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FCPPN/L

NEXUS project on Underground Laboratories

Neutron Flux measurements at CJPL

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FCPPN/L Workshop, IP2I Lyon, 29 June-3 July, 2026

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Underground Science in a map

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North-south EXchange for Underground Science (NEXUS)

CNRS
INFN
SKAO

Beneficiaries

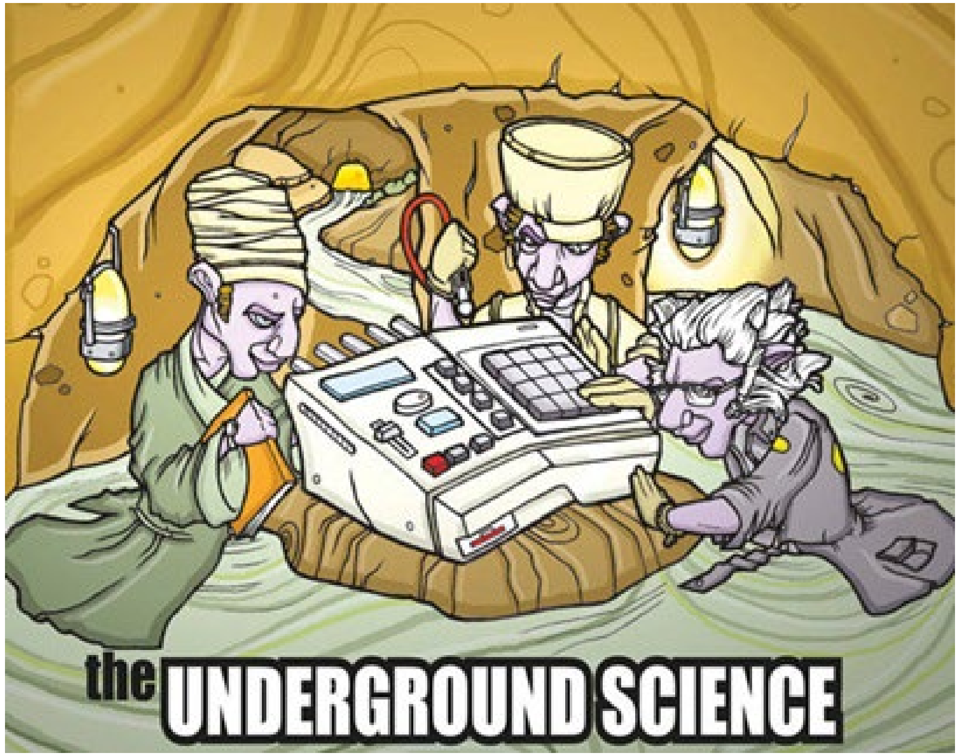
Associated Partners

Associated Partners linked to a Beneficiary

UKRI
Stellenbosch University
University of the Witwatersrand, Johannesburg
University of the Western Cape
UNISA
Sanford Underground Research Facility
The University of Melbourne
Adelaide University
Queen's University

Institut Mines-Télécom
Sorbonne Université
UGA Université Grenoble Alpes
Université Claude Bernard Lyon 1

LPSC Grenoble | Modane



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North-south EXchange for Underground Science (NEXUS)

European Commission

Call: HORIZON-MSCA-2024-SE-01
Type of Action: HORIZON-TMA-MSCA-SE
Acronym: NEXUS
Number: 101236929
Duration: 48 months
GA based on the: HE Unit MGA — Multi & Mono - 1.2
Estimated Project Cost: €0.00
Requested EU Contribution: €771,540.00
Current Phase: Grant Management
Start Date: 01 Jan 2026
Contact: Amir SPAHIC

Work Packages

Number			Name
1	✓		Low background technologies
2	✓		Muography and radiation measurements
3	✓		Modelling, Simulation and Machine learning
4	✓		Quantum science and technology
5	✓		Education and Training Activities
6	✓		Management and Coordination

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NEXUS-WP2 activities

- **Muography**
- **Gammas and other radiations**
- **Uls characterization**

Neutron flux measurements:

→ The neutrons are a critical source of background in an Underground Laboratory (UL) that requires careful control and understanding.

→ The main source of neutrons in UL is the **(α, n) nuclear reactions** produced in the rock of the walls of the laboratory. Alpha particles are primarily produced by the decay chains of uranium (U-238) and thorium (Th-232), which also give rise to the Rn-222 and Rn-220 chains.

→ **The neutron spectral and flux characterisation** in an underground laboratory is **one of the most important measurements** to be performed to understand the background of any rare event detector installed in UL.

