UF Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

SafeQuake Systems™

EML4502 Mechanical Engineering Design III

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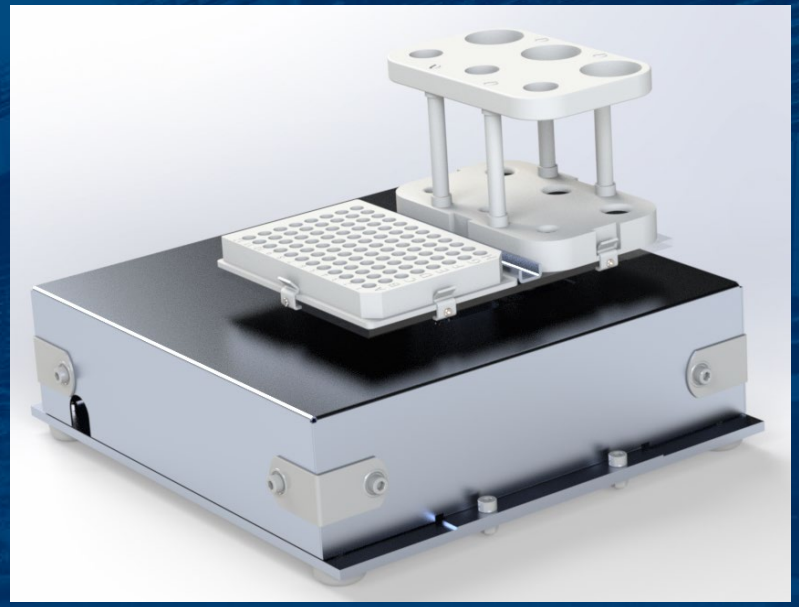
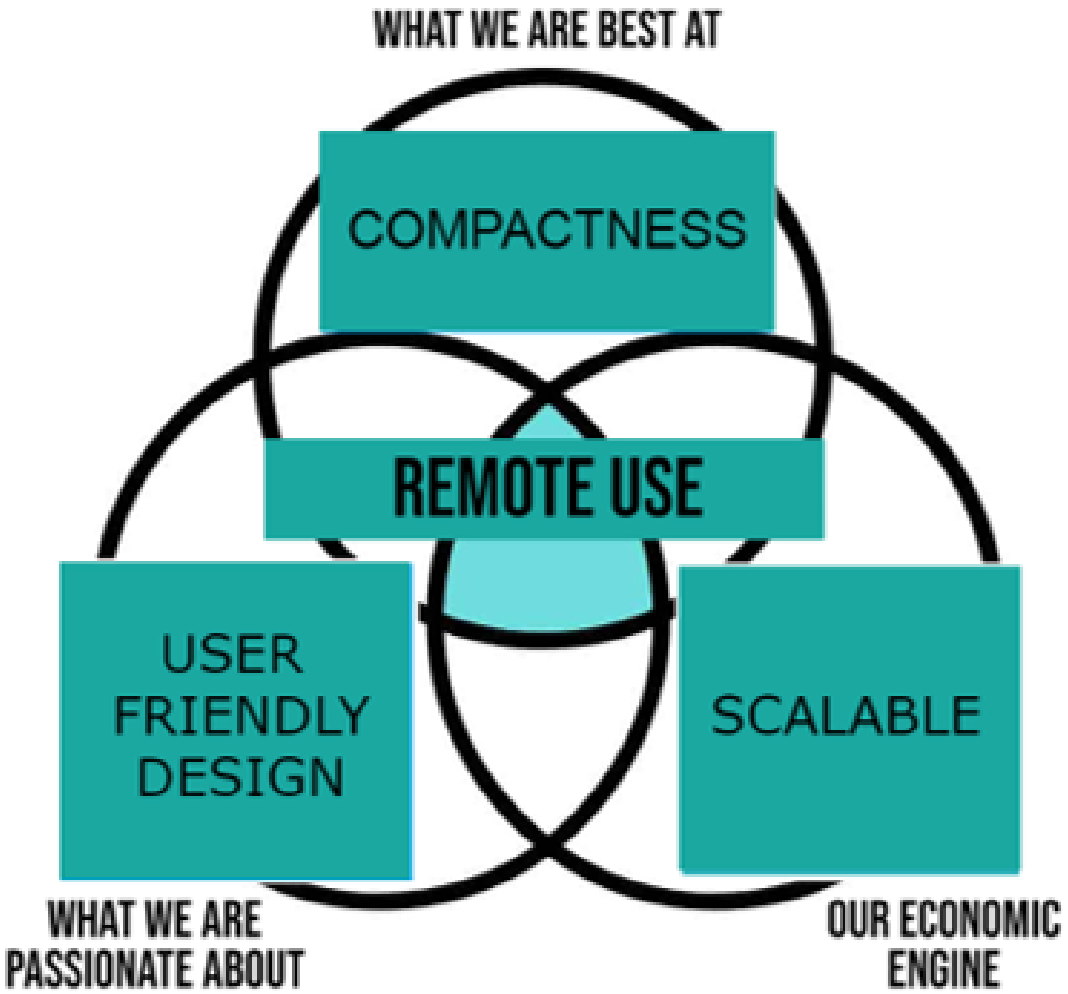


Table of Contents

- Team Mission 3
- Key Product Specifications 4
- Our Design 5
- Enclosure and Carriage 6
- Movement System 7
- Stepper Motors 8-9
- OD/FI 10
- Touch Screen 11
- Demonstration 12-14
- Product Testing 15
- Key Features 16-17
- Design Evolution 18-20
- Future Growth 21
- Cost Summary 22
- Acknowledgements 23

