



Intrinsic 13-C labeling environmental control module with autonomous CO2, pressure, and humidity control

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Objective

Develop an environmental control module (ECM) to autonomously control the CO2, pressure, and humidity throughout a plant's growing cycle, to be used for cellular metabolism research.

Background

- Plants exposed to carbon-13 during their photosynthetic process lead to a measurable and trackable change in the biochemical composition of the plant tissues.
- Carbon-13 intrinsic labeling is the standard for cellular metabolism research.
- Plants that have been labeled with 13-C are expensive to purchase, leading to difficulties performing cellular metabolism research.

Methods

Environmental Control Module Housing:

- A sealed environment must be created to stabilize gas that is pumped to a growth chamber.
- An improvised tool cart (Figure 1), measuring 28" in width, was used as our housing, which was caulked with Pelseal Viton fluoroelastomer around all edges and holes.

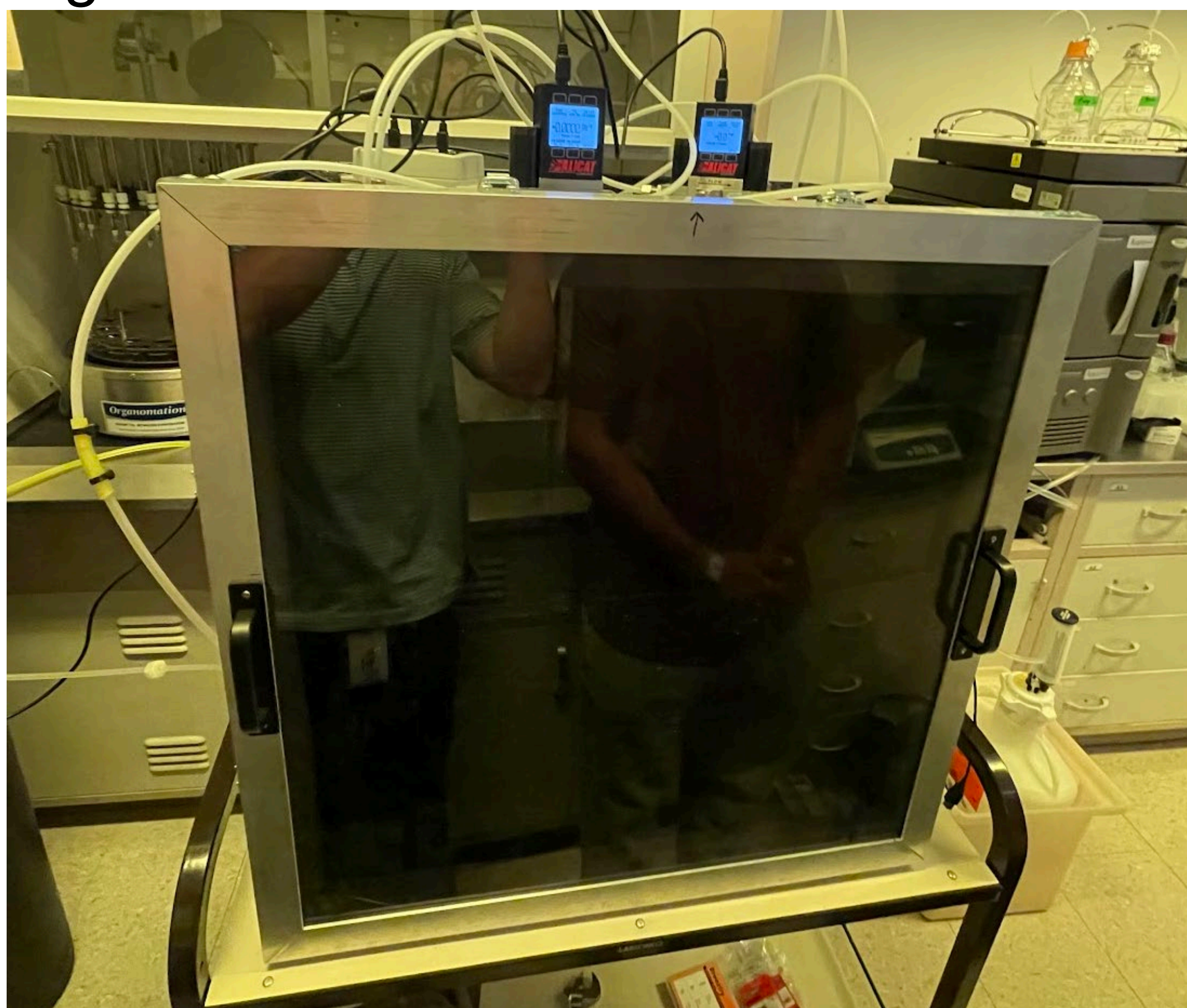


Figure 1: Improved tool cart, sealed with Pelseal Viton.

