



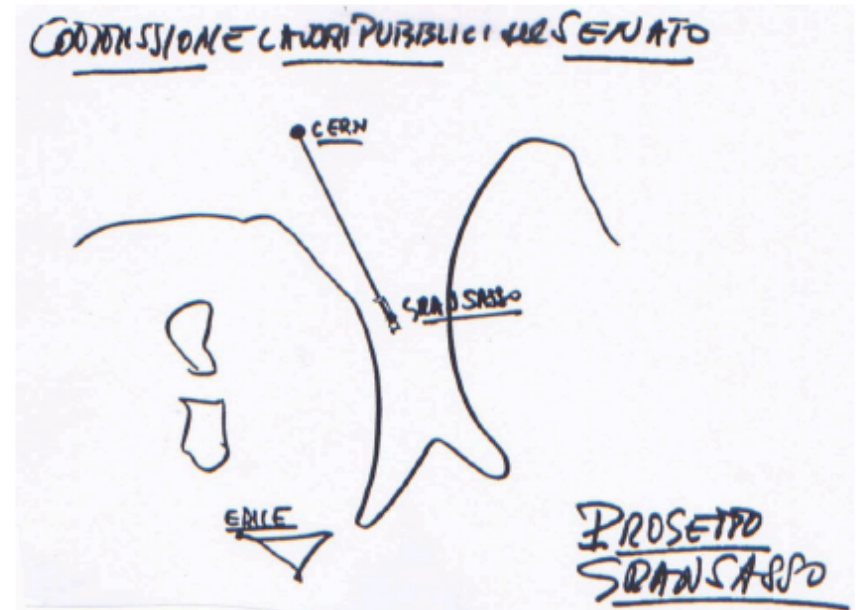
Laboratori Nazionali del Gran Sasso

Stefano Ragazzi

ECFA Meeting June 30, 2016

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).

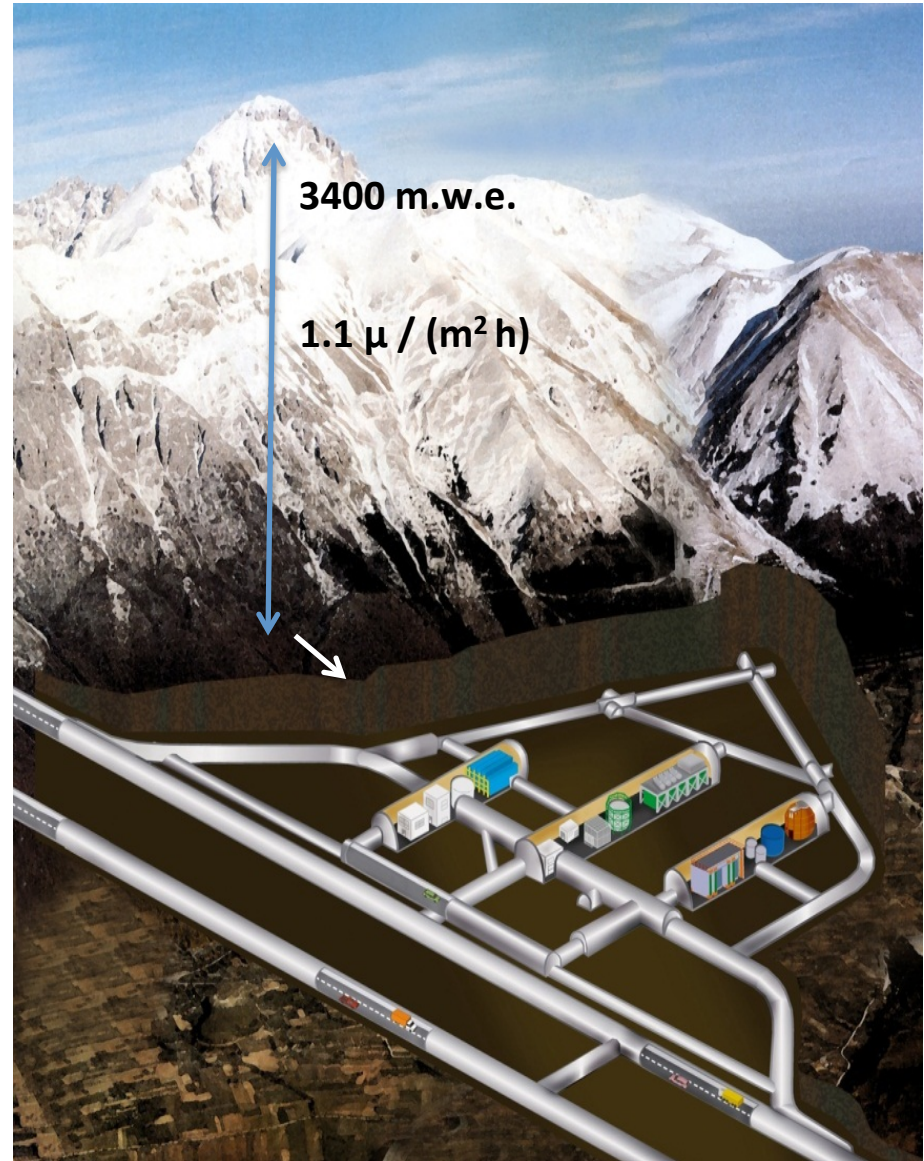
To summarize, the scientific aims of the "Gran Sasso" laboratory are the study of:

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

Not only
 $\tau_p \neq 0$

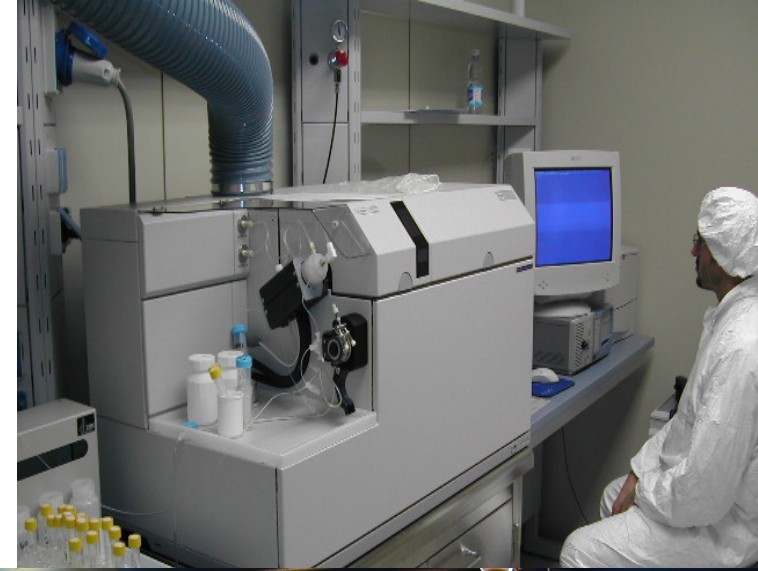
Laboratori Nazionali del Gran Sasso

- 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

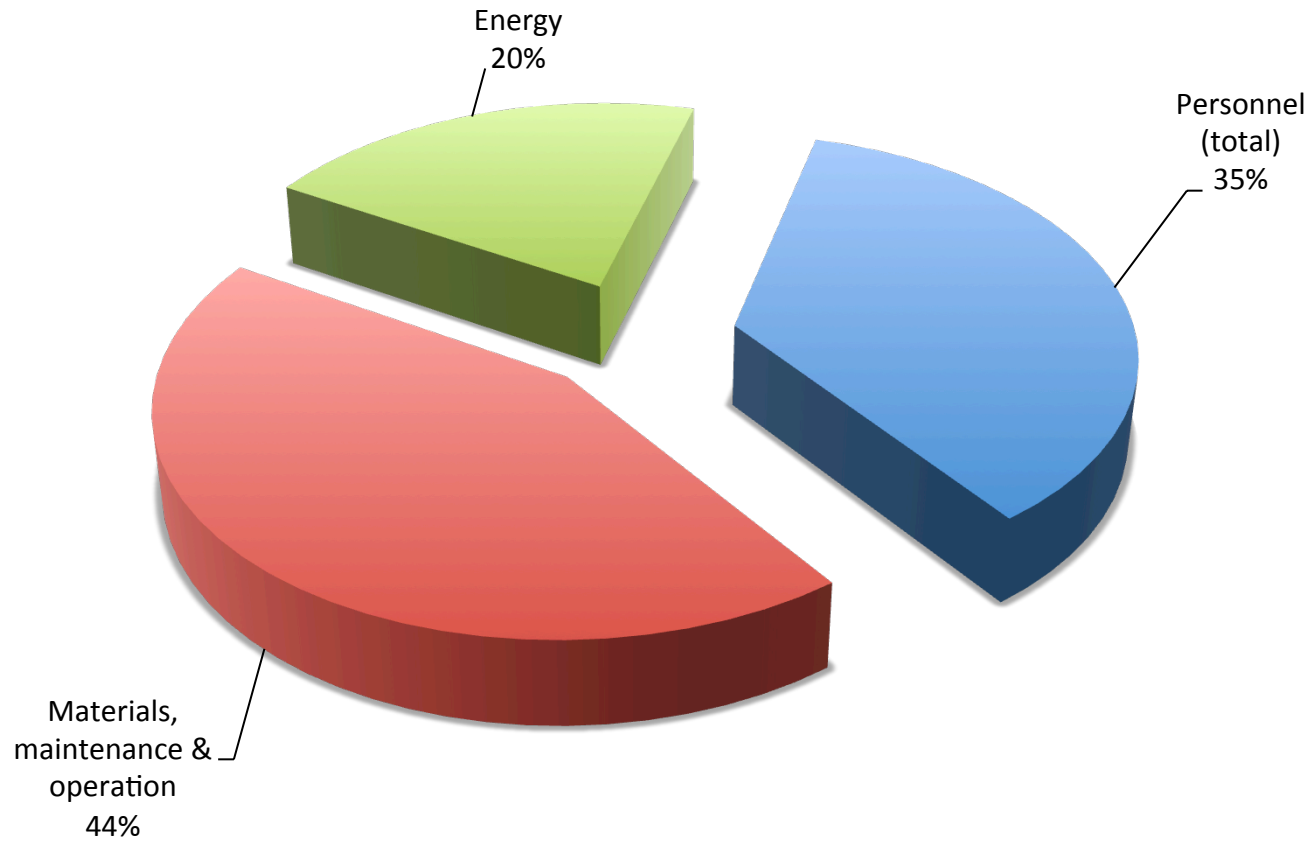
- Open access, excellence driven
- Proposals are peer-reviewed by the **Scientific Committee**
- International **Scientific Committee** :
 - Present composition: 9 members, 3 of them from Italian Institutions
 - Chair: Ken Peach till Sep. 23, Tatsuya Nakata Sep. 24
 - Recommends proposals for approval, monitors progress of experiments

