Carestream

Pediatric Imaging

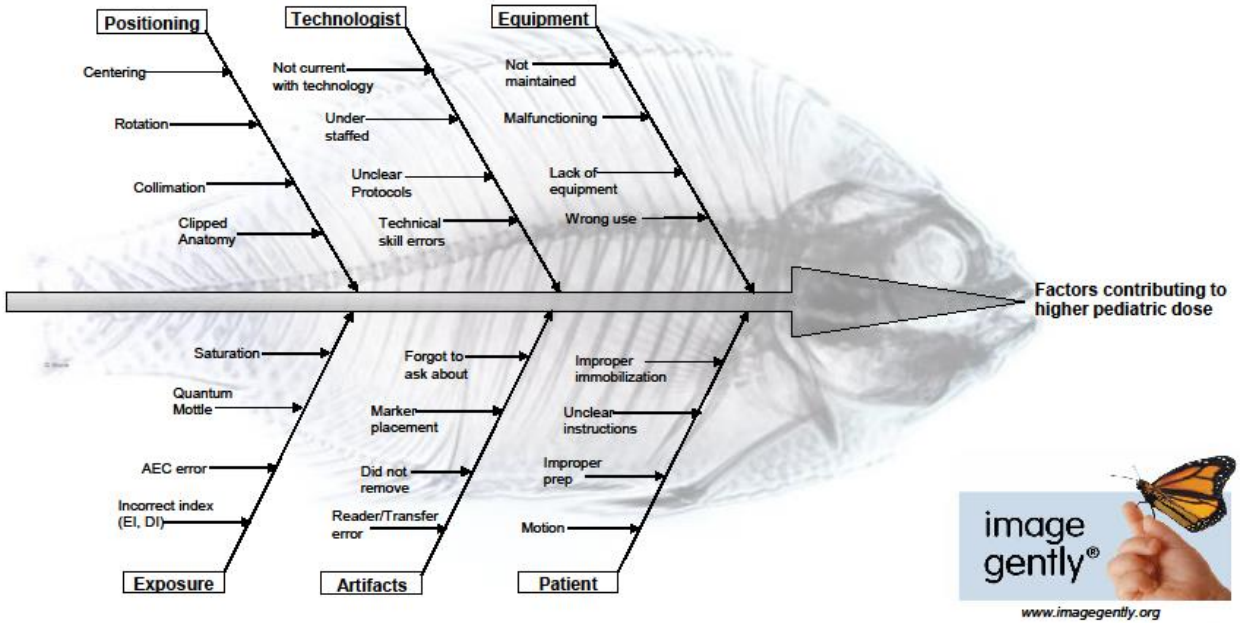
X-rays for Children

Carestream is committed to providing X-ray solutions that meet:

- The unique needs of pediatric patients
  - More sensitive to radiation induced cancer
  - Younger patients have a longer expected lifetime
  - Equipment designed for adults can result in excessive radiation exposure for children
- The recommendations of the Image Gently Alliance for Radiation Safety in Pediatric Imaging
- The radiation safety principle of **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA)
- Government guidelines for pediatric imaging

➢We can help you meet your goals for X-rays for Children

What is Image Gently?



Fishbone diagrams are useful to show cause-and-effect for undesired situations. In this case we want to lower pediatric dose, therefore, we have to consider all of the situations that could cause a child to have more radiation exposure than necessary. The goal is to prevent exposure creep, repeats, and errors by discovering their root cause. Once potential causes have been identified, plans and protocols should be developed to overcome deficient areas. The causes have been grouped into major categories along with corresponding subheadings to identify sources of variation.

What are Government Pediatric Guidelines?

Government agencies in the US (FDA) and in other countries have developed guidelines for pediatric imaging and dose:

- Defining the pediatric population by 7 age / weight categories
- Automatic exposure control (AEC) designed and tested for a broad range of patient sizes, including pediatric
- Proper filtration, positioning and shielding
- Display and recording of patient dose
- Quality control testing

➢Carestream has designed X-ray Solutions with these guidelines in mind

Draft Guidance for Industry and Food and Drug Administration Staff; May 10, 2012

European Guidelines on Quality Criteria for Diagnostic Radiographic Images in Paediatrics; July, 2000

Carestream Solutions

Image Acquisition | Image Processing | Quality Assurance

Our products keep the needs of children in mind throughout the imaging chain

Image Acquisition

Image Acquisition | Image Processing | Quality Assurance

Techniques tailored and optimized to body size
(Pediatric Image Optimization & Enhancement Software)

- 7 age/weight categories as recommended by FDA
- Exposure parameters automatically loaded based on size categories

Child-friendly hardware design

- Custom pediatric panels (DRX-Revolution)
- Easy to remove grids (DRX-Evolution / Ascend)
- Filter wheels (Evolution/Ascend/Revolution)
- Low absorption tabletop and Bucky covers (Evolution / Ascend)
- Babbix holder (Evolution)
- Long-length imaging (CR/Evolution/Ascend/DRX-1 System)

Pediatric Image Optimization & Enhancement Software

Subgroups Pediatric Subgroup	Approximate Age Range
Very Low Birth Weight	less than 1.5 Kg
Low Birth Weight	less than 2.5 Kg
Newborn	from birth to 1 month of age
Infant	greater than 1 month to 2 years of age
Child	greater than 2 to 11 years of age
Preadolescent	greater than 11 to 13 years of age
Adolescent	greater than 13 to 21 years of age

