



The Modane Underground Laboratory

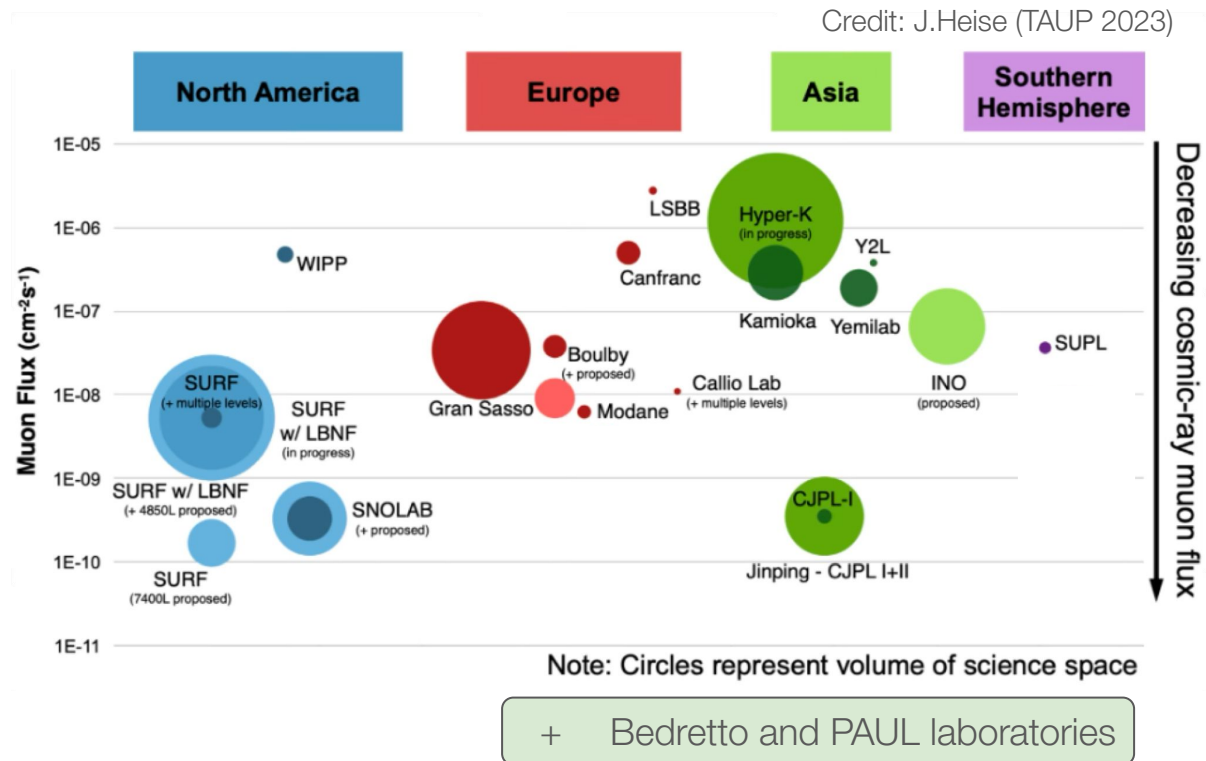


The Laboratory
The Science Programme
Current Activities

Silvia Scorza (LPSC-CNRS)

Worldwide Underground Laboratory

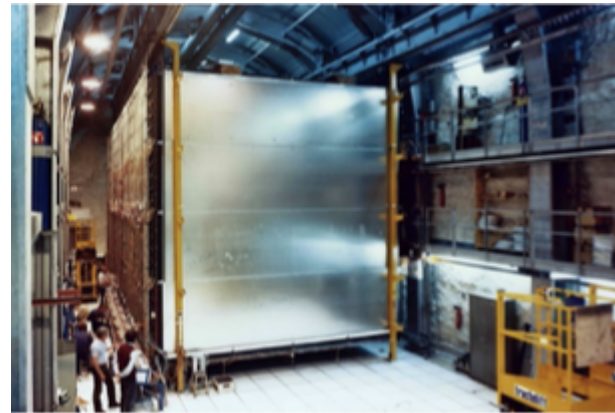
Underground facilities provide unique environments for astroparticle and multidisciplinary research with the main feature to be the overburden protection from cosmic-ray muons



