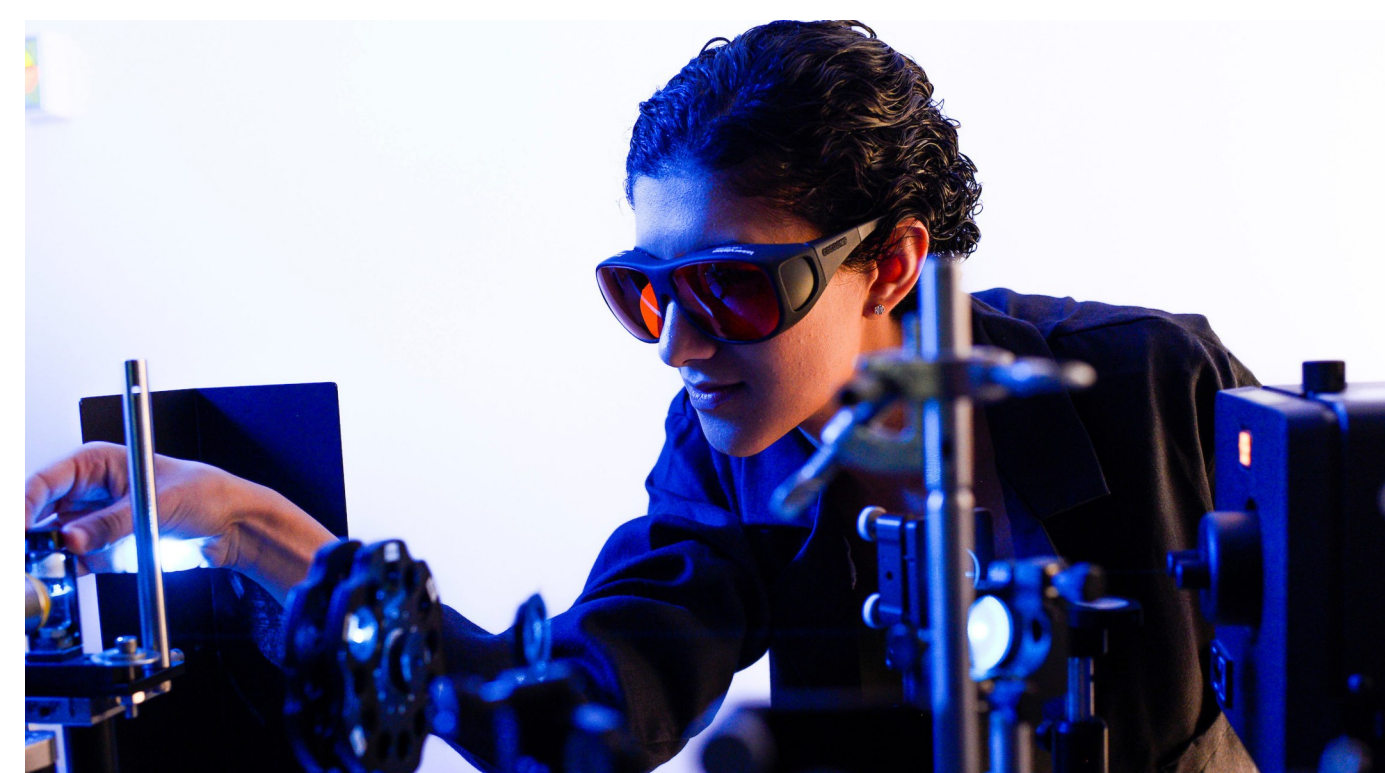


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## Introduction



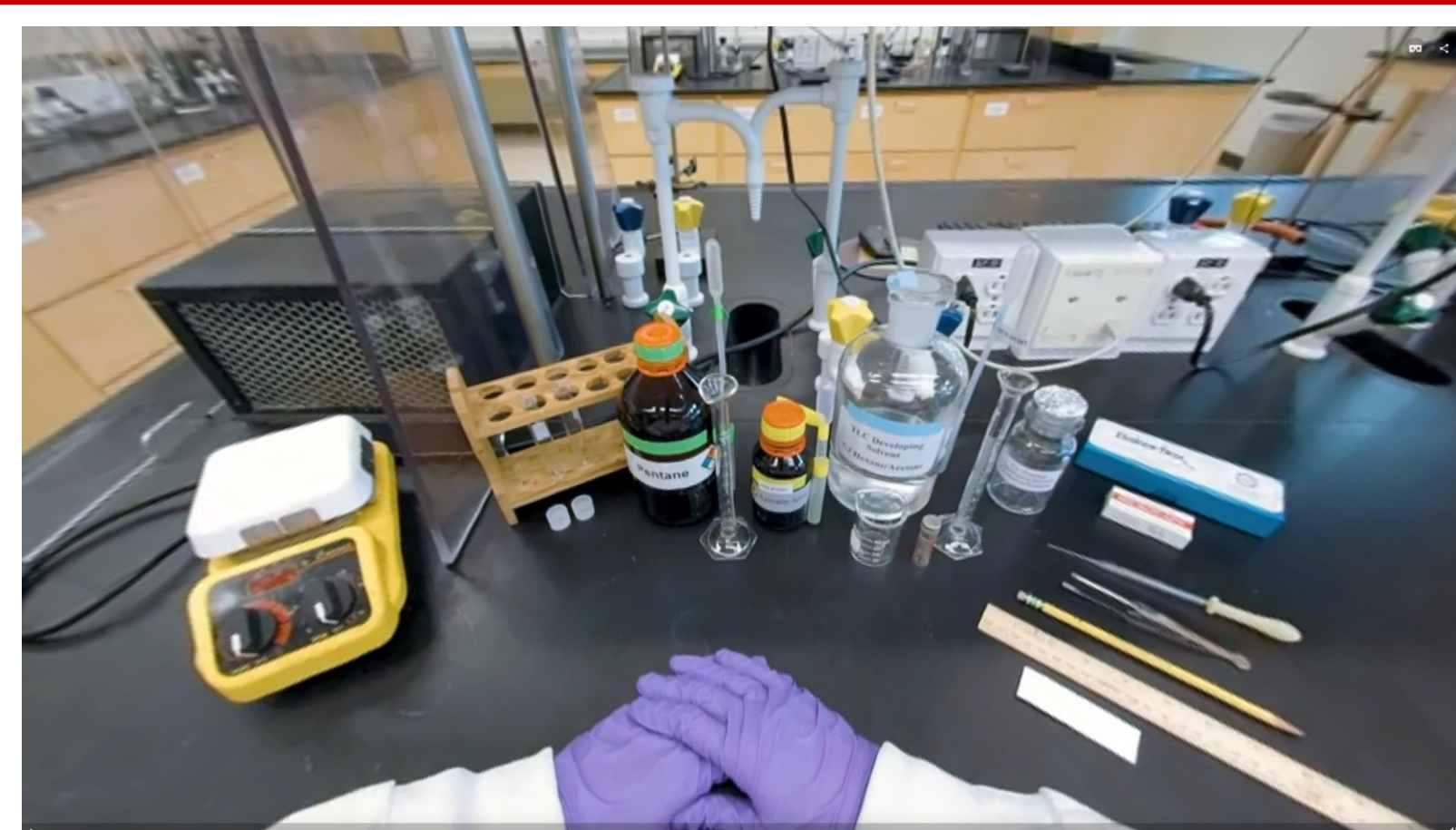
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Organic chemistry labs are a challenging environment in which students must learn to use and combine specific safety protocols and lab techniques in order to be successful. For many students, these environments can be stressful, inaccessible, or even dangerous.

