The Gran Sasso National Laboratory

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LNGS overview
LNGS Early History

• 1979: proposal by A. Zichichi to Italian Parliament
• 1982: Approval of LNGS construction
• 1987: construction completed
• 1989: Start data taking of first large experiment (MACRO)
LNGS Characteristics

- Surface: 17 800 m²
- Volume: 180 000 m³
- Ventilation: 1 vol / 3.5 hours
- Rn in air: 20-80 Bq m⁻³
- Muon flux: 3.0 \times 10^{-4} \text{ m}^{-2}\text{s}^{-1}
- Neutron flux:
  - \(2.92 \times 10^{-6} \text{ cm}^{-2}\text{s}^{-1}\) (0-1 keV)
  - \(0.86 \times 10^{-6} \text{ cm}^{-2}\text{s}^{-1}\) (> 1 keV)

rare events <-> weak signals
=> low radiation environment
Background sources

Cosmic rays

Primary cosmic rays: mostly protons
Create showers of secondary particles in atmosphere
in the end muons and neutrons reach surface

Natural radioactivity

Natural decay chains: Thorium & Uranium series
Potassium-40
Radon (from decay chains): gaseous

http://astro.uchicago.edu/cosmus/projects/aires/
LNGS Users Support and Facilities

- Ultra-low background techniques
- Chemistry lab and service
- Mechanics workshop
- Mechanics design & 3D-printing lab
- Electronics
- IT
- Technical Division
**LNGS research in a nutshell**

**Mission:** enable and attract frontier astroparticle research and science requiring low-background environment

Use of suitable shielding to suppress the environmental radioactivity around the detector (i.e. lead, copper, PE)

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**Our playground**
- Neutrino Physics
- Dark Matter searches
- Neutrino Astrophysics
- Nuclear Astrophysics

**Material screening**
In radiopurity assay

**Ultra Low-level Gamma ray Spectrometry**

**Inductively coupled plasma mass spectrometry (ICP MS)**

**Trace radioactivity measurements**

**Develop analytical procedures**
- matrix separation
- analyte pre-concentration
- background and contamination reduction
- increase of sensitivity

07/05/20
Ultra-low level radioactivity counting facilities

STELLA (SubTErranean Low Level Assay)
- γ spectrometry (High-Purity Ge Detectors)
- 15 detectors installed

Sensitivity (U/Th):
- commercial LB detectors (mBq/kg)
- commercial ULB detector (0.5 mBq/kg)
- custom ULB detector (MPIK/LNGS) (50 μBq/kg)

- α spectrometry (Silicon PIPS detectors)
- liquid scintillation counters

Inductively coupled plasma mass spectrometry (ICP-MS)
- 7500a Agilent quadrupole ICP-MS
- Element2 Thermo Double Focusing
  High Resolution ICP-MS
- Class 1000 clean room
- Sub boiling distillation system for reagent purification

Courtesy: S.Nisi
ICP-MS main activity

Material screening for low background physics applications (K, Pb, Th U)

- ≈ 200 samples/year (complex matrices)
- few hundreds samples/year (reagents and water)

Cu, TeO₂ and reagents
-CUORE-

Printed Circuit Board (PCB)
-GERDA-

Metals and alloys
-GERDA, XENON, DARKSIDE-

Al-Mylar insulating foils
-XENON, DARKSIDE-

Courtesy: S.Nisi
Access to LNGS RI resources

• Open access, excellence driven
• Proposals are peer-reviewed by the Scientific Committee
• International Scientific Committee:
  – Present composition: 9 members, 4 of them from Italian Institutions
  – Recommends proposals for approval, monitors progress of experiments
LNGS Activities
LNGS & Innovation

• LNGS is a reference player in Regional S3 (Smart Specialization Strategy)
• Access to “Regional” funds for innovation
• Partnership with innovative regional companies
  – Technology transfer to regional companies in order to build up a major LNGS resource
• A new infrastructure for testing and packaging photo-detectors based on SiPM

• ISO6 with a small sector ISO5 radon-free
  • ~250 m² and 750 m³ inside an existing building
  • One main Air Handling Unit (4000 m³/h) and four AHU for recirculation
    ▪ Can operate with 20 working people inside at the same time

• Ready by end of 2020.
  – First user: production of photo-detector-modules for DarkSide-20k
  – Interest to use the facility from other experiments (CTA, CMS, JUNO, …) under discussion
Preparation of Photo-Detector-Modules

- **Tiles assembling:**
  - SiPM preparation and flip-chip bonding on selected substrate
- **Tiles test:**
  - Low temperature test on samples
- **Mounting Front End Boards:**
  - Room and low temperature test on samples
- **PDM assembling:**
  - SiPM tile + FEB + plastic support
  - ~ 8000
- **Mother Board assembling**
  - each MB with 25 PDMs
30 years of operation
UG-GRI next step
Users

• Users constitute the life of the RI

- Tot. Users in 2018 n. 1029
- Tot. Countries n. 28
- Italian Users n. 442
- Foreign Users n. 587

• Drive them through best practices
UnderGround Global Research Infrastructure

• Proposed by LNGS and SNOLAB following an initiative by the Group of Senior Officials (GSO) of the G8+5

• GSO was proposing to bring it to the G20

https://ec.europa.eu/research/infrastructures/index_en.cfm?pg=gso
https://www.gsogri.org/
Build a reference global infrastructure for underground science

- serve the scientific community of the world
- accommodate in an efficient manner the needs of new experiments and the planning of novel upgrades and needs
- enable worldwide science and spread innovation
- UG-labs that share common challenges (maintenance and continuous upgrade, share and spread best practices, transnational access)
Outreach and Dissemination

Conferences and events 2017-2018

30° Anniversario LNGS with Italian President Mattarella
FameLab : 200 students
PINT OF SCIENCE (Atom to Galaxy) : 250 attendances
SCIENZA, GENERE E NUOVE GENERAZIONI :200 students
OPENDAY : 2000 visits
PHOTOWALK SHARPER: 30.000 visits

Dissemination in the schools 2017-2018

GRAN SASSO VIDEOGAME MIUR project (tested with 350 students)
Alternanza Scuola Lavoro activated  9 stages
ANCH’IO SCIENZIATO : about 2000 students
Concorso Nazionale (INFN-CNR)
“Donne e Fisica: Stereotipi e Pregiudizi”
300 students
Conference/events  SHARPER : 1800 students