ET ITALY
Einstein Telescope

The Sardinian Site for Einstein Telescope

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with inputs from D. D'Urso, L. Naticchioni, D.Rozza

Osaka, 25 June 2025

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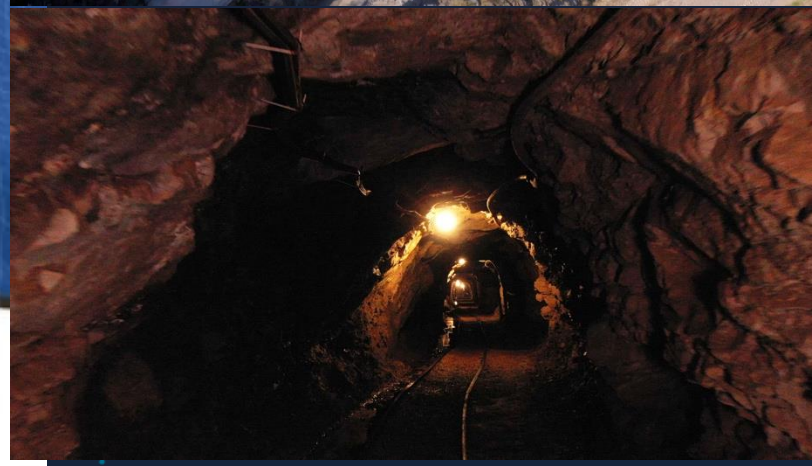

In the **SOS ENATTOS** former mine area, the **SARGRAV laboratory**, a seed of ET, can host:

UNDERGROUND EXPERIMENTS

CRYOGENIC PAYLOADS

LOW FREQUENCY AND CRYOGENIC SENSOR DEVELOPMENT

that need **LOW SEISMIC** and **ANTHROPOGENIC NOISE**

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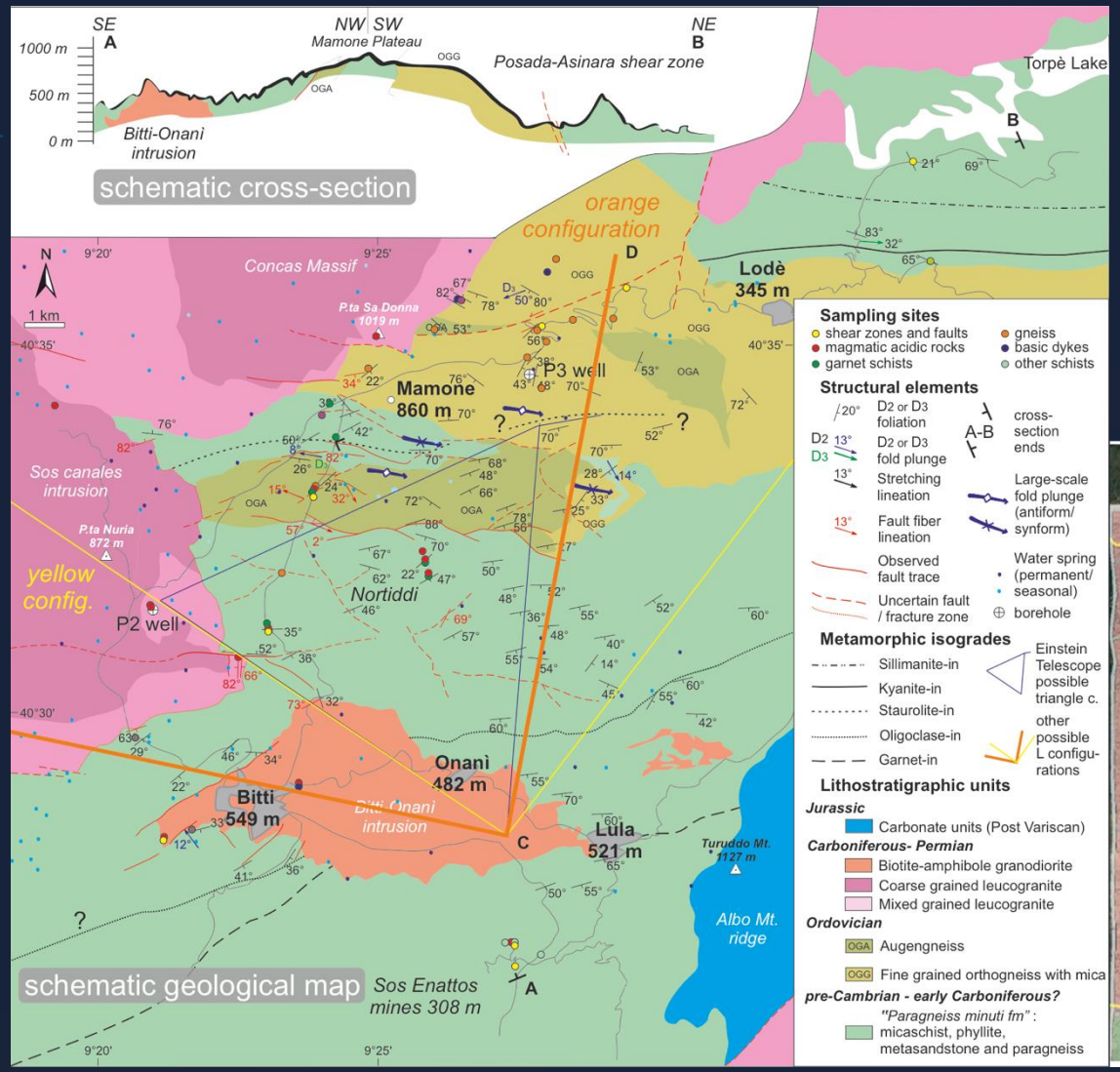
Geological Studies

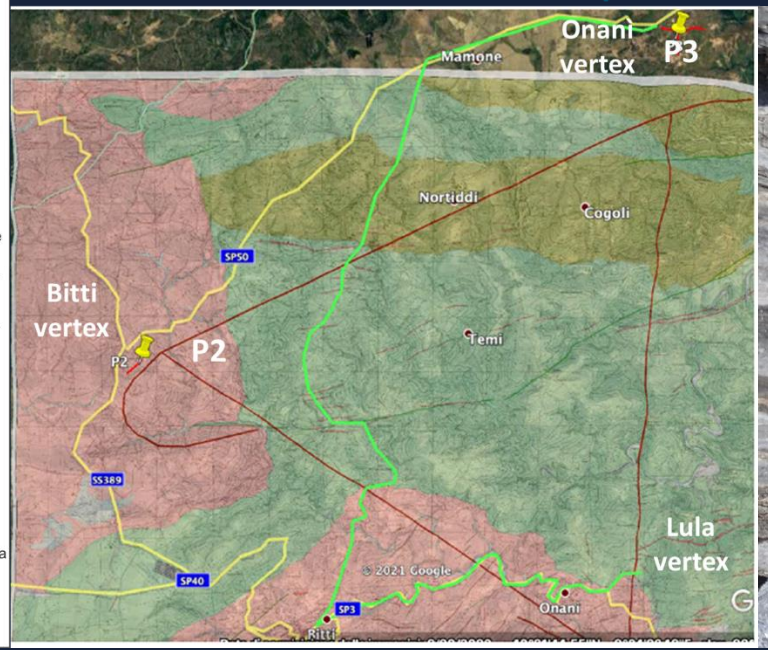
The ET Italian candidate site is located in the stable **VARISCAN BASEMENT OF SARDINIA**



LITHOLOGIES: Orthogneiss, granitoids, micaschists.

