

## Nolan Anderson

### EE 384 Classwork 11 Due 31 October 2021

#### Questions and Further Explorations:

1. Explain the frequency spectrum that you see in part 6.c.i. There appears to be frequency content above about 8.2GHz. Explain why this is not accurate.

Well, for starters that would be very harmful to humans. Most likely this is a noise that is beyond the capability of the radar, or an "initial" value that it starts with. Either way it should not be there.

2. Explain the purpose of the fftshift command. How is the plot obtained in 6.c.iii different than that from 6.c.i?

We need the shift command to see the whole plot from 6.c.i. To do this we use fftshift to center the data around 0 as opposed to the initial value starting at 0.

3. Describe the effects of the low pass filter on your data. Consider both the time and frequency domain.

When comparing 7b and 8a, we can see that the low pass filter only allows the lower frequencies. It will only allow frequencies below the stop frequency and block everything else.

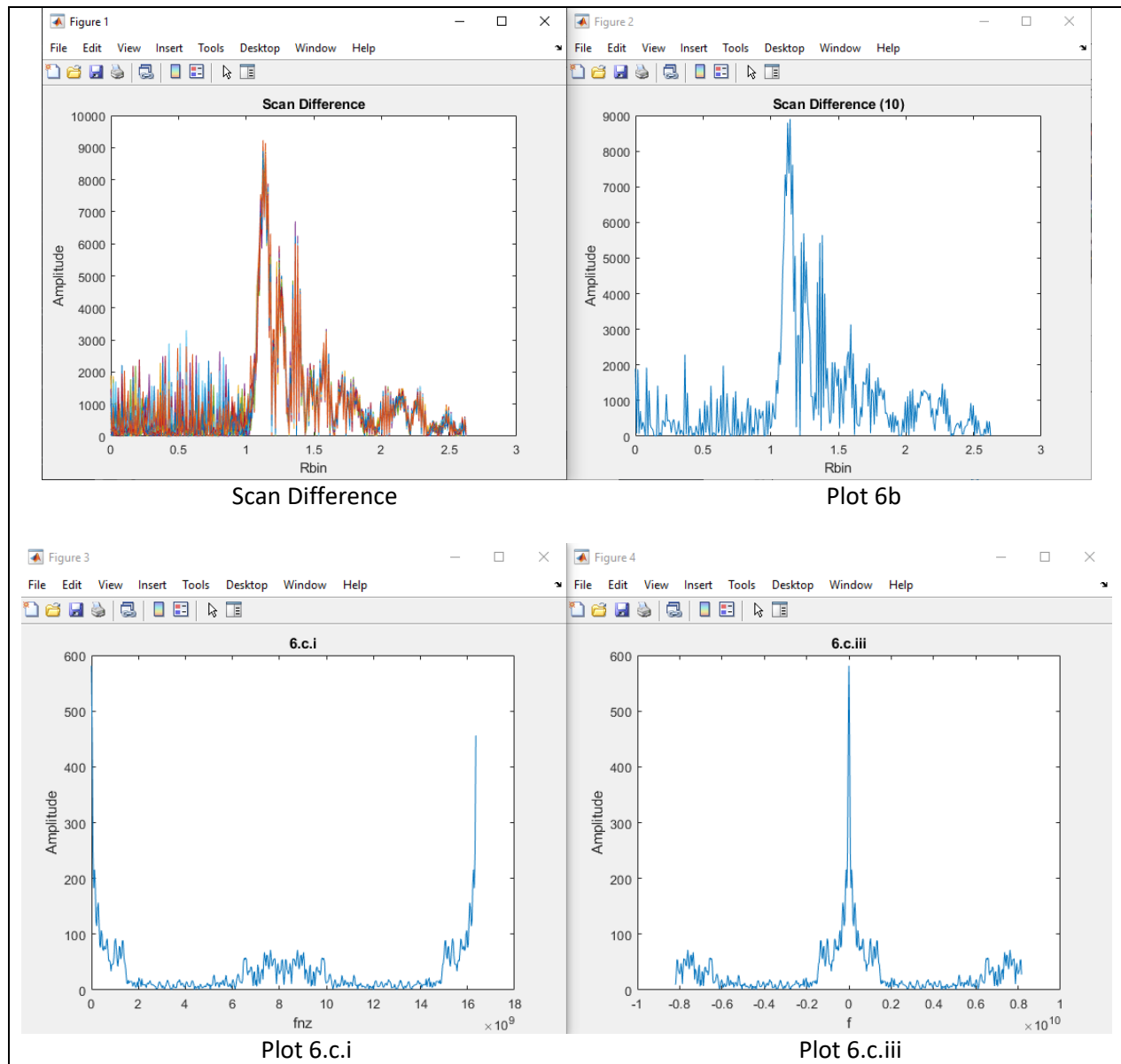
4. Describe the effects of the high pass filter on your data. Consider both the time and frequency domain.

