



Laboratori Nazionali del Gran Sasso

Main LNGS characteristics

- Shielded by 1400 m of rock (3800 m.w.e.)
- Muons flux reduction $\sim 10^6$
- Surface: 17 800 m²
- Volume: 180 000 m³
- 3 main experimental Halls (approx. 100 m length, 20 m width, 18 m height)
- Air ventilation: 1 volume / 3 hours
- Easy access directly through the A24 highway
- Long history and experience (this year we will celebrate 35 years since the birth of the lab)
- Wide variety of support services for the experimental researches



Neutrino astrophysics

- Solar neutrinos
- Geo-neutrinos
- Supernova neutrinos

Neutrino properties

- Neutrinoless Double Beta Decay
- Relic neutrinos

Dark Matter

- WIMPs direct searches

Nuclear Astrophysics

- Astrophysical nuclear reactions

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Nuclear Astrophysics

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Tests on quantum mechanics

- Electron decay
- Violation of Pauli principle

Radiobiology

- Biological effects from low radioactivity environments

Geophysics

- Earthquakes monitoring and study
- Analysis of water resources

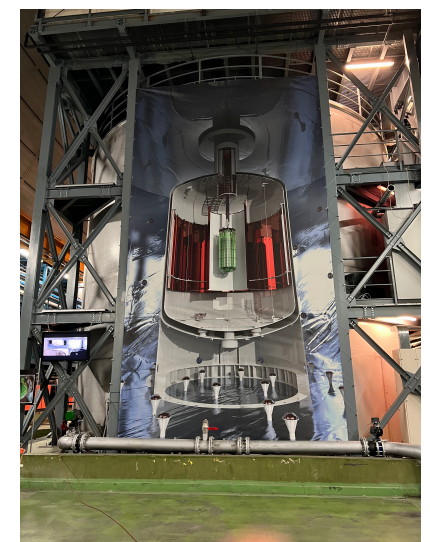
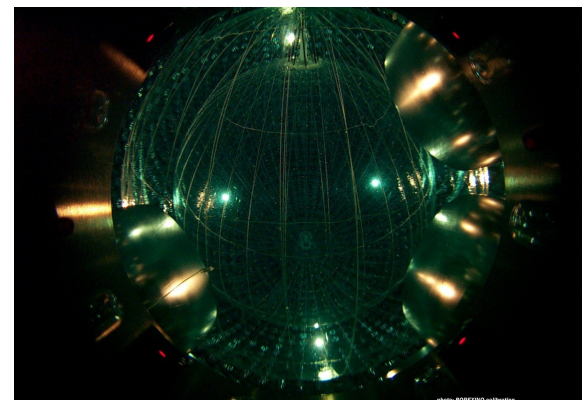
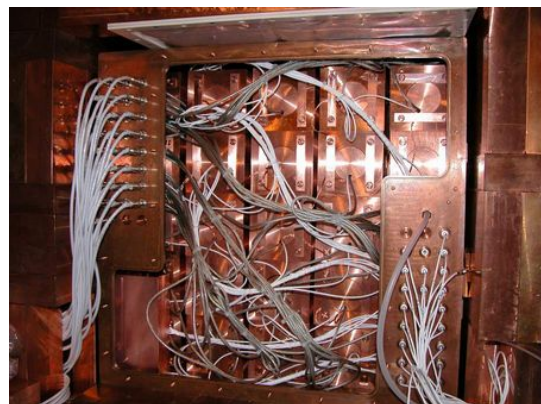
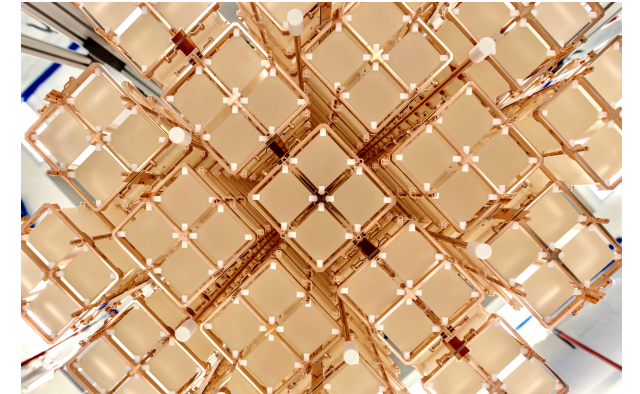
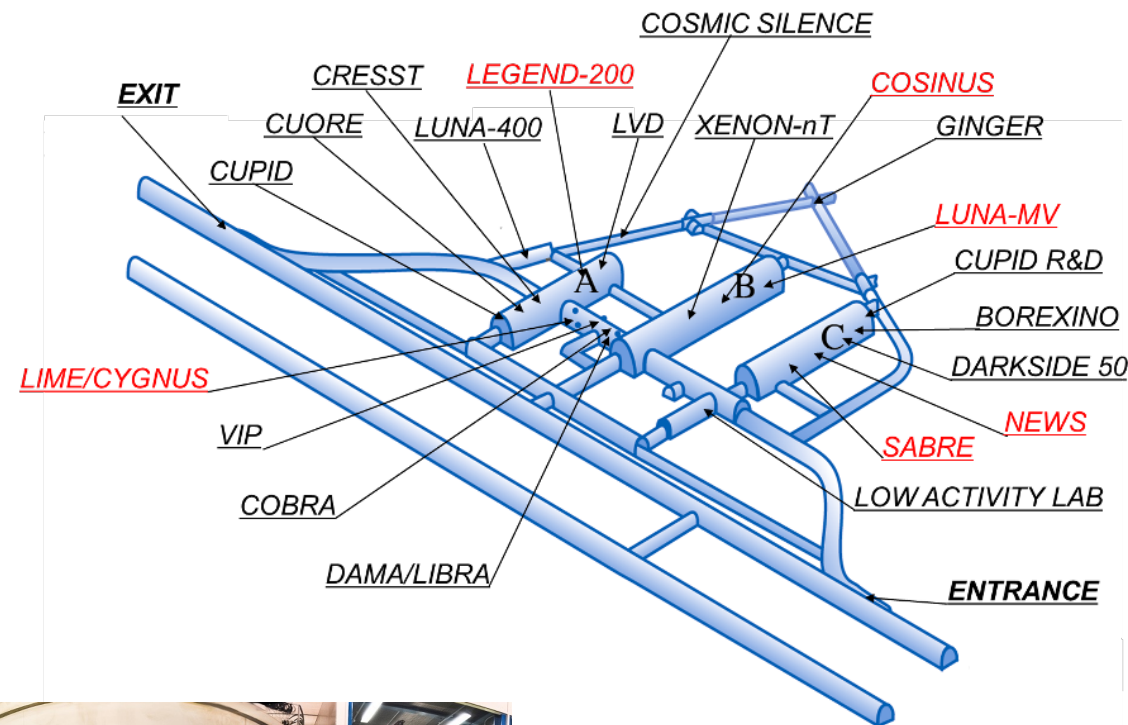
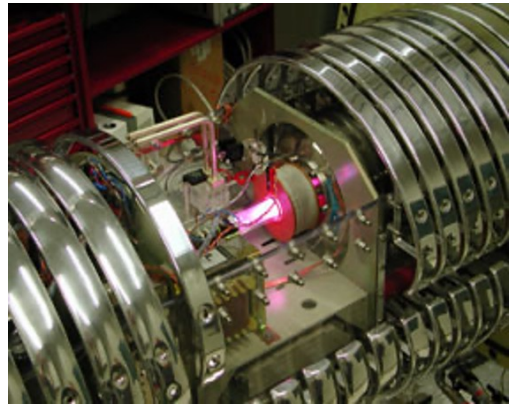
Ultra-pure materials

