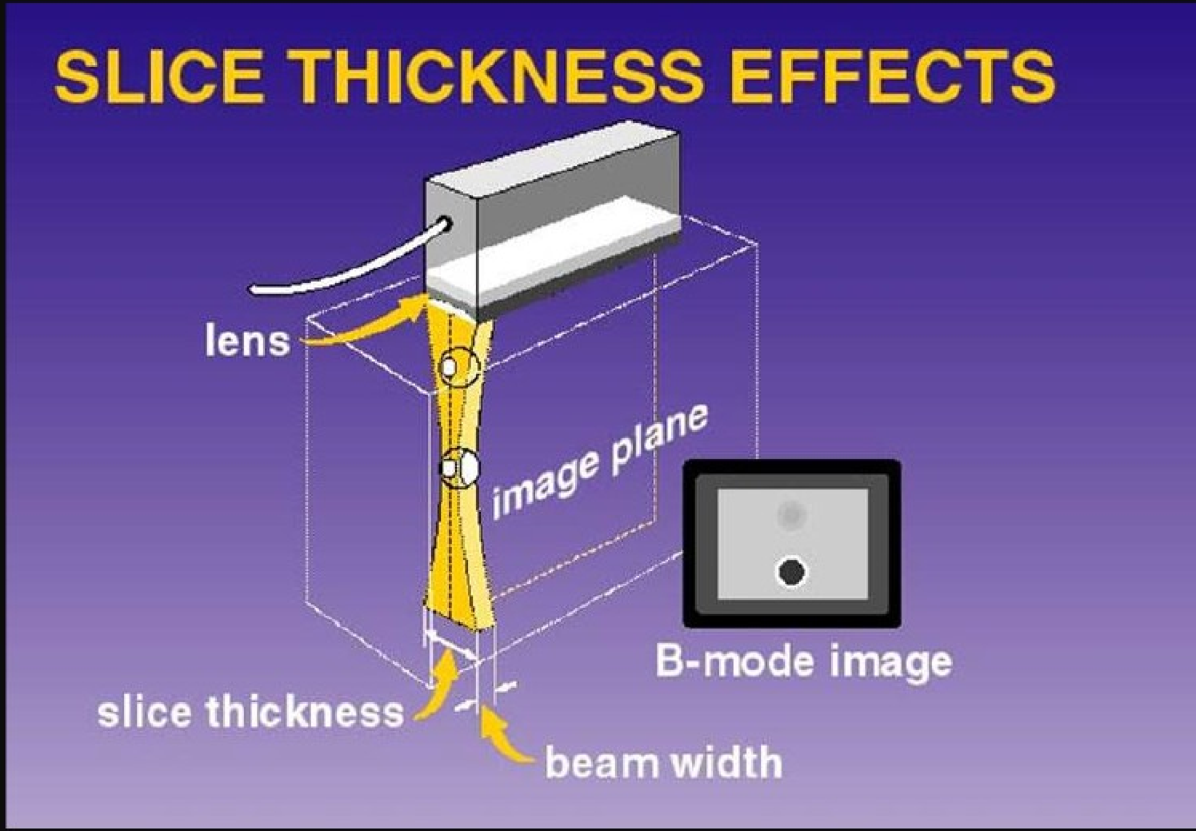
A potential revolutionary device for image optimization and Ultrasound Quality Assurance

Tunning the Ultrasound Scanner to eliminate subjectivity and give confidence to the Radiologist

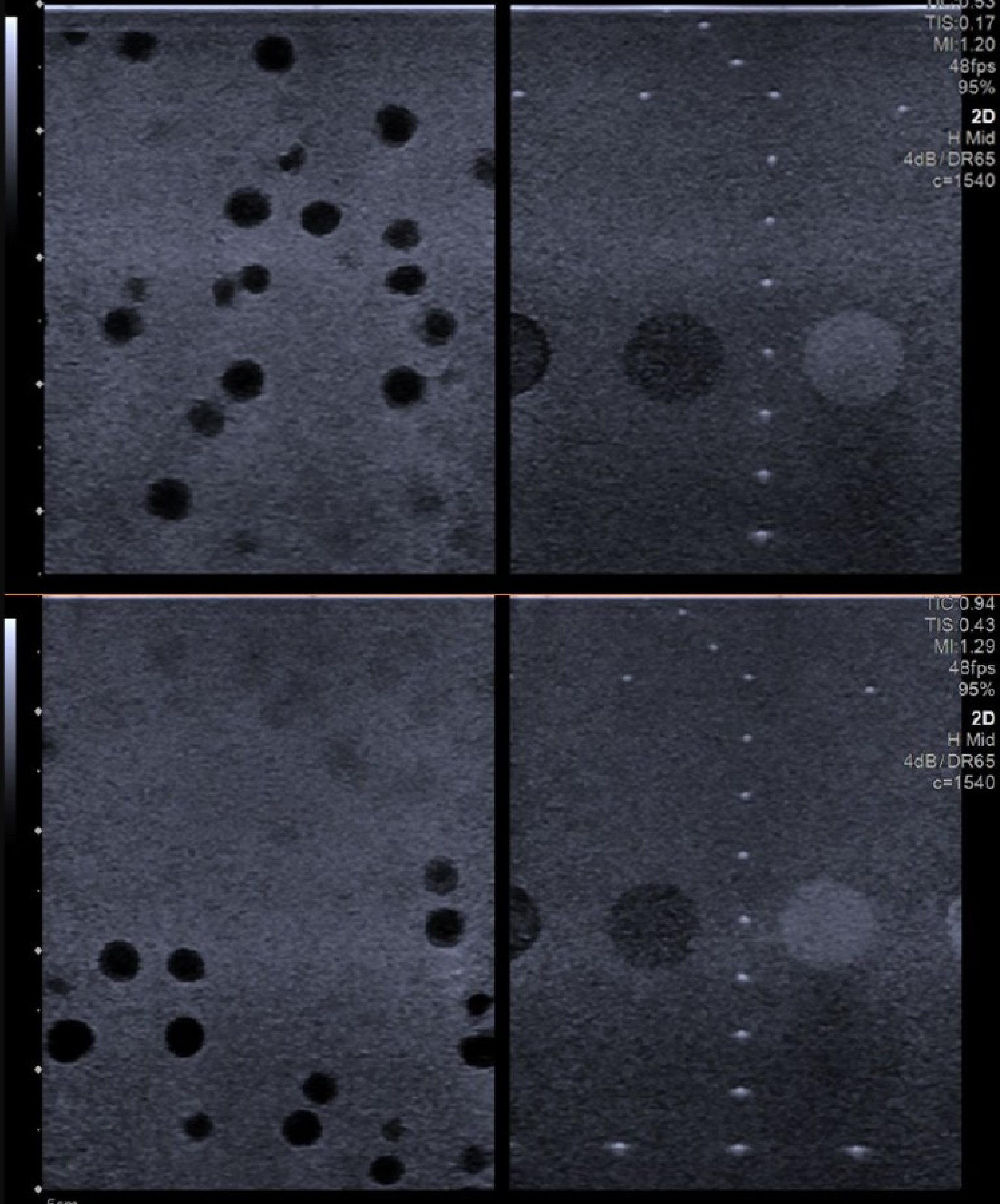
Slice Thickness Effect

- Slice thickness is generally the limiting factor when describing the 3-dimensional spatial resolution of ultrasound scanners. Multi-row array transducers affect the slice thickness by varying the elevational aperture with transmit focus adjustments. These adjustments can be automatically or, if available, manually.
- A 3D object may appear with a different contrast in an ultrasound image depending on its location