LSM Construction (1979-82) and First Experiment

Cavern dug out during the construction of the Fréjus Tunnel

1st experiment (1983-1989): proton lifetime



The LSM Underground Laboratory

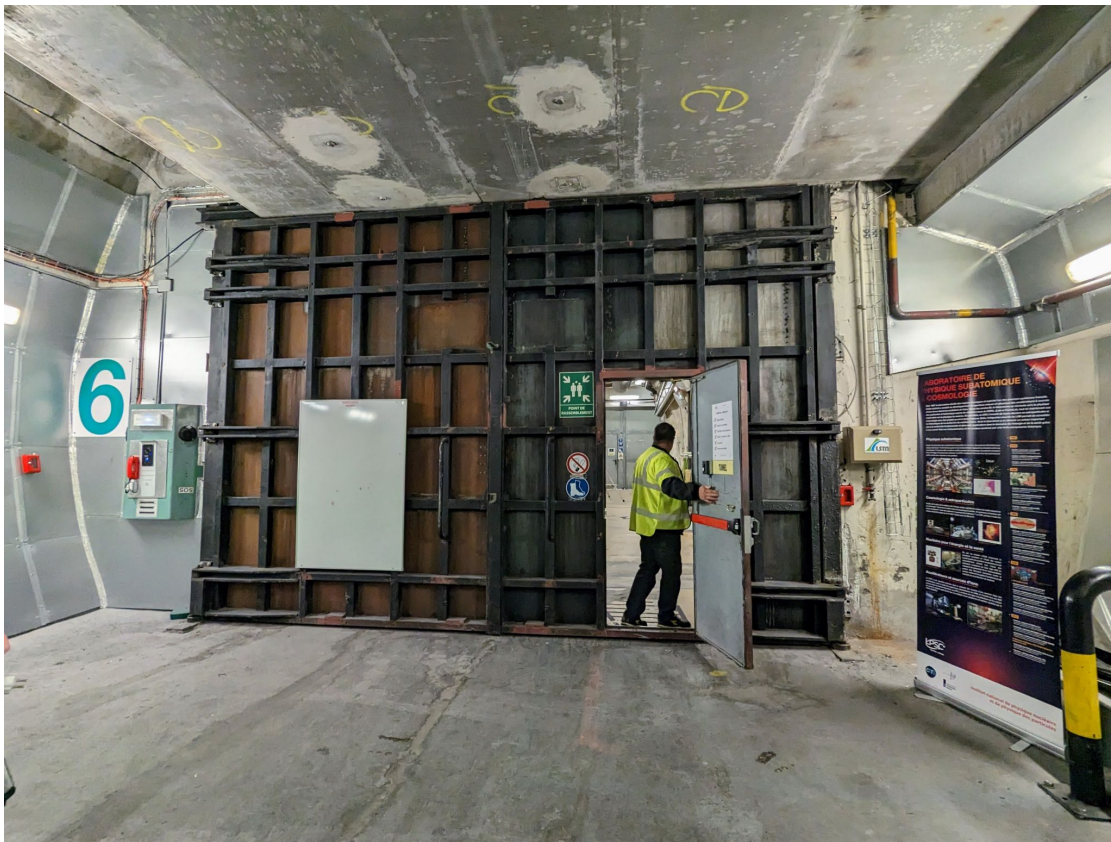


The LSM is a **French National Research Infrastructure**

- Experimental site midway in the 13km France/Italy highway road tunnel
- Surface lab (*office, garage, small museum*)

- **Deepest site in Europe** dedicated to astroparticle, nuclear & particle physics
- 4800 m.w.e: **muon flux reduced** by $>10^6$ relative to surface
- **Flexible access** (hall accessible to trucks up to 9m);
- **Natural radioactivity** due to radon of about $10\text{-}15\text{ Bq/m}^3$





- Spacious entrance level, providing horizontal access even for truck
- Hoists, forklifts and open the big double doors if needed

LSM Strategic Plan

OBJ 1

Scientific and Technological Leadership

Consolidate LSM's position at the forefront of nuclear and astroparticle physics by developing unique enabling technologies and attracting experiments of foremost importance.

