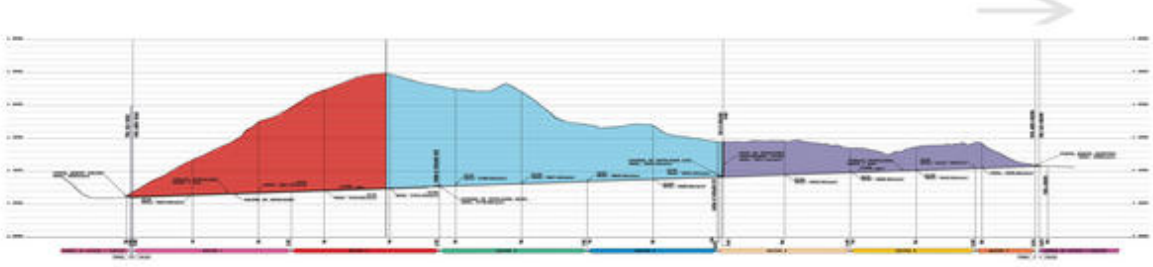
First International Workshop for the Design of the ANDES Underground Laboratory

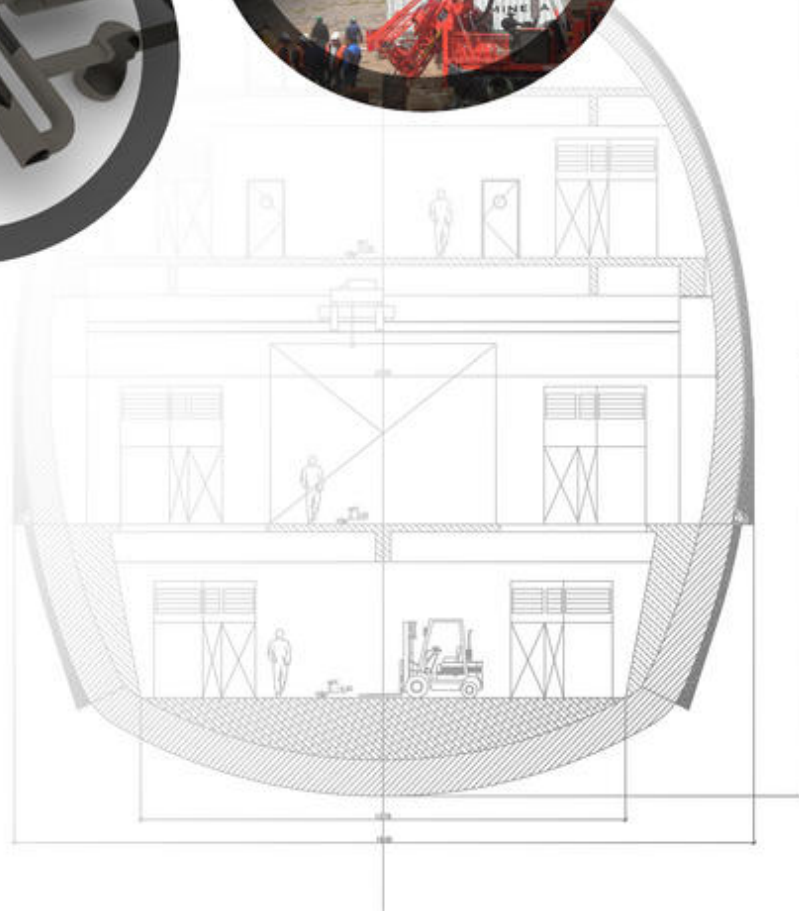
Centro Atómico Constituyentes, Buenos Aires, Argentina, 11-14 April 2011

The construction of the Agua Negra tunnel between Argentina and Chile gives the scientific community a unique opportunity to build an underground laboratory 1750m deep under the Earth surface in the southern hemisphere. The opening of the ANDES underground laboratory would be following the one of the Agua Negra tunnel in 2018, but its design has to be finalized in 2011.

The First International Workshop for the Design of the ANDES Underground Laboratory is a call to the international community in order to plan the laboratory according to the growing needs of underground experiments.

Program and registration: http://particulas.cnea.gov.ar/andes/ **Deadline: 15 March 2011**
Contact: andeslab@cab.cnea.gov.ar