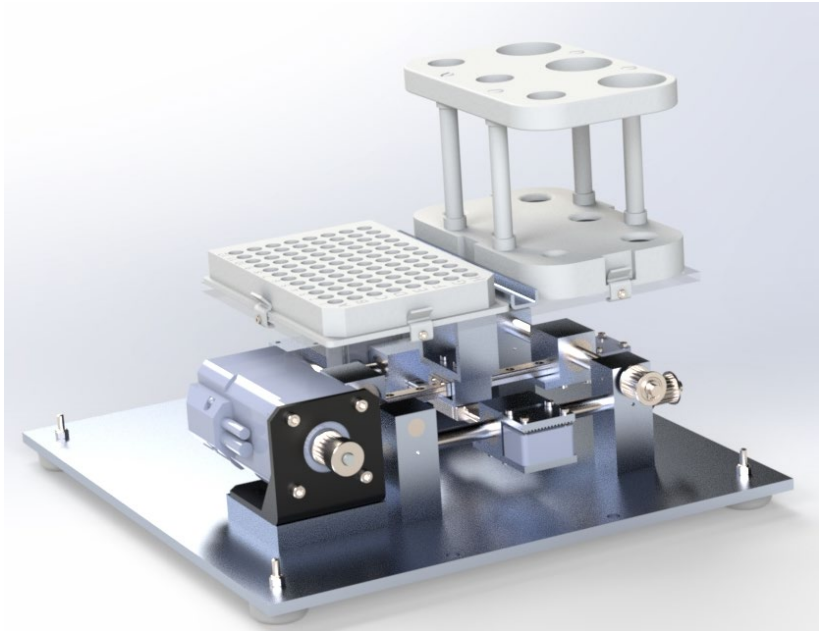
Team Mission



User-first design approach

SAFEQUAKE SYSTEMS ™

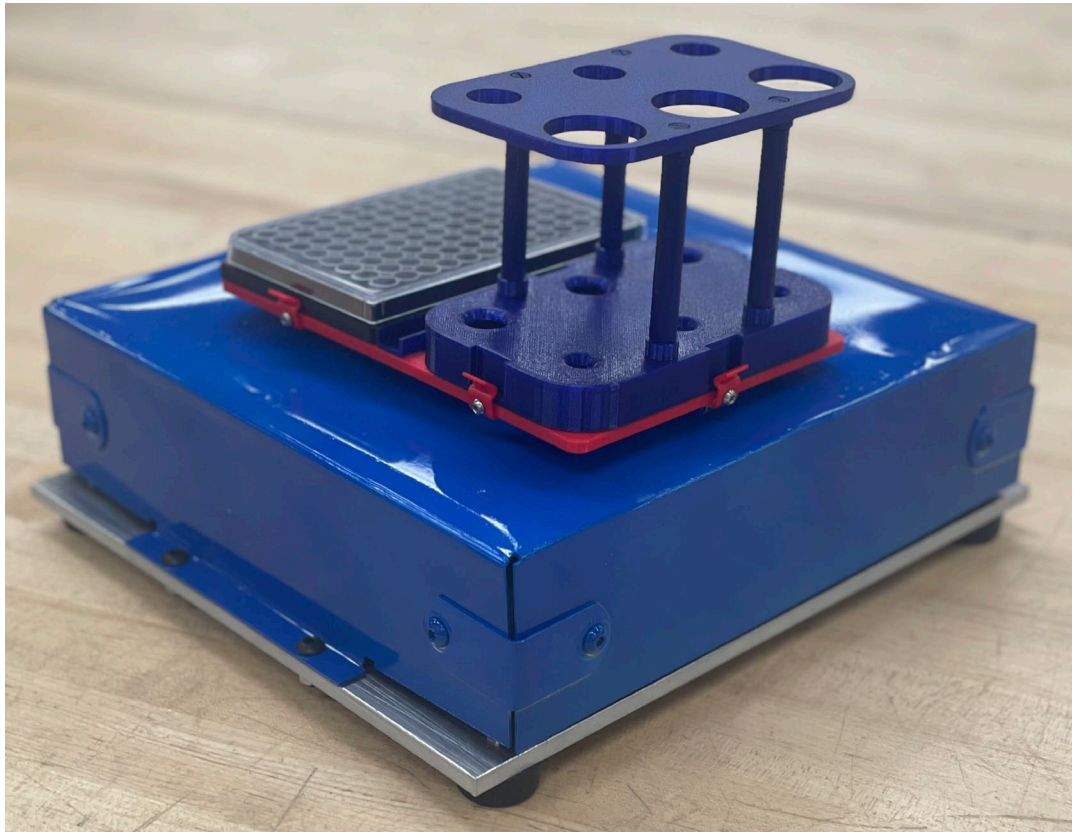
Key Product Specifications



- Survivable temperature range of 0-70°C
- Maximum speed of carriage is 350 rpm
- Water resistant
- 3 shaker patterns: linear, orbital and double orbital
- Adjustable radius
- Stepper motor driven
- Operated via touch screen
- Uses 12 V Power Supply

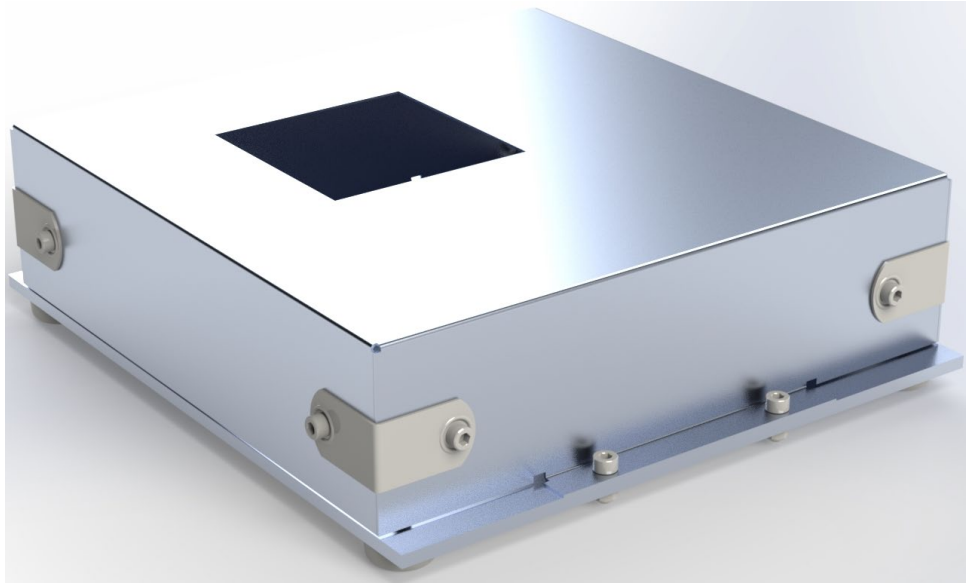
Our Design

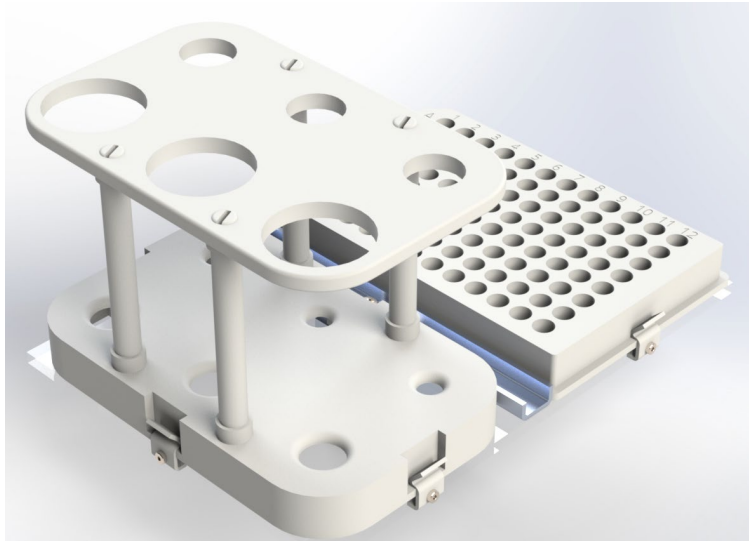
- Belt driven movement system
- Stainless steel and Aluminum construction for main assembly
- 2 closed loop Nema 17 Stepper Motors
- OD/FI sensor separate
  - OD/FI – Optical Density and Fluorescence Intensity
- Handheld user interface with touch screen
  - Wired and removable from shaker table



Enclosure & Carriage

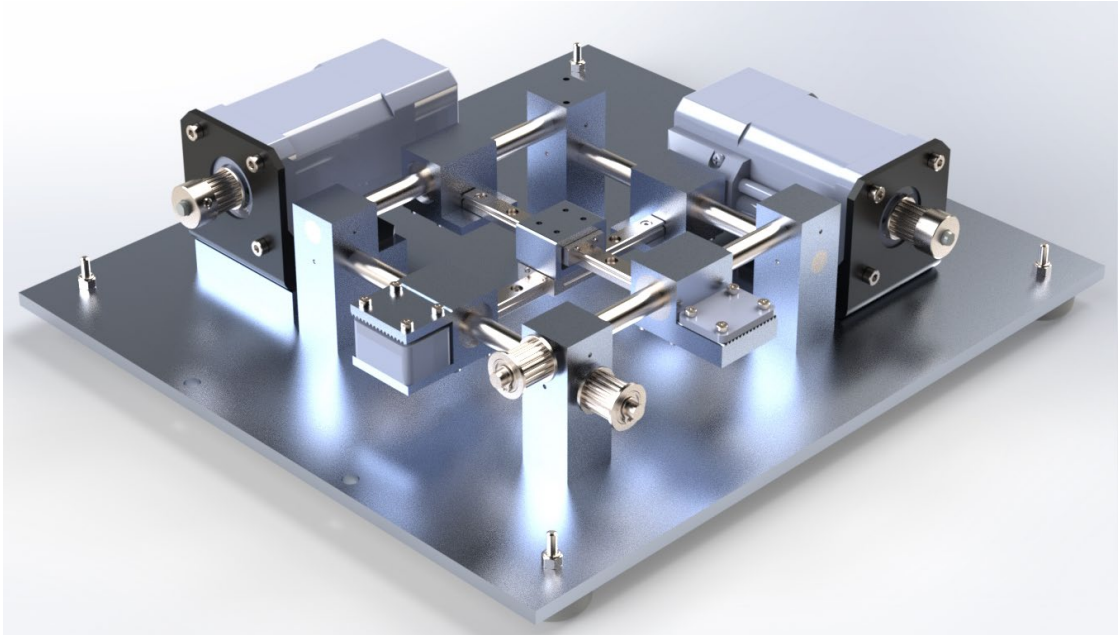
- Enclosure
  - Easily removable
  - Impact resistance
- Carriage
  - Snap in wells and test tube holders
  - Acrylic plate for ODFI

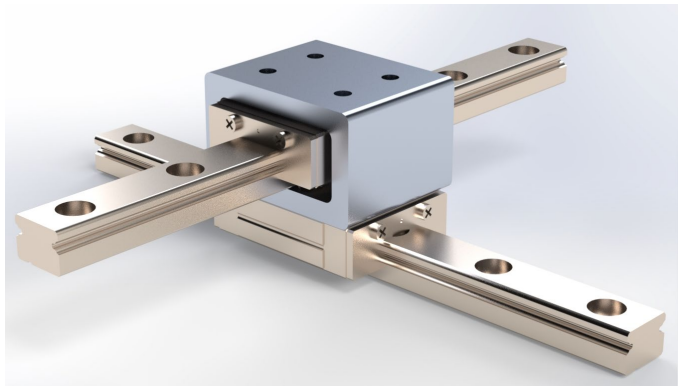




Movement System

- Belt driven
  - 9mm wide HTD Belts
- Linear rails for center movement to reduce sound
- Stepper Motor
  - Nema 17
  - Closed Loop to track carriage position
  - Water and Thermal Resistant
  - 0.72 Nm torque





