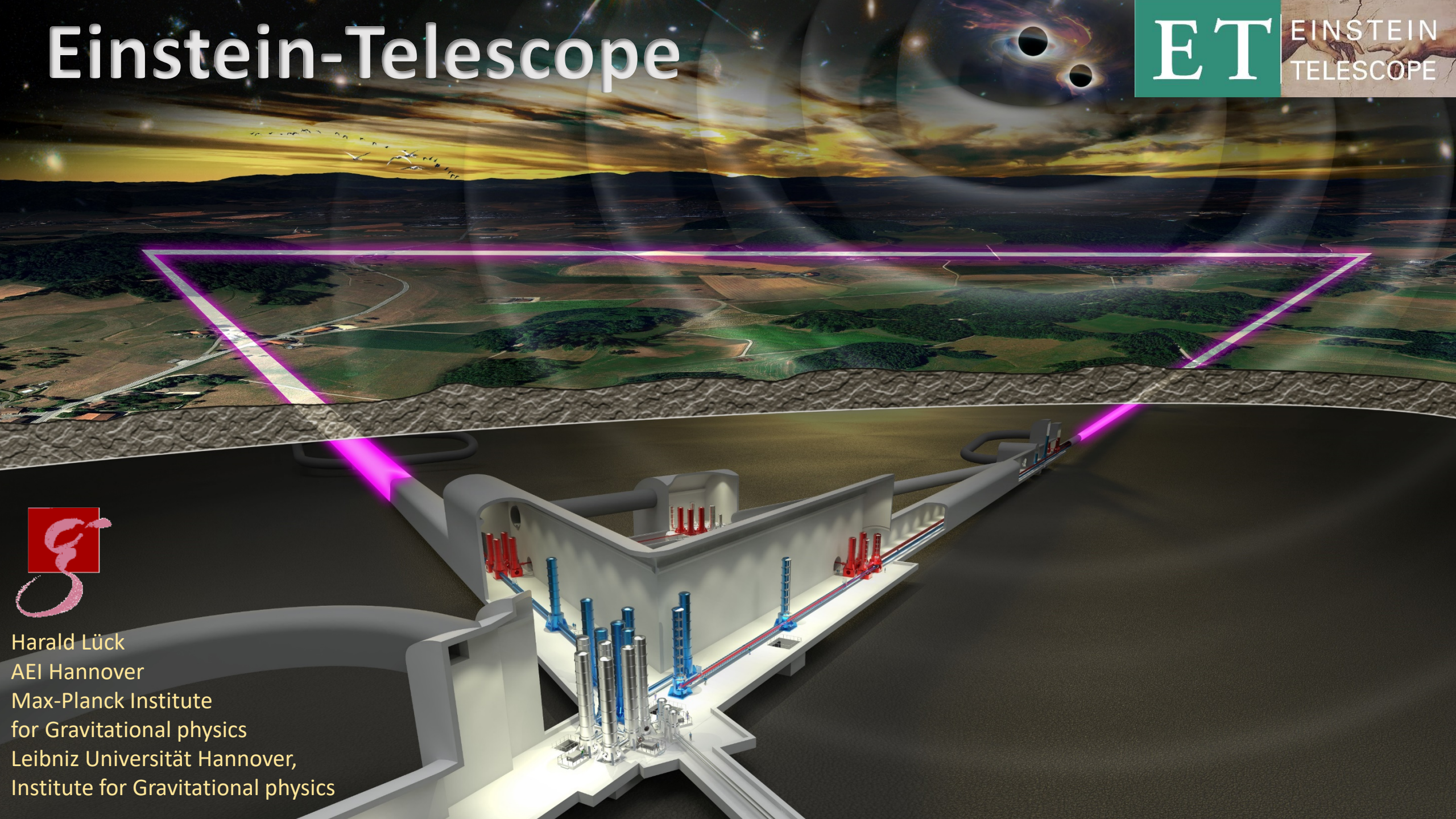


Einstein-Telescope

ET
EINSTEIN
TELESCOPE



Harald Lück
AEI Hannover
Max-Planck Institute
for Gravitational physics
Leibniz Universität Hannover,
Institute for Gravitational physics

ESFRI Roadmap

European Strategy Forum
on Research Infrastructures



ESFRI Strategy Forum on Research Infrastructures
ROADMAP 2021

CALL FOR PROPOSALS

New Deadline
September 9th, 2020

The poster features a blue background with a graphic of several overlapping, curved bands in various colors (orange, yellow, green, purple, pink, red, grey) on the left side.



Proposal submitted by:

- **Italy** (Lead Country)
- Netherlands
- Belgium
- Spain
- Poland

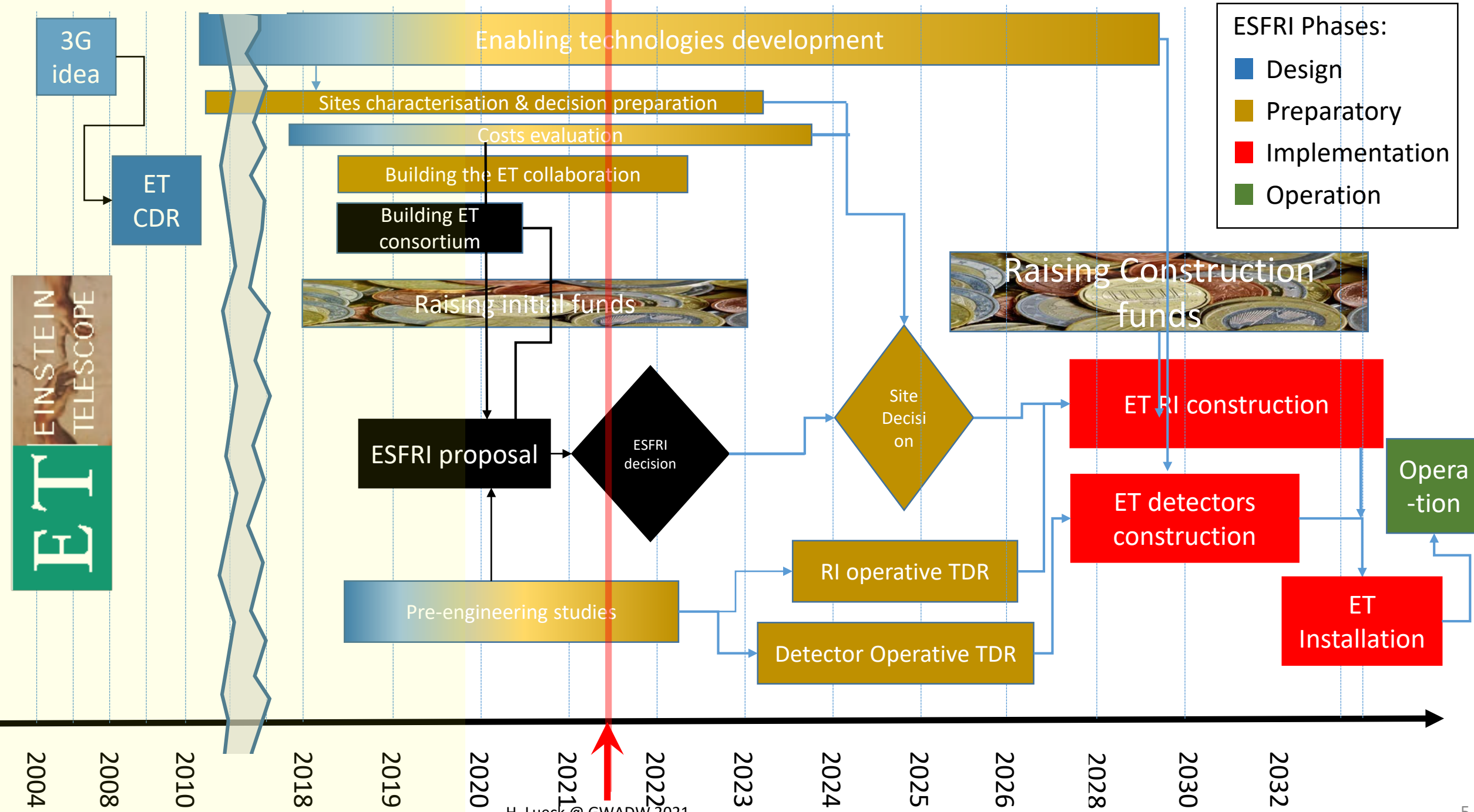
ET ESFRI Proposal: the consortium level

- The ET ESFRI consortium is composed by the institutions signing the ET consortium agreement (CA)
 - Very light CA at this level
 - 41 Institutions signed the ET consortium
 - The ET consortium is coordinated by INFN and Nikhef (Stan Bentvelsen, Antonio Zoccoli)

