



E-TEST Einstein Telescope
EMR Site & Technology

E-TEST

Einstein Telescope EMR Site & Technology

Kick-Off Meeting 09.10.2020

16.10.2020

Interreg
Euregio Meuse-Rhine
European Regional Development Fund



EUROPEAN UNION

Agenda Kick-Off Meeting E-TEST

- 9:30 am – 9:50 am:
 - Welcome by Mr. Willy Borsus, Minister and Vice-President of the Walloon Government
 - Welcome by Mr. Mark Vos, Interreg Programme Director
 - Welcome by Prof. Pierre Wolper, Rector of Uliège
- 9:50 am – 10:45 am: E-TEST Project Presentation
 - General introduction *by Annick Pierrard & Christophe Collette, ULiège*
 - WPT1 Ultra-cold vibration control *by Alessandro Bertolini, Nikhef*
 - WPT2 Optical engineering *by Oliver Fitzau, Fraunhofer ILT*
 - WPT3 EMR cross-border underground observatory *by Frédéric Nguyen, UEE ULiège*
 - WPT4 Geological modelling and Engineering Geology of the ET *by Florian Amann, RWTH Aachen*
 - Industrial Advisory Board & SMEs invitation, ET2SMEs & long term collaboration
 - The final word... by Albert
- 10:45 am – 11:00 am: Q/A



Welcome by Mr. Willy Borsus, Vice-President of Wallonia, Belgium
Minister for the Economy, Foreign Trade, Research and Innovation,
Digital, Agriculture, Spatial Planning, IFAPME and Competence Centres

16.10.2020



Welcome by Mr. Mark Vos, Interreg EMR Programme Coordinator, The Netherlands

16.10.2020

Interreg EMR

Euregio Meuse-Rhine
European Regional Development Fund

Kick-off conference E-Test
09/10/2020

16.10.2020

Managing Authority Interreg V-A Euregio Meuse-Rhine



Overview

- What is Interreg?
- Interreg EMR – State of Play
- E-Test as an Interreg EMR project
- Next Steps as an Programme

What is Interreg?

- 30 years (1990-2020) of cooperation across borders to foster European cohesion
- More than EUR 10 bn in programming period 2014-2020
- 100+ Interreg programmes, 60 cross-border programmes: 1 of them Interreg EMR

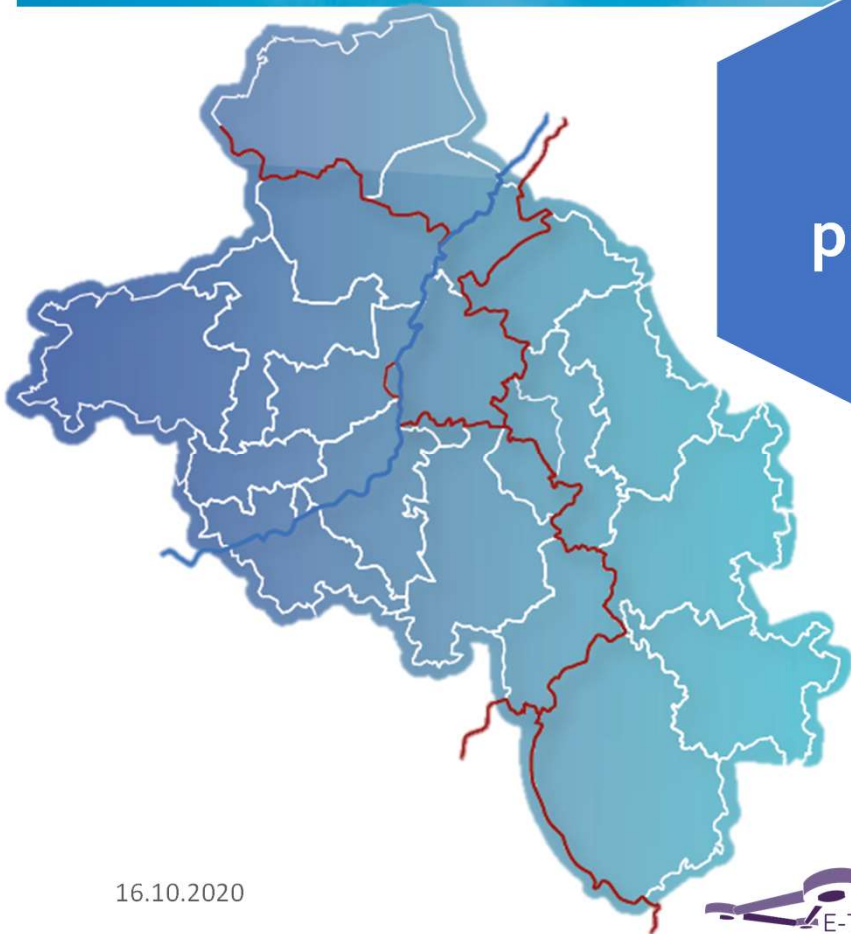
Interreg EMR: State of Play

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State of Play



48
projects

3 countries

250
partners

State of Play: 48 projects approved



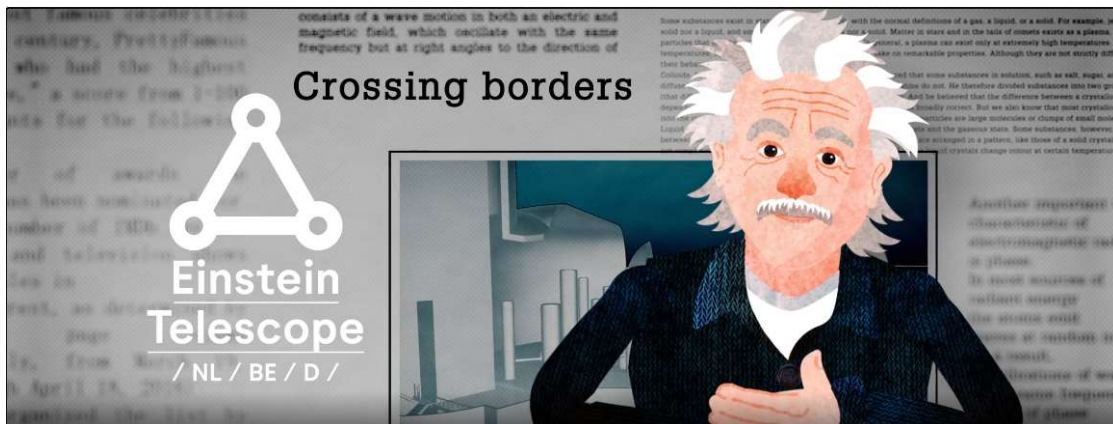
E-Test as an Interreg EMR project

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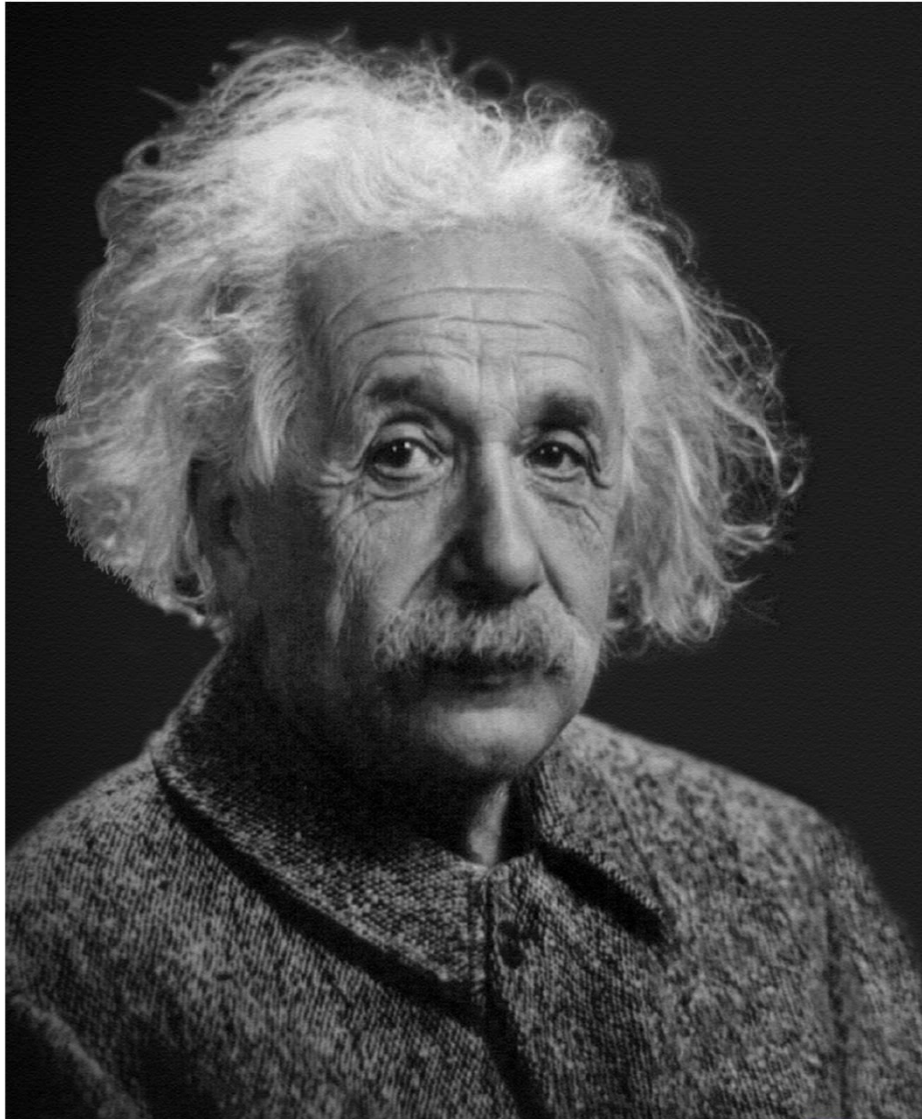


E-TEST as an Interreg EMR project



Scientist from **Belgium, Germany** and the **Netherlands** are coming together

- **Vision 1:** Enabling **major scientific breakthroughs** in our **Euregio Meuse-Rhine**
- **Vision 2:** significant **economic impact** on small and medium-sized enterprises in the **Euregio Meuse-Rhine**



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E-TEST as an Interreg EMR project

We are excited to accompany you
on your journey and see your
project results!

Next Steps as a Programme...

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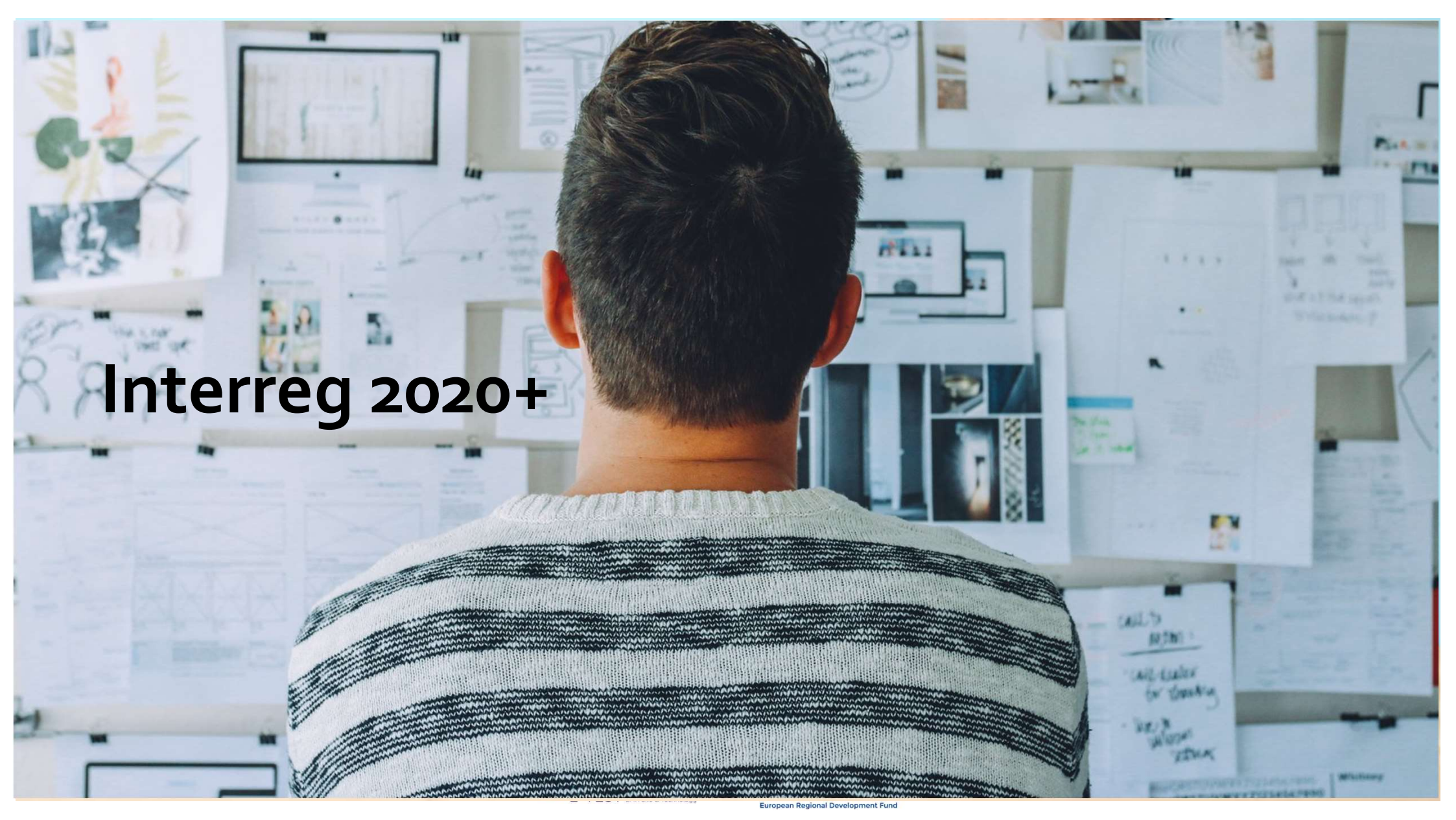
Still open for submissions!

More ideas for the Euregio Meuse-Rhine? Want to foster economic cooperation in the EMR? There is still some time to apply!

Deadlines

Final submission:
10 November 2020 @ 12am





Interreg 2020+

Interreg 2020+

- First stakeholder consultation started last year with an event in Maastricht
- Future programme 2021-2027 in preparation...

... So watch our **website and social media!**

More Information?



Website: www.interregemr.eu



LinkedIn: <https://www.linkedin.com/company/interreg-emr/>



Twitter: [@InterregEMR](https://twitter.com/InterregEMR)



Facebook: <https://www.facebook.com/InterregEMR>



Youtube: Interreg EMR <https://tinyurl.com/yauwk2mc>

Thank you for your attention!

Managing Authority Interreg V-A Euregio Meuse-Rhine

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Welcome by Prof. Pierre Wolper, Rector of ULiège, Belgium


16.10.2020

Let's start with a short survey...

I invite all of you to take your mobile phone and connect to this link:




How to participate?



WEB

- 1 Connect to www.wooclap.com/JROPIN
- 2 You can participate



SMS

- 1 Not yet connected? Send **@JROPIN** to **0460 200 711**
- 2 You can participate



Prof. Dr. Ir Christophe Collette

Director of Precision Mechatronics Laboratory (PML), ULiège, Belgium

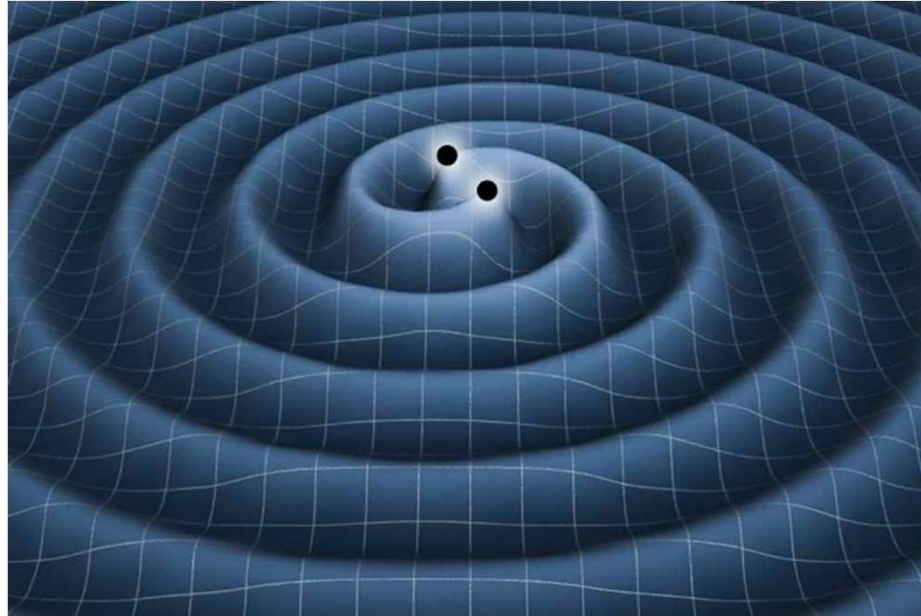
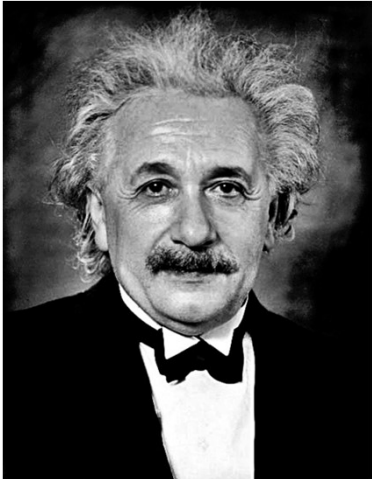
E-TEST Scientific Lead Partner - Prototype

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Why do we need an Einstein Telescope?

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1916: Theory of general relativity

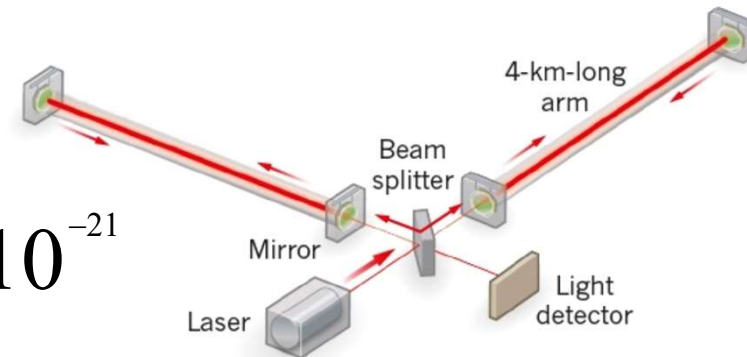


The merger of black holes generates deformations of space/time, corresponding to displacement of 10^{-18} m between object located 1km apart

