

EVALUATION



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Centre for Evidence-based Purchasing

Report 05068

**32 to 64 slice CT scanner
comparison report
version 13**

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32 to 64 slice CT scanner comparison report version 13

**David Platten, Nicholas Keat
Maria Lewis, Sue Edyvean**

ImPACT
Bence Jones Offices
St George's Hospital
London SW17 0QT

Tel: 020 8725 3366
Fax: 020 8725 3969

e-mail: impact@impactscan.org

For more information on ImPACT visit www.impactscan.org



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Contents

Contents	4
Introduction	5
Purpose of this report	5
Comparison method	5
Specification comparison.....	5
Scanners covered in this report.....	5
Specification comparison	7
Appendix 1: Image quality assessment and Q	22
Appendix 2: ImPACT	23
ImPACT	23
Support to purchasers and users	23

Introduction

Purpose of this report

The primary aim of these reports is to aid the equipment selection process by providing comparisons of CT scanners that are currently on the market. There are separate reports for six to ten, sixteen, and 32 to 64 slice CT scanners, as well as a report on wide bore systems.

The scope of this report is limited to CT scanners that are capable of acquiring between 32 and 64 data sets per tube rotation.

Comparison method

There are two main areas for comparison of the scanners: performance and specification. This report is restricted to a comparison of system specifications. At the time of publication none of the scanners in this report have been tested by ImPACT.

The data given in this report are representative of the scanners as of July 2005, and are liable to change as the performance of individual scanner models is changed and upgraded. In particular, optional features such as workstations and software packages may be listed as standard, but may not be included in specific purchases.

Specification comparison

The specification comparison is presented as a side-by-side summary comparison of the specification of each scanner, workstation and related equipment. It is grouped into a series of sub-sections relating to different aspects of the scanner, such as gantry, tube and detectors etc. Manufacturers supplied the specification data in response to a template issued by ImPACT. The data has not been verified by ImPACT.

Scanners covered in this report

At the time of writing, there are four manufacturers of medical CT scanners that sell their systems in the UK (in alphabetical order); GE Medical Systems, Philips Medical Systems, Siemens AG and Toshiba Medical Systems. The systems capable of imaging between 32 and 64 slices per gantry rotation are listed in Table 1.

Table 1: Scanners covered in this report

Manufacturer	Scanner model
GE	LightSpeed Pro ³²
GE	LightSpeed VCT
Philips	Brilliance CT 40 Power
Philips	Brilliance CT 64 Power
Siemens	Somatom Sensation 40
Siemens	Somatom Sensation 64
Toshiba	Aquilion 32
Toshiba	Aquilion 64

The GE LightSpeed Pro³² features a detector layout consisting of 64 x 0.625 mm detector banks with a z-axis coverage of 40 mm. The fastest gantry rotation time is 0.35 s. The main acquisition modes are 32 x 0.625 and 32 x 1.25 mm.

The GE LightSpeed VCT is a 64-slice system with 64 x 0.625 mm detector banks, and a z-axis coverage of 40 mm. The fastest gantry rotation time available is 0.35 s.

The Philips Brilliance CT 40 Power has 40 x 0.625 mm and 12 x 1.25 mm detector banks, covering 40 mm along the z-axis. The fastest rotation time available is 0.4 s.

The Philips Brilliance CT 64 Power comes with 64 x 0.625 mm detectors, allowing 40 mm z-axis coverage with 0.625 mm slices, and features a fastest gantry rotation time of 0.4 s.

The Siemens Somatom Sensation 64 has 32 x 0.6 mm and 8 x 1.2 mm detector rows. Using their z-Sharp technology, the 0.6 mm detectors are double sampled along the z-axis, resulting in 64 interleaved 0.6 mm data channels. The fastest gantry rotation time is 0.37 s, with an option to upgrade this to 0.33 s.

The Siemens Somatom Sensation 40 is based on similar hardware to the Sensation 64, but is capable of 40 images per rotation and also has a lower power x-ray generator. The Sensation 40 does not use the Siemens z-Sharp technology.

The Toshiba Aquilion 32 and 64 are based on the same hardware. The systems have 64 x 0.5 mm detector banks, and a fastest gantry rotation time of 0.4 s.

