Considerations for Evaluating Ultrasound Units

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Disclosure

No financial disclosures

Testing the "Misfit" Systems

1. Testing an automated whole breast ultrasound screening system (AB US)

2. Testing ultrasound image presentation consistency between a scanner display and a reading room review workstation display

3. Testing under what system settings and the effect of system settings on evaluating system performance

Testing the "Misfit" Systems

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2. Testing ultrasound image presentation
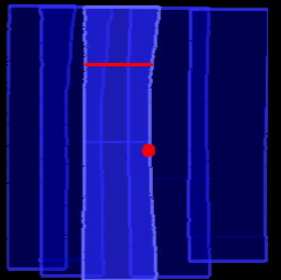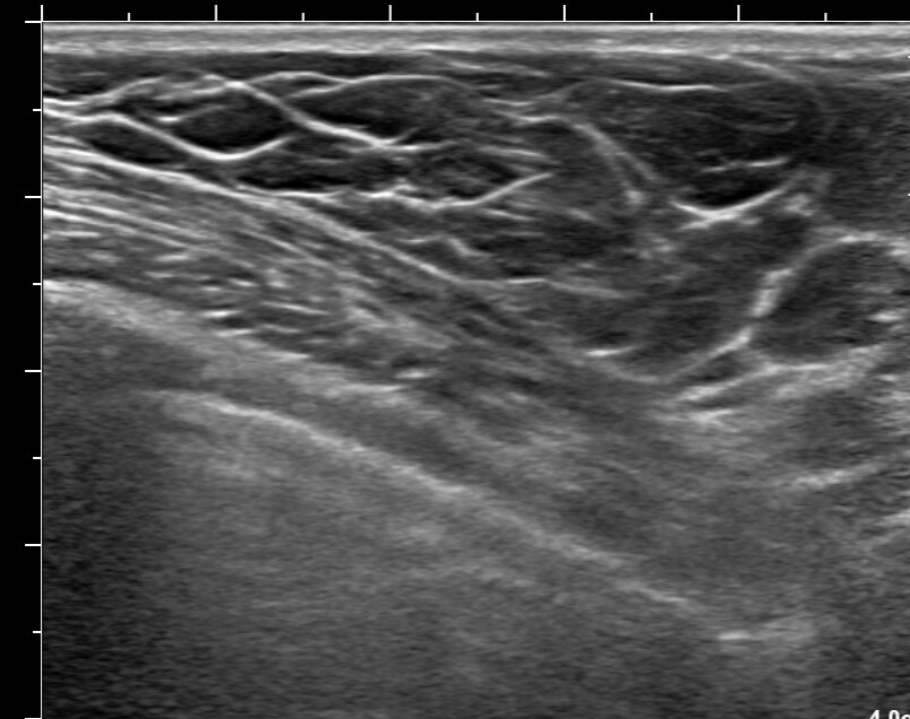   scan

3. Testing
   setti
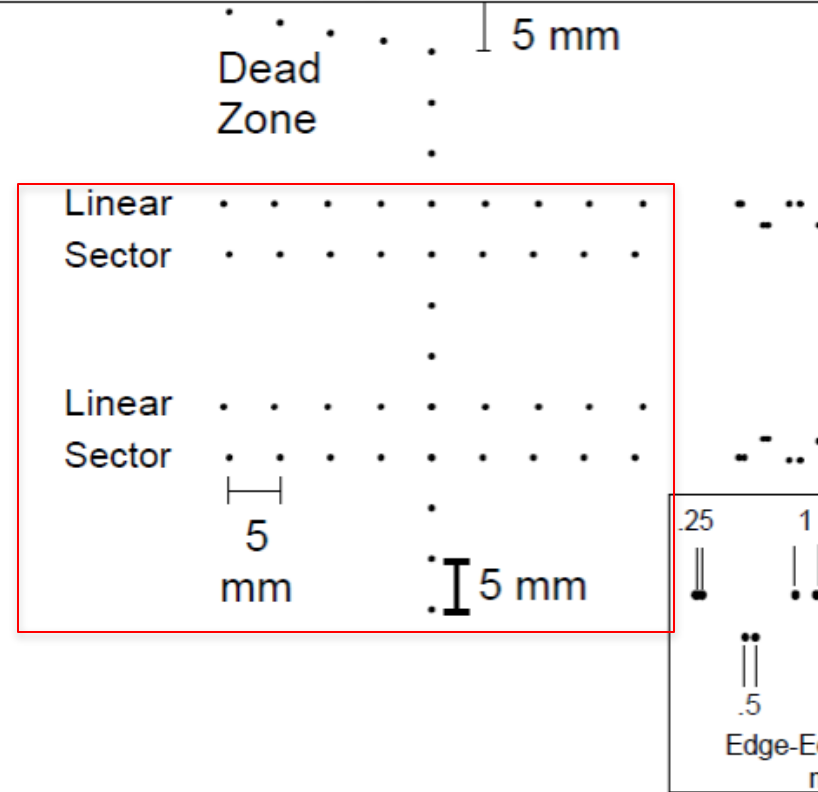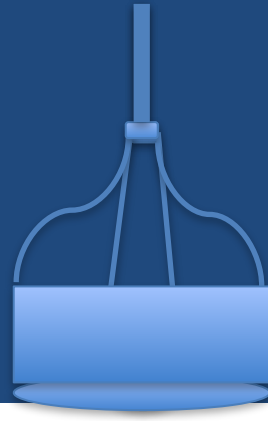

The Axial Cine Approach
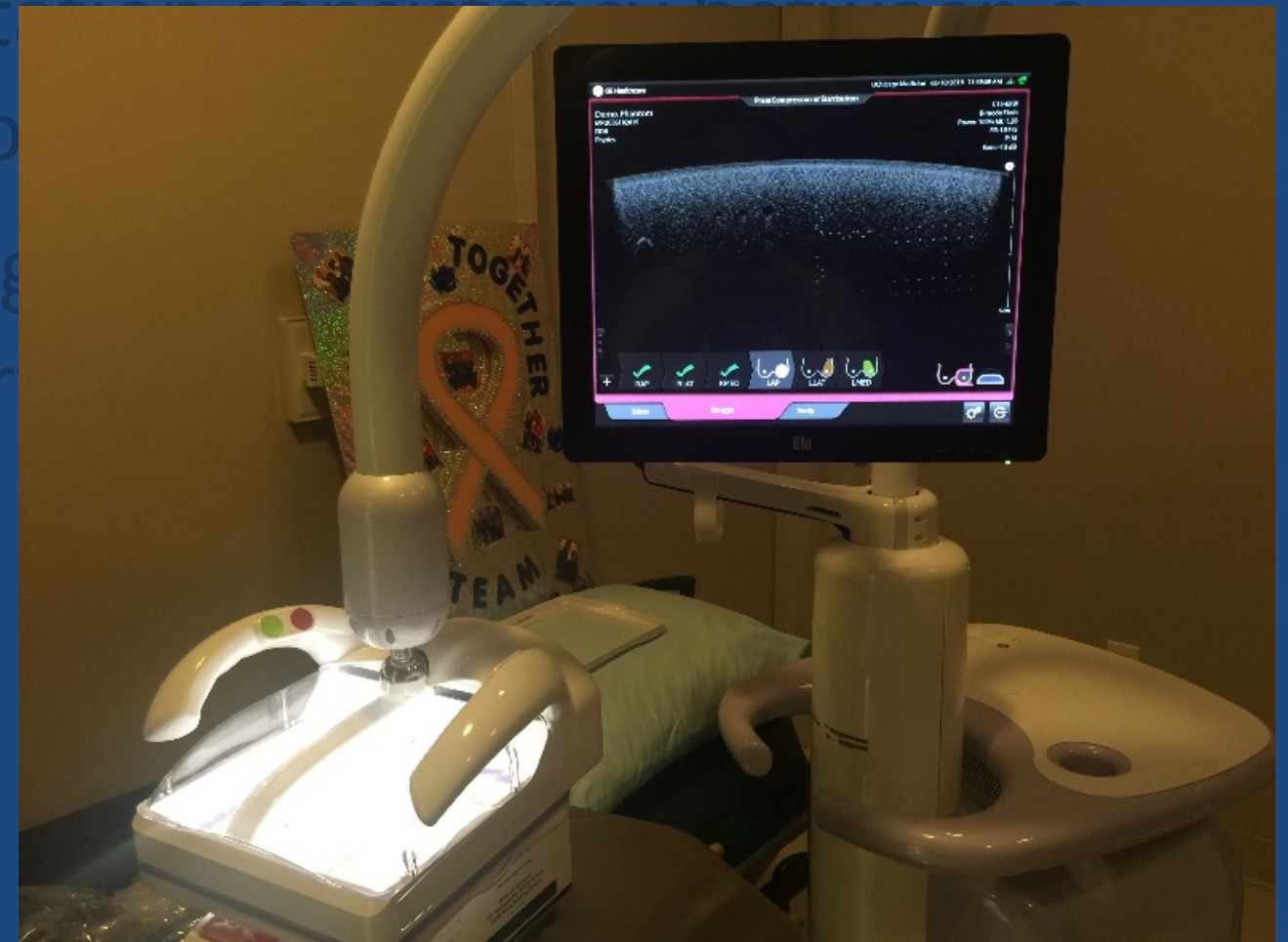
The Coronal Reconstruction Approach