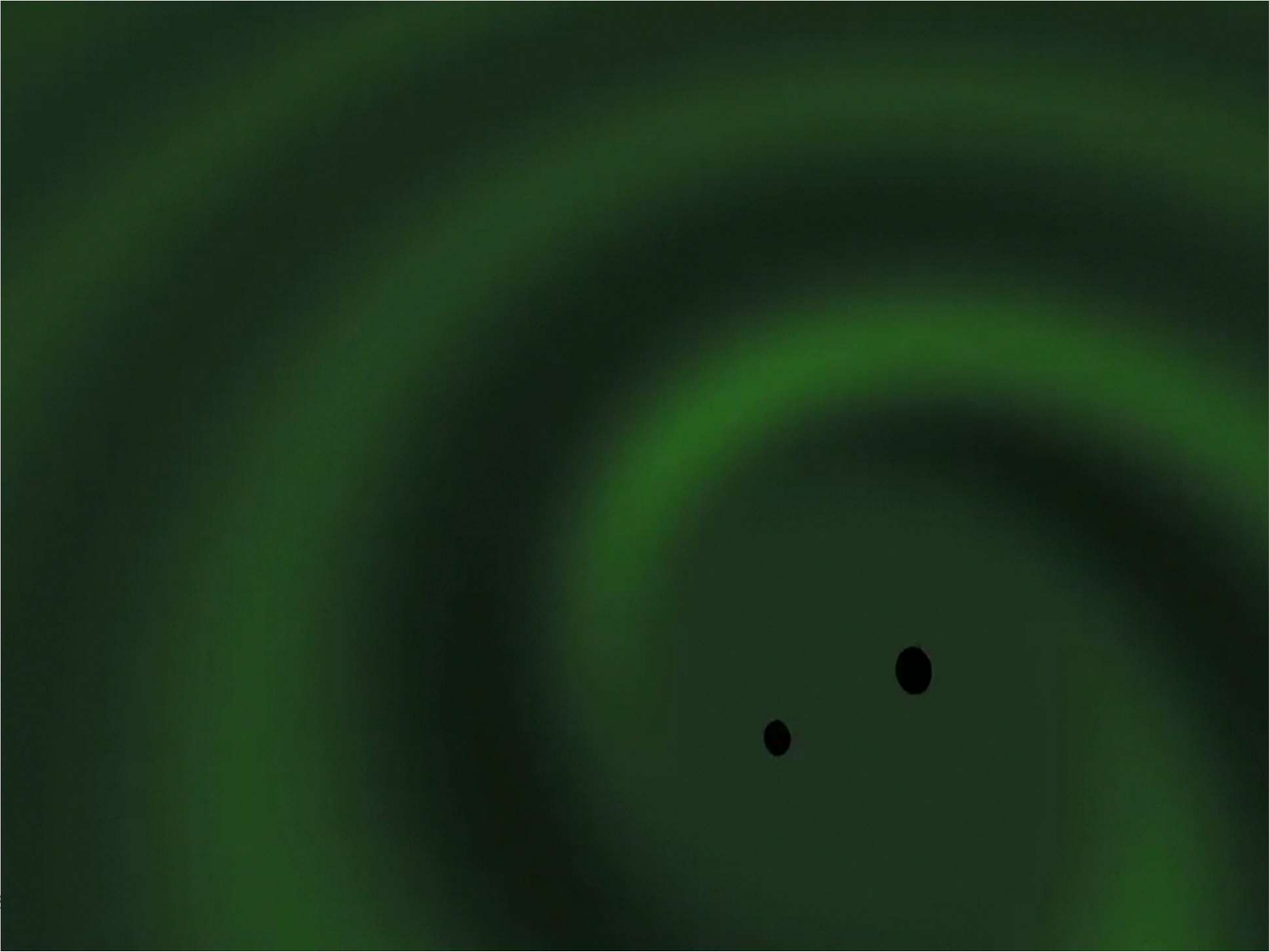
Existing observatories



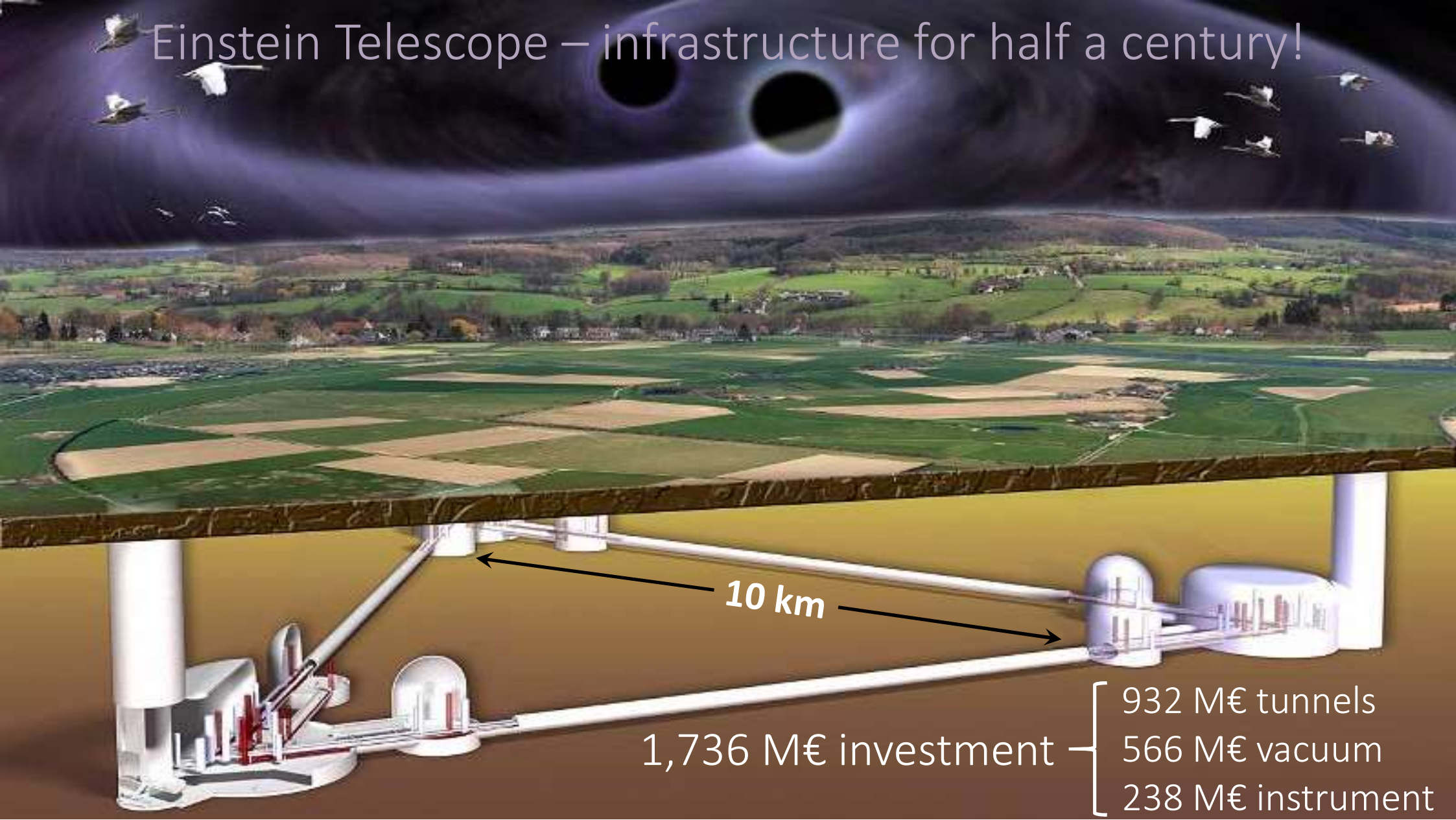
$$h \approx \frac{\Delta L}{L} = 10^{-21}$$



On September 14, 2015 at 09:50:45 UTC the two detectors of the Laser Interferometer Gravitational-Wave Observatory simultaneously observed a transient gravitational-wave signal.

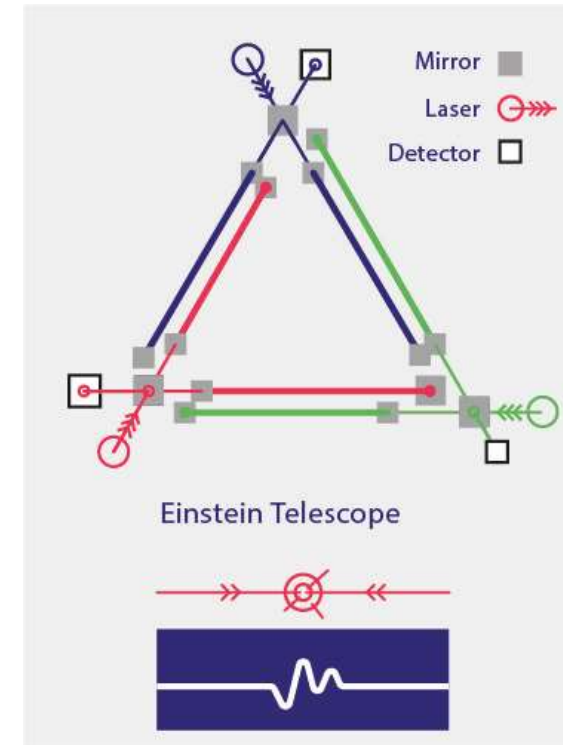


Einstein Telescope – infrastructure for half a century!



The Einstein Telescope: facts & figures

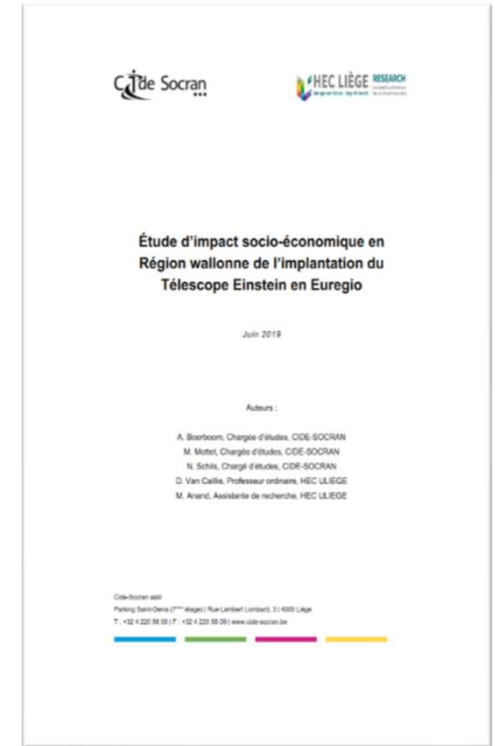
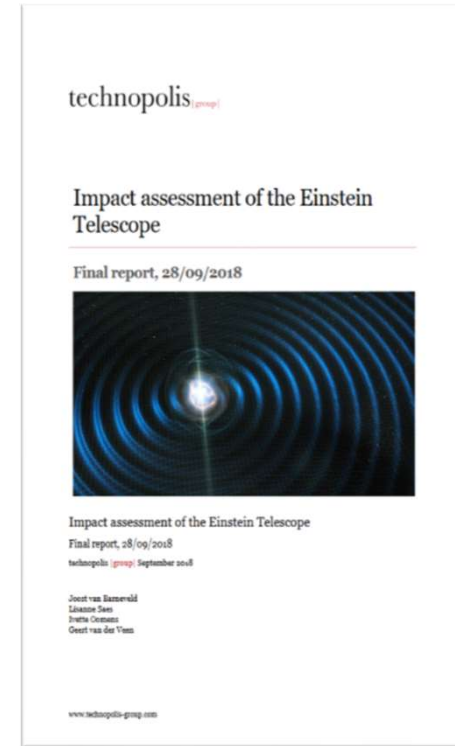
- Future underground observatory for gravitational waves
- 10 times more sensitive than current detectors, can detect a 1000x larger volume of the universe
- Can observe for the first time what happened directly after the big bang 14 billion years ago
- A triangle of 10x10x10 km, located 200-300m underground
- High-tech, safe & clean
- Quiet surroundings are essential for precise measurements
- Landscape will stay intact, aboveground activities will be linked to surrounding research institutes and universities



The Einstein Telescope: a unique opportunity

Significant benefits to be expected :

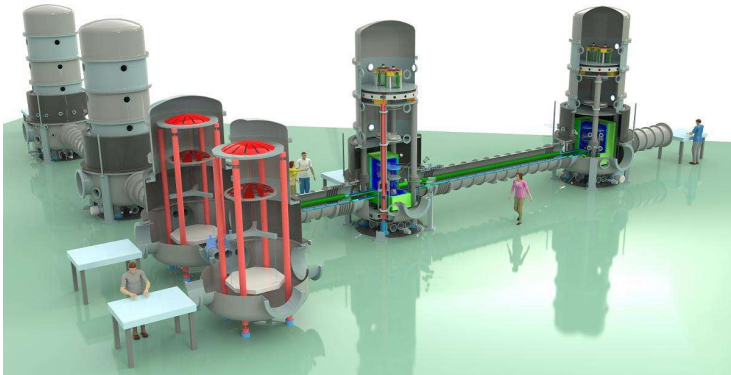
- Assignments for industry
- Improved collaboration between institutes and companies in the area
- Stronger position in science worldwide
- Attraction of talent and opportunities for education
- > 1500 jobs



ETpathfinder

R&D lab:

- Long term infrastructure for testing future technologies for detecting gravitational waves
- Complete interferometer
- For science and industry



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E-TEST

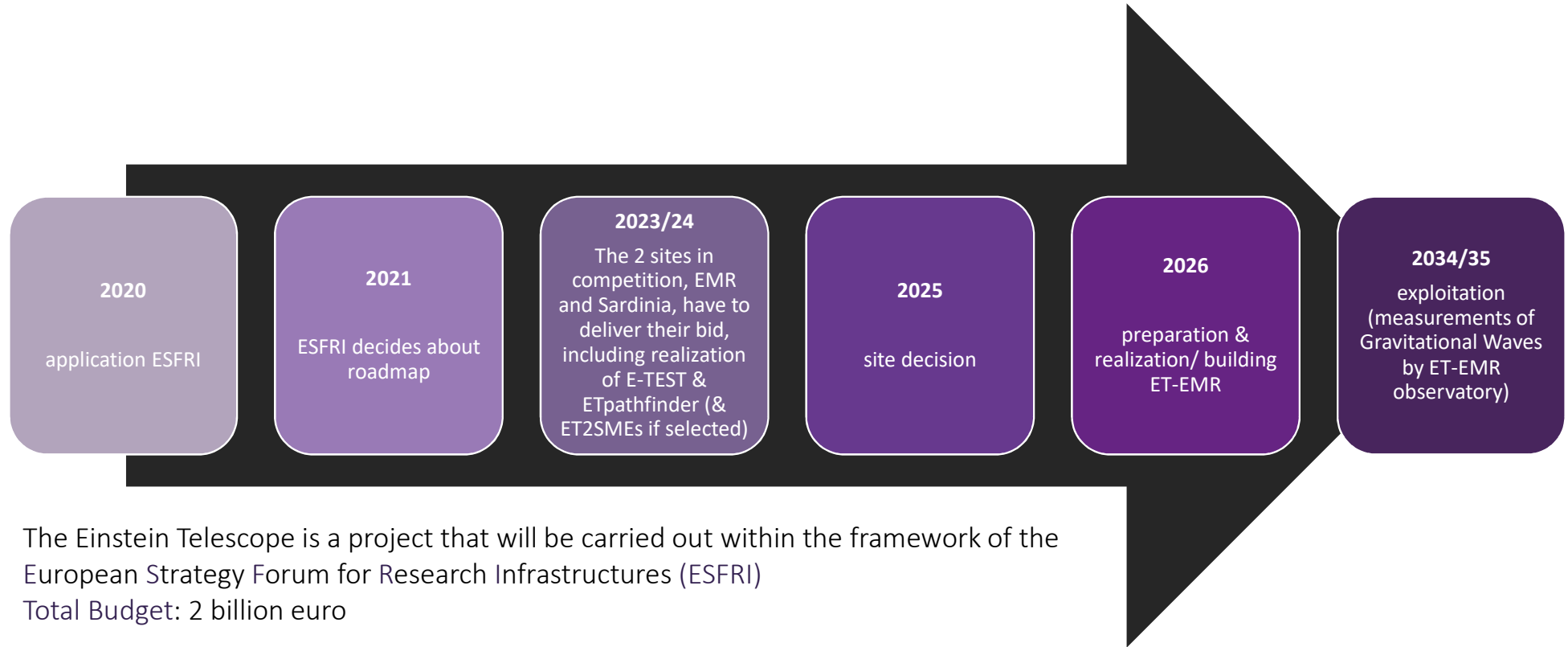
Geological studies:

- Unique subsurface studies of Euregio Meuse-Rhine
- Underground R&D lab

Prototype proof of concept:

- E-TEST will result in a prototype in a vacuum chamber and optical instruments working at 10 Kelvin, in cryogenic conditions (much colder than the 120 Kelvin foreseen for ETpathfinder in its initial phase)
- Knowledge institutes and companies can use E-TEST results to develop and test new products or gain new insights/knowledge

The Einstein Telescope ESFRI Call timeline



The Einstein Telescope is a project that will be carried out within the framework of the European Strategy Forum for Research Infrastructures (ESFRI)
Total Budget: 2 billion euro

Interreg V-A EMR E-TEST Project

Einstein Telescope EMR Site & Technology

01.02.2020 – 31.07.2023

15 M euro

16.10.2020



By Annick Pierrard, MSc
Senior Manager – Interreg Projects, Interface Entreprises-ULiège, Belgium
E-TEST project coordinator

Interreg V-A Euregio Meuse-Rhine Project E-TEST

The Interreg V-A EMR project E-TEST is a very important step of the Einstein Telescope, as it will be a proof of concept, both on the prototype side and on the geological side.

E-TEST will build a prototype – a large suspended mirror at cryogenic temperature (10 Kelvin) – to validate the Einstein Telescope's technology.

E-TEST will also run an underground study to map and model the geology of the Euregio Meuse-Rhine.

This will allow to define the optimal design and location of the future Einstein Telescope.

E-TEST, in a nutshell

- A rainy day of October 2018...the 30th... at 11:15 am...
- First submission in January ,Final submission in June 2019 in Call 5 Interreg V-A EMR
- Official Interreg Grant Letter 03.02.2020
- Timing 01.02.2020 – 31.07.2023
- Budget 15M euro

E-TEST consortium structure

Lead Partner – University of Liège

General coordination and communication WPM & WPC (+ NMWP) : ULiège - Interface Entreprises

Scientific Lead Partner: ULiège PML + UEE + GEO-ENV + CSL

WP T1

Ultra-cold vibration control

WP Head

Nikhef

Involved partners

ULiège CSL
ULiège PML
RWTH Aachen
KUL
UCL

WP T2

Optical Engineering

WP Head

Fraunhofer ILT

Involved partners

ULiège CSL
KUL
UHasselt
Nikhef
UMaastricht

WP T3

EMR cross-border underground observatory

WP Head

ULiège GEOLOGY

Involved partners

ULiège UEE +GEO-ENV
RWTH Aachen
UniBonn
KNMI
Nikhef

WP T4

Geological Modelling & Engineering
Geology of the ET

WP Head

RWTH

Involved partners

ULiège UEE+GEO-ENV
RWTH Aachen
UniBonn
KNMI
Nikhef

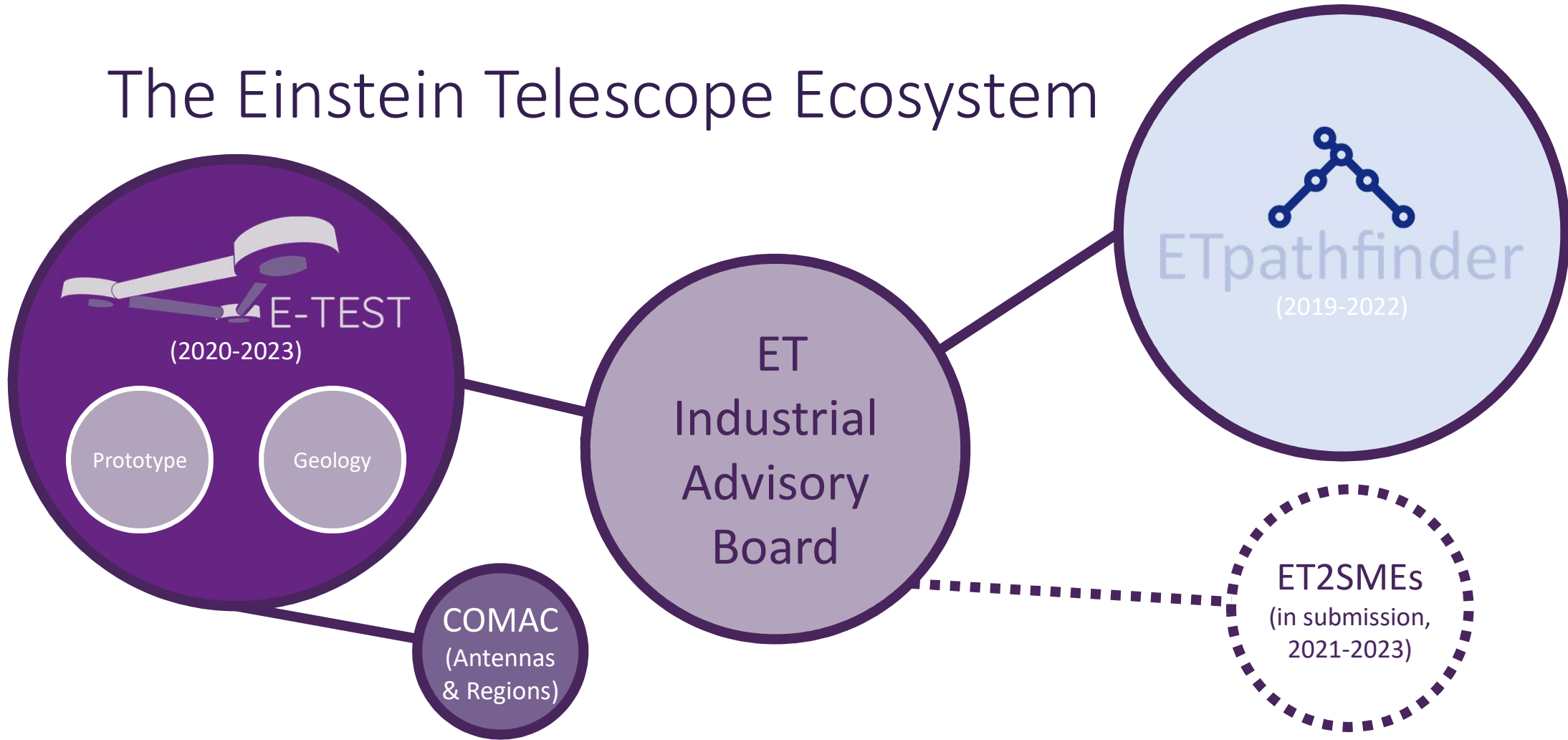
ET Industrial Advisory Board, lead by the project partners

Participants: SMEs, other Companies, Business Development Agencies, Sectorial Agencies, Enterprises networks, Clusters of competitiveness, Local/Regional Authorities, ...



