ANDES

AGUA NEGRA DEEP EXPERIMENT SITE

A Deep Underground Laboratory
in the Southern Hemisphere

Claudio Dib, UTFSM, Chile
on behalf of the ANDES Coord. team

SILAFAE XX-3/4, ICTP-SAIFR, Sao Paulo Nov 8-12, 2021

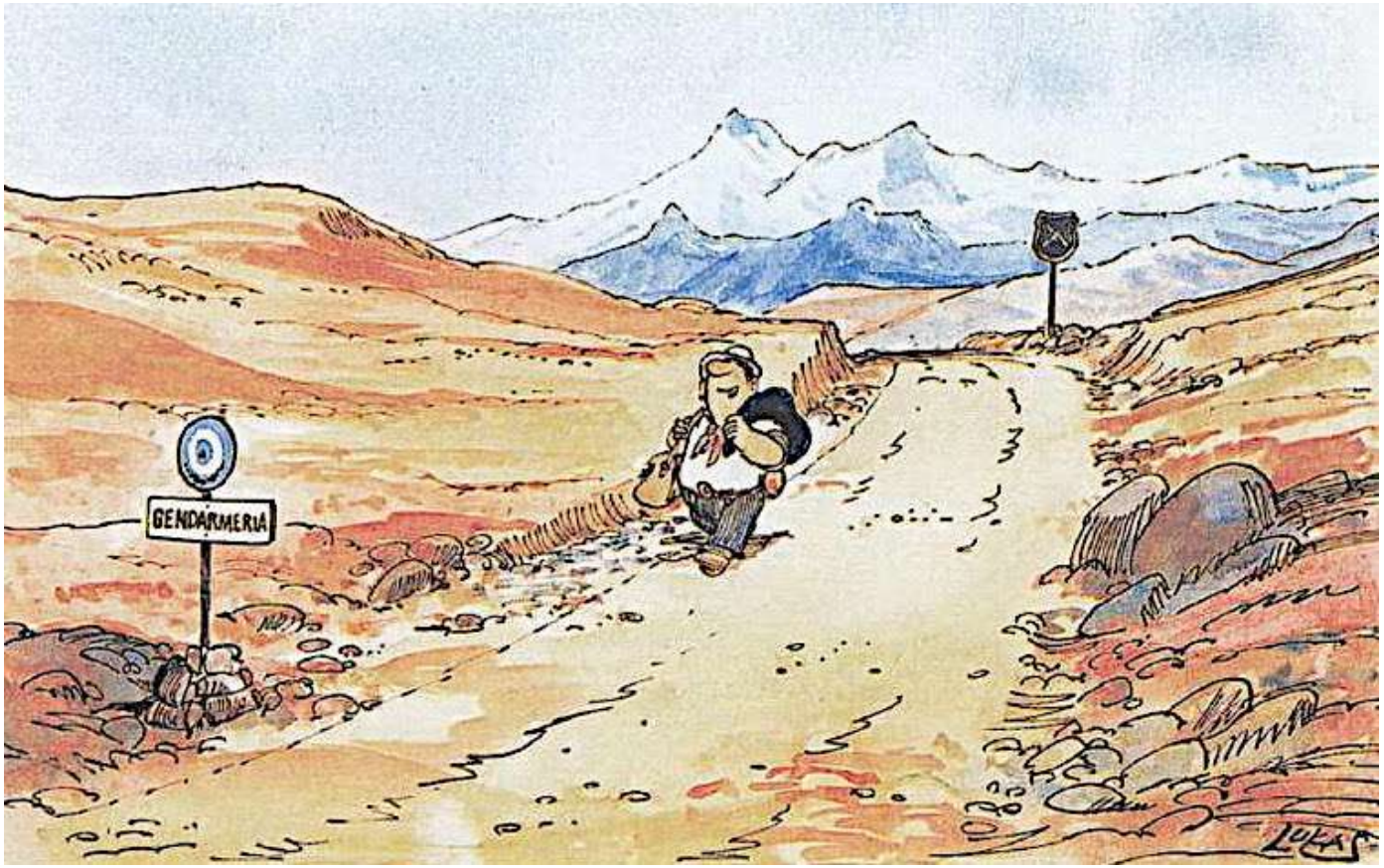
Centro Latinoamericano de Física

CCT Val
CENTRO CIENTÍFICO TECNOLÓGICO DE VALPARAÍSO

Content

- The Agua Negra Tunnel
- ANDES Lab proposal
  - Tentative Scientific programme
  - Current Design (IBA)
- Proposed Organization
- Current status

More than 10 years ago…



... a large **Tunnel** between Argentina and Chile was proposed…

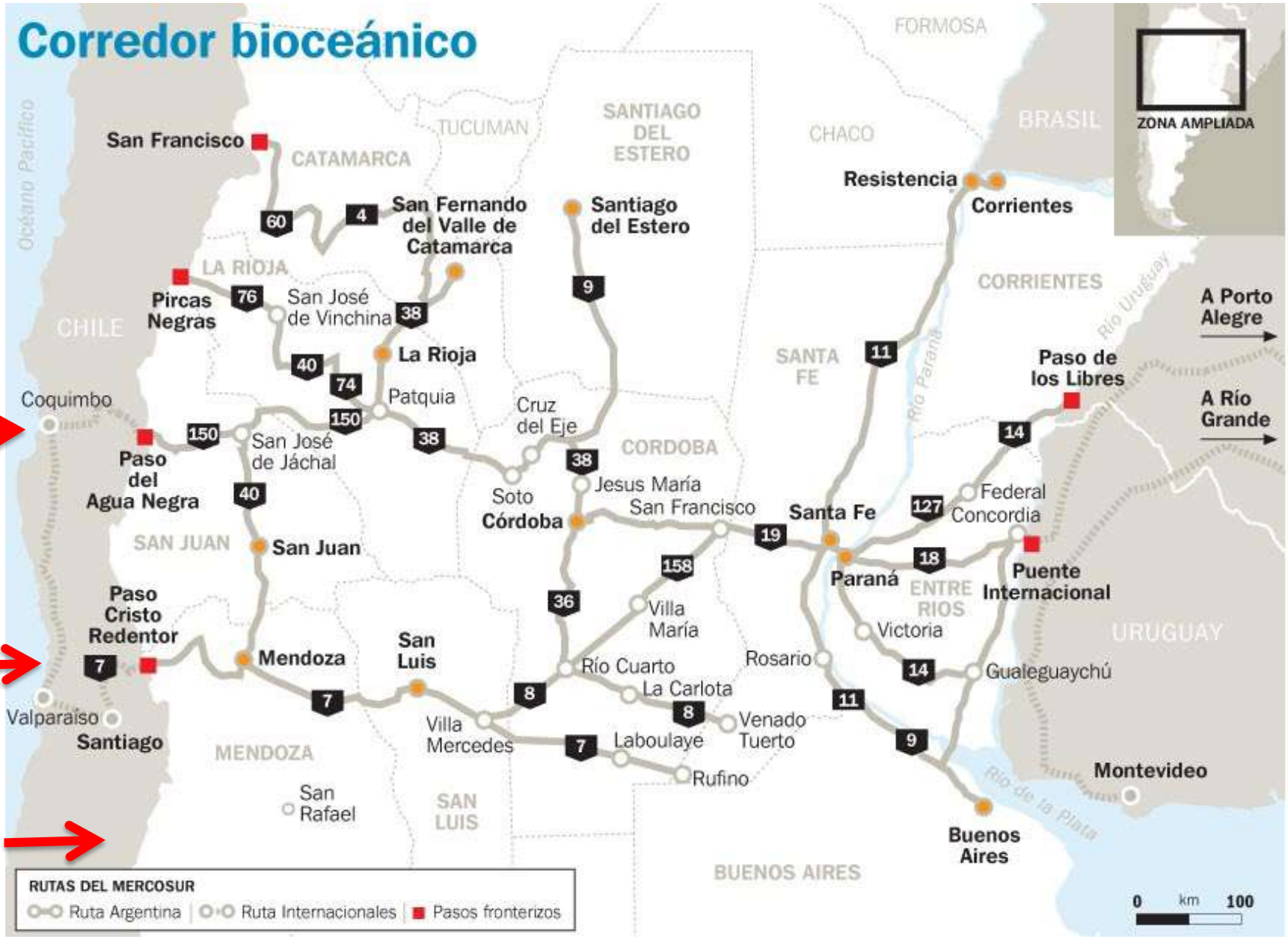
The Agua Negra Tunnel

The **Agua Negra Tunnel** Proposal

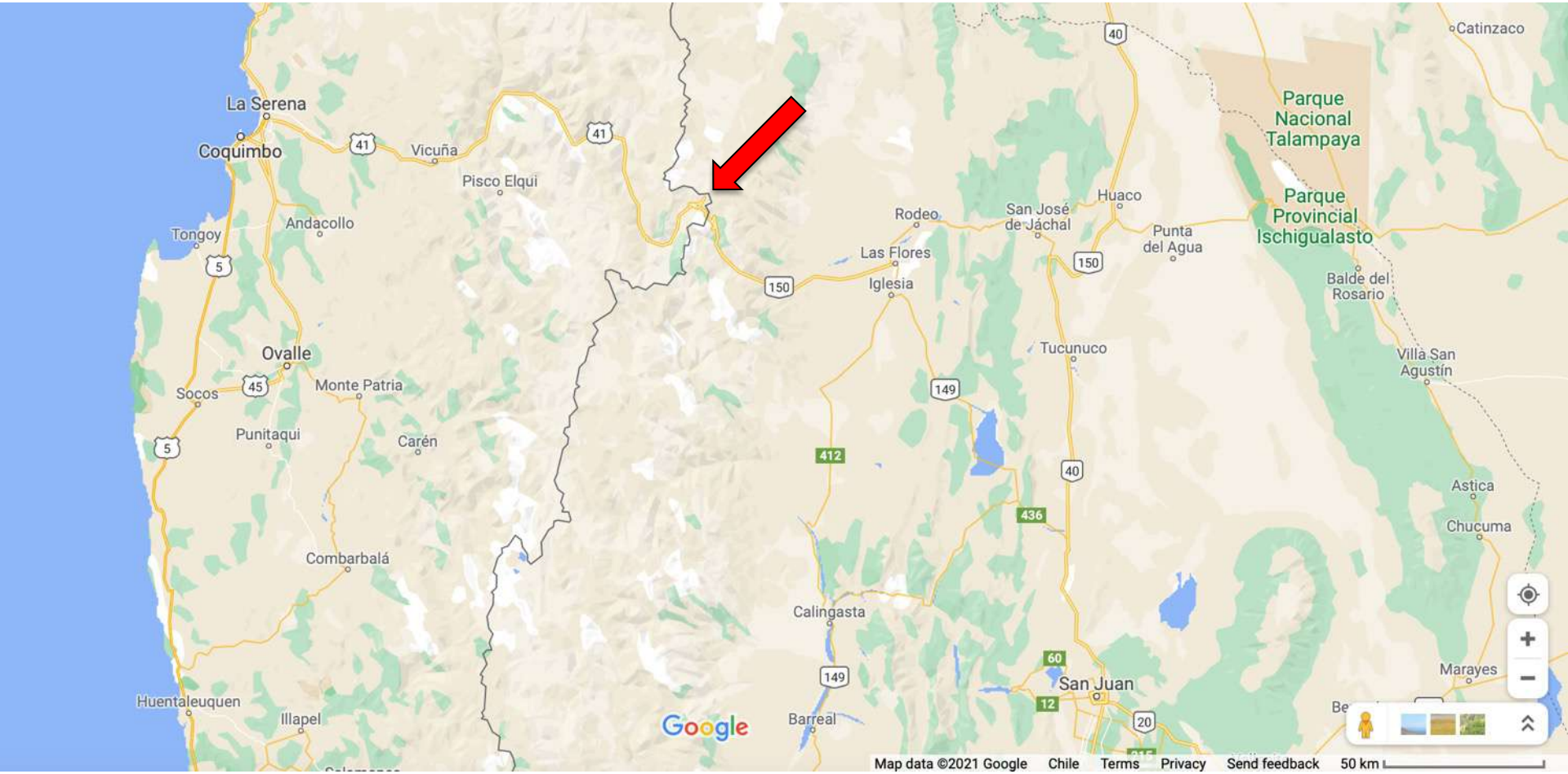
- To increase trade of **South America** with **Asia.**
- Shipping through Chilean ports → to cross the Andes.
- The mountain Pass suffers severe cuts in winter.

