ET - Site Studies and Characterization

Report of Contributions

https://agenda.infn.it/e/ETSiteStudiesWorkshop

Contribution ID: **1** Type: **Talk**

Updates on the ET repository

Tuesday, 9 November 2021 16:00 (20 minutes)

During the talk I will like to give an overview on the data server that we are using to store and analyze the ET site data, as well as updates and future plans.

Primary author: RAZZANO, Massimiliano (Istituto Nazionale di Fisica Nucleare)

Presenter: RAZZANO, Massimiliano (Istituto Nazionale di Fisica Nucleare)

Session Classification: Hands-on Session

Contribution ID: **2** Type: **Talk**

Seismic and Newtonian noise in underground GW detectors.

Wednesday, 10 November 2021 09:30 (30 minutes)

Gravitational-wave detectors are very sensitive instruments that suffer from a huge number of noises. If we aim to observe gravitational waves with Earth-based detectors, we need to take care of every source that can prevent that observation.
Seismic noise is a huge problem in the low frequency band and it is tackled with suspensions and active controls. The low frequency band can also be threatened by the so-called Newtonian noise, generated by the fluctuations of the gravity field. If this has not been a problem in the first generation gravitational-wave detectors, it will be so in the next runs and especially in the third-generation detectors, like the Einstein Telescope. We need then to be prepared to suppress as much as possible these noises, otherwise they might become the last wall for the sensitivity of the GW detectors.
This talk will explore environmental noises with a particular detail on Newtonian and seismic noise and the techniques that we can employ to reduce their effects.

Primary author: BADARACCO, Francesca (GSSI)

Presenter: BADARACCO, Francesca (GSSI)

Session Classification: Newton Noise Studies

Contribution ID: **3** Type: **Poster**

Wind noise at Sos Enattos

Wednesday, 10 November 2021 19:00 (1 hour)

Analysis of data recorded at Sos Enattos from April 2016-February 2017 and June 2020-March 2021 shows connections between wind and seismic waveforms. Wind speeds are typically below 4m/s, so strong seismic responses to wind are rare but weaker seismic responses are still detectable. The power spectral density of seismic data reveals increased seismic energy for higher wind speeds over a broad range of frequencies (0.3-30Hz). In some cases, the root-mean-square of seismic data increases parabolically with average wind speed. Comparing results for seismometers at the surface and underground consistently shows a reduced influence from the wind on deeper seismic waveforms.

Primary author: ENSING, Josiah

Presenter: ENSING, Josiah

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **4** Type: **Poster**

Characterizing the hydro-structural setting of the Einstein Telescope site of Sardinia (Italy): insights from Electrical Resistivity Tomography

Wednesday, 10 November 2021 19:00 (1 hour)

Characterizing the geological subsurface setting of a stratified aquifer and the structures that guide the flow paths is crucial for the realization of underground infrastructures such as the Einstein Telescope (ET), that is the European third-generation underground interferometric detector of gravitational waves. The triangular setting of this infrastructure (10 km long sides) has vertices located near the villages of Lula, Bitti and Onanì in Sardinia (Italy).
In order to trace the fractures and fault paths at these sites we have applied the Electrical resistivity tomography (ERT), which helped us tracing the structural data collected at depth.
In this contribution, we present the first results of 2D ERT surveys along with the structural and morphostructural analysis of the brittle structures affecting the crystalline basement to more accurately interpret the geophysical anomalies representative of the underground geology of the aquifer. The deep interpretation is also supported by the drilling performed at the Onanì and Bitti vertices (ca. 250 m total depth).
The tomographies show a complex internal resistivity stratification, that consists of up to three electrolayers with variable distribution and thickness. As supported by field observation, we have interpreted the more conductive electrolayers as regolith and alluvial units, while the most resistive electrolayers correspond with the less-altered granitoids.
The tomographies of the Onanì vertex, show that the conductive layer occurs either as: i) a discontinuous and well-localized layer near the surface (up to 20 m thick), or as ii) a broader anomaly zone of values around 1000 Ωm that locally occurs at a depth of 30-90 meters. On the base of the sudden trend of the isoresistivity lines, we identify three fault zones, NNW-, NNE- and WSW-oriented, that locally connect top to bottom the uppermost conductive electro-layer with the deeper resistivity anomalies. The tomography of the Bitti vertex shows a stratified resistivity array composed of: i) a near-surface resistive electrolayer; ii) an intermediate conductive layer and iii) a resistive deep electrolayer, which is characterized by a large deep conductive anomaly that is bounded by suddenly graded resistivity drop and corresponds to two fault systems that are broadly WSW-striking. In conclusion, the hydro-structural setting of the granodiorite of the Bitti vertex consists of a more complex internal structure of the aquifer with respect to the orthogneiss of the Onanì vertex. Provided that ERT is a low-cost, non-invasive and rapid tool that has allowed characterizing the hydro-structural setting of the ET vertices, survey will be conducted also on the tunnel traces.

Primary authors: LONGO, Vittorio (Università di Sassari); OGGIANO, Giacomo (Istituto Nazionale di Fisica Nucleare); CARDELLO, Giovanni Luca

Presenter: LONGO, Vittorio (Università di Sassari)

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **5** Type: **Talk**

Geological and geoelectrical survey of the metamorphic and intrusive rocks on the Einstein Telescope site (Sardinia, Italy)

Monday, 8 November 2021 09:00 (1 hour)

The geological characterization preceding the construction of a large-scale underground structure, such as the Einstein Telescope (ET), is a mandatory step of civil engineering studies. The ET Italian candidate site is located in the Variscan basement of Sardinia because of its geodynamic quietness, very low seismicity and anthropogenic seismic noise. The ET layout is currently projected as an underground triangular infrastructure (10 km long sides), whose vertices are located between the villages of Lula, Bitti and Onanì, and is confined within an area not crossed by main regional faults. The geological features of the Palaeozoic metamorphic rocks are the result of ductile deformation with folds and related planar and linear anisotropies. This polydeformed metamorphic basement was intruded by several granitic bodies and by mafic to acidic dykes, mostly of early Permian age. A brittle to ductile fault network affects the metamorphic-plutonic ensemble. Within such a structural frame it is difficult to accurately predict lithologies at depth by means of the geological survey alone. Thus, we started an integrated multidisciplinary cartographic, structural and Electrical Resistivity Tomography (ERT) study. The results as far obtained are useful to highlight the structural elements at depth, particularly lithological contacts and fault zones, which are relevant for the prediction of mechanic behaviour of the rocks along the tunnels tracks as well as the groundwater occurrence.

We have merged the lithologic information from published maps (also by comparing satellite images) and new data collected in the field. Newly traced morphostructural lineaments mark the distribution of fault zones from the areas that surround the boreholes drilled at two vertices. The analysis of satellite images has thus allowed to define the segmentation of principal faults, whose length is limited at surface to a few kilometers (2.5 km max).