Specification comparison

In order to limit the number of columns in the following comparison scanners with similar specifications have been listed together. Where differences exist, square brackets are used to denote the specification of the second system. This is the case for the following systems:

- GE LightSpeed Pro³² and LightSpeed VCT, where the VCT specifications are shown in square brackets
- Philips Brilliance CT 40 Power and 64 Power models, where the 64-slice system is in brackets
- Siemens Sensation 40 and Sensation 64 scanners, where the 64-slice specifications are in brackets
- Toshiba Aquilion 32 and 64 systems, where the 64-slice specifications are in brackets.

Table 2: Couch

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Couch top material	Carbon fibre	Carbon fibre	Carbon fibre	Carbon fibre
Couch top length and width (cm)	285 x 42	243 x 41	243 x 40	219 (std) or 189 (short) x 47
Horizontal movement range (cm)	200	200	200	219 (std) 189 (short)
Horizontal movement speeds (mm/sec)	up to 175	0.5 - 100	1 - 150	10 or 130
Accuracy/reproducibility of table positioning (mm)	± 0.25	± 0.25	± 0.25	± 0.25
Scannable horizontal range without table top extension (cm)	200 (Axial), 190 (Helical & Scout)	162	157	180 (std) 150 (short)
Scannable horizontal range with table top extension(s) (cm)	170 (Axial), 160 (Helical & Scout)	192	157	180 (std) 150 (short)
Vertical movement range out of gantry (cm)	43 - 99	52-104	53 - 102	31 - 95.4
Vertical movement range in gantry (cm)	78 - 99	85 - 104	86 - 102	77.9 - 95.4
Minimum couch top height outside gantry (cm)	43	52	53	31
Maximum weight allowed on couch (kg)	227	204	200	205
Maximum weight on couch which still achieves stated performance specifications (kg)	227 (±0.25mm)	204	200	205

Specification comparison

Table 3: Scanner gantry

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Generation	3rd	3rd	3rd	3rd
Slipping	Low voltage	Low voltage	Low voltage	Low voltage
Aperture (cm)	70	70	70	72
Scan fields of view (cm)	25 and 50	25 - 50	50, extended 70 option	18, 24, 32, 40, 50
Tilt range (degrees)	± 30	± 30	± 30	± 30
Type of positioning lights	Laser	Laser	Laser	Laser
Accuracy of positioning lights (mm)	± 1 at any laser to patient distance	± 0.5 at centre of gantry	± 1	± 1

Table 4: X-ray generator

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Type	High frequency	High frequency	High frequency	High frequency
Location	Rotation assembly	Rotation assembly	Rotation assembly	Rotation assembly
Power rating (kW)	100	60	70 [80]	60
kV settings available	80, 100, 120, 140	80, 90, 120, 140	80, 100, 120, 140	80, 100, 120, 135
mA range and step size	10 - 800 (5mA steps)	30 - 500 (1mA steps)	28 - 580 (1mA steps) [28 - 665 (1mA steps)]	10 - 50 (5mA steps) 50 - 500 (10mA steps)
Max. mA allowed for each kV	80kV: 675mA 100kV: 770mA 120kV: 800mA 140kV: 715mA	90kV: 500mA 120kV: 500mA 140kV: 430mA	80 kV: 500mA 100kV: 500mA 120kV: 580mA 140kV: 500mA [64 same as 40 except 120kV: 665mA]	80 kV: 500mA 100 kV: 500mA 120kV: 500mA 135kV: 430mA

Specification comparison

Table 5: X-ray tube

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Type and make	GE Performix Pro	Philips MRC	Siemens Straton	Toshiba Megacool
Focal spot size(s) (mm), quoted to IEC 336/93 standard	0.6 x 0.7 0.9 x 0.9	0.5 x 1.0 1.0 x 1.0	0.6x0.7, 0.7x0.7, 0.8x1.1	0.9 x 0.8 1.6 x 1.4
Settings at which focal spot changes. kW = kV x mA / 1000	80kV : 24kW 100kV : 31kW 120kV : 40kW 140kV : 47kW	Small focus in high res. mode, not kW limited	Change automatically; UHR: 45; normal 65 kW; large 80 kW	80kV : 36kW 100kV : 35kW 120 kV : 36kW 135 kV : 33.8kW
Total filtration (inherent + beam shaping filter) at central axis (mm Al equivalent)	6.8 (70kV, head) 9.5 (70kV, body)	7	6.8	> 1 (inherent) 1.5 - 10 (wedge dependent)
Anode heat capacity (MHU)	8	8	0.6, equiv to 30	7.5
Maximum anode cooling rate (kHU/min)	2100	1608	5000	1386
Method of cooling	Oil to air	Oil to air	Oil to air	Oil to forced air
Guaranteed tube life	1 year unlimited guarantee	1 year unlimited guarantee	1 year unlimited guarantee	300,000 rotations

