250 Hz sync signal

First Trigger event

Next Trigger event

~40 ms

~240 ms

~40 ms

RF data acquisition → Data transfer → Image reconstruction → RF data acq. →

Query system time and save

Query system time and save

Interval #1

Interval #2

Mean = 283.6ms
Median = 283 ms
Mode = 280 ms
σ = 3.98 ms
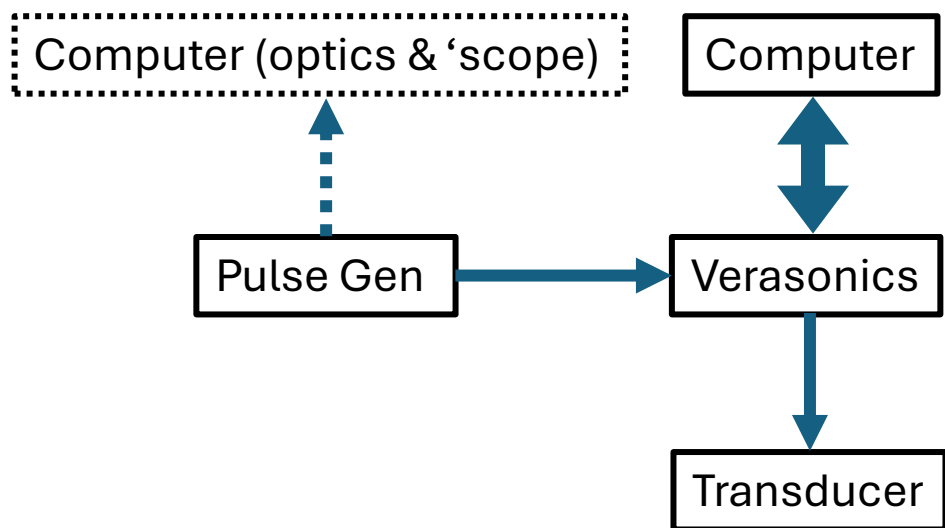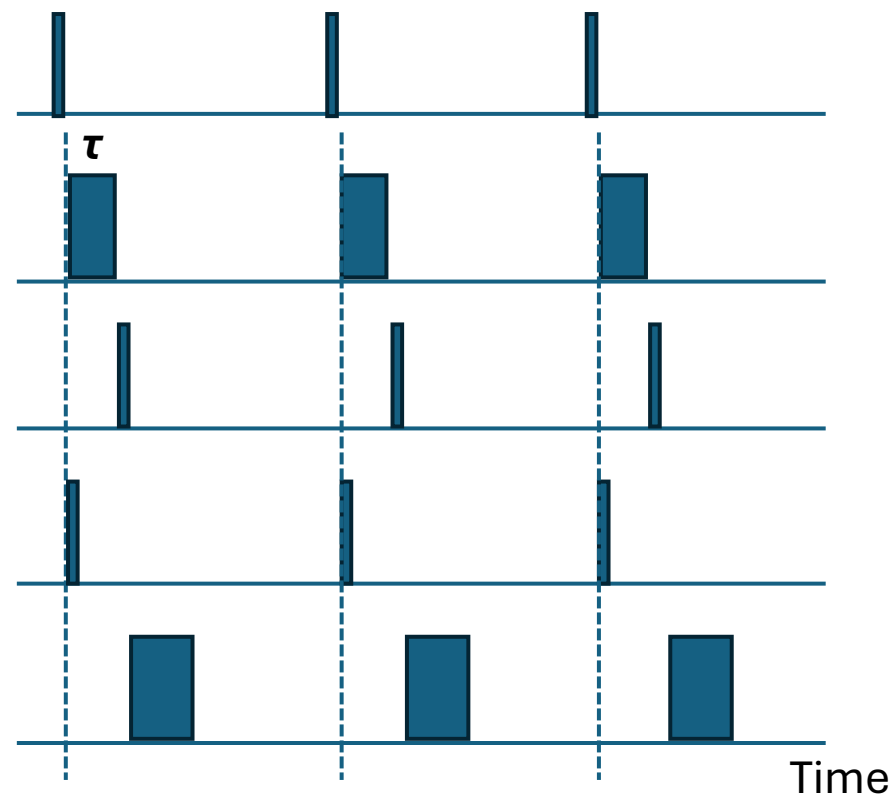Precision = 1 ms

