More than the Sum of Its Parts

Siemens Medical Solutions is not only aiming for optimized image quality in its flat detectors. The company is also looking to develop completely new functions that lighten hospital staff workload.

By Tim Schröder

X-ray devices have evolved over the past few decades from simple fluoroscopic units to high-tech systems. Moreover, image quality has been greatly improved using ever lower X-ray doses, and X-ray images are crisper and sharper than ever before. Improved image quality and lower X-ray doses have long since become routine for Siemens Medical Solutions' developers, who are after bigger game: cutting-edge technologies with new functions that create genuine value, are ideally suited for hospital work processes and create an optimal treatment environment. The Siemens developers show how this is done with their current flat detector technology.

Magnetically Driven

"In making the transition from standard image intensifiers to flat detector technology, other vendors have focused on improving image quality and reducing X-ray dose," notes Stefan Schaller, Siemens Medical Solutions' head of marketing for X-ray, fluoroscopy and angiography systems. "But we have created completely new applications that are only feasible with flat detector technology." Image intensifiers cannot be operated near a strong magnetic field because this

FLAT DETECTORS are not affected by magnetic fields – a decisive prerequisite for the development of the magnetic navigation imaging system.

FLAT DETECTOR TECHNOLOGY enhances image quality and reduces X-ray doses. At Siemens Medical Solutions completely new applications like the magnetic navigation and DynaCT have been created thanks to this entirely new approach.

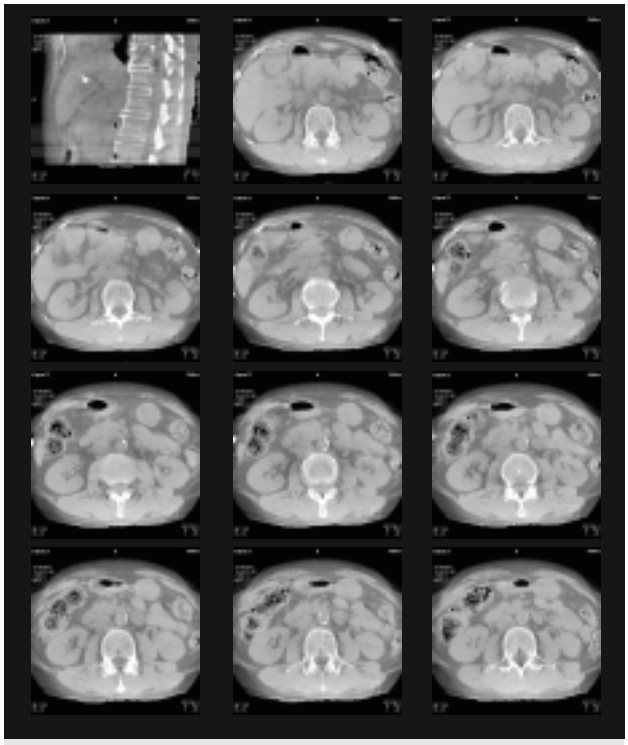
distorts the X-ray image. But flat detectors are not affected by magnetic fields, and this was the decisive prerequisite for the development of a magnetic navigation imaging system, in which a catheter with a magnetic tip is remotely guided by a magnetic field through the intricate latticework of the body's vascular system. Siemens has integrated magnetic navigation technology into its AXIOM Artis *d*FC Magnetic Navigation system and is currently the only vendor to have systems installed. Twenty customers around the world are already using this ultra-advanced technology.

Greater Room to Maneuver

This integrated system also makes X-ray equipment easier to operate, largely because the Siemens developers eliminated the large image intensifier, which is the size of a washing machine drum and greatly limits the operator's freedom of movement during interventions and precision work. The new Siemens flat detectors are optimally suited for a broad range of applications, also thanks to the relatively small size of the AXIOM flat detectors for angio-cardiography which measure only 18 centimeters squared. This is large enough to image the human heart, while being able to acquire extremely clear images and still leaving enough space for the operator to position himself optimally and guide the catheter through the heart's minute vessels. For angiography applications, Siemens developers decided to use a 30 x 40 centimeter detector. "With our rectangular flat detector we have achieved the impossible," stated Dr. Martin Ostermeier, product manager for ceiling-mounted angiography systems. "The unit's 30 x 40 centimeter dimensions make it ideal for patient access as well as for coverage of the entire body." The detector can be moved into either horizontal or vertical position by simply pushing a button. When the unit is positioned lengthways to the patient, the detector allows easy access, and in horizontal position coverage is extremely broad. Moreover, the detector can be moved easily to attain an acute angle to the patient.

Reducing the size of the detector to a minimum is also advantageous in that less load is placed on the C-arm, thus enabling it to move more rapidly. The AXIOM Artis can cover 60 degrees in one second. This new Siemens technology represents a first step toward the integration of conventional

THE FLAT DETECTORS of the AXIOM angiography systems are rectangular (30 cm x 40 cm). This improves patient access and allows for a vertical or broad horizontal coverage of the body.



