

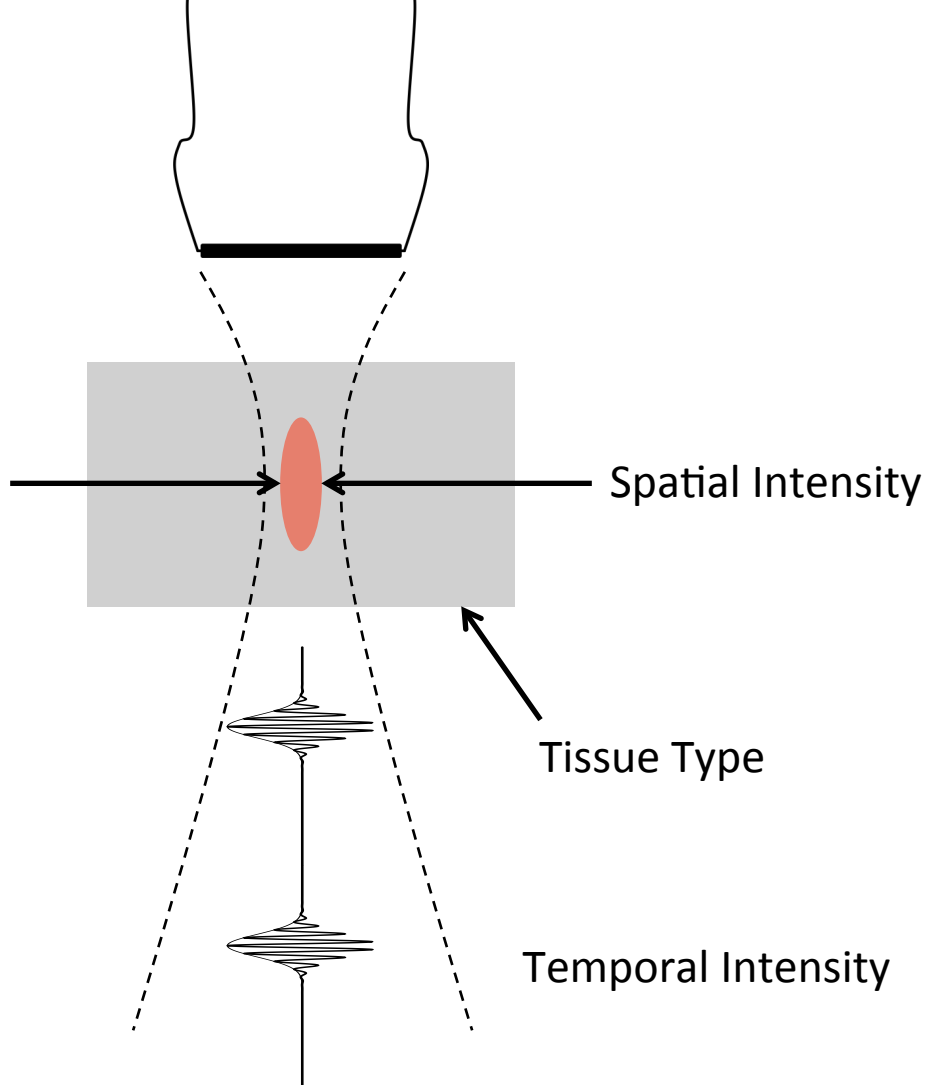
Ultrasound Physics (BWHRR.US)

