ARL AIAD : LADAR

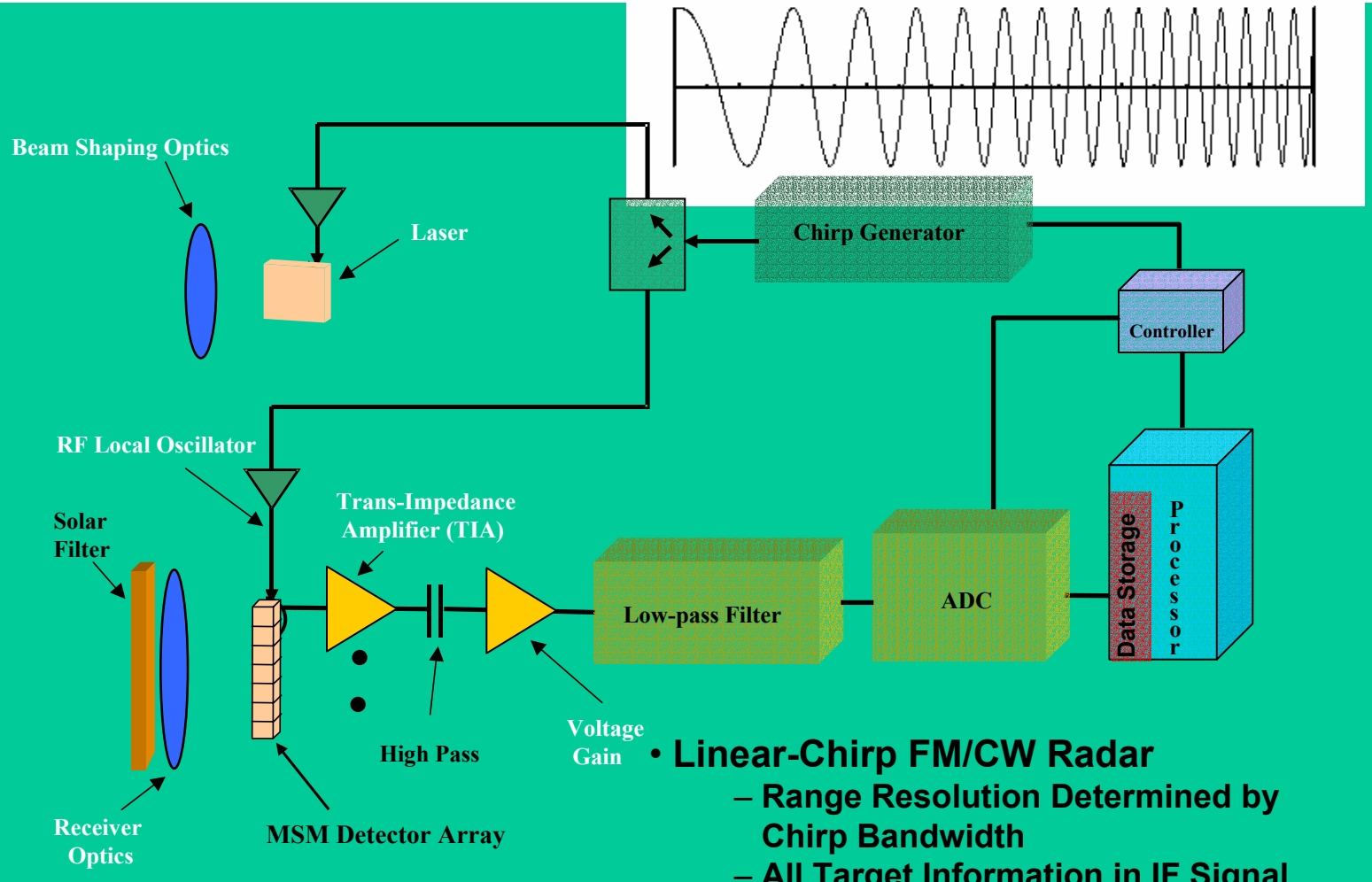
AY 2003-2004

Cadet Arnold Lee

Overview

- Provide information on the LADAR system currently being developed at ARL.
- Show military applications
- Show what I have been working on
- Questions

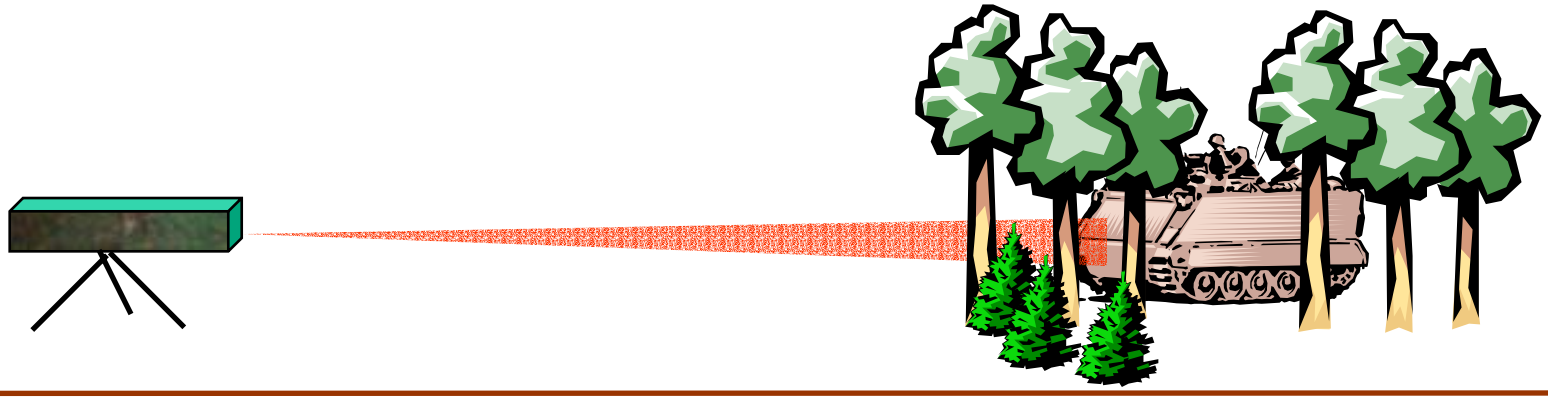
Chirped AM with Photonic Mixing

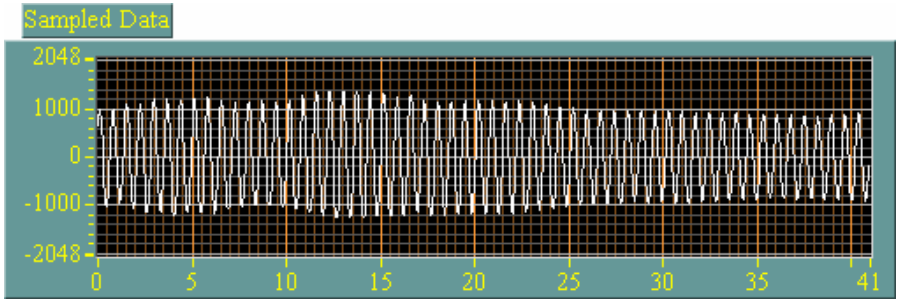


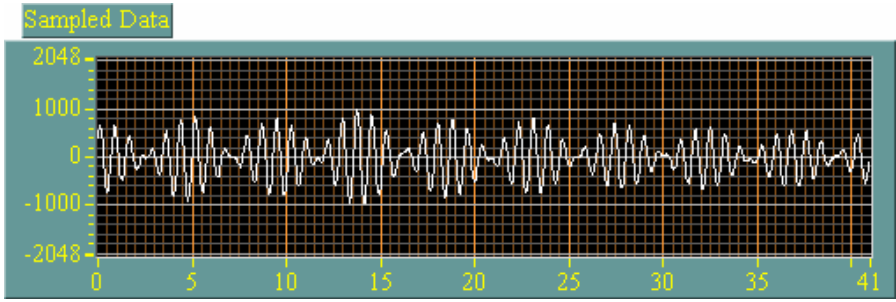
- **Linear-Chirp FM/CW Radar**
  - Range Resolution Determined by Chirp Bandwidth
  - All Target Information in IF Signal
- **Studied for More than 50 Years**
- **High Spatial Resolution due to Optical Wavelengths**