Field structural results provided evidence of at least two ductile phases (D2+3) almost completely transposing the original bedding and the oldest schistosity (S0+1). Faults are mainly NNW-, and WSW-striking and are associated with either more altered bedrock and/or cataclastic bands. The WSW-striking faults are often conjugated with E- to NE-striking faults. Fault zones can be associated with thick quartz veins, or thin chlorite fibers. Locally, they are crossed by intense fracture arrays, pseudotachilites and gouge that can be as thick as a meter.

Near the vertices that were site of drilling (ca. 250 m total depth), ERT tomography was carried out, providing a complex internal resistivity stratification, that consists of up to three levels with variable distribution and thickness. As supported by field observation, we have interpreted the more conductive electrolayer as regolith and alluvial units, while the most resistive electro-layers correspond with the less-altered granitoids. The sudden trend of the isoresistivity line, that also recognized from satellite images or field evidence, was related to saturated fractured zones.

Thus, matching the vertical information provided by the 2D ERT results and the geological information from the study area, we provide a more accurate estimate of satured fault geometry at depth. Beside the ET vertices, similar approach can be adopted in predicting zone of hazards during the tunnel drillings.

Primary author: Dr CARDELLO, Giovanni Luca (INFN Catania)

Co-authors: Prof. OGGIANO, Giacomo (Istituto Nazionale di Fisica Nucleare); Dr LONGO, Vittorio (Università di Sassari)

Presenter: Dr CARDELLO, Giovanni Luca (INFN Catania)

Session Classification: Sardinia Geology, Long and Short term measurements

Contribution ID: **6** Type: **Talk**

Geophysical characterization of the shallow subsurface in sites P2 and P3 from high-resolution active-source seismic profiling and downhole data: preliminary results

Monday, 8 November 2021 10:00 (30 minutes)

In the framework of the Project Einstein Telescope Sos Enattos, we report the preliminary results of the active-source seismic surveys performed by the INGV team in sites P2 (labelled as Onani) and P3 (labelled as Bitti) in July and September 2021. The main goal of these surveys was the reconstruction of the shallow subsurface velocity structure in correspondence of the two drilling sites.
In site P2, we acquired a 355 m-long high-resolution seismic profile using an array of 72, 5 m-spaced 4.5 Hz vertical geophones centred on the 245 m-deep borehole. The survey was complemented by a downhole seismic testing with average vertical shot spacing of 2 m and a maximum recording depth of 230 m. In both cases, the source of elastic energy was provided by a buffalo gun. We remark that unfavourable local logistic conditions prevented the deployment of a longer geophone array, as well as the use of a vibroseis source. Shots of the 2-D seismic survey were also recorded by two linear arrays of 3-component nodes operated by the Karlsruhe Institute of Technology (KIT) in the surroundings of the drilling site. First arrival traveltime data from the seismic profile have been handpicked and inverted using two different tomographic techniques: 1) a linearized inversion based on the iterative perturbation of an initial smooth gradient Vp model; 2) a fully non-linear inversion with no a priori constraint based on a multi-scale imaging strategy. In this case, synthetic traveltimes are computed by an advanced and high-precision finite-difference Eikonal solver that avoids ray-tracing and allows accounting for transmitted, diffracted or head waves in the presence of strongly heterogeneous medium. The multi-scale refraction tomography enabled a maximum investigation depth of about 90 m in the middle of the profile, and an average spatial resolution of about 10 m. The resulting 2-D P-wave velocity model shows a shallow layer of relatively low Vp about 15 km thick characterized by velocities rapidly increasing with depth from 1000 m/s to 3000 m/s. The upper layer can be interpreted as a high-to-weakly weathered and possibly water-bearing zone in the granitoid (Goceano-Bittese Granitoid Complex). It overlies very-high velocity rocks (from 4700 m/s to 6200 m/s) attributable to weakly fractured granitoids. Some important lateral velocity variations are evident, including a relatively low-velocity sub-vertical zone in the central part of the model. The low-velocity zone with Vp in the 4000-4500 m/s range is embedded in a fast region (Vp around 5000 m/s) and it shows an apparent dip to the south-west. It is located about 30 m to the west of the borehole. Results from the linearized approach provided similar results but in this case the penetration depth is shallower (about 60 m). The comparison with the resistivity model obtained by the co-located ERT survey performed by University of Sassari unravels very similar features, with low-Vp and high-Vp structures corresponding to conductive and high-resistivity regions. We stress that the sub-vertical low-Vp anomaly matches a comparable conductive structure. Therefore, it might represent a fractured region associated with a fault-zone.
In site P3, local logistical conditions enabled us to acquire two intersecting and nearly orthogonal seismic profiles that are 835 m and 715 m long. We deployed two fixed arrays of 168 and 144 5-m-spaced 4.5 Hz vertical geophones, respectively. One of the two profiles is tied to borehole P3, which was used for a downhole seismic testing with average vertical shot spacing of 2 m down to a depth of 230 m. We used a vibroseis (IVI Minivib) as a source of elastic energy, with shots

spaced on average 10 m. The acquisition geometry is not conventional, since it is based on the advanced multi-fold wide-aperture seismic profiling that allows the collection of both large-offset refraction data and high-fold near-vertical/wide-angle reflection data. In addition, the used source allows recording far offset refraction data up to maximum source-receiver distances of 700-1000 m and usable near-vertical deep reflections down to 500-1000 m depth, depending on the local environmental and geologic conditions. During the acquisition of the profile tied to the borehole, we also installed a downhole geophone. The in-line shots were recorded at three different depths (100, 150, and 200 m, respectively) to provide complementary borehole measurements for the non-linear refraction tomography. In-line shots were also recorded by a large-aperture/dense 3-D nodal array and by a DAS vertical array both installed by KIT. The seismic survey required the accurate GPS positioning of all shot points and geophones to take into account the rough topography. The pre-processing of both seismic profiles is in progress.

