

Low-cost, Controllable Hypoxia Chamber for Exploring Stem Cell Behavior

Team: Andrew Hartman, Jacob Knudson, Colin Marchus, Alexandra Morrison, Isabell Strawn | **Sponsor & Client:** Dr Nathan Schiele



Lead Instructor: Dr Dev Shrestha | **Shop Mentor:** Ian Glasgow

Objective

- The objective of this project is to design and manufacture a low-cost, controllable hypoxia chamber to examine stem cell behavior.

Background & Value Proposition

- Stem cells naturally grow in a low-oxygen environment and simulating this environment allows researchers to efficiently cultivate stem cells and conduct research regarding the effect of hypoxic environments on the cells' development.
- Commercial hypoxia chambers are expensive. This project aims to develop a hypoxia chamber that is both inexpensive and simple. This project will result in a simple hypoxia chamber design that will allow other researchers to utilize our technology.

Key Requirements

Functionality:

- Maintain O2 levels between 1% and 21%
- Maintain CO2 levels at 5%

Durability:

- Maintain hypoxic environment for 21 days min.
- Reusable for multiple experiments

Working Environment:

- Function within incubator conditions

Logistics:

- Have GUI for controlling & monitoring chamber
- Low-cost, simple & reproducible manufacturing

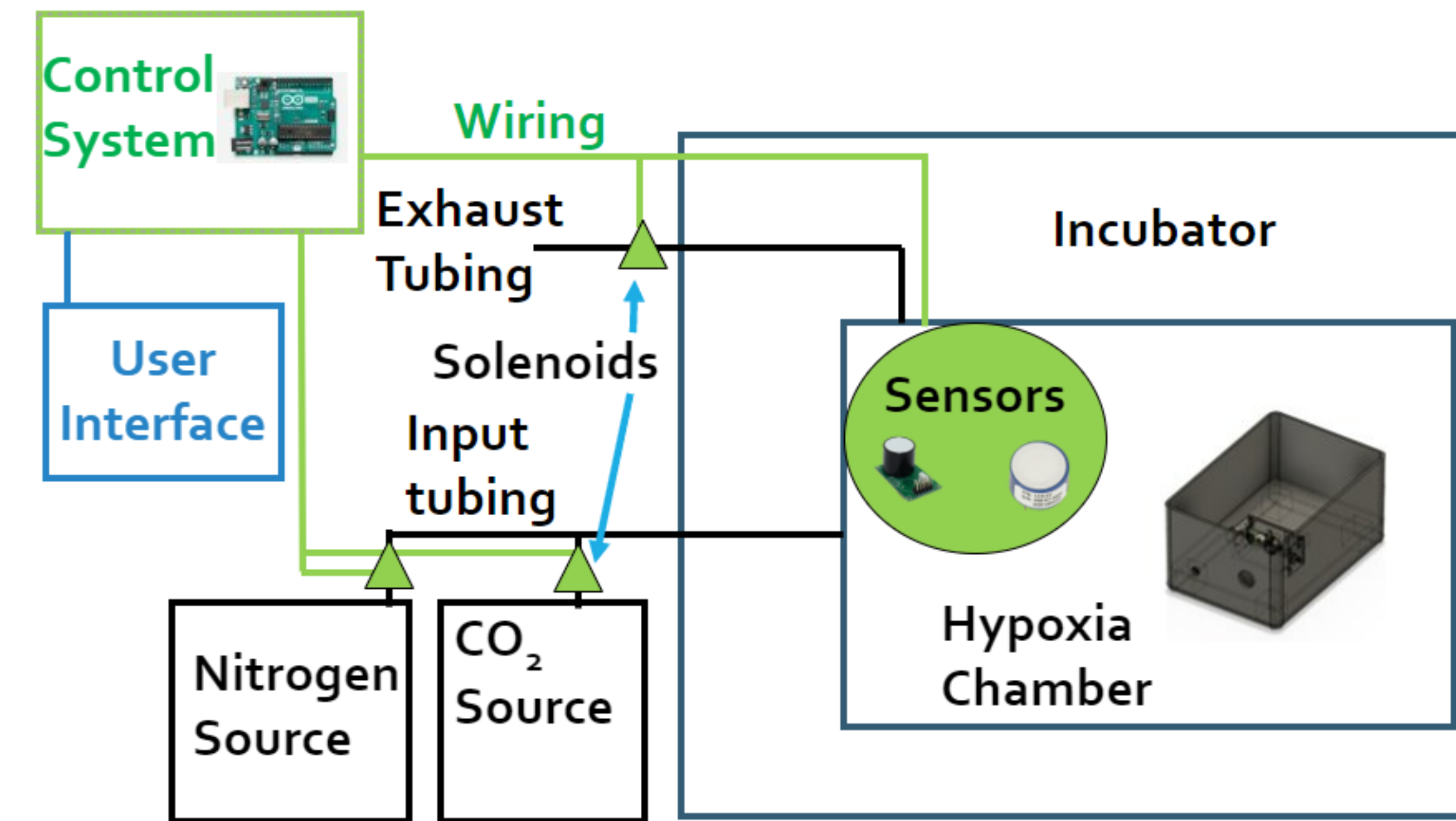
Physical Properties:

- Large enough to fit at least 4 well plates
- Transparent

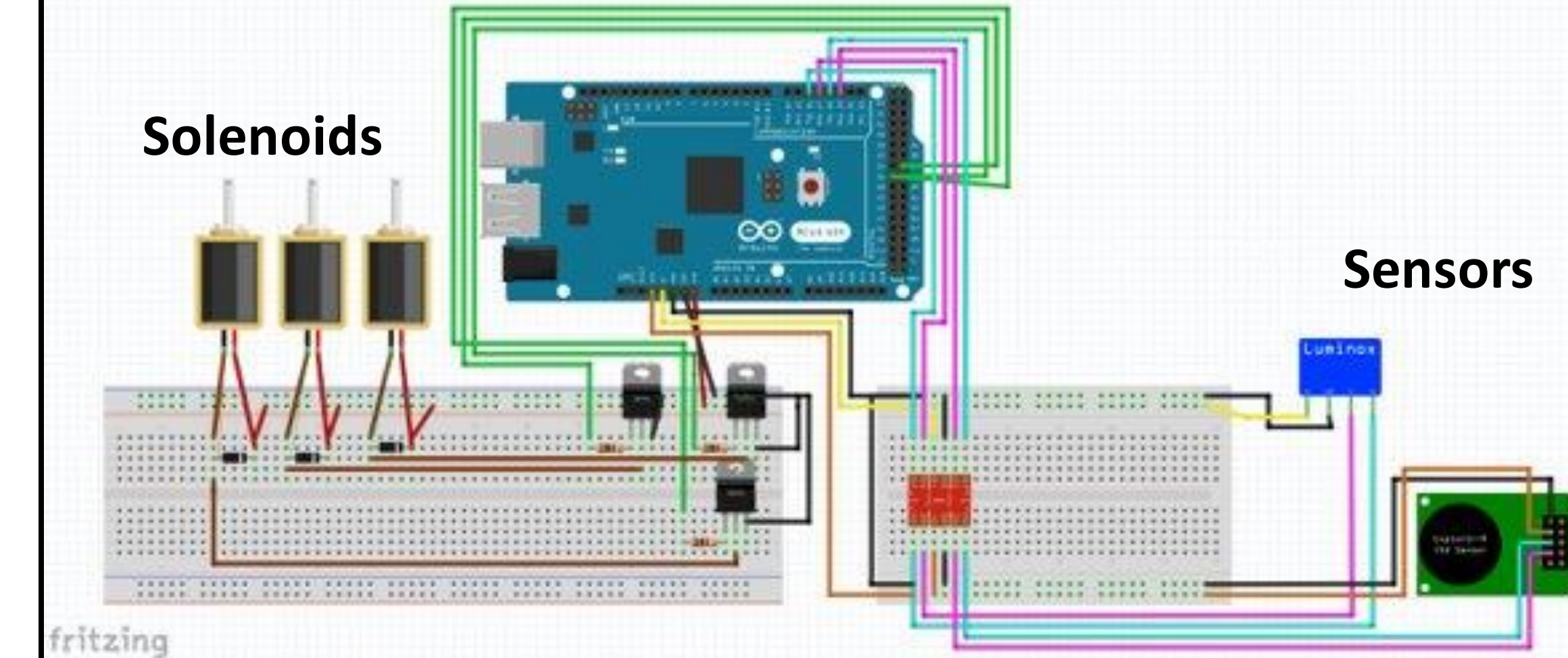
Current Progress

- Chamber has been constructed and control system is set up
- Some testing has been done using just nitrogen to verify the chamber is airtight and can reach appropriate O2 levels

