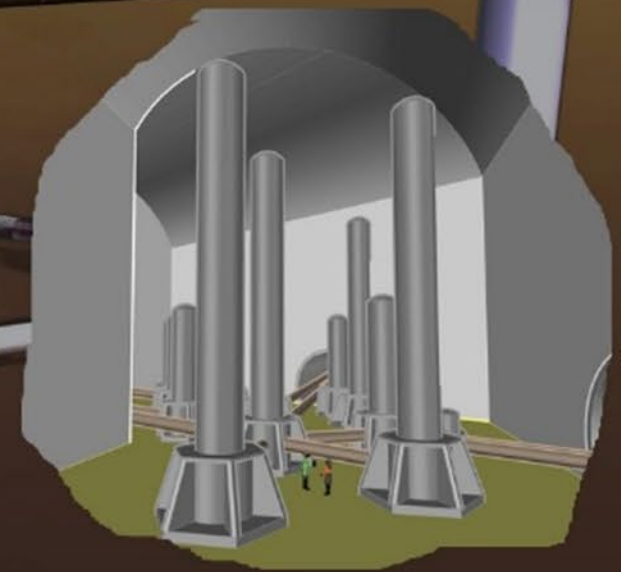
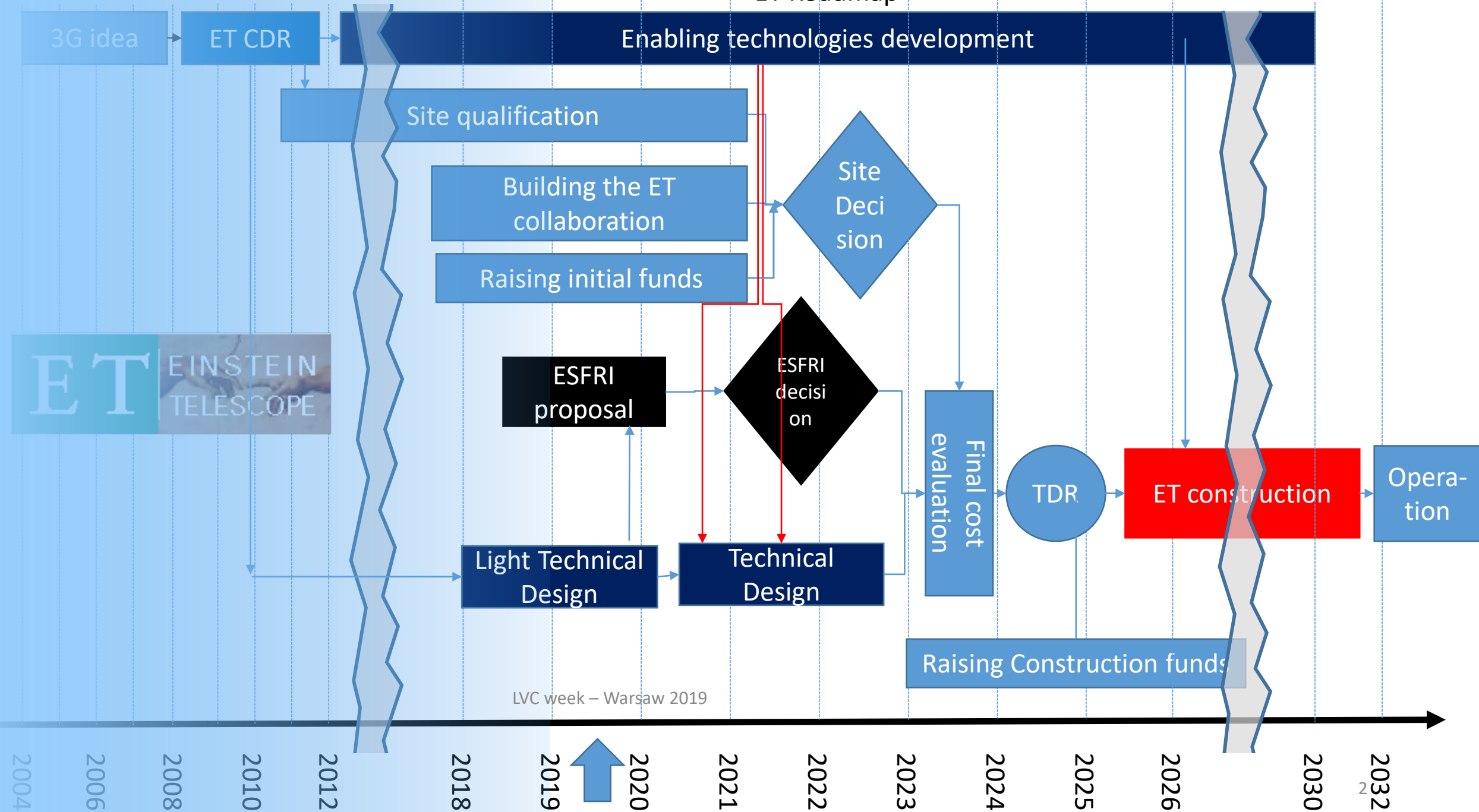


Einstein Telescope: Status

Michele Punturo
INFN Perugia

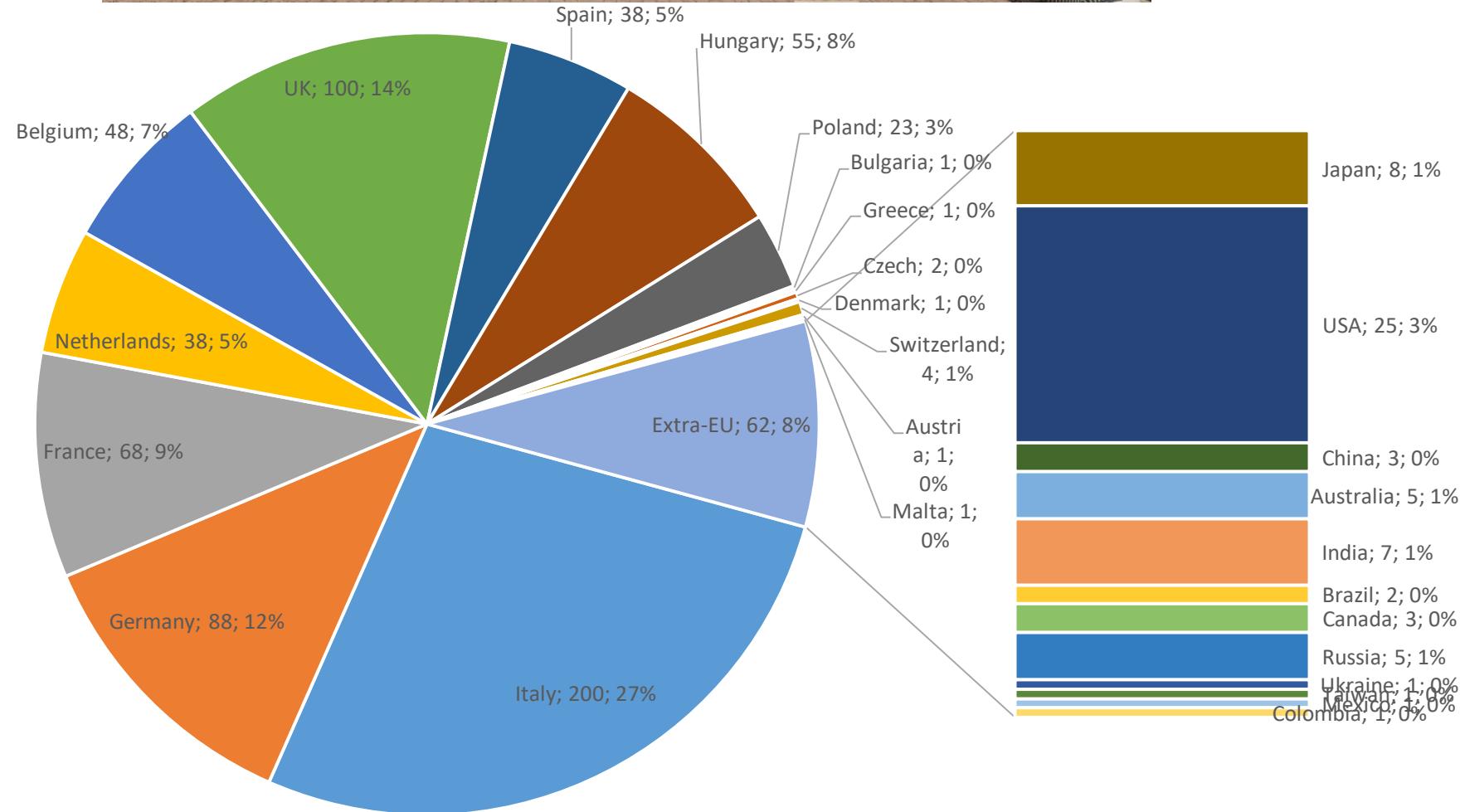


ET Roadmap



ET collaboration

- Launched the ET letter of intent @ the 9th ET symposium (April 2018)
- At the 10th ET symposium, April 2019, we collected more than 730 signatories



<http://www.et-gw.eu/index.php/letter-of-intent>

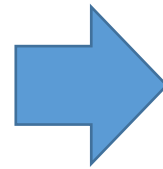
LVC week – Warsaw
2019

ET collaboration

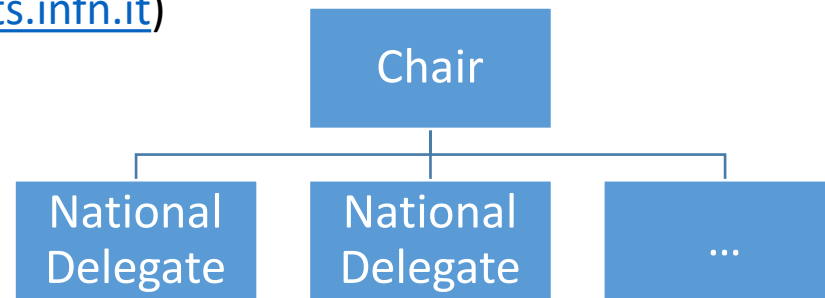
- Transition also in the management structure of the collaboration

ET steering committee (et-steering@lists.infn.it)

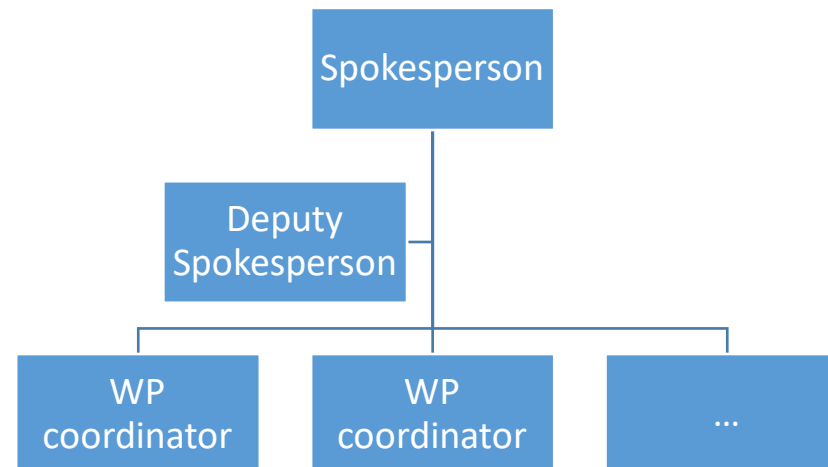
Name	Country
Nick van Remortel	Belgium
Nelson Christiansen	France
Matteo Barsuglia	France
Raffaele Flaminio	France
Karsten Danzmann	Germany
Harald Lueck	Germany
Achim Stahl	Germany
Peter Levai	Hungary
Michele Punturo	Italy
Enzo Brocato	Italy
Fulvio Ricci	Italy
Tomasz Bulik	Poland
Jo van den Brand	The Netherlands
Frank Linde	The Netherlands
Sheila Rowan	UK
Stefan Hild	UK
Andreas Freise	UK
Stavros Katsanevas	Observer-EGO
David Reitze	Observer-LIGO



