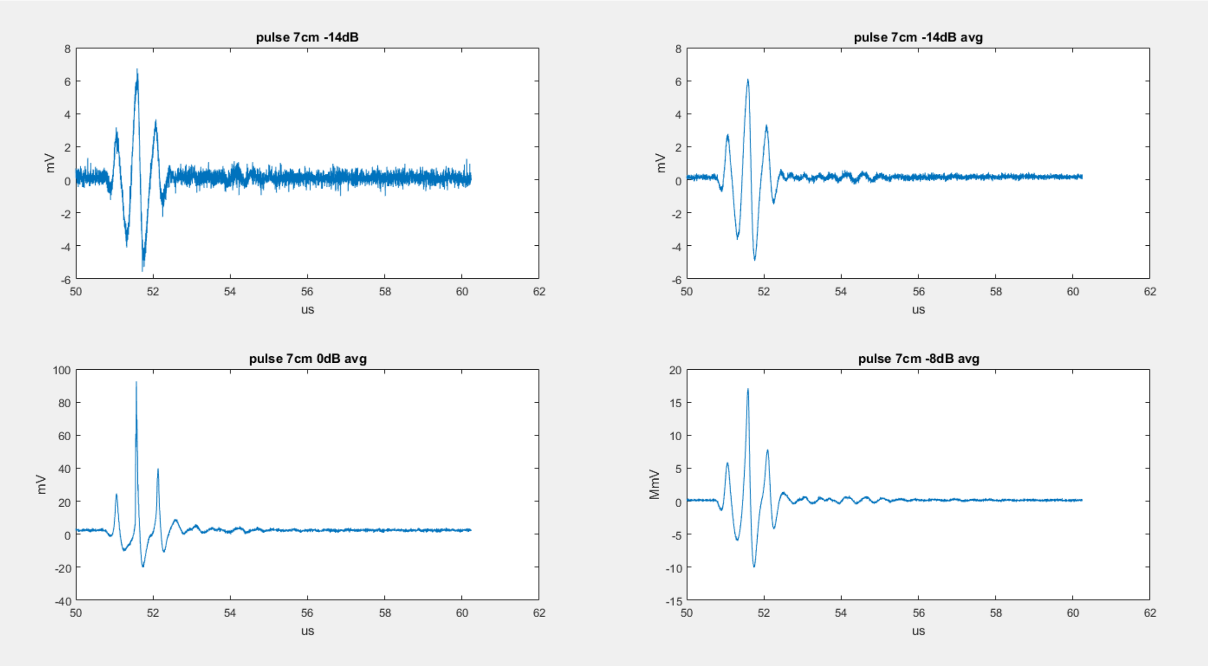
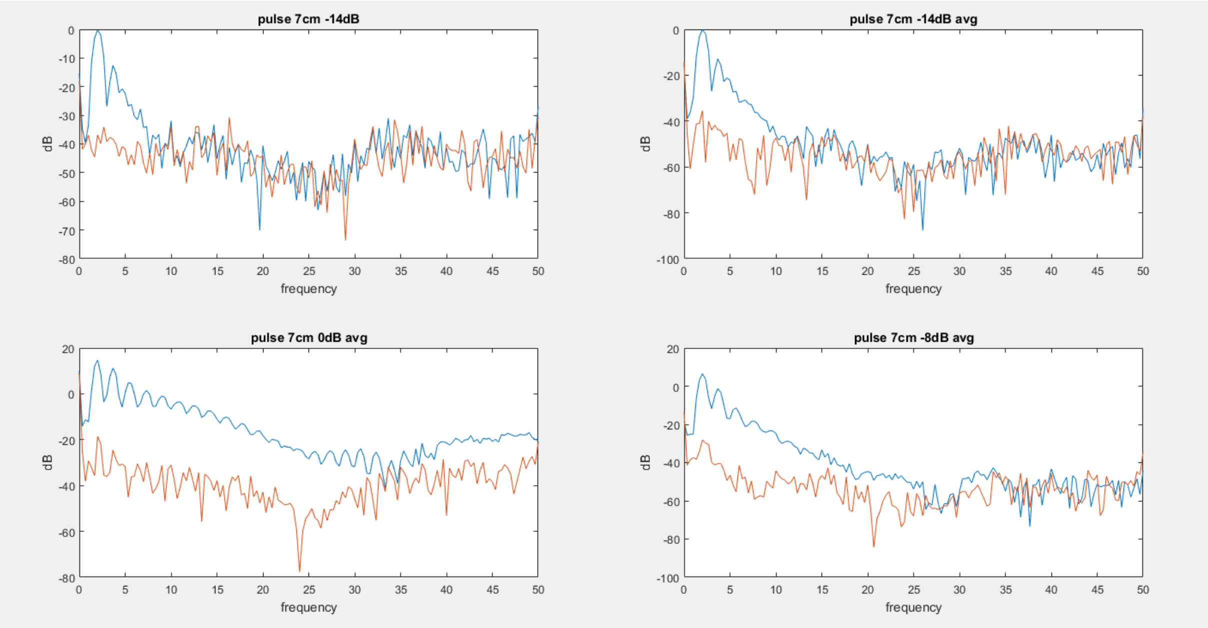
MEDT4165
Exercise 4

