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Low dose PET-CT attenuation correction – How low can you go?

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Summary

PROJECT RATIONALE

RESULTS

DISCUSSION POINTS

Rationale

- New clinical trial involving a novel PET tracer
- Long half-life (Zr-89, 3.3 days)
- “First in Man”, protocol specified daily PET-CT scans over course of 1 week
- Up to two administrations
- Up to 12 PET-CT AC&L scans

Initial Dose Calculation for MPE

- Dosimetry for radiopharmaceutical:

Type of investigation/therapy:	PET
Radionuclide:	89Zr
Proposed activity (MBq):	37 MBq
Route of administration:	IV
Number of administrations per participant:	2
Effective dose or target tissue dose per administration:	**25 mSv, Total 50 mSv**

Reference: Börjesson PK, Jawu YW, de Bree R, Roos JC, Castelijns JA, Leemans CR, et al. Radiation Dosimetry of 89Zr-Labeled Chimeric Monoclonal Antibody U36 as Used for Immuno-PET in Head and Neck Cancer Patients. *The Journal of nuclear medicine.* 2009; 50(11):1828-1836.

Computed Tomography (PET)

Examination	Mean DLP (mGycm)
	Churchill
	PET CT
PET FDG Head	425
PET FDG Whole Body	400

Based on local survey data

Initial Dose Calculation for MPE

- Dosimetry for PET-CT AC&L

Procedure	Routine	Additional	Effective Dose (mSv)
AC PET-CT standard dose	0	12	**8.4 mSv, total 100.8 mSv**

- Total trial dose: **150 mSv**

Discussions!

Trial team were not happy with these doses as they had found papers referencing low dose PET-CT.

Our local DRL is consistent with the National DRL and no other “low dose” protocols used clinically.

Optimisation project set-up to develop local low dose PET-CT protocol.

Optimisation Team

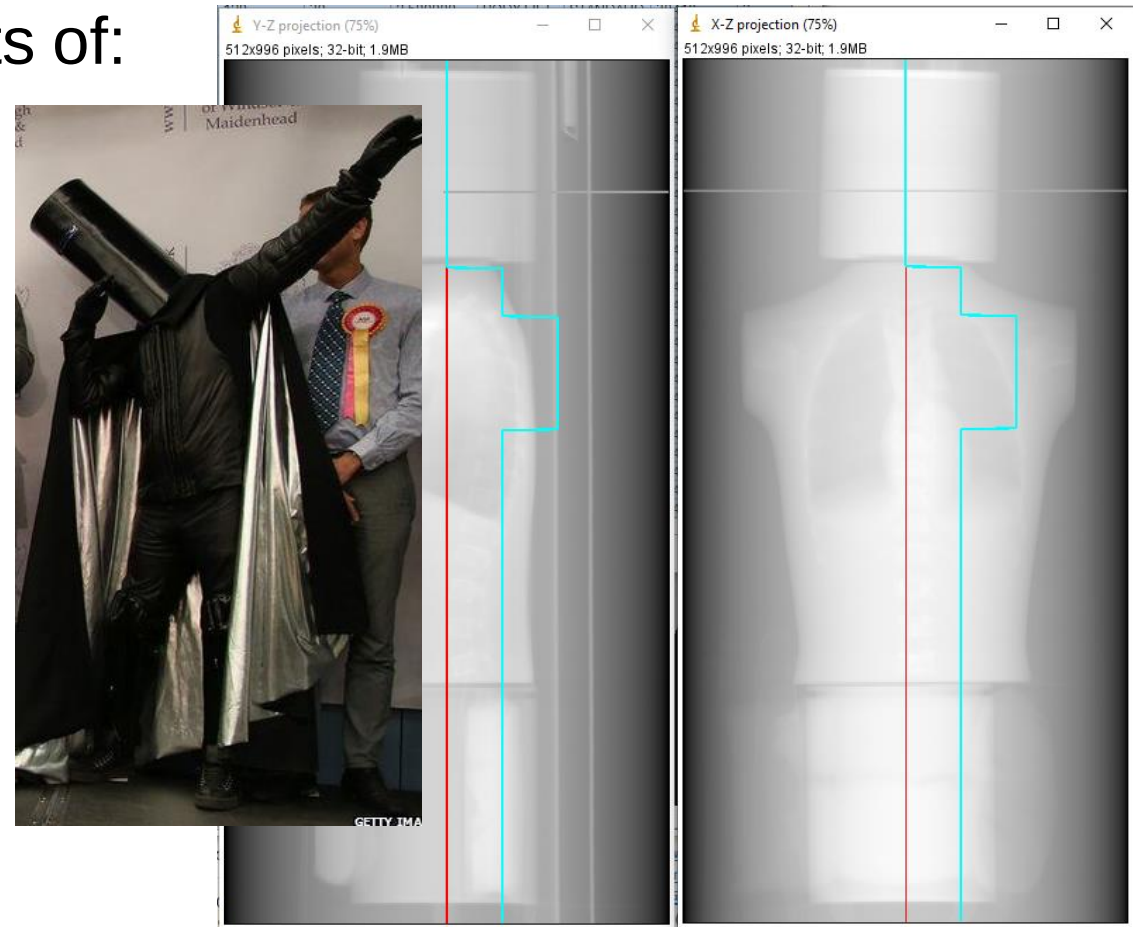
- Medical Physicists from both Imaging Physics and Radioisotope Physics Teams
- Consultant Radiologist and ARSAC practitioner
- Clinical Nuclear Medicine Staff
- Scanner: GE Discovery 710 (installed 2014)

