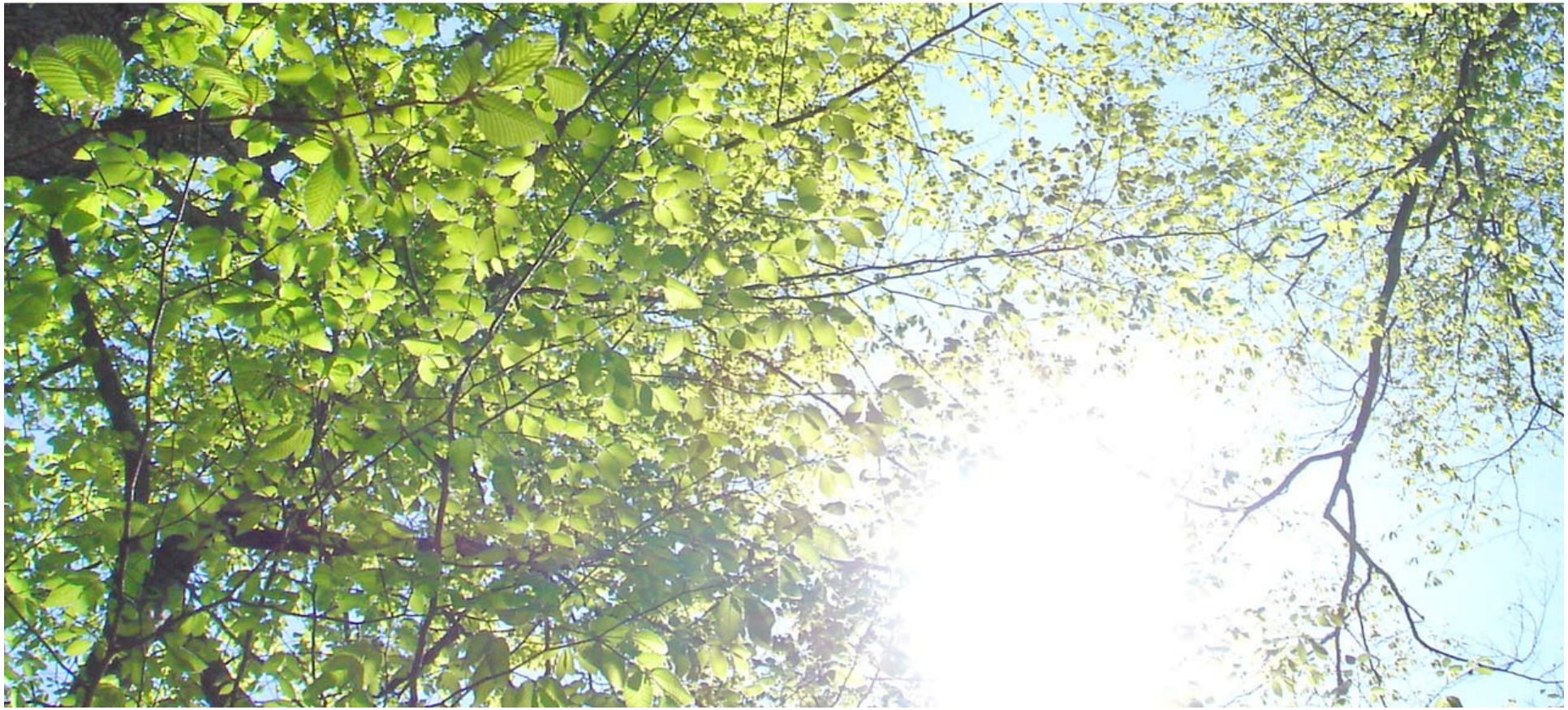
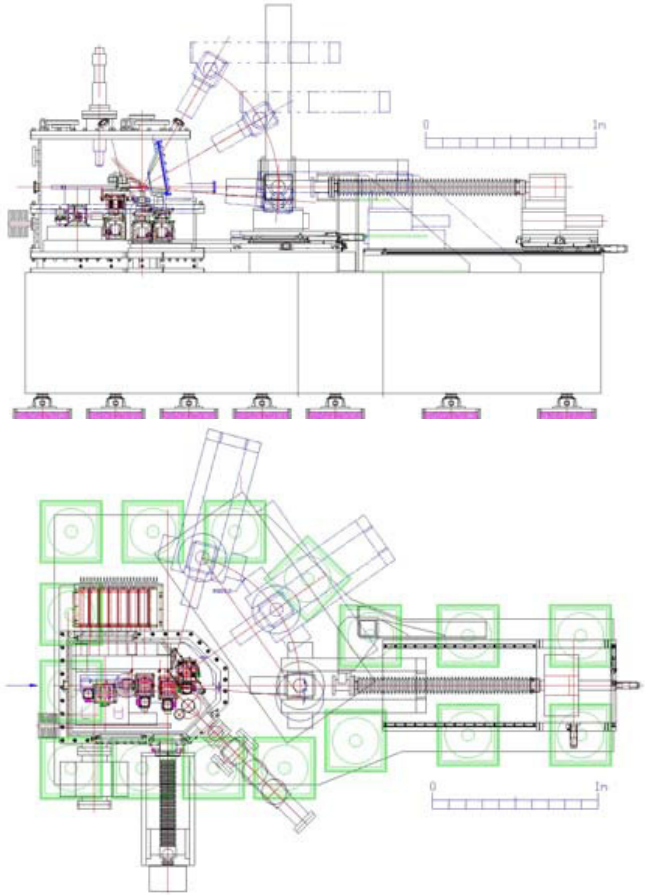
Improving Hard X-ray Nanoprobe

