

# SuperNEMO demonstrator Integration and commissioning status

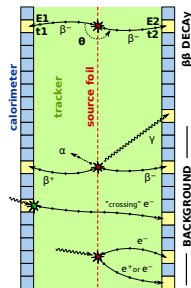
E. Chauveau  
for the SuperNEMO collaboration

LSM users annual meeting  
January 14, 2022



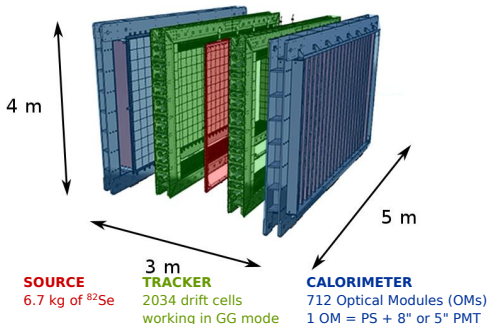
# Neutrinoless double beta research with SuperNEMO demonstrator

## "TRACKO-CALO" principle



\* internal  $\Delta t \sim 0$  ns      \* external  $\Delta t > 3$  ns

## SuperNEMO demonstrator



- $\beta\beta 0\nu$  search to probe Majorana neutrino and absolute mass scale of neutrinos
- SuperNEMO approach with tracker + segmented calorimeter providing **particles identification + full kinematics of  $\beta\beta$  decays ( $E_1, E_2, \cos\theta$ )**
  - ⇒ topological signature of events
  - ⇒ measurement and rejection of background
  - ⇒ study of  $\beta\beta 0\nu$  (new physics mechanism),  $\beta\beta 2\nu$ ,  $\beta\beta^*$ ,  $g_A$  quenching, etc.

# Overview of 2021 integration/commissioning activities @ LSM



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- finally significant progress on **gas tightness**
- installation of **coil** and **J-trap** (antiradon system for tracker gas) performed
- first campaign of **tracker commissioning** in autumn 2021
- iron shielding: call for tender passed, approved answer from Tiesco, China
- new FR scientific responsible: Francois Mauger → Laurent Simard
- 6+6 months contract for local technical support with **Zakaria Bahmed** started from Oct. 2021 (UK → CNRS funding)

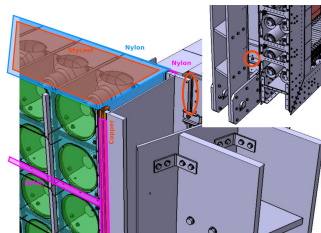
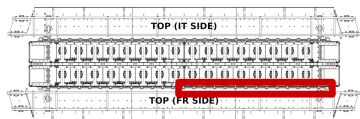
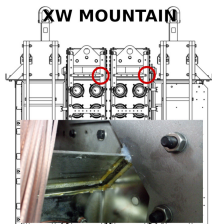
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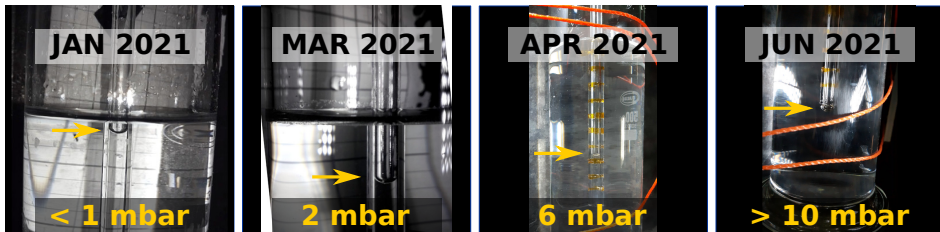
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- new FR scientific responsible: Francois Mauger → Laurent Simard
- 6+6 months contract for local technical support with **Zakaria Bahmed** started from Oct. 2021 (UK → CNRS funding)
- **strong support from all LSM staff & particularly Jean-Lou → thanks to all !**

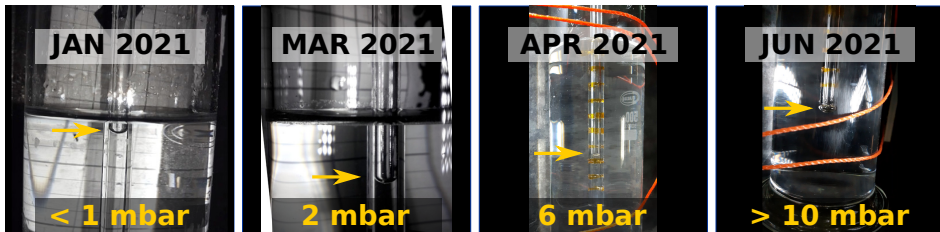
# Gas tightness



- iteration of leak search and gluing in various interfaces with difficult access

