Technical Brief Series

DRX-LC Detector

Authors: *Jay Zhou, Karina Ma, Lori Barski, Clifford Chen, Xiaolan Li, and Xiaohui Wang*

Introduction

Carestream is a vibrant global company with a proven history of superb imaging technology and unparalleled service. That history is now poised to continue with the DRX-LC panels—our second generation of single-shot, long-length imaging (LLI) panels designed to provide our customers with quantifiable gains and real-world benefits. This paper will describe the features and benefits of the DRX-LC panel (Figure 1)—a cesium-iodide (CsI) detector designed for long-length radiography (both in-room and portable) of the full spine and full leg with a single exposure. Key features of the DRX-LC are summarized in Table 1.

Figure 1. DRX-LC detector and optional stand

Active Pixel Matrix	3064 × 8696 Pixels
Active Imaging Area	16.76" x 47.6"/ 42.58 cm x 120.87 cm
Scintillator	CsI
Pixel Pitch	139 µm
Bit Depth (A/D)	16 bit
Data Transfer Mode	Wired or Wireless
X-ray Sync Control	Software or Automatic Exposure Detection (AED)
Power Supply	Battery or Wall Power
Battery Features	High-Capacity Batteries, Dual-Battery Design for Redundancy

Table 1. DRX-LC key features

Imaging Performance

Imaging performance was measured under RQA-5 beam conditions and compared with another single-shot LLI panel (Panel A) which has a 140 µm pixel pitch with GOS scintillator.

MTF Comparison

Figure 2 compares the MTF of the DRX-LC and Panel A. The DRX-LC's MTF demonstrates higher resolution which implies better resolving power for anatomical structures and features in clinical use.

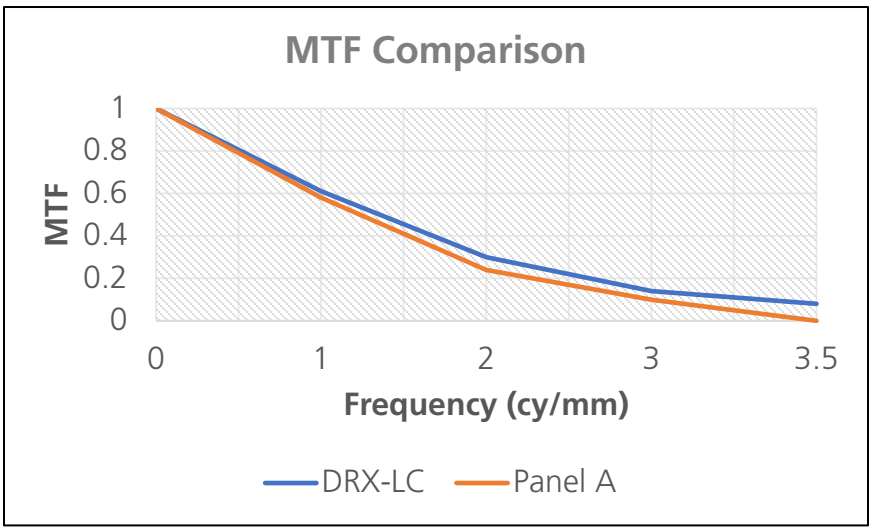


Figure 2. MTF comparison of the DRX-LC panel with Panel A

DQE Comparison

Figure 3 compares the DQE of the DRX-LC panel and Panel A. The DRX-LC's DQE performance is notably higher than Panel A which supports the use of a lower dose to achieve equivalent image quality compared to the GOS panel.