5. Ultrasound Safety and QA

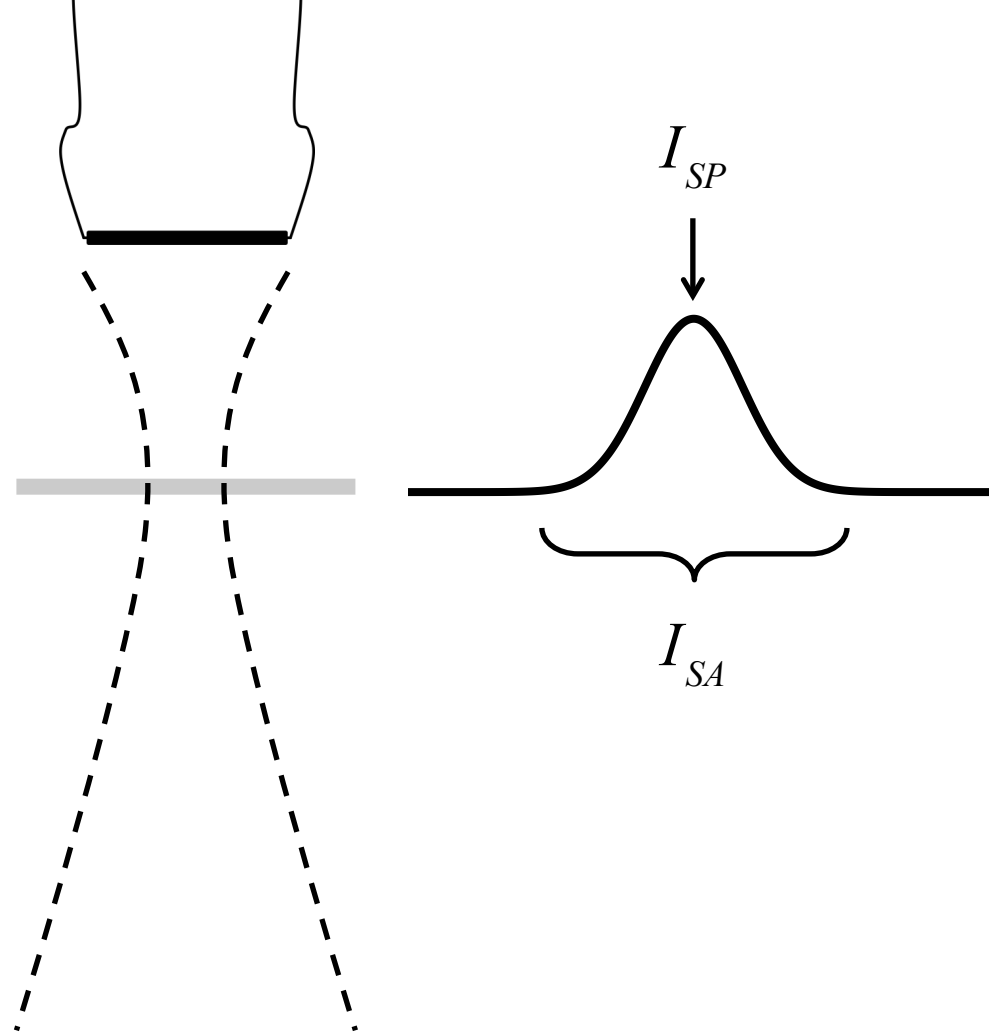


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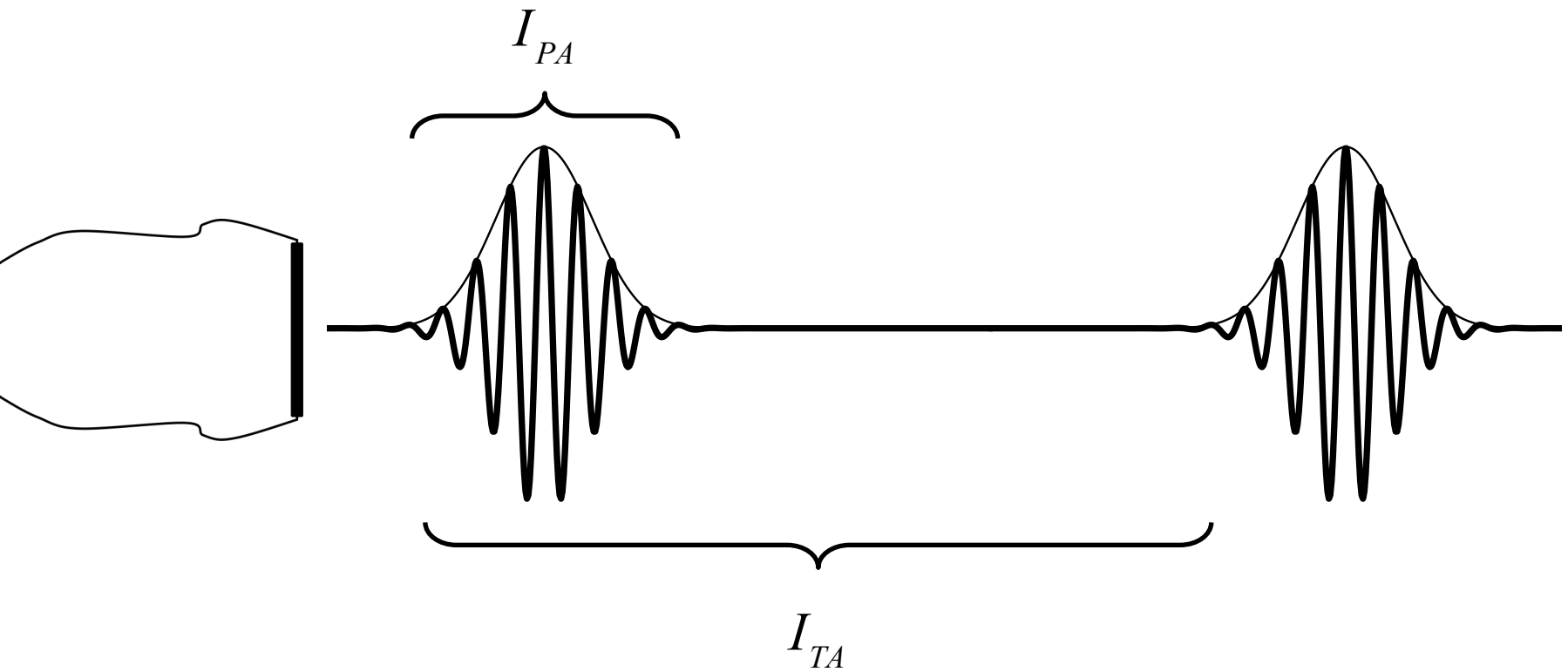
Contact: (617) 525-7465, white@bwh.harvard.edu



