

# Gran Sasso Hands-on 2023

PhD autumn school on experimental astroparticle physics



G

S

GRAN SASSO  
SCIENCE INSTITUTE

S

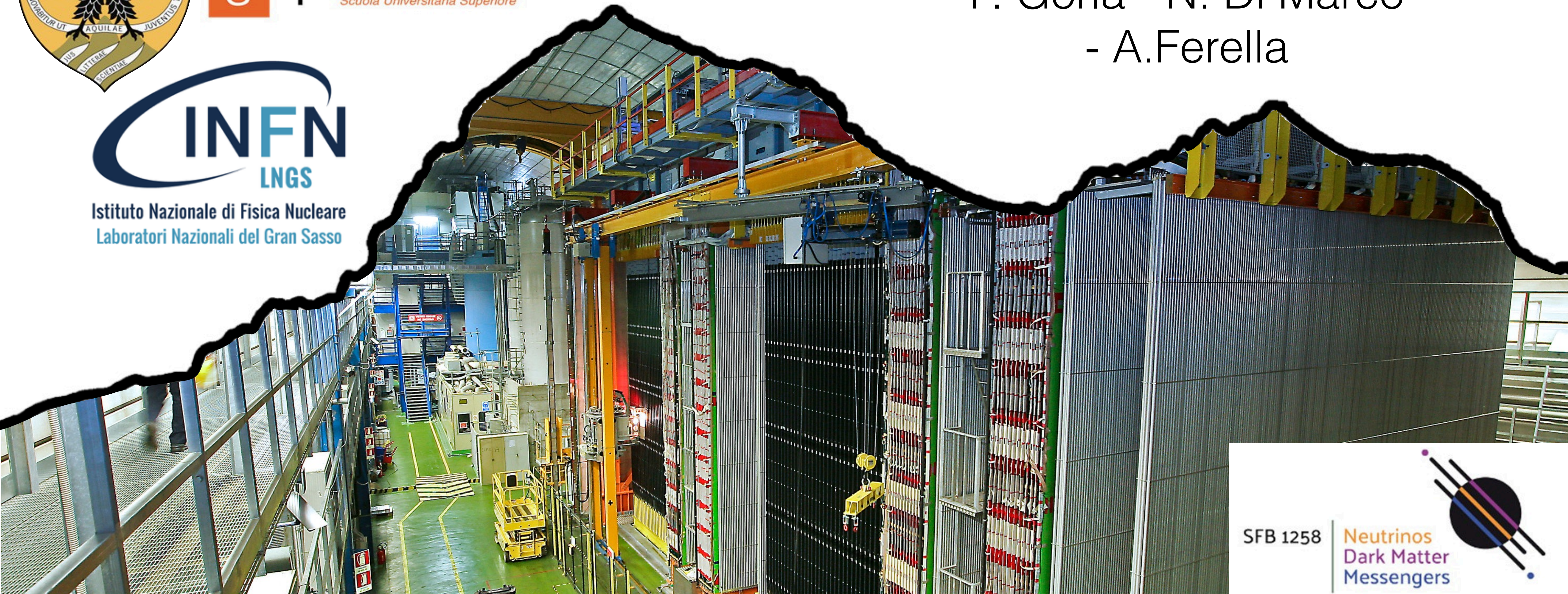
I

SCHOOL OF ADVANCED STUDIES  
*Scuola Universitaria Superiore*



Istituto Nazionale di Fisica Nucleare  
Laboratori Nazionali del Gran Sasso

P. Gorla - N. Di Marco  
- A. Ferella



SFB 1258

Neutrinos  
Dark Matter  
Messengers



# Gran Sasso HANDS-ON

Gran Sasso Hands-on 2023 is an autumn school offering PhD students the unique opportunity of being directly involved in the research project activities at the Laboratori Nazionali Gran Sasso of INFN (LNGS), the world-leading laboratory for underground physics, astroparticle physics, and nuclear astrophysics.

The school is jointly organized by LNGS, the Physics and Chemistry Department of L'Aquila University (DSFC - Univaq), and the Gran Sasso Science Institute (GSSI), with the contribution of the Technical University of Munich (TUM).



# LABORATORI NAZIONALI del GRAN SASSO of INFN

- In the last 35 years, LNGS has been the largest underground site for astroparticle physics worldwide.
- Its unique combination of technology, infrastructure, location, accessibility, and scientific community, made LNGS attractive to thousands of scientists from all around the world.
- The experimental achievement obtained from LNGS experiments deeply contributed to unveiling some of the most puzzling problems in the universe formation and evolution.