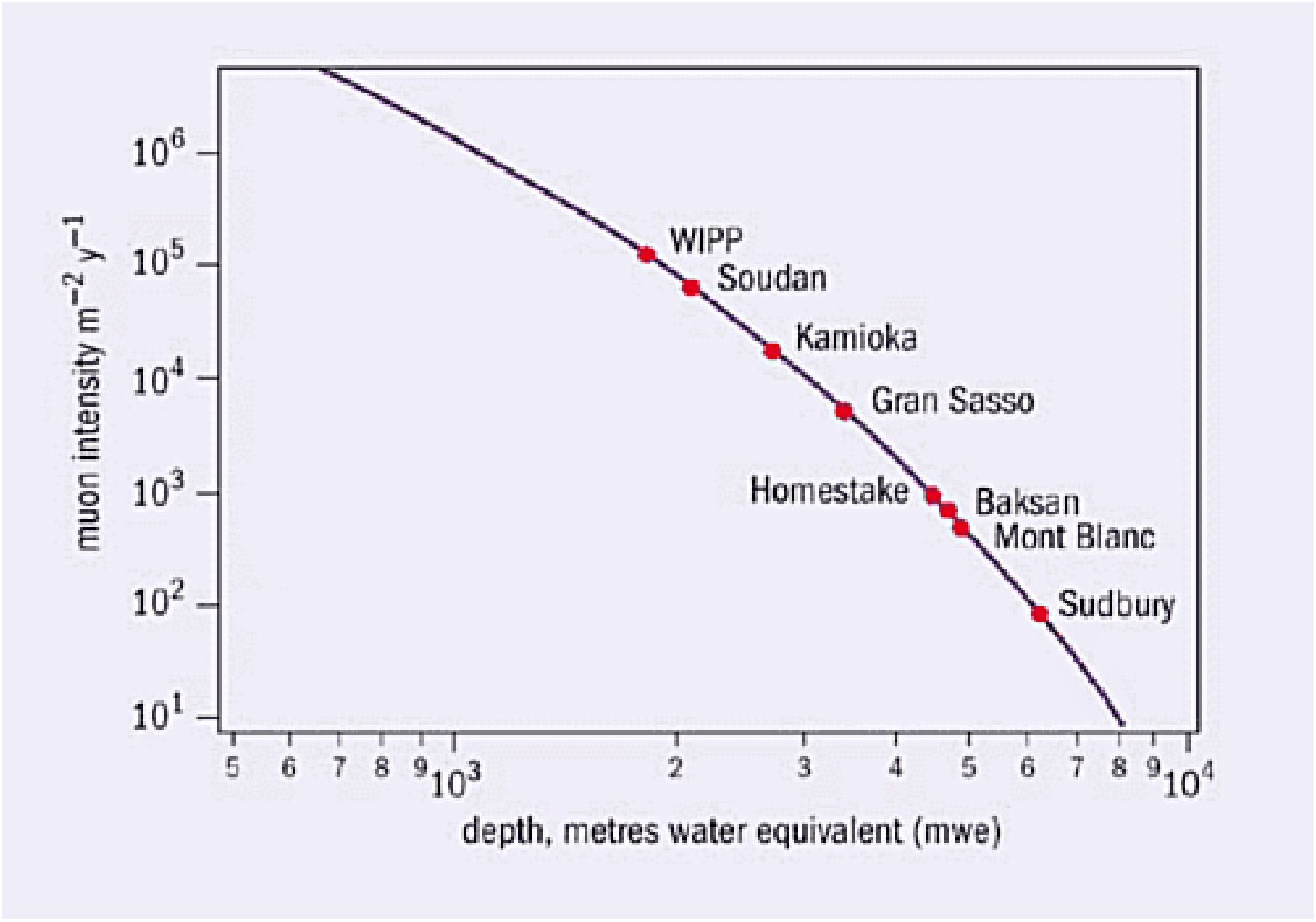




Underground Laboratories

Muon flux vs depth

Muon flux at sea level: few 100 $m^{-2}\,s^{-1}$



Experiments in Underground laboratories - ν

Neutrinos

- Particle able to cross millions of km of rock without interaction
- Solar neutrino flux: $\approx 10^{11}$ neutrino per cm^2 per second (day and night)

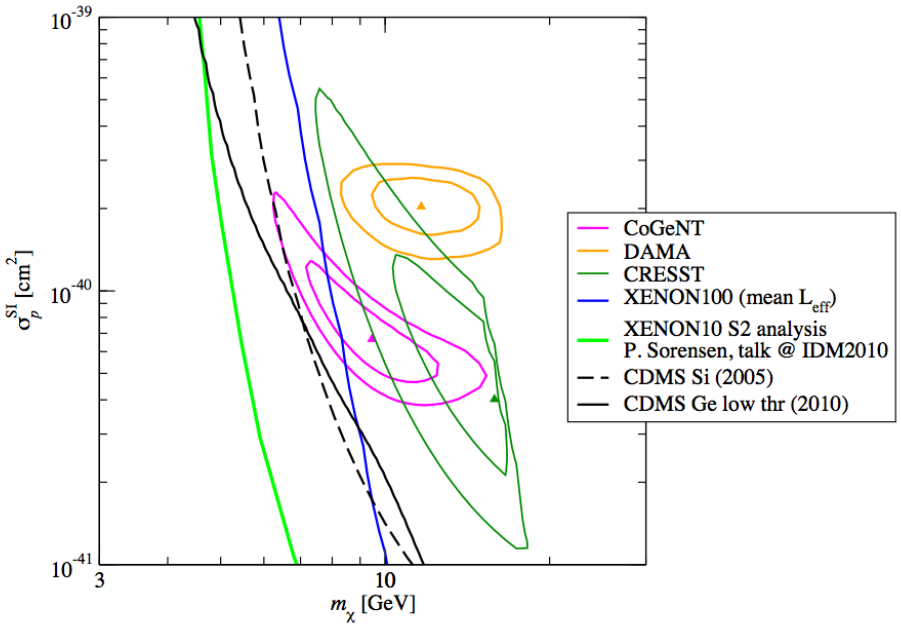
- nuclear reactor neutrinos
- particle accelerator neutrinos
- atmospheric neutrinos
- solar neutrinos
- extrasolar neutrino
- neutrino oscilation
- neutrino mass
- neutrino nature
- geoneutrinos

Experiments in Underground laboratories - DM

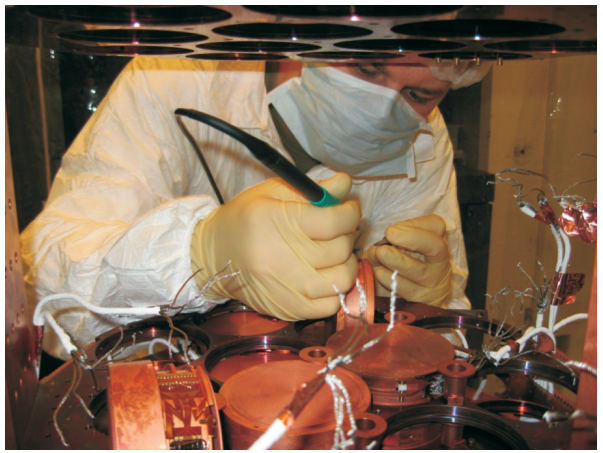
Dark Matter search

- Visible matter $\approx$ 0.4% Universe
- Adding intergalactic gas, reach 4%
- 24% of Universe formed by Dark Matter
- remaining 72%: Dark Energy

- different detector techniques (cryogenics, noble liquids, ...)