- Preadolescent
- Adolescent

Image Acquisition

Example Image Acquisition screen showing view name using 7 age/weight categories

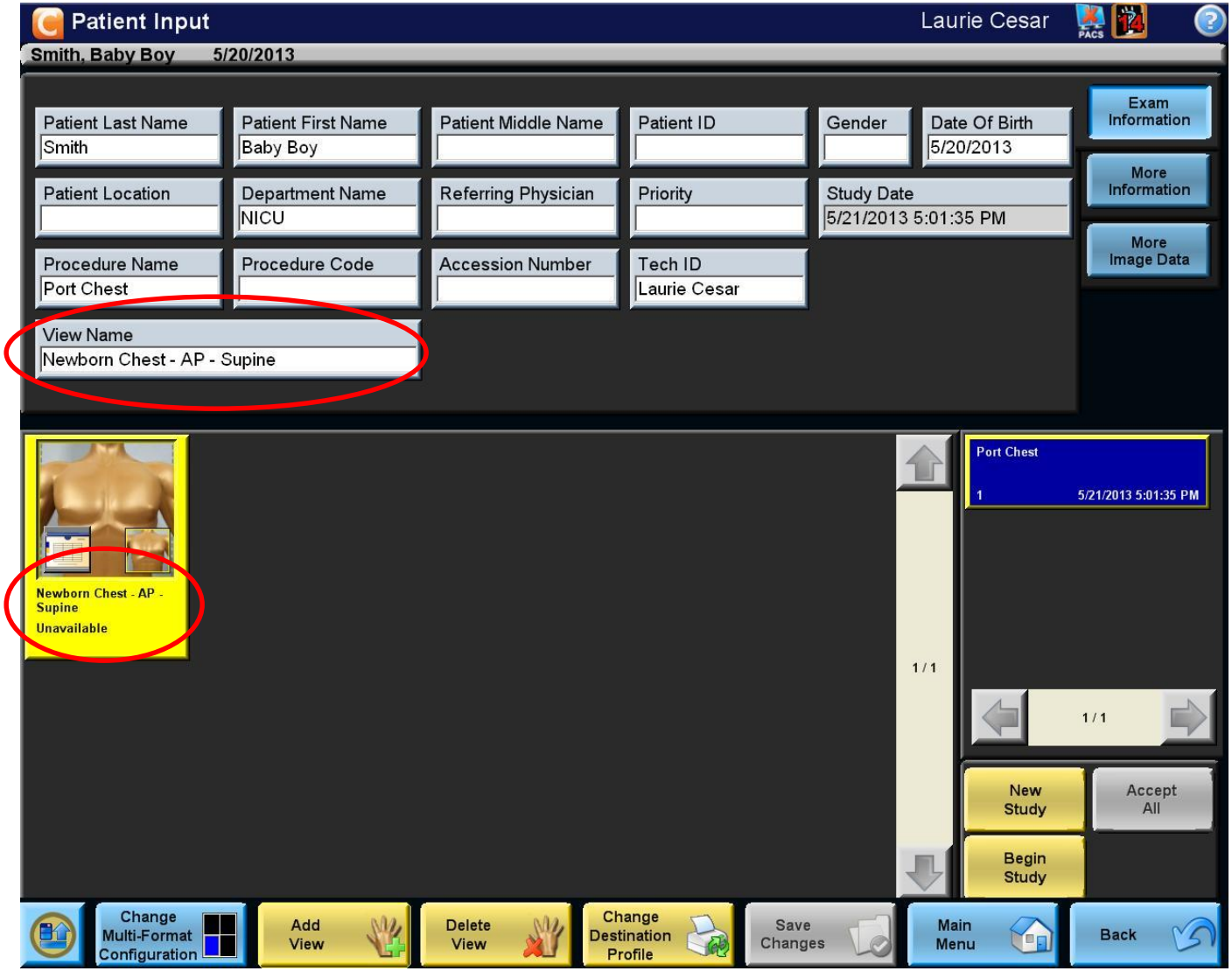


Image Acquisition

Image Acquisition | Image Processing | Quality Assurance

Low-dose wireless detectors

- CsI for high efficiency and lower dose
- DRX-1C (35x43 cm) and DRX 2530C (25x30cm)
- DRX 2530C fits in bassinets
- Fast positioning and preview time

Fast acquisition & workflow

- Less stressful for children
- More personal care dedicated to the child through saved time

"*We started noticing that we could drop our doses down, so we went down a little more. We found that with our DRX portable, we were cutting our dose in half*"

Casey Dye, Diagnostic Coordinator; Intermountain Primary Children's Hospital

"The ability to capture, view and transmit images directly to our PACs reduces waiting time and allows diagnosis and treatment to begin immediately"

Cathy Atkins, AnMed Health, Anderson, SC

Image Processing

Image Acquisition | Image Processing | Quality Assurance

Unique image processing parameters for 7 pediatric body size categories (Pediatric Image Optimization & Enhancement Software)

- Improved noise suppression and detail enhancement

Pediatric trauma views

- New views scaled appropriately to infants and children using specialized image processing that enhances the visibility of boney details while reducing noise appearance. (Trauma Views: Ribs, Skull, Upper Extremity, Lower Extremity)

"Our physicians and radiologists are extremely pleased with the improvement in visualization of soft tissue and small structures for all children, but the difference is especially pronounced in premature babies and infants."

Casey Dye, RT, Intermountain Primary Children's Medical Center

< 1 week old

6 – 12 month

2 – 6 yr

Quality Assurance

Image Acquisition | Image Processing | Quality Assurance

IEC Exposure Index

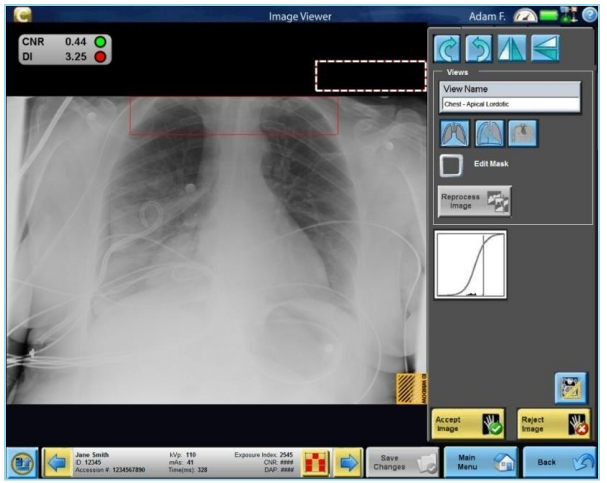
- Quick assessment of the amount of radiation used

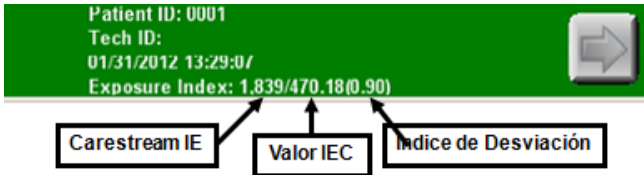
Deviation Index

- Allows an immediate evaluation compared to the hospital's target for exposures

Dose Reporting

- Reports back to the RIS, including rejects, via IHE Scheduled Workflow
- IHE Dose Reporting Software
  - Collects and distributes comprehensive dose information to PACs including DAP value, techniques, and exposure indicies



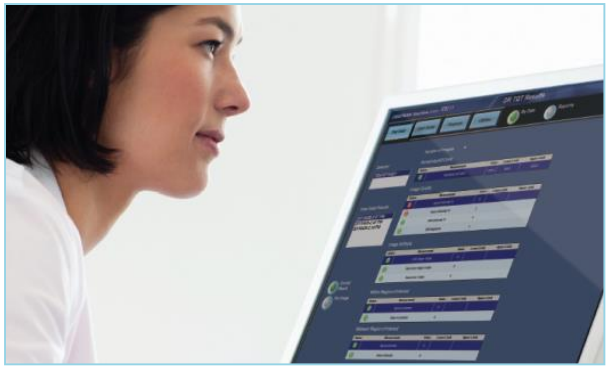


Quality Assurance

Image Acquisition | Image Processing | Quality Assurance

CR/DR Total Quality Tool

- Quality control phantom and software to assure the detector and cassettes are within specifications
- Quality assurance programs are recommended by Image Gently and Government guidelines for pediatric imaging



