The image features a dramatic sunset sky with orange and red clouds over a vast, flat landscape. Below the horizon, a 3D cutaway rendering of a tunnel system is shown. The tunnel is illuminated from within, revealing various pieces of equipment, including red and blue vertical structures, and blue horizontal pipes. Small human figures are placed throughout the tunnel to provide a sense of scale. The overall scene is a composite of a natural landscape and a technical engineering diagram.

Site Characterization/ Preparation Board ET-PP WP4: Updates

W. Walk & D. D'Urso

➤ **M1.1: physical variables:**

ET-0012A-23, discussed and finalized at the II SPB Workshop (Jan 2023) <https://apps.et-gw.eu/tds/?content=3&r=18113>

➤ **M1.2: measurements recommendations and standards:**

ET-0013A-23, discussed and finalized at the II SPB Workshop (Jan 2023) <https://apps.et-gw.eu/tds/?content=3&r=18114>

➤ **M1.3: data format standards and analysis tools**

ET-0270A-23, <https://apps.et-gw.eu/tds/?content=3&r=18398>

➤ **ET-PP M04.01:** *“Site-specific Characteristics impacting ET sensitivity and duty cycle”* (manly based on previous documents) ET-0252A-23, <https://apps.et-gw.eu/tds/?content=3&r=18379>

An aerial photograph of a vast, hilly landscape under a dramatic sunset sky with orange and red clouds. A semi-transparent cutaway of a tunnel system is overlaid on the image, showing the internal structure of the tunnel. The cutaway reveals a complex network of tunnels with various components, including red vertical structures, blue vertical structures, and a central shaft with several silver cylindrical components. The text "Updates from Sardinia" is centered over the landscape.

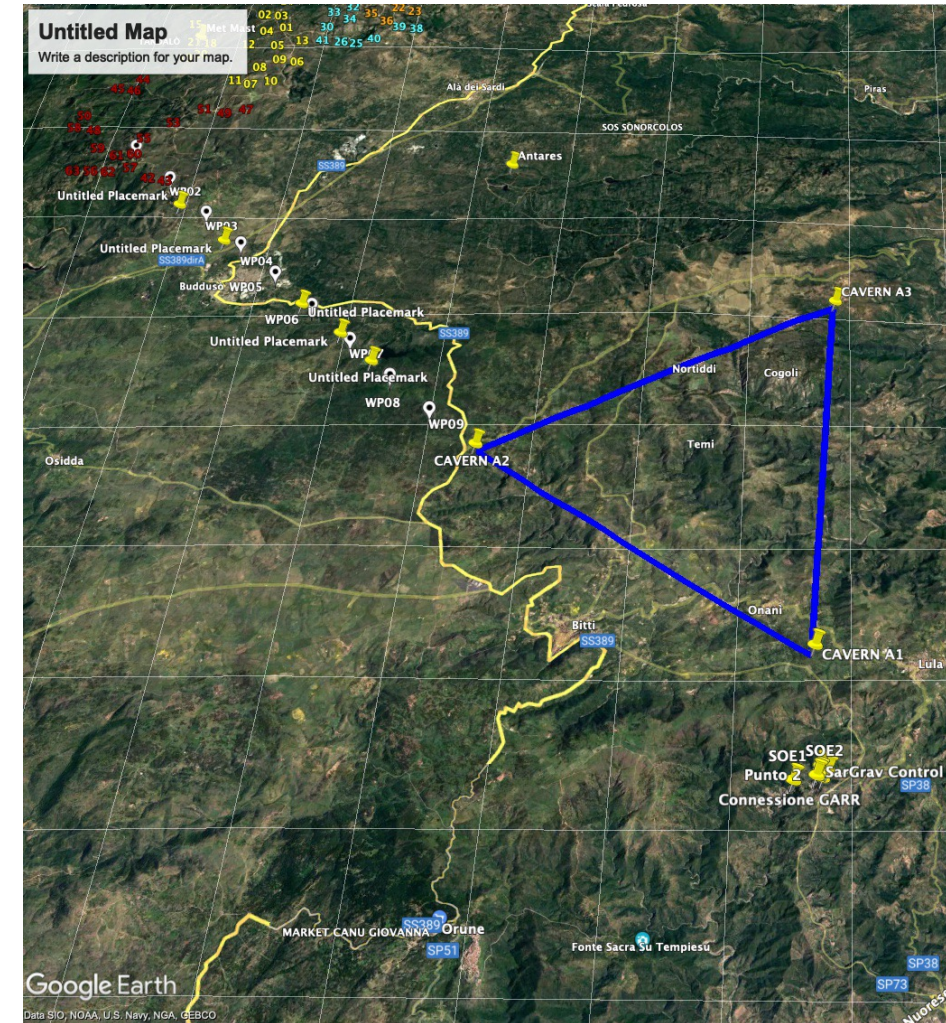
Updates from Sardinia

➤ General achievements:

- long-term seismic monitoring of all the area
- Borehole measurements on going since late September 2021 (P2 and P3 borehole)