Phantom Scans

- Phantom consists of:
- Catphan 600
- Chest Phantom
- SUV phantom

(solid Ge-68)

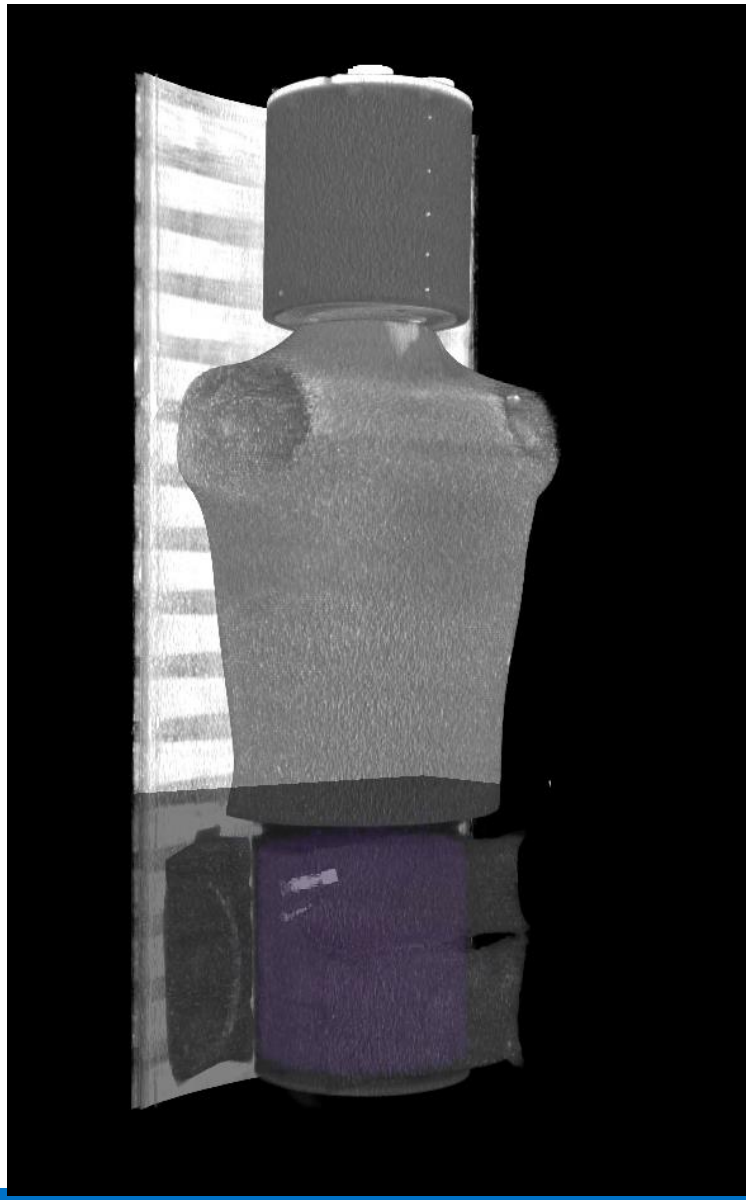
+ Saline bags



Loveland, J. (2011). SPICE-CT [computer software]. Edinburgh

SUV Analysis

- No SUV artefacts were observed in any of the scans
- Mean SUV (measured with a large cylindrical ROI) was equal to 1 in all scans
- Coefficient of variance in measured activity concentration (Bq/ml) was the same for the existing ‘low’ dose scan and the scan with NI=170



Protocols Tested