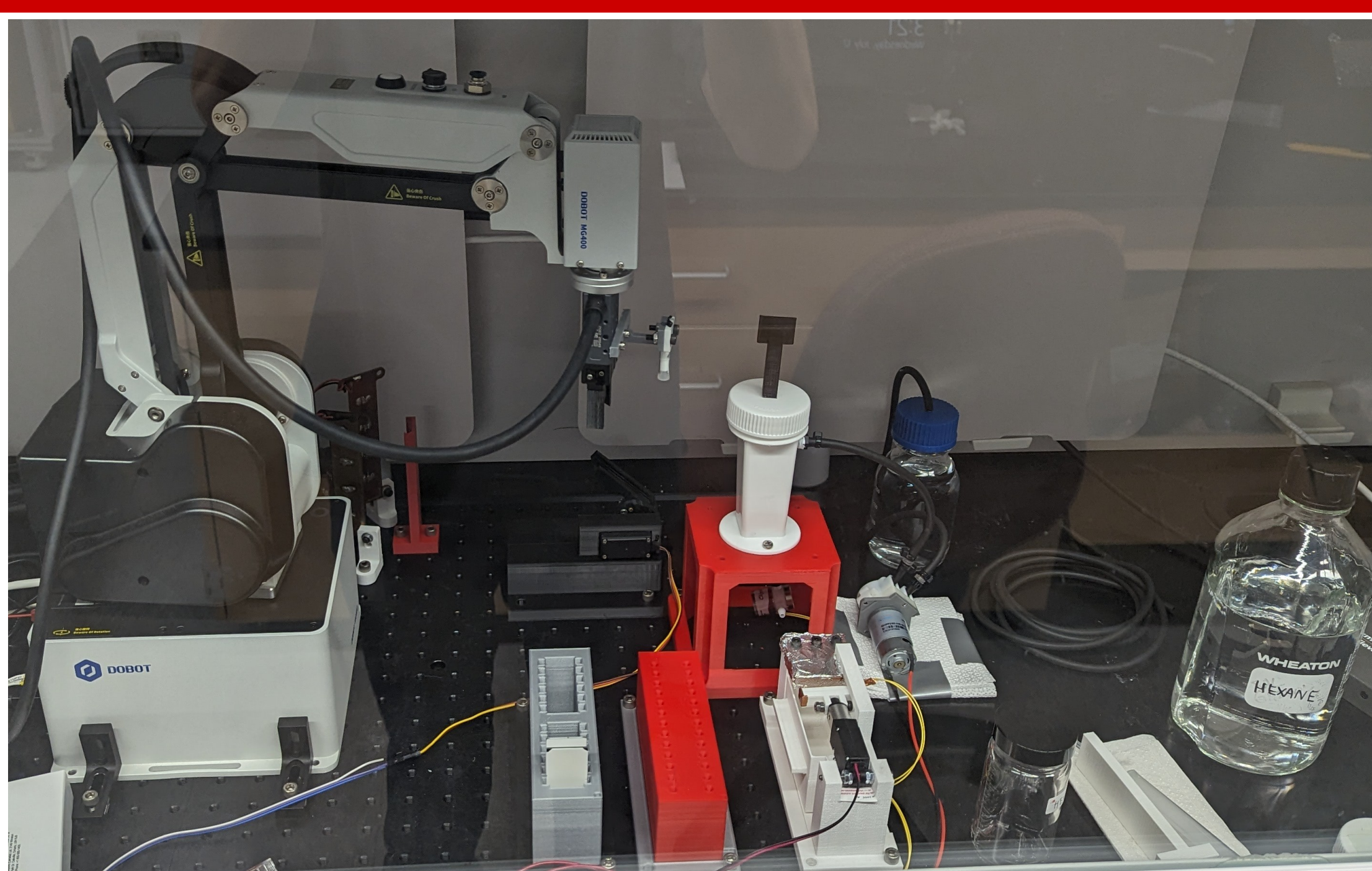
## Motivation



go.ncsu.edu/vrlab-tlc

There have been attempts to replicate this experience in video or virtual reality, but they run on rails and lack key components of practical laboratory courses; interpreting imperfect results, troubleshooting reactions and experimental setups and reasoning through varied and unexpected outcomes that are a natural part of real organic chemistry.