THE PANEL TECHNOLOGY enables completely new applications: this DynaCT image shows images comparable to those of a CT-system – acquired with a C-arm.

X-ray imaging with CT-like imaging. In CT scanners, an X-ray tube and a detector rotate rapidly around the patient, thus creating slices that can be combined to produce a seamless three-dimensional image. Image intensifier and flat detector C-arm systems that allow for three-dimensional imaging have been available for quite some time. But higher rotational speeds generate more precise CT slice images. Siemens DynaCT flat detector technology (see p. 46), which will be unveiled at RSNA 2004, allows for the generation of these slices using the C-arm. The fact that the system provides precise soft tissue differentiation in the angiography system itself potentially increases diagnostic accuracy.

Smart Integration

Siemens design engineers set out to replace the image intensifier or film cassettes with the flat detector and at the same time seamlessly integrate this technology with existing technologies. "Flat detectors have opened up numerous new horizons. In order to make optimal use of them, we developed the FD*i* system," comments Stefan Schaller. "The '*i*' stands for integrated, intelligent and inno-vative because the intelligent integration capabilities of our new technology allow for innovative solutions."

Schaller feels that in view of the many advantages of the new Siemens system compared with conventional technologies, flat detector technology will dominate the market in the coming years.

At a minimum the Siemens system considerably optimizes hospital workflows. "We have observed that FD technology reduces the number of work steps it takes to generate and archive an X-ray in the radiology department from 27 steps to somewhere between four and six," notes Sandy Anderson, OP Radiology & Imaging Services Director of Front Range Orthopedics Hospital in Colorado Springs, Colorado. This saves an enormous amount of time. For example, film cassettes no longer need to be replaced and film development and labor-intensive manual archiving are eliminated. An FD image is ready to be viewed in a matter of seconds, can be archived in multiple locations with a mouse click, and can be processed digitally. Siemens Medical Solution FD technology will serve the clients well in the coming years. Image quality, radiation dose, user convenience, plus integration into hospital workflows will enable Siemens Medical Solutions to provide hospitals with the best of all worlds for patient care.

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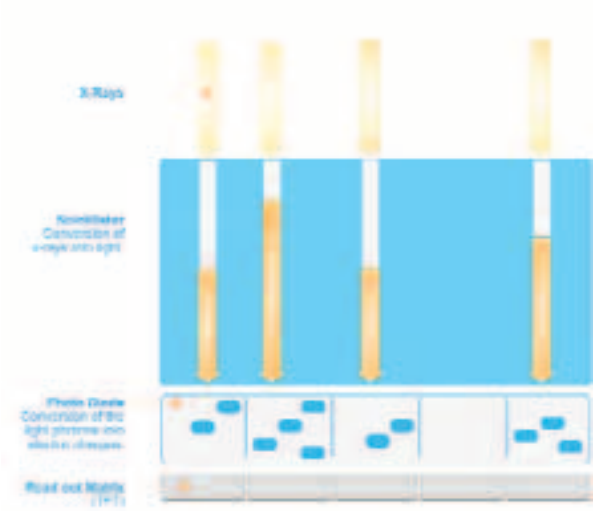
RADIOGRAPHY WORKSTATIONS integrate the FD*i*-concept as well.

Tightly Packed "Sandwich" Construction

Flat detectors deliver far superior image quality compared to conventional image intensifiers. This holds true for two-dimensional radiographic images as well as for three-dimensional images and images of the beating heart. This greatly superior quality is mainly attributable to the fact that X-ray quantums are con-verted into digital images more directly. Flat detectors employ a tightly packed "sandwich" construction in which the X-rays first strike the scintillator (a cesium iodide [CsI] layer), which converts the X-ray quantums into green light. This green light is absorbed by amorphous silicon photodiodes located under the scintillator that convert the light into electrical signals, which are then read and digitalized, thus making the information available as a digital image. Since silicon is ultrasensitive to green light, the light quantums are converted with a high degree of efficiency. The scintillator is also outfitted with minute cesium iodide rods that conduct the light to the photo-diodes, as in a tunnel, thus reducing light dispersal to an absolute minimum.

Image intensifiers, on the other hand, are constructed like cathode ray (television) vacuum tubes and thus have a far longer image chain. In these tubes, X-ray light accelerates activated electrons, which strike a phosphorous screen, thus generating light quantums. The light is then converted into an image by a CCD camera. The numerous conversion steps needed to convert the original X-ray signal into an image lead to reduced image quality. The contrast resolution provided by image intensifiers is inferior to that of flat detectors, and the resulting image is inhomogeneous and distorted. In addition, these systems do not perform well when operated in proximity to an electromagnetic field.



The most common type of flat detector is based on a two-step indirect conversion process. In the first step, X-rays are converted into light within a scintillator and in the next step the light is converted into an electronic signal by a photodiode. As scintillator materials GD_2O2_2 or CsI are typically used and amorphous silicon is the common material for the photodiodes.