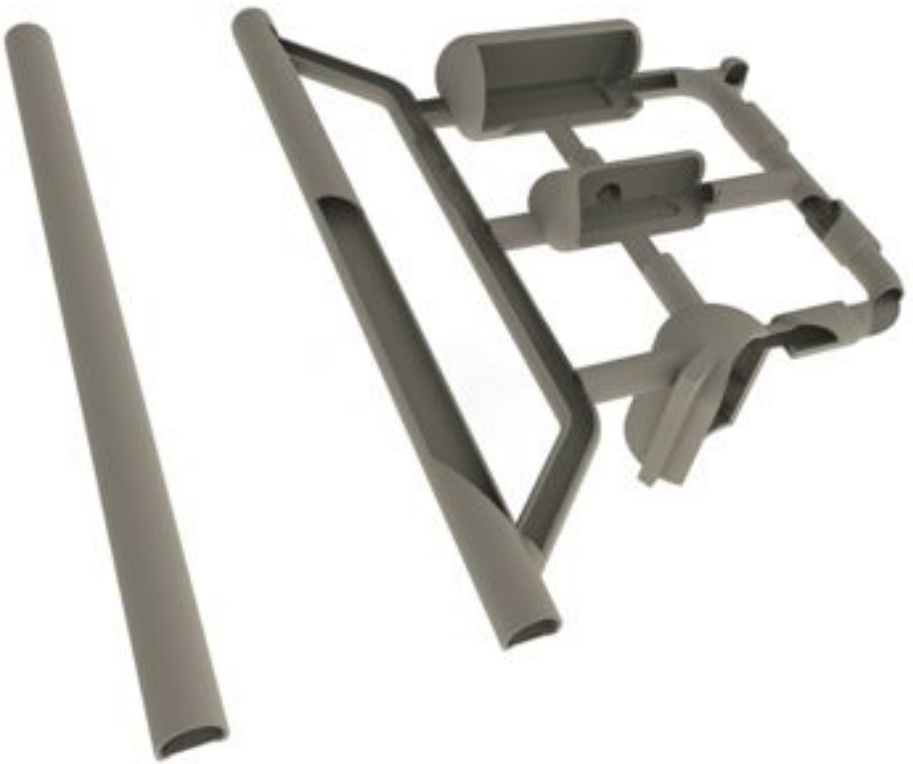
ANDES Status



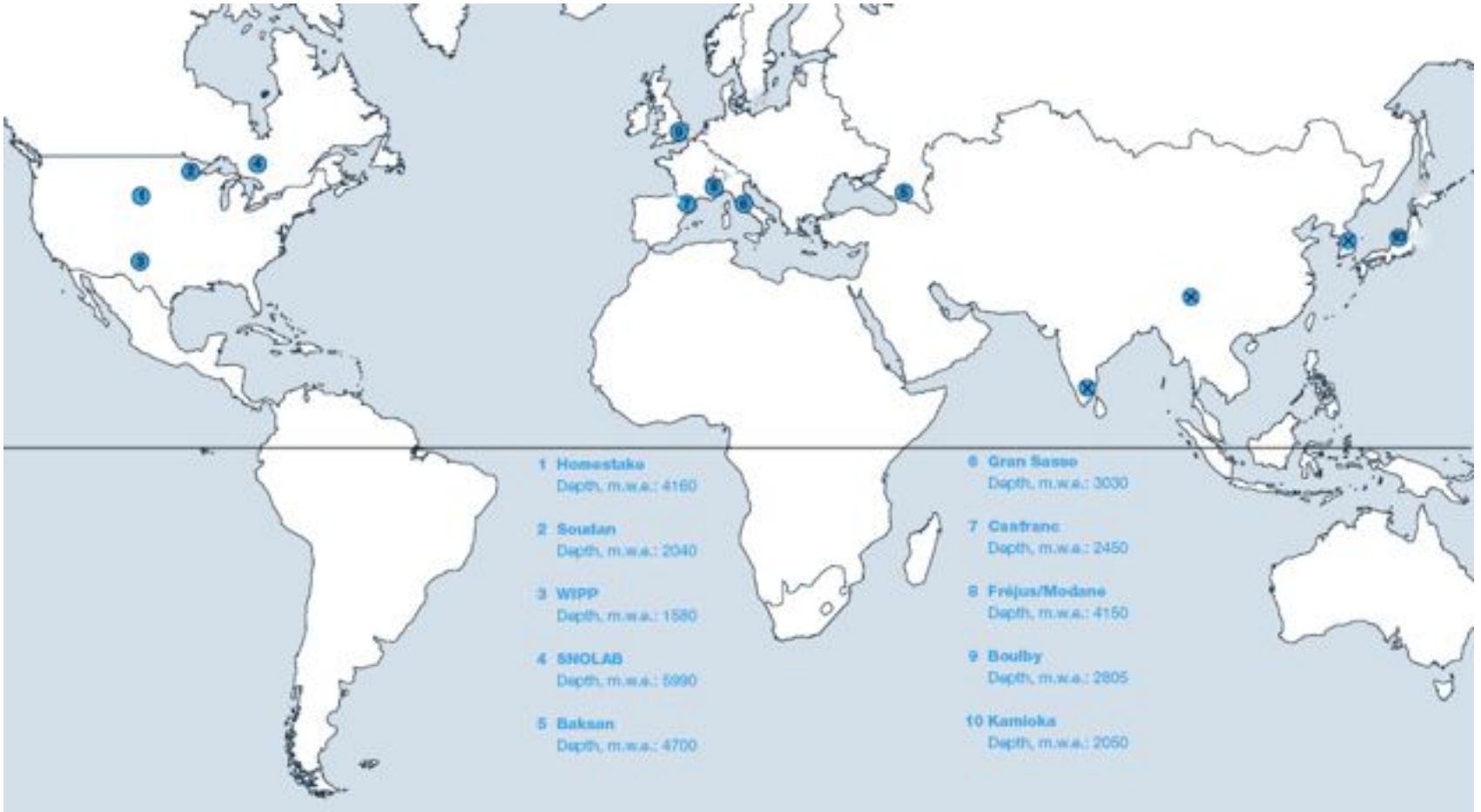
X. Bertou

Centro Atómico Bariloche, CNEA/CONICET

30 January 2014

Underground laboratories and the Southern hemisphere

Underground Laboratories



- All in the northern hemisphere

Underground physics in the Southern hemisphere

South Africa

- First atmospheric neutrinos in 1965 by Reines et al.
  - Phys. Rev. Lett. **15** (1965) 429
    (together with Achar et al. in India, Phys. Lett. **18** (1965))

