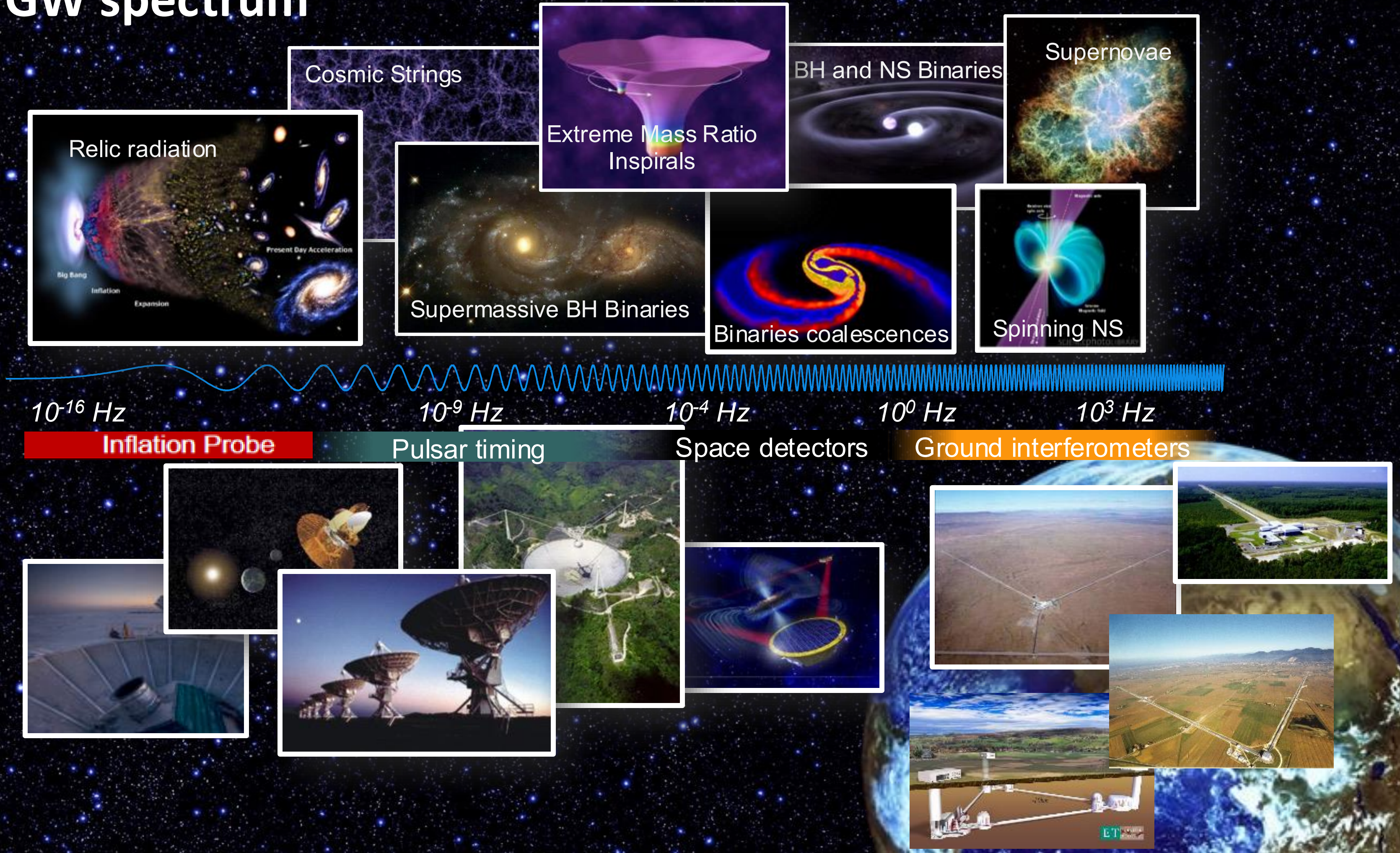
Status of the Einstein Telescope project

GDR OG – General assembly

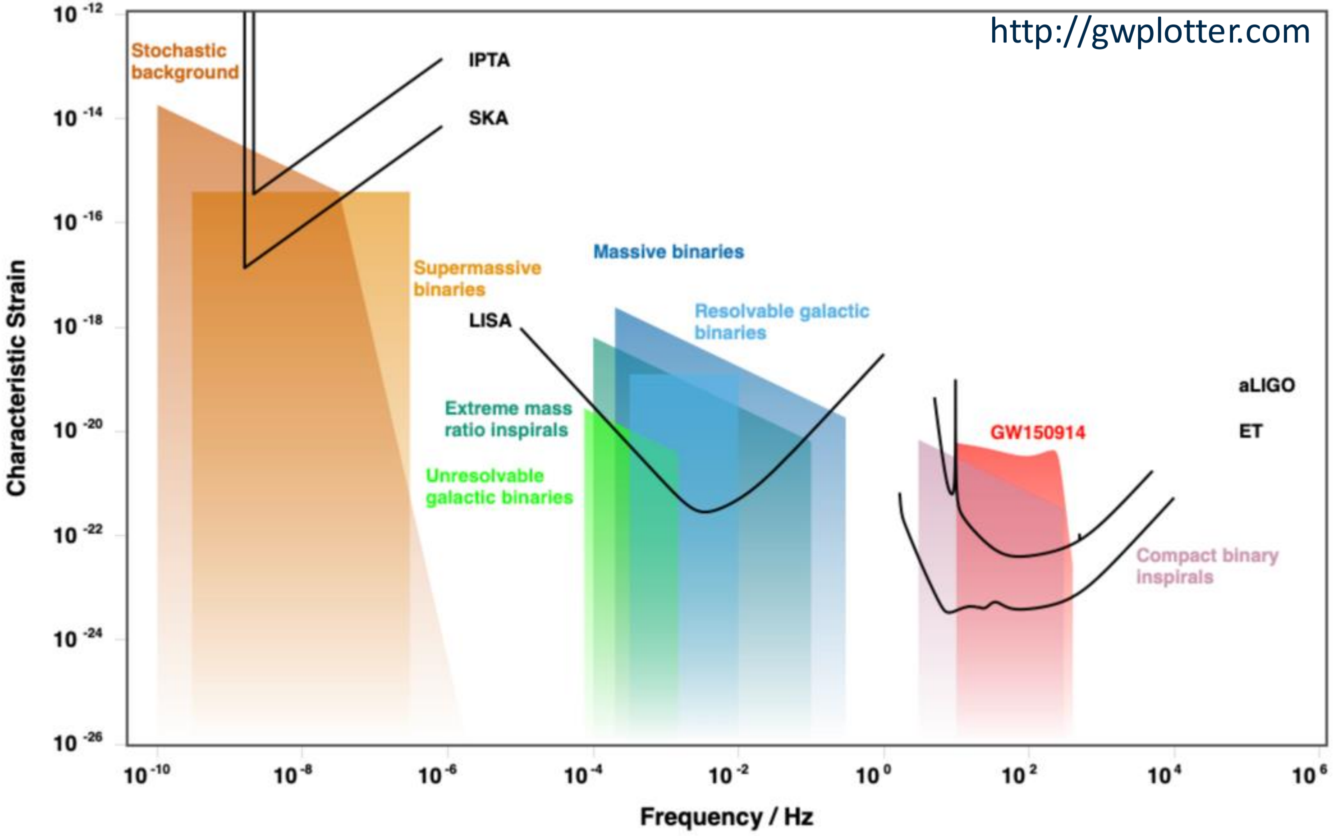
Paris – October 14th, 2025

Patrice Verdier (IP2I Lyon – IN2P3) - patrice.verdier@in2p3.fr

GW spectrum


Cosmic Strings
Extreme Mass Ratio Inspirals
BH and NS Binaries
Supernovae
Relic radiation
Present Day Acceleration
Big Bang
Inflation
Expansion
Supermassive BH Binaries
Binaries coalescences
Spinning NS
10^{-16} Hz
10^{-9} Hz
10^{-4} Hz
10^{0} Hz
10^{3} Hz
Inflation Probe
Pulsar timing
Space detectors
Ground interferometers

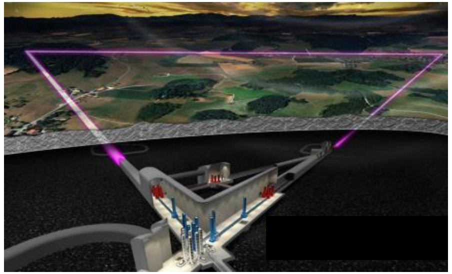
GW Detection



Einstein Telescope

ET pioneered the idea of 3rd generation GW observatory:

- A new infrastructure for >50 years
- Sensitivity at least 10 times better than 2nd generation
- Huge improvement in sensitivity at low frequency (a few Hz to 10 Hz)
- Essential French contribution since the initial studies



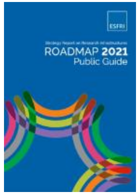
2005 | 2010 | 2015 | 2020 | 2025 | 2030

ILIAS FP6
Ideas on 3rd gen. GW interferometers

ET FP7
Conceptual Design Study

ET R&D funded by **ASPERA-2**

2021 ESFRI roadmap



June 2022
The Einstein Telescope Collaboration is established

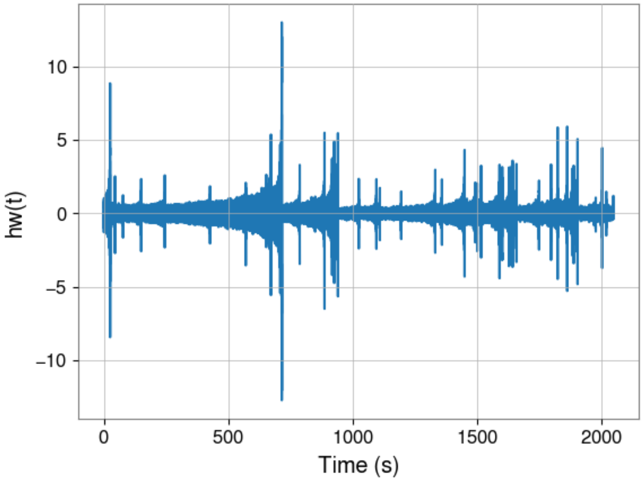
Infradev : ET Preparatory Phase
2023-2026

Pre-TDR for RI and detector
Computing Model
Science Book

Feb. 2023
Mandate for the Einstein Telescope Organization

Sept. 2023
France Joins the ET BGR

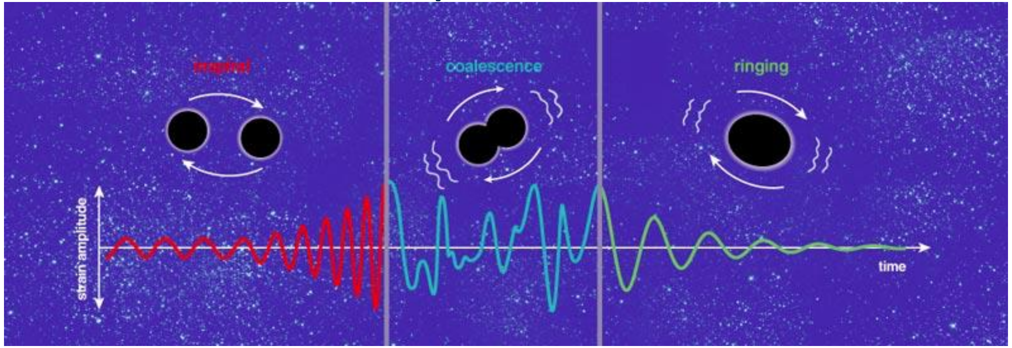
Compact Binary Coalescences in ET



Regimbau, Suresh arXiv:2506.12237

- O(10^5) BBH detections per year
- O(10^4)BNS detections per year among which ~100 with EM counterparts
- Early universe : up to z=100
- High SNR events
- Very long signals (up to minutes or hours): early warning alerts
- Overlapping events

The precision era !



