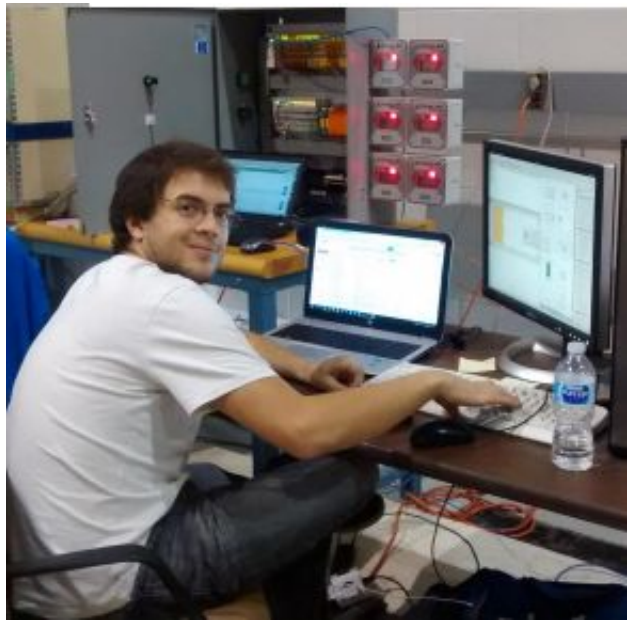
The nervous system of the LUX-ZEPLIN detector

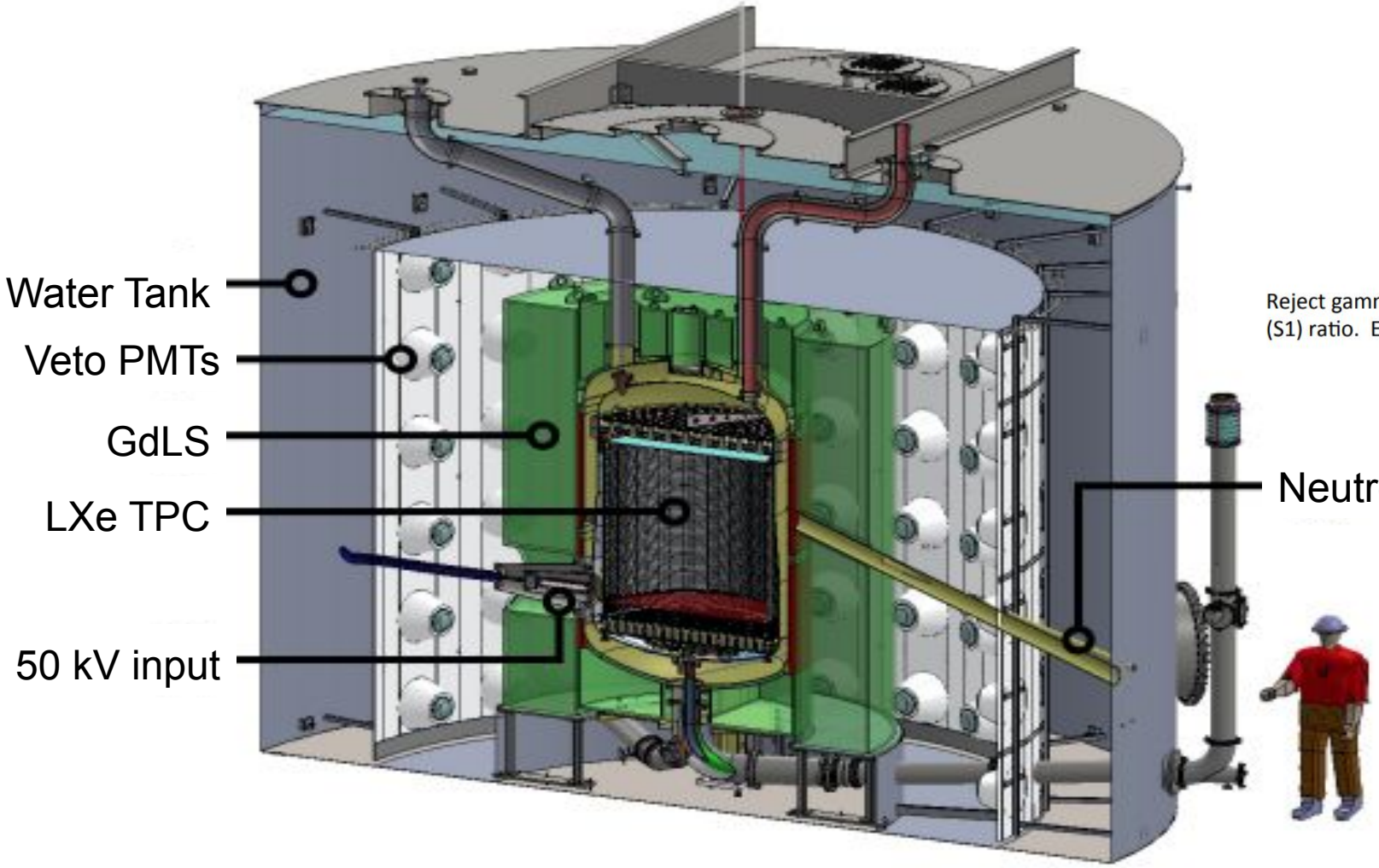
Guilherme Pereira| LIP Coimbra | June 27, 2020