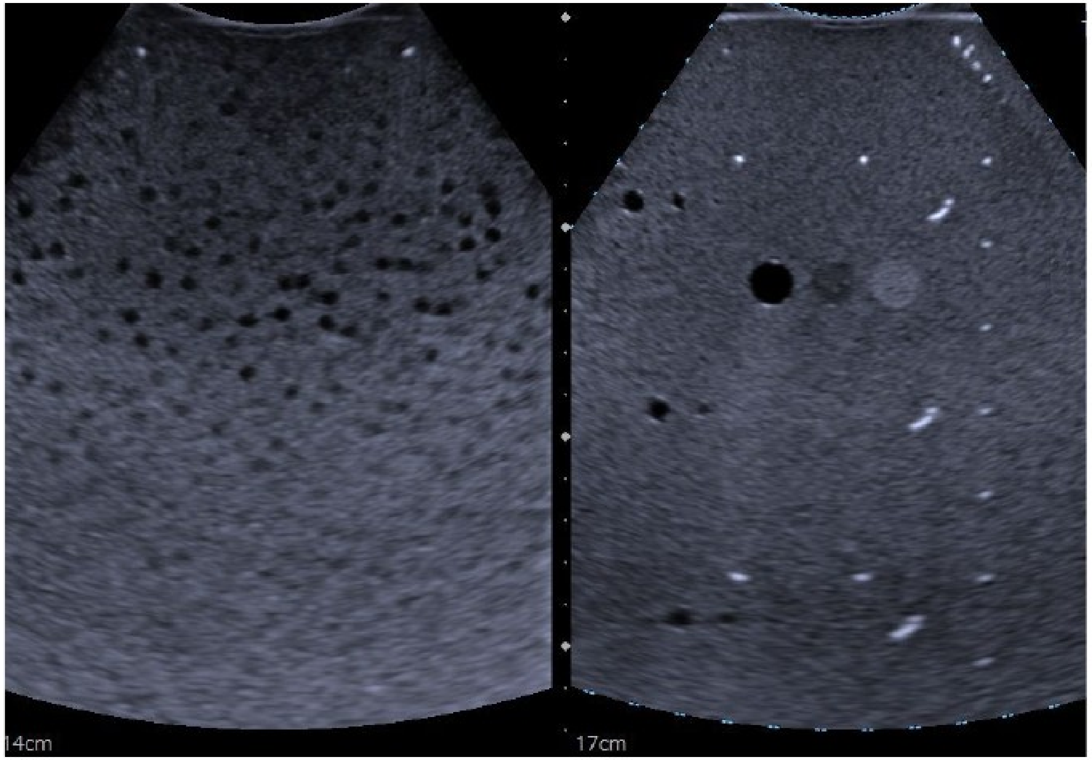
American College of Radiology recommended test phantoms do not address the slice thickness problem

- ACR requires the imaging of a phantom that contain wires to assess geometric accuracy. Because of the 2D nature and length of these wire the image is not affected by slice thickness. When the focusing depth is manually changed, the 3D objects in the first half of the images become less visible while the aspect of the strings is unchanged
- The difference between the two sets of images is the Field of View (FOV), set at 4.5 cm (above images) and 5 cm (below). The Otimizer image (left) shows fading/blurry 4 mm spheres to a depth of 2.5 cm if the FOV is set at 5 cm but the same spheres are clearly visible as hypoechoic structures if the FOV is set to 4.5 cm. The difference is not identified by using a string phantom as demonstrated with the 403 Sun Nuclear phantom imaged on the right side



Typical phantoms with strings, including for axial resolution, and cylinders may not be helpful for setting up a system

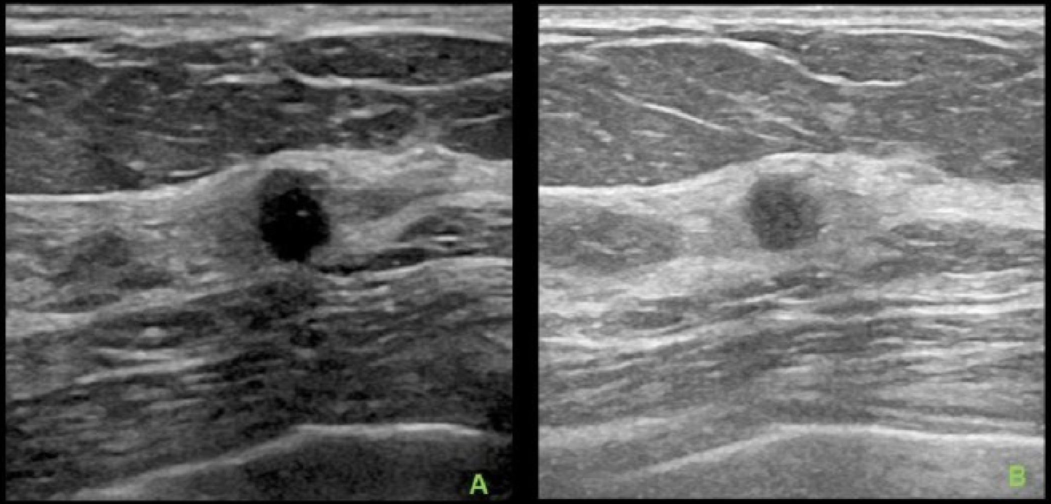
- The diameter of the cylinders in the right side of a commercially available phantom are 2, 4, and 6 mm diameter and visible even at 15 cm deep. The spheres in the Utune Optimizer device are about 4 mm diameter



Why does it matter?
Case 1:

Clínica Universidad de Navarra

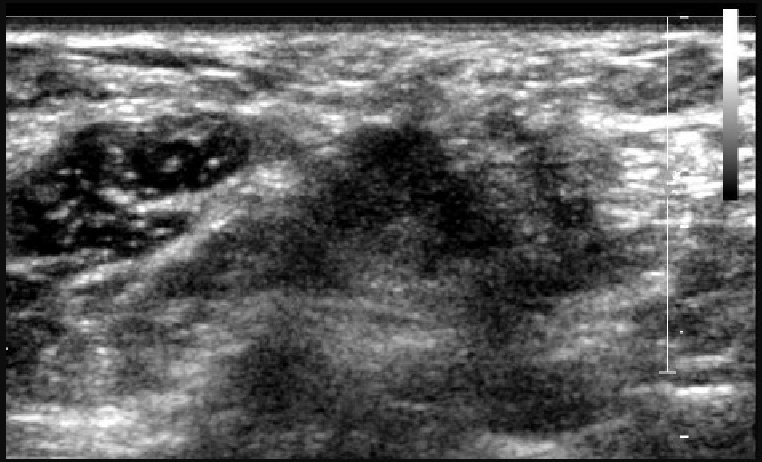
GAIN



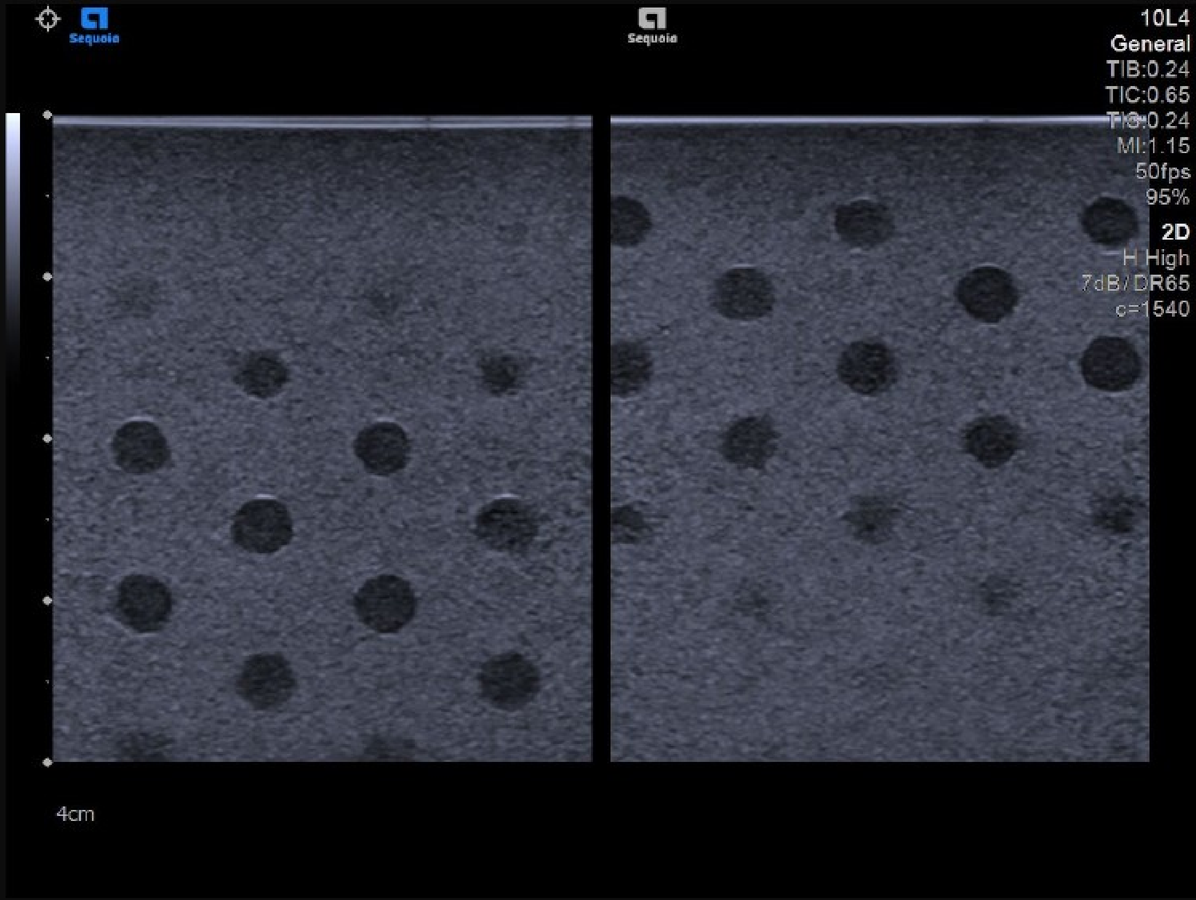
- The images in these pictures are taken with same scanner the only difference being made by changing one of the available control options, the Gain.
- The left image seems to show the presence of a cyst nodule that typically requires just monitoring over time. When the Gain is increased, the texture of the nodule becomes visible and a core needle biopsy confirms an invasive ductal carcinoma

Why does it matter
Case 2

- The images in these pictures were taken with two GE machines that were the same model , using the same software version, and using the same transducer.
- While with System 1 a nodule is easy to detect with System 2 it is hard to find.
- Both scanners passed all the routine QC tests that involved the use of typical multi-purpose ultrasound phantom.
- Eventually, the service engineer replaced all 4 circuit boards on System 2 and the image became satisfactory.



Currently available spherical lesion phantoms are very expensive (~$10K) and have functionality and quality issues. The Model 408 phantom, produced by Sun Nuclear, contains about 400 spheres placed on a vertical plane.

