ANDES

AGUA NEGRA DEEP EXPERIMENT SITE

Proposal for a Deep Underground Laboratory
in the Southern Hemisphere

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CBPF & Observatório Nacional, Brazil
On behalf of ANDES Coord. Team

Neutrino – Latin America Workshop
Fermilab, 27-28 April 2016

Proposal:

- To build an Underground Lab in the AGUA NEGRA tunnel.

First **deep underground Lab** in the **Southern Hemisphere.**

Content

- The Agua Negra Tunnel
- ANDES Lab proposal
  - Scientific programme (preliminary)
  - Conceptual design
- Organization (CLES)
- Current status

The Agua Negra Tunnel

The Tunnel Proposal

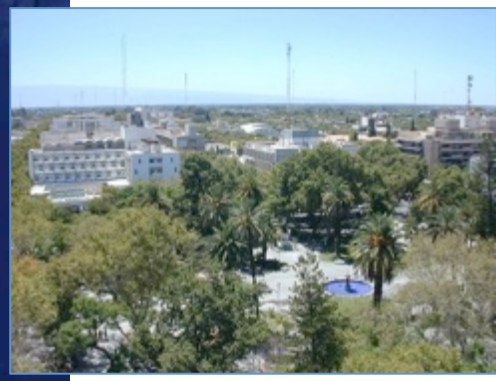
- Why a Road tunnel: - growing trade of Argentina and Brazil with Asia.
- Shipping through Chilean ports → to cross the Andes.
- The mountain Pass suffers severe cuts in winter.

Views of the Agua Negra pass at 4780 m a.s.l.

Tunnel approx. Coordinates: 30.19 South, 69.82 West

La Serena, Chile

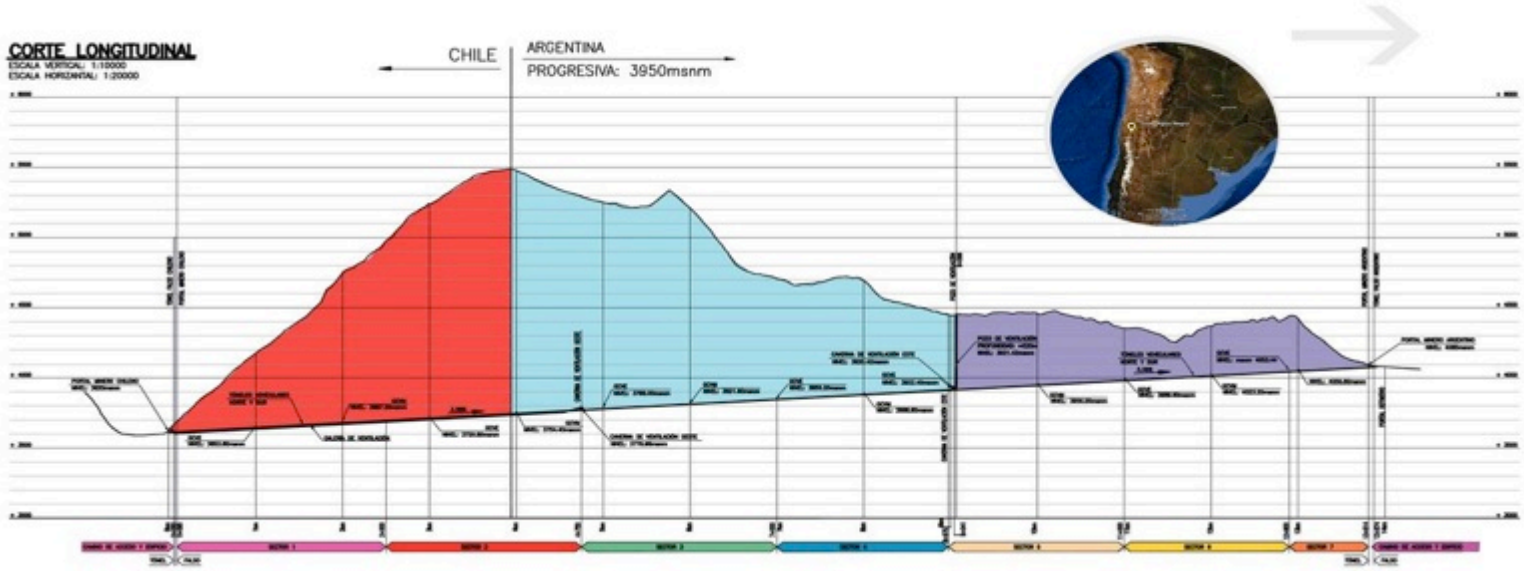
San Juan,
Argentina



Cerro Tololo
Int. Am. Observatory

Tunnel features

- Altitude: 3600 m asl (Chile), 4085 m asl (Argentina), slope ~ 3%
- Two parallel tunnels, 14 km long, 60 m separation
- 12 m diameter (two lanes each), connecting galleries every 500 m.
- Deepest point: 1750 m depth.
- Forced ventilation (14.5 MW).



Rock studies

Main rock: - Andesite
variations: - rhyolite
- basalt
- dacite
- trachyte

9 samples from 8 perforations up to 600 m deep

(Bq/kg):	Andesite	Basalt	Rhyolite 1	Rhyolite 2	Canfranc
U-238	9.2 ± 0.9	2.6 ± 0.5	14.7 ± 2.0	11.5 ± 1.3	4.5 -- 30
Th-232	5.2 ± 0.5	0.94 ± 0.09	4.5 ± 0.4	4.8 ± 0.5	8.5 -- 76
K-40	47 ± 3	50 ± 3	57 ± 3	52 ± 3	37 -- 880

Thanks to Laboratorio de Activación Neutrónica (Bariloche, Argentina)

Tunnel proposal updates

- Pre-feasibility study done in 2005, feasibility in 2008.
- 2009, October: presidents of Argentina and Chile signed a Bi-National Integration Treaty, including San Juan-Coquimbo.
- 2010, August: MERCOCUR Meeting in San Juan: "strong support for Agua Negra Tunnel", with President of Brazil pushing for tunnel tender.
- 2011, December: Argentina Congress voted a 800 MU$D guarantee fund for the Agua Negra tunnel.
- 2012, March: presidents of Argentina and Chile signed international agreement asking for the tender of the tunnel.
- 2013: New Conceptual Design and budget review.
- 2014: Detailed Engineering Design.
- 2015, June: Chile Congress approval for new budget.
- 2015: expected call for tender

The ANDES Laboratory proposal

ANDES: **A**gua **N**egra **D**eep **E**xperiment **S**ite

ANDES: the proposal

To build an Underground Laboratory in the deepest point of the Agua Negra Tunnel.

ANDES will be:
- an International, Latinamerican Laboratory (its first members and proponents are Argentina, Brazil, Chile and Mexico).
- the **First** deep Underground Lab in the **Southern Hemisphere**.
- **the Third deepest** in the **world.**

General coordinator: Xavier Bertou (Ctr Atómico Bariloche, Argentina)
in Chile: Claudio Dib (U. Federico Santa María, Valparaíso, Chile)
in Argentina: Osvaldo Civitarese (U. Nac. La Plata, Argentina)
in Brazil: Joao dos Anjos (CBPF, Rio de Janeiro, Brazil)
in Mexico: Juan Carlos D'Olivo (UNAM, Mexico D.F., Mexico)

