PlastiSense FPR

SDP Team 2
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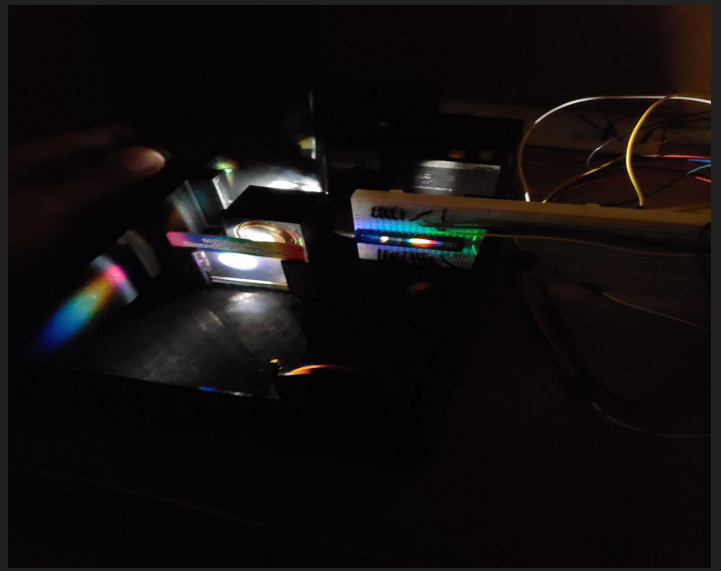
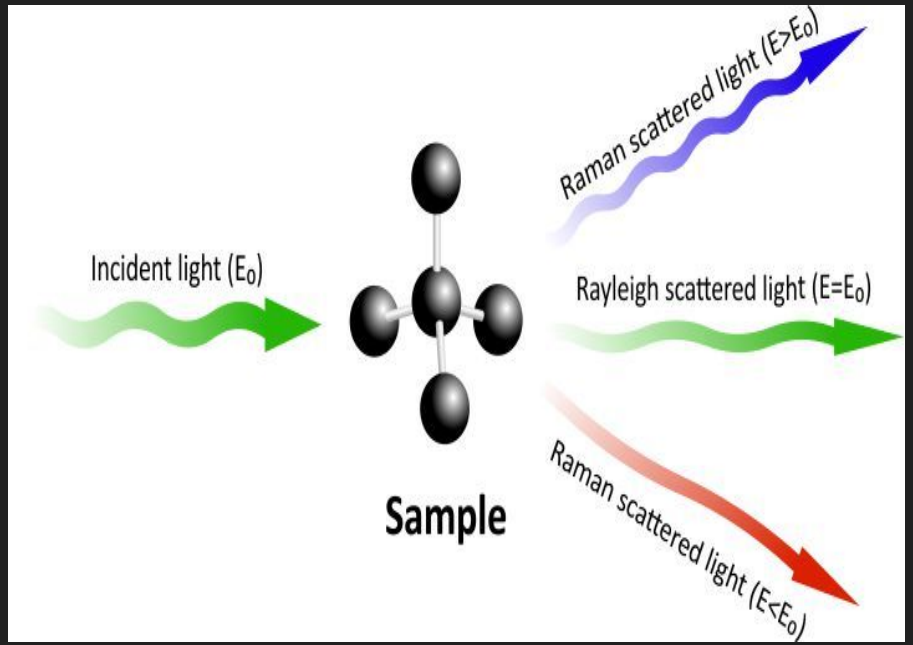
Problem Statement

- Did you know microplastics have been found in our rainwater and you could be consuming five grams of microplastics a week -- the equivalent to a credit card?
- This has been linked to negative effects on fertility and increased occurrences of cell mutations and cancer.[1]
- Find out the abundance of microplastics in your water with Plasti Sense, an optics-based microplastic sensing device!



[1] dalberg-advocacy-analysis_for-web.pdf

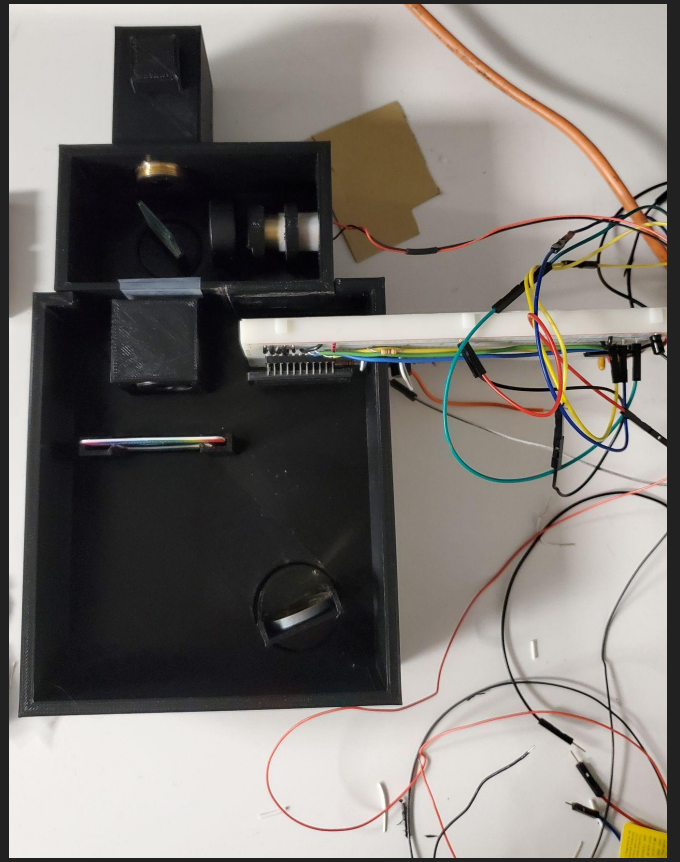
What is Raman Spectroscopy?



- Raman spectroscopy utilizes an incident laser that points toward a molecular substance
- Affected by the incident laser, the molecule starts to vibrate and let off its own energy in the form of a Raman signal response
- The Raman signal is response is what is measured to detect specific molecules (e.g. polystyrene).

Original Design Plan vs Current Edition

- Originally we planned to create a product that can show the user the intensity of polystyrene in a sample of water.
- We cannot demonstrate sensing, however we have created a spectrometer that has correct alignments.
    - If we were to have higher quality components, a user could sense a Raman response due to our alignments.
- Additionally, if we were able to obtain gold nanoparticles, this could make Raman sensing easier by amplifying the signal.



