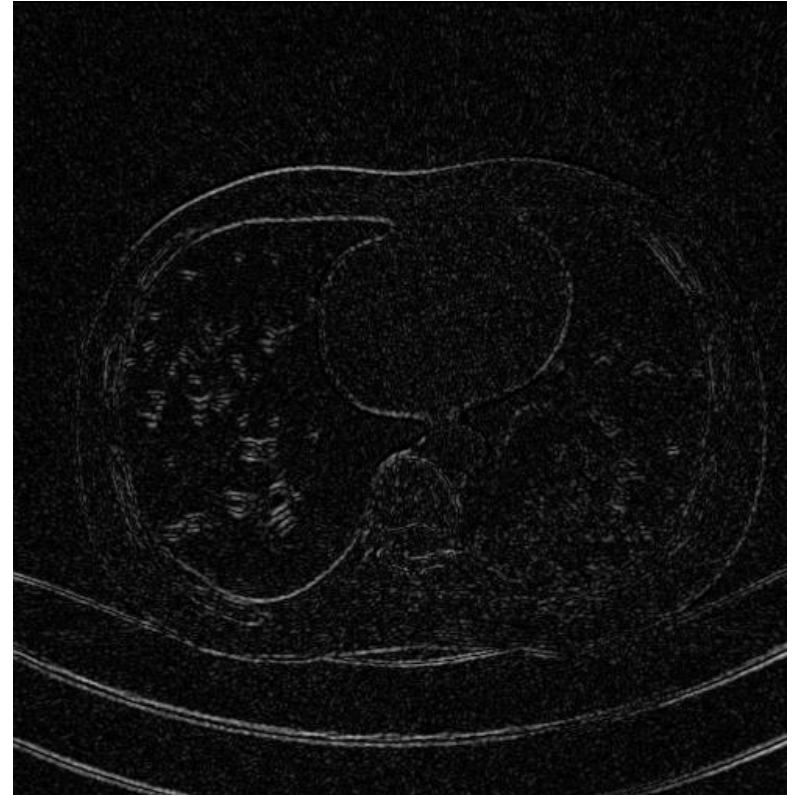
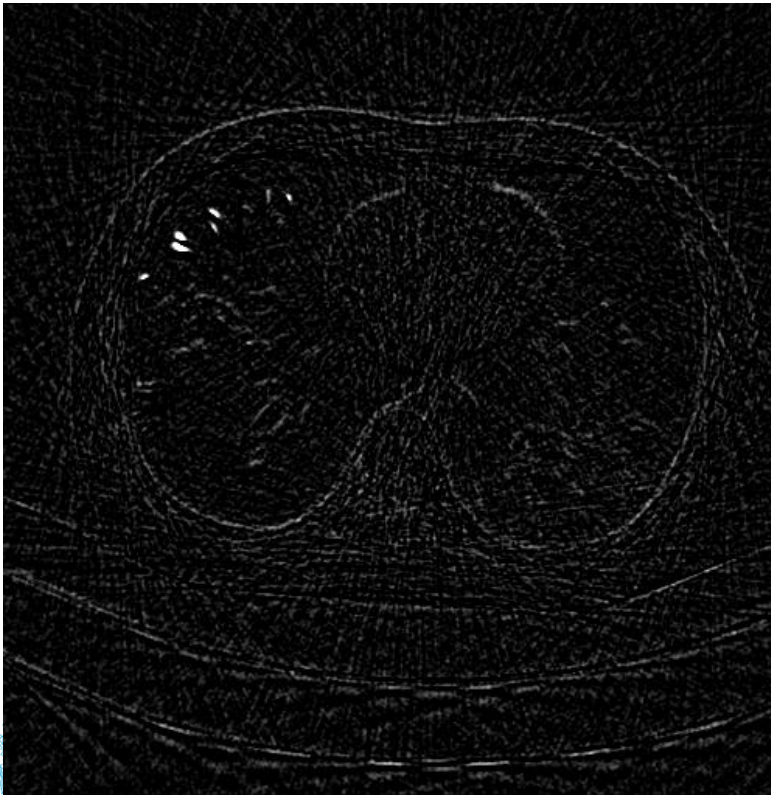
CNR

CNR vs Q_{ref} mAs for FBP and IR (soft tissue kernel).



Difference images

Difference images: show the effects of SAFIRE strength 3 (left) and ADMIRE strength 3 (right) (FBP minus IR)



Qualitative IQ assessment

- ADMIRE: lowest Q_{ref} mAs unacceptable
 - Chosen mAs: 147 (Siemens standard)
 - Other scanners at the trust with FBP: 170 mAs
 - ~ 16% dose reduction
- SAFIRE: two lowest Q_{ref} mAs unacceptable
 - Preferred series: 147 mAs with SAFIRE
 - Dose is not an issue
 - To be discussed with other clinicians and implemented as additional recon



Summary, conclusions, and limitations



Limitations

CNR: apparent linear relationship

Only one feature analysed

Different CNR levels required to see lesions of different sizes

Not sufficient to measure imaging capability of a system

General: lack of task-based evaluation

Accounts for different clinical tasks

Requires specific phantoms, software, and protocols that are not widely used



Summary & Conclusions

Quantitative analysis of IQ

MTF, NPS, CNR, and difference images

Improvement in noise reduction with IR

ADMIRE performs better than SAFIRE for specific tasks

Qualitative analysis of IQ

Kyoto images appraised by a consultant radiologist

In CS: ADMIRE strength 3 with the Siemens standard Q_{ref} mAs: (147 for TAP scans): 16% dose reduction

At the main sites: ongoing. SAFIRE to be included as additional recon



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