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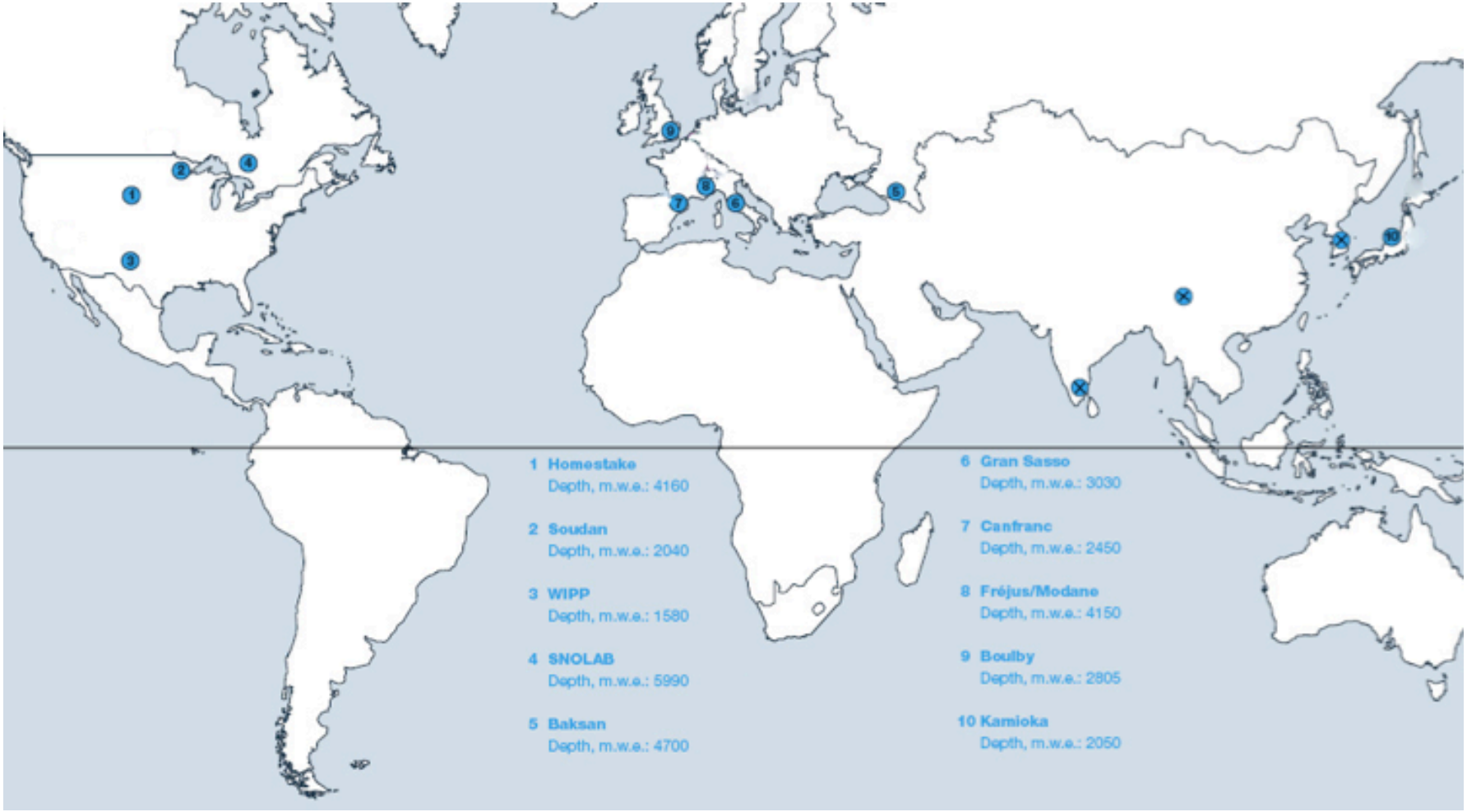
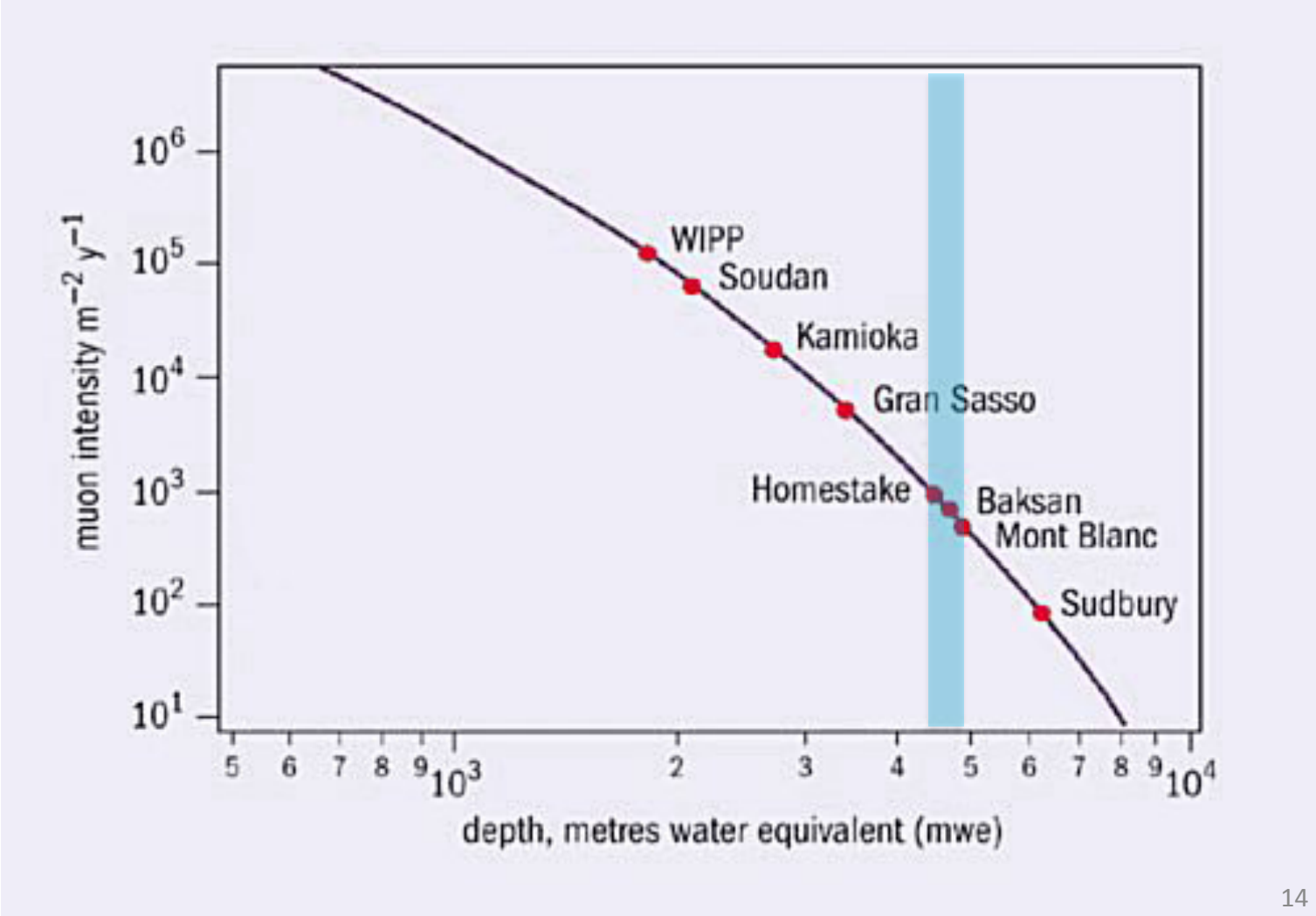


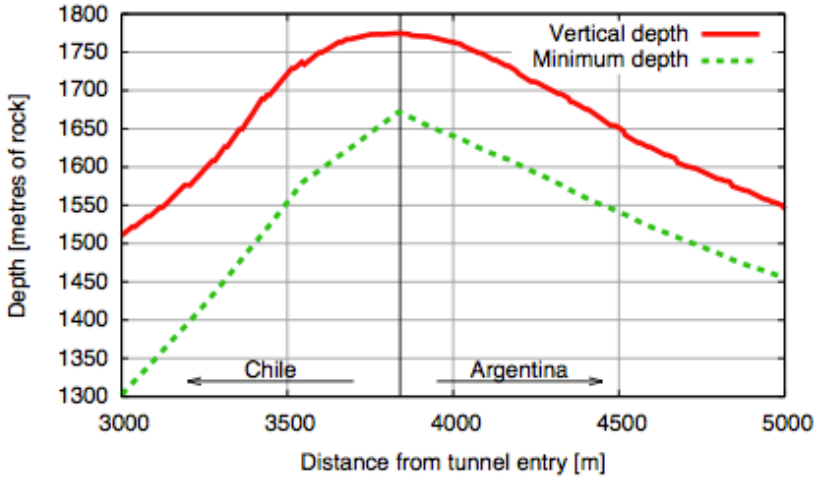
So far, all deep U. Labs are in the Northern Hemisphere.