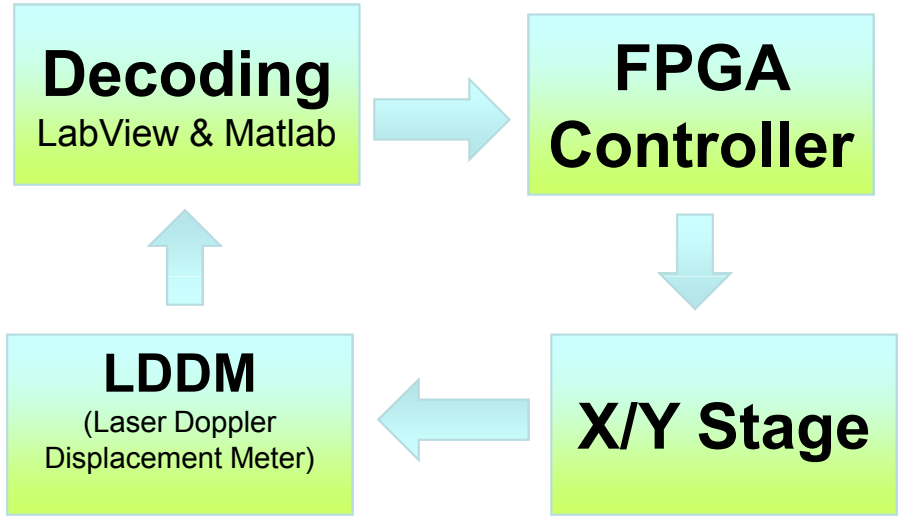
Qingyi Wang



The Hard X-Ray Nanoprobe



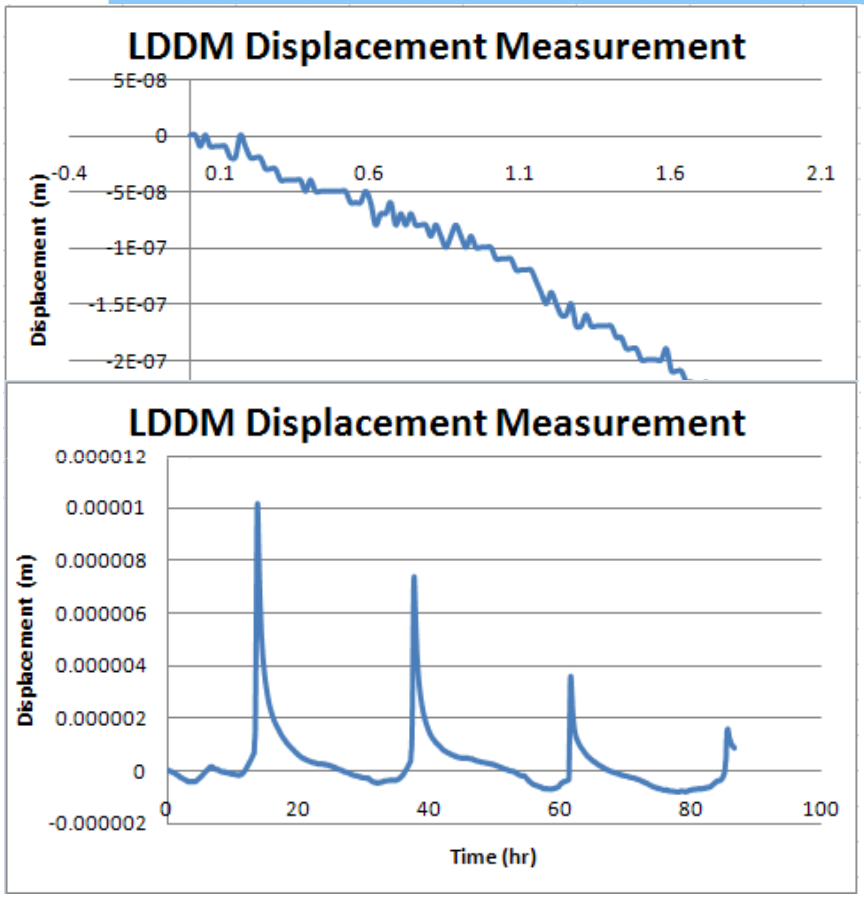
Schematics* of the hard X-ray nanoprobe structure.



Closed-Loop Control System

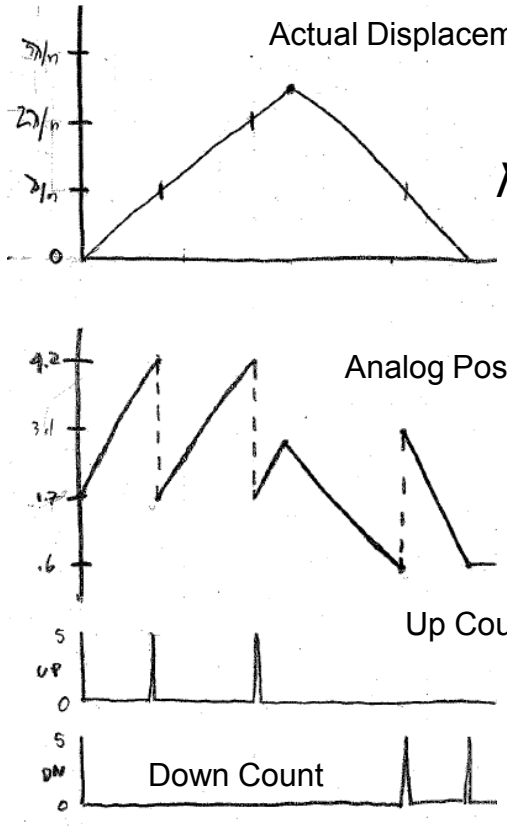
* *Optomechanical Design of a Hard X-ray Nanoprobe Instrument with Nanometer-Scale Active Vibration Control.* **D. Shu, et al.** s.l. : American Institute of Physics, 2007. Synchrotron Radiation Instrumentation: Ninth International Conference.

