



LNGS – Lessons From 30 Years of Activity

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ANDES Underground Laboratory Workshop

Buenos Aires

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Summary

1. LNGS overview

- a. Characteristics
- b. Facilities
- c. Science
- d. Outreach & dissemination
- e. Future

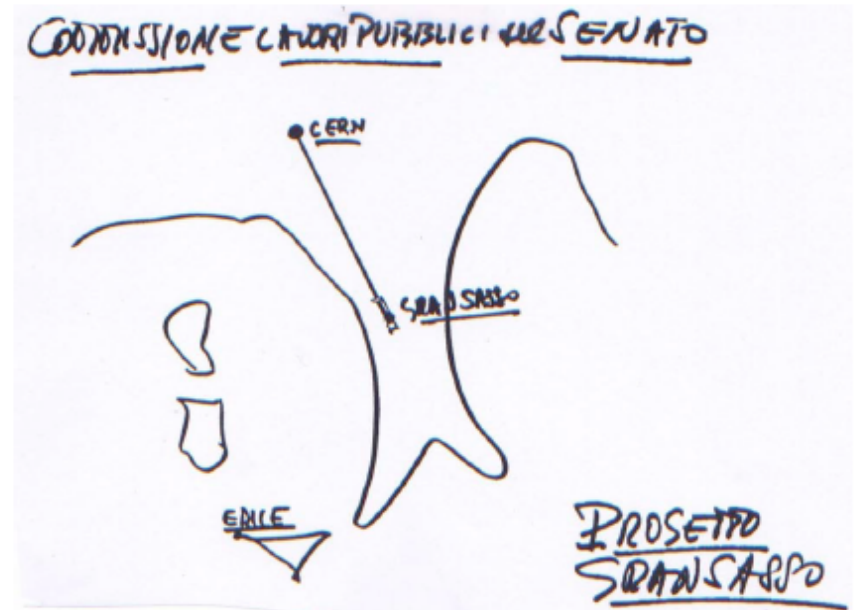
2. 30 years

- a. Safety
- b. Human resources
- c. Users

3. UG-GRI

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)



Note manoscritte di A. Zichichi presentate nella Seduta della Commissione Lavori Pubblici del Senato convocata con urgenza dal Presidente del Senato per discutere la proposta del Progetto Gran Sasso (1979).

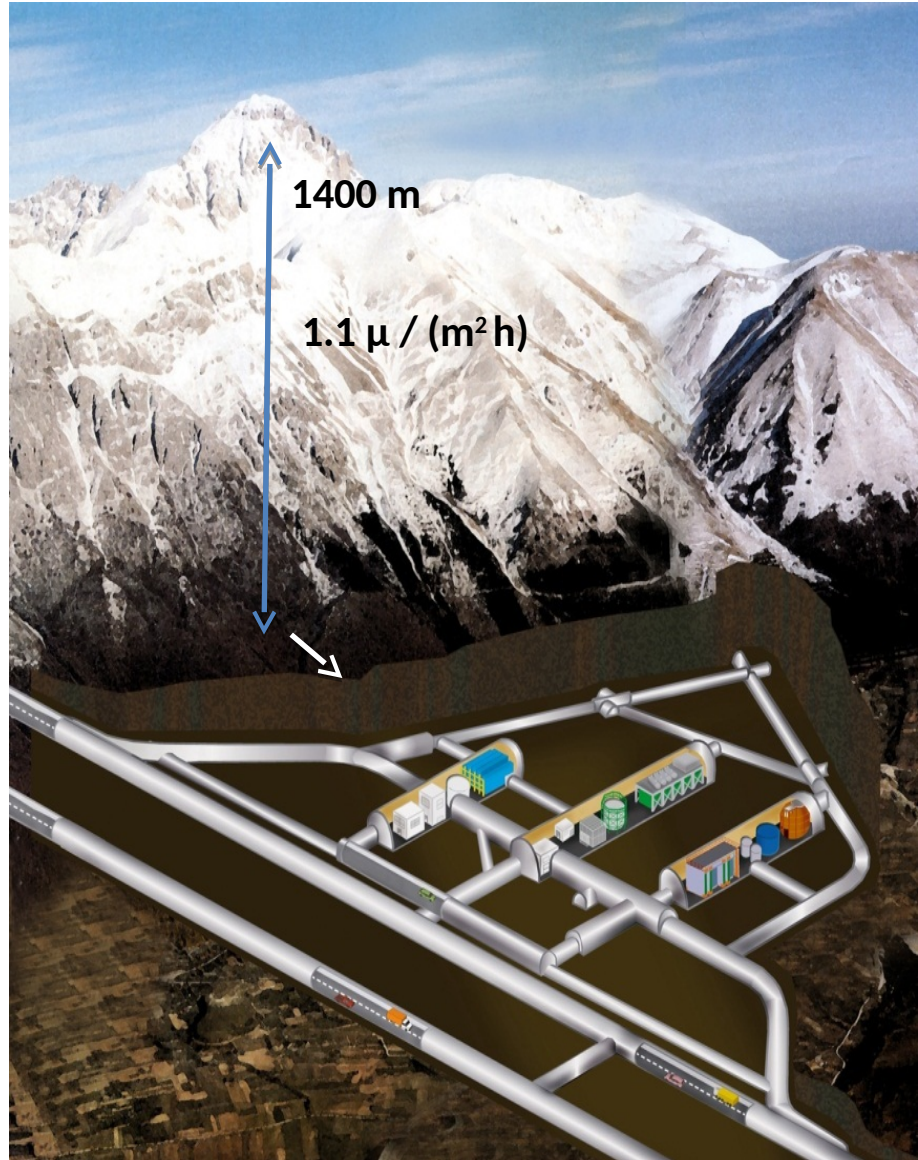
To summarize, the scientific aims of the "Gran Sasso" laboratory are the study of:

- 1) nuclear stability;
- 2) neutrino astrophysics;
- 3) new cosmic phenomenology;
- 4) neutrino oscillations;
- 5) biologically active matter;
- 6) ground stability.

Not only
 $\tau_p \neq \infty$

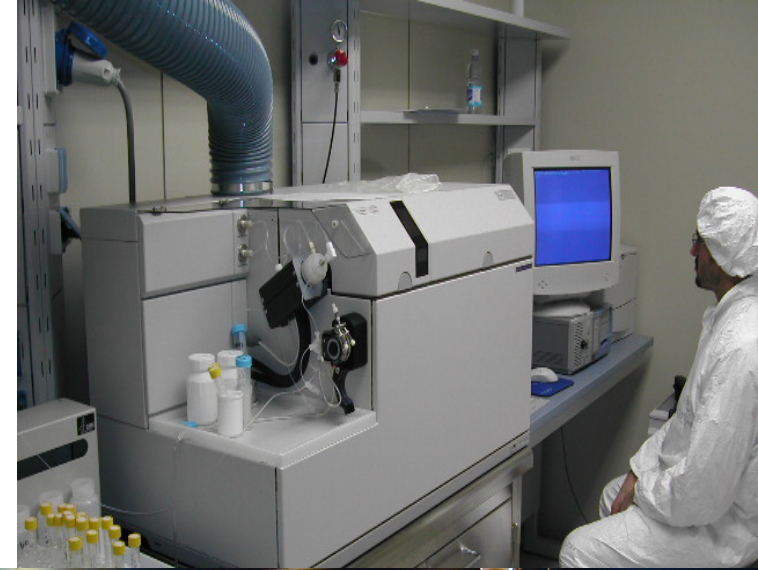
LNGS Characteristics

- 42.46°N 13.57°E
- Muon flux: $3.0 \cdot 10^{-4} \text{ m}^{-2}\text{s}^{-1}$
- Neutron flux:
 - $2.92 \cdot 10^{-6} \text{ cm}^{-2}\text{s}^{-1}$ (0-1 keV)
 - $0.86 \cdot 10^{-6} \text{ cm}^{-2}\text{s}^{-1}$ (> 1 keV)
- Rn in air: 20-80 Bq m⁻³
- Surface: 17 800 m²
- Volume: 180 000 m³
- Ventilation: 1 vol / 3.5 hours



