Dual Color Laser Scanning PIV System

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This project encompasses a dual-color scanning PIV (Particle Image Velocimetry) system that combines two DPSS lasers (green and blue) at a fixed separation angle and scans the beams at a programmable frequency. The apparatus integrates two lasers, beam-combining optics, a galvanometer mirror, and custom control electronics to generate synchronized scanning beams with user-defined parameters. A built-in interface allows users to configure scan settings and trigger timing for experiments.

This work is sponsored by Dr. Jun Chen's Experimental and Applied Fluid Dynamics Lab, Purdue University – West Lafayette, IN

Background

Particle Image Velocimetry (PIV) is a technique in fluids research to photograph flow properties. The technique involves suspending small reflective particles in a fluid, illuminating them, and capturing photographs of their changing positions to plot their movement.

Current PIV systems are heavy, expensive, and difficult to transport.

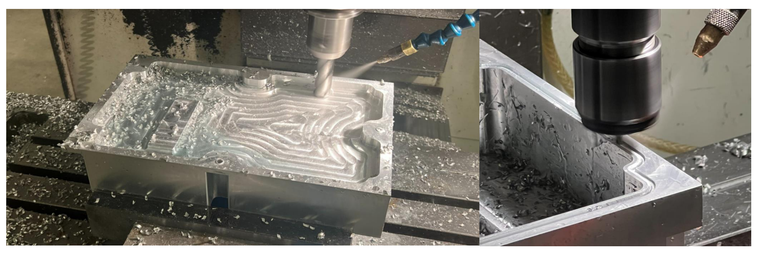
Dr. Jun Chen's fluid dynamics research lab has proven a scanning PIV system that uses laser pointers, and our team has developed this idea into a lightweight, lower cost, and portable system.

Market Potential

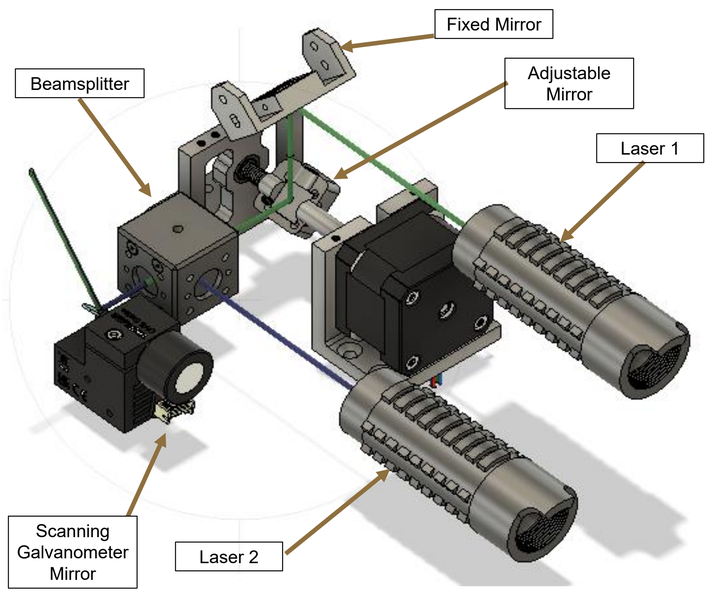
PIV, as it relates to fluid mechanics, can be used in multiple scientific fields, including meteorology and oceanography, as well as industries like automotive and aerospace, and an easily-transported and configurable system like this could be adapted for use out in the field or in other research lab settings.

The simplified optical equipment used in this design, mainly the two lasers, is cost-advantageous when compared with standard pulse laser PIV systems currently on the market, which makes this system more accessible to potential consumers.

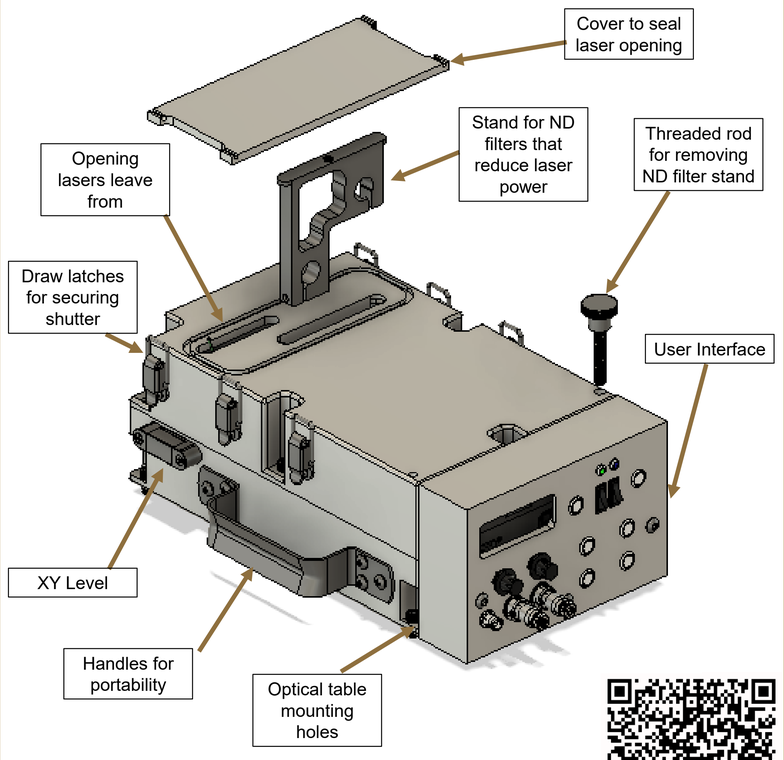
All custom-made parts were machined in-house mainly using CNC mills for maximum precision, so any company with access to a machine shop would have the ability to manufacture these parts on their own.



System Description



Feature	Function
Laser Scanning	Galvanometer mirror sweeps lasers across chosen angle range at a chosen frequency
Separation Angle	Stepper motor controlled-adjustable mirror separates laser beams at a chosen angle
Portability	Lightweight part design; side handles and tripod screw holes enable easy transport and mounting



Scan this code to see our final setup!

Validation and Improvements

Validation Testing

Test	Testing Parameter	Result
Beam Separation Angle	Adjustment range > 2°	✓
Adjustable Mirror Resolution	Resolution of ≤ 0.1°	✓
Input/Output Controls Relationships	Circuitry provides correct input/output power for each critical component	✓
Optical System Alignment	Lasers aligned in same plane, homing sets adj. mirror to 45°	✓
Thermal	Inside temperature remains below 70°C	✓

Scan this code to view our data from the Validation Testing!

This project's design for a dual-color scanning PIV system enhances the current design, provided by sponsor Dr. Jun Chen, by being lightweight, portable, and reduced in overall cost. However, this doesn't mean there isn't room for more improvements. Despite best efforts to reduce the weight of the system, the metal parts are still heavy, and although we reached our goal of under 30 lbs., more weight can be removed. In addition, more fillets could be added to multiple parts, specifically on the outside of the system, to make it easier to hold and transport.

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- **Dr. Euiwon Bae** – ME 463 Faculty Advisor

A portable, low-cost, dual-color laser scanner for visualizing fluid flow