

The Canfranc Underground Laboratory

A. Bettini



A bit of History

In 1985, the Nuclear and Astroparticle Physics research group from the University of Zaragoza, lead by Angel Morales, set off the Canfranc Underground Laboratory

A main hall of about 120 m² (now **Lab 2500**) and two halls of about 18 m² (now **Lab 780**).



The construction of a road tunnel between Spain and France, parallel to the railway one, provided the unique opportunity to build a new larger laboratory (Now **Lab 2400**).

The facility was completed in 2006. However, one year later signs of rock instabilities started to appear and the laboratory was closed. A complete revision of the original project was performed by the Saragossa University and the rock support structures necessary to guarantee the safety of the personnel and of the properties were installed.

Total area 1560 m², total volume 10500 m³

Status

The Lab 2400 is run by a Consortium between the Spanish MICINN, the Government of Aragon and the University of Saragossa. Lab 2500 and Lab 780 are being integrated in the LSC according to a MoU with the Saragossa University

The Governing Bodies of the Consortium are: the **Consejo Rector** and the **Comision Ejecutiva** (which, amongst others, has the charge to approve the experiments)

The law of the Consortium foresees its funding in the period **2006-15**
for a total of **19 301 925 €**

[35% cut in 2011]

2011, the Scientific Committee will prepare a report on the future opportunities, perspectives and capabilities of the LSC, to be submitted to the CR to start the discussions between the Institutions for the period after 2015

Completion of the civil works underground

30 June 2010. Infrastructures delivery ceremony. Saragossa University to the LSC Consortium





LSC

LSC. External building

Headquarters & Administration

Safety and Quality Assurance

16 offices for scientific users

7 offices for LSC personnel

4 specialised laboratories

Mechanical workshop & storage room

Meeting room & Library

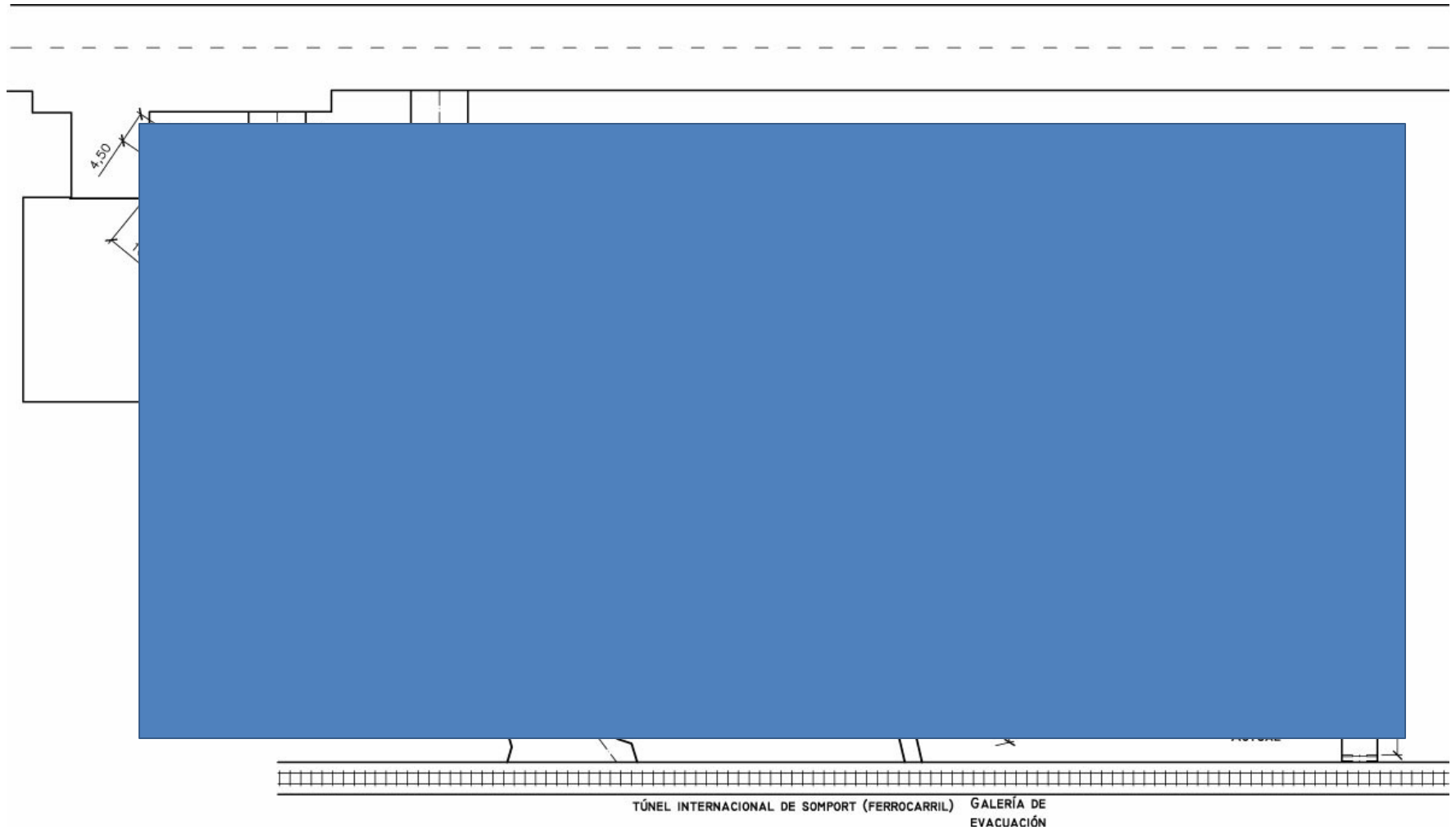
Conference room & Exhibitions room

2 apartments

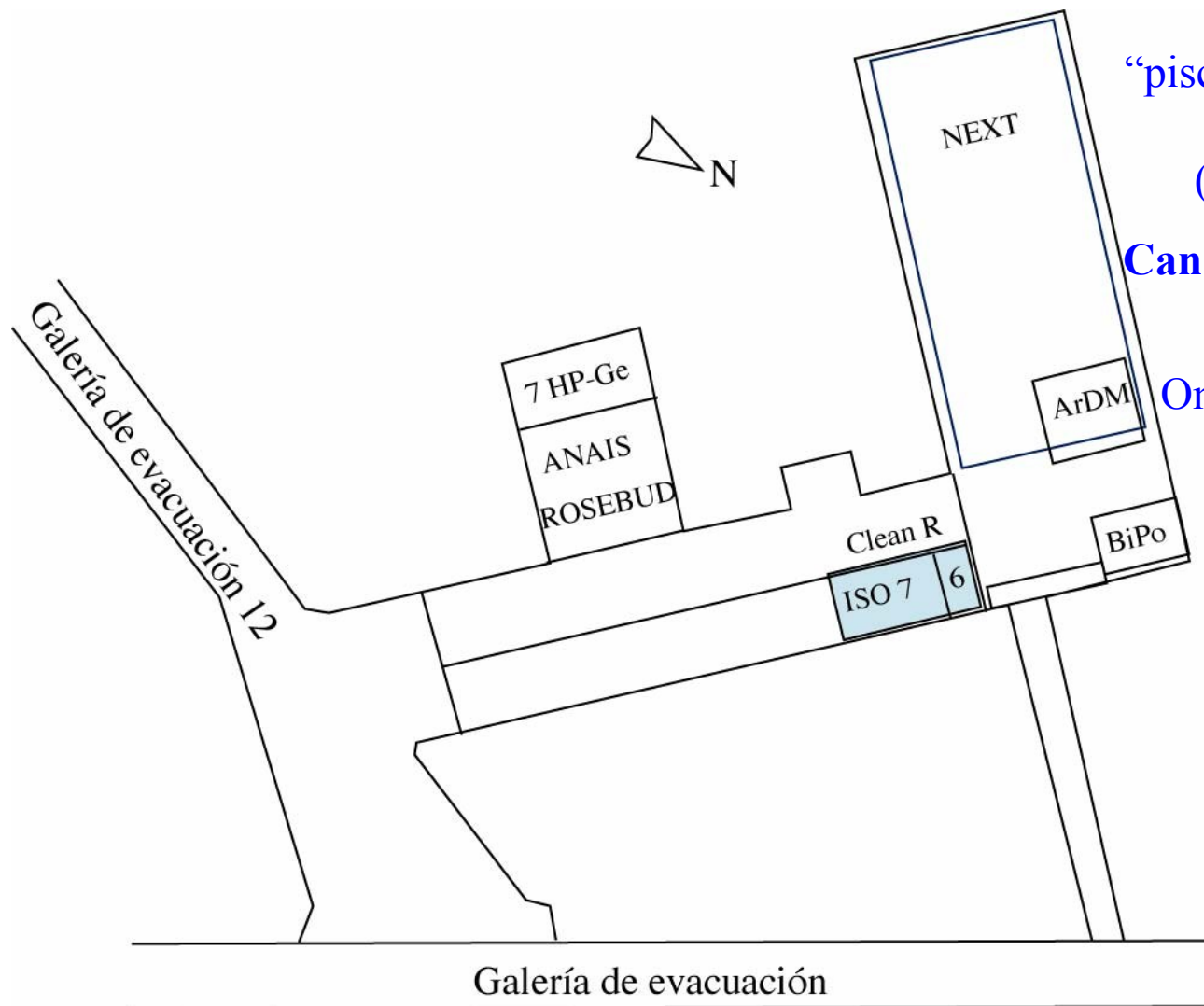
Completed January 2011



Map of LSC



Lab 2400. Location of the experiments

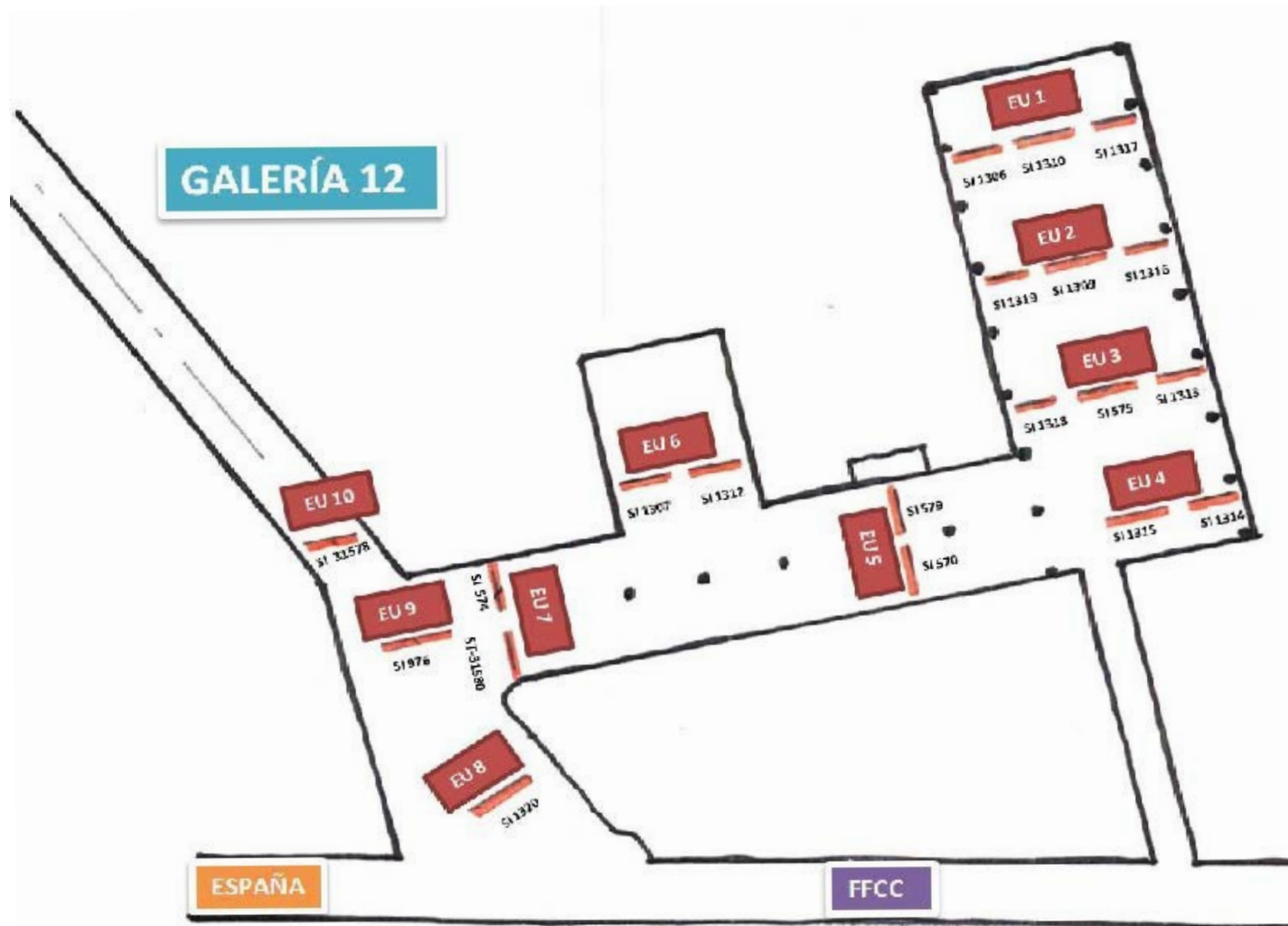


The lower part of the
“piscina” will be used as an
emergency container
(liquids or heavy gases)