Stepper Motors

- Need 350 RPM and $25\ mm$ diameter circular path on carriage vs $12\ mm$ diameter on motor pulley

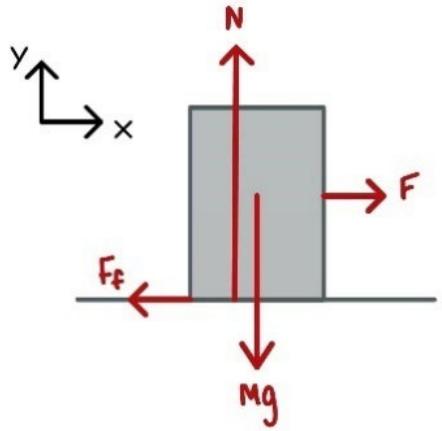
$$f = 350\frac{rotations}{minute} \cdot \frac{(\pi \cdot 25mm)}{(\pi \cdot 12\ mm)} = 729.2\ RPM$$

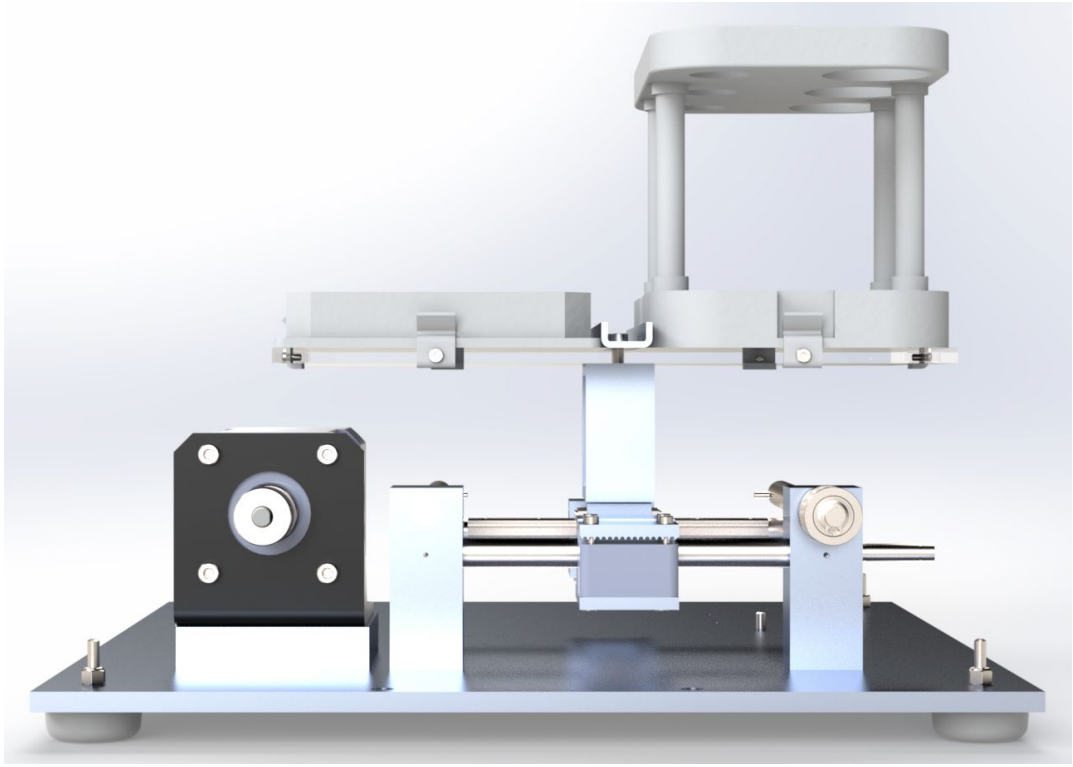
- Friction coefficient μ between carriage and linear rails estimated at 0.3

$$\tau = F_f \cdot L = \mu m g \cdot L$$

$$\tau = (0.3)(0.549\ kg)\left(9.81\ \frac{m}{s^2}\right) \cdot (0.155\ m) = 0.250\ N \cdot m$$

