WP4
Site Characterization & Preparation Board overview

W. Walk & D. D’Urso

ET Candidate Site(s)

- Currently there are two sites, in Europe, candidate to host ET:
  - The Sardinia site, close to the Sos Enattos mine
  - The EU Regio Rhine-Meusse (EMR) site, close to the NL-B-D border
- A third option in Saxony (Germany)

Proto-council

ESFRI Coordinators
Stan Bentvelsen, Antonio Zoccoli

BGR (Board Governm. Represent.)

BSR (Board Scient. Represent.)

Policy & monitoring

Advisory Bodies
Scientific and Technical Advisory Committee
Program Advisory Board

Project Directorate
F. Ferroni, A. Freise
M. Martinez

monitoring / reporting

Deliverables:
Beam pipe vacuum
Site Preparation
Civil infrastructure

INFRA-DEV
M. Martinez

- WP1 Coordination and Management
- WP2 Organization , Governance, Legal
- WP3 Financial Architecture
- WP4 Site Preparation
- WP5 Project Office /Engineering Dept.
- WP6Technical Design
- WP7Transfer of Technology
- WP8 Computing and Data Access
- WP9 Sustainable Development Strategy
- WP10 Education, Outreach, Citizen Engagement

monitoring / delivering

CERN
MOA CERN-INFN-Nikhef
P. Chiggiato

TDR ET Vacuum Pipe

Requirements & competences

setting

Communication Office

Project Office

Engineering Department

Strategy

ET Organization

ET Collaboration

Providing services

EB Executive Board

Policy proposals+ monitoring

Informing

CB Collaboration Board

managing

SSB Services and Standards Board

managing / reporting

advisory

FNR Forum of National Representatives

managing / reporting

SF Science Forum

Providing services

participating / supervisioning

ISB Instrument Science Board

EIB Electronics/Computational Infrastructure Board

OSB Observational Science Board

SCB Site Characterisation Board

Specific Boards

SCB/SPB: General Mission

The SCB/SPB must lead the effort on the Einstein Telescope site related activities

- It must coordinate the activities to acquire the required characteristics for each site proposing to host the Einstein Telescope;
- Collect, organize and/or produce all the characterizations and documentation needed for a fair comparison of the sites;
- Propose a common framework and common basis for the evaluation of the candidate sites.

Site Characterisation/Preparation Board

ET Collaboration

Project Directorate
Fernando Ferroni – Andreas Freise –
Mario Martinez

WD1 *physical variables & characterisation*

- WP1.1 *seismic noise*
- WP1.2 *gravimetry geodynamics*
- WP1.3 *magnetic noise*
- WP1.4 *other env. noise*

WD2 *geology*

- WP2.1 *structural geology*
- WP2.2 *hydro-geology*
- WP2.3 *geophysics*
- WP2.4 *geotechnics*

WD3 *bidbooks*

WD4 *costs, schedules & risk assessment*

WD5 *legal issues & site preservation*

WD6 *socio-economic & environmental impact*

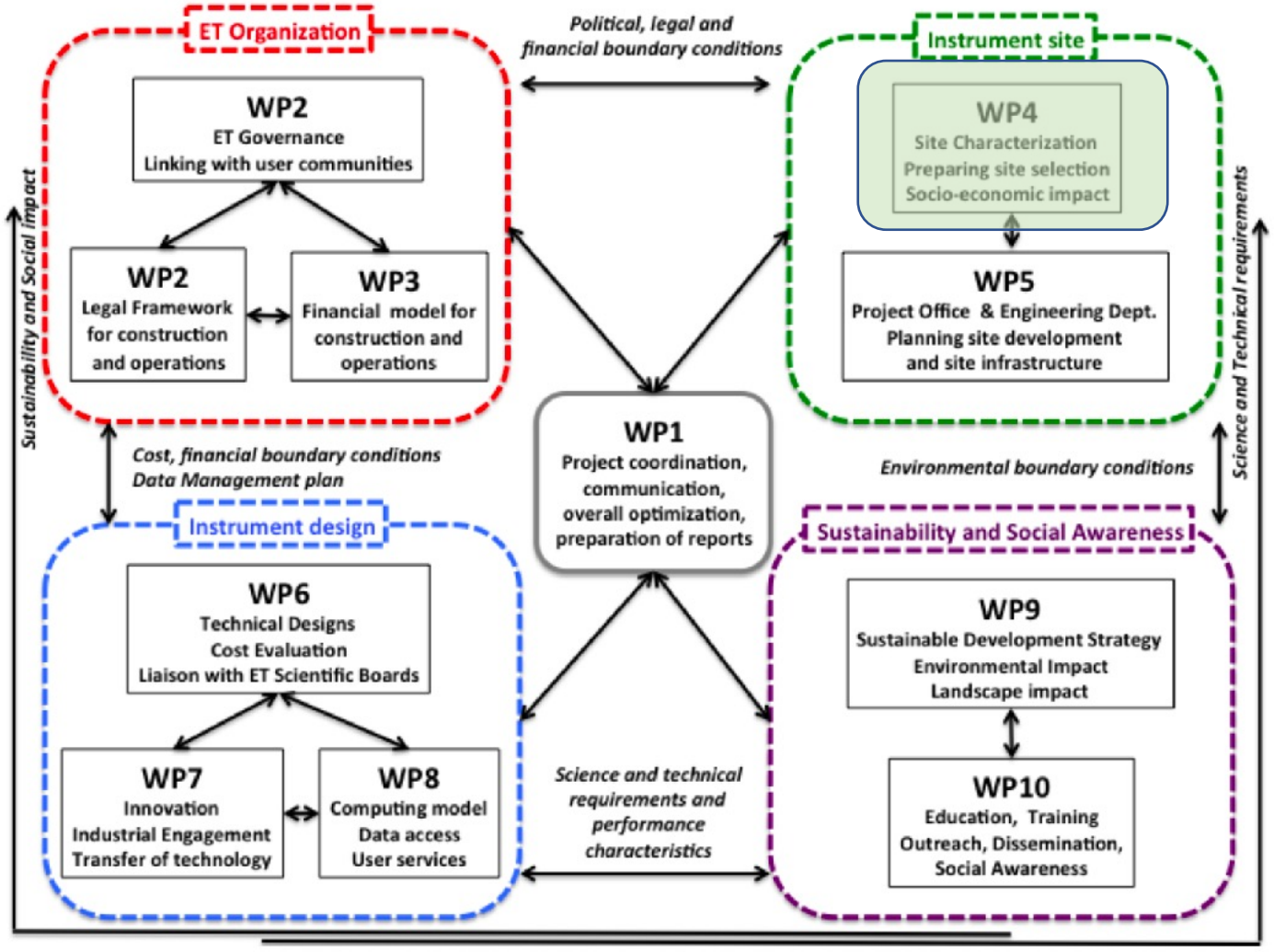
Want to join ?

https://wiki.et-gw.eu/SPB/WebHome

https://lists.infn.it/sympa/subscribe/et-spb?previous_action=review

INFRADEV: ET-PREPARATORY PHASE

- ET governance
- Legal framework
- Financial Model
- WP4: Site characterization
- Project Office & engineering
- Technical design
- Innovation
- Computing Model
- Sustainability Strategy and Environmental impact
- Outreach



WP4 Deliverables

Deliverable name – Date (in months)/Lead Institution

- **D4.1- M10/Nikhef:** ***Scan of legal procedures, permitting and land acquisitions, i.e. the steps to be taken prior to starting excavations***
- **D4.2 - M15/INFN:** ***Updated socio-economic impact studies. Scan of accessibility, quality of life etc.***
- **D4.3 - M28/UW:** ***Complete quantification of all the aspects impacting the ET performance for each site***
- **D4.4 - M30/INFN:** ***Report on 3D geology, hydrology, etc. model with localisation of the ET infrastructure***
- **D4.5 - M42/Nikhef:** ***Updated cost and schedule estimates of the excavations, including, if necessary: instrumentation for Newtonian Noise cancellation; costs of debris removal; costs of land acquisition, permitting, etc.***

(months from ET-PP start date, Sept. 1st)

ET SPB Wiki

You are here: ET - Einstein Telescope Wiki Pages > SPB Web > WebHome (20 Jan 2023, Bulik)

Edit | Attach | Subscribe

SPB - Site Preparation & Characterization Board

Composition of the Board

Chairs

Domenico D'Urso (ddurso@uniss.it), Wim Walk (wim.walk@nikhef.nl)

Divisions under the ET Collaboration

- **WD1: Physical Variables and Characterization** : Luca Naticchioni (luca.naticchioni@roma1.infn.it), Shahar Shani Kadmiel (shahar.shani.kadmiel@knmi.nl)
- **WD2: Geology** : Leonardo Casini (casini@uniss.it), Frédéric Nguyen (f.nguyen@uliege.be), Wim Walk (wim.walk@nikhef.nl)
- **WD3: Bidbooks** : Tomasz Bulik (tb@astrouw.edu.pl)

Divisions under the PD

- **WD4: Cost timing and risk assessment**
- **WD5: Legal and site preservation**
- **WD6: Socio-economic and environmental impact**

