

$$1. L_{\text{total}} = L_{\text{transmission}} + L_{\text{reflection}} = -60.5$$

$$L_{\text{transmission}} = -\alpha_{\text{muscle}} \cdot f \cdot x = \left(\frac{1.1 \text{ dB}}{10^3 \text{ m} \cdot \text{MHz}} \right) (4 \text{ MHz}) \cdot 1540 \frac{\text{m}}{\text{s}} \cdot 55 \times 10^6 = -37.27 \text{ dB}$$

$$L_{\text{reflection}} = -60.5 - (-37.27) = -23.23 \text{ dB}$$

Let Z_q is the acoustic impedance of the material on the other side of boundary

The reflected component is the residual that did not get through boundary:

$$R = 1 - T = 1 - \frac{2Z_q}{Z_{\text{muscle}} + Z_q} = \frac{Z_{\text{muscle}} - Z_q}{Z_{\text{muscle}} + Z_q}$$

$$L_{\text{reflection}} = 20 \times \log_{10}(R) = -23.23 \text{ dB}$$

$$\text{then } R = \frac{Z_{\text{muscle}} - Z_q}{Z_{\text{muscle}} + Z_q} = 10^{-23.23/20} = 0.0689 = \delta$$

$$Z_{\text{muscle}} - Z_q = \delta (Z_{\text{muscle}} + Z_q)$$

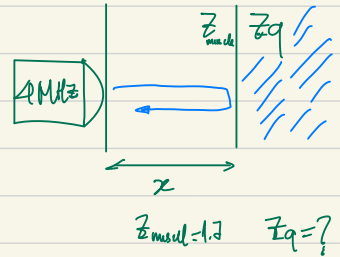
$$Z_q = Z_{\text{muscle}} \left(\frac{1 - \delta}{1 + \delta} \right) = 1.48 \text{ kg m}^{-2} \text{ s}^{-1} \times 10^6$$

Thus we have a watery cyst

$$2. f_0 = -\frac{2v_a}{c} f +$$

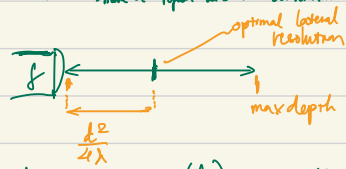
$$v_a = \frac{-1}{2} \frac{f_0 \cdot c}{f} = \frac{-1}{2} \cdot \frac{-1000}{2 \times 10^6} \times 1540 = 0.385 \text{ m/s}$$

Direction: away from transducer



3. Bandwidth = $-100\text{dB} = L_{\text{total}} = L_{\text{move}} + L_{\text{reflect}}$

where L_{move} & L_{reflect} are the attenuation caused by moving through tissue & reflection at boundary.



$$L_{\text{reflect}} = 20 \log_{10} \left(\frac{A_r}{A_i} \right) = 20 \log_{10} (0.01) = -40\text{dB}$$

$$L_{\text{move}} = L_{\text{total}} - L_{\text{reflect}} = -100 - (-40) = -60\text{dB}$$

