Seismic and Newtonian noise estimate at Terziet-

the Euregio Meuse-Rhine candidate site for Einstein Telescope

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Nikhef

Speaker

Soumen Koley (GSSI)

Description

The Einstein Telescope observatory aims to improve the low-frequency sensitivity of current detectors by more than three orders of magnitude at 10 Hz. This is a challenge, as Newtonian noise is expected to limit the low-frequency sensitivity. Surface array studies of vertical component seismic noise and single-station measurements at a depth of 250 m were conducted at Terziet, Netherlands. The observed surface wave dispersion and ellipticity was used to identify the modal contribution of surface wave noise and derive a subsurface velocity model up to a depth of 200 m. Cross-correlation analysis between surface and underground noise was used to understand the surface-body wave contribution to the underground noise. The observed underground noise attenuation and theoretical surface-wave attenuation estimates were used to understand the contribution of different surface wave modes to the underground noise. Further, the diurnal variation of seismic noise measured on the surface and underground was used to quantify the contribution of far-away body-wave sources to the underground noise. Using these parameters, elastic wave simulations were performed for both surface and body-wave sources to estimate the Newtonian noise at a depth of 250 m. The stochastic body-wave background was found to dominate our Newtonian noise predictions for the BGN-site and would constitute one of the main technical noise background for frequencies below 10 Hz and hence would also require a cancellation.

Australian Government
Australian Research Council

OzGrav

ARC Centre of Excellence for Gravitational Wave Discovery

Site Selection for Next Generation Surface Detectors

Bram Slagmolen

Kevin Kuns, Daniel Toyra, Francois Schiettekatte

CE-project members

The Australian National University

SWINBURNE UNIVERSITY OF TECHNOLOGY · Australian National University · MONASH University · THE UNIVERSITY of ADELAIDE · THE UNIVERSITY OF MELBOURNE · THE UNIVERSITY OF WESTERN AUSTRALIA · AAO · CSIRO

Speaker

Bram Slagmolen (The Australian Nati...

Description

Next generation surface-based gravitational wave detectors will have increased arm-length of up to 40 km. Due to the earth's curvature 30 m deep trenches or tunnels are required for a straight laser beam to reach the end-stations. Locations with minimal soil digging and filling could help reduce the construction cost. We use digital elevation data to find such optimal locations, in the USA, Canada and Australia for 20 km and 40 km long detectors. However, several physical and human geographical aspects have to be considered (e.g., geology, occupation of the land, local indigenous custodians and values, remoteness, etc) for the selection of a viable location.