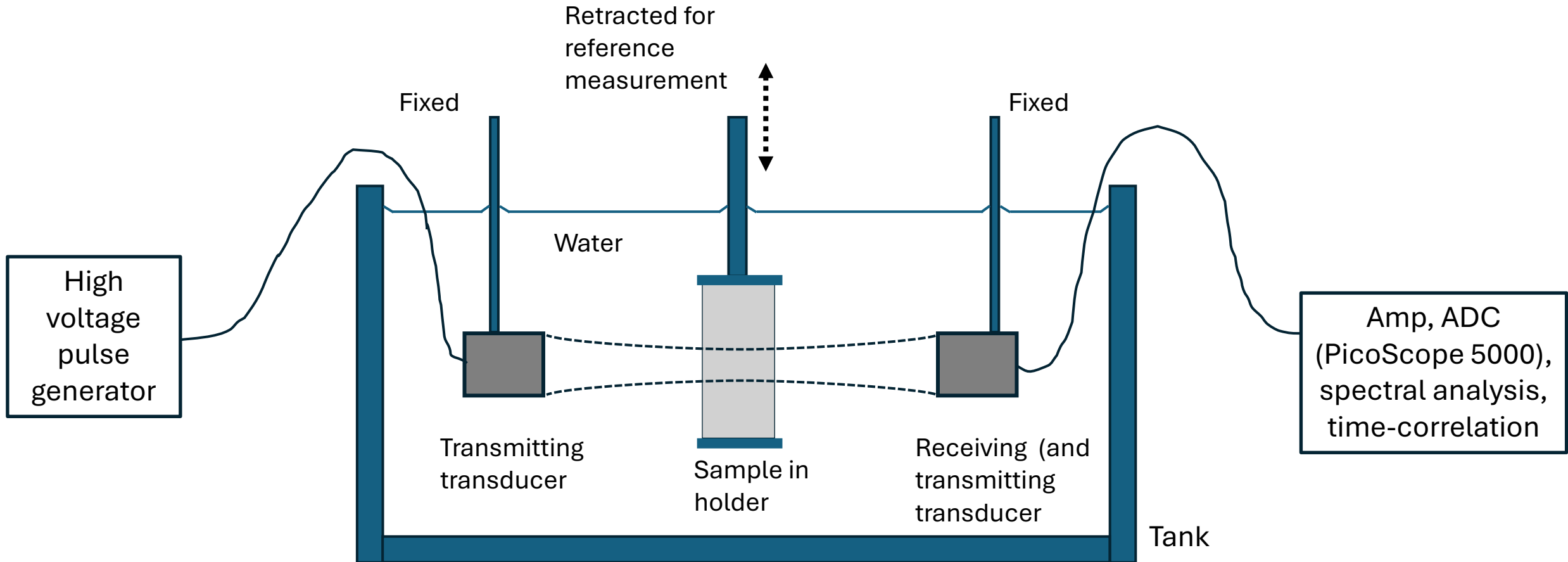# Verasonics data acquisition

Modified photoacoustics software:

- Trig

- Ionacoustic RF

- B-mode

- Time stamp

- Disc save

Discussion:

- Simulations to discover length of τ for maximum/adequate benefit of time reversal reconstruction
- Number of pulses likely to need? (not critical if save t disc as we receive each pulse)
- Online reconstruction using photoacoustic software, but offline reconstruction needed – code extraction from kWave to combine with data-reading subroutine. RF data, presumably (or IQ?).

Measurement of ultrasound speed and attenuation coefficient as a function of frequency

