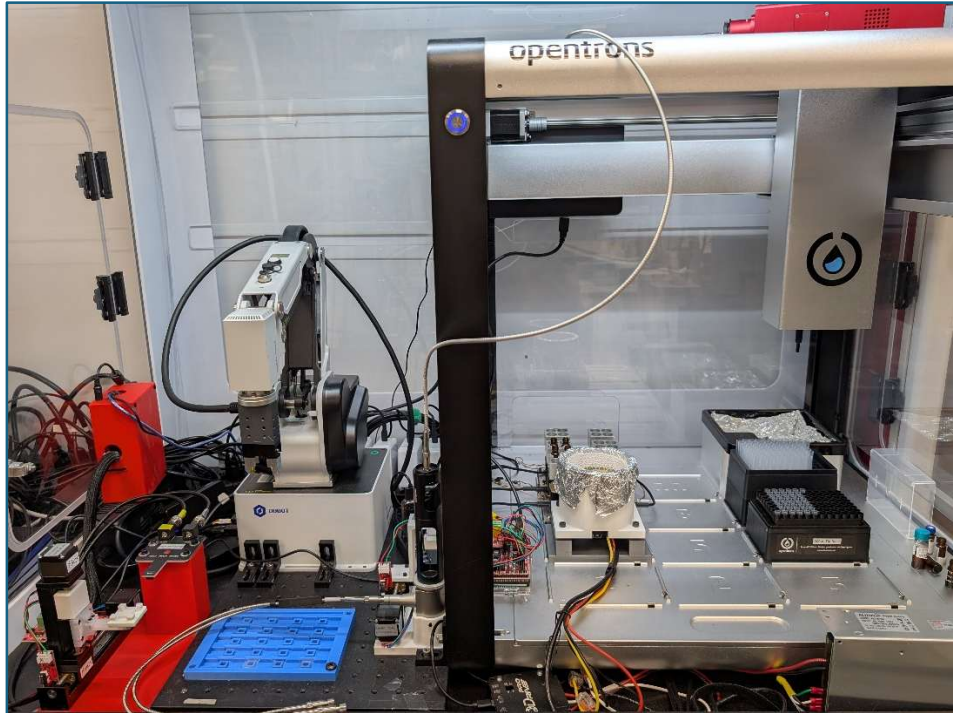


Automatic Material Discovery Platform - DopeBot

September 2022 – Present

Automation Engineer at NCSU



Skills Learned and Applied

- **Python programming**
- **Hardware design**
- Computer aided design
- 3D Printing
- **Process automation**
- Batch processing
- Web user interface design
- **Failsafe code design**
- **Transform ideas into real hardware**
- Node-RED hardware automation

