

Knobology & Physics of Ultrasound



**9th Congress of the
World Federation of
Pediatric Intensive &
Critical Care Societies**

9-13 June, 2018 | Singapore



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Chief

Department of Emergency & Critical Care Medicine

West Garden Hospital, Taiwan

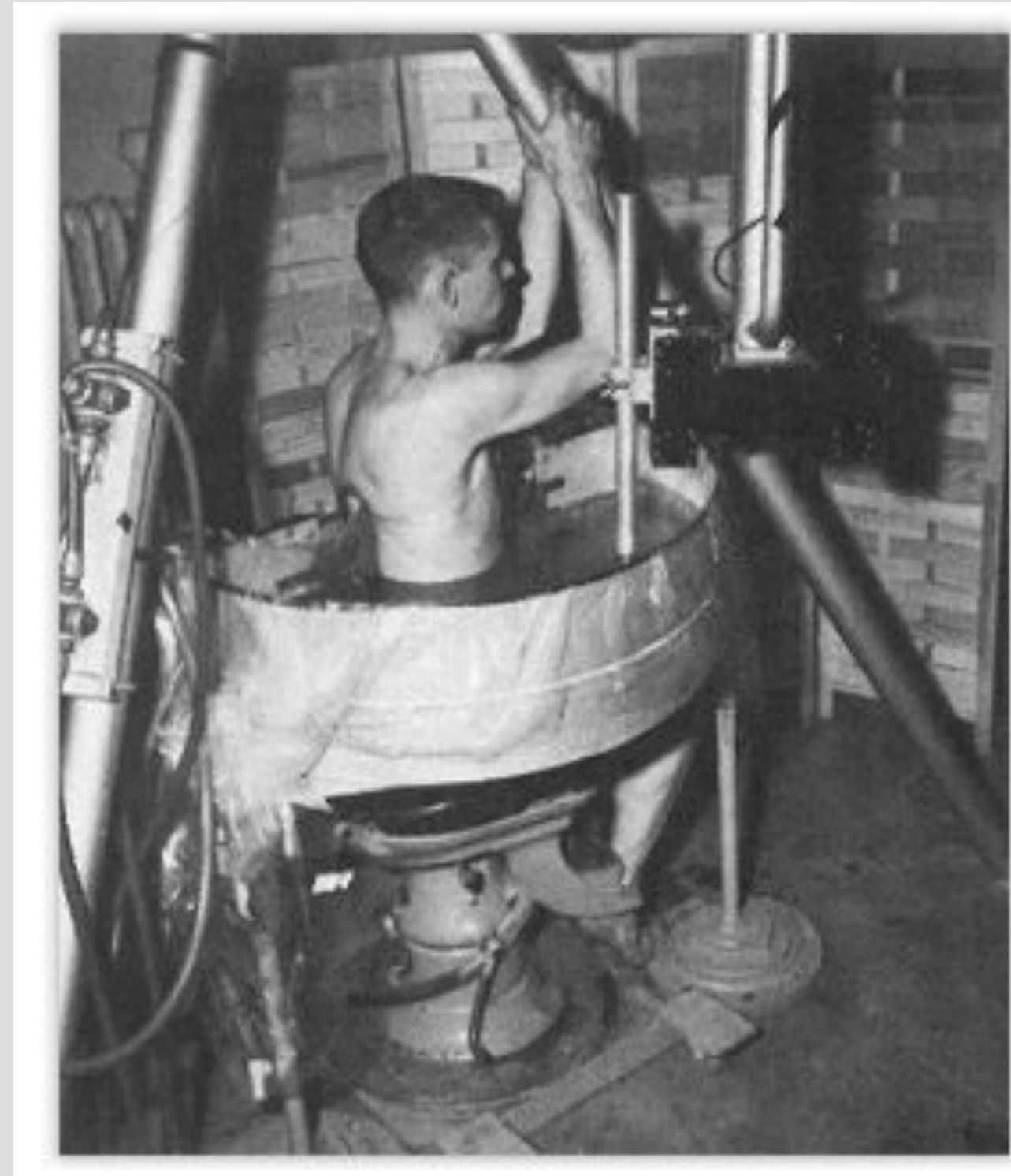
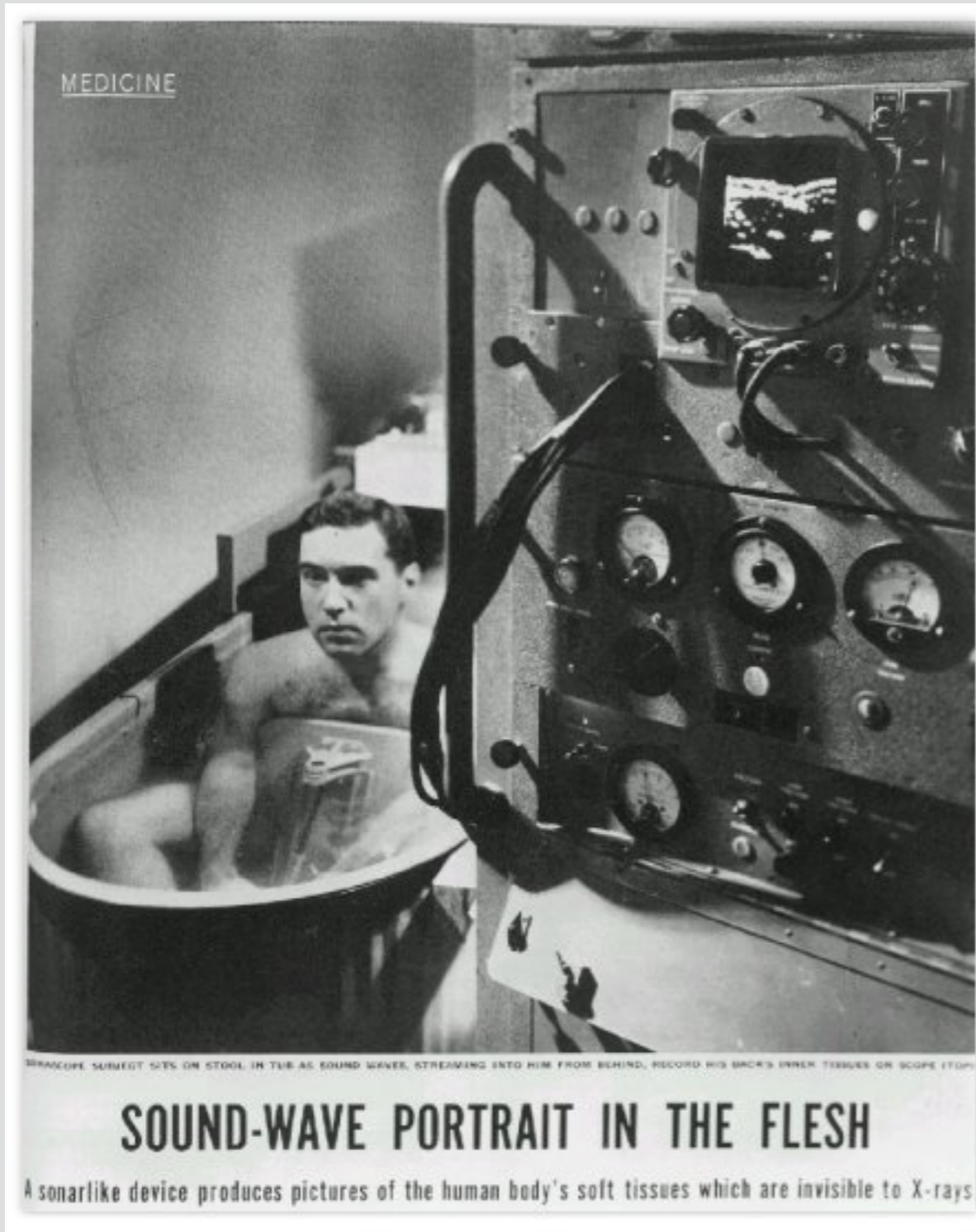
Taiwan



Conflict of Interest None



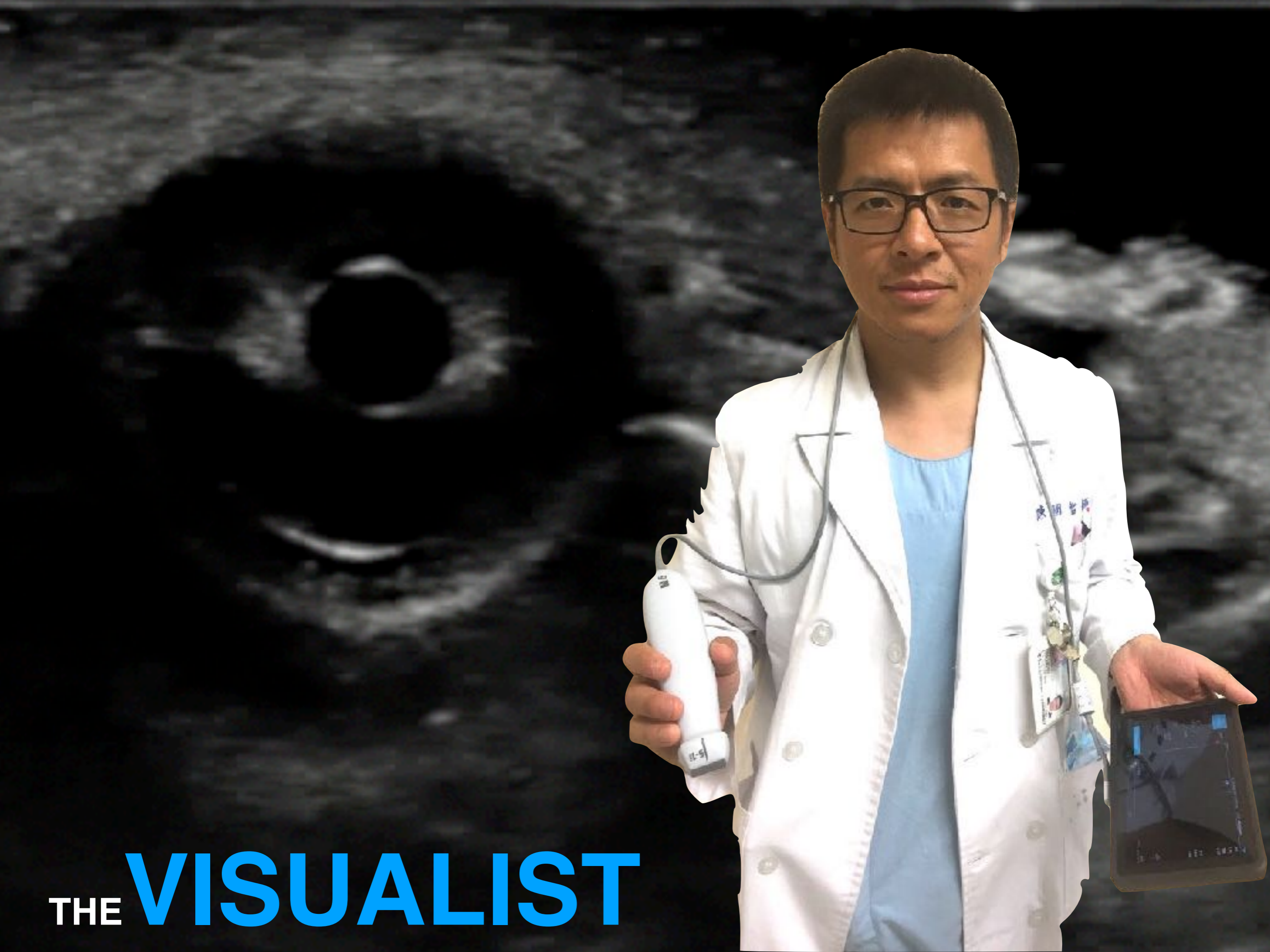
1954







Disruptive Innovation



THE **VISUALIST**

I-AIM

Indication

Acquisition

Interpretation

Making
decision

Transducers

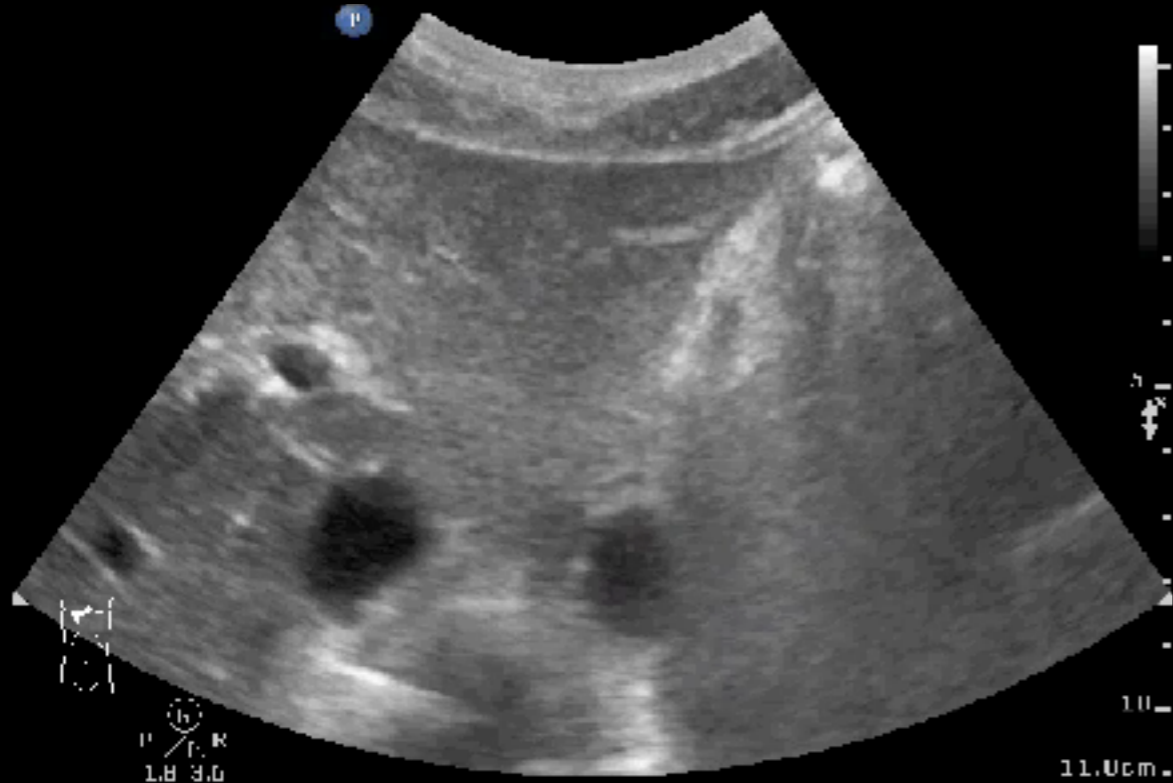


Target

Plane

Window

Abd Gen
0.5 1
42 Hz
11.0cm
2D
11Gen
Gn 100
0:56
3/3/3



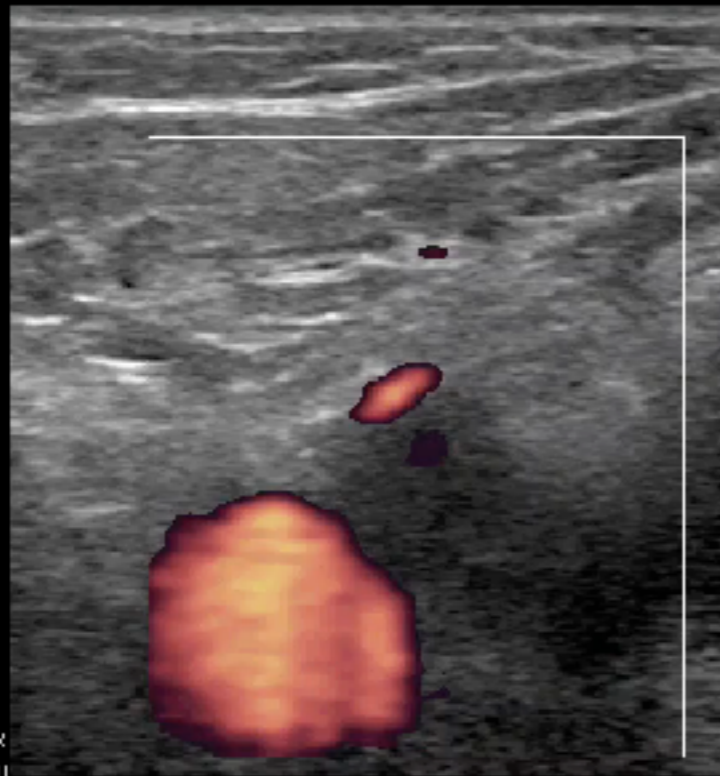
Abd Gen
0.5 1
42 Hz
11.0cm
2D
11Gen
Gn 100
0:56
3/3/3



