Royal Free Hampstead NHS
NHS Trust

CT Numbers:
Think of a number, double it, add 20, divide by 4……

"Who's been fooling around with these x-rays?"

Jane Edwards
Royal Free Hospital, London

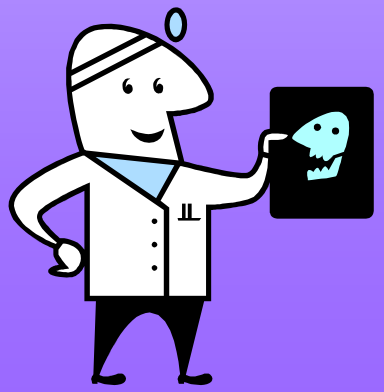
Background

- 2 different manufacturers CT scanners available on site:
  - GE Lightspeed Plus;
  - Philips Brilliance 64;
- Differences noted by clinicians in CT numbers for same pathology in same image viewed on different manufacturers workstations;

What where they looking for?

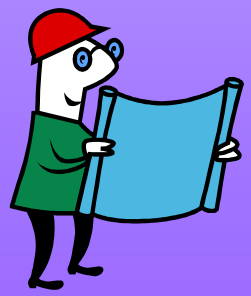
- Looking at cystic lesions in liver, kidney and pancreas to determine pathology;

HU	Classification
-10 to 10	Water
10-20	indeterminate
> 20	indeterminate/ suspicious

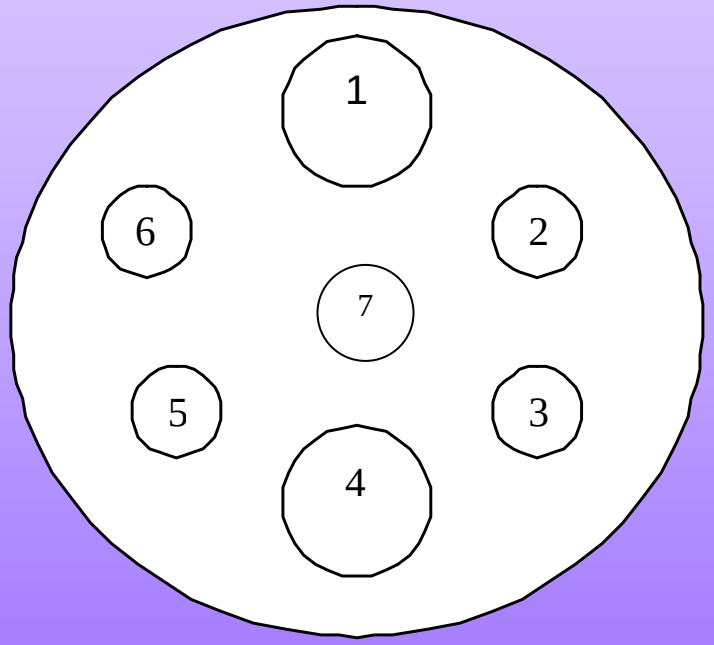


Plan of action

- Scan Philips IQ phantom on both scanners;



Philips CT Phantom



1 – Nylon [Calculus/Soft Tissue: 104HU]

2 – Polythene [Fat: -66HU]

3 – Teflon [Bone: 1022HU]

