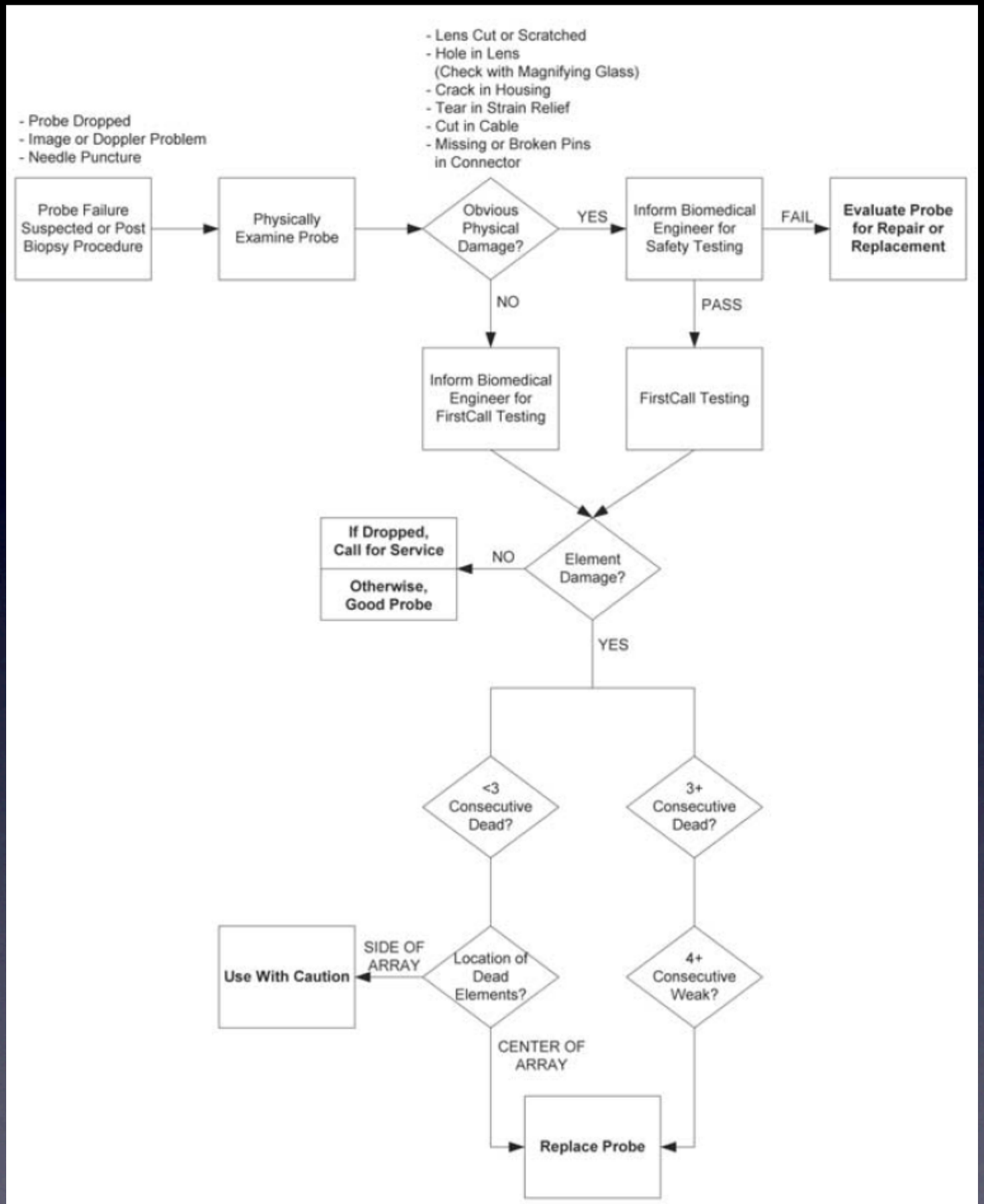
Electronic Testing Devices for Ultrasound Quality Control

US Hands-On Workshop

Evan J. Boote, Ph.D.
University of Missouri-Columbia

bootee@missouri.edu



Powis and Moore
The Silent Revolution: Catching up with the contemporary composite transducer
JDMS 2004