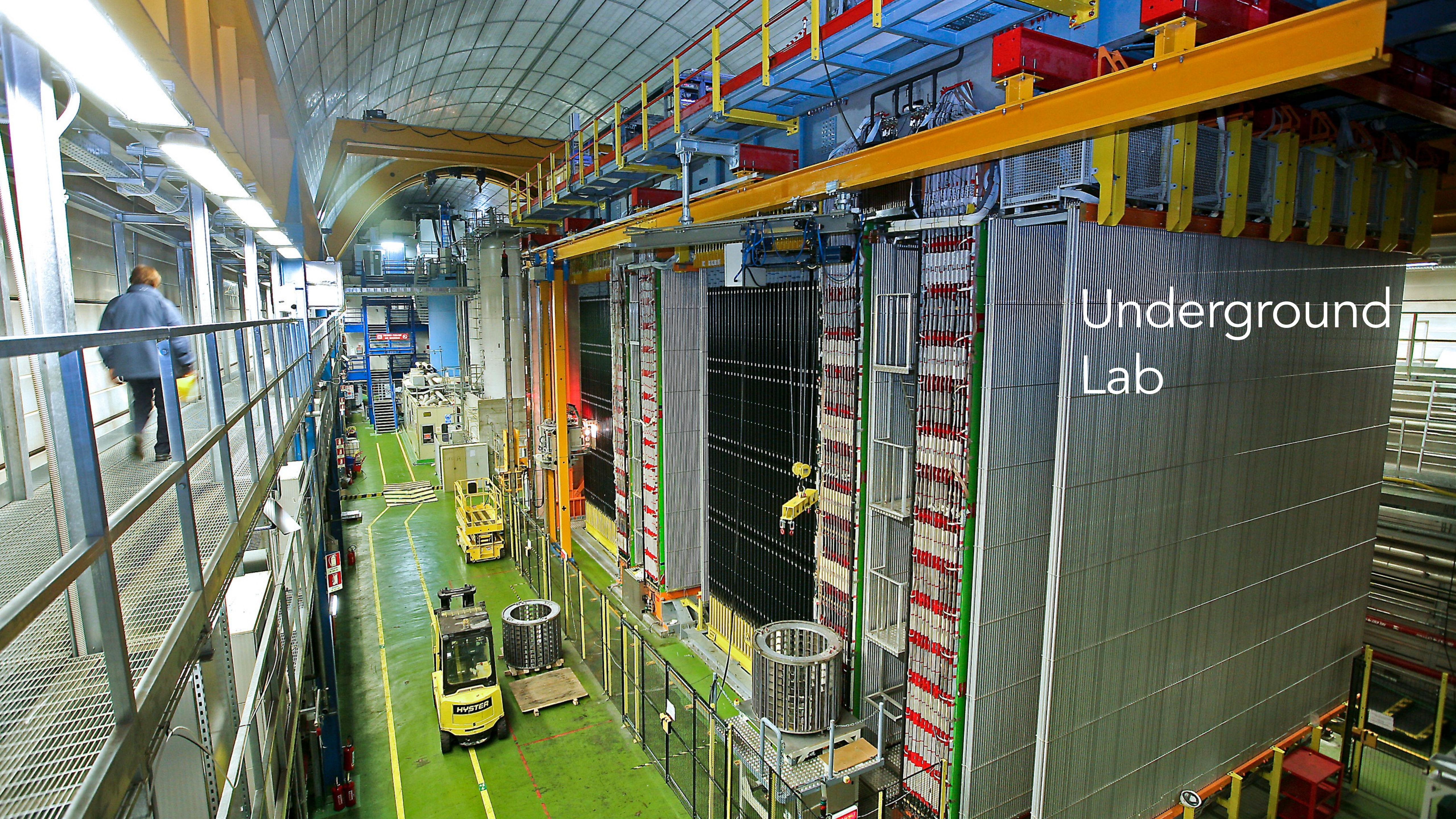




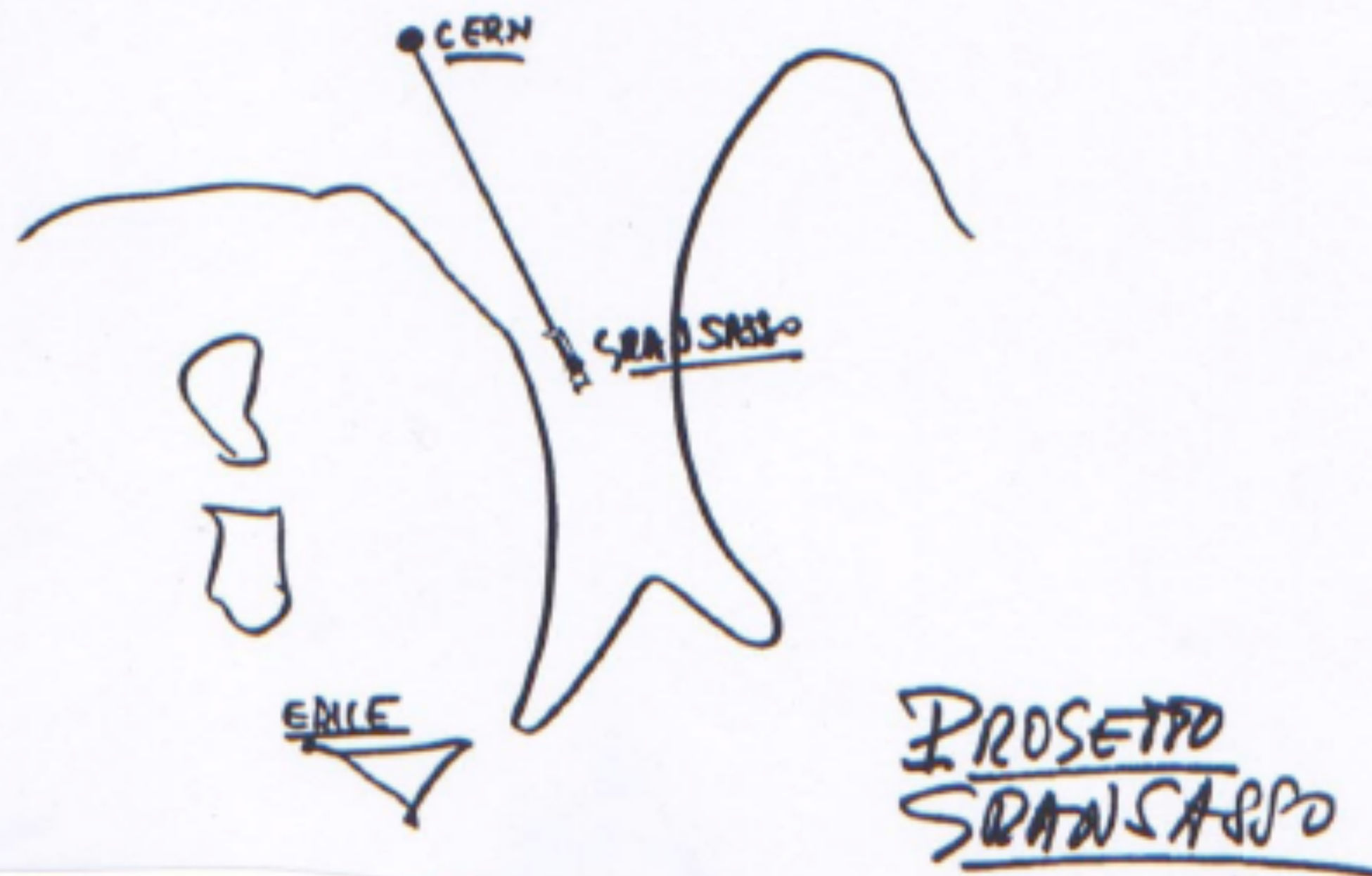


Above ground campus

# Underground Lab



COMMISSIONE LAVORI PUBBLICI DEL SENATO

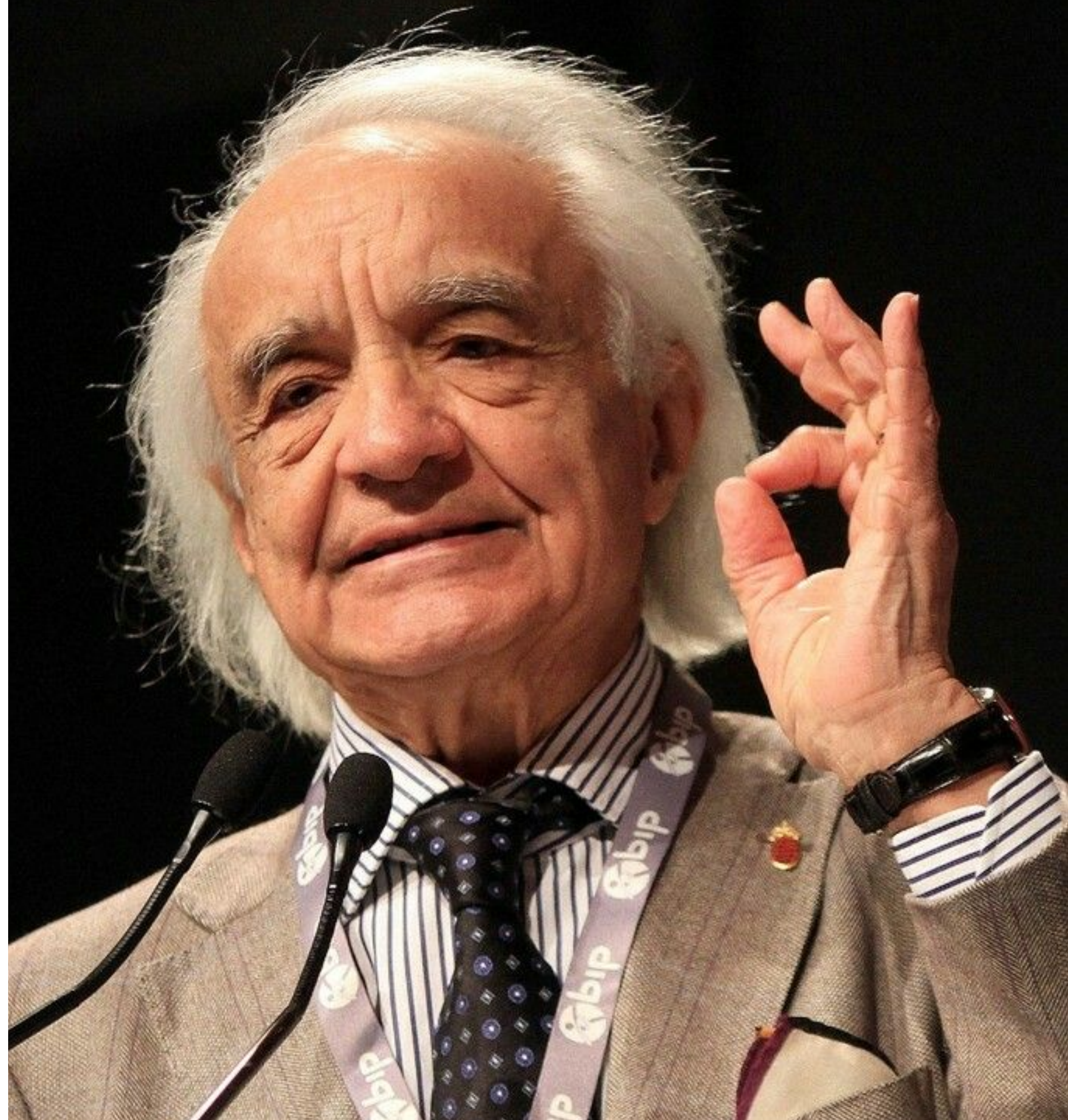


Note manoscritte di A. Zichichi presentate nella Seduta della Commissione Lavori Pubblici del Senato convocata con urgenza dal