- direct detection
- indirect search (modulation)



Experiments in Underground laboratories - continued

- Geoscience
  - seismograph (low frequency)
  - ¿geoneutrinos?
- Low radiation measurements
  - material selection
  - climatology, environment
  - microelectronics
- Biology

Some Underground laboratories

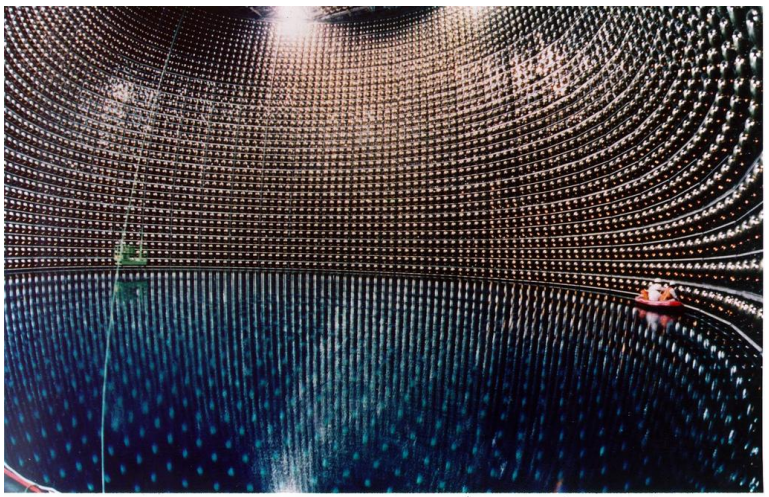
Laboratories in mines

- SNOLab, Kamiokande
- Homestake: possible extention (DUSEL)

