North Carolina Department of Health and Human Services
Division of Health Service Regulation

Pat McCrory
Governor

Aldona Z. Wos, M.D.
Ambassador (Ret.)
Secretary DHHS

Drexdal Pratt
Division Director

April 30, 2015

Elizabeth Kirkman
Assistant Vice President, CHS Management Company
2709 Water Ridge Parkway, Suite 200
Charlotte, NC 28217

Exempt from Review - Replacement Equipment

Facility:	Carolinas Medical Center-University (CMC-University)
Project Description:	Acquisition of Replacement of CT Scanner
County:	Mecklenburg
FID #:	923516

Dear Ms. Kirkman

The Healthcare Planning and Certificate of Need Section, Division of Health Service Regulation (Agency), determined that based on your letter of April 22, 2015, the above referenced proposal is exempt from certificate of need review in accordance with G.S 131E-184(a)(7). Therefore, you may proceed to acquire, without a certificate of need, the Siemens SOMATOM Definition AS CT Scanner to replace the existing Siemens Sensation 64 CT Scanner. This determination is based on your representations that the existing unit will be removed from North Carolina and will not be used again in the State without first obtaining a certificate of need.

Moreover, you need to contact the Agency's Construction and Acute and Home Care Licensure and Certification Sections to determine if they have any requirements for development of the proposed project.

It should be noted that the Agency's position is based solely on the facts represented by you and that any change in facts as represented would require further consideration by this office and a separate determination. If you have any questions concerning this matter, please feel free to contact this office.

Sincerely,

Fatimah Wilson
Project Analyst

Martha J. Frisone,
Assistant Chief, Certificate of Need

cc: Acute and Home Care Licensure and Certification Section, DHSR
Construction Section, DHSR
Assistant Chief, Healthcare Planning
Radiation Protection Section, DHSR

Carolinas HealthCare System

Edward J. Brown III
Chairman

Michael C. Tarwater, FACHE
Chief Executive Officer

Joseph G. Piemont
President & COO

April 22, 2015

Ms. Martha Frisone, Assistant Section Chief
Healthcare Planning and Certificate of Need Section
Division of Health Service Regulation
N.C. Department of Health & Human Services
809 Ruggles Drive
Raleigh, NC 27603

RE: Replacement of CT Scanner licensed under The Charlotte-Mecklenburg Hospital Authority d/b/a Carolinas Medical Center-University.

Dear Ms. Frisone:

Carolinas Medical Center-University (CMC-University) is planning to replace one of its existing CT scanners with new, technologically comparable equipment. CMC-University intends to purchase a Siemens SOMATOM Definition AS CT scanner to replace a 10 year-old Siemens Sensation 64 CT scanner currently located at CMC-University. The existing equipment is near the end of its useful life and is at risk for service interruptions due to downtime.

The Siemens SOMATOM Definition AS unit will be used for the same types of procedures as the existing equipment and it will not be used to provide a new health service. A chart comparing the existing equipment and the replacement equipment is included in Attachment A along with supporting documentation. The equipment is currently in use and documentation provided in Attachment B indicates 16,937 procedures were performed from January 2014 through December 2014.

The total cost to acquire, install, and make operational the replacement equipment is $1,011,030 which includes construction costs of $260,000, architecture and engineering fees of $34,300, equipment costs of $661,730 ($620,000 for the CT scanner, $11,280 for freight, and $30,450 for sales tax), and other fees of $55,000. Attachment C provides the quote for the CT scanner from Siemens with equipment costs. Please see Attachment D (and the Trade-In Addendum to the

Quote in Attachment C) for a letter documenting the equipment will be taken out of service and removed from North Carolina. The total capital cost schedule and certified cost estimate of the renovation required to install the new equipment are provided in Attachment E.

The North Carolina Certificate of Need statutes provide a definition of replacement equipment in N.C.G.S. 131E-176(22a). The definition requires the replacement equipment be comparable to the existing medical equipment and cost less than $2.0 million when installed. The statutes further provide in 131E-184(a)(7) an exemption from certificate of need review for replacement equipment projects if prior notice is provided to the CON Section.

This letter serves as prior notification of our intent to proceed with this project. We would appreciate your written concurrence that this project is exempt from CON review. If you have any questions or require further information regarding this project, please contact me at 704-446-8475.

Sincerely,

Elizabeth Kirkman

Elizabeth Kirkman, Assistant Vice-President
CHS Management Company

Attachments

Attachment A

Comparison of Existing and Replacement Equipment

EQUIPMENT COMPARISON

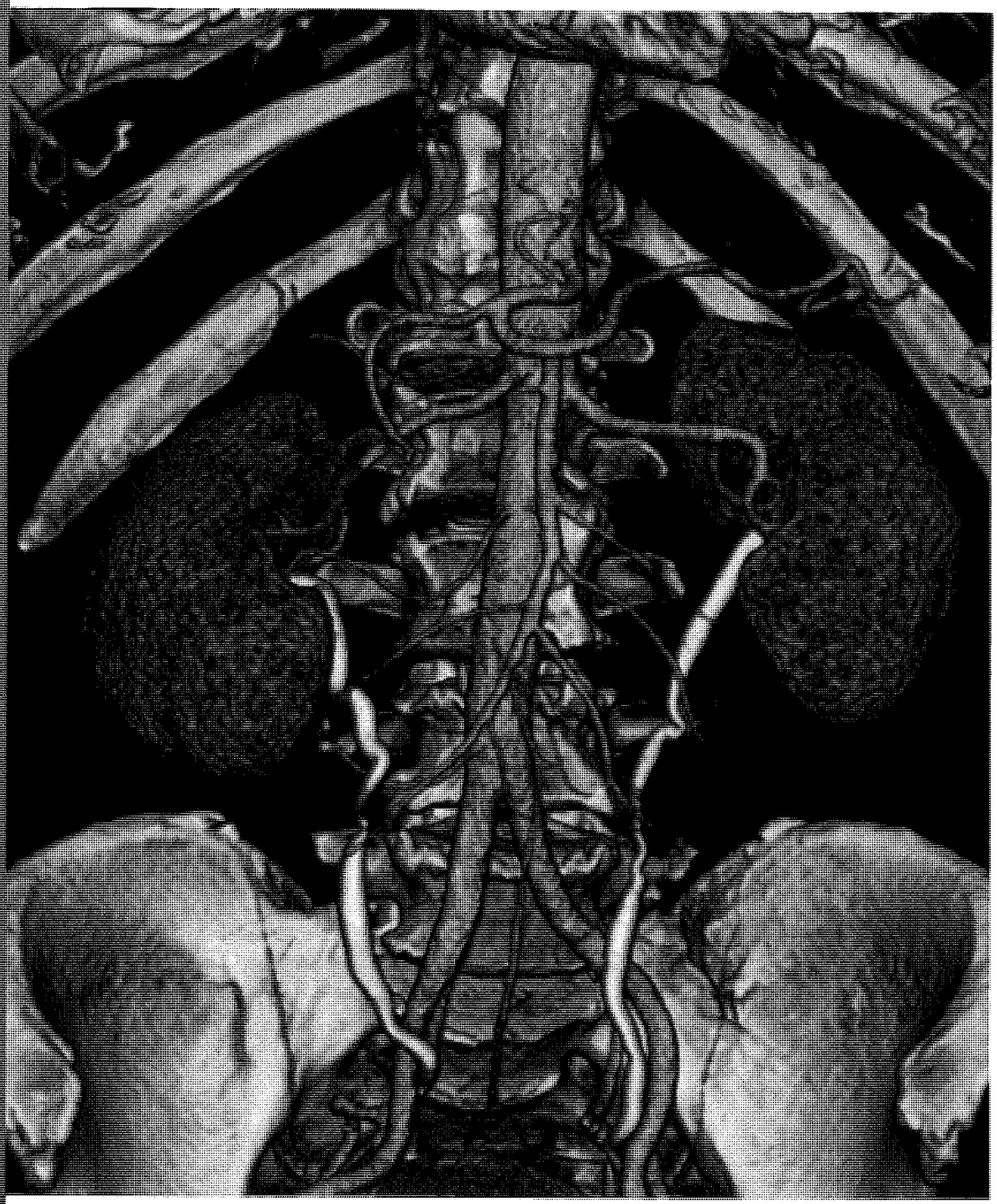
	Existing Equipment	Replacement Equipment
Type of Equipment (List each component)	SOMATOM Sensation 64	SOMATOM Definition AS
Manufacturer of Equipment	Siemens	Siemens
Tesla Rating for MRIs	N/A	N/A
Model Number	8377520	14440593
Serial Number	54445	Not Available Until Installed
Provider's Method of Identifying Equipment	CHS Asset # / Serial #	CHS Asset # / Serial #
Specify if Mobile or Fixed	Fixed	Fixed
Mobile Trailer Serial Number/VIN #	N/A	N/A
Mobile Tractor Serial Number/VIN #	N/A	N/A
Date of Acquisition of Each Component	August 2005	November 2015
Does Provider Hold Title to Equipment or Have a Capital Lease?	Title	Title
Specify if Equipment Was/Is New or Used When Acquired	New	New
Total Capital Cost of Project (Including Construction, etc.) <Use Attached Form>	$1,480,000	$1,011,030
Total Cost of Equipment	$1,350,000	$661,730
Fair Market Value of Equipment	$200,000	N/A
Net Purchase Price of Equipment	$1,350,000	$661,730
Locations Where Operated	8800 N Tryon Street, Charlotte, NC 28262	8800 N Tryon Street, Charlotte, NC 28262
Number Days in Use/To Be Used in N.C. per Year	365	365
Percent of Change in Patient Charges (by procedure)	None	None
Percent of Change in Per Procedure Operating Expenses (by procedure)	None	None
Type of Procedures Currently Performed on Existing Equipment	Abdomen/Pelvis Cardio/Vascular Chest Neuro MSK	N/A
Type of Procedures New Equipment is Capable of Performing	N/A	Better Cardiac, Low Dose Lung screening and overall radiation dose reduction in all exams performed.

No. 14/June 2004
Stanford University's
6th Annual International
Symposium on
Multidetector-Row CT
June 23–26, 2004

SOMATOM Sessions

www.siemens.com/medical

Highlights



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SIEMENS
medical

Richard Hausmann, PhD,
President CT Division

Dear Reader,

Advances in patient- and user-friendliness as well as clinical excellence have always been our goals at Siemens Medical Solutions' Computed Tomography Division. With the development of the SOMATOM® Sensation 64, we responded directly to the needs of our clinical users, and have established new benchmarks in image quality, resolution and speed. The SOMATOM Sensation 64's unmatched resolution provides a level of detail that we expect will open up entirely new applications for CT technology, proving that Siemens is once again pushing forward the boundaries and capabilities of medical imaging.

The first clinical results, which we are introducing in this issue of SOMATOM Sessions, are impressive. The new system delivers optimal image quality in cardiac, neurology and body imaging applications with a spatial resolution of 0.4 millimeter – within a few seconds. Read our Cover Story and the medical examples in our Clinical Outcomes section to learn more about the SOMATOM Sensation 64's outstanding technology and clinical capabilities.

With the last issue, we changed the SOMATOM Sessions into a news magazine on the world of computed tomography. Your resounding positive response is encouraging to our authors and Editorial Board. We are looking forward to more comments and feedback on this issue – and for your contributions and topic suggestions for future issues.

Enjoy reading.

Yours sincerly,

Richard Hausmann, PhD

COVER STORY

NEWS

BUSINESS

CLINICAL OUTCOMES

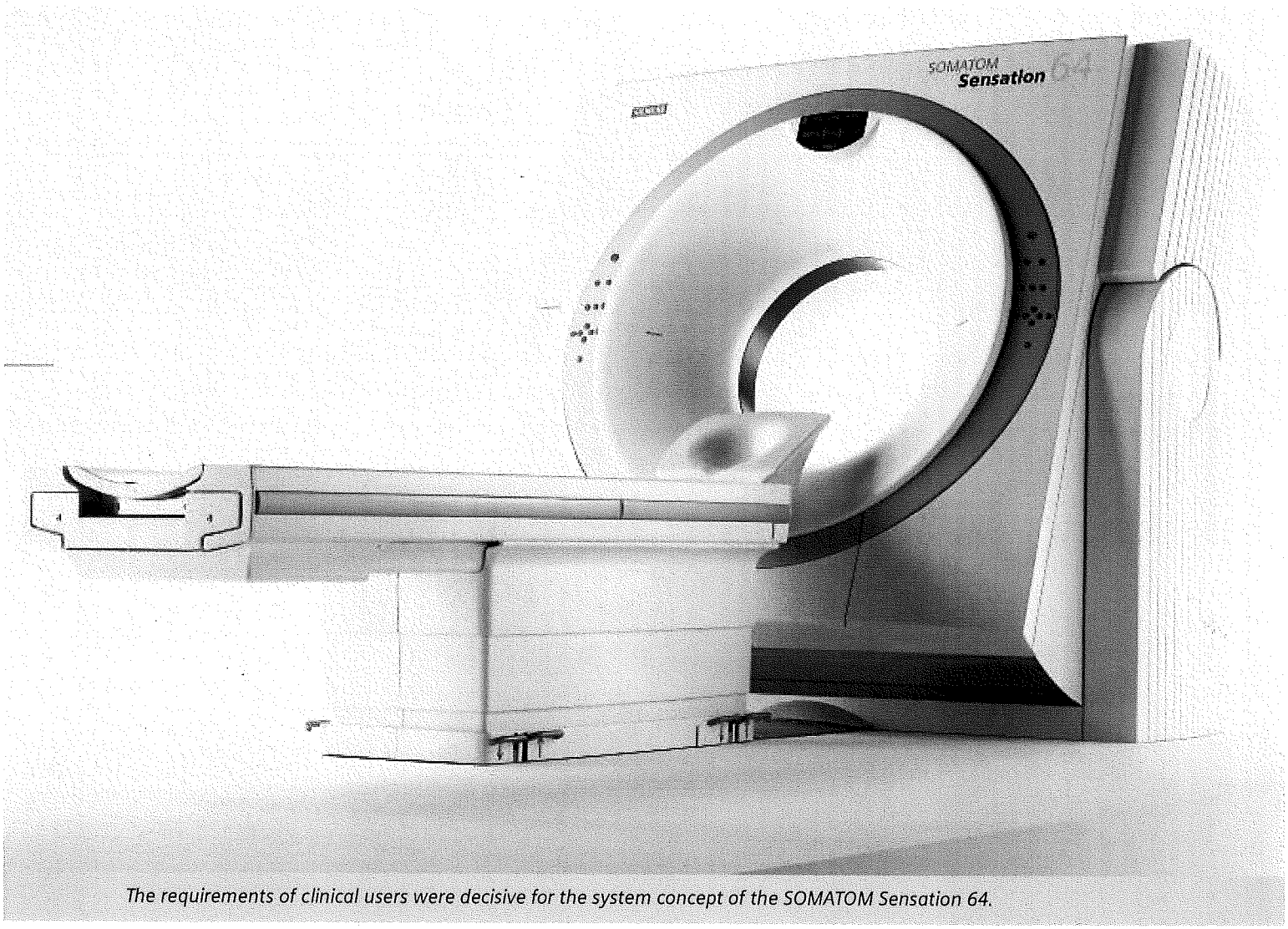
SCIENCE

CUSTOMER CARE

Unprecedented Detail, Speed and Image Quality

With the SOMATOM Sensation 64 Siemens Medical Solutions, the leader in computed tomography innovation for 30 years, once again sets the industry's benchmark for diagnostic excellence.

By Alexander Zimmermann, Global Product and Marketing Manager SOMATOM Sensation, & Doris Pischitz, Media and Public Relations, Siemens AG, Medical Solutions, CT Division



The requirements of clinical users were decisive for the system concept of the SOMATOM Sensation 64.

Today's physicians expect the latest CT technology to significantly increase the visualization of finest details while outperforming the highest volume coverage and acquisition speed already known with 16-slice scanners. The new SOMATOM Sensation 64 and its Siemens' exclusive leading-edge technology perfectly meets – and often exceeds – these expectations. It accomplishes acquisition of 64 sub-millimeter slices per rotation and allows physicians to routinely achieve unprecedented diagnostic detail with the industry's best isotropic resolution of 0.4 millimeter. Combined with the industry's fastest rotation speed of 0.33 seconds, the SOMATOM Sensation 64 routinely provides unmatched image quality through unprecedented temporal and spatial resolution. This image quality allows the display of the smallest intracranial, pulmonary, mesenteric, renal and peripheral vessels, as well as the detailed visualization of the entire coronary artery tree. In addition, it redefines CT plaque analysis and in-stent evaluation.

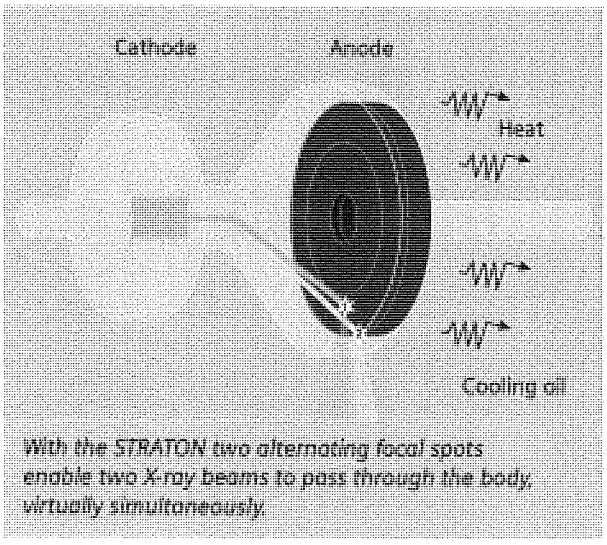
"Siemens has consistently taken the lead in the development of the most advanced CT innovations. Specifically, customer demands for more accurate and faster CT imaging have been addressed," said Richard Hausmann, PhD, President, CT Division, Siemens Medical Solutions. "The SOMATOM Sensation 64 establishes the new benchmark for diagnostic excellence and clinical workflow."
Recently introduced conventional 40- and 64-slice CT scanners simply increase the number of detector elements, resulting in higher scan speed without any increase in resolution. The SOMATOM Sensation 64 utilizes Siemens' lastest, exclusive technologies: the unique STRATON® X-ray tube, the revolutionary z-Sharp™ Technology and the cutting-edge UltraFastCeramic (UFC™) detector system. These leading-edge technologies enable both, increasing the number of detector elements necessary for high volume coverage and attaining previously unachieved 0.4 millimeter spatial resolution.

Unique STRATON X-ray tube

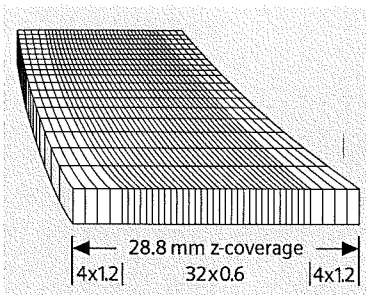
Conventional X-ray tubes utilize a rotating anode placed in a vacuum. This results in poor heat exchange between the anode and the cooling oil outside the vacuum. The end effect of this inefficient oil/vacuum interface is a slow cooling rate, anode heat buildup, and the need for large anodes capable of storing high amounts of heat. Instead of increasing the size of the tube's anode to compensate for the problem of inefficient heat transfer, the unique STRATON uses a directly cooled anode. The tube's – especially the anode's – direct contact with the cooling oil enables an extremely high, previously unmatched cooling rate of five Million Heat Units (MHU) per minute. Cooling delays experienced with conventional X-ray tubes during multiple long-range scans are eliminated, even for large patients. The revolutionary, high cooling rate eliminates the need for anode heat storage capacity – leading to 0 MHU. In addition, it allows for a compact anode design which is the key to the industry's fastest CT rotation time of 0.33 seconds. This enables, for instance, superb cardiac image quality without motion artifacts even at higher heart rates.

Revolutionary z-Sharp Technology

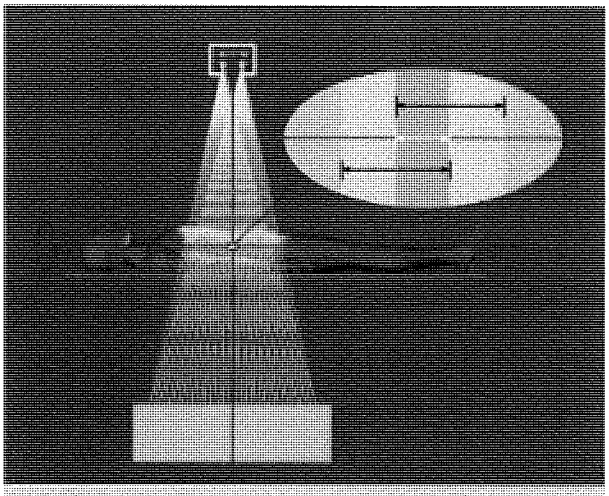
Acquisition of 64 slices per rotation is possible through the new STRATON X-ray tube's Double z-Sampling Technology, and the new Siemens proprietary detector technology. The STRATON's electron beam is accurately and rapidly deflected by an electromagnetic field, similar to a cathode-ray tube. Two focal spots are created on the anode plate that alternate precisely 4,640 times per second in the z-direction. This Double z-Sampling enables two X-ray beams to pass through the body in two different angles, virtually simultaneously. This



With the STRATON two alternating focal spots enable two X-ray beams to pass through the body, virtually simultaneously.



Siemens' proprietary adaptive array detector system with 0.6 and 1.2 millimeter collimation, shown at the center of rotation.



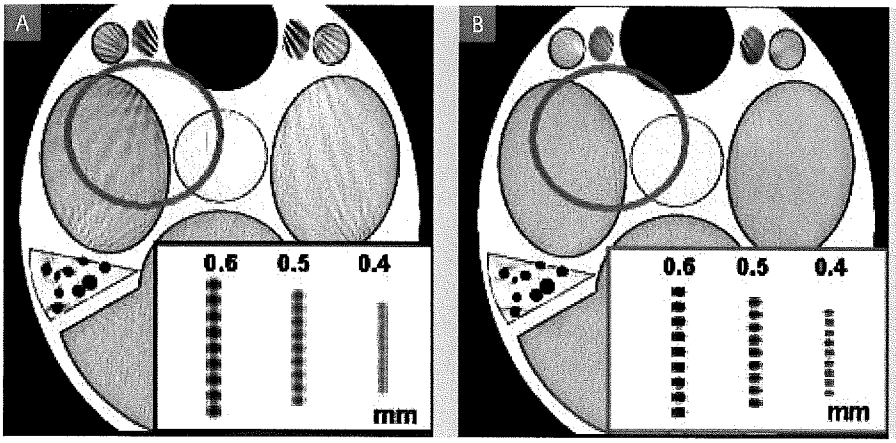
The focal spot moves between two z positions. Every two 32-slice projections are combined to form one 64-slice projection with 0.3 millimeter sampling distance.

STRATON technology doubles the X-ray projections reaching each detector element. The two overlapping projections result in an oversampling in z-direction. The resulting measurements interleave half a detector slice width, doubling the scan information. Siemens' proprietary, high-speed UFC detector enables a virtually simultaneous readout of two projections for each detector element – 2 x 32 slices for every viewing angle – resulting in a full 64-slice acquisition. Compared to conventional CT acquisition technology, each measurement requires half the time and half the dose.
Double z-Sampling provides visualization of 0.4 millimeter isotropic voxels with a corresponding elimination of spiral artifacts in all routine scan modes – at any spiral pitch.
The STRATON enabled Double z-Sampling Technology and Siemens' proprietary detector compose the so-called z-Sharp Technology – designed to see the difference.

Benchmark for Diagnostic Excellence

The requirements of clinical users were decisive for the system concept of the new 64-slice CT. While the image acquisition time of the SOMATOM Sensation 16 excellently meets the required speed for examinations with greater slice thickness, it remained a challenge to find an ideal balance between large volume coverage and resolution for sub-millimeter imaging, neccessary, for example, for cardiovascular and neurology examinations. First clinical experience shows that the new 64-slice technology can, for the first time, cover large scan areas with highest resolution of 0.4 millimeters, thus enabling a more precise physicians' diagnosis even of smallest changes. Just one example: up to now, evaluation of the coronary lumen inside stents was hampered by partial volume artifacts related to their smal size, and by motion artifacts due to coronary motion. The SOMATOM Sensation 64 solves these two issues: its gantry rotation speed of 0.33 seconds leads to a higher temporal resolution, which in turn allows cardiac imaging without motion artifacts even in patients with higher heart rates. "Due to its speed, the SOMATOM Sensation 64 stands alone in its ability to image the finest cardiac structures in detail without motion artifacts, even in those patients with higher heart rates," says Hausmann. With Double z-Sampling Technology, the 0.4 millimeter isotropic resolution preventing partial volume artifacts is possible without increasing dose. These features allow artifact-free evaluation of coronaries and follow-up assessment of stent patency with a high diagnostic confidence.

Prevention of artifacts by z-Sharp's Double z-Sampling Technology also facilitates neurology examinations. The technology, without imposing restrictions to pitch, eliminates windmill-artifacts that originate when the X-ray beam penetrates the edges of bones. Up to now, windmill-artifacts often occurred in spiral CT examinations of the head, for example in CT angiography examinations for aneurysms, of the neck and of the thorax. CTAs of the carotid arteries and the circle of Williis can now be routinely performed at a pitch of 1.5, leading to a scan time of only five seconds for 360 millimeter volume coverage with 0.4 millimeter isotropic resolution – a CTA in the pure arterial phase.

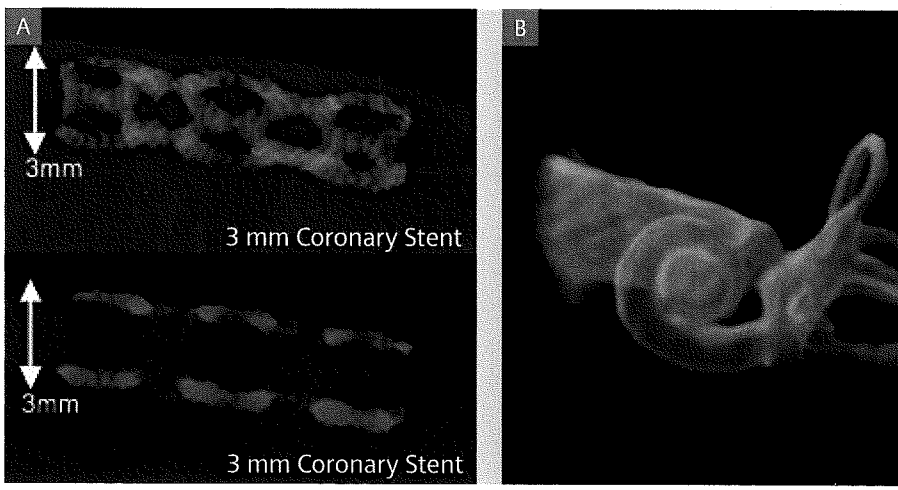


[A] *Conventional 64 x 0.6 mm (0.5 s, pitch 0.7, 150mAs, table feed 27 mm/rotation).*

[B] *Siemens 64 x 0.6 mm with z-Sharp Technology (0.5 s, pitch 1.5, 150 mAs, table feed 28 mm/rotation).*

High speed plus high resolution also leads to benefits in emergency situations. "The SOMATOM Sensation 64 has the potential to change the way chest pain of unclear origin is examined in the emergency room," says Bernd Ohnesorge, PhD, Vice President Marketing and Sales, CT Division, Siemens Medical Solutions. It is now possible to examine heart and lung in one scan for exclusion of, for example, pulmonary embolism or aortic dissection, and coronary artery stenosis. A few seconds are sufficient for a ECG-gated scan of the complete thorax. The physician with this one scan receives image data that can be analyzed for several possible causes of chest pain. The increased speed also facilitates data acquisition for other patients who have difficulty holding their breath, such as elderly or pediatric patients.

Together, all these innovations allow physicians to take full advantage of unprecedented image detail, quality and speed with the SOMATOM Sensation 64. After a comprehensive clinical testing phase, the system will be available as Siemens Medical Solutions' new CT flagship model beginning in the fall of 2004.



[A] *The SOMATOM Sensation 64 redefines follow-up of stent patency.*

[B] *New areas of unprecedented anatomical details can be monitored.*

Courtesy Institute of Diagnostic Radiology/Institute of Medical Physics, Friedrich-Alexander-University Erlangen-Nuremberg, Germany

Interview

"Now We Can See the Smallest of Details"

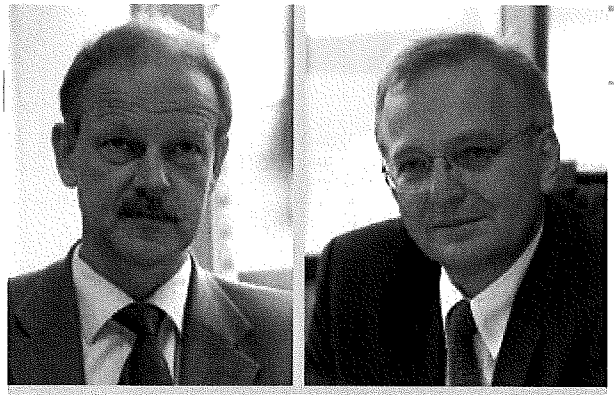
The first SOMATOM Sensation 64 is operated jointly by the Institute of Medical Physics and the Institute of Diagnostic Radiology at Friedrich-Alexander University Erlangen-Nuremberg. SOMATOM Sessions talked to the institutes' directors, Professor Willi A. Kalender, PhD, and Professor Werner Bautz, MD, about their first experience with the new system.

What did you expect from the SOMATOM Sensation 64?
BAUTZ: Actually we were very satisfied with our SOMATOM Sensation 16. For example, we would not have needed faster volume coverage, as today's 16-slice scanners already need a very refined bolus tracking in order not to overtake it. But to achieve a confident diagnosis, you always look for the highest isotropic resolution to visualize anatomical details. Here, the SOMATOM Sensation 64 offers true clinical advantages, particularly in resolution along the z-axis. Also, due to it's fast gantry rotation, it eliminates any motion artifacts.

How satisfied are you with the image quality of the SOMATOM Sensation 64?
BAUTZ: It is excellent. The system pushes temporal and spatial resolution to a new level , achieving previously impossible image quality. Besides this impressive image quality, casual spiral artifacts known from any CT I have seen so far are also gone.

Which clinical advantages, compared to a 16-slice CT, does the SOMATOM Sensation 64 offer? Which applications profit primarily from 0.4 millimeter isotropic resolution and 0.33 seconds gantry rotation speed?
BAUTZ: The SOMATOM Sensation 64's imaging quality, sharpness and speed gives us the opportunity to study the human anatomy at a level that has only been dreamt about. Through the eyes of the scanner, we now can image smallest pathology which may, for example, improve early diagnosis and treatment options. CT angio examinations show a lot more detail, and this is true for cranial, cardiac, thorax, and abdominal studies. We can run true arterial phases, for example of the carotis, without running into the venous phase. Also, we experience a significant reduction of spiral artifacts in the head, so the SOMATOM Sensation 64 greatly improves brain and neuro exams. We do not examine a lot of inner or middle ears, but from what we have reconstructed so far – based on cranial CT angio scans – the high isotropic resolution will also improve diagnosis there.
KALENDER: I would also expect improvements in bone structure exams for osteoporosis, and in examinations of the joints.

With the SOMATOM Sensation 64, Siemens introduces the new z-Sharp Technology: a focal spot that alternates along the patient's axis, which is the key for 0.4 millimeter isotropic resolution. What are the advantages, compared to a conventional 64 slice CT?
KALENDER: I think that the introduction of the new z-Sharp Technology is comparable to the invention of multi-slice CT. Conventional 64-slice solutions increase the number of detector elements, resulting in a larger z-coverage without any improvements in image quality. Instead, z-Sharp Technology's two overlapping X-ray beams improve the sampling rate, resulting in a significantly increased resolution and elimination of CT typical spiral artifacts. This innovative concept guarantees excellent image quality independent of the pitch value and without any increase in dose.



Professor Willi A. Kalender, PhD (l.), and Professor Werner Bautz, MD (r.), were the first to gather clinical experience with the SOMATOM Sensation 64.

Slices of 0.4 millimeter also lead to more raw data. How do you handle it?

BAUTZ: There are two aspects: the acquisition of scan data itself and the generation of diagnostic images. The combination of 0.4 millimeter imaging and 0.33 seconds rotation time allows us to routinely utilize high resolution even for large scan ranges, resulting in more raw data. However, the new software WorkStream4D™ allows us to utilize Siemens' 64-slice capabilities of increased detail while decreasing the axial data set size compared to a 16-slice CT. As part of the standard scan protocol, we can now directly generate sagittal, coronal, or double-oblique diagnostic images with full resolution. This immediate availability of images in any desired slice plane significantly reduces the amount of thin slice axial data and saves time.

With the SOMATOM Sensation 64, the resolution and the number of slices increased. Does patient dose increase as well?

KALENDER: No, instead of decreasing the detector elements size to increase the resolution, Siemens utilizes the already mentioned z-Sharp Technology. It simply does not require more dose to read out the detector slices twice. The radiation is there anyhow, it is now just utilized differently. The result is increased resolution, without paying the price of the smaller detector rows and its correspondent increase in dose.

What additional staffing and training issues were required?

KALENDER: Hardly any – thanks to *syngo*, Siemens' multimodality user interface.

BAUTZ: Beside the introduction of the new reconstruction platform for the direct generation of diagnostic images in arbitrary planes, the user interface indeed did not change. We experienced a seamless migration from the 16-slice CT to the new 64-slice solution. Beside the fact that we had to make the new reconstruction platform clear to ourselves, we recognized that the contrast injection timing was an area where we had to gather some experience to perfectly utilize the increased scan speed offered by the scanner. A new dose automation called CARE Dose4D helps us to further reduce the complexity of our scanner. The software provides us with a fully automated and real-time anatomy based dose regulation, resulting in a simplified workflow without the need of individual protocol optimization. We are using the time saved on the acquisition to explore the new range of clinical applications the scanner has to offer. The tendency also goes towards multiphase protocols with diagnostic advantages in, for example, liver tumors. Looking at the clinical workflow, the speed of the SOMATOM Sensation 64 greatly simplifies this.

What productivity efficiencies have been realized thus far?