Superficial
L12-3
24 Hz
4.0cm

2D
Res
Lin 76
F: 56
3/2/2

CPA
5.0 MHz
Lin 60
1/5/5
Fltr Med
Baseln 3

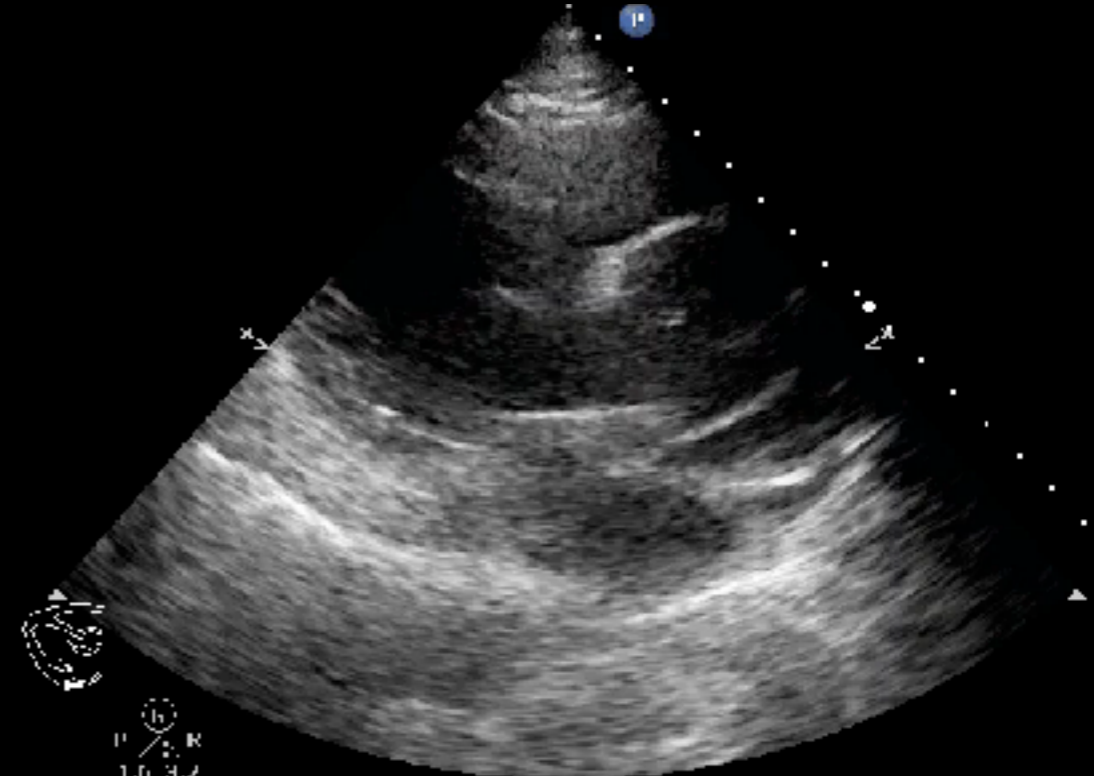


H
P R
3.0 12.0

0.8 Adult Echo
SS 1
31 Hz
17.0cm

2D
11Gen
Lin 50
F: 50
3/2/0

2
4.0cm



H
P R
1.0 3.2



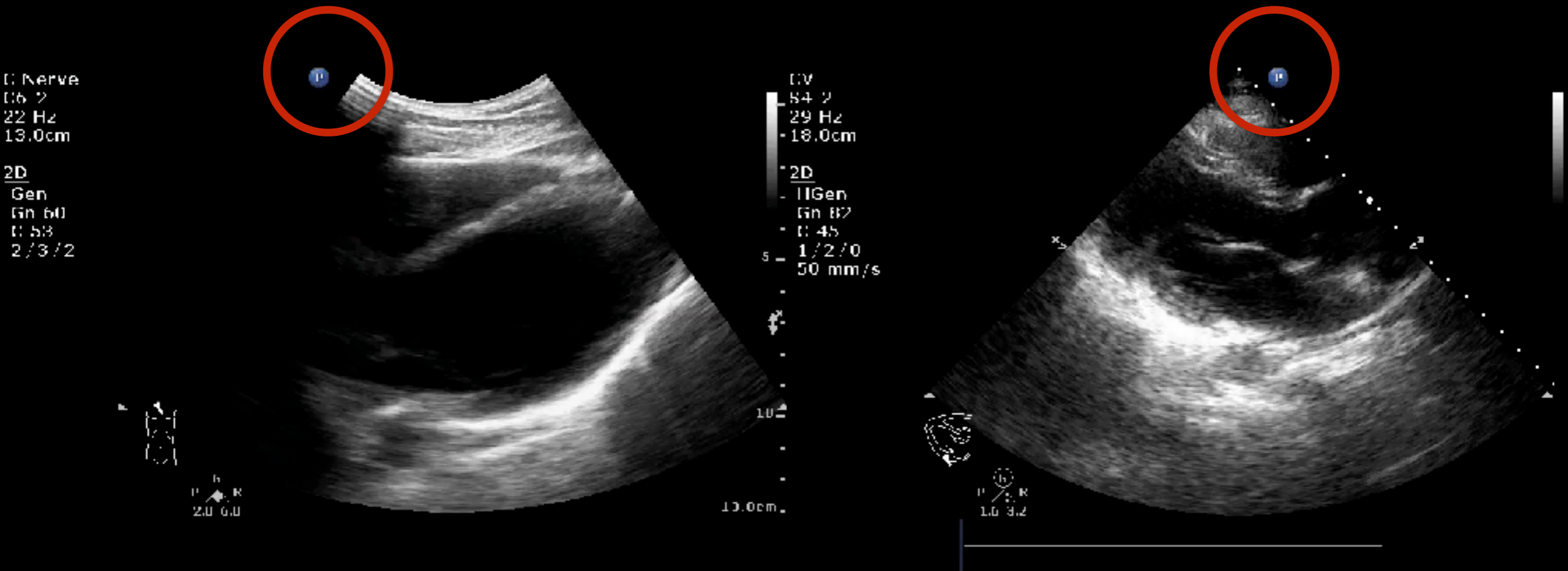
Indicator to right & head



Transducer
orientation
marker

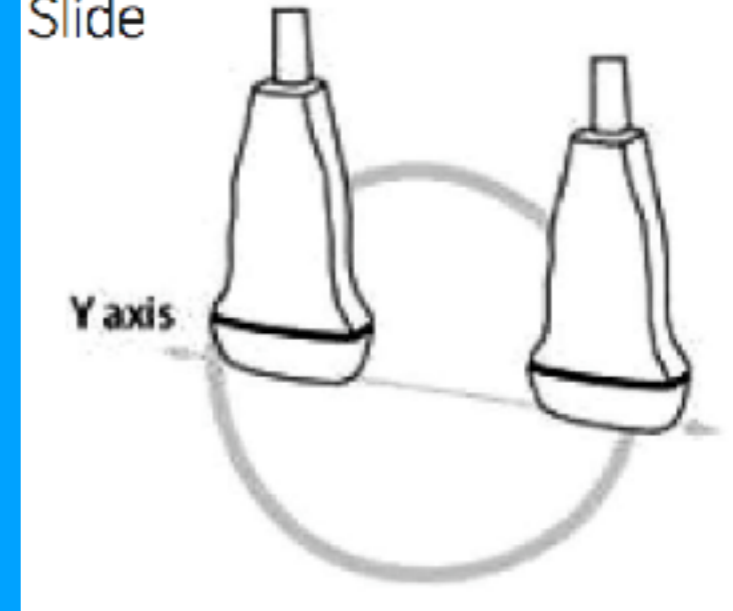
Attachment
point for
a needle guide

General v.s. Cardiac



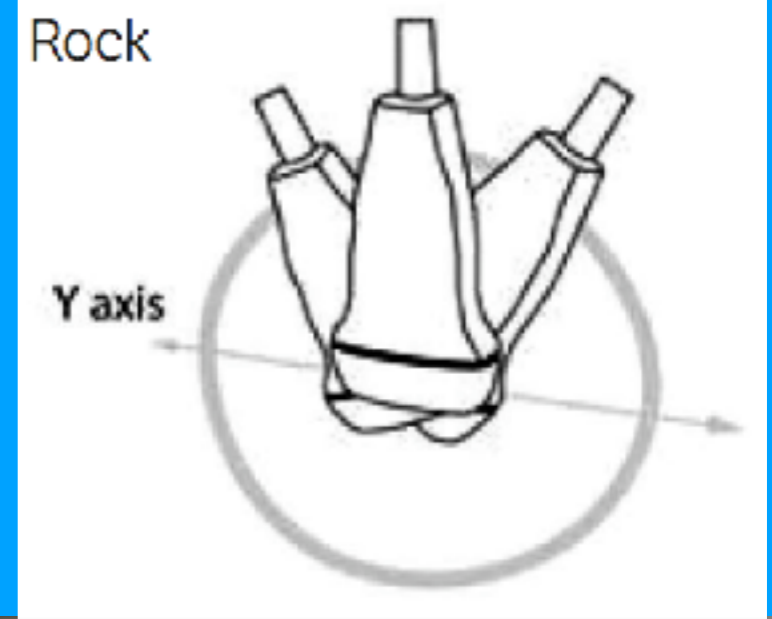
Slide

Y



Rock

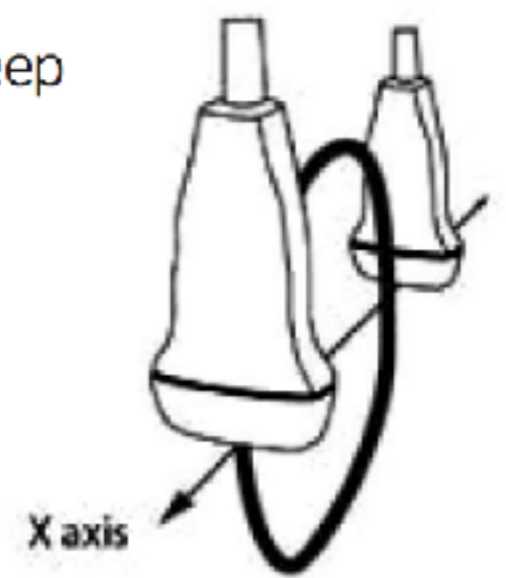
Y



Sweep

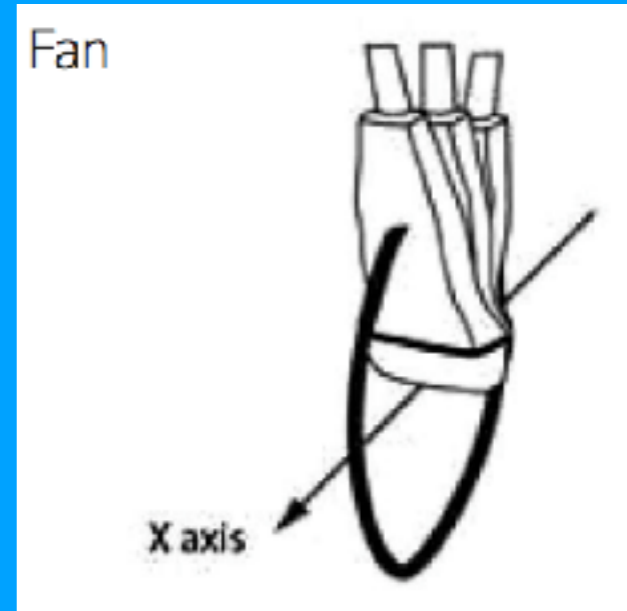
X

Sweep



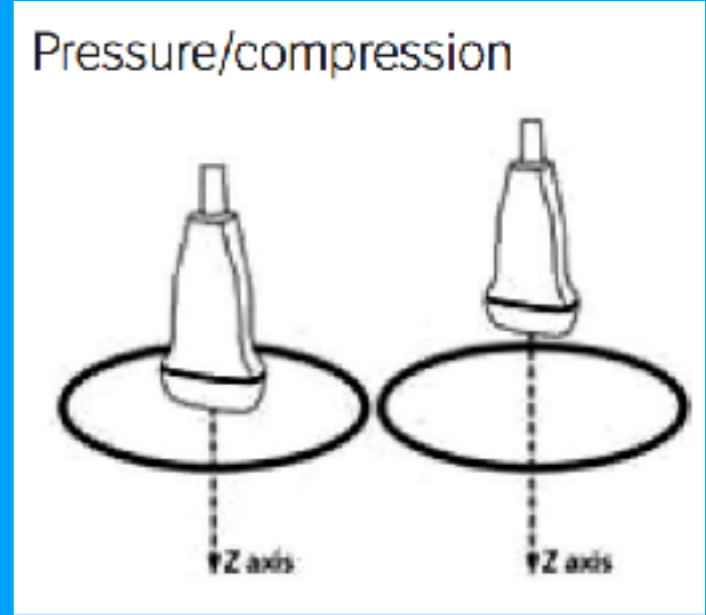
Fan

X



Pressure

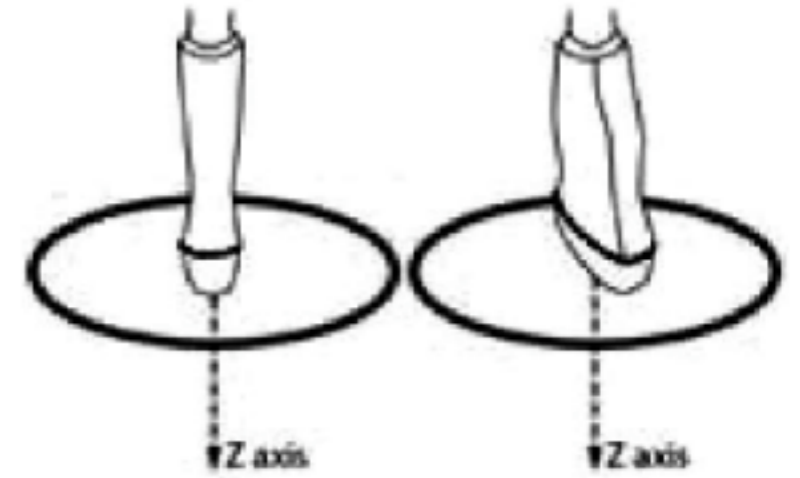
Z

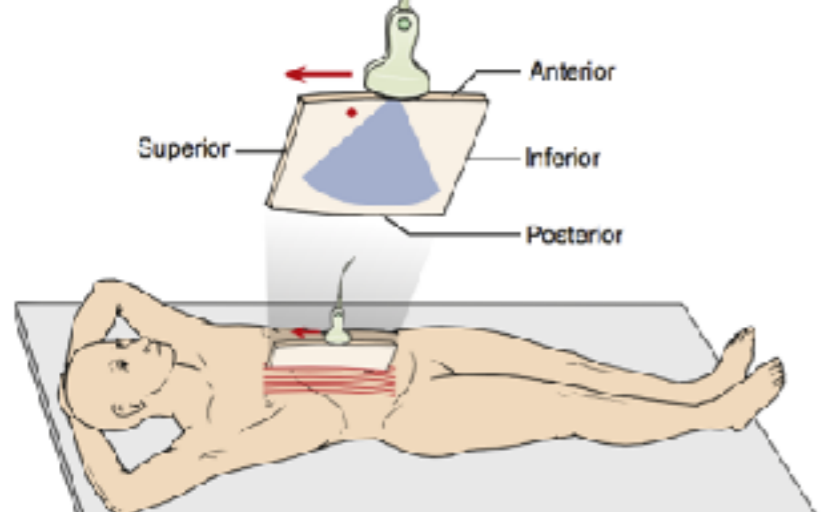


Rotation



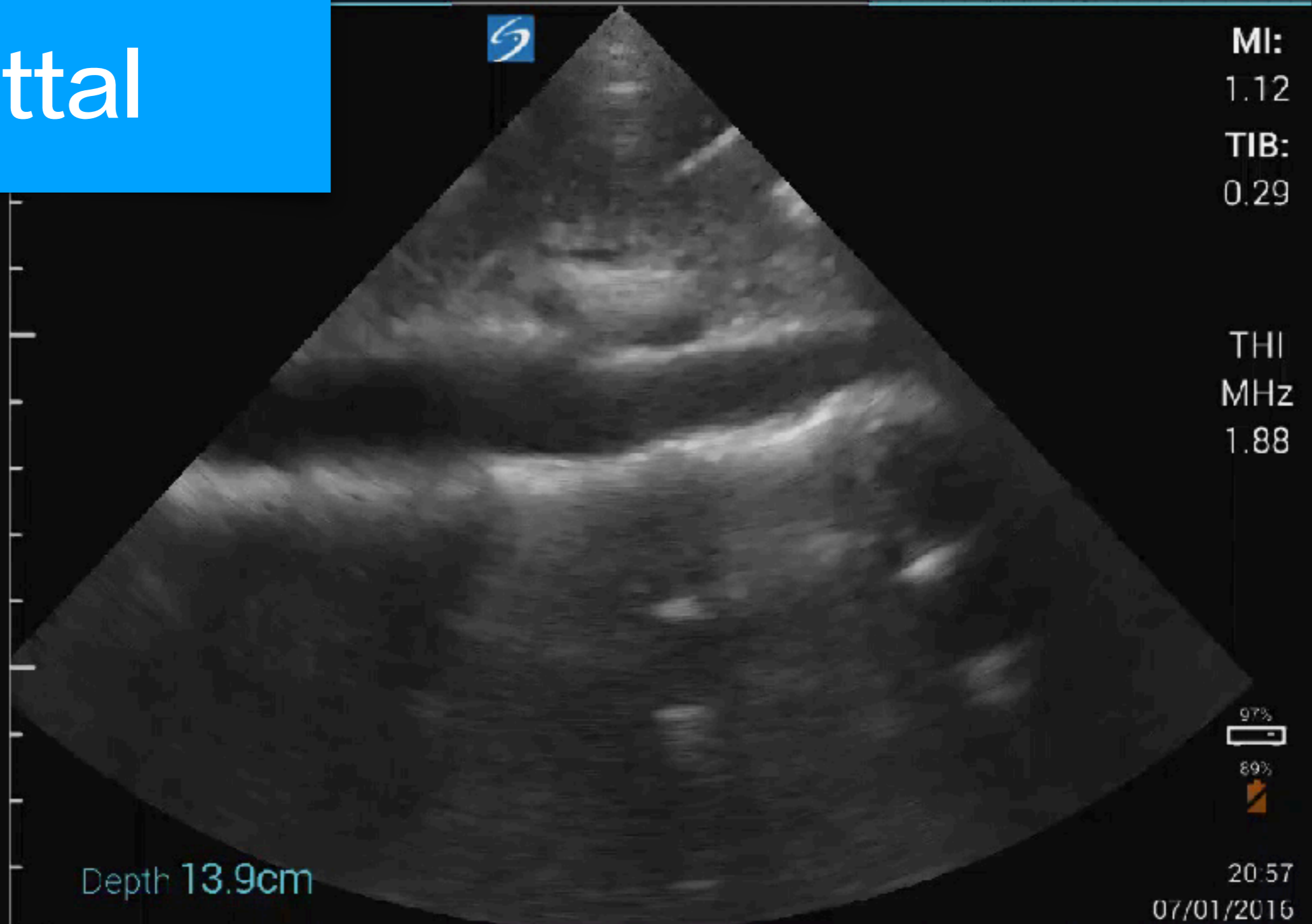
Rotation

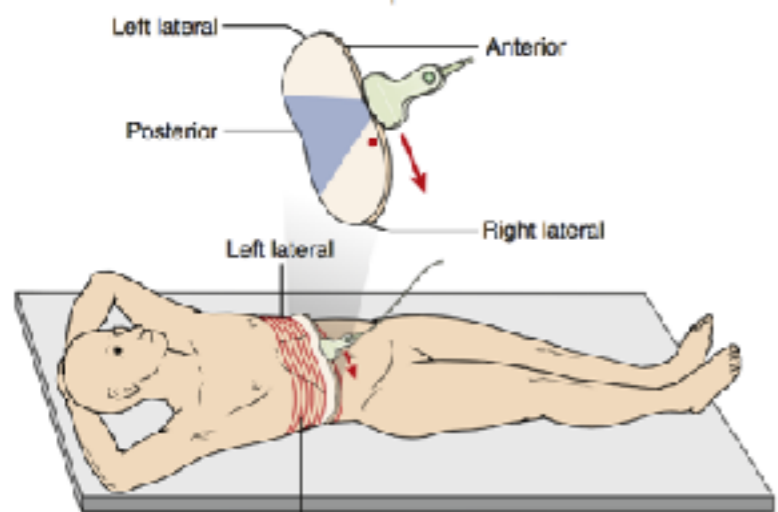




P21: Abdomen

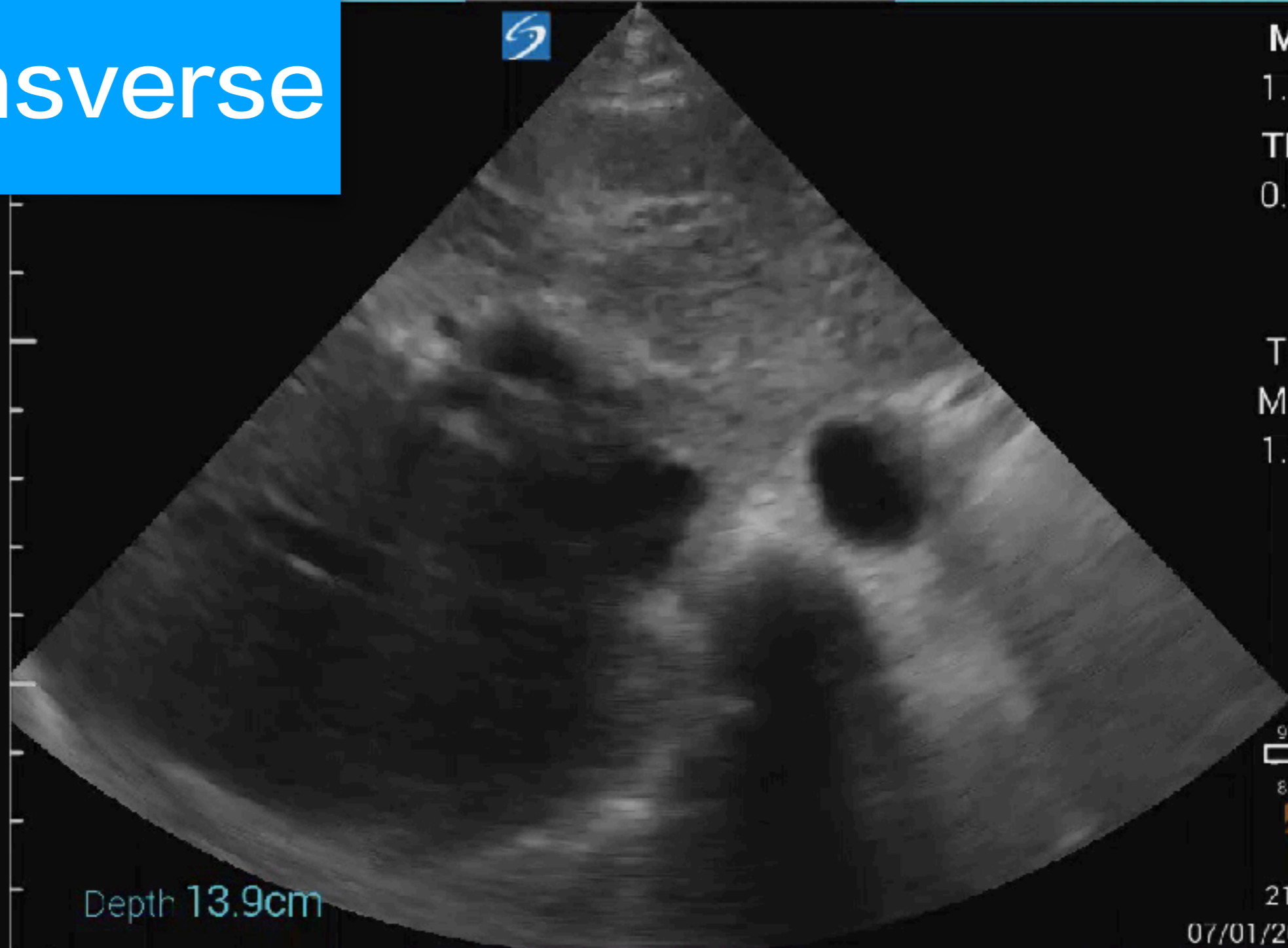
Sagittal





Transverse

P21: Abdomen



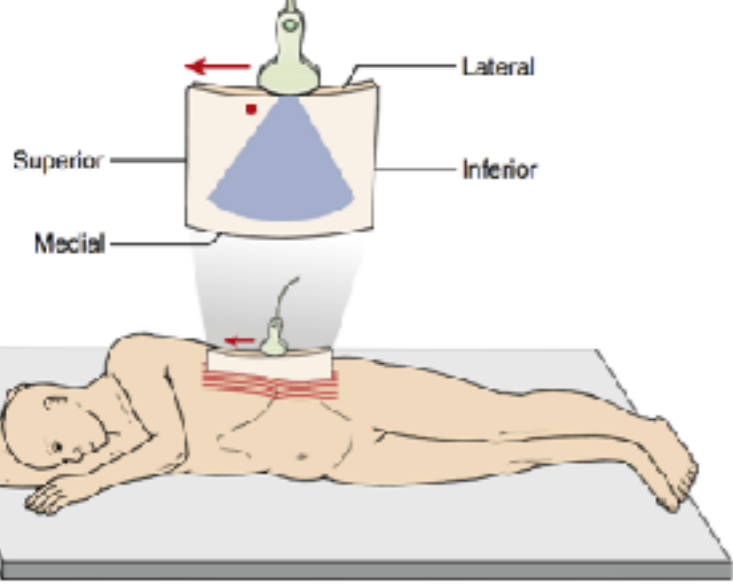
MI:
1.12
TIB:
0.29

THI
MHz
1.88

Depth 13.9cm

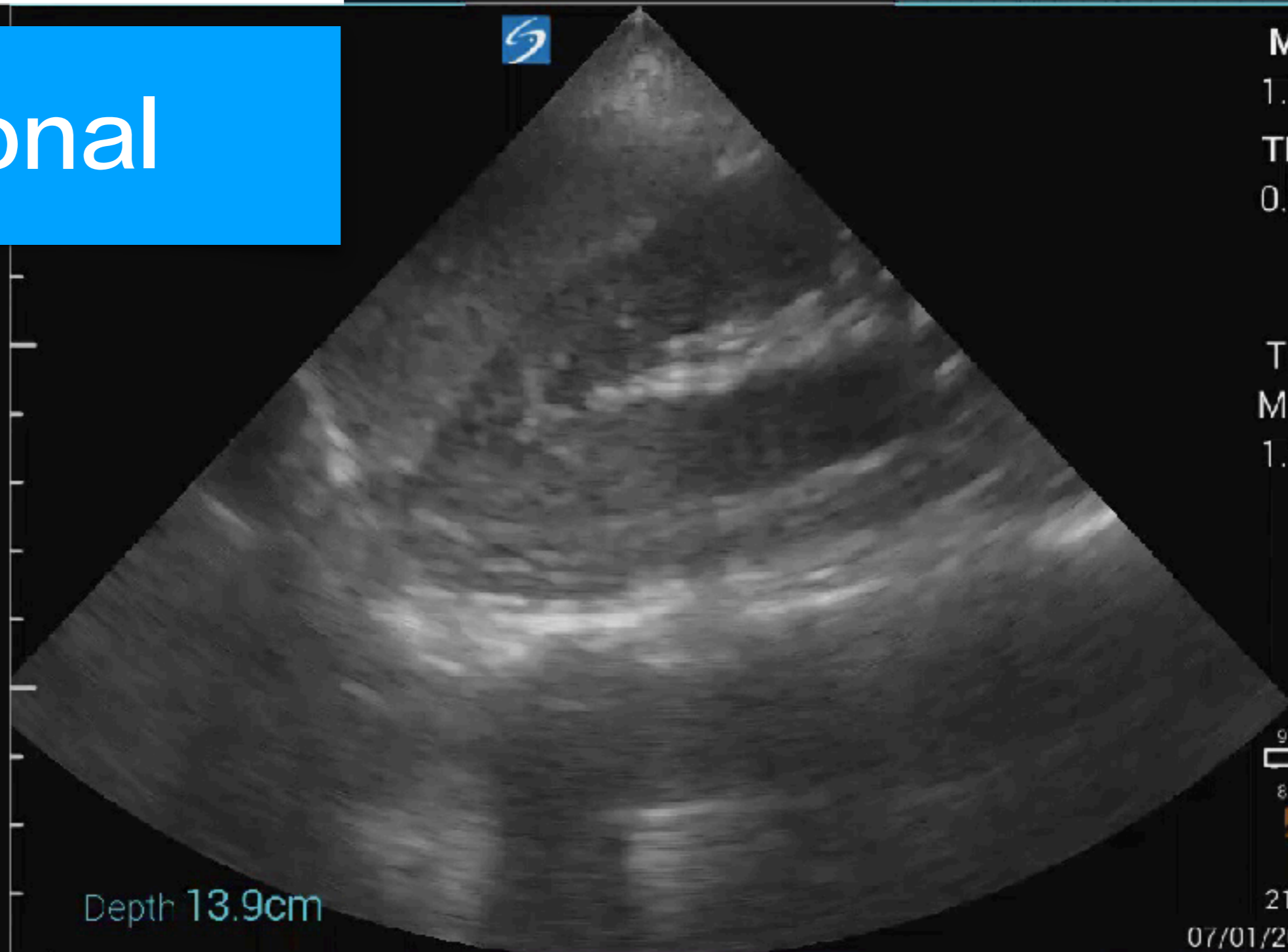
97%
82%

21:02
07/01/2016



P21: Abdomen 

Coronal



MI:
1.12
TIB:
0.29

THI
MHz
1.88

Depth 13.9cm

97% 
83% 

21:01
07/01/2016

How to create
a good **window** ?