$$L_{\text{move}} = -\alpha_0 f \alpha$$

$$= -\alpha_0 \cdot f \cdot 2(\text{max depth})$$

$$= -\alpha_0 \cdot f \cdot 4 \frac{d^2}{4\lambda}$$

$$= -\alpha_0 \cdot f^2 \cdot \frac{d^2}{c}$$

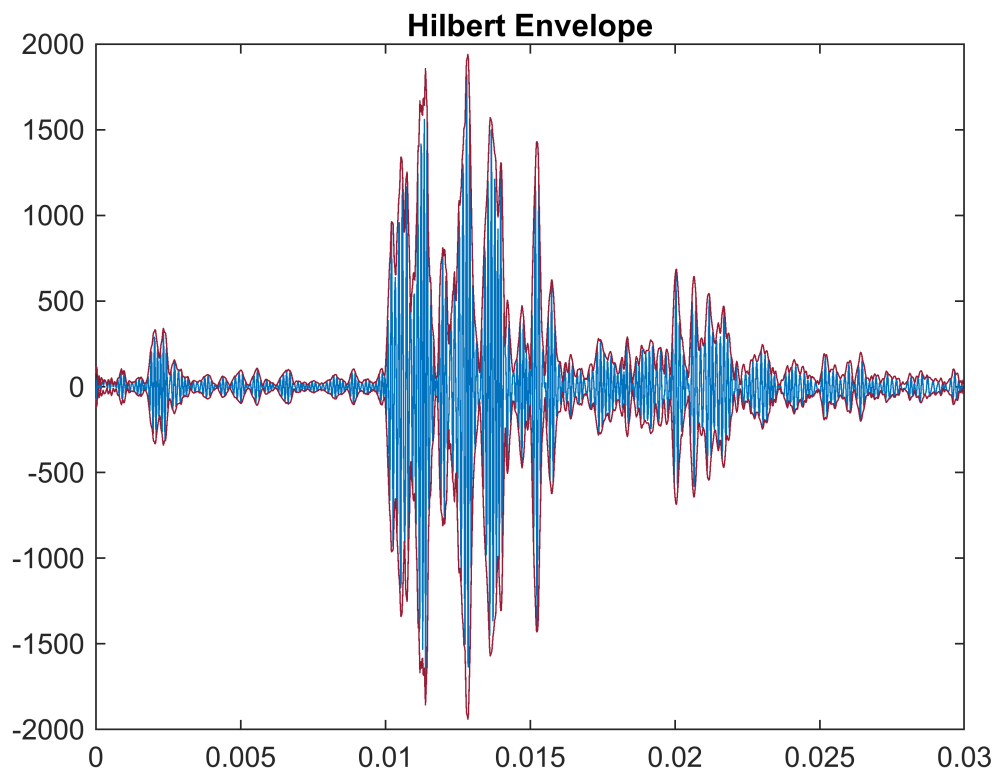
Thus

$$-60 = -\frac{0.9}{10^{-2} \times 10^6} \cdot f^2 \frac{(20 \times 10^{-3})^2}{1540}$$

$$f = 1.6 \text{ MHz}$$

```
load("carotid.mat");
```

```
[nRow, nCol] = size(rfdata);  
env = abs(hilbert(rfdata));  
col=5;  
  
% plotting  
figure  
plot(axial,rfdata(:,col));  
hold on  
plot_param = {'Color',[0.6 0.1 0.2],'Linewidth',0.5};  
plot(axial,env(:,col),plot_param{:})  
plot(axial,-env(:,col),plot_param{:})  
hold off  
title('Hilbert Envelope')
```