General Assembly



Executive Board



LVC week – Warsaw 2019

Management structure of the ET Collaboration

ET Steering Committee

Introduction: start-up of the collaboration and of its management structure

Oversight Committee



Funding Agencies

ET light TDR

- Task: to update the ET CDR generating a light TDR to be used as reference for the ESFRI proposal
 - The light-TDR will focus on
 - ET specific science case
 - ET infrastructure
 - ET enabling technologies

ET ITDR writing team

Name	Country
Marie Anne Bizouard	FR
Raffaele Flaminio	FR
Andreas Freise	UK
Gianluca Gemme	IT
Jan Harms	IT
Stefan Hild	UK→NL
Giovanni Losurdo	IT
Harald Lück	DE
Ettore Majorana	IT
Michele Maggiore	CH
Cristiano Palomba	IT
Michele Punturo	IT
Jo van den Brand	NL
Chris van den Broeck	NL

ET “specific” science case

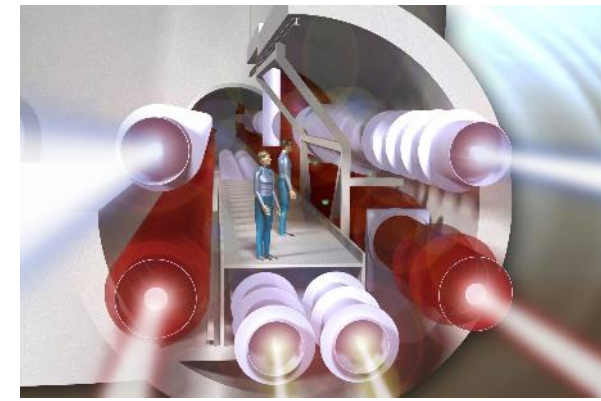
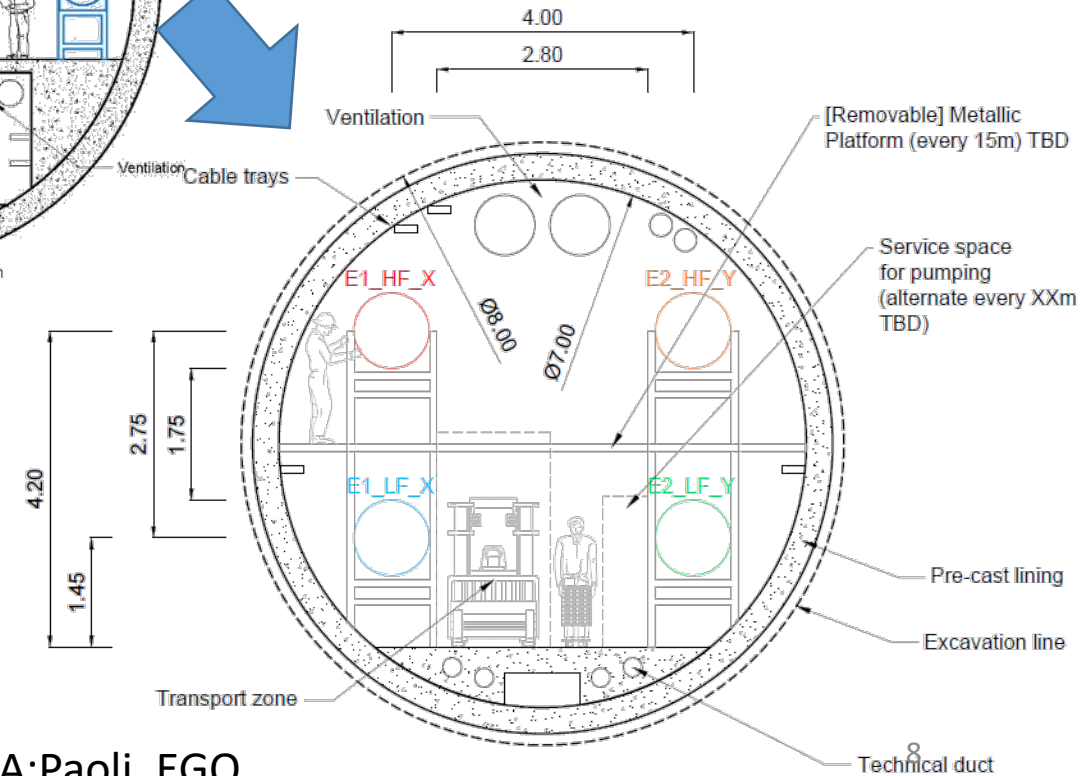
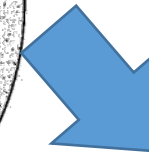
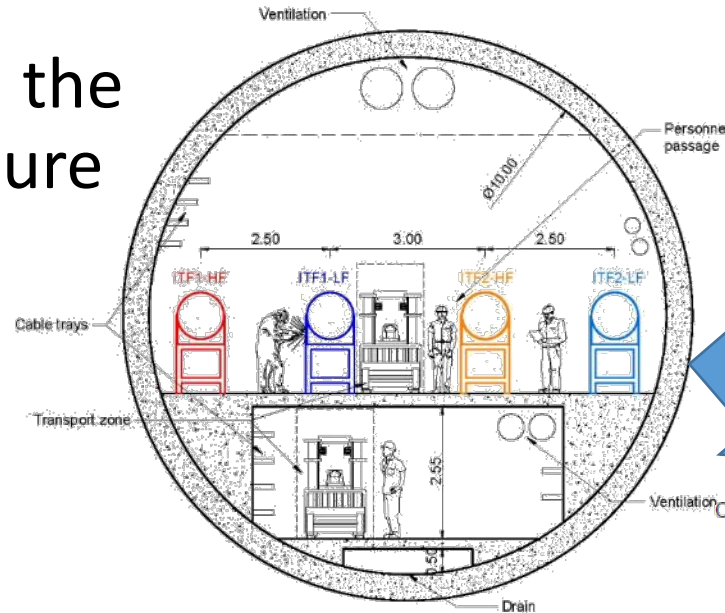
- GWIC-3G science case document is the background reference for all the 3G observatories
- But ET must show a scientific value also operating in a 2G+ context:
 - Identifying the specific cases:
 - Localisation given by the cooperation with the 2G+ network
 - Localisation offered by em counterpart
 - What is the role of the specific ET low frequency sensitivity?
 - Underground facility
 - What is the role of the polarisation resolving capabilities?
 - Triangular shape

ET “specific” Science Case Team

- A team (et-science-case@lists.infn.it) is working to finalise the ET specific Science Case:
 - Overall coordination: **Michele Maggiore**
 - Editorial Issues: **Harald Lueck**
 - Test of GR: **Chris van der Broeck**, Angelo Ricciardone (+), Mairi Sakellariadou
 - Cosmology: **Michele Maggiore**, Angelo Ricciardone (+), Mairi Sakellariadou, Sebastien Clesse, Juan Garcia-Bellido
 - MMA: **Marica Branchesi**, Marie-Anne Bizouard, Stefan Hild, Enzo Brocato
 - Nuclear Physics (NS): **Cristiano Palomba**, Tanja Hinderer
 - Fundamental Physics: **Chris van den Broeck**, Cristiano Palomba

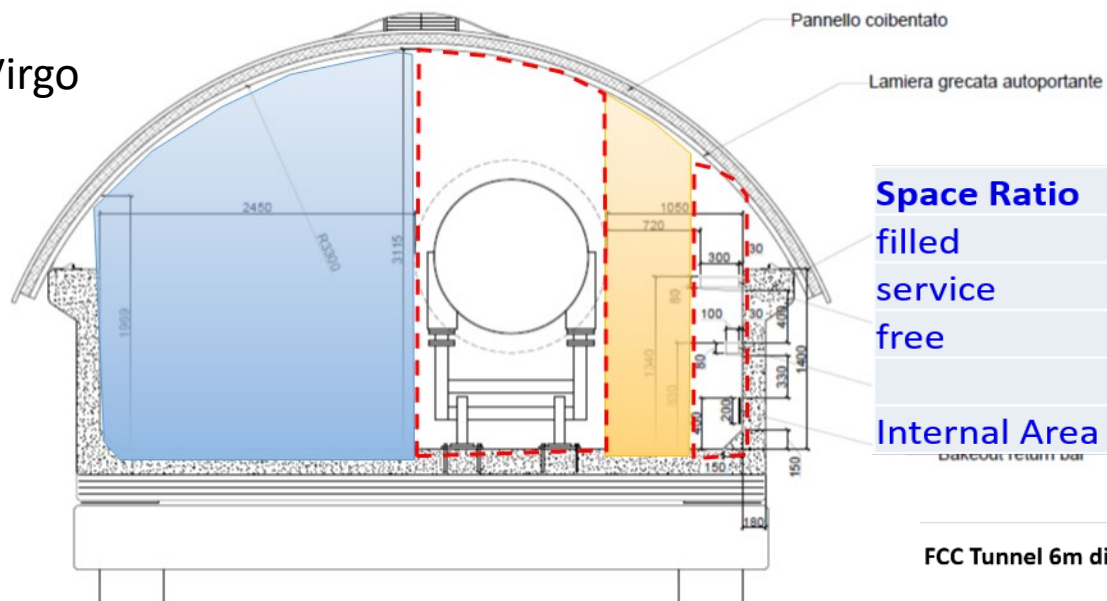
ET light TDR: Infrastructure

- In the ET conceptual design the solutions for the infrastructure were just drafted
 - Over-simplified design
 - Costs were not optimised
- Now is needed a more engineered approach
 - Evaluate requirements and constrains
 - Assembling, safety, costs



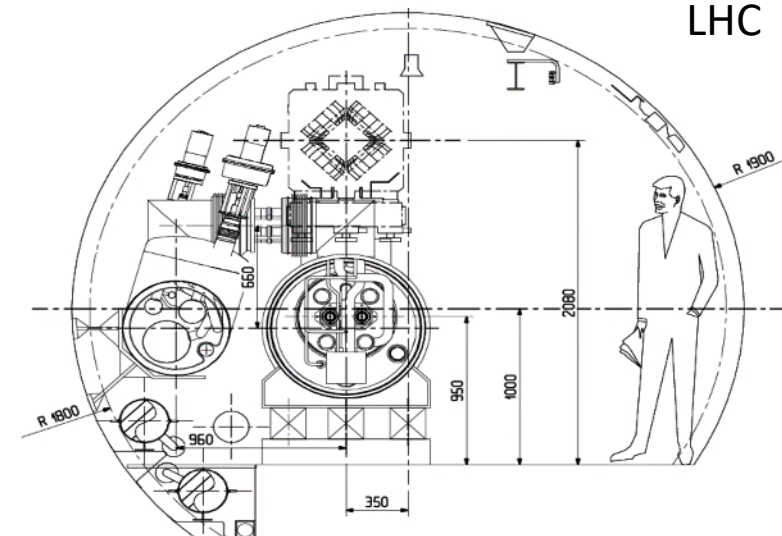
Comparative study

Virgo



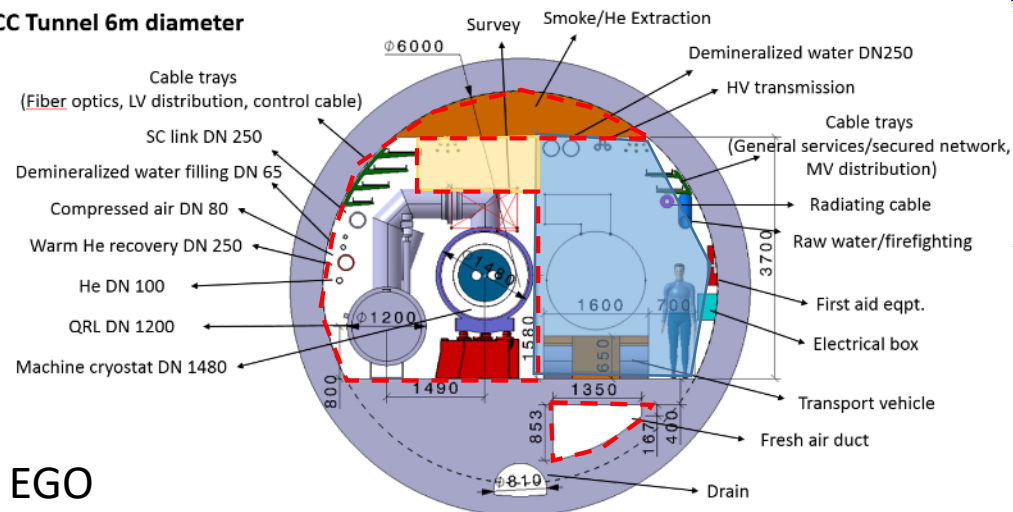
Space Ratio	
filled	39%
service	13%
free	48%
Internal Area [m ²]	
13.76	

