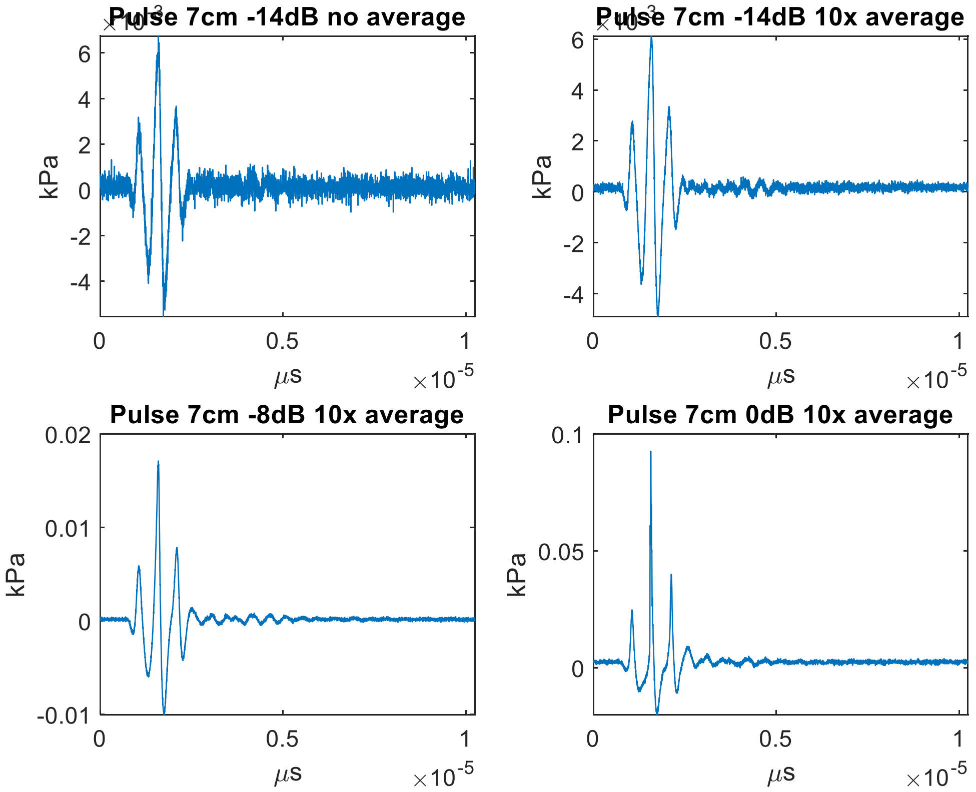
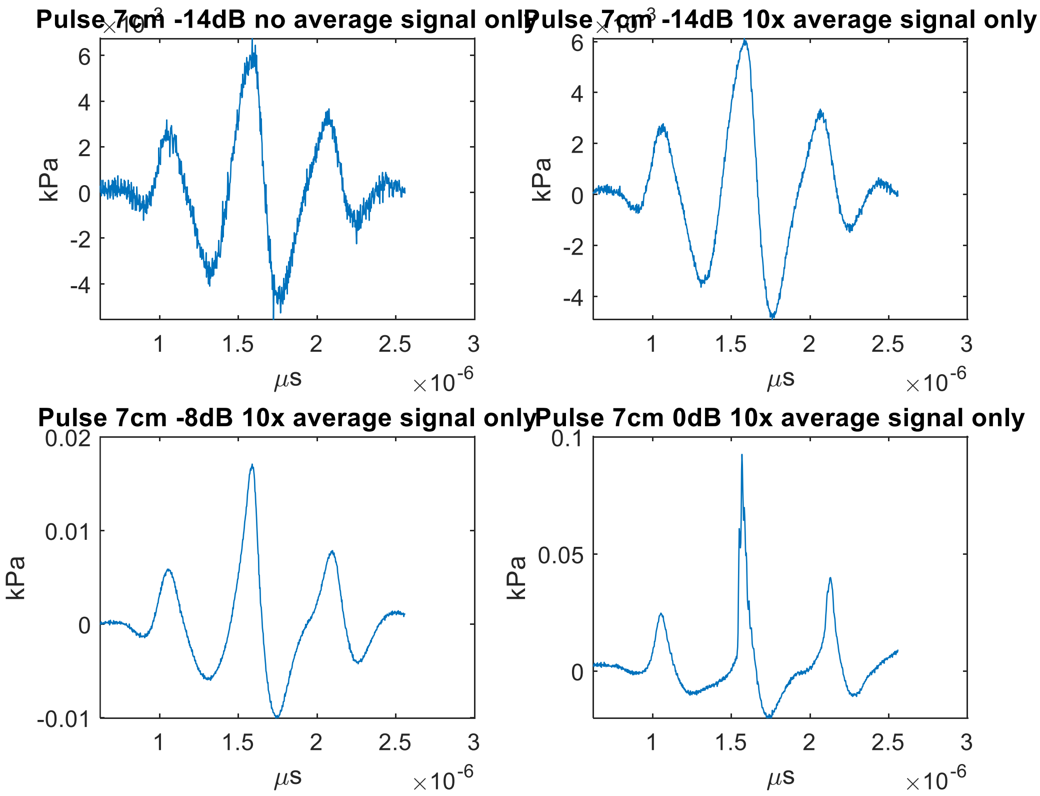
