Travel to Gran Sasso

Dates of Travel: 9/21/08 to 9/26/08

Travelers:
Steve Marks, Mechanical Engineer, EGME12
Dave Plate, Mechanical Engineer, EGME12

Organization: Ernest Orlando Lawrence Berkeley National Laboratory
One Cyclotron Rd., Berkeley, CA 94720

Trip Numbers: Steve Marks: 000060777
Dave Plate: 000060772

Destination: Gran Sasso underground laboratory

Purpose of Trip: The purpose of this trip was to assess installation of experiments at the Gran Sasso underground laboratory, which is very similar to the proposed DUSEL at Homestake.

Contacts: Roberto Tartaglia
Stefano Gazzana

Facility visited: Gran Sasso underground laboratory.

Abstract: Dave Plate and Steve Marks traveled with Steve Dangermond, the outside architect who has been contracted to develop an architectural program for the DUSEL preliminary design. We spent three days meeting primarily with Roberto Tartaglia and Stefano Gazzana. We reviewed general infrastructure of the Gran Sasso laboratory, such as their safety program and support facilities. We were able to see the installation of several experiments that are very similar those proposed for DUSEL. This was an excellent opportunity to see first hand issues related to experiment installation and support.

Detailed Trip Report

Additional Contacts

Borexino Experiment: Augusto Goretti, Andrea Ianni, David Montanari
LUNA Experiments: Matthias Junker
GERDA Experiment: Matthias Junker, Karl-Tasso Knopfle, Bernhard Schwingernheuer
Low Background Counting Facility: Alessia Giampaoli, Alba Formicola
Cryogenics and Chemical Support: Marco Balata

Laboratory Configuration

The Figure 1 shows the configuration of the laboratory with the location of the various experiments indicated. Halls A, B, and C are large excavations similar to those proposed for Homestake DUSEL; they contain the large detector experiments. Halls A and B are 18m wide; Hall C is 20m wide; they are each approximately 100m long. Several experiments are also contained in connecting service drifts. The underground facilities total approximately 13,600 m^2 of space (about 150,000 gsf) and the volume totals 180,000 m^3 of excavation (about 6.3 million cubic feet). Access/service tunnels that also serve as egress surround the main halls. Short tunnels between halls serve as third means of egress.