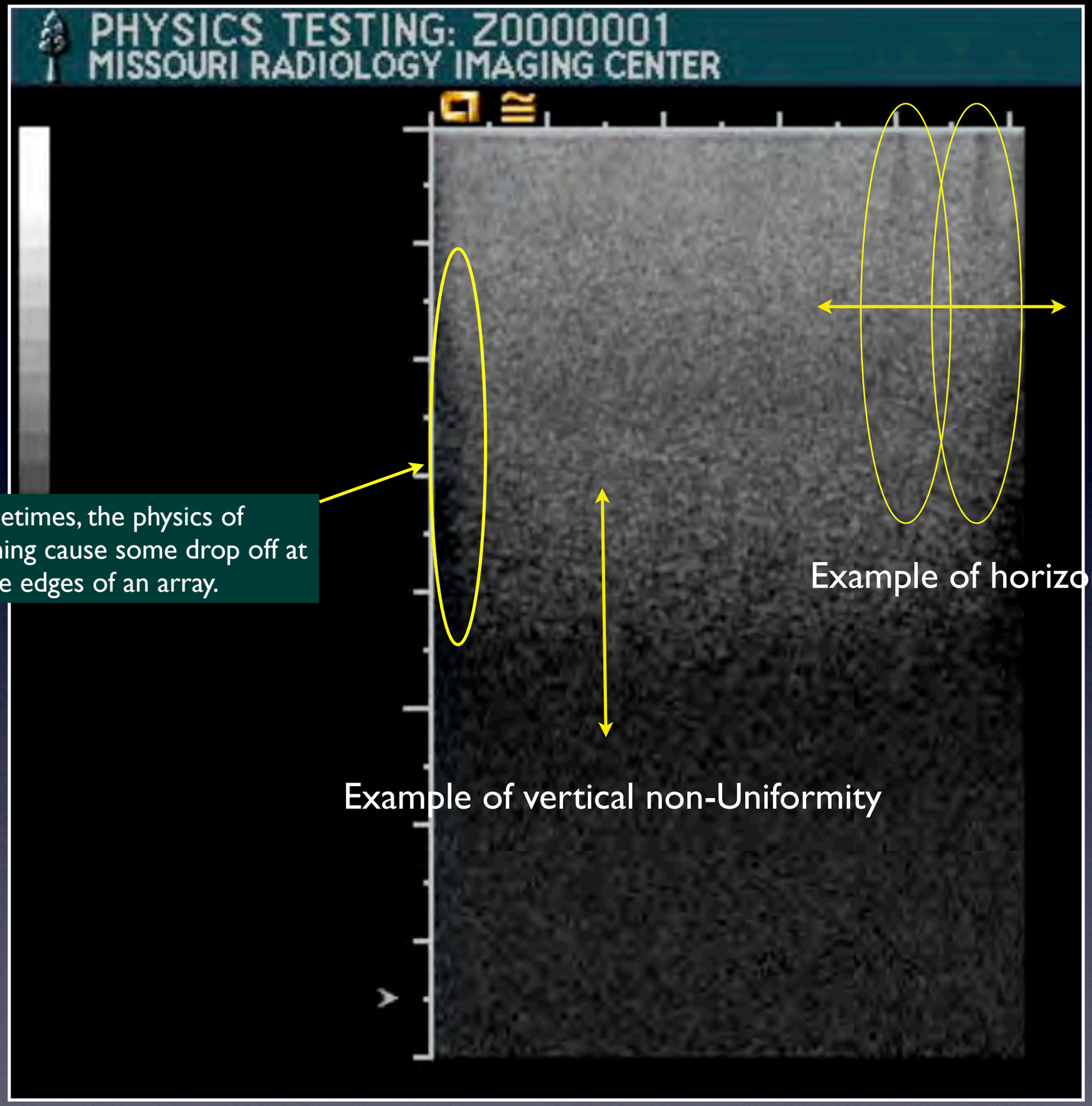
Electronic Testing of US

- Basic approaches to Electronic US system tests
  - Approach #1 - treat the scanner/transducers as a total system for which a failure/degradation source must be determined
    - Image Display is used to assess performance of total system qualitatively
  - Approach #2 - assume that the scanner components are essentially "computers" that do not fail/degrade - transducers are the principle "point of failure" that require extensive and thorough testing
    - Separate the transducer from the system and test it
    - "Quantitative report" on performance of probe

Approach #1 (total system)
basic system performance
initial diagnosis

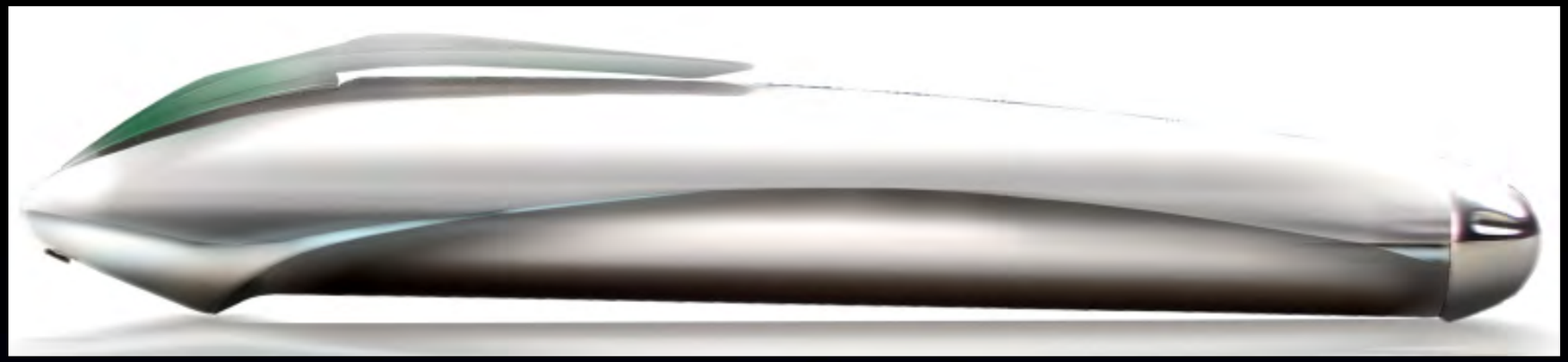
?

Approach #2 (Tx separate)
higher level diagnostics - Tx only


PHYSICS TESTING: Z00000001
MISSOURI RADIOLOGY IMAGING CENTER
Sometimes, the physics of beamforming cause some drop off at the edges of an array.
Example of horizontal non-Uniformity
Example of vertical non-Uniformity

- Approach #1 possible devices
  - Unisyn (Sonora) Nickel
  - Electronic Doppler Phantoms (Tx involved?)
    - Evans et al (1989)
    - Hoeks, et al (1997)
- Internal Test Programs

Evans, Price and Luhana, A novel testing device for Doppler ultrasound equipment, Phys Med Biol 34:1701 (1989)
Hoeks, Boulanger and Brands, Test signal injection for Doppler systems, Eur J Ultrasound 6:203 (1997)



- Nickel (Unisyn Medical Technologies)
  - battery powered
  - PVDF transducer detects acoustic pulse from individual elements and provides LED indication
  - "responds" with a simulated echo back to the same element
  - Test is accomplished by moving the device along the transducer face
  - May also be used for PW and CF Doppler
  - No quantification/specification of performance - visual inspection only and triage of probes

