Use of CT automated exposure control and image quality in PET-CT

D. Tout, K. Howard, P. Julyan, P. Hulse,
P. Manoharan, D. Hastings
North Western Medical Physics,
The Christie NHS Foundation Trust, Manchester

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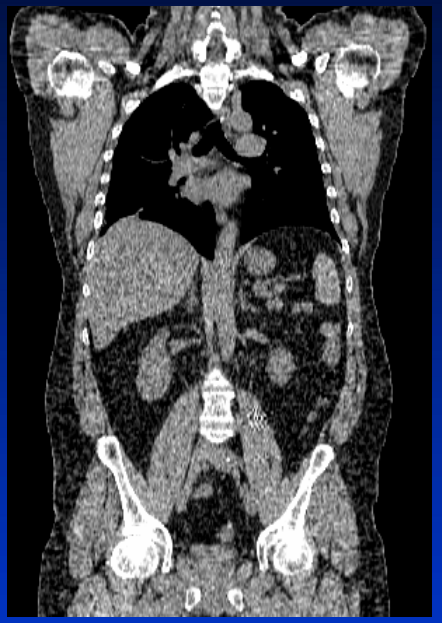
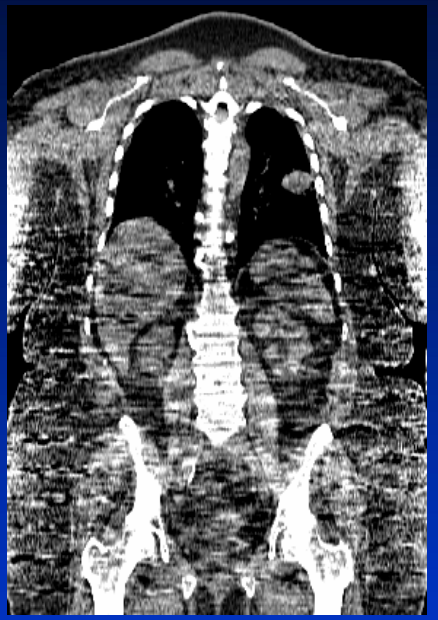
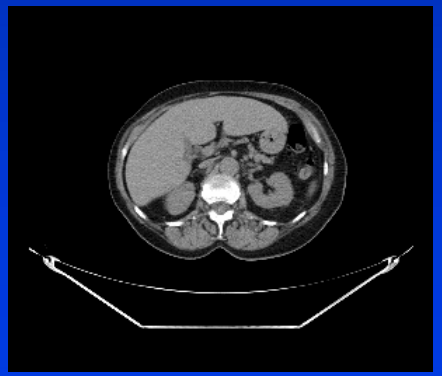
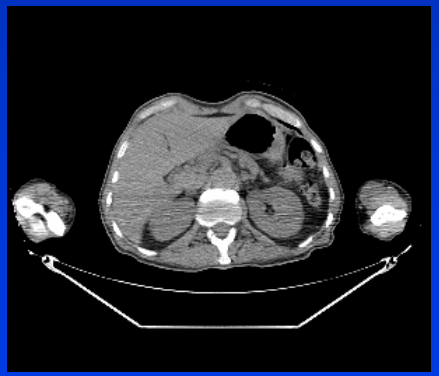
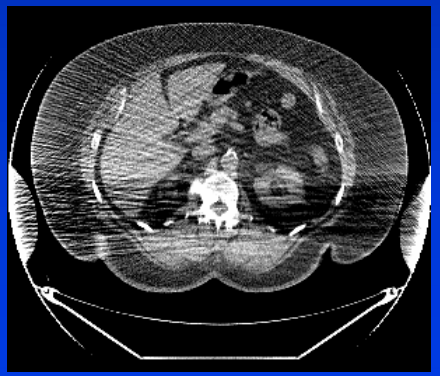
Background

- PET-CT installed 2007
  - GE Discovery STE8
- CT for attenuation correction and localisation
- CT Protocol
  - Manufacturer's default
  - UK PET SIG, CT Protocol survey 2005
  - Comparison with diagnostic CT (120 kV)