Retracted for reference measurement

Fixed

Fixed

Water

High voltage pulse generator

Transmitting transducer

Sample in holder

Receiving (and transmitting transducer

Amp, ADC (PicoScope 5000), spectral analysis, time-correlation
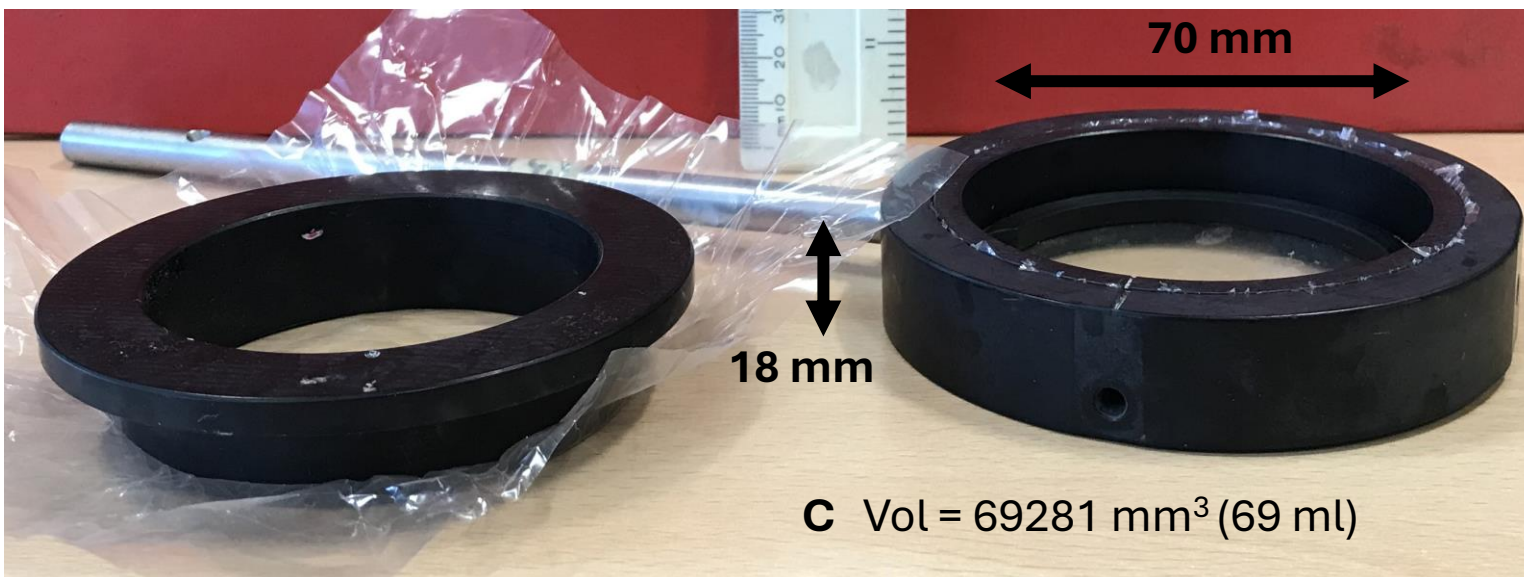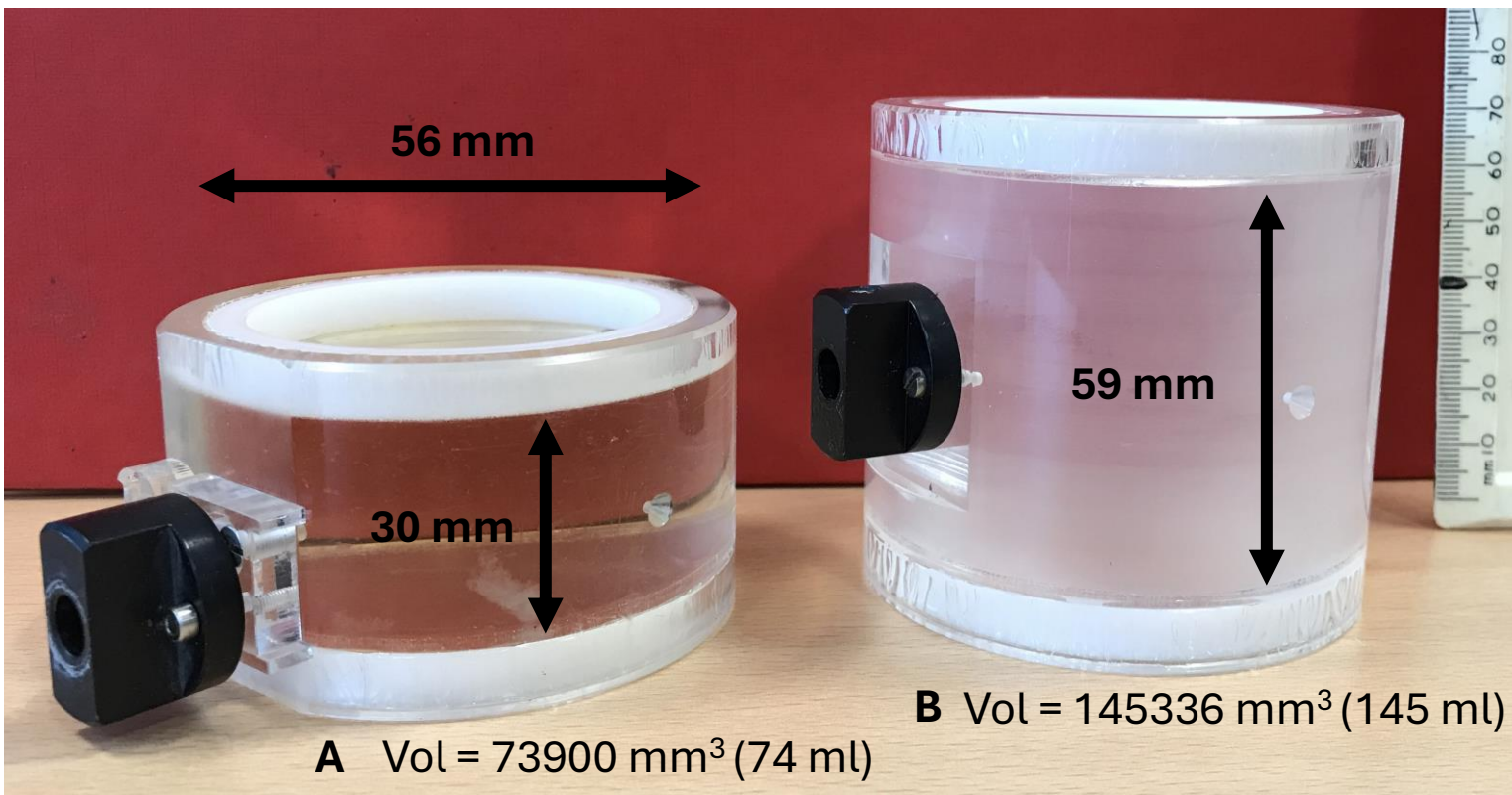
Tank

Known as the insertion method. See:

Bamber JC. Acoustical characteristics of biological media. pp.1703-1726 in: Crocker MJ (ed.) Encyclopedia of Acoustics, ISBN 0-471-80465-7, John Wiley, New York, 1997. Bamber JC. Attenuation and absorption. Ch.4 pp.93-166 in: Hill CR, Bamber JC, ter Haar GR (eds.) Physical Principles of Medical Ultrasonics, 2nd Edition, ISBN 978-047197002-6, John Wiley, Chichester, 2004. Bamber JC. Speed of sound. Ch.5 pp. 167-190 in: *opus citatum*.

