Low Radioactivity and Multidisciplinary Underground Laboratory of Modane (LSM)

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**Underground Laboratory of Modane**

**Introduction**

The LSM, deepest European underground laboratory, is located 1700 m (4800 m.w.e) below Fréjus peak (Alps chain) in the middle of the Fréjus tunnel between France and Italy. The LSM is a multidisciplinary platform for the experiments requiring low radioactivity environment and cosmic ray free background. Several experiments in Particle and Astroparticle Physics, low-level of high purity Germanium gamma ray spectroscopy, biology and home land security hosted in the LSM. It’s equipped by Anti-Radon facility where all of the detectors are flashed by Radon depleted air.

**EDELWEISS EXPERIMENT**

The Spherical gas detector (or Spherical Proportional Counter, SPC) is a novel type of particle detector, with a climate, retro-observation,...

**Developments of Ge**

1. The deepest European underground laboratory, Ge...
2. Goal: 20 detectors and 100 kg of Ge.
   - Background: 5 x 10^{-5} keV^2 cm^2 kg s^{-1} with severe requirements for internal radioactivity < 0.15 mBq/kg.
   - Source: Thin foil (50 mg cm^{-2}).
   - Source density: 4.2 Bq/kg.
   - Trackers: Cu calibration
   - FWHM: 388 ± 49 meV (Argon, 50 ppm).
   - Phase 3: Decay of the 2νββ (0 → 0) measurement with 10g of enriched 76Ge since 1 year.

**SEDINE/NEWS-G, LSM**

The spherical germanium detector (or Spherical Proportional Counter, SPC) is a novel type of particle detector, with a broad range of applications. SEDINE (≤0.5cm) is a low background detector installed at LSM, is currently being operated and its aims is dark matter searches, in particular Light WIMP’s (below 5GeV).

**SuperNEMO DEMONSTRATOR**

The demonstrator is under construction at the LSM. It will be fabricated by the end of this year. After blank assembly at LSM the calobricks are tested in a black box with radon tight glue seals between sub-detectors. The shielding will consist of 20 cm of pure iron and 30 cm of Lead.

**Neutrino**

**SuperNEMO DEMONSTRATOR**

- The demonstrator will reach the NEMO-3 sensitivity in only one year. The background is expected in the second year in 25 years for 7 kg of 56Fe (to be demonstrated).
- The final sensitivity after 17.5 kg y exposure (90% CI) is 10^{-2} < T_{1/2} < 3 x 10^{20} y.
- 56Fe source: Thin foil (50 mg cm{-2}) of 56Fe mixture with glue in 12 μm films.
- Copper foil for background and systematics.
- Tracker: 4 C-sections drift chamber with 2000 vertical cells. The tracking gas is a mixture of helium, ethanol and argon. All materials have been selected for radioactivity and low radon emanation levels.
- Calorimeter: 712 plastic scintillators coupled to 5” or 8” Hamamatsu PMTs and wrapped with scintillating fibers on the sides and 6 μm aluminumized mylar on the front. The main wall is covered by 25 μm radon tight nylon film. The PMTs are protected from the magnetic field by mu-metal or by pure iron shields. The latter serves also as supporting structure.
- Surroundings: a copper collar around the detector provides a vertical 25 m magnetic field. An air-tight tent flushed with radon-free air (< 15 mBq/m^3) closes the detector volume. The remaining radon will be stopped by radon tight glue seals between sub-detectors.
- The shielding will consist of 20 cm of pure iron and 30 cm of bonded carbon.

**Multidisciplinary**

**BIOLOGY**

Low background biological research has consistently shown that despite the natural radiation background already being incredibly small, it is nevertheless significant enough for living systems to sense it and respond to it. The adaptive and homeostatic effects that are natural and like backgrounds are not yet well understood, and significant experimental works is needed to better clarify them. Experimental approaches that draw from evolutionary biology are well adapted to this task. Physiological and genetic changes may occur at low radiation backgrounds. Whole sequence genotyping, proteomics, multi-generational studies, and long term evolution experiments are some of the mechanisms that may be applied in addressing this problem.

More experiment is necessary to improve this result (against right) and to reach our goal (above).

**MicroElectronics**

Due to miniaturization, the electronic sensitive to neutrons, at ground level, from cosmic rays and internal alpha particles contamination. The LSM is a unique test field for alpha particles contamination because cosmic rays are reduced to zero (SERC 2001).

- LSM laboratory has conducted since 2007 a series of underground experiments to quantify the importance of alpha particle emitter contamination in advanced SIAM memories.

- 25 alpha particles per mm^2.
- 0.5 ppp of 511 keV in Silicon 2.38 x 10^{-5} /cm^2/s
- 0.5 ppp of 511 keV in Silicon 0.18 x 10^{-5} /cm^2/s

**TPV EXPERIMENT**

Telescope Germanium Vertical is another experiment for double beta decay (0β). The experiment consists of 12 Germanium planar detectors (©Germanium).