LNGS Users Support and Facilities

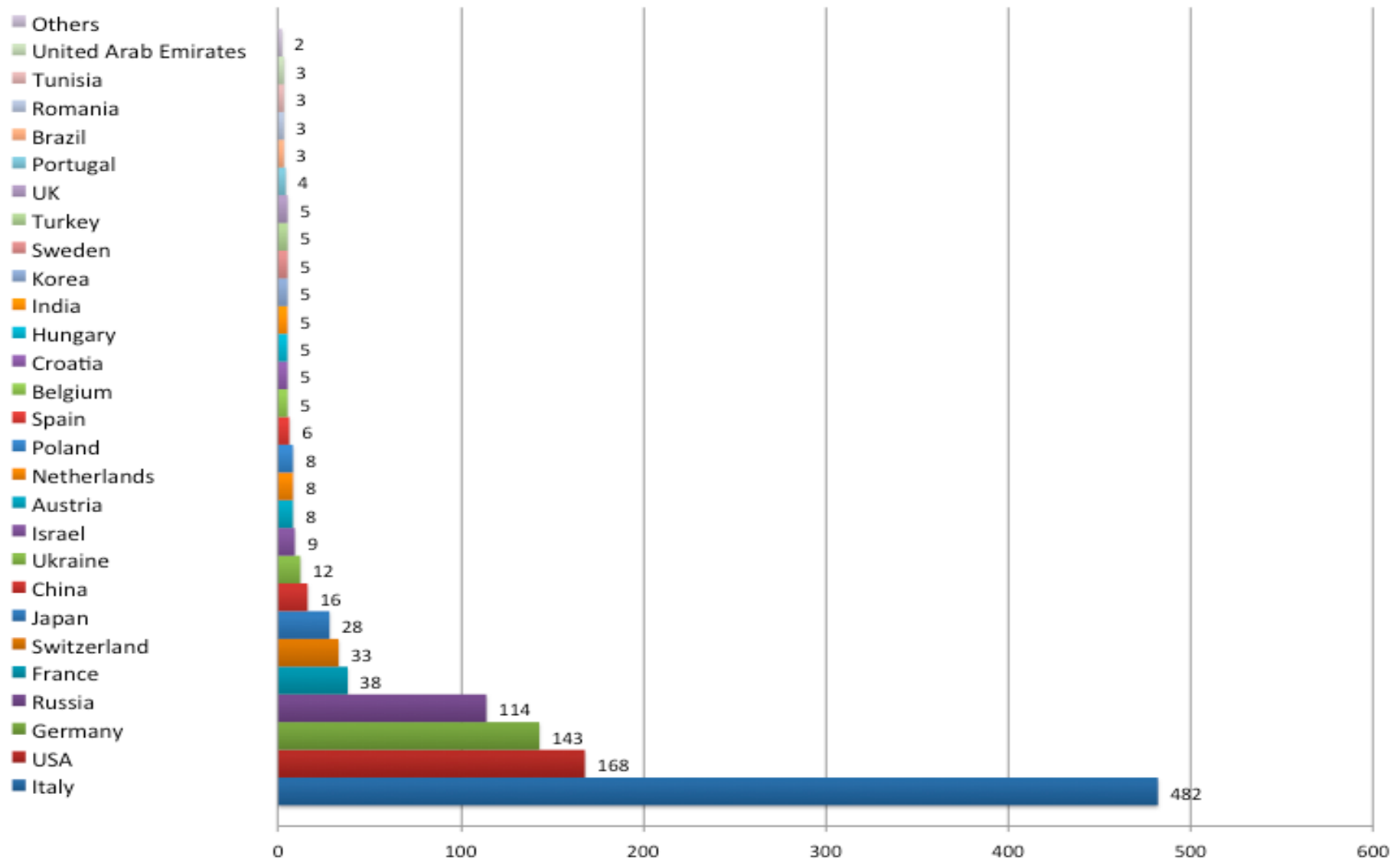
- Ultra-low background techniques
- Chemistry lab and service
- Mechanics workshop
- Mechanics design & 3D-lab
- Electronics
- IT
- Civil engineering