Table 6: Detection system

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Detector type	Solid state (HiLight / Lumex)	Solid state (High speed ceramic)	Solid state (Ultra Fast Ceramic)	Solid state
Number of detectors per row	888 (plus 18 reference detectors)	690	672 (1344 channels)	896 (plus 2 reference detectors)
Number of elements along z-axis	64	52 [64]	40	64
Effective length of each element at isocentre (mm)	64 x 0.625	40 x 0.625, 12 x 1.25 [64 x 0.625]	32 x 0.6, 8 x 1.2	64 x 0.5
Total effective length of detector array at isocentre (mm)	40	40	28.8	32
Option for more slices / rotation	64 [No]	64 [No]	64 [No]	Yes, 64 [No]

Specification comparison

Table 7: System start-up and calibration

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Power-on to warm-up time from fully off (mins)	2	2	4	2
Tube warm-up time from 'cold' to operating temperature (mins)	1.23	2 - 3	0	2 (0 in an emergency)
Time to perform detector calibrations at warm-up (mins)	Included in tube warm-up	Part of warm up procedure	5	1
Recommended frequency for any additional calibration by the radiographer	Once every 24 hours	1 every 3 weeks	Not required	Not required
Time to perform these additional calibrations (mins)	10	2	Not required	Not required
Total time from fully off to scanning in an emergency (mins)	< 3	2	4	2

Table 8: Scan parameters

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
kV settings available	80, 100, 120, 140	90, 120, 140	80, 100, 120, 140	80, 100, 120, 135
mA Range and Step size	10 - 800 (5mA steps)	30 - 500 (1mA steps)	28 - 580 (1mA steps) [28 - 665 (1mA steps)]	10 - 50 (5mA steps) 50 - 500 (10mA steps)
Max. mA allowed for each kV	80kV: 675mA 100kV: 770mA 120kV: 800mA 140kV: 715mA	90kV: 500mA 120kV: 500mA 140kV: 430mA	80 kV: 500mA 100kV: 500mA 120kV: 580mA 140kV: 500mA [64 same as 40 except 120kV: 665mA]	80 kV: 500mA 100 kV: 500mA 120kV: 500mA 135kV: 430mA
Maximum continuous scan time (s)	60	100	100	100

Specification comparison

Table 9: Helical and axial scanning

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Rotation times for axial scanning (s) * = Partial scans	0.3*, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2 (360° rotation)	0.3*,0.4 0.5, 0.75, 1, 1.5, 2	0.25*, 0.33*, 0.37, 0.5, 0.67*, 1.0 s [0.22* (option), 0.25*, 0.33*, 0.33 (option), 0.37, 0.5, 0.67*, 1.0]	(0.25* , 0.4 option) 0.32* , 0.5, 0.75, 1.0, 1.5, 2.0, 3.0
Rotation times for helical scanning (s)	0.35, 0.375, 0.4, 0.425, 0.45, 0.475, 0.5, 0.6, 0.7, 0.8, 0.9, 1	0.4, 0.5, 0.75, 1, 1.5	0.37, 0.5, 1.0 s [0.33 (option), 0.37, 0.5, 1.0]	0.5, 0.75, 1, 1.5 (0.4 option)
Axial slice widths (number x width, mm)	8x0.625, 32x0.625, 32x1.25 [8x0.625, 32x0.625, 64x0.625]	40x0.625, 32x1.25, 16x2.5, 2x0.5 [64x0.625, 2x0.5]	20x0.6, 6x0.6, 24x1.2, 2x1, 1x2, 1x5, 1x10 [30x0.6, 6x0.6, 24x1.2, 2x1, 1x2, 1x5, 1x10]	4x0.5, 4x1, 4x2, 4x3, 4x4, 4x6, 4x8
Helical acquisition widths (number of channels x width, mm)	Info. not available	40x0.625, 32x1.25, 16x2.5 [64x0.625, 32x1.25, 16x2.5]	6x0.6, 12x0.6, 20x0.6, 40x0.6, 24x1.2 [6x0.6, 12x0.6, 20x0.6, 64x0.6, 24x1.2]	32x0.5, 32x1, 16x1, 16x2 [64x0.5, 32x0.5, 32x1, 16x1, 16x2]
Pitches available for routine scanning (range and increment)	0.531 0.969 1.375 [0.515 0.984 1.375]	0-1.7 freely selectable	0.45 - 2.0 freely selectable	64-slice: 0.625-0.906 & 1.109-1.5 32-slice: 0.625-0.906 & 1.125-1.5 16-slice: 0.625-1.0 & 1.125-1.5 4-slice: 0.625-0.875 & 1.125-1.5
Recommended pitches for optimal image quality	0.531, 0.969, 1.375 [0.515, 0.984, 1.375]	0 -1.7 freely selectable	0.45 - 2.0 freely selectable	0.6875, 0.9375, 1.4375 [0.828]
Helical interpolation algorithms available	Volume Recon with conjugate ray reconstruction	Cobra - Cone Beam Reconstruction	SureView, AMPR cone-beam artefact reduction and z-sharp technology	TCOT and MUSCOT
Maximum number of rotations in one helical run at standard abdomen parameters	200 (270-380 mA at 0.6 s) [200 (230-325mA at 0.6 s)]	200	160 (324mA, .5s) 176 (300mA, .5s) 200 (273mA, .5s)	200 at 0.5s (250 at 0.4 option)
Starting with a cold tube, the maximum helical scan distance using a 1 mm imaged slice thickness and a pitch of 1.5 (mm)	1900 (at pitch of 1.375:1)	1920	1570	1750 (std) 1450 (short)
Gantry tilt range for helical scanning (degrees)	Tilt not available	± 30	Tilt not available	± 30