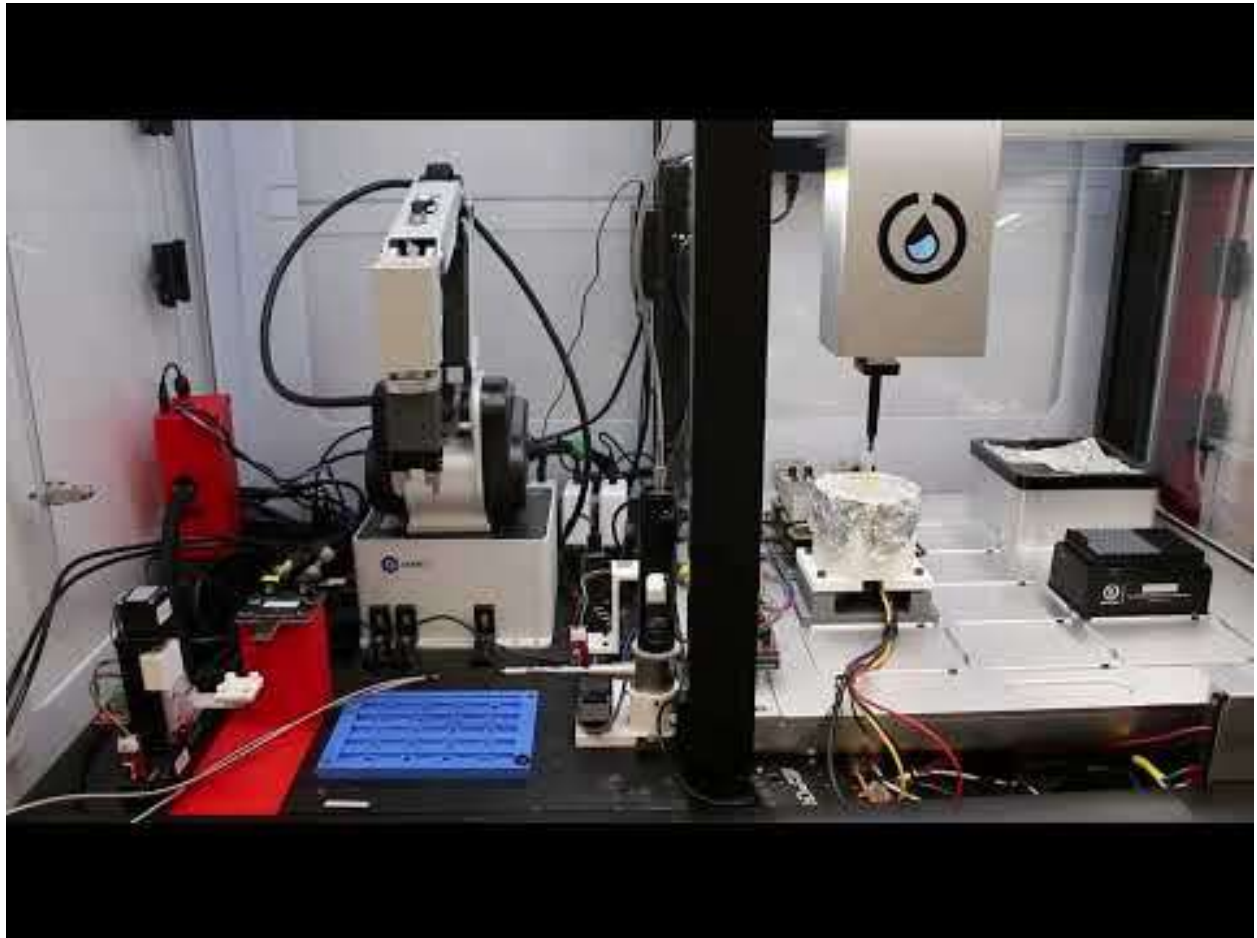
This platform combines many custom pieces of hardware that I developed. I successfully integrated a standard Opentrons liquid handling robot and Dobot robot arm with custom 3D printed modules. Here are the modules I designed, prototyped, and implemented: Precision spin coater, miniature hotplates, motorized four-point probe conductivity measurement, motorized optical characterizations using a spectrometer.

I coded custom protocols for various experiments run on this platform. I worked closely with graduate students and lab managers to design and program custom protocols. I designed custom hardware addons based on feedback from lab members. Protocols are setup to perform autonomous experimentation in a closed loop process using Bayesian optimization.

I used Node-RED as a global hardware scheduler. I used the Node-RED Dashboard library to create a flexible web user interface for controlling hardware modules in the DopeBot.