ET with Cosmic Explorer (3G in the US) in a network for multi-messengers astrophysics

ET science program

ASTROPHYSICS

Black hole properties
- origin (stellar vs. primordial)
- evolution, demography

Neutron star properties
- interior structure, equation of state & properties of dense matter, demography

Multi-band and –messenger astronomy
- joint GW/EM observations (GRB, kilonova,…)
- multiband GW detection (LISA)
- neutrinos

Detection of new astrophysical sources
- core collapse supernovae
- isolated neutron stars (Radio, X, g and GW, FRB, …)
- stochastic background of astrophysical origin

FUNDAMENTAL PHYSICS AND COSMOLOGY

The nature of compact objects
- near-horizon physics, tests of no-hair theorem
- exotic compact objects, phase transition in dense matter

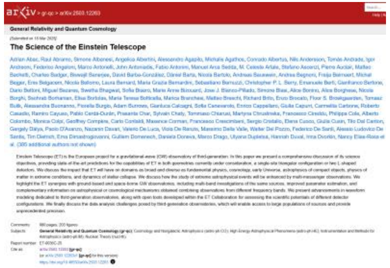
Tests of General Relativity
- post-Newtonian expansion, strong field regime

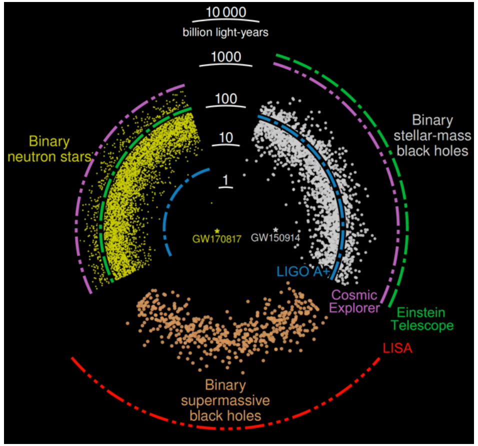
Dark matter
- primordial BHs
- axions, dark matter accreting on compact objects

Dark energy and modifications of gravity on cosmological scales
- dark energy equation of state,
- modified GW propagation

Stochastic backgrounds of cosmological origin inflation, phase transitions, cosmic strings

March 2025: ET blue book publication
https://arxiv.org/abs/2503.12263
Accepted by JCAP
880 pages document


General Relativity and Quantum Cosmology
The Science of the Einstein Telescope

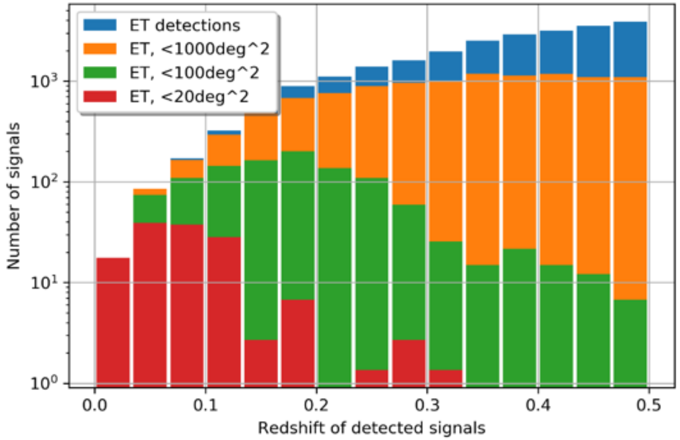


The “unexpected” ?

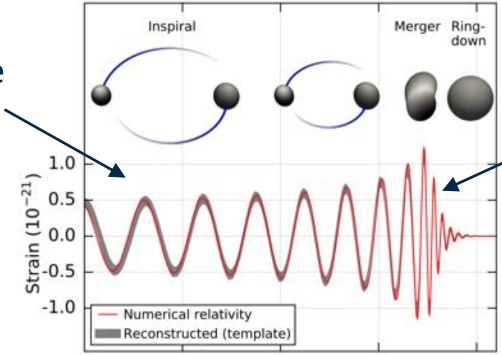
The discovery of GWs has opened a new avenue for the observation and study of the Universe: booming scientific field !

ET sensitivity

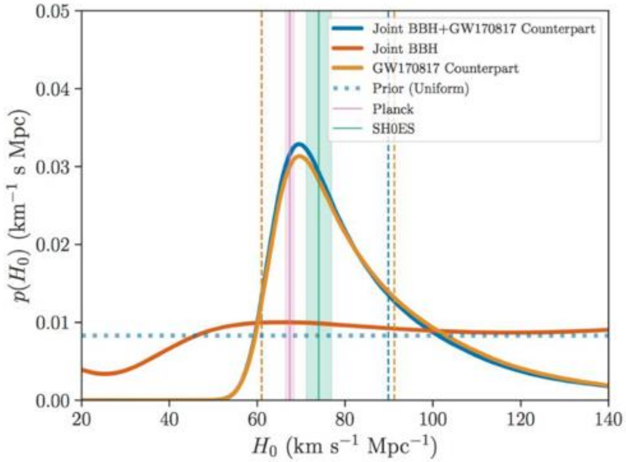
- **BNS detection with EM counterparts and localization precision < 20 deg²** : o(10-100) per year
- Overlap with many BBH signals
- Potentially, very long signals
- ET will be able to provide alerts few hours before the merger



Identify early the inspiral …



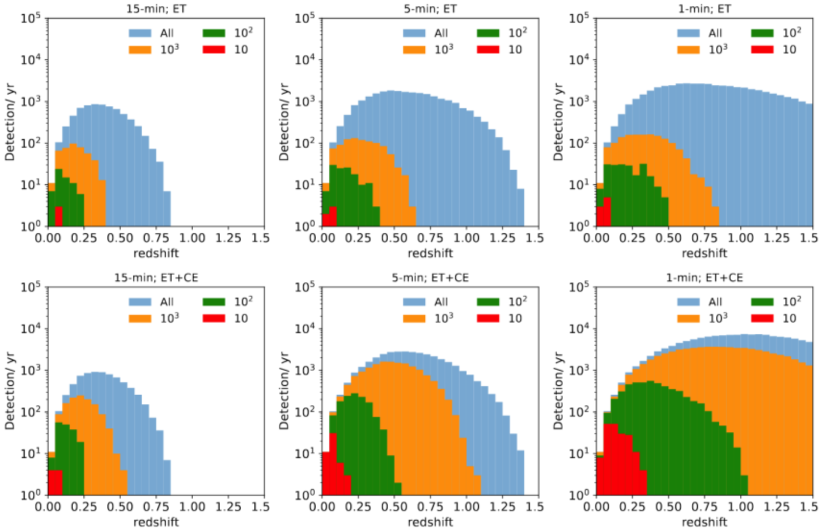
… and provide alert before the merger phase

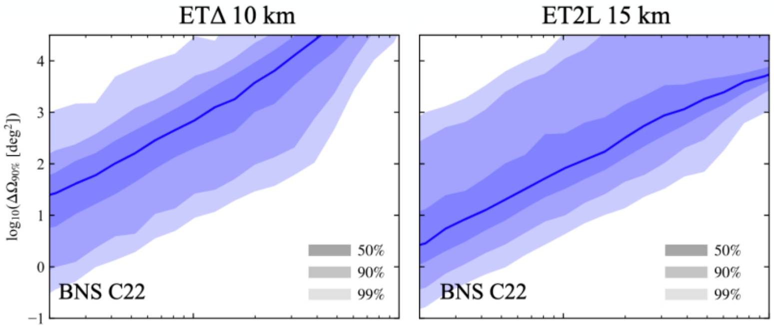


- And with ~500 BNS-EM detection, we can reach Planck resolution on H_0 measurement

Multi-messenger astrophysics

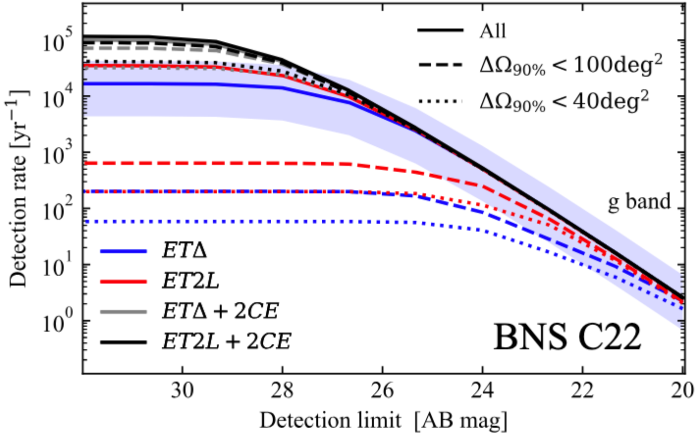
@Susanna Vergani





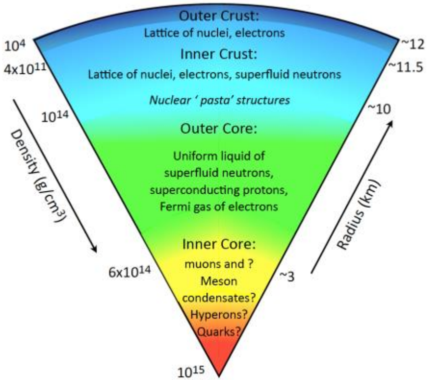
- MM astrophysics : A new way to explore the Universe
- Large numbers of events over a large volume
- Faint EM counterparts, large error regions and comoving volumes
- Rapid pointing capability
- EM fundamental to have a complete GW parameter estimation

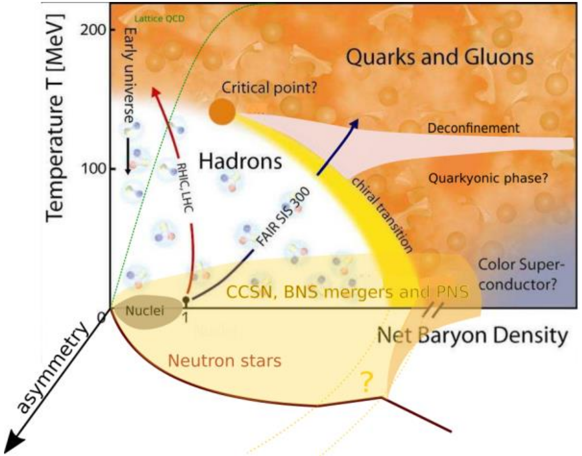
Kilonova detection rate



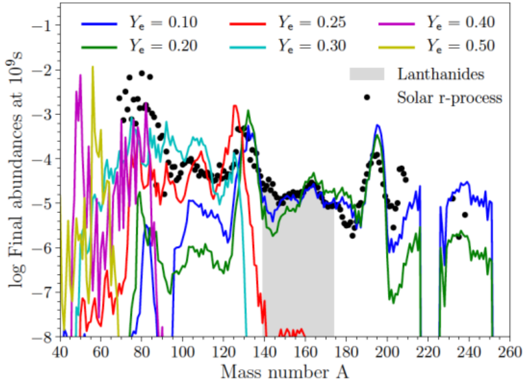
Neutron star equation of state

@Micaela Oertel





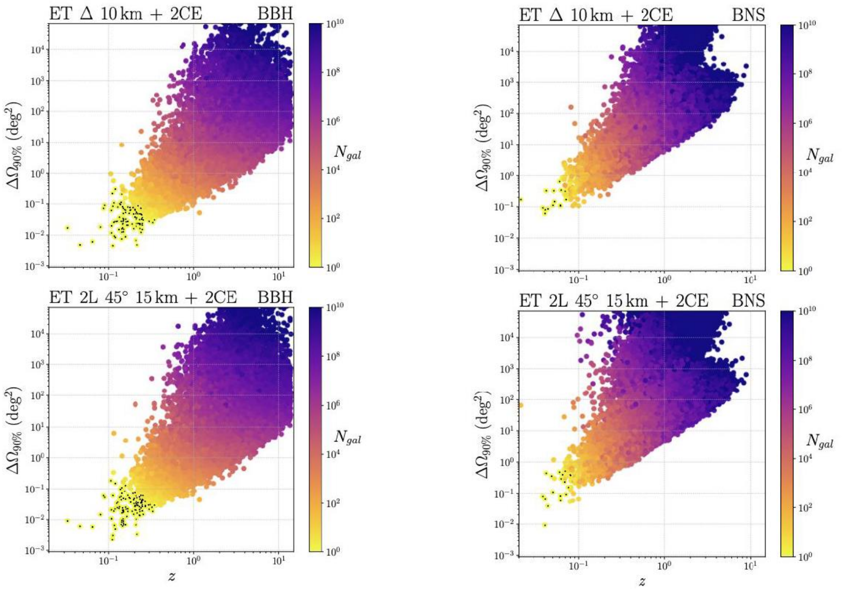
- Inspiral : NS EoS can be determined very precisely with 3rd generation detectors
- But : no information a priori about composition in absence of a phase transition
- During inspiral, a strong PT with a low density onset probably detectable, high density onset masked
- Post-merger : characteristic imprint of PT in dominant oscillation frequency