LDDM laser encoder system



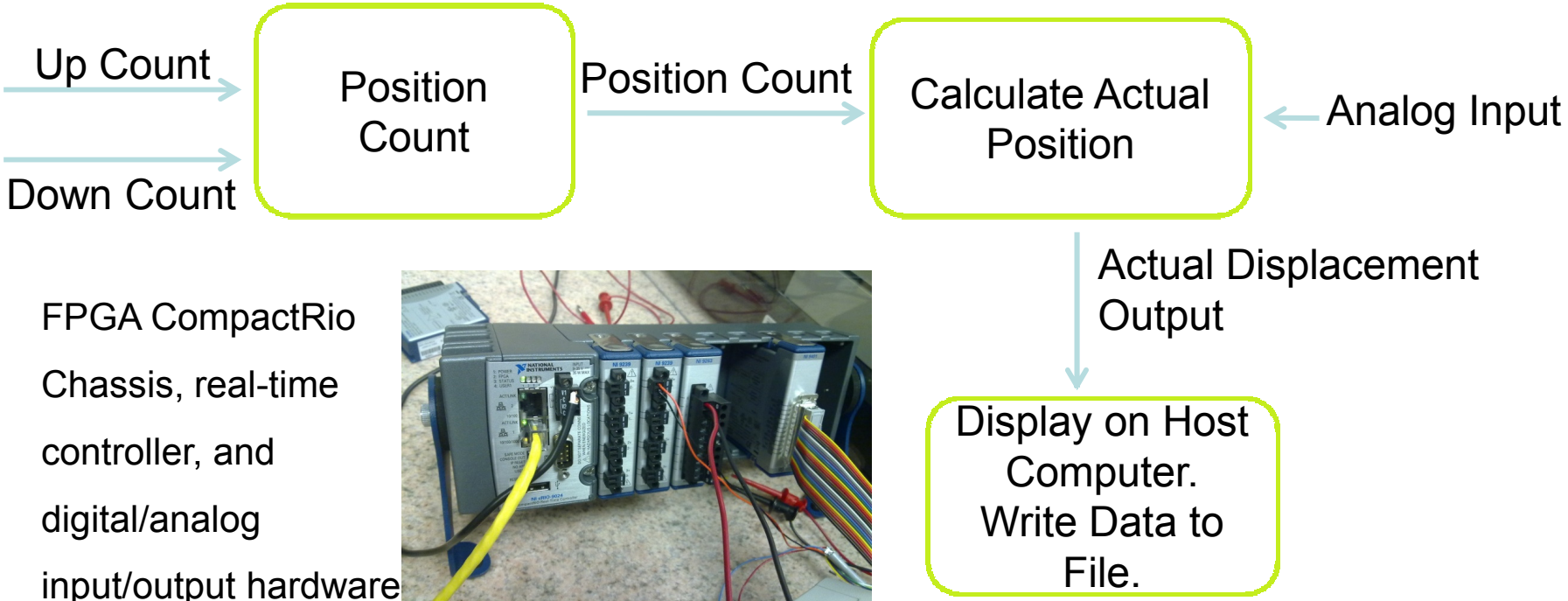
Rough measurement of the nanoprobe displacement over two hours and four days.

Example of LDDM encoder system outputs.