**Can be accessed only with
special procedures**

Only passive components

Continuous convergence monitor

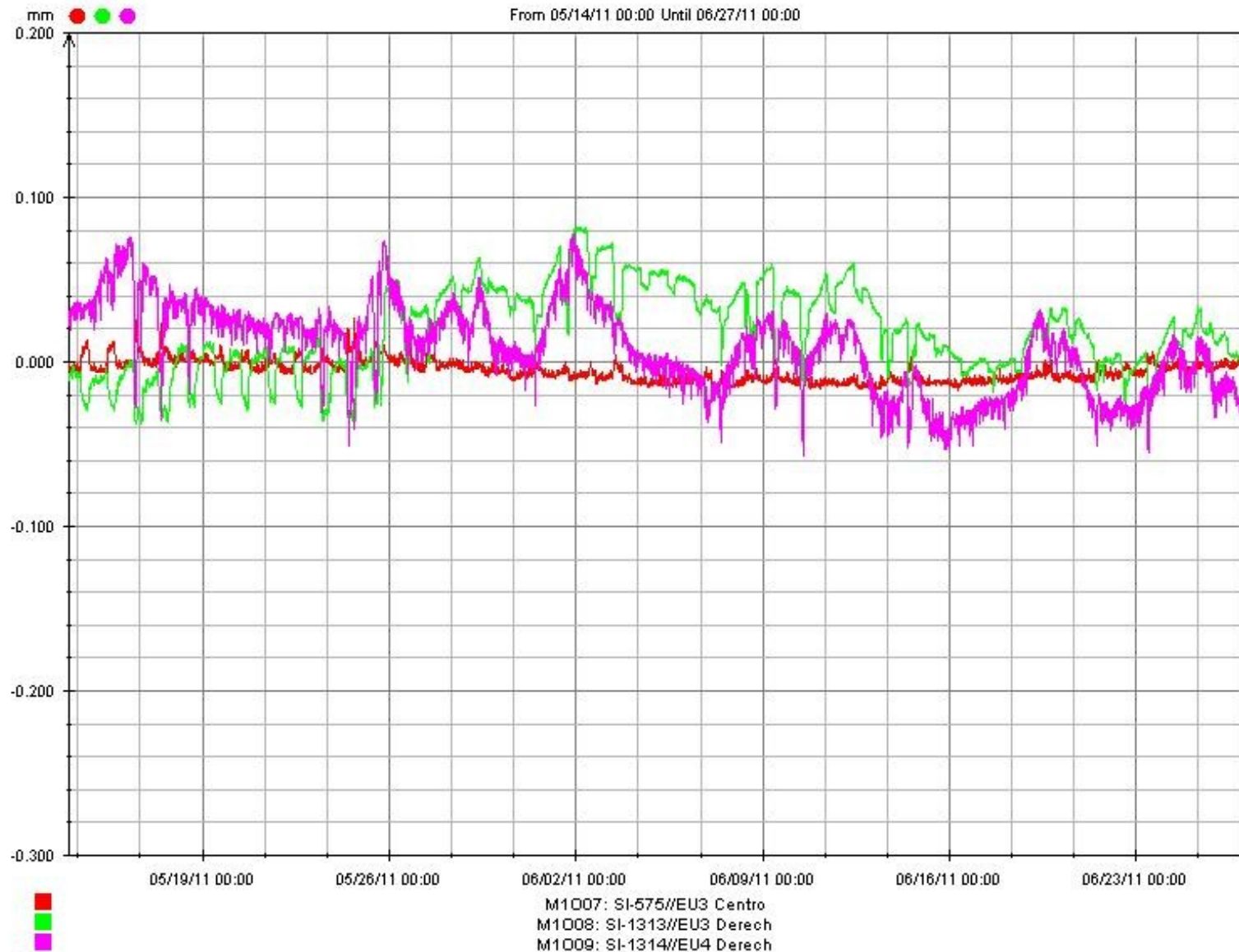


5 m long optical fibre sensors (2 µm resolution), thermometers and hygrometers on 10 sections