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The Einstein Telescope Ecosystem

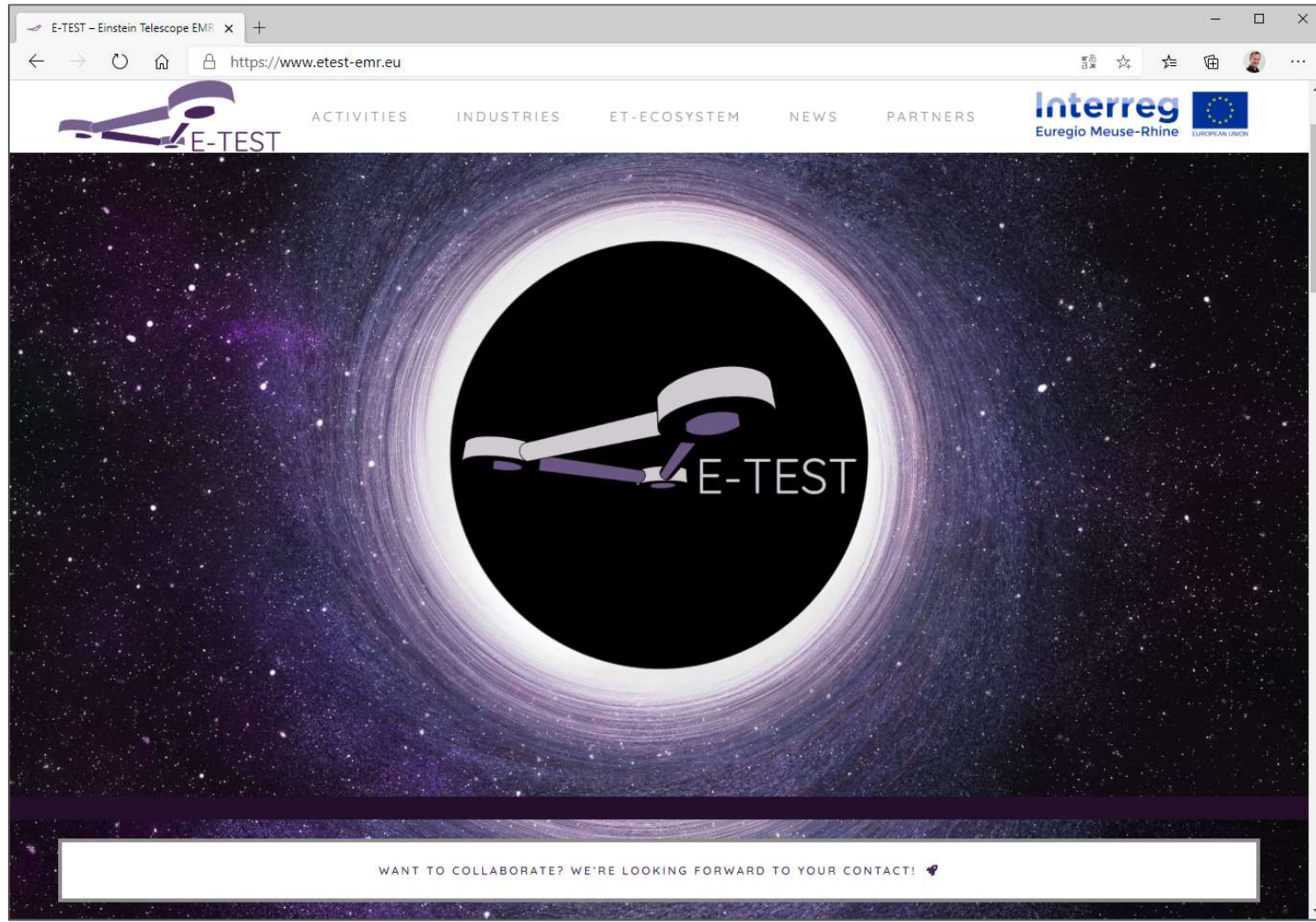


E-TEST Management

- 2020.10.09: Official Kick Off Meeting
- 2020.12: 1st ET Industrial Advisory Board Meeting
- Follow-up of all Procurement Procedures of all partners and publication via the usual channels and on the E-TEST website
- Publication of the Online Catalogue of Einstein Telescope Technologies
- 2021.05: Next COMAC Meeting in May 2021

E-TEST Communication

- Website www.etest-emr.eu online since May 2020 with an online form to allow the SMEs to contact us and participate to the Industrial Advisory Board
- Will be updated with Procurements, Activities, Online Catalogue of the ET technologies, News, Events, Press releases...
- Communication with SMEs/companies through the Industrial Advisory Board meetings
- Participation to big events (ex: Precisie Beurs in NL). Depending on the sanitary situation in the coming months
- Campaign of communication to the Society to inform them about the geological studies and the drilling sites
- Communication via Linked-in, Facebook, Twitter...
- Organisation of our own events and workshops. 4 specific workshops are planned



E-TEST WPT1

Ultra-cold vibration control

Timing 01.02.2020 – 31.07.2023

Budget: 3.8M€

16.10.2020



By Dr. Alessandro Bertolini

Staff researcher in Gravitational Waves instrumentation

Nikhef, National Institute for Subatomic Physics, Amsterdam, The Netherlands

E-TEST Prototype

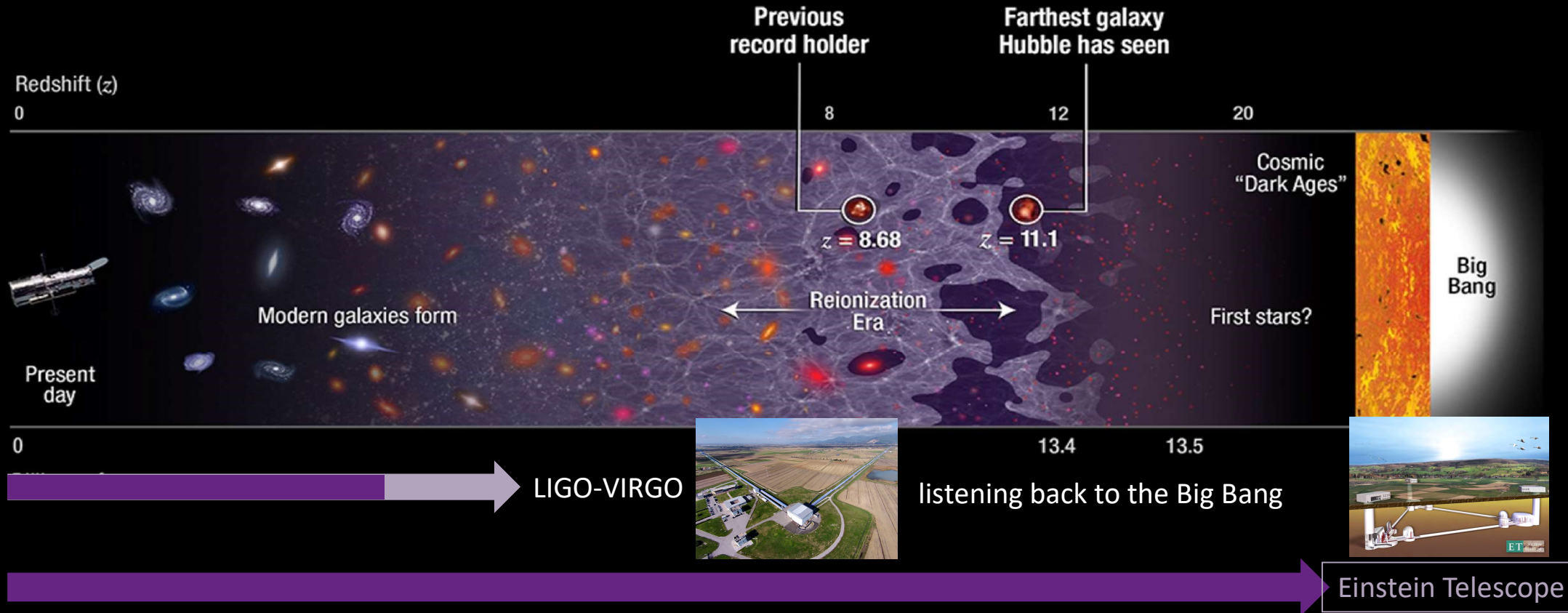
Development of a cryogenic facility to validate, improve and test active vibration control for gravitational wave telescope

- WPT1 Ultra-cold vibration control
 - Activity 1.1 Vacuum and cryogenics
 - Activity 1.2 Active vibration isolation for the heat link
 - Activity 1.3 Seismic isolation system

The Partners involved in the WP T1
– Ultra-cold vibration control –

WPT1 Ultra-cold vibration control

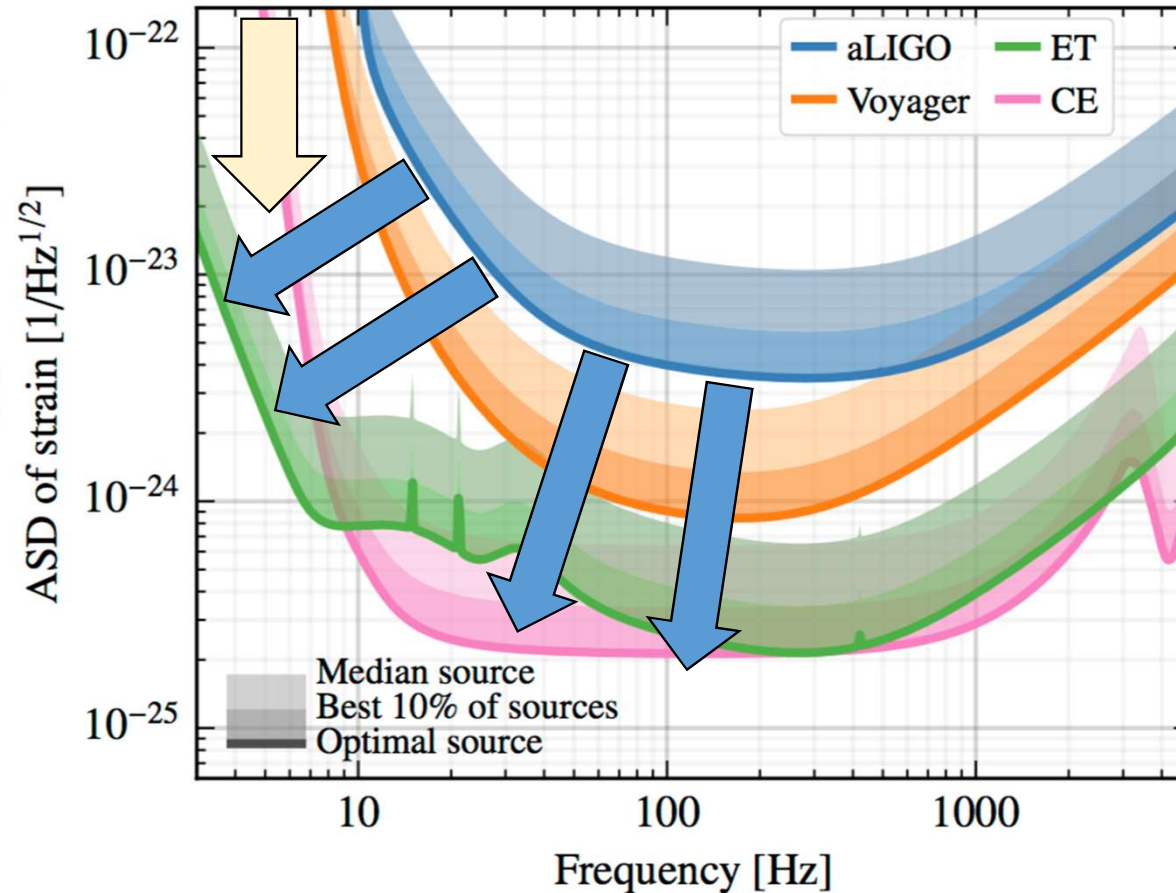
Distinctive feature of ET is the extension of the GW observation band down to 3 Hz



WPT1 Ultra-cold vibration control

The low frequency challenge

underground
facility
+
better
vibration
isolators



cryogenic (10K)
200kg mass
mirrors
to reduce
Brownian noise

WPT1 Ultra-cold vibration control

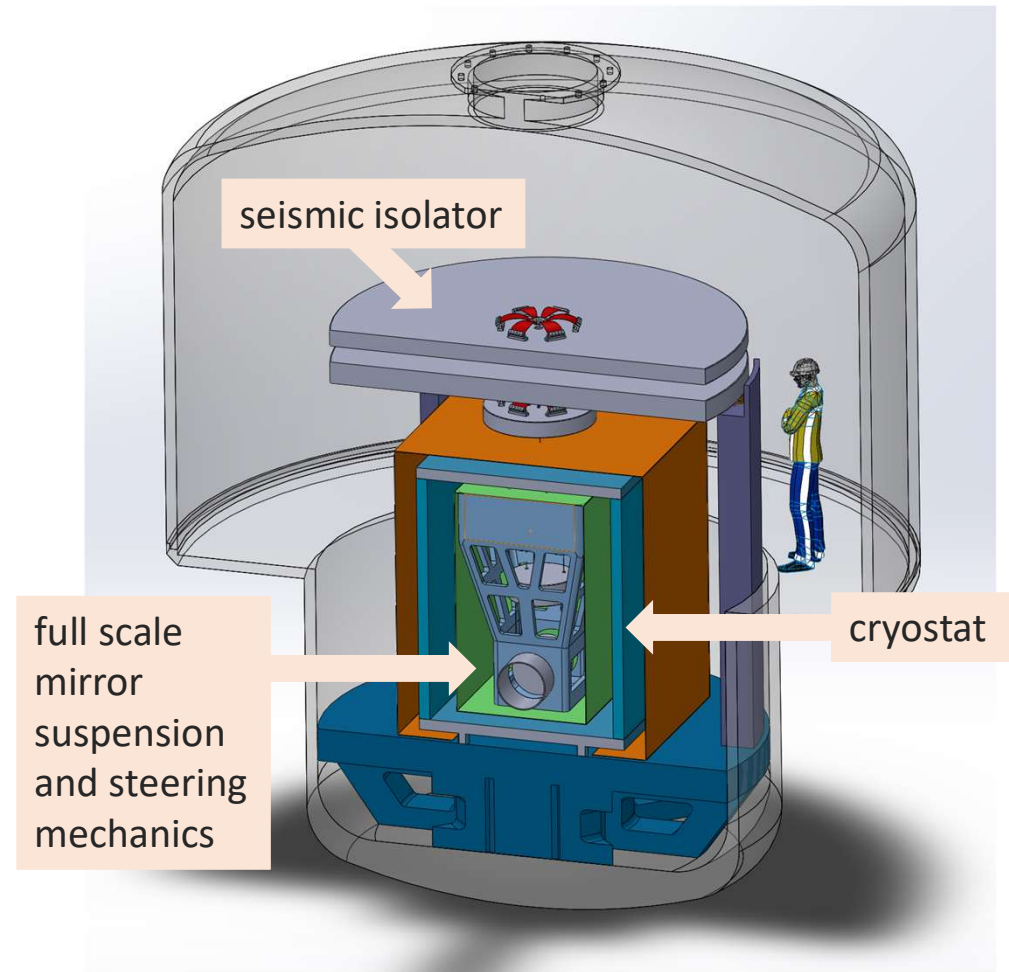
Tackling crucial engineering aspects of ET

Improving vibration isolation in the 0.01-10 Hz

- ✓ Testing novel hybrid (active + passive) attenuation schemes;
- ✓ Developing 'beyond state-of-the-art' inertial sensors.

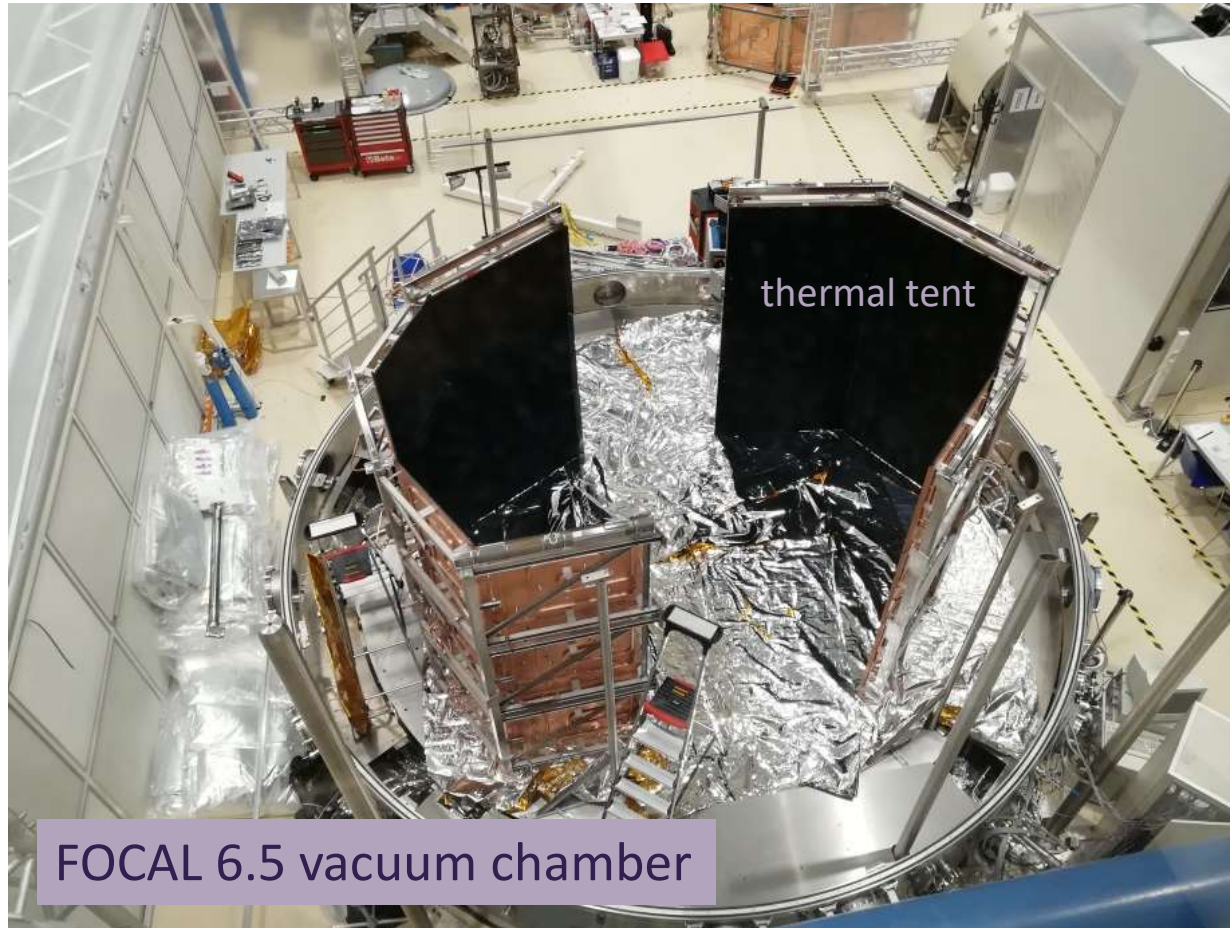
Cooling of large silicon mirrors below 20K

- ✓ Investigating strategies for the initial cooldown and the steady state operation;
- ✓ Devising solutions for the mechanical interface between the cryostat and the mirror suspension.



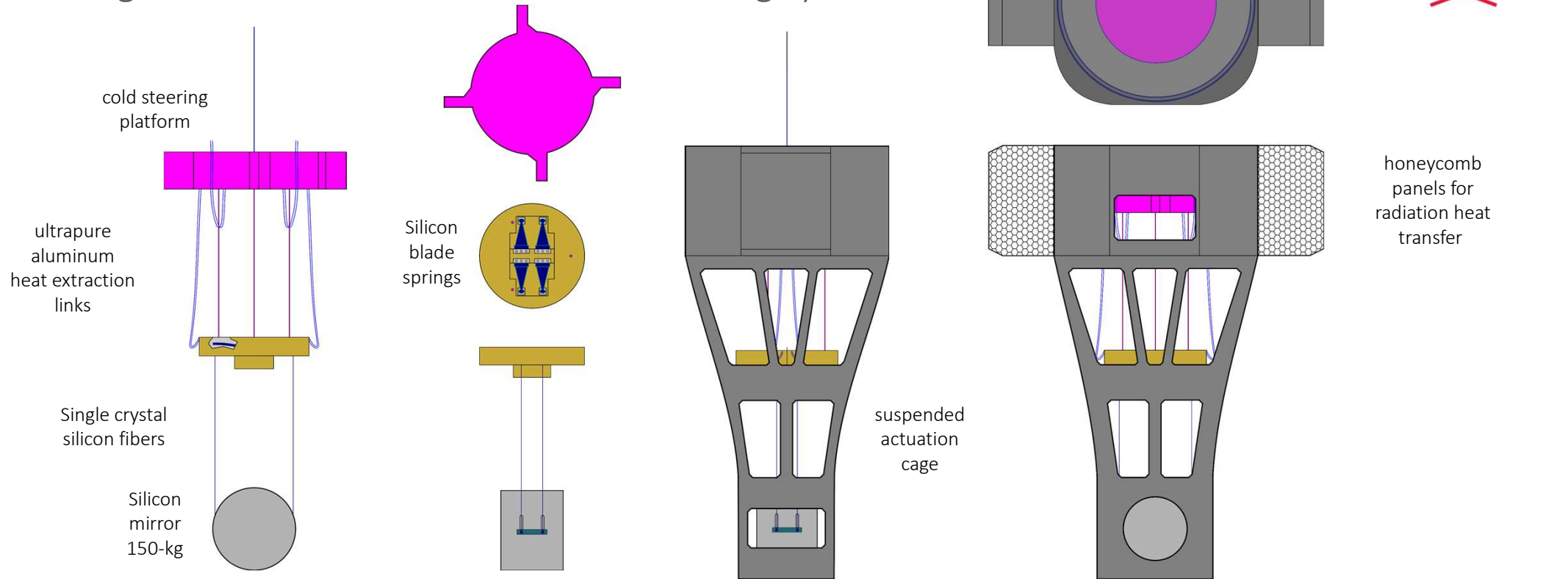
WPT1 Ultra-cold vibration control

Experimental infrastructure (cleanroom, vacuum and cryogenics) made available at CSL



WPT1 Ultra-cold vibration control

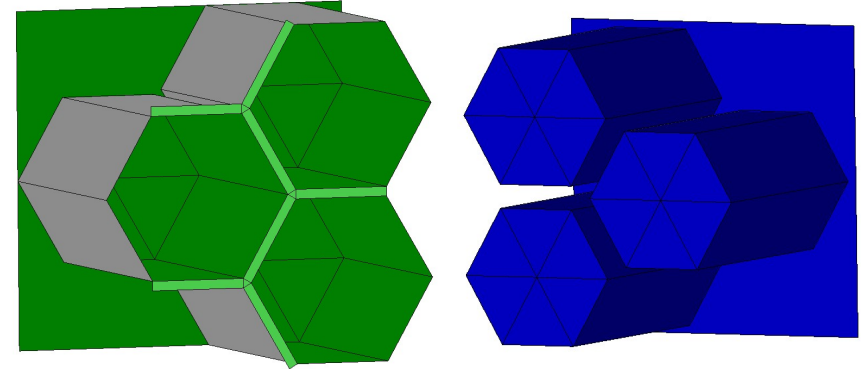
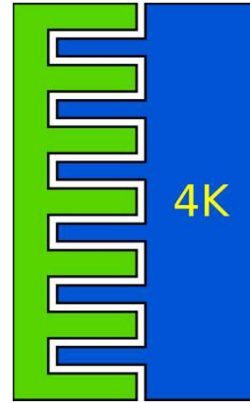
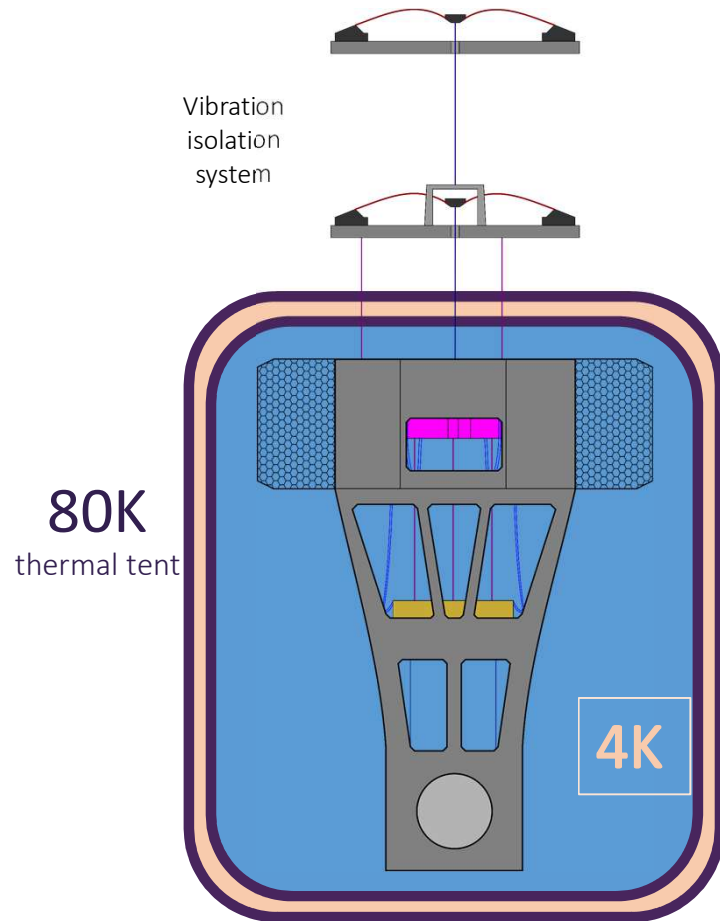
Choosing the architecture for the mirror cooling system



- A **payload** conceptual design, dimensioning and preliminary material selection has been produced
- Goal: informing the choice of the cooling system architecture and thermal design.