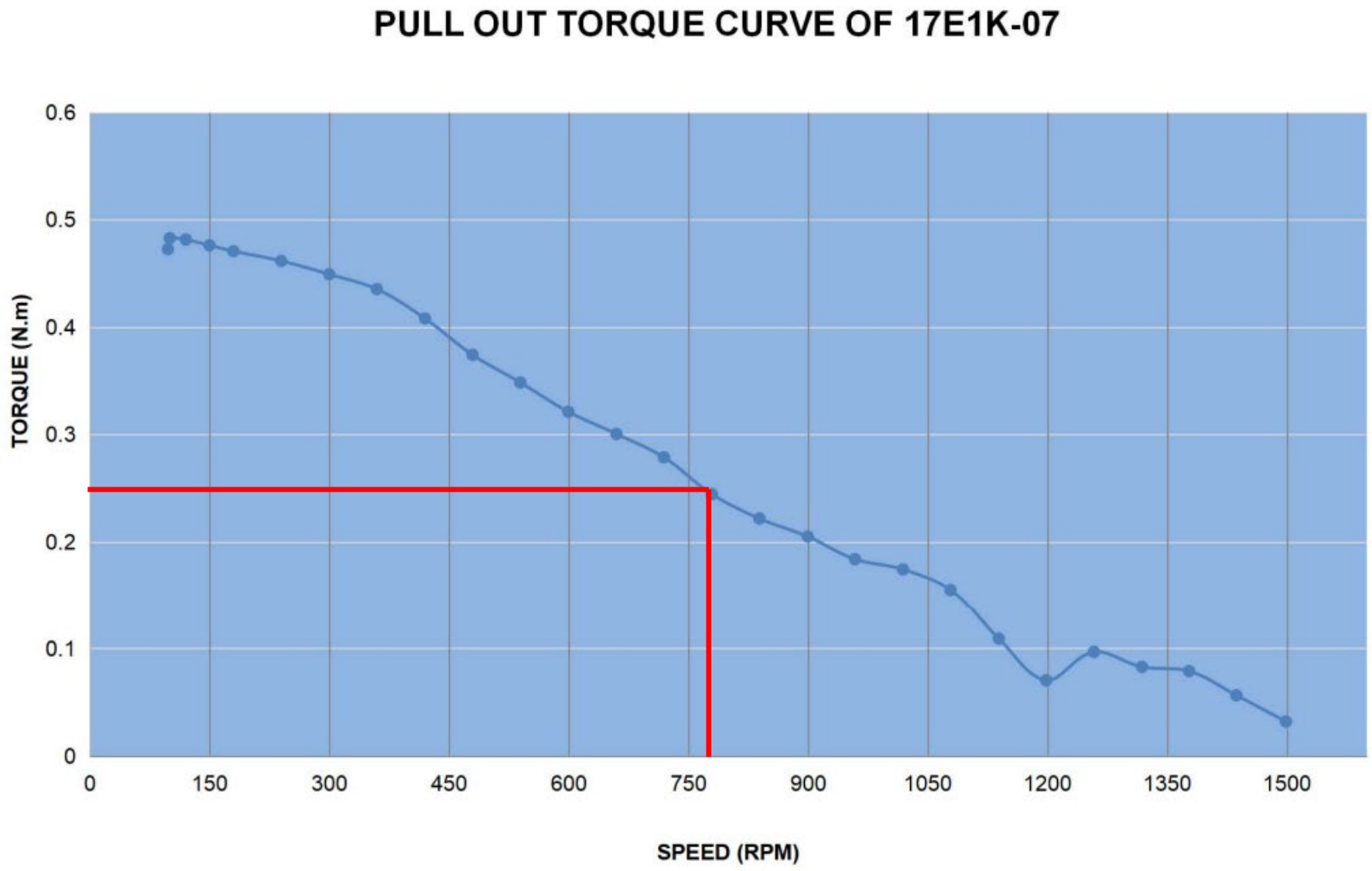
$$\tau > 0.250\ N \cdot m$$





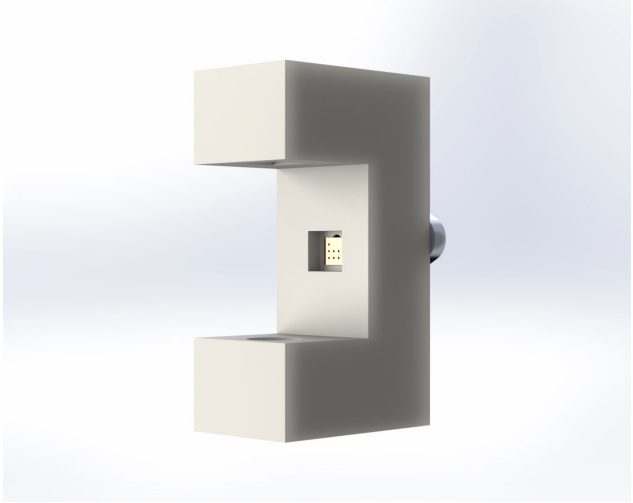
Stepper Motors

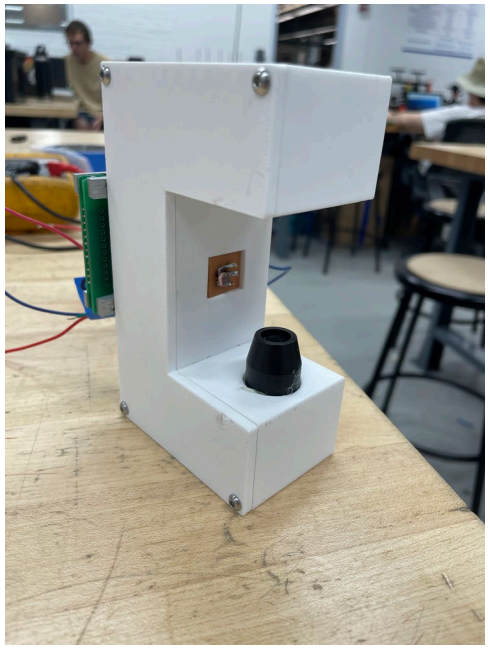
Needs for motor: $f = 729.2\ RPM$ $\tau > 0.250\ N \cdot m$



OD/FI

- Design Needs
  - Tube and well illumination at a proper OD and FI wavelength
  - OD/FI measurements must be accurate within 15%
  - Compatibility
- Final Design
  - UV LED emits light at a wavelength of $365nm$
  - Sensor package has an idle accuracy of 99%
  - Wiring housed within the sensor package

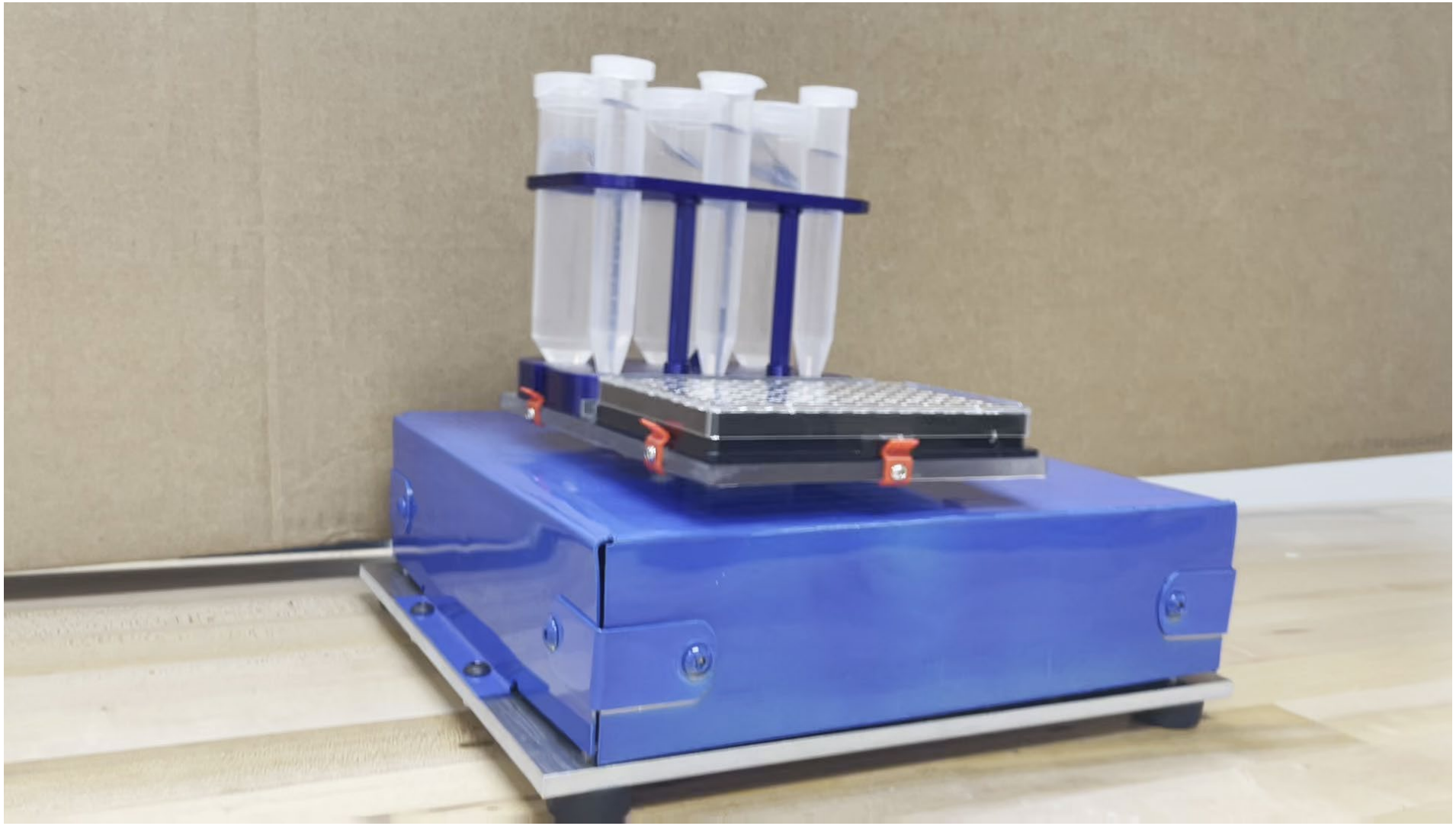




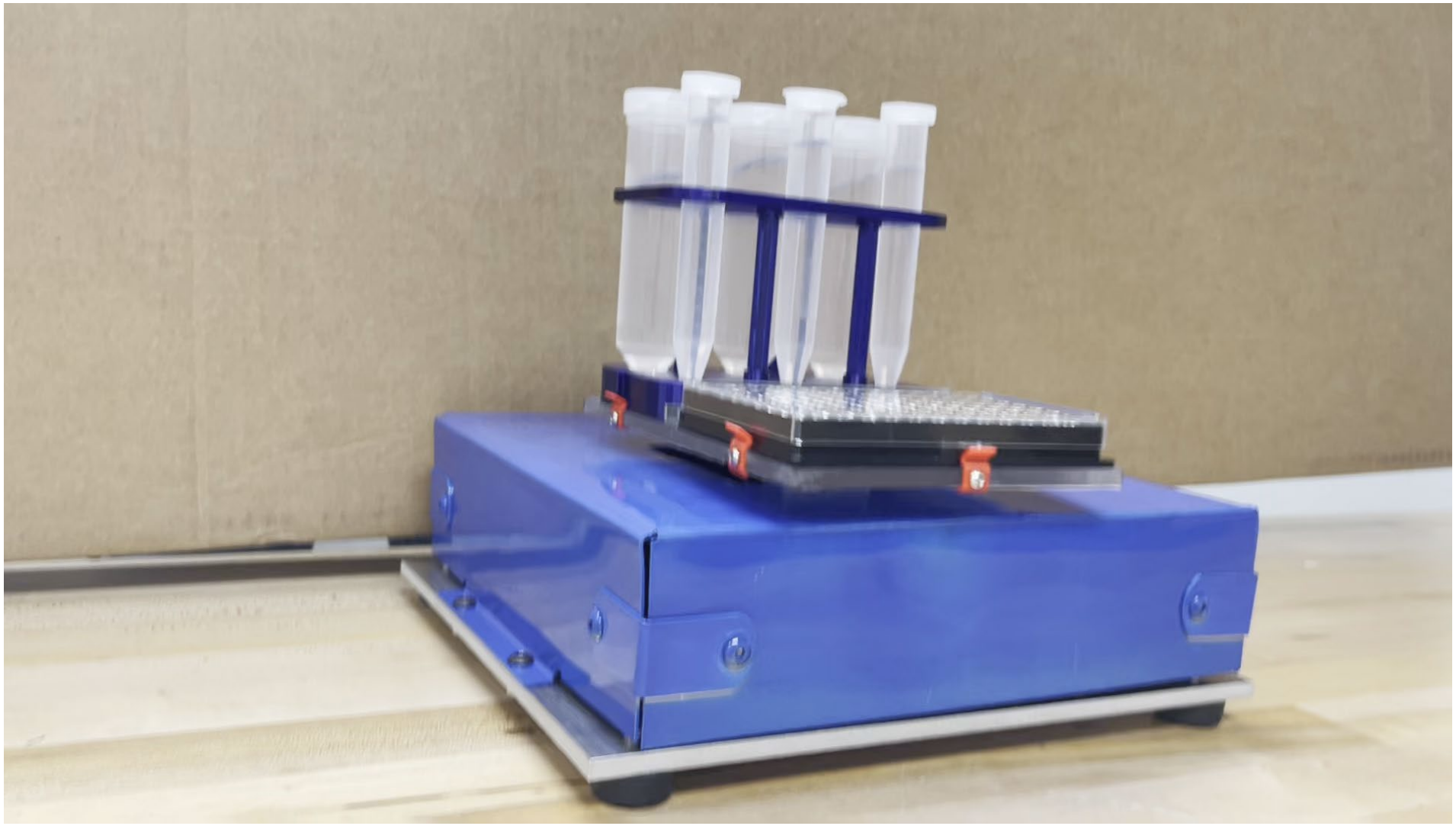
Touch Screen

- Easy to use Touch Screen
  - Resistive Touch Screen
    - Compatible while wearing gloves in lab setting
    - Sensitivity is programmed to search for a range of pressures
  - Color!

