Initial Project and Group Identification Document

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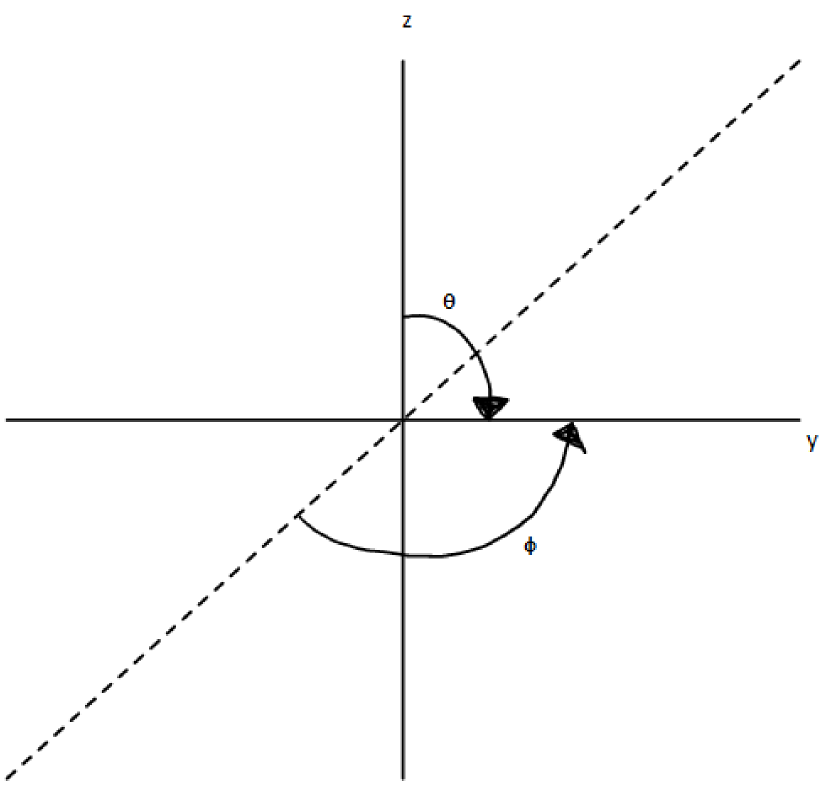
1. Group members are Duy-Hung Pham, Roberto Borja, and Chris Nergard. This project was initiated by Dr. Martin Richardson from CREOL, head of the Laser and Plasma Laboratory (LPL), and we will most likely be working closely with Dr. Lawrence Shah or one of the graduate students from the LPL group. Some required parts will be donated by CREOL and the finished product will go to CREOL. The basic of the project is to create a two axis (both rotational) positioning stage/mount for optical elements such as crystals and prisms.

2. The project was inspired by the desire to aid UCF's laser department to better its tests. Currently, an optical element is manually tweaked through various mechanics that hold the optical element in place. This method is unreliable and requires time to achieve a desired position and sometimes a certain position that was working well will suddenly stop, usually due to noise. The primary goal is to design a device that rotates an optical element accurately on various axes depending on the user's input. This will reduce the possibilities of human errors in manually tweaking the mechanics. The device should have two primary features. The first features to have a friendly user interface to accept the two rotational angle inputs. One angle will be responsible for rotating about the horizontal axis (Φ). The other angle will be responsible for rotating about the vertical axis (Θ). These values will be determined by a raster scan of the optical element in two ways. One way is to start at one of the extremes and then scan the entire object. Another way is to choose a position that would seem to be the zero point and then make large circle point scans until the true point is determined. With the scan, an algorithm will calculate the ideal position and communicate to the motors with information on how far they need to move. This is the second feature which will take in information from the motors and light sensor. The motors will rely back their position and the light sensor will rely back the amplitude of detected wavelengths. This light sensor should be highly precise due to the short band of wavelengths produced from the test. The goal is to have this device be able to scan and correct itself in real time without jump too much or frying the motors. Even with a good algorithm the calculated coordinates could still be off; therefore a person, using the UI, will be able to increase and decrease the rotation of each axis by a desired amount. Algorithms will need to be written to tell the motors how to move, how quickly to move, and how long to move for. This algorithm will then be used for the automated adjusting the scanning procedure. An accurate feedback of the optical element's position should be displayed for the user. This can be done through a screen. Overall the device can be portable enough to move between labs. The rotational mount needs to be small enough to fit into an optical cavity for Optical Parametric Oscillator test (OPO). However, mobility and portability is not a critical design criterion. It should be sizeable enough to work with various sample sizes. Since size of the optical elements may vary, an adjustable holder for the mount supporting the optical element is necessary.