@Nicola Tamanini

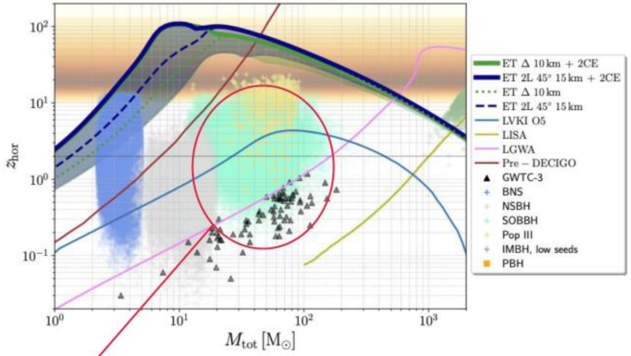
From OSB Div 5 Blue Book chapter

BBHs

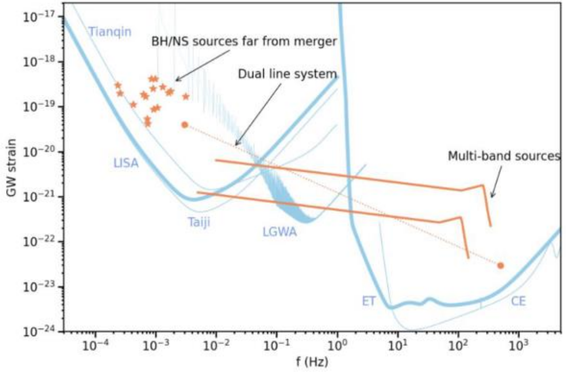


BNSs

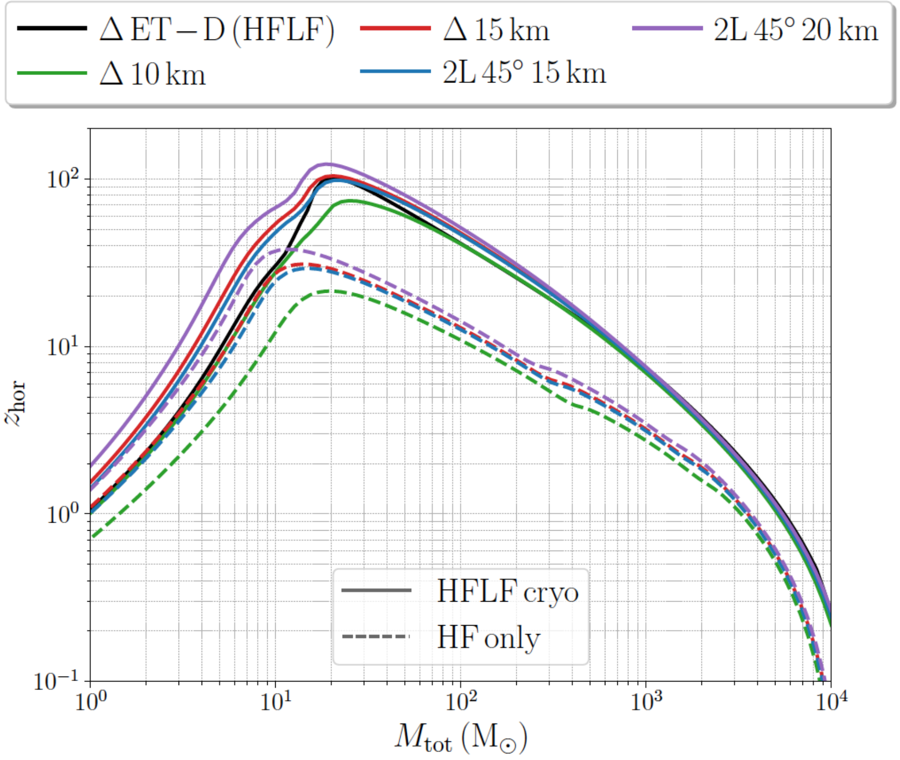
Synergy with CE essential for sky-localisation (cosmology, …)



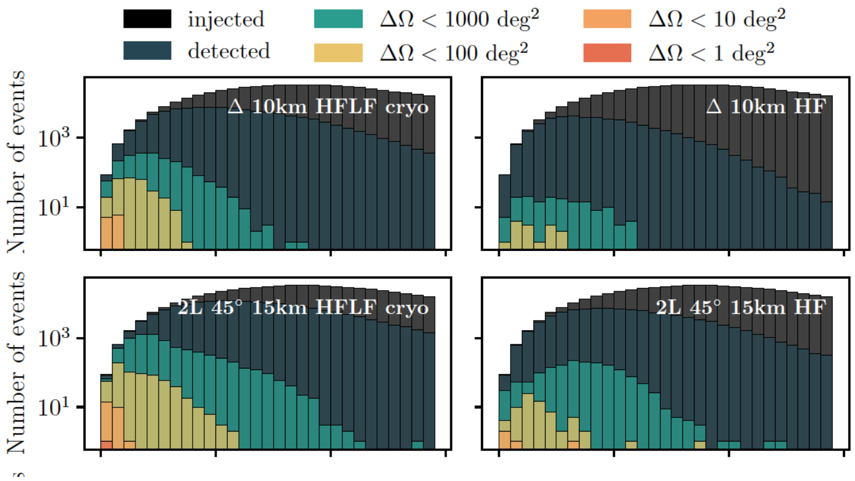
Stellar-mass BBHs synergies with LGWA, DECIGO, LISA, …



Stellar-mass BBHs synergies with LGWA, DECIGO, LISA, …



Redshift distribution of the uncertainty on sky-localization of BNSs at different cuts

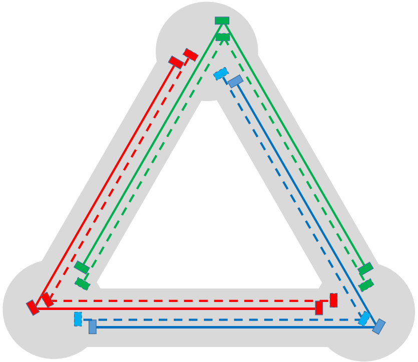


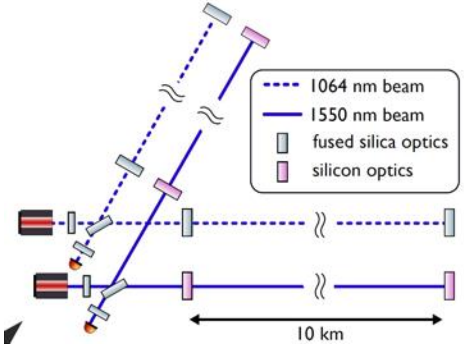
1 year of data taking including duty cycle

Interferometers, optical design and geometry

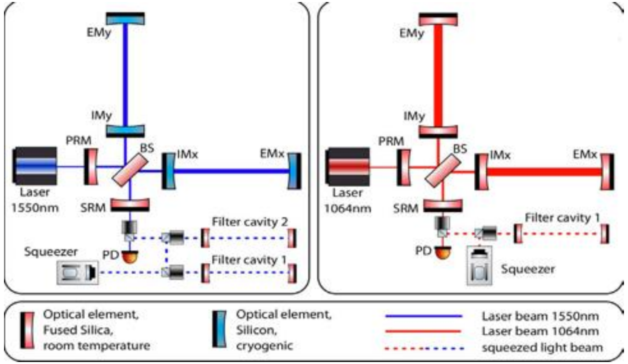
Xylophone design: 2 sensitive interferometers at different frequencies

ET-HF: LIGO-Virgo-like with huge technology improvement
ET-LF: new kind of interferometer – especially : cryogenic, new laser wavelength, new mirror substrate (silicon or sapphire)





4 or 6 interferometers depending on the geometry: L or triangle

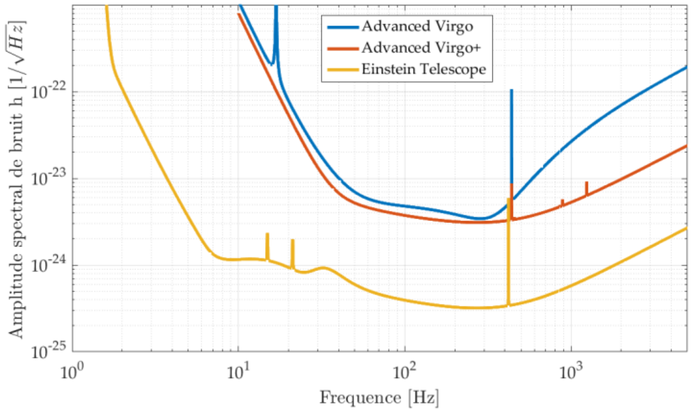


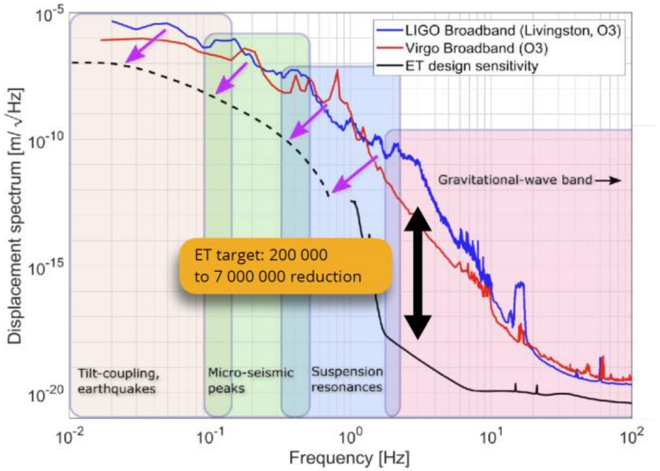
Parameter	ET-HF	ET-LF
Arm length	10 km	10 km
Input power (after IMC)	500 W	3 W
Arm power	3 MW	18 kW
Temperature	290 K	10-20 K
Mirror material	fused silica	silicon
Mirror diameter / thickness	62 cm / 30 cm	45 cm/ 57 cm
Mirror masses	200 kg	211 kg
Laser wavelength	1064 nm	1550 nm
SR-phase (rad)	tuned (0.0)	detuned (0.6)
SR transmittance	10 %	20 %
Quantum noise suppression	freq. dep. squeez.	freq. dep. squeez.
Filter cavities	1×300 m	2×1.0 km
Squeezing level	10 dB (effective)	10 dB (effective)
Beam shape	TEM_{00}	TEM_{00}
Beam radius	12.0 cm	9 cm
Scatter loss per surface	37 ppm	37 ppm
Seismic isolation	SA, 8 m tall	mod SA, 17 m tall
Seismic (for $f > 1$ Hz)	$5 \cdot 10^{-10}\,\mathrm{m}/f^2$	$5 \cdot 10^{-10}\,\mathrm{m}/f^2$
Gravity gradient subtraction	none	factor of a few

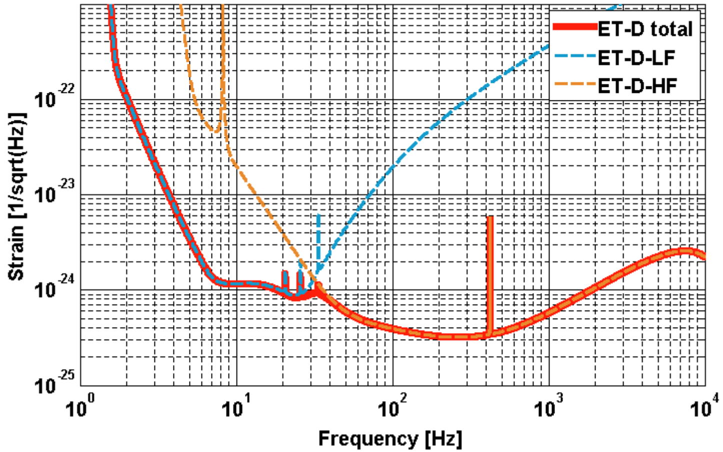
ET Sensitivity

- Improve the sensitivity by a factor 10 compared to LVK
- Dramatic improvement (10^6) in the 2-30 Hz band with ET-LF

A rich and ambitious R&D program to develop the technologies needed for ET-HF and ET-LF

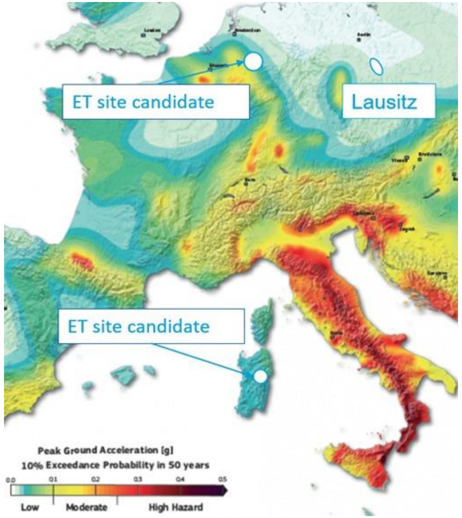






Site(s) and geometry

- **Three candidate sites** candidates to host ET: **EMR**, **Sardignia**, and **Lusastia**
  - Italy and the Netherlands have pledged to cover nearly half of the cost if their proposed sites are selected
  - Important budget in Italy (50M€), The Netherlands (42M€), and Germany(~90M€) to support **site characterizations** (boreholes, seismometer, environmental studies), **civil engineering studies** (tunnels and caverns), **Instrumental &D and physics studies**
  - **All 3 are underground :**
    - **Seismic noise attenuates with depth**
    - **Newtonian noise is less significant and NN cancelation system can be developed to reach sensitivity below 10 Hz**



- **Geometry:**
  - Studies of physics potential has led to two geometry possibilities which are jointly evaluated: "2L 15 km" is generally better (45° orientation) and less risky than the triangle
  - Site Selection Criteria Committee will provide recommendations to BGR in 2026

Decisions on site and geometry are expect in 2026-2027

Project Office & Engineering Dpt

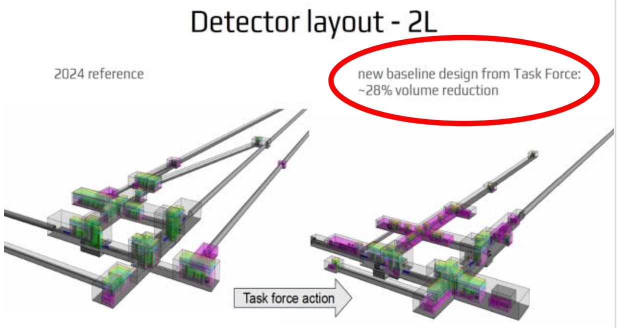
CNRS took important responsibilities in the ET-Preparatory Phase project (Infradev 2023-2026)
https://etpp.ifae.es/

