Medical biophysics II.

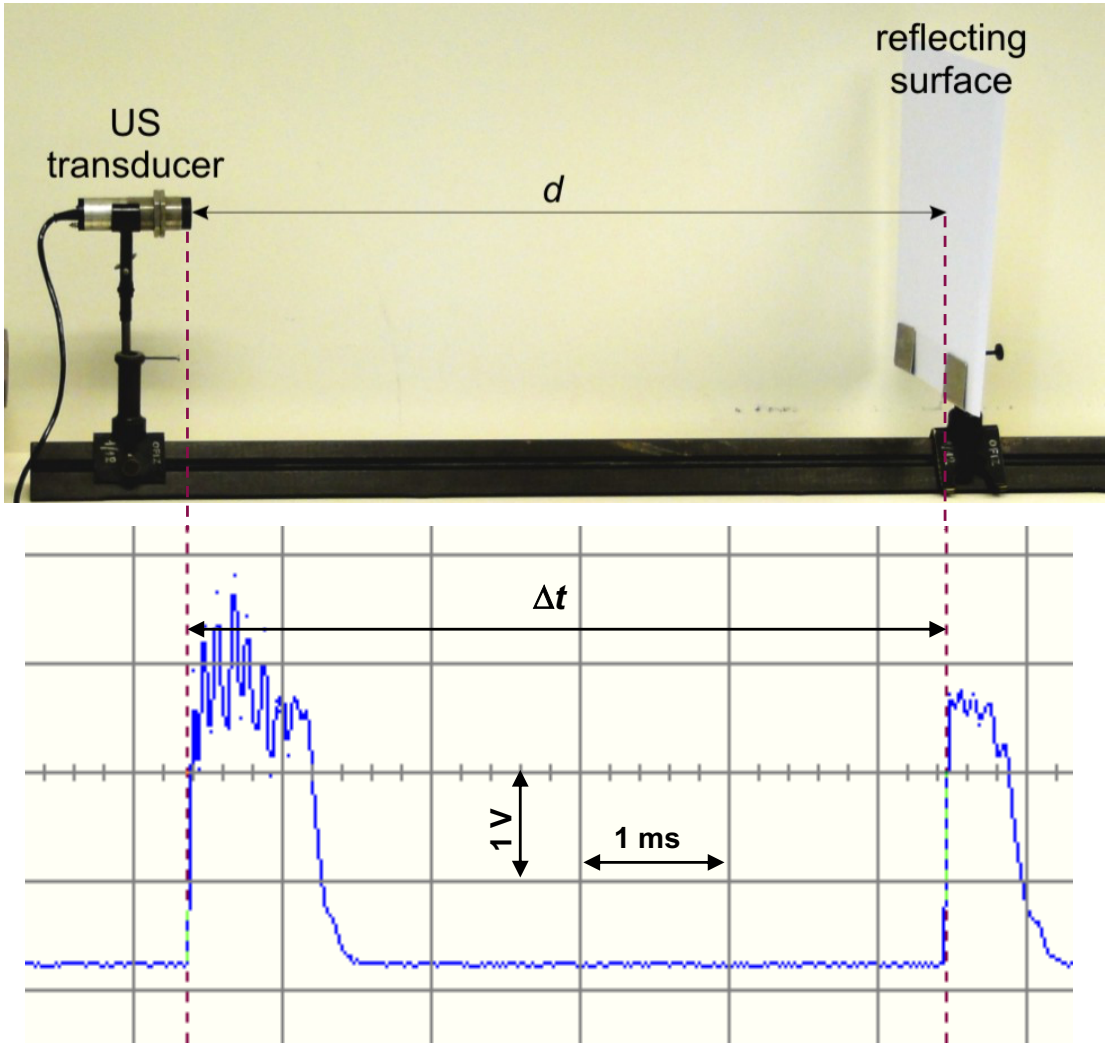
Ultrasound Lab

Department of Biophysics and Radiation Biology

1.) Task: To determine speed of sound in air using the A-mode. Distance measurement based on the pulse-echo principle.

❖ Video: 09_Sonography – Demonstration of the 1D A-mode image

The pulse echo principle

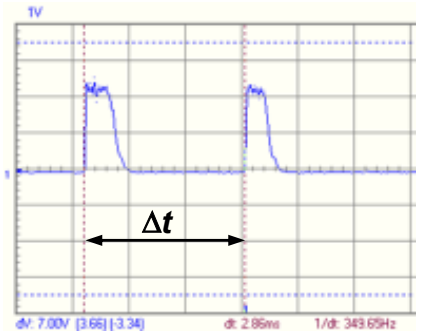


During the time of Δt the US pulse propagates a distance of $2d$, thus the distance d is given by:

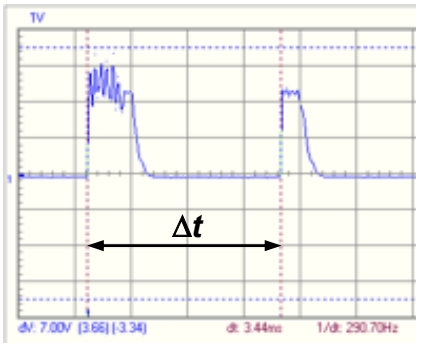
$$d = \frac{c \cdot \Delta t}{2}$$

Medium	Speed of sound, *c* (m/s)
Air (20 °C)	343
Water (20 °C)	1482
Soft tissue	1540

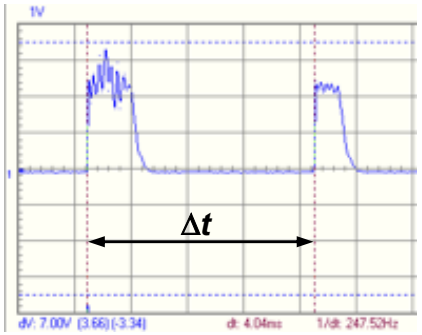
Measurement to determine speed of sound in air using the A-mode.



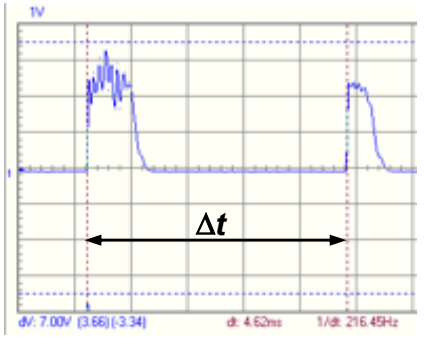
d = 50 cm
Δt = 2,86 ms



d = 60 cm
Δt = 3,44 ms



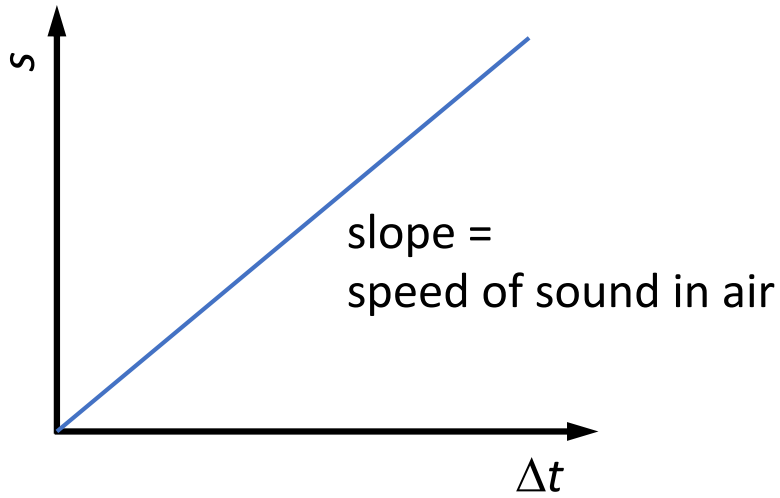
d = 70 cm
Δt = 4,04 ms



d = 80 cm
Δt = 4,62 ms

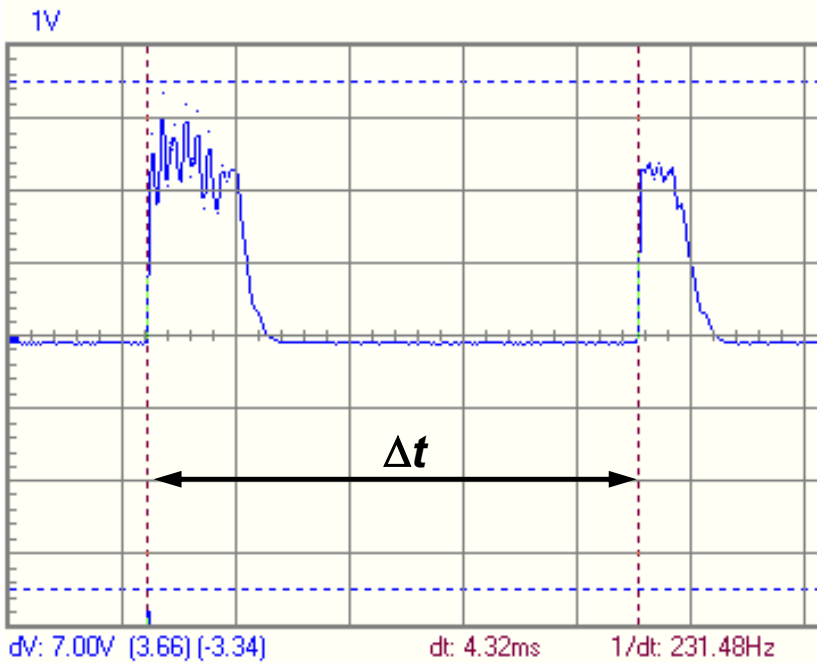
Distance of the reflecting surface from the tranducer is d, but the distance travelled by the US pulse is $s = 2d$!