South America

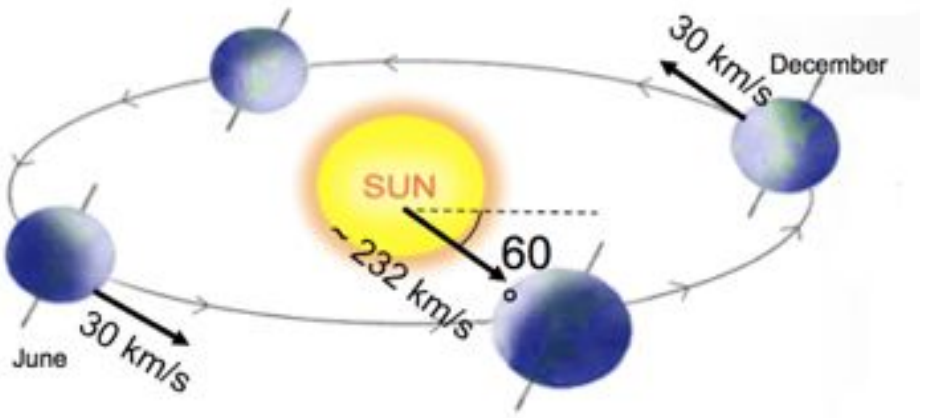
- Argentina: experiment at Sierra Grande mine (1000 wme)
  - Search for an annual modulation of dark-matter signals with a germanium spectrometer at the Sierra Grande laboratory
    Astropart.Phys. 10 (1999) 133-139
- Brazil: search for a mine by César Lattes
- Chile: El Teniente mine prospected

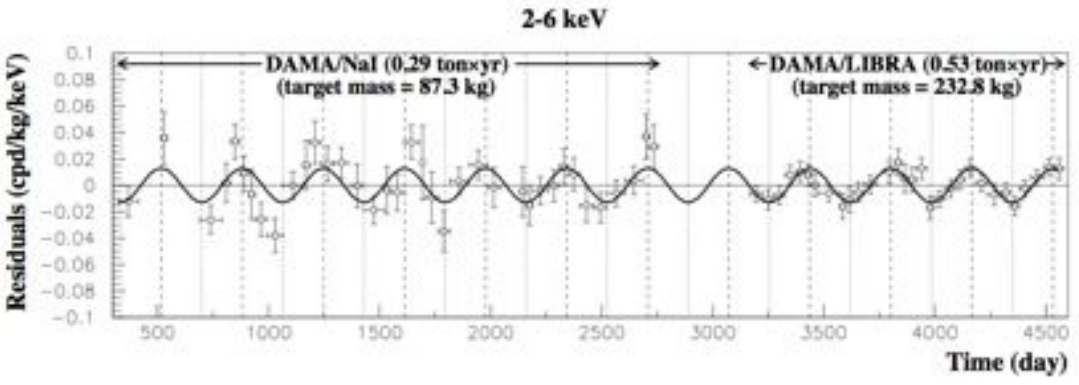
(Mexico)

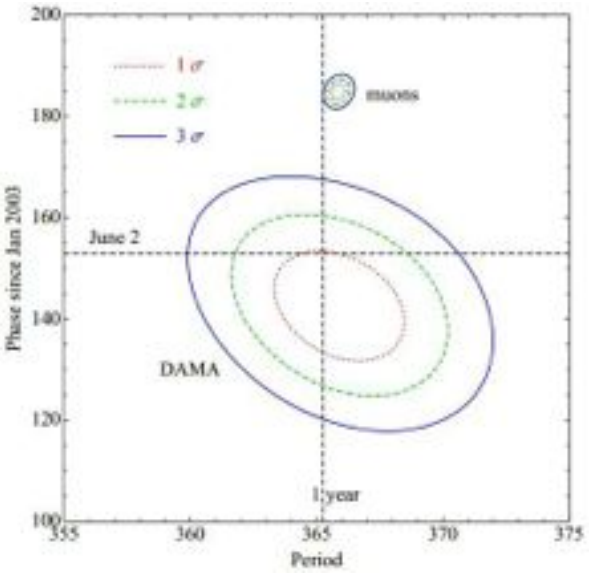
- Laboratorio Subterráneo Multidisciplinario Mexicano, Grandes Proyectos 2006

Going to the South

Observe Dark Matter modulation





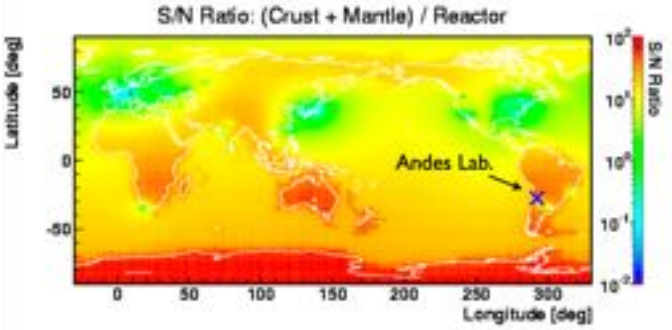


Going to the South

Observe Neutrinos

	Earth Matter Effect				
Case	Kamioka	South Pole	ANDES	Sudbury	Shadowing Prob. Mantle (Core)
(1)	No	No	No	No	0.008 (0.657)
(2)	Yes	No	No	No	0.206 (0.105)
(3)	No	Yes	No	No	0.034 (0.061)
(4)	No	No	Yes	No	0.001 (0.063)
(5)	No	No	No	Yes	0.016 (0.111)
(6)	Yes	Yes	No	No	0.205 (0.000)
(7)	Yes	No	Yes	No	0.000 (0.000)
(8)	Yes	No	No	Yes	0.282 (0.000)
(9)	No	Yes	Yes	No	0.163 (0.003)
(10)	No	Yes	No	Yes	0.000 (0.000)
(11)	No	No	Yes	Yes	0.127 (0.000)
(12)	No	Yes	Yes	Yes	0.091 (0.000)
(13)	Yes	No	Yes	Yes	0.047 (0.000)
(14)	Yes	Yes	No	Yes	0.011 (0.000)
(15)	Yes	Yes	Yes	No	0.012 (0.000)
(16)	Yes	Yes	Yes	Yes	0.008 (0.000)

Observe supernovae neutrinos directly and through the Earth



Observe geoneutrinos without nuclear reactor background

Long baselines

- Fermilab: 7600 km
- KEK: 12500 km

Going to the South

Latinamerican Particle and Astroparticle physics community

- Mature community
  - Local big experiments: Auger, HAWC
  - Participation in big collaborations (Fermilab, CERN)
- Countries with increasing spendings in science
  - Creation of the MinCyT in Argentina, increase by 50% of science funding in last 8 years
  - Mexico 6 year plan to increase by 150% science spendings

A laboratory in the south

- New space
- New people
- New funds
- New scientific experiments and opportunities

Going to the South

For Latinamerica

- Opportunity to enhance links within Latinamerica
- Opportunity to enhance links with another international community
- First experience for building a transnational scientific laboratory
- Postdoctoral organization in Underground physics at Latinamerican level
- First class laboratory with easy access
  - In particular for Argentina and Chile, link to the society
- Some scientific stability