Automated Whole Breast Screening Ultrasound:
The Axial Cine Approach

RIGHT : ROW 03
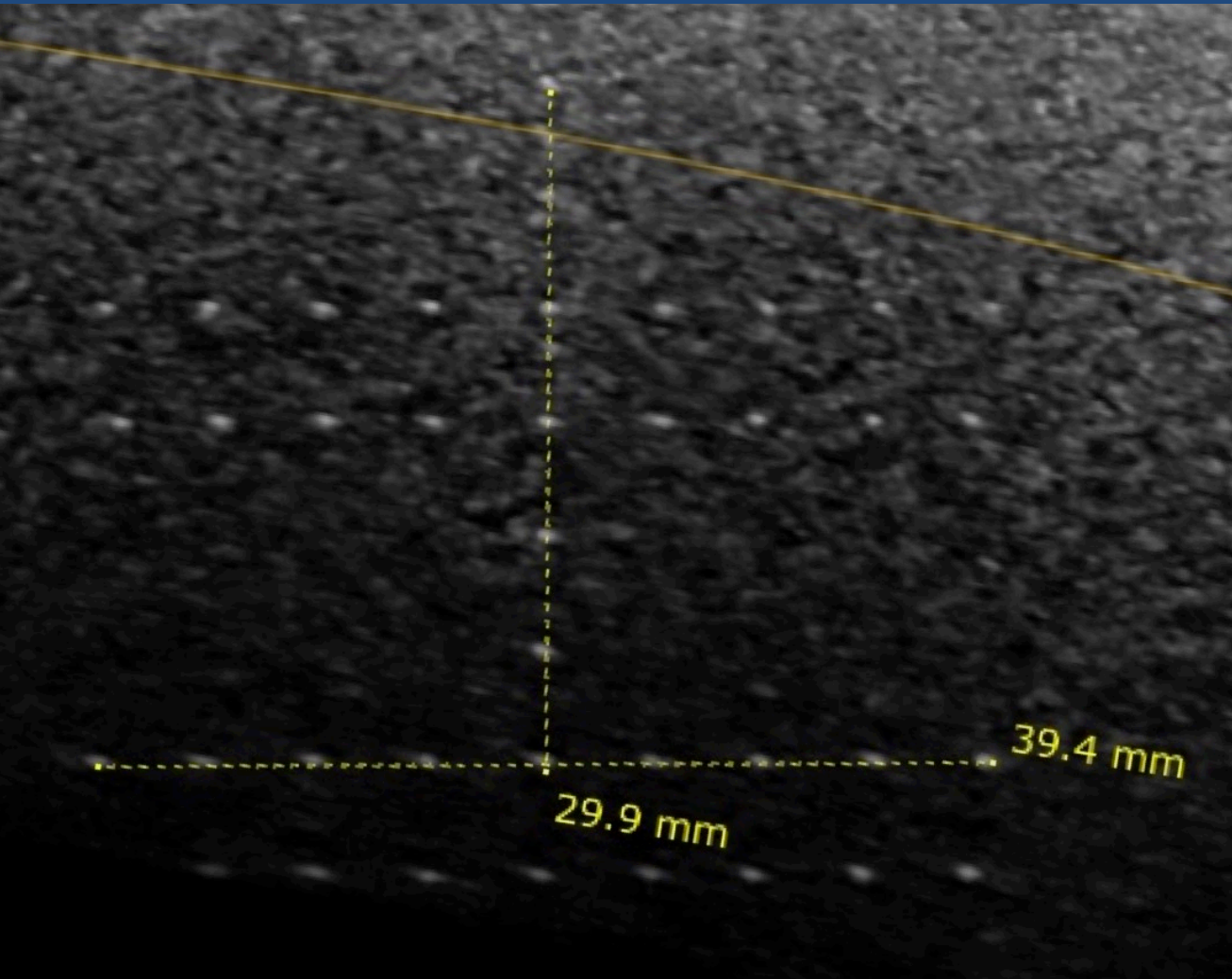FRAME 050
10:45 : 06.8cm

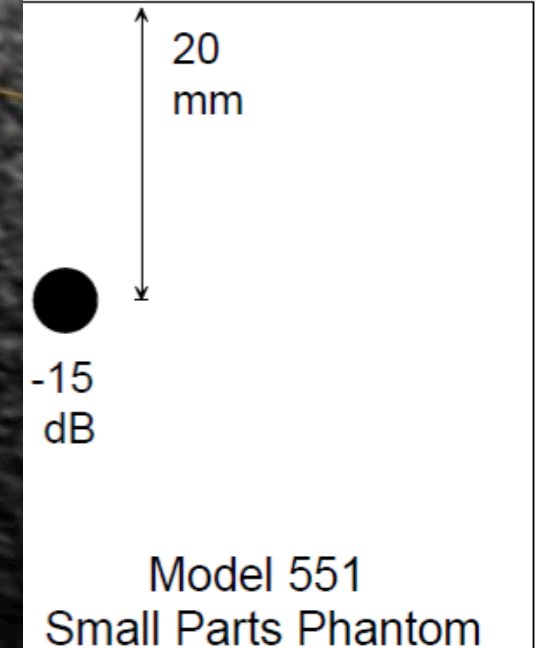# Automated Whole Breast Screening Ultrasound: The Axial Cine Approach

Small Parts QC Phantom

Automated Whole Breast Screening Ultrasound: The Axial Cine Approach

Small Parts QC Phantom

Automated Whole Breast Screening Ultrasound:
The Axial Cine Approach

Dead Zone

5 mm

20 mm

Linear Sector

45 mm

Linear Sector

5 mm

5 mm

.25   1   3

.5   2

Edge-Edge Spacing mm

Vertical - Horizontal Line Targets

Axial-Lateral Resolution Array

4 mm

An

RIGHT : ROW 01
FRAME 255
06:00 : 13.6cm
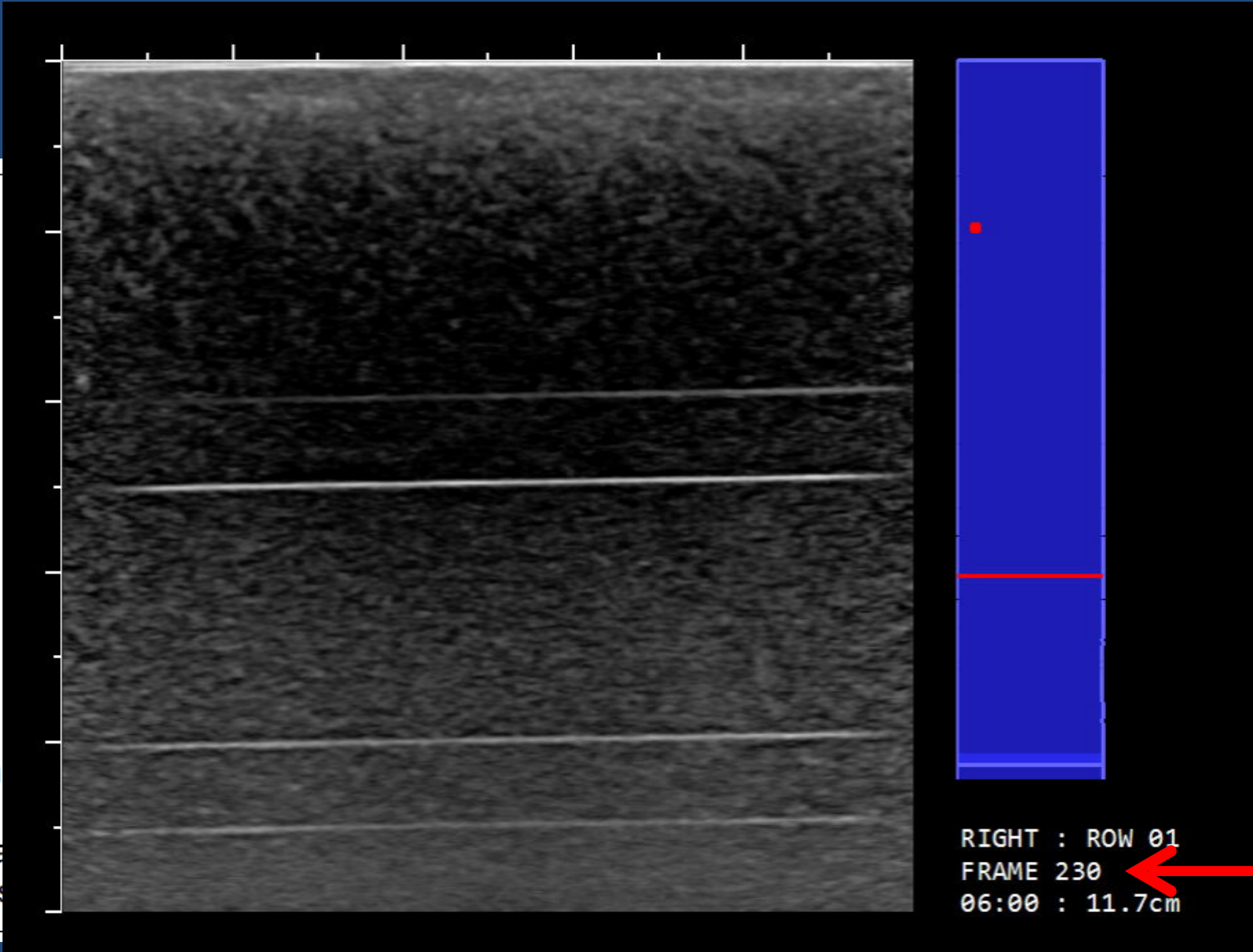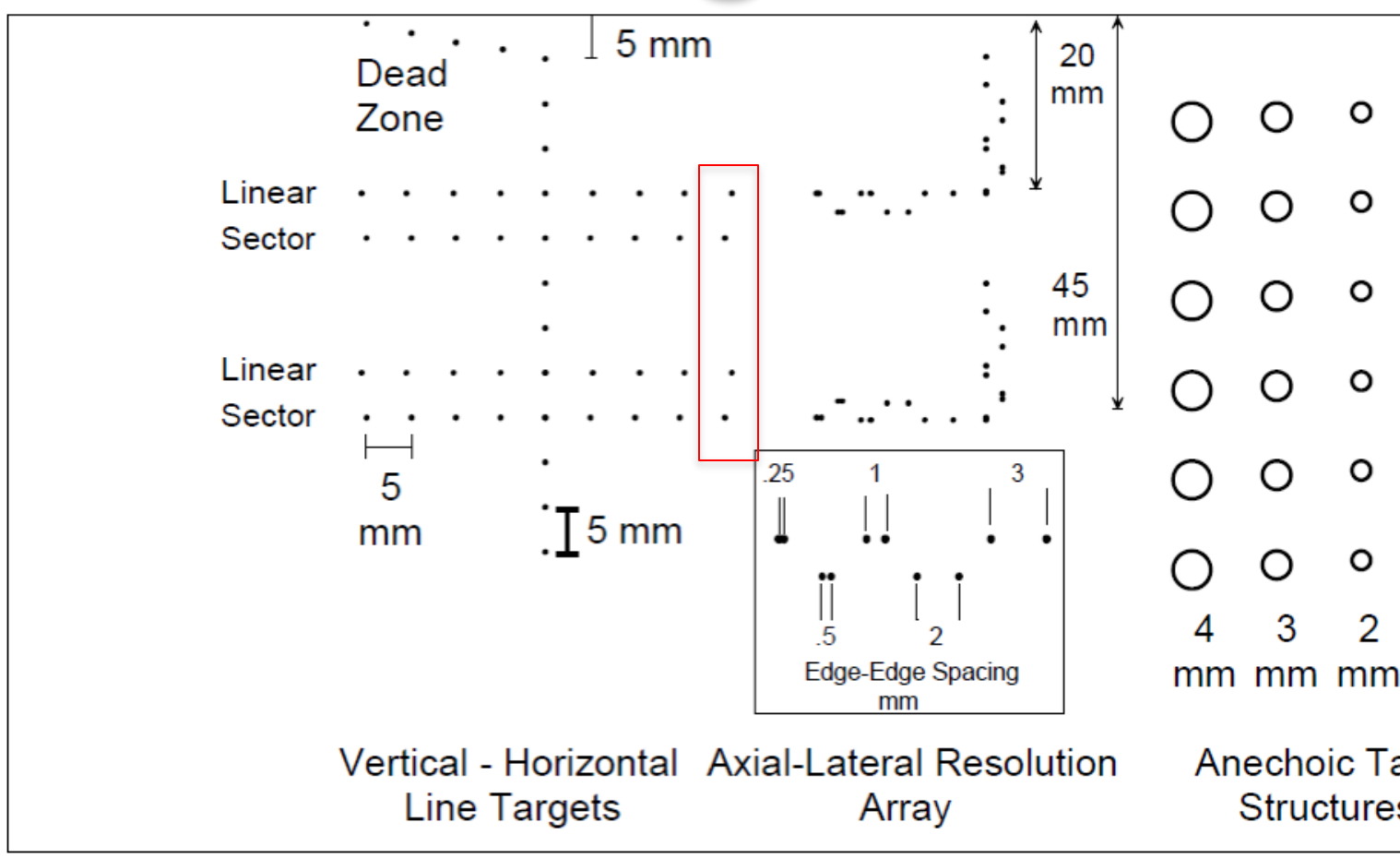
Small Parts QC Phantom