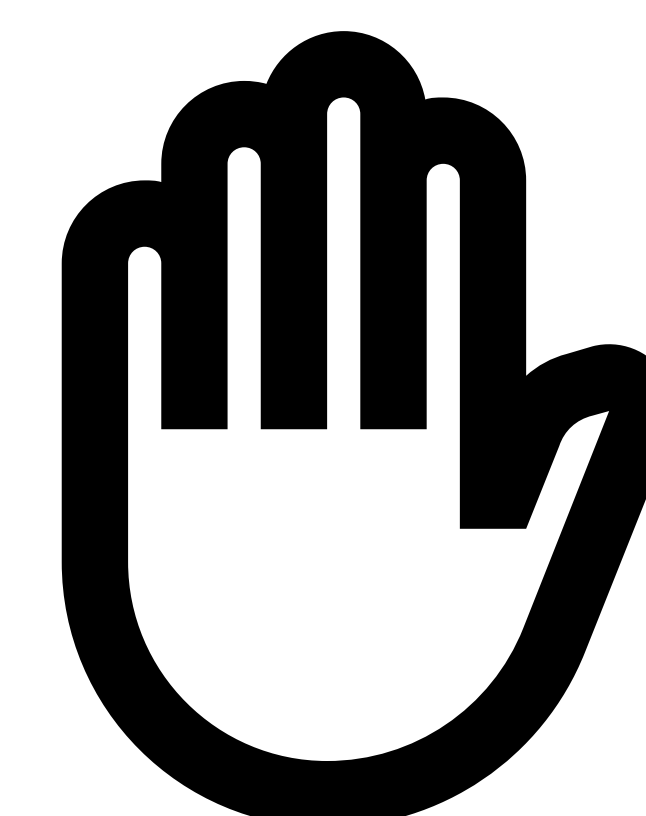
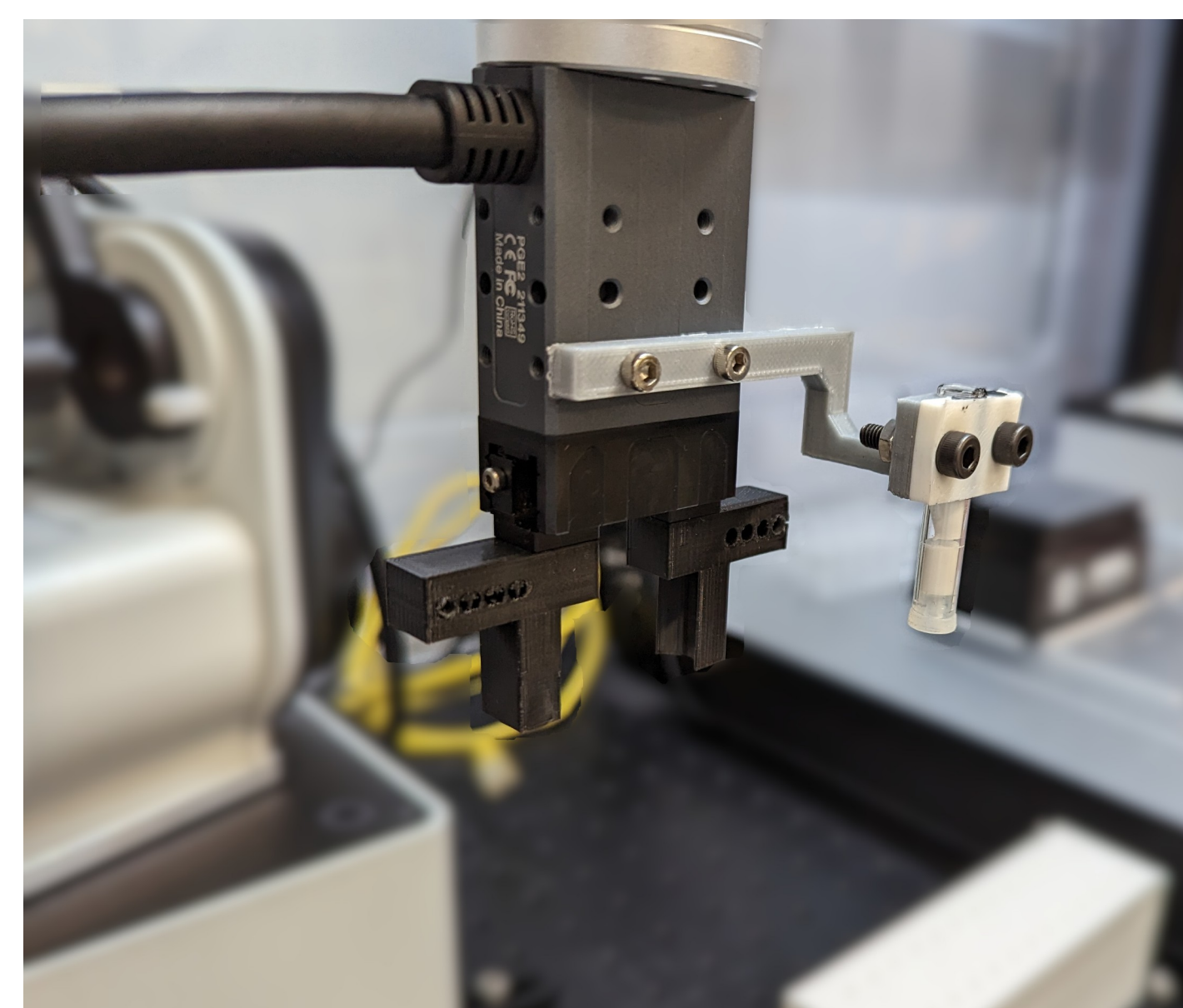
## Benefits of a Virtual Lab



