FSD cooldown and filling Plan

Current Status of the system

Storage Cryostat is full

level: 3350 mm LAr in the Storage >

Volume: ~ 6750 Liters

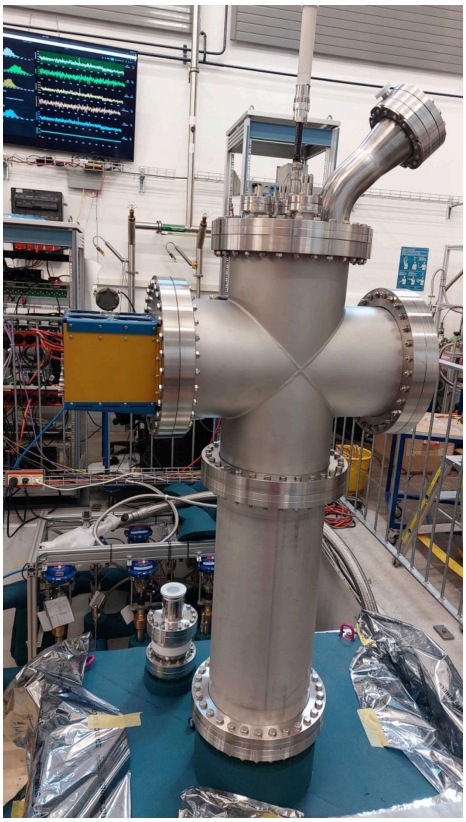
External LAr Tank:

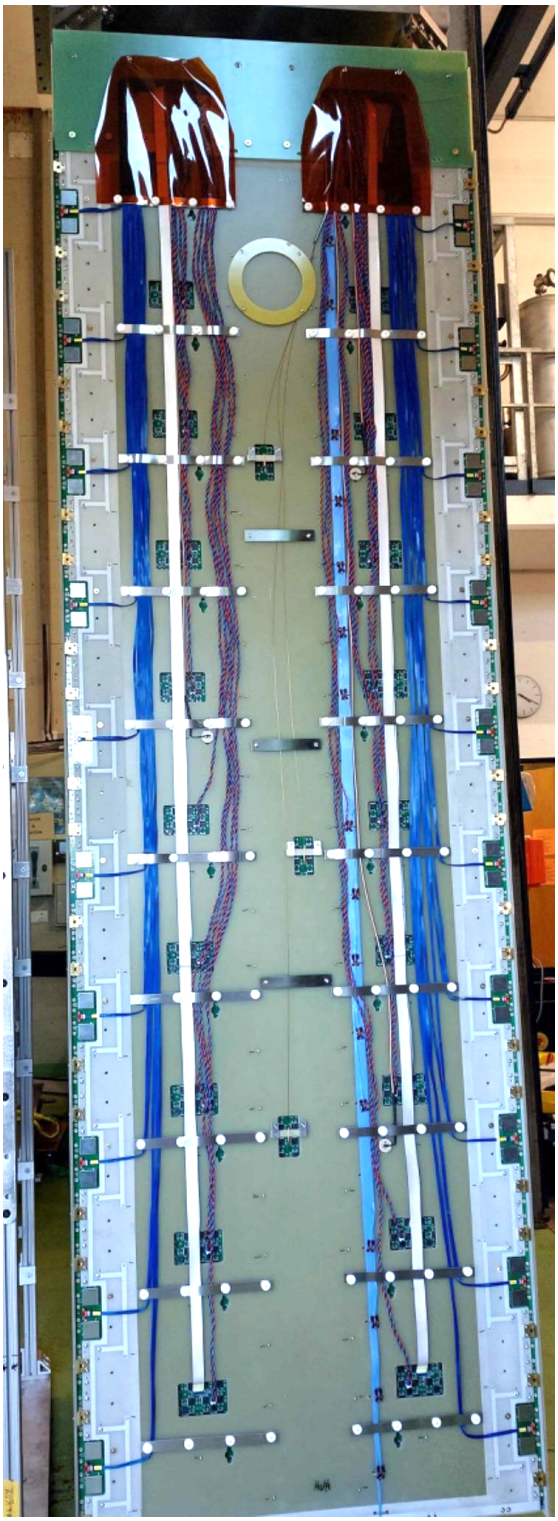
Volume: 1480 Liters

Warm Commissioning status

LRS: Warm LED calibration

CRS: Configuring the system





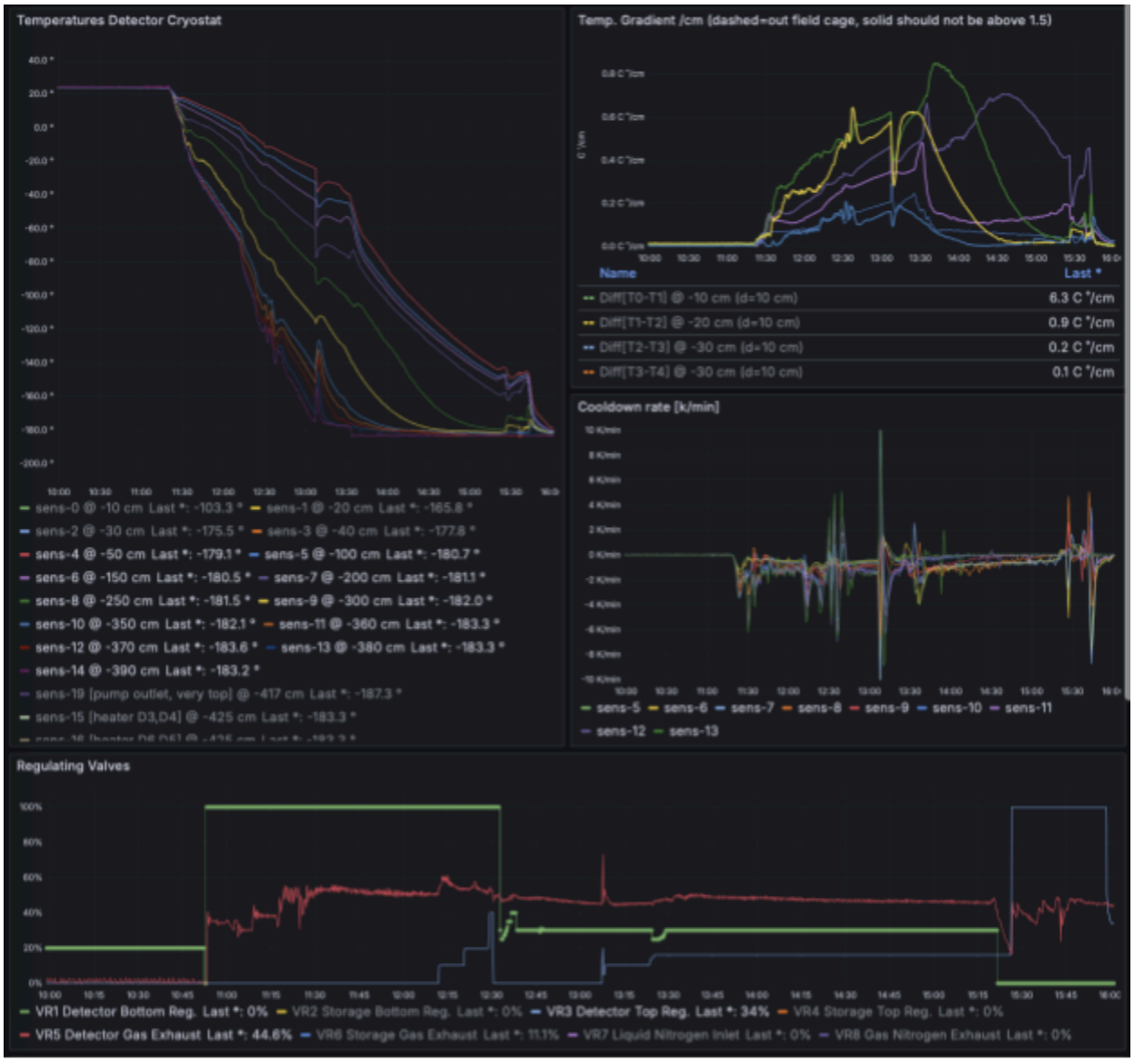
Previous cooldown data:

> Readiness test in July 2024

> Transfer from storage > Flow ~ 12kg/min

> After getting liquid into the cryostat, set valves to

- 30% bottom valve
- 16 % top valve



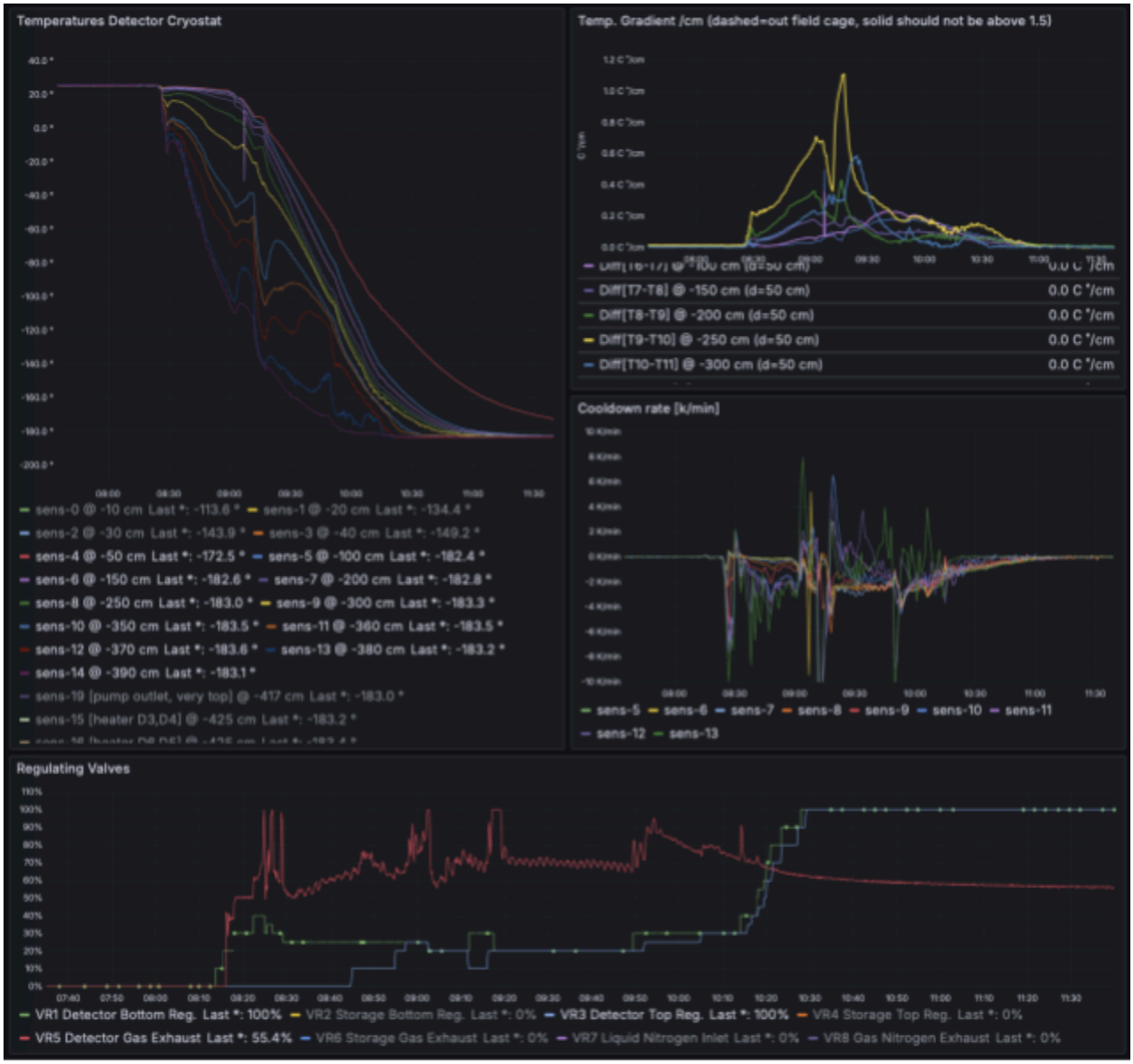
Readiness Test July 25th 2024

> Cryo Run w dummy module in August 2024

> Fill from external tank >> Flow ~ 2-3 kg/min

> After getting liquid into the Cryostat, set valves to

- 25% bottom valve setting
- 10 > 20 % top valve setting



Cryo Run w dummy module 23rd August 2024

Cooldown plan October 2024, fully instrumented module:

Overall timeline

Monday Morning Oct 21 shift: 8 am Start Cooldown
Monday evening shift: halfway full, continue filling
Tuesday owl shift: continue filling, stop the fill when the level is reached. []

Guidelines

- Temperature Gradients along the module [ArCLights] does not exceed 1.5 K/cm
- Cooling rate of Temperature sensors along the module does not exceed 10 K/min

State of system for cooldown

- LRS: OFF >> Power down bias voltage on SiPMs
- CRD: Start taking charge pedestal data for cooldown
- HV: OFF
- Ventilation ON