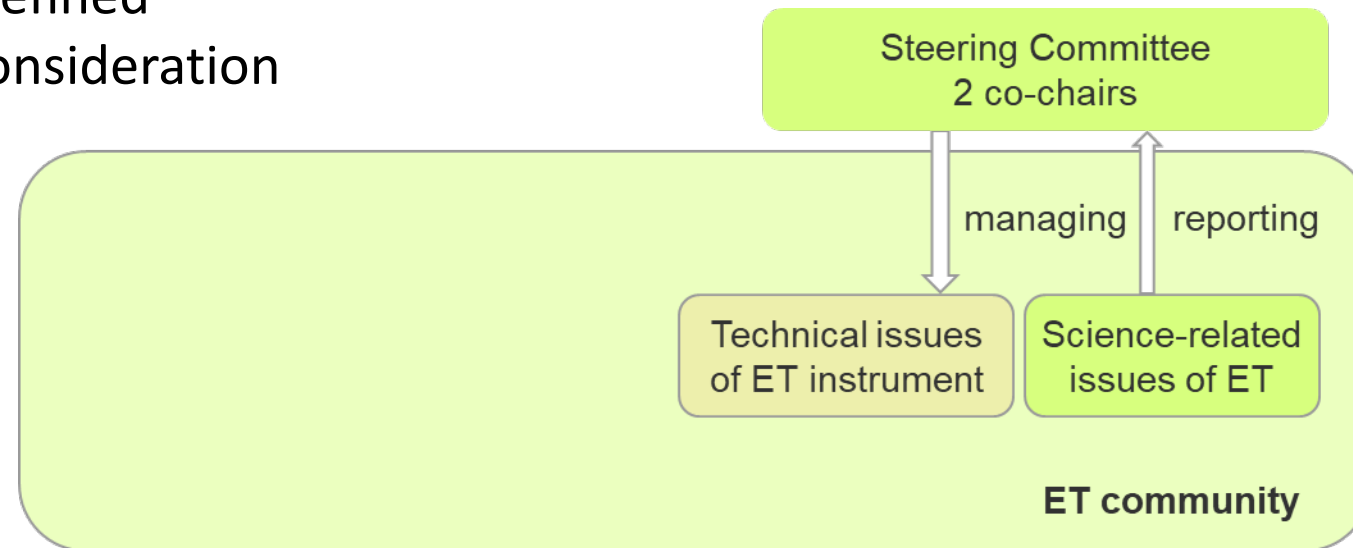


Roadmap 2021: next steps

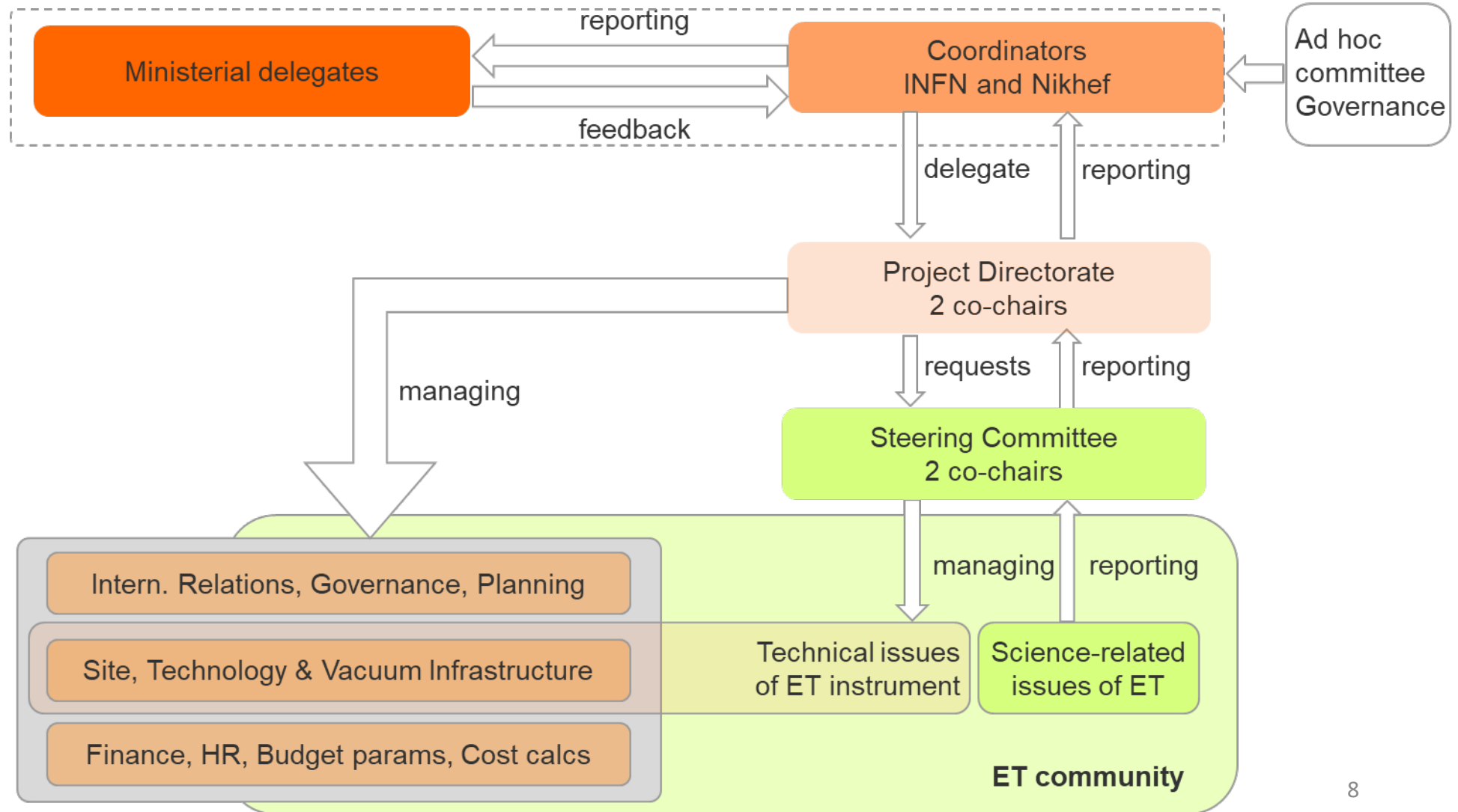
- OPEN CALL FOR PROPOSALS - 25 September 2019 ✓
- SUBMISSION OF PROPOSALS - 9 September 2020 ✓
- CRITICAL QUESTIONS & INVITATION TO HEARINGS – February-March 2021 ✓
- HEARING – April 14 2021 ✓
- ESFRI FORUM DECISION - June-September 2021
- ESFRI ROADMAP LAUNCH - October - November 2021



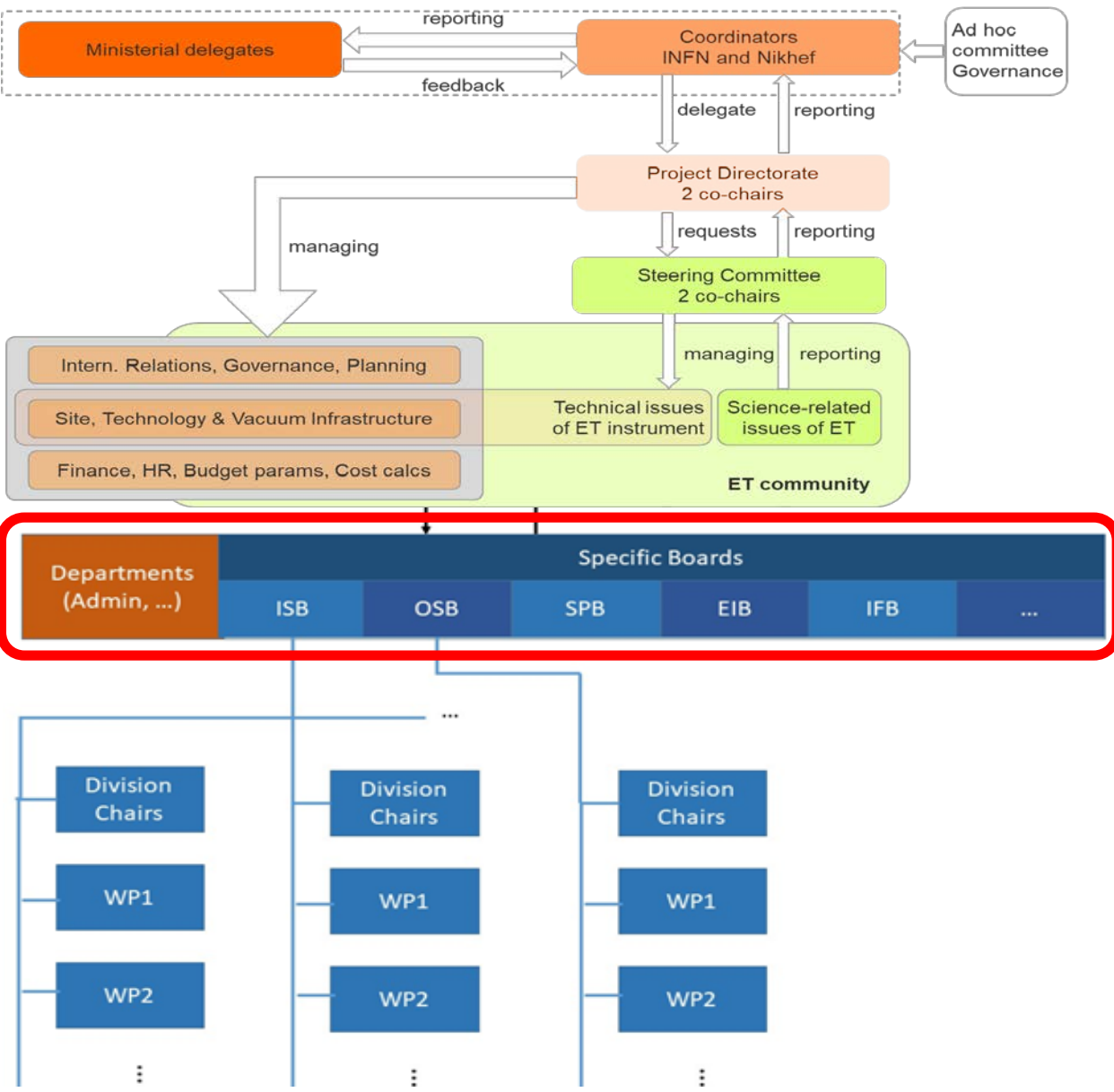
- **There is a broad ET scientific community**
- **Successful realization of ET needs a concerted effort from all angles**
 - Ministries, research organizations and scientific community
 - Impose a long-term governance structure within the framework of the phases of the ESFRI Life-cycle approach
- **Goals for 2021/2022: implement the Project management and governance**
- Now: establish the governance for the Preparatory phase
- Construction phase: being defined
- Exploitation phase: under consideration



Structure implemented by agencies: an interim structure for the ET project organization until establishment of a Council



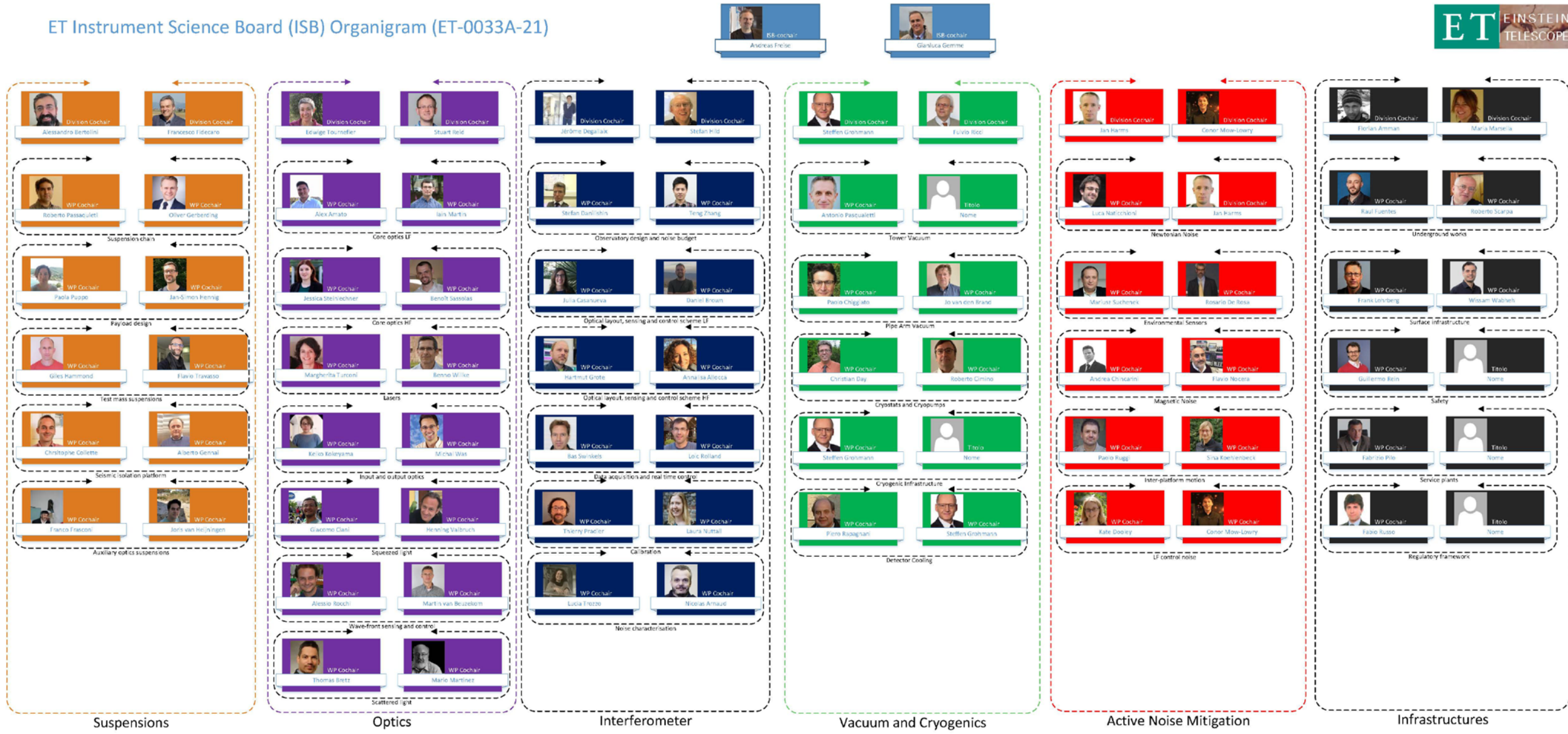
ET Governance Scheme



ET Boards

- **The Instrument Science Board (ISB)**
 - deliver the ET Technical Design Report (ET-TDR) for infrastructure and detectors
 - identify the missing technologies and suggest a (living) plan for R&D activities. first version ca. March 2021.
- **The Observational Science Board (OSB)**
 - will detail the ET science case
 - will prepare the data analysis requirements
 - will indicate the computing requirements for ET
- **The Site Preparation Board (SPB)**
 - will coordinate the effort on the site related activities
 - formulate the site specifications for Einstein Telescope
 - prepare the choice of the site for the Einstein Telescope observatory
- **The E-Infrastructures Board (EIB) -> Computing Infrastructure Board**
 - will define the computing and storage resources, networking, local and distributed e-infrastructures
 - will study the computing models that can be adopted in ET and the synergies with the e-infrastructures available or expected in Europe in the next decade.
- **The Internal Finance Board (IFB)**
 - will have the mandate to evaluate the financial needs
 - collecting and harmonizing the inputs received from the other technical boards
 - will suggest the funding tools needed to elaborate a financial strategy to be proposed to the Council.