Task 1)



Task 2)



Measurement of the SNR is done by comparing the peaks at fixed frequency, even though the center-frequency is 1.6MHz, I have used 2MHz to find SNR:

Signal power	SNR(signal-noise)[dB]
-14dB no avg	-0.21-(-36.8)=36.6
-14dB avg	-0.12-(-35.5)=35.4
0dB avg	14.7-(-18.5)=33.2
-8dB avg	6.6-(-28.2)=34.8

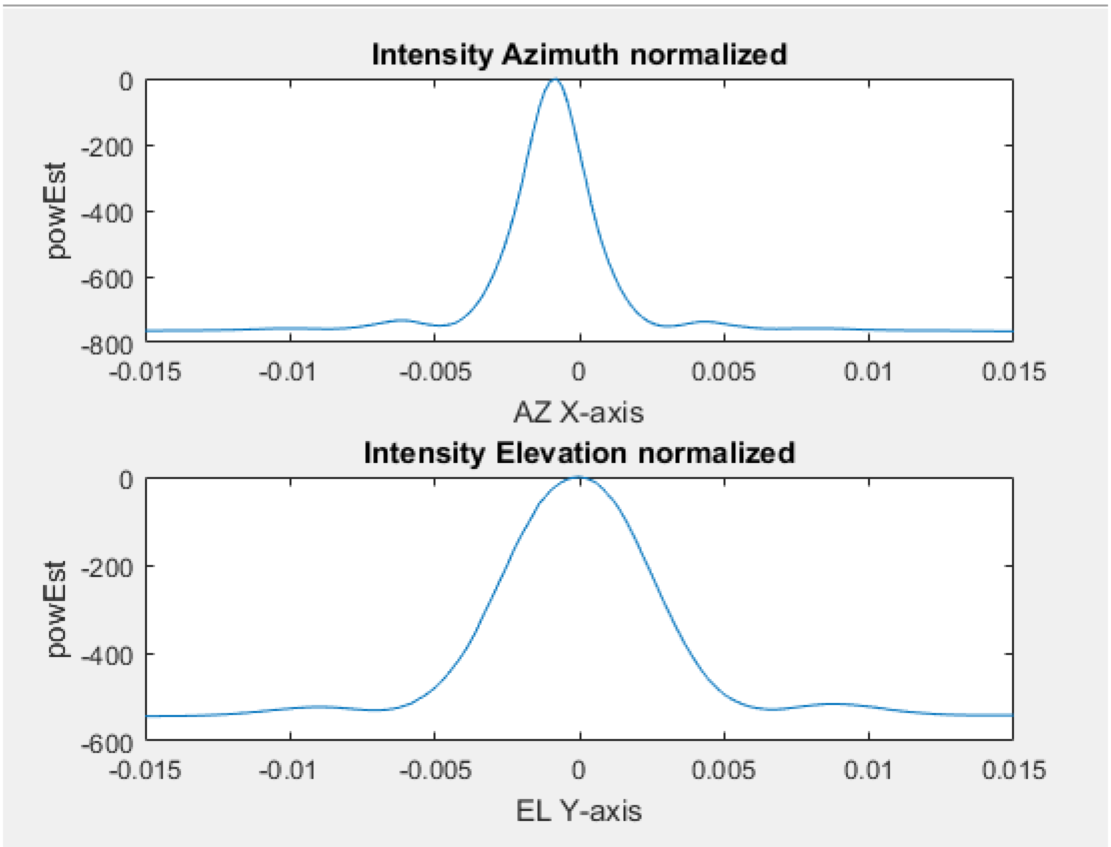
- The frequency that yields the strongest signal is the -14dB avg. power signal. The SNR of this signal is 35.4[dB]. The highest SNR is given by the -14dB power signal.
- White noise is supposed to flat, but that's not the in our case. The noise in our case is way more turbulent.
- I do not know
- As the power decreases the SNR gets higher. A reasonable assumption is that higher power contains more noise du to higher frequency components.