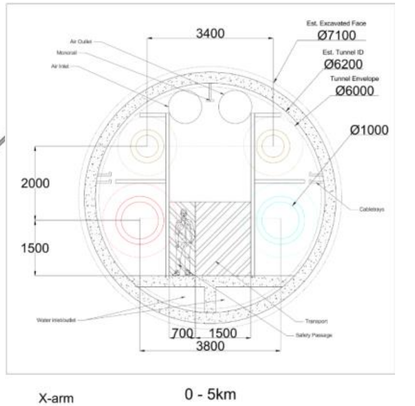
- Setting up the Project Office: Risk management, PBS database, schedule & configuration management
- Vacuum pipe design with CERN
- ET-LF Tower Design

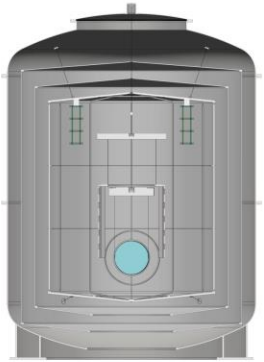
CNRS in-kind contribution ~250 person months

ETO has signed a INFN-Nikhef-CERN MOU and is paying CERN for :

- Vacuum pipe TDR (delivered in 2025)
- Civil Engineering
- Technical Infrastructure: HVAC, Electricity, Access & Alarms
- Safety
- Integration







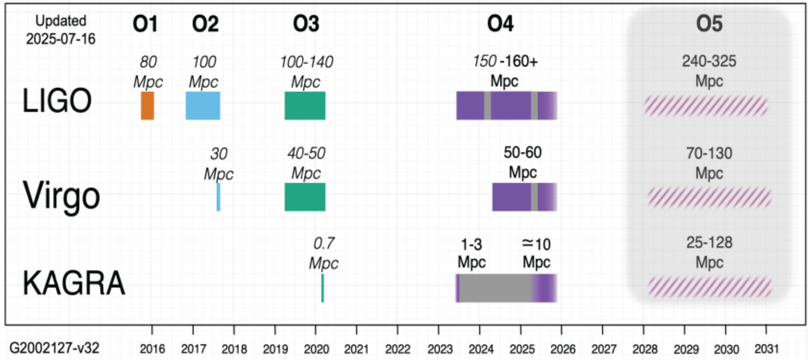
O(100) towers with heights from 13 to 18 m

Vacuum pipe – full pilot sector at CERN

120 km of 1m diameter vacuum pipes

Timeline : 2G and 3G

Current infrastructures



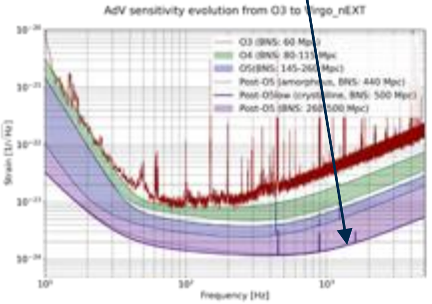
Advanced Virgo+
Advanced LIGO+

LIGO upgrade A#

Virgo_nEXT

KAGRA upgrade

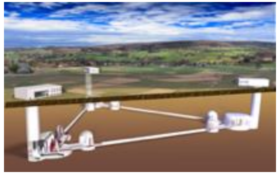
2030's



New infrastructures

Cosmic Explorer

Einstein Telescope



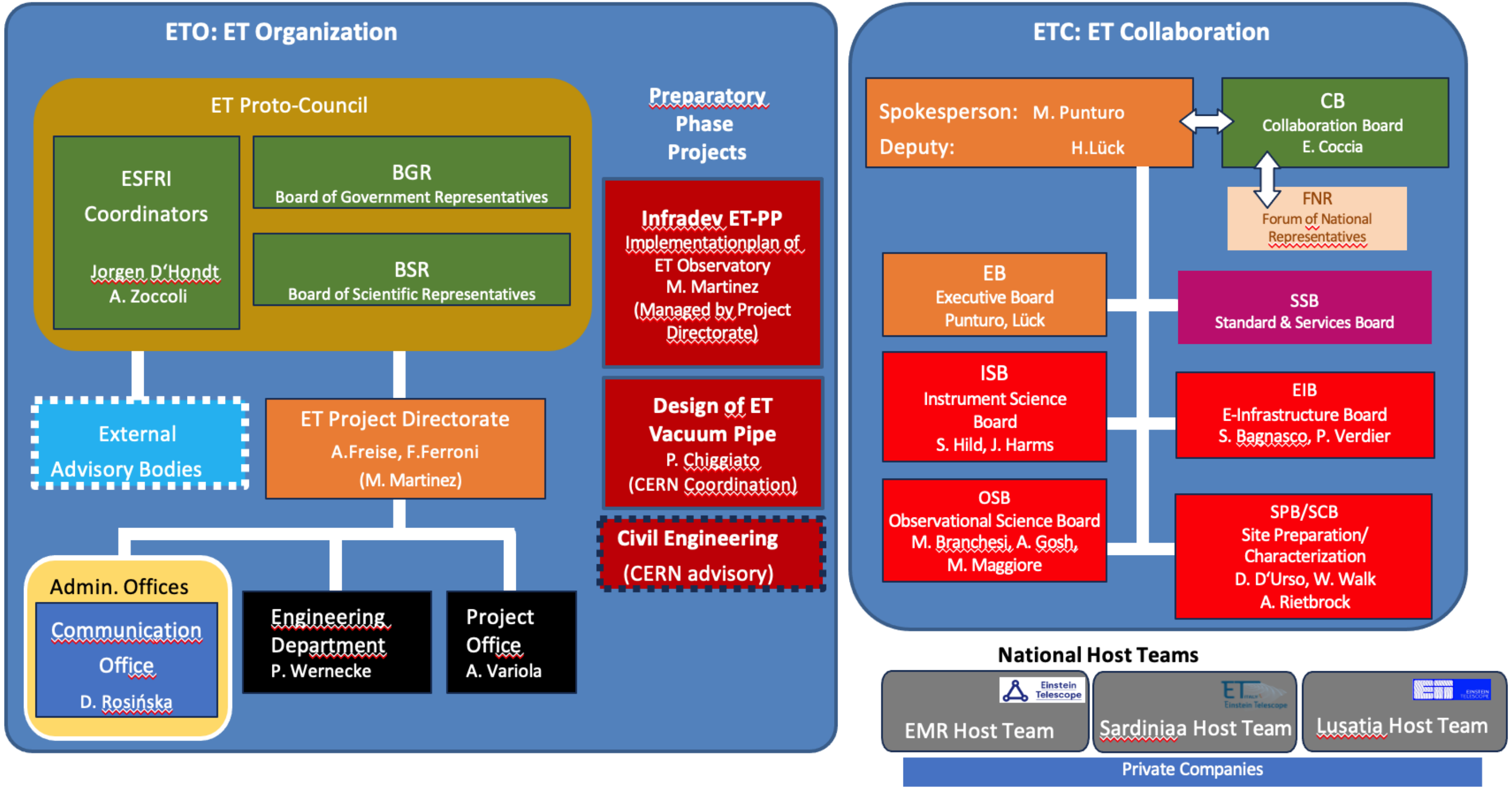
- First light before end of 2030' decade
- Full sensitivity a few years later (TBC)

ET Organization and ET Collaboration

The EU supports the creation of the ET infrastructure (ETO) through the financing of an Infradev project:

Einstein Telescope Preparatory Phase (ET-PP) 2023-2026

The Einstein Telescope Collaboration: 1900 scientists from 271 institutions



Since the summer of 2022, the ET structures are being put in place

French scientists took important responsibilities in ETC

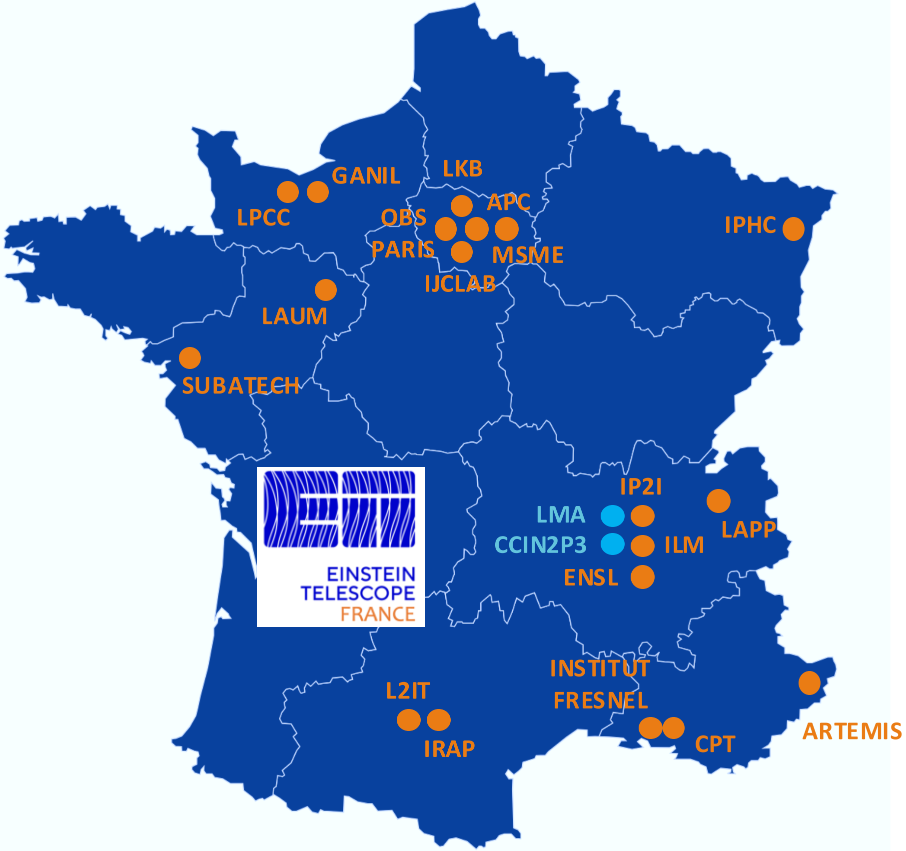
Einstein Telescope France

4 CNRS Institutes: IN2P3, INP, INSIS, INSU

ET-France web site: https://et-france.in2p3.fr

154 French collaborators officially joined the ET Collaboration
(~2/3 are also members of Virgo)

Organized in **8 Research Units** :
FTE threshold to get 1 voting voice at the ET Collaboration Board



R&Ds – ongoing and in preparation

In 2024, CNRS teams have elaborated a preliminary R&D roadmap for ground based GW interferometers : in common for Virgo and ET

Vacuum Tubes

- Approx. 120-130 km of ~1m diameter vacuum tubes
- 120,000 m^3 of vacuum (2000 m3 LHC at CERN for comparison) - ~100 vacuum revolutions
- Expected pressure < 10^{-10} mbar
- Many associated components: pumps, sensors, valves, etc
- Creation of a vacuum tube prototype – LAPP/IJCLab

Squeezing/Quantum Technology

- Quantum noise reduction through high-frequency squeezing -> Virgo/LIGO 3dB for 03, improvement in progress for 04
- 10dB expected for and Developments, Demonstrations, Improvements of Frequency-Dependent Vacuum Squeezing Sources – APC/IJCLab

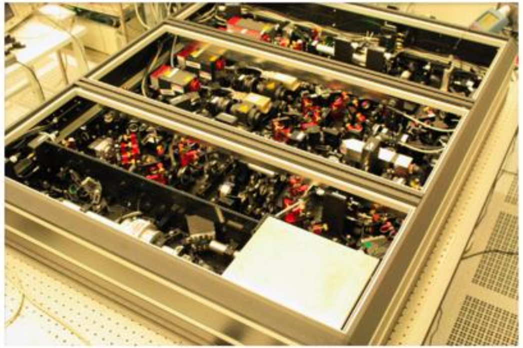
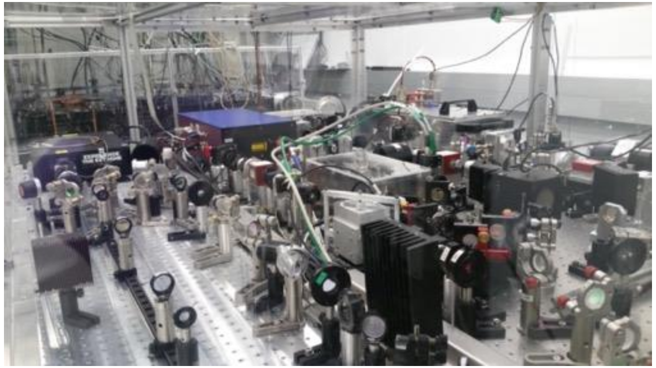