Automated Whole Breast Screening Ultrasound:
The Axial Cine Approach
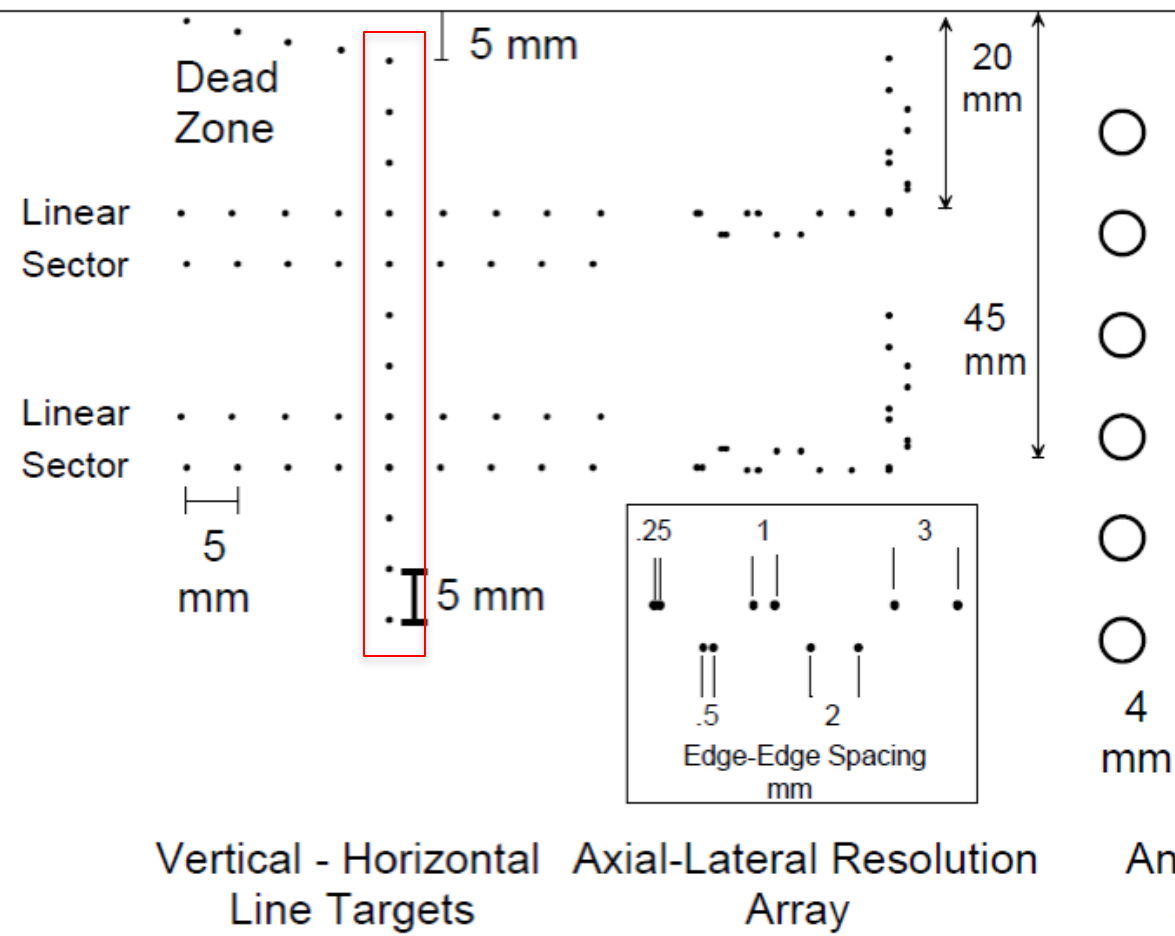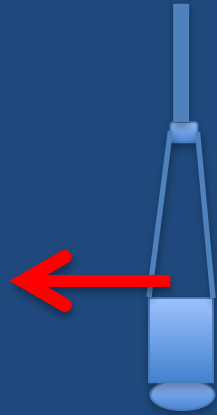
Frame 281   Frame 230

