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# XeLab

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A cryogenic setup to host a LXe double phase TPC in Paris

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presented by Luca Scotto Lavina - LPNHE  
on behalf of the whole XeLab team (LPNHE, Subatech)

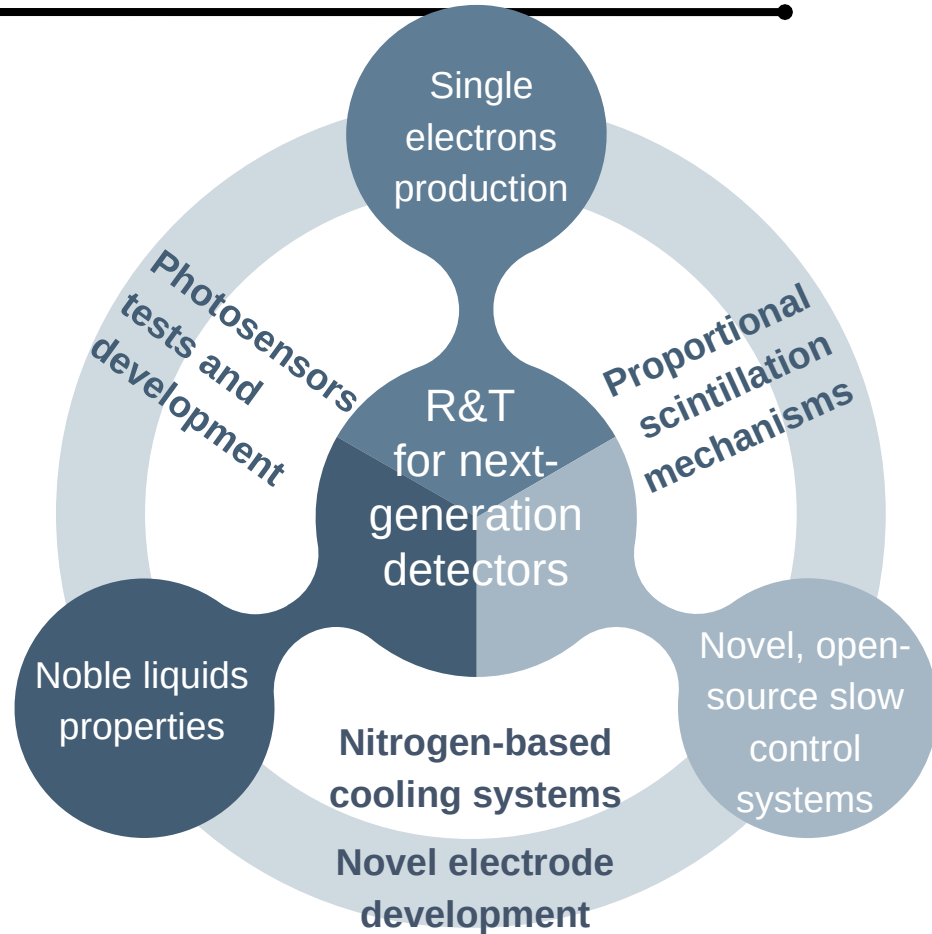


XeSAT2023, Nantes

# XeLab, an R&D meant for DARWIN



- First site in France working with a dual-phase LXe TPC (Subatech has only single, liquid phase)
- Meant as a platform to perform R&D for next-generation detectors
- Funded by IN2P3 with local support by LPNHE and Subatech
- Many side-projects on the way, nice attractor for students



## Main priority for XeLab

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XeLab aims to test the idea of **floating electrodes**, to keep the **double phase** and have a TPC design as close as possible to the current ones

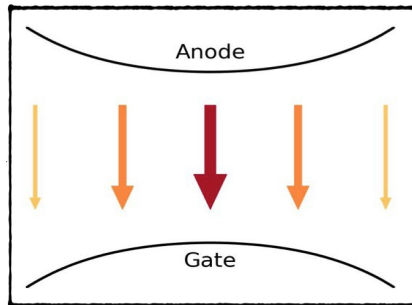
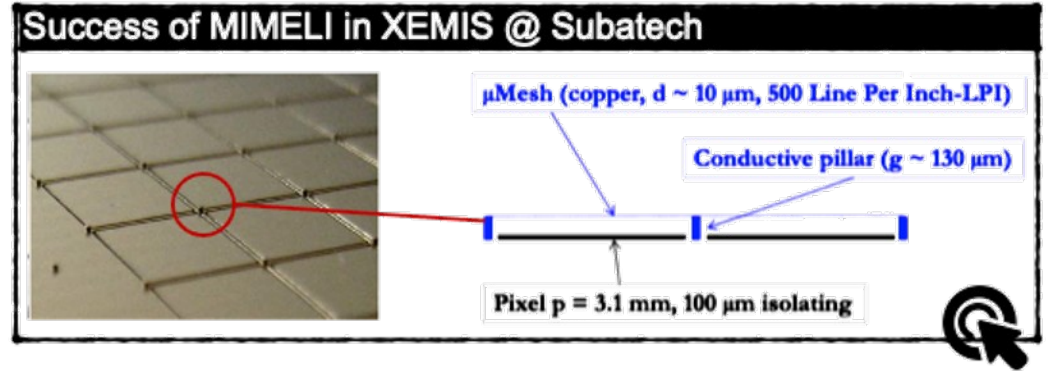
Small TPC to test solutions for large TPCs? Yes, because:

