ET-PP 1st review meeting

Horizon Europe: Coordination and Support Actions

14/12/2023

Grant agreement: № 101079696

WP 4: Introduction and objectives

- Duration: M1-M48
- WPL: NIKHEF.
- WP4 chairs: Domenico D'Urso (INFN), Wim Walk (NIKHEF)

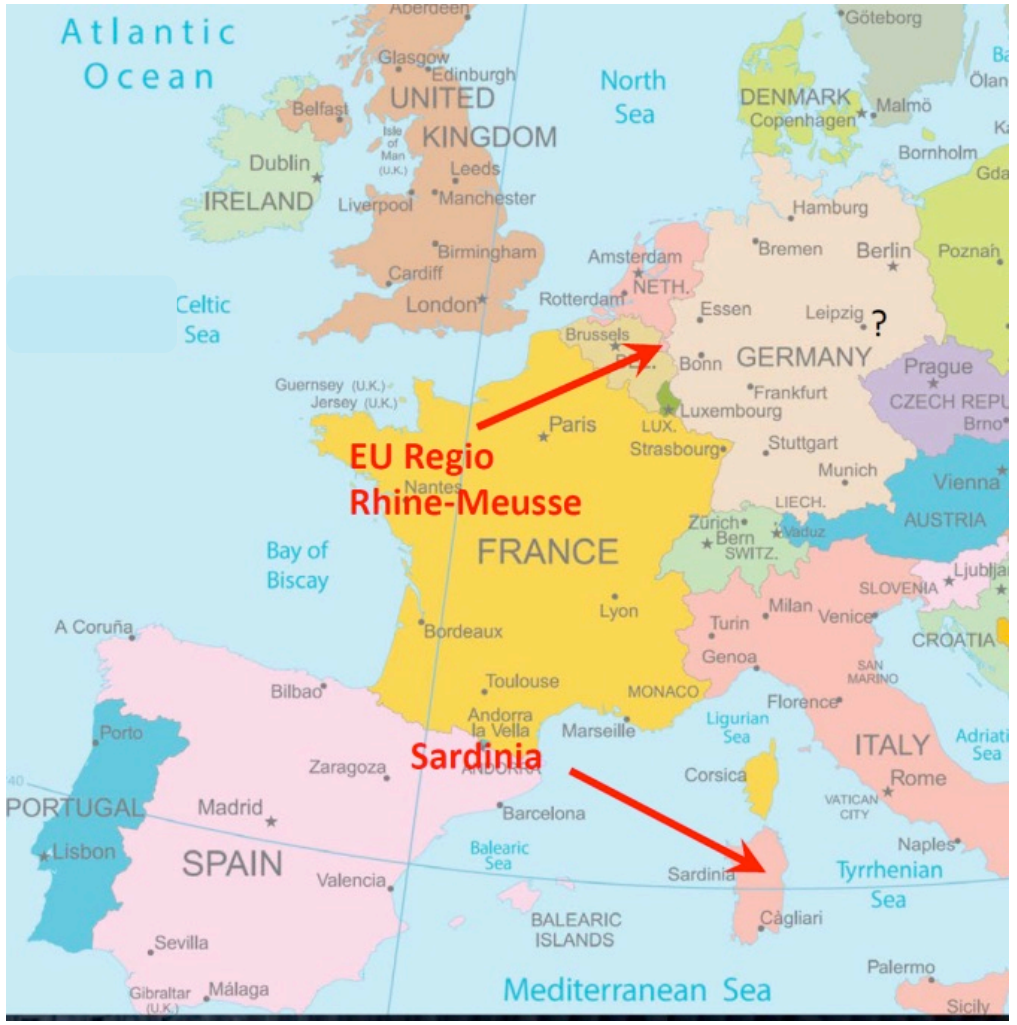
- General Objective: The general objective of WP4 is to facilitate the site selection process by collecting – and wherever possible quantifying – all relevant site-specific aspects entering the ET site selection process.