	mGy	mGycm						
Series Description	NI	CTDI	DLP	min mA	max mA	pitch	ASiR	slice width
CT Body	25	2.14	218.42	30	100	0.98	40%	2.5
CT Body NI170 (GE)	170	0.28	29.23	10	40	1.5	40%	2.5
CT Body NI170	170	0.28	29.23	10	40	1.5	100%	3.75
CT Body NI60	60	0.33	34.3	10	40	1.5	40%	2.5
CT Body NI40	40	0.66	69.37	10	40	1.5	40%	2.5
CT Body NI170 P0984	170	0.44	44.64	10	40	0.98	40%	2.5

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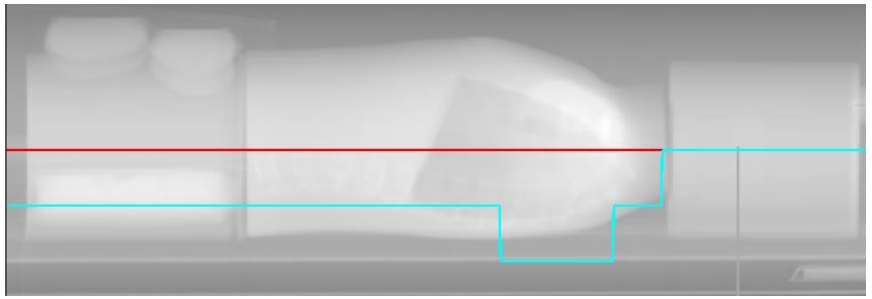
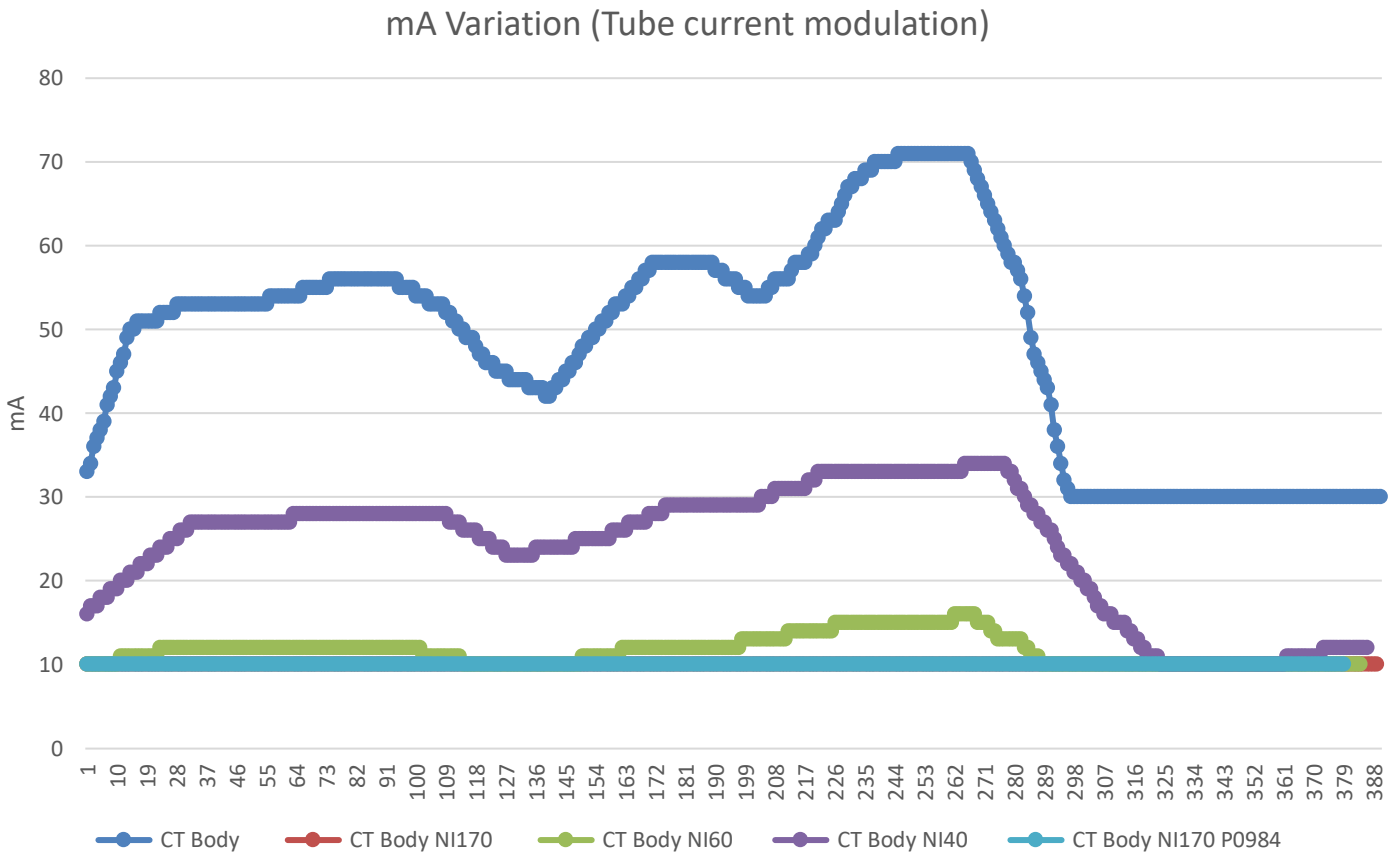
Tube Current Modulation





