



Evaluation Report

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Eight and Sixteen Slice CT Scanner Comparison Report

ImPACT report

MDA Evaluation Report

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Eight and Sixteen Slice CT Scanner Comparison Report

Version 6.01, March 2002

Manufacturer	Scanner model
GE	LightSpeed Ultra Advantage
Siemens	Somatom Sensation 16

Compiled and prepared by members of the ImPACT group

Table of Contents

TABLE OF CONTENTS	2
INTRODUCTION	3
Purpose of this report.....	3
Comparison method	3
Specification comparison	3
Scanners covered in this report	4
SPECIFICATION COMPARISON.....	5
Scanner gantry	5
Patient Couch	5
X-ray generator.....	6
X-ray tube.....	6
Detection system	6
System start-up and detector calibration	7
Scan parameters	7
Helical scanning.....	7
Scan projection radiograph (SPR)	8
Manufacturer’s performance data	8
Factors affecting image quality	9
Operator’s console	9
Main computer.....	10
Image storage.....	10
Image reconstruction.....	11
3D reconstruction	11
Optional features.....	12
Installation Requirements	13
Independent workstation	14
Image transfer and connectivity.....	14
APPENDIX 1: IMPACT AND THE MDA.....	15
Background	15
ImPACT	15
ImPACT and MDA support to purchasers and users.....	15

Introduction

■ Purpose of this report

In January 2000, the UK government announced the funding for the replacement, over a three-year period, of all non-helical CT scanners in use in England.

ImPACT has produced comparison reports for each phase of the purchase. 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.

The scope of this report is limited to CT scanners that are capable of acquiring eight or sixteen sets of attenuation data per tube rotation — rather than ‘single slice’, ‘dual’ or ‘twin slice’ and ‘quad’ or ‘four slice’ scanners, that can acquire one, two or four data sets per rotation.

■ Comparison method

The data given in this report are representative of the scanners as of January 2002, 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 for the scanner replacement programme, but may not be included in other, separate scanner purchases.

ImPACT has not yet had the opportunity to assess either of the scanners included in the report, so only specification comparison is included. Imaging and dose performance data for the scanners will be included in a future edition of this report.

Specification comparison

This is presented as a side-by-side comparison of the specification of each scanner, workstation and related equipment, showing the parameters that are considered to be most important for inter-scanner comparison. This is the full specification as found in Appendix 1 of ImPACT’s other comparison reports.

■ Scanners covered in this report

At the time of writing, there are five manufacturers of medical CT scanners; (in alphabetical order) GE Medical Systems, Philips Medical Systems, Shimadzu, Siemens AG and Toshiba Medical Systems. Of these, only GE currently markets an eight slice scanner. Siemens is the only manufacturer currently marketing a sixteen slice scanner. Other manufacturers should have sixteen slice scanners available during 2002.

Manufacturer	Scanner model
GE	LightSpeed Ultra Advantage
Siemens	Somatom Sensation 16

The LightSpeed Ultra Advantage is based upon the same design as the four slice LightSpeed Plus Advantage. In particular, the gantry, tube and detector layouts are identical. The most obvious difference between the two is the ability of the LightSpeed Ultra to acquire eight slices of data per gantry rotation.

ImPACT has not yet assessed the dosimetry and imaging performance of the LightSpeed Ultra. It is anticipated that the majority of imaging and dosimetry performance results of the LightSpeed Ultra will be similar to those of the LightSpeed Plus, although some scan acquisition parameters for routine scans will obviously be different.

The Siemens Somatom Sensation 16 is an upgraded version of the existing Somatom Sensation 4 (formerly Volume Zoom). It features a new detector design, image reconstruction techniques, and a fastest scan time of 0.42 seconds for cardiac scanning. This scanner has not yet been available for assessment by ImPACT.