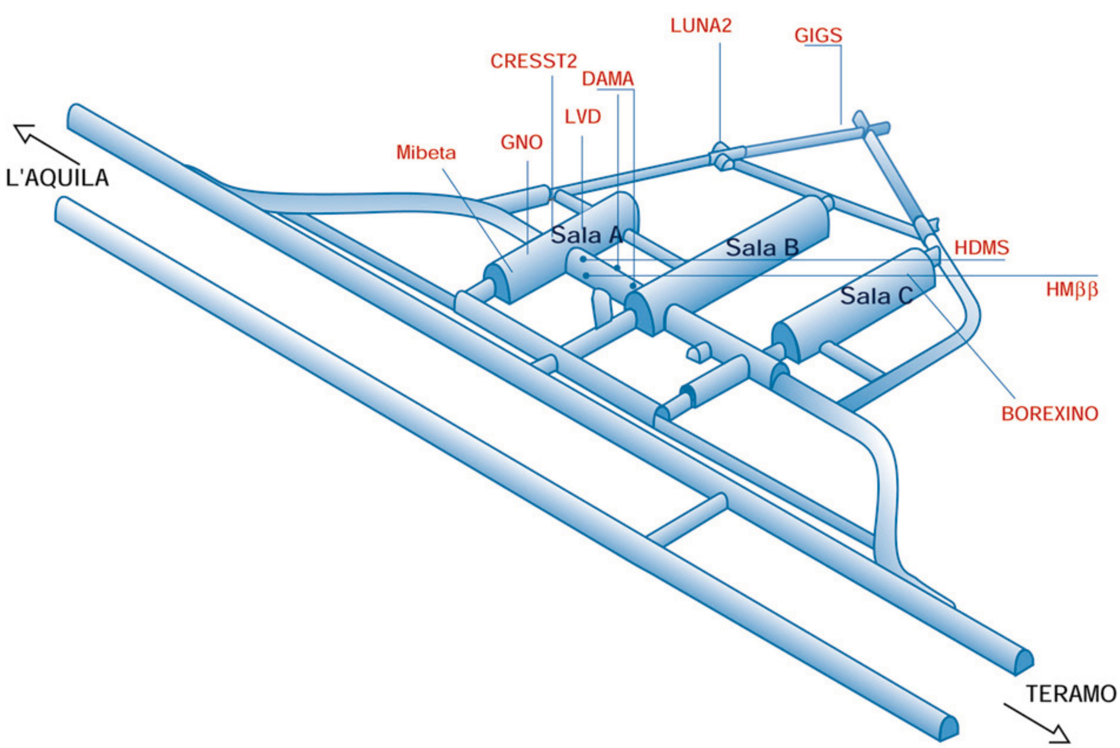

Figure 1. Laboratory configuration.

Borexino

The Borexino experiment is a solar neutrino detector. Figure 2 shows the configuration of the detector. The inner scintillator sphere consists of pseudocumene (PC), doped with PPO to act as a scintillation enhancer. This is surrounded by PC, doped with DMP to act as a scintillation quencher. The two PC volumes are separated by a thin nylon balloon. The total PC volume is contained within a stainless steel sphere, which is surrounded by a water shield contained within the outer stainless steel vessel. A total of 2200 photomultiplier tubes (PMTs) are attached to the inner stainless steel sphere, most of which are used to detect events within the scintillator volume; 200 are looking out into the water shield to provide the signals for a muon veto.