We first need to show that this solution, which will certainly reduce some performances (optical transparency), will allow us to have 100% extraction efficiency and high yields (with low voltages), with low penalty on S2 resolution

# Electrode R&T in XeLab

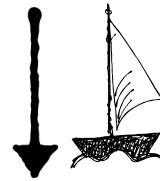
## Goals:

- Minimize mechanical distortion
  - possibility of reducing the grid ↔ anode distance
  - better energy resolution
- Optical transparency as close as possible to that of parallel wires
- More uniform signal response over x, y

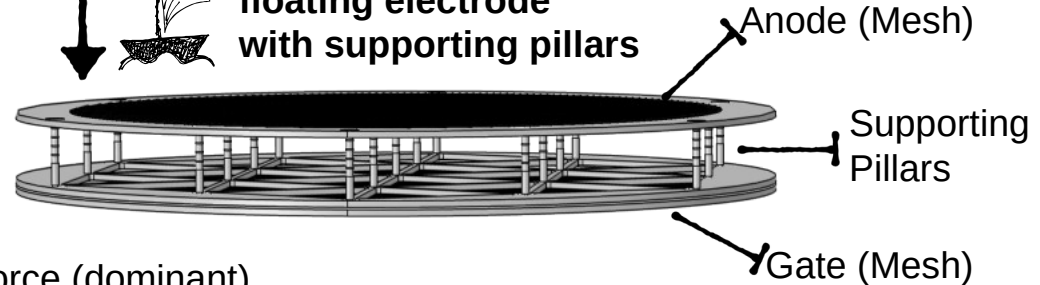


### Sagging

Electrostatic force (dominant)  
Gravitational force ( $\sim O(10)$  lower)

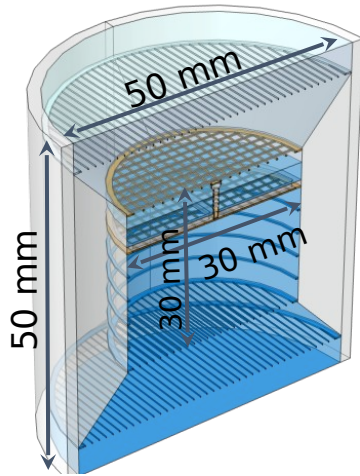


floating electrode  
with supporting pillars



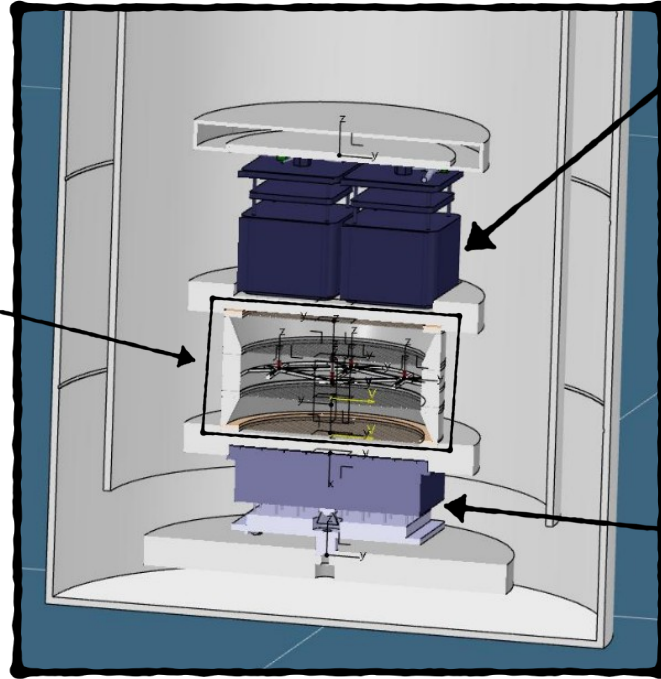
# TPC under development

Small-size TPC prototype to test the performance of novel electrode with support pillar