Ultrasound Safety



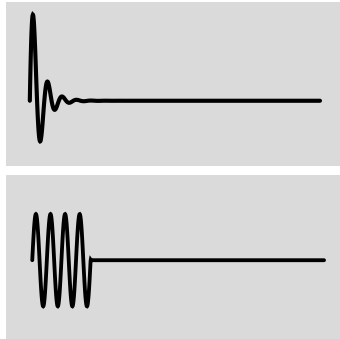
Spatial Intensity



Temporal Intensity

		Pressure (MPa)	Power (mW)	I_{SPTA} (mW/cm ²)	I_{SPPA} (mW/cm ²)
Mode					
Unscanned	B-Mode	2.09	64	175	174,000
	M-Mode	2.09	46	127	174,000
	Pulsed Doppler	2.18	144	1,570	288,000
	Color Doppler	2.41	138	429	325,000
				↑ Thermal Effects	↑ Mechanical Effects

Typical Values



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B-Mode	2.09	64	175	174,000
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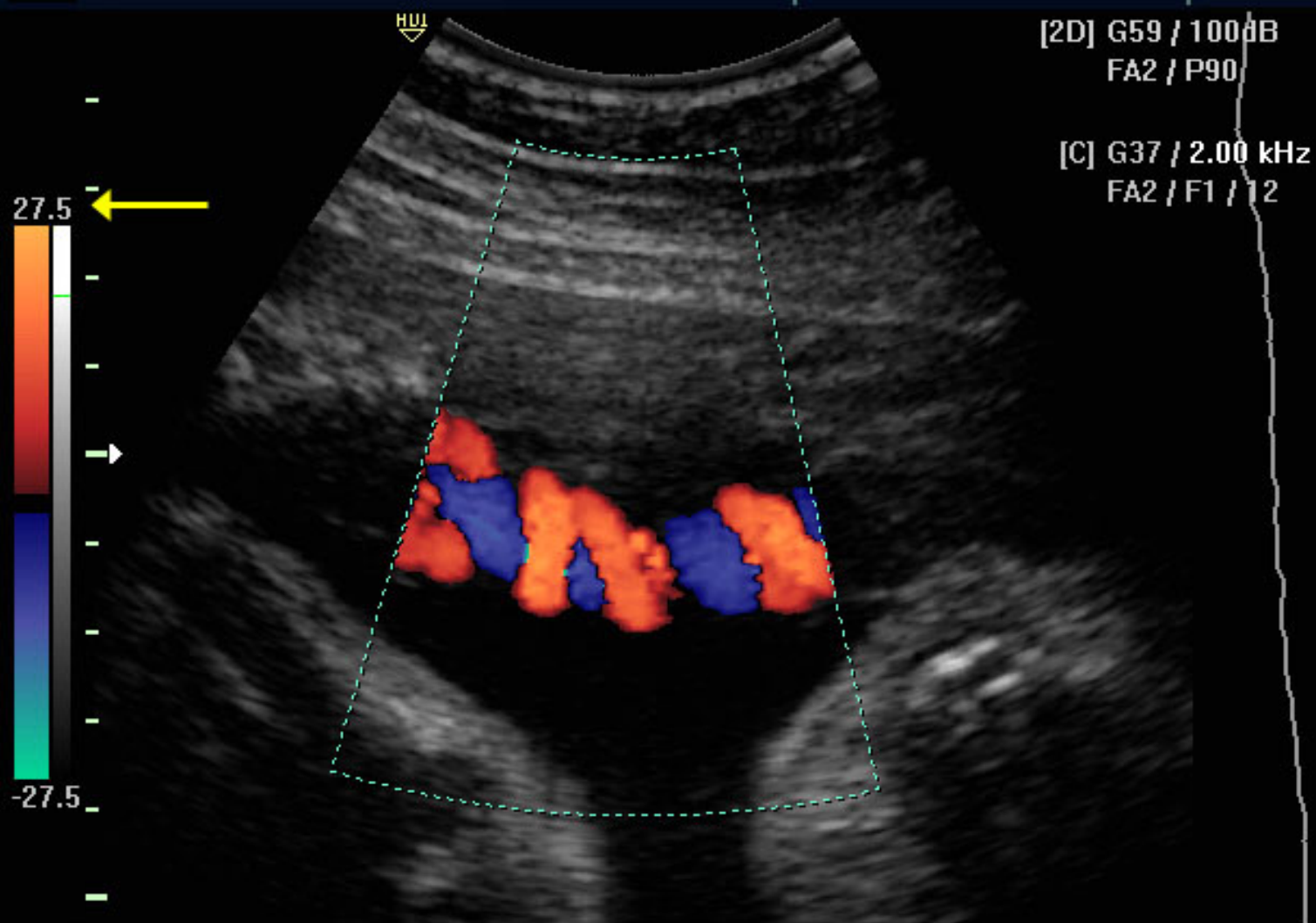
Typical Values

$$TI = \frac{P}{P_{1^\circ C}} \left\{ \begin{array}{l} TI_s \text{ Soft Tissue} \\ TI_B \text{ Bone (focus)} \\ TI_c \text{ Cranial Bone (surface)} \end{array} \right.$$

