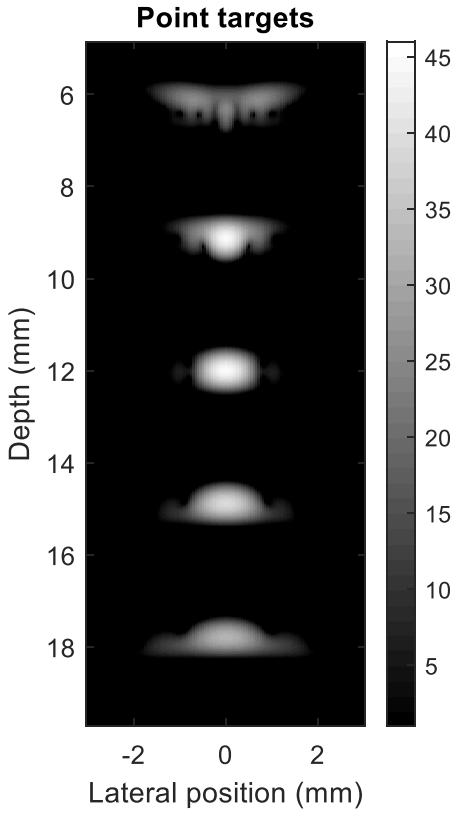
% EE441000 ªL¯S¦w 110061622 HW1 part1 04/09/2022

Introduction to Biomedical Imaging 110061622 林祐安

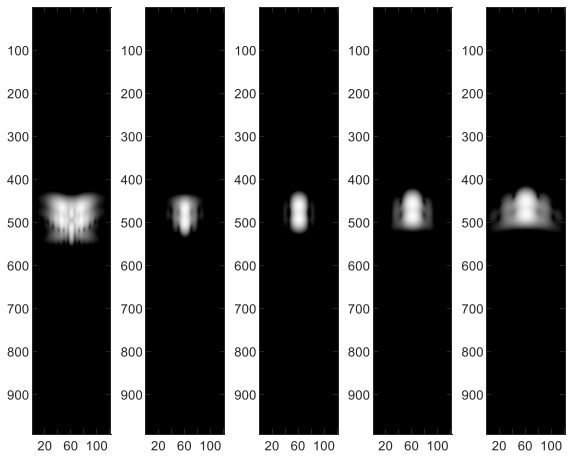
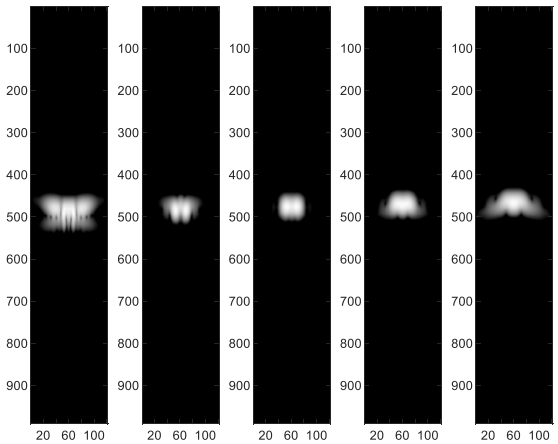
(a) (b)



Since the middle point has a neat shape without deformed, it should be at focal zone. Hence, the focal length is about 12 mm.

(c) 1500m/s

(d)

Axial resolution (0.45mm)	Lateral resolution (0.75mm)
	

Pictures from the first column to the last column represent PSF at different depth from shallow to deep. Both axial and lateral spatial resolution don't have the best performance at focal point.