Small Parts QC Phantom

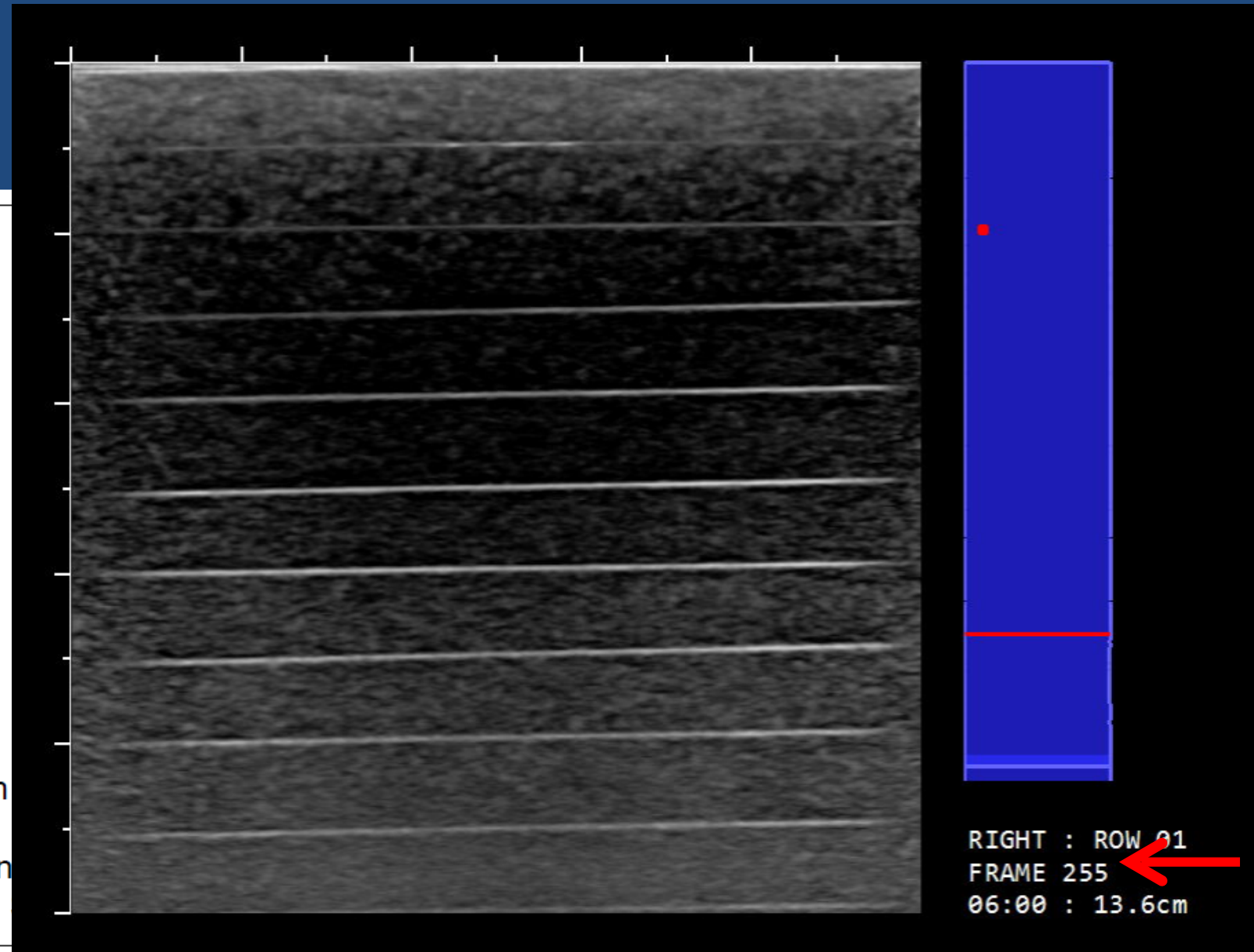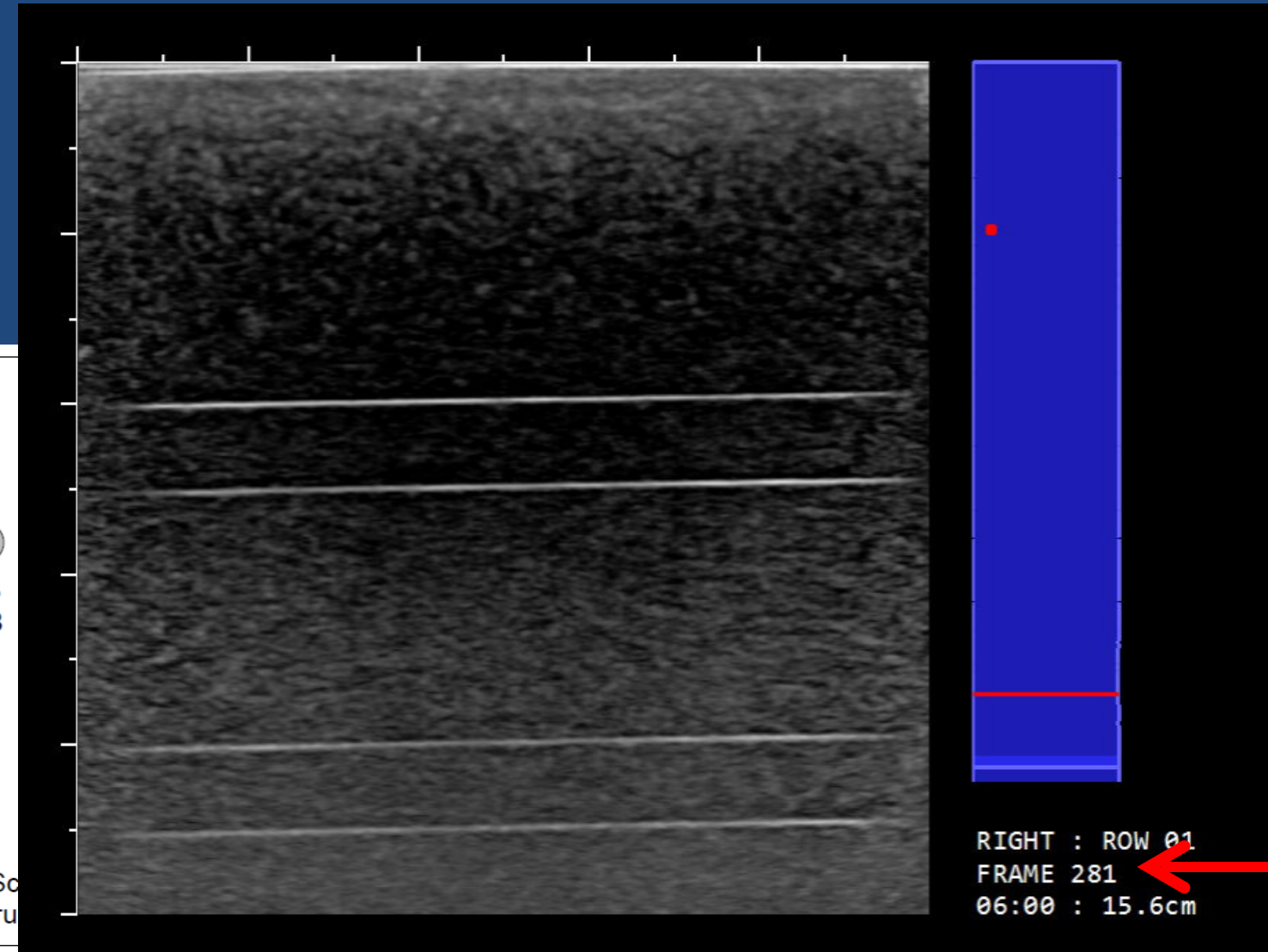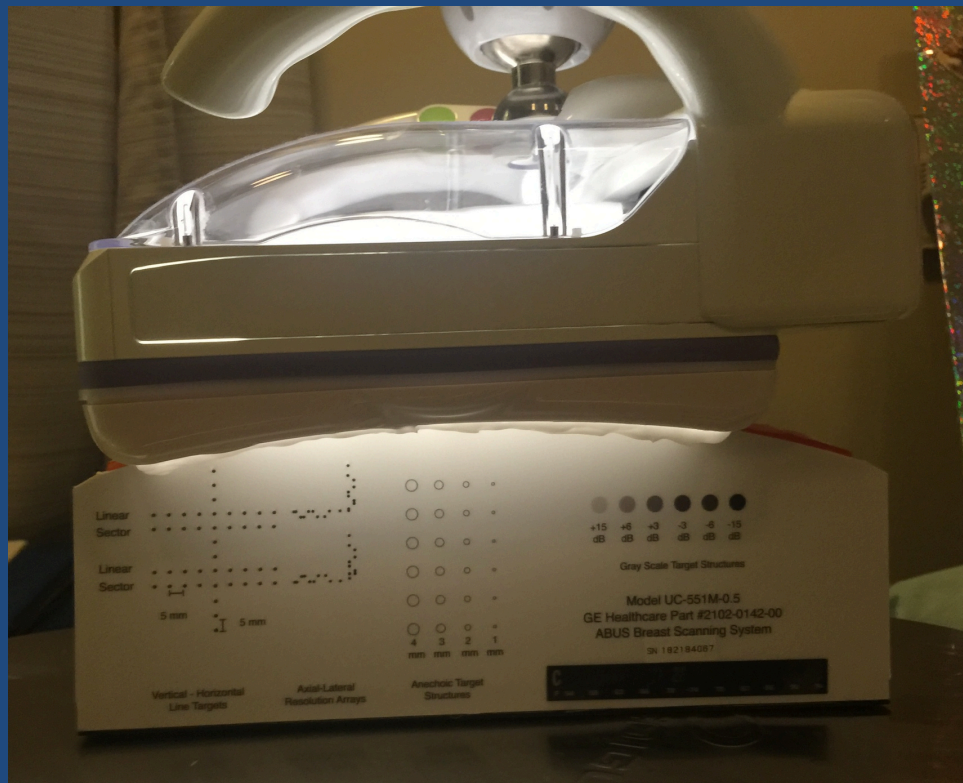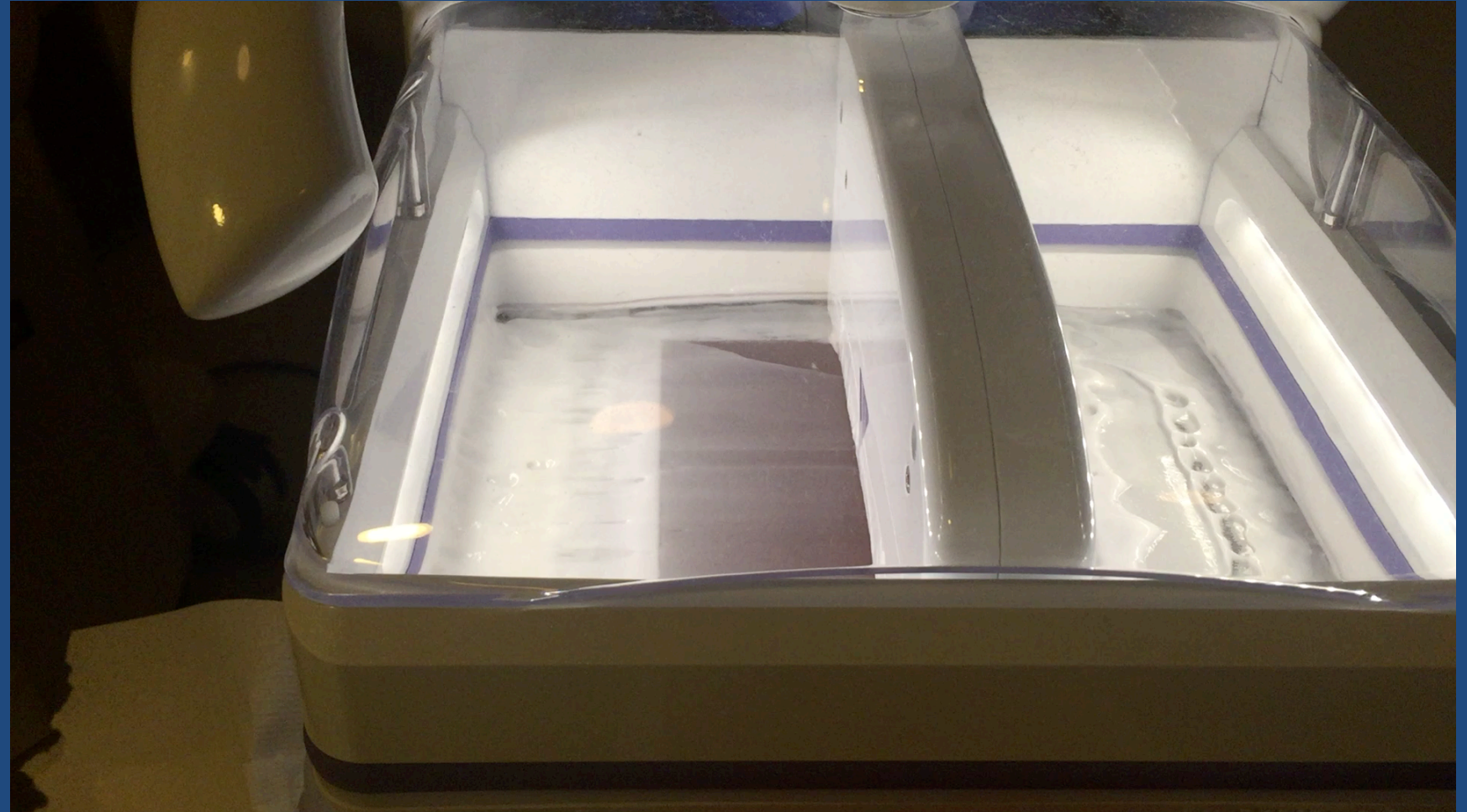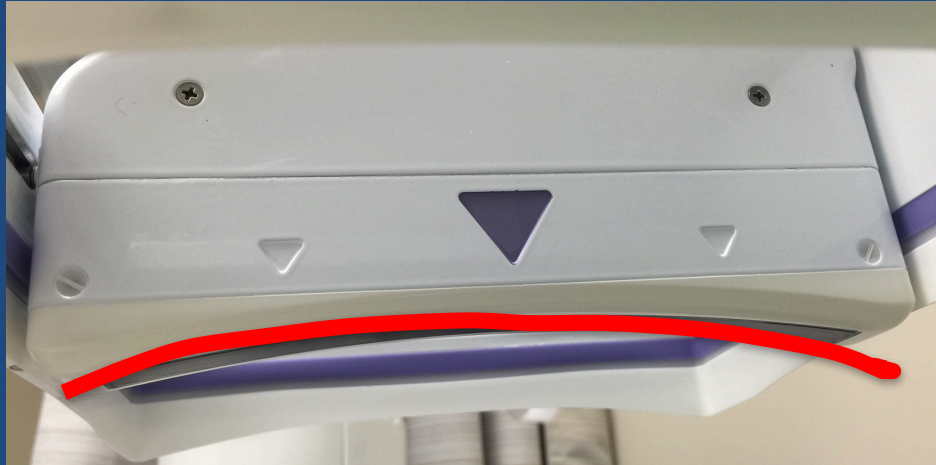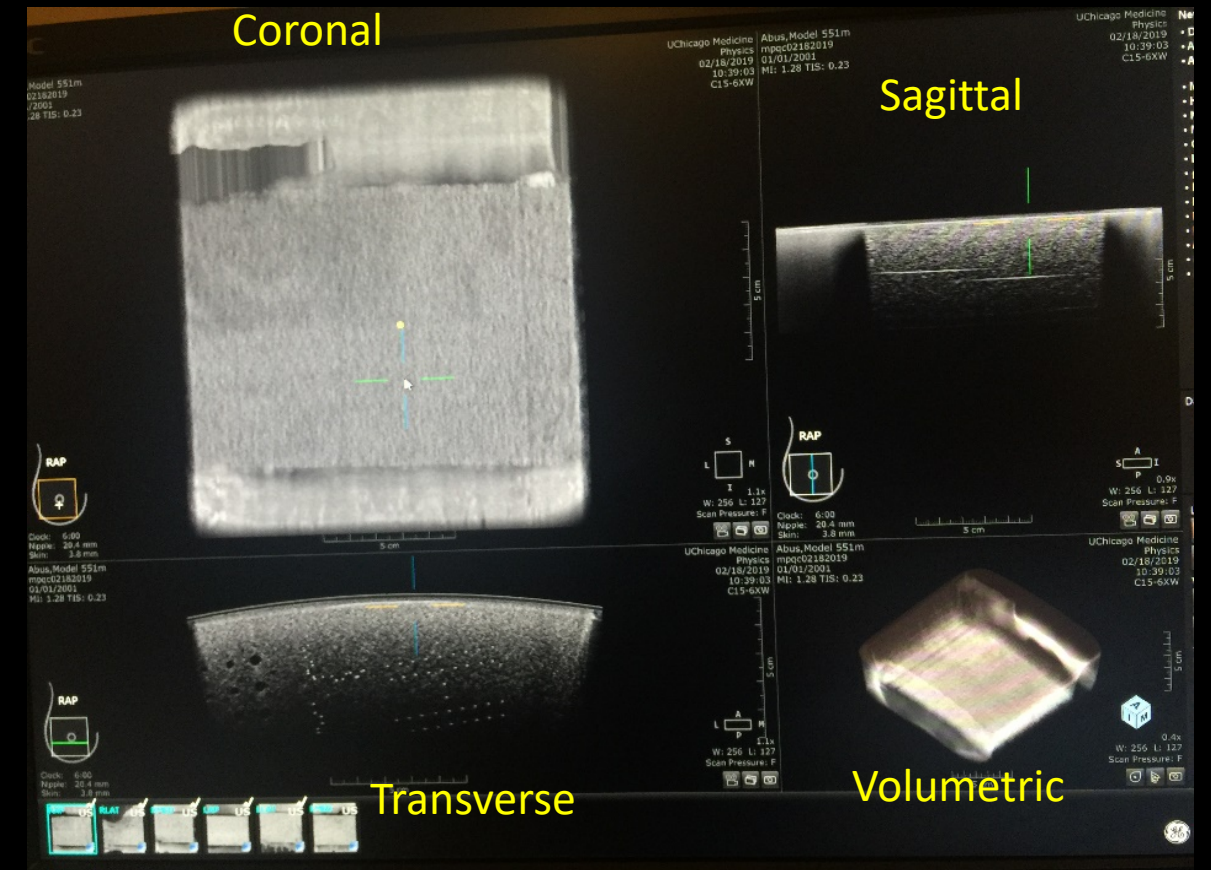40 mm /(281 – 230) = 0.784 mm per frame interval
Vendor spec: 0.8 mm

Automated Whole Breast Screening Ultrasound:
Enlarged Transducer and Coronal Reconstruction Approach

Automated Whole Breast Screening Ultrasound:
Enlarged Transducer and Coronal Reconstruction Approach

QC Measurements Performed on Review Workstation

Distance Accuracy in the Direction of the Transducer Movement

Required in an AB US QC phantom design:

Place line targets with known separation in the elevational direction, or place built-in targets with known sizes, for distance accuracy testing in the direction of transducer movement.