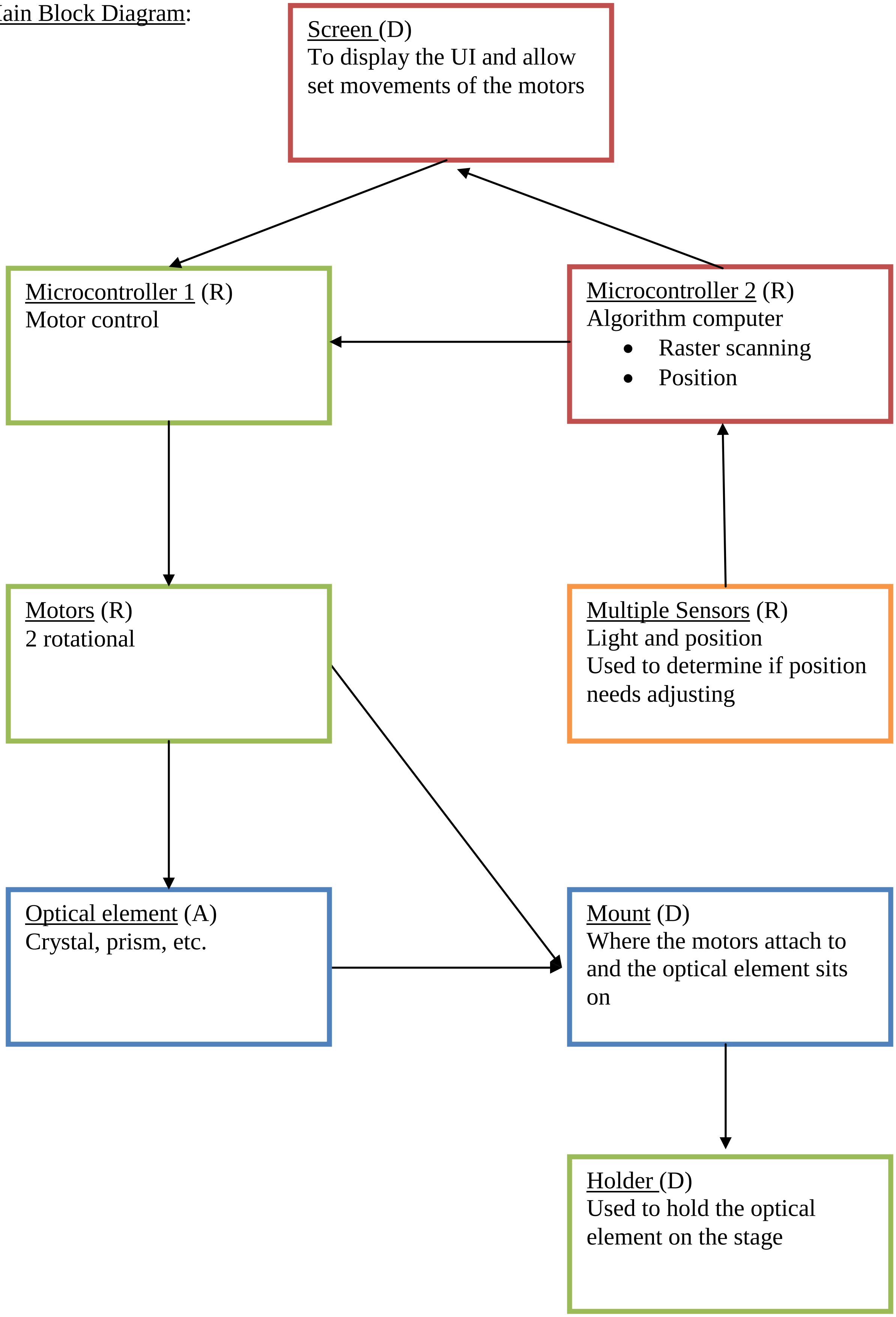
3. The motors of this project will have a precision of about 5 mrad. To better attenuate the laser to the crystal. In total it will have 2axes of movement: both rotational. LPL has a number of mounts that we can choose from or test and later buy, and will be provided upon request. The motor position will be sampled at 200 MHz using a microcontroller and using the measurements, it will control the rate so as to avoid overshoot. If necessary, two microcontrollers will be used for this: one to control the multiple 3D motor stations and one to run the optimization algorithm for the Difference Frequency Generation (DFG). The microcontroller running the algorithm will receive input from the light sensor, the motor controlling microcontroller and the user. Somehow the user must input the wavelengths of the input laser. The setup will attenuate the laser and prism for optimal conditions within 5 minutes so as to make it timesaving over human attenuation. The effort and precision of this project will allow experiments to be reproduced to the accuracy of this project. The user could also input previous experiment numbers, such as exact motor positions or a saved file, in order to reproduce them. As mentioned before, because of factors such as noise, there may still need to be some small adjusting to acquire the optimal position.