Specification comparison

■ Scanner gantry

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Generation	3rd	3rd
Slipring	Low voltage	Low voltage
Aperture (cm)	70	70
Scan fields of view (cm)	25 and 50	50
Nominal slice widths for axial scans (mm)	0.625, 1.25, 2.5, 3.75, 5, 7.5, 10	0.75, 1.0, 1.5, 3, 6, 9
Tilt range (degrees)	± 30	± 30
Type of positioning lights	Laser	Laser

■ Patient Couch

Couch top	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Material	Carbon fibre	Laminated wood + carbon fibre
Length x width (cm)	239 x 62 (or 42 just for cradle)	243 x 40
Horizontal movement		
Horizontal movement range (cm)	170	200
Horizontal movement speeds (mm/sec)	up to 100	1 - 150
Accuracy/reproducibility of table positioning (mm)	± 0.25	± 0.5
Scannable horizontal range (cm):		
(i) without table top extension	170	157
(ii) with table top extension(s)	170	165
Vertical movement		
Vertical movement range out of gantry (cm)	51 - 99	48 - 102
Vertical movement range in gantry (cm)	88 - 99	86 - 102
Minimum couch top height outside gantry (cm)	51	48
Weight bearing properties		
Maximum weight allowed on couch (kg)	205	200
Maximum weight on couch which still achieves stated performance specifications (kg)	180 (±0.25mm) 205 (±1mm)	200

Specification comparison

■ X-ray generator

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Type	High frequency	High frequency
Location	rotation assembly	rotation assembly
Power rating (kW)	53.2	60
kV settings available	80, 100, 120, 140	80, 120, 140
mA Range and Step size	10 - 440 (10mA steps)	28 - 500 (10mA steps)
Max. mA allowed for each kV	80kV: 400mA, 100kV: 420mA, 120kV: 440mA	120kV: 500mA, 140kV: 428mA

■ X-ray tube

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Type and make	GE Performix	Siemens Dura Akron-Q
Focal spot size(s) (mm), quoted to IEC 336/93 standard	0.6 x 0.7, 0.9 x 0.9	0.5 x 0.7, 0.8 x 1.2
Total filtration (inherent + beam shaping filter) at central axis (mm Al equivalent)	4.75 (70kV, head) 5.65 (70kV, body)	1.6mm PTFE, 0.6mm Ti (body mode) equivalent to 5.5mm Al
Anode heat capacity (MHU)	6.3	5.3 (run at 80% of full loading)
Maximum anode cooling rate (KHU/min)	840	730
Method of cooling	Oil to air	Oil to air
Guaranteed tube life	200,000 rotations	160,000 seconds

■ Detection system

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Detector type	Solid state (HiLight / Lumex)	Solid state (Ultra Fast Ceramic)
Number of detectors per row	880 (plus 32 reference elements)	Info. not available
Number of elements along z-axis	16	24
Effective length of each element at isocentre (mm)	16 x 1.25	16 x 0.75, 8 x 1.5
Total effective length of detector array at isocentre (mm)	20	24
Future option for more slices / rotation	Info. not available	Info. not available

■ **System start-up and detector calibration**

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Power-on to warm-up time (mins)	2 from fully off, 0 from standby	Info. not available
Tube warm-up time from 'cold' to operating temperature (mins)	45 secs	Info. not available
Time to perform detector calibrations at warm-up (mins)	Included in 45s tube warm-up	Info. not available
Recommended frequency for any additional calibration by the radiographer	Once every 24 hours	Info. not available
Time to perform these additional calibrations (mins)	12 including warm up	Info. not available
Total time from fully off to scanning in an emergency (mins)	< 3	Info. not available

■ **Scan parameters**

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Reconstruction fields of view (cm)	9.6 - 50	5 - 50
Number of simultaneous slices at each nominal axial slice width (mm)	2 x 0.625, 8 x 1.25, 8 x 2.5, 4 x 2.5, 4 x 3.75, 4 x 5	16 x 0.75, 16 x 1.5 Smaller numbers of wider slices.
Scan times for axial scans (s)	0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4	0.42 (HeartView option), 0.5, 0.75, 1.0, 1.5
kV settings available	80, 100, 120, 140	80, 120, 140
mA range and step size	10 - 440 (10mA steps)	28 - 500 (10mA steps)
Max. mA allowed for each kV	80kV: 400mA, 100kV: 420mA, 120kV: 440mA	120kV: 500mA, 140kV: 428mA