Meetings

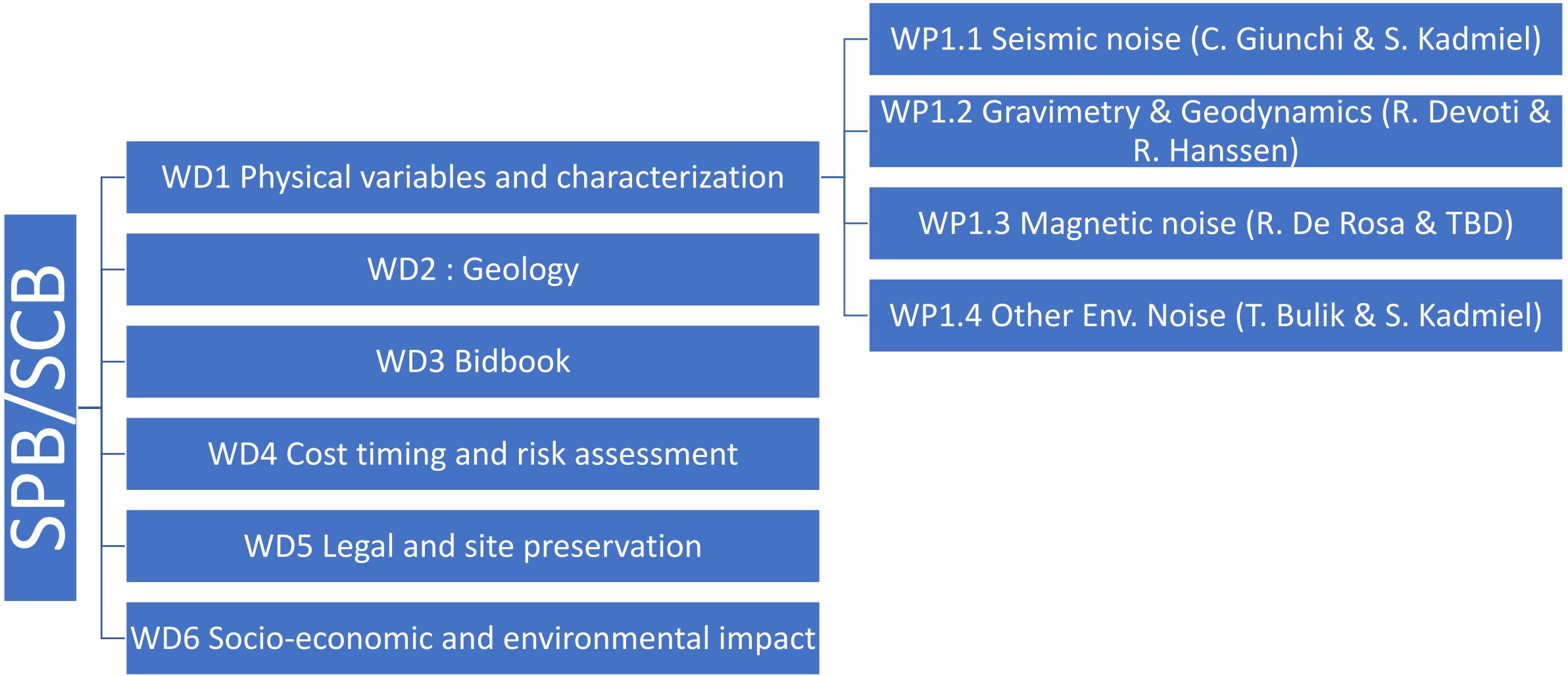
The SPB general meeting is scheduled every 2 weeks on Wednesday, 4PM CEST/CET.

- SPB general meetings and minutes

Documents and useful links

Mailing list: et-spb@list.infn.it Subscribe here

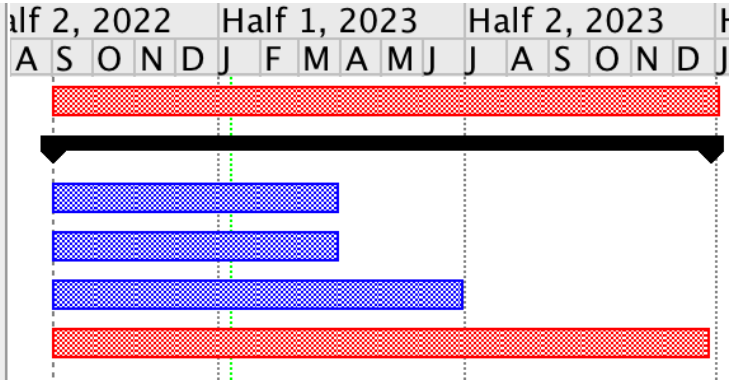
WD1 : Physical Variables and Characterization (L. Naticchioni, S. Kadmiel)



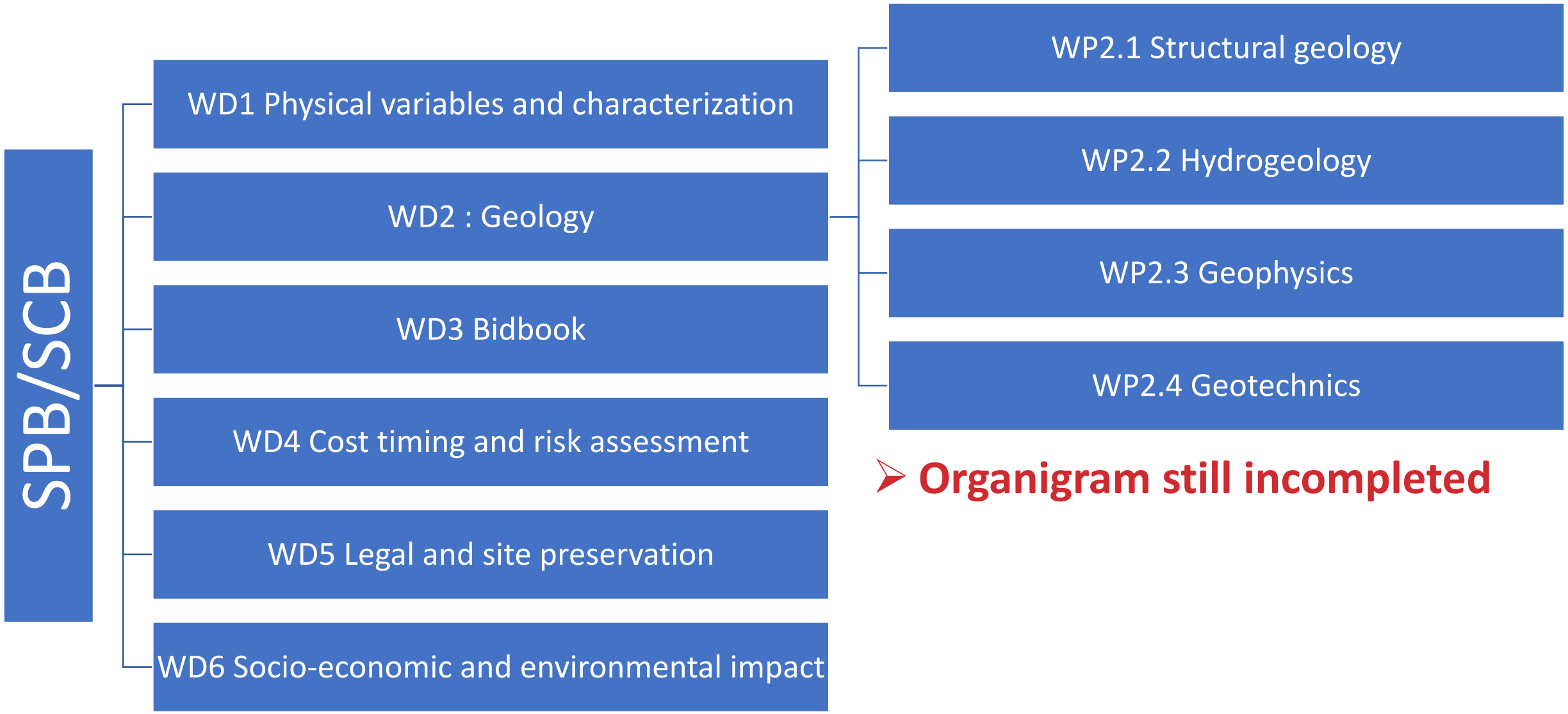
WD1 - Timeline

- Milestones:
  - **M1.1**: physical variables needed for the site characterization and for the evaluation of their impact on the detector performances - Q1/2023
  - **M1.2**: measurements recommendations and standards (setup, sensors, procedures, best practices…) - Q1/2023
  - **M1.3**: data format standards and analysis tools - Q2/2023
- Deliverables:
  - **D1.1**: quantification of sources impacting ET performances - Q4/2023

	Name	Duration	Start	Finish	Predec
	WP4 Site Preparatio	352 days?	9/1/22 8:00 AM	1/5/24 5:00 PM	
	WD1	347 days?	**9/1/22 8:00 AM**	**12/29/23 5:00 PM**	
	M1.1	152 days?	9/1/22 8:00 AM	3/31/23 5:00 PM	
	M1.2	152 days?	9/1/22 8:00 AM	3/31/23 5:00 PM	
	M1.3	217 days?	9/1/22 8:00 AM	6/30/23 5:00 PM	
	D1.1	347 days?	9/1/22 8:00 AM	12/29/23 5:00 PM	



WD2 : Geology (L. Casini, F. Ngueyen, W. Walk)



➢ **Organigram still incompleted**

WD2 - Deliverables

- WP2.1 - Structural Geology:
  - ❑ geological model and maps
- WP2.2 - Hydrogeology:
  - ❑Hydrogeological model
- WP2.3 - Geophysics:
  - ❑Multimodal images of the subsurface
  - ❑Petrophysical relationships (translation to hydro- or geotechnical parameters)
- WP2.4 – Geotechnics :
  - ❑Geotechnical testing on core samples
  - ❑Rock quality model for the tunnels and caverns

SPB-WD1 status

SPB-WD1: the path followed

- Characterization activities at the two sites started before the establishment and start of the SPB: *need to standardize and coordinate many activities ex post*;
- First “SPB” workshop in Nuoro, Oct. 2021;
- SPB structure and division chairs defined in mid-2022;
- WD1 activities started last year (Q3 2022);
  - WP chairs appointed;
  - Milestones defined;
  - Preparation of ET wiki pages:
    - https://wiki.et-gw.eu/SPB/WebHome , https://wiki.et-gw.eu/SPB/PhysicalVariables
  - Division meetings + dedicated WP meetings on Wednesday 4pm CET/CEST (antiphase with SPB meeting);
  - Delivering of the (urgent) documents related to the division milestones (see next slides).
- Fruitful 2nd SPB Workshop in Maastricht on January 2023!

SPB-WD1 status

SPB-WD1: Milestones and Deliverables

Division Milestones:

- **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 (*draft*)**:
  Draft delivered,
  https://drive.google.com/file/d/1EmddYQSXZYxmJHMwvOYq6E3b2FlJkNcN/view?usp=sharing

Status Activities

SPB-WD1 – WP1

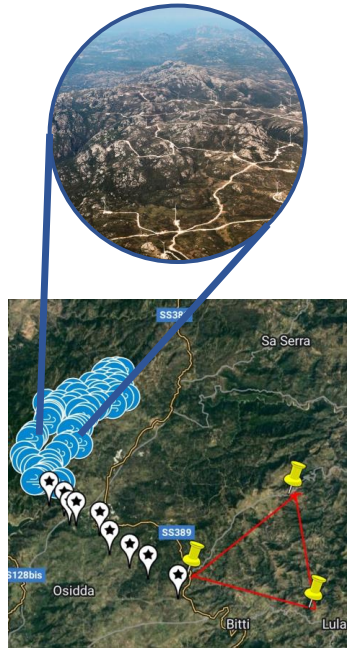
C. Giunchi & S. Shani-Kadmiel

General achievements:

- Long-term seismic monitoring of both sites started and going on;
- Borehole drilled at both (three) sites;
- First results published in several papers.