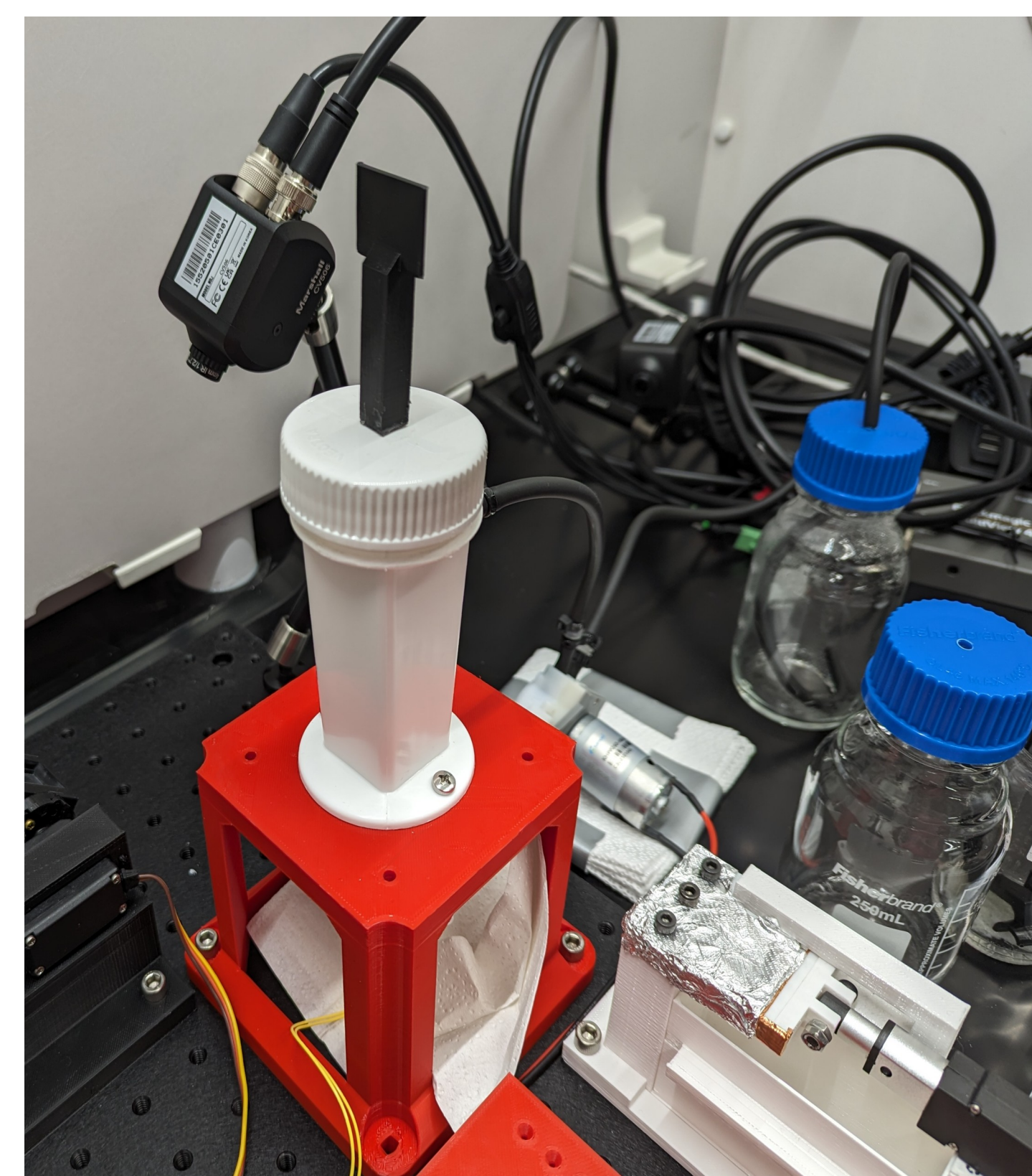
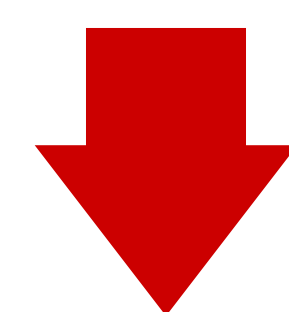
- Reduce anxiety by performing experiments in a safe controlled environment.
- Improve accessibility for students who cannot complete the in-person lab due to deployment, disability, or distance learning.
- Protection from hazardous chemicals, harmful vapors, and extreme temperatures.