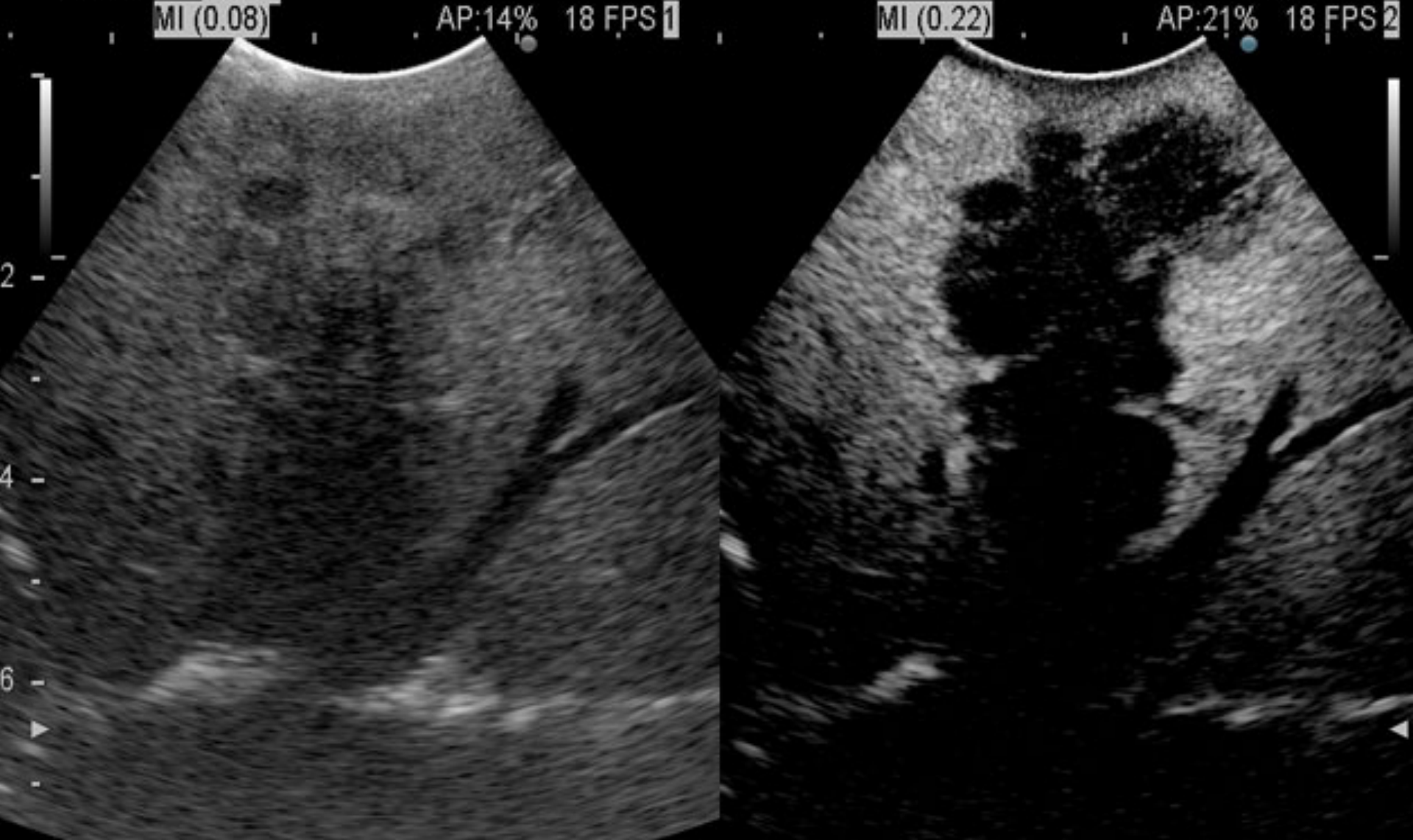
$$MI = \frac{PNP}{\sqrt{f_c}}$$

Output Display Standard (ODS 1992)

	Pre-natal	Post-natal
$TI = \frac{P}{P_{1^\circ C}}$	(< 1)	(< 2)
$MI = \frac{PNP}{\sqrt{f_c}}$	(< 0.4)	(< 0.4)



Color Flow Doppler (CFD)