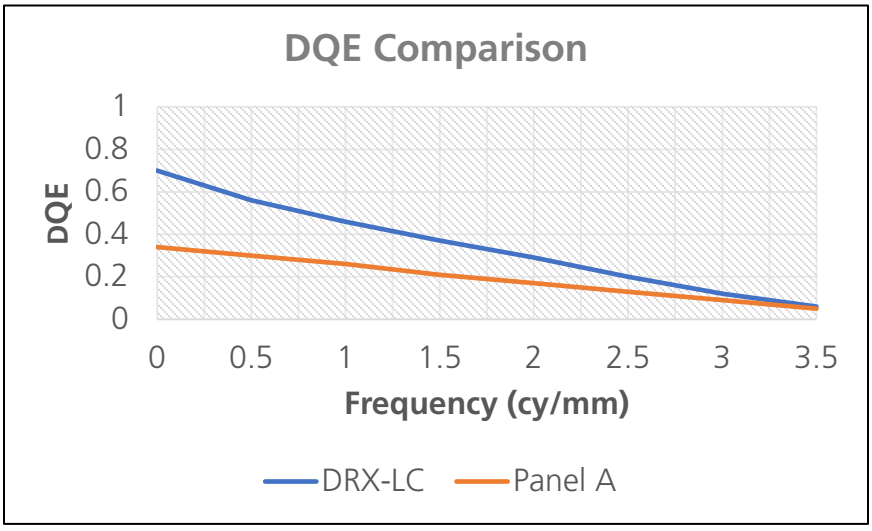


Figure 3. DQE comparison of the DRX-LC Panel with Panel A

Features

Singe-shot vs. Multi-shot Imaging – Reduced Dose Part 1

Using the single-shot DRX-LC panel results in less dose to the patient as compared with standard, multi-shot, long-bone or full-spine imaging methods, while providing the highest geometric accuracy available. In addition, the DRX-LC panel reduces exposure unevenness and therefore provides a more uniform and consistent brightness and contrast throughout the image.

On multi-shot LLI exams, such as a 3-panel acquisition, there are overlapping regions where stitching is required to construct the full-length image. These overlapping regions receive double exposure, hence more dose to the patient (Figure 4).

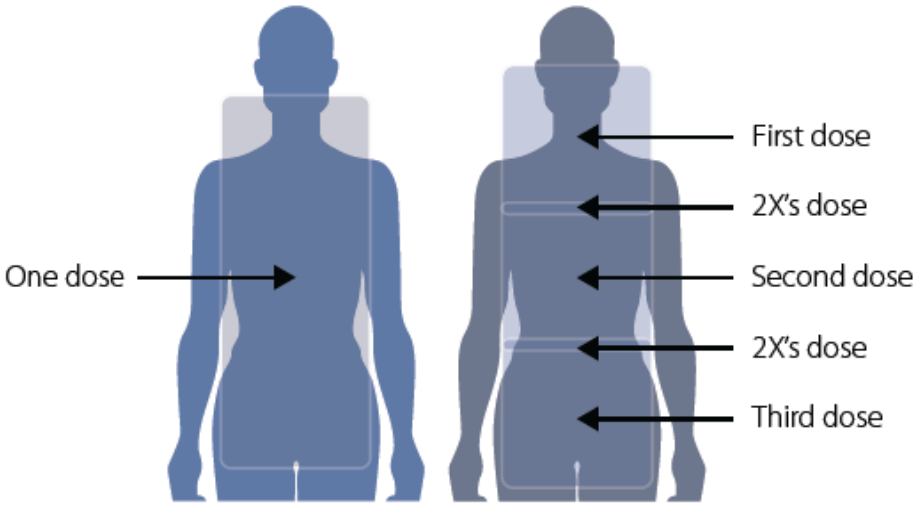
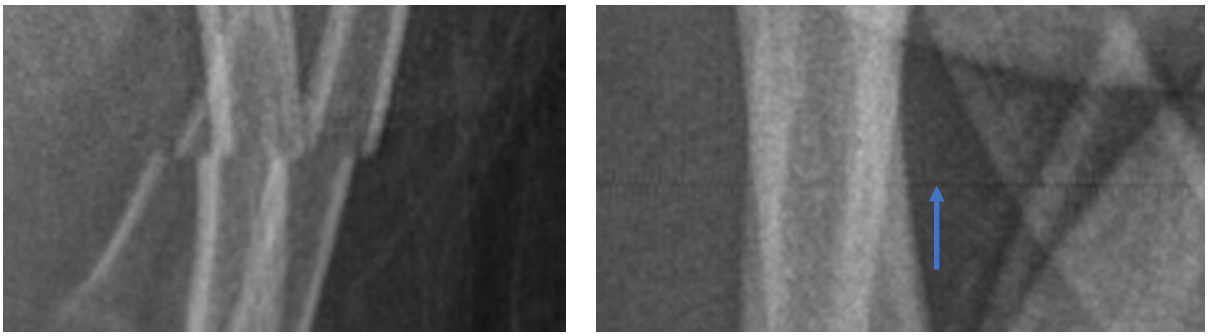


Figure 4. Single-shot LLI vs. multi-shot LLI

Performing three separate exposures enables the selection of different exposure techniques for the various anatomical regions; however, setting each exposure properly for individual patients is always a challenge. In addition, patient motion is frequently observed during the time period while multiple exposures are taken. When a single exposure is taken of the entire spine or leg with DRX-LC, shorter breath holds are used, which essentially eliminates anatomical motion and preserves geometric integrity. Additionally, motion-related exposure re-takes are eliminated, further reducing the dose to the patient.