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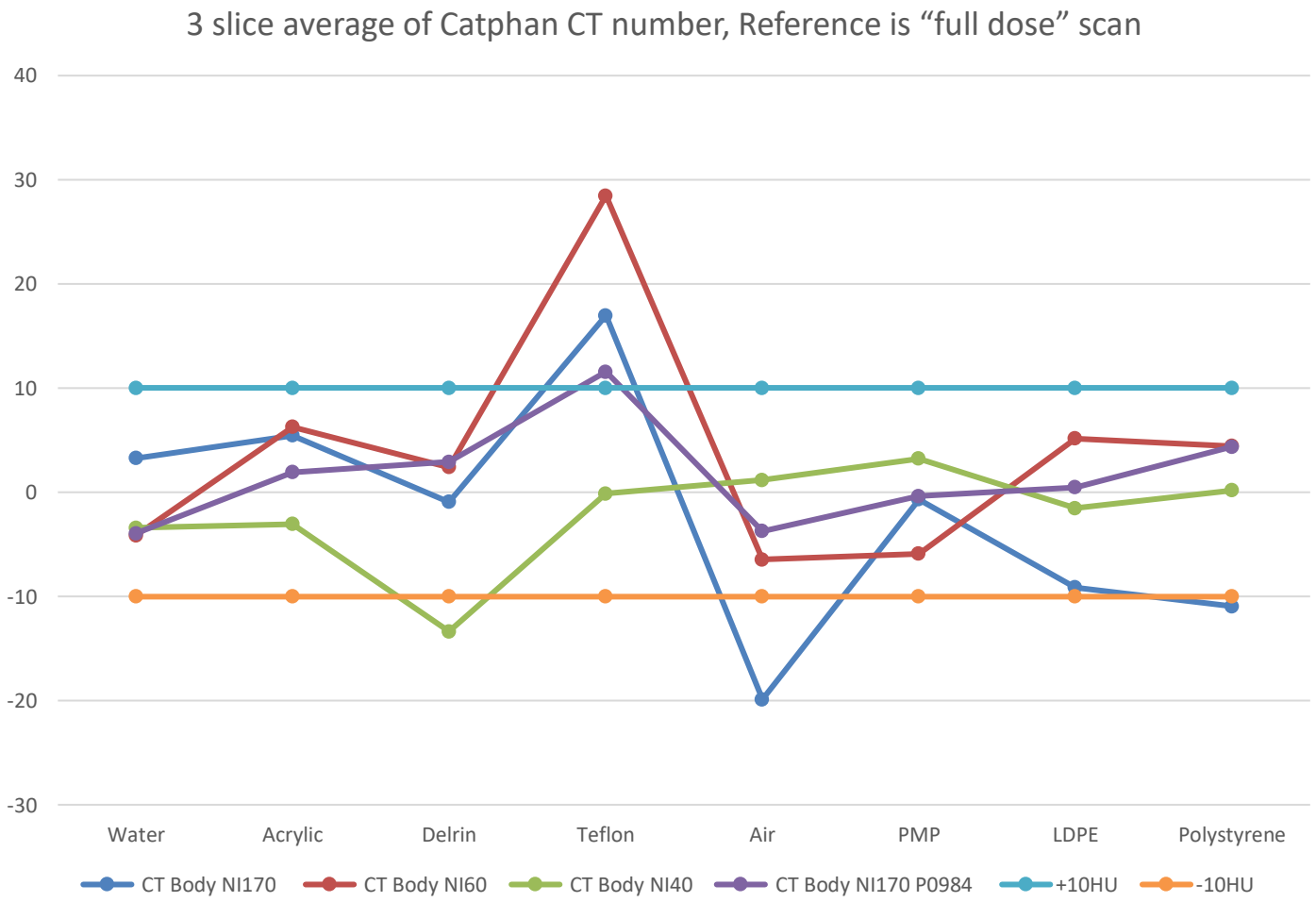
CT Number analysis



