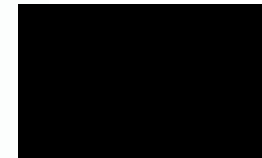


The Modane Underground Laboratory

GDRDUPhy - Plenary Meeting

Silvia Scorza
(CNRS-LPSC)



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*)

Modane:

- 130 km from Grenoble
- 200 km from Lyon
- 100 km from Torino
- 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 $10\text{-}15 \text{ Bq/m}^3$



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

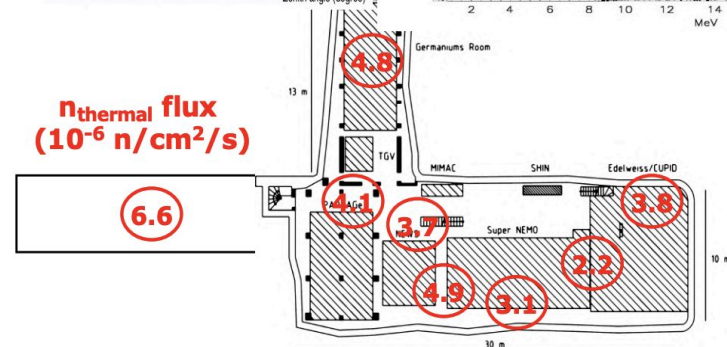
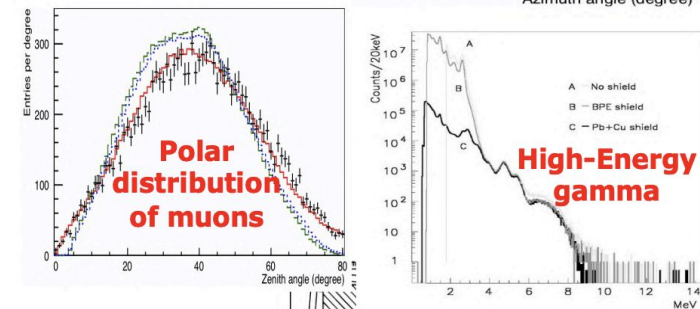
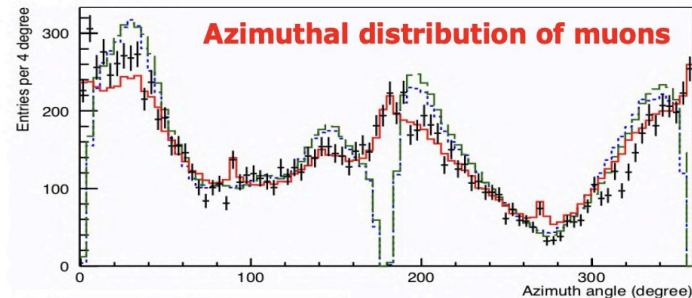
[Armengaud et al, Astrop. Phys. 47 (2013) 1]

- **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]



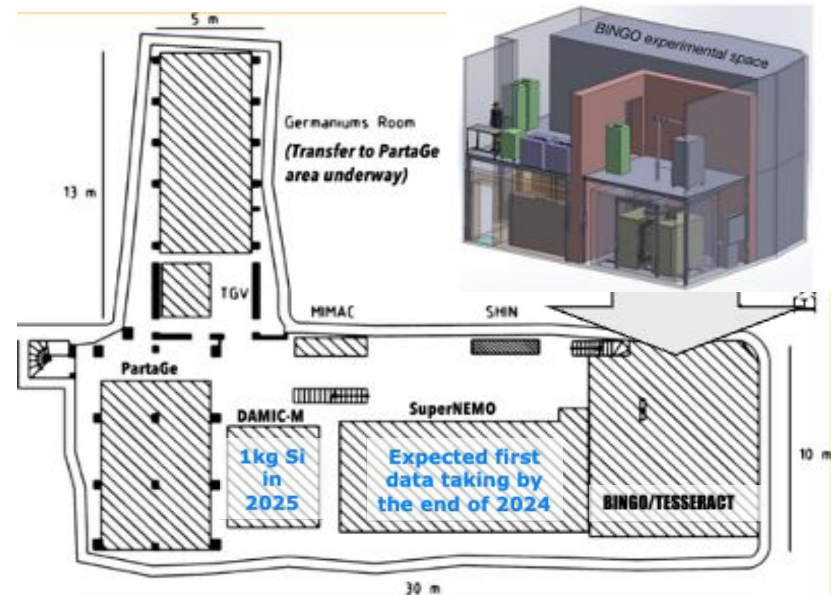
LSM Science Programme

Science programme adapted to LSM size:

- Low-mass Dark Matter Experiments
- $0\nu\beta\beta$ demonstrators & technologies
- HPGe array for low-radioactivity

Current experimental activities

Experiment	Focus	Technology	Activities in 2024
SuperNEMO	$\beta\beta 0\nu$	Tacko-calorieter	Final shielding installation, commissioning ongoing. Data taking starting soon.
BINGO	$\beta\beta 0\nu$	Cryogenic	Cryostat integration underground. Cryostat commissioning finalised in Sept 2024. Detector data taking starting soon
Obelix 82Se	ECEC 2ν	Ge ionisation	Counting of 6kg enriched 82Se sample from LNGS started in January 2022: ECEC 2ν to excited states. Renewal of agreement <i>in fieri</i> .
TGV	$\beta\beta 0\nu$	Ge ionisation	Detector upgrade delayed.
DAMIC-M	DM	Si CCD	Test chamber Physics run in 2022. Installation of kg-stage early 2025.
MIMAC	DM	TPC	Upgrading the detector. Commissioning in 2025



LSM Science Programme

Subatomic/Astroparticle physics Platform

Hosting fundamental physics experiments, in particular those supported by IN2P3, with international, bi-national or national collaborations.

Host R&D and detector physics for future experiments (larger detector deployed in larger DUL).

Provide technical support to experiments as agreed upon.

Priority topics (well-adapted to depth+size): Light Dark Matter, R&D for $0\nu\beta\beta$.

Improve infrastructure to develop hosting opportunities.

Develop R&D around underground physics.

Germanium gamma-ray material assaying

Very low radioactivity measurements.

Associated technology developments.

Opening to interdisciplinary applications

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

Communicate and promote the infrastructure

New website developed and will be published soon.

International Network of Deep Underground Laboratories (DULs)

- Stronger collaboration between underground laboratories to improve support for the scientific community
 - LSM Visit of SNOLAB executive and research directors (September 2023)
 - LSM Visit of SURF director and SNOLAB Research Manager (October 2023)
 - LSM Visit of PAUL lab (June 2024)
- DUL Directors meeting in Vienna in September 2023 as part of the international TAUP conference, with the creation of joint working groups
 - Sharing of good practices
 - Development in operational matters, Health and Safety, experience management, etc.
 - Low background counting/analysis (“Low Radioactivity Techniques” workshop series), shared databases
 - Workload sharing for low-background measurements
- Coordination of the response of underground laboratories to European calls for tenders

LSM Organization Updates Over Last Year

LSM management as of February 2024:

LSM DP: Silvia Scorza

LSM RO: Nadine Sauzet

LSM Ultra Low-Background Service (SUBR)

Team manager: Guillaume Warot

7 agents on-site at LSM

Non-SUBR staff

Administrative and financial service

Valérie Favre, on-site manager in Modane (~0.3 FTE)

Procurement, finance and HR support from LPSC (~0.2 FTE)