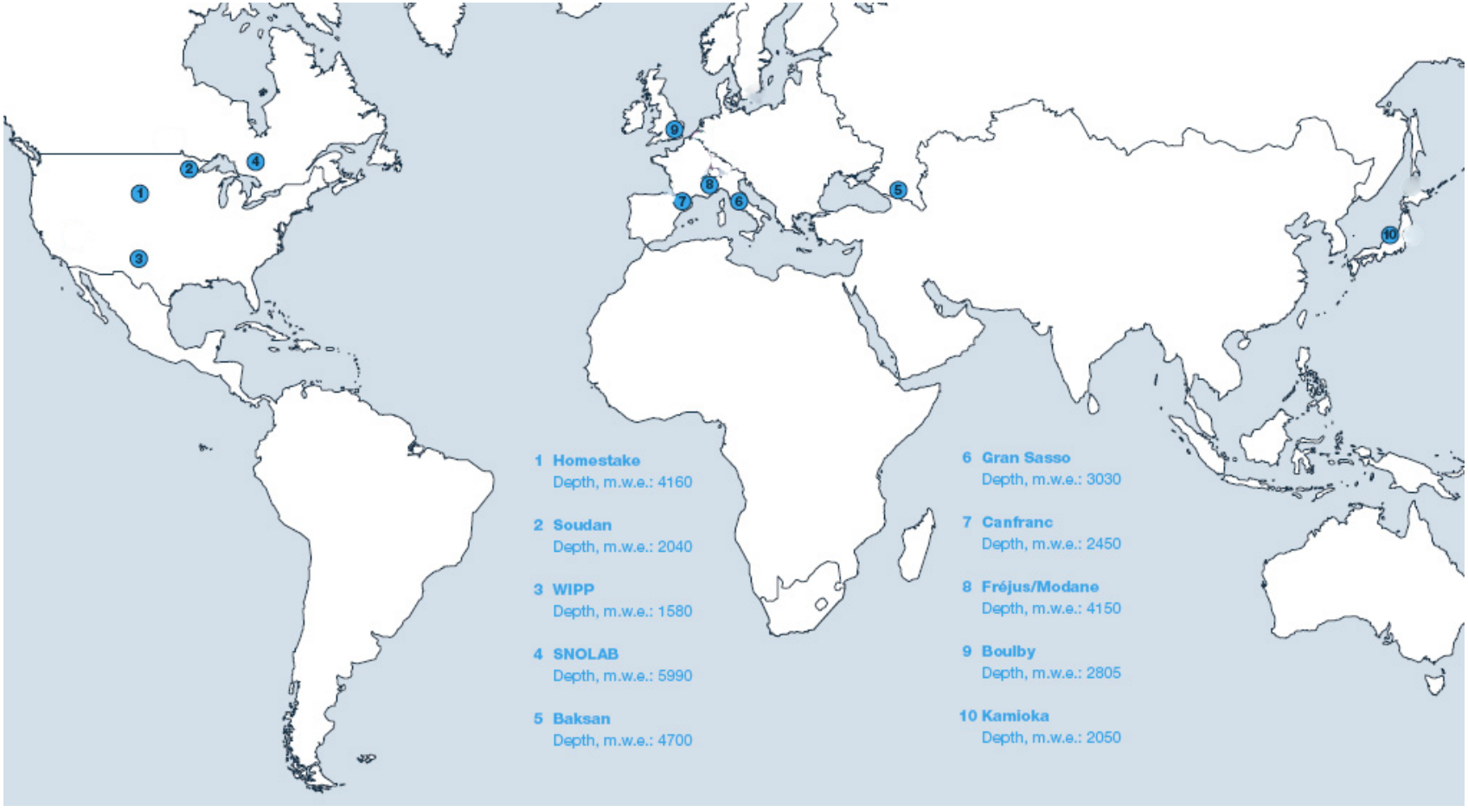
Laboratories in tunnels

- Gran Sasso: 3 halls of $(100 \times 20 \times 20)\,\mathrm{m}^3$
  Total volume: $180\,000\,\mathrm{m}^3$
- Modane: main hall of $(30 \times 10 \times 11)\,\mathrm{m}^3$
  3 secondary rooms $(70 + 18 + 21)\,\mathrm{m}^2 \times 4.5\,\mathrm{m}$

- Mines easier
  to build/expand
- Tunnels easier
  to access, to work within



Underground Laboratories



- None in the southern hemisphere

Southern hemisphere and Latin America?

South Africa

- First natural neutrino 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 Lattes
- Chile: El Teniente mine prospected

Latin America

- Mexico: proposal of the multidisciplinary mexican underground laboratory (LSMM) for Mega Proyectos 2006

The ANDES laboratory in the Agua Negra tunnel

Andes crossing

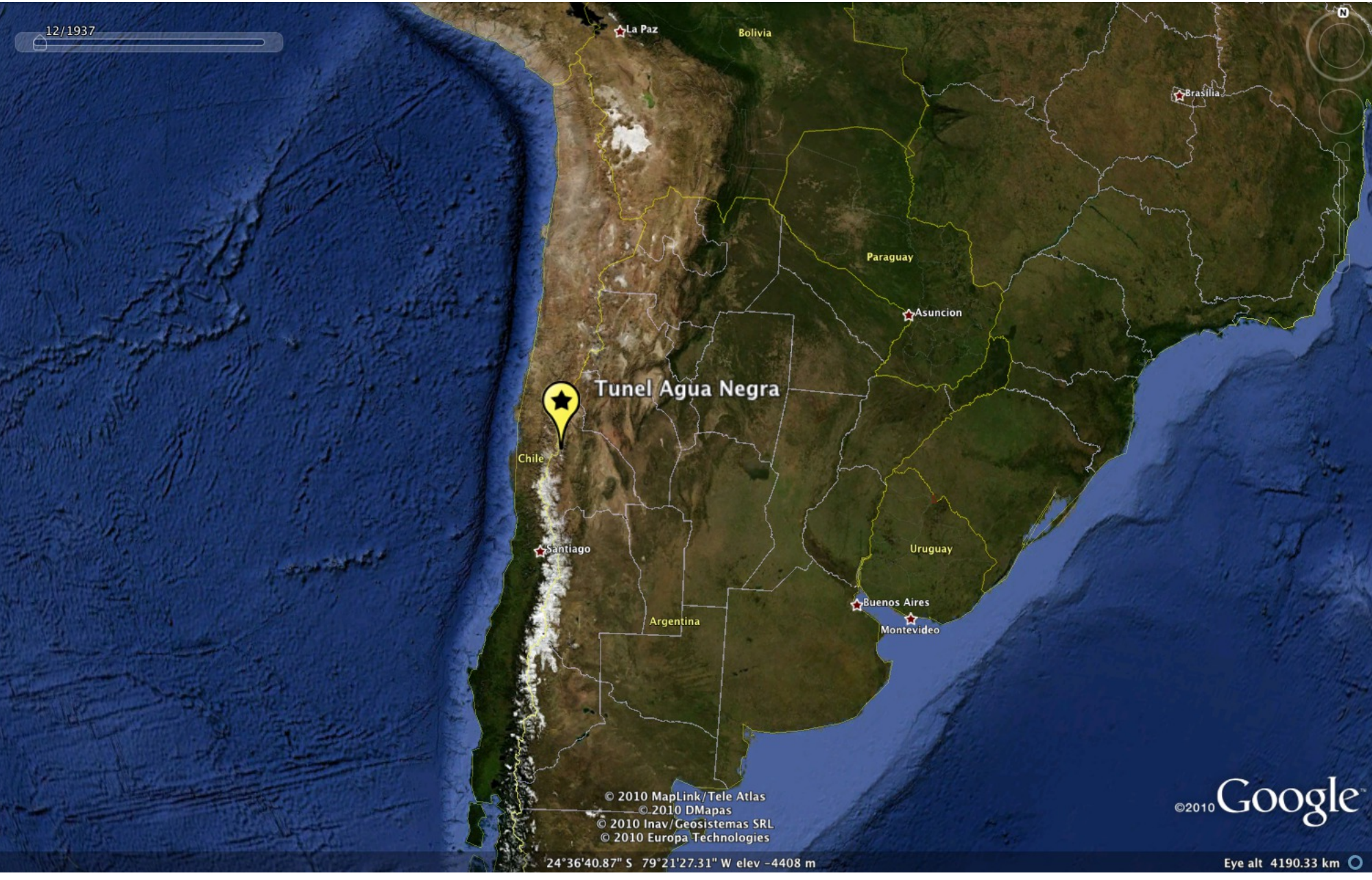
- It is of strategic importance for the region to increase exportation to the Asian market
- The natural way for Argentina and Brazil is to export by boat through Chile
- There are various passes. The main one, the Cristo Redentor tunnel from Mendoza to Santiago, cannot fulfil the increasing international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