- Low-radioactivity material screening
- Cultural heritage samples analysis
- Additive manufacturing

Experiments

Presently 22 experiments in data taking or under construction

- Borexino & LVD in decommissioning phase



Experiments

Neutrinos: BOREXINO, COBRA, CUORE/CUPID, GERDA/LEGEND, LVD

Dark Matter: CRESST, COSINUS, DAMA/LIBRA, DARKSIDE, XENON

Nuclear Astrophysics: LUNA-MV, LUNA-400

Fundamental physics and multidisciplinary activities: COSMIC SILENCE, GINGER, VIP

R&D programs: CYGNO, NEWS, PTOLEMY, SABRE



External labs

- Directorate
- Offices and meeting rooms
- Cafeteria and canteen
- Administration
- Technical Division
- Assembly and test Halls for large equipments
- Mechanical workshop
- Chemistry service
- Computing service
- Cryogenic service
- Electronics workshop



Personnel and Users

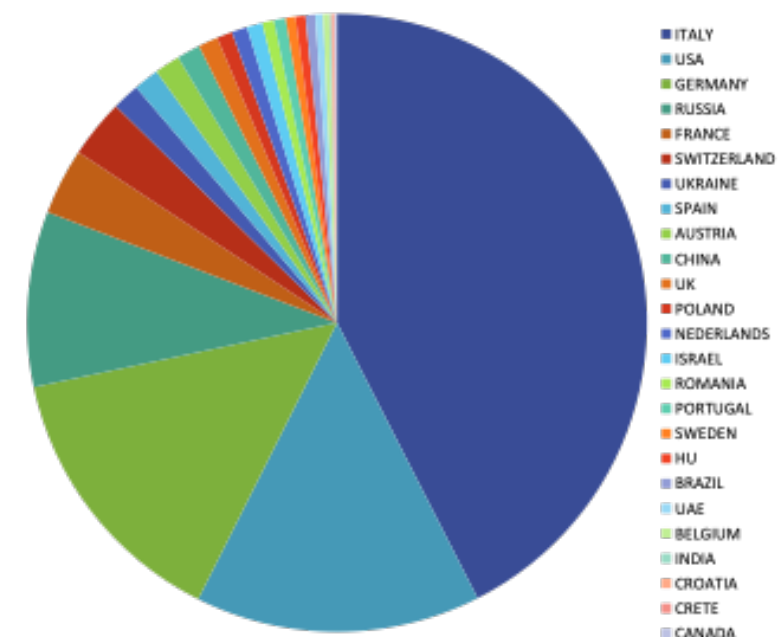
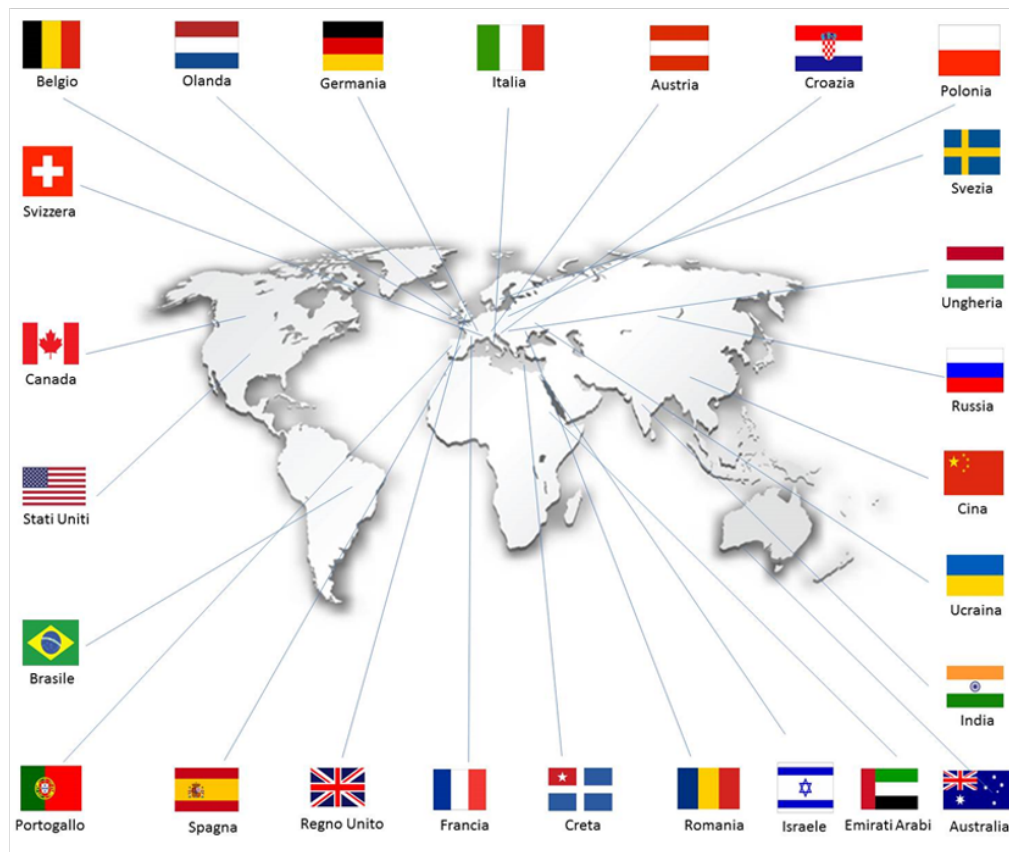
Personnel

- 110 Staff members (permanent or fixed-term)
 - 14 Researchers
 - 35 Technologists
 - 38 Tecnicians
 - 23 Administrative
- 95 associated members
 - Belonging also to University of L'Aquila and Gran Sasso Science Institute
 - Includes also undergraduate and PhD students

Users (2019)