Clinical situation

OK | large patient | arms down | large + arms down

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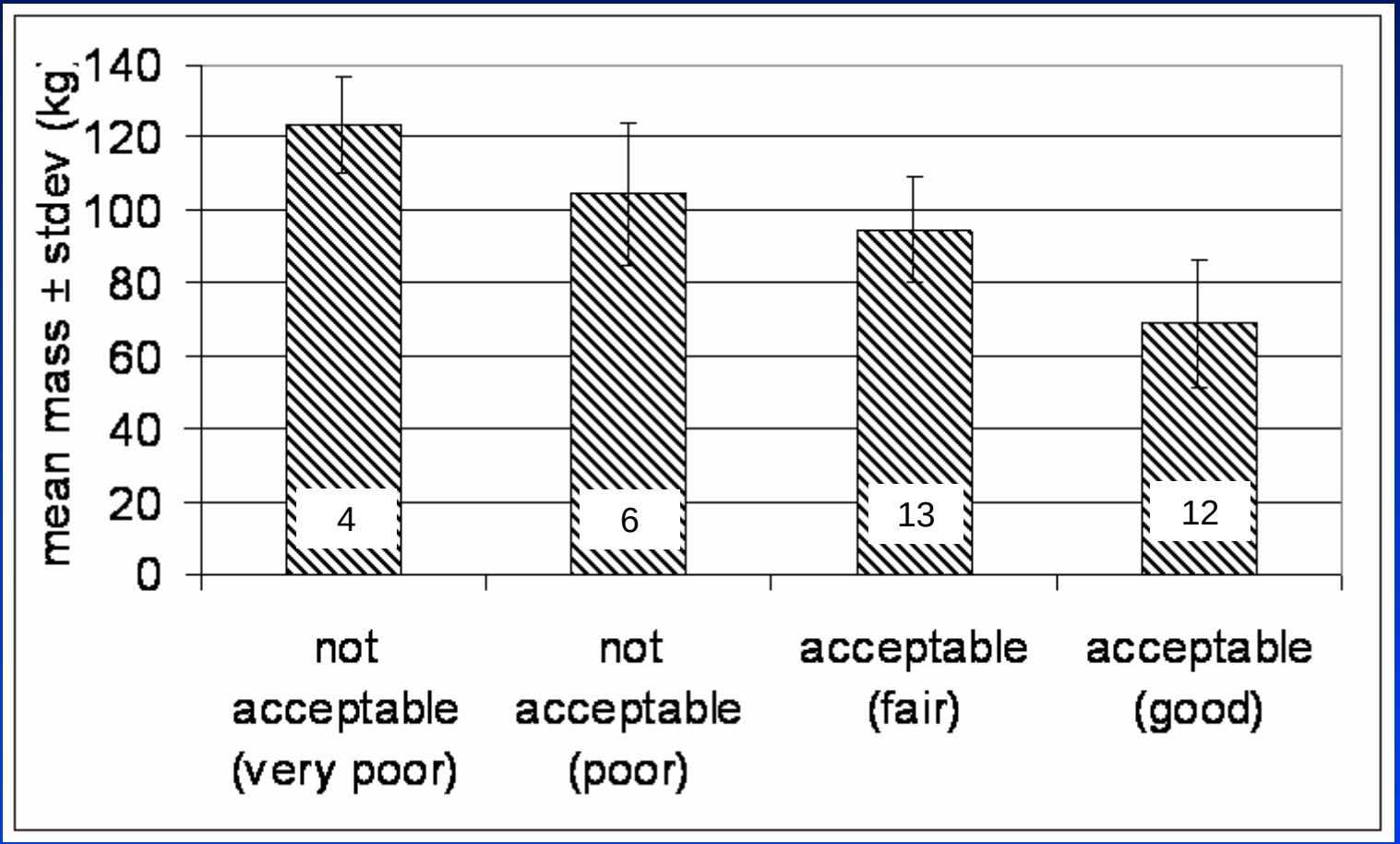
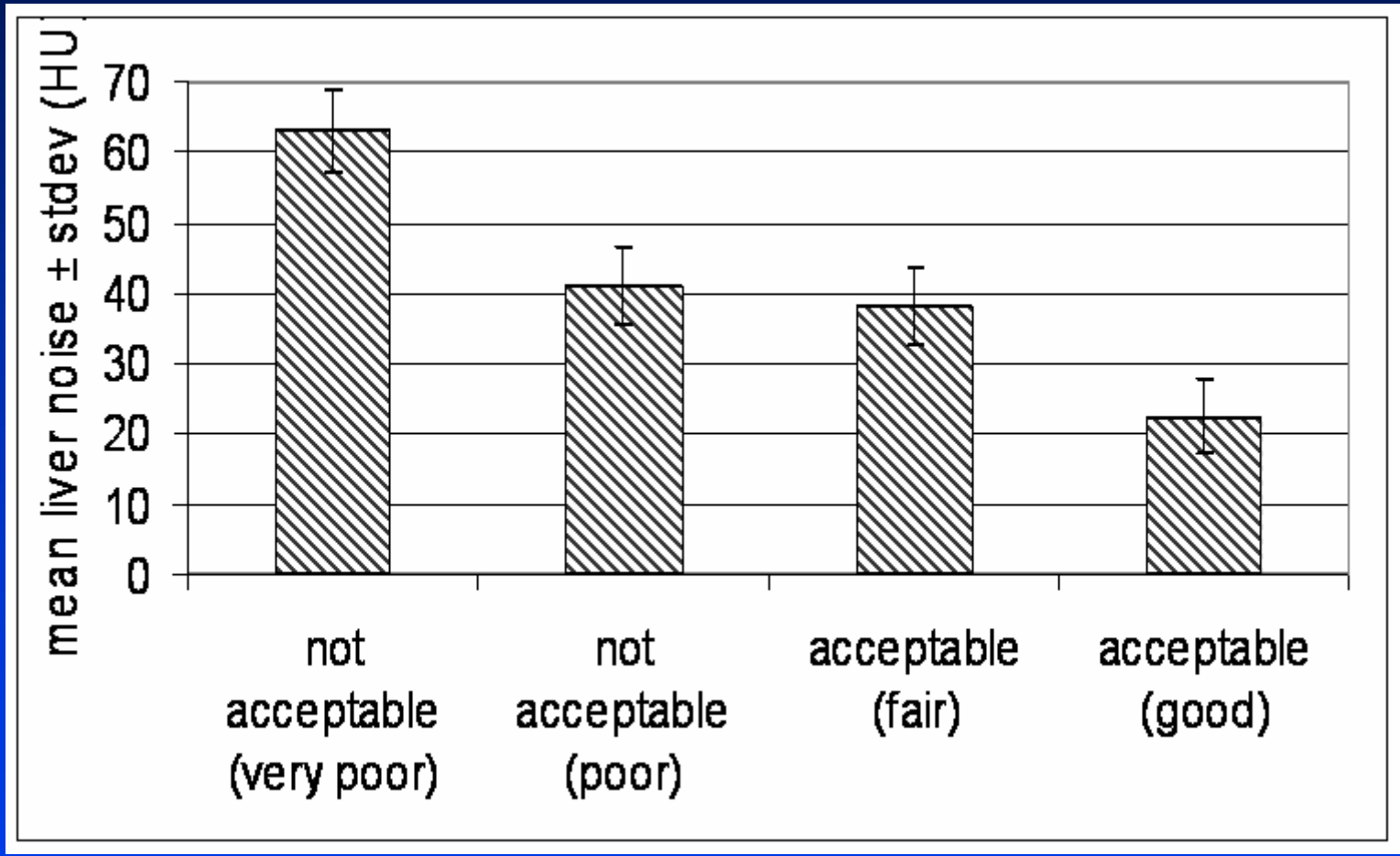
Image scores corresponded with patient size …