OBJ 2

Excellence of the Scientific Programme

Ensure delivery of world-leading scientific results, secure the next-generation flagship experiment, and broaden the research portfolio into new disciplines benefiting of an underground environment.

OBJ 3

Operational Excellence and World-Class Infrastructure

Transform LSM operations to meet the standards of the world's best deep underground laboratories, through the PRISME-LSM extension, a comprehensive infrastructure modernisation and rigorous project management.

OBJ 4

International Reach and Strategic Partnerships

Consolidate the role of France and LSM in global underground physics, lead the European underground laboratory network, and train the next generation of researchers.

LSM Background Measurements

Since 1983, large corpus of measurements of various LSM backgrounds by experiments

- Muons: total flux ($4.5 \mu\text{m}^2/\text{d}$), and angular map

[Rhode, PhD Thesis (Ruppertal, 1993) + Schmidt et al, Astrop. Phys. 44 (2013) 28]

- High-energy gamma rays.

[Ohsumi et al, NIMA 482 (2002) 832]

- Fast neutrons ($1.6 \times 10^{-6} \text{ n/cm}^2/\text{s}$)

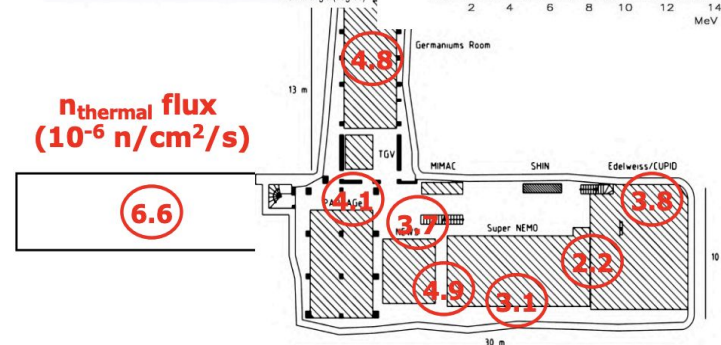
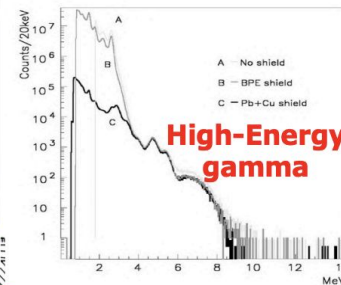
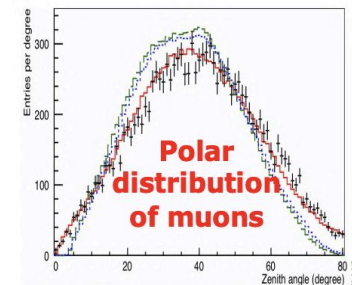
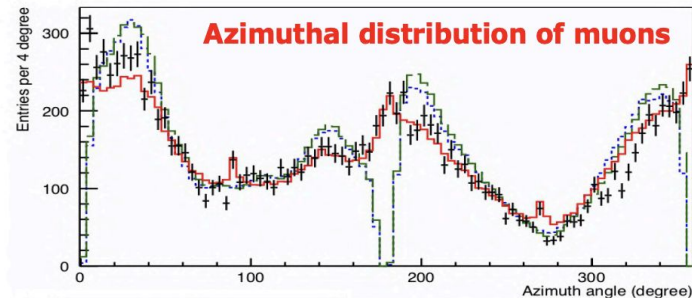
[Armengaud et al, Astrop. Phys. 47 (2013) 1]

- Thermal neutrons

[Rozov et al, BRAS 74 (2012) 464; arXiv:1001.4383]

- Radon ($\sim 15 \text{ Bq/m}^3$)

[Hodak et al, J. Phys. G 46 (2019) 11 + E. Armengaud et al, JINST 12 (2017) P08010]