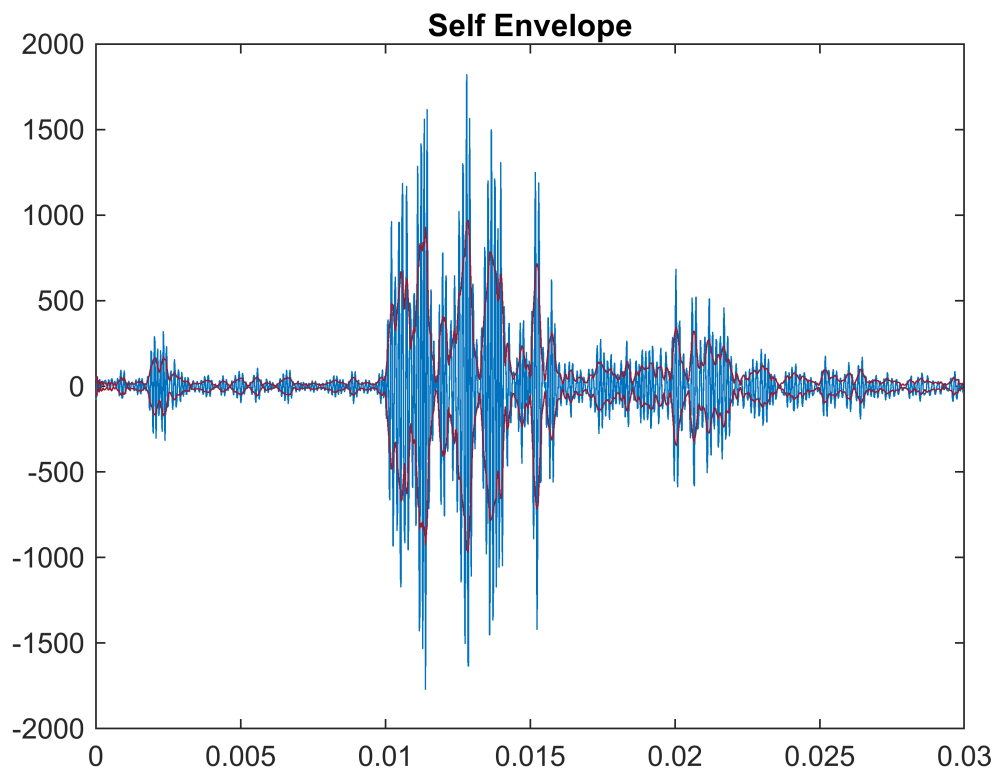
```
S = (fft(rfdata));  
N = length(S);  
S(1:N/2,:) = 0;  
si = ifft((S));
```

```
% plotting  
figure  
plot(axial,rfdata(:,col));
```

```

hold on
plot_param = {'Color',[0.6 0.1 0.2],'Linewidth',0.5};
plot(axial,abs(si(:,col)), plot_param{:})
plot(axial,-abs(si(:,col)), plot_param{:})
hold off
title('Self Envelope')

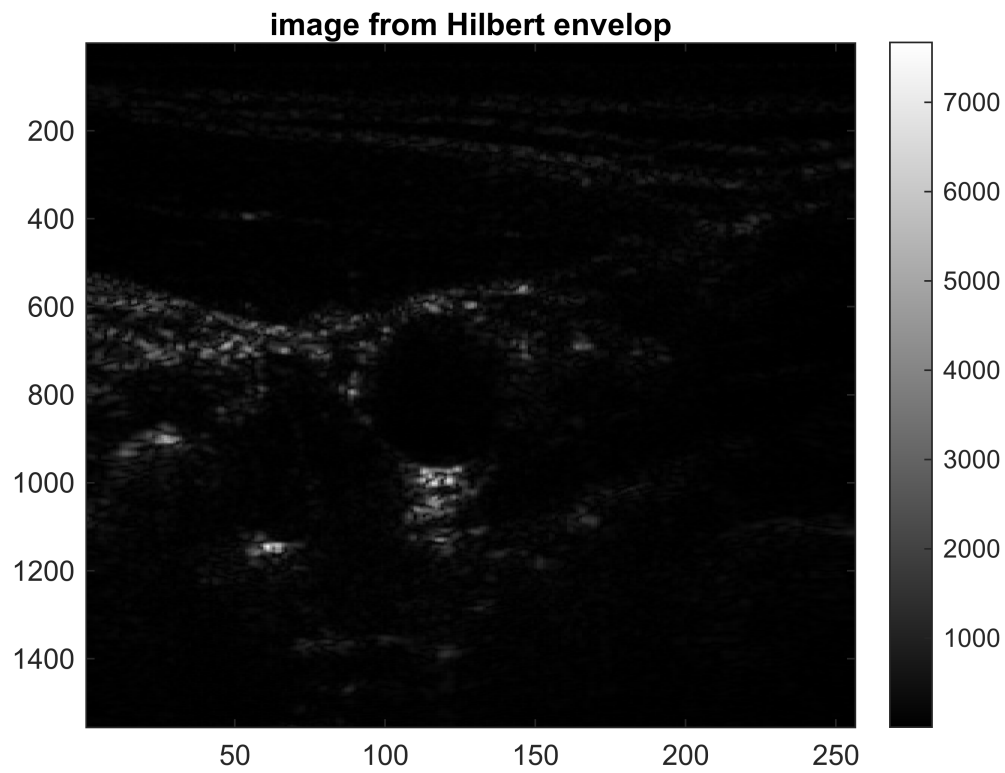
```



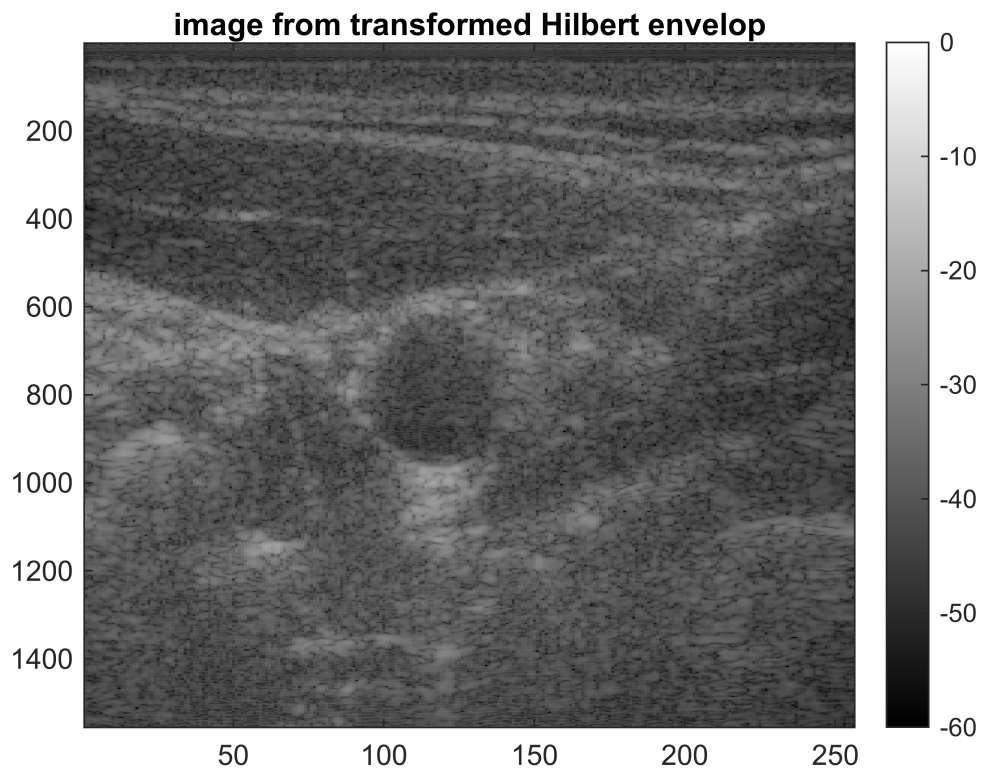
```

figure
imagesc(env), colormap('Gray'), colorbar
title('image from Hilbert envelop')

