

AXIOM Luminos dRF*: Fluoroscopy's bright future

By Simon Scott, PhD

The world of fluoroscopy is about to get flatter. Flat detectors have already displaced film cassettes in mammography and radiology suites and are gradually making image intensifiers on C-arm systems for angiography and cath labs redundant. Now they stand poised to enter the fluoroscopy suite as well.

Siemens recently introduced the AXIOM Luminos dRF fluoroscopy system, built around a state-of-the-art digital flat detector (FD). The new detector replaces not just the screen-film cassettes employed for acquiring static images during fluoroscopic exams, but also the image intensifiers that have long been the heart of real-time X-ray imaging. Compared to current remote-controlled

fluoroscopy systems, the flat-panel technology provides improved image quality and smoother workflow. In addition, the large, square, 43 cm x 43 cm field of view allows more anatomy to be captured in a single frame, facilitating examinations and procedures that were challenging to perform with the smaller, round field of view of an image intensifier.

The combination of a fluoroscopy system equipped with a flat detector offers even more: With this technology, a wide range of radiography examinations can be performed digitally, leading to significant workflow improvements and thereby to increased efficiency in your radiology department.



The 2-in-1 solution: Fluoroscopy and radiography

While the flat detector in the AXIOM Luminos dRF system provides considerable image quality and practical advantages for fluoroscopic imaging, the system's most compelling advantage may be the flexibility to use it for both imaging techniques – fluoroscopy and radiography. The very same detector can produce high-quality fluoroscopy exposures and dynamic sequences as well as high-quality static radiography images.

This ability enables the radiologist to perform both image techniques without compromise. And it becomes even more important when one considers the workflow of a fluoroscopic

examination such as a double-contrast barium enema, where single radiographs need to be performed. AXIOM Luminos dRF eliminates the need to pause and set up or reload a film cassette during the course of the examination. Since no film processing is required, the images are immediately available for the physician for a quick review to ensure that all relevant medical information is obtained or whether a retake is needed. However, because of the wide dynamic range and linearity of flat detector response, such retakes due to the overexposure or underexposure that frequently plague more finicky systems using film cassettes, would rarely be needed. The contrast of the digital images can simply be adjusted through straightforward postprocessing.

* **Pending 510(k)**

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The integration of dynamic and static acquisitions into a single digital detector also simplifies image management workflow. The static images are automatically saved in the patient folder on the fluoroscopy system, along with the fluoroscopic sequence. By contrast, on analog or image intensifier-based digital systems, the processed film needs to be digitized, and the resulting digitized images would have to be merged manually with the fluoroscopic exam on a PACS system. The resulting image quality is comparable to that of any diagnostic, flat detector-based radiography system, which means that the system could also be used for general radiographic examinations, allowing for maximum utilization of the equipment and the fluoroscopy suite. This versatility provides the ability to manage a high workload and adjust equipment utilization to a different future break-down of the clinical application range.

This symbiosis of fluoroscopy and radiography can only be achieved by using innovative detector technology. The AXIOM Luminos dRF system employs an indirect-conversion flat detector based on Cesium Iodide (CsI) and a 43 cm x 43 cm field of view. This large field of view represents a significant advantage for the AXIOM Luminos dRF's flat detector over image intensifiers. It covers nearly 50% more area than the largest 40 cm diameter image intensifier previously available. This large, square field of view makes possible a number of examinations that were previously impractical, including urological examinations that visualize the kidneys and bladder in a single view and barium-swallow esophageal exams covering the entire area from the upper esophagus to the cardia. With image intensifiers, such studies, if they are performed at all, may require two steps during the course of the

By replacing the image intensifier with a flat detector, the system can be lowered to 48 cm above the floor, making it easier for the patient to be placed on the examination table.



A paradigm shift : Analog to digital

To understand the significance of the shift to flat detectors, it helps to appreciate something of the long history of fluoroscopy, arguably the original X-ray imaging modality. The biggest innovation in the past decade has been the transition to digital fluoroscopy. Typically, the output of the image intensifier is coupled to a video camera for display on a television monitor and for recording of the imaging sequence. Traditionally, analog video cameras and recording devices were employed, although more recent systems have employed digital video cameras based on charge-coupled devices (CCDs), which allow for digital archiving of the image sequence. However, all image intensifiers suffer from pincushion distortions due to imperfect focusing of the accelerated electrons on the output screen. Scattering of output optical light in the glass housing of the image intensifier also leads to veiling glare that causes an apparent loss in brightness at the edge of the intensifier and a loss in contrast resolution. Neither of these effects arises in flat detectors, which are essentially distortion-free and uniform in response across their fields of view.

Moreover, unlike flat detectors, the image intensifier lacks the ability to acquire high-quality radiographic still images. Indeed, acquiring static, high-quality radiological images during the course of a fluoroscopic exam using an image intensifier generally entails the use of a separate screen-film cassette.

