



CERES

Project Manager: Bryce Logging

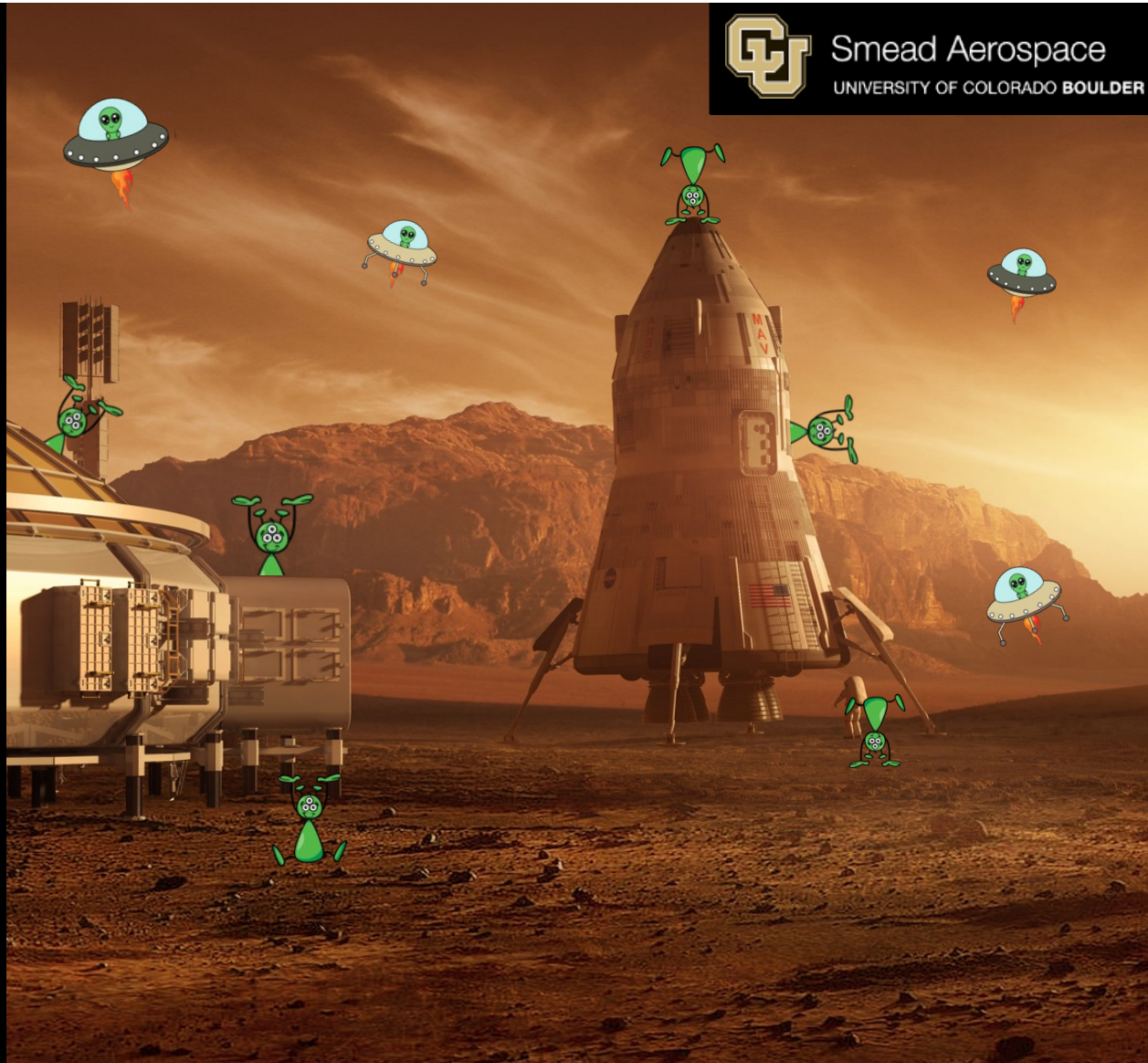
Systems Engineer: Jesús
E. Meléndez Gil

Advised by: Dr. James Nabity
Smead Aerospace Engineering
Sciences Dept.

October 14th, 2024



Smead Aerospace
UNIVERSITY OF COLORADO BOULDER





Agenda Overview

- Project Intro and Organization
- Project Overview
- Fall Deliverables
- Progress
- Project Status