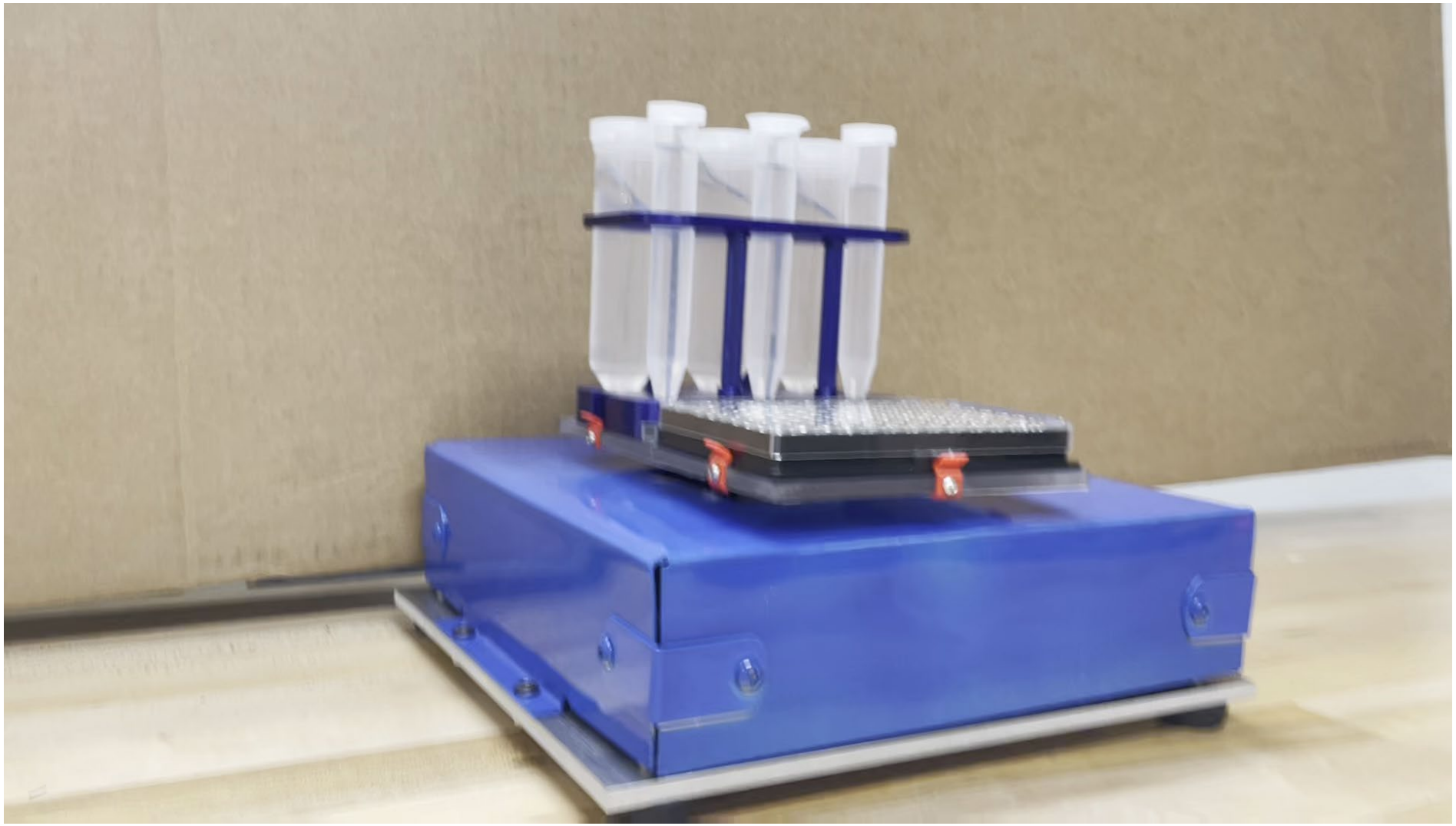
Demonstration: Linear Movement



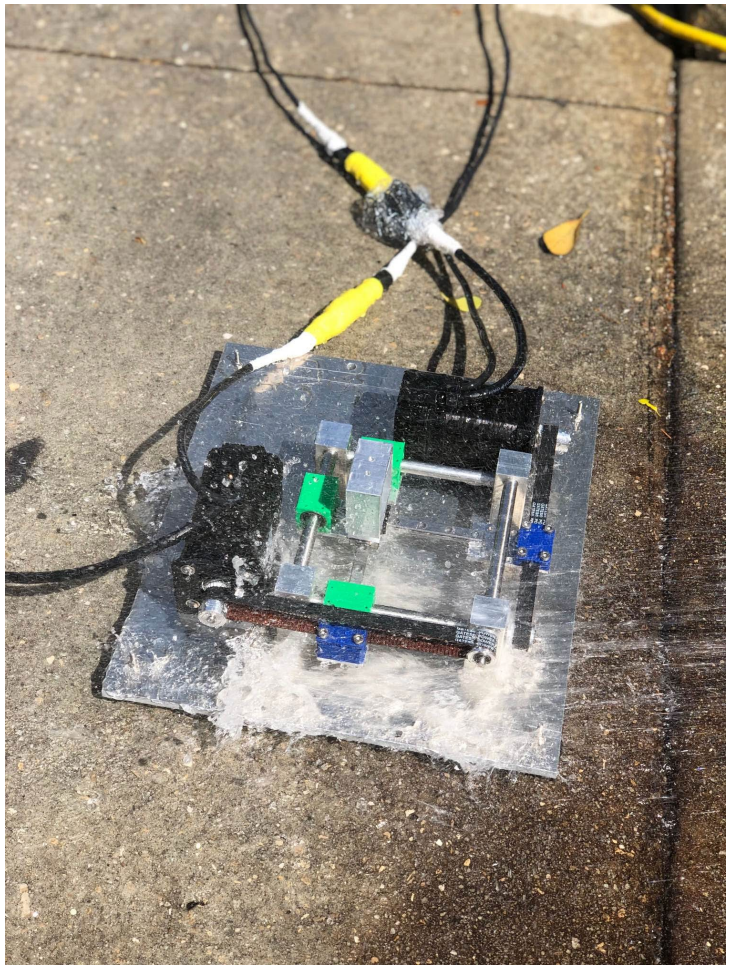
Demonstration: Orbital Movement



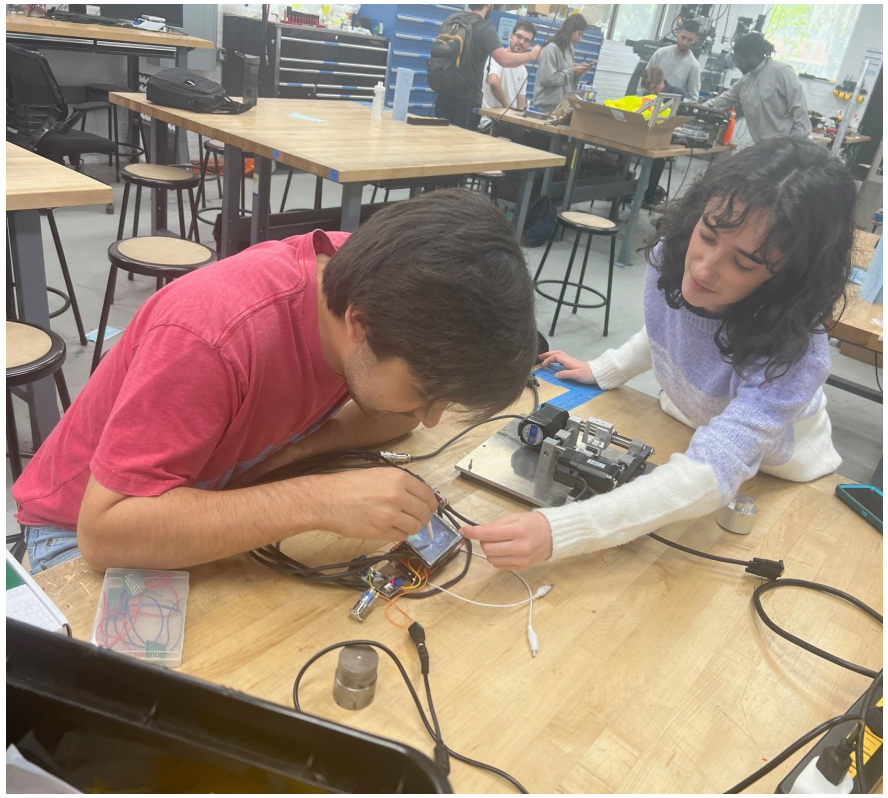
Demonstration: Double Orbital Movement



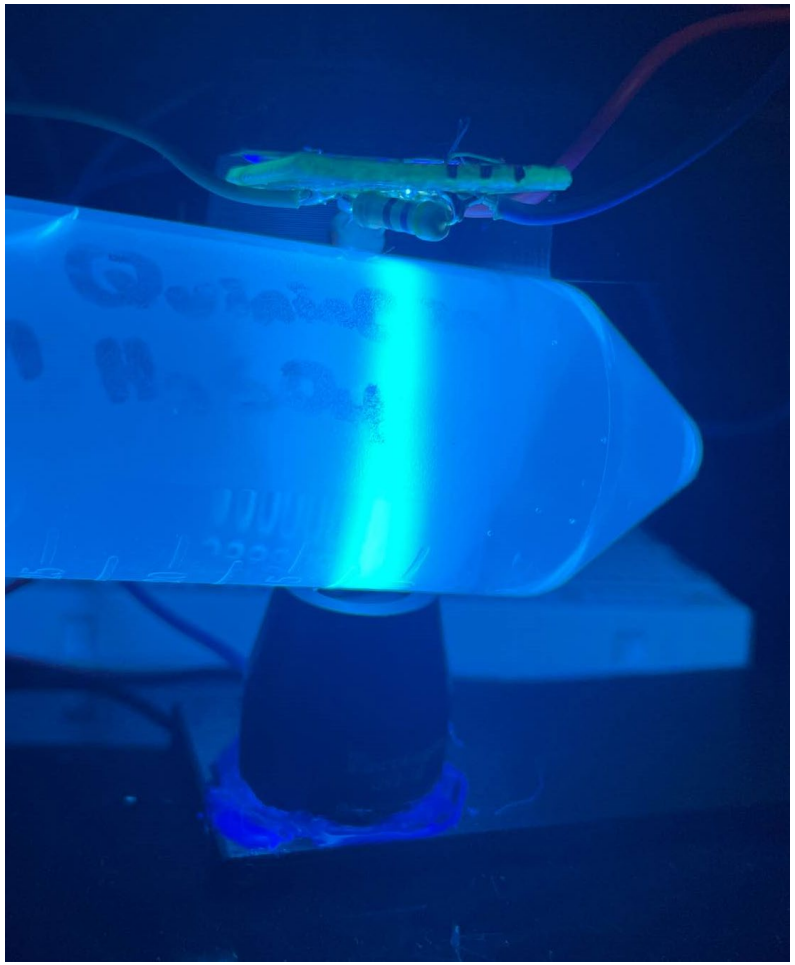
Product Testing