P2 and P3 are the borehole locations optimization is ongoing.

Credits to D. Rozza



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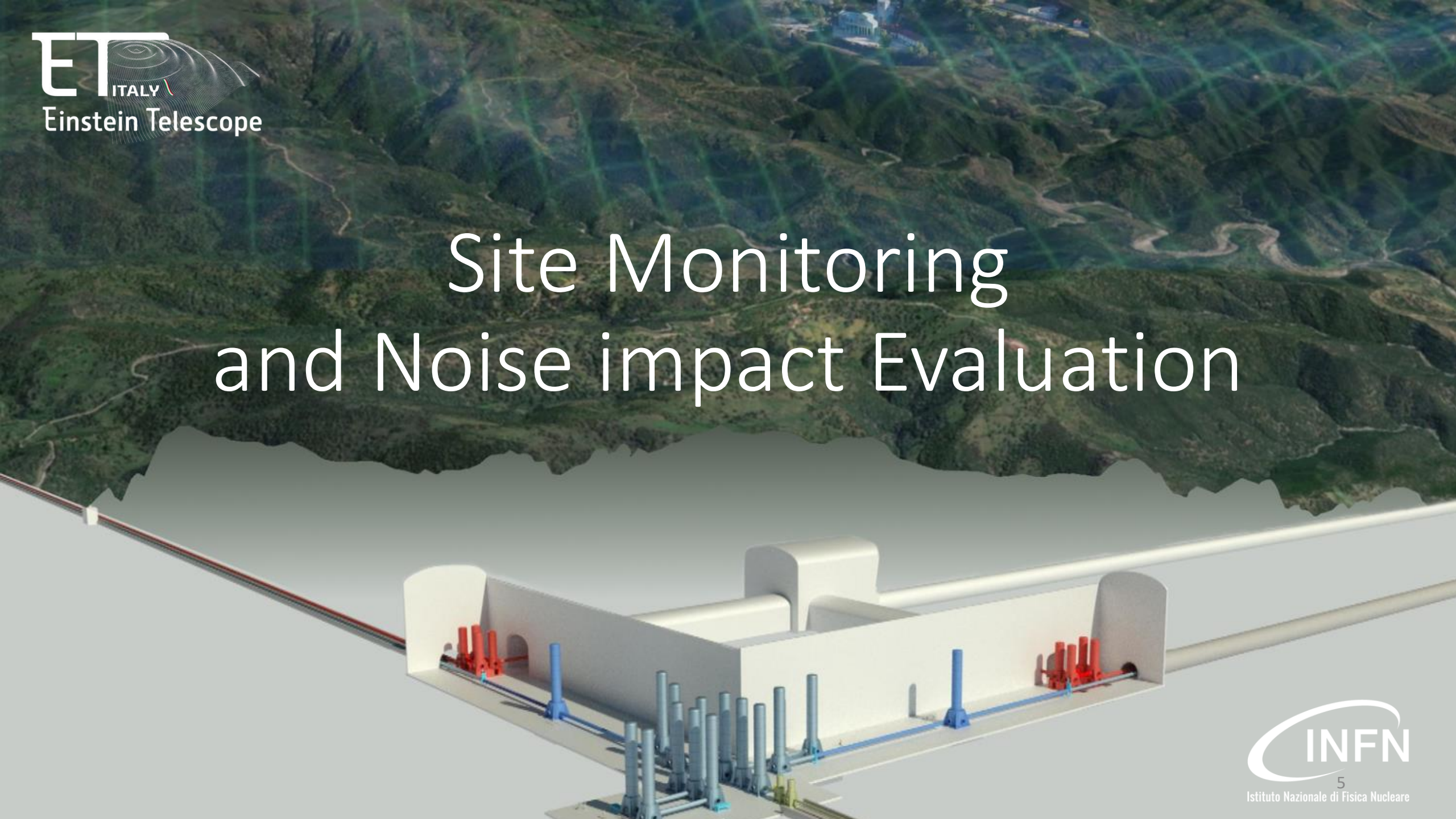
Site Monitoring and Noise impact Evaluation



