Path Length Stabilization Using a Field Programmable Gate Array

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Draft Abstract: Ultrafast Coherent Multidimensional Spectroscopy is a versatile spectroscopic tool used to gain insight into complicated coherent electronic processes associated with a variety of physically fundamental phenomena. Performing these experiments requires laser path stabilization of $\lambda/100$ or better. Using PI control algorithms to stabilize nested Michelson interferometers, path length stabilization of this quality can be achieved. Previously, analogue PI filters were used for this purpose, we report the development of a new instrument using a Field Programmable Gate Array to digitize and improve upon the performance of the analog filters.

I. INTRODUCTION

Ultrafast Multidimensional Coherent Spectroscopy (MDCS) provides unique and powerful insight into the structure, dynamics, and coupling of electron states in matter (CITE Gael, Steve, others). The primary advantage of MDCS over similar photon-echo and four-wave mixing spectroscopy lies in the ability to decongest complicated and entangle spectra over multiple frequency axes (CITE other review). A diverse array of physical systems have been studies with MDCS: (SOME shit.)

MDCS measurements require phase stability between pulses incident on a system of interest. (HOW 2D WORKS). Various schemes to achieve phase-stabilization have been employed. Generally these schemes can be subdivided into active- and passive-stabilization techniques. Among the favored passive-stabilization procedures are (PHASE SHIZ, OGALVIE). Active-stabilization, on the other hand, enables greater experimental flexibility in that longer time-delays between pulses can be achieved. Two successful experiments employing active-stabilization mechanisms are COPS and the JILA MONSTR. **Outline**

1. Introduction
   - 2D background.
   - Review of MONSTR configuration.
   - Review of current PI filter configuration
2. FPGA filter device
   - Analog amplifier circuits (purpose, config., and performance)
   - FPGA PI stabilization algorithm
   - FPGA liquid crystal/ shutter motor control algorithms
3. Results
   - Analog v. FPGA performance (abs. noise reduction, FFT noise analysis

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4. Conclusion

- FPGA algorithm a suitable replacement for analog filters, substantially easier to implement.