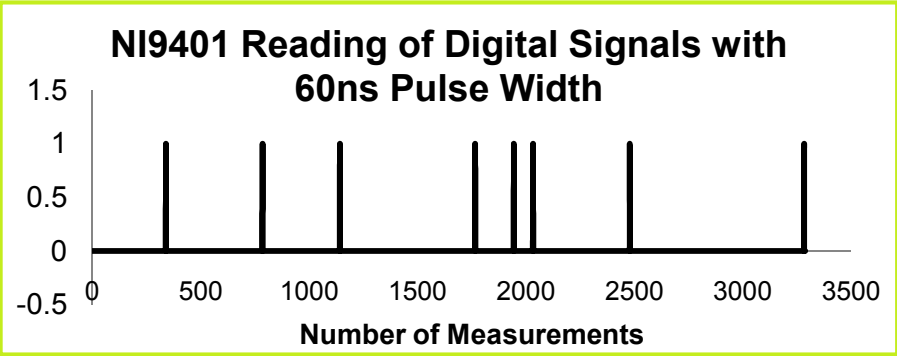
Data Reconstruction

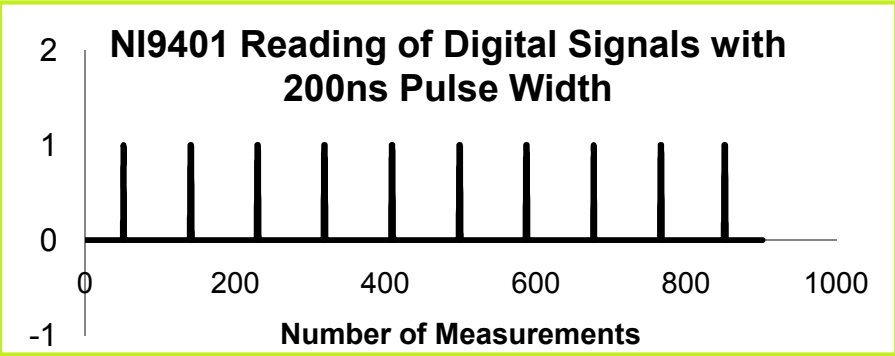
Block Diagram of the Data Reconstruction LabView FPGA module



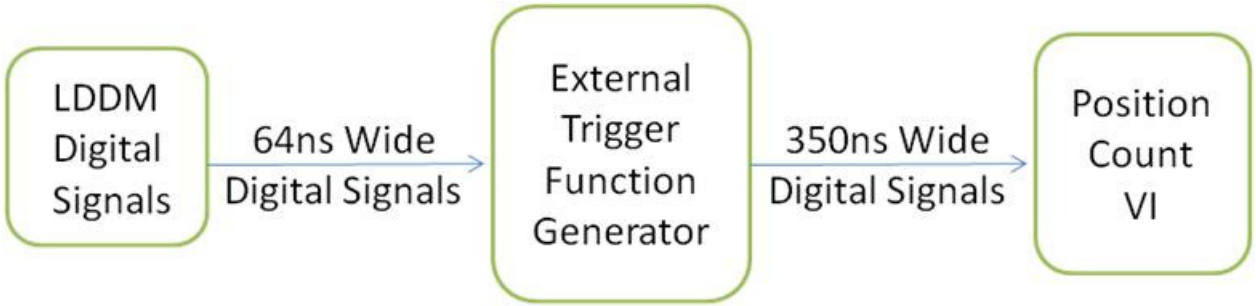
FPGA CompactRio Chassis, real-time controller, and digital/analog input/output hardware modules.

