Canfranc Underground Laboratory

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TAUP 2015

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Torino, Italy
850 m under mount Tobazo (~ 2500 m.w.e)
Muon flux ~ 4×10^{-3} \text{ m}^{-2} \text{ s}^{-1}
Inlet air flux ~ 20000 \text{ m}^3/\text{h}
Radon level 50 - 80 Bq/m^3
Neutron flux (<10 MeV) ~ 3.5×10^{-6} \text{ n/(cm}^2 \text{ s)}
Gamma rays flux ~ 2/(\text{cm}^2 \text{ s})
LSC Underground Facility

- LSC underground total volume ~10000 m³ for a total surface of 1600 m².
- Underground space divided as:
  - **LAB780**(L and R) since 1985:
    - two small halls 12 m² each and two 70 m long small tunnels
    - early installation in service space for railway tunnel
  - **LAB2500**:  
    - 118 m² hall in operation since 1994
  - **LAB2400**:  
    - Hall A has dimensions 40×15×12(h) m³ and Hall B has dimensions 15×10×8(h) m³
    - 45 m² clean room and 215 m² service space
    - In operation since 2006

- Protocol to enter underground area:
  - Entrance through road tunnel
  - Independent exit through the railway tunnel
LSC Underground Layout
LSC Service Facilities

- **Screening** underground laboratory
  - high purity germanium $\gamma$-spectrometers
  - Integral sensitivity of counters ($< 3$ MeV) $\sim$ mBq/kg
  - SAGe well detector being installed
  - This facility used by SuperKGd to select Gd salt for SuperKamiokande with Gd$_2$(SO$_4$)$_3$ see talk on EGADS

- **Clean room** ISO7 (ISO6 in a sector)

- **Radon abatement system** (being installed)

- **Chemistry laboratory**
  - Electroforming of copper, support for sample preparation, ICP-MS (in 2016)

- **Workshop**

- **Computing**
Services @ LSC for Users

On surface

✓ Chemistry
✓ Mechanics
✓ Electronics
✓ Computers&Network

Underground

✓ Low activity (screening) 7 HpGe counters and related analysis software
✓ Clean room  ISO 7 and 6 & mechanical shop
✓ Rock stability in experimental Halls and other locations
  – convergence meas. along sections of the tunnel
  – monitoring: 18 optical fibers 5m long with temperature and humidity sensors and distance measurement sensitivity ~ µm

Low activity 7 HpGe

Clean room
**Rn monitoring**

In Collaboration with LABAC Zaragoza Univ. environmental radiological characterization of underground experimental area
Experimental activities @ LSC

- **ANAIS** DarkMater (NaI(Tl), Annual modulation - operational)
- **ROSEBUD** DarkMatter (Scintill. Bolometers – stopped)
- **ArDM** DarkMatter (2phase LAr TPC – operational)
- **NEXT** $0\nu2\beta$ (Enr $^{136}$Xe gas TPC – demonstrator commissioning)
- **BiPo** $0\nu2\beta$ (specialized facility for SuperNEMO – operational)
- **SuperK-Gd** screening for SuperKamiokande-Gd – operational
- **GEODYN** Geodynamics – operational

Expressions of Interest under review
- **CUNA** Nuclear astrophysics
  - New 300 m² facility feasibility study
- **GOLLUM** deep-life: characterising subterranean bacterial
Research activities at Canfranc in Astroparticle Physics

• Neutrinoless double beta decay
  – **NEXT**: 100 kg of Xe (90% $^{136}\text{Xe}$) in a 15 bar pressure TPC
  – NEXT TPC is designed with a plane of PMTs on the cathode and a plane of SiPMs behind the anode to determine the energy and the topology of the event - see talk by Andrew Laing Neutrino B
  – A 10 kg demonstrator named NEW is under commissioning

