MAYO CLINIC

General Radiographic Image Artifacts

The Art of the Image: The Identification and Remediation of Image Artifacts in Projection Radiography, part II

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American Association of Physicists Meeting, Indianapolis
8/7/2013

Types of Radiographic Artifacts

- Acquisition Artifacts
  - •Object in beam-CR/DR
  - •Backscatter-CR/DR
  - •Grid issue-CR/DR
  - •Over/underexposure- CR/DR
- Detection artifacts
  - •Dirt and dust in reader-CR
  - •Imaging plate damage-CR
  - •Dead lines/pixels/detector - CR/DR
- Signal Processing Artifacts
  - •Bad plate erasure-CR
  - •DR lag-DR
  - •Saturation-CR/DR
  - •Flawed or limited flat-field compensation
  - • or shading correction –CR/DR
  - •Signal Transmission Artifact
  - •Readout failure or interference-CR/DR
- Image Processing or image construction issues (stitching)-CR/DR

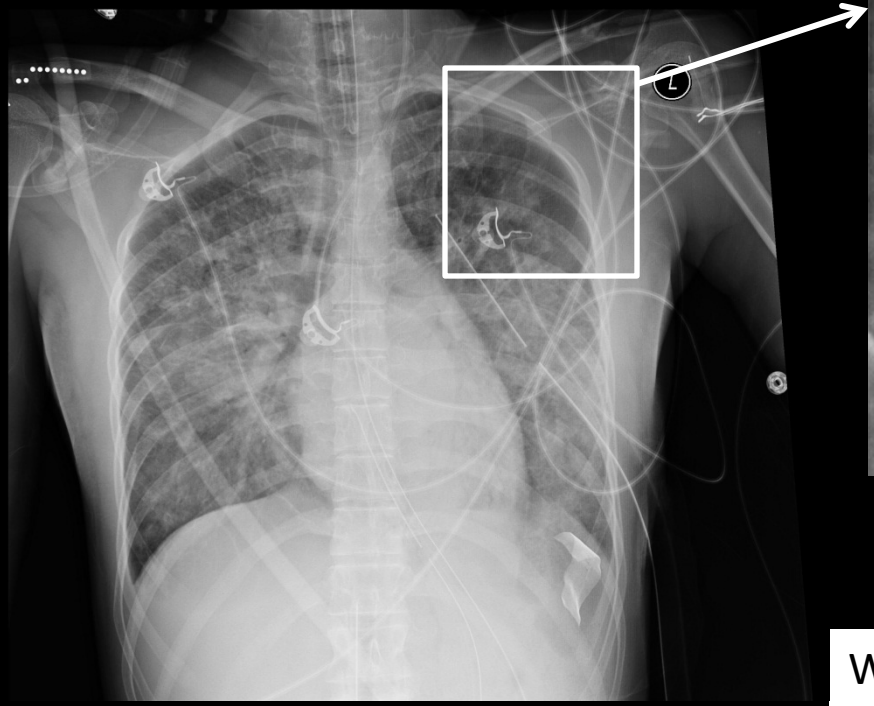
Could arise from any point in the imaging chain.

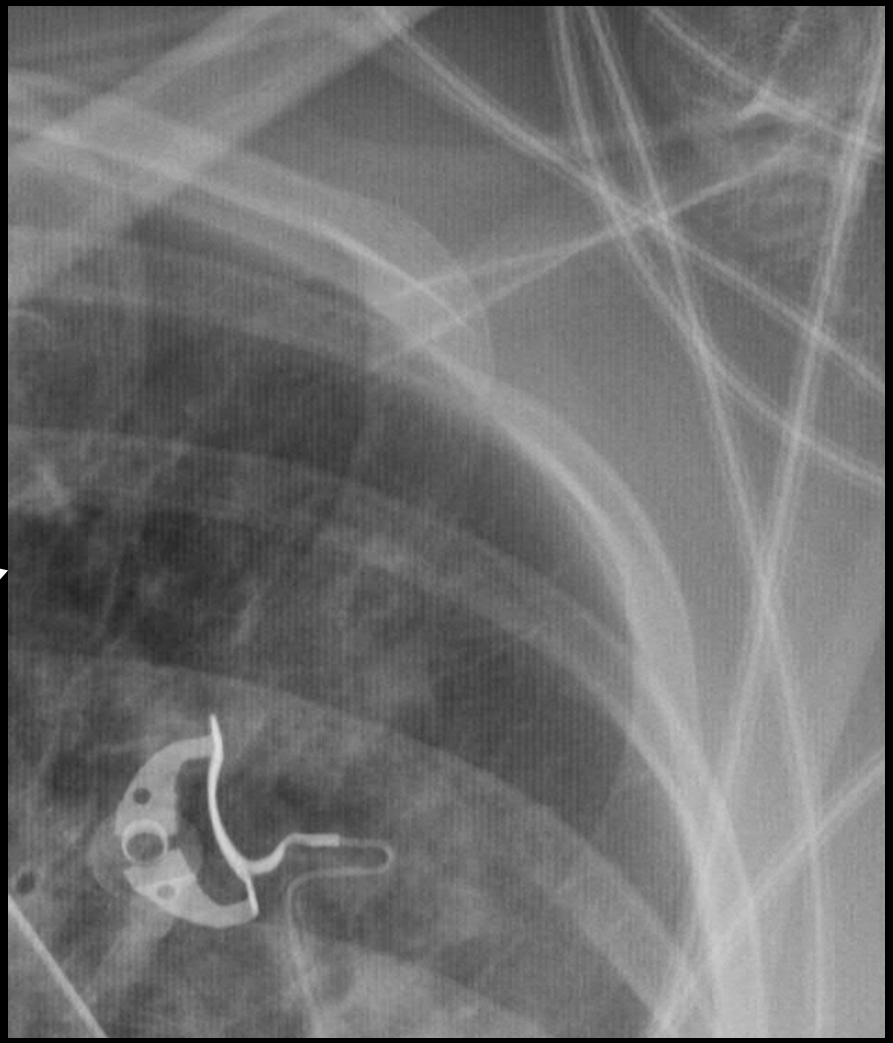
Acquisition Artifacts

- Grid issue
- Backscatter

Suppression of anti-scatter-grid lines in an image is handled by a number of mechanisms:

1. Moving grids- Buckys
2. High line rates
3. Grid Removal Software





Wrong line-rate grid

DR

Windowed to show grid-lines

Grid positioned transverse; grid removal software failed

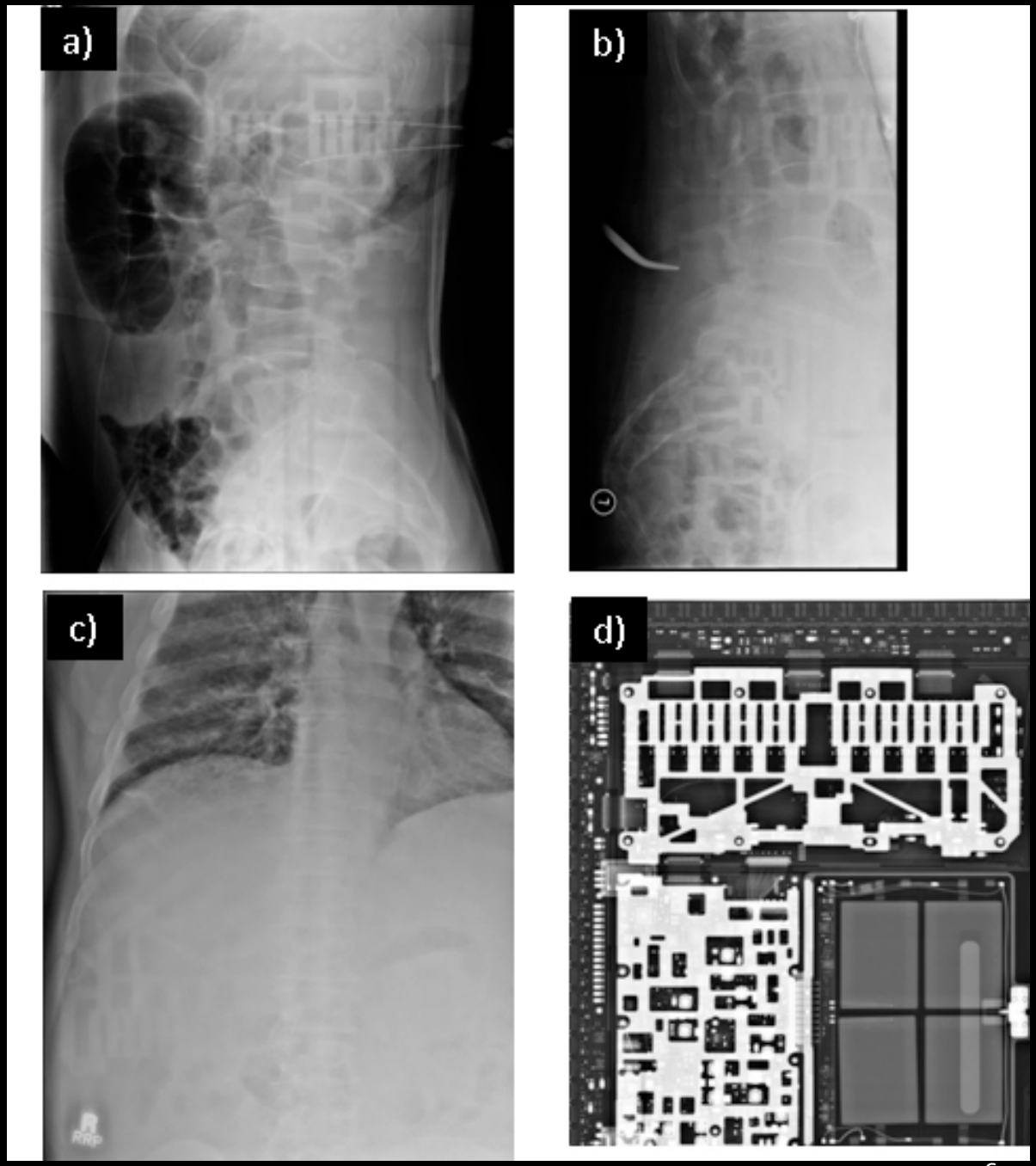
DR

Wireless detector

- Backscatter through the back of the detector.
- Frequently seen with large patients.

Temporary fix: place lead aprons behind the detector

Longer term fix:
More shielding attached to the back of the detector ; provided by vendor.



Detection Artifacts

- Dirt and dust in reader
- Imaging Plate damage

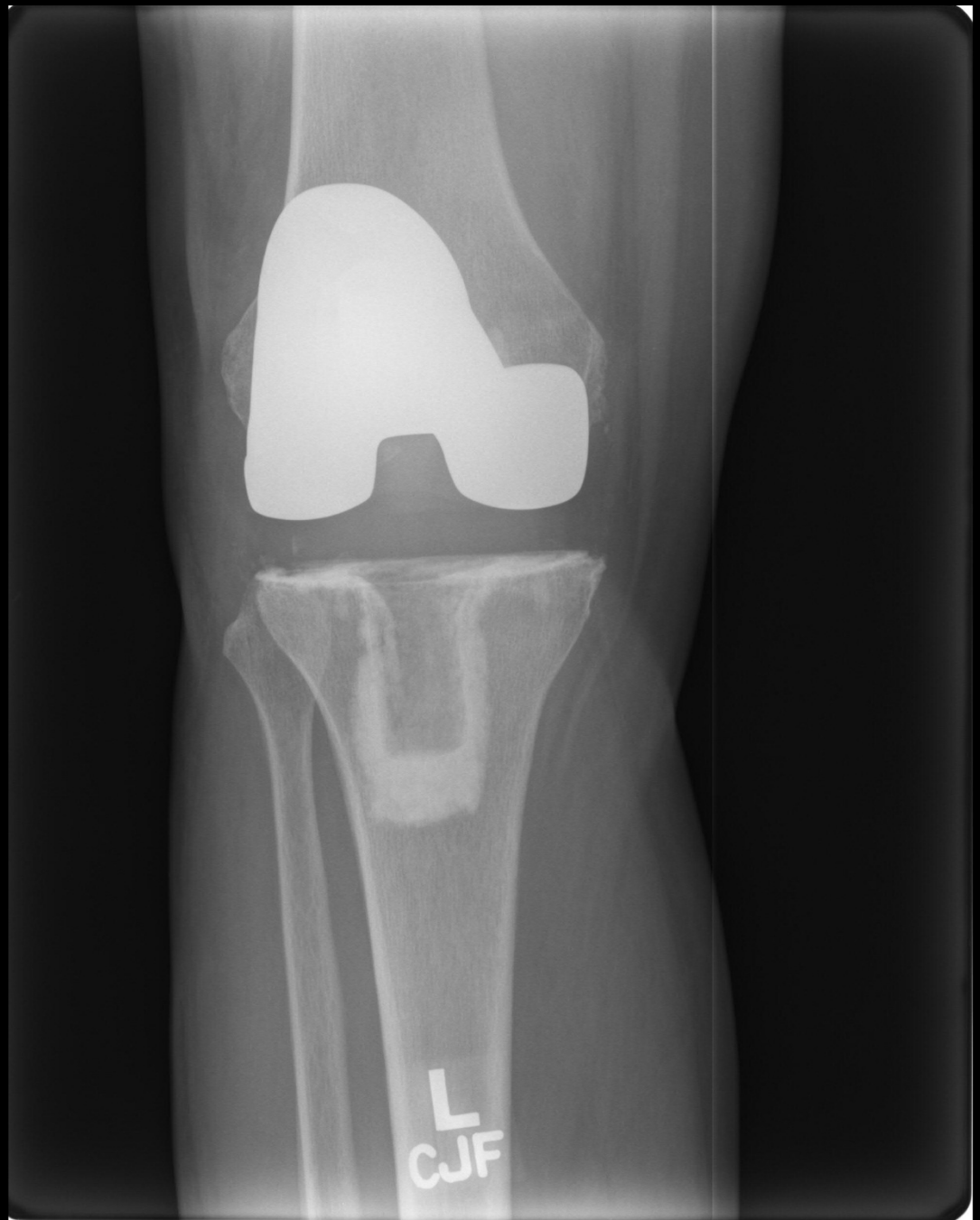
Dirt and dust in the reader.

Resolved itself.

CR

Dirt and dust in the reader.

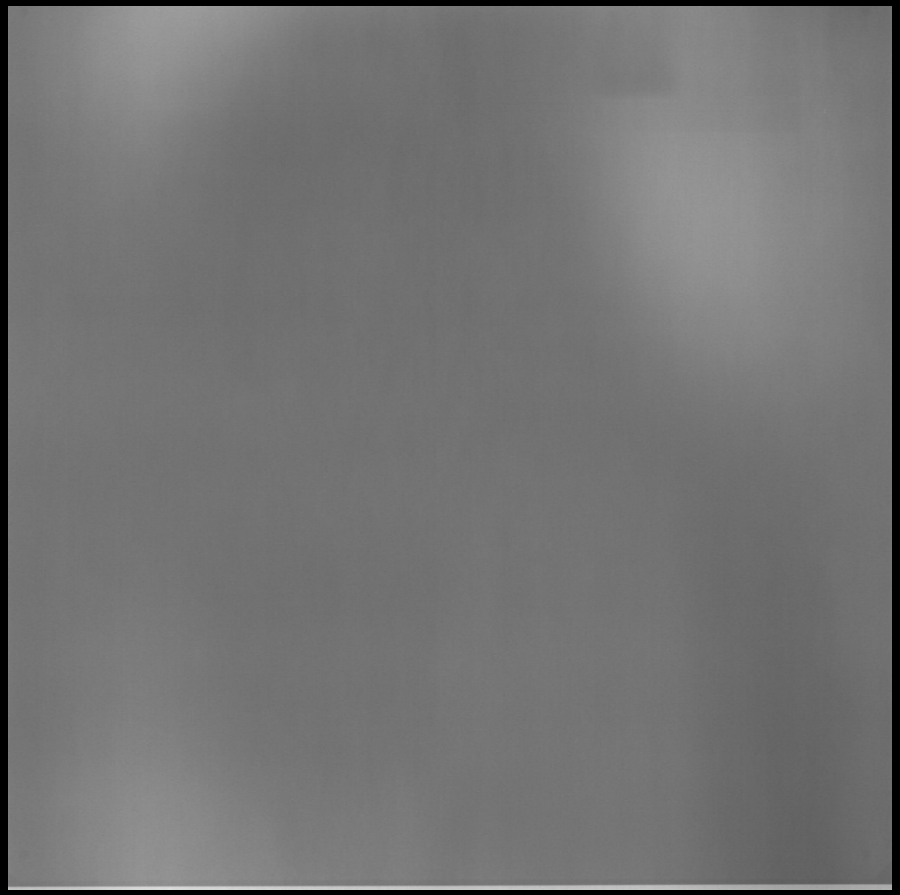
Reader cleaned.



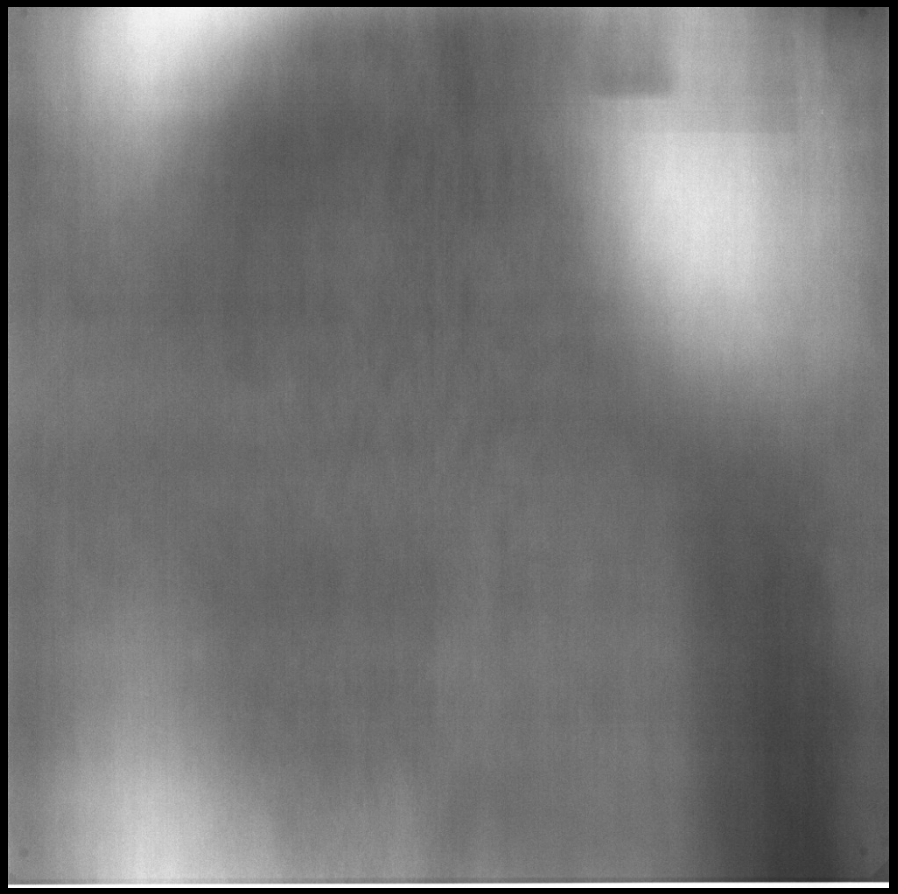
CR[9]

Ghosting on dedicated chest CR imaging plate

1mR exposure



Default clinical window-level



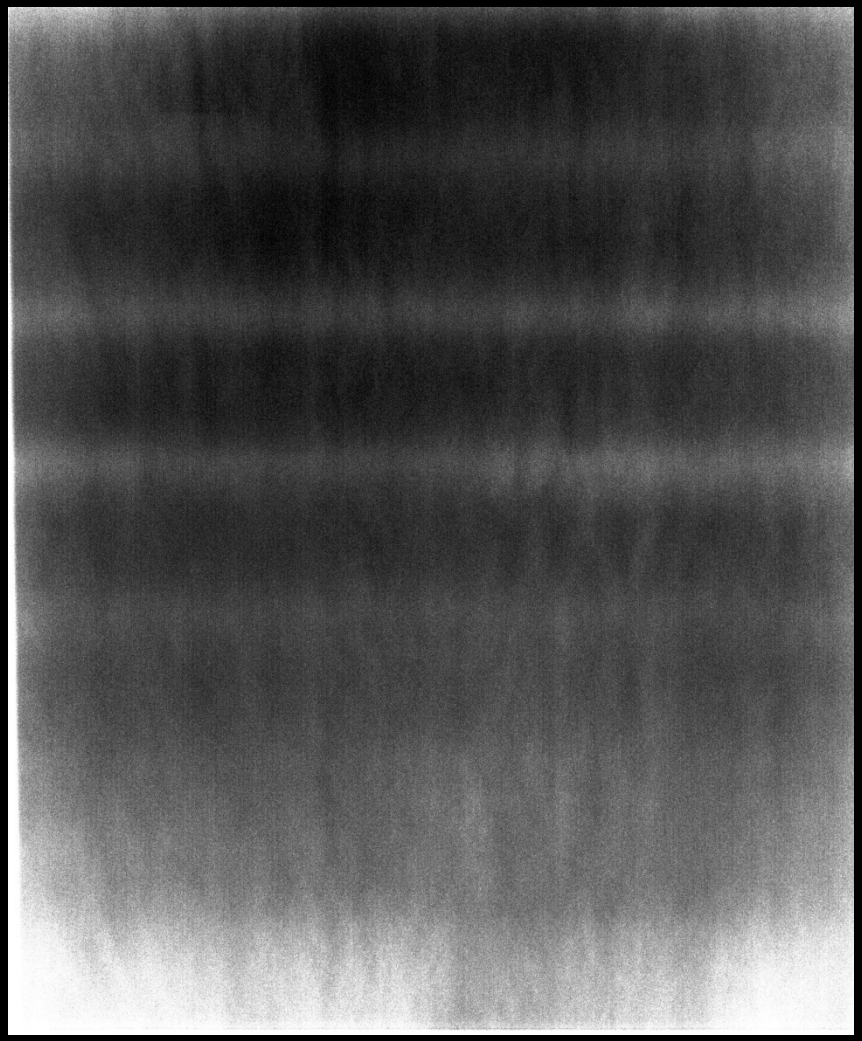
20% window

Repeated exposures of similar profile created a ghost. Plates with significat ghosting are replaced.