The Agua Negra tunnel

ANDES Workshops

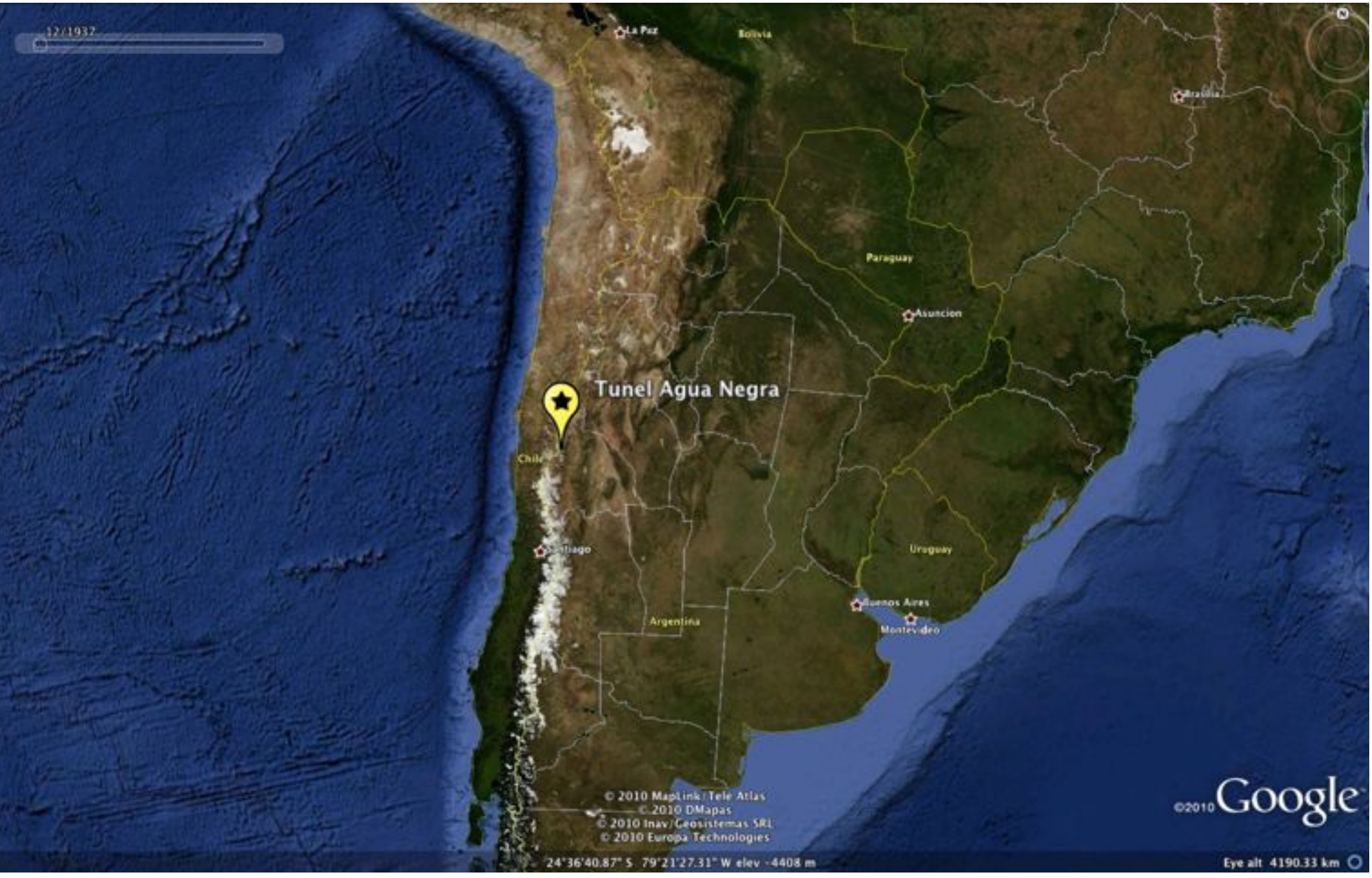
- First workshop in Buenos Aires, April 2011
- Second in Rio, June 2011
- Third in Valparaíso, January 2012
- Now in Mexico, January 2014

- 2 years without a workshop
- Delay in the tunnel planned construction date
  - Since 2011, tunnel tender was supposedly at talk date + 6 months, construction at talk date + 1 year

Tender started last year

- After 2 years of slow advances, the whole process is advancing again

The planned Agua Negra tunnel



Andes crossing

- It is of strategic importance for the region to increase exportation to the Asian market
- The natural way for Argentina and Brazil is to export by boat through Chile
- There are various passes. The main one, the Cristo Redentor tunnel from Mendoza to Santiago, cannot fulfil the increasing international demand, especially in winter when it has to close due to strong snows

- Argentina, Brazil and Chile have been looking for years at complementary options
- There have been various proposals for Mendoza - Santiago (train tunnel, Las Leñas pass) and San Juan - Coquimbo (Agua Negra)
- In recent years, the San Juan - Coquimbo option has been favoured and pushed forward

The Agua Negra tunnel recent history

- Pre-feasibility study done in 2005, feasibility in 2008
- Kirchner and Bachelet signed a Bi-National Integration treaty, including the San Juan - Coquimbo option, in October 2009, voted later on by both countries
- August 2010 MERCOSUR meeting was in San Juan and a strong support for the Agua Negra tunnel was given, with Lula pushing for the tunnel tender
- In December 2010 and January 2011 the governor of San Juan met with Piñera and his ministers. When Dilma visited Argentina, he presented her the tunnel project
- In April 2011, Piñera received 14 Argentine governors and stressed Agua Negra
- In December 2011 the Argentine congress voted a 800 MU$D guarantee fund for the Agua Negra tunnel, voted again in December 2012 and 2013
- In March 2012, Kirchner and Piñera signed an international agreement asking for the tender of the tunnel
- In January 2013, the call for tender process was officially started