WPT1 Ultra-cold vibration control

Choosing the architecture for the mirror cooling system

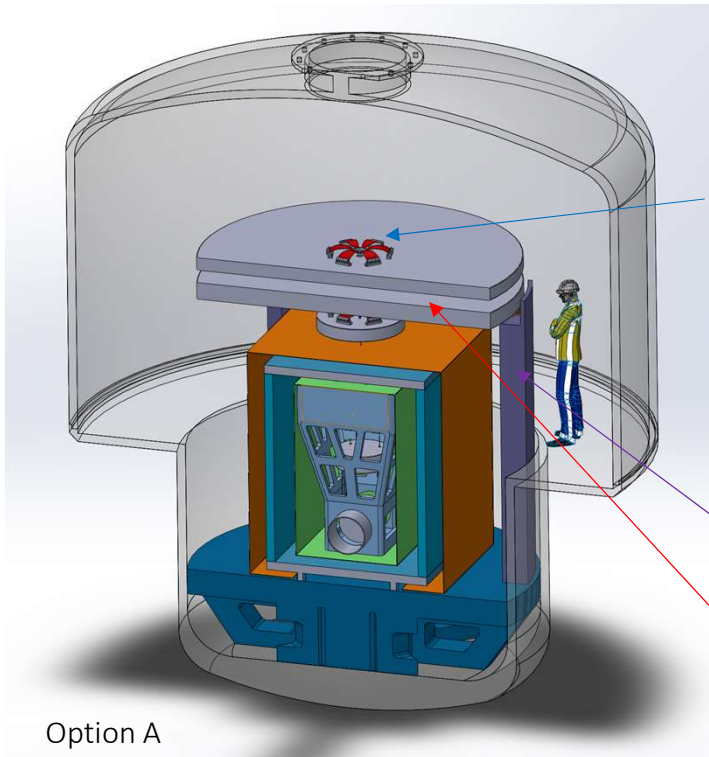


contactless heat exchanger based on interleaved honeycomb radiator design

- CSL engineers are currently exploring (thermal simulations) the possibility of cooling/keeping the mirror at 20K just by **heat radiation transfer**; **benefit would be outstanding in terms of spurious vibrations**
- Goal: evaluating whether it is a valid alternative to the more standard mechanical heat extraction link

WPT1 Ultra-cold vibration control

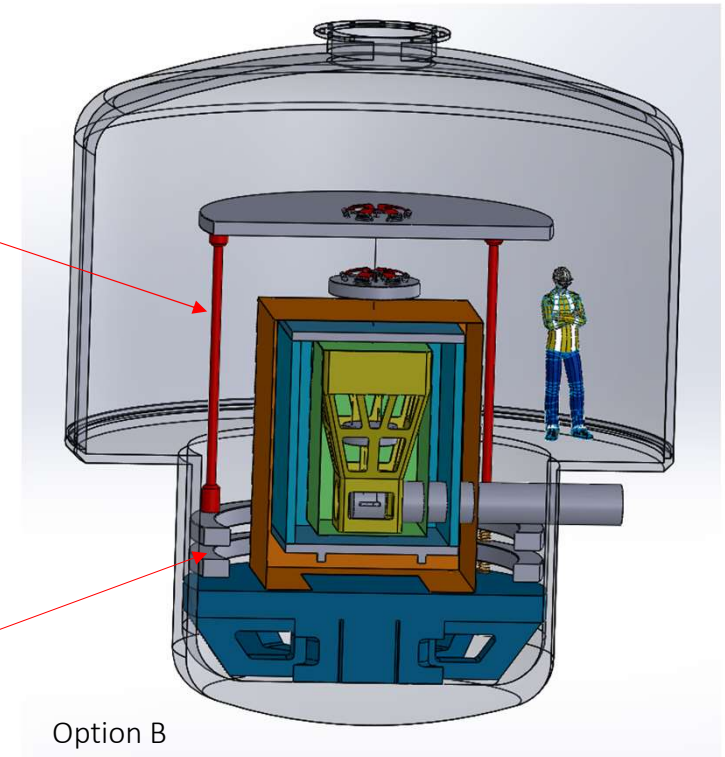
Selecting the architecture of the vibration isolation system



passive
isolation stages

rigid frame

two-stages six degrees of freedom
active
isolation platform



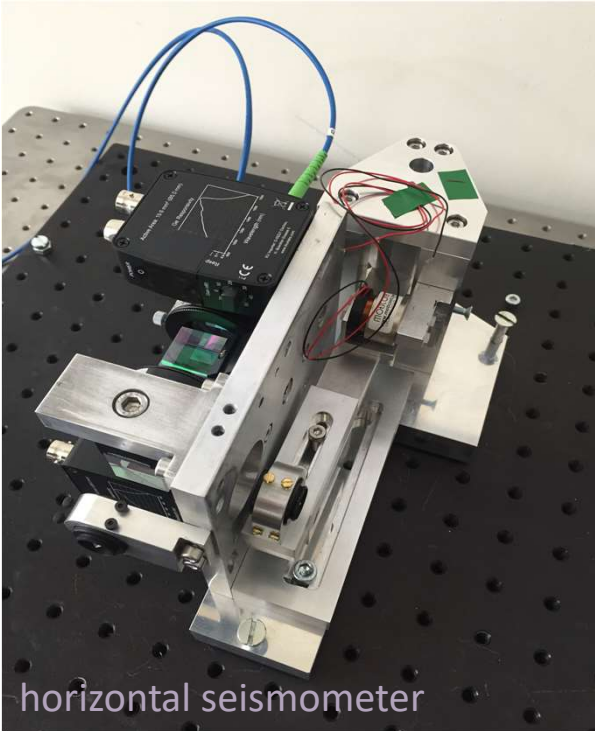
ultralow
natural frequency
inverted
pendulum
stage

Option B

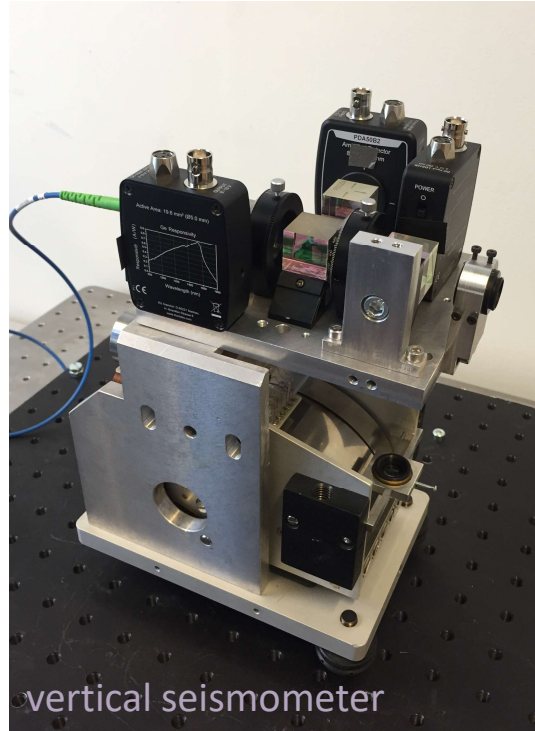
- Extensive rigid body modeling of mechanical response in open and closed-loop (assuming EMR-like input seismic noise) has been performed to evaluate different design options
- Two alternative configurations will undergo more complex simulations

WPT1 Ultra-cold vibration control

Inertial sensors development for active seismic attenuation at low frequency



horizontal seismometer

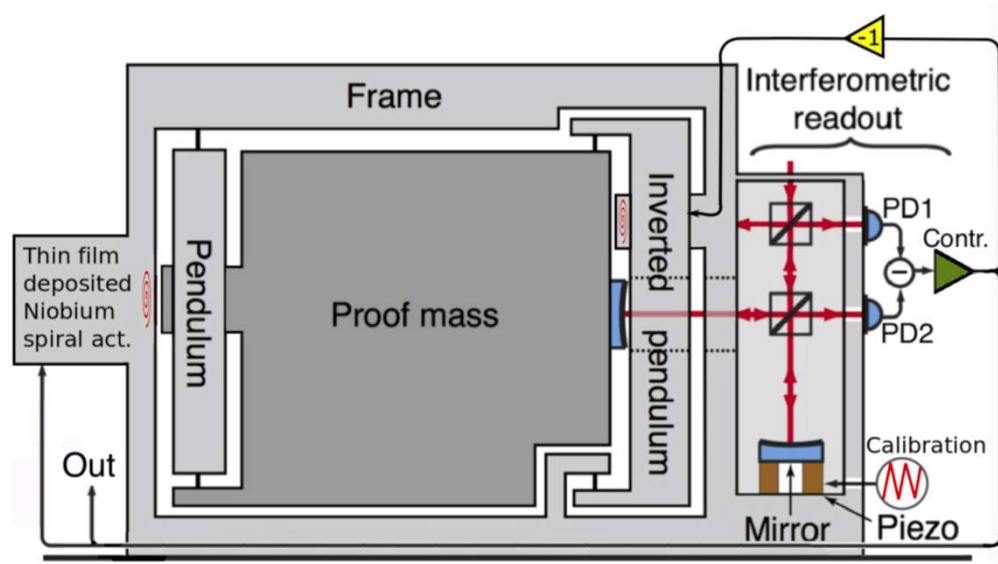


vertical seismometer

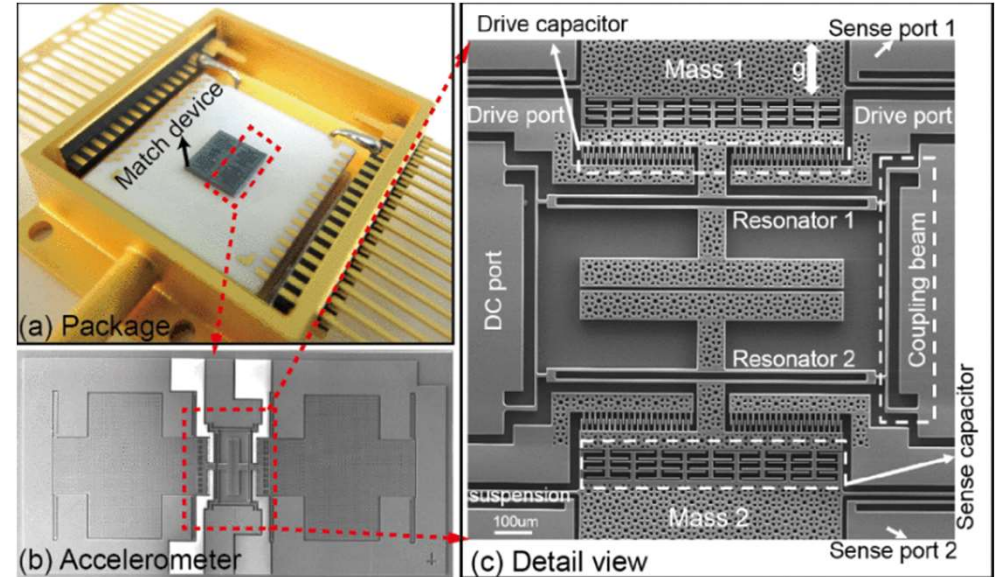
- **Negative stiffness design** applied to reduce the natural frequency: 0.1 Hz horizontal, 0.25 Hz vertical
- laser interferometer for ultrahigh precision measurement of the proof-mass displacement
- Sensitive to picometer level inertial motion over 10-100s timescales, outperform state-of-the-art commercial sensors

WPT1 Ultra-cold vibration control

Advanced inertial sensors compatible with a cryogenic environment



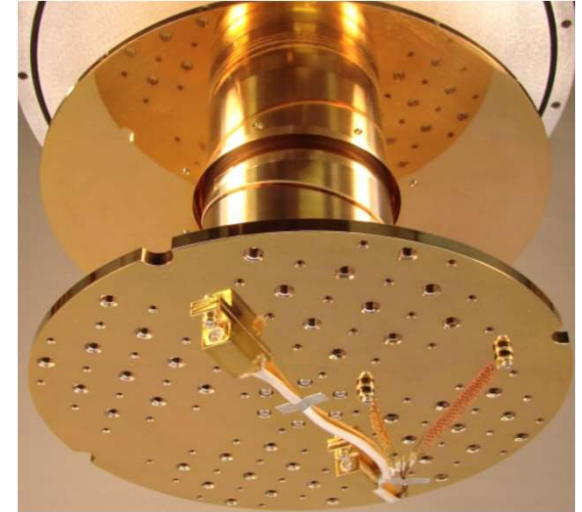
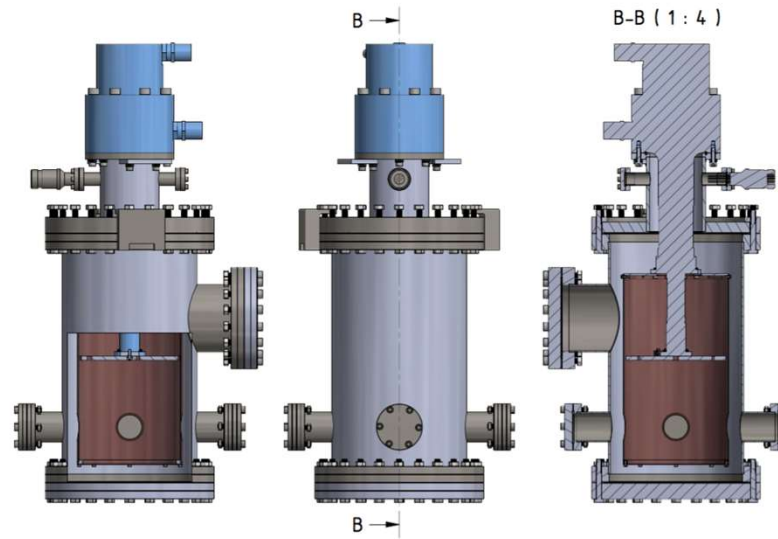
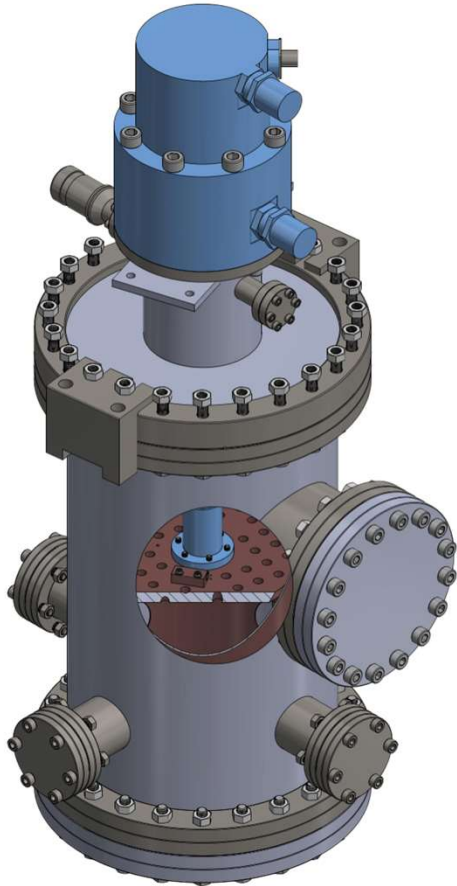
- **Monolithic niobium mechanics** and superconducting coil feedback actuator for extreme noise performance
- **Application:** cryogenic payload monitoring / control



- **MEMS accelerometers** with novel cryogenic CMOS signal conditioning integrated circuits
- **Application:** heat shield vibration monitoring and heat link active vibration isolation

WPT1 Ultra-cold vibration control

Fast turnaround cryogenic test setup for material and device characterization

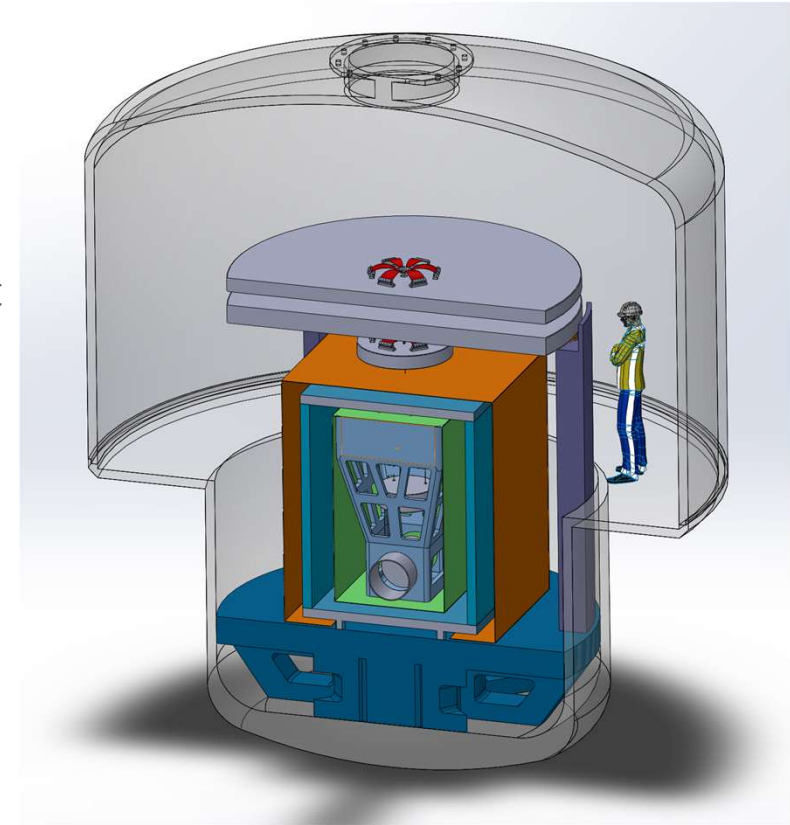


- Temperature reach: 10K
- Vacuum level: better than 10^{-9} mbar
- Equipped with a pulse tube cryocooler for low vibrations, short cooling time and low running costs
- Order was placed; delivery expected by mid-November

WPT1 Ultra-cold vibration control

Next months objectives

- progress on the prototype **system engineering**
- **vacuum chamber** modifications: executive design
- **cryogenics**:
 - ✓ completion of the design study, e.g. payload thermal model, heat transfer, cooldown time
 - ✓ architecture selection
 - ✓ cryostat engineering design
- **vibration isolator**:
 - ✓ completion of the design study and architecture selection
 - ✓ selection of sensors and actuators for the active isolation stages
 - ✓ engineering design
- **low temperature inertial sensors**:
 - ✓ prototype production design



Thank you!