Organization → Overview → Deliverables → Progress → Status



Meet the team



Project Manager
Bryce Logging
Bioastronautics
MS Student



Testing Lead
Senaa Mirza
Bioastronautics
MS Student



Systems Engineer
Jesús E Melendez Gil
Chemical Engineering
PhD Student



DAQ Lead
Steven Liu
Autonomous systems
MS Student



Deputy Project Manager
Marjorie Trahan
Bioastronautics
MS Student

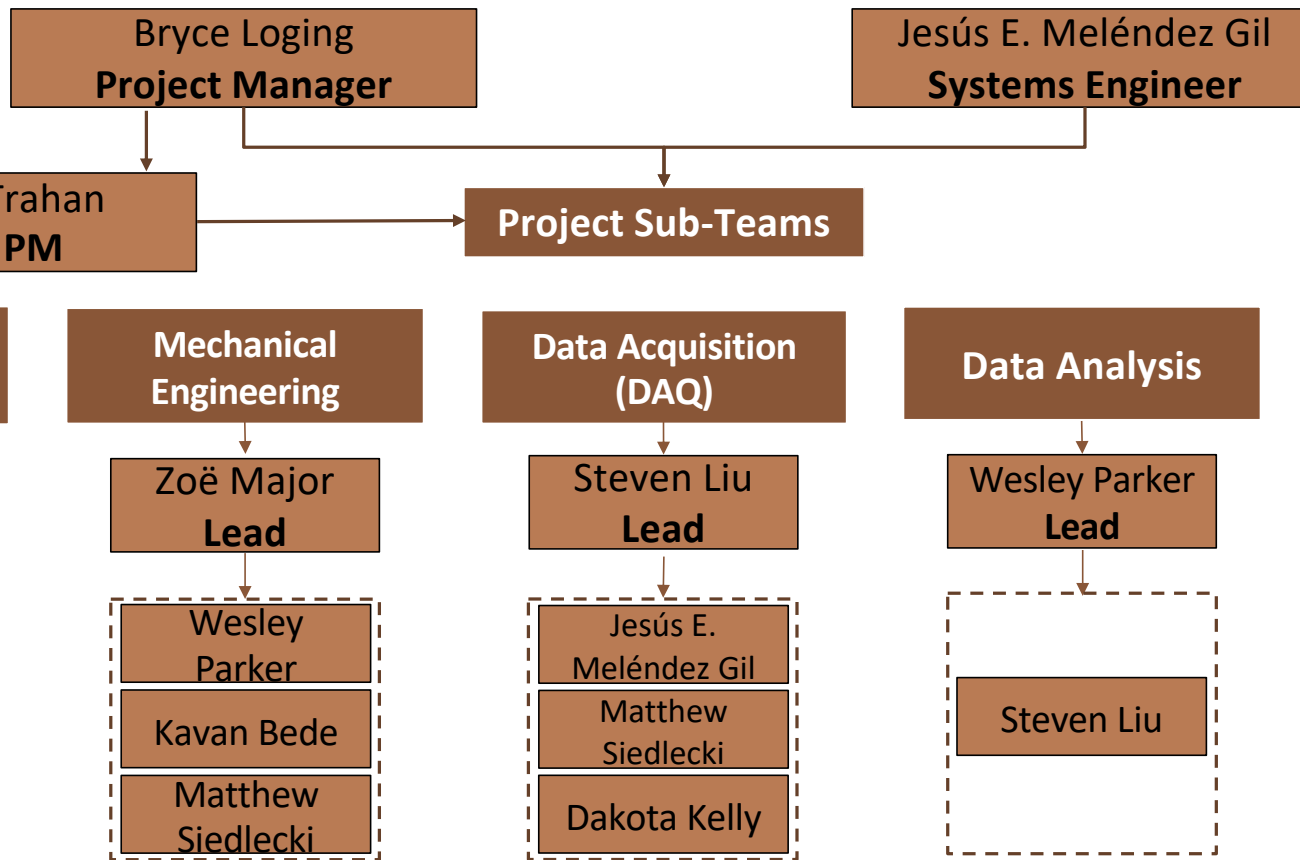


Mechanical Lead
Zoë Major
Fluids, Structures & Materials
MS Student

Organization ➡ Overview ➡ Deliverables ➡ Progress ➡ Status



CERES Spring 2024 Project Team



Organization ➔ Overview ➔ Deliverables ➔ Progress ➔ Status



Project Advisement Breakdown

Project Sponsor and Customer:

- Boeing Advanced Exploratory/Environmental Control and Life Support (ECLS) Group

Project Sponsor and Customer:

- Boeing Exploratory/ECLS Group
- CU Boulder Ann and H.J. Smead Aerospace Engineering Sciences Department

Faculty Advisor:

- Dr. James Naby – CU Bioastronautics



What is CERES?

CO₂ Environmental Removal for Extended-duration Spaceflight

Organization → Overview → Deliverables → Progress → Status

Earth's Atmosphere

$\%CO_2 \approx 0.04\%$

$>10\times$
higher!

ISS Atmosphere

$\%CO_2 \leq 0.4\%^*$

Research Focus

- Beat current ppCO₂ ISS requirements
- Additional focuses included
 - Regenerability
 - Survivability
 - Maintenance

Mild Symptoms Include

- Headache
- Dizziness
- Confusion



Scope Fall 2024:

- **Develop** and **test** a **low power CO₂ removal system**
- Focus on a **desorption system** with **Ionic Liquid**

Plan Fall 2024:

- **Assemble** and **Test** the CO₂ desorber prototype
- **Characterize** and **optimize** the **CO₂ desorption system**

Project requirements

- **Closed loop** (**↓consumables**, **↑regenerative capabilities**)
- No zeolites or amines
- 4 Crew members @ > 1 mm Hg pp CO₂
- ≤ 100 W Power Consumption
- 3 years operability **w/o performance degradation**



ECLSS

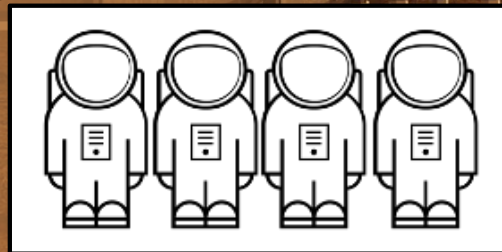
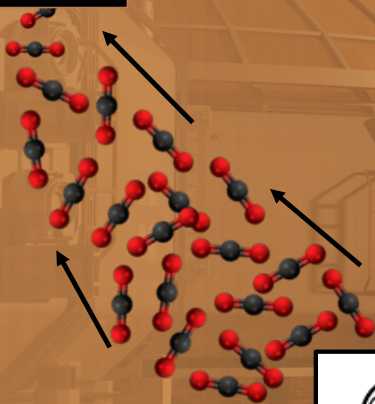
HAB ATMOSPHERE

Regulate to $< 1 \text{ mmHg ppCO}_2$

3 months

7 months

9 months



$\sim 1.3 \text{ Kg CO}_2 / \text{person/day}$



Fall Deliverables

Project Milestones

- Subsystem Testing
Oct. 13th thru Nov. 24th
- Boeing TRR
Oct. 29th
- Full System Integration and Testing
Oct. 20th onwards

Major Project Deliverables

Deliverable	Receiver	Due Date
Quad Charts/Sponsor Meeting	Boeing	Weekly
Project Charter	C. Koehler	09/16/24
Mid-Semester Presentation	C. Koehler	10/14/24
Test Readiness Review (TRR)	Boeing	10/29/24
ICES Abstract	ICES	11/14/24
Final Video	C. Koehler	12/12/24