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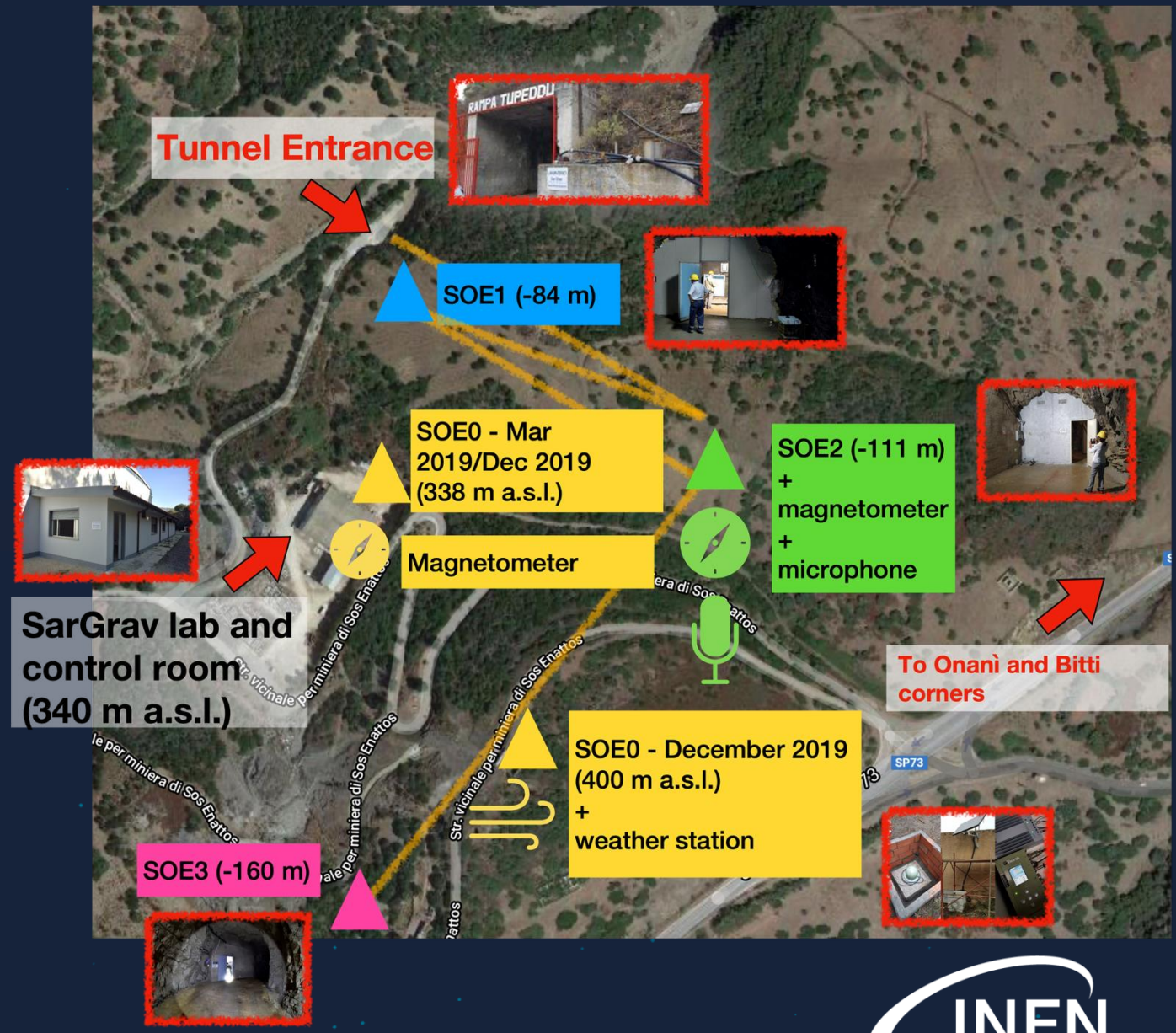
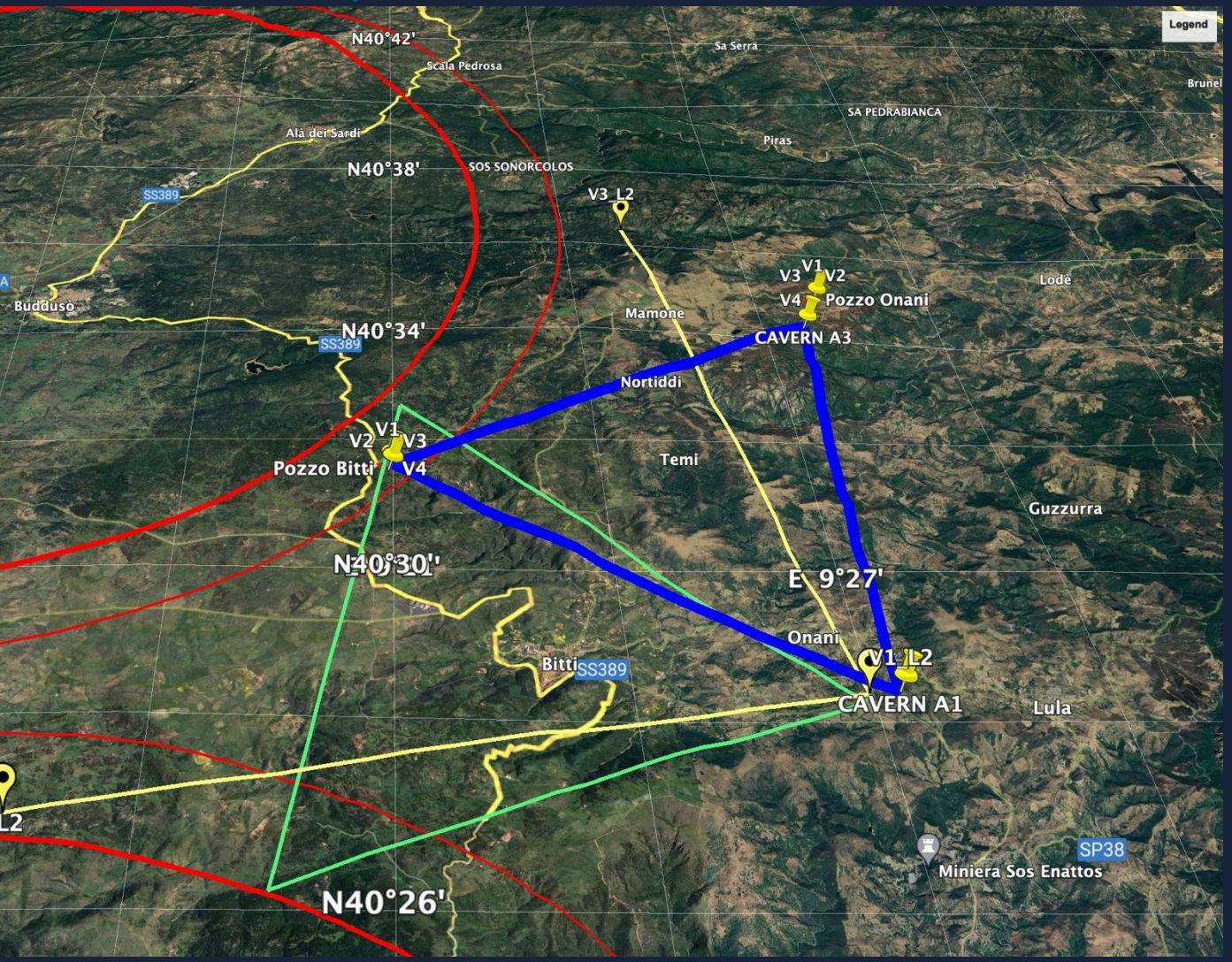
PERMANENT ARRAY in Sos Enattos since 2019

- 4 permanent seismic stations for long term studies (Trillium 240, 360 and 120 Horizon, Guralp 360)
- 1 weather station
- 1 microbarometer
- 3 magnetometers (MF6-06)
- 2 microphones
- 1 high precision tiltmeter (Archimedes prototype)



PERMANENT ARRAY since 2021

Since 2021, more permanent sensors have been installed at 2 of the proposed vertices (P2, P3)



2 broadband seismometers on surface

2 broadband seismometers in borehole

2 magnetometers at P2

- Acoustic measurement campaign at P2 completed
- Performed gravimetric measurement
- In the next months Sos Enattos area will be reached at 1 TB/s
- New measurement stations in the other candidate vertices

Hunting the noise sources

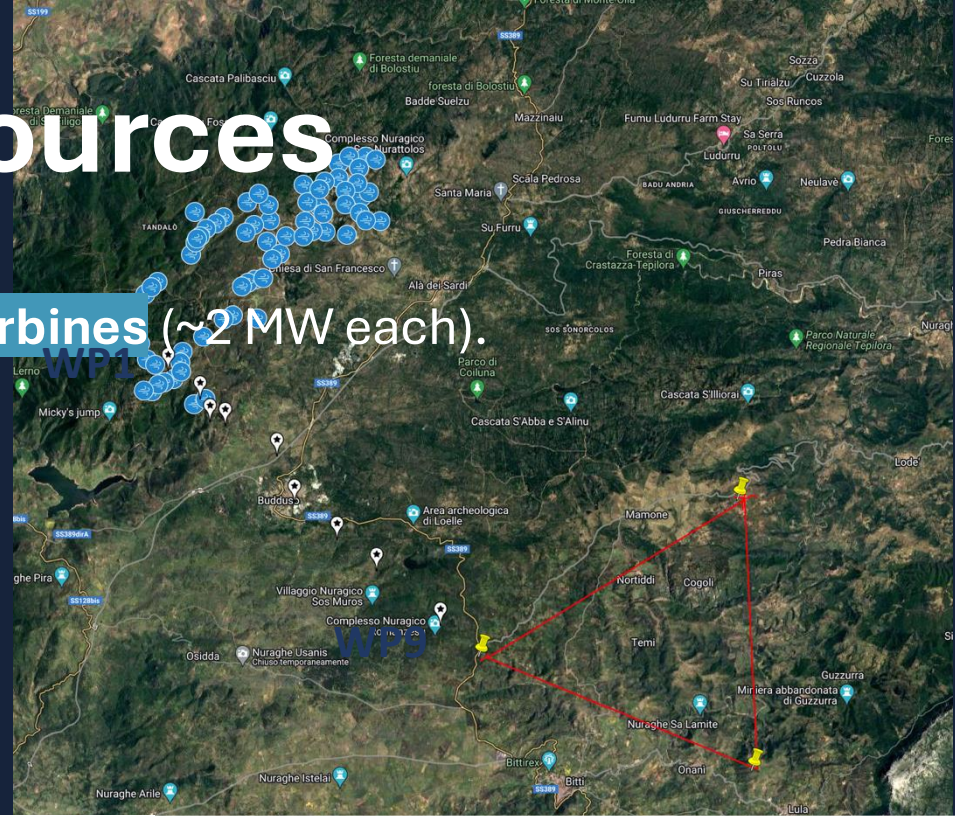
The **Buddusò Wind Park**: one of the largest wind parks in Italy. **69 turbines** (~2 MW each).