Specification comparison

Table 10: Scanned projection radiography (SPR)

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Maximum SPR length (mm)	1900	1500	1536	1800 (std) 1500 (short)
SPR field dimensions (mm x mm)	500 x 1900	500 x 1500	500 x 1536	width: 240, 400, 500 length: 200 - 1800 (std), 1500 (short)
Angular positions of X-ray tube available for SPR	0 - 359° (1° steps)	0°, 90°, 180°	AP, PA, LAT	0°, 90°, 180°, 270°, and any angle in 5° steps
Real time image	No	No	Yes	Yes
Accuracy of slice prescription from the scanogram (mm)	± 0.25	± 0.25	± 0.5	± 0.25
Accuracy of distance measurements from SPR's taken at isocentre (lateral and axial directions) (mm)	< 2 x image pixel size	± 0.25	± 0.5	< ± 0.5

Specification comparison

Table 11: Image reconstruction on main console

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Reconstruction fields of view (cm)	9.6 - 50	5 - 50	5 - 50	0.05 - 50
Extended scan field of view (cm)	Not available	Not available	70 option	Not available
Reconstruction matrix	512	512, 768, 1024	512	256, 512
Minimum reconstruction interval in helical scanning (mm)	0.1	0.1	0.1	0.1
Reconstruction time from the start of data acquisition to the appearance of the 30th image of a series for a standard axial brain scan (s)	19 sec 13 sec (w/Xtream2) [13 sec(with IBO)]	1.25	2 (20 f/s)	Defined by total scan time
Reconstruction time from the start of data acquisition to the appearance of the 30th image of a series for an axial spine scan (s)	15 sec 12 sec (w/Xtream2) [12 sec]	1.25	2 (20 f/s)	2
Reconstruction time from the start of data acquisition to the appearance of the 30th image of a series for a helical abdomen scan (s)	15 sec 12 sec (w/Xtream2) [12 sec]	1.25	2 (20 f/s)	2
Simultaneous scanning and reconstruction	Yes	Yes	Yes	Yes
Any delay in either scanning or reconstruction when performed concurrently	No	No	No	No
Simultaneous scanning and routine analysis	Yes	Yes	Yes	Yes
Simultaneous scanning and archiving and/or hard copying	Yes	Yes	Yes	Yes
Simultaneous scanning and transfer to second console/workstation	Yes	Yes	Yes	Yes

