LArFCS Cryogenic System Progress

Yichen, Sergey

8/10/22

Lab Safety

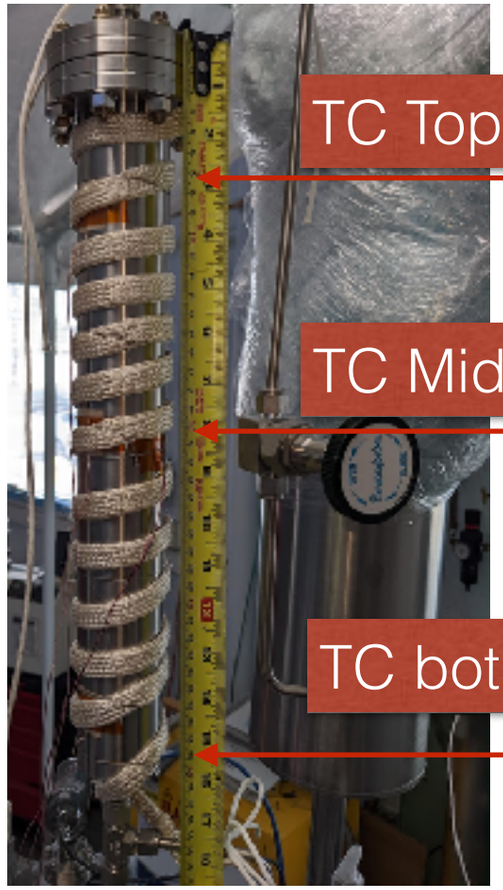
- **Lab Safety Reminders**
  - Watch out for the interns and summer students
  - The community COVID level is still at HIGH
  - Please follow the COVID rules, currently requiring face-mask onsite

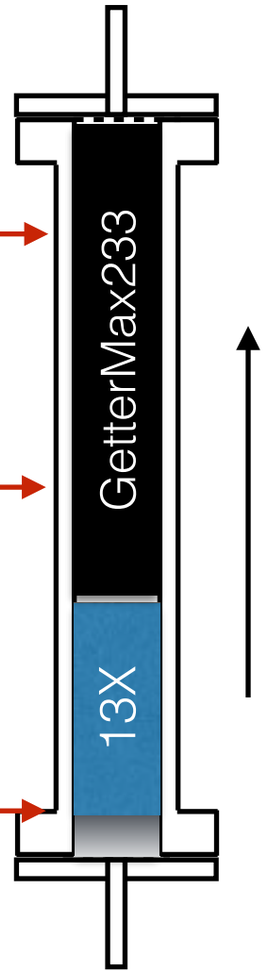
6000 gallon LN2 tank first refill

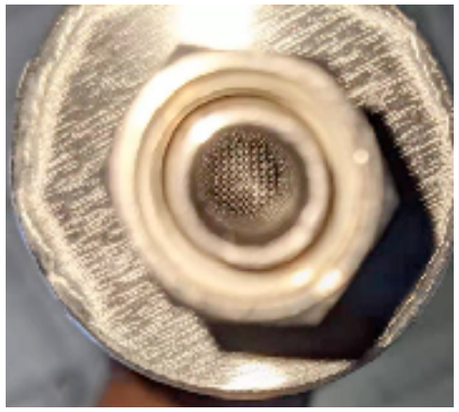
- **6000 gallon LN2 tank refill for the first time**
  - Ordered the same amount of 3000 gallon as the initial hot fill
  - Parking lot cleared
  - With about 15” LN2 left, the tank was filled to ~115”
  - The whole process between truck arrival/leave ~40 mins, actually filling ~25 mins
  - Making arrangement of discard/transfer LN2 mobile buggy outside highbay