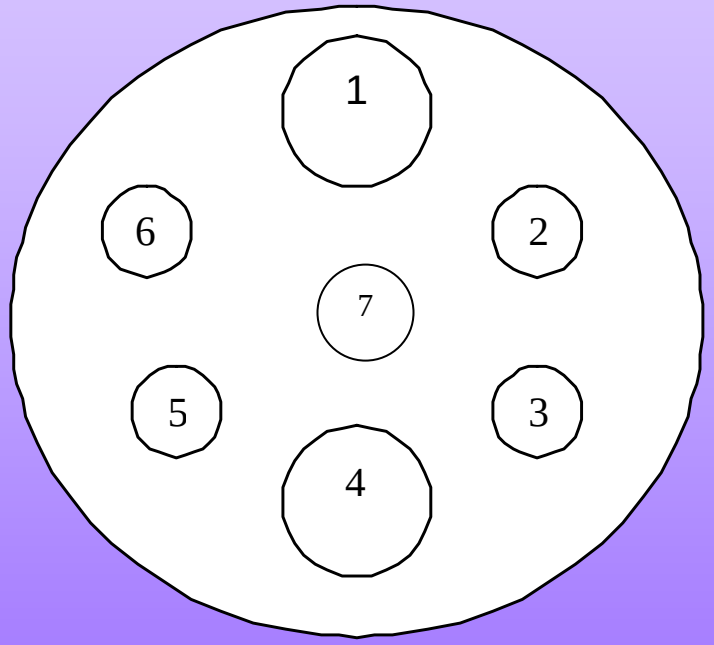
4 – Perspex

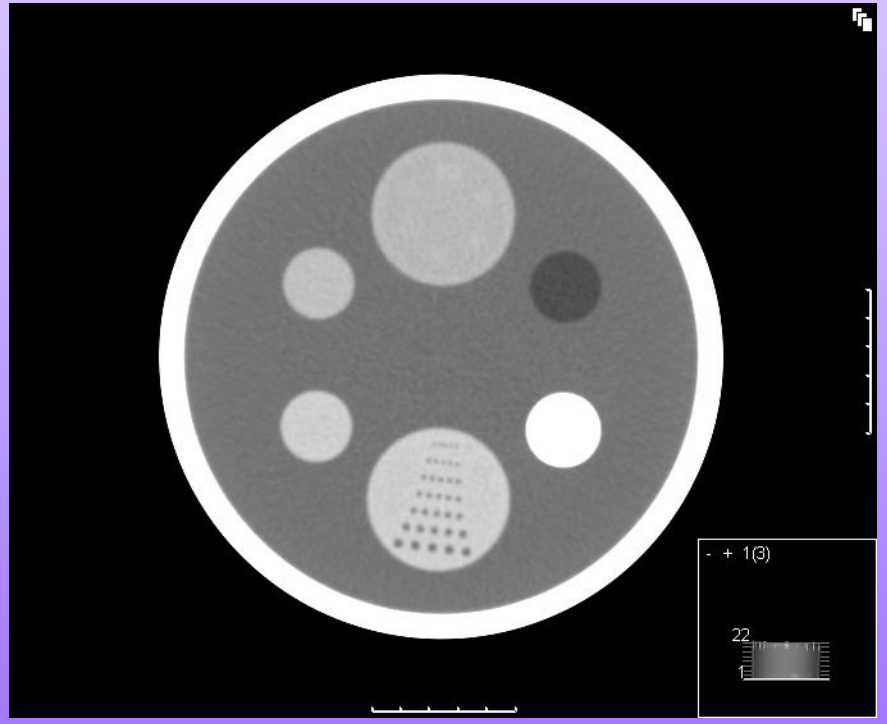
5 – Acrylic [Calculus: 141HU]

6 – Lexan [Calculus: 117HU]

7 – Water [-2.3HU]

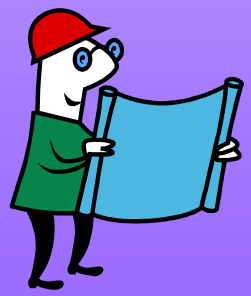
Philips CT Phantom





Plan of action

- Scan Philips IQ phantom on both scanners;
- Use ‘matching’ scan parameters;



Scan Parameters

- Philips

kV	120
Set mAs/slice	335
Scan time (s)	1
Collimated slice (mm)	40
Thickness (mm)	16x2.5
Increment	0
FOV (mm)	250
Resolution	Standard
Filter	Std Edge EB

- Analysis of middle image – Image 8

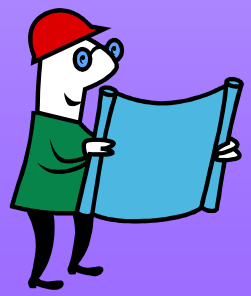
- GE

kV	120
Set mAs/slice	335
Scan time (s)	1
Collimated slice (mm)	10
Thickness (mm)	4x2.5
Increment	0
FOV	Small

