Improving Hard X-ray Nanoprobe

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The Hard X-Ray Nanoprobe

Schematics* of the hard X-ray nanoprobe structure.

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LDDM laser encoder system

Example of LDDM encoder system outputs.

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

$\lambda = 632.8 \text{nm}$
Data Reconstruction

Block Diagram of the Data Reconstruction LabView FPGA module

- **Up Count**
- **Position Count**
- **Position Count**
- **Calculate Actual Position**
- **Analog Input**
- **Actual Displacement Output**
- **Display on Host Computer. Write Data to File.**

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

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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

Position Count +2.5V (+632.8nm)
Up Count True
Down Count True
Position Count Output

Position Count -2.5V (-632.8nm)
Physik Instrument (PI) piezo actuators with strain-gauge sensor/servo control modules are used to drive the nanoprobe.

Y-axis sensitivity is

\[
\frac{1\text{V}}{10\text{V}} \times \frac{100\text{V}}{10\text{V}} \times \frac{15 \times 10^{-6}\text{m}}{100\text{V}} \times \frac{4 \times 10^{-6}\text{m}}{15 \times 10^{-6}\text{m}} = 0.4 \times 10^{-6}\text{m/V}
\]

which is 2.5mV /nm
Reconstructed Data vs. Analog Input when piezo actuators are driven by a sine wave.

Reconstructed Data vs. LDDM Serial Port Reading

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System Identification

Block diagram of the system identification FPGA VI

Waveform Generator $\rightarrow$ Random Waveform $\rightarrow$ PI Control Module $\rightarrow$ Laser Encoder System Measure Movement of the Nanoprobe

Control Signals $\rightarrow$ Up Count, Down Count, and Analog Signals

Frequency Response Analysis $\rightarrow$ Reconstructed Actual Displacement

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

• 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.
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