LSM Science Programme

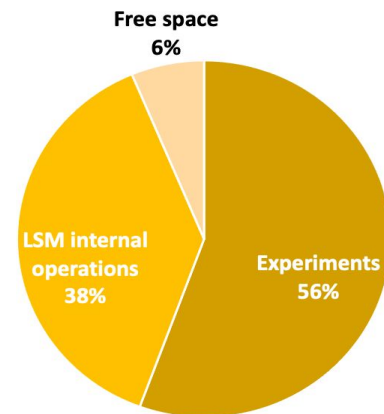
Experiment	Domain	Technology	Description / Status
SuperNEMO	$0\nu\beta\beta$	Tracking/ calorimetry	$0\nu\beta\beta$ demonstrator targeting $T_{1/2} > 6 \times 10^{24}$ yr (^{22}Se); first physics results expected 2026–2027
BINGO	$0\nu\beta\beta$ R&D	Cryogenic	Demonstrator targeting background index of 10^{-5} counts/(keV·kg·yr). Clean room (ISO 4) commissioned.
TESSERACT	Light dark matter	Cryogenic bolometers	Expected 2028–2031; targets Ge, LHe, Al_2O_3 , GaAs absorbers
DAMIC-M	Light dark matter	Silicon CCD	Data taking in 2026; ongoing R&D with LBC Module (since 2022)
MIMAC	Dark matter	Directional TPC	Innovative prototype with pixelated readout for directional dark matter detection
Obelix	82-Se ECEC2	Ge ionisation	Countied 6 kg enriched 82-Se for ECEC2 to excited states; stopped Feb 2026.
PARTAGe	Low background	HPGe spectroscopy	National / European platform for material radiopurity screening
RAMURE / CELL TEREQ / AQUA	Life sciences & metrology	Various	Radiation impact on biology, cell cryopreservation, quantum clocks

Science programme adapted to LSM size:

- Low-mass dark matter experiments
- $0\nu\beta\beta$ demonstrators & technologies
- HPGe array for low-radioactivity

Tight occupation of the available 640m^2

Design study to optimize volumes (PRISME-LSM Project via CPER funds)

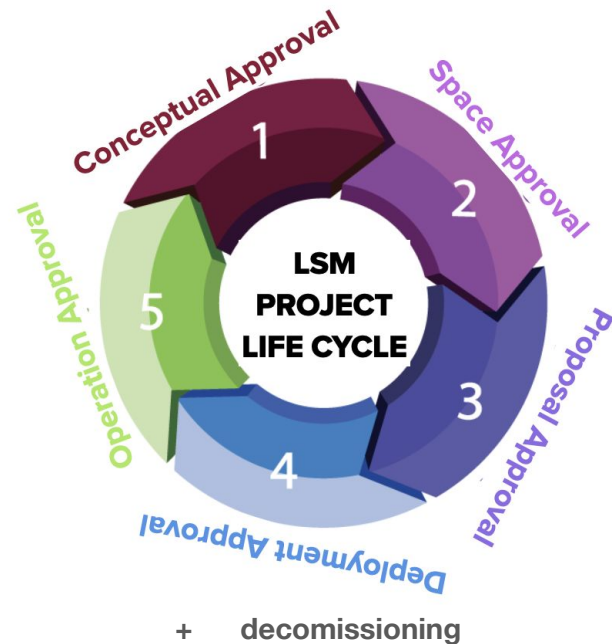


Space repartition underground

LSM Project Life Cycle

New **formalisation of the Experiment Life Cycle** at LSM

- Definition of the LSM responsibilities
- Definition of the Experiment responsibilities
- **Agreement on the occupied footprint** and LSM facility **needs** (timeline, surface, fluids, mechanical interfaces, environment constraints,...)
- **Agreement on the operations process:** technical review and analysis, list of documents required (risk assessment, prevention plan, review report.
- **Contracts** regularization in progress / new contracts for new experiments hosting
- LSM **code of conduct** and **user guide**



Screening and Material Assay Platform

Wide-range program for Astroparticles, Earth Sciences (sediment and ice core sample datation), environmental safety (CEA), biology, etc...