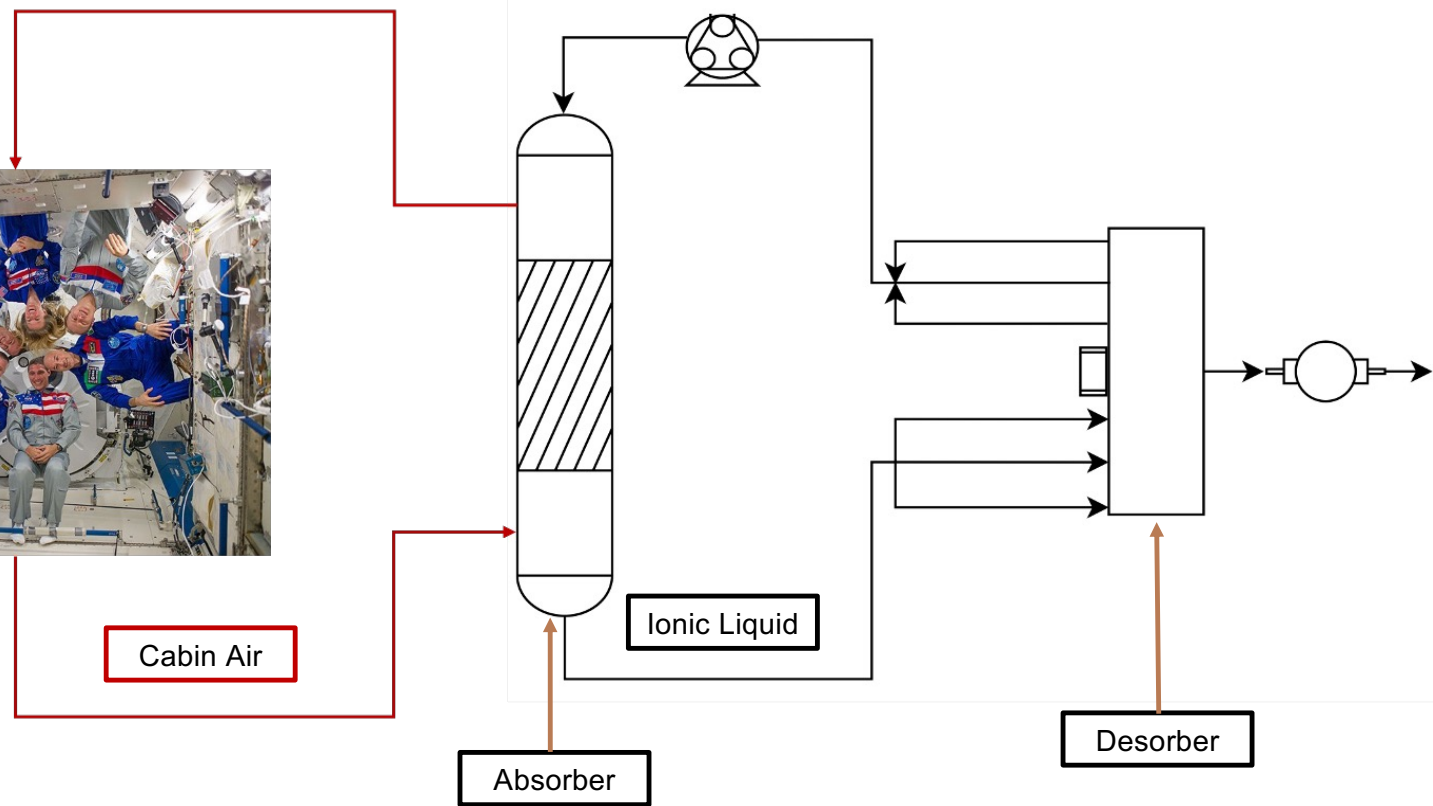


Fall 2024 Progress

System Diagram



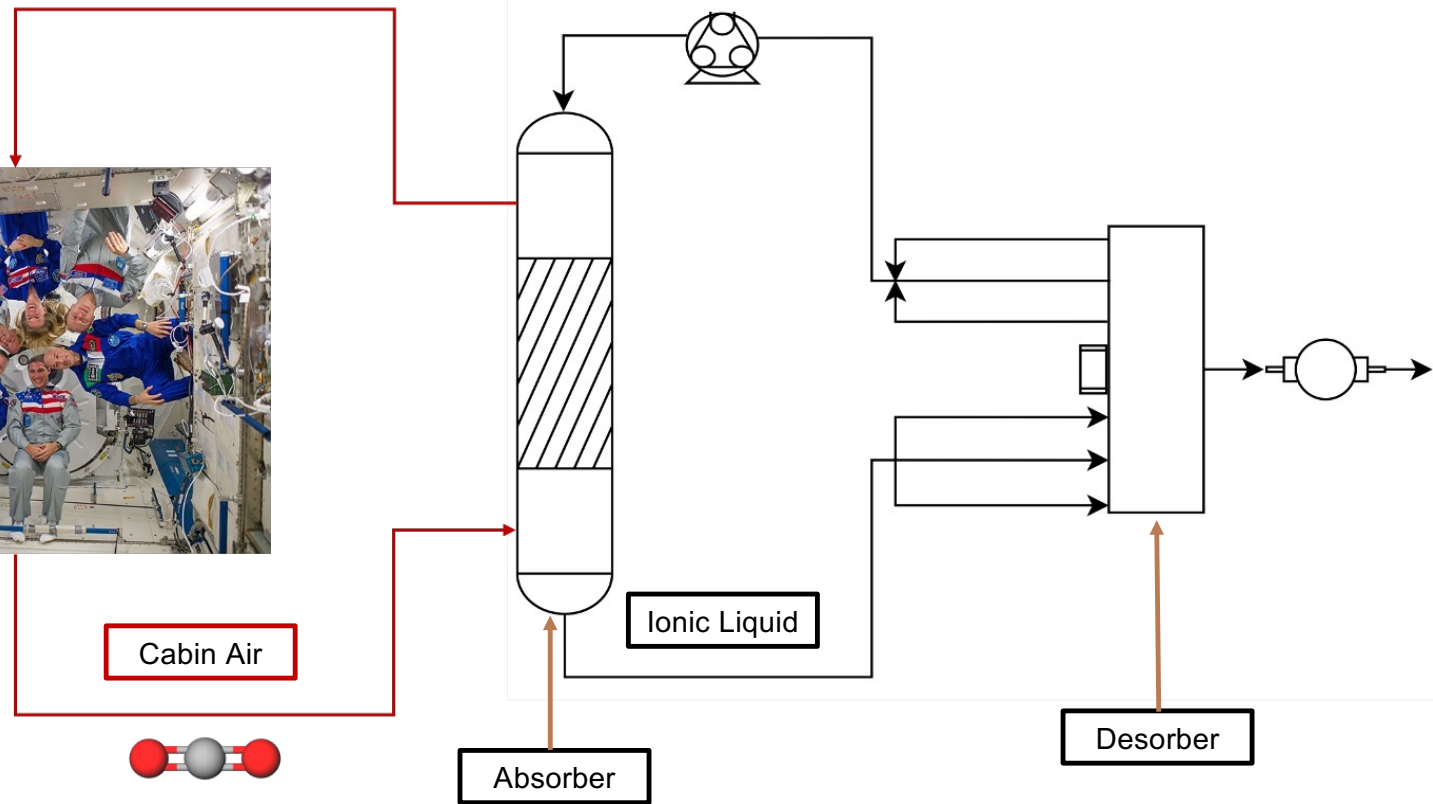
Happy Astronauts!



System Diagram



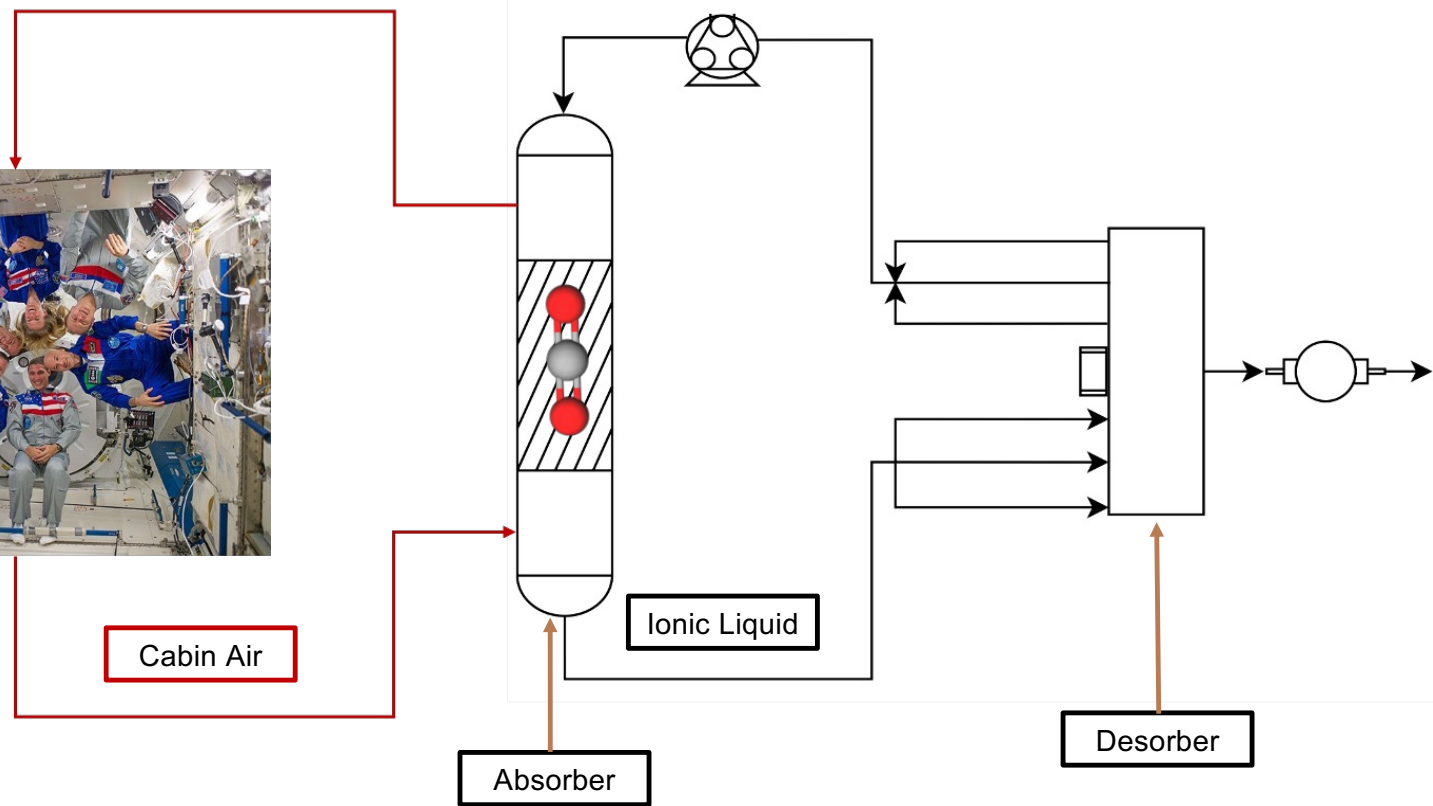
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System Diagram