Contrast Harmonic Imaging (CHI)

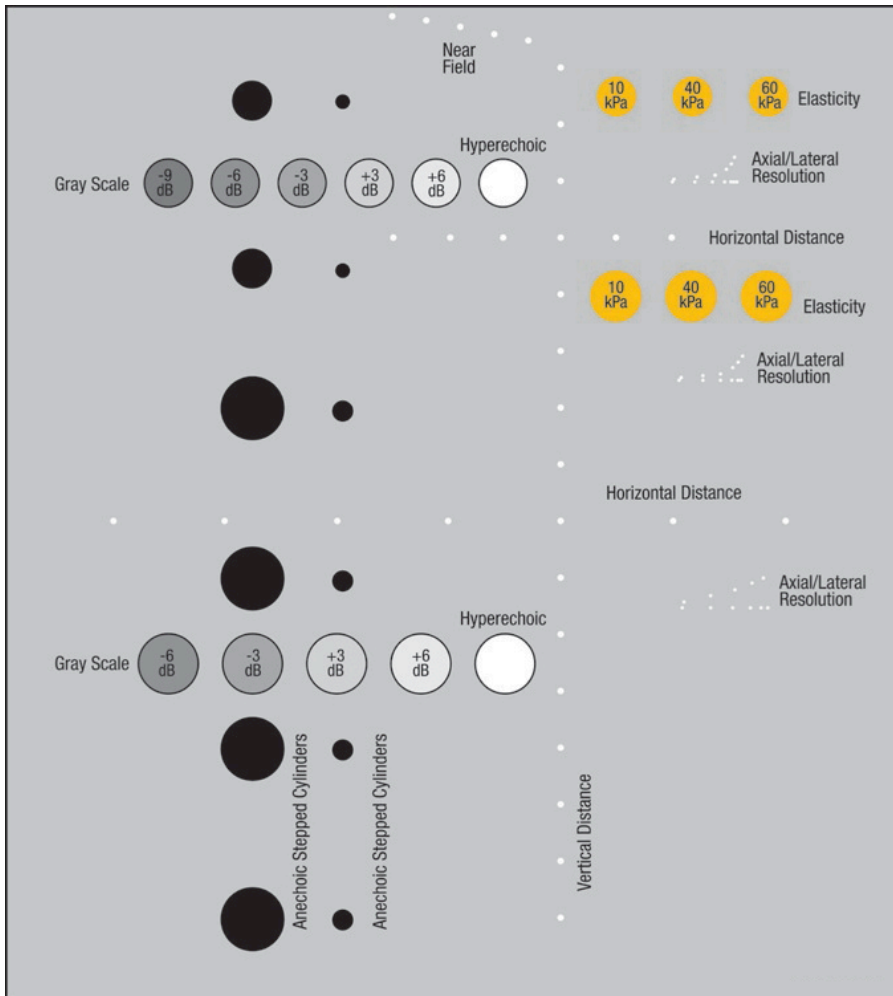
Application	I_{SPTA} (mW/cm ²)	TI	I_{SPPA} (mW/cm ²)	MI
Fetal Imaging	720	6	190,000	1.9
Cardiac	720	6	190,000	1.9
P/V	720	6	190,000	1.9
Ophthalmic	50	1	28,000	0.23