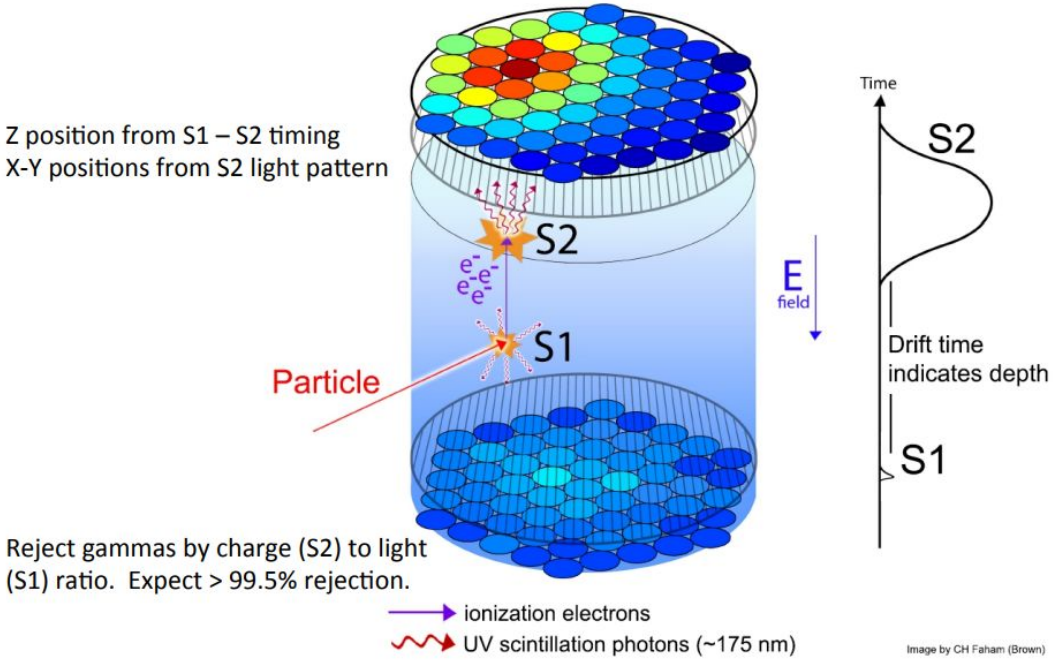
that’s me!



LZ detector

Top 241 PMTs grid and a bottom 253 PMTs grid are responsible for the detection of S2 and S1 signal. In addition 93 PMTs placed near the TPC walls increase background rejection efficiency.





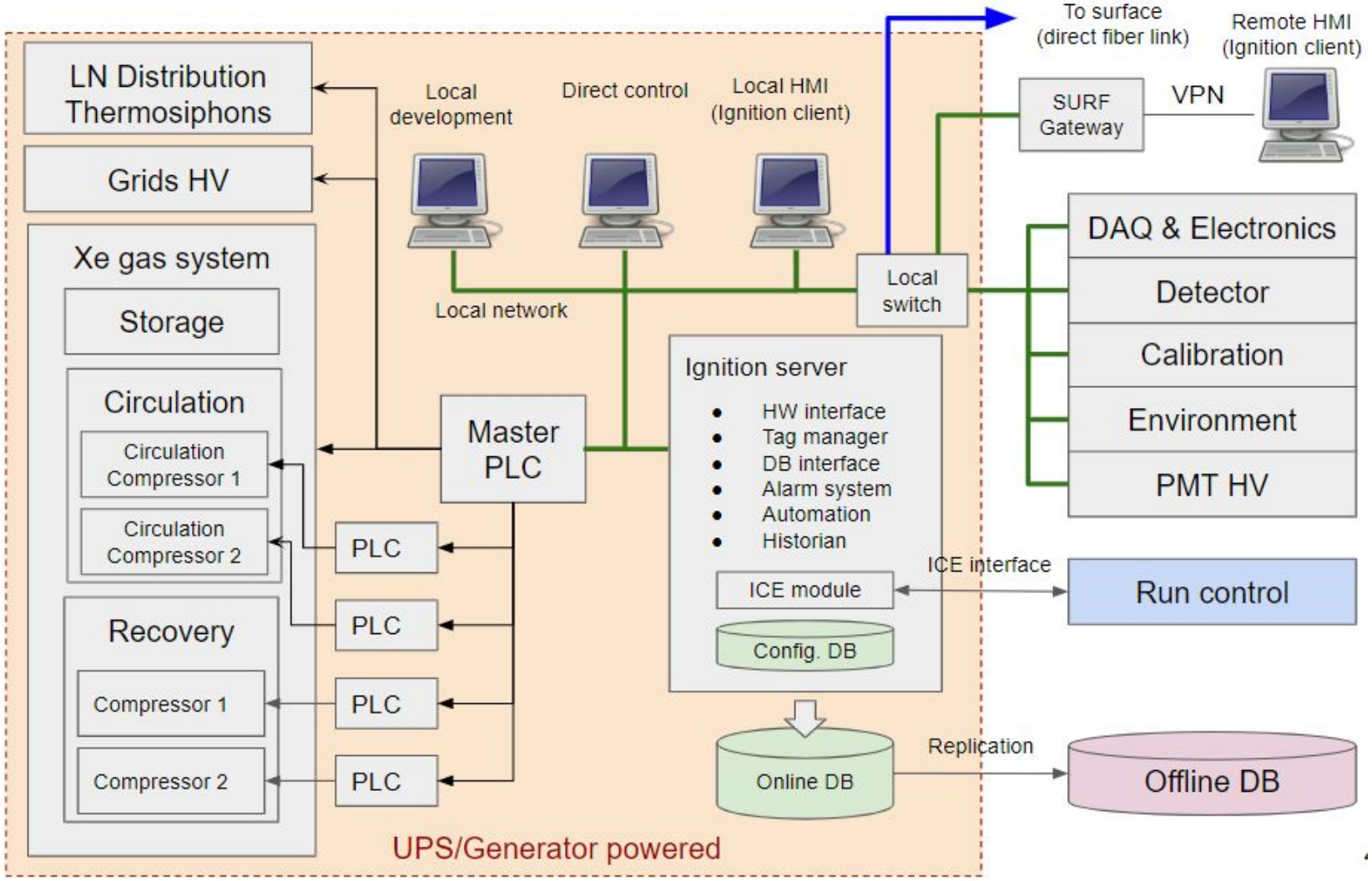
Located at Davis Cavern at SURF (Sanford Underground Research Facility) at a depth of 1500m (Lead, South Dakota)