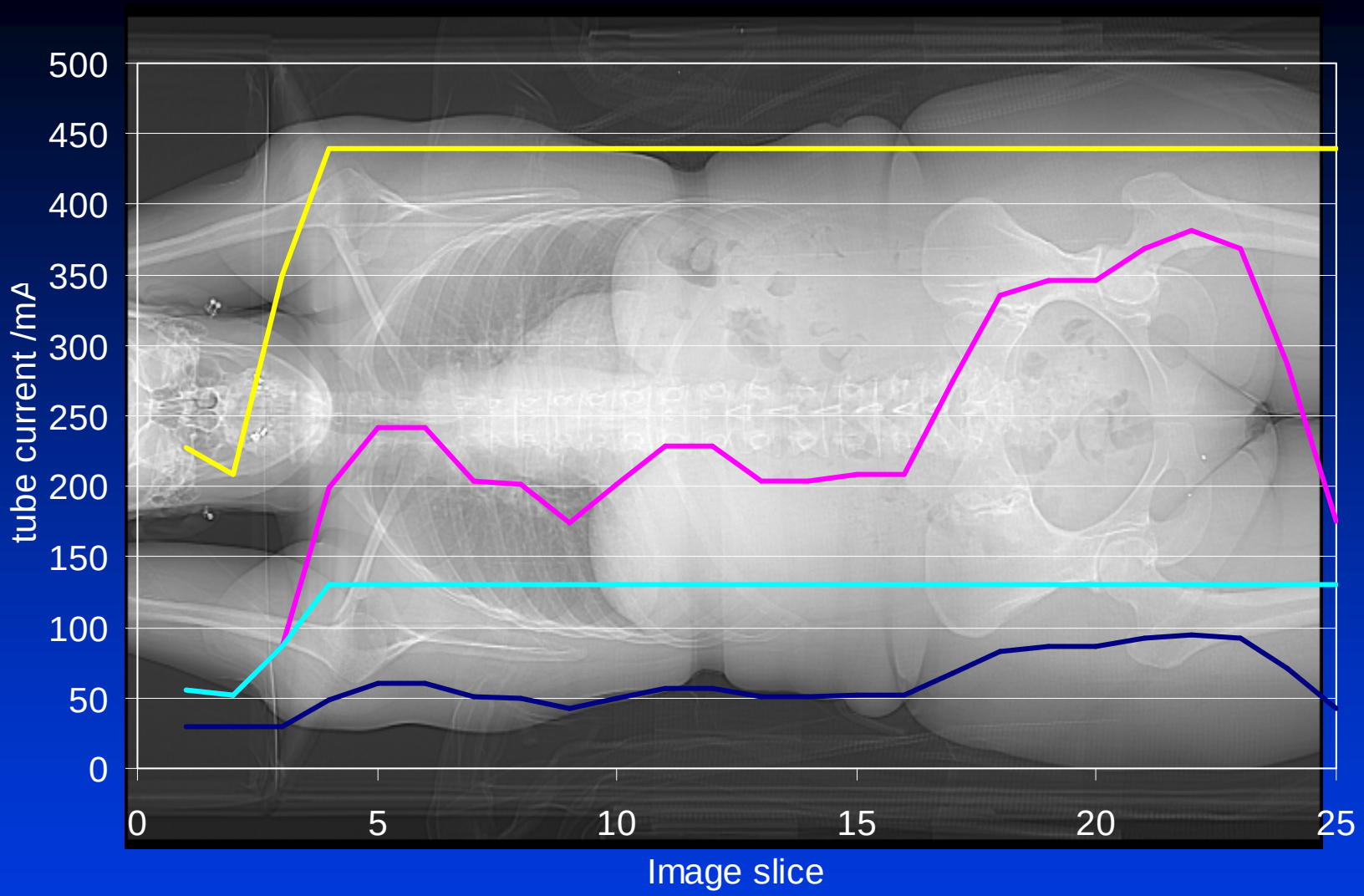


… and with liver noise



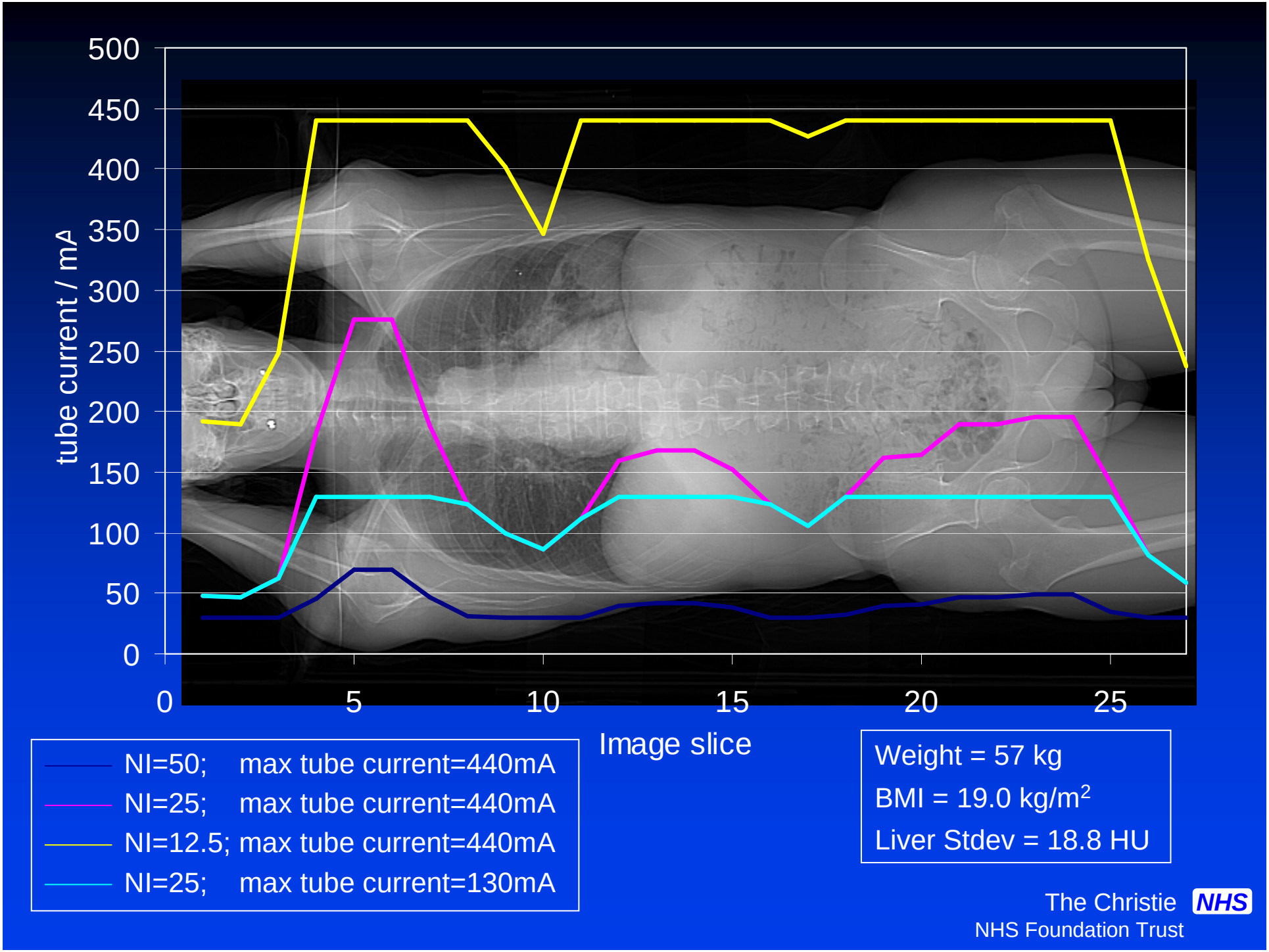
Auto mA settings

- mA tables
  - NI = 25 I_{max} = 130 mA (Initial)
  - NI = 25 I_{max} = 440 mA
  - NI = 12.5 I_{max} = 440 mA
  - NI = 50 I_{max} = 440 mA



NI=50; max tube current=440mA