Noise analysis – Catphan Uniformity section

Series Description	IPEM report 32 part iii Noise	IPEM report 32 part iii Uniformity
CT Body	1.65	-0.16
CT Body NI170	3.56	0.44
CT Body NI60	3.48	0.45
CT Body NI40	3.57	1.15
CT Body NI170 P0984	3.17	0.88

Noise analysis – SUV phantom

Series Description	IPEM report 32 part iii Noise	IPEM report 32 part iii Uniformity
CT Body	2.52	-0.51
CT Body NI170	7.04	2.02
CT Body NI60	6.80	1.75
CT Body NI40	3.66	-0.89
CT Body NI170 P0984	6.69	2.75

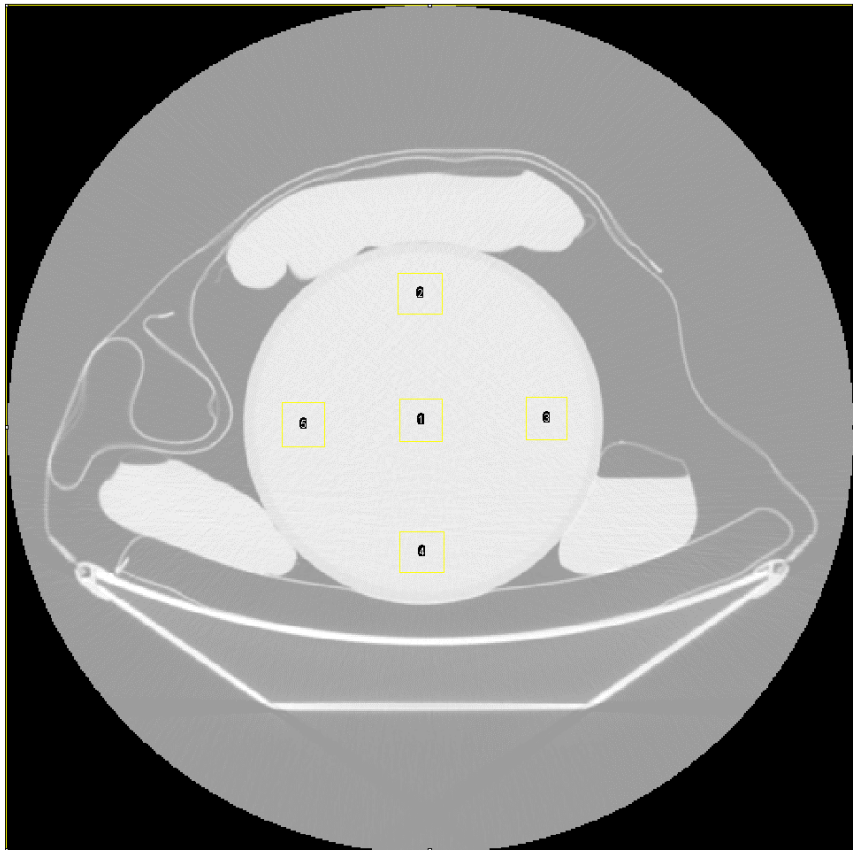
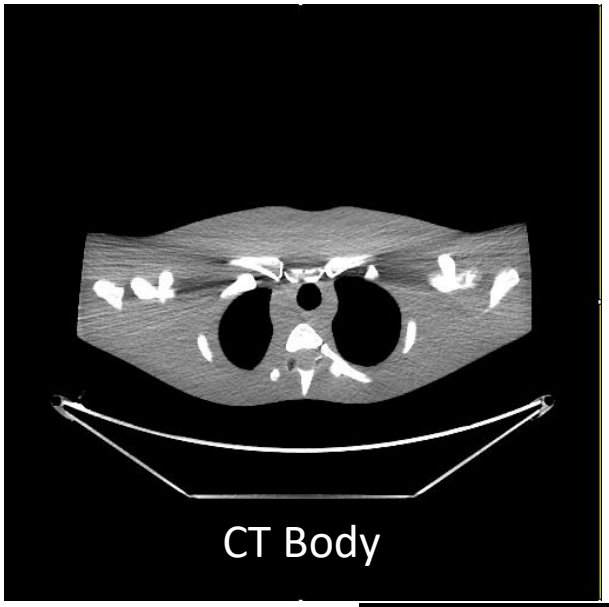
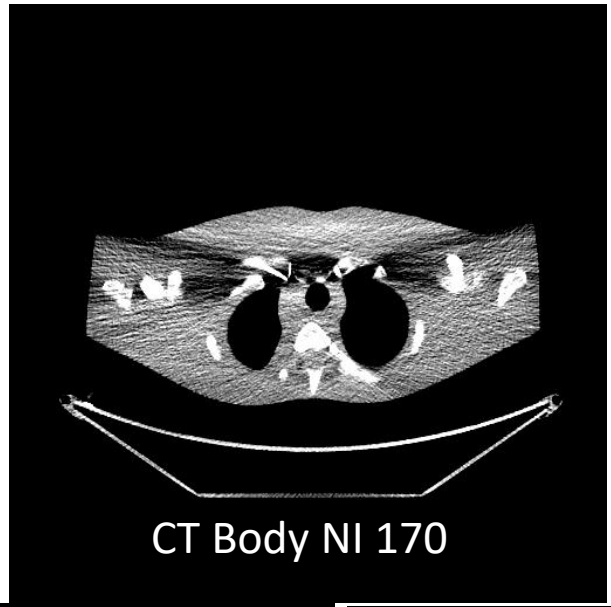
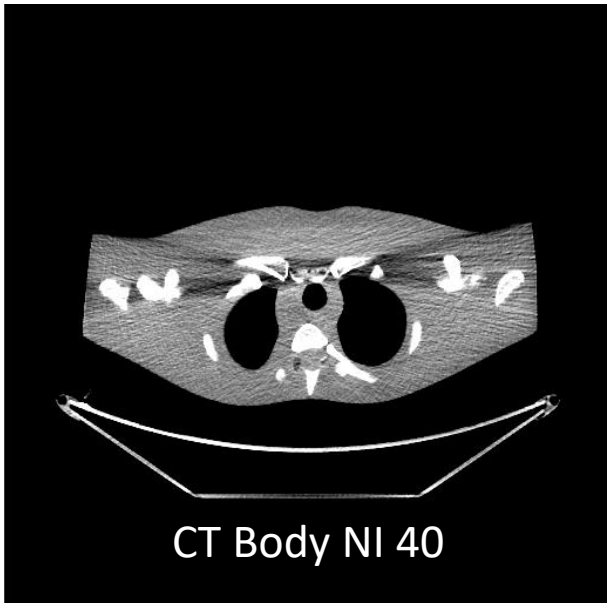
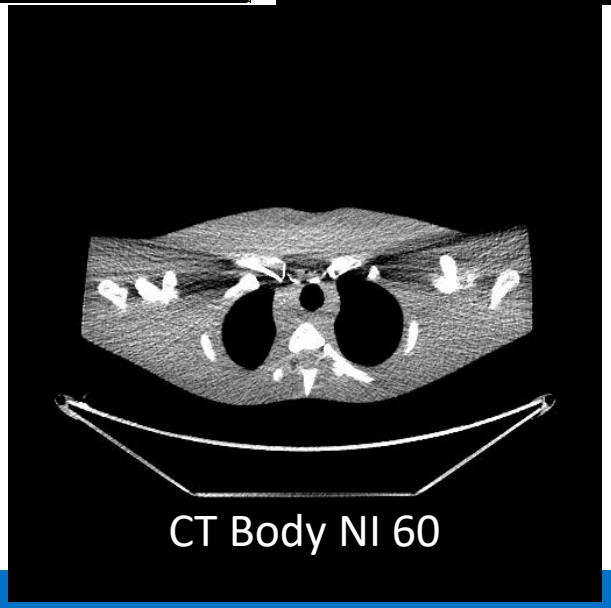