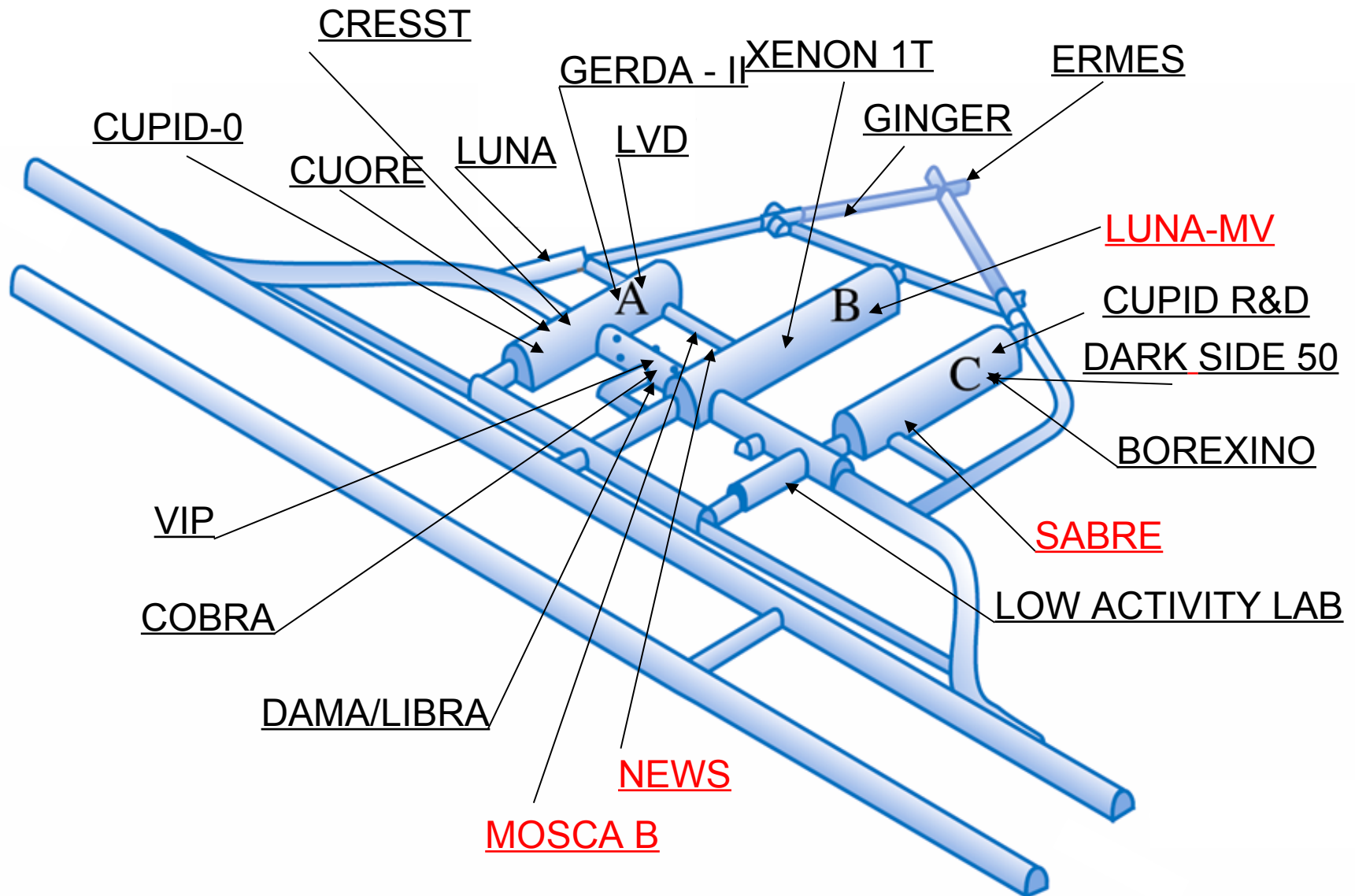
Access to RI resources

- Open access, excellence driven
- Proposals are peer-reviewed by the **Scientific Committee**
- International **Scientific Committee** :
 - Present composition: 9 members, 3 of them from Italian Institutions
 - Recommends proposals for approval, monitors progress of experiments

LNGS Users



LNGS Activities



Virtual tour

- From Google Street View

- www.google.it/maps/@42.4538978,13.5746863,3a,75y,266.25h,74.88t/data=!3m5!1e1!3m3!1sU33rehgjcSpsBNVVJXXT_w!2e0!3e5