Copious Gel



Plastic IV Bag



Glove & Tap water



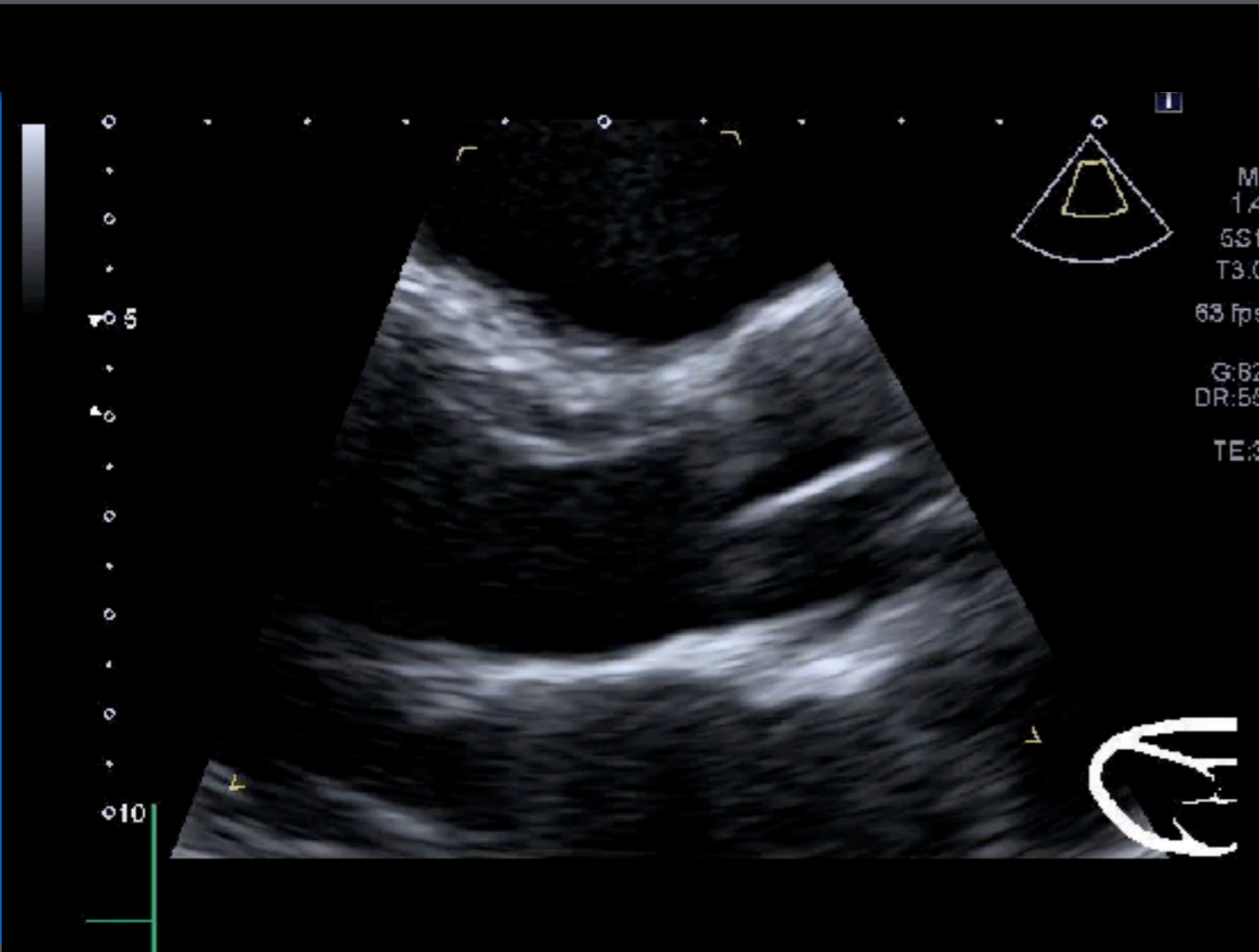
PHOTOALTO / ALE VENTURA / GETTY IMAGES



4
331p
DR7
2D
8



Zoom



POCUSAcademy©ChenKC

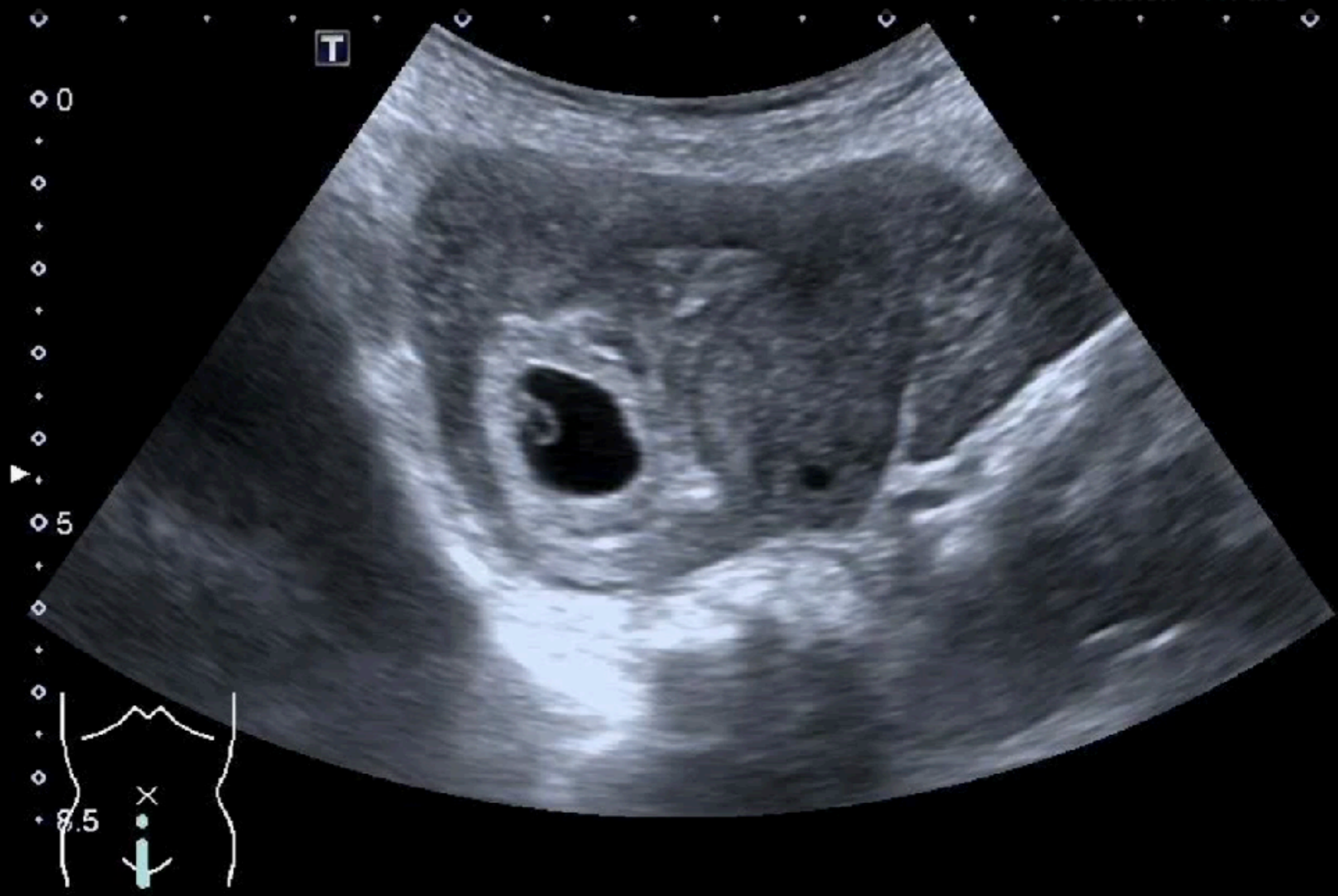
Precision A Pure+

T

0

5

8.5

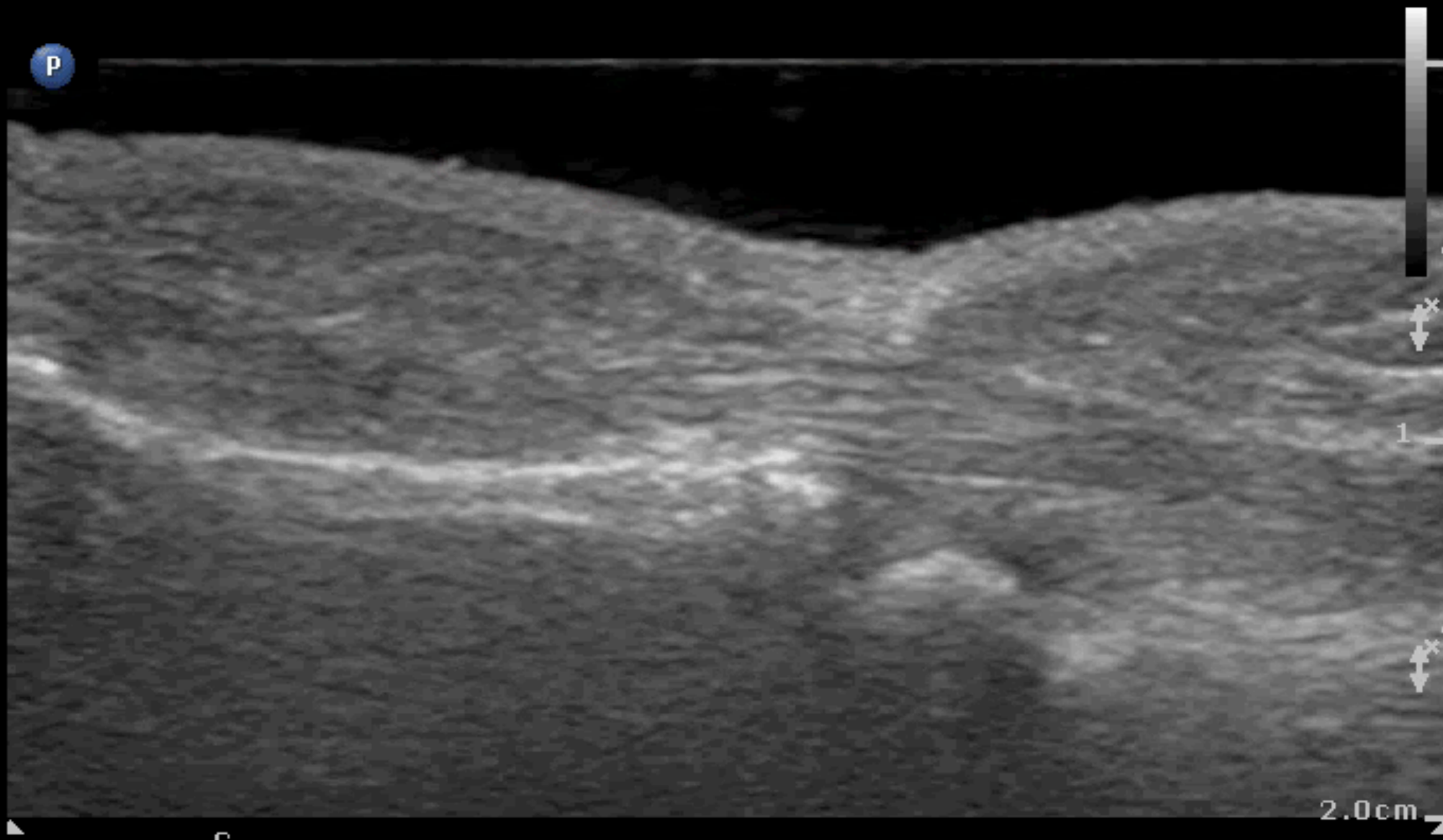


27
Q
C
D

Water Bath

Superficial
L12-3
50 Hz
2.0cm

2D
Res
Gn 60
C 57
3 / 2 / 1



Water Bath

50 Hz
2.0cm

2D

Res
Gn 60
C 56
3 / 2 / 1



G
P R
3.0 12.0

2.0cm

Water Bath



Indication

How to improve

Image Quality

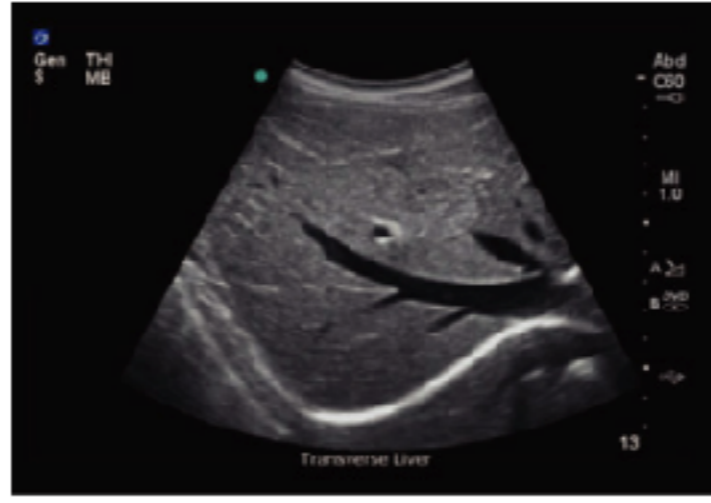
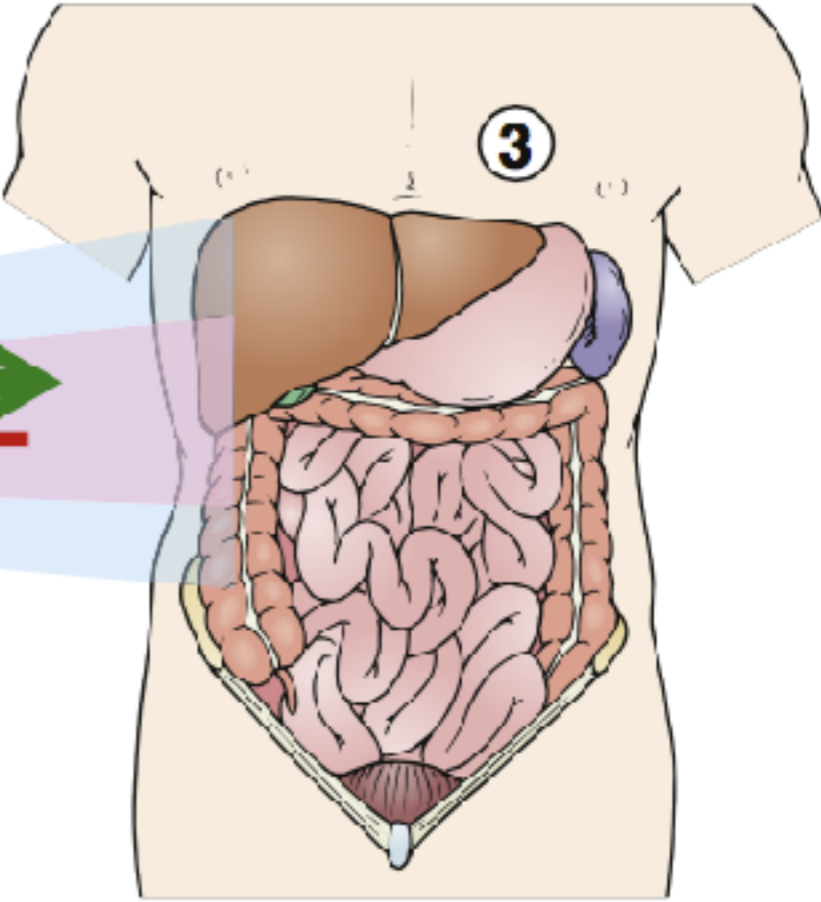
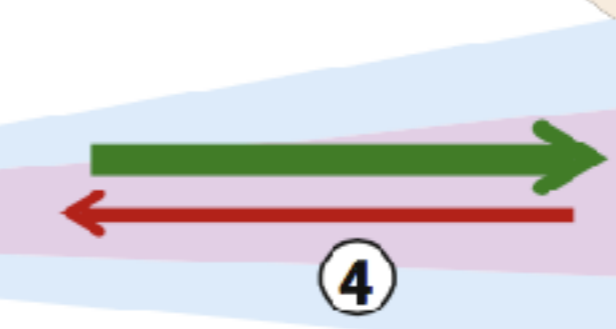
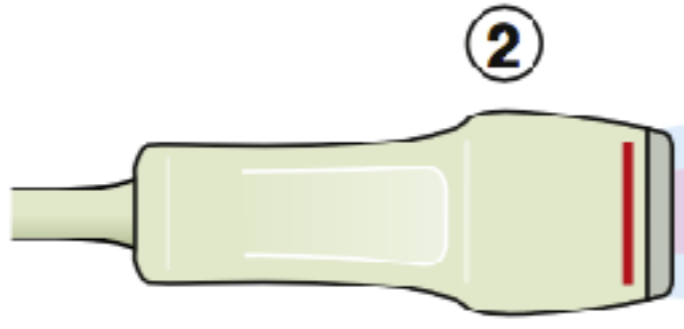
Acquisition