FDA Limits on Acoustic Output



Computerized
Imaging
Referencing
Systems, Inc.

Quality Assurance



Dead Zone

Horizontal Distance

Vertical Distance

Depth of Penetration

Image Uniformity

Axial Resolution

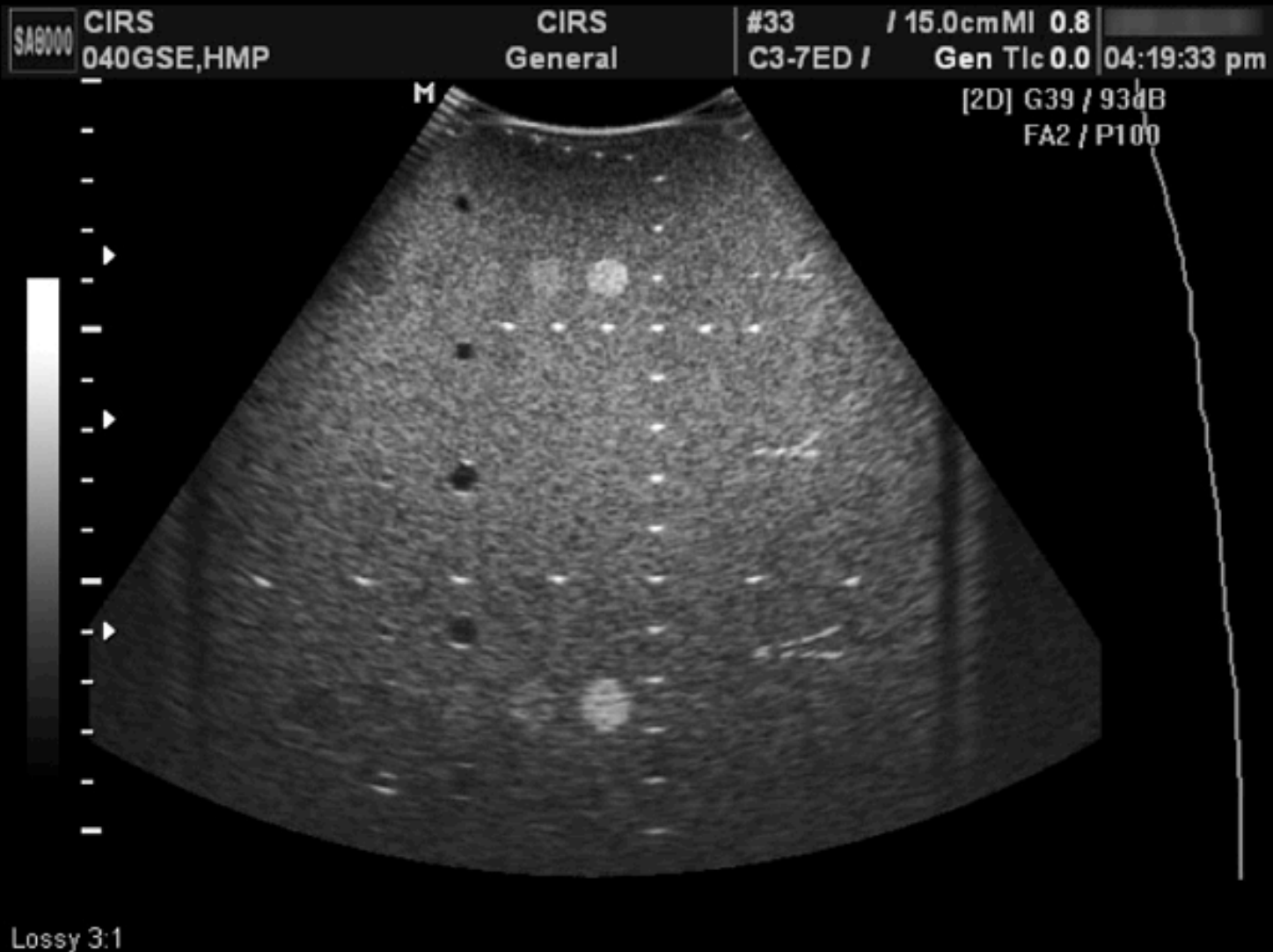
Lateral Resolution

Anechoic Mass Resolution

Grey Scale Contrast Resolution

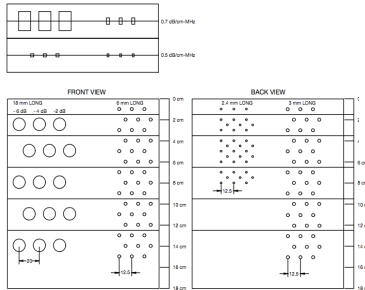
Elasticity Image Evaluation

Quality Assurance

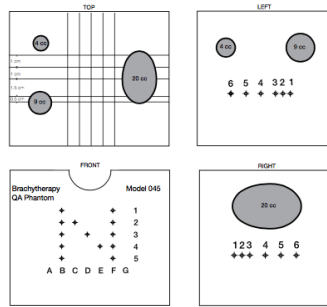


Quality Assurance

Resolution Phantom



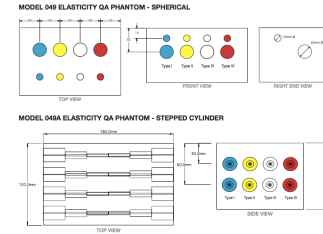