Experiment Control group overview

Main role: guarantee the safety of the detector and the Xe circulation system and also provide support for the hardware system,

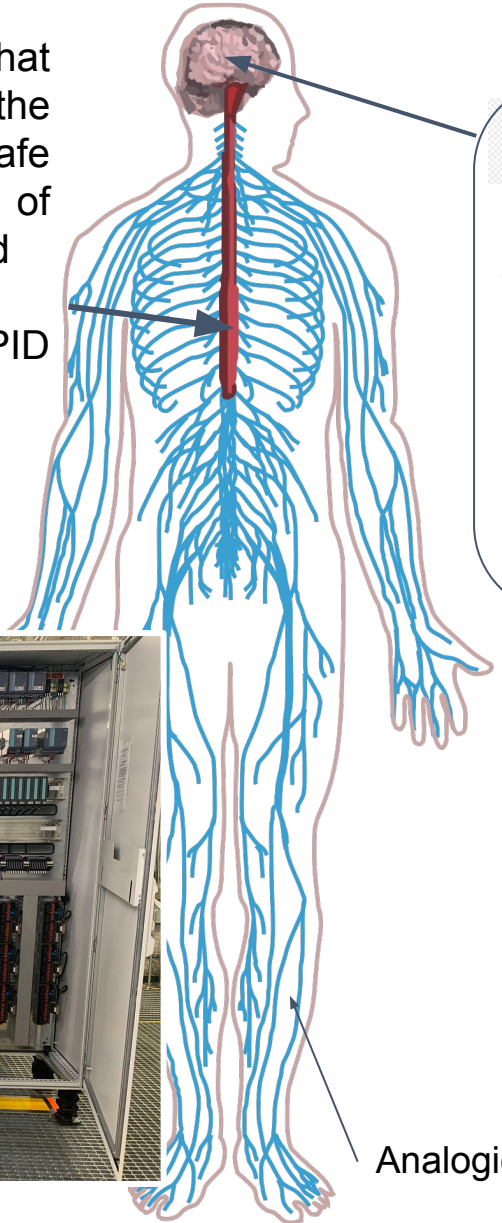
Monitor and control parameters critical to LXe conditions and to the detector operations

temperature, pressure and liquid level, field cage properties and PMT HV



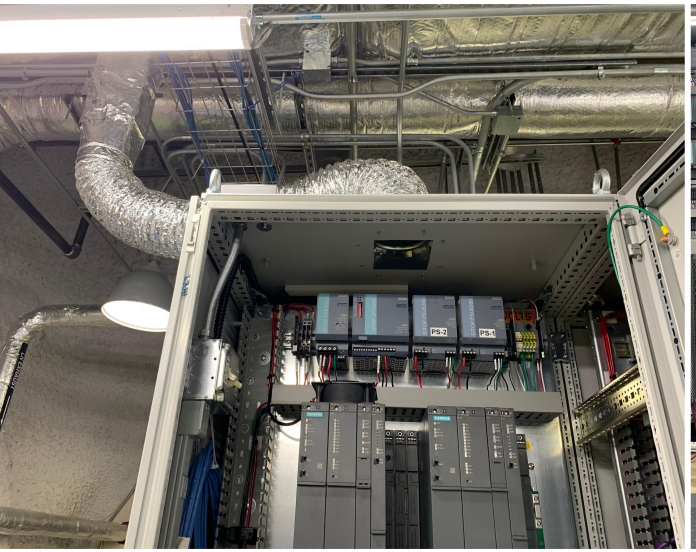
Experiment Control - nervous system

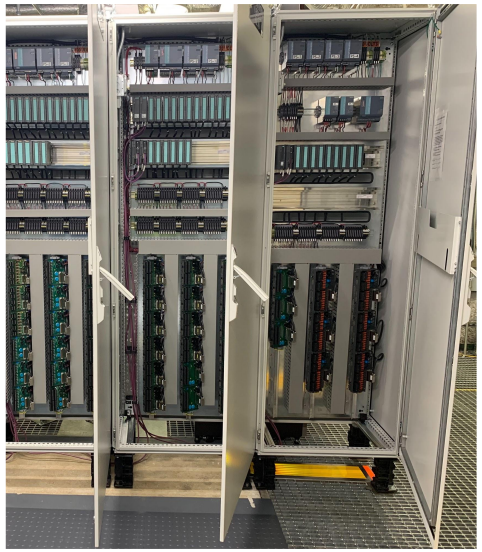
Master PLC that maintains the system in a safe state by means of pre-programmed interlocks (reflexes) and PID loops (homeostasis).



Ignition server

- Database with data history for all channel at a rate of ~5s (the rate depends on the purpose)
- Alarm system customisable for each sensor
- Web Interface accessible remotely
- High level automation script (e.g. put detector in neutron calibration mode)





High availability redundant system with automatic failover

- PLC: Dual-CPU Siemens S7-400 model
- Ignition SCADA: redundant two-server configuration
- Compressors: 2 circulation + 2 recovery (two pairs of 3 bar and 48 bar)
- Database: continuously replicated to a mirror on surfac
- Network: two physically separated 10 Gb/s links
- Redundancy in all important controls and sensors

Analogic wiring to sensors

Experiment Control channel count

Detector and Xe tower	290
Xe delivery and recovery	480
Xe circulation and purification	120
Cryogenics	335
Vacuum	284
Environment monitoring	8
Water Tank	30

Calibration	226
Purity monitor	15
Electronics Analog+Digital	2600+1500
Power distribution and UPS	78
PMT HV	5516
Total (SURF)	11404
Kr removal (SLAC)	1336