Administrative Analysis & Reporting Software

- Query all Carestream systems in the facility
- Reports exposure levels per exam per technologist, repeat rates, repeat reasons, techniques used and more
- Use as part of a quality program, continuing education and continuous improvement

Microsoft Office
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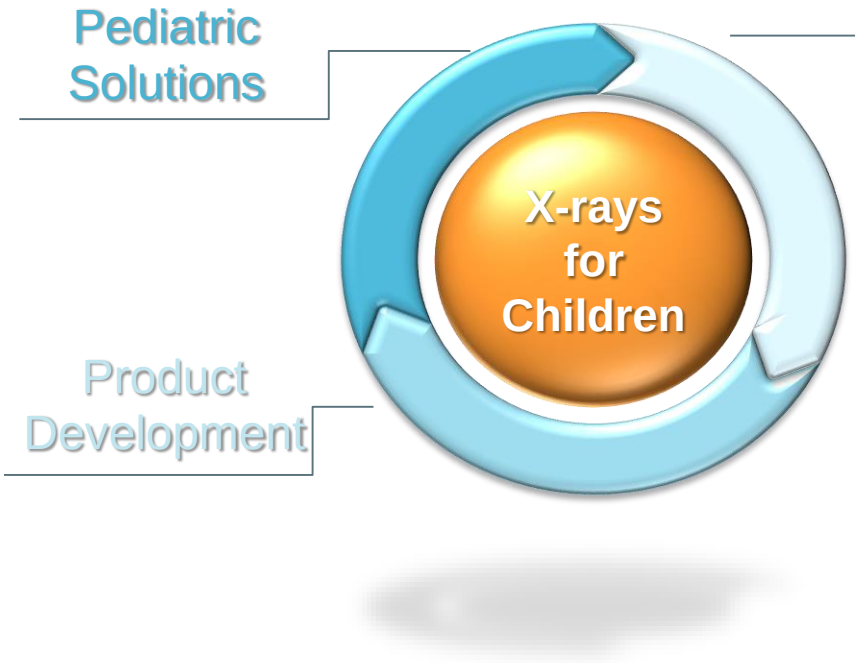
Commitment to Innovation

Carestream continues to conduct research leading to innovative product development and pediatric solutions built on the principals of Image Gently & ALARA



Examples of Recent Research

- Task-Specific Dose Reduction for Neonatal Chest Imaging (Carestream & Washington University School of Medicine, St. Louis, MO)
- Neonatal and Pediatric Chest Imaging: Weight-specific kVp Selection (Carestream & Washington University School of Medicine, St. Louis, MO)
- Potential for Pediatric DR Dose Reduction Using Customized Multi-Frequency Processing (Carestream & The Milton S. Hershey Medical Center, Hershey, PA)

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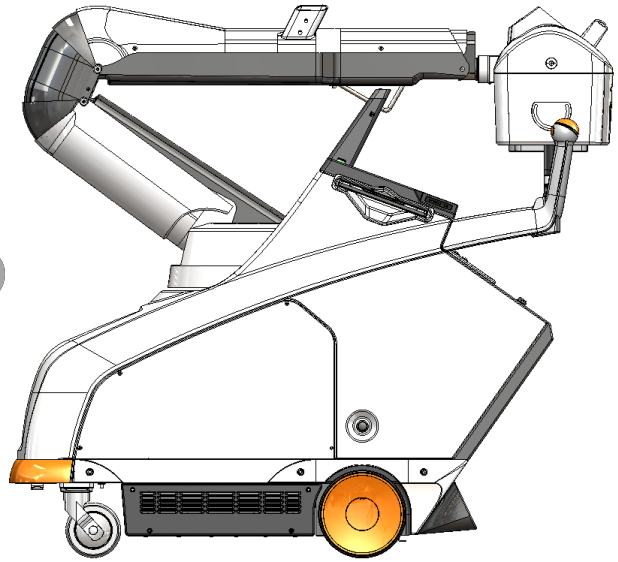
DRX Revolution Nano