ET Instrument Science Board (ISB) Organigram (ET-0033A-21)

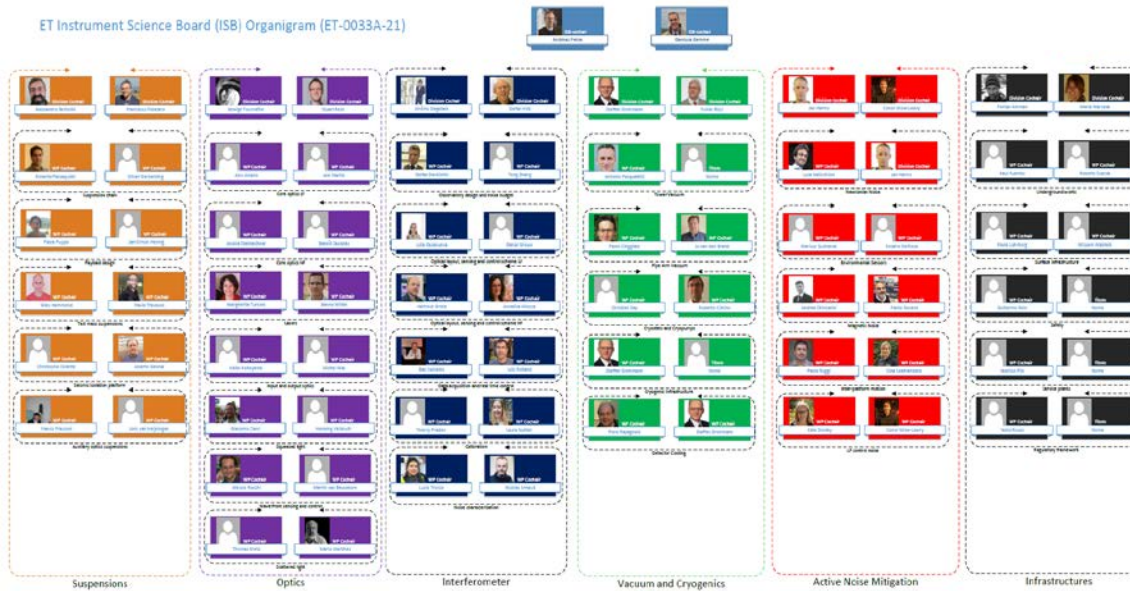


OSB: Observational Science Board

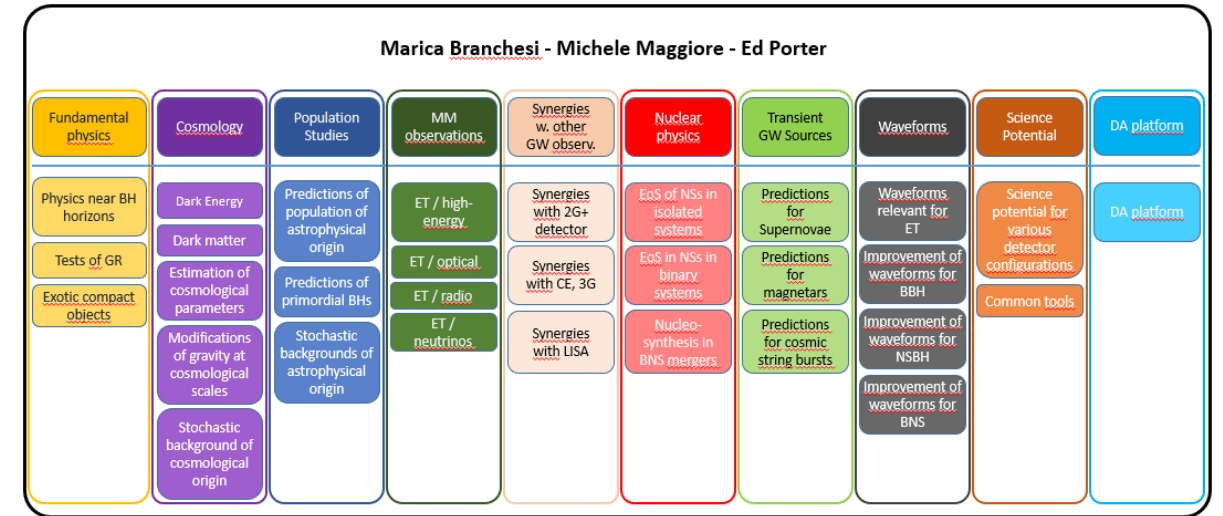
Marica Branchesi - Michele Maggiore - Ed Porter

Fundamental physics	Cosmology	Population Studies	MM observations	Synergies w. other GW observ.	Nuclear physics	Transient GW Sources	Waveforms	Science Potential	DA platform
Physics near BH horizons	Dark Energy	Predictions of population of astrophysical origin	ET / high-energy	Synergies with 2G+ detector	EoS of NSs in isolated systems	Predictions for Supernovae	Waveforms relevant for ET	Science potential for various detector configurations	DA platform
Tests of GR	Dark matter		ET / optical	Synergies with CE, 3G	EoS in NSs in binary systems	Predictions for magnetars	Improvement of waveforms for BBH		
Exotic compact objects	Estimation of cosmological parameters	Predictions of primordial BHs	ET / radio	Synergies with LISA	Nucleo-synthesis in BNS mergers	Predictions for cosmic string bursts	Improvement of waveforms for NSBH	Common tools	
	Modifications of gravity at cosmological scales	Stochastic backgrounds of astrophysical origin	ET / neutrinos				Improvement of waveforms for BNS		

Instrument Science Board



Observational Science



How to join?

If you are interested in contributing, please get in touch with one of the division or working group chairs

Check out the ISB webpage: <https://wiki.et-gw.eu/ISB/WelcomePage>

The Instrument Science Board (ISB) is described in more detail in:

<https://apps.et-gw.eu/tds/ql/?c=15709>

<https://apps.et-gw.eu/tds/ql/?c=15707>

Instrument Science Board workshop

- March 29/31 2021 online
- Topics:
 - Mirror Temperature
 - Low Frequency Noise
 - Facility Limits

ET-ISB workshop (day 1)

Monday 29 Mar 2021, 09:00 → 13:00 Europe/Rome
Andreas Freise (VU Amsterdam), Gianluca Gemme (INFN)

Description We are aiming at a hands-on workshop in which we start by discussing together, but then also have times for small groups to work on a specific task. That will happen during the days of the workshop but also on March 30th.

We will work on the following topics:

- Optimal mirror temperature for LF
- Low frequency noise strategy
- What are the facility limits?

The workshop will be held online on Zoom. Instructions for connecting are at [this link](#).

A working area where useful info will be stored is available at [this link](#).

ET-ISB workshop (day 2)

Wednesday 31 Mar 2021, 09:00 → 15:45 Europe/Rome
Andreas Freise (VU Amsterdam), Gianluca Gemme (INFN)

Description We are aiming at a hands-on workshop in which we start by discussing together, but then also have times for small groups to work on a specific task. That will happen during the days of the workshop but also on March 30th.

We will work on the following topics:

- Optimal mirror temperature for LF
- Low frequency noise strategy
- What are the facility limits?

The workshop will be held online on Zoom. Instructions for connecting are at [this link](#).

09:00 → 10:10 Joint session: Introductory talks

Conveners: Andreas Freise (VU Amsterdam), Gianluca Gemme (INFN)

- 09:00 Introduction**
Speaker: Andreas Freise
ET_ISB_workshop_I...
- 09:10 Mirror temperature**
Speaker: Steffen Grohmann (KIT, Germany)
210329 ET ISB-wide...
- 09:30 Low frequency noise**
Speaker: Conor Mow-Lowry
LowFrequencyNois...
- 09:50 Facility limits**
Speaker: Stefan Hild
ET-ISB-Workshop, F...

10:10 → 10:45 Joint session: Discussion

Conveners: Andreas Freise (VU Amsterdam), Gianluca Gemme (INFN)

10:45 → 11:00 Break

11:00 → 13:00 Parallel session 1: Mirror temperature

Conveners: Fulvio Ricci (University of Rome 'La Sapienza' and INFN), Steffen Grohmann (KIT)

11:00 → 13:00 Parallel session 2: Low frequency noise

Conveners: Conor Mow-Lowry (VU Amsterdam), Francesco Fidecaro (University of Pisa and INFN)

11:00 → 13:00 Parallel session 3: Facility limits

Conveners: Maria Marsella (University of Rome 'La Sapienza'), Stefan Hild (Maastricht University)

09:00 → 11:00 Parallel session 1: Mirror temperature

Conveners: Fulvio Ricci (University of Rome 'La Sapienza' and INFN), Steffen Grohmann (KIT)

09:00 → 11:00 Parallel session 2: Low frequency noise

Conveners: Conor Mow-Lowry (VU Amsterdam), Francesco Fidecaro (University of Pisa and INFN)

09:00 → 11:00 Parallel session 3: Facility limits

Conveners: Maria Marsella (University of Rome 'La Sapienza'), Stefan Hild (Maastricht University)

11:00 → 11:15 Break


11:15 → 12:15 Joint session: Summaries from the parallel sessions

Conveners: Andreas Freise (VU Amsterdam), Gianluca Gemme (INFN)

- 11:15 Mirror temperature**
Speaker: Steffen Grohmann (KIT)
210331 Summary o...
- 11:35 Low frequency noise**
Speaker: Conor Mow-Lowry
LowFrequencyNois...
- 11:55 Facility limits**
Speaker: Stefan Hild
Facility Limits worki...