Primary authors: Dr VILLANI, Fabio (Istituto Nazionale di Geofisica e Vulcanologia); Dr MARAIO, Stefano (Istituto Nazionale di Geofisica e Vulcanologia); Mrs CARADONNA, Cristina (Università di Siena - Centro di Geotecnologie); Dr IMPROTA, Luigi (Istituto Nazionale di Geofisica e Vulcanologia); Dr DE MARTINI, Paolo Marco (Istituto Nazionale di Geofisica e Vulcanologia); Dr BRUNORI, Carlo Alberto (Istituto Nazionale di Geofisica e Vulcanologia); Dr COLTELLI, Mauro (Istituto Nazionale di Geofisica e Vulcanologia); Dr CAVALLARO, Danilo (Istituto Nazionale di Geofisica e Vulcanologia); Dr FIRETTO CARLINO, Marco (Istituto Nazionale di Geofisica e Vulcanologia); Dr RAPISARDA, Salvatore (Istituto Nazionale di Geofisica e Vulcanologia)

Presenter: Dr VILLANI, Fabio (Istituto Nazionale di Geofisica e Vulcanologia)

Session Classification: Sardinia Geology, Long and Short term measurements

Contribution ID: **7** Type: **Talk**

8. Seismic and Remote Sensing Based Preliminary Results in the ET Region (Belgium)

Monday, 8 November 2021 18:50 (30 minutes)

The variations in ambient noise levels, subsurface elastic properties and surface deformation can affect the performance of Einstein Telescope (ET) in various ways. Therefore, the present study aims at providing an overview of integrated geophysical and remote sensing approaches in the Belgian side of prospective ET installation region, an advanced and super sensitive Gravitational-wave observatory. The study includes: i) assessing levels of ambient noise from the continuous data recorded at the borders and to quantify local seismicity, ii) seismic temporary arrays and HV measurements to retrieve the subsurface elastic properties and iii) remote sensing to detect the ground surface displacements and environmental changes (in perspectives).
Our continuous seismic data acquisition campaigns started in February 2020 to the present. Seven broadband velocimeters CMG-6TDs were installed in private properties (cellars) along the BE-NL-DE borders. Similar sensors were used for the temporary survey including passive seismic data at arrays of variable apertures and single station HV measurements. The remote sensing analyses consist in processing Sentinel-1 images with Synthetic Aperture Radar Interferometry (InSAR) techniques validated by corner reflectors and GNSS measurements. A Drone will also enable the creation of surface models of target areas along fault lines. The InSAR processing will include the use of the geohazard platform and multi-temporal small baselines (MSBAS) time series algorithms. The preprocessing of continuous data, includes removing instrumental response, demeaning, detrending and saving data in miniSEED files as per SEED standards. We calculated the displacement RMS amplitude at different frequency ranges (0.10-1.00, 1.00-20.00, 0.01-100.00) compared them with the people's mobility using change-point analysis (PCA) which found well correlated. Additionally, the time-lapse HVSR curves were also calculated at the semi-permanent array to see the possible changes in frequency and amplitude of the peak as a function of different socio-climatological factors. From the array measurements, 1D shear wave velocity profiles were retrieved at different sites from the inversion of surface wave dispersion properties. This study, on completion will help in better understanding of the sources of noise, subsurface elastic structures and ground surface displacements in the prospective site for installation of ET.

Keywords: Corner reflectors; ground surface displacements; HV; RMS amplitude; shear wave velocity

Primary author: HUSSAIN, Yawar (University of Liege)

Co-authors: Dr CAUCHIE, Léna (University of Liege); Dr SCHLÖGEL, Romy (University of Liege); Mr GERARD, Lucas (University of Liege); Dr HAVENITH, Hans-Balder (University of Liege)

Presenter: HUSSAIN, Yawar (University of Liege)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **8** Type: **Talk**

Wind Turbine Seismic Monitoring Campaign

Monday, 8 November 2021 18:20 (30 minutes)

Wind turbines emit seismic signals due to the rotation of the blades and the movement of the tower. Seismic signals radiated from wind turbines are known to interfere with operational seismic monitoring of natural and induced seismicity. With regard to the Einstein Telescope and the design of the passive and active vibration isolation systems, the seismic radiation from wind turbines poses a major challenge.

We deployed 5 seismic mini-arrays west of the Aachen wind park and recorded the ambient seismic field over the corse of 35 days. The motivation for deploying arrays, rather than single stations, is to in-addition to analyzing the power spectral density (PSD) at each station, beamform the wavefield and extract the direction to the various sources relative to each array.

Our analysis indicates that the amplitude of distinct spectral peaks decreases as a function of distance from the wind park. These spectral peaks are at 1.1, 2.2, and 3.2 Hz and can be attributed to the seismic signal emitted by the wind turbines in the Aachen wind park. The above spectral peaks are observed at the surface seismometer (depth=0 m) and at the borehole seismometer (depth=250 m) hosted in the seismic station TERZ (Terziet, The Netherlands), more than 10 km away from the wind park. Additionally, we found that the amplitude, of the entire spectrum, but specifically of the above spectral peaks is in correlation with wind speed.

Using a time-domain Fisher detector, the data was processed in several frequency bands. The broadband processing results nicely show diurnal variations in the detection density (detections above a certain SNR threshold, per back-azimuth bin, per time window), with an increased detection density during high wind periods, and some persistent sources at certain back-azimuths.

The assumption that the upper soil layer dampens noise from anthropogenic activity at the surface is correct, but for tall structures that are founded in the hard rock, this upper soil layer is of little significance.

Primary author: SHANI-KADMIEL, Shahar (R&D Seismology and Acoustics, KNMI, The Netherlands)

Presenter: SHANI-KADMIEL, Shahar (R&D Seismology and Acoustics, KNMI, The Netherlands)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **10** Type: **Talk**

Geology in the EMR Region and Geological Field Investigations

Monday, 8 November 2021 15:30 (30 minutes)

In order to find optimal position for the Einstein-Telescope (ET) in the Euregio Meuse-Rhine (EMR), a detailed understanding of the geological and structural conditions, both on the ground and subsurface is crucial. The short term (during excavation) and long-term performance of the ET underground infrastructures are primarily depended on the geological and structural conditions of the ground. Literature research provides (a) a description of the rocks occurring in the area, (b) spots where these rocks are present at the surface and (c) an overview of the geological structures being present. The structures in the EMR region can be subdivided in 2 sets based on their orientation. The first set are NE-SW striking structures include folds (synclines and anticlines) thrust faults and fractures. Both features result from the Variscian orogeny. The second set are NW-SE striking faults and fractures. These structures originate from Mid-Devonian tectonics but became reactivated several times. Also these NW-SE striking structures are active today and form the Lower Rhine Embayment.

Within the framework of the project, comprehensive geological and rock mechanical field investigations have taken place in the EMR area to obtain a detailed knowledge on possible host-rocks of the caverns and tunnels. In a first step, representative rocks from surface outcrops within the ET-Project area were subject to a geological and geotechnical assessment, comprising 1) in-situ investigations (determination of rock type, identification and orientation fracture sets and fracture networks), 2) laboratory work in order to determine the petrophysical and mechanical properties (UCS, BTS, P-Wave velocity) and 3) modelling (ground behavior prediction, hydro-mechanical fault zone properties).

