Laboratorio Subterráneo de Canfranc as a site for VLBAI experiments

Elías López Asamar

UAM Universidad Autónoma de Madrid

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Outline

Site description

Infrastructures available for VLBAI experiments

Environment conditions

Logistic considerations

Laboratorio Subterráneo de Canfranc (LSC)

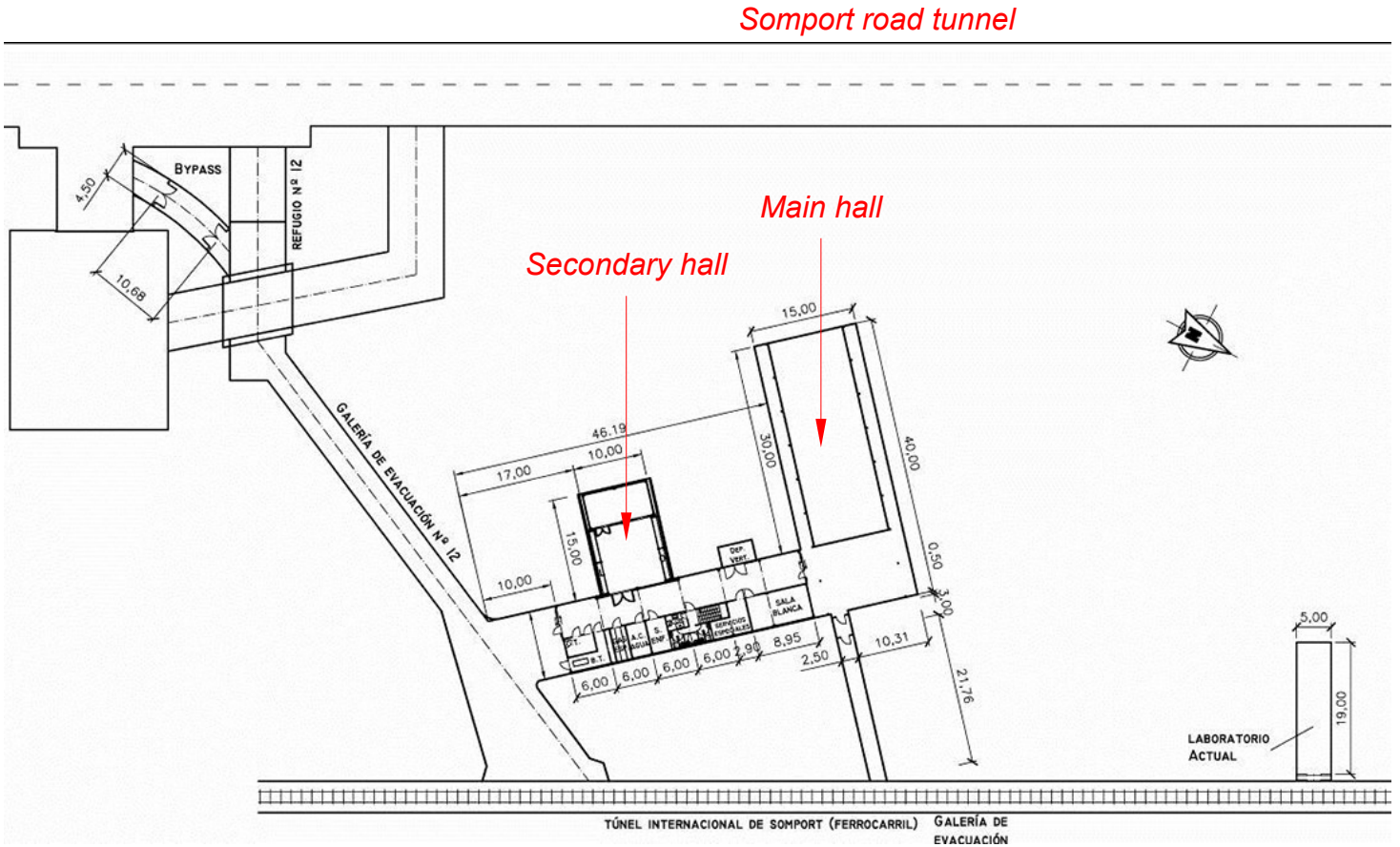
Located in Canfranc (Spain), on the Southern side of the Pyrenees