- A gasket was created using a closed-cell foam sheet that is roughly 3/4" thick.
- A polycarbonate sheet was cut and placed on top of the gasket, which is compressed via an aluminum frame and latches (Figure 2).

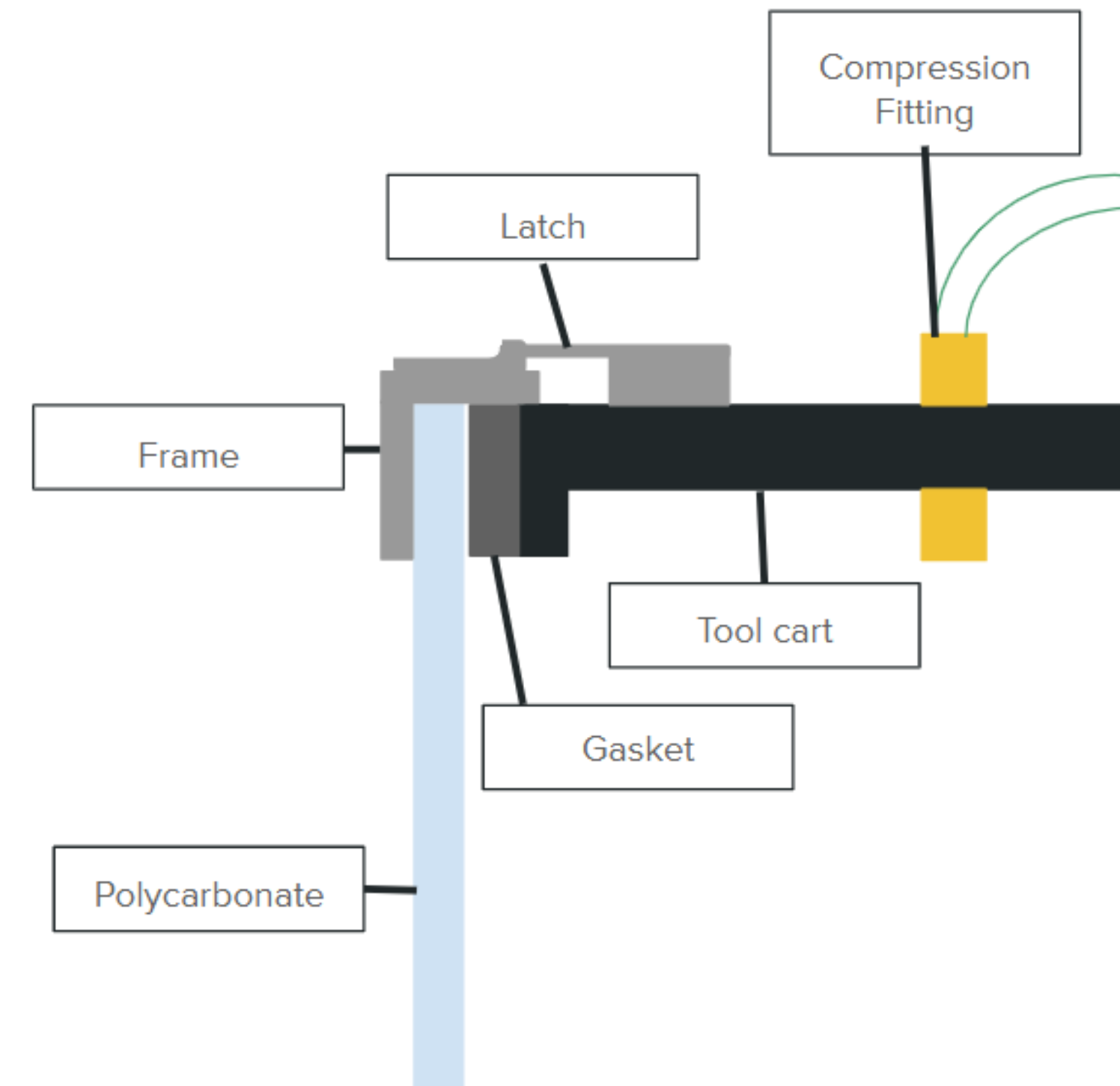


Figure 2: Cross section of the ECM.