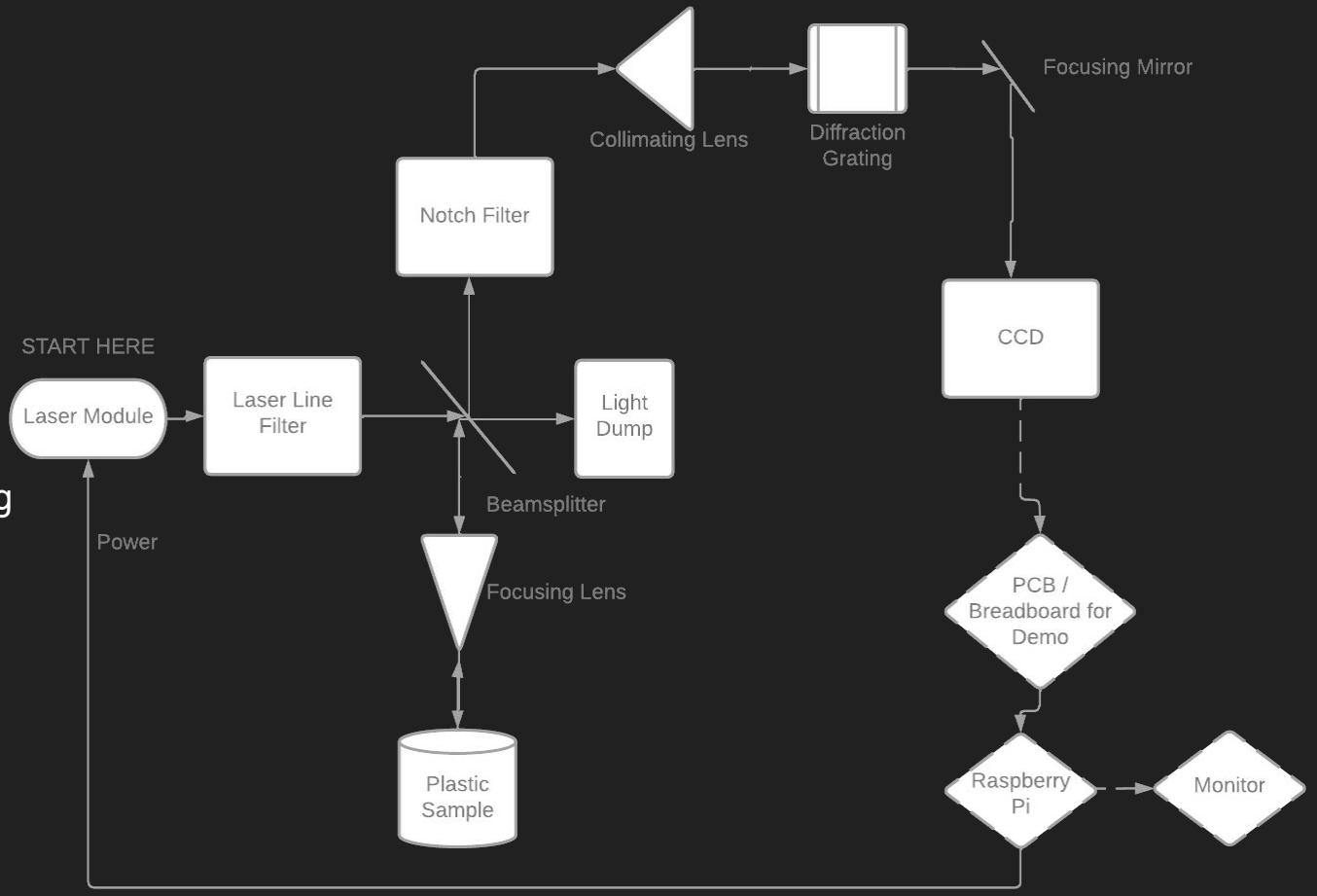
PlastiSense Quantitative Justifiable Specs

Requirements	**Specification**	**Value**
Portable	Weight Volume	<3kg 2500 cm^3
Responsive	Latency	< 5s reading
Sturdy	Alignment	Aligned through cad models & justified through inspection
Affordable	Cost	$800

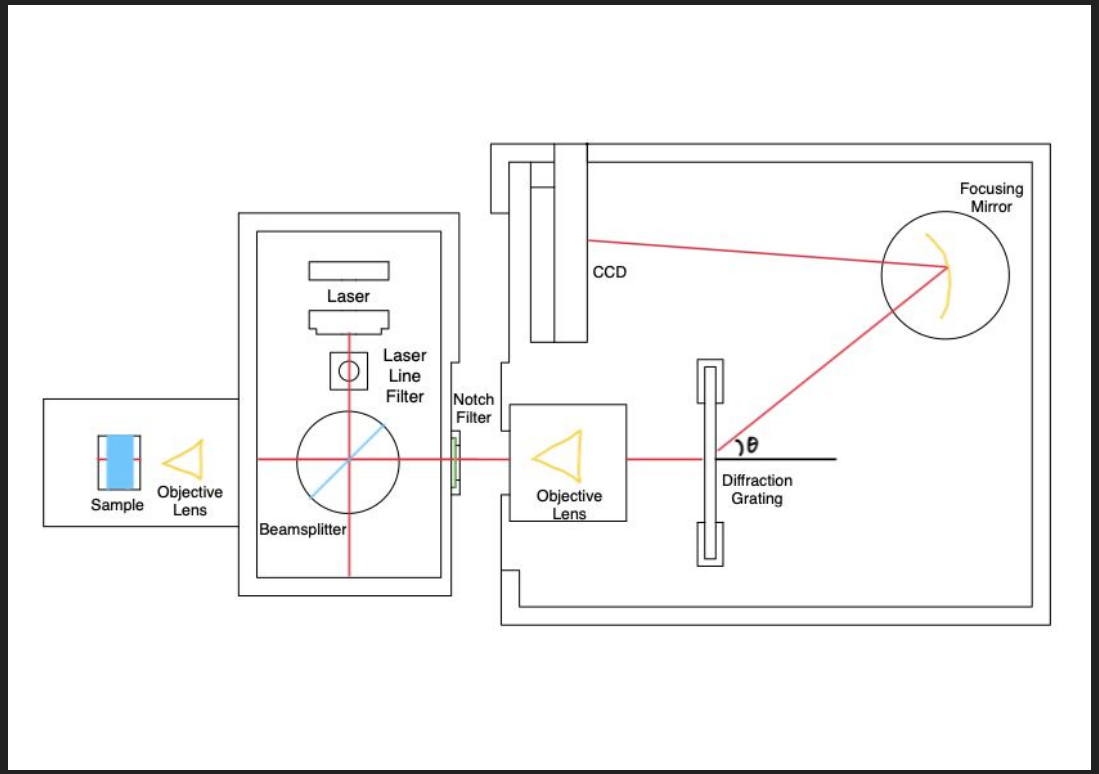
System Operation / Hardware Block Diagram