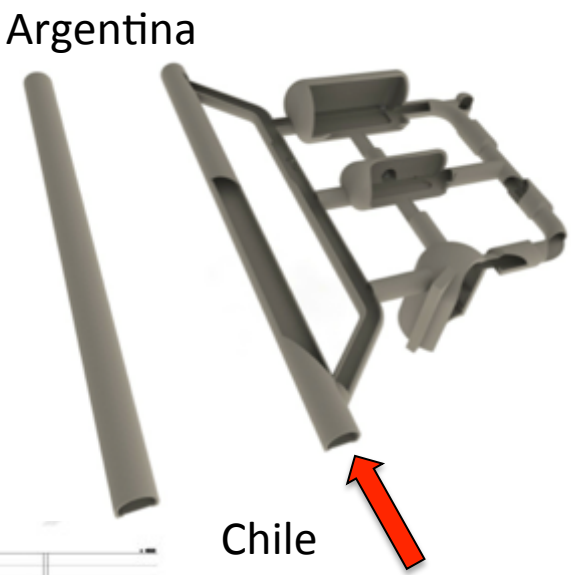
Flux at sea level ~ 100 /m^2 s ANDES: ~ 4500 mwe; atn: 10^{-7}

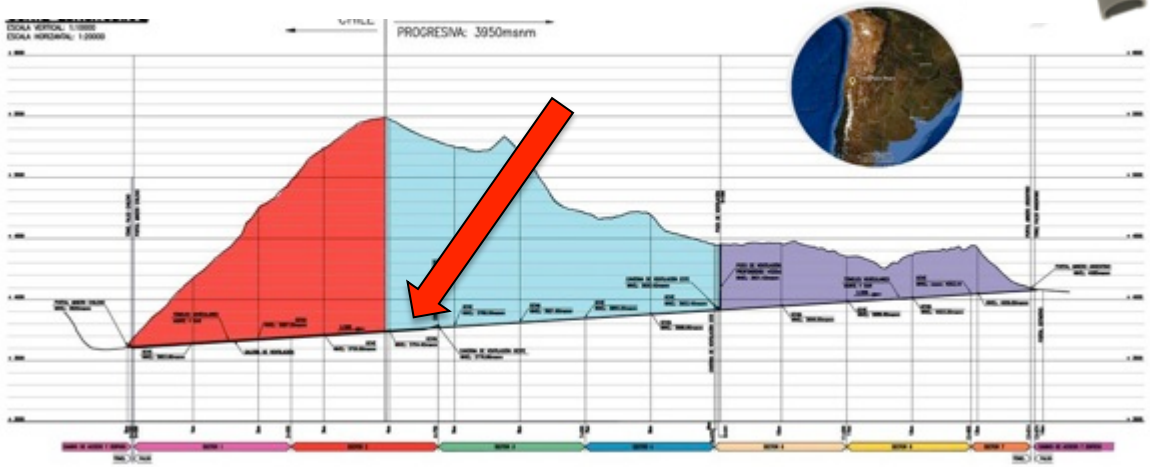


The ANDES Lab proposal

- Deepest point in tunnel (~ 1750 m deep)
  ≈ 3.5 km to Chile entrance, 10 km to Argentina exit







What makes ANDES special?

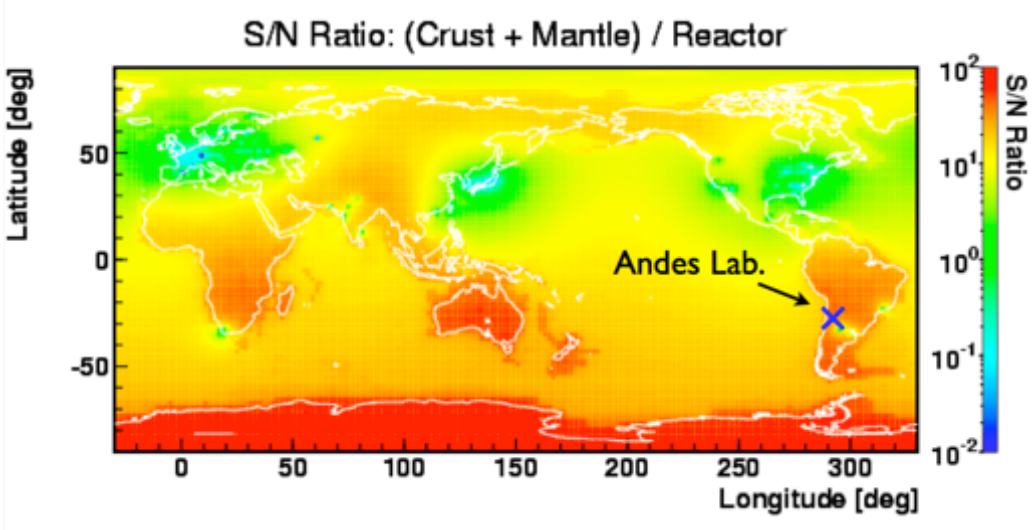
- Third deepest Lab in the world.

- First in the southern hemisphere
    - Opposite weather-induced modulations

- Low reactor neutrino bkg
  - Embalse: 2.1 GWth, 560 km
  - Atucha: 1.2 GWth, 1080 km
  - Atucha II: 2.1 GWth

- Geoactive Region
  - Geophysics experiments

- Very long baselines...?
  – CERN: 9920 km.
  – Fermilab: 7640 km.
  – KEK: 12400 km (1500 km from earth center)



ANDES scientific programme
(preliminary)

ANDES initial Scientific Programme

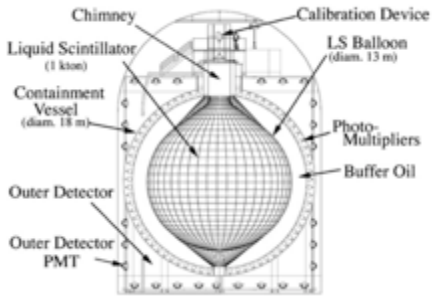
- Neutrino physics:
  - host double beta decay experiments
  - large neutrino detector (similar to KamLAND / Borexino)
    - focused on low energies (solar / SN / geoneutrinos)

- Dark Matter
  - modulation measurements
  - new technologies

- Geophysics
  - link Chile-Argentina seismograph networks
- Biology
- Low radiation measurements
- Nuclear Astrophysics (low energy beams)

Proposed **Large Latinamerican Neutrino Detector**

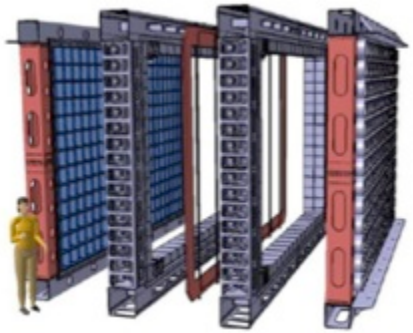
- 3 – 10 kton of liq. Scintillator
- arXiv:1027.5454
- Main topic for next ANDES workshop.



Double Beta experiments:

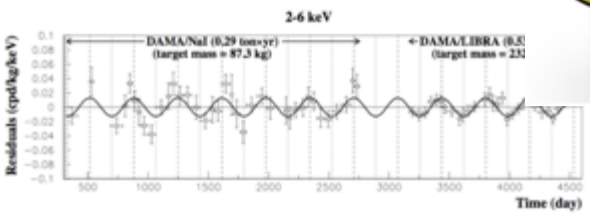
Manifested interest:

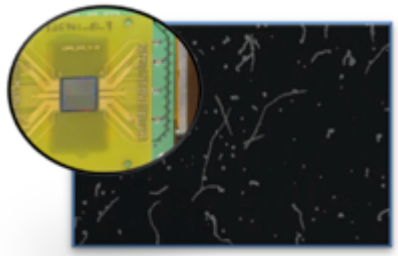
- NEXT
- SuperNEMO modules: ~ 100 kg ^{82}Se



Dark Matter:

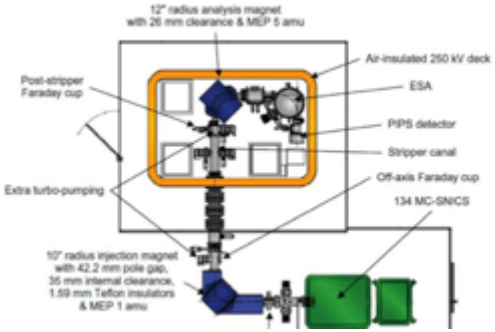
- Host a south copy of a DM experiment with modulation signal.
- Host a next gen. DM experiment.