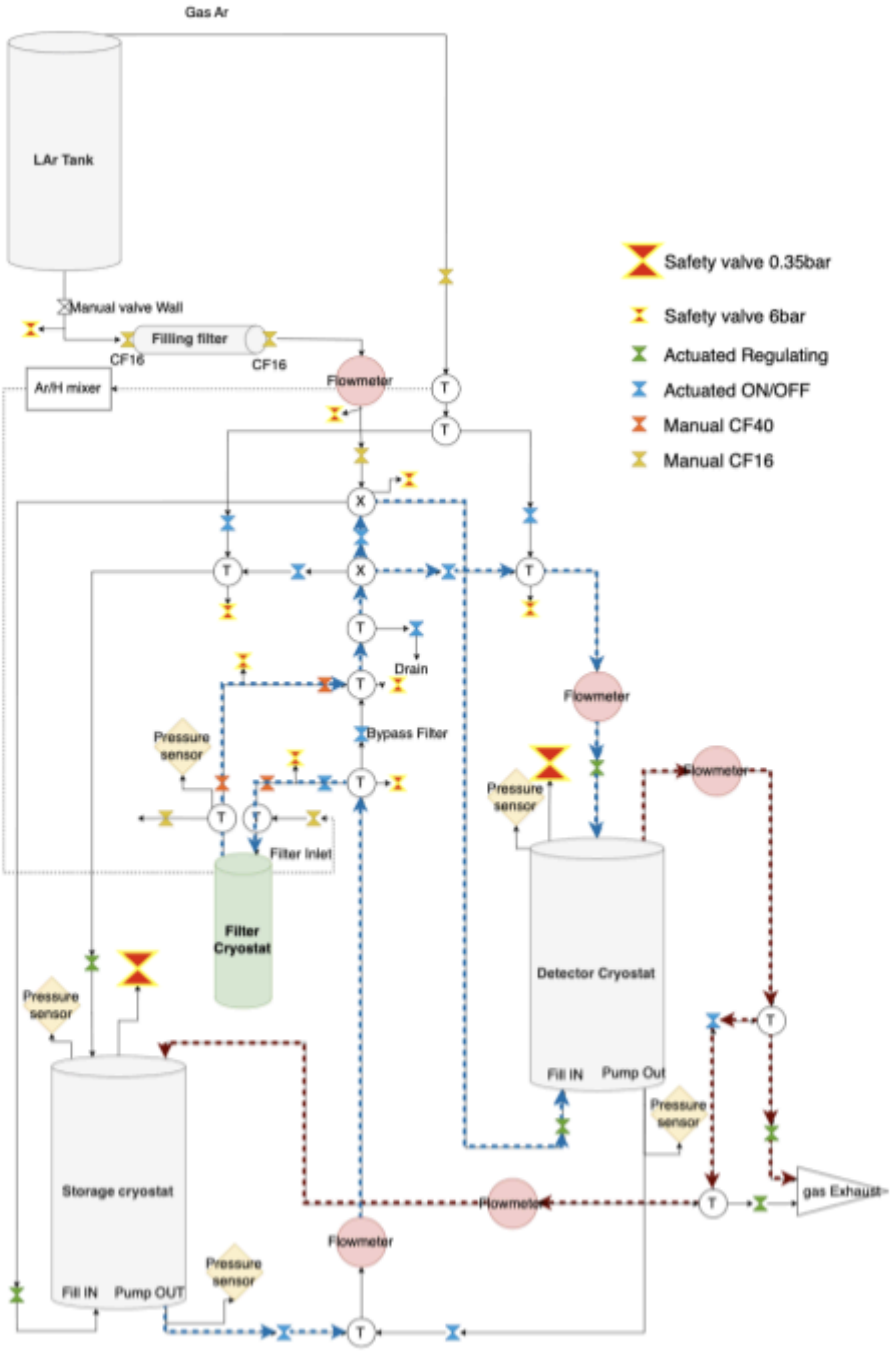
Procedure:

1. Storage cryostat LAr is being recirculated
2. To start cooldown, using the bottom fill line >> slowly open and watch exhaust gas flow meter become live
3. Slowly Open the top fill line
4. Watch the temperature gradients
5. When liquid starts to enter the cryostat adjust the top and bottom valve openings to maintain temperature gradient below 1.5 K/min. Expected %-setting to be at around 30% bottom, 15% top valve.
6. After the liquid level is above the heaters and all the 3 temperature sensors on the heaters are submerged, we can power the heaters to help with the gas mixture and temperature gradient profile in the cryostat [IMPORNANT NOTE: Heater might induce noise on the CRS pedestal data taking. This has not been tested before]

7. Stop Filling when level is at -70 cm from top flange, use temperature sensor markings.

Cryo system scheme

> Highlighted lines are used to transfer LAr from Storage Cryostat to Detector Cryostat



Operation mode: Filling from Storage Cryostat

Sign off for cooldown and filling procedure

ND-LAr Consortium management Lead ……..

Charge readout subsystem expert …….

Light readout subsystem expert …….

Field structure subsystem expert …….

HV subsystem expert ……..

Calibration subsystem expert ……..