As a second step and subsequent to the surface outcrop mapping, two drilling campaigns were started in Summer 2021 and are currently ongoing in the southernmost Netherlands. These two boreholes are planned to reach down to a target depth of 250 m by the end of November 2021. Upon completion of the borehole drilling, geophysical borehole-logging, in-situ hydraulic testing and stress measurements will be carried out. The planned in-situ and laboratory testing will generate a dataset, that is suitable for further assessments of the rocks and structures in the EMR region. In addition, 2-D seismic campaign is also planned which allows to map the structures and rock layers in the subsurface over a longer distance. The combination of literature research, borehole and core investigations and seismic interpretation will set the basis to identify best possible locations for ET in the EMR region.

Primary authors: ZINSER, Jonathan; WALDVOGEL, Marius (Geological Institute, RWTH Aachen University); BURCHARTZ, Raphael; Mr CHUDALLA, Nils (RWTH Aachen University); Dr HAMDI, Pooya (RWTH Aachen University)

Presenters: WALDVOGEL, Marius (Geological Institute, RWTH Aachen University); BURCHARTZ, Raphael

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **11** Type: **Talk**

3D Cross-border models –Geological modeling, uncertainty analysis for site investigation, and online GIS solutions

Monday, 8 November 2021 16:30 (30 minutes)

The requirements for the Einstein Telescope challenge geologists to come up with representations of the subsurface as accurate as possible. A state-of-the-art way are digital 3D models of the subsurface. Various measurements and interpretation of geological observations (e.g. geophysical methods, outcrop studies) serve as input for these models. However, one must also consider the inherent errors of these various methods to create realistic models of the subsurface. The resulting uncertainties can be helpful in decision making during site investigation and site construction.

We use an implicit modeling approach to model interfaces based on points and orientations gathered from literature research and field campaigns. In the EMR region, we deal with cross-border data which need to be homogenized in order to construct one model. The 3-D models of the EMR region are created using the open-source Python library GemPy. Uncertainties are determined with probabilistic methods after recomputing models and assigning each input point a random deviation from a normal distribution.

Another important topic is the accessibility of geological, geotechnical and geophysical data. As more information is generated, platforms must be deployed to share relevant spatial data between all involved parties. Therefore, an online GIS solution is being developed to visualize and download spatial data and engage the public in an outreach effort. We will discuss the functionality of the GIS Web App which is developed using the ArcGIS Experience builder.

Primary author: CHUDALLA, Nils (RWTH Aachen University - CGRE)

Co-author: Prof. WELLMANN, Florian (RWTH Aachen University - CGRE)

Presenter: CHUDALLA, Nils (RWTH Aachen University - CGRE)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **13** Type: **Talk**

Design and construction of two boreholes for seismometers installation in support of ET seismic characterization in Sardinia

Tuesday, 9 November 2021 11:30 (30 minutes)

One of the key activities in the context of seismic and environmental noise characterization has been the installation of two borehole seismometers in proximity of potential ET triangle corners. The design has been completed in July 2020, the boreholes excavation with relevant surface works between April and August 2021 and the sensors installation in September 2021.
The measurement station for each site is composed by the following main elements: a) a steel lined boreholes for the installation of the borehole seismometer; b) a surface seismometer located inside an inspection pit; c) an electronic box containing the DC power supply, the DAQ systems of seismometers and magnetometers and the UMTS modem for data transmission; d) photovoltaic panels.
The first measurement station (borehole named P2) is located in the Bitti municipality at about 770 m a.s.l. and it is excavated in ortogneiss up to about 270 m from the ground level to locate the sensor at a depth of 264 m. The second measurement station (P3) is located in the Onanì municipality at about 720 m a.s.l and it is excavated in granitoids up to about 260 m from the ground level; the sensor is located at a depth of about 252 m.
The boreholes excavation has also allowed to perform different investigations (cutting analysis, geophysical logs, acoustic camera BHTV) and consequently to obtain preliminary information on the quality of the rock mass that will host the underground works planned for the construction of the ET detector.
The first part of talk focuses on the design of the instrumented boreholes with particular attention to the following main issues: selection of the optimum location, borehole drilling requirements (dimensions, verticality, etc.), excavation techniques and construction material selections. The second part illustrates the construction activities, the final configuration of the works, final construction time and cost.

Primary authors: Mr ROSSINI, Claudio; Prof. NAPOLEONI, Quintilio; Prof. D'URSO, Domenico; Prof. RICCI, Fulvio; Mr SCHILLACI, Gaetano; Prof. OGGIANO, Giacomo; Dr NATICCHIONI, Luca; Prof. MARSELLA, Maria; Prof. RAPAGNANI, Piero

Presenter: Mr ROSSINI, Claudio

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **14** Type: **Talk**

Main geotechnical issues and planned investigations for the design of ET Infrastructure in Sardinia

Tuesday, 9 November 2021 09:30 (30 minutes)

An overall feasibility study is carried out in Sardinia as one of potential site for the construction of the Einstein Telescope (ET). One of the primary activities of this feasibility study is the design and implementation of a geotechnical and geophysical campaign aimed to acquire all the information for the development of an accurate geo-mechanical model of the rock masses which will host the underground infrastructures. The outcomes of this activity, together with a detailed geological and structural model, is fundamental for the development of underground works design, including the selection of the optimum orientation and geometry of the caverns, geotechnical stability and structural analysis, definition of temporary and the permanent lining of tunnels and caverns, evaluation of the excavation techniques, definition of a model for the risk assessment during tunnels construction, evaluation of time and cost.
The first part of talk focuses on the main geotechnical issues related to the design and construction of the ET underground infrastructures with particular reference to the specific geological and geotechnical characteristics of the Sardinia site. The second part illustrates geotechnical activities in progress and planned.

Primary authors: Mr ROSSINI, Claudio; Prof. MARSELLA, Maria; Prof. NAPOLEONI, Quintilio; Mr ROSSI, Francesco; Dr D'ARANNO , Peppe Junior Valentino

Presenter: Mr ROSSINI, Claudio

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **15** Type: **Talk**

Feasibility study for ET Infrastructure for Sardinia site: location optimization, GIS-BIM three-dimensional modelling, multicriteria analysis

Tuesday, 9 November 2021 09:00 (30 minutes)

The talk describes the feasibility study activities related to the selection of the optimal configuration and localization of the ET infrastructures in Sardinia. This analysis requires the simultaneous evaluation of several scientific, territorial, environmental and geological/geotechnical aspects. For this reason, a different specific tools, interconnected with each other, have been implemented.
A GIS geo-database, to store and manage all useful maps and data and to carry out geospatial and geostatistical analysis to evaluate the coherence with technical constraints and scientific requirements, is integrated with BIM model adopted for describing the civil infrastructures.
The capability of evaluating different geometric configurations/scenarios is strengthened by the development of a multiple criteria decision-making tool, aimed to make all the relevant quantitative limiting factors compliant with scientific and engineering requirements.
By adopting this analysis approach the study for the construction of ET infrastructure will be performed using an iterative process developed through multiple phases of analysis, verification and validation, to optimize the design solution both for triangular and L-shape configurations.