Personnel & Costs

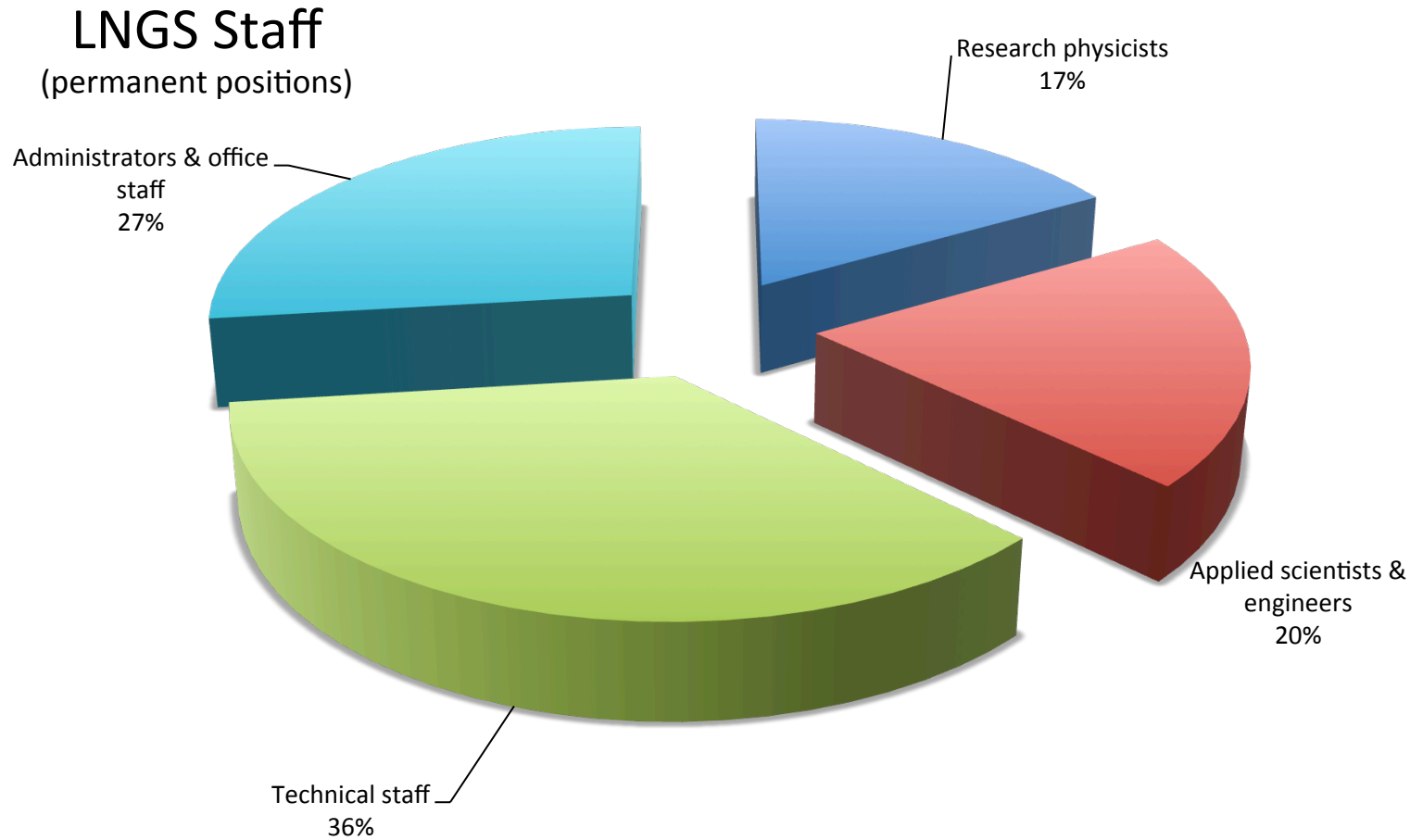
- 102 Staff (unlimited + limited time contracts)
fellowships excluded
- Average daily presence in 2014: ~ 250 people
- Costs
 - 4.7 M€/y Personnel
 - 8.0 M€/y maintenance & operation