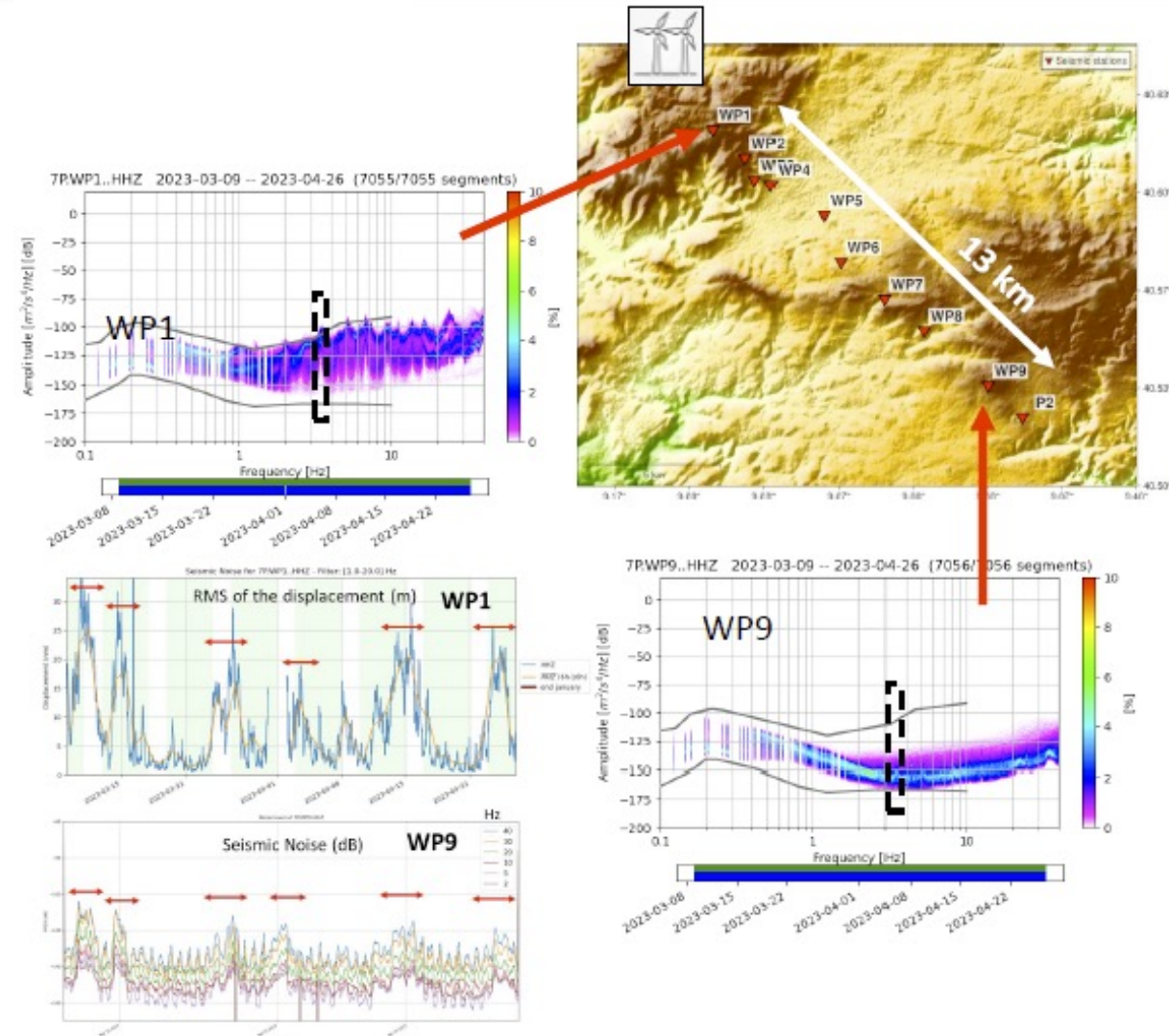
➤ Sardinia updates

- Temporary seismometer deployments to study the vibration input and decay due to wind farms;
- Ambient noise characterization (just published: M. Di Giovanni et al., Temporal variations of the ambient seismic field at the Sardinia candidate site of the Einstein Telescope, Geophysical Journal International, <https://doi.org/10.1093/gji/ggad178>);
- New long-term installation on going: seismic stations, geodetic measurements, etc ...



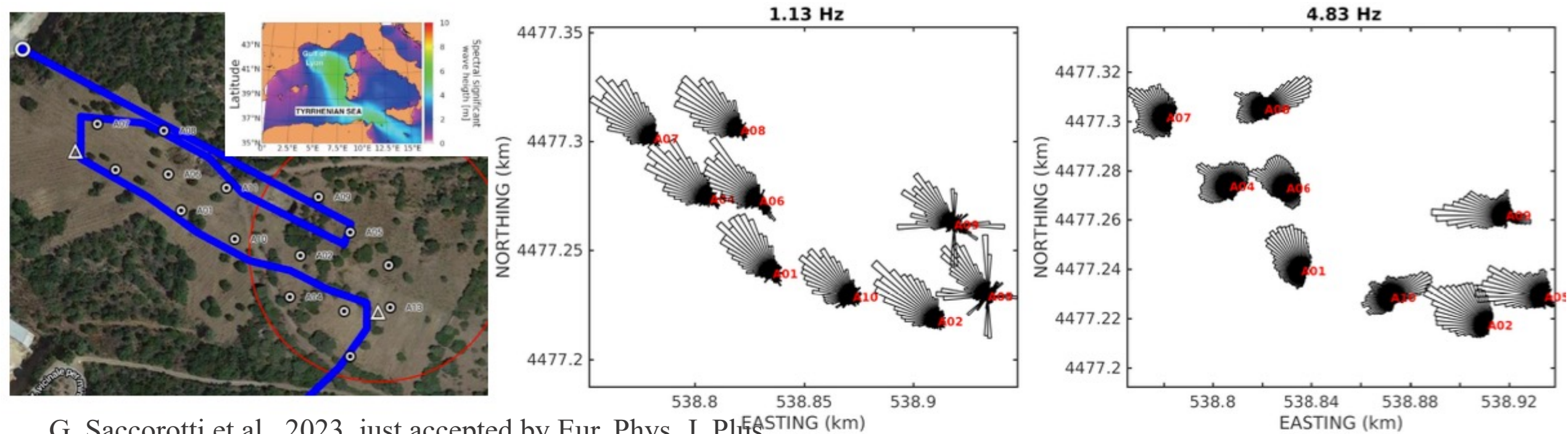
Status Activities: Wind farm study

- Main peak at 3Hz + harmonics close to the wind farm;
- Only main peak + first few harmonics close to P2, visible wrt to the low background (NLNM);
- Wind-correlated increase of noise rms;
- Analysis ongoing: spectral features and correlation with wind measured at weather stations close to the windfarm and with rotational speed of wind turbines.