- Objectives for this period:
  - Report on site-specific characteristics that impact ET sensitivity and its duty cycle
  - Report on a common methodology to estimate impact of site characteristics on ET performance
  - Inventory of Legal Procedures to be taken prior starting excavation

WP 4: Tasks

- Two sites, in Europe, candidate to host ET:
  - The Sardinia site, close to the Sos Enattos mine
  - The EU Regio Rhine-Meusse site, at the NL-B-D border

- Tasks and activities are leading by Site Host Teams, by the ET Collaboration and coordinated by the Site Preparation and Characterization Board of ET
- Measurement campaign and data analysis of environmental sensors to understand relevant site characteristics for ET detector performance.
- Data analysis of environmental data. Meetings to discuss results and methodology. Produce intermediate ET Collaboration papers and presentations.
- Develop geological and hydrogeological models for ET positioning
- Study of legal scenario of candidate country
- Update overall costs



WP 4: Critical risks, deviations from Annex I, contingency plans

Critical risks

- WP4 is the responsible for collecting and processing all the required information necessary for site qualification. Activities are managed directly by site Host Teams, which are implementing different organizational strategies, constrained by the national and regional fundings conditions (in 2022-2023 **42M€ for the EMR** team and **50M€ for the Sardinia** team).

- ET Collaboration is working on the definition of detector specification and on a common definition of standards for site characteristics measurements and of standard modelling and interpretation

WP 4: Critical risks, deviations from Annex I, contingency plans

Deviations from Annex 1

M4.2 Common methodology to estimate the impact of site characteristics on ET sensitivity and operation and, if required a scheme to compensate it (Not Achieved, due date 30/06/2023)

D4.1 Scan of legal procedures, permitting and land acquisitions

WP 4: Critical risks, deviations from Annex I, contingency plans

Deviations from Annex 1

M4.2 Common methodology to estimate the impact of site characteristics on ET sensitivity and operation and, if required a scheme to compensate it

- Crucial step towards the definition of a fair site evaluation procedure
- Einstein Telescope is expected to reach a sensitivity, in particular at low frequencies, well beyond those obtained by current 2G detectors
- Seismic fields need special attention since the main environmental noise predicted to set a low-frequency limit to ET's bandwidth was from gravity perturbations produced by seismic fields, so-called Newtonian Noise (NN).
- A consensus on how to estimate the NN, starting from seismic measurements, is not yet achieved and a detailed comparison of different approaches is ongoing.

WP 4: Critical risks, deviations from Annex I, contingency plans

Contingency Plans

M4.2 Common methodology to estimate the impact of site characteristics on ET sensitivity and operation and, if required a scheme to compensate it

- On Dec. 6th and 7th in Amsterdam a dedicated workshop was held to discuss the status of site noise understanding, taking into account the experience of VIRGO and KAGRA Collaborations.
- A special common working group has been set up and several additional thematic meetings will be organized
- Common, shared tools are being made available as starting framework for noise estimation
- A document will be prepared to report a standardization on measurement methodologies and agreements on common tools to be used for noise estimation.
- Conclusion of the processes expected at the end of Q1 2024.

WP 4: Critical risks, deviations from Annex I, contingency plans

Deviations from Annex 1

D4.1 Scan of legal procedures, permitting and land acquisitions

- Need to account for different regulations and the possibility to obtain a new legislation tailored for the ET infrastructure
- **EMR**: a first study of the engineering, legal, and permitting aspects ordered by the University of Liège using core funding of ULiège, RWTH, Provincie Limburg (NL) and Nikhef is available and it will act as a foundation for a second, more specific and detailed study, currently in development.
- **Sardinia**: a call for tender for "Preliminary studies to the feasibility study of ET infrastructure in Sardinia" using national funding will produce, within a wider framework where an engineering study and a geotechnical investigation will be produced, a complete scan of all the procedures, authorization and permits needed. Final outcome expected by the June 2025.

WP 4: Critical risks, deviations from Annex I, contingency plans

Contingency Plans

- An introductive overview is given in the present document, while the final complete report will be delivered by 31/12/2025. This delay does not interfere with other deliverables and will be complementary information to that in D4.5 scheduled for month 42 (spring 2026) in the ET-PP plan.

- D4.1 is composed of two parallel documents, referring to EMR and Sardinia respectively and reflecting the different strategies.

WP 4: Deliverables and milestones - overview

Milestones:

M4.1-M3: Document detailing the site-specific characteristics that impact ET sensitivity and its duty cycle

M4.2-M10: Common methodology to estimate impact of site characteristics on ET sensitivity and operation and, if required, a scheme to compensate it

Deliverables:

D4.1- M10: Scan of legal procedures, permitting and land acquisitions

D4.2 - M15: Updated socio-economic impact studies. Scan of accessibility, quality of life etc.