Second Harmonic components:

Signal power	SNR(signal-noise)[dB]
-14dB no avg	-12.6-(-38.3)= 26.3
-14dB avg	-12.8-(-43.7)=30.9
0dB avg	11.1-(-24.6)=35.7
-8dB avg	-1.3-(-40.5)=39.2

- As we can see from the table; -8dB has the highest SNR.

Task 3)



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- The beamwidth for azimuth is 1.1mm*2. For elevation is 3.9mm*2.

Azimuth=1.853cm

Elevation=1.2cm

Focus at 7cm for azimuth and elevation

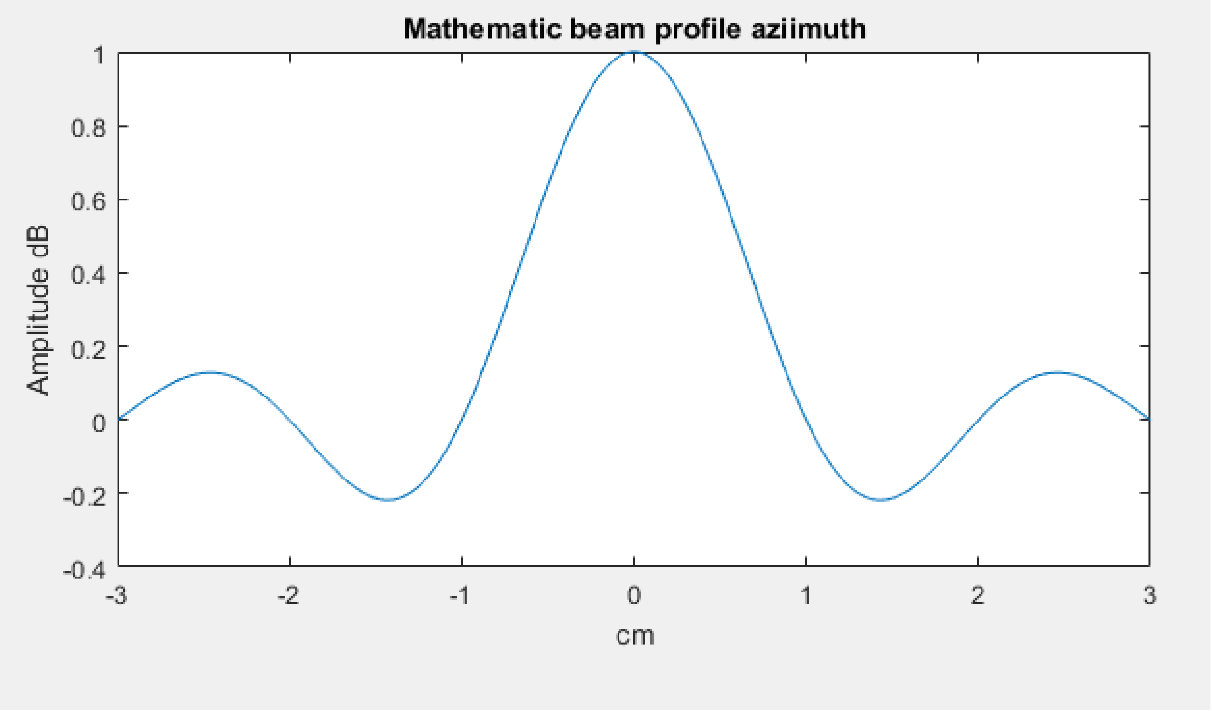
F#=Z/D, F-length to focus, D-dimension/diameter

