Microbial Pill Sensor

Detailed Design

SDMAY25-17

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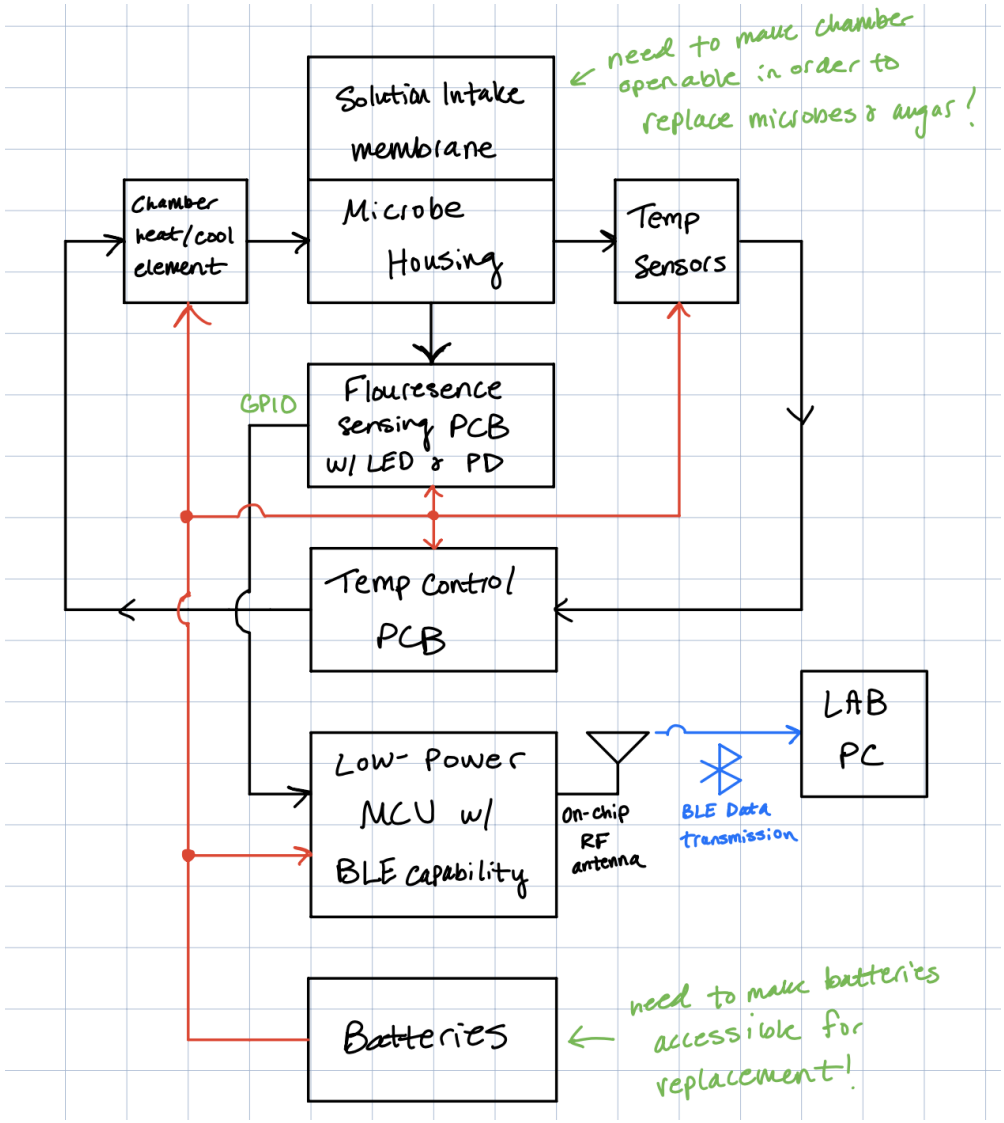
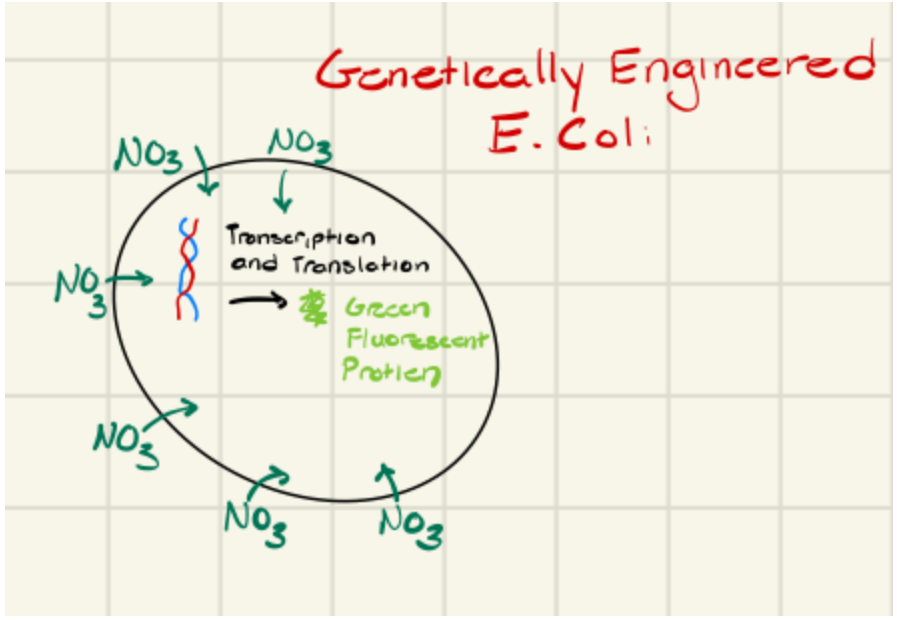
Project Overview