GWADW Online 2021

Gravitational Wave Advanced Detector Workshop

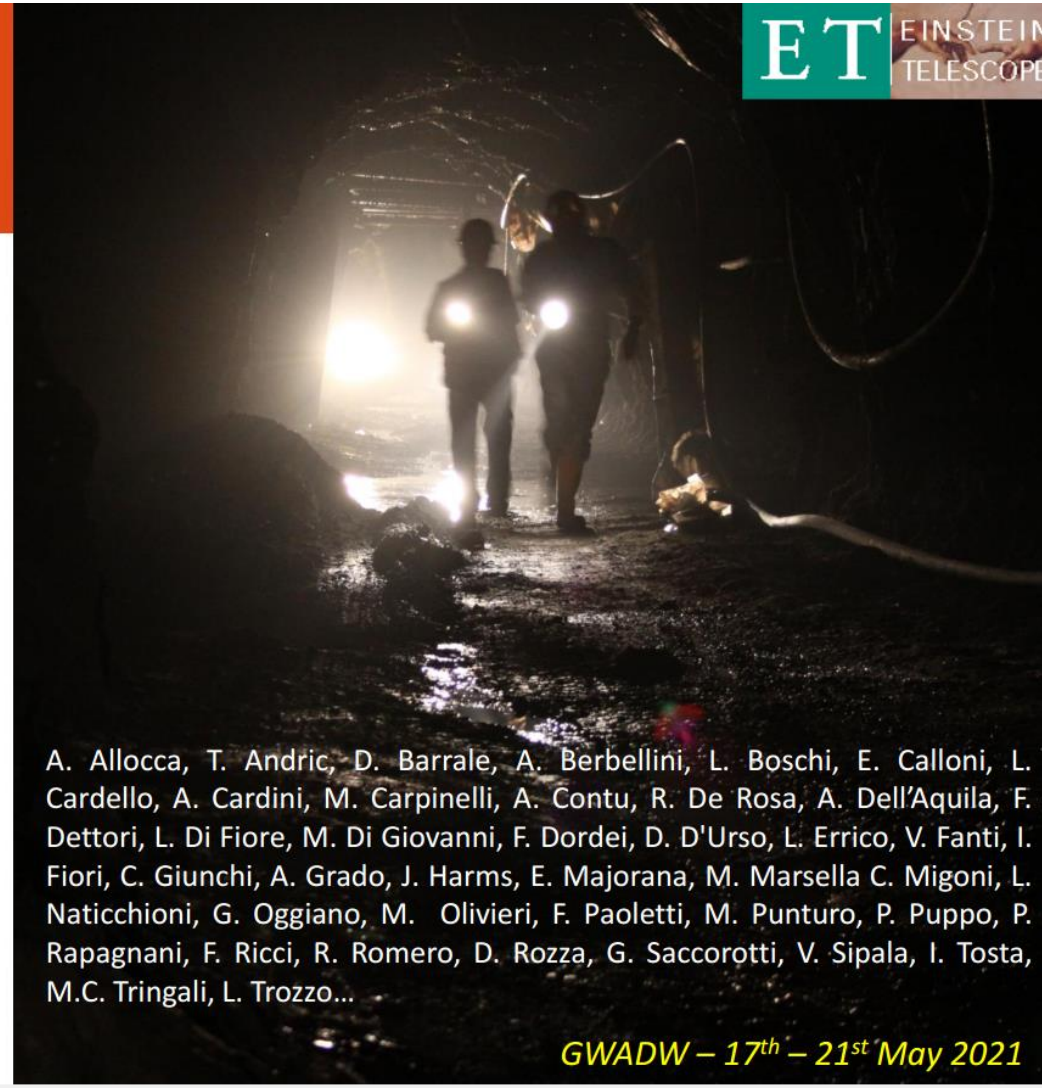
Seismic studies at Sos Enattos, the Sardinian site for the Einstein Telescope

Luca Naticchioni (INFN Roma)

on behalf of the ET Sardegna site characterisation team

INFN Istituto Nazionale di Fisica Nucleare · uniss Università degli Studi di Sassari · Sapienza Università di Roma · Istituto Nazionale di Geofisica e Vulcanologia · Università degli Studi di Napoli Federico II · GSSI Gran Sasso Science Institute, School of Advanced Studies, Scuola Universitaria Superiore

ET Einstein Telescope



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GWADW – 17th – 21st May 2021

Speaker

Dr Luca Naticchioni (INFN Roma)

Description

In this talk I will give an overview of the currently ongoing seismic characterisation of the Sos Enattos area, the proposed first corner site for ET in Sardinia. In 2019 we started an extensive measurement campaign proving the low environmental noise features of the area. Several measurement stations are installed at surface and at the different depths along the former mine tunnels. New borehole seismometers installations are ongoing at the other two corners planned for ET in Sardinia. Thanks to the peculiar geological frame and to the low population density, the local seismic noise is close to the Peterson's NLNM, even at surface. In particular, from the seismic point of view, the site is among the quietest in the world in the 1-10Hz band. This feature, along with the low EM noise and other favourable aspects, makes the site an ideal candidate for the Einstein Telescope.