Learn more: <https://go.ncsu.edu/wral-dope>

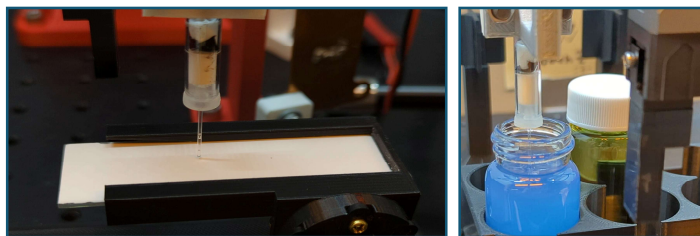
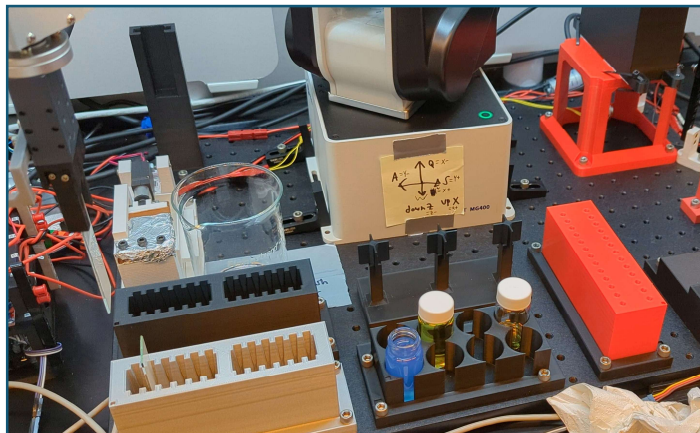
Full demo of the DopeBot 10x speed:



DELTA Chemistry Lab

September 2022 – October 2023

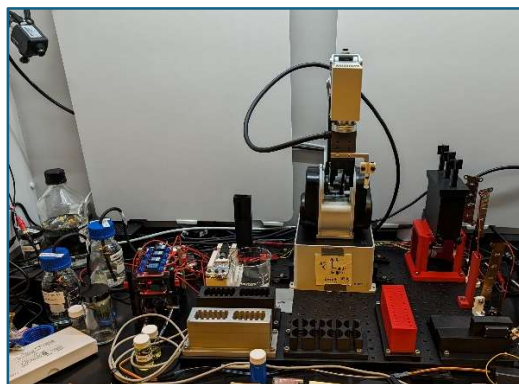
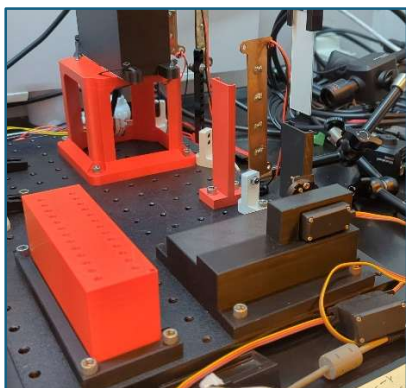
Automation Engineer at NCSU