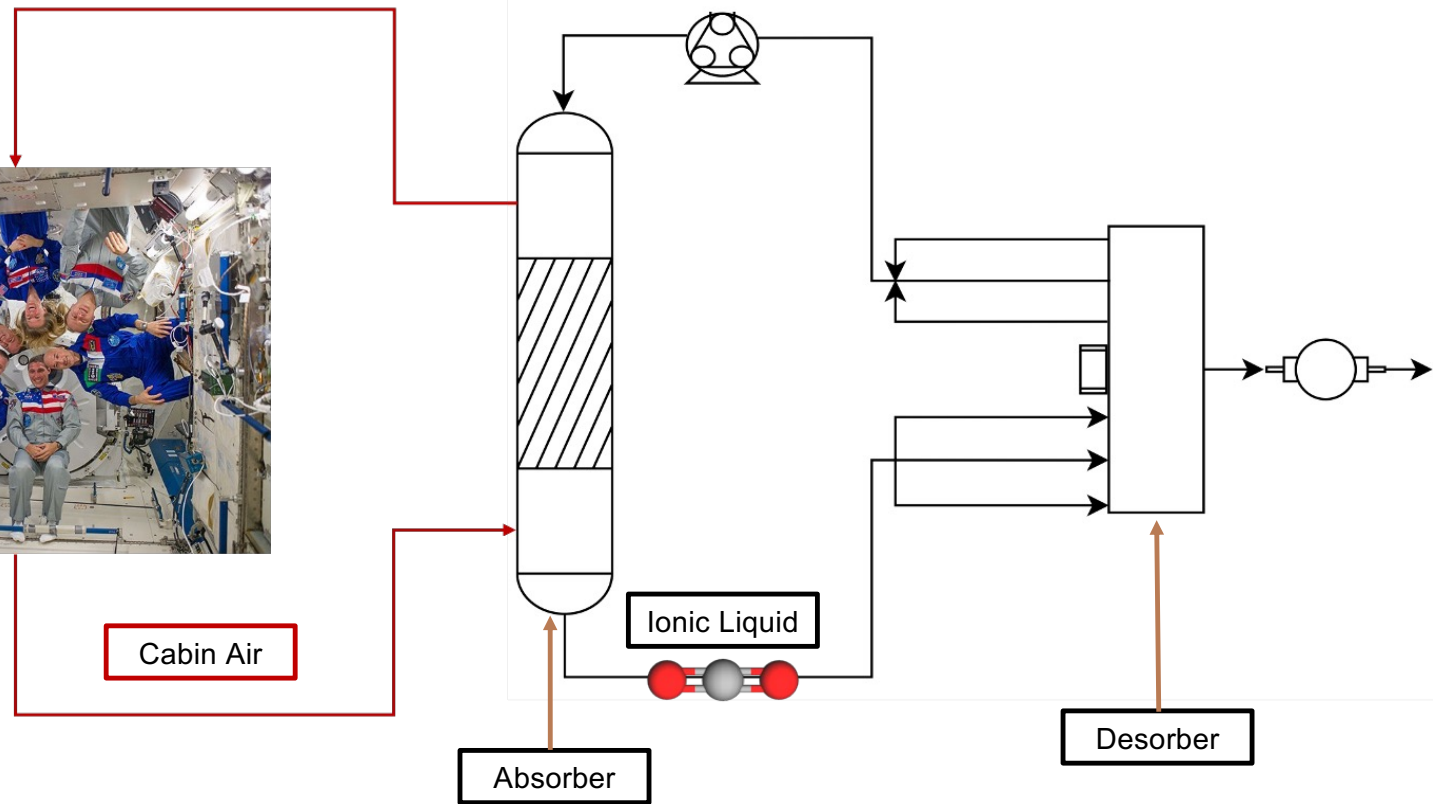
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System Diagram