asibility study on the construction of the underground infrastructure for the
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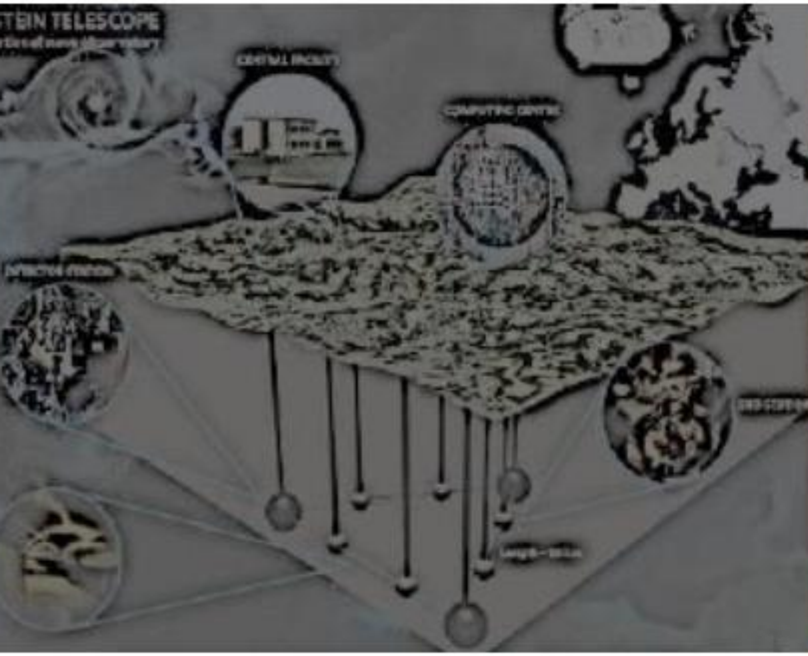

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Dipartimento di Ingegneria Civile Edile e Ambientale

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GWADW2021 Gravitational Wave Advanced Detector Workshop 17-21 May2021

Speaker

Maria Marsella (Sapienza University,...

Description

An overall feasibility study is carried out in Sardinia as one of potential site for the construction of the Einstein Telescope (ET), a third-generation gravitational wave underground observatory.
In order to optimize the location of the corner points of the tunnels hosting the interferometer a technical feasibility study is performed, also including cost-benefit analyses.
A 3D modeling of the ground and infrastructures represents the starting point for identifying the optimal location of the infrastructure. The design study is based on simultaneous evaluation of multiple environmental, geological and geotechnical aspects having the goal of minimize anthropogenic noises by reducing the distance from possible sources, optimize the surface facilities location and accessibility, guarantee the required rock coverage and define a proper the groundwater drainage system. In addition, a Geodetic Control Network for accurate positioning and deformation monitoring will be established.
In order to carry out a multi-criteria analysis a geo-database and GIS platform has been developed and will be continuously updated and integrated. The analysis of civil works on the surface and underground is supported by the integration with BIM models.
To enforce the capability of evaluating different geometric configurations a multiple criteria decision-making tool will be implemented to achieve that all the relevant quantitative limiting factors are compliant with scientific requirements.

SAR-GRAV underground laboratory (Sardinia): engineering challenges and key solutions

