SILAFAE 2012, Sao Paulo, Brasil
December 10-14 2012

ANDES
AGUA NEGRA DEEP EXPERIMENT SITE

Proposal for a

Deep Underground Laboratory
in the Southern Hemisphere

Claudio Dib
Universidad T. Federico Santa Maria, Valparaiso
Coordinator of ANDES in Chile

The proposal:

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

The AGUA NEGRA tunnel will be built under
the Andes Mountains between Chile and Argentina.

Content

- The Agua Negra Tunnel
- Underground Labs and ANDES Lab proposal
- ANDES Scientific programme (preliminary)
- ANDES conceptual design
- Organization: CLES
- Current status

The Agua Negra Tunnel

There is no Tunnel yet!

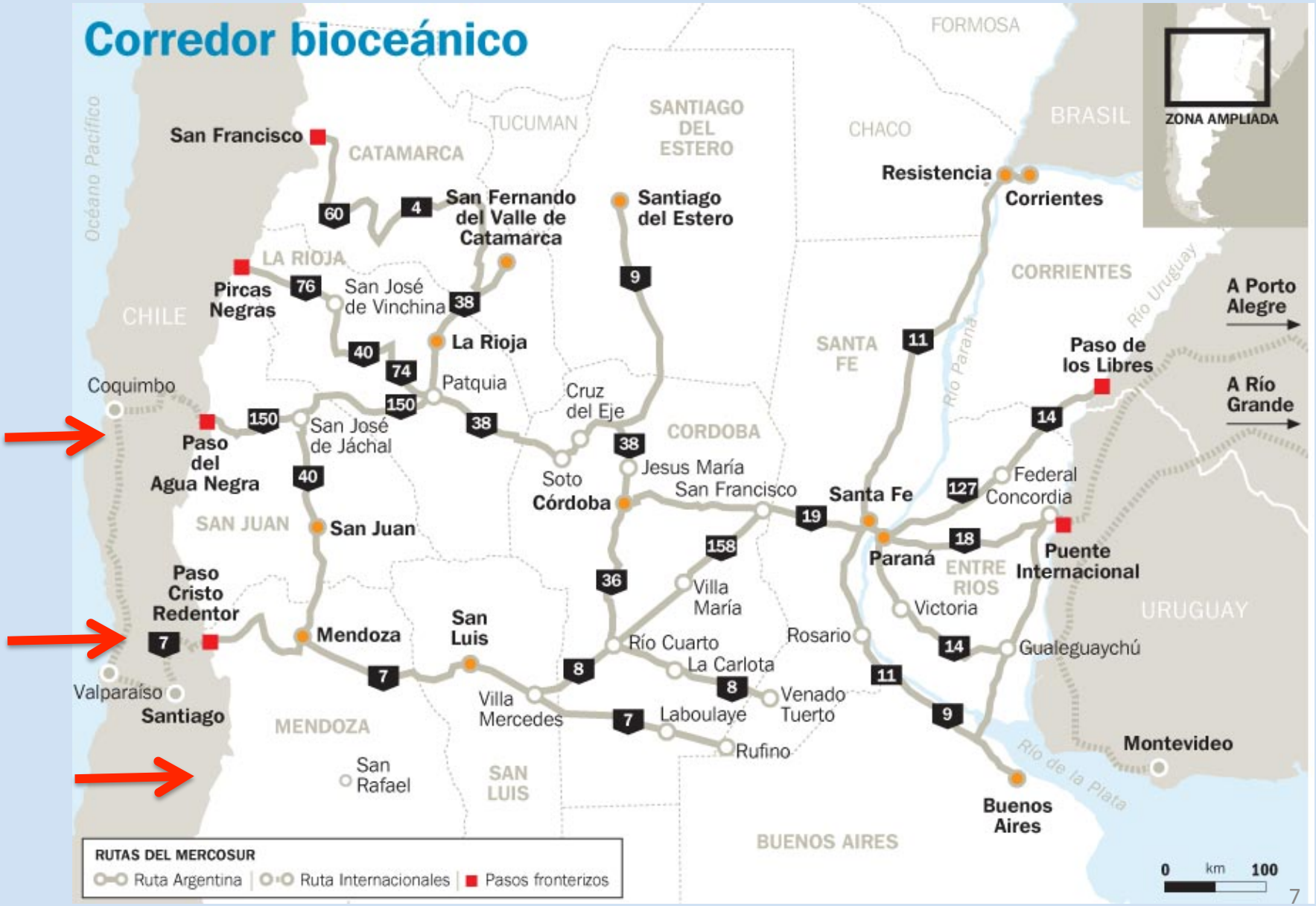
Views of the Agua Negra pass

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 passes suffer severe cuts in winter.

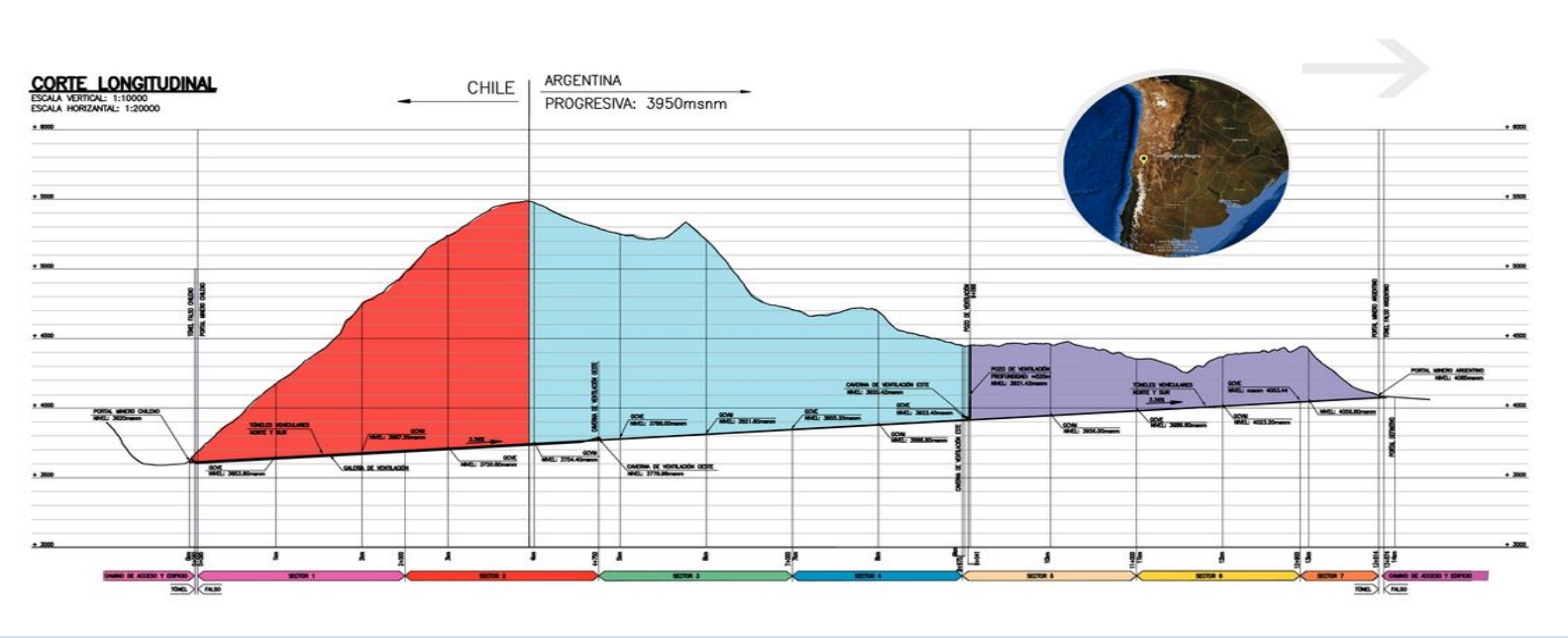
- Tunnel alternatives:
  - Agua Negra pass (Coquimbo – San Juan) ~ 14 km ✓
  - Aconcagua pass (Los Andes – Mendoza) ~ 50 km ✗
  - Las Leñas pass (Rancagua – Mendoza) ~ 12 km ✗