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 seismic stations will be deployed in the area;
- Talks of Carlo and Matteo in this session.



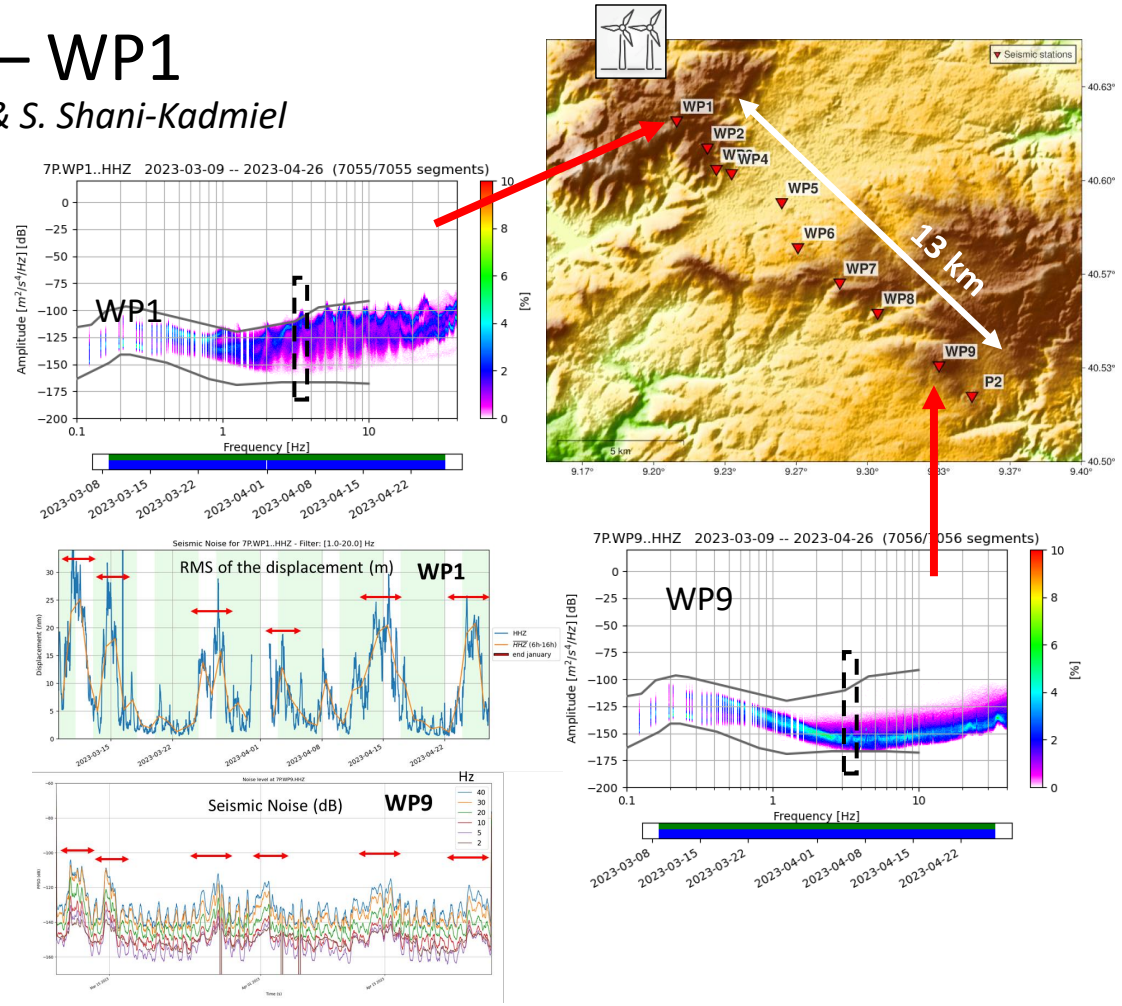
Status Activities

SPB-WD1 – WP1

C. Giunchi & S. Shani-Kadmiel

Wind farm study in Sardinia:
a first look at data

- 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.



L. Naticchioni, SPB/WD1 status - XIII ET Symposium – Cagliari, 8-12 May 2023

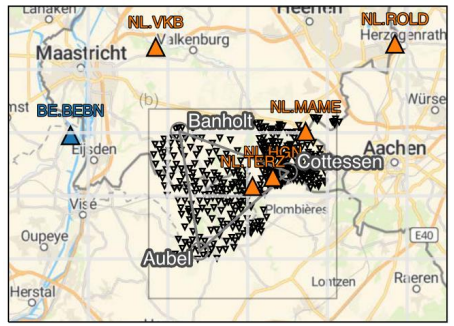
Status Activities

SPB-WD1 – WP1

C. Giunchi & S. Shani-Kadmiel

EMR updates:

- *Cottessen borehole* drilled (250m), reduced diameter due to casing issues, surface and borehole seismometers installed;
- *Banholt borehole* drilled (250m, but drill pipes stuck remained as casing. Usable depth reduced to 200m), borehole seismometer installation not successful due to data cable breaking, new installation planned.
- *Extensive ambient noise studies* at surface in the area, some sources identified. New nodes to be installed close to suspected sources of ambient noise to serve as pilot signals with surface and borehole stations.
- Talks of Shahar, Soumen and Achim in this session.



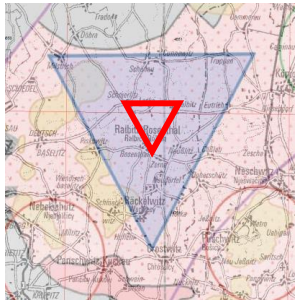
Status Activities

SPB-WD1 – WP1

C. Giunchi & S. Shani-Kadmiel

Lausitz Update:

- Currently 1 surface station running, 1 borehole station at 160m depth and 1 borehole station at 165m depth. The station at 165m depth will be lowered to 245m depth in the next couple of months. Additionally, there is one barometer running to monitor air pressure.
- The geophysical/geological site investigation is planned, currently waiting for the funding to be released. This will entail:
  - *Ambient noise monitoring* in the area of the possible ET location to have a 3D image of the contact between grandiorite and sedimentary rocks;
  - *Shallow reflection seismics* around the current borehole;
  - Identify *3-4 further borehole locations*;
  - Constructing a *3D geological model* based on all literature data;
  - *Characterisation of the cores*.
- The plan is to <u>start in early summer with first results early 2024</u>.



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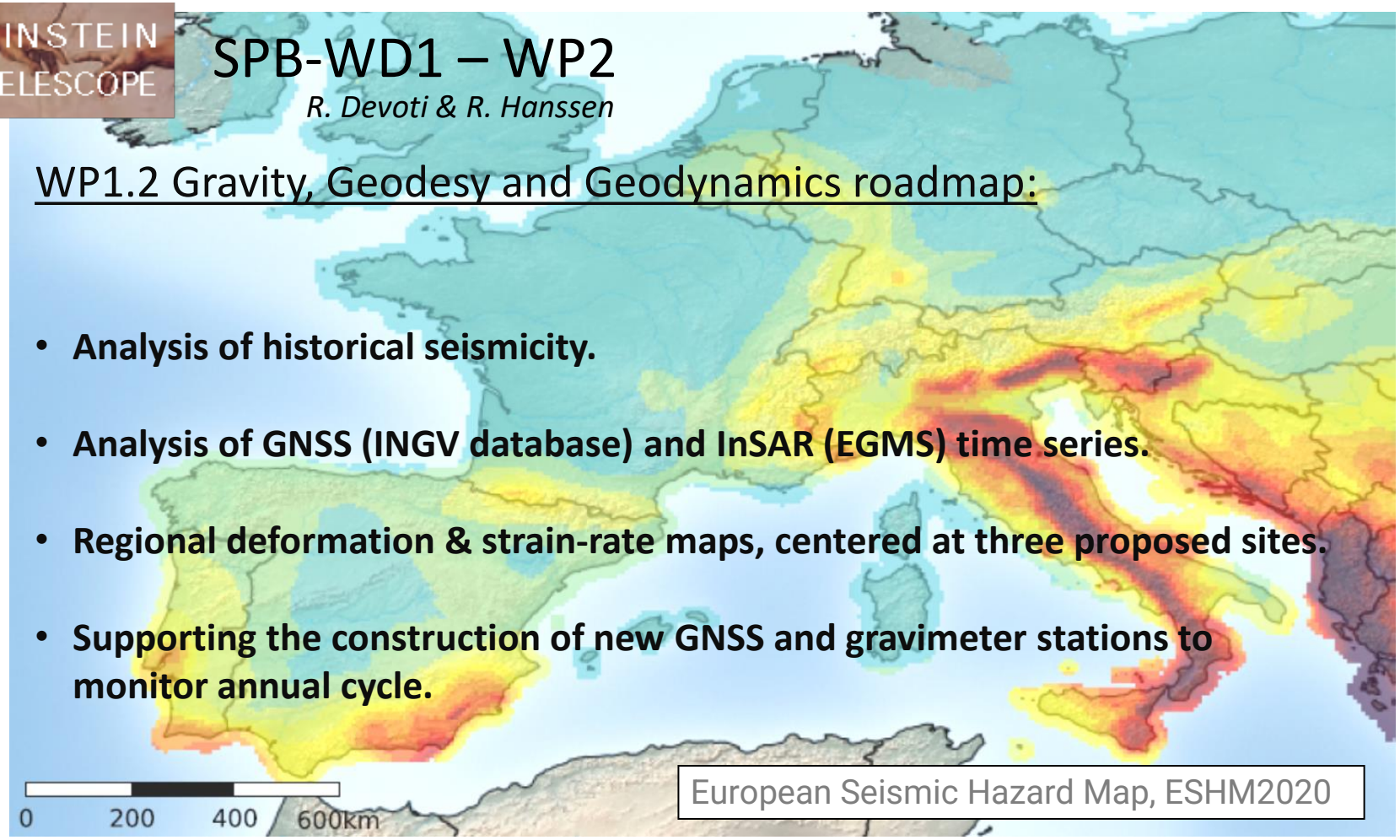
L. Naticchioni, SPB/WD1 status - XIII ET Symposium – Cagliari, 8-12 May 2023