NI=25; max tube current=440mA
NI=12.5; max tube current=440mA
NI=25; max tube current=130mA

Weight = 67 kg
BMI = 25.5 kg/m^2
Liver Stdev = 23.3 HU



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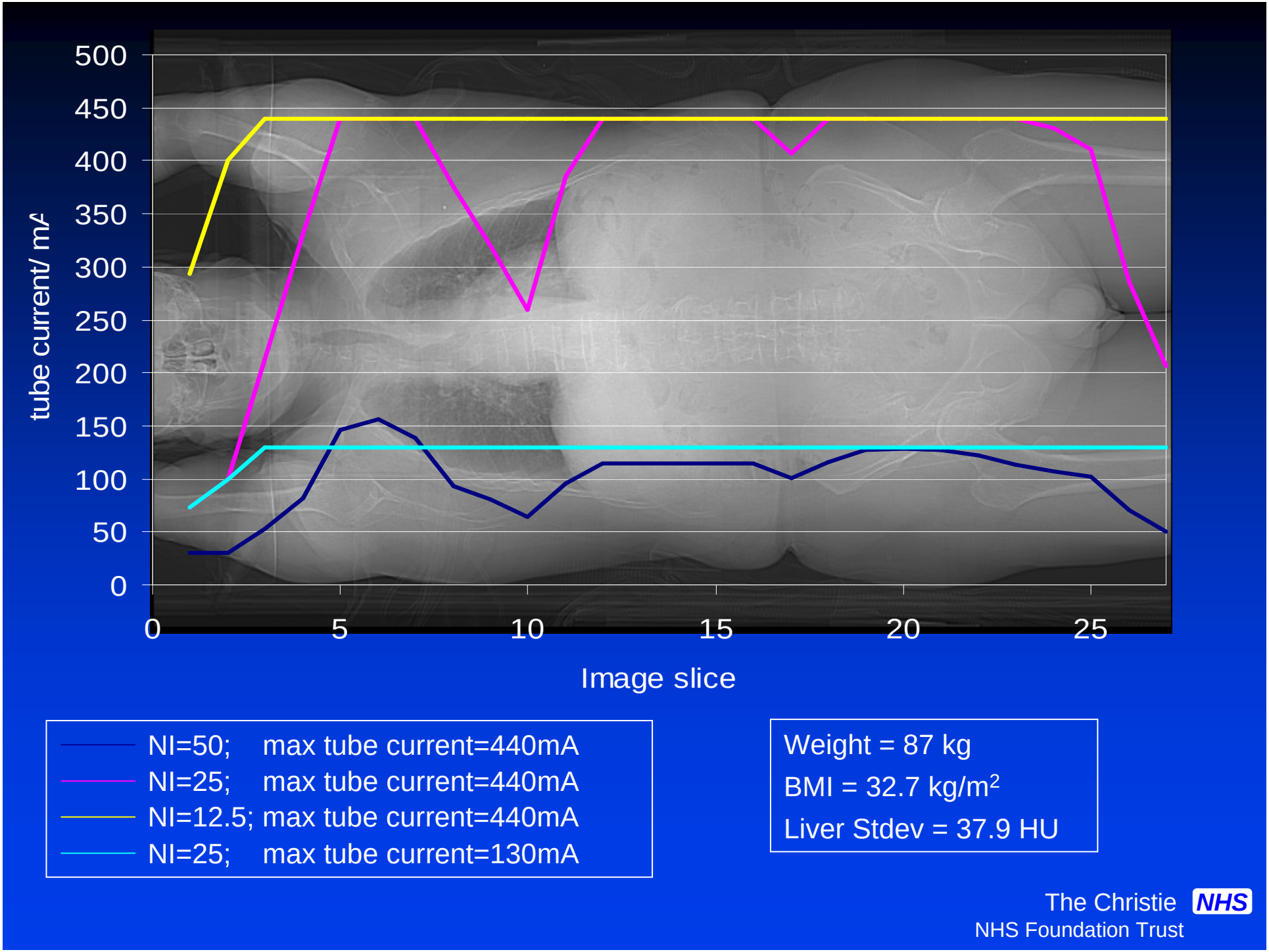
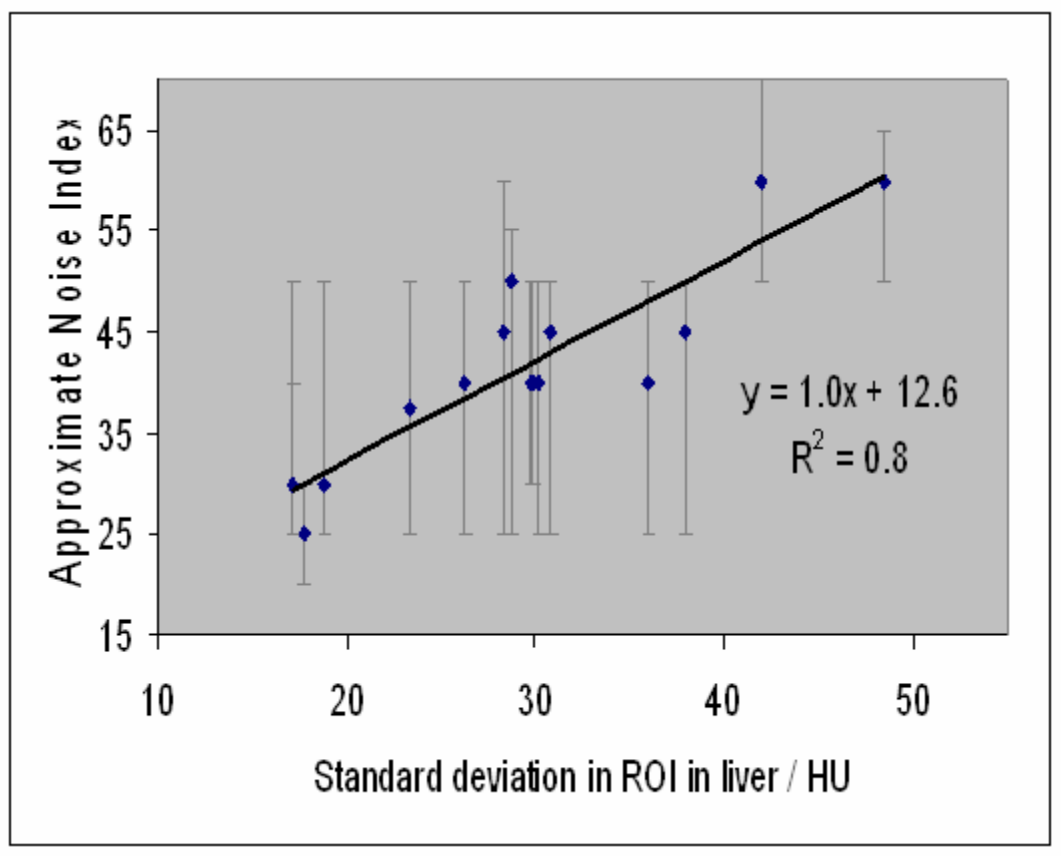

