

UVA Target Group Status and Goals

Speaker: Jordan “Jay” Roberts

Special Thanks: UVA Spin Group Team



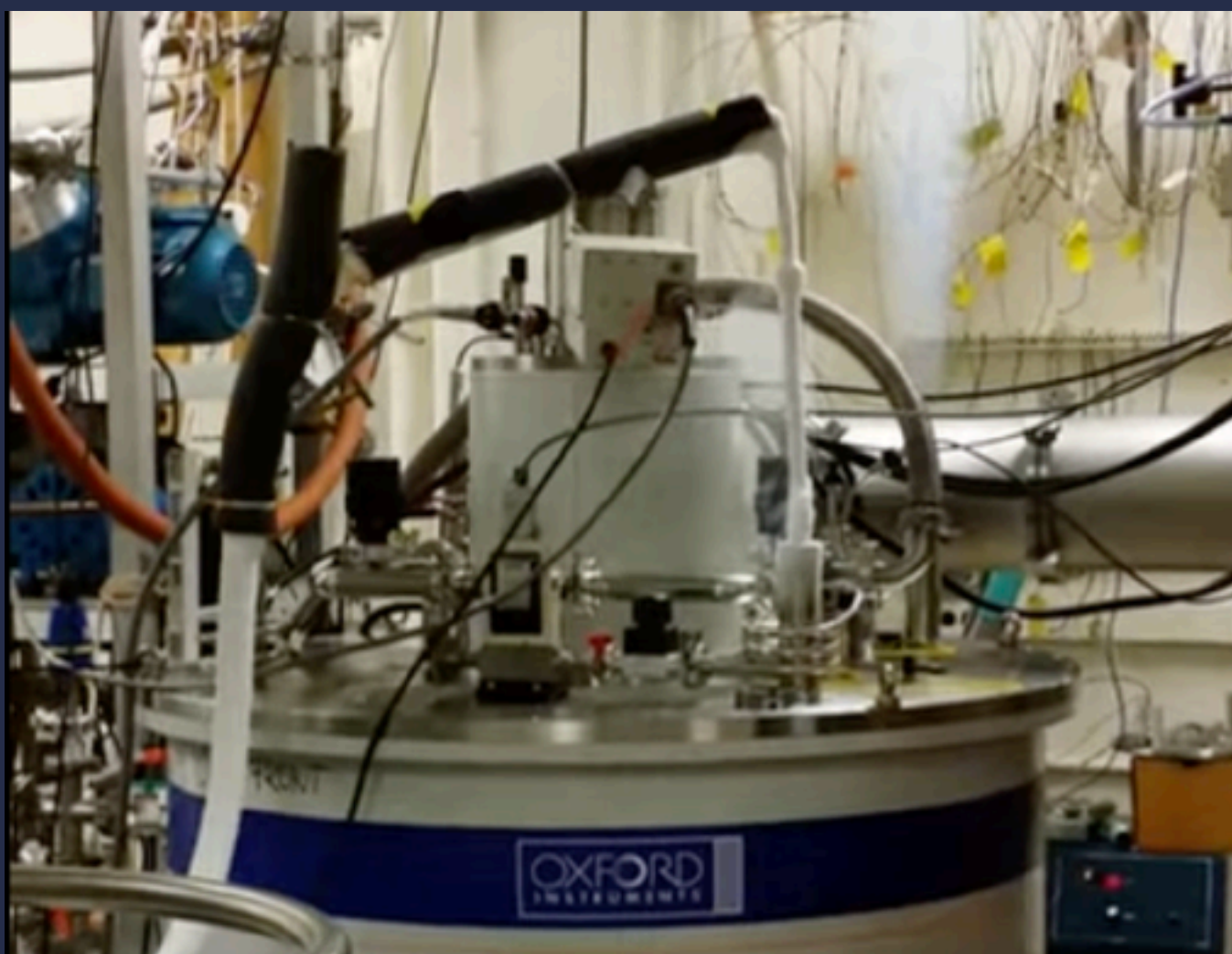
Outline

● Restarting

● Rebuilding

● Future work





2022

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Delays From Renovations

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2024

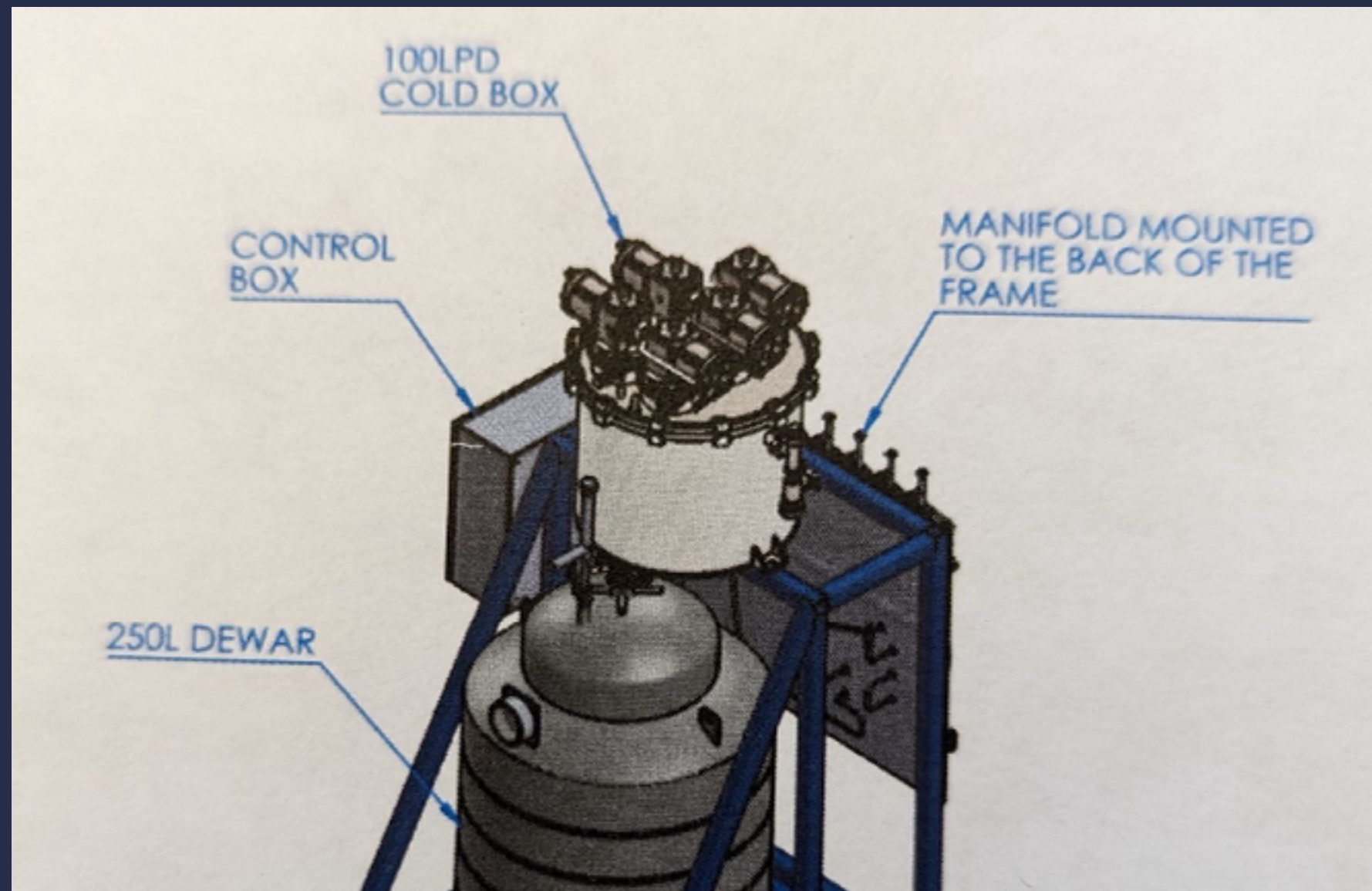


A Great Opportunity

We were able to upgrade several pieces of equipment.

Insert our new liquefier into the system.

Paving the way for material studies and
R&D for SpinQuest



Why is This Important?

This system allows us to perform fast development of new materials and targets.

Allows us to train for larger scale experiments.

Prepped targets for SpinQuest and then try new methods.

Gain hands on experience and education of polarized targets.

Some delays can be attributed to funding and shifting focus to SpinQuest commissioning.