Status activities

SPB-WD1 – WP2

R. Devoti & R. Hanssen



L. Naticchioni, SPB/WD1 status - XIII ET Symposium – Cagliari, 8-12 May 2023

Status Activities

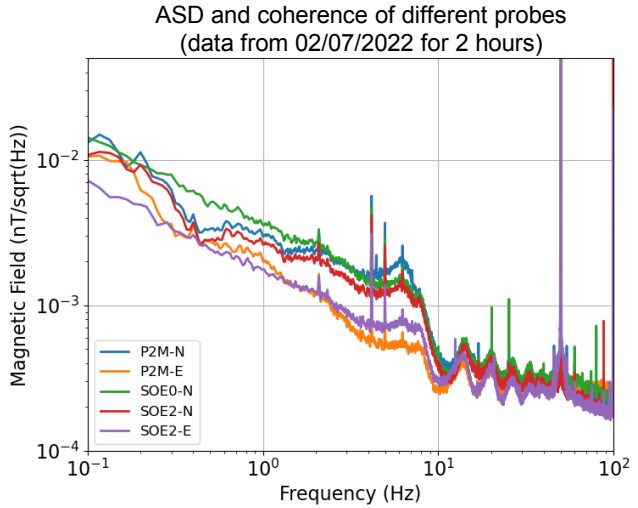
SPB-WD1 – WP3

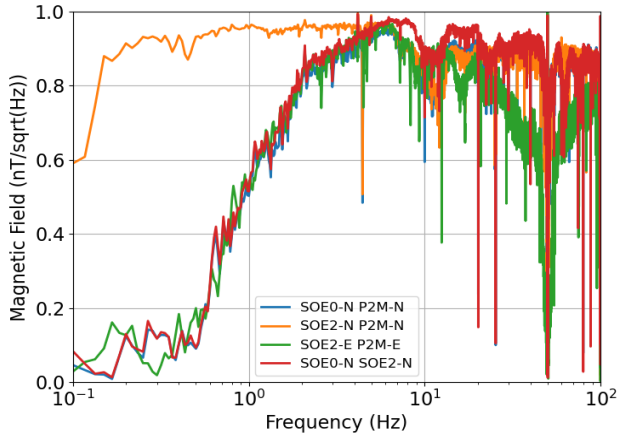
R. De Rosa

Sites Characterization

Currently there are:

- 1 mag. probe (N-S direction) in surface at Sos Enattos (SOE0)
- 2 mag. probes (N-S and E-W directions) at -111 m underground at Sos Enattos
- 2 mag. probes (N-S and E-W directions) in surface at Bitti (P2)





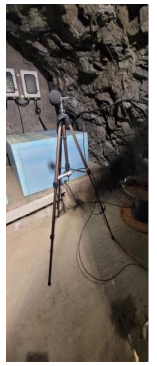
L. Naticchioni, SPB/WD1 status - XIII ET Symposium – Cagliari, 8-12 May 2023

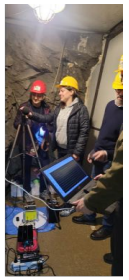
Status Activities

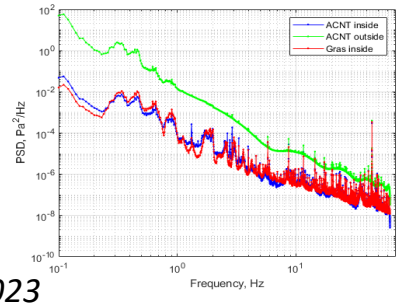
SPB-WD1 – WP4

T. Bulik & S. Shani-Kadmiel

- ❑ Studies concentrated on Sardinia (international collaboration):
  - 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
- ❑ LNGS experiment with noise in large cavern - see talk by Bulik
- ❑ No updates from the EMR side …..
- ❑ Planned GSSI campaign with new microphones and covers.
- ❑ Maintaining wiki site: https://wiki.et-gw.eu/SPB/OtherEvnNoise
- ❑ Data stored in: etrepo.df.unipi.it

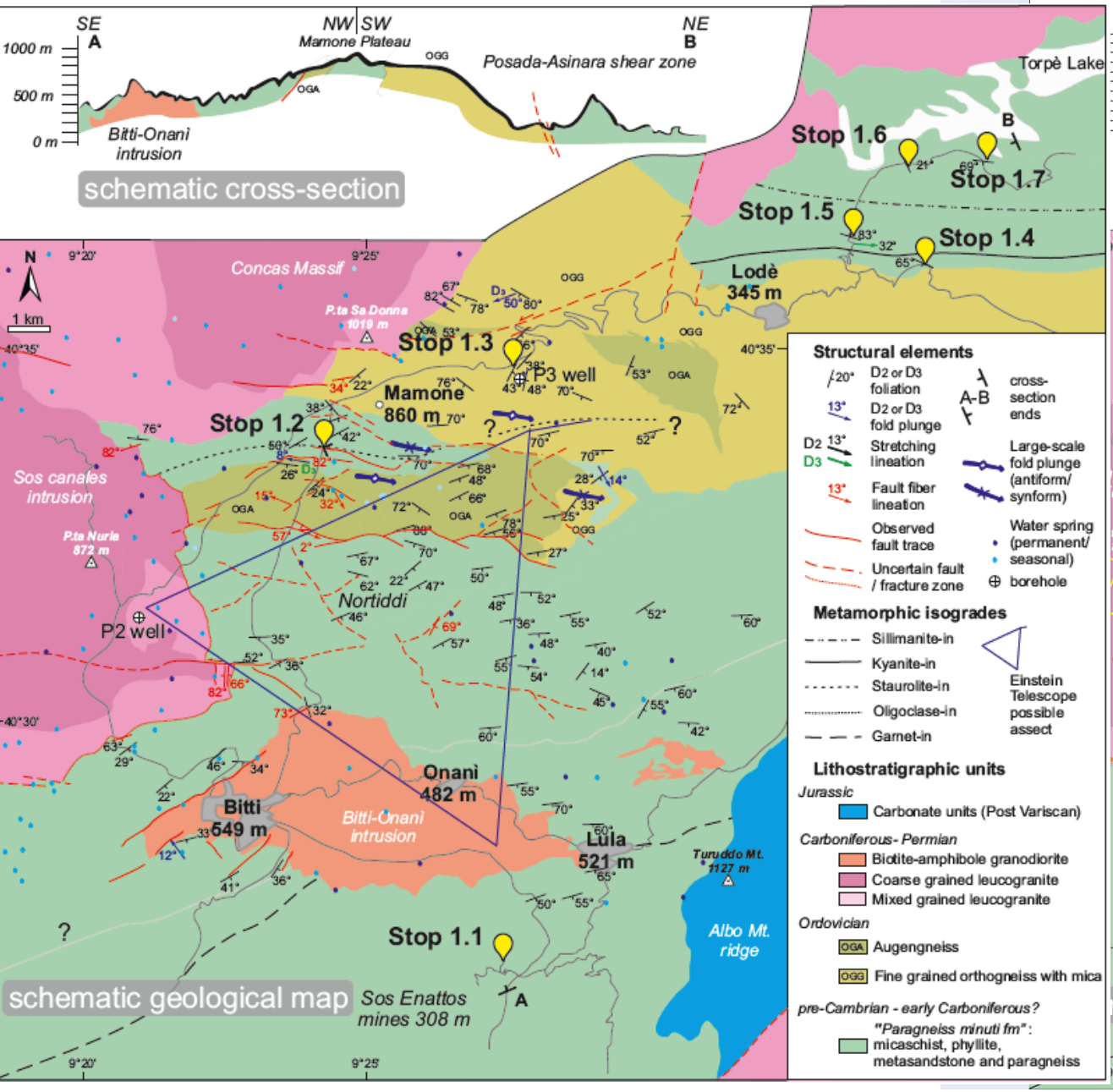


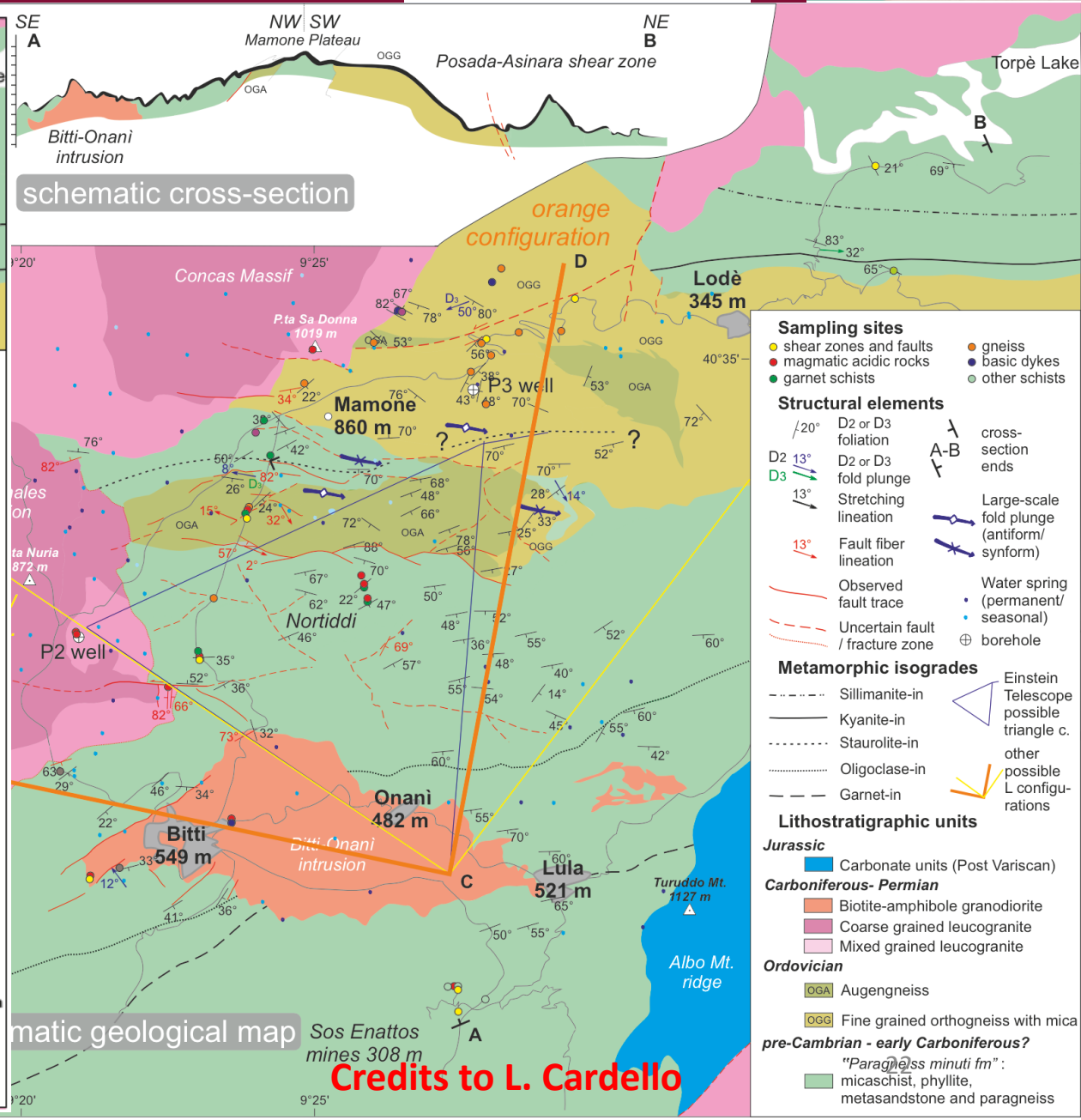




Talks in SPB and NN/env sessions: Tomek, Mariusz, Edit

THE 2022 STRUCTURAL MAP





Finanziato dall'Unione europea NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