Primary authors: Mr PAOLI, Andrea; Mr ROSSINI, Claudio; Prof. MARSELLA, Maria; Dr ALLOCCA, Annalisa; Mr CITTADINO, Daniele; Prof. CALLONI, Enrico; Mr ROSSI, Francesco; Mr SCHILLACI, Gaetano; Mr PAOLI, Luca; Dr D'ARANNO , Peppe Junior Valentino; Prof. NAPOLEONI, Quintilio

Presenter: Prof. MARSELLA, Maria

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **16** Type: **Talk**

Geotechnical Characterization Campaign for Design of ET Underground Infrastructures - Tunnelling Aspects and Challenges

Tuesday, 9 November 2021 10:30 (30 minutes)

The Einstein Telescope (ET) is an advanced gravitational-wave observatory, currently in the planning stage that allows to further understanding the Universe through the observation of gravitational waves. The border region between the Netherlands, Belgium and Germany (Euregio Meuse-Rhine) is being considered as a possible location to host the third generation gravitational wave observatory due to its tranquility and stable ground. The ET project involves construction of a triangular shape underground facility with 10 kilometers long arms at a depth of 200-300 meters below surface. The subsurface structure will then host multiple laser interferometers. As an initial step, a feasibility study to determine whether the Einstein telescope can be built in the Euregio Meuse-Rhine is planned to be carried out, involving a number of in-situ and laboratory tests to define the geological, structural, hydrological and mechanical characteristics of rocks that may be encountered during construction of the underground excavation.

The Einstein telescope sub-surface infrastructures involve constructing a series of large caverns (up to 30 m in height) at each corners and long tunnel drives with estimated length of 10 km to connect the corners. To allow for comprehensive planning, development of a preliminary tunnel design including alignment options, layout of the underground facilities, and time needed for construction are crucial. A detailed understanding of the geological, structural, hydrogeological and geotechnical conditions of the ground should be carried out to develop a rock mechanical and tunnel behavior model. These models allow the identification of problematic and cost-intensive geological zones in underground excavations and provide the basis for of the investigation of tunnel alignment options, tunnel excavation methods and schedule, estimate uncertainties and costs based on support classes, initial and long term water inflow rates and time dependent rock deformations (i.e. swelling or consolidation).

The presentation provides and overview of the current works being carried out in the framework of the prefeasibility study of Einstein Telescope in EMR region with the main focus on tunneling aspects and challenges. Here, we discussed the preliminary assessment of required underground layouts, potential excavation methods and their cost and benefits and particular challenges with respect to the ET project.

Primary authors: HAMDI, Pooya (Senior Scientist, RWTH University Aachen); Mr ZINSER, Jonathan (RWTH Aachen University); Mr OTT, Johannes (RWTH Aachen University); Prof. AMANN, Florian (Chair of Engineering Geology)

Presenter: HAMDI, Pooya (Senior Scientist, RWTH University Aachen)

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **17** Type: **Poster**

The Archimedes' prototype at SAR-GRAV laboratory

Wednesday, 10 November 2021 19:00 (1 hour)

As a prototype of the Archimedes experiment, a high sensitivity balance has been constructed. This balance can be used as a tiltmeter and nowadays it is installed at the SAR-GRAV laboratory in Sardinia. The laboratory is settled at the Sos-Enattos site (Lula, Nuoro), a former mine located in a region characterized by low seismic noise. The tiltmeter is a beam balance with an interferometric optical readout and it reaches a sub-picoradiant sensitivity in the frequency region between 2 and 20 Hz and therefore, the Archimedes prototype has the best sensitivity in the world. The result was obtained by a direct measurement of the ground tilt.

Primary authors: PESENTI, Luca (Istituto Nazionale di Fisica Nucleare); ROZZA, Davide (LNS)

Co-author: ON BEHALF OF ARCHIMEDES COLLABORATION

Presenters: PESENTI, Luca (Istituto Nazionale di Fisica Nucleare); ROZZA, Davide (LNS)

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **18** Type: **not specified**

Hydrogeophysical characterization of the E-Test site in the Euregio Maas-Rhine

The characterization of the subsurface in terms of geological structure and hydrogeological behavior is of great importance to design the Einstein Telescope at depths greater than a few hundreds of meters. Hydrogeophysical approaches aim at contributing to the conceptual models used in hydrogeology to study the environmental impacts and to understand the hydrodynamic response of the geological layers.

In order to perform an accurate hydrogeophysical characterization at depth, geoelectric surface measurements will be combined with results from cross-borehole measurements, which provide a better resolution at larger depths.

Two different approaches were chosen to address the geoelectric surface measurements. Conventional 2D ERT profiles are conducted to gather information on lithology and potential faults in the area of interest, especially in the potential corner points of the telescope.
In order to obtain data from the target depth of the Einstein Telescope deep 3D ERT surveys will be performed, requiring specific survey design accounting for realistic geological structures and lithological information.

To make a quantitative interpretation possible, an inversion approach, giving the opportunity to couple petrophysical models to the measured electrical parameters, is developed and validated on synthetic data. Laboratory measurements are performed on samples of the relevant rock formations, providing a basis for calibration of the inversion and for the interpretation of the results.

Primary authors: Prof. KEMNA, Andreas (University of Bonn); Prof. NGUYEN, Frédéric (University of Liège); Mr FORTH, Yannick (University of Liège); Mr HASE, Joost (University of Bonn)

Presenter: Mr FORTH, Yannick (University of Liège)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **19** Type: **Talk**

Preliminary results from the boreholes at the ET corners in Sardinia

Monday, 8 November 2021 12:30 (30 minutes)

In this talk we discuss the preparation of two boreholes at the corners, named P2 and P3, of the ET triangle in Sardinia. The boreholes are designed to host broadband seismometers dedicated to a long-term seismic monitoring at about 250m underground. We also report the principal aspects of the geophysical logs of the boreholes and the sensor installation downhole. Finally, we present the preliminary results from the first month of seismic monitoring, which demonstrate the remarkable quality of the site, showing a seismic noise background which crosses the Peterson's low noise model in a frequency range of 2-7Hz.

