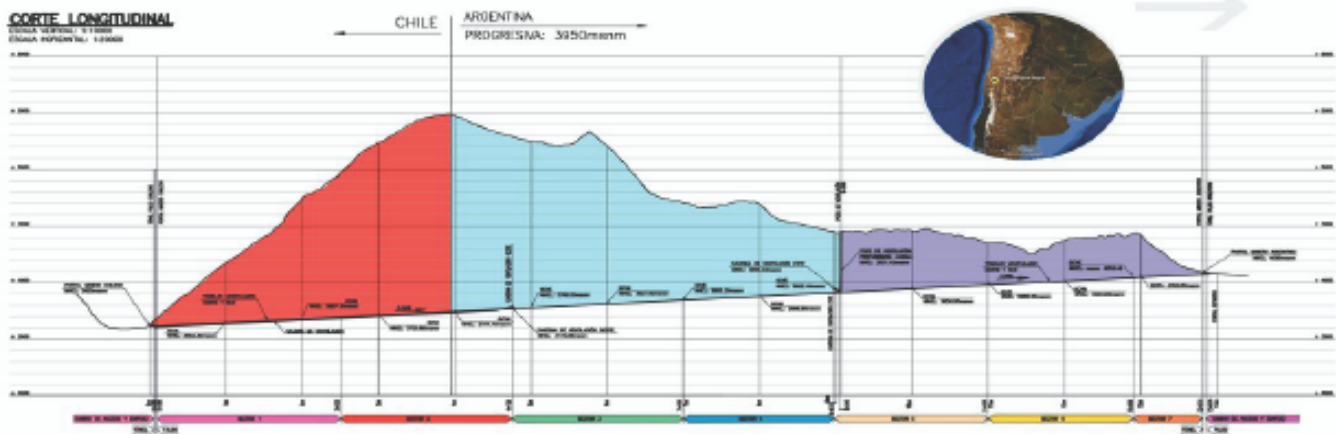


ANDES

The first deep underground laboratory of the Southern hemisphere.

A Latin American project in the Agua Negra tunnel



Thanks to the organizers

Topics usually part of a “basic” ANDES talk

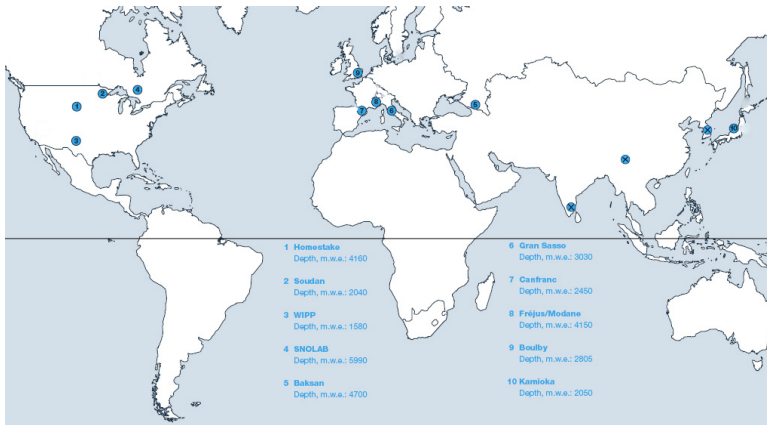
- Science programmes in deep underground research facilities
- Overview of Neutrino
- Overview of Dark Matter

Also related

- Gran Sasso Lab: a success story and an example for others
- The organization of big facilities
- Technologies for the future of astroparticle physics