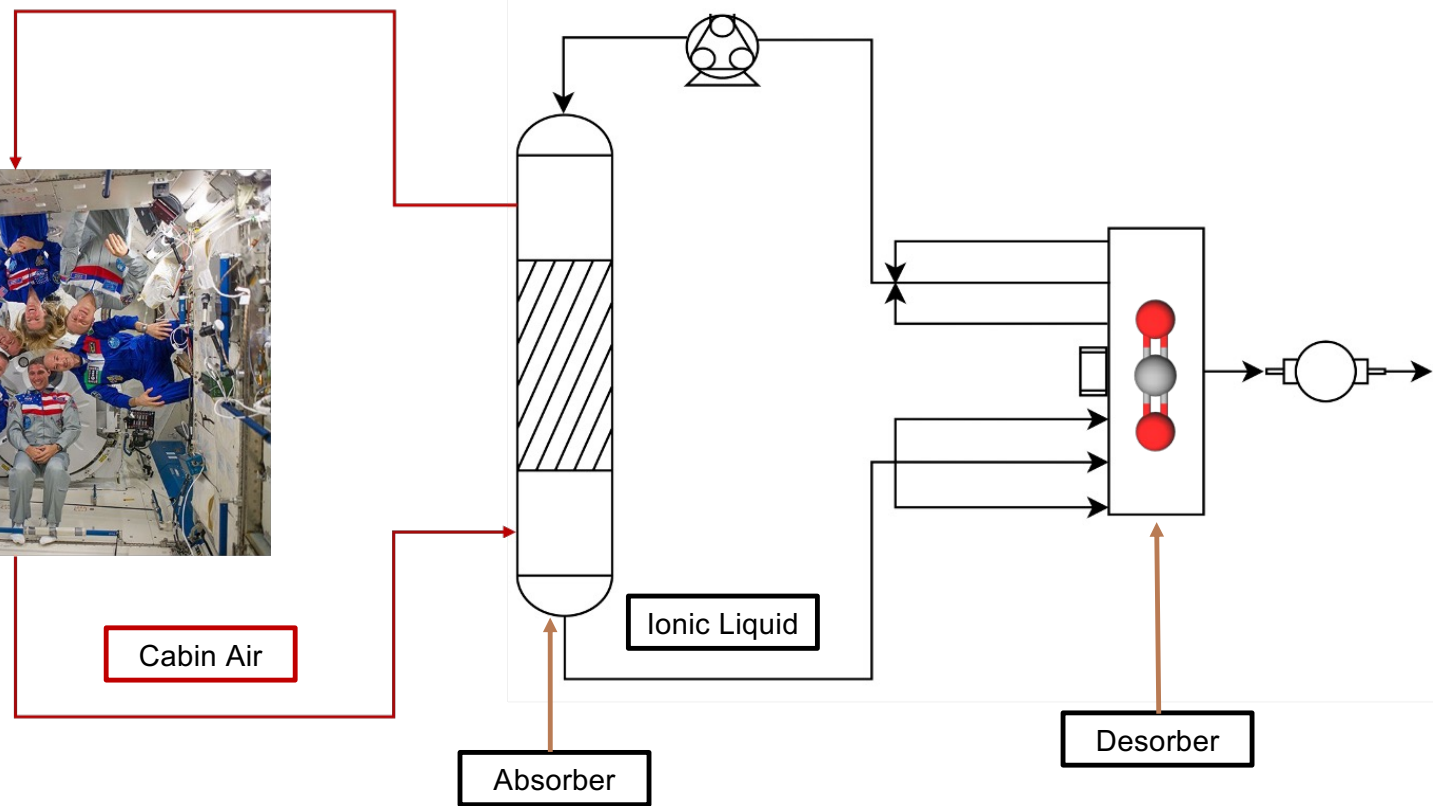
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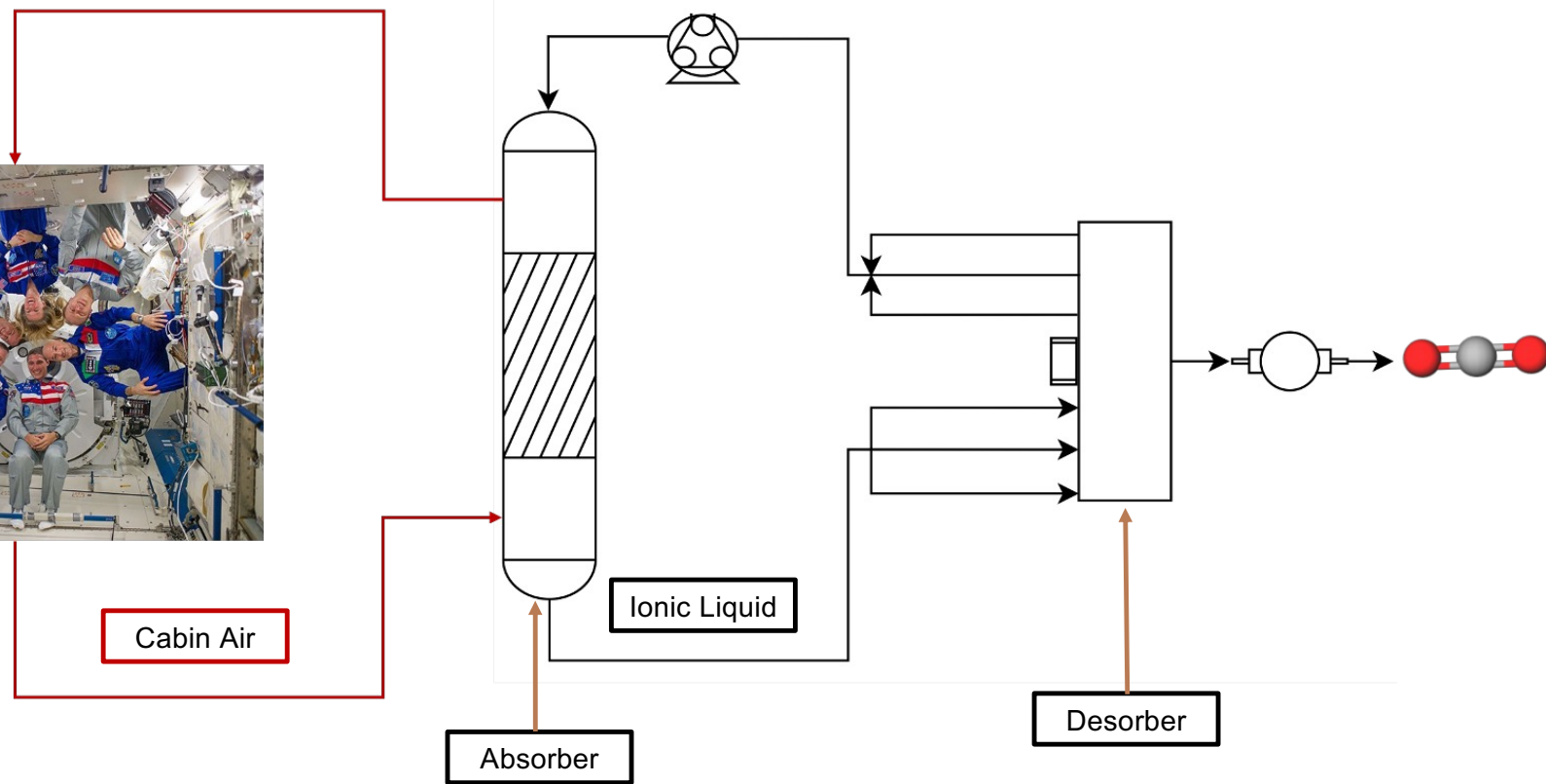
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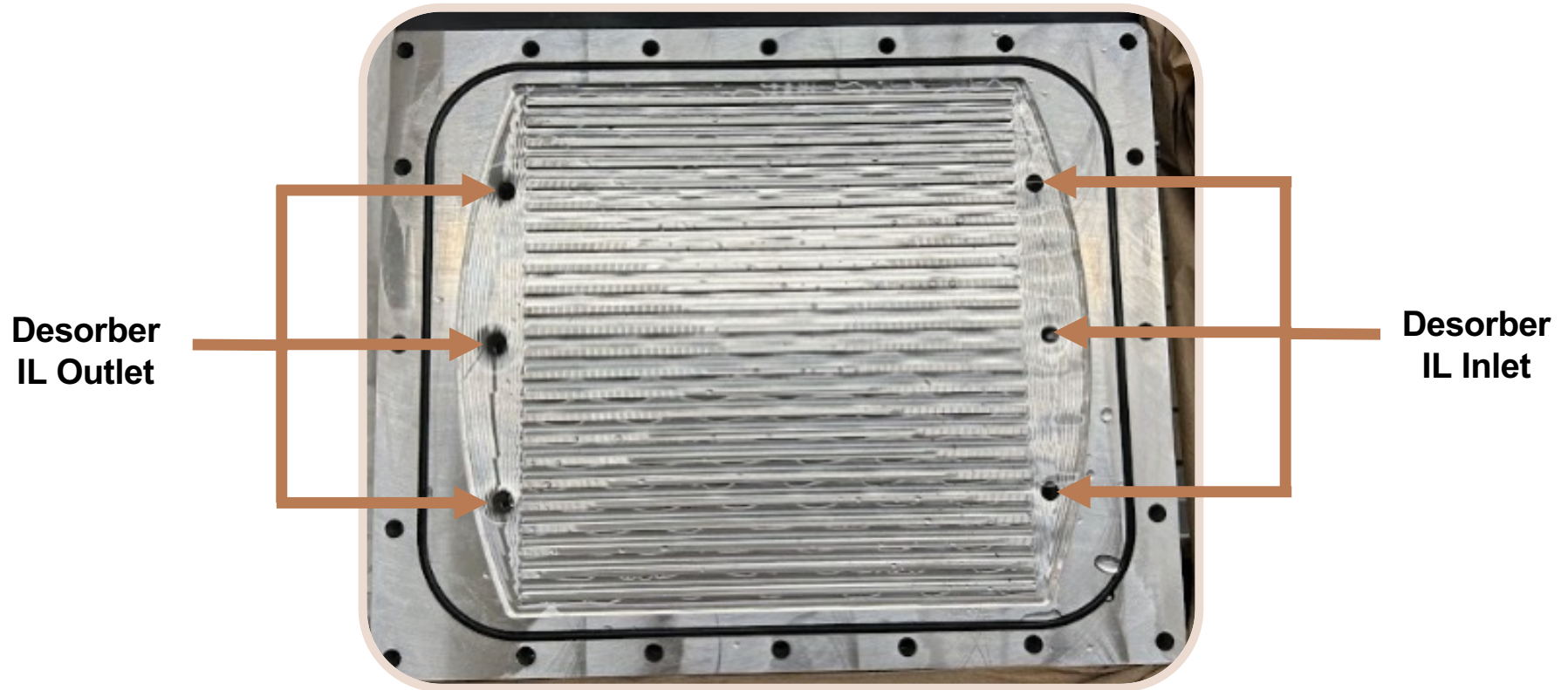
System Diagram