Azimuth F#: 7cm/1.853cm=3.77

Elevation F#: 7cm/1.2cm=5.83

Lambda=c/f

- According to theory, the beam function is described by the sinc function. For the mathematic model, the zero crossing is when x=1. While for the ultrasound model(aperture function of the transducer) the first zero crossing is F#*lambda=Z(depth)/D(dimension)*lambda. In other words, the ultrasound version is scaled by a factor → sinc(x/F#*lambda). Where we found the F# for the different angles. The estimated beamwidth is 2*6mm. The estimated distance to the first side lobe is 2.46cm



To find the scaling that matches the ultrasound beam:
Azimuth: sinc(x*f/0.26*c)→sinc((x*1.67MHz) / (03.77*1540m/s))
Elevation: sinc(x*f/0.17*c)→sinc((x*1.67MHz) / (5.83*1540m/s))

- As we can se from the figure below, the ultrasound beam has a wider lobe(poor lateral resolution) and reduces the sidelobes level more than the mathematical model:

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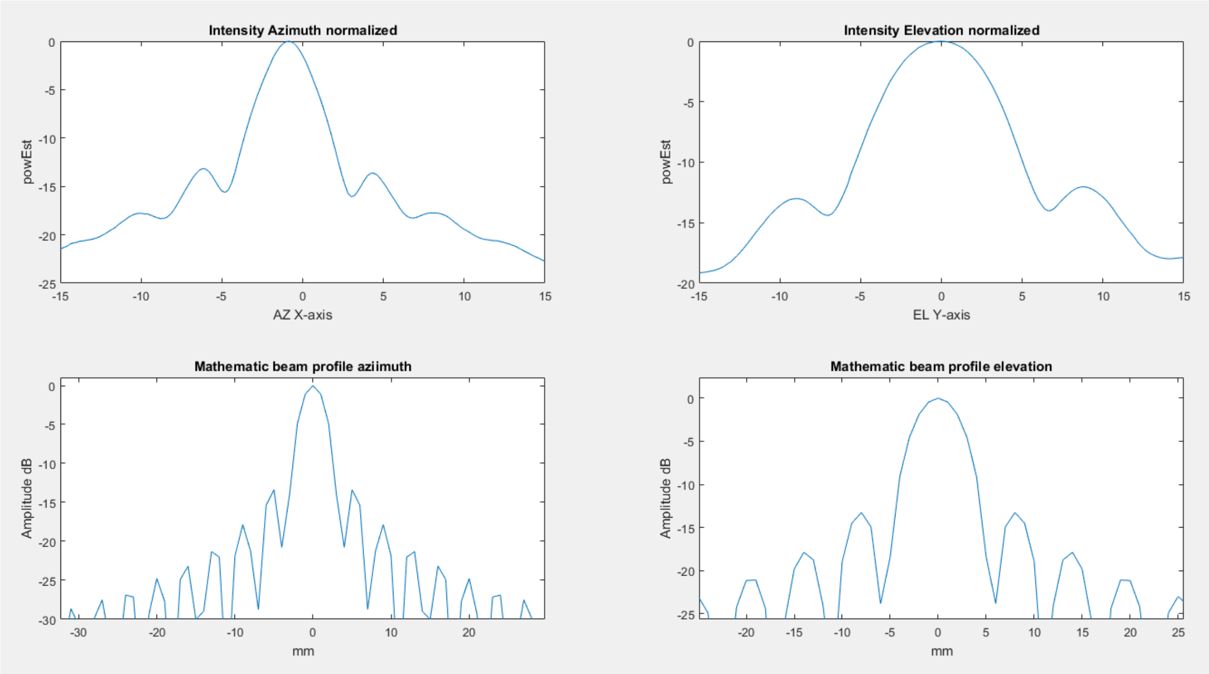
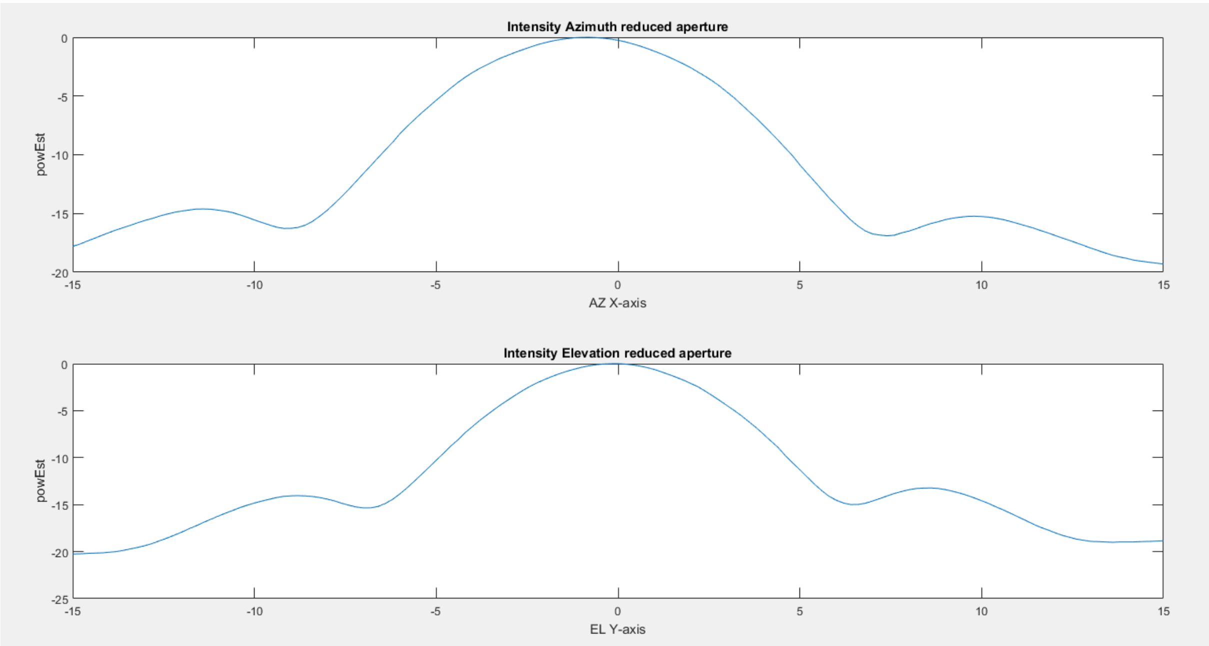


Task 4)



- The estimated beam width for reduced azimuth: 3.5cm*2
- The estimated distance to the first sidelobe for the azimuth direction is: 10cm
- The estimated beam width for reduced elevation: 3.5cm*2
- The estimated distance to the first sidelobe for the elevation direction is: 8.5cm