Current locations of underground laboratories



- All in the northern hemisphere
- Located in tunnels or mines

Underground physics in Southern hemisphere mines

South Africa

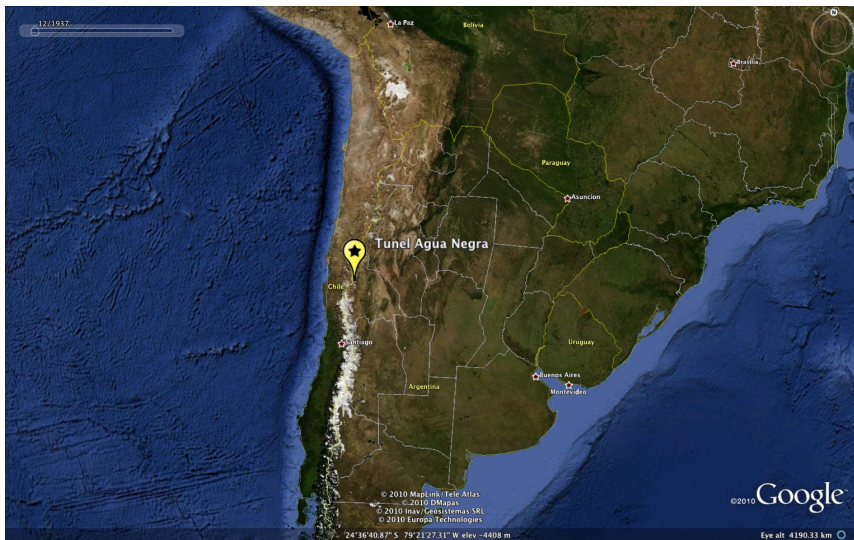
- First atmospheric neutrinos in 1965 by Reines et al.
 - Phys. Rev. Lett. **15** (1965) 429
(together with Achar et al. in India, Phys. Lett. **18** (1965))

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



The planned Agua Negra tunnel

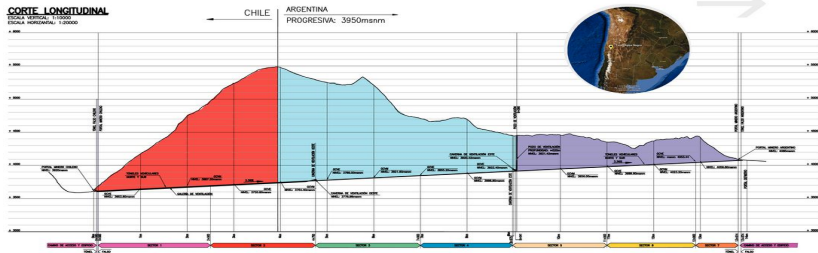


The Agua Negra tunnel recent history

- Pre-feasibility study done in 2005, feasibility in 2008
- Cristina Fernández de Kirchner and Michelle 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 Luis Inácio Lula da Silva pushing for the tunnel tender
- In December 2011 the Argentine congress voted a 800 MU\$D guarantee fund for the Agua Negra tunnel, voted again in December 2012, 2013
- In March 2012, Cristina Fernández de Kirchner and Sebastián Piñera signed an international agreement asking for the tender of the tunnel
- In January 2013, the call for tender process was officially started
- In June 2013, the international call for companies was issued
- Total cost estimated to about 1250 MU\$D



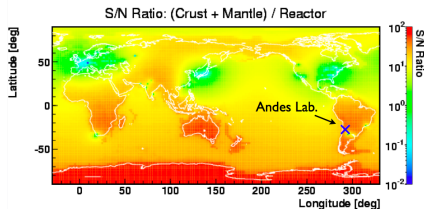
Tunnel proposed



- 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 2013-2015, Construction 2015-2023

A scientific opportunity in the south

- Opportunity for a big AND deep laboratory in the south
 - opposite weather modulation (dark matter)
 - complementary for supernovae neutrinos
- Geoneutrinos
 - Low nuclear power plant background
- Geoactive region
 - Underground geophysics laboratory



The Consorcio Latinoamericano de Experimentos Subterráneos (CLES)

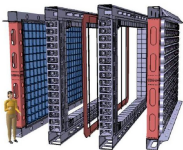
- Excellent opportunity to have an international laboratory
 - expand the MERCOSUR (UNASUR) aspect of the tunnel to the ANDES laboratory
- CLES as the seed of a “CERN” focused on underground science
 - high energy/astroparticle, geology, biology, technology...