Flat detectors for X-ray imaging come in two major varieties: indirect-conversion systems and direct-conversion systems. All flat-panel X-ray detectors must ultimately convert a flux of incident X-rays into a distribution

of electrical charge suitable for digitization in the readout matrix of the detector. In direct-conversion systems, often based on a material known as amorphous selenium, the X-rays directly produce a cascade of liberated electrons in the detector material, and these are collected in an appropriate electrode prior to readout. In indirect-conversion systems, the incident X-rays first get converted into optical photons, which subsequently impinge on a photodiode at the base of the detector where they are converted to electrons and stored until readout.

The AXIOM Luminos dRF* system employs an indirect conversion flat-panel detector based on Cesium Iodide (CsI), which has been found to have a number of advantages for fluoroscopic applications over the direct conversion systems based on amorphous selenium. CsI absorbs X-rays stronger than does amorphous selenium in the energy range employed in fluoroscopy, and it also has a higher detective quantum efficiency at these energies, which is essential for making maximum use of the relatively few photons that contribute to each image frame in a fluoroscopic sequence.

Compared to other scintillator choices for indirect conversion systems, one remarkable feature of CsI also helps minimize the degradation in image resolution that usually occurs when optical photons diffuse while traveling toward the photodiode: during their formation, the CsI crystals grow in long, narrow (5-10 micron) needle-like shapes, and these act as miniature fiber optics guiding the shower of optical photons created by each X-ray down toward the photodiode with a minimum of spreading.



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exam to inspect all relevant parts of the anatomy by repositioning the detector-tube or the tabletop, or even by moving the patient.

New System Design: Compact, Flexible, and Convenient

The use of a thin flat detector rather than a bulky image intensifier in the AXIOM Luminos dRF* also allows for more flexibility in table motion, including lowering the table to 48 cm above the ground rather than the

workflow is improved, resulting in increased throughput and efficiency for the department. For certain radiographic exposures of extremities it is not even necessary to position the patient on the table. Due to the low table height, the patient can remain seated in a wheelchair during an examination of metatarsals or the ankle. This results not only in workflow benefits due to simplified operation, but also in increased comfort for the patient. The open and compact design of the table offers the technicians excellent



80 cm achievable previously. This makes it both easier and faster for immobile or older patients to be placed on the table, especially when being transferred from wheelchairs or stretchers. Both patients and staff in the fluoroscopy suite thus profit from this newly achieved table flexibility. What is now more comfortable for the patient becomes even more convenient for the staff. Heavy or immobile patients are easier to handle, work becomes more ergonomic, and of course,

access to the patient, even from the rear of the system. Patient transfers from a stretcher and complex examinations, such as an endoscopic retrograde cholangiopancreatography (ERCP), can be performed in an comfortable manner. The workflow benefits of digital radiography apply to a broad range of exposures in upright position. By tilting the table, swallows in standing position or static images, for example, from the abdomen or the vertebral column can be accomplished.

Moreover, the images acquired with a flat detector do not show the intrinsic pincushion distortion known from image intensifiers, enabling the physician to conduct measurements for pre-surgical planning prior to hip surgery. The indirect-conversion flat-panel technology, with its high detective quantum efficiency, makes more efficient use of the X-rays that penetrate the patient than image intensifiers allowing for a reduction in dose both to the patient and to the physician. Naturally, the AXIOM Luminos dRF* system can be optionally equipped with Siemens' full suite of CARE (Combined Applications to Reduce Exposure) applications. These include CAREPROFILE, which allows radiation-free positioning of collimators and semi-transparent filters, as well as CAREPOSITION for quick and radiation-free positioning of the patient. Both techniques are supported by the last image hold (LIH) image. Tremendous dose savings in fluoroscopy can be attained by using CAREVISION, which employs pulsed fluoroscopy using selectable pulse rates instead of performing continuous fluoroscopy. The way to a fully digital radiology department is supported by the advanced networking capabilities of the AXIOM Luminos dRF. Starting with an easy patient registration via the hospital and radiology information systems (HIS/RIS), the comprehensive DICOM functionality enables the acquired data to be sent to various destinations in the HIS. As a result, the requirements of clinical data management are completely met and work procedures are accelerated. The introduction of flat detectors to fluoroscopy represents the latest in a long line of innovations in real-time X-ray imaging. By incorporating this technology into the AXIOM Luminos dRF system, Siemens created a system of rare versatility that excels in both radiological and fluoroscopic imaging without compromising on image quality or ease-of-use.

AXIOM Luminos dRF at a glance

- Fully digital 2-in-1 solution for a future-proof and efficient investment in the radiology department
- Excellent image quality at a large coverage of 43 cm x 43 cm provided by a dynamic flat detector for static and dynamic imaging
- Enhanced ease of use for patients and staff enabled by a minimum table height of 48 cm



State-of-the-art fluoroscopic and radiographic examinations on one system are now a reality with AXIOM Luminos dRF.

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**For more detailed information,
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