Digital Signal Processing





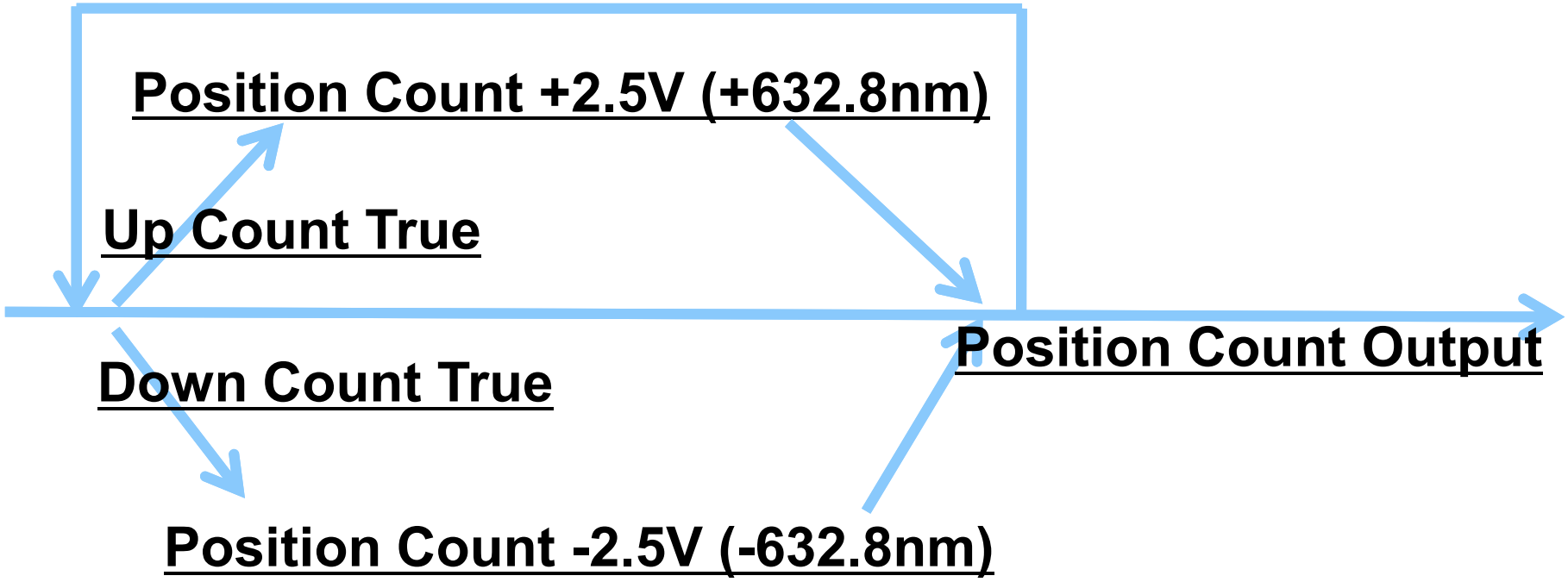
Digital signals are only recognizable when the pulse width is greater than 100ns.
Digital outputs from our laser encoder system has only 64ns pulse width.