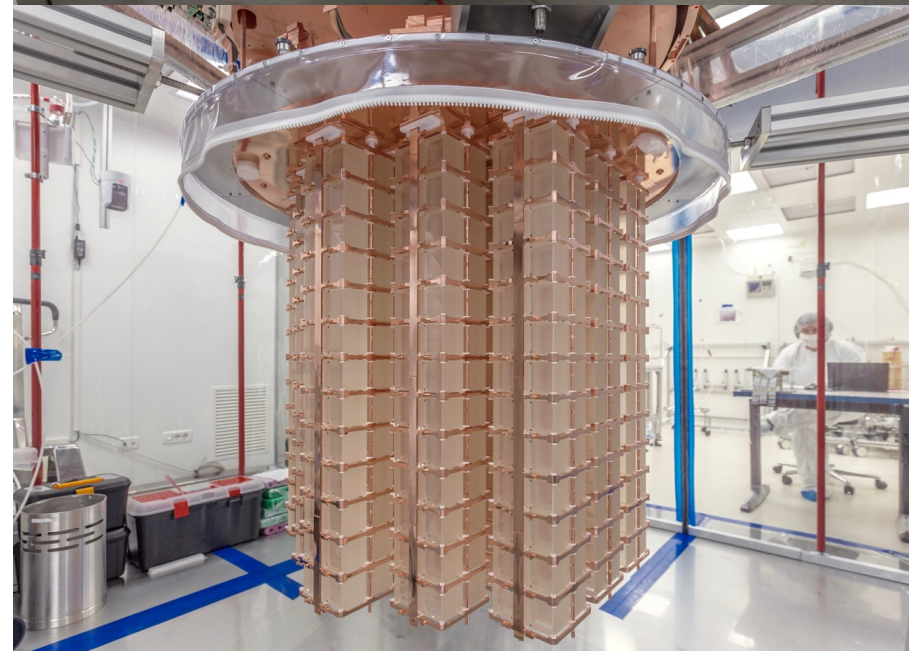
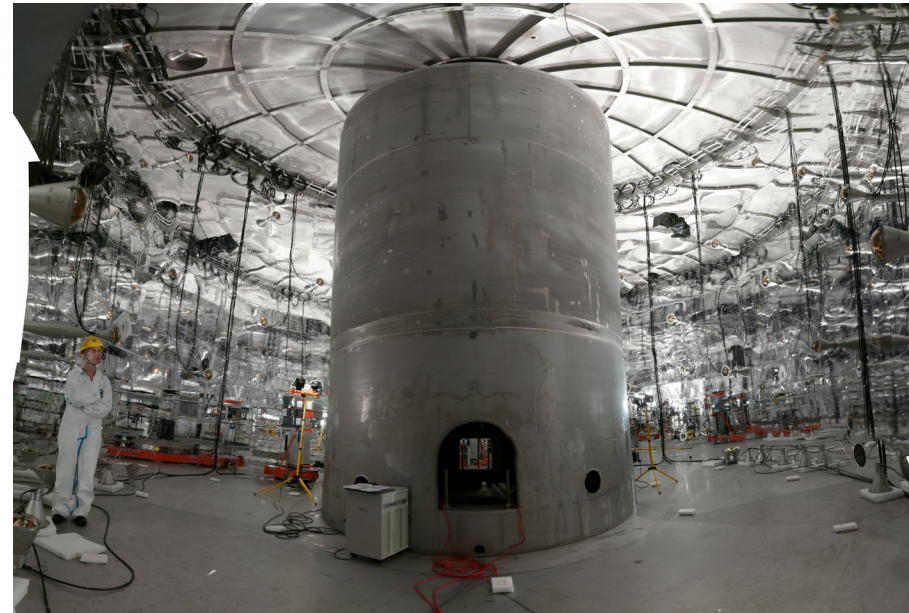


LNGS main research activities

- Neutrino Physics
- Dark Matter searches
- Neutrino Astrophysics
- Nuclear Astrophysics

Neutrino Physics

- Double Beta Decay
 - Gerda / Gerda-II: ^{76}Ge
 - **CUORE** – *the coldest m^3 in the world* : ^{130}Te (TeO_2 crystals)
 - Cobra: ^{116}Cd
 - CUPID-0: ^{82}Se (enriched ZnSe crystals)
- Sterile Neutrino?
 - Borexino-SOX (CeSOX first)