Phosphor wear

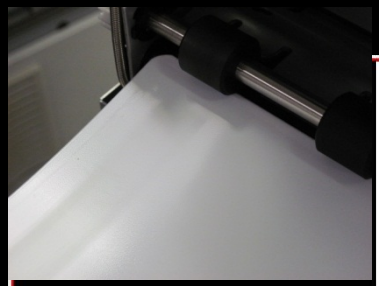
1mR exposure

Default clinical window-level

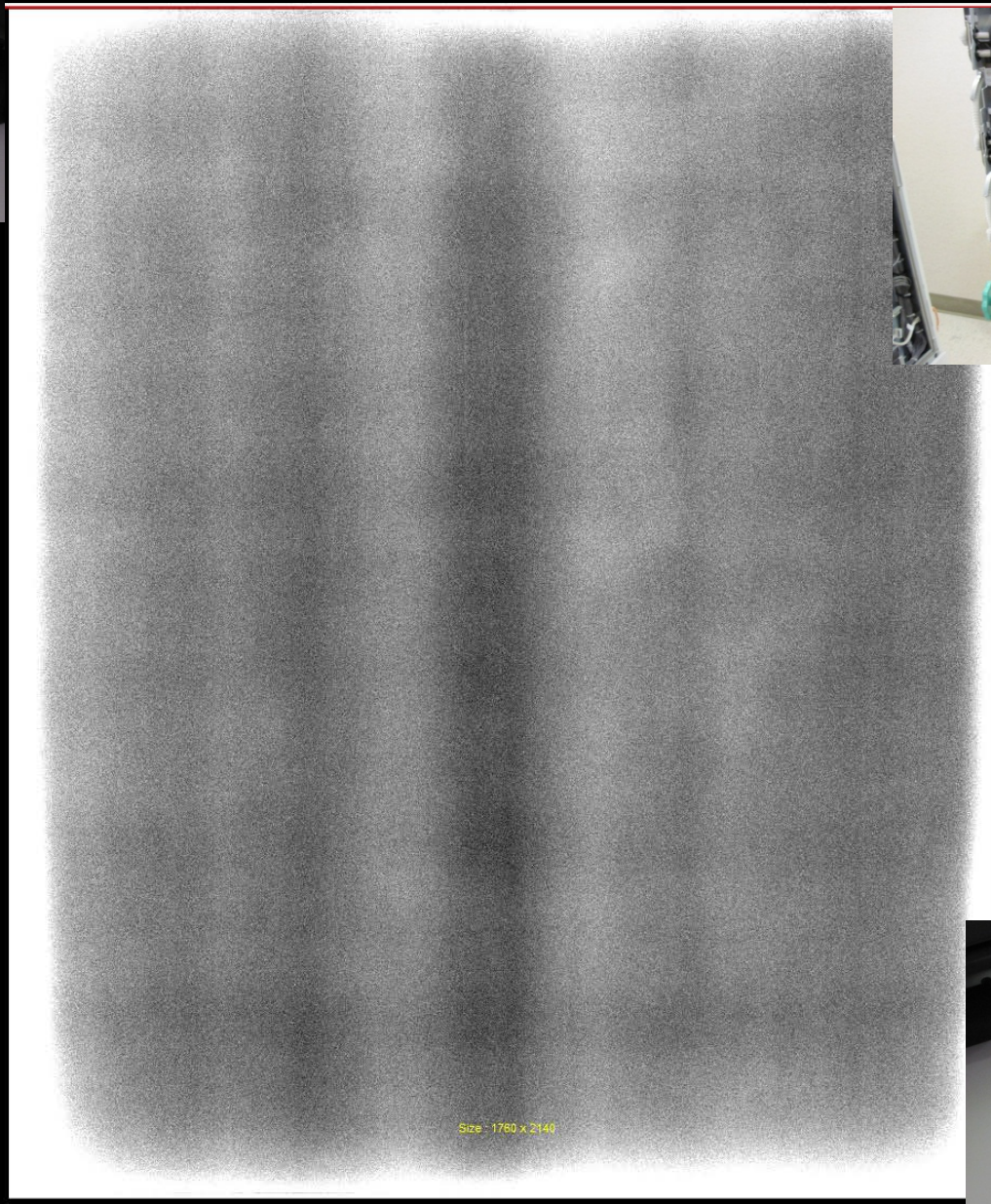


20% window

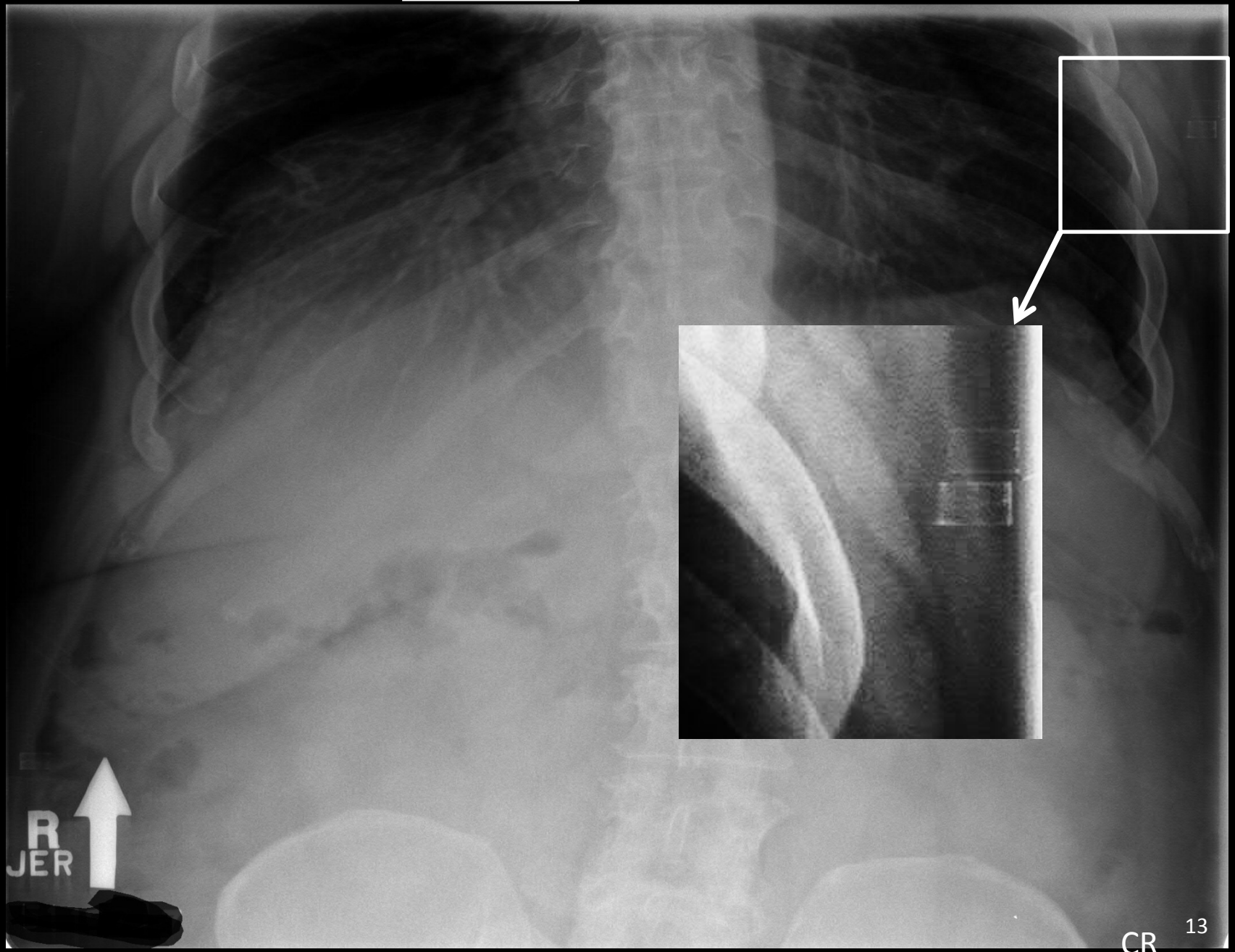
CR



Roller damage



Wear marks

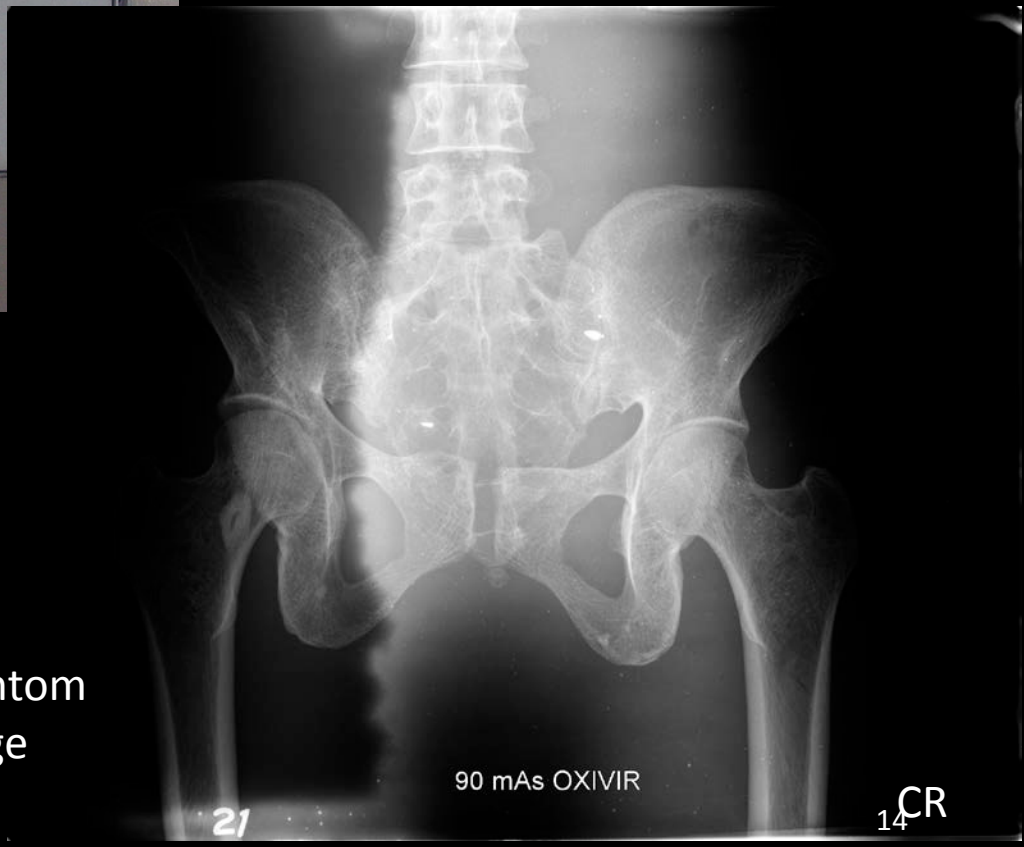


CR

Plate yellowing from cleaning agent, Oxivir,

Resolution: Oxivir no longer used for cleaning cassettes for infection control. Switched to SaniCloth.

Phantom image



CR

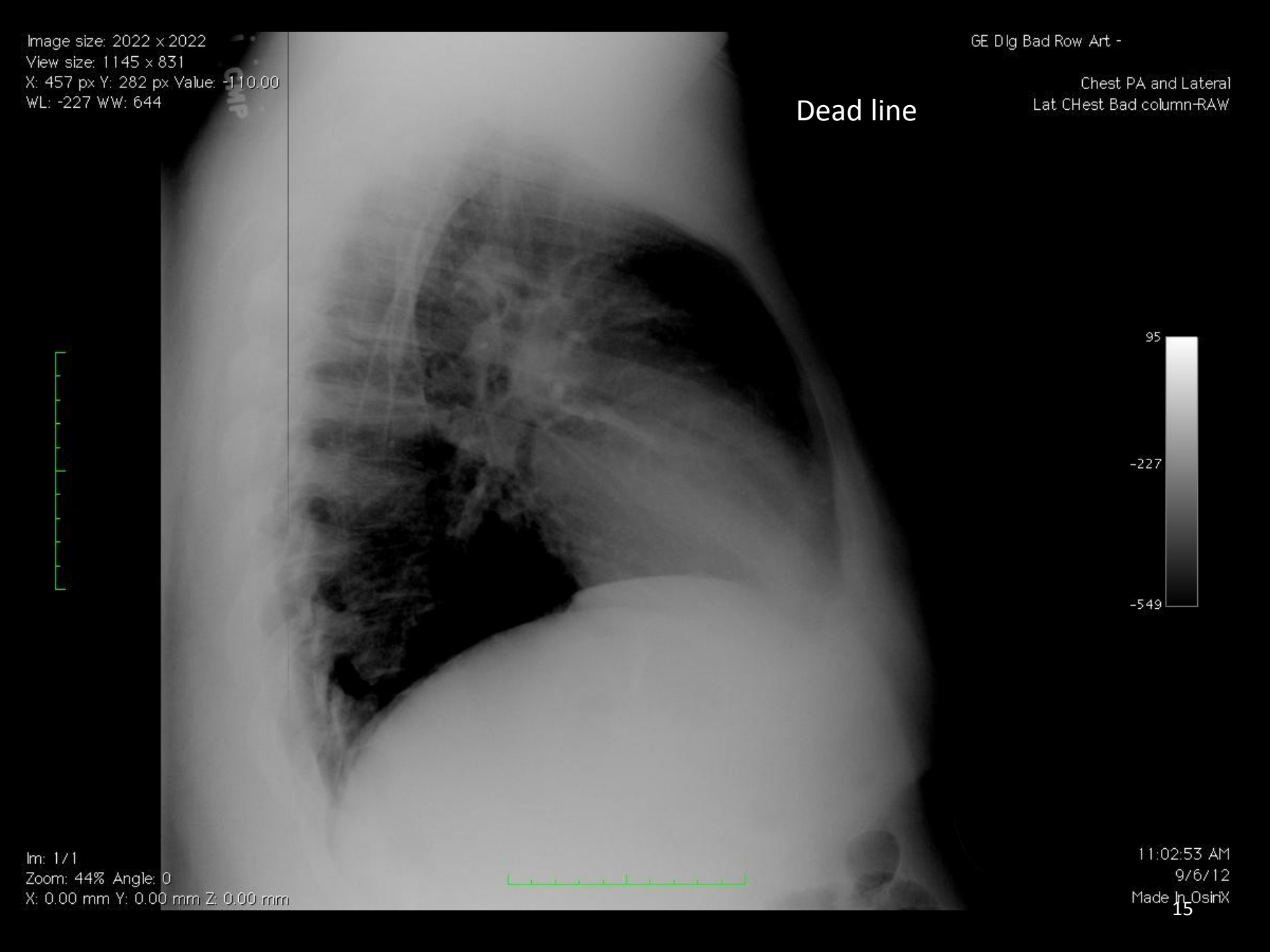


Image size: 2022 x 2022
View size: 1145 x 831
X: 457 px Y: 282 px Value: -110.00
WL: -227 WW: 644
GE Dlg Bad Row Art -
Chest PA and Lateral
Lat CHest Bad column-RAW
Dead line
95
-227
-549
Im: 1/1
Zoom: 44% Angle: 0
X: 0.00 mm Y: 0.00 mm Z: 0.00 mm
11:02:53 AM
9/6/12
Made In OsiriX

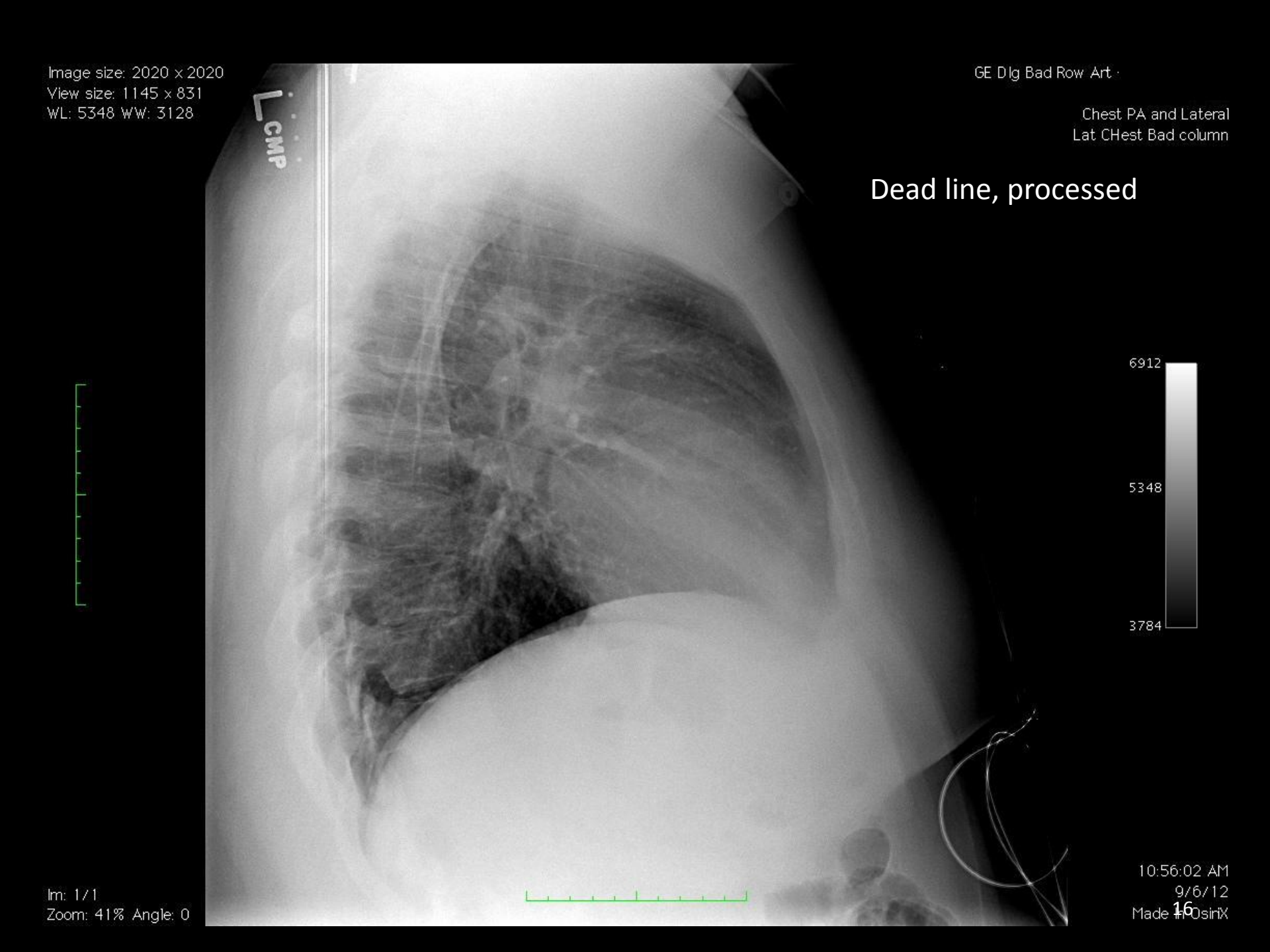
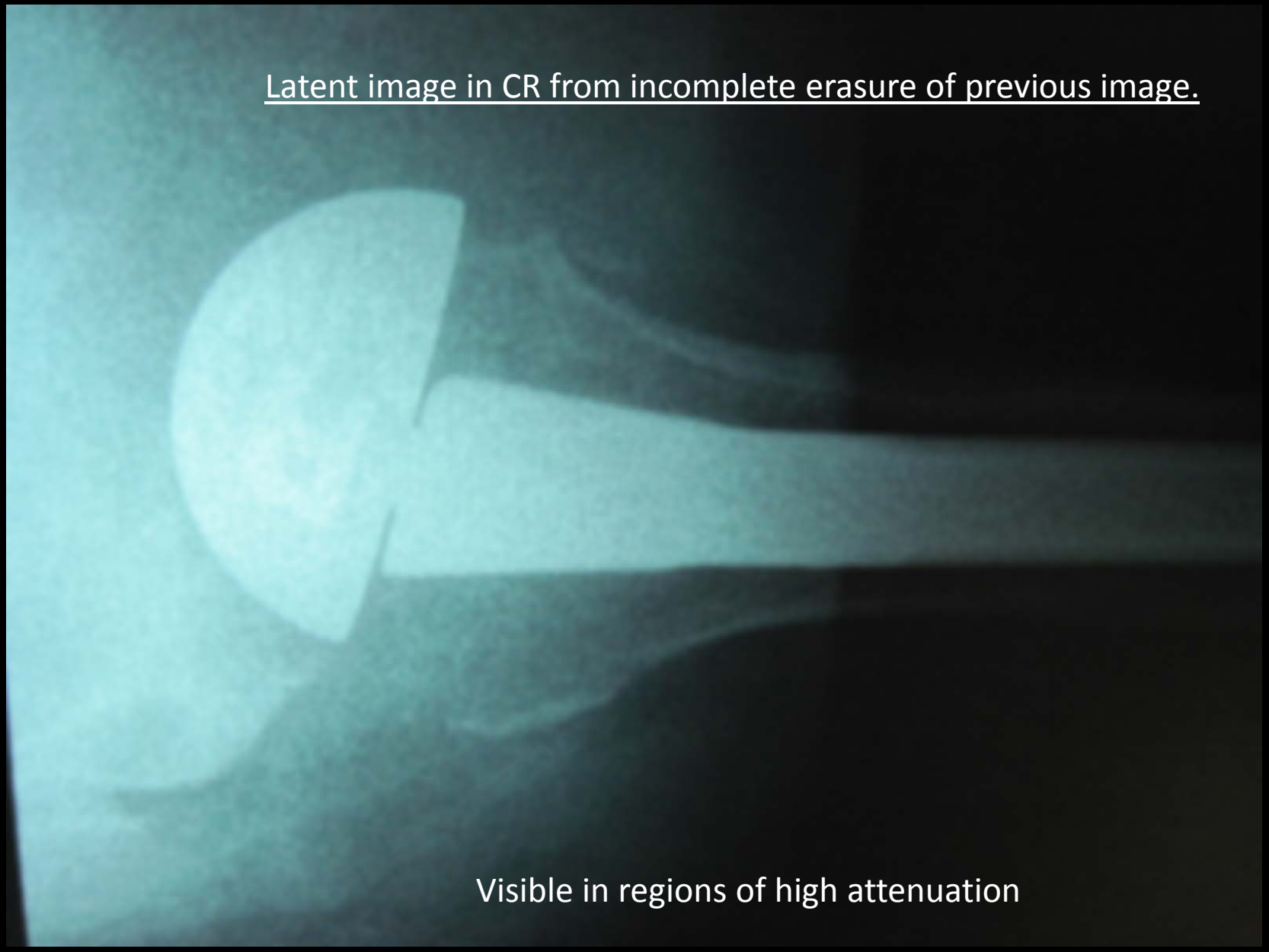