We use external trigger function generator to increase pulse width.

Position Count

Logic of the Position Count VI



Piezo Controller

Physik Instrument (PI) piezo actuators with strain-gauge sensor/servo control modules are used to drive the nanoprobe.

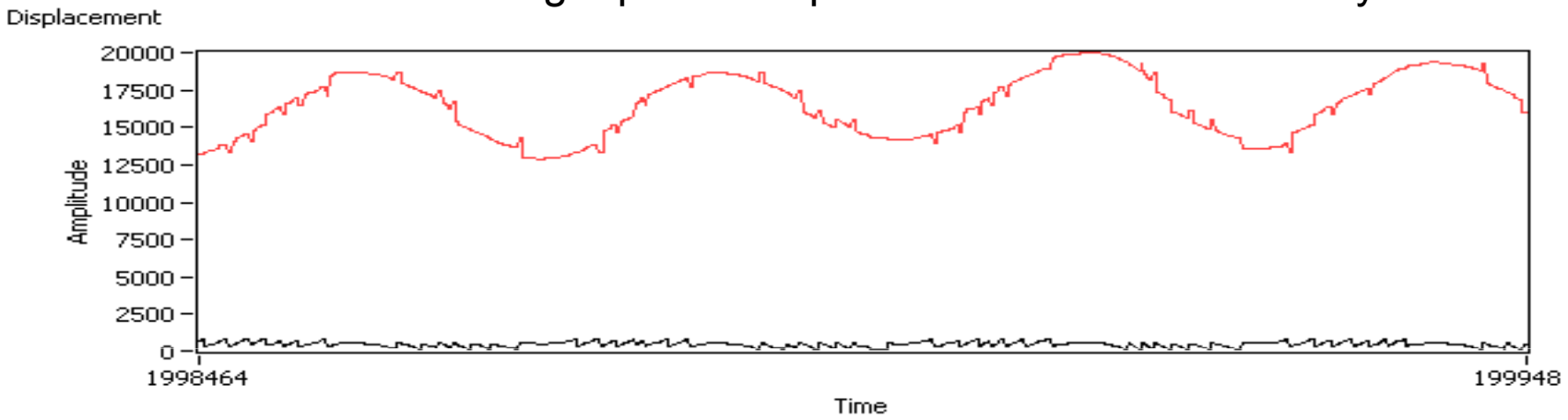
Y-axis sensitivity is

$$\frac{1V}{1} \times \frac{100V}{10V} \times \frac{15 \times 10^{-6}m}{100V} \times \frac{4 \times 10^{-6}m}{15 \times 10^{-6}m} = 0.4 \times 10^{-6}\,{}^{m}/_{V}$$