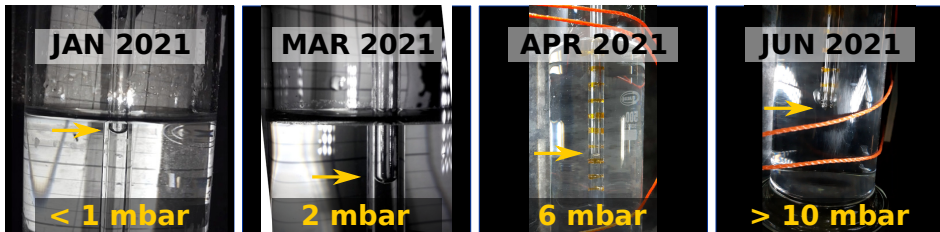


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- **big progresses finally in spring 2021**
  - today >10 mbar with 40L/min of Ar
  - green light to proceed tracker commissioning

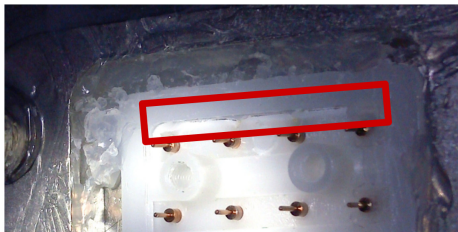
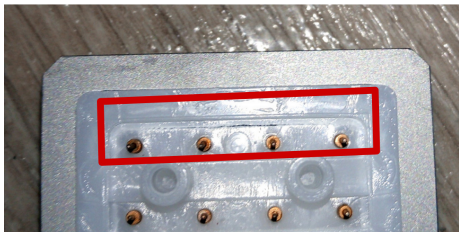


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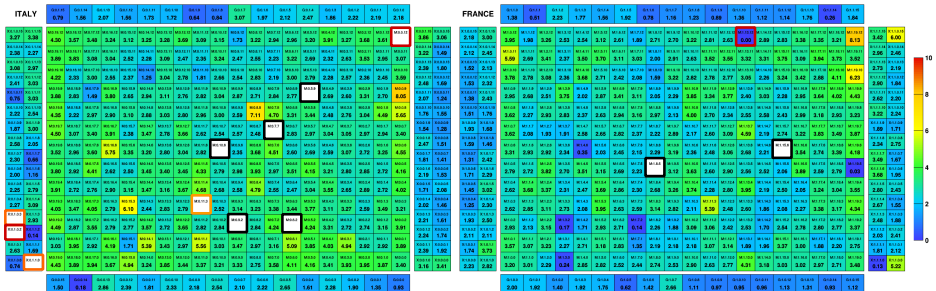
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- **main leak remaining @ tracker cabling interface (feedthrough, x112)**
  - **tracker commissioning done before sealing this HV/signal interface**
  - **plan on-going to fix and/or replace them**

# Calorimeter status & commissioning

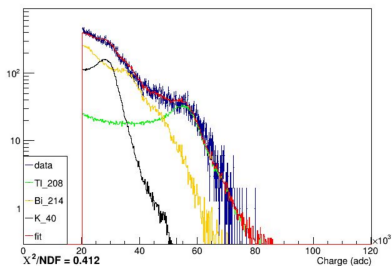
## RUN 672 – Counting rate in Hz above 350 mV ( $\approx 2$ MeV)



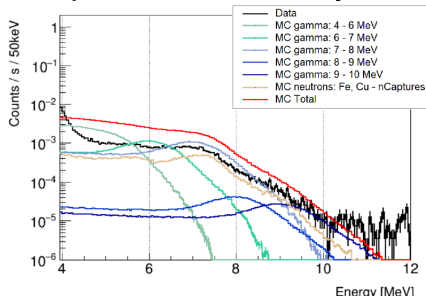
- channel fixes during 2021 : HV/signal cabling, VD repairing/replacement, etc.
- channel status today : 10+3 missing channels (< 2%)

# Calorimeter status & commissioning

Optical module spectrum  $\leq 2.6$  MeV  
with MC fit  $^{40}\text{K}$  +  $^{214}\text{Bi}$  +  $^{208}\text{Tl}$



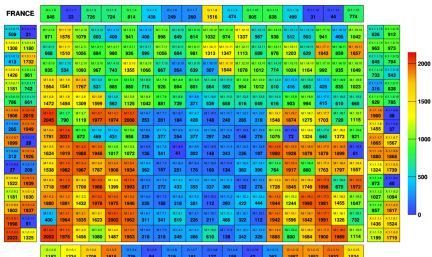
LSM published ambient flux ( $\gamma+n$ )  
vs SuperNEMO calorimeter-only data



- channel fixes during 2021 : HV/signal cabling, VD repairing/replacement, etc.
- channel status today : 10+3 missing channels ( $< 2\%$ )
- **calorimeter commissioning and analysis** : energy/time calibration, stability, afterpulses, BG counting rate, ... possibly some papers to come !