DRX Revolution Nano

Non-motorized

Wireless Communication

Variable Focal Spot



Small Footprint

Carbon Nano Tube X-Ray Source

Carestream DirectView Software

Easy Maneuverability

Light Weight

SmartGrid

Convenient Storage

Mobile Portfolio Comparison

Revolution Nano

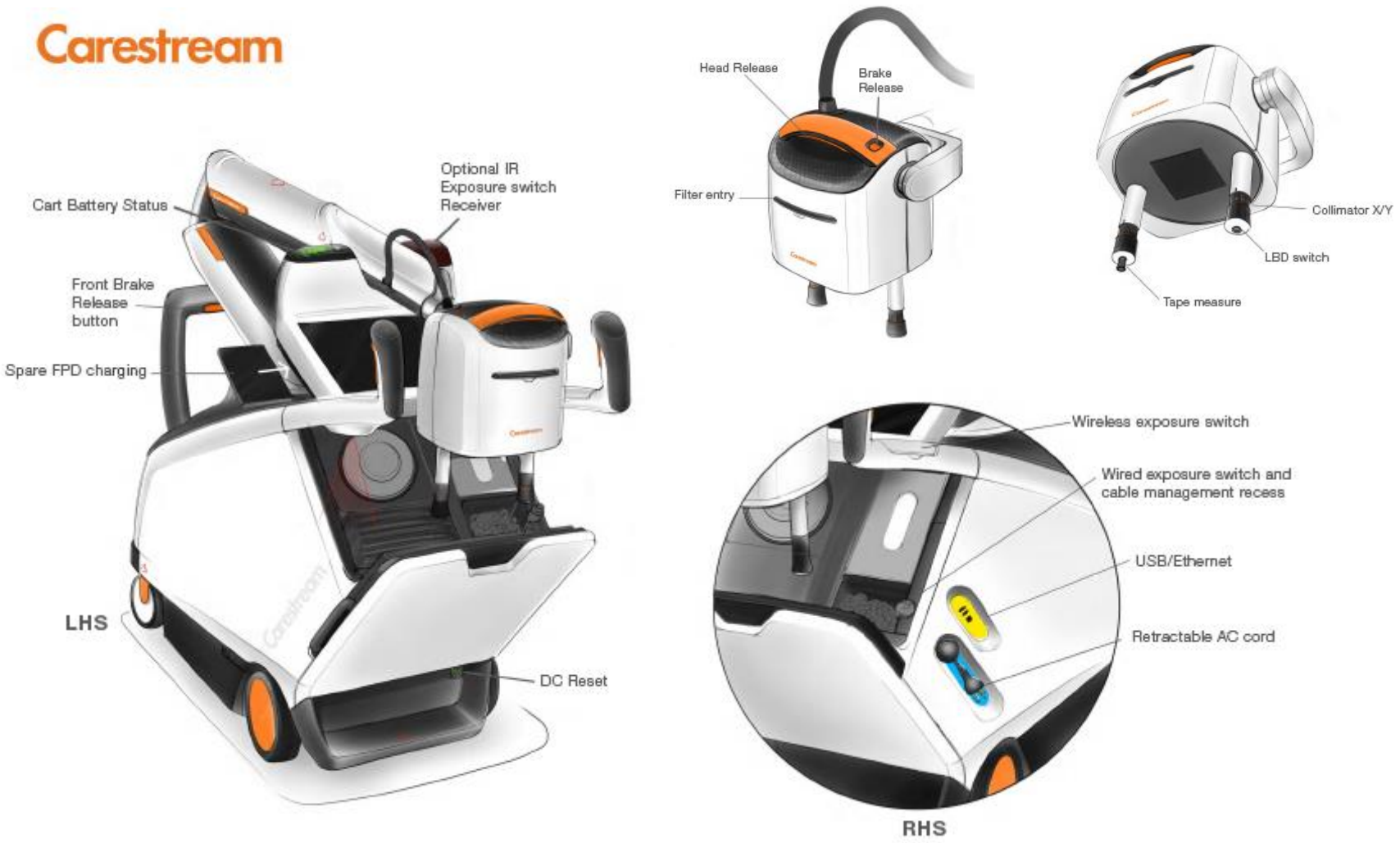
- Integrated DR Portable
- Innovative lightweight Carbon Nano tube technology
- Non Motorized
- 8 kW
- Less than (93 kg)

Revolution

- Integrated DR Portable
- Standard tube technology
- Motorized
- 32 kW
- 575 kg

Solutions to fit all mobile needs!

Features



DRX-Revolution Nano System

USB/Ethernet

Retractable AC Cord

Cart Battery Status: One for the computer and one for detector battery

RFID Badge Reader: Single badge sign-in for the system and software

Bar Code Reader: For easy patient entry

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Carbon Nano Tube

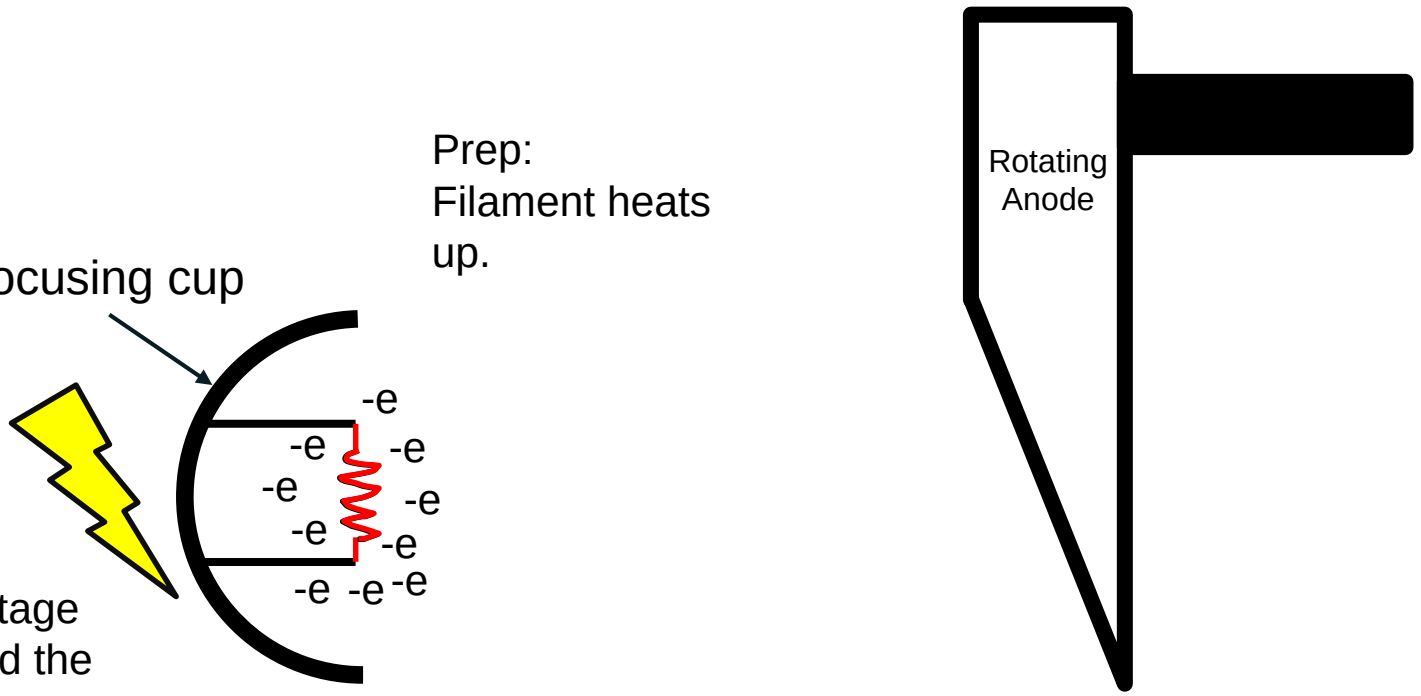
Traditional Thermionic X-Ray Tubes

X-Rays are produced by the impact of an accelerated electron beam on a tungsten target in a vacuum tube.

Traditional X-Ray tubes are known as thermionic tubes, These tubes employ one or more filaments, similar to an incandescent light bulb.