LHC



Space Ratio	
filled	62%
service	4%
free	34%
Internal Area [m ²]	
9.50	

FCC Tunnel 6m diameter



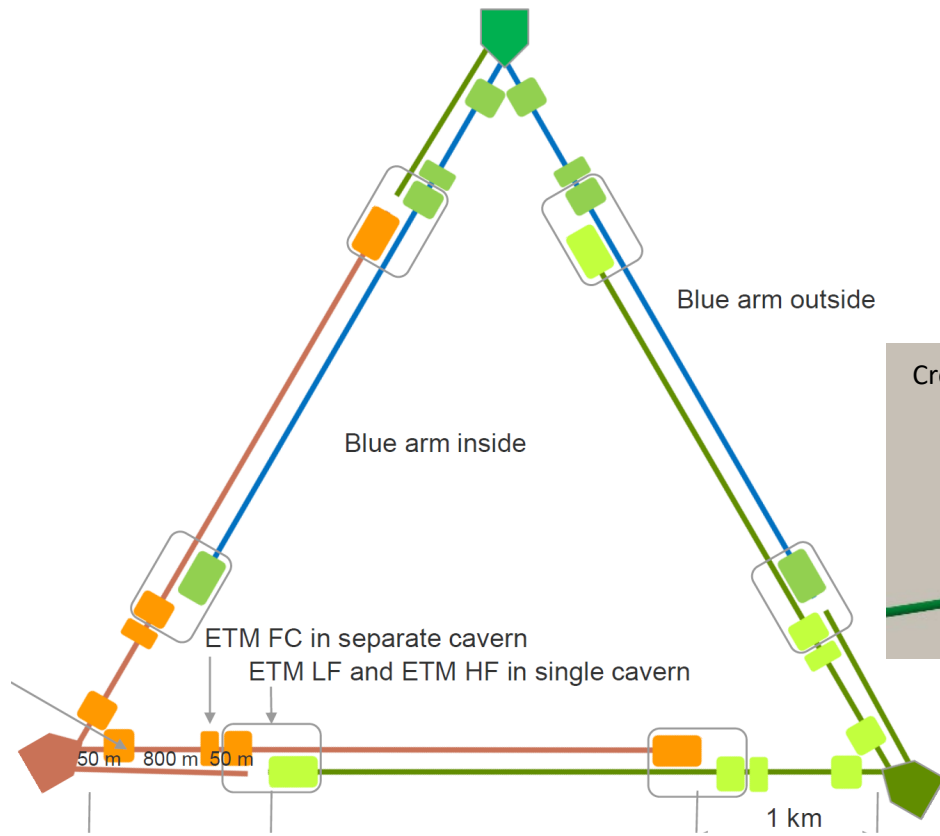
Space Ratio	
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service	6%
free	37%
Internal Area [m ²]	
23.01	

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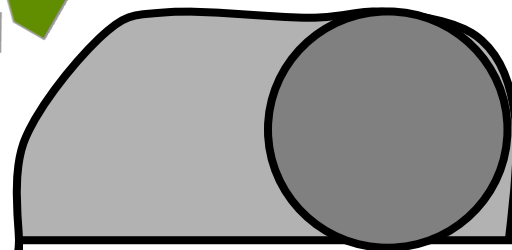
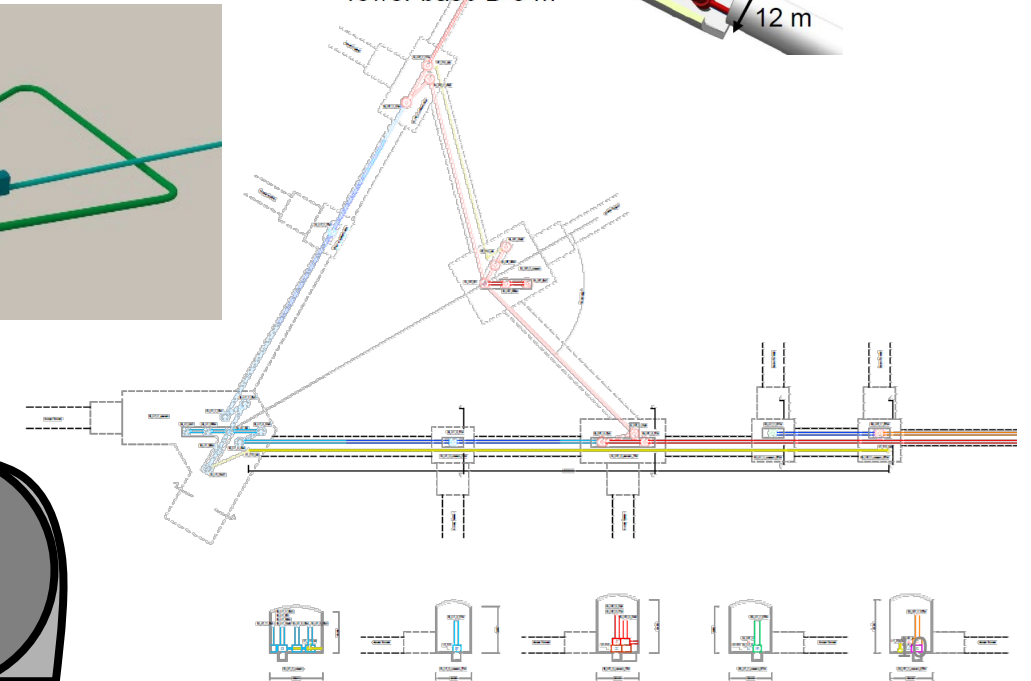
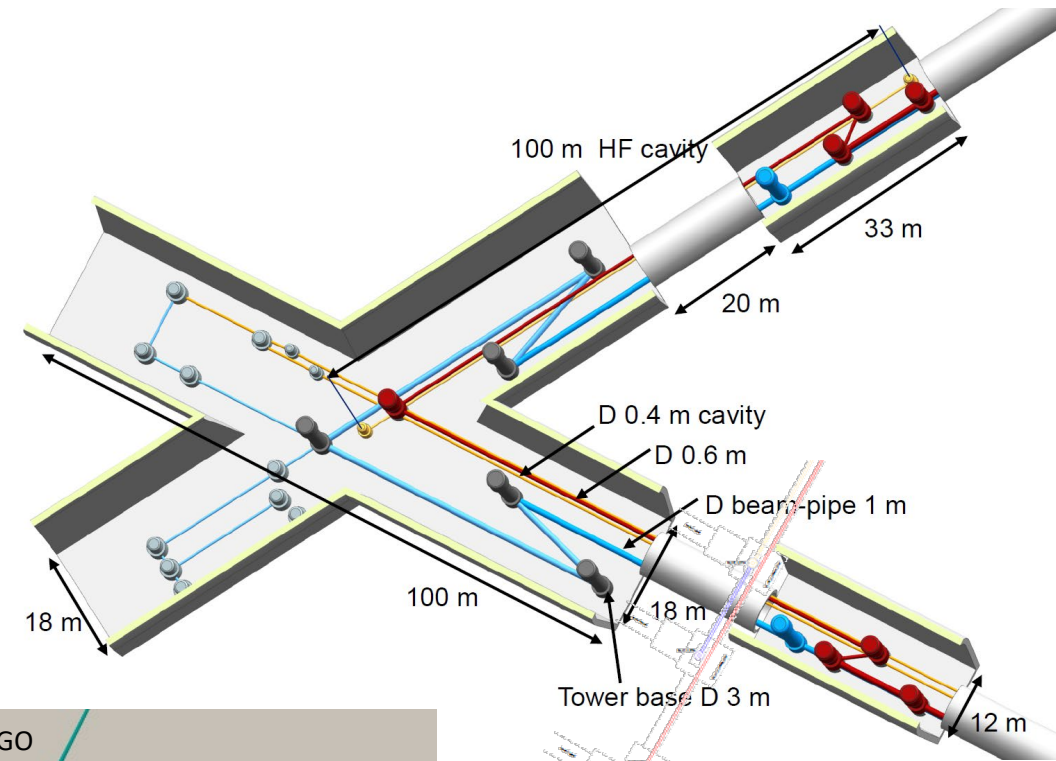
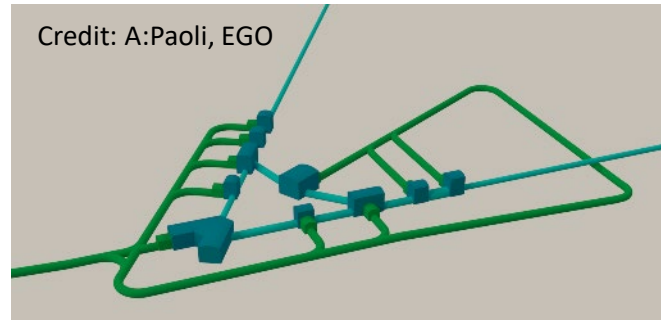