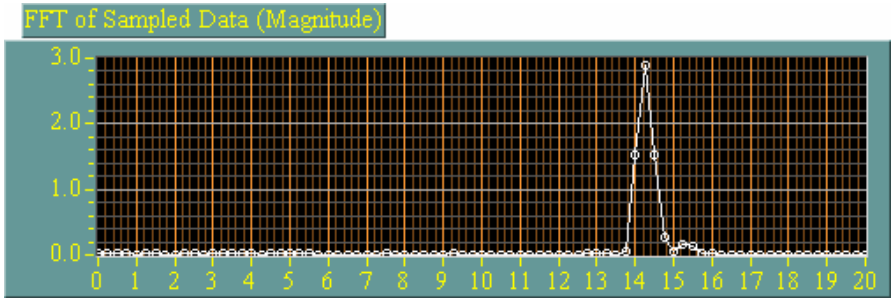
CHAMP Ladar Block Diagram

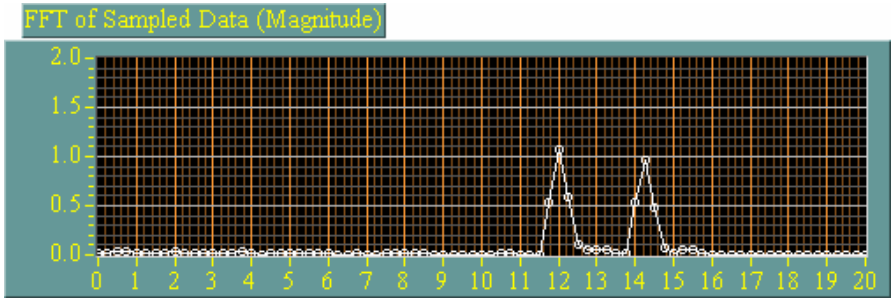
Resolution of Multiple Targets









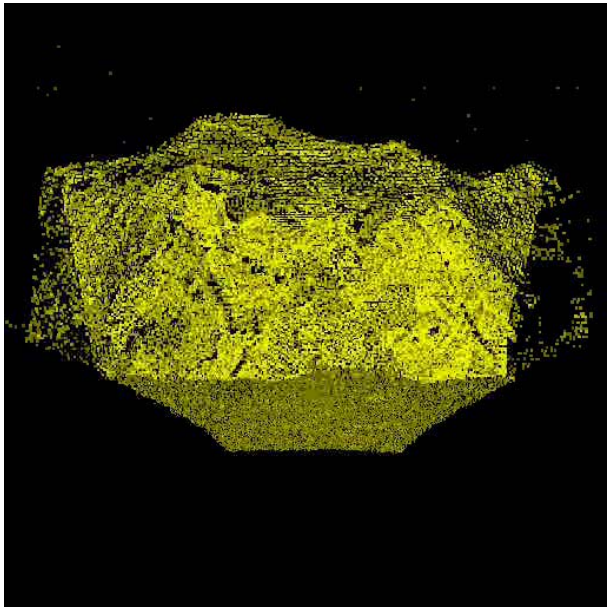


One target in beam/pixel

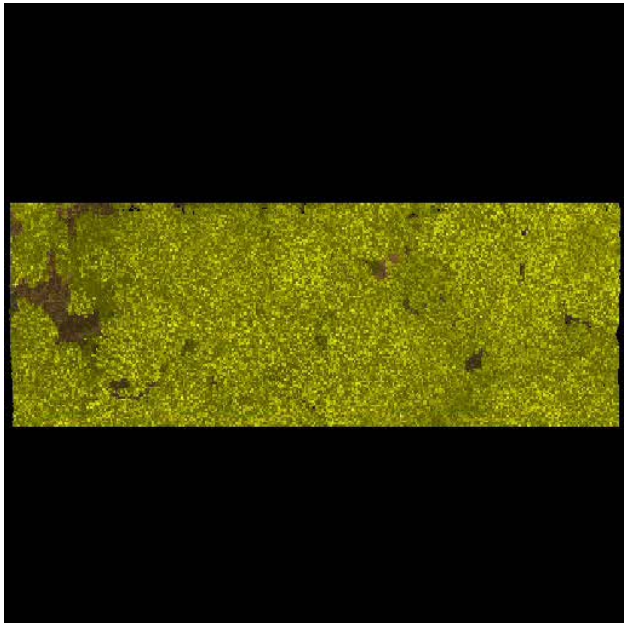
Two targets in beam/pixel

Military Applications

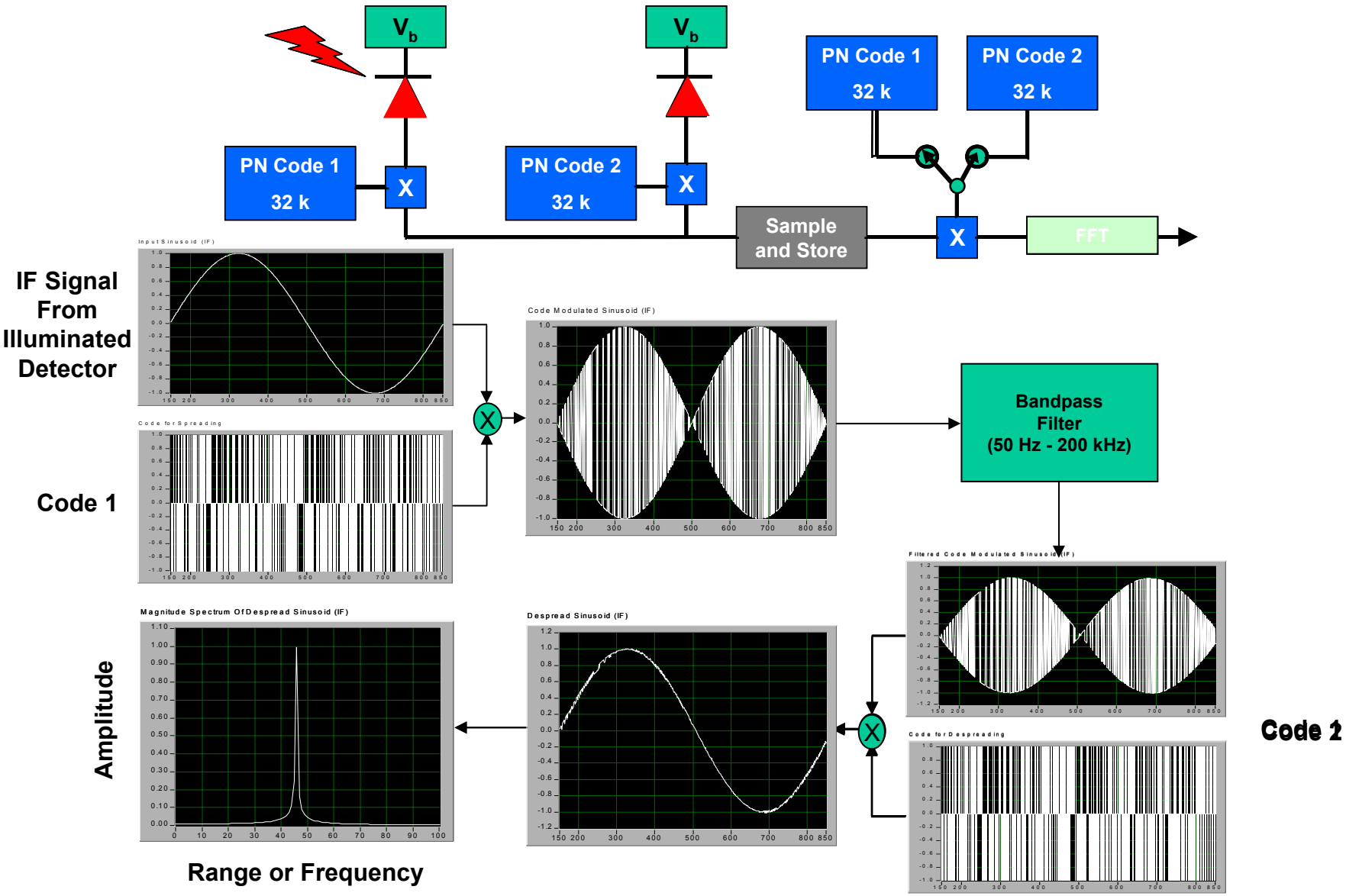
Camouflage Penetration



Foliage Penetration



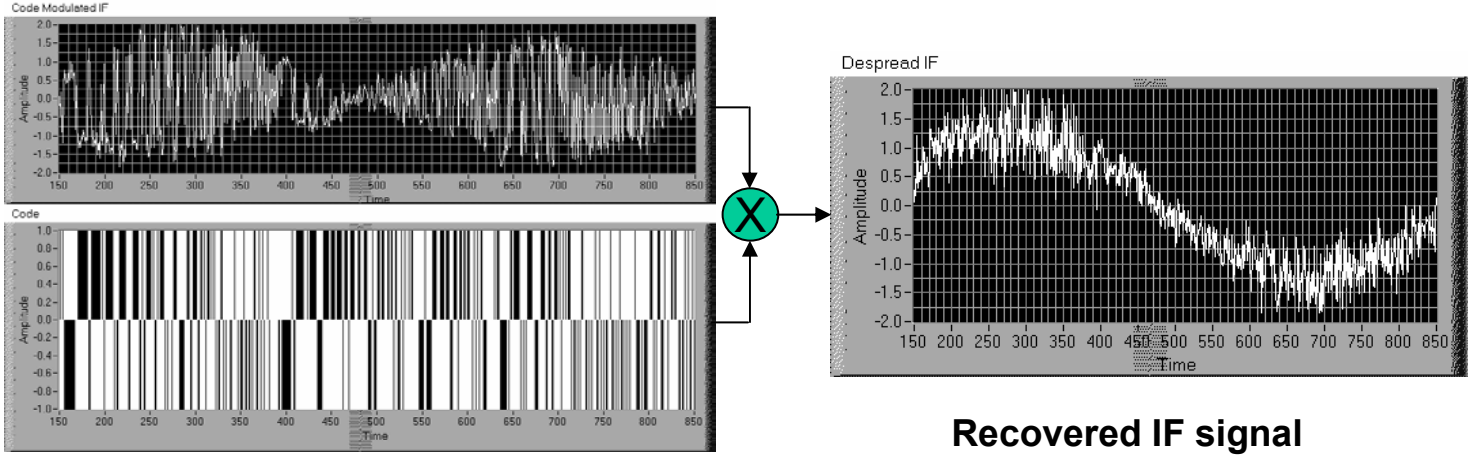
CDMA Read-out Theory



2D FPA Staring CHAMP Ladar Prototype
Demuxing Waveforms (Single Pixel Illuminated)