Phased array probe
all element response displayed

Leicester Doppler Phantom

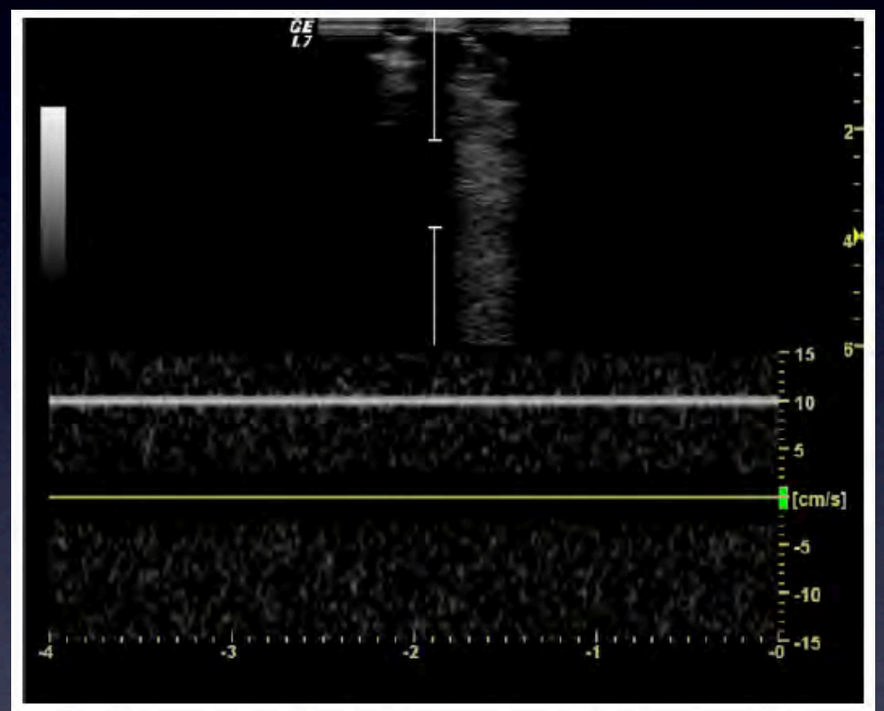
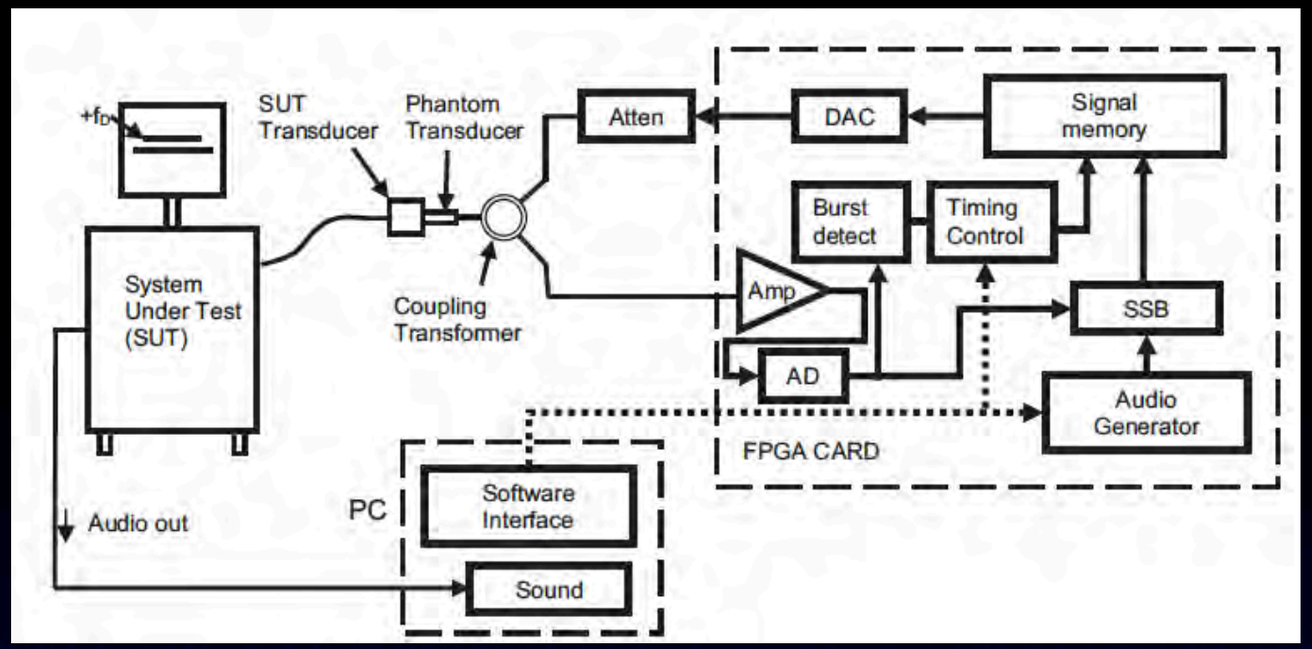
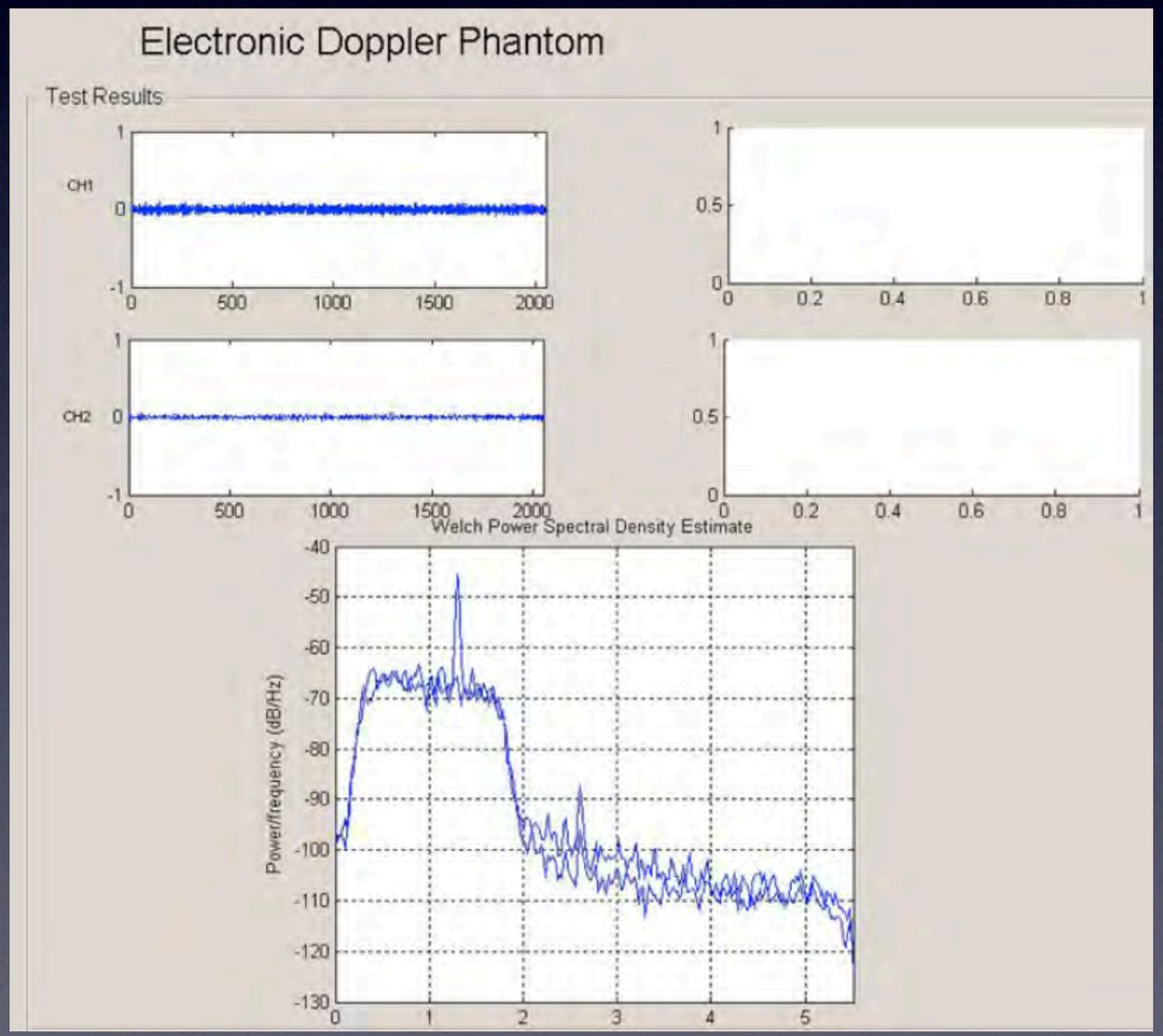


Fig. 4. A sonogram display in response to a simulated forward 10 cm s^{-1} continuous Doppler signal. The spectral width of the simulated Doppler shift signal is narrow and the simulated velocity value agrees closely with the display scale.