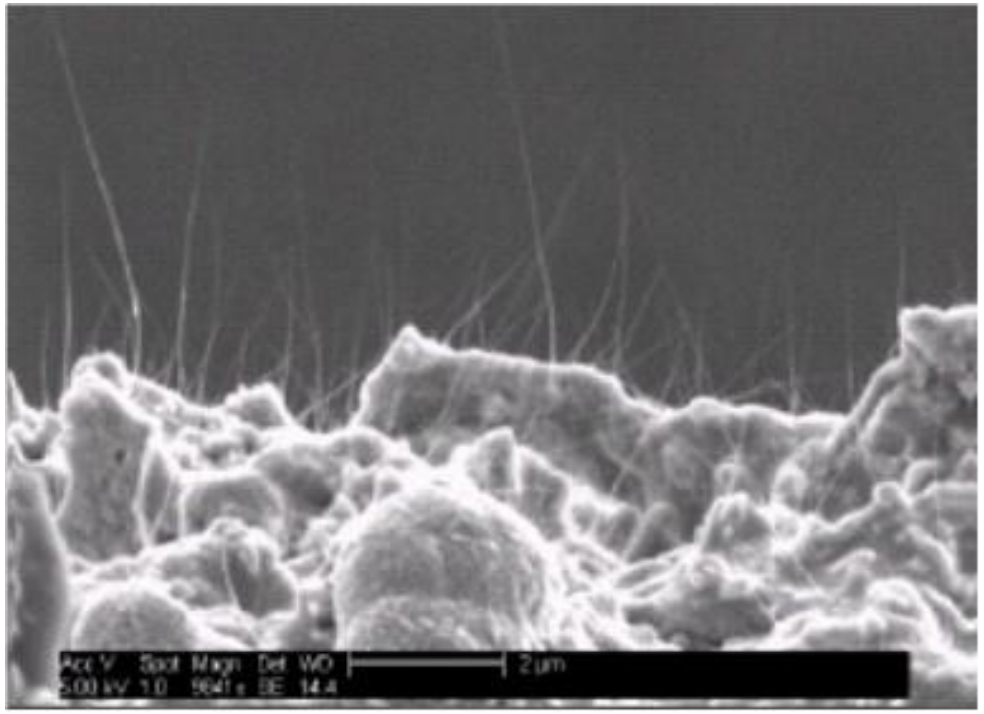
Traditional Thermionic X-Ray Tubes

The filament is heated to in excess of 1000° C, liberating the electrons needed for X-Ray production. This “boiling off” of electrons is very inefficient as the energy is mostly wasted in heating up the filaments.



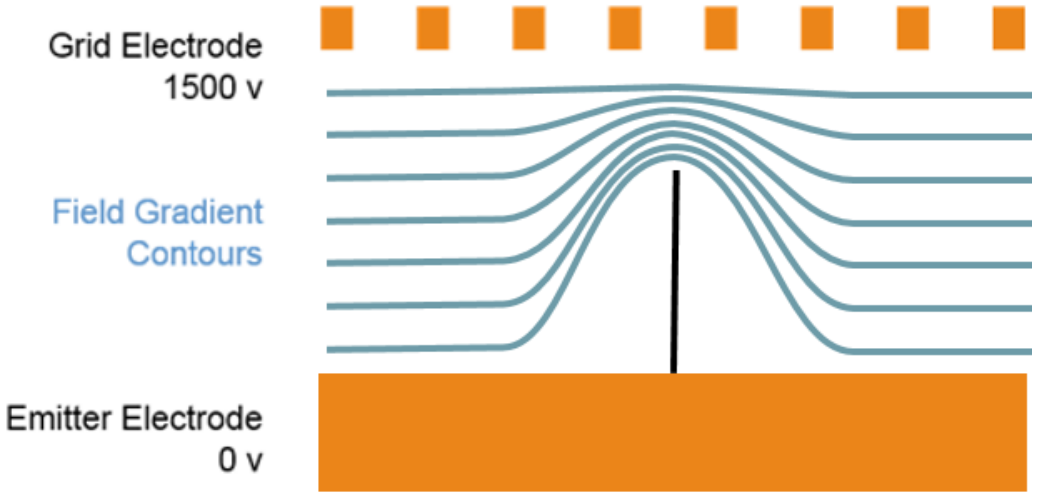
CNT Field Emitter X-Ray Tubes

The configuration of a Carbon Nano Tube (CNT) field emitter tube differs significantly from a thermionic tube. The CNT emitter used in an X-Ray tube consists of a large number of CNT's arranged vertically on a conductive substrate and replaces the traditional filament.



CNT Field Emitter X-Ray Tubes

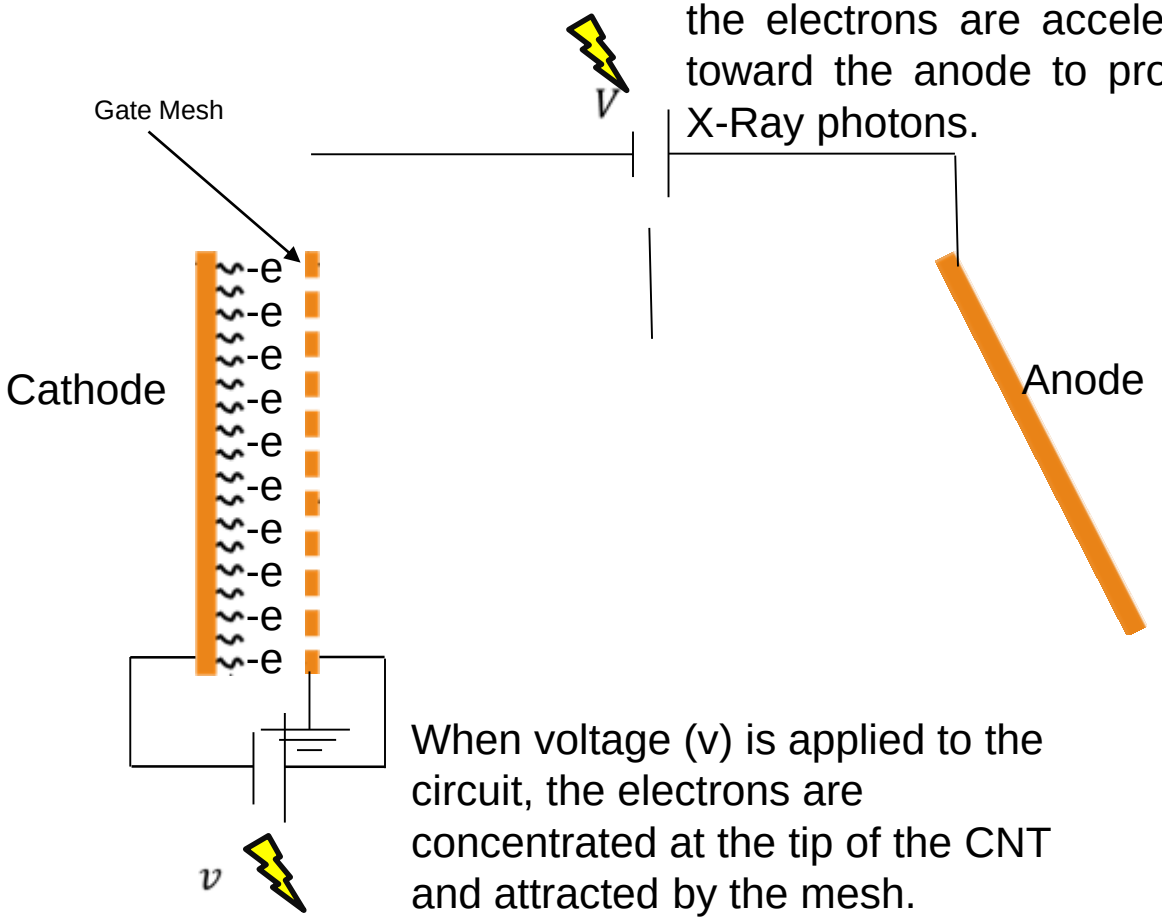
A mesh structure, very similar to an X-Ray grid, is placed just above the sharp tips of the CNT's. When the radiographer manipulates the two position exposure switch to the prep position, a voltage is applied between the mesh and the substrate. The electric field strength concentrated at the tips forces field emission of negatively charged electrons to occur at the tips of the CNT's.