Nuclear Astrophysics:

- proposal for a 300 keV high intensity ion beam (similar to LUNA)
- Study nuclear reactions of stars



ANDES Conceptual Design

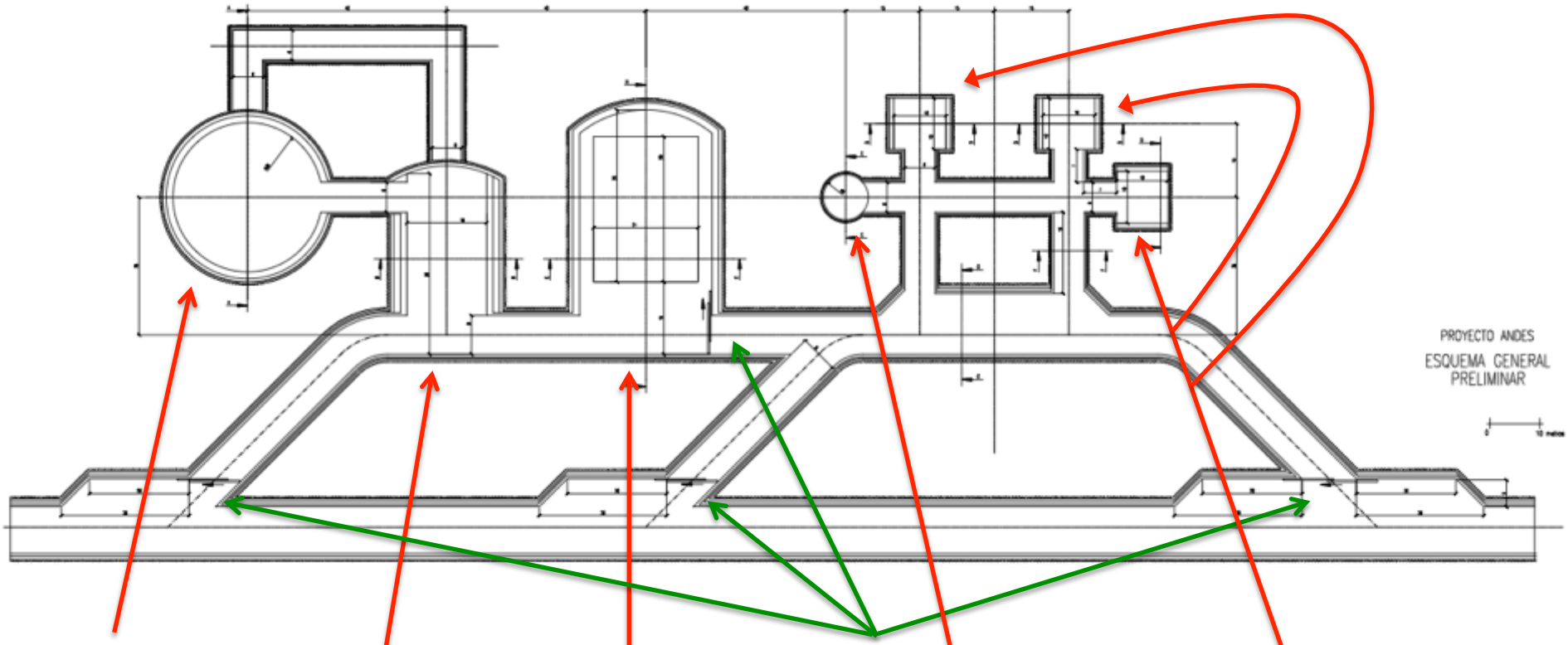
ANDES proposed infrastructure

- **The underground Lab itself:**
  - 2 horizontal caverns, 1 large pit, 1 small pit, service room, access galeries.

- **Support Laboratories:**
  - One in Chile (La Serena), and one in Argentina (Rodeo)
  - To host Laboratories, administration, offices and an Outreach Center.