```



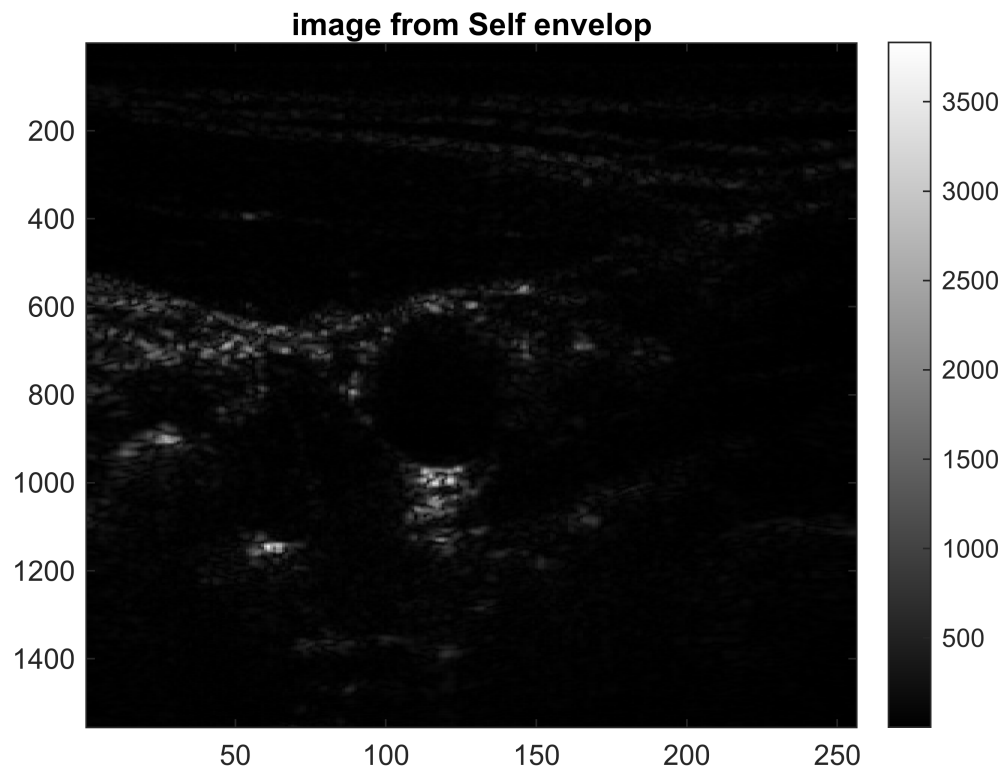
```
figure
transformedEnv = 10*log10(env/(10^6));
imagesc(transformedEnv,[-60,0]), colormap('Gray'), colorbar
title('image from transformed Hilbert envelop')
```



'Carotid artery with potential plaques on the right wall is seen'

```
ans =  
'Carotid artery with potential plaques on the right wall is seen'
```

```
% ---- self envelop  
figure  
imagesc(abs(si)), colormap('Gray'), colorbar  
title('image from Self envelop')
```



```
figure
transformedEnv2 = 10*log10(abs(si)/(10^6));
imagesc(transformedEnv2,[-60,0]), colormap('Gray'), colorbar
title('image from transformed Self envelop')
```



'Carotid artery with potential plaques on the right wall is seen'

```
ans =  
'Carotid artery with potential plaques on the right wall is seen'
```