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

Several tunnel proposals

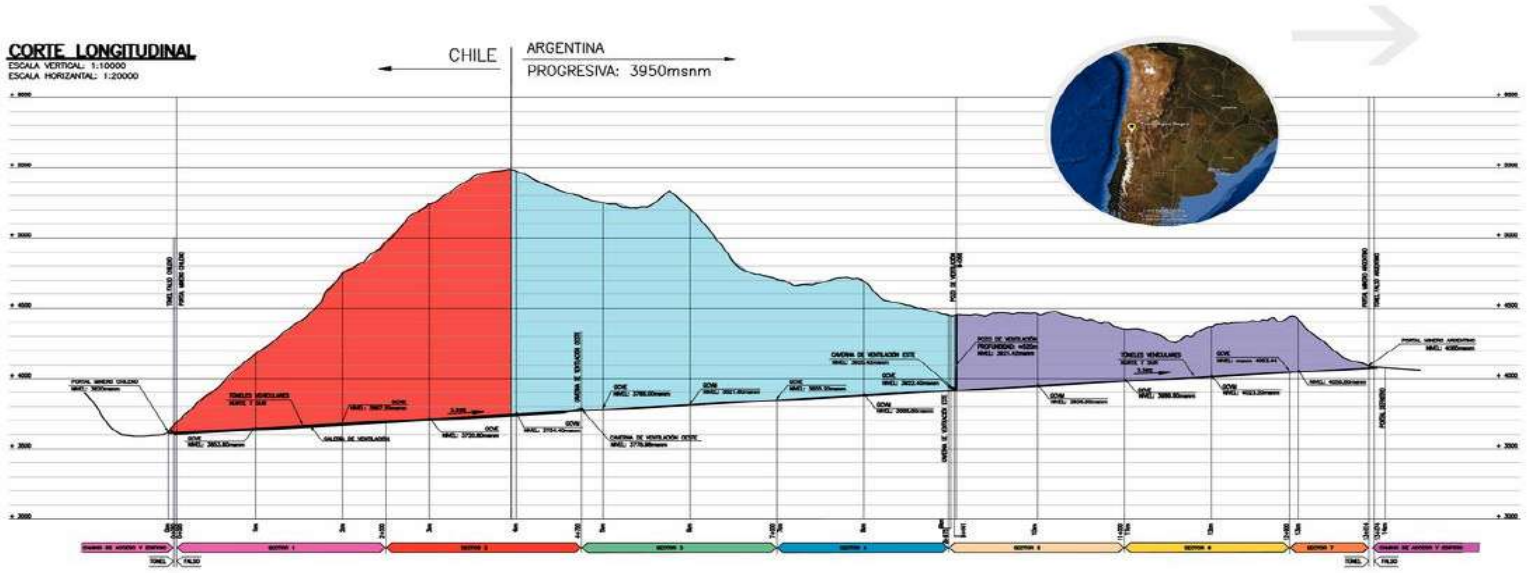


Tunnel approx. Coordinates: 30.19 South, 69.82 West



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).



… but a tunnel is just a road…

…Don’t you want to add “for a few dollars more”

… **the first Deep UG Laboratory** in the So. Hemisphere?

Gran Sasso tunnel, Italy

LNGS

Tunnel status

- Bi-national Entity to manage the tunnel project:
  EBITAN (Entidad Binacional Tunel Agua Negra) since 2009.

- Engineering Design completed, call for tender in process.

- Interamerican Development Bank (BID) will lend the 1.5 billion USD for the tunnel construction, to be paid by Chile/Argentina.

- Economic review, geological studies, environmental impact, etc.

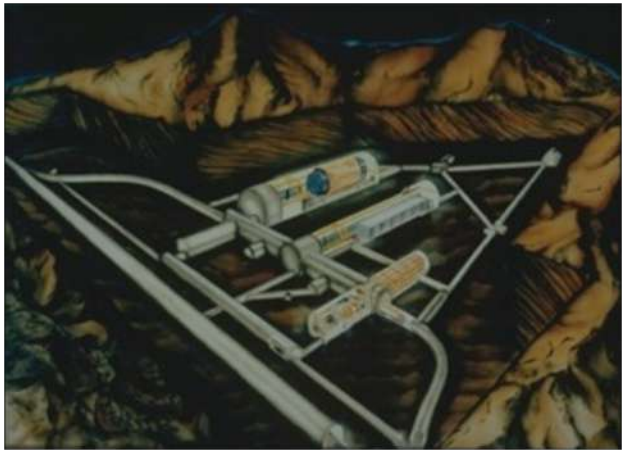
- Construction pending.

The ANDES Laboratory proposal

ANDES:
Agua Negra Deep Experiment Site

ANDES Proposal:

- **Underground site** at deepest point inside the Agua Negra Tunnel (border ~ 4 km from Chile entrance).
  - 2 large horizontal caverns + 1 large pit.
  - Other isolated rooms, clean rooms, …



Gentileza: Lab. Gran Sasso, Italia

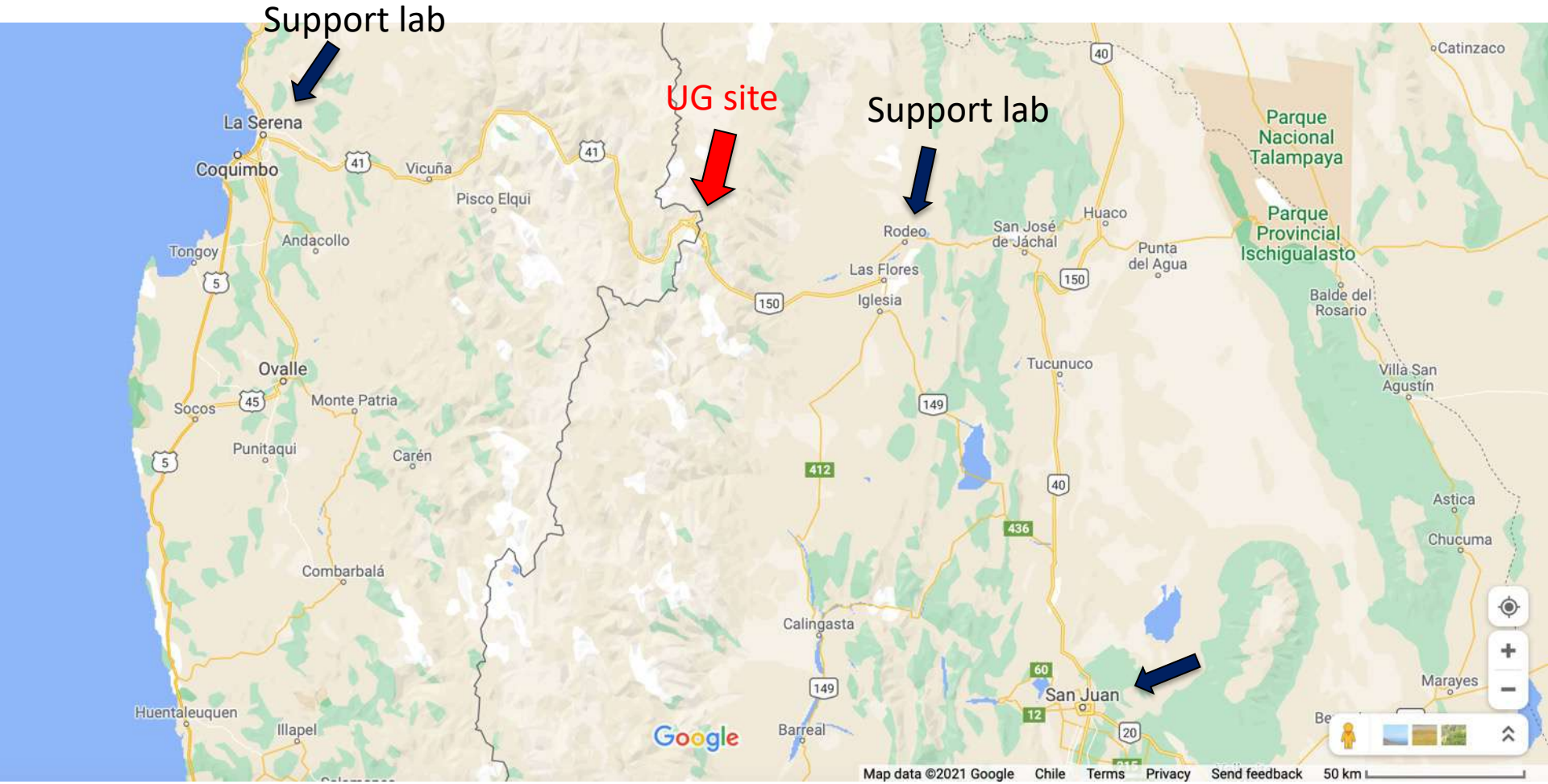
- **2 Support Labs at the surface:**
  - La Serena (Chile); Rodeo (Argentina): Administration, tech. workshops, and Visitor Center.

Gentileza: : Lab. Apoyo y Centro de Difusión, Modane, Francia

- **Sites at the portals:**
  - Lodging, office, storage.