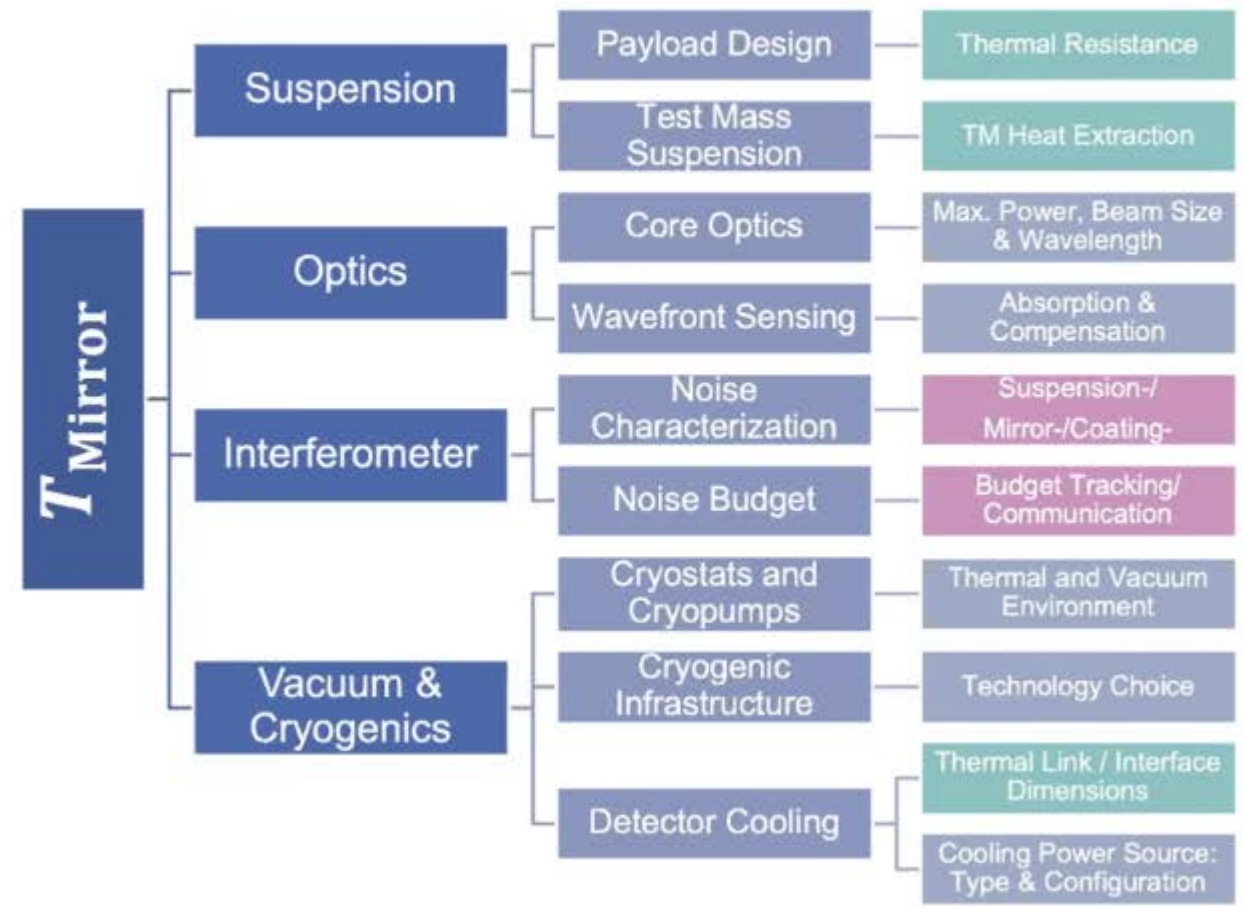
12:15 → 13:00 Joint session: Discussion

Conveners: Andreas Freise (VU Amsterdam), Gianluca Gemme (INFN)

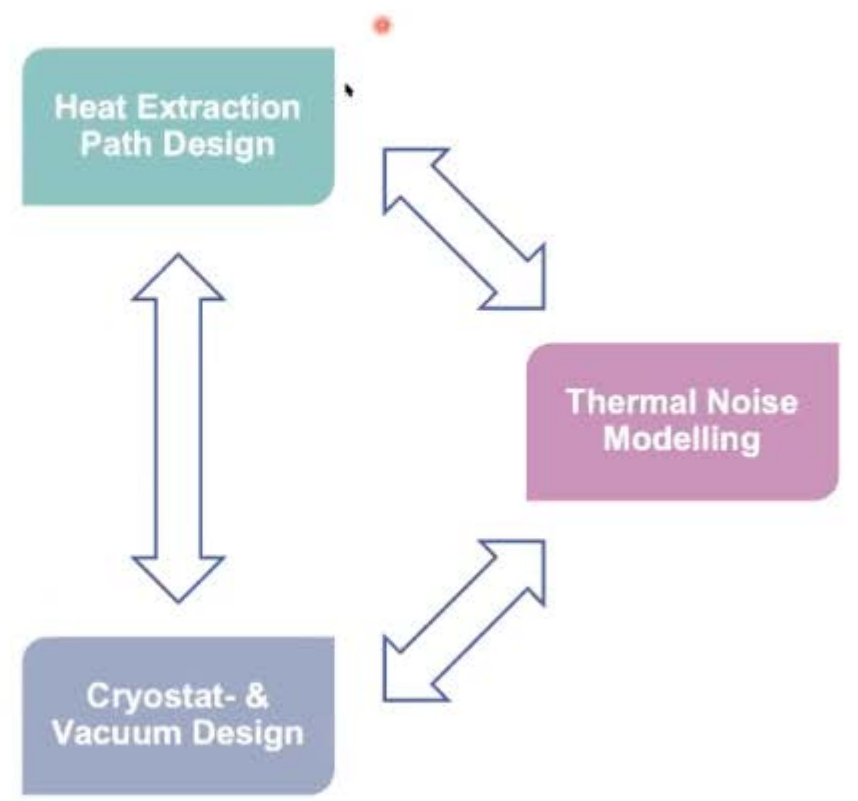




Contributing Aspects – Collaboration Potential



Breakout Rooms:





Breakout Rooms

Heat Extraction Path Design

Moderator: Piero Rapagnani

WPs:

- Payload Design
- Test Mass Suspension
- Detector Cooling

Thermal Noise Modelling

Moderator: Jérôme Degallaix?

WPs:

- Noise Characterization
- Noise Budget

Cryostat- & Vacuum Design

Moderator: Christian Day

WPs:

- Core Optics
- Wavefront Sensing
- Cryostats and Cryopumps
- Cryogenic Infrastructure
- Detector Cooling

1. Work break-down structure element determination
2. Interface potential determination
3. Collaboration work organization