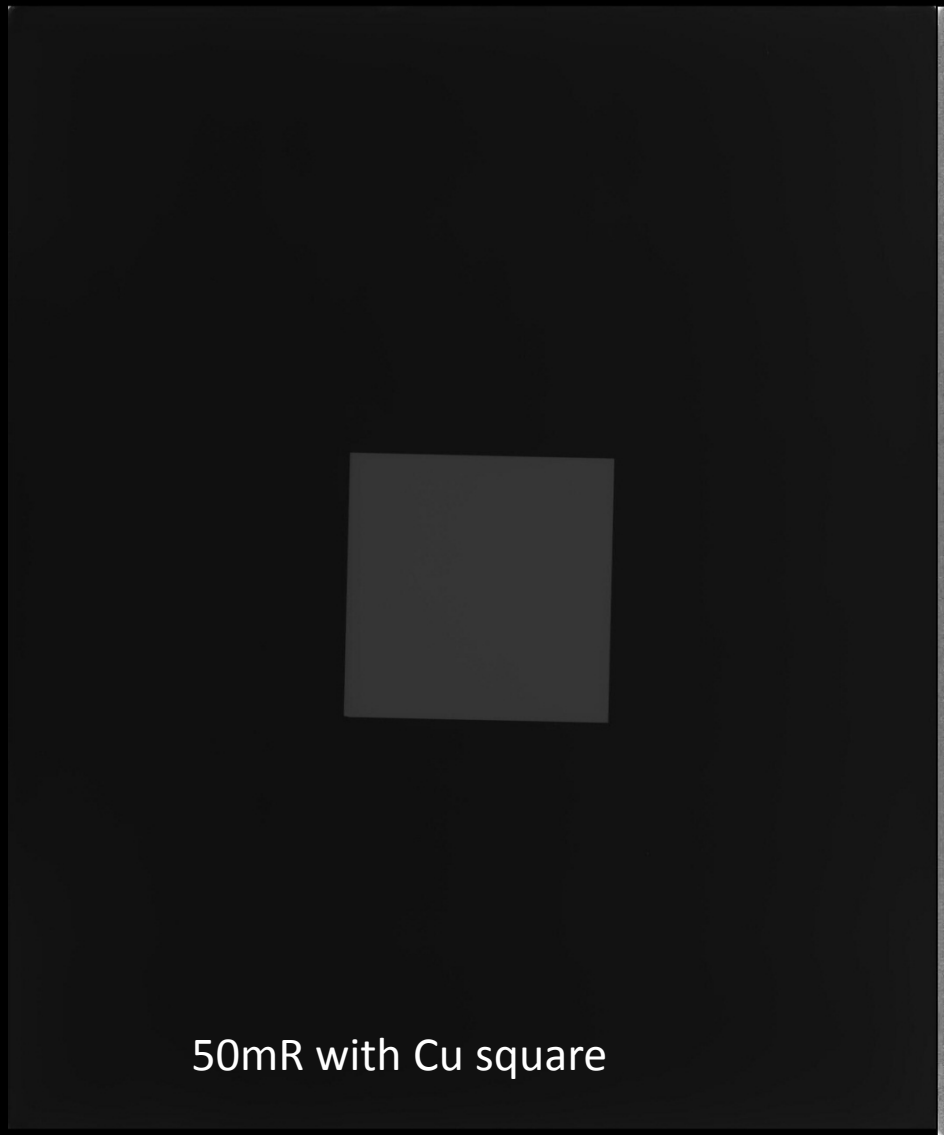
Image size: 2020 x 2020
View size: 1145 x 831
WL: 5348 WW: 3128
GE Dlg Bad Row Art
Chest PA and Lateral
Lat CHest Bad column
Dead line, processed
L
CMP
6912
5348
3784
Im: 1/1
Zoom: 41% Angle: 0
10:56:02 AM
9/6/12
Made in OsiriX

Signal Processing Artifacts

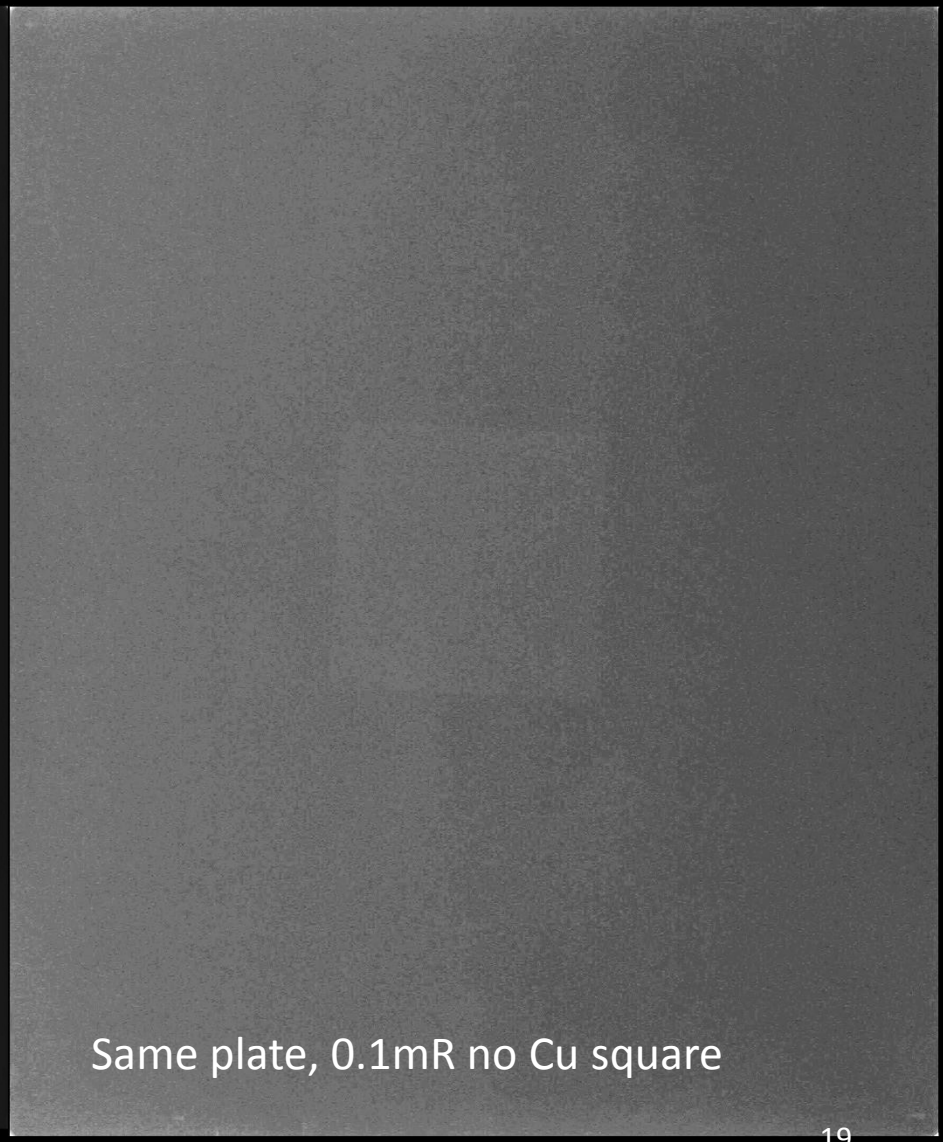
- Bad plate erasure
- DR lag
- Saturation
- Flawed or limited flat-field compensation or shading correction


Latent image in CR from incomplete erasure of previous image.
Visible in regions of high attenuation