NEXUS-WP2 activities

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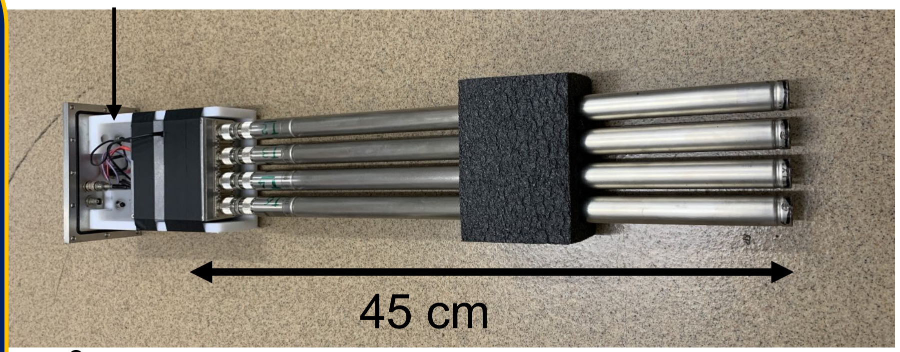
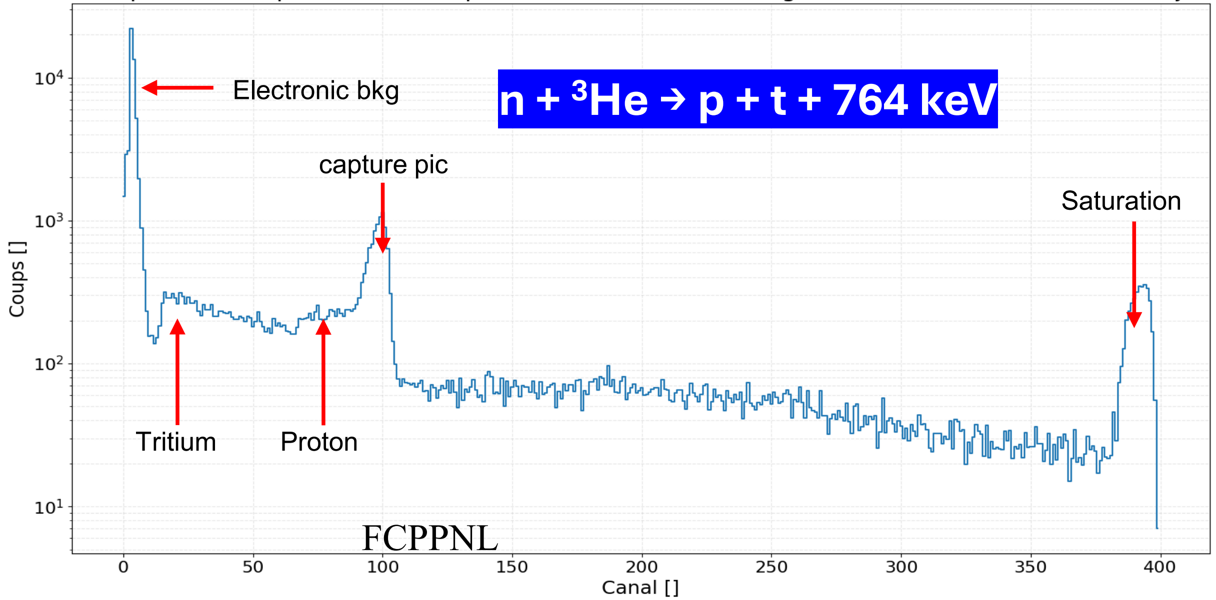
→The LPSC developed 4 He-3 counter tubes, coupled to a custom acquisition system, enabling remote operation.
→ Thanks to the IRN PAULINE project*, it has been shipped early December 2025 to South Africa and has been collecting data in the Huguenot Tunnel in the Cape-Town region where the future PAUL underground Laboratory will be built.
→It has taken a series of measurements at different points in the tunnel.
→It was shipped back to Grenoble mid-June 2026 and the data are being analysed since January 2026.



^{3}He proportional counter tubes

Nombre de coups mesurés par canal de déposition dans le tunnel Huguenot entre décembre 2025 et janvier 2026.

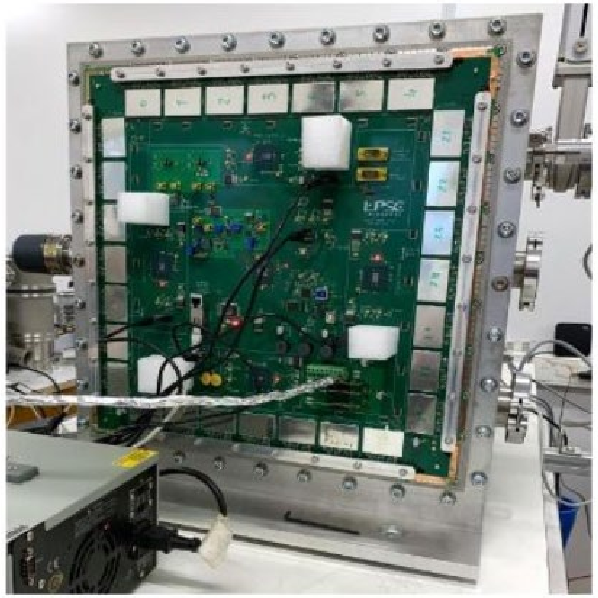


*IRN PAULINE (https://pauline.in2p3.fr)