Presidente del Senato per discutere la proposta del Progetto Gran Sasso (1979).

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

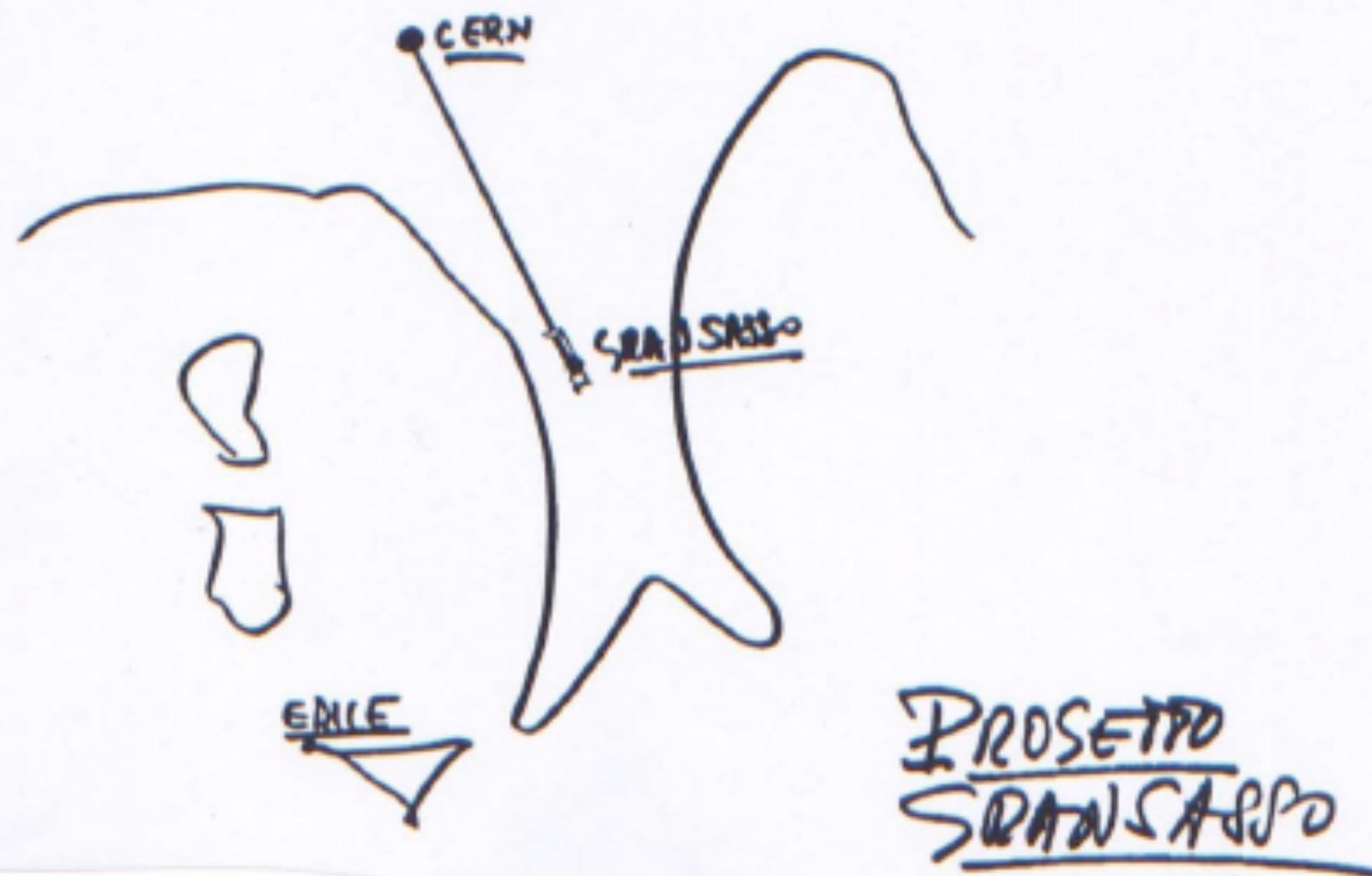
- 1) nuclear stability;
- 2) neutrino astrophysics;
- 3) new cosmic phenomenology;
- 4) neutrino oscillations;
- 5) biologically active matter;
- 6) ground stability.