Photo: AEI/GEO600

Mirrors: Coatings and Substrates

- Large mirrors with extreme optical properties
- Thin-film coatings with low optical and mechanical losses
- Lack of diffusion and absorption points
- New Technology: Crystalline Coatings— LAPP/LMA/CEA LETI/LAAS
- Improvement of amorphous coatings – LMA/ILM
- Studies and development of new crystalline coatings – LAPP/LMA
- Sapphire substrate studies – ILM/IP2I

R&Ds – ongoing and in preparation

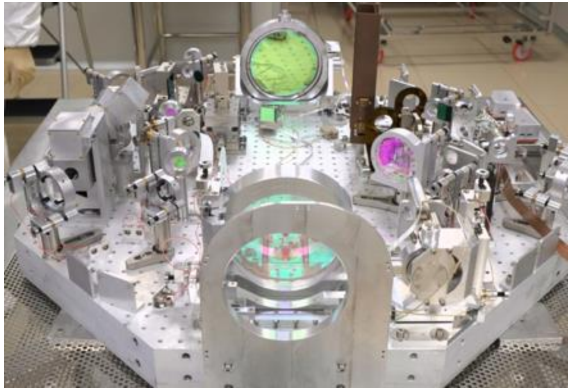


High Power Laser

- Two wavelengths: 1064 nm and 1550 nm
- Ultra-stable continuous lasers – amplified up to ~ hundred W
- Bandwidth <1 kHz and stabilization at ~mHz
- Low noise of RIN intensity
- Low phase noise
    - High-power, ultra-stable laser R&D developments – ARTEMIS

Auxiliary optics: telescopes, mode-cleaner

- Telescopes, mode-cleaner (among others) – ultra-stable optics, motorized mounts
- Associated Opto-Mechanics
- Adaptive Optics
- Thermal compensation
    - Optical and mechanical developments, simulations, design, realization – APC/L2IT/LAPP
    - Development of a suspended bench for optical and mechanical tests – LAPP



Electronics – real-time

- Several thousand sensors, actuators, controllers
- Need for electronic developments
    - Real-time electronics – specific developments – LAPP/IP2I
    - White Rabbit Upgrade – IJCLab

R&Ds – ongoing and in preparation

Stray Light

- Limiting Factor of Gravitational Wave Detectors
    - Development of tools for more accurate calculations – measurements and control - Institut Fresnel/APC

Optical Simulations

- Need to understand, control and improve gravitational wave detectors
- Implement reliable and robust simulation tools
- Linear simulations: studying linear effects, opto-mechanical effects, the impact of high power
- Time-domain simulations to study control noise
    - 3D simulation
    - The French community is being set up in this area – APC/L2IT/LMA/LAPP

Other aspects under study:

- Sizing of Cryogenic Ultra Vacuum Towers (IJCLab)
- Calibration (LAPP/IPHC)
- Acoustics (LAUM)

New developments not studied for Virgo (Virgo_nEXT) or LIGO, to be prepared for ET:

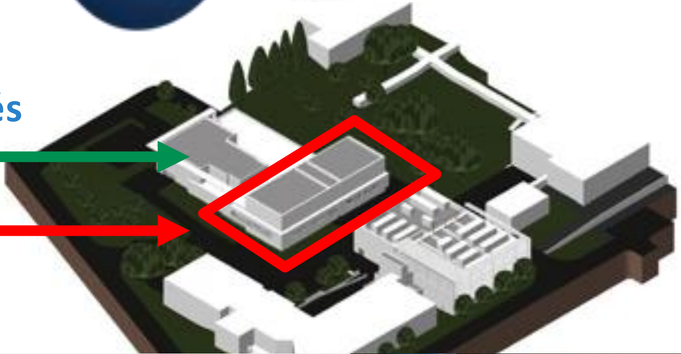
- Cryogenics – R&Ds in preparation (IJCLab/APC)
- 1550 nm
- Machine Learning / AI / High Parallel Computing: Analyses & Detectors

Extension of the LMA in Lyon

Laboratoire des Matériaux Avancés

Current

Extension



Contrat de Plan Etat-Région 2021-2027

An investment for:

- the extension of the LMA building
- the construction of a new coater allowing the deposition of thin films on very large substrates: Ø 1.6 m, 600 kg
- associated optical and metrology tools

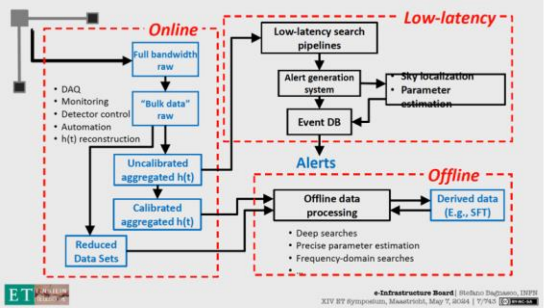
LMA is a research infrastructure unique in the world: coating of Virgo-LIGO-KAGRA large mirrors

Developing technologies for future experiments e.g. Einstein Telescope & Cosmic Explorer

E-Infrastructure

ET will use a **distributed computing infrastructure** in Europe, based largely on existing infrastructures such as CC-IN2P3 in France : ET = ~10% of an LHC exp. at CERN.

CC-IN2P3



Increasing use of **high-performance parallel computing** (HPC) vs HTC computing.

ET active in EuCAIFCon -- European Coalition for AI in Fundamental Physics

Use of tools and services developed in the framework of the **European Open Science Cloud** and European projects such as ESCAPE for **multi-messenger physics**

Mock-Data-Challenge in progress

ET joined the ESCAPE consortium in 2023 : 2 OSCARs project funded !

ET-PP Deliverables in February 2026

Computing model

Data Access Policy

Sustainability plan

eosc

Industrial partnerships

First meeting organized in March 2023 with MESR to present ET to the French industries interested by this project

=> About 30 companies were present and have shown interest to works with us, either through dedicated/joint R&D program, either as manufacturer of components

Follow-up in Sept. 2023 with a network of French companies (PIGES) involved in Big Sciences

We are following and contributing to ET-PP WP7 dedicated to industrial partnerships => Big Science Business Forum at Trieste in Oct. 2024:

ET was very well represented

Preparing an ET + Industry meeting on Computing (Spring 2026)

Contact: patrice.verdier@in2p3.fr

Einstein Telescope France

by Patrice Verdier on janvier 31, 2023

Organisé **le 23 mars 2023 à l'APC (Paris)** par le CNRS et le service du Ministère de l'Enseignement Supérieur et de la Recherche en charge de la liaison avec les industriels sur les Infrastructures de Recherche, ce premier séminaire a pour objectif de réunir scientifiques du monde académique et industriels en France. Pour préparer la contribution française à ce projet Européen, nous invitons les partenaires industriels qui aimeraient s'informer Einstein Telescope et éventuellement se joindre à nous dans ce défi.

Informations et inscriptions sur:

https://indico.in2p3.fr/event/28704/

https://indico.in2p3.fr/event/28704

PIGES

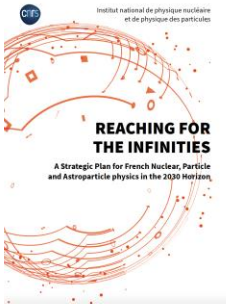
https://www.piges.eu

https://www.bsbf2024.org

Prospectives for 3rd Gen. GW detection

The ET project entered the ESFRI roadmap in 2021

ET received a good evaluation for the 2026 update



ET is a strong priority in the French strategic plan for Nuclear, Particle, and astroparticle physics (2021)

« Participate in the 3G GW interferometer development guided by the leveraging of French Virgo expertise and facilities. »

Conseil Scientifique de l'IN2P3 (2023)

"ce qui conduit le Conseil à recommander, … , de contribuer à Virgo_nEXT prioritairement sur les sujets qui permettront aux équipes de se préparer et de se positionner au mieux dans ET. De plus, l'expertise des laboratoires français pourrait apporter un avantage significatif pour les développements technologiques nécessaires entre autres à ET-LF. Ainsi, la perspective des avantages de ET sur Cosmic Explorer pourrait contribuer à attirer plus de (jeunes) scientifiques dans le projet."

- Almost 40% of survey **answers mentioning gravitational-waves**
- **Einstein Telescope** is the most cited experiment, followed by LISA and Virgo

- *Based on the survey, **ET stands out as the most indicated next-generation infrastructure to be included in the roadmap**.*
- *It is of interest not only to the GW community but also to a **broader range of astroparticle scientists***

Conclusion

Einstein Telescope is a very ambitious project for the late 2030s :

- Allowing a rich physics program with **high discovery potential**
- Included in a **3G GW detection network** together with neutrino and EM telescope detectors **for multi-messengers studies of the Universe**
- Increased synergies between the astroparticle, astrophysics and geophysics communities
- R&D roadmap in preparation between European Funding Agencies

There are important synergies between Einstein Telescope, existing 2G detectors (LIGO-Virgo-KAGRA) and other future detectors (Cosmic Explorer): CNRS teams and laboratories have acquired essential knowledge and skills in EGO-Virgo and LVK:

- Building on Virgo to prepare ET-HF
- Building especially on ET-Pathfinder (Maastricht) and KAGRA to prepare ET-LF

2026 will be end of the ET Preparatory-Phase:

Preparing all documentation (including governance & financial model, socio-economic

to allow a wise site-decision and proceed to the next stage of the project

Discussion

Question: Pros and cons des différentes géométries et des différents sites : ET France a-t-il une préférence ?

Plusieurs études ont eu lieu et sont en cours sur la questions des différentes géométries pour ET:

- En 2024, l'analyse COBA a fait émerger 2 scénarios: 2L de 15 km vs 1 triangle de 10km
- Un « rapport sur la géometrie » est en préparation dans ET et sera rendu au BGR dans l'année qui vient
- A ce jour, les études de caractérisation des 3 sites n'ont pas montré d'éléments bloquants pour accueillir ET

2L 15km

Pros

- **Bras des ITFs plus longs : meilleure sensibilité**
- Meilleure sensibilité pour les CBCs, bursts et physique multi-messagers
- Possibilité d'allonger les cavités de filtrages de squeezing LF
- Meilleure localisation avec CE grâce au bras de levier entre les ITFs

Cons

- 7% de volume d'excavation en plus et coûts de construction et de fonctionnement plus importants
- Besoin d'un autre ITF dans le monde pour la localisation

Triangle 10km

Pros

- Meilleure sensibilité pour le fond stocchastique
- Utilisation du null stream pour l'estimation du bruit de fonds
- Moins de contrainte sur le frequency noise en entrée de l'ITF (bras plus courts)

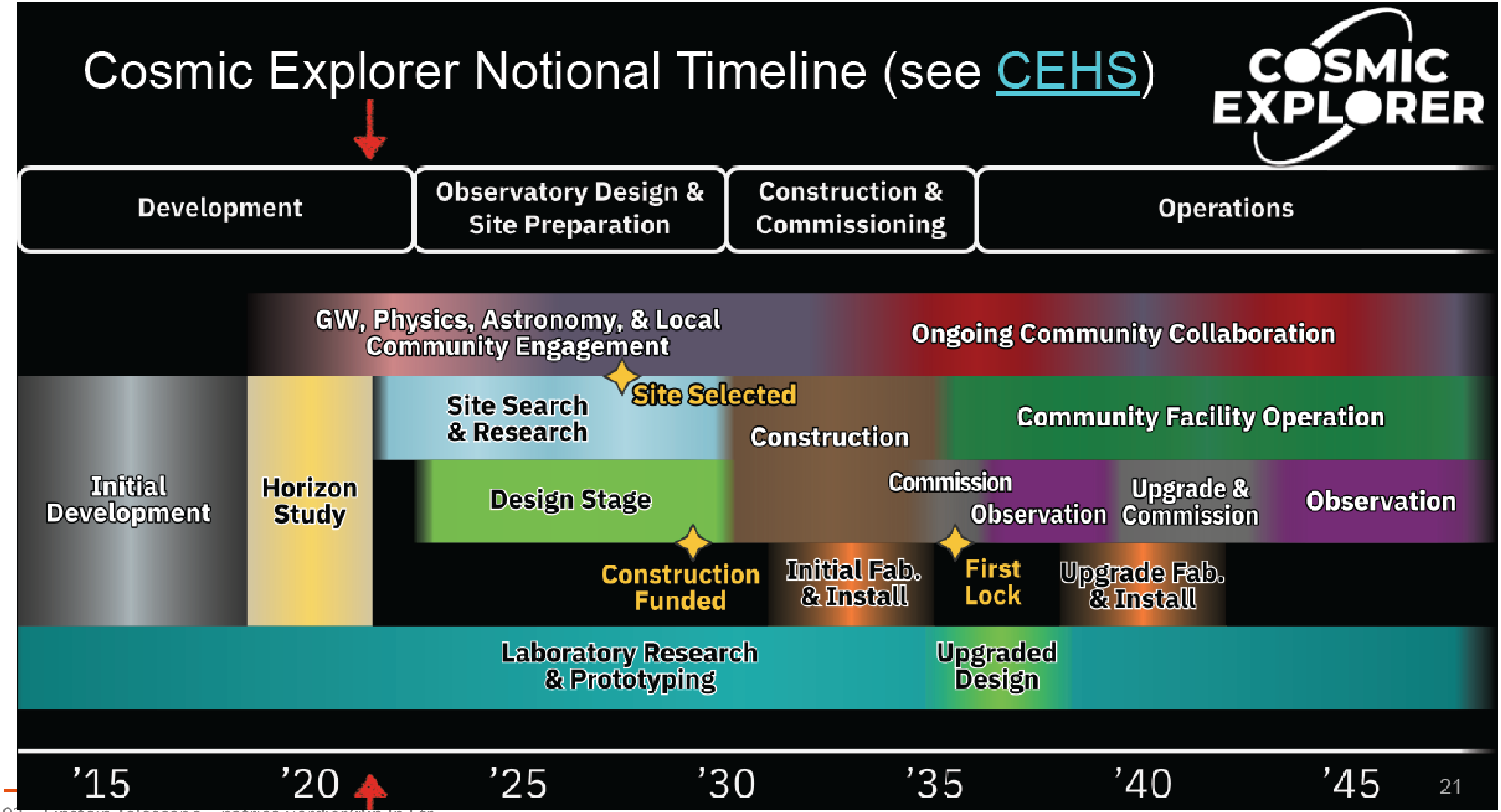
Cons

- **Longueur des bras certainement limitée a 10km**
- Duty cycle des 3 interféromètres pour l'utilisation du null stream
- Fortes contraintes sur l'encombrement des tunnels et cavernes
- Complexité et risques techniques plus importants