He3 proportional counter being upgraded

The detector is operating in a proportional regime, gas filled at 4 bar, 950 V Composition: 90% ^{3}He, 1% Ar, 9% CH_4 Spectrum initially measured over 10,000 channels, compressed to 400 channels to match the detector resolution (35 keV)

→ New electronics: using the Micro TPC Matrix of Chambers (MIMAC): Gaseous detector operating in the proportional regime Specifications: 35 x 35 x 29 cm, 512 µm gap, 390 µm spatial resolution;
→ resolution for a volume of this size Enables 3D visualization of tracks



NEXUS, CJPL and FCPPNL

1. NEXUS amendment to allow 2 new labs to join

- IBS-Yemilab, South Korea
- CJPL, China

2. With China joining NEXUS, The 4 He-3 counter tubes detector and its acquisition system will also be installed at **CJPL** (China Jinping Underground Laboratory) in collaboration with Prof. Qian Yue and his team.
3. Same experiment will be done at **INFN (LNGS)** for a longer time and at **SUPL (Australia)** for a period of at least one year to be able to identify any modulation-related effect on the neutrons flux.
4. A short period of data taking is also expected at **SNOLAB**

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BACK-UP

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BACK-UP

Mesure du spectre neutronique en laboratoire souterrain :
Se fait avec des dispositifs de mesure complexes, parfois nécessitent de postuler la forme du flux neutronique

Expérience au Laboratoire Souterrain de Modane : utilise un scintillateur liquide dopé au lithium 6
Réaction : n + Li ➜ α + t + 4,78 MeV

Principe de mesure : mesurer en coïncidence la première collision élastique d'un neutron rapide avec la capture du même neutron une fois thermalisé
Critères temporels (moins de 180µs entre les deux), énergétiques (au moins 260 keV d'énergie déposée)

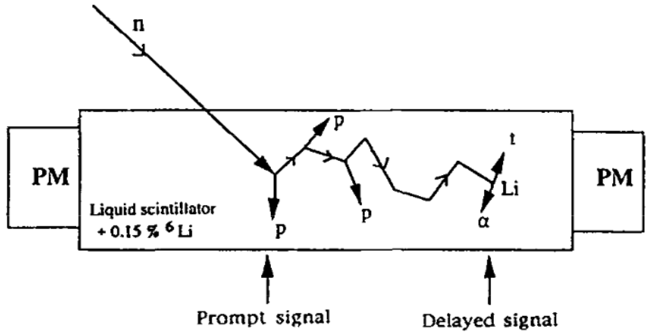
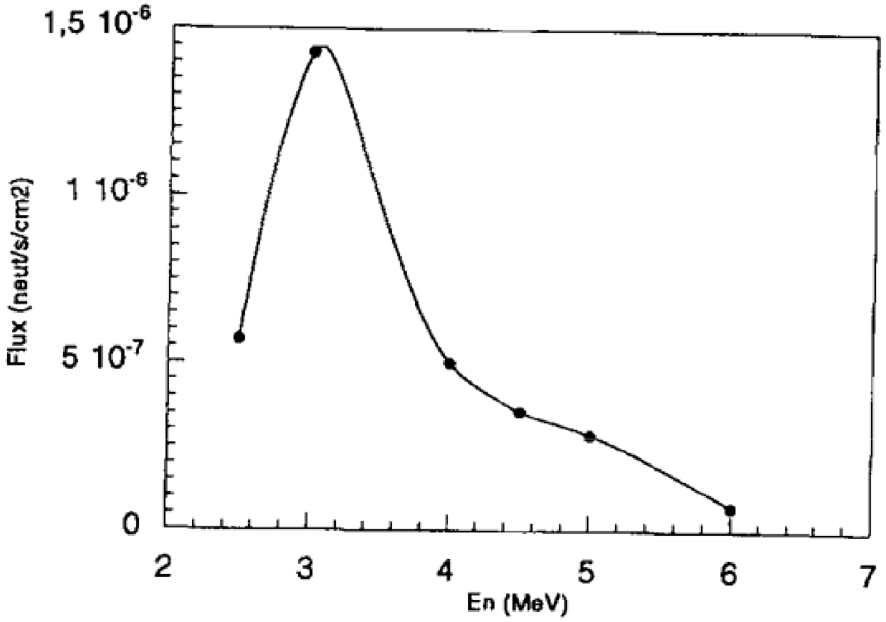
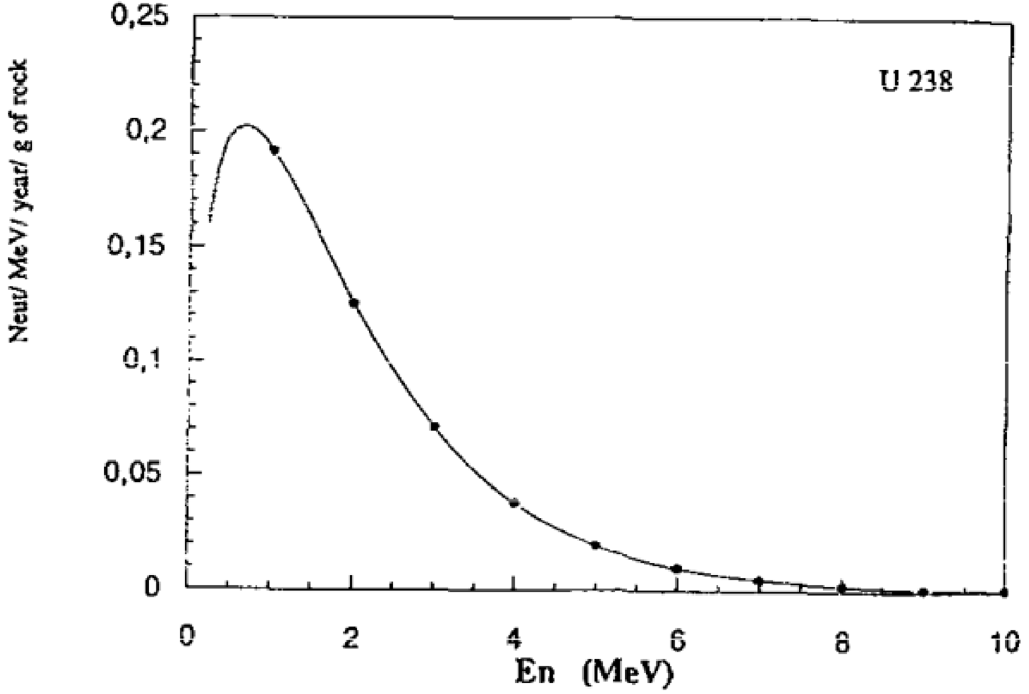