Seam management is required with multi-shot LLI imaging because of the need to stitch together multiple panel images. Figure 5a demonstrates a challenging seam situation for a multi-shot exam. In single-shot LLI imaging with the DRX-LC panel, the seam is typically imperceptible; however, the butt-line of the grid is often visible (Figure 5b).



a b

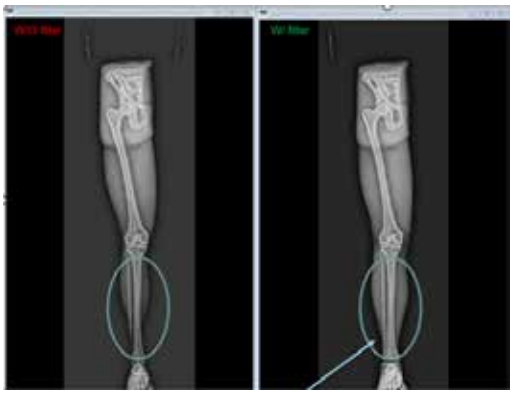
Figure 5. Seam challenge for multi-shot LLI stitching (a) vs. clean seams for single-shot LLI (b)
Note: the faint line shown in b is not a seam, but rather the butt-joint of the grid.

Scintillator Improvement – Reduced Dose Part 2

The DRX-LC panel scintillator is made of state-of-the-art CsI material which has the advantage of higher conversion efficiency from x-ray energy to light as compared to gadolinium oxysulphide (GOS) scintillators used in Panel A where light is scattered between the grains of phosphor. It has been shown that CsI detectors can operate at approximately 40% less dose than GOS detectors to achieve comparable image quality[1] due to the significant increase in detective quantum efficiency (DQE, see Figure 3) that CsI panels offer.

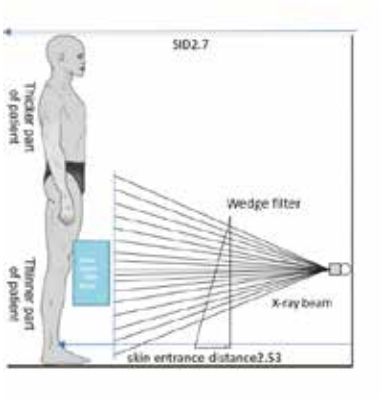
Compensation Filters – Reduced Dose Part 3

With single-shot LLI, a compensation filter that is shaped based upon the application is used to distribute the dose appropriately for the different anatomical regions.[2] Thus, a technique chosen to adequately image the thicker portion of the anatomy can be used without fear of overexposing the thinner, less attenuated anatomy. These filters facilitate dose reduction,[3] improve image quality, and are the recommended best practice for single-shot LLI. The benefit of using a wedge compensation filter is demonstrated using a leg-length phantom with and without a wedge filter where the technique is set for appropriate exposure of the hip. Without the wedge filter, the lower leg is overexposed (Figure 6). With the wedge filter, the overall patient dose is reduced, and the beam is shaped to yield more uniform exposure at the detector which improves image quality.



No Filter With Filter

Figure 6. Image quality benefit of a wedge filter



Wedge filter principle

AP leg length filter over the x-ray aperture

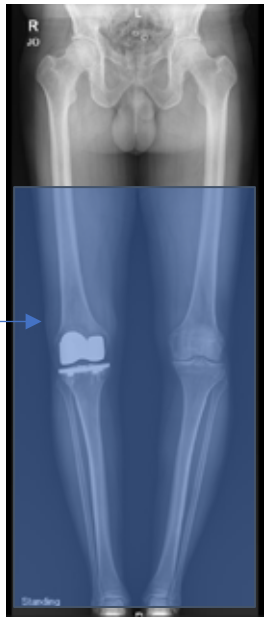


Figure 7. Wedge filter dose comparison set-up

Figure 7 illustrates the setup for the wedge filter dose comparison, where the filter is placed near the aperture of the collimator with the thickest part of the wedge positioned over the thinner region (ankles) of the phantom. Skin entrance dose measurements were taken at the level of the thigh for various exposure levels during acquisitions made with and without the use of a wedge filter.

The skin entrance dose reduction factor for the leg phantom with the wedge filter is greater than 6x when measured over the thigh. Figure 8 illustrates the relative differences as a function of mAs value.