Maps

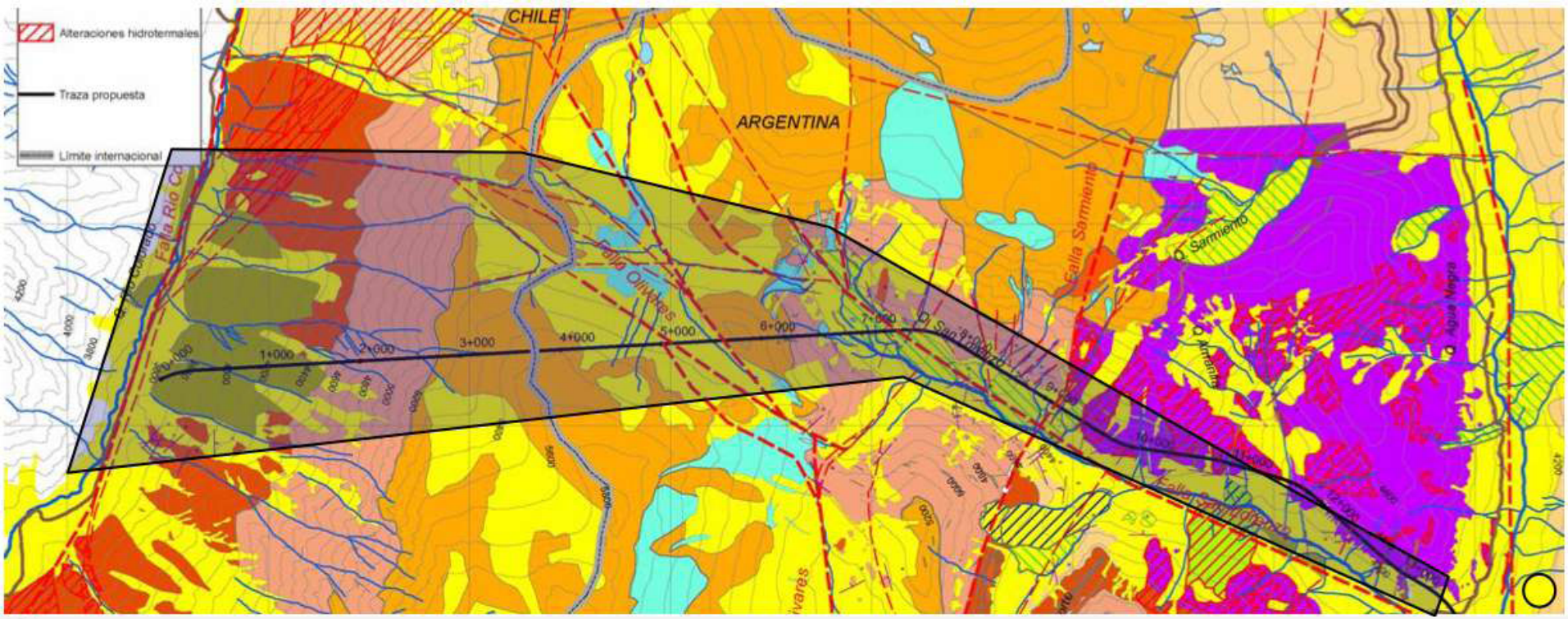

Corredor bioceánico
Océano Pacífico
CHILE
FORMOSA
BRASIL
ZONA AMPLIADA
TUCUMAN
SANTIAGO DEL ESTERO
CHACO
CATAMARCA
LA RIOJA
CORRIENTES
SANTA FE
CORDOBA
SAN JUAN
MENDOZA
SAN LUIS
ENTRE RIOS
BUENOS AIRES
URUGUAY
Río Paraná
Río Uruguay
Río de la Plata
San Francisco
San Fernando del Valle de Catamarca
Santiago del Estero
Resistencia
Corrientes
Pircas Negras
San José de Vinchina
La Rioja
Patquia
Cruz del Eje
Coquimbo
Paso del Agua Negra
San José de Jáchal
Soto
Córdoba
Jesus María
San Francisco
Santa Fe
Federal
Concordia
Paso de los Libres
A Porto Alegre
A Río Grande
San Juan
Paso Cristo Redentor
Mendoza
San Luis
Villa María
Río Cuarto
La Carlota
Paraná
Victoria
Rosario
Puente Internacional
Gualeguaychú
Valparaíso
Santiago
Villa Mercedes
Laboulaye
Venado Tuerto
Rufino
San Rafael
Montevideo
Buenos Aires
RUTAS DEL MERCOSUR
Ruta Argentina
Ruta Internacionales
Pasos fronterizos
0 km 100

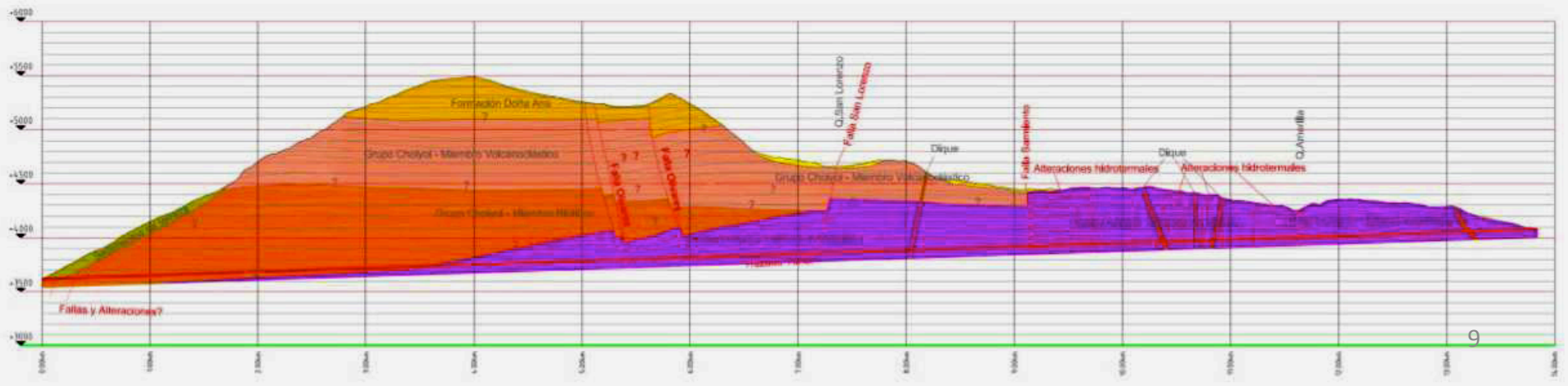
Tunnel features

- Double Tunnel between Coquimbo Region, Chile – San Juan Province, Argentina.
- 12 m diameter (two lanes each), 14 km long.
- Parallel separation: > 60 m, Connecting galleries every 500 m.
- Altitude: 3600 m asl (Chile), 4085 m asl (Argentina).
- Deepest point: 1750 m depth.
- Forced ventilation (14.5 MW).