- 981 users
 - 25 nations
 - 417 Italian users
 - 564 Foreign users
- Despite the pandemic outbreak
 - 444 users in 2020 (245 Italians)
 - Several experiments continued the data-taking (Borexino, CUORE, etc.)
 - Some experiments continued the installation (LEGEND-200, XENON-nT)

Restrictions due to pandemic are reduced and we are again (almost) fully operational



LNGS upgrades

The excellence of the lab is strictly connected with the quality of the provided support

- A medium-long term strategy is fundamental to identify the priorities for the experiments; those priorities have an impact on the needed supports
- The LNGS lab is ~35 years old: needs modernisations in various parts
- We are working on several upgrades and renovations with the aim of maintaining a high-level support

Material screening

STELLA (SubTERRanean Low Level Assay)

15 HPGe detectors

- 11 p-type coaxial detectors, all LB or ULB
- 1 ULB well-type detector
- 1 BEGe ULB detector
- 1 multiple p-type crystal ULB detector
- 1 n-type LB detector

Alpha spectrometers

Liquid scintillator counters

Sensitivity (Th/U)

- commercial LB detectors $O(\text{mBq/kg})$
- commercial ULB detector $O(0.5 \text{ mBq/kg})$
- custom ULB detector $O(10\text{-}50 \mu\text{Bq/kg})$

STELLA upgrade underway

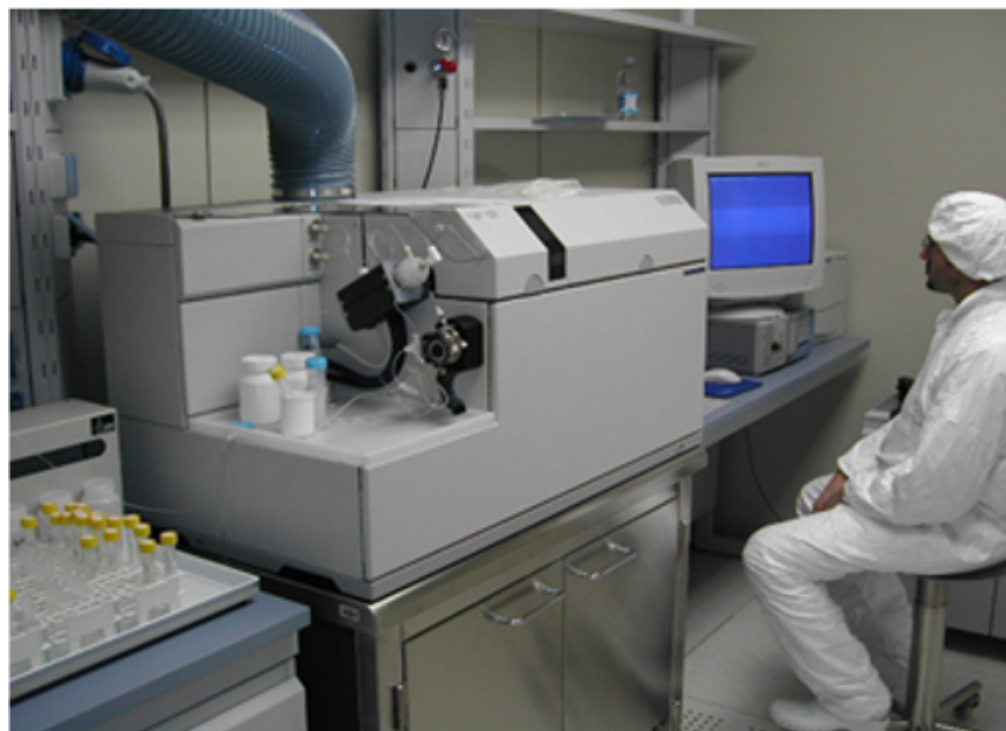
- new HPGe detectors with improved sensitivities
- Agreement between INFN-LNGS and BMBF



Activities

- material screening for LNGS experiments
- small fundamental physics research projects
- meteorite measurements
- environmental radioactivity
- CELLAR (Collaboration of European Low-level underground LABoratories)

Material screening



Chemical labs for Ultra-Trace Analysis equipped with

- Clean Room ISO6
- Chemical equipment for treatments and preparation of samples
- Magnetic Sector ICP-MS
- TIMS for isotopic measurements
- New ICP-MS quadrupole
- New Laser Ablation ICP-MS (Agreement between INFN-LNGS and BMBF)