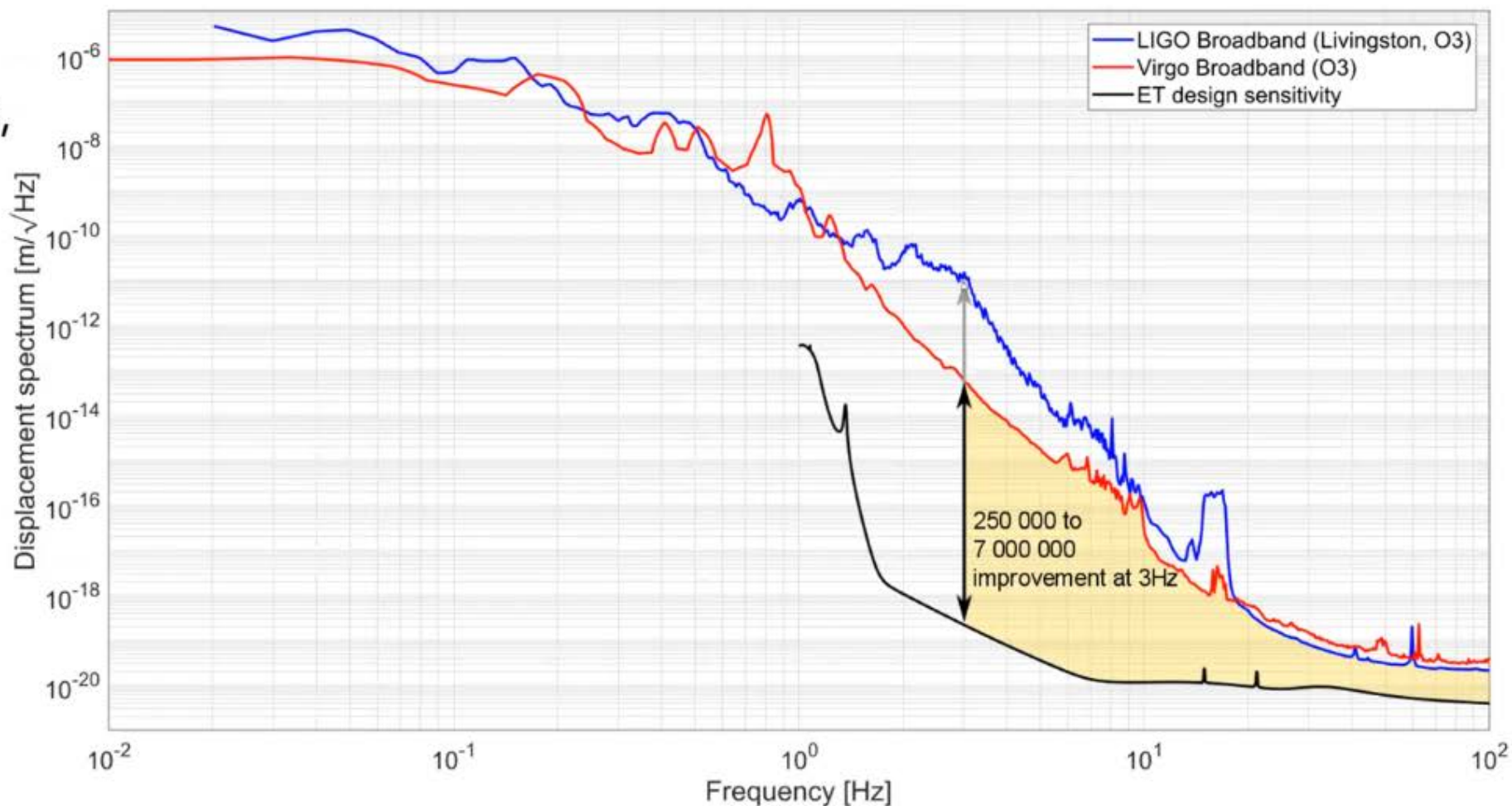


Low-frequency noise

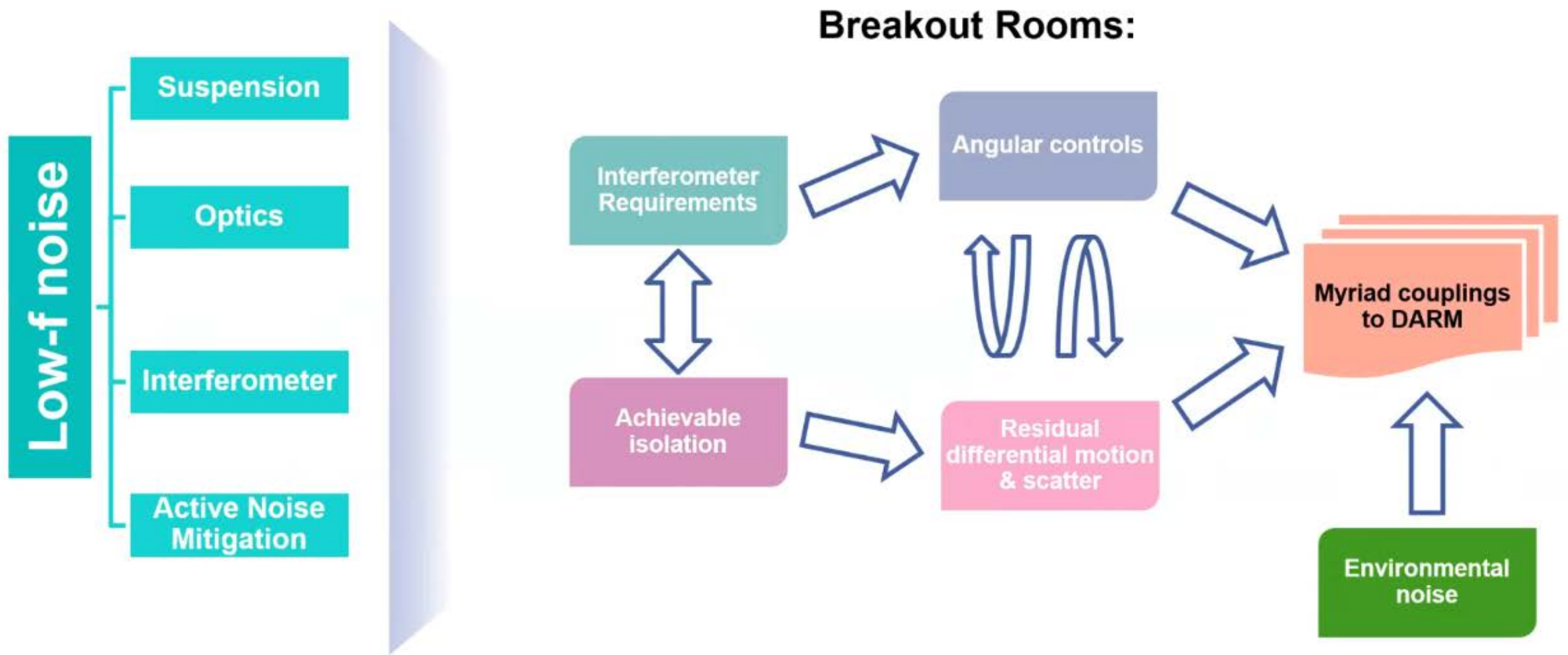
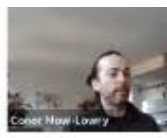
ET is not 10x better than 2nd gen detectors, it is a million times better at 3Hz.

We need to systematically identify and mitigate LF noise by reducing

- RMS motion
- Actuation forces
- A2L couplings
- ... and many more



Spanning (at least) 4 divisions





ET-ISB-Workshop, March 2021

Topic 3:

Facility Limits of the Einstein Telescope

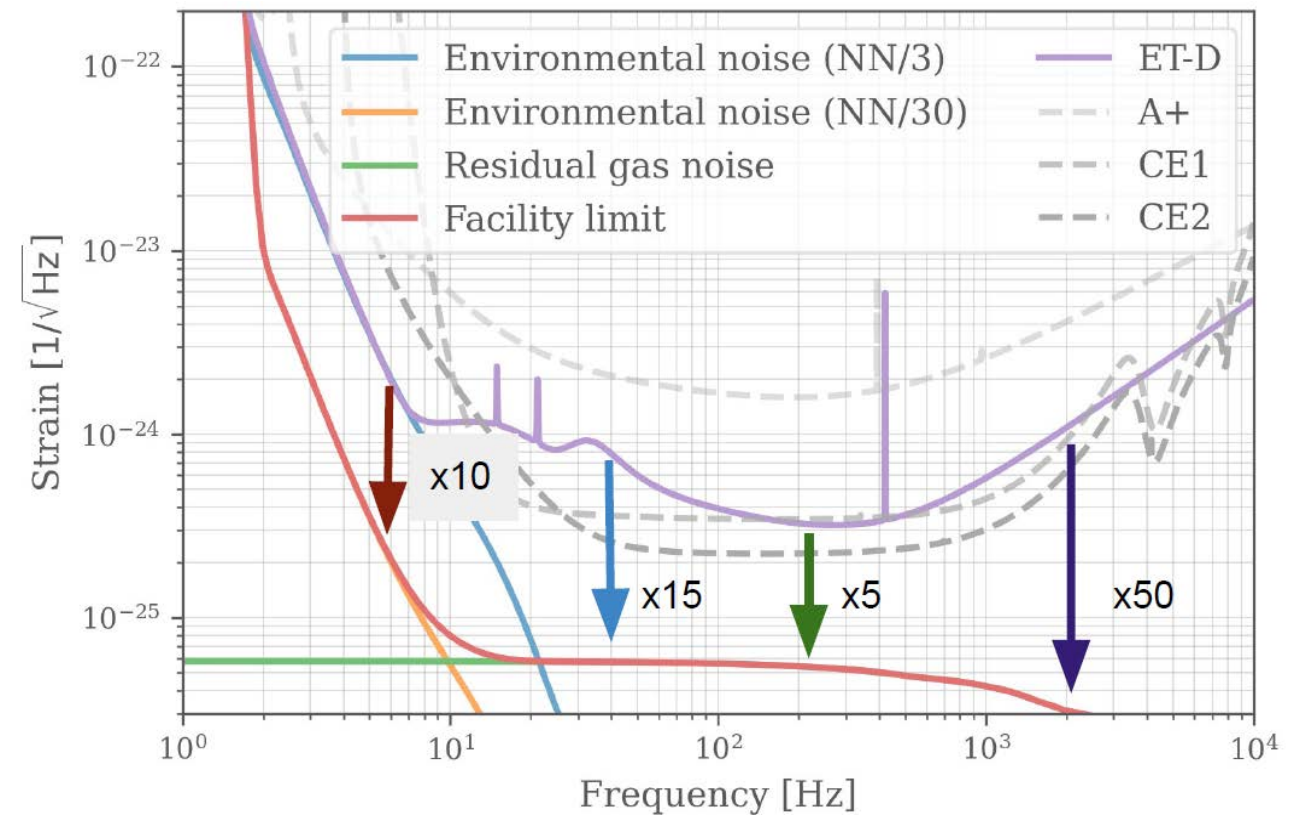
S. Hild, A. Allocca, T. Zhang, S. Danilishin,
F. Ammann, M. Marsella, A. Utina ...

Goals:

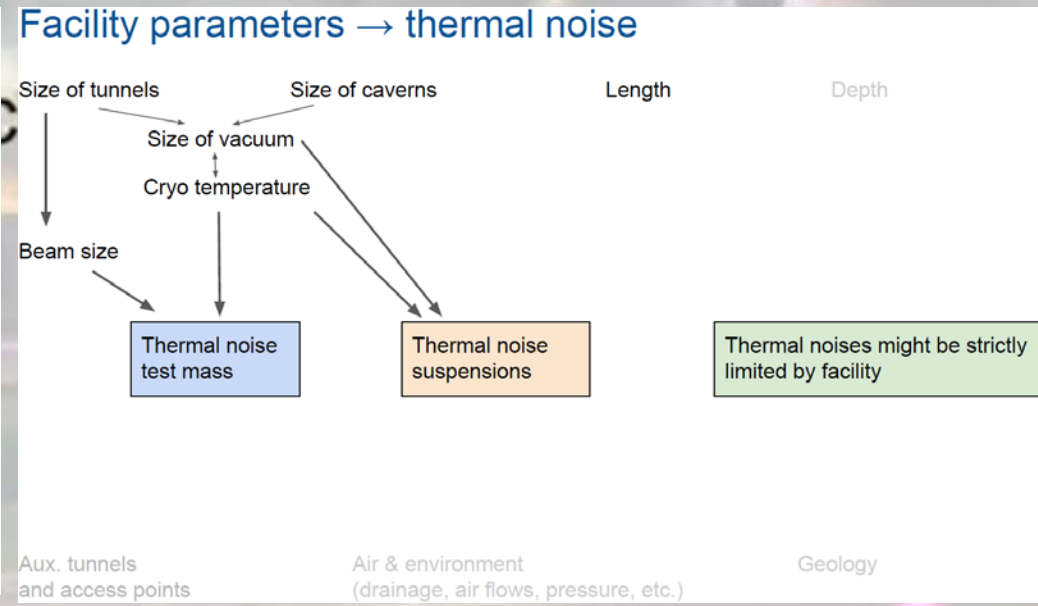
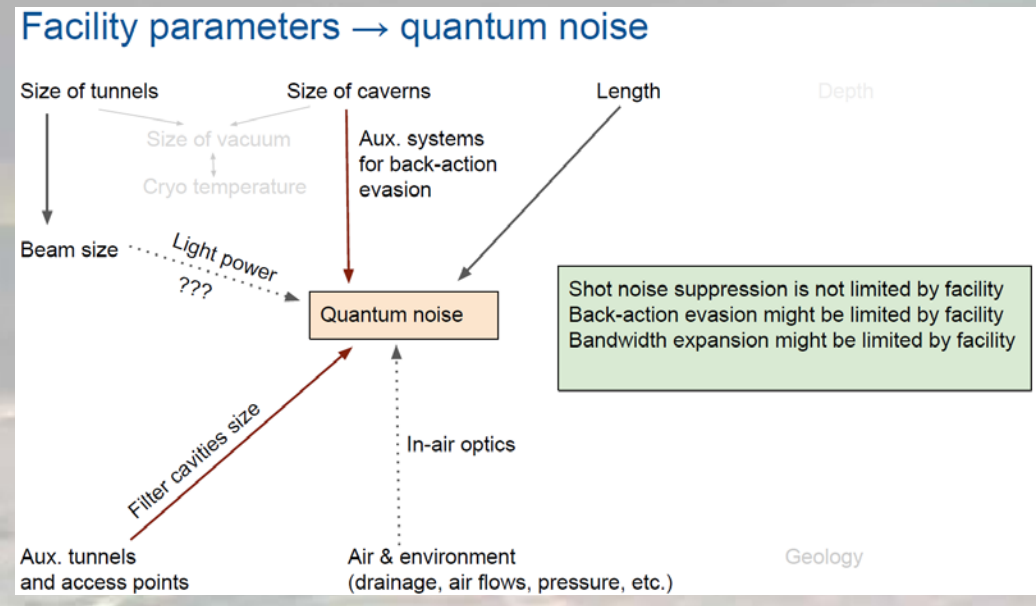
ET-0308A-21

