

Wire Position Monitors

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Wire Position Monitors (WPMs)

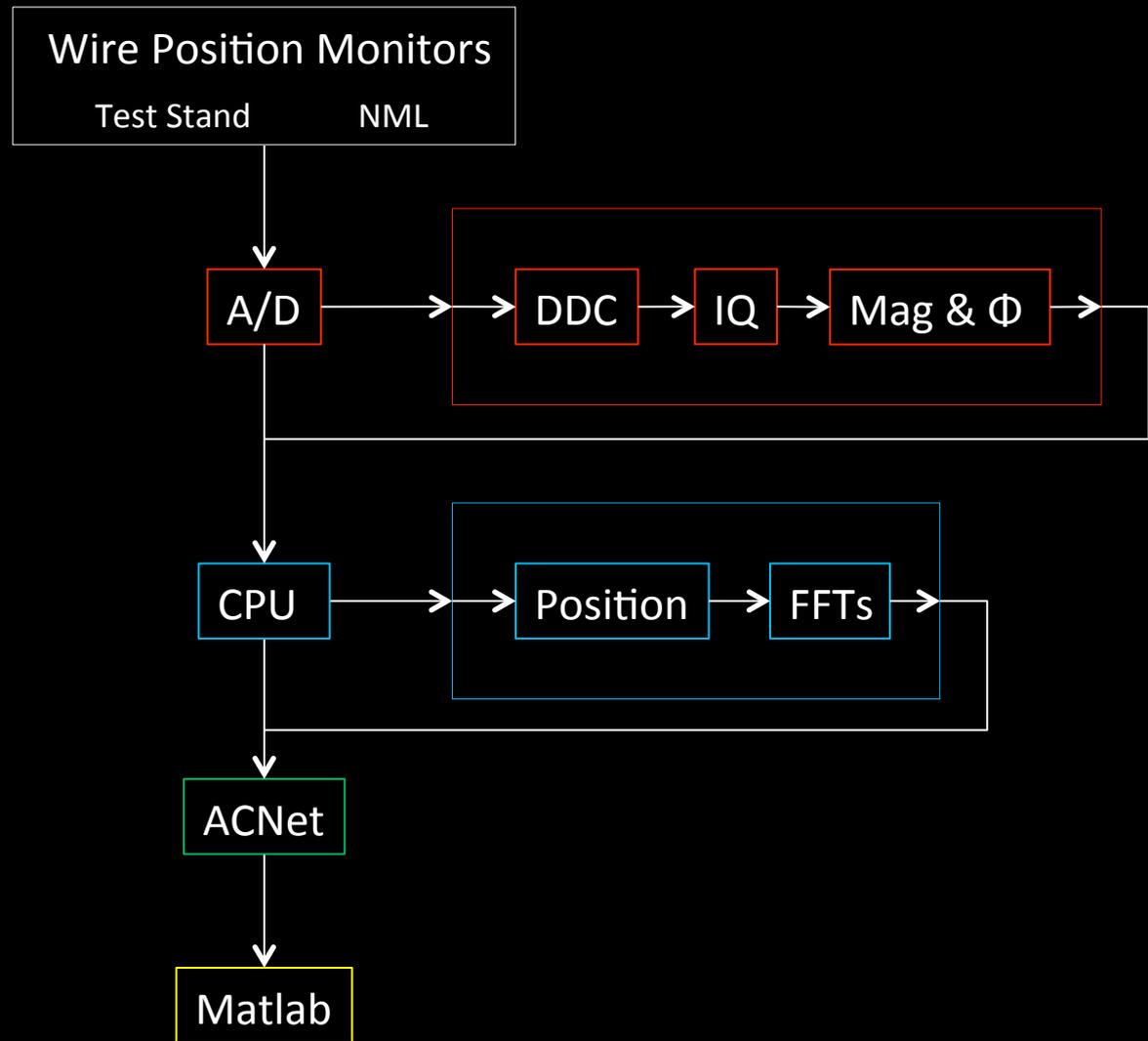
- WPMs are pickups with 4 microstrips spaced 90° apart
- Our WPMs are attached to the main beam pipe in a cryomodule



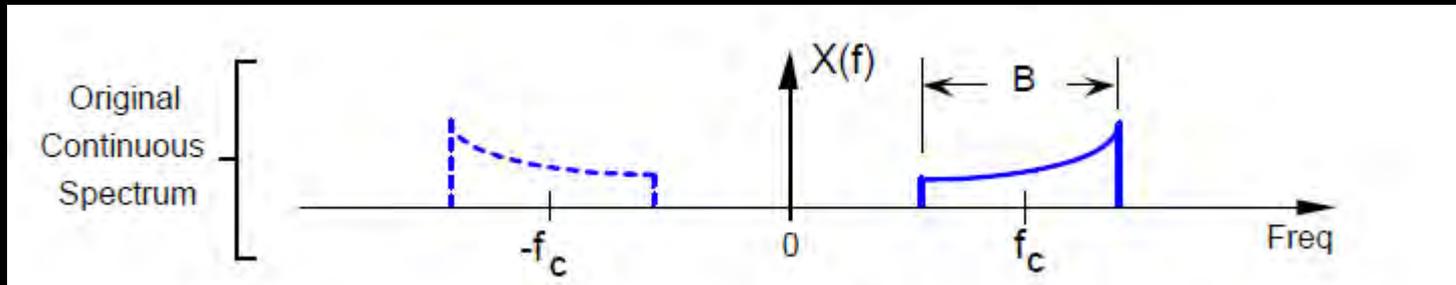
WPMs continued

- Used to infer the motion of the acceleration cavities during cool down
- Does so through comparison of the position of the WPMs and a wire stretched through the cryomodule which we are driving at 325MHz
- Collects data once every 4 seconds
- Data collected contains average positions and 16k samples at a rate of 4kHz