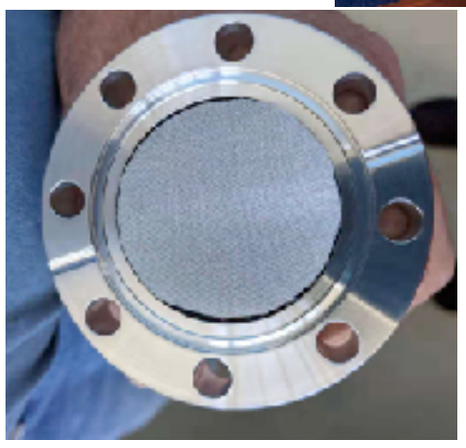
260L System Purifer activation

- **260L purifier assembly**
  - Cylinder filled with the scrubber materials
    - ~220ml, 180g 13X molecular sieve to remove water:
    - ~440ml, 561g GetterMax 233 to remove O2
    - Stainless steel wool at the bottom to disturb gas
    - Capped with mesh at the top and bottom to hold the materials
    - 3x thermal couple installed along the cylinder







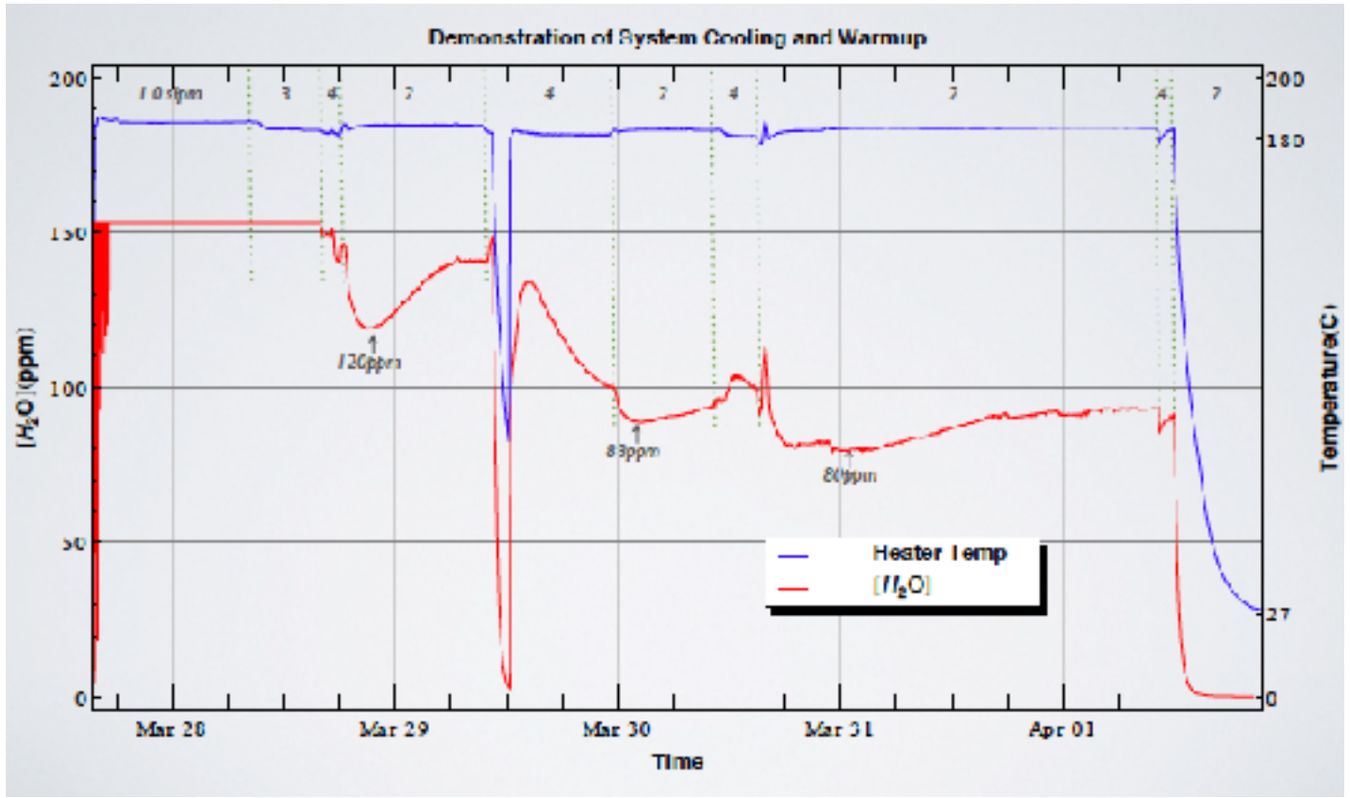


Principle of Activation

- Molecular Sieve(Heated):
  $Na_2O \cdot Al_2O_3 \cdot m\ SiO_2 \cdot n\ H_2O \rightarrow Na_2O \cdot Al_2O_3 \cdot m\ SiO_2 + H_2O$
- GetterMax 233: $CuO + H_2 \rightarrow Cu + H_2O$
- Water generated from both processes