Critical channels (PLC channels via OPCUA+MODBUS)

Non critical channels (SNMP and MODBUS)

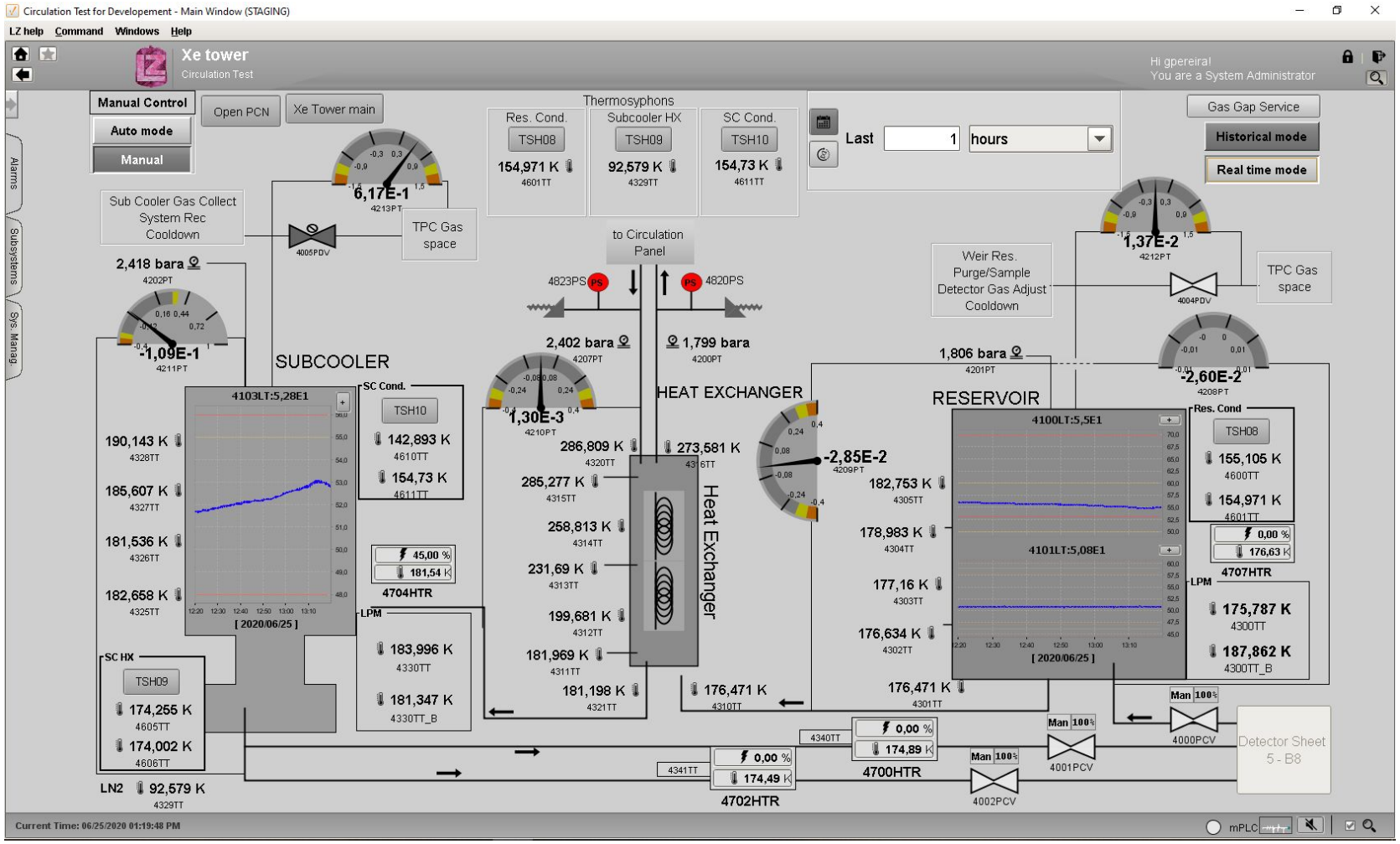
Undergoes long and exhaustive Quality Assurance process (almost 1 year of testing and checking)

Experiment Control group - Xe Tower

Purification start here!

1. Fluid flows from the **Reservoir** to the **Heat Exchanger** where it's boiled.
2. From Heat Exchanger the fluid is pumped by the C. Compressors into the **Getter** (not represented)
3. From the Getter back into the Xe Tower where pure Xenon is recondensed and cooled with LN (subcooler)