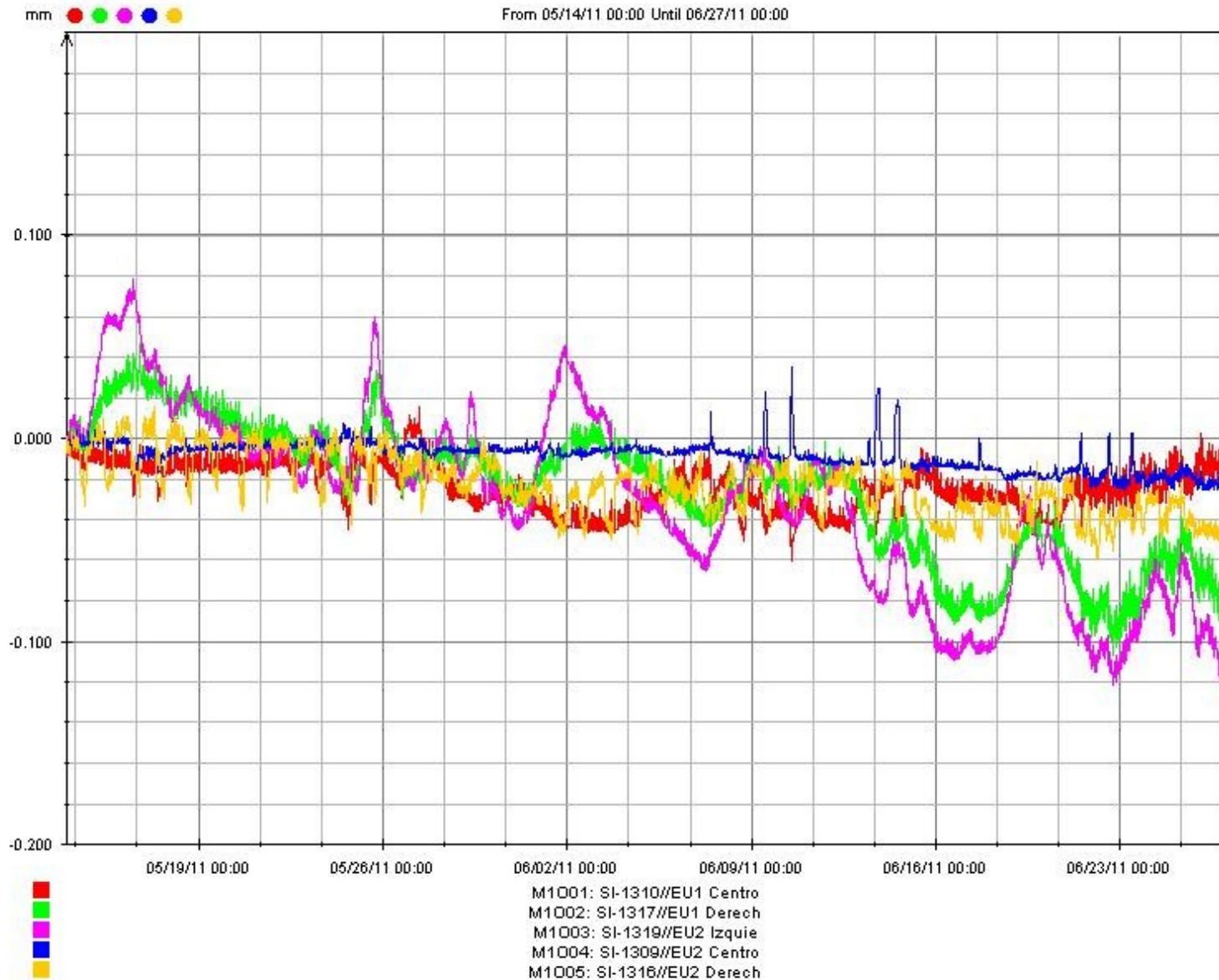
Installing the monitoring system



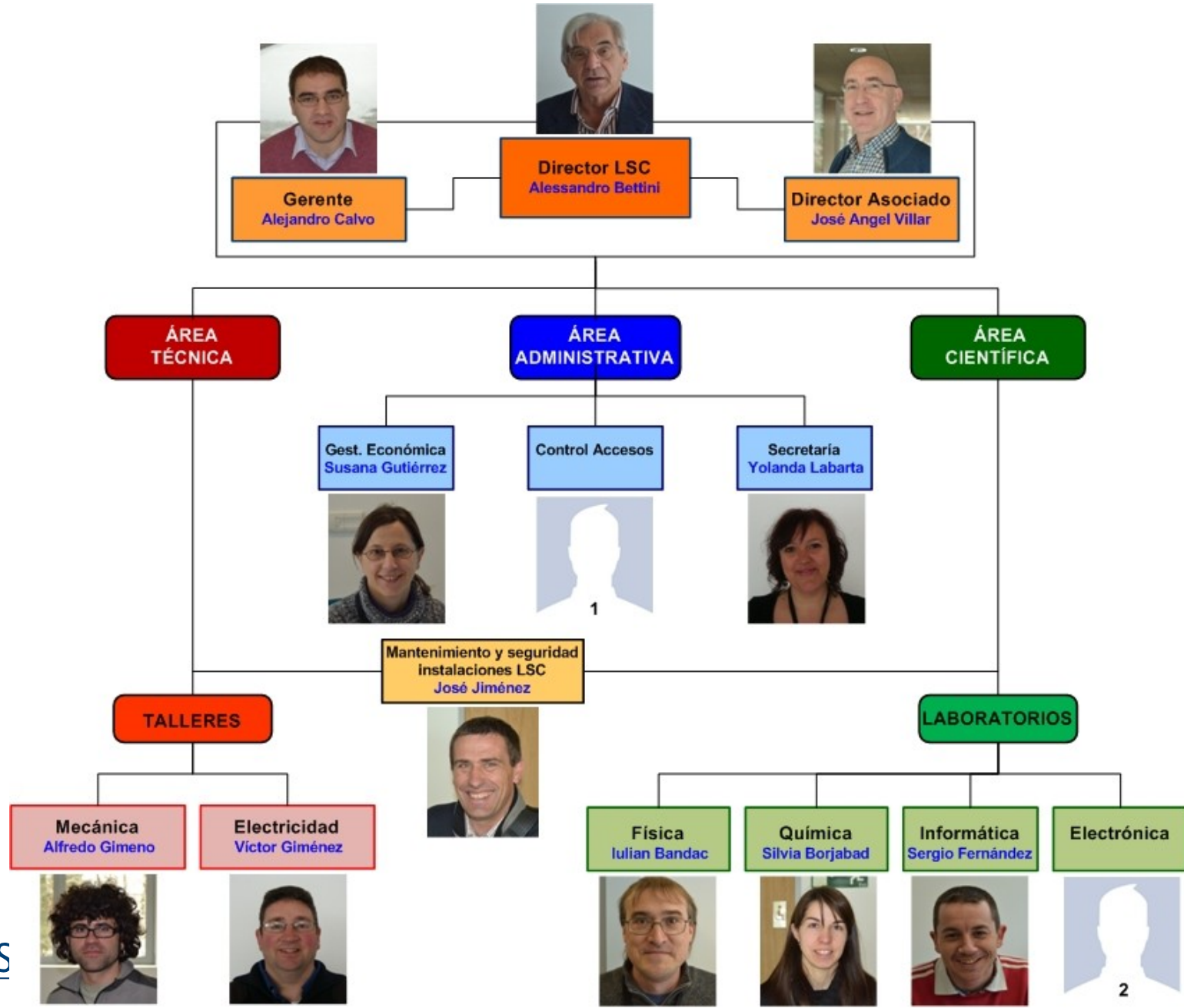
Rocks and concrete live



Rocks and concrete live



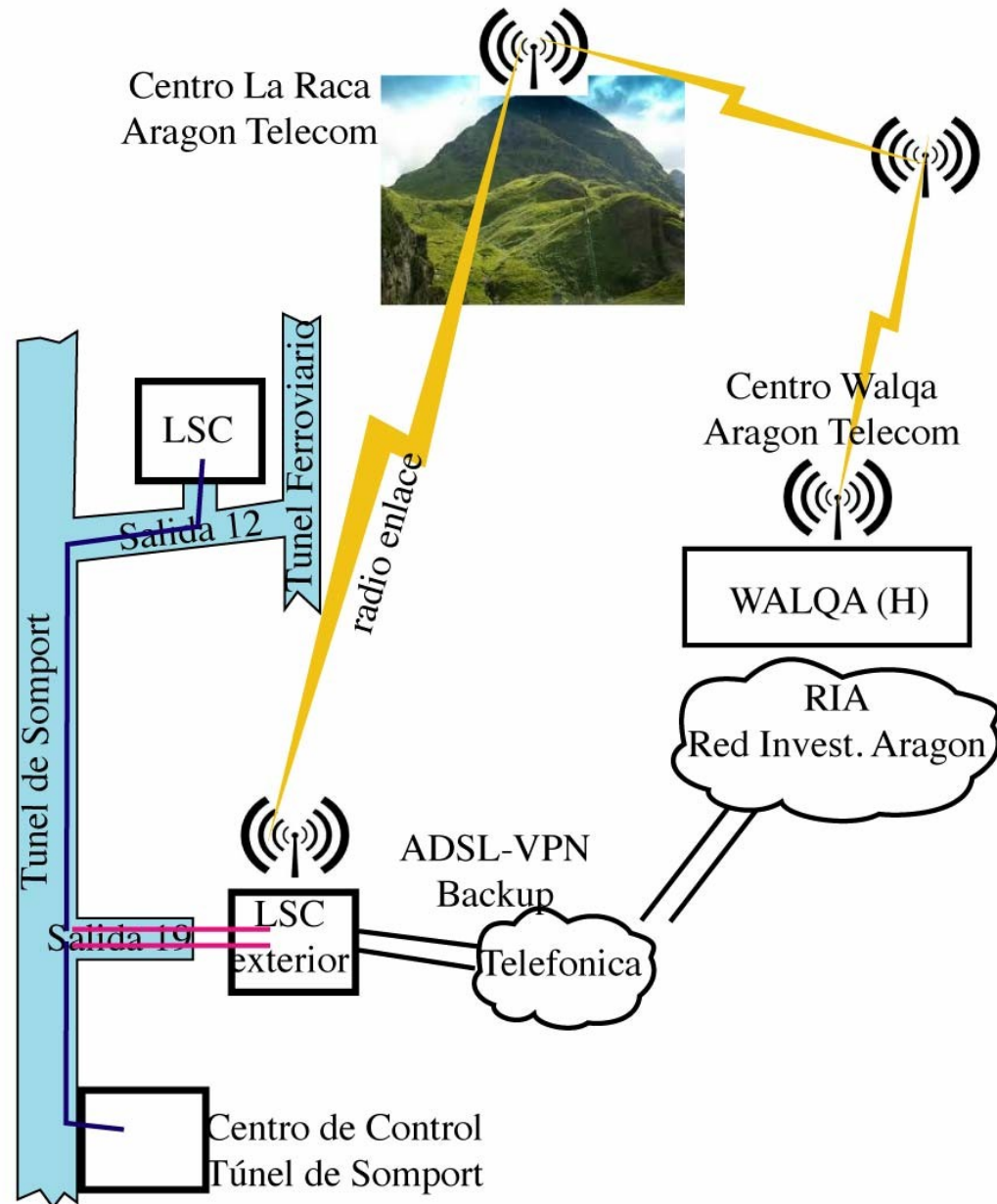
Personnel



Internet Connection and Phone

Radio-link (64 MB/s) to
RIA (Red de Investigación
de Aragón)
(DGA contribution)
Telefonics IP

11 RJ 11
pairs (telephone)
7 fibres+1 spare



Rules

- LSC is conceived as a service to the external users. No research staff
- Rules for submitting and processing proposals have been defined
 - <http://www.lsc-canfranc.es/pagina-305/>
- Safety of personnel, lab users, freeway users and environmental are a priority
- Users must follow the safety and environmental rules
 - GLIMOS should be appointed by all approved experiments**
 - Experiments must go through a risk analysis**
 - Seismic risk analysis, with proper codes and on the complete structure
 - Complete analysis by a specialised company

Safety

Access rules and safety procedures have been integrated in the Somport Tunnel system

- A simulation in September 2010



Eols, Lols, Eps, EXPs

- Approved experiments (3 years running)
 - ✓ **EXP-01-2008;LoI-2009 (ANAI5)** Dark Matter (NaI, Annual modulation)
 - ✓ **EXP-02-2008;LoI-2009 (ROSEBUD)** Dark Matter (Scintillating bolometers)
 - ✓ **EXP-03-2008;LoI-2009 (BiPo)** $0\nu2\beta$ decay (Ancillary to Super-NEMO)
 - ✓ **EXP-05-2008;LoI-2009 (NEXT)** $0\nu2\beta$ decay (Enriched ^{136}Xe TPC)
 - ✓ **EXP-06-2009 (SuperK-Gd)** Material screening for SuperK Gd
 - ✓ **EXP-08-2010 (ArDM)** Dark Matter (Liquid Argon TPC)
- Approved observatory
 - ✓ **EXP-07-2009 (GEODYN)** Geodynamics (Underground & surface)
- Expressions of Interest
 - ✓ **EoI-12-2009 (CUNA)** Nuclear astrophysics (New facility)
 - ✓ Part of LAGUNA project

Users

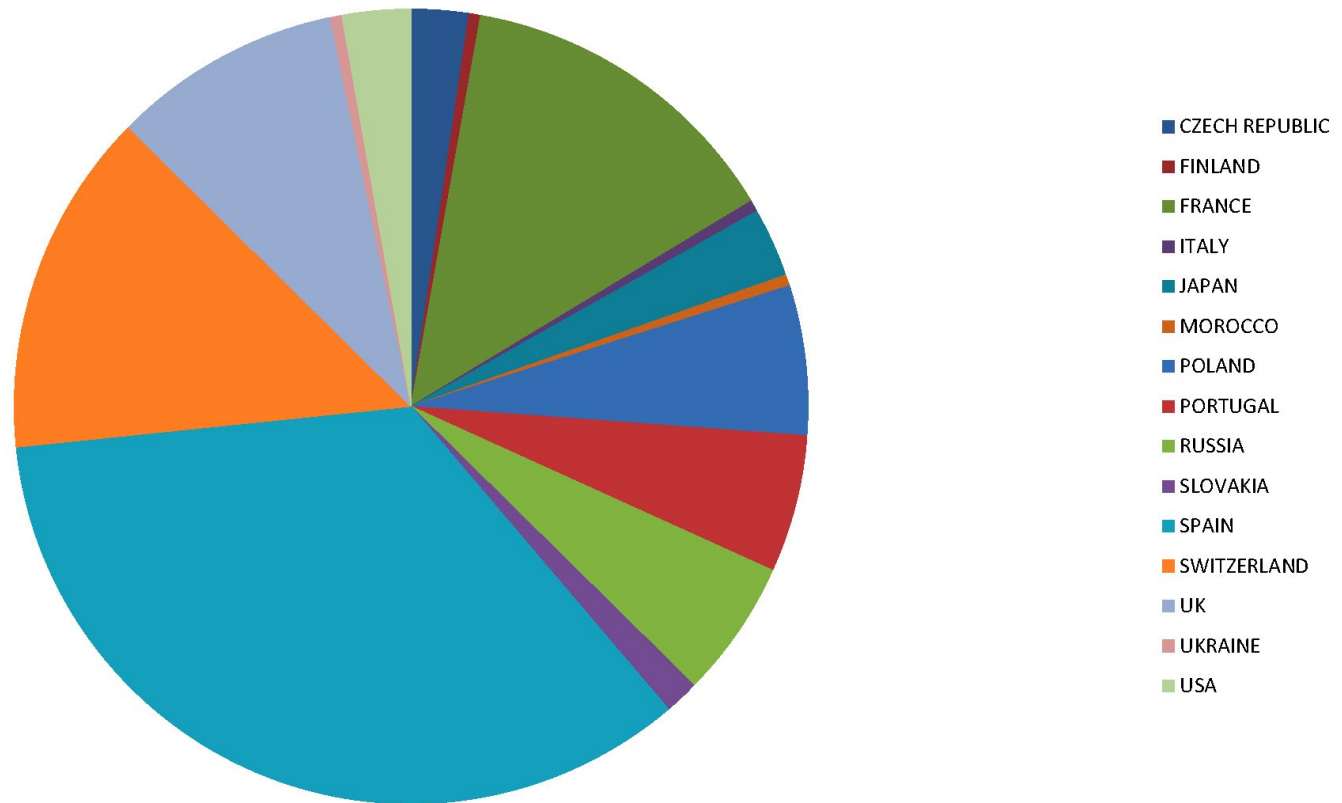
User = signature on an approved experiment

- Including Super-Nemo, of which BiPo is a task
- Not including the vast Community of TOPO-EUROPE, TOPO-IBERIA, GEODYN (open access)

VISITS in 2011 = 503

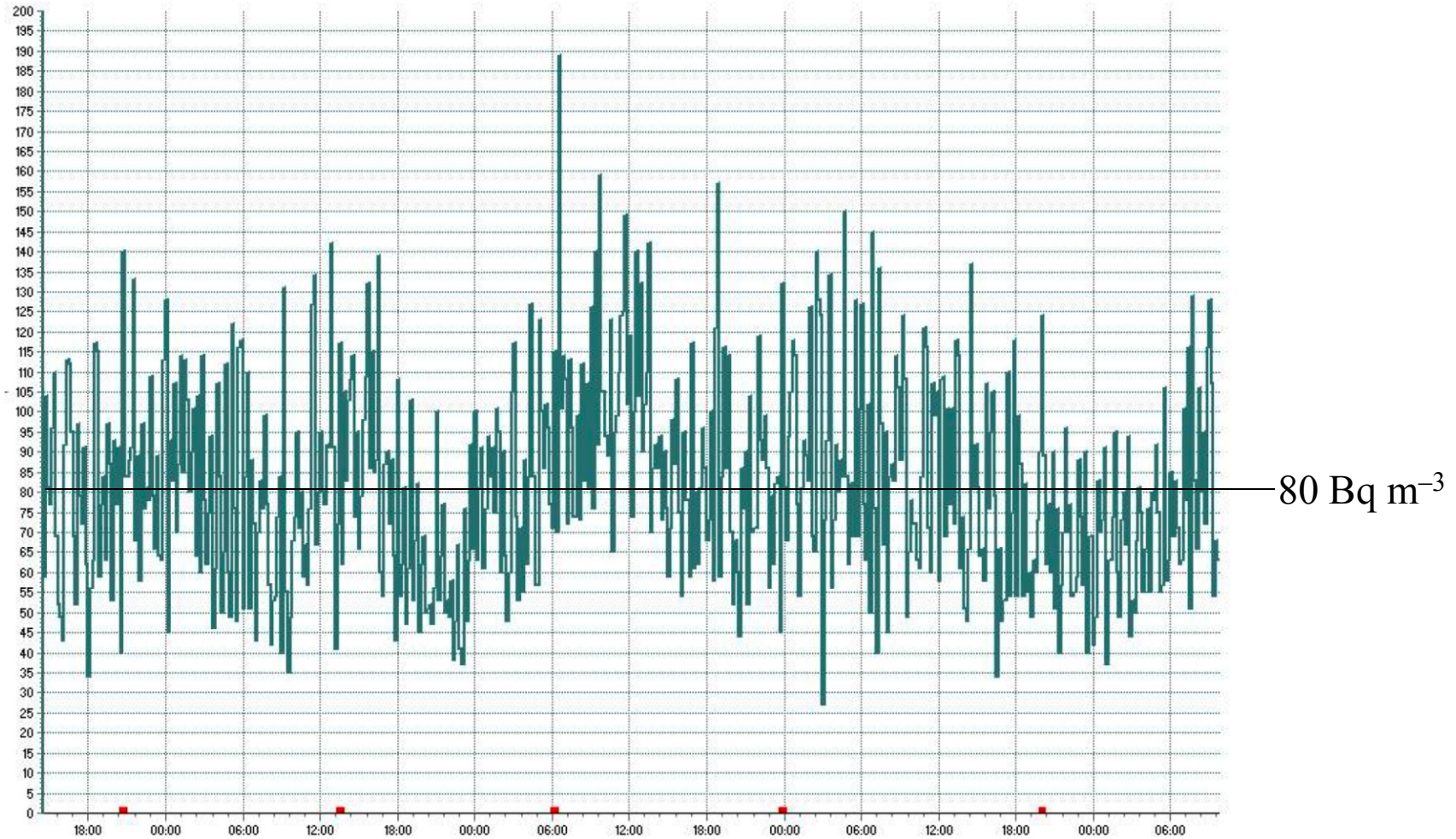
Total 214

LSC USERS BY COUNTRY



Rn Hall C

Preview C:\Users\iulian\Documents\lucru\2011\may2011\radon_meas\alphaguard_EF203





Air quality

LSC air comes from the chimney to Rio Seta built to input fresh air in the central sectors of the road tunnel