Electrodes

Electrostatic and further mechanic simulation with COMSOL and Ansys

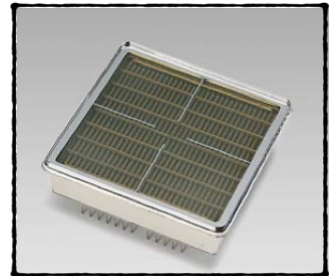


Top PMTs array



Hamamatsu R8520-406  
Effective area: 20.5 x 20.5 mm

Bottom PMT



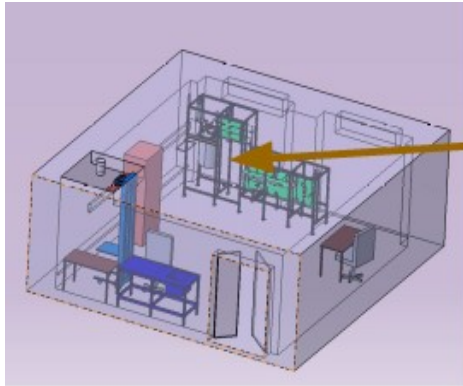
Hamamatsu R12699-406-M4  
2 x 2 multianode  
Effective area: 48.5 x 48.5 mm

# Installation in LPNHE

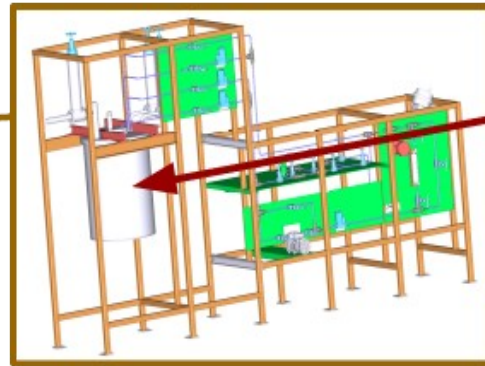


Dedicated direct line with a 15k liters nitrogen reservoir from Sorbonne, Jussieu

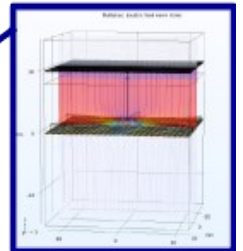
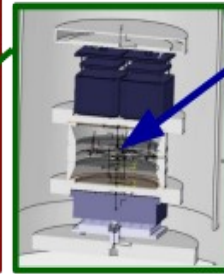
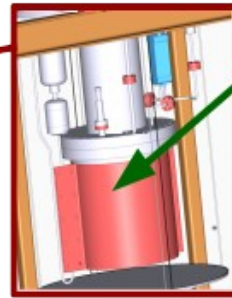
Installations starts... tomorrow!