Pixel 1 encoded IF signal

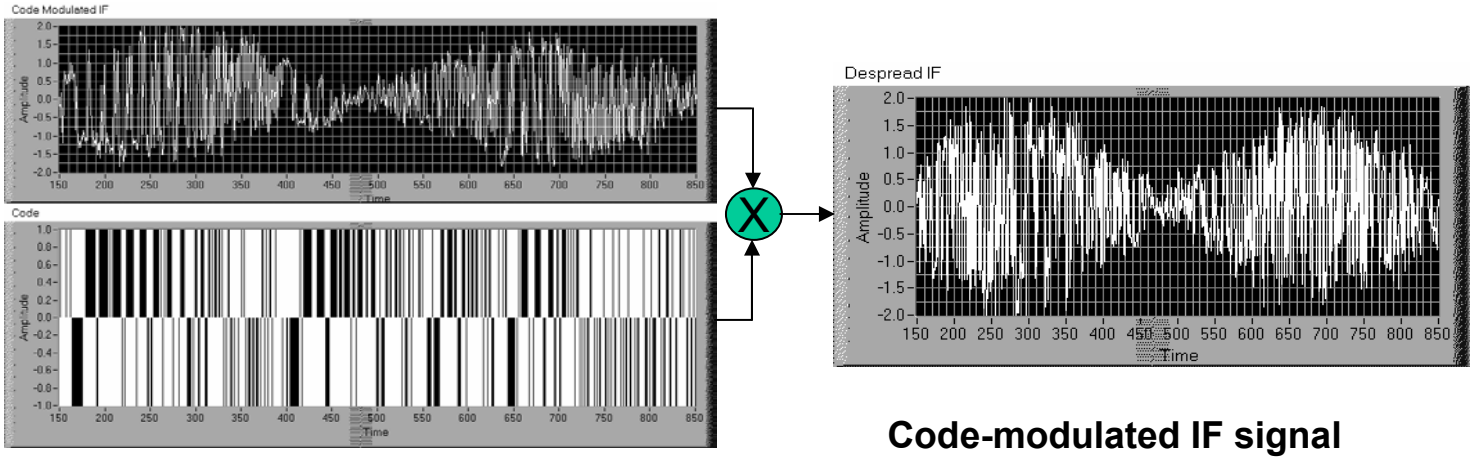
Code 1



Recovered IF signal

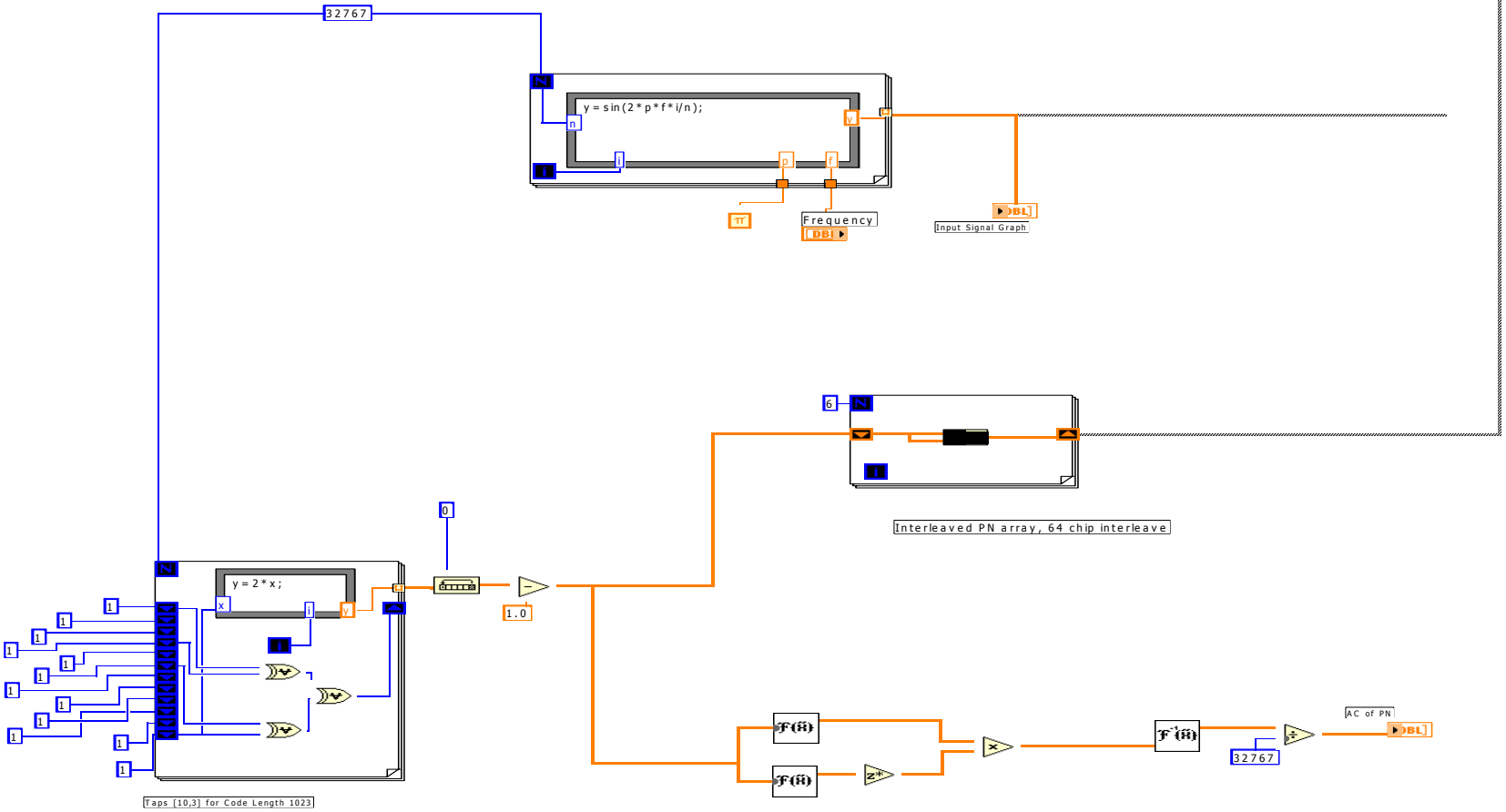
Pixel 1 encoded IF signal

Code 2

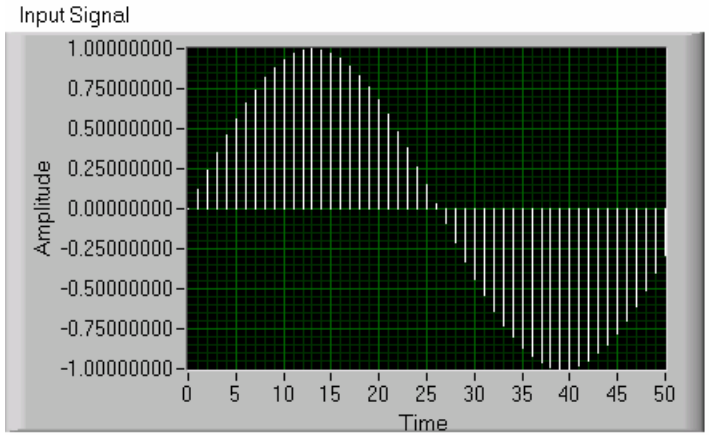


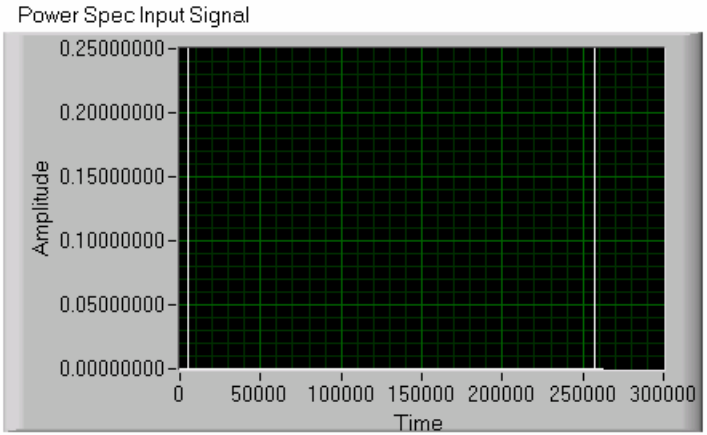
Code-modulated IF signal

PN Section of Code



Results (PN Only - Correct)



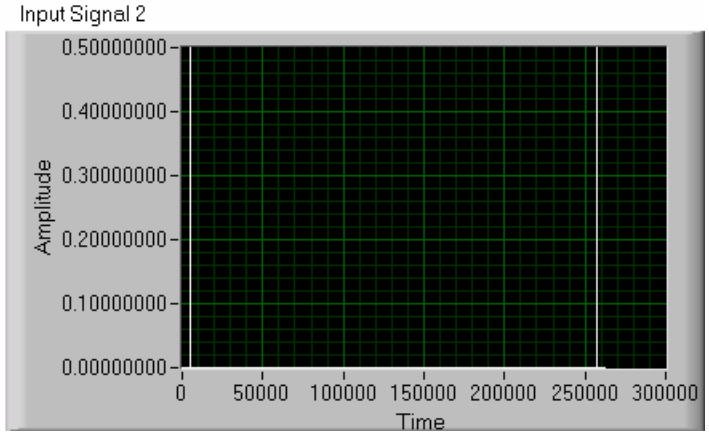


Number of Shifts
2

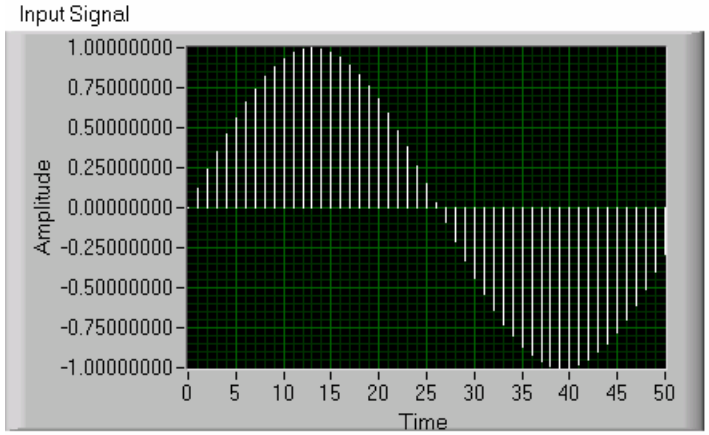
Index
0

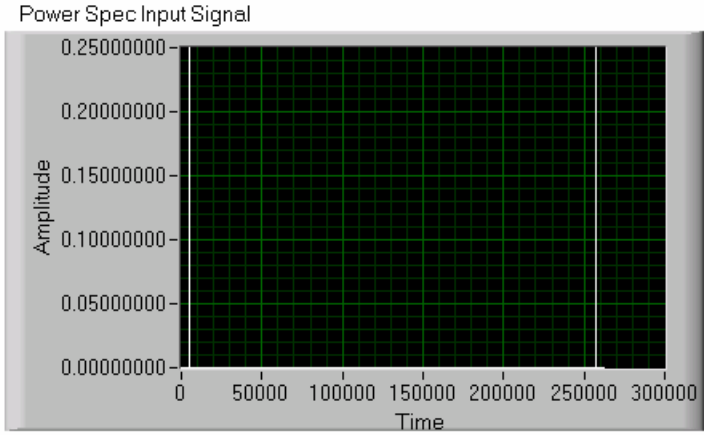
REMEMBER TO MODIFY INPUTS!