16.10.2020

E-TEST WPT2

Optical engineering

Timing 01.02.2020 – 31.07.2023

Budget: 3.2M€

16.10.2020



By Dr. Oliver Fitzau
Group Manager Fiber Lasers
Fraunhofer Institute for Laser Technology ILT, Aachen, Germany

E-TEST Prototype

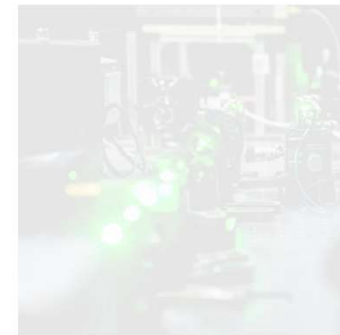
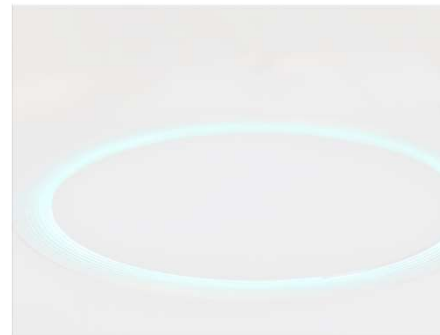
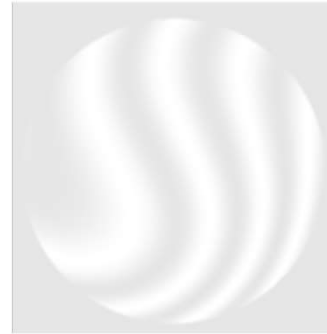
Development of a cryogenic facility to validate, improve and test active vibration control for gravitational wave telescope

- WPT2 Optical engineering
 - Activity 2.1. Large Silicon Mirror Manufacture and test
 - Activity 2.2 Laser and optics at 2 microns wavelength
 - Activity 2.3 Assembly and validation of the whole setup

The Partners involved in the WP T2
– Optical Engineering –

Agenda

- Introduction WPT2
- Topics
 - Silicon mirror manufacturing
 - Silicon mirror coating
 - Laser development
 - Sensors
- Current Work



Introduction

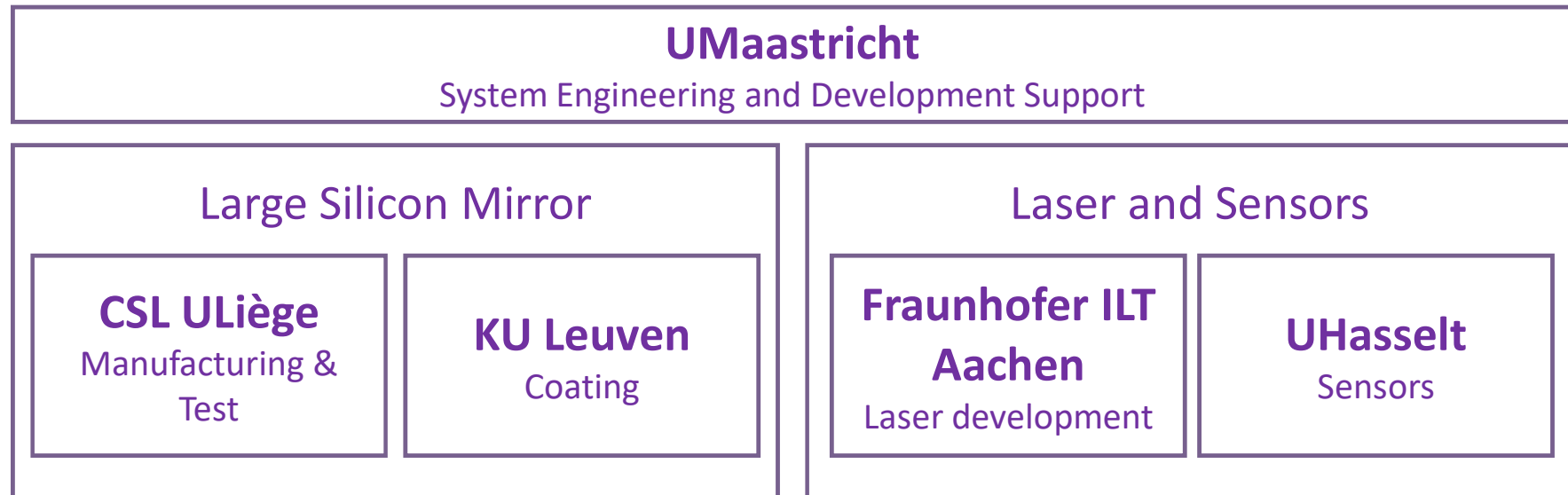
Goal for ET: Establish measurement at wavelength of 2 μm to:

- Reduce noise
- Improve accuracy

Work divided in three Sub-WPs:

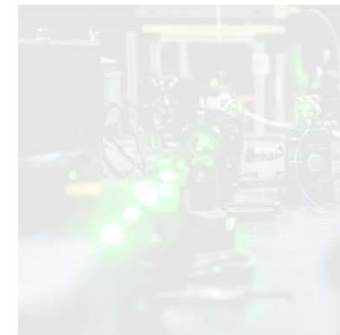
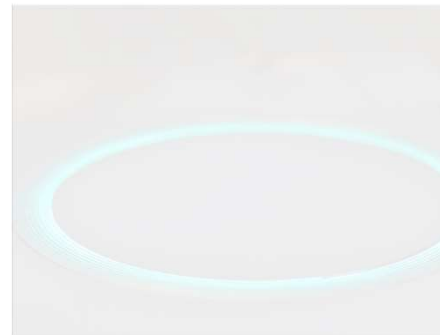
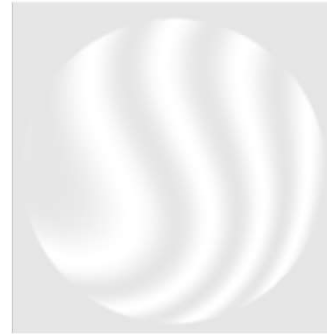
1. Large silicon mirror manufacture and test
2. Laser and optics at 2 μm wavelength
3. Assembly and validation of the subsystems

Introduction



Agenda

- Introduction WPT2
- Topics
 - Silicon mirror manufacturing
 - Silicon mirror coating
 - Laser development
 - Sensors
- Current Work

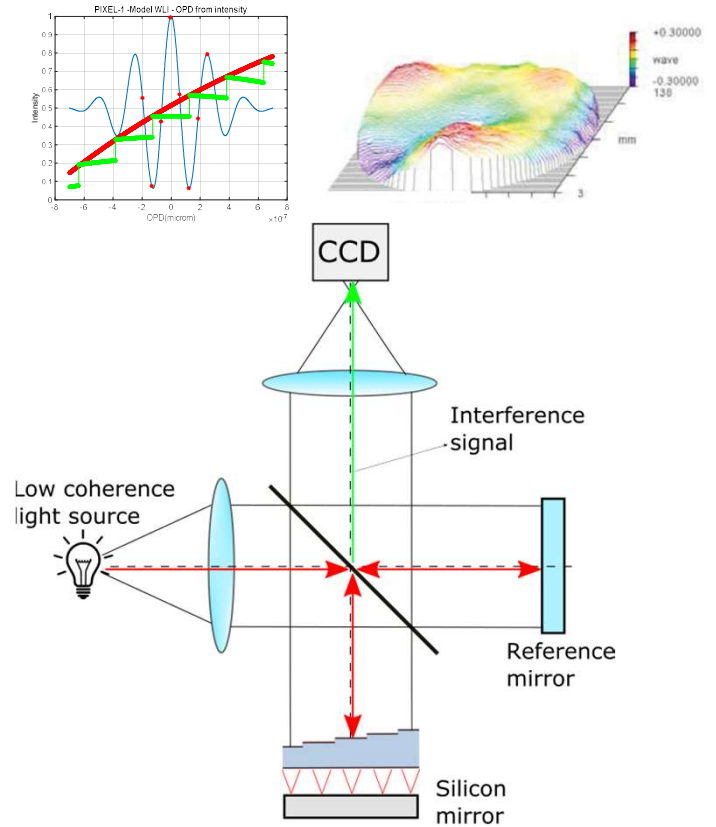


Silicon Mirror Manufacturing & Test

- Use of Silicon mirrors improves mechanical and noise properties in cryogenic setups
- To reduce vibration from radiation pressure, massive mirrors are implemented
- Improvements in manufacturing are necessary
- Key to achieving highly accurate mirrors is the characterization of the mirror surfaces

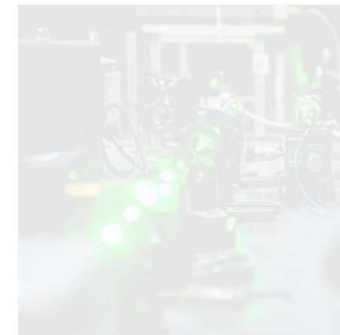
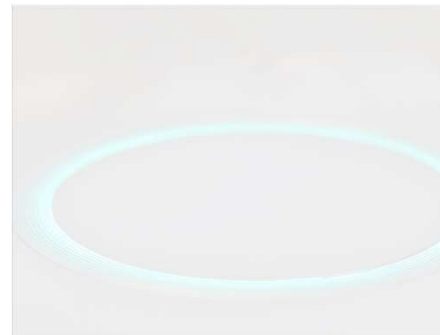
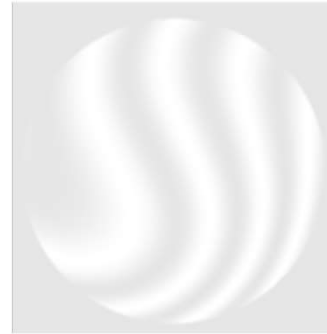
Silicon Mirror Manufacturing & Test

- **Problem:**
The mirror shape might change due to the extreme temperature variations
- **Envisaged Solution:**
Use of interferometry for continuous mirror shape monitoring with sub-nanometer precision
- **Innovation:**
 - Low coherence interferometry for large fields of view
 - A dynamical design (no movable parts)



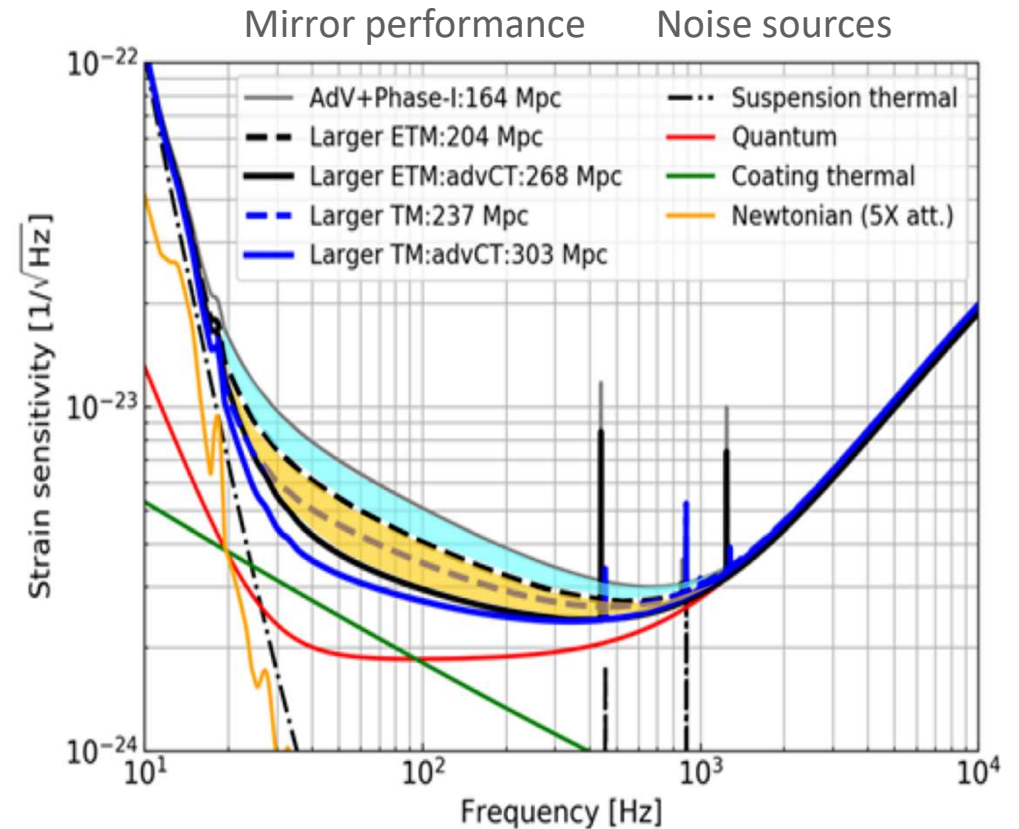
Agenda

- Introduction WPT2
- Topics
 - Silicon mirror manufacturing
 - **Silicon mirror coating**
 - Laser development
 - Sensors
- Current Work



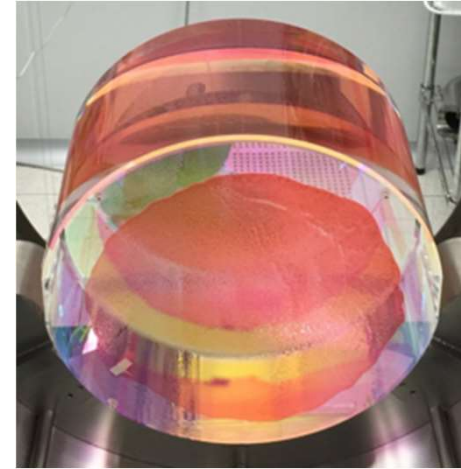
Silicon Mirror Coating

Coating thermal noise has largest contribution to the total mirror performance!



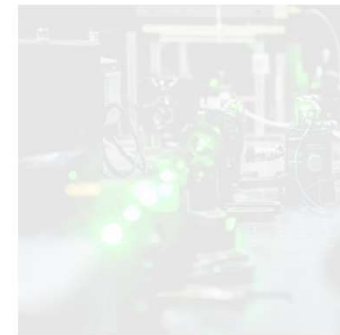
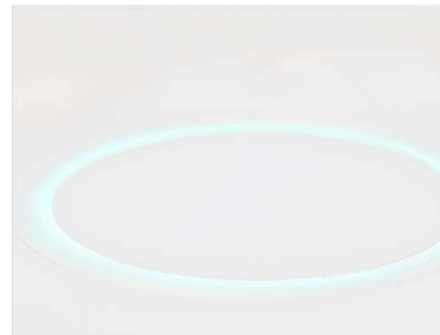
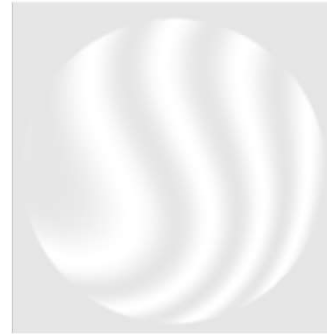
Silicon Mirror Coating

- Noise of state-of-the-art amorphous ($\text{SiO}_2/\text{Ta}_2\text{O}_5$) coatings is the main performance limitation for GW telescopes
- Our goal: high quality single crystal oxide mirror coatings
- E-Test drives the following developments:
 - Explore the quality and noise performance of different material classes of single crystalline oxide coatings
 - Experiment with layer transfer and wafer bonding techniques to transfer a mirror coating grown on a substrate to a mirror body
- This expertise will expand towards electronic and photonic thin films for use in valorization actions.



Agenda

- Introduction WPT2
- Topics
 - Silicon mirror manufacturing
 - Silicon mirror coating
 - Laser development
 - Sensors
- Current Work



Laser Development

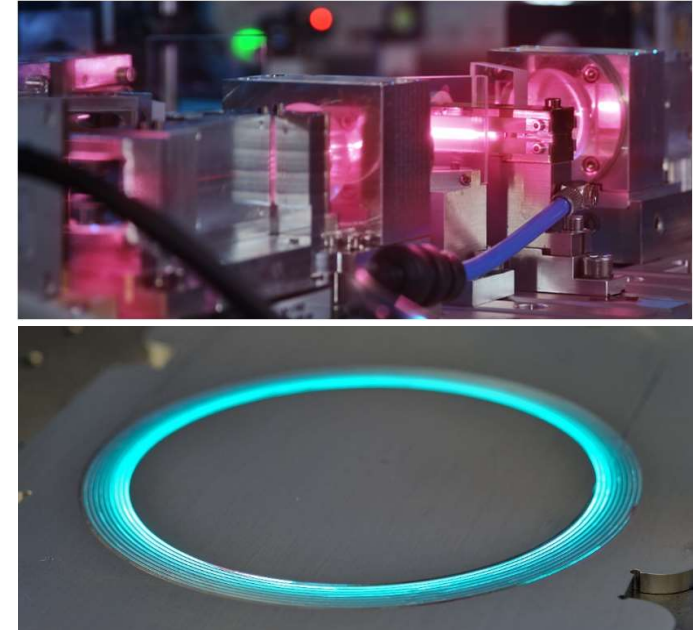
- Laser requirements
 - Stable output power and frequency
 - Narrow linewidth
 - Emission at around 2 μm wavelength
- Basic laser design
 - Two-stage setup
 - Crystal-based seed source defines spectral properties
 - Fiber-based amplifier for power scaling
 - Decoupling of frequency and power actuators



Laser Development

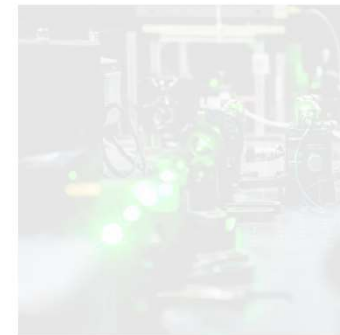
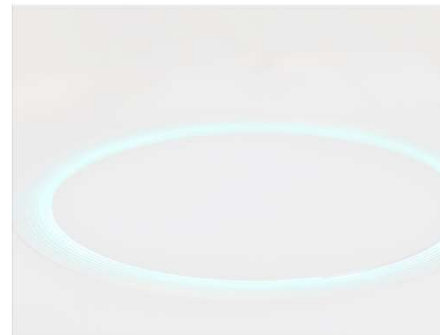
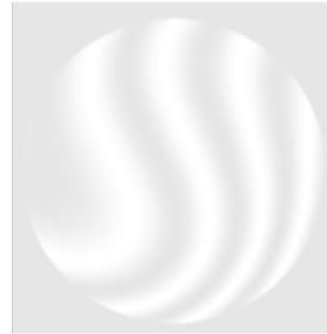
Work at Fraunhofer ILT

- Development of a solid-state laser seed source for $2.xx \mu\text{m}$
- Development of a fiber amplifier design
- Power scaling to $\sim 10 \text{ W}$
- Stabilization of output power and frequency



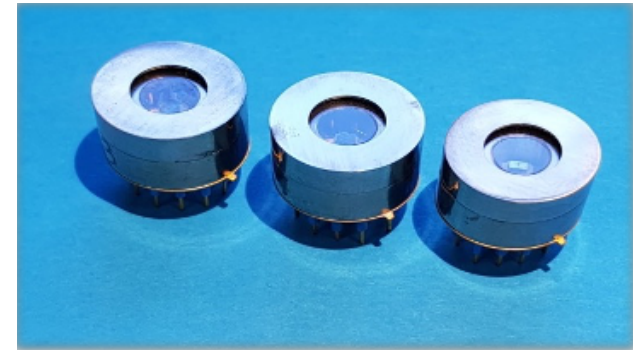
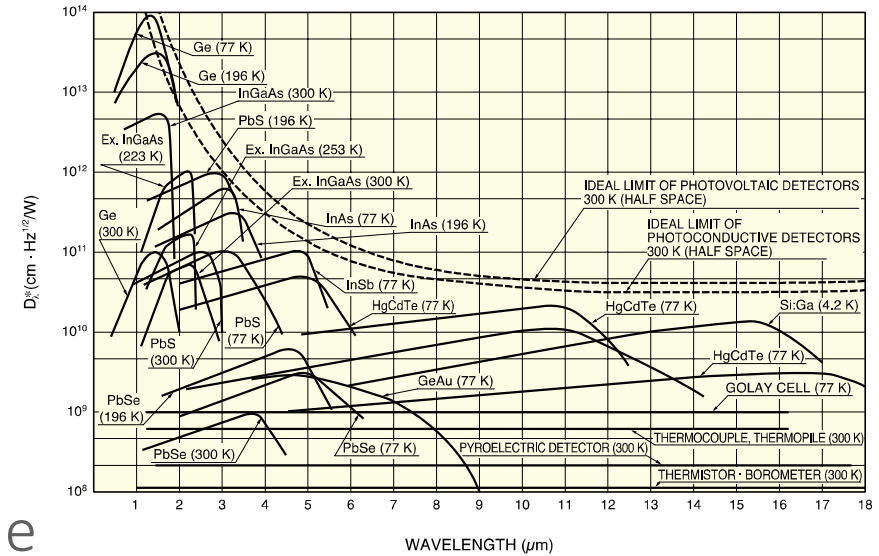
Agenda

- Introduction WPT2
- Topics
 - Silicon mirror manufacturing
 - Silicon mirror coating
 - Laser development
 - Sensors
- Current Work



Sensor development

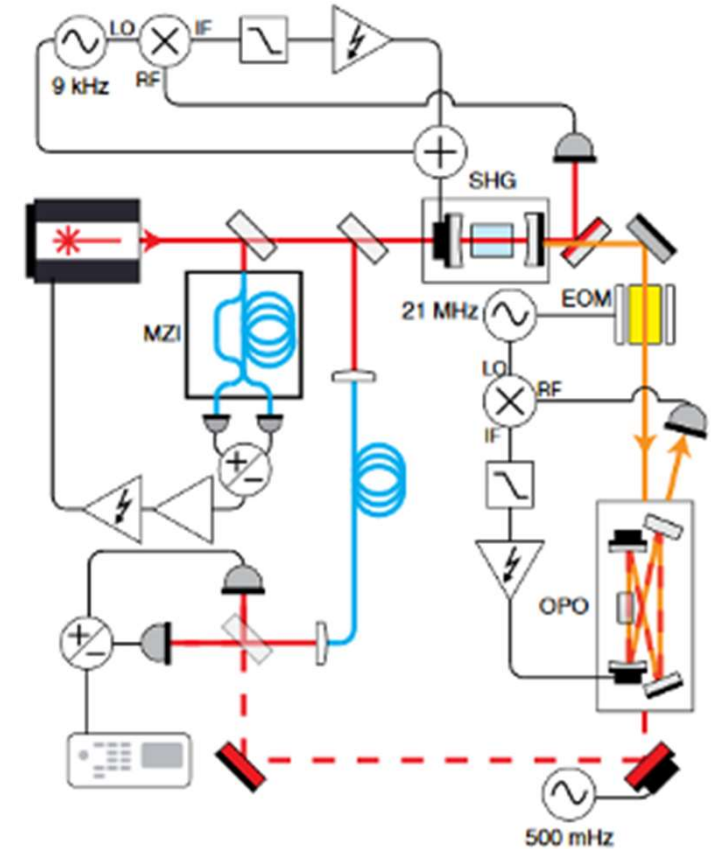
- Photosensors are used to measure power fluctuations from
 - Interferometric setup
 - Changes in ambient conditions
 - Beam source noise
- Light squeezing is a method to increase the signal-to-noise ratio of the setup and thus increase the interferometer performance



Sensor development

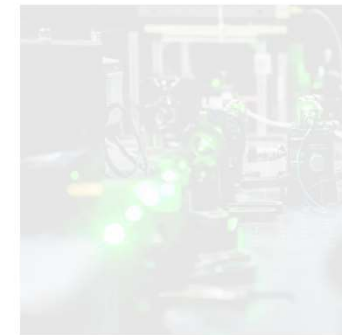
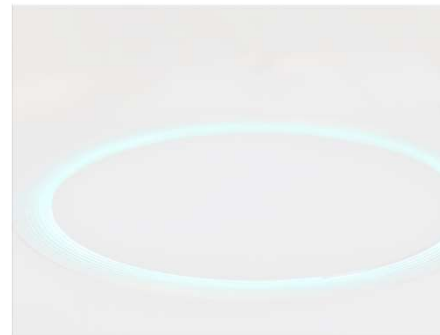
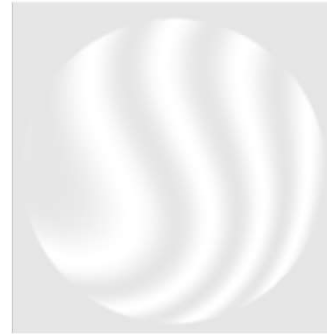
Work within E-TEST

- Selection procedures for photon detectors and characteristics evaluation: Spectral dependence of quantum efficiency, noise, stability
- Optimisation of readout protocols: S/N, speed
- Optimal wavelength matching to ILT lasers
- Development of light squeezing scheme at 2 microns



Agenda

- Introduction WPT2
- Topics
 - Silicon mirror manufacturing
 - Silicon mirror coating
 - Laser development
 - Sensors
- Current Work



Current Work

Silicon Test Mass

- Design of suspension stage
- Design of white light interferometer

Silicon Mirror Coatings

- Assessment of coating options for the 2 micron range

Current Work

Laser Technology

- Wavelength baseline established
- Design of seeder and amplifier

Detectors

- Review detectors for 2 micron detection range
- Installation of low vibrational optical table dedicated for the measurements
- Optical setup design for measurement of IQE, noise and spectral characteristics of photodetectors

Thank you!