Not only  
 $\tau_p \neq \infty$





COMMISSIONE LAVORI PUBBLICI DEL SENATO

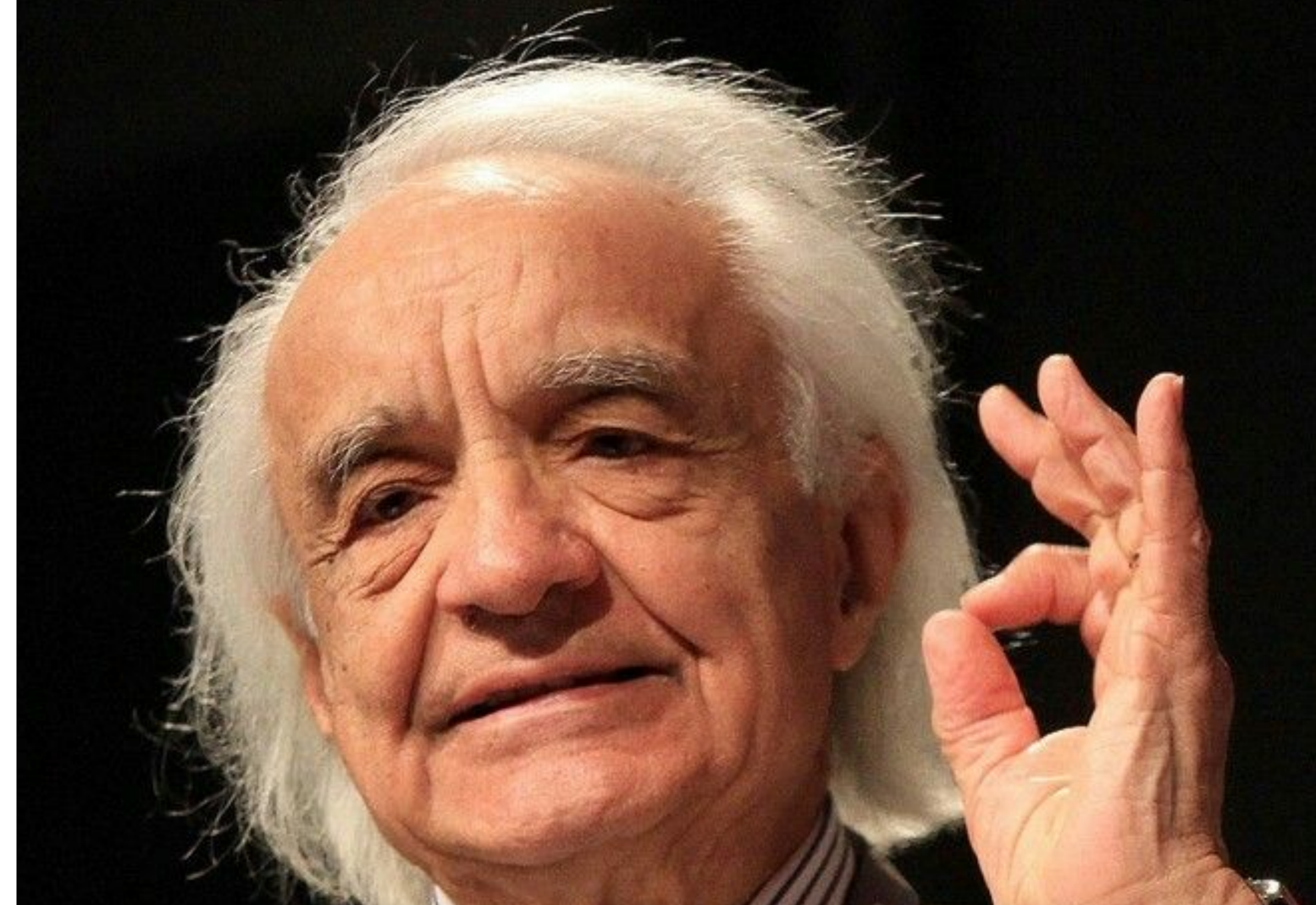


Note manoscritte di A. Zichichi presentate nella Seduta della Commissione Lavori Pubblici del Senato convocata con urgenza dal Presidente del Senato per discutere la proposta del Progetto Gran Sasso (1979).

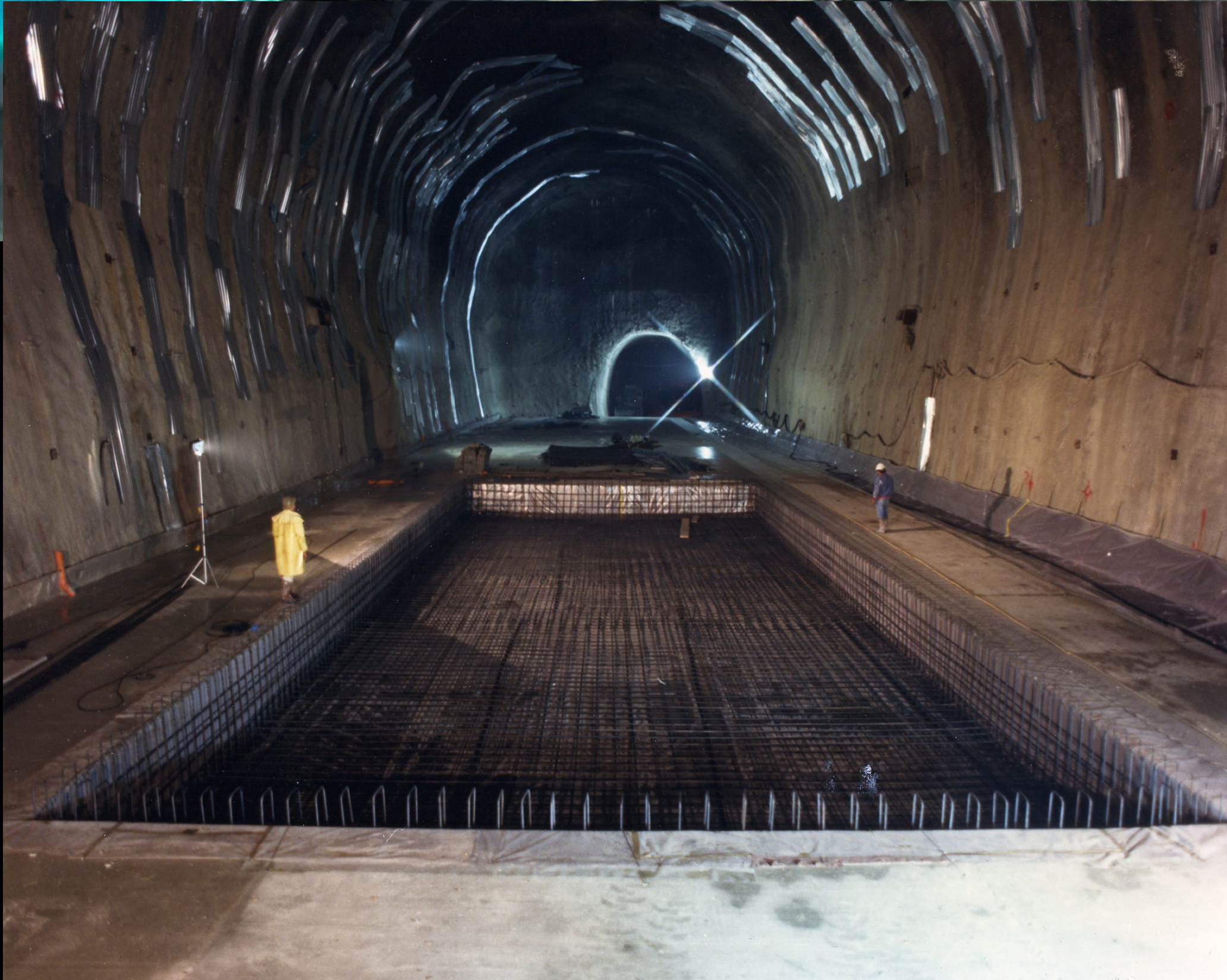
To summarize, the scientific aims of the "Gran Sasso" laboratory are the study of:

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

Not only  
 $\tau_p \neq \infty$



- 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  
construction  
phases



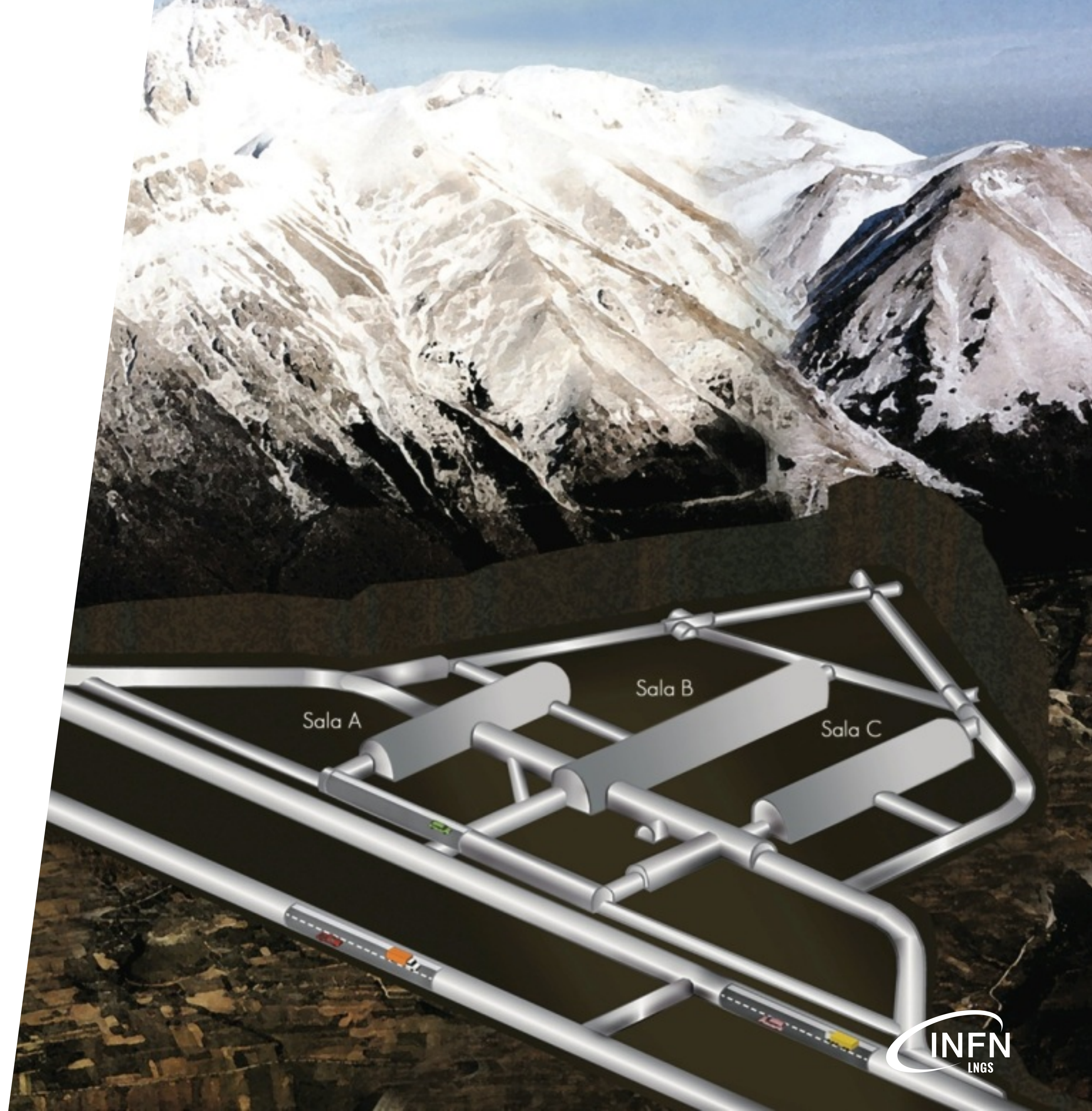
MACRO - first LNGS experiment



LNGS construction phases

# The Underground Lab in numbers

- 1400 m (3800 m.w.e. vertical depth)
- Muon rate  $\sim 1/(m^2 h)$
- Surface: 17 800 m<sup>2</sup>
- Volume: 180 000 m<sup>3</sup>
- Ventilation: 1 vol / 3 hours
- 3 large experimental halls  
( $\sim 100 \times 20 \times 18$  m<sup>3</sup>)
- 22 experiments currently running
- Easy accessible via highway tunnel