Hardware List

- Laser or Light Source
- Optical Devices
  - LL Filter
  - Notch Filter
  - Diffraction Grating
  - Collimating Lens
  - Beamsplitter
- CCD
- RaspberryPi
- PCB/Nucleo Board

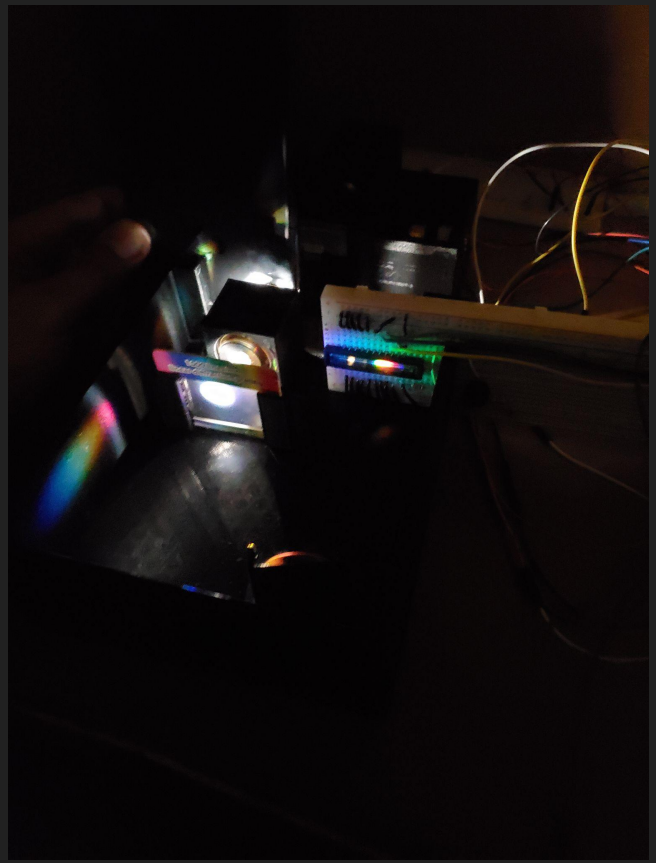


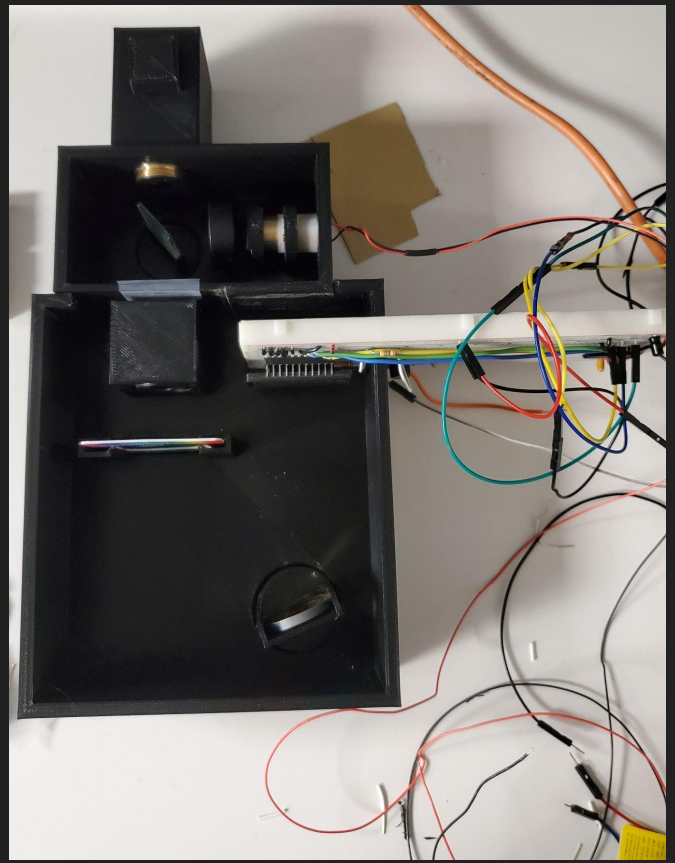
Aerial Diagram of 3D Print



- Most challenging part was to have correct alignments & distances between components.
  - Raman response is already very difficult to obtain.
- Any errors or imperfections between the alignments degrades our signal strength.
- We had no optical bench.