Campus Jussieu, LPNHE, Salle 12-13-SS03

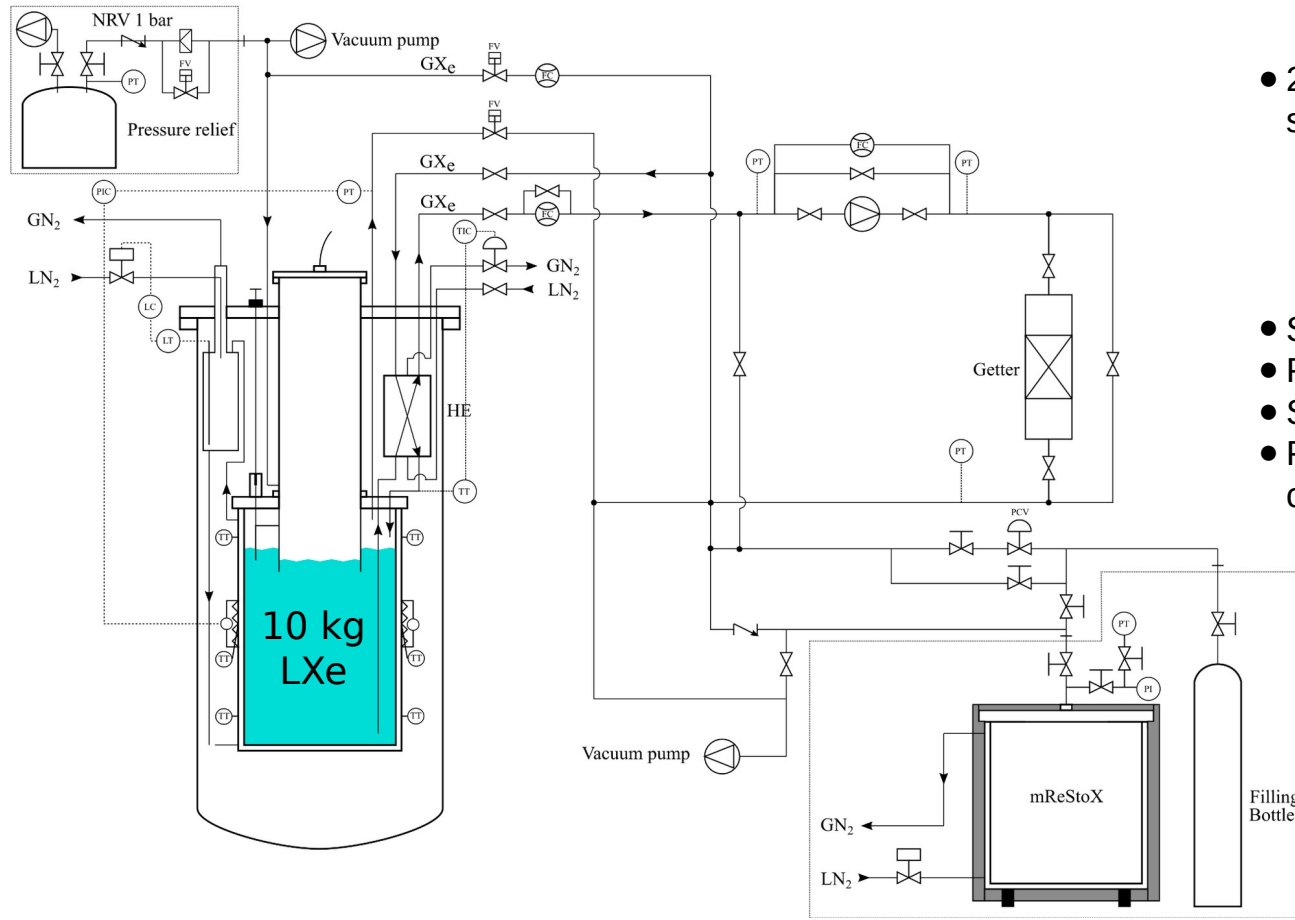


Designed by LPNHE and under construction by DATE company



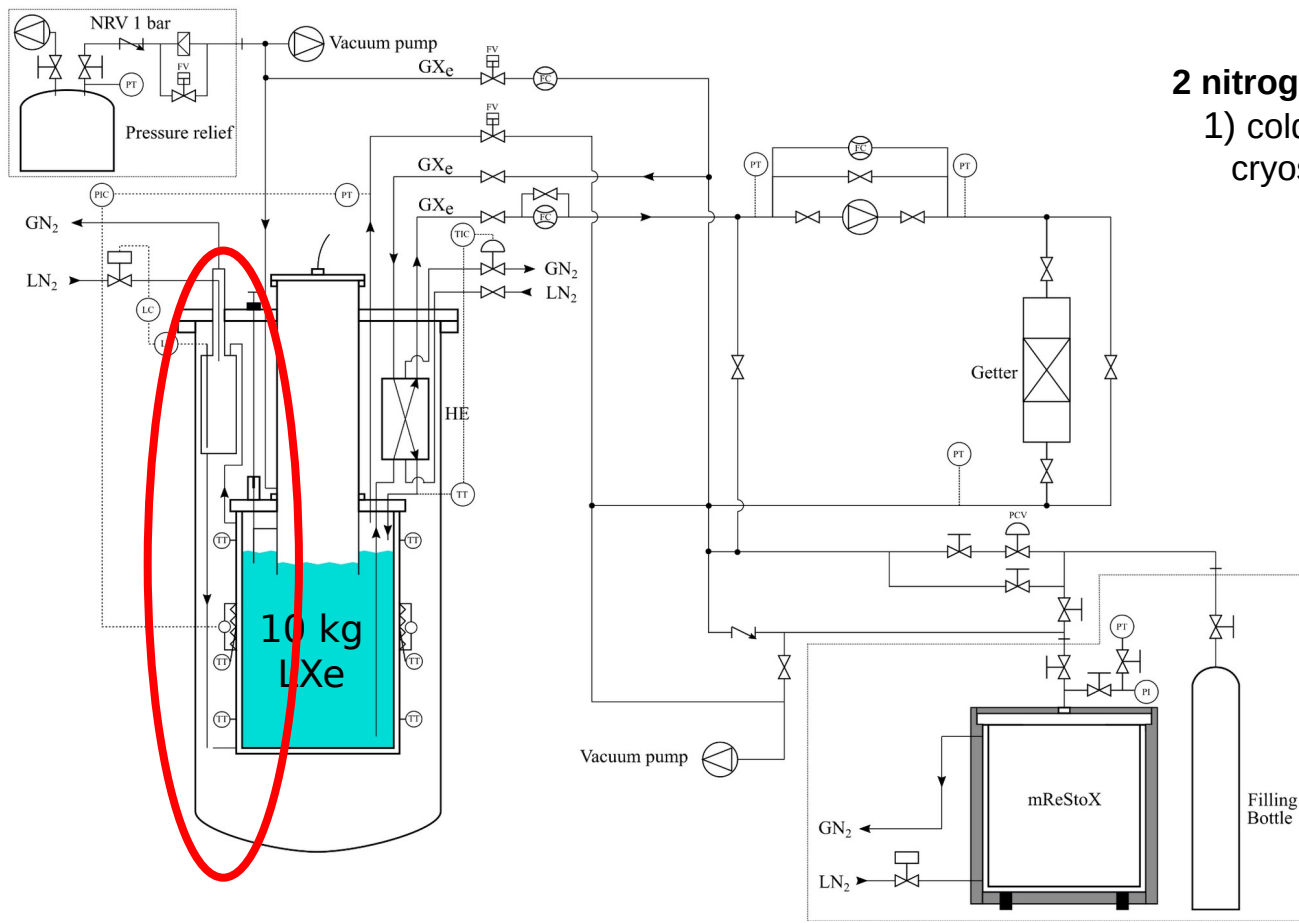
Under design by Subatech

# Process & Instrumentation Diagram (P&ID)



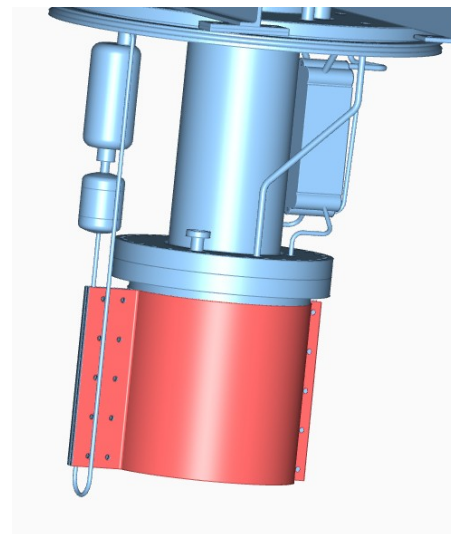
- 2 nitrogen-based cooling systems
  - cold copper belt around inner cryostat
  - three-phase heat exchanger
- Standard purification
- Precise liquid level tuning
- Storage and recovery system
- Pressure release system in case of accident