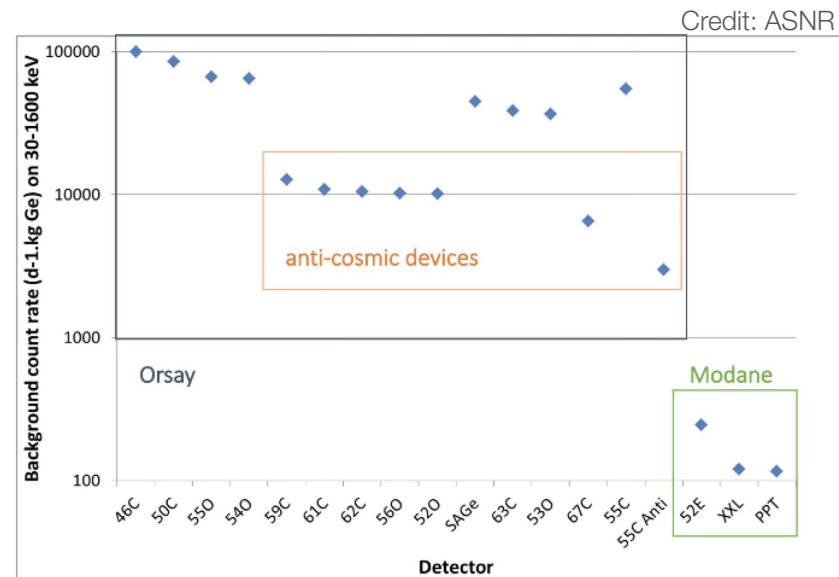
- HPGe gamma spectroscopy
- Alpha surface contamination via the XIA-UltraLo1800 counter
 - Commissioning at LPSC (surface cleanroom)

Material assays for experiments based at LSM (SuperNEMO, EDELWEISS, CUPID-Mo, DAMIC-M), and also for other experiments (ex: JUNO, RICOCHET, Q-BITS Canada)

Pluri-disciplinary program open to academic and industrial users and partners

France: ASNR, CEA, CENBG, IP2I, LSCE (Université Paris-Saclay, CEA, CNRS), EDYTEM (CNRS, U. Savoie Mont-Blanc)

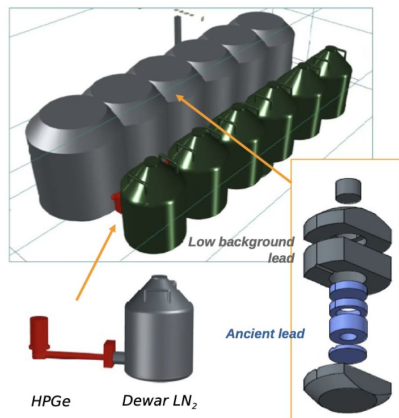
International: UTEF Prague and SURO (Czech Republic)



Screening and Assay Facilities: PARTAGe

Footprint optimization for HPGe screening detectors

Evaporation of dewar 2.3 L/day
leading to 1.1L/min of N₂ Gas



25 detectors in hands at LSM
15 installed in PARTAGe
5 detectors belonging to LSM



First PARTAGe detector row ready

Infrastructure Upgrade

Anti-radon system

- Complete system installation done by LSM
- Start of the continuous operation of the system on October 2025
- Nominal features of the deradonized compressed air at the system outlet: 4.6 bars and 115 to 250 Nm³/h



Shared clean room for instrument prototyping

- A home-made modular design, based on aluminum profiles, polycarbonate panels and 13 Fan Filter Units.
- ISO 5 classification
- Currently used for CCD testing and Low-Background Chamber acquisition within the DAMIC-M project



Underground lab supervision system

Ongoing renovation with a new architecture and Programmable Logic Controllers

LSM Interdisciplinary Focus

LSM hosts small experiments that can benefit from the exceptional low-radioactivity environment and the staff expertise in this domain (ex: biology, earth sciences..)

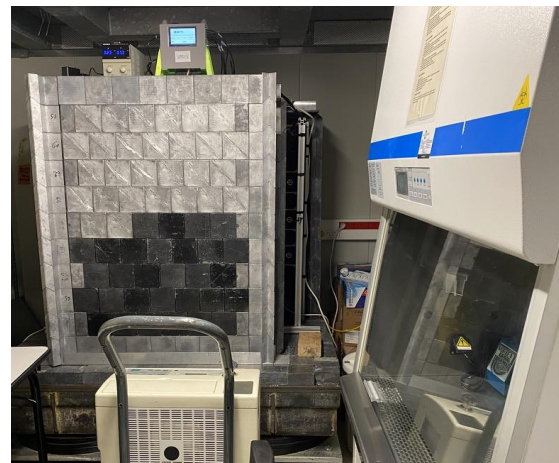
Stem cells storage underground

Allowed to test a stem cell storage shielded from natural radioactivity and terrestrial cosmic rays

- CellTEREO startup (France)
- Cell cryopreservation under extremely low radiation background (CVUT)

RAMUR project

- Funded by CNRS interdisciplinary mission
- Study of the long-term impact of natural radioactivity on living organisms, in particular those inhabiting aquatic ecosystems (three species of diatoms).
- Reduced radiation levels lead to various physiological consequences, such as growth inhibition and increased sensitivity to chemical mutagens.