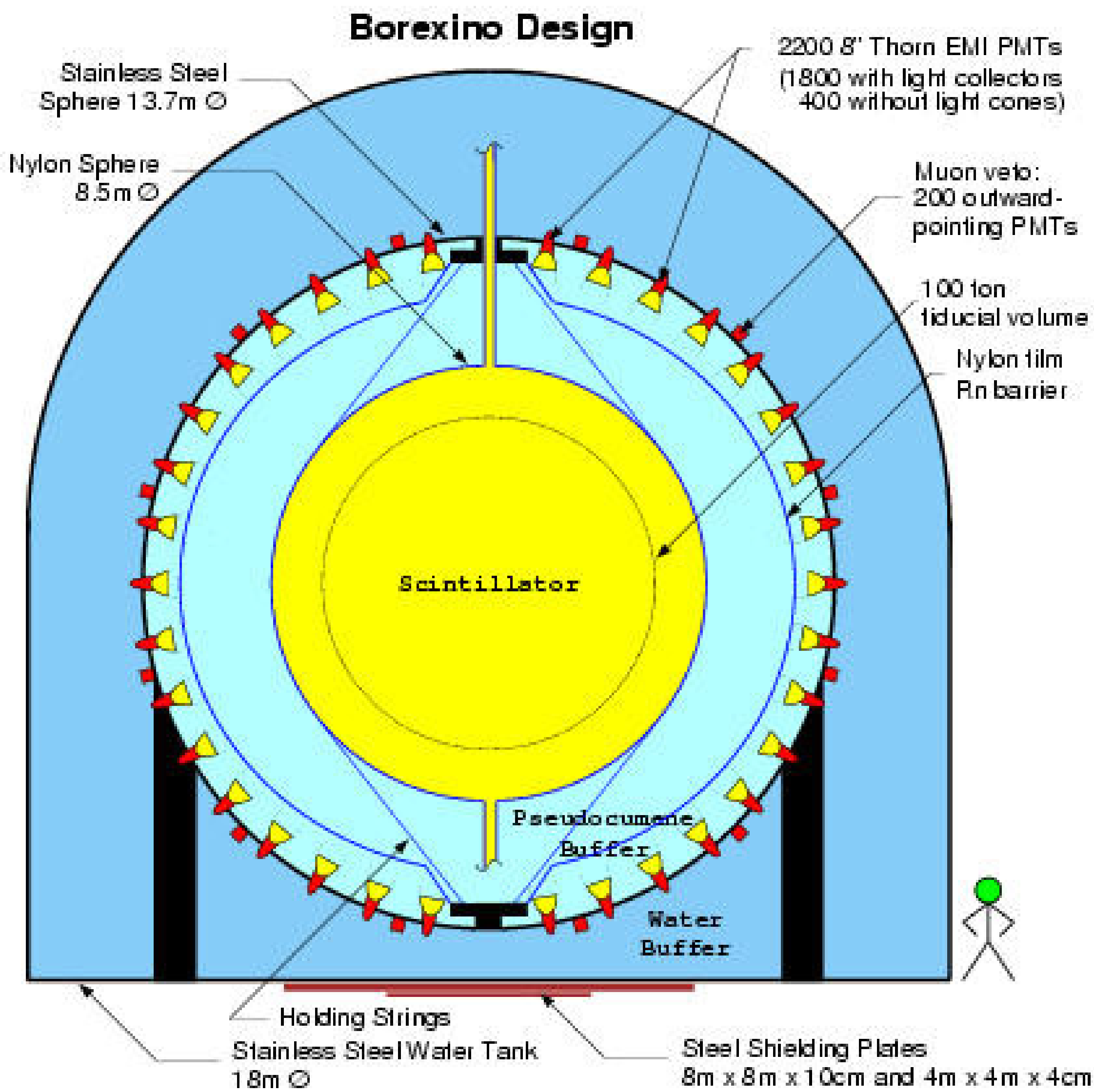

Figure 2. Borexino experiment.

Figure 3 shows a representation of Borexino and CMT (the Borexino prototype), as they are situated in Hall C. The diameter and height of Borexino detector represents the limit of what will fit within Hall C. The walls adjacent to the detector had to be reconfigured and utilities had to be removed from the floor area to accommodate the 18m diameter of the outer vessel. Figure 4 shows the 1m wide walkway.