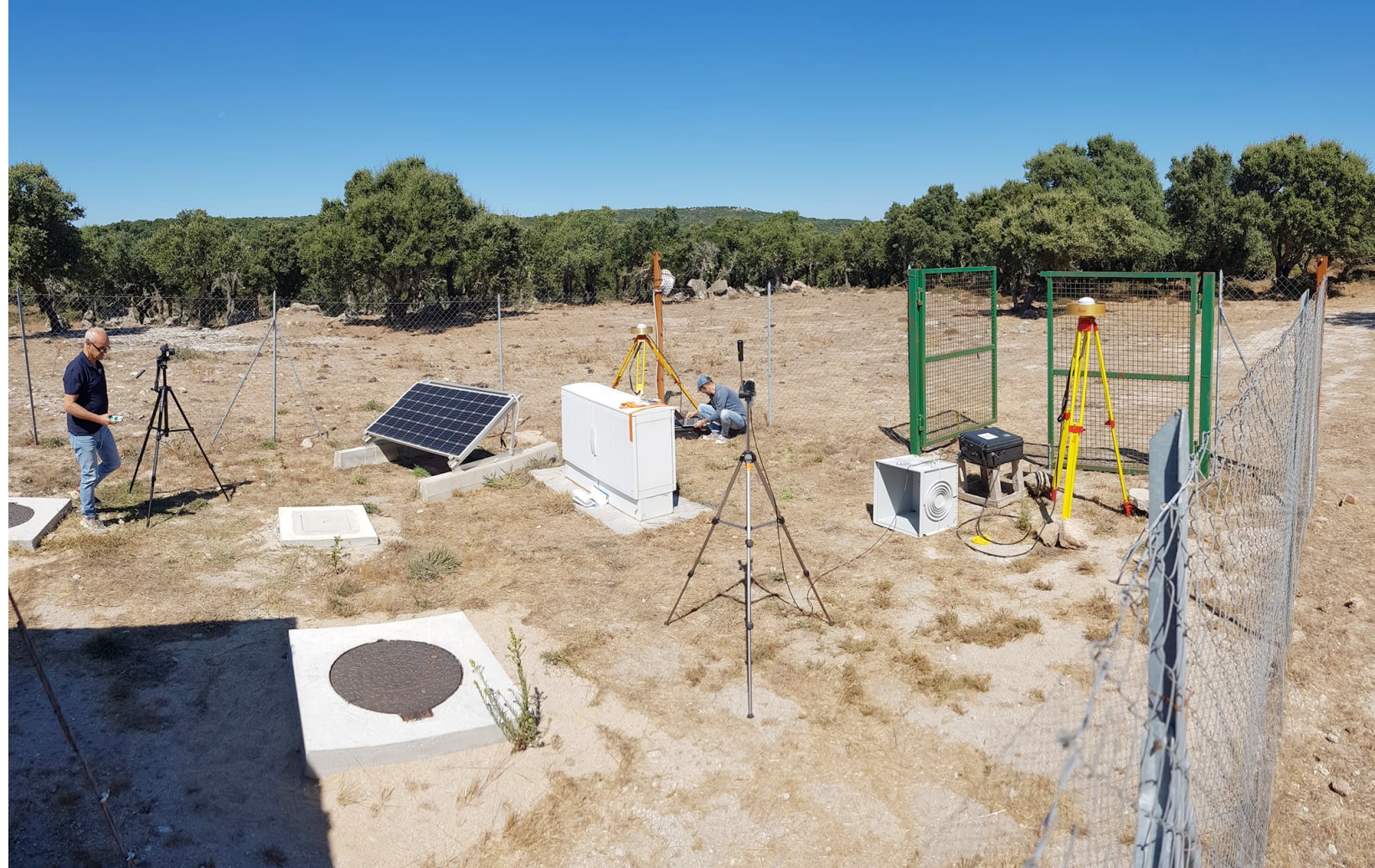
Status Activities: Seismometer array results

- At low frequencies, the polarization directions are rather uniform; they are oriented toward NW (marine micro-seismic source). At higher frequencies, the variability of polarization directions throughout the array deployment indicates a strong influence of topography.



G. Saccorotti et al., 2023, just accepted by Eur. Phys. J. Plus

- On going test by ASI and E-GEOS to install stations for geodetic measurements

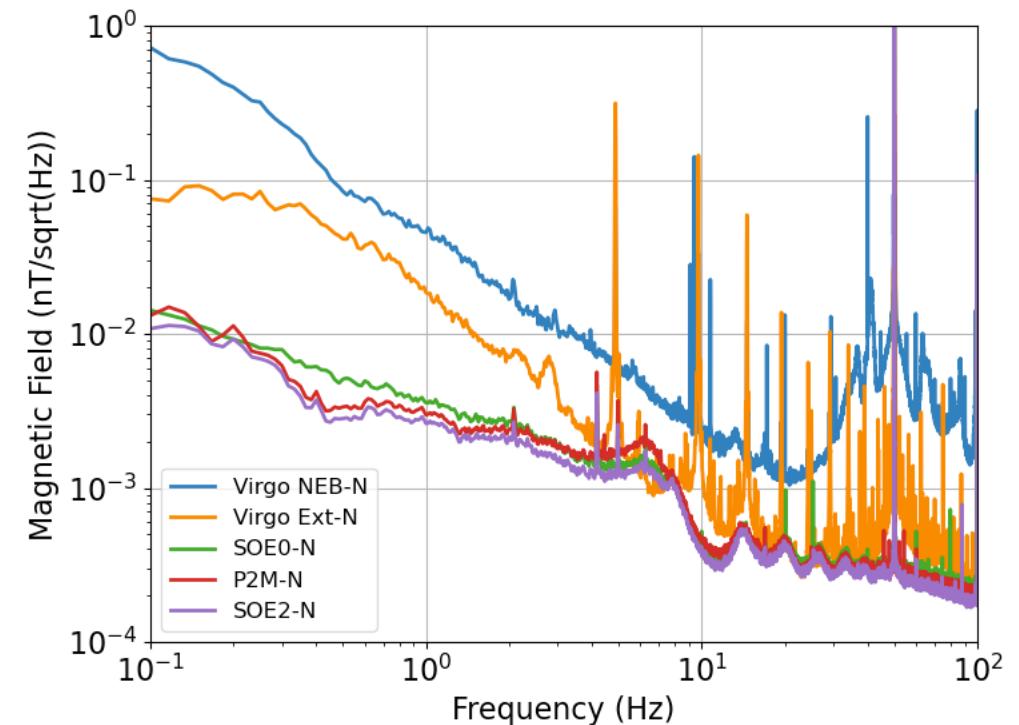


- Installed microphones in the mine:
 - ❑ Italian (EGO microphones)
 - ❑ Polish UW (Astrocent microphones) - from Nov 26, '22
 - ❑ Hungarian campaign - Nov 21-26, '22
- Installed microphones outside the mine:
 - ❑ Astrocent from Nov 26, '22
- GSSI campaign with new microphones and covers planned in the next months



Status Activities: magnetic noise

- 1 mag. probe on surface in Sos Enattos (NS direction)
- 2 mag. probe (NS and EW directions) at – 111 m (SOE2);
- 3 mag. probe(NS and EW directions) on surface at P2
- A new magnetic station will be soon installed on surface at P3





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Ministero
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e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Preparatory activities for the ET sustainable design

Maria Marsella – ETIC -WP6 Leader
Sapienza DICEA –Roma1 INFN
maria.marsella@uniroma1.it



Call for tenders of the PNRR ETIC project for the preliminary feasibility study for ET in Sardinia (14 Million of euro , to be assigned by dec. 2023 and delivered by dec. 25) in different geometric configurations (closed on July 26th)