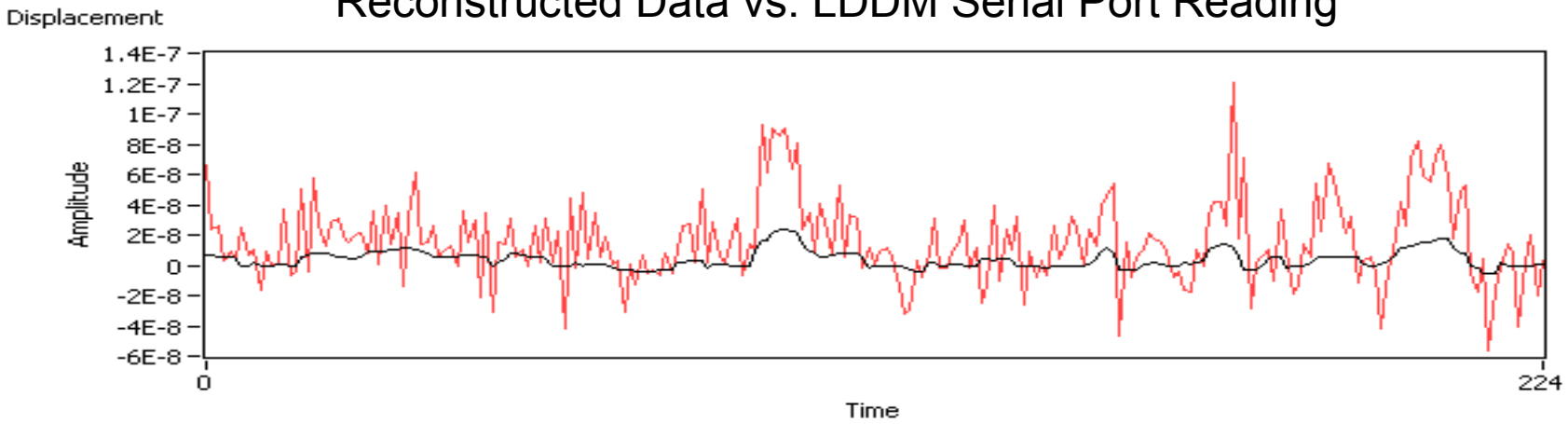
which is 2.5mV /nm

Data Reconstruction Result

Reconstructed Data vs. Analog Input when piezo actuators are driven by a sine wave.