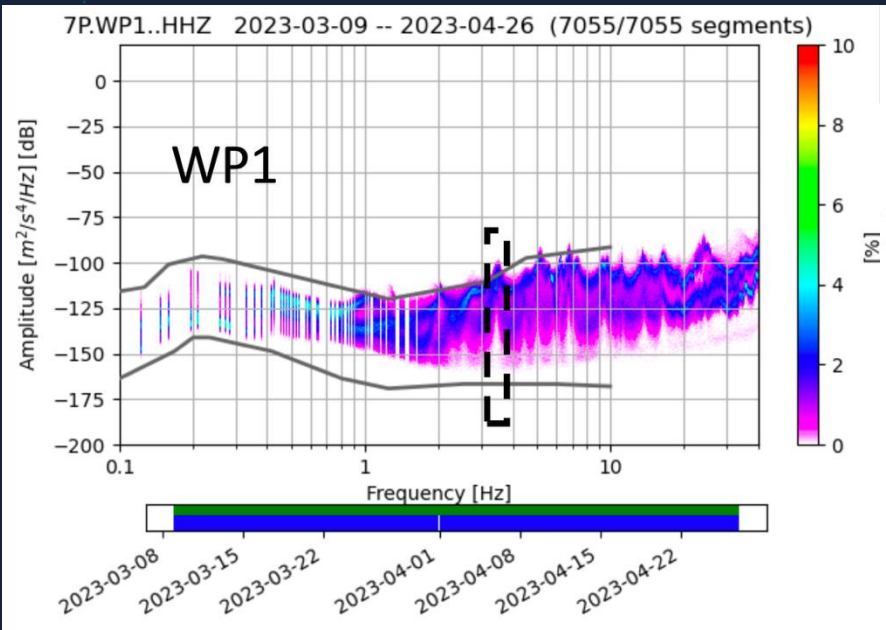
A total of **130 MW installed**.

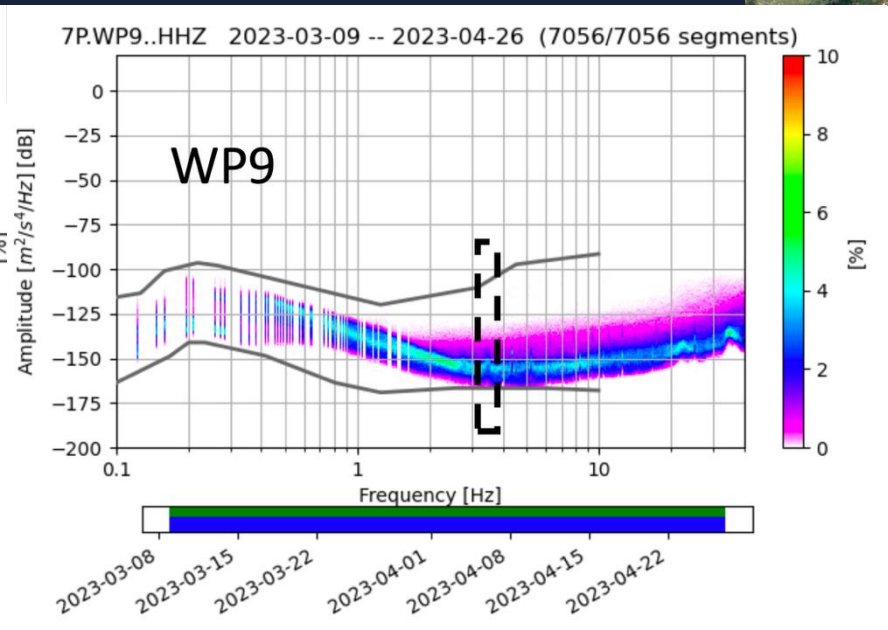
Blades motion is **transferred** to tower and to the ground.

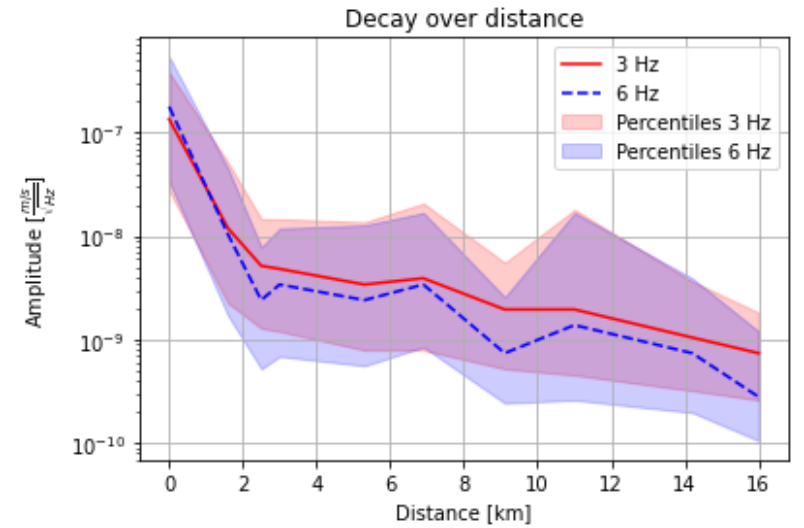
Seismic noise propagates as **surface waves**

Generated noise is found in the **1-10 Hz** frequency band.