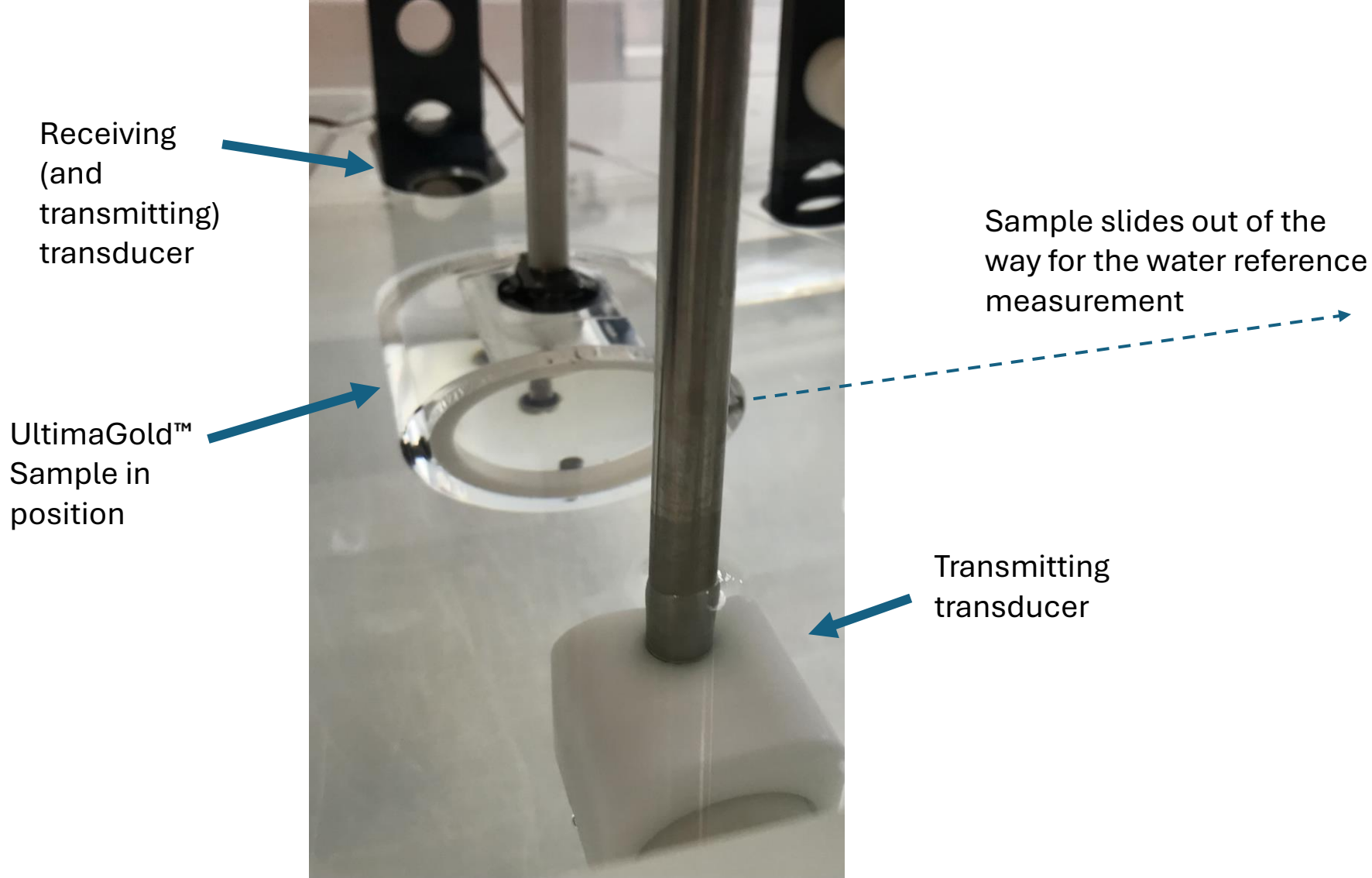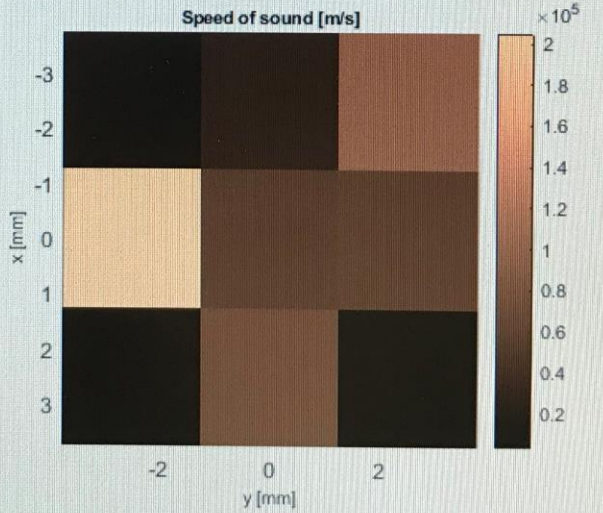Two-part design, for tissue but has been used for liquids (likely to leak)
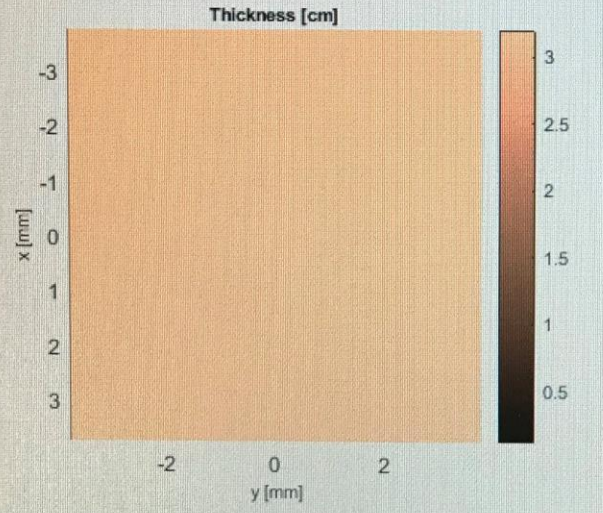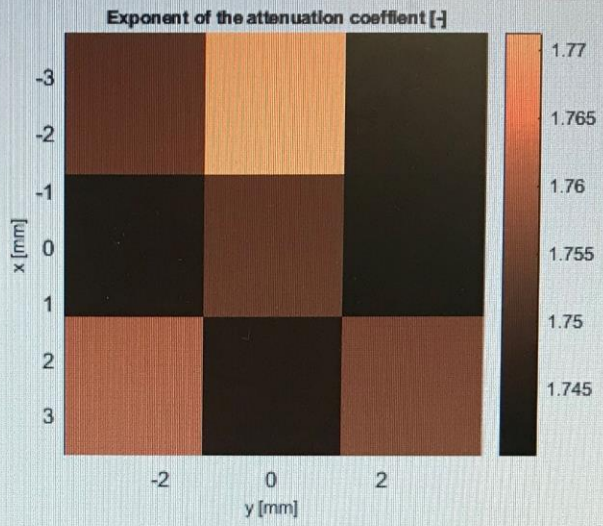
Designed for liquids. Castor oil (above) has not leaked for years