M. Marsella[7]

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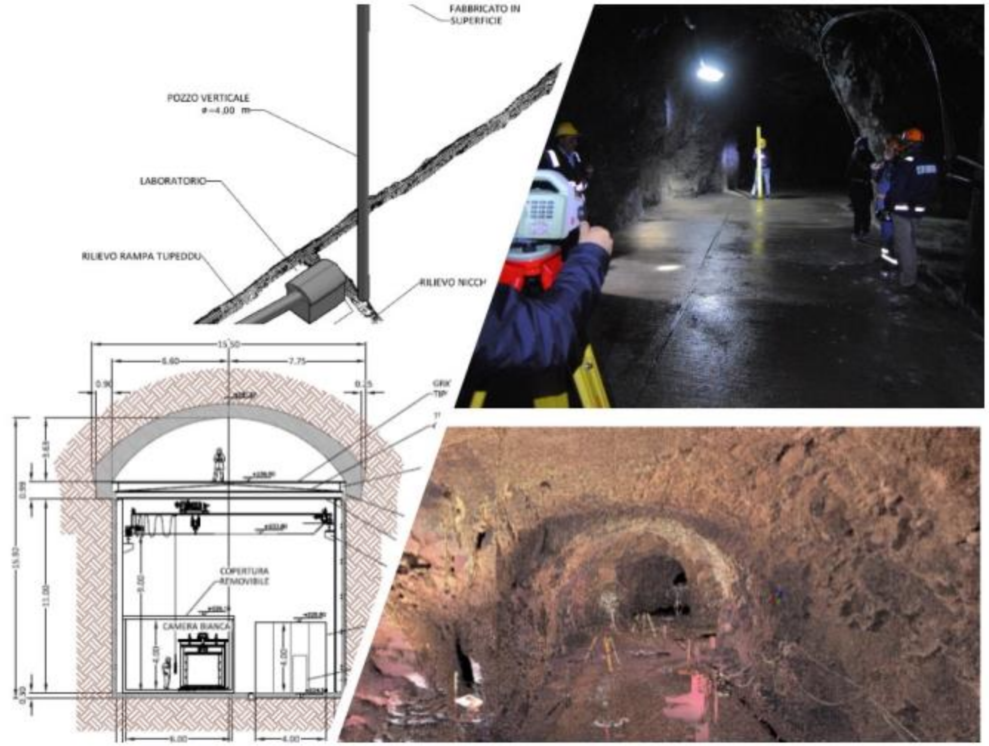

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IGEA SPA Interventi Geo Ambientali

GWADW2021 Gravitational Wave Advanced Detector Workshop 17-21 May2021

Speaker

Claudio Rossini (Sapienza DICEZ)

Description

The SAR-GRAV underground laboratory is located in SOS-ENATTOS mine area (Lula Mining District, Sardinia) and was designed to host small-to-medium-sized experiments, intended as individual experiments of fundamental physics and geophysics, and prototypes of equipment for larger experiments, such as future gravitational wave detectors. The laboratory, which will host the ARCHIMEDE experiment funded by INFN in the first instance, considered a seed for the design the larger infrastructure dedicated to the Einstein Telescope.

The key components of the laboratory area a surface building which currently hosts the first phase of the Archimede experiment and in the future will host the control room and auxiliary laboratory areas and an underground cavern located at about 200 m below the ground level, which will host the liquid nitrogen cryostat and a white room for laser applications. Two access ramps will connect the lab to the existing Sos-Enattos mine tunnels and a service shaft will connect the laboratory with the surface for ventilation and the passage of the installations.

The talk focuses on the main engineering challenges and key solutions that led to the preparation of the feasibility study to design the underground facility which included first mapping and surveying and geological and geotechnical characterization, etc.) and then technical, economic, safety and environmental aspects to setup the feasibility study for the laboratory.

Interreg Euregio Meuse-Rhine EUROPEAN UNION

GWADW2021 Gravitational Wave Advanced Detector Workshop

E-TEST Einstein Telescope EMR Site & Technology

Geophysical imaging and characterization to study the implementation of the Einstein Telescope infrastructure

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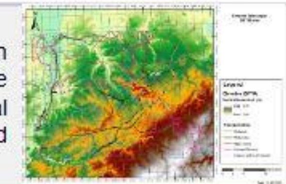
Introduction

In the feasibility study E-TEST, the potential of the border region between Belgium, Germany and the Netherlands (Fig. 1) to host the Einstein Telescope (ET) infrastructure is investigated. As ET is planned to be installed in ca. 250 m depth, a firm understanding of the subsurface needs to be accomplished in the E-TEST project. Geophysical techniques allow to image and characterise the subsurface. Therefore, different geophysical methods will be used during the E-TEST project. The results of these geophysical survey will serve as input for geological, geotechnical and hydrogeological models.



Shallow seismic survey

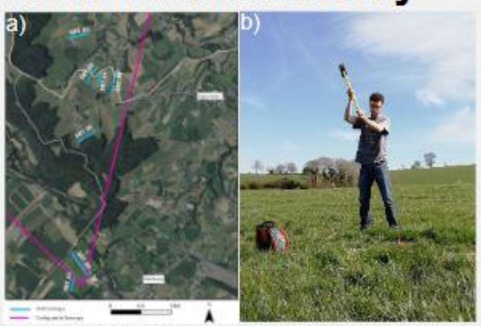


Fig. 2: a) Shallow seismic survey lines (blue) around a potential corner point of the ET triangle (pink). b) Energy input using a sledge hammer.