Interpretation

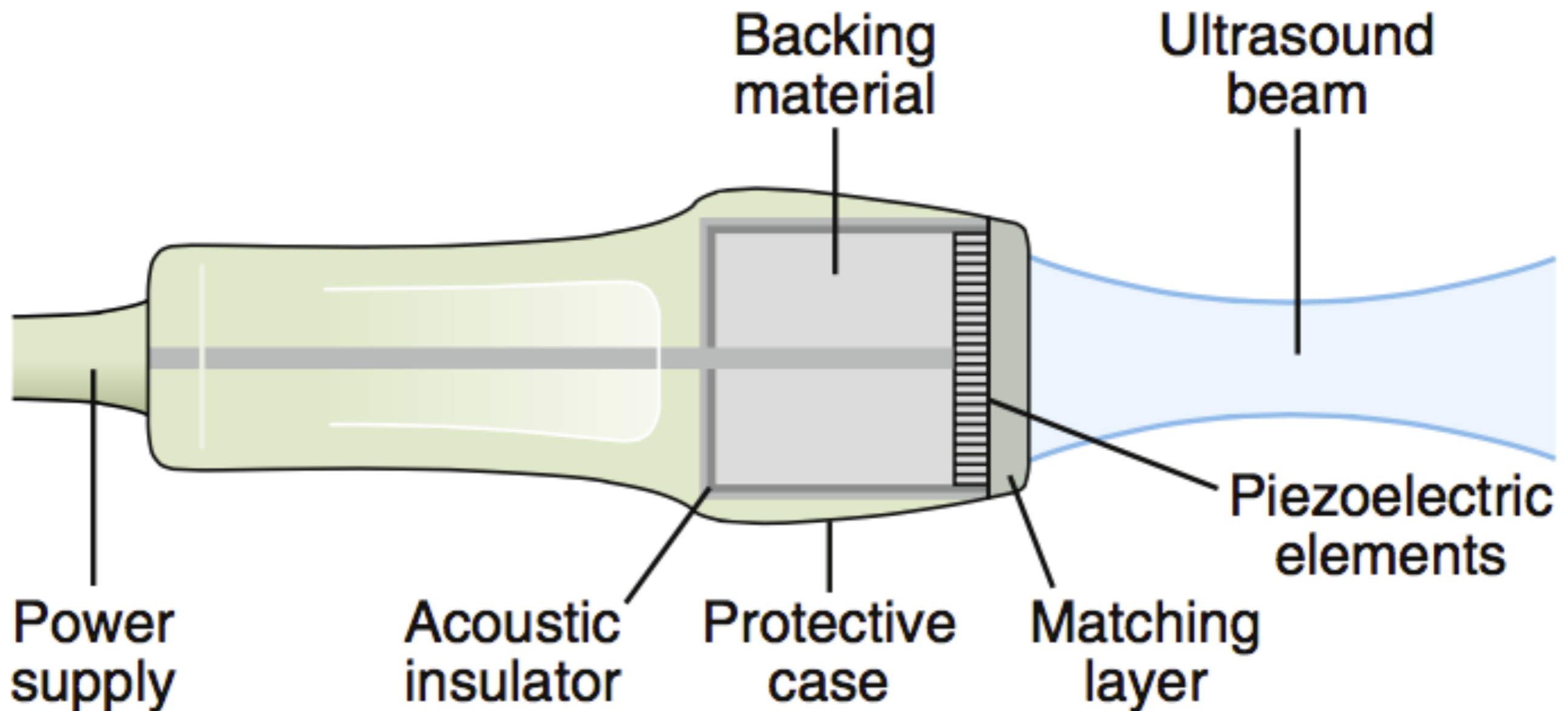
Making
decision

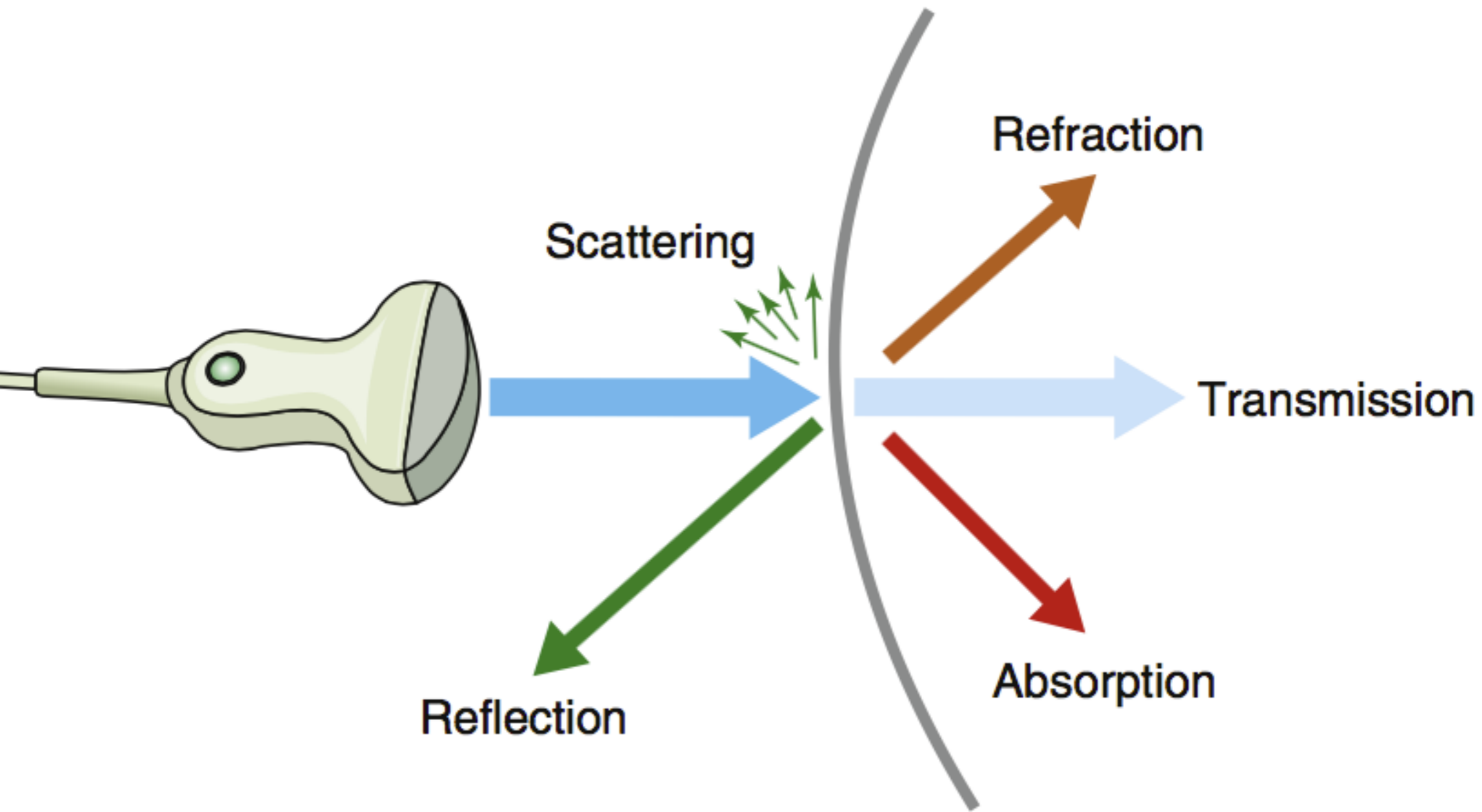
US > 20 kHz

① Electricity

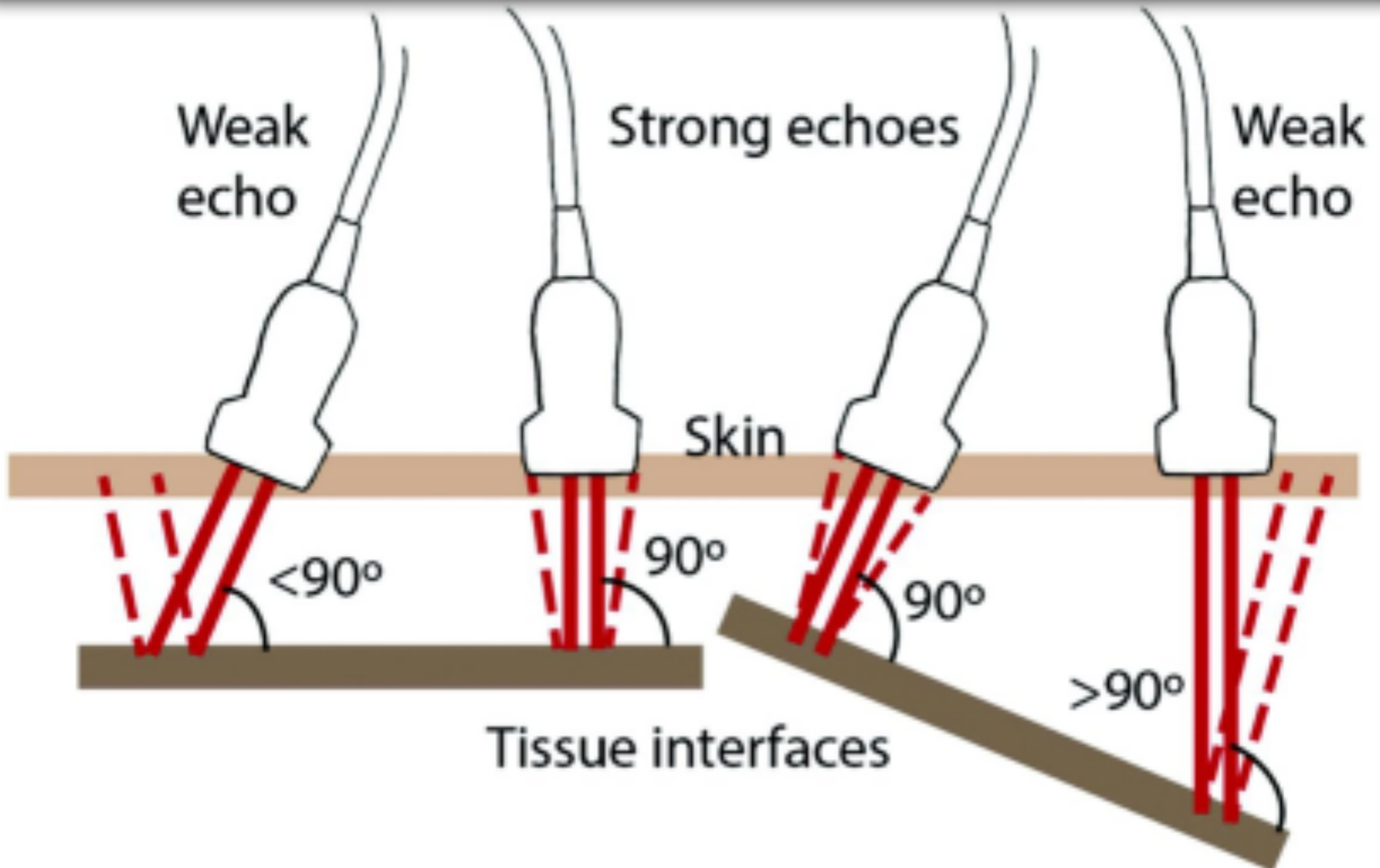


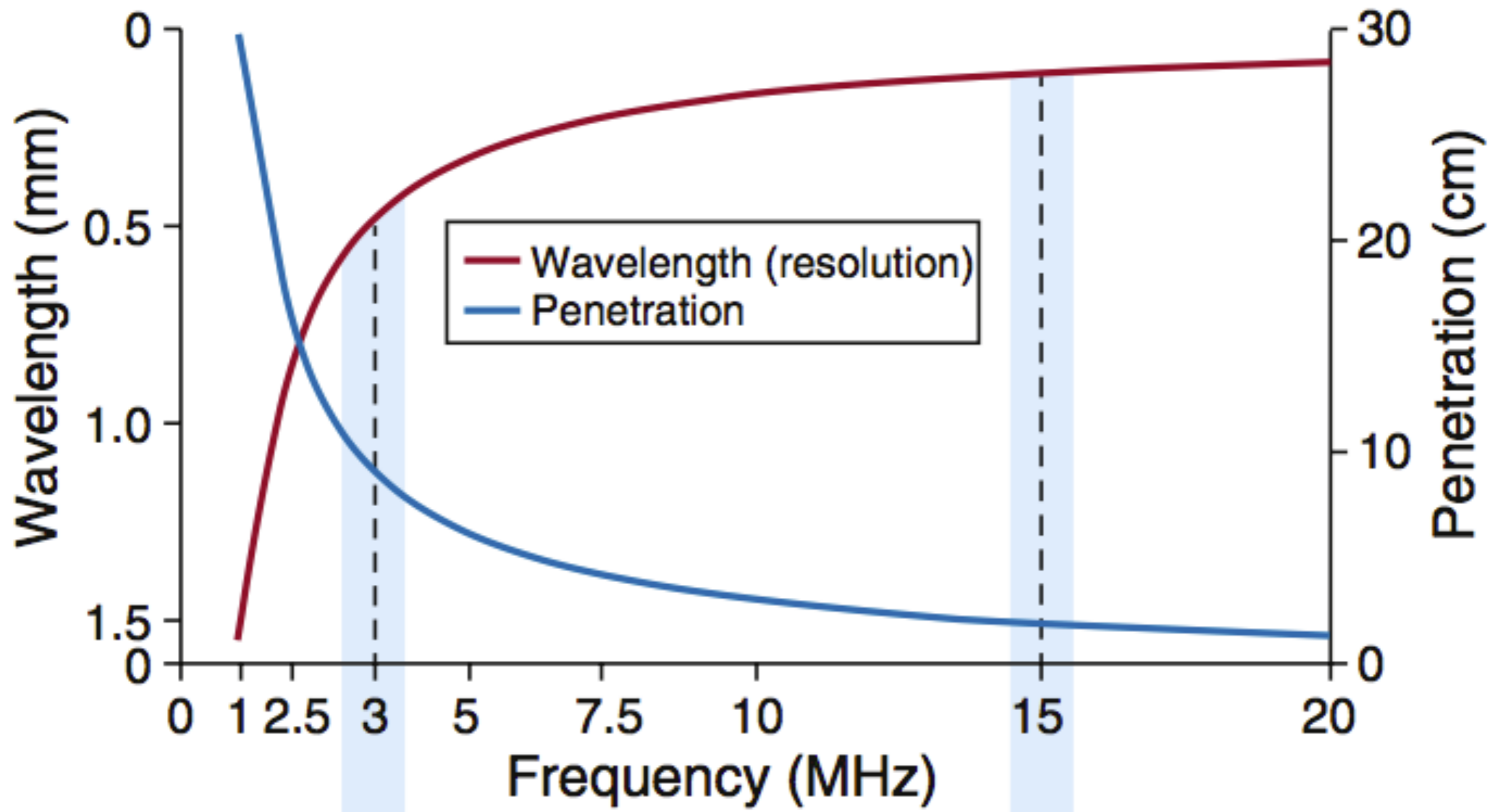
Transducer





Perpendicular to the target





Low-frequency transducer



High-frequency transducer



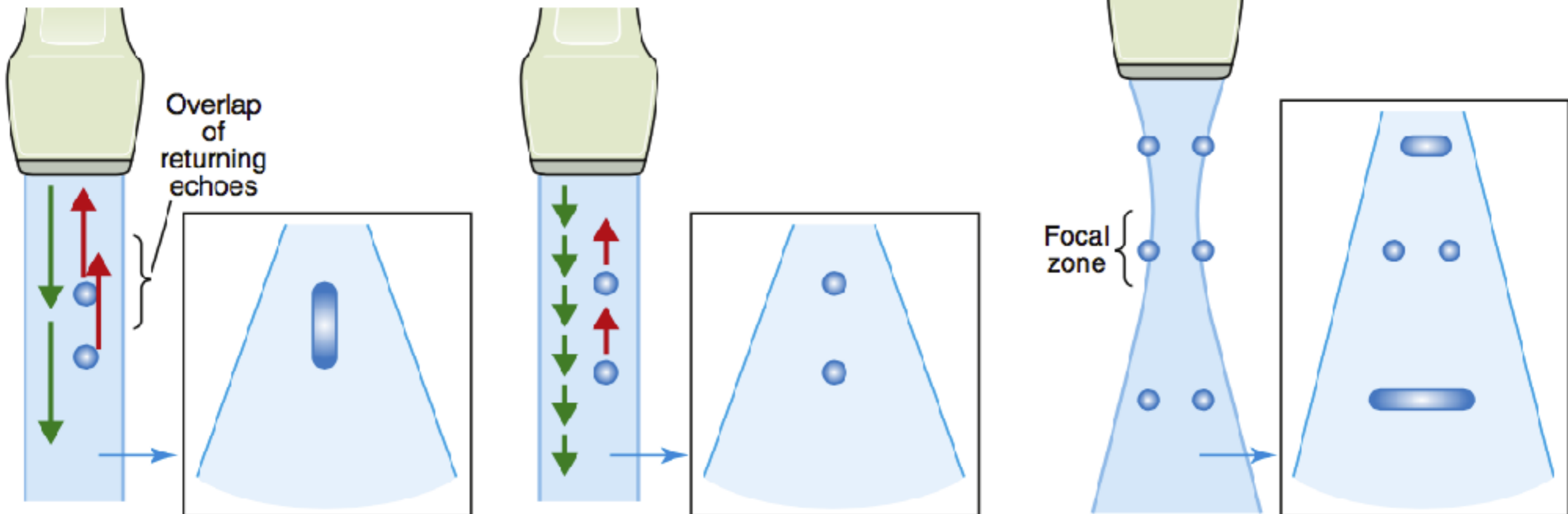
Resolution

Axial resolution

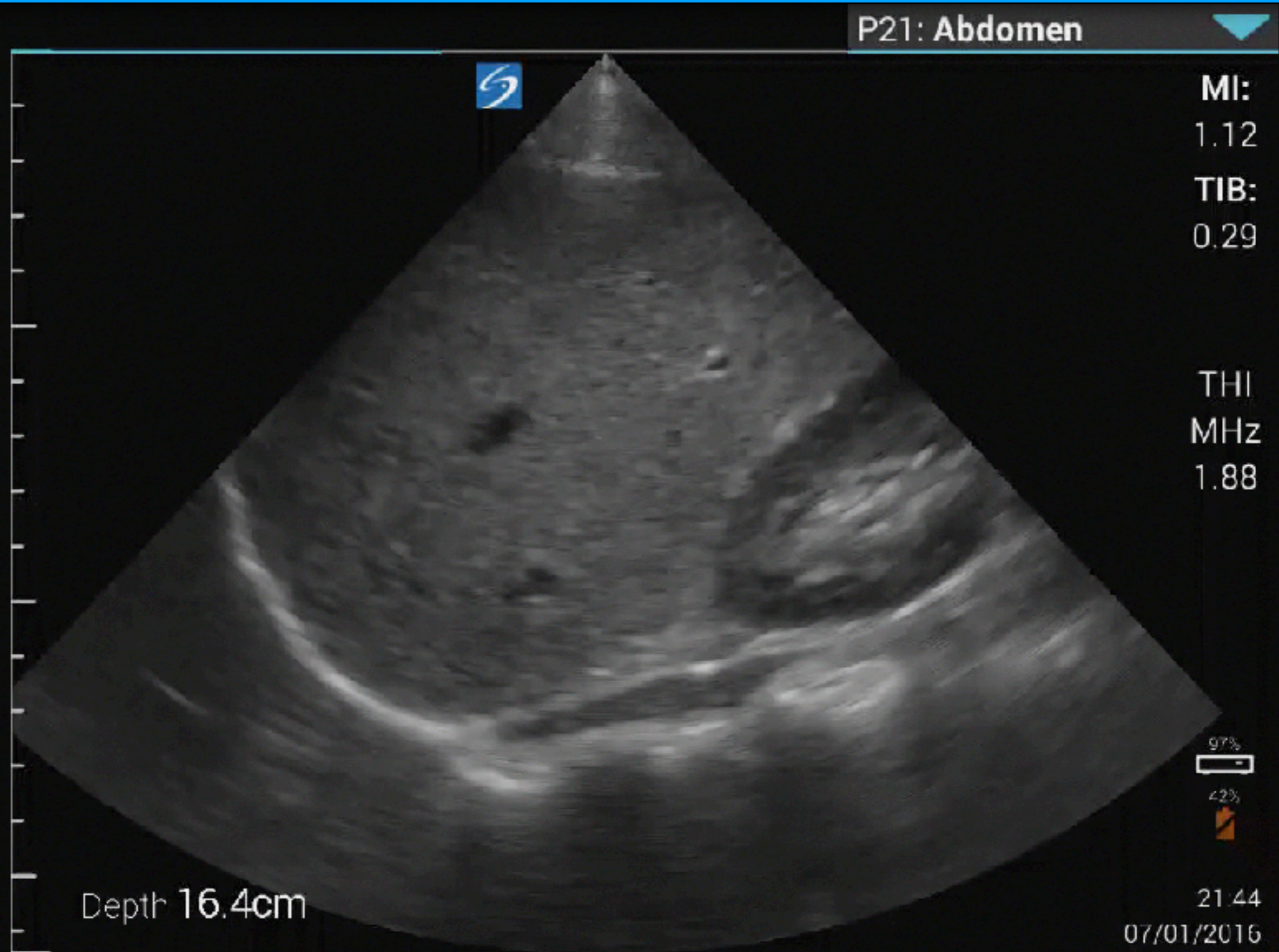
Lateral resolution

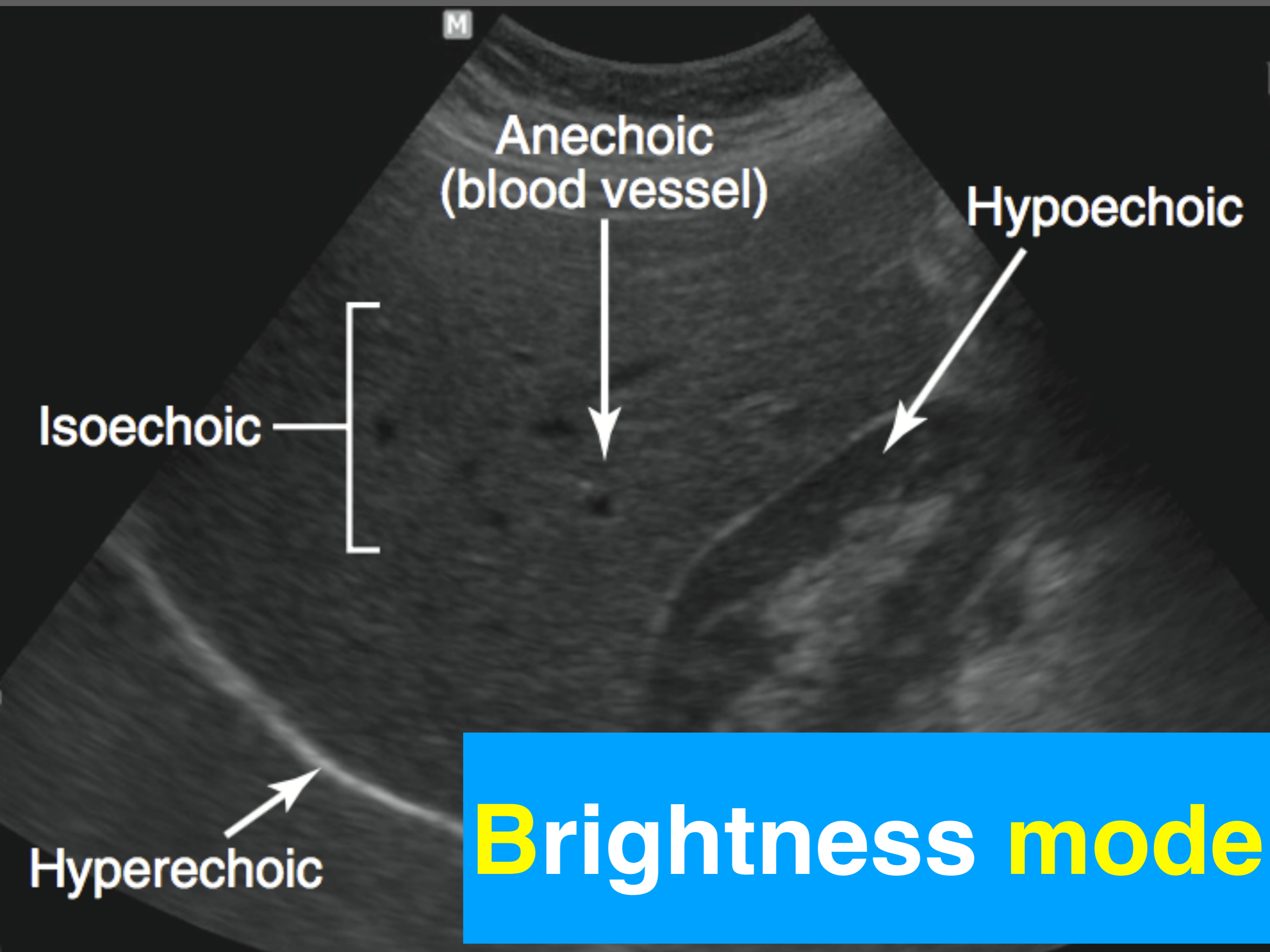
Lower frequency

Higher frequency



Mode & Echogenicity ?