- Develop biosensing system that will house, monitor, and transmit data using bioengineered detection mechanism.
- Monitor and control the temperature of the housing unit to maintain cell growth.
- Optical circuit to emit light and measure fluorescent output
- Transmit the collected data through a Low-Energy Bluetooth connection.



Biosensing Mechanism

- Genetically engineered E. Coli expresses Green-Fluorescent-Protein upon presence of Nitrate
- Absorption of blue light by GFP causes emission of green light
- Measuring intensity of green light emission gives concentration of Nitrate in solution
- Generalizable mechanism to different microbes and analytes via bioengineering – Not our job!!



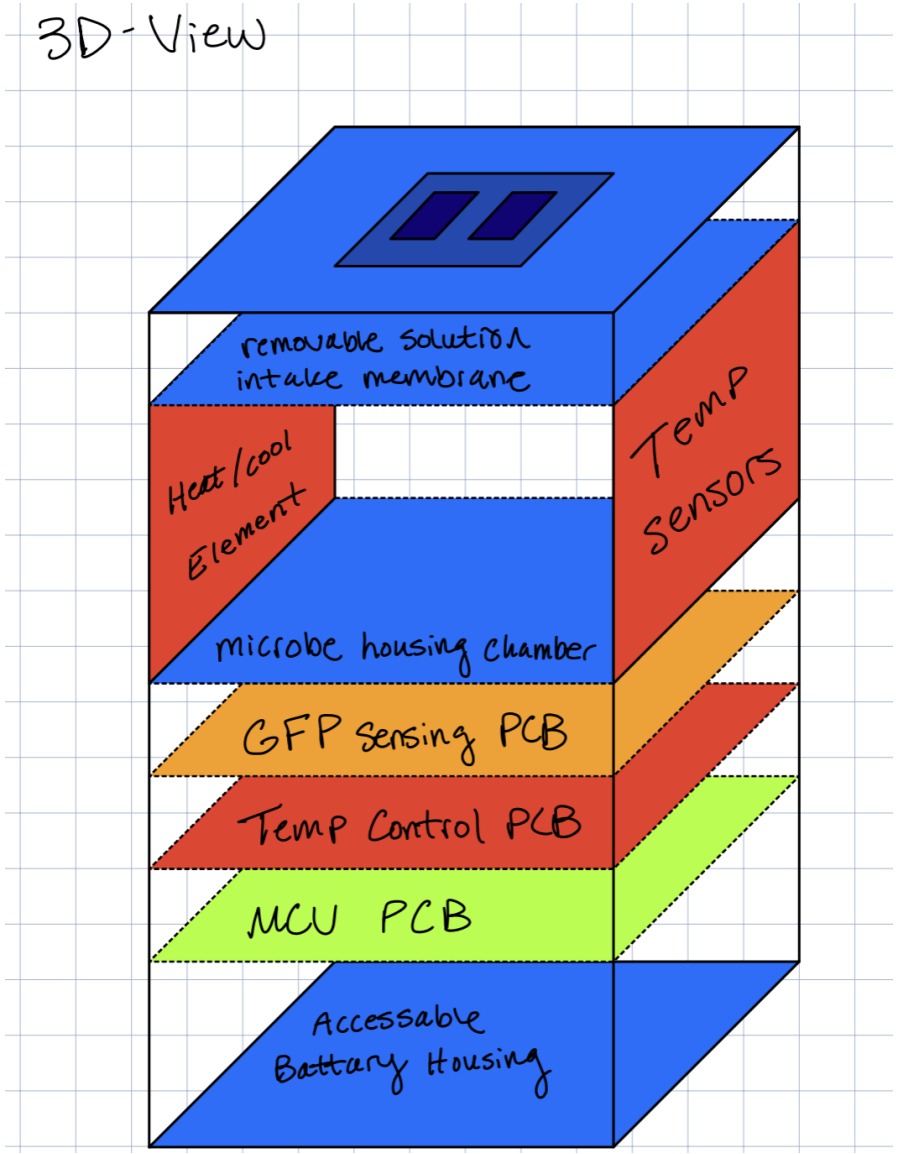
3D Design

Module 1: Microbe Housing Chamber

- House for bioengineered microbes
- Maintains conditions to support cell growth
- Flow in of solution with analyte

Module 2: GFP Sensing PCB

- Detects fluorescent response from microbes
- Activation of LED for biodetection
- Measurement of light intensity via photodetector