16.10.2020

E-TEST WPT4

EMR Geological modelling and Engineering Geology of the ET

Timing 01.02.2020 – 31.07.2023

Budget: 5.4M€

16.10.2020



By Prof. Dr. rer. nat. Florian Amann
Chair of Engineering Geology and Hydrogeology, RWTH Aachen, Germany

E-TEST Geology

Advanced studies of the underground in the EMR leading to an open geo-model and an in-situ observatory

- WPT4: Geological modelling and Engineering Geology of the ET
 - Activity 4.1 Cross-border open geological model
 - Activity 4.2 Einstein telescope feasibility and optimal positioning in the EMR

The Partners involved in the WP T4
– Geological Modelling & Engineering Geology of the ET –

Main Objectives

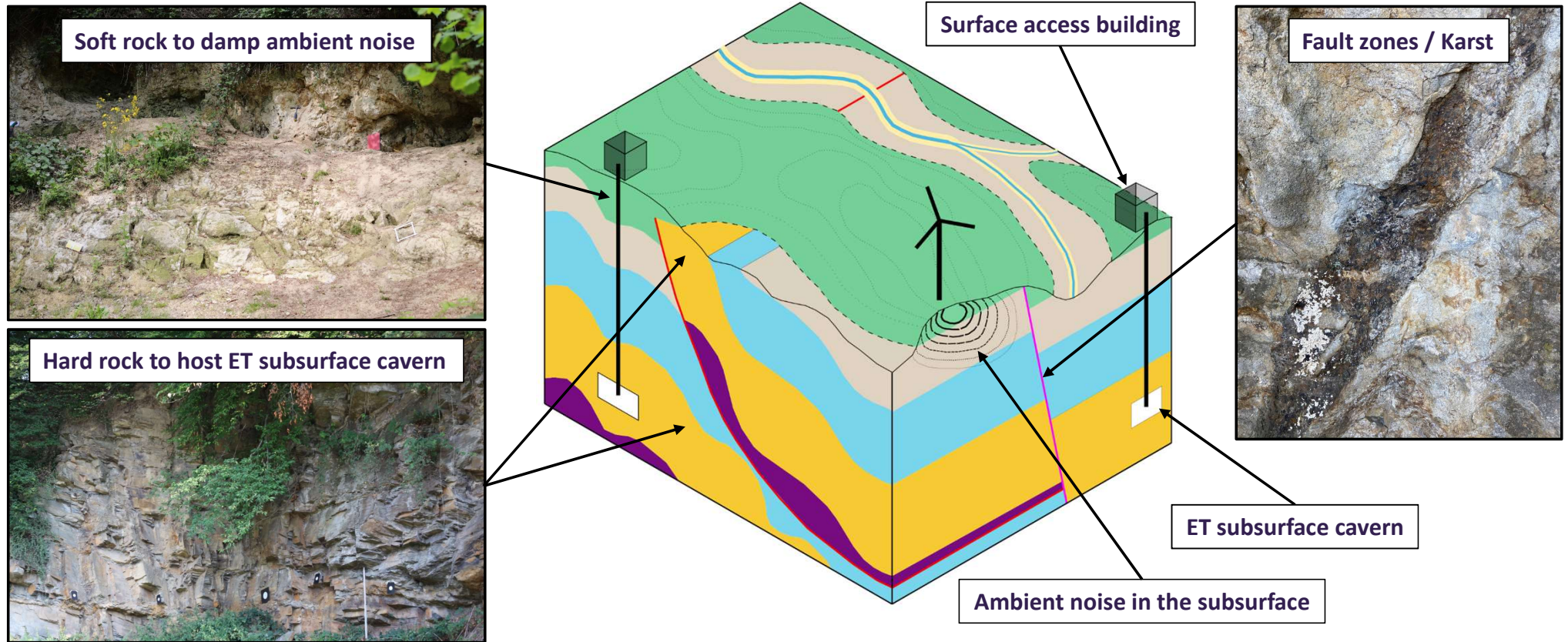
- 3D Cross-Border Geological Model
 - Evaluation and incorporation of existing geological data sets
 - Implementation of new boreholes
 - Active and passive seismic survey
- ET-Design
 - Feasibility study and optimal positioning of the ET triangle
 - Extensive multi-disciplinary in-situ and laboratory testing campaign
 - Assessment of regional fracture characteristics by outcrop analogue studies



16.10.2020



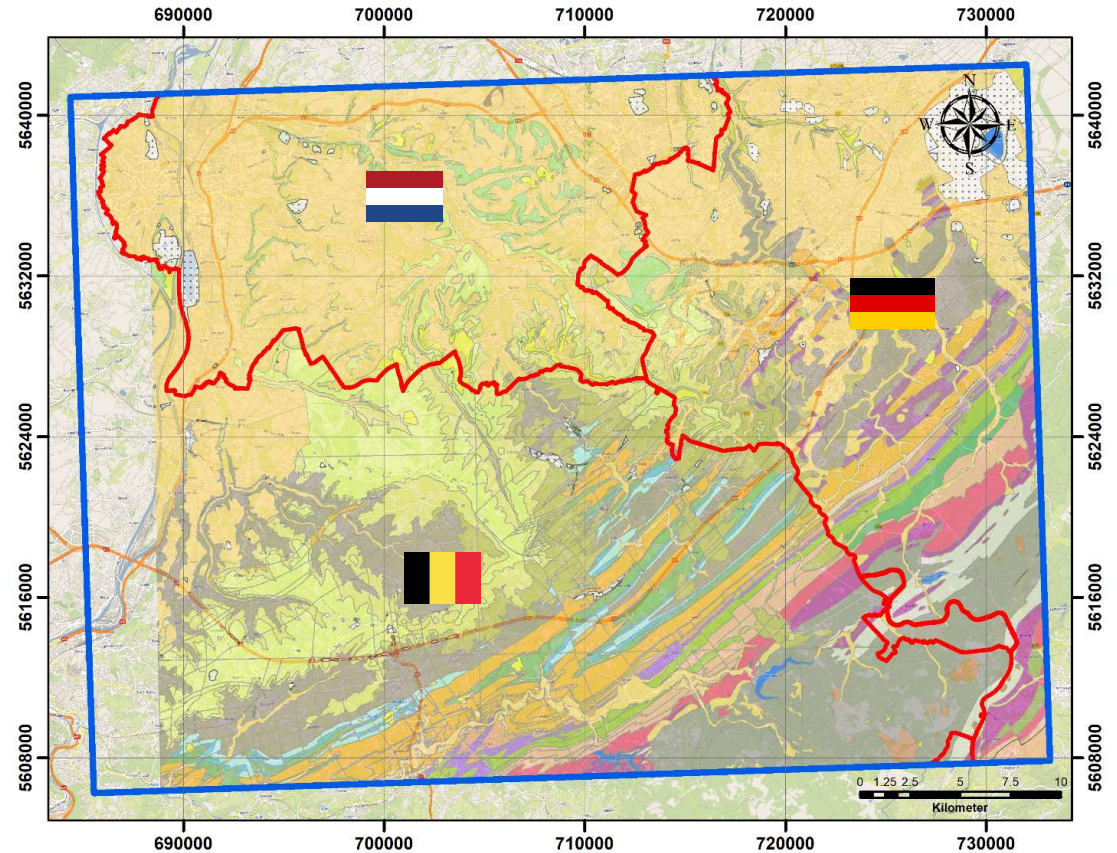
Boundary Conditions for ET Construction



Cross-Border Database (GIS-Project)

Surface Geological Map:

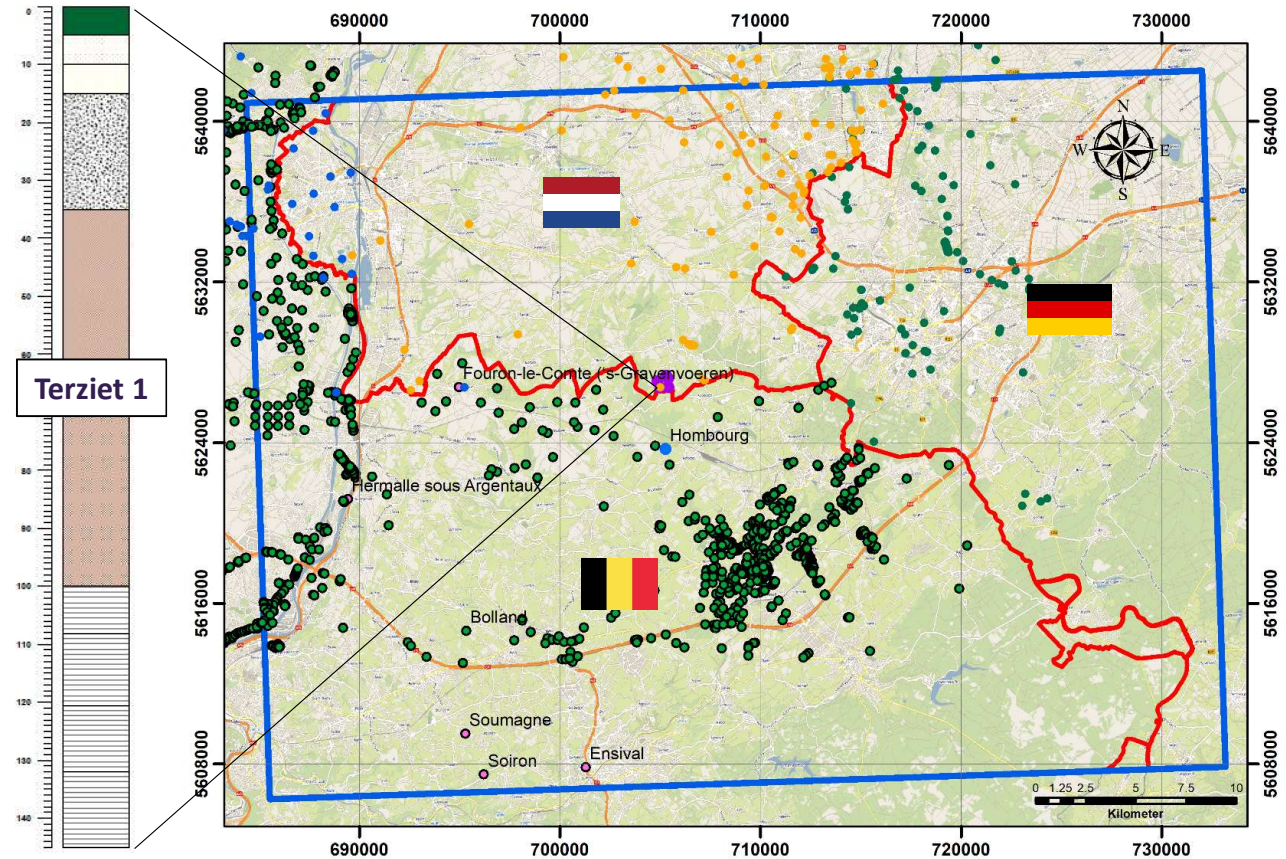
- Indications on solid rock in the subsurface to host ET installations
- Indications on possible fault zones
- Presence of soft rock at the surface to reduce ambient noise



Cross-Border Database (GIS-Project)

Subsurface Borehole data:

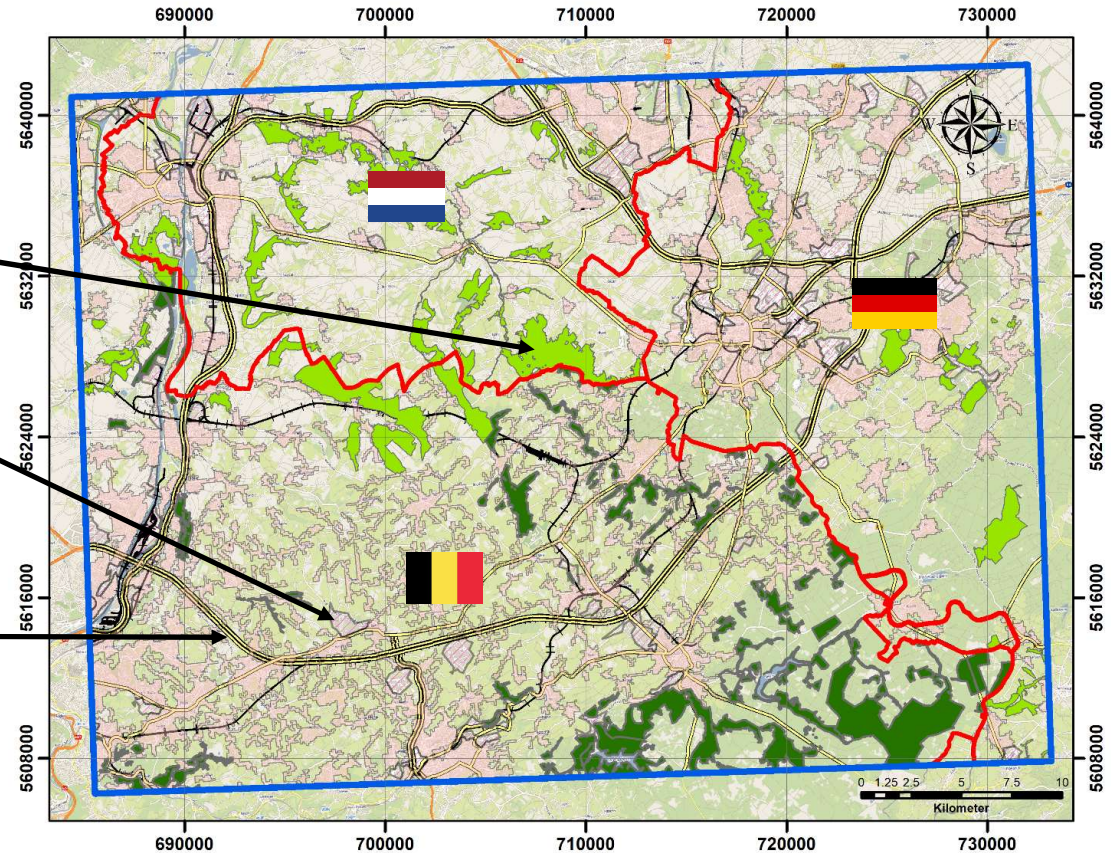
- Lithological profile (e.g. Terziet 1)
- Information about fault zones
- (Hydrogeological data)



Cross-Border Database (GIS-Project)

Landuse information:

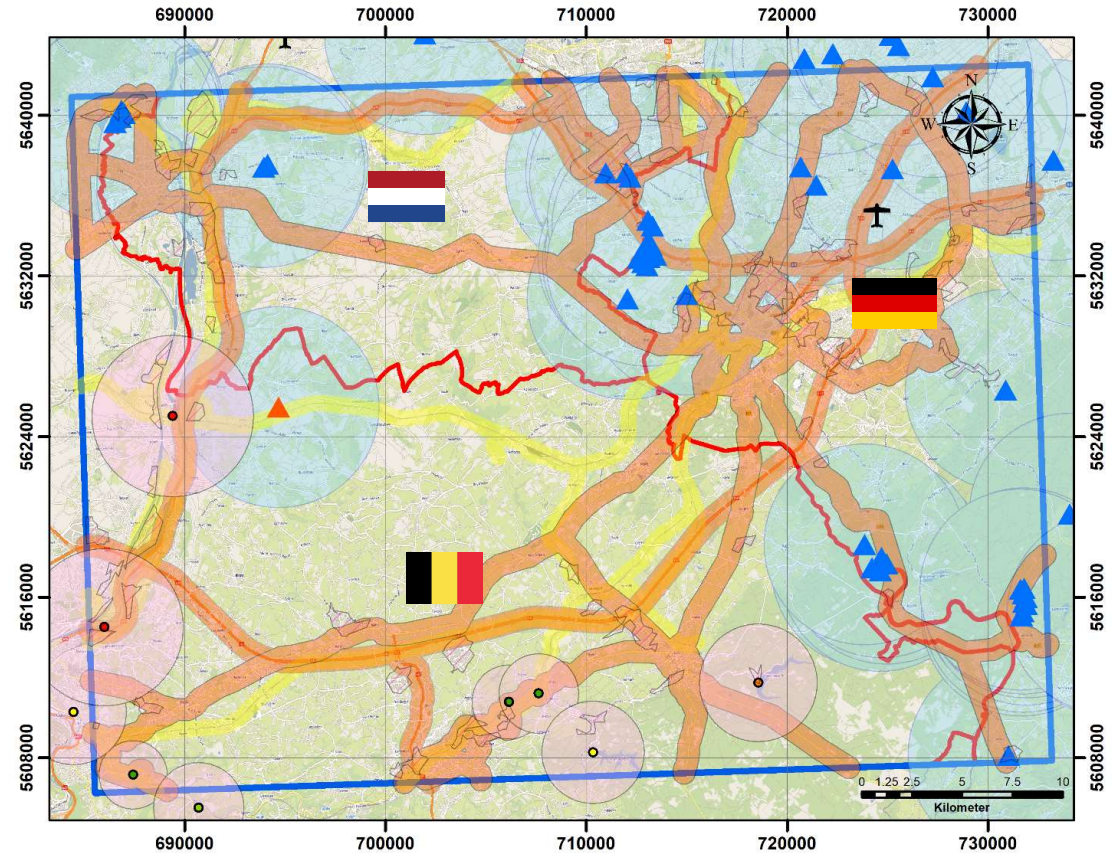
- Access to ET subsurface installations outside of Natura 2000 areas
- Subsurface installations not beneath industrial or urban areas
- Existing infrastructure important for construction sites



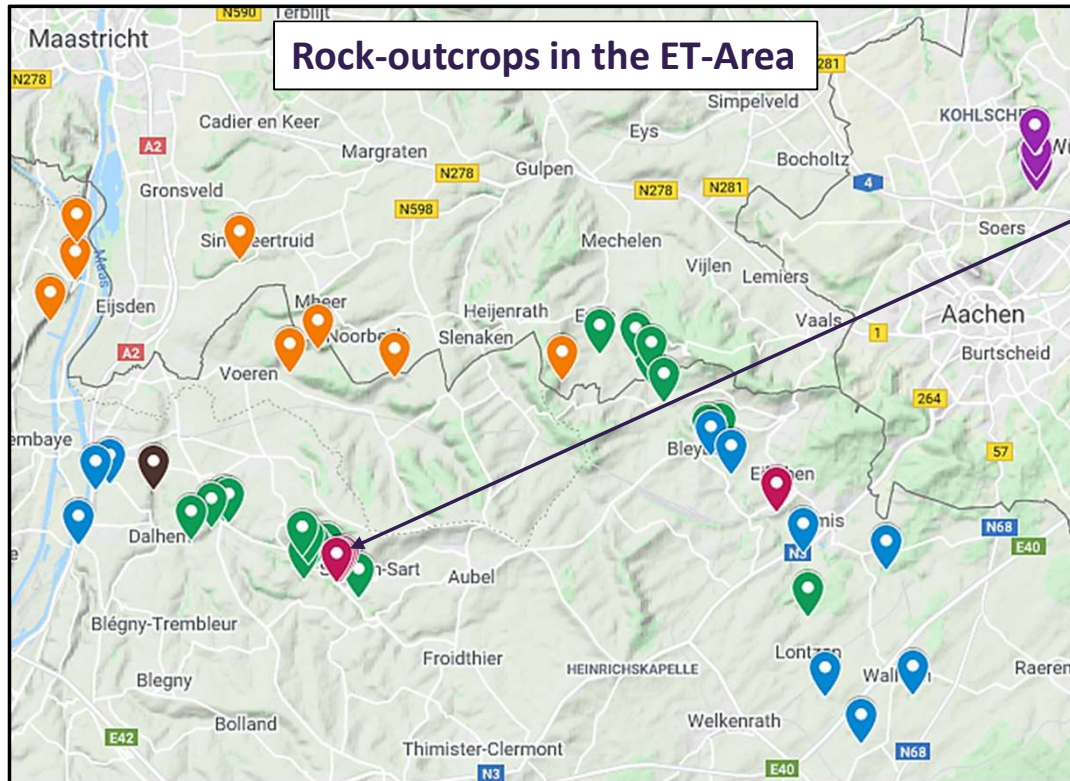
Cross-Border Database (GIS-Project)

Estimated influence zones of ambient noise sources:

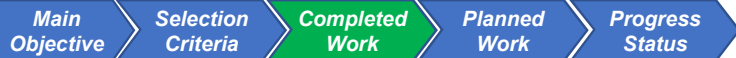
- Surface facilities (streets, roads, wind power plants) emit noise
- Buffer zones around these facilities to minimize the effect of the noise on the ET subsurface installations



In-situ Engineering Rock Mass Characterization

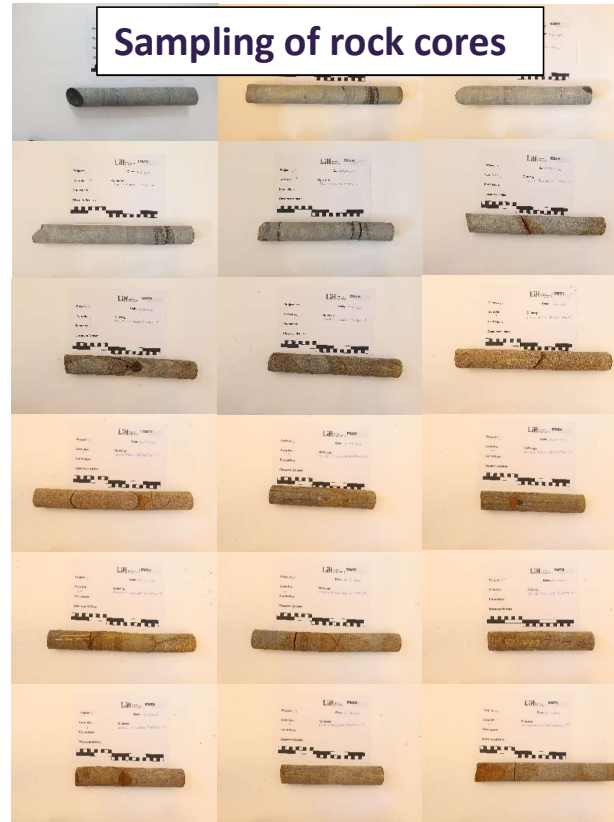


3D model using photogrammetry method



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Laboratory Engineering Rock Mass Characterization