hot (450ºC) zirconium getter to remove electronegative impurities



I know, it's not the best picture

Experiment Control group - Compressor

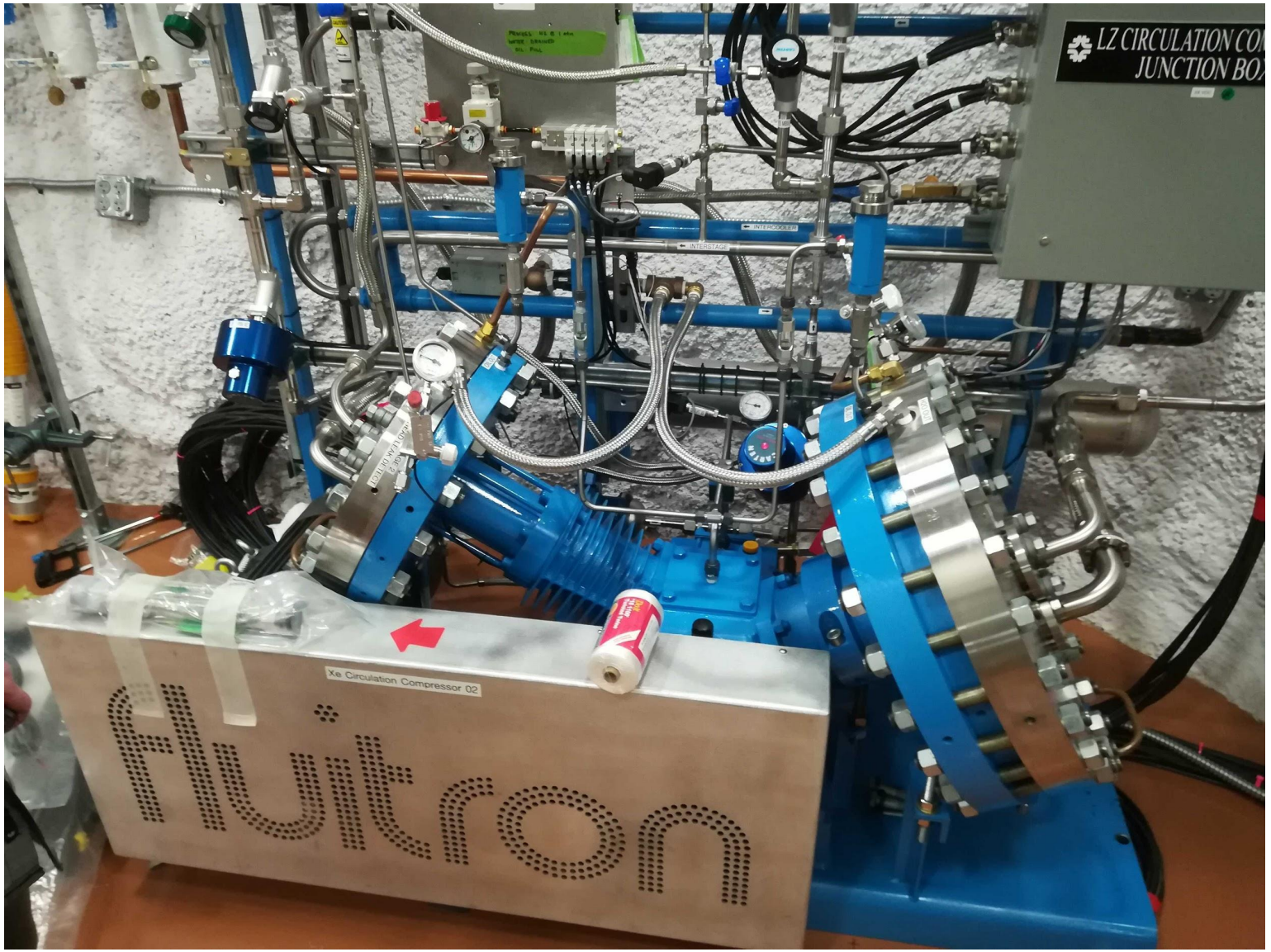
The Circulation Compressor are the heart that pump (gaseous) “blood”.

Circulation compressor 2 and 1 (Slytherin) keep the Xe flowing through the system.

- operate at 600 slpm
- can flow the 10 tons of Xenon in 2.3 days

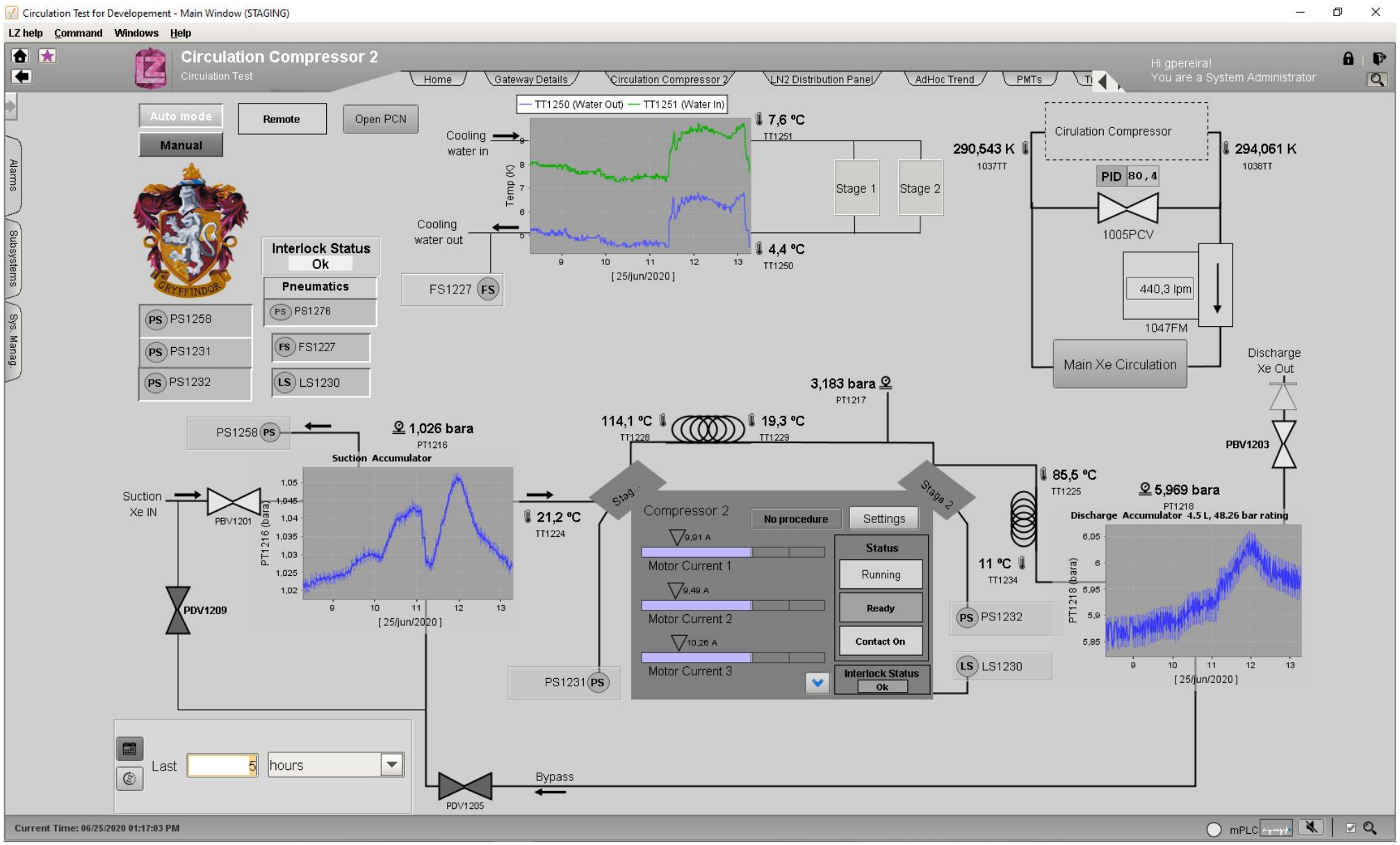
Compressor 1 is Slytherin is because it was not operating well in the first phase of commissioning