Latent image test for that reader



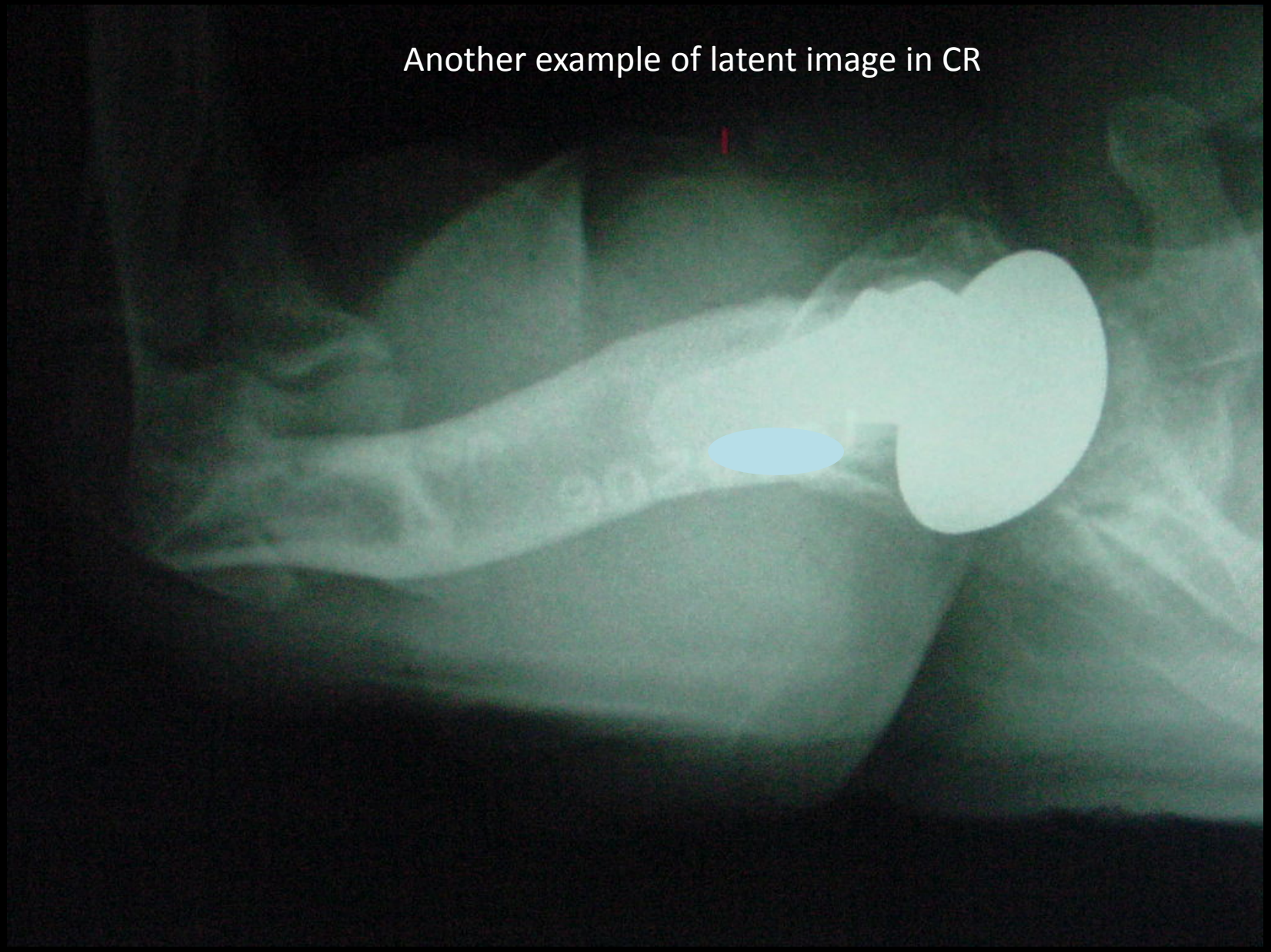
50mR with Cu square

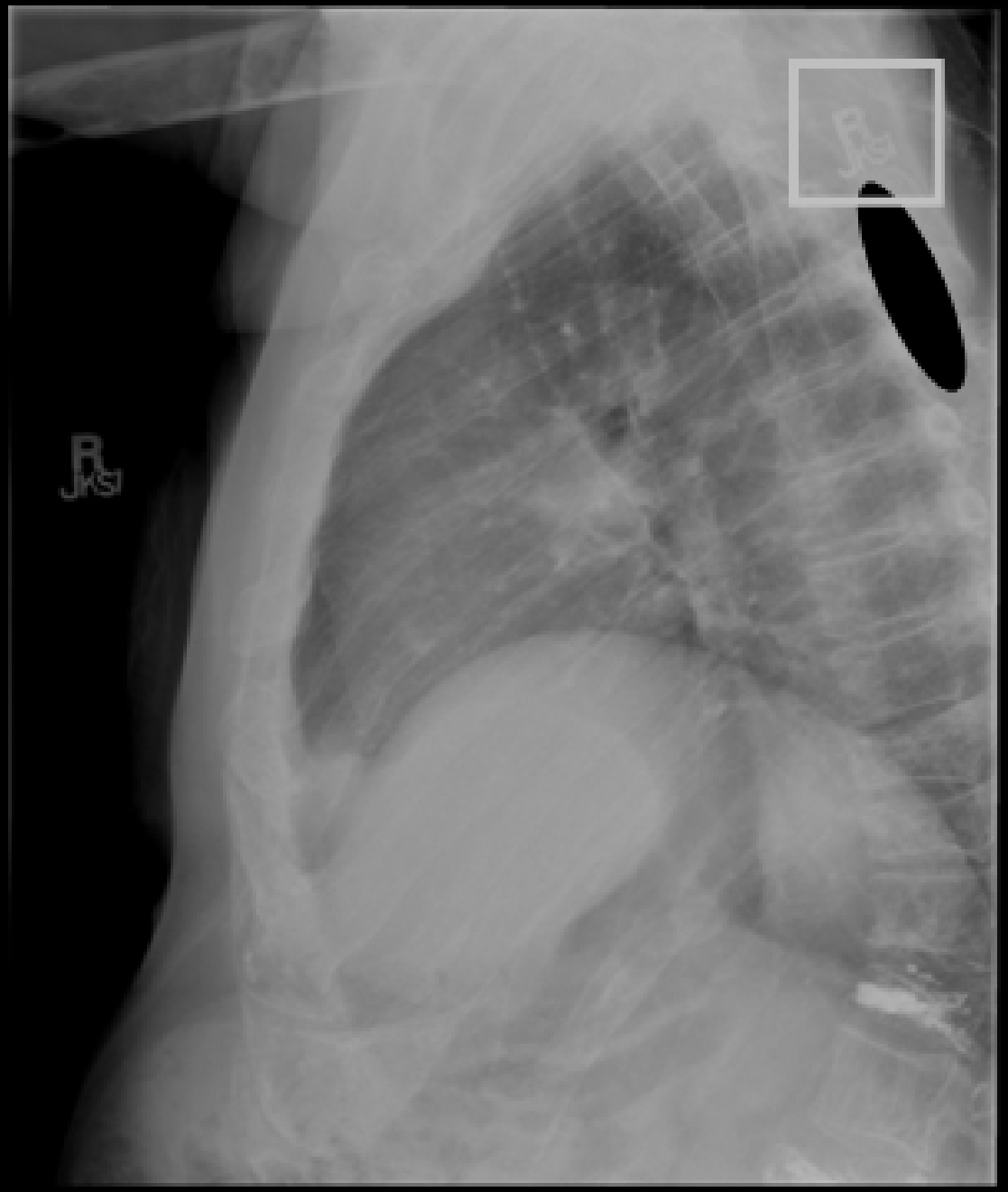


Same plate, 0.1mR no Cu square

CR

Another example of latent image in CR

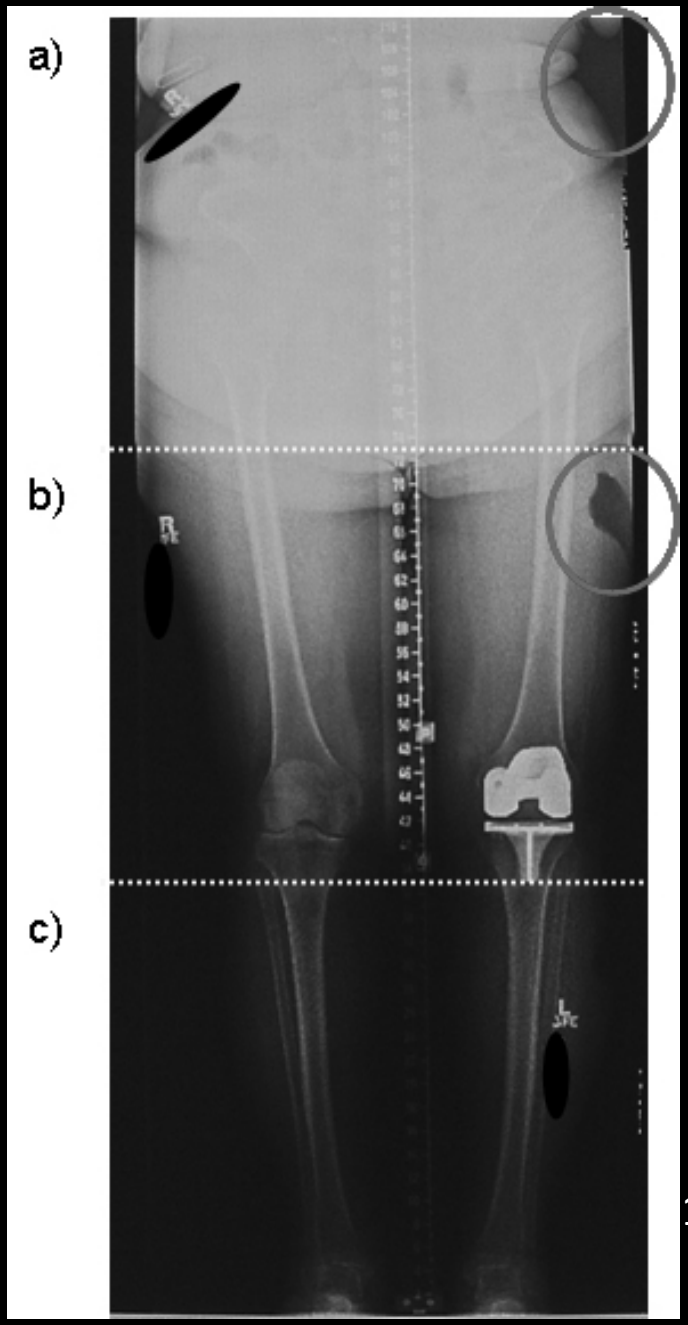




DR Lag

Lead marker from prior image is visible

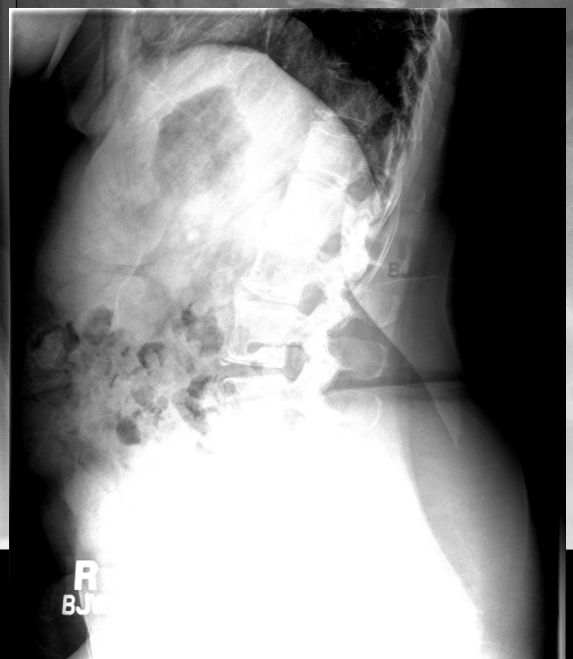
DR Lag
Stitched image



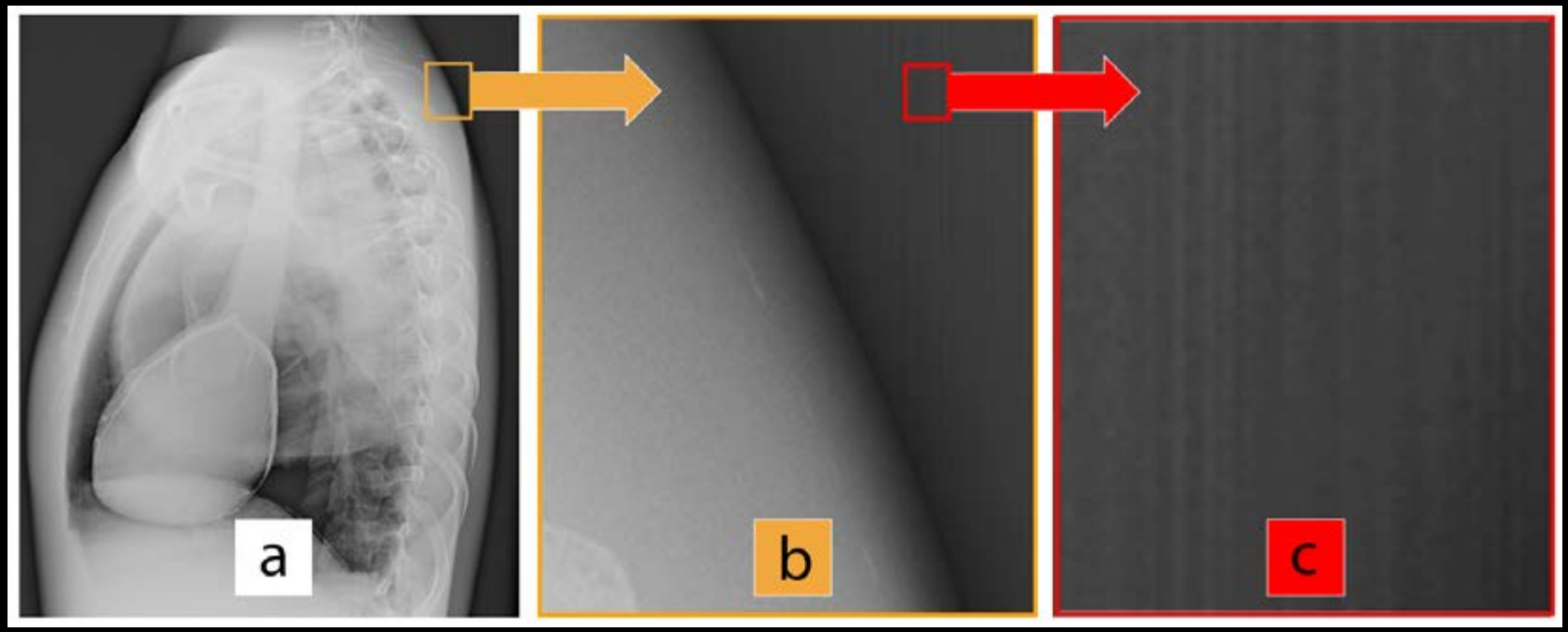
6 seconds later

18 seconds later

Inverse of DR Lag; Lag signal is recorded in signal offset map.



Resolution: Software update from vendor which handles detector lag differently.



Variation in saturation thresholds visible in raw radiation.
Not a clinical artifact but sometimes asked about by technologists.

Fuji DR

Shows the saturation threshold behavior ascribed to the previous image.

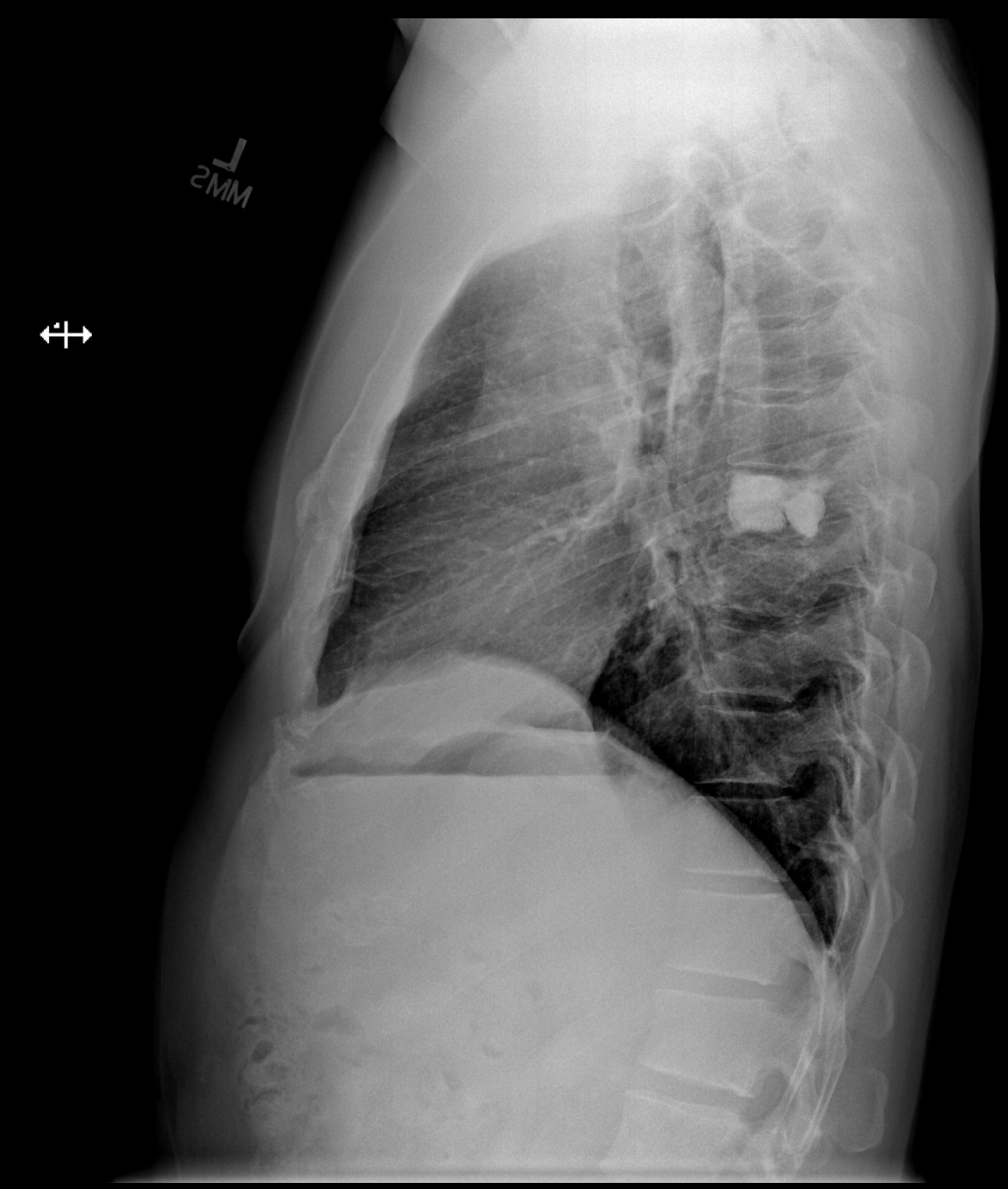
DR

Structure visible in raw radiation.
Not a clinically relevant artifact

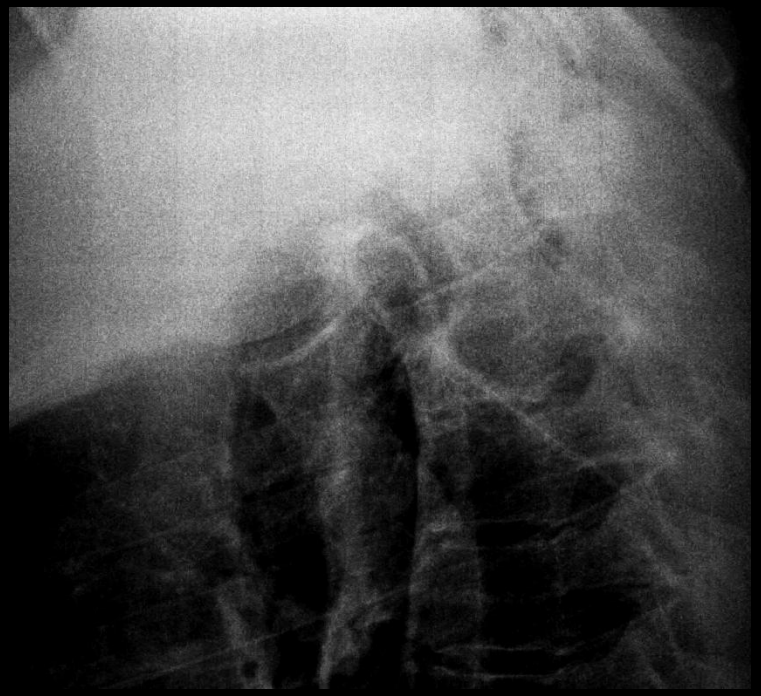
Carestream DR

Structure visible in raw radiation. Not a clinically relevant artifact

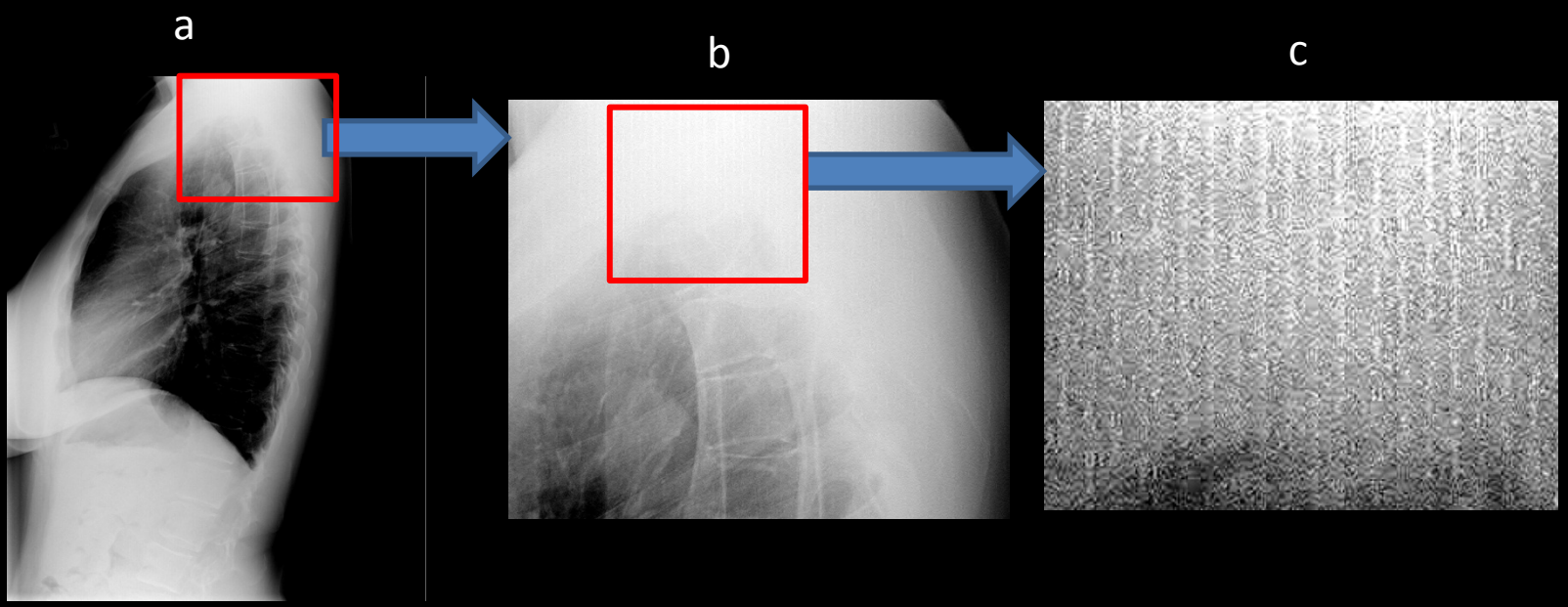
Siemens DR-Varian Detector



Visible detector structure in anatomy



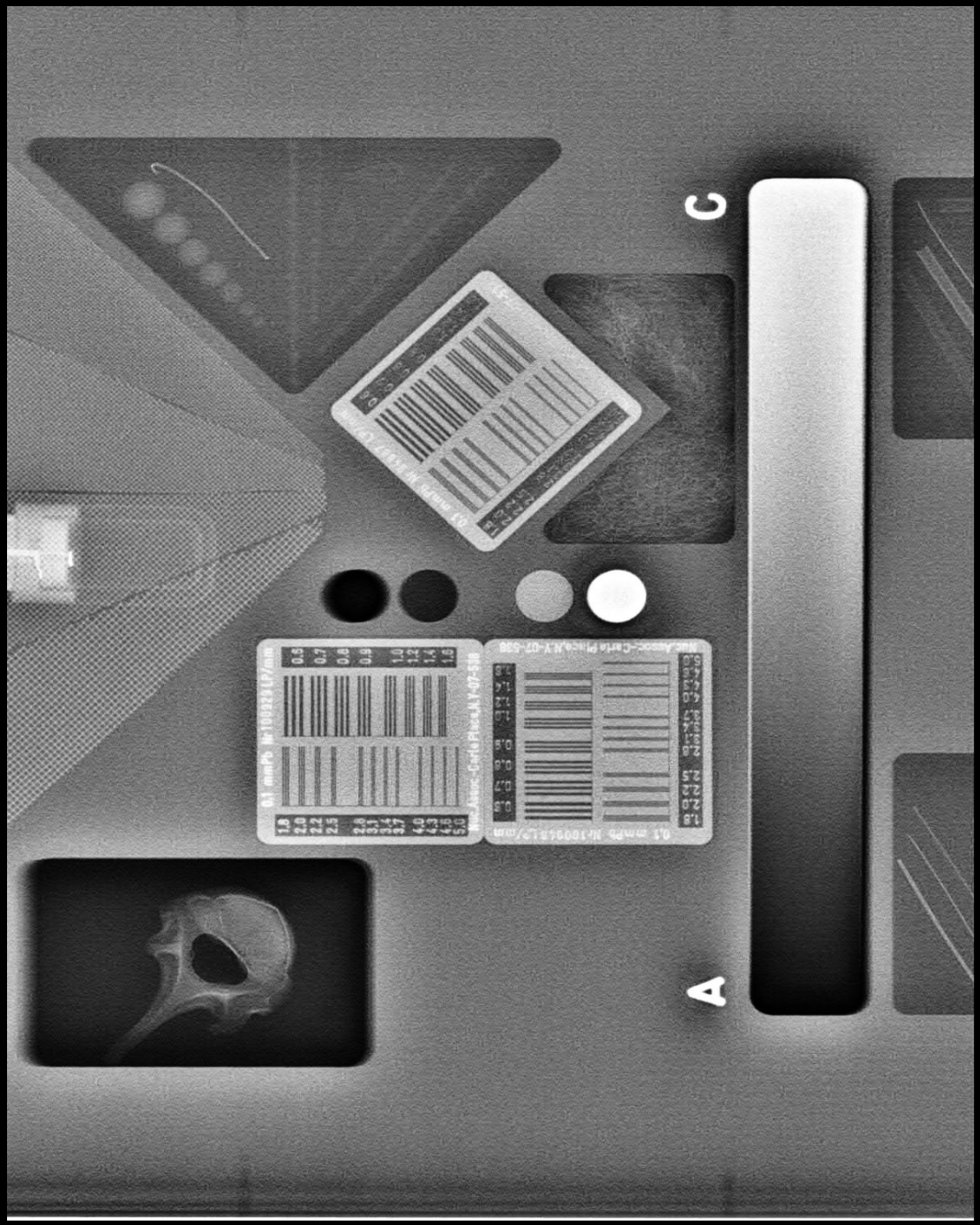
The corduroy artifact seen in the anatomy is caused by a combination of uniformly-spaced components within the detector and the sampling rate in the acquired image



Resolution:
Software update by vendor that changed the sampling rate fixed the problem.

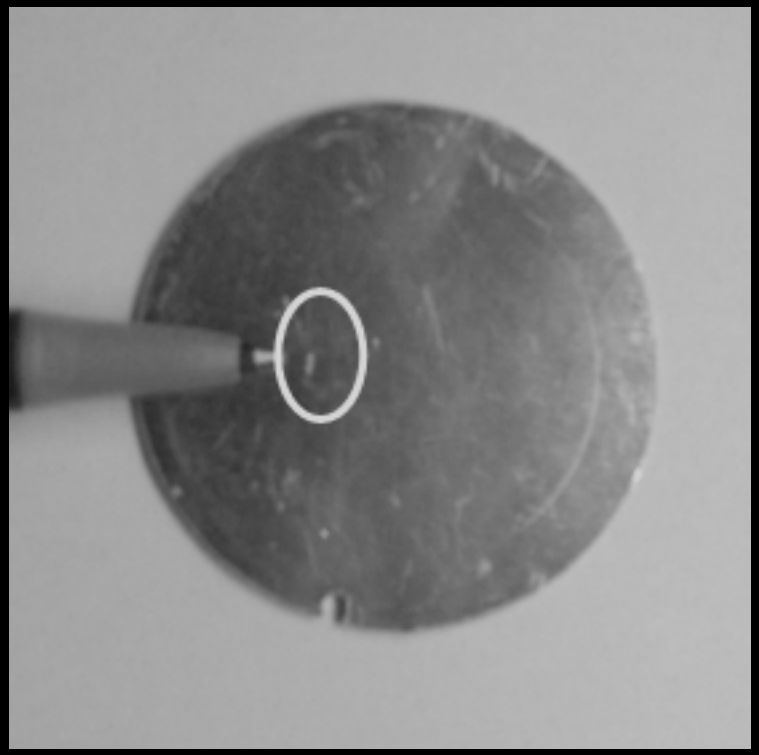
Slot scan system
Lines visible in rapid readout

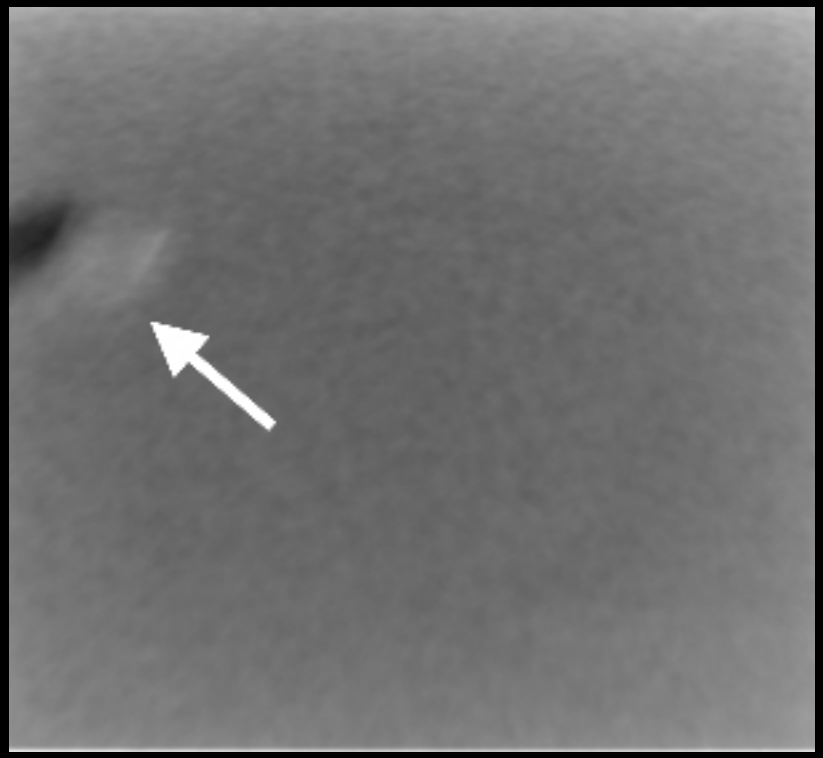
Resolution:
Slower scan speed.



DR

Defect in calibration. Visible with change in SID.