Frequency of Signal
5000.00



Results (PN Only - Incorrect)



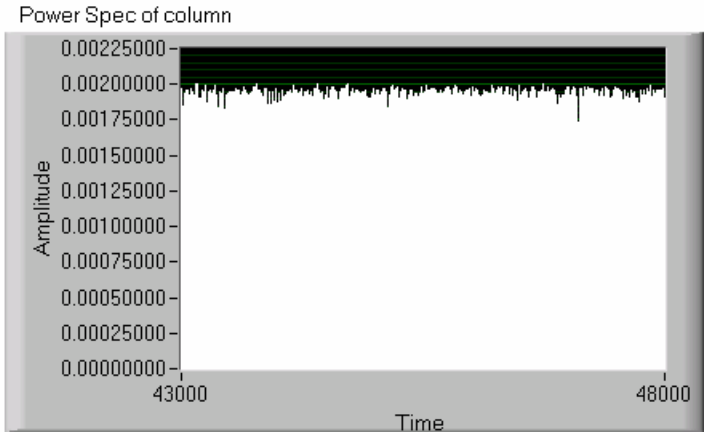


Number of Shifts
2

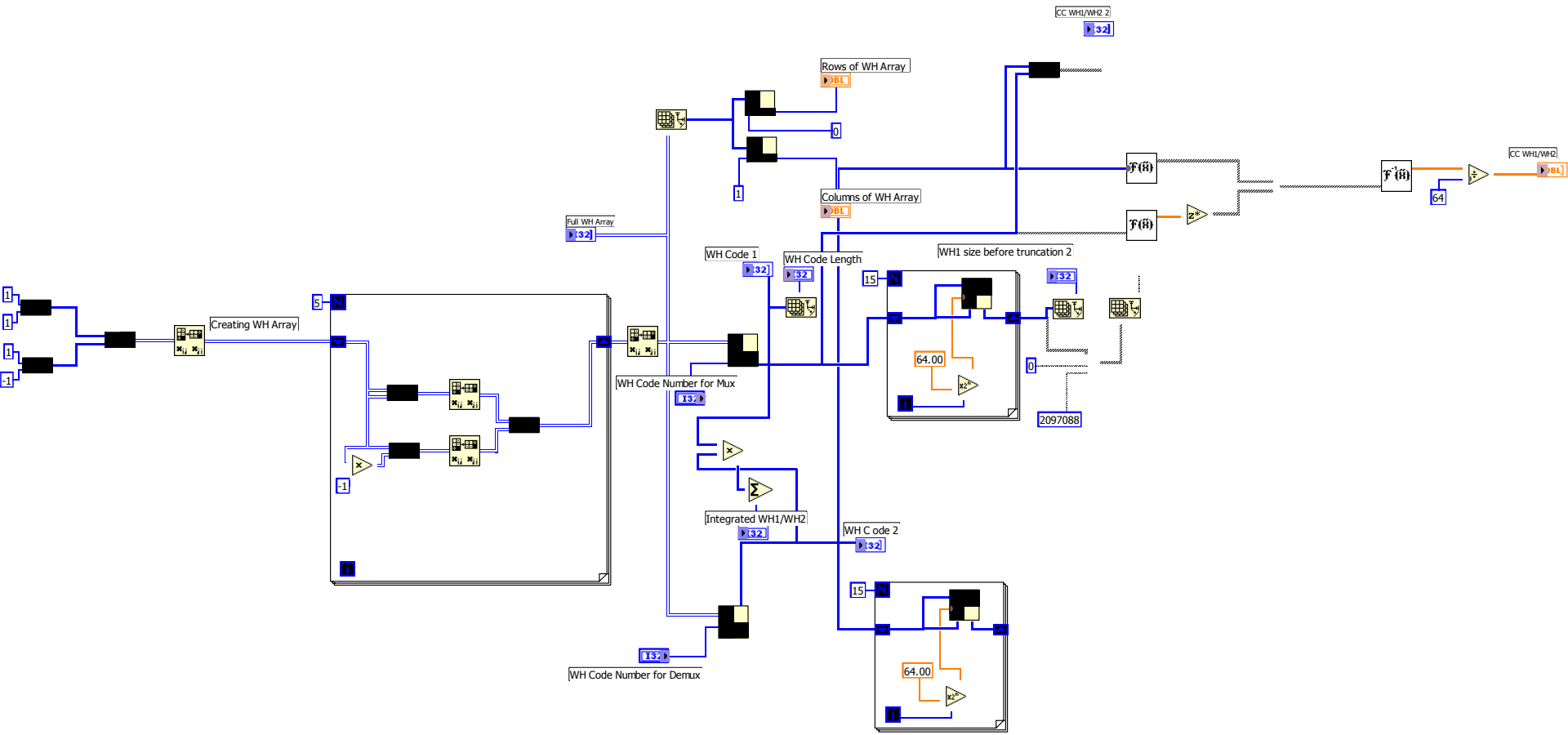
Index
1

REMEMBER TO MODIFY INPUTS!

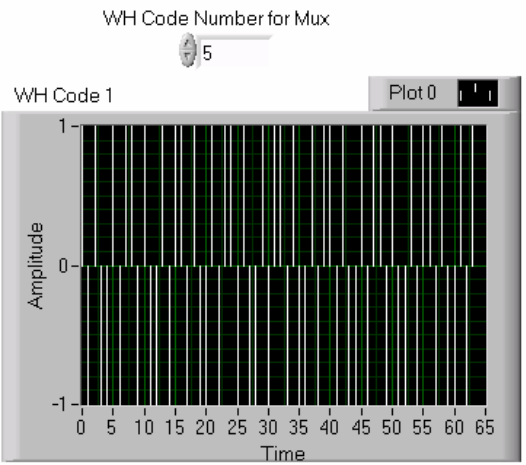
Frequency of Signal
5000.00

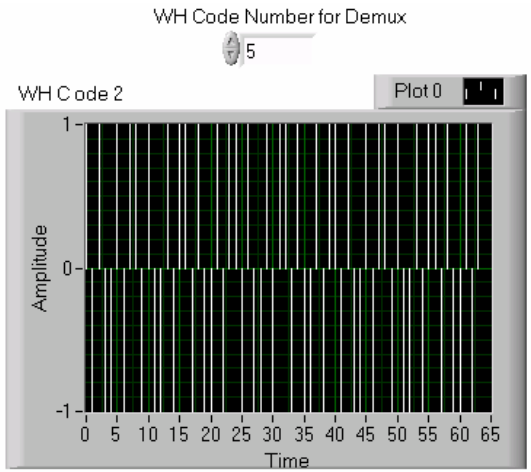


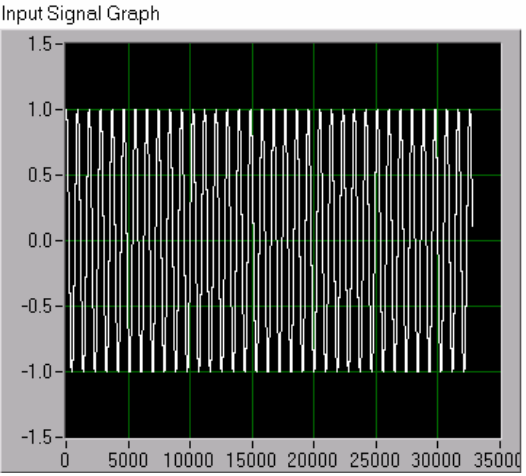
W-H Matrix Addition

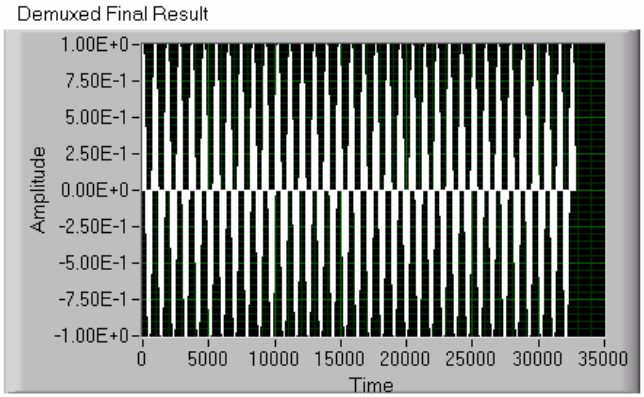


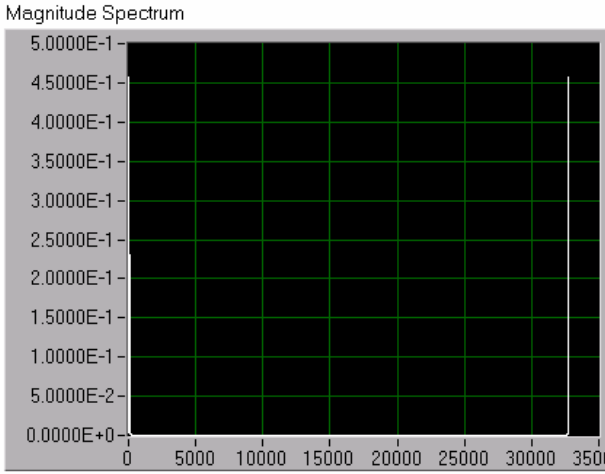
Results (WH - Correct)