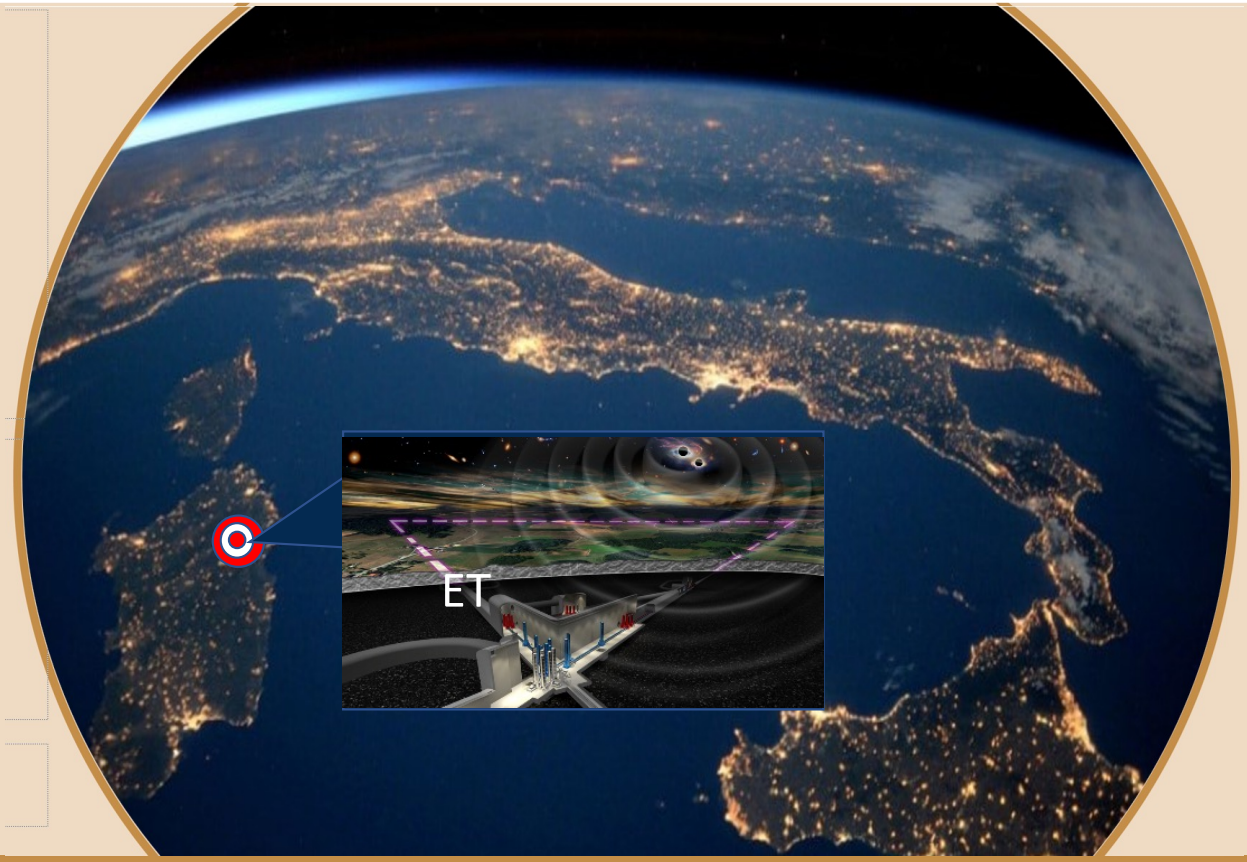
INFN

ET EINSTEIN TELESCOPE

Preparatory activities for the ET sustainable design

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

ET Symposium –Cagliari – 8-12 may 2023



Credits to M. Marsella

ET sustainable design

- Modeling and Layouts
- Preliminary cost estimate (excavation)
- Evaluation of TBM configuration and tunnel monitoring
- Preliminary indications on the management of excavated lands and rocks
- Preliminary strategy on the management of excavated soil and rock
- 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

EMR Region

- Subsurface Challenge:
  - Find three acceptable corner points and trajectory.
  - De-risk and Increase Confidence Level of Bidbook Recommendation
- Establish Initial Geological Model
- Confirm, Refine, De-risk geo-mechanical Interpretation
- Subsurface is interesting:
  - Energy dissipating
  - Complicated and largely unknown Geology (but it's all about Geo-mechanics) - Constraints from development/construction, natura2000, anthropogenic noise (wind-turbines, roads, railroads)

Credits to W. Walk

Credits to W. Walk

Phase 1 Construction Initial Model	Phase 2 Thorough geophysical and geological investigations to refine subsurface model and focus on a set of risk prioritized trajectories	Phase 3 Selection most promising traject, determination of remaining mitigation	Phase 4 Mitigation selected trajectory

Baseline model and pilots

- Construction Baseline Geological Model
- Pilot testing active seismic and EM, conclusions on effectiveness
- Analyze existing cores geomechanically

First set of ~10 boreholes

Second set of ~10 boreholes

- Ranking, procurement and implementation boreholes

Active Seismic

- Active seismic: procurement and implementation

ERT, Passive Seismic, Anthropogenic noise measurements

- Wind turbine noise measurements and conclusion/recommendation
- Passive seismic and ERT measurements.
- Gravitational and Magnetic measurements

Geomechanical Interpretation

- Central de-risking activity
- Intimate involvement of tunneling companies

Vertical test shaft

- Test Shaft
- Horizontal drilling

Updating and converging 3D digital hydro-geological model

- Integration of incoming measurements
- Geomechanically converging trajectories and vertices

now

Recommendation Bidbook

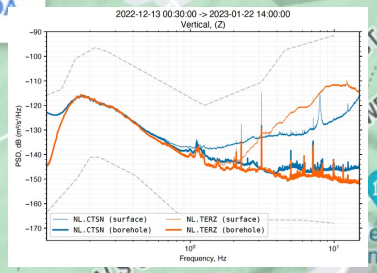
Internal FTEs

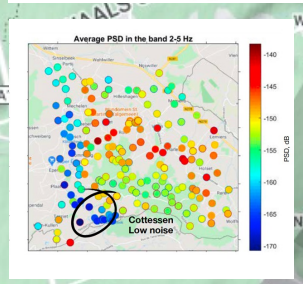
External FTEs

- Contract and hire expertise postdocs and industry: TNO, Fugro, Amberg, TEC, TU/D, etc.
- Management of integrated 3D digital subsurface model

Critical milestones

- Active seismic effective
- Sufficient availability drilling firms
- Drilling procedures (permits, implementation, costs) effective
- Geomechanical translation to feasibility corner points
- Refinement of baseline model indicates feasible trajectories
- Promising trajectory and corner points identified
- Sufficient budget for further mitigation Phase 4
- Substantiated recommendation Bidbook





Maastricht
Fort Eben-Emael
E25 railway
Montzen Line
buffer 2km
Fort Aubin-Neufchâteau
Booze Val Dieu Block
2 km buffer
E40 +TGV
Liège
Fort de la Chartreuse
Fort de Battice
Thimister-Clermont
Aachen
Lindt Werksverkauf Aachen
Uniklinik RWTH Aachen
Drielandenpunt
Molen van Medael | Groepsaccommodaties...
Cimetière américain de Henri-Chapelle
Golf & Hotel Henri-Chapelle
Abdij van Val Dieu
Clinique André Renard
Hypermarkt Carrefour HERSTAL
Shop & Go Delhaize Hauts Sarts
De Grindgroeve van Brock
Blegny-Mine
VLAAMS GEWEST
WAALS GEWEST
DEUTSCHLAND
BELGIË
NEDERLAND

Still to determine by the geo-surveys:

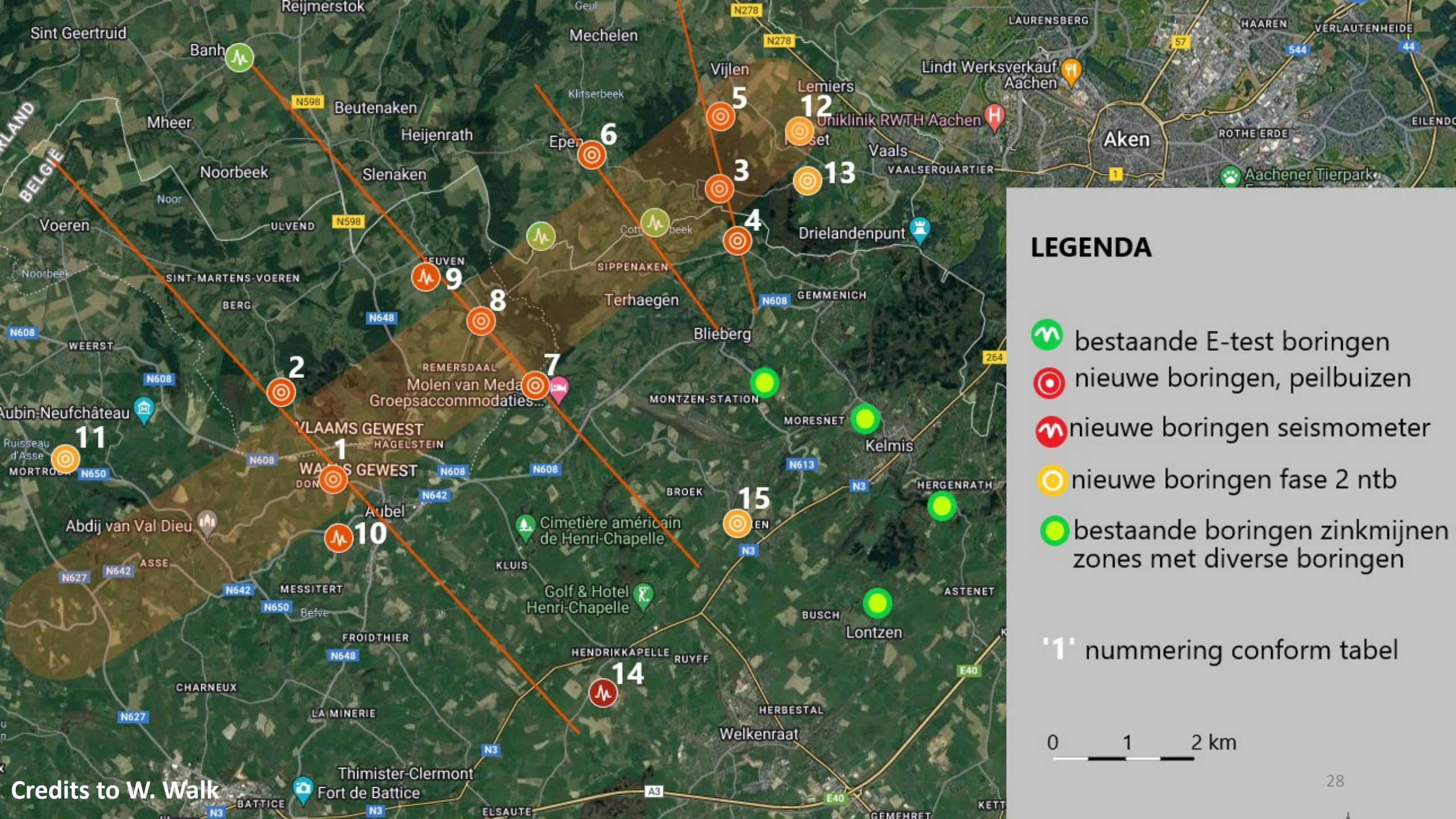
Width Bufferzones
seismic Infra-noise
Railways & Highways

Extent of the
Booze Val Dieu Block

Possible area triangle

Contraints are conservative and must be confirmed, however:
They allow and suggest a prioritized Action Plan, possibly saving time

Credits to W. Walk


LEGENDA
bestaande E-test boringen
nieuwe boringen, peilbuizen
nieuwe boringen seismometer
nieuwe boringen fase 2 ntb
bestaande boringen zinkmijnen
zones met diverse boringen
'1' nummering conform tabel
0
1
2 km
VLAAMS GEWEST
WALLONS GEWEST
Credits to W. Walk

Planned Boreholes 2023 (first set)

nr	profiel nr	onderzoekslocatie beschrijving	x-coord	y-coord	opmerking
done	-	Terziet 1, 160 m	50.756320	5.906717	
done	-	Terziet 2, 260 m	50.756645	5.906134	Seismometer station
done	2	Cottessen, 251 m (E-test)	50.759160	5.940609	Seismometer station
done	4	Banholt, 252 m (E-test)	50.791045	5.814159	Seismometer station
1 Set 1	1	Aubel, 250 m (E-Test)	50.709971	5.842804	
2 Set 1	1	Sint Pieters Voeren (Vlaanderen)	50.726931	5.826128	
3 Set 1	2	Vijlener Bos Parking	50.765920	5.960121	
4 Set 1	2	Gemmenich 200 m noord v. tankstation	50.756148	5.965649	
5 Set 1	2	dal 500 m zuid v. Vijlen	50.781584	5.964245	
6 Set 1	3	Epen ntb adhv ERT Parkeerplaats	50.772322	5.921207	
7 Set 1	4	Hombourg 1 km noordelijk van dorp	50.728433	5.903590	
8 Set 1	4	Obsinnich spoorviaduct Gulp	50.740388	5.887724	
9 Se t 1	4	Teuven bij straat Mostert	50.750040	5.872287	seismometer station
10 Set 1	1	Val-Dieu of Aubel-west	50.698617	5.844381	seismometer station
14 Set 1	1	Zuid v. Henri-Chapelle,	50.668872	5.924650	Seismometer station

Credits to W. Walk

SPB – WD3 Bidbook

SPB Mandate

- Site Characteristics
  - ❑ Physical variables
  - ❑ Geological, geophysical and geotechnical information
  - ❑ Costs and timing
  - ❑ Legal aspects and site quality preservation
  - ❑ Socio-economic-environmental impact
  - ❑ Risk Assessment
  - ❑ **Bidbook: standard, monitoring and collecting**

Bidbook content

Chairs: Tomek Bulik, Rosario De Rosa (Sardinia) and Martijin Rumpen (EMR)

- the needed legal documentation
- the procedures to realize the ET infrastructure
- the timing
- the cost according the evaluations of the infrastructure team, of the collaboration (for the detectors) and of the Host Teams for what concerns the specific costs
- the financial plan distinguishing the infrastructure from the detectors
- the site related risk assessment
- the socio-economic impact
- The environmental impact
- The scientific performance according to the standards defined by the collaboration
- …

Bidbook content

- **Common Template for scientific aspects!**
- Standards and best practices for site noise measurement and evaluation
- Evaluation of site characteristics on ET performances (Host Teams and ET Collaboration)
- Site noise mitigation (ET Collaboration)
- Costs and timing (Host teams and PD/Project Dept./Infrastructures)
- Risk assessment (scientific -> ET Collaboration)

Expected Output

- The output of this activity is a template of bidbook, a list of required documents (legal, formal, ...)

SPB role

- SPB suggests to the agencies, through the PD, and to the collaboration, through the Executive Board, a methodology to compare the bid books.
- SPB collects and implements suggestions on that methodology by the PD, the Executive Board, the infrastructure team, ...
- SPB monitors the production of the bidbooks, the respect of the standards and of the timing.
- SPB collects all the documentation within the due time and performs an initial comparison according to the methodology

Discussion evolution of SPB/SCB

- Split WD3 (bidbook) into two activities:
  - Collaboration will have responsibility on standards and coordinating with WD1/2 and other related ET Boards
  - ETO will take care of the formal bidbook processes (framework, communication with BGR, ...)
- Split WD4 (costs, schedules & risk ass.): risk related to scientific aspects will, mitigation strategy and so on will be under the responsibility of the Collaboration
- SPB/SCB chairs to report at regular meetings of ETO management

To be discussed with PD/EB …

Discussion just started

SPB – ISB Thematic Session: Newtonian and Env noise impact

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

Atmospheric Newtonian noise modeling for third-generation gravitational-wave detectors

Speaker: Mauro Oi

In collaboration with:
Davide Brundu
Mariano Cadoni
Piero Olla
Andrea P. Sanna

Based on: Phys. Rev. D (2022) **106**, 064040
Datasets: github.com/maurooi/AtmosphericNN
More plots: 10.5281/zenodo.6758920.svg

Motivations:

- Understanding the effect of site noise on the apparatus
- Identify critical physical variables and
- Evaluate safety values
- Identification of possible mitigation strategy

Newtonian and Env noise impact

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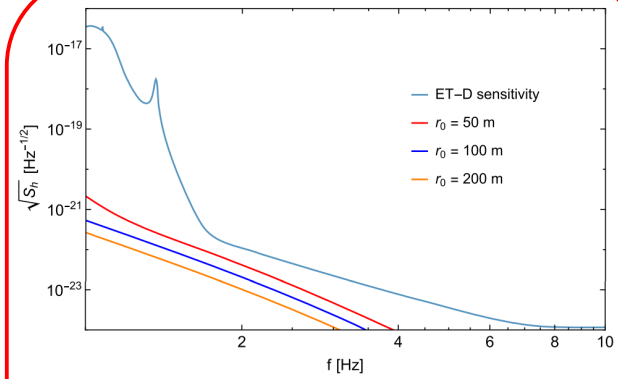
Conclusions

We improved previous models for the atmospheric contribution to NN by studying

- Time decay of turbulent structures
- Inhomogeneities along the vertical direction
- Dependency of NN from the detector depth

General features

- Noise is always suppressed at large frequencies
- Noise is partially mitigated placing the detector underground



Passive mitigation can be insufficient!

Newtonian and Env noise impact

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Newtonian noise estimate at Terziet- *the Euregio Meuse-Rhine (EMR) candidate site for Einstein Telescope*

Soumen Koley
Maria Bader
Jo van den Brand
Henk Jan Bulten
X Campman
Frank Linde
Bjorn Vink

GSSI, L'Aquila, Italy
soumen.koley@gssi.it
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XIII ET Symposium, Cagliari, 2023

Newtonian and Env noise impact

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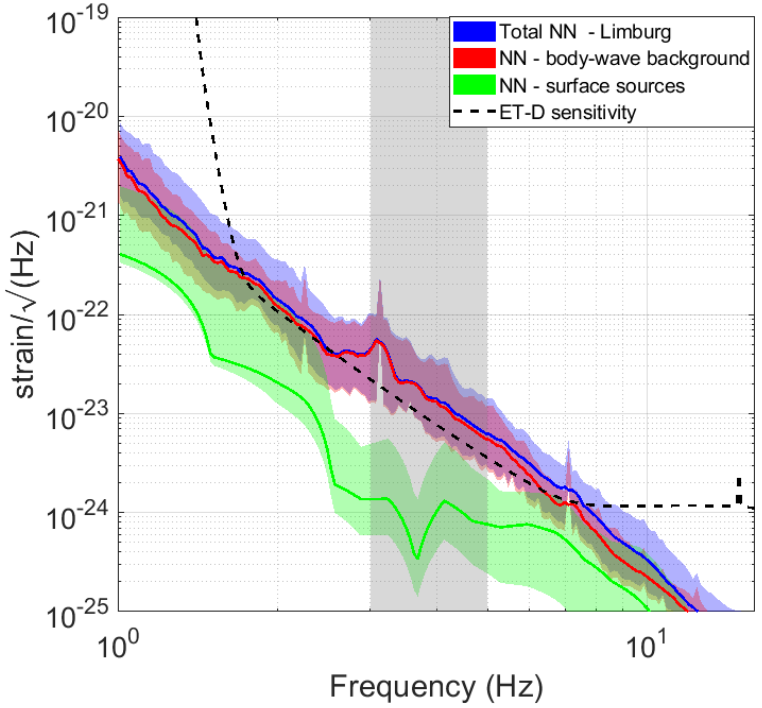
Newtonian noise predicted for EMR-site