Brachytherapy Phantom



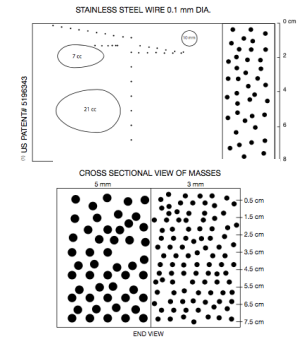
Gray Scale Phantom



Elasticity Phantom



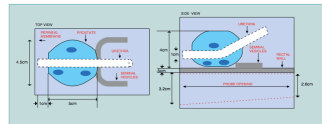
Near field Phantom



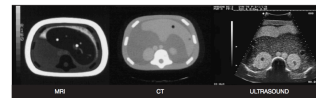
Breast Biopsy Phantom



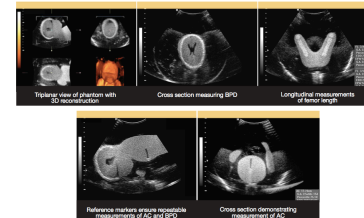
Prostate Phantom



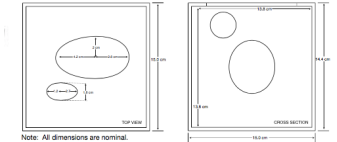
Triple Modality Phantom



Fetal Biometrics Phantom



3D Ultrasound Phantom



Quality Assurance

Ultrasound Intensity

Thermal Index (TI)

Mechanical Index (MI)

FDA Limits

Quality Assurance (QA)

Summary