500
450
400
350
300
250
200
150
100
50
0
tube current/ mA
0
5
10
15
20
25
Image slice
NI=50; max tube current=440mA
NI=25; max tube current=440mA
NI=12.5; max tube current=440mA
NI=25; max tube current=130mA
Weight = 87 kg
BMI = 32.7 kg/m2
Liver Stdev = 37.9 HU

NI achieved and noise measured



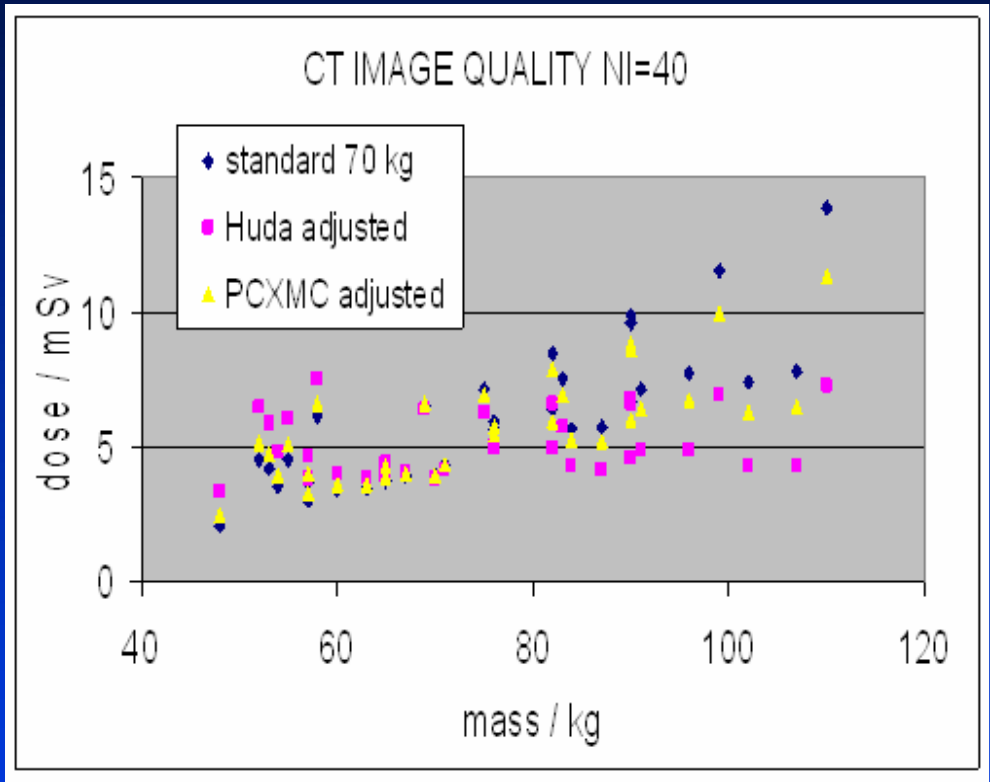
- 'Good' images
  - Mean noise = 23 HU
  - Range: 17 to 38 HU
- Expected NI for 'good'
  - Range: 30 to 51
  - Central value: 40

Protocol change

Parameter	Protocol 1	Protocol 2
Rotation time (s)	0.5	0.5
Beam collimation (mm)	20	20
Pitch (helical)	1.675	1.675
Gantry tilt (°)	0	0
Tube potential (kV)	120	120
Noise Index	25	40
Min mA setting	30	30
Max mA setting	130	440
Average mA	126 ± 2	60 ± 20
DLP (mGy.cm)	213 ± 5	110 ± 40

Effective doses

- ImPACT Dosimetry Calculator (v. 0.99x)
- Mass adjusted using W. Huda formula[1]
  - $E_{adj} = 290E_{70kg}m^{-1.3}$
- Mass adjusted using PCXMC[2]