Purifier activation(Previous Runs)

- **Activation instructions Early version**
  - Heat up the bed at temperature 180-220C, flow constant H2 mixture (1.5-2.0%) for a specific amount of time
    - 5.0 SPLM per kg of catalyst for 24 hours
    - 15.0 SPLM per kg of catalyst for 5 hours
  - Monitoring the moisture concentration with gas analyzer of at the exhaust
- **This the approach we used previously for activation**
  - Moisture analyzer reading gas with high moisture concentration for long period of time

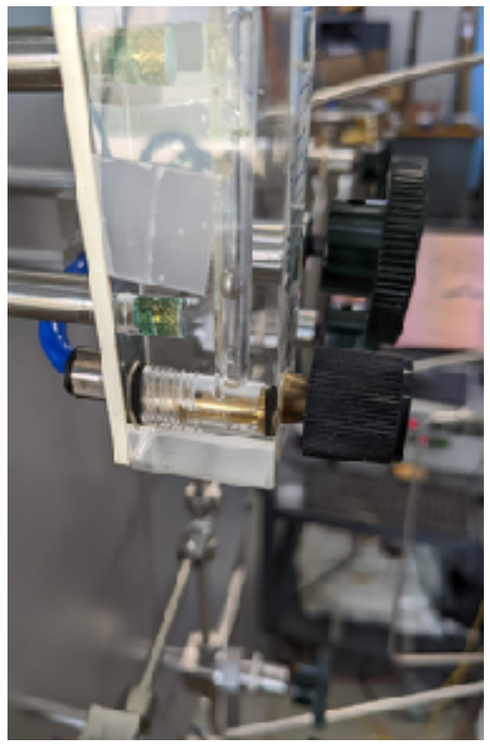


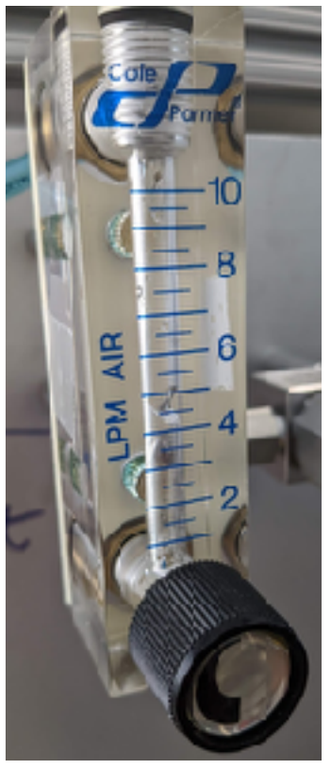
Purifier activation(This Run)

- **Activation instructions updates(in addition)**
  - Hot spot travel fully through the bed, no further heat release and bed temperature will be stable or subsiding(Recommended approach by the vendor)
  - Measure H2 concentration
  - Condensed water produced by the process will be seen to have stoped
- **The original plan**
  - Repeat the previous activation process monitoring with water analyzer
    - Set the heater at 180-225C
    - Preheat the bed for at least 2 hours with pure GAr
    - Switch to Ar+3%H2 mixture running with ~2.5 SLPM flow
    - Run the activation for about 24 hours until the moisture analyzer gets off saturation

Purifier activation(This Run)