Credit: A:Paoli, EGO

Complex layout

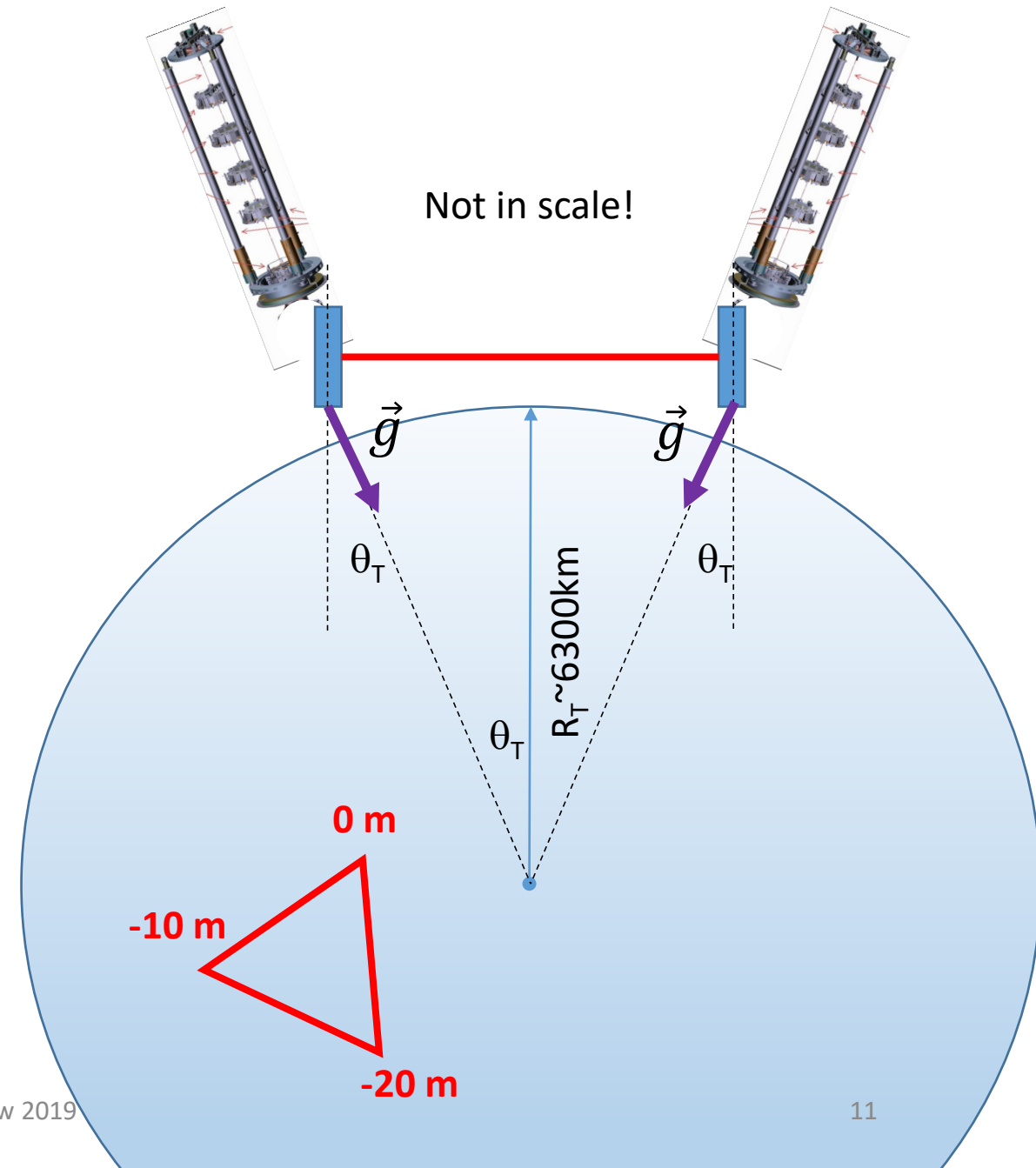


Credit: Martin Doetz, Nikhef



Tunnel inclination

- Vertical-to-Horizontal coupling due to:
 - Earth curvature: $\theta_T \sim 10^{-3} \text{ rad}$
 - Mechanical defects: $\theta_M \sim 10^{-3} \text{ rad}$
- Coupling due to inclination of the tunnel for water collecting must be $O(10^{-3})$: $\sim 10 \text{ m}$ over 10 km .
- Water currently collected in the Sardinian site (few tens of km of tunnels $\sim 1 \text{ l/s}$)
 - Current requirement $\leq 10 \text{ l/s}$



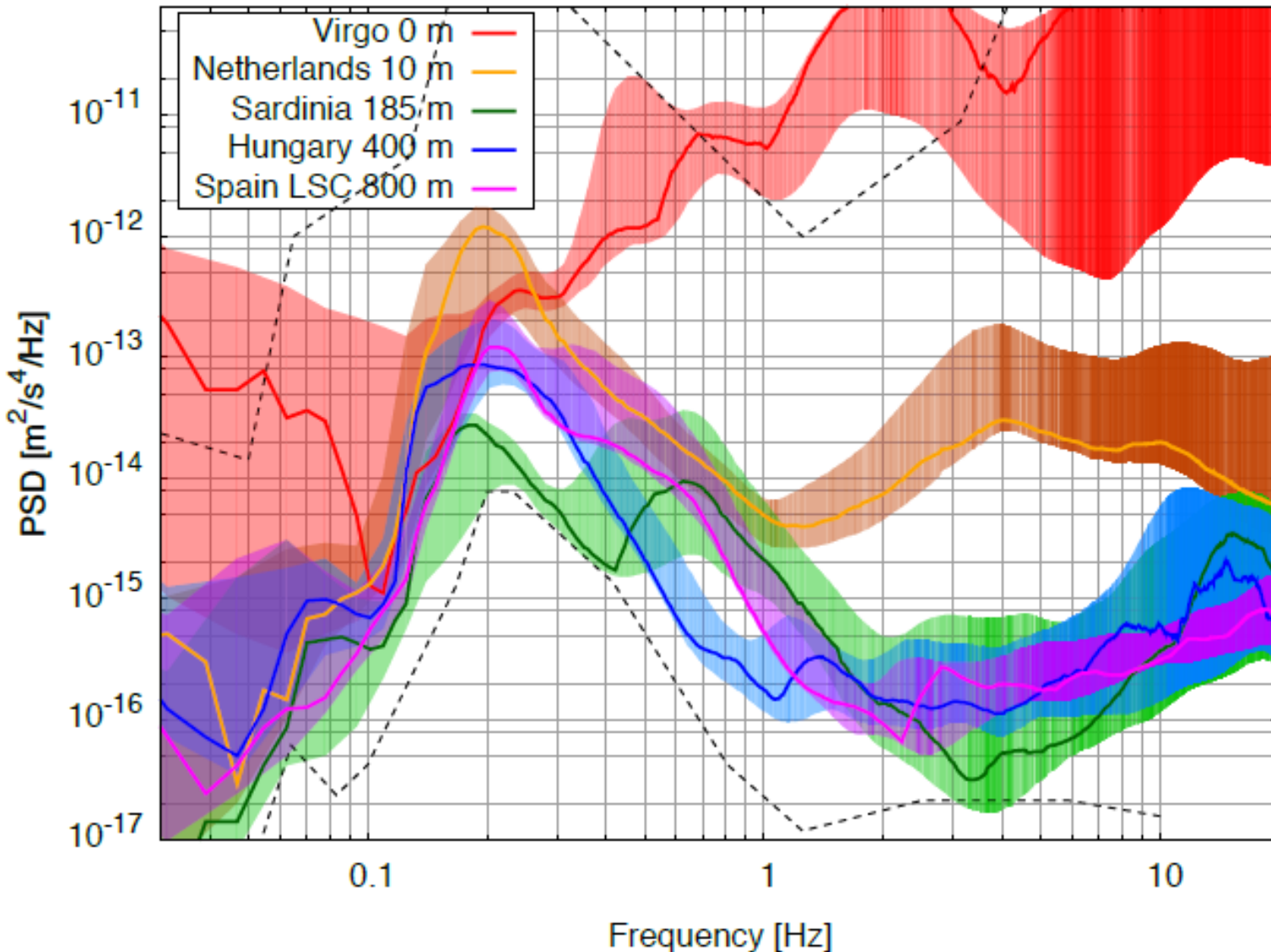
ET 3D design team

- A team (et_3d_design@lists.infn.it) of people is meeting and discussing these subjects
- Recent focus on providing inputs to an external company (Implenia) who is realising a cost and feasibility preliminary study for the infrastructure
 - Focused on the 3 borders site
 - In 2018 we had a very preliminary study by another company focused on Sardina

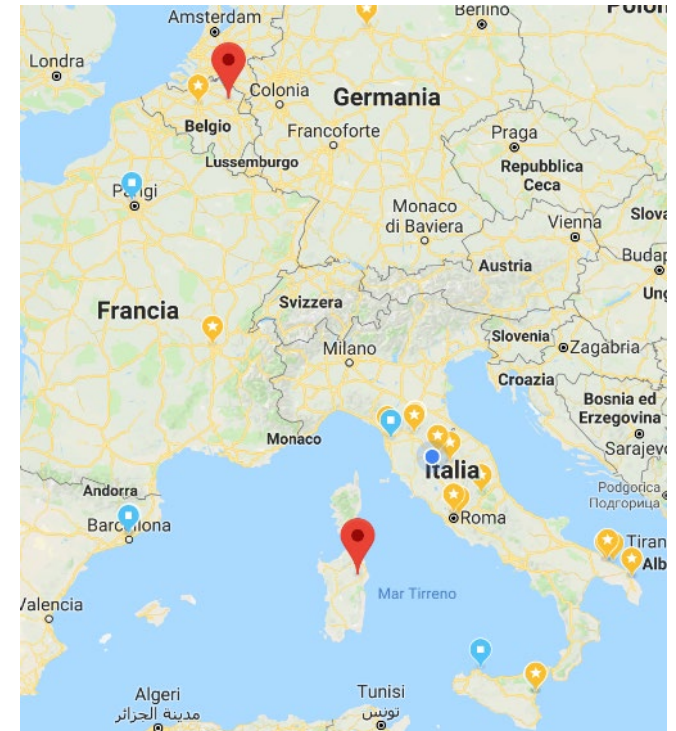


ET site: 2 candidates

Horizontal spectral motion at various sites



- 3 borders site (NL-B-DE)
- Sardinia site (IT)



Sites qualification



- Team (etsites@lists.infn.it), chaired by Jan Harms, aiming to define the technical selection parameters
 - Define what are the important parameters needed to compare the sites
 - Geology
 - Seismology
 - Natural radioactivity
 - Water content
 - Suggest a list of tests to be realised
 - 4 WGs, reports in progress

WG2 – Sensor installation

Marco Olivieri, Edit Fenyvesi, Irene Fiori, Vuk Mandic, Federico Paoletti, Alicia M Sintes

Working Group 4: Environmental Noise

Tomek Bulik, Carlo Giunchi, Jan Harms, Vuk Mandic, Patrick Meyers, Davide Piccinini, Wolfango Plastino, Paolo Ruggi, Gilberto Saccorotti, Laszlo Somlai, Matyas Vasuth, Zoltan Zimboras
(Dated: August 2, 2019)

This document explains the models implemented in RUMOR, the Einstein Telescope environmental-noise simulator, and gives a brief guideline of measurement targets for environmental-noise characterization at ET candidate sites. The environmental noise to be considered is associated with atmospheric, seismic, and (electro)magnetic fields. Several coupling mechanisms with the GW detector need to be considered for each field. For all three categories, sources can be natural or anthropogenic. This means that site measurements need to be planned to be able to characterize variations of the fields over short timescales up to a full year.

WG3: ET site-selection criteria

Geological and infrastructural aspects

Stefano Cuccuru, Alain Dassargues, Riccardo DeSalvo, Jan Harms, László Kovács, Giovanni Losurdo, **Aniello Grado**, Maria Marsella, Frédéric Nguyen, Giacomo Oggiano, Andrea Paoli, Wolfango Plastino, Peter Van, Dorota Rosinska