Characterise air quality (not only Rn activity) at Rio Seta, at the end of the chimney and in the LSC entrance



Gamma flux. Hall A

Iulian Bandac 2011 Hall A

^{40}K : $0.17 \pm 0.03 \text{ cm}^{-2}\text{s}^{-1}$

^{232}Th : $0.38 \pm 0.02 \text{ cm}^{-2}\text{s}^{-1}$

^{238}U : $0.68 \pm 0.17 \text{ cm}^{-2}\text{s}^{-1}$

Tot: $1.23 \pm 0.17 \text{ cm}^{-2}\text{s}^{-1}$

Julio Morales 2006 Hall B

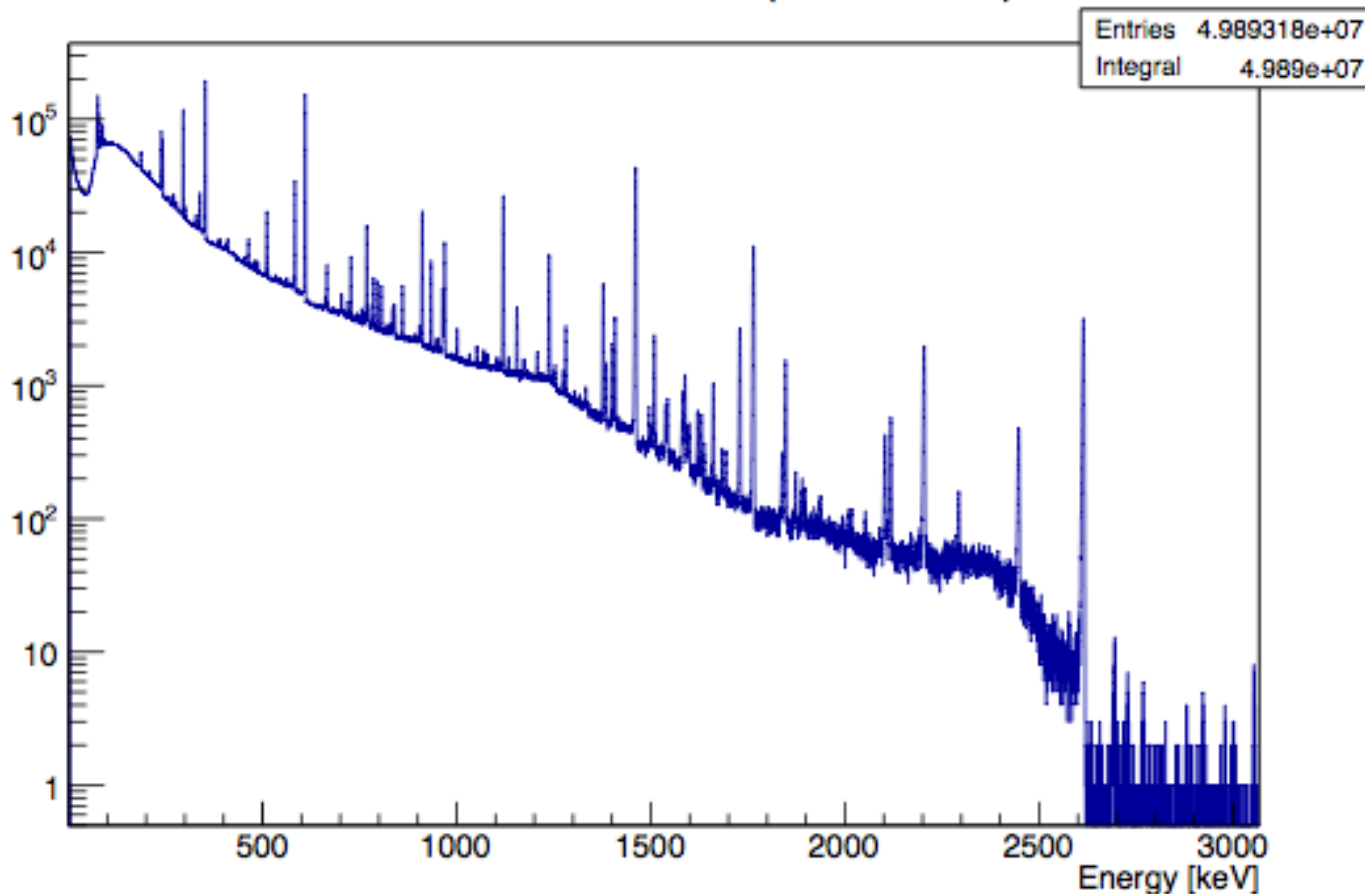
^{40}K : $0.33 \pm 0.01 \text{ cm}^{-2}\text{s}^{-1}$

^{232}Th : $0.85 \pm 0.07 \text{ cm}^{-2}\text{s}^{-1}$

^{238}U : $0.71 \pm 0.12 \text{ cm}^{-2}\text{s}^{-1}$

Total: $1.9 \pm 0.2 \text{ cm}^{-2}\text{s}^{-1}$

GeOROEL - BKG Hall A (240784 sec.)



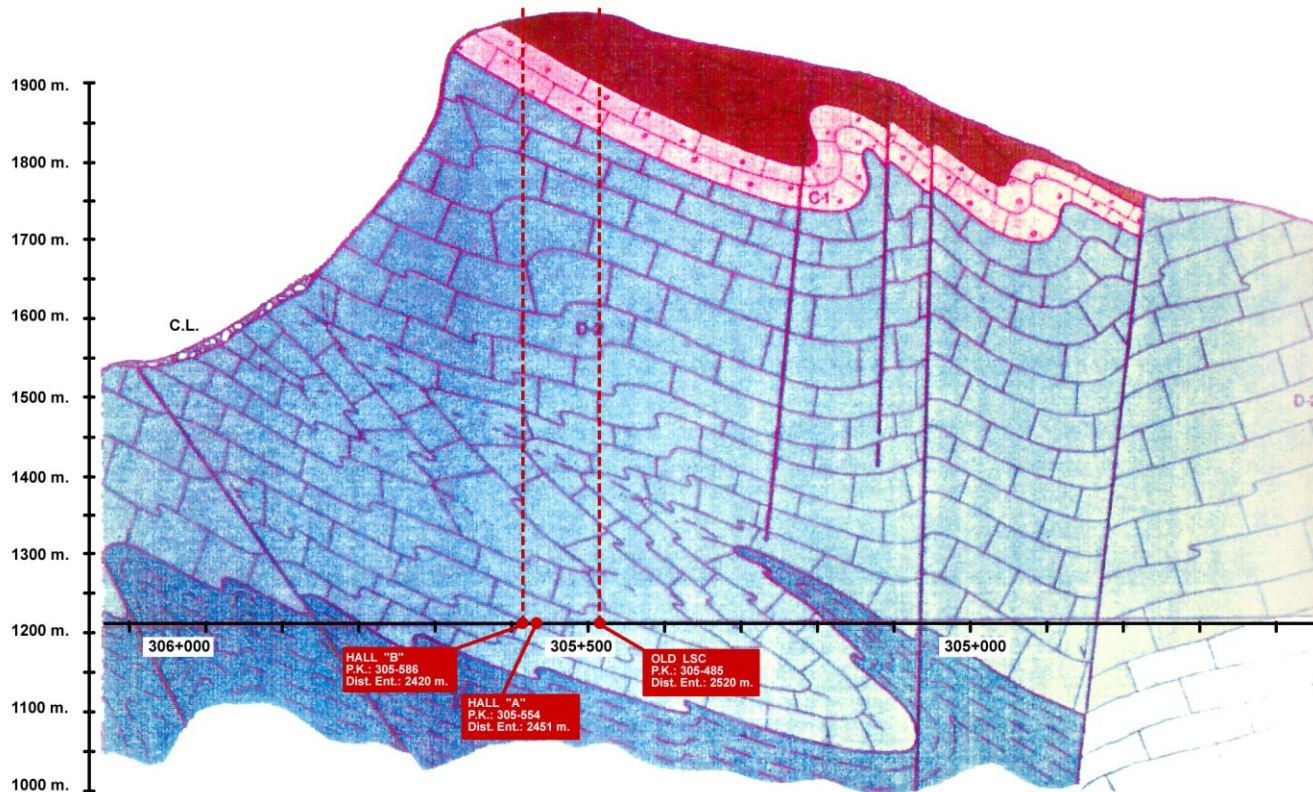
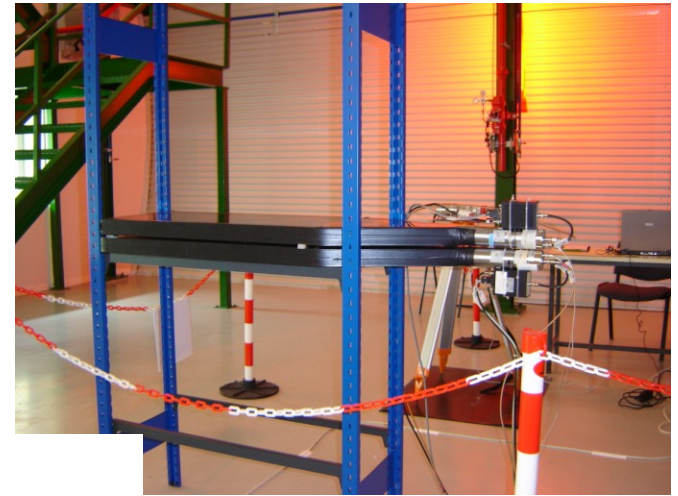
Muon flux

Measurements had been started in 2006 by Julio Morales

Preliminary results (1 month data in Hall B)

