HERD
Mid-Semester Review

March 13, 2023

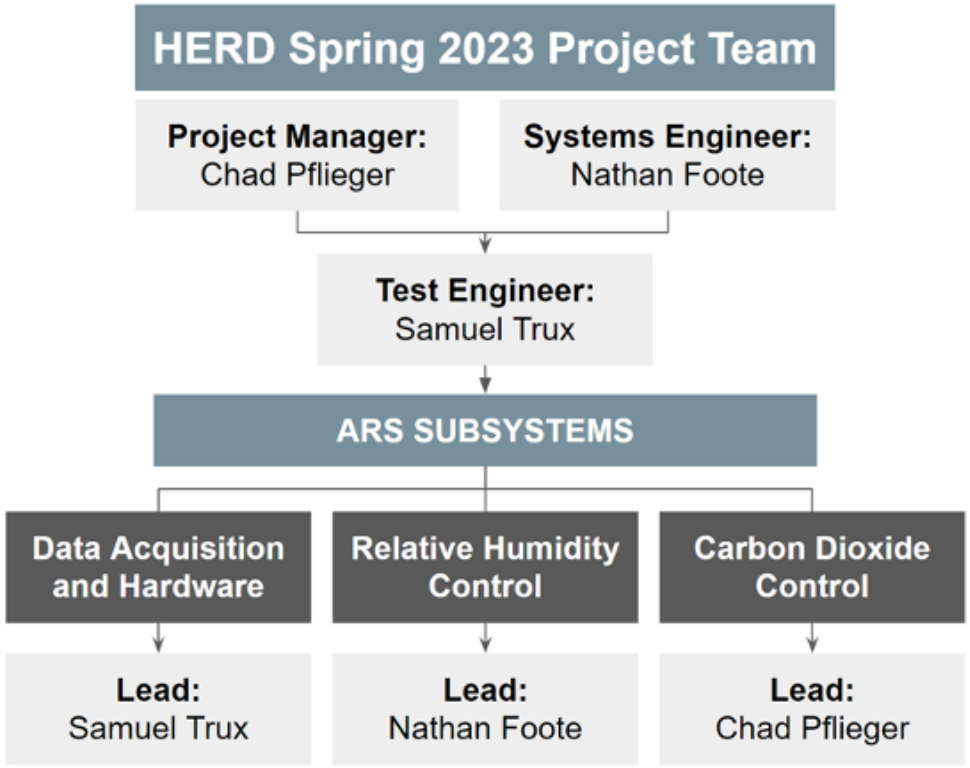
Project Advisor: Stuart Tozer
Customer: Dr. James Nabity

Team Members: Nathan Foote, Chad Pflieger, Samuel Trux

Project Description

- **HERD:** HLS ECLSS Research and Design
- Working in collaboration with Professor Nabity, Stuart Tozer and Cody Bahan, the team is developing an air revitalization system (ARS) test-bed to aid the ECLSS application with short mission duration technologies.

Work Breakdown



Customer:
Professor Nabity

Faculty Advisor:
Stuart Tozer

Research Assistant:
Cody Bahan

Mission Statement

“To aid the ECLSS application by designing and testing traded technologies for an HLS to characterize carbon dioxide and humidity removal in an airstream”