Current laboratory has been operating since June 2010

Site overview

Accessed by road through Somport tunnel

Featuring two halls to host experiments (40×15×12 m^3 and 15×10×7 m^3)



Site overview

Accessed by road through Somport tunnel

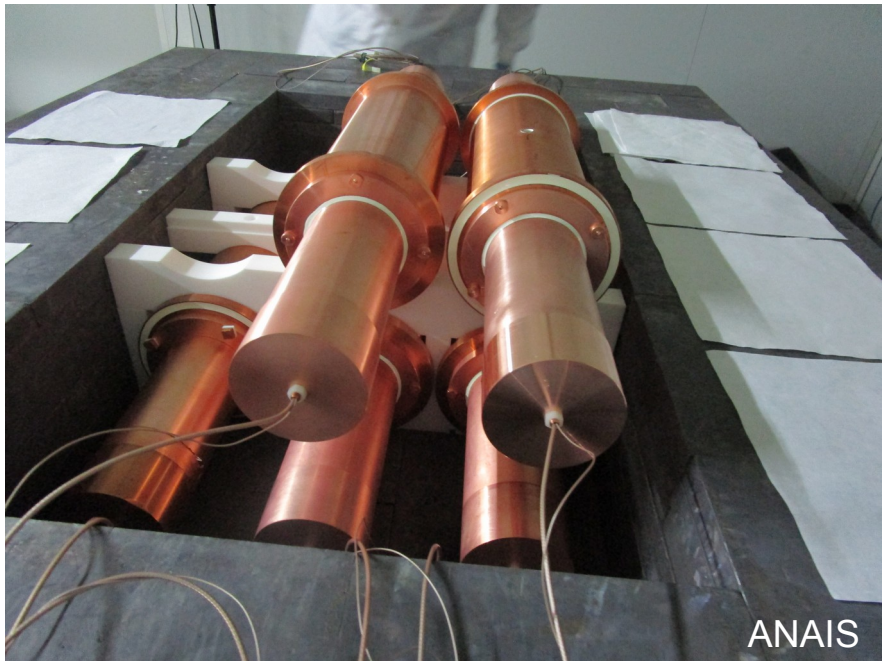
Featuring two halls to host experiments (40×15×12 m^3 and 15×10×7 m^3)

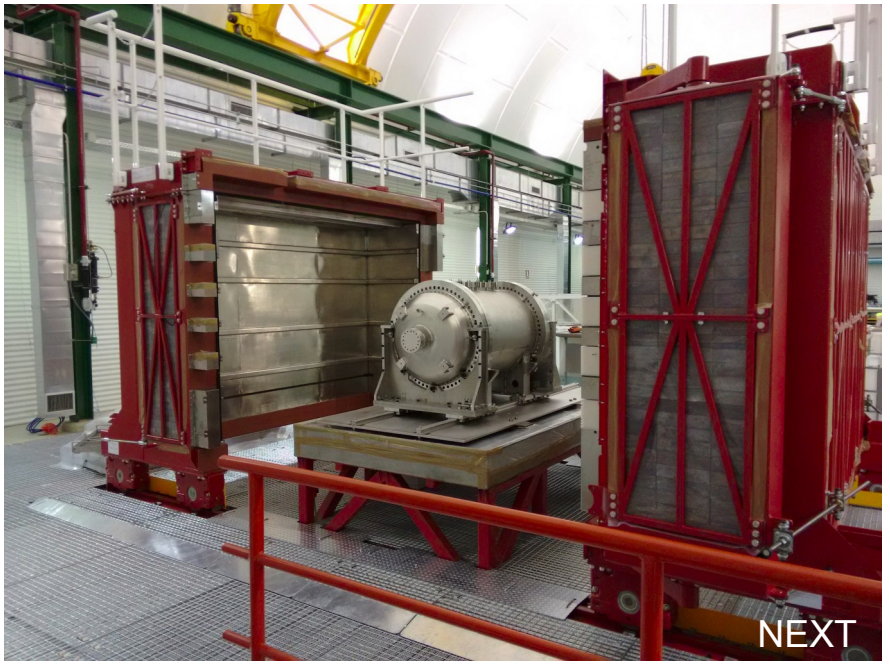
Site overview

LSC is home of several physics experiments:

- Dark matter: ANAIS, DArT, TREX-DM
- Neutrinoless double beta decay: NEXT, CROSS
- Quantum technology: ICRQ

Also considered as a site option for the Einstein Telescope project


ANAIS


NEXT

Site overview

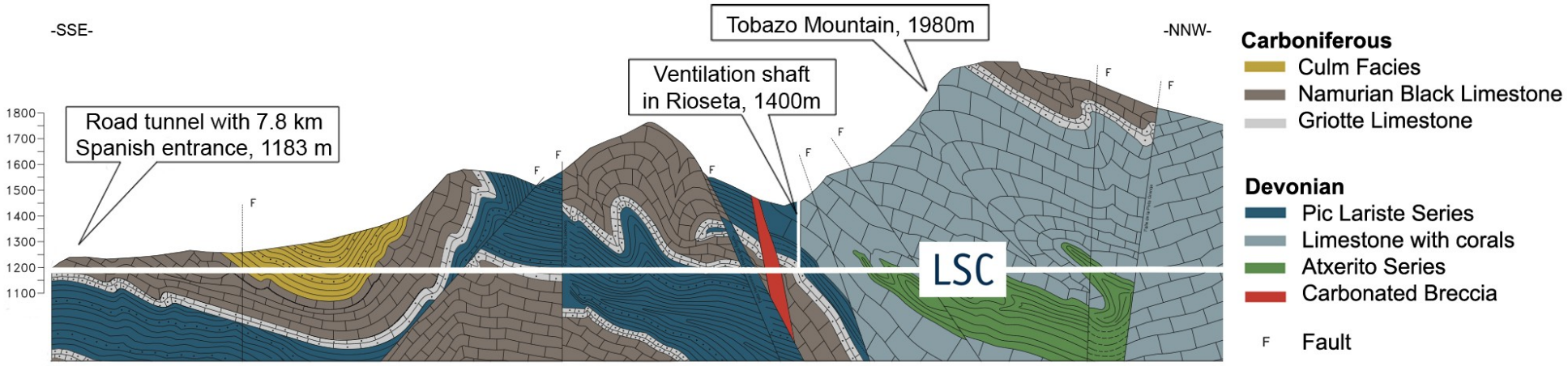
Services available at LSC include ISO 7 cleanroom (35.5 m^2, can be partly upgraded to ISO 6 upon demand), mechanical workshop, gas storage room and offices

LSC headquarters in external building at Canfranc-Estación: mechanical workshop, laboratories and offices