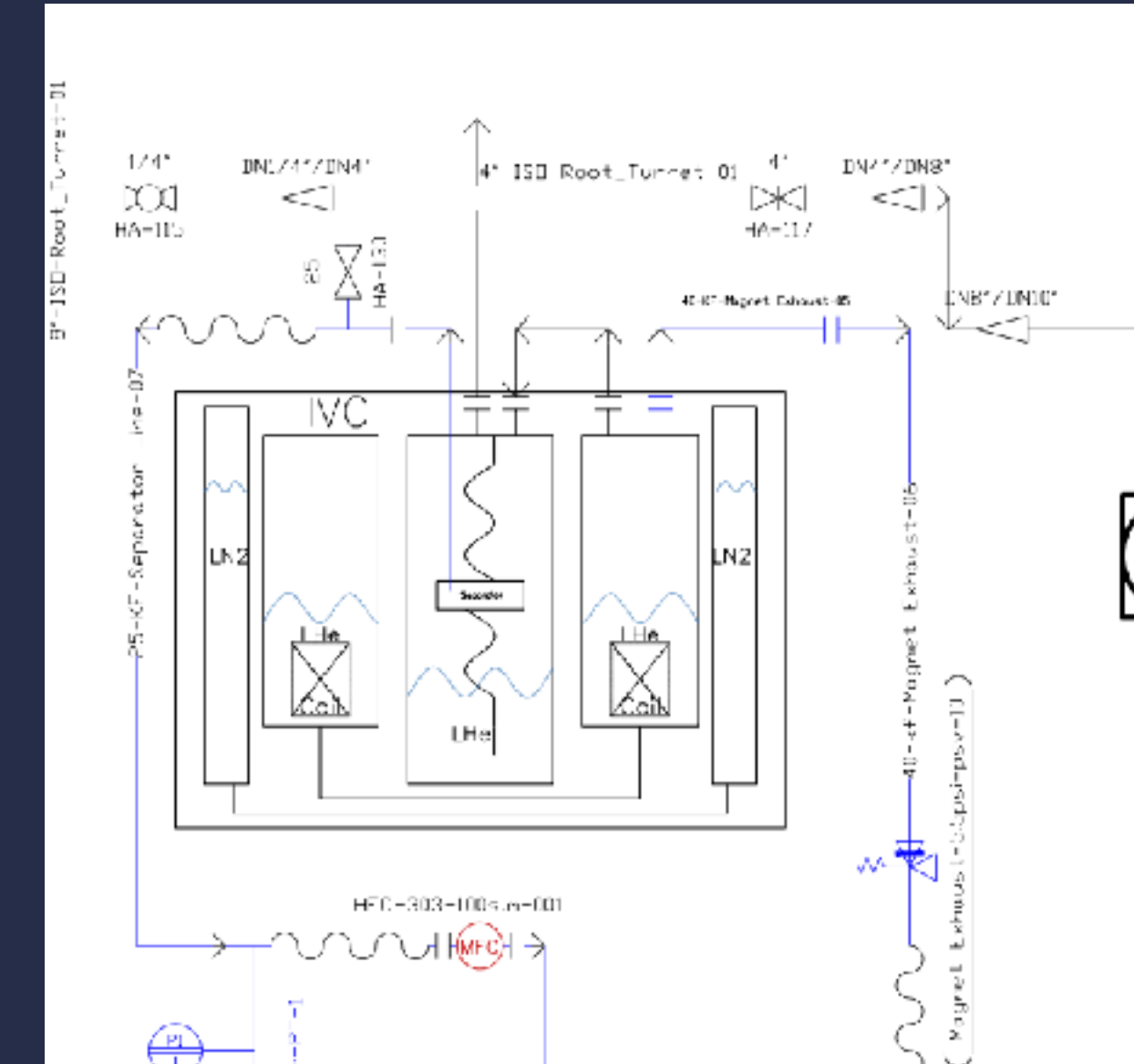
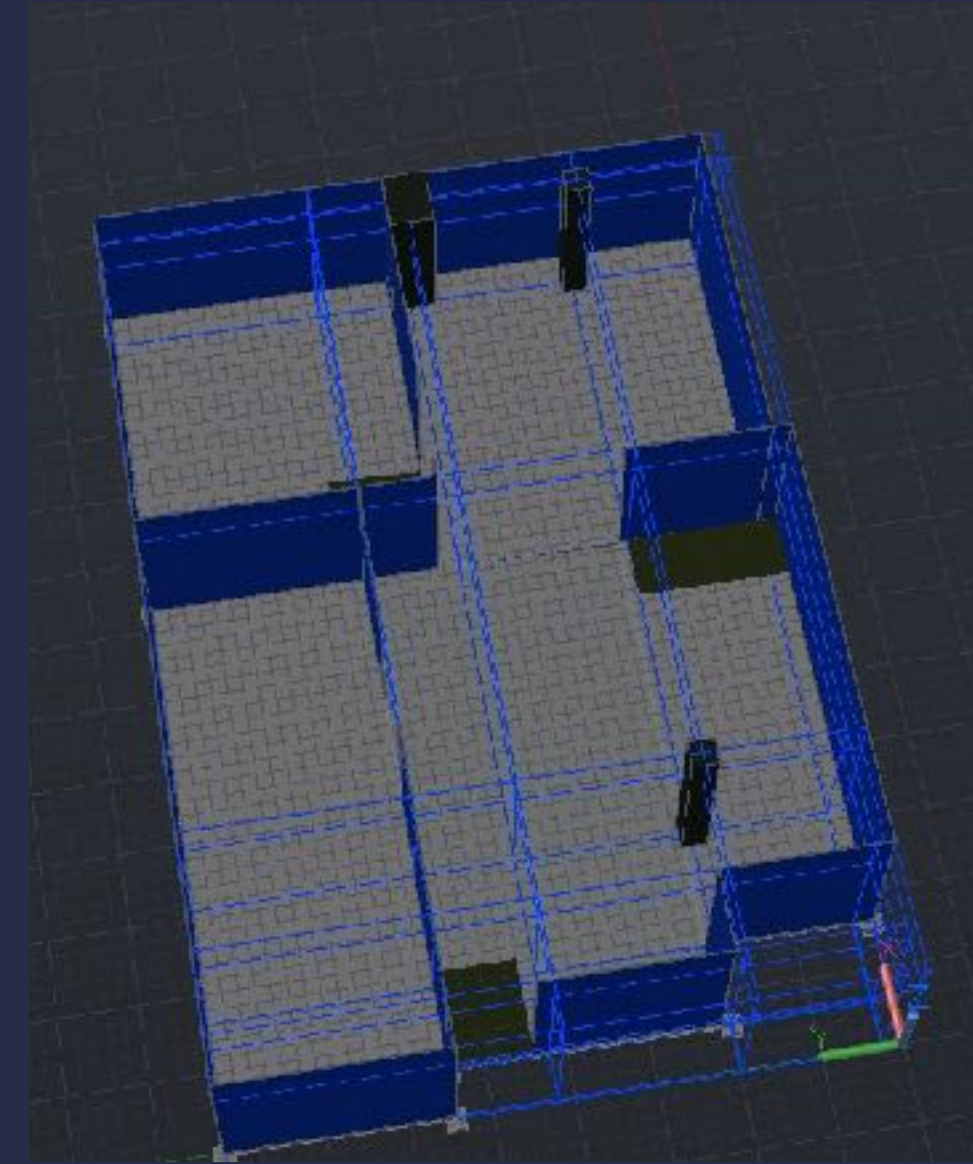
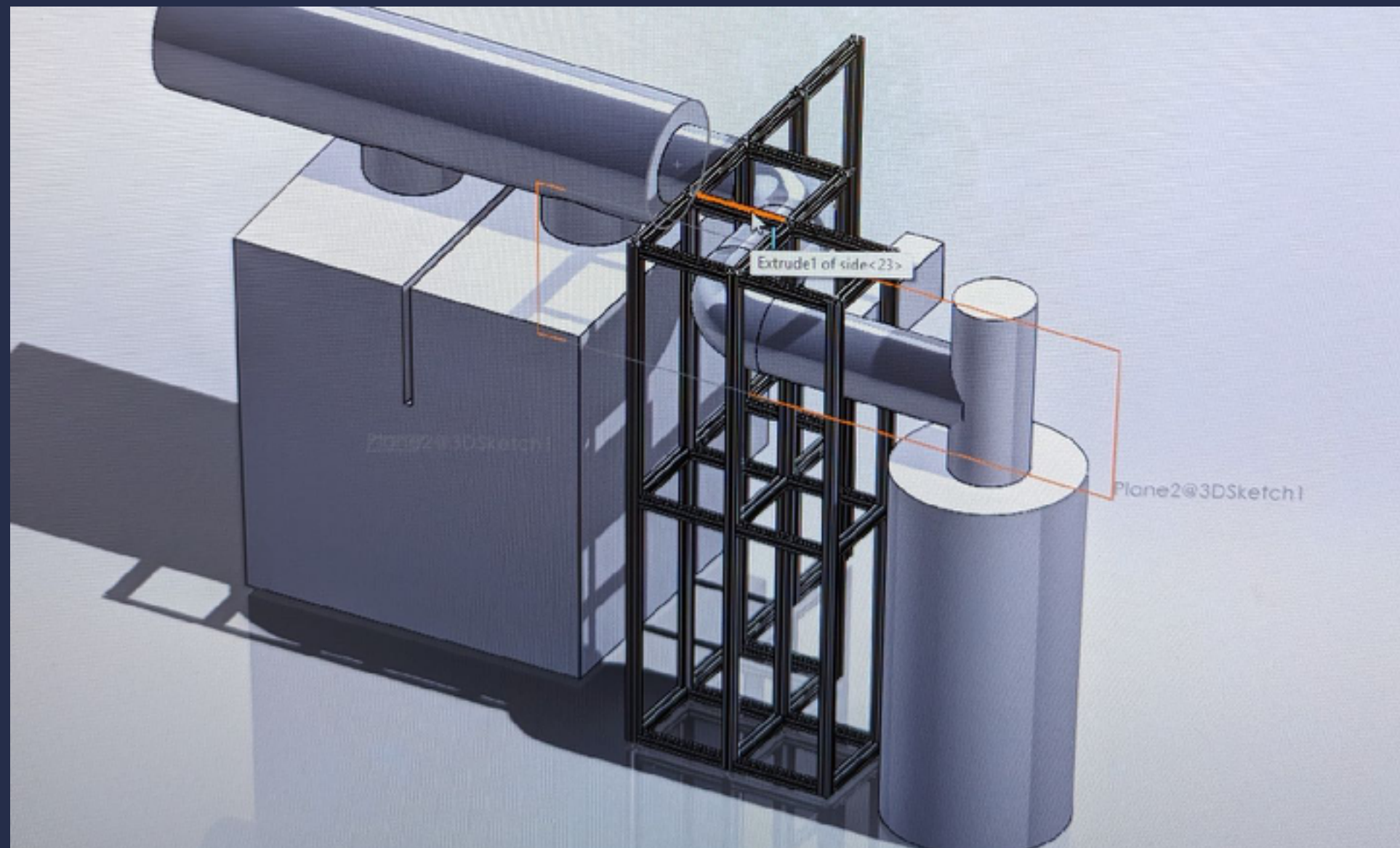


A Fresh Start

We wanted to mimic SpinQuest as closely as possible.

We wanted to get it running ASAP.

Work within a low budget.



Goals:

We needed to finalize the lab.

Test the liquefier and produce LHe.

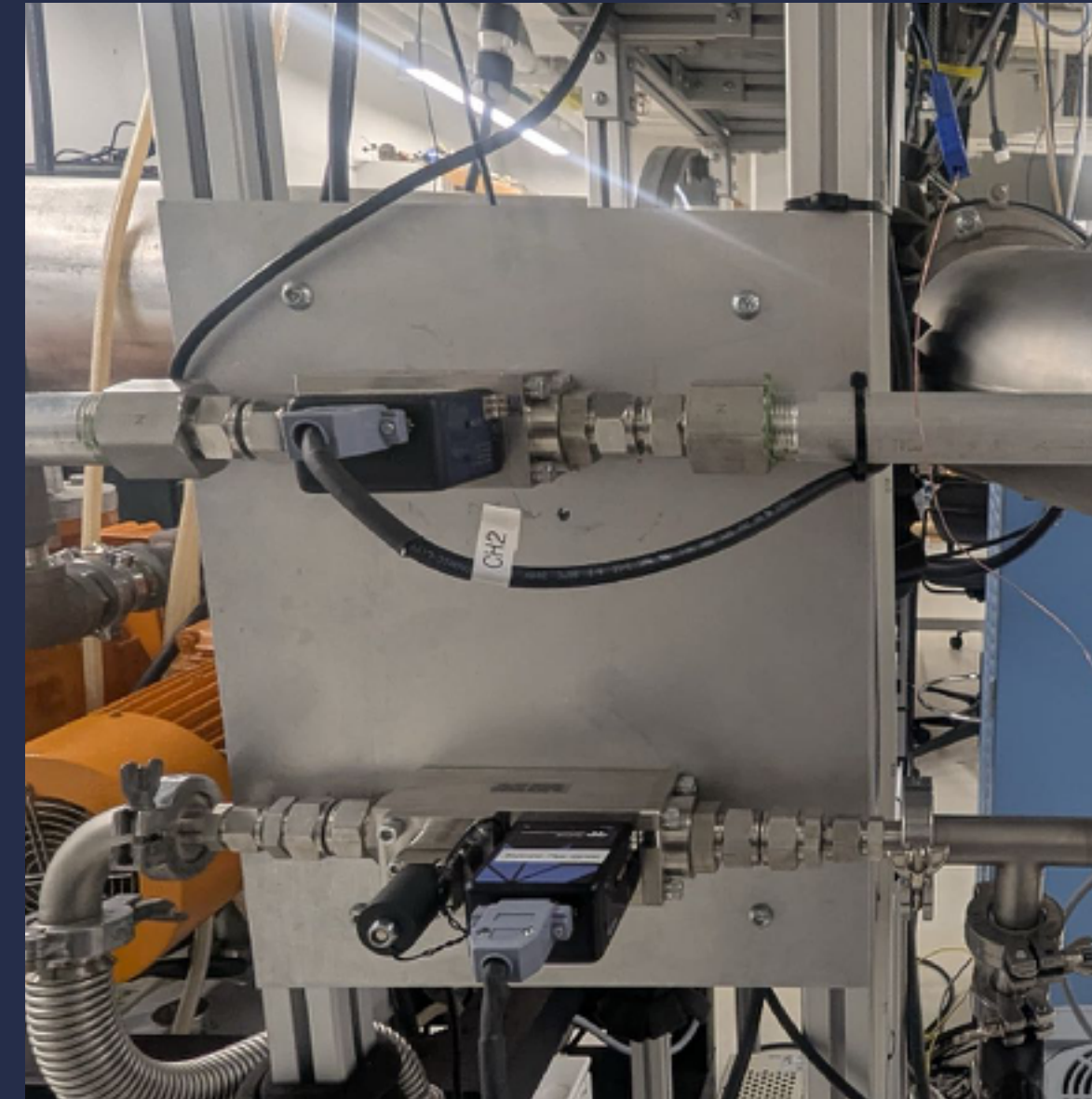
Test the circulation and flow management. (45 SLM - 100 SLM)

Test cool down methods and instruments/pumps.