Agua Negra geology





Rock studies

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

9 samples
from 8 perforations up to 600 m deep

	Andesite	Basalt	Rhyolite 1	Rhyolite 2
U-238	9.2 ± 0.9	2.6 ± 0.5	14.7 ± 2.0	11.5 ± 1.3
Th-232	5.2 ± 0.5	0.94 ± 0.09	4.5 ± 0.4	4.8 ± 0.5
K-40	47 ± 3	50 ± 3	57 ± 3	52 ± 3

Bq/kg

Thanks to Laboratorio de Activación Neutrónica (Bariloche, Argentina)

Tunnel proposal updates

- Pre-feasibility study done in 2005, feasibility in 2008.
- 2009, October: presidents C. Fernández and M. Bachelet signed a Bi-National Integration Treaty, including San Juan-Coquimbo.
- 2010, August: MERCOCUR Meeting in San Juan: “strong support for Agua Negra Tunnel”. L.I. Lula da Silva pushing for tunnel tender.
- 2011, December: Argentina Congress voted a 800 MU$D guarantee fund for the Agua Negra tunnel.
- 2012, March: presidents C. Fernández and S. Piñera signed international agreement asking for the tender of the tunnel.
- 2012: December: first call for tender.

- Total cost estimated: 850 MU$D.

Underground Laboratories

- in mines: build anytime, difficult access.
- In tunnels: build with Tunnel, easy access.

Deep underground Laboratories in the world

+ China, Korea, India (not shown in the map)

→ None in the Southern Hemisphere

Previous experience in the Southern Hemisphere…

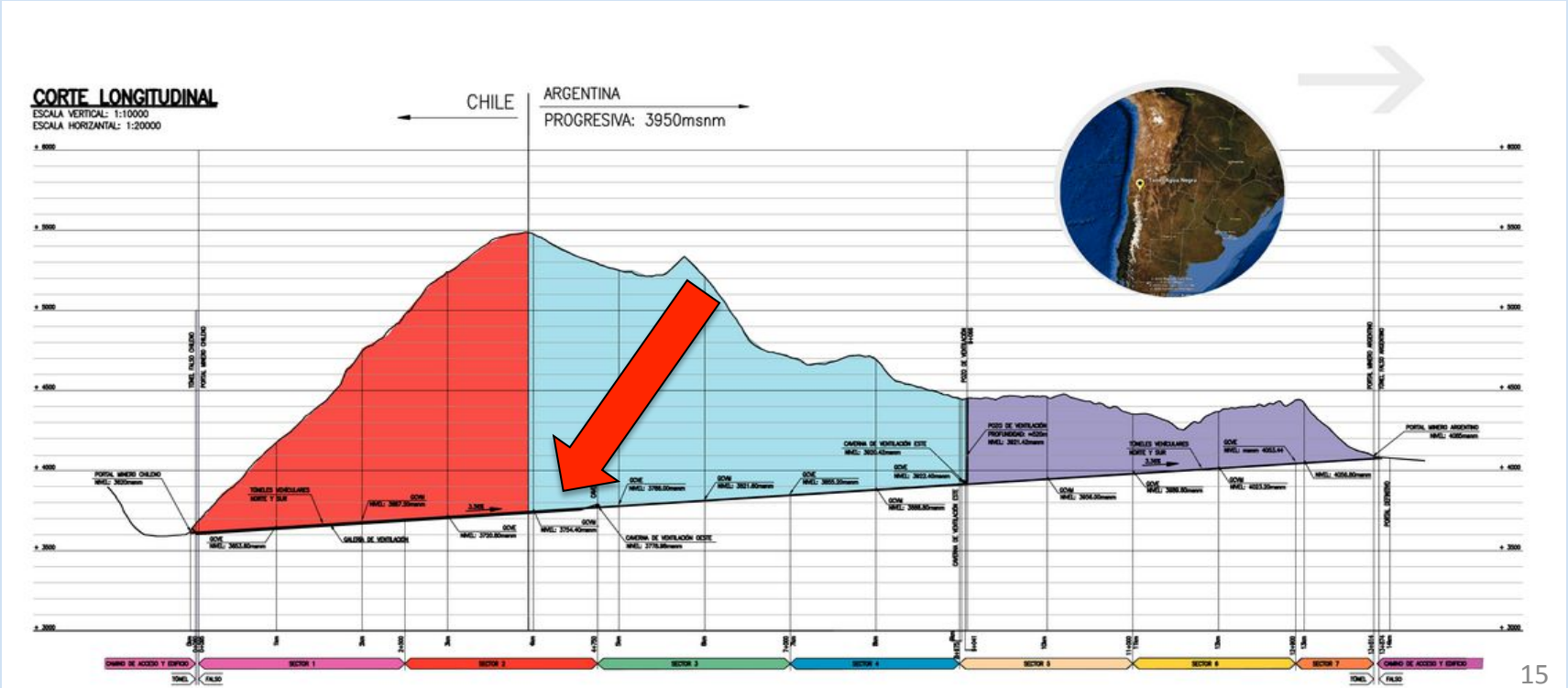
- South Africa: neutrino detection in gold mines (1965…)

- South America:
  - Brazil: search for a mine by C. Lattes.
  - Argentina: Dark Matter search experiment at Sierra Grande mine (1000 mwe)
    Astropart. Phys. 10, 133 (1999).
  - Chile: search for site in El Teniente mine, 2001.

- Mexico: proposal of the Multidisciplinary Mexican Underground Laboratory (LSMM), 2006.