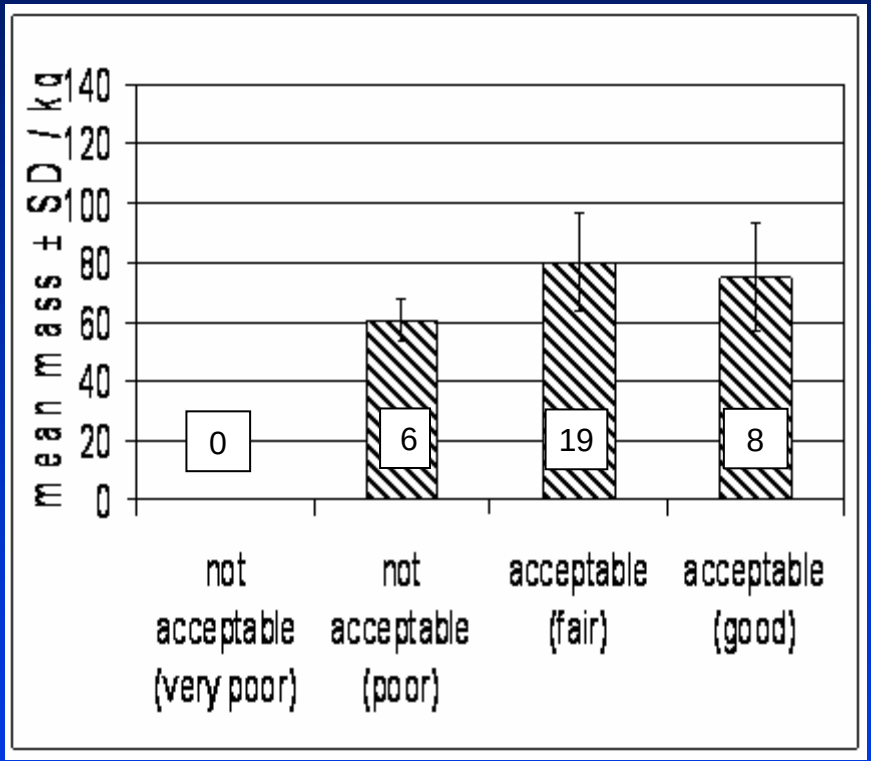


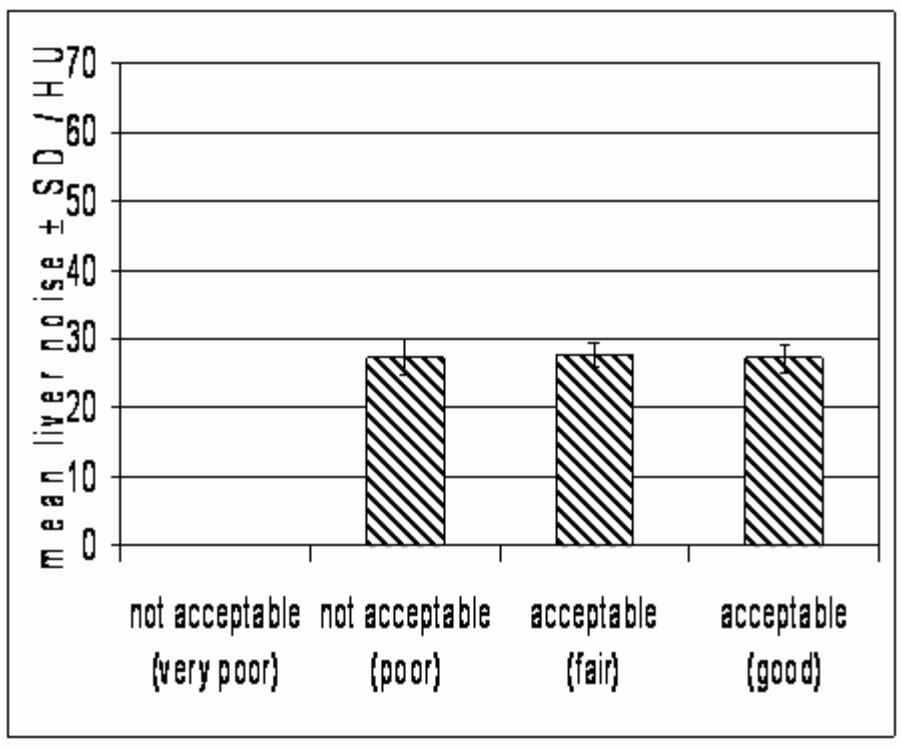
1. W. Huda, E Scalzetti and M Roskopf, *Effective doses to patients undergoing thoracic computed tomography examinations*, Medical Physics, 2000, 27: 838-844.

   W. Huda and A Vance, *Patient Radiation Doses from Adult and Pediatric CT*, AJR, 2007, 188: 540-546

2. Tapiovaara M, Lakkisto M, Servomaa A, PCXMC: A PC-based Monte Carlo program for calculating patient doses in medical x-ray examinations, Report STUK-A139, Helsinki: Finnish Centre for Radiation and Nuclear Safety, 1997