LNGS costs

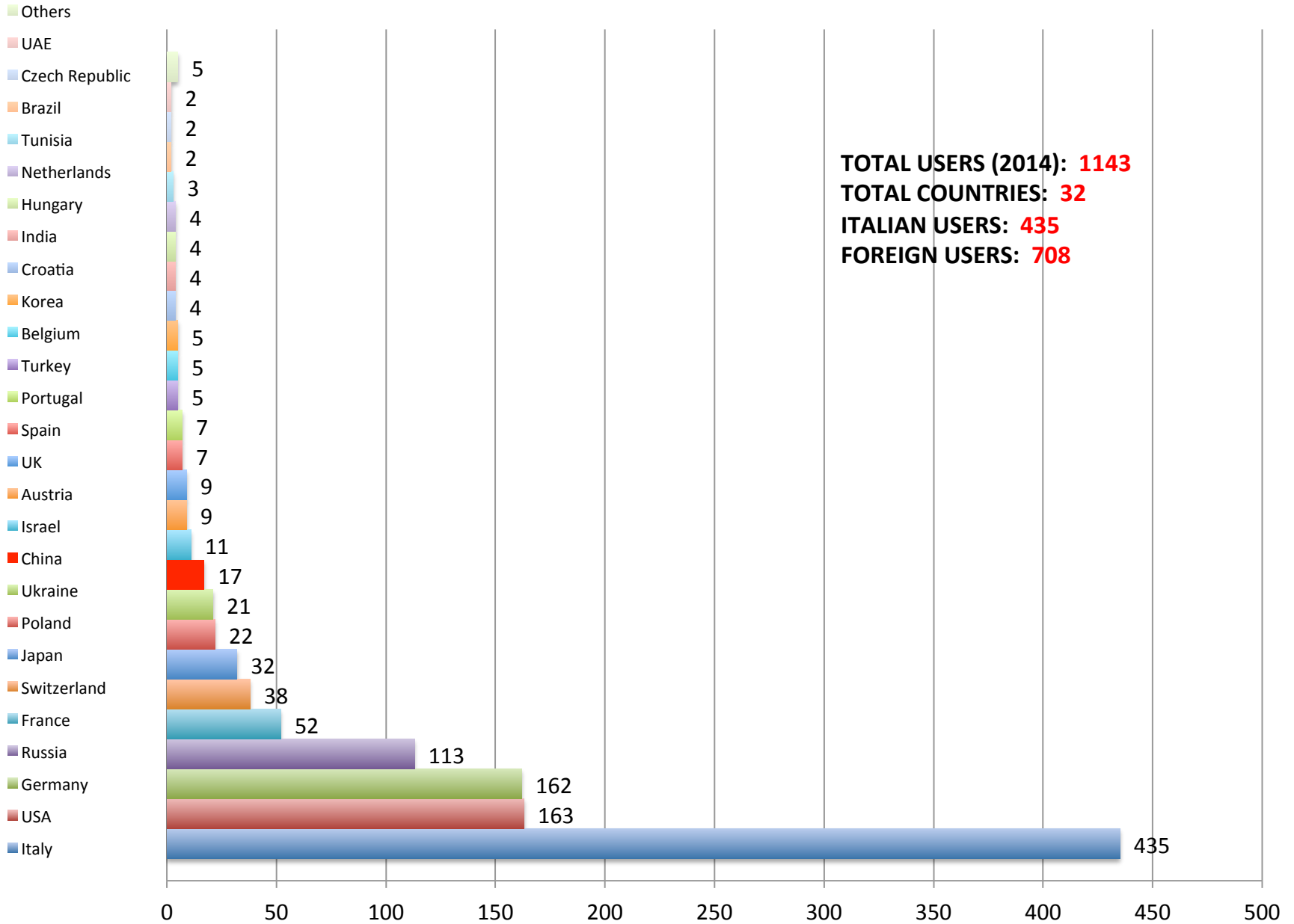
LNGS Costs



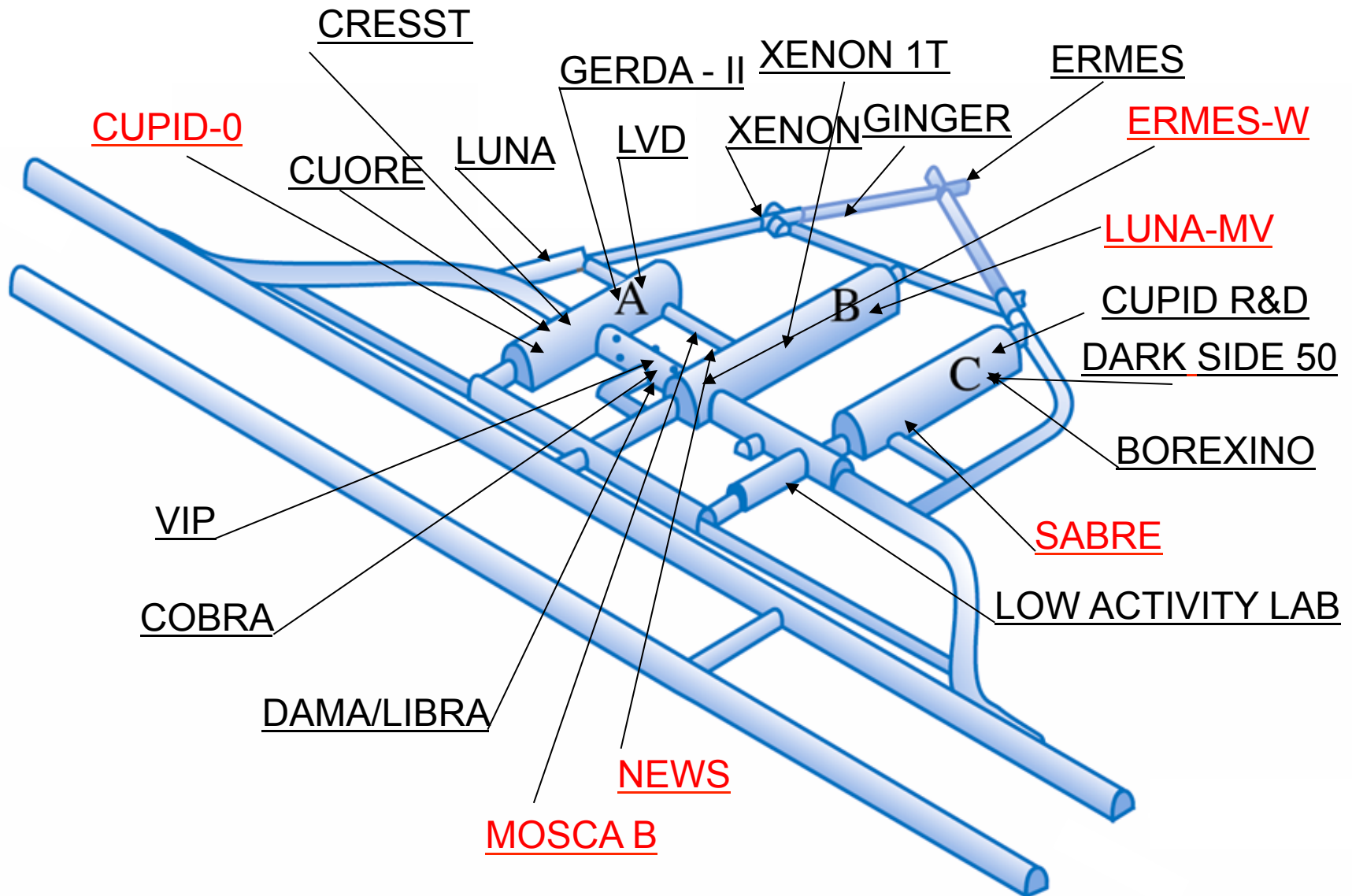
LNGS staff



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!1sU33rehgicSpsBNVVJXXT_w!2e0!3e5

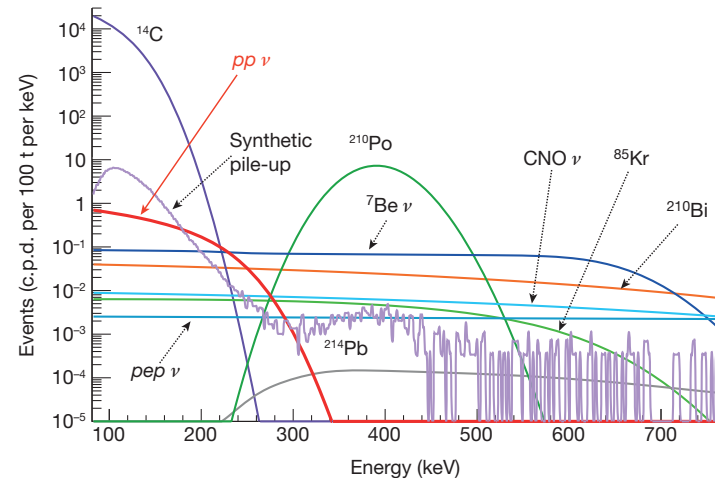


LNGS main research activities

- Neutrino Astrophysics
- Neutrino Physics
- Dark Matter searches: particle physics, astrophysics, cosmology
- Nuclear Astrophysics:
 - Study of Nuclear reactions relevant to Big Bang Nucleosynthesis and Star Nucleosynthesis