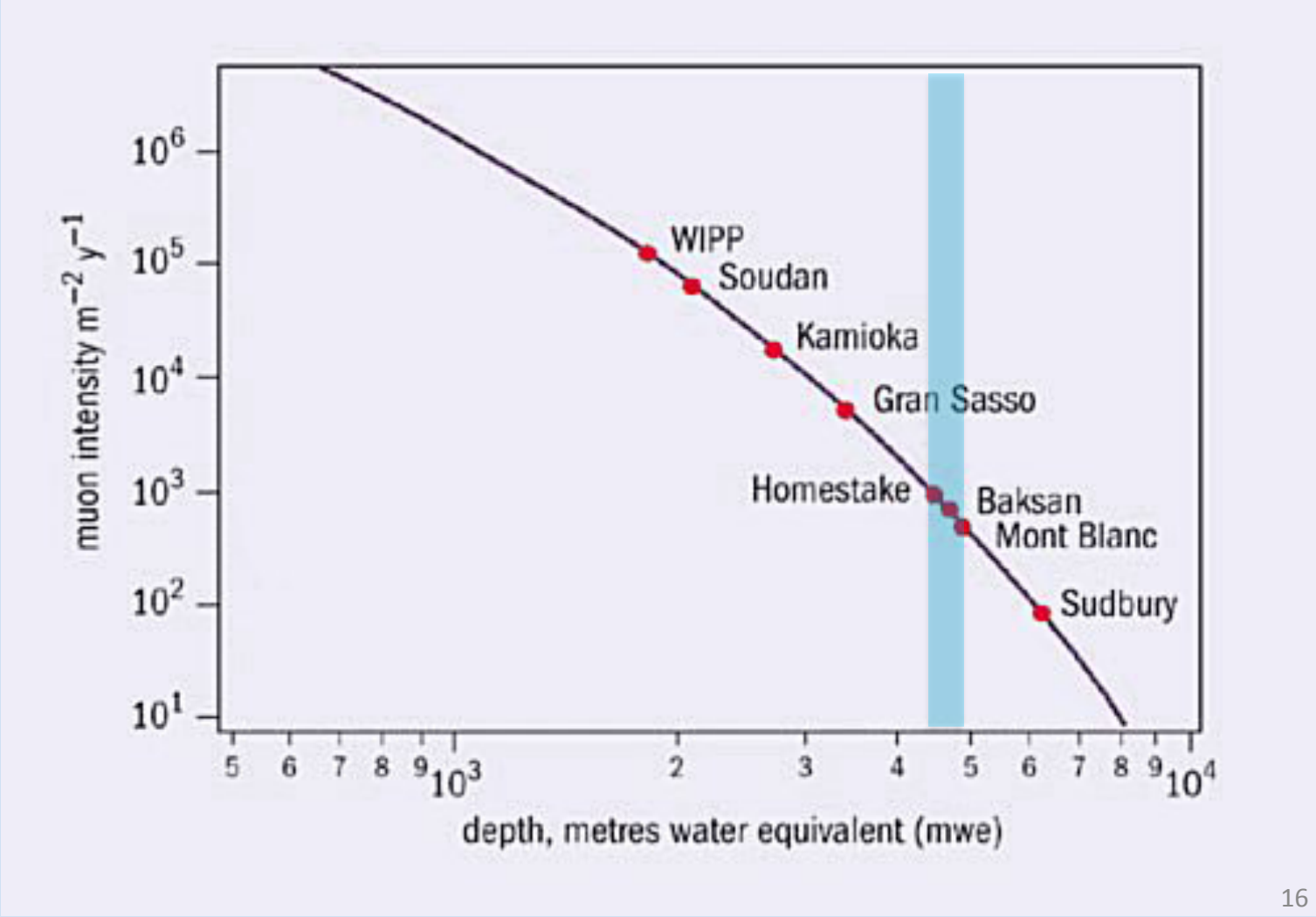
The ANDES Lab proposal

- Build a U-Lab at the deepest point in tunnel (~ 1750 m deep)
- 3.5 km to Chilean entrance, 10 km to Argentinean entrance



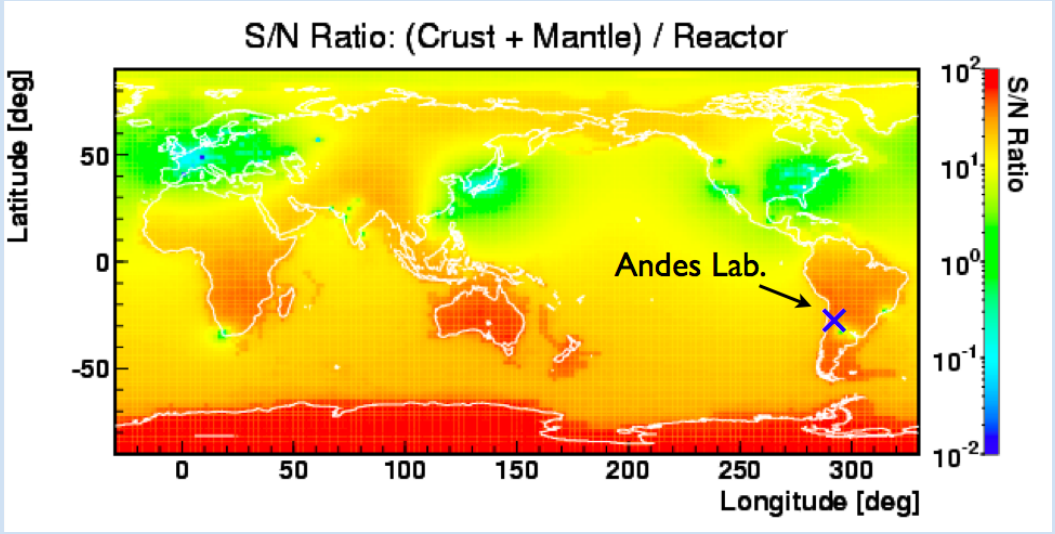
World Labs: Muon flux vs. depth

Flux at sea level ~ 100 /m^2 s ANDES depth: ~ 4500 – 4800 mwe



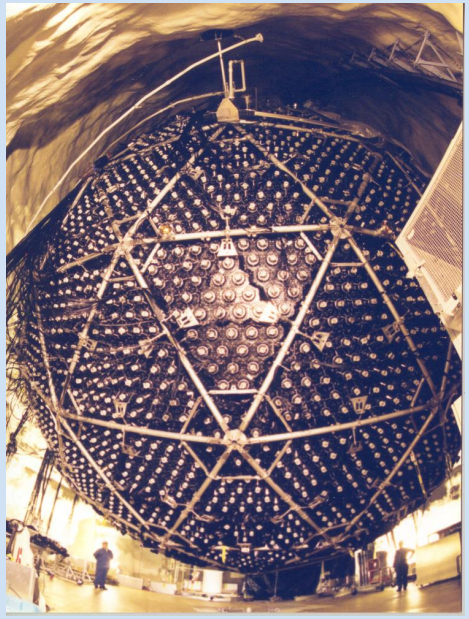
What makes ANDES special?

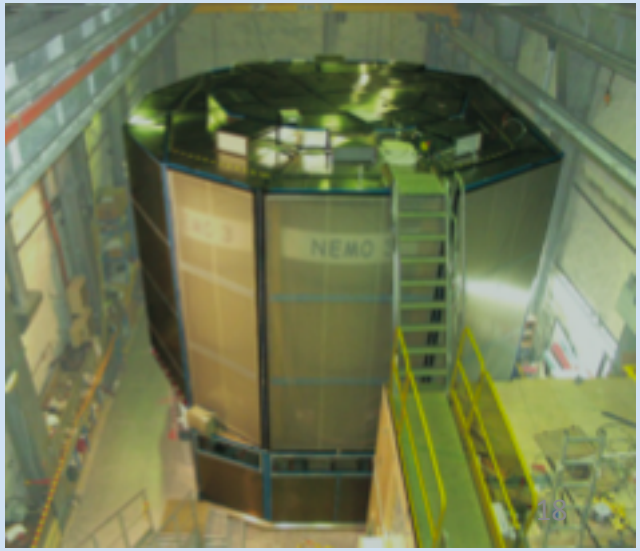
- Third deepest Lab in the world.
- Only deep underground lab in southern hemisphere
  - Opposite weather-induced modulations
- Low reactor neutrino bkg
  - Embalse: 2.1 GWt, 560 km
  - Atucha: 1.2 GWt, 1080 km
  - Atucha II: 2.1 GWt
- Geoactive Region
  - Geophysics experiments
- Very long baselines…?
  - CERN: 9920 km.
  - Fermilab: 7640 km.
  - KEK: 12400 km (1500 km from earth center)



Experiments in underground Labs:

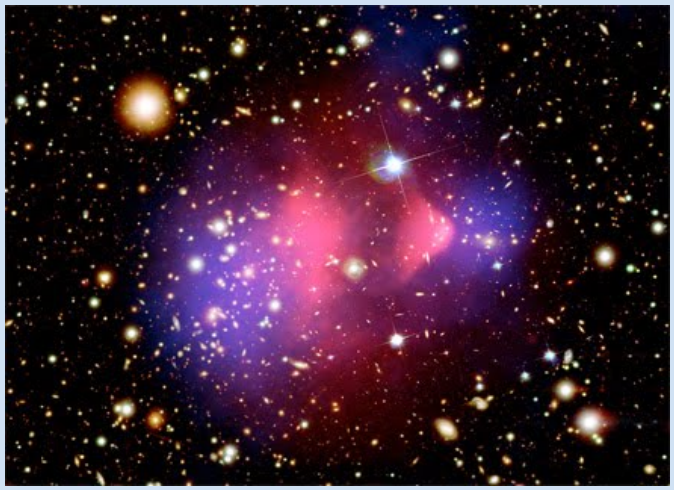
- **Neutrinos:**
  - from nuclear reactors
  - from accelerators
  - from the atmosphere
  - from the Sun
  - cosmic and Supernovae
  - from inside the Earth