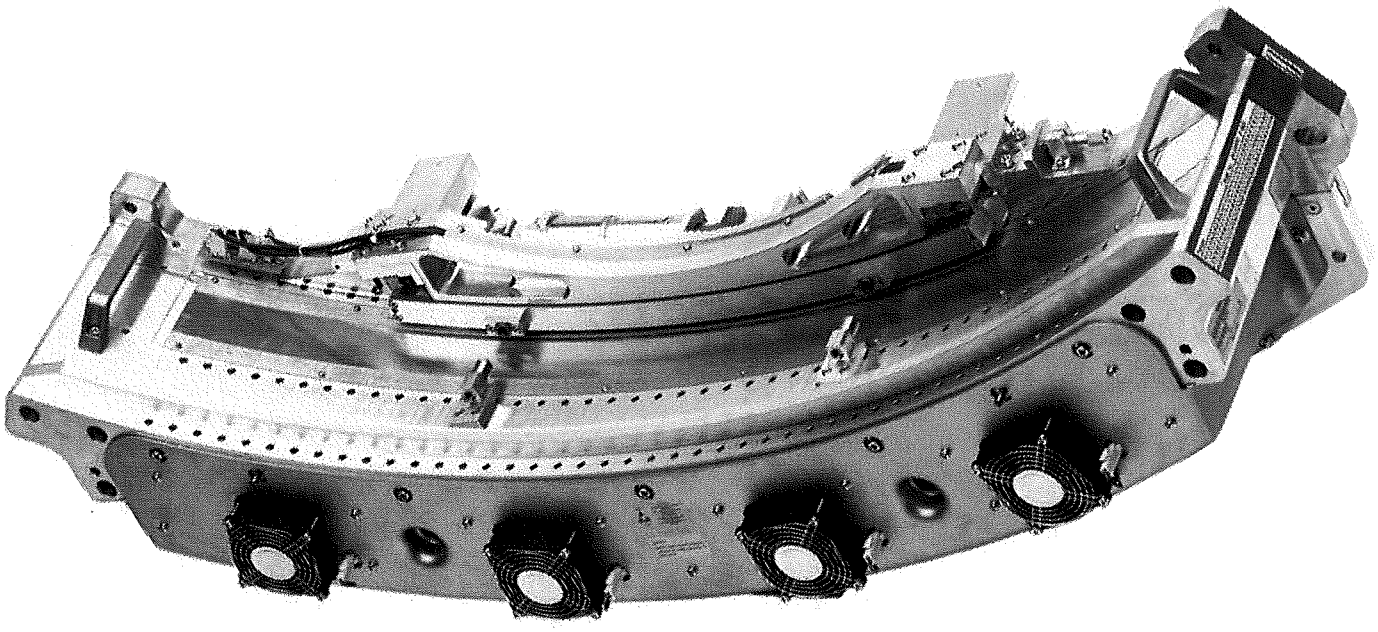
BAUTZ: With its routine 0.33 seconds gantry rotation, the system provides up to 87 millimeters table feed per second with sub-millimeter collimation. Thus, isotropic 0.4 millimeter resolution goes hand in hand with considerably reduced scan times, increasing patient throughput, facilitating examination of patients with limited ability to co-operate and reducing the amount of contrast material needed. A CT-Angio of the supra-aortic vessels requires only five seconds scan acquisition time for a scan range of 350 millimeter. For the first time, true arterial phase imaging of the entire carotid artery and the circle of Willis can be performed with 0.4 millimeter spatial resolution.

CT DETECTOR KNOW-HOW

How Ceramic and Electronics become Medical Technology

A giant leap for CT: cutting-edge electronics and detector material UFC, developed by Siemens, provide the basis for the world's first 64-slice computed tomography system.

By Tim Schröder



Complete Detector System of the SOMATOM Sensation 64 Computed Tomography System

Computed Tomography (CT) systems are one of the pillars of modern medicine, providing reliable diagnostic images within a few seconds. Siemens alone has nearly 10,000 systems installed worldwide and the demand continues. Multi-slice CT technology introduces a host of new clinical applications, for example, for cardiac imaging or CT colonography. X-ray tubes as well as detector systems are key differentiation criteria in the CT market. Developments that carry far into the future assure Siemens' market position of innovation leader in CT. One of the objectives is to further enhance Siemens' top-level competence in the development and manufacturing of detector arrays in order to be able to offer Siemens-own, innovative, and cost-effective solutions.

The important core components of a CT system, the X-ray

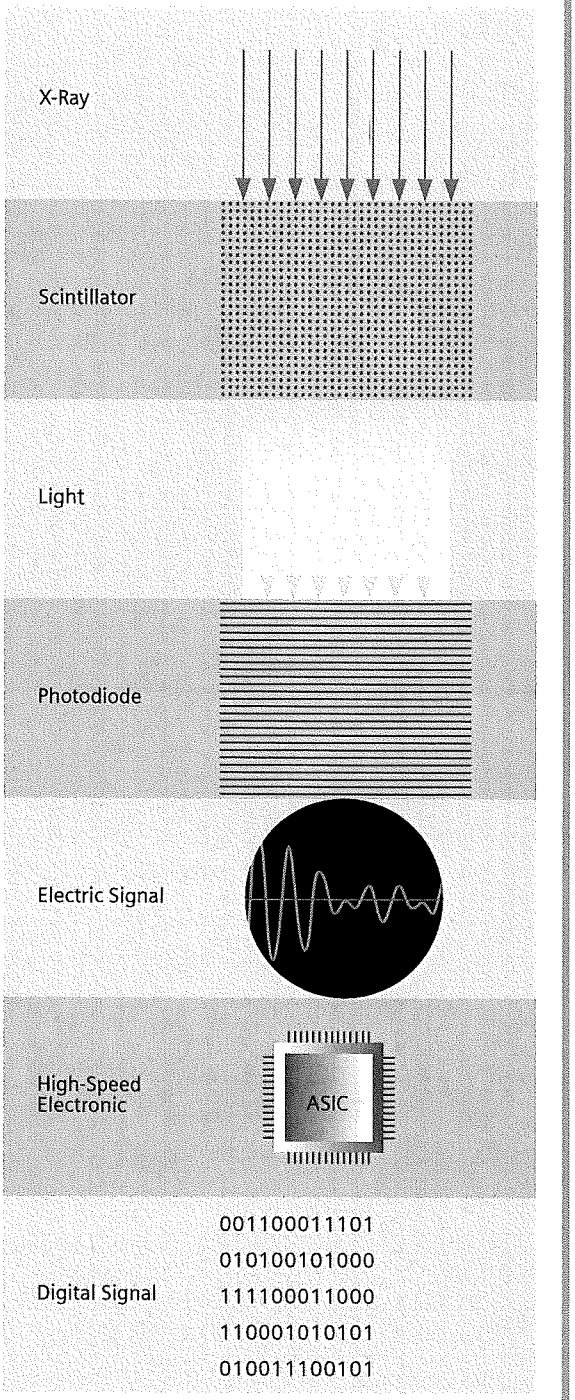
tube and the detector system, are located opposite one another in a ring measuring 1 1/2 meters in diameter. This ring is known as the gantry. The level of performance obtained by a CT detector is a function of the actual X-ray detector and the electronics that convert the X-ray generated electrical pulses in the detector into image data.

In Forchheim, Germany, Siemens develops, tests and manufactures all these core components under one roof. From cost-optimized single-slice systems like the SOMATOM Smile up to the latest high-end performance system SOMATOM Sensation 64, all Siemens CT systems are equipped with these detectors.

One of the most important results obtained through this bundling of competencies is the special detector material, the scintillator, the quality of which considerably outdistances conventional mixtures. A CT detector basically consists of several components. The scintillator mentioned above, converts the radiation into light signals. The photodiodes, located directly beneath it, 'catch' the fluorescent light and process it into electric pulses. These signals are transmitted via numerous electrical channels and finally processed into an image (refer to box). The more efficient the detector is in converting the radiation, the less dose is required. For this reason, detector materials have to be as effective as possible in absorbing X-ray quanta and converting them into light signals. The detector material developed by Siemens Medical Solutions meets these requirements exceptionally well. Additionally, the detector ceramic manufactured by the CT specialists is extraordinarily fast. It reacts within fractions of a second to changes in the radiation attenuation caused by the patient. This is an important factor, for example, when the gantry rotates around the patient in less than half a second and the X-ray beam penetrates first soft tissue and then bone. Soft tissue allows more radiation to pass through, whereas bone tissue absorbs X-ray quanta. A CT image shows this transition as a light-dark contrast. The brilliance of the image depends directly on the detector material, because each substance has some afterglow, that is, fluorescent light is emitted longer than required. For sharp contrast between soft tissue and bone, the afterglow has to be as short as possible. Just as the radiation is reduced abruptly at the transition from soft tissue to bone, afterglow of the detector is to cease instantly. If not, sharp transition between tissue types of different densities is smeared. In other words,

Transforming X-rays

Scintillator, photodiode and electronic board are transforming radiation into digital signals.



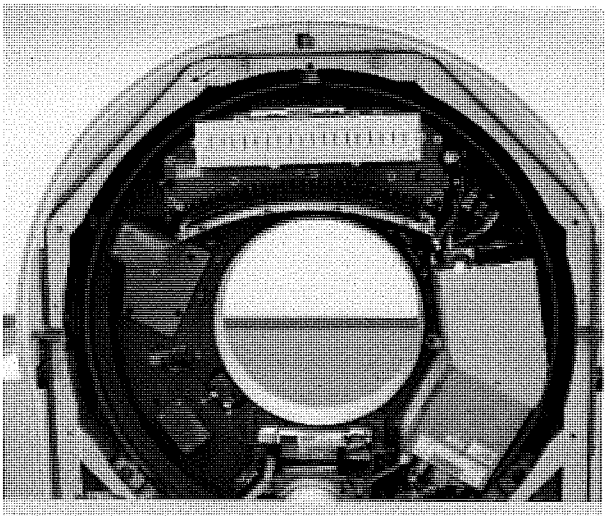
the shorter the afterglow, the sharper the image. This is the only way to achieve gantry rotation times of 0.33 seconds.

UFC is almost as valuable as gold

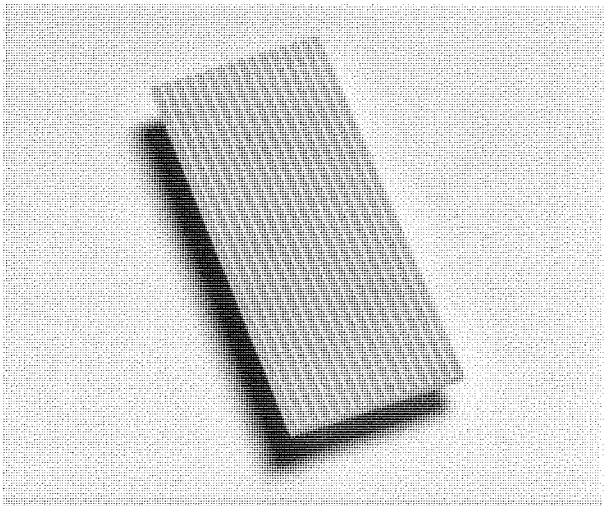
The afterglow of the detector material developed in Forchheim decays 400 times faster than yttrium gadolinium oxide (YGO) used for some time now by competitors in the CT field. This is the reason why the Siemens developer called their ceramic UFC – UltraFastCeramic. How to produce it, remains the secret of Siemens' scientists. "It's the same as with Coca Cola", says Thomas von der Haar, PhD, Head of CT Detector Development at Siemens Medical Solutions. "The ingredients are known, but aside from the manufacturer, nobody really knows the full recipe." One thing is known for sure: aside from the rare earth element gadolinium, the UFC ceramic also includes sulfur and other additives. The ceramic material is the result of a process that involves mixing, chemical reduction, sintering and pressing. The end product is a hard, yellow substance that resembles plastic more than it does ceramic and weighs about as much as gold – and is just about as valuable. Only a few tons of this expensive basic material are needed annually. Since the scintillator material has a significant effect on the characteristics of a computed tomography system, UFC, especially optimized for CT, creates considerable competitive advantages for Siemens Medical Solutions – one of the reasons for the in-house UFC development.

In addition to its minimal afterglow, UFC shows additional advantages: it can be processed with saws and tools from the silicon industry and cut into small, stamp-sized plates – approximately the size of a detector element. Needless to say, highest precision is required for processing. The tolerance range does not exceed a few micrometer. Not without reason: after all, the resolution of a CT system depends on it.

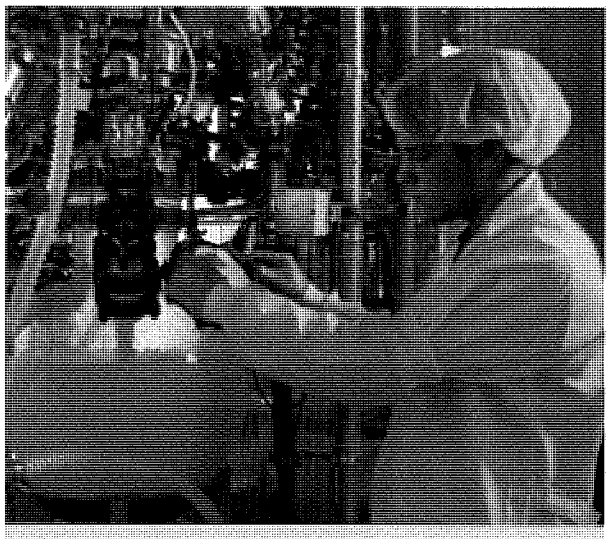
The small UFC plates are structured into a millimeter fine, chessboard-like pattern. The number of detector lines in the chessboard pattern is important. Until a few years ago, computed tomography systems had only one single detector line, which meant that only a single slice could be acquired per rotation. These systems were followed by so-called multi-slice systems. They featured several detector lines located next to each other. During one rotation, several adjoining slices are acquired. As a result, a wider body region can be displayed within the same time period and with improved image quality. This provides the patient with the additional advantage of drastically reduced examination times, an



The detector manufacturing in Forchheim also delivers the detector systems for the production of the SOMATOM Smile in China.



Highest precision in structuring the UFC-plates is of utmost importance because this process significantly affects the resolution of a CT system.



An interdisciplinary team of experts is working in the Detector Center in the area of research, development and manufacturing for detector and data electronics, production process development and management.

The SOMATOM Sensation 16 has a total of more than 10,000 pixels on its 42 detector elements – therefore providing also more than 10,000 transmission channels.

important improvement, considering that, for thorax or heart examinations, the patient has to hold his or her breath to ensure that the image quality is not compromised by movements of the thorax. Breath holding became considerably shorter with multi-slice systems.

One example: the SOMATOM Sensation 16, a 16-slice computed tomography system. Its detector array consists of a total of 42 detector modules. These are located next to each other over a distance of approximately one meter in the gantry. This is wide enough to image a patient from shoulder to shoulder. Each detector module comprises a single 16-row detector plate, including the photodiode layer located underneath it as well as the signal processing electronics. Since the UFC detector layers are divided not only by rows but also by columns, a multitude of single pixels measuring between one to two square millimeters in size result per plate. The 16-row system has a total of more than 10,000 pixels on its 42 detector elements. The signals of these pixels are routed over their own electronic channel.

64-Slice CT

This know-how created the basis for the development of the detector array for the world's first 64-slice computed tomography system – a giant step forward. For one, the z-coverage that can be scanned per rotation is larger. For the other, resolution is increased because the detector chessboard has an even finer grid. Siemens is going to outdistance the competition by more than one-upmanship and maintain its position as a trendsetter in CT development, a role that has been exclusively Siemens' since the seventies.

In its unique CT system design, the new SOMATOM Sensation 64 combines a 40-row multi-slice detector array (32 x 0.6 millimeter detector rows, eight x 1.2 millimeter detector rows) with a special mobile focus – the so-called Double z-Sampling Technology – of the new STRATON X-ray tube.

Having developed this detector for the SOMATOM Sensation 64, are there any remaining challenges? Stefan Pflaum, Head of the Detector Center in Forchheim, explains: "Sure there are. The ultimate goal is to create even larger area detector elements with an acquisition width of approximately 12 cm." This would allow to completely image the human heart with just one single rotation of the gantry. While the UFC technology could handle this easily, the challenge is to integrate and process the growing amount of pixel channels and image information within a small area at reasonable costs. It is clear that CT technology has not reached its limits by far. For Pflaum it is just a matter of time until area detectors become a commercial reality.

Author: *Tim Schroeder is a biologist and former editor of the science section of the Berliner Zeitung. He is now a freelance writer in Oldenburg and publishes his work regularly in scientific journals such as Spektrum der Wissenschaft, Max Planck Forschung and Fraunhofer Magazine.*

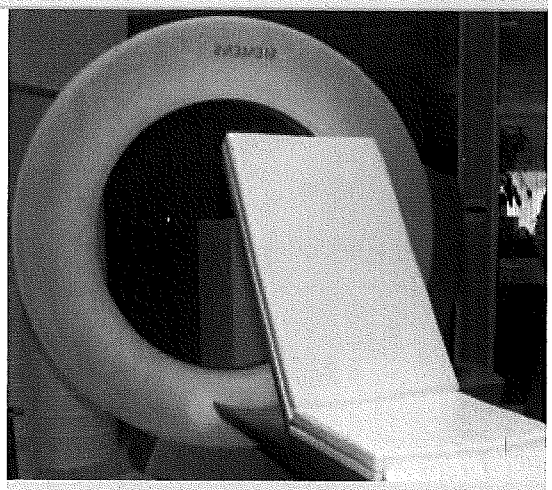
ECR 2004

Introducing the Latest Technology

The European Congress of Radiology grew by another ten percent this year: Over 8000 medical professionals attended the congress and visited the technical exhibition. Siemens Medical Solutions, supporting their status as innovation leaders, took this opportunity to introduce new technologies in CT, from the latest developments in clinical applications to high-end CT scanners. The highlight was clearly the SOMATOM Sensation 64 CT scanner, including Speed4D™ Technology with the STRATON, a revolutionary new x-ray tube that requires no cooling delays, WorkStream4D for workflow optimization, *syngo* InSpace4D™ for evaluation of the moving heart and CARE Dose4D for automated real-time dose adaptation. These components enable utilization of high-end, multi-slice CT technology and integration of advanced imaging applications in daily clinical practice.

Taking the lead in extended applications, Siemens Medical Solutions presented its new *syngo* LungCARE CT NEV (Nodule Enhanced Viewing) application for visualization of small lung nodules. With great success, *syngo* LungCARE CT and *syngo* LungCARE CT NEV headed the Scientific Chest Session with seven out of ten presentations.

In the so called "Matrix" development area of the ECR, Siemens Medical Solutions presented their latest innovative approaches in CT: a plaque lens for cardiac plaque analyses, fast volume acquisition techniques, bone substraction CTA and colon CAD tools for detection of suspicious structures in the colon. These work-in-progress applications are not yet commercially available as products, but nevertheless evoked great interest in visitors.



"The best way to predict the future, is to design it." This design study of future Computed Tomography, shown at the EPOS Area of ECR, is the manifestation of Siemens Medical Solutions' visionary mind-set and additional proof of leadership in innovation.

CT IN CARDIOLOGY

PROCAM Calculator plus CT-Examination Support Treatment of Coronary Events

In collaboration with the International Task Force for Prevention of Coronary Heart Disease, Siemens Medical Solutions supports a refined method for the assessment of a patient's risk for coronary heart disease. It consists of the combined use of the Prospective Cardiovascular Muenster (PROCAM) Calculator and a multi-slice CT examination of the heart to identify individuals at high risk for a future coronary event according to their PROCAM score.

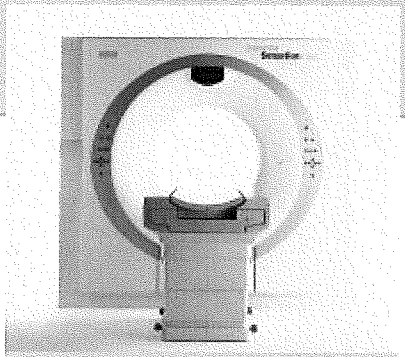
Scientists, led by Professor Gerd Assmann, MD, at the Institute of Arteriosclerosis research in Muenster, Germany, have developed a simple point-scoring scheme that virtually any physician can use to accurately assess his or her patient's risk of suffering a coronary event in a simple calculation. The various factors that contribute to heart attack risk, including age, gender, blood lipids, high blood pressure, family history, smoking and diabetes are taken into account.

Assmann now combines the simple calculator with advanced multi-slice CT technology from Siemens Medical Solutions. Recent studies at the University of Muenster have shown that more than 80 percent of CT-examinations of persons at high risk of a coronary event according to the PROCAM score demonstrate calcified and non-calcified lesions in the coronary arteries. Non-invasive coronary calcium quantification and multi-slice CT angiography for the identification of the so called "vulnerable patient" in the intermediate risk group has also been proposed by a leading international expert panel and the American Association of Eradication of Heart Attack.

Further Information:
www.chd-taskforce.de

SOMATOM Sensation Open

World's First 20-Slice Open CT System



Based on Siemens' new 20-slice technology and with 0.5 second gantry rotation speed, the SOMATOM Sensation Open incorporates the revolutionary, compact STRATON X-ray tube.

As the world's first open 20-slice system, the SOMATOM Sensation Open enables new levels of diagnostic support for CT-based radiation therapy planning, trauma applications, interventional procedures, and imaging of bariatric patients. With an 82 centimeter extended field of view and 82 centimeter large gantry bore, it is designed to facilitate improved patient accessibility and positioning.

One of the first installations of the new system will be William Beaumont Hospital, Detroit, USA. John Wong, PhD, Director of Clinical Physics, explains: "The large bore with the 82 centimeter extended field of view made the SOMATOM Sensation Open particularly attractive to us. And, of course, we are really excited about the STRATON X-ray tube and the benefits it offers in terms of scanning speed and no cooling delays. In fact, with the 20-slice system, we will be able to employ very high resolution CT, such as that in virtual colonoscopy, for target delineation which may help to reduce some of the existing uncertainties."

"The SOMATOM Sensation Open represents a special CT solution that enables faster examinations in acute settings where every second matters, and that can enhance workflow in virtually all applications where patient positioning is a challenge," says Richard Hausmann, PhD, president of CT Division, Siemens Medical Solutions.

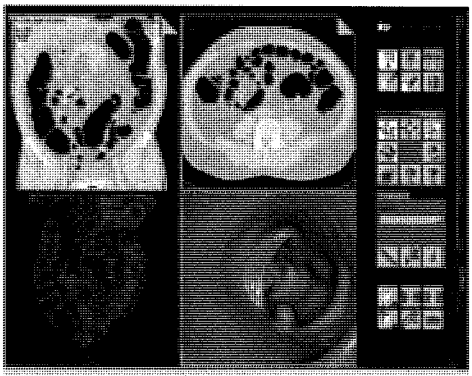
syngo InSpace

New Features

A wealth of exciting new features will be available with the latest version of *syngo* InSpace, including *syngo* InSpace4D. With the 4th – temporal – dimension, it is possible to display the beating heart by playing multiple reconstruction phases as a movie. Anatomy can be examined interactively.

What's more, a number of workflow enhancing tools and features have been implemented. Two studies can be loaded, viewed and compared in parallel. For quick and easy display of data, a broad selection of presets is provided, together with the possibility to define individual default settings, numeric adjustment of the zoom factor, improved handling of regions of interest (ROI) and the possibility to perform 2D measurements in the 3D volume.

Further Information:
www.siemens.com/computed-tomography



syngo Colonography is an affordable and comfortable non-invasive diagnostic tool to locate and evaluate lesions in the colon.

syngo COLONOGRAPHY

Hot Topic – Affordable for Everyone

The early detection of colon polyps and other lesions in the large intestine with subsequent follow-up and appropriate treatment may dramatically increase cure and survival rate of colon cancer [1]. CT colonography can enable early visualization and also plays an important role after incomplete colonoscopy in patients with clinical suspicion of colonic malignancy – not only for evaluation of the colon, but also for the evaluation of extracolonic structures. Siemens Medical Solutions is offering their dedicated colon software, *syngo* Colonography, at a new lower price. For more information on this hot deal or to ask about getting a free 90-day trial for *syngo* Colonography, the local Siemens representative should be contacted.

1 Johnson, CD, Dachmann, AH. CT Colonography: The Next Colon Screening Examination? Radiology 2000; 216: 331-341

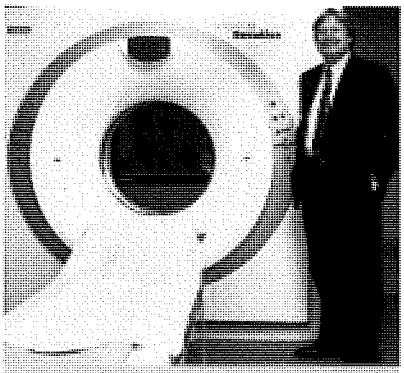
WorkStream

Efficient Workflow and Intelligent Post-Processing with *syngo*-Speaking Workplaces

By Louise A. McKenna, PhD, Global Product Marketing Manager LEONARDO and Workplaces, Siemens AG, Medical Solutions, CT Division

Finding the right workplace solution is essential for any modern radiology environment. In today's world of multi-slice CT, the management of large data sets is the key to workflow efficiency. Not five years ago, the typical CT exam resulted in an average of 200 to 400 images, a meagre number compared to the 1,000 to 1,500 images produced by today's SOMATOM Sensation 16. The SOMATOM Sensation 64 will produce datasets upwards of 2,000 to 2,500 images for a full body scan. These kind of data sets can only be effectively managed electronically. Additionally, the paradigm shift from 2D to volumetric 3D reading drives radiologists to an efficient film-less workflow where fast reconstruction and 3D volume rendering are a must. "Since we have three or less millimeter sections on all studies, interactive 3D viewing is the natural approach to image reporting," says Roman Fischbach, MD, University Hospital Muenster, Germany. Furthermore, innovative workflow tools like WorkStream4D help improve data management by faciliating direct generation of diagnostic images, effectively eliminating the need for time consuming manual reconstruction.

Clinically, the goal posts are constantly shifting and clinical expectations of radiologists, referring physicians and patients have expanded exponentially with recent leaps in CT scanner technology. Not only are advanced clinical applications gaining acceptance in routine radiology, but the need to deliver the right clinical outcome reliably and efficiently means that radiologists need access to 3D workplaces with intuitive post-processing tools that facilitate fast and confident diagnoses. For today's radiologist, a post-processing workplace is no longer a nice-to-have, but a must-have.



"Volume reading is where the future lies," says Professor Elliot Fishman of Johns Hopkins Medical Centre, Baltimore MD, USA.

Siemens Medical Solutions offers three *syngo*-speaking workplace solutions, which can be tailored to optimize data management and clinical performance in any radiology environment. The Navigator scanning console, located at the CT scanner, offers fully asynchronous reconstruction with WorkStream4D and selected routine post-processing applications including *syngo* 3D-VRT, *syngo* Fly Through, *syngo* Dental CT and *syngo* Osteo CT.

The Wizard console is a dedicated CT workplace located at, or close to, the CT scanner, with all the benefits of a shared data base for instant access to original datasets, WorkStream4D and a full portfolio of clinical applications such as *syngo* InSpace, *syngo* 3D-VRT, *syngo* Vessel View, *syngo* Colonography CT and *syngo* LungCARE CT with Nodule Enhanced Viewing.

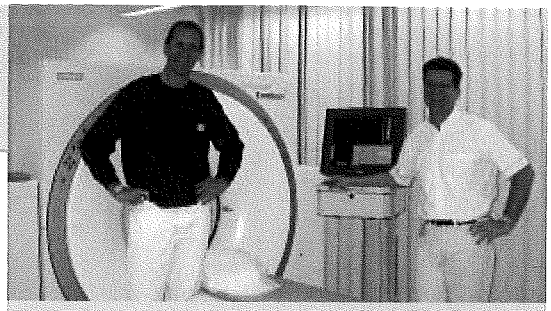
LEONARDO is a CT and multi-modality workplace. Ideally suited to managing clinical diagnostic workflow anywhere within the clinical environment, radiologists and clinicians also benefit from access to post-processing applications for Nuclear Medicine, Radiation Therapy, Magnetic Resonance, Angiography and Fluoroscopy imaging modalities.

"The Siemens LEONARDO Workstation with InSpace provides spectacular 3D images from multi-slice spiral CT scan datasets. When I use *syngo* InSpace, I find I rarely need to do any image editing, and I can easily create .avi digital movie files, DICOM images or TIFF files for the referring physicians," said Brian Herts, MD, radiologist at The Cleveland Clinic, Cleveland, Ohio, USA. "The 3D visualization we provide helps our referring surgeons plan many complex surgical procedures." Concurs Geoffrey Browne, MD, Chief Radiologist at Alamance Regional Medical Centre, Burlington, North Carolina, USA: "We use InSpace on the LEONARDO to look at the majority of CT cases, especially all vascular and orthopaedic cases and any case involving a mass, complex cyst, kidneys or the pancreas."

Further Information:
www.siemens.com/ computed-tomography

SOMATOM Emotion 6

Optimizing Workflow for Outpatient Imaging Center



Ralph Wolkewitz, MD, and his colleague Thomas Krambrich, MD, are convinced of the economical and clinical benefits of their new SOMATOM Emotion 6.

With more than 300 systems sold since the start of production one year ago, the SOMATOM Emotion 6 is one of the most successful CT systems in the world. The cost-effective system was developed especially for customers with limited budgets and space availability, making it a high performance-oriented CT scanner for daily routine examinations.

This works smoothly, according to Ralph Wolkewitz, MD at the multidisciplinary joint practice of the Marienhospital in Soest, Germany: "We are scanning up to 60 patients within an eight-hour work day without problems. Most patients get an appointment for the day they call." This is one reason that the SOMATOM Emotion 6 is patient friendly. The other, of course, is its fast acquisition and therefore, short breathhold time.

In Wolkewitz's practice, five physicians and 50 employees examine and treat up to 400 patients a day with a wide range of imaging and radiology equipment, from X-ray, CT, Angiography and Mammography to Magnetic Resonance Imaging and Nuclear Medicine. The SOMATOM Emotion 6, installed last November, is mainly employed for thorax scans, abdominal and neurological studies, and calcium scoring. Wolkewitz and his team also plan to start using CT colonography soon.

But it is not just the speed of the scanner itself that enables this workload. "Together with the intuitive user interface *syngo*, and the fast 3D reconstructions on the LEONARDO workstation, we can also speed up workflow and physicians' diagnosis," says Wolkewitz. "We are sure that, with the SOMATOM Emotion 6, we will easily be able to handle another ten percent increase in patient throughput which we expect from the radiation therapy center that is currently being built." The SOMATOM Emotion 6 will then additionally be used for radiation therapy planning, as well as preventive and follow-up care.

To further enhance it's capabilities and cost effectiveness, Siemens Medical Solutions recently introduced new clinical application software – *syngo* LungCARE CT, CARE Dose4D, and CARE Vision – as well as the durable new Dura 422 liquid bearing X-ray tube for the SOMATOM Emotion 6.

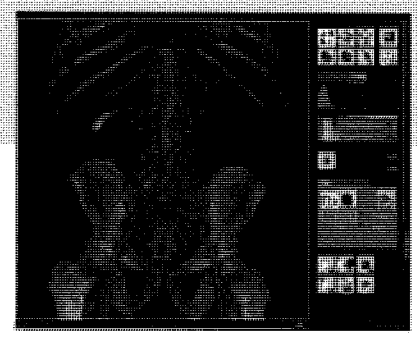
Further Information:
www.arzt-radiologie-soest.de

syngo InSpace

Exclusive Agreement for further Development of Medical Imaging Software

Siemens Medical Solutions and HipGraphics, Inc., have announced an exclusive agreement for further development of the state-of-the-art, interactive 3D medical imaging application, *syngo* InSpace. Under this agreement, the two companies – which have been cooperating successfully on the development of 3D diagnostic imaging applications since 1992 – will continue to advance the capabilities of this unique software. *syngo* InSpace is an advanced medical imaging application powered by *syngo*, Siemens' exclusive software solution that is designed for an intuitive and seamless workflow across all imaging modalities. *syngo* InSpace, which has been installed on more than 1,000 Siemens systems since its introduction in 2002, enables the real-time 3D processing of very large volume data sets, such as produced by the company's SOMATOM Sensation multi-slice CT scanners. The latest version of this software – *syngo* InSpace4D – also enables 4D evaluation of the moving heart.

Further Information:
www.insideinspace.com



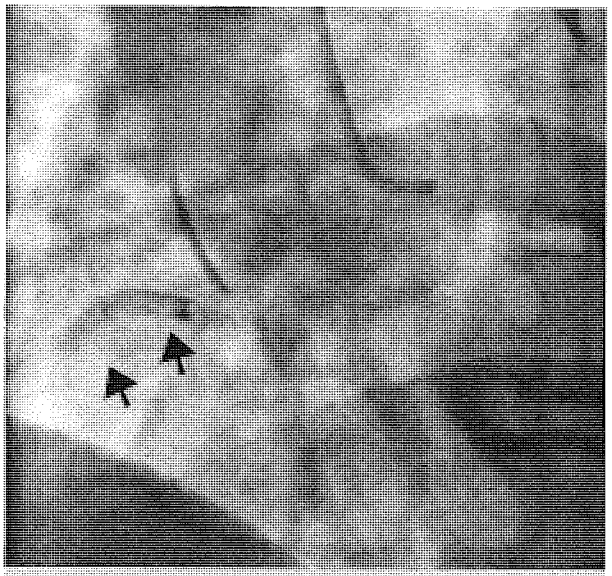
Providing excellent image quality, syngo InSpace offers high performance 3D interaction for a variety of rendering techniques.

Case 1:
Multi-slice CT after Inferior Myocardial Infarction

By S. Achenbach, MD, W. G. Daniel, MD, D. K. Pohle, MD, D. Ropers, MD, Department of Internal Medicine II,
K. Anders, MD, U. Baum, MD, W. Bautz, MD, Institute of Diagnostic Radiology,
W. A. Kalender, MD, Institute of Medical Physics, University of Erlangen, Germany

HISTORY

A 63 year old male patient, previously symptom free, experienced acute inferior myocardial infarction as the first manifestation of coronary artery disease. Immediate coronary angiography showed complete thrombotic occlusion of the right coronary artery with a large amount of thrombus as well as retrograde filling of the distal right coronary artery via collaterals from the left coronary system, so that mechanical recanalization was not attempted. The patient was treated with antiplatelet medication.
Symptoms resolved rapidly and, after an interval of 2 weeks, the patient was re-evaluated by cardiac CT and invasive angiography.



[1] *Initial coronary angiogram with a large thrombus in the proximal right coronary artery (arrow)*

DIAGNOSIS AND COMMENTS

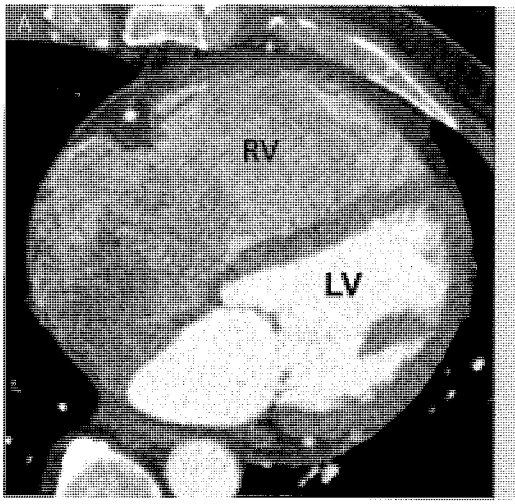
After acute inferior myocardial infarction, MSCT demonstrated right ventricular enlargement as a sign of involvement of the right ventricular myocardium and showed absence of significant luminal narrowing after thrombotic occlusion of the proximal right coronary artery.
The new 64-slice CT technology facilitates visualization of the heart and coronary arteries with improved spatial resolution of 0.4 millimeter isotropic in a breathhold of 10 seconds. This new technology may thus significantly increase the clinical value of cardiac computed tomography.