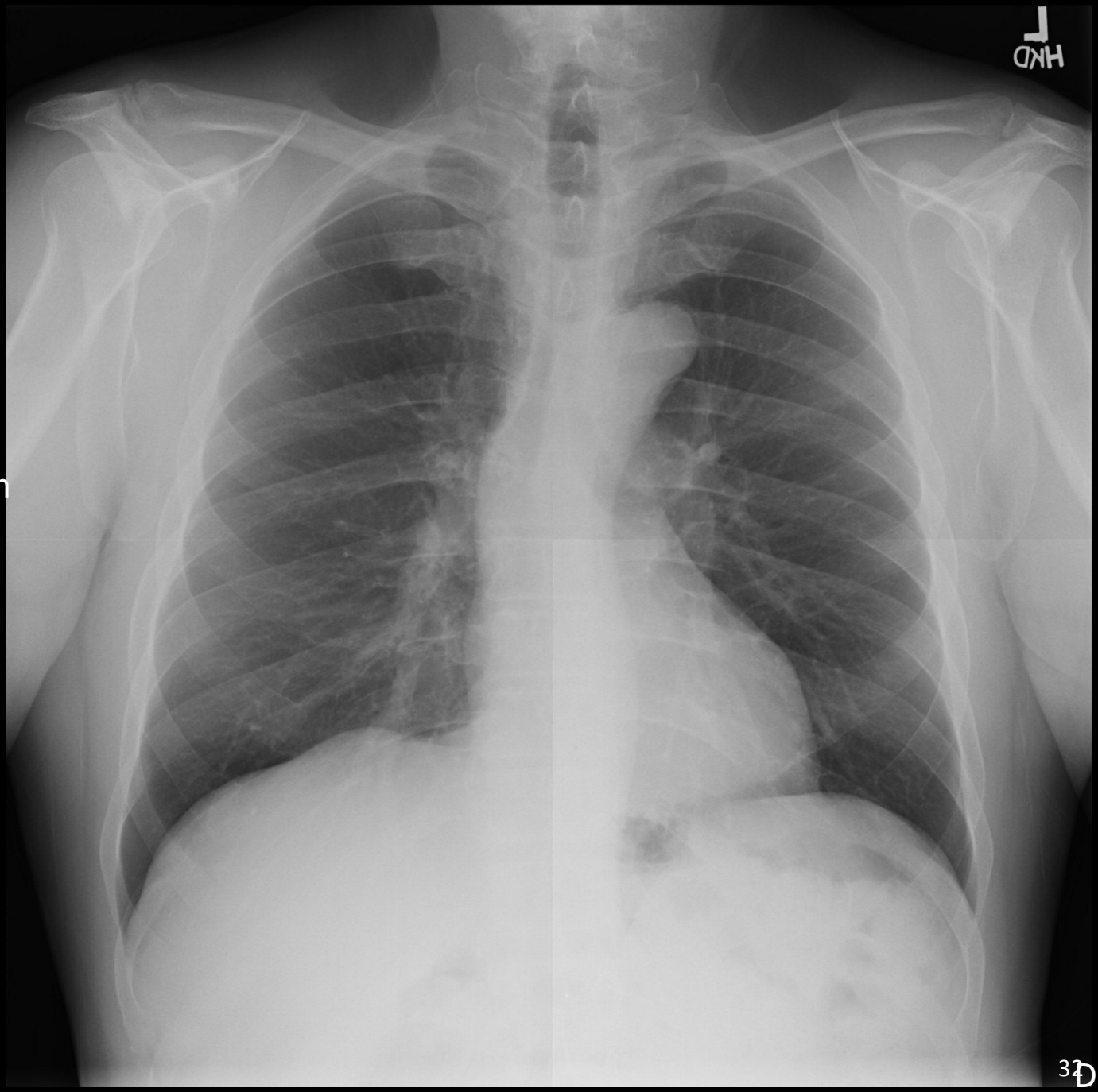


Resolution: New filter and recalibration.

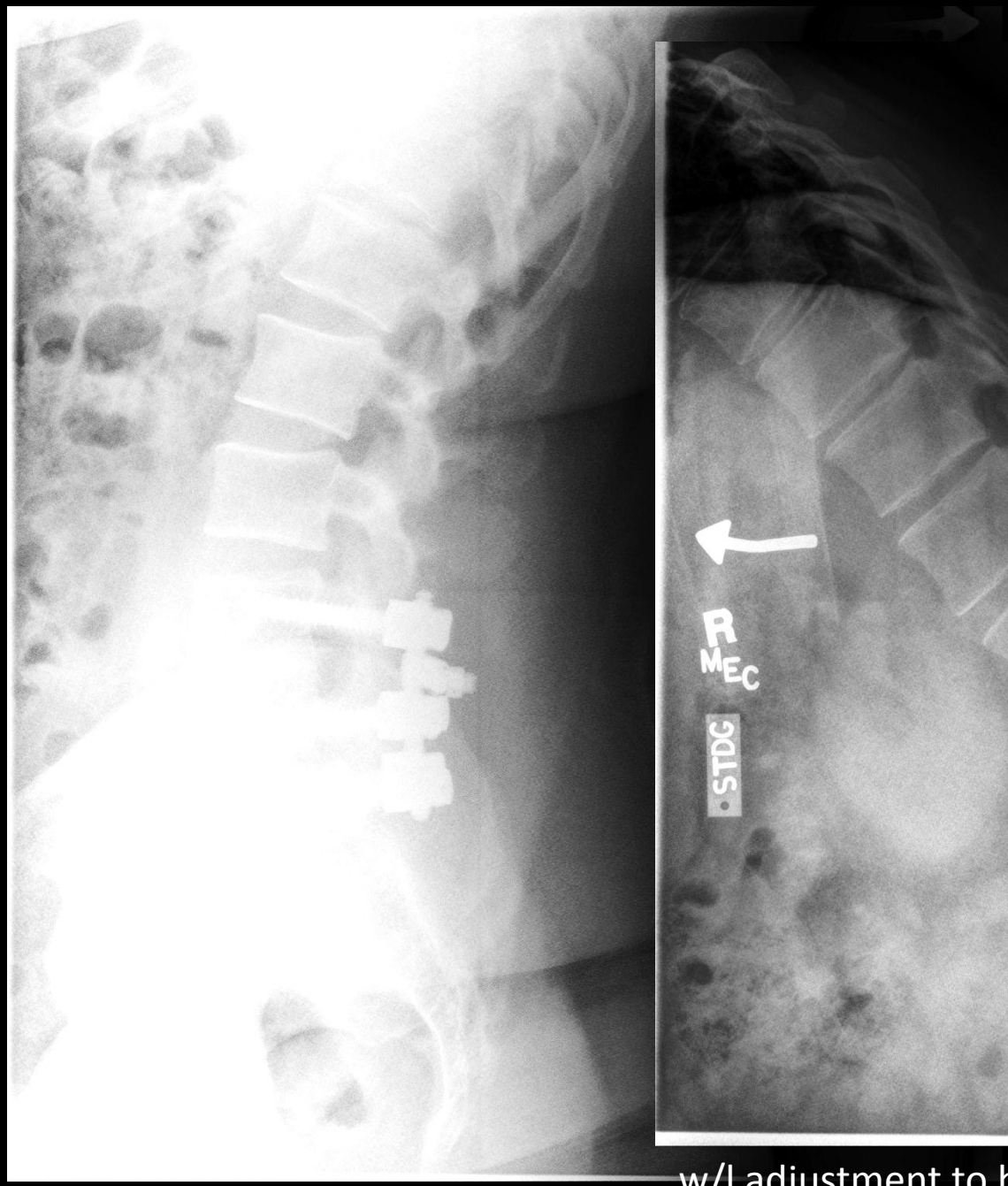
<u>Visible detector tiling</u>

Seen with room temperature change and use.

Resolution: recalibration; room temperature stabilization



DR



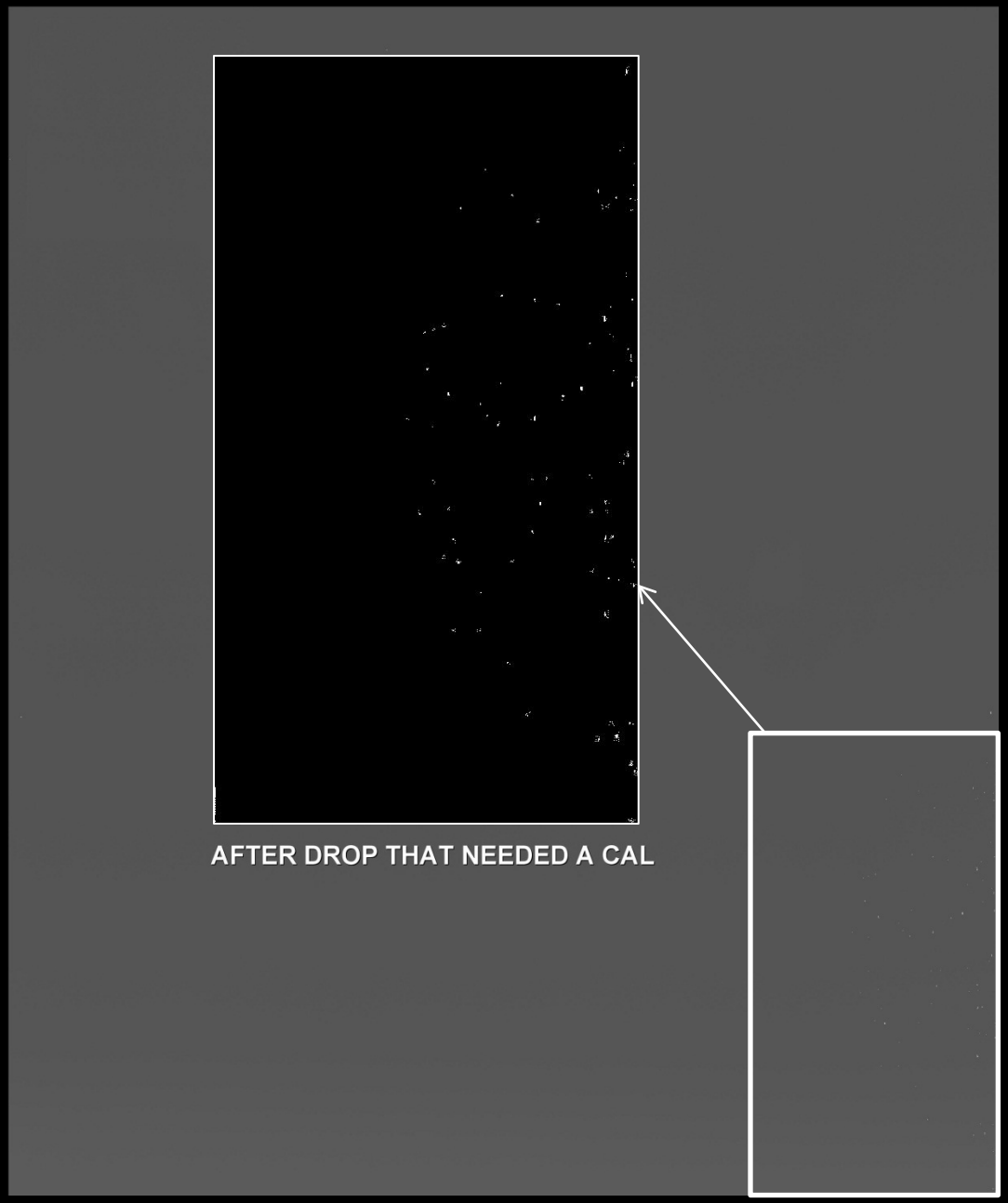
Visible detector tiling

Particular to this view and technique. This artifact is not resolved by detector calibration.