Les physiciens francais d'ET soutiennent l'idée qu'ET doit avoir une longueur de bras la plus grande possible

RESERVE

CE Timeline


Cosmic Explorer Notional Timeline (see CEHS)
COSMIC EXPLORER
Development
Observatory Design & Site Preparation
Construction & Commissioning
Operations
GW, Physics, Astronomy, & Local Community Engagement
Ongoing Community Collaboration
Initial Development
Horizon Study
Site Search & Research
Site Selected
Construction
Community Facility Operation
Design Stage
Commission
Observation
Upgrade & Commission
Observation
Construction Funded
Initial Fab. & Install
First Lock
Upgrade Fab. & Install
Laboratory Research & Prototyping
Upgraded Design
'15
'20
'25
'30
'35
'40
'45
21

ET noise budget

HF

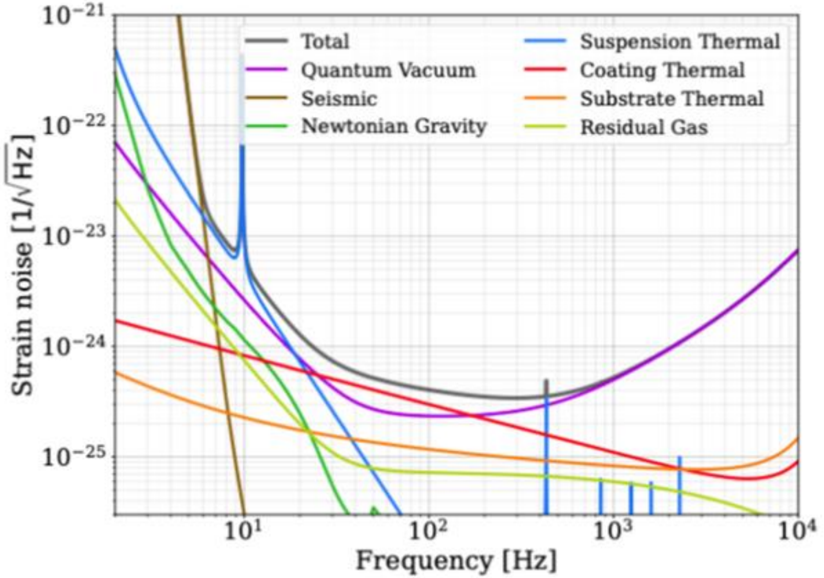


Figure 1: Strain noise budget of the HF detector. Noise traces shown in this figure correspond to a single interferometer with an intersection angle of 90 degrees ("L" shape).

LF

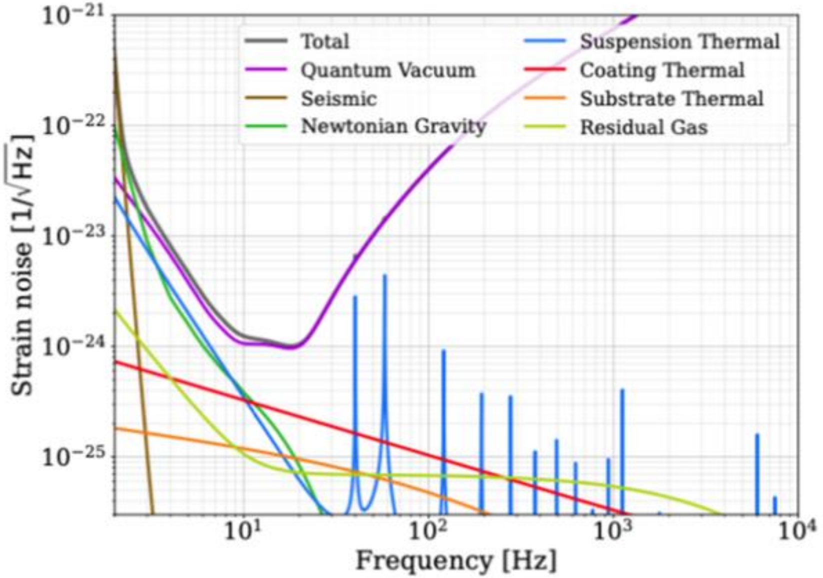
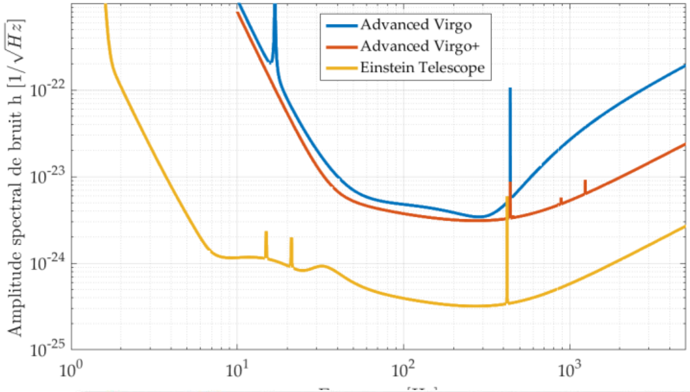
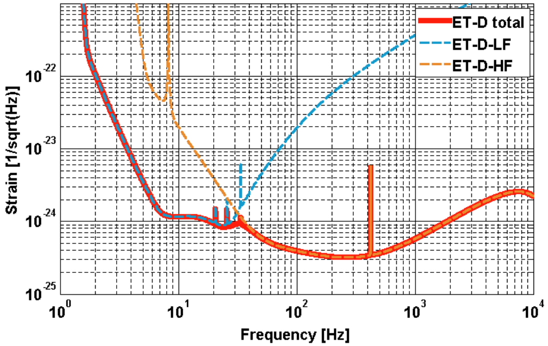
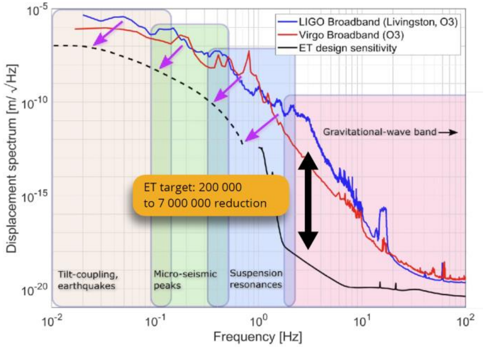


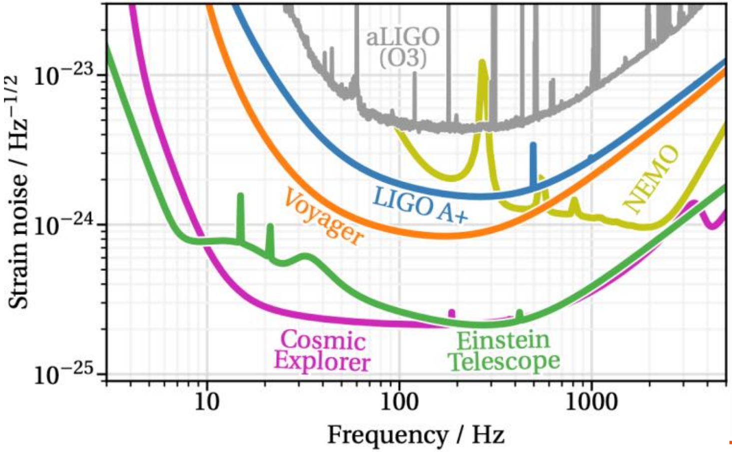
Figure 2: Strain noise budget of the LF detector. Noise traces shown in this figure correspond to a single interferometer with an intersection angle of 90 degrees ("L" shape).