IP-X5 Infiltration Test



Functional Demonstration

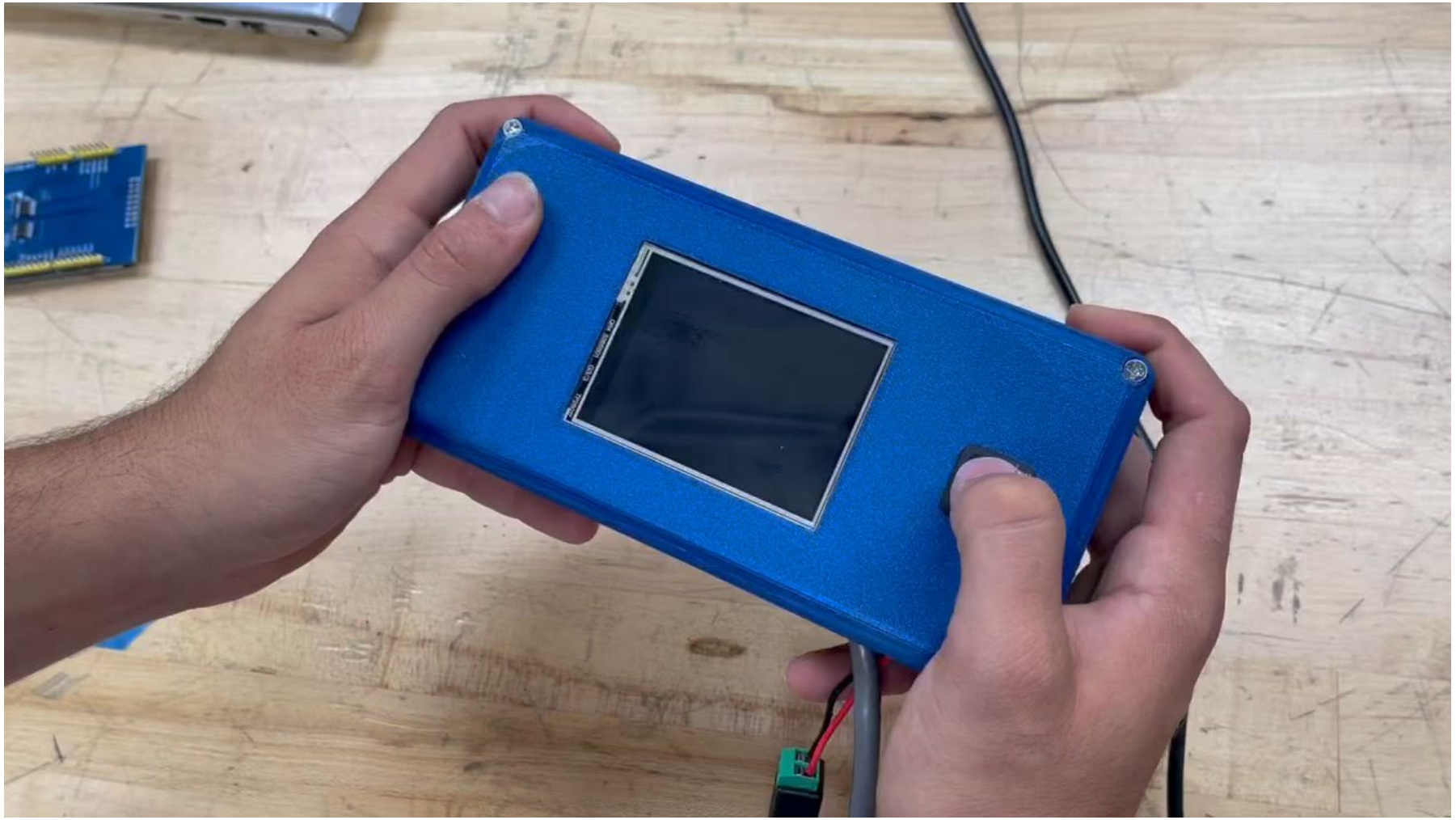


OD/FI Test

Key Features

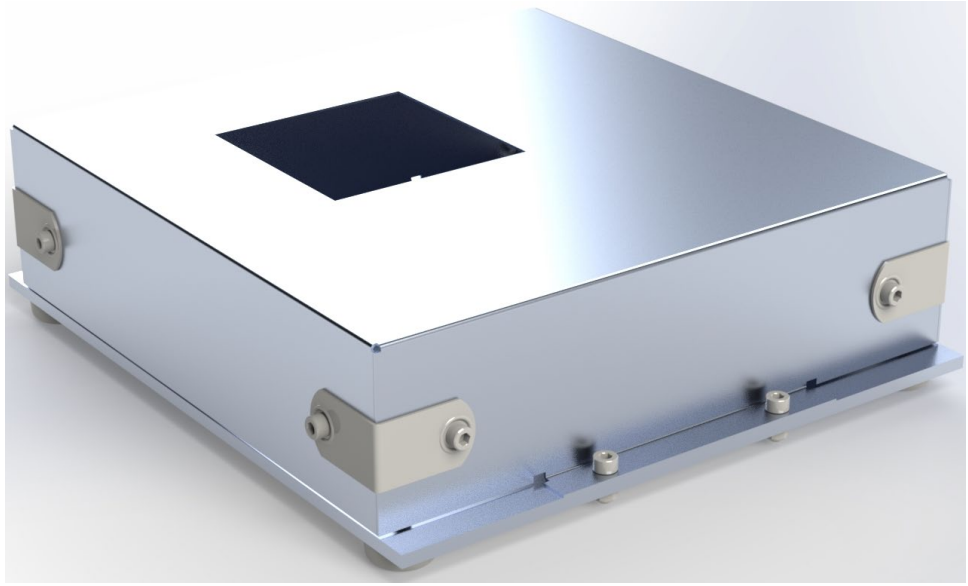
- Handheld remote
  - UI Casing is 7” x 3.5”
  - Human Hand is about 3.5” wide
- Touch Screen
  - User-Friendly Design and Layout