• Dark Matter
  – **ANAIS**: array of high purity NaI(Tl) crystals to search for Dark Matter annual modulation (like in DAMA/LIBRA) – see talk by Maria Luisa Sarsa DM A
    • New 12.5 kg high purity crystal under measurement: $16.3\pm0.6$ p.e./keV
    • 1 keVee detection threshold feasible
    • In 2016 will take data with 112 kg target mass
  – **ArDM**: 2 tons of liquid argon for WIMPs detection in a two-phase TPC.
    • It has been in operation in single phase
    • At present upgrade to start two-phase operation mode
NEXT demonstrator
NEXT TPC

High pressure Xe TPC
Enriched at 90% in $^{136}\text{Xe}$
Operating at 15 bar in EL mode

**Energy Plane:**
to measure energy of event

**Tracking Plane:**
to determine topology of event

NEXT demonstrator (NEW): 10kg active region; 50cm drift; 12 PMT @ EP;
1800 SiPMs @ TP
Commissioning full set-up by December 2015
MC simulation at 15 bar of signal ($\beta\beta0\nu$) and background ($\gamma$) in NEXT
ANAIS set-up @ LSC
ANAIS NaI + PMT assembling
BiPo

- Set-up to measure $^{214}\text{Bi}$ and $^{208}\text{Tl}$ contamination at $\mu\text{Bq/kg}$ level on planar geometry structures by Bi-Po fast coincidence $\beta-\alpha$ correlated decays
- 3.6 m$^2$ equipped with 40 sectors each with 2 PMTs + light guides + polystyrene scintillators surrounding the thin foil
- At present in use for SuperNEMO foil screening (40mg/cm$^2$ $^{82}\text{Se}$)
Nuclear Astrophysics

• CUNA @ LSC is a project to develop a facility to measure cross sections of interest in nuclear astrophysics (s-process) such as
  - $^{22}\text{Ne}(\alpha,n)^{25}\text{Mg}$ and $^{13}\text{C}(\alpha,n)^{16}\text{O}$

• A new and independent excavation is needed

• Measurement to characterize the neutron background underground have been performed
Geophysics

• LSC is equipped with a geodynamic facility which aims to study local and global events
• The facility consists of
  – A broadband seismometer and accelerometer
  – Two 70 m long laser strainmeters with exceptional low background at the LSC site
  – Two GPS stations on surface
• Research activity:
  – deformation due to non-linear shallow –water tidal loading
  – local, regional and teleseismic earthquakes
  – effect of underground water on rock strain
  – seismic monitoring of Aragon river
Laser strainmeter in LAB780
Life in extreme environments

Life on Earth extends into the deep subsurface and extreme environments

Canfranc railway tunnel offers a unique opportunity to study microorganism communities

The **GOLLUM** project, at present being proposed and under review, aims to characterize microbial communities by extraction of DNA in rock samples
Drilling sites to probe deep-life

T.L.Kieft private communication on Workshop to develop deep-life continental scientific drilling projects

LSC proposed to be a new site with GOLLUM
New Facility @ LSC

- ROSEBUD in the framework of EURECA took data at LSC to characterize scintillating bolometers
- At present the infrastructure used by ROSEBUD is available for new proposals
  - A hut 3x3x4.8 m³ in a Faraday cage, acoustically isolated
Conclusions

• LSC is one of the four deep underground laboratories in Europe
• LSC has some 280 users from international collaborations
• LSC is a multidisciplinary infrastructure
  – astroparticle, geophysics, biology
• LSC well equipped to support existing experimental activities
• LSC facilities can give support to new R&D and activities carried out in other laboratories
Workshop on
Deep Underground Laboratory Integrating Activity
in biology (DULIA-bio)
Canfranc, Spain
October 13-14 (2015)

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Program
Astrobiology
Extremophile Biotechnology
Life in Deep Biosphere
Life in Low Radio Environment

Workshop webpage
http://www.lsc-canfranc.es

Sponsored by:
Expected electron tracks in NEXT

Unique technique for neutrinoless double beta decay