1. The facility and facility noises

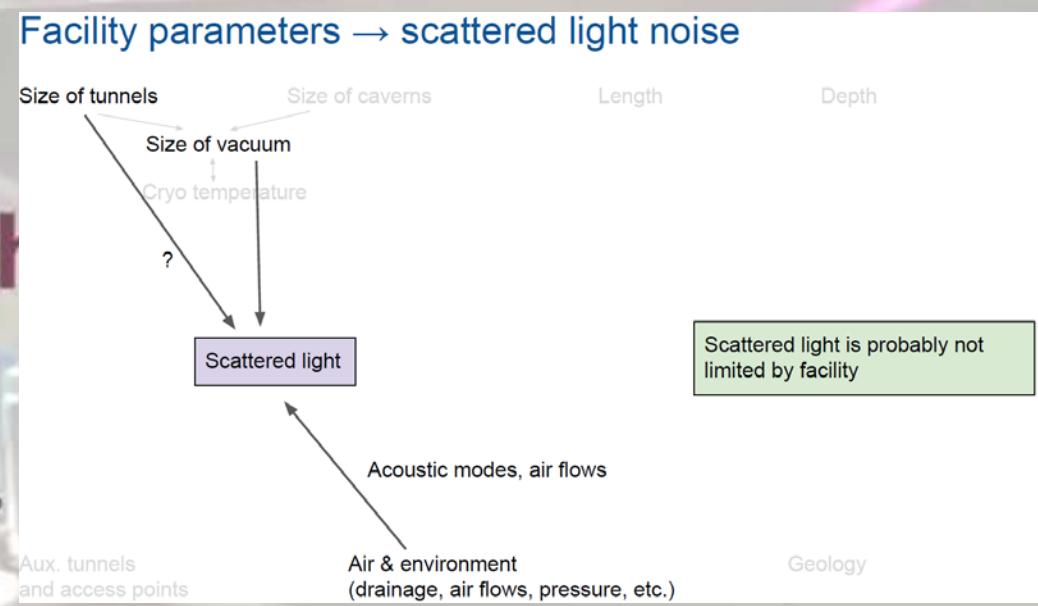
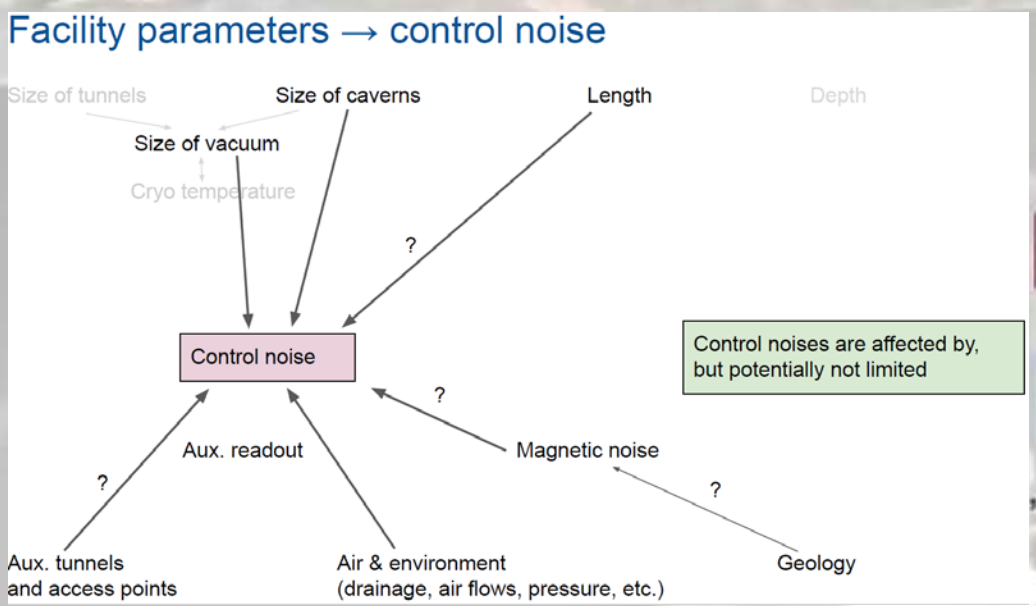
- A: Environment:
 - Seismic noise
 - Newtonian noise
 - Magnetic noise
- B: Vacuum:
 - Residual gas noise



2. How does facility limit other fundamental noises?



- **Low Frequencies limited by facility**
- **Cross-Coupling between facility parameters and various noise sources need to be understood**



Activities in the Euregio Meuse-Rhine



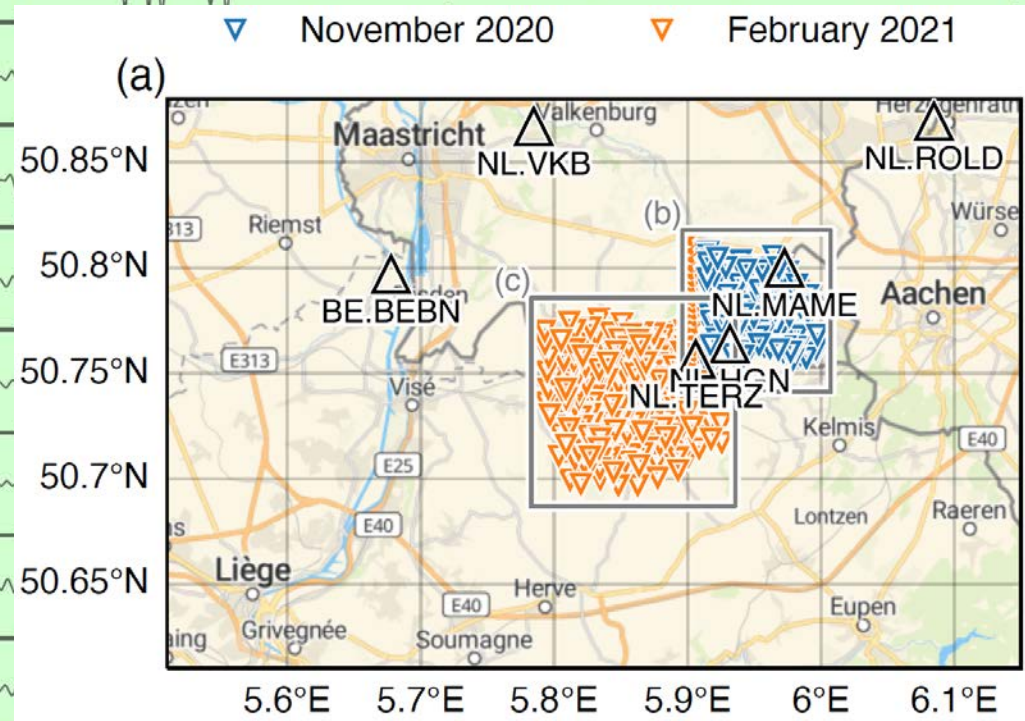
- A 250-m deep borehole has been drilled and is equipped with
 - Seismic data under acquisition and analysis
- 3-5 more boreholes in 2021/22
- Extensive active and passive site characterisation with sensor arrays in 2021
- ET pathfinder lab under construction making good progress



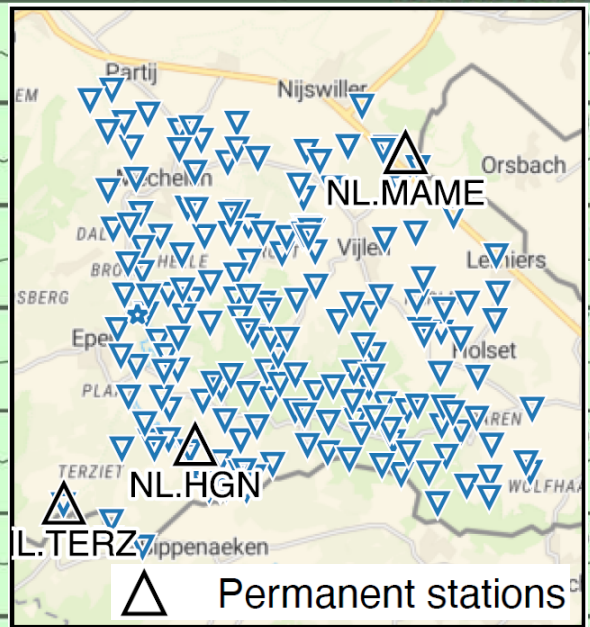
“Site-selection criteria for the Einstein Telescope”, RSI 91, 094504 (2020) <https://doi.org/10.1063/5.0018414>
Site Preparation Board: Define common/comparable measurement methods

Measurements in the Euregio Meuse-Rhine

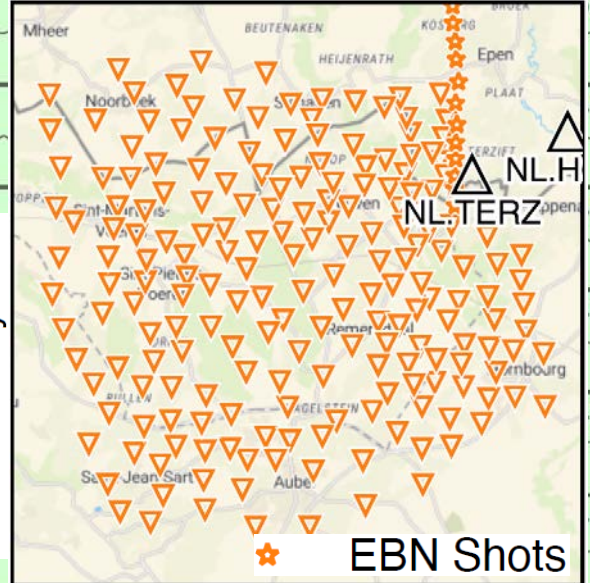
Data: https://www.fdsn.org/networks/detail/3T_2020/



November 2020

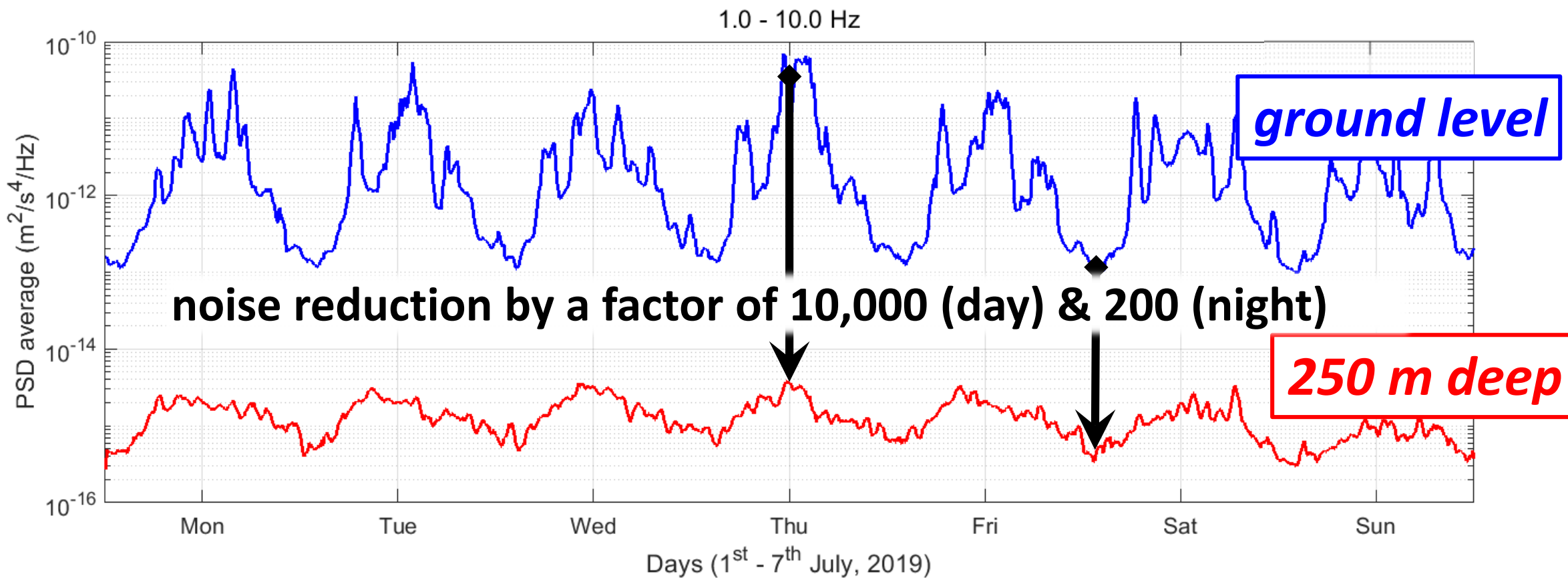


February 2021



Terziet: Live data:
<http://www.orfeus-eu.org/data/odc/realttime/?network=NL&station=TERZ>
 First three: on ground
 Lower three: down hole sensor