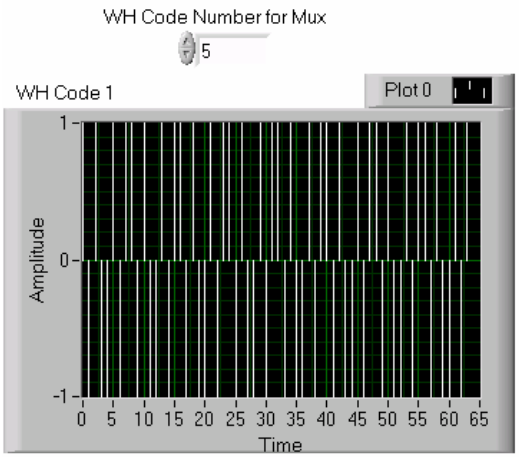


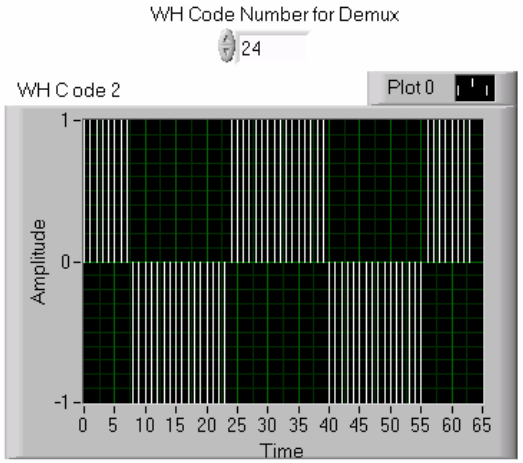


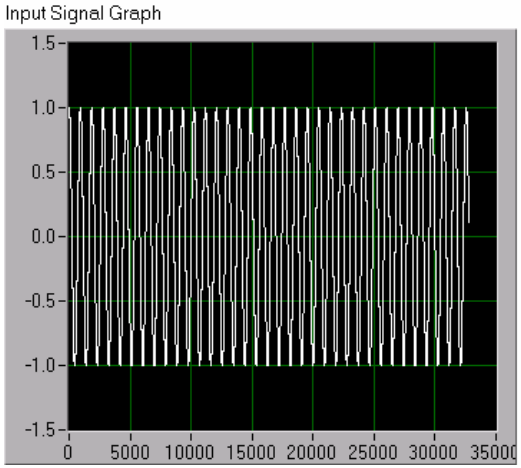


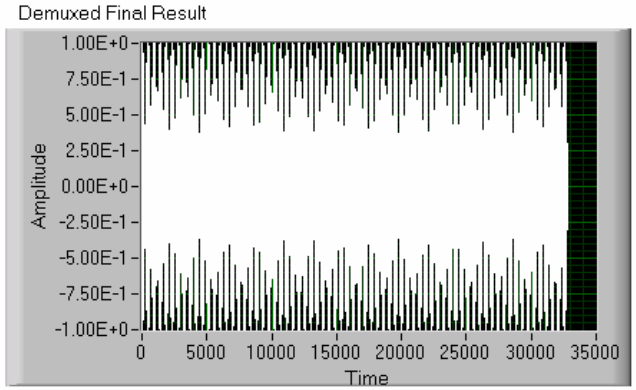


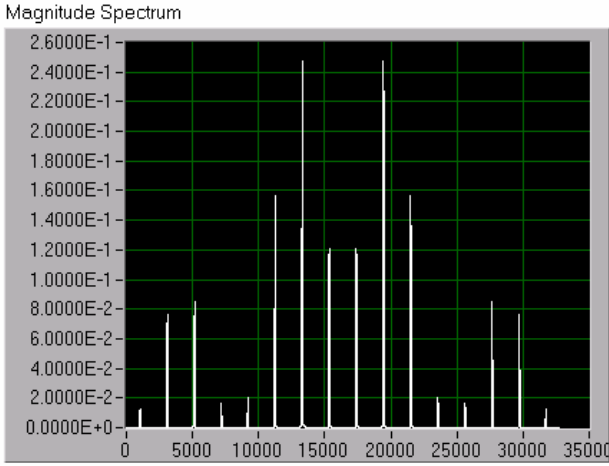
Results (WH - Incorrect)



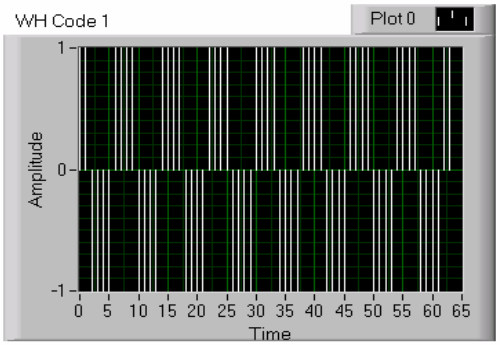


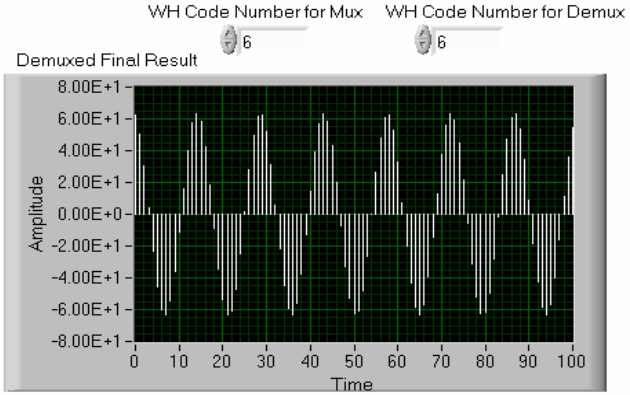


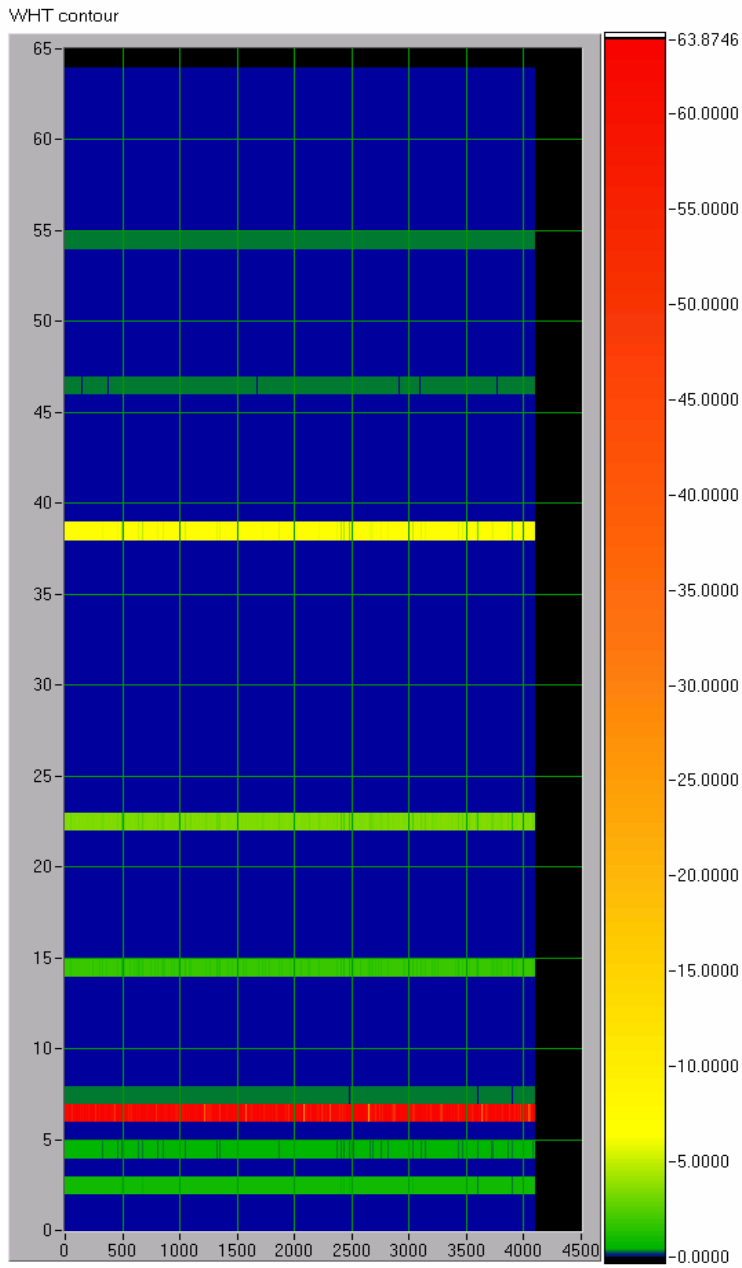


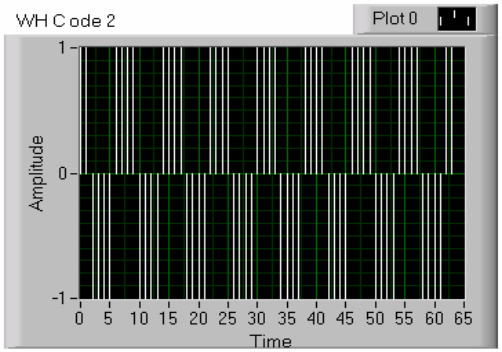


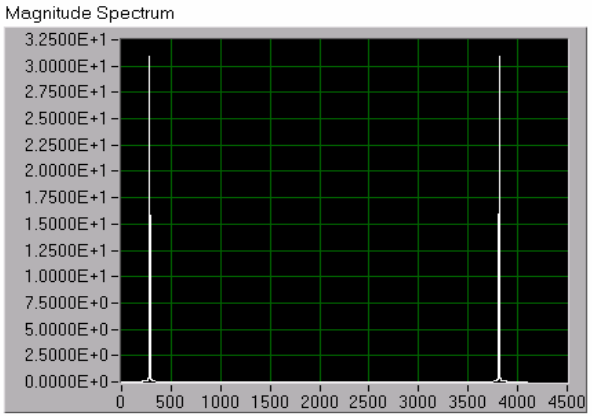
Results (WH/PN - Correct)