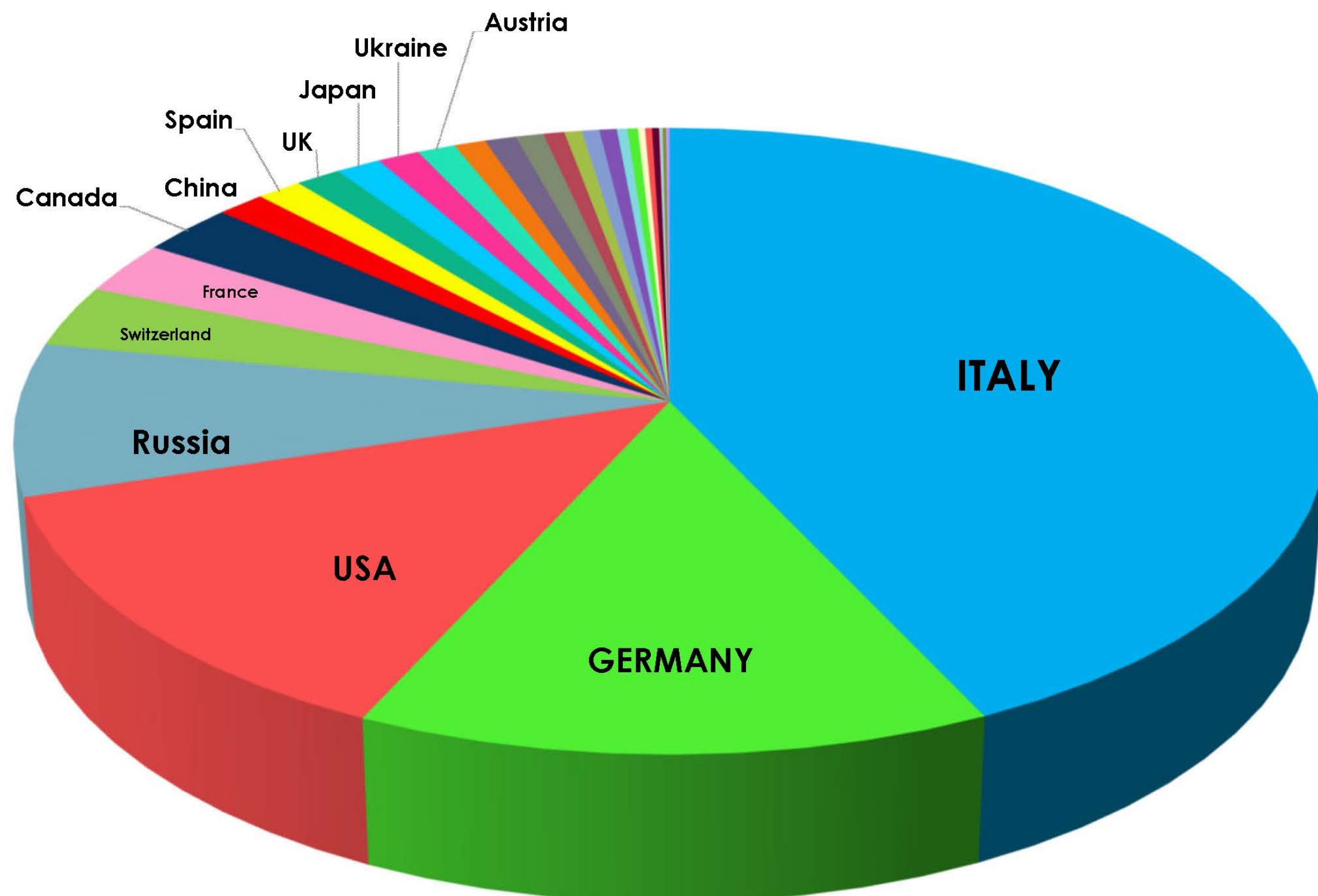
# Worldwide LNGS access

Since its beginning, LNGS has always been characterized as an international Lab

Total users: N. 981

Italian users: N. 417

Foreign users: N. 564



\* data source: 2019

# Science network

LNGS is one of the corners of a high-level science and education triangle in the Gran Sasso area.

The University of L'Aquila and the Gran Sasso Science Institute are the primary partners of the LNGS development and culture promotion strategy.



Università degli Studi dell'Aquila

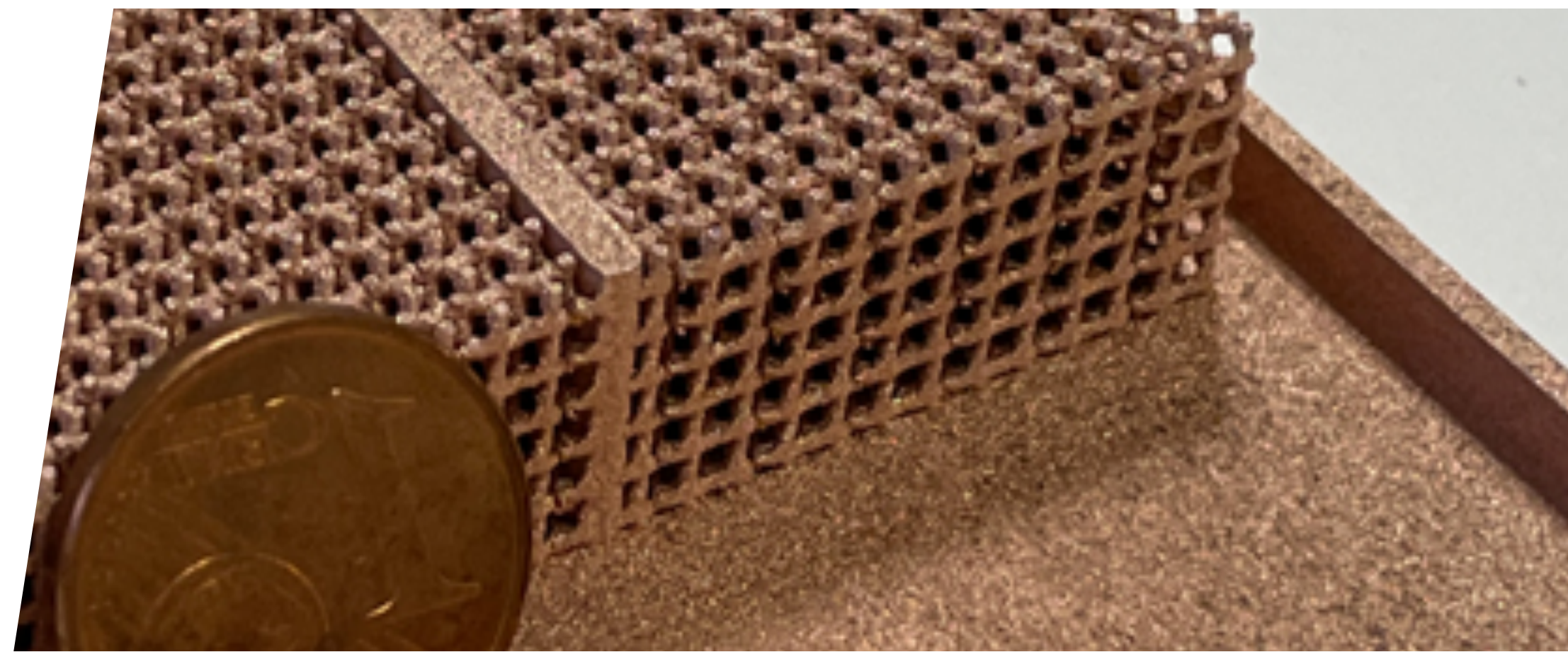


Gran Sasso Science Institute

# Integrated infrastructures

What makes LNGS a unique place for research is the combination of integrated infrastructures and support laboratories.