Current Design

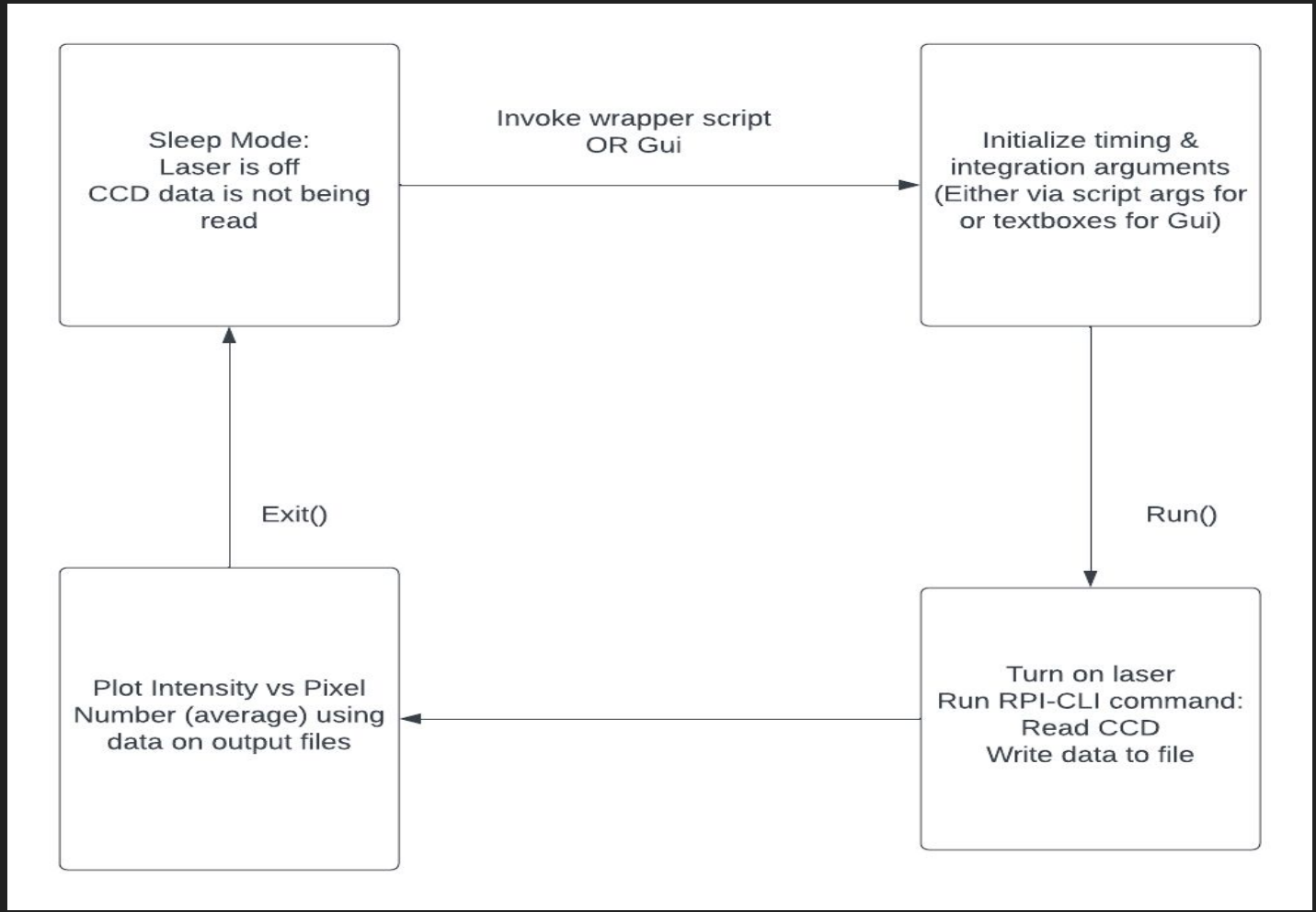




Software Block Diagram

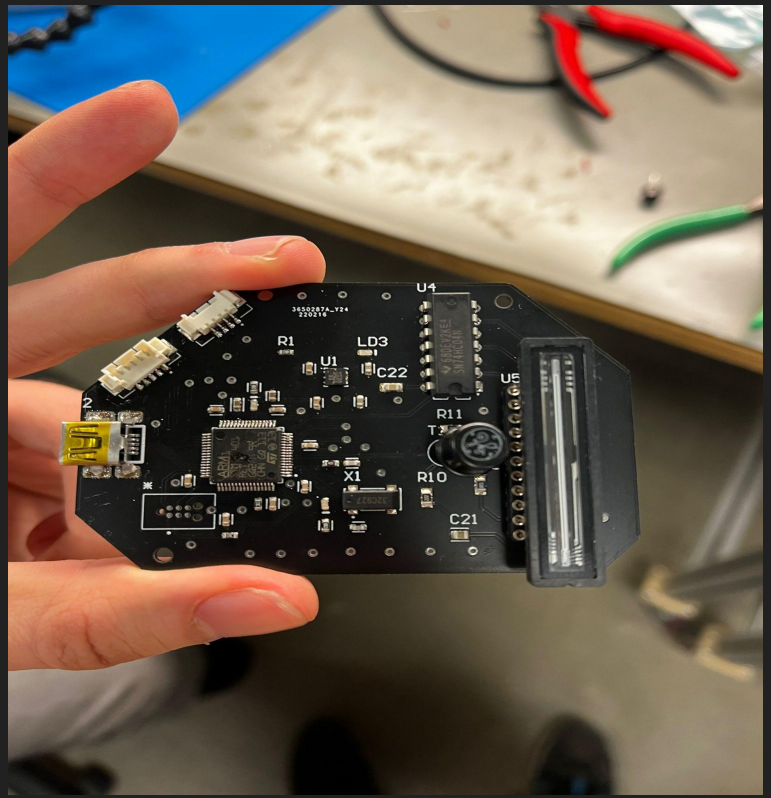
Software List

- CCD UART FW/CLI [1]
- Wrapper.py
- Gnuplot
- SSH/VNC



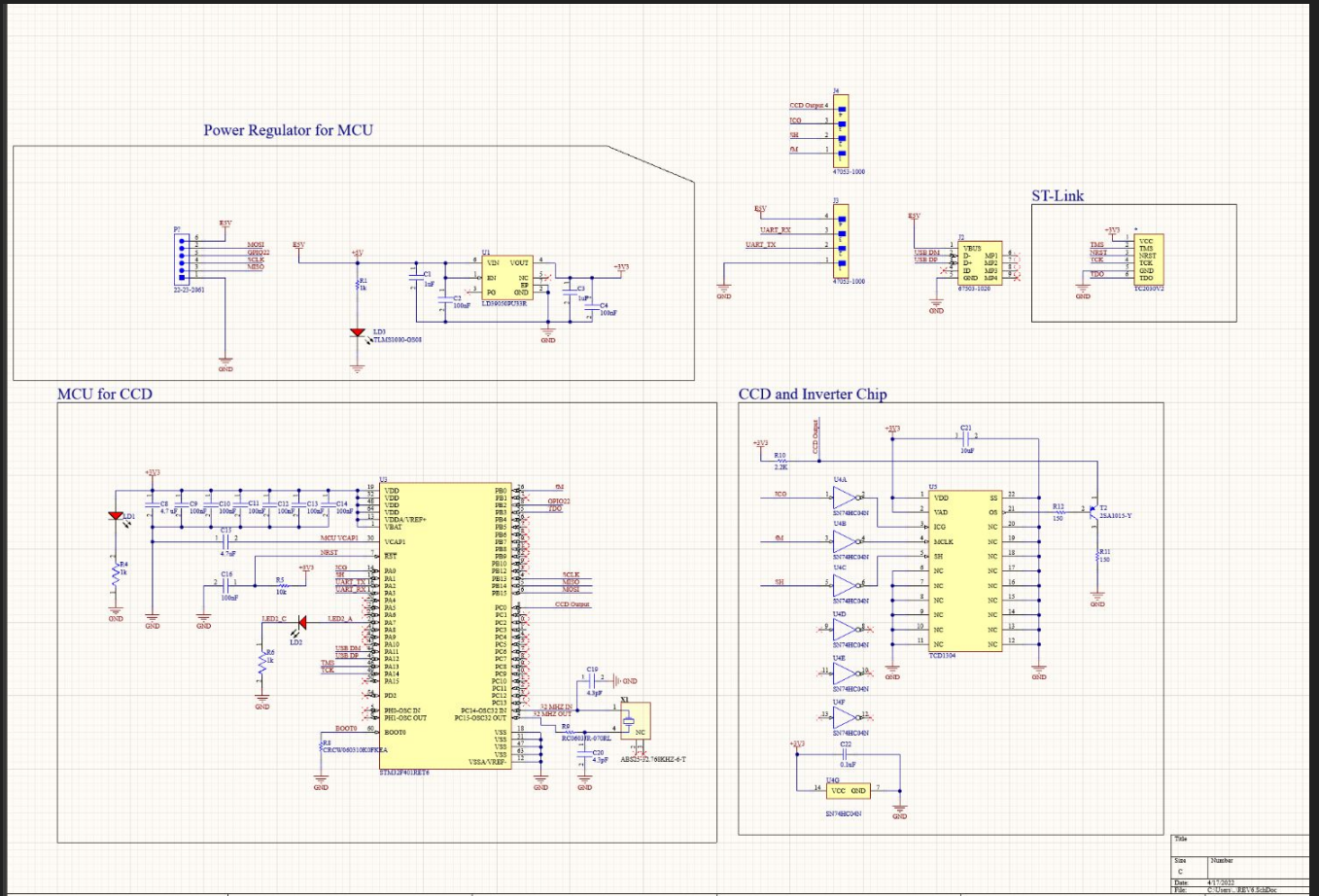
[1] Esben Rossel, (2017). The linear CCD module [Firmware]