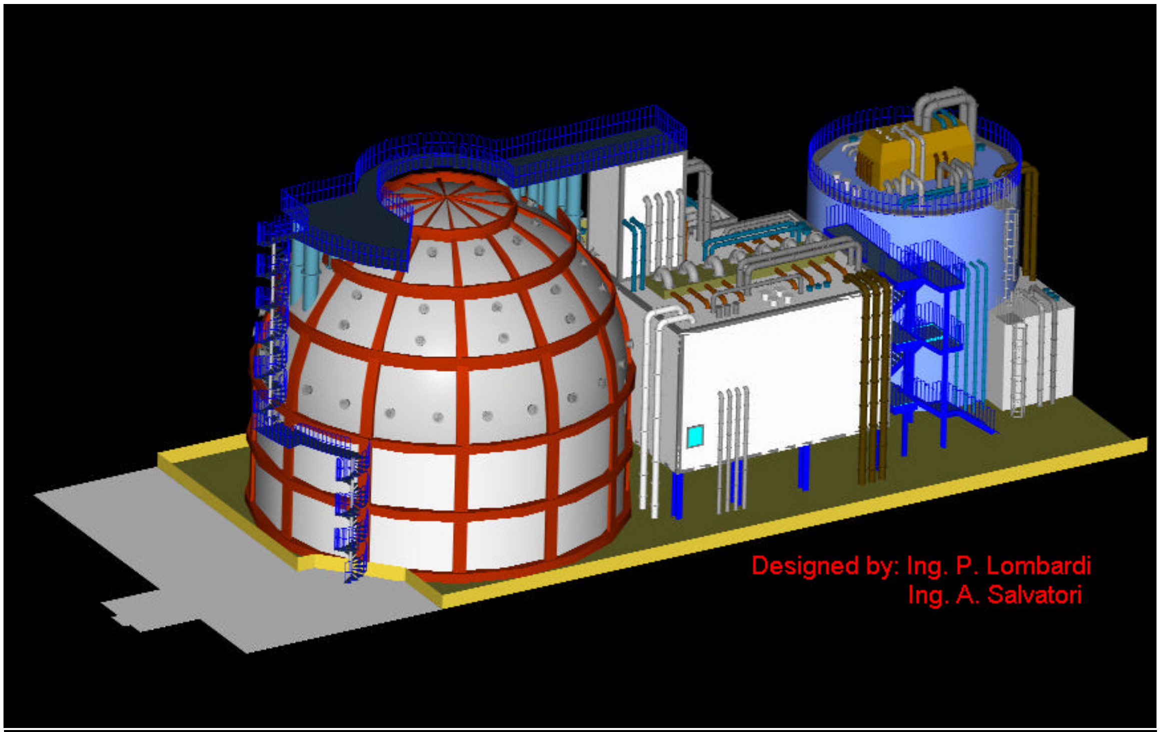

Figure 3. Borexino and CTF experiments.

Figure 4. Walkway around Borexino detector.

Areas around the detector accommodate various utilities including water and PC treatment plants. The total floor space occupied by the experiment is approximately double that of the detector.

Figure 5 is a view from the top of the detector looking toward the OPERA experiment at the entrance to Hall C. In the foreground are PC storage tanks. Figure 6 shows a view of the water treatment plant as seen from the top of the detector. Figure 7 shows the control room. Behind the door is a room that contains electronics for the 2200 PMTs. The footprint for the electronics room is roughly 6m by 5m. In addition, there was tower directly above the control room used to collect and route the PMT cables (all cables must be of the same length to maintain signal timing). To first order one can assume that the required area scales by the number of PMTs.

Figure 5. View from the top of Borexino detector.

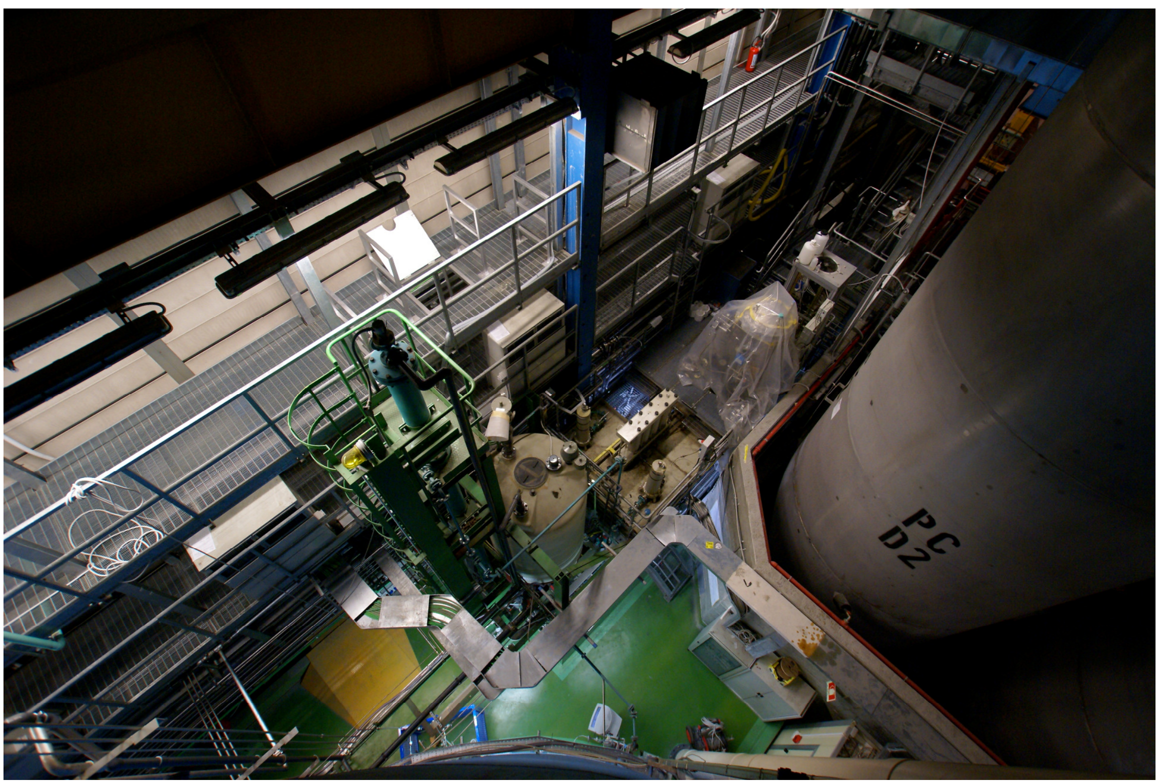

Figure 6. View of water treatment plant from the top of Borexino detector.