$$(5.04 \pm 0.25) 10^{-3} \text{ m}^{-2}\text{s}^{-1}$$

About twice as in the Lab 2500



Maximum vertical coverage
= 850 m

Angle dependence of the flux
expected to be important

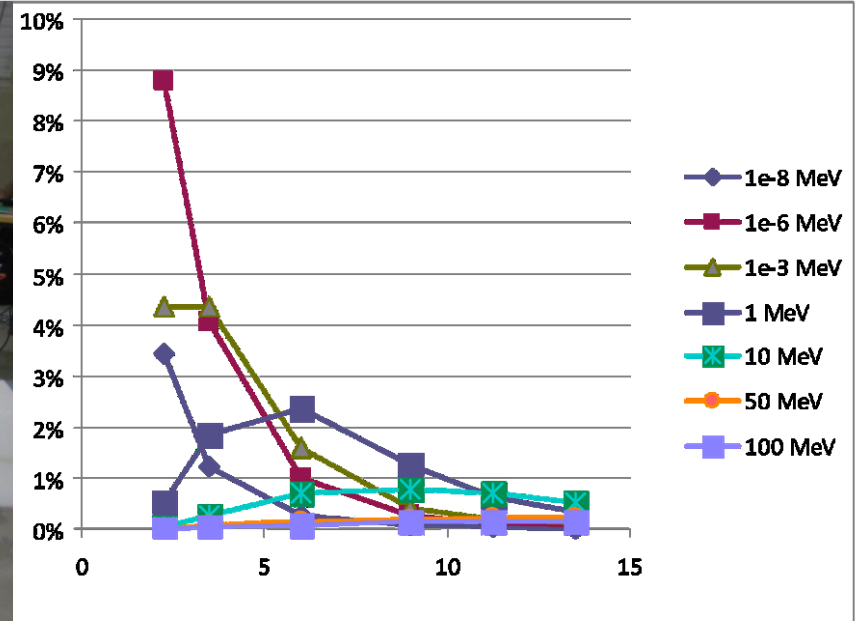
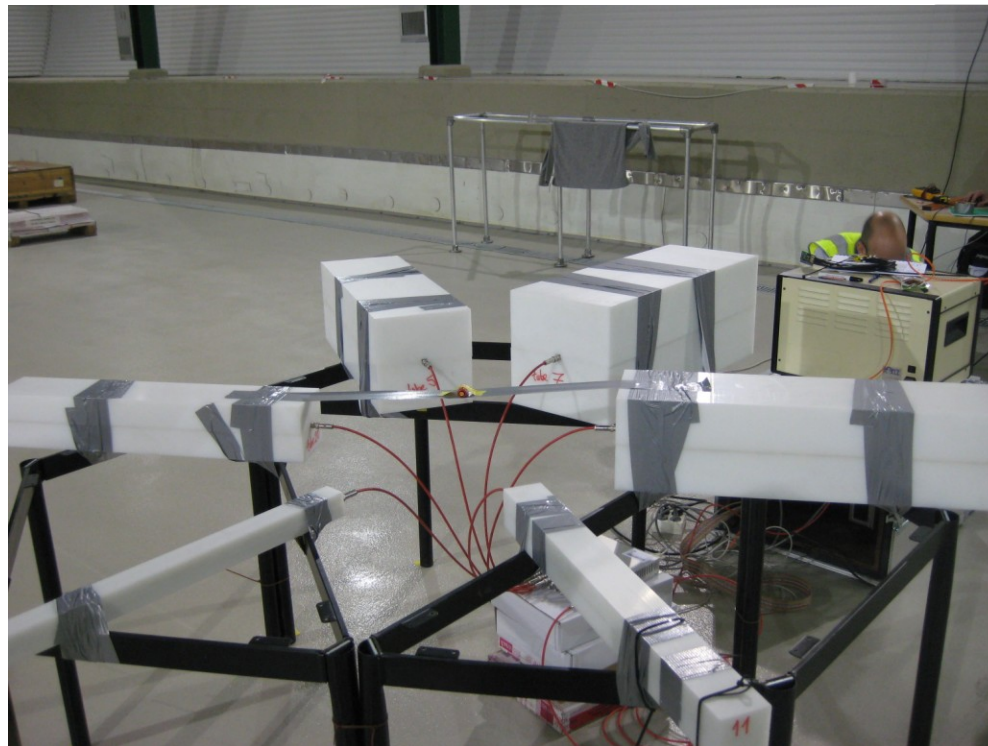
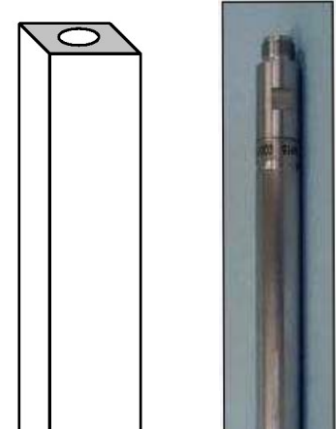
**New measurements being
planned now**

Neutron flux & energy spectrum

José Luis Taín (IFIC-Valencia) coordinating the campaign for measurements of neutron background at LSC with ^3He counters

LSC produced 6 polyethylene matrices of different thickness

Measurements being done now



HP-Ge Counters. Hall C

- A LSC service for the assay of the LSC experiments, and possibly other users
- Seven HP-Ge counters + shielding can fit in the dedicated Hall C

• 3 counters operational (GeOroel, GeTobazo, GeAnayet)

- anti Rn boxes & shield opening will be improved with time

• 2 counters of the Saragossa Uni. being refurbished at Camberra

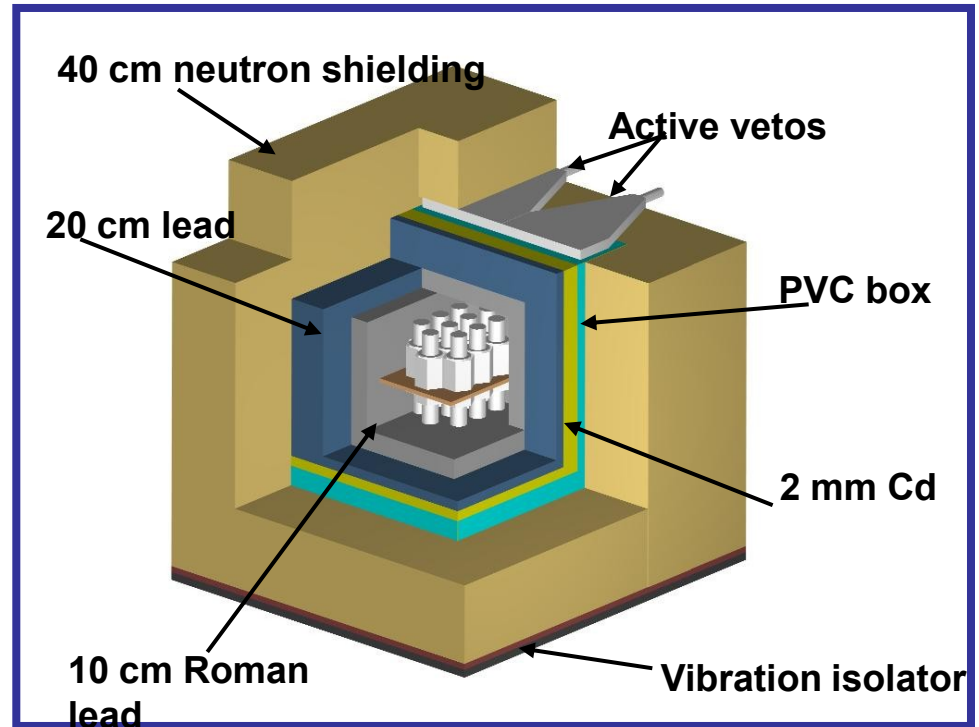
• 2 counters foreseen to be installed later this year

• 2 counters foreseen to be installed in 2012



EXP-01-2008 ANAIS

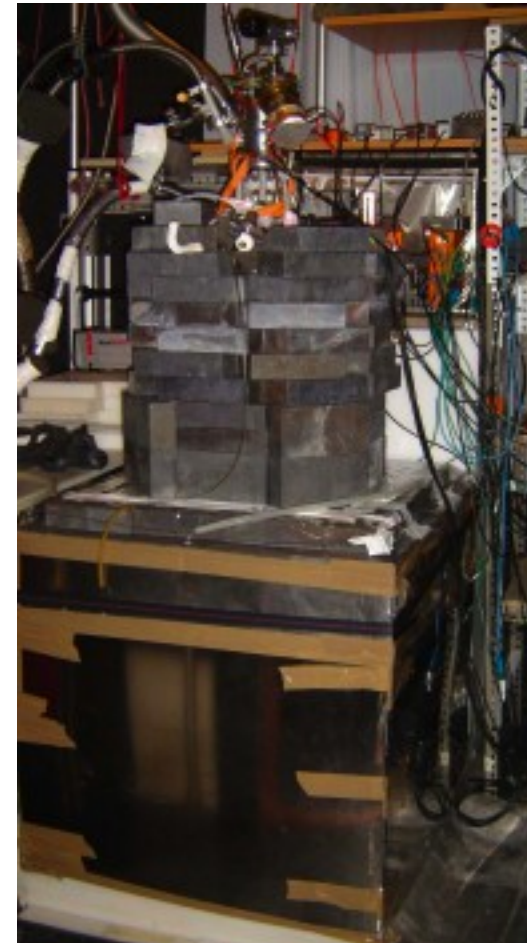
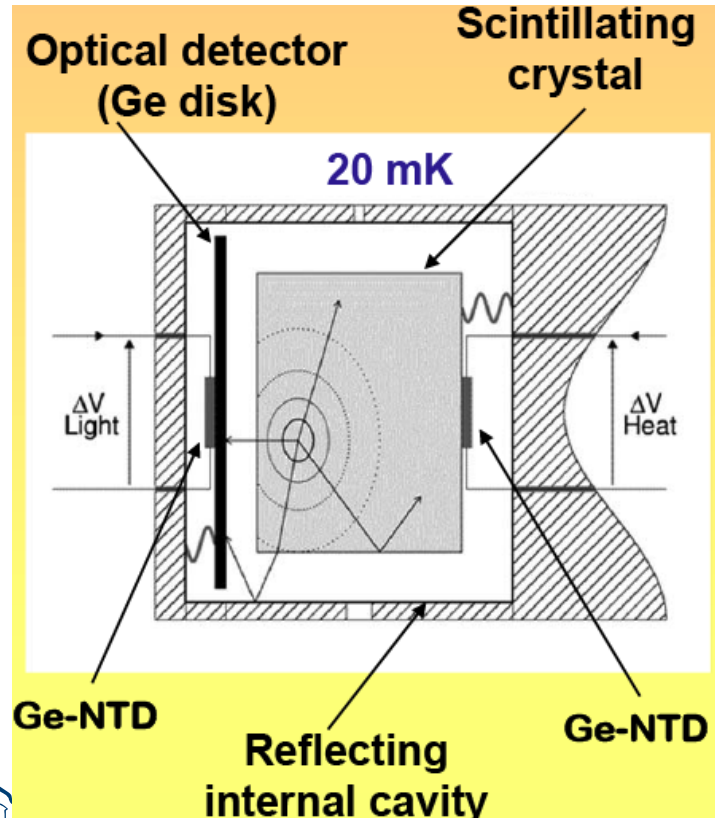
- ANAIS: Direct search for WIMPs through annual modulation on NaI(Tl) scintillating crystals at LSC.
- Goal up to 250 kg
- ANAIS: uses same target as DAMA
- Purification procedure started to achieve best possible Bkg (goal 1c/(keV kg day))
- **Prototype installed**
- If crystals available start data taking 2012



EXP-02-2008 ROSEBUD

Develop cryogenic temperatures bolometers with heat and scintillation light readout, focussing on prototypes for EURECA (next-generation European project for DM search with bolometers)

Installed



Hall B. Infrastructures for ANAIS and ROSEBUD

Faraday cage etc of
ROSEBUD



ANAIS control room

ANAIS experimental
room

EXP-03-2008 BiPo

Installation in 2011

$\Delta E_{FWHM}/E$ @ 1MeV

NEMO3 = 14-17%

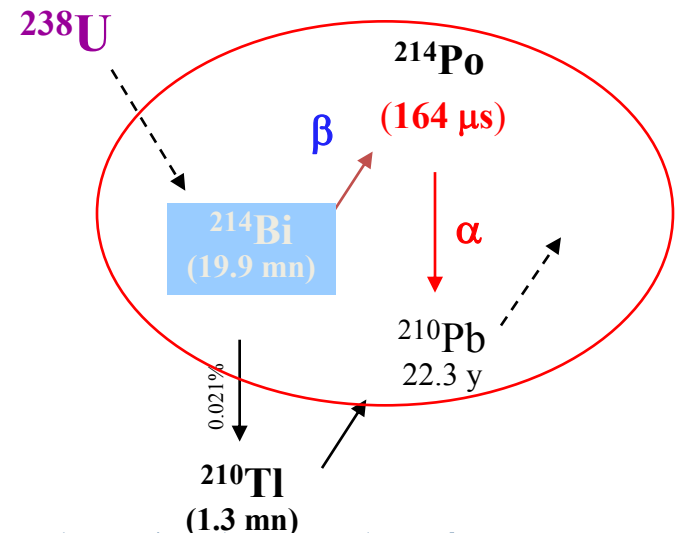
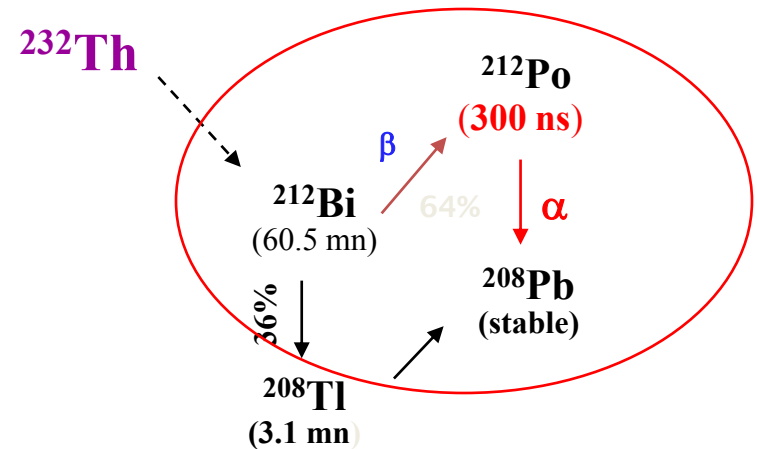
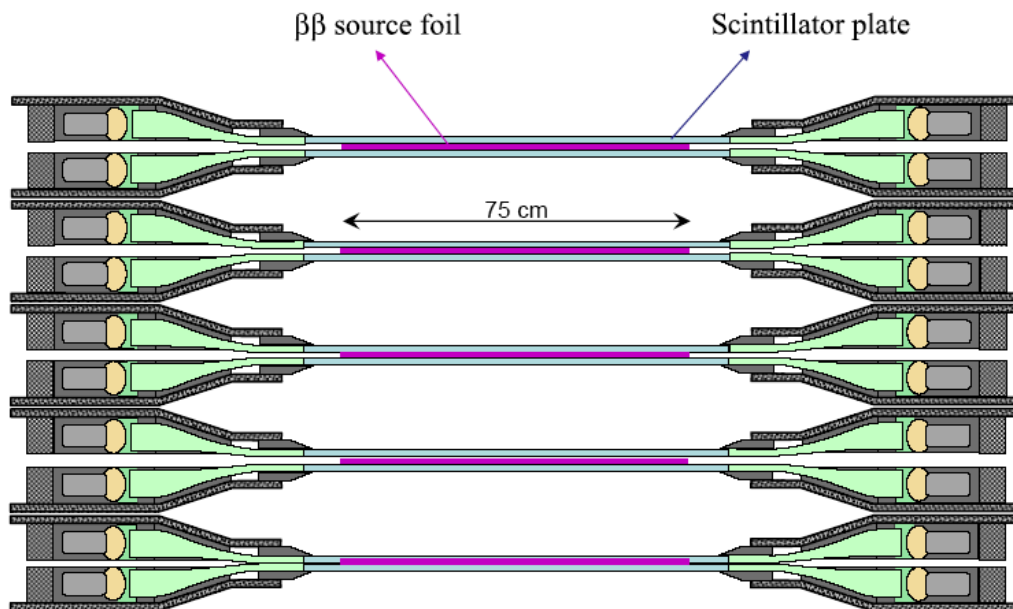
Best prototype so far = 8%