56 mm

30 mm

A Vol = 73900 mm^3 (74 ml)

59 mm

B Vol = 145336 mm^3 (145 ml)

70 mm

18 mm

C Vol = 69281 mm^3 (69 ml)

Sample in position for measurement

Receiving (and transmitting) transducer

UltimaGold™ Sample in position

Sample slides out of the way for the water reference measurement

Transmitting transducer

Figure 2: Parametric Post-Proc

Attenuation coefficient @ 1MHz[dB/cm]

Exponent of the attenuation coeffient [-]

Thickness [cm]

Speed of sound [m/s]
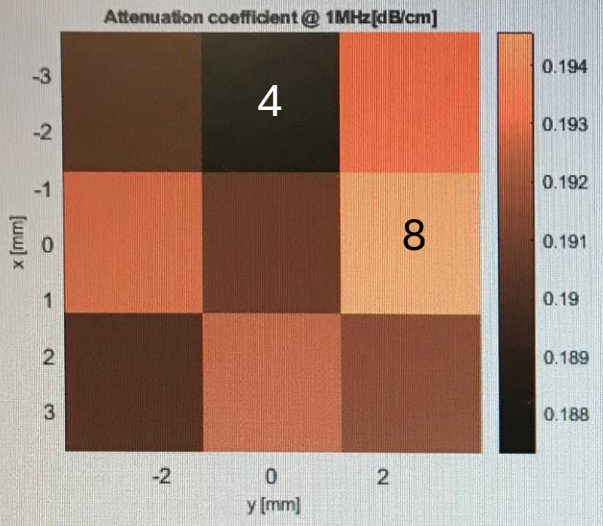
RESULTS

Alpha	0.191+/-0.0021
N	1.75+/-0.00962
Thick.	5.9+/-9.42e-16
SoS	6.149e+04+/-6.4e+04
n =	9 of 9
Temp.	21.8 & 21.8