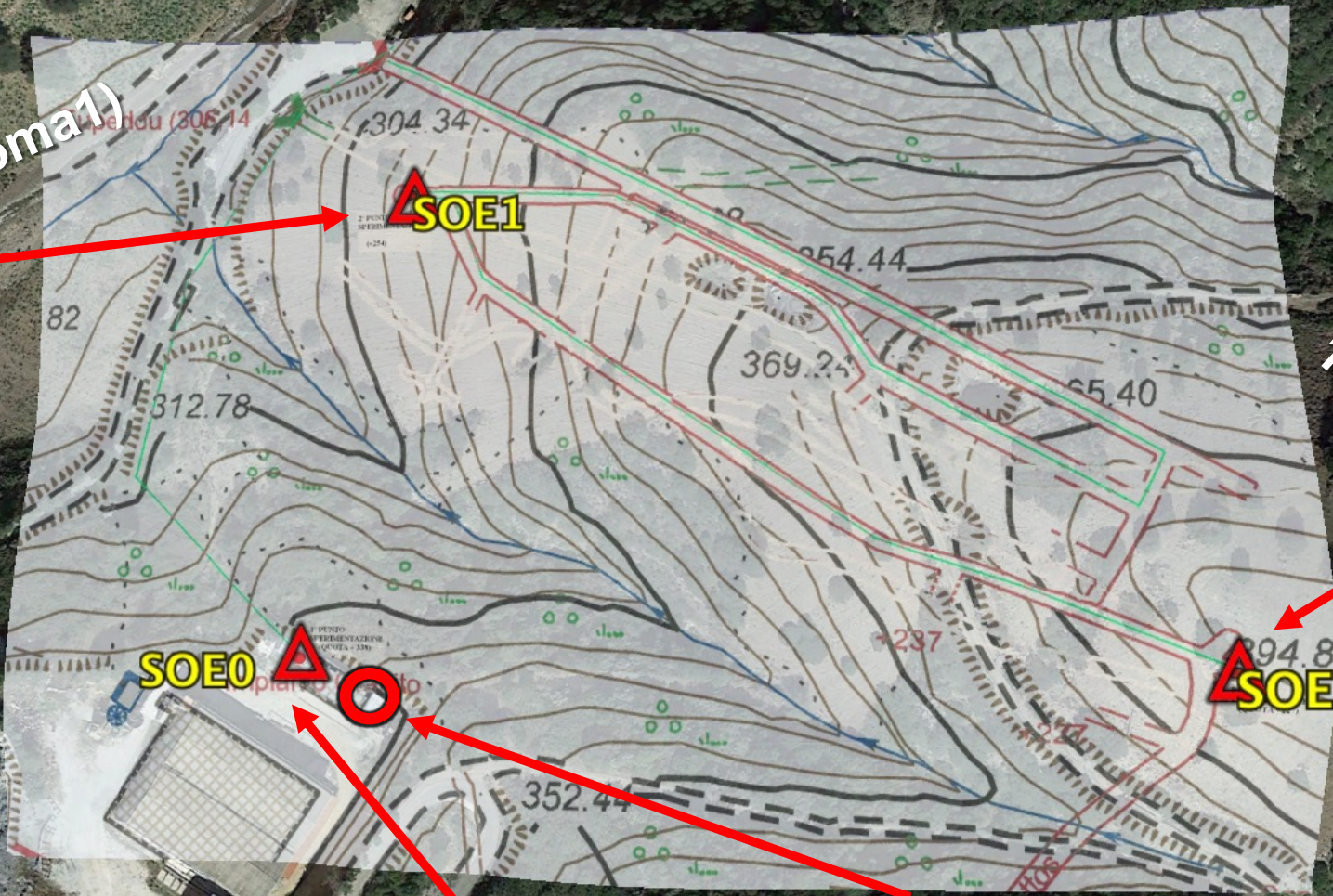
Sites qualification

- How the sites match these parameters?
 - 3 borders site:
 - Borehole completed and instrumented with a seismic sensor @-250m in May 2019
 - By mid August we will be able to access both on surface and in borehole sensor (@1st of August)
 - Complete the qualification for Sardinian site
 - Sos Enattos site qualified since long time (~2011)
 - Intensive qualification restarted in the underground mine coordinated by Luca Naticchioni and involving University of Rome, University of Sassari, INFN, INGV, GSSI



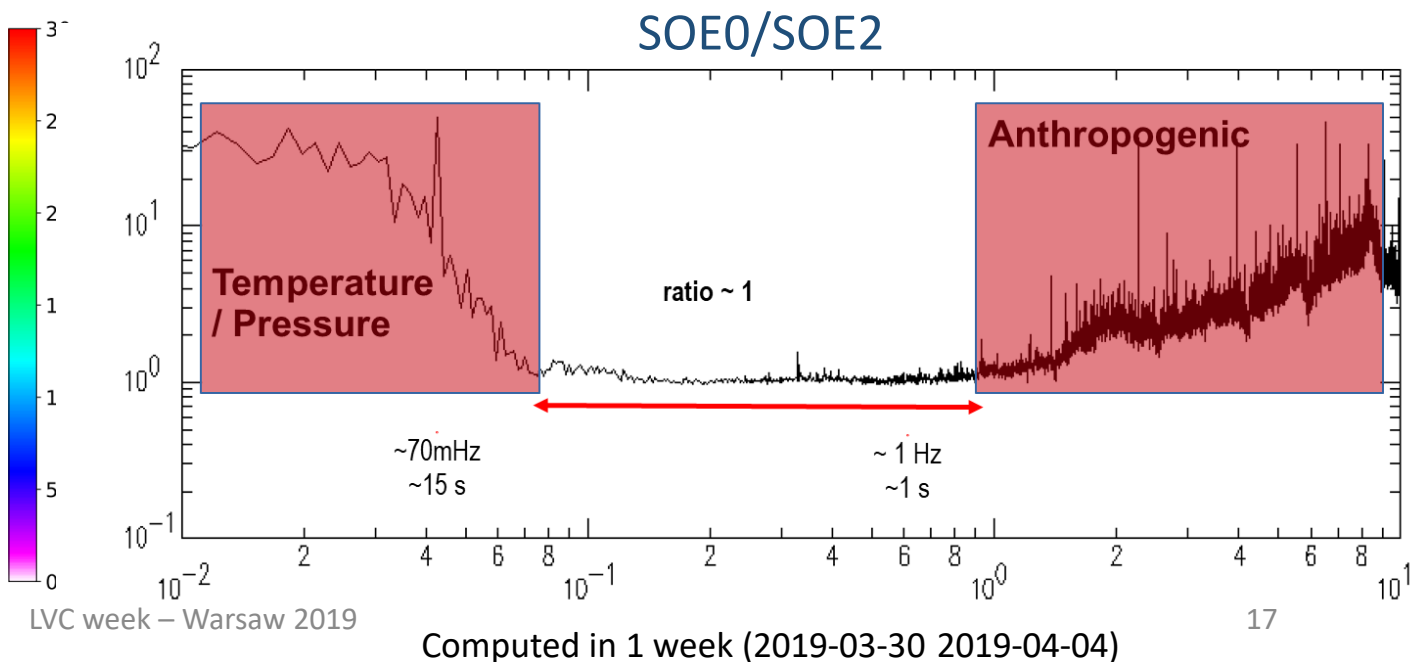
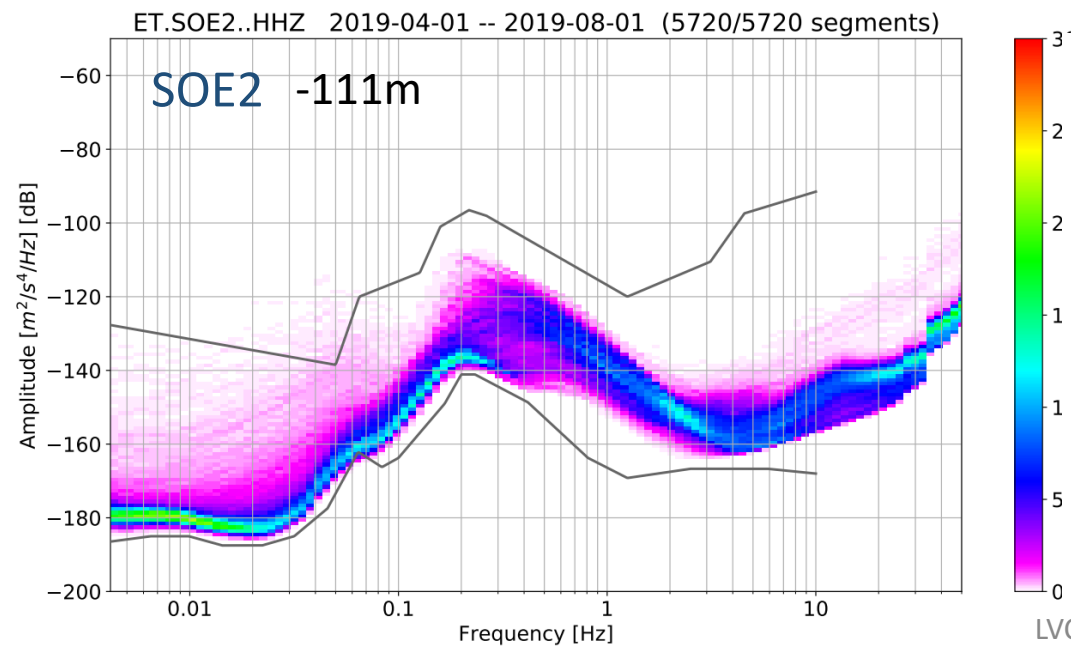
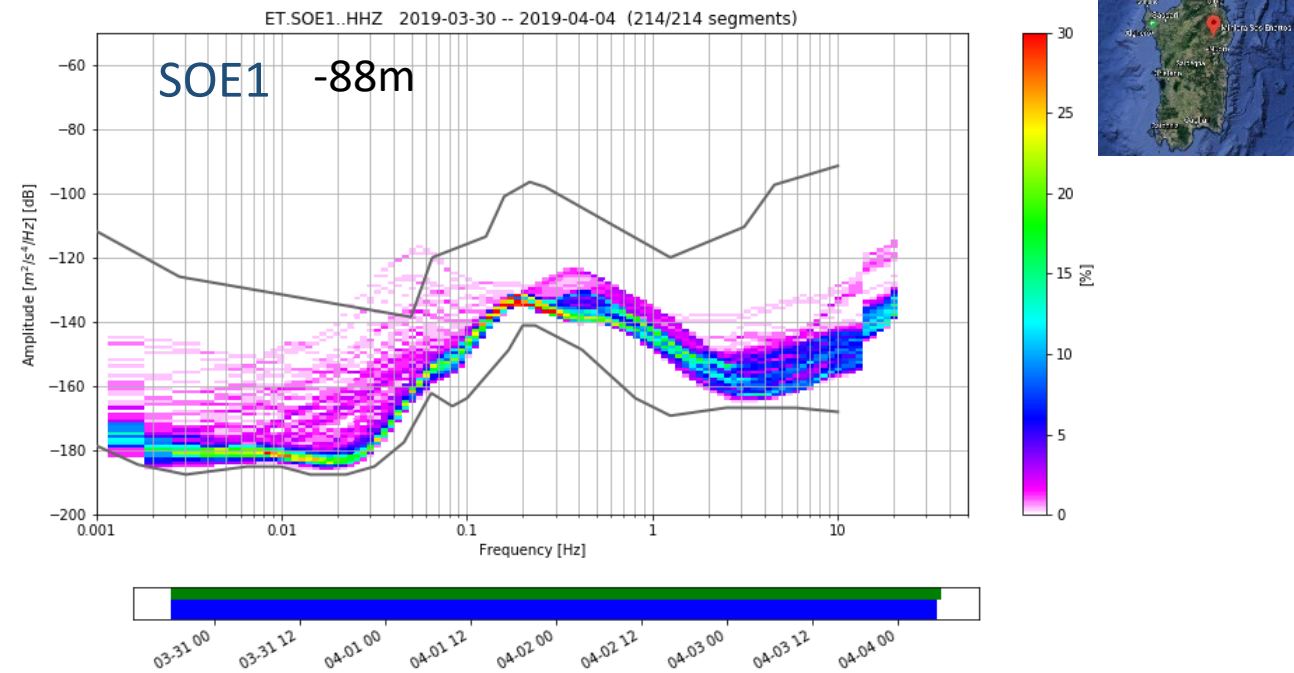
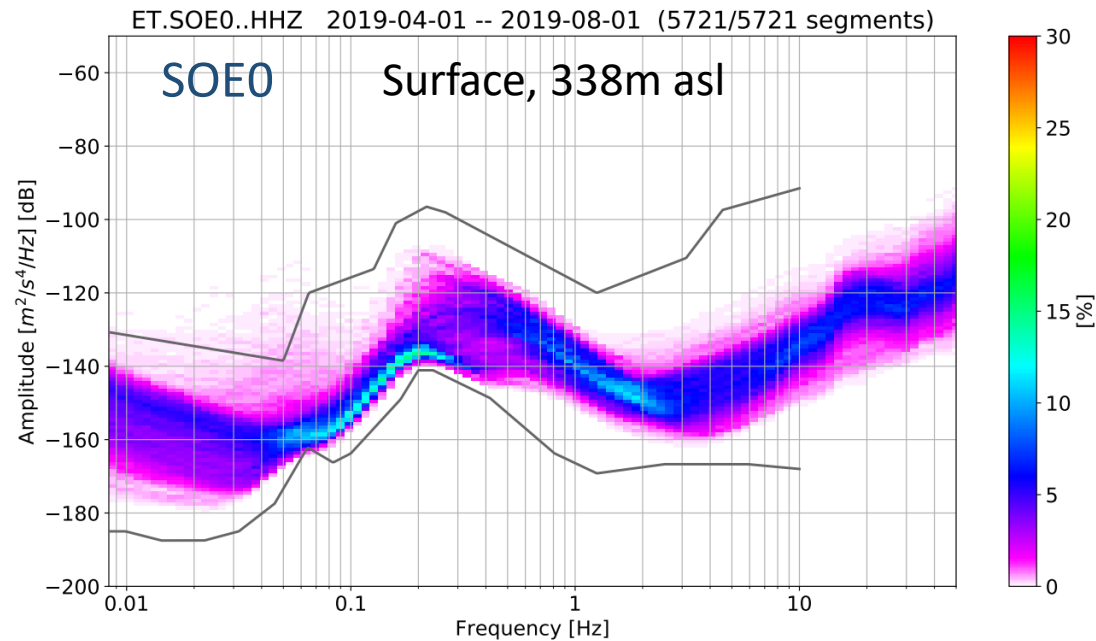
Sos Enattos setup 2019 March-August