PCB Explained

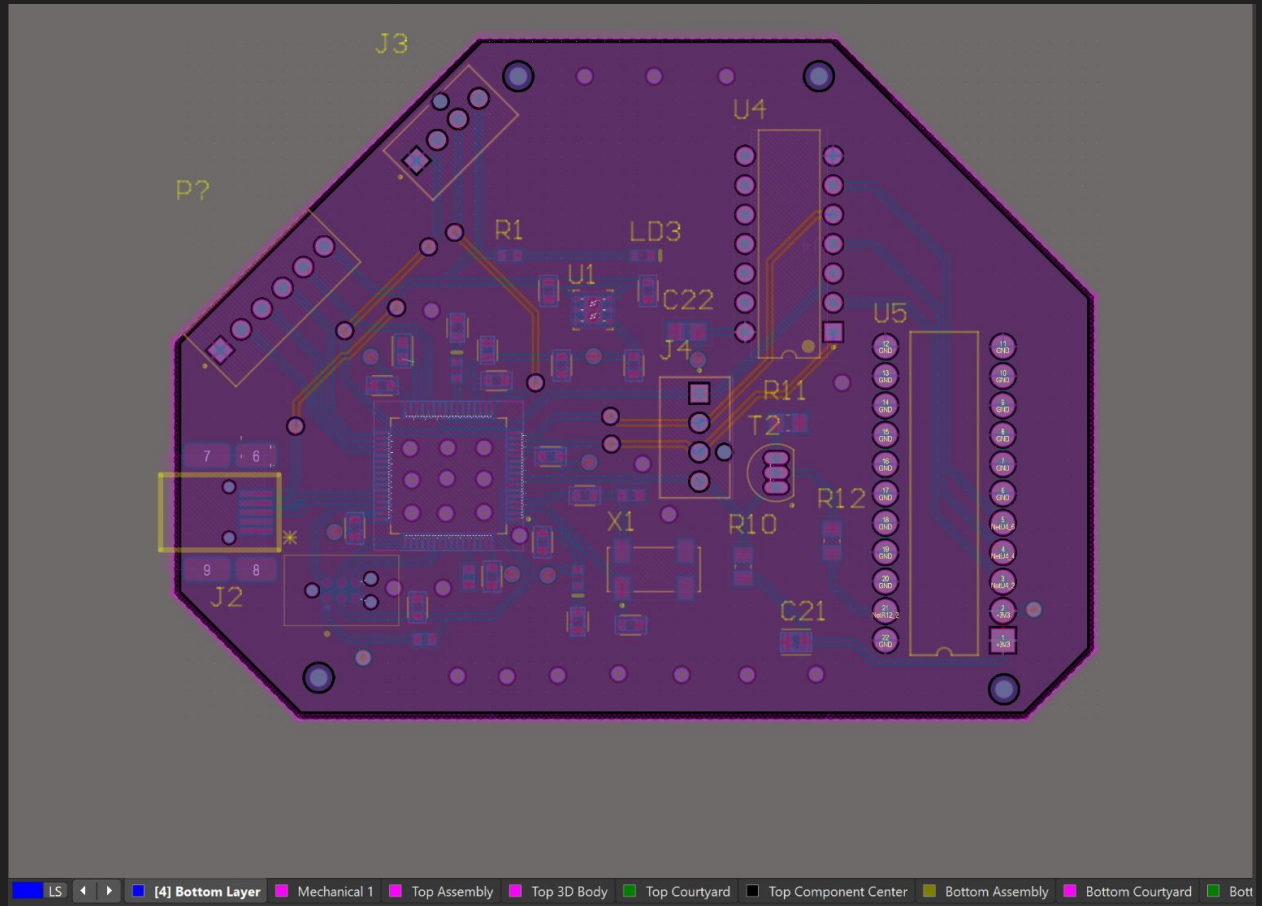


- The basics:
  - STM32F01RE MCU
  - Power regulator
  - Signal inverter
  - 32 kHz crystal
  - CCD Sensor
- All of these components were on our STM Dev Board / breadboard for MDR