- Geophones along a straight line.
- Energy input by a sledge hammer.
- Measuring of seismic wave velocities.
- Seismic waves velocities to map subsurface.
- Imaging to a depth of ca. 50 m.
- Seismic properties characterise rock type and / or rock properties.
- Change in seismic properties allow to map structures

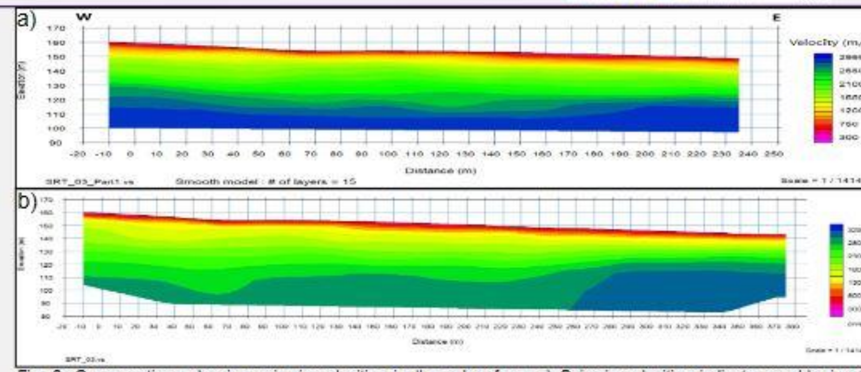
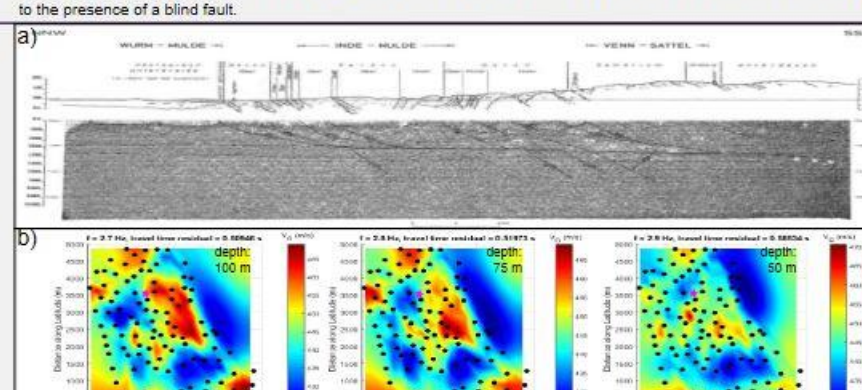


Fig. 3: Cross-sections showing seismic velocities in the subsurface. a) Seismic velocities indicate a subhorizontal layering of rocks in the subsurface. b) Seismic velocities reveal the disappearance of a high-velocity layer. This can hint to the presence of a blind fault.

Active and passive seismic survey

- Active survey: Energy input by vibration
- Passive survey: Any occurring seismicity
- Measuring of seismic wave velocities.
- Seismic waves velocities to map subsurface.
- Imaging to a depth of several km depth.
- Mapping of rock layers and structures.
- Mapping as cross-sections or maps



Speaker

Marius Waldvogel (Geological Institute,...

Description

The Einstein Telescope (ET) is a third generation gravitational wave observatory, currently in the planning stage in Europe. The ET project involves the construction of a triangular shape underground facility with 10 kilometres long arms buried in ca. 250 m depth. At the corner points, large caverns host the required infrastructure. The border region between the Netherlands, Belgium and Germany is considered a potential location and is investigated in a multidisciplinary feasibility study, E-TEST, funded by the EU and various authorities of the involved countries.