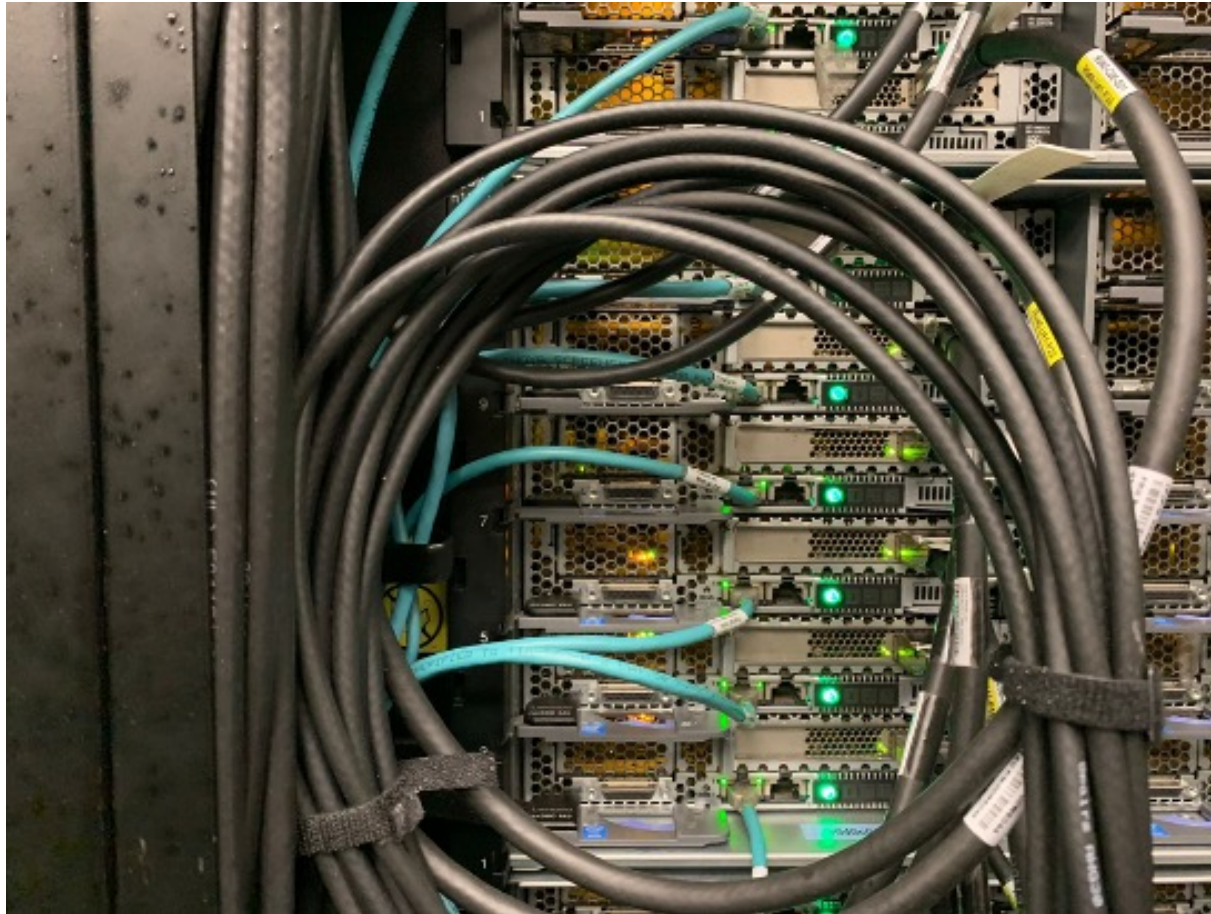
Sensitivity (Th/U)

- few $\mu\text{Bq/kg}$



High Performance Computing

HPC4DR (High Performance Computing for Disaster Resilience)



A cluster of 400 servers has been recently installed

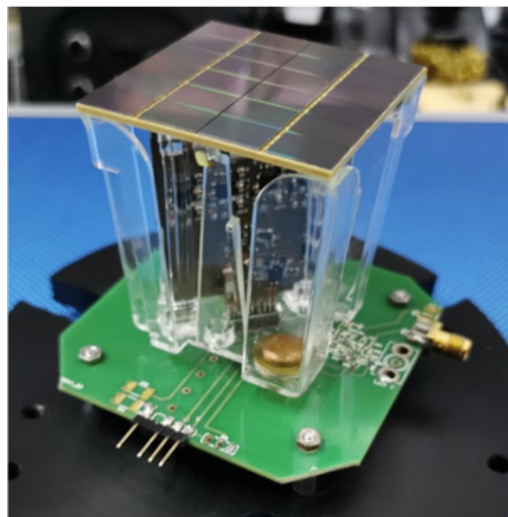
- multicore processors Intel Xeon E5-2697 v4 (Broadwell)
- Interconnection via a high speed network at 100Gb/s
- high computing power