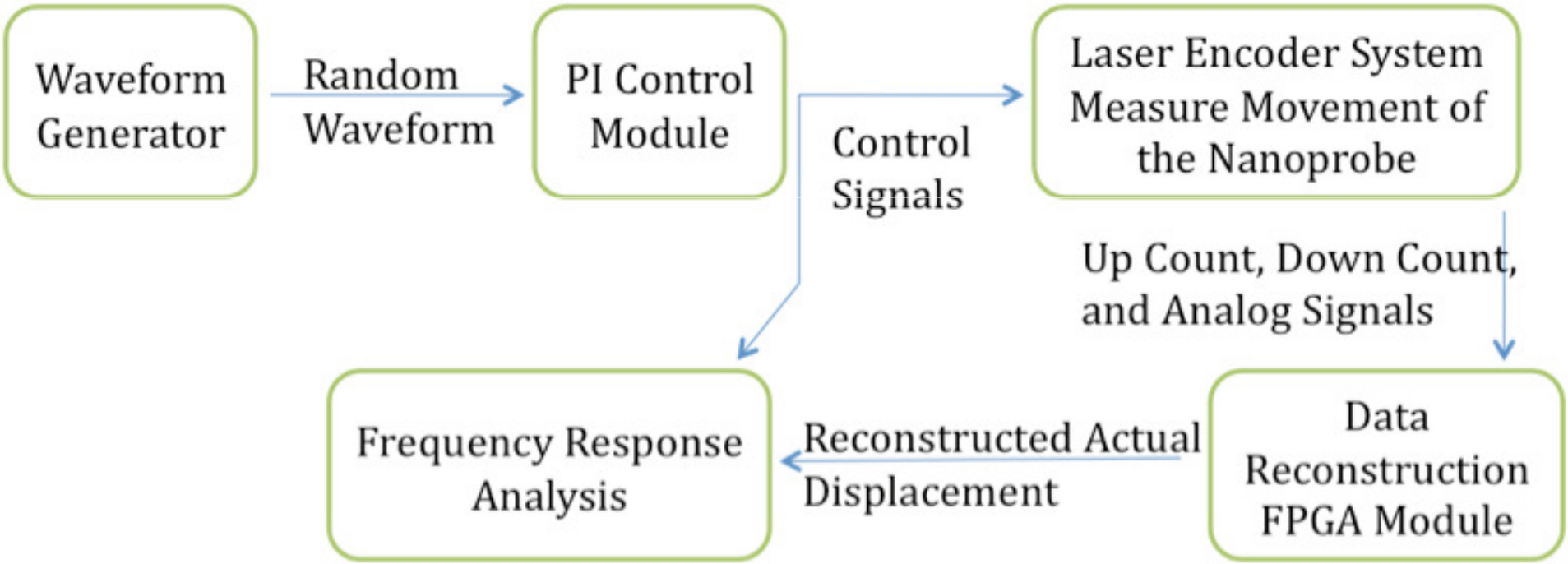


Reconstructed Data vs. LDDM Serial Port Reading



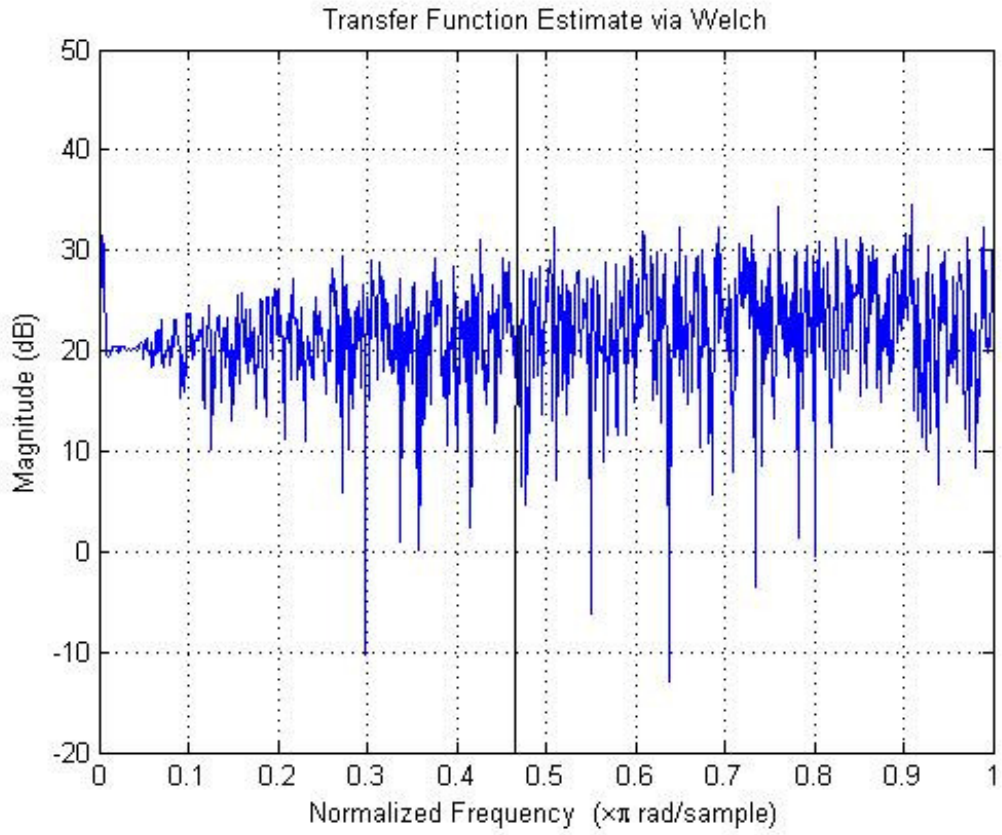
System Identification

Block diagram of the system identification FPGA VI



Frequency Response Function

We would expect it to be one or a few peaks in the 5 kHz range (on the left of the black line).



Conclusion

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- Developed a module that utilizes the LDDM signals to reconstruct the actual displacement of the nanoprobe correctly.

- Still need to find out a way to conduct calculations on the FPGA more efficiently.

Acknowledgement

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