Refrigeration

High power 1K ^4He evaporation refrigerator driven by a root stack.

Flow control and monitoring.



Specifications

2 parralle CIT-ALCATEL 2000 m³/h
Roots

PFEIFFER Okta 500 670 m³/h

2 parralle A-100 100 m³/h Dry Roots

5 T superconducting magnet holding 49L

Several insulation layers:

High Vacuum layer

LN2 Cold insulation

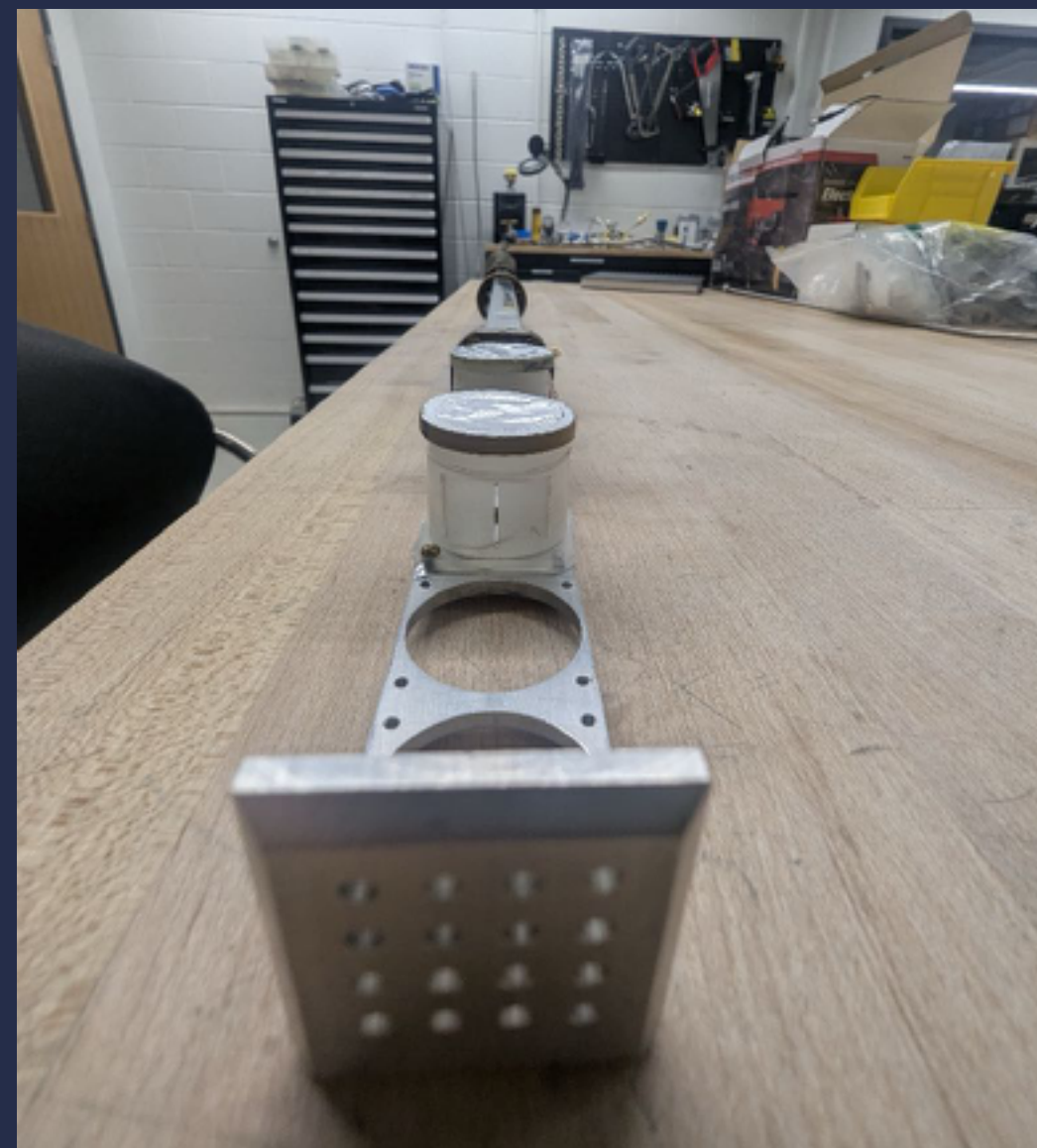
Mylar-Web mesh

Instrumentation

Several Sensors (pressure, temperature, flow)

Wide range of NMR and microwave capabilities

In-house produced target inserts



Specifications

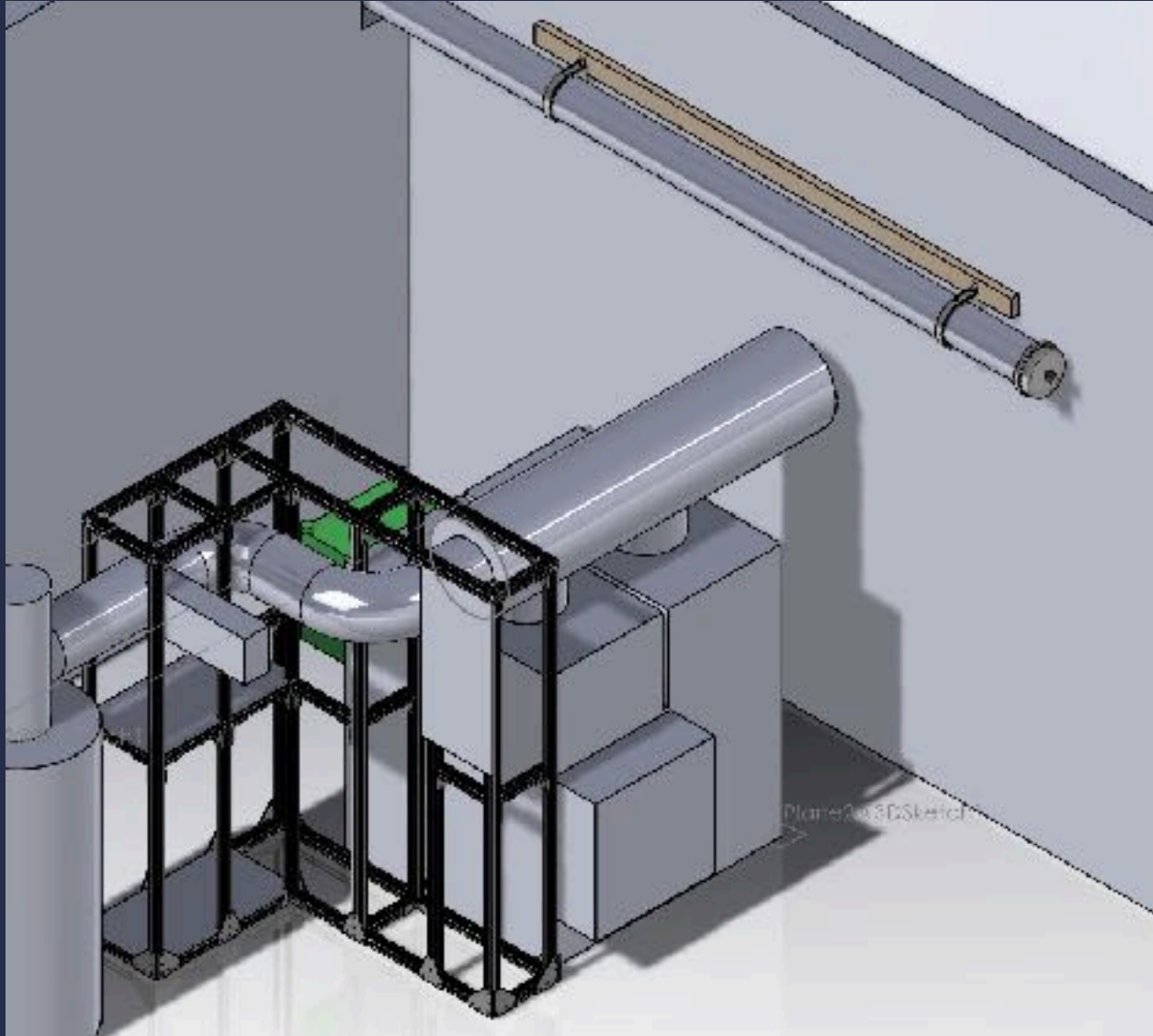
Liverpool-style Q-Meter NMR system with tank resonance range of 3-300 MHz.

LANL-style Q-Meter NMR system with modernized components and design.

EIO tube running at 140 GHz with tunable resonant cavity.

Several form factor target inserts with CERNOX temperature sensors and Lambda/2 coils.

The Liquefier



We obtained a low cost purifier. Awaiting a larger dewar and purification system.



The Liquefier

Specifications

100 L/day of Helium (Tested 1 bottle/hour).

Fast cooldown time of less than 24 hours.