Design figure = 4% @ 3 MeV

Contamination of the (large) source foil
BiPo detectors for requested sensitivity

$^{208}\text{Tl} < 20 \mu\text{Bq/kg} \Rightarrow < 2 \mu\text{Bq/kg}$

$^{214}\text{Bi} < 300 \mu\text{Bq/kg} \Rightarrow < 10 \mu\text{Bq/kg}$



Hall A. BiPo3 prototype

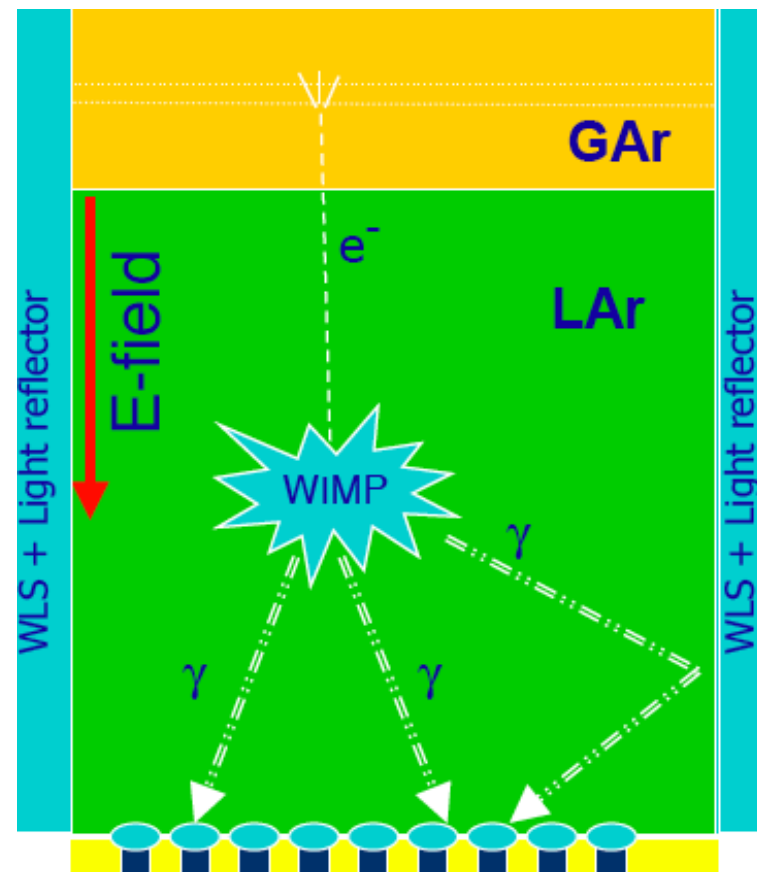
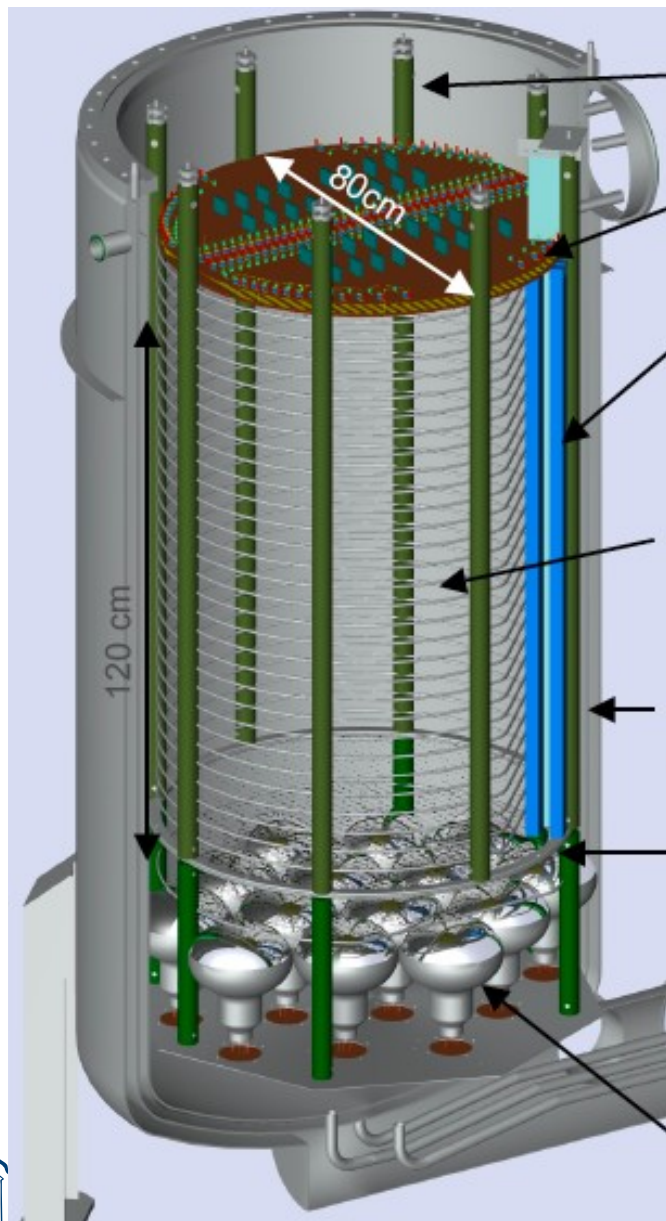


EXP-08-2010 ArDM

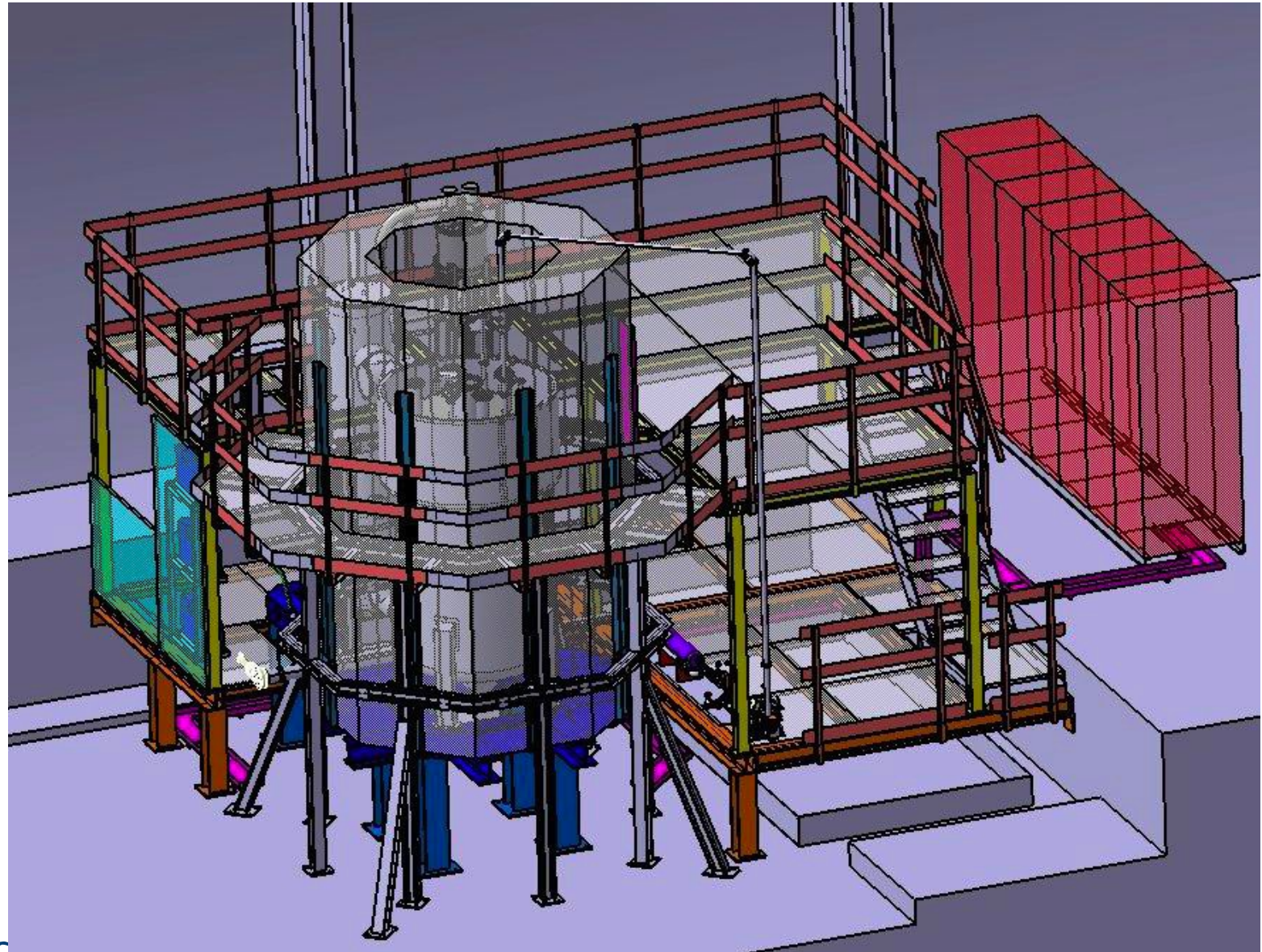
Ar two-phase TPC

Tests on 1 t prototype going on at CERN

Installation in 2011



EXP-08-2010 ArDM Hall A

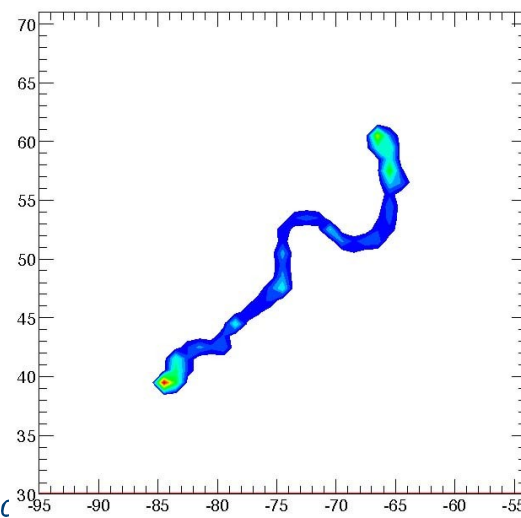
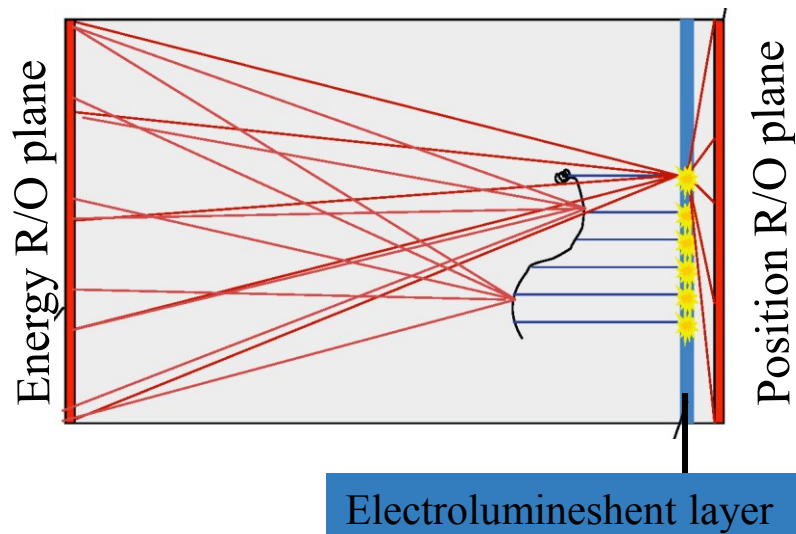