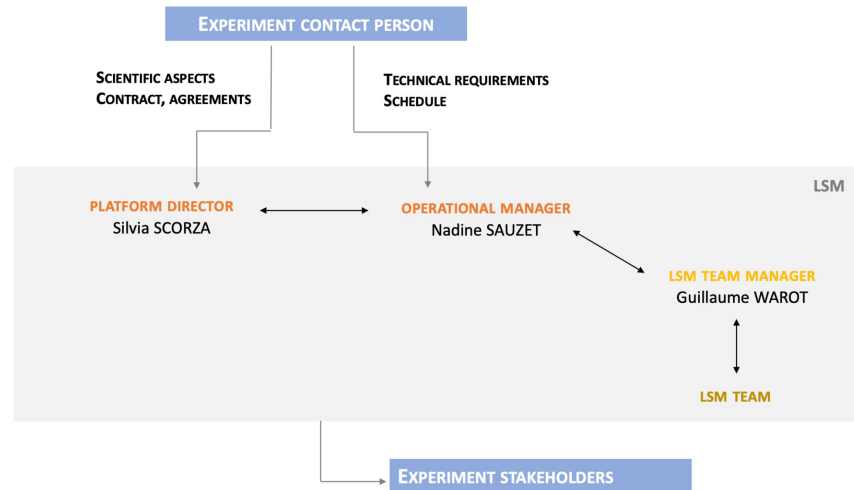
IT Department

Support on the Grenoble site (~0.3 FTE)

Technical Departments (mechanical, electronic, etc.)

Design and production for SKID anti-radon (SERM ~0.3 FTE)

Update security automation (SE ~0.5 FTE)



LSM Organization Updates Over Last Year

EXTERNAL STRATEGIC COMMITTEE

Aldo Ianni	- LNGS
Marie Davidková	- NPI CAS
Sean Paling	- Boulby
Stefan Schönert	- TU München
Nigel Smith	- TRIUMF

CODir CNRS

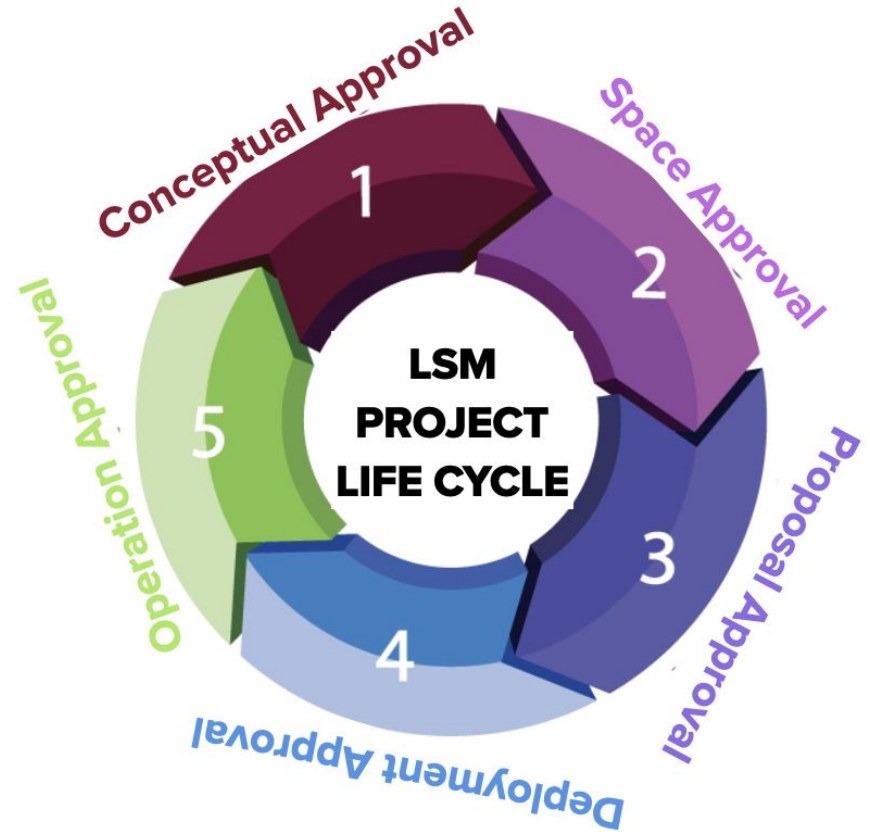
DAS Astro-particules, DAT	- IN2P3
Représentant Pôle PAGE	- UGA
DU, DP, DO	- LPSC/LSM

DAS: Scientific Adjunct Director
DAT: Technical Adjunct Director
DU: Lab Director - L.Derome
DP: Platform Director - S.Scorza
DO: Ops Director - N.Sauzet