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 experience (LSM)
- ▶ 100 – 200 kg of ^{82}Se
- ▶ neutrino mass sensitivity: $\approx 0.05 - 0.1$ eV
- ▶ modular design: ≈ 20 modules
- ▶ demonstrator for 2013



- ▶ design and schedule well adapted to ANDES
- ▶ strong interest from SuperNEMO representatives

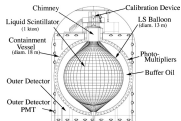
15/25

Large Latinamerican Neutrino Detector

- ▶ similar design to Borexino and KamLAND
- ▶ 3 – 10 kton of scintillator volume



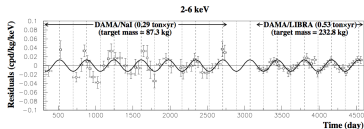
- ▶ unique site for geoneutrinos
- ▶ complementarity for supernova neutrinos analysis
arXiv:1027.5454



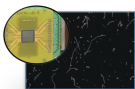
- ▶ design under study
- ▶ main topic of next ANDES Workshop

15/25

Dark Matter in ANDES



- ▶ host a copy of a DM experiment observing a modulation signal
- ▶ host a 3rd gen. DM experiment
- ▶ work on new technologies (fast evolving topic)



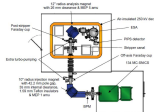
17/25

Nuclear Astrophysics

LUNA: Laboratory for Underground Nuclear Astrophysics

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

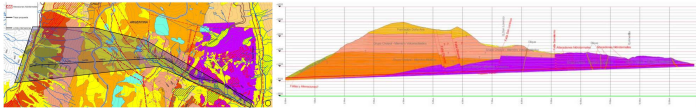
Proposal from Galindo-Uribarri, Padilla-Rodal and Vega for a 300 kV high intensity platform at ANDES



18/25

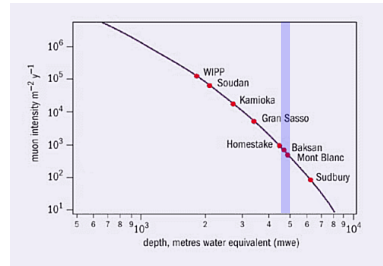
Agua Negra Geology studies

- data from 8 main perforations of up to ≈ 600 m deep



Main rocks

- Andesite
- Rhyolite
- Basalt
- Dacite
- Trachyte



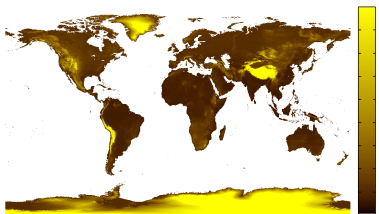
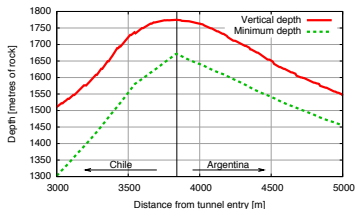
1750 m depth: 4600-5000 mwe