ET Symposium –Cagliari – 8-12 may 2023



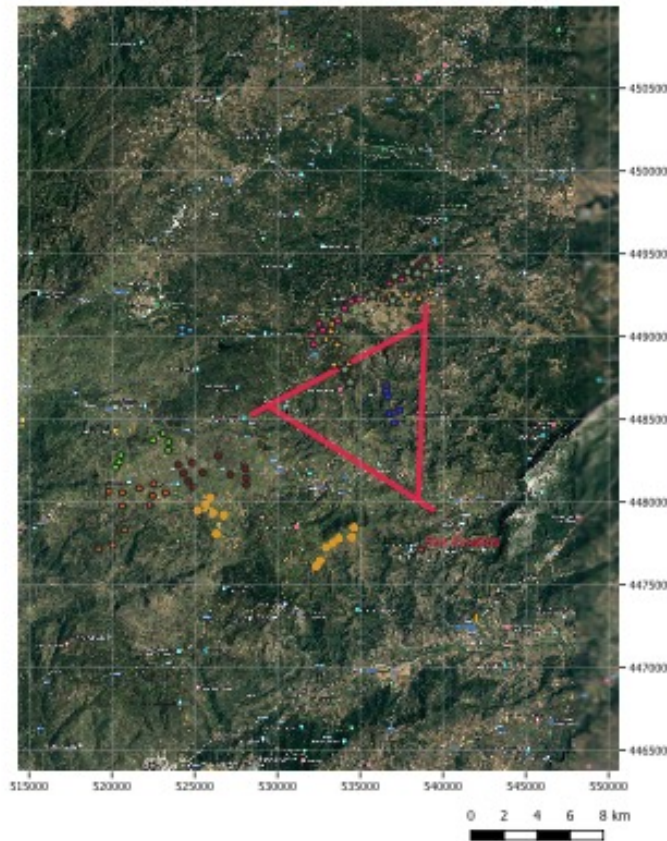
CONTROL STRATEGIES FOR MECHANICAL VIBRATIONS OF WIND TURBINES

*Maria Marsella and Jacopo Di Cave (PhD Aeronautical and Space engineering) - WP5&WP9
ET - PP INFRA- DEV Annual Meeting - 12-13 June 2023 Barcellona*

Credits to M. Marsella

Wind Farm mitigation strategy for ET

- ✓ problem of vibrations in the wind sector and devices for their reduction
- ✓ solutions present are currently purely at the research and development or experimental level
- ✓ contact companies that design some of the devices for vibration control and possibility and evaluate alternative solutions to blocking new plant project



- Miniera di Sos Enattos
- ★ ESISTENTI
- ORANIE - Istruttoria tecnica
- Nule Benevutti - Istruttoria tecnica
- Nule Osidda e Buddusò
- Buddusò- Via negativo
- Bitti-Riano d'Ertille
- Bitti-Carzedda Giuliano
- Bitti Aree PIP
- Bitti Terenzas
- Bitti Buddusò- Istruttoria tecnica
- Gomoretta-Bloccato
- TC

Site location	turbine type	overall power [mw]	nominal turbine power [mw]
number of wind turbines		rotor diameter [m]	engine [turns/min]
tower height [m]	cut_in velocity [m/s]	nominal velocity [m/s]	v_cut off [m/s]
foundation type/soil	enviromental permit status	Proponent/ company	web site

survey and classification



Updates from EMR

Current Activities

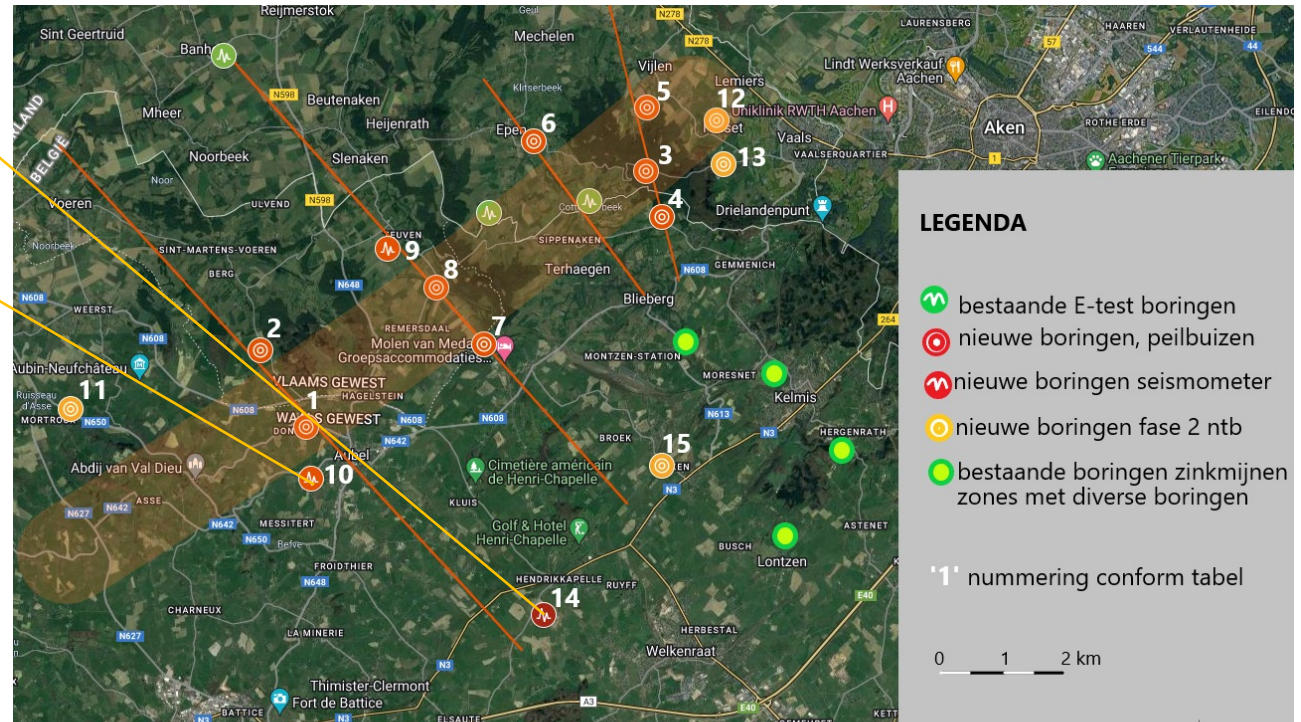
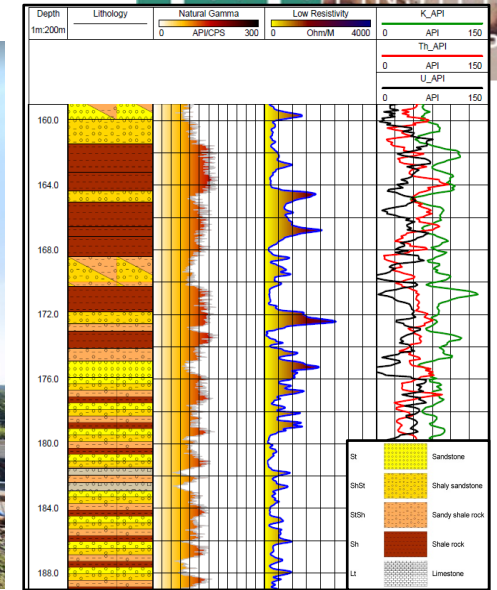
Boreholes: planning ~20 additional sites
 Tender closes this month
 Next borehole @ Henri-Chapelle
 early November