International Network of Deep Underground Laboratories (DULs)

- **Stronger collaboration between underground laboratories** to improve support for the scientific community
- DUL creation of **joint working groups**
 - Sharing of good practices
 - Development in operational matters, Health and Safety, experience management, etc.
 - Low background counting/analysis, shared databases
- **DULIA** Network
- **iDMEU** <https://www.idmeu.org/> [Initiative for Dark Matter in EUrope and beyond]
- **DMInfraNet** <https://arxiv.org/abs/2504.01688> [Enhancing European Cooperation in the Search for Dark Matter]
- **ISAPP Network** (LSM participatig in SC since 06.06.2025)
- Coordination of the response of underground laboratories to **European calls** for tenders
 - EU INFRADEV-01-01
 - MSCA-SE February 2025 - NEXUS

NEXUS: North-south EXchange for Underground Science

Consortium: EU(CNRS,INFN,LSC,UKRI, SKAO), SNOLAB, SURF, UoMelbourne, UoAdelaide, ZA(SU,UWC,UNISA,Wits)

Project Coordinator: [F. Malek](#) (CNRS DR11-IN2P3)

Grant amount: 771 540.00 EUR

Project duration: 48 months

Project Start: 1st January 2026

5 Working packages (WP):

- 1- Low background Technologies: [S. Scorza](#) (CNRS)
- 2- Muons and radiation Measurements: [N. D'ambrosio](#) (INFN)
- 3- Modelling and Computing: [L. Mantile](#) (UNISA,ZA)
- 4- Quantum science and Technology: [R. Bunker](#) (SNOLAB)
- 5- Education, Training, Communication: [C. Oana](#) (INFN)

		EUROPEAN COMMISSION		Evaluation Summary		
		Horizon Europe Framework Programme (HORIZON)		Report - Staff Exchanges		
Call:		HORIZON-MSCA-2024-SE-01				
Type of action:		HORIZON-TMA-MSCA-SE				
Proposal number:		101236929				
Proposal acronym:		NEXUS				
Duration (months):		48				
Proposal title:		North-south EXchange for Underground Science				
Activity:		PHY				
N.	Proposer name	Country	Total eligible costs	%	Grant Requested	%
1	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	FR	210,420	27.27%	210,420	27.27%
2	ISTITUTO NAZIONALE DI FISICA NUCLEARE	IT	350,700	45.45%	350,700	45.45%
3	CONSORCIO PARA EL EQUIPAMIENTO Y EXPLOTACION DEL LABORATORIO SUBTERRANEO DE CANFRANC	ES	0	0.00%	0	0.00%
4	THE SQUARE KILOMETRE ARRAY OBSERVATORY	UK	10,020	1.30%	10,020	1.30%
5	STELLENBOSCH UNIVERSITY	ZA	110,220	14.29%	110,220	14.29%
6	UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	ZA	10,020	1.30%	10,020	1.30%
7	UNIVERSITY OF THE WESTERN CAPE	ZA	55,110	7.14%	55,110	7.14%
8	QUEEN'S UNIVERSITY AT KINGSTON	CA	0	0.00%	0	0.00%
9	THE UNIVERSITY OF ADELAIDE	AU	0	0.00%	0	0.00%
10	UNIVERSITY OF MELBOURNE	AU	0	0.00%	0	0.00%
11	UNITED KINGDOM RESEARCH AND INNOVATION	UK	0	0.00%	0	0.00%
12	UNIVERSITY OF SOUTH AFRICA	ZA	25,050	3.25%	25,050	3.25%
13	South Dakota Science & Technology Authority	US	0	0.00%	0	0.00%

Thank you