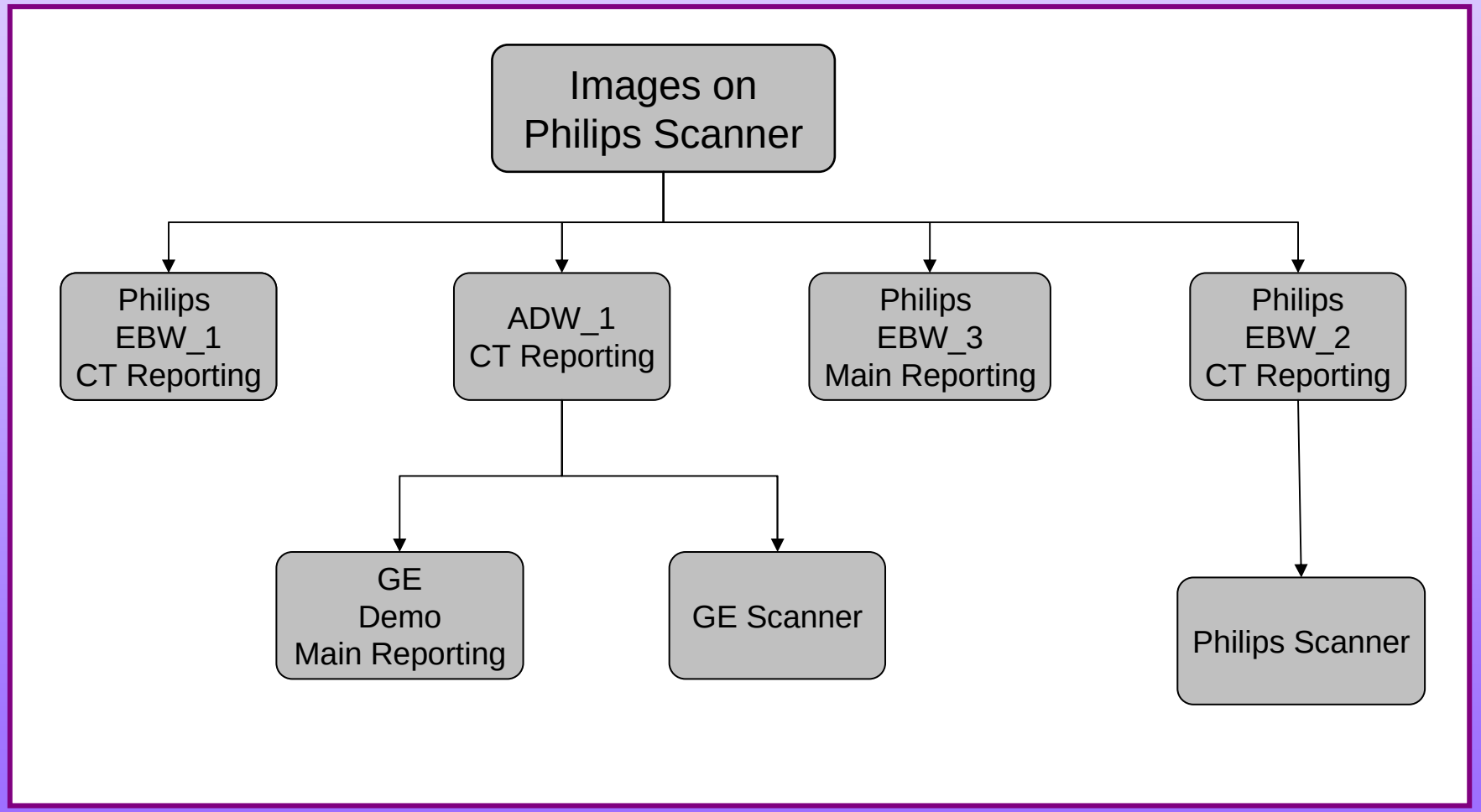
- Analysis of middle image – Image 2

Plan of action

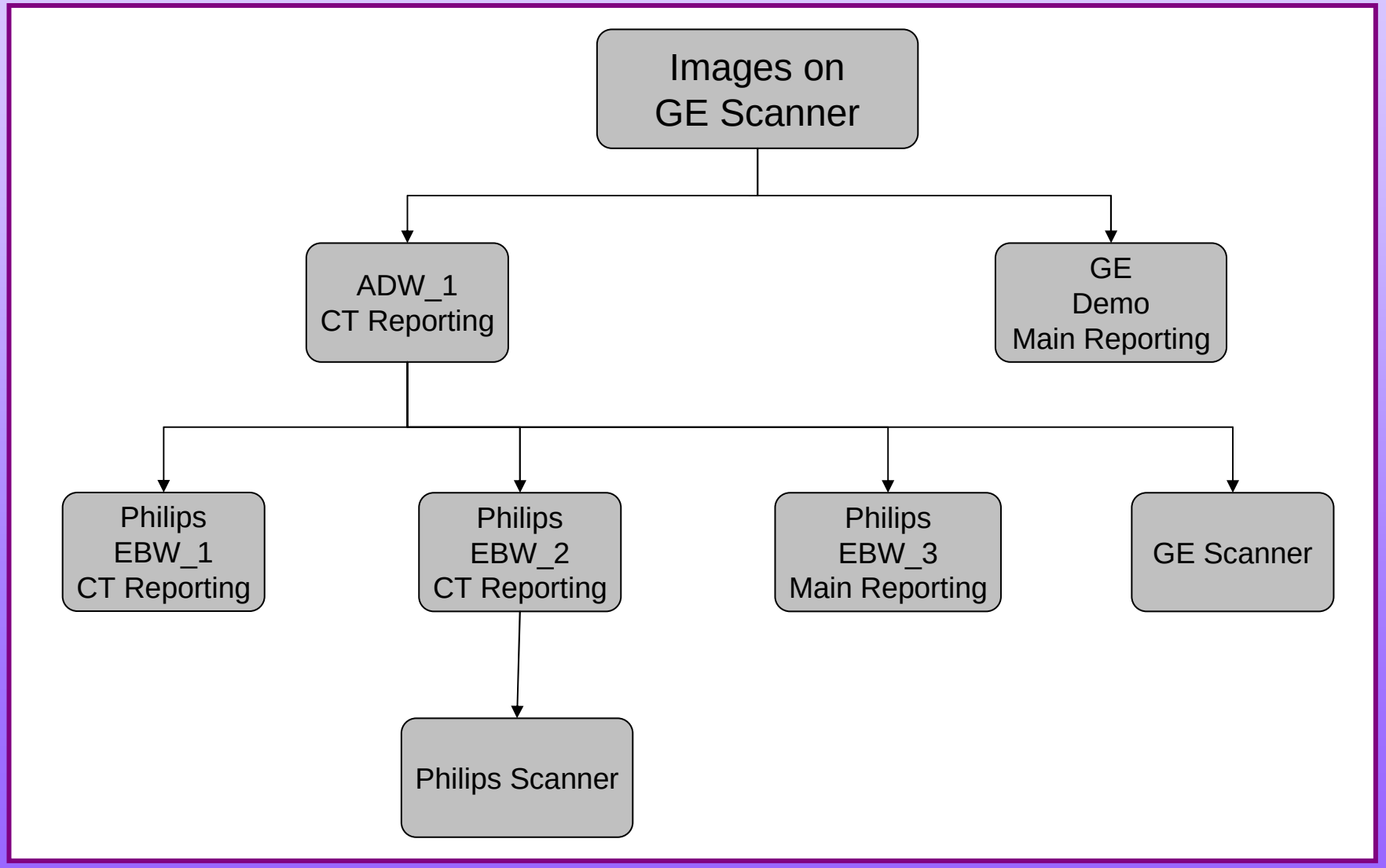
- Scan Philips IQ phantom on both scanners;
- Use ‘matching’ scan parameters;
- Send images to all combinations of workstations and scanners available;



Philips Scanner

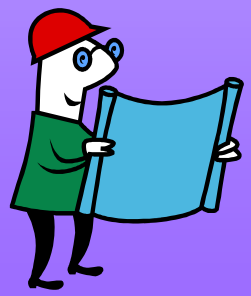


GE Scanner


Images on
GE Scanner
ADW_1
CT Reporting
GE
Demo
Main Reporting
Philips
EBW_1
CT Reporting
Philips
EBW_2
CT Reporting
Philips
EBW_3
Main Reporting
GE Scanner
Philips Scanner

Plan of action

- Scan Philips IQ phantom on both scanners;
- Use ‘matching’ scan parameters;
- Send images to all combinations of workstations and scanners available;
- Analyse images;