# Process & Instrumentation Diagram (P&ID)



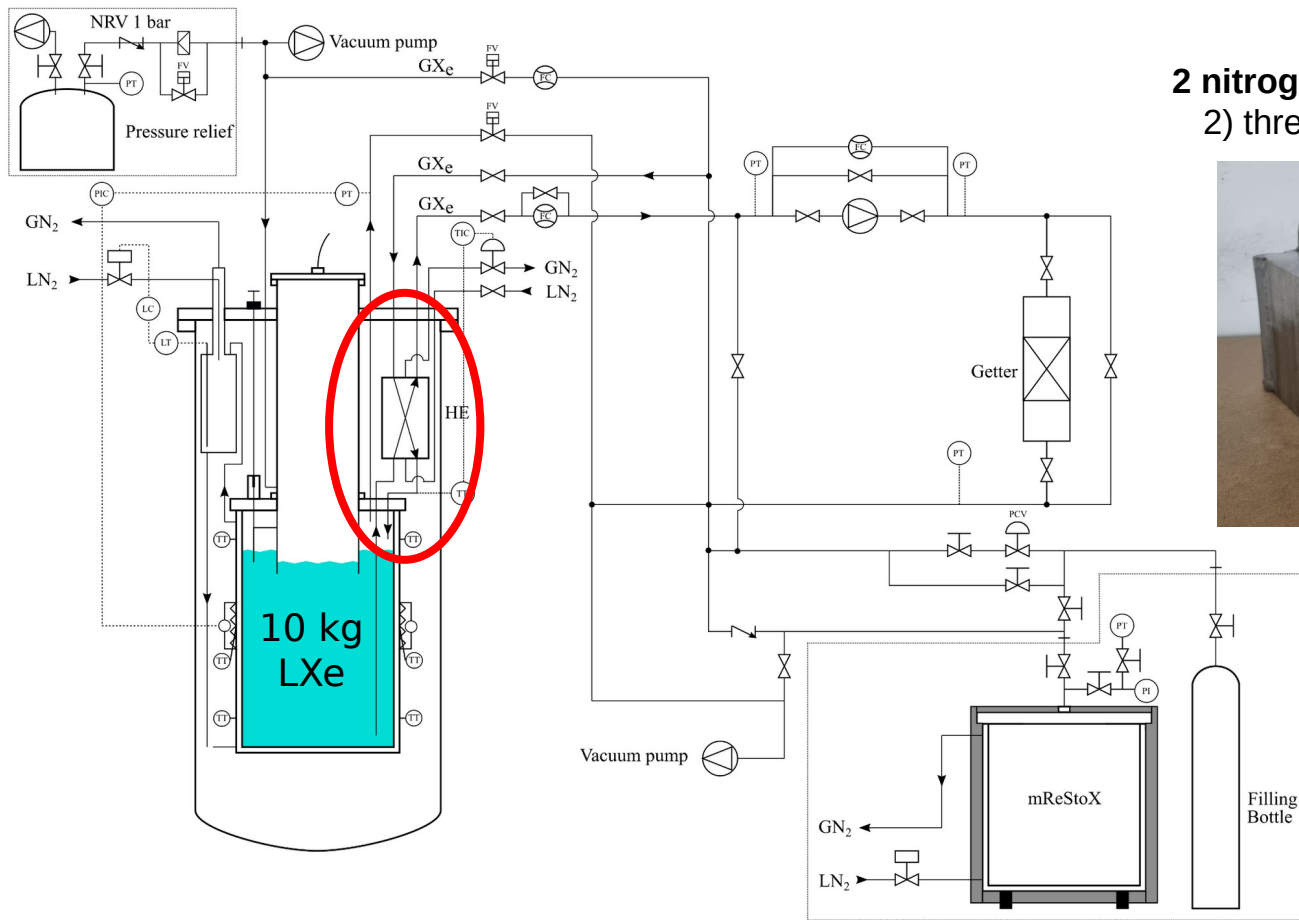
## 2 nitrogen-based cooling systems

- 1) cold copper belt around inner cryostat

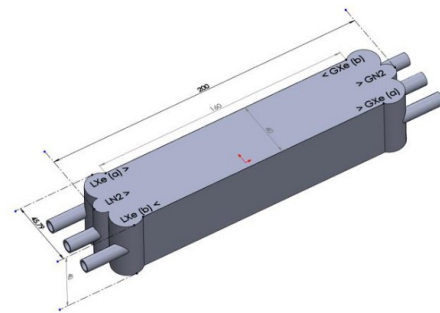




# Process & Instrumentation Diagram (P&ID)



2 nitrogen-based cooling systems  
2) three-phase heat exchanger



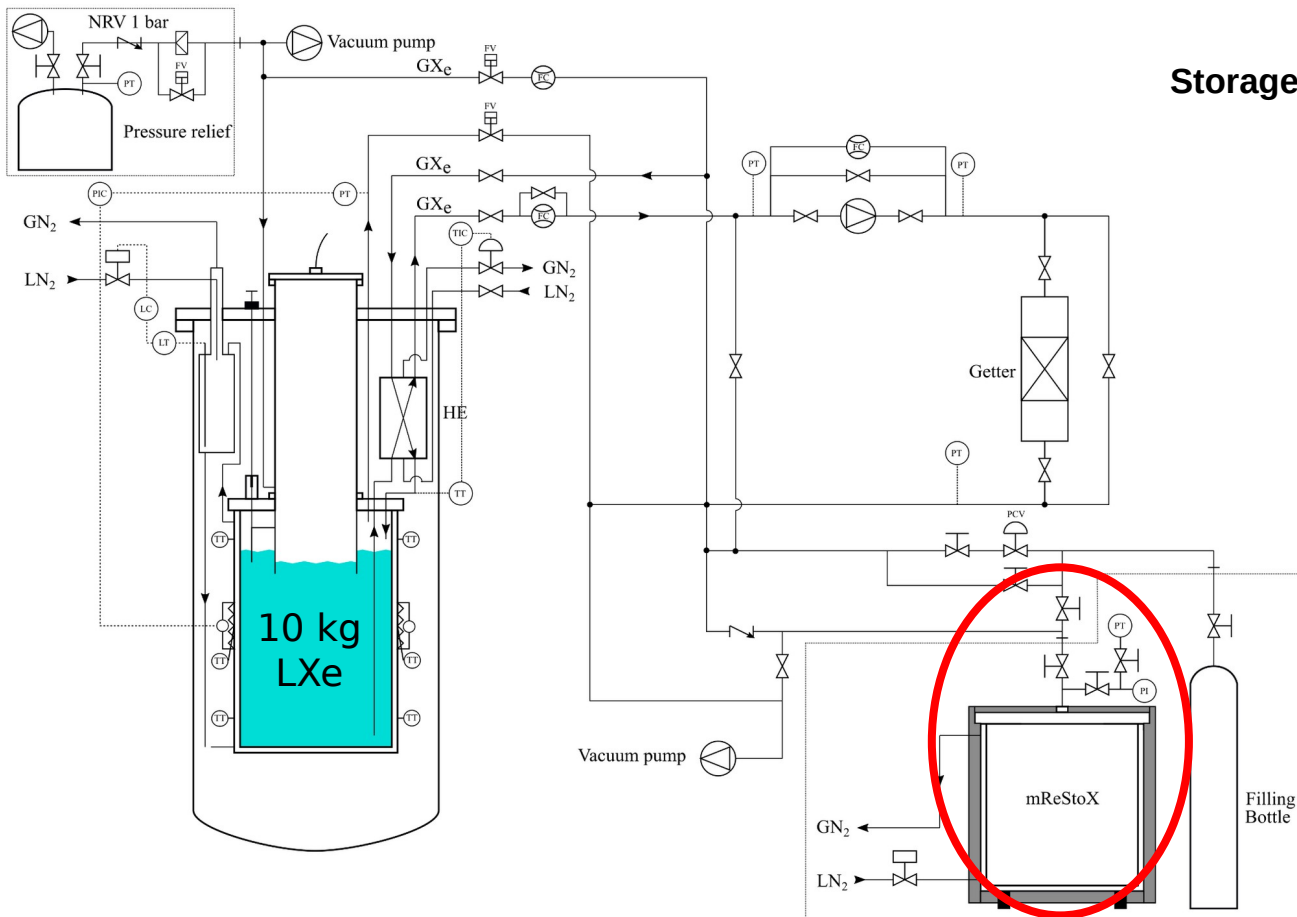
# Process & Instrumentation Diagram (P&ID)