ET Sensitivity

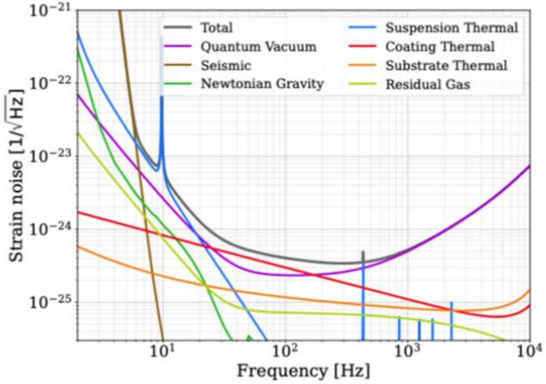




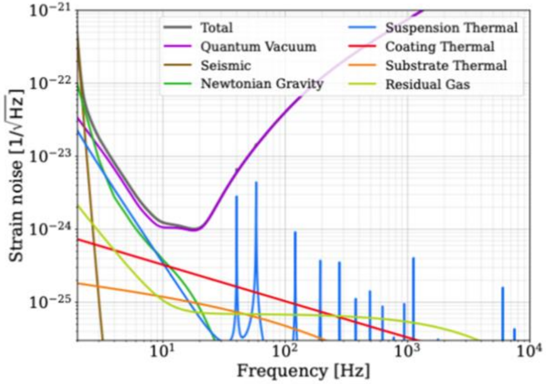




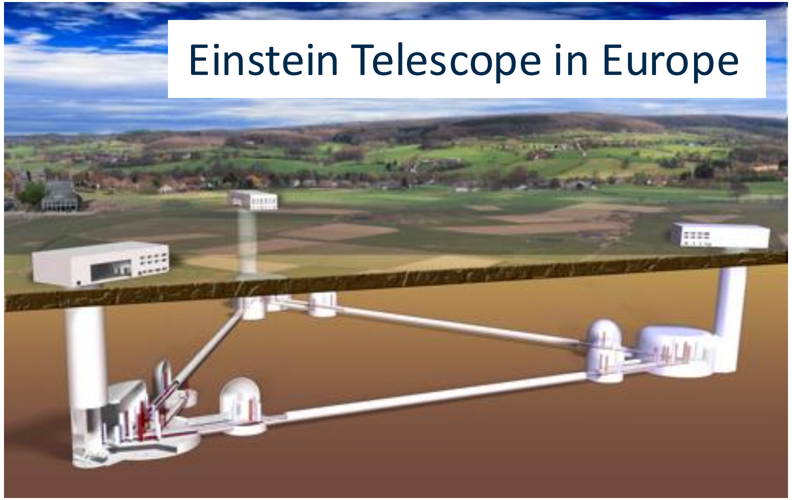
HF

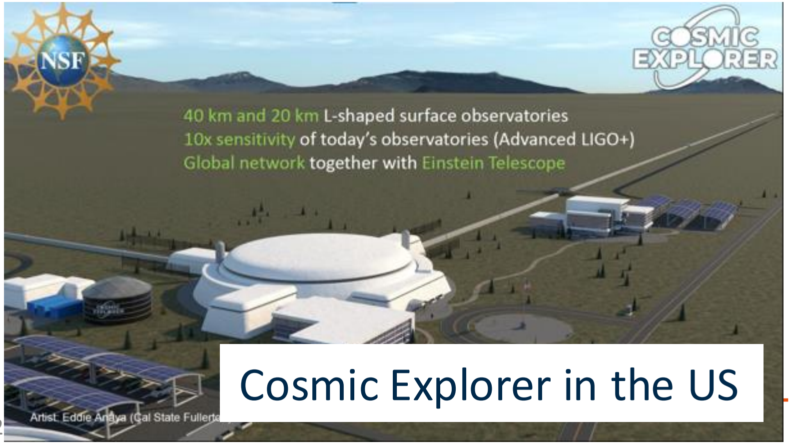


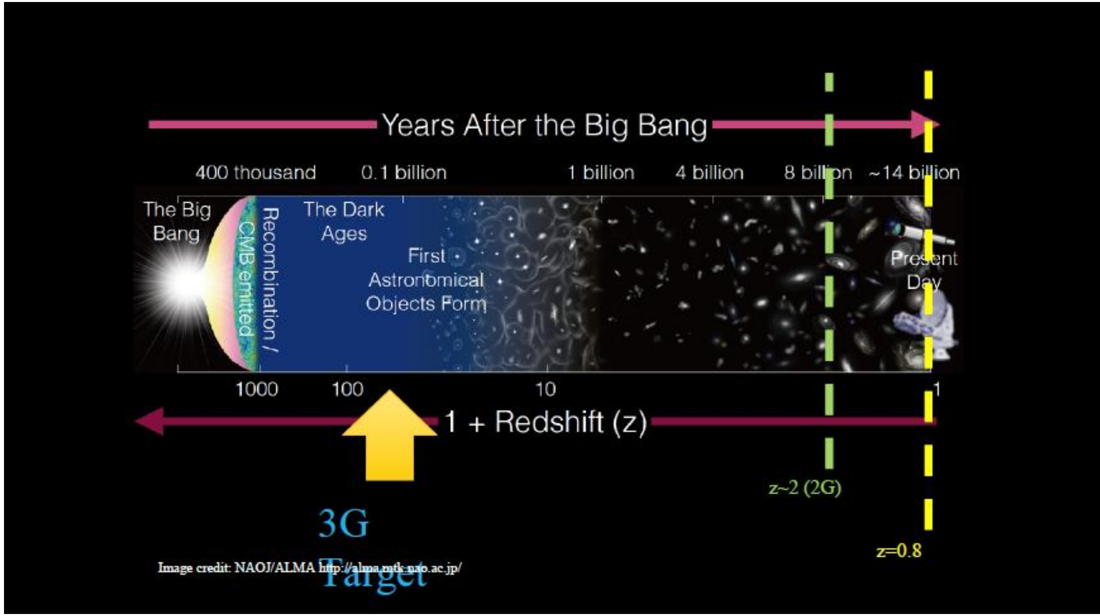
LF



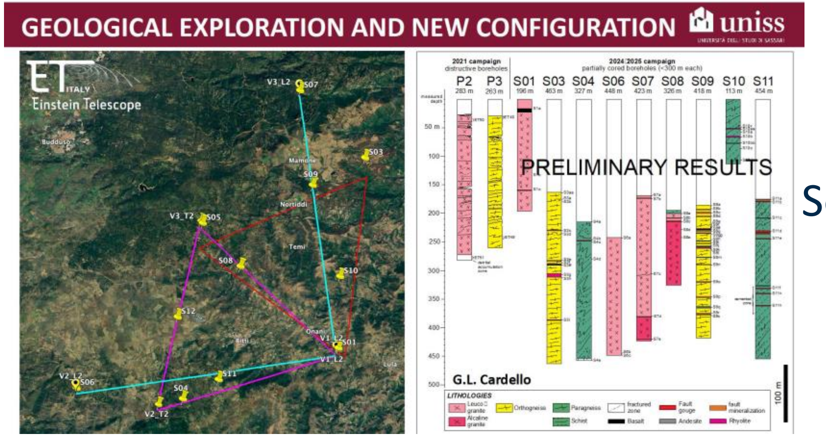
GW detection with 3rd gen. interferometers



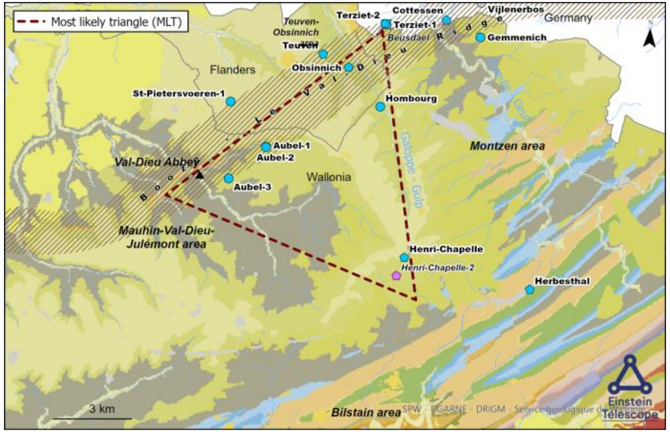




Sites canddiats



Sos Enattos - Sardinia



EMR

Site candidates

There are currently two sites in Europe that are candidates to host ET:

- The Sardinia site, near the Sos Enattos mine
- The EU Regio Rhine-Meuse site, close to the NL-B-D border

[A third option in Saxony in the future ?]

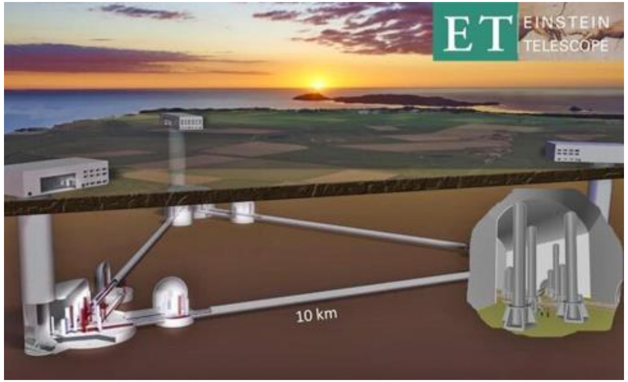
The sites are studied through

- Seismic noise measurements at surface, in boreholes and mines (Sardinia)
- Magnetic and ambient noise measurements
- Geophysical and geotechnical characterizations

Significant funds are required to develop and submit a site application

Site candidates

Sardinia – Italy



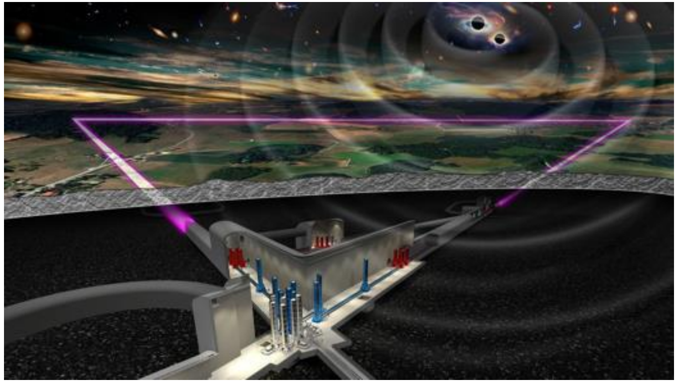
€50 million for R&D and preparatory work

ETIC in Italy

Einstein Telescope Infrastructure Consortium

"Multi-100 M€" financing to support ET's site in Sardinia

Euregio Meuse-Rhin Netherland



€42 million for R&D and preparatory work

ET-Pathfinder in Maastricht

"Multi-100 M€" financing if the ET site is in Euregio Meuse-Rhine

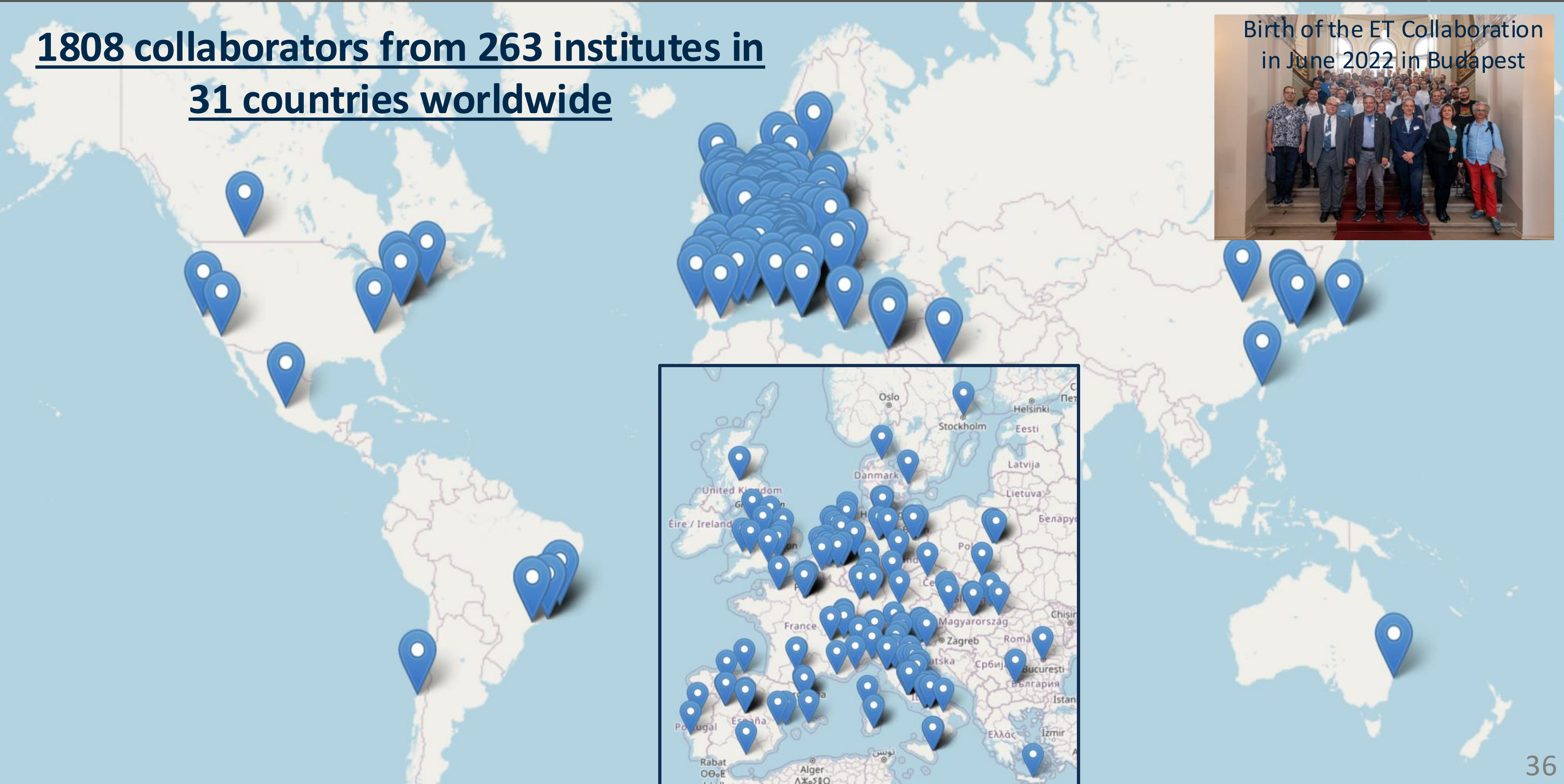
Saxe – Germany

New DZA laboratory (2022)

170 M€/year over 10 years

3 pillars: astrophysics, data science, technology

ET Collaboration



1808 collaborators from 263 institutes in 31 countries worldwide

Birth of the ET Collaboration in June 2022 in Budapest

ET Specific Boards

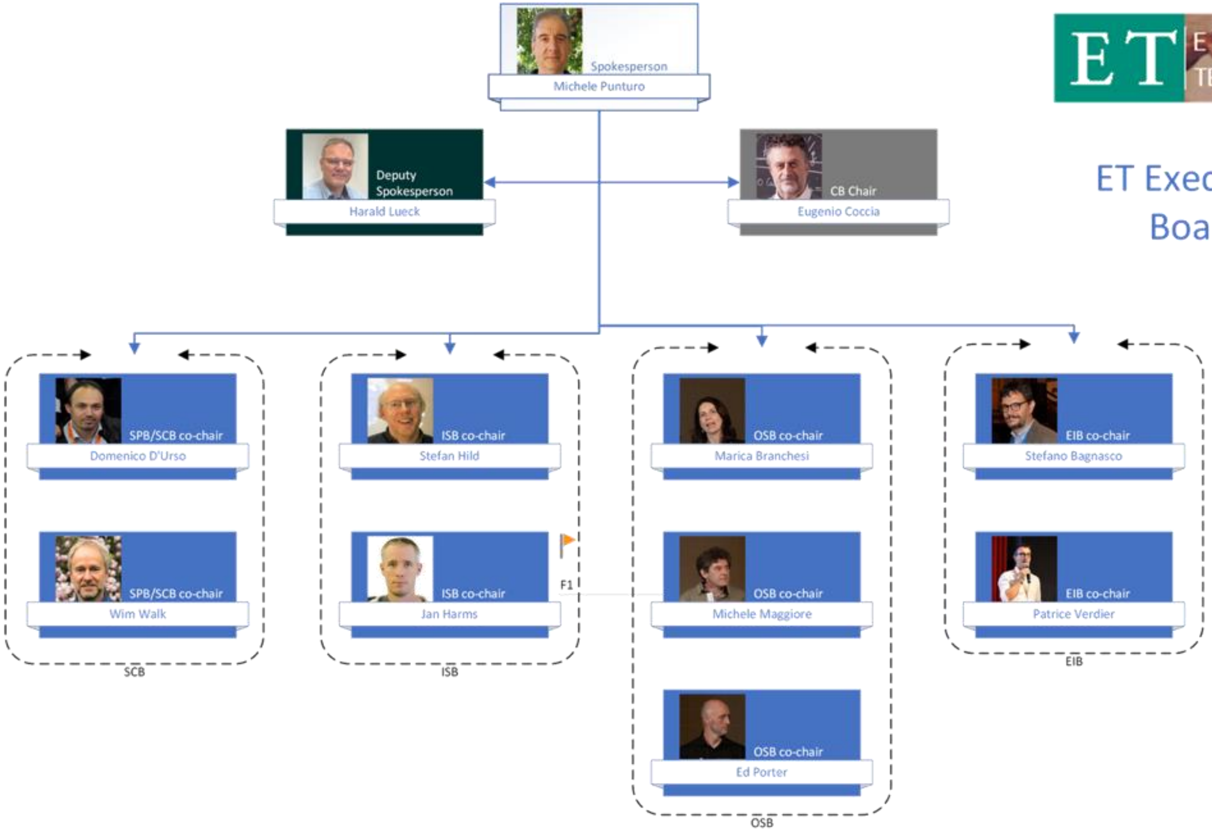
ET Executive Board

Specific Boards

- **SPB** – Site Preparation Board
  - WD1 Physical variables and characterization
  - WD2 Geology
  - WD3 Bidbooks
  - PD management:
    - WD4 Cost timing and risk assessment
    - WD5 Legal and site preservation
    - WD6 Socio-Economic and environmental impact
- **OSB** – Observation Science Board
  - Fundamental Physics
  - Cosmology
  - Population Studies
  - Multimessenger Obs.
  - Synergies with GWDs
  - Nuclear Physics
  - Transient GW Sources
  - Waveforms
  - Scientific potentials ...
  - Data Analysis Platform
- **ISB** – Instrument Science Board
  - Suspensions
  - Optics
  - Interferometer
  - Vacuum and Cryogenics
  - Active Noise Mitigation
- **EIB** – E-Infrastructure Board
  - On-site Infrastructure
  - Distributed infrastructure
  - Software & frameworks