■ **Helical scanning**

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Rotation times for helical scanning (s)	0.5, 0.6, 0.7, 0.8, 0.9, 1	0.42 (with HeartView option), 0.5, 0.75, 1, 1.5
Pitches available for routine scanning (range and increment)	2 slices: 1 (2); 4 slices: 0.75, 1.5 (3, 6); 8 slices: 0.625, 0.875, 1.35, 1.675 (5, 7, 10.8, 13.4)	0.5 to 1.5 (8 to 24), freely selectable
Recommended pitches for optimal image quality	2 slices: 1 (2); 4 slices: 0.75, 1.5 (3, 6); 8 slices: 0.625, 0.875, 1.35, 1.675 (5, 7, 10.8, 13.4)	Info. not available
Helical interpolation algorithms available	180° LI, 360° and z-filter interpolation	Info. not available
Maximum number of rotations in one helical run at standard abdomen parameters	70 (300mA) 90 (270mA) 110 (250mA)	Info. not available
Maximum continuous scan time (s)	120	100
Gantry tilt range for helical scanning (degrees)	± 30	± 30

Specification comparison

■ Scan projection radiograph (SPR)

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Maximum SPR length (mm)	1600	1024
SPR field dimensions (mm x mm)	500 x 1600	512 x 1024
Angular positions of X-ray tube available for SPR (degrees)	any angle from 0 - 355 (5° steps)	AP, PA, LAT (oblique in 10° steps)
Real time image	Yes	Yes
Accuracy of slice prescription from the scanogram (mm)	± 0.25	± 0.5
Accuracy of distance measurements from SPR's taken at isocentre (lateral and axial directions) (mm)	< 2 x image pixel size	± 0.5

■ Manufacturer's performance data

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
High contrast spatial resolution		
Resolution (lp/cm) for sharpest clinical algorithm	0% MTF: 15.4 lp/cm (10cmDFOV, Edge alg, Small Focus)	2% MTF: 24 lp/cm (0.75 s scan)
Low contrast resolution		
Smallest rod size (mm) discernable at given parameters in 20 cm CATPHAN	5mm @ 0.3% @ 18mGy: 120kV, 140mAs, 0.5 - 2.0s, 10mm, 2i, 25cmDFOV, Std alg	5mm @ 0.3% @ 21mGy: 120kV, 150 mAs - std body, 100mAs - special head mode, 1 x 10mm
Dose		
CTDI (mGy/100 mAs) for axial standard brain scans at given parameters:	120 kVp, 10 mm, 25 cm FOV	120 kV, 0.75 s, 20 mm
- centre of CTDI phantom	18.2	18.3
- periphery of CTDI phantom	18.5	22.2
CTDI (mGy/100mAs) for axial standard abdomen scans at given parameters	120 kVp, 10 mm, 25 cm FOV	120 kV, 0.5 s, 20 mm
- centre of CTDI phantom	5.5	5.0
- periphery of CTDI phantom	11.4	10.3
Dose profile FWHM (mm) (focal spot size in brackets)	20: 20.8(l), 15: 17.2 (s), 10: 11.5 (s), 5: 7.1 (s), 1.25: 3.5 (s), 2 x 0.63:1.9(s)	Info. not available

■ Factors affecting image quality

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Dose		
Post-patient collimation for narrow slices	No	Yes
Automatic mA adjustment according to body dimensions or density during examination	Available	Yes - CARE Dose
Noise		
Adaptive filtration for noise reduction	Low signal correction	Yes (automatic)
Resolution		
Quarter detector shift	Yes	Yes
Moving (dynamic/flying) focal spot	No	Yes
Number of imaging detectors per row	880	Info. not available
Sampling frequency (Hz)	1408	Info. not available
Artefacts		
Artefact reduction algorithms	Iterative Bone Option (IBO), Motion correction	Info. not available
Cone beam correction	Info. not available	Yes, Cone beam reconstruction

■ Operator's console

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Image monitor		
Diagonal dimension of image screen (inches)	20	18.1
Number of monitors at console (functions of each if > 1)	2 (patient info and technique selection/image display)	2 (acquisition/review and processing) (shared database)
Image display		
Image area matrix dimensions	512 x 512, 768 x 768, 1024 x 1024	1024 x 1024
Usual range of CT Number displayed (HU)	-1024 to +3071	-1024 to +3071 (-10,240 to +30,710 if metal implants)
Dose information		
Weighted CTDI (CTDI _w) displayed on console	Yes	Yes
Dose Length Product (DLP) displayed on console	Yes	Yes
Geometric Efficiency displayed on console when <70%	Yes	No
Hardware interface		
Control methods	Mouse, trackball, keyboard	Mouse, keyboard