The mean Newtonian-noise estimate is up to a factor of 2 higher than the ET-D design sensitivity for frequencies up to about 8 Hz, and the body-wave background dominates

Parameters for background body-wave NN

- Both the displacement amplitude and the wave direction are assumed to be distributed isotropically
  - 1/3rd P-waves and 2/3rd S-waves.
- Fixed P-wave speed - 4.50 km/s, and 2.82 km/s for S-waves
- Random phase offsets for each component.
- The assumption of plane waves implies:
  - we do not consider re-scattering and instrinsic-dispersion of the waves
  - the waves are not modified when crossing a soil layer boundary and the amplitude is constant everywhere in space
- Therefore we expect that the modeled results for the body waves may add inaccuracies



Newtonian and Env noise impact

98 - Atmospheric NN model	*Mauro Oi*
99 - NN at EMR	*Soumen Koley*
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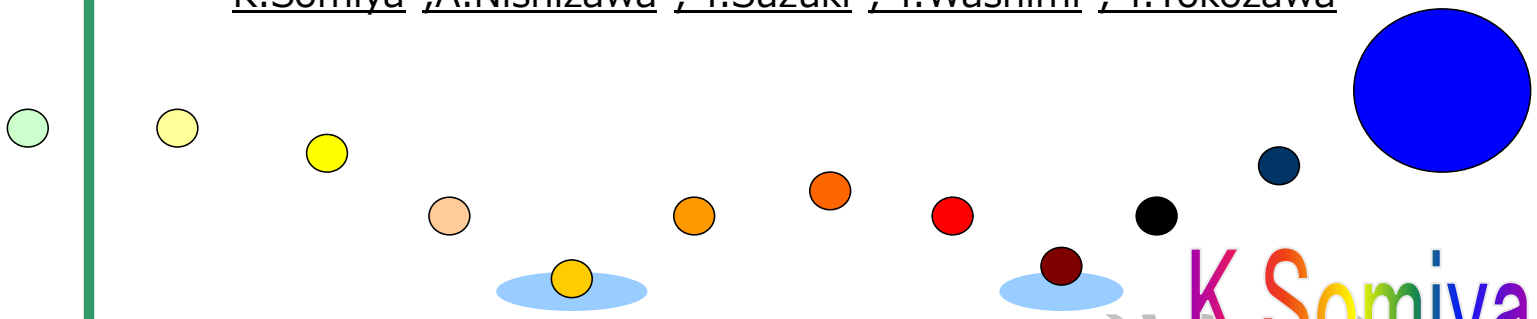
Newtonian Noise of underground water in Kamioka mine

ET Symposium
May 2023

Tokyo Tech[A], RESCEU[B], NAOJ[C], ICRR[D]
K.Somiya[A],A.Nishizawa[B], T.Suzuki[A], T.Washimi[C], T.Yokozawa[D]



Newtonian and Env noise impact

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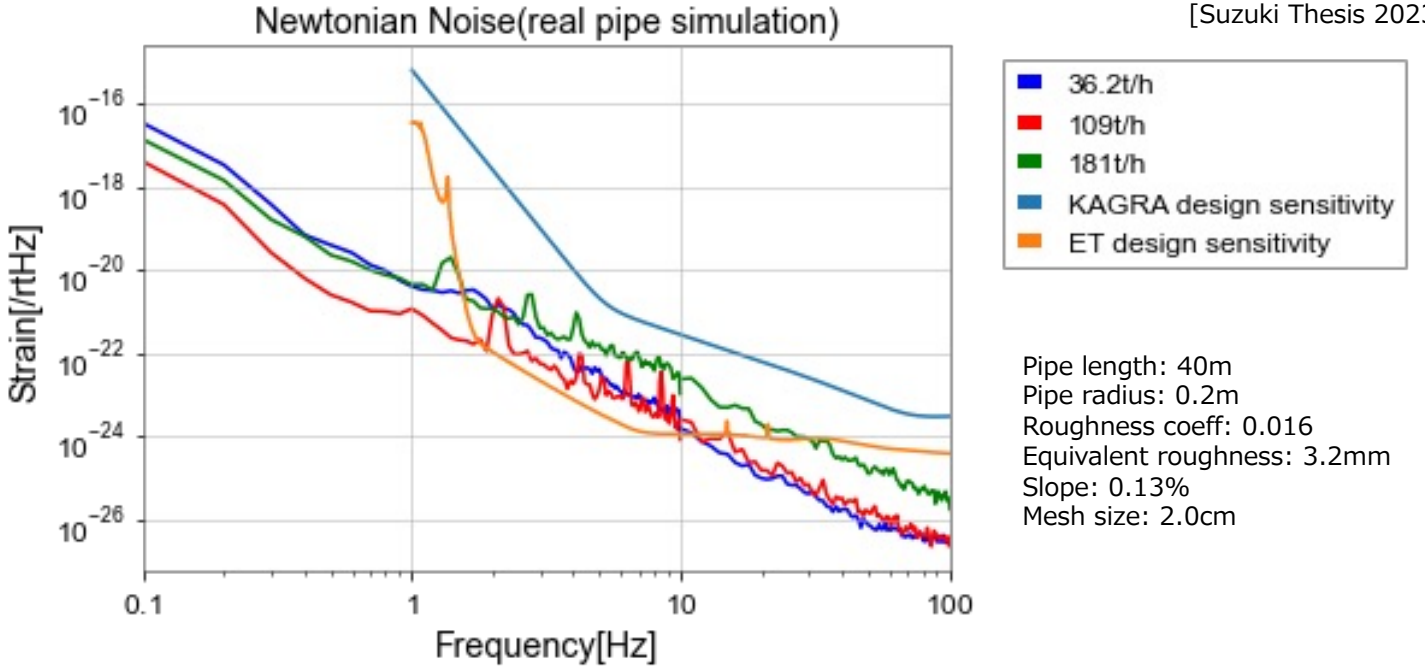
Sim-2 : NN calculation with KAGRA-like pipe

[Suzuki Thesis 2023]



Pipe length: 40m
Pipe radius: 0.2m
Roughness coeff: 0.016
Equivalent roughness: 3.2mm
Slope: 0.13%
Mesh size: 2.0cm

- **Newtonian Noise level was calculated with three different water amount.**
- **The spectra look a little different with different water amount, but they do not limit the KAGRA sensitivity.**

Newtonian and Env noise impact

98 - Atmospheric NN model	*Mauro Oi*
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Newtonian Noise: State of the art and future perspectives

Francesca Badaracco

INFN GENOVA

ET symposium 2023, Cagliari

Newtonian and Env noise impact

98 - Atmospheric NN model	
99 - NN at EMR	Soum
100 - NN from underground groundwater	Kentar
101 - Newtonian Noise in ET: state of the art and beyond	Francesca B
102 - Glitches and NN @ Sardinia	Rosario
103 - Schumann Res. amplification	Tatsuki
104 - Train noise at Virgo and LIGO	Federic
105 - Acoustic NN noise based on the LNGS case	Mariusz Suche

Publications about Terziet:

Class. Quantum Grav. 39 025008 (2022)

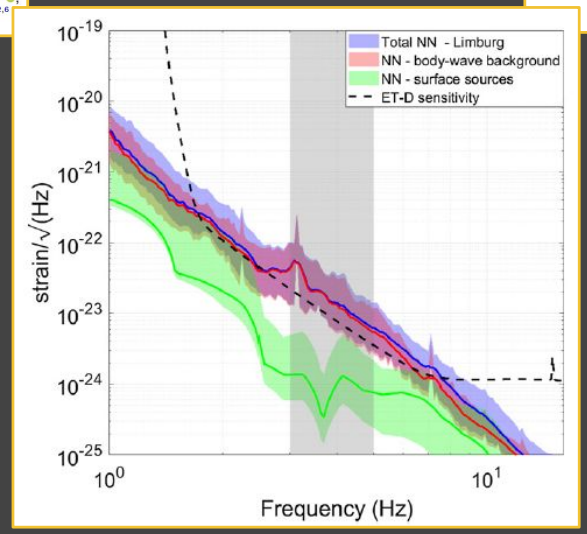
Surface and underground seismic characterization at Terziet in Limburg—the Euregio Meuse–Rhine candidate site for Einstein Telescope

Soumen Koley[1,2,*], Maria Bader[2], Jo van den Brand[2,3], Xander Campman[4], Henk Jan Bulten[2,5], Frank Linde[2,6] and Bjorn Vink[7]

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[1,3,5], Xander Campman[4], Henk Jan Bulten[1,5], Frank Linde[1,6] and Bjorn Vink[7]



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 Perciballi[2], F Ricci[1,2], E Coccia[3,4], V Malvezzi[3], F Acernese[5,6], F Barone[5,6], G Giordano[5], R Romano[5,6], M Punturo[7], R De Rosa[6,8], P Calia[9] and G Loddo[9]

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

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

A. Allocca[1,2], A. Berbellini[3], L. Boschi[3,4,5], E. Calloni[1,2,a], G. L. Cardello[6,7], A. Cardini[8], 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 Fiore[2], M. Di Giovanni[11,12,13], S. Di Pace[14,15], L. Errico[1,2], I. Fiori[9], C. Giunchi[11], A. Grado[16], J. Harms[12], E. Majorana[14,15], V. Mangano[14,15], M Marsella[14,15], C. Migoni[8], L. Naticchioni[14,15], M. Olivieri[3], G. Oggiano[6,7], F. Paoletti[17], M. Punturo[18], P. Puppo[15], P. Rapagnani[14,15], . Ricci[14,15], D. Rozza[6,7], G. Saccorotti[11], V. Sequino[1,2], V. Sipala[6,7], . Tosta E Melo[6,7], L. Trozzo[2]