- **Lodging at the borders (portals).**
  - Office, bedrooms, storage

Proposed schematic layout



Large pit
30 m diam
42 m deep

Access:
at 30 m high
and
at bottom

Service hall
40 m long
16 m wide
15 m high
Oval section

Main hall
50 m long
21 m wide
23 m high
Oval section

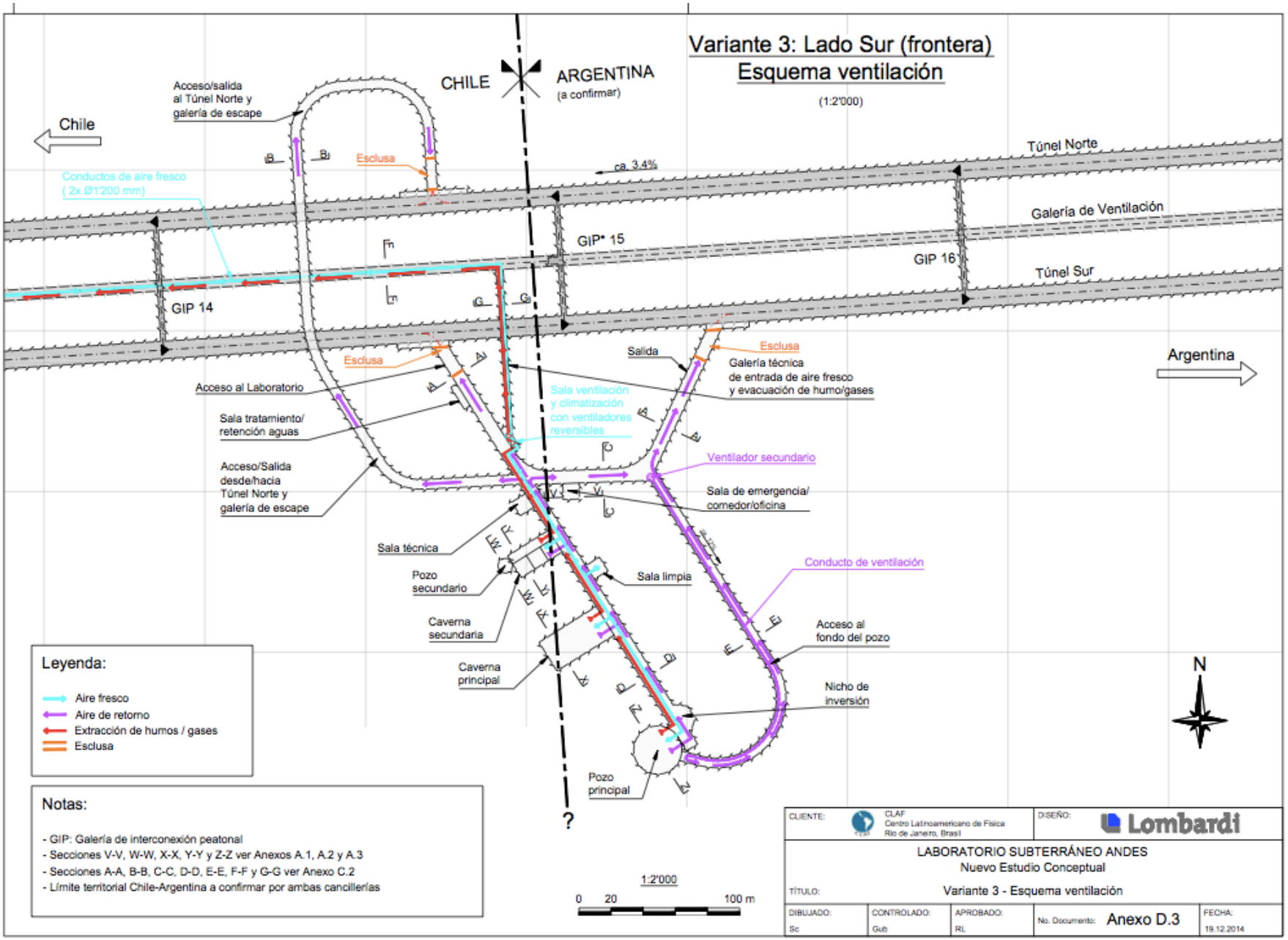
Gates

Ultra low radiation pit
9 m diam
15 m deep

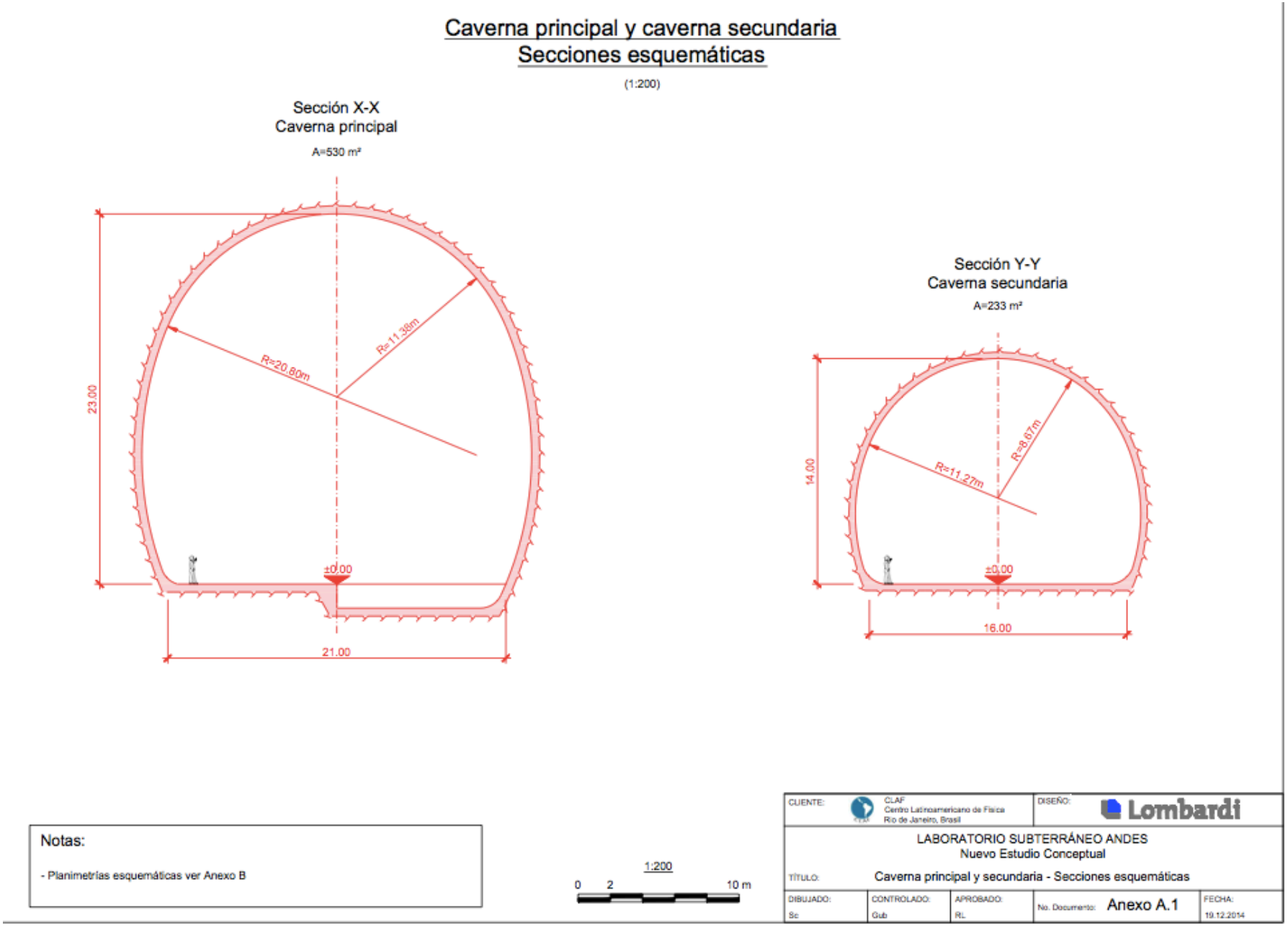
Access:
At 10 m high and bottom

3 secondary caverns
10 x 10 x 10 m

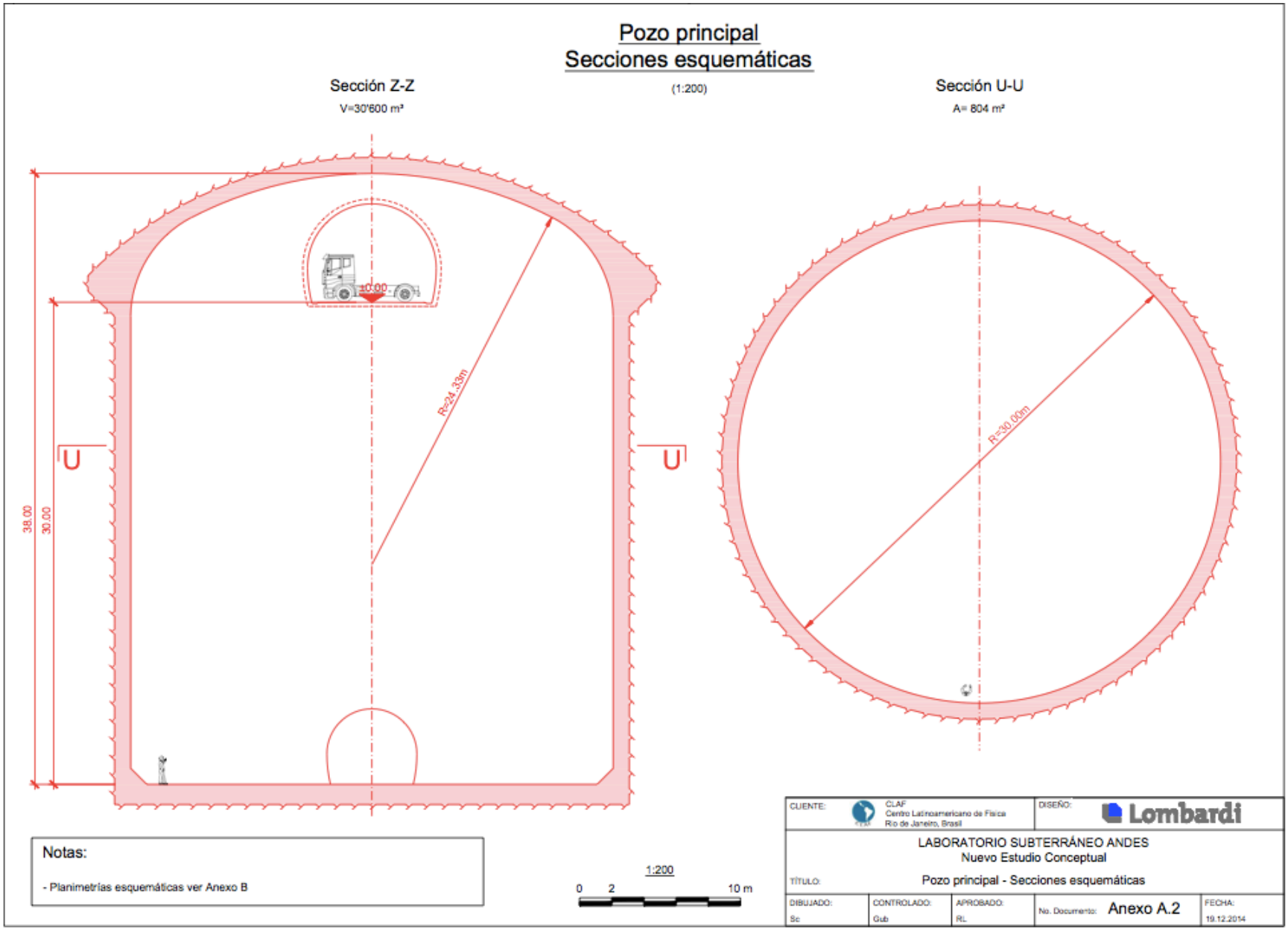
Conceptual Design (by Lombardi): Layout



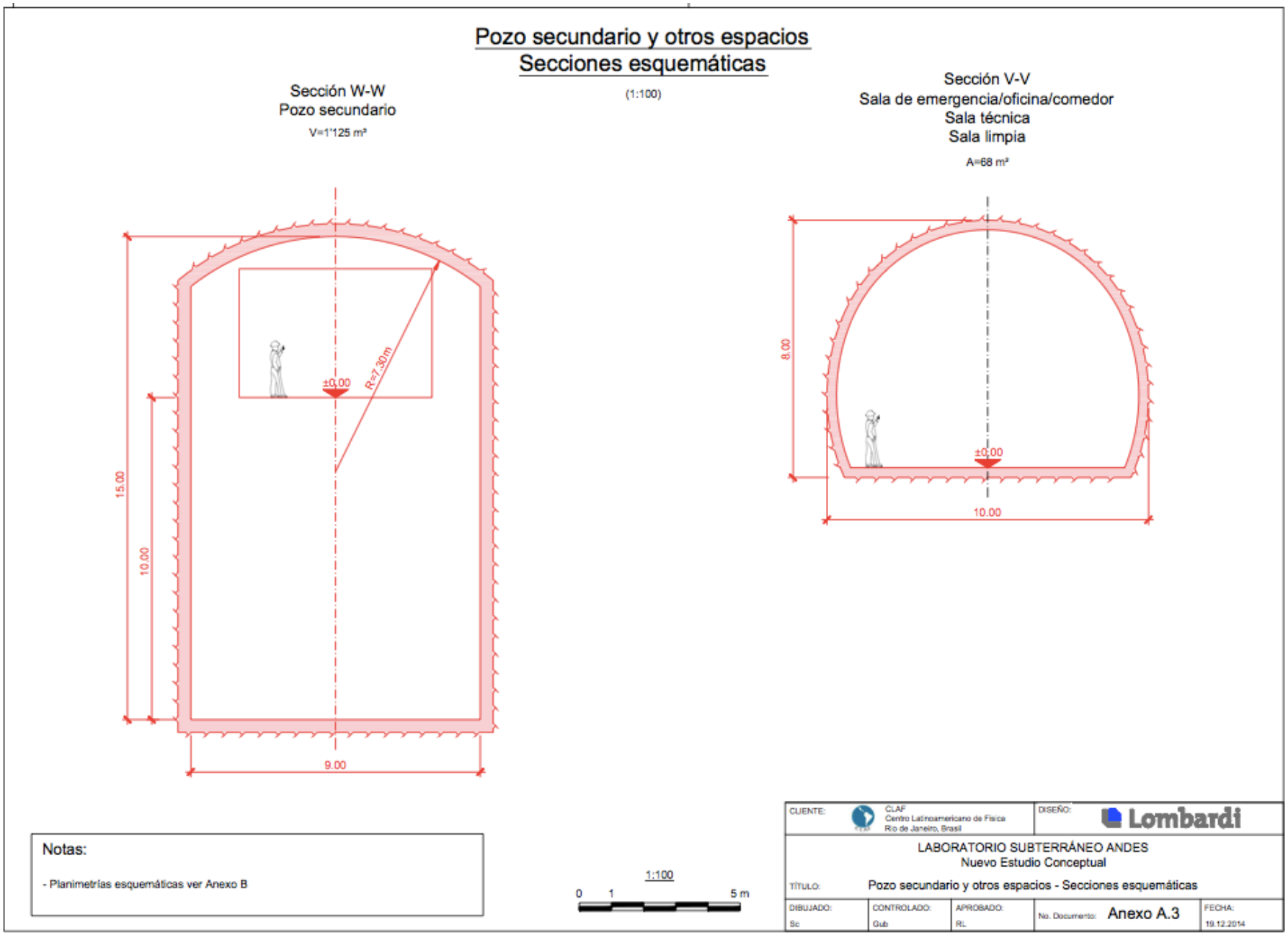
Conceptual Design (by Lombardi): Cavern sections