Aubel borehole completed
 Finalizing core measurements
 Geomechanical evaluation

Active & Passive Seismic
 Campaigns being designed

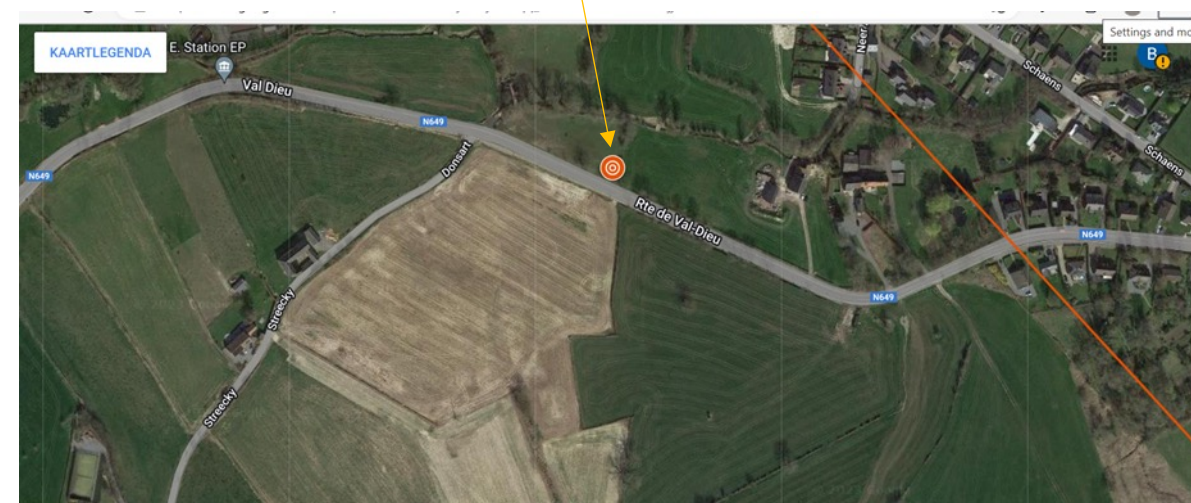
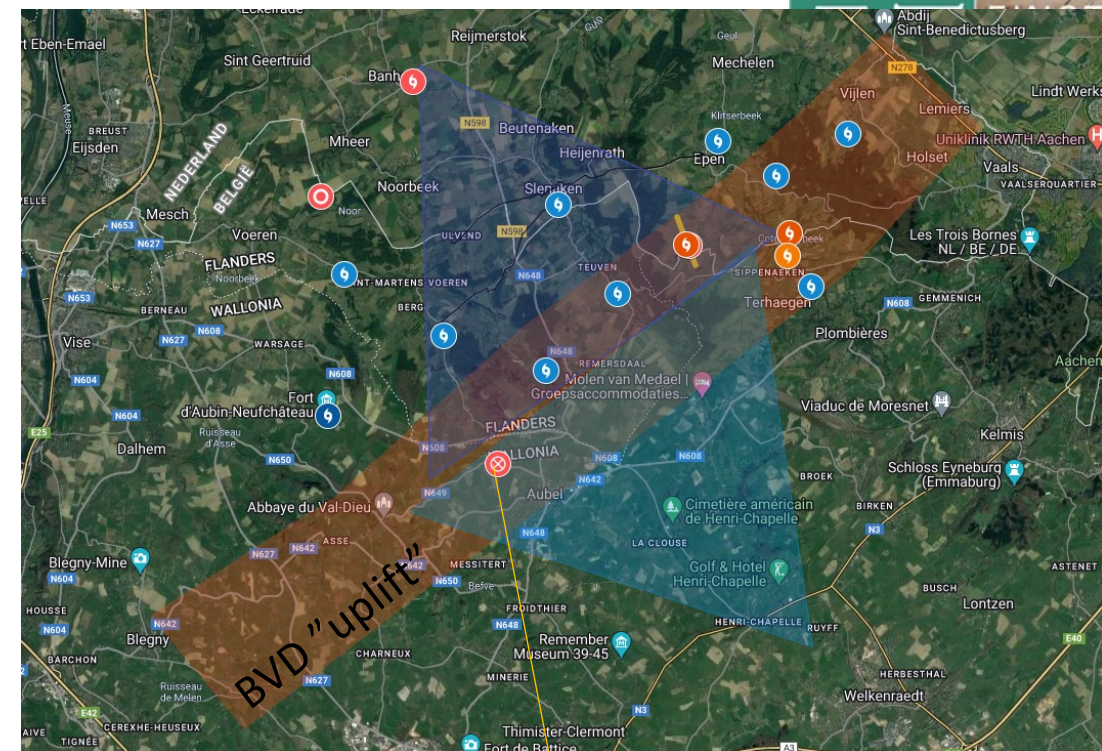
ERT & Gravimetric surveys planned

Anthropogenic Noise Studies
 Wind-Turbine project defined
 Sub-surface measurements ongoing