Dark Matter

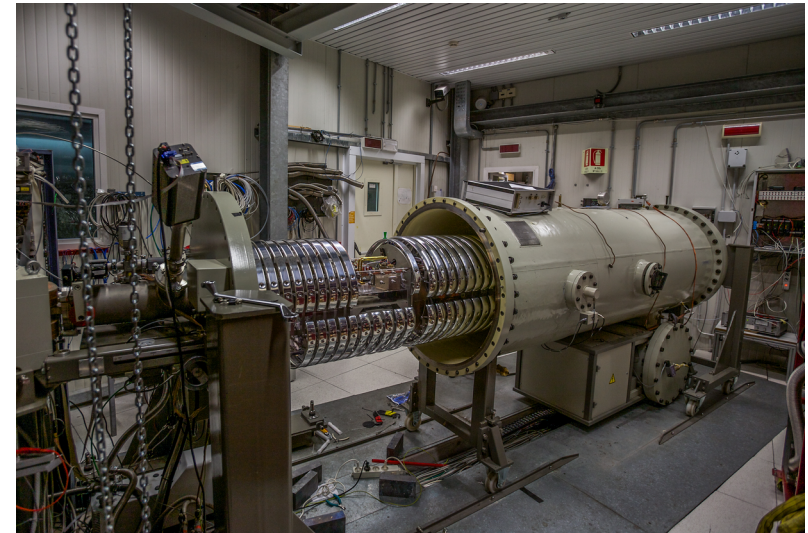
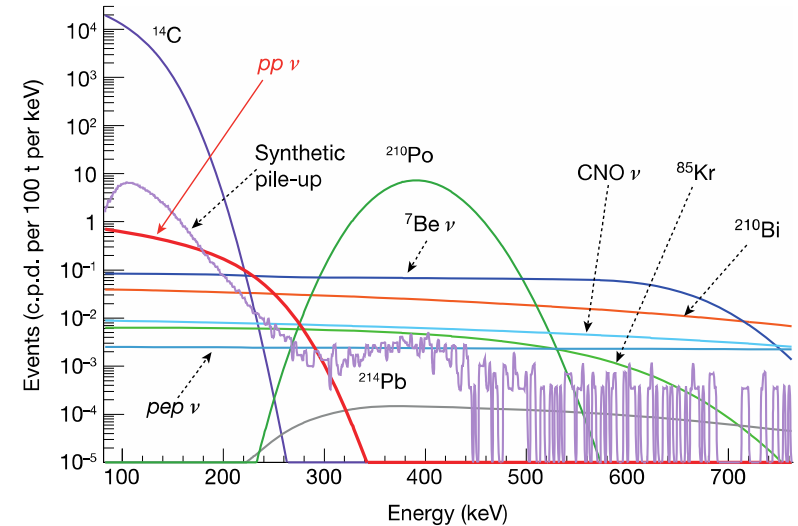
- DAMA/Libra: NaI
 - Reports annual modulation
- NaI
 - INFN/LNGS is going to support independent test of DAMA result: **SABRE**
- CRESST
 - CaWO_4 scint with bolometric r/o
- XENON family
 - Double phase liquid Xe TPC
- DarkSide
 - Liquid Ar TPC double phase



Neutrino Astrophysics

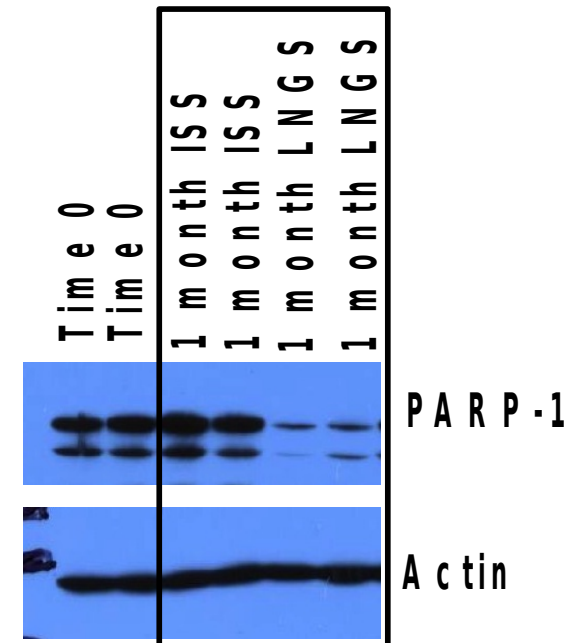
Nuclear Astrophysics

- LVD
 - SN neutrino observatory
- Borexino
 - real time observation of ^7Be and pp neutrinos
 - Next challenge: CNO neutrinos
- LUNA family
 - Measurement of x-sections relevant for star burning, stellar nucleosynthesis, primordial nucleosynthesis



LNGS General, Multidisciplinary

- **GINGER**
 - Ring-laser to probe Lense-Thirring effect
- **Cosmic Silence**
 - Study effect of very low radiation doses on cells, fleas, ...
 - Test Linear No Threshold model
- **ERMES-W**
 - Primary resources, global geodynamic...
- **VIP**
 - Test Pauli Exclusion Principle