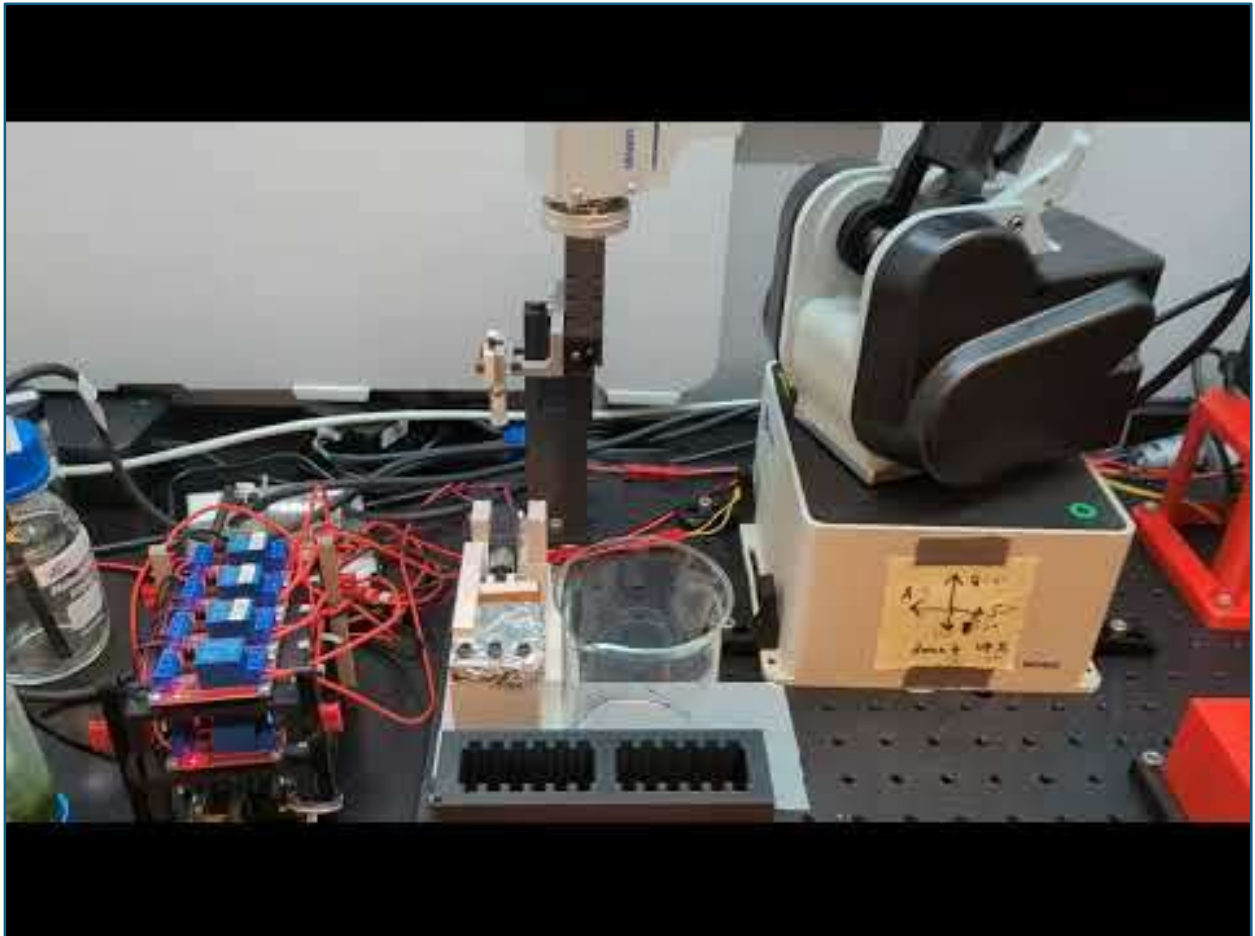
Skills Learned and Applied

- **Python programming**
- Hardware design
- Computer aided design
- 3D Printing
- **Process automation**
- Batch processing
- Live streaming video
- Web user interface
- **Failsafe code design**
- **Transform ideas into real hardware**

I designed, prototyped, and finalized all hardware to build a robotic chemistry lab that students in a CH222 class used to run experiments remotely over the internet. I took ideas from Professor Chiechi and translated them into hardware that allowed a Dobot robotic arm to perform a TLC lab experiment. I designed all hardware to accommodate inaccuracies and tolerances in the robotic arm end effector. I wrote Python code to operate and sequence motorized processes in a failsafe manner. I worked closely with David Tredwell and Stephen Waddell to integrate a webpage user interface with the hardware such that errors in the hardware could recover appropriately by student users. Learn more: <https://go.ncsu.edu/delta-project>