Recovery compressor 1 and 2 (Hufflepuff and Ravenclaw) are responsible to quickly flow the Xe into a safety vessel if something terribly wrong happens during operations.



Circulation Compressor 2 (aka Gryffindor).

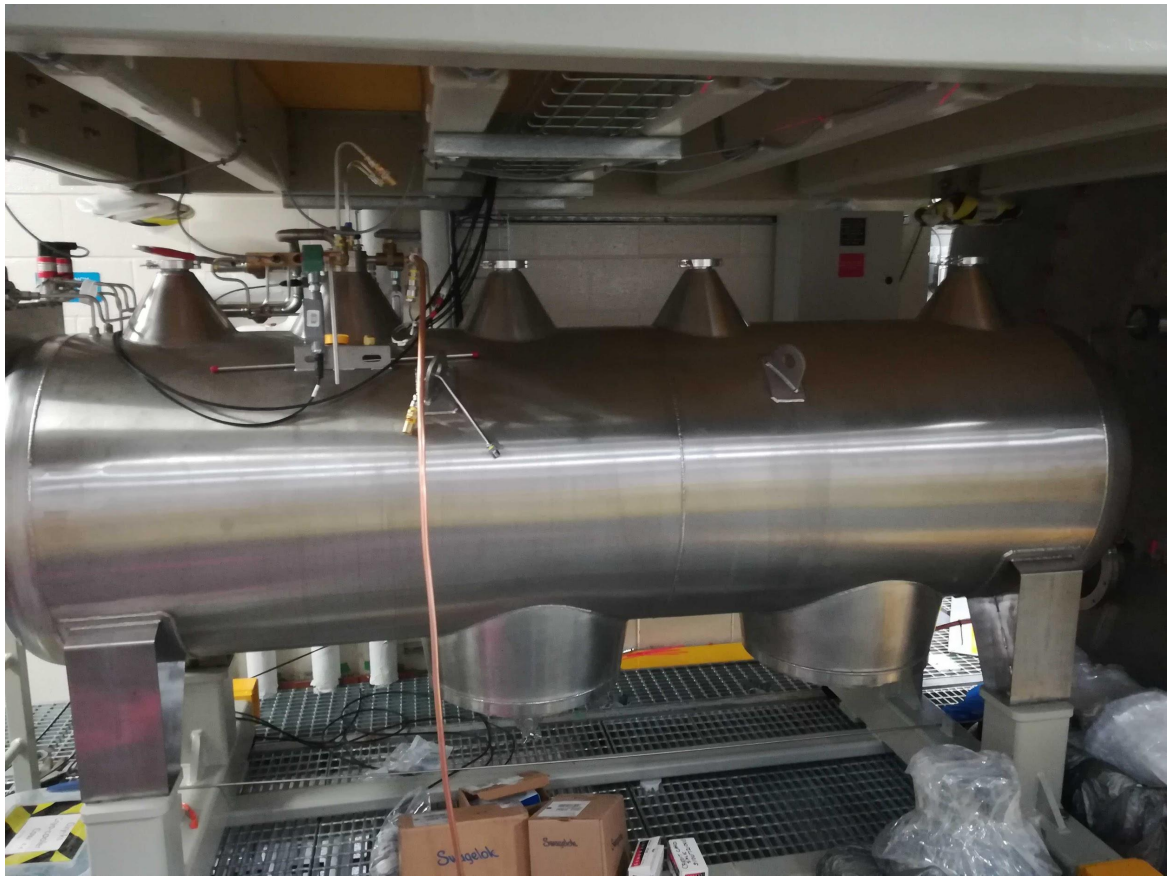
Experiment Control group HMI GUIs - Compressor