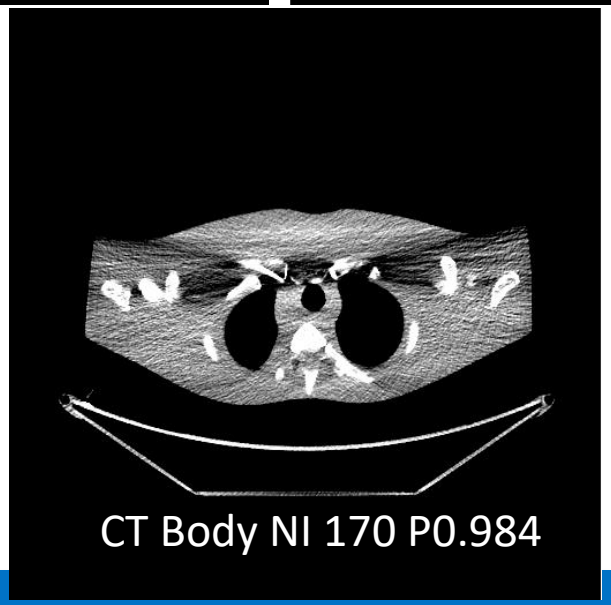
Image Quality











Other Applications

- Incident where pregnancy discovered on scout scan.
- Low dose protocol could be used as patient already injected.
- Other research projects.
- Work could also contribute to reducing current doses and optimising new scanners.

Positives

- Creation of PET-CT optimisation group

Minutes: September '23 NM CTAC Meeting

07 July 2023 13:38

Agenda for meeting 26/09/2023 9am	Actions
Attendees *RB (chair), RC (minutes), LH, JR, AP, NP, MW, SJ, MK, AT, DM* Quorum: Representative from Physics, Modality Lead and Radiologist	
Apologies *FG, DGM, AS, AN, SM, MB*	
Actions from Previous Meeting N/a as first NM, PET & CTAC Optimisation Meeting	
Specific/Ongoing Projects • **Ultra-low dose CTAC** phantom work has been carried out in CRIC to determine a protocol for ultra-low dose CTAC discuss actions needed to implement this. *NP has reviewed images of phantoms acquired on ultra-low dose CT protocol and is happy with the quality of image sent with 40% ACER. Discussion was had around reducing the dose from the normal CTAC, considering the nDRL and possible patient impact. MK raised concerns over image quality in the lungs, particularly for sarcoma patients. AP raised concerns about using a lower mA range for larger patients and suggested a possible weight cut off for a*	RC AS AP RB

Conclusions

- Small projects can be a good starting point.
- Patient imaging will need review once trial begins.
- Other projects in discussion:
  - Standardisation work between both scanners
  - SPECT-CT optimisation

Thank-you!