Data Acquisition Overview

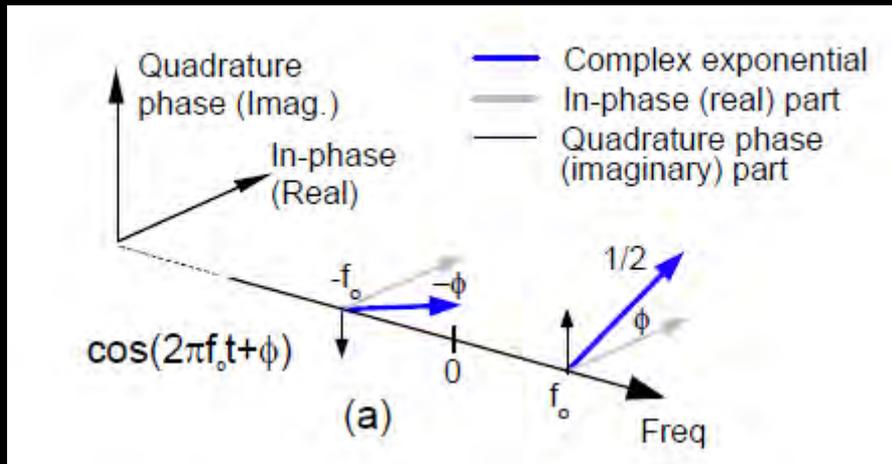


Digital Data



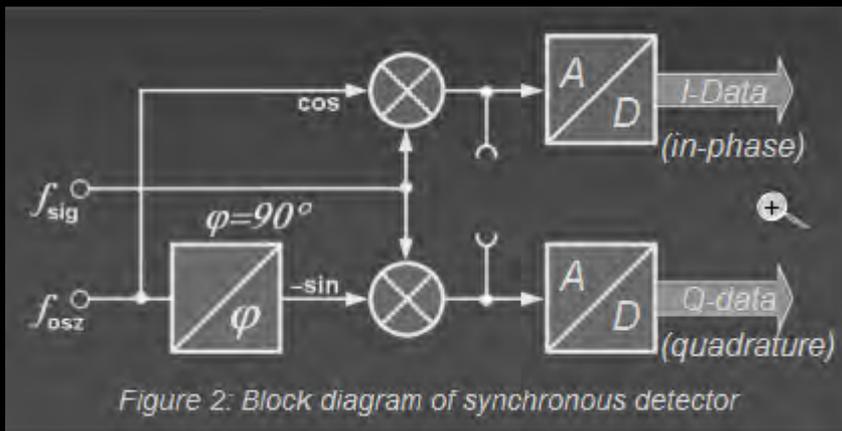
In-Phase and Quadrature

- Two-dimensional signals whose value at some time (or in our case some frequency) can be interpreted as a single complex number
- In-Phase represents the real part of the complex number
- Quadrature represents the imaginary part of the complex number

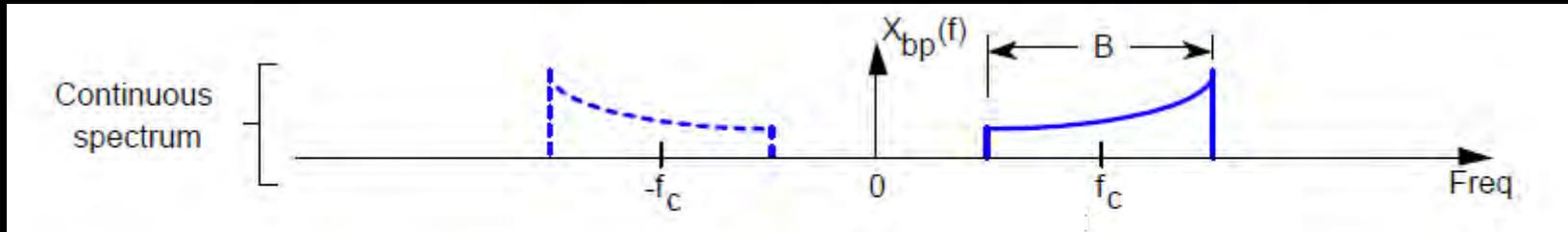


Benefits of pulling IQ

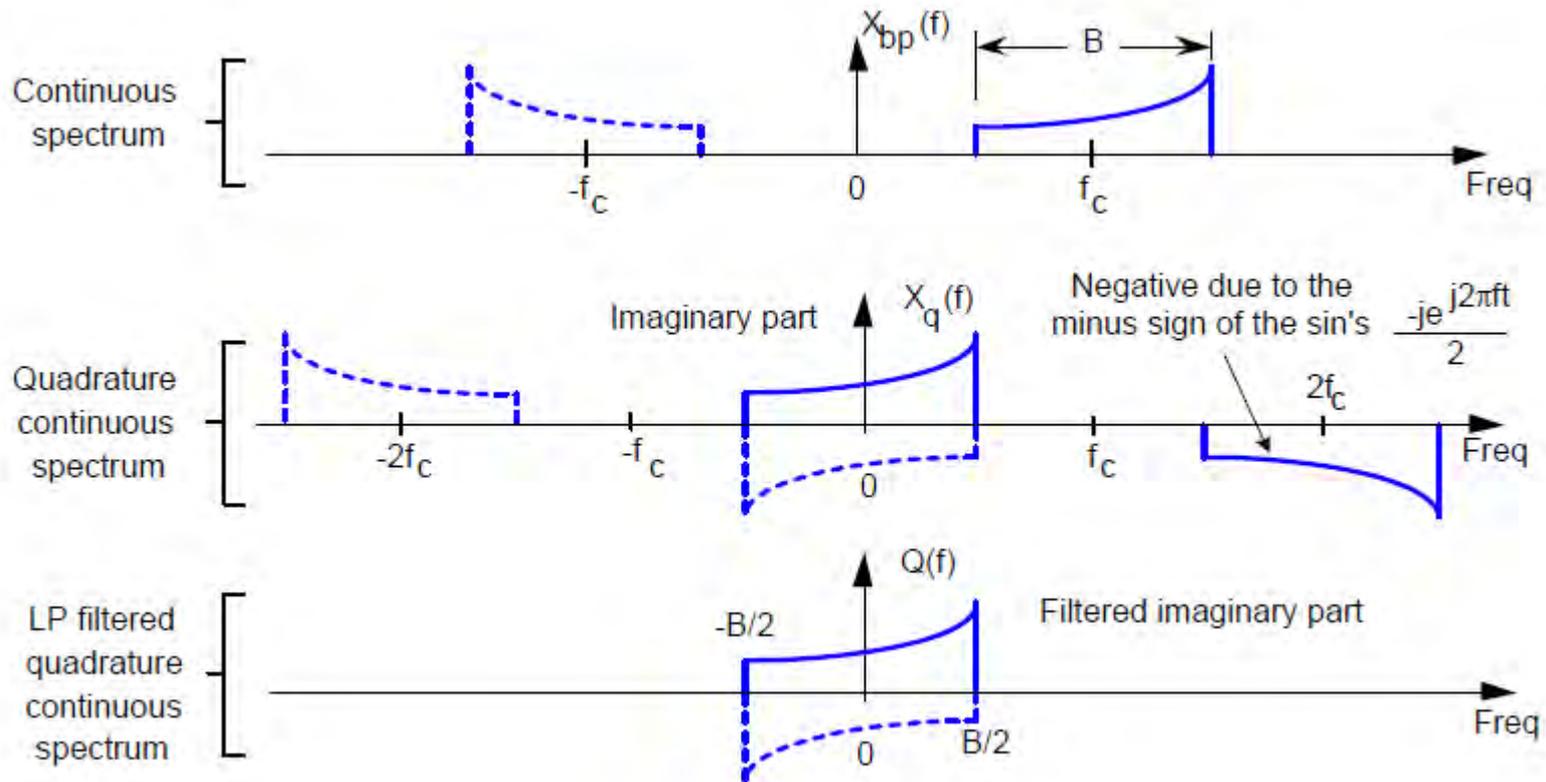
- Reduces the number of signals we need to read if we have the full complex number
 - Only issue is A/D converters cannot read imaginary data
 - Process it with a phase