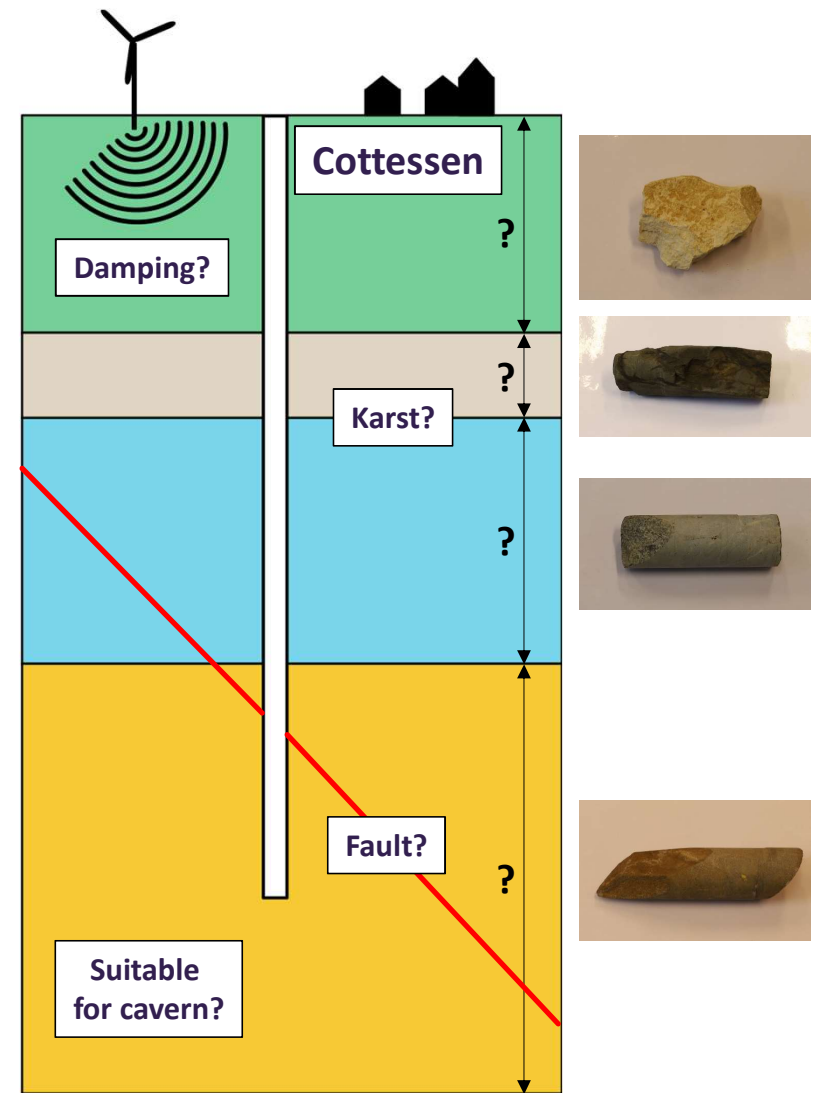
Sampling and Testing in the Subsurface

- Planned borehole close to Cottessen (NL) (**Not Confirmed**)



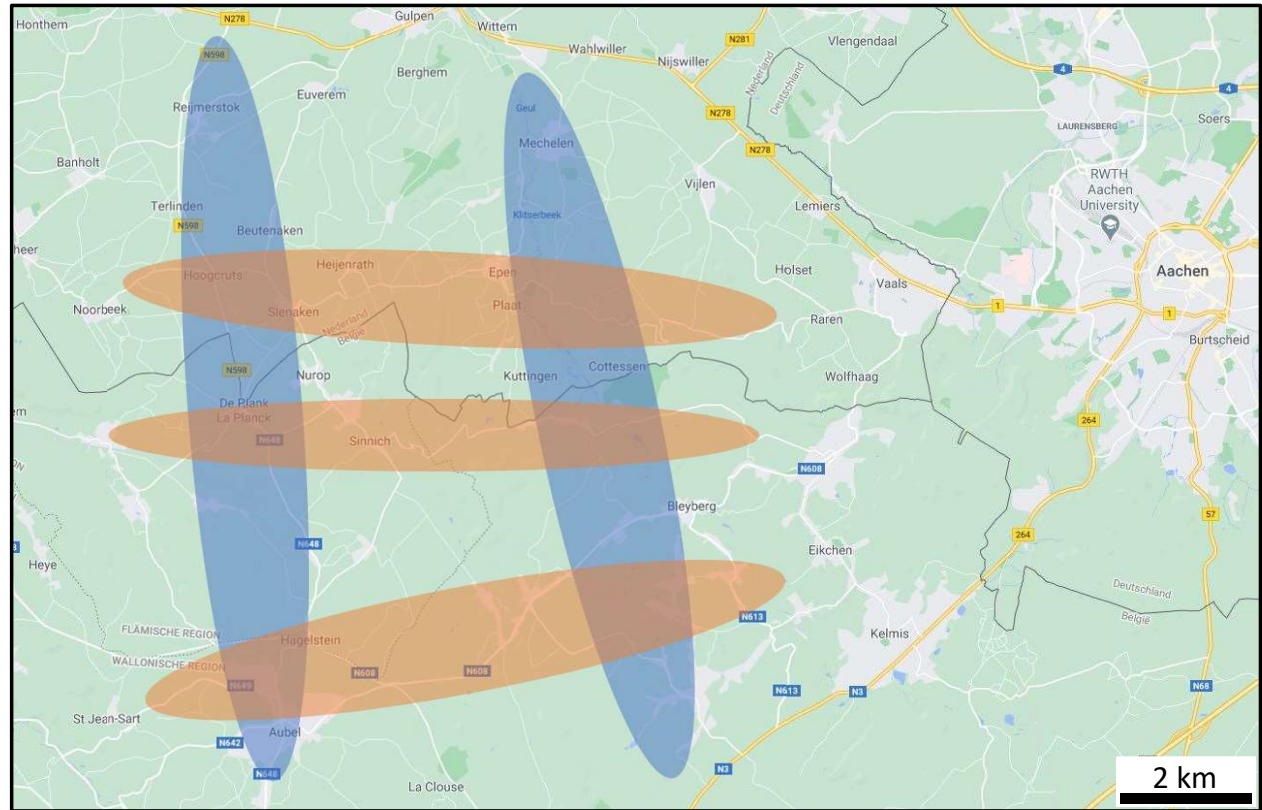
Planned Borehole Close to Cottessen (Not Confirmed)

- Geological exploration in an area with exemplary subsurface conditions
- Cores for excessive geomechanical testing campaign
- Hydraulic in-situ testing
- Geophysical borehole logging
- Long time Ambient noise measurements



Active Seismic Survey

- Sub-surface imaging for faults and rock detection
- 2 lines running NNW-SSE
- 2-3 lines running E-W
- Use of existing infrastructure
- Positions of survey lines are **not confirmed** yet



Thank you!

16.10.2020

E-TEST WPT3 EMR cross-border underground observatory

Timing 01.02.2020 – 31.07.2023

Budget: 1.5M€

16.10.2020



By Prof. Dr. Ir. Frédéric Nguyen
Chair of Applied Geophysics
Director of Urban and Environmental Engineering (UEE), ULiège, Belgium
E-TEST Scientific Lead Partner – Geology

16.10.2020

E-TEST Geology

Advanced studies of the underground in the EMR leading to an open geo-model and an in-situ observatory

- WPT3: EMR cross-border underground observatory
 - Activity 3.1 Hydro-geophysical observatory and monitoring public database
 - Activity 3.2 Open cross-border groundwater model for ecosystem services
 - Activity 3.3 Seismic noise model
 - Activity 3.4 Improved cross-border seismic hazard map

The Partners involved in the WP T3
– EMR cross-border underground observatory –

WP T3 Activities and deliverables

1. Open cross-border **models** for
 1. Groundwater and ecosystem services
 2. Seismic noise
 3. Seismic hazard
2. Hydrogeophysical **observatory** and monitoring public database

Both results are tools for a **sustainable management** of the underground resources and **key for positioning the ET** in the Region

WP T3 Activities and deliverables

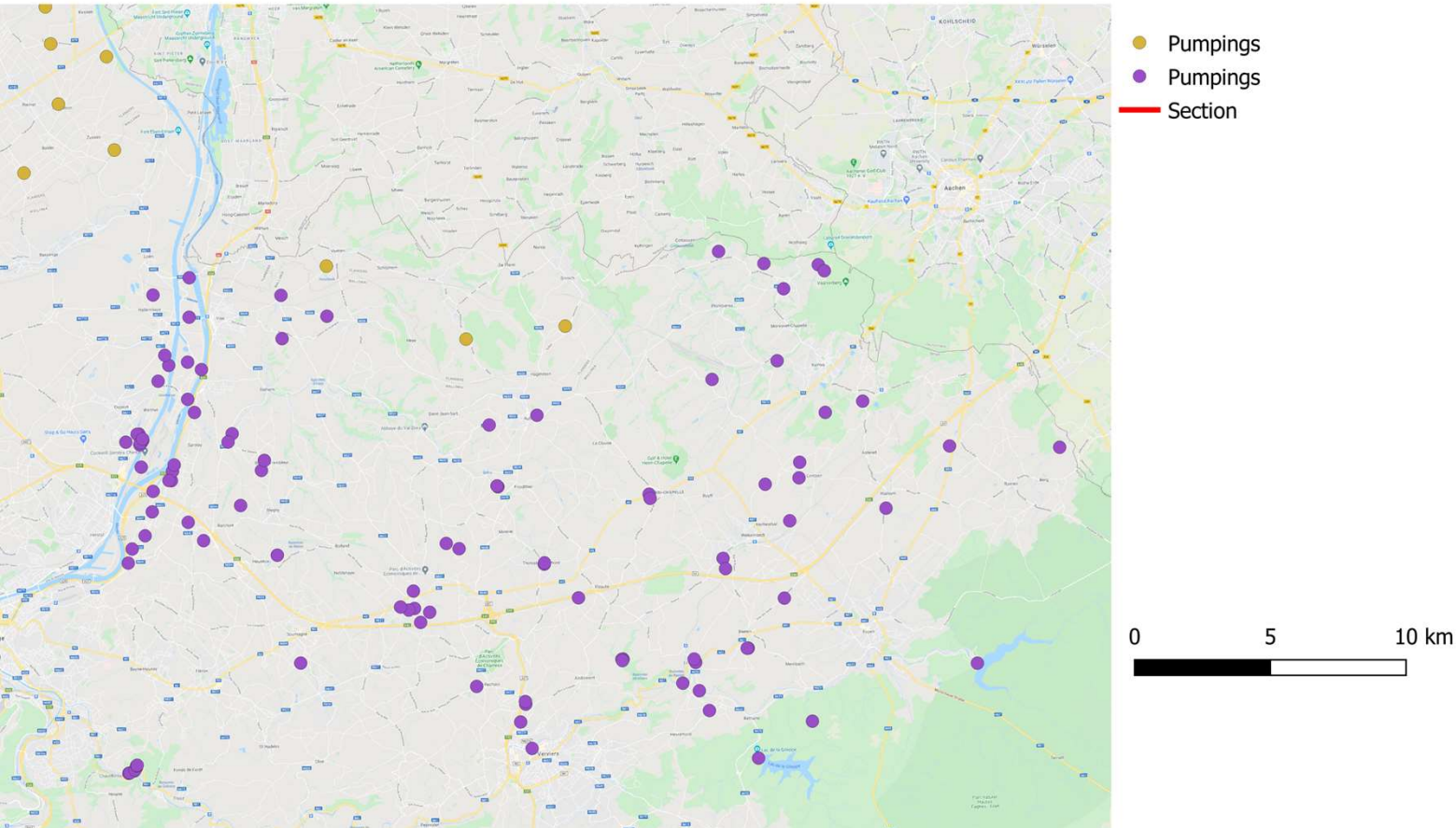
1. Open cross-border models for
 1. **Groundwater** and ecosystem services
 2. Seismic noise
 3. Seismic hazard
2. Hydrogeophysical observatory and monitoring public database



Why studying hydrogeological conditions ?

- Groundwater is a key factor for any successful underground project.
- It is mainly controlled by strata discontinuities
- Controlling water inflow is critical for both the **construction** phase and the **exploitation** phase
- It is a critical input for the design of the Einstein Telescope in WP T4
- Data required at various scales

A cross-border EMR groundwater model enables



A sustainable management of ecosystem services:

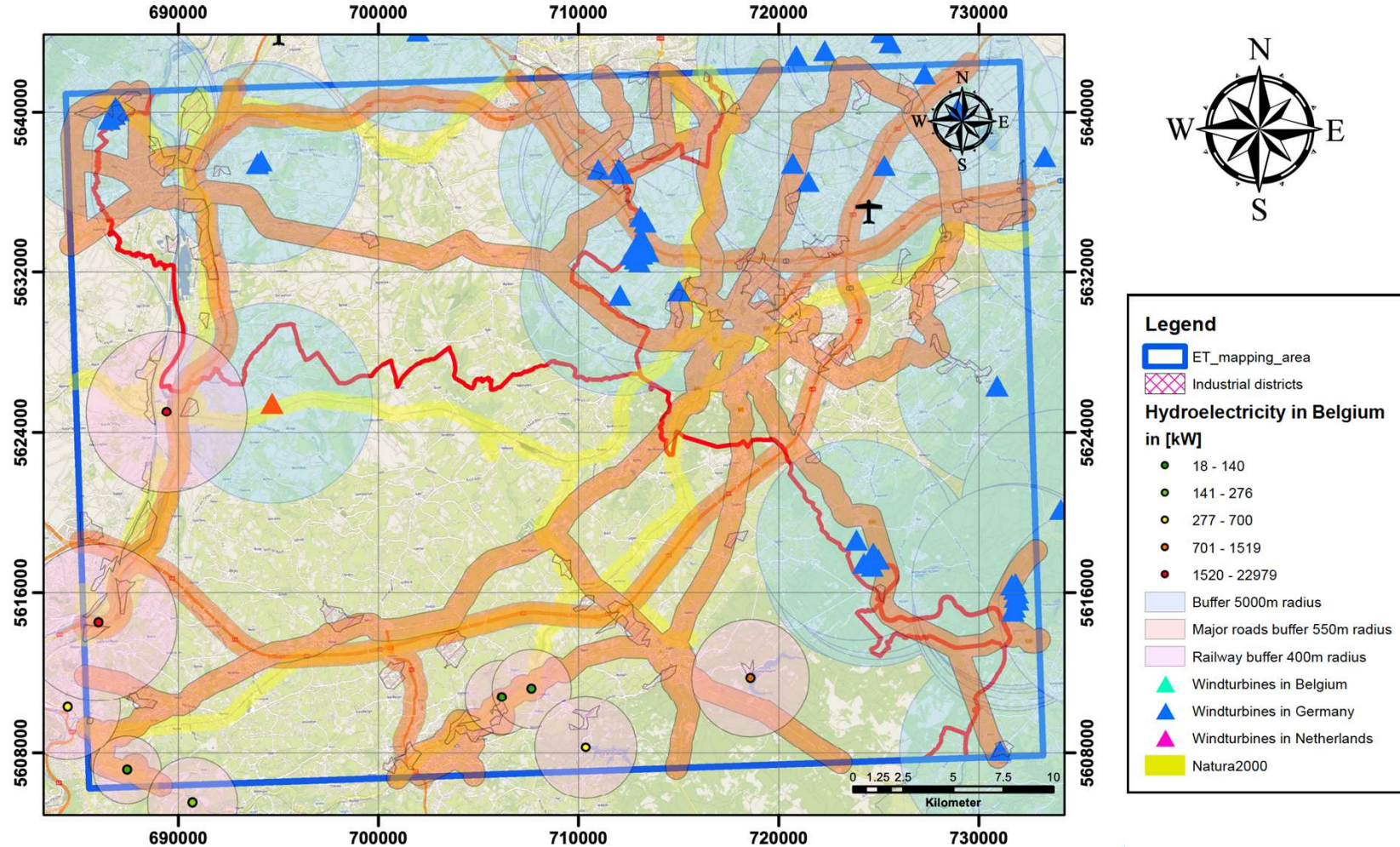
- Water abstraction
- Shallow geothermy potential
- Environmental impact assessment

WP T3 Activities and deliverables

1. Open cross-border models for
 1. Groundwater and ecosystem services
 2. Seismic noise
 3. Seismic hazard
2. Hydrogeophysical observatory and monitoring public database

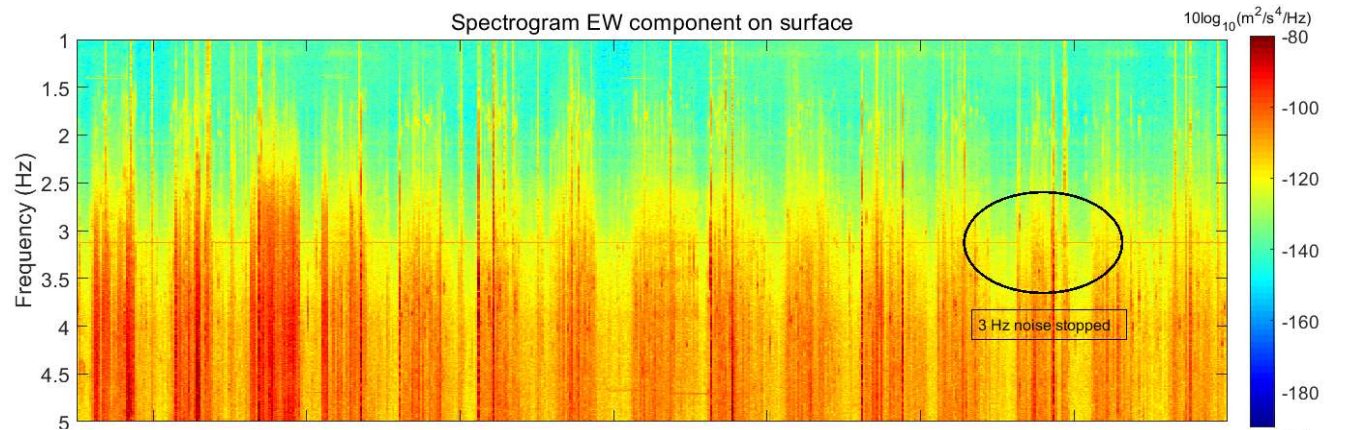
To understand how vibrations vary we need

- To identify and characterize the sources
- Measure and model the vibration propagation in the underground

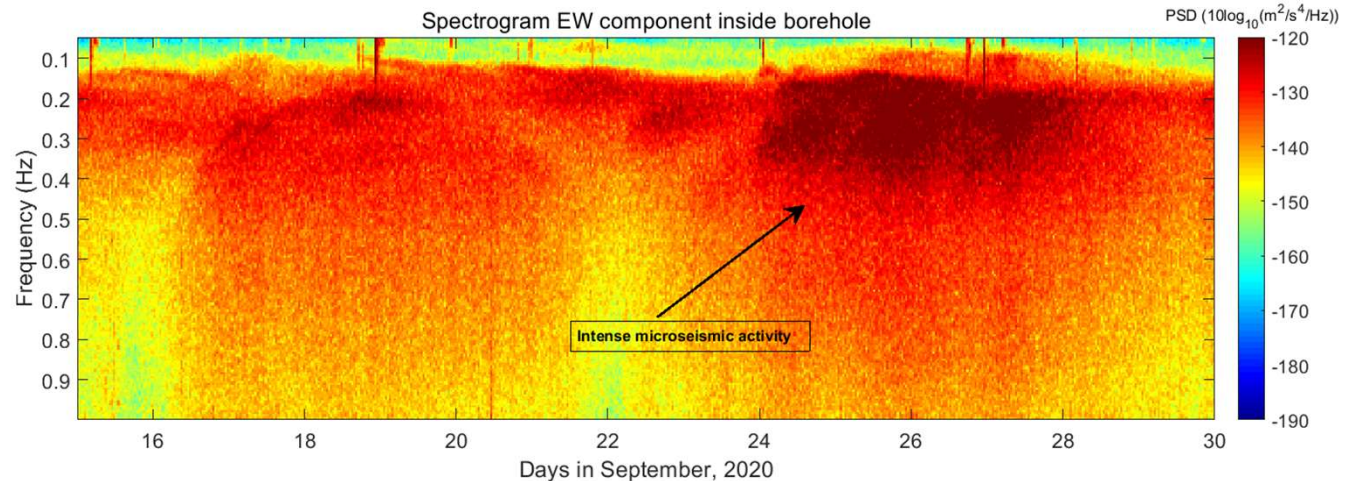


Seismic noise = ambient (under)ground vibrations

Vibrations measured at the surface



Vibration measured at depth



WP T3 Activities and deliverables

1. Open cross-border models for
 1. Groundwater and ecosystem services
 2. Seismic noise
 3. Seismic hazard
2. Hydrogeophysical observatory and monitoring public database

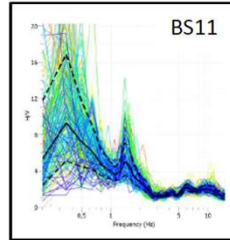
Seismic hazard map

- Definition of the seismic sources, the site effect and ground motion, and the seismic hazard.
- Different scenarios of earthquakes propagation will be run to assess their impacts on the potential ET.