w/l adjustment to better show quadrants

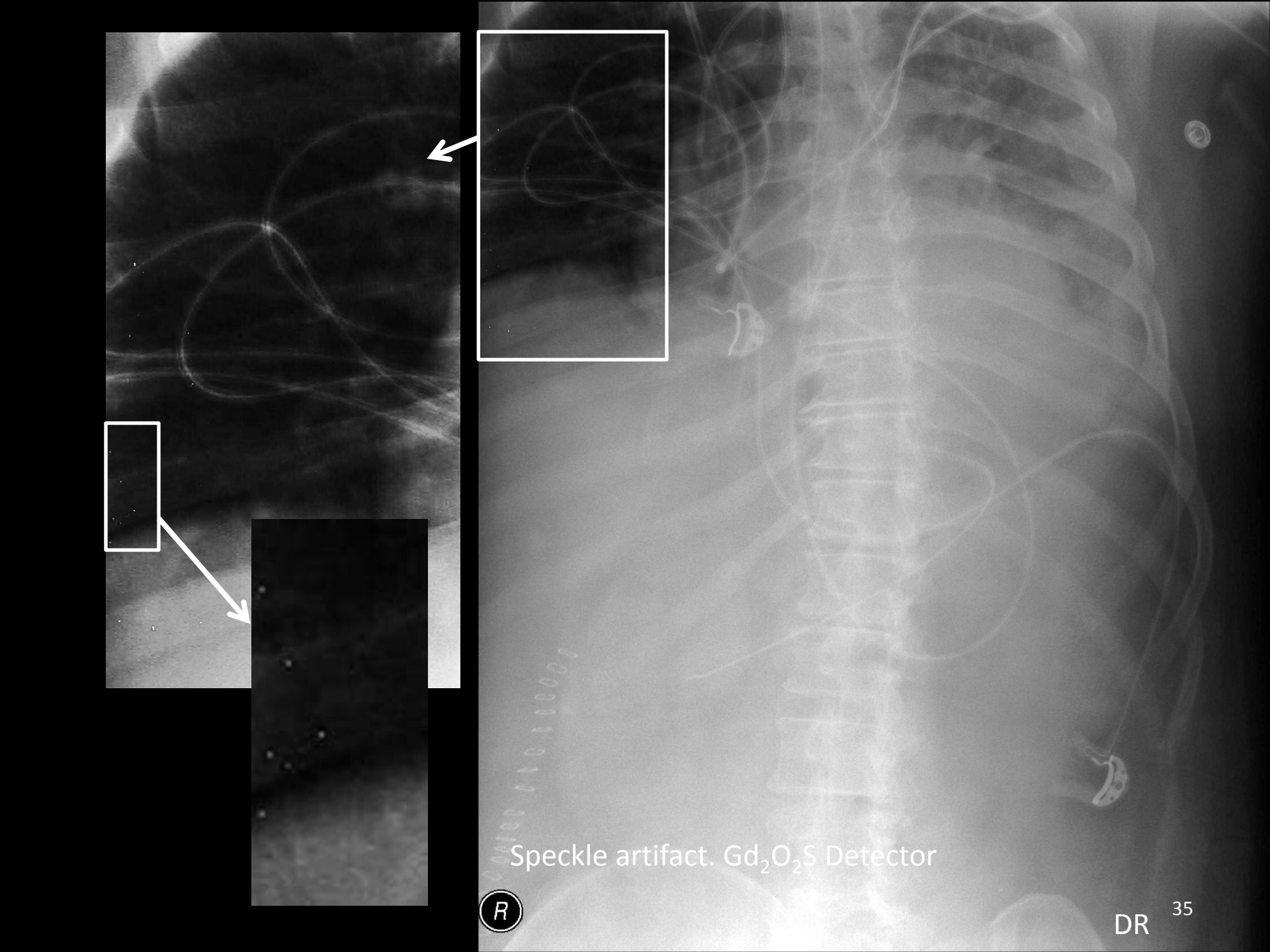
DR

Speckle artifact, after detector drop. Gd_2O_2S Detector



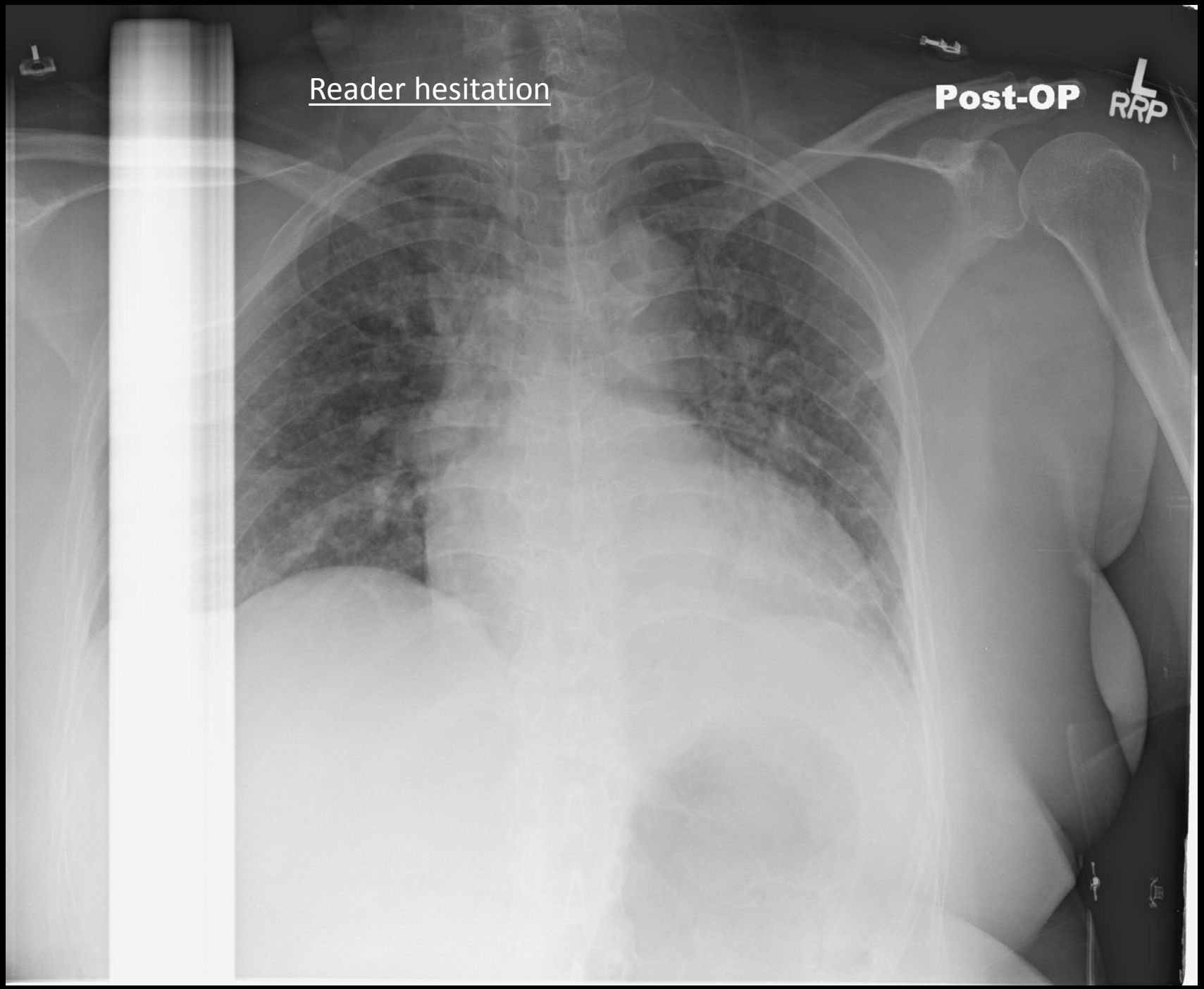
Resolved by re-calibration

DR


Speckle artifact. Gd_2O_2S Detector
R
DR

Signal Transmission Artifacts

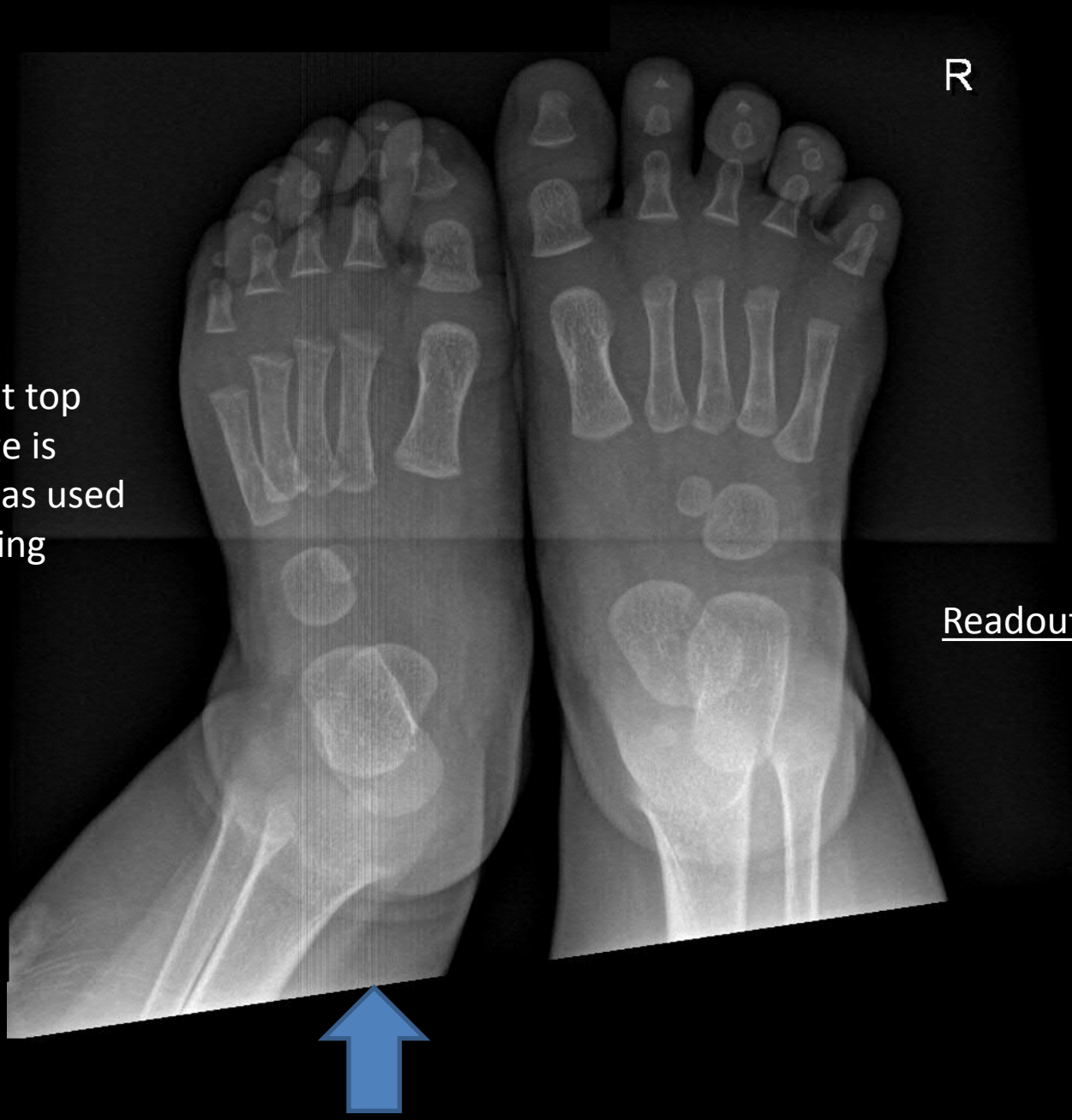
- Failed readout or interference



^{37}CR

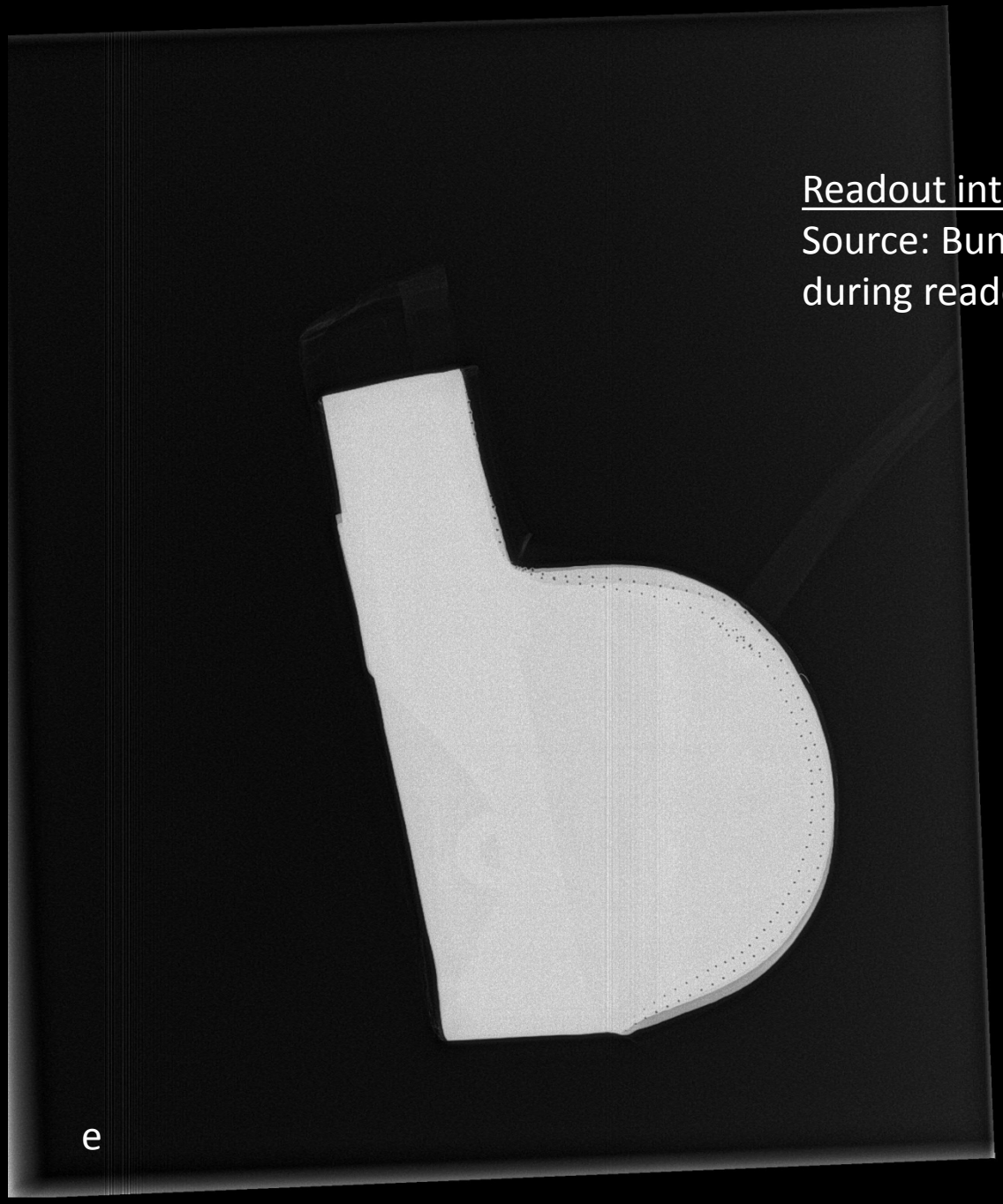
Plate feed error

CR



Attenuation difference at top half of image is from plexiglas used for positioning

<u>Readout interference.</u>

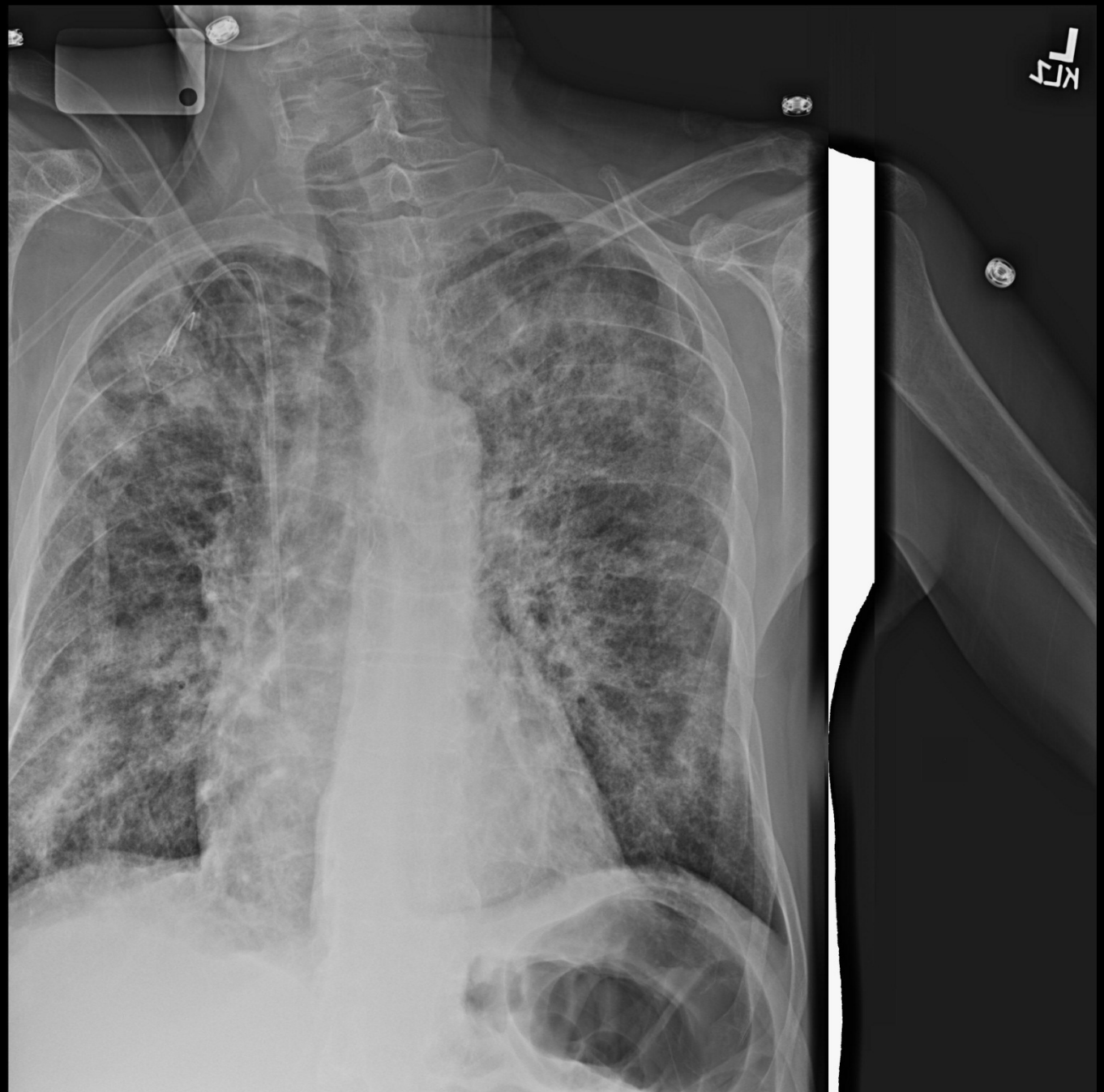


Readout interference
Source: Bumped during readout

Readout failure

Source:
unknown
Resolution:
Rebooted the system a few times.
Recalibrated the detector.

DR

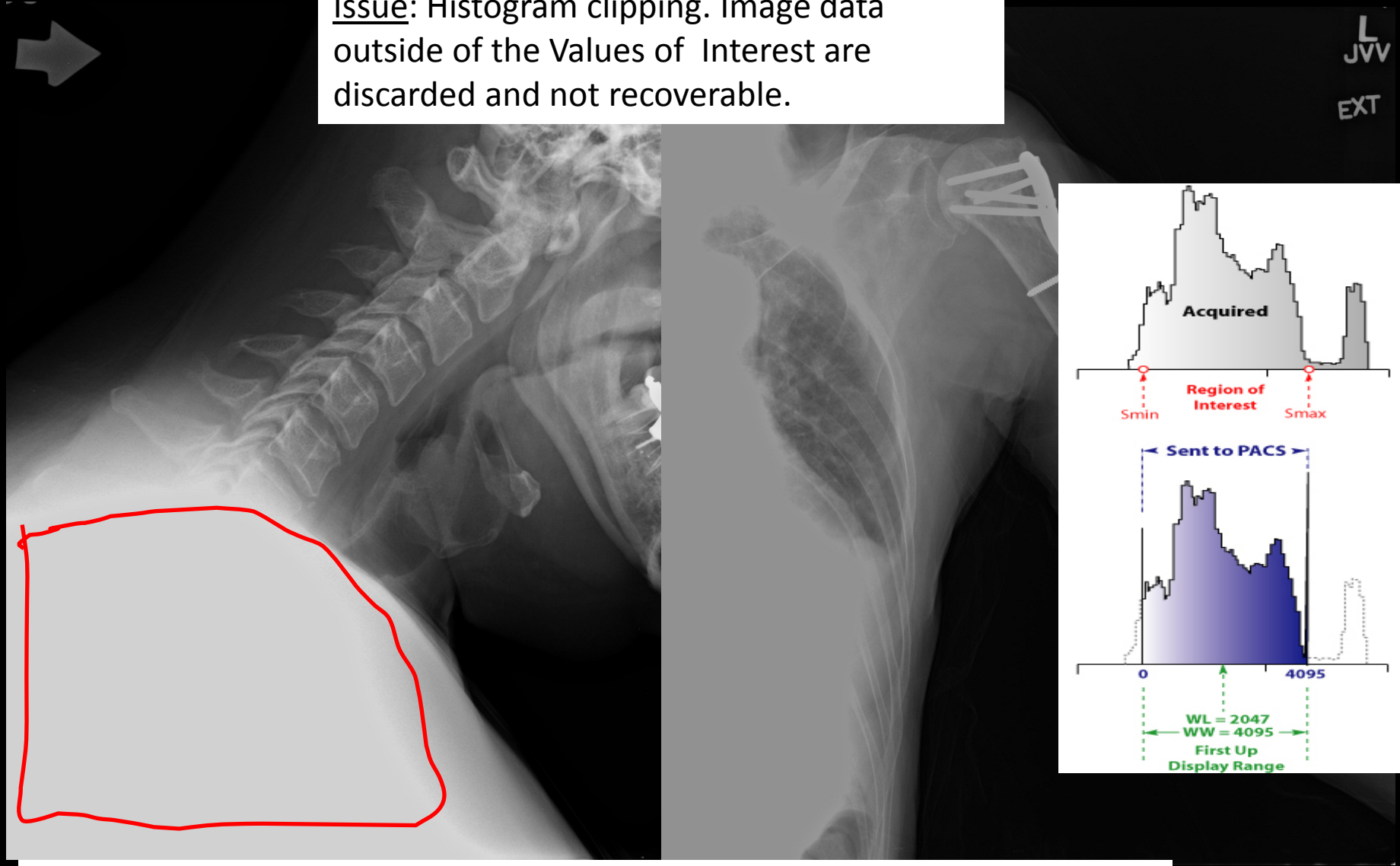


DR

Image Processing or image construction issues

- Histogram clipping
- Other poor processing
- Image Composition (“stitching”)

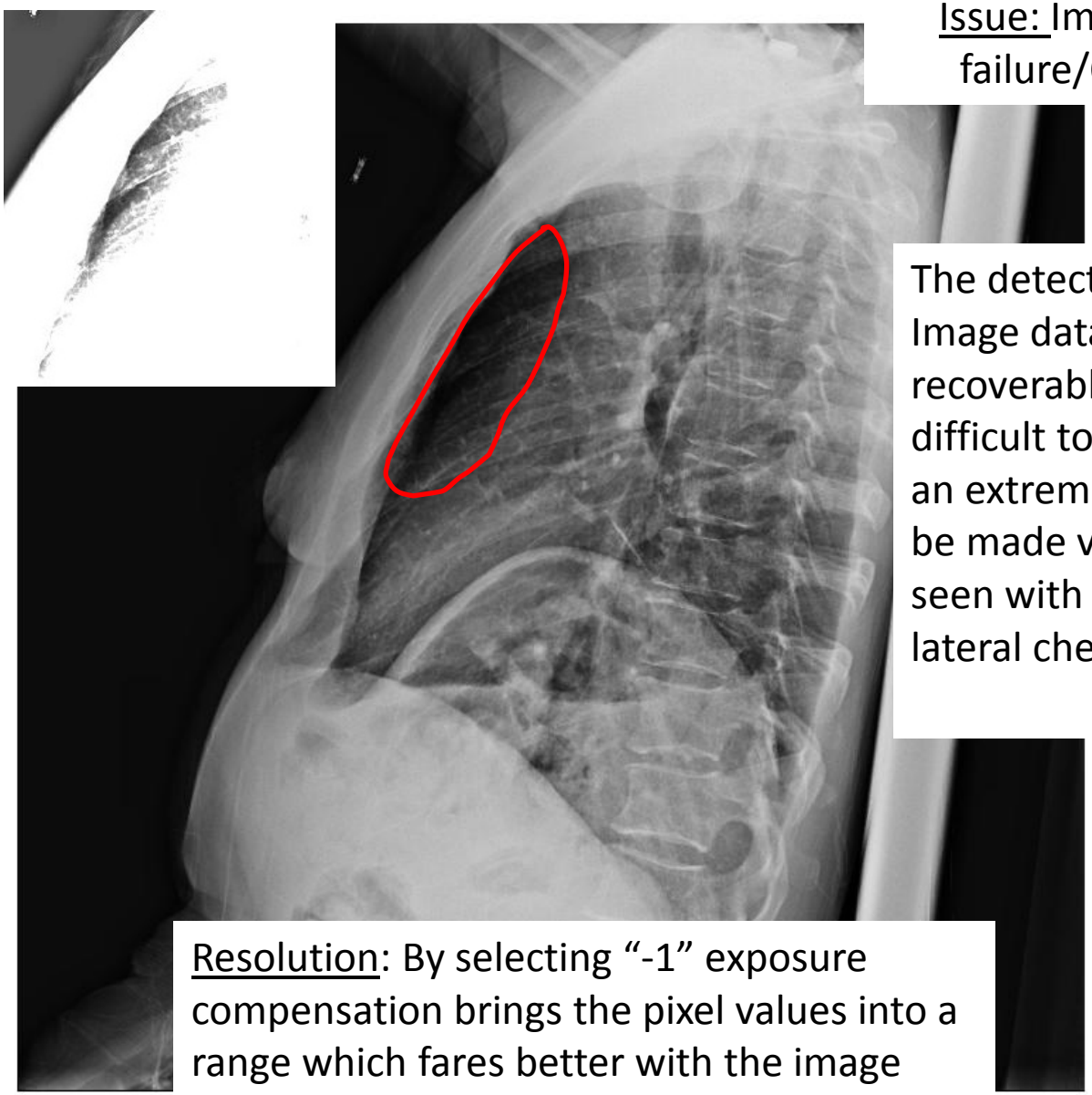
Issue: Histogram clipping. Image data outside of the Values of Interest are discarded and not recoverable.



Resolution:

Re-processed the images under a different setting with a fixed latitude

This issue is addressed by an upgrade to vendor software.

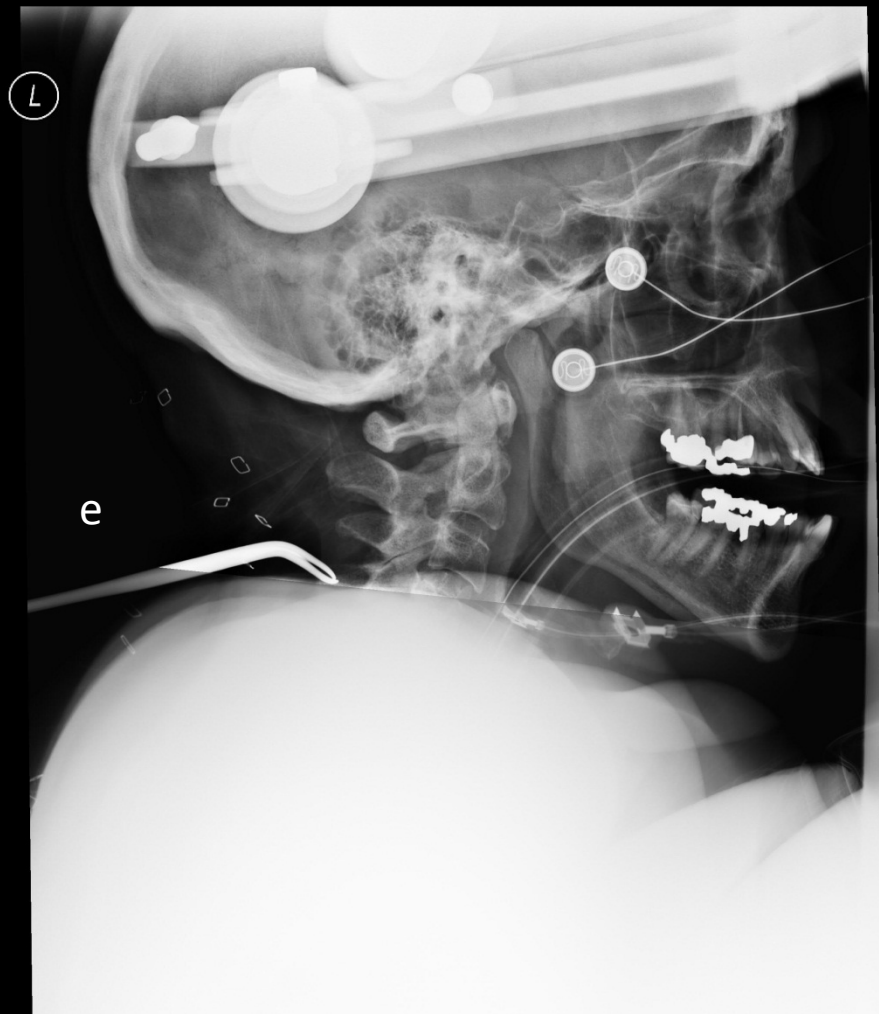


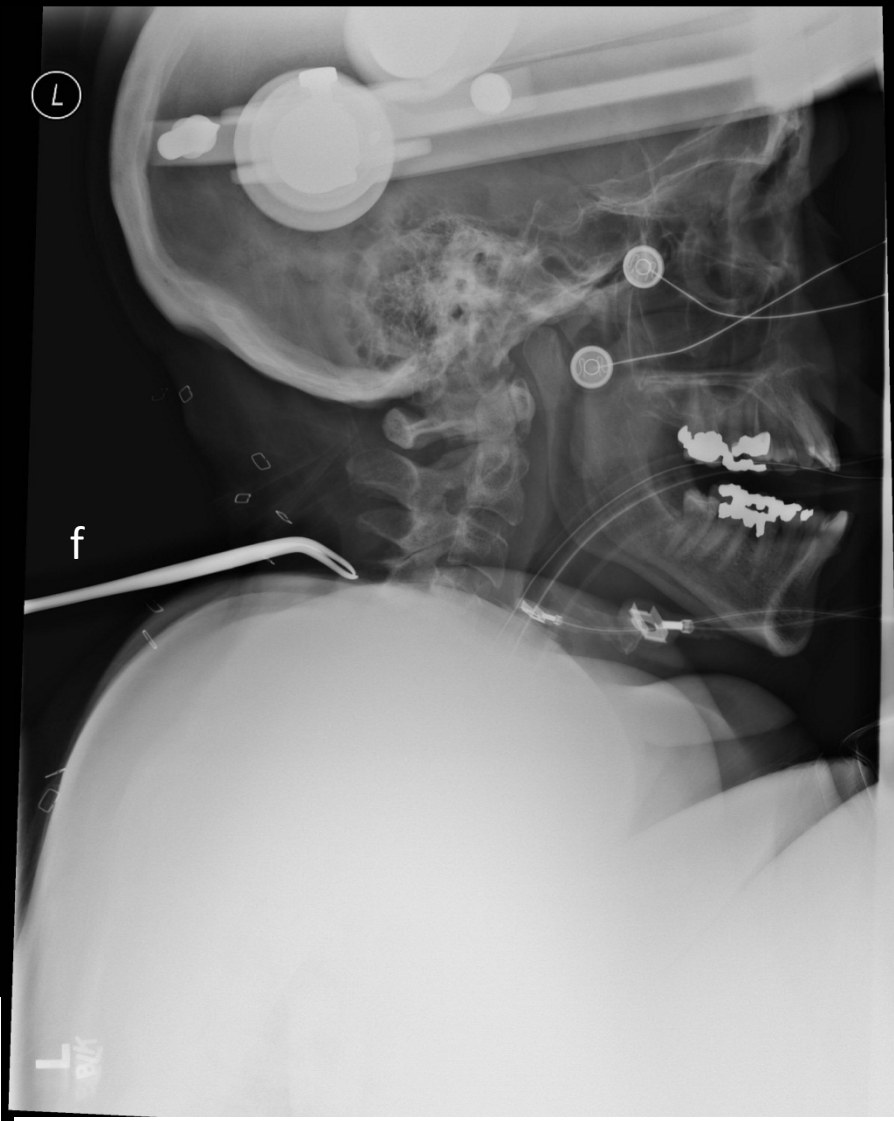
Issue: Image processing failure/Overexposure

The detector is not saturated. Image data in the region is recoverable. However, it is difficult to see and must have an extreme window/level to be made visible. It is often seen with small patients in lateral chest images.