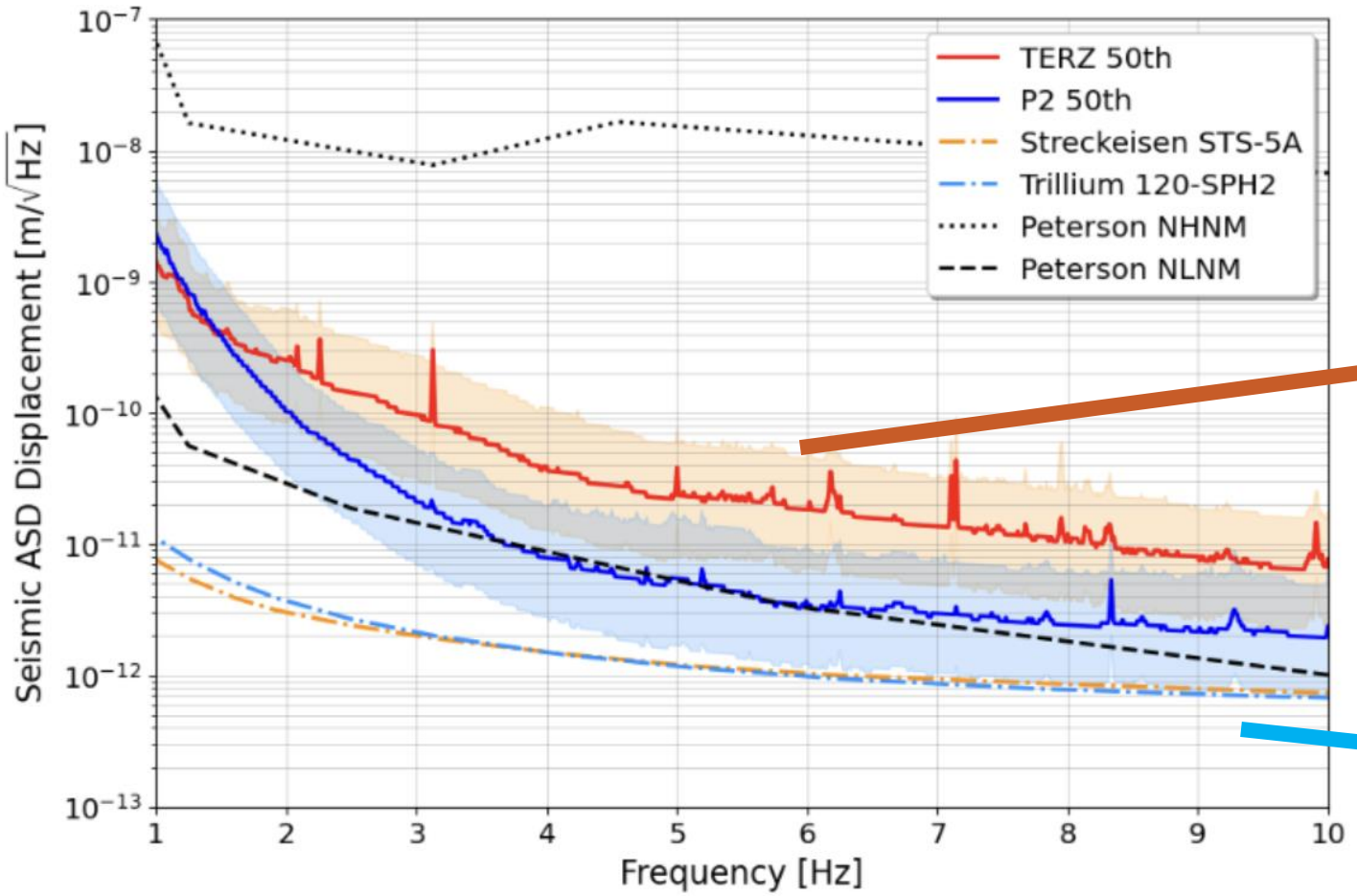








Sardinia vs EMR



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Seismic noise / frequency

Manuscript available at https://arxiv.org/abs/2503.02166

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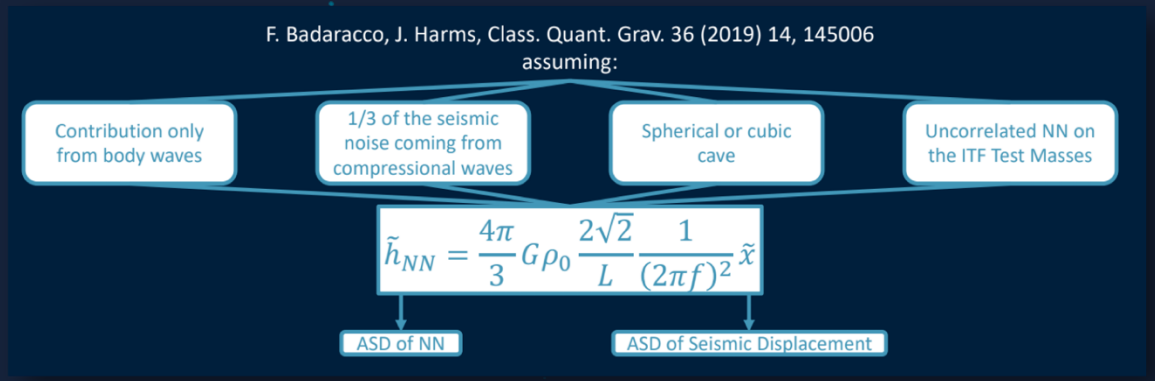
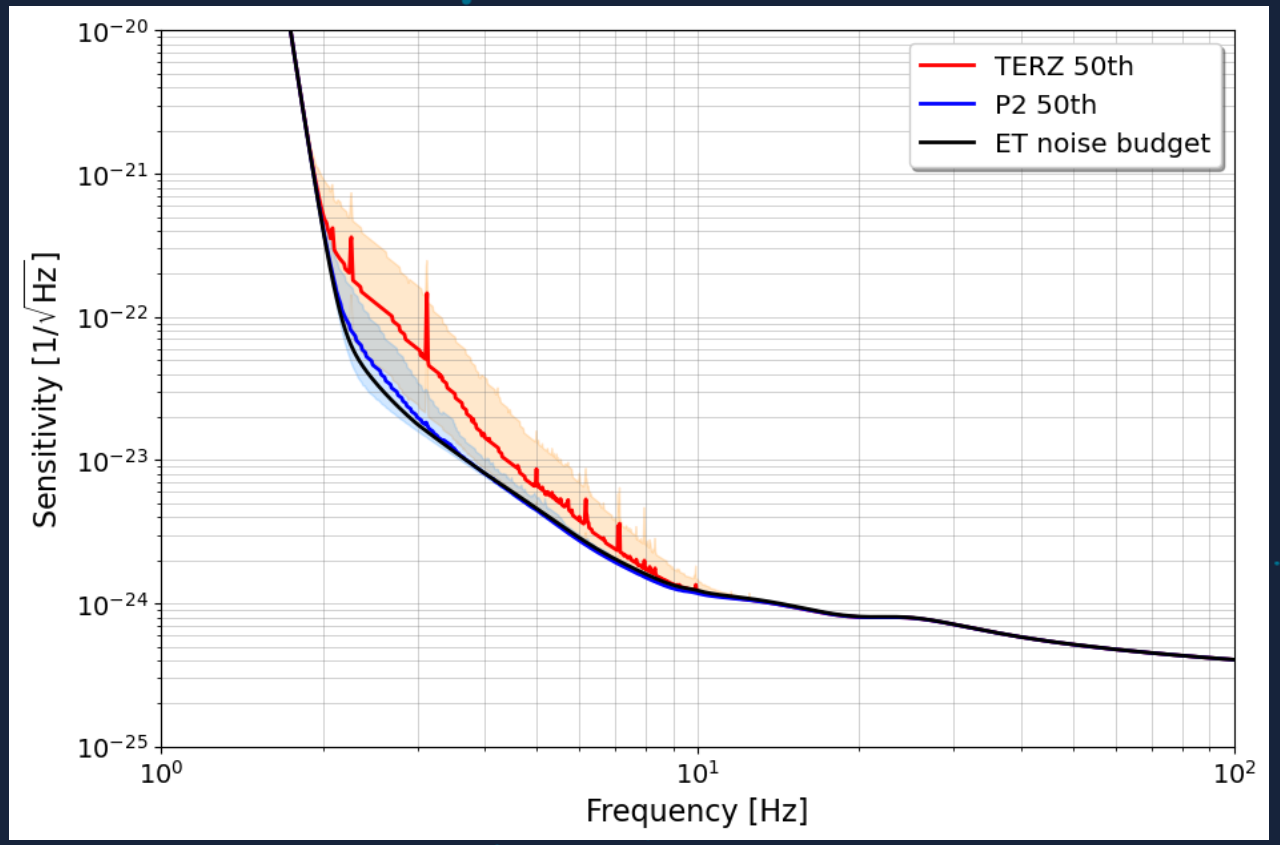
The Ideal Site