Gentileza: Paso Pino Hachado, Chile

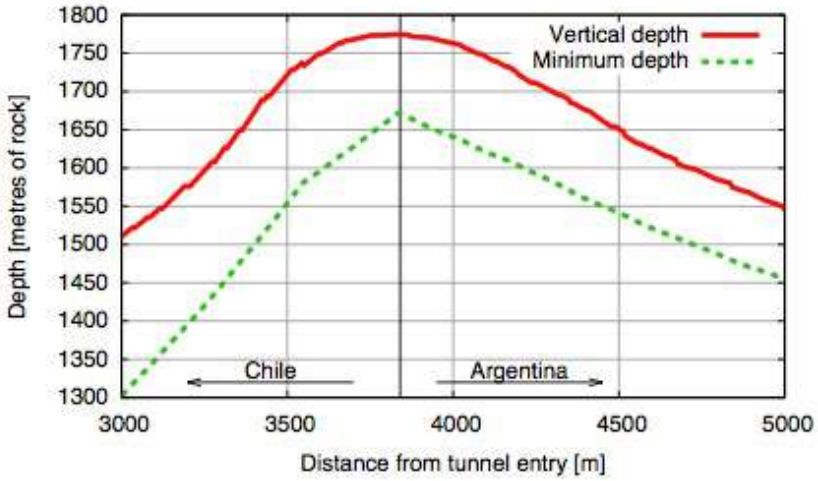
ANDES: underground site + 2 support labs

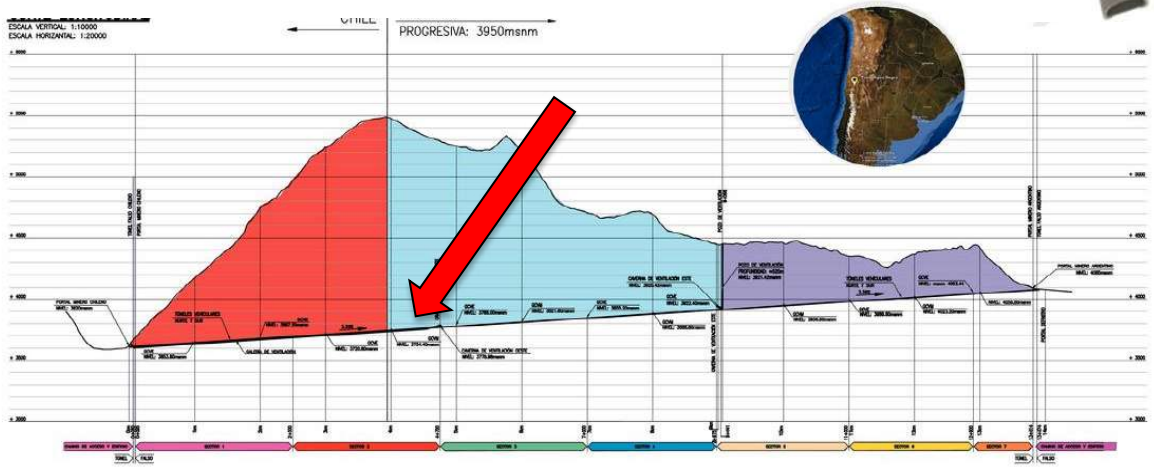


The ANDES underground site

- Deepest point in tunnel (~ 1750 m deep)

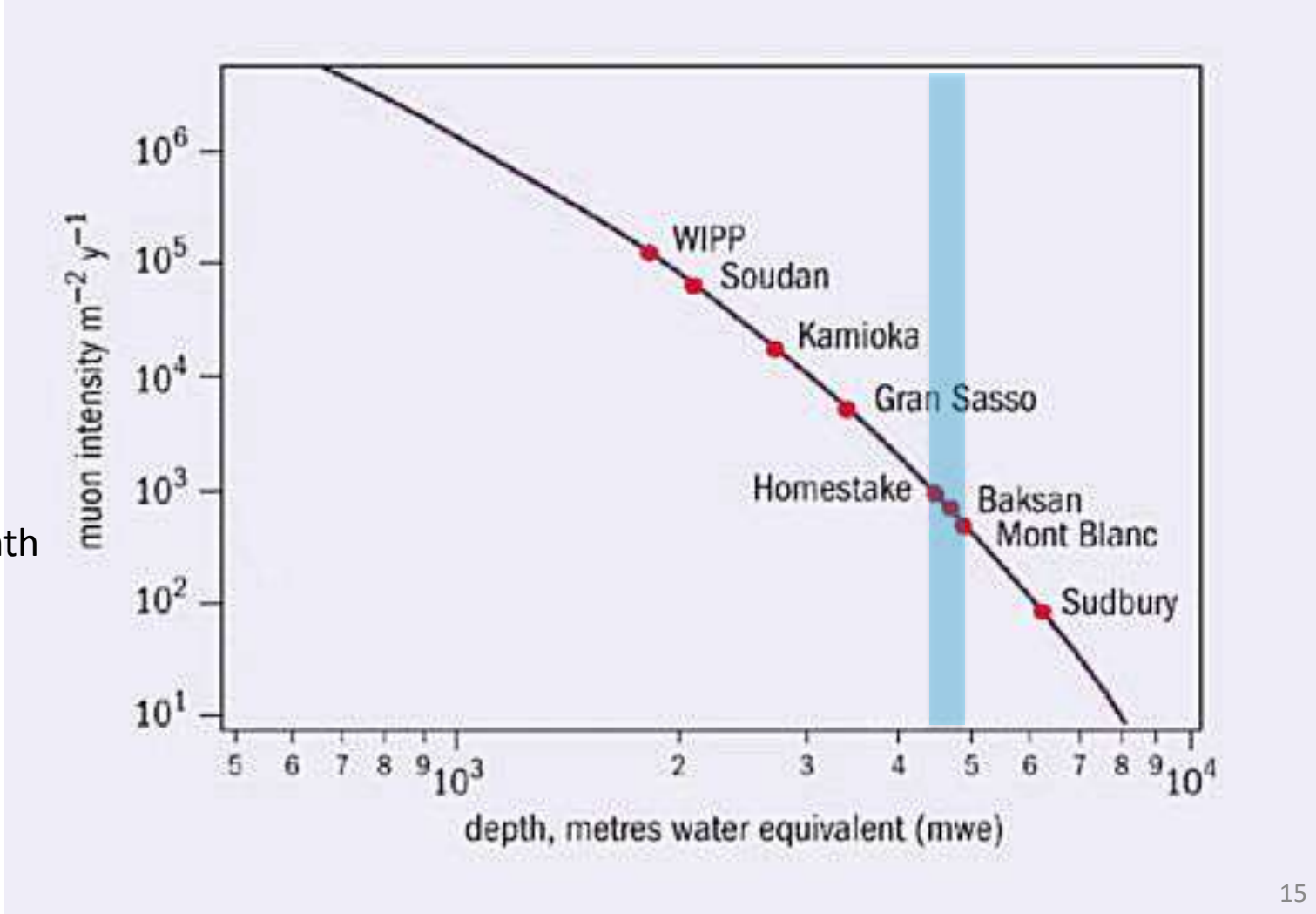
  ≈ 4 km to Chile entrance, ~ 10 km to Argentina exit