# Light Injection system

## RUN 564 (Apr/18)



## RUN 599 (Aug/31)



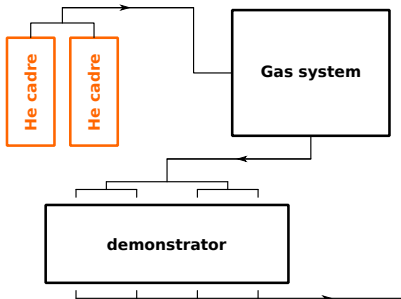
- Light Injection (LI) system:
  - UV LED light flashes injected by optical fibers into 712 calorimeter modules
  - intensity monitored/calibrated by reference optical modules with  $\alpha$  sources
  - to be used for quick and daily relative energy calibration of the calorimeter
- final fixes and equalisation of LI intensities during spring/summer 2021:
  - fibers broken or with low intensity replaced with spares
  - sabotage of fibers with too high intensities (surface unpolishing)

## Gas system finalisation (summer 2021)



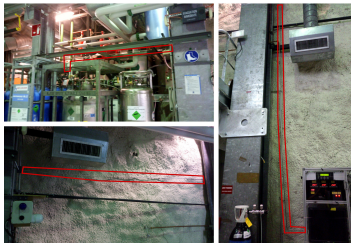
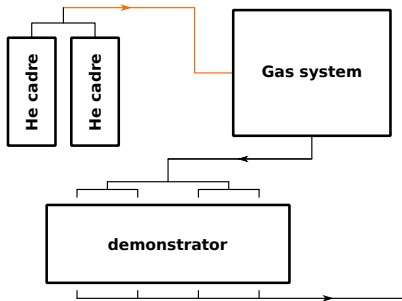
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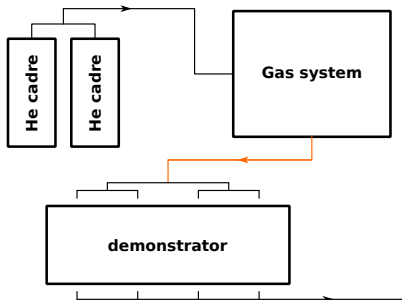
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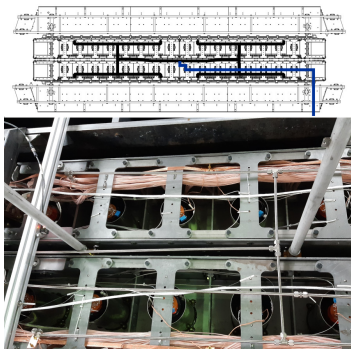
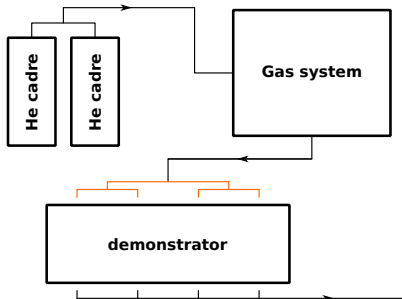


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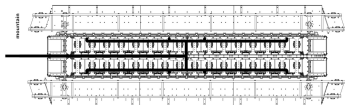
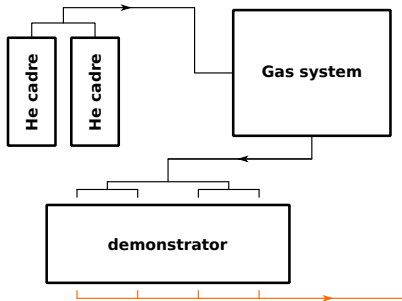
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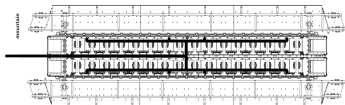
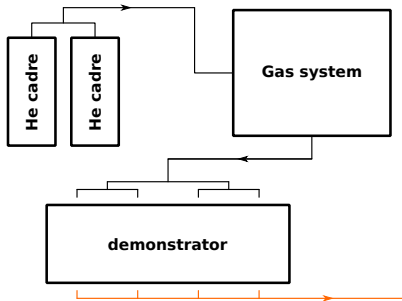
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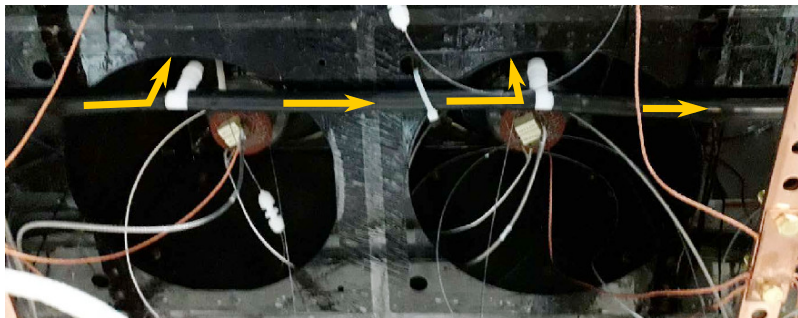
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- 8 exhaust bottom lines merged and send to bubbler (taken from NEMO-3)
- brainstorming on-going for possible recycling of He