LSM Project Life Cycle

- |

- Formalisation of the Experiment Life Cycle
- Clearer definition of the LSM and Experiment responsibilities
- Agreement on the occupied footprint and LSM facility needs (timeline, m2)
- EOI
<https://forms.gle/bh9hR3e13qBhYQG5A>
- New LSM User Guide
- Code of Conduct
- New Tool for work request at LSM



LSM Code of Conduct

- The purpose of the Modane Underground Laboratory (LSM) Code of Conduct is to affirm the ethical environment of LSM's workplace by providing guidance on workplace standards of conduct in the performance of their duties and relationships with others and reporting violations of the Code of Conduct.
- The Code of Conduct policy applies to all employees, contractors, users and visitors.
- Active from July 2024

Screening and Material Assay Platform

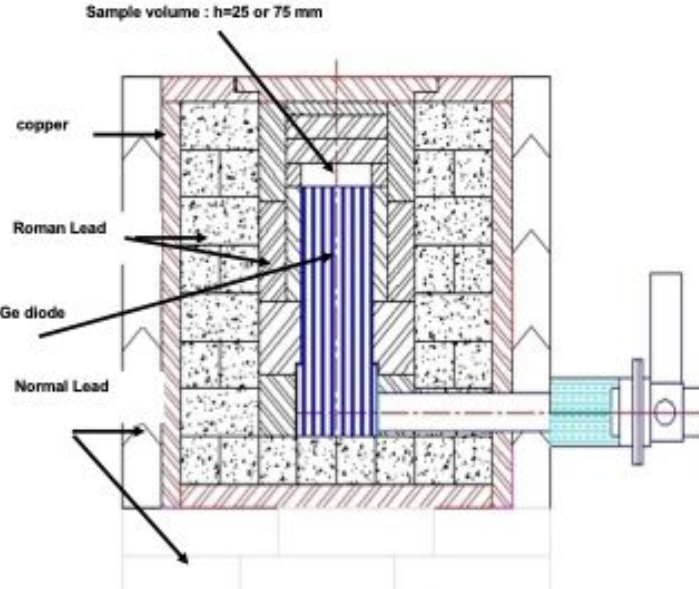
Wide-range program for Astroparticles, Earth Sciences (sediment and ice core sample datation), environmental safety (CEA), biology, etc...

- 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)
- Agreement with LNGS for long term (~ year) measurement of ECEC decay of ^{82}Se (6 kg) to excited state on large (600 cc) Obelix HPGe.

HPGe Obelix at LSM



The HPGe for astroparticle screening measurements



Gentiane

Available for Edelweiss collaboration since November 1997

High Purity Ge diode 210cm^3 n-type

- Closed-ended coaxial detector
- Ultra-low background cryostat
- Archeological lead shielding
- Nitrogen flux 150cc/min

Sensitivities

- Background counting rate $<6.3\text{cts/hr}$ [0-3MeV]
- $\sim\text{mbq/kg}$ [0.1-0.2 ppb for U/Th]
- $10/\mu\text{Bq/kg}$ [^{60}Co in Cu]



The HPGe for astroparticle screening measurements



JASMIN

Available for NEMO collaboration

High Purity Ge diode 400cm³

- Ultra-low background cryostat
- Archeological lead shielding
- Nitrogen flux 150cc/min