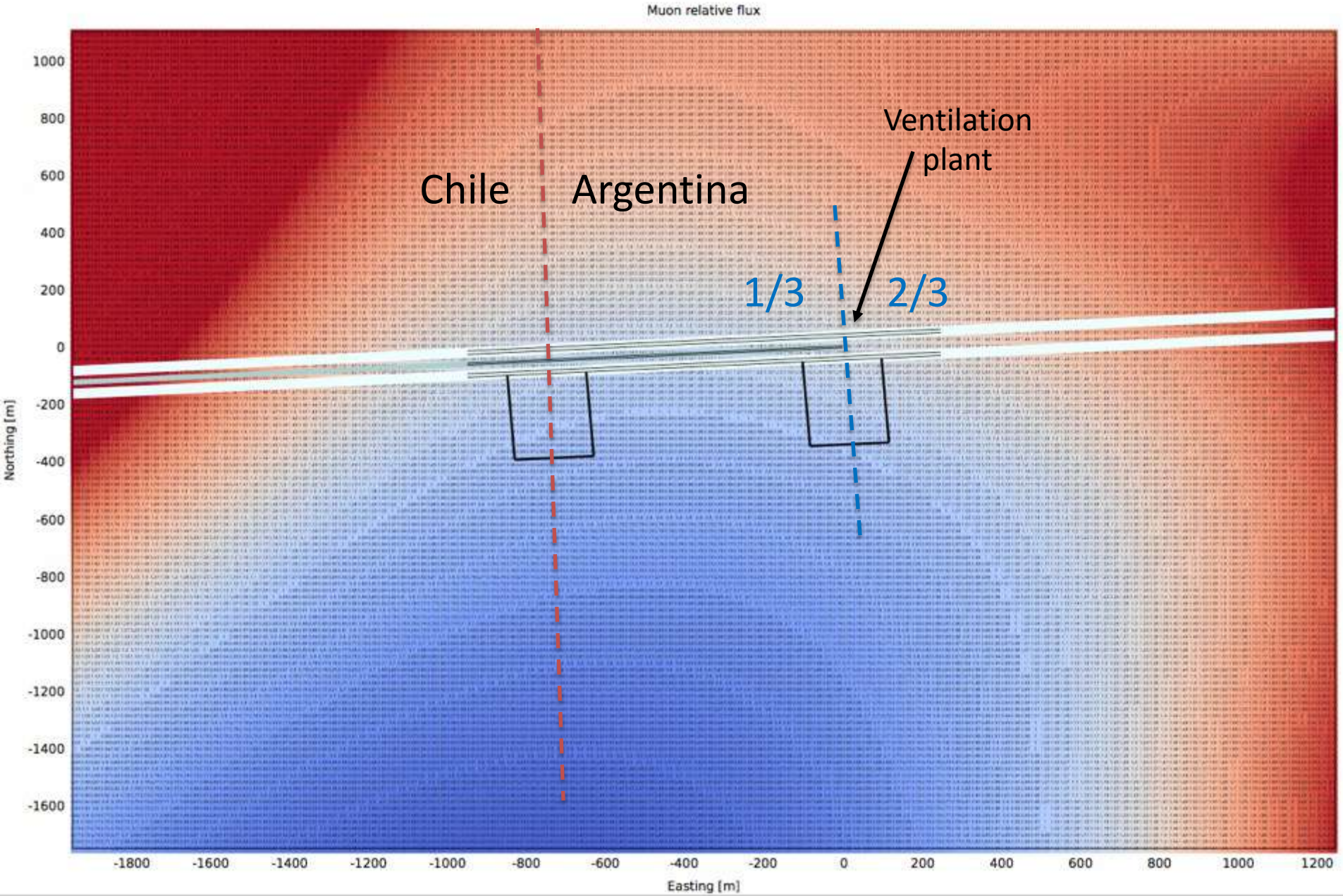


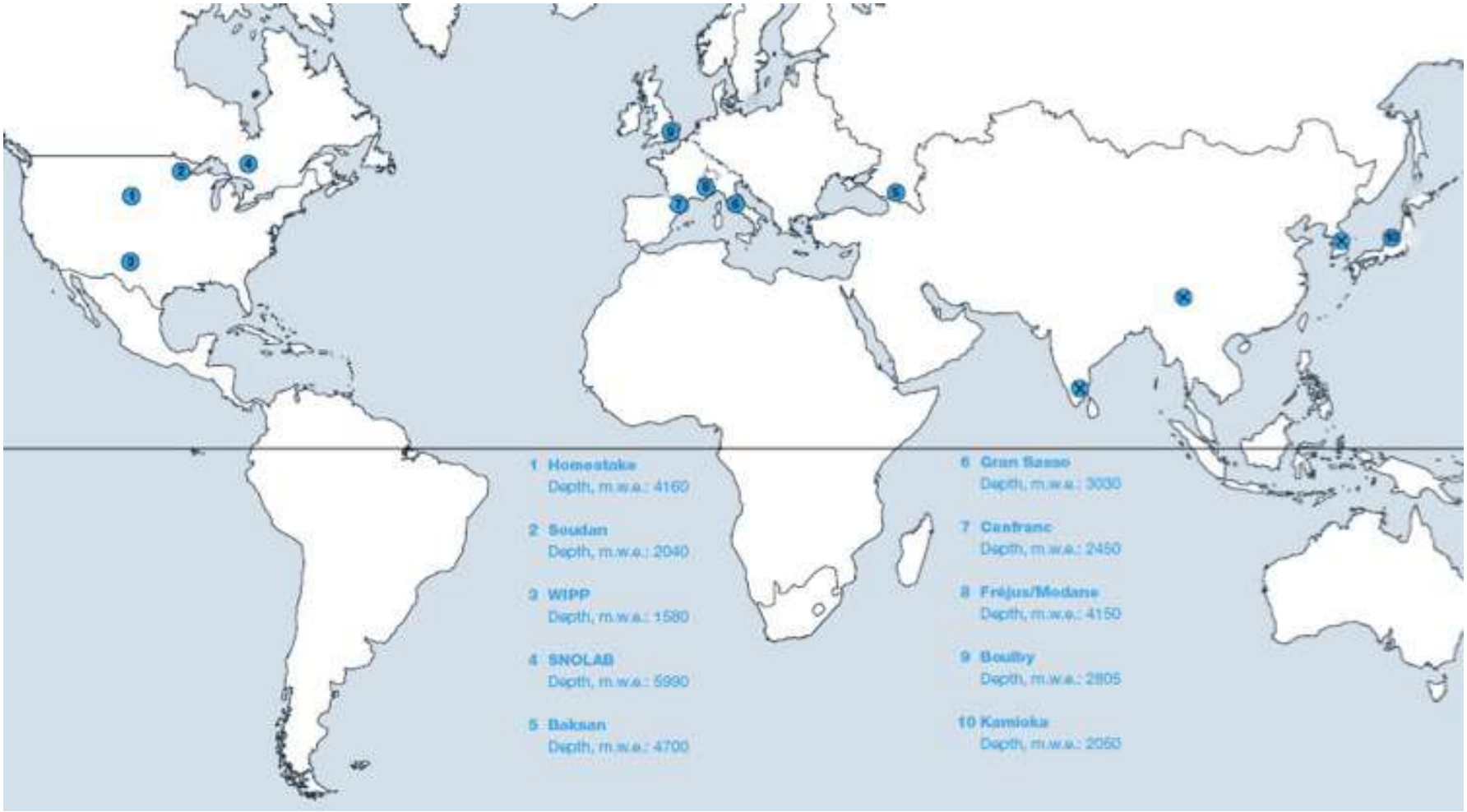
Flux at sea level ~ 100 /m^2 s ANDES: ~ 4500 mwe; atn: 10^{-7}

~20 /m^2 month



Relative muon omnidirectional flux





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

(and Stawell Underground Physics Lab. currently under construction in Australia)

ANDES
scientific programme and design

ANDES tentative Scientific Programme

- Neutrino physics:
  - Neutrinoless double beta decays
  - large neutrino detector
  - focus on low energies? (solar / SN / geoneutrinos)
- Dark Matter
  - modulation measurements
  - going for low mass WIMPS, new technologies
- Nuclear Astrophysics
  - low energy beams
- Geophysics
  - seismograph networks, rock studies
- Biology
- Low radiation measurements

ANDES Design

Conceptual Design (by Lombardi, 2015)

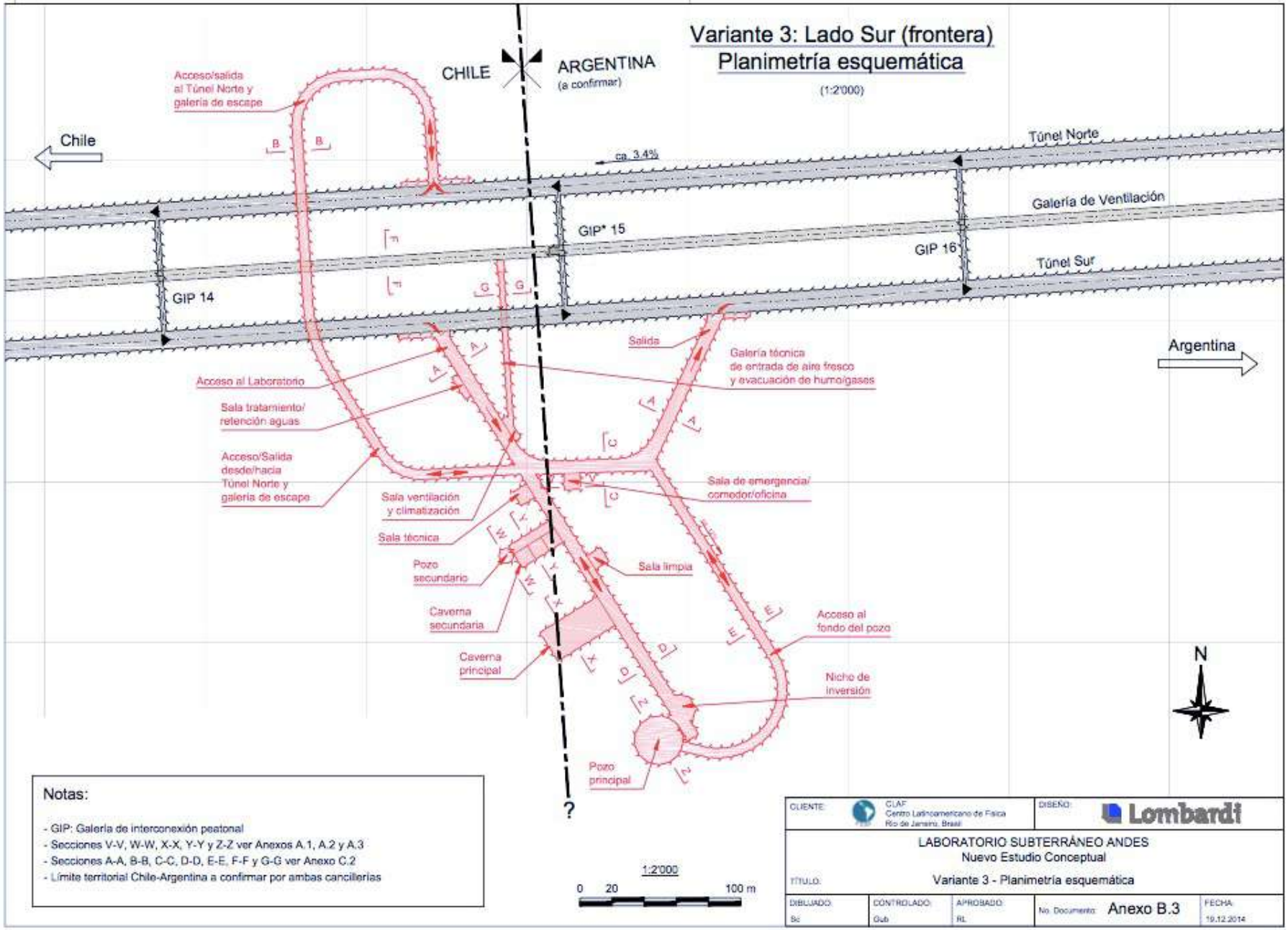
CLAF
Centro Latinoamericano de Física
Rio de Janeiro
Brasil

LABORATORIO SUBTERRÁNEO ANDES

Nuevo Estudio Conceptual

Informe Técnico

Conceptual Design (Layout 2015 by Lombardi)



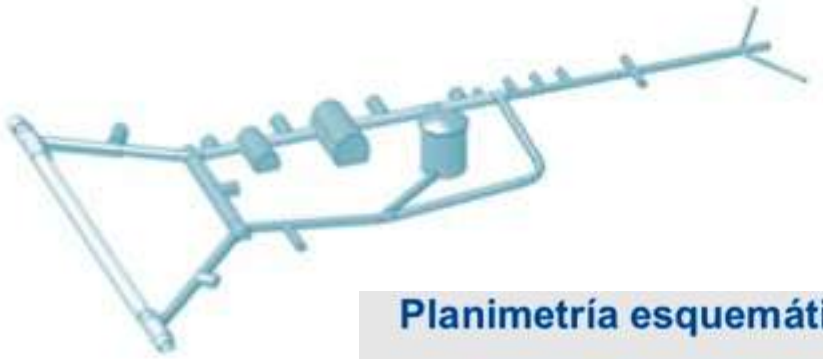
Basic Engineering (IBA) by Lombardi 2019.