Anechoic
(blood vessel)

Hypoechoic

Isoechoic

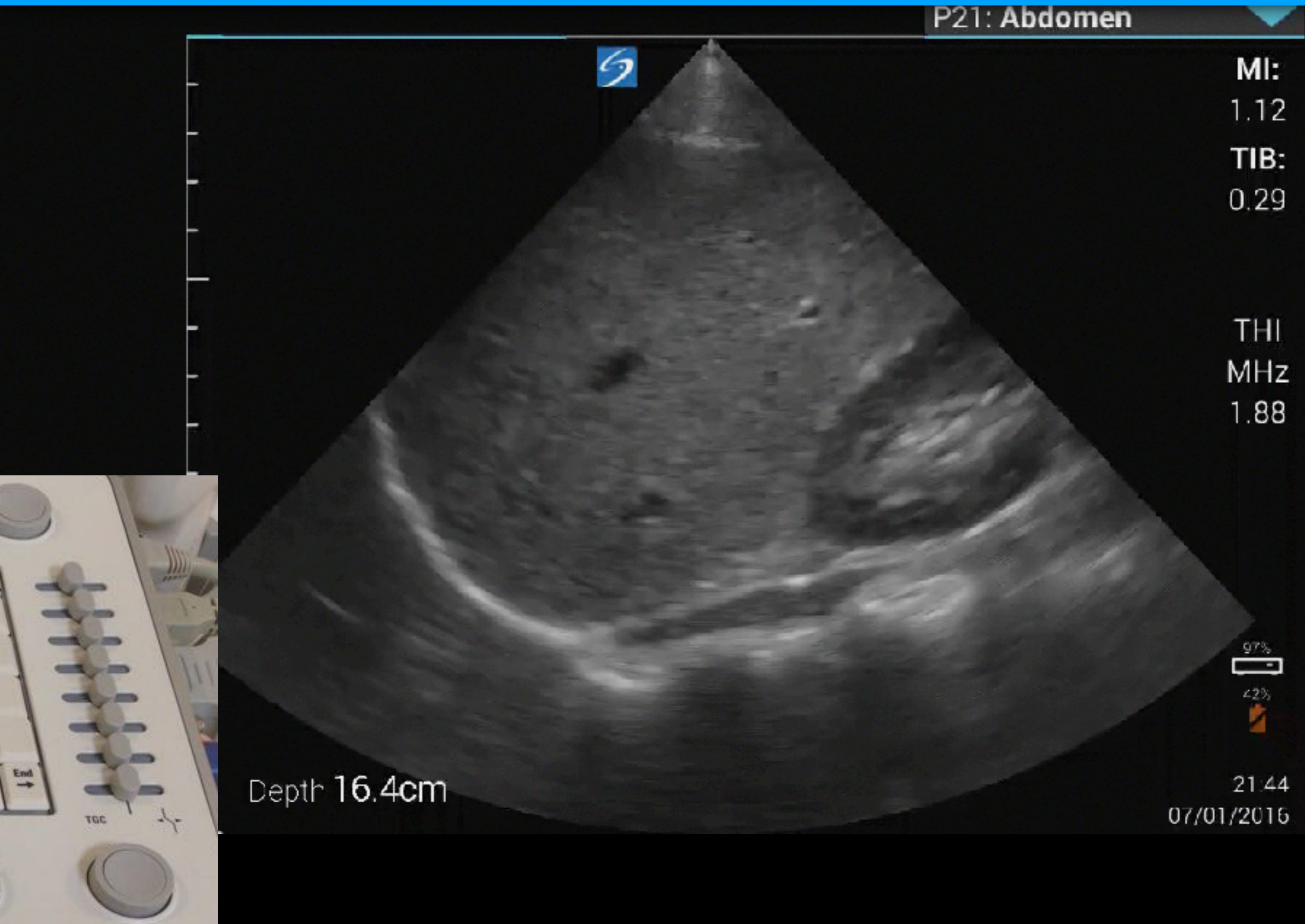
Hyperechoic

Brightness mode

Attenuation

Tissue or Material	Attenuation (dB/cm/MHz)
Water	0.0022
Blood	0.15
Soft tissues	0.75
Air	7.50
Bone	15.00

Time Gain Compensation



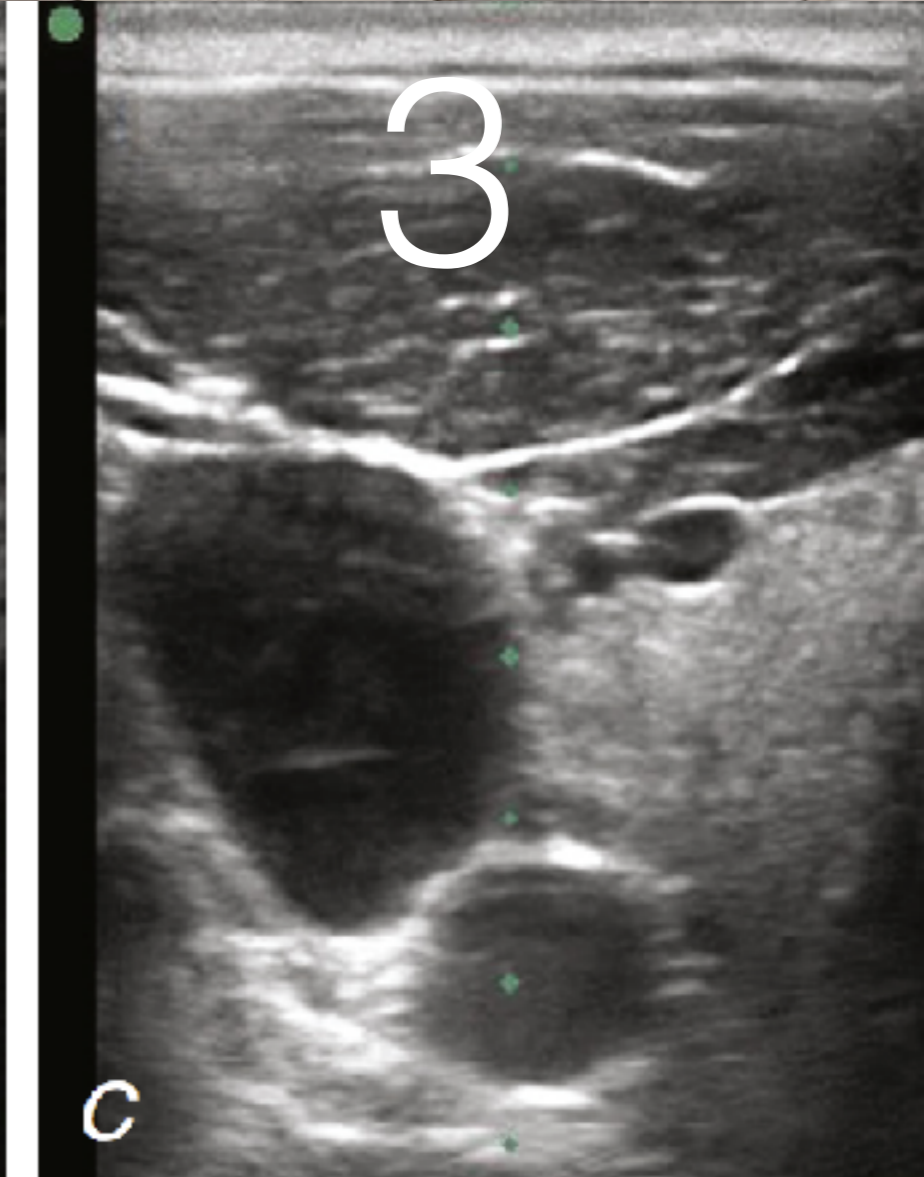
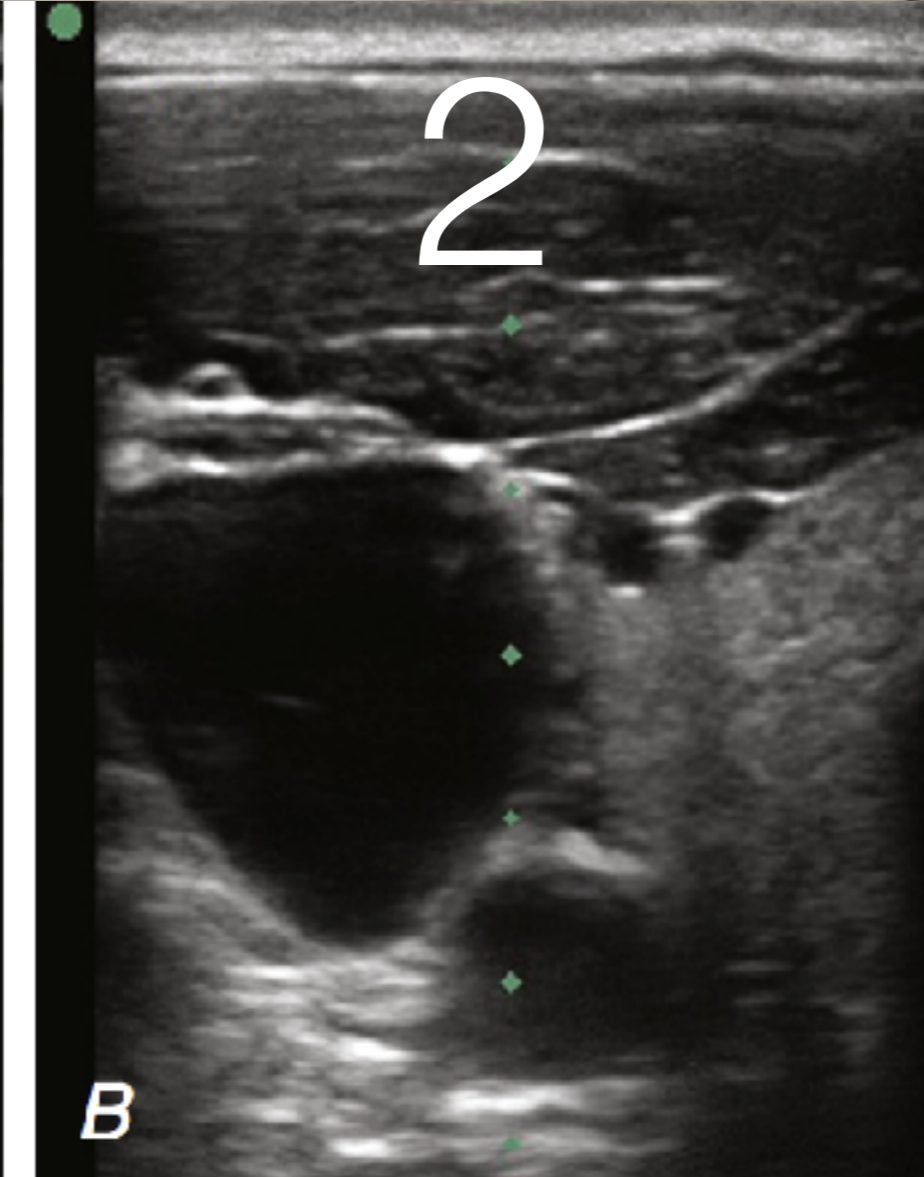
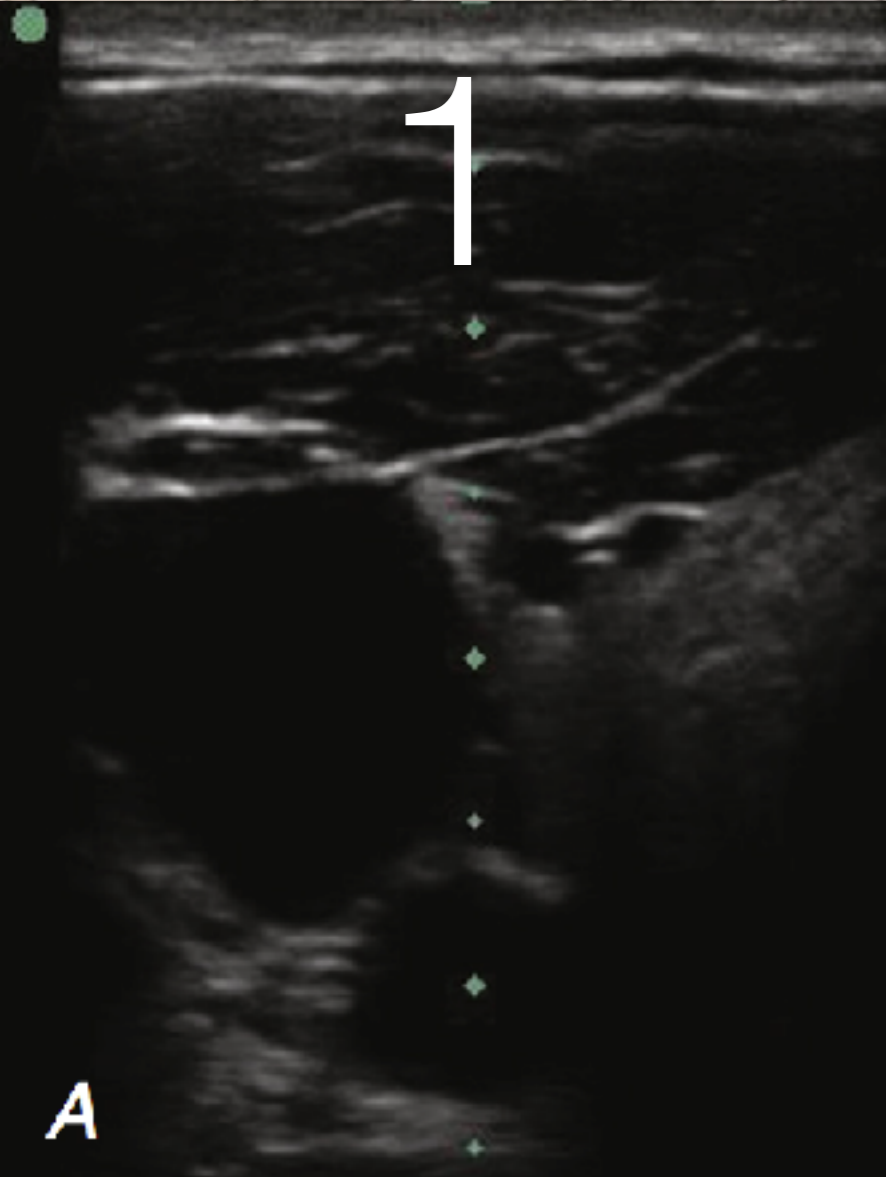
Knobology



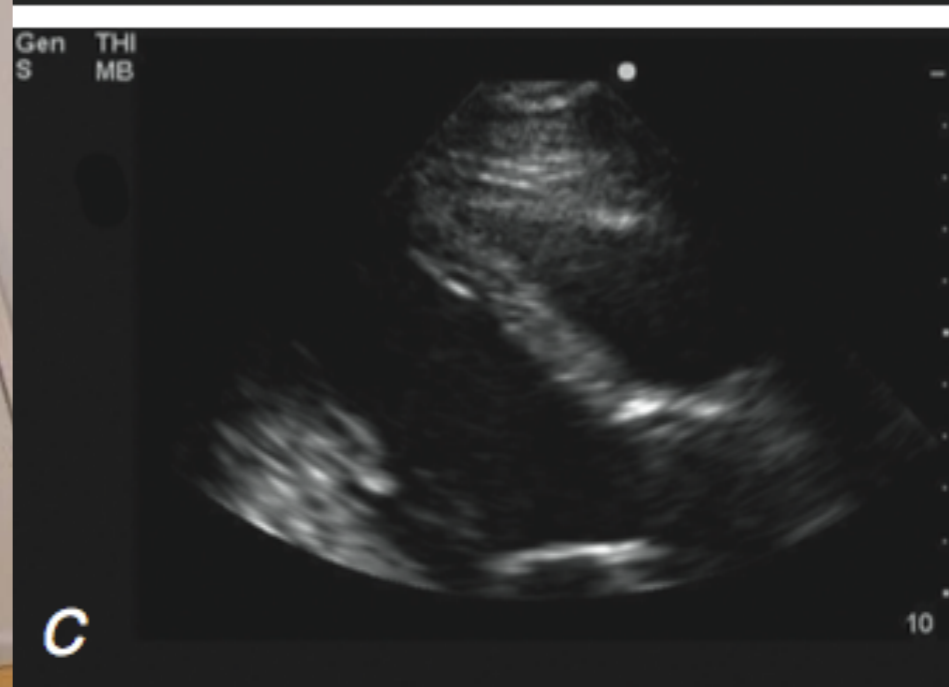
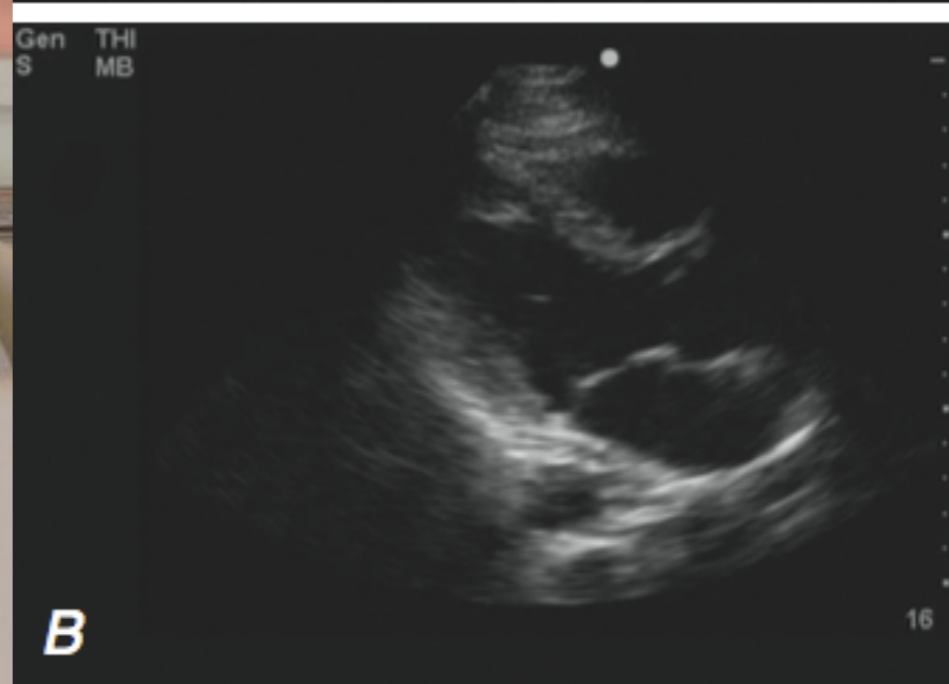
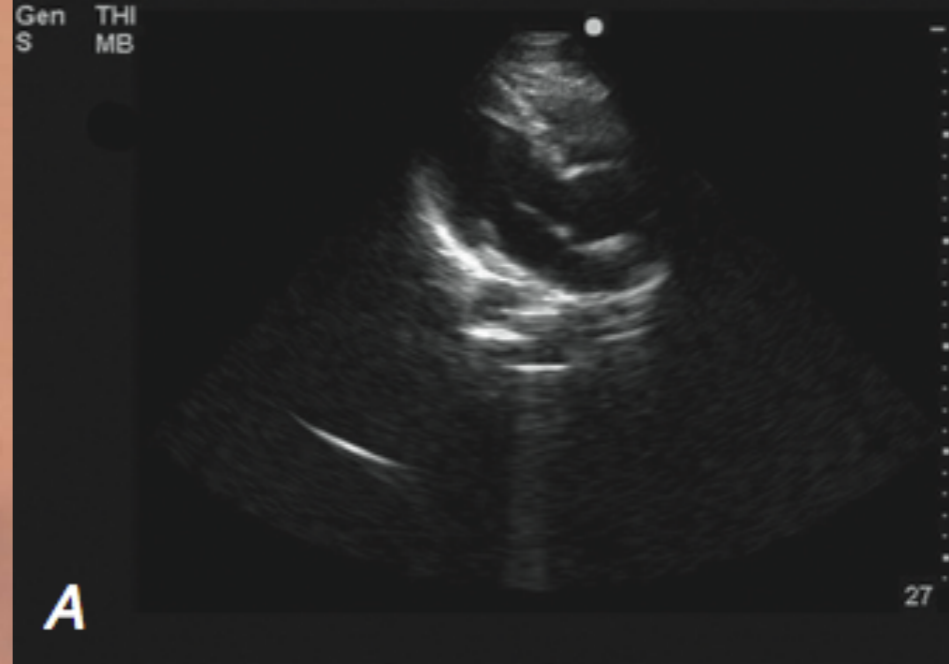
Knobology ?



Best image ?



Best image ?



Impedance

HGen
Gn 63
C 56
3/3/3

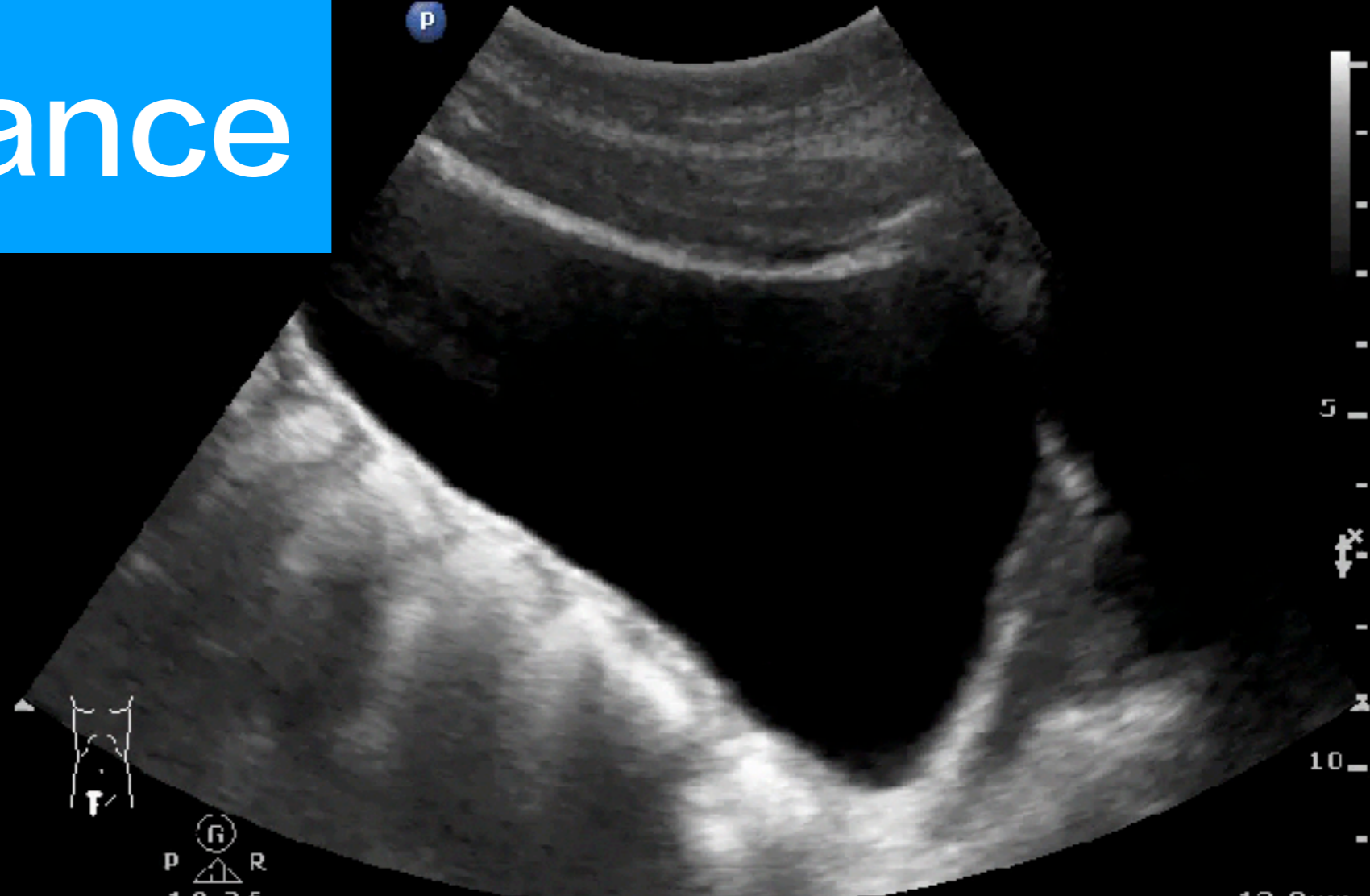
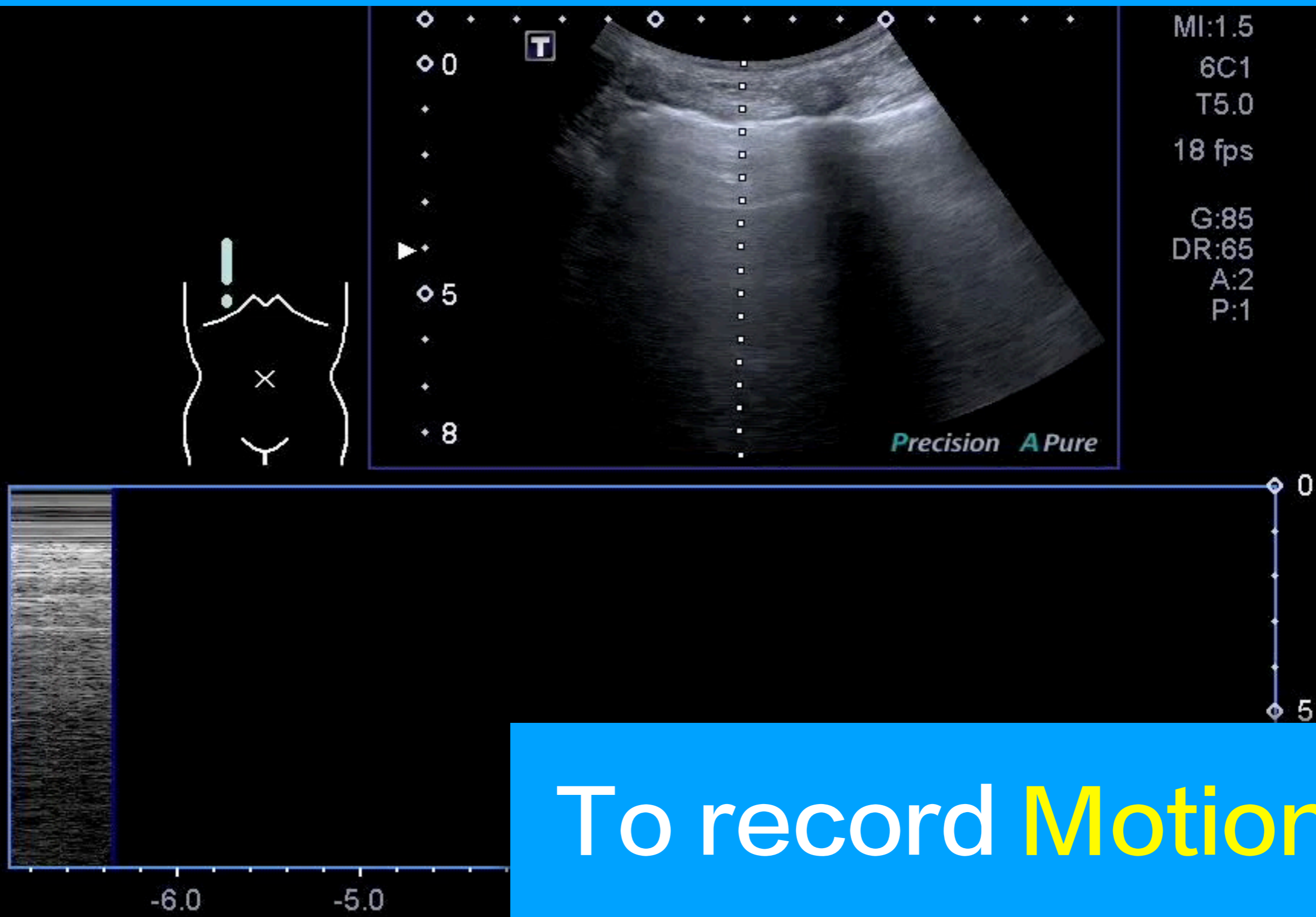