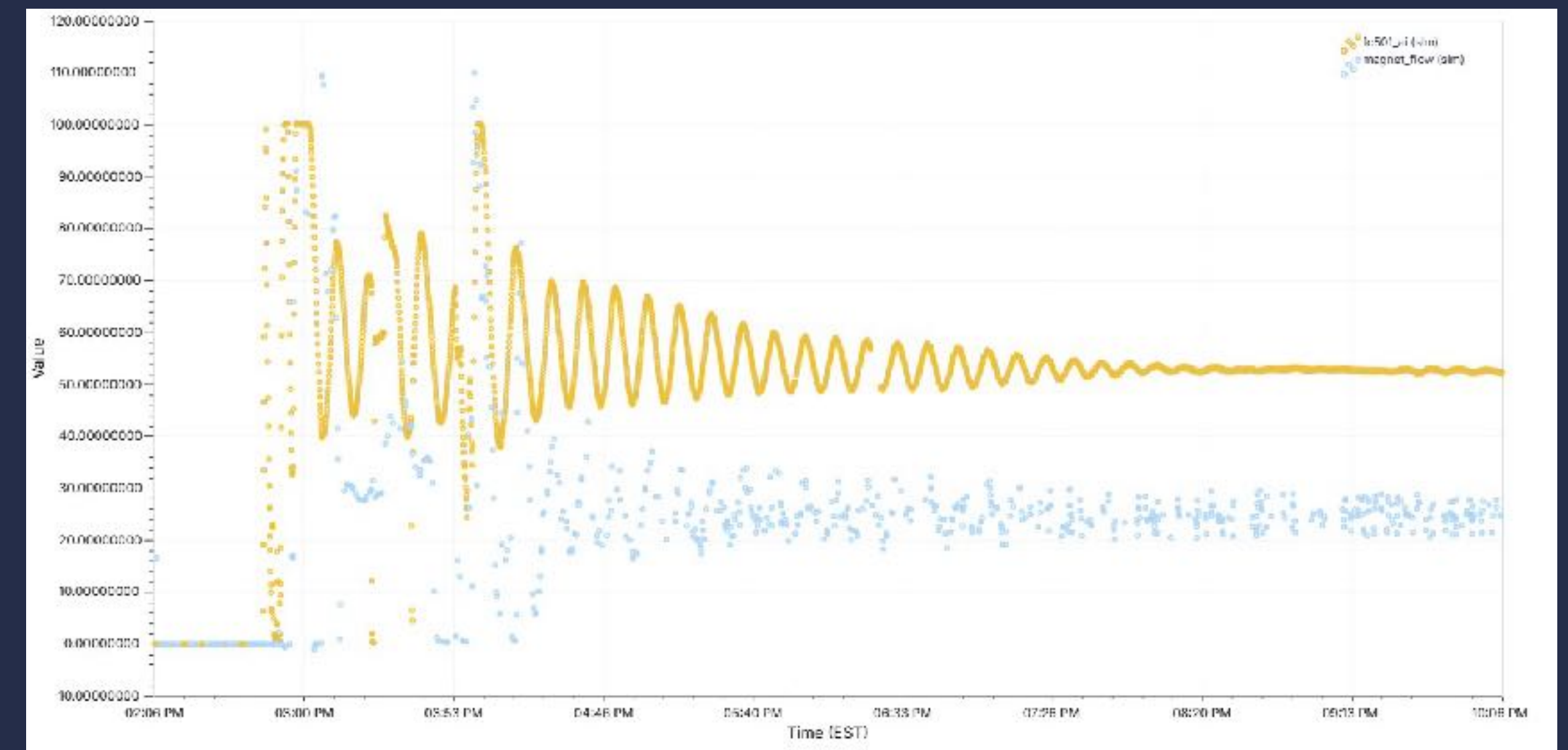
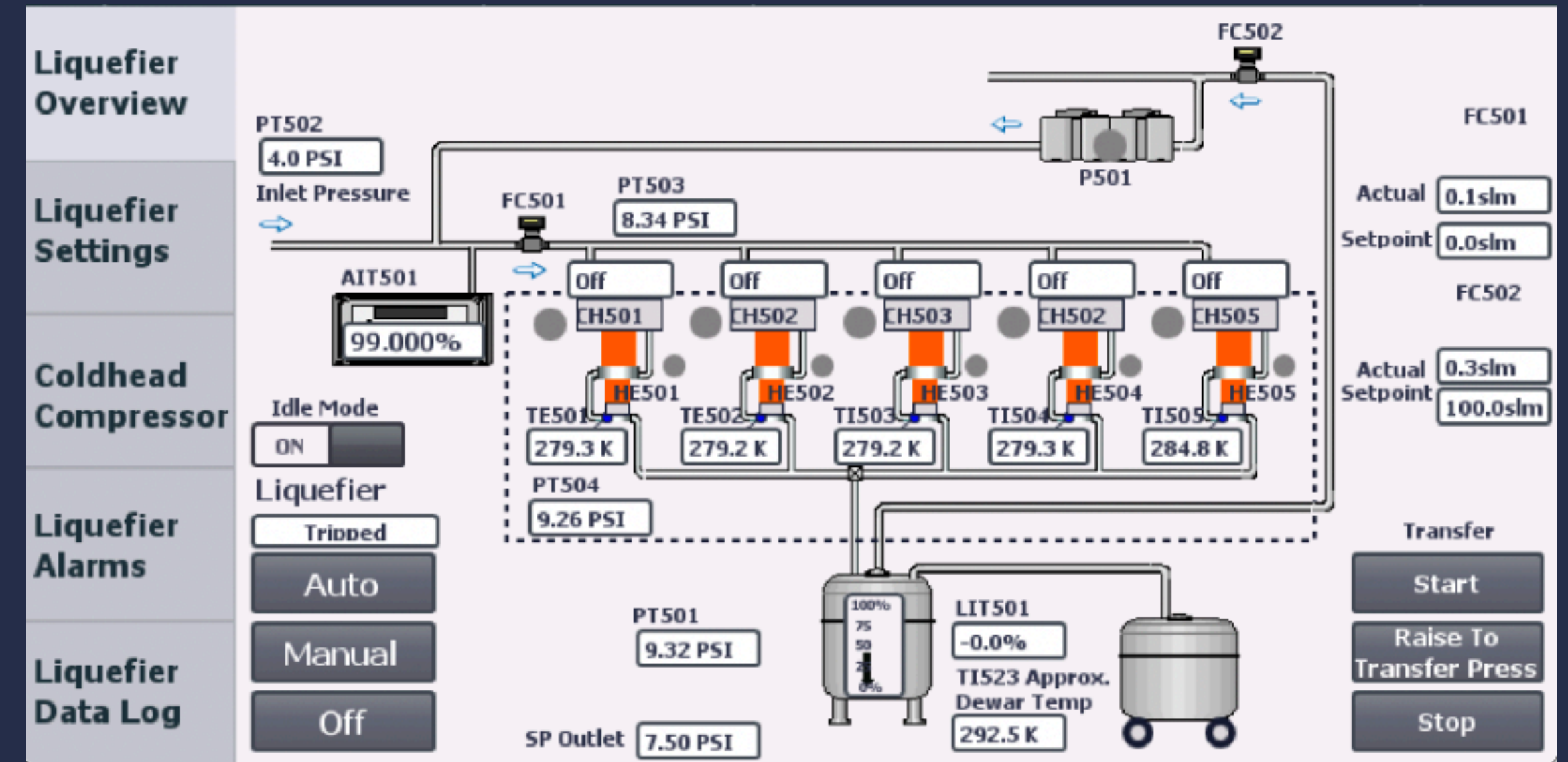
Large volume 250L storage dewar.

Five water cooled helium compressors (9L/min).

Five GM-Cryo coolers.

HMI with a TCP server for data acquisition and flow control.

Easily connected to routed piping.