Specification comparison

Table 12: Factors affecting image quality and dose

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Post-patient collimation for narrow slices	No	No	No	No
Automatic mA control (AEC / mA modulation) software	3D Dose Modulation	Doseright ACS and DOM + cardiac	Yes (CAREdose 4D)	SureExposure
- mA adjustment for patient size	Yes	Yes	Yes	Yes
- mA adjustment along the z-axis	Yes	Yes	Yes	Yes
- mA modulation during rotation	Yes	Yes	Yes	No
Number of helical gantry rotations required at each end of total imaged volume.	Info. not available	0.5	Info. not available	2.3 max [2.2 max]
Adaptive filtration for noise reduction	Low signal correction	Adaptive image enhancement or smoothing for three density ranges	Yes (automatic)	Yes (quantum denoising)
Quarter detector shift	Yes	Yes	Yes	Yes
Moving (dynamic/flying) focal spot, xy plane	No	Yes	Yes	No
Number of imaging detectors per row	888	672	672 (1344 channels)	896
Sampling frequency (Hz)	2460	4640	4640	1800 (0.5s scan) 1200 (>0.5s)
Artefact reduction algorithms	Iterative Bone Option (IBO), Motion correction Reconstruction of thick slices from thinner ones to reduce partial volume effects	Iterative bone correction, COBRA cone beam reconstruction, combined slice	Modified beam hardening (abdomen, pelvis, shoulder), Motion correction (sequential modes), Posterior Fossa optimisation, z-Sharp Reconstruction	Beam hardening correction Raster Art. Suppression Protocol (RASP) Stack scanning Automatic patient motion correction
Cone beam correction	GE Proprietary Volume Recon	Cone beam reconstruction (COBRA)	Yes, SureView and AMPR cone-beam artefact reduction	TCOT (modified Feldkamp method)

Specification comparison

Table 13: Manufacturer's performance data

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
In plane spatial resolution (lp/cm) for sharpest clinical algorithm. Acquisition parameters in brackets.	MTF0: 15.4 MTF10: 13.9 (10cm DFOV, Edge alg, Small Focus)	MTF0: 24 (0.75 s, 2.5 mm slice, 25 cm scan FOV, E alg)	MTF0: 30 (0.75 s, U95u, 50 mm FOV, small focus)	MTF2: 21.4 (120 kV, 200mA, 2 mm slice width, 1s, 240 mm FOV, FC90 alg, small focus)
Contrast resolution: smallest rod size (mm) discernable at given parameters in 20 cm CATPHAN	5 mm @ 0.3% at 7.5 mGy CTDIvol: 120 kV, 105mAs, 10mm	4.0 mm @ 0.3% 120 kVp, 248 mAs, 10 mm, EB filter, 27 mGy at phantom surface	Spiral: 5 mm @ 0.3% @ 17 mGy: 120 kV, 180 mAs, 10 mm	2 mm @ 0.3% @ 26.7 mGy: 120kV, 240 mAs, 8 mm, FC41 with adaptive filter
CT number accuracy (HU)	Water : ± 3	± 4	Air: ± 10 Water: ± 4	Water: ± 3
CTDI settings for std head	120kVp, 20 mm	120kV, 40 mm	120kV, 28.8 mm	120kV, 16 mm
CTDI (mGy/100mAs), centre of head phantom	12.9	10.4	13.6	10.0 (Wedge 1) 18.4 (Wedge 2)
CTDI (mGy/100mAs), periphery of head phantom	13.7	11.3	13.9	11.1 (Wedge 1) 21.5 (Wedge 2)
CTDI settings for std body	120 kVp, 20 mm	120kV, 40 mm	120kV, 28.8 mm	120kV, 16 mm
CTDI (mGy/100mAs), centre of body phantom	3.5	3.4	4.4	3.5 (Wedge 1) 6.6 (Wedge 2)
CTDI (mGy/100mAs), periphery of body phantom	8.3	6.8	7.9	7.3 (Wedge 1) 14.8 (Wedge 2)
Dose profile FWHM (mm) (focal spot size in brackets)	Info not available	$\pm 10\%$ for all collimations	28.8 : 32 (s)	32 : 38 \pm 9.5 (s) 16 : 20 \pm 5.0 (s) 8 : 12 \pm 3.6 (s)