Plot the distance travelled by the US pulse in air as a function of the reflection time:



Distance measurement based on the pulse-echo principle.

Calculate the distance of the reflecting surface using this A-mode image:



d = ? cm

Δt = 4,32 ms

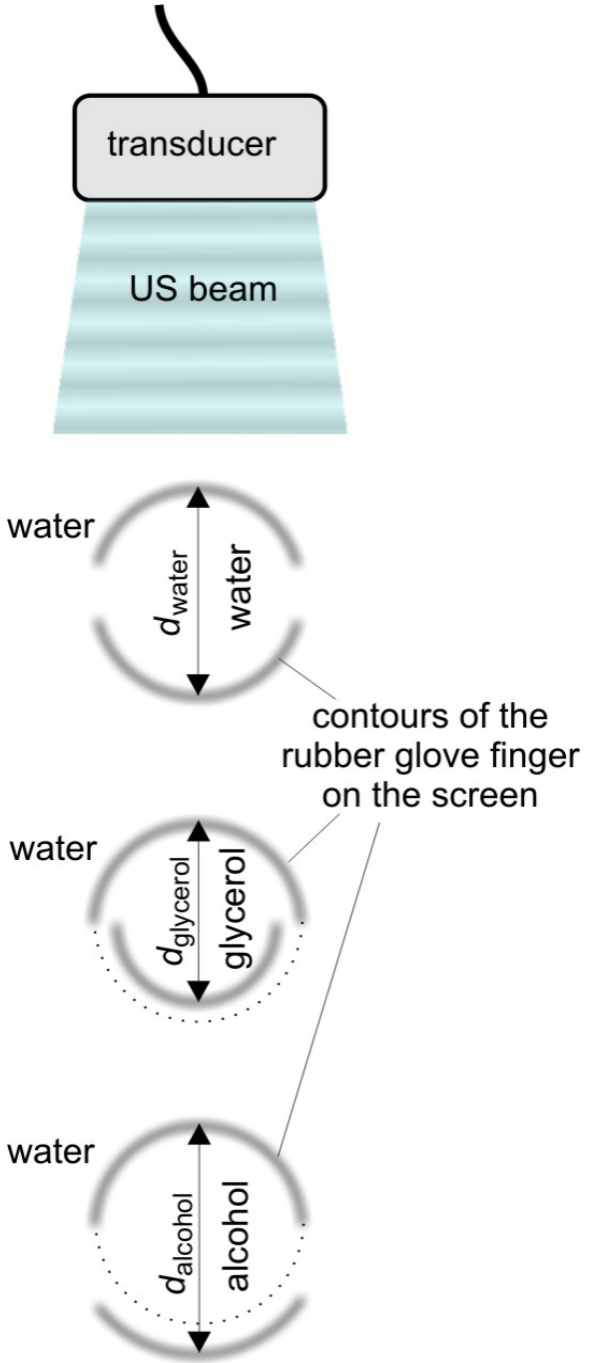
For your calculation, use the speed of sound determined previously.

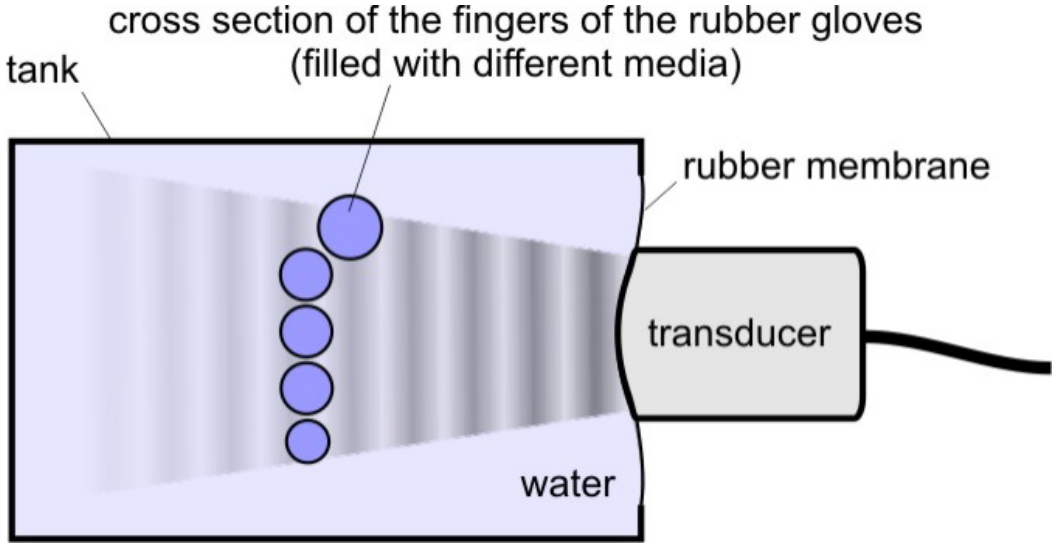
$$d = \frac{c \cdot \Delta t}{2}$$

2.) Task: B-mode imaging of phantoms filled with different media. To determine speed of sound for these media.