- Compression fittings, GatorLock fittings, and the dehumidifier were installed.
- The ECM was pressure tested by pressurizing it to 1 kPa and observing the pressure over time.

Environmental Automation:

- LabVIEW was used to run MFCs parallel to the CO2 sensor in loops
- At the end of every loop, the parameters were updated based on the logic (Figure 3) to maintain environmental conditions.
- A custom GUI was developed for users to select setpoints and view/download data.

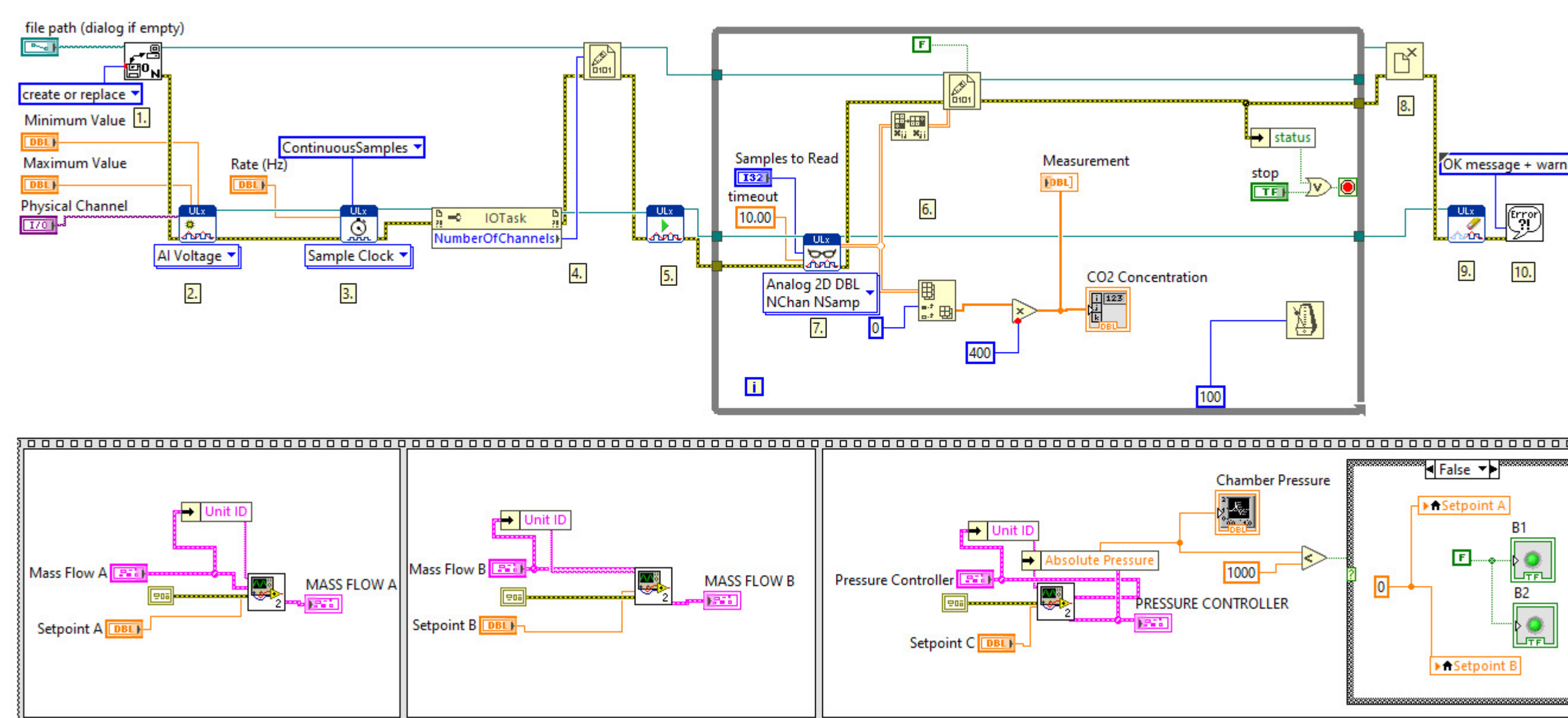


Figure 3: LabVIEW logic determining the necessary MFC action to reach a setpoint.

Results

- Automation system testing indicates that the system will properly manage CO2 concentration and pressure when used with a sealed vessel.
- Three iterations of the ECM saw large improvements in the reduction of leaks (Figure 4).
- Iteration 1: Caulk sealed edges (Test 1 & 2)
- Iteration 2: Filled leaks and caulked gasket edges (Test 3 & 4).
- Iteration 3: Improved rigidity of the frame to evenly disperse force onto the gasket (Test 5 & 6).