Goals

- provide computing resources to Universities and Research Institutions of Abruzzo, Marche e Molise, in order to increase, through computational methods and data analysis, the resilience of local systems to natural disasters
- improve the computing power for LNGS experiments

NOA (Nuova Officina Assergi)

- Large (450 m²) Clean Room suitable for Radon-free operation
- Equipped for photodetector assembly
 - Cryo-probe
 - Dicing
 - Flip-chip
 - Wire bonding
- Construction underway



Advanced Cryogenics

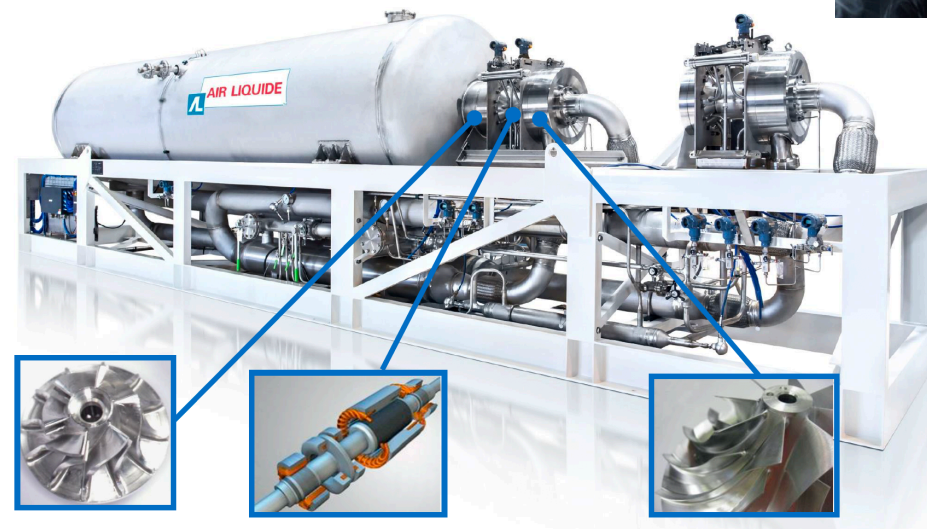
Nowadays most experiments @ LNGS utilise cryogenic technologies

- wide range of temperature (from ~ 165 K down to 0.005 K)
- 6 dilution refrigerators presently underground, more in the future
- increased need of cryogenic and vacuum support
- some projects planned to enlarge the cryogenic equipment



LN₂ liquefier & re-liquefier

- will cover the needs of DarkSide and LNGS
- Large power (40 kW @ 68 K)



New LHe liquefier

- Support to the “wet” dilution fridges
- Production rate ~ 20 liters/hour

Testing facilities at “high” temperature

- Pulse Tube based
- Characterisation of materials and devices down to ~ 3 K



Cryo-platform

A new cryogenic setup conceived to perform measurements of detectors and devices at very low Temperature