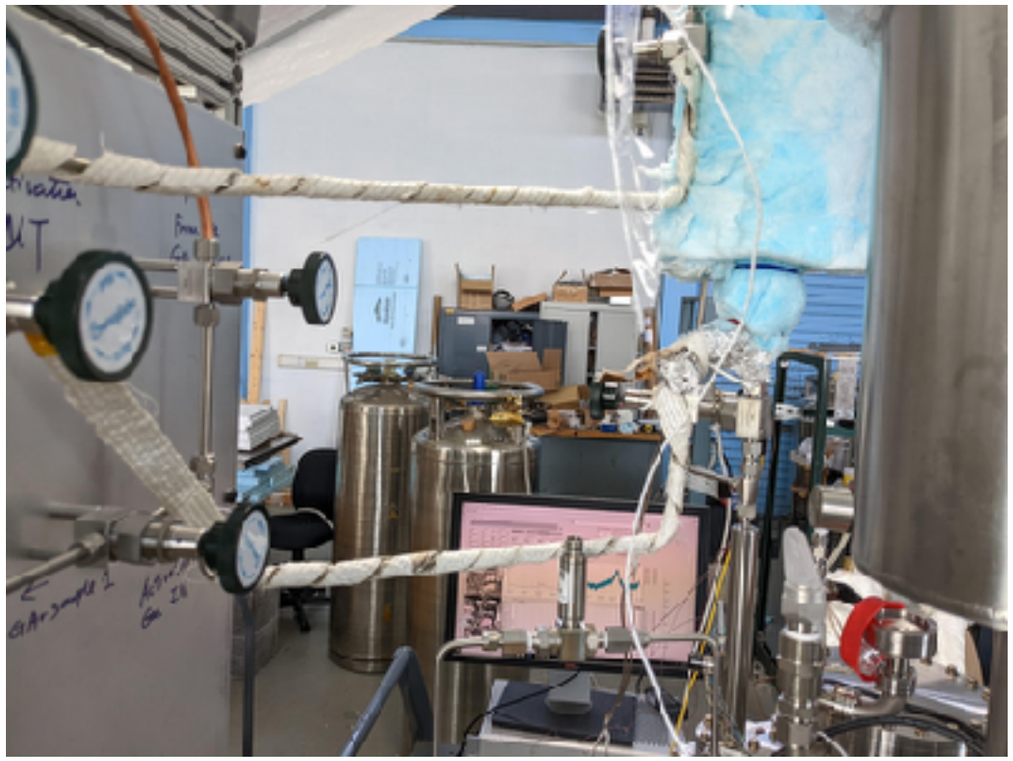
- **Activation troubleshooting**
  - Ran into problem this time
    - Water condensation again at the flow meter even with venting tube coil set downwards
    - Moisture analyzer ran into the malfunctioning status with 2 mins reading the activation venting gas

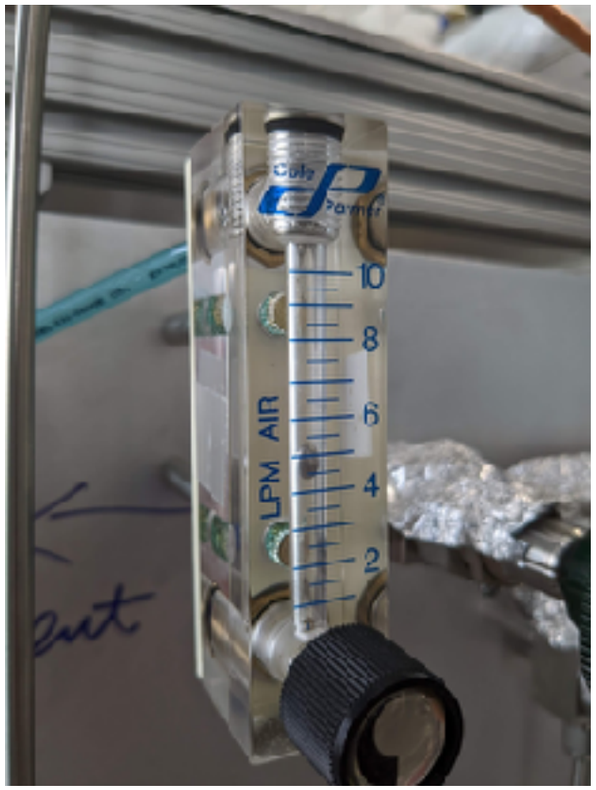




Purifier activation(This Run)