Background estimation

- 600 m deep rock samples measured for natural radioactivity

(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



ANDES Laboratory concept

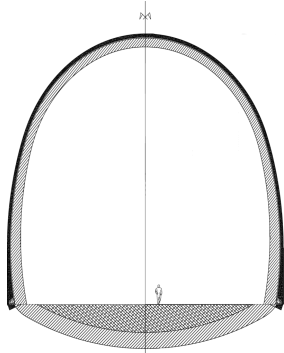


ANDES Laboratory proposal

Located at km 3.5-5

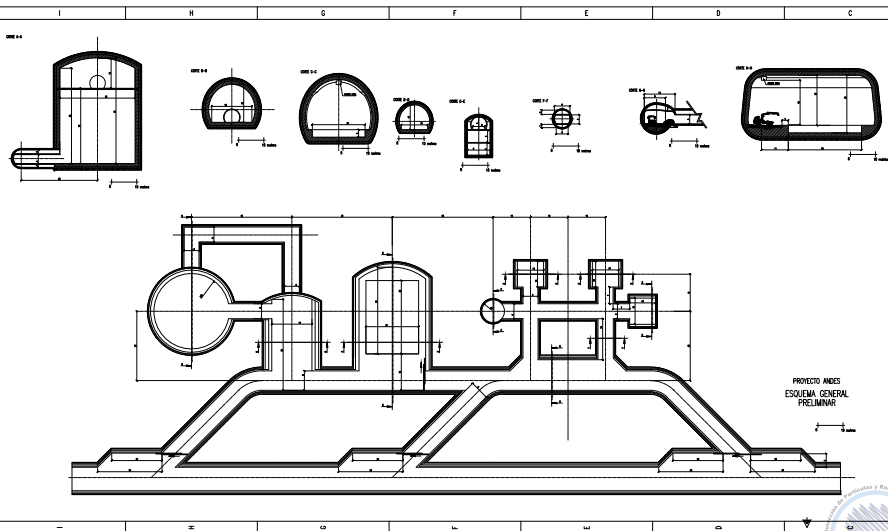
- main hall:
(21×23×50) m³
- secondary hall:
(16×14×40) m³
- multiple halls:
3 × (9×6×15) m³
- ultra-low radiation pit:
∅9 m, 9 m depth
- single experiment pit:
∅30 m, 30 m depth

Total civil work cost:
< 2% of tunnel cost

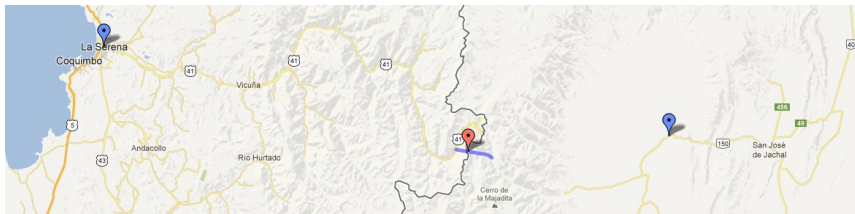


- + scientific equipment cost
- + 2 external labs
- + experiments cost

Preliminary laboratory layout



ANDES surroundings



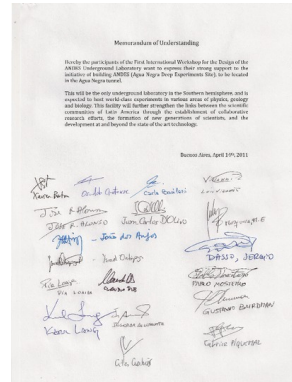
- Offices at the portals (for short stays)
- Two support labs, in La Serena (Chile) and Rodeo (Argentina)
- Integration with local universities, host visitor centers...



Current Status

- International community support:
 - 19 support letters
(underground lab directors, international projects spokespersons, national physics associations and academies...)
- Regional interest:
 - 27 letters from Latin American groups
- Organization of anual workshops:
Buenos Aires, 04/2011, Rio de Janeiro, 06/2011,
Valparaíso, 01/2012, México DF, 01/2014
- 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.)

CLAF - ANDES Unit

- ANDES Unit created in CLAF in January 2014
- First step towards the CLES

Tunnel tender process started in January 2013

- International call issued in June 2013
- Process is on-going in 2014, construction planned for mid 2015

ANDES design studies with Lombardi

- Approved by Argentine minister of planification
- Conceptual study, end 2014
- Detailed engineering study, mid 2015
- ANDES will go as an “adicional de obra”
 - ▶ Written confirmation from Governor of San Juan



What next? (for those interested in participating)

- Prepare next workshop
 - San Juan, Argentina, end 2015
 - Official announcement for ANDES
 - Get your pick-axe excursion to Agua Negra
- Work in existing Neutrino/Dark Matter experiments
- Start Neutrino flag experiment collaboration
- Work on human resource formation
 - With well established laboratories
 - Gran Sasso
 - SNOLAB
 - In running/planned experiments
 - Postgraduation and, on mid-term, schools

<http://andeslab.org/>
info@andeslab.org



On behalf of the ANDES initiative

Name	Country	function	e-mail
Joao Anjou	Brasil	participant	
Xavier Bertou	Argentina	coordinator (C-PI)	
Oswaldo Civitarese	Argentina	participant (C-PI)	osvaldo.civitarese@fisica.unlp.edu.ar
Claudio Dib	Chile	participant	
Juan Carlos D'Olivo	Mexico	participant	

Thank you!