D4.3 - M28: Complete quantification of all the aspects impacting the ET performance for each site

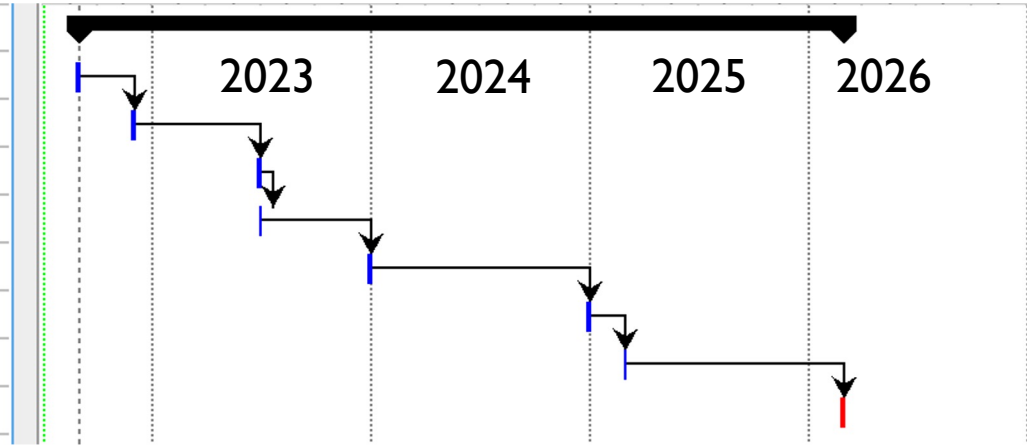
D4.4 - M30: Report on 3D geology, hydrology, etc. model with localisation of the ET infrastructure

D4.5 - M42: 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.

WP 4: Deliverables and milestones - overview

WP4 Gantt chart. Starting date assumed to be 1-Sept-2022.

WP4. Site Preparation
Start of ET-PP
M4.1 Document detailing the site-specific characteristics
M4.2 Common methodology to estimate impact of site characteristics on ET sensitivity
D4.1 Scan of legal procedures
D4.2 Updated socio-ecnomic impact studies
D4.3 Complete quantification of all the aspectes impacting the Einstein Telescope performances
D4.4 3D geology, hydrogeology, etc model
D4.5 Updated cost and schedule estimates of the excavations.



WP 4: Deliverables and milestones – I year

- M4.1: Document detailing the site-specific characteristics that impact ET sensitivity and its duty cycle.
  Achieved on 31/01/2023 (due date 30/11/2022)

- M4.2: Common methodology to estimate impact of site characteristics on ET sensitivity and operation and, if required, a scheme to compensate it.
  Not Achieved (due date 30/06/2023, new due date 31/03/24)

- D4.1: Scan of legal procedures, permitting and land acquisitions
  Submitted on 31/10/2023 (due date 30/06/2023)

WP 4: Milestone M4.1

- **M4.1.Document detailing the site-specific characteristics that impact ET sensitivity and its duty cycle. Achieved on 31/01/2023 (due date 30/11/2022)**

- Site conditions influence the construction feasibility, costs and lifetime of the infrastructure and, at the same time, may impact detector performance

- environmental noises (e.g. seismic motion) have a direct impact on the detector sensitivity and duty cycle

- Physical Variables: Seismic field, Geodetic site characterization, Magnetic noise, Other environmental noises like acoustic and barometric noise

- Site characteristics – geological, geophysical and geotechnical information: Sub-surface geology, groundwater flow, rock quality and geomechanical parameters

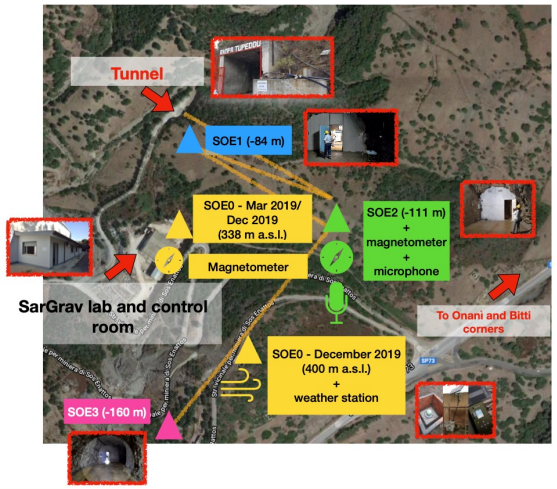
WP 4: Milestone M4.1

- **M4.1.Document detailing the site-specific characteristics that impact ET sensitivity and its duty cycle. Achieved on 31/01/2023 (due date 30/11/2022)**

Permanent Instrument Network

Since 2019, in Sos Enattos there are:

- 4 permanent seismic stations for long term studies:
  - Surface: SOE0;
  - Underground: SOE1, SOE2, SOE3;
- 1 weather station;
- 1 microbarometer;
- High precision tilmeter as part of the Archimedes experiment;
- 2 microphones;
- 1 movable array composed of 8 short-period tri-axial seismometers;
- 3 magnetometers;
  - Surface: control room;
  - Underground: SOE2;
- All permanent seismic stations are provided with broadband seismometers (Trillium 240, 360 and 120 Horizon, Guralp 360);



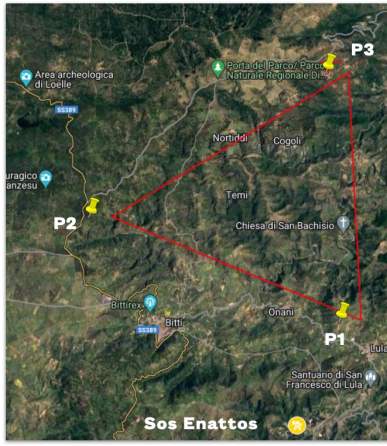
Credits. to M. Di Giovanni

Permanent Instrument Network

In 2021, more permanent sensors have been installed at 2 of the proposed vertices (P2/3):

- 2 broadband seismometers on surface;
- 2 broadband seismometers in borehole;
- 2 magnetometers at P2

In the near future, more sensors will be installed at P1 as well.



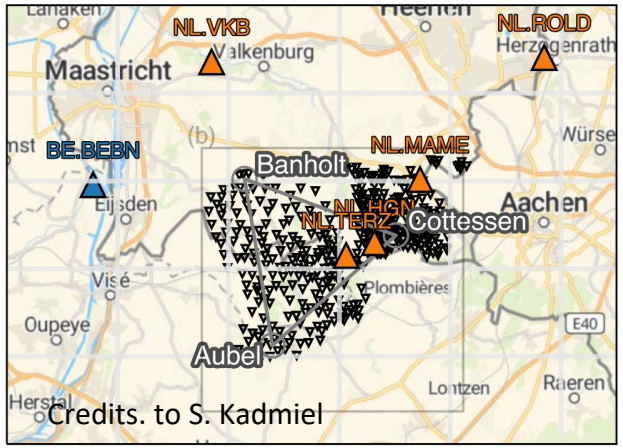
Credits. to M. Di Giovanni

WP 4: Milestone M4.1

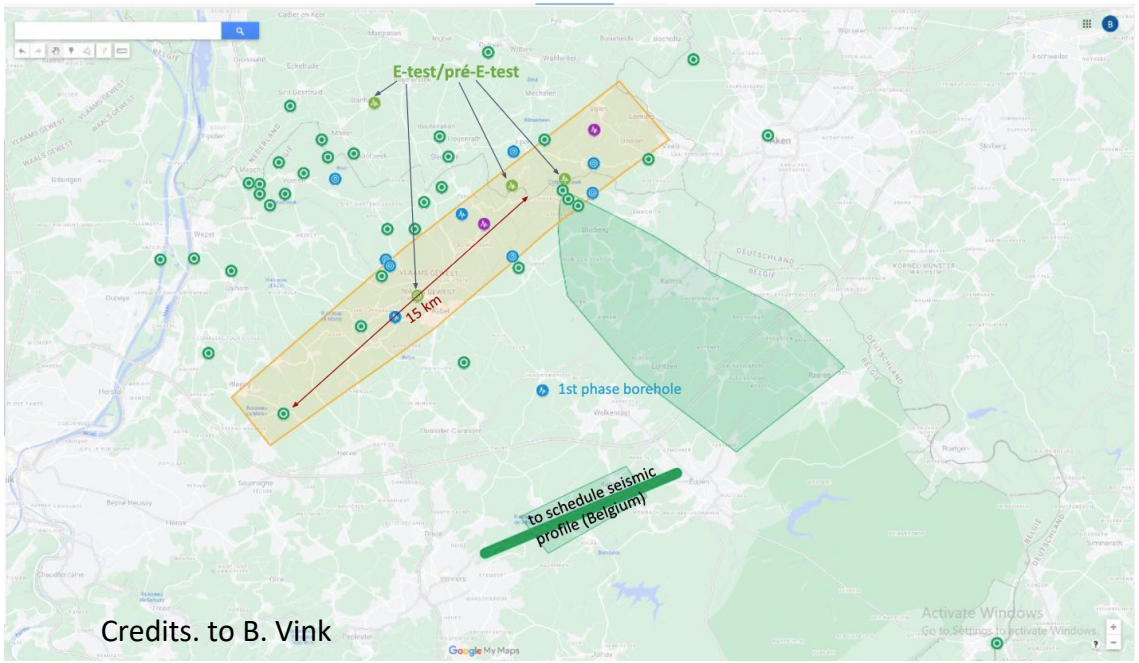
- **M4.1.Document detailing the site-specific characteristics that impact ET sensitivity and its duty cycle. Achieved on 31/01/2023 (due date 30/11/2022)**