EXP-05-2008 NEXT

High pressure gas TPC with enriched ^{136}Xe

Status. TDR presented

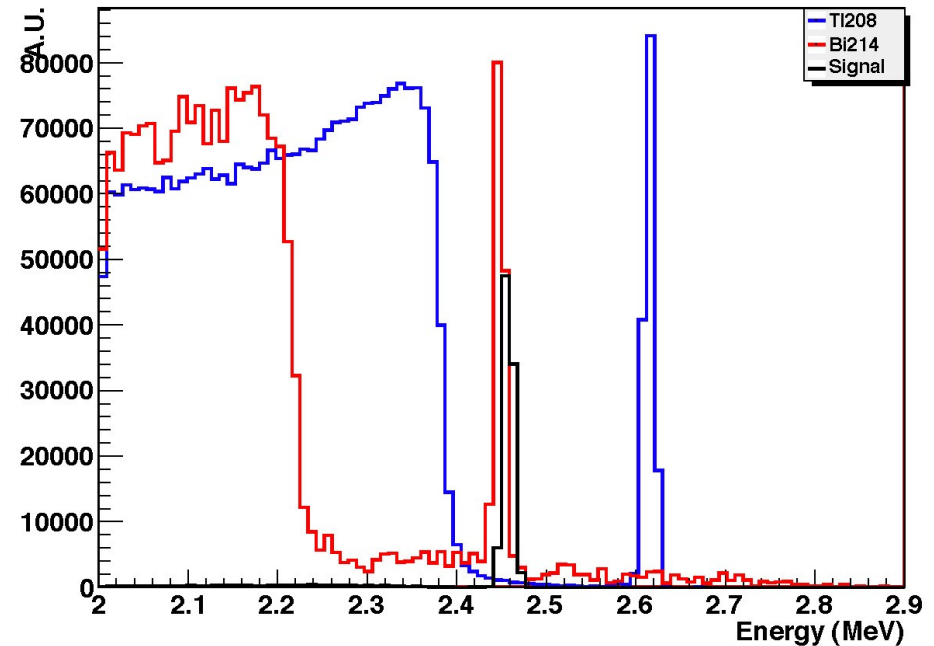
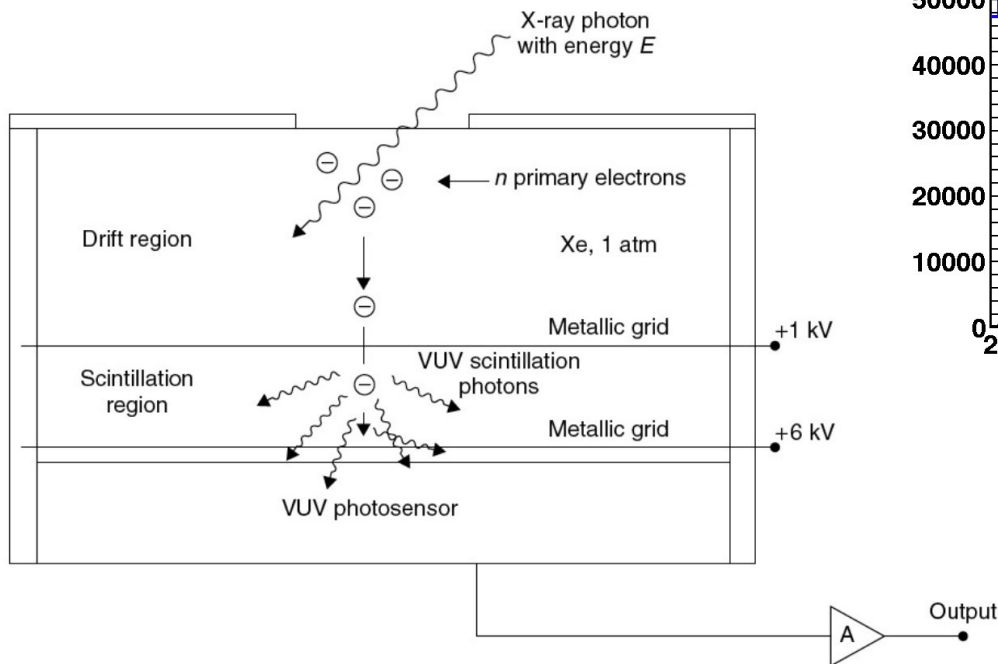
- Avoid background from surfaces by eliminating surfaces, based on event reconstruction and fiducialisation
- Obtain fine topological information
 - Tag signal by topology: 2 balls at the end of the spaghetti
 - Expected reduction of (dominant) gamma background > 100
- FWHM resolution $O(1\%)$ appears feasible with latest TPC R/O techniques
- Montecarlo evaluation of the tolerable radioactive contaminants in materials & screening
- PB+Cu shielding



Energy resolution matters

Employ proportional scintillation regime

Do not amplify charges (avoid gain fluctuations)



Depleted & enriched ^{136}Xe

4 deliveries completed

1st. 100 kg depleted in ^{136}Xe

2nd. 33 kg enriched ^{136}Xe

3th. 33 kg enriched ^{136}Xe

4th 34 kg enriched ^{136}Xe .

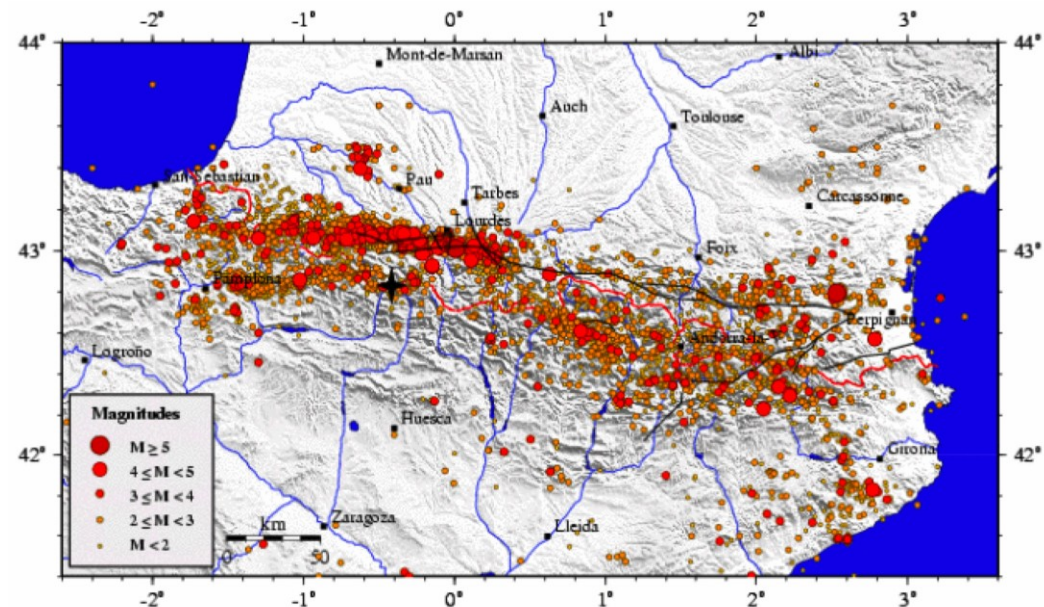
Received June 2011



EXP-07-2009 GEODYN

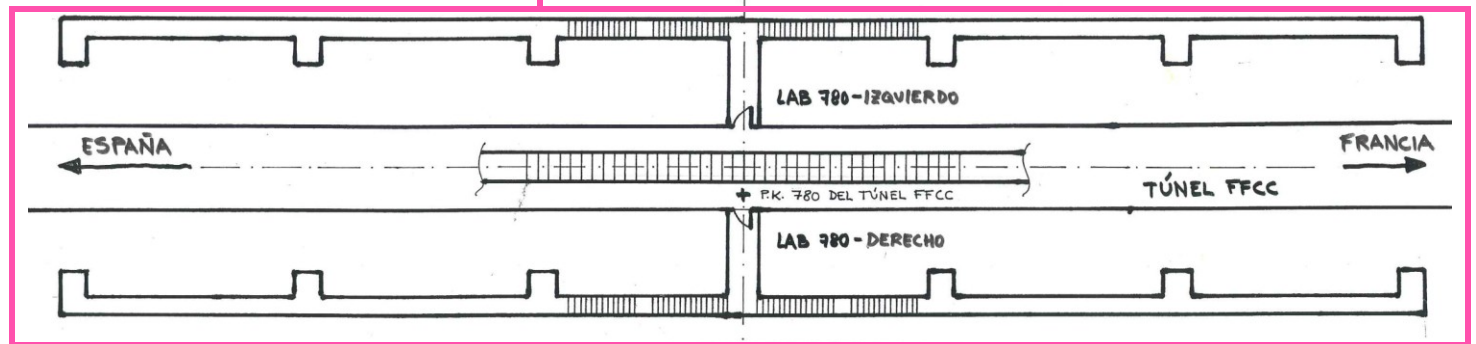
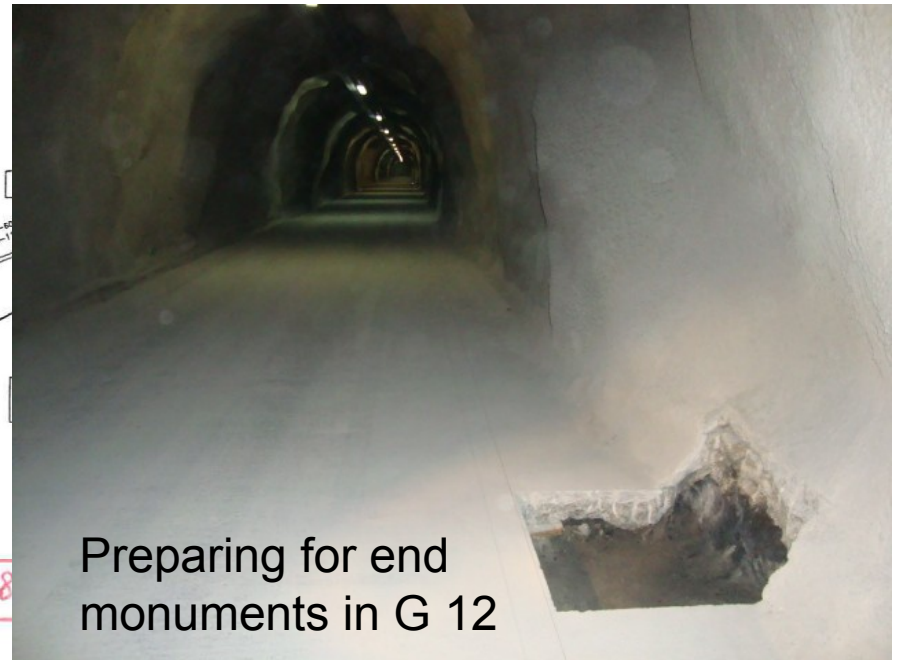
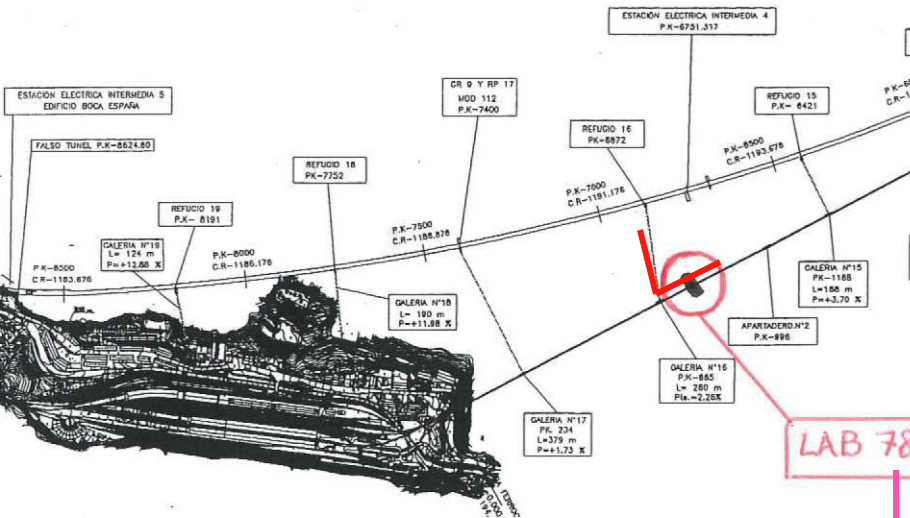
- LSC is located underground in one seismically very active areas in Europe
- Ideal position for an advanced geodynamic observatory with
 - two perpendicular LASER strainmeters
 - broad-band and strong motion seismometers
 - CGPS stations on the surface
- Integrate in the TOPO-IBERIA project
- Local phenomena
 - measure seismic phase velocity
 - Slow earthquakes
 - Strain seasonal changes
 - Tectonic deformation
- Global phenomena
 - Seismic core modes
 - Free oscillations of the Earth
 - Free core nutation