Estudio Conceptual del Túnel de Agua Negra

Tunnel Agua Negra – Conceptual Design

GEOCONSULT

Lombardi

PASO DE AGUA NEGRA

CONSTRUCCIÓN DEL TÚNEL INTERNACIONAL

ENTIDAD BINACIONAL TÚNEL INTERNACIONAL PASO AGUA NEGRA (EBITAN) - INFRAESTRUCTURA VIAL

INVITACIÓN A PRESENTAR EXPRESIONES DE INTERÉS Y ANTECEDENTES

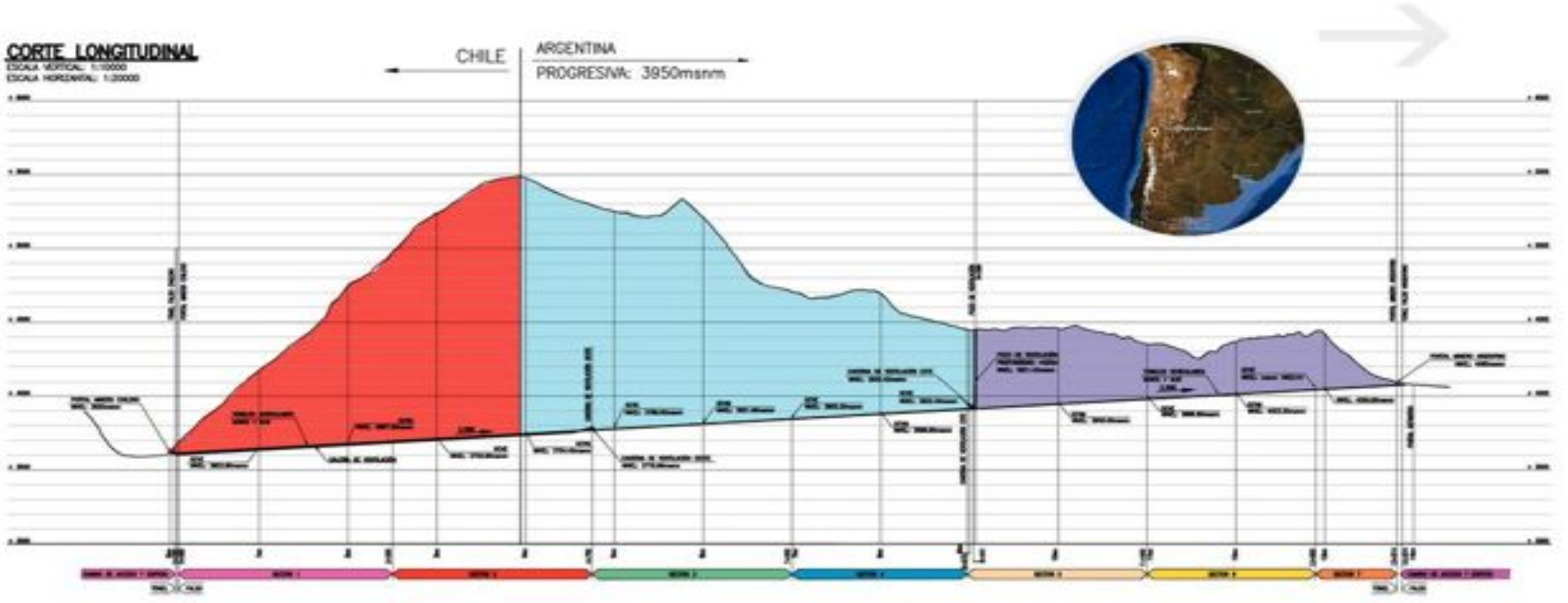
La ENTIDAD BINACIONAL TÚNEL INTERNACIONAL PASO AGUA NEGRA (EBITAN), constituida por la REPÚBLICA DE CHILE y la REPÚBLICA ARGENTINA, de conformidad al TRATADO DE MAIPÚ y regulada por su PROTOCOLO COMPLEMENTARIO de constitución, invita a empresas a manifestar interés en la construcción del Túnel Agua Negra, que atravesará la Cordillera de los Andes a la altura del paso

Circulante, declarados en los balances correspondientes. En caso de consorcios, dicho capital de trabajo se podrá acreditar sumando los aportes individuales de los integrantes del mismo.

(VI) La voluntad de expresar interés. En caso de presentarse bajo la forma de consorcio, esta voluntad deberá formularse de manera conjunta.

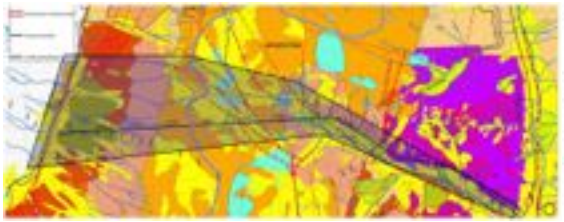
Tunnel proposed

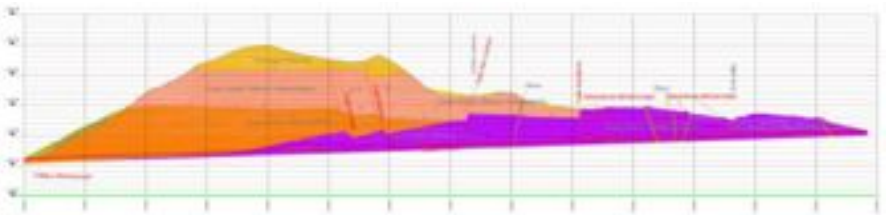
- 2 tunnels, 12 m $\varnothing$ each, separated by 60 m, $\approx$ 14 km long
- Argentine entry point at the Quebrada San Lorenzo, 4085 m a.s.l.
- Chilean entry point on a ridge, at $\approx$ 3600 m a.s.l.
- Internal connexion galleries every 500 m
- Deepest point at $\approx$ 1750 m depth
- Tender in 2013-2014, Construction 2015-2022(?)