Workaround:

The coronal view was reconstructed from the set of transverse images acquired as the transducer traveled. The string lines were along the transducer movement direction. The phantom dimension is 10.6 cm according to the vendor specification. The measured phantom width from this test was 102.4 mm. Therefore, the deviation was within 5%.
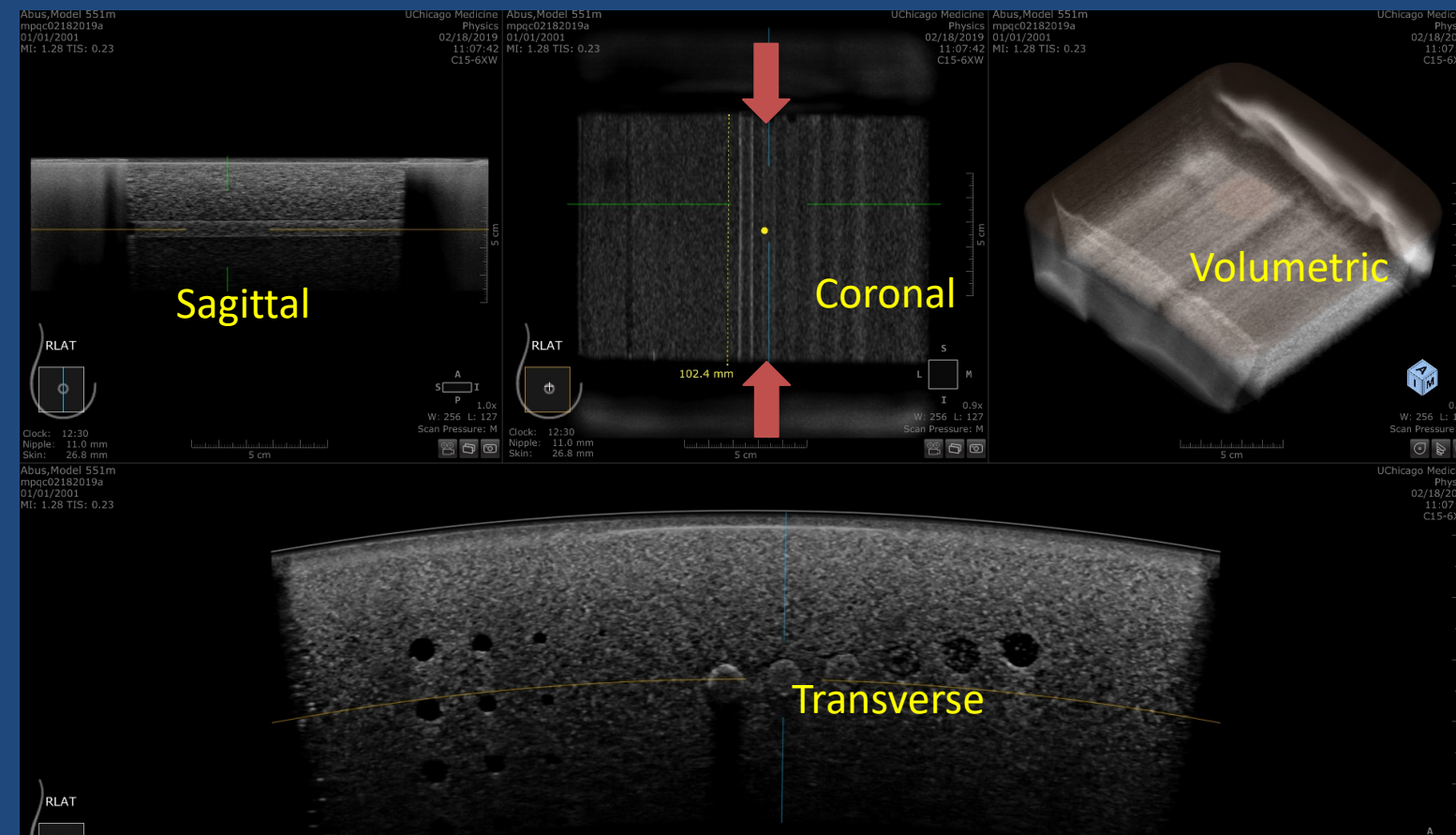
coming soon

A prototype AB US phantom has included spherical voids as well as other targets. This prototype phantom is being tested right now.

Testing the "Misfit" Systems

1. Testing an automated whole breast ultrasound screening system (AB US)

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3. Testing under what system settings and the effect of system settings on evaluating system performance

Image Display Consistency: Between Scanner Display and Reading Room Display
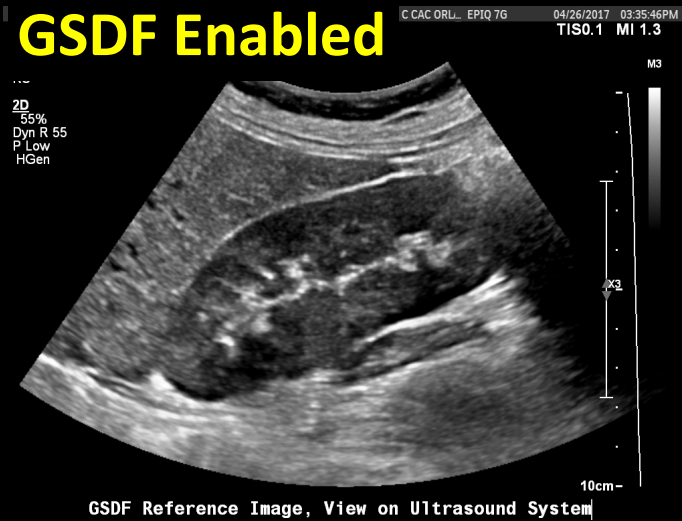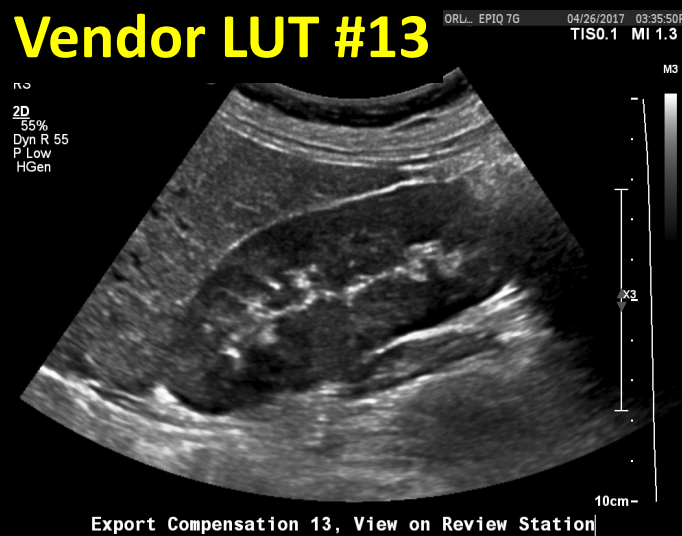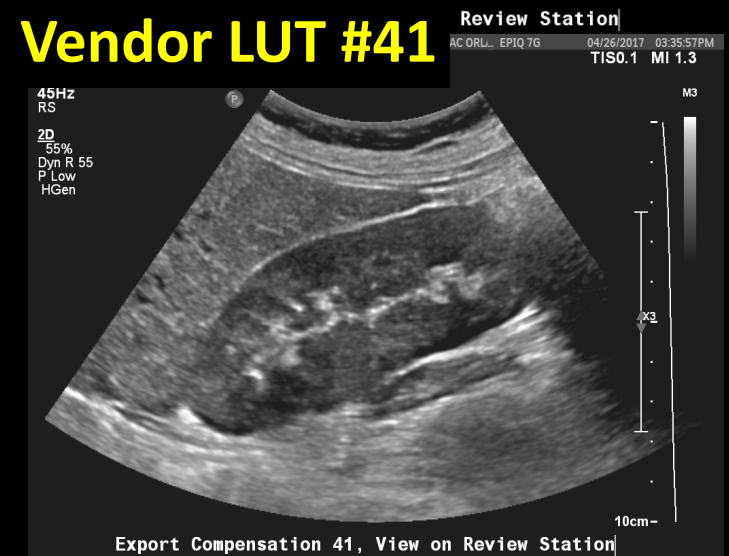
How to match presentation on various displays?

DICOM GSDF

*NEMA DICOM Part 14 (*http://dicom.nema.org/medical/dicom/current/output/pdf/part14.pdf*)*

Digital Driving Level (DDL): A digital value given as an input to a display system to produce a luminance.

Standardized Display System: A device that produces luminance values that are related to input P-values by the Grayscale Standard Display Function (GSDF).
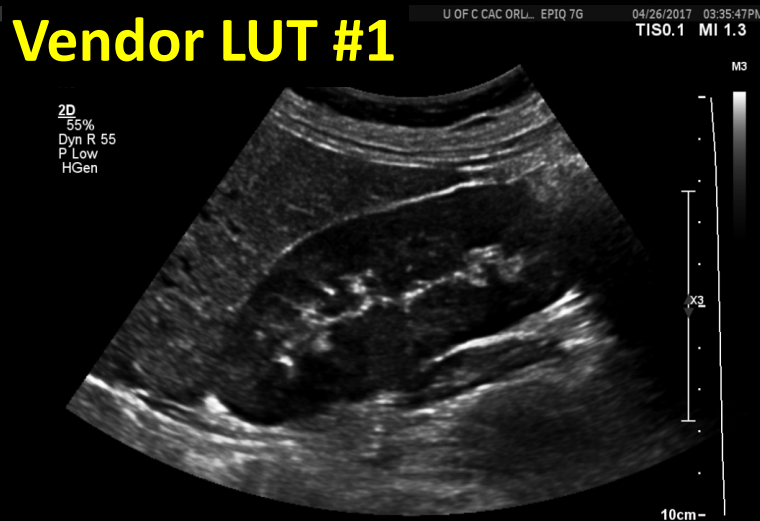
P-Value: P stands for presentation. P-values are the digital image values sent to a Standard Display System. According to DICOM Part 3, P-Values are intended to be independent of the specific class or characteristics of the display device.
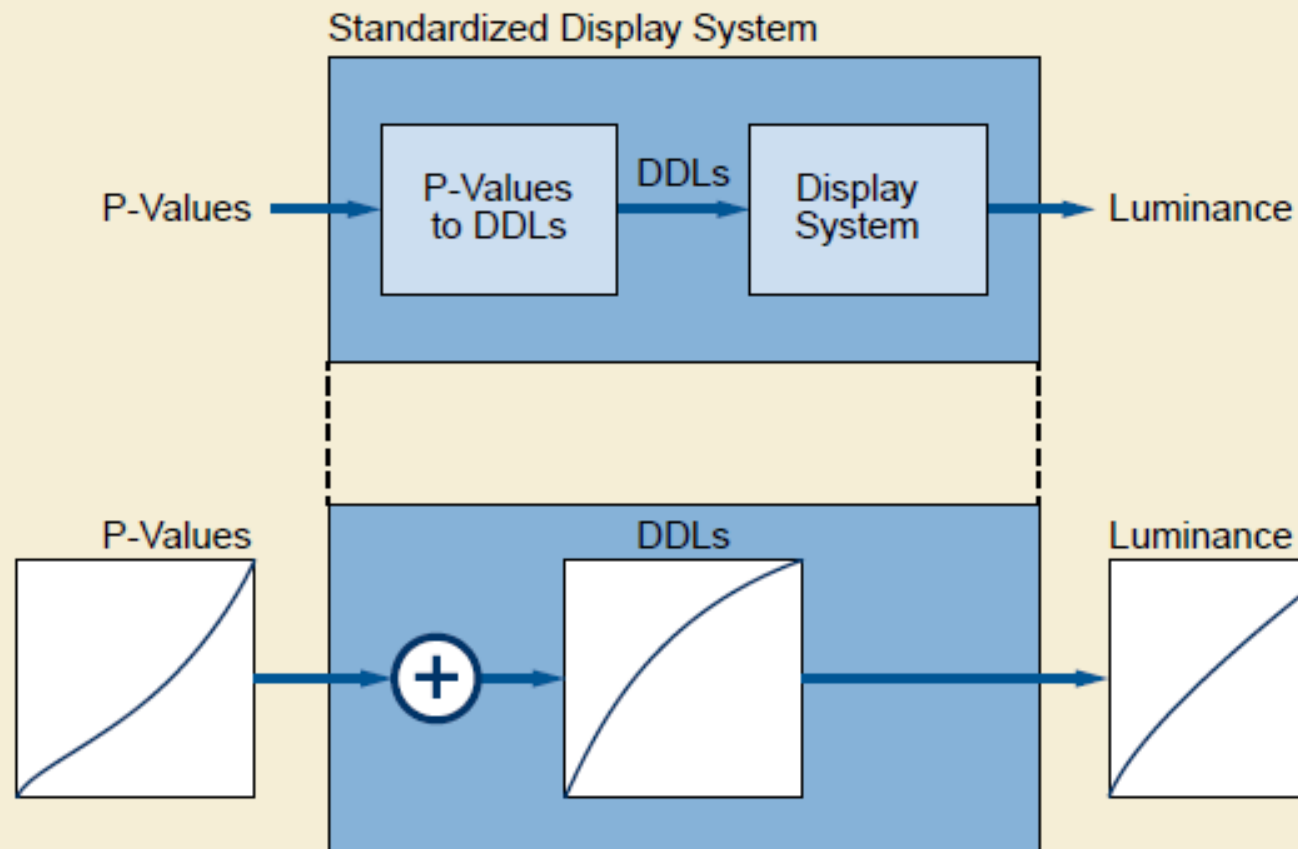
Steps to Achieve Image Presentation Consistency