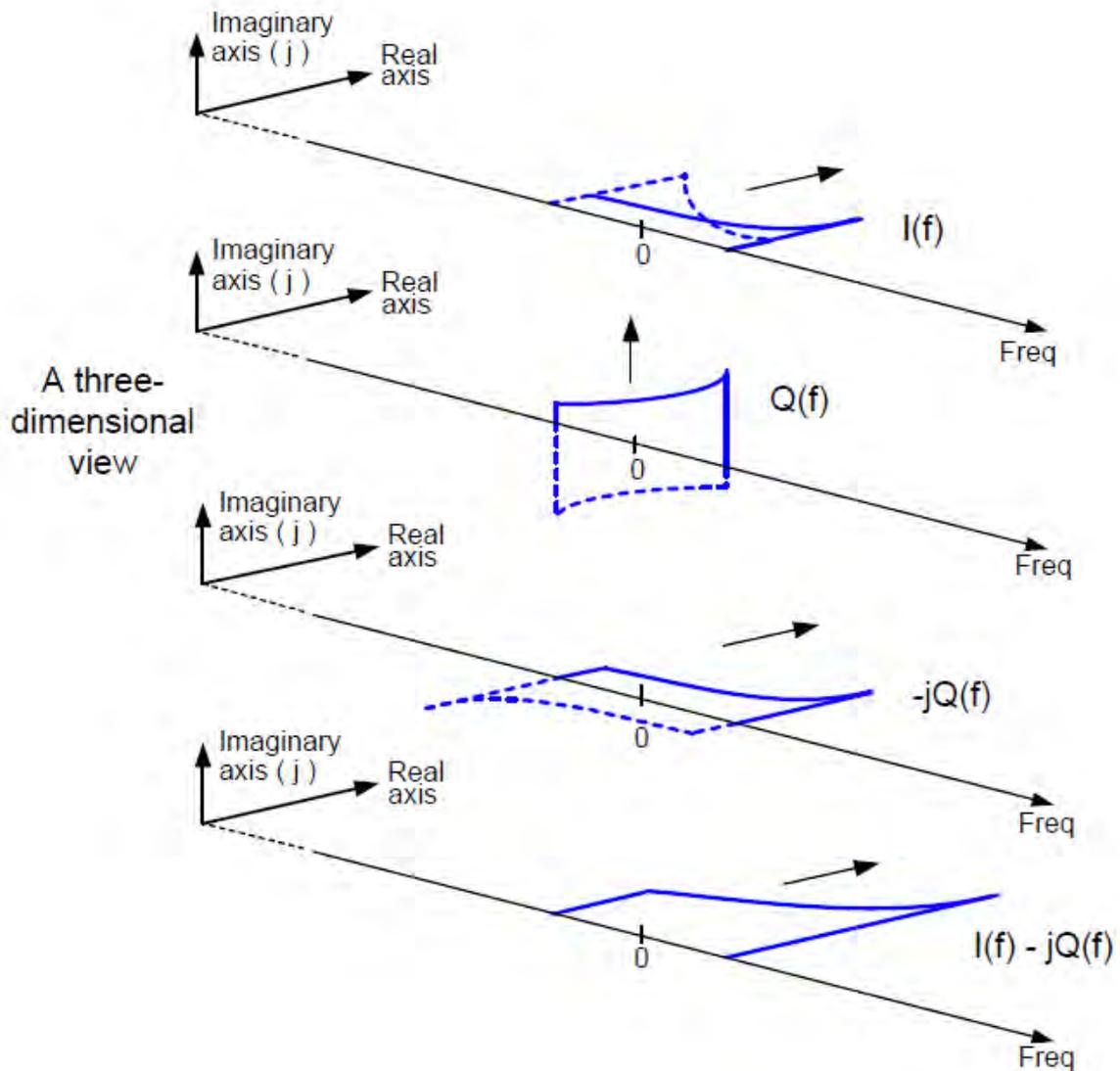
I processing



Q processing



I-jQ processing



Magnitude and Phase

- Magnitude

$$M = \sqrt{I^2 + Q^2}$$

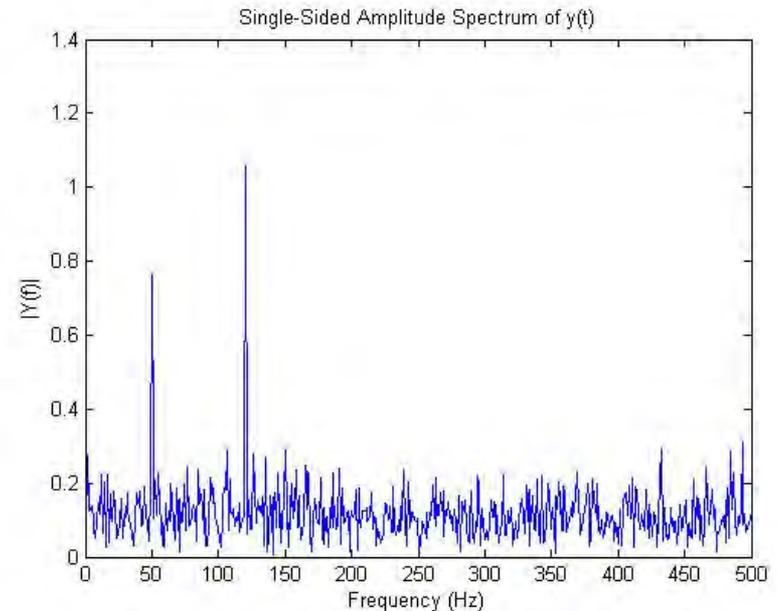
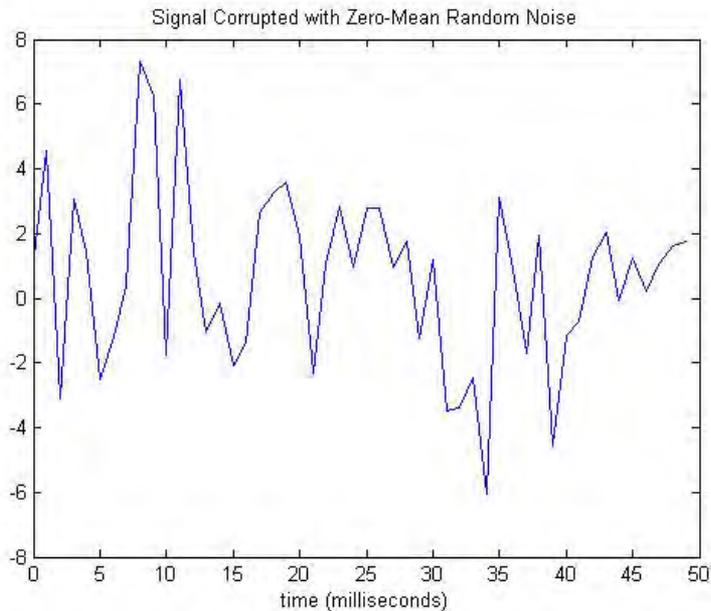
- Phase

$$\Phi = \text{atan2}(Q, I)$$

– (Matlab function)