Trillium 240s
+ Taurus DAQ
(INFN-RM1/UniRoma1)
84 m depth

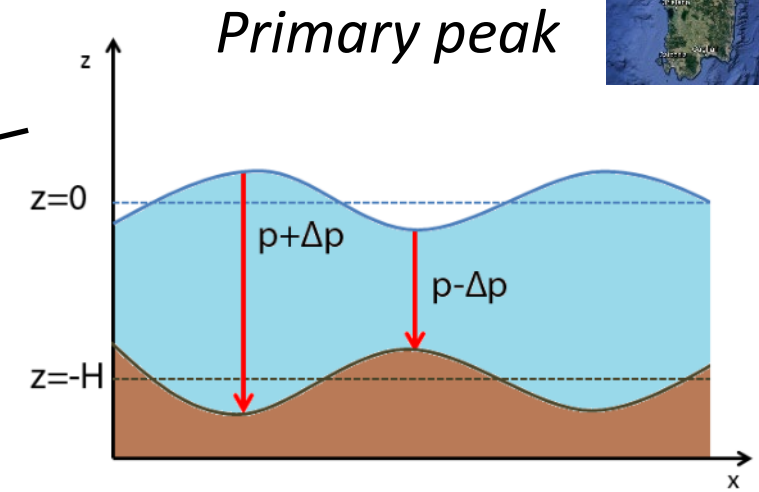
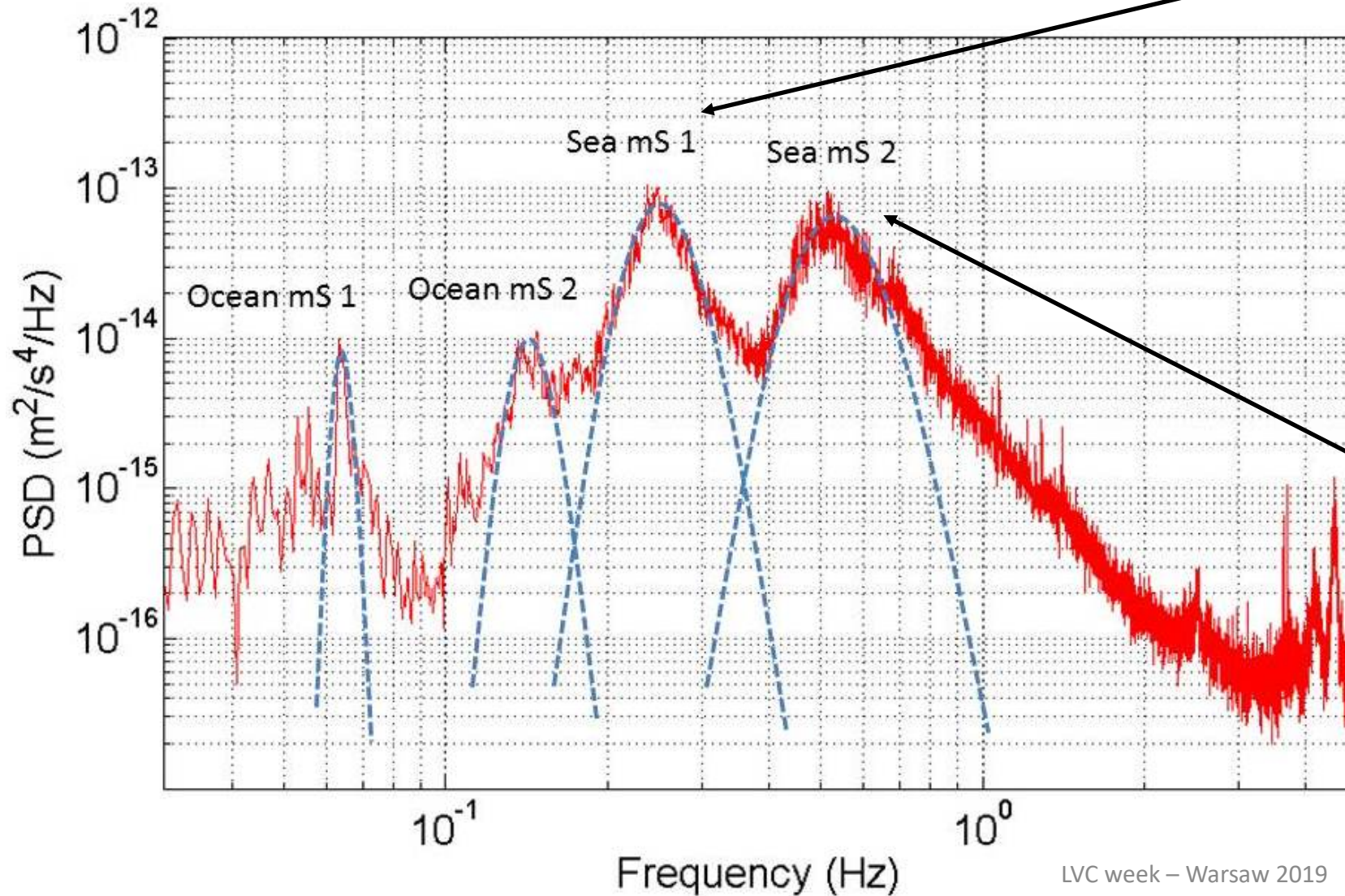


Trillium 240s (INGV-RM1)
+ Magnetometer (INFN-NA1)
+ Centaur-6ch DAQ (INGV-NA1)
111 m depth

Guralp 120s (INGV-NA1)
Router & UMTS Modem
338 m asl

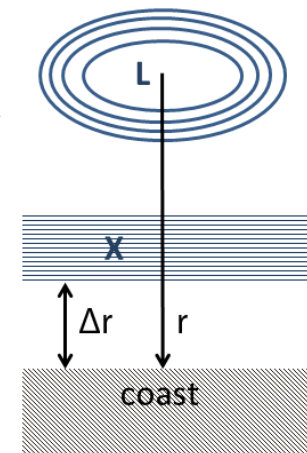


Microseism generation



a)

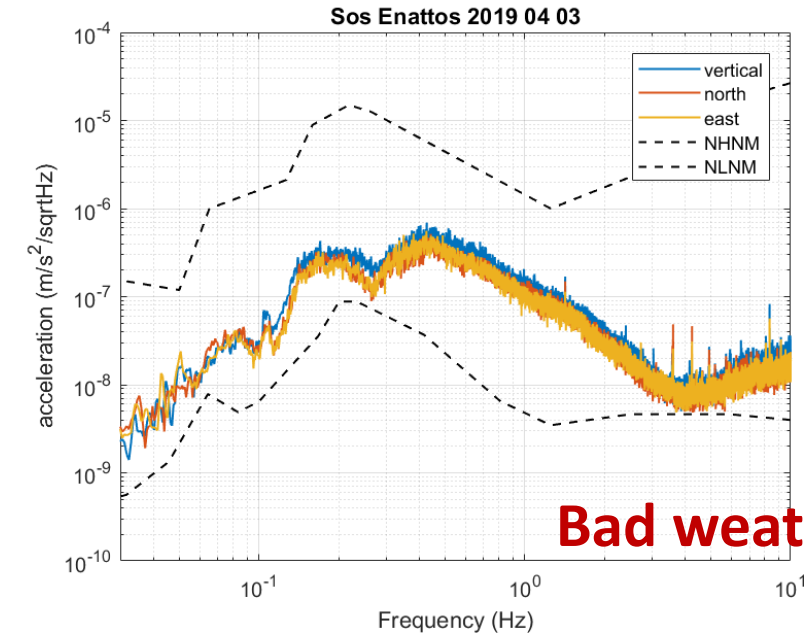
Secondary peak



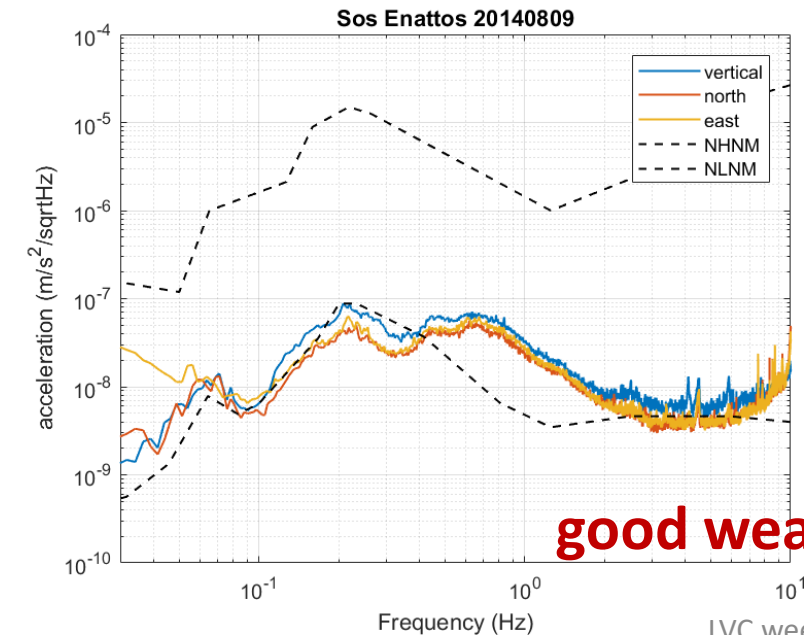
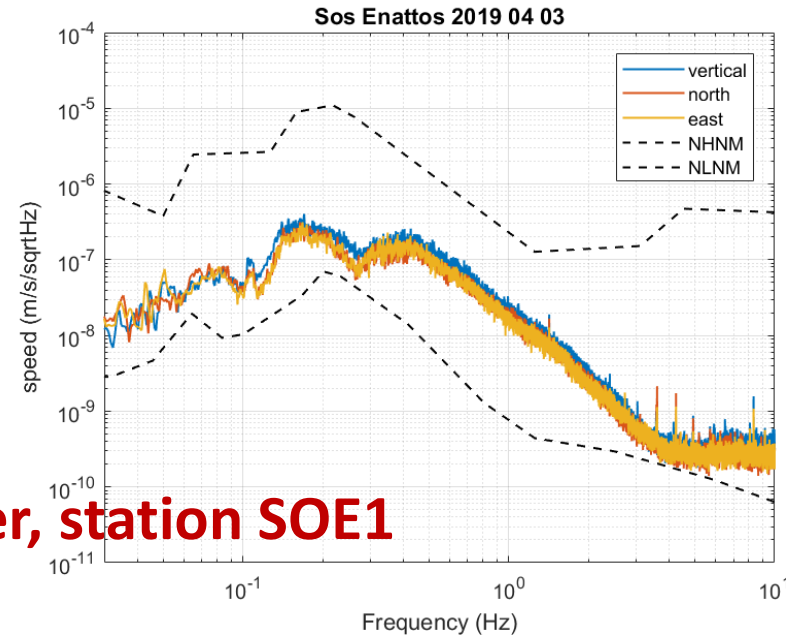
b)