3D Design

Module 3: Temperature Control

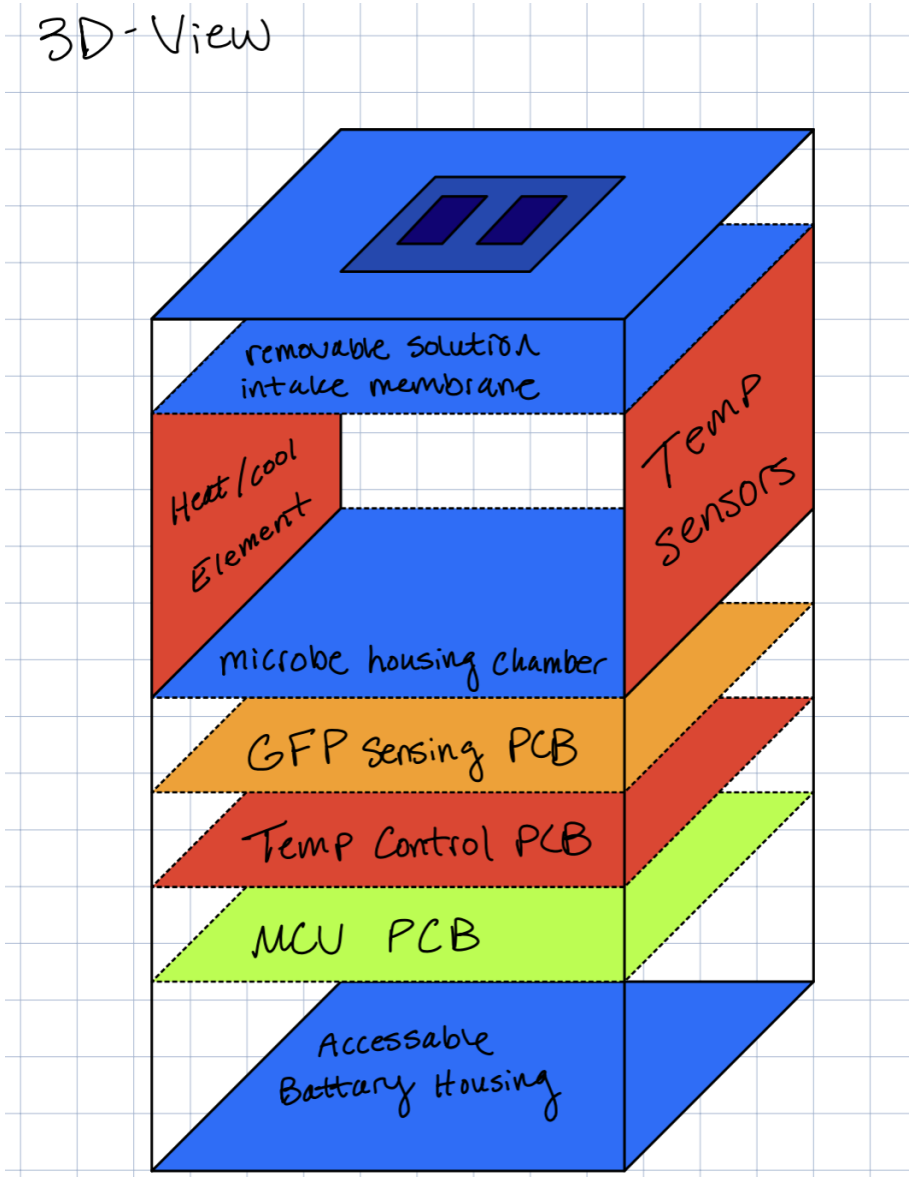
- Maintains temperature environment

Module 4: Microcontroller PCB

- Controls LED activation
- Enables Bluetooth data transmission

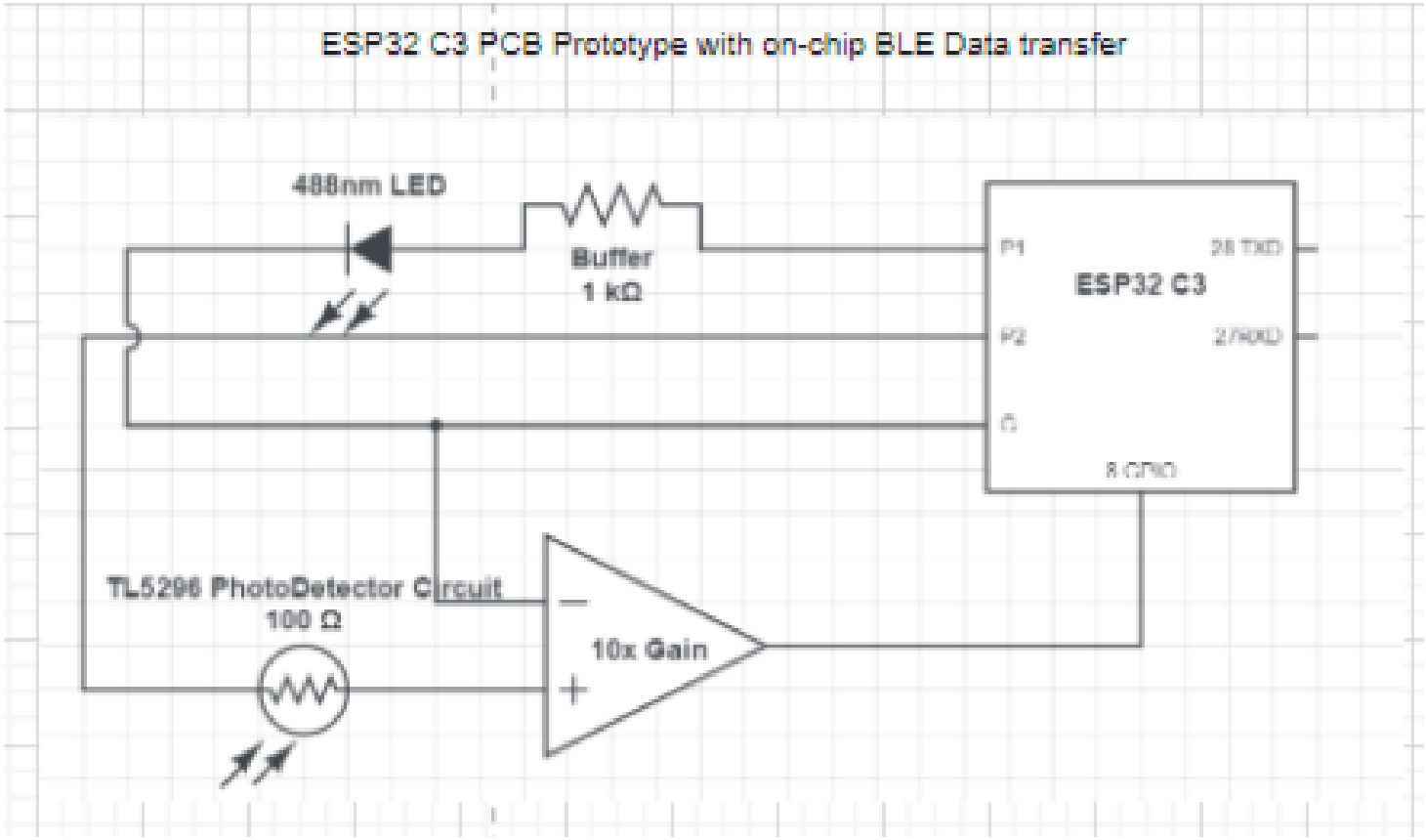
Module 5: Power Chamber