Fast Fourier Transforms (FFTs)

- Basically takes a signal or data set, converts it to sine waves and plots which frequencies of sine waves are present



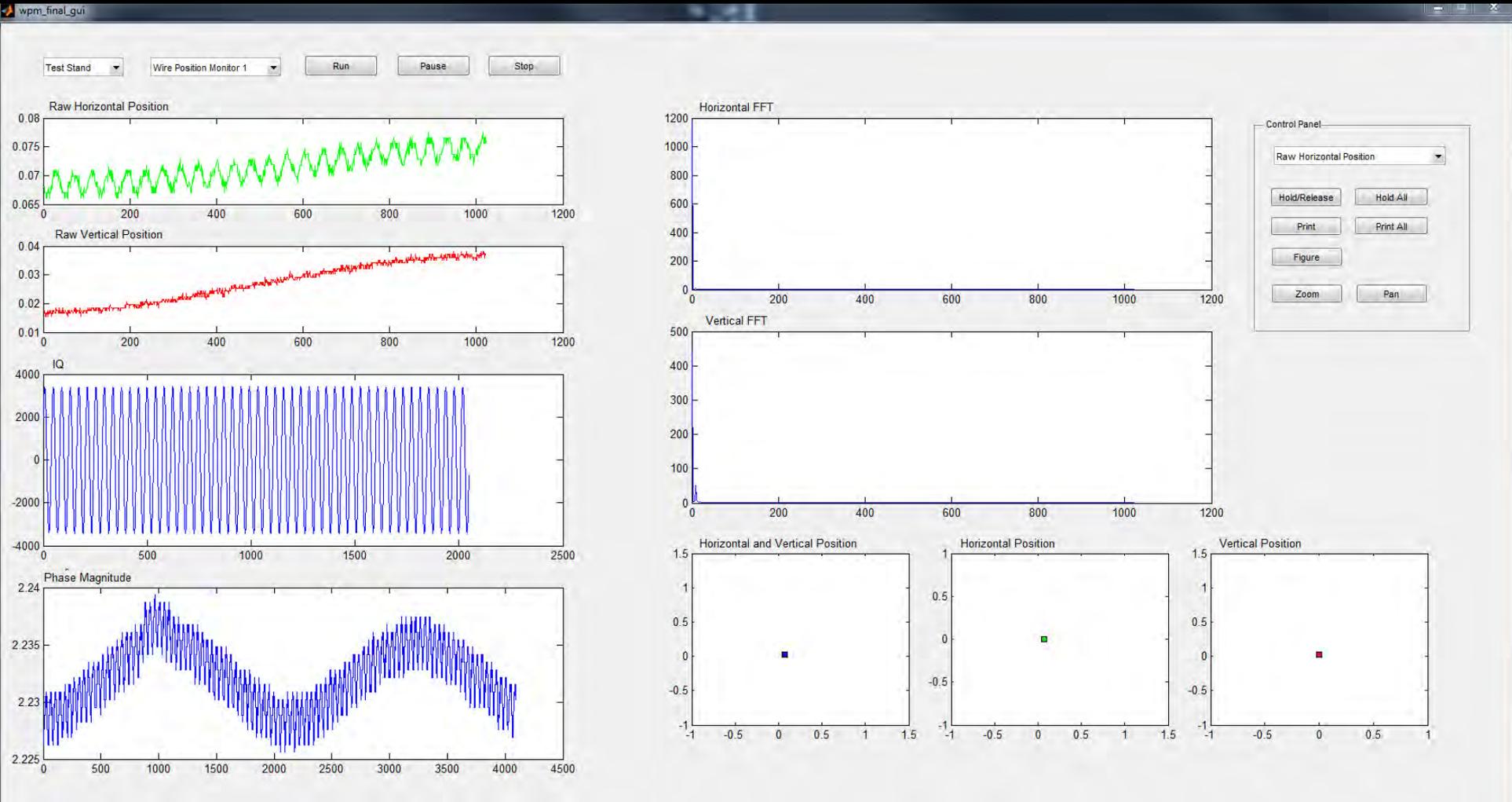
FFTs continued

- Two sets of FFTs, one corresponding to horizontal position data and one to vertical are constructed
- The horizontal and vertical data are based on the vibrations of the hardware
- The FFTs show any vibrational frequencies of the cavities