LNGS Neutrino

- SN neutrino:
 - LVD 1 kton liquid scint. Waiting for SN since 1992
- Solar Neutrino:
 - Borexino: real-time measurement of pp neutrino, ..., Geo-neutrinos
- Double Beta Decay
 - Gerda / Gerda-II: ^{76}Ge
 - **CUORE** – *the coldest m^3 in the world* : ^{130}Te
 - Cobra: ^{116}Cd
 - LUCIFER: R&D phase on crystals
- Sterile Neutrino
 - Borexino-SOX (CeSOX first)

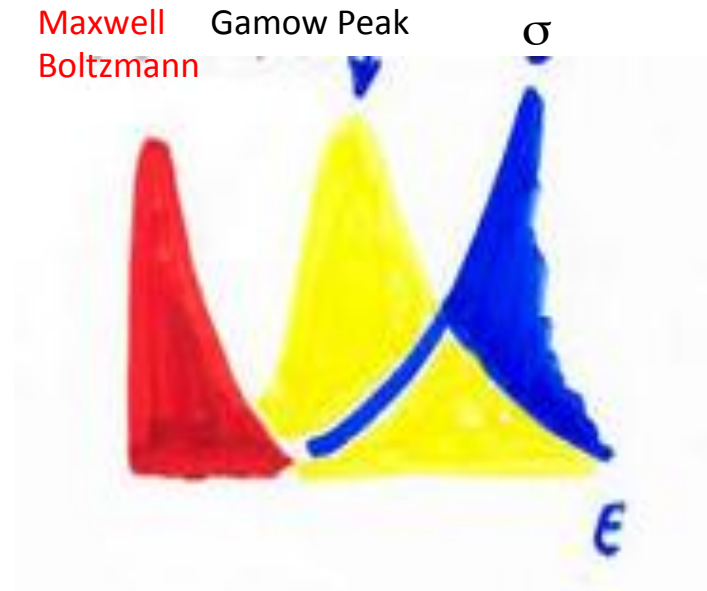


LNGS Dark Matter

- 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



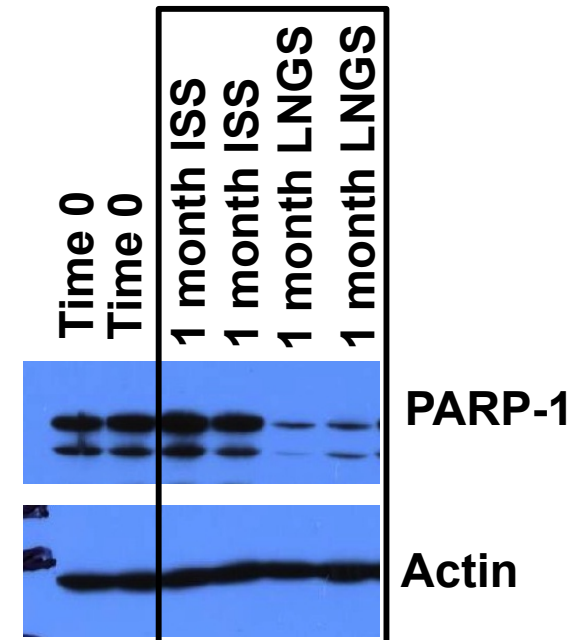
LNGS Nuclear Astrophysics



- LUNA-400 – LUNA-MV
 - Measurement of small x-sections relevant to star and primordial nucleosynthesis
 - LUNA-MV upgraded with intense C-beam