❖Video: 07_Ultrasound – Demonstration of the 2D B-mode image

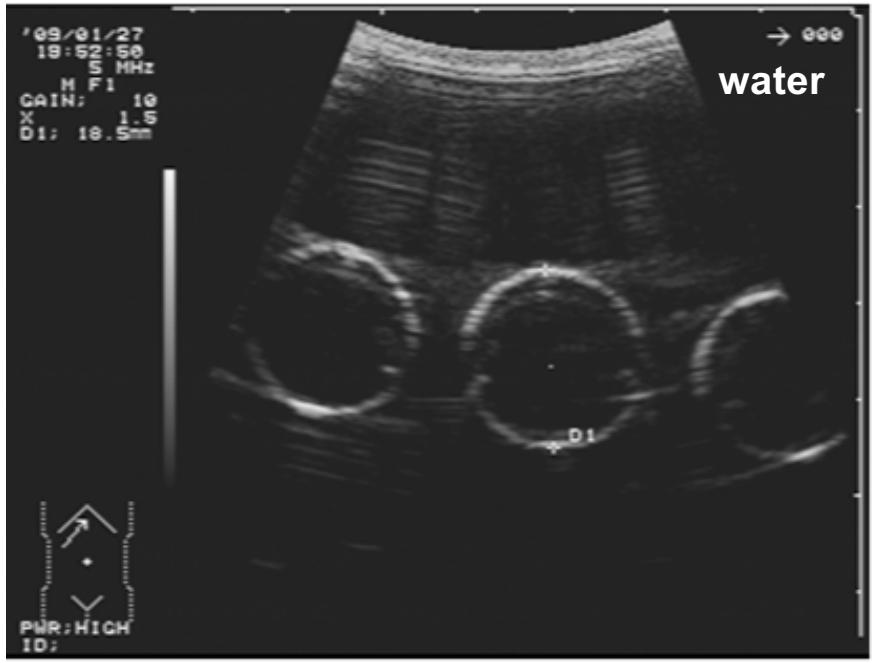
B-mode imaging of phantoms filled with different media.