Experiment Control group - LN2 system

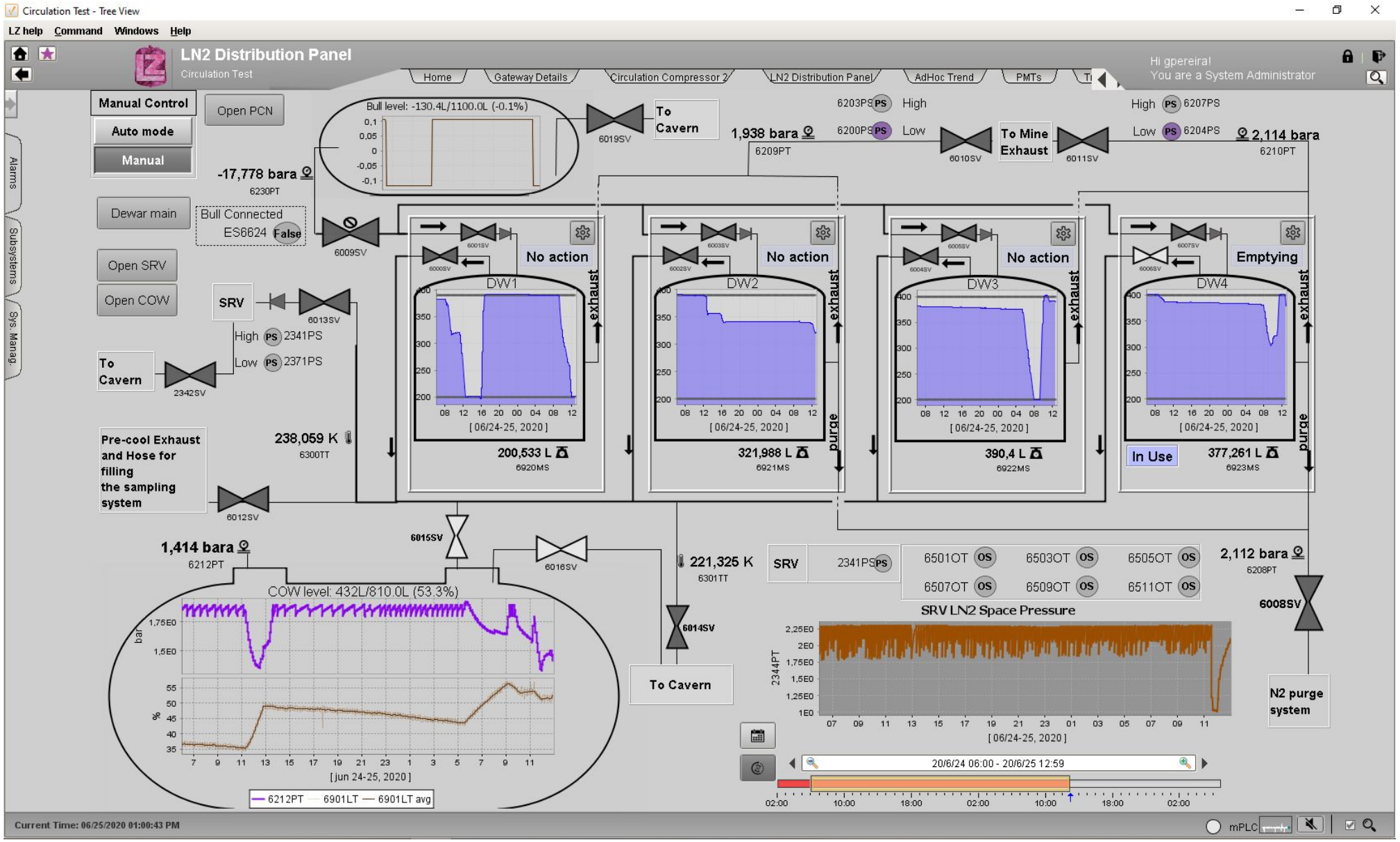
Ideal operating temperature is -104 ºC (169 K)