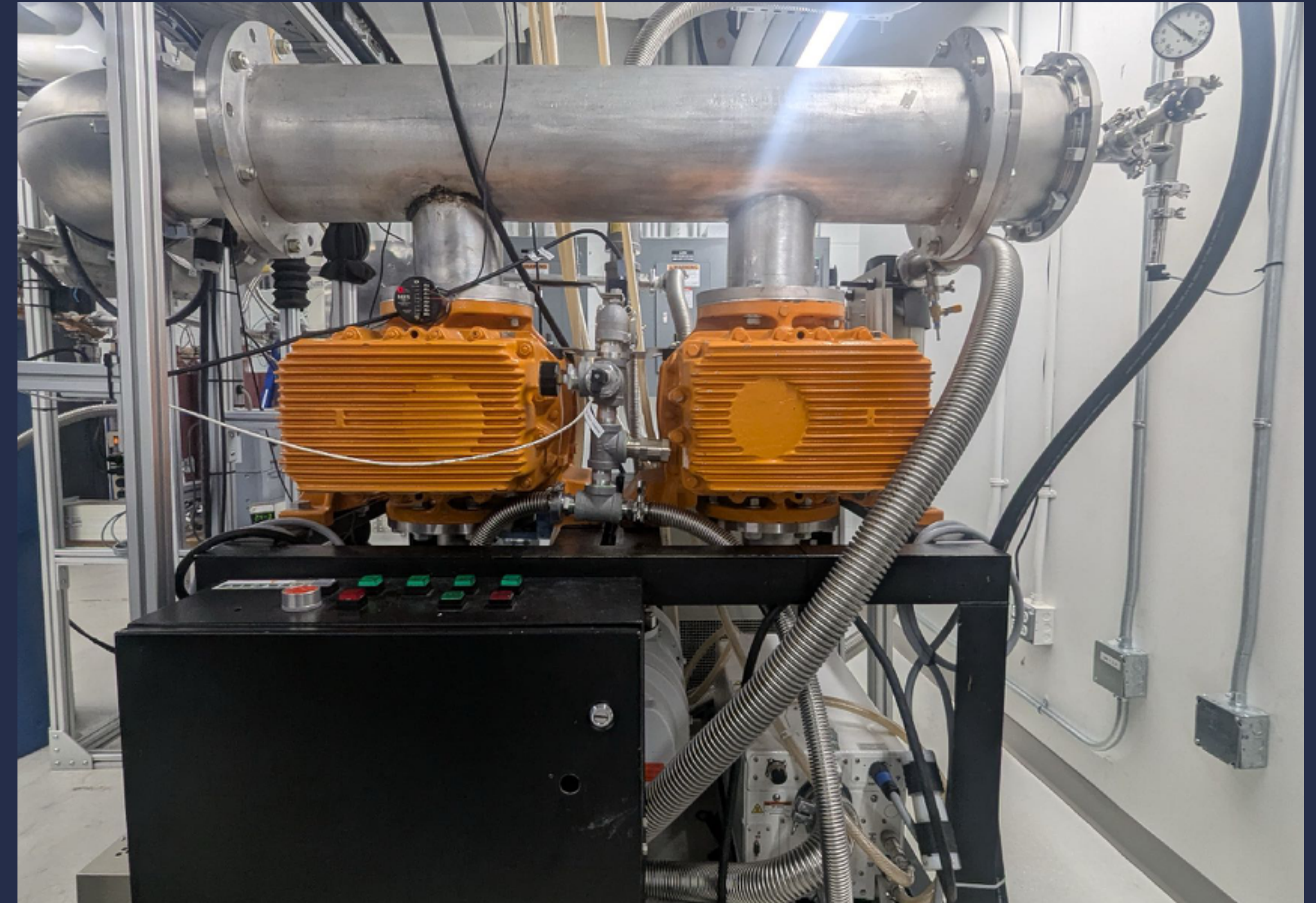


Initial Problems

Initial leaks needed to be addressed

Dewar neck connection required replacement

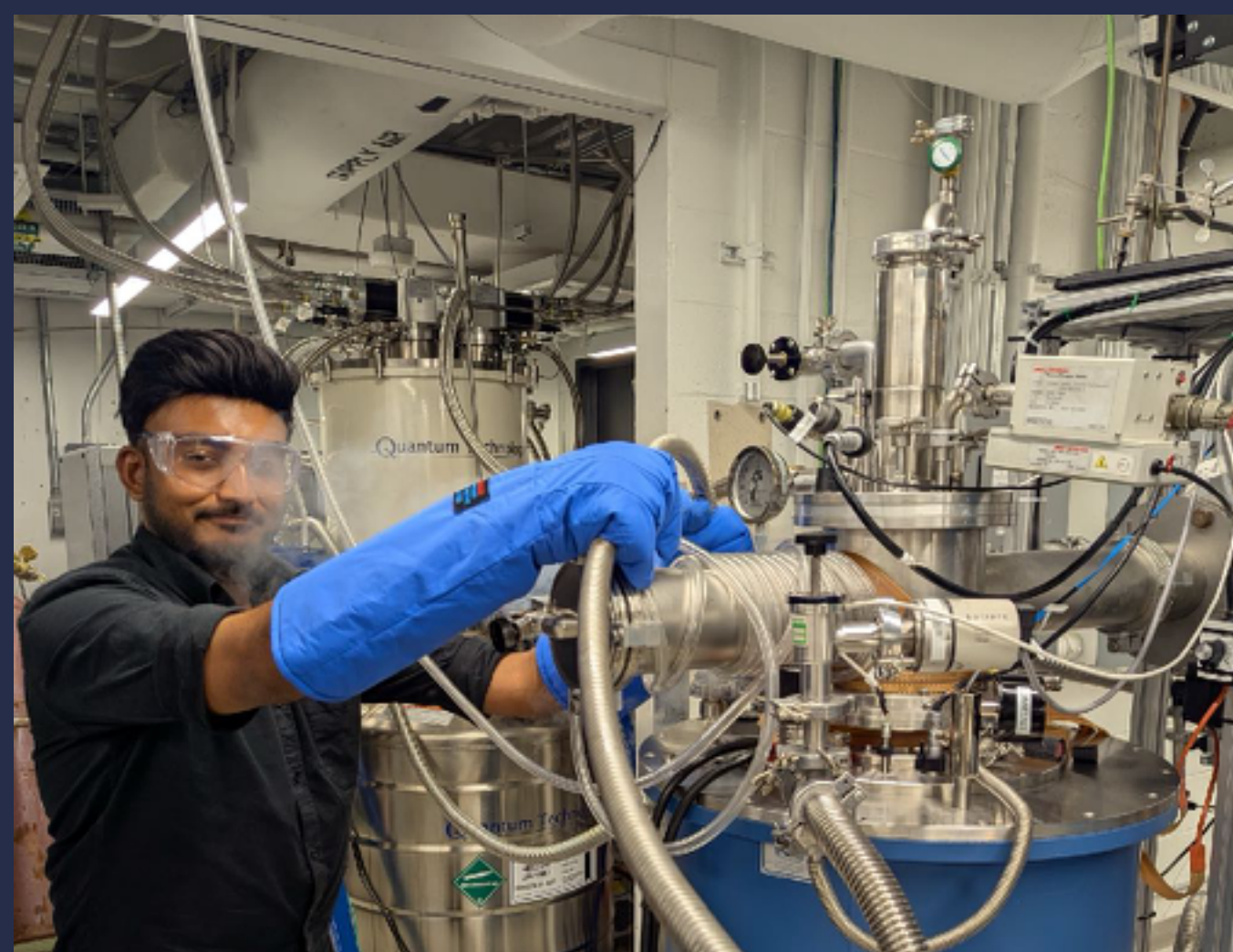
Root control box needed repair and rewiring



We successfully repaired the system to a leak tight status and it was now ready for a first run.



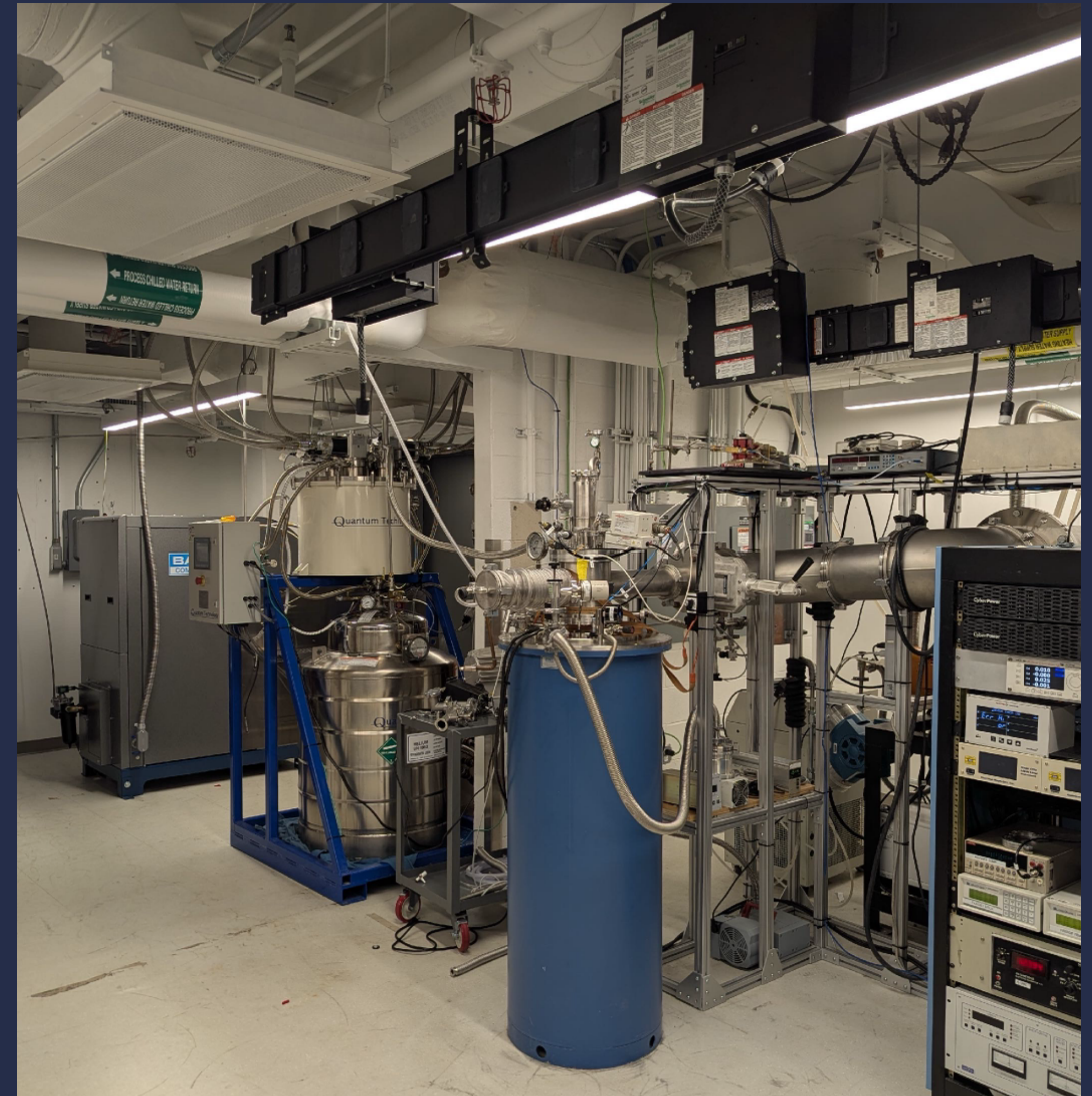
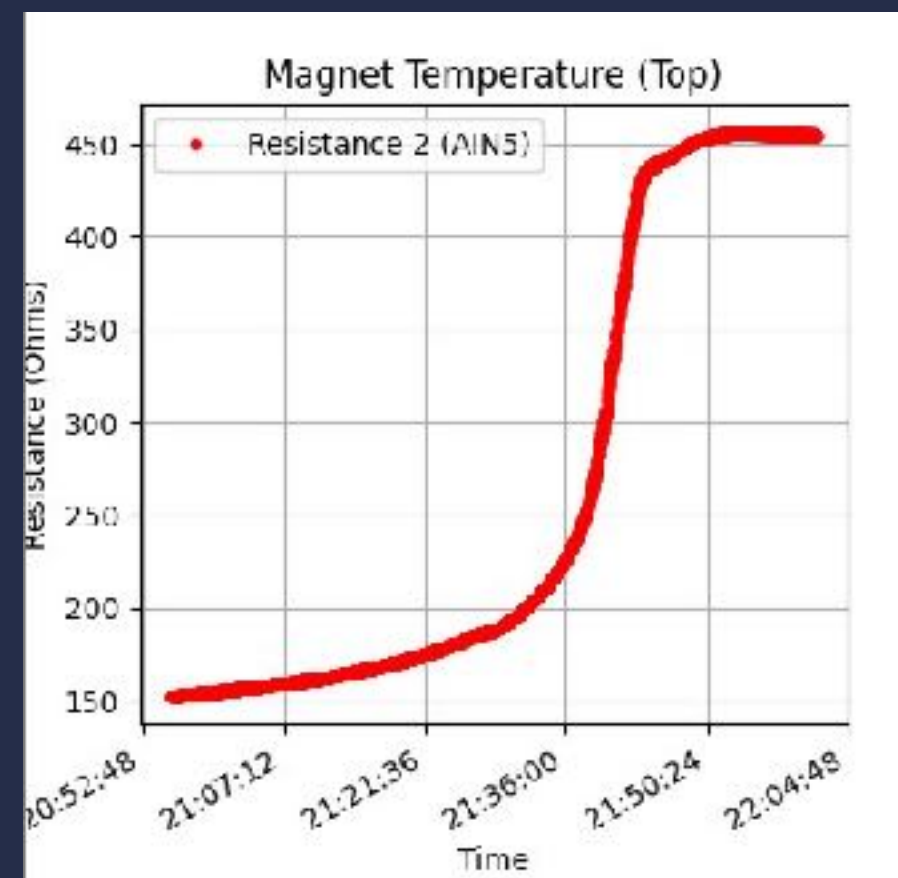
We Kept Iterating...