Seismic noise at the Terziet site



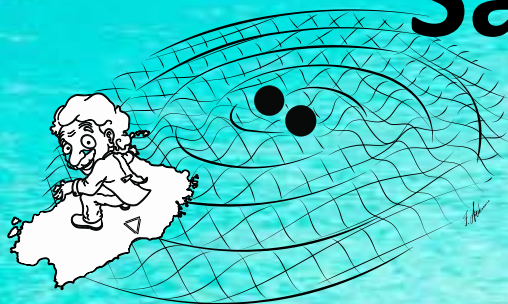
Ground conditions in South Limburg :

- soft top layer
- on hard rock
- good for tunnel construction 😊
- 😊 Excellent damping

ET

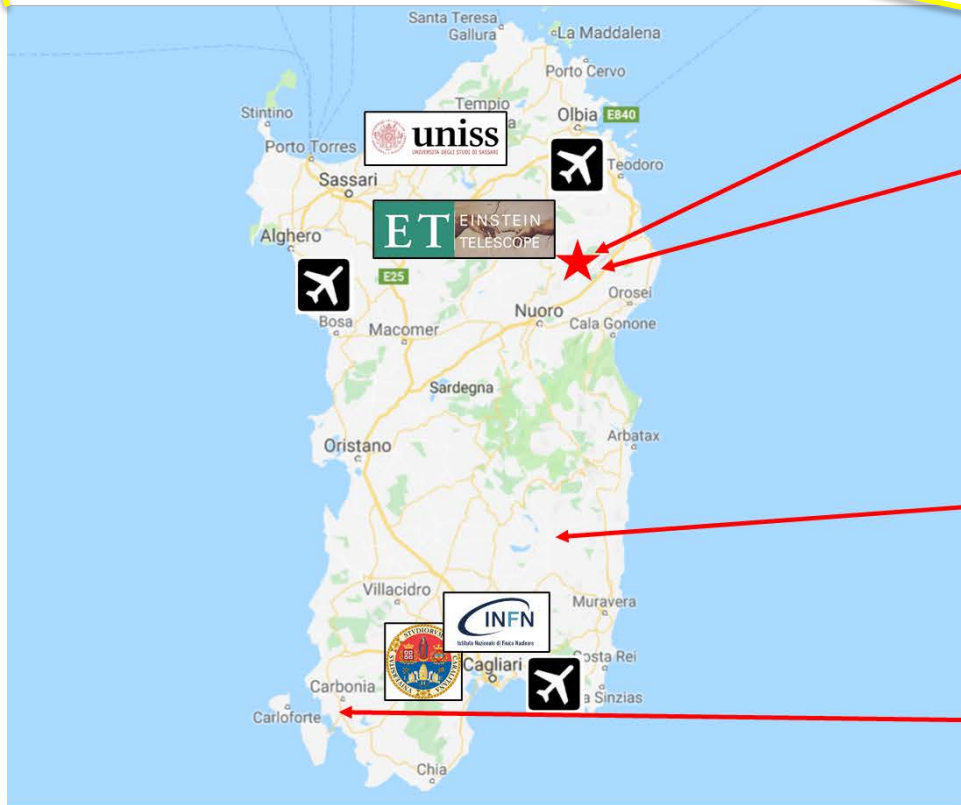
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Sardinia Site Activities





The Sos Enattos site



Site access: 50' (85km) drive from Olbia airport (highway)

SarGrav underground laboratory



Sardinia Radio Telescope

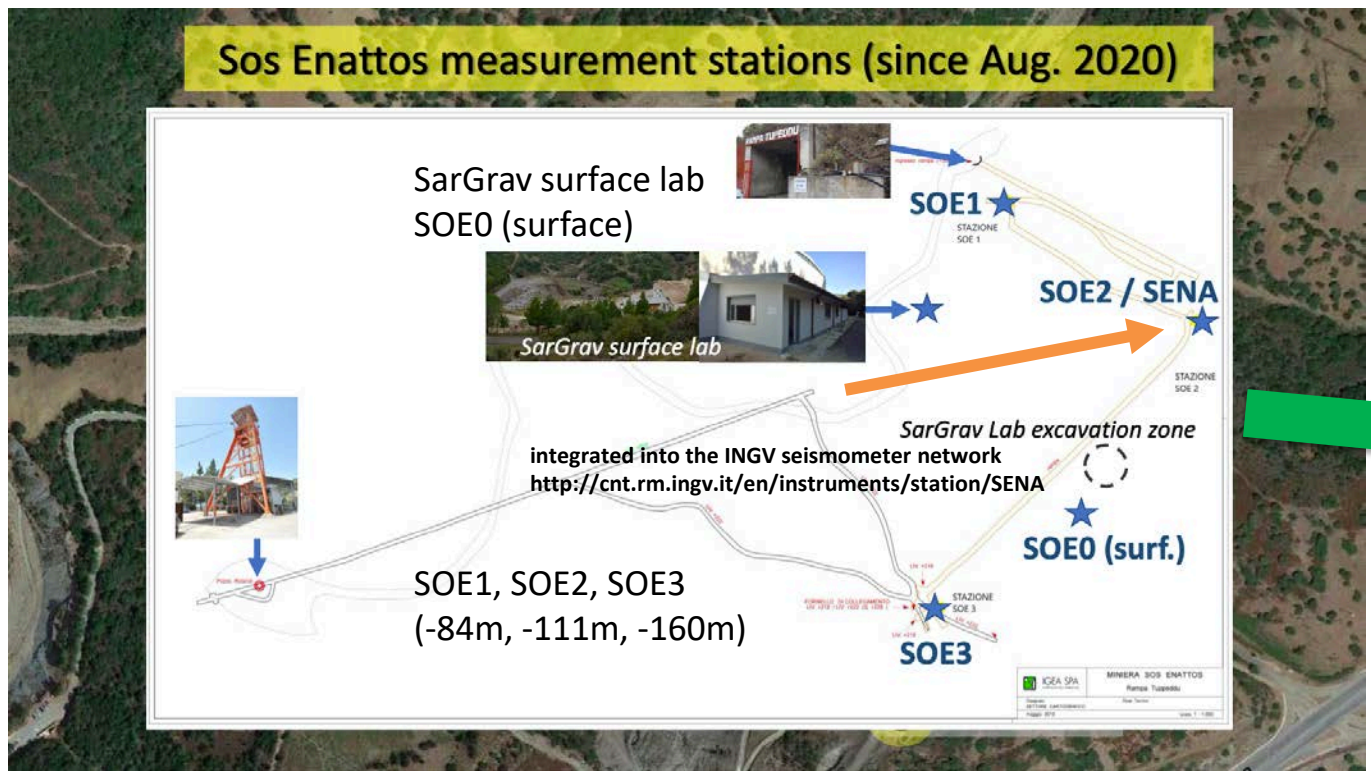
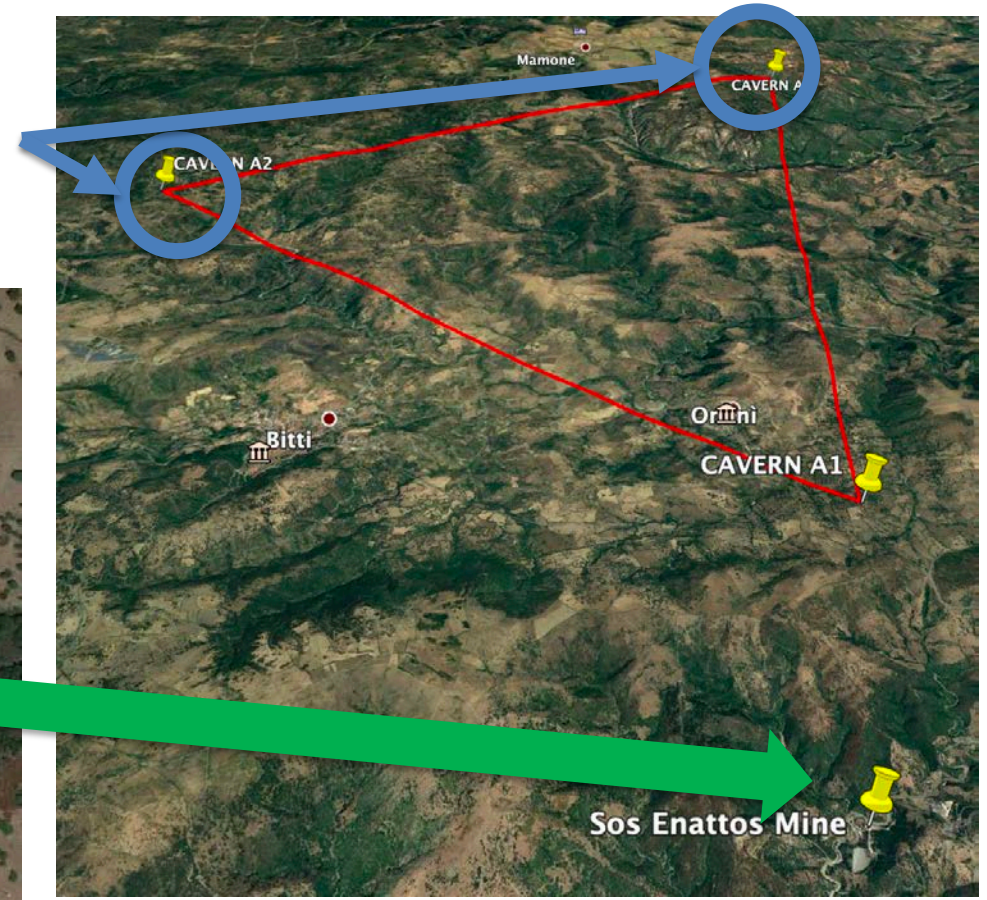


"ARIA" project (for Gran Sasso Dark Side DM det.)