June 8<sup>th</sup>, 2023

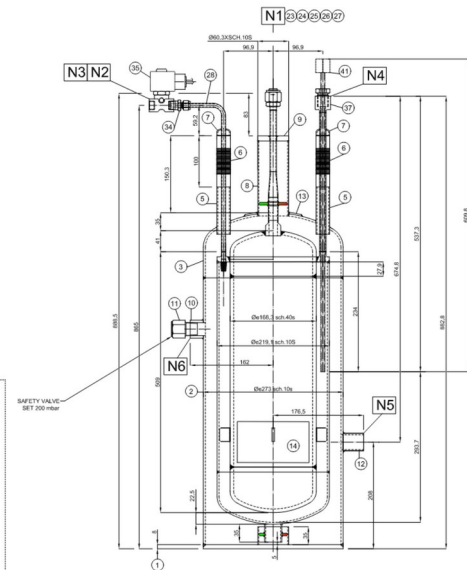
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## Storage and recovery system



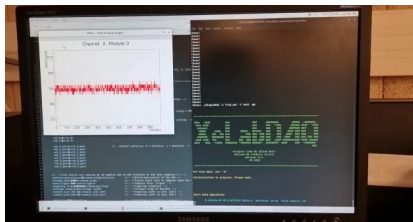
# And many other ongoing activities

- DAQ



### CAEN v1720

Dynamic range: 2.0 Vpp  
Resolution: 12-bit  
Bandwidth: 250 MS/s  
# of channels: 8



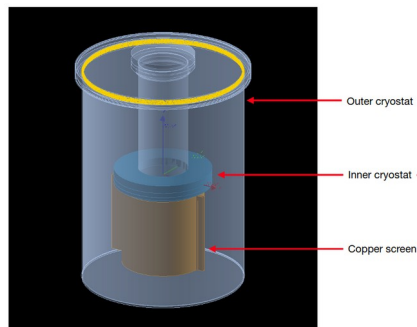
- Slow Control



### RevPI + A/D modules

CODESYS standard  
Astro Slow Control backend/frontend  
Grafana as extra frontend

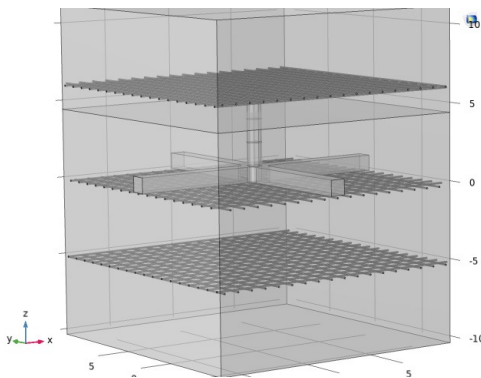
- G4 simulations



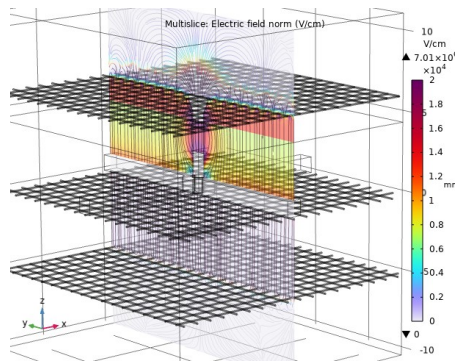
# Xelab: Electrons / TPC model

Integration of the electron drift model in the 3D electrostatic model.

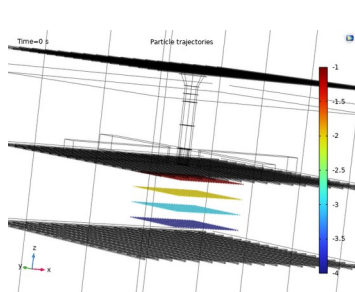
Response Function of the TPC ,  
to use with Garfield for photon  
emission : possible interpolation  
of the electron exit position at  
interface.



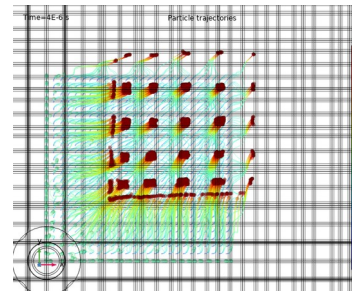
Geometry of the TPC electrodes.