TABLE 2.1 ■ Acoustic Impedance of Different Tissues⁶⁻⁸

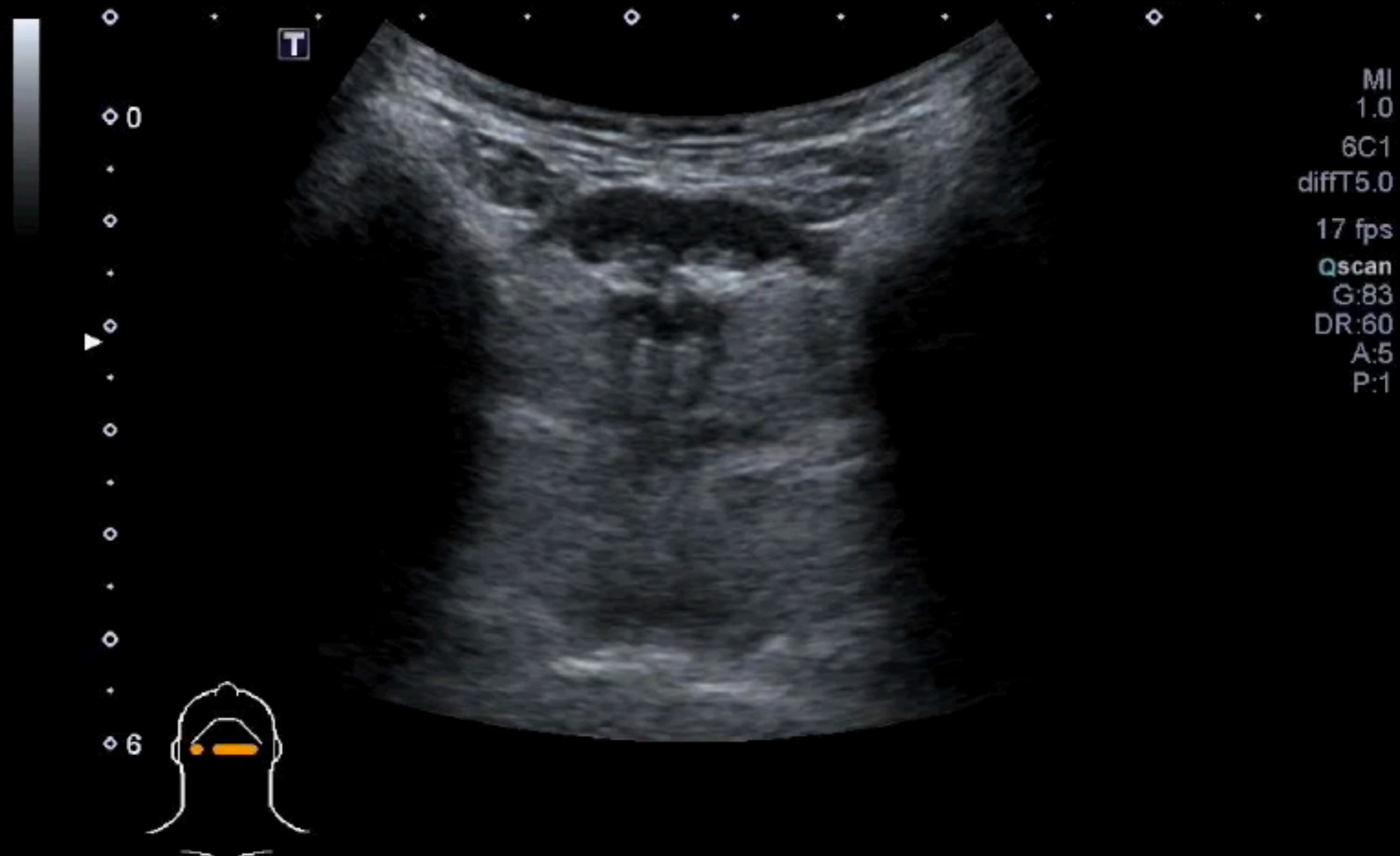
Tissue or Material	Density (g/cm ³)	Speed of Sound (m/s)	Acoustic Impedance (kg/(s m ²)) × 10 ⁶
Air	0.001225	340	0.0004
Fat	0.95	1450	1.38
Blood	1.055	1575	1.66
Liver	1.06	1590	1.69
Bone	1.9	4080	7.75
Metal (e.g., titanium)	4.5	5090	22.9

Motion mode

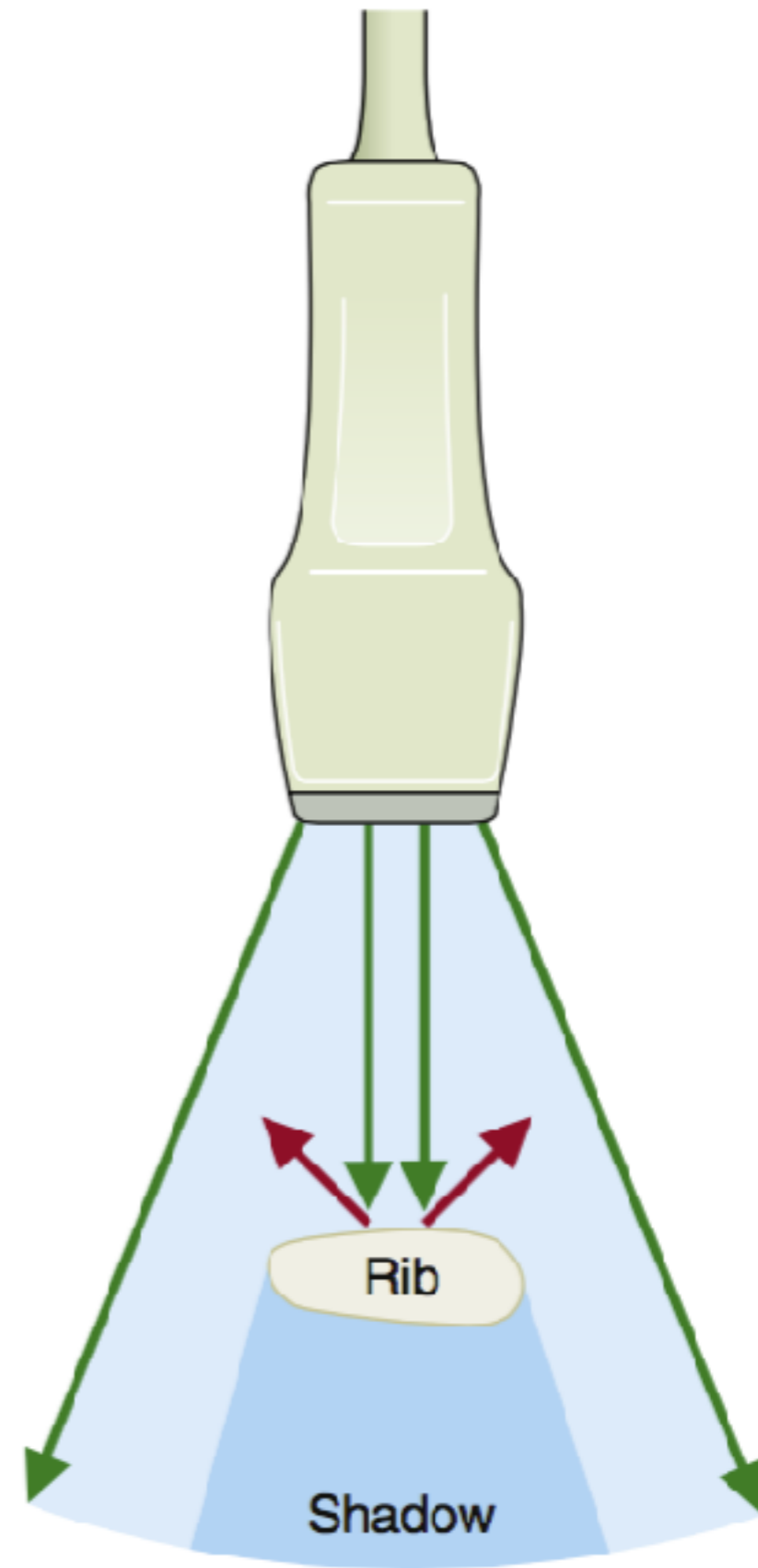
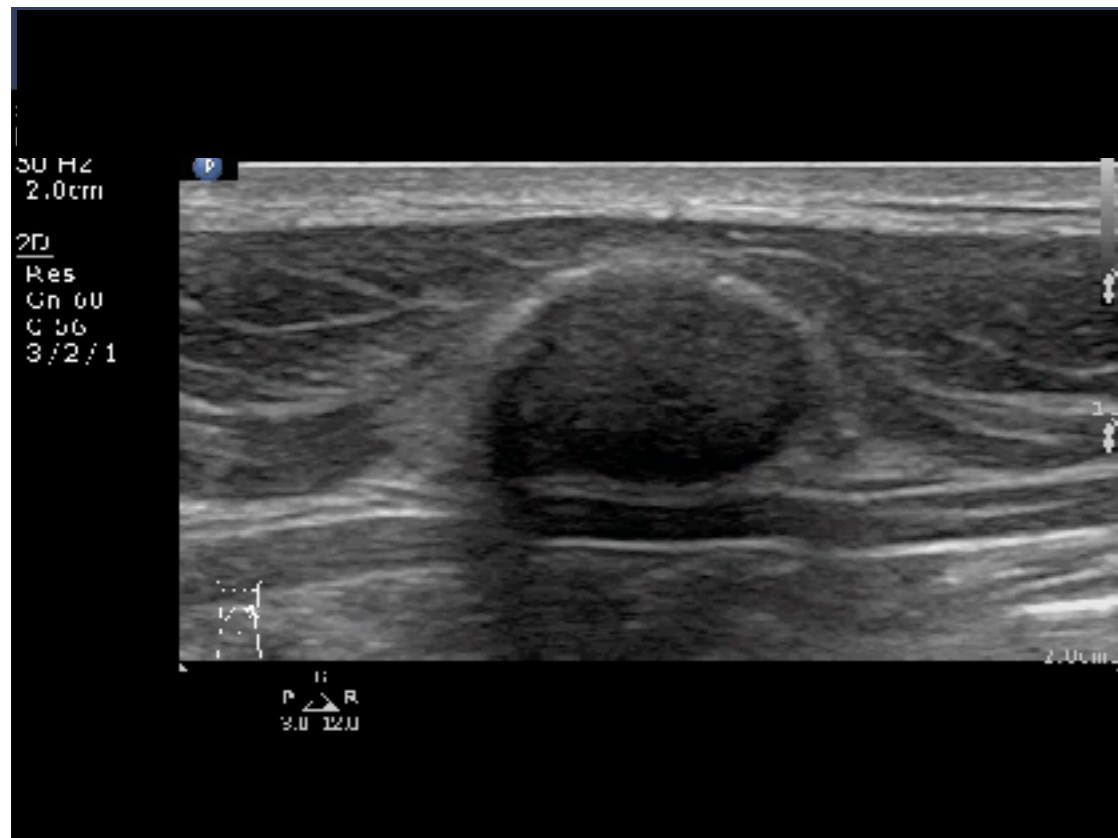


Artifact ? Why ?

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Acoustic Shadowing



Attenuation

Tissue or Material	Attenuation (dB/cm/MHz)
Water	0.0022
Blood	0.15
Soft tissues	0.75
Air	7.50
Bone	15.00

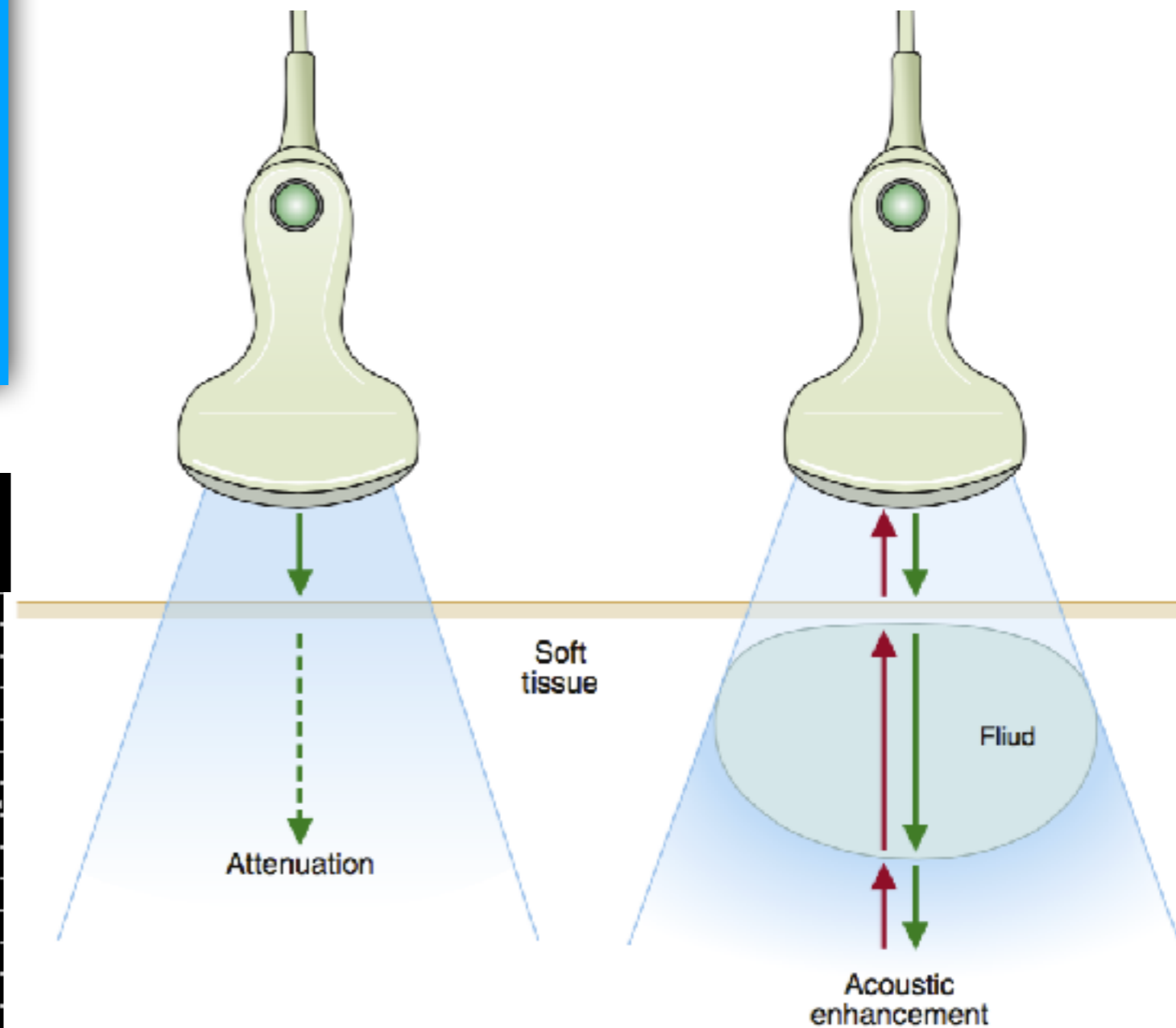
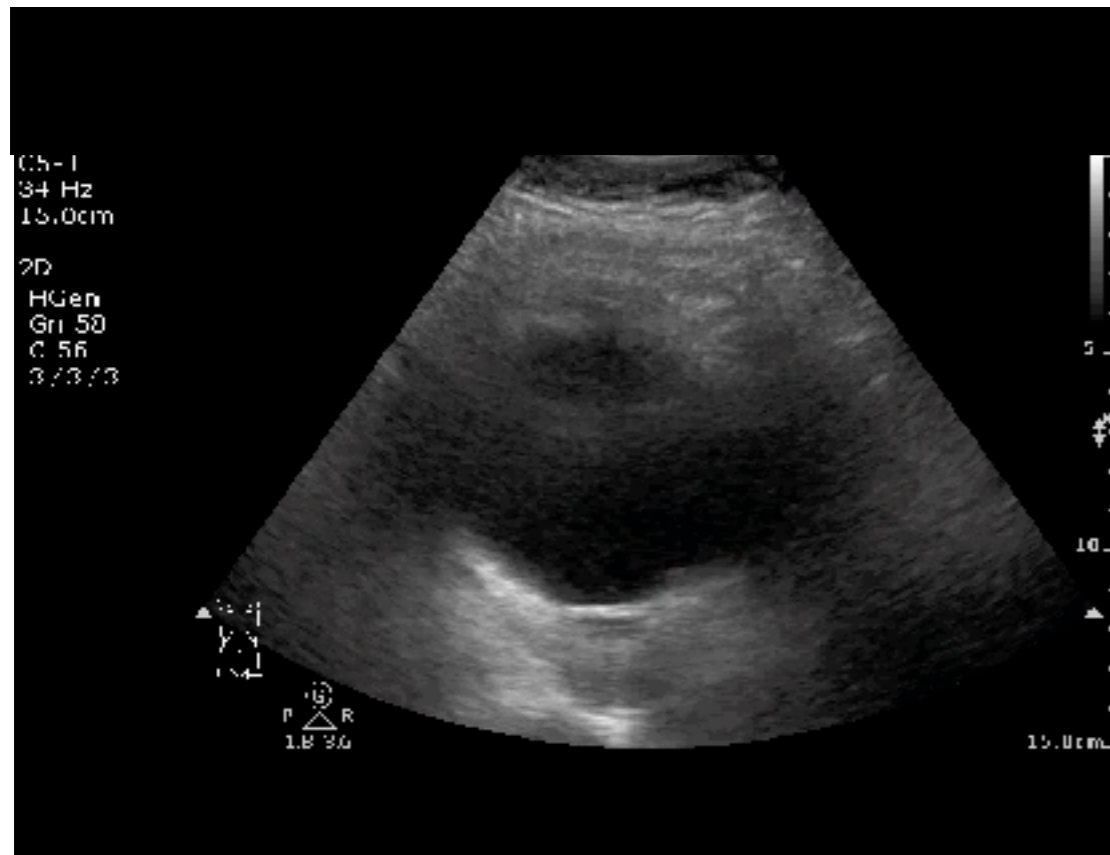
Artifact ? Why ?

