

Physics Department Senior Design Project Proposal

Project Mentor:

Chip Durfee, x3894 cdurfee@mines.edu

Project Title: Development of a Pulse Shaper for Amplified Ultrafast Pulses

Project Type: [X] Team; Number of students 3 [] Honors

Objective

(What is the science and/or engineering in this project?)

Design, build, calibrate and install a device that can control the temporal shape of ultrafast laser pulses. The optics (prism or diffraction grating) spatially disperse the frequency components of the laser pulse. The manipulation is done in this Fourier domain: the phase and amplitude of each frequency component is computer-controlled by a liquid crystal array. When the beam is passed back through the system, the changes to the spectrum turn into changes in the temporal shape. The students will use interferometric methods we have developed to characterize what the shaper does to the pulses. This adaptive control over the laser pulse will be used to affect nonlinear interactions of the amplified, intense pulses, in processes such as micromachining or nonlinear beam propagation.

Prior Background

A previous SD student (J. Field) has designed and built a similar pulse shaper. This system will be designed and optimized for much wider bandwidth and greater shaping flexibility for use at the beginning stage of an amplifier system.

Student Expectations

While the students will all collaborate, the students will primary responsibility for different aspects of the project. One student working on this project will be working with a mix of programming (Labview or Matlab) for control and calibration of the modulator, using a device we have in the lab. The other two students will initially work on the design so that optics can be ordered (by October). One will then specialize in modeling the shaper, while the other will concentrate on the optical alignment and characterization of the device. The deliverable at the end of the project will be a pulse shaper that is operational, characterized and modeled.

Supervision Plan

Day-to-day supervision by a postdoc. Weekly meetings as a team with Dr. Durfee.

Resources

The modulator will cost around \$10,000 and is being purchased on a research grant, as will the optics (~\$1000). The students will extend the functionality of control and modeling software that has been developed.

Technical References

See Boulder Nonlinear Systems (<http://www.bnonlinear.com/index.php>) for a description of the modulator technology. See our paper for a description of the shaper: J. Field et al, "Quartic-phase-limited, grism-based ultrashort pulse shaper," Optics Letters, Vol. 32 Issue 21, pp.3101-3103 (2007). The book "Fourier Optics" by Goodman has a chapter on pulse shaping.