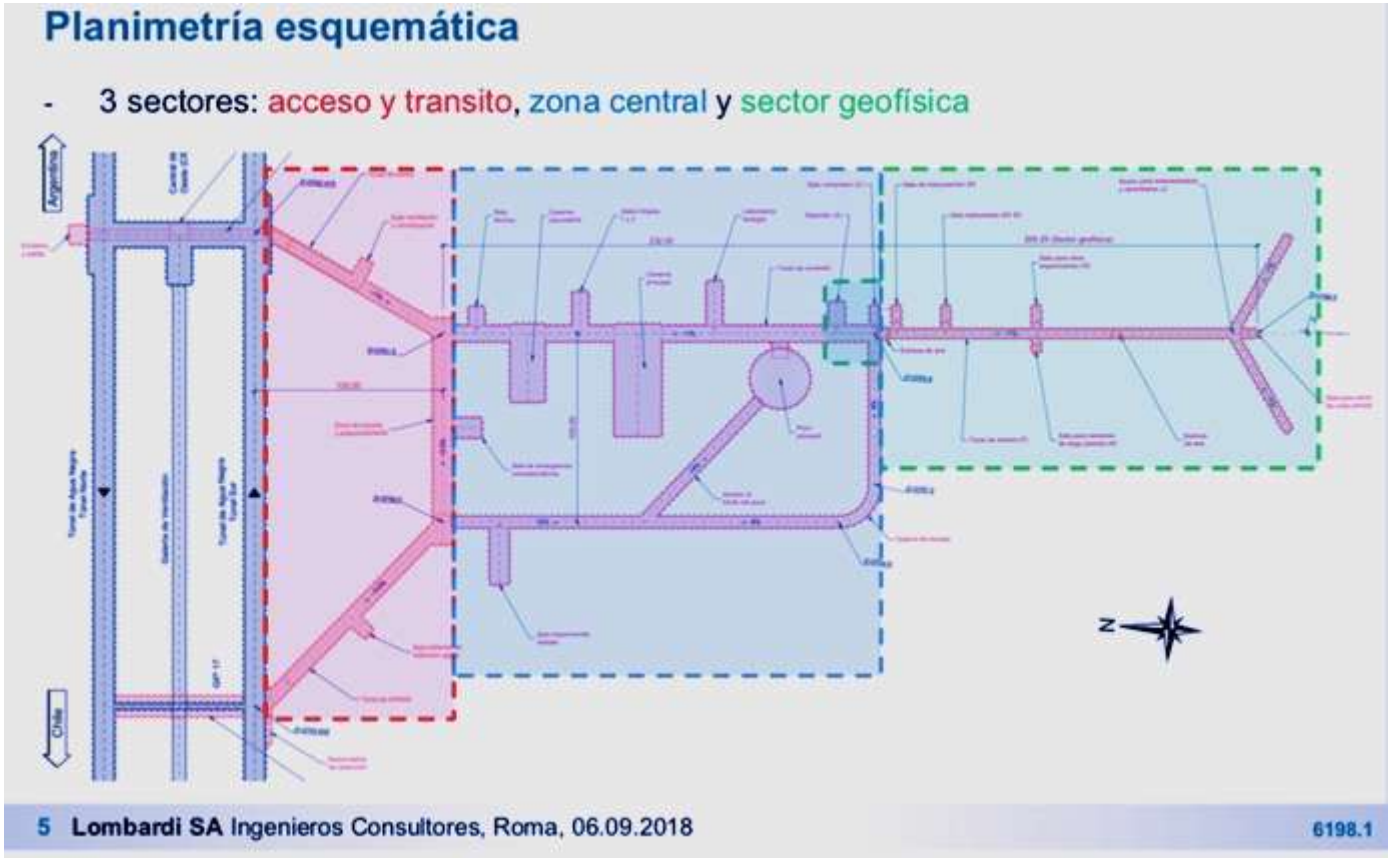
CLAF
Centro Latinoamericano de Física
Rio de Janeiro
Brasil

LABORATORIO SUBTERRÁNEO ANDES

Ingeniería Básica de Anteproyecto

Basic Engineering (IBA) by Lombardi 2018.

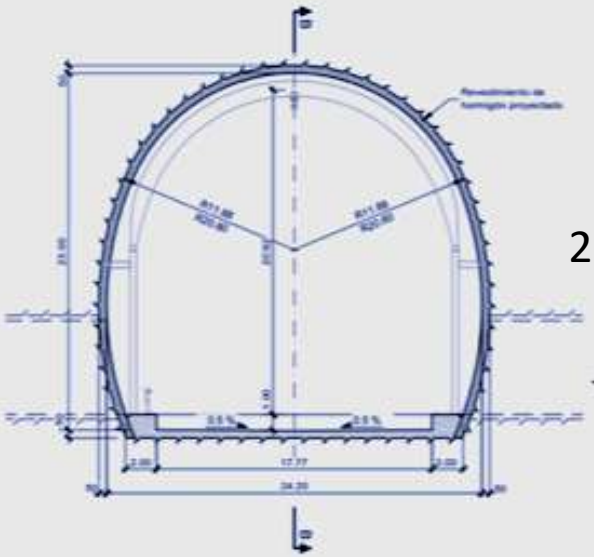




Main cavern

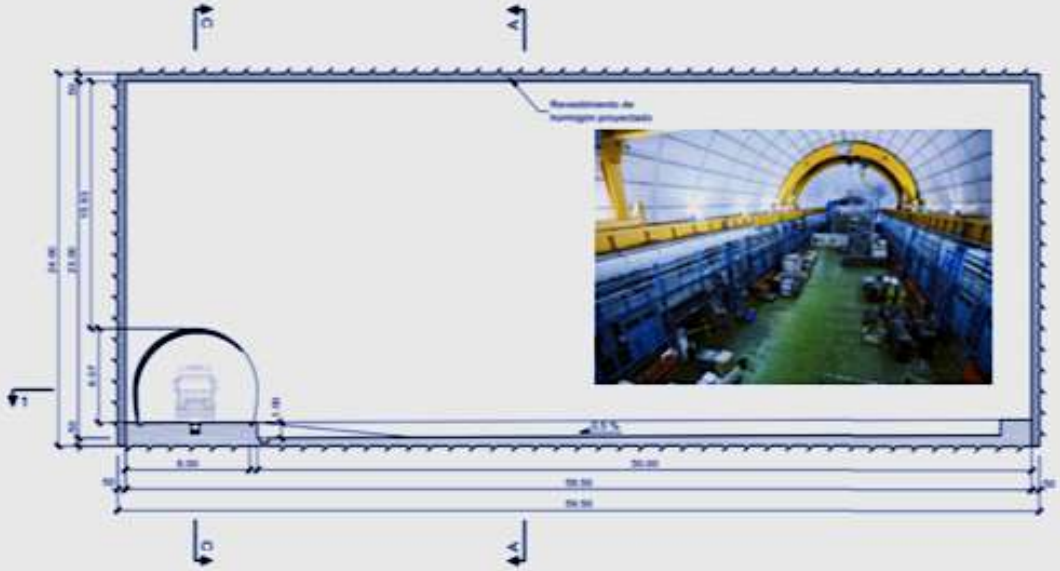
2.3 Caverna principal

- Sala experimental principal
- Taller mecánico para soldaduras o similares.
- Una cubeta de retención con un volumen de 500 m3 para contener un eventual derrame de líquidos
- Canaletas técnicas en la solera o bandejas portacables
- Puente grúa curvo de 40 t



20 m

23 m

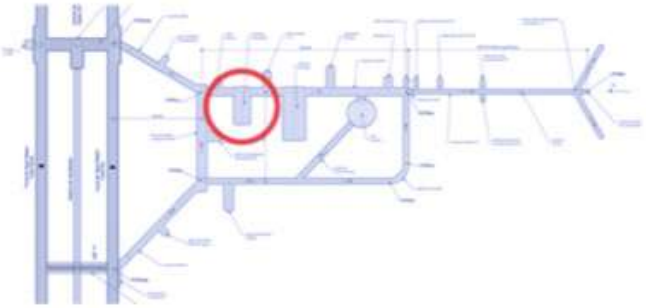


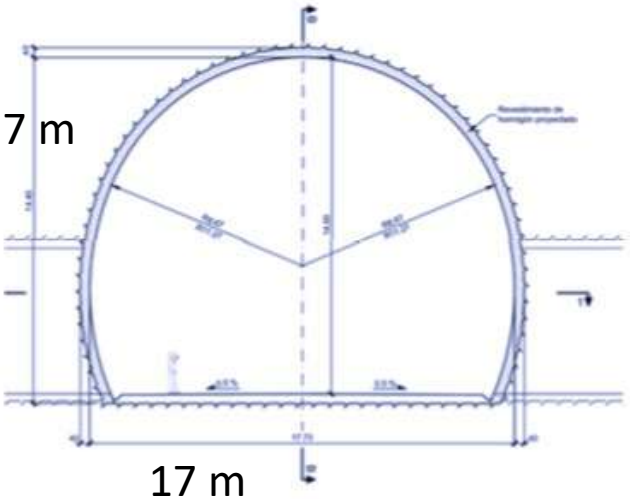
50 m

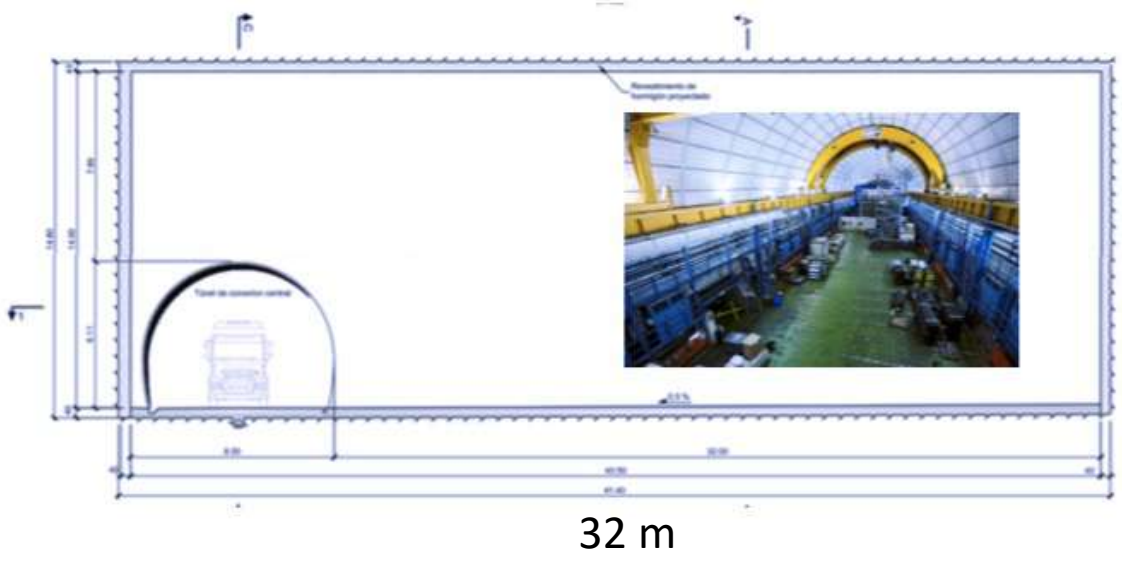
Secondary cavern

2.5 Caverna secundaria

- Espacio para experimentos de tamaño menor, oficinas e instalaciones secundarias
- Puente grúa principal de 40 t de capacidad?
- Cubeta de retención?