- Houses battery for power



Circuit Design

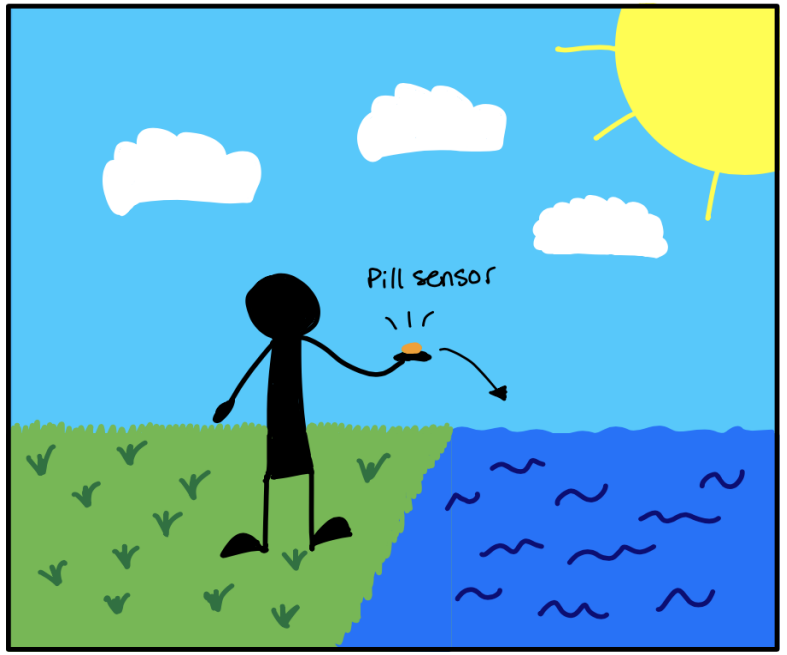
- **ESP32 C3** activates **LED** at desired timing interval
- **Photodetector circuit** converts GFP emitted light into measurable voltage
- **ESP32 C3** transmits voltage via low power Bluetooth