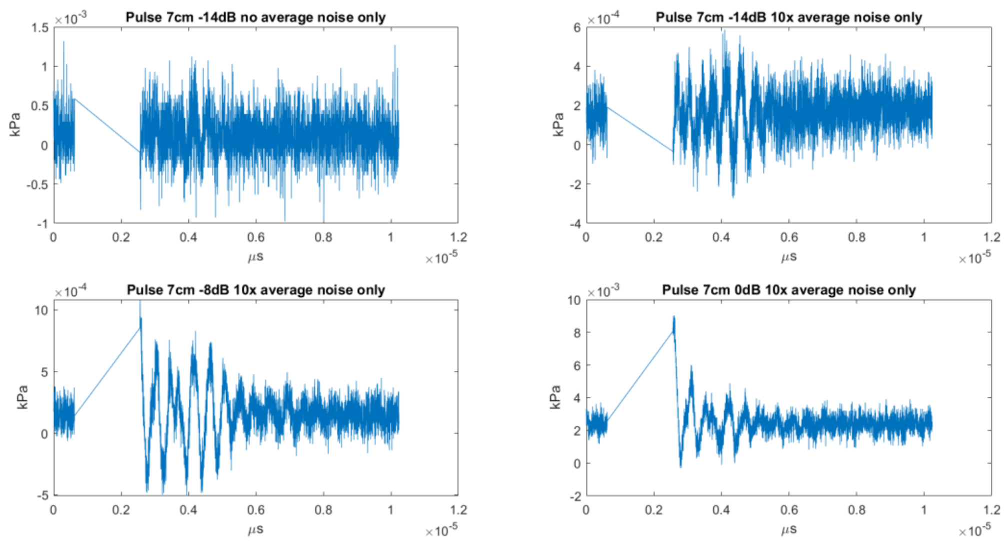
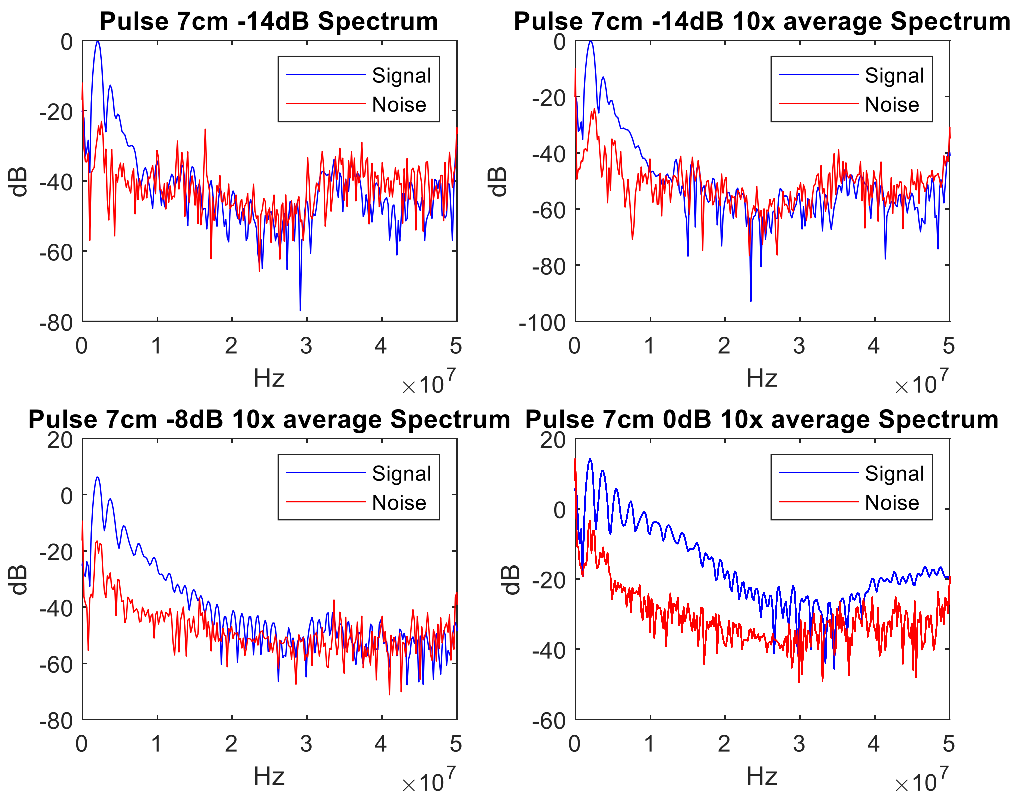
Task 1:


Pulse 7cm -14dB no average
Pulse 7cm -14dB 10x average
Pulse 7cm -8dB 10x average
Pulse 7cm 0dB 10x average
kPa
μs
$\times 10^{-3}$
$\times 10^{-5}$


Pulse 7cm -14dB no average signal only
Pulse 7cm -14dB 10x average signal only
Pulse 7cm -8dB 10x average signal only
Pulse 7cm 0dB 10x average signal only
kPa
μs
$\times 10^{-3}$
$\times 10^{-6}$





Task 2:

Q: What frequency yields the strongest signal? What is the approximate spectral signal to noise ratio (spectral SNR) for the different pulses on this frequency? Spectral SNR here refers to the difference in dB between a signal component and the noise floor in the spectrum.

A: Strongest signal from around 3MHz SNR seems to be around.

SNR Pulse 7cm -14dB Spectrum 11 dB

SNR Pulse 7cm -14dB 10x average Spectrum 1.4 dB

SNR Pulse 7cm -8dB 10x average Spectrum 8 dB

SNR Pulse 7cm 0dB 10x average Spectrum 19 dB

Q: If the noise is white, it should have approximately equal power for all frequencies. Is the noise white? If not, can you explain why? How does this influence the SNR estimates above?

A: The fact that the noise spectra show a gradual increase in dB levels indicates that the noise power is not constant across all frequencies. And that we have a colored spectrum. The SNR estimates will therefore not be accurate for different frequencies.

Q: How much SNR should you gain when averaging over 10 pulses? Do you see the same gain in the results?

A: For each additional pulse averaged, you can expect the square root of that number as an increase in SNR. For example, if you average 10 pulses, you might expect an SNR gain of sqrt(10)≈3.16 times. I don't exactly see this relationship.

Q: Measure the peak power at the fundamental frequency when increasing power from -14dB to -8db to 0dB? Is this as expected?