- Argentina, Brazil and Chile have been looking for years at an alternative based on a low altitude tunnel
- There have been various proposals for Mendoza - Santiago (train tunnel, Las Leñas pass) and San Juan - Coquimbo (Agua Negra)

The Agua Negra tunnel context

- Recently the San Juan - Coquimbo option is favoured
- A pre-feasibility study started in 2005
- In 2008 more complex studies and prospectives were made to conclude on the feasibility of the project
- 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 Lula da Silva pushing for the tunnel tender
- In December 2010 and January 2011 the governor of San Juan met with Sebastián Piñera and his ministers. When Dilma visited Argentina, he presented the tunnel project to her
- Tender foreseen to start September 2011
- Total cost is about 850 MU$D

Location of the Agua Negra pass

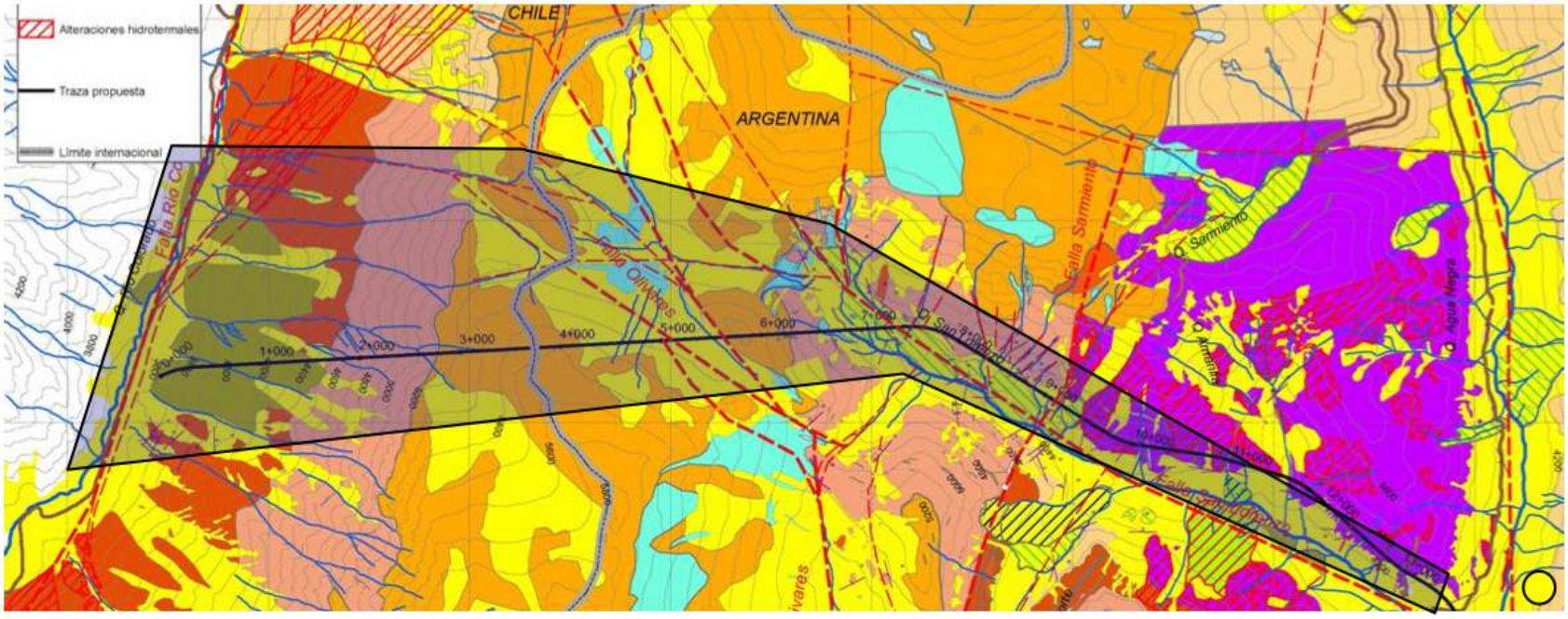


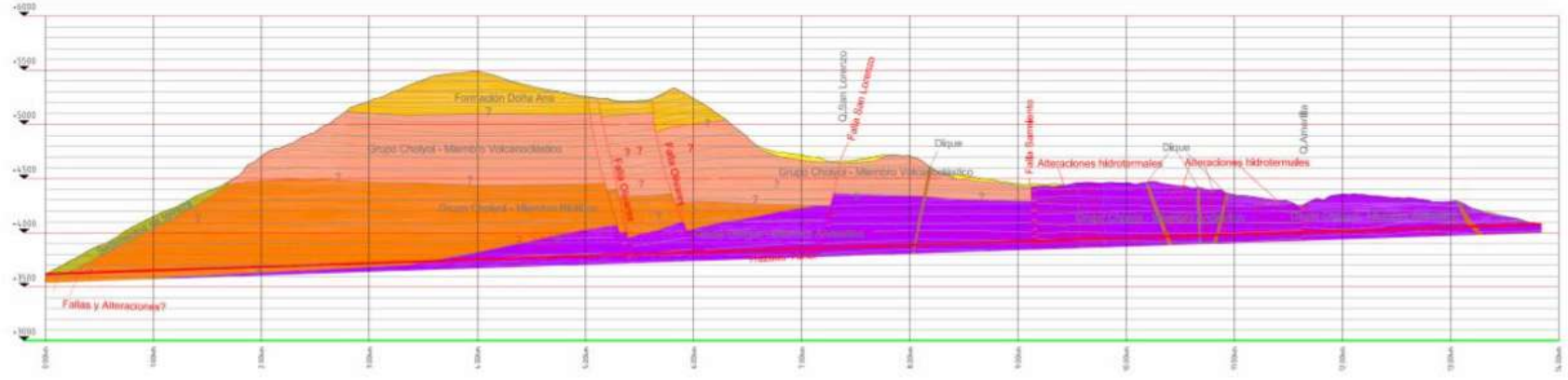
Tunnel proposed

- 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

- $\approx$ 3700 m of altitude
- relatively remote
- “hot” tunnel $\approx 30 - 40^\circ$ C
- Ideal depth for an Underground Laboratory ($\approx$ Frejus-Modane)