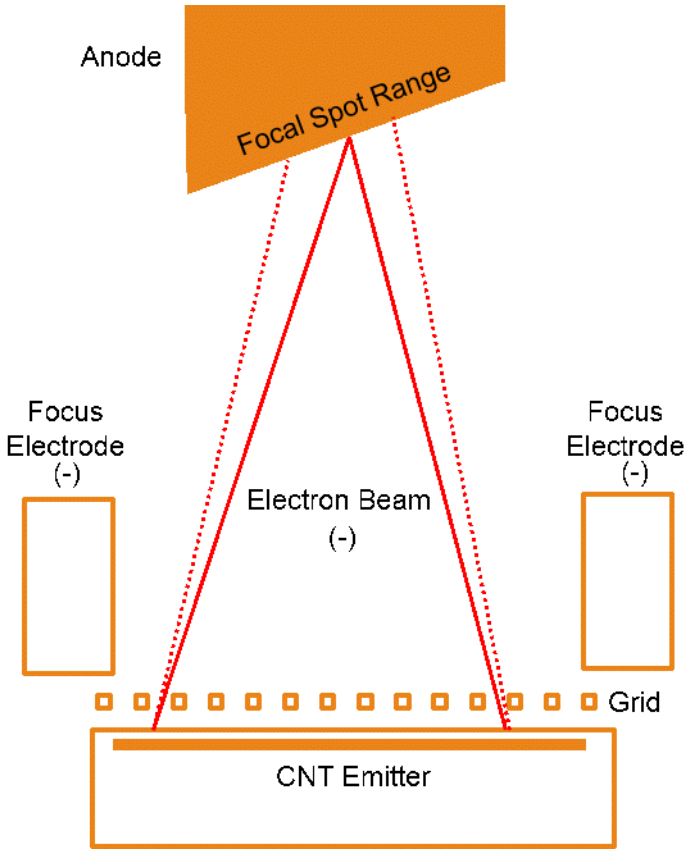
CNT Field Emitter X-Ray Tubes

As no high temperature “boiling off” is needed, this translates to power-saving benefits in battery-operated X-Ray systems..

The CNT field emitter is therefore called a cold cathode tube. The cold cathode using the CNT emitter replaces the filament



Sliding Focal Spot



The CNT cold cathode X-Ray tube has an electro-optic focus lens built inside to dynamically adjust the focal spot size. The lens is a collar-shaped electrode through which the electron beam passes. Changing the voltage applied to the collar electrode will alter the electron paths and change the amount of focusing of the beam. This translates into a continuously variable focal spot (fs) on the anode.

Sliding Focal Spot

The focal spot is variable between 0.9 mm thru 1.9 mm and is determined automatically by the technique selected. The lower the technique factors, the smaller the focal spot and vice versa.

A sliding focal spot gives the system more flexibility in imaging and lengthens the life of the tube. In a conventional tube with two focal spots, electrons are concentrated only in those areas. Continuous bombardment of electrons in one area, causes “pitting” which contributes to tube life decay. The sliding focal spot of the CNT, uses the entire collar electrode to expand the focus area of electrons on the anode. With additional area of electron bombardment, tube life is lengthened.

Size Does Matter

By eliminating the traditional filament, rotating anode and stator, the CNT field emitter offers unique advantages over traditional tubes for mobile X-Ray imaging. The tube head and collimator are considerably smaller and lighter which means the size and operation of the tube arm and column can be decreased, reducing the weight and size of the overall system.

The CNT field emitter weighs less than 5 lbs. or 2.26 kg, compared to a traditional tube which may weigh as much as 40 lbs. or 18 kg, not including the collimator assembly.

The CNT field emitter is approximately one fifth the weight of a traditional tube and collimator assembly.

CNT Field Emitter X-Ray Tubes

Traditional tube and insert (top row) compared to the CNT field emitter tube.