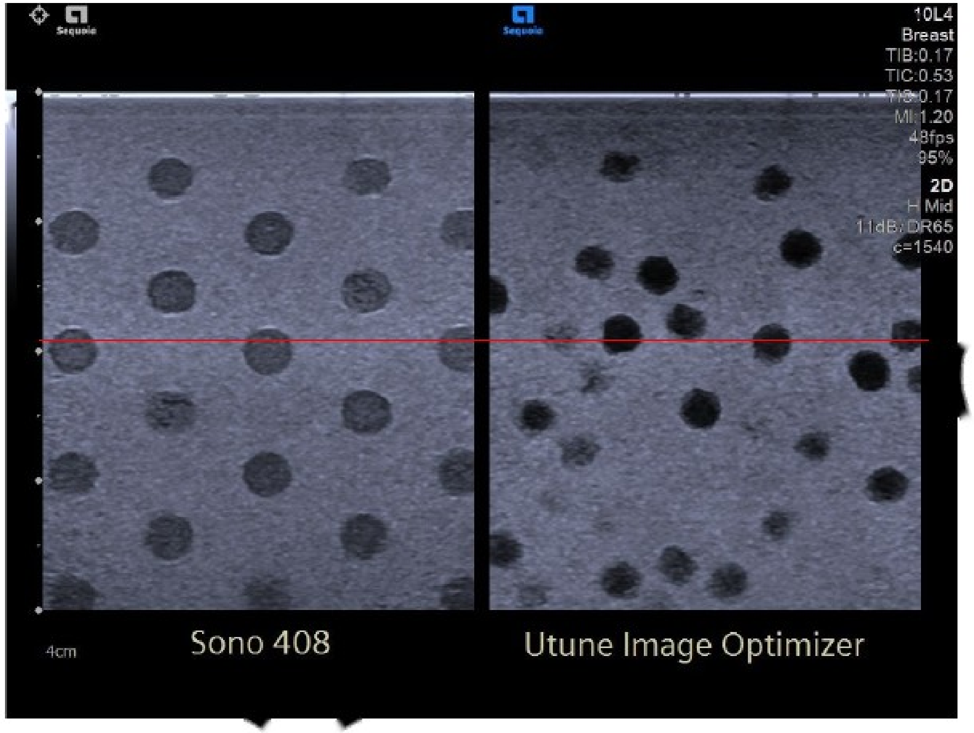


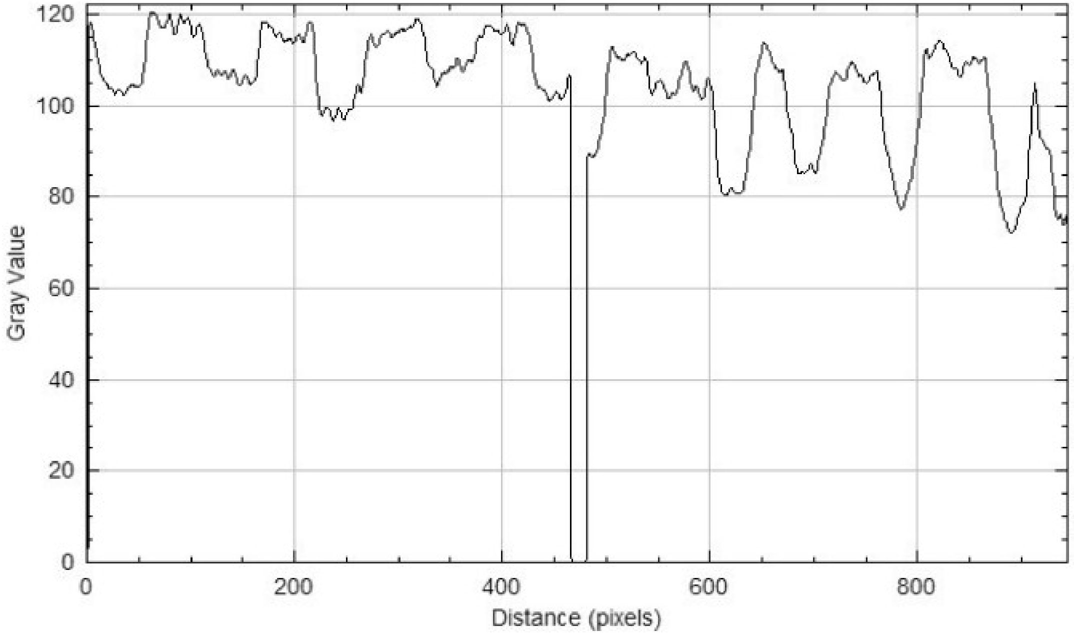
These two images are taken without changing any preset on the ultrasound scanner, so difference doesn’t come from the effect of the slice thickness but from a slight inclination of the transducer relative to the spheres plane.

This phantom is made using agar based gels and ingredients to control the speed of sound, attenuation and backscatter. Because even ultrapure Agarose gels have intrinsic structure, the spheres quality is not acceptable with a contrast much below the 40 dB level required by IEC Technical Standards 62736 and 62791

A highly hypoechoic spherical lesion provides a reference for optimizing image settings and improving differentiation between a cystic and a solid lesion.

A phantom image acquired at the beginning of each examination could provide a standardized, study-specific reference for the radiologist—and potentially for AI-based diagnostic tools—when interpreting the clinical images.





Selecting a system for optimal imaging of a specific clinical application

Phantom: Tissue-mimicking gel background with randomly distributed 2mm-diameter spherical voids.
Transducers: C9-2, C5-1, and mC12-3 on the Philip Ultrasound System

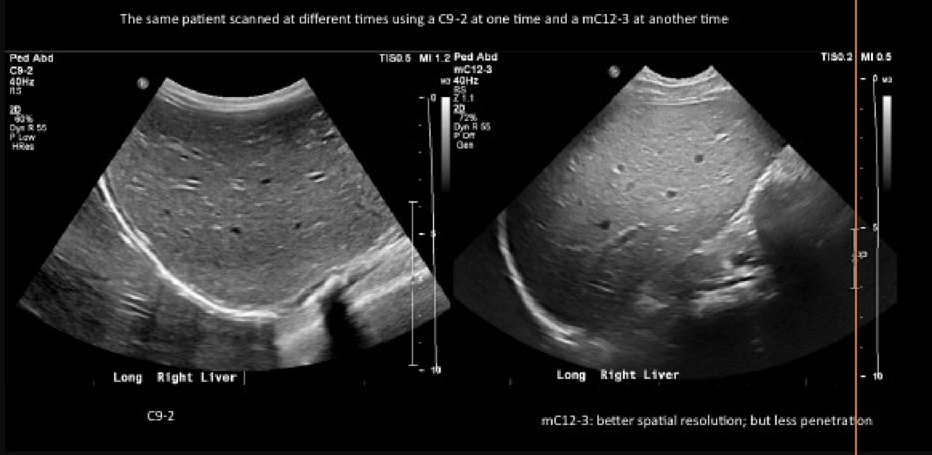
C9-2

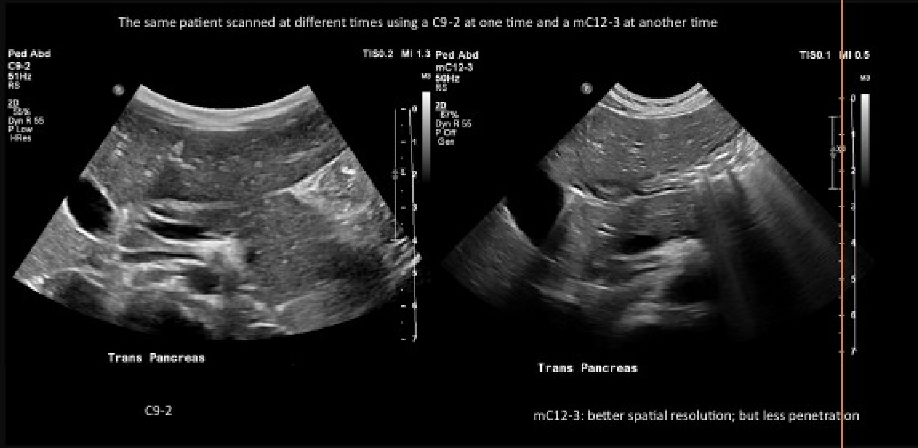
C5-1

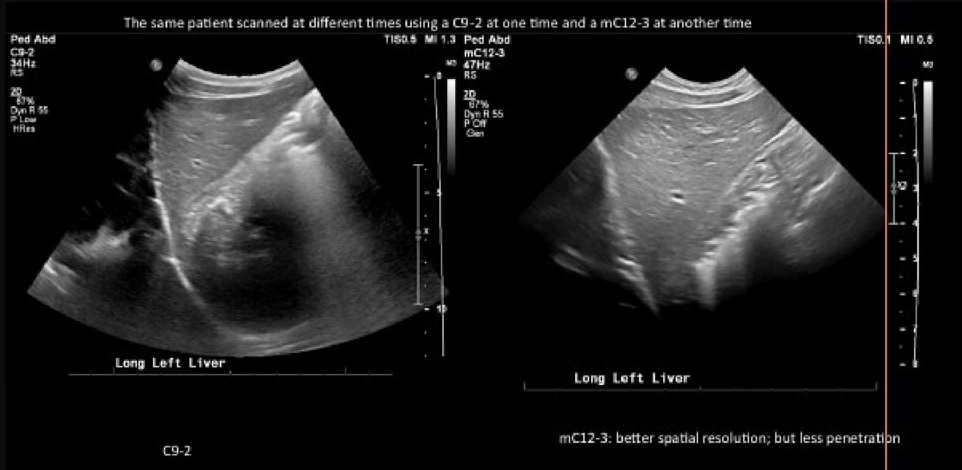
mC12-3: better spatial resolution; but less penetration

Clinical application

- Different patients may need a different system for imaging of the same organ.
- For example, when imaging a liver, the weight of the patient is important as it may place the liver at a different depth and the ultrasound penetration needs to be different.