Infrastructures available for VLBAI experiments

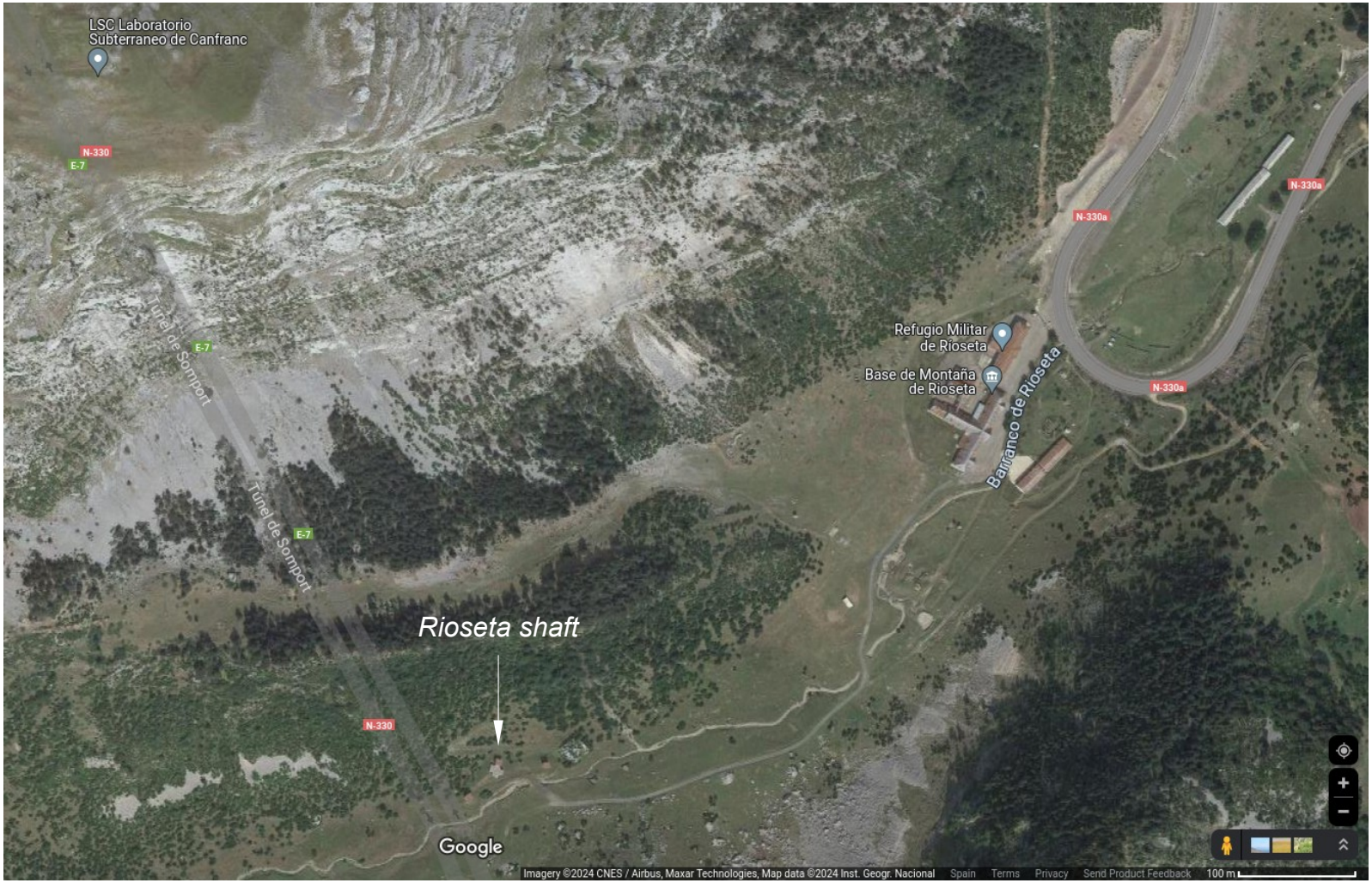
LSC has two infrastructures that could be used for both vertical or horizontal VLBAI experiments:

- Rioseta ventilation shaft
- Old railroad tunnel, running paralel to Somport tunnel (100 m separation)