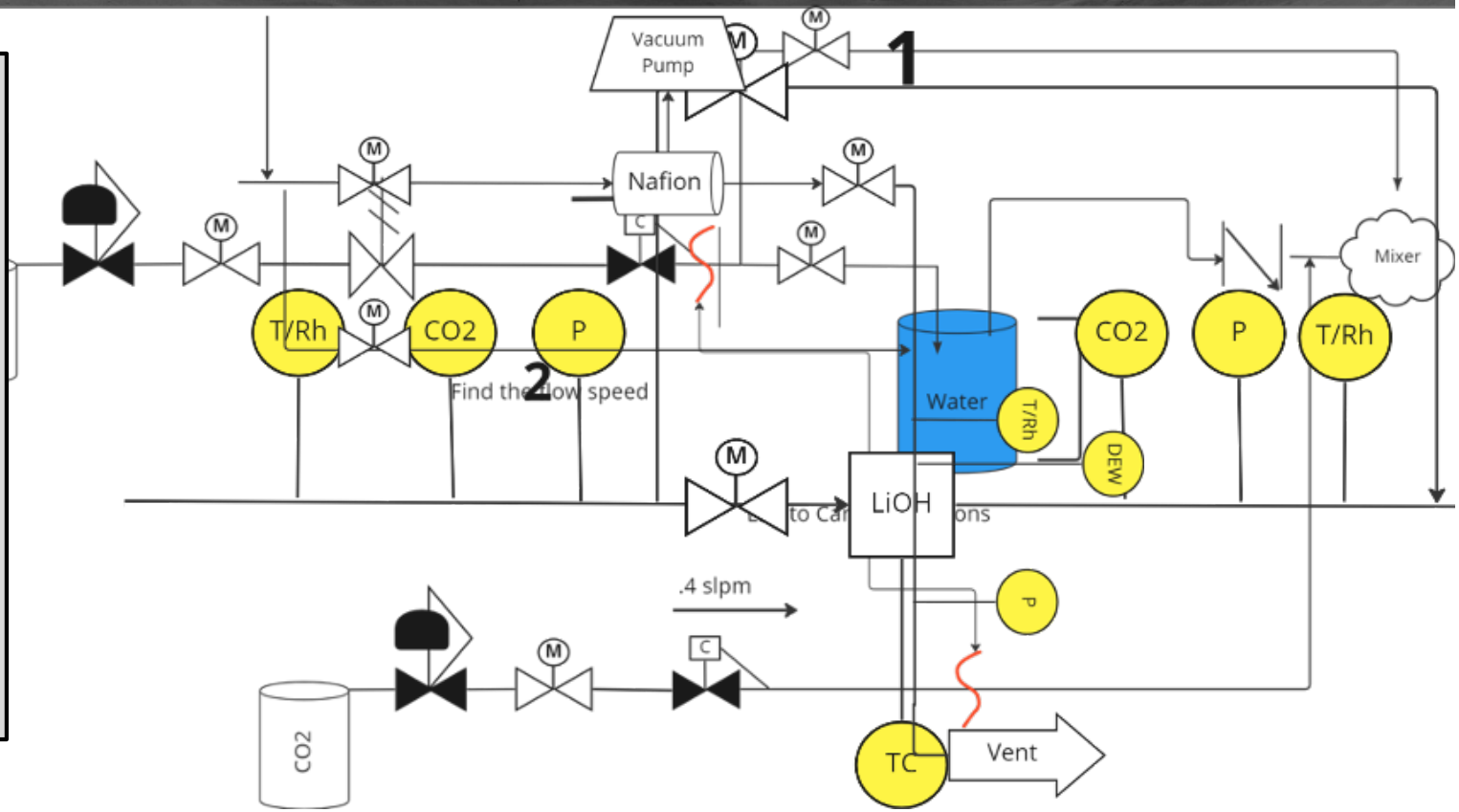
Project Requirements

Requirement	Definition
H1	Complete fabrication of a small-scale breadboard HLS ECLSS
H2	Conduct a Test Readiness Review
H3	Conduct experiments to assess HLS ECLSS performance
H4	Draft a conference or journal article for publication

HLS & ConOps Scenarios

PHASE 2
Humidity Removal:

- ARS collects air data before scrubbing (Nafion)
- For characterization of other ARS elements, scrubber can be bypassed
- Air characterization follows scrubbing
- Venting to fume hood after characterization



Deliverables and Milestones

Major Design Milestones:

- Design and Procure
  - 01/17/23 to 03/17/23
- Assembly and Test
  - 03/21/23 to 05/10/23

Major Project Deliverables	
Project Charter and Mission Statement	February 12th
Final Subsystem Design and Procurements	March 17th
Test Readiness Review	March 23rd
ARS Assembly	April 7th
ARS Characterization	April 14th
ARS Test Conclusion	May 10th
Final Review	TBD