THICKNESS SETTING

Method	Fixed
Value	5.9
Manual	N/A N/A

ATTENUATION SETTING

Method	Unknown
Manual	N/A N/A

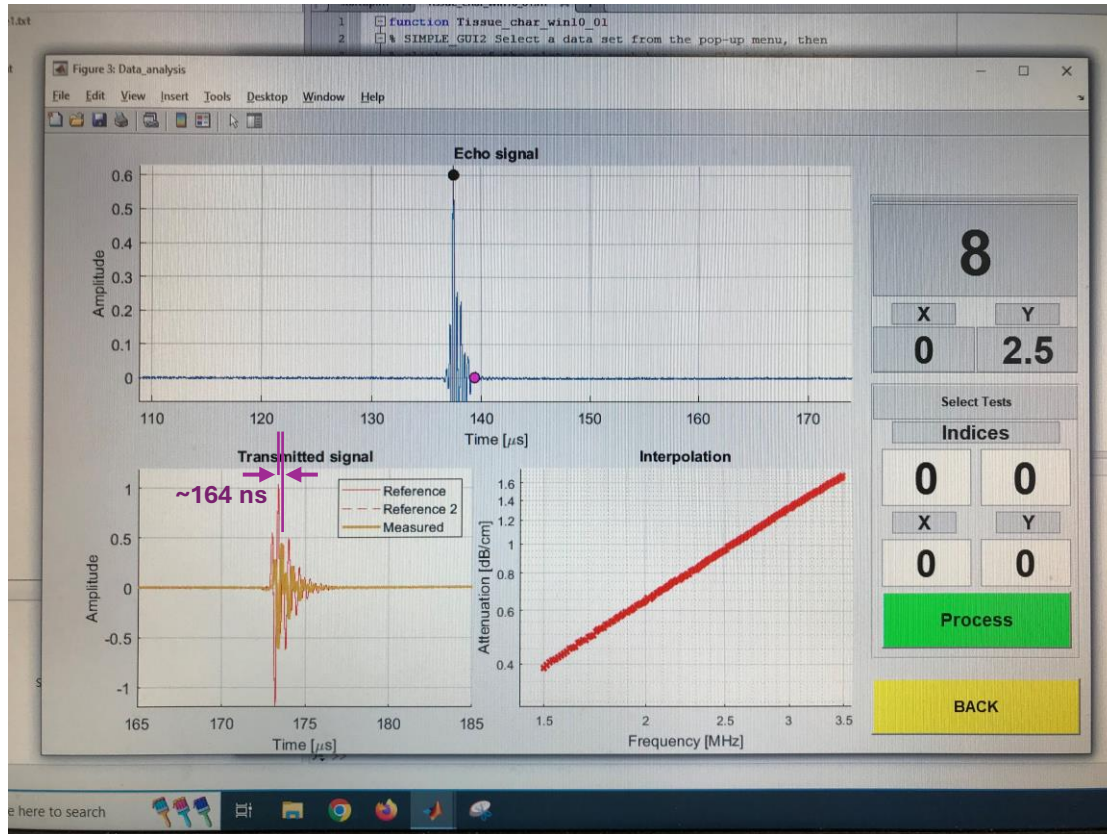**ERROR FILTER**

TOGGLE   dB dev.   0.2

FREQUENCY SETTING

Range   1.5   3.5

Inspect   Thickness
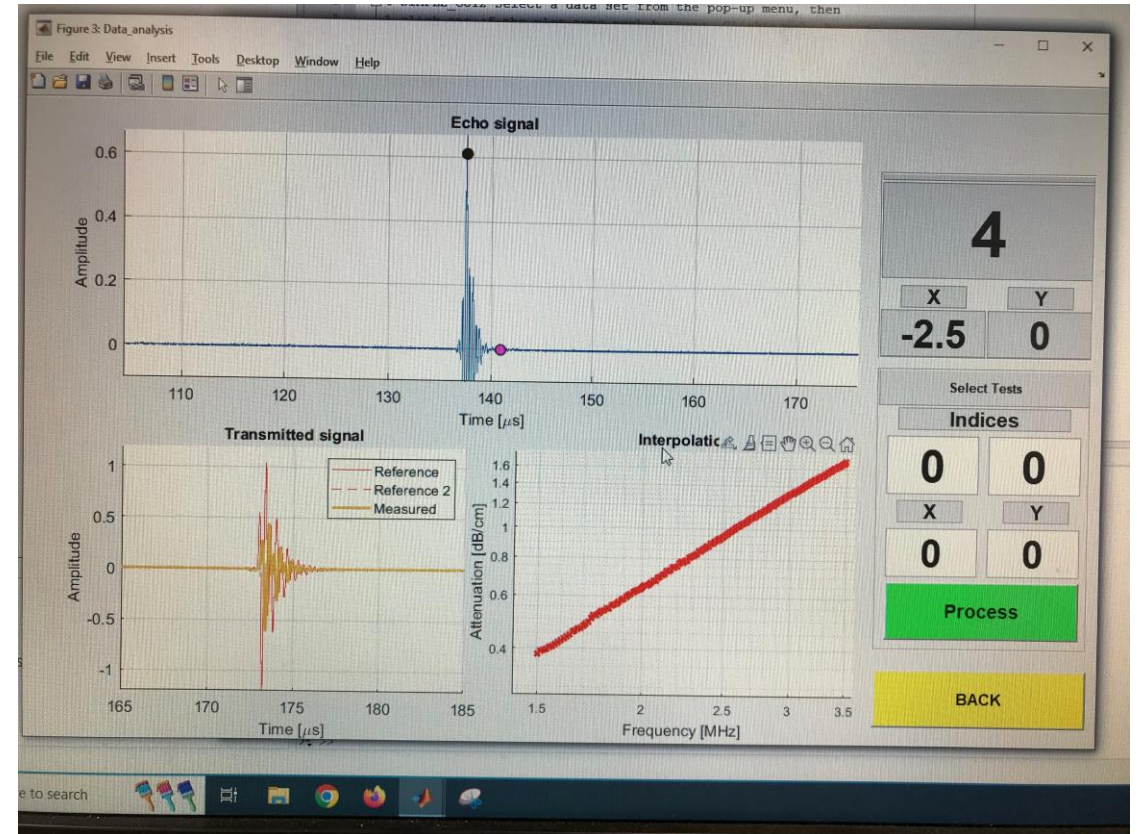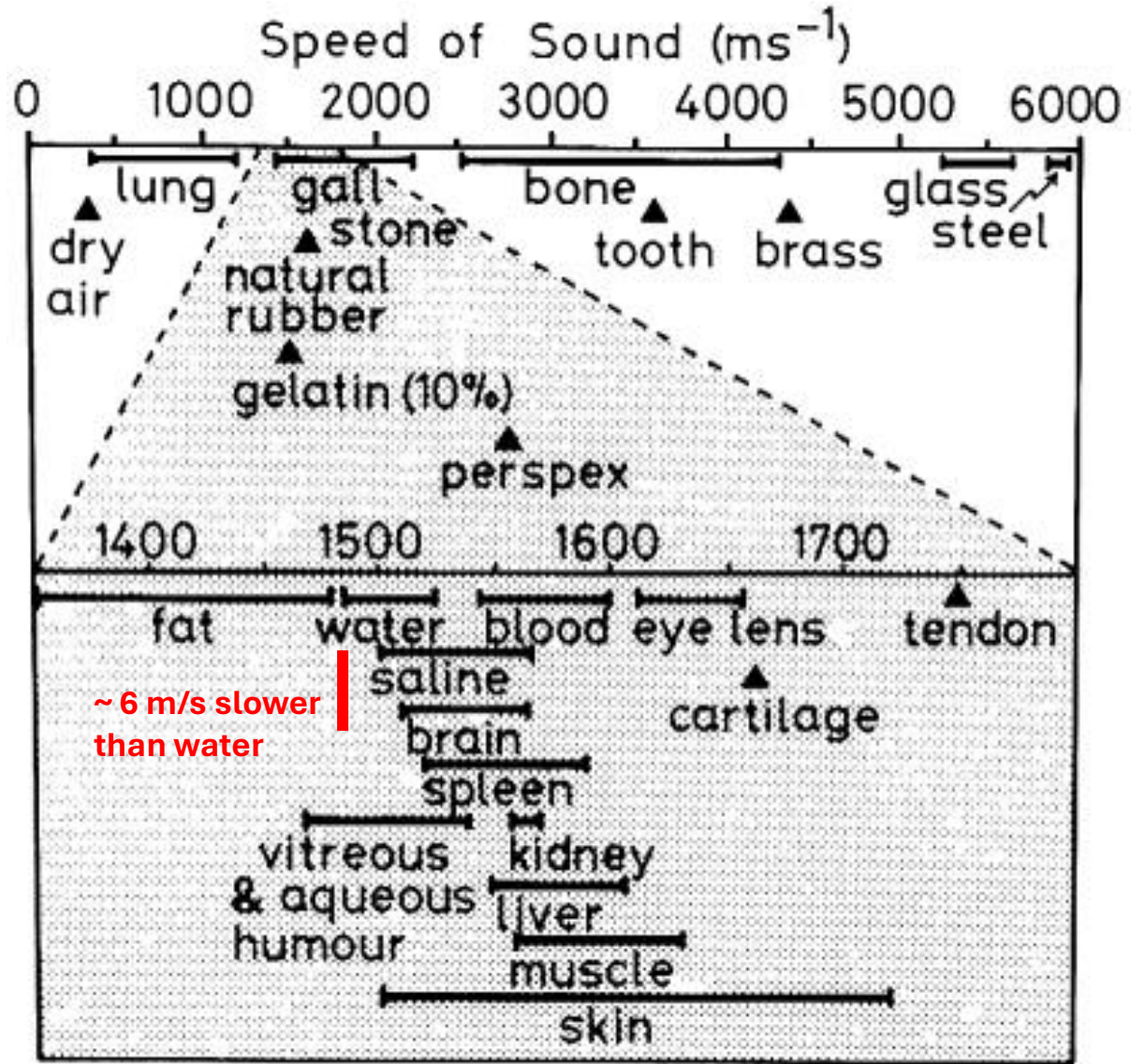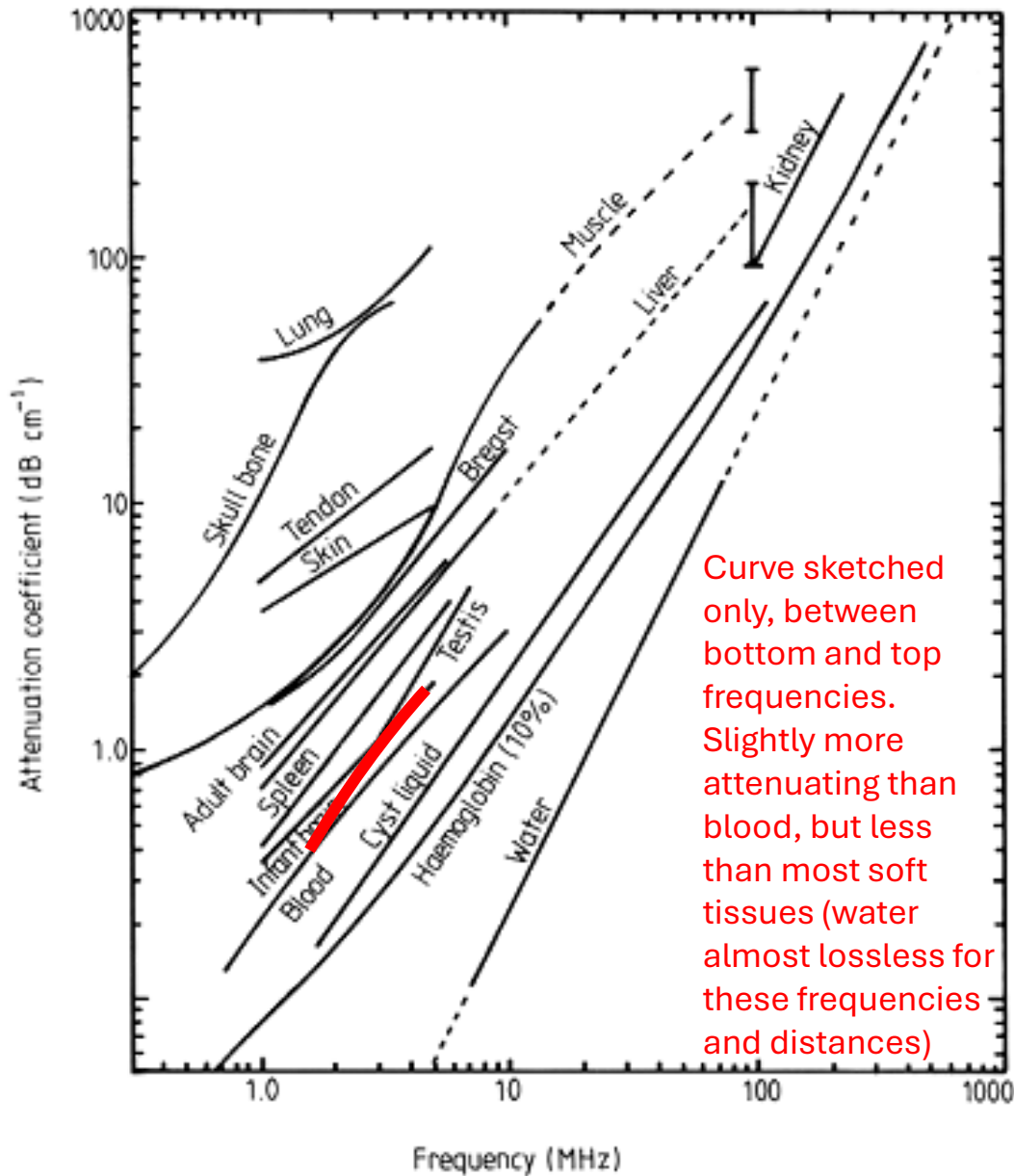
SAVE   BACK

Highest value

Lowest value

Very rough first estimates in relation to published values for various media (pending further analysis)

Curve sketched only, between bottom and top frequencies. Slightly more attenuating than blood, but less than most soft tissues (water almost lossless for these frequencies and distances)

~ 6 m/s slower than water

Discussion

- Ultrasound attenuation coefficient of UltimaGold™ is not high enough to cause great concern for signal detectability in the smartphantom

- Speed of sound also not so low as to cause concern

- Both can be incorporated into modelling and image reconstruction. Effect of sound speed should be negligible. Attenuation coefficient needs to be measured over a much wider bandwidth although preliminary estimates could be made by extrapolation of these data.

- These are not the only potentially important acoustic characteristics – in the long term it may be interesting to know B/A although it is reasonable to neglect nonlinear propagation for now.