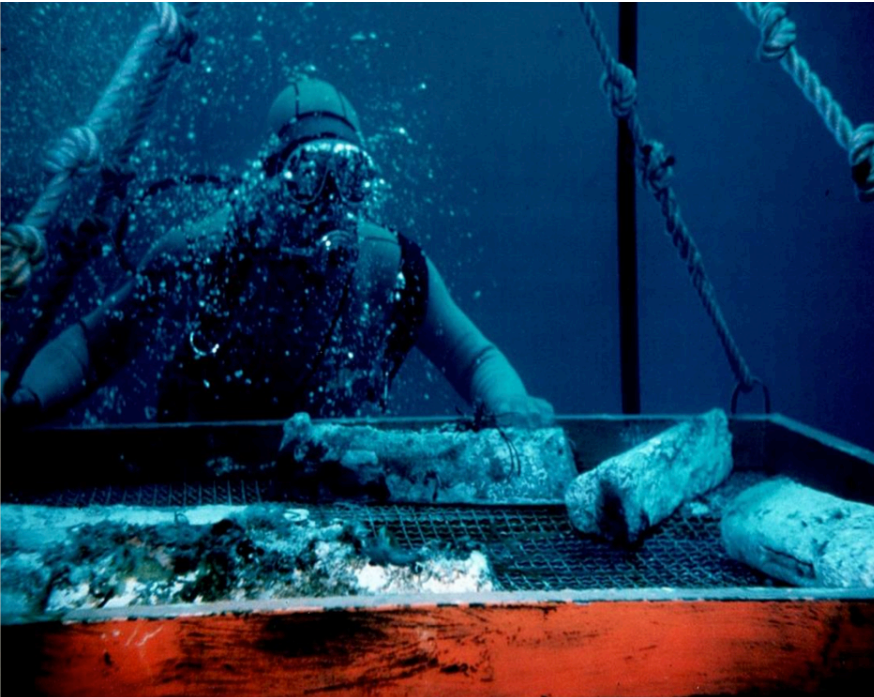
LNGS General, Multidisciplinary

- **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



Physics & Archaeology

AKA: 2000 Years Old Low Radiation Technologies



A couple of hundred ingots
for the CUORE shielding



^{210}Pb free (22.3 y half-life)

2000 y shielded by sea water

LNGS – 2020 and Beyond

A lively one-day meeting
on April 28

- [https://agenda.infn.it/
conferenceDisplay.py?
confId=9608](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 Schwingerheuer (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 > 2020

- 28 April 2015
 - Strong, challenging, engaging program for
 - Direct DM (WIMPs) searches
 - Experimental program of 3rd generation DM experiments will include precision measurements of solar neutrinos
 - Neutrino-less Double Beta Decay
- + LUNA-MV program, which extends beyond 2030

Outreach & Education



- 8000 visitors/year
- 1500-2000 visitors at LNGS open day
- 2014 European researcher's night with GSSI and L'Aquila University: 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€**



Synergy with GSSI

- GSSI: Doctoral School in L'Aquila recommended by OECD for after-quake recovery



The international PhD school *Gran Sasso Science Institute* has started its educational and scientific activities in 2013, and has been established as a *new Italian University* on June 2016



4 courses:

- *Astroparticle Physics*
- *Mathematics in Natural, Social and Life Science*
- *Computer Science*
- *Urban Studies*

36 PhD students selected in the first year 2013-2014

40 PhD students selected for the second year 2014-2015

40 PhD students selected for the third year 2015-2016

Also appointed: 28 Post-docs with two-years research grants

Director: E. Coccia

Coordinators: F. Vissani (INFN), P. Marcati (L'Aquila), R. De Nicola (IMT) , A. Calafati (Ancona).

Scientific Committee: F. Barca (MEF, Italy, Chair); R. Barbieri (SNS, Italy); B. Barish (Caltech, USA); S. Iammarino (London School of Economics, UK); A. Quarteroni (EPFL, CH); A. Sangiovanni Vincentelli (Berkley, USA).

LNGS & Innovation

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