Measurement in Sardinia

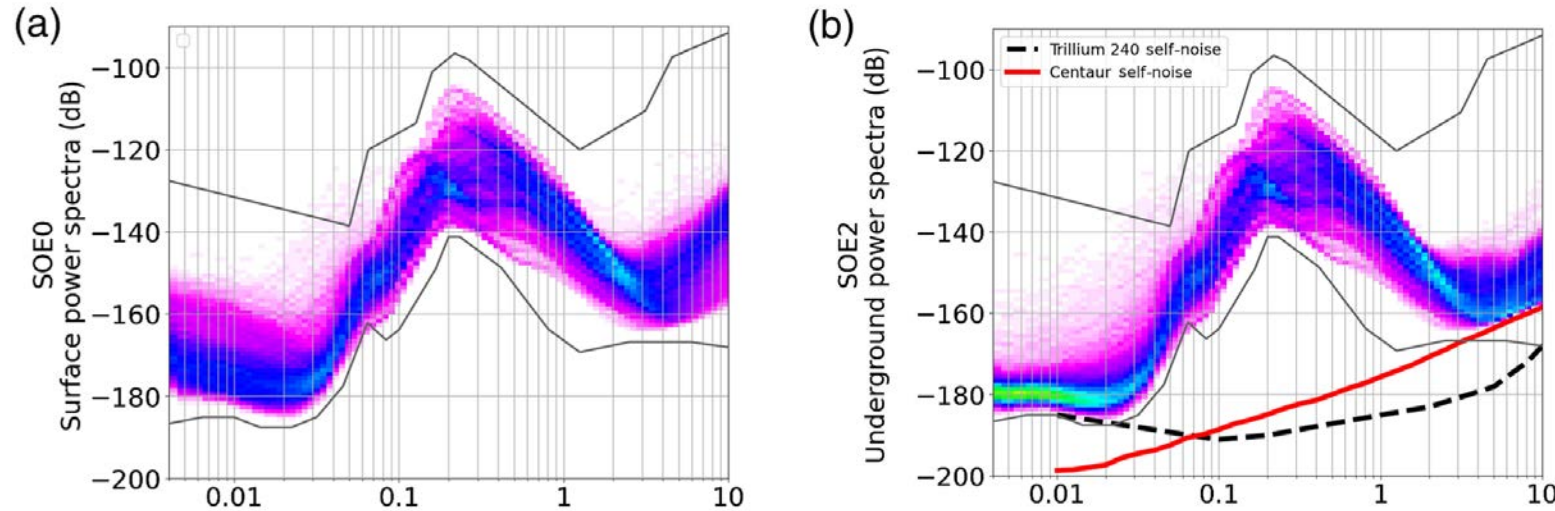


Characterization of the Bitti and Onanì corners:
Surface and underground seismic and environmental measurements will start soon



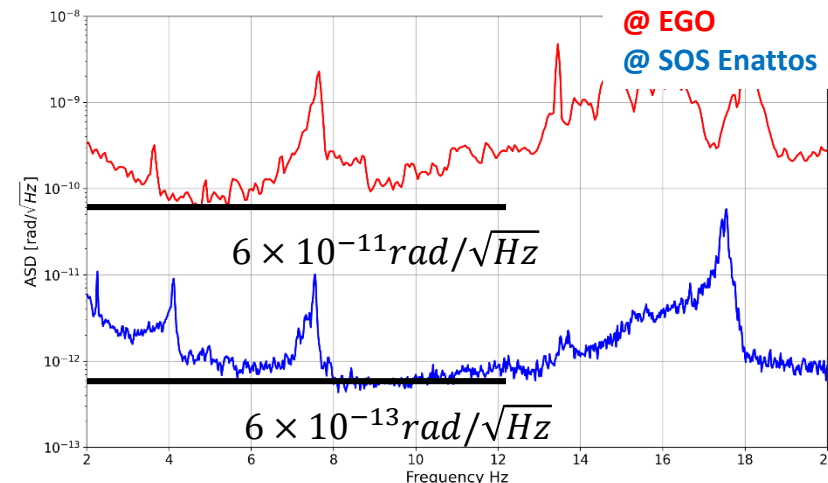
4 broadband seismometers, 3 short-period seismometers, 2 magnetometers, 1 tiltmeter distributed over underground and surface stations

Measurement Results



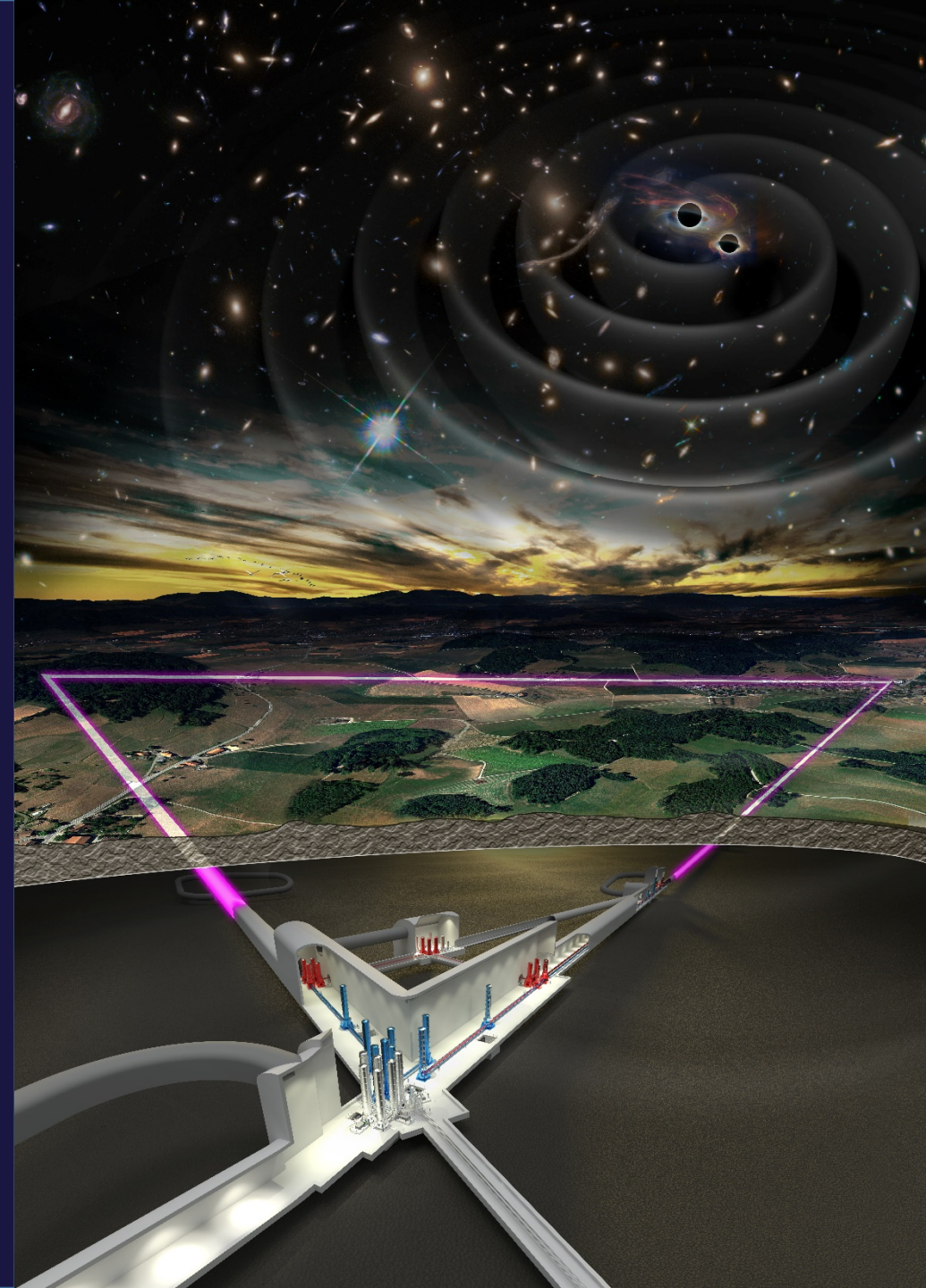
➤ First year of seismic characterization measurements at Sos Enattos published (JPCS 1468, 2020, SRL <https://doi.org/10.1785/0220200186>): extremely low-noise conditions in the range 2-10Hz. SOE2 measurements are biased by the low-gain setting of the ACQ (compliant to the national monitoring program).

➤ Preliminary sensitivity of Archimedes Prototype balance (tiltmeter) (<https://doi.org/10.1103/PhysRevD.90.022002>)



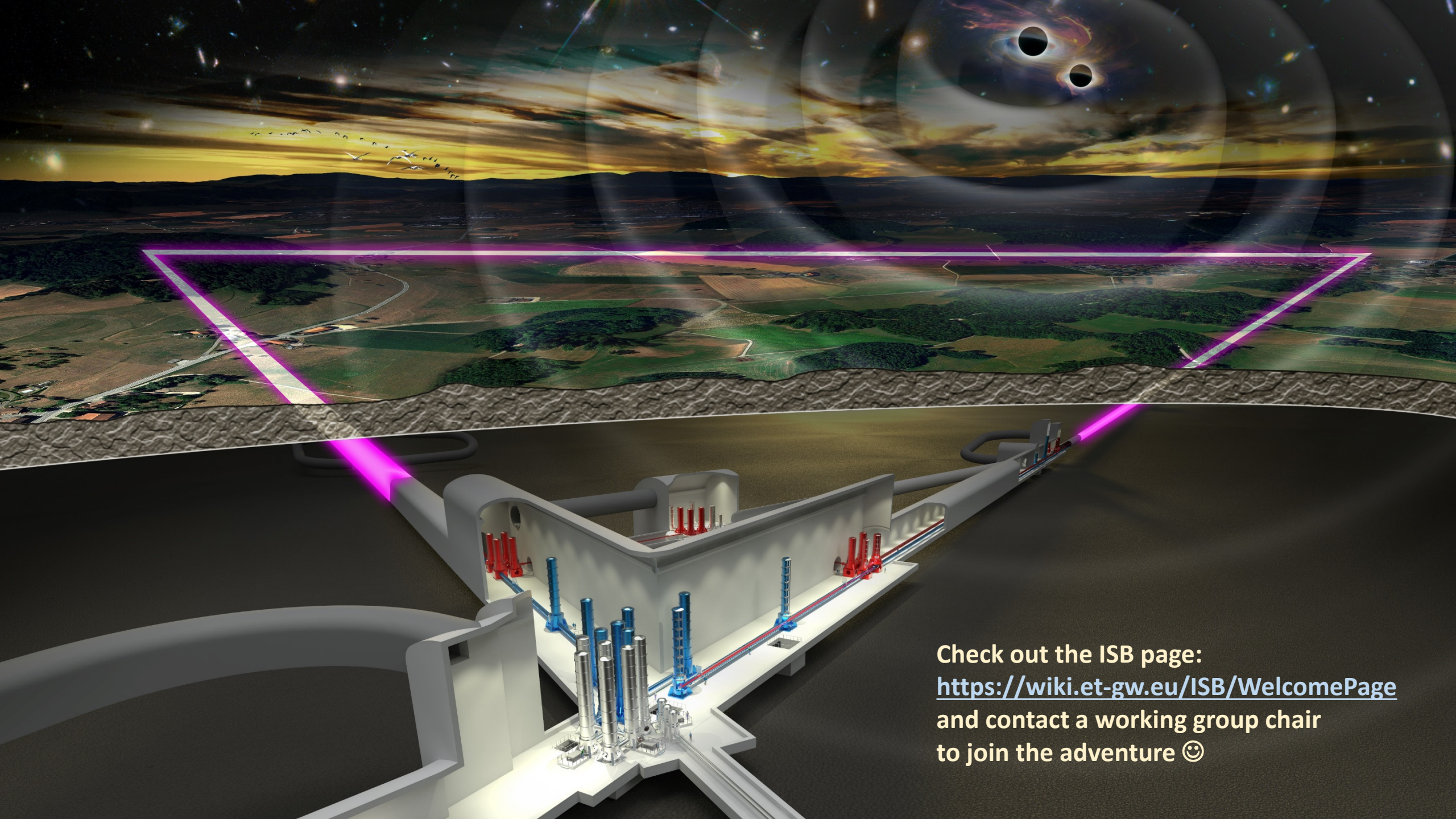
The main steps for the next years:

- Form the ET Collaboration and Project (2021)
- Update and detail the Technical Design (2021 – 2026)
- Characterise sites and prepare site selection (→ 2024)
- Site selection (→ 2025)



Video by Marco Kraan, Nikhef

Einstein Telescope



Check out the ISB page:
<https://wiki.et-gw.eu/ISB/WelcomePage>
and contact a working group chair
to join the adventure ☺