PCB Schematic

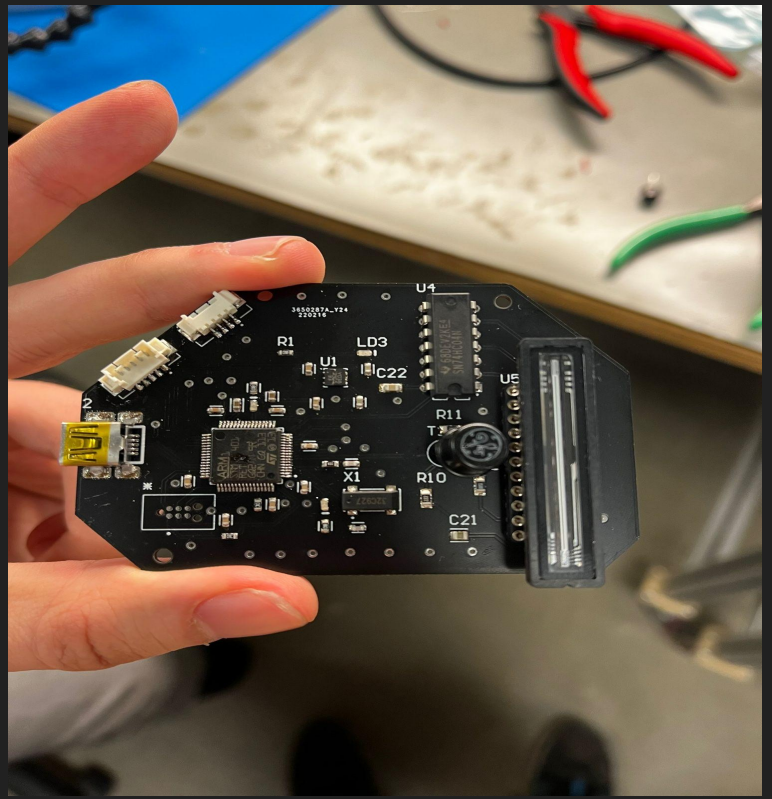


Updated PCB Layout



PCB Progress From CDR

- The last time we met:
  - Populated, but MCU not functioning.
  - MCU was out of stock, so we had to desolder from dev board, and re-solder on PCB.
- This time we have a working MCU on PCB, but have problems with our clocking signals to drive the CCD

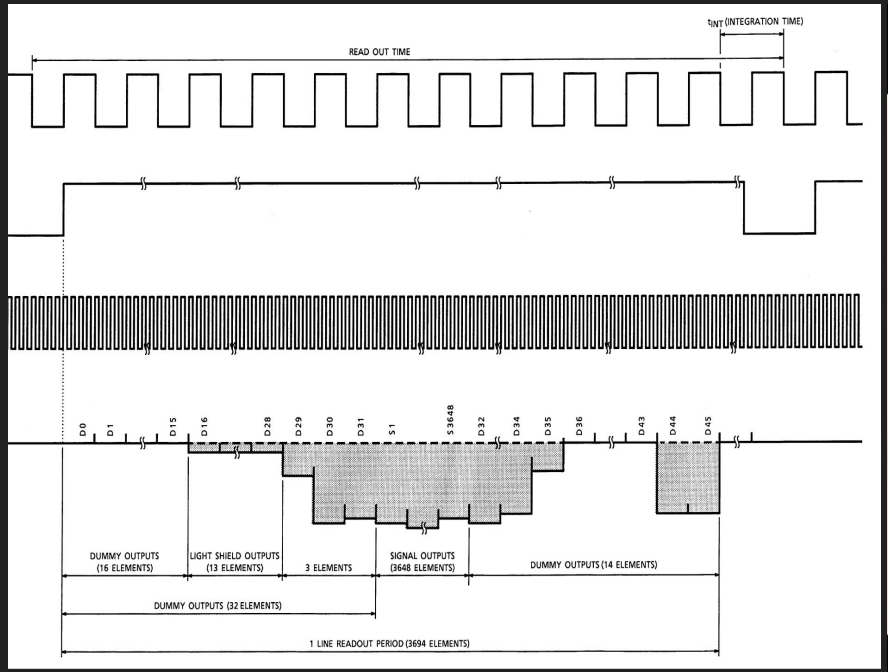


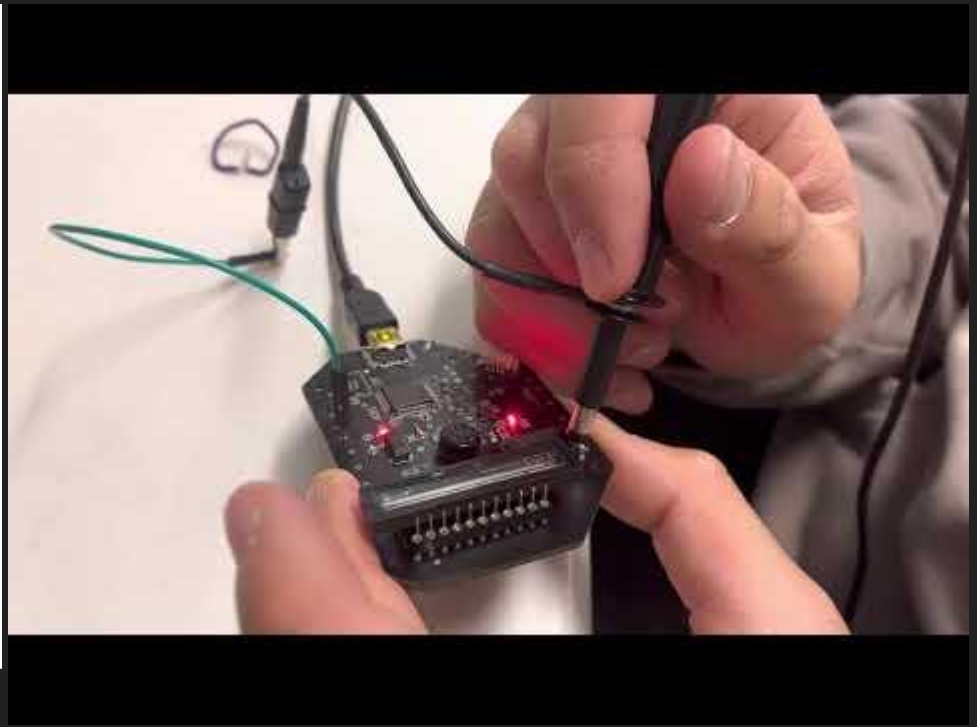
Our Blink LED Code Works!

We are able to program the MCU on our PCB!