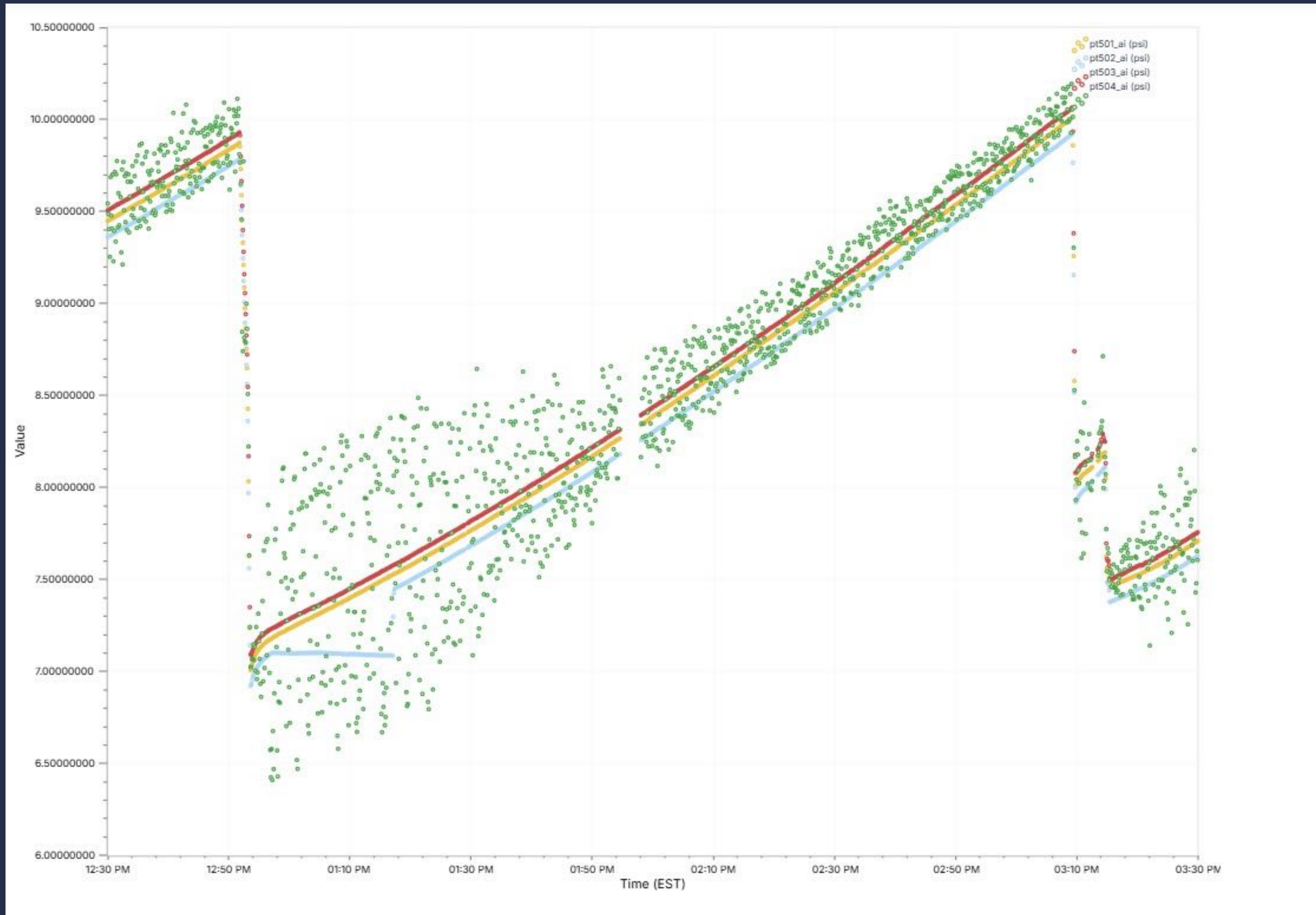


We Rebuilt the Polarized Target

We attempted to fill the magnet with liquid helium.

We successfully cooled down to ~4K, transferred, and recovered the helium.





Test Performance

We can produce LHe very efficiently at a rate of <100 L/day at higher flow rates.

Root Loop: 5-80 SLM

QT Loop: 2-150 SLM

We can transfer and cool down to 4K in >24 hours mostly using helium vapor.



We required a robust helium recovery system.

Our purification system requires upgrading.

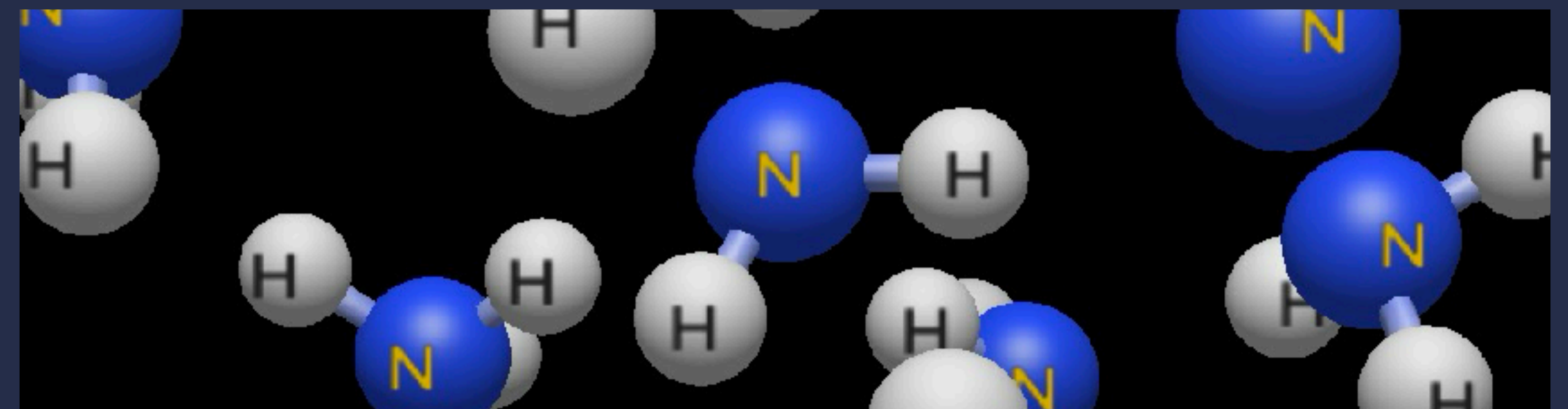
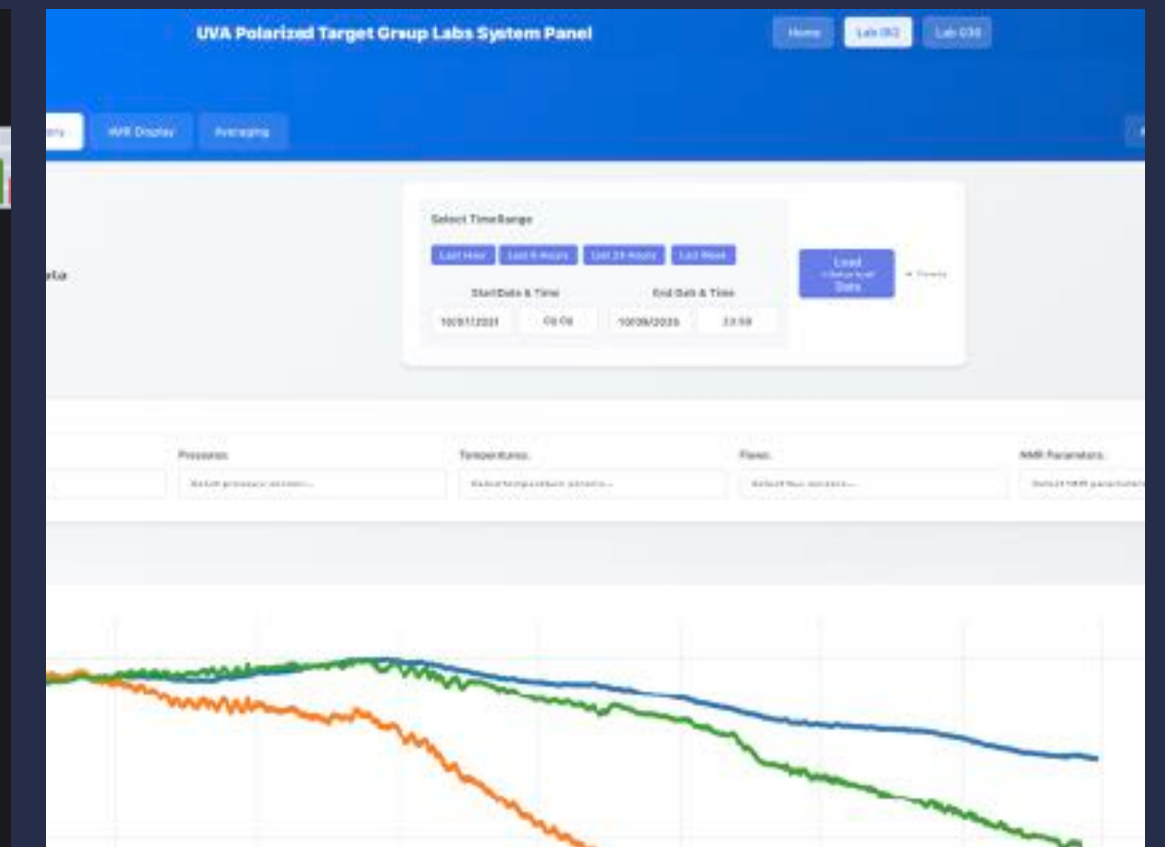
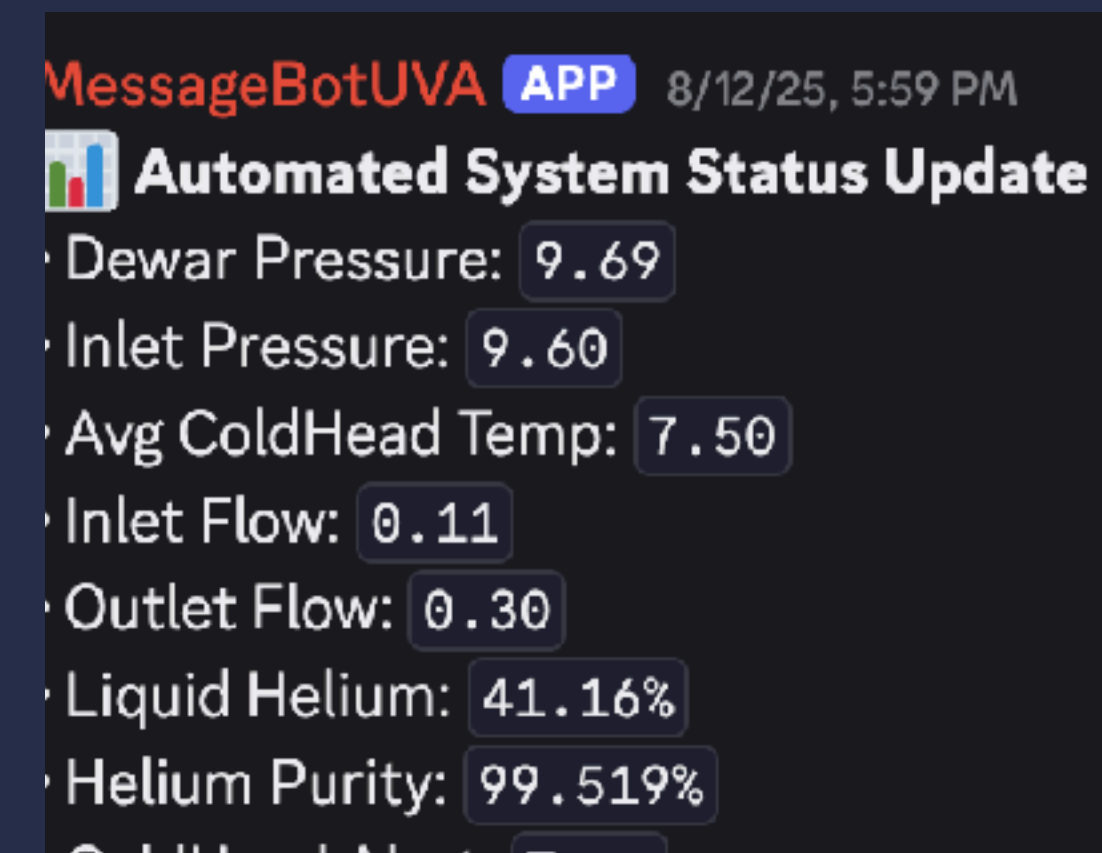
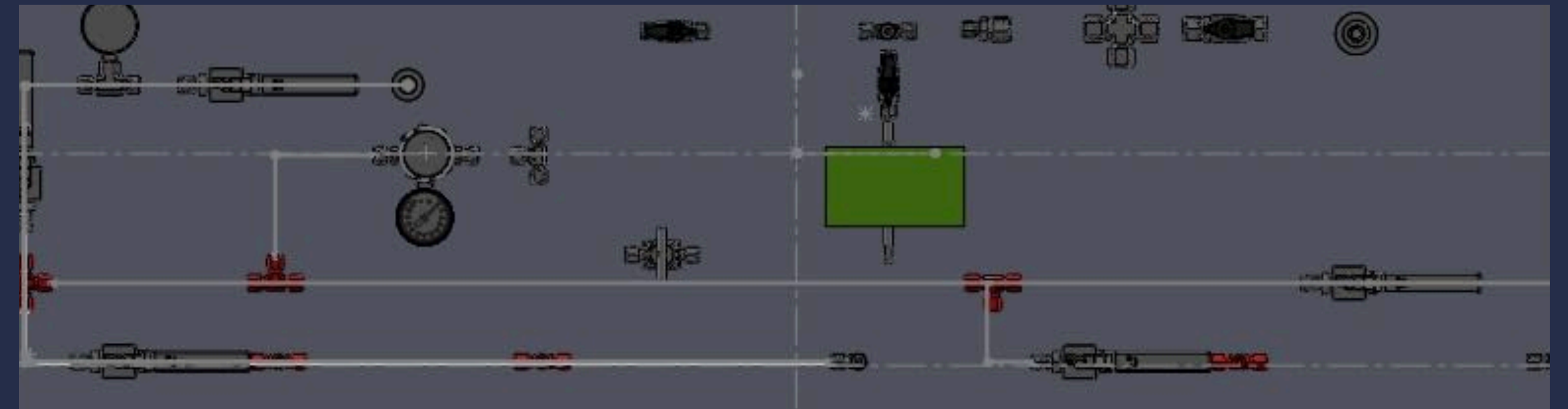
We need to explore methods of purging cold heads of contamination.