Primary author: Dr NATICCHIONI, Luca (INFN Roma)

Co-authors: Dr CARDELLO, Luca (UNISS); Dr CITTADINO, Daniele (INFN); Dr GIUNCHI, Carlo (INGV); D'URSO, Domenico (University of Sassari and INFN-LNS); Prof. NAPOLEONI, Quintilio (Sapienza univ. di Roma); DI GIOVANNI, Matteo (Istituto Nazionale di Fisica Nucleare); OGGIANO, Giacomo (Istituto Nazionale di Fisica Nucleare); PERCIBALLI, Maurizio (ROMA1); RAPAGNANI, Piero (Istituto Nazionale di Fisica Nucleare); RICCI, Fulvio (Istituto Nazionale di Fisica Nucleare); ROSSINI, Claudio; SACCOROTTI, Gilberto (Istituto Nazionale di Geofisica e Vulcanologia); SCHILLACI, Gaetano (Istituto Nazionale di Fisica Nucleare); MARSELLA, maria (Sapienza University, Rome)

Presenter: Dr NATICCHIONI, Luca (INFN Roma)

Session Classification: Sardinia Geology, Long and Short term measurements

Contribution ID: **20** Type: **Talk**

Broadband seisometer deployment in boreholes

Wednesday, 10 November 2021 11:30 (30 minutes)

In this talk I summarize the principal aspects to be considered for broadband seismometer deployment in boreholes, which are useful sensing devices for a Newtonian Noise subtraction system. I show what we learned from this kind of installations in Sardinia, e.g. costs and technical aspects to be considered. Finally, I point out some considerations about the development of seismometer chains for borehole installations.

Primary author: Dr NATICCHIONI, Luca (INFN Roma)

Presenter: Dr NATICCHIONI, Luca (INFN Roma)

Session Classification: Newton Noise Studies

Contribution ID: **21** Type: **Poster**

Underground magnetic noise at the SoS Enattos site

Wednesday, 10 November 2021 19:00 (1 hour)

We present an extended report on the magnetic noise at the SoS Enattos site, using data collected underground (-111 m) from 2020/09/22 to 2021/11/01 for the N-S magnetic component. To track the time evolution of the noise, we use the Band-Limited Root Mean Square (BLRMS) analizing different frequency bands. We show the diurnal and seasonal variability of the first Schumann resonances. The observed variability is compatible with other measurements performed in different observatories. We also report interesting results in the low frequency region between 1 Hz and 5 Hz where an important disturb is found during the spring and summer period, and in the 50 Hz region showing a diurnal variability for the 50 Hz peak.

Primary author: D'ONOFRIO, Luca (Istituto Nazionale di Fisica Nucleare)

Presenter: D'ONOFRIO, Luca (Istituto Nazionale di Fisica Nucleare)

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **22** Type: **Poster**

Thermal modulation of YBCO samples through radiation heat transfer for the Archimedes experiment

Wednesday, 10 November 2021 19:00 (1 hour)

The main scientific goal of Archimedes experiment, installed in the SarGrav laboratory in Sardinia (one of the quietest places in Europe and candidate site for the third generation GW detector Einstein Telescope), is to investigate whether and how vacuum fluctuations interact with gravity.
A high sensitive balance will measure the small weight variations of two YBCO superconducting disks (type II high Tc), suspended at the ends of its arm. By modulating the temperature of these disks around their critical temperature (91 K) with a modulation frequency of a few mHz, the vacuum energy contained in them will be modulated and, if it gravitates, its weight. This modulation can only occur through the radiative heat exchange mechanism: the system must be isolated from any external interaction that could add energies other than that of vacuum.
With this objective in mind, a first small-scale prototype was developed by the INFN Roma 1 division to study temperature variation of a YBCO sample through radiation heat transfer alone. The first cryogenics tests have already started, and the data is being analysed.

Primary author: VALENTINA MANGANO ON BEHALF OF THE ARCHIMEDES COLLABORATION

Presenter: VALENTINA MANGANO ON BEHALF OF THE ARCHIMEDES COLLABORATION

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **23** Type: **Poster**

Weighing quantum vacuum with Archimedes experiment

Wednesday, 10 November 2021 19:00 (1 hour)

The Archimedes experiment aims at measuring the interaction between vacuum fluctuations and gravity. Archimedes will measure the force exerted by the gravitational field on a Casimir cavity whose vacuum energy is modulated with a superconductive transition, by using a balance as a small force detector. If the vacuum energy does interact with gravity, a force directed upwards acts on the cavity and can be interpreted as the lack of weight of the expelled EM modes, in similarity with the Archimedes buoyancy of fluid. The expected torque generated with this modulation is of the order of $10^{-13}\ Nm/\sqrt{Hz}$. To detect such a small force, a very sensitive beam-balance has been suitably designed. A first prototype has been installed and tested in the SarGrav Laboratories at the Sos-Enattos site (Lula, Nuoro) which is seismically very quiet. In the region of tens of mHz, at which the Archimedes modulation will take place, the torque sensitivity has been recently measured to be around $5 \times 10^{-12} Nm/\sqrt{Hz}$. At present, the final setup is being installed at the SarGrav surface Laboratories in view of the final measurement of the quantum vacuum weight, which is expected to be performed in 2024.

Primary authors: ALLOCCA, Annalisa (Universita' di Pisa - INFN Pisa); Mr ERRICO, Luciano (Università Federico II Napoli); ON BEHALF OF ARCHIMEDES COLLABORATION

Presenter: ALLOCCA, Annalisa (Universita' di Pisa - INFN Pisa)

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **24** Type: **Poster**

A nested inverted pendulum for ET suspensions: preliminary studies

Wednesday, 10 November 2021 19:00 (1 hour)

For ground-based GW detectors, seismic vibration is the dominating source of noise in low frequency region (0.1 to 10 Hz), limiting both sensitivity and duty cycle. Thanks to high performant suspension systems, like the Virgo Superattenuator, the presently operational 2nd generation advanced GW antennas have extended their detection band down to 10 Hz. The plan for future 3rd generation detectors, like the Einstein Telescope (ET) aim to further extend the detection band down to 2-3 Hz. This requires, underground locations, where seismic noise is about 100 time smaller than on surface, together to other technological improvements like cryogenic payloads
and reduced thermal noise. Anyway to achieve the attenuation value of 10^-18m/sqrt(Hz) at few Hz, the suspensions of the optical components must be upgraded with respect to the 2nd generation ones, in order to improve seismic attenuation in low frequency and reduce as far as possible the frequency of mechanical resonances below the detection band. In this poster, preliminary studies and performances of a seismic isolation system adopting a nested, double inverted pendulum will be presented. Residual motion of the test mass, calculated by combining the transfer function and seismic noise measured at Sos-Enattos site, will be compared with respect the nominal ET's sensitivity curve for evaluating benefits, limits and technological challenges connected to the development of this system,and define requirements for control strategies.