In practice, the wedge filter is magnetically attached to the collimator aperture on the x-ray tube head. Compensation filters are available with the DRX-LC panel and are sold as a set with filters for Lateral C-spine, Leg Length, and AP/PA Scoliosis exams.

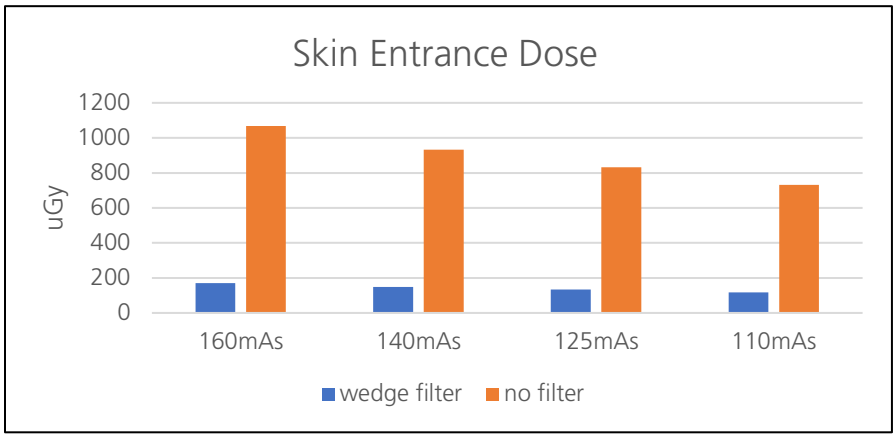
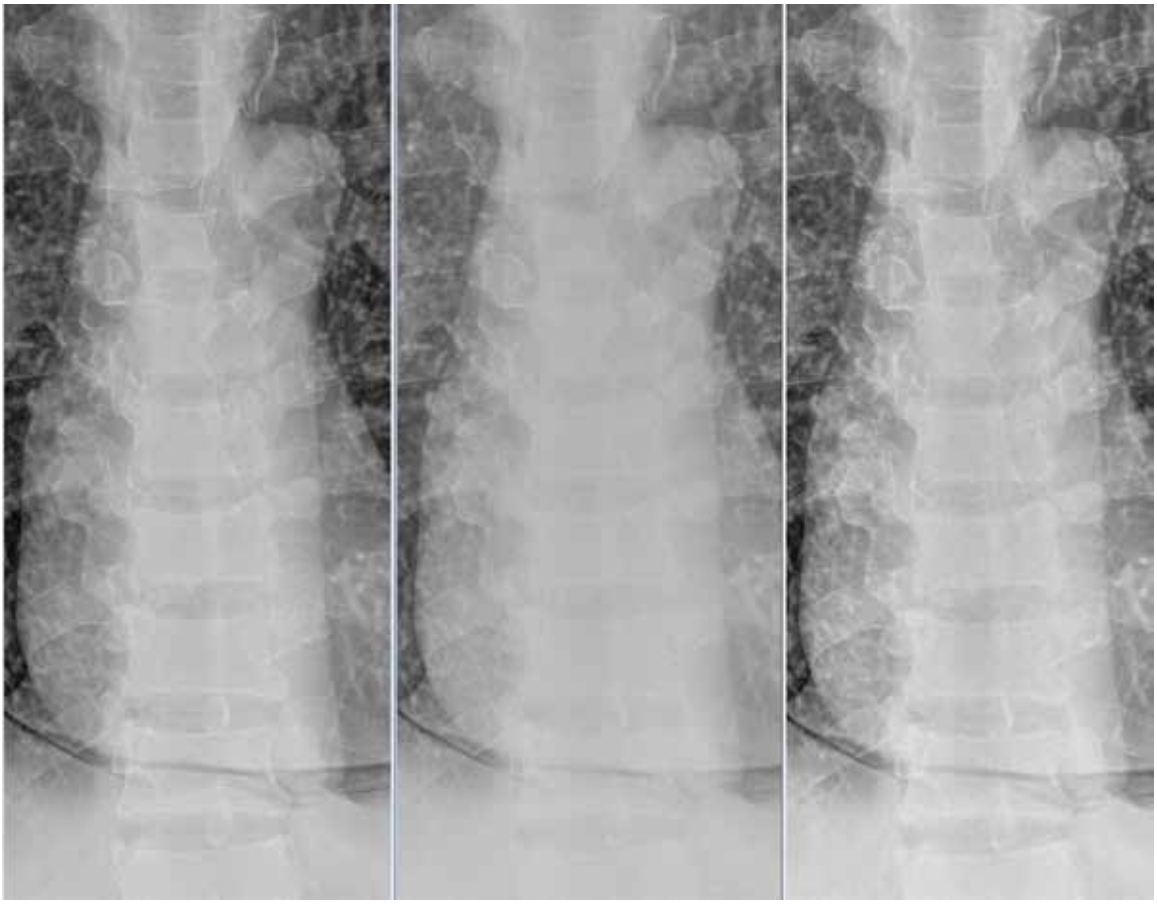