Current Effort

Upgrade our purification system & gas distribution in an effort to clean the recovered gas to 99.999%.

Currently we monitor the system utilizing web interfaces and in-house created bots that alert us. We aim to explore adding ML base methods of FDD.

We are exploring ways to create and test novel targets in preparation for our full cool down. Our run date is funding dependent but expect quick updates.

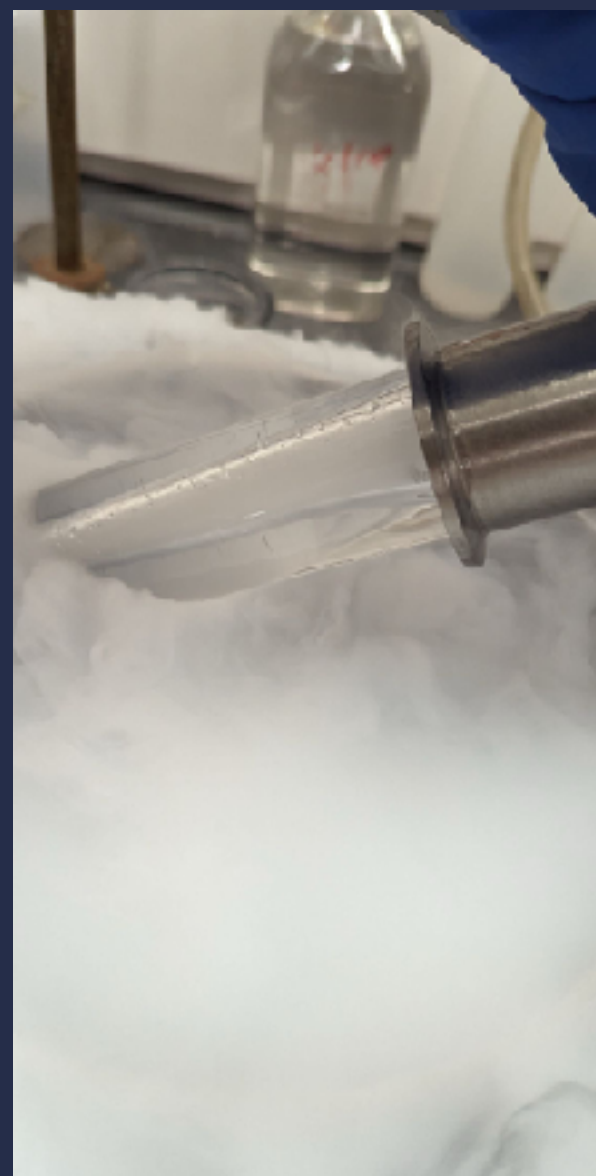
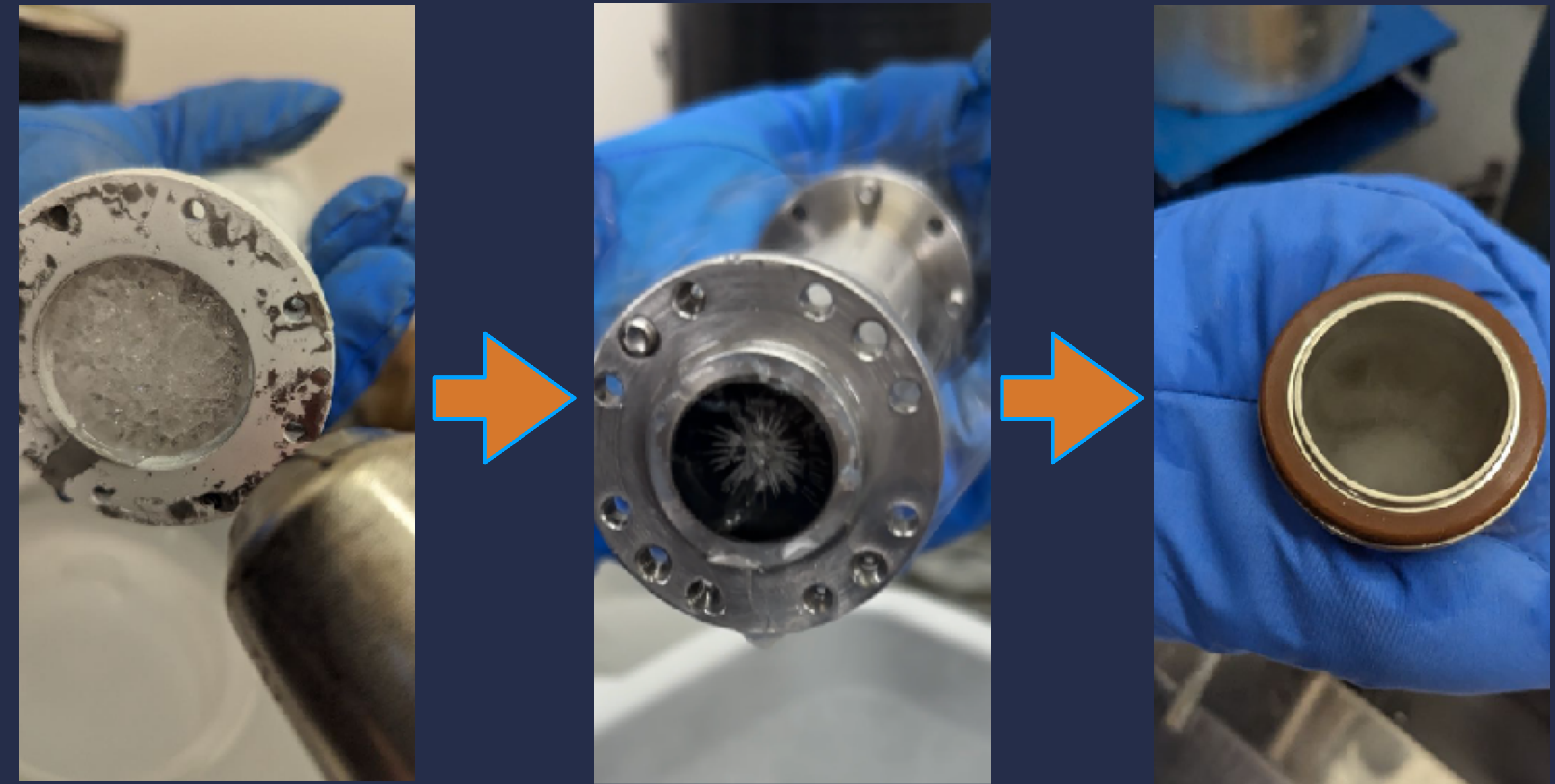