When comparing 7b and 8a, we can see that the high pass filter only allows the high frequencies. It will only allow frequencies above the stop frequency and block everything else.

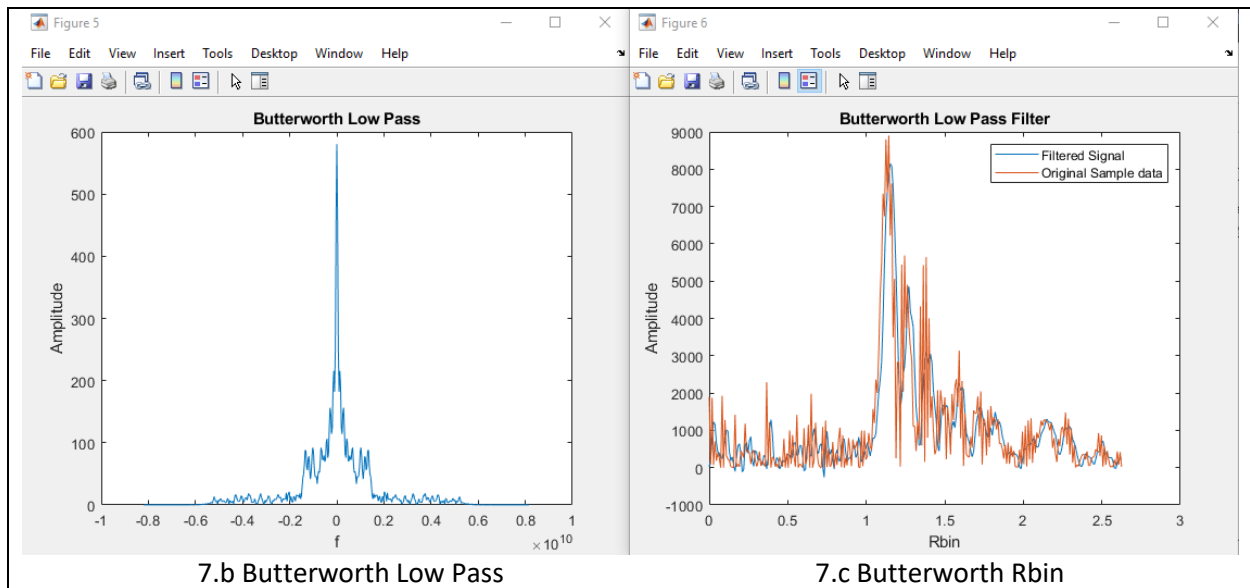
5. What order do you need for your different filters? Do you notice any difference between the performance of the Butterworth filter and the other filter you chose in part 8?

In this lab we do low pass then high pass filtering. This is ok, and if you were doing a band stop filter then the order would matter. Here it makes no difference as they filters are done separately. The filter for part 8 is smoother than the Butterworth filter implemented previously. Similarly, the original signal is cleaner as well.