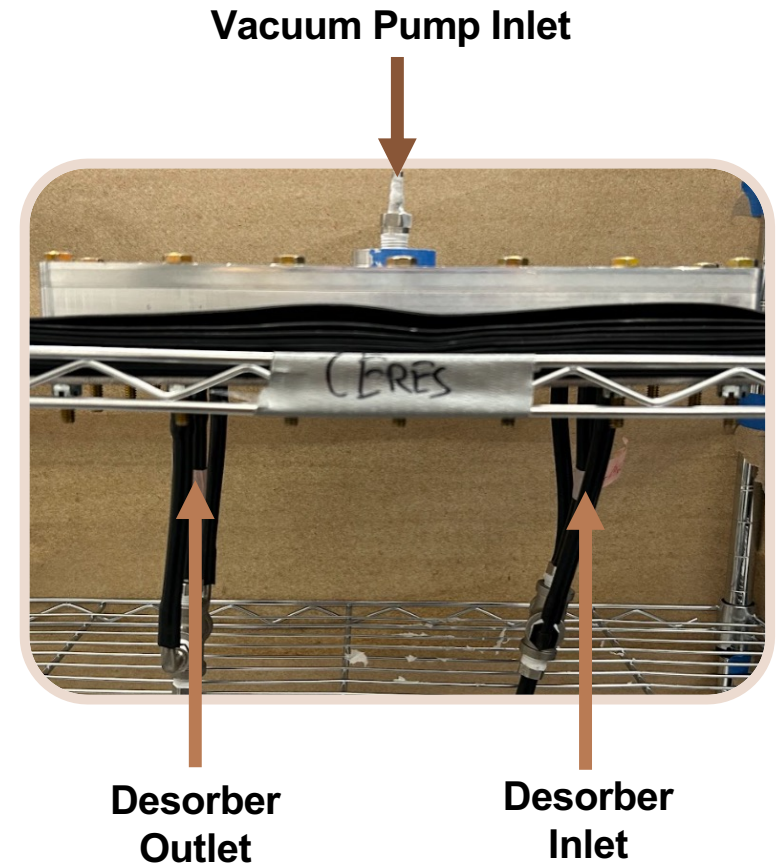
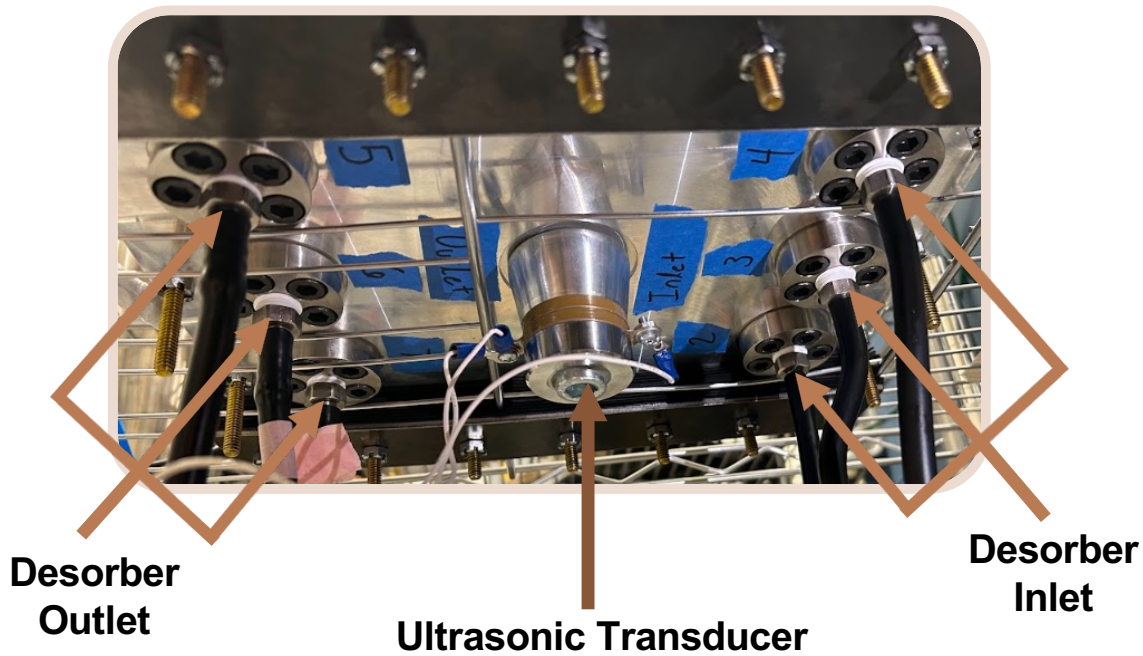
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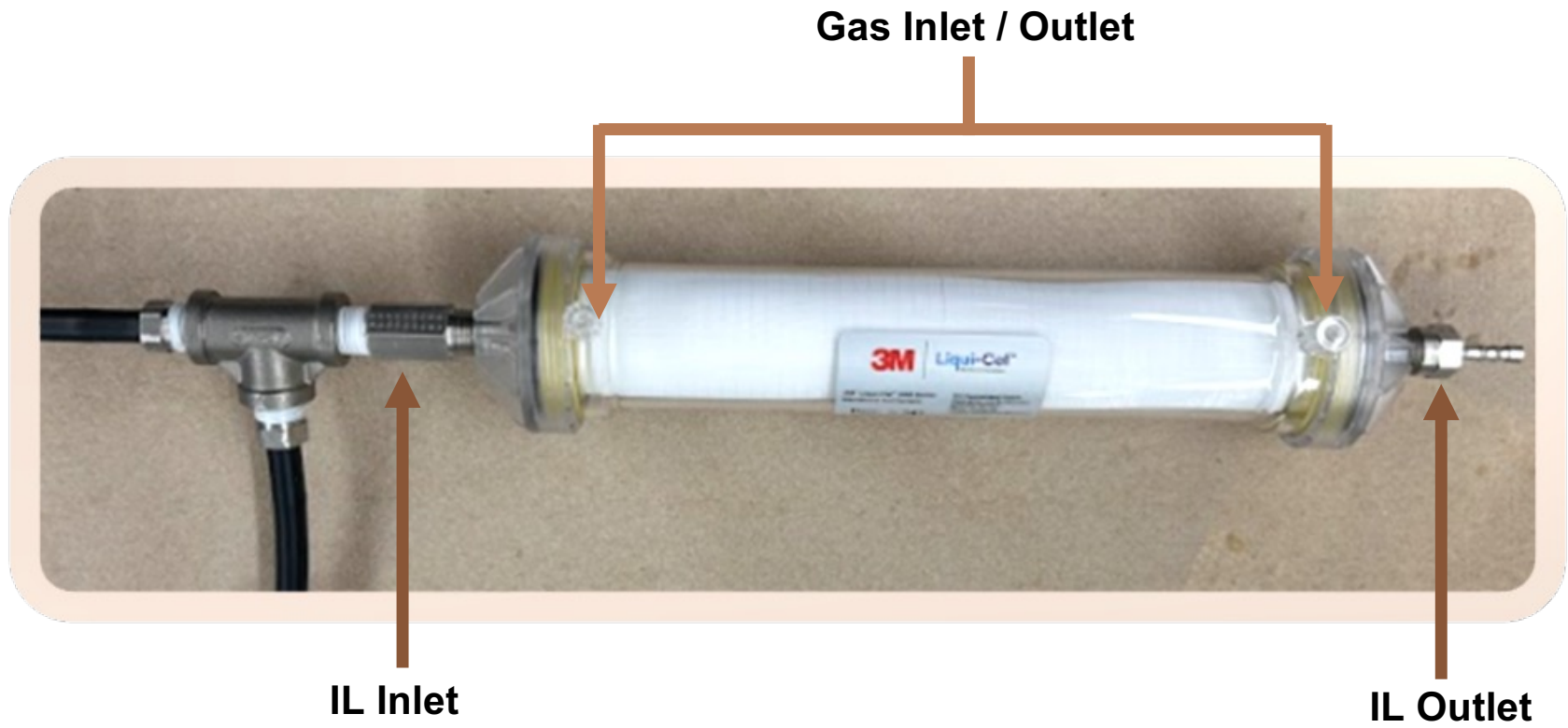
Desorber