Specification comparison

Table 14: Main console

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Diagonal dimension of image screen (inches)	19	19	19	18
Number of monitors at console (functions of each if > 1)	2 (acquisition / review and processing)	2 (acquisition / review and processing)	Up to 6 (shared database)	2 (acquisition/ review and processing)
Image area matrix dimensions	512 x 512, 768 x 768, 1024 x 1024	1024 x 1024	1024 x 1024	512 x 512, 640 x 640, 1024 x 1024
Usual range of CT Number displayed (HU)	-31743 to +31743	-1024 to + 3094	-1024 to +3071 (-10,240 to 30,710 if metal implants)	-1024 to +8191
Accuracy of distance measurements in x-y plane (mm)	< 2 times image pixel size	± 0.25	depends on pixel size	< 1
Weighted CTDI (CTDI _w or CTDI _{vol}) displayed on console	Yes	Yes	Yes	Yes
Dose Length Product (DLP) displayed on console	Yes	Yes	Yes	Yes
Geometric Efficiency displayed on console when <70%	Yes	Yes	Yes	Yes
Control methods	Mouse, trackball, keyboard	Mouse, keyboard	Mouse, keyboard	Mouse, keyboard

Table 15: Main computer

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Make and model	HP XW8000	Dell Xeon	Siemens PC compatible with array processors	2 x Dual Processor Reconstruction processor
Operating system	Fedora Linux Core 2	Windows XP	Windows XP	Windows
Type and speed of CPU	2 x 2.66 GHz	2 x 3.06 GHz	Pentium Xeon 3.6 GHz	3.06GHz (scan console and display console)
Amount of computer RAM supplied as standard (Gbytes)	4	4	20	3.0 (scan console) 3.0 (display console) 76.0 (recon unit)
Maximum amount of computer RAM (Gbytes)	22	4	20	3.0 (scan console) 3.0 (display console) 76.0 (recon unit)

Specification comparison

Table 16: Image storage

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Total standard hard disk capacity (Gbytes)	803	880	883	1060
Maximum hard disk capacity (Gbytes)	803	880	883	1060
Hard disk capacity for image storage (Gbytes and no. of uncompressed 512x512 images)	146 (250,000 images)	292 (514,000 images)	146 (260,000 images)	180 (160,000 images)
Hard disk capacity for storage of raw data files (Gbytes and no. of data files)	584 (9540 32 slice axial raw data files) [584 (4770 64 slice axial raw data files)]	588 (195,000 data files)	300	720 (3600 rotations)
Archive options	MOD (images) & DVD (scan data, protocols) (standard)	MOD and CD writer (standard)	MOD and CD writer (standard)	MOD (option) DVD-RAM DICOM Media CD-ROM
Capacity of a single archive disk (Gbytes and no. of images)	4.6 (9400 losslessly compressed 512x512 images or 37 raw data files)	9.1 (39,000 losslessly compressed 512x512 images. Factor 2-3 compression)	MOD: 4.1GB (26,000 lossless images), CD-R: 0.65GB (4100 lossless images) 512 x 512	9.4 (DVD)
Time to mount an archive disk or tape (s)	5-6 in background operation	Info. not available	Approx 30 for full disk	Less than 20
Archive data transfer rate (images / s)	1 (read) 0.7 (write)	> 1	2 - 3	Info. not available

Specification comparison

Table 17: Independent workstation

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Is a workstation provided?	Yes	Yes, Brilliance Extended Workspace	Yes, LEONARDO	Yes
Computer make and model	HP XW8200	Dell Xeon	Siemens Fujitsu Xeon	Dual processor
Operating system	Fedora Linux (Kernel 2.6)	Windows XP	Windows XP	Windows
Type and speed (GHz) of CPU	2 x 3.4	2 x 3.06	2 x Xeon 3.2	X86 3.06
Amount of computer RAM supplied as standard (Gbytes)	2	4	2	3
Maximum amount of computer RAM (Gbytes)	4	4	3	3
Total hard disk storage capacity supplied as standard (Gbytes)	182	146	147	180 (shared storage)
Maximum total hard disk storage capacity (Gbytes)	182	438	147	180 (shared storage)
Archive options	CD-R standard MOD optional	CD-R standard EOD option	CD-R standard MOD option	MOD option DVD-RAM
Capacity of a single archive disk (Gbytes)	4.6	9.1	MOD: 4.1 CD-R: 0.65	9.4 (DVD)
Environmental requirements (max/min temperature, humidity) for workstation	10-40 °C, 20-80 % relative humidity	0-40 °C	10-35 °C, 20-80% relative humidity	18-28 °C, 40-80% relative humidity

Table 18: 3D reconstruction display (MC – main console, WS – workstation)