Effect on ET Sensitivity

- The higher noise levels at the EMR site have a much stronger effect on the ET sensitivity than the Sardinia site which is very close to design.





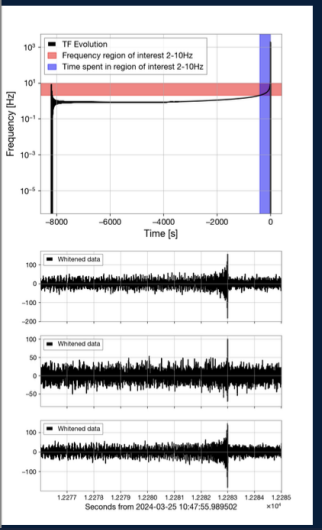
Results obtained without any noise mitigation

Manuscript available at https://arxiv.org/abs/2503.02166

Effect on ET Sensitivity

GW150914-like event at cosmological distance

M1 = 35 M_sun
M2 = 30 M_sun
D = 4000 Mpc (z = 1)



T 2 Hz - 10 Hz	T 2 Hz - to merger	Design SNR 2 Hz-10 Hz
400 s	403 s	41

P2 10%	P2 50%	P2 90%
43 (+5%)	42 (+2%)	40 (-3%)

TERZ 10%	TERZ 50%	TERZ 90%
42 (+2%)	37 (-10%)	27 (-35%)

In current generation detectors, similar signals last few hundred milliseconds from 20 Hz to merger

GW170817-like event at cosmological distance

M1 = 1.4 M_sun
M2 = 1.4 M_sun
D = 1000 Mpc (z = 0.2)

T 2 Hz - 10 Hz	T 2 Hz - to merger	Design SNR 2 Hz-10 Hz
20 h	-	18.2

P2 10%	P2 50%	P2 90%
19.3 (+6%)	19 (+4%)	17.7 (-3%)

TERZ 10%	TERZ 50%	TERZ 90%
18.6 (+2%)	15.7 (-24%)	11 (-39%)

SNR fractions with respect to design are compatible with the previous cases.

Manuscript available at https://arxiv.org/abs/2503.02166

Site comparison with other candidates

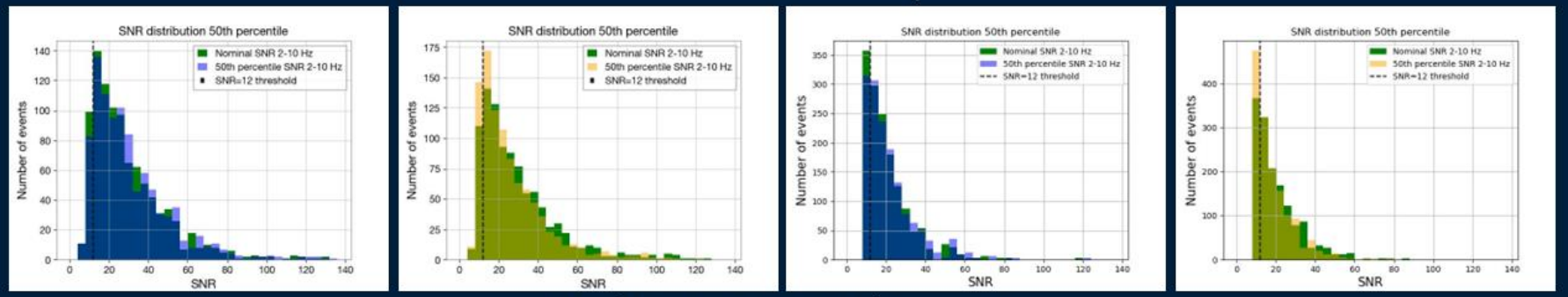
Seismic Newtonian Noise effect on GW signal detection