Aubel Drilling Completed

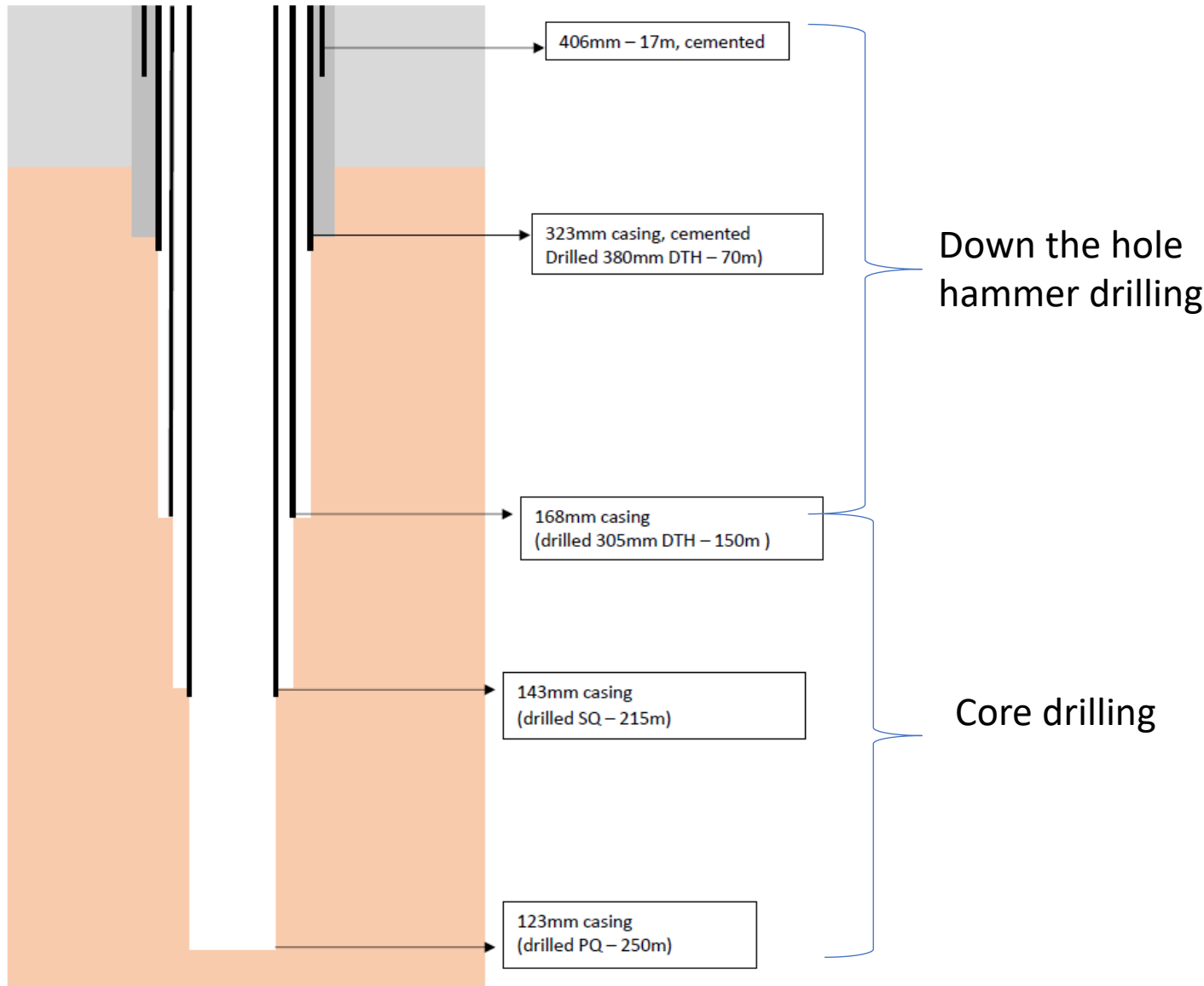
Preliminary conclusion: Stable, hard rock below 120m meeting BVD model expectations