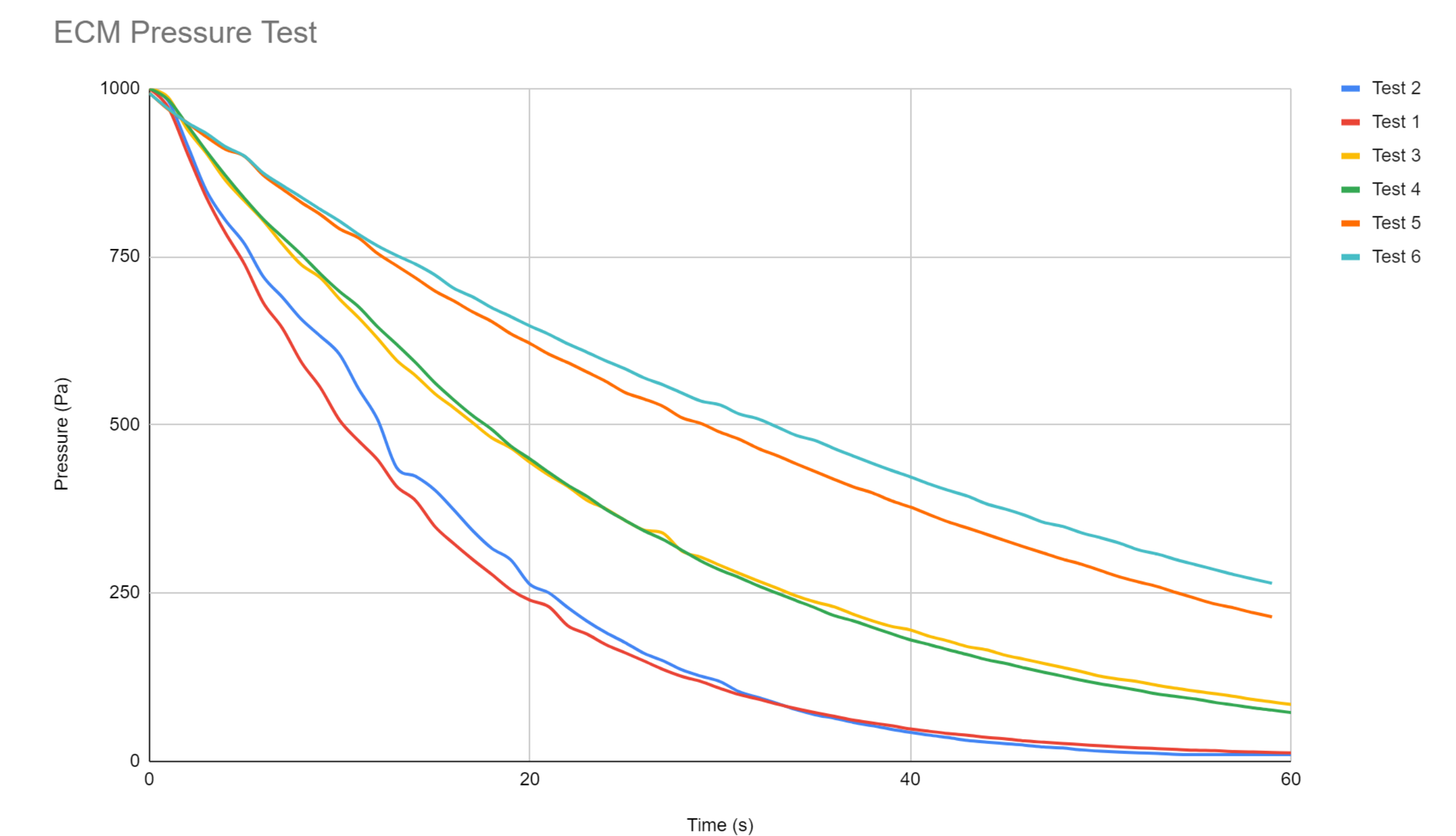


Figure 4: ECM Pressure test results indicating the pressure over a 60 second period, starting at 1 kPa.

Conclusion

- A fully functional automation system was created to manage the CO2 concentration, pressure, and humidity of any sealed environment.
- This system could be improved by implementing a welded housing to prevent further leaks, creating a more sturdy mounting system for MFCs, and observing long-term testing with plants.

Acknowledgements

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