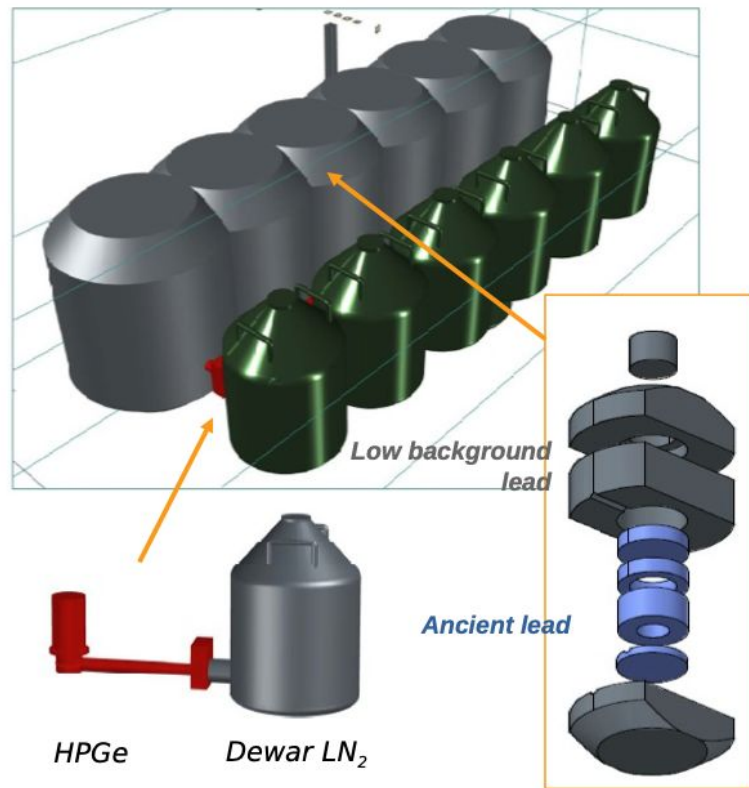
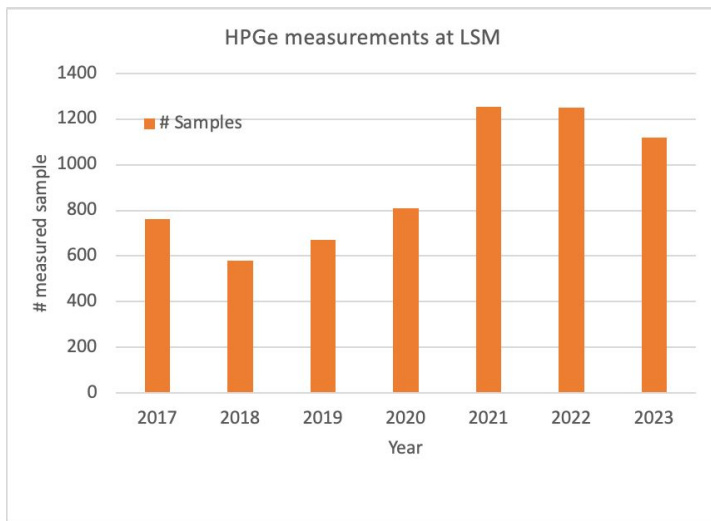
Sensitivities

- Background counting rate <250cts/d [0.05-3MeV]
- ~mbq/kg

PARTAGe

Footprint optimization for HPGe screening det

More efficient use of space
Shielding optimisation
Ease of operation (LN2 refill)



PARTAGe

Footprint optimization for HPGe screening detectors

- 25 detectors in hands at LSM
- 15 installed in PARTAGe
- 5 detectors belonging to LSM
- ~1000 samples/year