The Results – Philips Scanner

	ROI Area (mm^2)	Material	Lexan	Perspex	Teflon	Polyethylene	Aculon	Water
Philips Scanner	200	Mean CT No	119.9	143.3	1013.1	-66.3	102.2	-1.2
CT Workstation (ADW_1)	202	Mean CT No	120.98	144.45	1014.32	-65.55	103.21	-0.45
EBW_2 Philips WS (CT reporting)	199	Mean CT No	119.9	143.9	1012.4	-65.6	103.1	4
EBW_1 Philips WS (CT reporting)	200	Mean CT No	120.1	143.9	1012.8	-65.5	103	1
EBW_3 Philips WS (Main reporting)	201.9	Mean CT No	119.8	143.8	1012.5	-65.5	103	4
Demo GE WS (Main reporting)	204	Mean CT No	120.88	144.32	1014.36	-65.39	103.23	-0.57
Philips Scanner (re-sent)	200	Mean CT No	118.4	141.8	1010.6	-67.3	101.3	-0.9
GE Scanner	200	Mean CT No	120.85	144.35	1014.36	-65.45	103.04	-0.27
PACS		Mean CT No	122	146	1017	-66	103	-1

The Results – GE Scanner

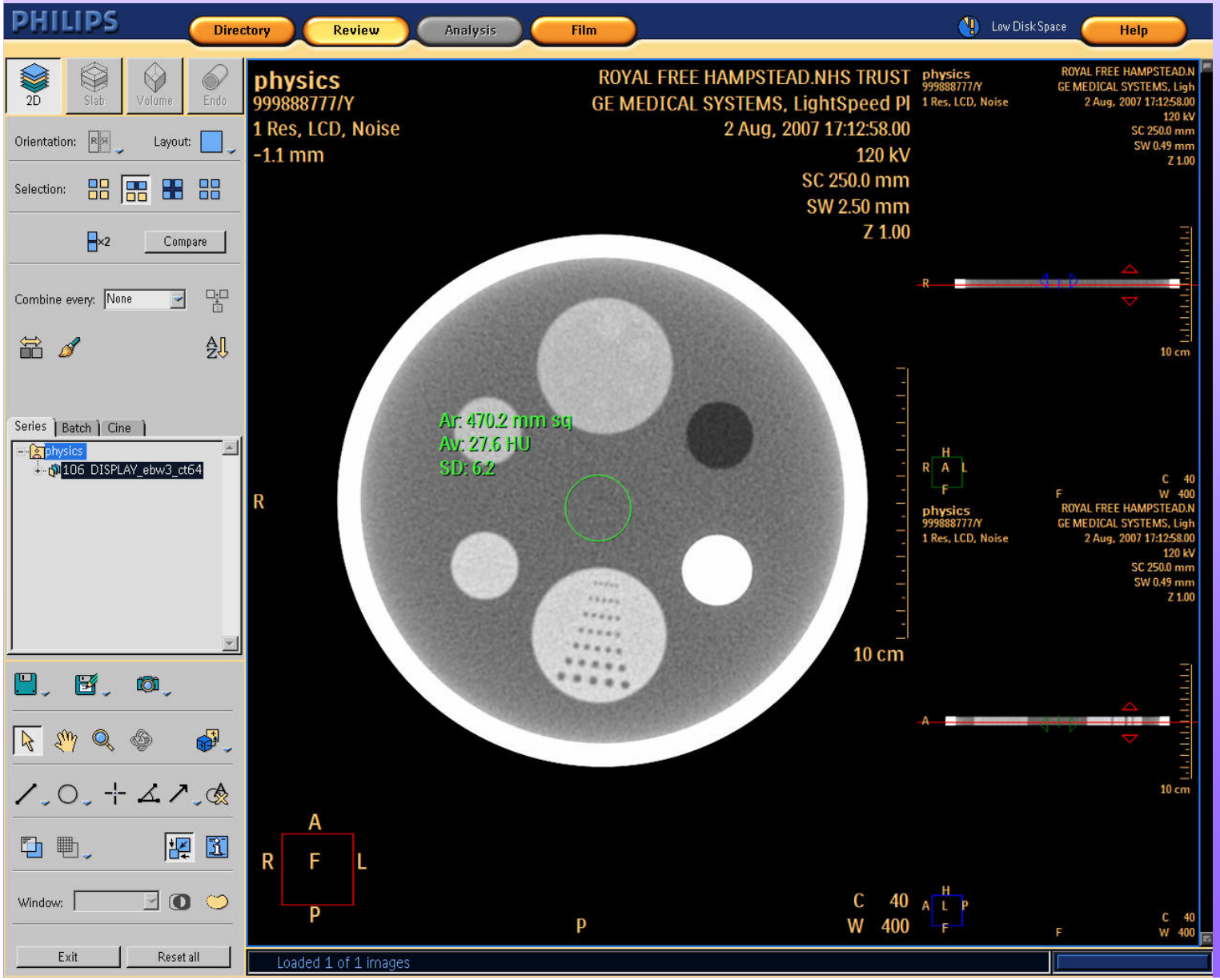
	ROI Area (mm^2)	Material	Lexan	Perspex	Teflon	Polyethylene	Aculon	Water
GE Scanner	200	Mean CT No	112.19	133.17	915.46	-54.1	101.08	3.42
CT Workstation (ADW_1)	203	Mean CT No	112.2	133.17	916.49	-54.15	101.1	3.5
EBW_2 Philips WS (CT reporting)	201	Mean CT No	135.7	157	940.2	-30.6	124.6	27.9
EBW_1 Philips WS (CT reporting)	201.5	Mean CT No	111.7	132.9	916.4	-54.6	100.6	3.8
EBW_3 Philips WS (Main reporting)	201.9	Mean CT No	135.7	156.9	940.3	-30.6	124.6	27.7
Demo GE WS (Main Reporting)	204	Mean CT No	112.09	133.23	916.39	-54.19	100.98	3.1
Philips Scanner	200	Mean CT No	110.3	132.1	914.9	-56	98.9	2.4
GE Scanner (re-sent)	200	Mean CT No	112.04	133.32	916.63	-54.1	101.14	3.1
PACS		Mean CT No	112.1	133.2	915.4	-54.1	101.1	3.4