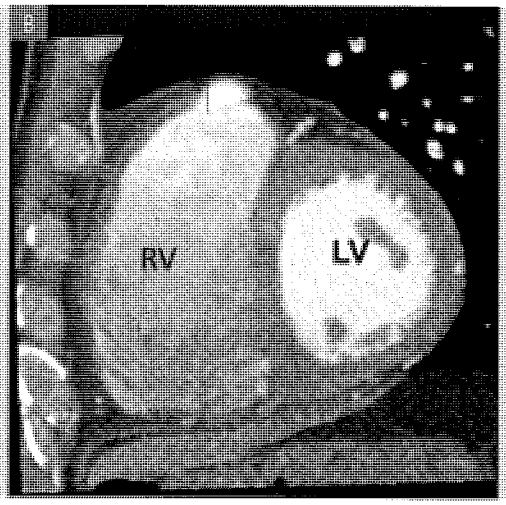
EXAMINATION PROTOCOLS

Scanner	*SOMATOM Sensation 64*
Scan Area	*tracheal bifurcation to diaphragmal face of the heart*
Scan length	*130 mm*
Scan time	*10.7 s*
Scan direction	*cranio-caudal*
kV	*120 kV*
Effective mAs	*446 mAs*
Rotation time	*0.37 s*
Slice collimation	*64 x 0.6 mm*
Slice width	*0.6 mm*
Pitch	*0.24*
Reconstruction increment	*0.3 mm*
Kernel	*B30f*

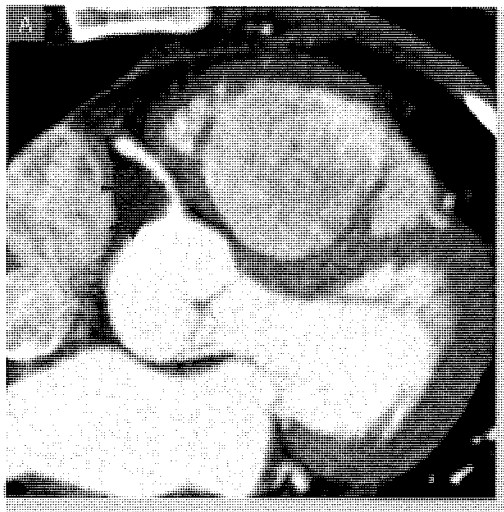
Contrast	*370 mg iodine/ml*
Volume	*80 ml*
Flow rate	*5 ml/s*
Start delay	*23 s*

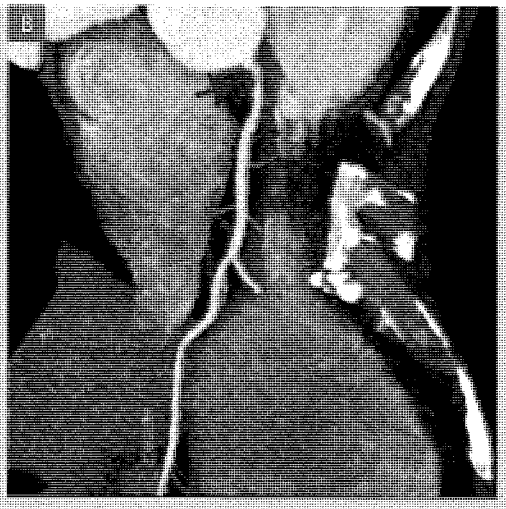
Postprocessing	*VRT*



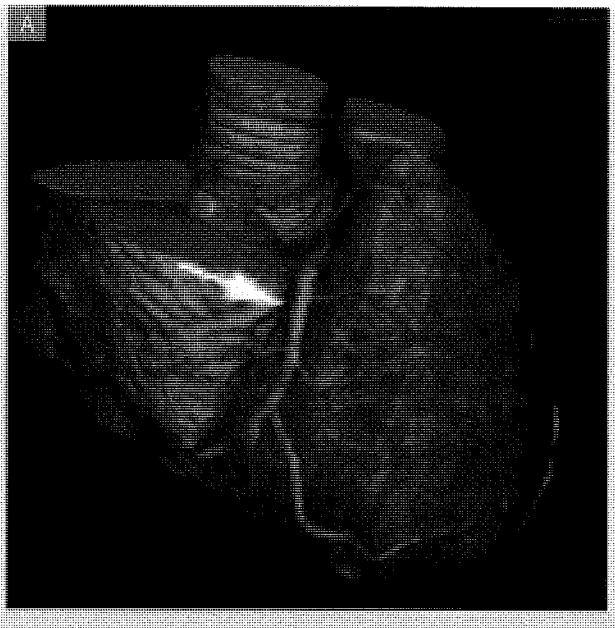


[2A and 2B] *Pronounced right ventricular enlargement in the MSCT scan performed two weeks after the acute event (2A: axial image; 2B: „short axis" reformat) as evidence of right ventricular involvement in inferior myocardial infarction*



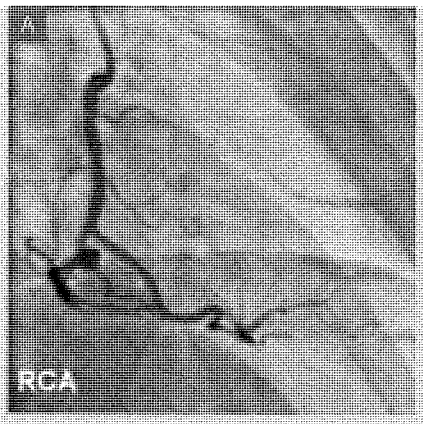


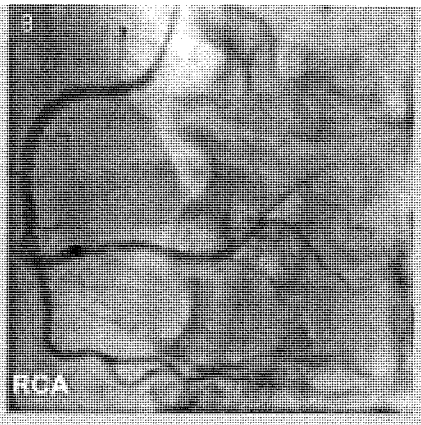
[3] *Axial image (A) and curved maximum intensity projection reconstructions (B, C) of the right coronary artery. A non-calcified plaque/thrombus is visible at the proximal right coronary artery (arrows), but there is no significant stenosis.*

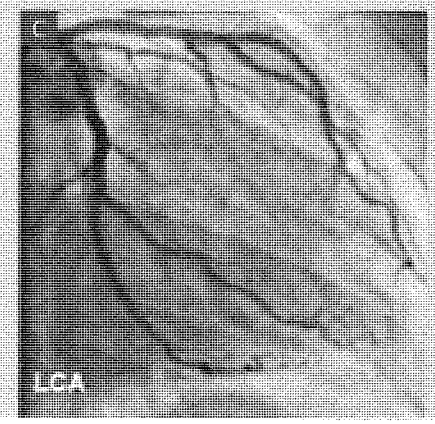


[4A] *3-dimensional reconstruction of the right coronary artery (arrow)*

[4B] *3-dimensional reconstruction of the left coronary artery (arrows), again demonstrating absence of significant coronary artery stenosis*







[5] *Repeat invasive angiogram displays absence of significant lumen reduction in the right coronary artery [A, B] and left coronary artery system [C].*

Case 2:
Whole Body Arterial Run-off

By A. Küttner, MD, Department of Radiology, Eberhard-Karls-University, Tuebingen,
J. E. Wildberger, Assc. Professor, Department of Diagnostic Radiology, University Hospital Aachen,
M. Lell, MD, Department of Diagnostic Radiology, University of Erlangen,
A. Blaha, Siemens Medical Solutions, Forchheim, Germany

HISTORY

A 67 year old male patient with a history of hypercholesterinemia, arterial hypertension and a known family history of cardiovascular disease including myocardial infarction, stroke and peripheral arterial vascular disease was examined using the latest 64-slice CT technology to rule out significant arterial wall changes and/or relevant stenoses.

EXAMINATION PROTOCOLS

Scanner	*SOMATOM Sensation 64*
Scan Area	*from skull base to plantar arch*
Scan length	*157 cm*
Scan time	*33 s**
Scan direction	*cranio-caudal*
kV	*120 kV*
Effective mAs	*148 mAs*
Rotation time	*0.5 s*
Slice collimation	*64 x 0.6 mm*
Slice width	*0.75 mm*
Pitch	*1.2*
Reconstruction increment	*0.5 images/s*
Kernel	*B20f*

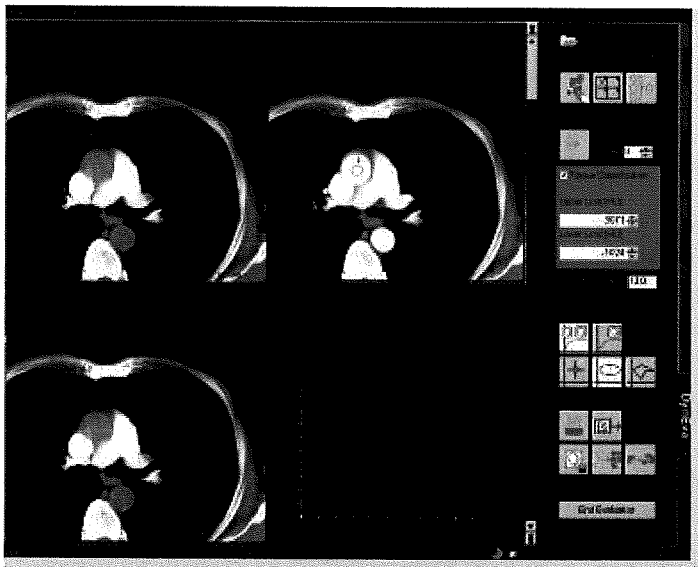
Contrast	*400 mg Iodine/ml*
Volume	*100 ml*
Flow rate	*4 ml/s + 100 ml saline chaser*
Start delay	*test-bolus 20/4 CM, 50/4 NaCl Delay was calculated according to the test-bolus methology using Dynamic Evaluation™ software*

Postprocessing	*VRT (standard preset)*

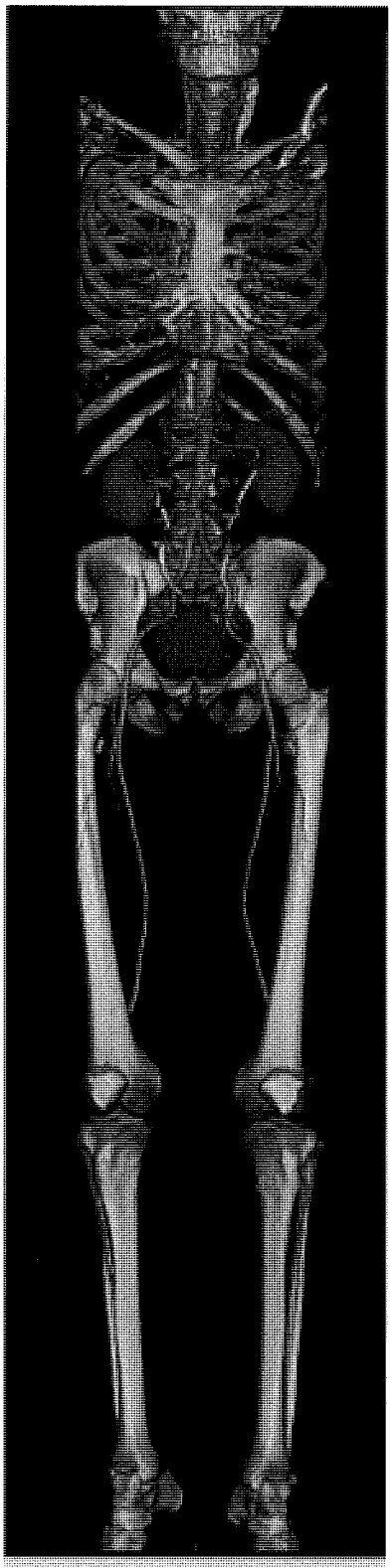
*bolus-adapted increase of scan time

DIAGNOSIS AND COMMENTS

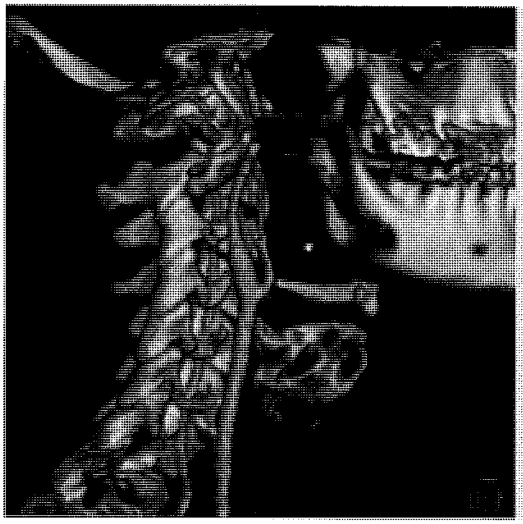
CTA revealed a normal vascular anatomy with the exception of a small excentric non-calcified plaque in the right common iliac artery.
The use of 64-slice technology enabled us to perform a 157 cm full body run off in a single breath hold. Uniquely, this technology facilitated the visualization and assessment of thoracic and abdominal aorta without motion artifacts, the celiac trunk, superior and inferior mesenteric arteries, and the renal arteries as well as the femoral and popliteal arteries from a single CT exam. This case clearly demonstrates the powerful clinical application of 64-slice CT technology for non-invasive assessment of the complete vascular system, in one breath hold.



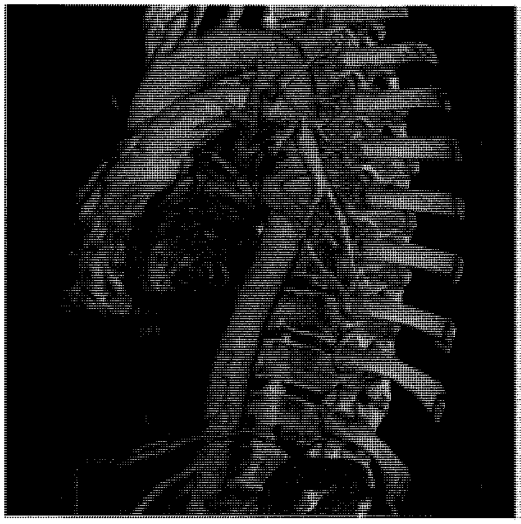
[1] *Screenshot of the syngo-based Dynamic Evaluation application. From a test-bolus injection with 20 ml of contrast material, best contrast enhancement can be calculated interactively. Low-dose sequential scan at the level of the aortic arch (120 kV, 40 mAs eff.)*



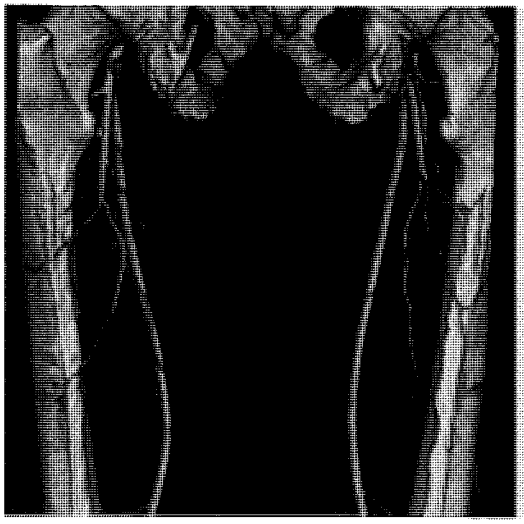
[2] *Whole body arterial run-off.*



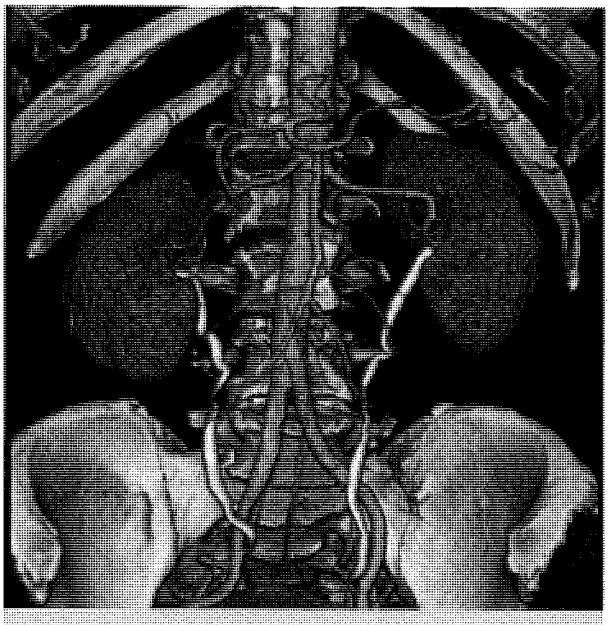
[3] *Sagittal VRT-zoom of the right carotid bifurcation. No relevant stenosis is seen; note the detailed depiction of the right vertebral artery.*



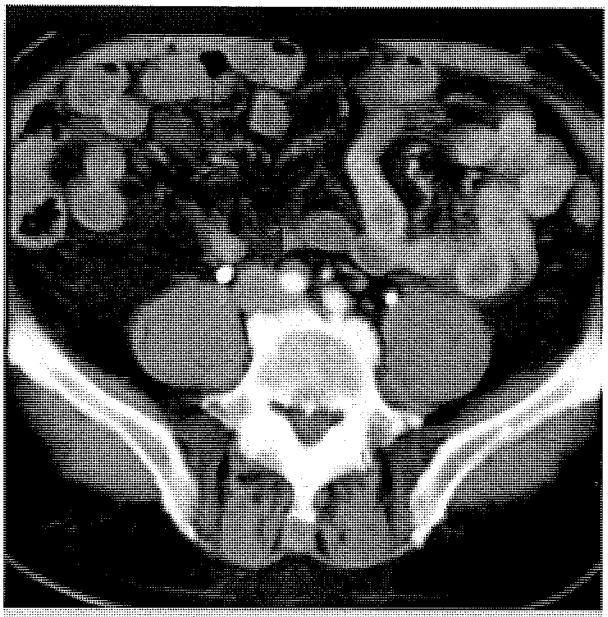
[4] *VRT of the ungated aortic arch.*



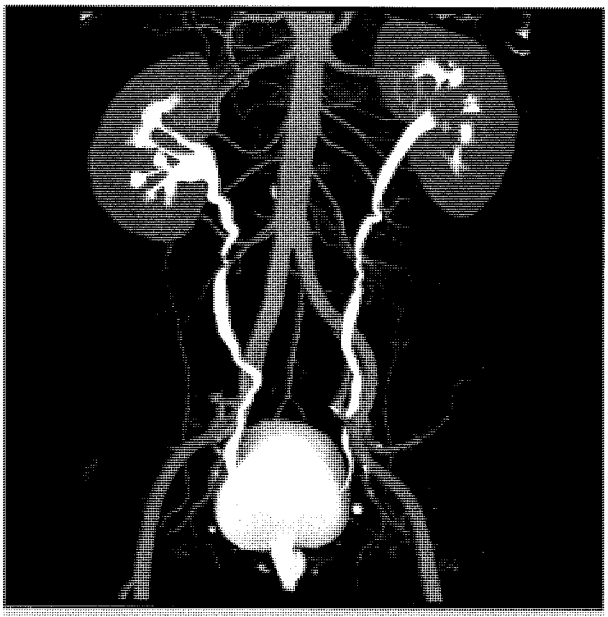
[5] *VRT-zoom at the proximal thigh. The distal common femoral artery, the superficial femoral artery, as well as the deep femoral artery are homogeneously contrasted.*



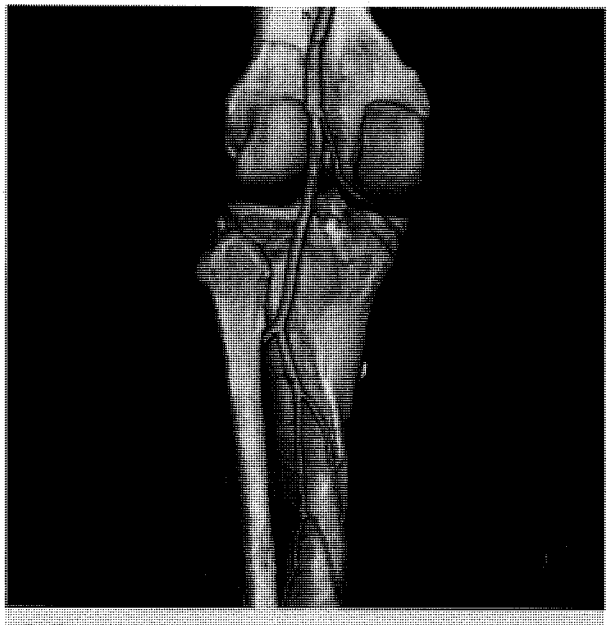
[6] *VRT-zoom at the level of the renal arteries. Normal single vascular supply is demonstrated for both kidneys. Note the homogeneous opacification of the urinary tract down to the iliac decussation due to the previous contrast application.*



[7] *MPR of the soft plaque (arrow) in the right common iliac artery.*



[8] *MIP of the renal arteries.*



[9] *VRT-zoom at the proximal calf: The popliteal artery, with the soleus arteries, as well as the proximal portion of the anterior and posterior tibial artery, and the fibular artery are depicted clearly.*

syngo Perfusion CT – Brain Tumor Perfusion

syngo Perfusion CT* is an established tool to assist physicians with the diagnosis of ischemic or hemorrhagic stroke [1]. The application provides information about brain perfusion, which permits differentiation of irreversibly damaged brain tissue from reversible "tissue at risk". In combination with plain CT and CT angiography, stenoses or occlusions of extra- and intracranial arteries can be visualized in order to rapidly obtain comprehensive information regarding the extent of ischemic lesions. When "time is brain", complete stroke assessment can be performed in less than 15 minutes [1]. Additionally, the extended *syngo* Perfusion CT option provides the opportunity of analysing brain tumor perfusion for brain tumor angiogenesis and assessing treatment efficacy in oncology. The case presented below describes the capability of brain tumor perfusion allowing differential diagnosis of brain tumors.

1 Tomandl et al. Comprehensive imaging of ischemic stroke with multisection CT. Radiographics; 2003, 23: 565-592

* This software is available on a 90-day free trial basis. For more information please contact your local Siemens Representative.

Case 3:
Perfusion CT of Intra-axial Brain Tumors: Intracerebral Lymphoma

By Peter Schramm, MD, Department of Neuroradiology, University Heidelberg Medical Center, Heidelberg, Germany

In the past decades, incidence rates for primary central nervous system lymphomas have been increasing, especially in elderly patients and patients with immune compromise [1]. Since the specific therapy of these tumors completely differs from those of glioma, it is absolutely necessary to identify these tumors and to separate them from other intracranial masses.

HISTORY

A 72 year old male presented to the Department of Neurology suffering from diplopic images for eight weeks. The patient also noticed an increasing shakiness when walking. He was fully orientated.

DIAGNOSIS AND COMMENTS

The standard protocol for the neuroradiologic examination was performed, consisting of a cranial non-enhanced CT (NECT) scan followed by Perfusion CT (PCT). NECT revealed a tumor in the right basal ganglia with space effect and compression of the lateral ventricle. The tumor was hyperdense on NECT, and on the MIP images of PCT the mass showed distinctive homogenous contrast enhancement [Fig. 1]. The calculated maps of cerebral blood volume (CBV) showed no increased CBV within the tumor, whereas the Permeability

EXAMINATION PROTOCOLS

Scanner	*SOMATOM Sensation 4*
Scan Area	*through the tumor (in this case basal ganglia)*
Scan length	*20 mm*
Scan time	*40 s*
kV	*80 kV*
Effective mAs	*250 mAs*
Rotation time	*1.0 s*
Slice collimation	*4 x 5 mm*
Slice width	*2 x 10 mm*
Table feed / rotation	*0 mm*
Reconstruction increment	*1 image/s*
Kernel	*H40s*

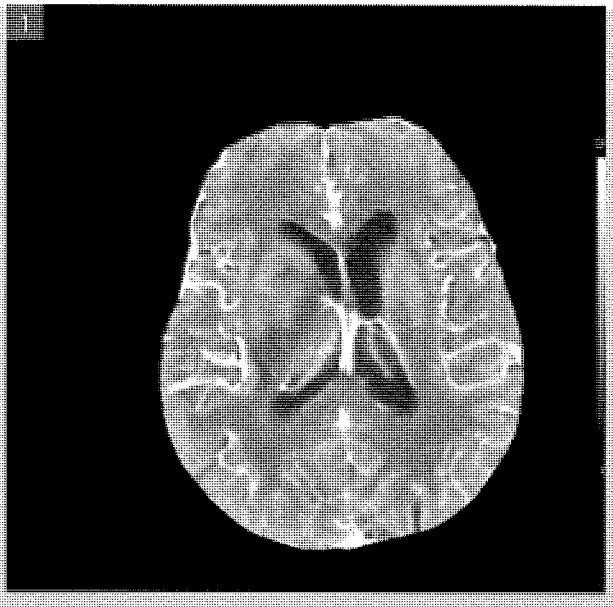
Contrast	*non-ionic contrast media (300 mg iodine per ml)*
Volume	*50 ml*
Flow rate	*8 ml/s**
Start delay	*4 s*

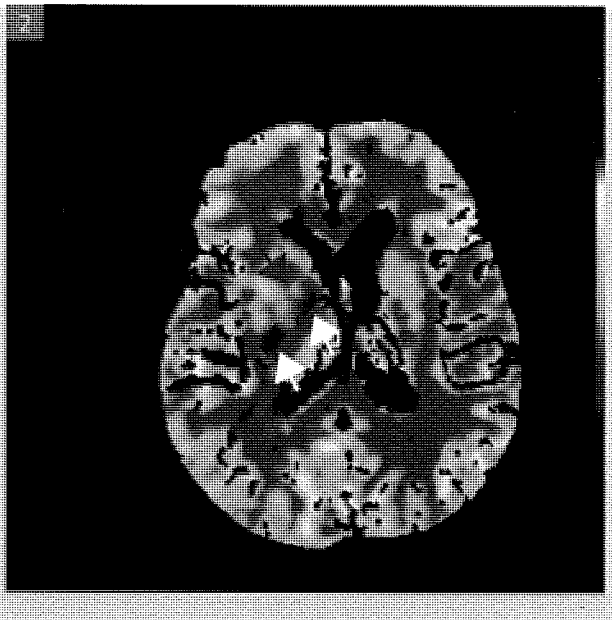
Postprocessing	*syngo Perfusion CT*

*Usually, we use a flow rate from 5-8 ml/s. For precise diagnosis of brain tumors, or in case of a suspected stroke, we are using a flow rate of 6-8 ml/s. This has been proven in more than 400 patients who underwent Perfusion CT without any complications.

Maps of PCT revealed a massive disruption of the blood-brain-barrier within the tumor.

Obviously the contrast enhancement is not due to hypervascularization or neoangiogenesis of the tumor but to contrast leakage through the disrupted blood-brain-barrier. This combination is typical for lymphoma. This case illustrates that contrast enhancement within brain tumors allows differential diagnosis with the *syngo* Perfusion CT software, enabling drug therapy in this case. Therefore, our patient was treated with corticosteroids which led to a significant reduction of the tumor volume and to clinical restitutio ad integrum.





[1] *MIP image. The tumor can be seen in the right lentiform nucleus. It shows homogenous contrast enhancement. Notice the space occupying effect of the mass resulting in compression of the right lateral ventricle.*

[2] *PCT CBV image. There is no visible elevation of CBV within the tumor (red arrow). Instead, a decrease of CBV can be found in the surrounding edema (white arrows).*

[3] *PCT Permeability image. Note the massive disruption of the blood-brain-barrier within the tumor (red arrow). The combination of missing increase of CBV and increased blood-brain-barrier disturbance leads to the diagnosis of intracerebral lymphoma.*

1. Cote TR, Manninen, Hardy CR, Yellin FJ, Hange P. Epidemiology of brain lymphoma among people with or without acquired immunodeficiency syndrome. AIDS/Cancer Study Group. J Natl Cancer Inst. 1996 May 15; 88(10): 675-9.

CARE Vision CT with HandCARE and CAREView

Within the Siemens CARE (Combined Applications to Reduce Exposure) program, CARE Vision CT with HandCARE™ offers the possibility to reduce X-ray exposure for the patient and the physician in interventional procedures. CARE View™ is a CT fluoroscopic mode for intervention. With up to ten frames, it displays up to three images simultaneously for optimal orientation*. The case below describes the capabilities of this feature to combine low dose CT scans with highly sophisticated methods in interventional procedures.

*depending on hardware configuration

Case 4: Postosteosynthetic Vertebroplasty for a Burst Fracture of L1

By T. Bouziane, MD, & J. Kirsch, MD, Head of Radiology Department, Radiology Department, Clinique Notre-Dame, Tournai, Belgium

HISTORY

A 21 year old male was admitted to our hospital as an emergency case following a fall from a ladder. He complained of disabling dorsal pain in the lumbar region associated with a paraparesis of the lower limbs.

DIAGNOSIS

Conventional radiological examination followed by an immediate MSCT examination showed evidence of a burst fracture of L1. This is a matter of a communitive fracture of the vertebral body, resulting from an axial compression mechanism associated with a recoil of the marginal posterosuperior angle and cuneiform deformation of the vertebral body with greater than 50% sagging of the anterior wall occurring in the canal and reducing the anteroposterior mensuration.

Multiple osteosynthesis was performed on D11, D12, L2 and L3 using transpedicular screws in order to minimize the stress on L1. Surgical exploration confirmed the integrity of the attached vertebral disks (Sharpey's fibers) and of the common posterior vertebral ligament.

The traction, implemented along the spinal axis as a result of osteosynthesis, permits a reduction of the posterosuperior fragment displacement and, above all, relieves the stenosis and the canal compression. Furthermore, the height of the anterior wall could be restored to about 80%. A central neocavity was created during the reduction of this mulifragmentary fracture. We performed a cementoplasty on the second day after the operation in order to fill in this central cavity. An osteo-cement (Cortoss™) was chosen due to the patient's age. For this technique, the patient was positioned in ventral decubitus without any special premedication.

Using the CARE View feature allows precise placement of local anesthesia up to the cortical level, placing a needle transpedicular from the right, obliquely, the extremity of which was positioned at the level of the centrovertebral neocavity (Gangi – Optimed set).

4 ml of the osteo-cement were injected. No escape of cement was observed on the outside of the vertebral body of L1 in spite of the different cortical caudocranial interruptions toward the intervertebral disks and even posterior interruptions toward the canal.

With this procedure, the residual symptomatological pain completely disappeared the following day. Furthermore, the injection of cement guaranteed the permanence of the vertebral reconstruction and therefore prevented any secondary displacement (following possible secondary mobility of the osteosynthetic material). In the same manner, the cementoplasty prevents the later sagging of the fractured vertebra following removal of the osteosynthetic material.

COMMENTS

Vertebroplasty is an interventional radiological technique consisting of the injection of an acrylic cement into a pathological vertebra by a percutaneous path in order to obtain an antalgic effect and a consolidation of the vertebra [1, 2, 3]. The procedure consists, on the one hand, of stabilizing the vertebral body and, on the other, of the antalgesic effect and the consolidation of the fractures, as well as the destruction of the intracorporeal nerve ends, resulting from the toxic effect and the thermal release of the cement during the solidification phase.

The puncture required for the injection of the cement was performed under tomodensitometric guidance in order to avoid the known classical complications, above all, with the epidural escape of cement. In this case, given the multifragmentation of the vertebral body, we preferred to use a single transpedicular path [4].

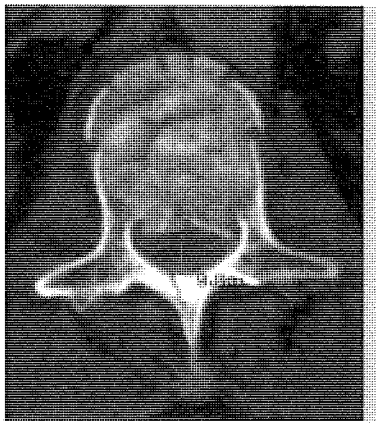
Also, in view of the patient's age, we chose an osteo-cement instead of a classical cement. These new cements with osteoblastic capability are still undergoing investigation. Cementoplasties are indicated, above all, for compressions of osteoporotic origin, for essentially lytic spinal metastases and finally, for aggressive vertebral angioma.

EXAMINATION PROTOCOLS

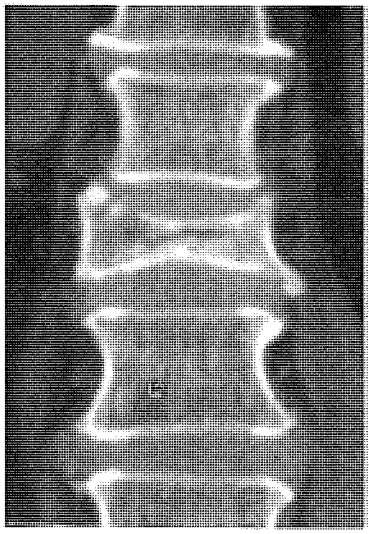
Scanner	*SOMATOM Emotion 6 with CARE Vision and CARE View*
Scan Area	*lumbar spine*
kV	*130 kV*
Effective mAs	*30 mAs*
Rotation time	*0.6 s*
Slice collimation	*6 x 3.0 mm*
Slice width	*3 x 6 mm*
Kernel	*B31s*

1 Gangi, A, et al. CT-guided interventional procedures for pain management in the lumbosacral spine. Radiographics 1998; 18: 621–633
2 Mathis, JM, et al. Percutaneous vertebroplasty : a developing standard of care for vertebral compression fractures. Am J. Neuroradiol. 2001; 22: 273–381
3 Cotten, A, et al. Percutaneous vertebroplasty for osteolytic metastases and myeloma: effects of the percentage of lesions filling and the leakage of methyl-methacrylate at clinical follow-up. Radiology 1996; 200: 525–530
4 Tohmeh, AG, et al. Biomechanical efficacy of unipedicular versus bipedicular vertebroplasty for the management of osteoporotic compression fractures. Spine 1999; 24: 1772–1776

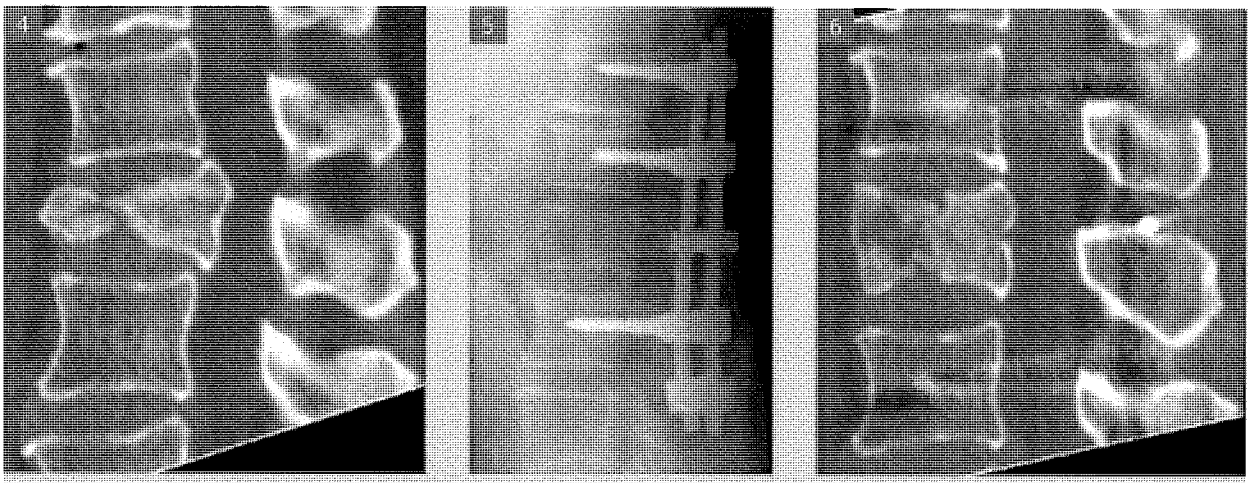
[1] *Radiographic profile of the dorsolumbar hinge : Burst fracture of L1 with recoil of the posterosuperior marginal angle, responsible for canal stenosis.*



[2] *Axial slice of L1 confirming impairment of the posterior wall and canal stenosis.*



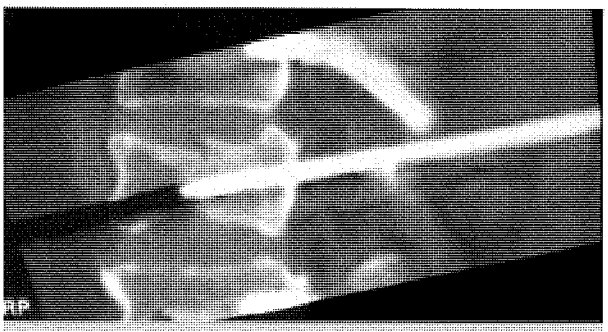
[3] *Multiplanar frontal reconstruction: Burst fracture of L1 with reduction of the height of the anterior wall.*



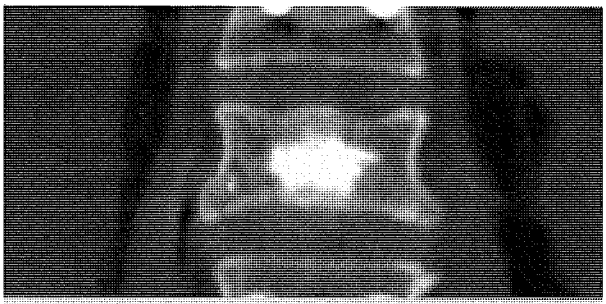
[4] *Multiplanar sagittal reconstruction: Burst fracture of L1 with recoil of the posterior angle and canal stenosis.*

[5] *Radiographic profile immediately following operation: the osteosynthetic material is well positioned and post-distraction vertebral reconstruction is satisfactory.*

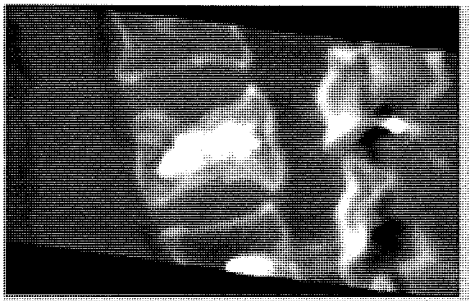
[6] *Pre-cementoplasty CT showing the newly formed centrocorporeal cavity following the operation.*



[7] *Needle positioned within the corporeal cavity.*



[8] *Multiplanar frontal reconstruction: post-cementoplasty control with filling of the central cavity.*



[9] *Multiplanar sagittal reconstruction: post-cementoplasty control confirming the filling of the newly formed centrocorporeal cavity.*

COMPUTER-ASSISTED DIAGNOSIS (CAD)
Current Status and Future Applications

By David P. Naidich, MD, FACCP, & Jane Ko, MD, Department of Radiology, New York University Medical Center, Tisch Hospital, New York, USA

With the introduction, and now widespread availability of multidetector CT (MDCT) scanners, the need for advanced imaging tools for detecting and characterizing lung nodules has become imperative. Faced with the daunting task of evaluating between 250 and 350 high resolution 1.5 mm images now routinely provided by 4- and especially 16-slice CT scanners, radiologists already are clearly in need of more sophisticated methods of image evaluation than simple perusal of 5 to 7 mm axial CT images [1].