E-TEST aims to construct geological, hydrogeological and geotechnical models of the potential ET area. Subsurface data are crucial to develop these models. Several geophysical methods allow to collect these data from various depth ranges in different resolutions. Planned geophysical surveys are (I) ERT / IP measurements and (II) active seismic surveys using a sledge hammer to map the shallow subsurface, (III) active seismic surveys using vibro-seis trucks and (IV) passive seismic surveys using naturally occurring seismicity to image the shallow and deep subsurface. 5 dry boreholes hosting seismometers will be drilled. Geophysical logging of these boreholes will take place prior to installation. The combination of all these geophysical data acts as a solid base for the subsurface models of the E-TEST area. The presentation at GWADW2021 provides an insight on the geophysical surveys conducted in the E-TEST project.

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GWADW2021 Gravitational Wave Advanced Detector Workshop

E-TEST Einstein Telescope EMR Site & Technology

Feasibility Study of the Einstein Telescope - Geological exploration

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a: RWTH Aachen University; b: University of Liège; c: KNMI; d: NIKHEF; e: Antea Group

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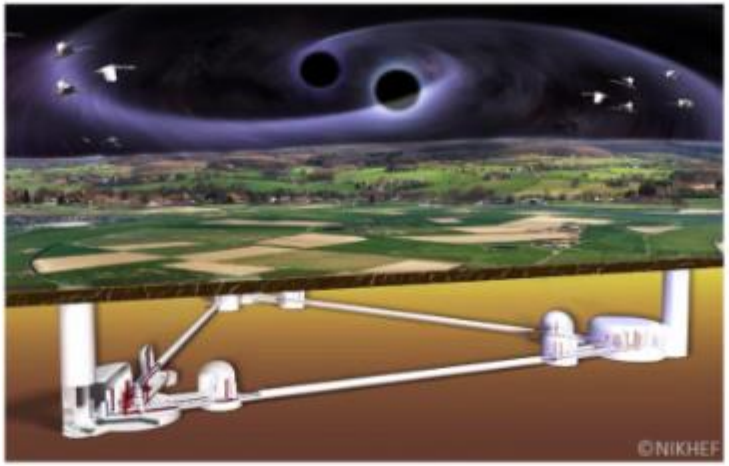
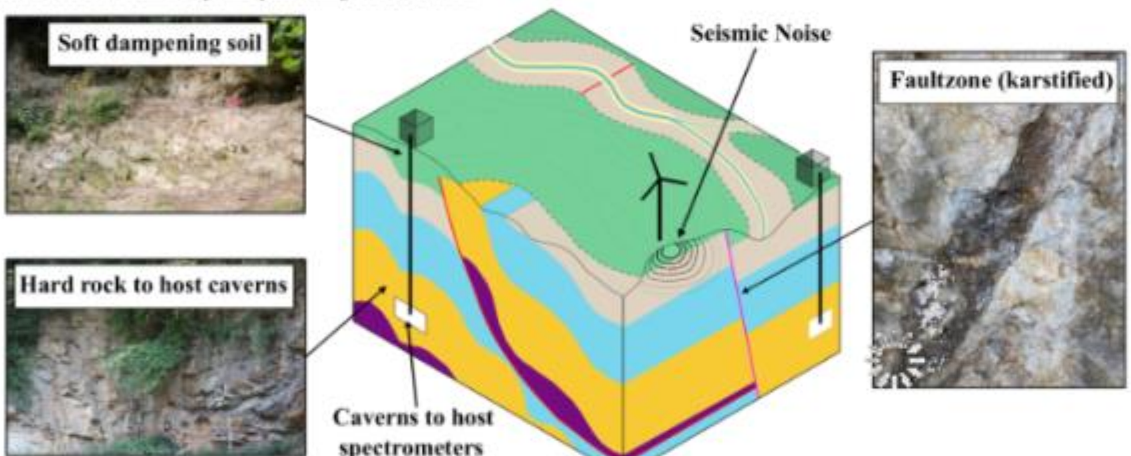
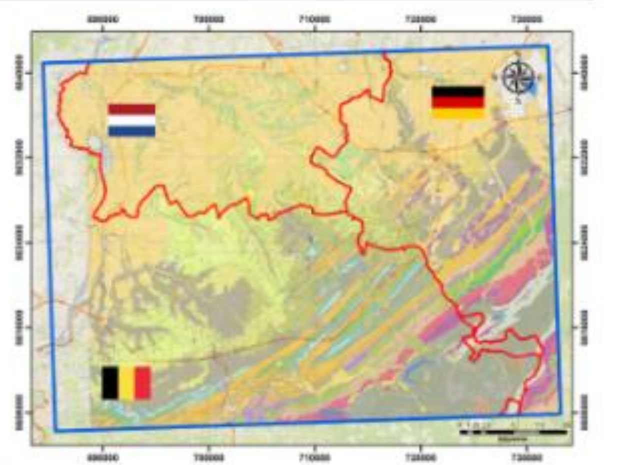
The Einstein Telescope (ET) is an advanced, third generation gravitational wave observatory, currently in the planning stage in Europe. The ET project involves the construction of a triangular shape underground facility with 10 kilometres long arms. At the corner points of the three arms, large caverns host the infrastructure needed for the spectrometers. The border region between the Netherlands, Belgium and Germany is considered a potential location and will be further investigated in a feasibility study funded by the European Union, the Dutch Ministry of Economic Affairs, the Land of North Rhine-Westphalia, the Province of Flemish Brabant, the Province of Belgian Limburg, the Province of Dutch Limburg, Flanders and Wallonia.