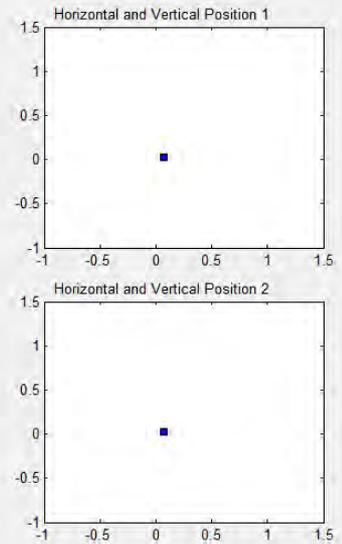
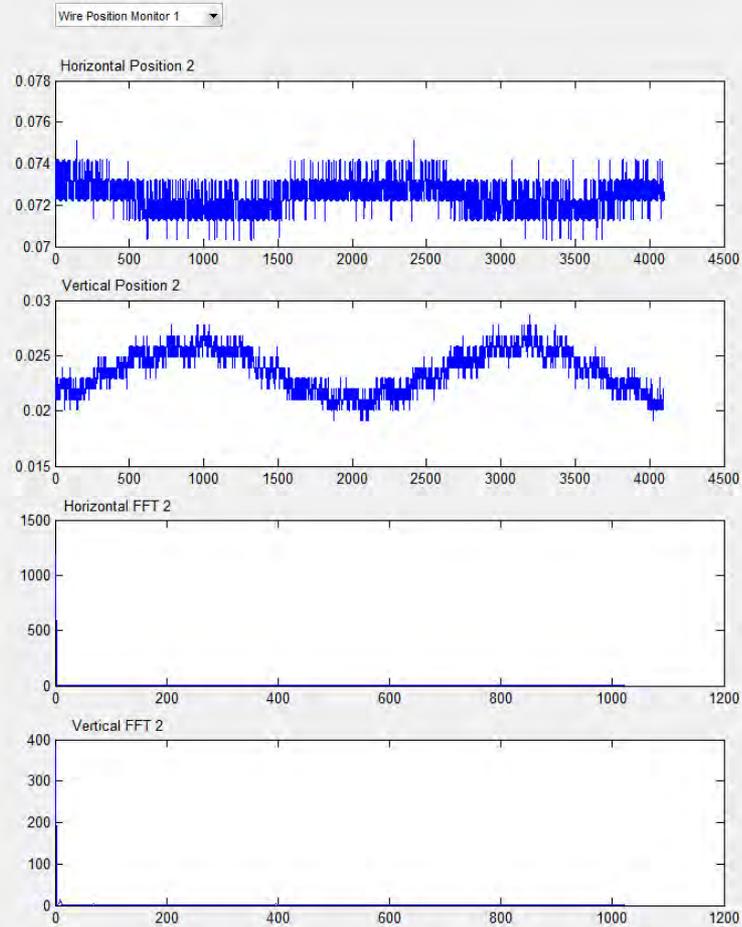
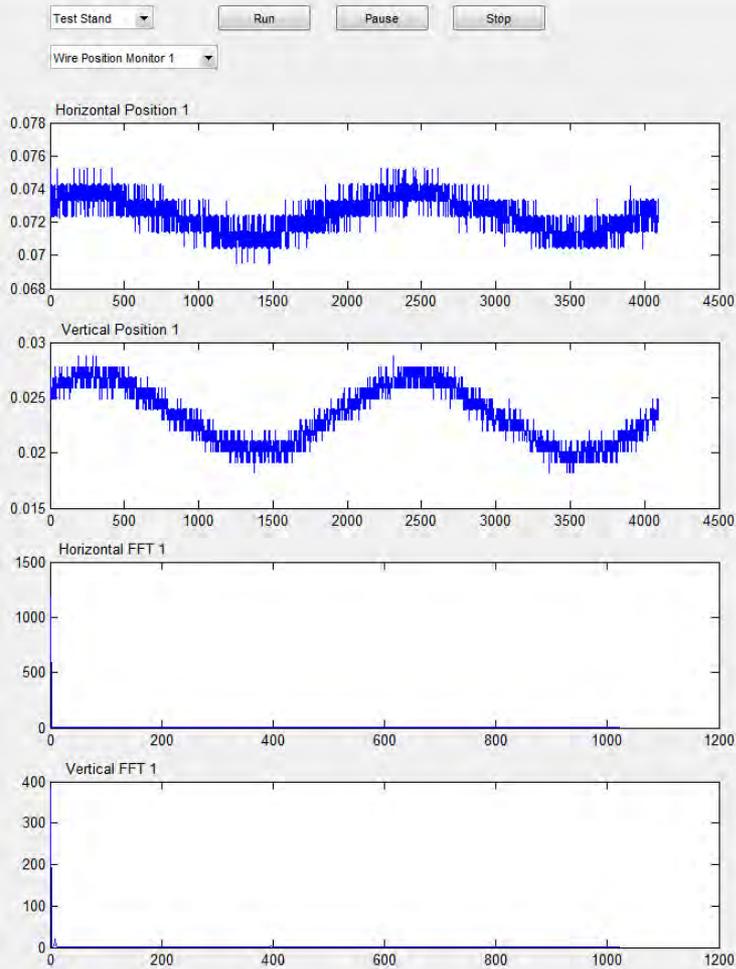
Matlab

- Building a GUI that presents all the aforementioned data to act as a checking and monitoring system
- Challenges
 - Constant, automatic, simultaneous updates
 - Only able to pull 4k of data instead of 16k
 - Printing Data
 - Multiple input variables
- Building a tool that is still in development