Agua Negra cross section





ANDES Laboratory proposal

Located at km 3.5-5

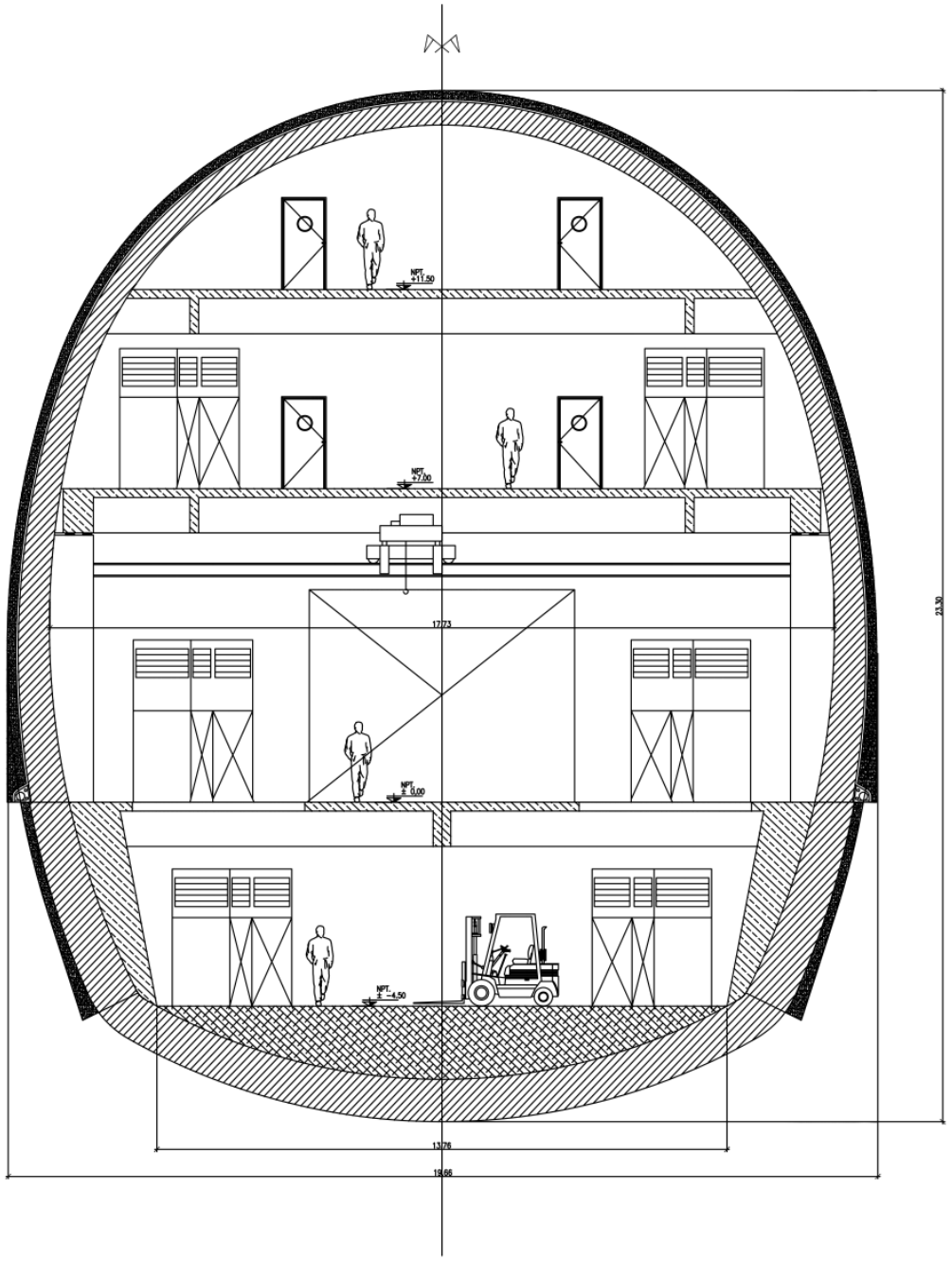
3 big halls:

- 2 main halls: $(19 \times 23 \times 50)\,\mathrm{m}^3$
- hall 3: pit $\varnothing 20$ m, 20 m depth