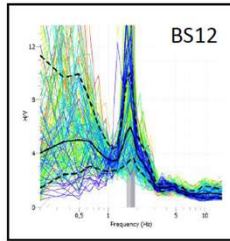
HV_Array 1B

Beusdael (Belgium) 20/07/2020

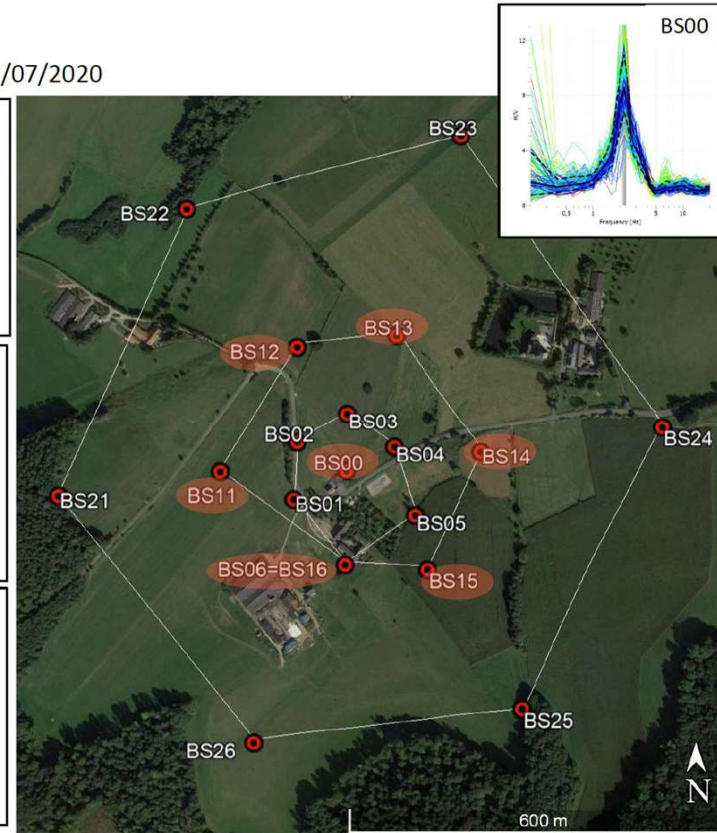
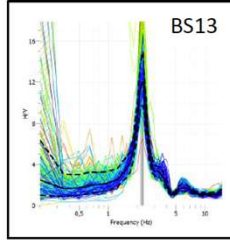
$f_0 = 0,35$
 $f_1 = 1,40$



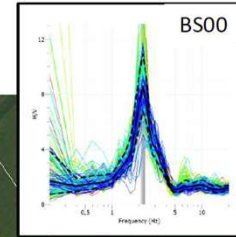
$f_0 = 1,72$



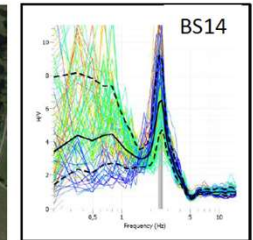
$f_0 = 2,24$



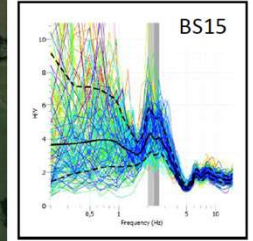
$f_0 = 2,20$



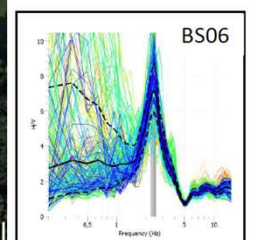
$f_0 = 2,52$



$f_0 = 2,31$

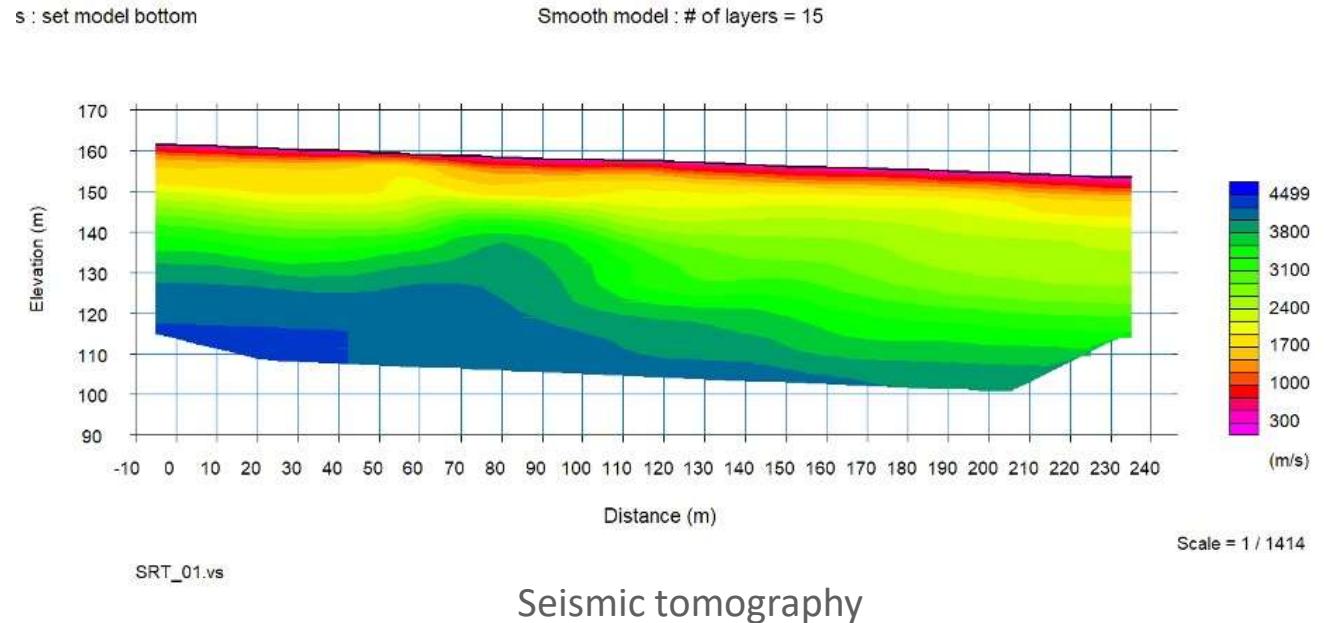


$f_0 = 2,40$



Seismic hazard map

- Definition of the seismic sources, the site effect and ground motion, and the seismic hazard.
- Different scenarios of earthquakes propagation will be run to assess their impacts on the potential ET.



WP T3 Activities and deliverables

1. Open cross-border models for
 1. Groundwater and ecosystem services
 2. Seismic noise
 3. Seismic hazard
2. Hydrogeophysical observatory and monitoring public database

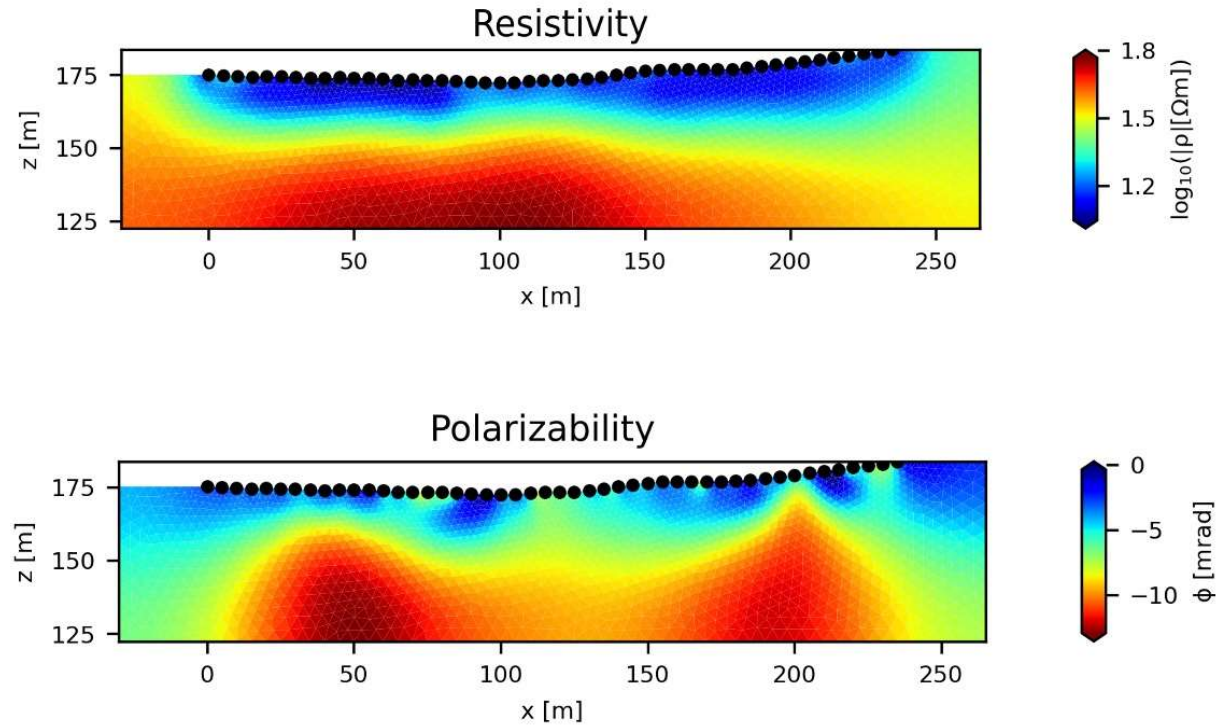
Hydrogeophysical observatory and monitoring public database

- Identify a site to host the underground R&D lab (**not yet defined**)
- Installing electrical, hydraulic and seismic sensors for monitoring the subsurface of the EMR
 - Gather seismic noise data
 - Perform hydrogeophysical tests
- Calibrate the EMR groundwater and seismic noise models

Measurement campaign August 2020

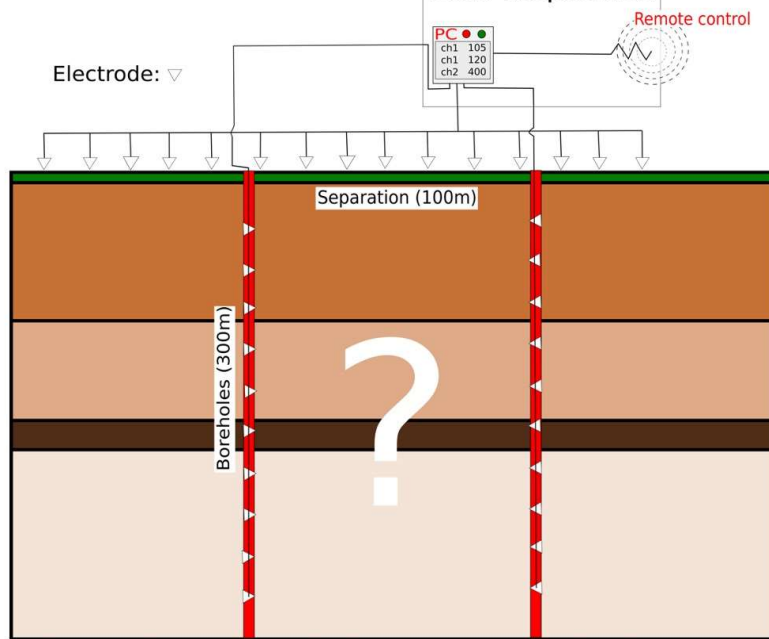


Surface measurement layout and positioning via GPS



Subsurfaces images of electrical resistivity and polarizability

Data acquisition



- Sensors in boreholes for improved spatial resolution at depth

- Automated data acquisition for continuous monitoring with high temporal resolution



Activities are in progress

Thanks to the local authorities and population for their support.

In the coming months:

- Site selection for drillings/observatory and discussion on ET corners
- Open seminars and dissemination in the region
- Seismic lines tenders
- Boreholes/hydraulic testing tenders
- Geophysical imaging
- Seismic noise measurements
- Geological modeling and hydrogeological conceptual model

Thank you!

16.10.2020

Invitation to the 1st ET Industrial Advisory Board: December 2020

16.10.2020

Invitation to the 1st ET Industrial Advisory Board

The technologies required for the [Einstein Telescope](#) are :

- cryogenics
- vacuum
- Precision mechanics
- Precision engineering
- Metrology
- Mechatronics
- Optics
- mirrors towards 50-60 cm Ø
- polishing and coating of mirrors
- Controls
- Quantum optics
- Lasers
- Sensors
- Computing/algorithms
- Modelling

In addition, specific technologies are also required for the geology aspects:

- Tunnel boring machine
- Civil engineering, building and technical services
- Geophysical imaging
- Borehole logging
- Sensors and instruments (from seismic, pressure to physico-chemical)
- 3D subsurface modelling/augmented reality
- Hydraulic tests (deep)
- Geo-mechanical testing
- Environmental monitoring
- Remote/automated monitoring
- Information technology

Invitation to the 1st ET Industrial Advisory Board

- The 1st IAB will be organized beginning December 2020
- 2/year
- Lead by the E-TEST / ETpathfinder project partners
- Participants:
 - all SMEs/other companies active in the field of the ET technologies (Interferometer prototype + all geology aspects)
 - business development agencies
 - sectorial agencies
 - clusters of competitiveness
 - Local/regional Authorities



Expression of interest / Registration via the E-TEST website online form, in the “Industries” tab in the Menu

www.etest-emr/eu

ET2SMEs under submission

(EMR146)

in the Interreg V-A EMR Call 6 – Axis 1 Innovation – umbrella project

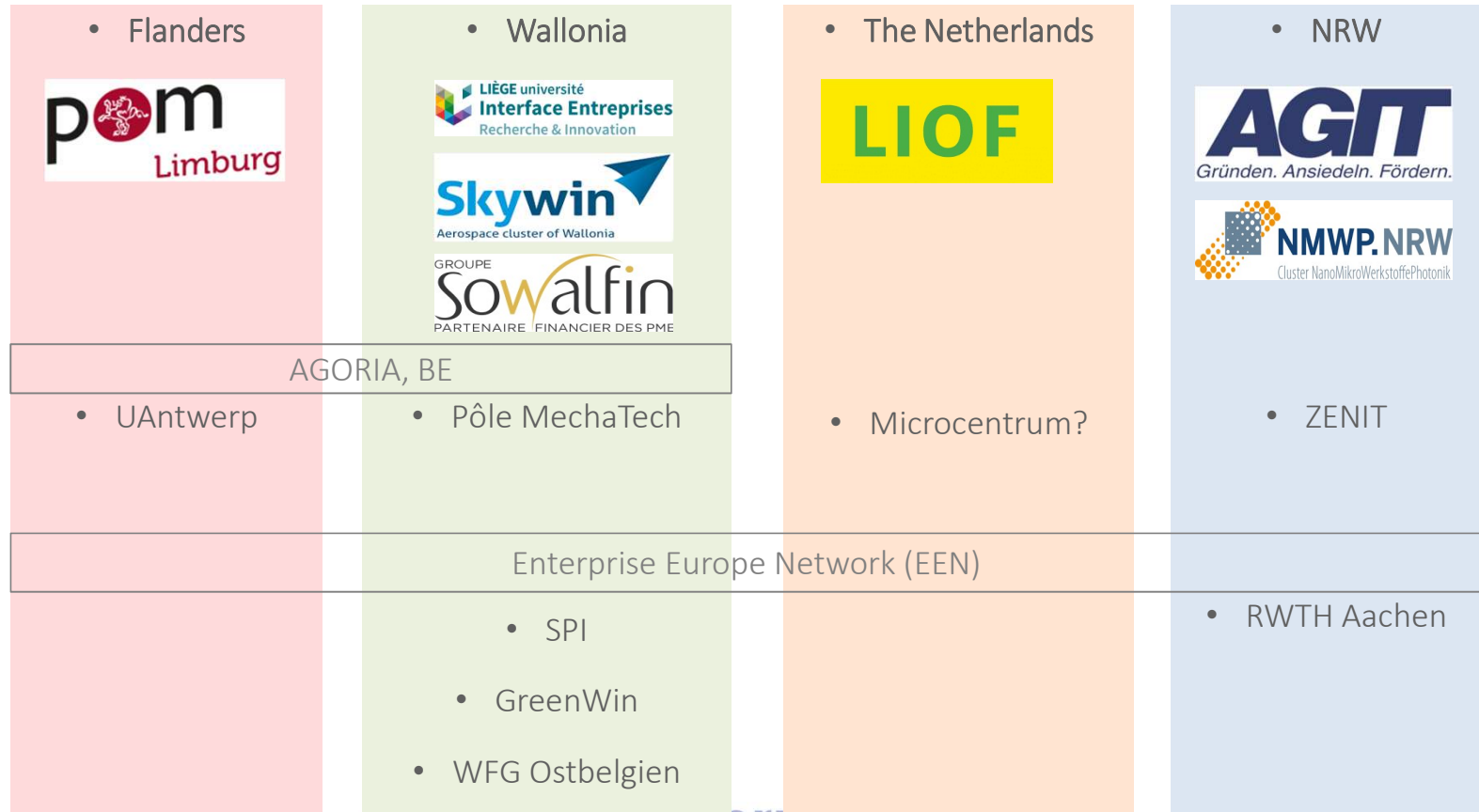
16.10.2020

ET2SMEs under submission

- **Objective** Maximizing the social & economic impact of the implementation of the Einstein Telescope in the extended Euregio Meuse-Rhine
- **Phase 1 submission** 14.09.2020
- **Final submission** 10.11.2020
- **Project Timing** 01.03.2021 – 31.08.2023
- **Total budget** 2.3 M euro – Axis 1 Innovation – Umbrella project – 4 Regions
- **Voucher envelop** of 1 M euro dedicated to SMEs (financed at 50%)

ET2SMEs partner consortium, associated partners & supporters

- Project partners:

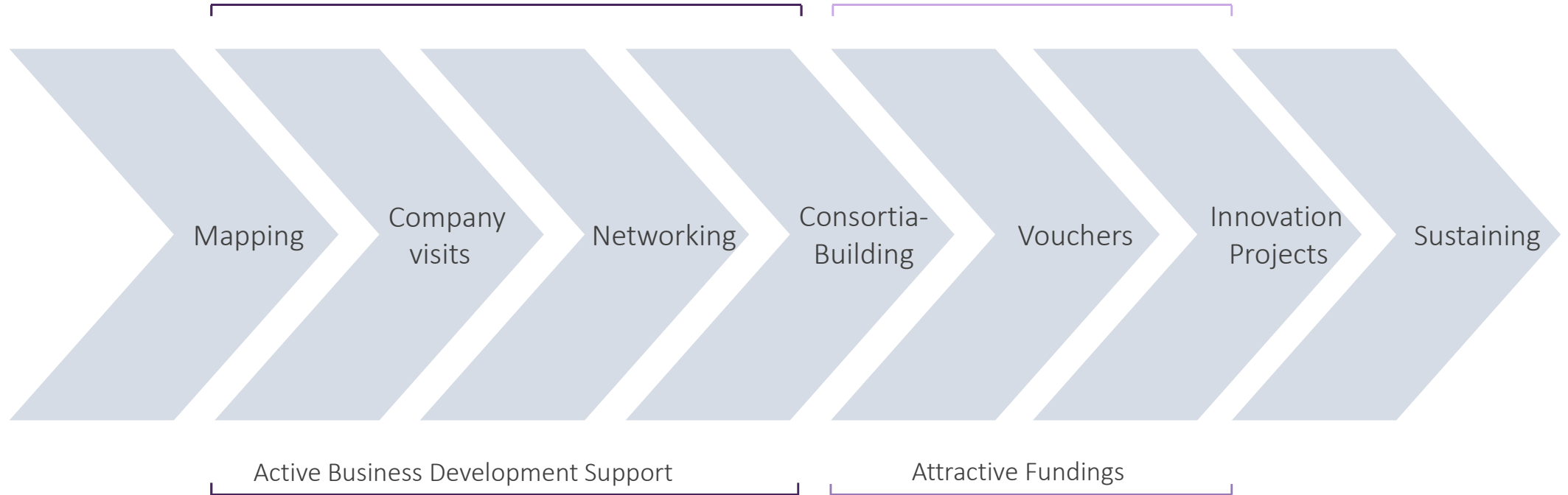


- Associated partners

- LOIs from:

16.10.2020

ET2SMEs „A cross-border value chain for innovation“



ET2SMEs under submission...



Funding, financiers & partners

16.10.2020

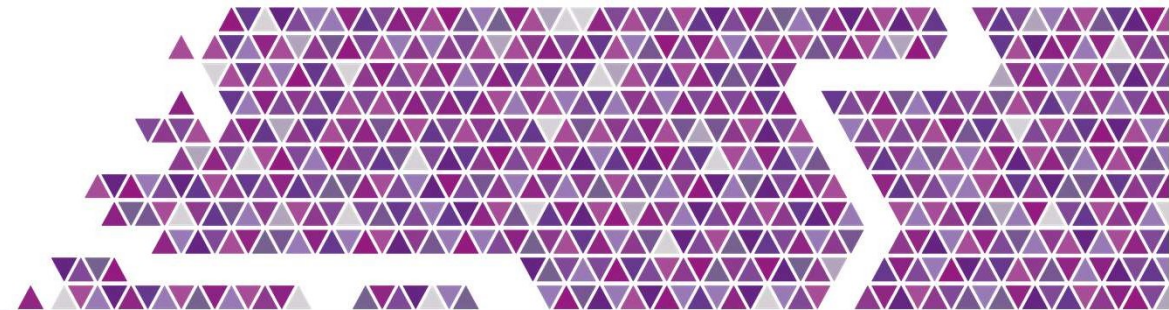
Funding

Interreg is the European Union's tool to support cross-border projects which otherwise would not be carried out.

The Interreg V-A Euregio Meuse-Rhine (EMR) programme invests almost EUR 100 million in the development of our region until the end of 2020.

The E-TEST project is carried out under the Interreg V-A Euregio Meuse-Rhine Programme, with €7.5 million from the European Regional Development Fund (ERDF).

By investing EU funds in Interreg projects, the European Union invests directly in economic development, innovation, territorial development, social inclusion and education in the Euregio Meuse-Rhine.



The Financiers



provincie limburg

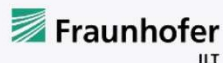


Ministerie van Economische Zaken
en Klimaat

Ministerium für Wirtschaft, Innovation,
Digitalisierung und Energie
des Landes Nordrhein-Westfalen



The Partners



The final word...by Albert

16.10.2020



Questions / Answers

16.10.2020

Thank You!
Dank U! Dankeschön! Merci!

16.10.2020

E-TEST Coordination Office

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<https://www.etest-emr.eu/>