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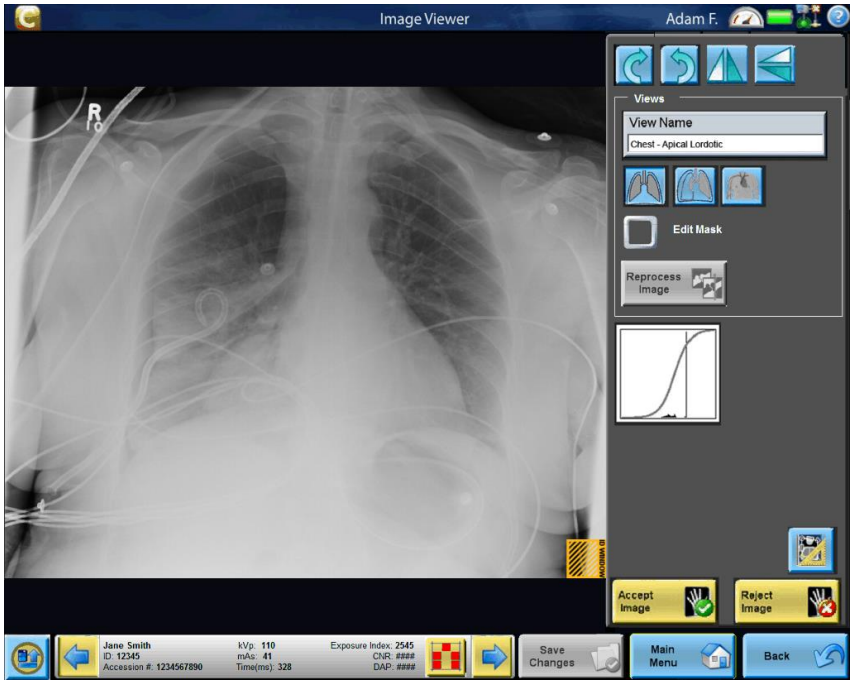
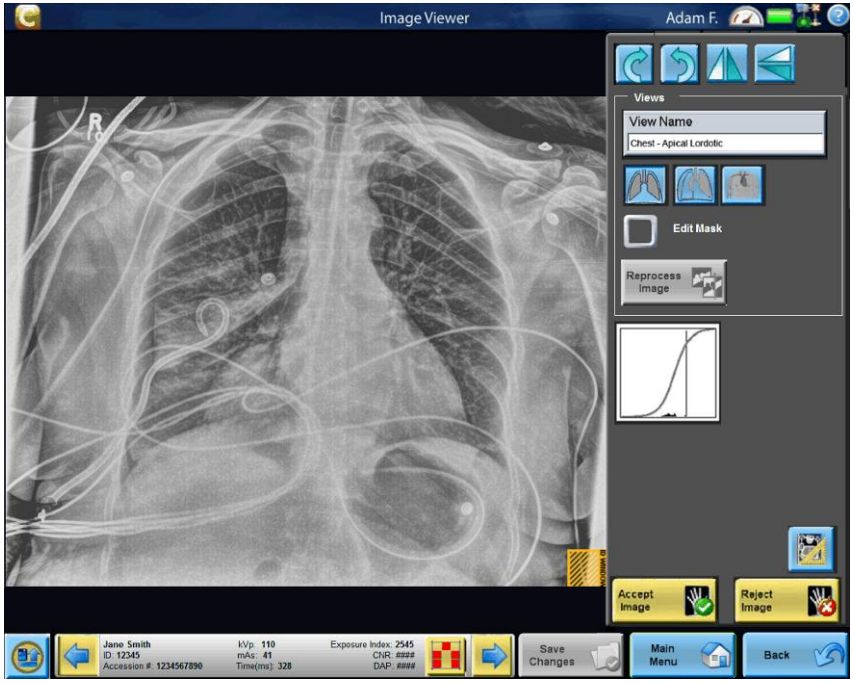
Direct View Software

Tube and Line Visualization Software

A companion image is automatically created from the original (standard) exposure that enhances the visibility so that the Radiologist and Referring Physician can see tubes and lines without the need to window and level



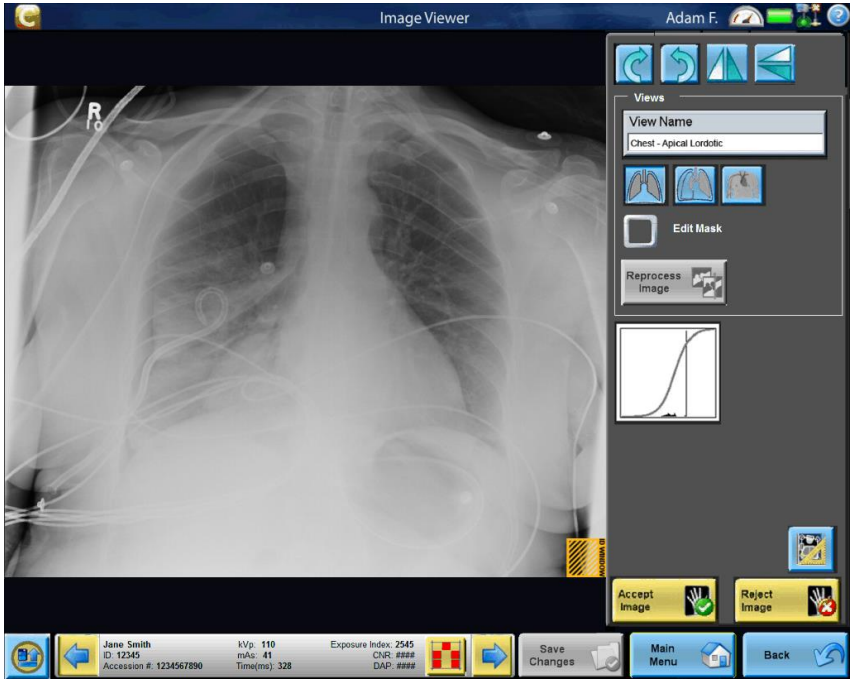
Diagnostic Image



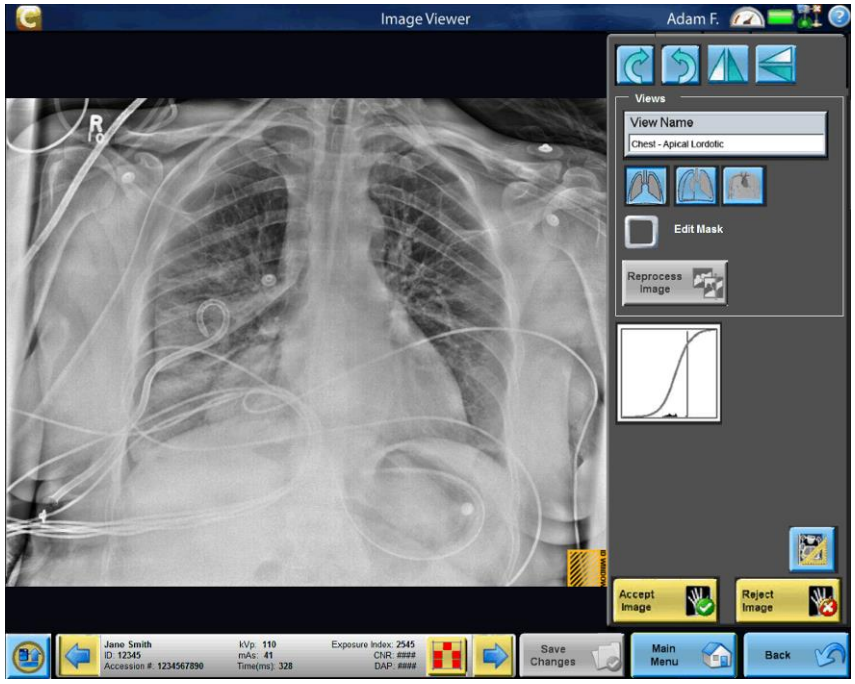
Companion Image

Pneumothorax Visualization Software

Creates a companion image from the original exposure for easier visualization of pneumothorax—optimized to accentuate the appearance of free air in the chest cavity