A rich network of seismic sensors

1. Seismic noise characterisation for the optimal location of the ET corner-points.
2. Imaging the subsurface to support geotechnical engineering efforts.
3. Extending the existing seismic network in the region: 15 new broadband seismic stations (surface) & 4 new broadband borehole seismic stations (250 m depth)



Planned boreholes first phase



WP 4: Milestone M4.2

M4.2. Common methodology to estimate the impact of site characteristics on ET sensitivity and operation and, if required a scheme to compensate it.

Not Achieved (due date 30/06/2023, new due date 31/03/24)

Contingency Plan

- Special working group has been set up to standardize noise measurements in general and to eliminate differences between the different approaches.

- At a special SPB workshop (Dec 2023) the current status, intermediate reports and papers and approach to NN has been be discussed.

- Following the workshop, a document will be prepared to report a standardization on measurement methodologies and agreements on common tools to be used for noise estimation.

- To fully understand and eliminate different measurement approaches, as well as to create appropriate standards, as described in the process above, Milestone 4.2 had to be delayed.

- The conclusion of this process and delivery of Milestone 4.2 is expected at the end of Q1 2024.

WP 4: Deliverable D4.1

- **D4.1 Scan of legal procedures, permitting and land acquisitions**
  Submitted on 15/11/2023 (due date 31/10/2023)
- Two parallel documents, referring to EMR and Sardinia respectively and reflecting the different strategies.
- An overview of the legal, permitting and acquisition procedures with regards to public and private, listing public and private stakeholders, private and public authorizations and permits.

- Two attachment as annex:

  -The complete report obtained by the EMR host team. Assumptions: ET is located in The Netherlands and Belgium, it has a triangular shape, the access to ET are vertical shafts, and the tunnels will be dug at least at a depth of 200 m, more likely at 250 m depth.

  - Tender Specifications of the “Preliminary studies to the feasibility study of ET infrastructure in Sardinia. Assumptions: ET located in the area of Sos Enattos (NU, Italy), considering both triangular (six interferometers inserted in a system of tunnels and caverns with an equilateral triangle layout on a side about 11 km) and L shape (two interferometers inserted in a system of tunnels and caverns with an 'L’ layout on a side about 16 km) configurations.

WP 4: Contribution from each partner

INSTITUTION		PM as per Annex I	PM in the period
1 Nikhef	CONTRIBUTIVES	10	2.74
	REQUESTED EC	0	0
2 INFN	CONTRIBUTIVES	10	0
	REQUESTED EC	0	0
3 UW	CONTRIBUTIVES	12.0	0.9
	REQUESTED EC	0	0
Wigner RCP	CONTRIBUTIVES	13.2	3.3
	REQUESTED EC	0	0
Total Person Months	**CONTRIBUTIVES**	**45.2**	**4.94**
Total Person Months	**REQUESTED EC**	**0**	**0**
		45.2	**4.94**

% PMs used = 10.9

WP 4: Outlook and perspectives

- Delivery of Milestone 4.2 is expected at the end of Q1 2024

- Continue measurement campaign and data analysis of environmental sensors to understand relevant site characteristics for ET detector performance.
  - EMR sensor surface of 4C seismic sensors and subsurface downhole network of seismometers at target depth to be installed. Develop and execute measurement plan in Q1-Q4 2024
  - EMR Wind Turbines project to start in Q1 2024, ending Q4 2025
  - General Tender procedure in Sardinia will be closed by the end of 2023, final results expected by June 2025.
  - Overall measurements of site noise in Sardinia on going thanks to a wide network of sensors (seismometers, magnetometers, micro-barometers, weather stations and tiltmeters)

- Initially estimated timeline not easy to follow.

- Activities are managed directly by Site Host Teams which are implementing different organizational strategies constrained by the national and regional fundings conditions (**42M€** for the EMR team and **50M€** for the Sardinia team). Not always easy to uniform and harmonize results, products and timeline.

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