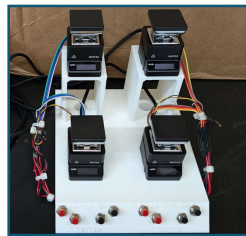
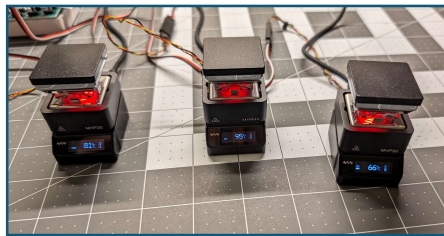
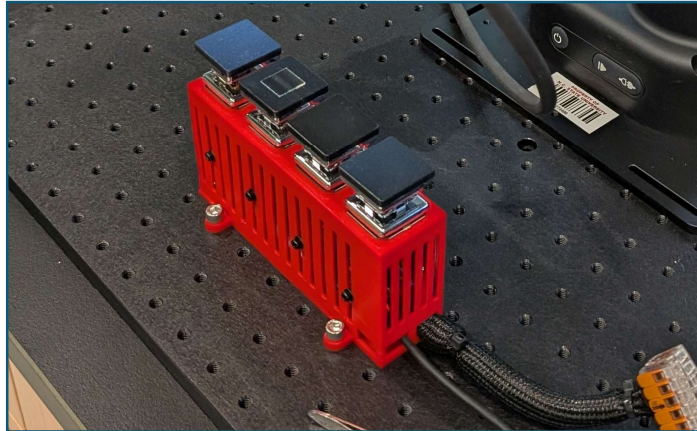
Full demo of the DELTA platform:



Miniature Computer Controlled Hotplates

December 2023 – April 2025

Automation Engineer at NCSU



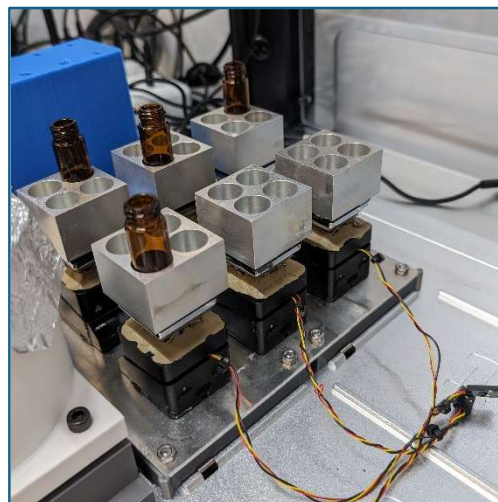
Skills Learned and Applied

- **Python programming**
- Hardware design
- Computer aided design
- 3D Printing
- **Reverse engineering**
- STM32 MCU debugging and programming
- Circuit design
- RP2040 MCU programming
- PID Tuning

I reverse engineered the MHP30 miniature hotplate to add computer control. I created custom circuit boards to control the hotplates over I2C based on computer communication with an Arduino. I modified the public project IronOS source code to enable I2C communication on the same bus as the OLED screen.

I transitioned from the MHP30 control circuit board to my own custom circuit using an RP2040 microcontroller, a MOSFET driver, and a thermocouple amplifier. I built a custom program that allows for temperature heating controls over a serial port on the RP2040. This program also has automatic PID tuning using a public library.

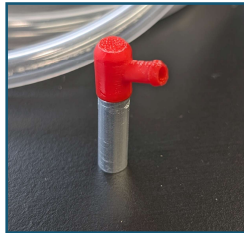
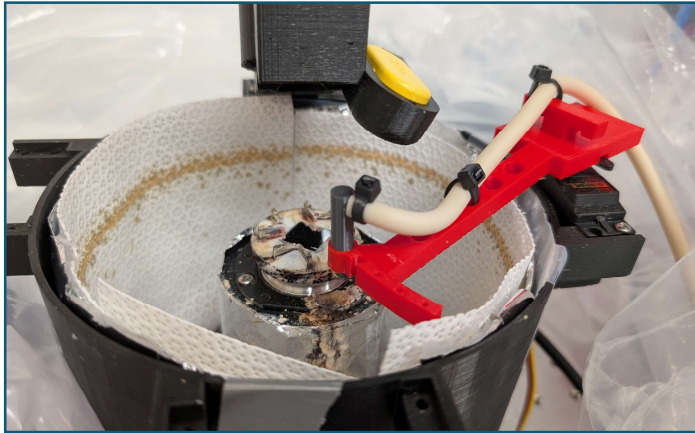
I designed the initial version of these hotplates for the DopeBot to keep vials of solution hot. This allows the DopeBot platform to hot-cast solutions on the spin coater.