…..didnt find the relationship…

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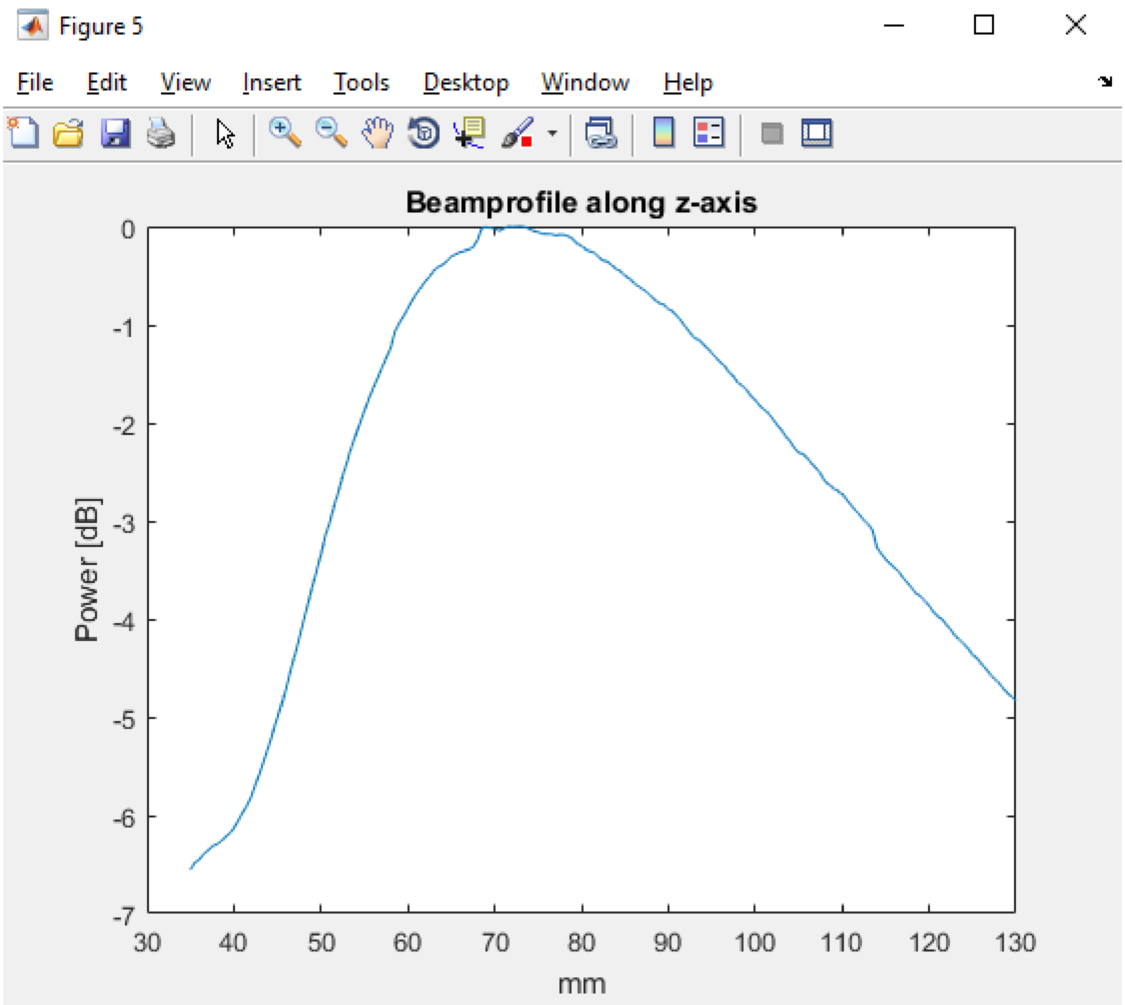
Task 5)



As we can see from the figure above, the maximum intensity is around 68-73mm depth. This makes sense because the hydrophone is placed at 7 cm depth from the surface of the transducer, and we want to maximize the intensity at that point.

