Progress in Developing Laser Tweezers and Control Systems

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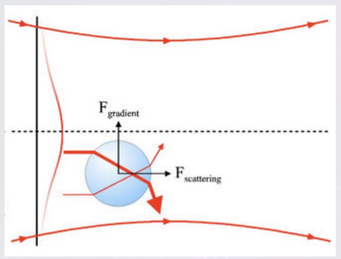
Abstract

Optical tweezers are a Nobel Prize-winning technology capable of trapping microscopic and sub-microscopic particles using a laser beam. They can be used heavily in many different capacities within our organization and the research collaboration of ISLAND CURE. Some possible uses would be making measurements on DNA that we have synthesized. While that one of goals, another main reason for completing this would be to make this technology available at other smaller research institutions that cannot afford prebought systems. This would allow for more undergraduate research and opportunities all around the states. While executing our plan for developing our system while handling the natural complications that come with doing research, we have developed progress in our beam setup, temperature control system, and the current driver. The construction of the laser diode module and current driver been the focus of this year. We continue to develop closer to our end goals by combining our homebuilt inverted microscope with our beam setup. This will allow us to begin collecting data and optimizing our system from what it is now into a system that would be widely applicable for many other research purposes.

Optical Tweezers Concept

- Highly sensitive and precise devices that allow for manipulation at some of the smallest levels
- Creates two different forces on a single particle using properties of light, it creates a force on the other side of the particle creating a trap for the particle
- The laser beam can then be slightly manipulated to make tiny adjustments
- Amount of force can be precisely monitored to reduce chance of damage to the particles

Laser Light



Homemade Current Driver

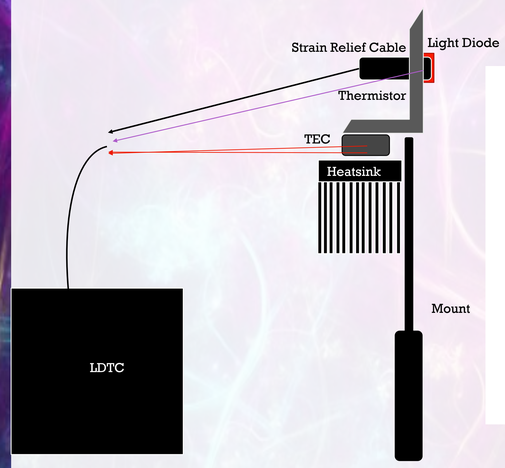
Commercial bought current driver

- We began progress on building our own current driver for approximately half the cost of a bought one
- The main concepts are altering current using resistance, stops, and capacitors to deftly and accurately manipulate the current feeding the laser diode module
- Refer to Homemade Laser Driver Circuitry for specifics on how it is wired

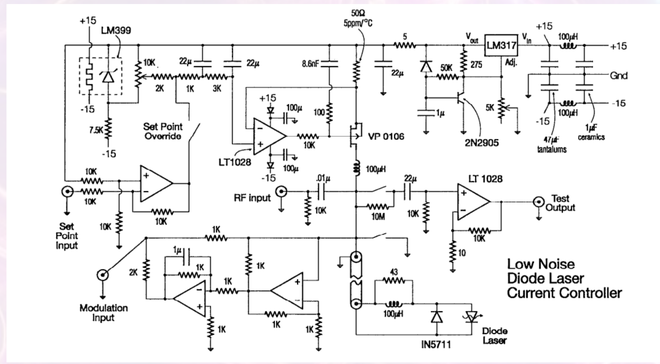
Laser System Design

- Our laser diode is mounter and attached to a strain relief cable to help handle and maintain the control we need over the beam output
- We will connect the current driver to the other end to power the beam
- The temperature control system is connected by a physical thermal connection directly beneath the laser diode
- This works with a combination of a TEC and a thermistor used to modulate and detect the temperature of the laser diode

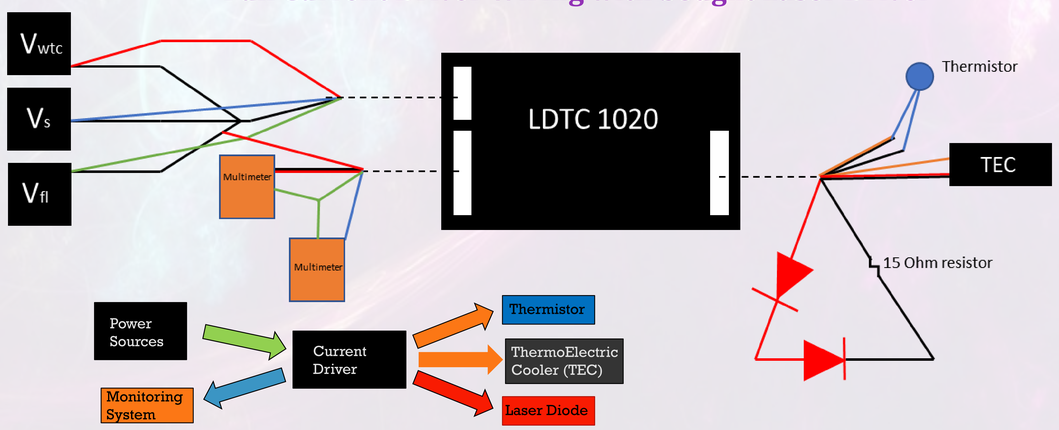
Laser Diode Setup



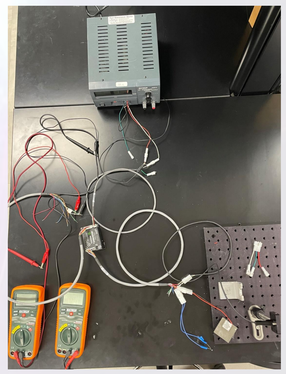
Homemade Laser Driver Circuitry



Full Current Driver Wiring with bought Laser Driver

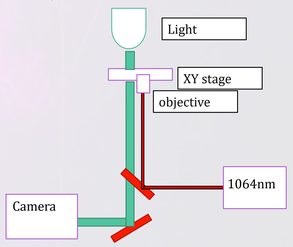


Present System Pictures



Next Steps

- Finish construction on our Current driver
- Incorporate our microscope with our laser system to create working a laser tweezer
- Use the working laser tweezer in future research projects in conjunction with our Biochemistry partners



References

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3. Libbrecht, K. G., and John L. Hall. "A low-noise high-speed diode laser current controller." *Review of scientific instruments* 64.8 (1993): 2133-2135.