Rioseta ventilation shaft

Coordinates: 42.76947º N, 0.52485º W, 700 m S-SE from LSC



Rioseta ventilation shaft

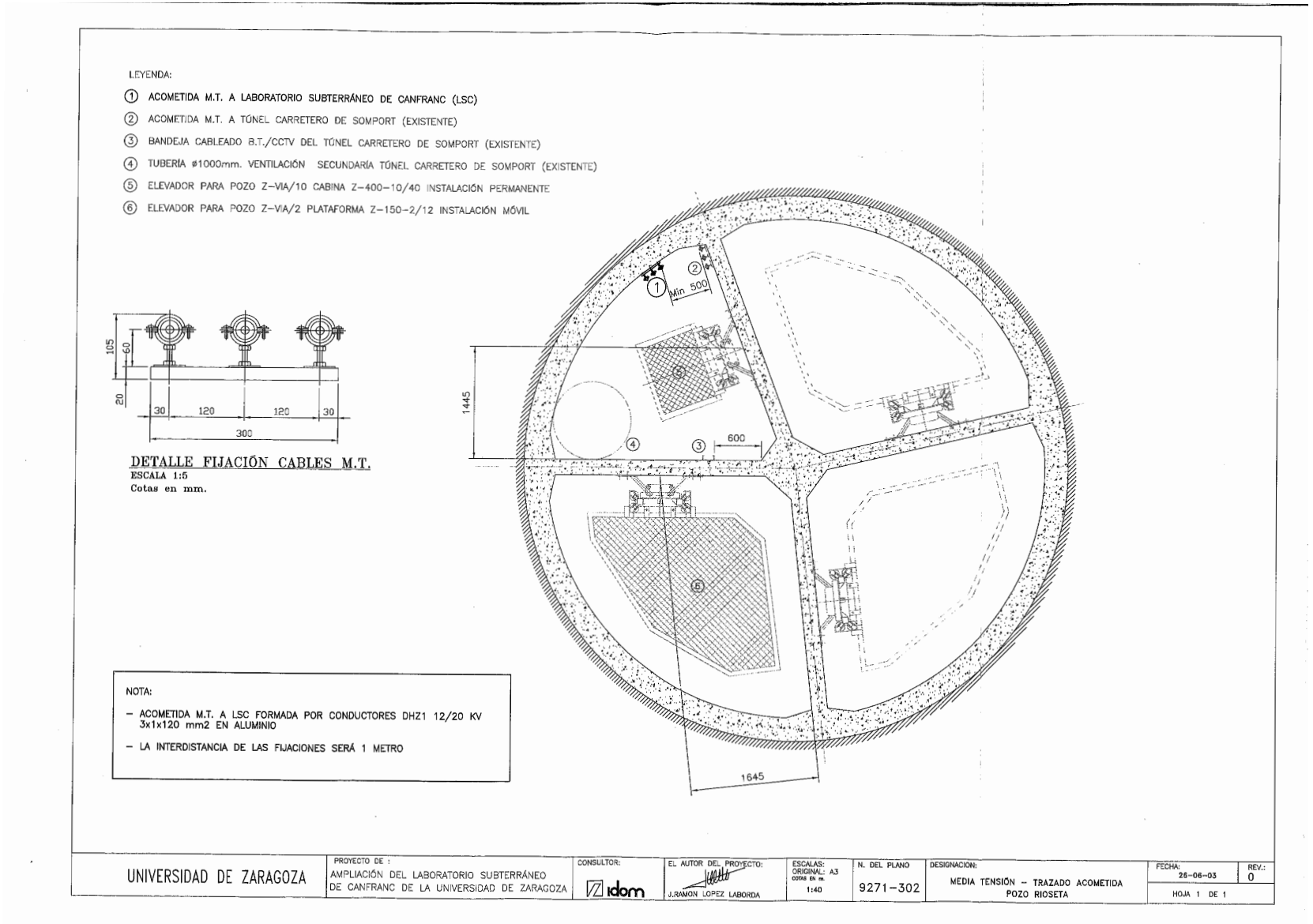
Depth: 220 m, inner diameter: 5.4 m

Divided in four sectors:

- Smaller sector already available
- Other sectors require permission from Spanish railway infrastructure manager (ADIF)