## Platform Overview

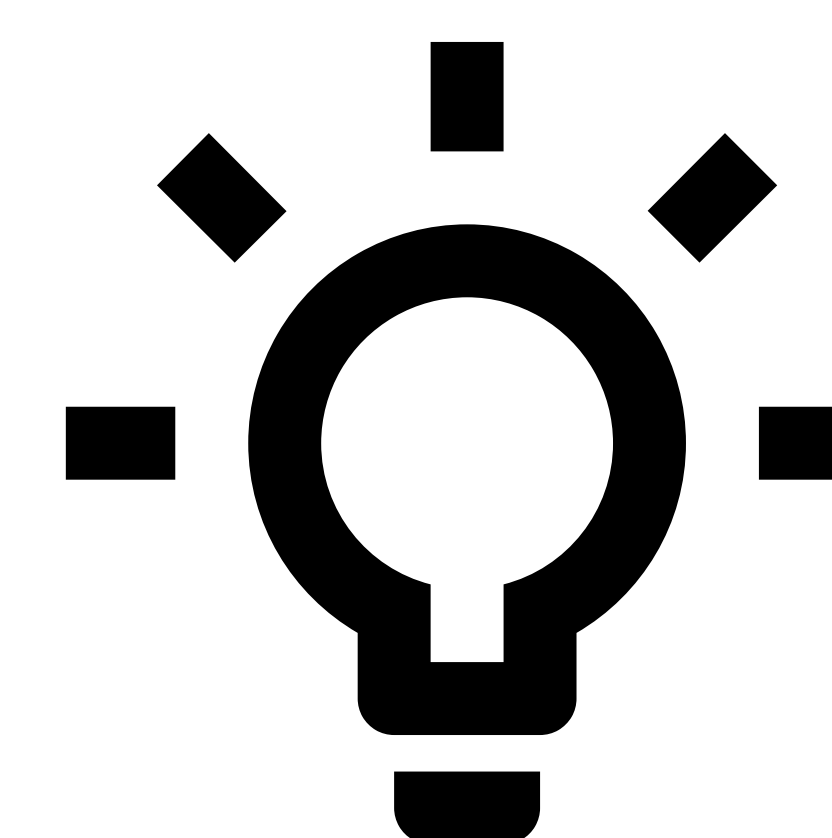
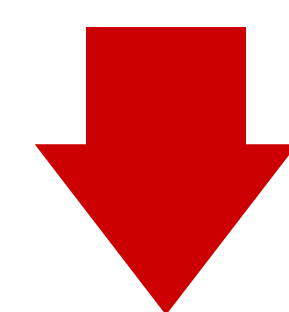
Our platform incorporates three stages of the Thin Layer Chromatography (TLC) experiment.



TLC plate and pipette manipulators



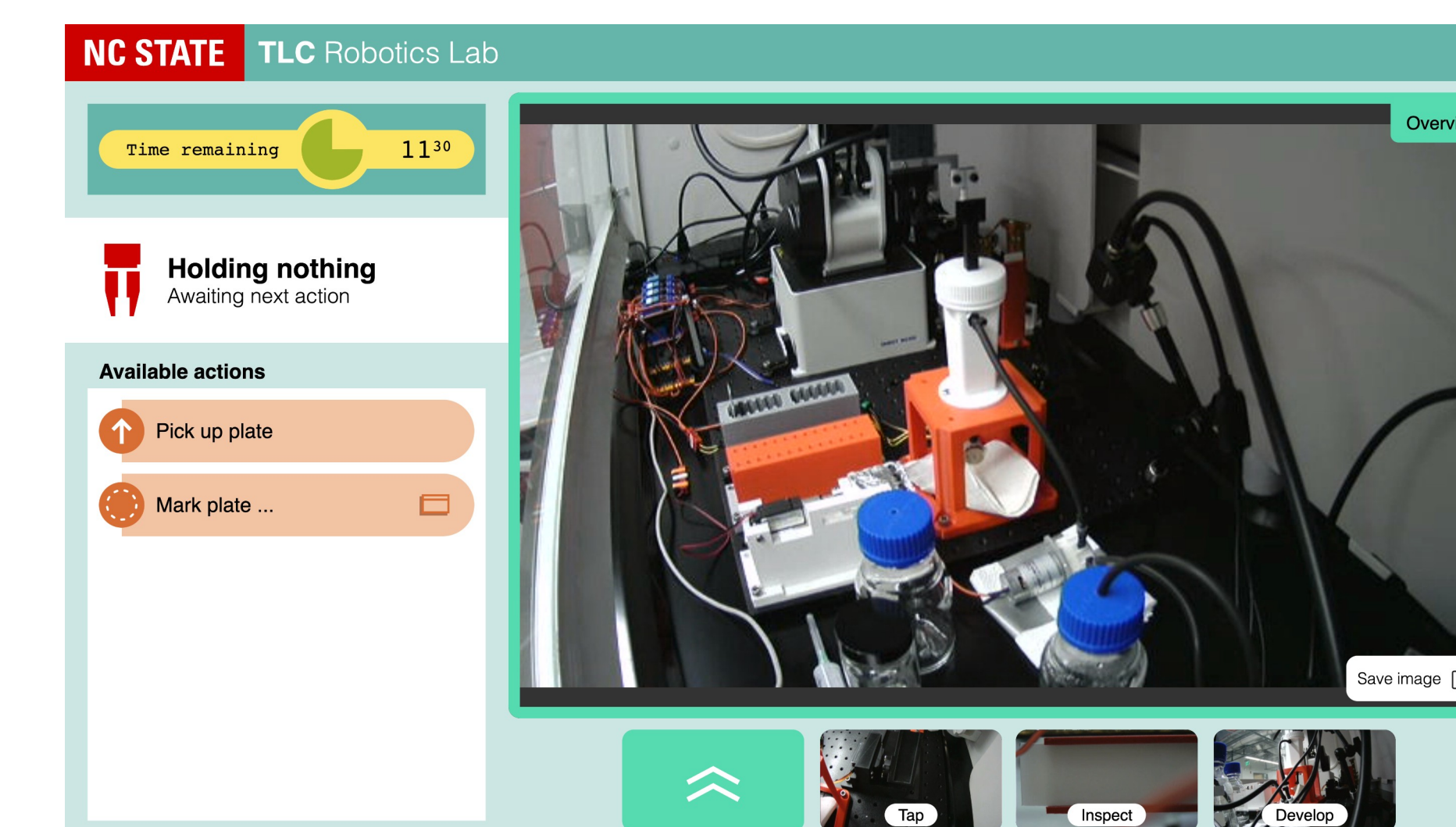
Developing chamber with chemical pump and drain