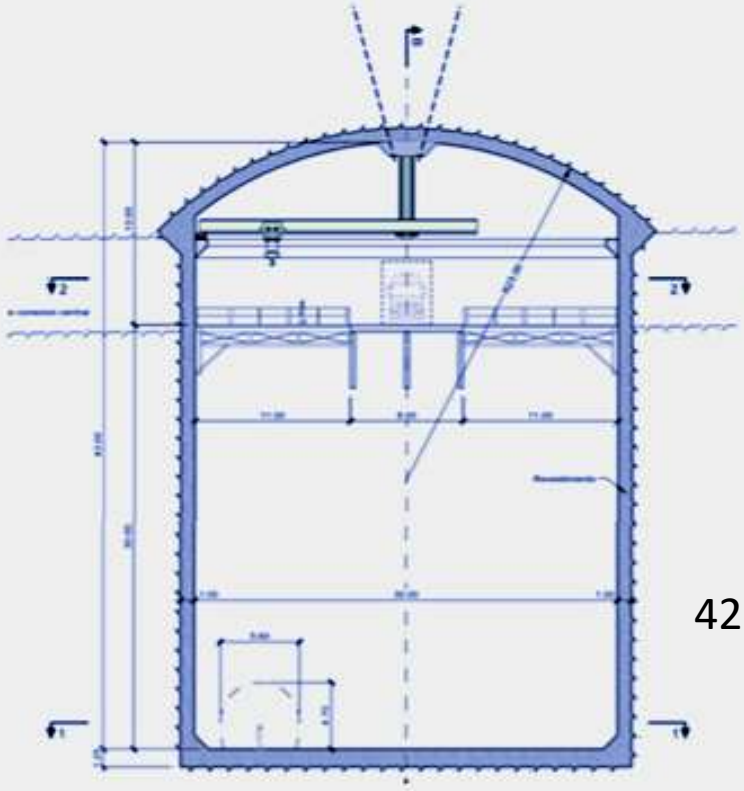




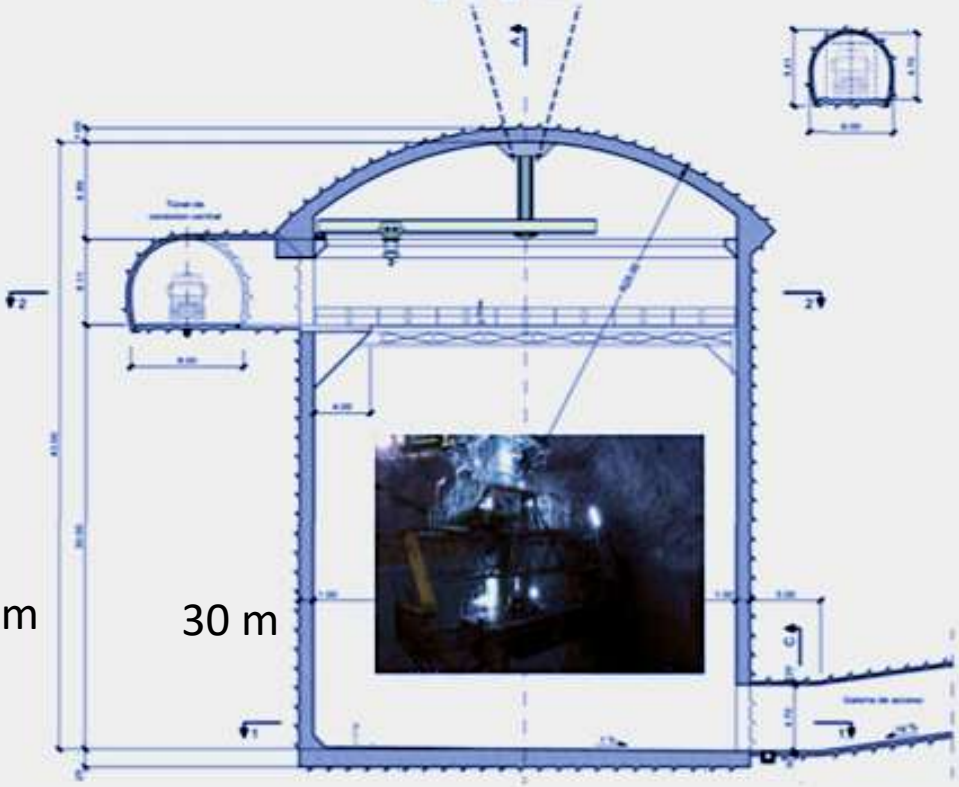
Main Pit (the only pit)

2.4 Pozo principal

- Espacio para experimentos de gran tamaño
- Aparejo central de 40 t de capacidad
- Revestimiento del pozo impermeable



42 m



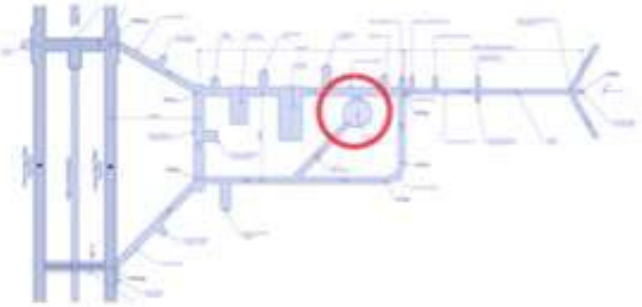
30 m

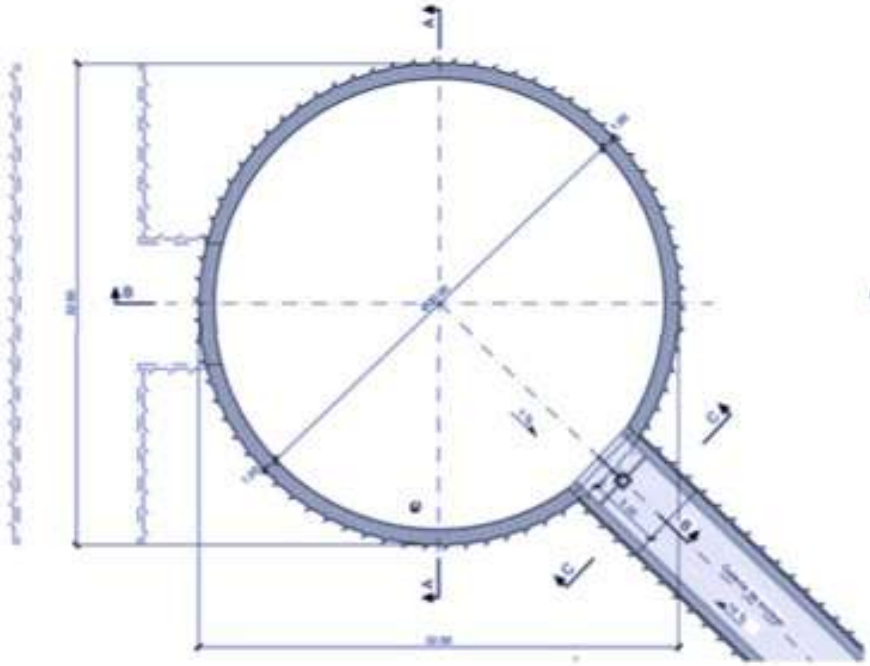
32 m

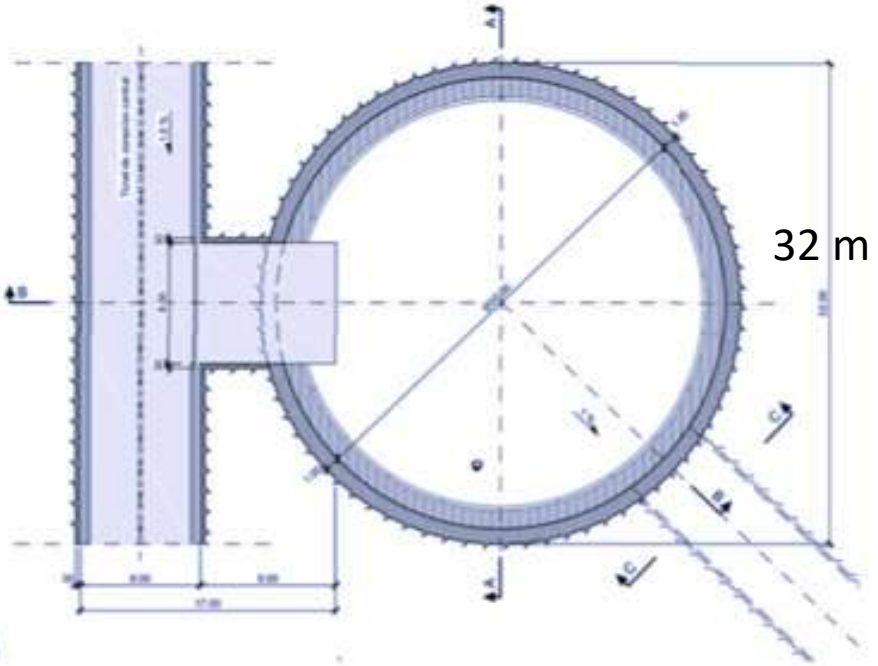
Main Pit

2.4 Pozo principal

- Andamio perimetral
- Entrada con plataforma voladiza
- Puerta estanca al fondo del pozo