Although usually interpreted to be limited to lung nodule detection, CAD is best defined for radiologists as any of a number of methods of assisting interpretation by means of computerized image analysis. Broadly interpreted, this includes both methods of detection and of characterization [2]. In fact, many of these computer tools are already available. These include: rapid real time transitions between cine displays of thick and thin (1-1.5 mm) sections, multi-planar reconstructions (MPR) and sliding maximum intensity projection images (MIP), all in a variety of user defined imaging planes. Once identified, additional tools to further characterize lesions are also now available, including: 180 degree cartwheel projections (allowing rapid differentiation between lung nodules and similar sized blood vessels), as well as real time 3D segmentation, providing automatic assessment of nodule diameters and volumes. These data are critical for accurate assessment of interval growth, especially for smaller lung nodules that are notoriously difficult to reproducibly measure even with the use of electronic calipers [3].

In cases in which nodule densitometry is required following administration of intravenous contrast media, it is now also possible to automatically acquire average density measurements of an entire nodule at various timed intervals, replacing the need for obtaining user defined single axial sections. It is also now possible to automatically register the location of nodules on follow-up scans once identified on prior studies – a major improvement in time utilization. As documented by Novak et al, in a study of 16 patients, an automated nodule detection system provided exact correspondence between nodules on scans performed at two separate times within three contiguous 1 mm high resolution axial sections in 99% of cases [4].

In addition to these applications, CAD also offers the opportunity as a "second reader," providing automatic detection of otherwise overlooked lung nodules. As recently documented by Swensen et al, in an evaluation of annual incidence screening CT scans, up to 26% of nodules may be missed [5]. As reported by Armato et al, CAD allowed detection of 78% of 18 overlooked nodules in studies in which contiguous 10 mm thick sections only were obtained [6]. Similarly, Wormanns et al, using a CAD system specifically designed to detect nodules larger than 5 mm, found that up to 15% of nodules were identified solely by computer [7]. As importantly, Novak et al, in an evaluation of 13 studies using MDCT screening with 1.25 mm contiguous sections initially interpreted as negative, showed that use of CAD allowed identification of an additional 10 actionable nodules – defined as larger than 3 mm – in 46% of cases. As important, CAD also offers the potential to markedly diminish interobserver variability [8]. It should be emphasized that, with ever expanding data sets providing greater and greater numbers of high resolution thin CT sections, the applicability of CAD for detecting lung nodules will only expand.

The introduction of a new Siemens software tool named NEV (Nodule Enhanced Viewing) represents a big step in this direction. NEV in conjunction with the other tools provided by *syngo* LungCARE CT is designed to support the physician in confirming the presence or absence of identified lung lesions (e.g., nodules).

It is apparent that, in this era of MSCT, the the future is especially bright for the continued development and utilization of computer methods for assessing the thorax. In addition to already established uses such as nodule detection and characterization, CAD offers considerable promise for automatic detection of subtle sub-segmental pulmonary emboli. Of particular interest is the potential for CAD to provide CT evaluation of both global and regional lung morphology and function, including such diverse indications as measuring pulmonary ventilation as a measure of likely success of lung volume reduction surgery [9].

Case Study
NEV in the Evaluation of Recurrent Lung Cancer

By David P. Naidich, MD, FACCP, Department of Radiology, New York University Medical Center, Tisch Hospital, New York, USA

HISTORY

A 67 year old man was evaluated with routine follow-up low-dose surveillance CT scans since 1997. Before initial presentation, the patient had previously undergone a right upper lobe resection for non-small cell lung cancer, followed by adjuvant chemotherapy. In our institution, periodic six to twelve month follow-up CT examinations are obtained to identify potential tumor recurrence. Given an increased risk of second lung primaries, we also scan to identify potential new lung neoplasms.

DIAGNOSIS

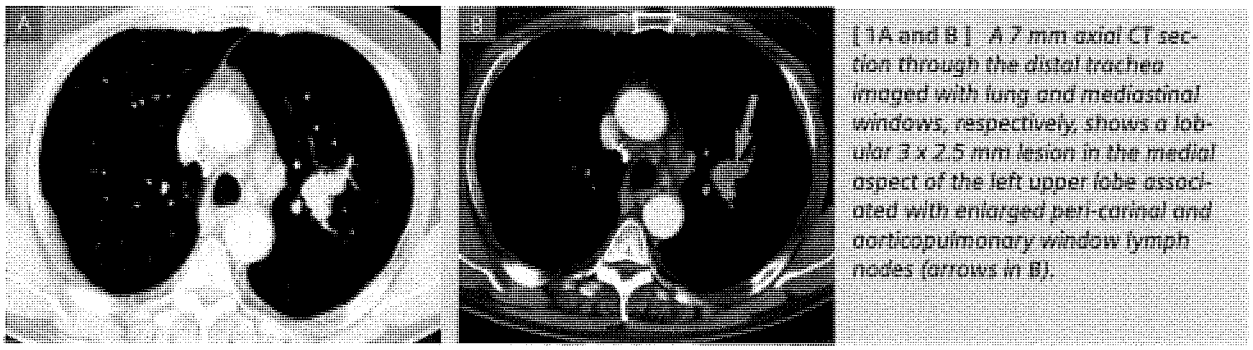
In this case, follow-up CT studies over the course of several years periodically failed to identify the presence of new nodules requiring additional chemotherapy. On the most recent CT examination, performed in March, 2004, a 3 x 2.5 cm lobular mass is clearly identifiable in the medial aspect of the left upper lobe extending to the left hilum associated with enlarged peri-carinal and aorticopulmonary lymph nodes [Fig. 1]. These findings proved consistent with advanced disease recurrence.

COMMENTS

Retrospective evaluation of the previous CT examination, performed six months prior, showed that a subtle sub-centimeter nodule was indeed present in the left upper lobe although difficult to identify due to its close proximity to adjacent central vascular structures [Fig. 2A]. Re-evaluation of this study using Nodule Enhanced Viewing (NEV) facilitated identification of this lesion a [Fig. 2B]. This lesion could have been further characterized by the physician using the variety of tools available on *syngo* LungCARE CT, including 180 degree cartwheel projections allowing small nodules to be easily differentiated from similar sized blood vessels, as well as real-time 3D segmentation providing accurate cross-sectional diameters and precise determination of nodule volume and overall density [Fig. 3].

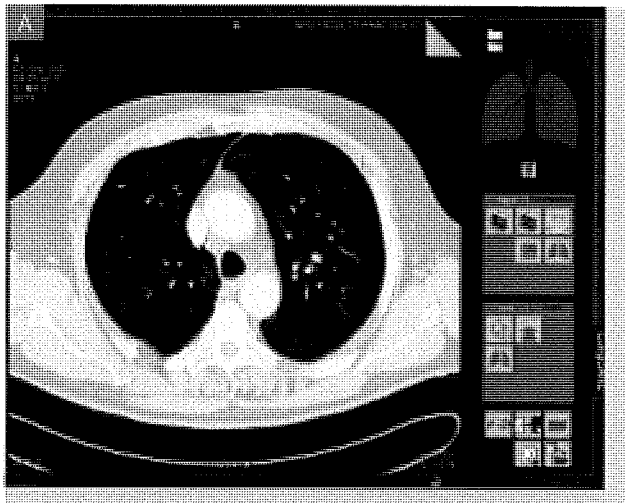
EXAMINATION PROTOCOLS

Scanner	*SOMATOM Volume Zoom*
Scan Area	*from thoracic inlet to the hemidiaphragms*
Scan length	*320 mm*
Scan time	*22 s*
Scan direction	*cephalo-caudal*
kV	*120 kV*
Effective mAs	*33 mAs with CARE Dose4D*
Rotation time	*0.5 s*
Slice collimation	*4 x 1 mm*
Slice width	*1.25 and 7 mm*
Pitch	*1.8*
Reconstruction increment	*1 and 6 mm, respectively*
Kernel	*B60f*
Postprocessing	*syngo LungCARE CT with NEV*

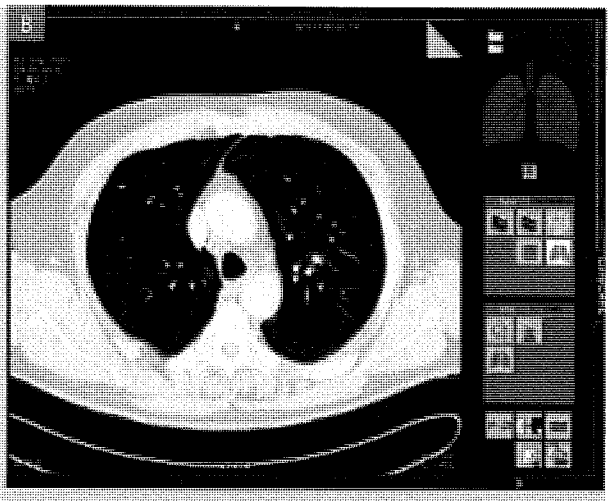


[1A and B] A 7 mm axial CT section through the distal trachea imaged with lung and mediastinal windows, respectively, shows a lobular 3 x 2.5 mm lesion in the medial aspect of the left upper lobe associated with enlarged peri-carinal and aorticopulmonary window lymph nodes (arrows in B).

If NEV had been used during the initial review of the prior exam, this lesion, which subsequently proved to represent recurrent tumor, might not have been missed. Software tools which enhance the ability of the physician to detect both early recurrences as well as new primary lung cancers represent an important addition to our imaging armamentarium. This case example demonstrates the potential future value of lung CAD.



[2A] *Axial CT section using syngo LungCARE CT at the same level as shown in [1], obtained six months earlier. Although a subtle lesion is present in the medial aspect of the left upper lobe, this was not identified prospectively.*



[2B] *The same section now is marked with a red circle identifying a central nodular density. Re-evaluation with NEV successfully outlined this previously overlooked potential abnormality.*

[3] *Images obtained using syngo LungCARE CT to retrospectively assess questionable nodule identified in Figure 2B by NEV. In this case, a subtle nodule is clearly present adjacent to central pulmonary vessels, most easily identified using 3D segmentation. In this image the lung nodule is outlined in yellow to facilitate identification. Note that syngo LungCARE CT provides automatic assessment of this nodule's diameter, volume and density.*

1 Ko, JP, Naidich, DP. Lung nodule detection and characterization with multislice CT. Radiol Clin N Amer, 2003; 41: 575–597
2 Giger, ML. Computer-aided diagnosis in radiology. Acad Radiol, 2002; 9(1): 1–3
3 Erasmus, JJ, et al. Interobserver and intraobserver variability in measurement of non-small-cell carcinoma lung lesions: implications for assessment of tumor response. J Clin Oncol, 2003; 21(13): 2574–82
4 Novak, CL, et al. Performance of an automatic system for nodule correspondence in follow-up CT studies of the lung. Radiology, 2002; 225 (P): 476–476
5 Swensen, SJ, et al. Screening for lung cancer with low-dose spiral computed tomography. Am J Respir Crit Care Med, 2002; 165(4): 508–513
6 Armato, SG, 3rd, et al. Lung cancer: performance of automated lung nodule detection applied to cancers missed in a CT screening program. Radiology, 2002; 225(3): 685–92
7 Wormanns, D, et al. Automatic detection of pulmonary nodules at spiral CT: clinical application of a computer-aided diagnosis system. Eur Radiol, 2002; 12(5): 1052–7
8 Novak, CL, et al. Identification of missed pulmonary nodules on low-dose CT lung cancer screening studies using an automatic detection system. in SPIE. 2003; Proc SPIE
9 Hoffman, EA, et al. Characterization of the interstitial lung diseases via density-based and texture-based analysis of computed tomography images of lung structure and function. Acad Radiol, 2003; 10: 1104–1118

**syngo* LungCARE CT including the NEV software is available on a 90-day free trial basis. For more information please contact your local Siemens Representative. If you have Siemens Remote Service connectivity, you can order your free trial software directly via SOMATOM Life @ Your Scanner from your Navigator or Wizard console. *syngo* LungCARE CT NEV is available for the SOMATOM Emotion 6, SOMATOM Sensation Scanners and for the LEONARDO workstation.

CARE Dose4D
Clinical Evaluation on a SOMATOM Emotion 6

CARE Dose4D and its real-time mA adjustment ensures good image quality at the lowest dose. Based on experience with more than 400 patients, the authors achieved 20 to 72% dose reduction in comparison with fixed mA level, while maintaining good diagnostic image quality.

By T. H. Mulkens, MD, P. Bellinck, MD, & J. L. Termote, MD, Department of Radiology, H.-Hart Ziekenhuis, Lier, Belgium

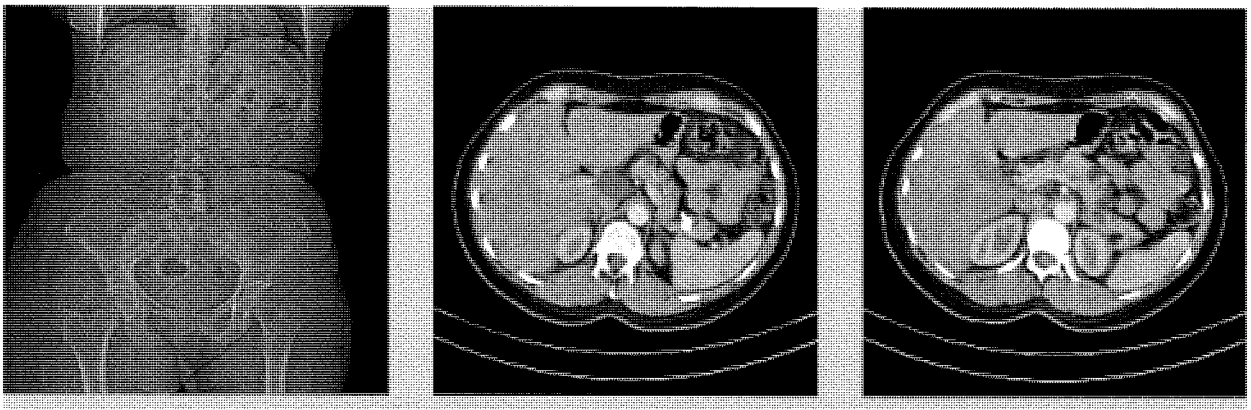
Recent technological advances have markedly enhanced the clinical applications of CT. While the benefits of CT exceed the harmful effects of radiation exposure in patients, increasing radiation dose to the population has raised a compelling case for reduction of radiation exposure from CT [1, 2]. Various methods and strategies based on individual patient attributes and CT technology have been explored for dose optimization [1].

Owing to the ongoing technological boom during the past ten years, there has been a corresponding, notable increase in the number of CT examinations being performed around the world: surveys performed in the United States reveal that the annual number of CT examinations has increased almost tenfold in less than two decades – from 3.6 million in 1980 to 33 million in 1998 [2, 3]. An estimated 2.7 million CT studies were performed in children under the age of 15 years in 2000 [4]. While CT accounts for only 11 to 13% of X-ray-based examinations in the United States, it delivers over two-thirds of the total radiation dose associated with medical imaging and about one-third of the collective population dose [1, 2].

Recent articles have focused on the estimated risk of cancer development due to the use of diagnostic X-rays in adults [3] and children [4]. The radiation dose from CT can approach, and sometimes exceed, the level known to increase the probability of cancer and can add a small, but statistically significant, risk to the lifetime cancer mortality risk of the natural background cancer rate.

The broadened use of CT in clinical practice has thereby raised concerns about mounting radiation exposure, thus emphasizing the need for appropriate strategies to optimize CT and, if possible, reduce radiation dose due to CT, while preserving the required image quality and medical benefit.

In this paper, we will present our clinical data about the use



[1] 45-year-old female (165 cm, 66 kg, BMI=24.24). CT multiphase examination of the abdomen superior for clinical history of recurrent pancreatitis. Mean effective mAs of 70 ($CTDI_{vol}$ = 8.0 mGy) which means 33% reduction compared to the reference mAs level of 105. Calculated effective dose for the whole multiphase examination is 14.3 mSv. CT images in the arterial phase show multiple pancreas pseudocysts and pancreatic calcifications.

[2] 35-year-old-man (150 cm, 54 kg, BMI=24.02). CT examination of C-spine for evaluation of cervical pain without irradiation. Mean effective mAs of 45 which is a dose reduction of nearly 75 % in comparison with the reference level of 175 mAs. CT shows disk protrusion at disk level C5-C6. Calculated effective dose for the whole examination is only 0.54 mSv.

of CARE Dose4D, a fully automated, real-time and anatomy-based dose regulation program to optimize CT dose and image quality.

Automatic Modulation of Tube Current in CT

The modulation of X-ray tube current is a technical innovation that substantially reduces radiation dose. By adjusting the tube current to follow the changing patient anatomy, dose efficiency will be improved [1, 5, 6, 7].

There are two methods used on CT scanners today: z-axis modulation and angular (x- and y-axis) modulation. Both methods have a complementary role in minimizing patient dose and are both incorporated in the CARE Dose4D mechanism.

In z-axis modulation, tube current is adjusted to maintain a user-selected level in the image data. Noise is regulated on the final image to a level desired by the user. In this sense, z-axis modulation is the CT equivalent of the auto-exposure control systems used for many years with conventional X-ray systems. Z-Axis modulation is an attempt to render all images with similar noise, independent of patient size and anatomy. The dose savings with z-axis modulation are expected to be greater than those with fixed-tube current methods, since the tube current will be automatically reduced for smaller patients and anatomic regions [1].

Z-Axis modulation has been introduced for multi-detector row CT scanners in the new CARE Dose4D mechanism. Tube current modulation is determined from the attenuation values and shape obtained by refined data analysis of one single projection radiogram (Topogram) of the patient just prior to the CT scans. Clinical results of this technique have not yet been published [1].

Angular (x-y-axis) modulation has a different objective than z-modulation [5, 6, 7]. In angular modulation, the tube current is adjusted to minimize X-rays in projections (angles) that have less importance for the reduction of overall image noise content. In anatomy that is highly asymmetric (e.g. the shoulders), X-rays are much less attenuated in the anterior-posterior direction than in the lateral direction [5]. Thus, the overwhelming abundance of anterior-posterior X-rays can often be reduced dramatically without a marked effect on overall image noise. Angular tube current modulation has been introduced on multi-detector row CT scanners by Siemens with the CARE Dose program. In this implementation, the modulation is determined in real time by using projection data that lag 180° from the X-ray generation angle. In clinical studies, CARE Dose gives dose reduction of typically 10 to 50%, with mean reduction of 10% for head region, 53% for shoulder region, 22% for thorax region, 15% for abdomen region and 25% for pelvis region [7]. A recent investigation of 100 helical CT imaging studies in children in whose angular modulation was used, showed a 10 to 60% decrease in dose, with a mean reduction of 22.3% (neck, 20%; thorax, 23%; abdomen, 23%; thorax and abdomen, 22%) without loss of image quality [8].

The ideal CT scanner will employ both z-axis and angular modulation techniques. When available in all commercial CT scanners, use of manual techniques, whereby a tube current value is selected on the basis of some simple measure of the patient (e.g. weight or cross-sectional dimensions), will be replaced with this computerized objective approach [1]. With these developments, tube current modulation in CT scanners is comparable to photographic timing or automatic brightness controls currently used in conventional radiogra-

[Table 1]

Examples of dose reduction compared to a standard reference level using CARE Dose4D.

	reference mAs	effective mAs mean	dose reduction mean %	effective mAs range	number of patients
Abdomen - Pelvis	105	71,6	32	39–121	53
Abdomen - Liver	95	51,57	46	41–99	23
L-spine medium	200	129,6	35	92–200	42
C-spine	175	52,12	70	43–70	26

phy. Indeed, automatic tube current modulation promises to be an important optimization of scanning parameters that will help eliminate the guesswork involved in parameter selection.

Evaluation of CARE Dose4D

A preliminary test version of the new Siemens software was implemented on our SOMATOM Emotion 6 multi-detector CT in December, 2003. Among the new features included in this newest software version is CARE Dose4D.

We started to evaluate CARE Dose4D, beginning with a limited number of scan protocols that we used most and which constitute the majority of our daily CT work, described for the following regions: thorax spiral exams: routine and 'lung embolism' protocol; abdomen spiral exams: abdomen-pelvis protocol (whole abdomen), abdomen multiphase liver and kidney protocol and abdomen low dose protocol for urolithiasis search; spine exams: L-spine spirals, in medium and large size patients and C-spine spirals [table 1]. In the initial period, we looked for the best 'reference mAs level' for each scan protocol: this is the preset mAs level from which the CARE Dose4D program starts and which gives good image quality for a mean, normal-sized patient. After trying different reference 'mAs' levels for each scan protocol, we agreed, based on subjective impression of good image quality, about the reference mAs levels of our different scan protocols.

Since beginning in December 2003, we have done about 450 CT examinations with CARE Dose4D. We collected patient data and examination data for 325 patients. We can say that the software program of CARE Dose4D is stable and that for each scan region/protocol the results are consistent. When we compare with the level of mAs reduction/dose gain with the previous CARE DOSE system, what we know from our data and from the literature, we have a greater mean dose gain in CT abdomen and CT pelvis : 32 to 45% for CARE Dose4D (mean 38%) and 15 to 25% for CARE DOSE, respectively. We have comparable mAs reduction in CT thorax: about 20% with CARE Dose4D and CARE DOSE, and obviously more in the L-spine examinations: mean mAs reduction of 35% with CARE Dose4D in comparison with 10 to 20% for CARE DOSE. The most spectacular mAs reduction we got in C-spine spiral examinations: mean reduction of 70%, consistent in more than 25 patients (15 to 20% for CARE DOSE): mAs reduction from 175 reference mAs level to about 50–55 effective mAs, or reduction of $CTDI_{vol}$ from 23.3 mGy to 7.4 mGy!

The quality of the images is good and consistent. In very slim patients the system gives very low mAs settings, so that the images are quite noisy, compared to the previous scan technique. But the system permits fine-tuning of the settings of the CARE Dose4D program, so that for very slim patients the power of the program is adjusted properly.

Our conclusion: The use of CARE Dose4D is very simple and clear. Once the standard reference level of mAs is adapted for each scan protocol to a level of good image quality for a standard normal sized patient, and once it is activated in the scan protocol, it really works as an "automatic exposure control" mechanism and adapts the dose to the individual patient size (including large or bariatric patients) without need for further modifications.

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Results may vary. Data on File.

New Clinical Frontiers
SARS – Correlation of Follow-up Methods

By Ting-lok Kwan, MD, FRCR, & Susan Chi-hum Chan, MD, FRCR, Department of Radiology and Imaging, Queen Elizabeth Hospital, Hong Kong, China

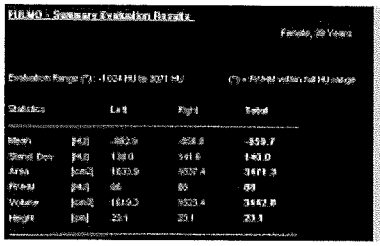
Severe acute respiratory syndrome (SARS) is caused by the SARS corona-virus (SARS-CoV). Considerable morbidity and mortality were noted. Due to severe pneumonia, residual deficits in the structural and physiological functions of the respiratory system were likely in survivors. High resolution CT is used to assess the residual effects of their lung injury. Our study compared automatic quantification with visual assessment and lung function tests.

50 post-SARS patients (mean age 37.5 ± 9.72, 36% male) had CT examinations (SOMATOM Sensation 16, 0.75 mm detector collimation; 13.5 mm feed/rotation; 0.5 s/rotation; 120 kV and 120 effective mAs) and pulmonary function tests performed at the sixth month of convalescence.

The *syngo* Pulmo CT software* automatically isolated the lung parenchyma from other tissues and structures, tracing the lung contours in each scan. After assessing all scans from the lung apices to the bases with 1 cm interval, a summary of the value of mean lung attenuation (MLA), standard deviation (SD), full width half maximum (FWHM) of the total lung was generated automatically [Fig. 1]. Post-SARS lung injury was characterized by residual ground glass opacity and fibrotic lung changes [1]. In our visual assessment, each lung segment (total 18 segments) was assessed from grade 0 (normal) to grade 3 (significant fibrosis). Addition of the grades resulted in the visual lung score (VLS).

15 patients had normal lung function (30%), 27 restrictive (54%), 4 obstructive (8%), and 4 mixed (8%). Reduction in DLco occurred in 32 patients (64%). For the CT scan, 13 patients (26%) were normal. The median score of VLS was 3 (IQR 0-12.3). There was significant correlation between the VLS and quantitative CT parameters (MLA, FWHM, and SD). The majority of post-SARS patients showed a restrictive lung pattern that is easily understandable because fibrosis may set in after SARS infection. In these patients, some statistically significant correlations were found [table 1]. The correlation of FWHM, an indirect measure of kurtosis, with FVC was consistent with a study on idiopathic pulmonary fibrosis [2]. Remy-Jardin M et al. reported extensive ground glass opacification on CT images which was significantly associated with a lower DLco in chronic diffuse infiltrative lung disease [3]. Residual ground glass opacification was noted in most of these post-SARS patients.

Visual estimation has its greatest advantage in the simplicity of its approach. The disadvantages are subjectivity and difficulty in estimating the contribution of different components of disease (ground glass opacity, architectural distortion, traction bronchiectasis etc.) and integrating them to derive a quantitative measure. The *syngo* Pulmo CT quantitative measures of MLA, FWHM, and SD provide objective findings. FWHM and MLA had significant correlation with different lung functions.



[1] *Automatically generated evaluation summary of syngo Pulmo CT assessment.*

[Table 1]

Comparison of correlation coefficient of quantitative and visual lung scores with pulmonary functions.

	MLA vs DLco	FWHM vs FEV1	FWHM vs FVC	VLS vs DLco
Unselected 50 patients	-0.215	-0.257	-0.075	-0.242
Exclusion of 4 patients with obstructive lung pattern	-0.326*	-0.188	-0.051	0.316*
Exclusion of another 4 patients with mixed lung pattern	-0.303*	-0.269	-0.095	-0.342*
Patients with restrictive lung pattern (27 patients)	-0.383*	-0.487*	-0.406*	-0.391*

*$p < 0.05$

1 Antonio GE, Wong KT, Hui DSC et al. Thin-section CT in patients with severe acute respiratory syndrome following hospital discharge: preliminary experience. Radiology 2003; 228: 810–815

2 Best AC, Lynch AM, Bozic CM, Miller D, Grunwald GK, Lynch DA. Quantitative CT indexes in idiopathic pulmonary fibrosis: relationship with physiological impairment. Radiology 2003; 228: 407–414

3 Remy-Jardin M, Giraud F, Remy J, et al. Importance of ground glass attenuation in chronic diffuse infiltrative lung disease: pathologic-CT correlation. Radiology 1993; 189: 693–698

* This software is available on a 90-day free trial basis. For more information please contact your local Siemens Representative.

LIFE – SOMATOM EDUCATE

Clinical Training for Cutting-Edge CT Expertise

One important factor in providing excellent health care today is ongoing, highest level training of the clinical staff. Therefore SOMATOM Educate delivers continous support to develop the clinical skills of all SOMATOM multi-slice CT users. The University of Vienna, Austria, is one of Siemens' partners who offer dedicated clinical training courses.

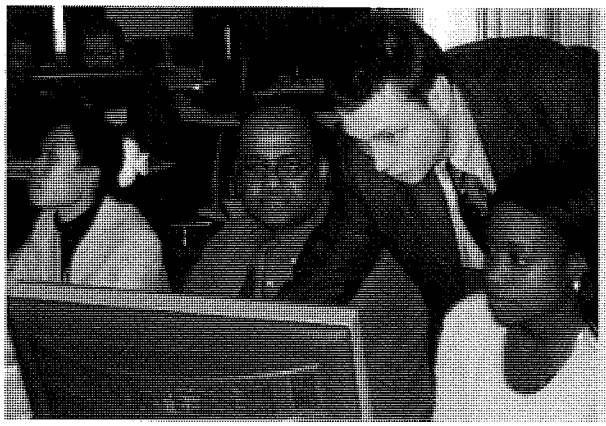
Clinical Training for modern multislice CT technology provides Siemens customers with advantages in the operating of highly advanced applications like HeartView CT, *syngo* LungCARE CT or *syngo* Colonography. With the SOMATOM Educate Program, Siemens Medical Solutions offers high-quality customer training at the world's leading institutions. One clinical partner in the Educate program is the University of Vienna's Department of Diagnostic Radiology, headed by Professor Gerhard Lechner, MD.

The training there includes international multi-slice CT courses adapted to the new challenges faced by radiologists and medical radiology assistants. The goal is to offer solid training on special subjects like 3D imaging or virtual colonoscopy, to achieve standard examination procedures and to optimize workflow.

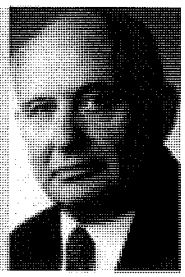
The training also consists of scientific lectures, *syngo* user-interface presentations, live demonstrations and hands-on sessions. Other important topics are patient preparation, examination planning and conducting, functionality of the *syngo* user interface, data analysis, diagnostic possibilities and workflow concepts. Maximum training impact is achieved by small group training with no more than ten participants, who, away from their daily routine, have the chance to intensively work with the new technologies and share experience. A standardized, consistent training concept ensures the quality of the courses. The course rooms are well equipped technically with LEONARDO training workstations installed.

The lecturers are renowned radiologists and experienced medical radiology assistants. To confirm the clinical relevance of the new diagnostic possibilities, and to round off the respective topics with established, diagnostic methods, guest speakers – internists, cardiologists, surgeons or gastroenterologists – enrich the training.

This clinical training program convinces the enthusiastic participants. Lisa Mohammed, MD, from Trinidad, says: "This workshop has made me a better radiologist in no uncertain term. The technology out there is mind boggling." All participants agreed they would also recommend the trainings to their colleagues.



Participants receive close personal support on their LEONARDO training workstations during their courses.



Professor Gerhard Lechner, MD, heads the University Hospital for Radio-Diagnostics in Vienna, Austria, one of Siemens Medical Solutions' partners for high-quality customer trainings.

Further Information:
CTMailCenter@siemens.com
Dates and Registration:
www.siemensmedical.com/SOMATOMEducate

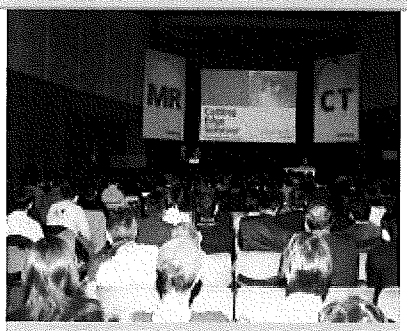
CUSTOMER EVENT

Introducing the Latest Technology

Siemens Medical Solutions introduced the latest product and clinical news to a wide, Japanese, expert audience at the 4th Siemens Cutting Edge Seminar in Tokyo. The key topics of this year's event, jointly organized by Computed Tomography (CT) and Magnetic Resonance (MR) Divisions, were the SOMATOM Sensation 64 and MR's Total Imaging Matrix (TIM). While the annual event attracted mainly radiology experts in the past, cardiology interest notably increased this year due to the new possibilities of Speed4D Technology and fast rotation times.

Bernd Ohnesorge, PhD, Vice President Marketing of the CT Division, gave an insight into the present and future of CT with the SOMATOM Sensation 64. Several applications have recently become clinical routine recently due to the fast spread of 16-slice scanners, for example, the identification of coronary artery disease and low-dose lung evaluation with comfortable breathhold times. But there are also new possibilities on the horizon, including improved lung nodule evaluation and automated CT digital substraction angiography (DSA).

Stefan Achenbach, MD at the University of Erlangen, Germany, added a clinical perspective on Cardiac CT in daily routine. As one of the first users of the STRATON X-ray tube and 0.37 seconds rotation speed, he shared his experience on the improved diagnostic confidence and shortened workflow times of the latest SOMATOM Sensation Cardiac with Speed4D Technology. He made a strong case for the growing role of CT in cardiology, illustrated with a variety of spectacular cases from his hospital. The presentations opened many opportunities for discussion at the following reception.



A record of more than 500 customers joined the 4th Siemens Cutting Edge Seminar in Tokyo.

SERVICE

Frequently Asked Questions

Via the SOMATOM World User Lounges, Siemens applications specialists answer your questions on "how to ..." easily use Siemens Computed Tomography scanners and applications in daily clinical practice. Additionally, SOMATOM Sessions offers a regular column with frequently asked questions for offline reference.

Is there a way in syngo InSpace to combine the slab clip plane with the VOI punch tool so that the punch is restricted only to the slab? This would be very useful for selective editing, for example to remove the femoral head so that an acetabular fracture could be viewed en face?

Yes, you can affect the VOI punch with clip planes. This is a powerful editing feature. It is also pretty intuitive when you punch using „Keep Inside". To use it, just turn on and position as many clip planes as you like. Then draw your ROI. Before punching, select the "Clip ROI" box on the VOI punching dialog box. Then click "Keep Inside". The punch will proceed as normal; but when you turn off the clip planes, you'll notice that the volume which they were hiding has been removed. Thus, with "Keep Inside", using "Clip ROI" has the effect of making your clip planes semi-permanent.

The effect of "Clip ROI" is not as intuitive when you punch with "Keep Outside". In both cases, the volume clipped by the clip plane(s) affects the punch volume. In this case, though, because you are keeping what is outside of the punch volume, "Clip ROI" plus "Keep Outside" has the effect of masking the volume removal to only the volume as clipped.

How do we see images that have been burned to a CD from the scanner on a regular PC/laptop computer with a CD-ROM drive?

The PC/laptop you are using must have a DICOM viewer loaded before you can access the DICOM formatted images on the CD. Usually, regular image programs on computers are not equipped to view DICOM formatted images. Entering in the search words "free DICOM viewer" in a search engine yields a variety of free downloads from the Internet. Our latest software version also includes a DICOM viewer. Please contact you local Siemens sales representative for further information.