Abd Gen
C5-1
39 Hz
12.0cm

2D
HGen
Gn 72
C 56
3 / 3 / 3



Acoustic Enhancement



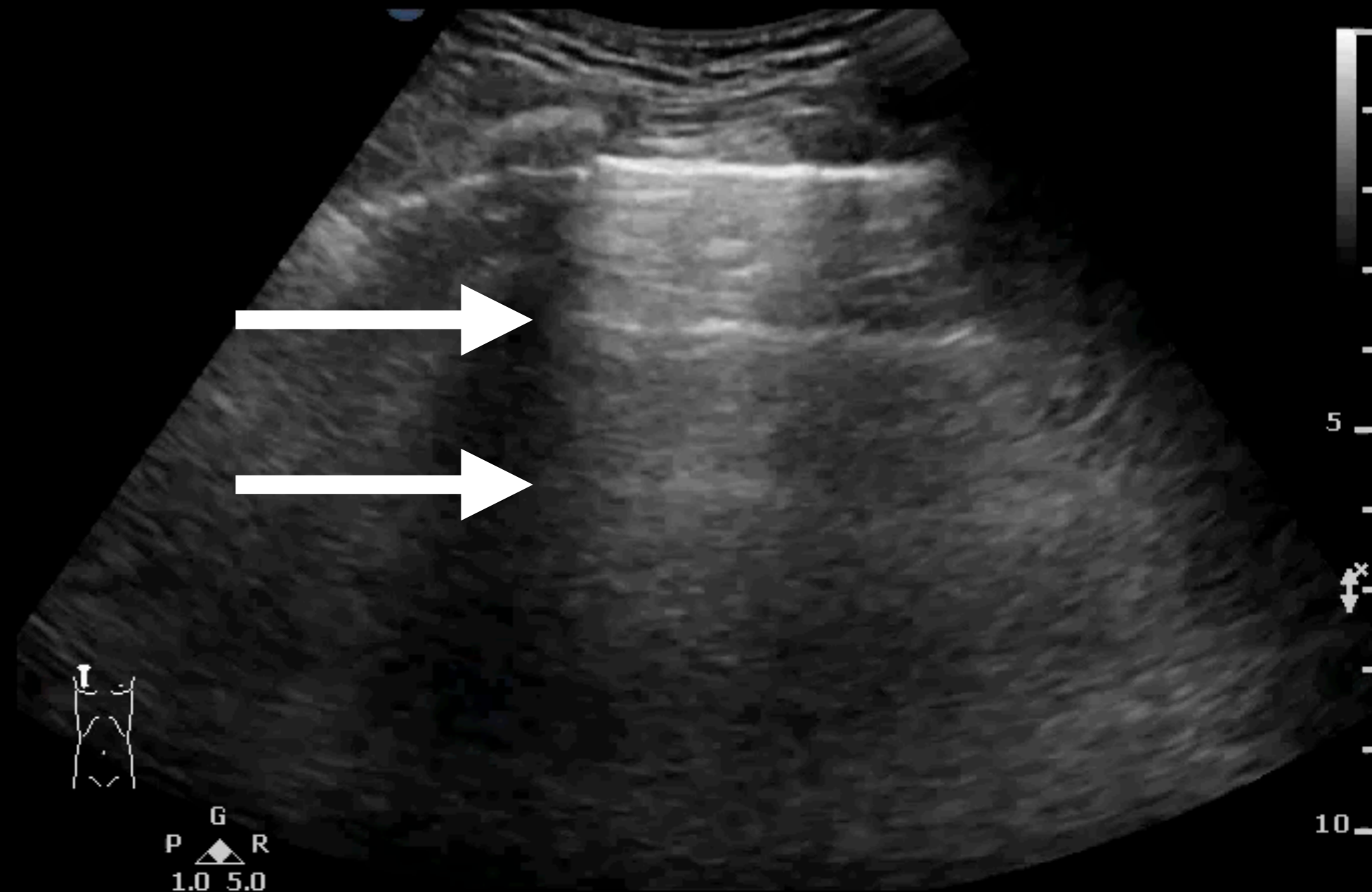
Attenuation

Tissue or Material	Attenuation (dB/cm/MHz)
Water	0.0022
Blood	0.15
Soft tissues	0.75
Air	7.50
Bone	15.00

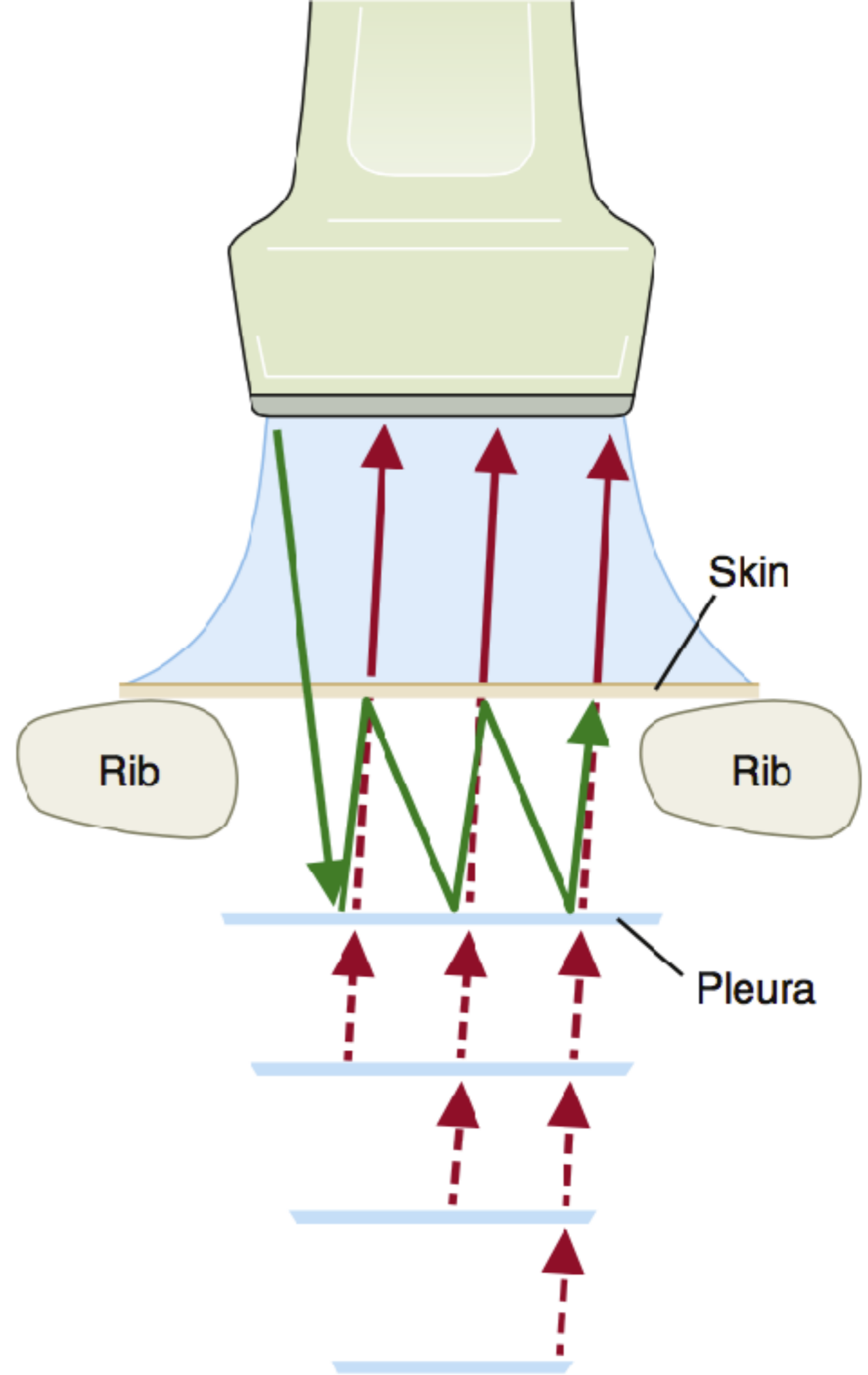
Artifact ? Why ?

FAST
C5-1
42 Hz
11.0cm

2D
Gen
Gn 60
C 56
1 / 3 / 3



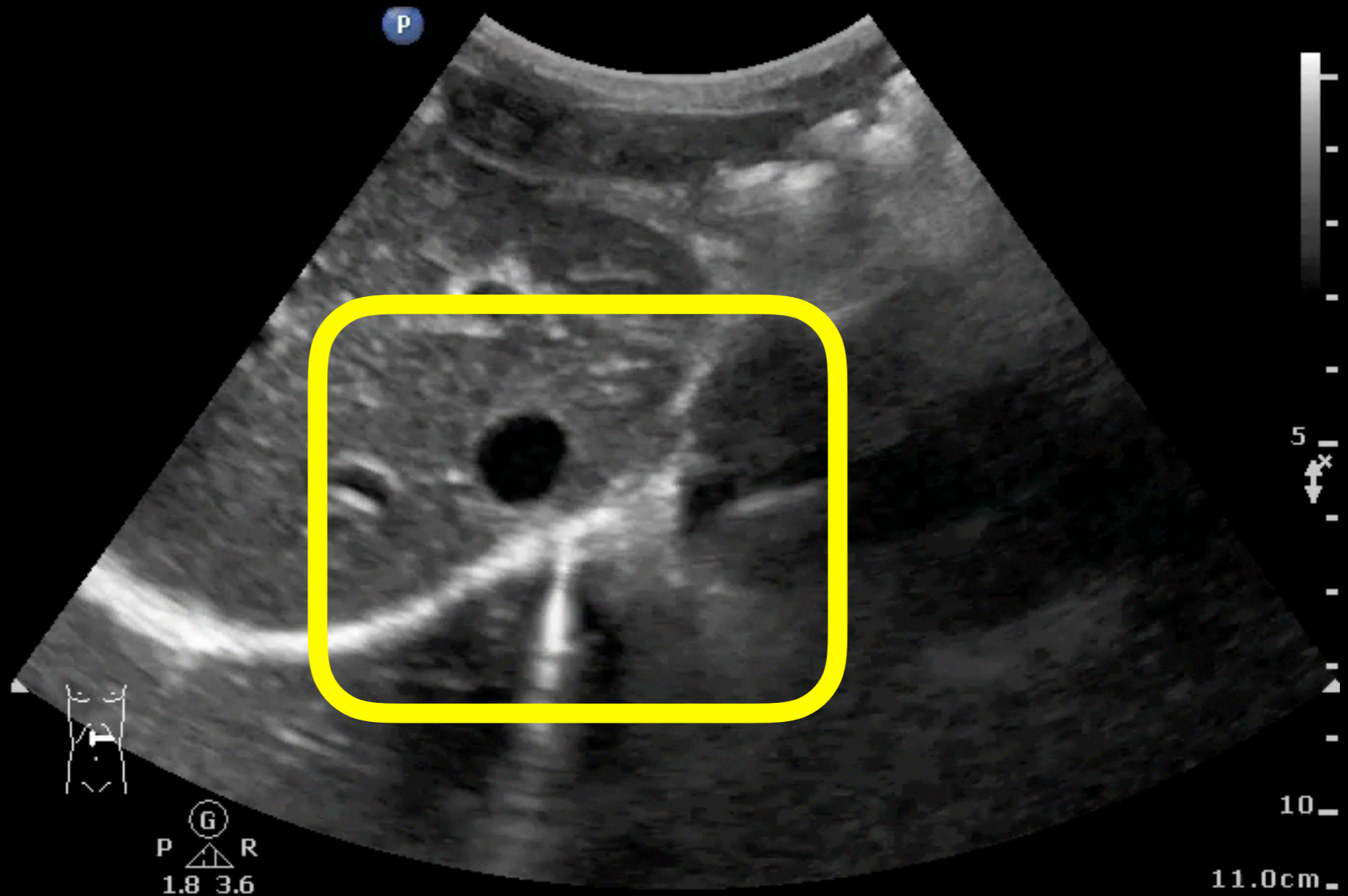
Reverberation



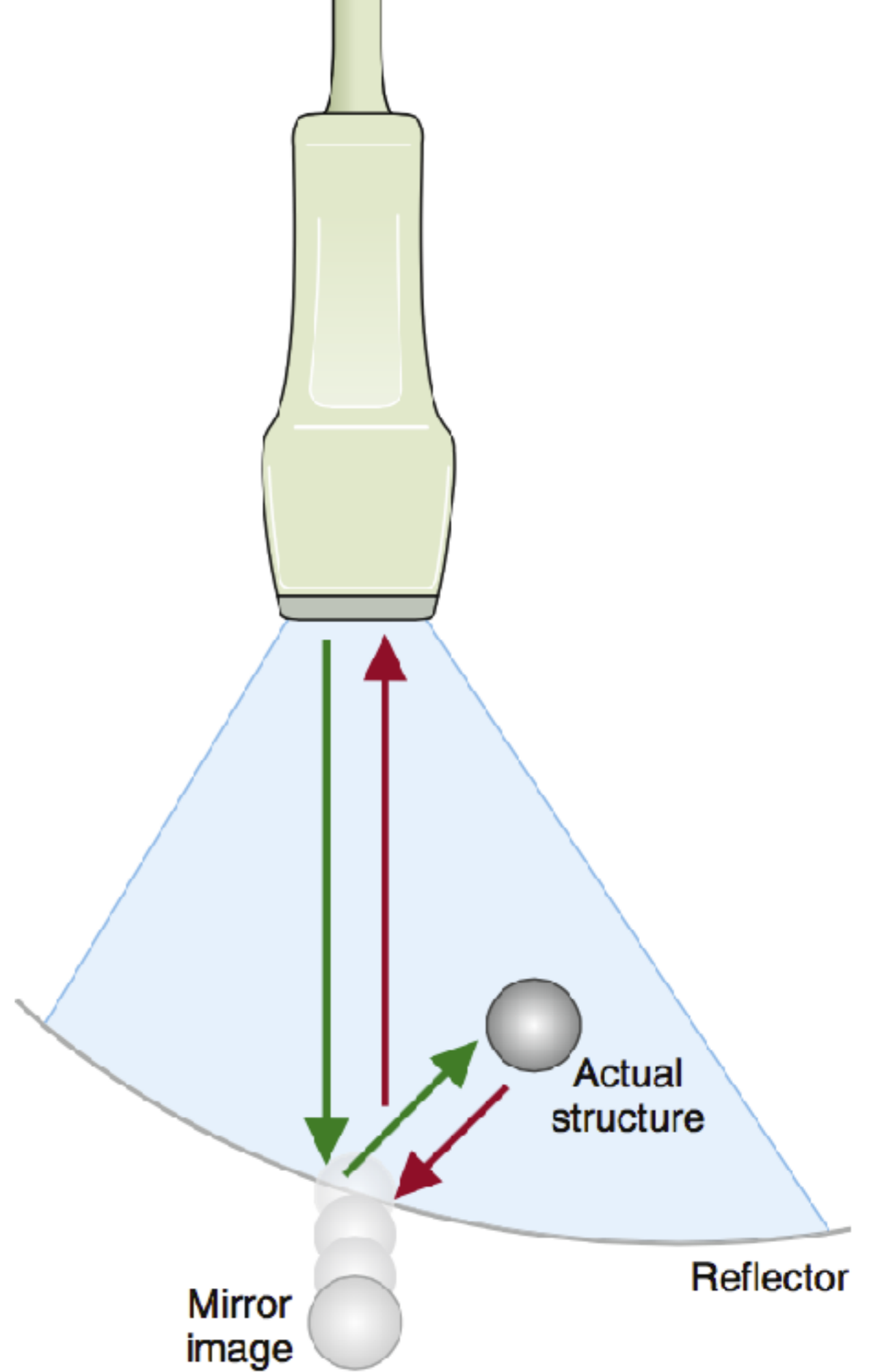
Artifact ? Why ?

Abd Gen
C5-1
42 Hz
11.0cm

2D
HGen
Gn 81
C 56
3 / 3 / 3

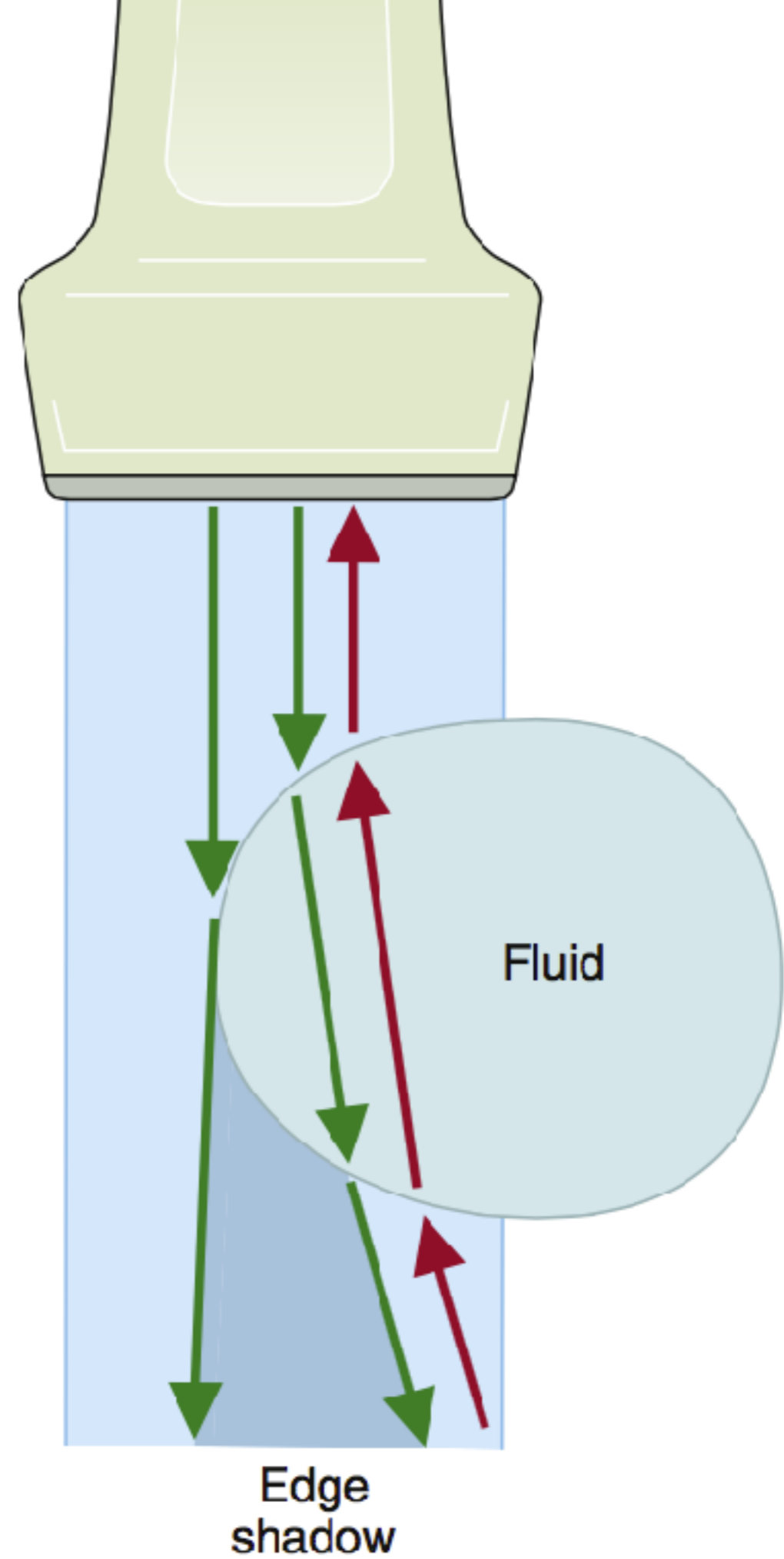
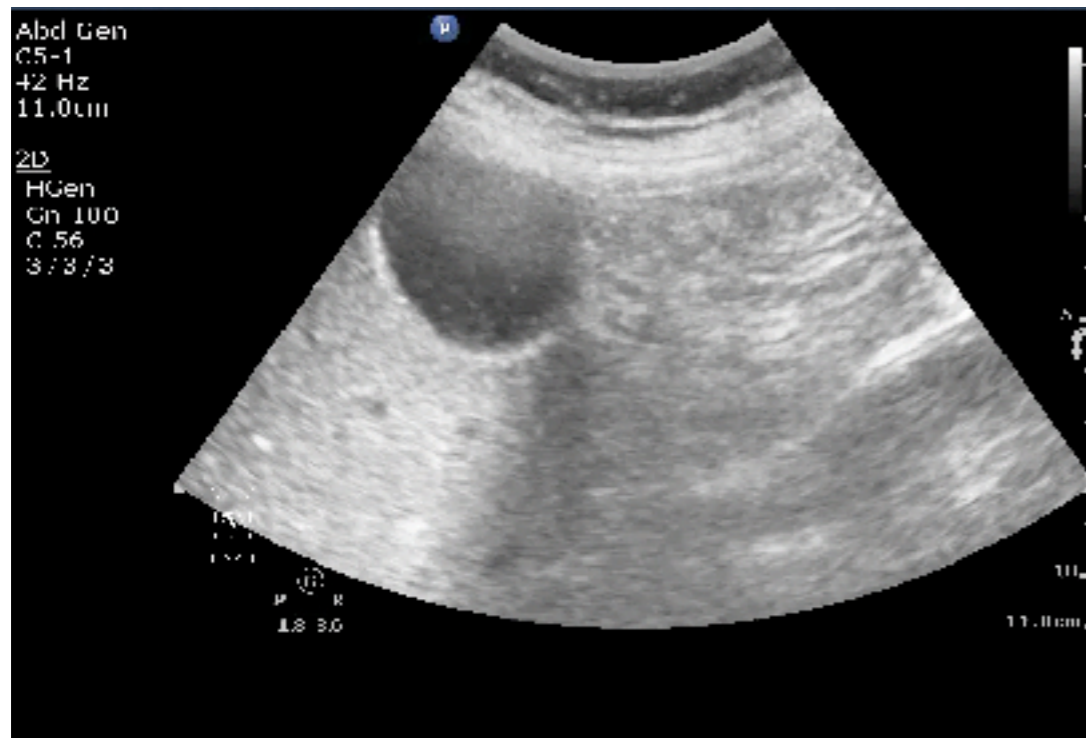