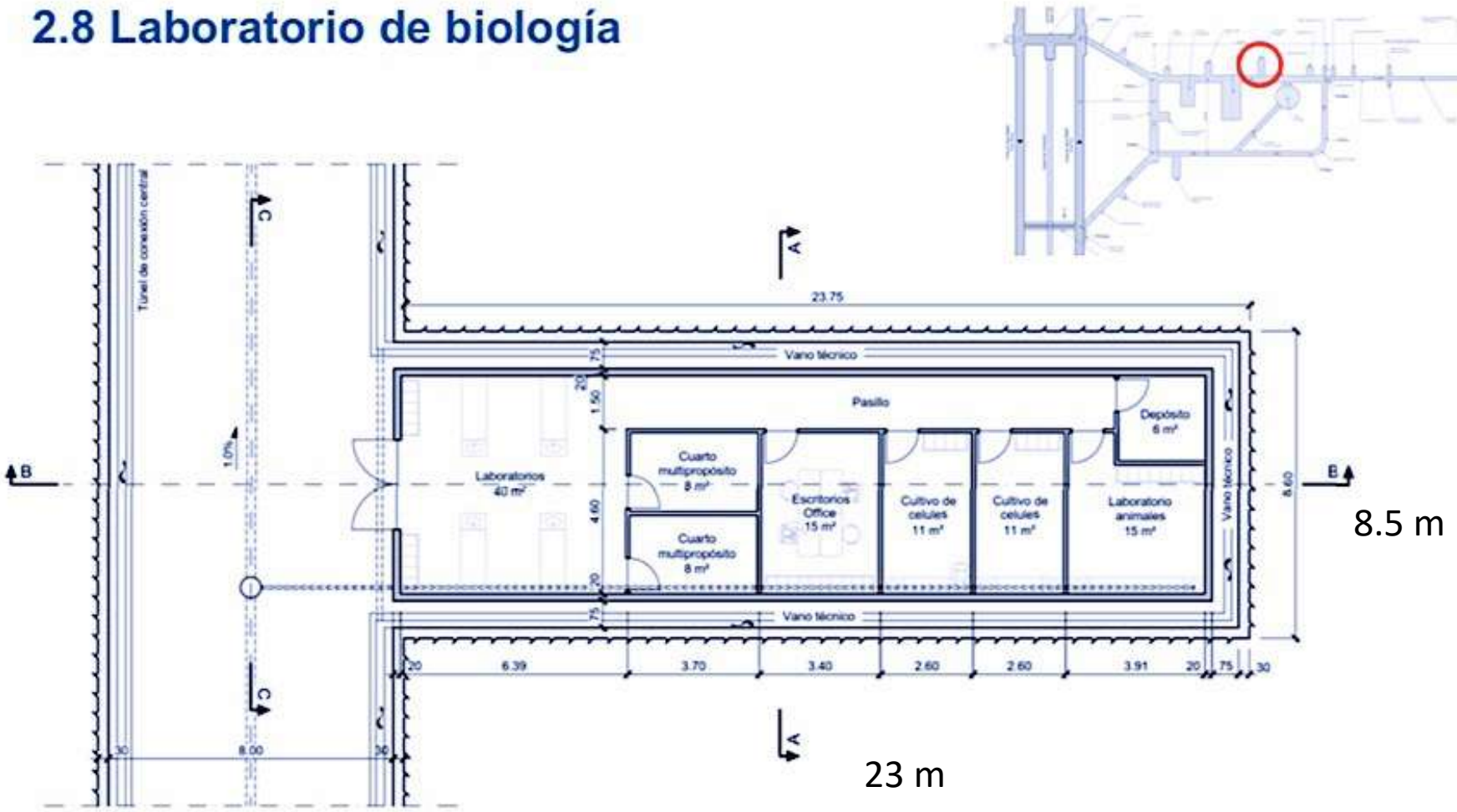




32 m

Biology Lab

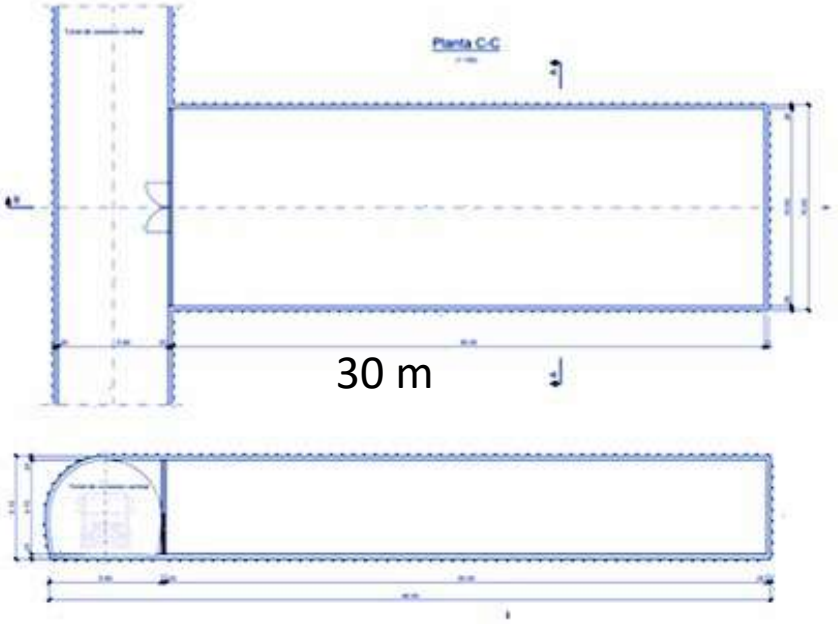
2.8 Laboratorio de biología

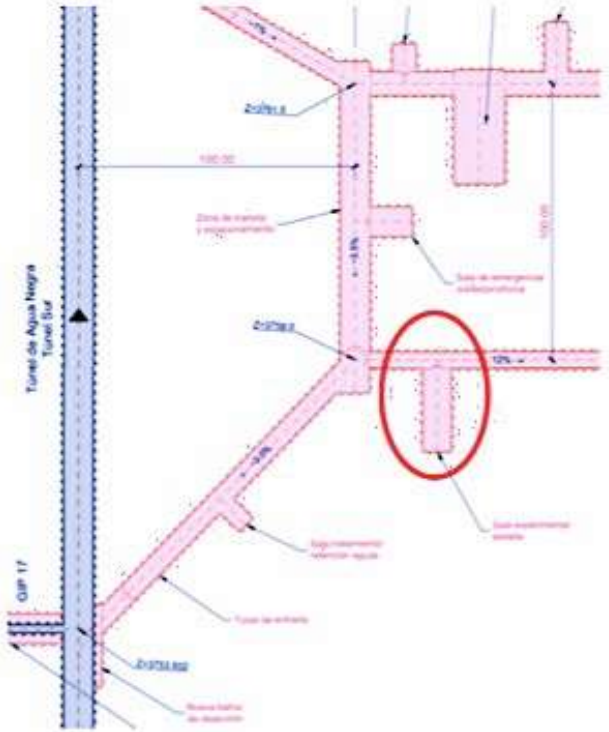


Isolated room (Nuclear Astrophysics)

2.9 Sala experimental aislada

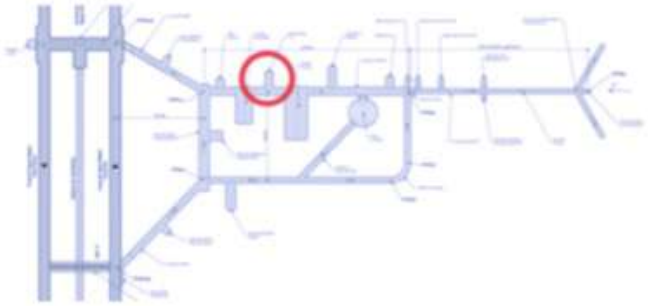
- Espacio para experimentos aislados
- Posición alejada
- Acceso en bajada con pendiente 12% y galibo reducido
- Posible reubicación, dimensiones?





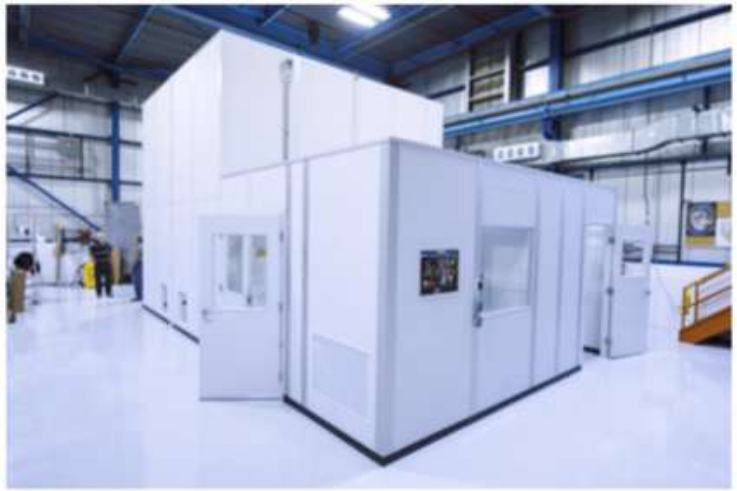
Clean rooms

2.7 Salas limpias



Exigencia:

- 2 salas separadas con espacio libre interno de 10 m de ancho y 10 m de largo
- Las salas limpias deberán cumplir la norma ISO Class 6 o Federal Standard Class 1000 con presión positiva.



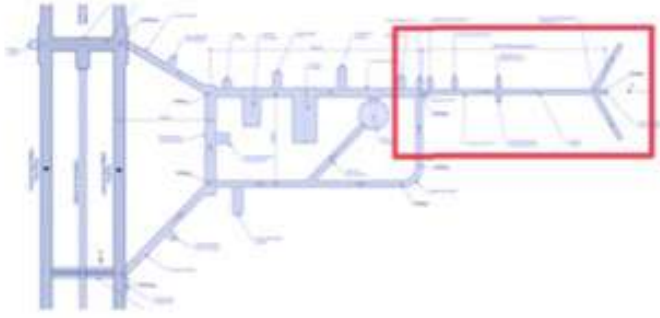
Propuesta:

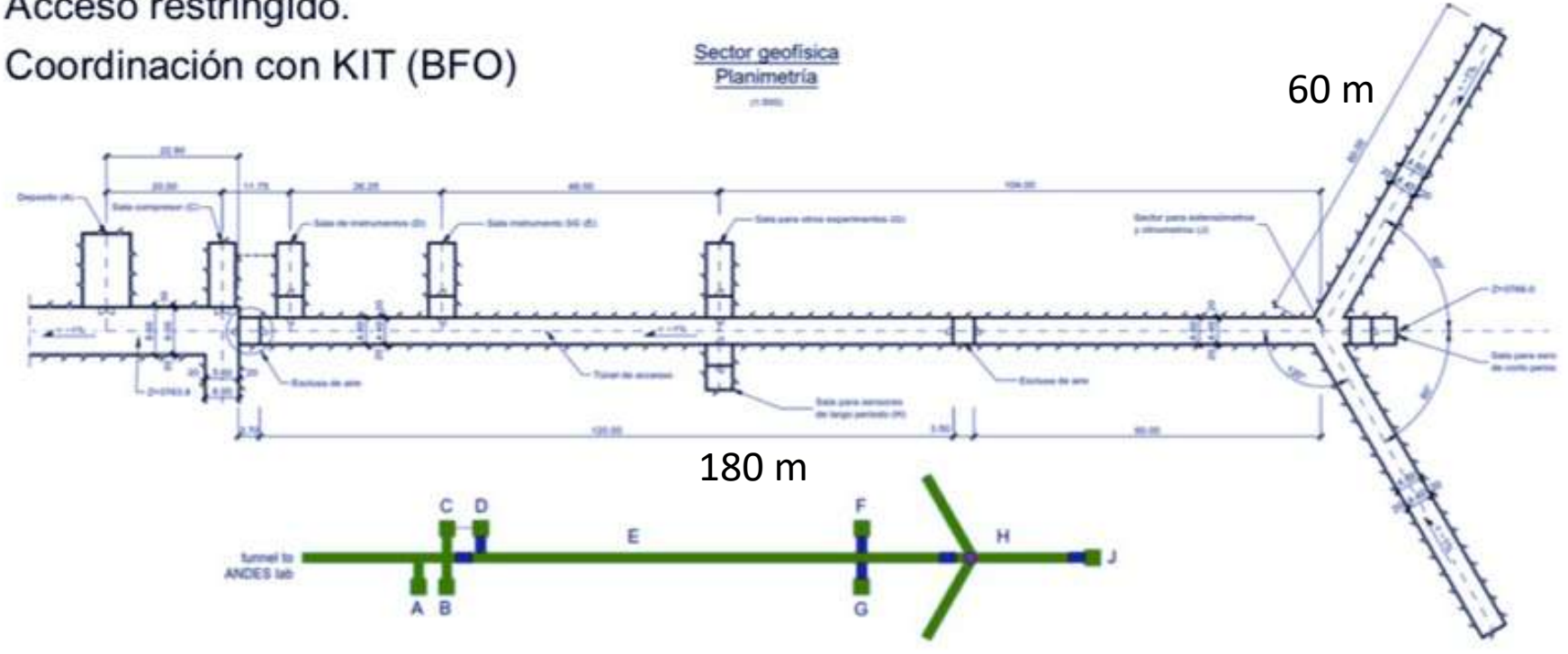
- Preparación de una caverna con impermeabilización y revestimiento interno
- Dimensionamiento conexiones de ventilación y equipamientos
- Salas limpias construida con sistema modular según exigencias especificas