What happened next….

- Philips engineers called in to investigate…
- Showed them the problem and they agreed to investigate;

The Images….

The Images….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GE MEDICAL SYSTEMS, LightSpeed Pl
2 Aug, 2007 17:12:58.00
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SC 250.0 mm
SW 2.50 mm
Z 1.00
Ar: 470.2 mm sq
Av: 27.6 HU
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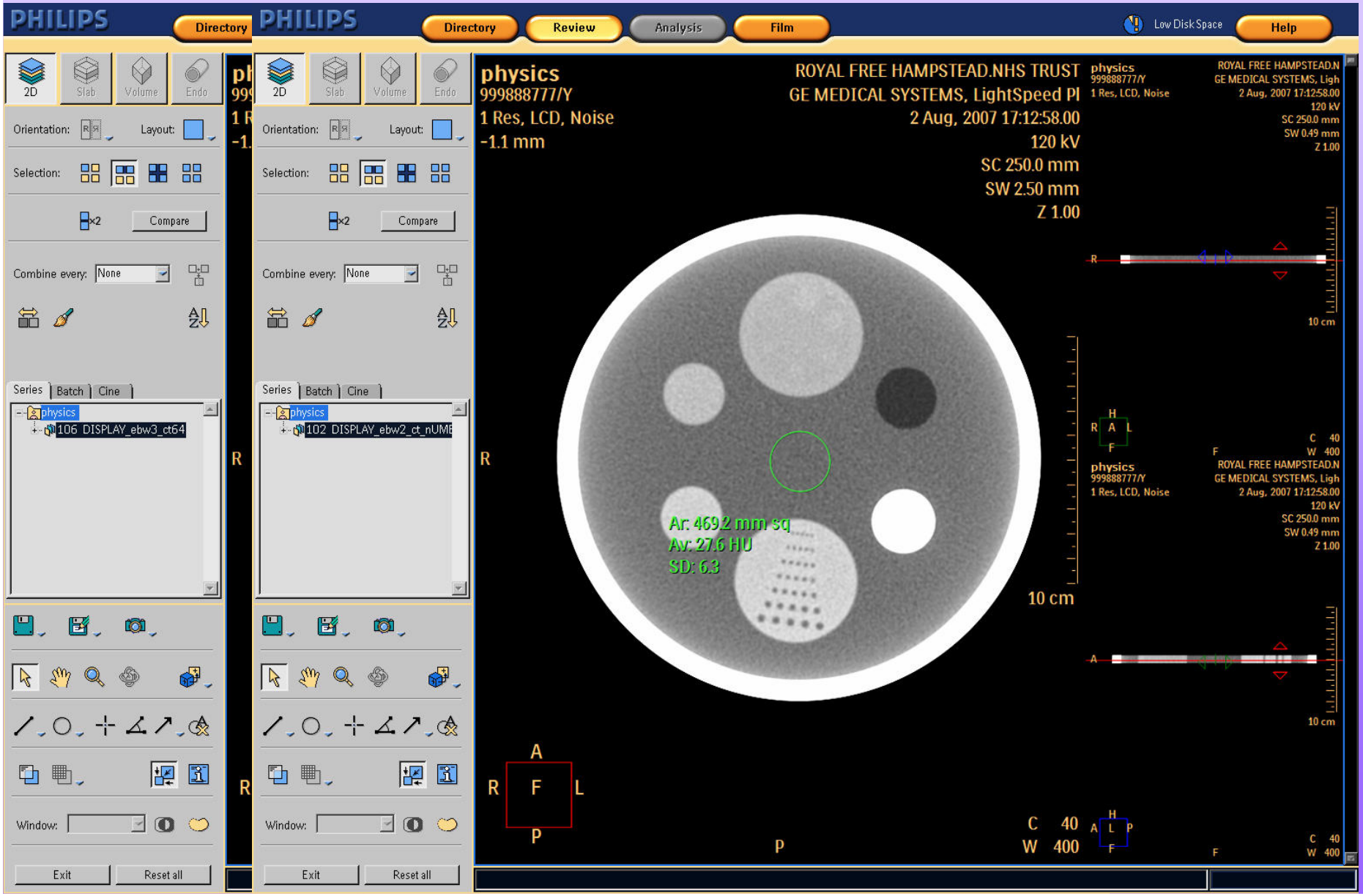
The Images….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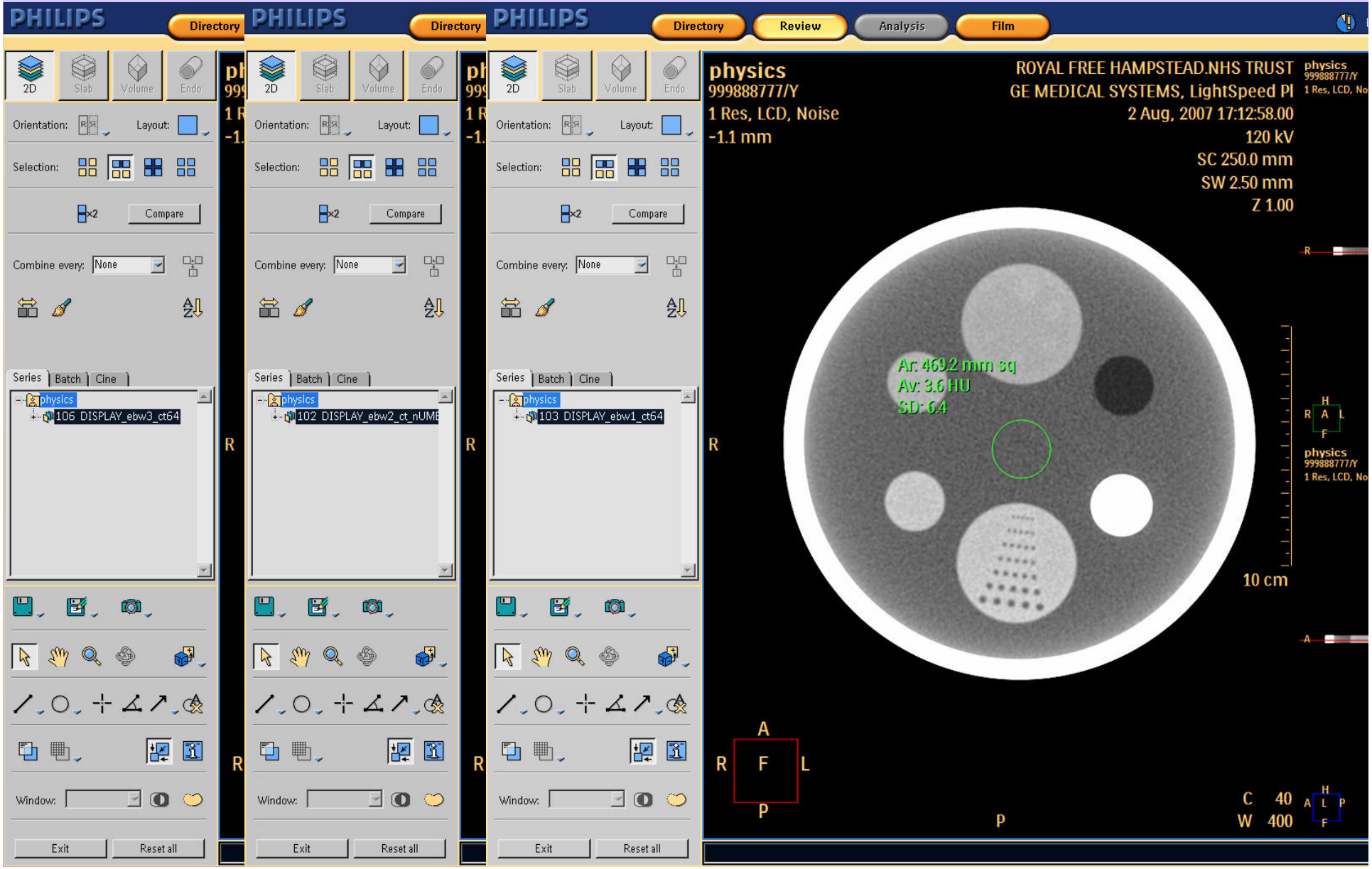
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What happened next….