Outreach & Education



- Up to 8000 visitors/year
- 1500-2000 visitors at LNGS open day
- 2016 European researcher's night with GSSI and UNIVAQ: 15,000 participants in L'Aquila
- Educational activities at several levels: from youngest to post-Doc and Physics teachers
- 3 education and high-education projects with Abruzzo Region on **EU funds 2007-2013: 5.4 M€**



Future

- LNGS beyond 2020: April 2015 meeting
 - Strong, challenging, engaging program for
 - Direct DM (WIMPs) searches
 - Neutrino-less Double Beta Decay
 - LUNA-MV program extends beyond 2030
- Invest on key techniques
 - Material screening
 - Crystals?
- Driving force for innovation
 - TT program connected with DarkSide20k

LNGS – 2020 and Beyond

A lively one-day meeting
on April 28, 2015

- <https://agenda.infn.it/conferenceDisplay.py?confId=9608>

Tuesday, 28 April 2015	
09:00 - 10:30	Introduction
09:00	INFN 30' Speaker: Antonio Masiero (INFN) Material: Slides
09:30	LNGS 30' Speaker: Stefano Ragazzi (LNGS) Material: Slides
10:00	INFN - What Next 30' Speaker: Francesco Terranova (LNF) Material: Slides
10:30 - 12:30	Double Beta Decay
10:30	Gerda Extended - 200 kg Ge experiment 40' Speaker: Bernhard Schwingenheuer (MPI Heidelberg) Material: Abstract Slides
11:10	Coffee break 10'
11:20	CUPID - Cuore Upgrade with Particle IDentification 40' Speaker: Stefano Pirro (LNGS) Material: Abstract Slides
12:00	Towards a large scale double beta decay experiment based on CdZnTe detectors (COBRA) 30' Speaker: Kai Zuber (TU Dresden) Material: Abstract Slides
12:30 - 13:10	Supernovae
12:30	A Future Lead-based Supernova Detector at LNGS 30' Speaker: Clarence Virtue (Laurentian University / SNOLAB) Material: Abstract Slides
13:10 - 14:30	Lunch ()
14:30 - 18:30	Dark Matter
14:30	CRESST - ideas on CRESST upscale 30' Speaker: Federica Petricca (MPI Munich) Material: Slides
15:00	Investigating DM With Directionality (DAMA et al.) - anisotropic crystals 40' Speaker: Riccardo Cerulli (LNGS) Material: Slides
15:40	NEWS - Nuclear Emulsion for Wimp Search 40' Speaker: Giovanni De Lellis (NA) Material: Abstract Slides
16:20	Coffee break 20'
16:40	DarkSide and Argo - DM and solar neutrino with Ar 40' Speaker: Dr. Cristiano Galbiati (LNGS) Material: Slides
17:20	XENON1T+ DARWIN-Lxe - DM and neutrinos with Xe 50' Speakers: Elena Aprile, Laura Baudis Material: Abstract Slides

LNGS & Innovation

- LNGS is a reference player in Regional S3 (Smart Specialization Strategy)
- Access to “Regional” funds for innovation
- Partnership with innovative regional companies
 - TT to regional companies in order to build up a major LNGS resource

Suggestions/warnings from 30 years of operation

Safety

- Safety is top priority. It includes
 - Occupational health and safety
 - Environmental protection
 - Safety of equipment and installation
 - Operational safety
- Address and periodically review all these aspects at design, execution, operational level
- There will be interactions and interferences at least with the highway system

Human Resources

- Take time for training and selecting them
- Good casting is essential for smooth operation

Users

- Users constitute the life of the RI
- Don't let them be its death
- Drive them through best practices

Under Ground Global Research Infrastructure

- Proposed by LNGS and SNOLAB following an initiative by the Group of Senior Officers of G8+5
- Now GSO is proposing to bring it to G20

- 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

Implement a coherent UG RIs strategy and vision
Facilitate networking and information exchange
between UG-labs that share common challenges:

- a. Robust experiment assignment protocols
- b. Common Safety and Risk assessment guidelines
- c. Maintenance and continuous upgrade
- d. Human resource management of permanent staff
- e. Share and Spread Best Practices
- f. Transnational access

Conclusion

UG-GRI will constitute for ANDES a great opportunity to take advantage from experience and best practices of existing UG RIs