Key Features: Touch Screen Remote

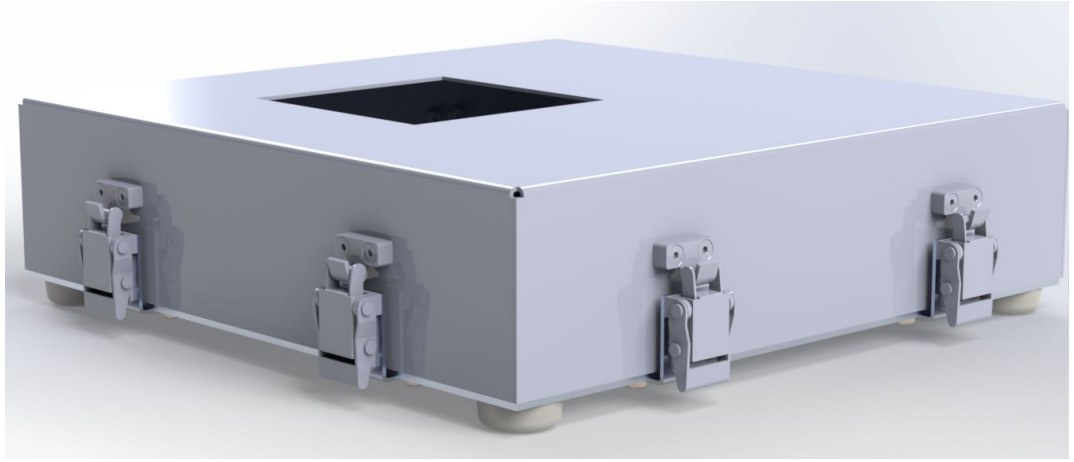


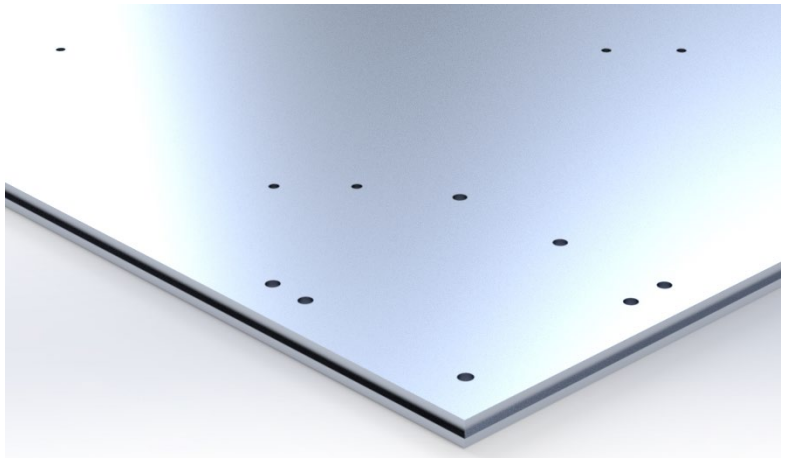
Design Evolution

- Method of mounting housing
  - Initial housing design clipped to the base plate using a groove that was difficult to manufacture
  - Housing mounted using screws
  - CNC vs AWJ



Final housing mount design

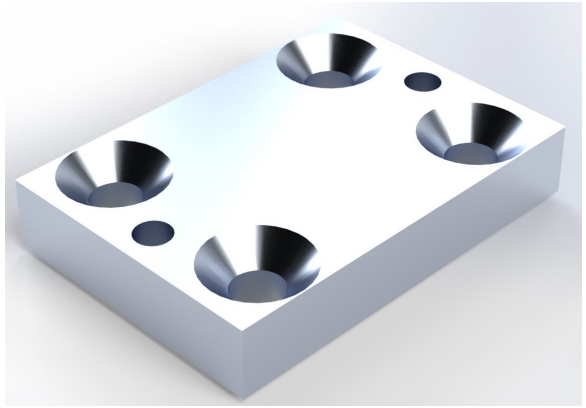


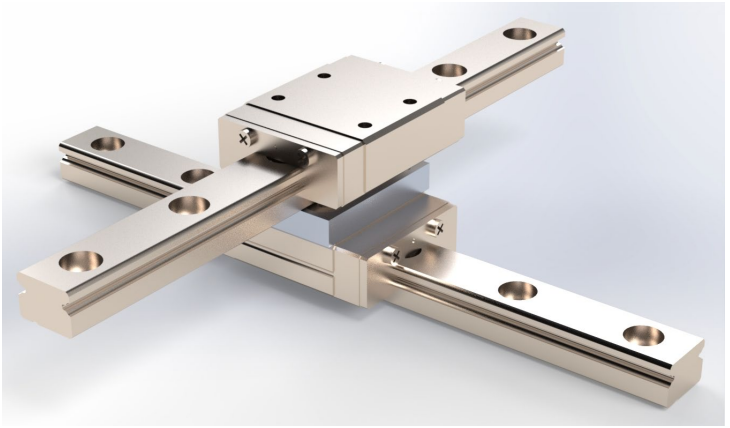


Initial housing mount design

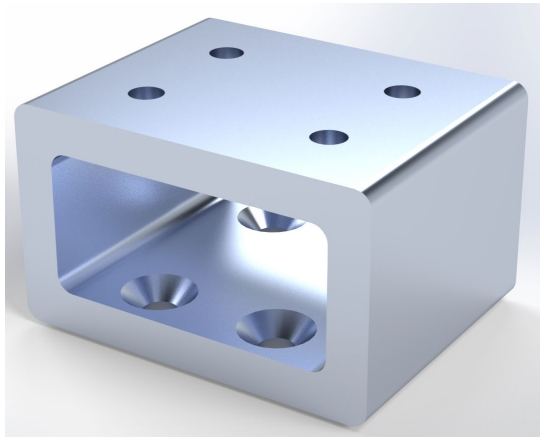
Design Evolution

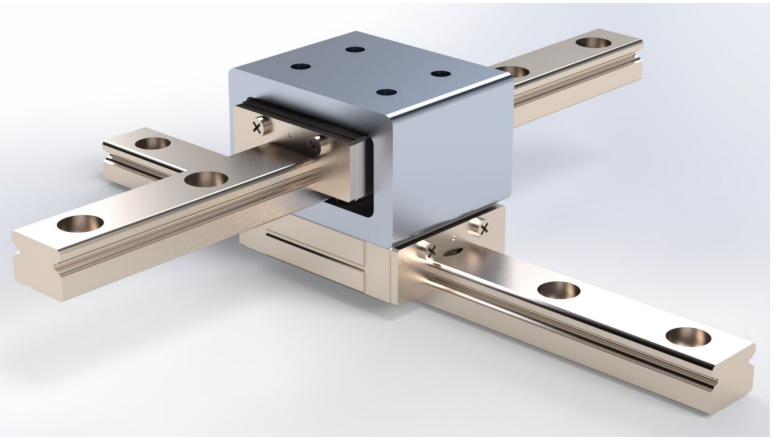
- Mounting of the carriage
  - Initial mounting design was not functional
  - Carriage to carriage mounting