Weather influence on microseisms

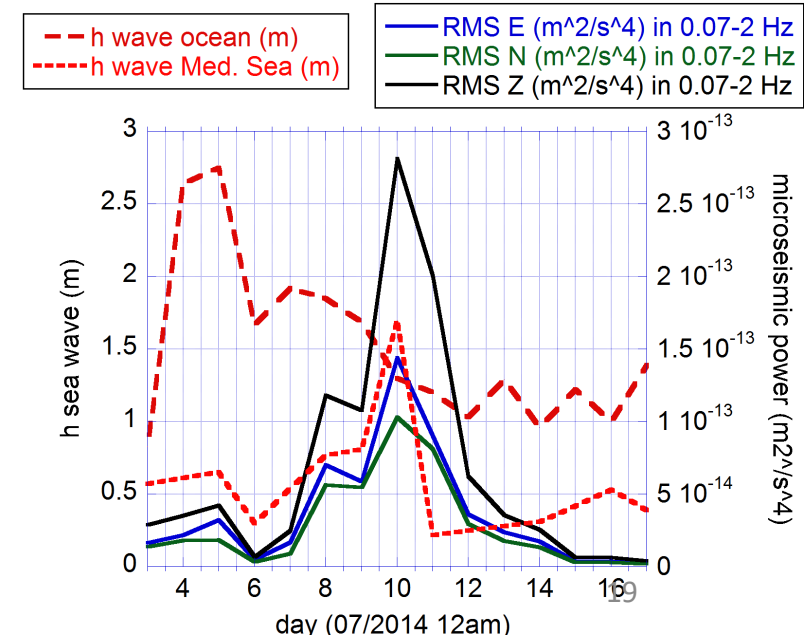
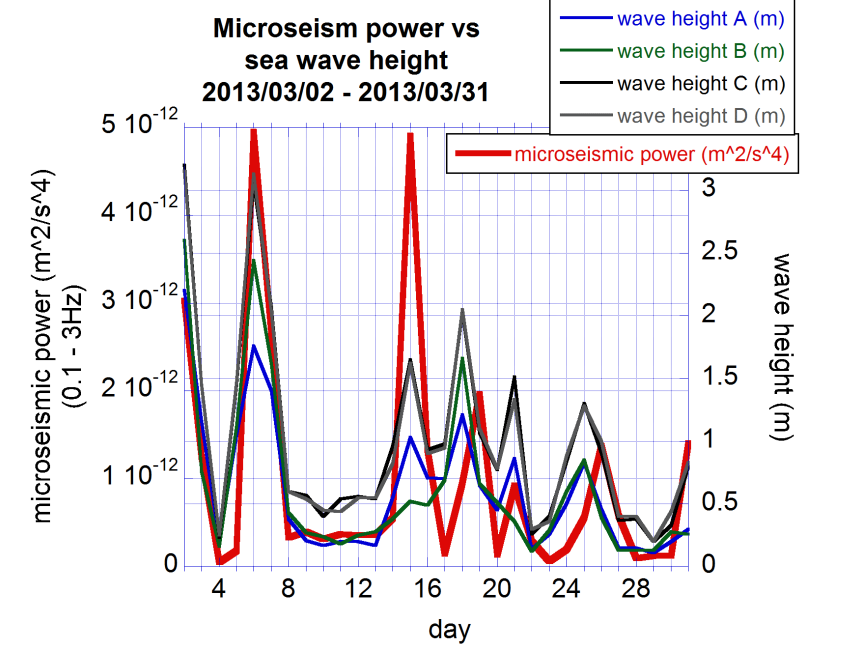
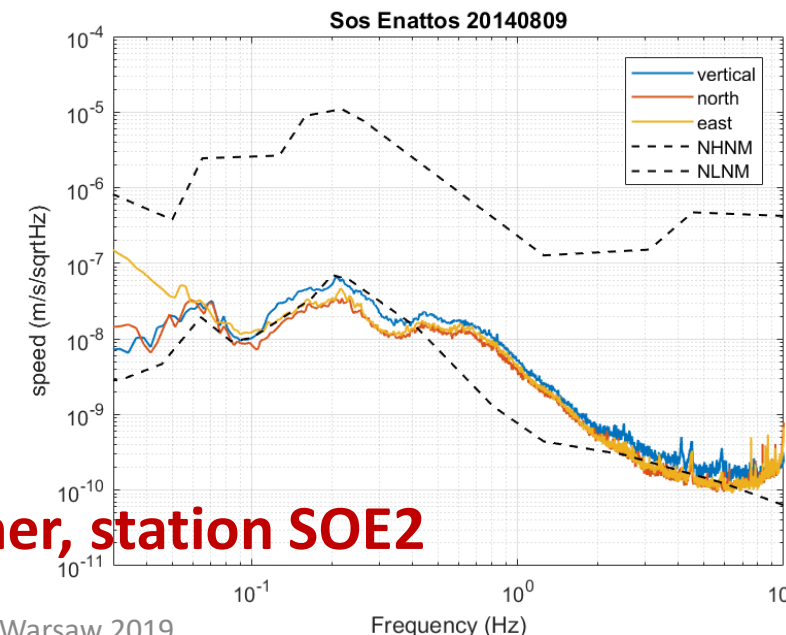
From L Naticchioni et al., 2014, Class. Quantum Grav. 3



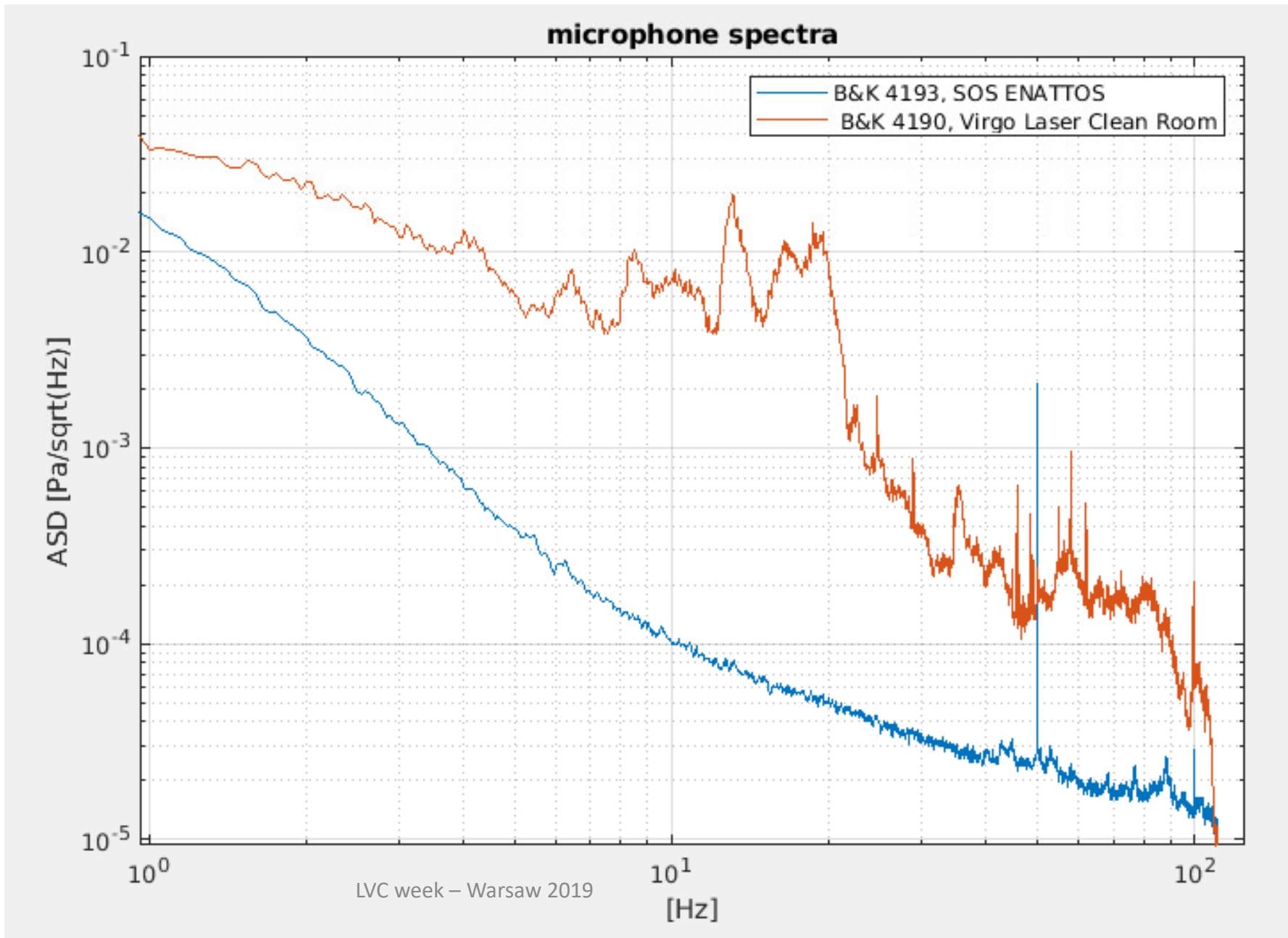
Bad weather, station SOE1



good weather, station SOE2



Acoustic noise



Geological and Geophysical characterisation



Fondata nel 1562

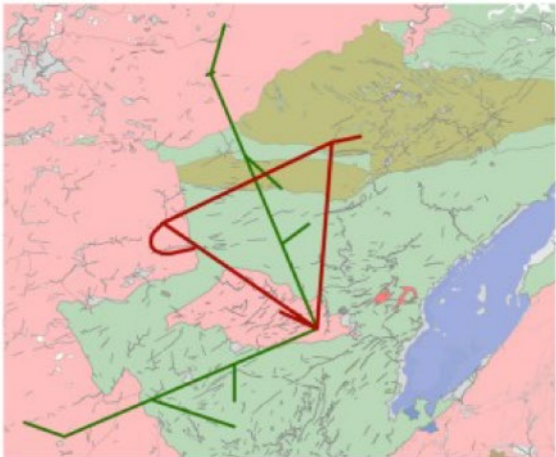
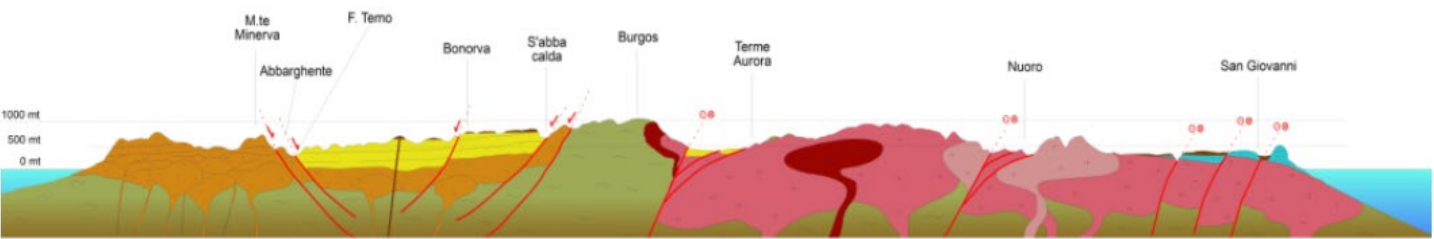
Dipartimento di Chimica e Farmacia

Preliminary geological and geotechnical characterization of the Sos Enattos ET site

Prof. Giacomo Oggiano

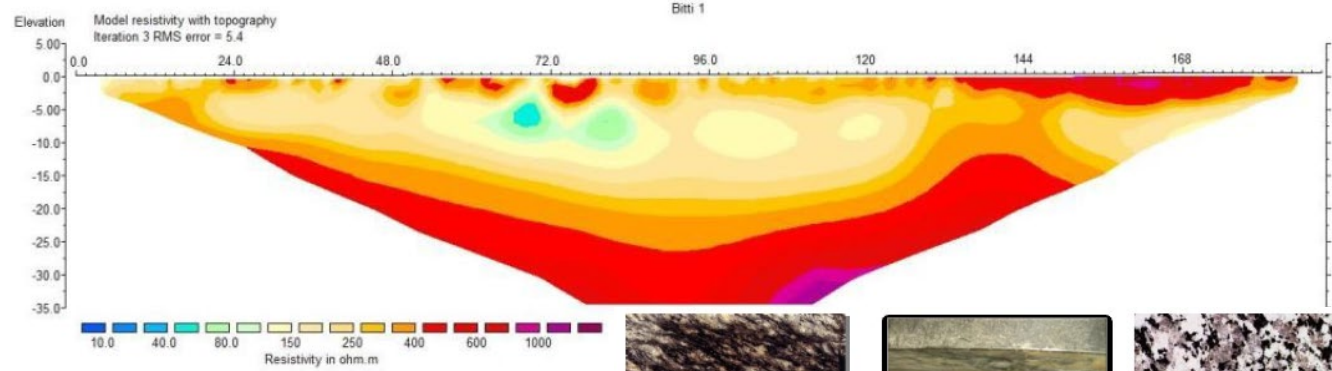
Dr. Stefano Cuccuru

Giugno 2019



Main lithological units:

- Sedimentary covers
- Mesozoic limestones
- Variscan granitoids
- Orthogneiss
- Micaschists and quartzites



Horizontal scale is 10.20 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 m.
Last electrode is located at 189.0 m.