Baltimore, 7 a.m.: each of the 13 hands-on sessions at both meetings was oversubscribed.

CLINICAL TRAINING

Hands-on the LEONARDO

The Johns Hopkins Medical Centre is well known for its continuing medical education courses, not least Professor Elliot Fishman, MD, for his popular multi-detector CT (MDCT) workshops. In March and April, Siemens Medical Solutions hosted hands-on workstation training sessions at his "Advanced Topics in CT Scanning" courses in Los Angeles and Baltimore. At both meetings, more than 300 radiologists and technologists took advantage of the opportunity for hands-on training in the principles of 3D and virtual imaging with *syngo* InSpace, CT angiography, cardiac CT, virtual colonography and lung imaging. Siemens provided 20 LEONARDO workplaces, enabling participants to work individually in the hugely popular hands-on sessions. Each 90 minute session began with a "how-to" demo lead by both the Hopkins course faculty and Siemens applications specialists, which highlighted the principles of the techniques and their clinical applications. Participants then dived in to a wealth of specially chosen clinical cases, supported by a team of Siemens applications specialists who made sure that, by the end of the session, everyone walked away with a good grasp of the principles and clinical application of 3D and virtual post-processing techniques.

Further Information:
www.CTisus.com, www.siemens.com/SOMATOMEducate

CT ONLINE

What's interesting in the On-Line world of CT?

www.ctisus.com
This is a dedicated CT website hosted by Professor Elliot Fishman, MD, of Johns Hopkins University. With CT education in mind, anyone interested in learning more about MDCT, CT angiography, PET-CT and many other clinical applications for CT will find useful teaching modules, presentations and information about upcoming Johns Hopkins CME courses.

www.siemens.com/SOMATOMWorld
Within our SOMATOM user lounges, you will find interesting news about your CT scanner. Additionally, you can share your experiences with your colleagues – either in a discussion board posting or by publishing your own case studies. Many of your colleagues, from all over the world, have already joined and experienced its benefits.

Upcoming Events & Courses

Title	Location	Short Description	Date	Contact
Cardiac CT	Nuremberg, Germany	5th international conference on Cardiac CT	July 23–24, 2004	www.cardiac-ct.org
ESC	Munich, Germany	Congress European Society of Cardiology	Aug. 28–Sept.1, 2004	www.escardio.org
ESGAR CT Colonoscopy Workshop	Rome, Italy	How to do CT Colonoscopy; 2 day hands-on workshop	Sept. 16–17 and 17–18, 2004	www.esgar.org email: office@esgar.org
ASTRO	Atlanta, USA	American Society for Therapeutic Radiology and Oncology	Oct. 3–7, 2004	www.astro.org
AHA	New Orleans, USA	American Heart Association Scientific Sessions	Nov. 9–12, 2004	www.americanheart.org www.scientificsessions.org
RSNA	Chicago, USA	Radiological Society of North America	Nov. 28–Dec. 3, 2004	www.rsna.org
CME Courses	Johns Hopkins University, Baltimore, USA	Focus on multidetector CT scanning and post-processing	ongoing	www.CTisus.com

In addition, you can always find the latest CT courses offered by Siemens Medical Solutions at www.siemens.com/SOMATOMEducate.

SOMATOM Sessions – IMPRINT

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In the imprint of the last issue, we overlooked to mention Filippo Cademartiri, MD and Nico Mollet, MD, Department of Radiology and Cardiology, Erasmus Medical Center, Rotterdam, The Netherlands. We sincerely apologize for the mistake.

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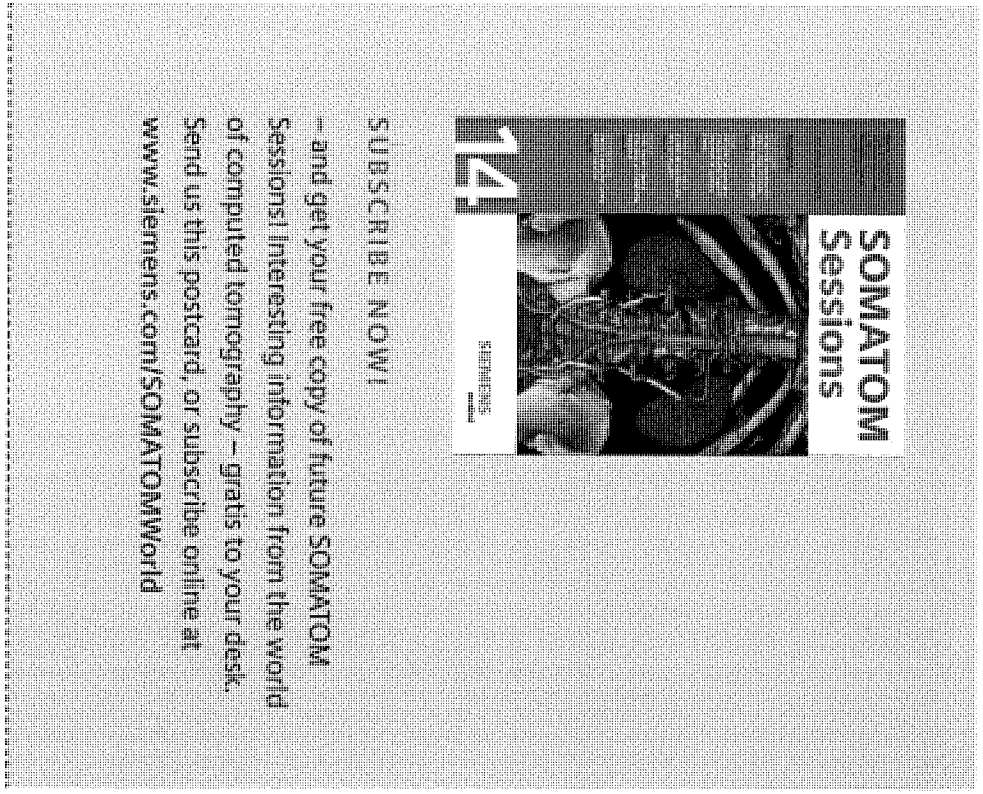

SOMATOM Sessions
Issue No. 14/June 2004

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The information in this document contains general technical descriptions of specifications and options as well as standard and optional features which do not always have to be present in individual cases.

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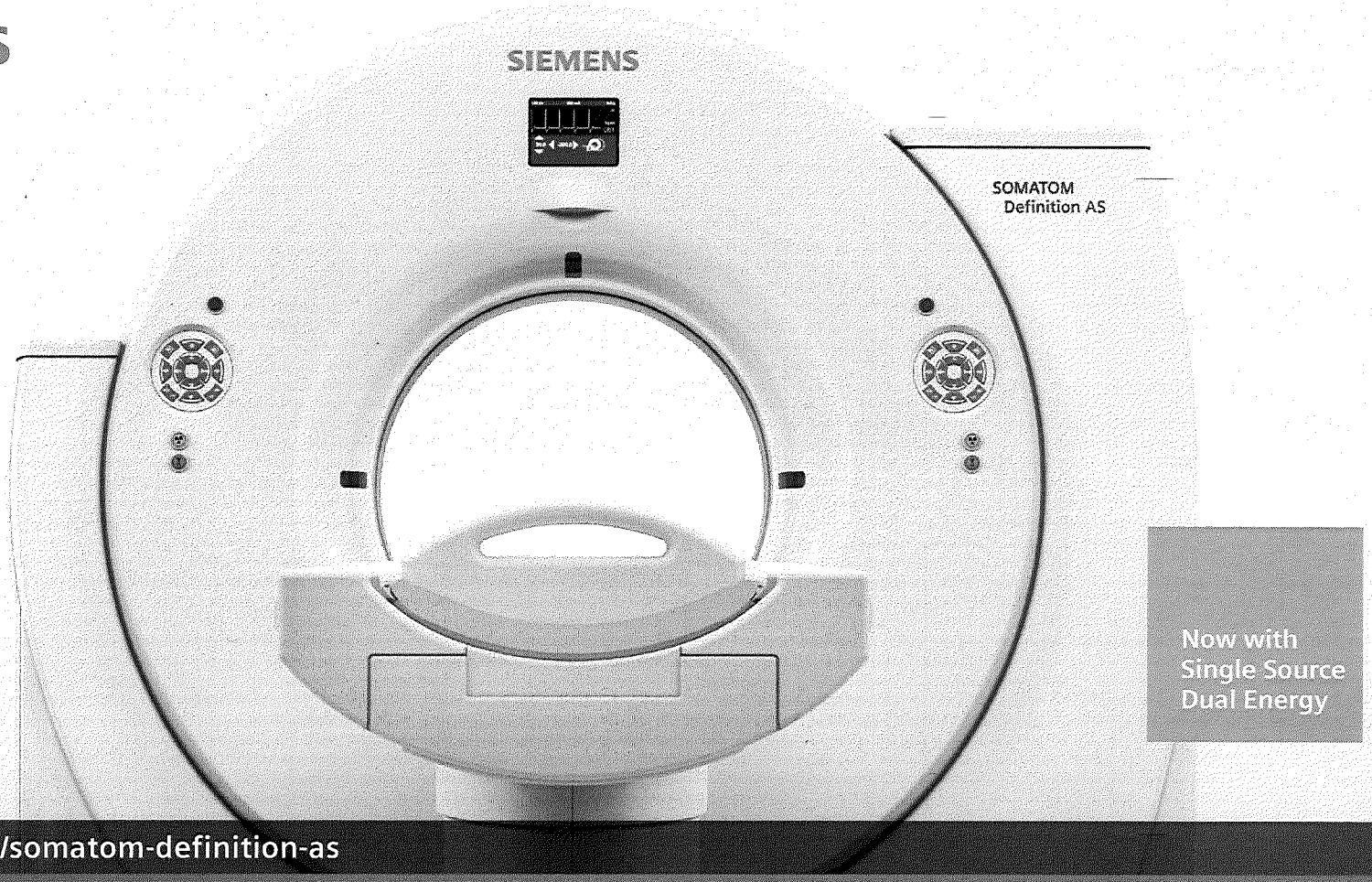


Now with
Single Source
Dual Energy

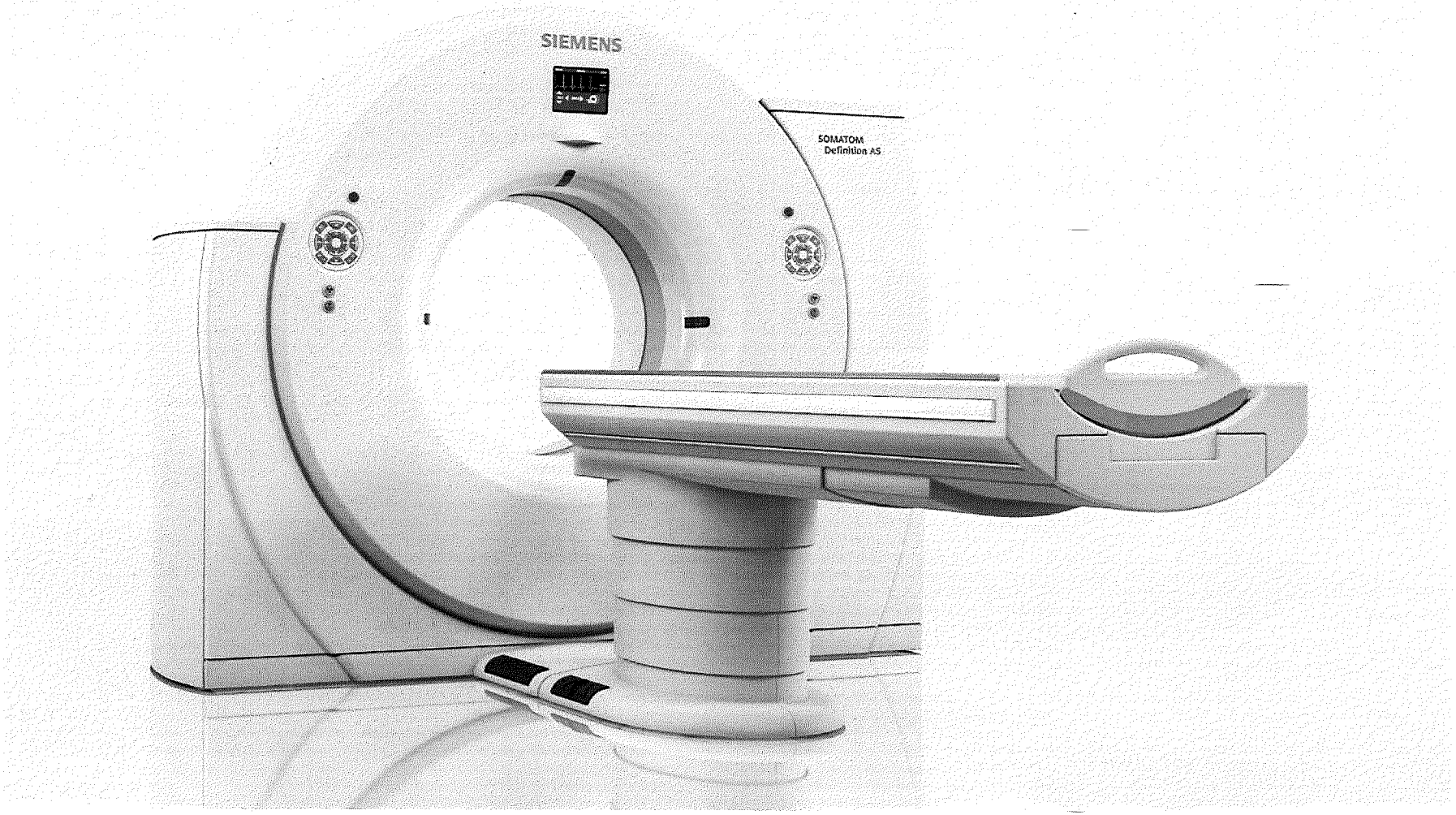
www.siemens.com/somatom-definition-as

Maximize Outcome. Minimize Dose.

SOMATOM Definition AS

International version. Not for distribution in the US.

Answers for life.



SOMATOM Definition AS

Maximize Outcome. Minimize Dose.

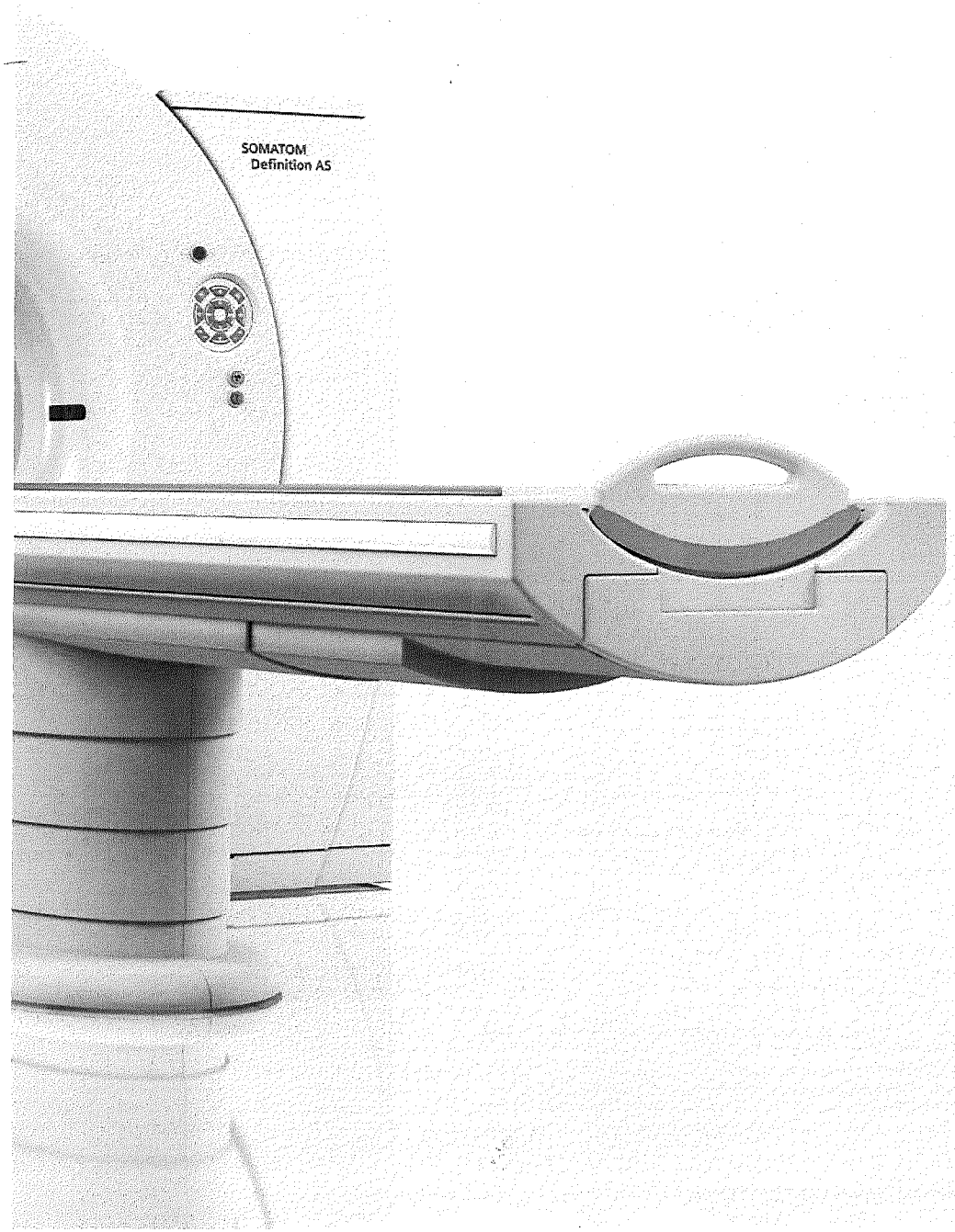
SOMATOM Definition AS

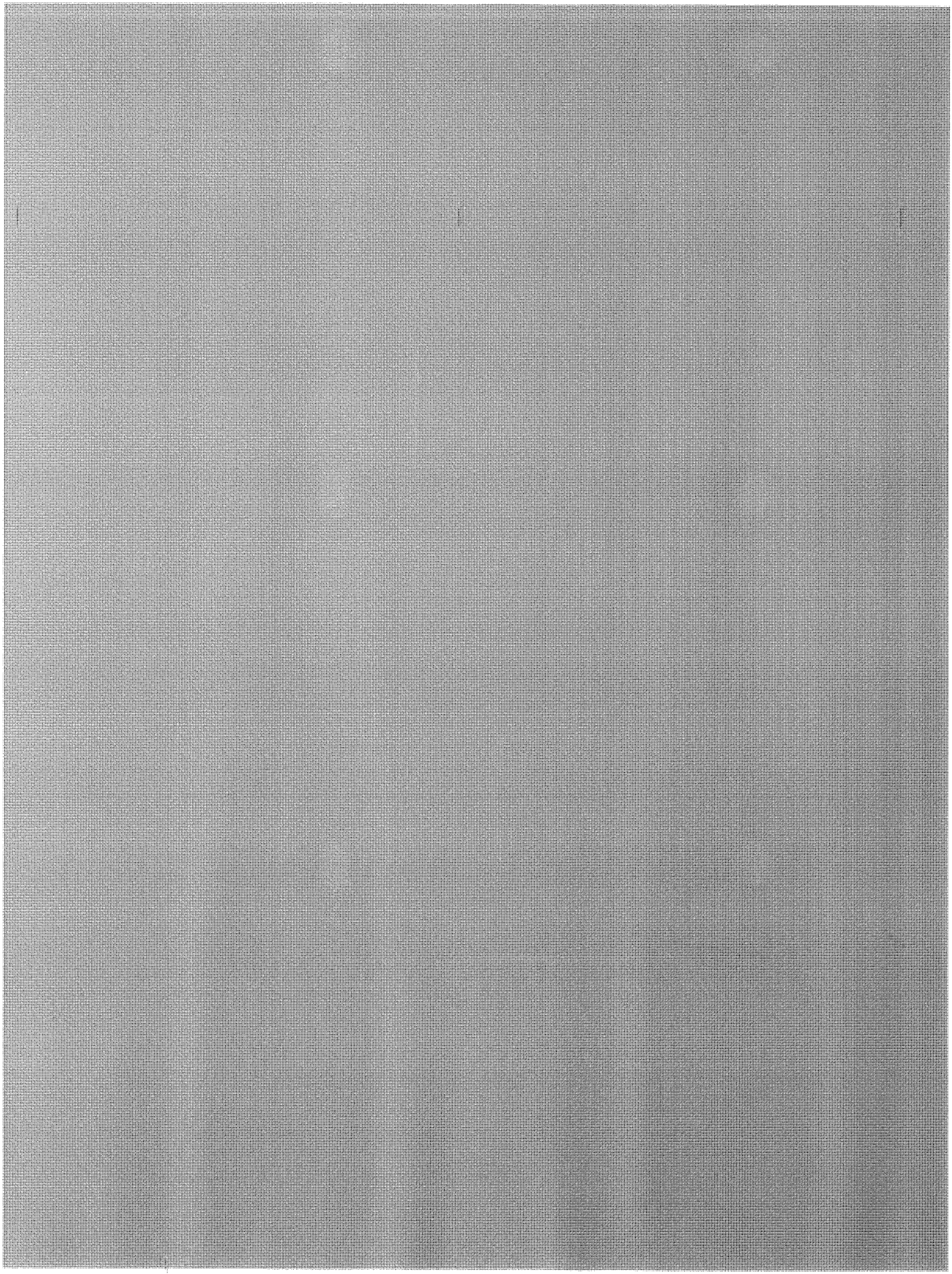
Maximize Outcome. Minimize Dose.

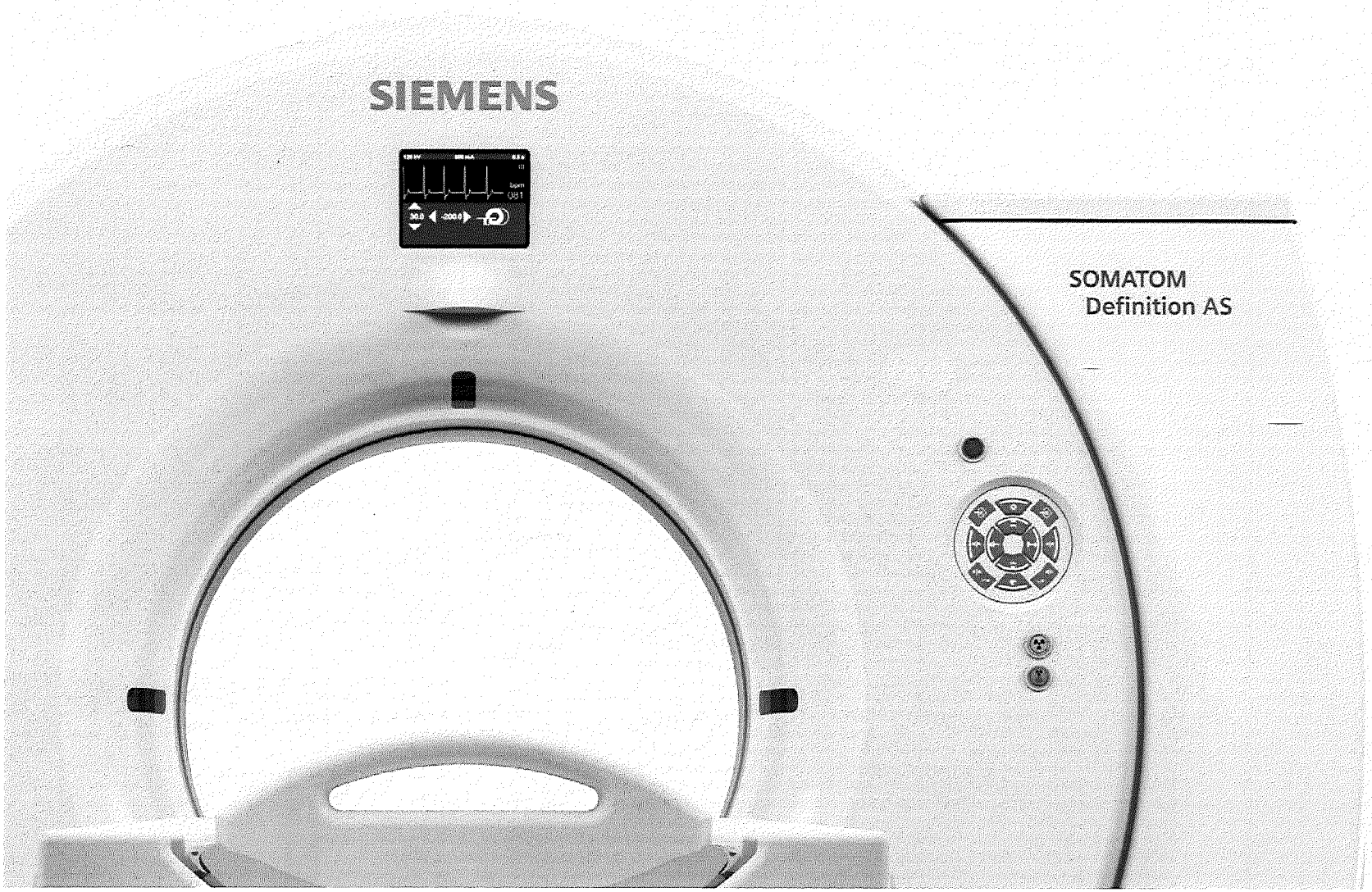
With the SOMATOM Definition AS, Siemens has established a scanner that for the first time is capable of adapting to virtually every patient and every clinical question. With its great flexibility, the system has proven to be the right choice when it comes to high-end CT imaging – no matter whether it is set to be used for routine diagnostic imaging, high-end cardiac settings, or to add functional and material information to morphology with Dual Energy or dynamic datasets. Furthermore, the system can be tailored to fit specialized clinical settings like high-end surgery, a two room acute care solution with a Sliding Gantry, a dedicated radio therapy planning scenario with a large bore, or a highly efficient interventional setting with outstanding 3D capabilities. All this comes along with Siemens' unique FAST CARE technology. Outstanding clinical results and more time with your patients: it's simply made to maximize clinical outcomes and patient-centric productivity.

In addition, the system is designed to minimize dose. From the very beginning, one of the most important topics for Siemens CT has been patient safety. In Computed Tomography, patient safety translates primarily into dose reduction. Over the years, Siemens has been highly successful in integrating many innovations into the Siemens scanners that significantly reduce radiation dose in comparison to other systems available on the CT market. Examples for this are the Adaptive Dose Shield or SAFIRE* with the capability to reduce dose by up to 60%. Along with the CARE features like CARE kV – the industry's first automated exam-specific kV setting – the system gives users every means to minimize dose and consequently take best care of their patients' well-being.

*In clinical practice, the use of SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. The following test method was used to determine a 54 to 60% dose reduction when using the SAFIRE reconstruction software: noise, CT numbers, homogeneity, low-contrast resolution, and high contrast resolution were assessed in a Gammex 438 phantom. Low dose data reconstructed with SAFIRE showed the same image quality compared to full dose data based on this test. Data on file.







Product Benefits

Single-Click Readiness

Equipped with FAST CARE technology and Single Source Dual Energy, the SOMATOM Definition AS leads to faster and more reliable clinical results.

FAST CARE technology

To give medical professionals more time to take better care of their patients, our new FAST CARE technology accelerates workflow and lowers radiation exposure to previously unseen levels – to help users leverage untapped potential in patient-centric productivity. FAST CARE technology offers comprehensive software packages adjusted to customers' needs and clinical fields.

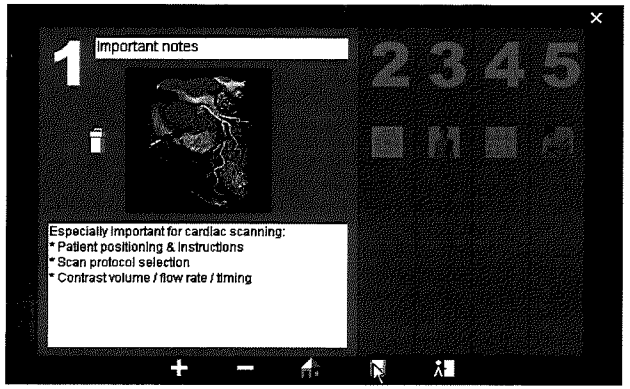
FAST CARE technology – Be FAST

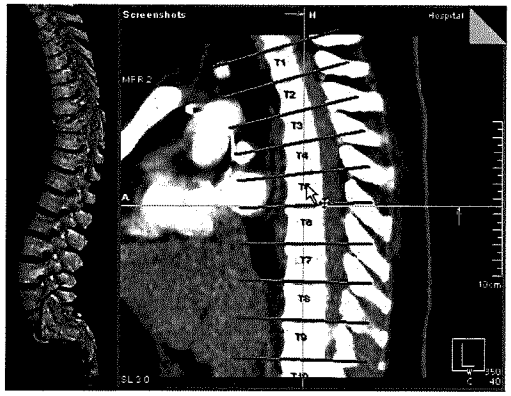
With the Fully Assisting Scanner Technologies (FAST) features, typically time-consuming and complex procedures during the scan process are simplified and automated, not only improving workflow efficiency, but optimizing the overall clinical outcome by creating reproducible results. This makes diagnosis more reliable and reduces patient burden through streamlined examinations. The technology helps the user in every step of the scan procedure – no matter if it is preparation, scanning, or reconstruction.

Efficient scan and recon planning

FAST Planning prepares the scan and recon settings based on the characteristics of the chosen organ. This not only reduces the efforts needed to set up an examination, but makes them highly reproducible and less error-prone. With FAST Adjust, parameters can be simply adjusted or, when in doubt, defined just with the push of a button. The FAST Scan Assistant offers a user-friendly, streamlined interface for adjusting and adapting scan parameters depending on the individual patient.

FAST Cardio Wizard guides the user intuitively through the preparation of cardiac examinations with easy to follow step-by-step explanations.





Anatomically correct spine reconstructions are typically very time consuming procedures, as every spinal vertebrae and disc needs to have its own recon layer depending on its individual position. With FAST Spine, these manual steps can be simplified to just a single click.

Guided routine in cardiac CT

One of the most sophisticated examinations is cardiac CT. The SOMATOM Definition AS provides ideal specifications for cardiac CT with a rotation speed as low as 0.30 s and dedicated scan modes like Adaptive ECG Pulsing or the Adaptive Cardio Sequence. Additionally, FAST CARE technology offers a unique feature to support this particular workflow. The FAST Cardio Wizard uses a step-by-step approach showing how to achieve an optimal cardiac scan, either for training purposes or in a real-life situation, thus helping to set institutional standards and uniform quality.

Focus on the patient, not the system

Unfortunately, complexity can become a source of inefficiency or, even worse, errors. Typical examples are spine exams. With conventional CT scanners, this means a lot of cumbersome, manual preparation steps, which make spine recon especially time-consuming. This is simplified to ideally just a single click with FAST Spine, saving not only valuable time, but making these tasks more reliable. At the end of the day, the SOMATOM Definition AS with FAST CARE technology helps to save highly valuable time, so that it can be spent on diagnosis and the interaction with patients.

Single Source Dual Energy as easy as a spiral scan

Dual energy makes it possible to add functional and material information to morphology. Now the combination of a routine-ready scan mode and enhanced low-kV image quality is available on every SOMATOM Definition AS. This offers new applications and opportunities to expand both the clinical and the research portfolio in everyday practice. And even better, the Dual Energy scan mode is as easy as a spiral scan.

Your Single Source for Right Dose

Equipped with a variety of unique dose protection and reduction features, the SOMATOM Definition AS will lead you to excellent clinical results taking CARE of the right dose.

FAST CARE technology – Take CARE

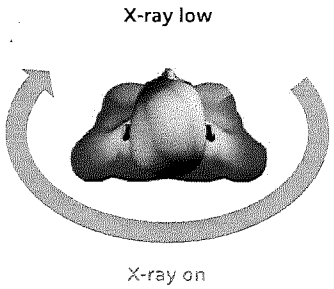
Applying the lowest radiation dose possible is of utmost importance both for users, and, of course, patients. With the Combined Applications to Reduce Exposure (CARE) the SOMATOM Definition AS offers an outstanding dose protection portfolio to achieve highest dose protection and reduce radiation to a level as low as possible. This satisfies the desire for the lowest possible radiation exposure while on the other hand delivering excellent image quality. And all this is fully automated and integrated into the scan process.

Completing the picture for patient-centric imaging with CARE kV

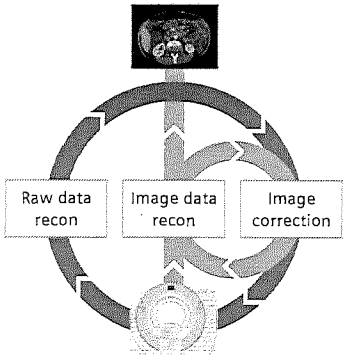
For decades, Siemens has put the patient in the center of the examination, especially with regard to radiation protection. CARE Dose4D™ has proven its qualities for many years with its unique real-time dose modulation that guarantees an unparalleled combination of outstanding image quality at minimum dose for every patient. A new dimension has been added with CARE kV. It automatically sets the appropriate voltage for the examination and adjusts other scan parameters according to the individual patient and selected examination type, thus delivering certainty of having highest dose efficiency in every scan.

Dedicated pediatric imaging with 70 kV protocols

Besides the ability to offer our customers the combination of maximum speed and exceptional image quality with no cooling delays, the STRATON X-ray tube has another unique feature: CARE Child, a dedicated pediatric CT imaging tool which includes 70 kV scan modes and specific CARE Dose4D curves and protocols, comes as a standard feature with every SOMATOM Definition AS. This makes it possible to scan even the most vulnerable patients, if necessary, with a good conscience.



X-CARE reduces the tube current close to zero within a certain range of projections, minimizing direct exposure for highly dose sensitive body regions.



SAFIRE

- More powerful dose reduction than image-based methods
- Well-established image impression
- Superior image quality
- Fast reconstruction in image and raw-data space and improved workflow with variable settings

Organ-sensitive dose protection

Previous attempts at dose reduction were very successful but did not specifically take into consideration highly dose sensitive areas such as women's breasts or the heart. Here, the SOMATOM Definition AS can selectively reduce exposure in sensitive areas with X-CARE. Furthermore, the gantry tilt protects dose sensitive organs like the eyes or the thyroid gland by moving them out of the x-ray beam in sequential or spiral scans. And finally, the Adaptive Dose Shield protects patients from unnecessary spiral over-radiation, which is crucial, for example, in cardiac examinations.

Iterative reconstruction with SAFIRE

Iterative reconstruction can achieve significantly increased image quality with reduced dose. The further integration of raw data beyond the initial reconstruction process, however, posed considerable restrains regarding the computational power available – up to now: with Sinogram Affirmed Iterative Reconstruction – SAFIRE* – Siemens introduced a new and unique approach to iterative reconstruction. Raw data information is utilized to enhance the image quality or reduce dose. This is made possible by a new reconstruction algorithm, as well as an image reconstruction system, delivering the required reconstruction power.

Dose-optimized Dual Energy scan

In order to avoid doubling the dose, both scans of the Dual Energy scan are performed at approximately half the dose utilizing all dose reduction functionalities: e.g. CARE Dose4D, SAFIRE, and Adaptive Dose Shield. The result is a dose-optimized Dual Energy scan that helps to add functional and material information to morphology.

*In clinical practice, the use of SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. The following test method was used to determine a 4 to 60% dose reduction when using the SAFIRE reconstruction software: noise, CT numbers, homogeneity, low-contrast resolution, and high contrast resolution were assessed in a Gammex 438 phantom. Low dose data reconstructed with SAFIRE showed the same image quality compared to full dose data based on this test. Data on file.

Open for all Patients

The outstanding flexibility of the SOMATOM Definition AS addresses the versatile needs of physicians and patients, thus offering a solution for every clinical demand.