(e)

	6mm	9mm	12mm	15mm	18mm

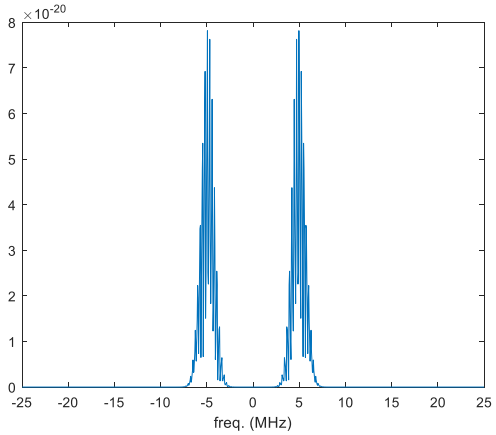
Lateral 6dB	2.05	0.55	0.65	0.85	0.95
Axial 6dB	0.675	0.405	0.405	0.405	0.405
Lateral 20dB	3.25	1.25	1.15	1.45	2.45
Axial 20dB	1.08	0.75	0.735	0.735	0.735

In the previous problem, we set the spatial resolution according to the focal point, and it may have some round-off error due to the conversion from distance to pixel. The eye examination says the axial resolution and lateral resolution are 0.45mm and 0.75mm respectively and our measurements are 0.405 mm and 0.735mm.

(f)

focal length = d = 12 mm

theoretical lateral resolution = f#*lambda = d/D*lambda => D = 5.5950



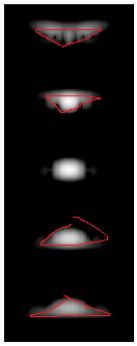
Center frequency is at about 5MHz.

(g)

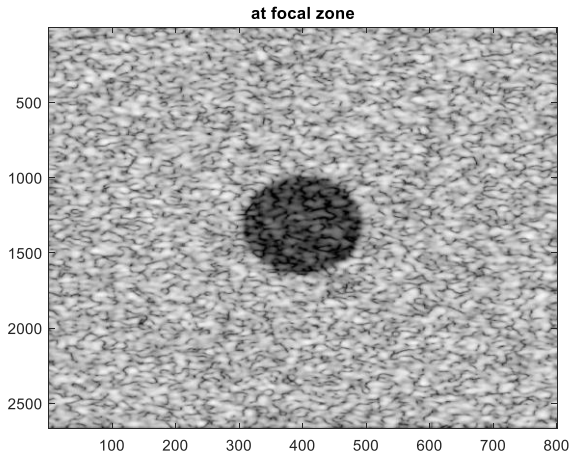
Axial resolution should be a constant at different depth due to the consistent pulse length, but lateral resolution should become better before focal point and worse after focal point. In the other word, axial resolution is independent of position but lateral resolution is dependent of position.

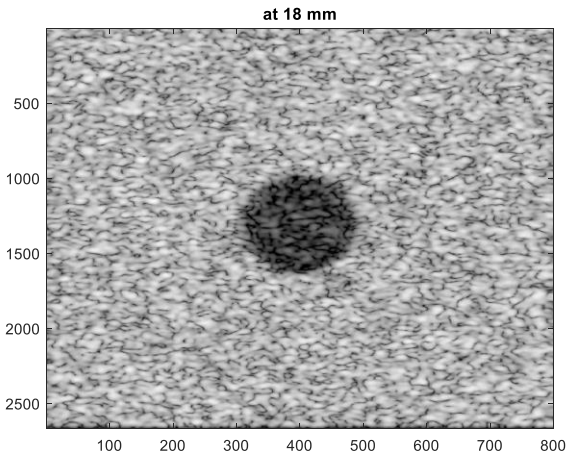
(h)

Before the focal point, PSFs have the shape like inverted triangular due to the acoustic field, otherwise they have triangular shape.



(i)





Note that the reflection coefficient is set as 0.1 at anechoic zone, otherwise it's 1.

The average intensity in the region of background and interesting is about -13.2113 dB and -33.1552 dB.

Contrast ratio = 19.9439 dB

(j)

baseband demodulation:

frequency shift by fc -> applying LPF

```
% (j) Bonus
DemodData = rf_data.*repmat(exp(-1j*2*pi*fc*time_axis'),1,n); % freq. shift
f_order = 40;
fcut = 0.2;
f = [0 fcut fcut 1];
mag = [1 1 0 0];
b1 = fir2(f_order,f,mag); % design a LPF
BaseData = abs(filter(b1,1,DemodData));
envelope_dB = 20*log10(BaseData/max(max(BaseData))+eps);
figure
image(x_axis,z_axis, envelope_dB + DR)
colormap(gray(DR))
axis image
```