Target Production

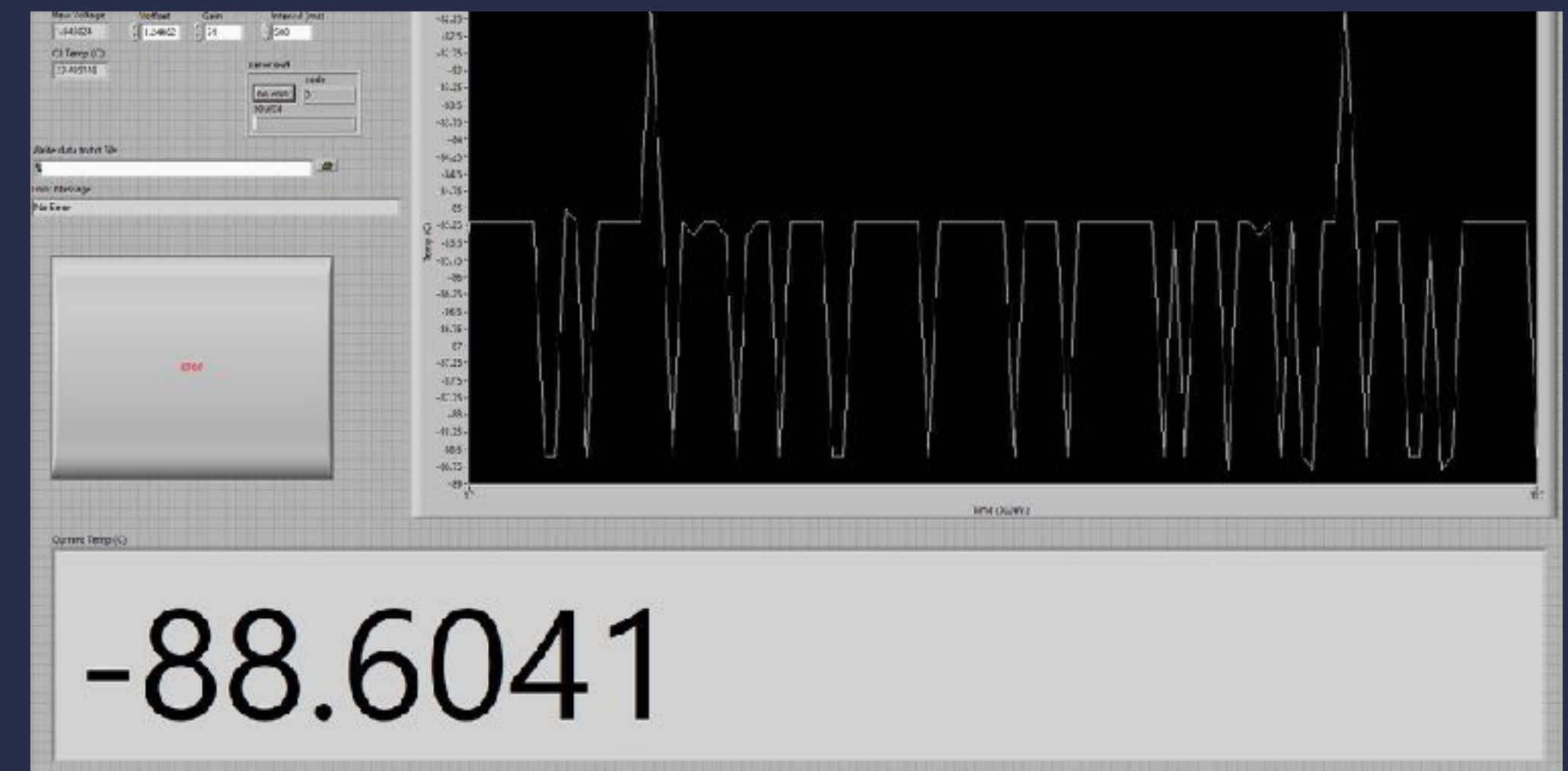
Ability to crystalize ammonia targets at high efficiency. Prep: 30 minutes.

Largest yield: 147 g in 1hour 30 minutes.

Research and development of novel targets and production methods underway



% H ₂ O in MeOH	Temp (°C)
0%	-97.6
14%	-128
20%	N/A
30%	-72
40%	-64
50%	-47
60%	-36
70%	-20
80%	-12.5
90%	-5.5
100%	0



Target Production

We created a method of bulk irradiating target material.

This method uses a rotating vessel that is dimensioned to allow an even irradiation.



All of our irradiation is done in partnership with NIST MIRF accelerator.

Other irradiation methods are being studied.

In house irradiation is down using dopants.

<https://doi.org/10.1016/j.nima.2024.169717>

Low Temperature Lab

Goals for the 50 mK dilution refrigerator:

Confirm the state of the sensors and heater within the fridge.

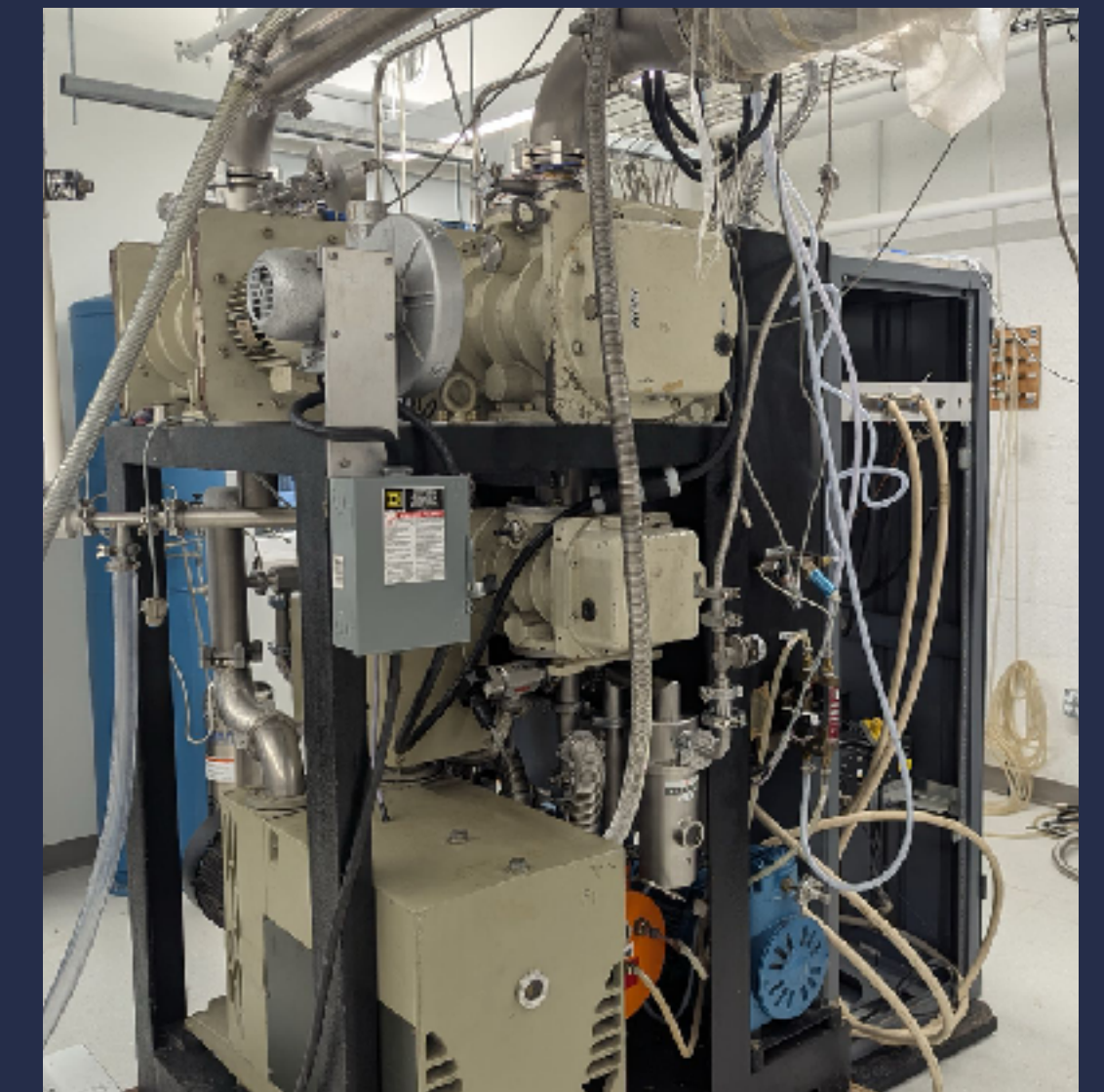
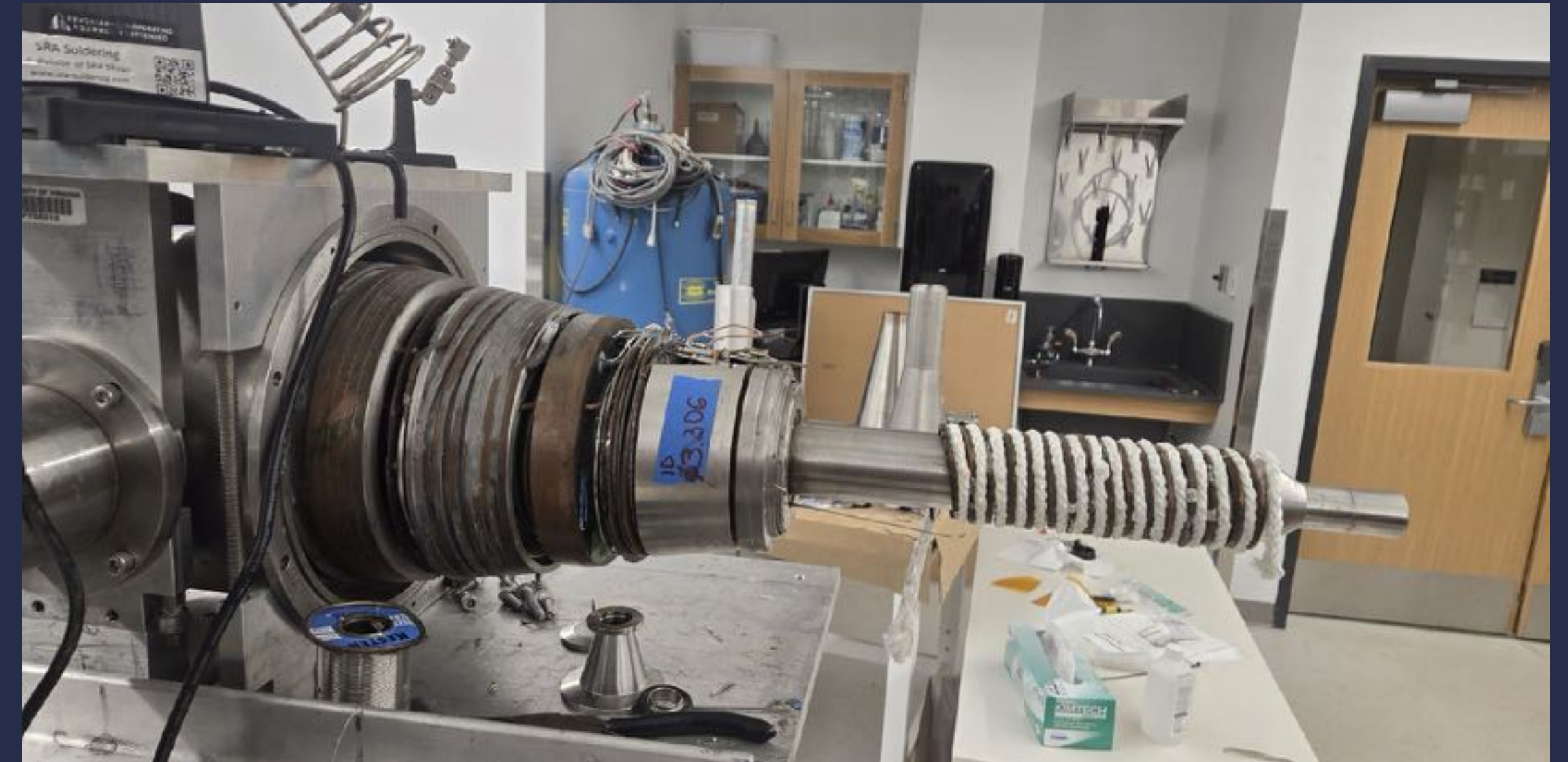
Finalization of the monitoring scheme.

Constructing the helium mixture recovery line.

Repair the ^3He line and leak check the system.

Connect the helium recovery lines to other lab.

Ran by: Dr. Matt Roberts at UVA



Conclusion

We have rebuilt our polarized target over the course of several delays.

We are currently testing and upgrading the system to fully run. Our next run date is funding dependent, but meanwhile we are cleaning our recovered gas.

We have several state of the art pieces of equipment such as our evaporation refrigerator, helium liquefier, and NMR.

We are constantly improving and searching for better methods to create new targets and cool down to 1K.

Special Thanks!