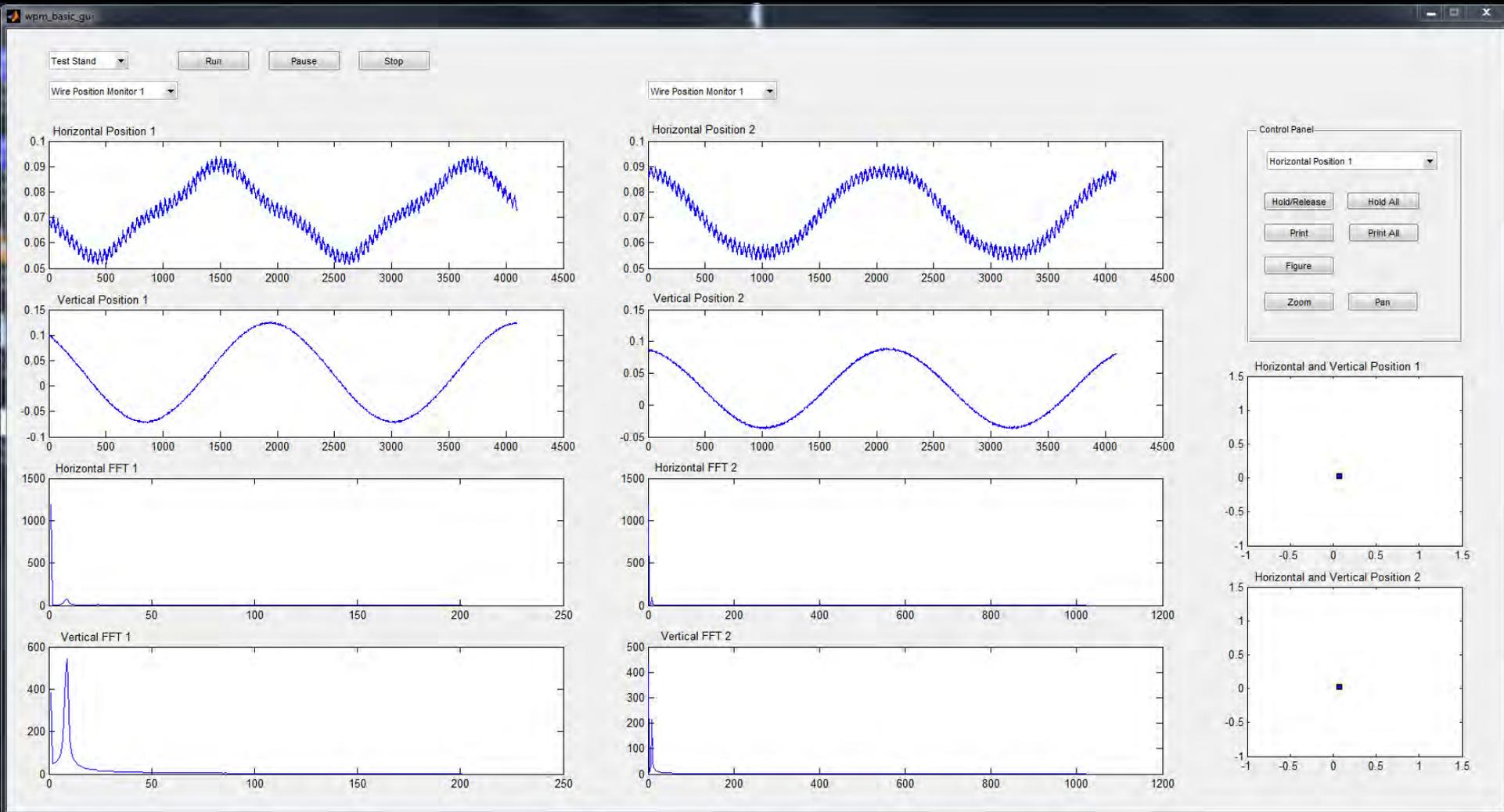
Early stages



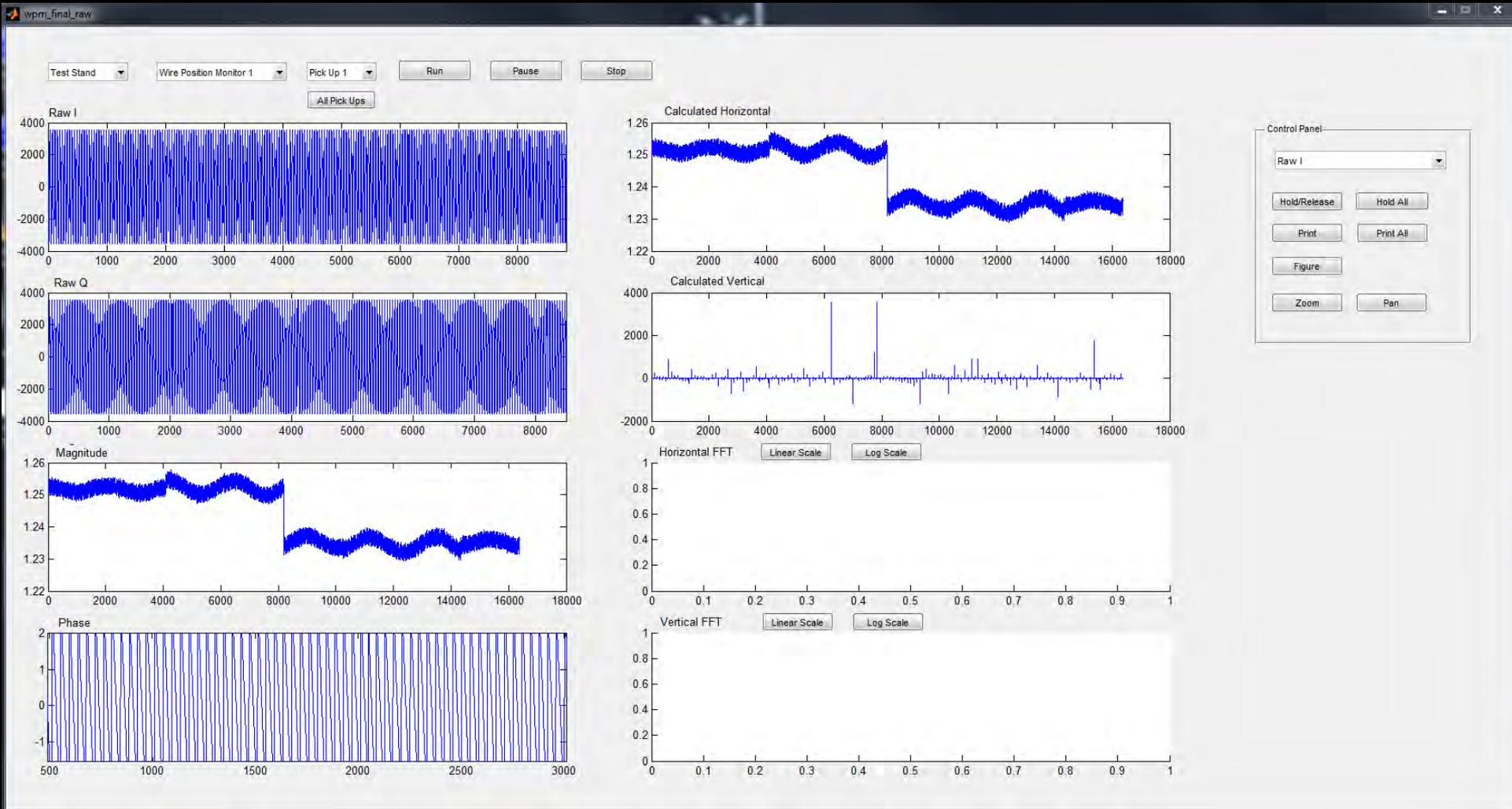
Early Stages



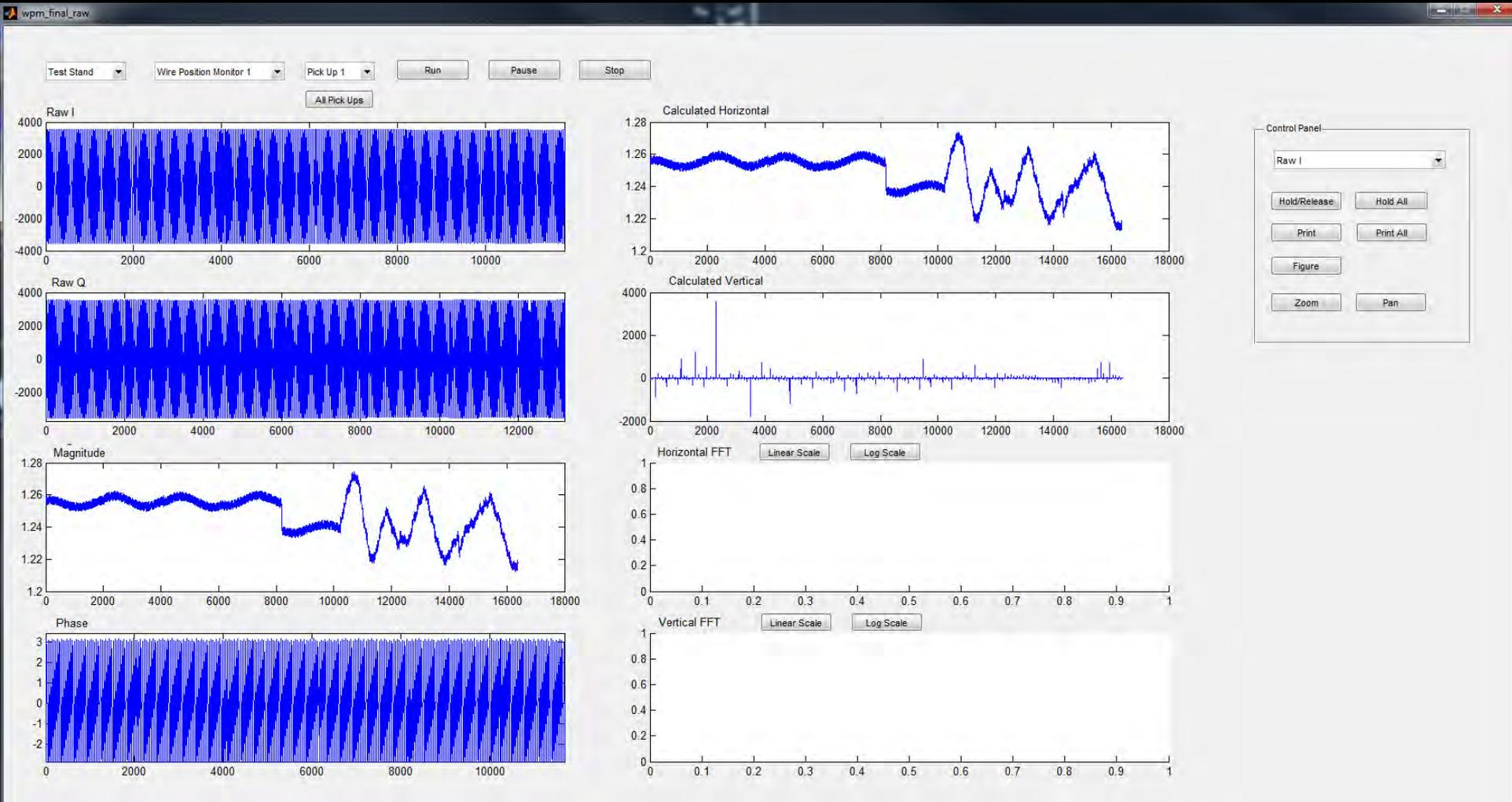
Reaction to Noise



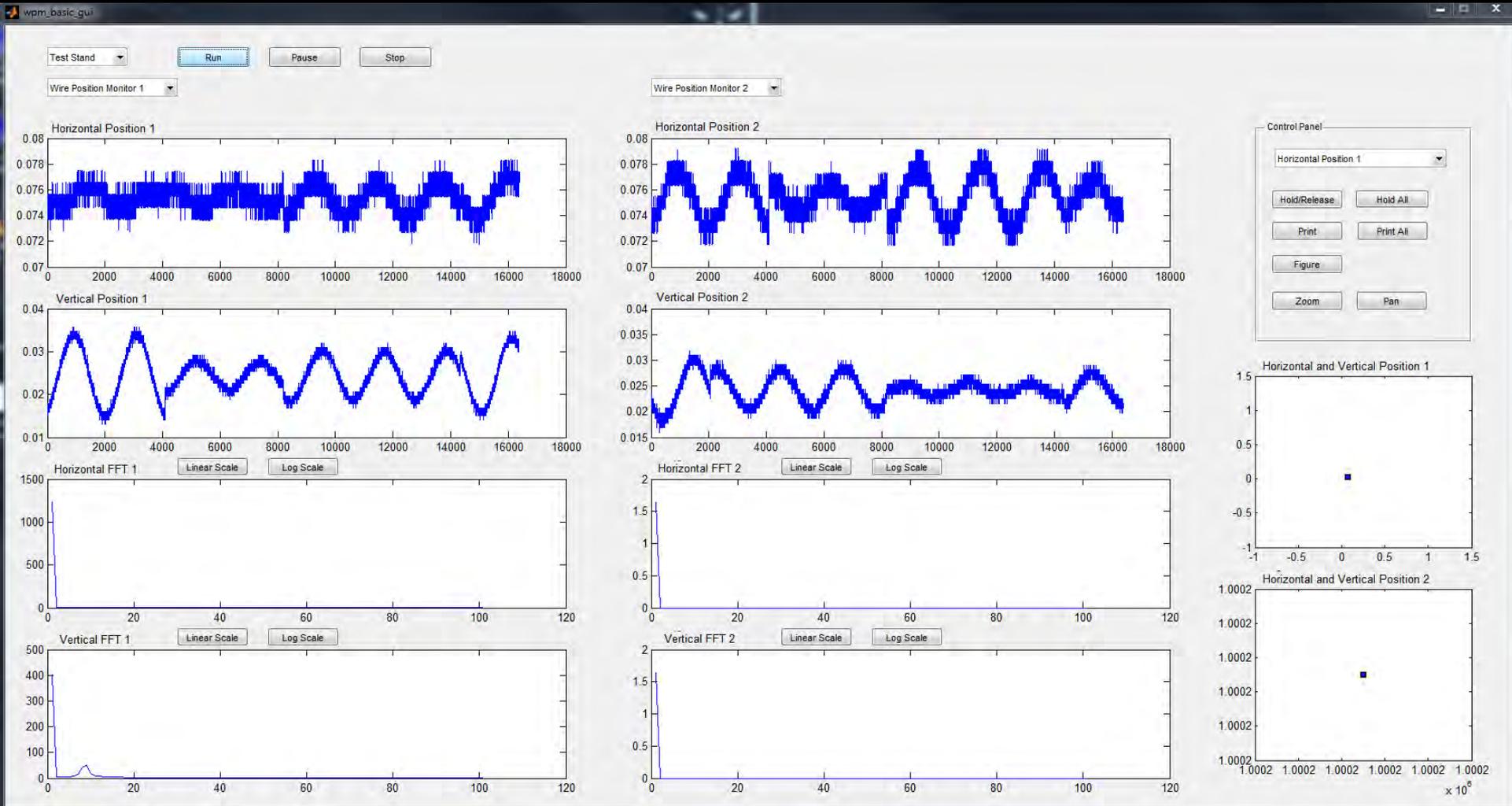
Final Raw Data GUI



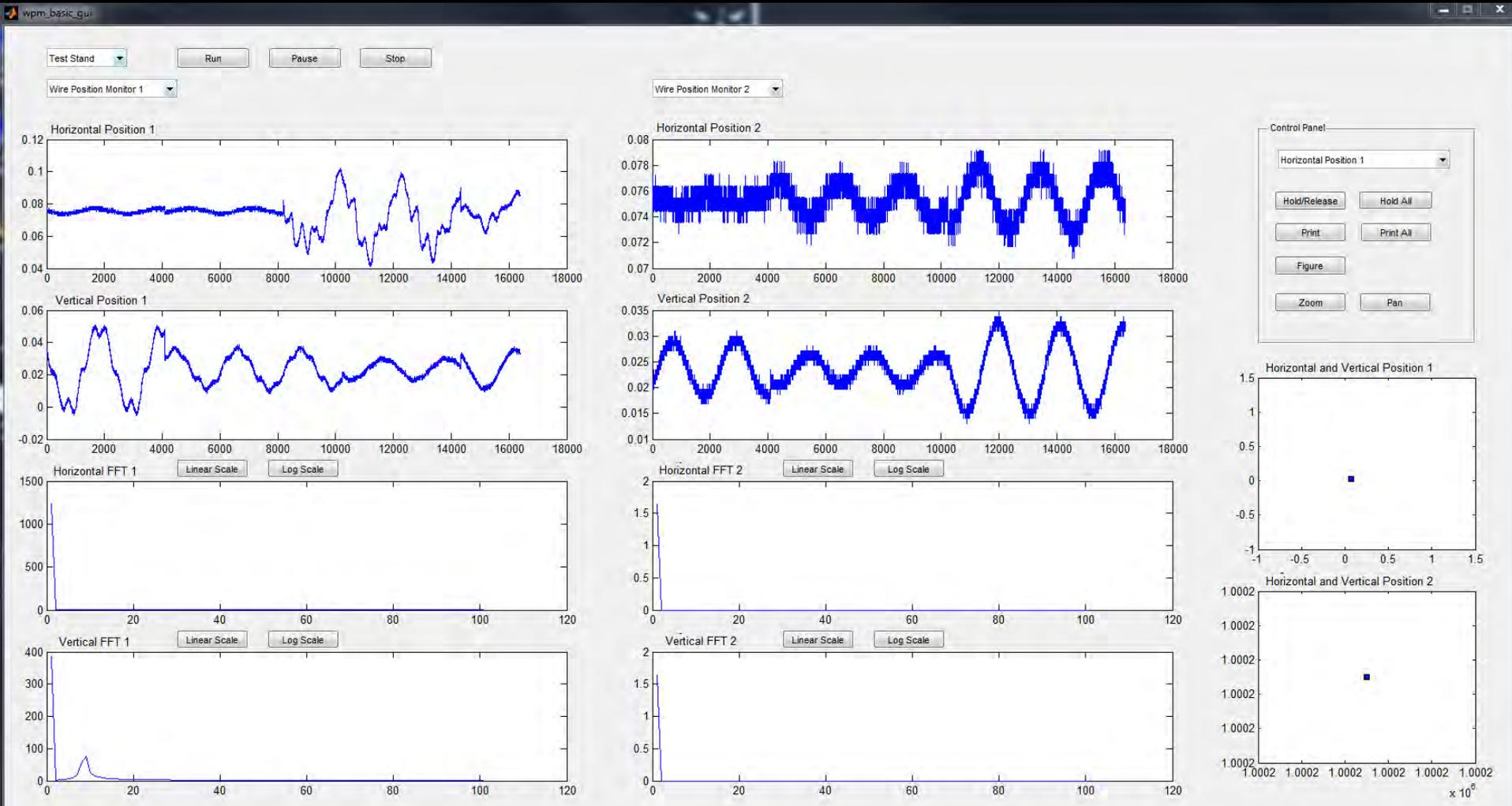
Reaction to Noise



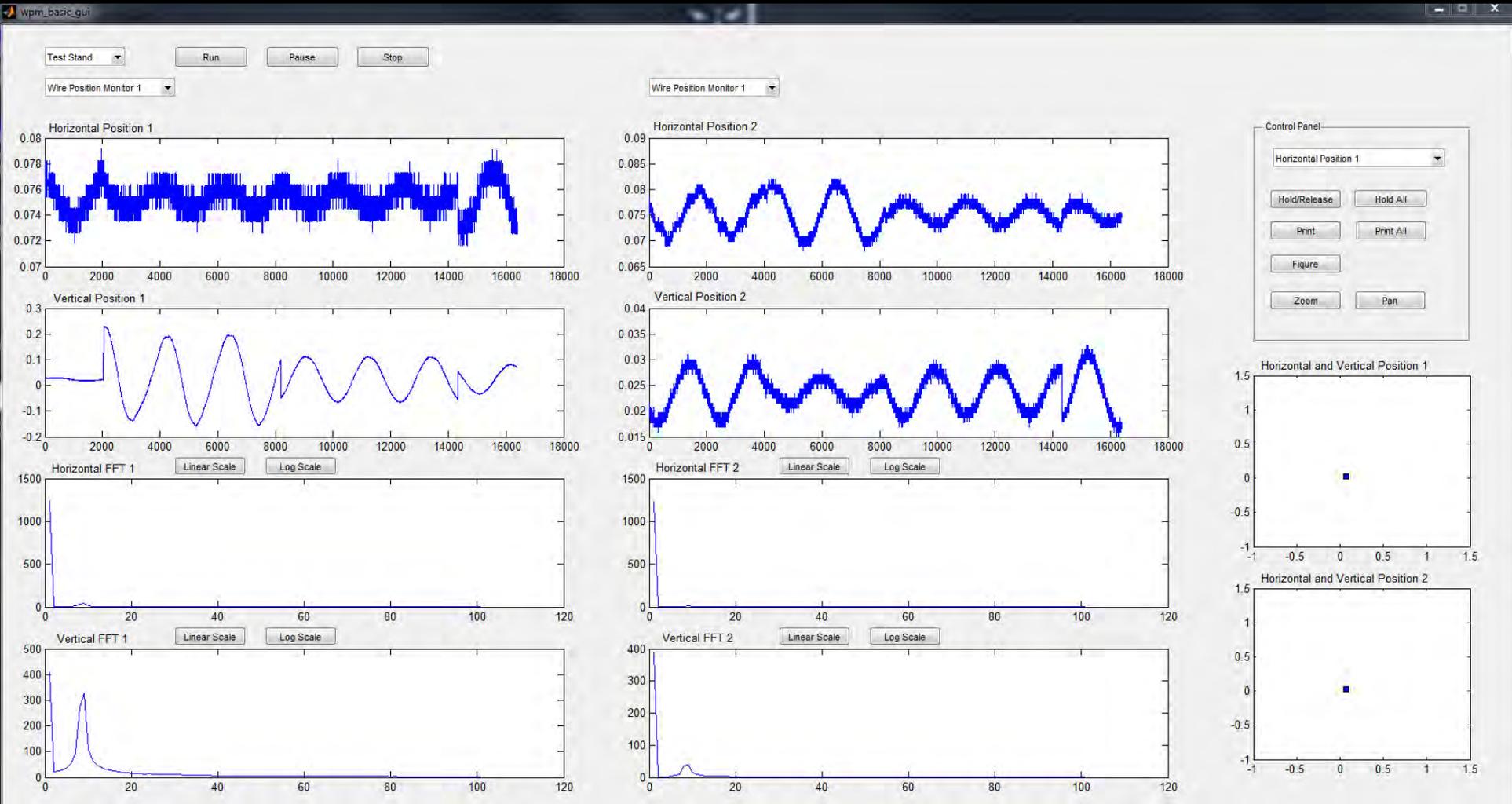
Final Basic GUI



Reaction to Noise



Reaction to Noise



Time

- We pull 16k of I, Q, Φ and Magnitude data each for a total of 64k
- We pull in 4kB increments so we pull 16 times
- This takes Matlab approximately 30 seconds
- Our data updates every 4 seconds
- Anywhere from 8-10 different sets of data represented

Future Steps

- Dealing with the time issue
- Creating a log which can track printed data and be used to keep notes
- Calculation of FFTs and comparison to FFTs provided to us
- Need to convert units to time scale

Thank You

- Nathan Eddy
- Roger Tokarek
- Dave Slimmer
- Duane Voy
- Accelerator Controls Department
- And everyone we spoke to about I,Q and FFTs

Citations

- Wolff, C. (2013). *In-phase & quadrature procedure*. Retrieved from <http://www.radartutorial.eu/10.processing/sp06.en.html>
- Lyons, R. (2008, November). *A quadrature signals tutorial: Complex, but not complicated*. Retrieved from <http://www.dsprelated.com/showarticle/192.php>