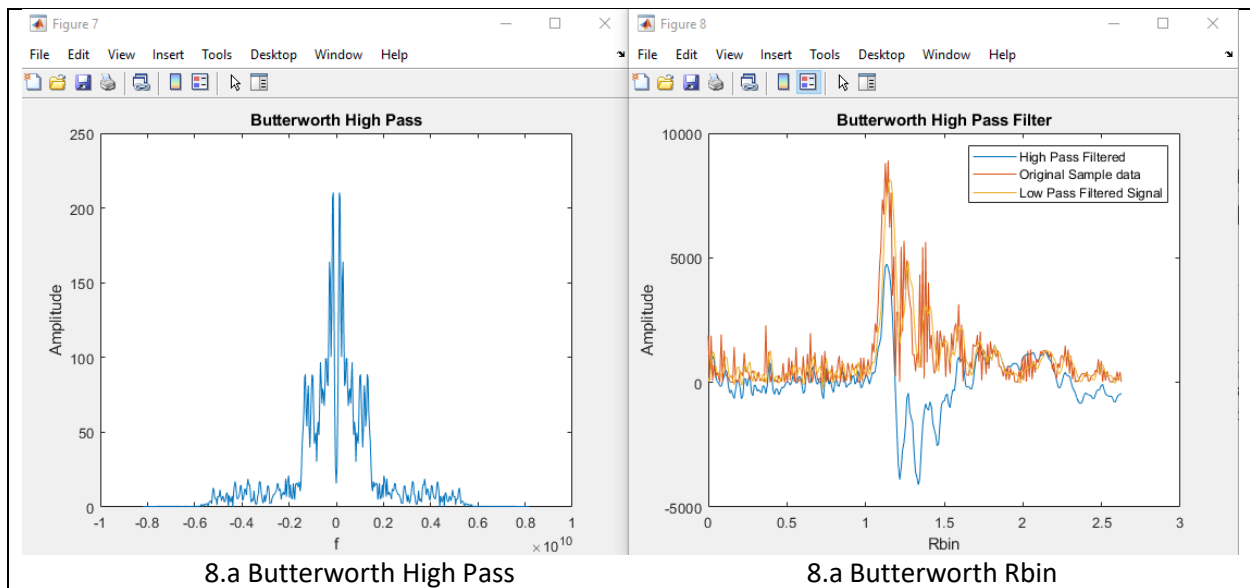
6:



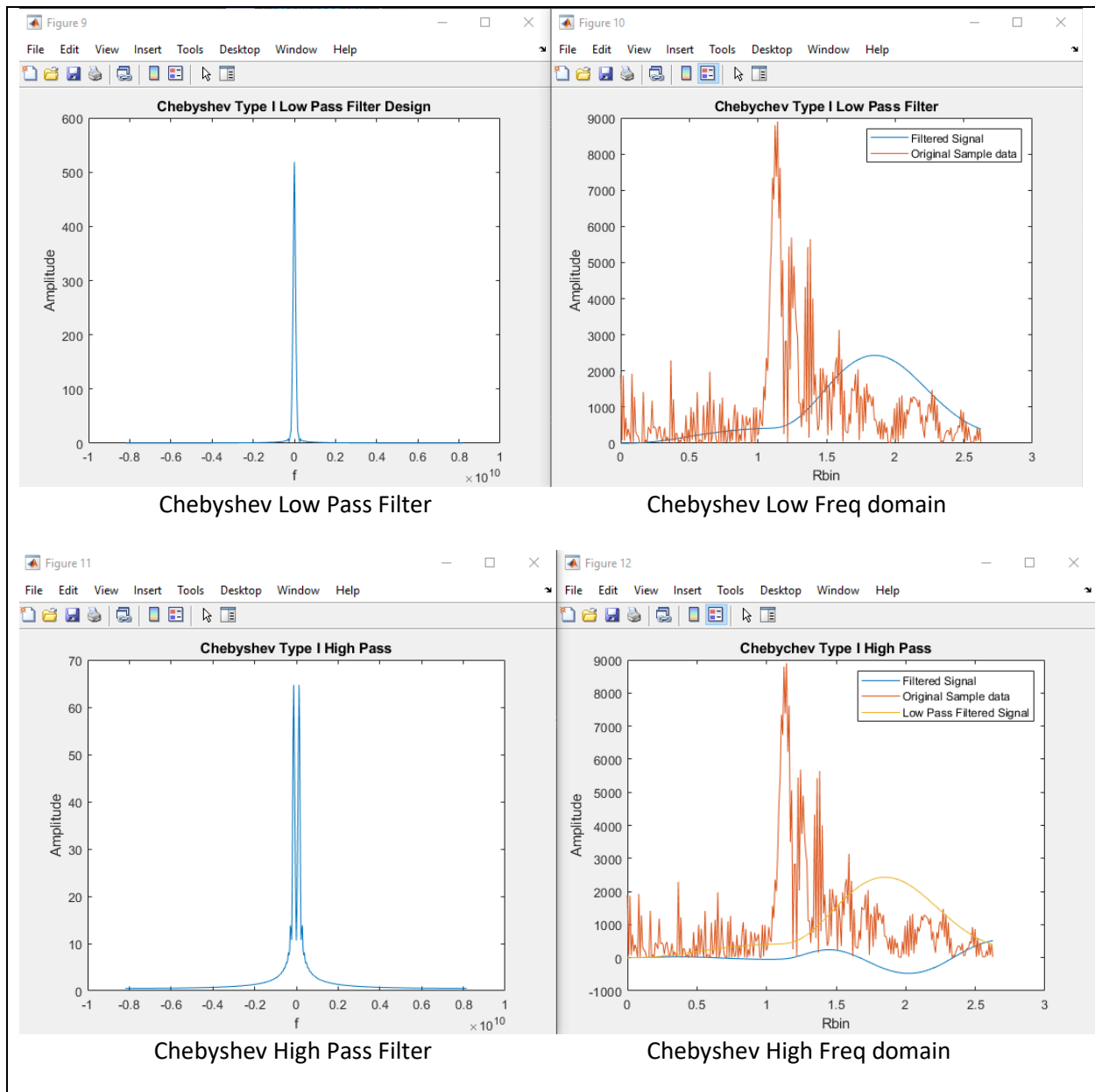
7:



8:



## 9: I used the Chebyshev Type I filter.



## MATLAB code:

```
%% Lab 11
clear all; close all; clc

%% Query user for logfile
[fnmb,dnmb] = uigetfile('*.csv');
fprintf('Reading logfile1 %s\n',fullfile(dnmb,fnmb));
[cfgb,reqb,scnb,detb] = readMrmRetLog(fullfile(dnmb,fnmb));

[fnmt,dnmt] = uigetfile('*.csv');
fprintf('Reading logfile2 %s\n',fullfile(dnmt,fnmt));
[cfgt,reqt,scnt,dett] = readMrmRetLog(fullfile(dnmt,fnmt));

%% Pull out raw scans
rawscansI = find([scnb.Nfilt] == 1);
rawscansV_background = reshape([scnb(rawscansI).scn],[],length(rawscansI));
rawscansI1 = find([scnt.Nfilt] == 1);
rawscansV_target = reshape([scnt(rawscansI1).scn],[],length(rawscansI1));
scan_difference = abs(rawscansV_background-rawscansV_target);

%% Create the horizontal and vertical axes
Tbin = 32/(512*1.024); T0 = 0; c = 0.29979; % m/ns
Rbin = c*(Tbin*(0:size(scan_difference(1,:),2)-1) - T0)/2; % Range Bins in
meters

figure; plot(Rbin,scan_difference); title('Scan Difference');
xlabel('Rbin'); ylabel('Amplitude');
figure; plot(Rbin,scan_difference(10,:)); title('Scan Difference (10)');
xlabel('Rbin'); ylabel('Amplitude');

%% 6. Plot the spectrum of the signal
x = scan_difference(10,:); % Sample Data
L = length(x); % Window length
n = pow2(nextpow2(L)); % Next power of 2 from length of y
y_dft= fft(x,n); % DFT
y_s = fftshift(y_dft); % Rearrange y values
Ts = Tbin*1e-9; % Tbin is given in nsec
fs = 1/Ts;
f = (-n/2:n/2-1)*(fs/n); % 0-centered frequency range
fnz = (0:n-1)*(fs/n); % Nonzero-centered frequency range

figure; plot(fnz,abs(y_dft)/n); title('6.c.i'); xlabel('fnz');
ylabel('Amplitude');
figure; plot(f,abs(y_s)/n); title('6.c.iii'); xlabel('f');
ylabel('Amplitude');

%% Butterworth Low Pass
fpass = 4.9e9; fstop = 5.6e9;
Wp = (2*fpass)/fs; Ws = (2*fstop)/fs;
Rp = 1; Rs = 20;
[n,Wn] = buttord(Wp,Ws,Rp,Rs);
[b,a] = butter(n,Wn,'low');
yf = filter(b,a,x);
[samp, L, n, y_dft, y_s, Ts, fs, f] = freqpull(yf, Tbin);
```

```

figure; plot(f,abs(y_s)/n); title('Butterworth Low Pass');
xlabel('f'); ylabel('Amplitude');
figure; plot(Rbin,yf,Rbin,x); title('Butterworth Low Pass Filter');
xlabel('Rbin'); ylabel('Amplitude'); legend('Filtered Signal','Original
Sample data');

%% Butterworth High Pass
fpass = .1e9; fstop = .05e9;
Wp = (2*fpass)/fs; Ws = (2*fstop)/fs;
Rp = 1; Rs = 20;
[n,Wn] = buttord(Wp,Ws,Rp,Rs);
[b,a] = butter(n,Wn,'high');
yfh = filter(b,a,yf);
[samp, L, n, y_dft, y_s, Ts, fs, f] = freqpull(yfh, Tbin);

figure; plot(f,abs(y_s)/n); title('Butterworth High Pass');
xlabel('f'); ylabel('Amplitude');

figure; plot(Rbin,yfh,Rbin,x,Rbin,yf); title('Butterworth High Pass
Filter');
xlabel('Rbin'); ylabel('Amplitude');
legend('High Pass Filtered','Original Sample data','Low Pass Filtered
Signal');

%% Chebyshev Type I Low Pass
Wp = (2*fpass)/fs; Ws = (2*fstop)/fs;
Rp = 1; Rs = 20;
[n,Wn] = cheblord(Wp,Ws,Rp,Rs);
[b,a] = cheby1(n,Rp,Wp,'low');
yf = filter(b,a,x);
[samp, L, n, y_dft, y_s, Ts, fs, f] = freqpull(yf, Tbin);

figure; plot(f,abs(y_s)/n); title('Chebyshev Type I Low Pass Filter
Design');
xlabel('f'); ylabel('Amplitude');

figure; plot(Rbin,yf,Rbin,x); title('Chebychev Type I Low Pass Filter');
xlabel('Rbin'); ylabel('Amplitude'); legend('Filtered Signal','Original
Sample data');

%% Chebyshev Type I High Pass
Wp = (2*fpass)/fs; Ws = (2*fstop)/fs;
Rp = 1; Rs = 20;
[n,Wn] = cheblord(Wp,Ws,Rp,Rs);
[b,a] = cheby1(n,Rp,Wp,'high');
yfh = filter(b,a,yf);
[samp, L, n, y_dft, y_s, Ts, fs, f] = freqpull(yfh, Tbin);

figure; plot(f,abs(y_s)/n); title('Chebyshev Type I High Pass');
xlabel('f'); ylabel('Amplitude');

figure; plot(Rbin,yfh,Rbin,x,Rbin,yf);
title('Chebychev Type I High Pass'); xlabel('Rbin'); ylabel('Amplitude');
legend('Filtered Signal','Original Sample data','Low Pass Filtered Signal')

```

```
%% Function(s)
function[samp, L, n, y_dft, y_s, Ts, fs, f] = freqpull(yfh, Tbin)
    samp = yfh;
    L = length(samp);
    n = pow2(nextpow2(L));
    y_dft= fft(samp,n);
    y_s = fftshift(y_dft);
    Ts = Tbin*1e-9;
    fs = 1/Ts;
    f = (-n/2:n/2-1)*(fs/n);
end
```