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
MIPs and MinIPs (maximum and minimum intensity projections)	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard
SSD (3D Shaded Surface Display)	MC-option WS-standard	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard
3D Volume rendering software	MC-option WS-standard	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard
3D Virtual endoscopy	MC-option WS-standard	MC-standard WS-standard	MC-standard WS-standard	MC-option WS-standard
MPR (Multi-planar reconstruction)	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard
Planes available in MPR	Axial, para-axial, sagittal, coronal, oblique, curvilinear	All planes, any oblique (identical on console and workstations)	Axial, sagittal, coronal, oblique, curvilinear	Axial, sagittal, coronal, oblique, curved with cross cut through the curved reformat

Specification comparison

Table 19: Optional facilities (MC – main console, WS – workstation)

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Contrast injector	Option	Option	Option	Option
Contrast media bolus tracking	Standard (SmartPrep)	Standard	Standard (CAREBolus)	Standard
CT fluoroscopy software and hardware	Option (SmartStep)	Option (Continuous CT Imaging)	Option (CAREVision with HandCARE)	Option
Hard-copy imaging device	Option	Option	Option	Option
Radiotherapy planning table top	Option (RT flat pad and Exact couch top)	Option (Exact table top)	Option	Option
Carbon fibre breast board	Option	Option	Option	Not available
Means for attaching patient immobilisation devices and a stereotactic frame to the end of the couch	Option (Exact couch)	Option	Option	Option
Bone Mineral Densitometry	MC-Not available WS-option (BMD)	MC-option WS-option	MC-option WS-option (Osteo CT)	MC-option WS-Not available
CT Angiography	MC-standard WS-standard AVA (Vessel Assessment) option on WS	MC-standard WS-standard	MC-standard WS-standard	MC-standard WS-standard
Dental	MC-option WS-option (Dentascan)	MC-option WS-option	MC-option WS-option (Dental CT)	MC-option WS-option
Radiotherapy CT simulation software	MC-Not available WS-option (CT sim)	MC-option WS-option	Coherence Dosimetrist (separate workstation)	MC-Not available WS-option
Prospective ECG-triggered cardiac software	MC-option WS-option (SmartScore)	MC/WS option (Prospective Gating)	MC-option WS-option (post-processing only) (HeartView CS)	MC-option WS-option
Retrospective ECG-gated cardiac software	MC-option (Snapshot, Burst) MC+WS-option (Cardiac Imaging)	MC/WS-option (Retrospective Tagging)	MC-option WS-option (post-processing only) (HeartView CI)	MC-option WS-option (Prospective Gating)
CT Perfusion software	MC-option WS-option (CT Perfusion)	MC-option WS-option (head + body perfusion)	MC-option WS-option (Perfusion CT)	MC-option WS-Not available

Specification comparison

Table 20: Installation requirements

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Environmental requirements (max/min temperature, humidity) in scanner room	18-26 °C, 30-60% relative humidity	15-24 °C, 20-75% relative humidity	15-28 °C, 15-75% relative humidity	18-28 °C, 40-80% relative humidity
Environmental requirements (max/min temperature, humidity) in scanner control room	18-26 °C, 30-60% relative humidity	15-28 °C, 20-75% relative humidity	15-28 °C, 15-75% relative humidity	18-28 °C, 40-80% relative humidity
Peak heat output from system during scanning (kW)	17	5.9	1.53 (add 0.07 for CT fluoro)	10.5 max
System cooling method	Output to air	Oil to air	Water - water	Output to air
Air conditioning requirements for scanner room of minimum floor area	Recommended	Not required, other than for patient comfort	None	Not necessary but recommended
Minimum floor area required for the system (m ²)	24	25	30	27 (std) 25 (short)
Gantry dimensions (H x W x D (mm)) and weight (kg)	1887x2230x1007 1954kg	2030x2290x940 1764kg	1990x2280x940 2000kg	1950x2330x960 1750kg
Couch dimensions (H x W x L (mm)) and weight (kg)	1094x650x2850 445kg	1010x690x2490 383 kg	1022x690x2430 500 kg	450x630x2690 450kg(std) 450x630x2390 420kg(short)
Supplementary unit dimensions (H x W x D (mm)) and weight (kg)	Power unit: 1067x711x559 350kg	Power unit: 1120x560x530	Power unit: 1815 x 905 x 800, 550kg Cooling unit: 1815 x 905 x 860, 200kg	Power unit: 980 x 800 x 770, 550kg
Power supply requirements	3 phase 380-480V, 150kVA	3 phase 380-480V, 90kVA	3 phase 380-480V 104kVA	3 phase 380-440V, 100kVA