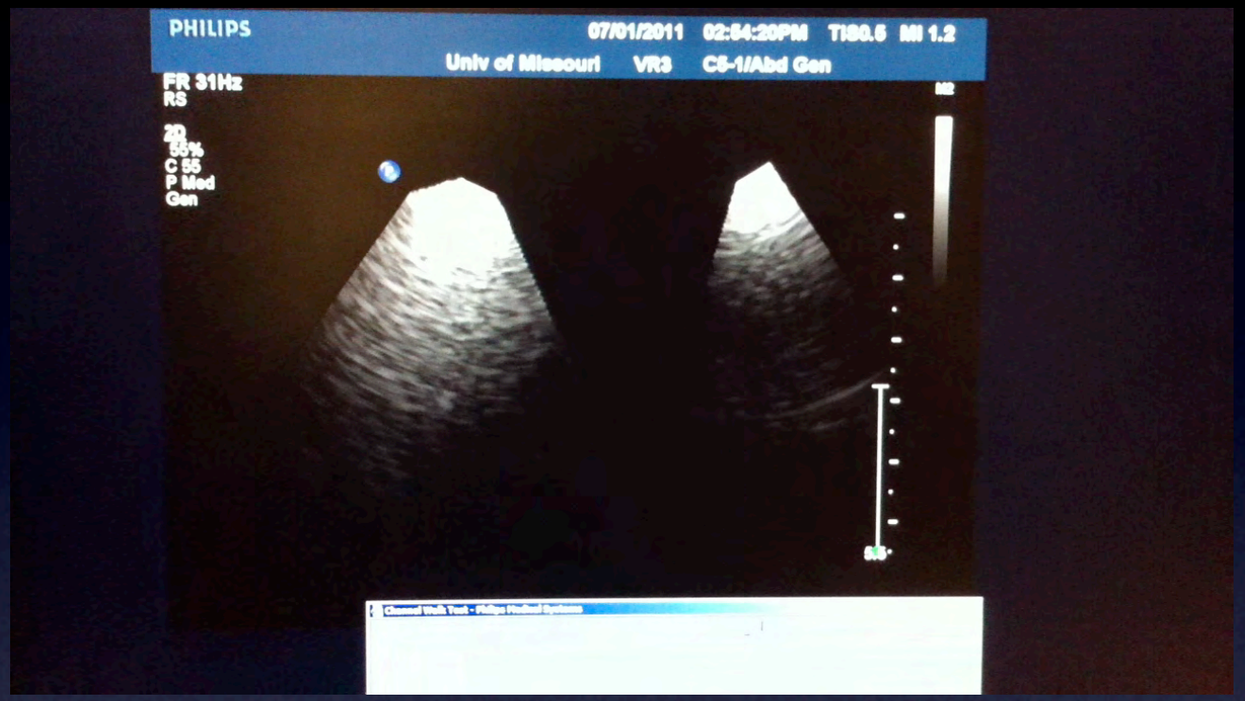


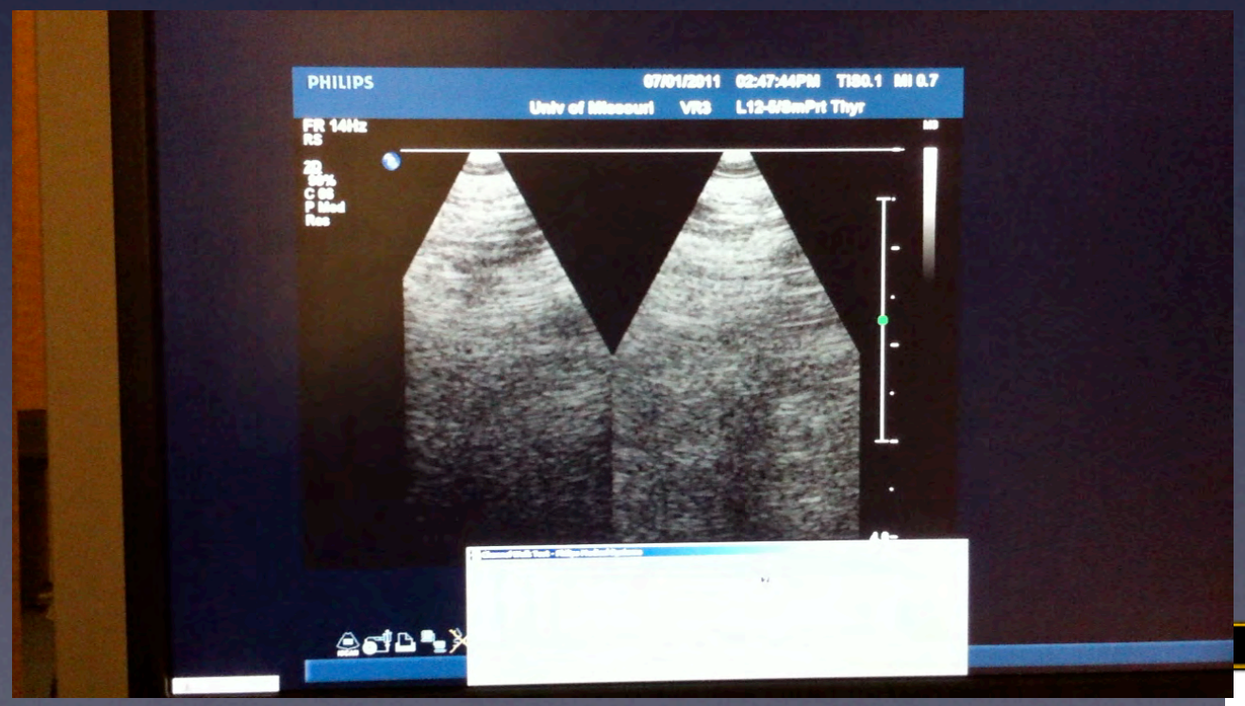


Gittins and Martin, The Leicester Doppler phantom, Ultrasound Med & Biol 36:647 (2010)

Internal System testing

- Philips IU-22
  - "channel walk"
  - also have board level tests
  - used to perform other system checks
  - Intended primary for service engineers to identify problems and replace components
  - can be used in place of the Nickel device