Resolution: By selecting “-1” exposure compensation brings the pixel values into a range which fares better with the image processing and remaining image quality is sufficient.

DR

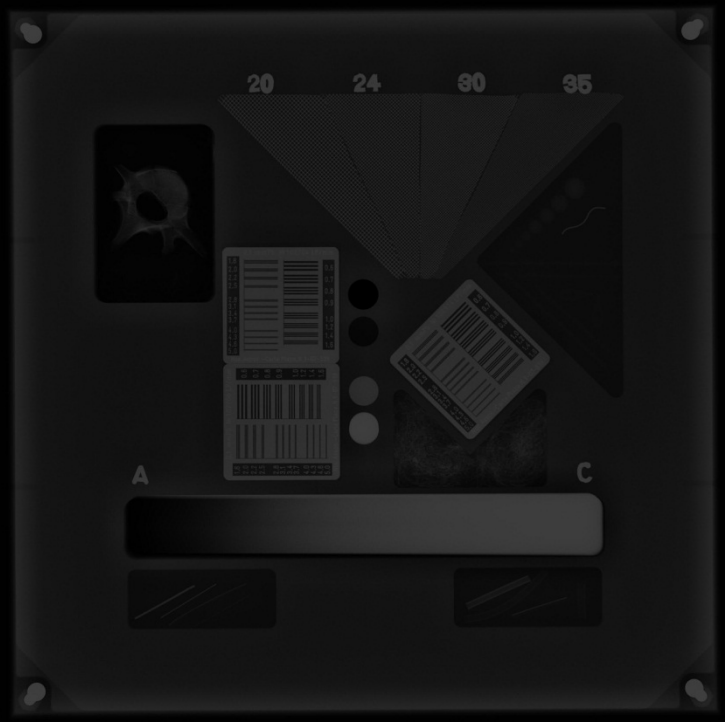




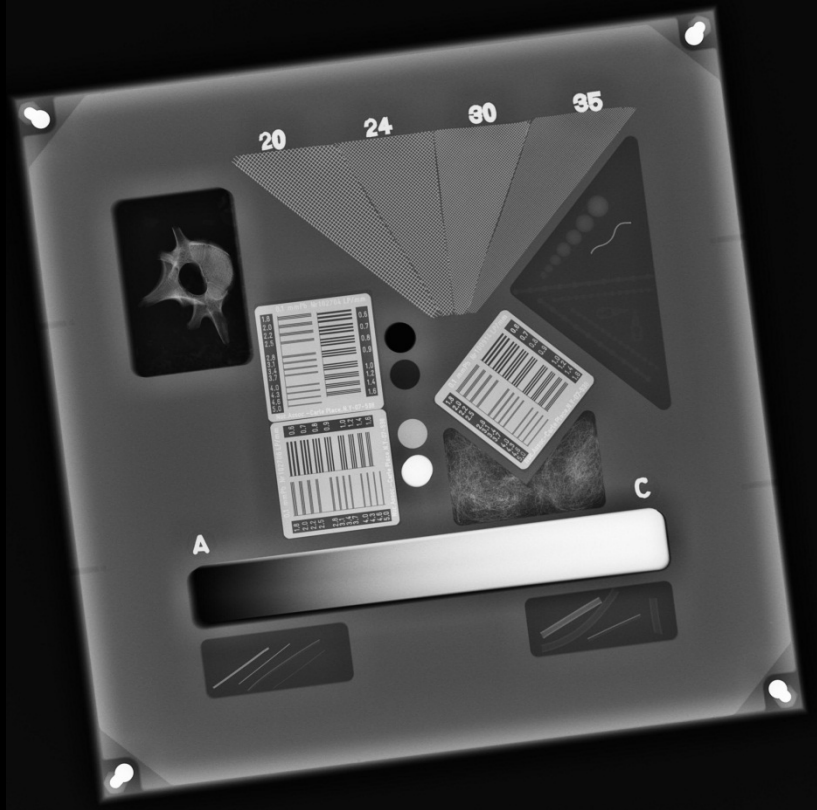
Issue: Incomplete image processing from incorrect shuttering.
Electronic shutter which selects region for processing triggers on the wrong area

Resolution: Shuttering can be manually modified.

VOI LUT not received or recognized

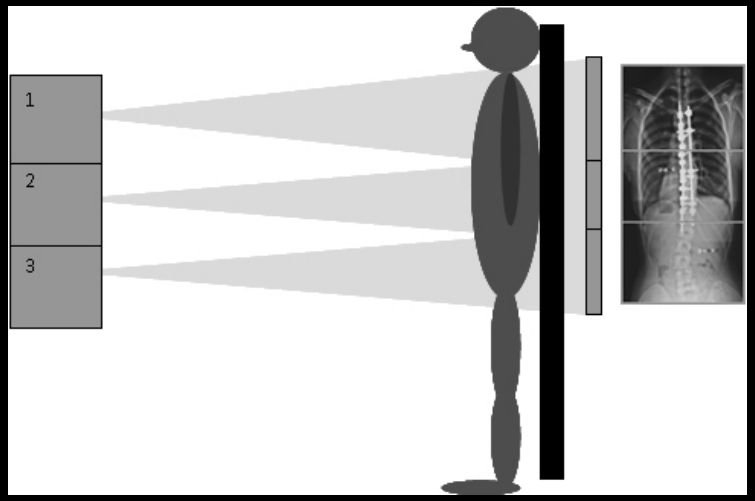


VOI LUT recognized



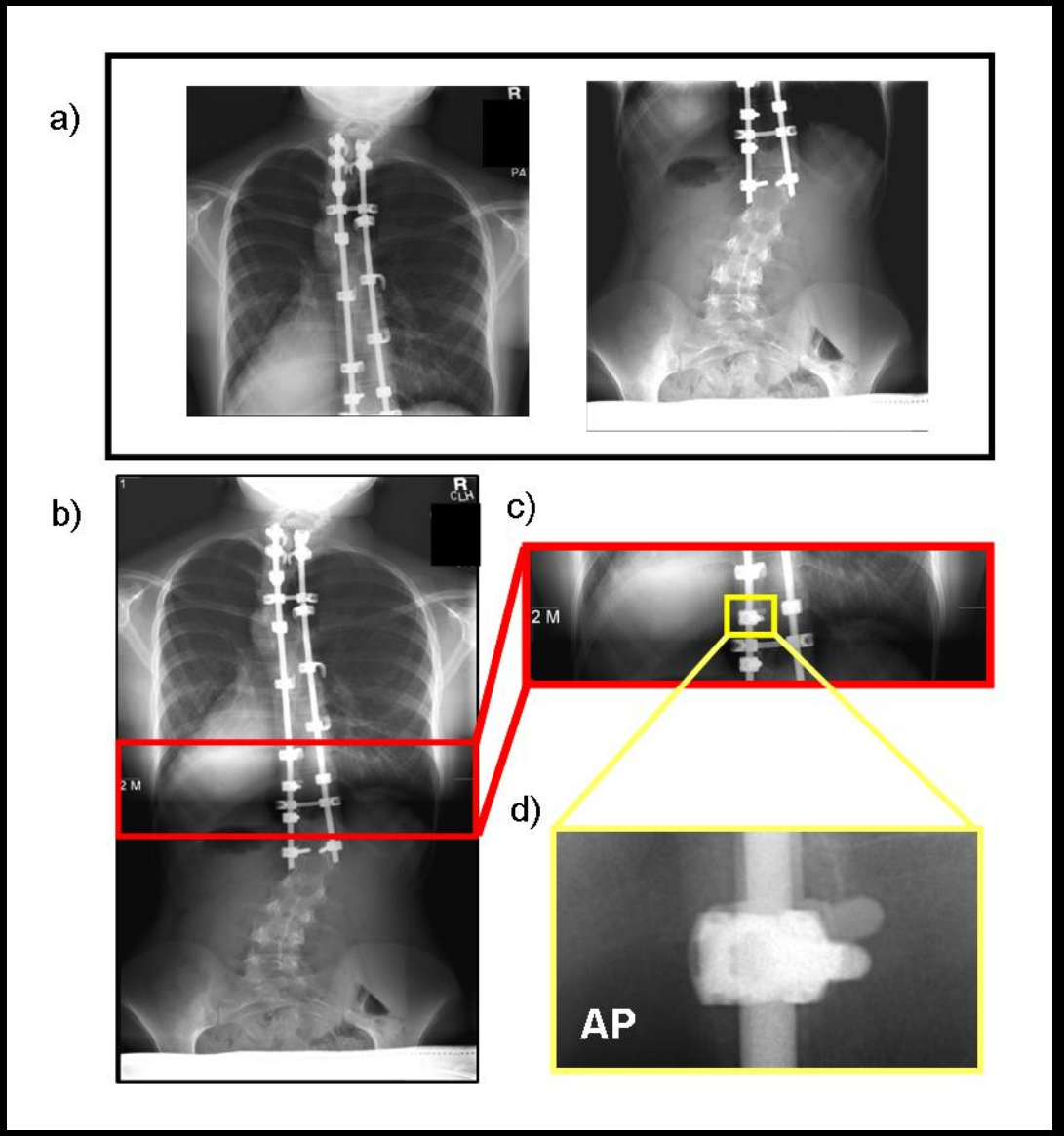
Issue: VOI-LUT is not transmitted because of incorrect configuration. For the same system, this VOI-LUT is not recognized by downstream viewers.

Stitching artifact



Different projections of the same object are combined into a single image.

Resolution: Vendor employs a different method for stitching where the source is stationary.



DR

General Considerations

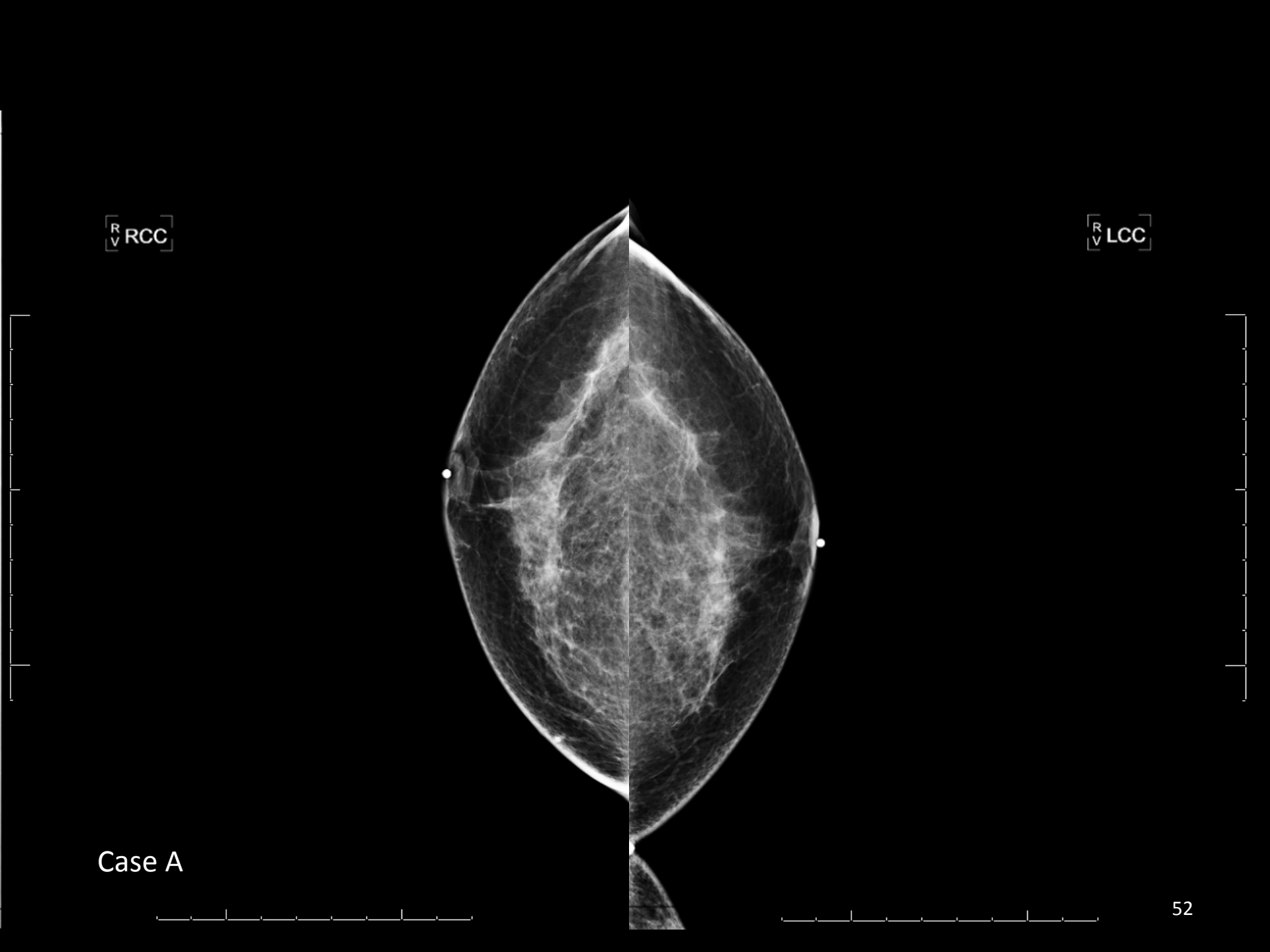
- Know how your system works (mechanics/image formation) in order to know what the risk areas are for artifacts and how to troubleshoot
- We rely on technologists to find and report clinical artifacts
  - Promote a culture of safety which encourages reporting
  - Teach techs about what they should be looking for with different systems

Discussion

The Art of the Image: The Identification and Remediation of Image Artifacts in Projection Radiography, part III

3 mammography cases
3 general cases

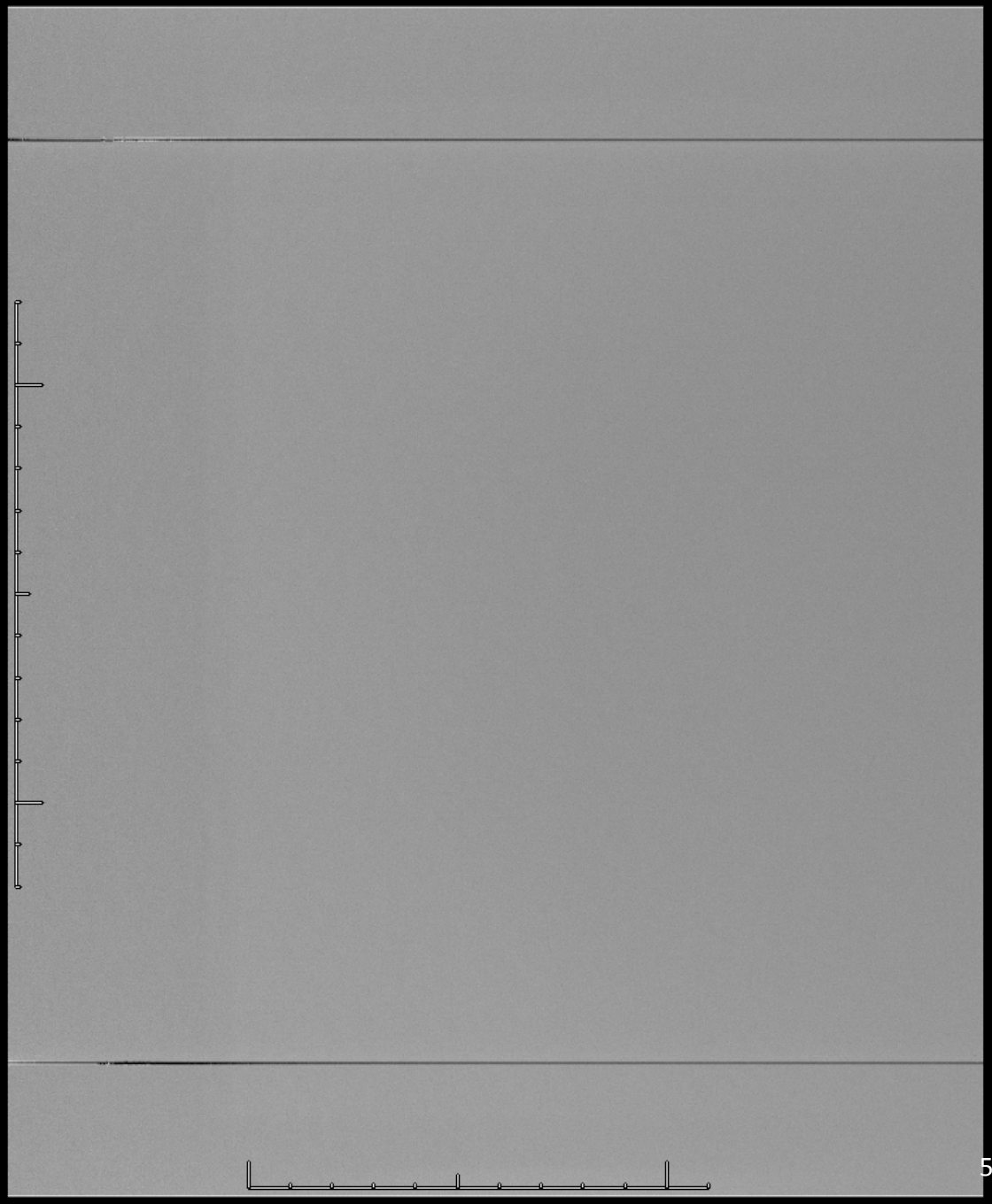
CasE A



Case A

Case A

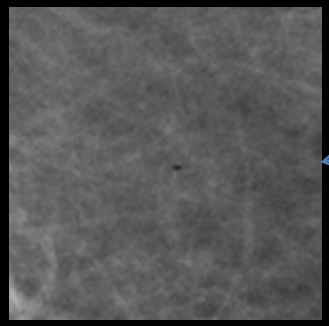
Flat Field Test

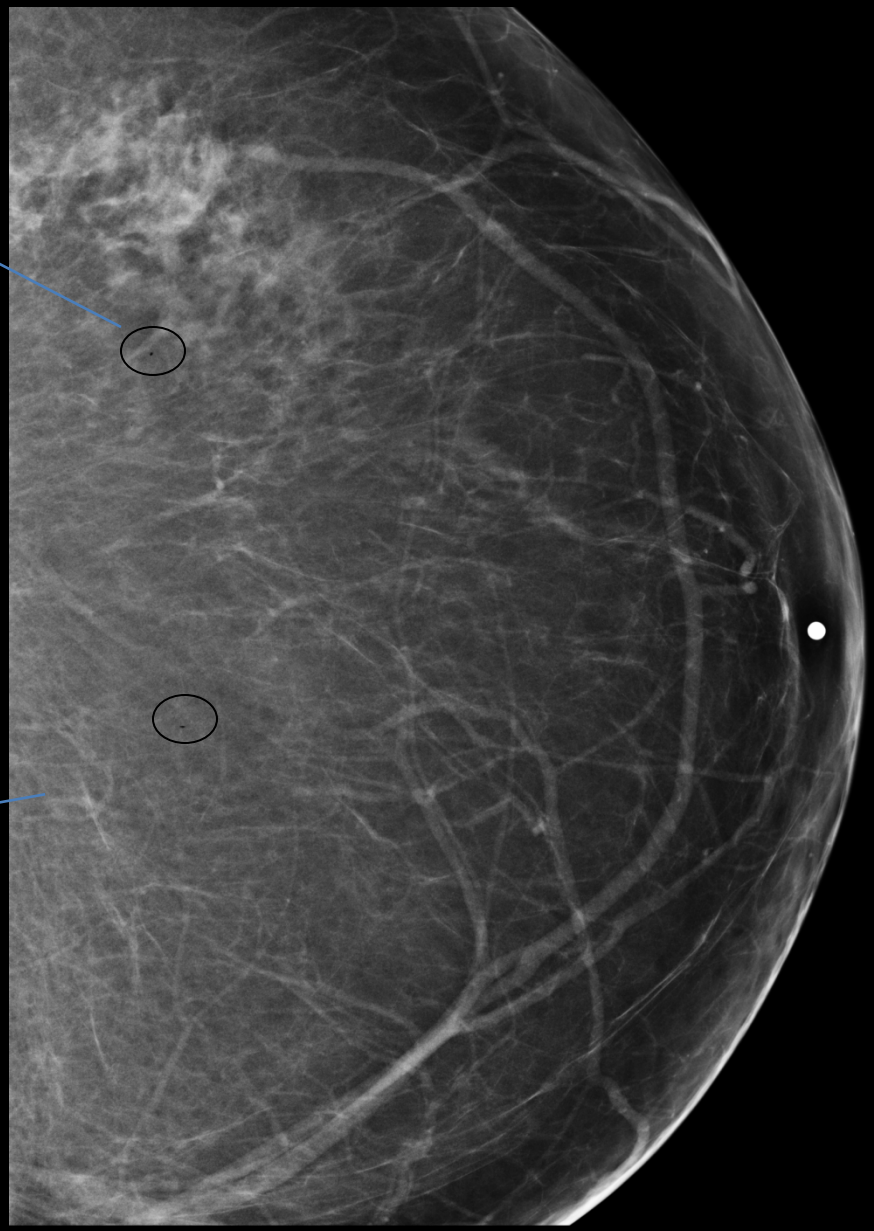


Case A

CasE B

View: LCC
kVp: 28
mAs: 127
Compression Thickness: 7.2 cm
Compression Force: 20.9 lbs