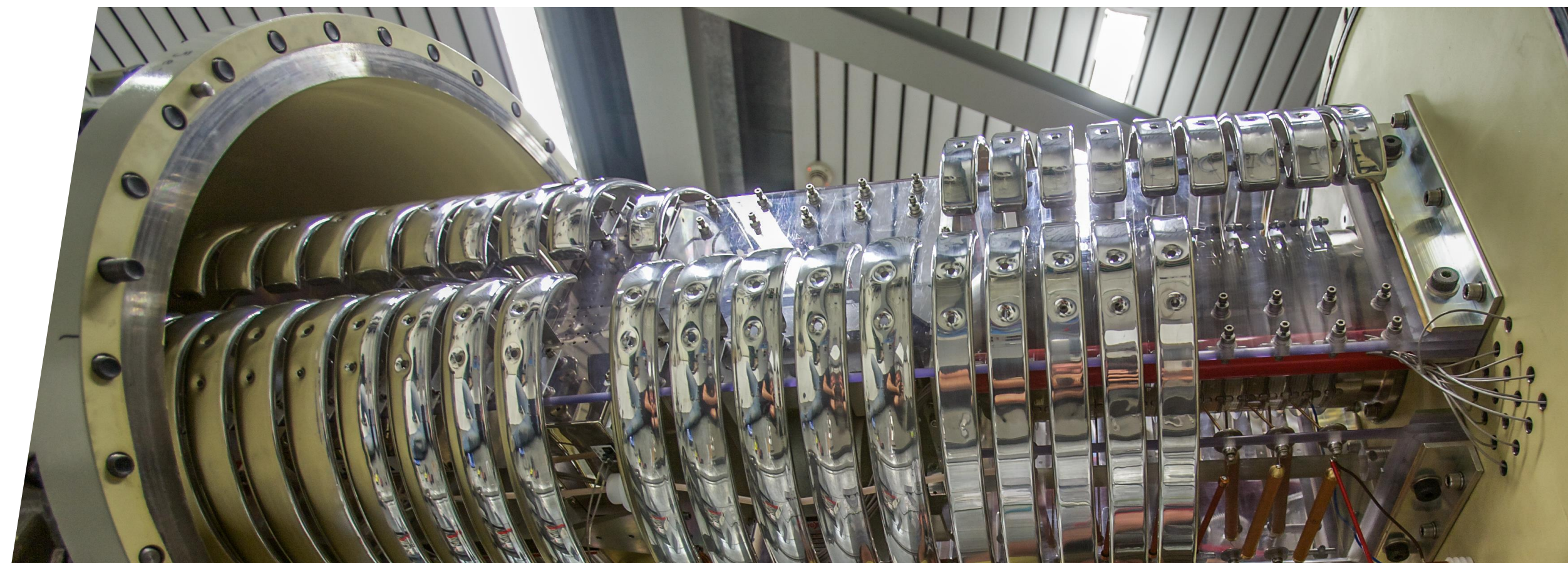
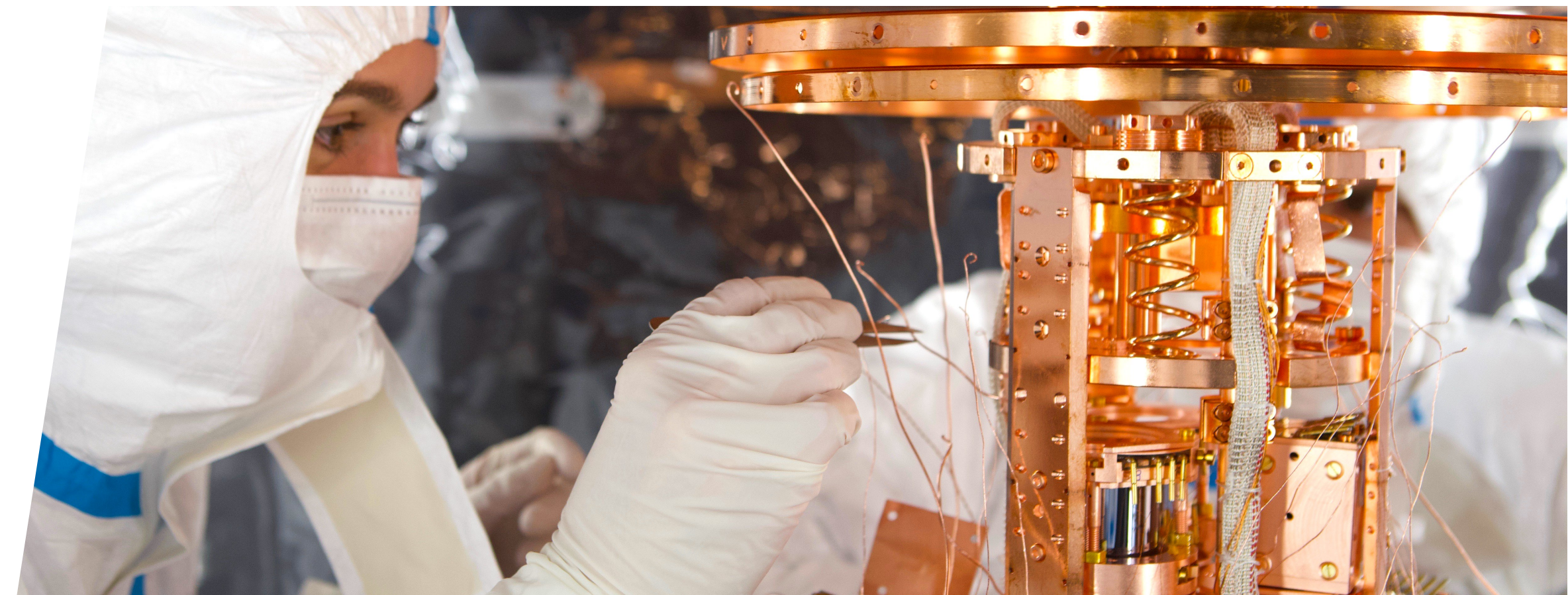
The low background lab STELLA (see talk from M.Laubenstein), the ICPMS trace identification facility, electronics and chemistry workshops, mechanical workshop (and the new additive manufacturing lab HAMMER) allow scientists advanced prototyping, contaminant identification and material selection, detector development, ...



# Scientific programs

The leading science research lines in this age of LNGS are:

- **neutrino physics**
  - Majorana neutrino program (LEGEND, CUORE/CUPID,...)
- **dark matter search**
  - Direct DM search programs (XENON-nT, DarkSide, CRESST, DAMA, COSINUS, CYGNO, SABRE, NEWS,...)
- **nuclear astrophysics**
  - Bellotti Ion Beam Facility MV accelerator (open to the LUNA program, and more...)