- Philips engineers called in to investigate…
- Showed them the problem and they agreed to investigate;
- Updated software on ‘rogue’ workstation;

What happened next….

- Philips engineers called in to investigate…
- Showed them the problem and they agreed to investigate;
- Updated software on ‘rogue’ workstation;
- Now **all** Philips workstations display offset CT numbers for non Philips images;

And then what?

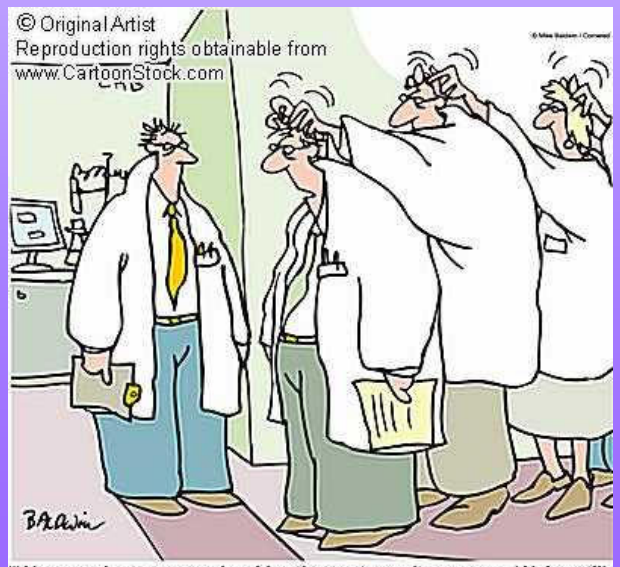
- Reported the problem to the radiologists;
- Tried to get some more input from Philips;
- Started looking at the DICOM headers for each set of images;
- Repeated the test following a software upgrade on the scanner…

Conclusions

- Private DICOM tags are being applied to the GE images to cause this offset;
- Only a problem on certain versions of software provided;
- Only appears to be a problem on the Extended Brilliance Workspace (EBW) software available on workstations;

The Outcome

- The clinicians no longer analyse non-Philips images on Philips Workstations to prevent misdiagnosis occurring;



Any ideas?

- Any ideas of other things we can look at would be greatly appreciated…