Specification comparison

Table 21: Image transfer and connectivity

	GE LightSpeed Pro32 [VCT]	Philips Brilliance CT 40 [64]	Siemens Sensation 40 [64]	Toshiba Aquilion 32 [64]
Speed of scanner / workstation connections to local area networks (Mbits/s)	1000	100 or 1000	1000	1000
Remote PC access to images on workstation	Option	Option (Easyweb)	Option	Option
DICOM services on Main Console				
Storage	SCU, SCP	SCU, SCP	SCU, SCP	SCU, SCP
Print	SCU	SCU	SCU	SCU
Query / retrieve	SCU, SCP	SCU, SCP	SCU, SCP	SCU, SCP
Modality worklist	SCU	SCU	SCU	SCU
Performed procedure step	SCU	SCP	SCU	SCU
Storage commitment	SCU	Not available	SCU	SCU
DICOM services on Workstation				
Storage	SCU, SCP	SCU, SCP	SCU, SCP	SCU, SCP
Print	SCU	SCU	SCU	SCU
Query / retrieve	SCU, SCP	SCU, SCP	SCU, SCP	SCU, SCP
Modality worklist management	Not available	SCU	Not available	Not available
Performed procedure step	Not available	SCP	Not available	Not available
Storage commitment	Not available	Not available	SCU	Not available

Appendix 1: Image quality assessment and Q

Image noise, scan plane spatial resolution and imaged slice width are fundamental parameters describing the amount of object information retrievable from an image, or its image quality. Radiation dose can be regarded as a 'cost' of this information. In general, it is meaningless to quote any one of these measurements without reference to the others.

It is possible to incorporate dose, noise, spatial resolution and slice width into one number, using formulae derived from the relationships between image quality and dose. Figures of merit such as this can take a number of forms depending on how the various parameters are measured and quoted. ImPACT use the Q_2 value, whose formula and methods of measurement are given below.

High Q_2 values result from CT scanners that produce images with lower noise at a set spatial resolution, when dose and image width are taken into account.

The parameters used in Q are standard imaging performance parameters. However it should be noted that the quantification of perceived image quality is a complicated process and as such will not be fully described by the single descriptors used for each of the parameters.

Comparisons between scanners are more reliable when comparing scans reconstructed with similar convolution filters. The uncertainty in quoted values of Q_2 is up to about $\pm 15\%$, with a conservative estimate of $\pm 10\%$.

Q_2 is calculated as follows:

$$Q_2 = \sqrt{\frac{f_{av}^3}{\sigma^2 z_1 \text{CTDI}_{vol}}}$$

σ = image noise, expressed as a percentage, for a 5 cm^2 region of interest at the centre of the field of view in the standard ImPACT water phantoms.

f_{av} = spatial resolution, given as $(\text{MTF}_{50} + \text{MTF}_{10})/2$, where MTF_{50} and MTF_{10} are the spatial frequencies corresponding to the 50 % and 10 % modulation transfer function values respectively (in line pairs per cm). Reconstruction kernels with standard spatial resolution values are chosen to minimise the dependency of Q_2 upon reconstruction kernels. The reconstruction kernel with MTF_{50} and MTF_{10} values as close as possible to 3.4 c/cm and 6.0 c/cm is used (c/mm used in the calculation for consistency of units with z-sensitivity).

z_1 = the full width at half maximum (FWHM) of the imaged slice profile (z-sensitivity). This is measured using the inclined plates method (mm).

CTDI_{vol} = volume weighted CT dose index (mGy).

Appendix 2: ImPACT

ImPACT

ImPACT (Imaging Performance Assessment of Computed Tomography) is the Department of Health's CT evaluation facility. It is based at St George's Hospital, London, part of St George's Healthcare NHS Trust.

ImPACT has developed test objects and measurement procedures suitable for inter-comparing CT scanner performance. For each CT evaluation hundreds of images are obtained from the system under test and subsequently analysed using custom written software. Dose measurements are made using ion chambers, and x-ray film is used to obtain additional x-ray dose information.

Support to purchasers and users

The ImPACT team is available to answer any queries with regard to the details of this report, and also to offer general technical and user advice on CT purchasing, acceptance testing and quality assurance.

ImPACT
Bence Jones Offices
St George's Hospital
London SW17 0QT

T: +44 (0) 20 8725 3366
F: +44 (0) 20 8725 3969
E: impact@impactscan.org
W: www.impactscan.org