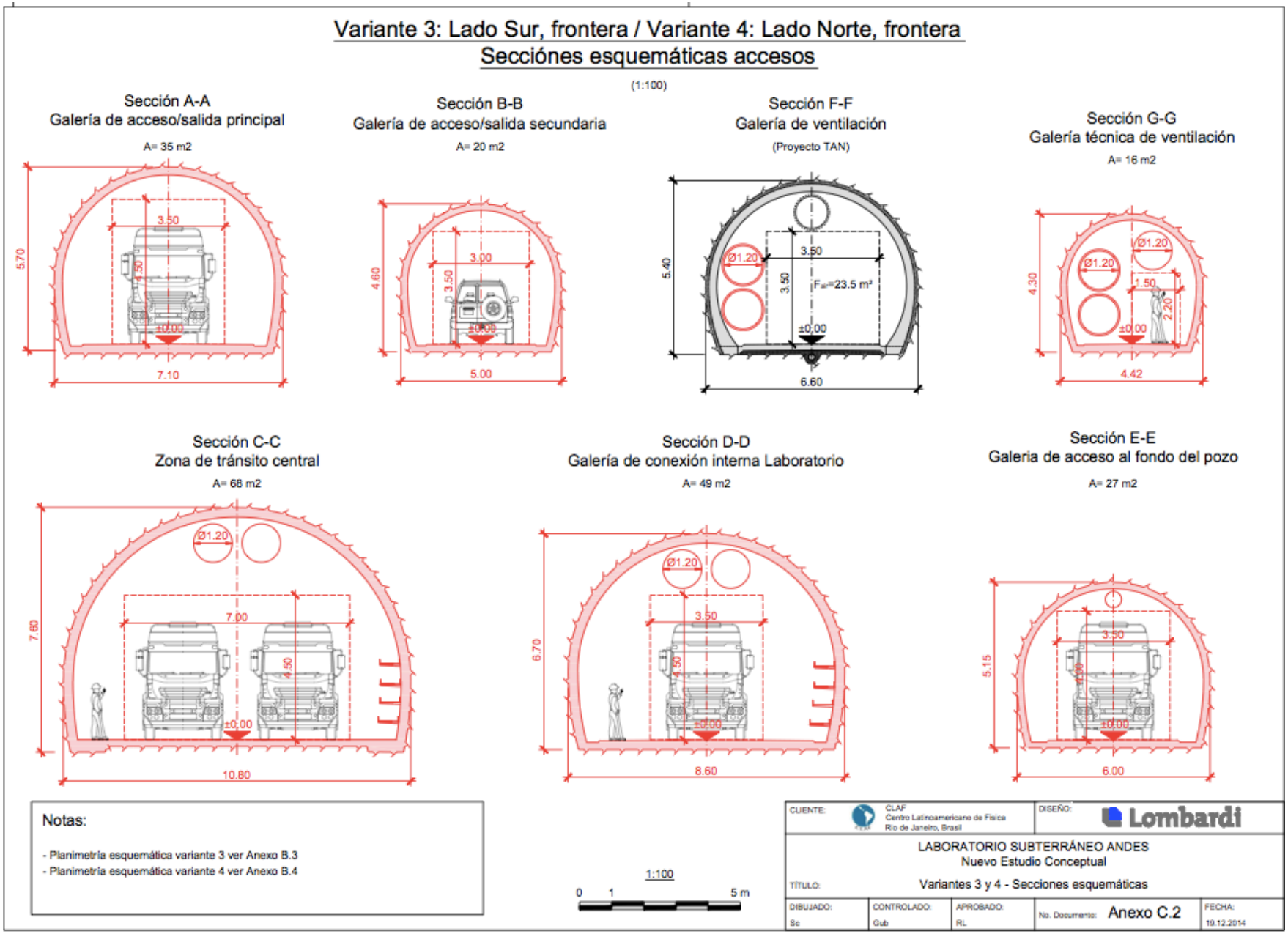
Conceptual Design (by Lombardi): Main pit sections



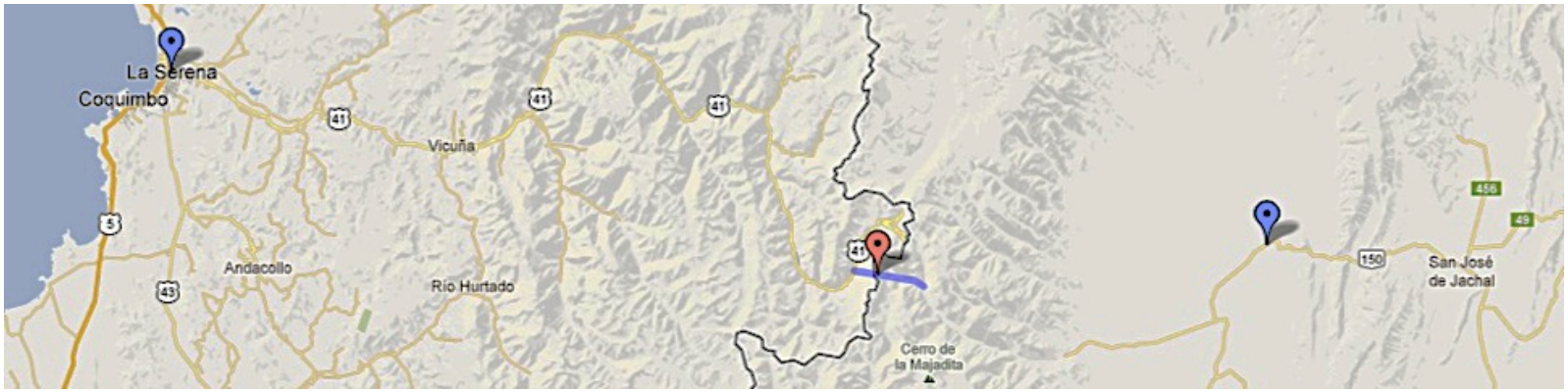
Conceptual Design (by Lombardi): Secondary pit sections



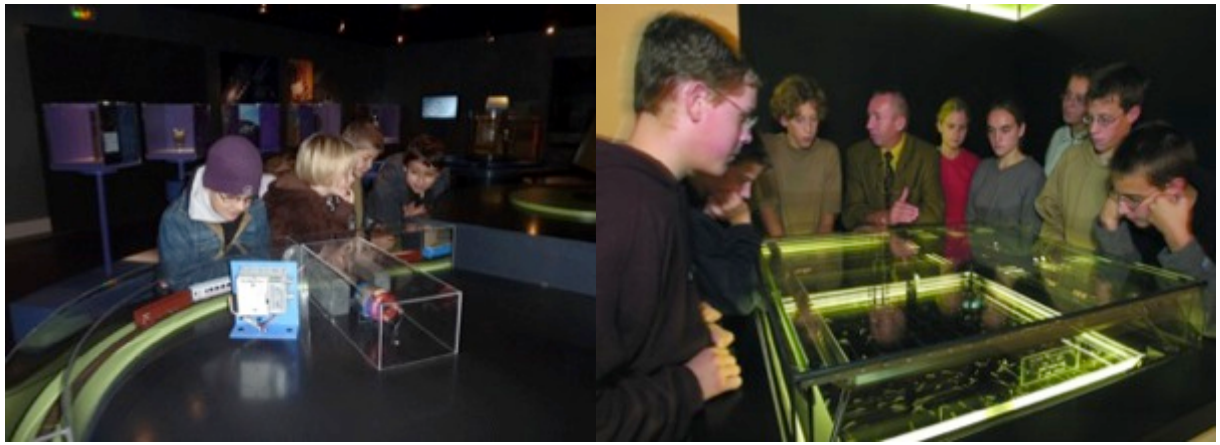
Conceptual Design (by Lombardi): Access sections



Support Labs



- **Two Support Labs** (one on each side):
  - Tentative sites: La Serena (Chile) , Rodeo (Argentina)
  - Integration with local Universities
  - Host a visitor center



Organization

Proposal for Organization: **CLES**

"**C**onsorcio **L**atinoamericano de **E**studios **S**ubterráneos"
(Latin American Consortium for Underground Studies).