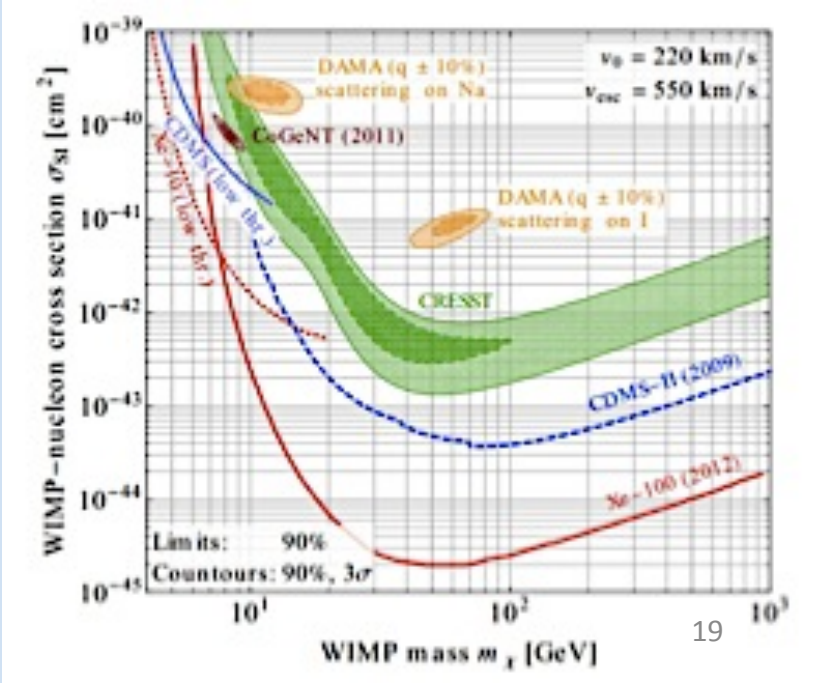


Experiments in underground Labs:

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

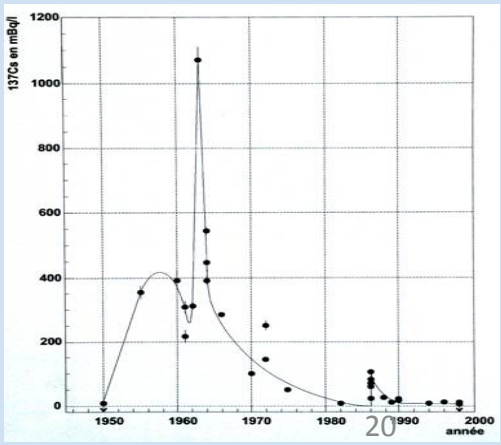


  - Direct Detection
  - Yearly modulation



Experiments in underground Labs:

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



ANDES scientific programme
(preliminary)

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)