1. GSDF standardized monitors are desirable for ultrasound scanners (manufacturers).

2. The digital values sent to PACS are in P-value space (manufacturers).

    DICOM Standard

3. Performance evaluation and quality control testing on ultrasound image displays are needed (both users and manufacturers)

Visual Inspection TG18-QC

TG18-QC Pattern
modified version
Copyright © 2001 by AAPM

Manufactuer	Model	S/N	Unit ID	DOM
-	-	-	-	-

DISPLAY MONTIOR PERFORMANCE

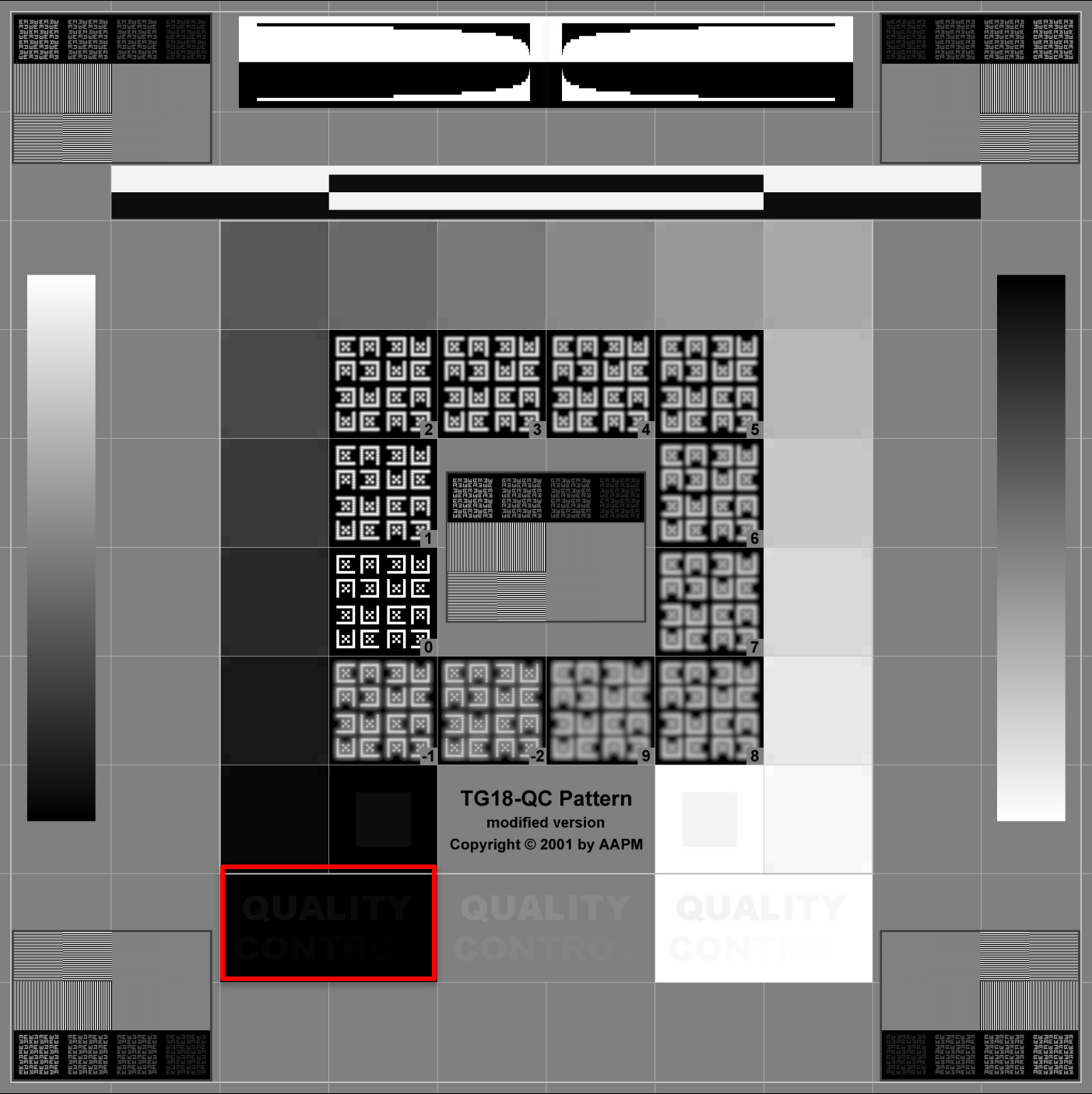| 1) Display Cleanliness		Pass

2) Visual Inspection of Display Performance With Test Patterns:

Overall Display Quality Assessment: TG18-QC	0%-5% contrast patches visible?		pass	
	95%-100% contrast patches visible?		pass	
	Line-pair patterns distinct (center & corners)?		pass	
	Grayscale ramps smooth?		pass	
	Three "Quality Control" with various contrasts visible (TG18-QC)?	QUALITY CONTROL	QUALITY CONTROL	QUALITY CONTROL
	Four low contrast corner patches in sixteen luminance patches from darkest to brightest (TG18-QC): Circle the patchs that the four corner patches are visible.	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 13; 14; 16;		
	No artifacts (corss talk, video signal artifacts, etc.) ?		pass	

Luminance Response Visual Inspection: TG18-CT	Half-moon target at the center of each patch visible: Circle the patchs that the half-moon targets are visible.	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 13; 14; 16;		
	Four corner patches at each patch visible: Circle the patchs that the four corner patches are visible.	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 13; 14; 16;		

Luminance Uniformity Visual Inspection: TG18-UN80	No small- to medium-sized, low-contrast, and irregularly-shaped patterns or region visible?	pass
	Luminance uniform over the entire display area (i.e. global uniformity)?	Pass

3) Photometer Measurements of Display Performance

Luminance Response Function: TG18-LN (18 points)	L'min (cd/m^2)	0.06
	L'max (cd/m^2)	163.12
	LR = L'max / L'min	2529
	*Criteria[1-3]: LR > 250	pass
Ambient Luminance	*Criteria [3]: AR = Lmin/Lamb >= 1.5?	pass
Contrast Response	*Criteria [3]: GSDF deviation from baseline within 20%?	pass

*Criteria references: 1) IEC 62563-1 Medical electrical equipment - Medical imaging display systems - Part 1: Evaluation methods; 2) ACR-AAPM-SIIM Technical Standard for l... "Assessment of Display Performance For Medical Ima...

TG316 Work-in-progress

Photometer Measurements Luminance Response Function
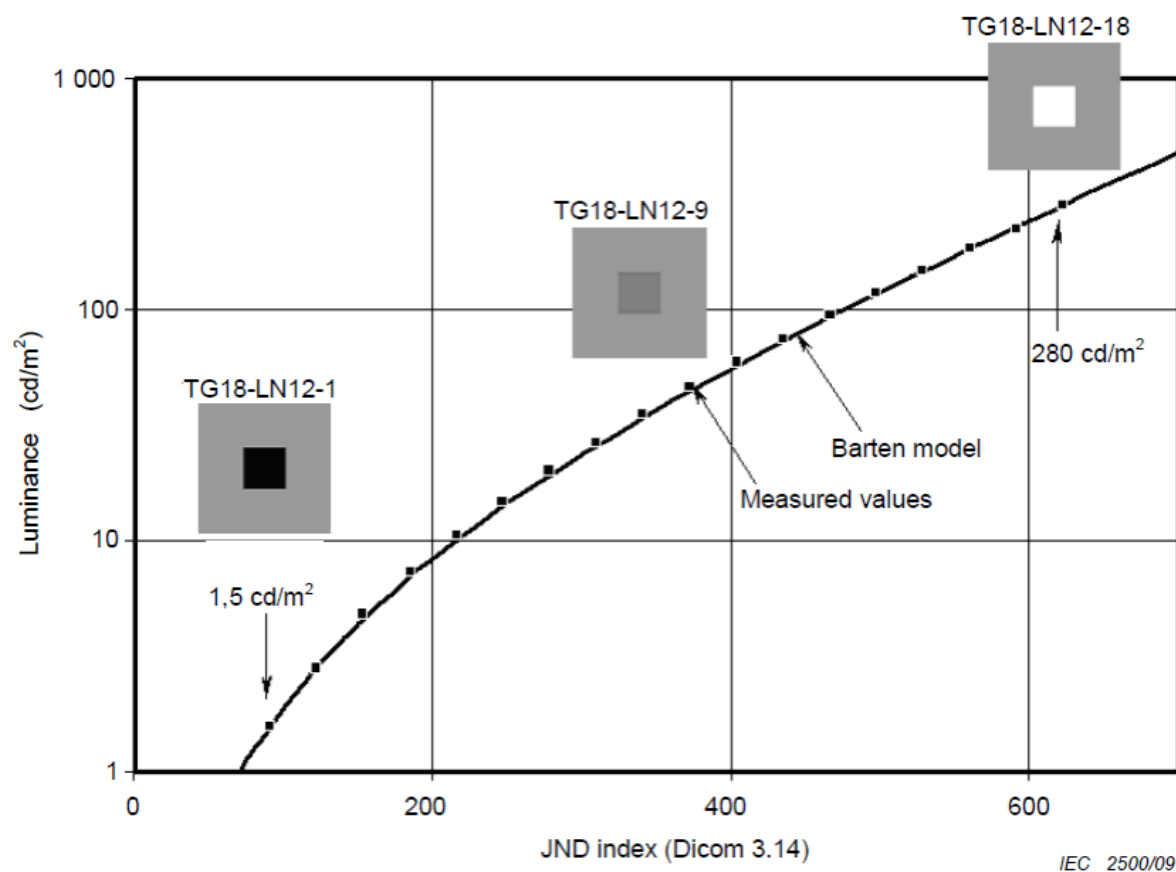
IEC 62563-1 Edition 1.0 2009-12
"Medical electrical equipment – Medical image display systems
– Part 1: Evaluation methods