4.

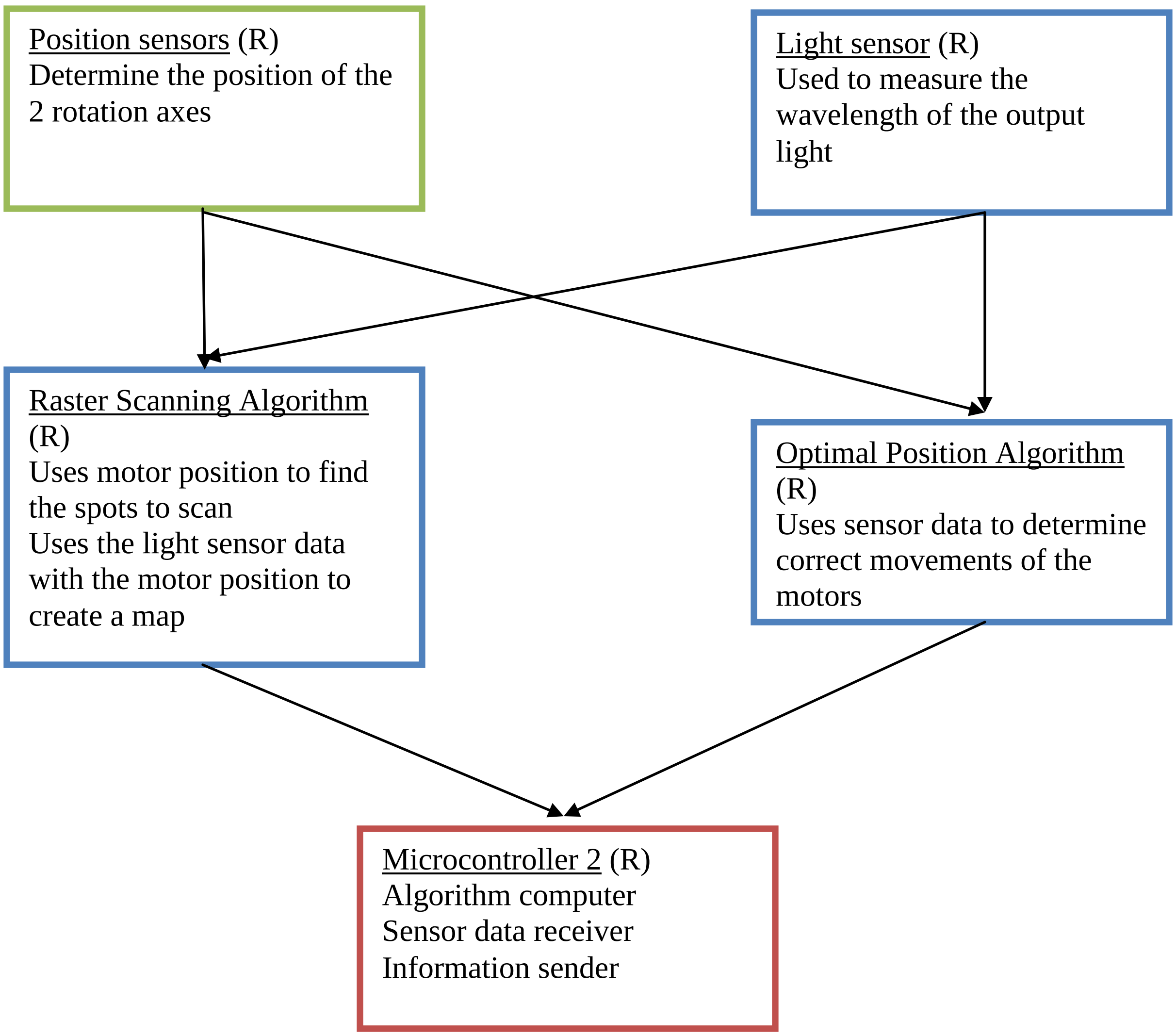


The two axes of our stage (Θ, Φ)