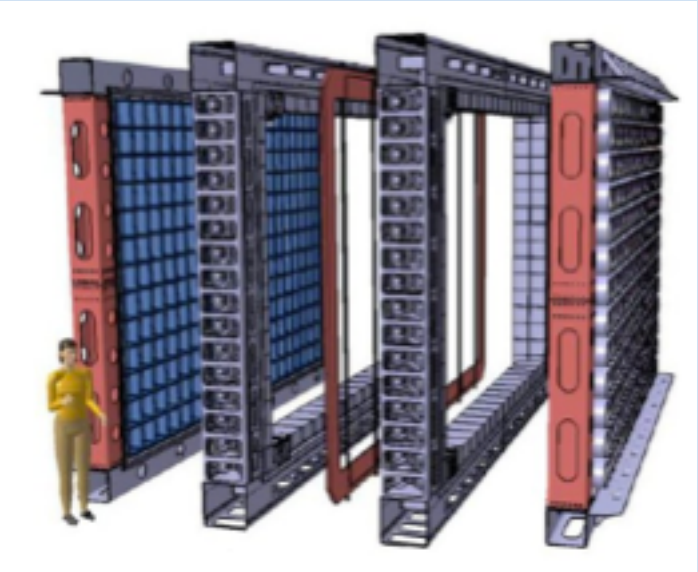
Double beta decay experiment

- 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



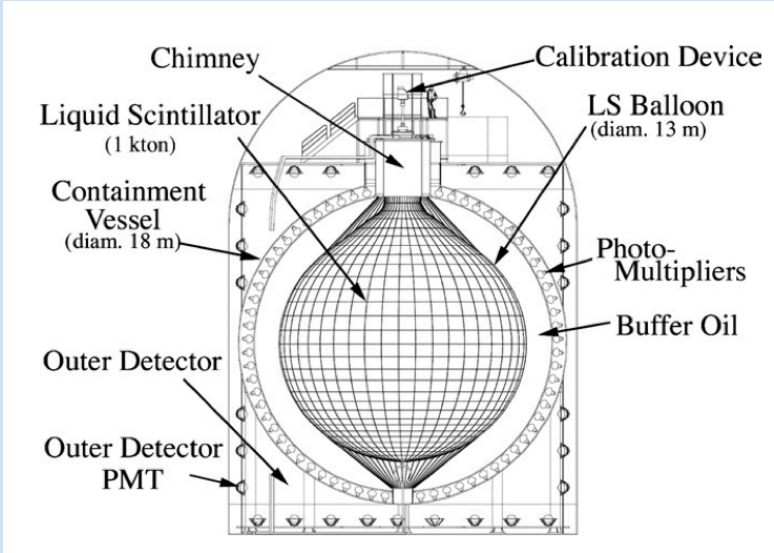
Proposed Neutrino detector

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

- ANDES: unique site for geo nu's

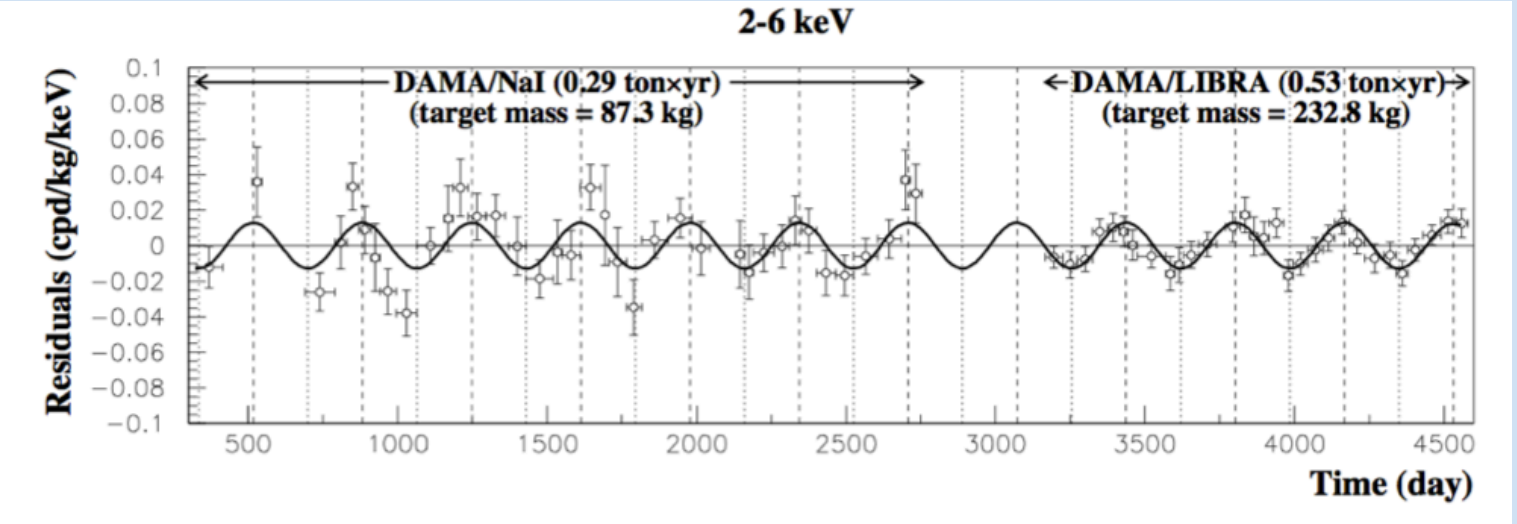
- Can be used for Supernova nu's

- arXiv:1027.5454



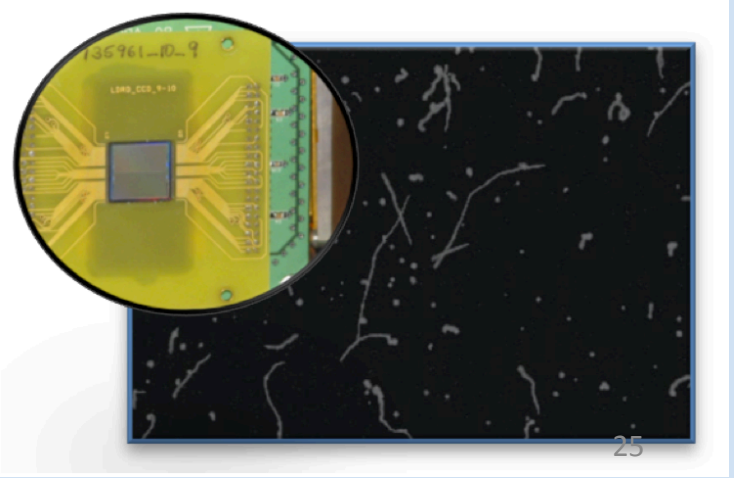
- To be studied at the next ANDES workshop

Dark Matter at ANDES



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

- Work on new techniques…



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

ANDES Conceptual Design

ANDES Lab concept

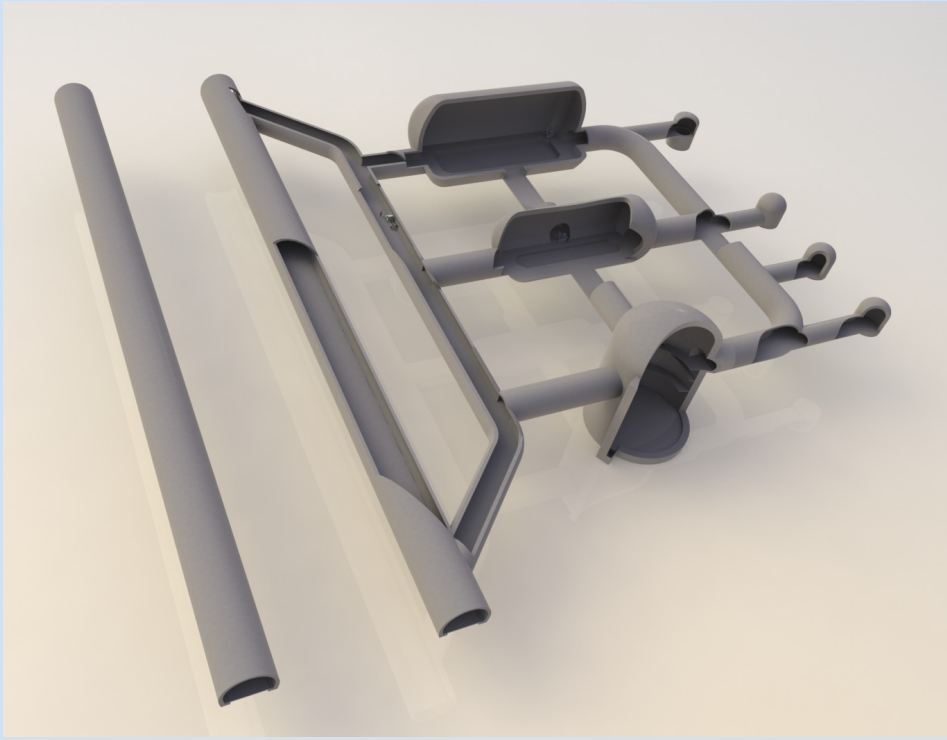
- Main hall: 21 x 23 x 50 m3

- Secondary hall: 16 x 14 x 40 m3

- 3 caverns 9m ϕ, 7m height

- Single experiment pit:
  30m ϕ, 30m depth

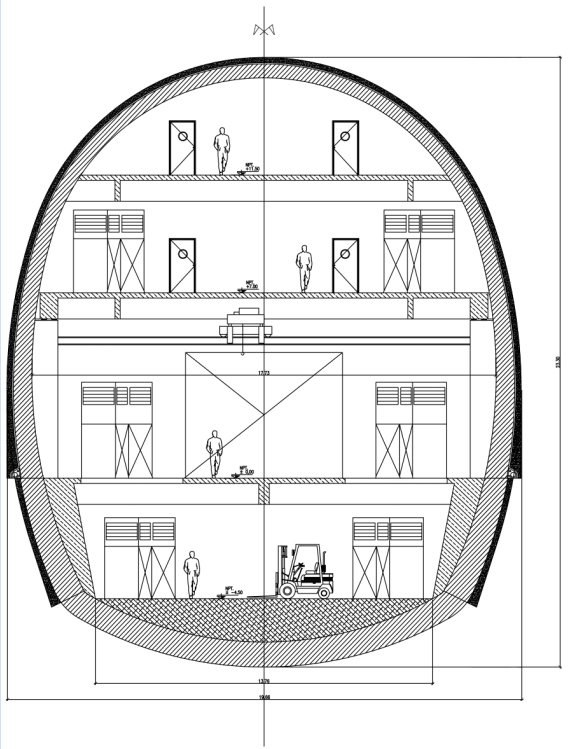
- Ultra low radiation pit:
  9m ϕ, 9m depth