Specification comparison

■ Main computer

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Make and model	Silicon Graphics Octane	2 x Siemens PC compatible with array processors (Volume Wizard and Volume Navigator)
Operating system	IRIX 6.5	Windows NT
Type and speed (MHz) of CPU	MIPS R12000 CPU 300 MHz	Info. not available
Amount of computer RAM (Mbytes):		
(i) supplied as standard	512	Wiz: 1536 Nav: 1024
(ii) maximum	512	Wiz: 1536 Nav: 1024

■ Image storage

Hard disk storage	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Total standard hard disk capacity (Gbytes)	40.5	108
Maximum hard disk capacity (Gbytes)	40.5	108
Hard disk capacity for image storage (Gbytes and no. of uncompressed 512 x 512 images)	18 (20,000 images)	36 (60,000 images)
Hard disk capacity for storage of raw data files (Gbytes and no. of data files)	18 (2000 data files)	72 (70,000 data files)
Archive options		
Archive options	MOD (standard)	MOD and CD writer (standard)
Capacity of a single archive disk (GBytes and no. of images)	2.3 (9400 losslessly compressed 512 x 512 images or 700 raw data files)	MOD: 4.1 (26,000 losslessly compressed images) CD-R: 0.65 (4800 compressed images) 256 x 256 matrix
Time to mount an archive disk or tape (s)	5 - 6 in background operation	Approx. 30 for full disk
Archive data transfer rate (images/s)	1 (read) 0.7 (write)	2 - 3

■ **Image reconstruction**

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Reconstruction matrix	512 x 512	256 x 256, 512 x 512
Minimum reconstruction interval in helical scanning (mm)	0.1	0.1
Reconstruction times		
Time (s) from the start of data acquisition to the appearance of the 30th image of a series:		
(i) standard axial brain scan	Info. not available	Info. not available
(ii) axial spine scan	Info. not available	Info. not available
(iii) helical abdomen scan	Info. not available	Info. not available
Parallel Processing details		
Simultaneous scanning and reconstruction	Yes	Yes
Any delay in either scanning or reconstruction when performed concurrently	No	No
Simultaneous scanning and routine analysis	Yes	Yes
Simultaneous scanning and archiving and/or hard copying	Yes	Yes
Simultaneous scanning and transfer to second console/workstation	Yes	Yes

■ **3D reconstruction**

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
MIPs and MiniIPs (maximum and minimum intensity projections)	MC-standard, WS-standard	MC-standard, WS-standard
SSD (3D shaded surface display)	MC-optional, WS-standard (3D)	MC-standard, WS-standard
3D volume rendering software	MC-N/A, WS-standard (Volume Rendering)	MC-Standard, WS-standard
3D virtual endoscopy	MC-optional, WS-standard (Navigator)	MC-WIP, WS-standard
MPR (multi-planar reconstruction)	MC-standard, WS-standard (MPR & MPVR)	MC-standard, WS-standard
Planes available in MPR	Axial, para-axial, sagittal, coronal, oblique, curvilinear	Axial, sagittal, coronal, oblique, curvilinear

Specification comparison

■ Optional features

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Contrast injector	Optional	Optional
Contrast media bolus tracking	Standard (SmartPrep)	Standard (CARE Bolus)
CT fluoroscopy software and hardware	Level 1 standard (level 2 opt.)	Optional (CARE Vision)
Hard-copy imaging device	Optional	Optional
Radiotherapy planning accessories		
Radiotherapy planning table top	Optional (RT flat pad and 'Exact' couch top)	Optional
Carbon fibre breast board	Optional	Info. not available
Means for attaching patient immobilisation devices and a stereotactic frame to the end of the couch	Optional (Exact couch E8505MA)	Optional
Software Packages on main console (MC) and workstation (WS)		
Bone mineral densitometry	MC-N/A, WS-optional (BMD)	MC-optional (Osteo CT), WS-N/A
CT angiography	MC-standard, WS-standard	MC-standard, WS-standard
Dental	MC-optional, WS-optional (Dentascan)	MC-optional (Dental CT), WS-N/A
Radiotherapy CT simulation software	MC-N/A, WS-optional (CT sim)	Available from 3rd party
Prospective ECG-triggered cardiac software	MC-optional, WS-optional (SmartScore)	MC-optional (Heart View), WS-N/A
Retrospective ECG-gated cardiac software	MC-N/A, WS-optional coronary artery imaging (CardIQ)	MC-optional (Heart View), WS-N/A