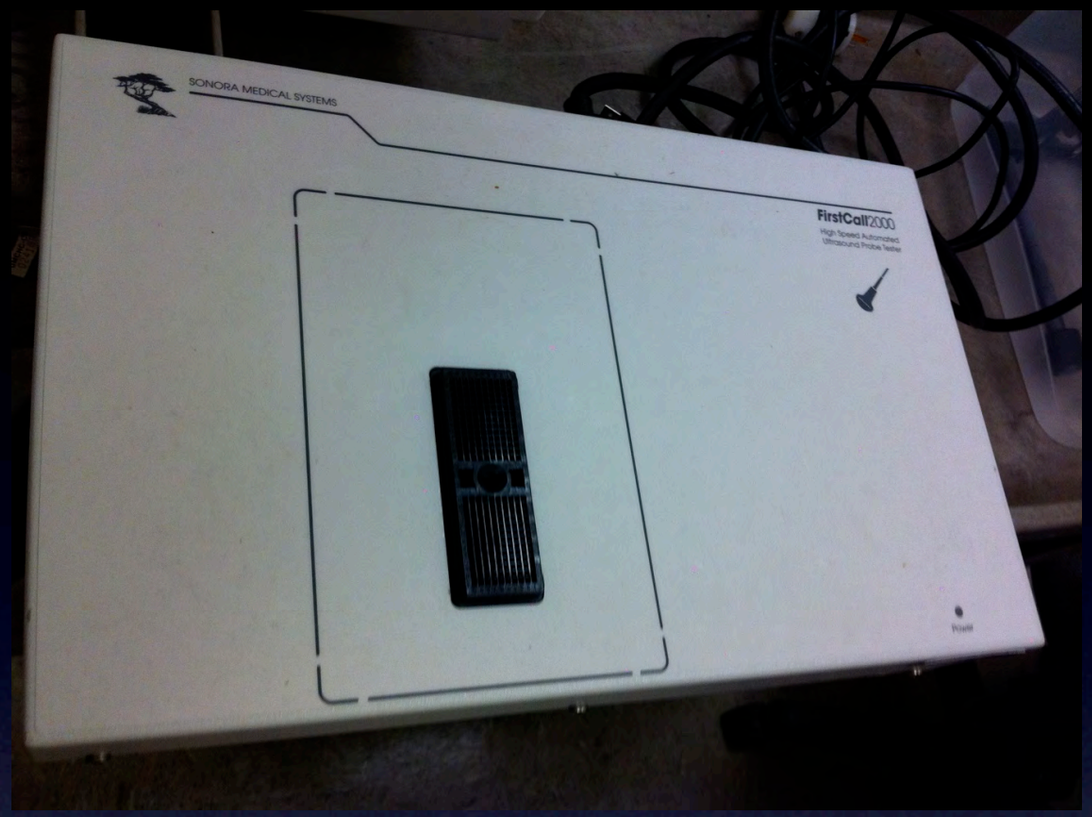




Electronic Test Approach #2

FirstCall aPerio

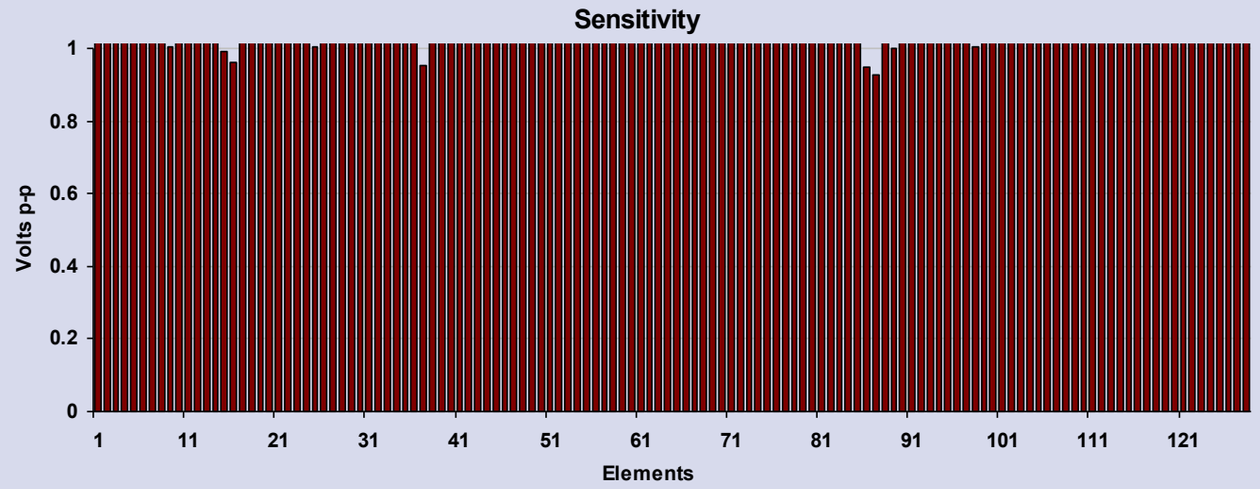
Sonora (now Unisyn Medical Technologies)



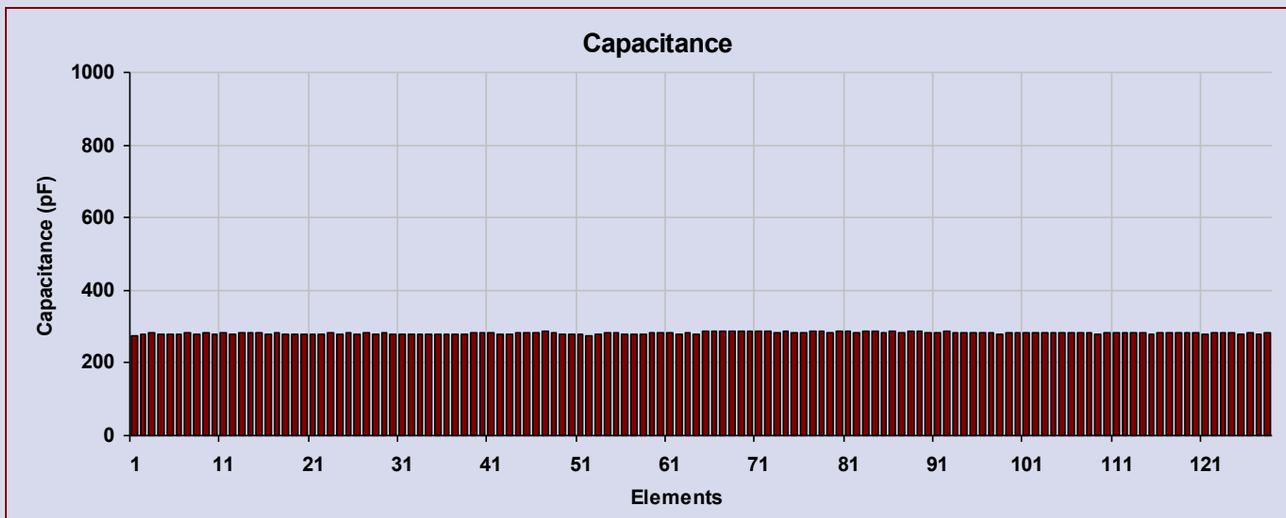
1) Reflector(s) placed in water tank
2) USB connection of main unit to computer
3)adapter placed on unit to fit various OEM probe connectors

Transducer Evaluation Report

Manufacturer:	Acuson	**Customer:**	Radiology	**Contact:**	Carmen Mann
Probe Model:	Sequoia_8V5	**Address:**	Imaging Center		
Serial Number:	44065009	**City:**		**State:**	**Zip Code:**
Test Date:	1/20/2005 11:22 AM			**Phone Number:**	
Test ID:	5	**Operator:**	Lisa Kile	**Fax Number:**	
Purpose:	Test Type	**DX/Comments:**	CE#15216<LF>New 1/20/05		



Mean: 1.017 **Max:** 1.020 **Min:** 0.928 **Std Dev:** 0.013 **Gain:** 30 dB



Mean: 282.297 **Max:** 289.346 **Min:** 274.773 **Std Dev:** 2.966

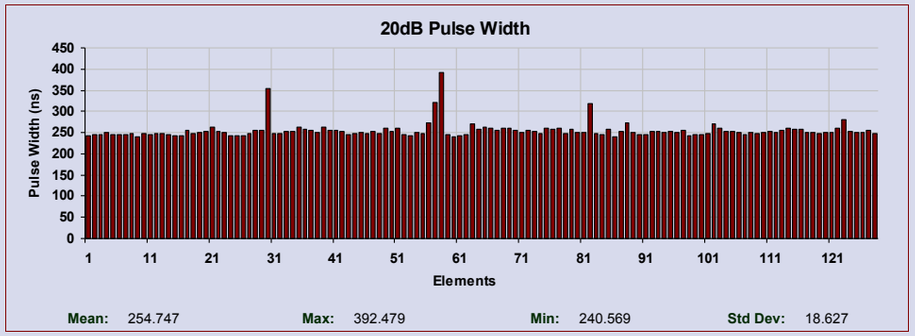
Sonora Medical Systems, Inc.
2021 Miller Drive
Longmont, CO 80501

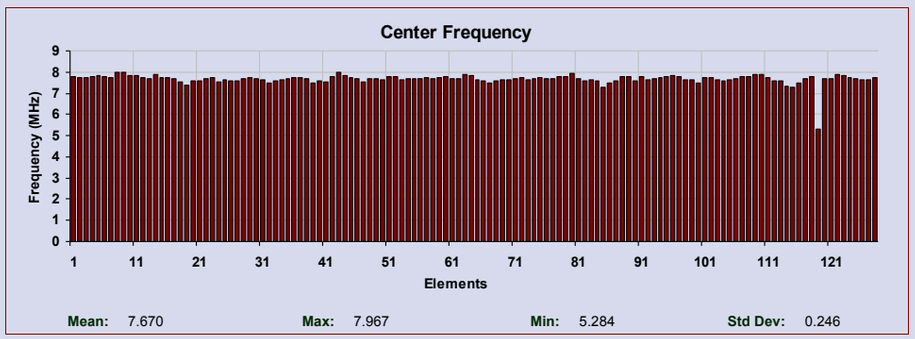
Voice: (303) 682-5871
FAX: (303) 682-5915