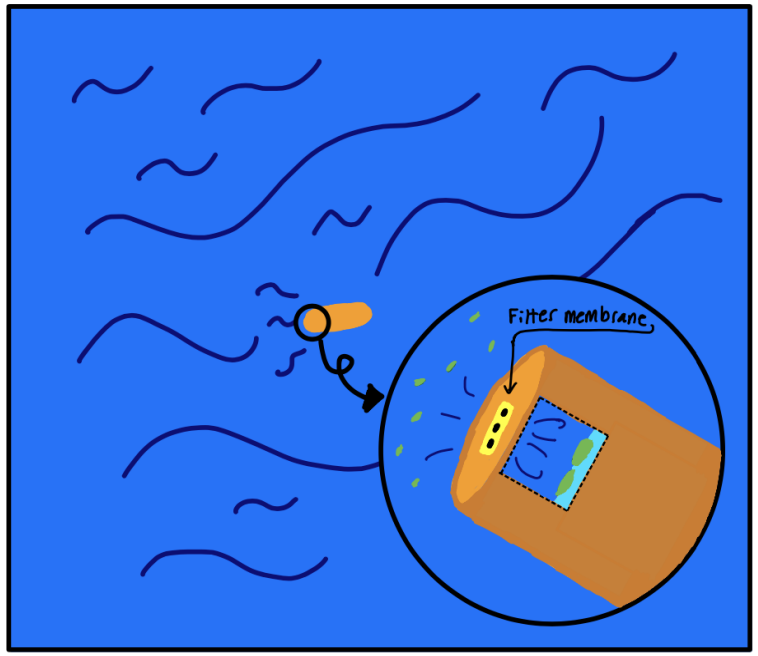


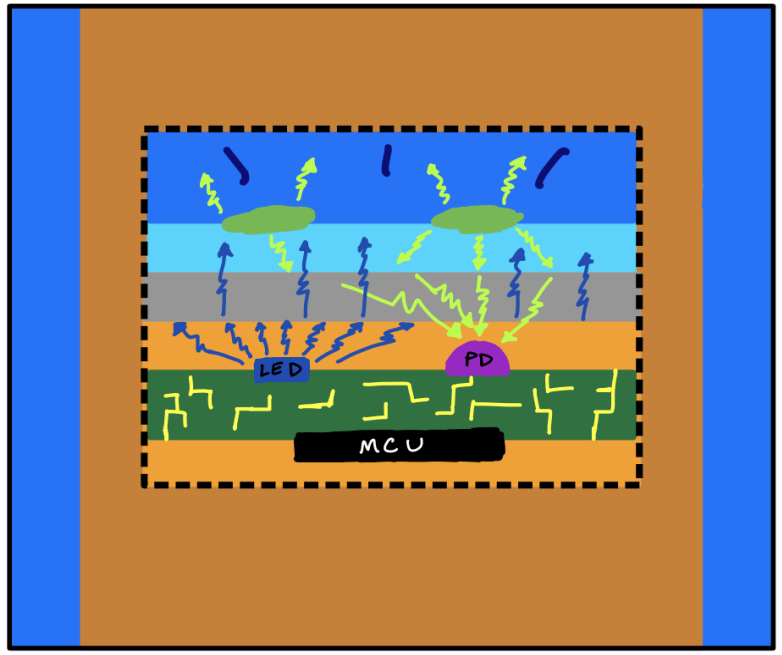
- Lensing needed to uniform distribute light from LED in chamber
- Filtering needed to ensure only measuring emitted light from GFP response

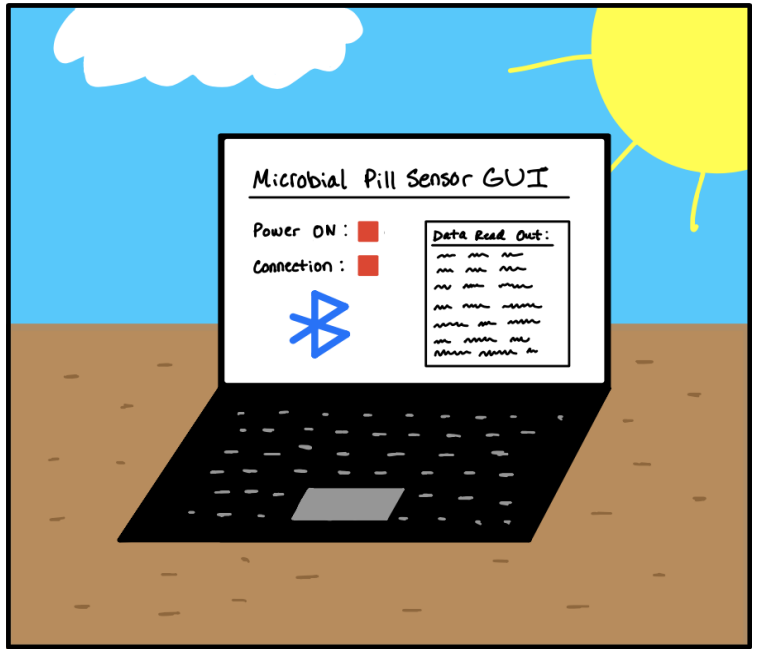
Functionality

- User places pill sensor in environment
- Solution intake membrane filters environment into housing
- GFP sensing PCB module does its function
- User sees output of sensors on GUI