Fig. 35. Resistivity tomography of Bitti granite.

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Fig. 14: Orthogneiss "Lodè type"



Fig. 15: Micaschist after UCS test

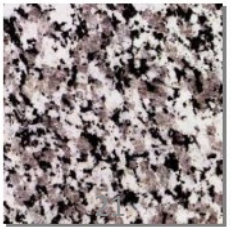


Fig. 16: Granodiorite "Bitti type"

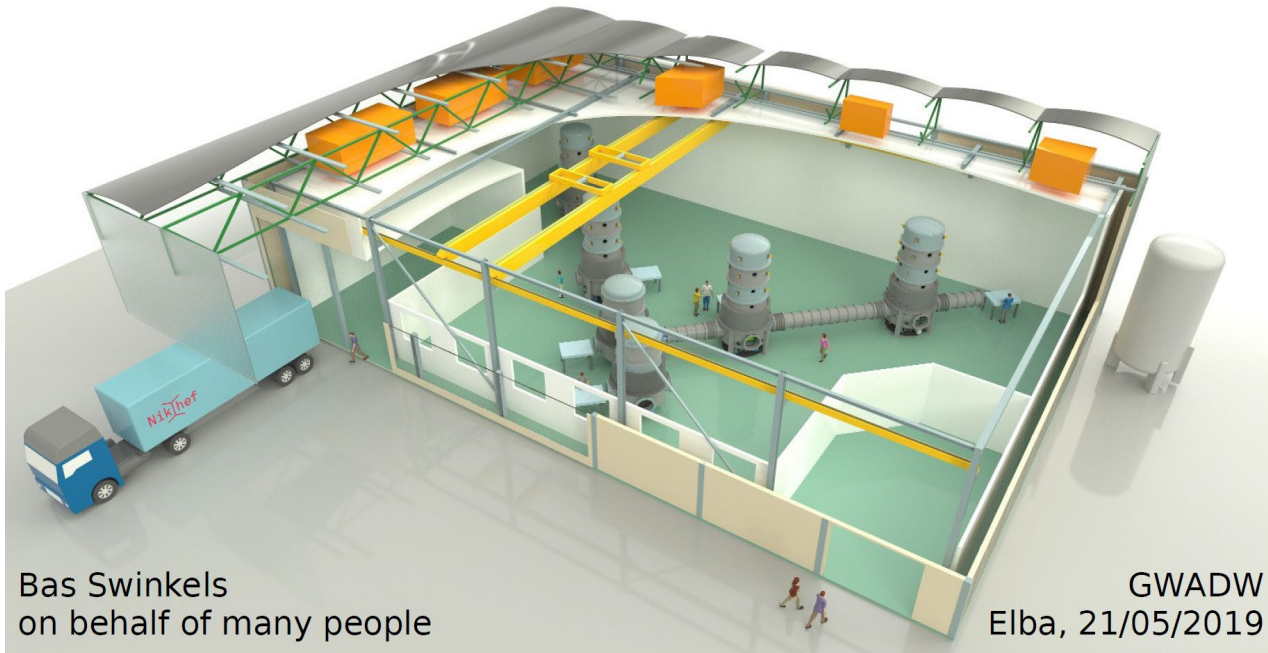
Initial funds raising

- The site qualifications, the engineering studies, the enabling technologies development require initial funding
- Some initial funding has been delivered in the most proactive countries to realise facilities and to candidate the sites

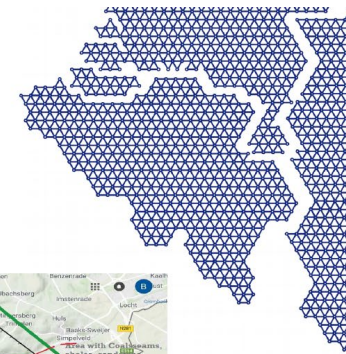


ET Pathfinder activities

ET Pathfinder in Maastricht



LVC week – Warsaw 2019



Funding & partners



- Obtained ~14.5 MEuro funding from unconventional sources:
 - InterReg Flanders-South of NL (European fund for cross-border development)
 - Province of Limburg (NL), Dutch and Belgian national ministries
 - Matched contribution by partners
- Partners: Nikhef, universities of Antwerpen, Eindhoven, Ghent, Hasselt, Leuven, Maastricht
- Satellite partners: Aachen, Brussels, Fraunhofer, Liège, Louvain la Neuve, Twente, TNO
- Additional input from Glasgow, AEI, Perugia ...
- 100+ person-years (staff scientists and engineers) committed over the next 5 years
- New collaborators are welcome



Financial support for the Sos Enattos site

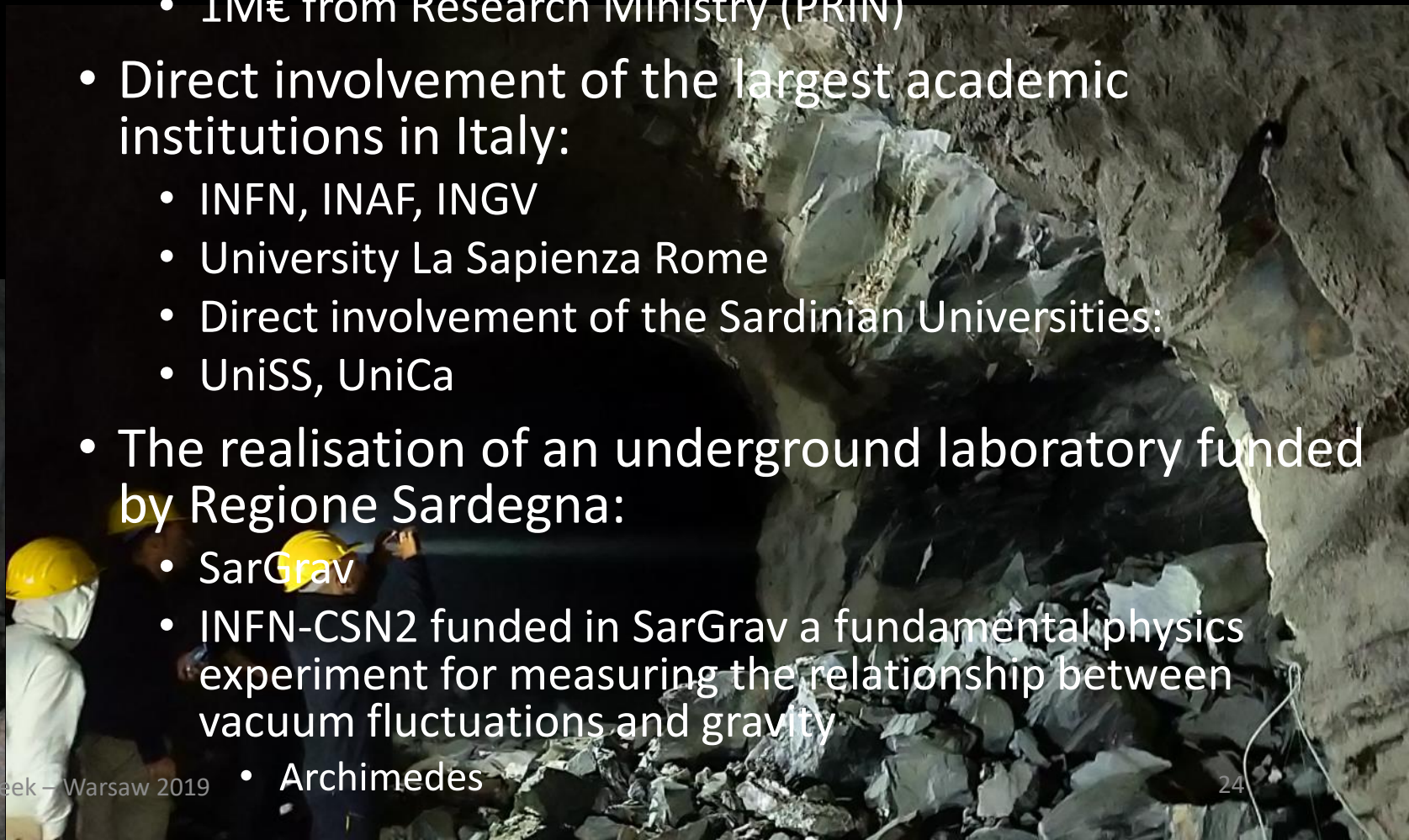
04.10.2018



04.10.2018

18th week – Warsaw 2019

- Support of the Italian Government:
 - 17 M€ promised to support AdV+ and the ET site candidature
 - 5.5M€ delivered in 2018
 - 5.5M€ allocated in 2019 (July)
 - 3.5M€ delivered by Sardinia region
 - 1M€ from Research Ministry (PRIN)
- Direct involvement of the largest academic institutions in Italy:
 - INFN, INAF, INGV
 - University La Sapienza Rome
 - Direct involvement of the Sardinian Universities:
 - UniSS, UniCa
- The realisation of an underground laboratory funded by Regione Sardegna:
 - SarGrav
 - INFN-CSN2 funded in SarGrav a fundamental physics experiment for measuring the relationship between vacuum fluctuations and gravity
 - Archimedes



24

Inauguration of the SarGrav control room



10th ET symposium: visit at the site

In the last week of August, all the optical fibres collecting the data from the underground and surface sensors, have been connected to the control room and now it is operative



Positioning ET in the EU context

- Key activity: make ET a recognised experiment in the EU context
 - ET and future GW projects in the European Strategy for Particle Physics
 - “Successful” submission of the GW contribution
 - “Interested” reaction by CERN council and community
 - Request from CERN management of a **UNIQUE** MOU between ET and CERN focusing on the possible collaboration on technical aspects on:
 - Vacuum technologies
 - Cryogenics
 - Infrastructures
 - Computing
 - MOU should be inclusive, allowing the participation of the whole 3G community
 - Fulvio Ricci is coordinating the MOU writing activity

Positioning ET in the EU context

- Submission of the ET proposal to the ESFRI (European Strategic Forum on Research Infrastructures) roadmap
 - Key goal for the ET project
 - Technical/scientific activity
 - Infrastructure design and costs
 - Detector draft design and costs
 - Political activity
 - Focus funding agencies and governments in a common project
 - Defining the governments signing the Expression of Support (EoS)
 - ESFRI roadmap update kick-off meeting:
 - Brussels, 25th of September 2019
 - Submission deadline: 5th of May 2020

Conclusions

- The ET project is in a very hot period:
 - Next months will be crucial to produce a successful ESFRI proposal and to stimulate the interest and support of the national governments
 - The design of the infrastructure and the characterisation of the sites are progressing in these weeks
 - A more intense and direct involvement of a larger number of colleagues is desirable and necessary