UVC LEDs for final measurements



## Web Interface

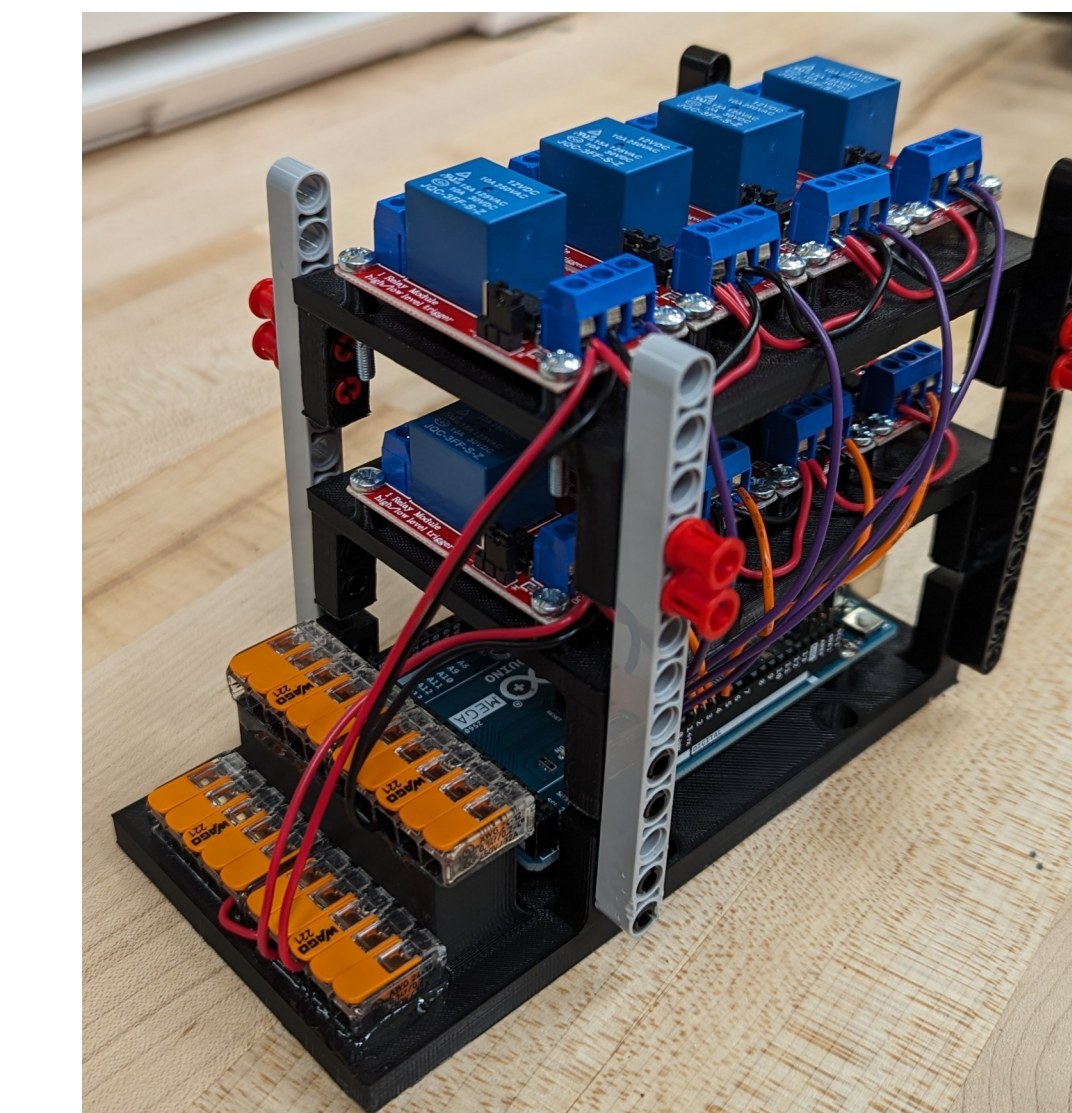
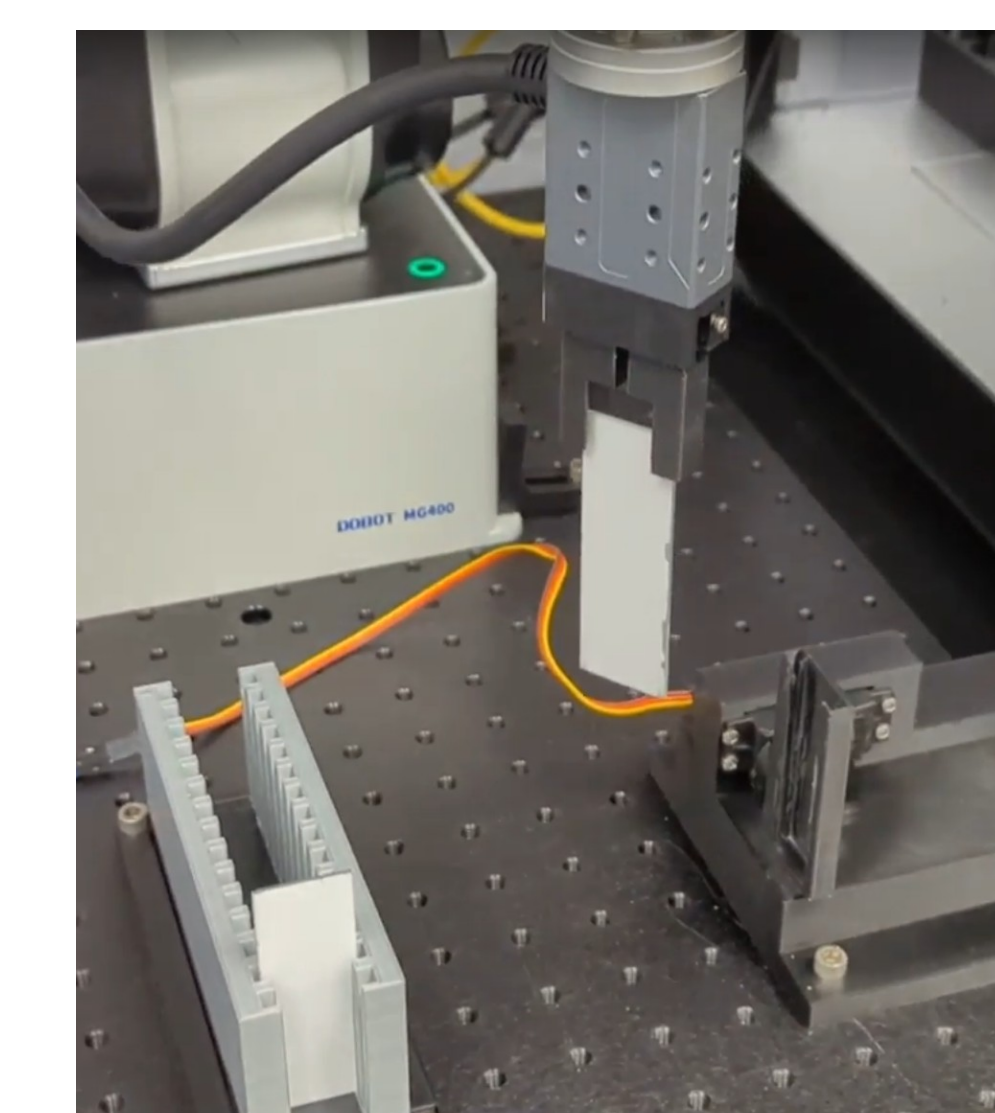


- Accessible worldwide using NC State's virtual private network.
- Easy remote monitoring for TAs and administrators
- Time slots for easy student lab time management

## Achievements

Our current platform can perform the following functions:

- TLC plate manipulation
- Capillary pipette tapping
- Chemical pumping and draining
- UVC LED for TLC plate inspection



## Next Steps

- Introduce additional lab steps and characterization for more detailed experiments.
- Enable students to create solution ratios inside the lab for the robot to tap.
- Implementing motion capture technology to facilitate more natural control of the robotic arm.