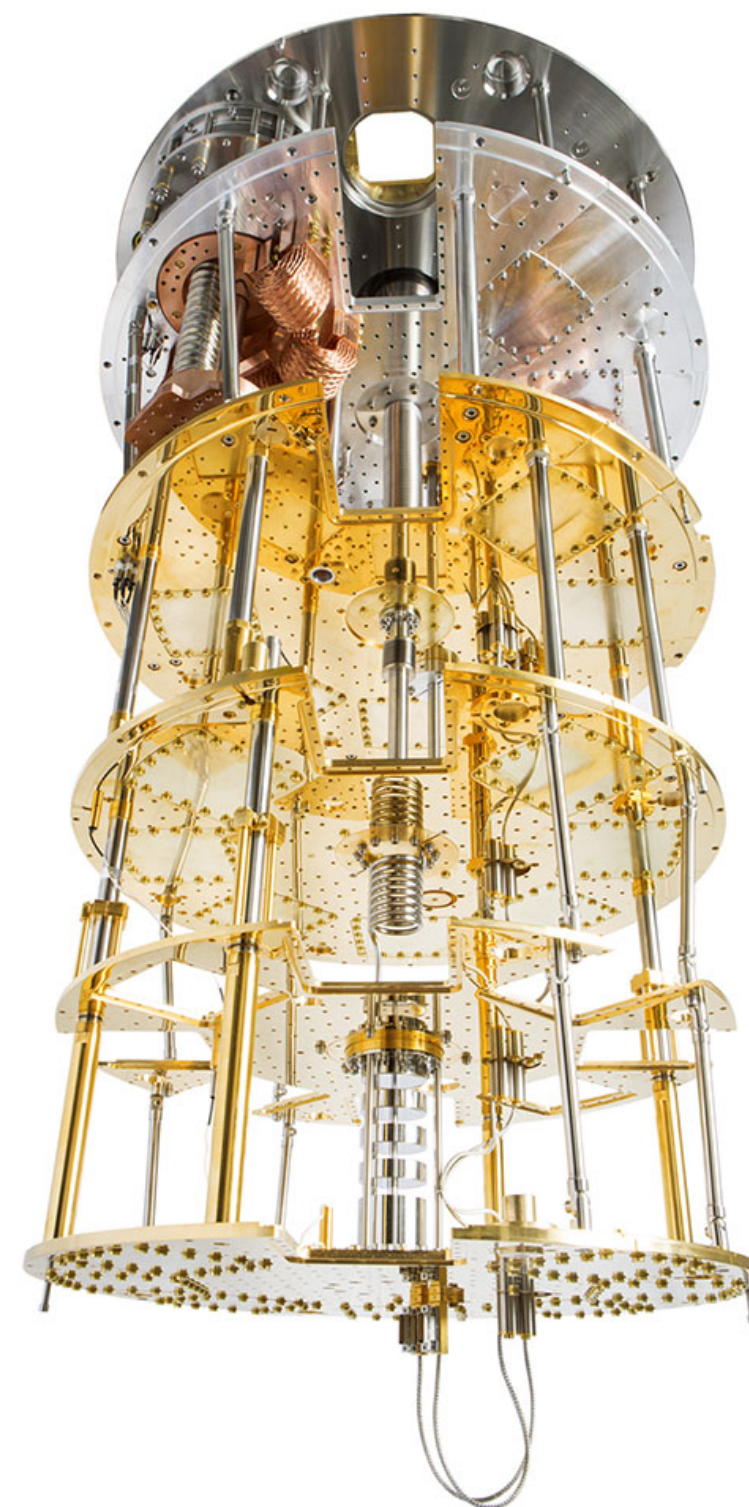
- dry $^3\text{He}/^4\text{He}$ dilution refrigerator
- Large experimental space: \varnothing 50 cm, h 75 cm
- Base temperature < 10 mK
- Low radioactivity & low vibration environment
- Funded by INFN, BMBF and SQMS

Useful for low-background tests of

- Cryogenic detectors equipped with TES, NTD, ...
- Qubits

The Cryo-Platform facility will be available in 2023

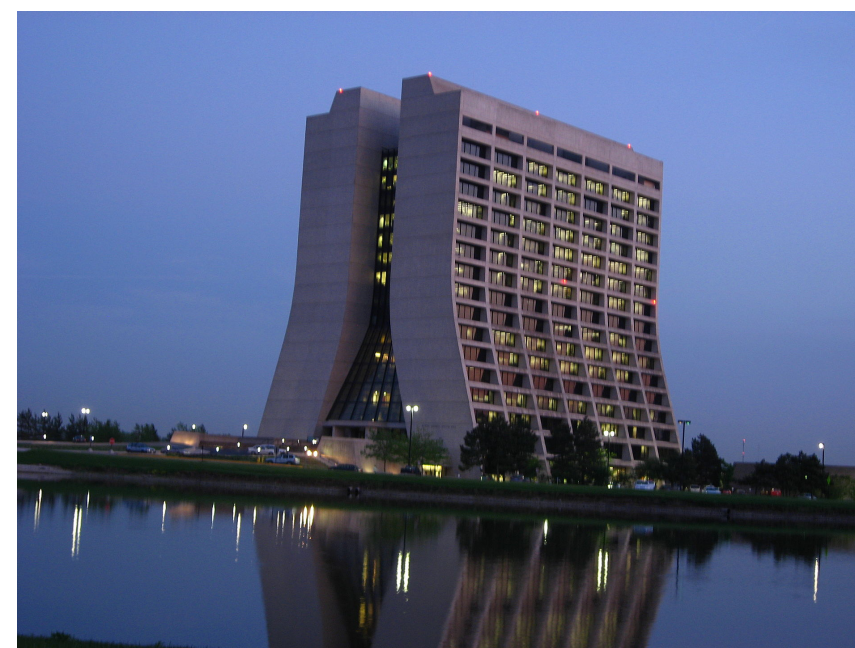
- Access procedures regulated by a PAC



Quantum Computing

In the last few years there is an increasing interest and numerous R&D addressed at Quantum Computing