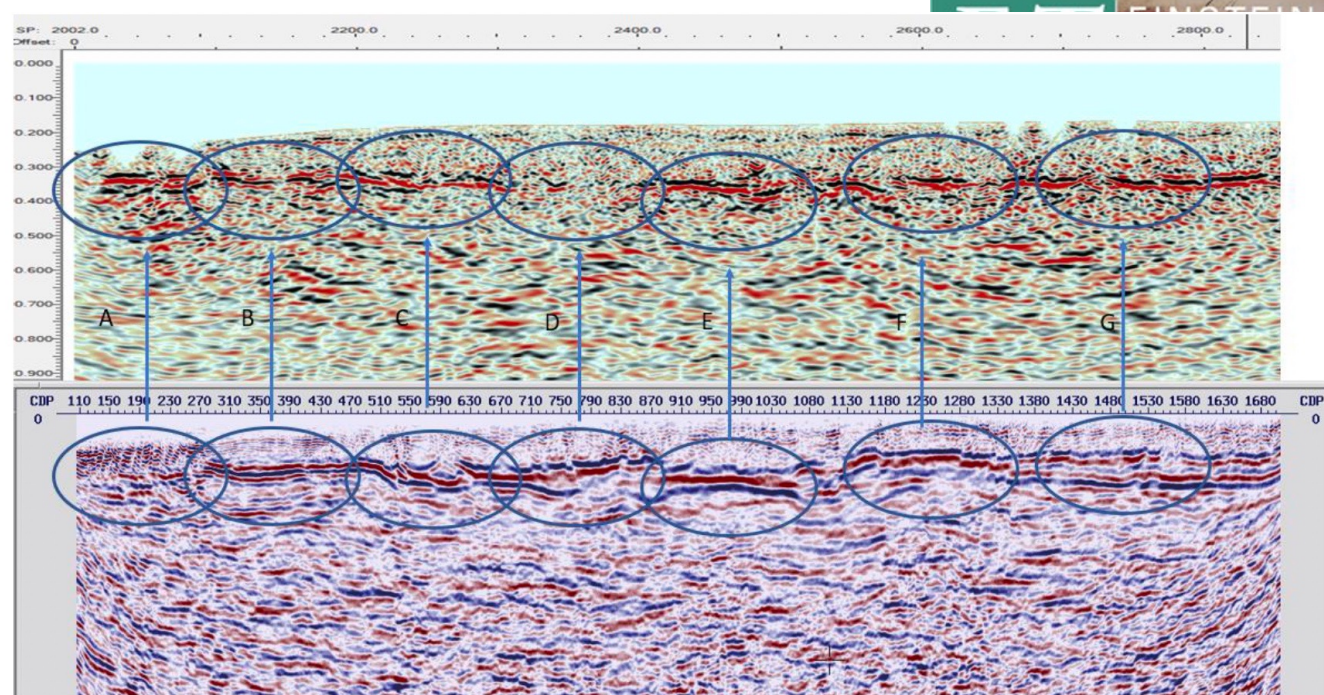


Drilling

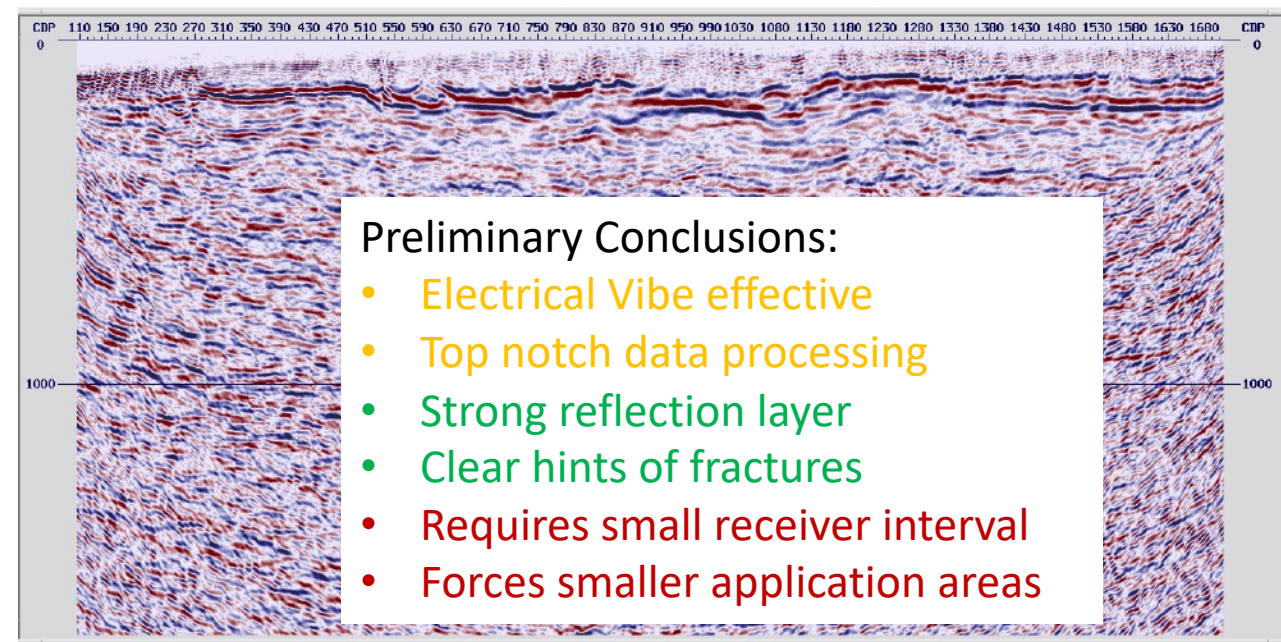
- Start : 22/05/23
- End: mid july 23 reached 250 m, stable
- Target rock (famennian) little fractured at 250m
- Hydraulic testing, logging 02/08 – 11/08
- Between 150 and 250 m
 - OPTV logging, BHTV logging
 - Fullwave sonic logging
 - Gamma ray logging
 - Flow measurements

Sketch – Drilling operations





Shallow Processing Flow : Pre-Stack Time Migration



Preliminary Conclusions:

- Electrical Vibe effective
- Top notch data processing
- Strong reflection layer
- Clear hints of fractures
- Requires small receiver interval
- Forces smaller application areas

Technical compatibility of wind turbines with ET

Rechnerische Eigenformen des Turms aus Voruntersuchung

Eigenmodes

Find technical measures to

- reduce excitations
- dampen vibrations
- decrease coupling to the subsurface

Technical measures

girder masts

(almost) transparent to wind -> excitation

- tech. okay
- cost okay
- social acceptance?



enlarged foundations

reduces coupling to subsurface

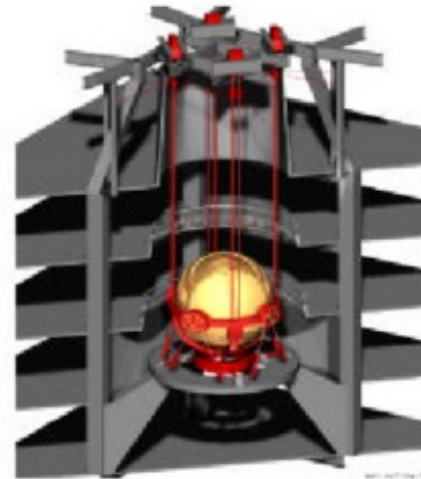
- 30% to 40% reduct.
- cost increase < 10%



tuned mass dampers

dampens a certain vibration mode

- effectiveness high, but limited to one frequency
- cost 30 ... 50 k€



pitch control

adjust pitch of the blades to minimize excitation

- included in modern turbines
- reduces mechanical stress
- effectiveness still unclear
- other targets for optimization

active damping

actively move masses on the foundation to counteract motion.

- demonstrated in lab experiments
- effectiveness and cost unclear



- 1.- Model the wind turbine and its dynamic interaction with the ground in order (1) to understand how vibration propagates from structure to ground and (2) to assess the efficiency of vibration mitigation measures.
 - Validation of model predictions using in situ vibration measurements.
- 2.- Creating a subsurface propagation model to simulate the different wave types propagating from surface sources.
 - Three levels of complexity will be considered in terms of seismic properties.
 - Homogeneous model
 - Layered model
 - Including or not the presence of the attenuating cretaceous layers for instance to represent the known ground conditions.
 - A realistic model based on the most recent geological model available (link with E-TEST)
 - Relevant heterogeneities will be defined in a few scenarios where lateral variations are present to study their impact with respect to the layered model
3. From the seismic fields, calculation of expected Newtonian noise in underground test masses



Open issues

98 - Atmospheric NN model

Mauro Oi

99 - NN at EMR

Soumen Koley

100 - NN from underground groundwater

Kentaro Somiya

101 - Newtonian Noise in ET: state of the art and beyond

102 - Glitches and NN @ Sardinia

103 - Schumann Res. amplification

104 - Train noise at Virgo and LIGO

105 - Acoustic NN noise based on the LNGS case

Newtonian Noise: State of the art and future perspectives

Francesca Badaracco



ET symposium 2023, Cagliari

Newtonian and Env noise impact

98 - Atmospheric NN model

99 - NN at EMR

100 - NN from underground groundwater

101 - Newtonian Noise in ET: state of the art and beyond

102 - Glitches and NN @ Sardinia

103 - Schumann Res. amplification

104 - Train noise at Virgo and LIGO

105 - Acoustic NN noise based on the LNGS case

Soumen Koley

Kentaro

Francesca B

Rosario

Tatsuki

Federico

Mariusz Suche

Publications about Terziet:

Class. Quantum Grav. 39 025008 (2022)

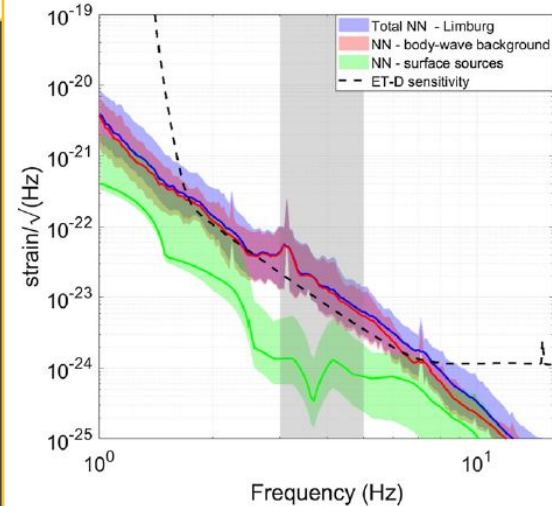
Surface and underground seismic characterization at Terziet in Limburg—the Euregio Meuse–Rhine candidate site for Einstein Telescope