Mirror Image



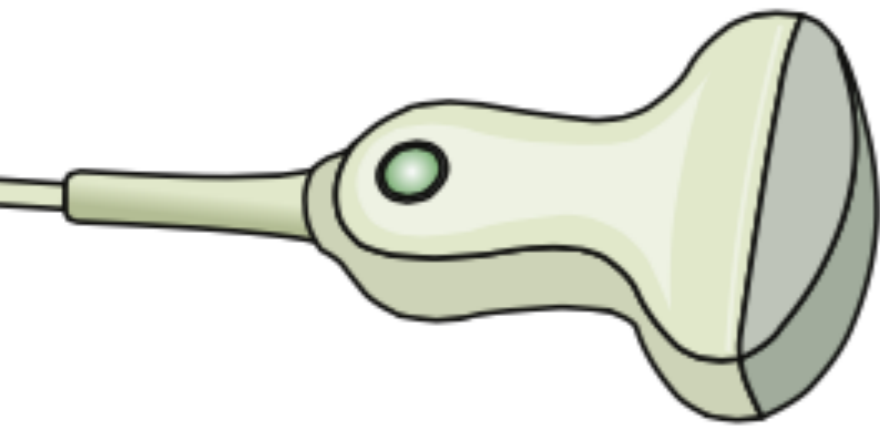
Edge shadow

Side lobe



Impedance

Probe



Scattering



Refraction



Edge

Transmission



Gain

Mirror

Reflection



Absorption



Attenuation

ADU GENZ
C5-1
45 Hz
10.0cm

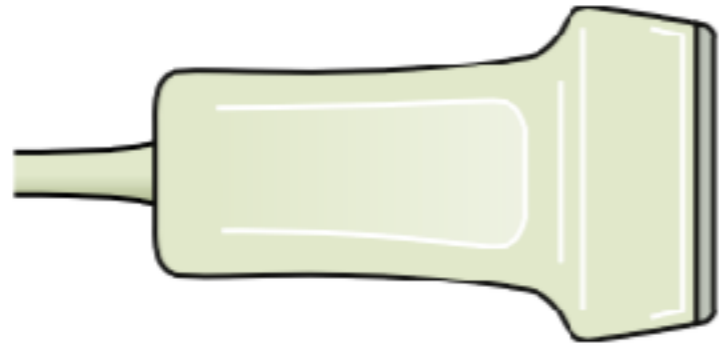
2D
HGen
Gn 78
C 56
3 / 3 / 3



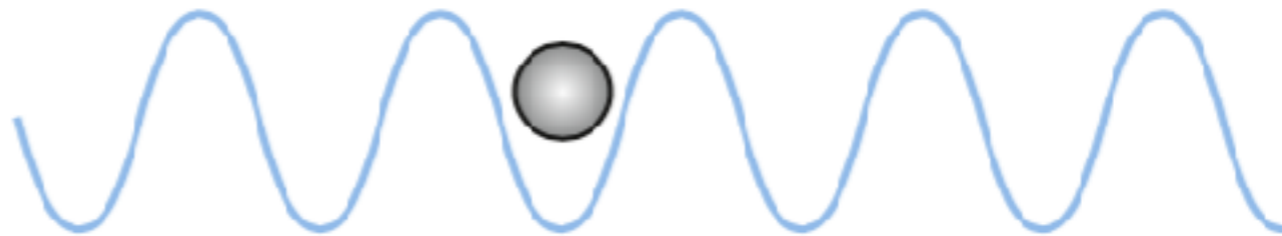
Noise
Reduction

1

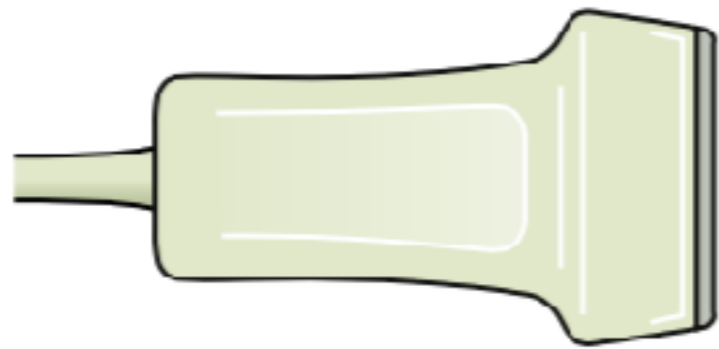
Stationary transducer



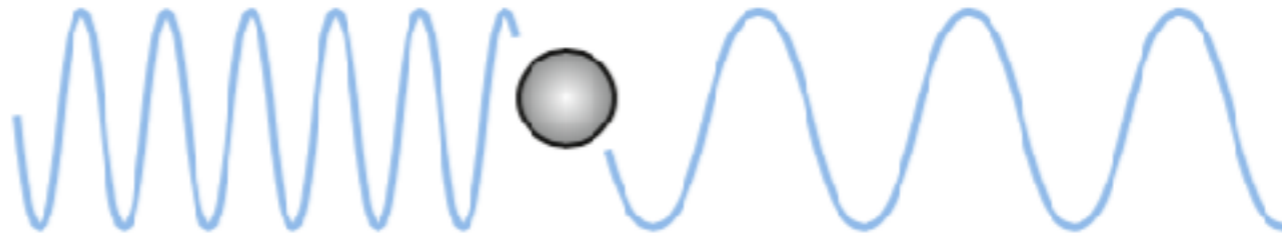
Stationary reflector



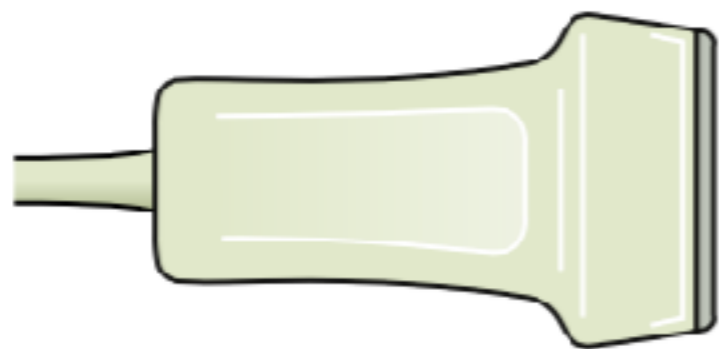
**No change
in frequency**



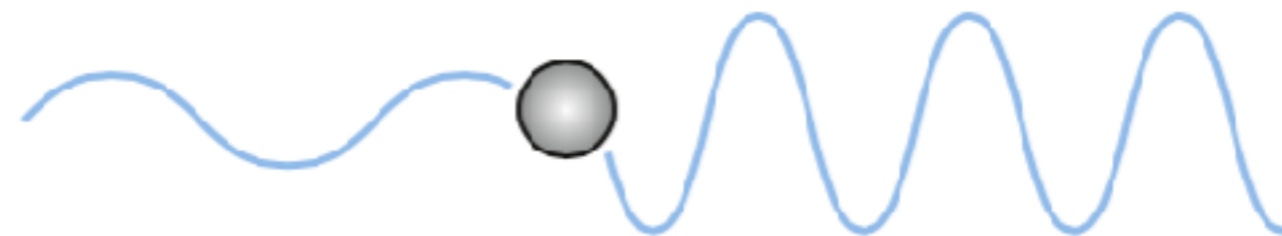
**Reflector moving
toward transducer**



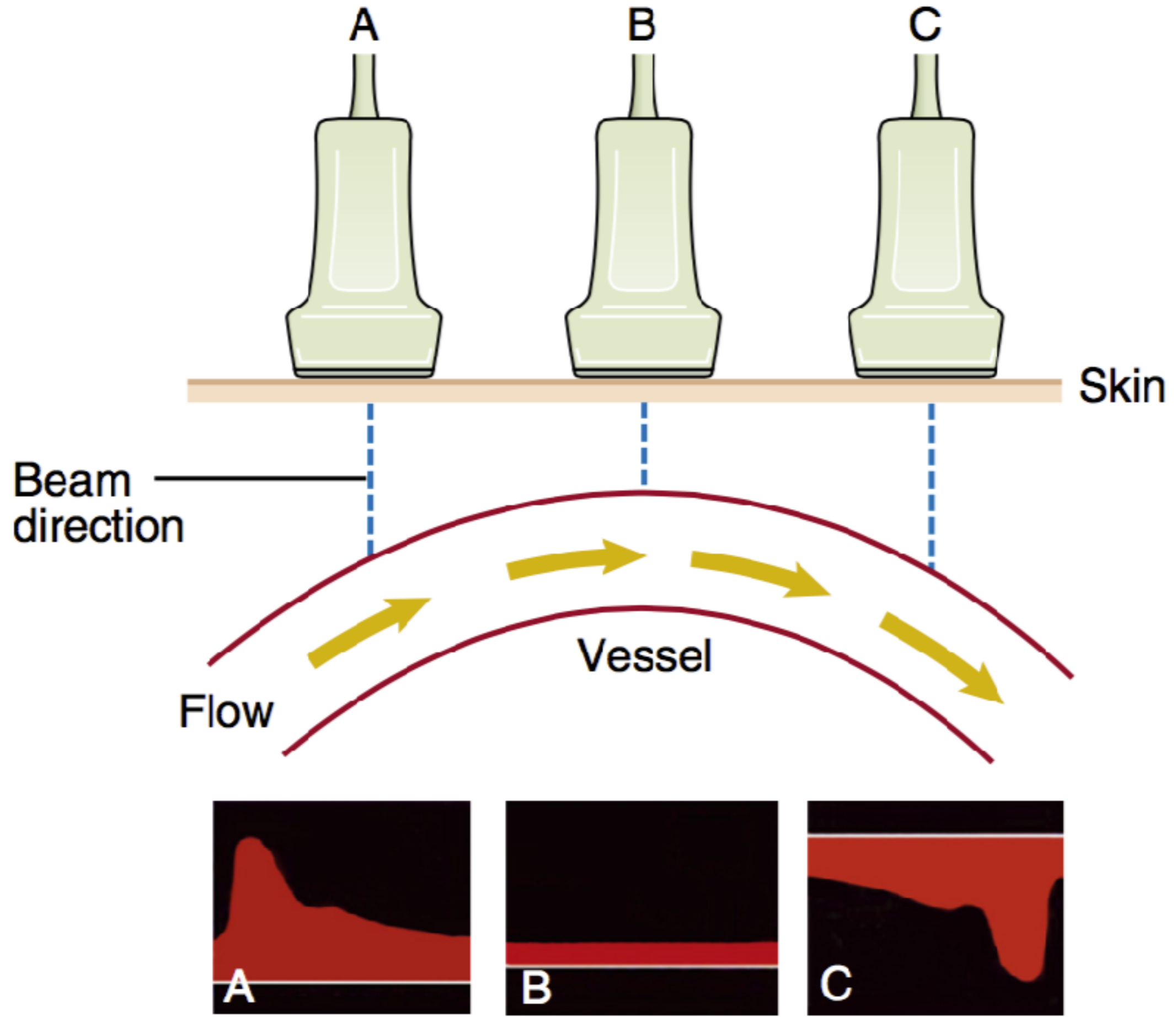
Frequency increased



**Reflector moving
away from transducer**



Frequency decreased



Doppler

Power Doppler for Low Flow

Superficial

P

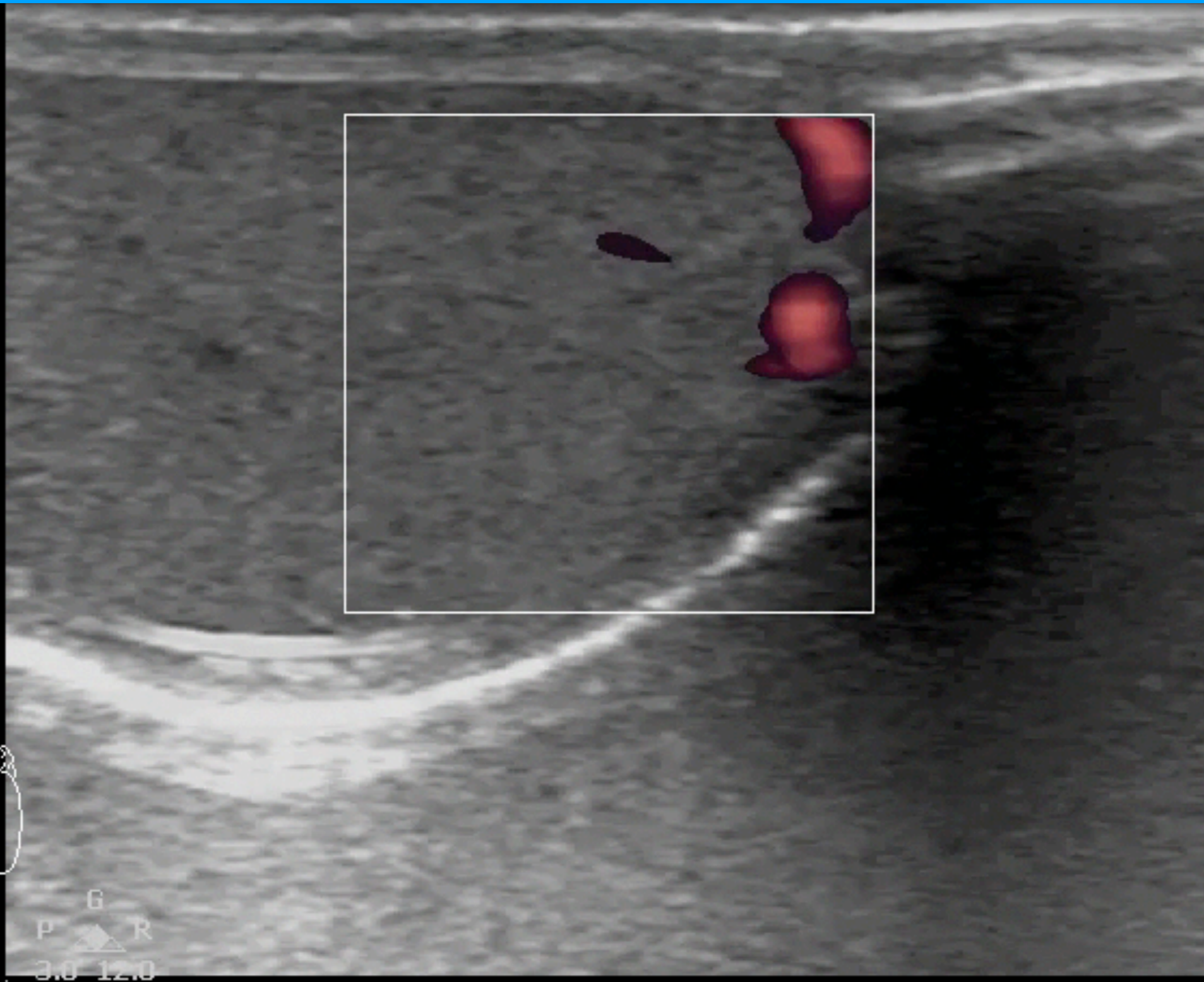
L12-3
42 Hz
3.0cm

2D

Gen
Gn 100
C 52
4/3/2

CPA

5.0 MHz
Gn 57
1/5/4
Filtr Med
BaseIn 3



1.0

PRF

2

3.0cm

G
P R
3.0 12.0

Color Doppler with Directions

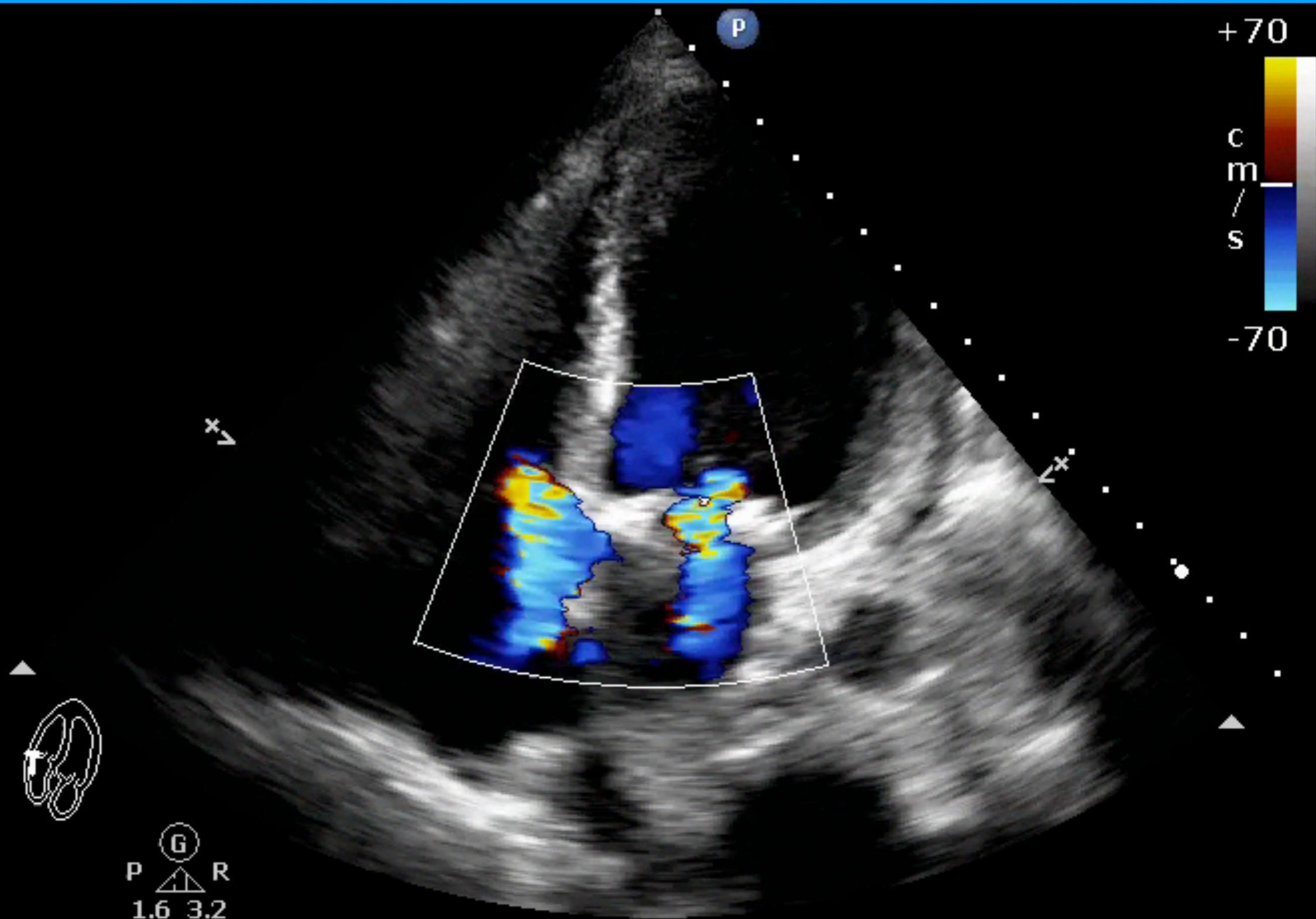
Adult Echo
S5-1
18 Hz
18.0cm

2D

HGen
Gn 34
C 50
3 / 2 / 0

Color

2.5 MHz
Gn 60
4 / 5 / 0
Filtr High



Blue Away Red Toward

Superficial

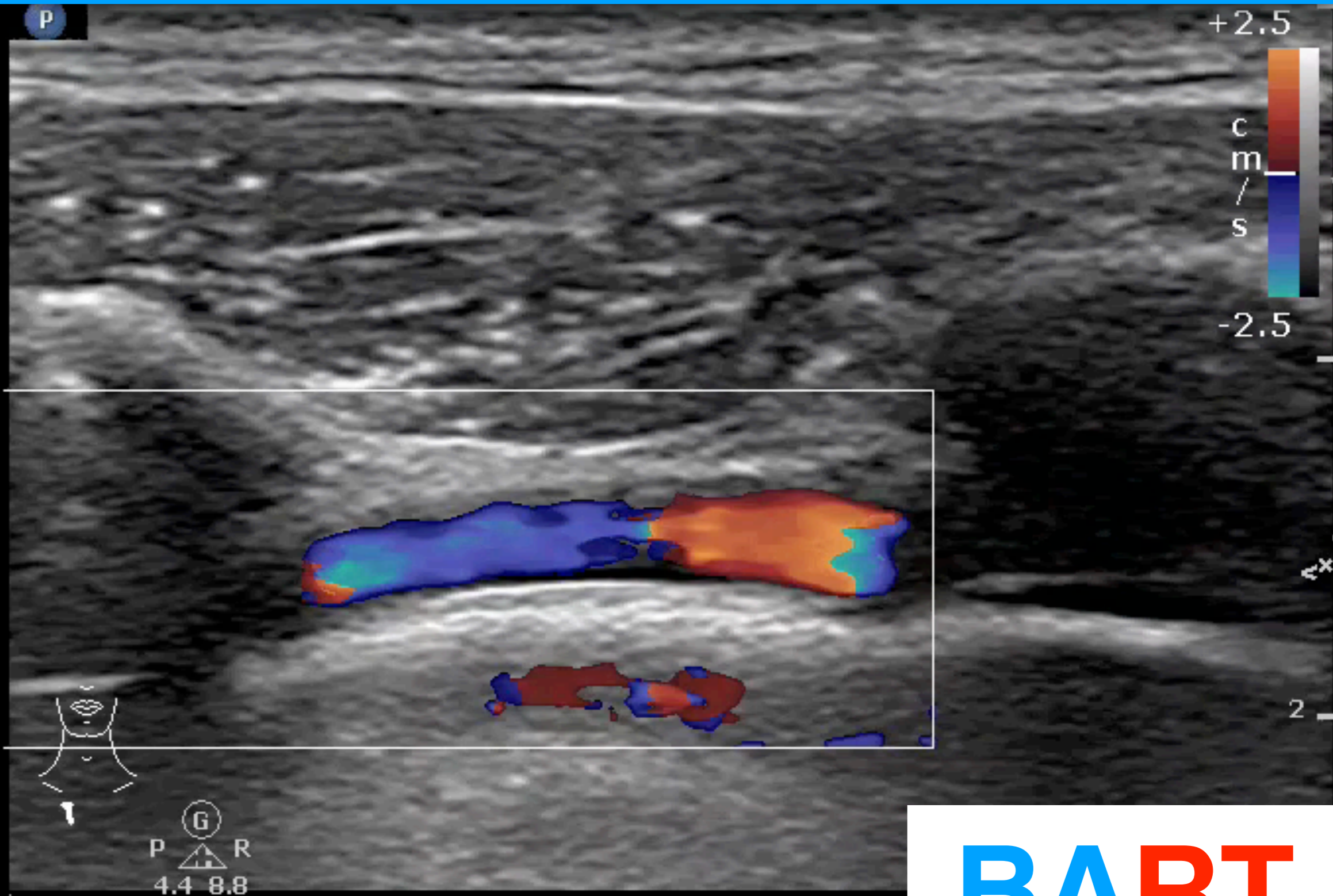
L12-3
17 Hz
2.5cm

2D

HGen
Gn 60
C 56
3/2/2

Color

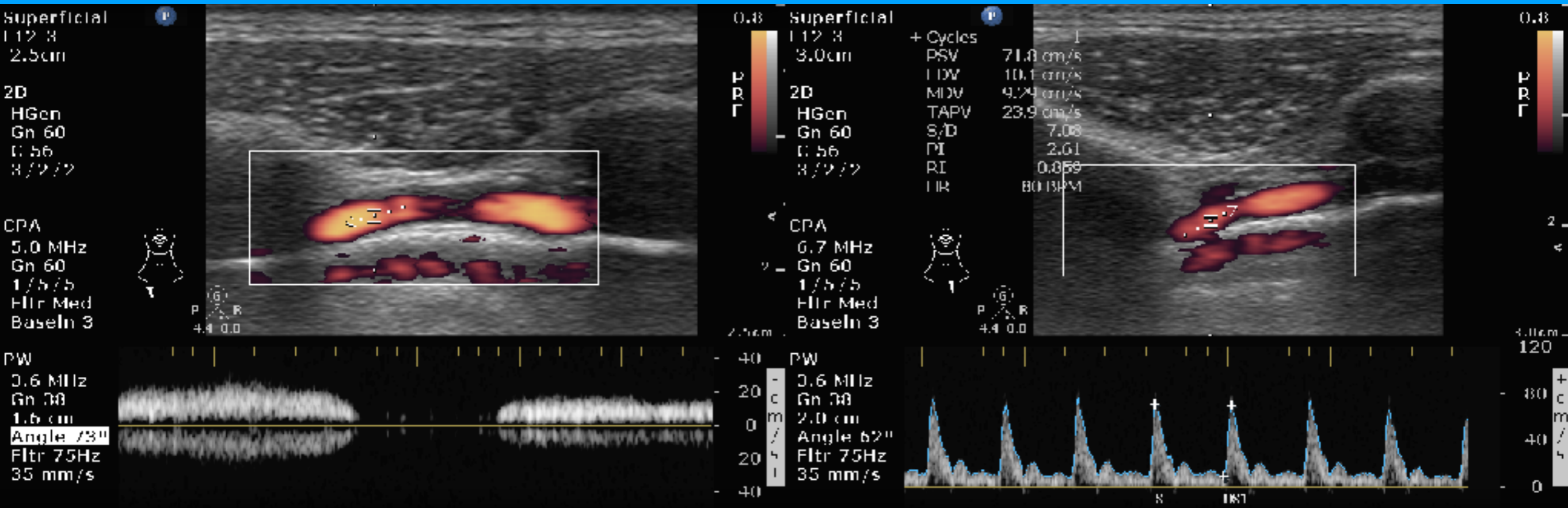
6.7 MHz
Gn 41
1/3/4
Filtr Med



BART

Vein

Artery



Duplex

B mode & Doppler spectral display

Needle visualization

Superficial
L12-3
46 Hz
3.0cm

P

2D

Res
Gn 96
C 56
3 / 2 / 1



G
P R
3.0 12.0

3.0cm

PHILIPS

SKH-EUTC©ChenKC

Abd Gen
C5-1
38 Hz
13.0cm

2D

HGen
Gn 58
C 53
3 / 3 / 3



POCUS Academy

Let's transform EM practice



juice119@gmail.com

FB: Emergency Ultrasound Training Center