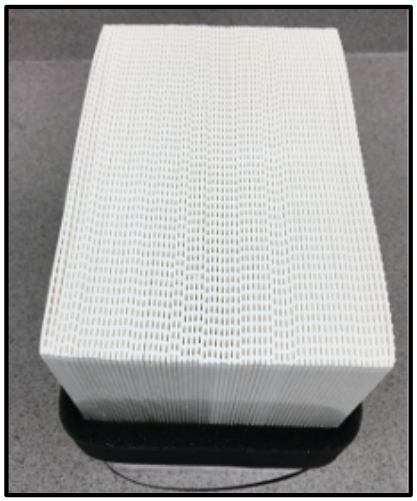
Carbon Dioxide Removal Subsystem

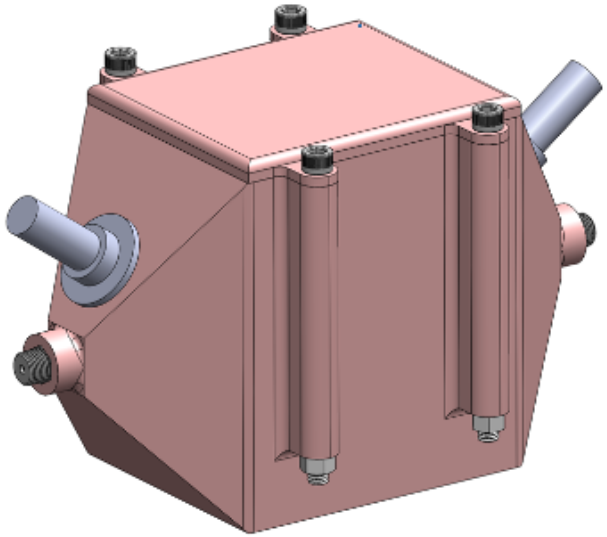
Driving Requirement

HLS-REQ-006 No.	Name	Description
HLS-S-HMTA-0018	Nominal Vehicle/Habitat Carbon Dioxide Levels	The HLS shall limit the 1-hour average partial pressure of carbon dioxide ($ppCO_2$) in the habitable volume to <3 mmHg.

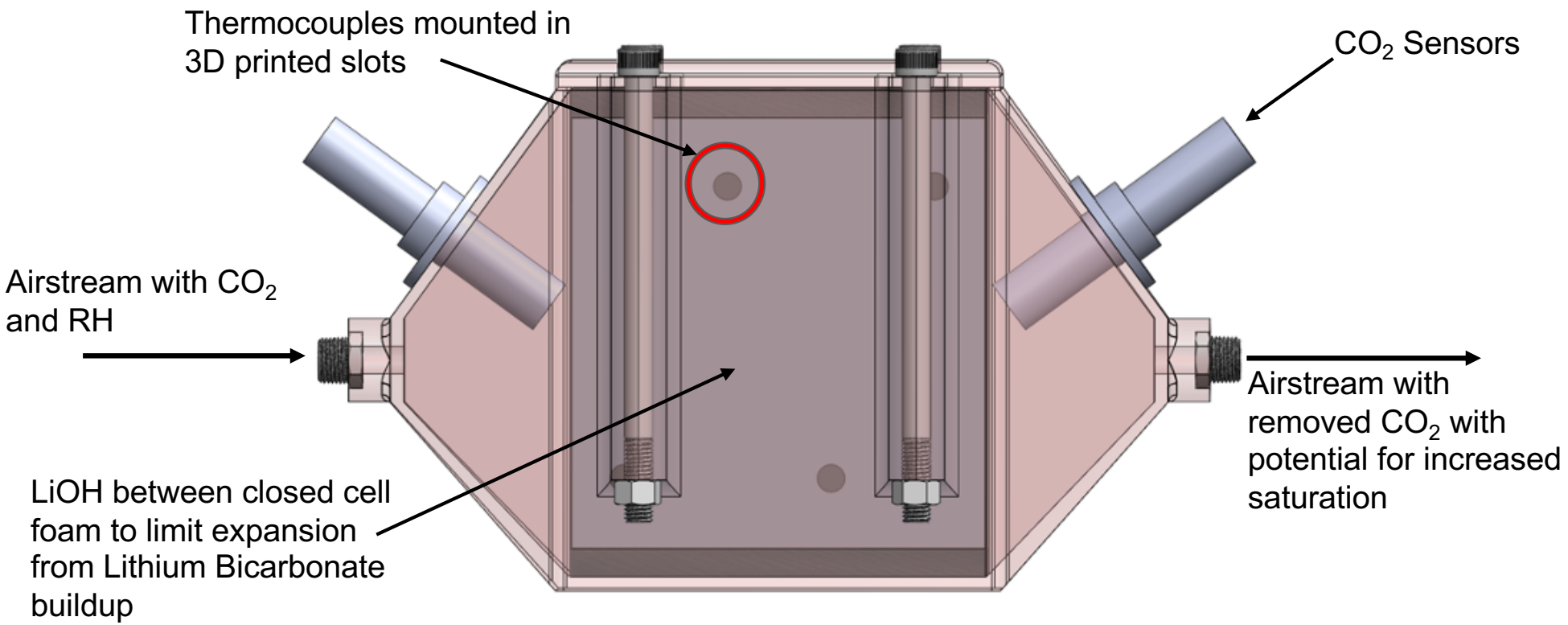
Chosen Technology:
Lithium Hydroxide:
- Micropore PowerCube

Enclosure:
- 3D printed Material (PLA +)
- 3D printed card to hold thermocouples
- HEPA sheets behind LiOH to remove particulates from reaction
- Air sealed with neoprene gasket and epoxy resin