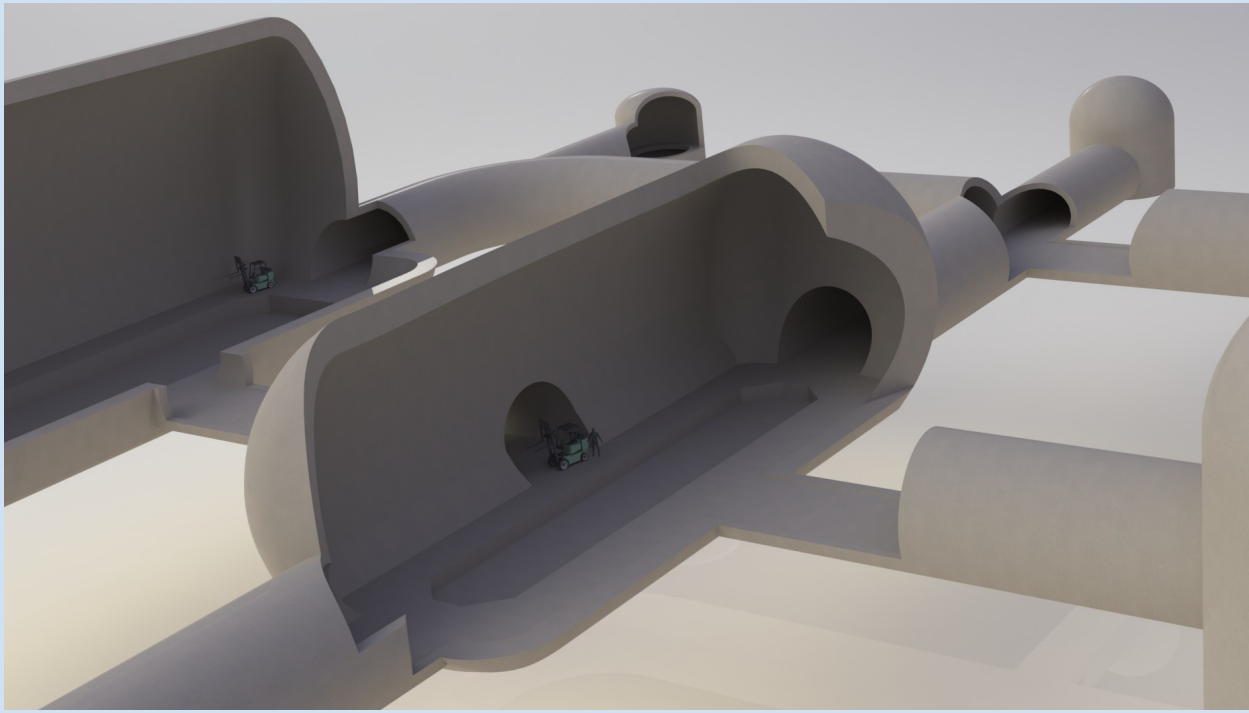


- Linear tunnel for interferometers.

Total volume: 65 000 m3 Total surface: 3 500 m2

ANDES Lab concept

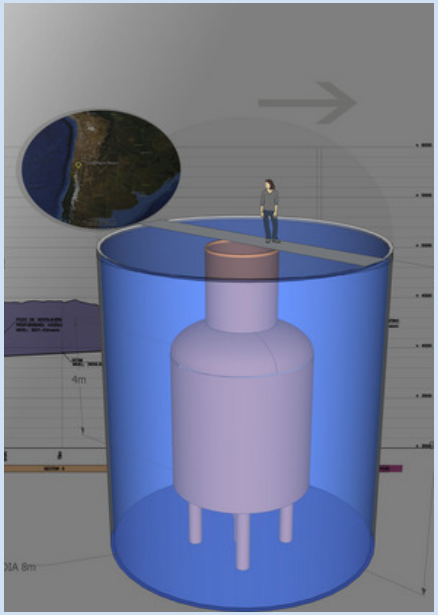




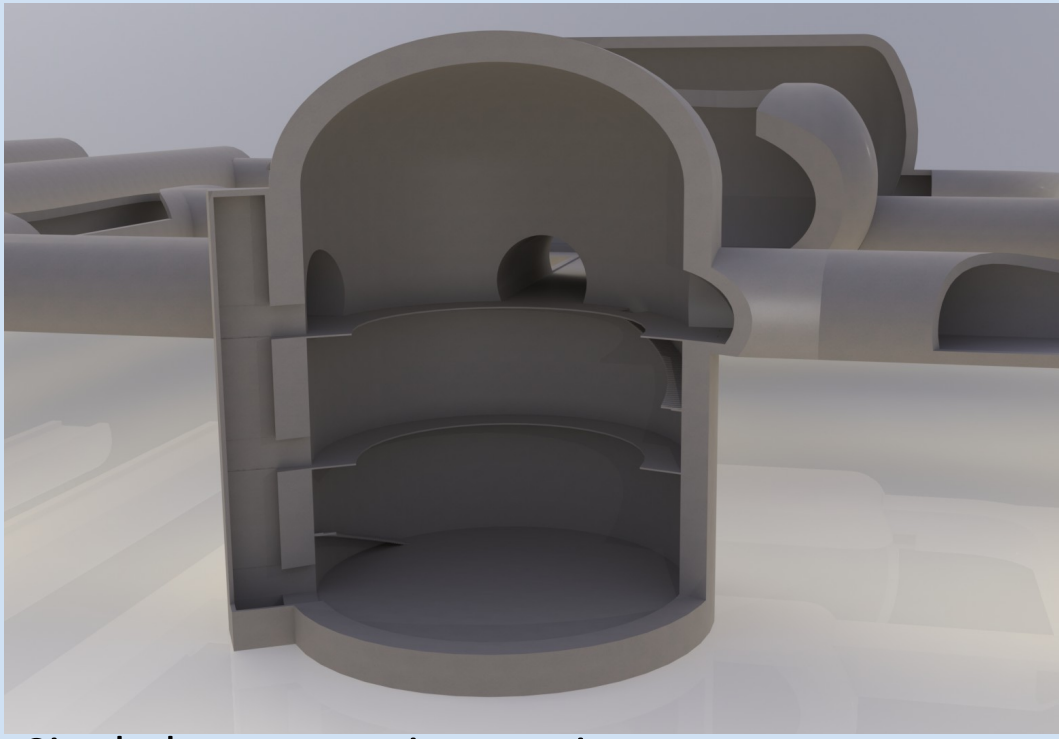
Main hall: 21 x 23 x 50 m3

Secondary hall: 16 x 14 x 40 m3

ANDES Lab Concept



Ultra low radiation pit
Copper vessel 5m ϕ, 4m h

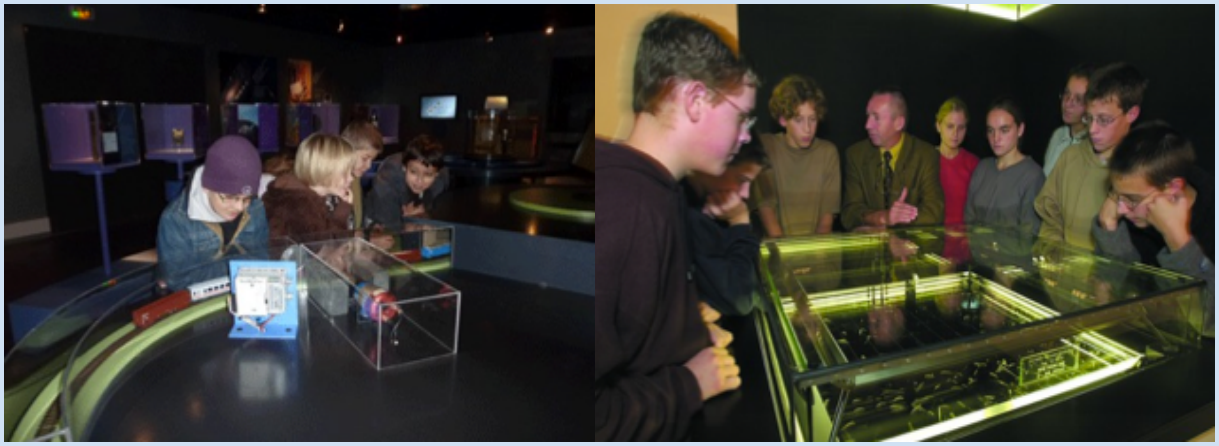


Single large experiment pit:
30m ϕ, 30m depth

Estimated civil work cost of Lab < 2% of tunnel cost
+ scientific equipment cost
+ external support labs

Support Labs

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



Organization

Proposal:

CLES: "Consorcio Latinoamericano de Estudios Subterráneos" (Latin American Consortium for Underground Studies).

- CLES manages the ANDES Laboratory
  - With support from external international scientific advisory board.
- ANDES operation and operating funds: shared participation.
- Initial participants: Argentina Brazil, Chile and Mexico.