Installation in 2011
Lab 780



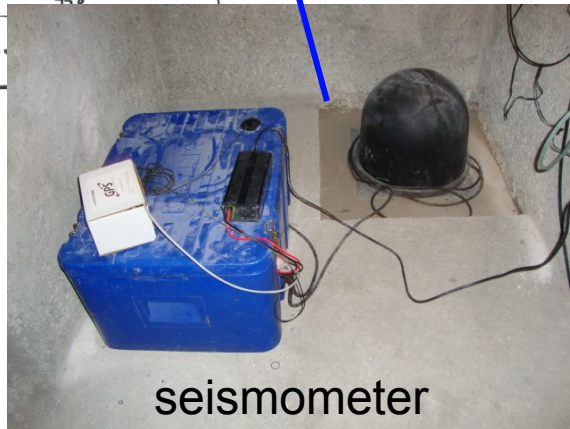
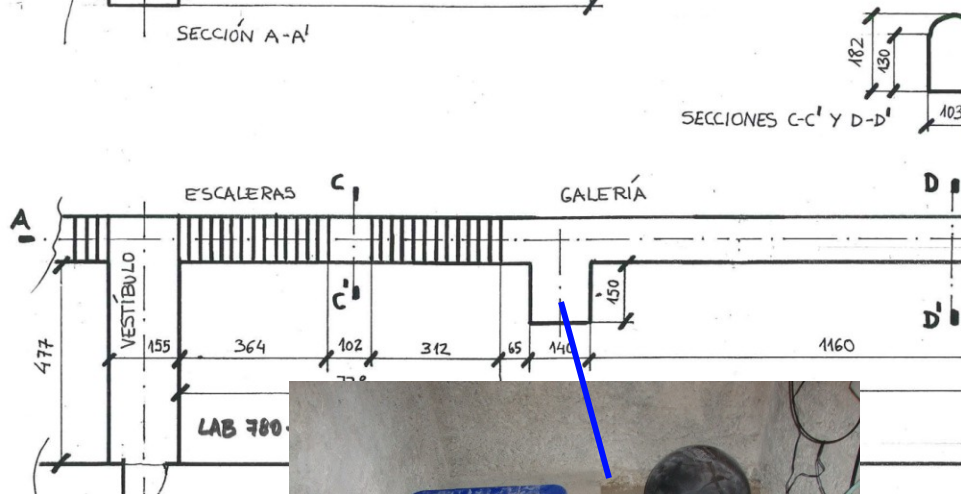
PLANTA DEL TÚNEL DE SUDORT

Lab 780 and Gallery 12



Lab 780 L

200 mm bore completed



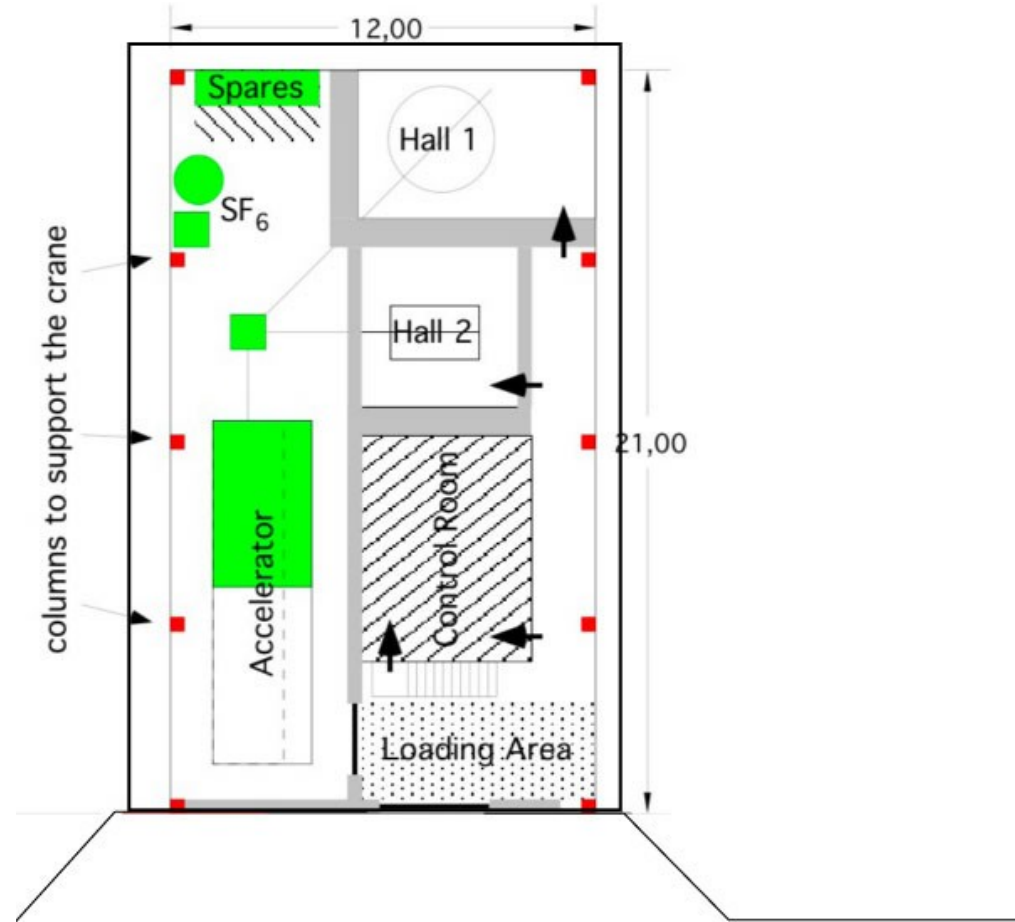
seismometer



Preparing for the end monuments

CUNA, Canfranc Nuclear Asrtophysics facility

- New dedicated hall & Accelerator (about 3 MeV)
- Develop synergic program with LNGS
- Preliminary design hall now
- Final design of hall in 2012



"Train" tunnel (existing)

Dark Life

- **Microbiology**

- How deeply in the earth does life extend?
- What makes life successful deep under the surface?
- What can life underground teach us about how life evolved?

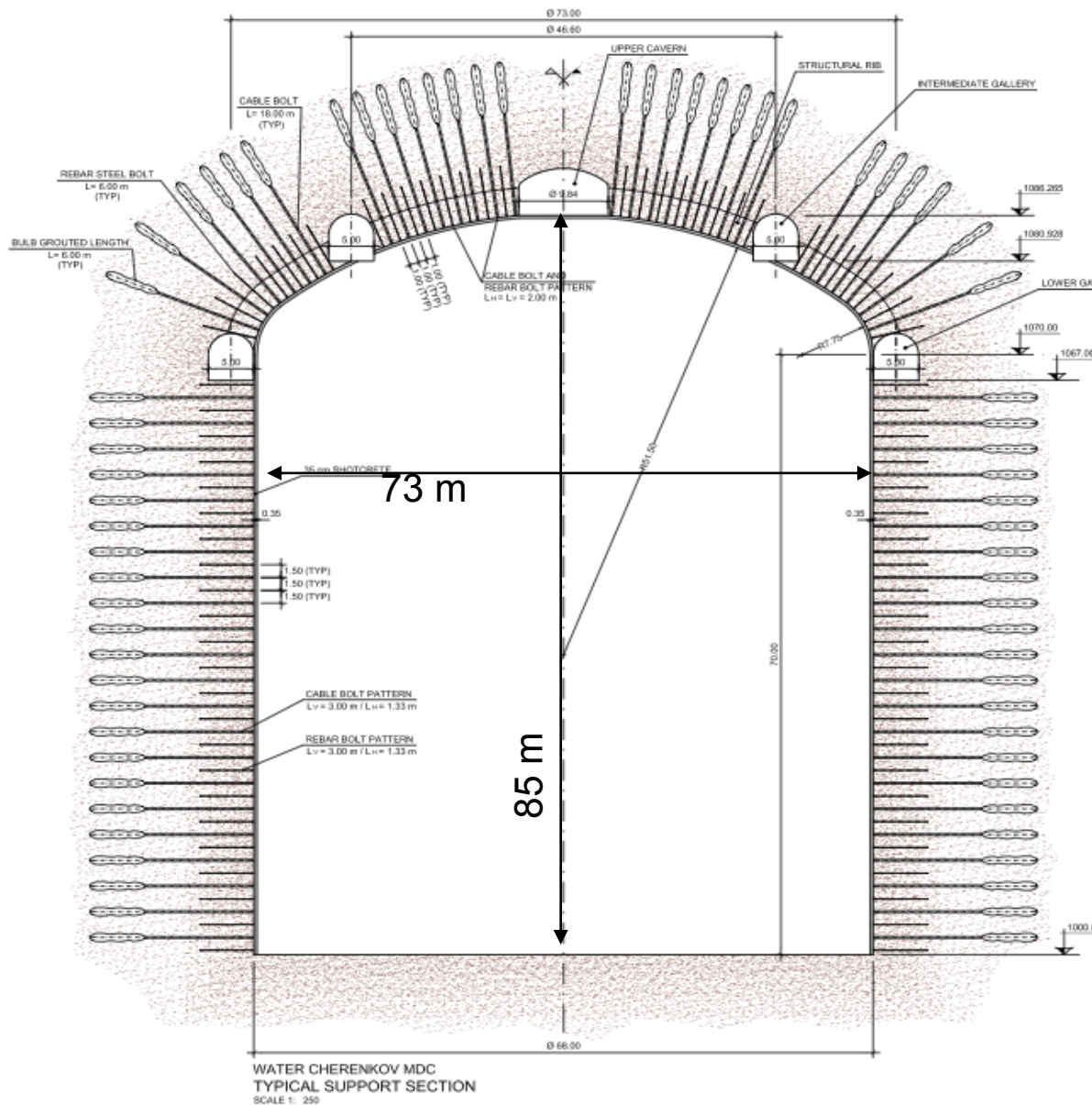
- **Cross-disciplinary work between biologists and geologists**

- Do bacteria enter into the genesis of minerals and rocks?

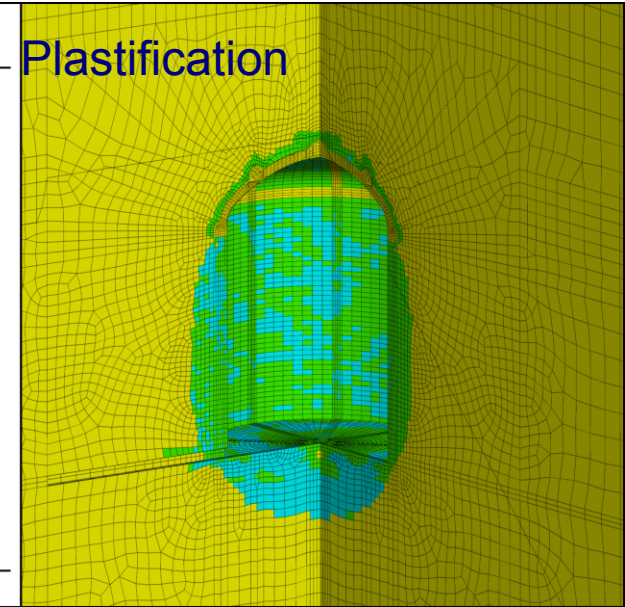
Subject considered, in particular, by the DUSEL projects in the USA

No proposal yet

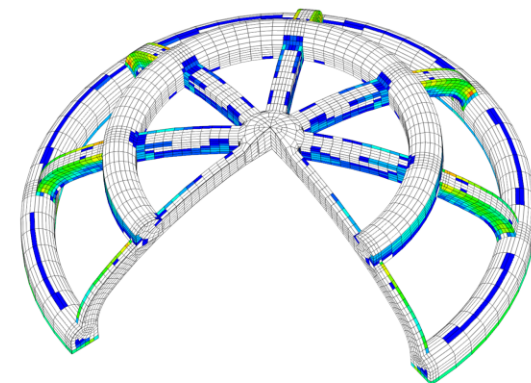
LAGUNA. Preliminary design. 1 of 3 WC cavities



Plastification



Supports of the dome





Thank you