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

Characterization of the Sos Enattos site for the Einstein Telescope

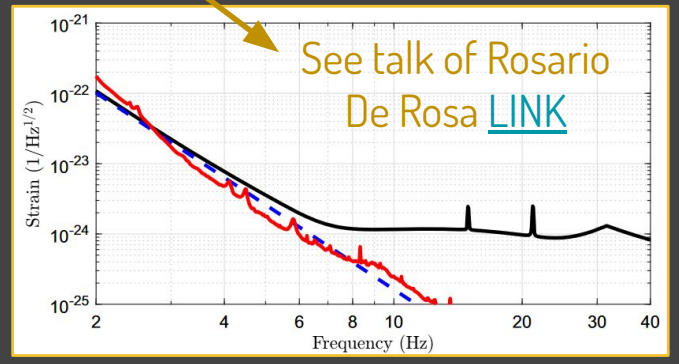
L Naticchioni[1], V Boschi[3], E Calloni[2], M Capello[8], A Cardini[5], M Carpinelli[6,7], S Cuccuru[7], M D'Ambrosio[8], R de Rosa[2], M Di Giovanni[8], D d'Urso[6,7], I Fiori[11], S Gaviano[8], C Giunchi[8], E Majorana[1], C Migoni[5,10], G Oggiano[7], M Olivieri[9], F Paoletti[3], M Paratore[8], M Perciballi[1], D Piccinini[8], M Punturo[4], P Puppo[1], P Rapagnani[1], F Ricci[1], G Saccorotti[8], V Sipala[7], M C Tringali[12]

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 Giunchi[1], Gilberto Saccorotti[1], Andrea Berbellini[4], Lapo Boschi[4,5,6], Marco Olivieri[4], Rosario De Rosa[7,8], Luca Naticchioni[9,10], Giacomo Oggiano[11,12], Massimo Carpinelli[11,12], Domenico D'Urso[11,12], Stefano Cuccuru[11,12], Valeria Sipala[11,12], Enrico Calloni[7,8], Luciano Di Fiore[7], Aniello Grado[13], Carlo Migoni[14], Alessandro Cardini[14], Federico Paoletti[15], Irene Fiori[16], Jan Harms[2,3], Ettore Majorana[9,10], Piero Rapagnani[9,10], Fulvio Ricci[9,10], and Michele Punturo[17]

Projection of NN contribution at Sos Enattos



See talk of Rosario De Rosa LINK

Geophysical Journal International, ggad178 (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

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

Newtonian and Env noise impact

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SEISMIC GLITCHNESS AND NEWTONIAN NOISE AT THE CANDIDATE SITES

R. De Rosa

with the contribution of many other people involved in these activities…

A. Allocca, E. Calloni, A. Cardini, M. Carpinelli, A. Contu, L. Di Fiore, M. Di Giovanni, L. D'Onofrio, D. D'Urso, L. Errico, I. Fiori, C. Giunchi, A. Grado, J. Harms, E. Majorana, M. Marsella, C. Migoni, L. Naticchioni, M. Olivieri, F. Paoletti, M. Punturo, P. Rapagnani, F. Ricci, D. Rozza, G. Saccorotti, M. C. Tringali, L. Trozzo.

Newtonian and Env noise impact

98 - Atmospheric NN model	*Mauro Oi*
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101 - Newtonian Noise in ET: state of the art and beyond	*Francesca Badaracco*
102 - Glitches and NN @ Sardinia	*Rosario De Rosa*
103 - Schumann Res. amplification	*Tatsuki Washimi*
104 - Train noise at Virgo and LIGO	*Federico Paoletti*
105 - Acoustic NN noise based on the LNGS case	*Mariusz Suchenek et al.*

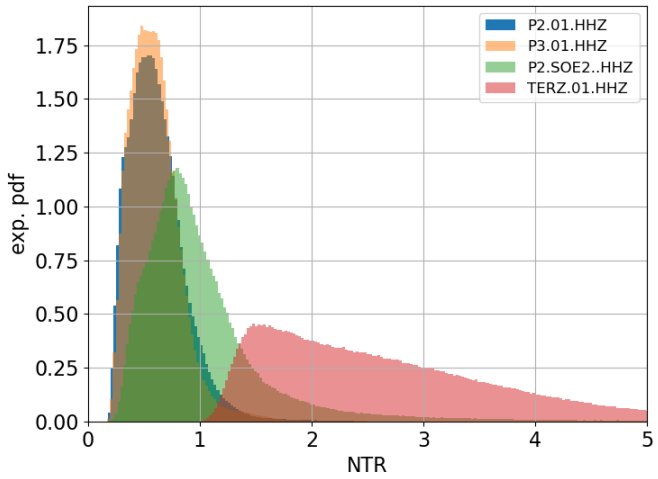
Conclusions

- Clear indication that, at least for Sardinia, NN could be a limited issue for sources whose spectrum is limited in the 2-10 Hz frequency band;
- Otherwise, a NN cancellation of a factor 5 is needed to recover to final ET sensitivity for more than 90% of time;
- A change in the detector geometry and length (L shape, 15 km long) should reduce the effect of NN.

Results of the Analysis

Full NTR Comparison

- Comparison of the full distributions for each site



P2:	P(NTR>1)=6.5%
P3:	P(NTR>1)=4.7%
SOE2:	P(NTR>1)=38.6%
TERZ:	P(NTR>5)=8.9%

Newtonian and Env nc

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Investigations for the Schumann Resonances Amplification in KAGRA

2023-05-10 XIII ET Symposium
Tatsuki Washimi (NAOJ)
Isamu Fukunaga (OMU)

Conclusion

- Amplification of the Schumann resonance observed in the KAGRA underground site is caused by the 3-km vacuum tube.
  - It is also observed at the Virgo site.
  - It was not confirmed at the CLIO site (Kamioka underground, 100m arms).
  - It is not a characteristic of the underground environment.

We will write a paper

- Calculation for the magnetic field induced by the vacuum tube:
  - Almost consistent with the KAGRA data (with tuning the current).
  - No magnetic field inside of the tube.

- How it will behave at ET (triangle-circulated vacuum tube)?
  - need simulations?
- Can we mitigate this effect? (*e.g.*, inserting non-metal tubes)

Newtonian and Env nois

98 - Atmospheric NN model	
99 - NN at EMR	Sour
100 - NN from underground groundwater	Kenta
101 - Newtonian Noise in ET: state of the art and beyond	Francesca E
102 - Glitches and NN @ Sardinia	Rosario
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Trains noise: experience in current interferometers

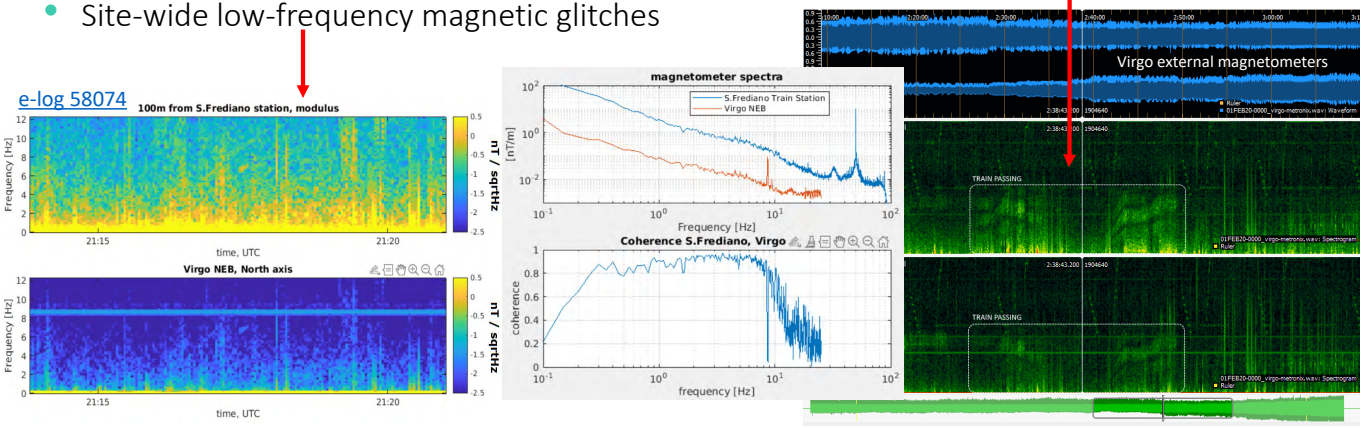
Federico Paoletti, Irene Fiori, Maria Tringali, Renato Romero

Magnetic noise pattern

We found two kinds of noise

- Correlated "butterfly" pattern
- Site-wide low-frequency magnetic glitches

Credit: Renato Romero (www.vlf.it)



- The "butterfly" is the magnetic pattern of the train change of speed while approaching the station.
- The glitches are spikes of current travelling on the overhead line and returning to ground via railways and trough the soil (F. J. Lowes, 2009)

Conclusions

- Initial measurements suggest that trains could be sources of noise:

  acoustic, seismic, magnetic.

- Open question:

  how some of these noises propagate underground

- Could trains play a role for Newtonian Noise?

  leave the floor to the experts

Thank you for your attention

Newtonian and Env noise impact

98 - Atmospheric NN model	
99 - NN at EMR	*So*
100 - NN from underground groundwater	*Ken*
101 - Newtonian Noise in ET: state of the art and beyond	*Francesca*
102 - Glitches and NN @ Sardinia	*Rosa*
103 - Schumann Res. amplification	*Tats*
104 - Train noise at Virgo and LIGO	*Fede*
105 - Acoustic NN noise based on the LNGS case	*Mariusz Suc*

ET Acoustic Newtonian noise based on LNGS case

T Bulik, M Suchenek + LNGS team
University of Warsaw
Astrocent, CAMK, Warsaw, Poland

What to make of it?

Acoustic NN is not negligible

LNGS measurement can be considered as upper limit

Current noise level in tunnels is too high

Lower limit - from ambient noise can also affect ET sensitivity.

We need to take actions to lower this noise:

- silence all equipment?
- decrease pressure?
- build ET in several smaller halls?

This needs to be investigated now to prepare for the construction and noise mitigation.

Next Urgent Steps

- SPB organizational chart completion (urgent)
- Urgent tasks: study of wind farm noise (vibrational, EM, acoustic), measurement of ambient magnetic noise (surface and V-channel in borehole) and possible railway sources at EMR.
  - Evaluation of local noise source impact (Windmills measurements) and definition of a safety range
- Agreement on data interpretation and analysis to be discussed within the ISB devoted working group

- Start the activity on Bidbook!

- Common paper
  - Seismic comparison between borehole measurements at the sites.

Want to join ? https://wiki.et-gw.eu/SPB/WebHome
https://lists.infn.it/sympa/subscribe/et-spb?previous_action=review