Open for every clinical demand

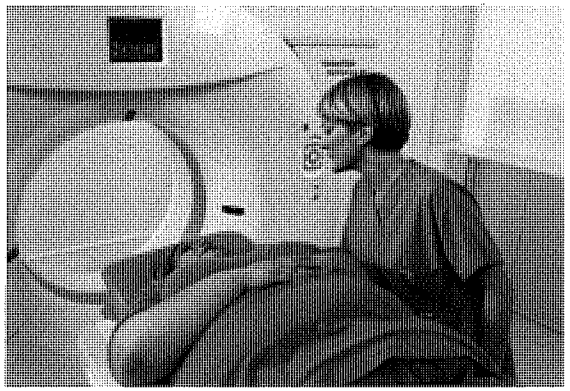
The SOMATOM Definition AS can be configured and customized to fit virtually any setting. Its full on-site upgradeability from 20- to 128-slice configuration permits specifying the system precisely to the customer's clinical requirements and financial situation. It also gives investment protection and assurance to grow with future demands. With its small footprint and freely selectable air- or water-cooling, it perfectly adapts to every clinical setting, e.g. acute care where a sterile environment is of utmost importance.

Open for functional imaging

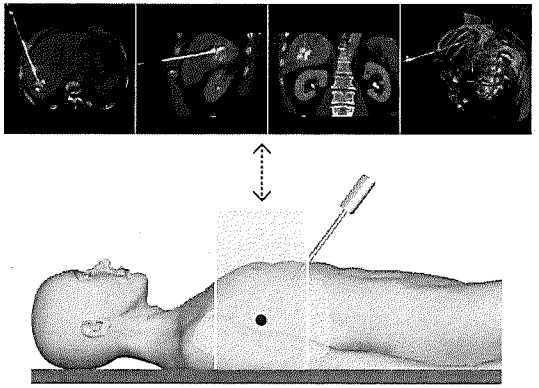
Dynamic imaging has become a new dimension in CT over recent years. With the innovative Adaptive 4D Spiral, the SOMATOM Definition AS offers whole brain perfusion or long-range CTAs. Able to cover up to 42 cm, it overcomes the limitations of a static detector design when imaging whole organs or regions. Furthermore, the system offers Siemens' easy-to-use Dual Energy functionality with different clinical applications. This enables users to answer a wide range of diagnostic challenges and widen the clinical portfolio.

Open for bariatric patients

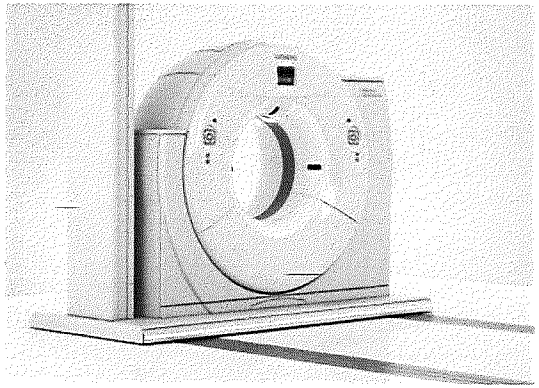
No one should be excluded because of the limitations of a system. For bariatric patients, patient accommodation and power reserves are the key. Here, the SOMATOM Definition AS offers up to 80 cm bore diameter, 307 kg table load capacity, and a 100 kW power generator. All this results in great image quality, performance, and clinical efficiency.



The SOMATOM Definition AS delivers clinical excellence and opens CT for all patients - regardless of the given conditions.



Adaptive 3D Interventions offers real time 3D during intervention procedures.



The Sliding Gantry solution can serve two rooms with one CT.

Open for intervention

Intervention in CT has established itself in recent years. Over 30% of existing SOMATOM Definition AS customers use the Siemens' unique intervention solution. It puts users in full control in any plane with 3D-guided interventions. Additionally, it delivers a more accurate overview of needle position and surrounding organs during difficult procedures. All this can be done without leaving the patient's side, managing the entire procedure with just the touch of a button with i-Control. With 3D guided guidance for minimally invasive procedures, the system makes interventions more accurate, thus safer and, in the end, more efficient.

Open for radiation therapy

Over recent years, computed tomography has become the preferred choice for virtual simulation. Radiation therapy is evolving towards more precise and more powerful treatment delivery techniques. With the SOMATOM Definition AS, Siemens offers an outstanding versatile large bore that fulfills the needs both of radiation therapy and general diagnostics. With the RT Pro Edition, dedicated features have been developed for high-end radiation therapy planning. On the other hand, the system can serve as a perfect back-up system for radiology if needed.

Open for specialized clinical settings

Nevertheless, there are clinical settings where a regular CT reaches barriers that seem to be insuperable. Not the SOMATOM Definition AS. The system can even be mounted as a Sliding Gantry, offering access to solutions such as two rooms being served with one gantry. Dedicated high-end surgery settings in combination with surgery tables can be realized, opening new paths into completely new directions. It enables high-resolution CT imaging to be utilized during surgical procedures without the need to move the anaesthetized patient.

Added Benefits of *syngo*.via

Regardless of volume or disease, *syngo*.via helps in preparing cases, eases interdisciplinary collaboration, and helps generate a faster and more reliable diagnosis.

syngo®.via for sustainable care

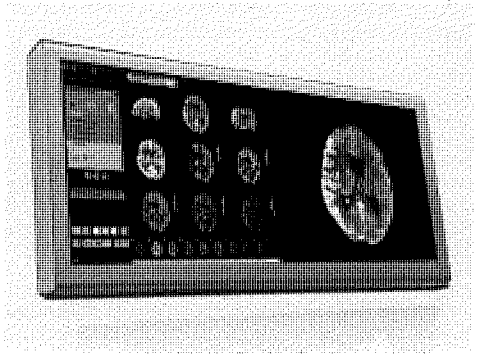
As the number of chronic disease patients rises, the demand for high-quality, efficient care is increasing. *syngo*.via* is Siemens' state-of-the-art imaging software, creating an exciting experience in efficiency and ease of use. *syngo*.via can help foster sustainable care by equipping physicians with workflows and applications for evaluating images from multiple modalities. In the case of cardiovascular CT, it makes possible a rule-out of coronary artery disease in less than a minute.

Automated

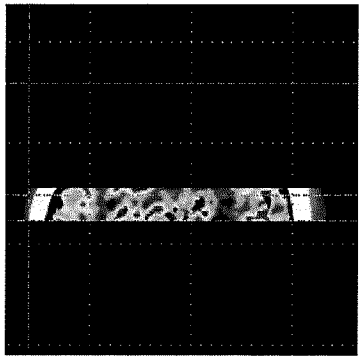
syngo.via helps physicians to analyze the individual case, prepares images, suggests an optimized workflow, and offers guidance when needed. For example, when a cardiac case is opened, the Automated Case Preparation has already pre-processed the images and displays them in the appropriate layout together with the right evaluation tools. Evaluation of the coronary vessels, the functional parameters, and the prepared calcium score can start immediately.

Image networking

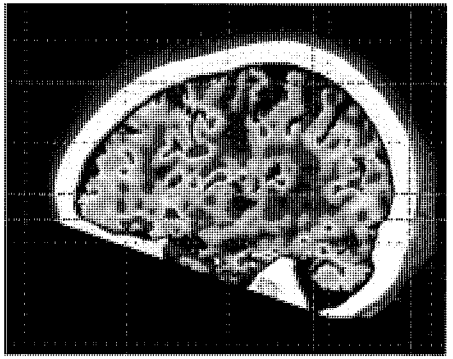
syngo.via speeds up the way users connect and share information with clinical partners and patients – even on the go.** *syngo*.via's client-server based nature supports a smooth, teamwork-like sharing of tasks, just as it is required in 3D labs and larger radiology departments. Images can be shared among multiple users at once, providing a sound basis for joint pre-procedural planning.



syngo Volume Perfusion CT Neuro



Conventional Perfusion



Adaptive 4D Spiral Perfusion

Fast answers

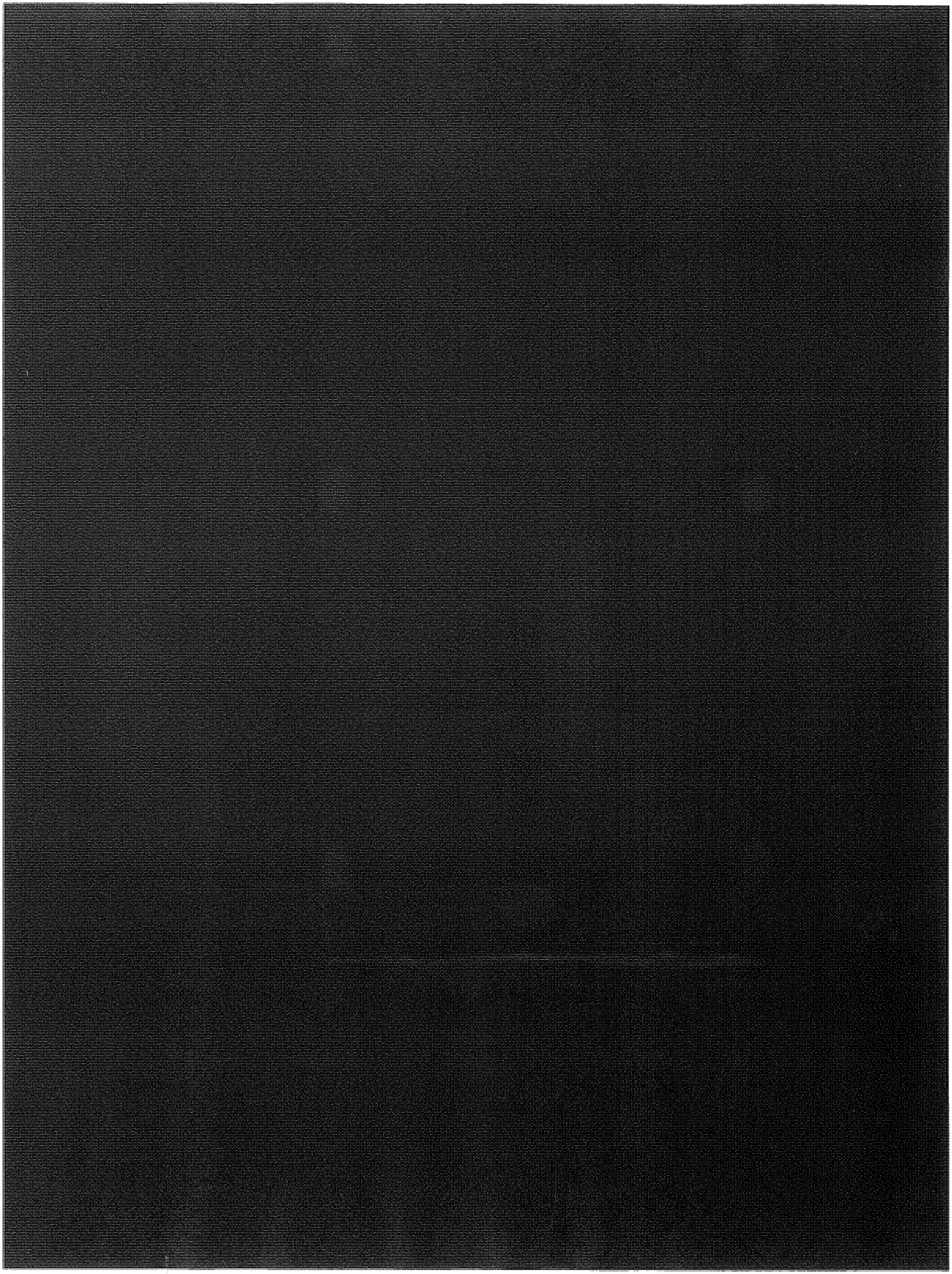
Using the SOMATOM Definition AS together with the CT Neuro Engine leads to unsurpassed workflow efficiency delivering fast answers to fundamental questions in stroke. These questions in stroke assessment vary: Is it caused by bleeding, what size and location has a possible clot, how big is the infarct and what does the blood flow look like in a dynamic way? The CT Neuro Engine offers a complete diagnostic stroke solution.

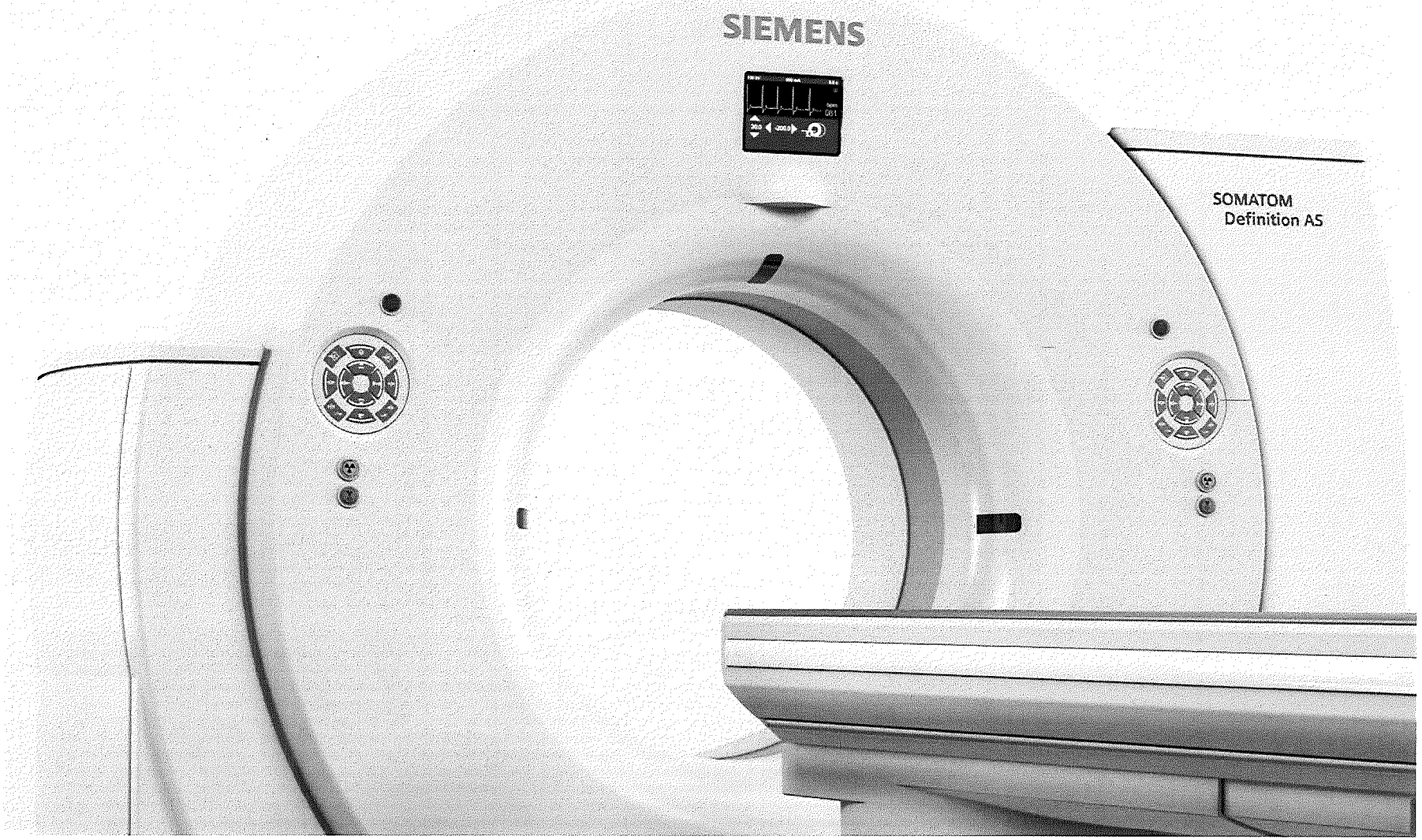
High precision and speed

Innovations such as whole brain CT Perfusion, Neuro BestContrast, or Dual Energy applications have dramatically changed the diagnostic approach for reading physicians by enabling new indications and improved times in the examination of patients with acute neurological diseases. In stroke evaluation, "time is brain." The CT Neuro Engine helps users answer the key questions so they can decide on optimal treatment – with high precision and speed.

* *syngo*.via can be used as a stand-alone device or together with a variety of *syngo*.via-based software options, which are medical devices on their own rights. These products are pending regulatory clearance in some countries and therefore not yet commercially available in all countries. Usage of *syngo*.via in an operating room or for an emergency case requires customers to provide respective emergency measures in case of non-availability of system or network.

** Prerequisites include: internet connection to clinical network, DICOM compliance, meeting of minimum hardware requirements, and adherence to local data security regulations.





Clinical Images

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
5.0 s

scan length:
116 mm

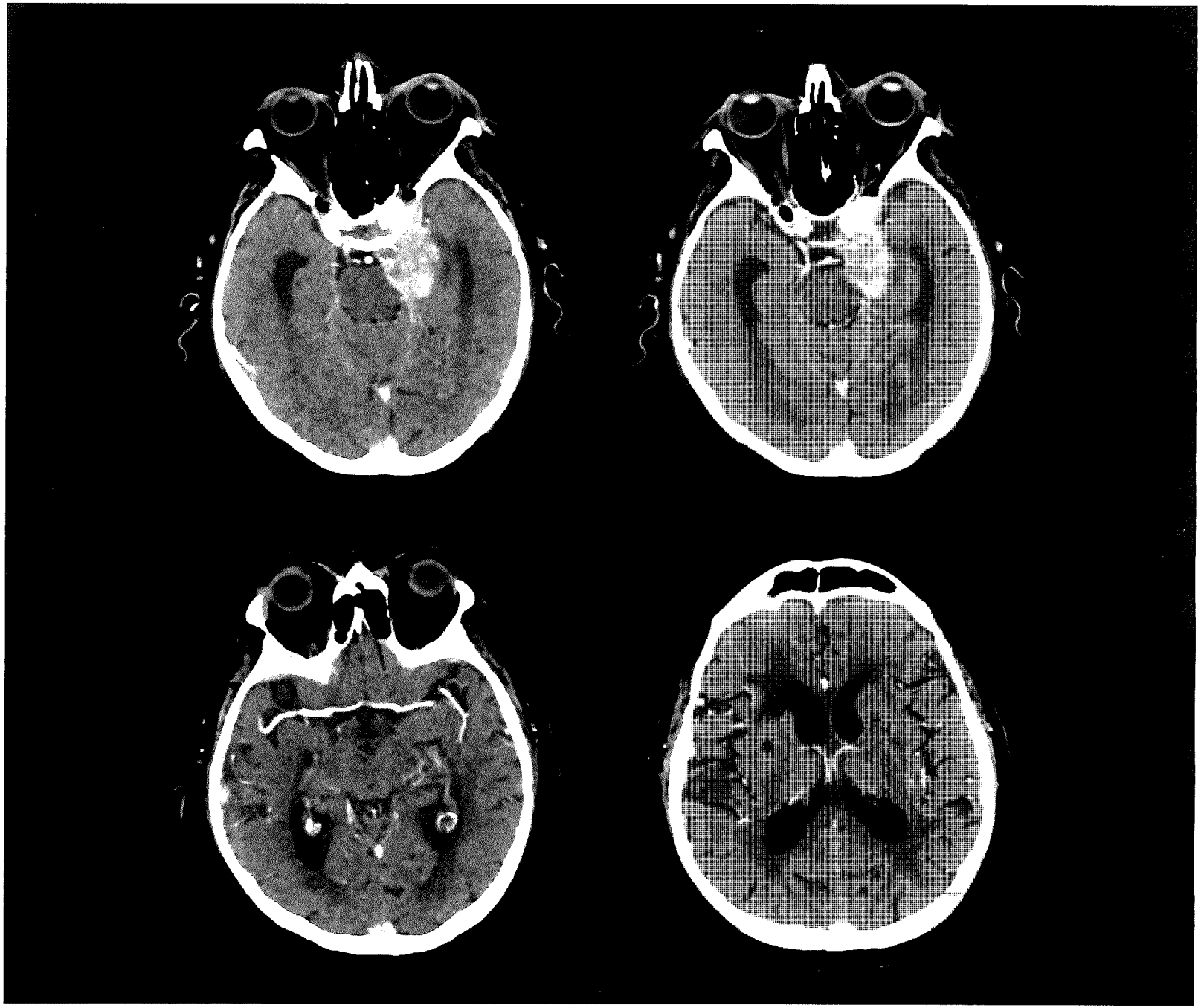
rotation time:
1.0 s

tube settings:
120 kV, 380 eff. mAs

CTDIvol:
54.08 mGy

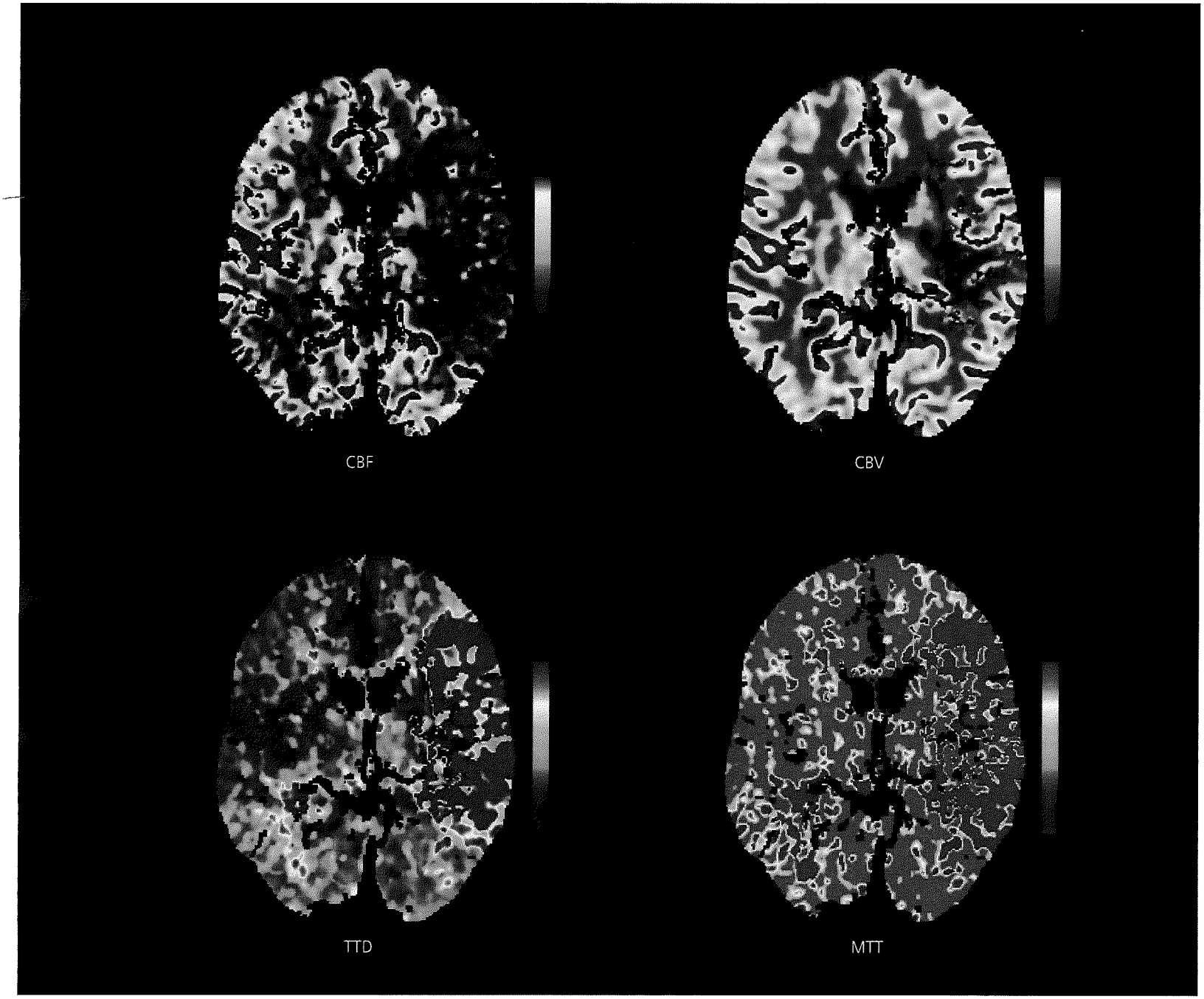
DLP:
916 mGy cm

eff. dose:
1.92 mSv



Cerebral CT –
Contrast enhanced axial images show a suspected meningioma extruding the pons and bilateral lacunar infarctions in the basal ganglia area.

Centre Hospitalier Caremeau, Nimes, France



University of Goettingen, Goettingen, Germany

system:
SOMATOM Definition AS+

collimation:
32 x 1.2 mm

scan time:
45.0 s

scan length:
84 mm

rotation time:
0.6 s

tube settings:
80 kV, 200 eff. mAs

CTDIvol:
218.99 mGy

DLP:
2505 mGy cm

eff. dose:
5.3 mSv

Volume Perfusion CT –
VPCT images show significantly reduced blood flow, along with a prolonged time to drain and a mean transit time with partially reduced blood volume in the left MCA territory.

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
3.5 s

scan length:
375.9 mm

rotation time:
0.5 s

tube settings:
100 kV, 90 eff. mAs

CTDIvol:
2.83 mGy

DLP:
116 mGy cm

eff. dose:
2.204 mSv

Sliding Gantry CT –
allows a fast patient triage and emergency management, as for this injured young boy.

Wels KH UNF, Wels, Austria

University of Radiology Diagnostic, Salzburg, Austria

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
7.0 s

scan length:
677 mm

rotation time:
0.5 s

tube settings:
120 kV, 186 eff. mAs

CTDIvol:
12.59 mGy

DLP:
889 mGy cm

eff. dose:
13.34 mSv

Polytrauma CT –
MPR images present multiple costal and spinal fractures with vertebral subluxation, a C2- fracture , and a right-sided pleural effusion with pulmonary atelectasis.

system:
SOMATOM Definition AS 64

collimation:
20 x 0.6 mm

scan time:
21.0 s

scan length:
203 mm

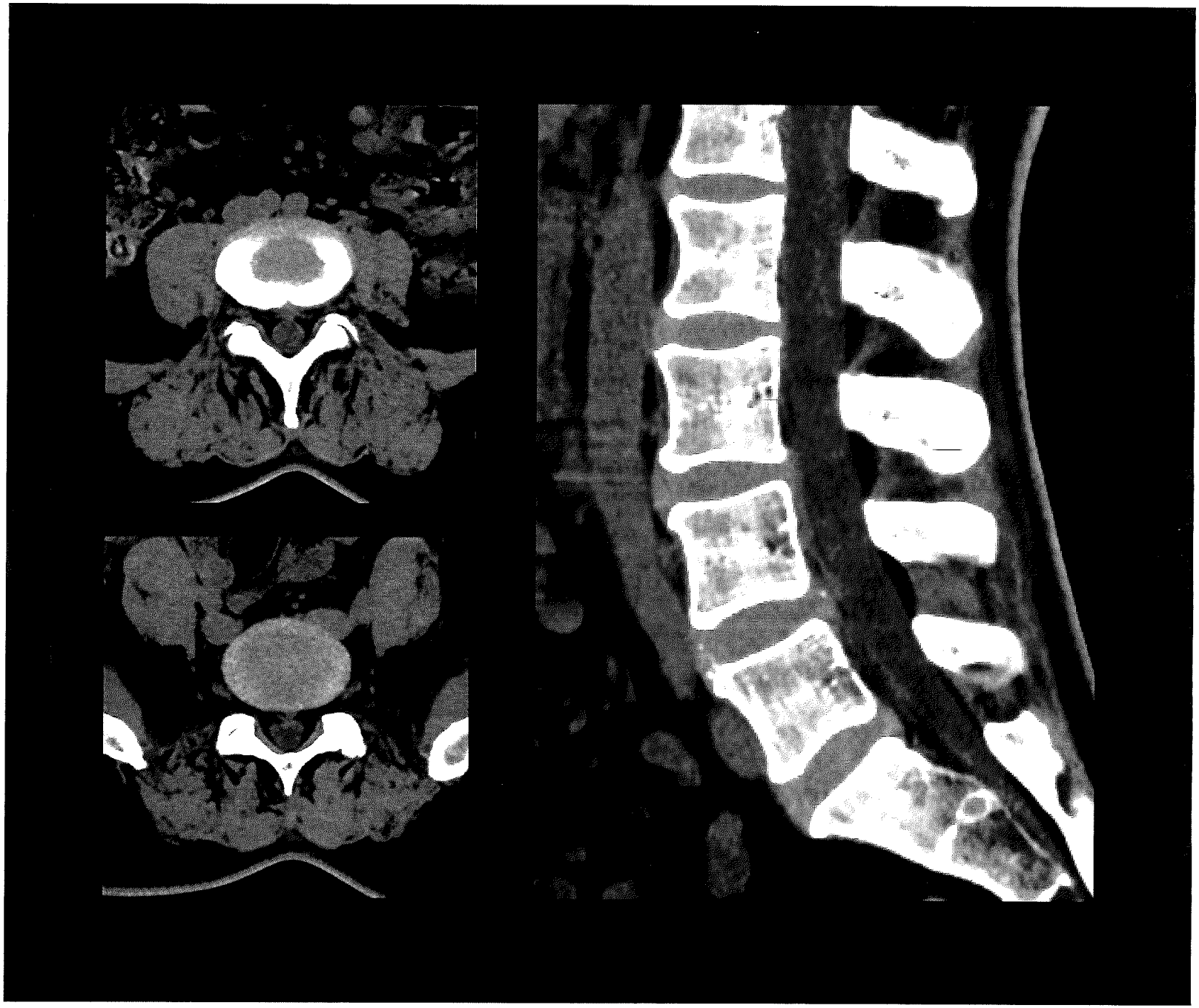
rotation time:
1.0 s

tube settings:
100 kV, 395 eff. mAs

CTDIvol:
18.72 mGy

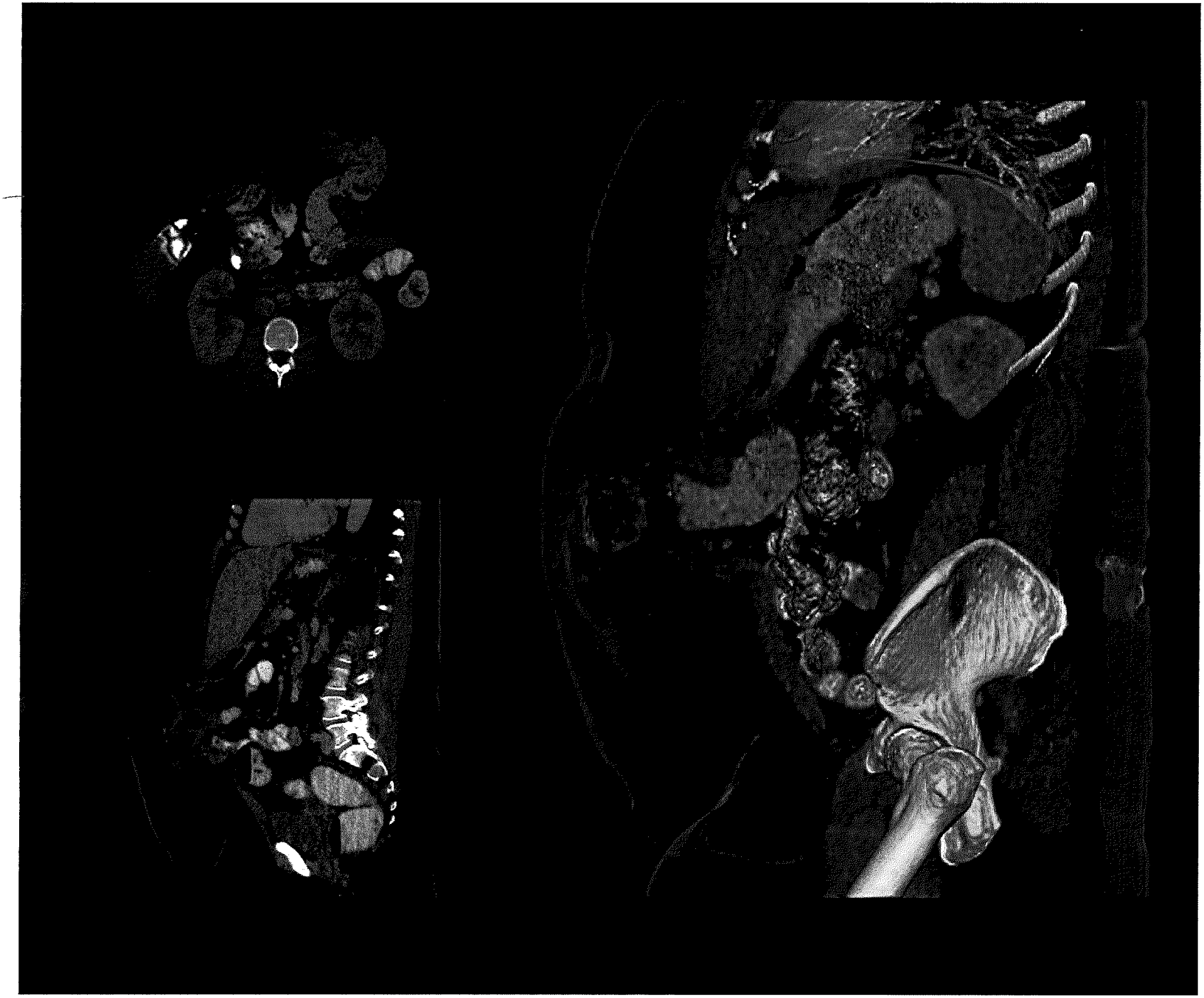
DLP:
398 mGy cm

eff. dose:
5.97 mSv



Spinal CT –
MPR images present a protruded disc with calcification at L4/5 and a bulging disc at L5/S1.