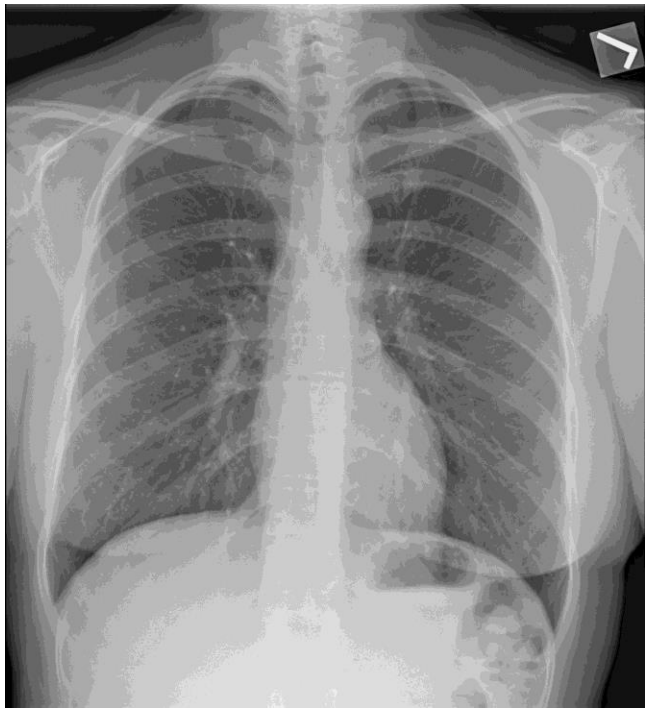
Diagnostic Image



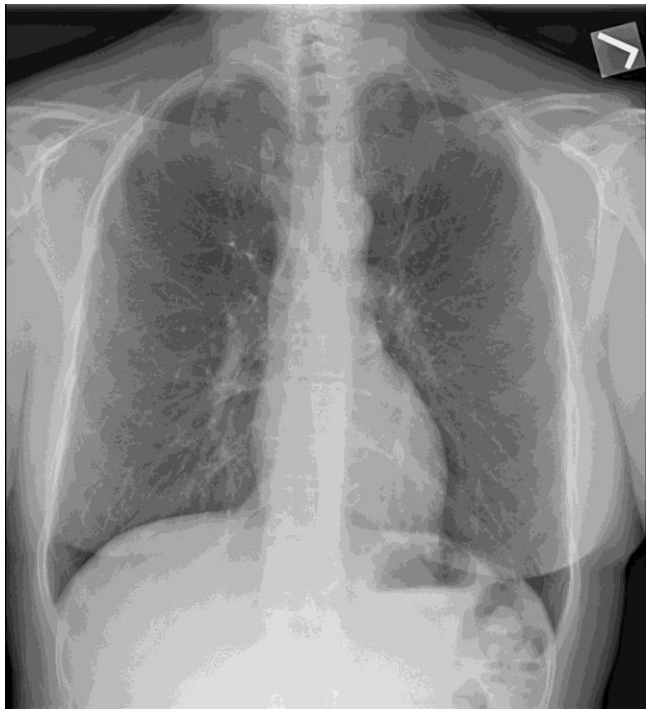
Companion Image

Bone Suppression Clinical Study Results

Creates a companion image to the original exposure (Chest PA or AP views) which suppresse the appearance of posterior ribs and clavicles and enhances the visualization of soft tissue. Requires no additional exposure to the patient. Has potential to increase the confidence of pathology assessment due to improved visibility



Original Image



Companion Image

NOTE: The amount of rib/clavicle suppression can vary but each companion image does provide an enhanced visualization of soft tissue

Tech Assist Software

Contrast to Noise Ratio (CNR)

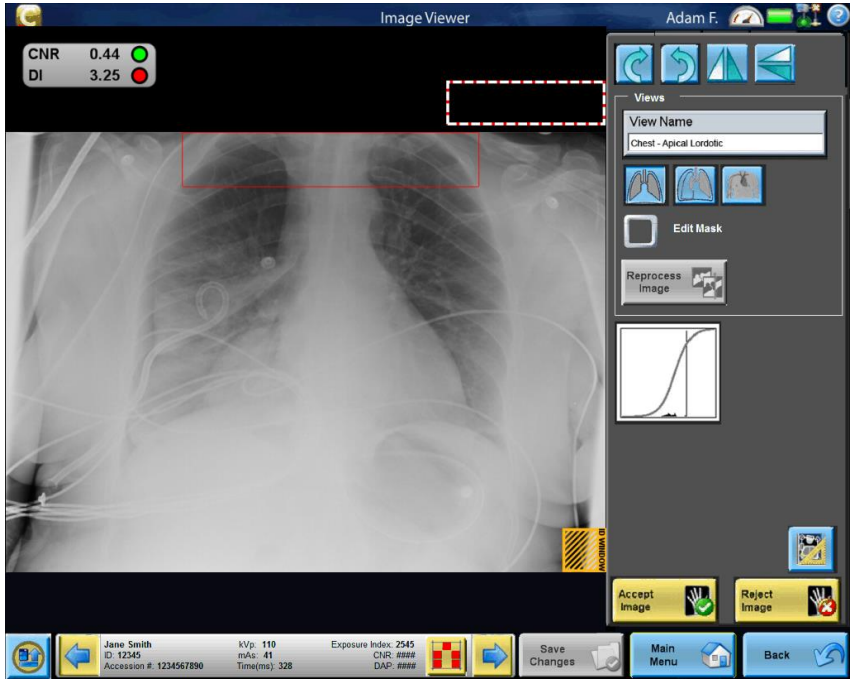
- Target contrast is chosen by the Radiologist
- Lower limit is set
- If the CNR on the acquired image is outside of this range the user is notified

Deviation Index (DI)

- Quantifies the deviation of the actual exposure index from the target
- Range is set by the Radiologist
- If the DI on the acquired image is outside of this range the user is notified

Anatomy Clipping Software

- Outlines areas where the SW has determined the chest anatomy may have been collimated off of the image



Anatomy Clipping Visualization

SmartGrid Imaging Software

SmartGrid is a software option that provides, upon request by the user, a diagnostic radiographic image with a reduction in visible X-Ray scatter similar to the effect of an anti-scatter radiographic grid.

SmartGrid is ***not*** designed to replace a physical grid. A grid should always be used whenever possible. SmartGrid may not work on large patients as the amount of scatter produced may be to great causing saturation of the detector.

SmartGrid & the DRX-Revolution Nano

On larger body parts, where scatter radiation is increased, the use of a grid is essential, however, this requires more dose.

Since the Revolution Nano X-Ray tube is not as powerful as a thermionic tube, SmartGrid allows the user to acquire images with less dose than would be necessary with a physical grid, but still produce an image with good contrast to noise ratio.

This negates the need for a physical grid while maintaining low dose imaging.

SmartGrid

Clinical DRX-1C Abdomen

a) 80 kVp, 1.8 mAs, no grid

b) 80 kVp, 3.2 mAs, 8:1, 40 l/cm Al. interspacer grid

c) image (a) enhanced with SmartGrid

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