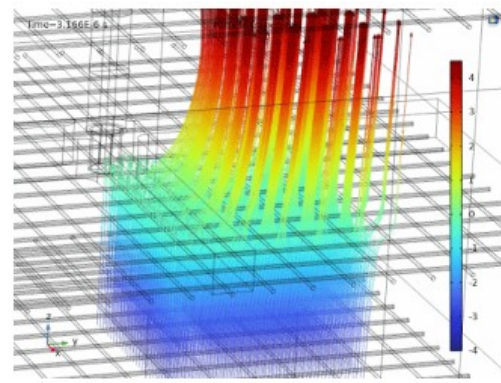
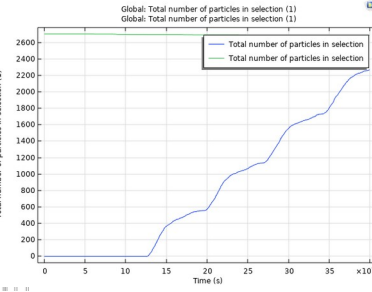
E-field with wire electrodes (1mm pitch , 0.1mm wire)



Electrons Release grid in LXe



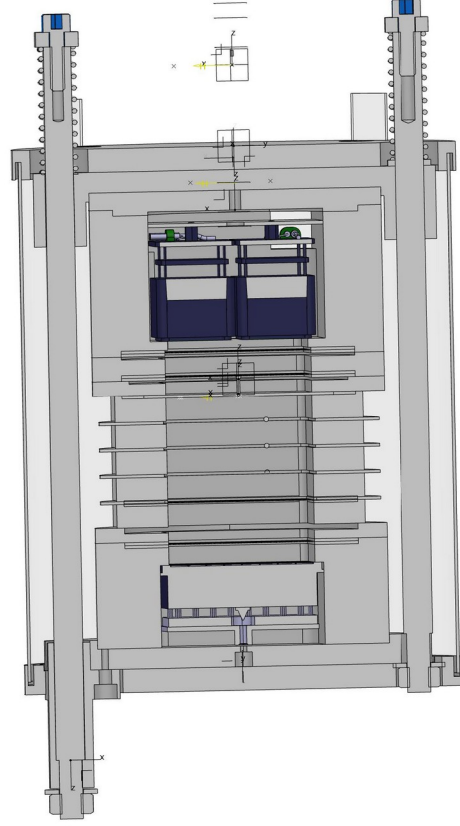
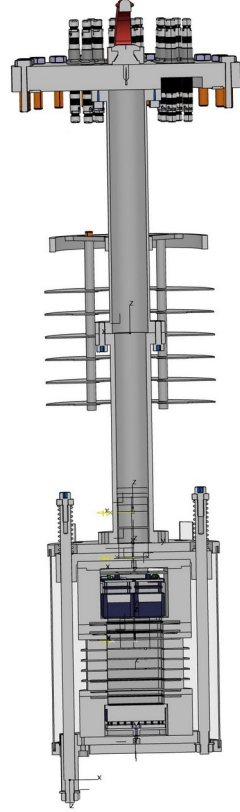
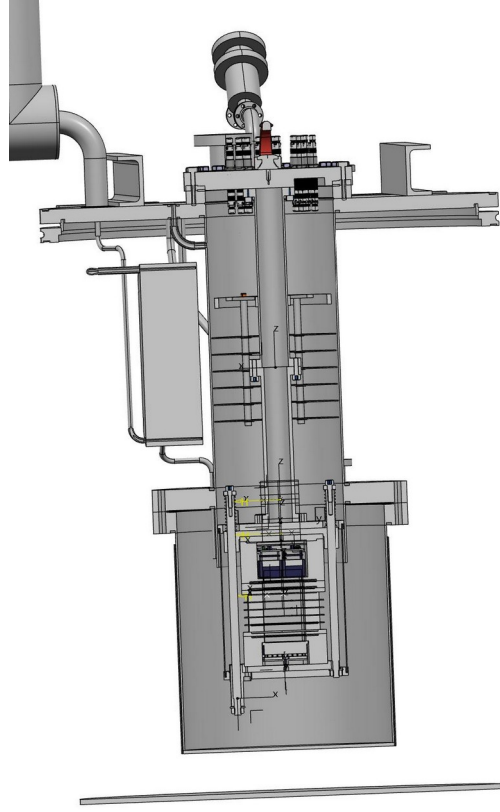
Top View : Electrons Release grid in LXe



Full Electron Drift path in LXe

# Integration TPC / cryostat

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## Next steps

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- Installation of the entire cryogenic system end of June 2023
- Installation of mReStoX in July 2023
  - 3 month of commissioning (leaks, cooling, filling and recovery)
- Freezing the material choice for the electrodes (pillars)
- TPC design almost completed then its construction will start