All sectors are equipped with an elevator

Rioseta ventilation shaft



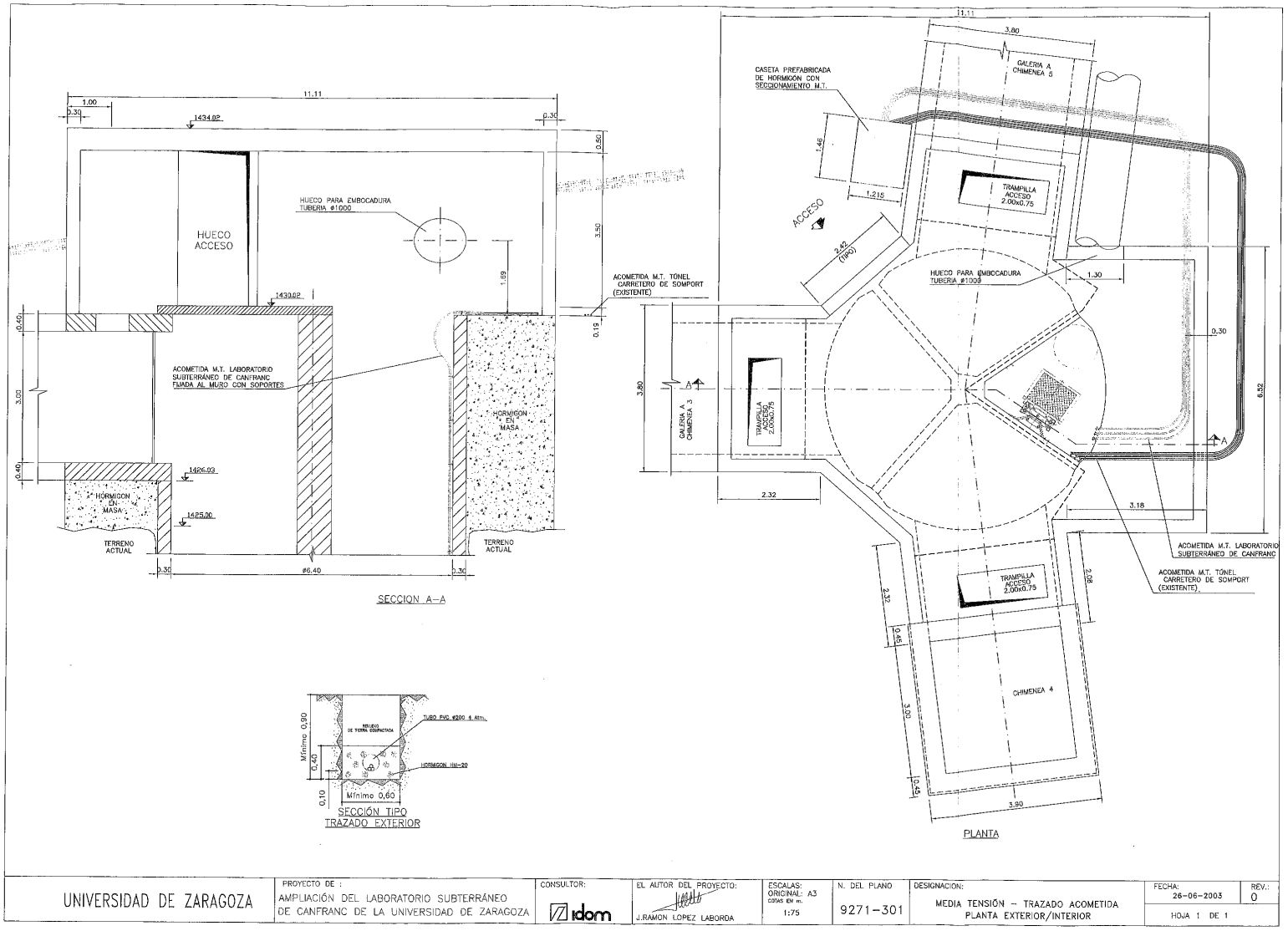
Rioseta ventilation shaft

Top of the shaft is enclosed by a building, accessible by vehicle (500 m from main road)

Base of the shaft is located between Somport tunnel and old railroad tunnel (50 m from each tunnel)

Both tunnels are connected to the base of the shaft

Rioseta ventilation shaft



Old railroad tunnel

Length: 7874 m, also features an orthogonal arm of 200 m

Currently used as an evacuation route

Can be entirely used to deploy a horizontal VLBAI experiment

Connected to LSC through a 20 m corridor

Environment conditions

Vibrational noise already measured in old railroad tunnel (100 m distance from Somport tunnel)