Centre Hospitalier de Vitre, Vitre, France



University Erlangen Radiologie, Erlangen, Germany

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
9.0 s

scan length:
506 mm

rotation time:
0.5 s

tube settings:
120 kV, 361 eff. mAs

CTDIvol:
23.83 mGy

DLP:
1304 mGy cm

eff. dose:
19.56 mSv

CT for Obesity –
MPR images show an abdominal hernia in an obese patient.

system:
SOMATOM Definition AS 64

collimation:
64 x 0.6 mm

scan time:
7.0 s

scan length:
118 mm

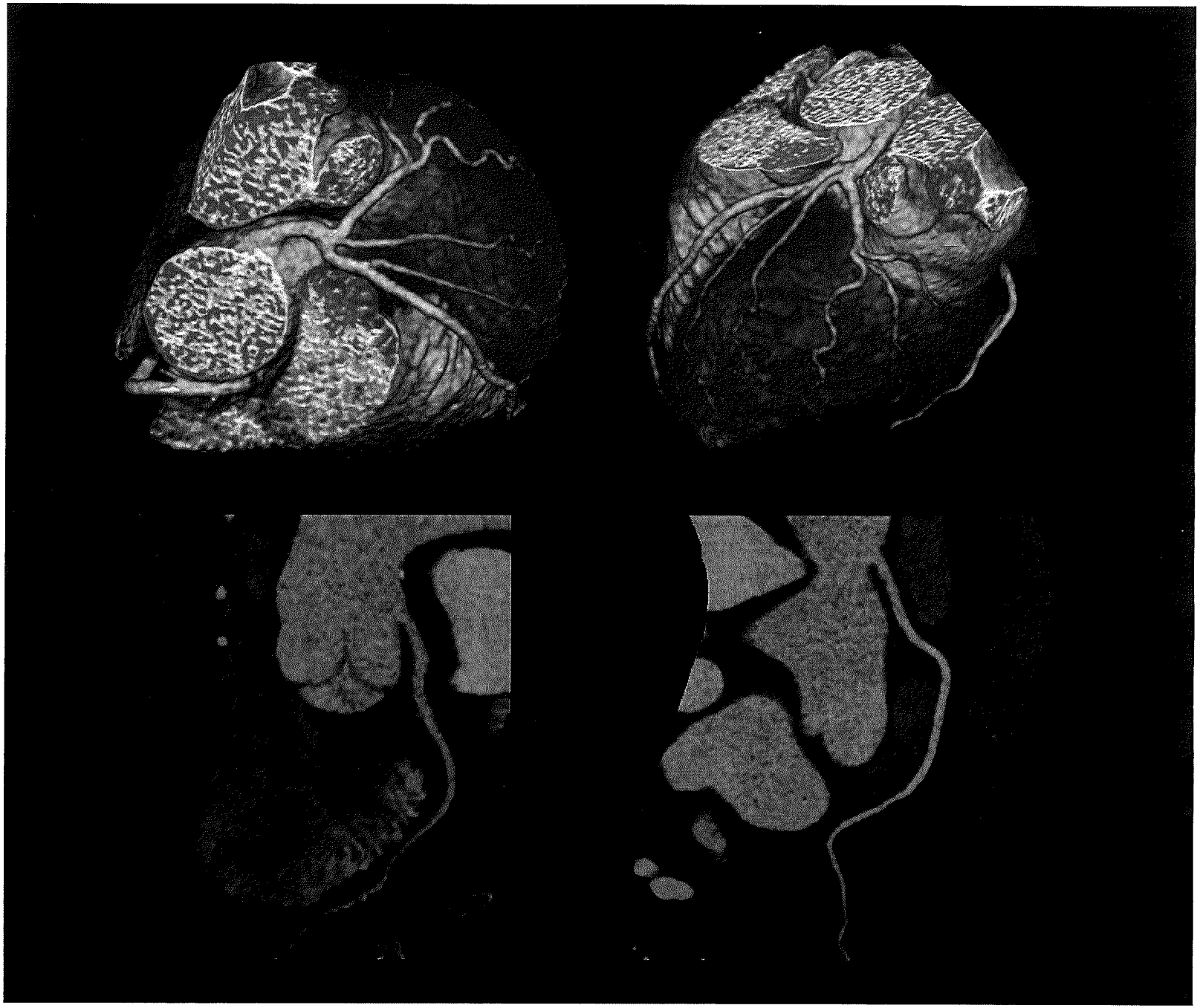
rotation time:
0.42 s

tube settings:
120 kV, 205 eff. mAs

CTDIvol:
13.92 mGy

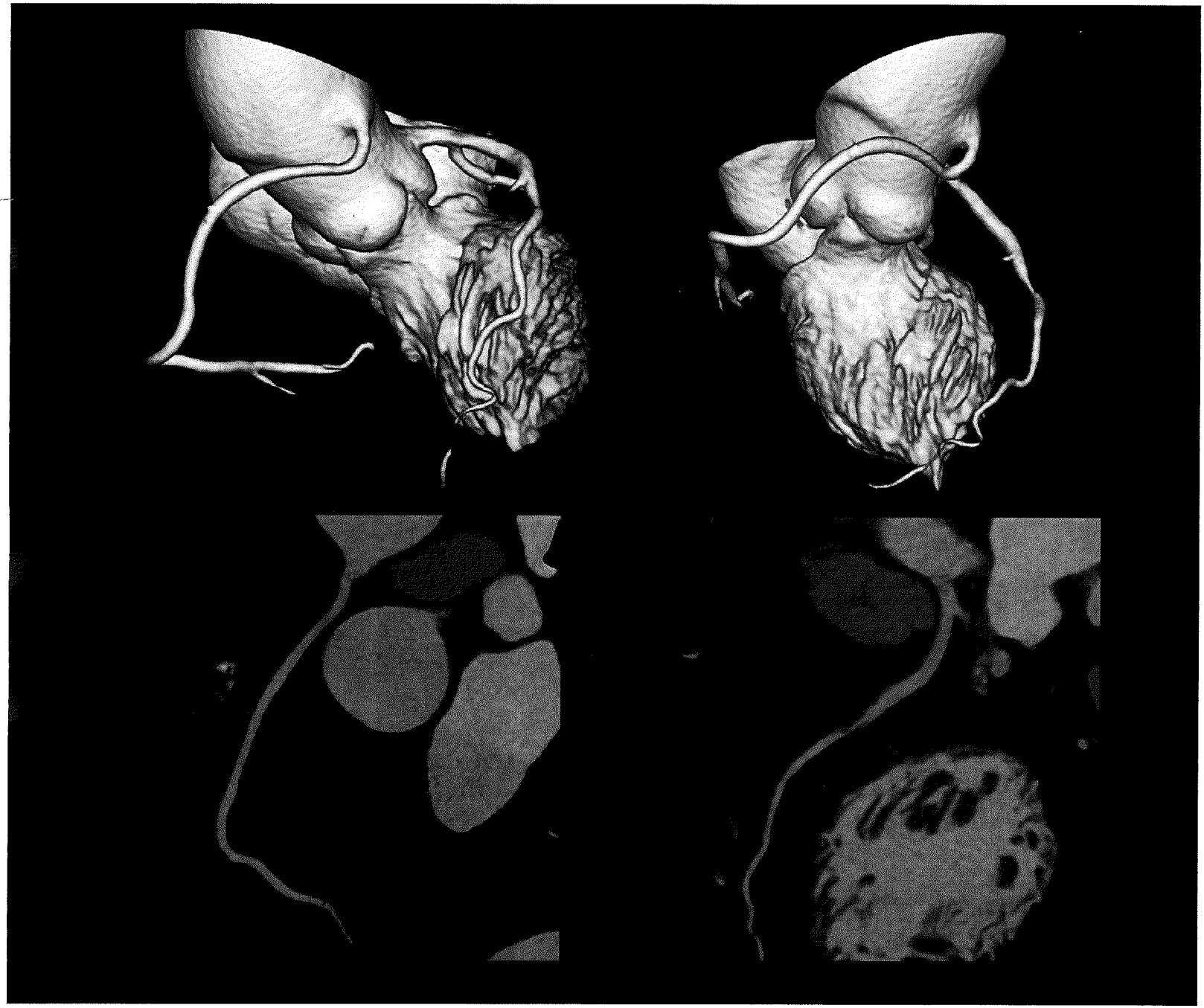
DLP:
166 mGy cm

eff. dose:
2.32 mSv



Cardiac CT –
VRT & Curved MPR images allow the exclusion of a coronary stenosis.

Radiologische Praxis am Diakonissenkrankenhaus, Dresden, Germany



University Erlangen Radiologie, Erlangen, Germany

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
3.0 s

scan length:
103 mm

rotation time:
0.22 s

tube settings:
100 kV, 123 eff. mAs

CTDIvol:
4.02 mGy

DLP:
42 mGy cm

eff. dose:
0.56 mSv

Cardiac CT –
VRT & Curved MPR images reveal a stenosis in the mid-LAD.

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
0.91 s

scan length:
175 mm

rotation time:
0.3 s

tube settings:
70 kV, 29 eff. mAs

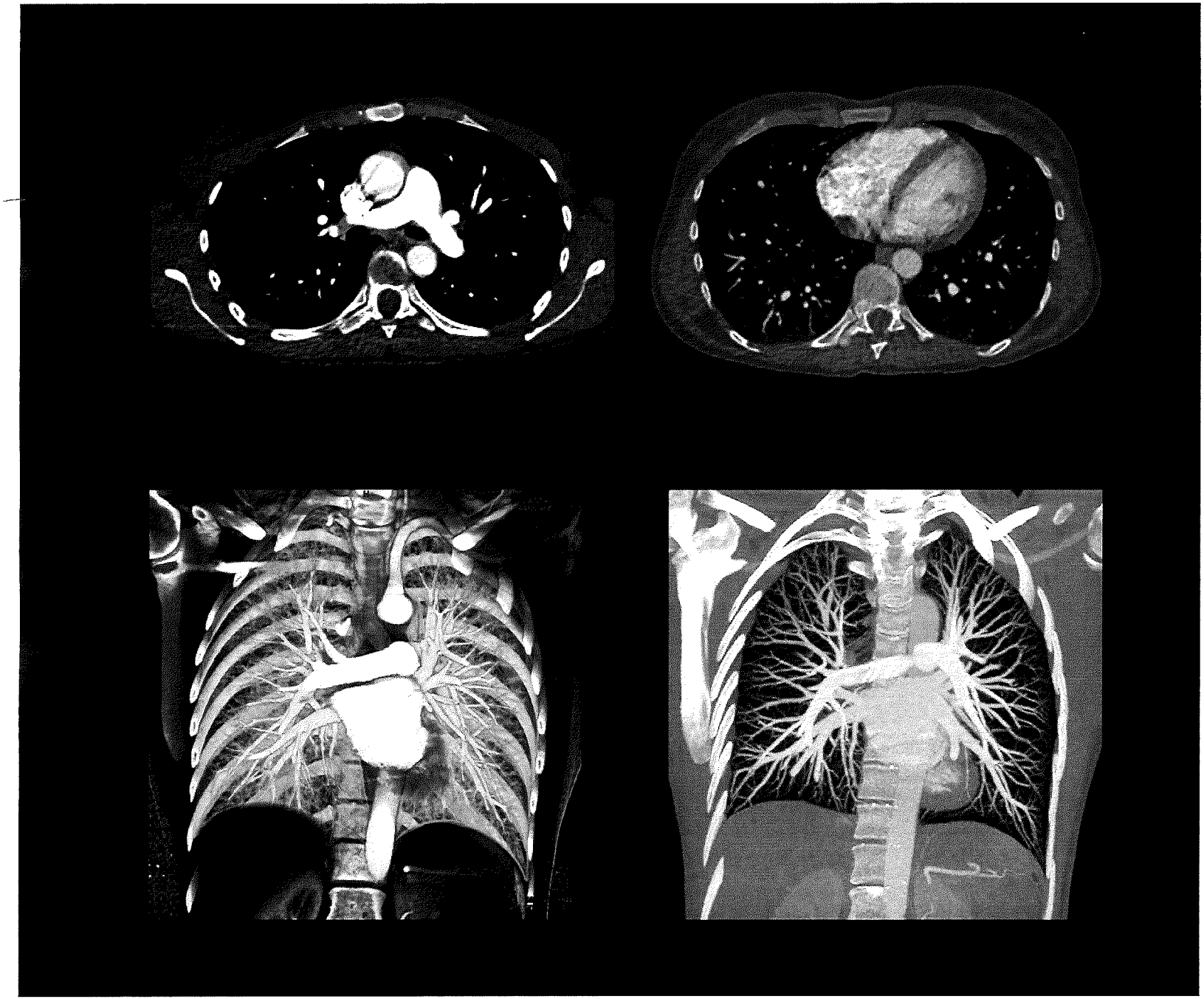
CTDIvol:
0.26 mGy

DLP:
7 mGy cm

eff. dose:
0.23 mSv

CARE kV CT –
Excellently enhanced images, using 70 kV, demonstrate an aortic coarctation in an 8-year-old boy.

TDM Ste-Marie, Osny, France



system:
SOMATOM Definition AS 64

collimation:
64 x 0.6 mm

scan time:
6.02 s

scan length:
277.5 mm

rotation time:
0.5 s

tube settings:
70 kV, 141 eff. mAs

CTDIvol:
1.85 mGy

DLP: ——
55 mGy cm

eff. dose:
0.77 mSv

CARE kV CT –
Excellently enhanced images, using 70 kV and SAFIRE, allow reliable exclusion of a PE, although only 60 mL contrast was applied.

Department of Diagnostic and Interventional Radiology, Goethe University Frankfurt, Germany

system:
SOMATOM Definition AS 64

collimation:
64 x 0.6 mm

scan time:
41.0 s

scan length:
1558 mm

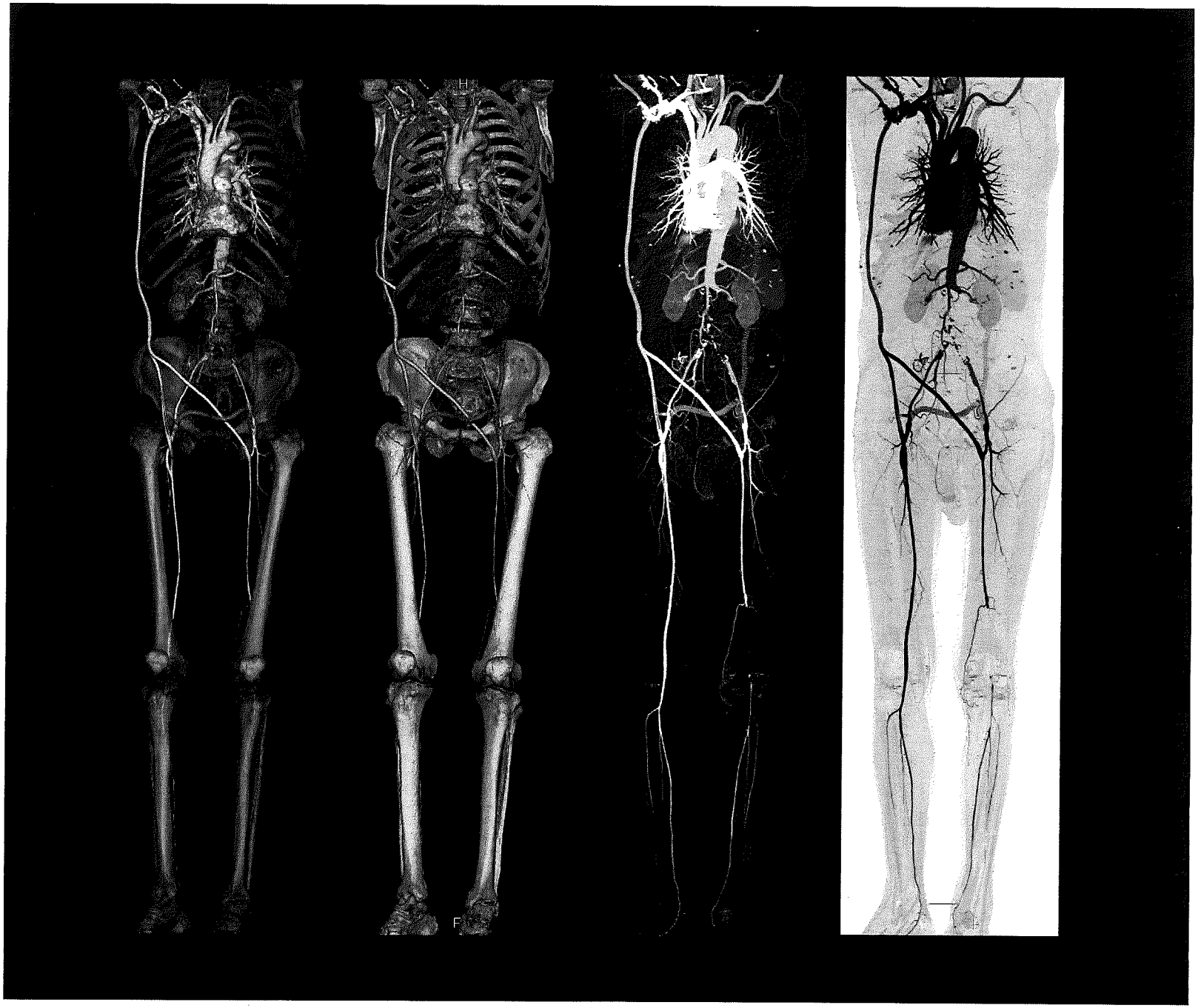
rotation time:
0.6 s

tube settings:
120 kV, 67 eff. mAs

CTDIvol:
5.13 mGy

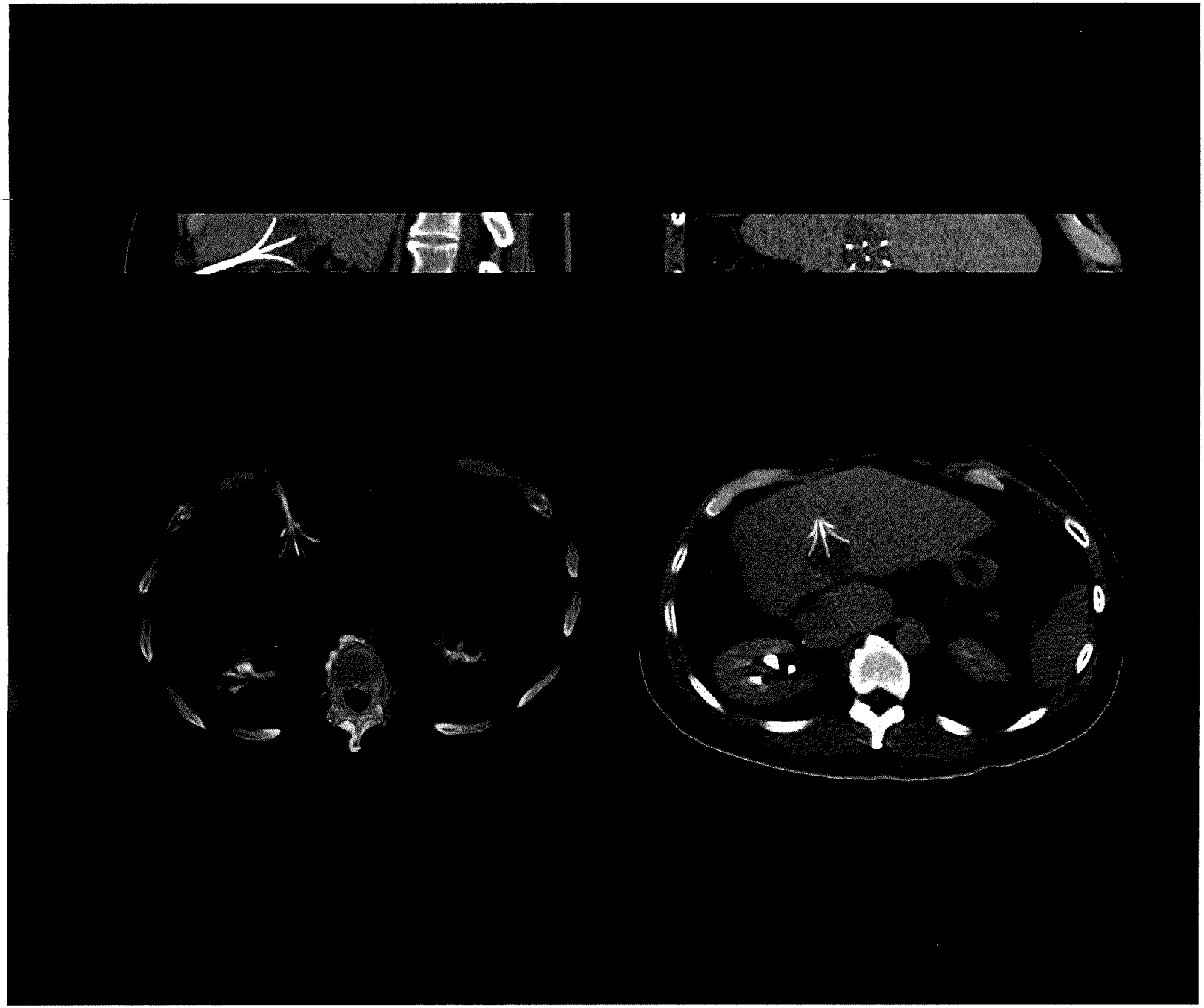
DLP:
805 mGy cm

eff. dose:
6.359 mSv



Whole Body CTA –
VRT & MIP images show bilateral axillo-fermoral bypasses – patent on the right and occluded on the left. An occlusion of left poplitean artery can also be clearly seen.

RadiologySA, Kent Town, Australia



system:
SOMATOM Definition AS 20

collimation:
16 x 1.2 mm

scan time:
1.0 s

scan length:
31.5 mm

rotation time:
0.5 s

tube settings:
120 kV, 143 eff. mAs

CTDIvol:
10.46 mGy

DLP:
84 mGy cm

eff. dose:
1.26 mSv

3D Interventional CT –
VRT & MPR images demonstrate the RFA needle electrode in three dimensions, as it is accurately positioned into a liver tumor.

University Erlangen Radiologie, Erlangen, Germany

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
7.0 s

scan length:
208.5 mm

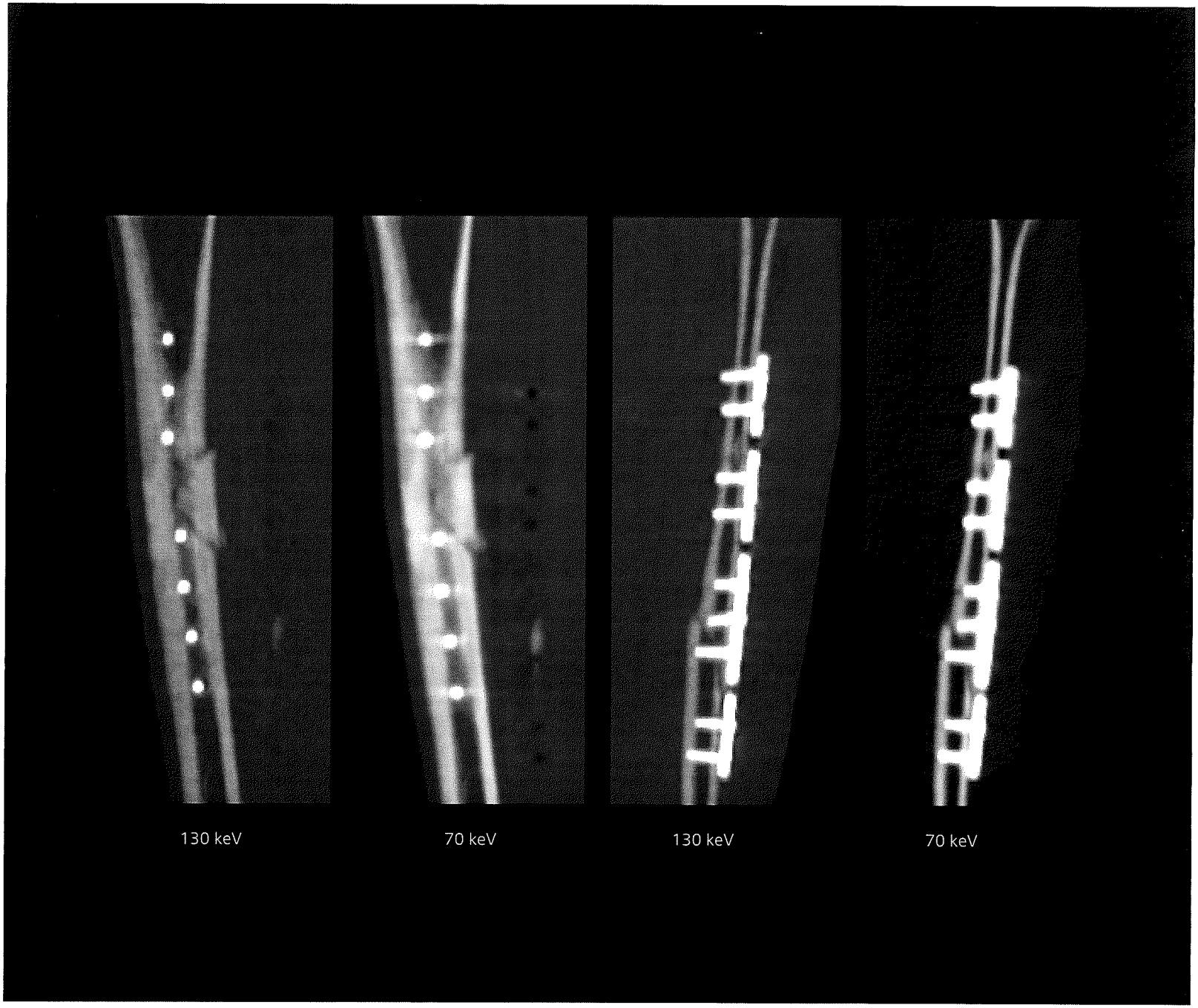
rotation time:
0.5 s

tube settings:
80 kV / Sn 140 kV
40 / 22 eff. mAs

CTDIvol:
0.74 / 2.32 mGy

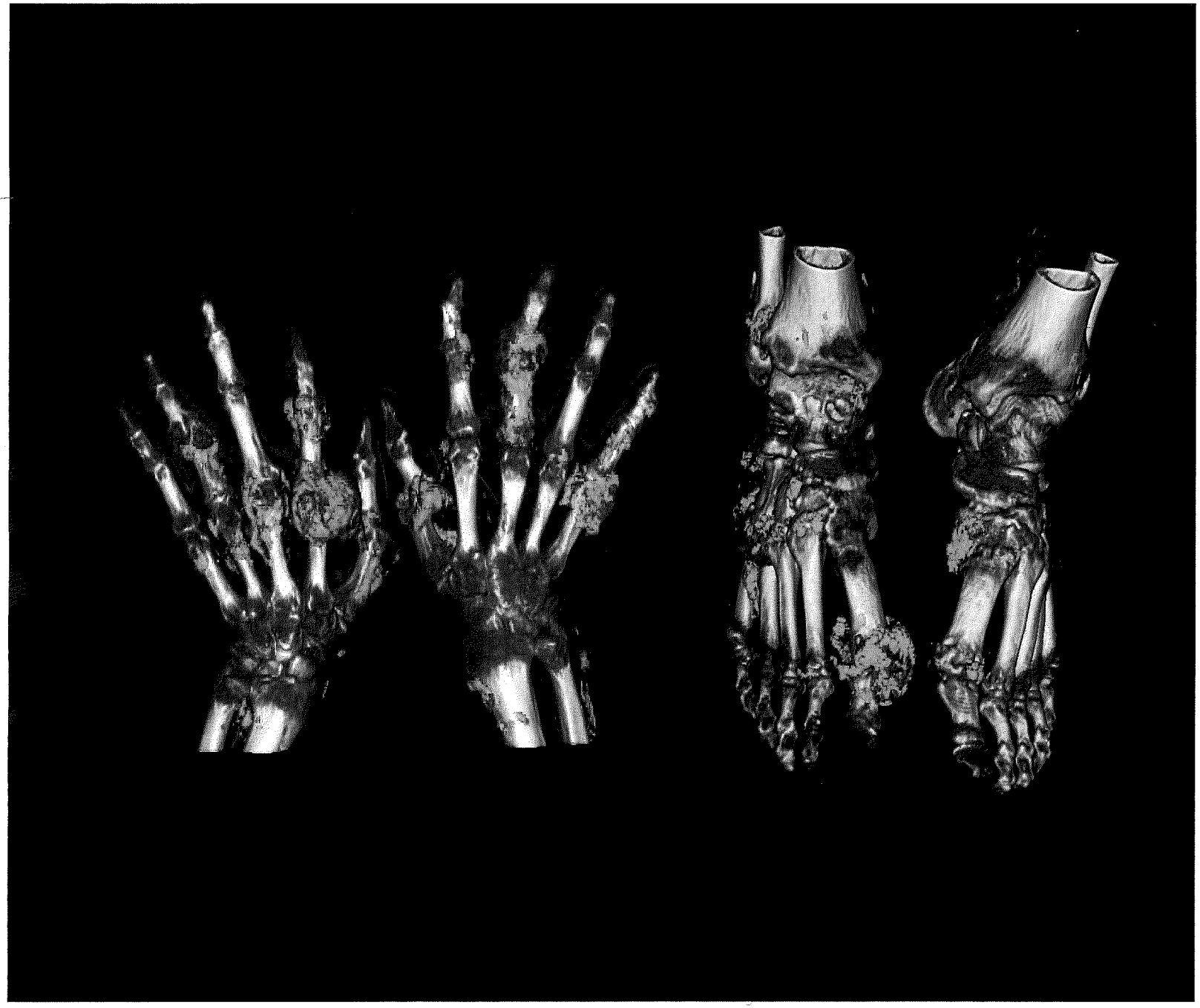
DLP:
17 / 56 mGy cm

eff. dose:
0.013 / 0.044 mSv



Monoenergetic CT –
in comparison to images at 70 keV, those acquired at 130 keV show a significant reduction of metal artifacts, thus making possible a better evaluation of the fracture.

Nan Xi Shan Hospital, Guilin, P. R. China



Nan Xi Shan Hospital, Guilin, P.R. China

system:
SOMATOM Definition AS+

collimation:
128 x 0.6 mm

scan time:
5.0 s

scan length:
220.5 mm

rotation time:
1.0 s

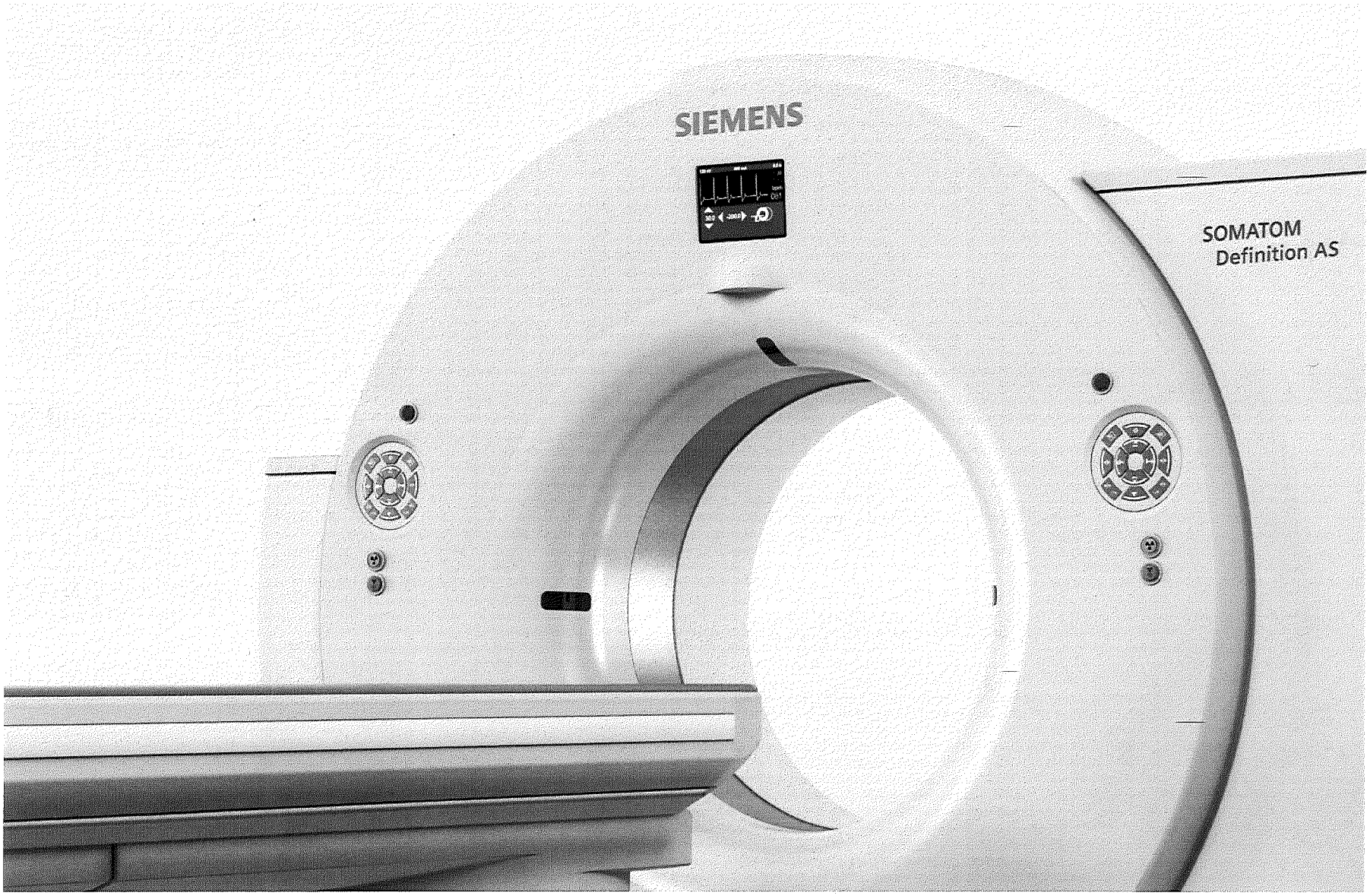
tube settings:
80 kV / Sn 140 kV
178 / 43 eff. mAs

CTDIvol:
3.32 / 4.46 mGy

DLP:
71 / 95 mGy cm

eff. dose:
0.06 / 0.08 mSv

Dual Energy CT –
3D images of hands and feet, of a patient with chronic gout demonstrate extensive tophaceous deposits.



Core Technology

Unique STRATON X-ray Tube

The unparalleled 0 MHU STRATON X-ray tube offers the combination of maximum speed and exceptional image quality eliminating the need for heat storage capacity at a compact design.

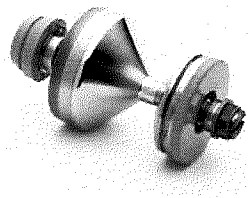
Revolutionary design

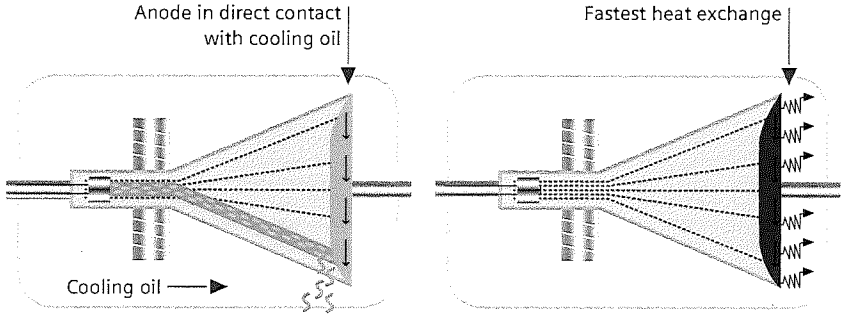
The core technology behind the SOMATOM Definition AS' clinical excellence is the highly renowned STRATON™ tube with z-Sharp™. Its revolutionary design based on a direct anode cooling eliminates the need for heat storage and results in an unmatched compact design, thus allowing true temporal resolution of up to 150 ms.

High isotropic resolution of 0.33 m

The STRATON tube provides true isotropic resolution of 0.33 mm at any scan and rotation speed, and at any position within the scan field. This, for instance, allows to significantly reduce motion artifacts of the heart to perform accurate stenosis measurements or stent planning with outstanding precision. It facilitates fast whole body sub-mm imaging at highest pitch revealing outstanding details in long-range vascular studies or polytrauma patients. With its fast pitch of 1.5, a scan range of 2 meters is covered in approximately 10 seconds.

The STRATON tube enables long high-power scans without cooling delays.





STRATON tube design. The backside of the anode can be cooled directly. Therefore, large heat storage capacity is not necessary, which allows for a very compact design.

No cooling delays

The specific construction of the anode plate constitutes an outer wall of the rotating tube housing; it is therefore in direct contact with the cooling oil and can be efficiently cooled. This way, very high power of up to 100 kW and a very high heat dissipation rate of 7.3 MHU/min are achieved. This eliminates the need for heat storage in the anode, which consequently has a heat storage capacity close to zero (0.6 MHU). Thanks to the fast cooling, the system can perform long high-power scans in rapid succession without cooling delays. The STRATON tube completely cools down to its original state within 20 seconds.