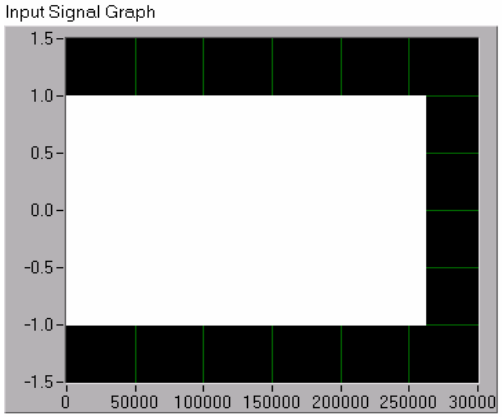


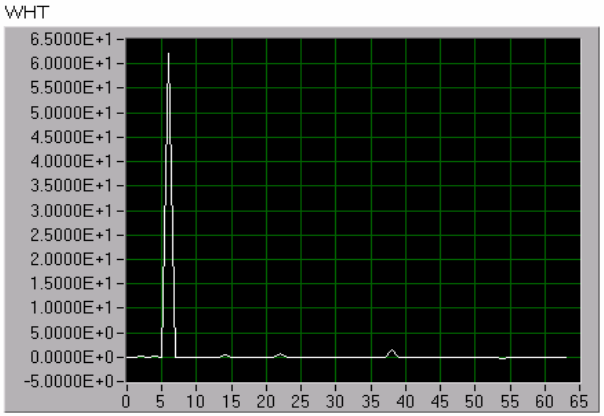




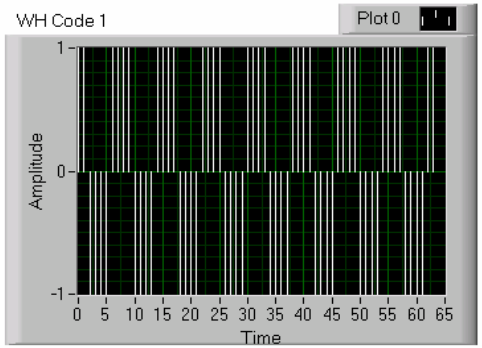


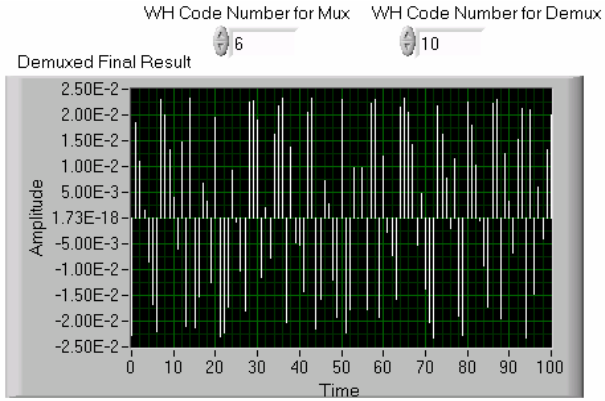


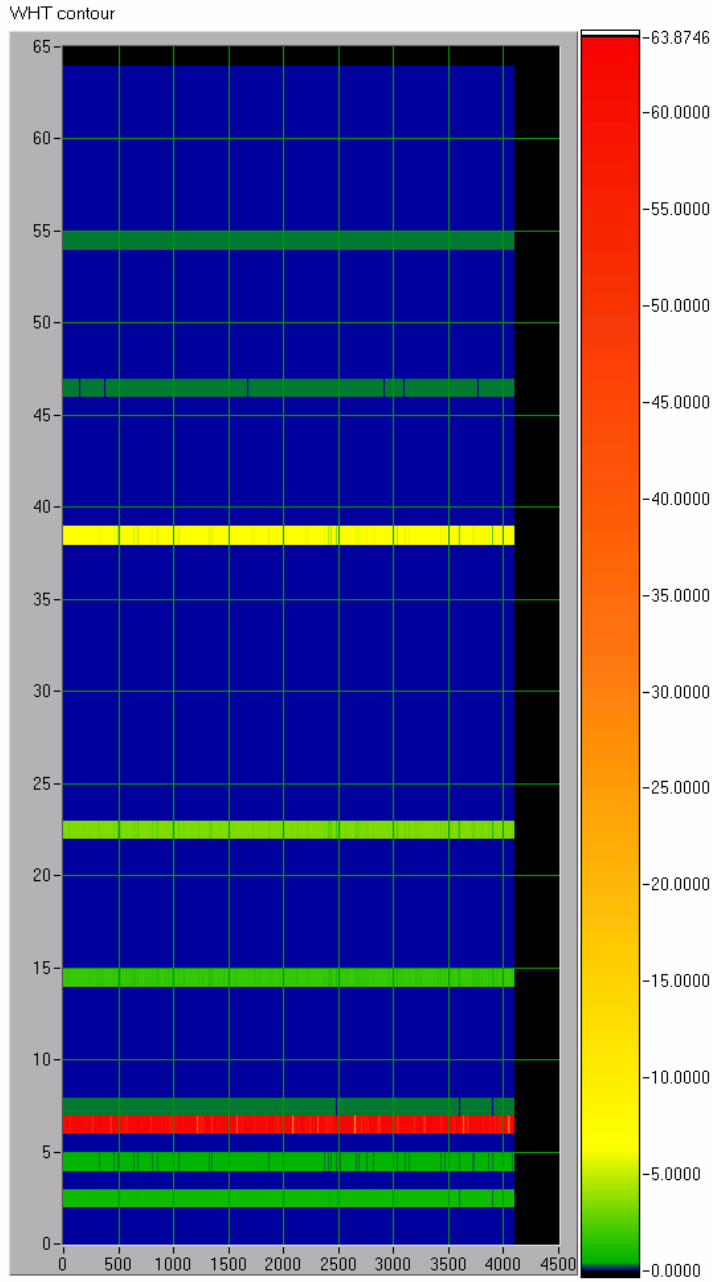


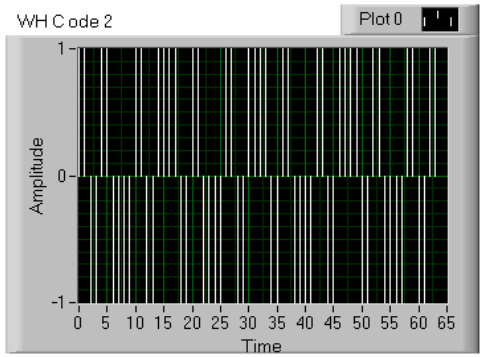


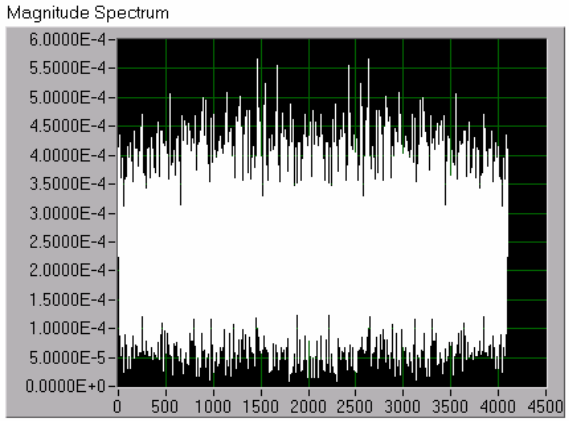
Results (WH/PN - Incorrect)