Agua Negra Geology studies

- data from 8 main perforations of up to $\approx$ 600 m deep

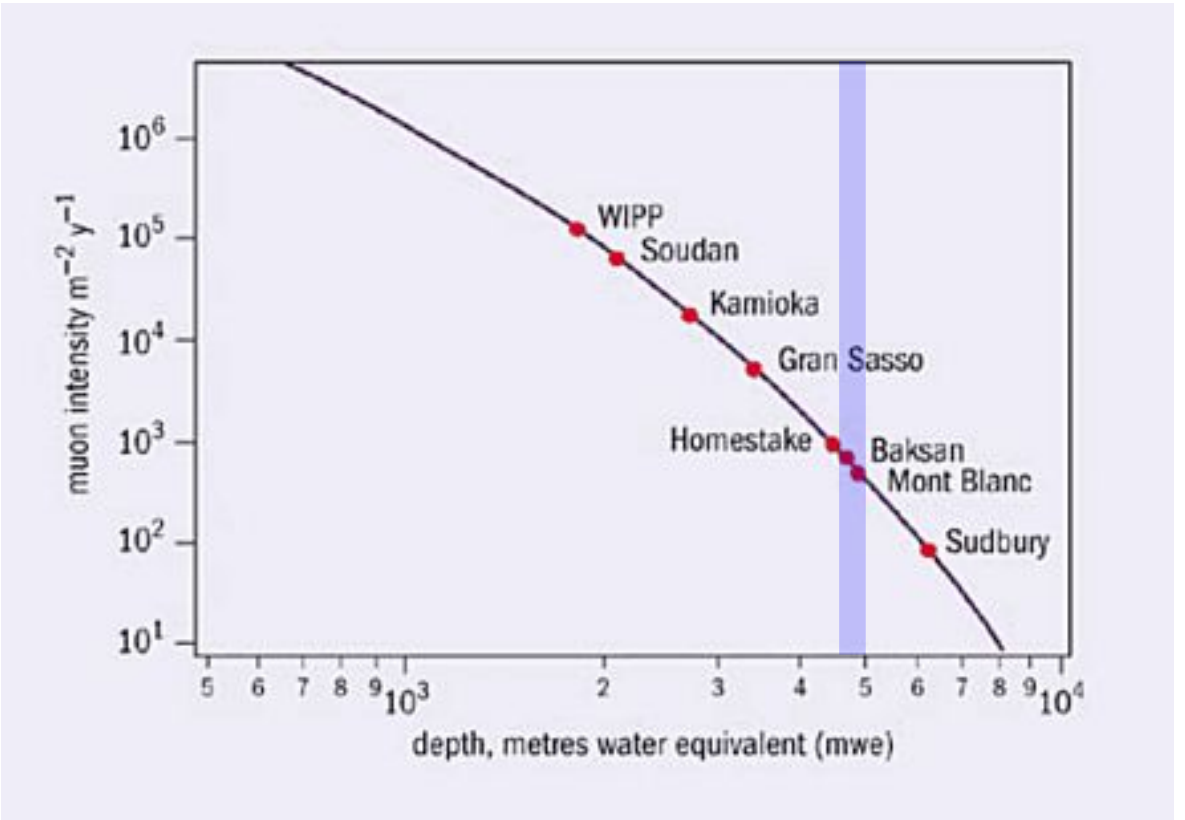




Main rocks

- Andesite
- Rhyolite
- Basalt
- Dacite
- Trachyte

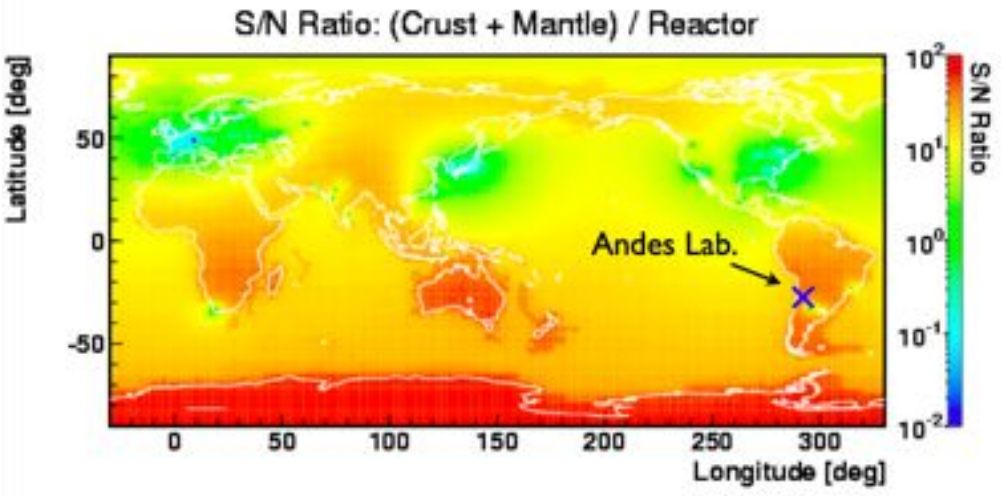
1750 m depth:
4600-5000 mwe



- World class location (probably third to Jin Ping and SNOLab)

A scientific opportunity in the south

- Opportunity for a big AND deep laboratory
- only deep underground laboratory in the south
  - opposite weather modulation (dark matter)
  - complementary for supernovae neutrinos
- Geoneutrinos
  (Low neutrino flux from nuclear power plants)
- Geoactive region
  - Underground geophysics laboratory



The Consorcio Latinoamericano de Experimentos Subterráneos (CLES)

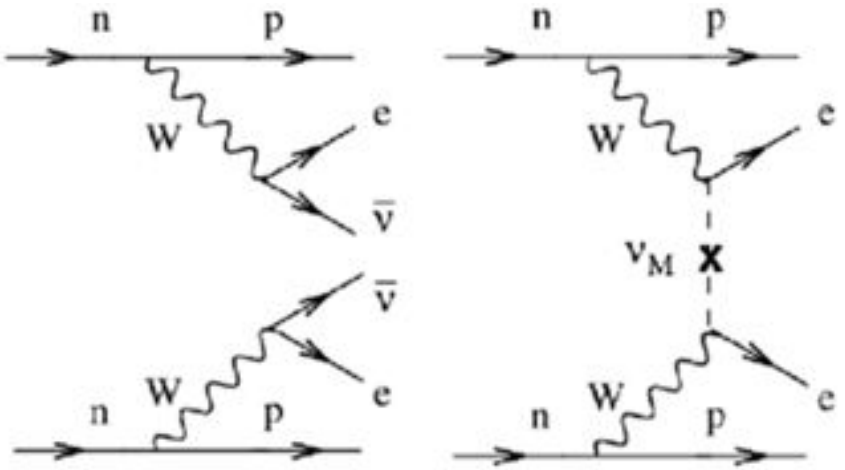
- Excellent opportunity to have an international laboratory
  expand the MERCOSUR (UNASUR) aspect of the tunnel to the ANDES laboratory
- The CLES would be the seed of a “CERN” focused on underground science (high energies, geology, biology, technology...)

Original scientific programme for ANDES

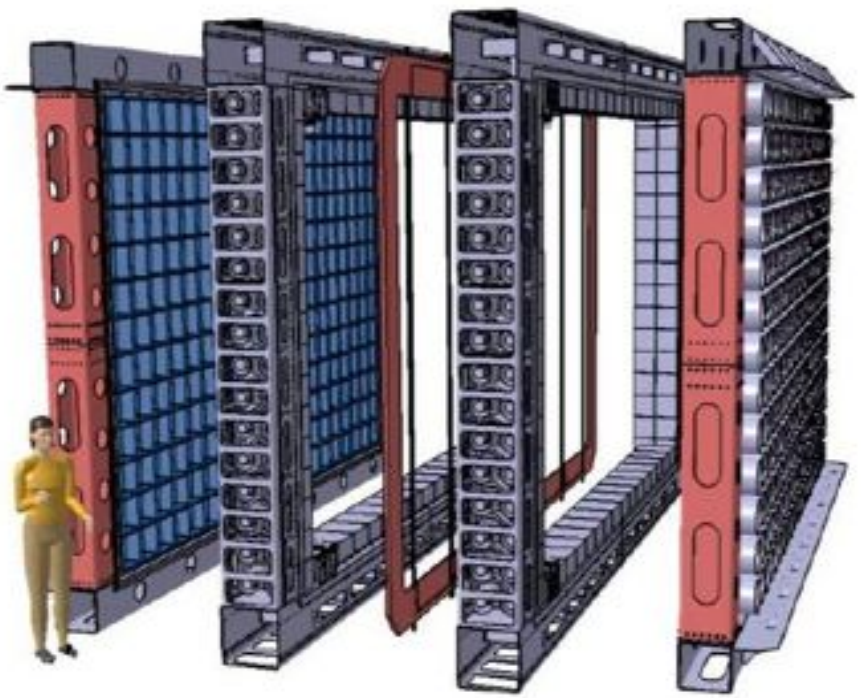
- Neutrino
  - host a double beta decay experiment
  - build a large Latin American neutrino detector
    - similar to KamLAND/Borexino
    - focused on low energies
    - solar/supernovae/geo-neutrinos
- Dark Matter
  - modulation measurements
  - new technologies
- Geophysics
  - Natural link of seismograph networks
  - “flat slab” study
- Biology
- Low radiation measurements
- Accelerator
  - Nuclear astrophysics
  - DAR neutrino beam?