Great progress because before we were not able to contact the MCU

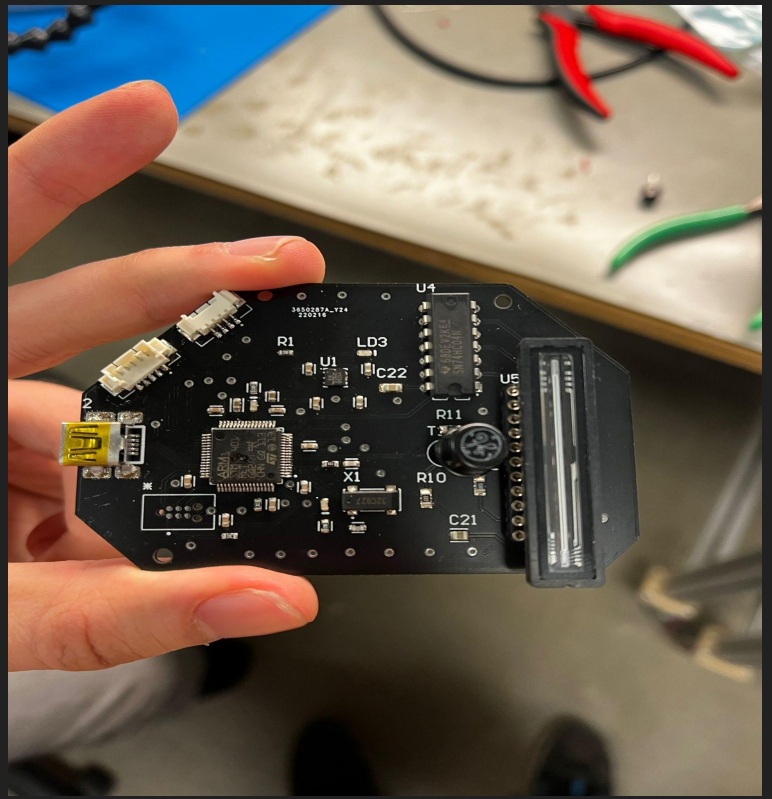
Signal Lines For CCD on PCB (Inputs OK, no Output)



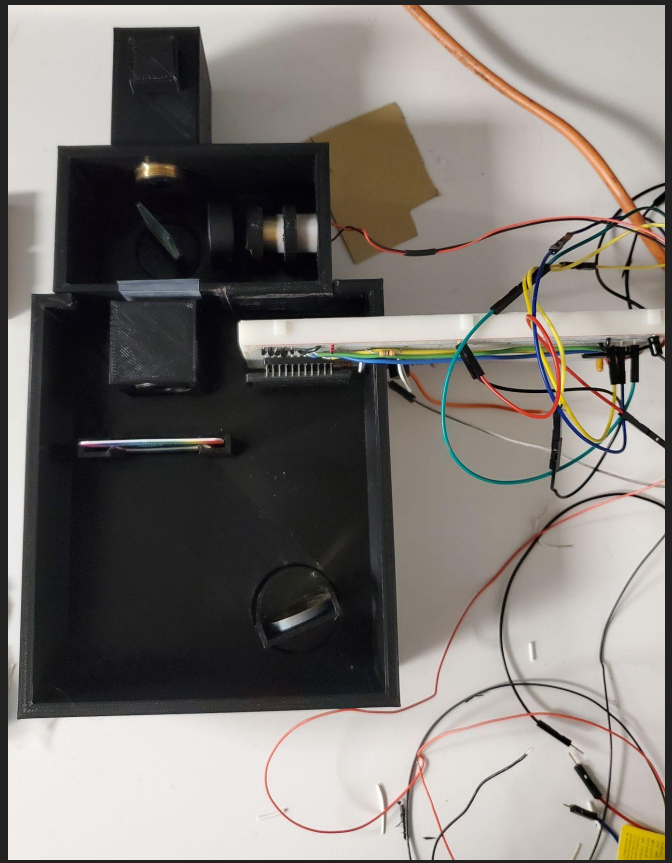


Current Difficulties with PCB

- We aren’t getting a clean input / output signal from the CCD on the PCB on the oscilloscope.
  - Mostly ICG data line is ruining the output data



Spectroscope Progress from CDR



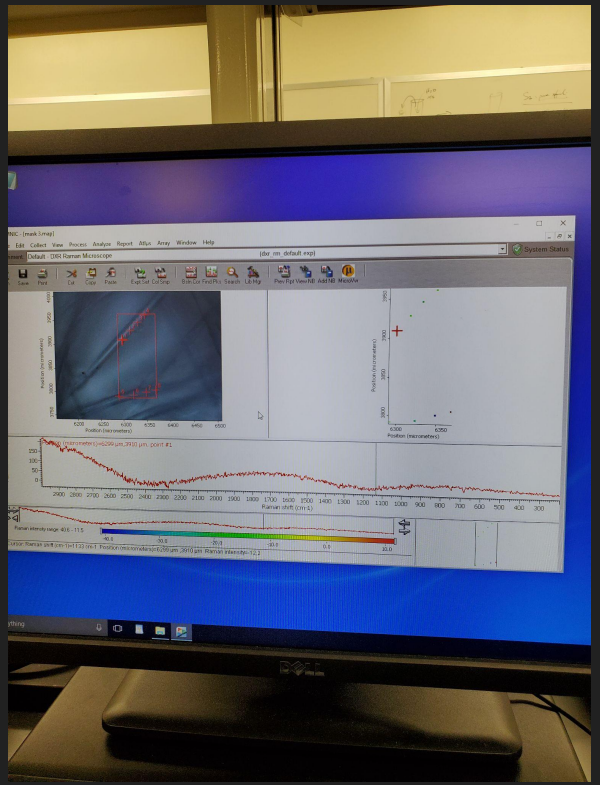
- Since CDR we have finished the remaining spectroscopy chambers
  - Our newest chamber houses the Grating, Collimating Lens, and CCD as shown in our problem statement slide
  - A mount for a breadboard was added to replace faulty PCB
- Since we can only show proof of concept the newest chamber can also be used separately, without the laser chamber, as a simple spectrometer.

Professional Raman Lab Visit

- Our group went to the Raman, IR, XRF Lab on campus.
- We were curious to see if the professional grade ($50k) Raman spectrometer could sense our sample of polystyrene….
- It couldn’t :(
- The Lab Technician Zili Gao told us that to sense microplastics in their experiments they add gold nanoparticles.