Geoscience sector

2.12 Sector geofísica

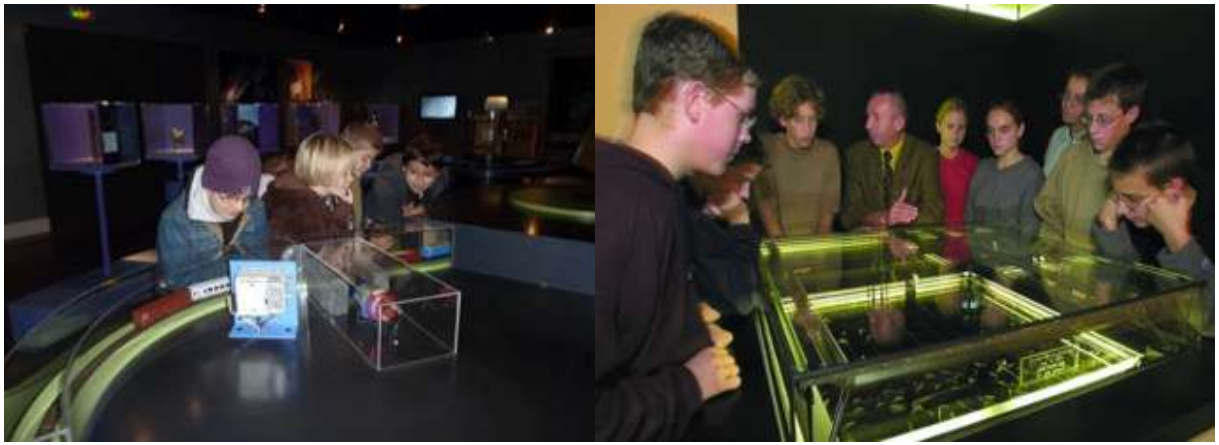
- Sector específico destinado para experimentos y mediciones en el ámbito de la geofísica.
- Exigencia diferentes (temperatura y presión constante, etc.).
- Acceso restringido.
- Coordinación con KIT (BFO)





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

ANDES International Consortium (tentative):

Organizational structure:

(inspired in the organization of SESAME -www.sesame.org.jo)

1. The Council (governing body of ANDES)
   Representatives of the participating nations, which are Members and Observers.

2. A Scientific Advisory Committee to the Council

3. The Executives: Director, Directorate and Staff.

ANDES International Consortium (tentative):

Operation:

- Member countries of the Consortium would be the owners of the infrastructure.
  The Consortium calls for experiments to be installed at ANDES.

- Major experiments are international collaborations who should build and operate their own detectors.

- Member countries will have participation privileges in all steps of the experiments.

Costs

ANDES estimated costs:

- Infraestructure (financed by Chile/Argentina):
    - Underground site: 40-80 M USD (2% of Tunnel cost).
    - Support Lab: 2 M USD.
- Yearly Operation (financed by the Consortium):
    - 2 M USD/yr (with lab full).
- Experiments:
    - Property of each collaboration (not cost of the lab). Estimated capital when full: 500 MUSD.
    - Large experiments pay lab services.

Support and status

Support

- Official support from MinCyT, Argentina (2012).
- CLAF (Centro Latinoamericano de Fisica) creates ANDES unit (2014).
- ANDES presented to new Ministry of Science, Chile – May 2019.

- ANDES in the top 4 recommendations of LASF4RI-HECAP
  (Lat.Am. Strategy Forum for Research Infrastructure in HEPCAP) -2020

- > 40 support letters from International scientific community

  (underground lab directors, intl. exp spokespersons,
  Physics associations, Universities etc., including 2 Nobel laureates,
  and 30 letters from latin american groups.

Extracts from T. Kajita's letter of support (2011):

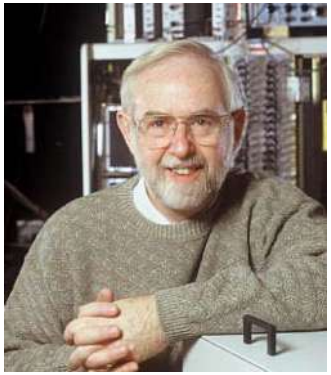
"…underground laboratories will be one of the most important infrastructures for basic science in the next decades…."

"…The underground lab in Kamioka, Japan, is still growing with more experiments in the areas of dark matter search, double beta decay, gravitational wave detection, etc."

"There are several underground labs in the world, however they are all in the northern hemisphere. It will be extremely important to have an underground lab in the southern hemisphere. I mention two examples: … "

"…from the experience and reasons mentioned above, I strongly support the proposal of the ANDES Underground lab. If you want to hear more, please do not hesitate to ask me. I am very happy to write more."

Extracts from Art McDonald's letter to Chilean Minister of Education (August 2016)



"The world-wide interest in experiments performed in an environment such as will be achieved at ANDES is increasing at a high rate."

"As we have observed with SNOLAB, this provides major opportunities for our Canadian university faculty and students to work with the best scientists in the world …"

"As Ministra de Educacion, I urge you to approve this laboratory as a major educational opportunity for Chile that will develop new generations of students working side by side with the best scientists in the world and developing skills that will be of substantial value to Chile in the longer term."

"There are international advisors who have been providing expert reviews of the plans for this laboratory, including my colleague Professor A. J. Noble from Queen's University, former Director of SNOLAB…"

Collaboration agreements:

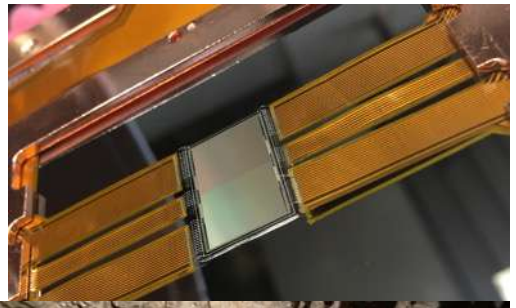
- MoU for IRLA (Inst. Regional Latinam. Astropart.) Brazil-Argentina.
- CNEA, Argentina – INFN, Italy: for ANDES – LNGS on Astroparticles.
- CNEA, Arg. – KIT, Germany: for detector technologies.
- UNSAM, Arg. – KIT, Germany: joint graduation Astropart. & Tech.
- CNEA-MinCyT-CONICET-Gob. San Juan: for the development of ANDES.
- USM, Chile – KIT, Germany: exchange program for students and scientists.

Advances and status

- 6 workshops for the Lab design (Argentina, Brazil, Chile, Mexico).
- Technical assessment of the proposal, led by T. Noble, former SNO Lab Director (2014).
- ANDES Conceptual Design, by Lombardi S.A., paid 50/50 by Chile and Argentina (2015).
- Design of Geoscience sector, in coll. with Karlsruhe and Heidelberg (2018).
- Design of Biology sector, in coll. with ISS, Rome (2018).
- First ANDES Geoscience Workshop (San Juan, Arg., Nov 2018)
- Government of San Juan (Argentina) commits full funds for the Basic Engineering Design (IBA) , 2018.
- Engineering Design (IBA) by Lombardi – December 2018.

Other sites in the meantime…

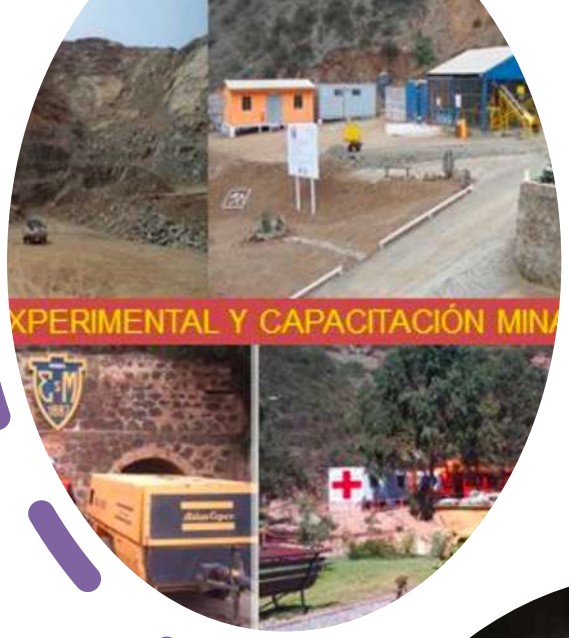
- Mina Sierra Grande, Río Negro, Argentina.
  - 400 m underground.
  - Used before for DM searches (1994-1999).
  - New plan for light DM searches with skipper CCD.



- Mina Casposo, San Juan, Argentina.
  - 300 m underground.
  - Muon flux measurements and applications to mining industry.

Other sites in the meantime…

- Mina Escuela Brillador (mining school, U La Serena) ~ 400 m.
- Mina Distrito Corcovado ~ 100 m.
- Chuquicamata UG mine ~ 900 m.



ANDES Coordination Team

- **General coordinator:**
  Xavier Bertou (CAB)
- **Country coordinators:**
  - **Argentina:** Osvaldo Civitarese, UNLP (Alberto Etchegoyen, UNSAM)
  - **Chile:** Claudio Dib (USM) (Juan Carlos Helo, ULS)
  - **Brasil:** Ronald C. Shellard (CBPF) (Joao dos Anjos, id.)
  - **Mexico:** Juan Carlos D'Olivo (UNAM) (Luis Villaseñor, id.)

+ the work and contribution of many other colleagues. Thanks to all.

Summary

- ANDES is a unique opportunity for a deep and large underground lab in Southern Hemisphere:
  - To educate new scientists.
  - To cultivate international collaboration.
  - To integrate Latin American nations around science objectives.
- International support, interest from world exp. Collaborations.
- Tunnel call for tender and ANDES inclusion in progress (estimated construction time: 8 years).
- More info at http://andeslab.org

Thank you