Technology Considerations

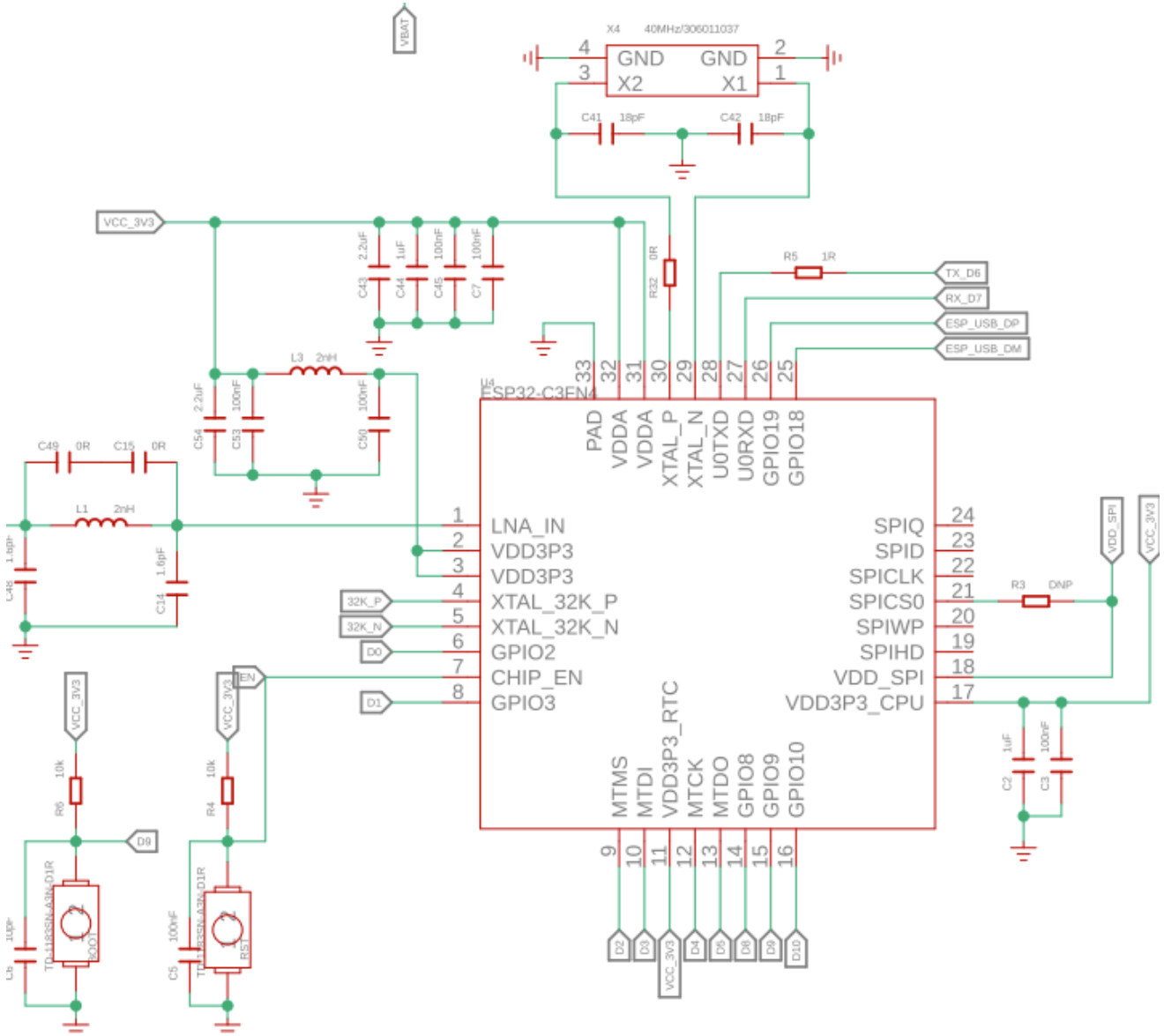
- XIAO ESP32-C3 MCU kit to transfer data via BLE (Bluetooth Low-Energy)
  - + Preserves battery life
  - - Short range data transmission
- TSL2591 Photodetector Circuit
  - + Accurate readings with minimal noise
  - - Overprocesses data and drains battery life