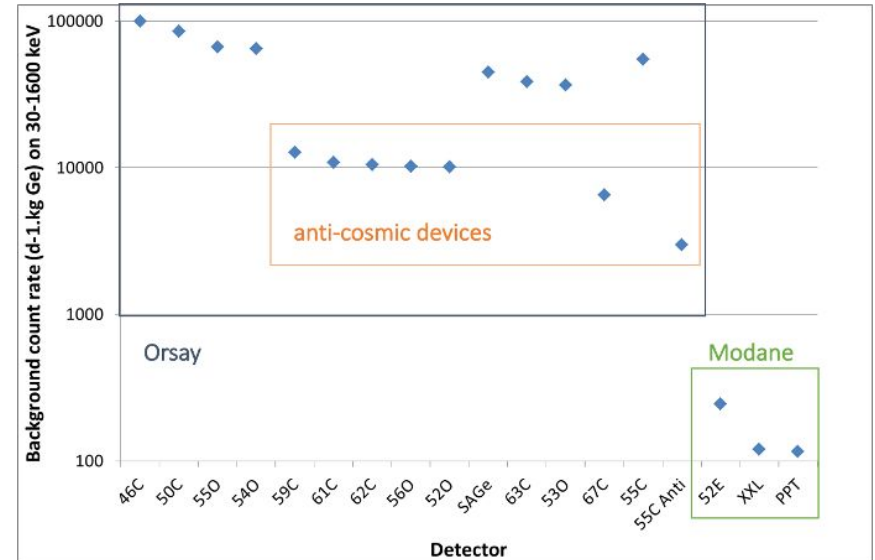


Germanium Platform

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

- Pluri-disciplinary program open to academic and industrial users and partners
- *Covering very lowest-rate background end of their measurements*
- *France: IRSN, CEA, CENBG, IP2I, LSCE (Université Paris-Saclay, CEA, CNRS), EDYTEM (CNRS, U. Savoie Mont-Blanc)*
- *International: UTEF Prague and SURO (Czech Republic)*

Source
: **IRSN**
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE



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

- LSM-pasteur institute collaboration
- Funded by CNRS interdisciplinary mission
- Allowed to test a stem cell storage shielded from natural radioactivity and terrestrial cosmic rays
- Patented cryostat

RAMURe 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.

Interdisciplinary Activities

International interdisciplinary workshop hosted at LSM in October 2023. Goal to promote and enhance interdisciplinary activities at the Underground laboratory of Modane Foreign underground lab representative Boulby^r, LNGS^r, LSBB, LSC^r, SNOLAB et SURF.

Workshop Committee in place
 ➔ Recommendations document centered on a strategic plan for the development of interdisciplinarity at LSM sent to IN2P3.

	Introduction	<i>Silvia Scorza</i>	14:00	Bio at LSM	<i>Vincent Breton</i>
		09:30 - 09:45			13:45 - 14:02
	LSM	<i>Jules Gascon</i>		Medicine al LSM	<i>Fabrice Piquemal</i>
		09:45 - 10:00			14:02 - 14:19
10:00	SURF	<i>Jaret Heise</i>		GDR MI2B - LabEx PRIMES	<i>Denis Dauvergne</i>
		10:00 - 10:20			14:19 - 14:36
	SNOLAB	<i>Sekula Steve</i>		EDYTEM, INSU and INEE	<i>Fabien Arnaud</i>
		10:20 - 10:40	15:00		14:36 - 14:53
	Boulby	<i>Sean Paling</i>		Radon &Co.	<i>José Busto</i>
		10:40 - 11:00			14:53 - 15:10
11:00	Coffee Break			Gamma Spectroscopy	<i>Guillaume Warot</i>
		11:00 - 11:15			15:10 - 15:27
	LSBB	<i>Ignacio Lazaro</i>		Qbits @underground	<i>Silvia Scorza</i>
		11:15 - 11:35			15:27 - 15:44
	LSC	<i>Carlos Pena Garay</i>		Coffee Break	
		11:35 - 11:55	16:00		15:45 - 16:00
12:00	LNGS	<i>Gaetano De Luca et al.</i>		Discussion	<i>Jules Gascon</i>
		11:55 - 12:15	17:00		16:00 - 18:00
			18:00		

LSM Strategic Plan

- *Enhance the laboratory visibility at the forefront of nuclear and astroparticle physics by delivering world-class science and boosting its scientific leadership;*
- *Maintain a strong focus on the delivery of science, and support to the continued progress of current and future experiments; and*
- *Strengthen its global partnerships with European and international laboratories to further consolidate the role of France and IN2P3 in world-class physics research in the domain of deep underground physics.*

THE END

Thank You!

LSM Strategic Plan

- *Enhance the laboratory visibility at the forefront of nuclear and astroparticle physics by delivering world-class science and boosting its scientific leadership;*
- *Maintain a strong focus on the delivery of science, and support to the continued progress of current and future experiments; and*
- *Strengthen its global partnerships with European and international laboratories to further consolidate the role of France and IN2P3 in world-class physics research in the domain of deep underground physics.*