- The groups which developed low temperature detectors have the same expertise (low temperature, low vibration, low noise, ...)
- There are evidences that cosmic rays and radioactivity have some impact on the coherence time of superconducting qubits
- Can ULs become reference centers for quantum computer development?
- INFN is the only non-US partner of the SQMS (Superconducting Quantum Materials and Systems Center) project
- Some measurements are already going on in a small dilution fridge at LNGS (Yeti)
- In the future we plan to test large qubit arrays in the Cryo-platform



Educational Laboratories



“Anch’io scienziato” contest

15^a Edizione

I Laboratori Nazionali del Gran Sasso

in collaborazione con
l'AIIF - Associazione per l'insegnamento della Fisica - Sez. di L'Aquila
bandiscono, per l'anno scolastico 2017-2018

il Concorso
Anch'io Scienziato
riservato agli studenti degli istituti di ogni ordine e grado d'Abruzzo

Siete affascinati dal mondo della scienza?
Vi lasciate incuriosire dal mondo della ricerca?
Vorreste diventare scienziati per un po'?
Il concorso "Anch'io Scienziato" è ciò che fa per voi!

CHI può partecipare
Il concorso, aperto a classi, gruppi o singoli studenti, consiste nella realizzazione di lavori scientifici a tema libero. I lavori potranno riguardare progetti, macchine, immagini, esperienze o risultati di esperimenti e dovranno essere accompagnati da una relazione in formato dattiloscritto o multimediale e di una bibliografia.

COME partecipare
Per partecipare è necessario compilare la scheda di adesione scaricabile al sito <https://www.lngs.infn.it/concorsi-per-scuole> entro il 12 aprile 2018 e inviarla alla segreteria del concorso via mail all'indirizzo: concorso-scientista@lngs.infn.it

DOVE inviare i progetti
I progetti completi e definitivi dovranno essere spediti all'indirizzo mail concorso-scientista@lngs.infn.it qualora si trattasse di elaborati che è possibile spedire per via telematica, oppure, a carico del proponente, per posta ordinaria all'indirizzo **Laboratori Nazionali del Gran Sasso - Via Giovanni Agnelli, 22 - 67100 Assergi (AQ)**, entro il 24 aprile 2018. Ogni singolo progetto non potrà essere presentato da più di 30 alunni.

QUANDO avverrà la premiazione
Per ogni ordine di scuola saranno premiati i primi 5 progetti classificati. La Commissione valuterà i progetti in base all'originalità, la forma espressiva e la riproducibilità di un eventuale esperimento scientifico. I vincitori saranno proclamati e premiati durante la giornata dell'Open Day del Laboratorio prevista per la fine del mese di maggio 2018. Importante: la comunicazione dei vincitori avverrà solo ed esclusivamente via mail. Pertanto si invita ad indicare nella scheda di adesione, in modo leggibile, un indirizzo mail dell'istituto scolastico e che quest'ultimo venga controllato periodicamente da chi ha inoltrato la domanda.

Premio speciale
La Commissione si riserva di assegnare un premio speciale sul tema: "Riciclamo, riutilizziamo, risparmiamo" e per lavori sperimentali ritenuti originali. I lavori saranno esposti per tutta la durata della manifestazione Open Day e potranno essere restituiti, a partire dal giorno seguente, entro e non oltre i 10 gg. successivi.

PREMI per le SCUOLE
I primi 5 progetti classificati, di ogni ordine di scuola, riceveranno come premio una GIFT CARD da spendere presso negozi di elettronica.

Segreteria del Concorso:
concorso-scientista@lngs.infn.it - tel. 0862 437205 - fax 0862 437559
Per maggiori informazioni ed aggiornamenti relativi al concorso, consultare il sito: www.lngs.infn.it/concorsi-per-scuole

AIIF Associazione per l'insegnamento della Fisica Sez. di L'Aquila

Open Day & Sharper



Visits



Conclusions

We are working to refurbish and improve the LNGS infrastructure in order to provide always the best support for research

- I didn't mention many planned interventions mainly on the technical infrastructure (Additive manufacturing, Power distribution, UPS, HVAC, Network, Safety, ...)

Besides, and to some extent regardless of the outcome of the APOGEIA proposal, it is crucial and beneficial for all the ULs to:

- Establish a strong collaboration between EU-ULs
- Develop a coordinated multidisciplinary strategy