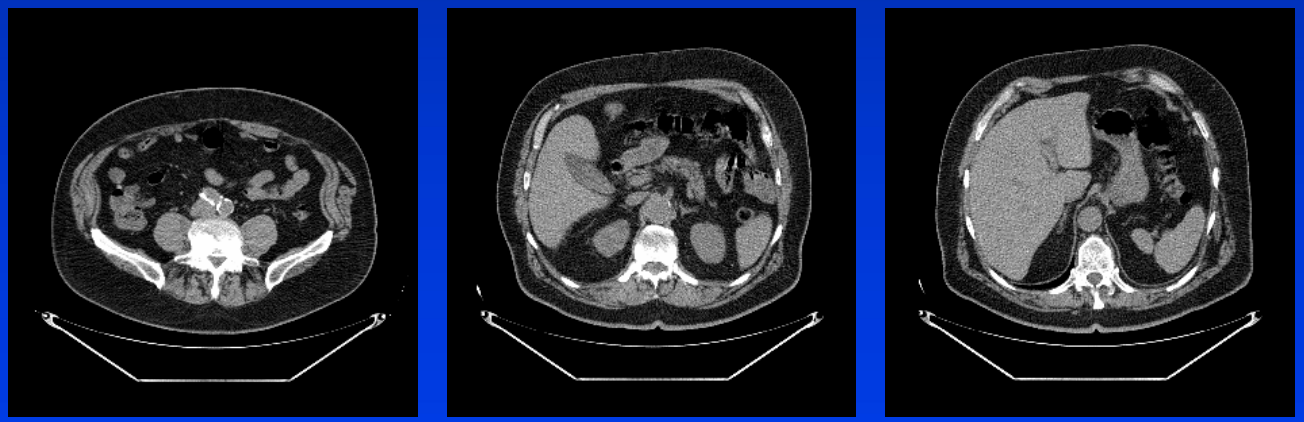
Image scores after protocol change





Presence of Body Fat

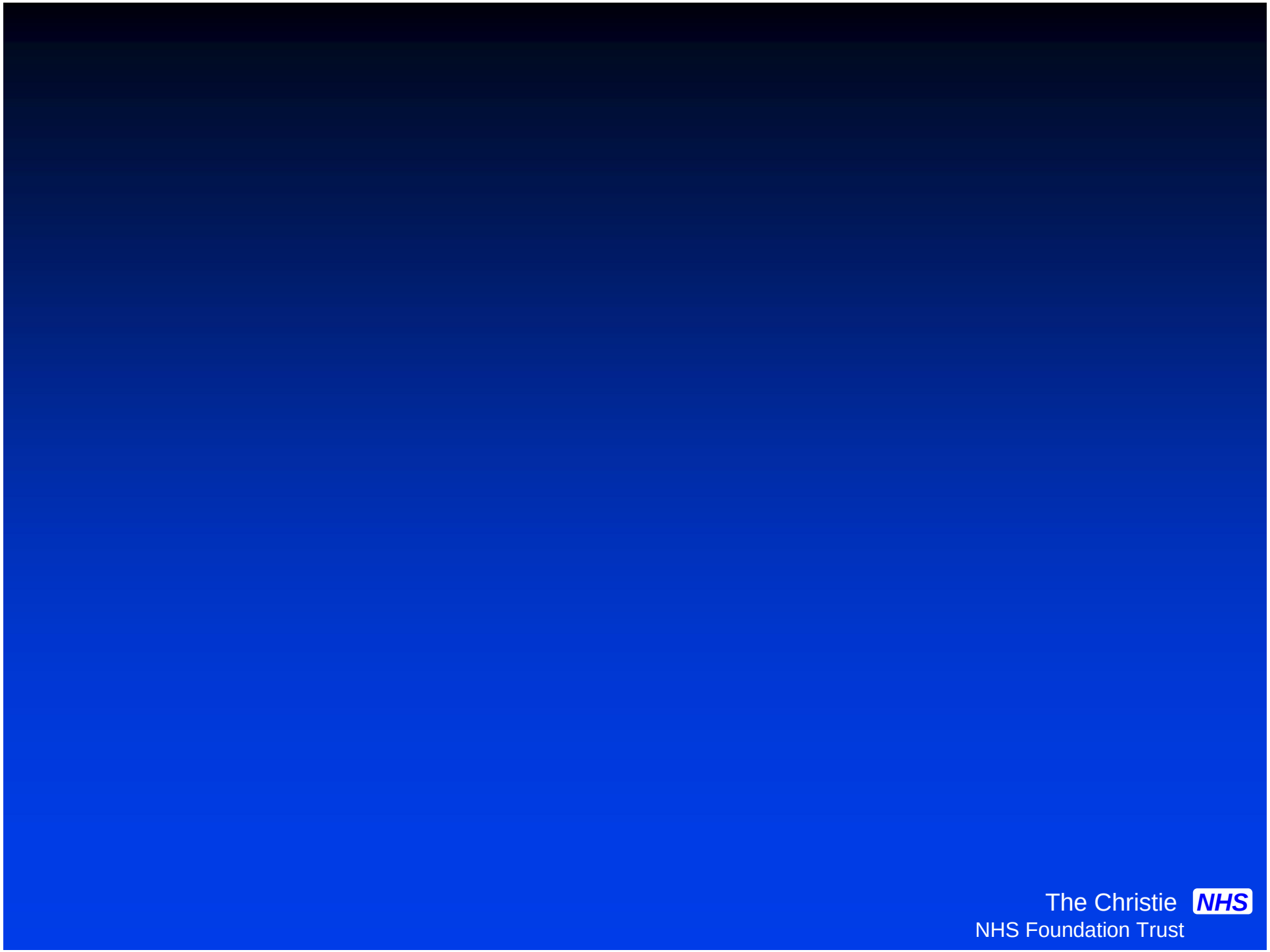
"Not acceptable"
Mass = 57 kg
Liver StDev = 28 HU