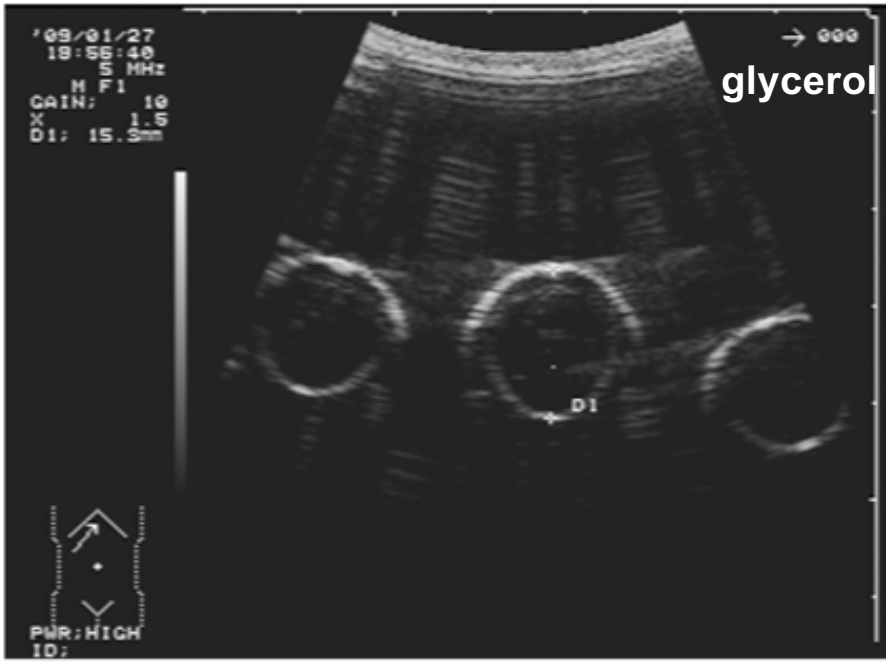


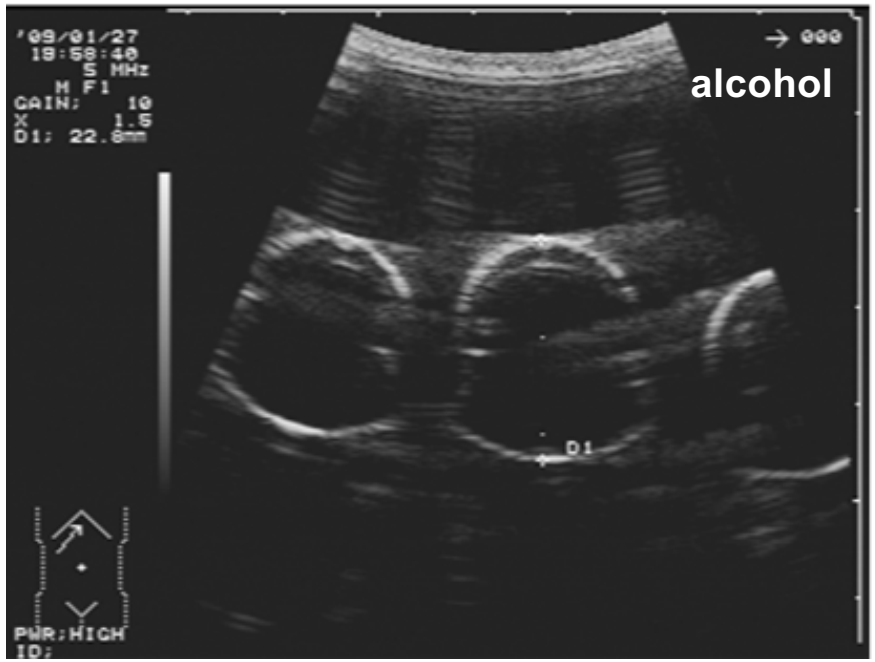


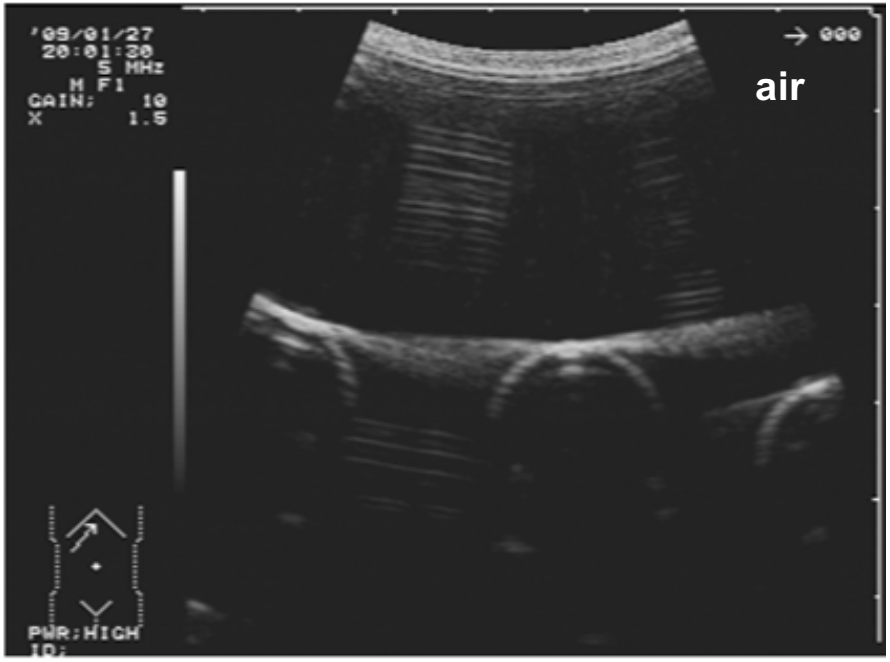
$$c_{medium} = c_{water} \frac{d_{water}}{d_{medium}}$$