Carbon Dioxide Removal Subsystem



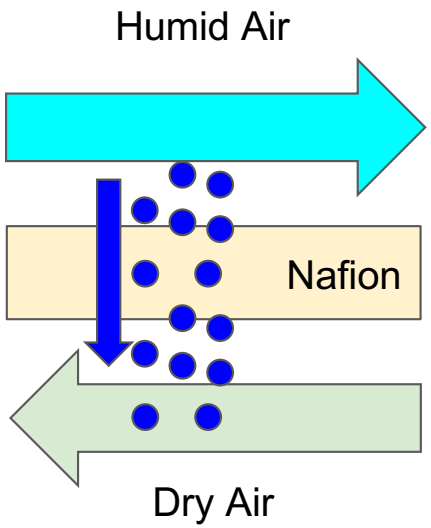
Humidity Removal Subsystem

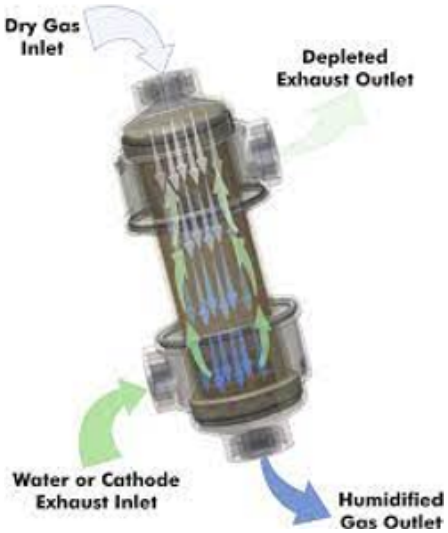
Driving Requirement

HLS-REQ-006 No.	Name	Description
HLS-S-HMTA-0023	Comfort Zone	Relative humidity between 25% and 75% during all nominal operations.

Chosen Technology:
Nafion Humidifier

- Plastic Membrane that is selectively permeable to water
- Used in SpaceX Dragon and Boeing Starliner
- Alternative to condensing heat exchanger traditionally used on spacecraft





Data Acquisition Subsystem

- CO_2, relative humidity/dewpoint, temperature, pressure, mass flow
- Sample rate < 1 Hz
- 16 bit accuracy
- 0-5v analog I/O
- Labview

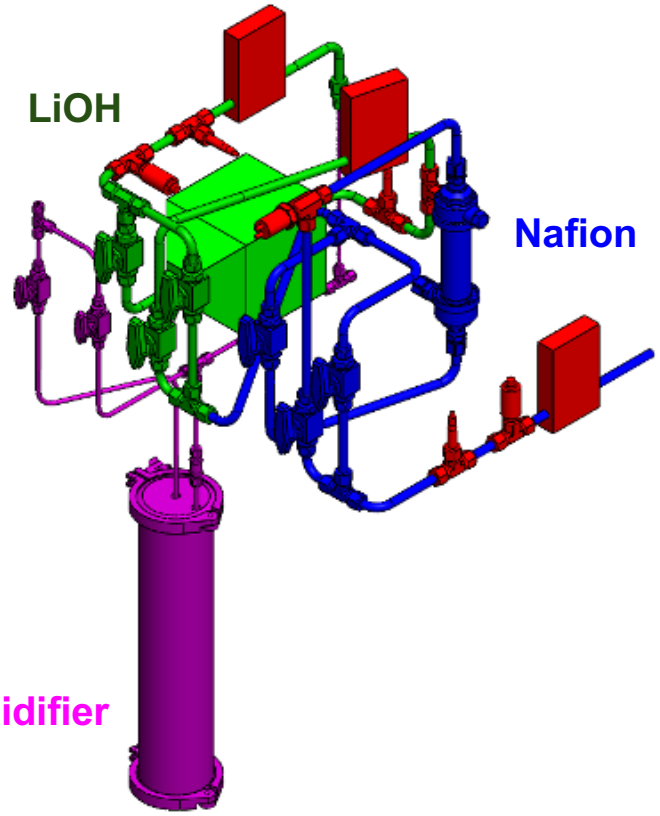




Not shown: Thermocouples




ARS System Design



- **Air Supply**
- **CO_2 Removal**
- **H_2O Removal**
- **Sensors**

Not shown:
- Cart
- CO_2 Canister
- Data Acquisition Hardware
- Vacuum Pump

Worries/Need

- Long lead times
  - Some desired components are not available for 6 months (alternatives required)
- One by-product of LiOH and CO_2 is heat, and has reached up 45^{o}C in previous studies with the PowerCube
  - Glass transition for PLA + is 60^{o}C
- LiOH currently in Wallops, VA
  - Finding contact there to ship
  - Expired 1 year ago (shelf life of 4 years)
- Potential issues during assembly and test

Thank you! Are there any questions?