A: Max amplitude of spectrum -14dB no average is -0.33 at frequency 1953125.00 Hz

Max amplitude of spectrum -14dB 10x average is -0.25 at frequency 2148437.50 Hz

Max amplitude of spectrum -8dB 10x average is 6.31 at frequency 1953125.00 Hz

Max amplitude of spectrum 0dB 10x average is 14.18 at frequency 1953125.00 Hz

This is expected. The max amplitude of the spectrum increases as the power increases.

Q: Measure the peak power of the second harmonic frequency when increasing power from -14 dB to -8dB to 0dB. Compare to the corresponding results for the fundamental frequency. Can you explain your observations? How does this affect the pulse shape?

A: I don't know how to find this second harmonic.

Task 3:

Q: Calculate the wavelength λ and the F-number in azimuth and elevation.

A:

For Azimuth:

1. Calculate F-number (F#):

F#_azimuth = 7 cm / 1.853 cm ≈ 3.78 cm

2. Calculate Wavelength (λ):

   λ_azimuth = 2.1 mm / (1.2 * 3.78 cm) ≈ 0.463 mm

For Elevation:

1. Calculate F-number (F#):

   F#_elevation = 7 cm / 1.853 cm ≈ 5.83 cm

2. Calculate Wavelength (λ):

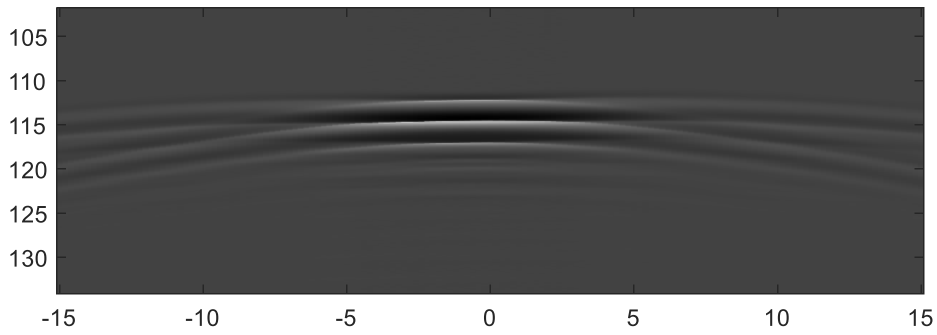
   λ_elevation = 4.1 mm / (1.2 * 5.83 cm) ≈ 0.586 mm

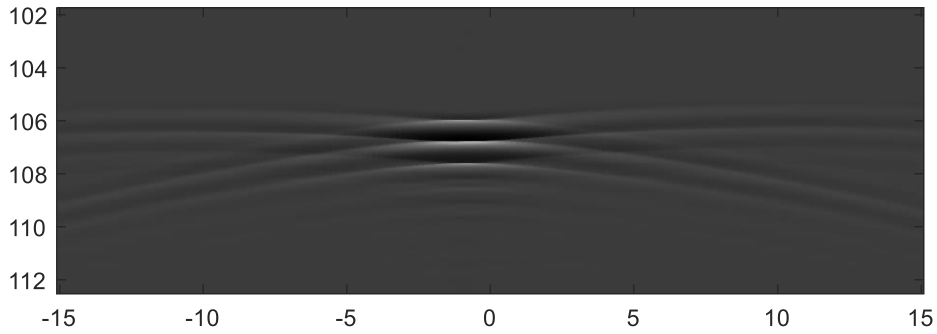
Q: According to theory, which mathematical function should describe the beam profiles? Create a suitable position axis and plot the power of this function vs position in Matlab, using logarithmic scale. Estimate the beam width, distance to the sidelobes, and the sidelobe level. If you have not considered this already, how should this function be rescaled (along the x-axis) to match the measured beam profiles in azimuth and elevation.

A: The Gaussian curve should describe the beam profile.

Are the measured beam profiles as expected? (Beam width, distance to sidelobes, sidelobe level).

Task 6:





The edges get less sharp when it is reduced, and they get stretched.