SuperNEMO: double beta decay experiment

- based on NEMO-NEMO3 expertise (LSM)
- $100 - 200$ kg of ^{82}Se
- sensitive to a neutrino mass of $\approx 0.05 - 0.1$ eV



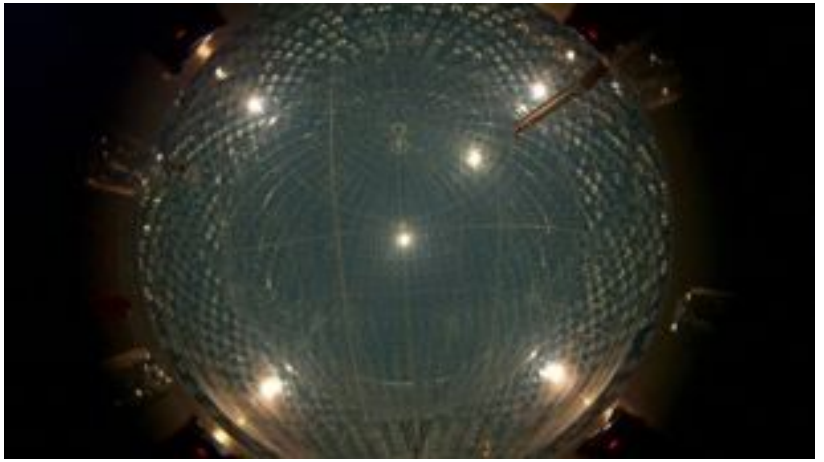
- modular design: ≈ 20 modules
- prototype for 2014



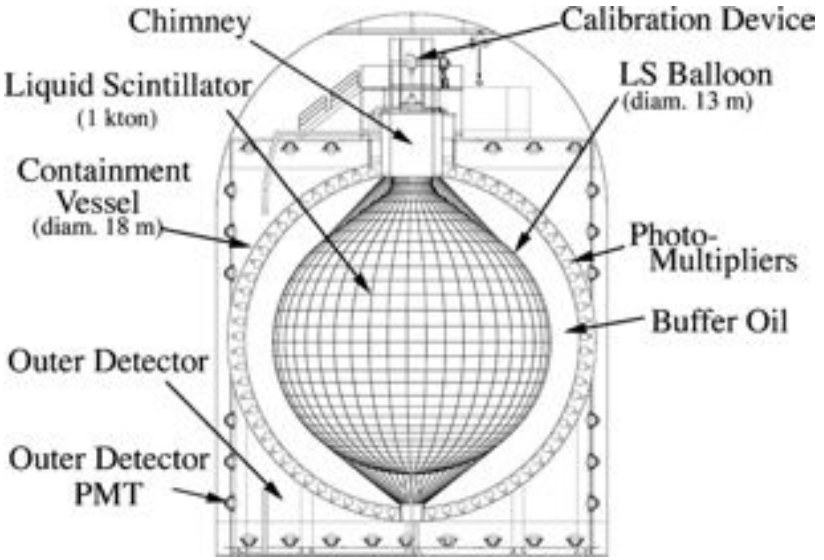
- Installation at LSM extension (Modane, France)
- Complement in ANDES

Large Latin American Neutrino Detector

- design similar to Borexino and KamLAND
- 3+ kton of scintillator

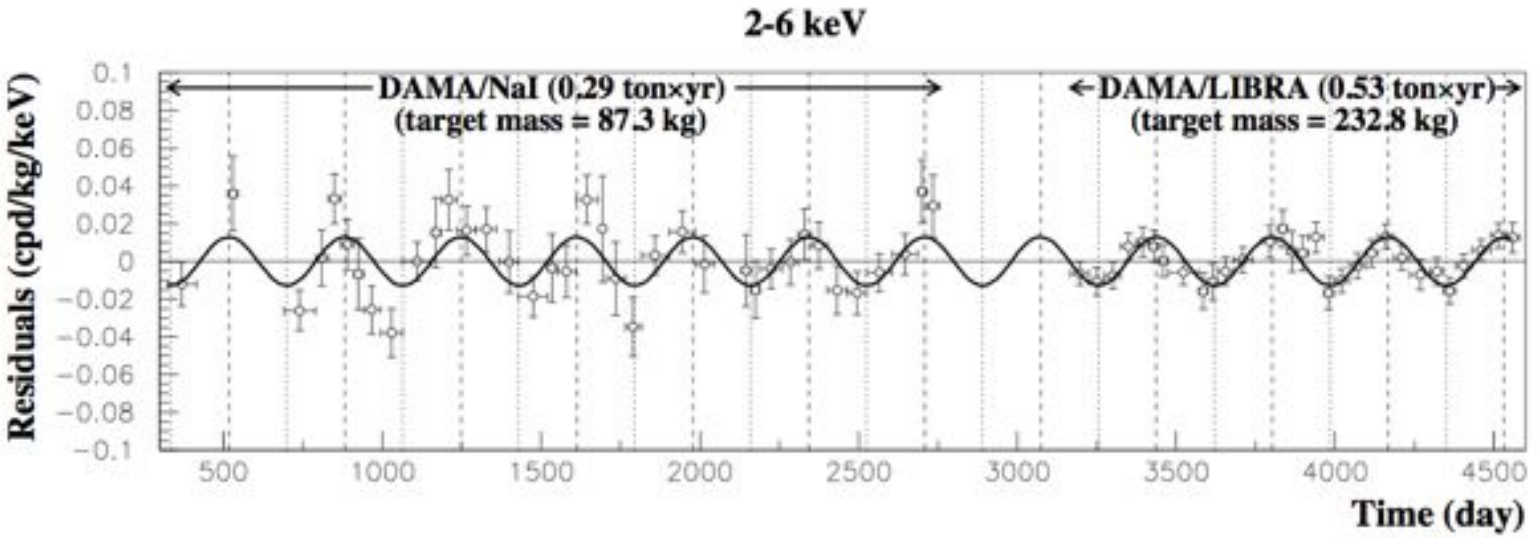


- unique site for geoneutrinos
- complementary for supernovae neutrino measurements: arXiv:1027.5454

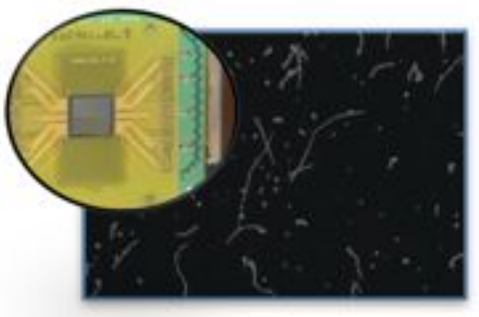


- is it the right topic (CP violation in the leptonic sector?)
- is it the right technology (Argon?)