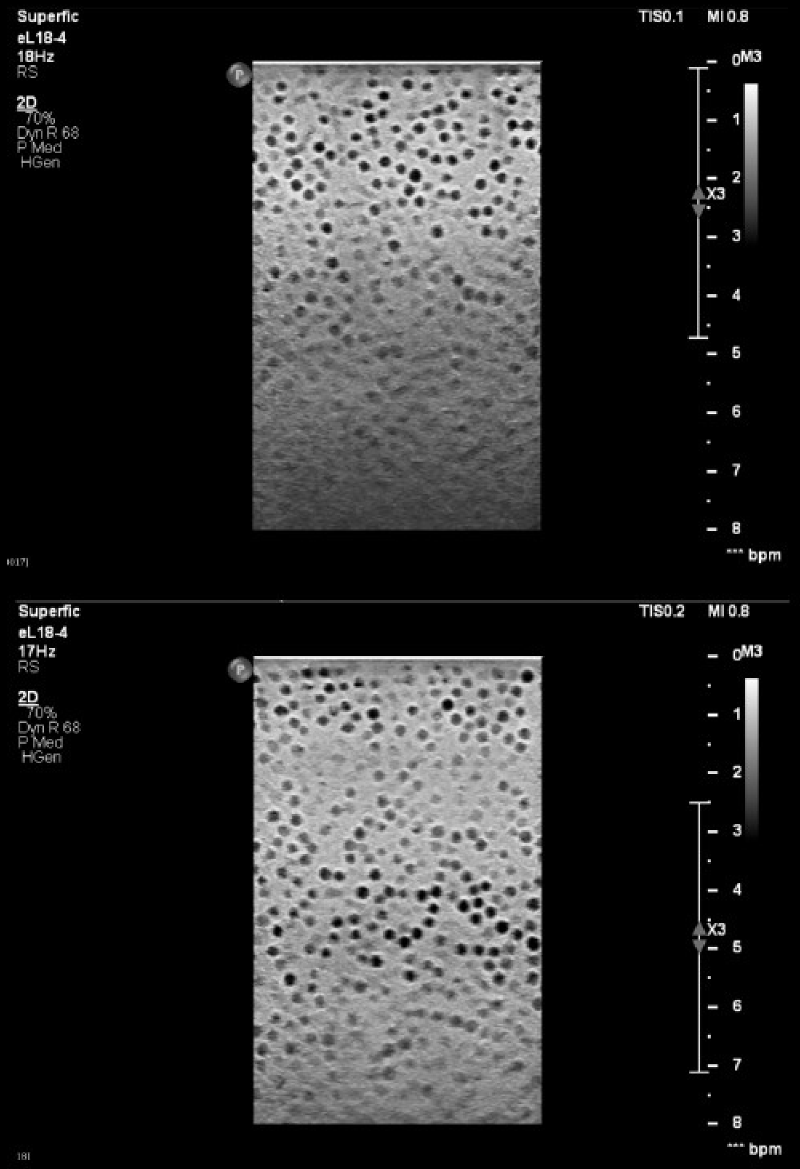


Randomly distributed, high density spherical lesion phantoms

- A phantom containing randomly distributed spheres was proposed by Prof Ernest Madsen and described in IEC TS 62736. The spheres in that phantom are made by using an Agarose based gel and molds. The molds are introduced in the molten gel, closed and let cure. The spheres are then removed, and quality controlled for defects like air and other contaminants. Because of the high cost of producing the spheres their concentration in the IEC standard described phantom is limited to about 3% . Because of this, locating the center of a spheres requires the use of a precise mechanical device capable of moving an ultrasound transducer in very fine increments.
- While eliminating the alignment problem posed by the Sun Nuclear's SONO408 model this proposed solution is not reducing the cost and does not resolve the contrast issue.

High density Spherical lesion application for setup/tunning a preset of an ultrasound scanner

- Images acquired by an eL18-4 transducer on a Philips EPIQ Elite system. The nominal frequency is 12 MHz. The image matrix is 294 x 458 with a pixel size of 0.167 x $0.167mm^2$. **Top:** focal range is 0 – 5cm; **Bottom:** focal range is 2.5 – 7cm.



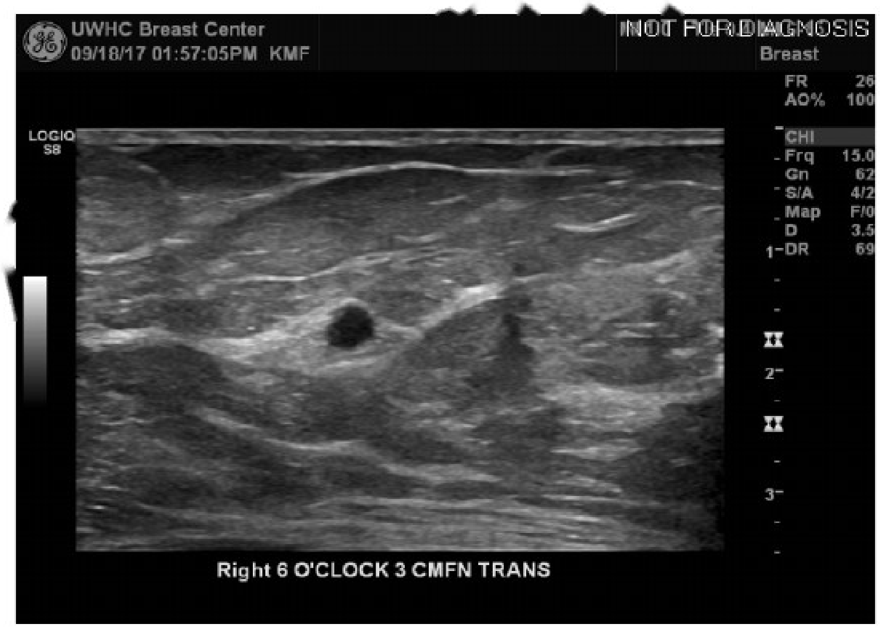
Needed solution

- High density (15% - 50% by volume) spheres in a uniform scattering background.
- Spheroidal targets in a range of 1 – 10 mm diameter. For most application 3-5 mm targets will provide the needed information.
- Smaller targets for high frequency transducers
- Larger targets for low frequency/high penetration transducers

Clinical impact
Optimal presets for optimal images

1.5cm focal depth, mass solid?

2.0 cm focal depth, mass cystic?