IMBH — About 1000 events

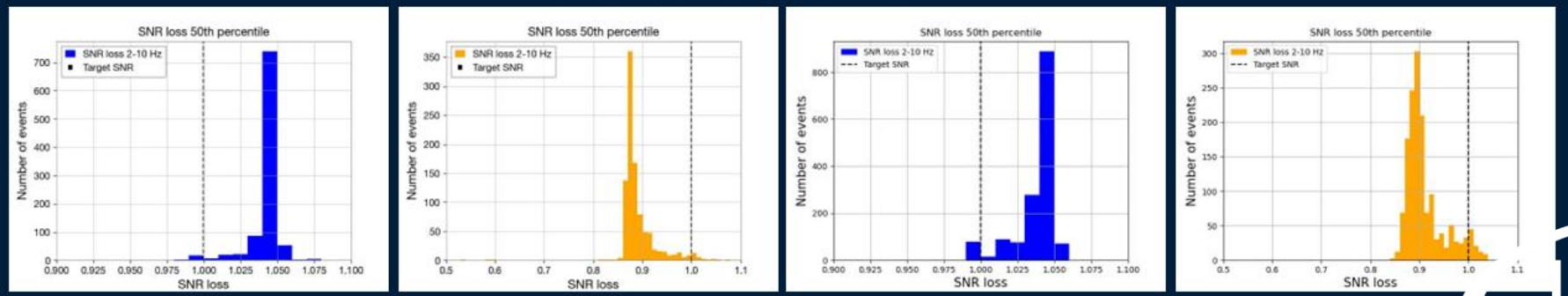
BNS — About 1500 events

IMBH Sardinia	IMBH EMR	BNS Sardinia	BNS EMR

Nominal SNR distribution and 50th percentile



SNR/SNR_design using 50th percentile



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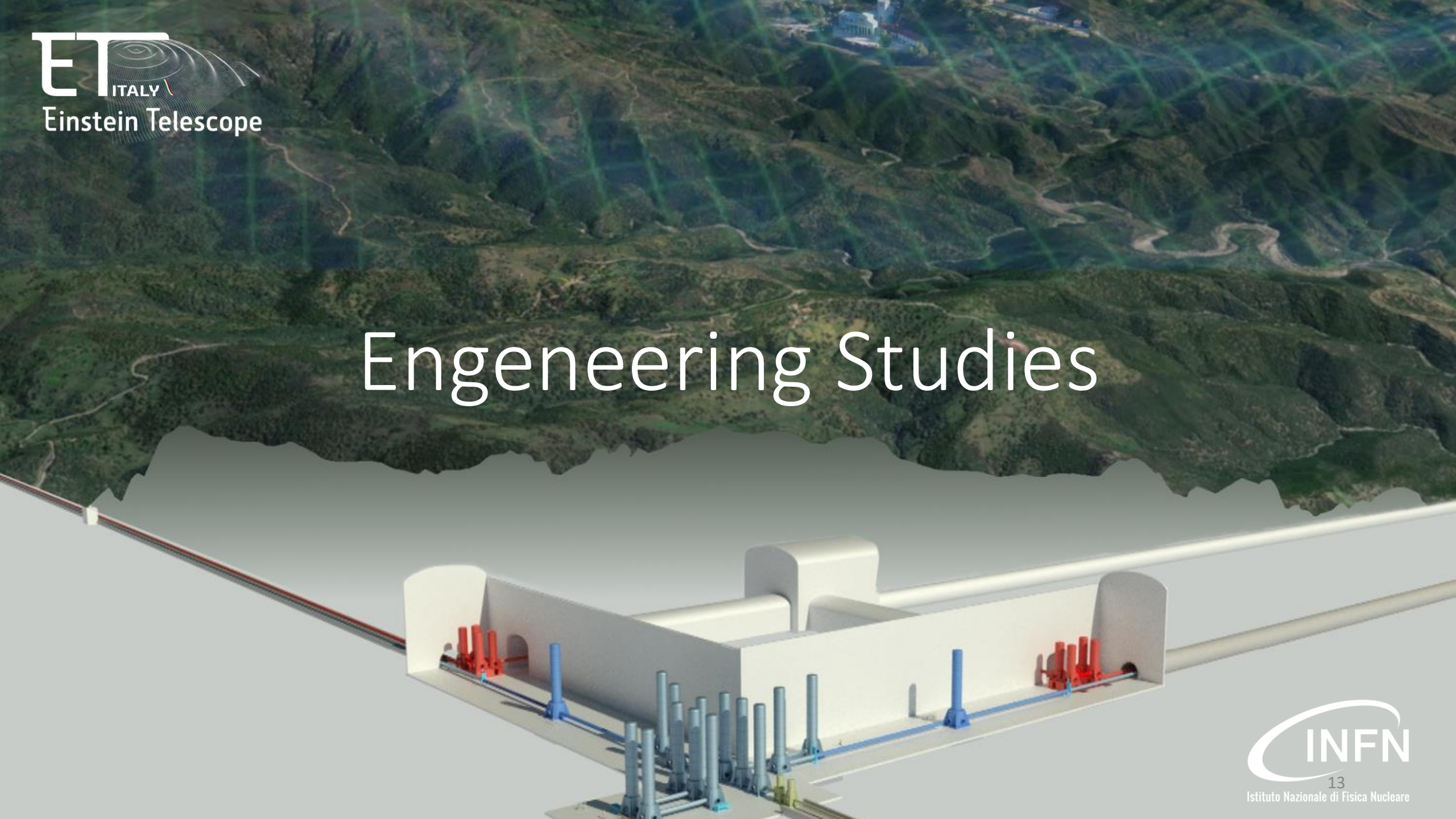
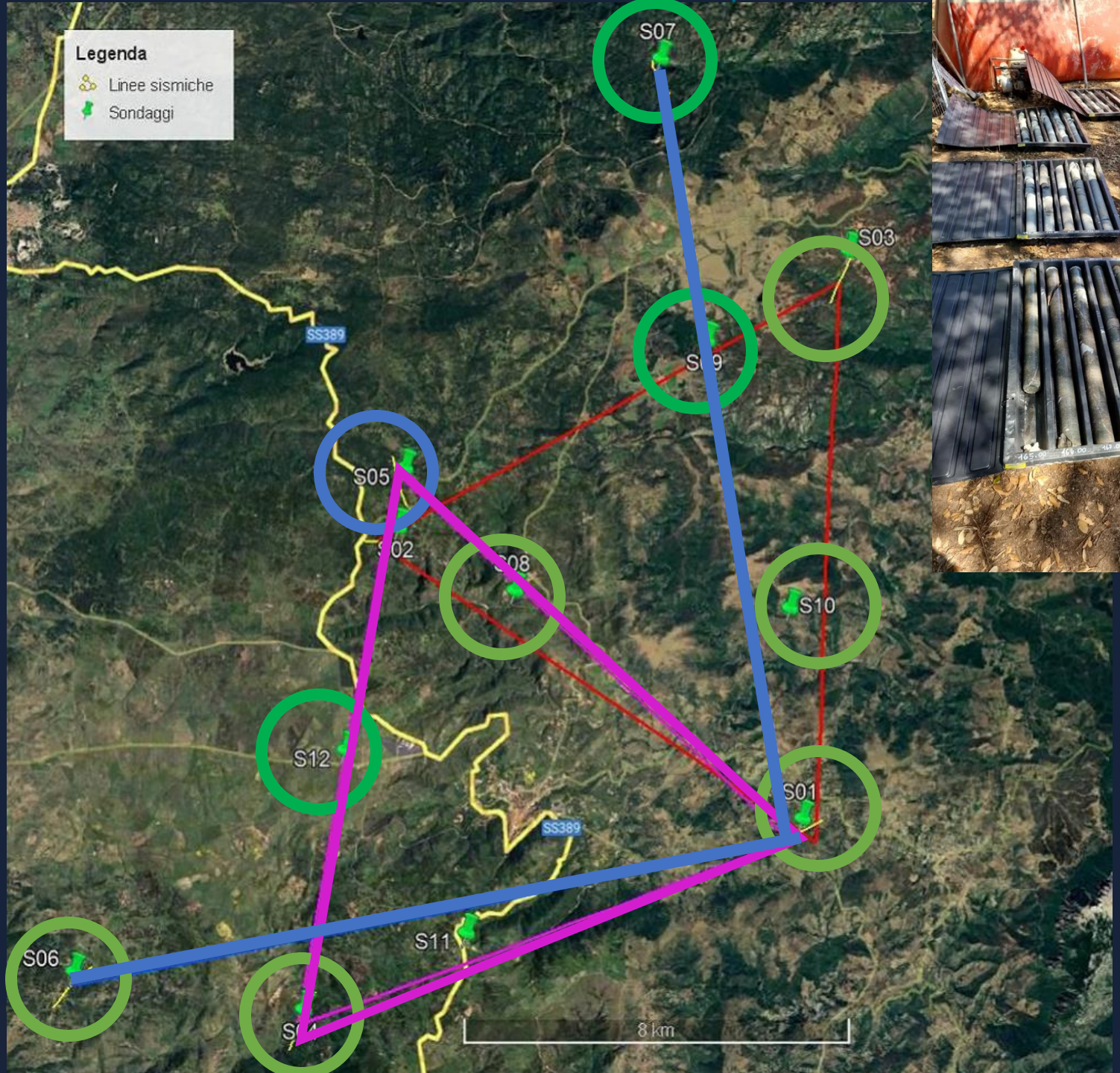
Engeneering Studies





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New Drilling Campaign started in July ‘24