RoboCoater Platform Gas Quenching Upgrade

January 2025 – April 2025

Automation Engineer at NCSU



Skills Learned and Applied

- **Python programming**
- Hardware design
- Computer aided design
- 3D Printing
- **Process automation**
- Batch processing
- Pneumatic system architecture and controls

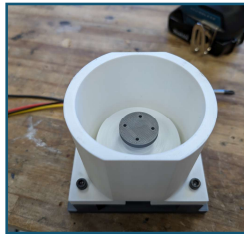
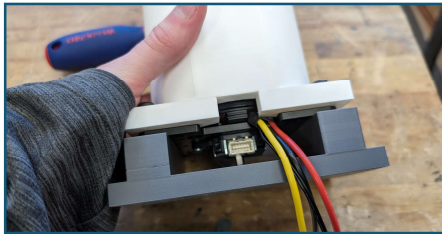
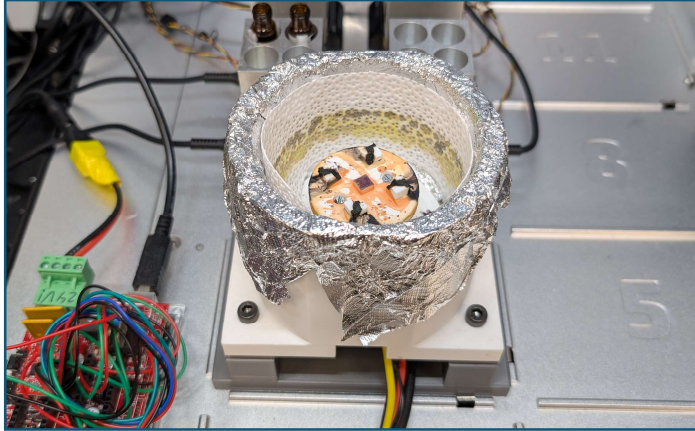
I added a nitrogen gas quenching automated system to the RoboCoater platform. The platform makes spin coated films while taking spectrometer measurements. The nitrogen gas quenching system blows gas through a small nozzle onto the film during production.

I updated the batch program to accept start and duration times for gas quenching to automatically trigger the gas quenching. I referenced existing literature to help design the nozzle and gas pressure.

Precision Positioning Spin Coater with Computer Control

March 2024 – April 2024

Automation Engineer at NCSU



Skills Learned and Applied

- **Python programming**
- Hardware design
- Computer aided design
- 3D Printing
- **PID Tuning**
- Process automation

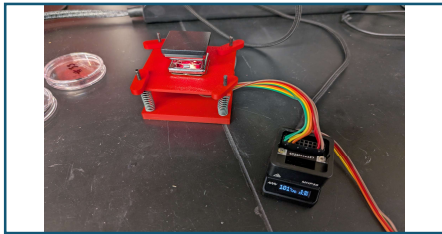
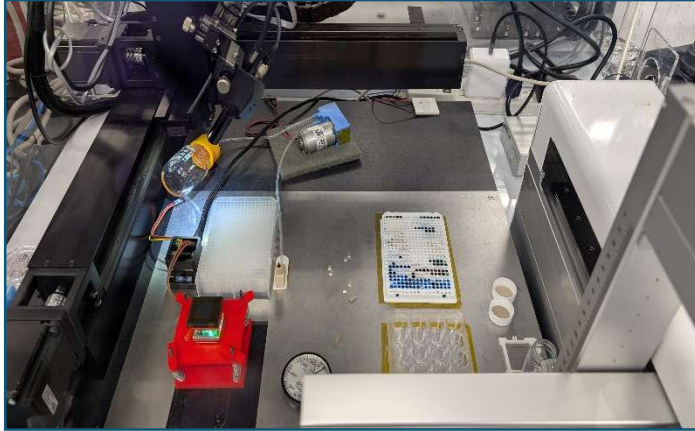
I developed a computer-controlled spin coater to hold glass substrates. This spin coater fits inside of a standard well plate base. I designed, modeled, and 3D printed all the parts to make this spin coater. It uses an O-Drive brushless motor controller with an encoder for rotational position tracking.