Lowest vibrational noise (above 2 Hz) among 15 international facilities

Location	Depth [m]	Elevation [m]	Seismic noise [nm] (RMS, $f_c = 2$ Hz)	Geology
Spain - LSC, Canfranc	900	1600	0.070	Hard rock
Italy - Sardinia	185	205	0.077†	Hard rock
Hungary - Gyöngyösoroszi	400	400	0.082	Hard rock
	70	400	0.12	
France - LSM, Modane	1750	1000	0.10	Hard rock
Japan - Kamioka	1000	358	0.11	Hard rock
Finland - Sumiainen	0	185	0.11	Surface rock
Italy - Gran Sasso	1400	970	0.13	Hard rock
Germany - Black forest	95	850	0.20	Granite
Romania - Slănic-Prahova	190	195	0.25†	Salt
USA - Dusel, Lead, SD	1250	350	0.64†	Hard rock
	640	960	1.12†	
Germany - Moxa	35	455	0.70	Hard rock
Netherlands - Heimansgroeve	10	135	1.07	Surface rock
Belgium - Mol	230	-205	2.10	Clay
Italy - Sicily	60	-30	9.24†	Salt
Italy - Virgo, Pisa	0	5	54.52	Sedimentary soil

Table 1. Summary of the locations investigated as part of the ET seismic studies. The seismic noise RMS level is obtained from displacement spectra averaged over several days and integrated for frequencies above 2 Hz. A displacement spectrum of 0.5 nm/$\sqrt{\text{Hz}}$ $(\text{Hz}/f)^2$ above 1 Hz, provides a seismic noise RMS of 0.1 nm. For numbers denoted by a dagger (†) mining or other underground activities were underway during data taking.

M G Beker *et al.*, J. Phys.: Conf. Ser. 363 012004 (2012)

Environment conditions

Negligible midnight-to-midday noise variations ⇒ Very low anthropogenic contributions to noise (1.4 people/km^2)

Similar noise conditions expected at Rioseta shaft (50 m distance from Somport road tunnel)

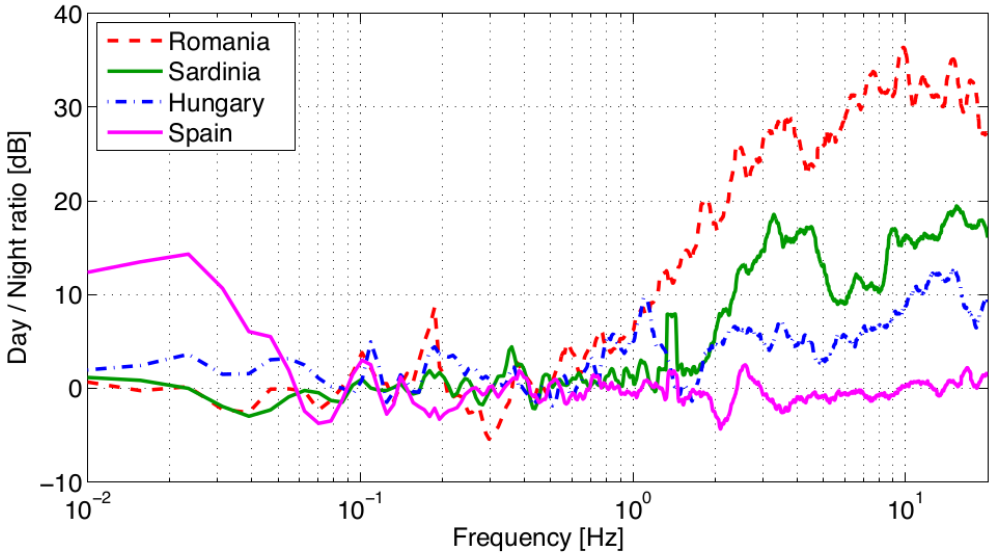


Figure 4. Midday versus midnight noise PSD ratios as a function of frequency. The variations show a strong correlation between seismic noise and human activity at frequencies above 1 Hz. The Romanian site is an extreme case due to the mining activities in the same mine during data taking.