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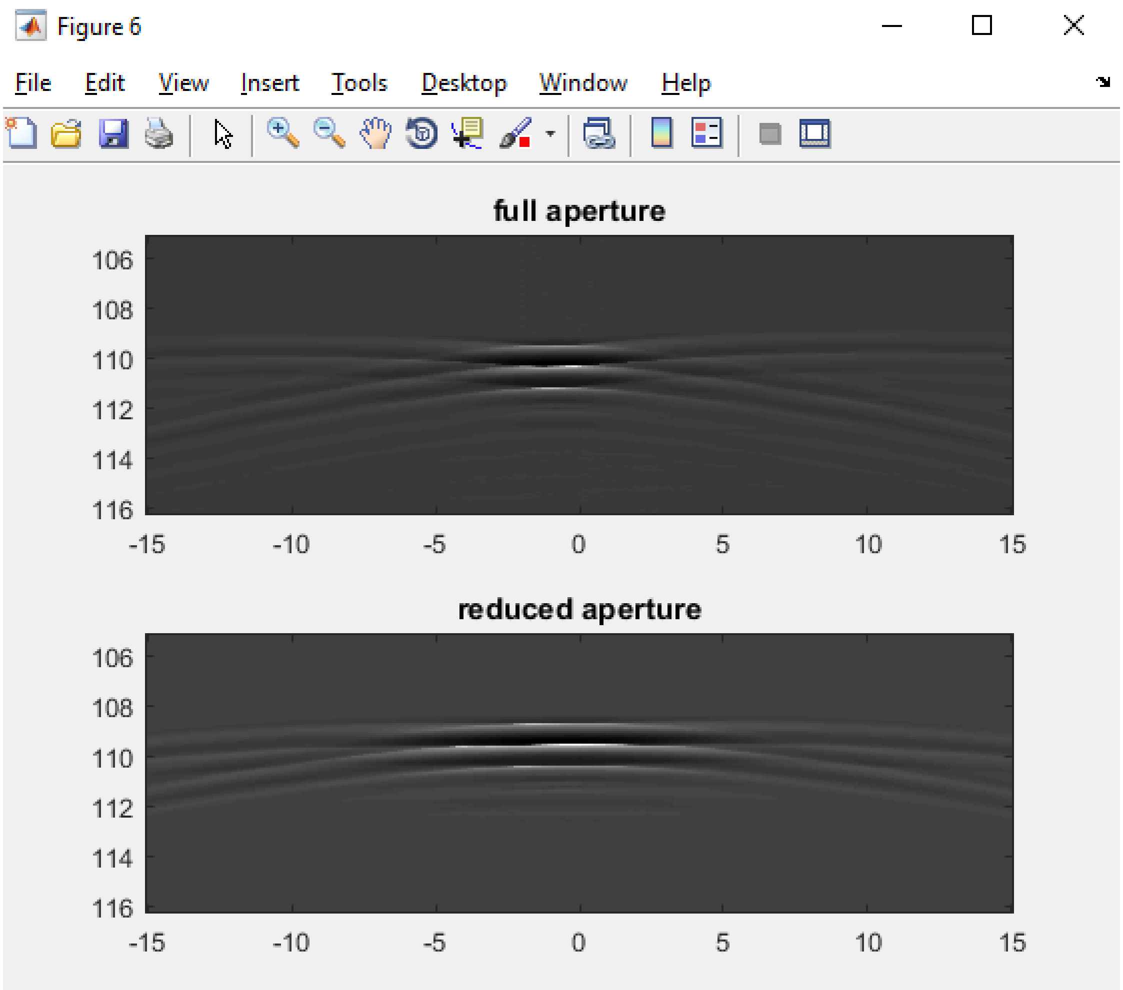
Task 6)



The lateral resolution decreases as we reduce the aperture. This can clearly be seen in the figure above. Full aperture gives narrower and more focused beam at the focal depth. While the reduced beam is more spread in the focal depth, hence reduced lateral resolution.