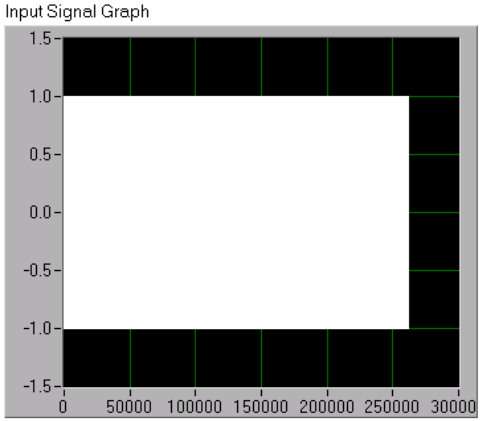


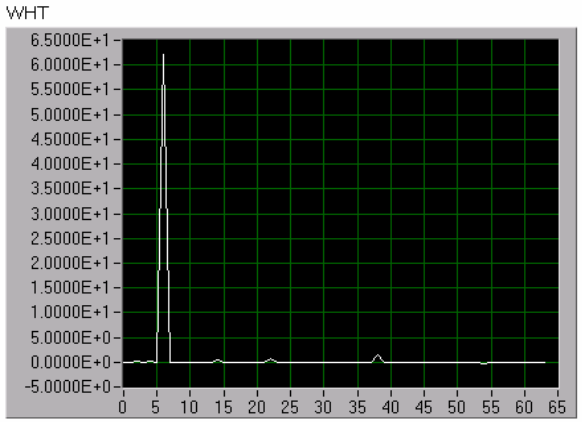




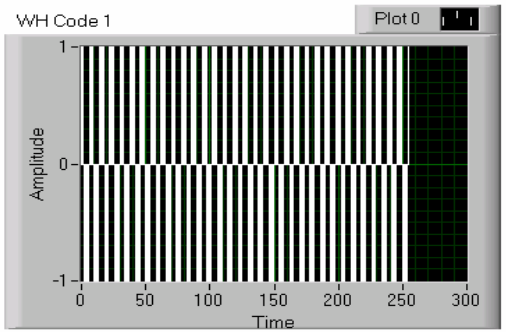


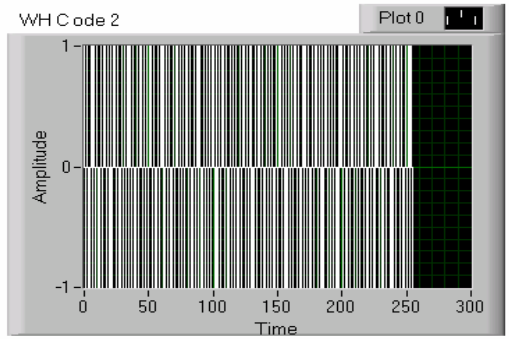


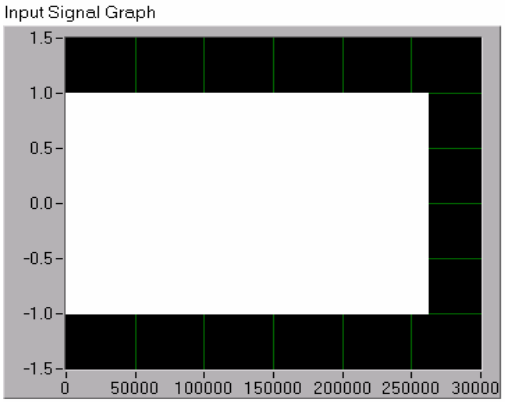


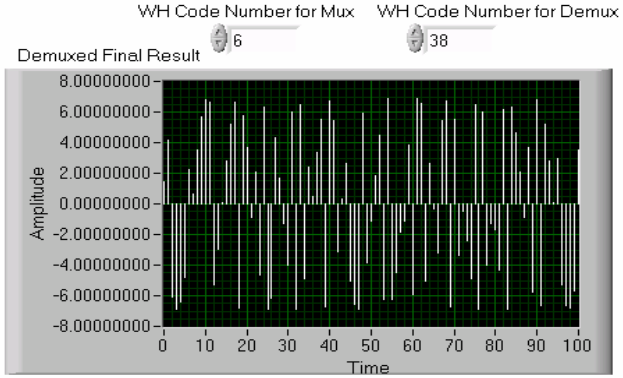


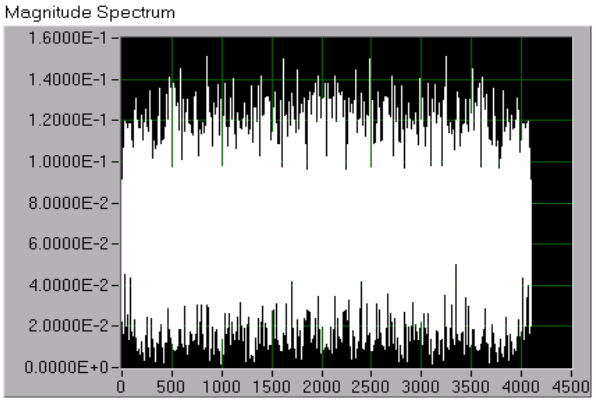
Results (WH/PN - Incorrect 2)

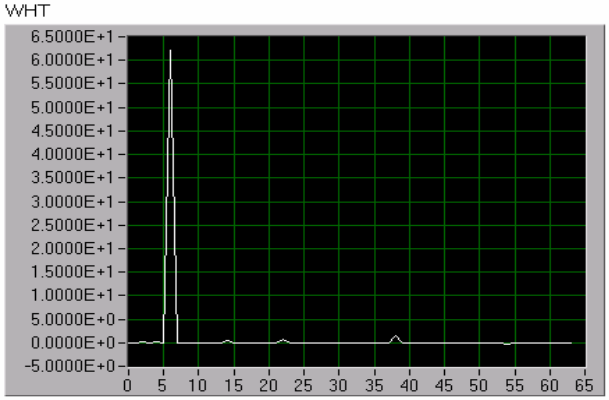


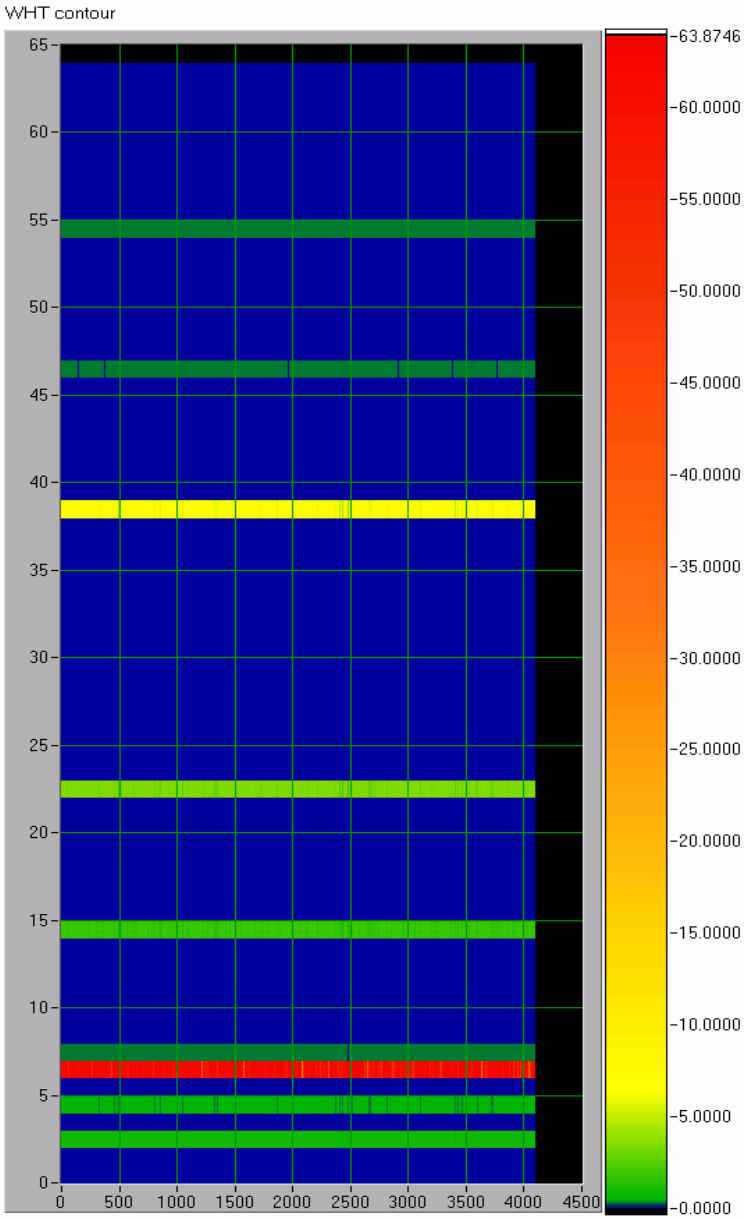












Discussion of Results

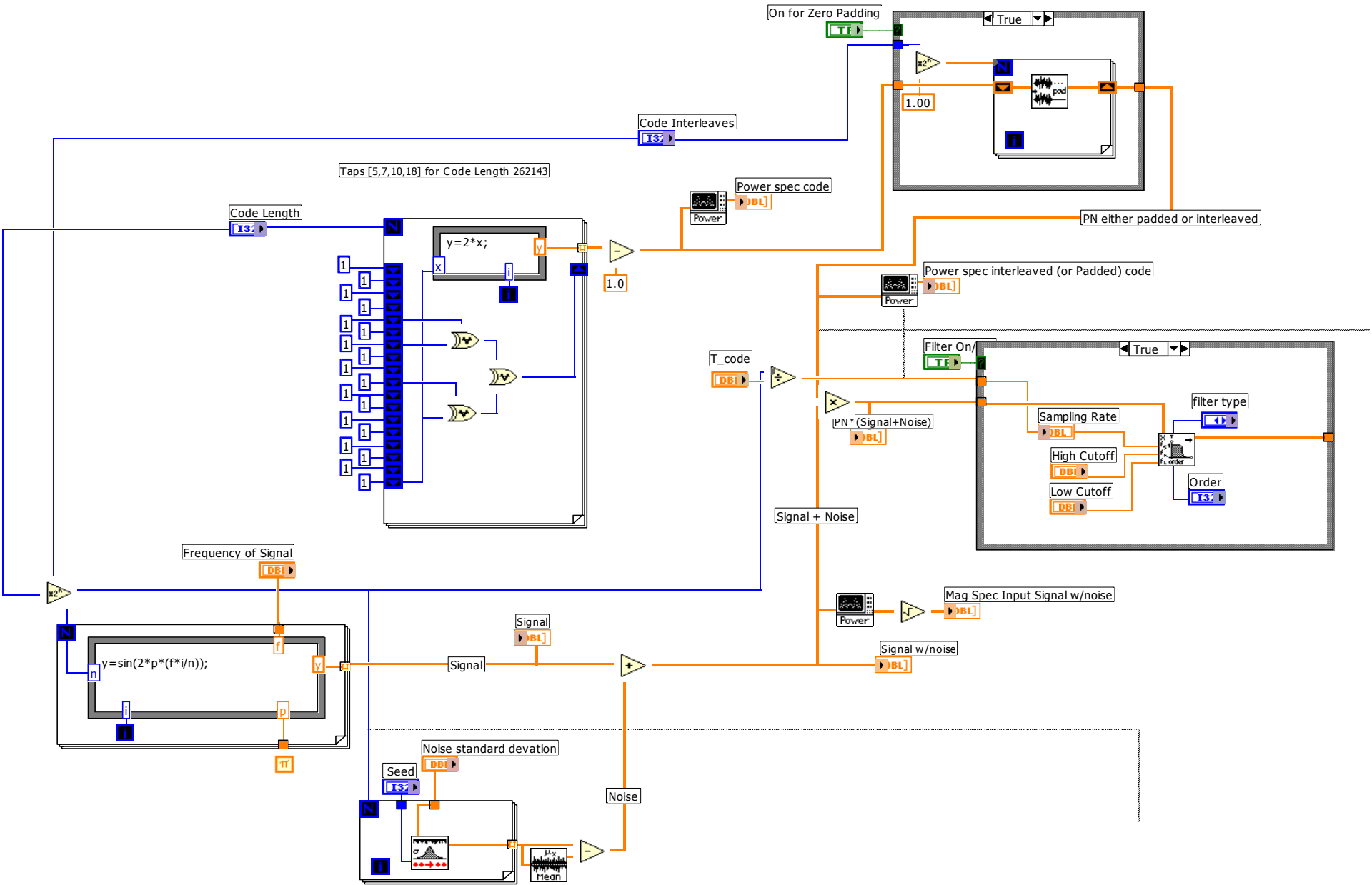
- W-H decodes perfectly, and without the correct code, shows some potential to have low noise.
- PN decodes well, but with the wrong code, has constant noise.
- The idea was to combine the two and create a code which, when using the incorrect code, gave us less noise than if we just used a PN code. Unfortunately, the combined code gives us noise which at some points is much lower than that of PN alone, and a some points is much higher.