Location:	-		Test Date:	-
Physicist:	-			

Manufactuer	Model	S/N	Unit ID	DOM
-	-	-	-	-

DISPLAY MONTIOR PERFORMANCE

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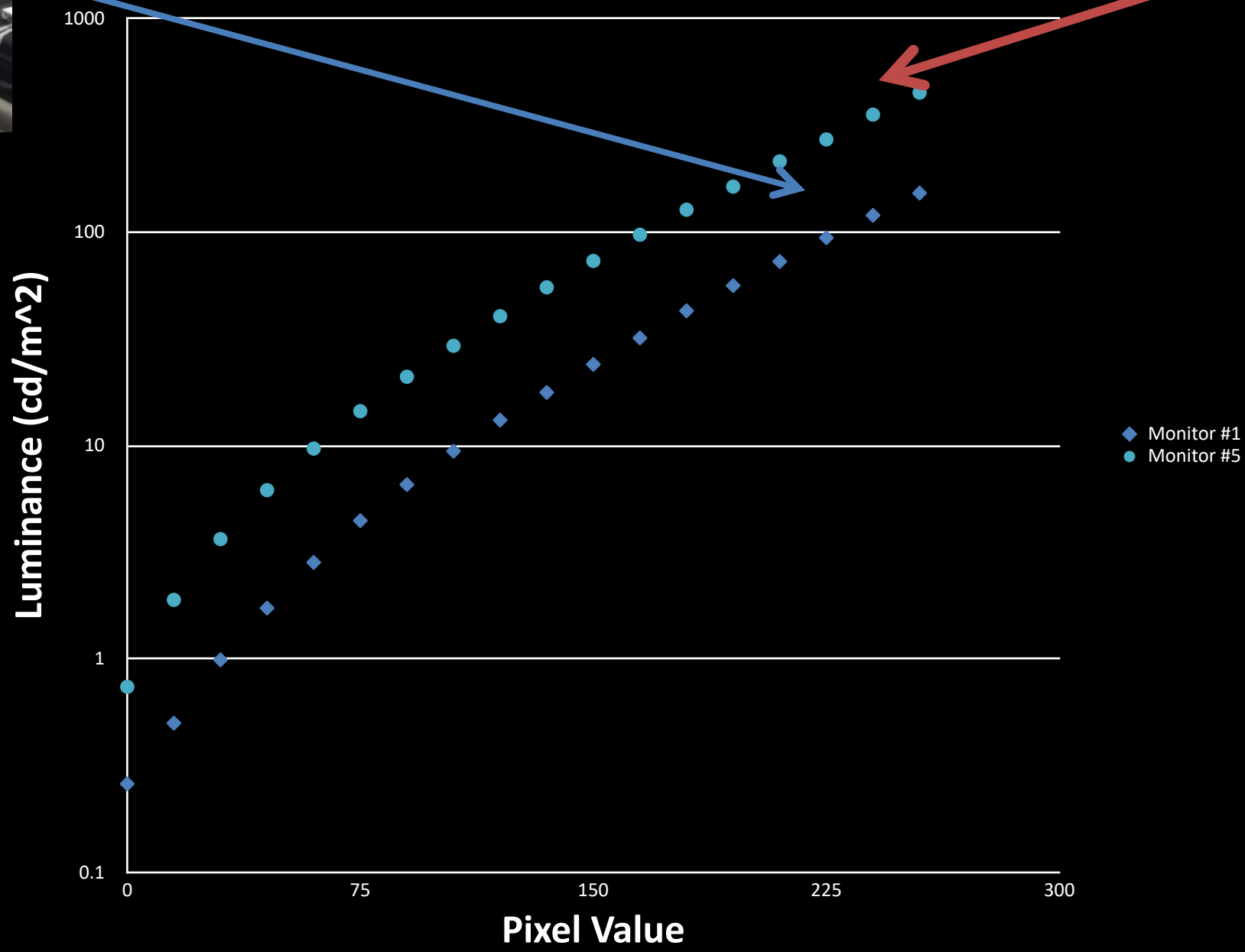
TG316 Work-in-progress
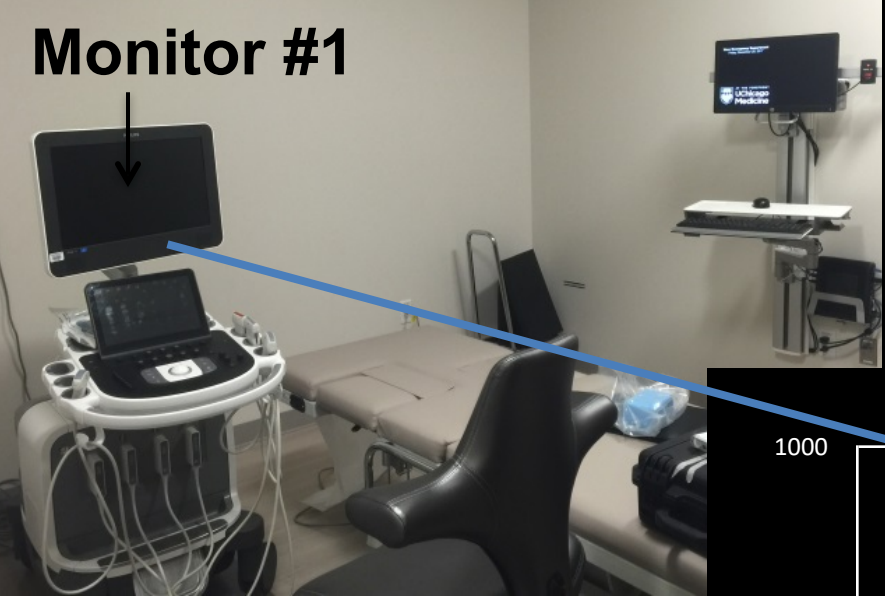
Variations Within the Image Presentation Chain

Monitor #1

Monitor #5

Luminance (cd/m^2)

Pixel Value

Monitor #1
Monitor #5

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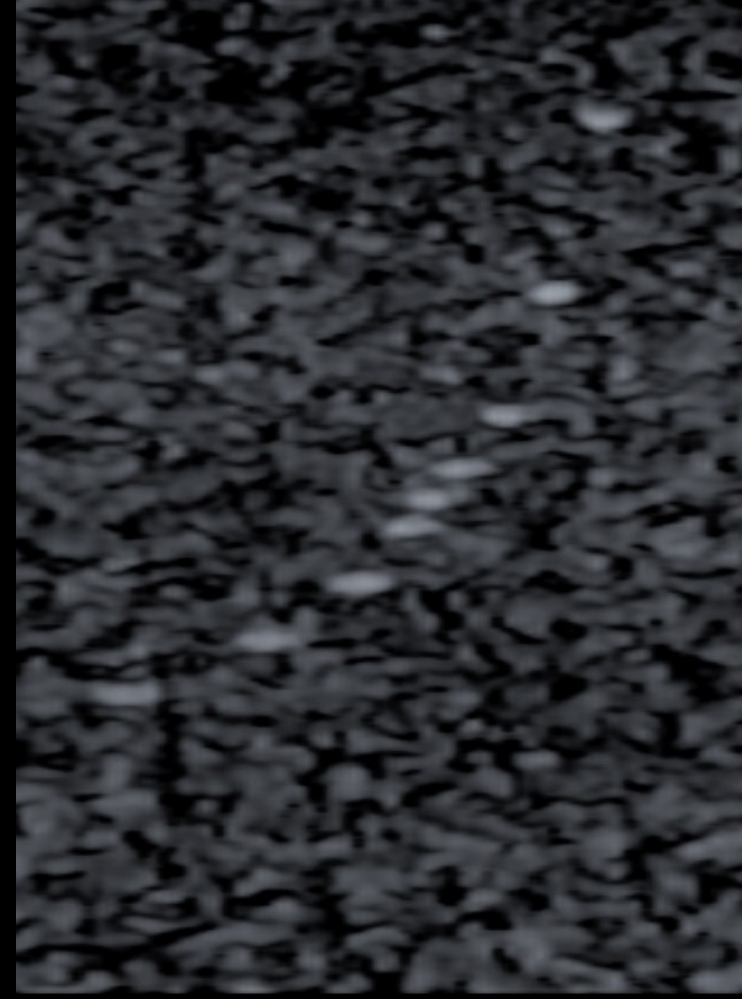3. Testing under what system settings and the effect of system settings on evaluating system performance
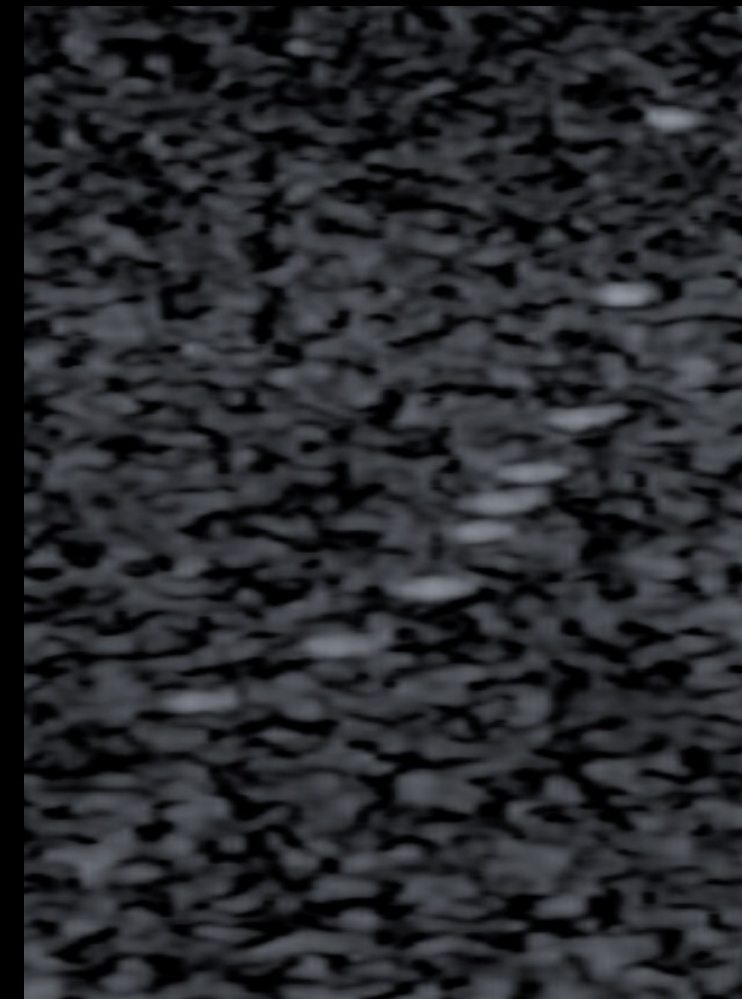
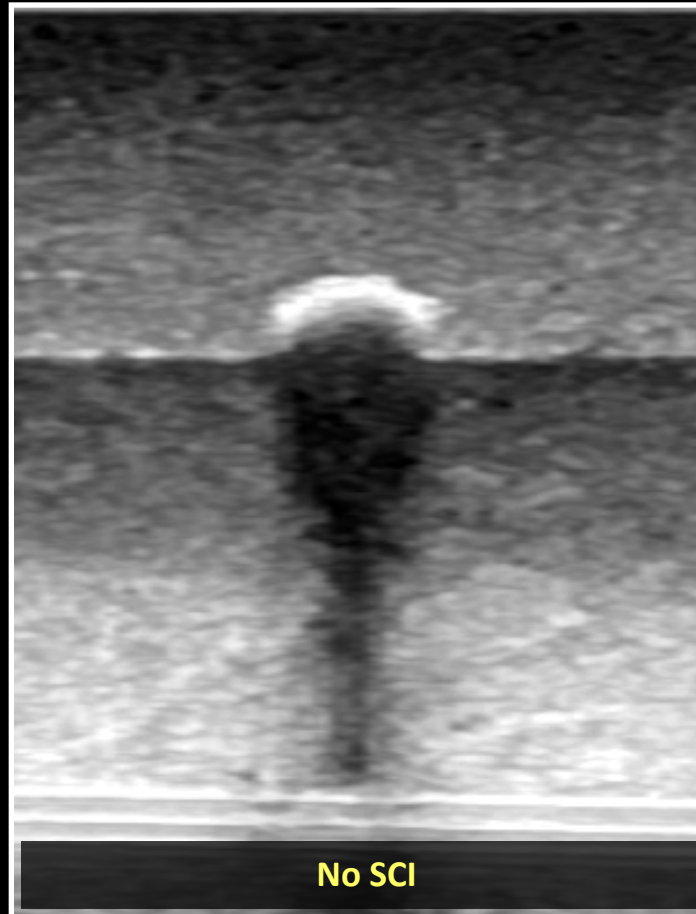# #1 Speed of Sound Effect
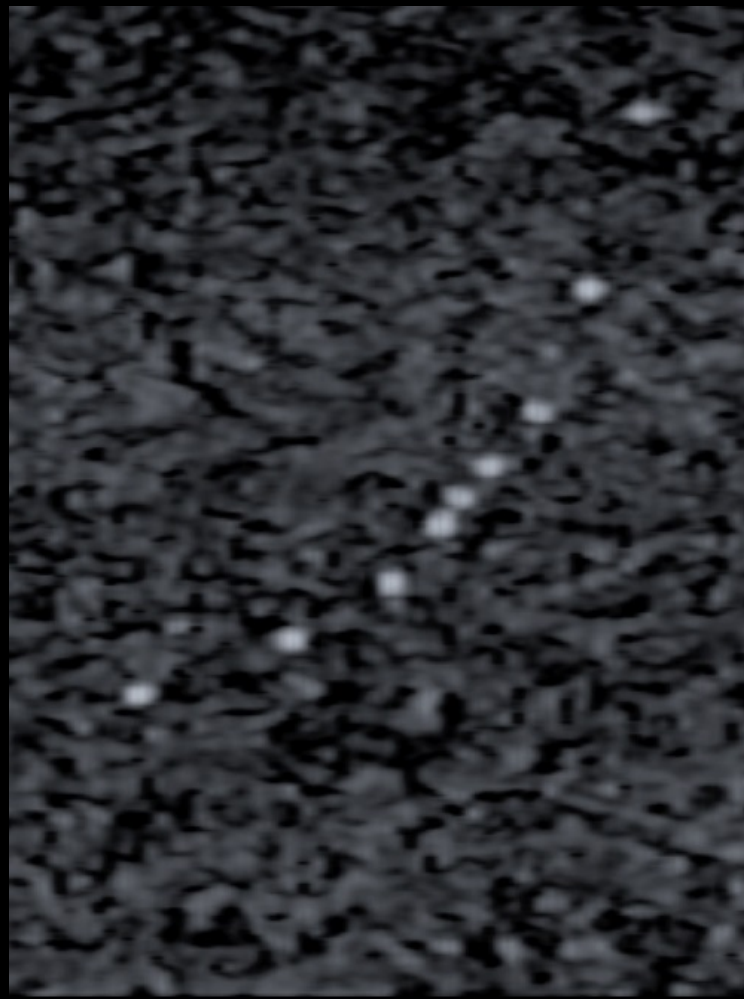
SOS 1460
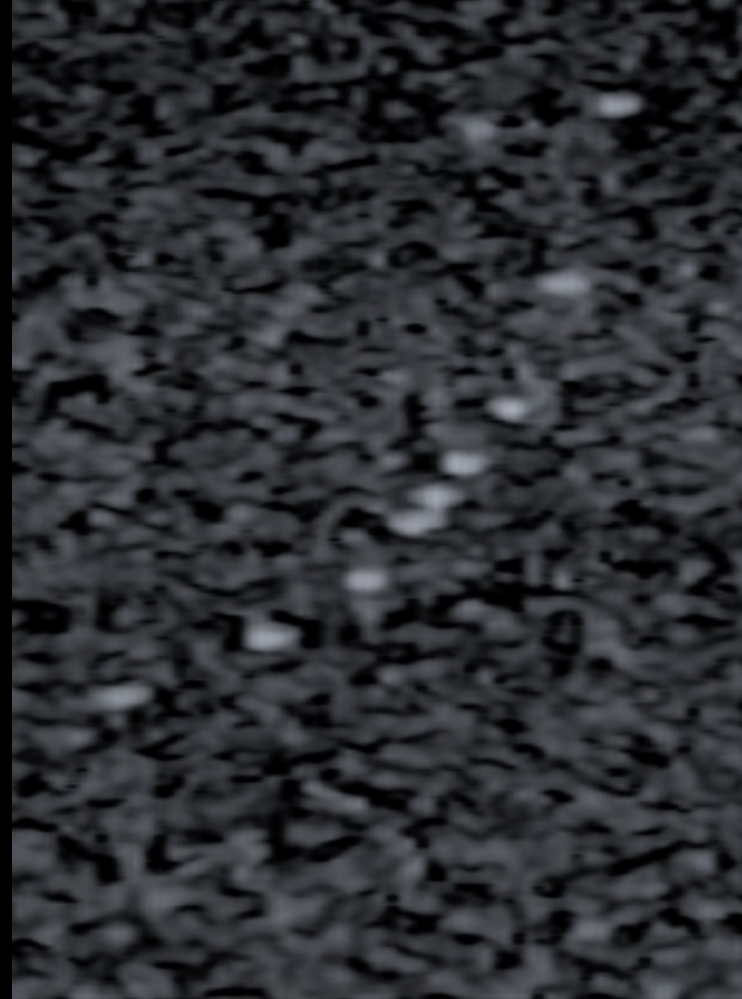
SOS 1500