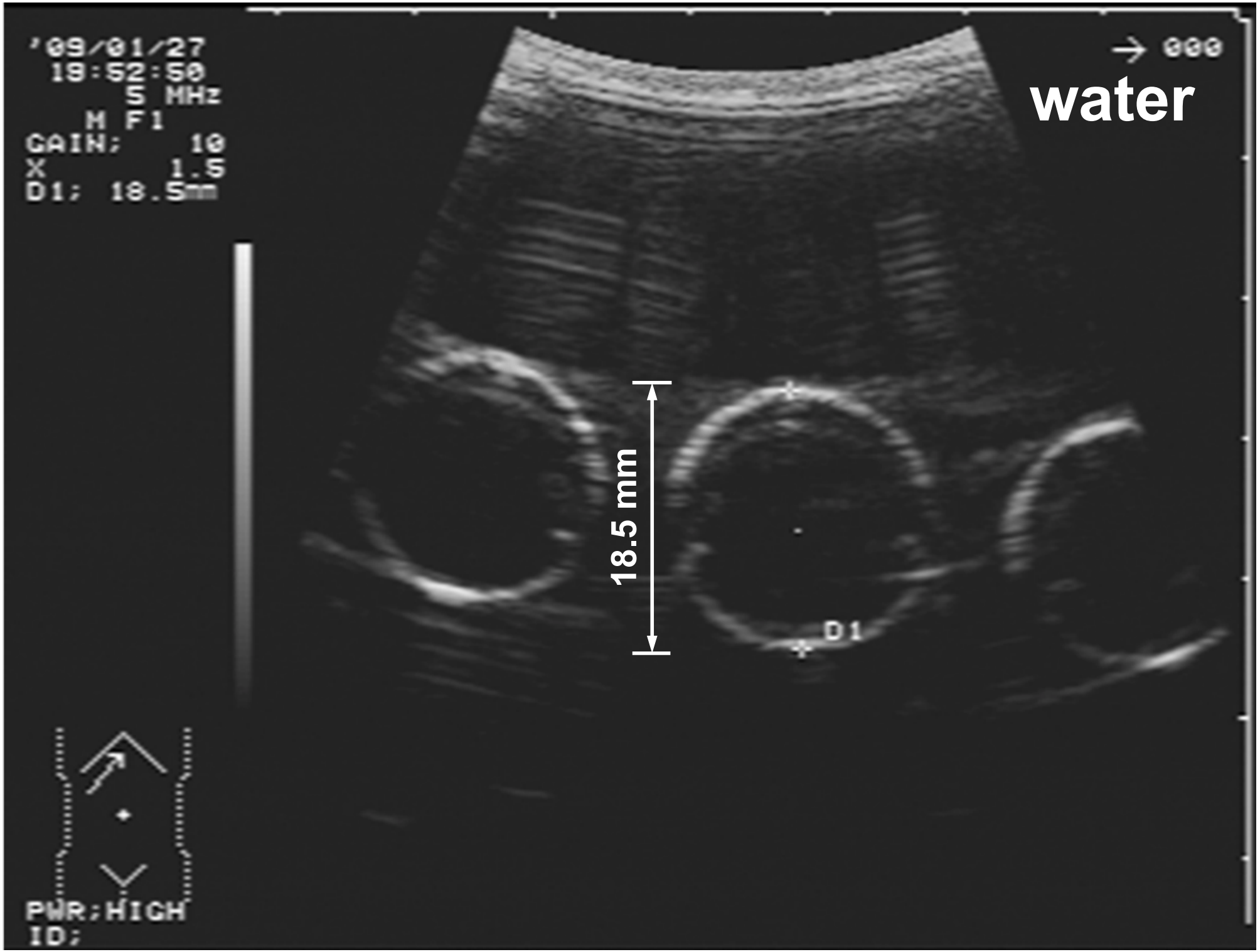
B-mode imaging of phantoms filled with different media.