Figure 7. Borexino control room.

GERDA

GERDA is a double beta decay experiment currently under construction. This experiment shares many features common to many of the experiments proposed for DUSEL. In particular, the configuration consists of 30T of LAr surrounded by a water shield. The safety and engineering review process executed for this experiment provide a very valuable example for us in planning the experiments for DUSEL. Two accident scenarios were considered:

1. One wall of the vacuum barrier separating the LAr vessel from the water vessel is breached, so that heat is conducted through a single stainless steel wall. Analysis and tests demonstrated that the maximum evaporation rate is less than the maximum allowable venting rate of 10,000m^3/hr for this condition.
2. In the case where the physical separation between the water and LAr is maintained, but vacuum is lost, the maximum venting is predicted to be less than 1500m^3/hr.

The worst case scenario would be if both walls of the vacuum barrier are breached, allowing water and LAr mixing. A conclusion of a probability analysis was that this scenario is so unlikely that it need not be considered. This analysis was performed by an outside consultant.

LUNA

The LUNA nuclear astrophysics facility consists of a 400kV ion accelerator, with solid targets and H and He gas targets. The facility is used to measure low energy nuclear reaction cross sections typical of those occurring in stars. The DIANA proposal for DUSEL would be a similar facility targeting the same mission. Due to the energy and operational limits, LUNA does not generate neutrons. The only shielding around the accelerator is a modest lead x-ray shield around the target area. Figure 8 shows the accelerator, which is a commercial unit. Figure 9 shows the gas target end station.

Figure 8. LUNA accelerator.