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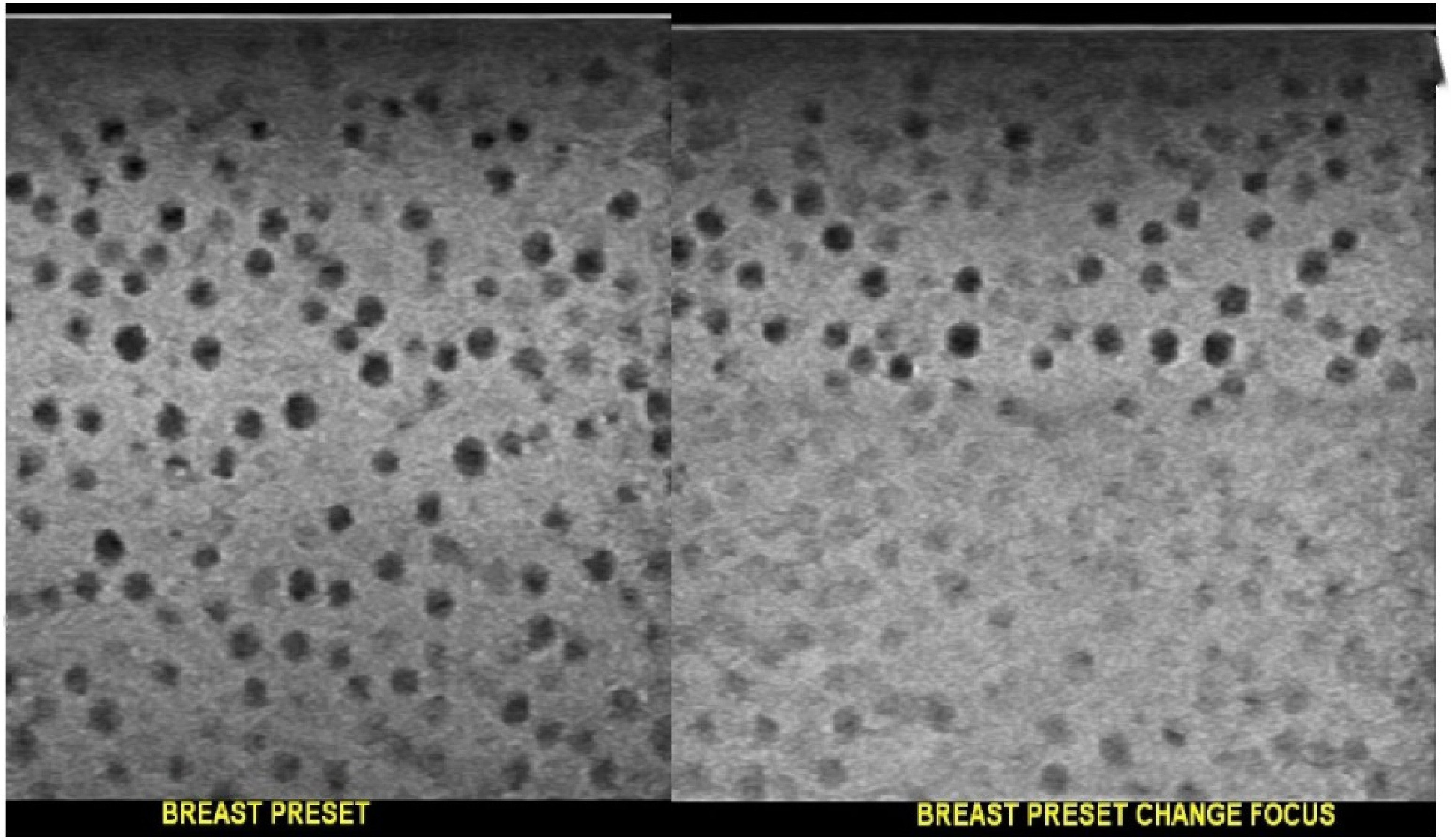
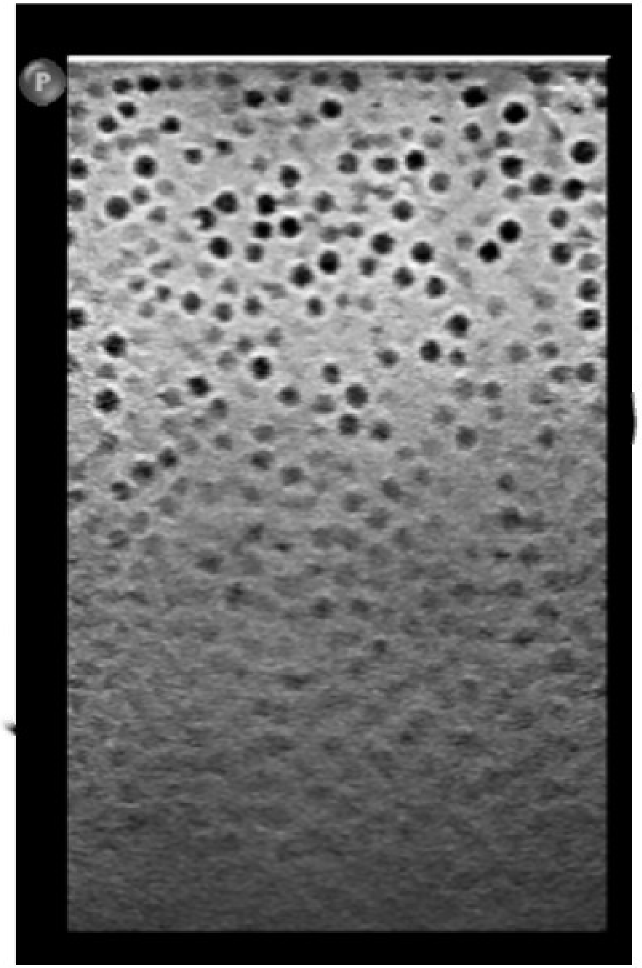
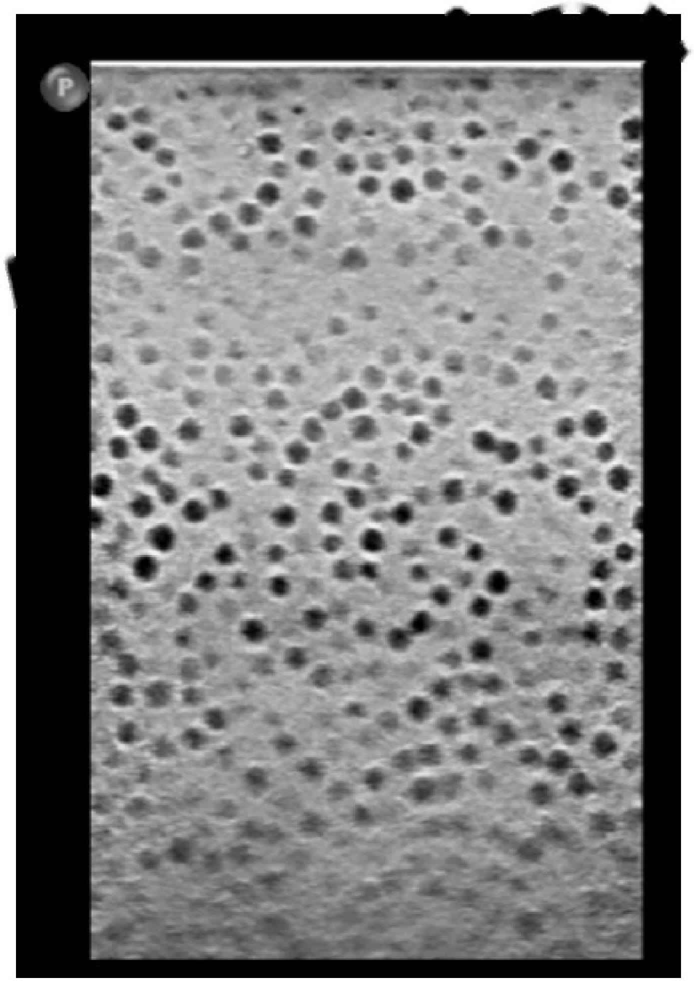
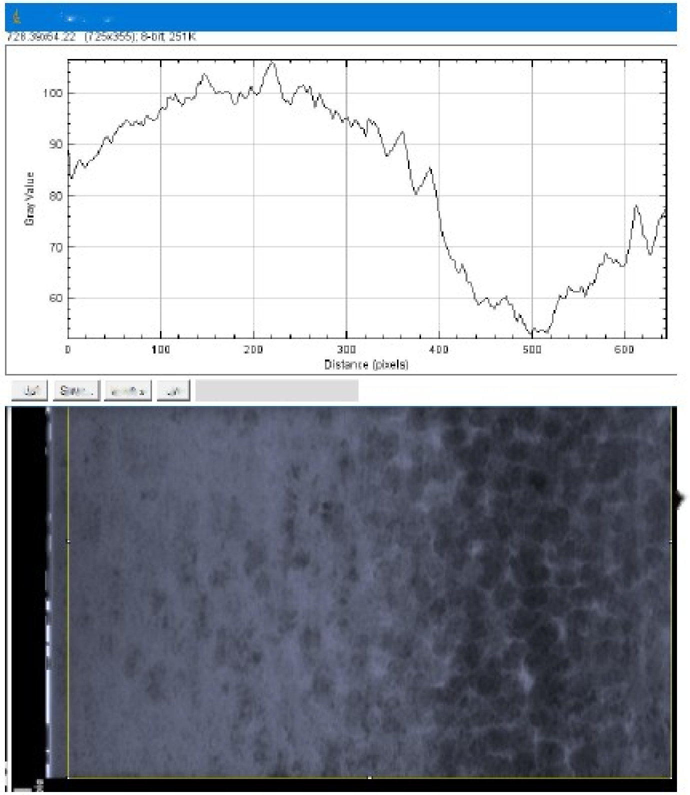