- CLES will manage the ANDES Laboratory
  - With support from external international scientific advisory board.

- Initial participanting countries: Argentina Brazil, Chile and Mexico. Recent interest from Colombia.

- CLES could be the seed for a small CERN-like organization with focus on all underground science (Physics, Biology, etc…)

Current status

Memorandum of Understanding

Hereby the participants of the First International Workshop for the Design of the ANDES Underground Laboratory want to express their strong support to the initiative of building ANDES (Agua Negra Deep Experiments Site), to be located in the Agua Negra tunnel.

This will be the only underground laboratory in the Southern hemisphere, and is expected to host world-class experiments in various areas of physics, geology and biology. This facility will further strengthen the links between the scientific communities of Latin America through the establishment of collaborative research efforts, the formation of new generations of scientists, and the development at and beyond the state of the art technology.

Buenos Aires, April 19th, 2011

- > 20 support letters from International community
  (underground lab directors, intl. exp spokespersons, natl. physics associations and academies,…)
- Regional interest: 26 letters from latin american groups.
- Official support from MinCyT (Argentina) and EBITAN (Entidad Binacional Túnel Agua Negra).

- 4 workshops for the Lab design (Argentina, Brazil, Chile, Mexico).
- CLAF (Centro Latinoamericano de Fisica) creates ANDES unit.
- Conceptual Design
  (done by Lombardi S.A., paid 50/50 by Chile and Argentina)

- In Chile: proposal well received in all geovernment instances, waiting for oficial evaluation (and approval) .

Summary

- ANDES is a unique opportunity for a deep and large underground lab in Southern Hemisphere:
  - To educate new scientists within Latinamerica.
  - To establish international collaboration in many sciences.
  - To integrate Latin American nations around science objectives.

- International support, interest from world exp. collaborations.

- CLES: Opportunity for a Latin American Science integration.

- Expected Construction: 2016 -- finished in ~ 10 years

- More info at http://andeslab.org

ECONOMÍA

El BID pagó U$S40 millones y comprometió el financiamiento del túnel de Agua Negra entre Argentina y Chile

El apoyo inicial consistirá de dos créditos simultáneos de 20 millones de dólares, uno por cada país, para financiar en común los estudios y actividades binacionales.

(0) Enviar Imprimir viernes, 15 de abril de 2016

Thank you

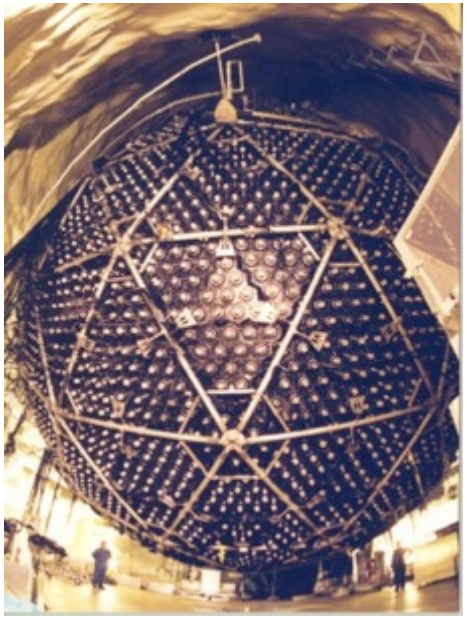
Backup slides

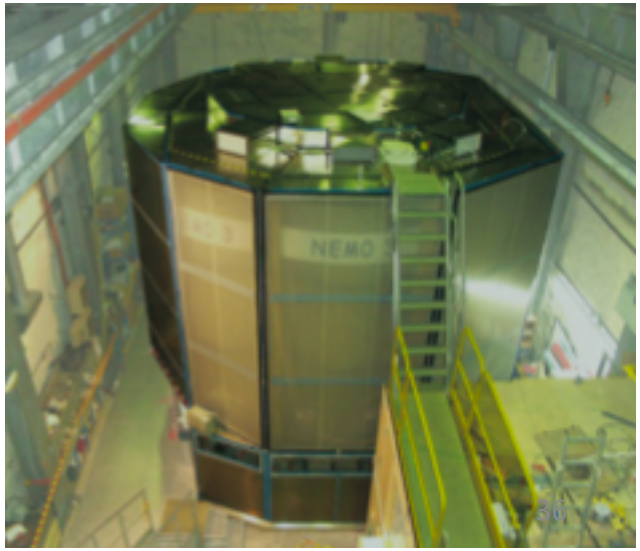
Experiments in U Labs

Experiments in underground Labs:

- **Neutrinos:**

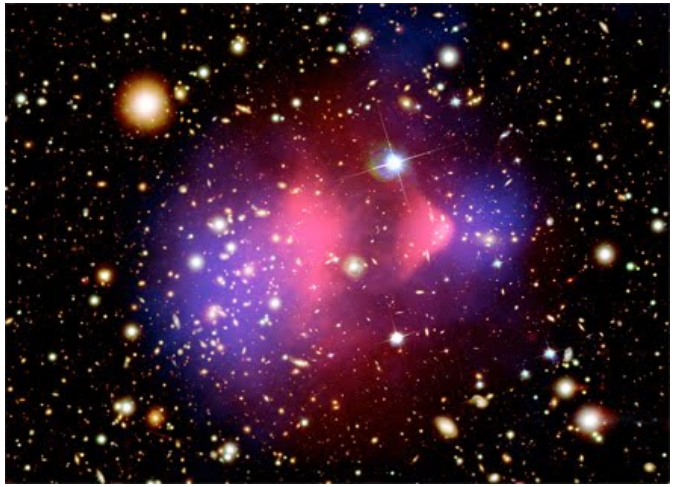
  - from nuclear reactors
  - from accelerators
  - from the atmosphere
  - from the Sun
  - cosmic and Supernovae
  - from inside the Earth



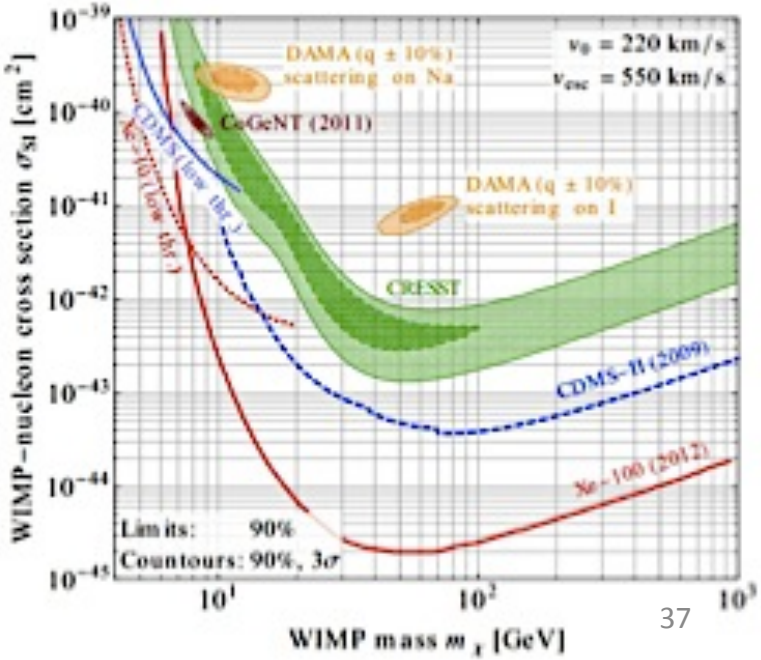


Experiments in underground Labs:

- **Dark Matter search:**
  - Needs different detector techniques (noble gas/liquid, …)
  - New techniques (bubble chambers, CCD, …)

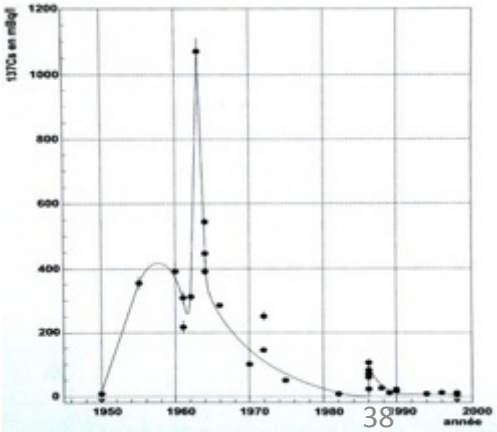


  - Direct Detection
  - Yearly modulation



Experiments in underground Labs:

- **Geoscience**
  - Low frec. Seismographs
  - Radon measurements
  - geoneutrinos
- **Low radiation measurements**
  - Material selection
  - Environment pollution
  - microelectronics
- **Biology**



Preliminary
ANDES Science program

ANDES initial Scientific Programme

- Neutrino physics:
  - host double beta decay experiments
  - large Latin American neutrino detector
    - KamLAND / Borexino style
    - focus on low energy
    - Solar / Supernova / Geo neutrinos
- Dark Matter
  - modulation measurements
  - new technologies
- Geophysics
  - link Chile-Argentina seismograph networks
- Biology
  - life in extreme and low radiation environments
- Low background measurements
- Nuclear Astrophysics (low energy beams)

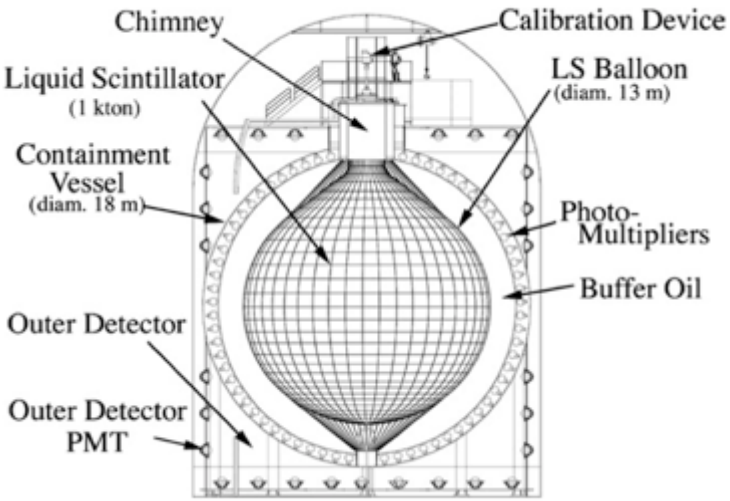
eg. Proposed Neutrino detector

- 3 – 10 kton of liq. Scintillator
- similar to Borexino or KamLAND

- ANDES: unique site for geo nu's

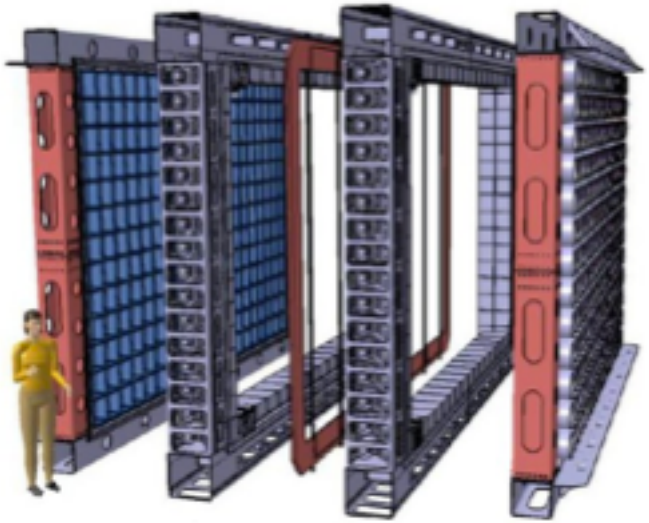
- Can be used for Supernova nu's

- arXiv:1027.5454



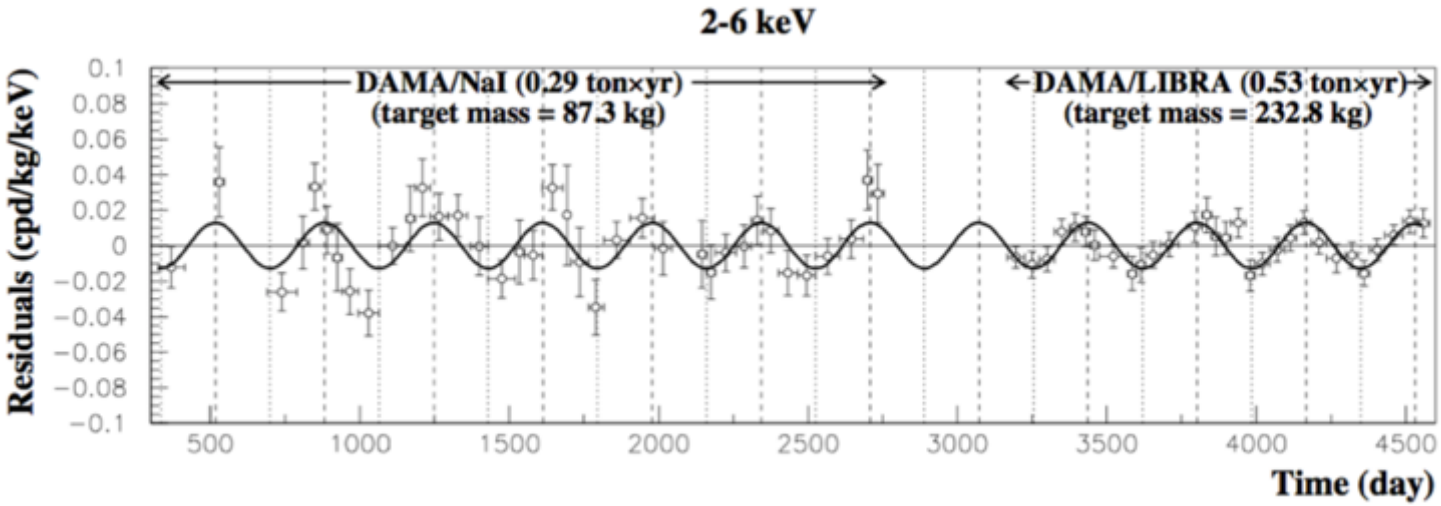
Double beta decay experiments

- eg. SuperNEMO:
  - 100 – 200 kg of ^{82}Se
  - Larger experiment,
    based on NEMO, NEMO3 (LSM).
  - Modular design ≈ 20 modules
  - Neutrino mass sensitivity ≈ 0.05 eV
  - Design and schedule fits ANDES
  - strong interest from SuperNEMO



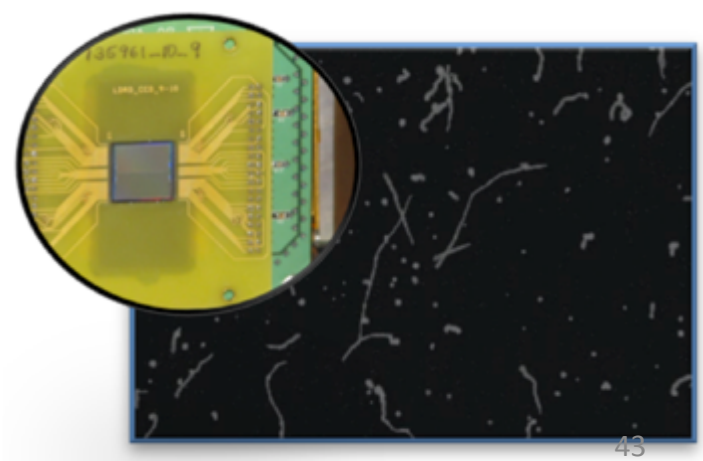
- Also: NEXT.
- others

Dark Matter at ANDES



- To host copy of northern DM modulation exp.
- Host a 3rd generation DM exp.

- Work on new techniques…
  - e.g. CCD's, DNA chains, et c.



Nuclear reactions for Astrophysics

- LUNA (Laboratory for Underground Nuclear Astrophysics).
- installed at Gran Sasso
- 50 kV accelerator

- LUNA II: 400 kV

- Study low energy nuclear reactions in stars (Gamow peak)

- Proposal for a 300 kV, high intensity setup at ANDES