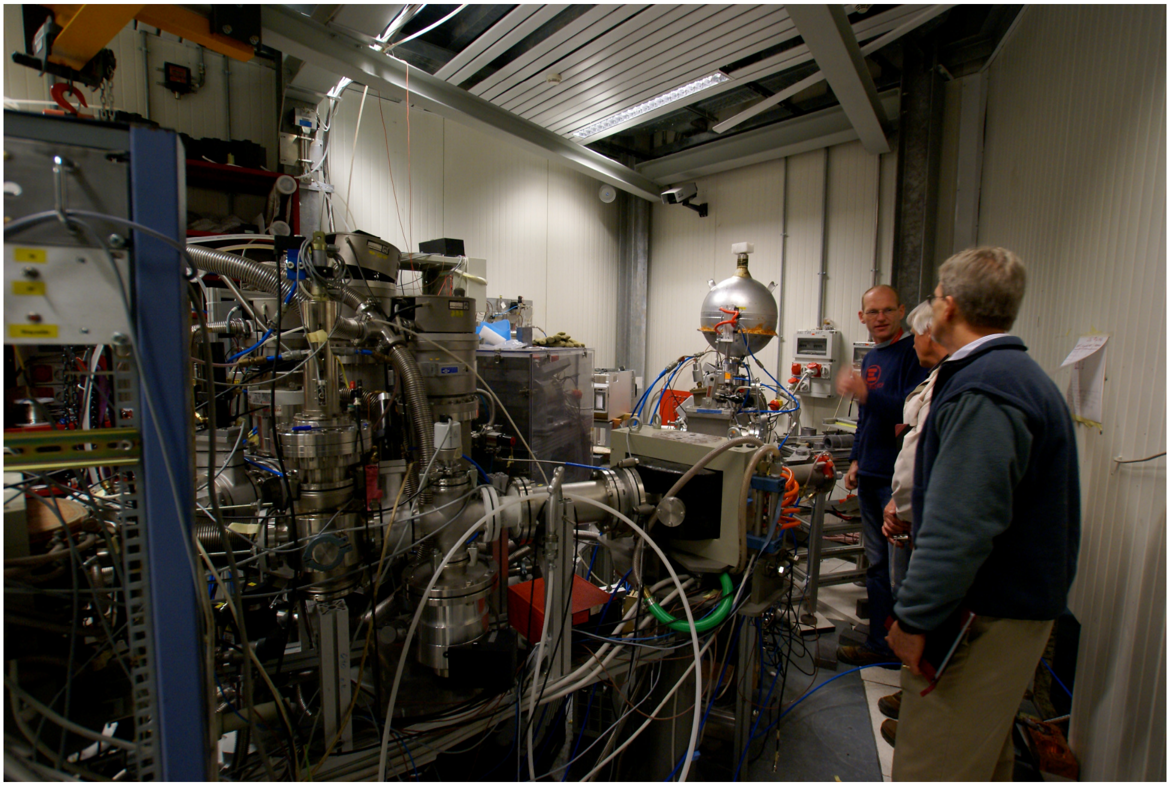

Figure 9. LUNA gas target end station.

Low Background Counting Facility

The low background counting facility at LNGS is provided as a service for use by the experiments. Included are a Si α detector, and six Ge γ detectors, which can hold a 20cm×20cm×20cm sample. A staff of 3.5 FTEs are dedicated to the facility.

Cryogen handling

LNGS cryogen handling, as is much of their operation, is dominated by the fact that they have drive-in access to the laboratory. In particular, liquid cryogens are delivered by truck directly underground to storage facilities. We obviously have to develop a different model for DUSEL.

We met with Marco Balata, who is responsible for maintaining their cryogenics infrastructure. He discussed the maintenance and liability issues associated with renting cryogen storage vessels versus owning them. LNGS has decided to rent them.

Laboratory Support Facilities – Surface Campus

In addition to the underground laboratory facilities, there is a well-developed surface campus of approximately 150,000 gross s.f. of offices and support facilities as follows:

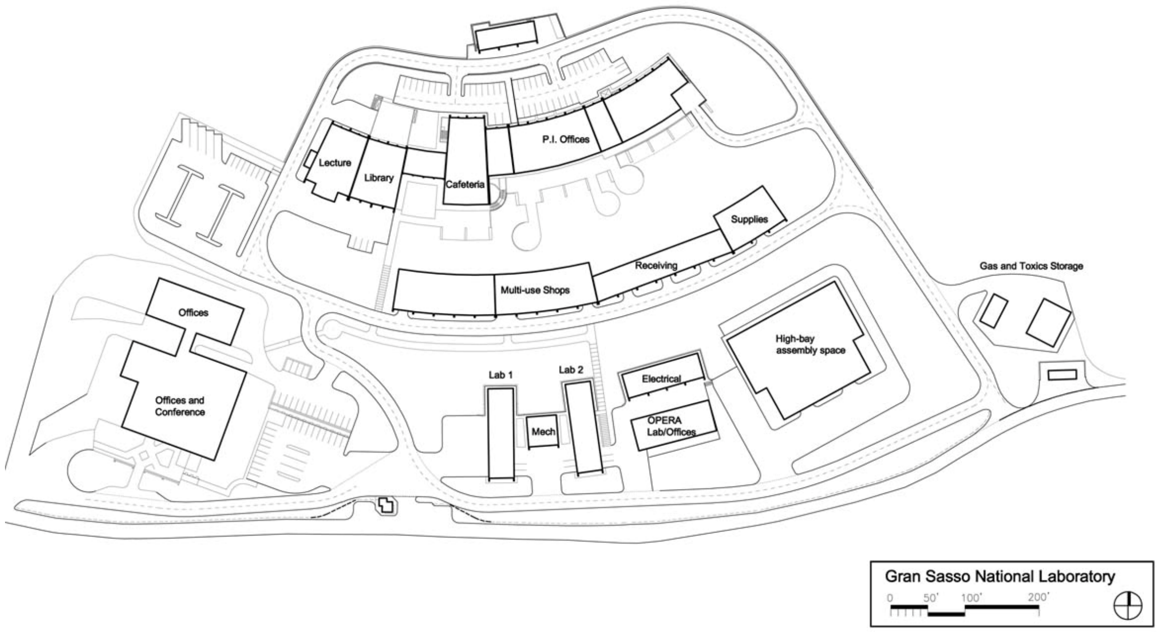

Figure 10 - LNGS Surface Campus

Administration Building

Administrative offices wing (8,000 gsf)

Office and Conference wing (20,000 gsf)

- Conference and Meeting Rooms; main conference room with control room, and sophisticated a/v capabilities, seating at movable tables for up to 75; break-out to outdoor terrace
- Separate breakout conference rooms
- Computer room
- Staff offices

Central Commons Building (41,500 gsf)

- Cafeteria w/ single food line seating 75; connection to outdoor terrace, and separate coffee bar/social space
- Kitchen and storage
- Researchers offices (15,500 gsf)
- Library (9,000 gsf)
- Large lecture hall; ~225 seats at fixed linear tables, tiered stadium-style arrangement (7,500 gsf)
- Commons building centralizes all of the spaces that generate activity and group use into a central building that encourages interaction between all of the lab population and visitors

Lab building 1 – 2 stories (8,240 gsf)

Lab Building 2 – 2 stories (8,240 gsf)

Lower level – chemistry labs
- Offices
- Glass wash and cleaning with hood
- Storage
- Analytical lab with mass spec, grinder
- Analytical lab with ovens and hood
- Chemical storage in hallway with no rated partitions and no sprinklers

Upper level – electronics lab

Dedicated OPERA building (9,240 gsf) – 2 stories, offices and labs

Flexible assembly/storage/shop/lab building (14,600)

- high-bay flexible "raw" space with large doors opening directly to the outdoors, flexible for many uses
- Modular Class 1000 clean room built inside
- Machine shop

Central receiving and storage building (11,000 gsf)

- Supplies Storage
- General storage
- Receives all shipments including those going to the underground lab for control purposes

Mechanical Services Buildings (8300 gsf)

- Mechanical Plant
- Electrical
- Gas and toxics storage

Temporary building (5,000 gsf)

- Overflow/flex space, offices

Guard/security entrance building (300 gsf)

Perimeter fence with reinforcement at high-security entrance and arm gates

Figure 11 - Administration Building - LNGS surface buildings are cast-in-place concrete structures that harmonize with the landscape.

Figure 12 - Multi-story library space

Figure 13 - Stadium-style lecture hall seats about 225 at linear desks

Figure 14 - Machine shop

In general the surface facilities are designed to be generic and flexible, as was done with the underground experiment halls. Offices are created from demountable modular partition systems that can be reconfigured. A large amount of generic, high-bay, assembly space has been created, within which modular clean rooms and mezzanines can be installed to suit specific experimental requirements.

Visitor Access

LNGS does not have any specific facilities for visitors to the lab, such as an exhibit or outreach facility. Visitation to the lab is limited to scheduled tours on weekends in small manageable groups that are taken underground by guides.

Staff, Occupancy, and Visitation Statistics

- There are a total of 18 experiments installed in the underground facility.
- LNGS has a staff that averages between 60 and 70, half of which are administration.
- Approximately 700 researchers are involved in all of the collaborations at LNGS – a typical experiment involves around 100 people. As many as 50 may be on site during experiment installations; during typical operations there may be half a dozen to a dozen on-site.
- On a typical day there are around 60 people underground, but that may sometimes increase to around 100.
- There may be as many as 30 to 60 employees of external service companies at the Lab on busy days, creating security and control concerns. Special operations and procedures are in place to coordinate the work of outside contractors.
- There may be as many as 60 visitors per day at the lab in various capacities.
- Every 5 to 6 days a semi-truck delivers liquid nitrogen to the lab.