Primary author: TROZZO, Lucia (Istituto Nazionale di Fisica Nucleare)

Presenter: TROZZO, Lucia (Istituto Nazionale di Fisica Nucleare)

Session Classification: Poster Session @ Sos Enattos Mine

Contribution ID: **25** Type: **Talk**

Array analyses of the seismic noise wavefield at the possible vertices of the Einstein Telescope in Sardinia (Italy)

Monday, 8 November 2021 12:00 (30 minutes)

The region surrounding the dismissed mine of Sos Enattos (Sardinia, Italy) is the Italian candidate site for hosting Einstein Telescope (ET), the next-generation gravitational wave (GW) detector. The site that will host ET must fulfill stringent requirements on seismic disturbances, particularly in the bandwidth 1-10 Hz, where the seismic noise is expected to be dominated by sources of anthropogenic origin. Here, we describe the field surveys conducted over the past year, with the specific goal of characterizing the noise wavefield at three specific locations within the area of interest. Data have been gathered using small-aperture (150-300m) seismic arrays instrumented with low-noise broad-band sensors. The first array, deployed in proximity to the Sos Enattos mine, was composed of 15 stations which operated for a 15-day-long period. The other two arrays were composed of up to 21 sensors, and were deployed in proximity of two boreholes specifically drilled for sampling the seismic wavefield at depth, and for deriving accurate 1-D velocity profiles through downhole seismic probing (see respectively the contributions by L. Naticchioni and F. Villani, this workshop). The performances of the different arrays are analysed in terms of (a) spatial coherence, (b) response functions to vertically-incident plane waves at different target frequencies, and (c) site response, evaluated through Horizontal-to-Vertical Spectral Ratios (HVSR). At all the sites, day-to-night spectral ratios indicate that anthropogenic sources are mostly associated with a wide spectral lobe spanning the 2-20 Hz frequency band. At the Sos Enattos site, superimposed to that lobe are narrow spectral peaks located within the 2-8 Hz frequency range. Results from slowness analyses indicate that those peaks are likely related to vehicle traffic along the main road running east of the mine. At the same site, the dispersive properties of surface waves are evaluated from the recordings of a mine blast, and then inverted for a 1-D shear-wave velocity (Vs) profile. Results indicate Vs spanning the 1800-2000 m/s and 2500-2700] m/s intervals at the surface and at ~200 m depth, respectively. Analysis of the noise wavefield at the other two sites yield similar results: anthropogenic sources are transient in nature, and mostly associated with the (sporadic) vehicle traffic. Rayleigh-wave phase velocities derived from the SPatial AutoCorrelation method are in the range 2500-3200 m/s over the 5-10 Hz frequency interval, consistent with the high velocities derived from refraction tomography. Overall, the data gathering has been challenged by the very low noise amplitudes at the sites, often below the sensitivity of the instruments.

Primary authors: GIUNCHI, Carlo (INGV); D'URSO, Domenico; NATICCHIONI, Luca; SACCOROTTI, Gilberto (Istituto Nazionale di Geofisica e Vulcanologia); CARDINI, Alessandro (Istituto Nazionale di Fisica Nucleare); BIAGINI, Damiano (Istituto Nazionale di Geofisica e Vulcanologia); CAPELLO, Marco (Istituto Nazionale di Geofisica e Vulcanologia); ENSING, Josiah; IDŹKOWSKI, Bartosz (ASTROCENT); MANGANO, Valentina (Istituto Nazionale di Fisica Nucleare); PERCIBALLI, Maurizio (ROMA1); SUCHENEK, Mariusz; D'AMBROSIO, Michele (Istituto Nazionale di Geofisica e Vulcanologia)

Presenter: SACCOROTTI, Gilberto (Istituto Nazionale di Geofisica e Vulcanologia)

Session Classification: Sardinia Geology, Long and Short term measurements

Contribution ID: **26** Type: **Talk**

A summary of seismic data analyses at the ET candidate site in Sardinia (Italy)

Wednesday, 10 November 2021 09:00 (15 minutes)

Almost ten years after the first seismic measurements at the Sos Enattos mine, the characterization of the seismic noise wavefield at the ET candidate site in Sardinia has progressed considerably. In this talk, I present a summary of the main results from the active and passive seismic surveys conducted thus far. Particular emphasis is put on those parameters which are most relevant to the thorough modeling of Newtonian Noise (NN), such as surface / underground spectral ratios, wavefield composition, surface-wave dispersion characteristics. Finally, I conclude by outlining some further elements which are required for an improved understanding of wave propagation throughout the target media.

Primary author: Dr SACCOROTTI, Gilberto (Istituto Nazionale di Geofisica e Vulcanologia)

Presenter: Dr SACCOROTTI, Gilberto (Istituto Nazionale di Geofisica e Vulcanologia)

Session Classification: Newton Noise Studies

Contribution ID: **27** Type: **Talk**

Environmental noise measurements at Sos Enattos

Monday, 8 November 2021 11:30 (30 minutes)

In this talk I present an update of the long term measurement campaign going on in Sardinia, for the environmental noise characterization of the ET candidate vertexes. I will mainly focus on the magnetic noise measured both in surface and underground of the Sos Enattos site, as well as in P2 (Bitti). A comparison of the Schumann resonances behavior in both sites and a projection of their impact on ET background noise will be given.

Primary author: DE ROSA, Rosario (Istituto Nazionale di Fisica Nucleare)

Presenter: DE ROSA, Rosario (Istituto Nazionale di Fisica Nucleare)

Session Classification: Sardinia Geology, Long and Short term measurements

Contribution ID: **28** Type: **Talk**

Ground Tilt

Tuesday, 9 November 2021 12:00 (30 minutes)

The coupling of ground tilt with the longitudinal degree of freedom is addressed, both in low frequency, below 100 mHz, and the the new frequency region addressed by ET, namely above 2 Hz.
It is shown, at the present stage of ET design, the need of a strong interaction with suspension design WPs, in order to recover the site conditions needed for the planned ET sensitivity.

Primary author: CALLONI, Enrico (Istituto Nazionale di Fisica Nucleare)

Presenter: CALLONI, Enrico (Istituto Nazionale di Fisica Nucleare)

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **29** Type: **Talk**

Summary of long term seismic characterization activities at Sos Enattos

Monday, 8 November 2021 10:30 (30 minutes)

During the last two years, Sos Enattos has been the subject of an extensive seismic characterization campaign with the installation of several permanent and temporary seismic stations. In this presentation, I will give an overview of this long-term characterization campaign highlighting the main results that have been obtained so far, including the very low noise levels that have been measured at Sos Enattos, that ranks among the quietest sites on Earth in the 2 Hz - 10 Hz band, and the effect of weather conditions on our measurements.