■ Installation Requirements

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Environmental requirements (max/min temperature, humidity) in scanner room	20-28 °C, 30-60% non-cond. rel. humidity	15-28 °C, rel. air humidity 15-75%
Environmental requirements (max/min temperature, humidity) in scanner control room	20-28 °C, 30-60% non-cond. rel. humidity	15-28 °C, rel. air humidity 15-75%
Peak heat output from system during scanning (kW)	7.1 (75 rot/patient, 4 patient/hour)	13.5
System cooling method	Output to air	Water-Water
Air conditioning requirements for scanner room of minimum floor area	Recommended	None
Minimum floor area required for the system (m ²)	28	25
Dimensions of:		
(i) Gantry (H x W x D (mm)) and weight	1887 x 2230 x 1007, 1350kg	1990 x 2220 x 890, 2100kg
(ii) Couch (H x W x L (mm)) and weight	1120 x 610 x 2387, 335kg	850 x 680 x 2430, 500kg
(iii) Supplementary units (H x W x D (mm)) and weight	Power Unit: 1270 x 762 x 585, 363kg	Power Unit: 1815 x 905 x 800, 550kg Cooling Unit: 1815 x 905 x 860, 200kg
Power supply requirements	3 phase 380-480V, 90kVA	3 phase 380-480V, 66-83kVA

Specification comparison

■ Independent workstation

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Is a workstation provided?	Standard	Standard: LEONARDO
Computer make and model	Sun ultra advantage 80 for 8 slice	Siemens Fujitsu Pentium 4
Operating system	Solaris 2.7	Windows NT
Type and speed (MHz) of CPU	Four 450 MHZ ultra advantage SPARC II	2 x Pentium (at least 850 MHz)
Amount of computer RAM (MBytes):		
(i) supplied as standard	2048	1024
(ii) maximum	2048	1024
Total hard disk storage capacity (Gbytes):		
(i) supplied as standard	72	Minimum 36
(ii) maximum	72	Currently 36
Archive options	CD-R/W	CD Rom (Standard), MOD (optional)
Capacity of a single archive disk (Gbytes)	0.644	MOD: 4.1 (26,000 losslessly compressed images), CD-R: 0.65 (4800 compressed images) 256 x 256 matrix
Environmental requirements (max/min temperature, humidity) for workstation	10-40 °C, 20-80 % rel. non-cond. humidity at 40 °C	15-30 °C, 20-85% rel. humidity

■ Image transfer and connectivity

	GE LightSpeed Ultra Advantage	Siemens Sensation 16
Speed of scanner/workstation connections to local area networks (Mbits/s)	100	100
Remote PC access to images on workstation	Optional	Optional
DICOM service classes provided by CT console (SCP and SCU)	Storage SCU and SCP and query/retrieve. Modality worklist (opt.), performed procedure step(opt.)	Storage SCU and SCP, query/retrieve, print, modality worklist
DICOM service classes provided by Independent workstation (SCP and SCU)	Storage SCU and SCP, query/retrieve SCU, print, media interchange	Storage SCU and SCP, query/retrieve, print

Appendix 1: ImPACT and the MDA

■ Background

One of the roles of the Medical Devices Agency (MDA) is to fund evaluation programmes for medical devices and equipment. The programme includes evaluation of x-ray Computed Tomography Equipment currently available on the UK market.

MDA aims to ensure that evaluation techniques keep abreast of improvements in CT imaging performance and that MDA reports present evaluation information that is timely, useful and readily understood.

■ ImPACT

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

ImPACT have 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.

Members of ImPACT contributing to and writing this report: N. Keat, M. A. Lewis, J. F. Barrett and S. Edyvean (ImPACT Group Leader).

■ ImPACT and MDA 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
Tel: 020 8725 3366
Fax: 020 8725 3969

email: impact@impactscan.org

web site: <http://www.impactscan.org>

MDA contact point for general information on the CT evaluation programme:

Debbie Smith
Programme Manager
Room 1207, Hannibal House
Elephant and Castle
London SE1 6TQ
Tel: 020 7972 8155
Fax: 020 7972 8105

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