This spinner replaces an old design that used a hard drive motor. My upgraded design I designed to work with our Dobot robotic arm in the DOPE platform. This spinner allows for precision rotational position control to enable the robotic arm to remove and install glass substrates without human intervention.

RoboMapper Autonomous Liquid Handler Platform

Fall 2022 – Present

Automation Engineer at NCSU



Skills Learned and Applied

- **Python programming**
- Python threading
- Python QT GUI Framework
- LabVIEW debugging
- Hardware design
- Computer aided design
- 3D Printing
- STM32 MCU Flashing

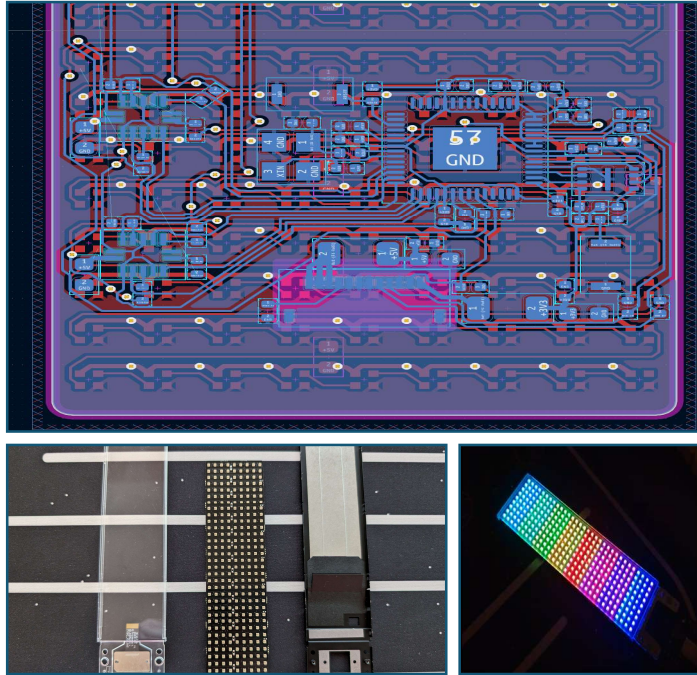
I worked close with Tonghui Wang and Boyu Guo to upgrade this autonomous liquid handling platform. I introduced new hardware to the platform. I improved Python and LabVIEW control software. I developed new features in the control software based on user feedback. The software modifications I implemented enabled autonomous platform operation with a full cycle of repeated liquid formulation followed by liquid coating.

Working with Boyu Guo I added the red hotplate module pictured above. This hotplate enables liquid coating on heated glass substrates for perovskite experiments.

Framework 16 Laptop RGB LED Matrix

October 2023 – April 2024

Personal project



Skills Learned and Applied

- **KiCAD PCB Design**
- PCB Design for Manufacturing
- PCB Assembly
- **Embedded Arduino Software**
- **Entrepreneurship**
- Webpage Storefront
- Advertising
- Community Relations
- Manufacturing and shipping logistics

I learned how to design, prototype, and manufacture custom printed circuit boards. I built a pick-and-place machine to help automate assembly of the circuit boards. I documented setup procedures for graduate students in the lab. I created programming documentation for the hardware.

This project started as a fun idea after seeing the official Framework Laptop LED Matrix modules for the Framework Laptop 16. Being in the computer gaming space I just had to see a full color version instead of the white only version of the official LED Matrix. I designed and made a prototype with the help of the Framework Discord community. After posting that design on the Framework forum Framework's CEO Nirav Patel contacted me to help adjust my design to fit in their existing LED Matrix plastic and metal housing.

After showing the updated design Nirav sent me all the plastic and metal parts to build full modules. I sold them on my personal website. I ended up selling around seventy modules to people in the Framework Laptop community.