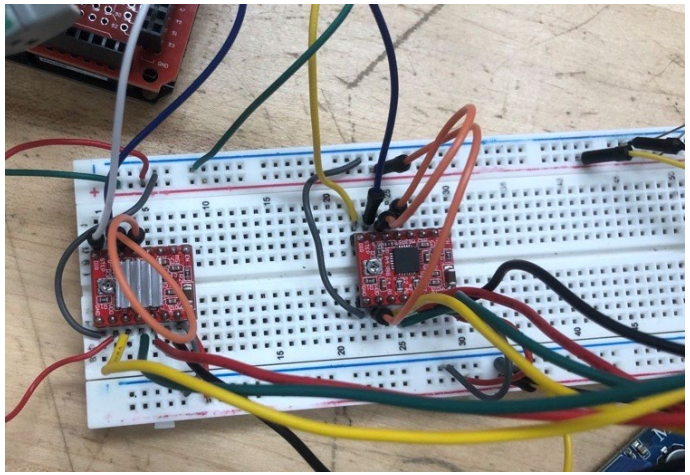
Initial carriage mount design

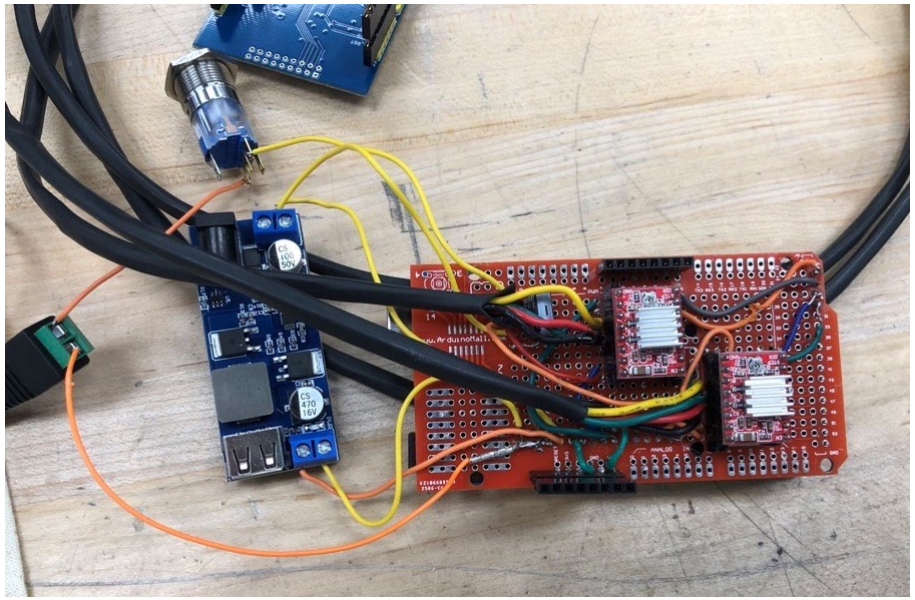


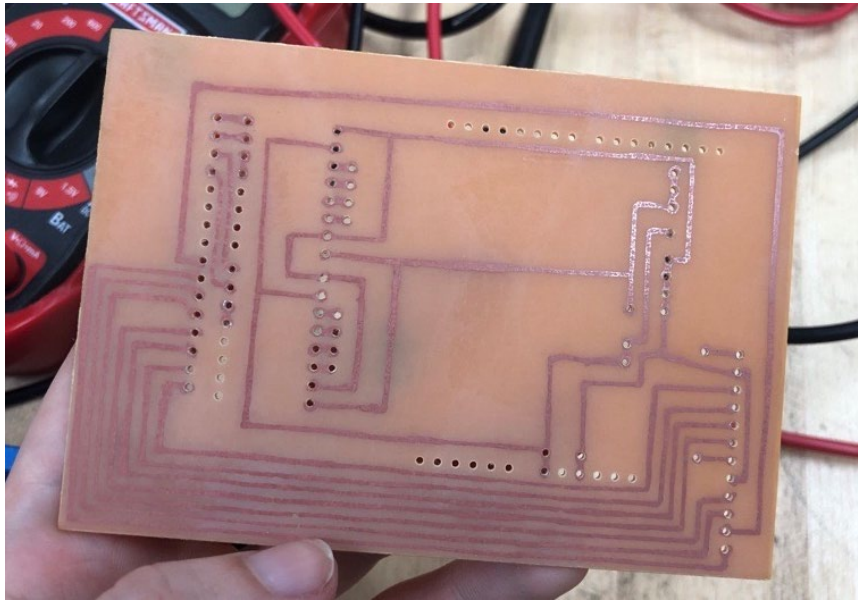


Final carriage mount design

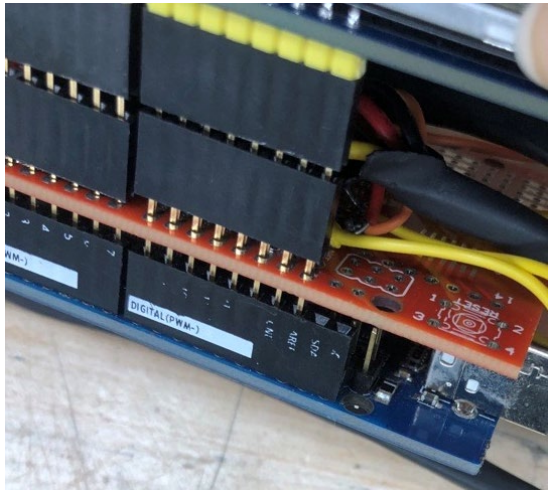
Design Evolution

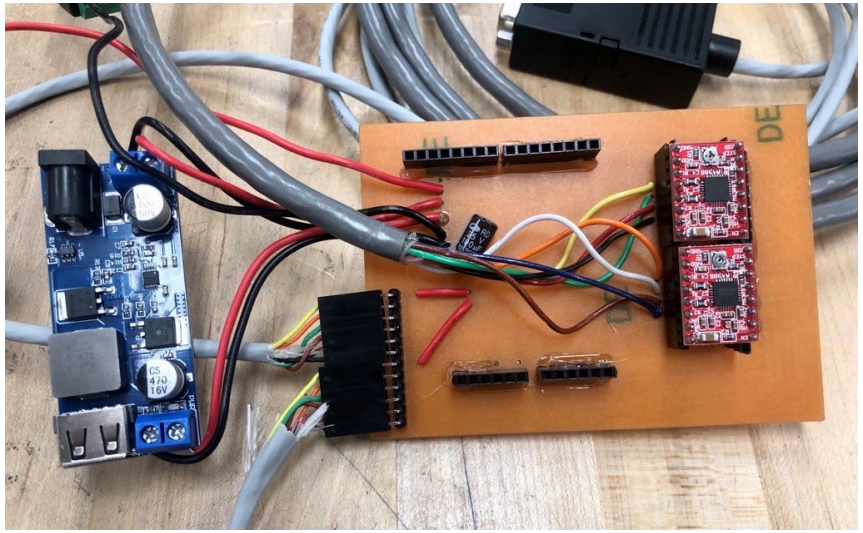






- Perf board on Arduino Mega 2560 Rev3 Shield
- Customized PCB with copper-etching method





Future Growth

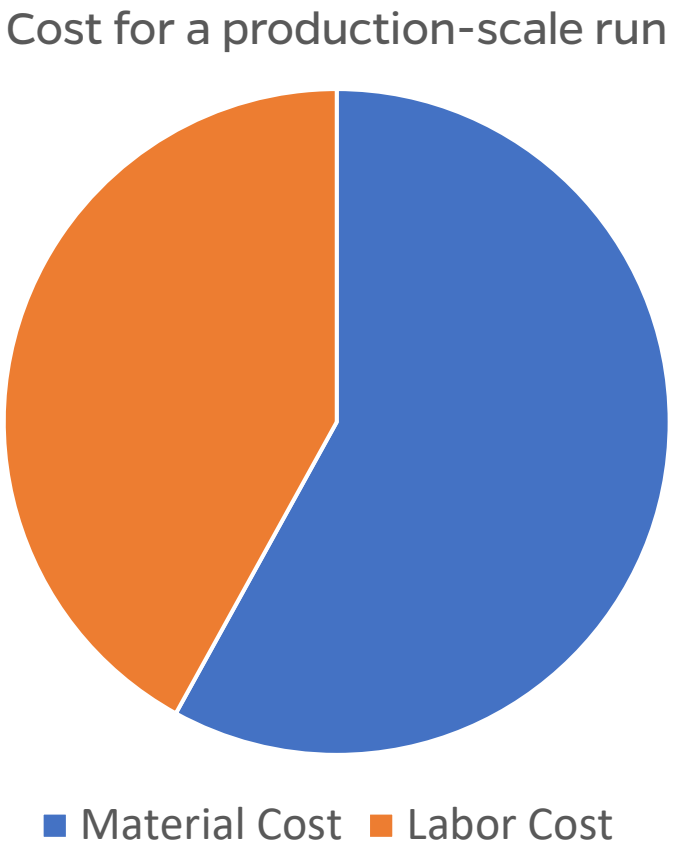
- Plans to go wireless in the future
  - Remote monitoring
  - Data monitoring
- Wi-Fi Module

Handheld Remote

Wi-fi Module

Cost Summary

- Cost to build one prototype
  - $608.04
- Cost for a production-scale run of 1000 units
  - Total Cost: $485,628
    - Material Cost: $285,628
    - Labor Cost: $200,000



Acknowledgements

- Thank you:
  - EML4502 Corporate Sponsors
  - EML4502 Teaching Team
  - UF MERGE Lab
- Questions?

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