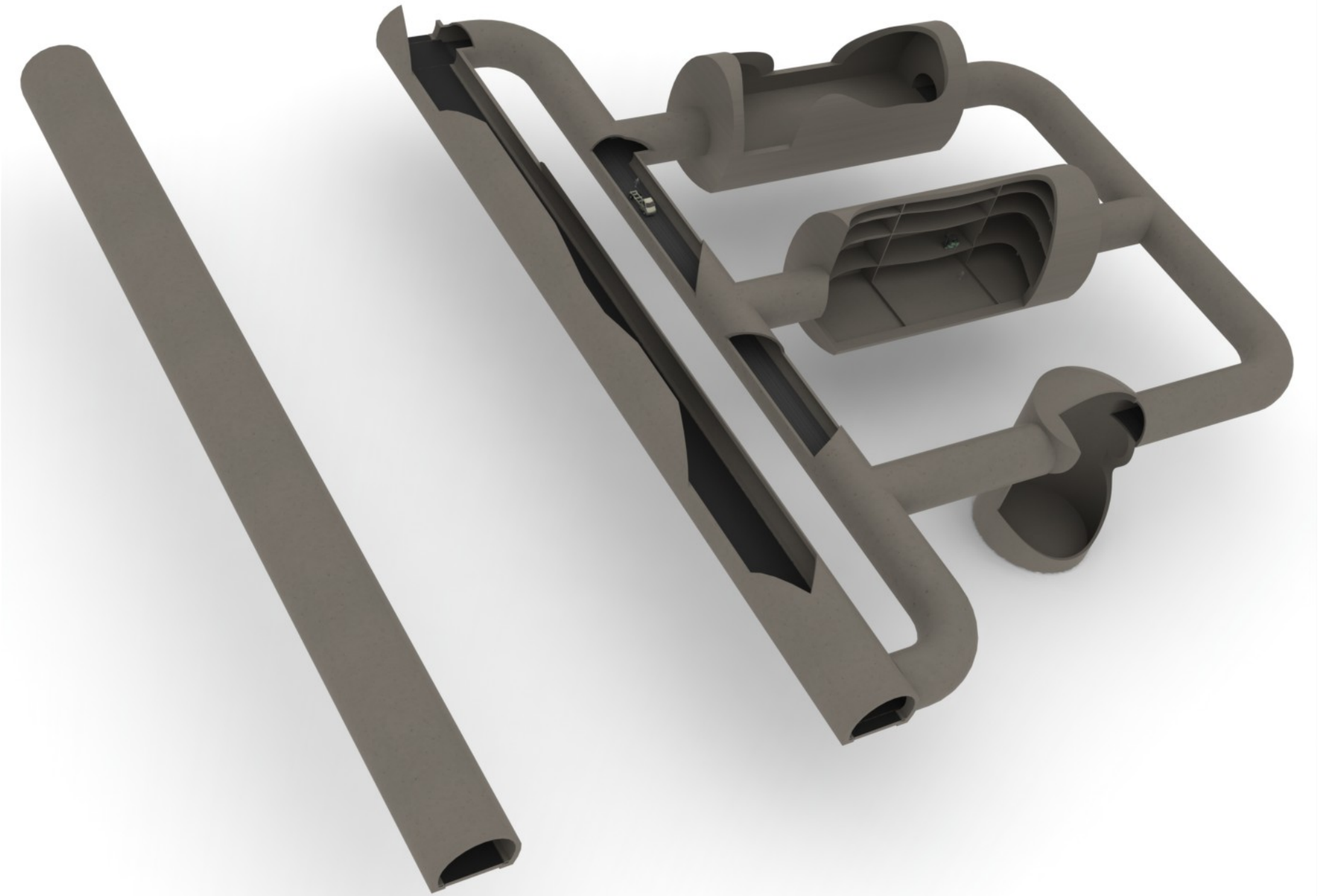
Linear tunnel for interferometer/accelerator

Total cost $\approx$ 10 MU$D

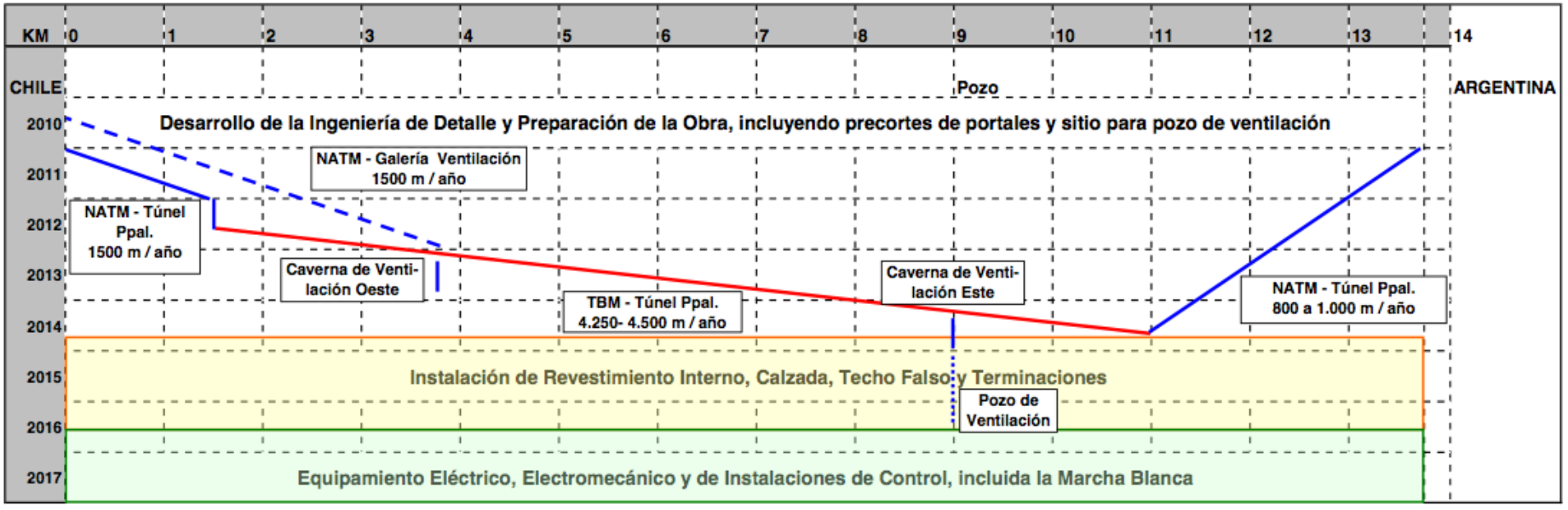
- + 2 external labs
- + experiments cost



ANDES Laboratory concept



Tunnel schedule



Inauguration in 2017 (2018?)