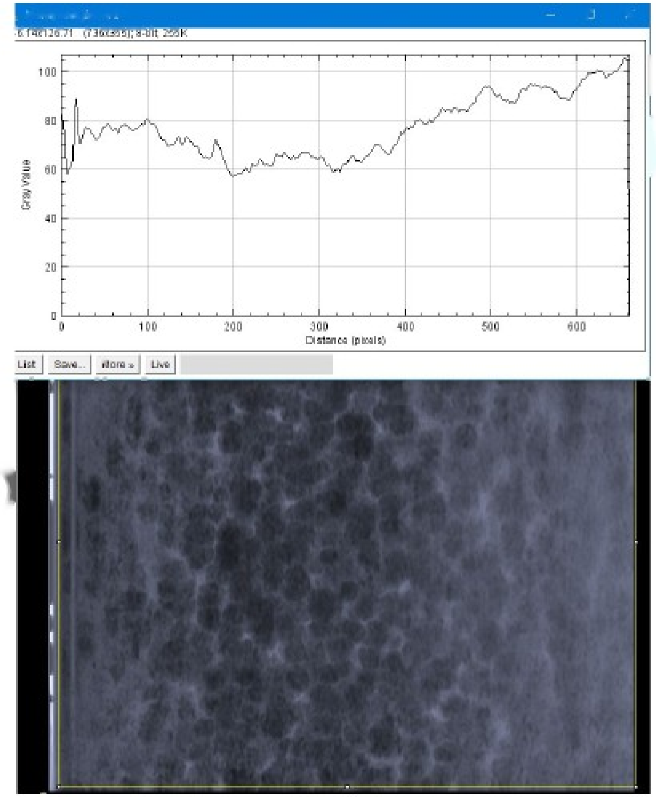
Clinical impact
Optimal presets for optimal images

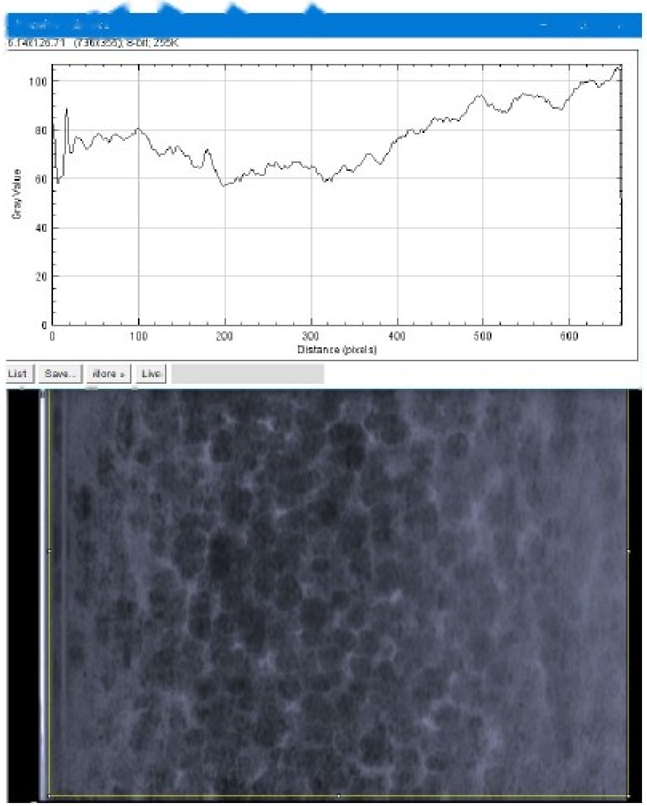




Plots created using ImageJ software and 3 seconds cineloops of the Utune Phantom. All images are taken with the same scanner, phantom and transducer but with different machine settings.







Published Validation of the Random Hypoechoic Sphere Phantom

Baihui Yu et al., “Assessing Imaging Performance of Ultrasound Systems Using a Random Hypoechoic Sphere Phantom with Freehand Scanning” — Figure 6