Concept Development

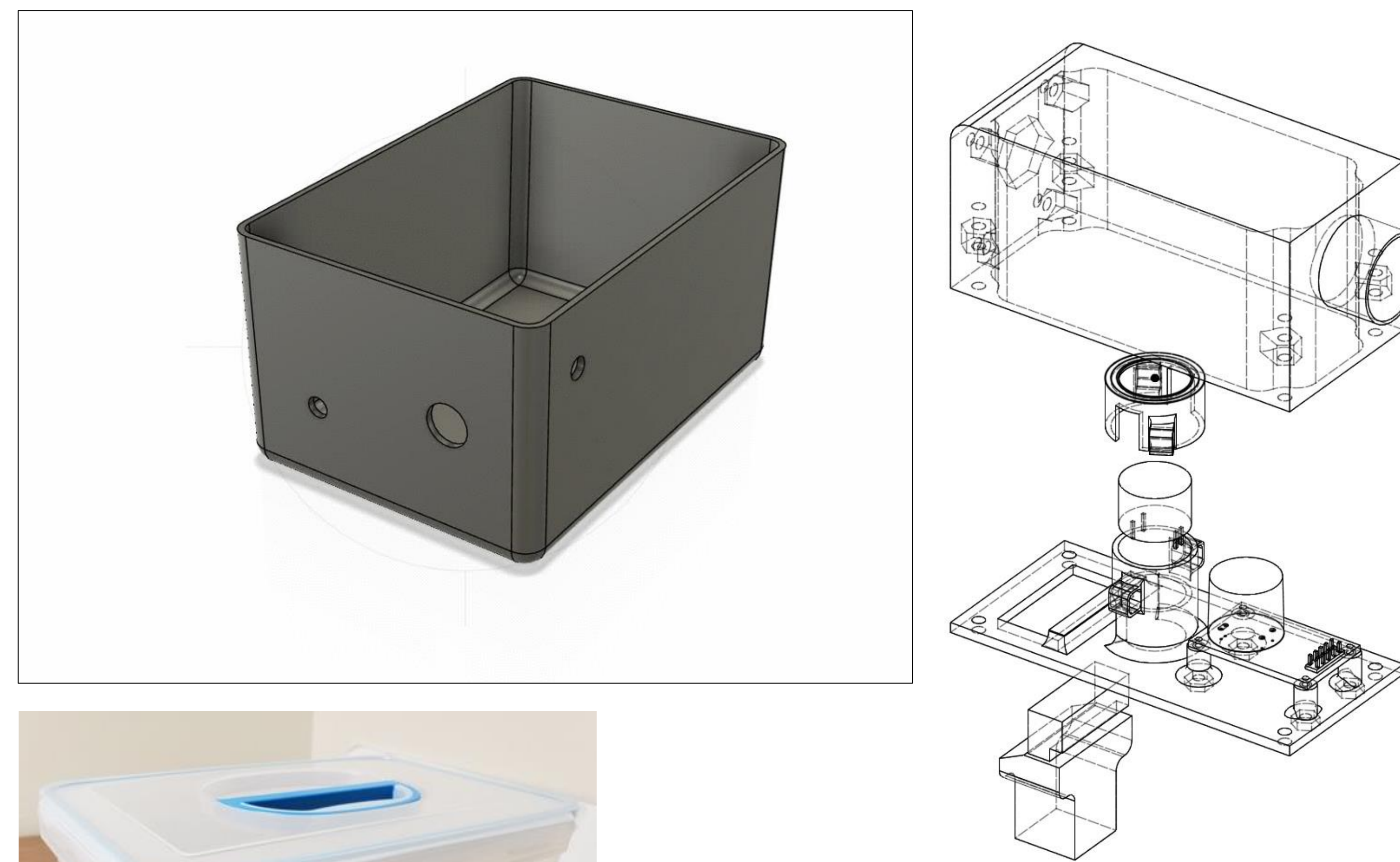


Control System



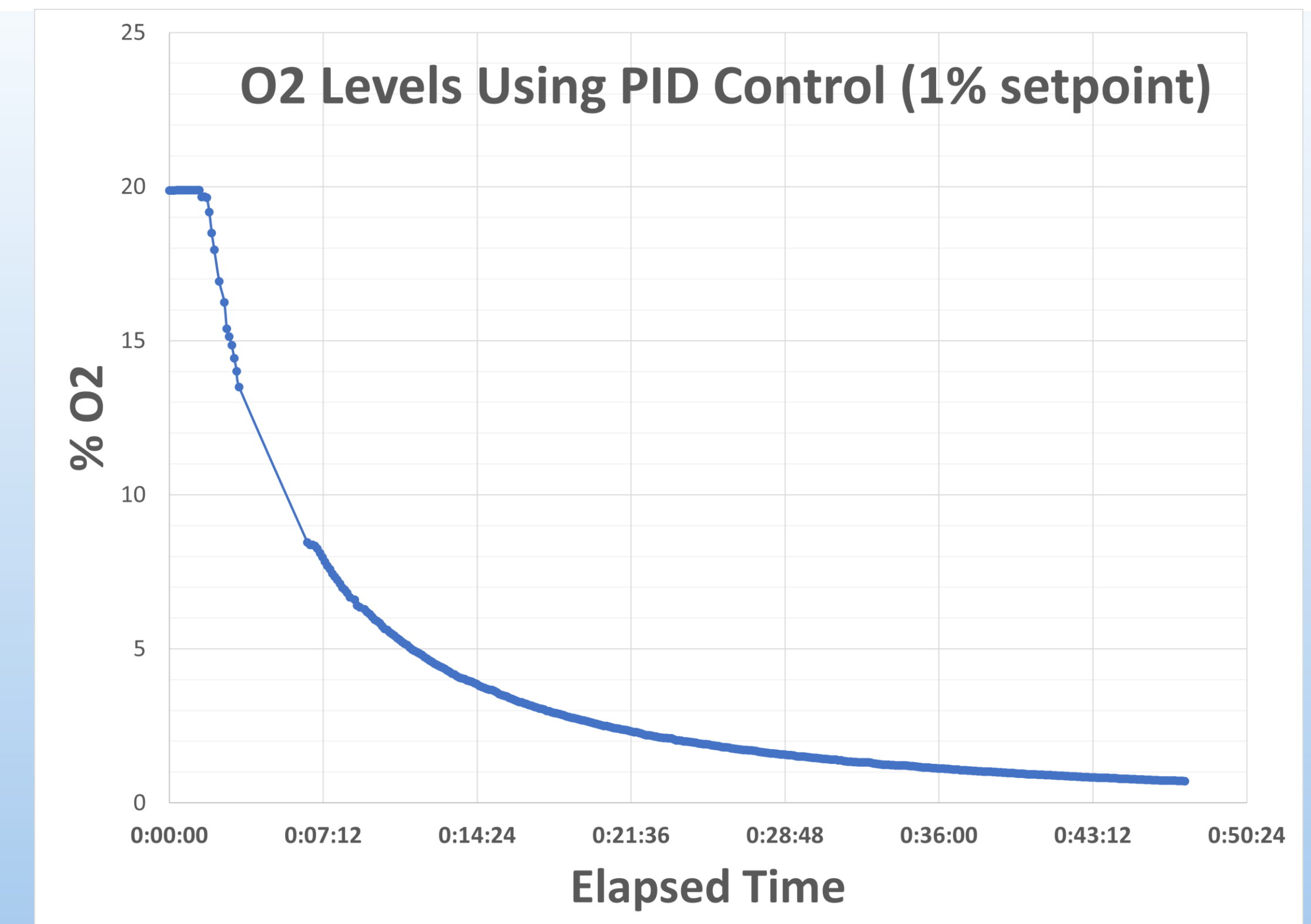
- Solenoids controlled by Arduino using diodes, BJT transistors, and resistors
- O2 and CO2 sensors controlled by Arduino

Chamber Design



- Chamber manufacturing progress (above)
- Experimental setup for testing the system with N2 gas (right)

Design Validation Testing



- Assembled the chamber and connected the nitrogen line
- Ran our PID control algorithm to reach a setpoint of 1% O2
- Overshot the setpoint, need to tune I & D constants

Looking Forward

- Continue testing to refine control system response, use both CO2 and N2 to reach O2 & CO2 setpoints
- Create a PCB and housing for the control system components
- Implement a user interface using Raspberry Pi