Wide spectrum of selectable tube voltages – 70 kV

The STRATON tube offers a spectrum of selectable tube voltages from 70 kV up to 140 kV. With 70 kV, Siemens has introduced a tube voltage for optimized X-ray spectra also in the smallest patients. Low tube voltages are especially beneficial for saving dose in small patients and children who are most sensitive to radiation. It ideally partners with CARE kV, another core technology of the system.

z-Sharp Technology

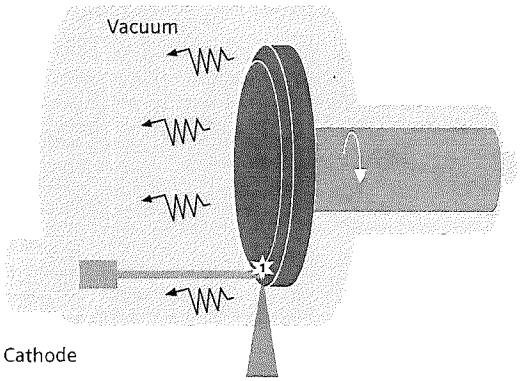
With the STRATON's revolutionary z-Sharp technology, resolution can be significantly increased – getting double the information in half the time and half the dose.

z-Sharp technology

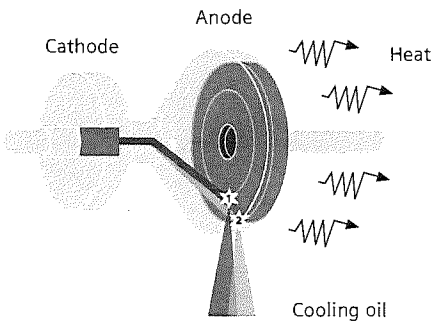
The acquisition of up to 128 slices per rotation with the SOMATOM Definition AS is possible through STRATON X-ray tube's double z-sampling technology (z-Sharp). The tube's electron beam is accurately and rapidly deflected by an electromagnetic field, similar to a cathode-ray tube. Two focal spots are created on the anode plate that alternate precisely 4,640 times per second in the z-direction. This double z-sampling enables two X-ray beams to pass through the body in two different angles, virtually simultaneously.

Double information in half the time and half the dose

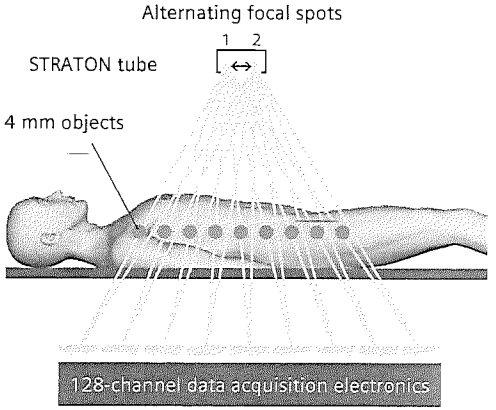
z-Sharp doubles the X-ray projections reaching each detector element. The two overlapping projections result in an oversampling in z-direction. The resulting measurements interleave half a detector slice width, doubling the scan information. Siemens' proprietary, high-speed UFC detector enables a virtually simultaneous readout of two projections for each detector element. Compared to conventional CT acquisition technology, each measurement requires half the time and half the dose.



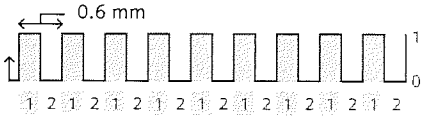
Conventional tube technology.



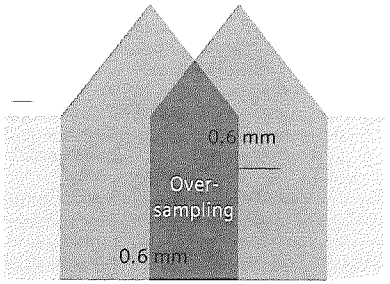
STRATON X-ray tube with z-Sharp generating two distinct X-ray projections.



Measured signal per detector element



Resulting resolution



Oversampling

Higher resolution and reduction of artifacts

The simultaneous acquisition leads to twice the number of overlapping slices, which makes possible an increase of longitudinal resolution and reduction of spiral artifacts independent of the selected pitch. Besides being more effective in increasing the resolution in z-direction, this approach is also much more flexible, since it can be utilized in virtually all scan modes. The result is the acquisition of twice the number of slices with less artifacts and higher resolution.

Eliminating windmill-artifacts

Prevention of artifacts by z-Sharp's double z-sampling technology also facilitates neurology examinations. Up to now, windmill-artifacts often occurred in spiral CT examinations of the head, for example in CT angiography examinations for aneurysms, of the neck, and of the thorax. Whithout imposing restrictions to pitch, z-Sharp technology eliminates windmill-artifacts that originate when the X-ray beam penetrates the edges of bones. CTAs of the carotid arteries and the circle of Willis can now be routinely performed at a high pitch.

CARE kV

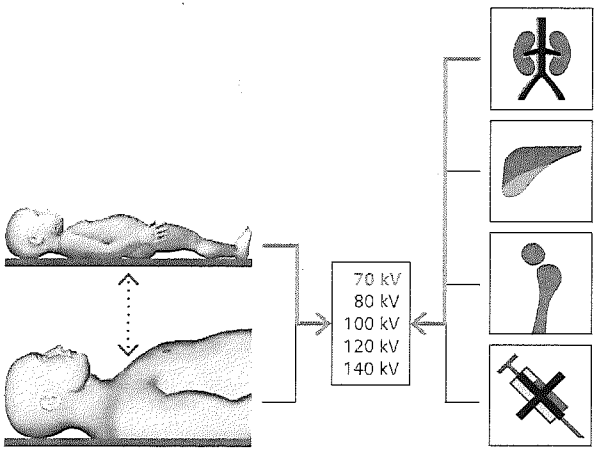
The STRATON tube in combination with FAST CARE technology provides unique features to optimize image quality and reduce dose.

Best clinical results in high-demanding environments

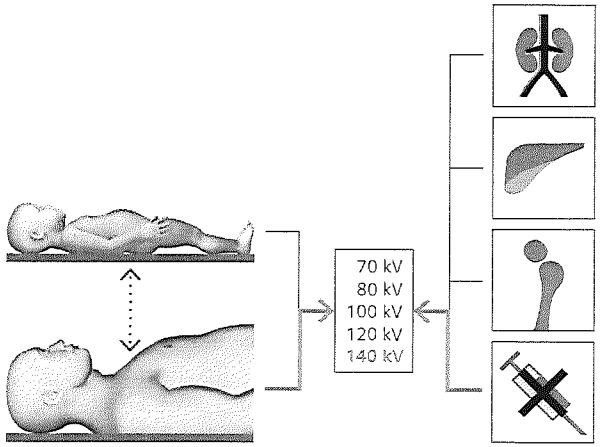
FAST Adjust helps to set the right system parameters like scan time, pitch, or tube current to achieve best clinical results. This is not always easy - especially when working in highly demanding environments such as an emergency department or with bariatric or pediatric patients. With an easy-to-understand and easy-to-use interface, parameters can be simply adjusted or, when in doubt, defined just with the push of a button.

CARE kV for optimized kV setting

Following the scan process, the right kV setting plays an important role in achieving optimal clinical outcome. Changing kV values, however, always comes with the need to adapt all other values according to the respective patient. Up to now, this had to be done manually and required a lot of expertise, so that the full potential for dose reduction often remained untapped. Siemens' unique CARE kV breaks this barrier. It automatically suggests kV and eff. mAs to optimize the contrast-to-noise ratio (CNR) of the image while limiting the applied dose.



Example 1: For a contrast media enhanced vessel examination of a small patient, CARE kV suggests a scan with 70 kV and sets the other values accordingly.



Example 2: For a non-contrast examination of a large patient, CARE kV suggests a scan with 140 kV and sets the other values accordingly.

Automated kV setting for best image quality

The system's proposal is based on the attenuation as measured in the topogram and the user-defined acquisition type (non-contrast, bone, soft tissue, vascular). The main goal is to keep the CNR, the key parameter for image quality, the same. For each patient exam, the topogram and the corresponding attenuation information are used to determine the optimal kV. Even in bariatric patients, CARE kV sets the parameters to make full use of the system's reserves to optimize CNR and acquire the best image quality possible for the patients.

Dedicated pediatric scanner settings

Reducing the tube voltage helps to reduce radiation exposure to patients. While other tubes are limited to a minimum voltage setting of 80 kV, with the STRATON tube the voltage range is extended as low as 70 kV. This helps to further reduce radiation dose to small pediatric or neonate patients. These dedicated pediatric scan modes, bundled with CARE kV and specific pediatric CARE Dose4D curves and protocols, take care of the well-being of our youngest patients. Overall with these features, an additional dose reduction of up to 60% is possible.

Fully customizable

CARE kV is, of course, fully customizable, meaning that users can not only set their individual quality reference mAs, but can also choose the degree of system assistance between none, semi, and full. As the complete SOMATOM Definition AS system, it offers full flexibility to users and adapts to their specific needs and clinical challenges.

Customer Services

A range of innovative service solutions that provide the answers to best support users in raising quality and productivity in healthcare.

Maintainable healthcare

Providing economically viable healthcare means efficiently and productively delivering the highest quality care possible. This is why Siemens works closely with its customers, offering experience and innovative solutions to increase uptime, improve performance, and optimize workflow for maintainable healthcare. This means raised quality, better productivity, and greater cost-effectiveness.

Increased availability with System Services

Peak performances and higher uptime are achieved by proactively enabling system availability with innovative service solutions. Siemens Remote Services, for example, establishes a highly efficient, secure, and certified remote connection between CT systems and Siemens' service organization for remote monitoring and remote fixing in order to maximize availability and performance.

Proactive maintenance

With the Siemens Guardian Program™ including TubeGuard, potential tube downtime can be predicted ahead of time. This allows healthcare institutions to schedule maintenance without impairing regular patient hours for higher system efficiency.

Improved operation with User Services

Personalized education and training are the key to more expertise, greater efficiency, and higher productivity of the system operators. In addition, dedicated consultancy services facilitate further improvement of system usage. Optimize CARE CT, for example, is a comprehensive program to help customers reduce radiation in CT scanning. The program provides expert insights, methods, and tools that help customers develop a customized roadmap towards improving their CT dose.

Optimized utilization with Management Services

Increased workflow optimization and better productivity through process optimization and consulting help improve efficiency, system utilization, and return on investment. Utilization Management Consulting combines quantitative data from the Utilization Management report with technical experience and radiological workflow management. Customers can then learn about their strengths and improvement potential across all professional groups.

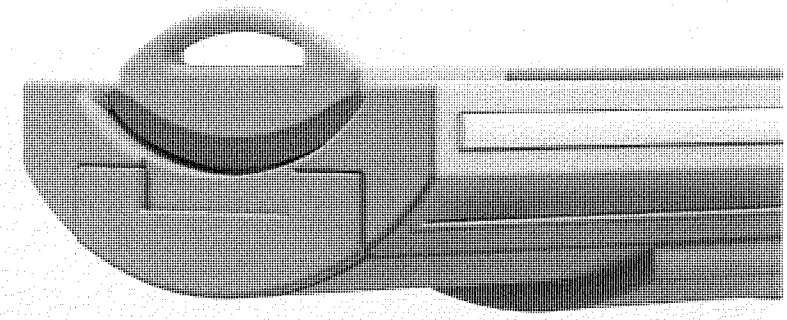
SOMATOM Definition AS

Maximize Outcome. Minimize Dose.

Single-Click Readiness

FAST CARE technology and Single Source Dual Energy for better results

- Efficient scan and recon planning
- Guided scan and recon procedures
- Single Source Dual Energy as easy as a spiral scan



Your Single Source for Right Dose

Dose protection and reduction features taking CARE of the right dose

- Automated voltage setting with excellent image quality
- Dedicated pediatric imaging with 70 kV protocols
- Iterative reconstruction with SAFIRE

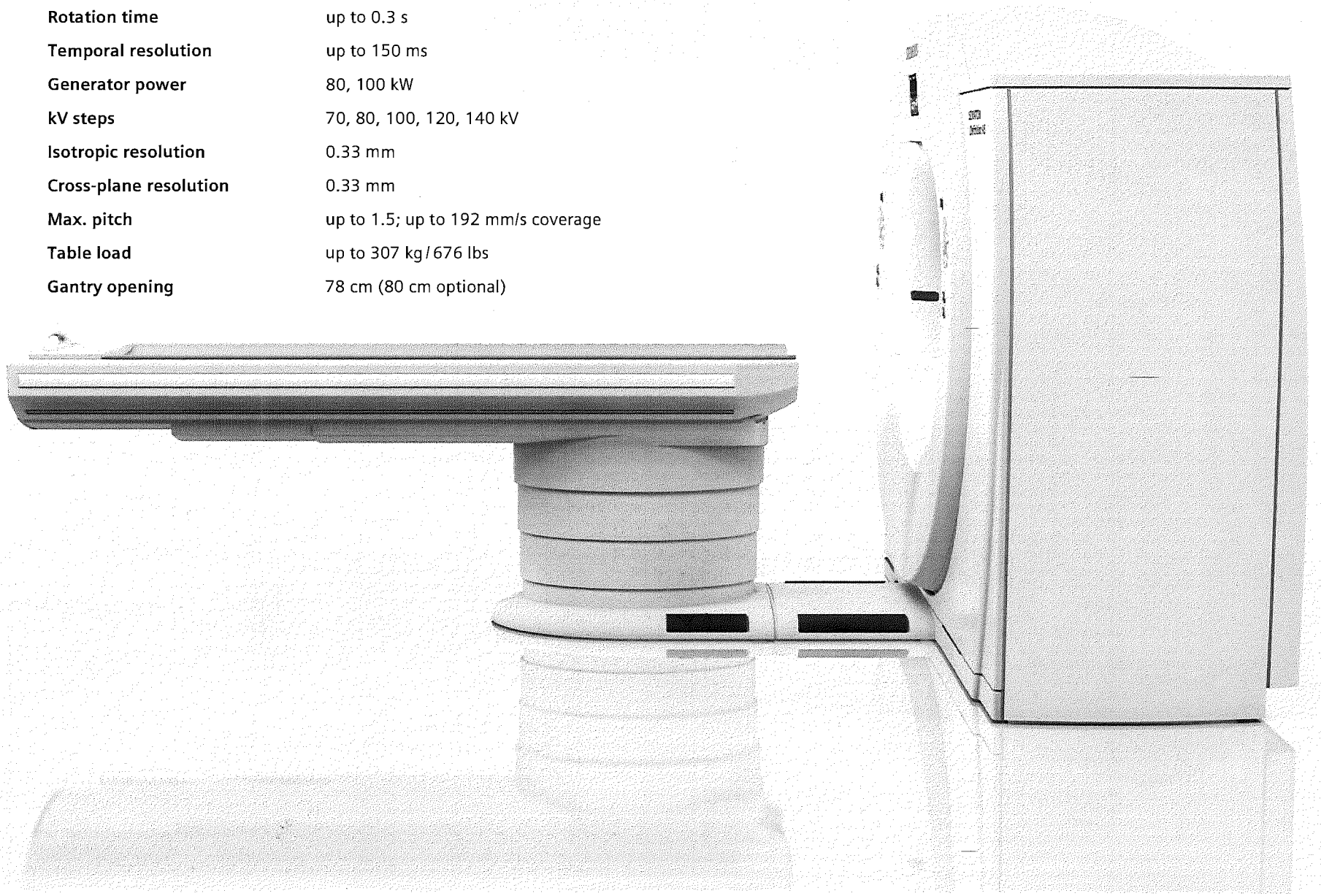
Open for all Patients

Outstanding flexibility offers a solution for every clinical demand

- Full on-site upgradeability
- Functional imaging with Adaptive 4D Spiral and Dual Energy
- Variety of solutions for different specialized clinical settings


SIEMENS
SOMATOM
Definition AS

Detector	Ultra Fast Ceramic (UFC)
Number of acquired slices	20, 40, 64, 128
Rotation time	up to 0.3 s
Temporal resolution	up to 150 ms
Generator power	80, 100 kW
kV steps	70, 80, 100, 120, 140 kV
Isotropic resolution	0.33 mm
Cross-plane resolution	0.33 mm
Max. pitch	up to 1.5; up to 192 mm/s coverage
Table load	up to 307 kg / 676 lbs
Gantry opening	78 cm (80 cm optional)



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www.siemens.com/healthcare

Attachment B

Equipment Use Documentation

University CT Volume

Jan-14	1,406
Feb-14	1,405
Mar-14	1,479
Apr-14	1,356
May-14	1,390
Jun-14	1,398
Jul-14	1,417
Aug-14	1,390
Sep-14	1,420
Oct-14	1,503
Nov-14	1,352
Dec-14	1,421
TOTAL	**16,937**

Attachment C

Equipment Vendor Quote

SIEMENS

Siemens Medical Solutions USA, Inc.
51 Valley Stream Parkway, Malvern, PA 19355
Fax: (336) 856-9995

SIEMENS REPRESENTATIVE
Edwin Winicki - (336) 688-0978

Customer Number: 0000035965

Date: 2/20/2015

CAROLINAS HEALTHCARE SYSTEM
1000 BLYTHE BLVD
CHARLOTTE, NC 28203

Siemens Medical Solutions, USA, Inc. is pleased to submit the following quotation for the products and services described herein at the stated prices and terms, subject to your acceptance of the terms and conditions on the face and back hereof, and on any attachment hereto.

Quote Nr:	**1-A653RQ, Rev. 1**
Trade:	**Siemens Sensation 64**
Terms of Payment	**00% Down, 80% Delivery, 20% Installation**
	Free On Board: Destination
Purchasing Agreement	**Premier Purchasing Partners**
Terms and Conditions	**Premier terms and conditions apply**
Proposal Valid Until	**9/30/2015**

Siemens Definition AS-64

1 14440593

SOMATOM Definition AS-64

The SOMATOM Definition AS (64-slice configuration) is Siemens' state-of-the-art single source CT that provides the possibility to maximize clinical outcome and to minimize radiation dose. The unique STRATON X-ray source utilizes an electron beam that is accurately and rapidly deflected, creating two precise focal spots alternating 4,608 times per second. This doubles the X-ray projections reaching each detector element. The two overlapping projections result in an oversampling in z-direction. The resulting measurements interleave half a detector slice width, doubling the scan information without a corresponding increase in dose. Siemens' proprietary UFC (Ultra Fast Ceramic) detectors and the corresponding 64-slice detector electronics enable a virtually simultaneous readout of two projections for each detector element - resulting in a full 64-slice acquisition. This sampling scheme is identical to that of a 64 x 0.3 mm allowing for reconstruction of 192 slices using 0.1 mm reconstruction interval increment The fast rotation time of 0.33 seconds (0.3 s optional) delivers excellent temporal resolution. The SOMATOM Definition AS is set to raise the standard of patient-centric productivity with FAST CARE Technology. With Siemens' FAST - Fully Assisting Scanner Technologies - the SOMATOM Definition AS can simplify typically time consuming and complex procedures during a CT examination: the scanning process gets more intuitive and the results become more reproducible. The CARE technology includes many unique features like CARE kV that sets the ideal voltage for every examination and adjusts the respective scan parameters or industry's first Adaptive Dose Shield that prevents clinically irrelevant over radiation in spiral scanning. Additionally, its large bore of 78 cm and a table load capacity of up to 307 kg (optional) opens CT to virtually all patients, meaning that virtually no patient is excluded.

1 14408145

ELEVATE R 40-/64-slice>AS40/64

The SOMATOM Definition AS is a scalable 20 to 128 slice platform. The new Definition AS configuration can be field upgraded to the next generation of integrated detector technology with the Stellar detector.

1	14420766	**SAFIRE #AWP** The Sinogram Affirmed Iterative Reconstruction (SAFIRE) enhances spatial resolution, reduces image noise and increases sharpness by introducing multiple iteration steps in the reconstruction process. The resulting superior image quality enables to reduce dose by up to 60%*. *In clinical practice, the use of SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. The following test method was used to determine a 54 to 60% dose reduction when using the SAFIRE reconstruction software. Noise, CT numbers, homogenity, low-contast resolution and high contrast resolution were assessed in a Gammex 438 phantom. Low dose data reconstructed with SAFIRE showed the same image quality compared to full dose data based on this test. Data on file.
1	14408147	**Adaptive 4D Spiral**
1	14420773	**FAST CARE Platform** Siemens' unique FAST CARE platform is set to raise the standard of patient-centric productivity. Utilizing FAST - Fully Assisting Scanner Technologies -, typically time-consuming and complex procedures during the scan process are extremely simplified and automated, not only improving workflow efficiency, but optimizing the overall clinical outcome by creating reproducible results, making diagnosis more reliable and reducing patient burden through streamlined examinations. Siemens' desire for as little radiation exposure as possible lies at the heart of the CARE - Combined Applications to Reduce Exposure - research and development philosophy offering a unique portfolio of dose saving features, many of them being introduced as industry's first.
1	14420771	**CARE Child** Dedicated pediatric CT imaging, including 70 kV scan modes and specific CARE Dose4D curves and protocols
1	14433993	**FAST Planning #AWP** Direct, organ-based setting of scan and recon ranges for a faster and more standardized workflow
1	14419142	**Workstream 4D #AWP** WorkStream 4D further enhances the already superb workflow of the SOMATOM Definition AS CT system by offering direct generation of sagittal, coronal, oblique or double-oblique reconstructed images directly from CT raw data as part of the CT protocol.
1	14419144	**DICOM SR Viewer #AWP** The DICOM SR (structured report) Viewer allows to read reports created with specific applications (e.g. Circulation, Lung Care, Calcium Scoring and Onco) without the application itself being on the respective computer.
1	14420824	**Standard IRS** Reconstruction computer for the preprocessing and reconstruction of the CT raw data. The reconstruction computer contains a cluster of 2 high-performance GPU boards performing the preprocessing and reconstruction of the CT data. The raw data memory is 900 GByte. The peak recon performance is 40 frames/sec.
1	14428058	**Gantry tilt incl. tilted spiral** Allows for sequential scanning with a tilted gantry between +/- 30°, depending on the vertical position of the table. Using the gantry tilt sensitive organs (like eye lenses) can be moved out of the scan range or it eases access during interventional procedures. The tilted spiral allows to utilize the gantry tilt for spiral scan modes.
1	14408111	**Extended Field of View #AWP** Software program with special reconstruction algorithms that allow for visualization of objects using a FOV up to 78 cm (non-diagnostic image quality). License to use software on a single unit.
1	CT_LUNGIMAGING AS64	**Lung Imaging**
1	CT_PM	**CT Project Management**
1	CT_TRADE_IN_ALLOW	**Project 2014-2056**
1	14408152	**UHR** UHR mode delivers Ultra High resolution in plane of up to 24lp/cm for high defined imaging of small structures such as inner ear, joints or fractures of the bone
1	14408032	**Rear cover incl. gantry panels** Rear Cover including gantry control panels with control functionality from the backside.

1	14408094	**Keyboard English** Keyboard in the above-mentioned language.
1	14408023	**Cooling System Water** Water heat exchanger for the dissipation of heat loss generated in the gantry to an environmentally friendly cooling water circulation system. This optimizes system availability independently of the cooling water flow rate and temperature. System operation temperature 4 - 16 degrees C and 500 - 2500 l/h flow rate.
1	14408026	**Hose pipe insulated 30 m** Hose pipes to connect the "Cooling System" with the gantry.
1	14408027	**Cooling System Water/Air #split** Water-to-air heat exchanger for the dissipation (to the air outside) of heat, generated in the gantry.
1	14410140	**Trafo for Cooling system Water/Air** The Trafo powers the Cooling System Water/Air
1	14410248	**Service Switch** Service switch to shut off the outdoor cooling unit for maintenance or in case of emergency
1	14408031	**Cable loom 25 m** Cable loom used to connect the power distribution system (PDS) with the gantry.
1	14420777	**Patient Table 2000 mm** Patient table to support up to 200cm scan range. Motor-driven table height adjustment from min. 48 cm to max. 92 cm, longitudinal movement of the tabletop 200 cm in increments of 0.5 mm, positioning accuracy +/- 0.25 mm from any direction. Horizontal scan range 200 cm. Table height can be controlled alternatively by means of foot switch (2 each on both sides of the patient table). In the case of emergency stop or power failure, the tabletop can also be moved manually in horizontal direction. Max. table load: 227 kg/500 lbs, Table feed speed: 2-200 mm/s, Distance between gantry front and table base 40 cm. Positioning aids: Positioning mattress, mattress protector, head-arm support (inclusive cushion), and non-tiltable head holders with positioning cushion set, patient restraining system for head fixation, restraining-strap set with body fixation strap that can be directly connected to the patient table top, headrest, table extension with positioning mattress, knee-leg support.
1	14408101	**Computer Desk #AWP** New CT desk to accommodate the control components and color monitor. Width: 1200 mm, Depth: 800 mm, Height: 720 mm.
1	14408102	**Computer Cabinet #AWP** New cabinet to accommodate the computer system and UPS. Matched to the design of the control console table. Width: 800 mm, Depth: 800 mm, Height: 720 mm
1	CT_RECON_192	**AS-64 slice configuration z-Sharp Tech.** The unique STRATON X-ray source utilizes an electron beam that is accurately and rapidly deflected, creating two precise focal spots alternating 4,608 times per second. This doubles the X-ray projections reaching each detector element. The two overlapping projections result in an oversampling in z-direction. The resulting measurements interleave half a detector slice width, doubling the scan information without a corresponding increase in dose. Siemens' proprietary UFC (Ultra Fast Ceramic) detectors and the corresponding 64-slice detector electronics enable a virtually simultaneous readout of two projections for each detector element - resulting in a full 64-slice acquisition. This sampling scheme is identical to that of a 64 x 0.3 mm allowing for reconstruction of 192 slices using 0.1 mm reconstruction interval increment. z-Sharp Technology, utilizing the STRATON X-ray sources and the UFC detectors, provides scan speed independent visualization of 0.33 mm isotropic voxels and a corresponding elimination of spiral artifacts in the daily clinical routine at any position within the scan field.
1	ADAPT_DOSE_SHIELD	**Adaptive Dose Shield** Adaptive Dose Shield for spiral acquisition to eliminate pre- and post-spiral over-radiation.
1	FAST_ADJUST	**FAST Adjust** FAST Adjust: assists the user to handle system settings in a fast and easy way by automatically solving of conflicts within user defined limits by one single click on the FAST Adjust button. The limits for scan time and tube current per scan are defined via the Scan Protocol Assistant. FAST Adjust offers an undo functionality to return to previously set values.

1	FAST_SCAN_ASSIST	**FAST Scan Assistant** FAST Scan Assistant: An intuitive user interface for solving conflicts by changing the scan time, resp. the pitch and/or the maximum tube current manually.
1	CARE_DOSE4D	**CARE Dose4D** CARE Dose4D delivers the highest possible image quality at the lowest possible dose for patients - maximum detail, minimum dose. Adaptive dose modulation for up to 60% dose reduction
1	CARE_KV	**CARE kV** CARE kV: First automated, organ-sensitive voltage setting to improve image quality and contrast-to-noise-ratio while optimizing dose and potentially reducing it by up to 60%.
1	CARE_PROFLE	**CARE Profile** CARE Profile: Visualization of the dose distribution along the topogram prior to the scan
1	CARE_DASHBOARD	**CARE Dashboard** Visualization of activated dose reduction features and technologies for each scan range of an examination to analyze and manage the dose to be applied in the scan
1	DICOM_SR	**DICOM SR Dose Reports** DICOM structured file allows for the extraction of dose values (CDTIvol, DLP)
1	DOSE_ALERT	**Dose Alert** Dose Alert: As requested by the new release of the standard IEC 60601 3rd edition, the SOMATOM Definition automatically adds up CTDIvol and DLP depending on z-position (scan axis). The Dose Alert window appears, if either of these cumulative values exceeds a user-defined threshold.
1	DOSE_NOTIFICATION	**Dose Notification** Dose Notification: As requested by the new release of the standard IEC 60601 3rd edition, the SOMATOM Definition AS provides the ability to set dose reference values (CTDIvol, DLP) for each scan range. If these reference values are exceeded the Dose Notification window informs the user.
1	ACCESS_PROTECT	**Access Protection** Scan Protocols are password protected allowing only authorized staff members to access and permanently change protocols
1	NEMA_XR-29	**NEMA_XR-29 Standard** This system is in compliance with NEMA XR-29 Standard Attributes on CT Equipment Related to Dose Optimization and Management, also known as Smart Dose.
1	14408037	**HeartView CT**
1	14408215	**Physiological Monitoring Module**
1	14408040	**ECG cable IEC2 #D**
1	14420795	**syngo CT.3D Workplace # CTWP**
1	14420798	**SAFIRE # CTWP**
1	14430742	**CARE Profile #CTWP**
1	14420998	**FAST Planning #CTWP**
1	14408094	**Keyboard English**
1	14408134	**Cable 25m # CTWP**
1	14408122	**Syngo InSpace 4D AVA #CTWP**
1	CT_BUDG_ADDL_RIG	**Additional Rigging CT $6,880**
1	CT_PM	**CT Project Management**

A Siemens Project Manager (PM) will be the single point of contact for the implementation of your Siemen's equipment. The assigned PM will work with the customer's facilities management, architect or building contractor to assist you in ensuring that your site is ready for installation. Your PM will provide initial and final drawings and will coordinate the scheduling of the equipment, installation, and rigging, as well as the initiation of on-site clinical education.

1	CT_SERV_CONTRACT	**Service Evolve**
1	CT_STD_RIG_INST	**CT Standard Rigging and Installation**

This quotation includes standard rigging and installation of your CT new system. Standard rigging into a room with reasonable access, as determined by Siemens Project Management, during standard working hours (Mon. - Fri./ 8 a.m. to 5 p.m.) It remains the responsibility of the Customer to prepare the room in accordance with the SIEMENS planning documents. Any special rigging requirements (Crane, stairs, etc.) and/or special site requirements (e.g. removal of existing systems, etc.) is an incremental cost and the responsibility of the Customer. All other "out of scope" charges (not covered by the standard rigging and installation) will be identified during the site assessment and remain the responsibility of the Customer.

1	CT_STD_DEINSTALL	**CT Standard De-Installation**
1	4SPAS014	**Low Contrast CT Phantom & Holder**
1	PSPD250480Y3K	**Surge Protective Device (SPD)**
1	CTSDEF01	**CT Slicker**

Thermoseal seams and flaps deflect fluids, reducing contaminant penetration into the cushion and table. Contaminants are retained on the tabletop or shunted to the floor. Cleanup is faster, more thorough, and contaminant build-up is reduced. Built using heavy, clear, micro matte vinyl, and top grade hook and loop fastening strips (Velcro) to better fit the specified table. Custom vinyl resists tears and minimizes radiologic interference. Latex free. Set includes CT Skirts. Shipped with main cover, a catheter bag holder, and 3 restraining belts unless otherwise noted. Includes warranty from RADSCAN Medical.

1	CT_INST_RIEDEL_01	**Riedel Chiller Start-up by SBT**
1	CT_AS64X_ER4064_BN	**AS64 Excel Elevate R 40 64 Bonus**
2	CT_DEFSYNGO_BCLS	**Definition Systems Basic syngo Class**
1	CT_INITIAL_32	**Initial onsite training 32 hrs – done at turnover**

Up to (32) hours of on-site clinical education training, scheduled consecutively (Monday - Friday) during standard business hours for a maximum of (4) imaging professionals. Training will cover agenda items on the ASRT approved checklist. Uptime Clinical Education phone support is provided during the warranty period for specified posted hours. This educational offering must be completed (12) months from install end date. If training is not completed within the applicable time period, Siemens obligation to provide the training will expire without refund.

1	CT_FOLLOWUP_32	**Follow-up training 32 hrs – pre-schedule for 4-6 weeks after turnover**

Up to (32) hours of on-site clinical education training, scheduled consecutively (Monday - Friday) during standard business hours for a maximum of (4) imaging professionals. Training will cover agenda items on the ASRT approved checklist. Uptime Clinical Education phone support is provided during the warranty period for specified posted hours. This educational offering must be completed (12) months from install end date. If training is not completed within the applicable time period, Siemens obligation to provide the training will expire without refund.

1	CT_TECH_SYMP	**Siemens Technologists Symposium**

Registration, Travel and lodging to the Annual Innovations Users Meeting and Educational Symposium.

Sell Price (excluding trade):	$620,000
Sensation 64 Trade Value:	($200,000)
Final Price (including trade):	$420,000

Estimated Tax (final tax is computed at time of installation): $30,450

Attachment D

Equipment Disposal Letter

SIEMENS

February 21, 2015

Carolinas Healthcare System
Attn: Mr. Jeff Aho
Associate Vice President
Carolinas Medical Center
1000 Blythe Boulevard
Charlotte, NC 28203

Dear Jeff Aho,

The purpose of this letter is to confirm that Siemens Medical Solutions USA, Inc. (Siemens) will be responsible for removing your existing Siemens Sensation 64 with Serial Number 54445 ("existing equipment") as part of your purchase of the Siemens Definition AS-64 for Carolinas Medical Center - University. The cost for the de-installation and removal is included in the price quotation for the replacement equipment, which totals $420,000 ($620,000 sale price minus $ 200,000 trade).

The system will be removed from Service by a broker designated by Siemens for either re-sale purposes or parts. The system will not be placed into Service by Siemens in North Carolina without proper state approvals.

Sincerely,

Edwin Winicki
Key Account Executive
Siemens Healthcare, USA

Siemens Healthcare, USA
51 Valley Stream Parkway
Malvern, PA 19351

www.SiemensMedical.com

Attachment E

Capital Cost Schedule and Architect Signature

PROPOSED TOTAL CAPITAL COST OF PROJECT

Project name: 2814627-CMC University CT Replacement

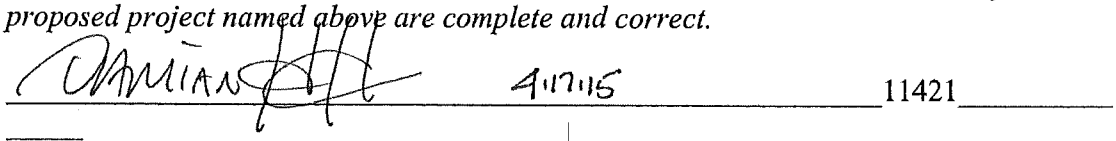
Provider/Company: Carolinas HealthCare System

A.	**Site Costs**			
(1)	Full purchase price of land			N/A
	Acres	Price per Acre $		
(2)	Closing costs			N/A
(3)	Site Inspection and Survey			N/A
(4)	Legal fees and subsoil investigation			N/A
(5)	Site Preparation Costs			
	Soil Borings			
	Clearing-Earthwork			
	Fine Grade for Slab			
	Roads-Paving			
	Concrete Sidewalks			
	Water and Sewer			
	Footing Excavation			
	Footing Backfill			
	Termite Treatment			
	Other (Specify)			
	Sub-Total Site Preparation Costs			N/A
(6)	Other (Specify)			N/A
(7)	**Sub-Total Site Costs**			N/A
B.	**Construction Contract**			
(8)	Cost of Materials			
	General Requirements		included	
	Concrete/Masonary		included	
	Woods/Doors & Windows/Finishes		included	
	Thermal & Moisture Protection		included	
	Equipment/Specialty Items		included	
	Mechanical/Electrical		included	
	Other (Specify)		included	
	Sub-total Cost of Materials			included
(9)	Cost of Labor			included
(10)	Other (Specify)			included
(11)	**Sub-Total Construction Contract**			$260,000
C.	**Miscellaneous Project Costs**			
(12)	Building Purchase			N/A
(13)	Fixed Equipment Purchase/Lease			$661,730
(14)	Movable Equipment Purchase/Lease			N/A
(15)	Furniture			N/A
(16)	Landscaping			N/A
(17)	Consultant Fees			
	Architect and Engineering Fees		$34,300	
	Legal Fees		N/A	
	Market Analysis		N/A	
	Other (Specify)		N/A	
	Other (Abatement)		N/A	
	Sub-Total Consultant Fees			$34,300
(18)	Financing Costs (e.g., Bond, Loan, etc.)			N/A
(19)	Interest During Construction			N/A
(20)	Other (Security, Internal Resources, Contingency)			$55,000
(21)	**Sub-Total Miscellaneous**			$751,030
(22)	**Total Capital Cost of Project** (Sum A-C above)			$1,011,030

PROPOSED TOTAL CAPITAL COST OF PROJECT

Project Name:
Provider/Company:

I certify that, to the best of my knowledge, the above construction related costs of the proposed project named above are complete and correct.



(Signature of Licensed Architect or Engineer)