Soumen Koley^{1,2,*}, Maria Bader², Jo van den Brand^{2,3}, Xander Campman⁴, Henk Jan Bulten^{2,5}, Frank Linde^{2,6} and Bjorn Vink⁷

Class. Quantum Grav. 39 025009 (2022)

Newtonian-noise characterization at Terziet in Limburg—the Euregio Meuse–Rhine candidate site for Einstein Telescope

Maria Bader^{1,5}, Soumen Koley^{1,2,*}, Jo van den Brand^{1,3,6}, Xander Campman⁴, Henk Jan Bulten^{1,5}, Frank Linde^{1,6} and Bjorn Vink⁷



See talk of Soumen Koley [LINK](#)

Publications about Sos Enattos:

Class. Quantum Grav. 31 105016 (2014)

Microseismic studies of an underground site for a new interferometric gravitational wave detector

L Naticchioni^{1,2}, M Perciballi³, F Ricci^{1,2}, E Coccia^{3,4}, V Malvezzi³, F Acernese^{3,6}, F Barone^{5,6}, G Giordano³, R Romano^{3,6}, M Punturo³, R De Rosa^{6,8}, P Calia⁹ and G Loddo⁹

Seismological Research Letters (2021) 92 (1): 352–364.

A Seismological Study of the Sos Enattos Area—the Sardinia Candidate Site for the Einstein Telescope

Matteo Di Giovanni^{1,2,3}, Carlo Giunchi³, Gilberto Saccorotti¹, Andrea Berbellini¹, Lapo Boschi^{4,5,6}, Marco Olivieri⁴, Rosario De Rosa^{4,8}, Luca Naticchioni^{9,10}, Giacomo Oggiano^{11,12}, Massimo Carpinelli^{13,12}, Domenico D'Urso^{14,12}, Stefano Cuccuro^{11,12}, Valeria Sipala^{11,12}, Enrico Calloni¹⁴, Luciano Di Fiore², Aniello Grado¹⁴, Carlo Migoni¹⁴, Alessandro Cardini¹⁴, Federico Paoletti¹⁵, Irene Fiori¹⁶, Jan Harms¹⁷, Ettore Majorana¹⁸, Piero Rapagnani¹⁹, Fulvio Ricci¹⁹, and Michele Punturo¹⁷

Geophysical Journal International, ggd178 (2023)

Temporal variations of the ambient seismic field at the Sardinia candidate site of the Einstein Telescope

M Di Giovanni, S Koley ✉, J X Ensing, T Andric, J Harms, D D'Urso, L Naticchioni, R De Rosa, C Giunchi, A Allocca, M Cadoni, E Calloni, A Cardini, M Carpinelli, A Contu, L Errico, V Mangano, M Olivieri, M Punturo, P Rapagnani, F Ricci, D Rozza, G Saccorotti, L Trozzo, D Dell'aquila, L Pesenti, V Sipala, I Tosta e Melo

J. Phys.: Conf. Ser. 1468 012242 (2020)

Characterization of the Sos Enattos site for the Einstein Telescope

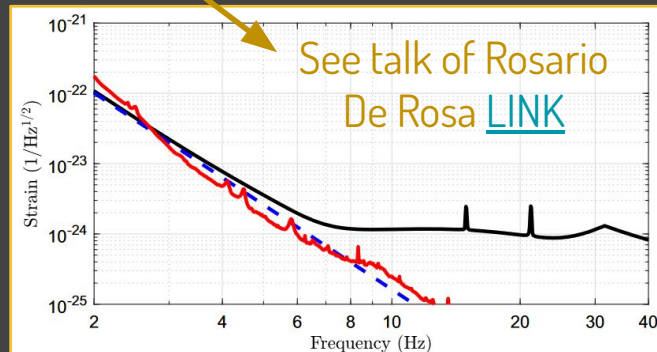
L Naticchioni¹, V Boschi³, E Calloni², M Capello³, A Cardini³, M Carpinelli^{6,7}, S Cuccuro⁷, M D'Ambrosio⁸, R de Rosa², M Di Giovanni⁸, D d'Urso^{6,7}, I Fiori¹¹, S Gaviano⁸, C Giunchi⁸, E Majorana¹, C Migoni¹⁰, G Oggiano², M Olivieri¹³, F Paoletti¹³, M Paratore⁸, M Perciballi¹, D Plecinini⁸, M Punturo⁴, P Puppo¹, P Rapagnani¹, F Ricci¹, G Saccorotti⁸, V Sipala², M C Tringali¹²

The European Physical Journal Plus volume 136, Article number: 511 (2021)

Seismic glitchiness at Sos Enattos site: impact on intermediate black hole binaries detection efficiency

A. Allocca^{1,2}, A. Berbellini³, L. Boschi^{3,4,5}, E. Calloni^{2,8}, G. L. Cardello^{6,7}, A. Cardini⁸, M. Carpinelli^{6,7,9}, A. Contu^{8,10}, L. D'Onofrio^{1,2}, D. D'Urso^{6,7}, D. Dell'Aquila^{6,7}, R. De Rosa^{1,2}, L. Di Fiore², M. Di Giovanni^{11,12,13}, S. Di Pace¹, L. Errico^{1,2}, I. Fiori⁹, C. Giunchi¹¹, A. Grado¹⁶, J. Harms¹², E. Majorana^{14,15}, V. Mangano^{14,15}, M. Marsella^{14,15}, C. Migoni⁸, L. Naticchioni^{14,15}, M. Olivieri¹, G. Oggiano^{6,7}, F. Paoletti¹⁷, M. Punturo¹⁸, P. Puppo¹⁵, P. Rapagnani^{14,15}, F. Ricci^{14,15}, D. Rozza^{6,7}, G. Saccorotti¹¹, V. Sequino^{1,2}, V. Sipala^{6,7}, I. Tosta E Melo^{6,7}, L. Trozzo²

Projection of NN contribution at Sos Enattos



See talk of Rosario De Rosa [LINK](#)

- Common tools and methodology missing
- Need to find a common agreement on NN modeling and estimation

- Discussion with ISB on WDs and WPs

- Dedicate session at ET Annual Meeting in November

- Dedicated Workshop including related WPs from ISB
 - ❑ Define a common methodology to estimate impact of site characteristics on ET sensitivity and operation and, if required, a possible mitigation strategies
 - ✓ For logistical problems the workshop has been postponed, probably at the beginning of December

- Report by End of 2023