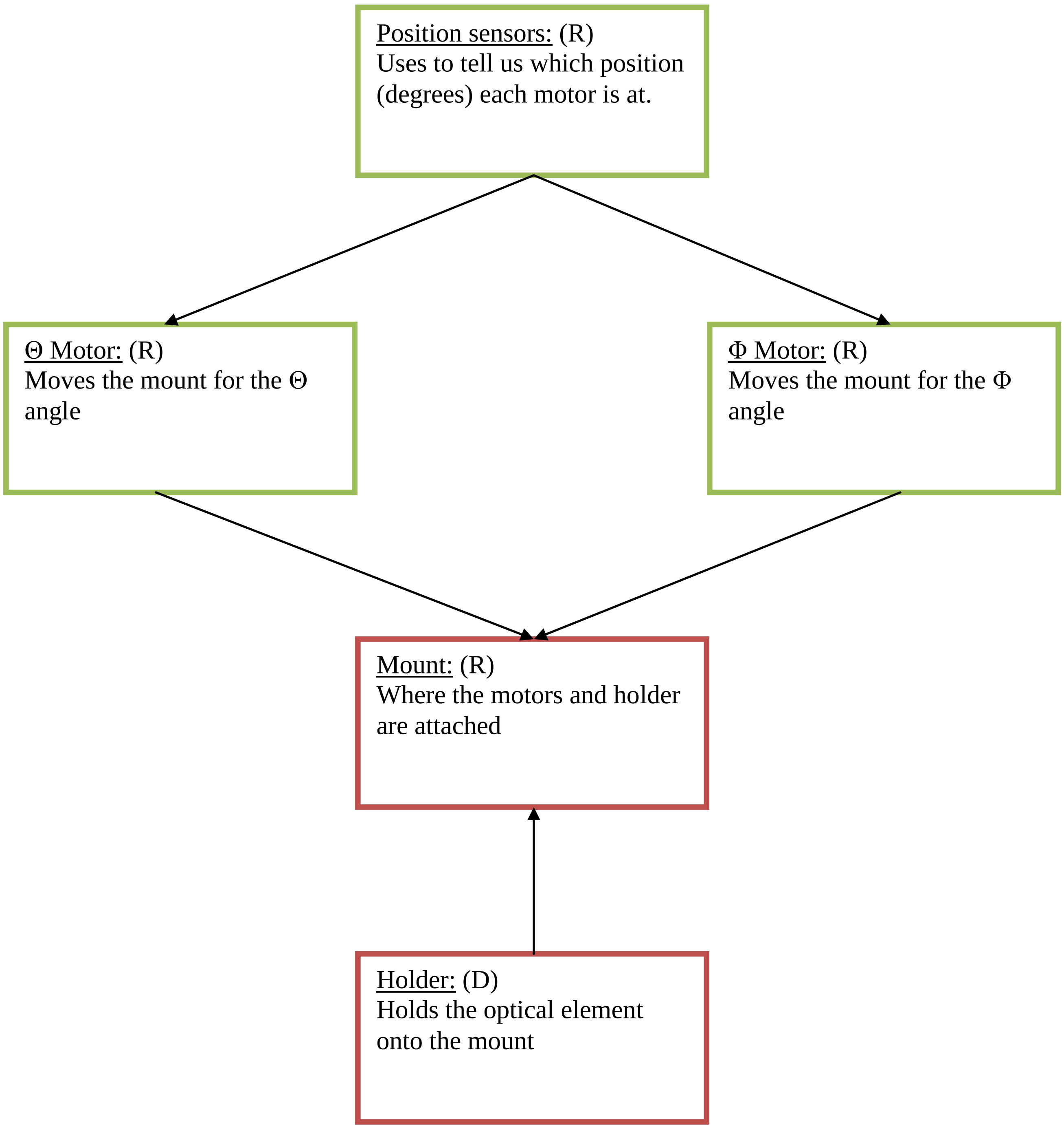
Main Block Diagram:



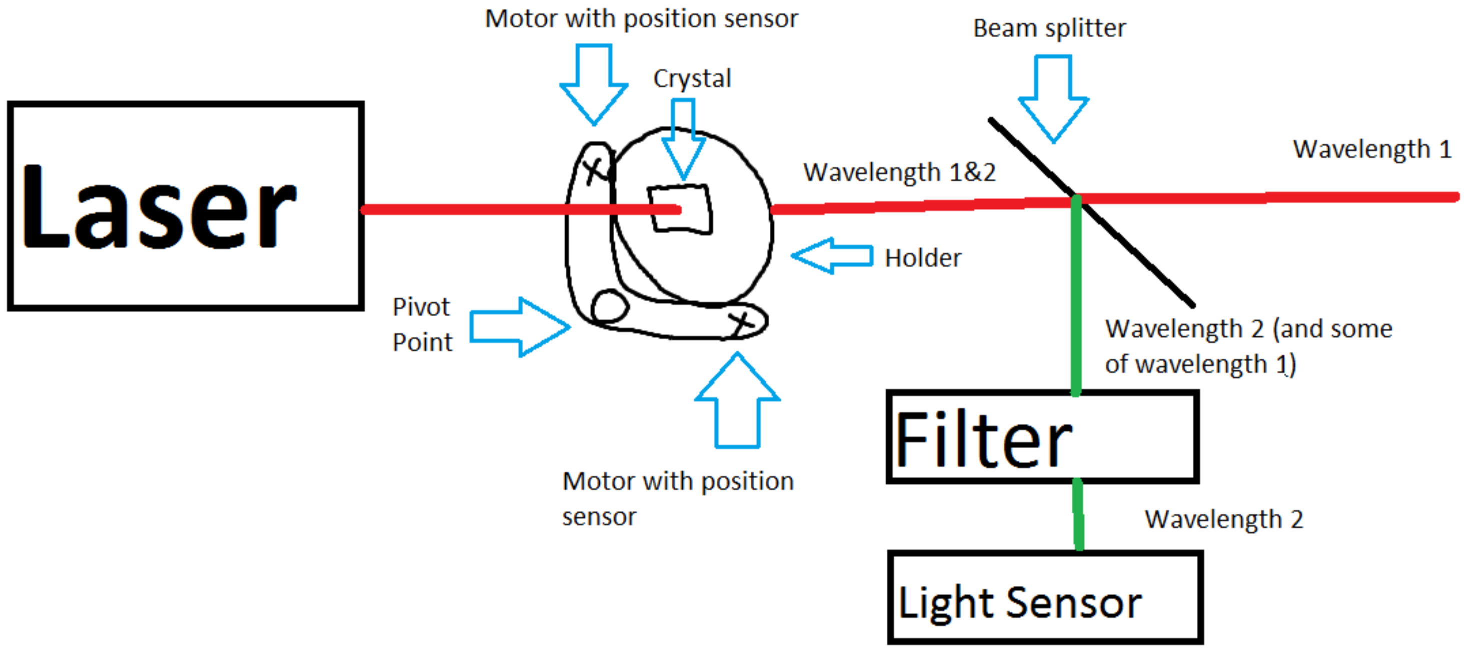
Block Diagram for algorithms:



Block diagram for stage:



DFG Experiment Setup



OBO Experiment Setup

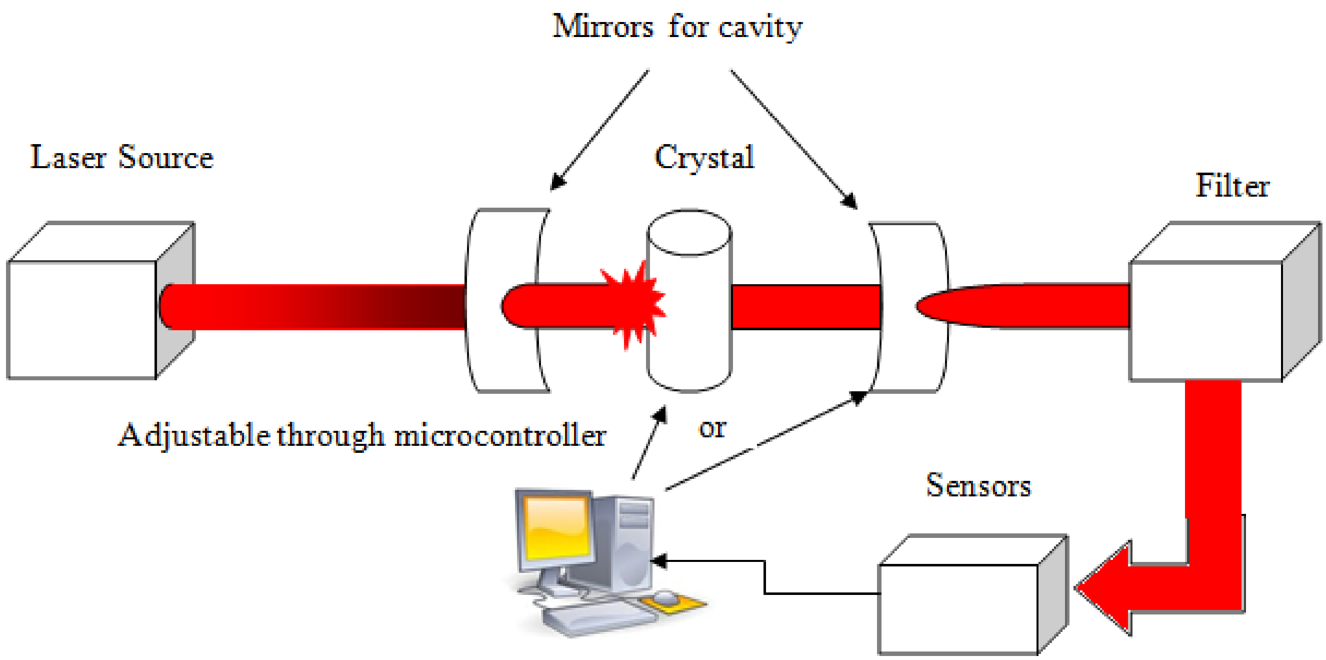


Diagram Legend:

Blue box = Chris's responsibility

Red box = Roberto's responsibility

Green box = Hung's responsibility

Orange box = Chris and Hung's responsibility

Block Statues:

(A) = Acquired

(R) = Research

(D) = Design

(P) = Prototype

(C) = Complete

Acronyms:

LPL: Laser and Plasma Laboratory

CREOL: Center for Research and Education in Optics and Lasers

DFG: Difference Frequency Generation

OPO: Optical Parametric Oscillator

UCF: University of Central Florida

UI: User Interface

mrad: micro-radians

PCB: printed circuit board

5. Based on how precise the positioning needs to be, stages range from $5,000 to $60,000 and our estimated budget doesn't include lasers and filters, as seen in the diagrams, since we are not working on that aspect of the experiment. Although our stage will need to be very precise, we are looking at this costing around $5,000. Dr. Martin Richardson will be funding the project as well as providing the necessary equipment needed. Access to this equipment for testing, calibrating and designing interfaces will be provided upon request.

6. Semester 1 Milestones:

- Decide on a one or two microcontroller design
- Pick out all the parts we will need
- Decide on motor
- Decide on position/light sensors.
- Design the UI
- Design PCB
- Design how the sample will be held and how the motors will attach to it
- Finish paper

Semester 2 Milestones:

- Receive all parts
- Build the stage (mount and holder)
- Connect the electronics
- Connect all components together (have everything built and connected)
- Complete all testing (project is completed)