Filtering

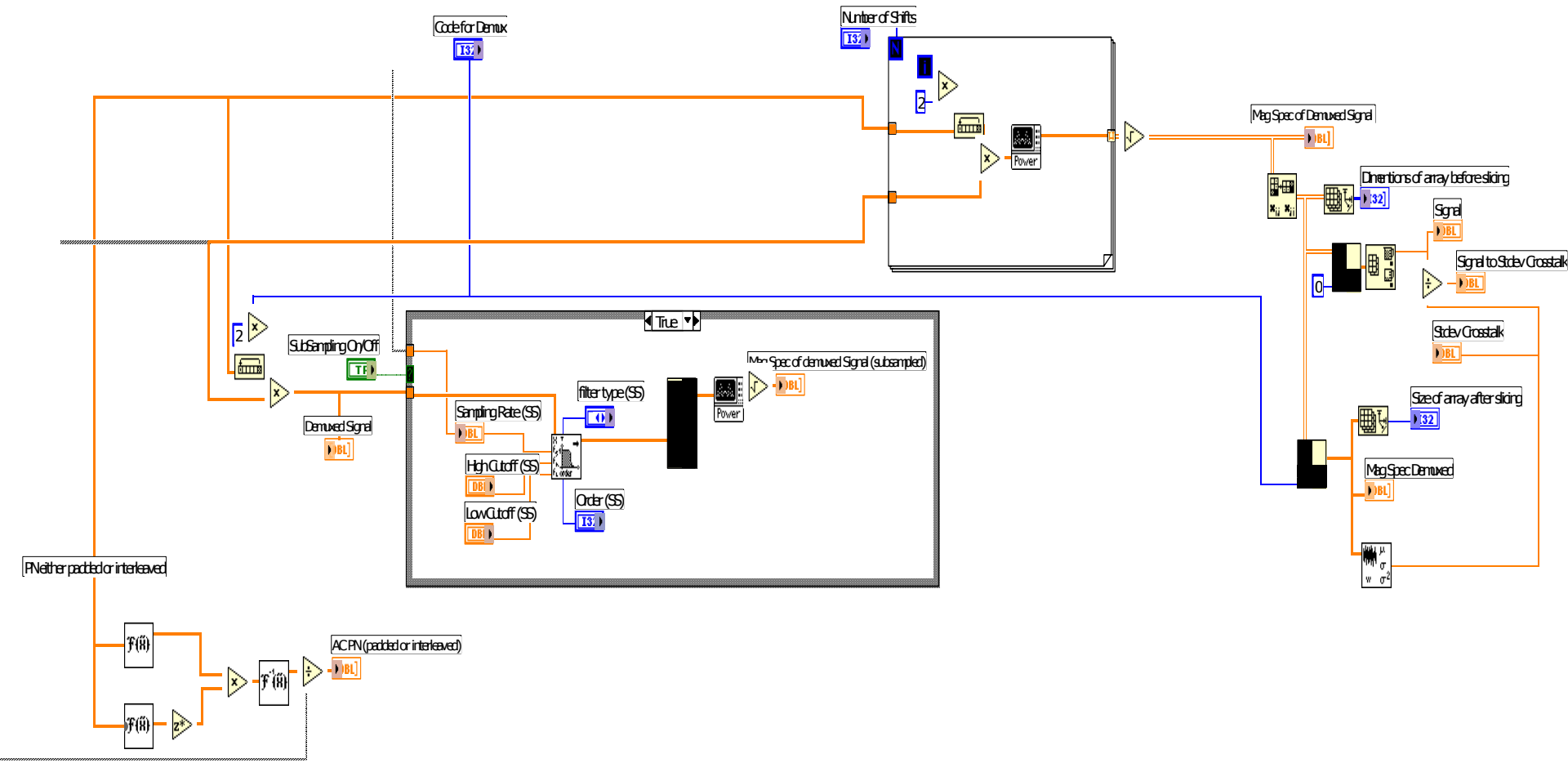
- The next project was to study the effects of filtering on the experimental setup.

- We setup two filters – one which simulated the filtering done by the electronics, and one which simulated a filter “package” which could be added on at the receiving stage.

Circuit Diagram 1



Circuit Diagram 2



Results

Filter On/Off

Sampling Rate
198587.8

High Cutoff
99000.00

Low Cutoff
10000.0000

Order
1

filter type
Bandpass

SubSampling On/Off

Sampling Rate (SS)
198587.8

High Cutoff (SS)
20000.00

Low Cutoff (SS)
10000.0000

Order (SS)
2

filter type (SS)
Lowpass

On for Zero Padding

Code Length
32767

Code Interleaves
1

T_code
0.33

Signal to Stdev Crosstalk
19.07

Signal
0.22933557

Stdev Crosstalk
0.01202606

Noise standard devation
10.0000

Seed
-1

Number of Shifts
4

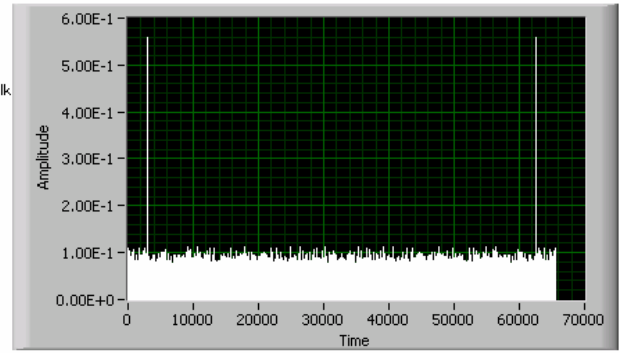
Code for Demux
0 (0) is the non-shifted code

Frequency of Signal
3000

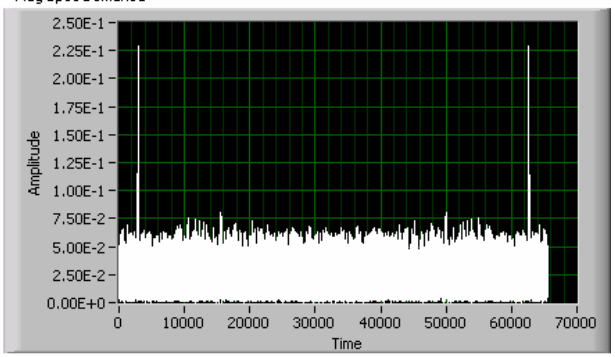
Size of array after slicing
65534

Dimentions of array before slicing
0 65534

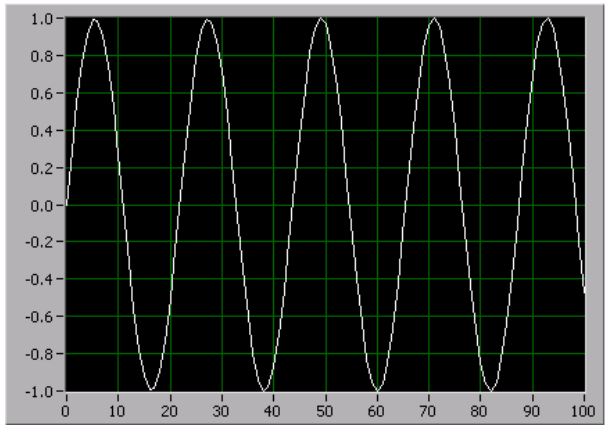
Mag Spec Input Signal w/noise



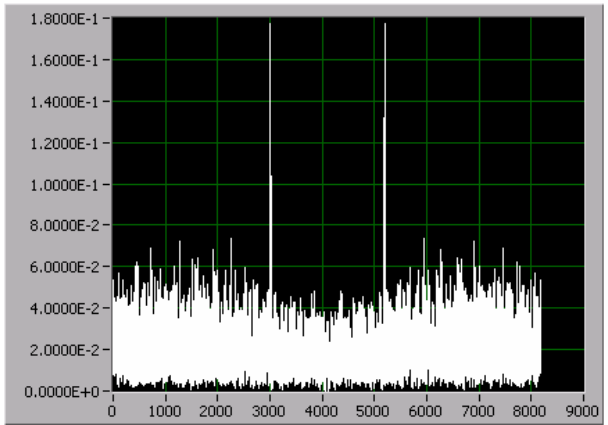
Mag Spec Demuxed



Signal 2



Mag Spec of demuxed Signal (subsampled)



Discussion of Results

We found several things while trying out various filter settings.

1) The filters seem to maintain the signal to noise ratio.

2) Spurious peaks are created when you oversample – or when you aggressively filter the signal.

3) Padding the signal with zeroes is better than interleaving the signal – and more closely simulates the experimental setup.

What I Learned

- We now have a good set of tools to better understand and attack sources of code-crosstalk in the experimental setup.
- Working in ARL has been an enriching experience which has given me valuable time in a research environment.

Questions?