- **COMPLETED**
- **Candidate Triangle**
- **Candidate L**

Collateral Activities

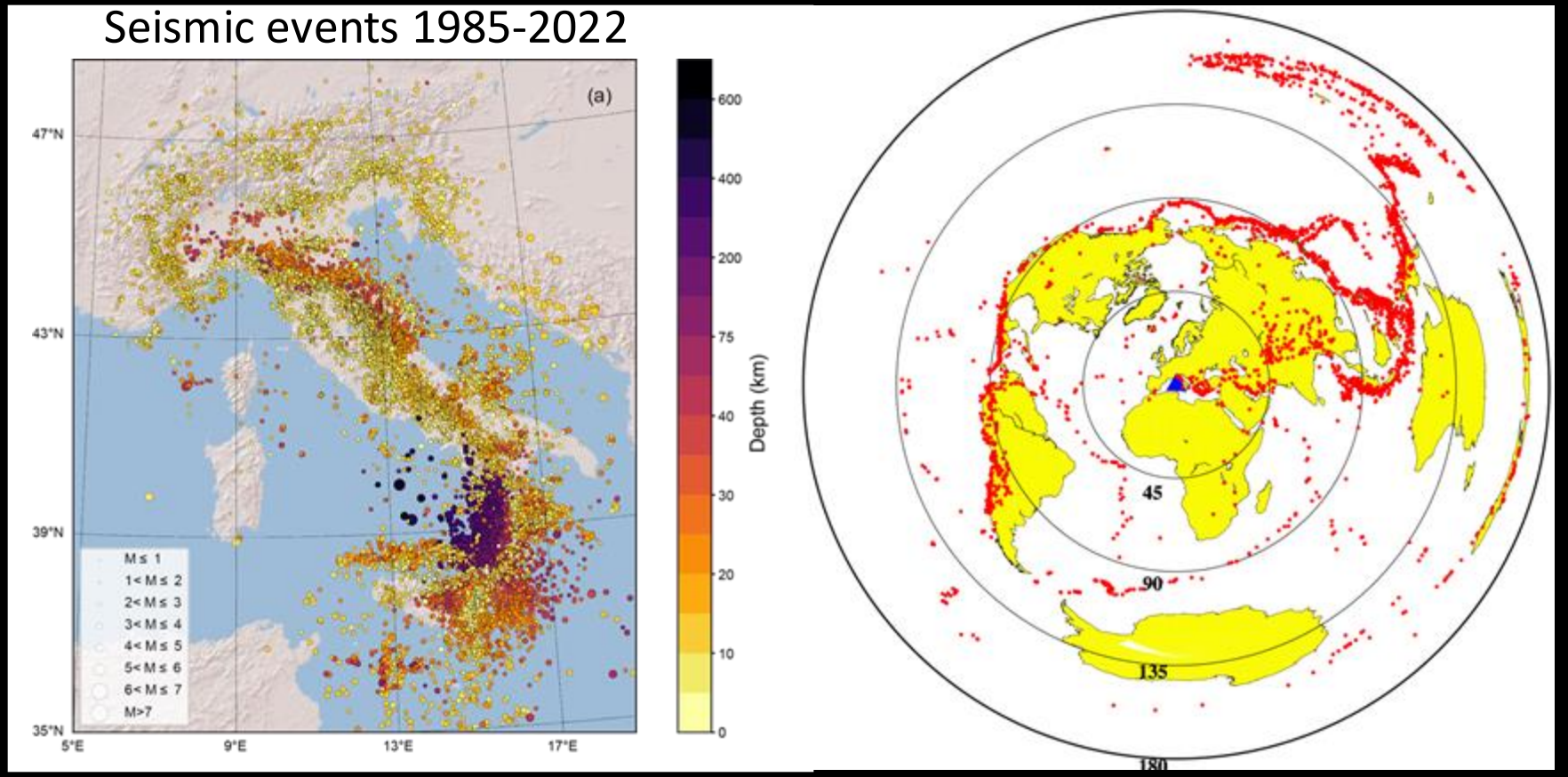
ET – SUNLab (INFN + INGV + INAF)

- Realization of a Research Center in the Sos Enattos former-mine

Sardinia Far Fault Observatory

SARDINIA
FABER
FAR FAULT OBSERVATORY

Seismic events 1985-2022



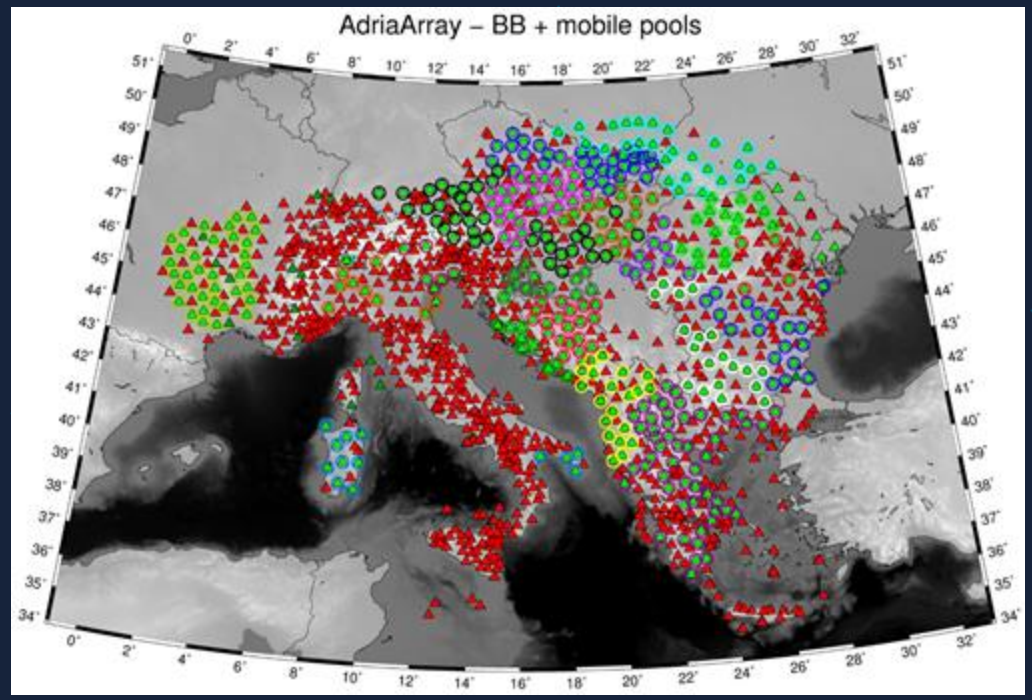
→ Earth Telescope

AdriaArray

- 8 broadband seismic stations
- 2 years

GOALS

- Improve capability to record earthquakes and quarry explosions in Sardinia
- Improving the crustal velocity model
- Contribute to the AdraArray project to better understand the Adra plate



Credits to M. Olivieri - INGV

Conclusions

- The characterisation team is working hard to support the Italian candidacy to host ET
- **Data shows the sardinian site is ideal to host ET**, one of the best in the world
- **Both triangular and L shape are being considered** and their possible positioning already assessed
- The goodness of the Sardinian site goes beyond ET and already attracts partners and research institutes: **SUnLAB** construction **functional but independent from the hosting of ET**

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Thanks for your attention!