SOS 1540

SOS 1580

- Urethane phantom with the actual speed of sound of 1450 m/s.
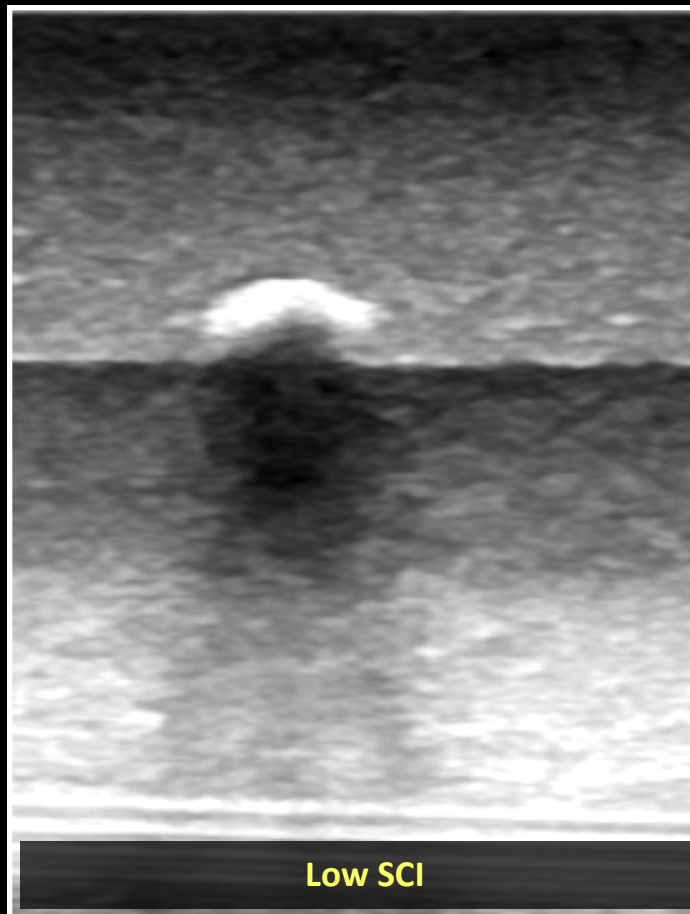- When speed of sound is not correct, decreased lateral resolution is observed
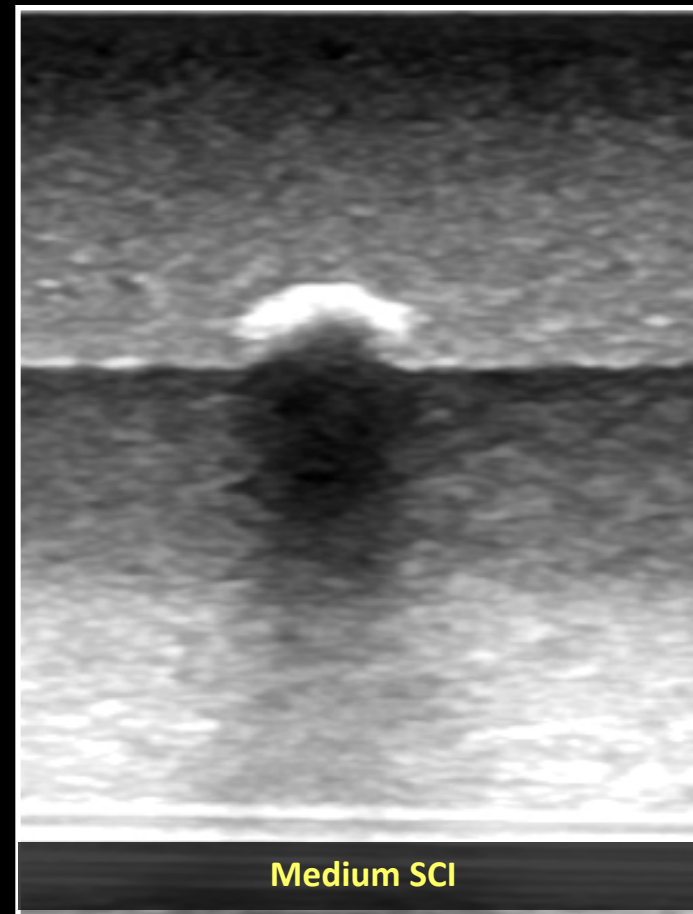
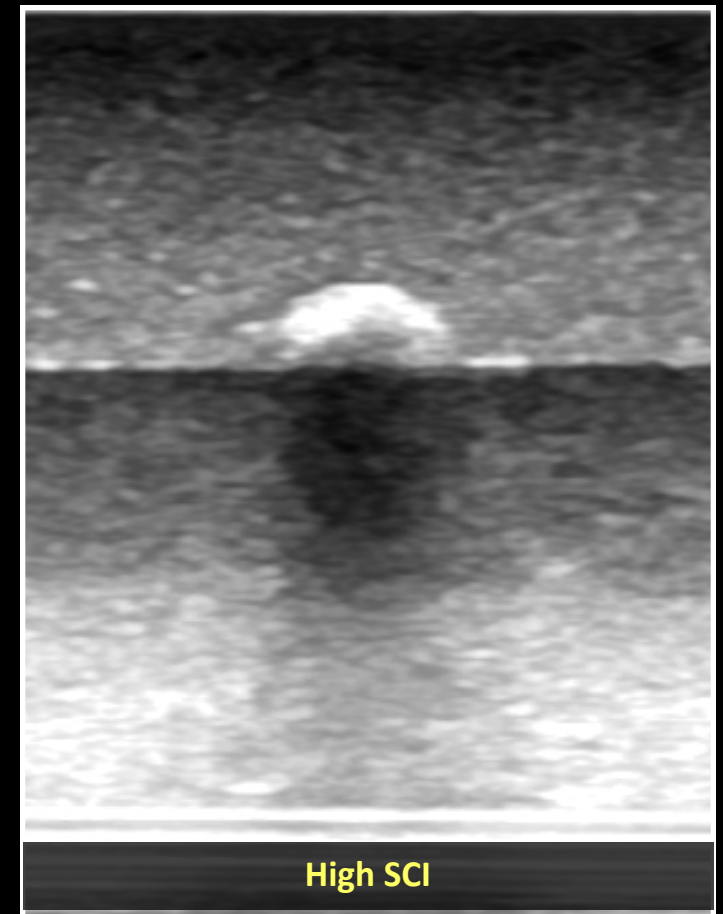# #2 Spatial Compound Imaging Effect

No SCI | Increasing SCI →

No SCI | Low SCI | Medium SCI | High SCI

- **Ultrasound beam is steered into different angles and multiple steered frames are rendered**
- **The resultant image is less speckled and has higher signal-to-noise ratio**
- **As spatial compounding is increased, shadowing is decreased**

M Baad, et al, "Ultrasound artifacts: where have all the shadows gone?", SPR 2016 Annual Meeting

#2 Spatial Compound Imaging Effect

No spatial compounding

With spatial compounding

#2 Spatial Compound Imaging Effect

No spatial compounding

With spatial compounding

Acknowledgement

ANY QUESTIONS?

Contact Zheng Feng Lu at:
   zlu@radiology.bsd.uchicago.edu