## Detector flushing with de-radon-ized air



- flushing lines installed around/toward calorimeter's PMT :
  - bring/flush antiradon air around the detector
  - flush He which may accumulate around PMT due to remaining leaks
- initially connected to LSM antiradon air at early tracker commissioning, but drawing too much for the current antiradon facility with limited flux

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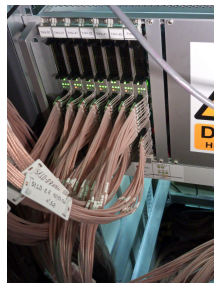
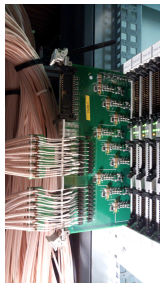
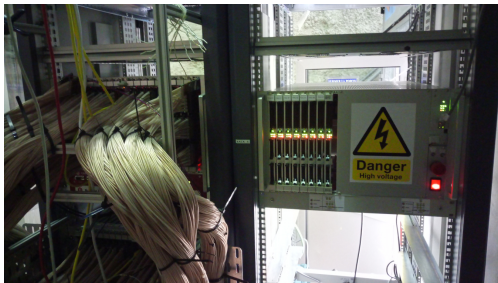
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- **150-200 m<sup>3</sup>/h needed to reach 20 mBq/m<sup>3</sup> in clean tent for physics data taking**

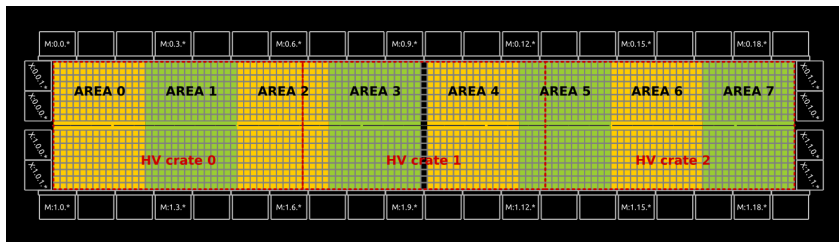
# Tracker HV



- tracker HV system : 3 crates x 19 boards each, to power 2034 GG cells
- all HV boards produced showing serious issues on random components
- a crate with only 7 fixed boards finally received @ LSM on Aug 12th  
→ used to power the full tracking chamber by fraction of 252 cells (1/8th)
- “plan B” = new production of all boards on-going in UK
  - 1 crate fully populated with new HV boards ready at Manchester
  - expect full system ready in spring 2022

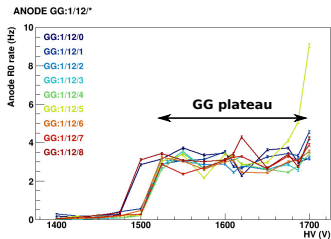
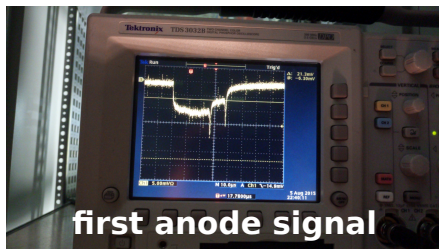


