

# High-Repetition Laser Interlock

## Project

### Laser Research

There is ongoing research using lasers in academia and industry, including:

- Laser Fusion
- Silicon Fabrication
- Gravitational Waves (LIGO)
- X-Ray generation

Our Interlock system identifies damage, then shuts down the laser system within the period of a laser pulse.

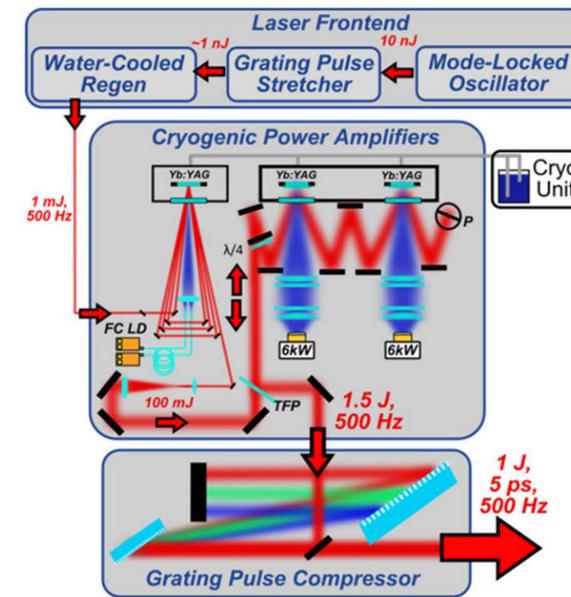
### Problem

Research into lasers is often slowed down by problems with the experimental setup.

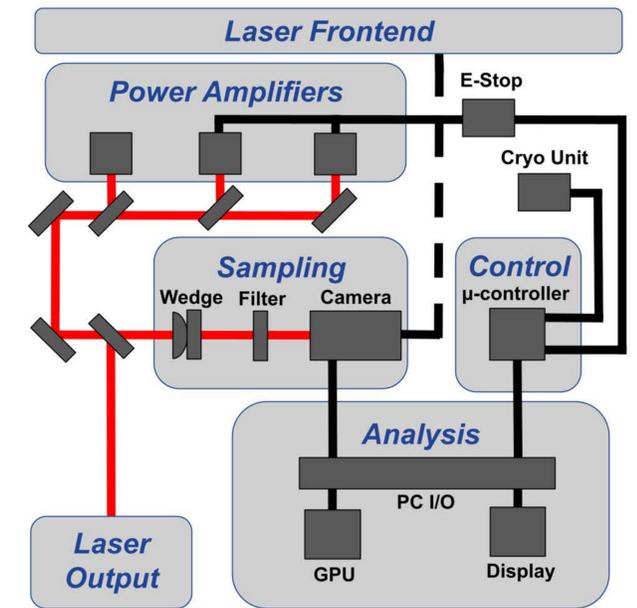
- Laser systems contain hundreds of expensive optics
- Critical optics may become damaged, damage propagates to other optics
- Lasers with a high rep-rate can cause immense damage in milliseconds

## System

### Laser System



### Interlock System

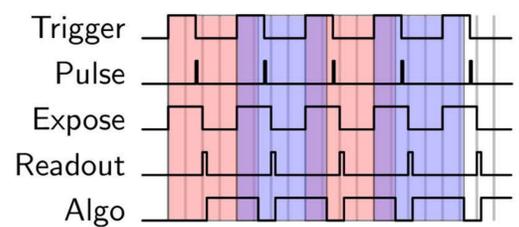


## Methods

### Sampling

Laser is sampled by CMOS camera.

- Camera exposure triggered by laser timing
- Beam intensity controlled by wedge and filter



Division 250µs  
Exposure 500µs

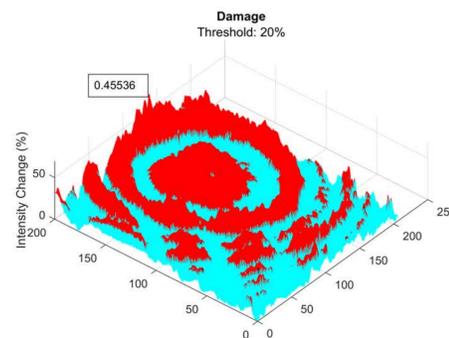
Trigger 400µs  
Readout 60µs

Pulse 5µs  
Algorithm 750µs

### Analysis

Analysis is performed by GPU, I/O using the PC.

- Compare each pixel of two frames, if difference is above a threshold, flag the pixel
- If enough pixels are flagged, shut down laser

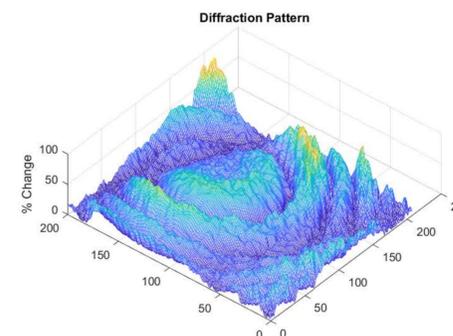


## Conclusion

### Functionality

The Interlock system identifies damage and shuts down the laser with the following:

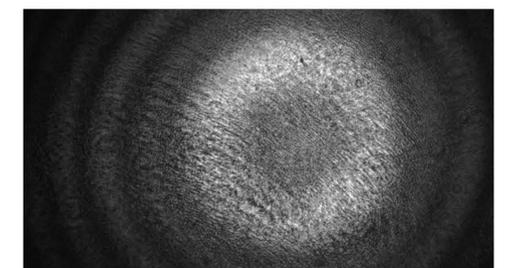
- Damage occurs on the order of a laser pulse
- Number of Pixels flagged from noise is less than pixels flagged from damage



### Future Work

Damage may occur over the span of minutes. Improvements could include:

- Machine learning or histogram to identify damage
- FPGA implementation to remove user start-up, compact system.



**Control** Microcontroller controls diodes based on input from the Cryo Unit and Analysis.

Team Members:

Timothy Goodale, Samuel Kiguthi

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Dr. Jorge Rocca, Buzz Walter, Yong Wang



College of Engineering  
UtahStateUniversity