Primary author: DI GIOVANNI, Matteo (Istituto Nazionale di Fisica Nucleare)

Presenter: DI GIOVANNI, Matteo (Istituto Nazionale di Fisica Nucleare)

Session Classification: Sardinia Geology, Long and Short term measurements

Contribution ID: **30** Type: **Talk**

Introduction: Subsidies in Euregio Meuse-Rhine and future opportunities

Monday, 8 November 2021 15:00 (30 minutes)

Introduction: Subsidies in Euregio Meuse-Rhine and future opportunities

Primary authors: LINDE, Frank (Nikhef - APPEC); NGUYEN, Frédéric (University of Liège)

Presenters: LINDE, Frank (Nikhef - APPEC); NGUYEN, Frédéric (University of Liège)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **31** Type: **Talk**

Geology in the EMR Region and Geological Field Investigations

Geology in the EMR Region and Geological Field Investigations

Primary authors: WALDVOGEL, Marius (Geological Institute, RWTH Aachen University); BURCHARTZ, Raphael

Presenter: BURCHARTZ, Raphael

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **32** Type: **Talk**

Hydro geophysical Characterization –Active & Passive Seismic

Monday, 8 November 2021 16:00 (30 minutes)

Hydro geophysical Characterization –Active & Passive Seismic

Primary authors: WALDVOGEL, Marius (Geological Institute, RWTH Aachen University); FORTH, Yannick (University of Liège)

Presenters: WALDVOGEL, Marius (Geological Institute, RWTH Aachen University); FORTH, Yannick (University of Liège)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **33** Type: **Talk**

Hydro geophysical characterization of the E-Test site in the Euregio Maas-Rhine

Hydro geophysical characterization of the E-Test site in the Euregio Maas-Rhine

Primary authors: VEECKMANS, Mathieu (Uliege); ORBAN, Philippe (University of Liege)

Presenters: VEECKMANS, Mathieu (Uliege); ORBAN, Philippe (University of Liege)

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **34** Type: **Talk**

Passive Seismic with Medium Aperture Arrays in Limburg

Monday, 8 November 2021 17:50 (30 minutes)

Passive Seismic with Medium Aperture Arrays in Limburg

Primary author: KOLEY, Soumen (Istituto Nazionale di Fisica Nucleare)

Presenter: KOLEY, Soumen (Istituto Nazionale di Fisica Nucleare)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **36** Type: **Talk**

Bayesian ML algorithm for array optimization

Wednesday, 10 November 2021 12:00 (30 minutes)

Newtonian noise (NN) will be the very last sensitivity wall in GW detectors below 10-30 Hz. A NN cancellation system is already foreseen in Virgo for O4. For cancelling this noise, we need arrays of seismic sensors deployed in an optimal way close to the test masses. However, when the seismic field deviates from homogeneity and isotropy, finding the optimal array becomes very challenging. An algorithm has been developed to deal with this issue in Virgo and it exploits Gaussian processes. Designing the optimal array for ET will be even more challenging since we will need seismic data which are expensive to collect in an underground environment: we then need to face these issues with new tools.

Primary author: BADARACCO, Francesca (GSSI)

Presenter: BADARACCO, Francesca (GSSI)

Session Classification: Newton Noise Studies

Contribution ID: **37** Type: **not specified**

SCIENCE IMPACT FOR DIFFERENT MACRO-OPTIONS and GEOMETRY of ET

Tuesday, 9 November 2021 12:50 (30 minutes)

Presenter: FREISE, Andreas (Nikhef and VU Amsterdam)

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **38** Type: **not specified**

The Center for Astrophysics in Lusatia - a possible ET site?

Tuesday, 9 November 2021 10:00 (30 minutes)

Presenter: Prof. HASINGER, Guenther

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **39** Type: **not specified**

Summary of NN relevant analyses of seismic data from EMR site

Wednesday, 10 November 2021 09:15 (15 minutes)

Summary of NN relevant analyses of seismic data from EMR site

Presenter: KOLEY, Soumen (Istituto Nazionale di Fisica Nucleare)

Session Classification: Newton Noise Studies

Contribution ID: **40** Type: **not specified**

Modeling NN for multilayer geology

Wednesday, 10 November 2021 10:00 (30 minutes)

Presenter: BULTEN, henk (Vrije Universiteit Amsterdam/Nikhef)

Session Classification: Newton Noise Studies

Contribution ID: **41** Type: **not specified**

Summary of NN modeling techniques

Wednesday, 10 November 2021 10:30 (30 minutes)

Presenter: HARMS, Jan (Istituto Nazionale di Fisica Nucleare)

Session Classification: Newton Noise Studies

Contribution ID: **42** Type: **not specified**

Seismonet: a deep neural network for NN prediction

Wednesday, 10 November 2021 12:30 (30 minutes)

Presenter: Dr VAN BEVEREN, Vincent

Session Classification: Newton Noise Studies

Contribution ID: **43** Type: **not specified**

Providing priors to Bayesian array optimization

Wednesday, 10 November 2021 13:00 (15 minutes)

Presenter: ANDRIĆ, Tomislav (Istituto Nazionale di Fisica Nucleare)

Session Classification: Newton Noise Studies

Contribution ID: **44** Type: **not specified**

Groundwater Flow Modeling for the EMR Region

Monday, 8 November 2021 17:30 (20 minutes)

Presenters: VEECKMANS, Mathieu (Uliege); ORBAN, Philippe (University of Liege)

Session Classification: EMR Geology, Long and Short term measurements

Contribution ID: **45** Type: **not specified**

Borehole strainmeter measurements

Tuesday, 9 November 2021 12:30 (20 minutes)

Presenter: Prof. RIETBROCK, Andreas (GPI - Geophysical Institute)

Session Classification: Civil Engineering, layouts, prospects

Contribution ID: **46** Type: **not specified**

Welcome

Presenter: Prof. D'URSO, Domenico (University of Sassari and INFN-LNS)

Contribution ID: **47** Type: **not specified**

Excursion

Wednesday, 10 November 2021 14:00 (4 hours)

Session Classification: Visit to Sos Enattos

Contribution ID: **48** Type: **not specified**

Visit to the Canteen Oliena

Wednesday, 10 November 2021 15:00 (3 hours)

Session Classification: Visit to Sos Enattos

Contribution ID: **50** Type: **not specified**

Visit to Sos Enattos Mine

Wednesday, 10 November 2021 18:00 (1 hour)

Session Classification: Visit to Sos Enattos

Contribution ID: **51** Type: **not specified**

Social Dinner

Wednesday, 10 November 2021 20:00 (2 hours)

Session Classification: Visit to Sos Enattos

Contribution ID: **52** Type: **not specified**

Sardinia site studies and characterization - Hands on session

Tuesday, 9 November 2021 16:20 (30 minutes)

Presenter: DI GIOVANNI, Matteo (Istituto Nazionale di Fisica Nucleare)

Session Classification: Hands-on Session