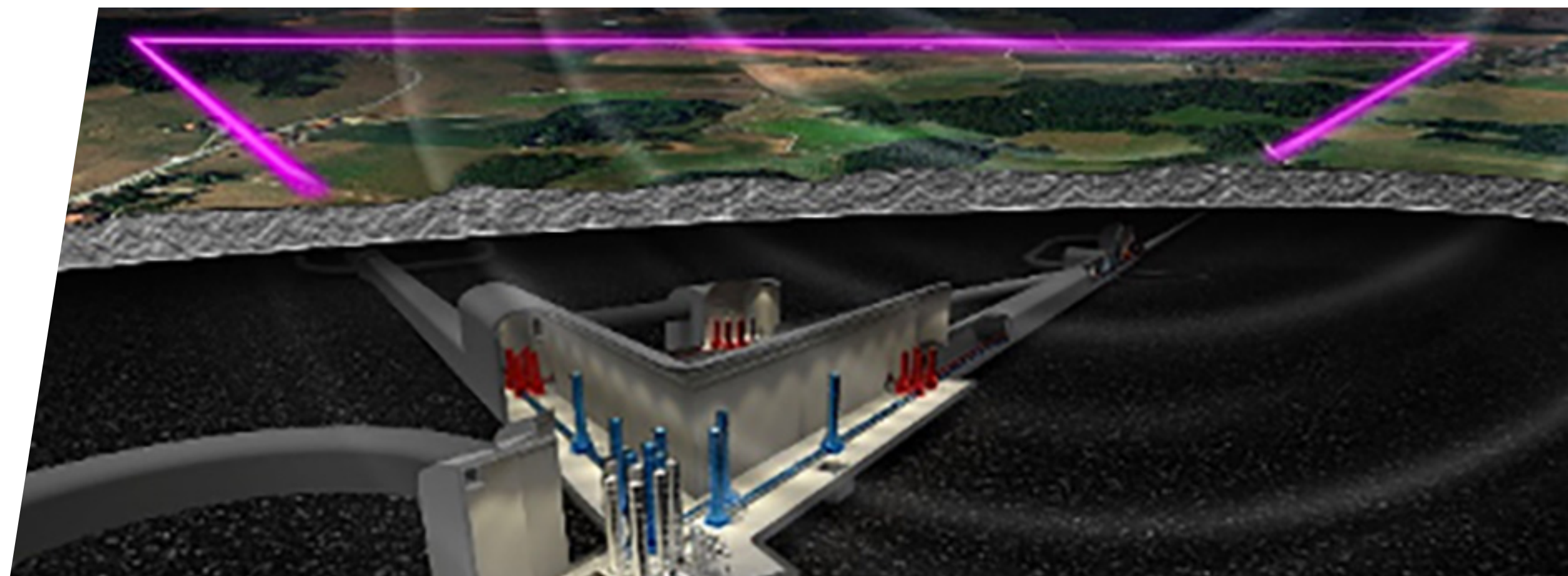
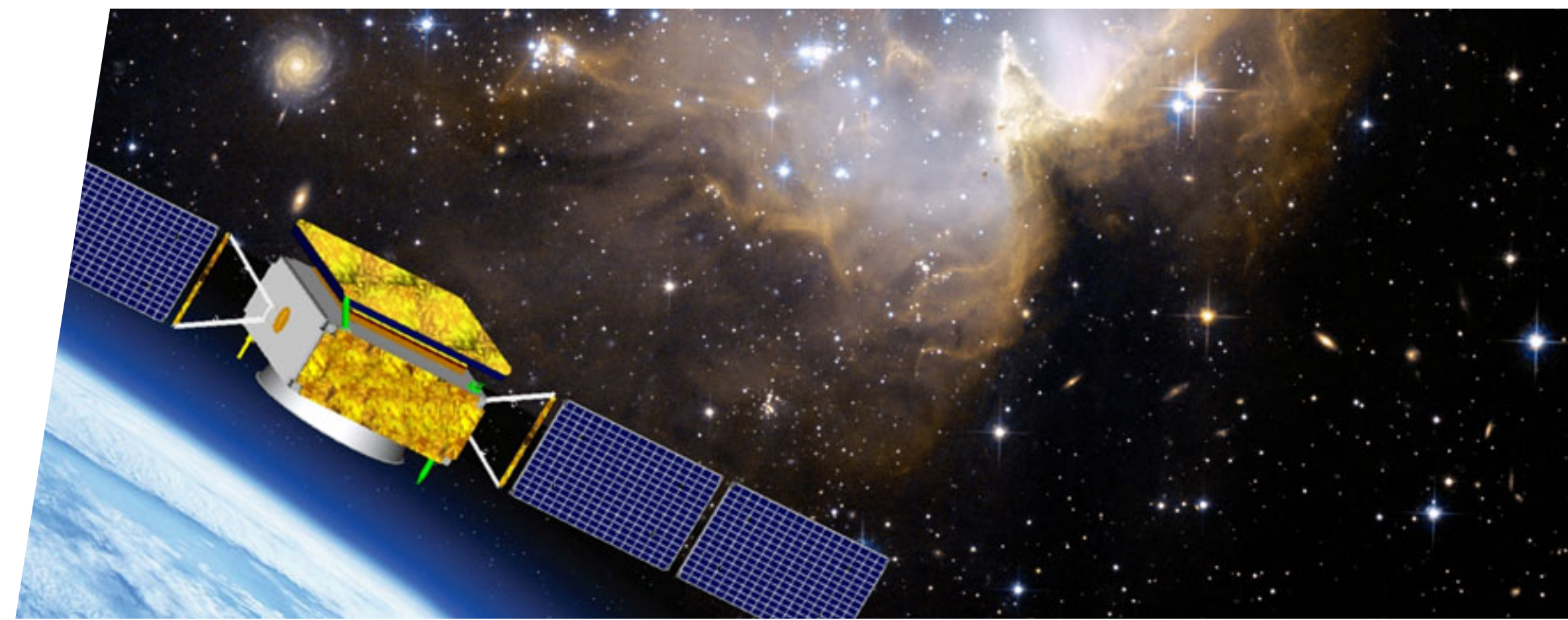
# And much more...

- **Gravitation and General Physics**
  - Precision measurements
  - Tests in highly reduced seismic noise environment
- **Geophysics and geology**
  - Underground water, trace radioactivity
  - Antineutrinos from the earth
- **Quantum Computing**
  - Low background studies
- **Biology**
  - Effects of very low doses on living organisms
- **Material science**
  - Ultrapure crystals for DM and DBD

# And more...

The Gran Sasso community has wide interests also in non-underground projects :

- cosmic rays
  - On earth (AUGER, CTA,...)
  - In space (DAMPE, HERD...)
- gravitation waves
  - VIRGO, EINSTEIN TELESCOPE,...
- multi-messenger astronomy



# Location

- Lectures:
  - Lectures will take place in the Pontecorvo room (this room)
- Hands-on activity:
  - Students will meet their supervisors tomorrow 26/09 after lunch
  - Hands-on activity will be performed in specific lab/offices
- Workspace/office
  - The LNGS library is accessible. On the ground floor, 10 desks have been reserved for Hands-on students
  - Pontecorvo room (this room) will be always open and is reserved for Hands-on students

# Practical infos

- Lunches:
  - Lunches will be offered at the LNGS canteen. Hands-on students will need just to sign a spreadsheet at the cashier of the canteen.
  - Lunch includes a first course, second course, side, and fruit.

Enjoy your Hands-on  
experience!