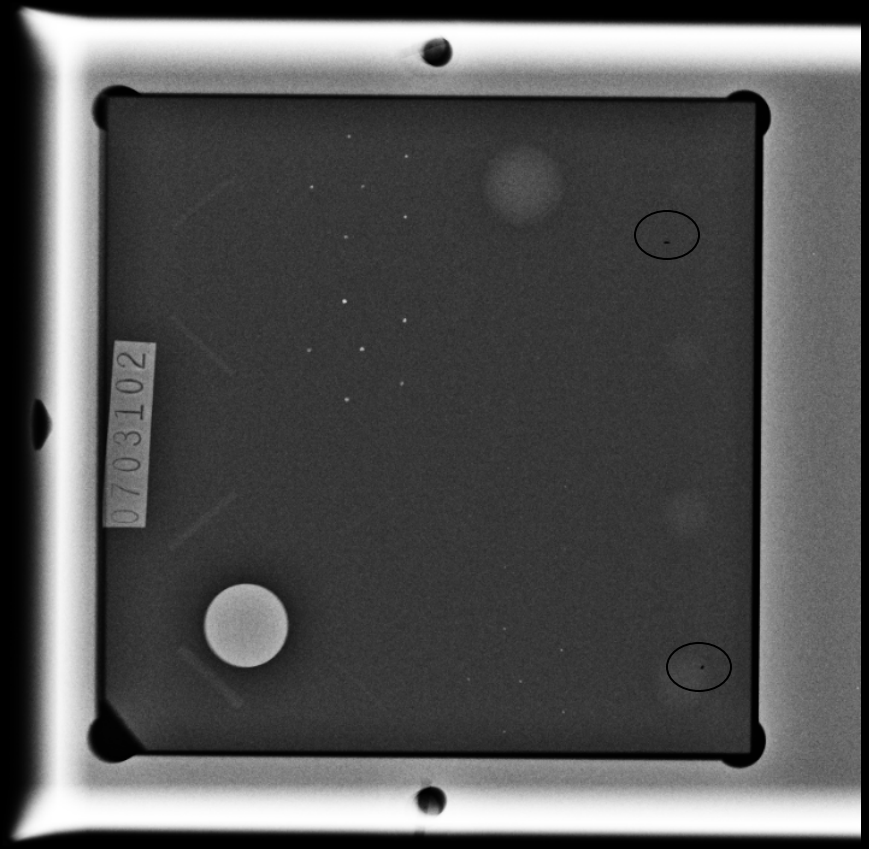
Case B

kVp: 28

mAs: 75

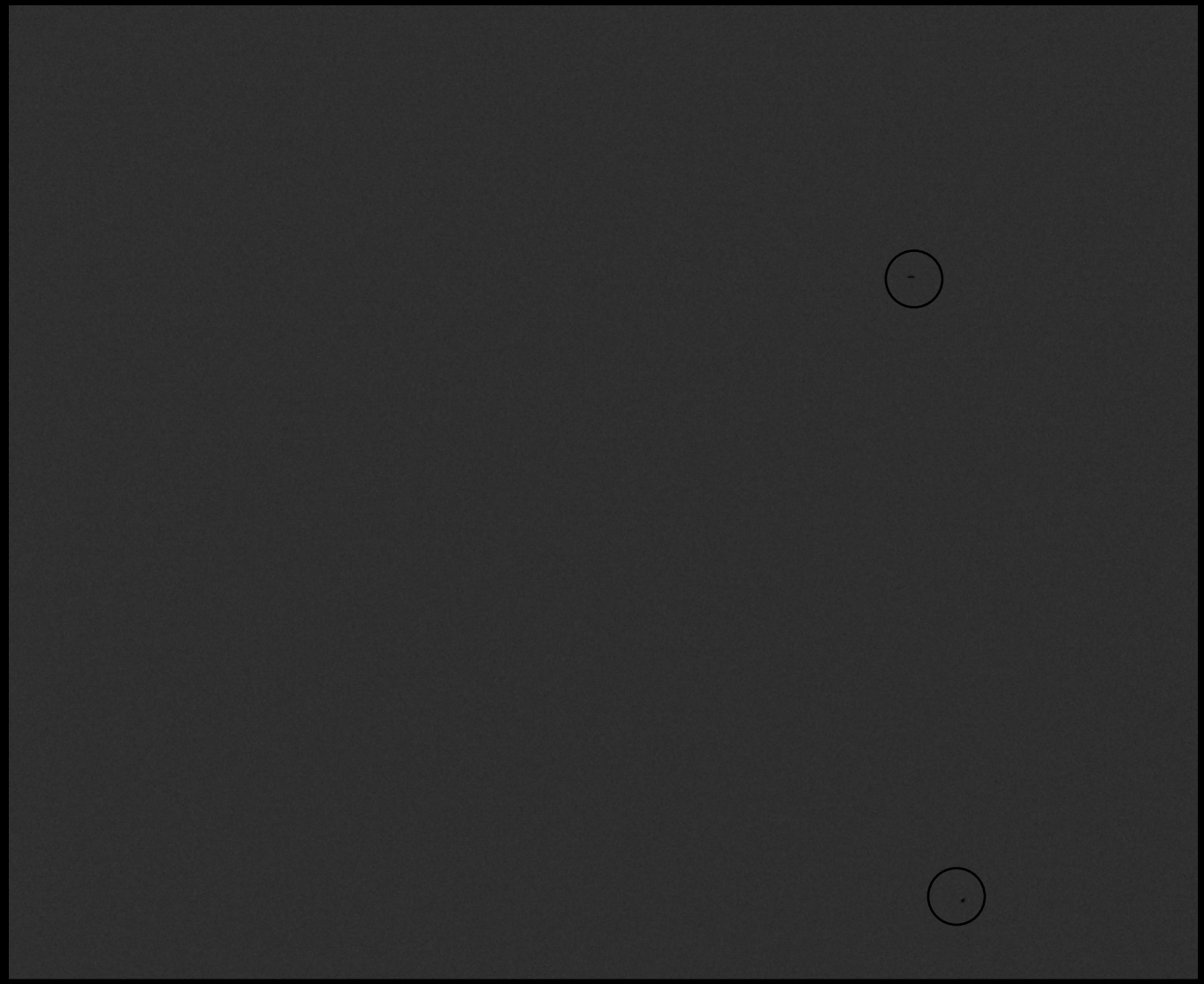
Compression Thickness: 5.0 cm

Compression Force: 20 lb



Case B

View: Flat Field
kVp: 28
mAs: 65
Compression Thickness: N/A
Compression Force: N/A



Case B

CasE C

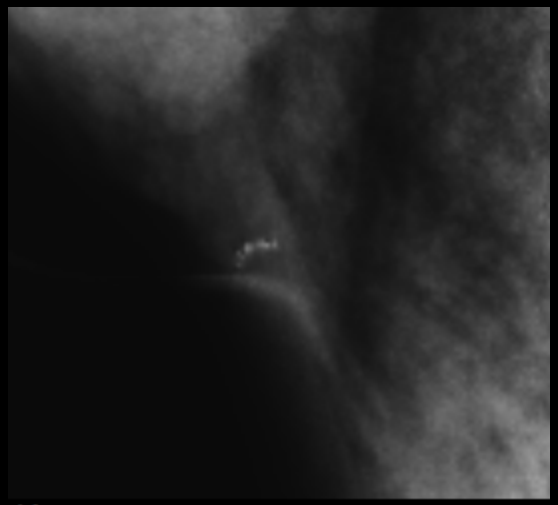
Calk Like Artifact RCC

View: RCC

kVp: 26

mAs: 65

Thickness: 39 mm



Case C

Calc Like Artifact - LMLO

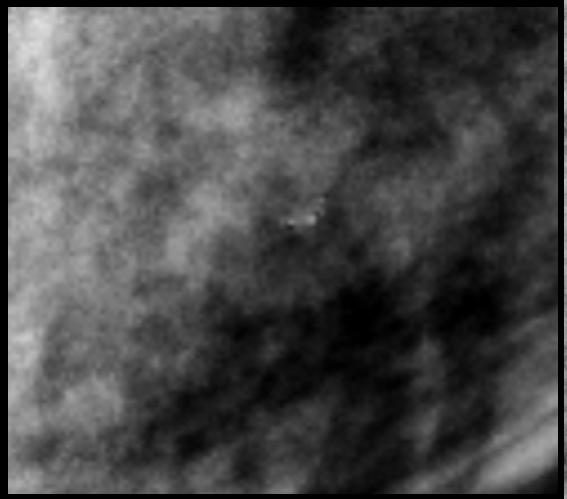
kVp:

mAs:

Compressed Thickness:

Compression Force:

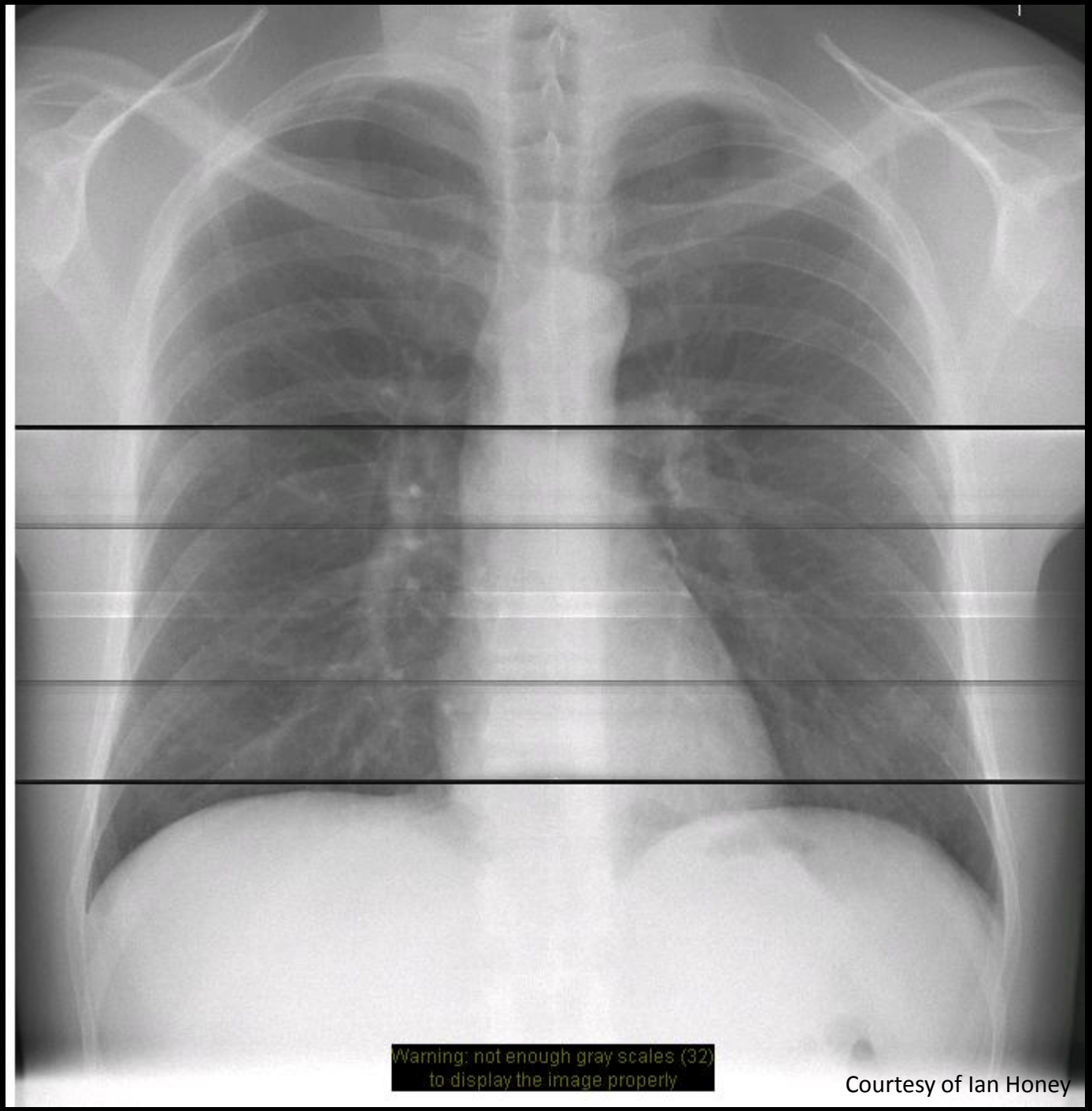
Exposure Index:



Case C

CasE D

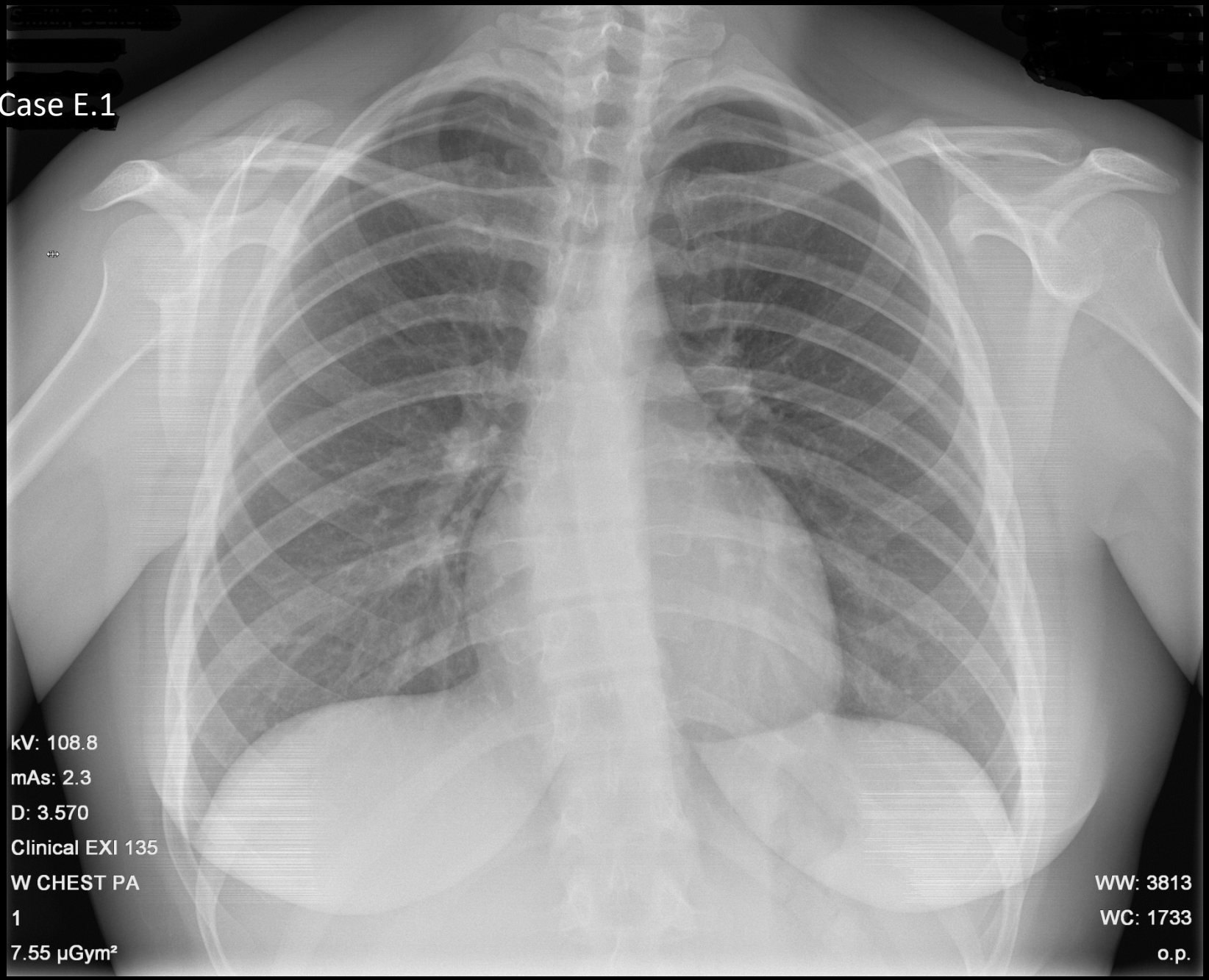
Case D



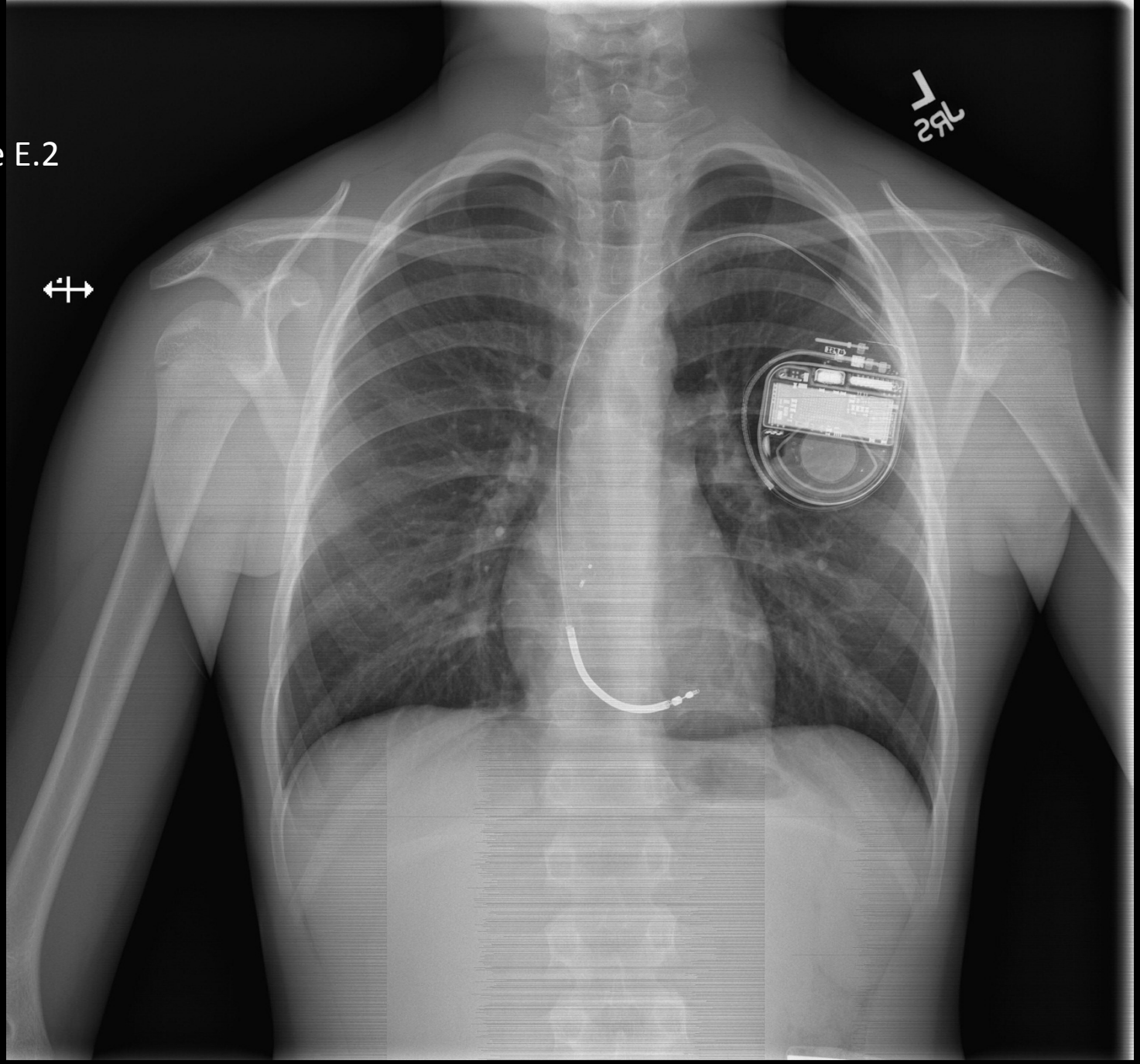
Courtesy of Ian Honey

CasE E

Case E.1


kV: 108.8
mAs: 2.3
D: 3.570
Clinical EXI 135
W CHEST PA
1
7.55 µGym²
WW: 3813
WC: 1733
o.p.

Case E.2



CasE F

Courtesy of David Gauntt