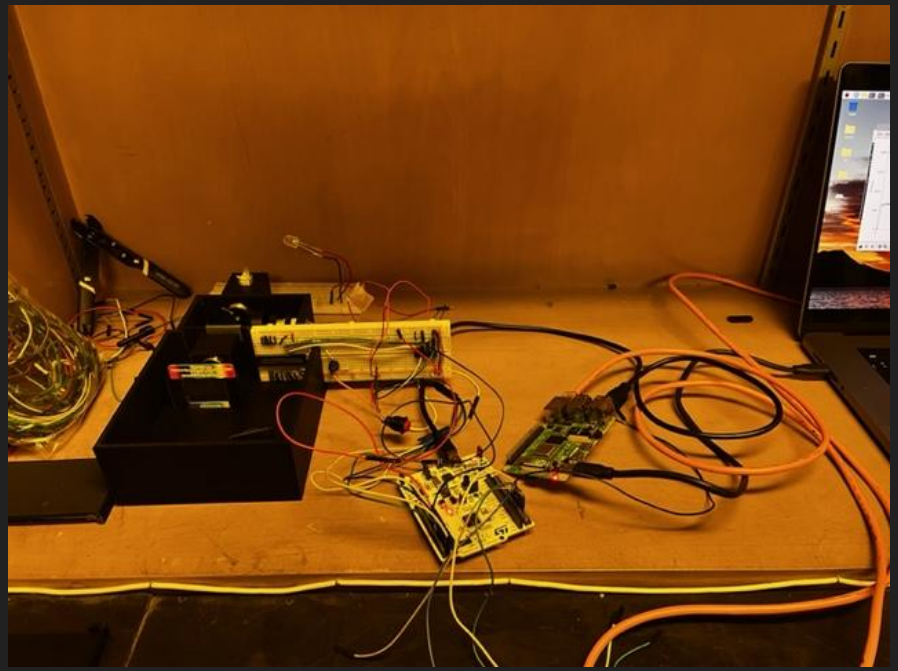
Polypropylene Would Have Been A Better Sample

- Polypropylene is the main plastic found in blue Covid maks
- When we inspected the Raman response of polypropylene, we noticed a Raman intensity peak at 3000 cm^-1
- After doing calculations, this means the Raman response is in infrared frequency: 780 nm. This is too far in the infrared for our CCD to pick up.

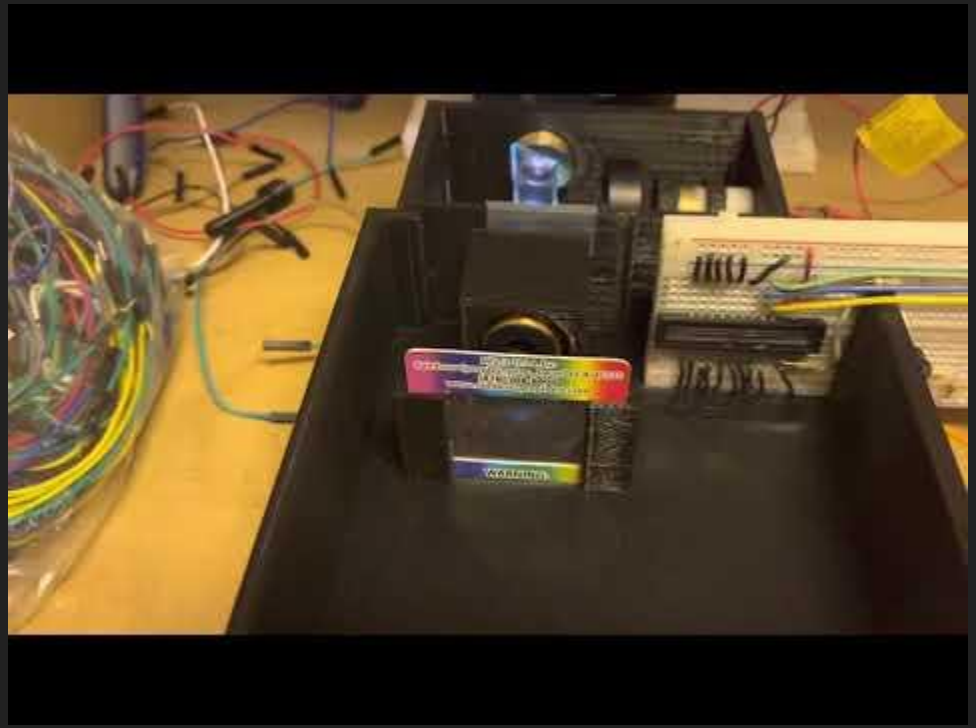


Live Demo

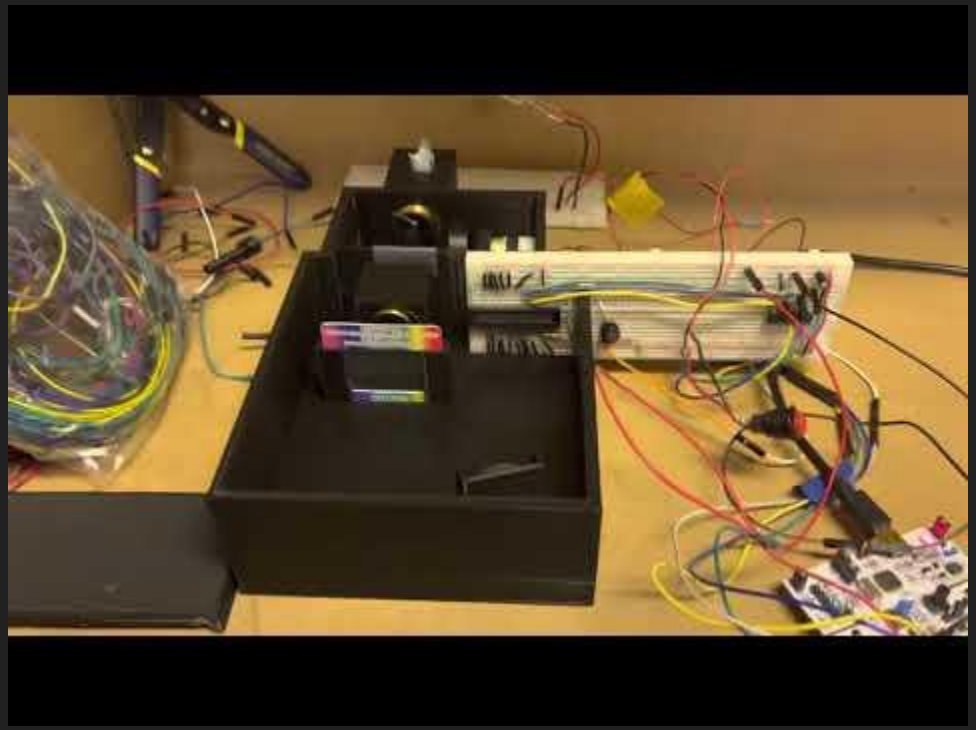
Please follow us to Marcus SDP Labs for a live demo of PlastiSense



Spectroscope & CCD Alignment Recorded Demo



Laser Alignment Demo for Raman Proof-of-Concept



Team Responsibilities

Aaron Achildiyev

- Team Coordinator
- PCB Design

Aidan Belanger

- PCB Design
- Optical Design

Victor Lam

- Software Design
- 3D Modeler

Adrian Mora

- Hardware Design
- Software Design