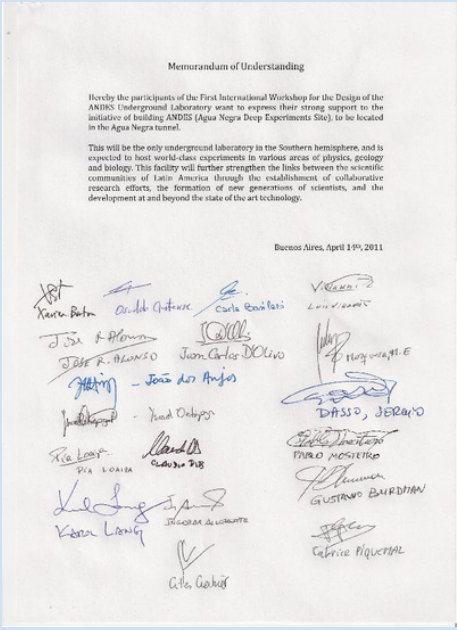
- Excellent opportunity to have an international Laboratory, not only international experiments.
- CLES could be the seed for a small CERN-like organization with focus on all underground science (HEP, Geophysics, Biology, etc…)

Current status

Current status

- International community support:
  - >20 support letters

    (underground lab directors, intl. exp spokespersons, natl. physics associations and academies,…)
- Regional interest:
  - 26 letters from latin american groups.


Memurandum 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

- Official support from MinCyT (Argentina).
- Official support from EBITAN (Entidad Binacional Túnel Agua Negra).
- In process:
  - engineering study of the Laboratory
  - To include the laboratory in the tunnel tender
  - To produce science and laboratory white papers

Current status

Workshops for ANDES design:

- First: April 2011, Buenos Aires.
- Second: June 2011, Rio de Janeiro.
- Third: January 2012, Valparaiso.
- Fourth: March 2013(?), Mexico.

Science task forces:

- Neutrinos: R. Zukanovich Funchal
- Dark Matter: …
- Geology/Seismology: …
- Other: …

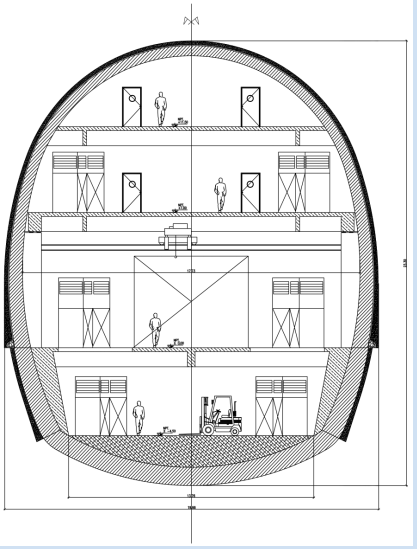
Contact people

- Country representatives:
  - Coordinator: Xavier Bertou
  - Argentina: Osvaldo Civitarese
  - Brazil: Ronald C. Shellard
  - Mexico: Juan Carlos D'Olivo
  - Chile: C.D.

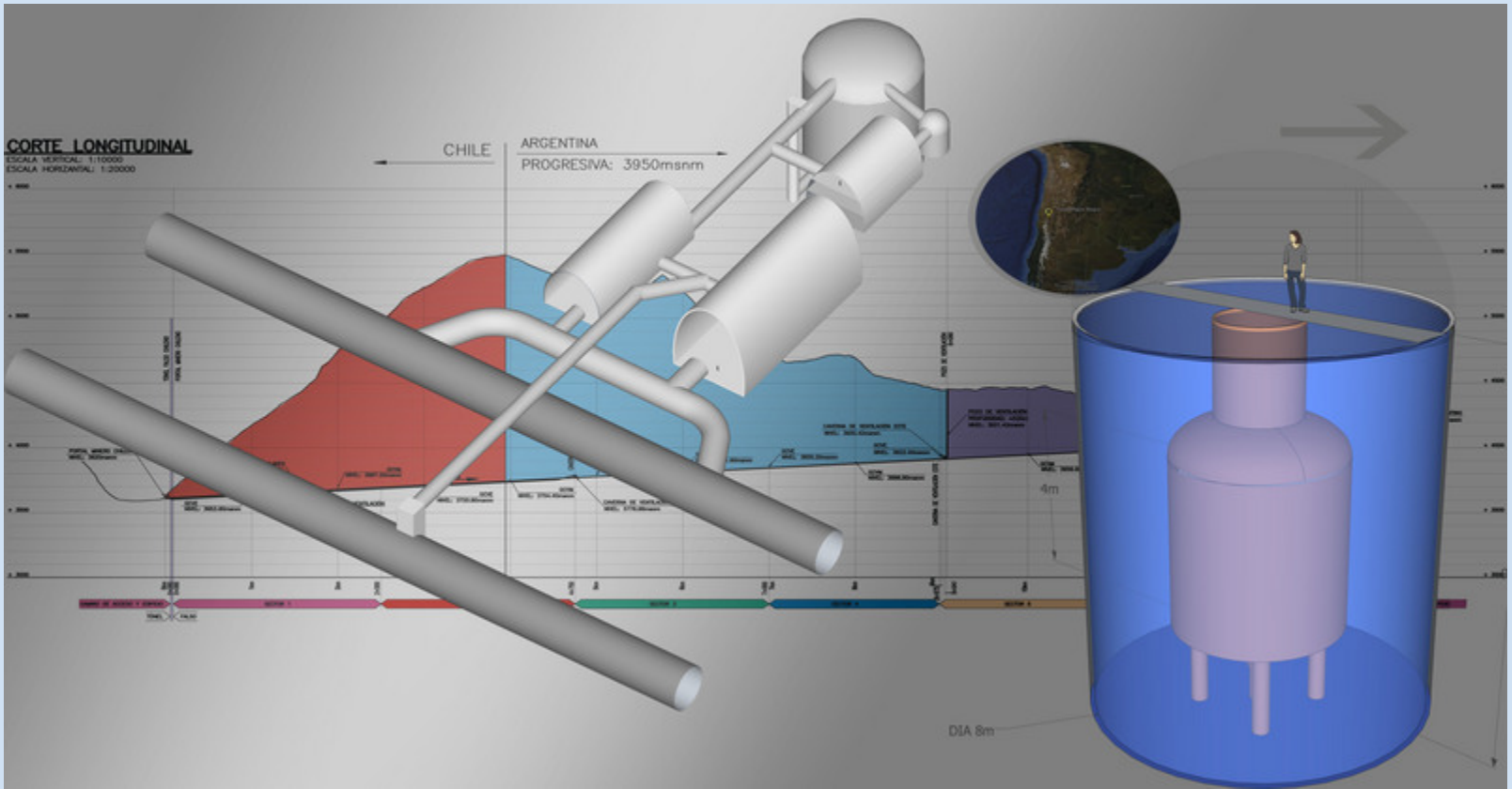
Summary

- Tunnel under the Andes Mts.: unique opportunity for a Deep U-Lab
- Deep AND Big underground lab in Southern Hemisphere
- Unique position on earth crust
- CLES: Opportunity for a Latin American Science integration
- Project status:
  - Scientific support, political support
  - Conceptual design of the Lab
  - Some proposals for experiments
  - Lab accepted to be included in the Tunnel
  - Lab feasibility study still pending
  - Now: first call for tender for Tunnel construction

- More info at http://andeslab.org



Thank you!


CORTE LONGITUDINAL
CHILE
ARGENTINA
PROGRESIVA: 3950msnm
4m
DIA 8m