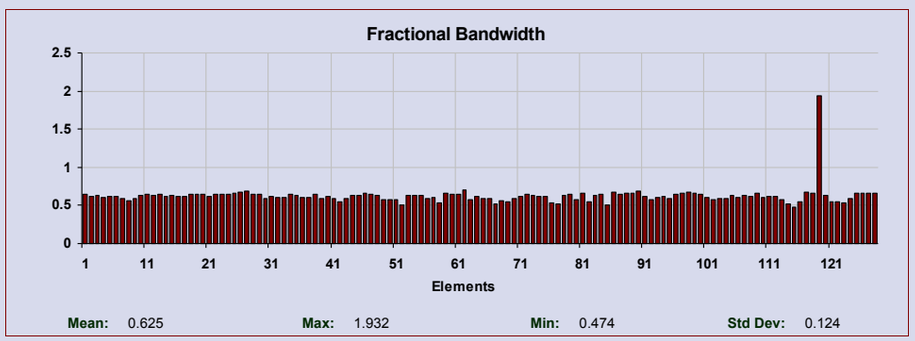
Sonora Medical Systems, Inc.

Transducer Evaluation Report

Page 2 of 3







Sonora Medical Systems, Inc.
2021 Miller Drive
Longmont, CO 80501

Voice: (303) 682-5871
FAX: (303) 682-5915

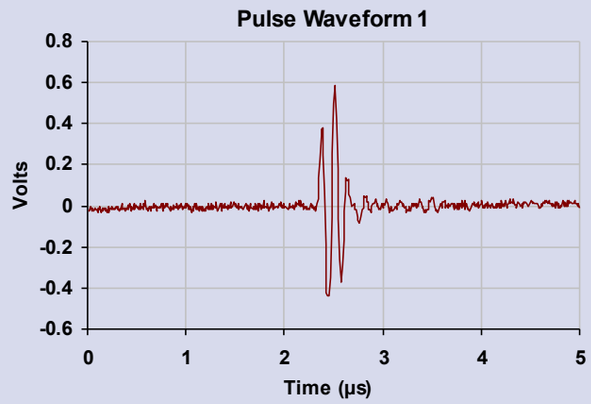
Test ID: 5
Page 2 of 3
Operator: Lisa Kile
1/20/2005 11:22 AM

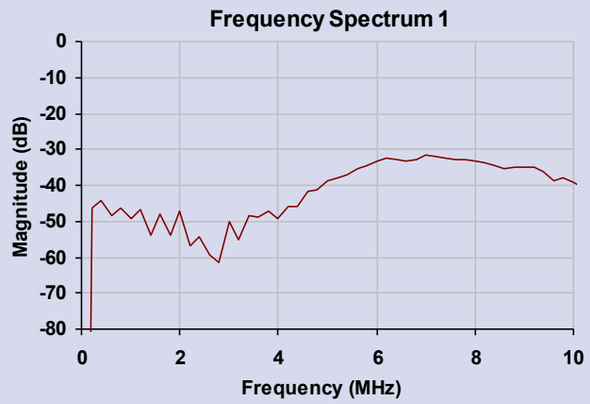
Sonora Medical Systems, Inc.