Dark Matter in ANDES



- host a copy of an experiment observing a modulation
- host a 3rd generation experiment

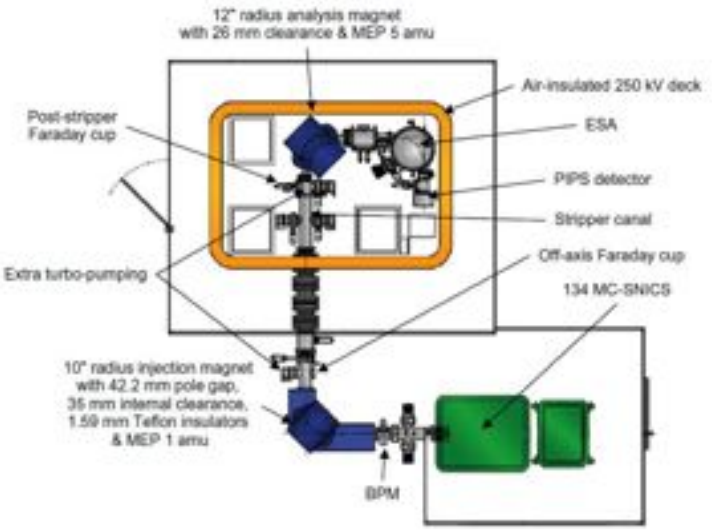


- work on new technologies (actively evolving area)
  - ex: DAMIC (Dark Matter Identification with CCD) Collaboration with Fermilab

LUNA: Laboratory for Underground Nuclear Astrophysics

- installed at LNGS (Gran Sasso)
- 50 kV accelerator
- 400 kV (LUNA II)
  - study nuclear reactions at low energies, relevant for astrophysics processes (Gamow peak)
  - ex: $^{3}He(^{3}He,2p)^{4}He$ below 21 keV

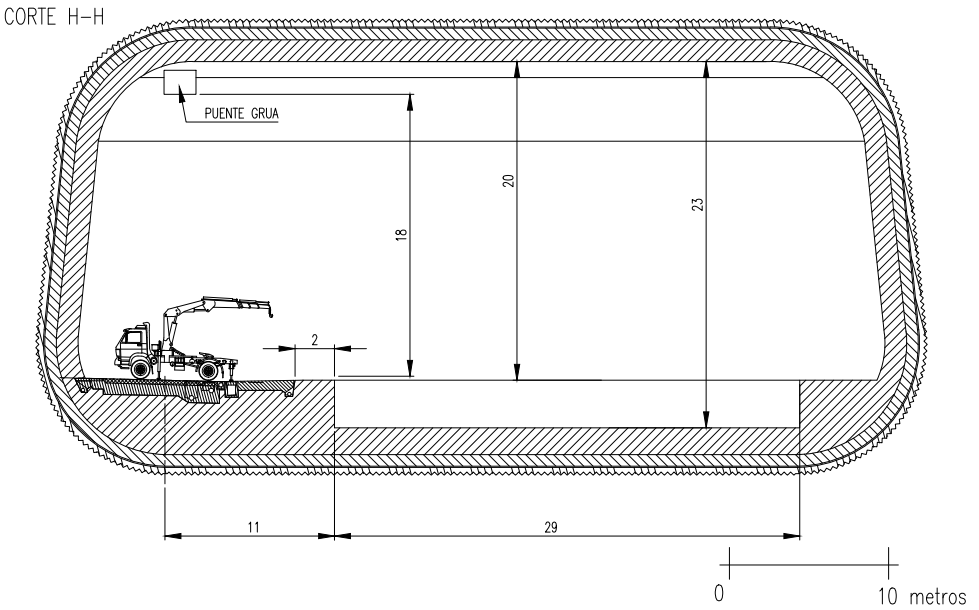
Proposal from Galindo-Uribarri, Padilla-Rodal and Vega for a 300 kV high intensity platform for ANDES



Proposal for the ANDES laboratory

Located at km 3.5-5

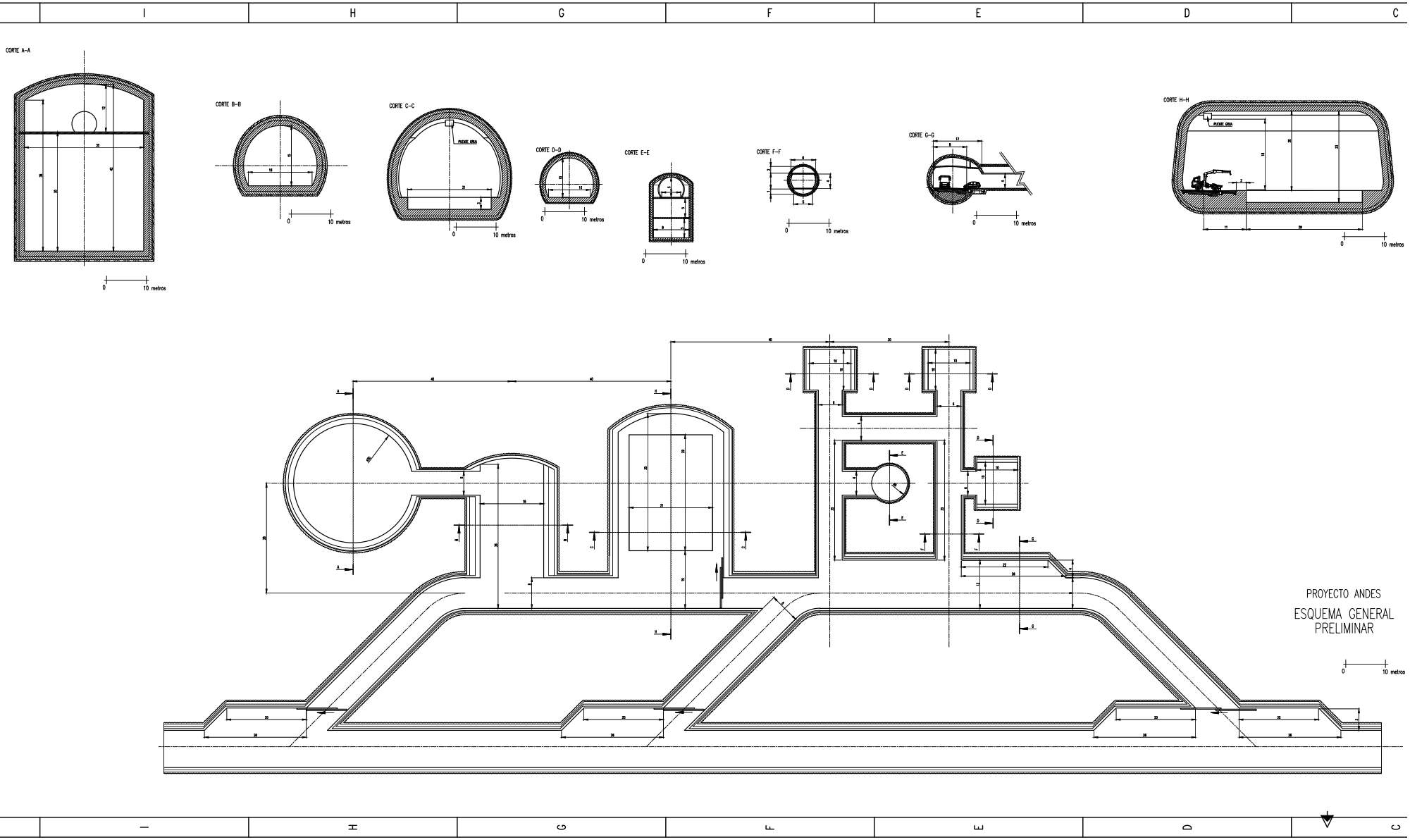
- Main hall
  - $(21 \times 23 \times 50)\,m^3$
- Secundary hall
  - $(16 \times 14 \times 40)\,m^3$
- Offices and small laboratories
  - 3 halls of $100\,m^2$
- Low radiation pit
  - $\varnothing 9\,m$, $9\,m$ tall
- Large experimental pit
  - $\varnothing 30\,m$, $30\,m$ tall