Environment conditions

Electromagnetic (EM) radiation levels expected to be very low as well

Six medium-voltage power lines (12 kV) along Rioseta shaft

Very suppressed high-frequency contribution from telecommunications at the top of the Rioseta shaft: remote location, at the bottom of a valley

Logistic considerations

Travel options:

- Flight to Zaragoza (London STN, Paris BVA)+drive to Canfranc (1 h 50 m)
- Flight to BCN+drive to Canfranc (4 h)
- Flight to BCN or MAD+high speed train to Zaragoza (1 h 30 m)+drive to Canfranc

Several accommodation options due to proximity of ski resort:

- Canfranc-Estación (entrance of Somport road tunnel)
- Candanchú (6 km from Canfranc-Estación)
- Jaca (25 km from Canfranc-Estación)

Logistic considerations

LSC has ample experience supporting physics experiments, and has already expressed interest in hosting a VLBAI experiment

The laboratory provides services such as cleanrooms or mechanical workshops, and has a network of local industries that deliver solutions to the facility

To date, seven Spanish institutions have expressed interest in atom interferometry:

- ICE, IFAE, UB, UPM (Barcelona)
- UIB (Balearic Islands)
- UdL (Lleida)
- UAM (Madrid)

Summary

LSC is an underground laboratory on the Southern side of the Pyrenees, that hosts several physics experiments

Two infrastructures related to LSC can be used to deploy VLBAI experiments: Rioseta shaft and the old railroad tunnel

Rioseta shaft (220 m depth, 5.4 m diameter) is enclosed by a building at the top, and its base can be accessed by road

Old railroad tunnel (7874 m long+200 m orthogonal arm) can be entirely used to deploy a TVLBAI experiment

LSC features the lowest vibrational noise among 15 international facilities

Reasonable travel options to reach LSC, plus several accommodation options near the site

Contact: Diego Blas (dblas@ifae.es), Elias Lopez (elias.lopez@uam.es)

Environment conditions

Vibrational noise already measured in old railroad tunnel (100 m distance from Somport tunnel)

Lowest vibrational noise (above 2 Hz) among 15 international facilities

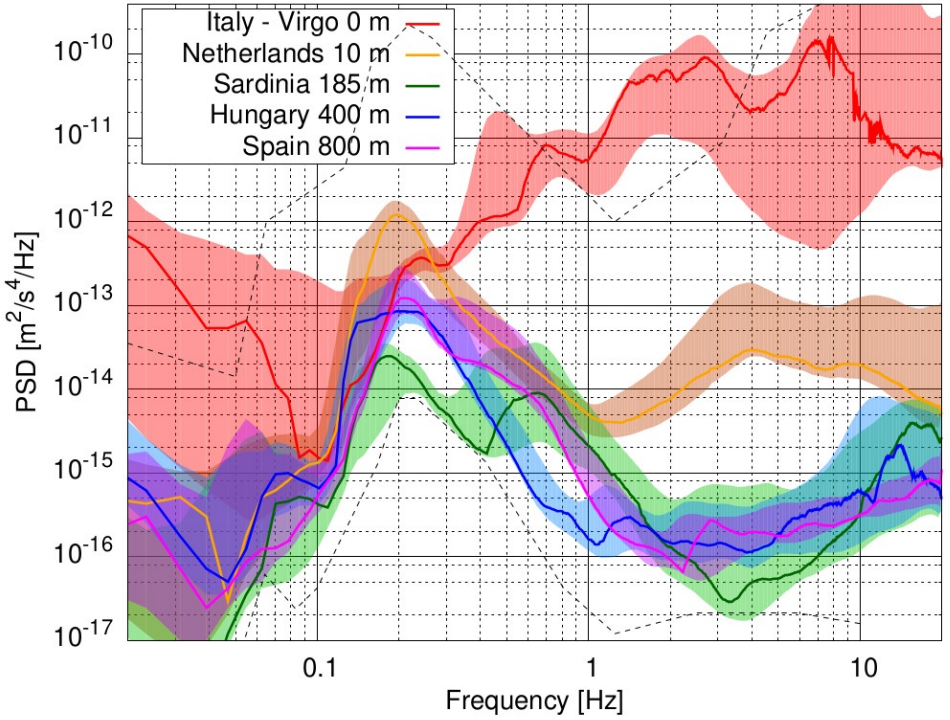


Figure 3. Spectral variation results for various sites. The transparent color regions are bounded by the 90 and 10 percentiles while the solid curves represent the mode or most common PSD value in each frequency bin. The dashed black curves indicate the Peterson new high and low noise models.

M G Beker *et al.*, J. Phys.: Conf. Ser. 363 012004 (2012)