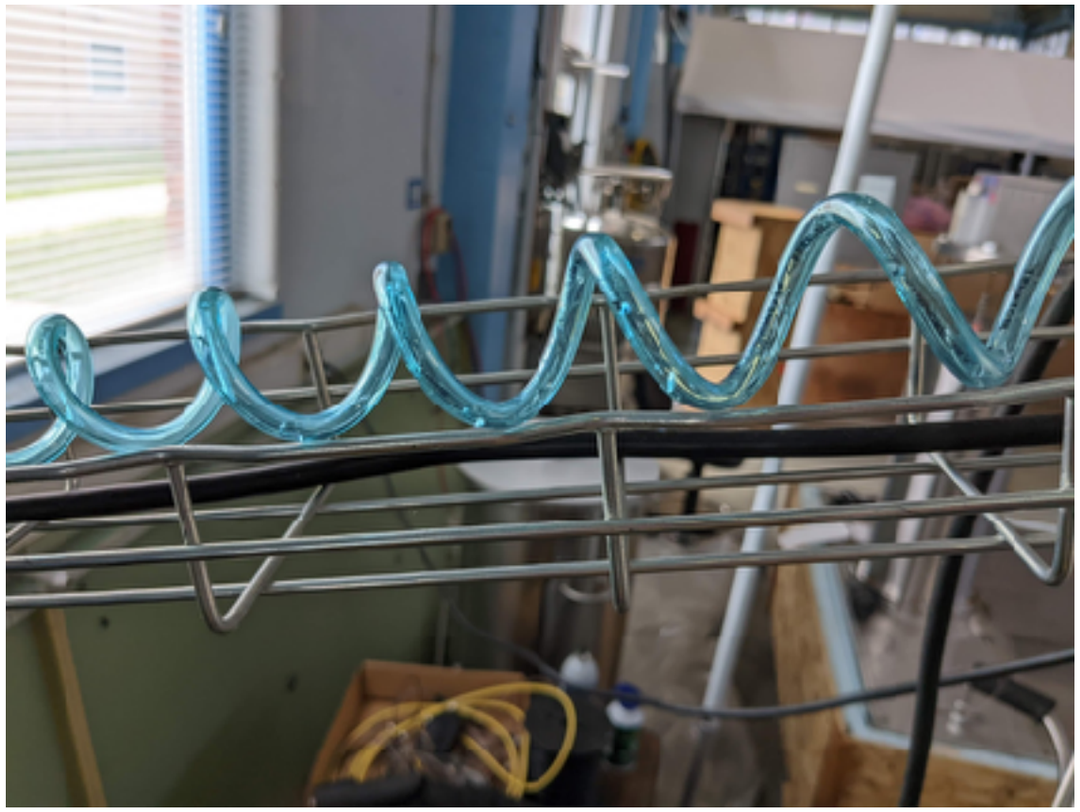
- **Solutions**
  - Heating tape added to the inlet and outlet of the purifier
    - Inlet to increase the activation gas temperature
    - Outlet to bake the tube
  - Effects:
    - No water at the bottom of the flow meter
    - Obvious water condensation at in the tube coil