"Acceptable"
Mass = 118 kg
Liver StDev = 32 HU

Conclusions

- Protocol
  - NI = 40, maximum tube current = 440 mA
- Noise standardised in patients
  - Various sizes
  - Arms up or down
- Reduced, not eliminated, number of inadequate images
  - Patient size is not the only factor
  - Average patients, arms down, no fat delineation
    - Perhaps don't need same image quality for large patients
  - Movement artefacts
- Dose
- Whole situation changes in December
  - Start using contrast, aiming for 'diagnostic quality images'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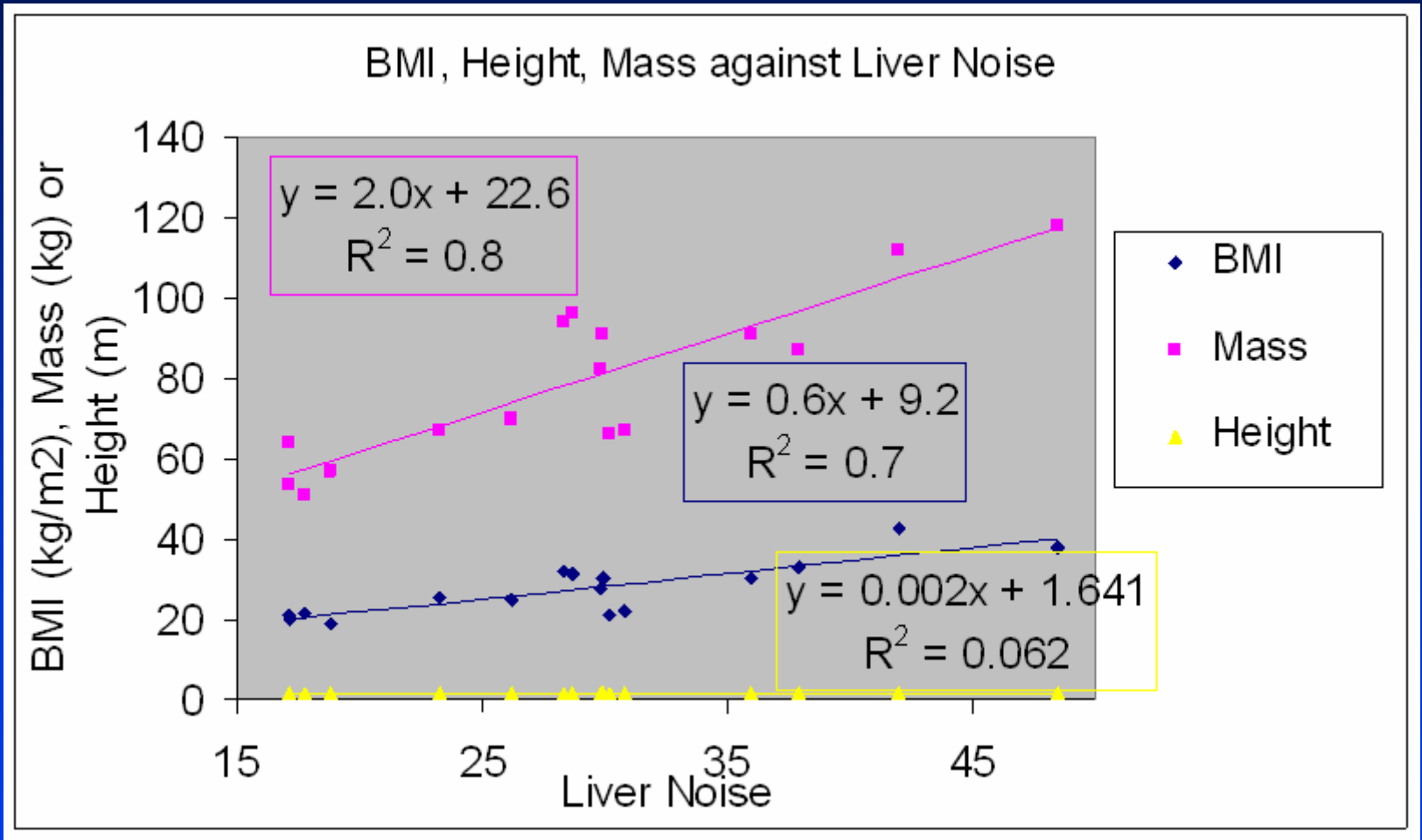
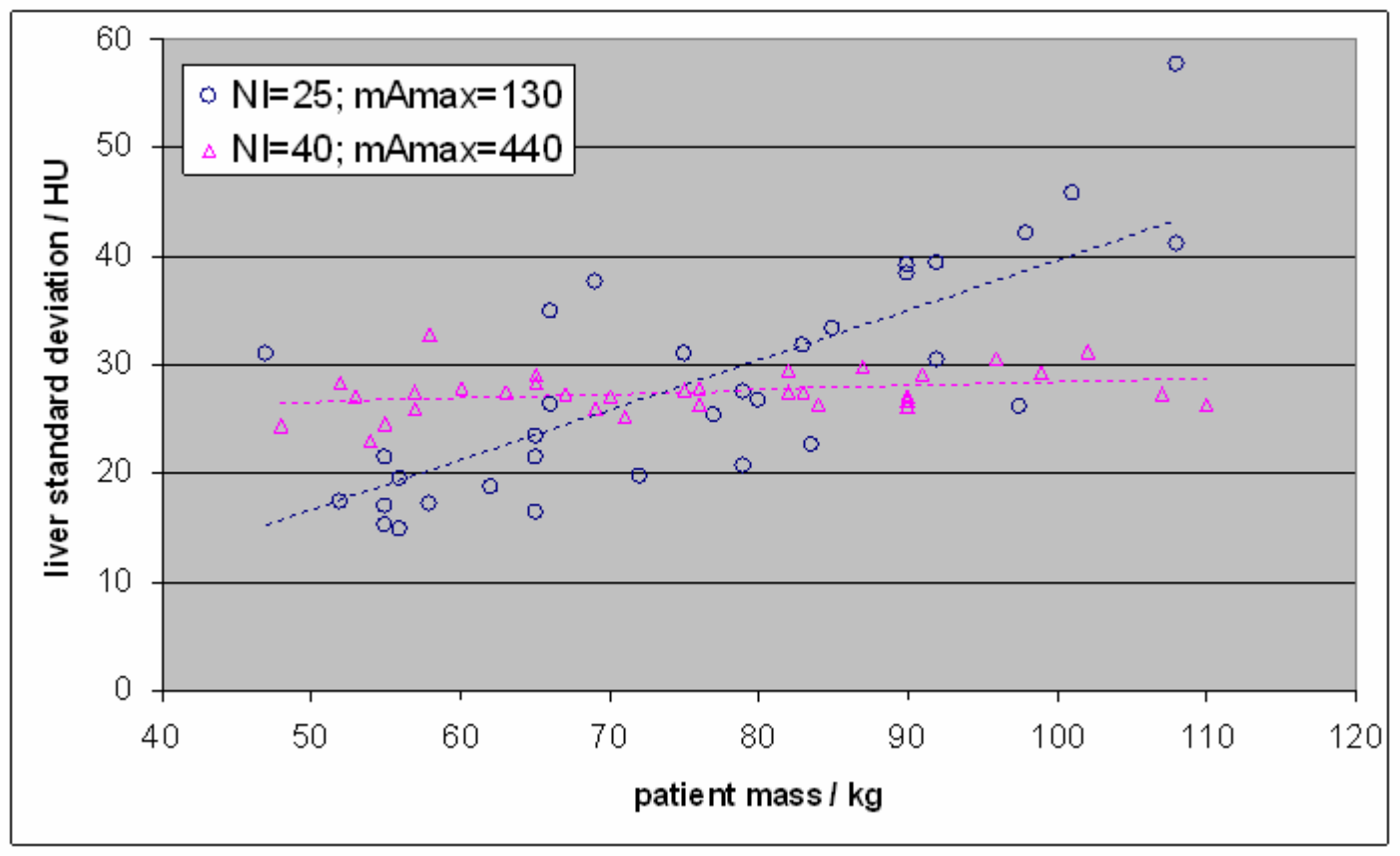
Noise with patient size



Liver noise before and after change



UK PET SIG: Protocol Survey 2005

Centre	1	2	3	4	5	6
Tube current	130mA	80mA	88mA	66mA	80mA	80mA
Rotation speed	0.5s	0.8s	0.8s	0.75s	0.9s	0.8s
Tube voltage	140kV	140kV	130kV	120kV	140kV	140kV
Pitch	1.5	1.5	1.5	1.5	1.5	1.5
mAs (≈ dose)	**65mAs**	**64mAs**	**70mAs**	**50mAs**	**72mAs**	**64mAs**

CT Tube Voltage

CT Water Phantom