# Tracker commissioning



- commissioning of full tracking chamber in 8 steps during autumn 2021

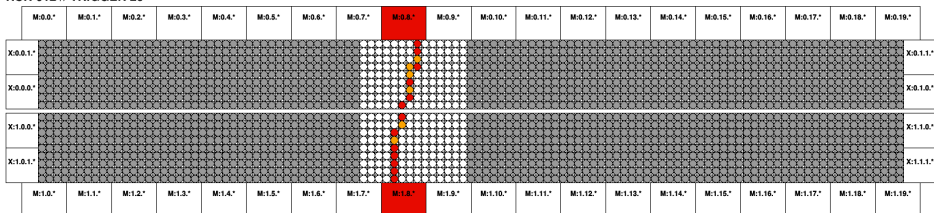
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→ BIG relief ! – following sagging issue story of 2020

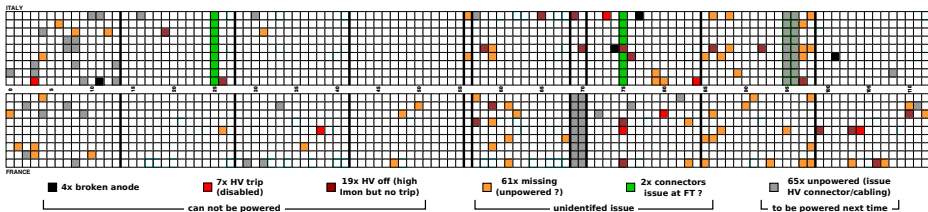
# Tracker commissioning

RUN 612 // TRIGGER 26



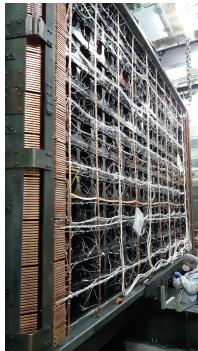
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- observation of tracks ; 58 runs of tracker+calorimeter data taken  
→ validation of trigger strategy and DAQ
- preliminary cells status : **91.5 % working + 8 % recoverable + 0.5 % dead**  
→ hopes to get down to  $\gtrsim 1$  % of issues after fixes

# Coil delivery & installation

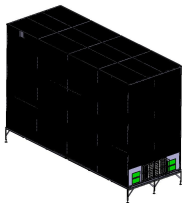


- delivery to Modane (Aug.) and underground installation (Sept.)
- integration of large pieces which required the opening of the clean tent
- overall LSM cleaning happened just before the installation – thanks a lot !!  
→ suggestion: opportunity to review cleanliness procedures underground ?!

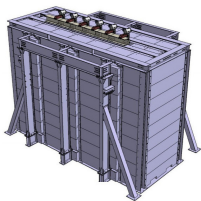
## J-trap with dedicated platform



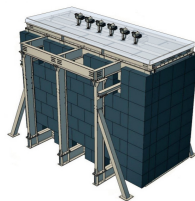
# Foreseen activities in 2022 @ LSM



**anti-radon tent**



**iron shielding**

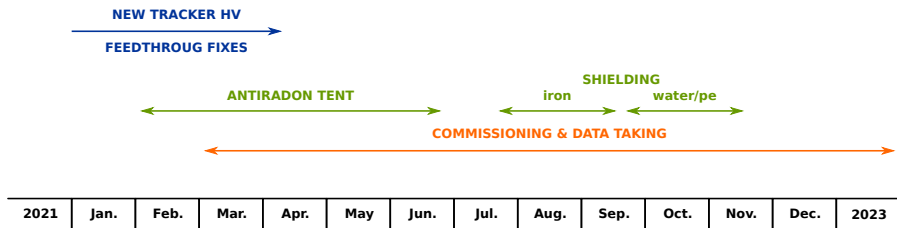


**water+PE shielding**

## Activities in 2022

- last 3 big integration steps: anti-radon tent, iron shielding and water/PE shielding  
→ data taking is foreseen between steps to analyse/validate BG suppression
- tracker: feedthrough fixes, new HV, further commissioning & physics

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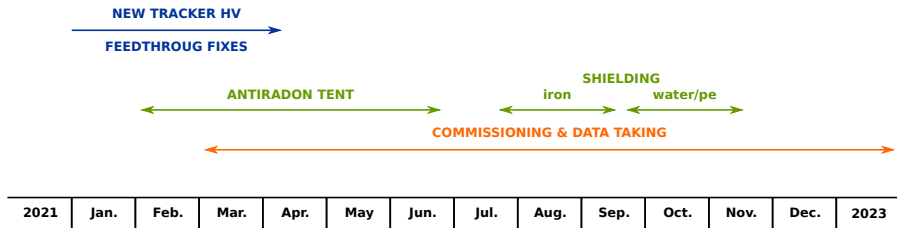


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## Need for 2022

- major logistics for reception/installation of shielding
- new anti-radon air factory with higher flux
- opening of EDW front wall to access electronics racks when shielding installed