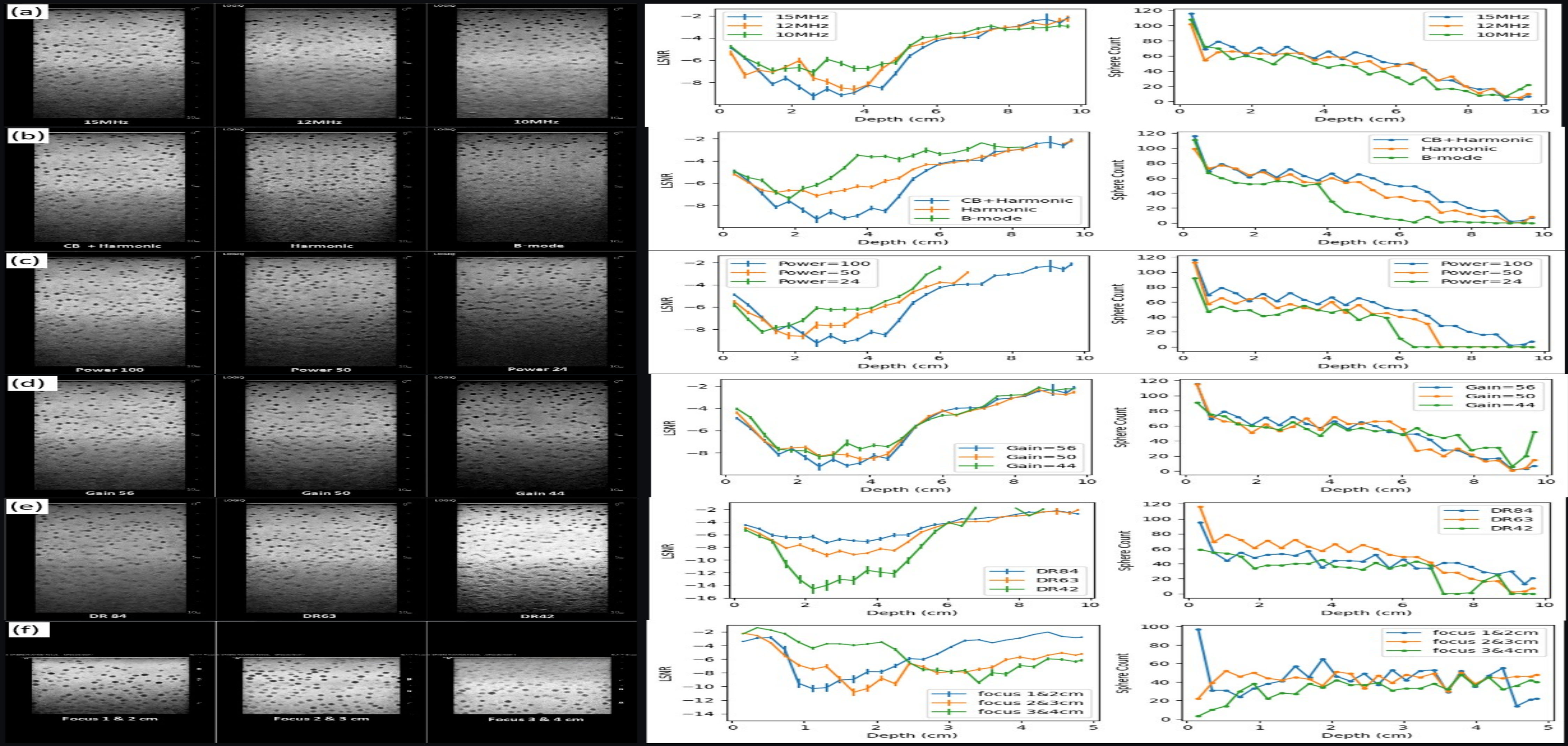
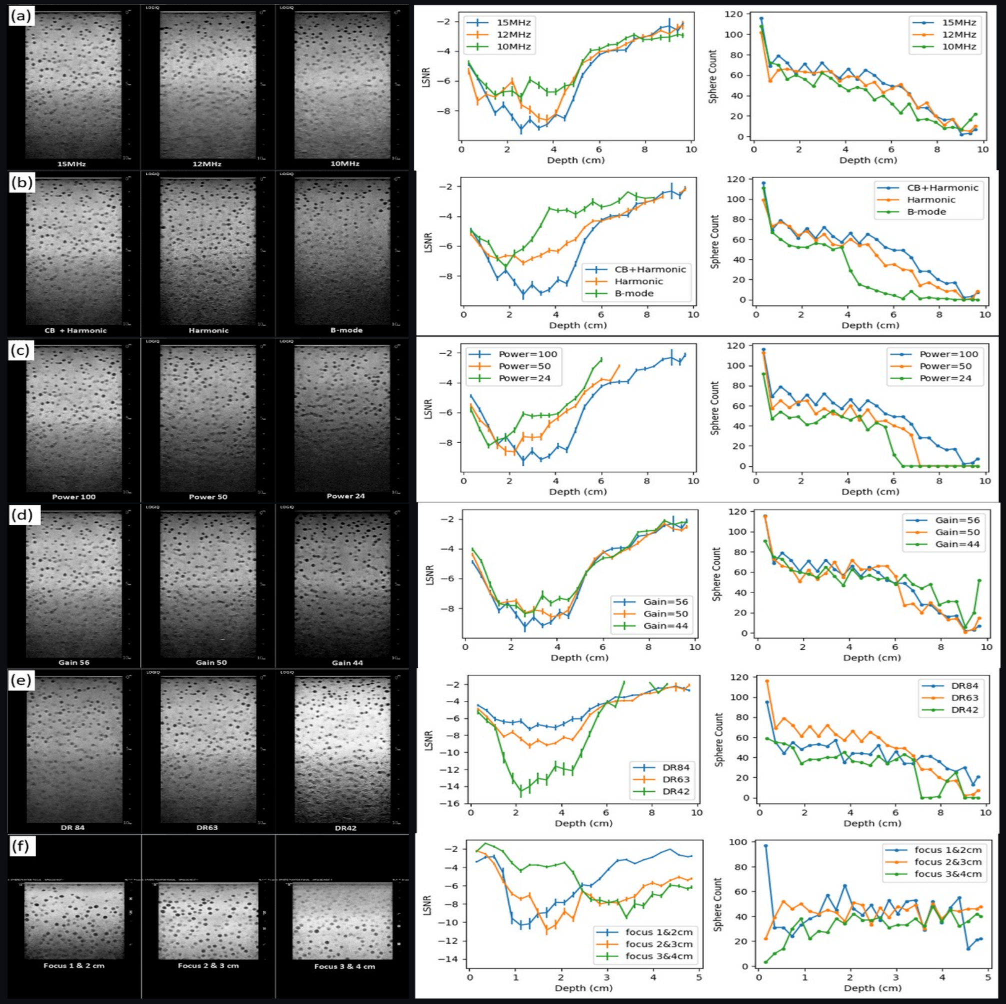


Figure 6: frequency, imaging/compounding mode, transmit power, gain, dynamic range, and transmit focus.

What Figure 6 demonstrates

The high-density random sphere phantom converts visible image differences into quantitative LSNR-versus-depth measurements.



Frequency: 15 MHz produced better LSNR than 12 and 10 MHz at nearly all depths, despite greater penetration at lower frequency.

Imaging mode: Harmonic + compounding performed best, especially at approximately 2–6 cm.

Transmit power: Higher power preserved lesion detectability deeper in the phantom.

Gain: Large visual brightness changes produced little change in LSNR because signal and background noise scale together.

Dynamic range: Lower dynamic range increased measured LSNR, likely partly from saturation/noise clipping—a useful warning that “better” numbers can reflect processing.

Transmit focus: LSNR peaks shifted with focal depth; the 2 & 3 cm dual-focus setting gave the best overall performance from 0–5 cm in this experiment.

Key point: the phantom can be used to optimize presets—not only to pass/fail routine QC.

ACR–AAPM Technical Standard · Diagnostic Ultrasound QC

Medical Physics Performance Monitoring of Diagnostic Ultrasound Equipment (Revised 2026)

“A newer method with randomly placed spherical lesions is available that provides more rapid evaluation of system sensitivity, contrast resolution and spatial resolution. Use of these tests is recommended as available and verified.”

For continuous QC programs: “It is strongly recommended that the program include newer tests with randomly placed spherical lesions.”

The Utune Optimizer implements this randomized spherical-target approach.

Source text supplied for ACR–AAPM Technical Standard (Revised 2026).