Stable underground conditions with minimal ambient noise are essential for the interferometers to be hosted in the ET corner points. A detailed geological, structural, hydrogeological and geotechnical model is required to ensure the desired performance of the underground infrastructures. The current multi-disciplinary feasibility study allows to collect the required data to (1) optimise the location and orientation of the ET triangle and corner points, (2) plan the construction of subsurface caverns and tunnels, (3) model the tunnelling operation in terms of methodology, machinery and time frame, (4) construct a sophisticated, three-dimensional, cross-border geological model of the study area, (5) evaluate the geological risks of the border region between Germany, the Netherlands and Belgium and (6) establish new surveillance methods. The data presented here are based on detailed studies of geological maps, on measurements already carried out and on various political boundary conditions. In addition, further planned work is described and presented.



The expected sequence of geological layers in the Rhine-Meuse region is well suited for the construction of a gravitational wave detector, as disturbing influences are attenuated by a layer of loose chalk sediments at the surface. At the same time, a stable bedrock offers good conditions for the construction of the caverns in the corner points. Part of the feasibility study is therefore to create a high-resolution 3D model of the bedrock to ensure optimal positioning of the caverns.





The map shows the cross-border geological map based on the records of the different geological services (Geologischer Dienst NRW, Service géologique de Wallonie, Rijks Geologischen Dienst, Databank Ondergrond Vlaanderen). An effort has been made to homogenize the surface geology between the three

Speaker

Mr Jonathan Zinser (LIH RWTH Aachen)

Description

The Einstein Telescope (ET) is an advanced, third generation gravitational wave observatory, currently in the planning stage in Europe. The ET project involves construction of a triangular shape underground facility with 10 kilometres long arms. The border region between the Netherlands, Belgium and Germany is considered as a potential location and will be further investigated in a feasibility study funded by the EU, the Dutch Ministry of Economic Affairs, the State of North Rhine-Westphalia, the Province of Flemish Brabant, the Province of Belgian Limburg, the Province of Dutch Limburg, Flanders and Wallonia.

Stable underground conditions with minimal ambient noise are essential for the interferometers to be hosted in the caverns of the ET corner points. A detailed geological, structural, hydrogeological and geotechnical model is required to ensure the desired performance of the underground infrastructures. The current multi-disciplinary feasibility study (E-TEST) allows to collect the required data to (1) optimise the location and orientation of the ET triangle and corner points, (2) plan the construction of subsurface caverns and tunnels, (3) construct a sophisticated, three-dimensional, cross-border geological model of the study area and (4) establish new surveillance methods. This presentation provides a short overview on the geological exploration targets and methods used in the feasibility study E-TEST.