Desorber

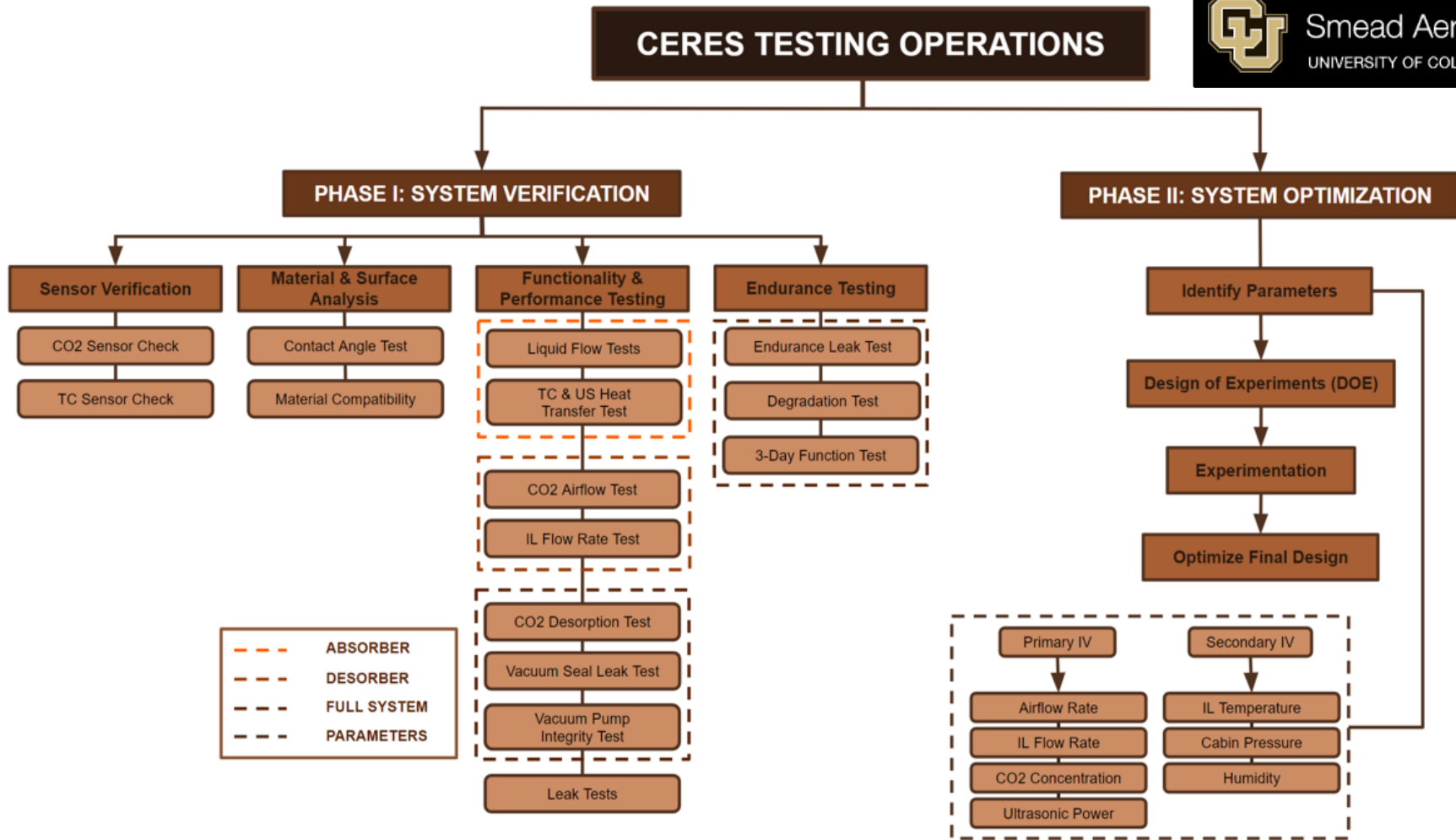


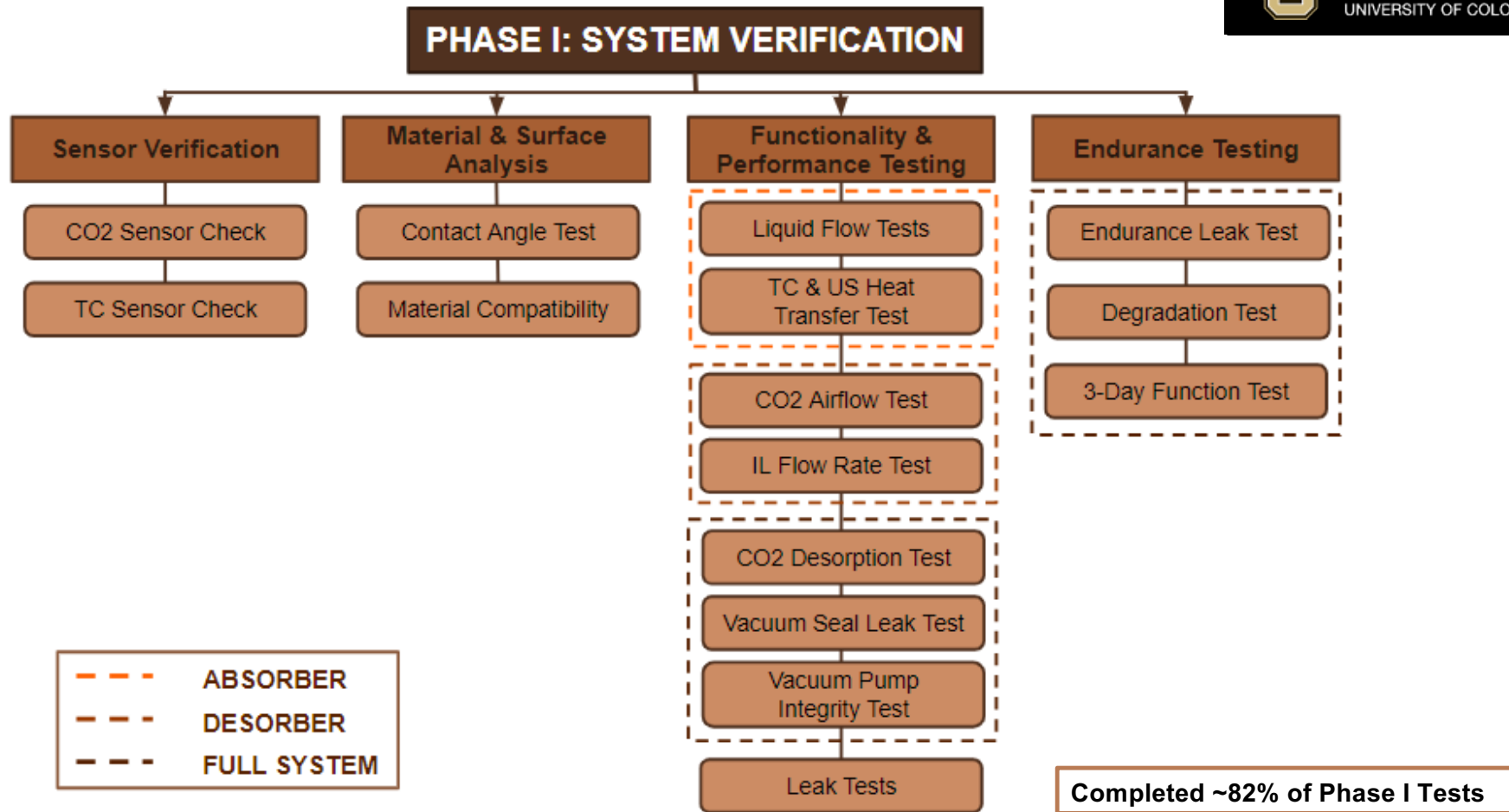
Absorber



Mechanical Concerns and Solutions

Concern	Proposed Solution	Progress
Fitting Leaks	-Increase quantity of Teflon tape -Tighten fittings	Completed Retesting in-progress
IL Overflow in Desorber Channels	-Mill out ½ of existing channels	Waiting to see if necessary
Excess Pooling at Desorber Outlet	-Add chamfers to outlet ports to encourage flow	Planned to occur by 10/28
IL Entering the Vacuum Pump	-Add a hydrophobic membrane to maintain gas headspace	Found Membrane Waiting on Procurement
Potential of Damaging Absorber	-Generate Standard Operating Procedures (SOP) for install and wetting	Complete



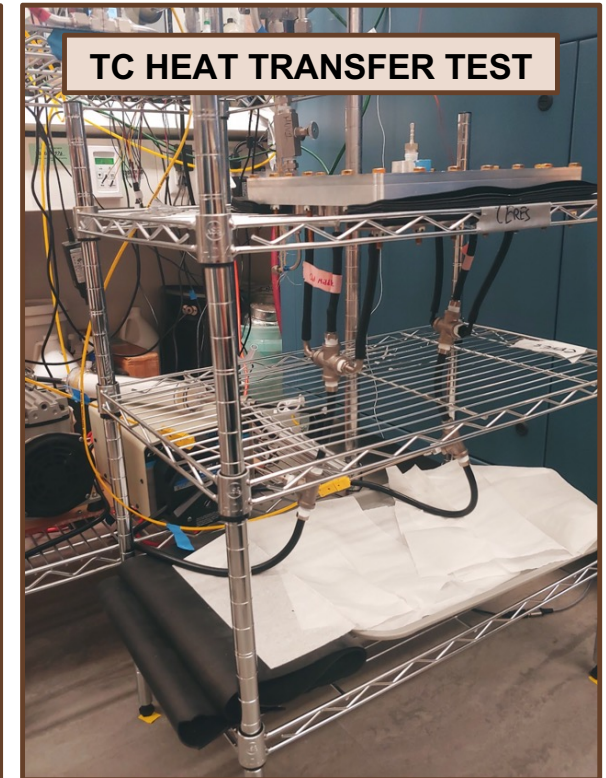


Testing Activities



Organization ➡ Overview ➡ Deliverables ➡ Progress ➡ Status

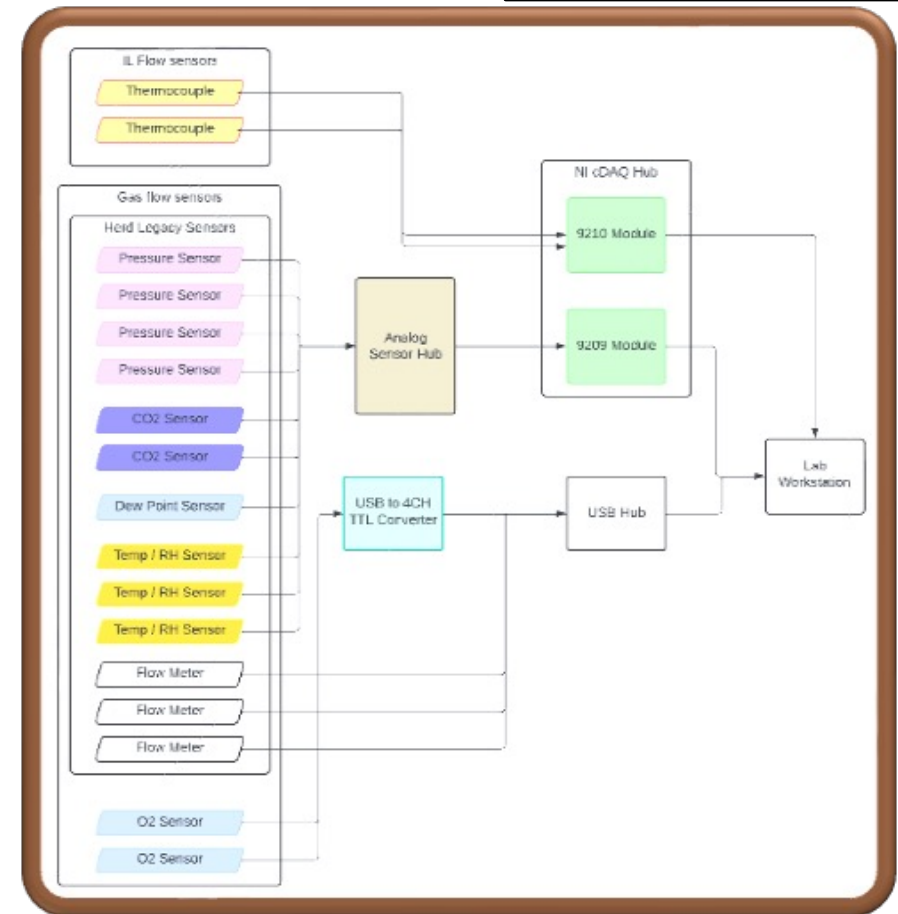
Testing Activities



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Data Acquisition

- Integrated LabVIEW software and National Instruments DAQ hardware
- Characterize CO2 removal using flow meters, CO2 sensors and gas analyzer, pressure, temperature/humidity
- Thermocouples in IL to characterise heat transfer



Sensor List

Sensor/ Equipment	Purpose
Type K thermocouples	Measures IL temperature
Pressure transducers	Characterize gas flow
Temperature/Humidity sensors	Characterize gas flow
Flow meters	Characterize gas flow
CO2 sensors	Measures CO2 removal capability
O2 sensors	Fault detection/unforeseen interactions



Concerns/Significant Challenges

Challenges:

- Team Member Training/Onboarding
- Lab Space Scheduling
- Testing Time Allocation
- Team Communication

Concerns:

- Insufficient System Performance
- Component Faults During Testing



Project Status / Next Steps

Fall 2024:

- Submission of **ICES Abstract**
- **Ultrasonic** Desorption Testing
- **Boeing TRR**
- **Full System Test** Campaign Kickoff

Spring 2024:

- Writing/Submission of **ICES Paper**
- **Alternative Desorption** Testing (Microwaves etc.)
- **Full Characterization** of CERES Assembly

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Thank You!

Any Questions/Comments?

Email bryce.loging@colorado.edu for any questions or interest!