Figure 8. Filter effect on skin entrance dose

Gridless Imaging with Eclipse SmartGrid – Reduced Dose Part 4

Anti-scatter grids are by far the most popular means of reducing scatter in portable imaging, but they present challenges to radiographers (e.g., positioning and alignment) and they increase the dose to the patient. As an alternative to a grid, Carestream offers the SmartGrid feature as part of its Eclipse Image Processing software. SmartGrid is a proven scatter removal algorithm[4] that provides the benefit of a grid without the hassle of using a grid. Positioning and alignment challenges associated with the grid are significantly reduced, which is greatly appreciated in areas such the operating room. And when imaging pediatrics, where dose is of greatest concern, SmartGrid can provide excellent image quality and facilitate ALARA (as low as reasonably achievable) dose levels, for both in-room and portable environments.

The SmartGrid algorithm estimates the scattered x-ray field in the acquired image and then subtracts it, resulting in an image with improved subject contrast. Figure 9 illustrates the effectiveness of SmartGrid by comparing a spine phantom acquired with a physical grid (left, 80 kVp, 55 mAs), without a physical grid (center, 80 kVp, 28 mAs), and the same non-grid image processed with SmartGrid (right). Observe the improved subject contrast when SmartGrid is utilized.



With grid | Non-grid | Non-grid with SmartGrid

Figure 9. Effectiveness of SmartGrid

Workflow

Better for the Patient and Technologist

Single-shot LLI enables fast acquisitions with short breath holds, typically less than 1 second. This contrasts with multi-shot imaging which can require a hold time of approximately 8–10 seconds for a 3-exposure LLI exam. When imaging the elderly, or any unstable patient, the ability to image quickly with a single shot significantly reduces the risk of motion and the need to repeat exams.

With the DRX-LC panel, the total exposure to the patient is lower than multi-shot LLI. And when a compensation filter is used and/or SmartGrid is enabled, even greater dose reduction is possible—a benefit for both patient and staff, particularly in the operating room.

Better for the Physician

Single-shot LLI provides a more comprehensive view of the bone or joint in question without geometric distortion. This allows the physician to see the entire length of the spine or bone (provided SID can be achieved), unencumbered by stitching artifacts, to assess any potential damage or instability. This can help streamline the diagnostic process and reduce the overall time needed for the procedure.

Conclusion

Carestream pioneered the concept of portable, wireless, cassette-sized DR detectors and this leadership position continues with the launch of the DRX-LC detector. But it takes more than a quality detector to meet the needs of a busy department—just as important is providing images with superior quality, acquired in a timely fashion without geometric distortion at the lowest possible dose to the benefit of both patients and technologists. The DRX-LC panel coupled with Carestream's Eclipse Image Processing marries the superior technology embedded in the DRX-LC panel with world-class image processing to provide outstanding images to physicians around the globe.

References

[1] Kohsei Kudo, Minoru Osanai, Megumi Tsushima, Junichi Hirota, Yuhiko Otani, Satoshi Naraki, Katsumasa Suzaki, Masahiko Aoki, and Yoichiro Hosokawa, Quantitative and Visual Image Quality Evaluation between CsI and Gd2O2S: Tb Scintillator Types of Irradiation Side Sampling Flat-Panel Detector Systems for Reduction of Radiation Exposure, Radiation Environment and Medicine, Vol 8, Issue 1, 2019.

[2] Murphy A, Jones J, Kusel K, Compensating filters. Reference article, Radiopaedia.org (Accessed on 31 May 2023) https://doi.org/10.53347/rID-58714.

[3] Toshizo Katsuda, Jasaji Okazaki, Chikazumi Kuroda, Using Compensation Filters to Reduce Radiation Dose, Radiologic Technology Vol 68, Issue 1, Sept. 1996.

[4] Lori L. Barski (MS), Dong Yang (Ph.D.), Mary Couwenhoven (MS), Image Quality Impact of SmartGrid Processing in Bedside Chest Imaging.

"Rx only"