810L COW (Cryogen On Wheels) - provides the resupply of LN from the surface

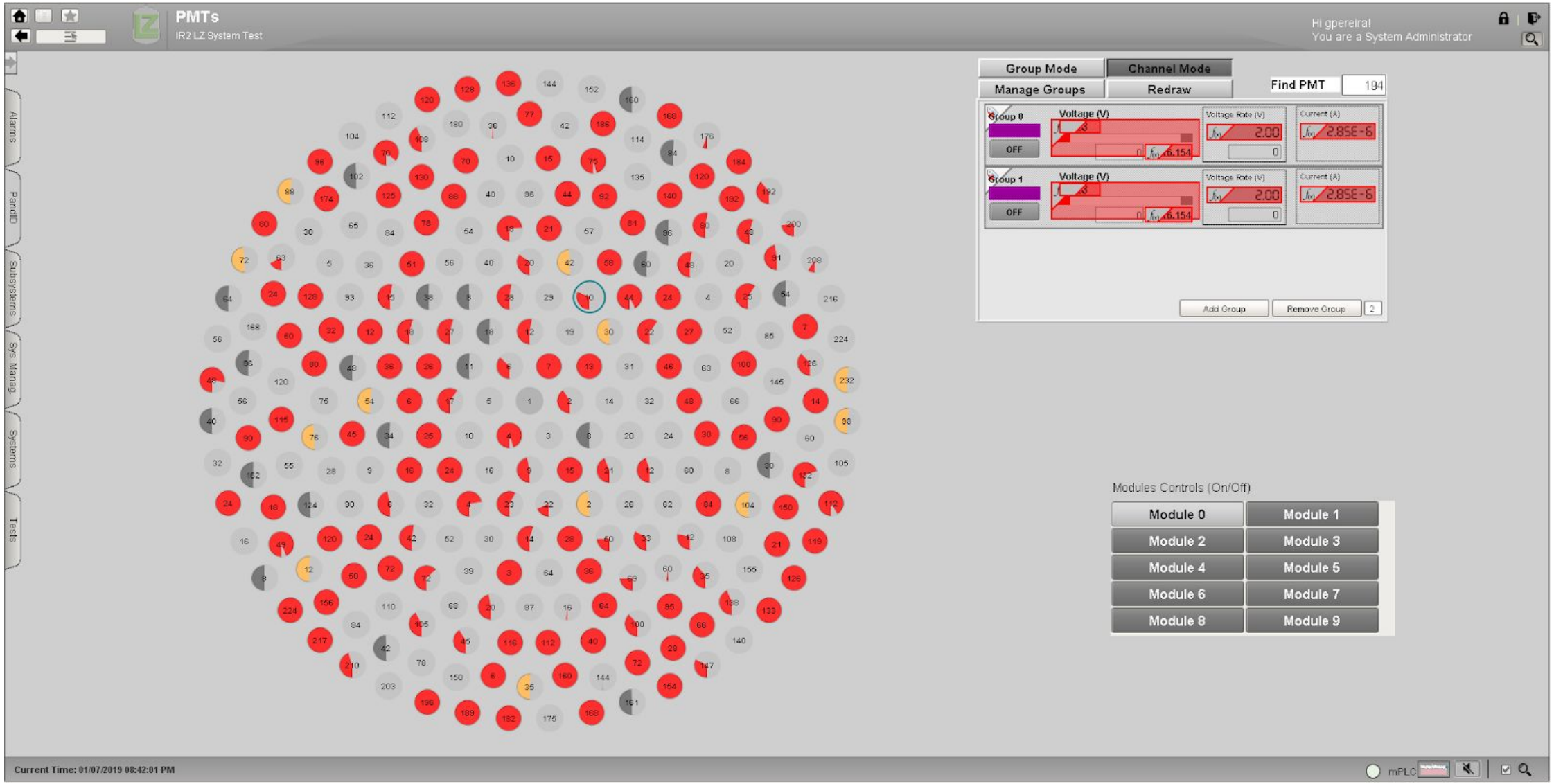


Circulation system equipped with 4 450L dewars that store Liquid nitrogen.

Experiment Control group - LN2 system GUI



Experiment Control group HMI GUIs - PMTs HV

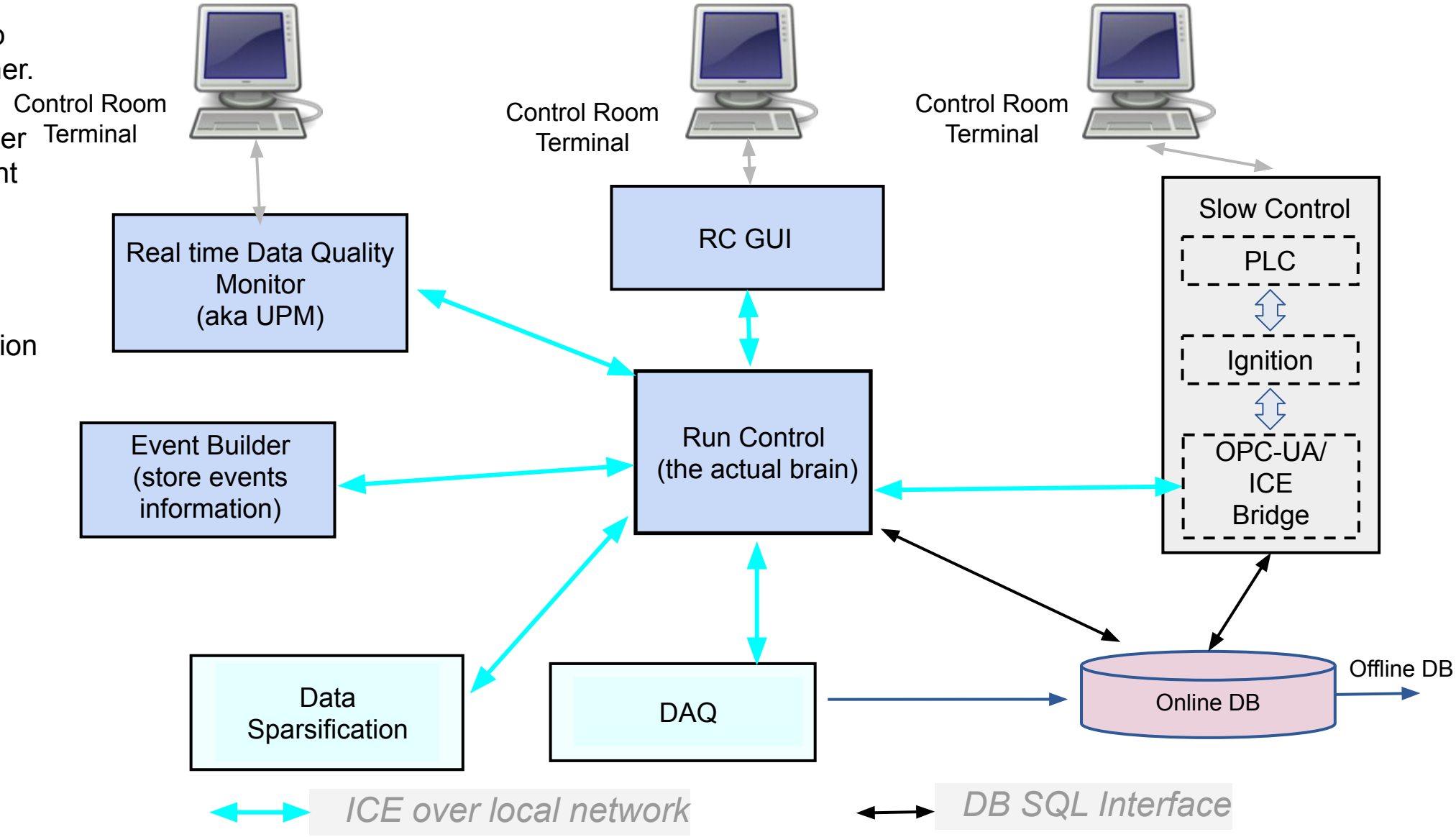


Experiment Control group - Online System

Run Control is the maestro that puts everything together.

Routines initiated by an user send commands to different subsystems to start data collection in different acquisition modes, for example

- Start neutron calibration
- Start WIMP search
- Start brewing coffee



Conclusion

- The LZ detector will start its operations in the next months of this year
- LIP has a very strong presence in the detector operations, commissioning and development
- Personally I'm excited and grateful to be a part of this project, because it combines and increases my knowledge in physics and engineering

Thank you! (imagine claps)

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