XIAO ESP32-C3 MCU KIT

TSL2591 Photodetector

Technology Solutions and Alternatives

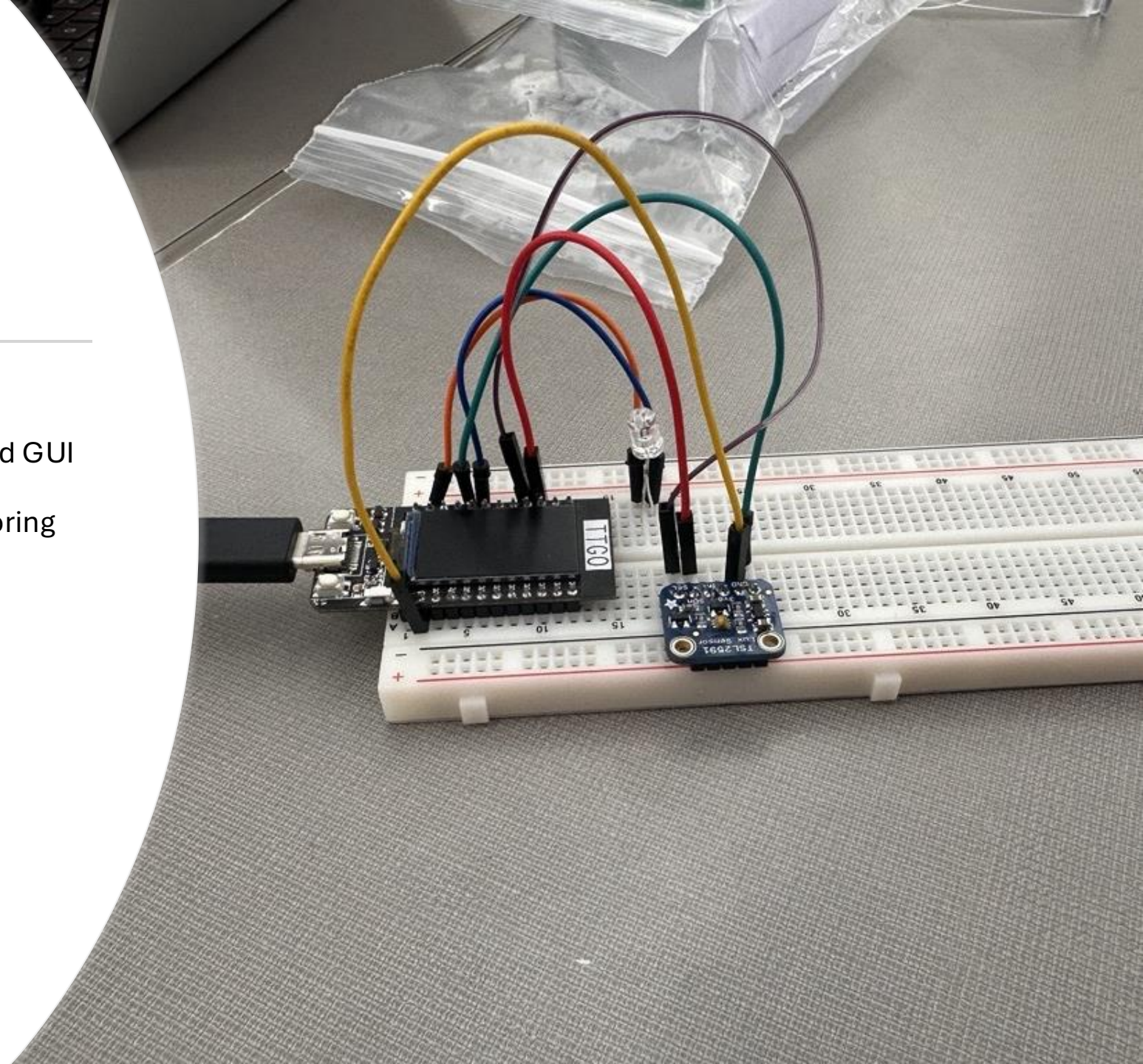
- Project technological demands are simple
- Simplify current designs to remove extra unneeded components
  - No need for on board data processing
  - Remove extra GPIO ports from the ESP32-C3 MCU



Areas of Concern and Development

- Concerns
  - Current design lacks a consistent front-end GUI for users
  - No implementation of temperature monitoring and controls on current design
  - Biosensor testing

- Development
  - Completed basic testing with simplified prototype
  - Creating GUI and processing
  - Refinement of ESP32-C3 DevKit
  - Design of optical detection module



Conclusion

- Breaking the project into modules simplifies design steps
- Focusing on the user's needs to refine current designs
- Select simple components to minimize battery usage and processing
- Develop GUI and temperature controls after developing first prototype to ensure progression

Thank you!
Any Questions?