Ultrasonics 2017
Exercise 5.

1. *Image basics.*

data1.mat contains a data set representing two ultrasonic pulse-echo linear scans (N=32), done by a 128 element, 2MHz linear array (pitch 1mm). Material specs: c=1670m/s, 1mm side drill holes. Sample rate is 50MHz. The first centimeter in axial direction is windowed out from both of the scans.

a) Plot a B-mode image of both scans. Use both linear- and dB-scales (try at least 40dB and 60dB dynamic range). Plot correct x- and y-axes and use millimeters as axis units.

b) What is the approximate electronic focal depth in both scans?

c) What is the approximate beam width at the focus and the spatial impulse response?

d) Point out side lobes and grating lobes.

`HINT: Take the envelope of the signal first. (abs, hilbert, imagesc)`

2. *US signals. Bandwidth, resolution, and attenuation.*

a) Generate and plot a bandwidth limited ("ultrasonic") signal. Specs: peak at T=5µs, frequency 10MHz, fractional FWHM-bandwidth=50%. Plot in the range of t=0-10µs.

b) What would be the axial resolution (assuming no attenuation) of a system using such a signal? How the center frequency affects the axial resolution? Visualize the situation by plotting two barely resolvable signals.

c) Assume 2dB/cm attenuation @ 1MHz. n=2 (f^n). Plot the signal @ s=5cm and 10cm. (c=1500m/s).

`HINT: Do almost all in the frequency domain.`

3. *Beam simulation basics. Point sources and transducer beam.*

Five point sources are positioned as shown in Fig 1. Pitch = 3 mm. Assume that the sources are transmitting continuous wave signal at the same phase. F= 5 MHz, c=1500m/s. Take geometric spreading into account, but not attenuation.

a) Calculate the sum-field amplitude along the axial (y=1cm-35cm) direction of the middle element (the red dotted line in the fig). What would happen if you increase the number of point sources within the same aperture (e.g. 41 elements and 0.3 mm pitch)?

b) What happens if the sources are positioned as given in Fig 1. b? i.e. the sources 1-2 and 4-5 are offset in the y-direction.

`HINT: Pythagoras. Symmetry. Wave-equation solution (CW, t=0). 1/r.`

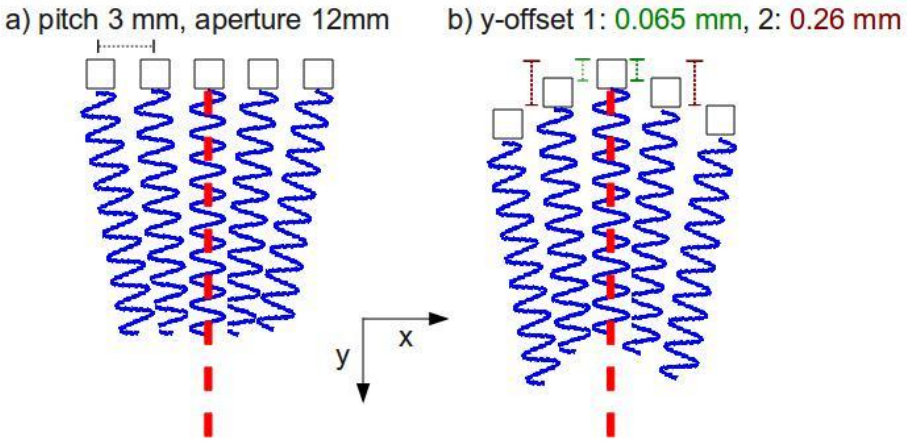

Figure 1.