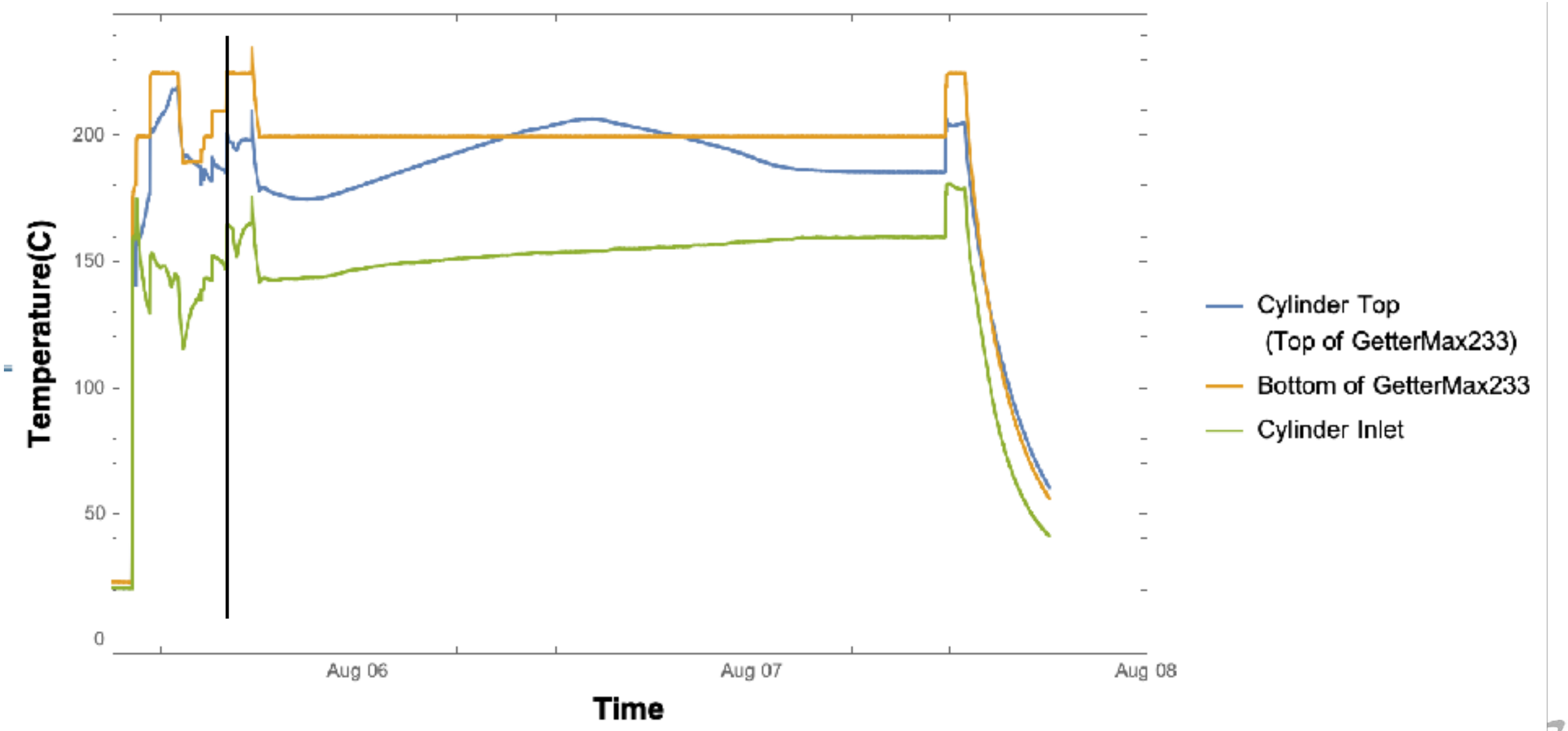
Purifier activation(This Run)

- **New findings this run**
  - Significant water condensation in the coil tube
  - Literally formed water flow down the tube: https://www.youtube.com/watch?v=nM6zLh2PpKw
  - Never observed in the previous activations
  - A simple water collection device setup to collect the water
    - Can use the collected to check the completion of the activation process



Purifier activation(This Run)

- **Activation process**
  - Preheated to 225C(middle TC temperature) for ~3 hrs with GAr
  - Reduce to 200C to protect GetterMax233, flow with Ar+3%H2 mixture for ~36 hrs
  - Clear move of “heat wave” observed
  - No water generation after ~36hrs(tube coil dry by visual), ~50 gram of water collected
  - No further water generation with temperature increased 225C at the end



Purifier activation Summary

- **Purifier activation completed**
  - Clear signature of move of hot spot in the bed observed
  - No further water generation
  - Suggested runtime with specified flow rate achieved
- Learned something new
  - The high concentration moisture could be the reason of previous moisture analyzer malfunctions. Checking with Servomex
  - Should not observe the activation gas with the moisture analyzer
  - Only 1 out 3 H2 mixture gas consumed in the process. Have plenty for future generation

260 L purification demo fill

- LAr delivered onsite to the wrong location to Bldg 902
- Arranging for move by compressed gas team today
- Redoing the cryogenic insulation by Russ
- Setting up the DAQ for cryogenic operation
- Plan to start the fill on Thursday after lunch