Transducer Evaluation Report

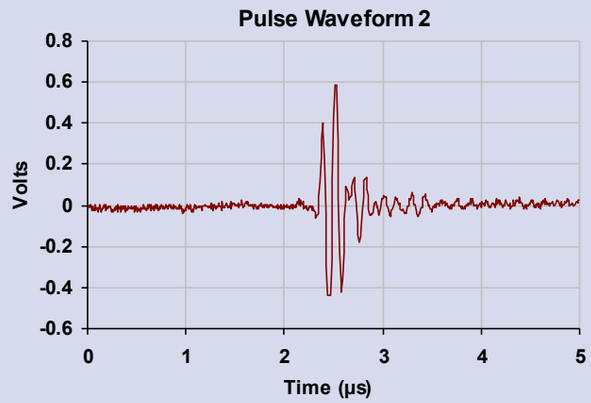
Page 3 of 3

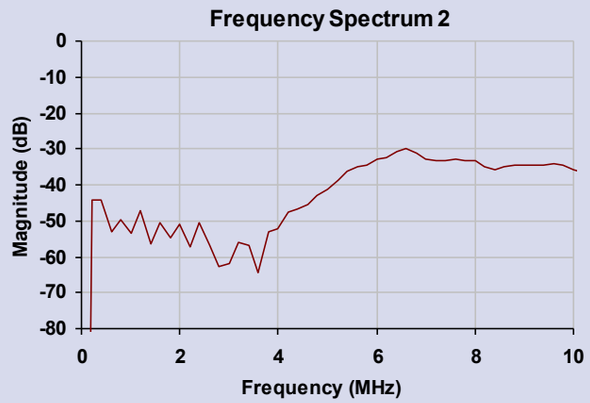
First Element Number: 32



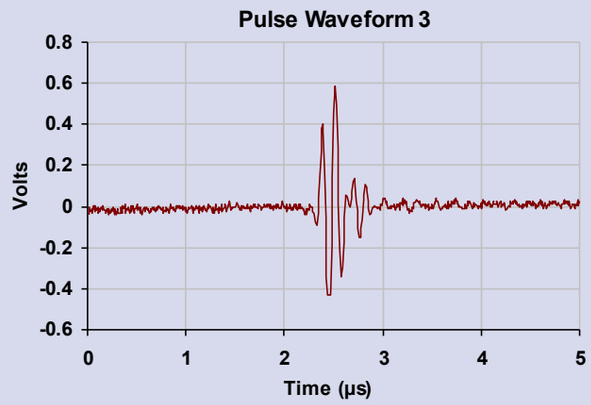


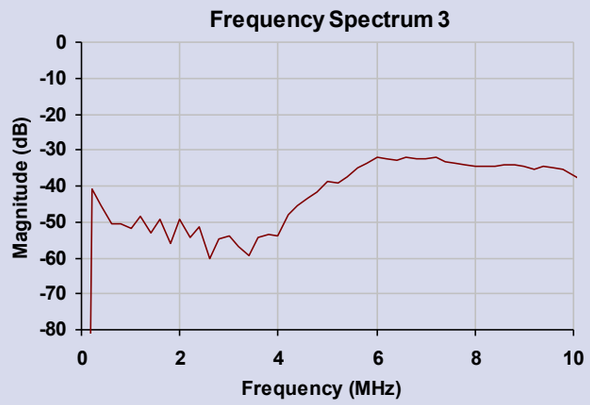
Middle Element Number: 64





Last Element Number: 96

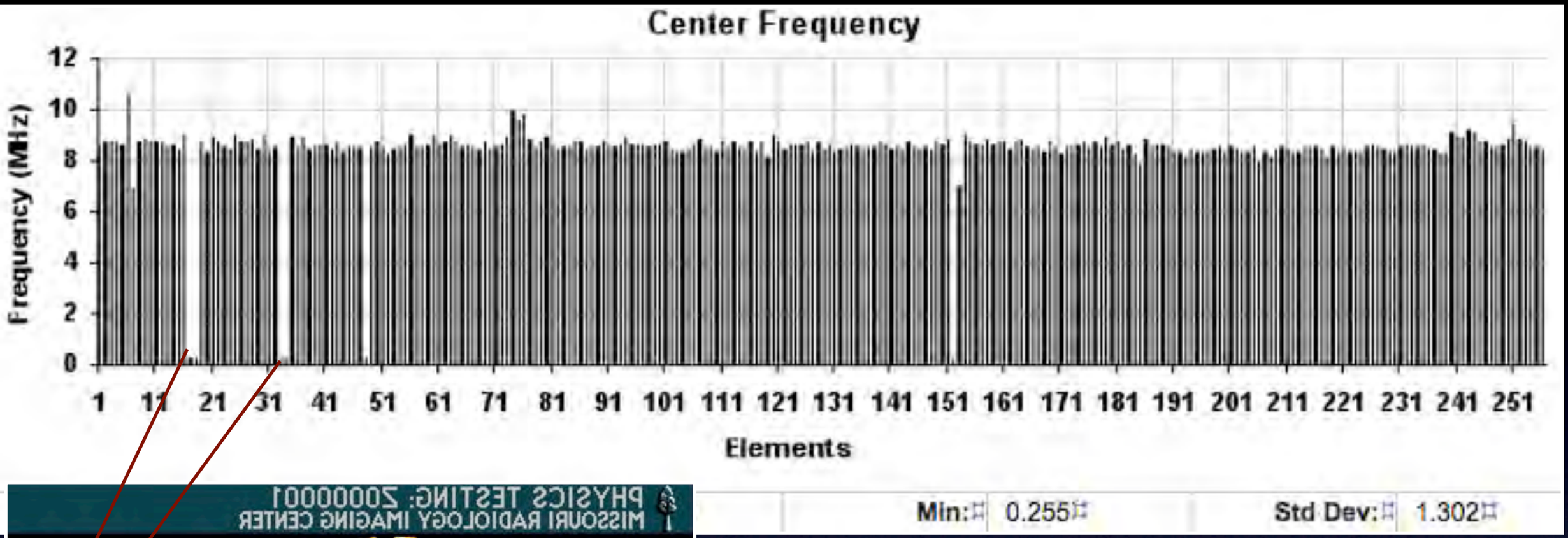


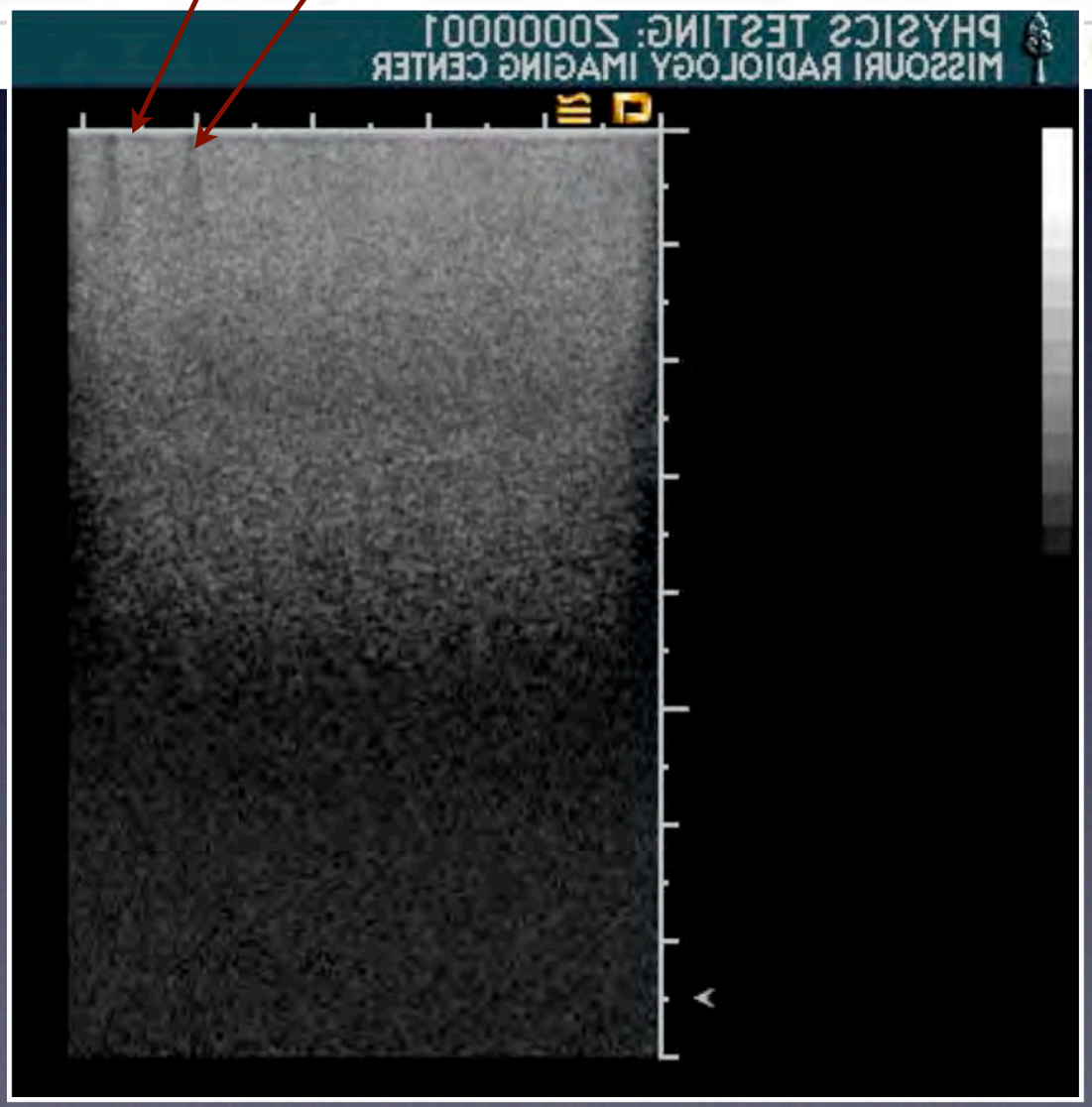


Sonora Medical Systems, Inc.
2021 Miller Drive
Longmont, CO 80501

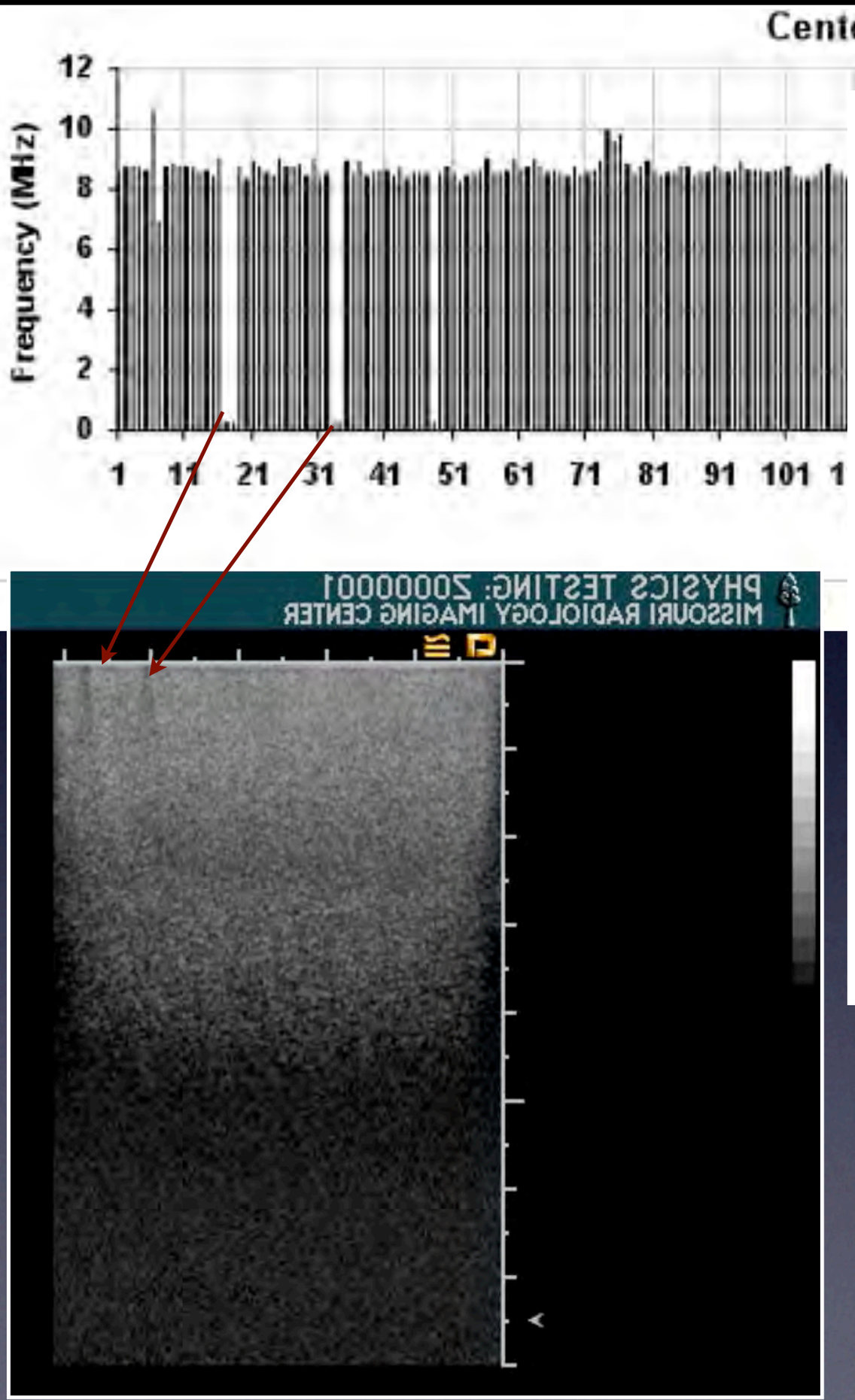
Voice: (303) 682-5871
FAX: (303) 682-5915

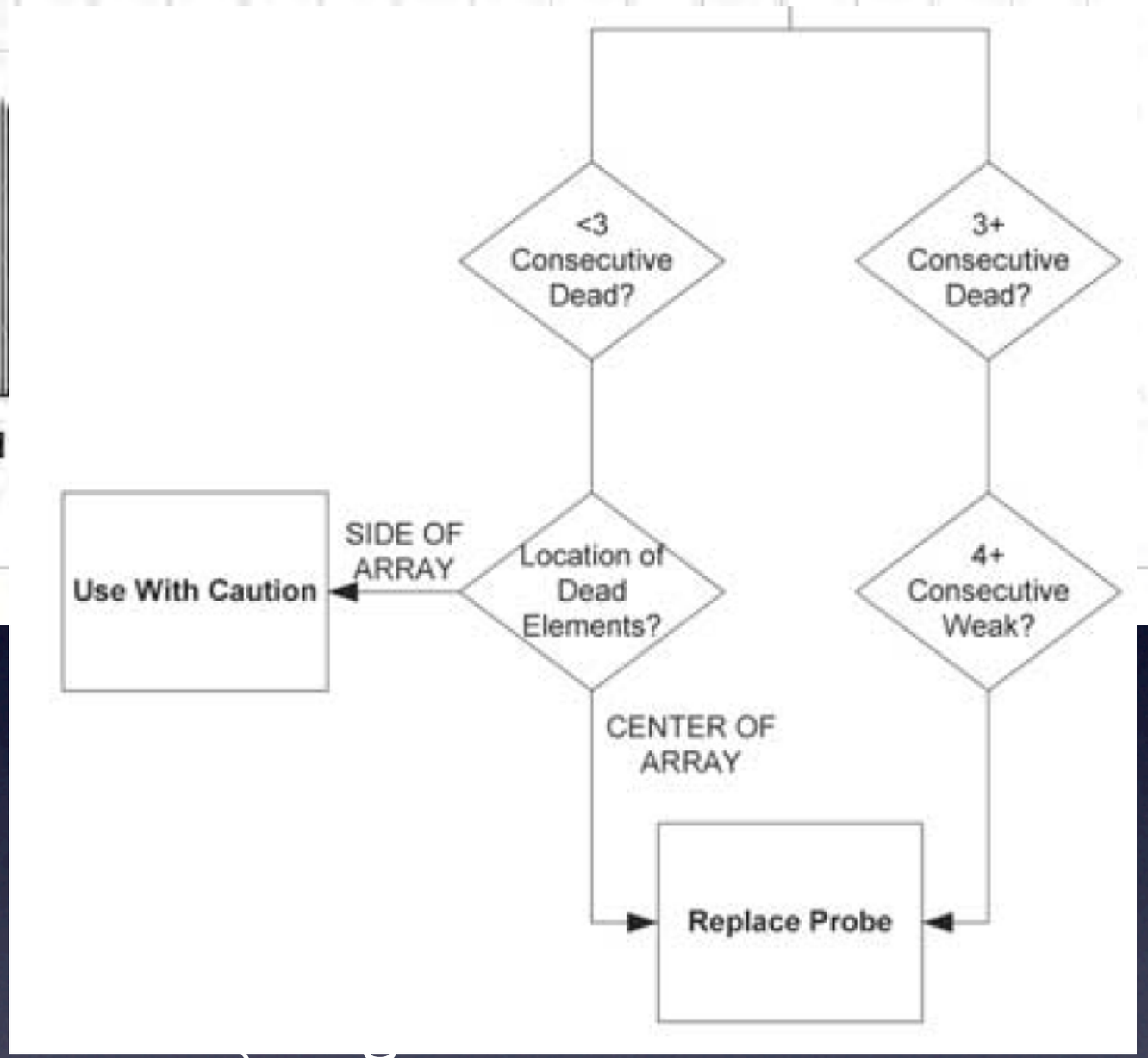
Test ID: 5
Page 3 of 3
Operator: Lisa Kile
1/20/2005 11:22 AM





Signal dropout corresponds to lost elements
(image reversed to show correlation to element dropout)





correlation to element dropout)

Summary

- Ultrasound Systems are complex with a number of components (some treated as a “black box”)
- The most external and exposed component (transducers) are most subject to damage from use and probably deserve most attention
- The cost of extensive testing is higher in equipment and effort / time
  - Simpler e-test approaches do not separate out Tx
- When to recommendation repair?!?