Civil work cost estimated $< 2\%$ of tunnel cost

- + Laboratory equipment
- + 2 support laboratories
- + Experiments

Preliminary laboratory layout



Two support laboratories

- At La Serena (Chile) and Rodeo (Argentina)
- Workshops for the underground activities
- Integration with local universities (academic activity)
- Visitor centres

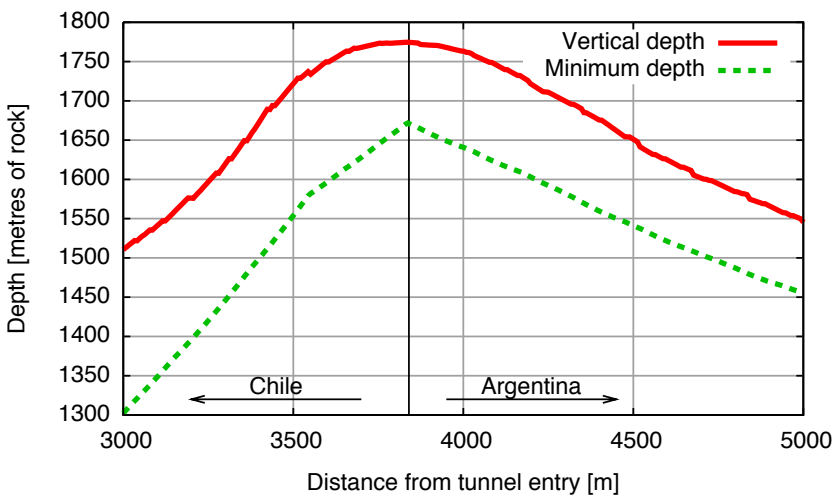


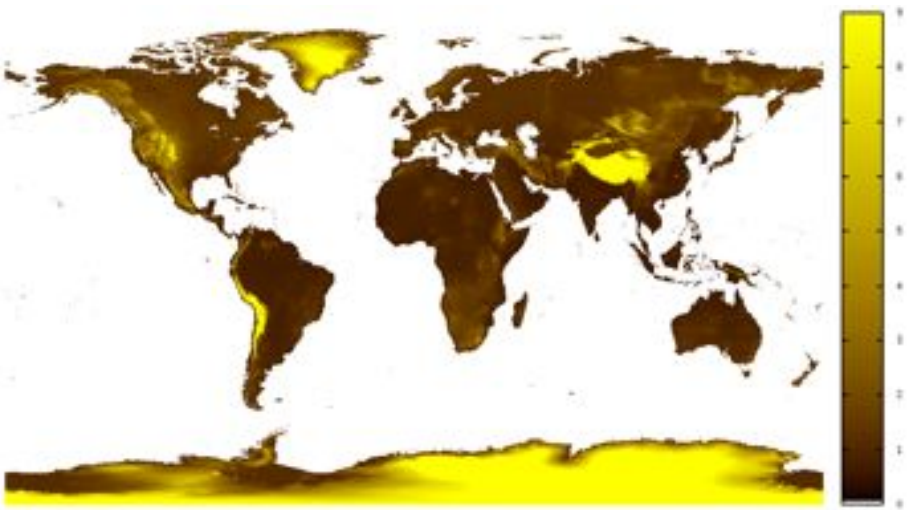
Background estimation

- 600 m deep rock samples measured for natural radioactivity (LAAN, M. Arribere)

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

- Depth, muon flux and neutron activation calculations





Current Status

- International community support:
  - 19 support letters
    (underground lab directors, international projects spokespersons, national physics associations and academies...)
- Regional interest:
  - 26 letters from Latin American groups
- First workshop in Buenos Aires, April 2011
- Second in Rio, June 2011
- Third in Valparaíso, January 2012
- Official support from Argentine MinCyT (Comisión Asesora Grandes Instrumentos)
- Official support from EBITAN (Entidad bi-nacional túnel Agua Negra)

Memorandum of Understanding (First workshop, Buenos Aires, April 2011)

Current status (cont.)

March 2012

- approved by the MinCyT (CAGICyT) and EBITAN
  - ANDES will go as an ”adicional de obra”

Tunnel tender process started in January 2013

- International call issued in June 2013
- Companies selected in October 2013
- Detailed engineering foreseen for March 2014
- Company chosen before end of the year?

ANDES relevant part

- Conceptual study of ANDES (6-8 weeks), April 2014
- Detailed engineering of ANDES (3-4 months)
- Tender documentation to insert ANDES in the civil work

Lombardi

Lombardi SA, CH-6648 Minusio

Laboratorio Detección de Partículas y Radiación
Centro Atómico Bariloche
Av. Bustillo 9500
San Carlos de Bariloche
Argentina

Fecha Minusio, 27.01.2014 Nuestra ref.: Ing. Rondi/RL/Inc.- Vuestra ref.:

Contacto leonardo.rondi@lombardi.ch, teléfono +41 (0)91 735 31 00

Asunto **Proyecto Laboratorio Andes - Carta de Manifestación de Interés**

This ANDES Workshop

Discussion among us

- Tonight dinner
  - Tacos at a simple but good restaurant
  - Mexican dinner in a more elaborated restaurant
- Discuss about the physics
  - Create task forces (Neutrino, Dark Matter)
- Discuss about the flag neutrino experiment
- Modified tomorrow afternoon program
  - No geophysics talk
  - 15h00 - 16h30: round table

Workshop document

- More support letters from Mexican groups
- Work with CLAF for coordination
  - ANDES Unit in CLAF to be signed tomorrow