Schéma de principe de la mesure de Chazal et al.

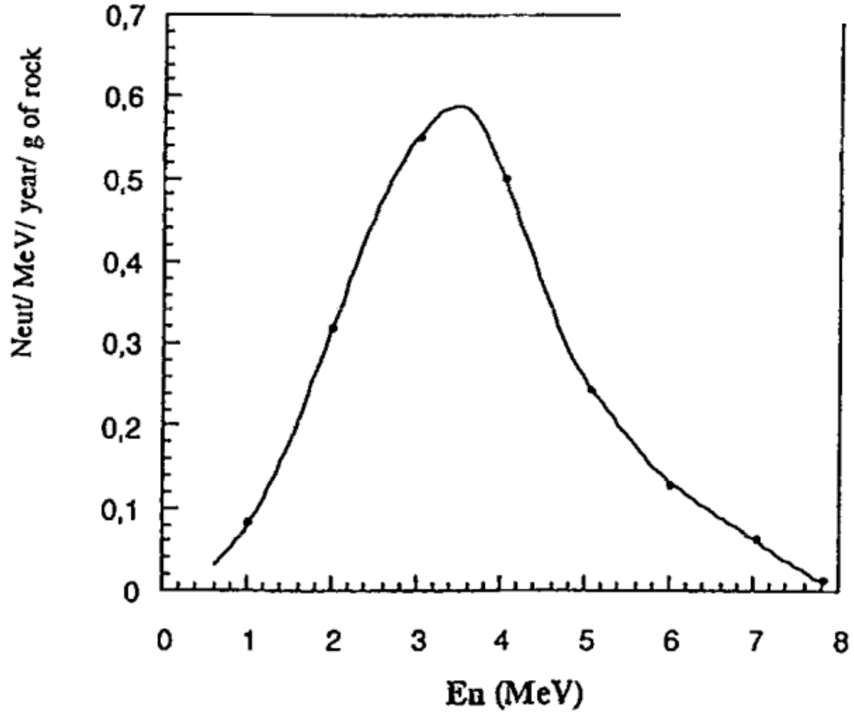


Distribution énergétique du flux neutronique déterminé par l'expérience au LSM.

BACK-UP



Spectre d'émission de neutrons par fission spontanée de ^{238}U.
L'intégrale donne 0,47 n/an/g de roche au laboratoire de Modane.



Spectre d'émission de neutrons par réaction (α, n).
L'intégrale donne 1,93 n/an/g de roche au laboratoire de Modane.