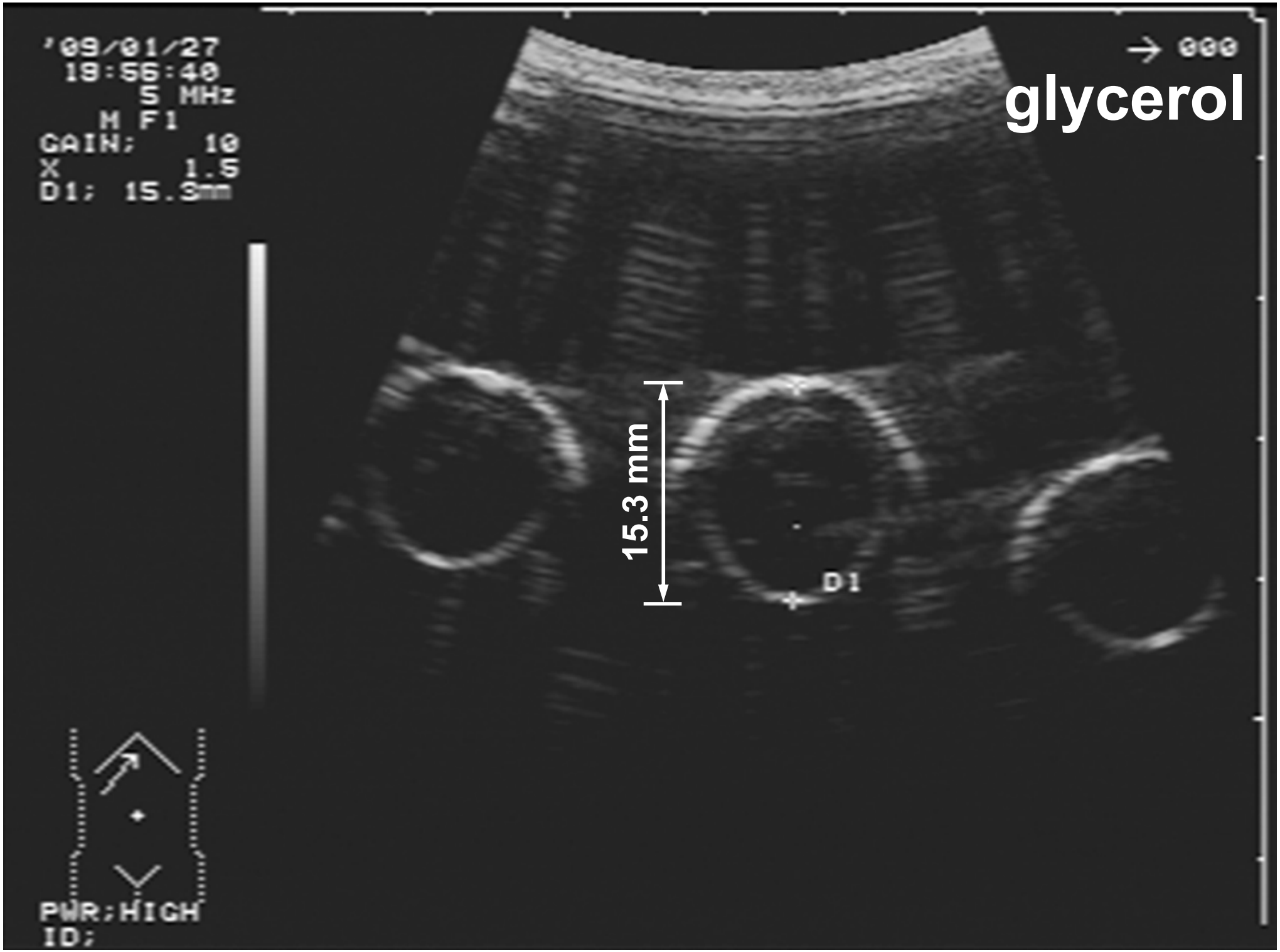


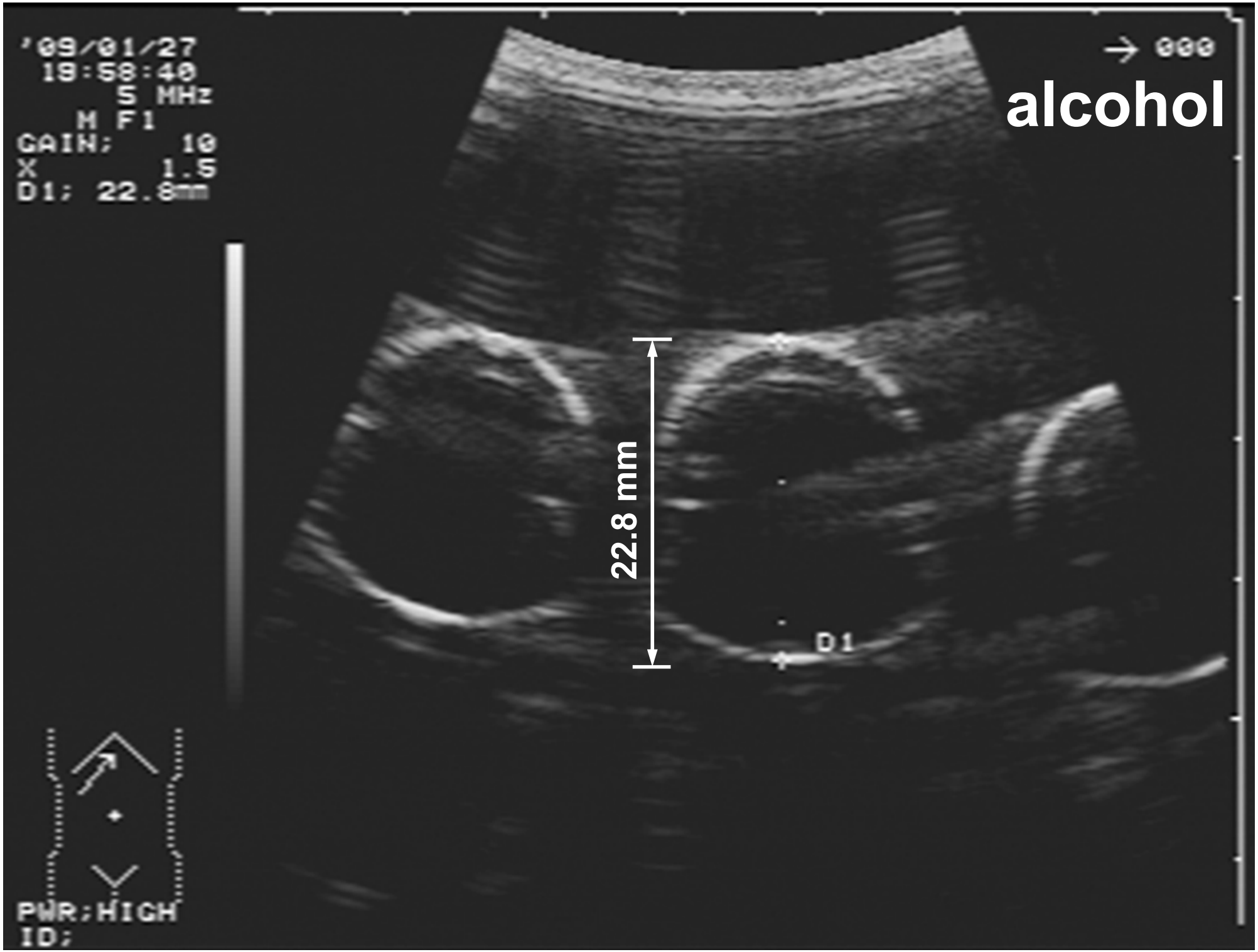


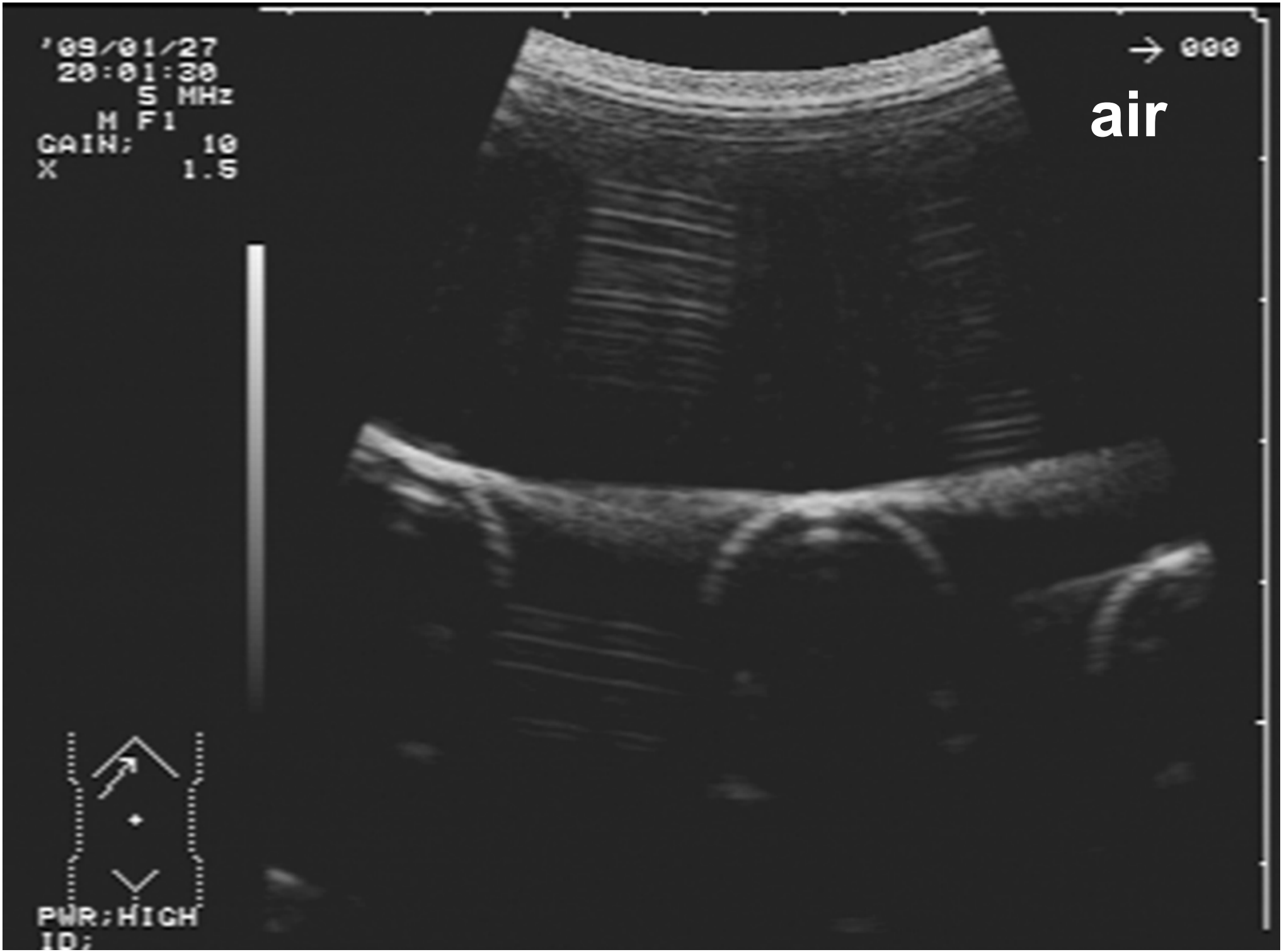





'09/01/27
19:52:50
5 MHz
M F1
GAIN: 10
X 1.5
D1; 18.5mm
→ 000
water
18.5 mm
D1
PWR:HIGH
ID:


'09/01/27
19:56:40
5 MHz
M F1
GAIN: 10
X 1.5
D1: 15.3mm
→ 000
glycerol
15.3 mm
D1
PWR:HIGH
ID:


'09/01/27
19:58:40
5 MHz
M F1
GAIN; 10
X 1.5
D1; 22.8mm
→ 000
alcohol
22.8 mm
D1
PWR:HIGH
ID:


'09/01/27
20:01:30
5 MHz
M F1
GAIN; 10
X 1.5
000
air
PWR;HIGH
ID;

Calculate the speed of sound for each medium based on the measured axial diameter of each phatom.

$$c_{medium} = c_{water} \frac{d_{water}}{d_{medium}}$$

3.) Task: measure the diameter of the carotid artery!

❖Video: 08_Ultrasound – Sonography of the neck