- The laboratory would be in the km 3.5-5
  - Lab construction starting in 2013 (2014?)

Have the civil work included in the tunnel tender

Need to have factibility studies mid 2011
Cost $\approx$ 1% of lab cost (150 kU$D)

First International Workshop for the Design of the ANDES Underground Laboratory

Monday 11/04

Conference-style day

- centered on neutrino physics
- two extra presentations:
  - networks
  - biology

9h30 - 10h00	Registration and Welcome
10h00 - 10h30	***ANDES Workshop presentation*** *Bertou and Civitarese*
11h00 - 11h30	*Kemp Ernesto* *Detecting supernovae neutrinos: a brief overview*
11h30 - 12h00	*Mosquera Mercedes* *Neutrino Cosmology: neutrino mixing and BBN cosmology*
13h30 - 14h00	*Anjos Joao* *Experimental Neutrino Physics Activities in Brazil*
14h00 - 14h30	*Mariano Alejandro* *neutrino-nucleon scattering at the GeV region*
14h30 - 15h00	*Alonso Jose* *DAEdALUS: oscillation and CP violation in neutrino sector*
15h00 - 15h30	*Civitarese Osvaldo* *Neutrino mass limits from double beta decay searches*
15h30 - 16h00	*Lang Karol* *Recent results from NEMO-3*
16h30 - 17h00	*Lang Karol* *Plans for SuperNEMO*
17h00 - 17h30	*Zukanovich Funchal Renata* *Observation of Geonetrinos at ANDES Laboratory*
17h30 - 18h00	*Nunez Luis* *Networking Infrastructure linking Virtual Research Communities en Latin America*
18h00 - 18h30	*Juárez Katy* *Biodiversity of deep-subsurface microorganisms and their potential aplication*

Tuesday 12/04

Conference-style day

- description of Undergound Laboratories
- afternoon centered on Dark Matter
- two extra presentations:
  - low radioactivity measurements
  - geophysics

9h00 - 9h30	Registration
9h30 - 10h00	*Bertou Xavier* *The ANDES laboratory configuration*
Coffee break	
10h30 - 11h15	*Noble Anthony* *Development of the SNOLAB Underground Facility for Astroparticle Physics*
11h15 - 12h00	*Alonso Jose* *Development and Current Status of Sanford Laboratory at Homestake*
Lunch	
13h30 - 14h15	*Piquemal Fabrice* *The European deep underground laboratories*
14h15 - 14h45	*Mosteiro Pablo* *The DarkSide Program*
14h45 - 15h15	*Gerbier Gilles* *Spherical gaz detector for low energy rare signal search.*
15h15 - 15h45	*Ortigoza Paredes Ysrael Richard* *Cryogenic particle detection at the Canfranc Underground Laboratory*
15h45 - 16h15	*Gerbier Gilles* *Searching for dark matter with cryogenic detectors : from Edelweiss/CRESST to EURECA*
Coffee break	
16h45 - 17h15	*Gerbier Gilles* *Searching for dark matter with cryogenic detectors : from Edelweiss/CRESST to EURECA*
17h15 - 17h45	*Molina Jorge* *Search for Dark Matter In CCDs (DAMIC Experiment)*
17h45 - 18h00	*Aguilar-arevalo Alexis* *Dark Matter experiment with a CCD detector*
18h00 - 18h30	*Loaiza Pia* *Low radioactivity measurements*
18h30 - 19h00	*Spagnotto Silvana* *Seismological laboratory in Agua Negra tunnel*

Wednesday 13/04

Wed 13/04	morning	ANDES Workshop session 1
		Possible experiments in ANDES
		Contacts with other labs, experiments selection protocol
	afternoon	ANDES Workshop session 2
		The Consorcio Latinoamericano de Experimentos Subterráneos
		Academic aspects of ANDES
		Organigram, Chronogram, ANDES Contacts and responsibles
		Final summary

Round table style day

- started 9h30
- ended 19h30
- open discussion
- presence of 2 engineers of Geoconsult BsAs

Conclusions

- agreed to refine the design of the civil work as a function of planned experiments
- found a need to have a norm and requirement sheet for experiments to be hosted in ANDES
- formed a work group to define priorities in the selection of possible experiments for ANDES
- formed a steering group of country representatives in charge of coordinating and promoting ANDES, both within the scientific community and with governmental, cientific and technology authority of their countries:
  - Coordinator: Xavier Bertou
  - Argentina: Osvaldo Civitarese
  - Brazil: Ronald Shellard
  - Chile: Claudio Dib
  - Mexico: Juan Carlos D'Olivo

Conclusions

- agreed on the need to advance in the elaboration of the Consorcio Latinoamericano de Estudios Subterráneos, to ensure the continuity of ANDES and its scientific and academic integration
- defined next meetings on a short time scale:
  - SBF meeting, Brasil, June
  - Mexican school of particles and fields, Mexico, October
  - High Energy Physics in the LHC Era, Chile, January
- signed an MOU among all participants to express the strong interest in promoting the ANDES underground laboratory