Divisions

The Executive Board

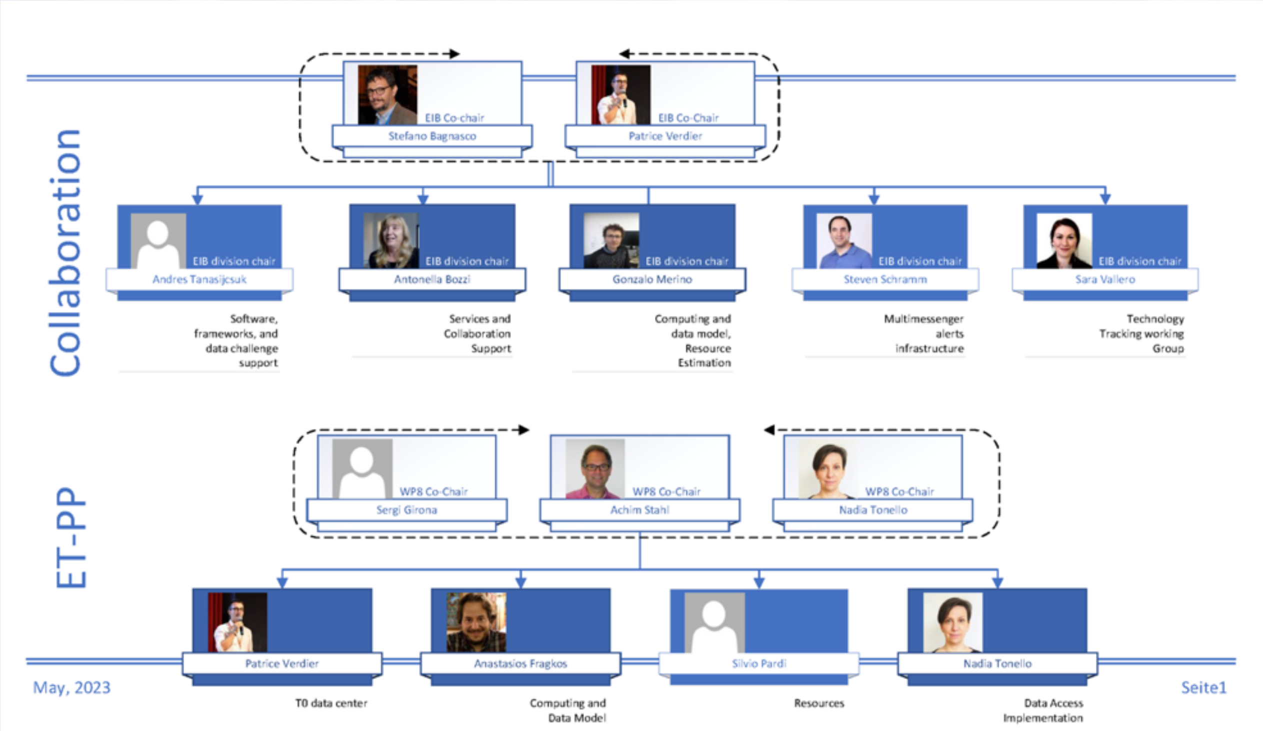


ET Executive Board

The Observational Science Board

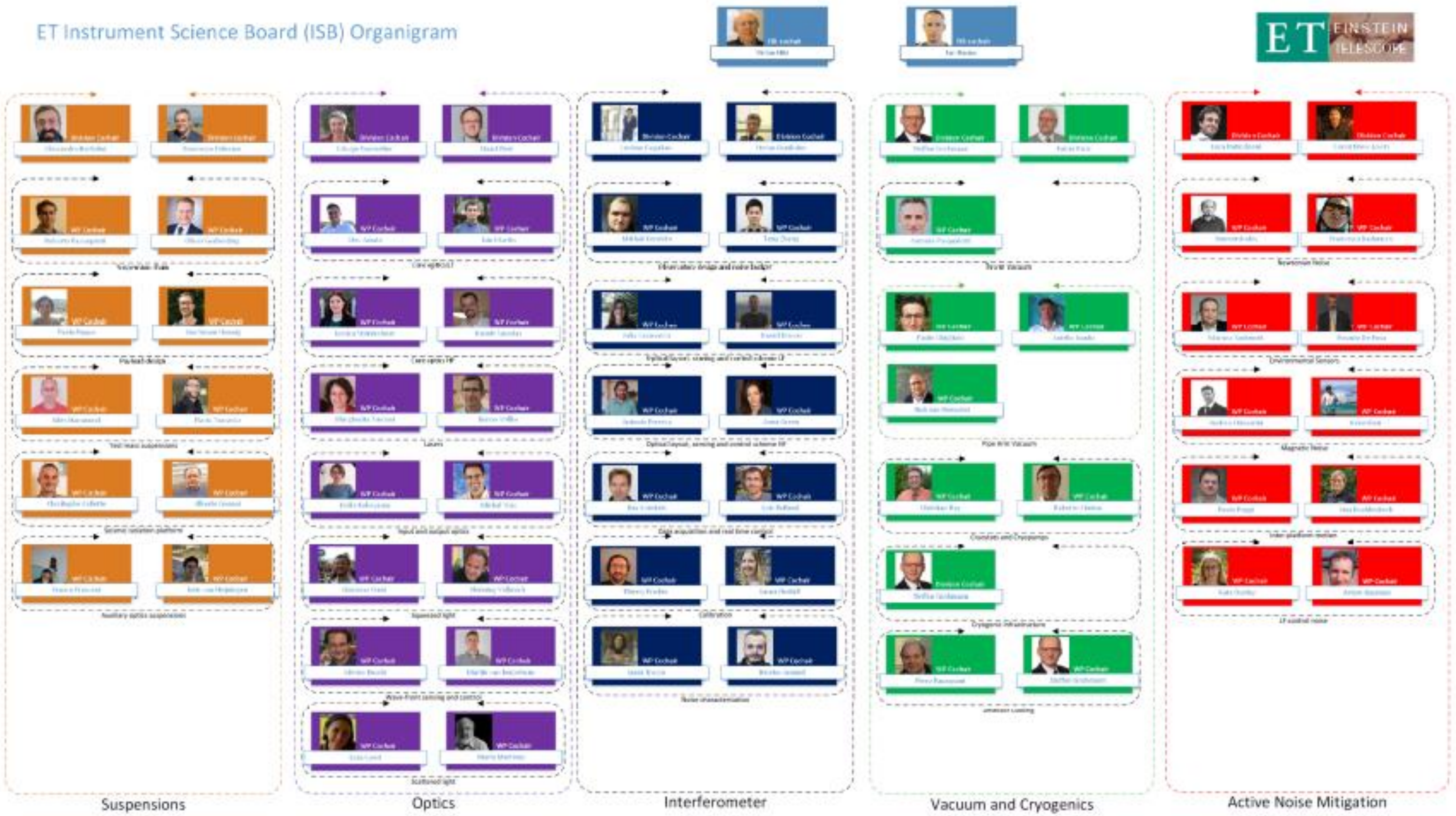
- Targets:
  - Update the ET science case (Blue Book)
  - Address the optimization of the science return of ET
  - Prepare the data analysis in ET
  - Strengthen the collaboration with all the partners in Multimessenger Astronomy

The e-Infrastructures Board



The mandate of the e-Infrastructure board is to design, create and operate an evolving, efficient and functional e-infrastructure environment at a reasonable cost.
Initially the focus is on the development of a Computing Model for the ET.

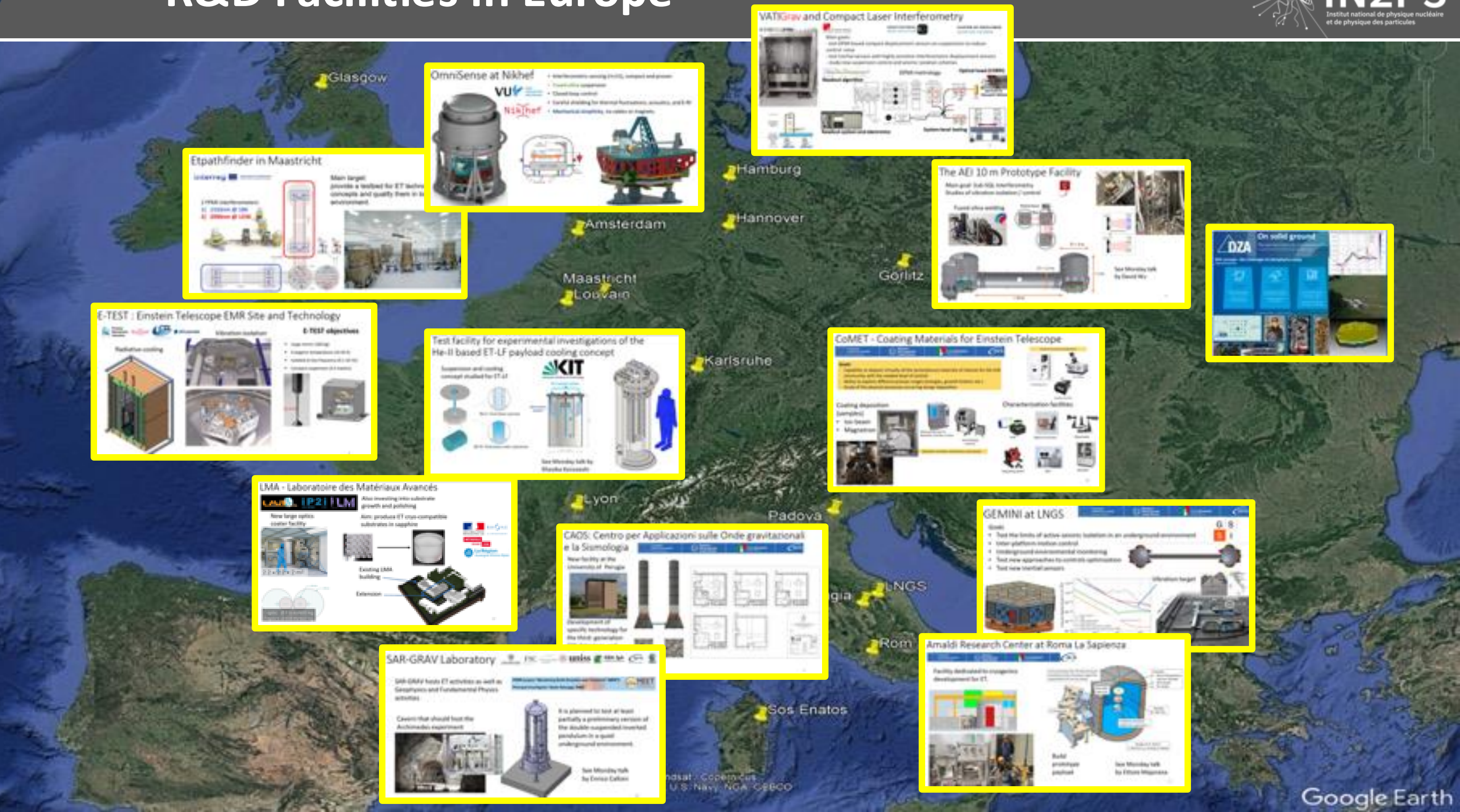
The Instrument Science Board



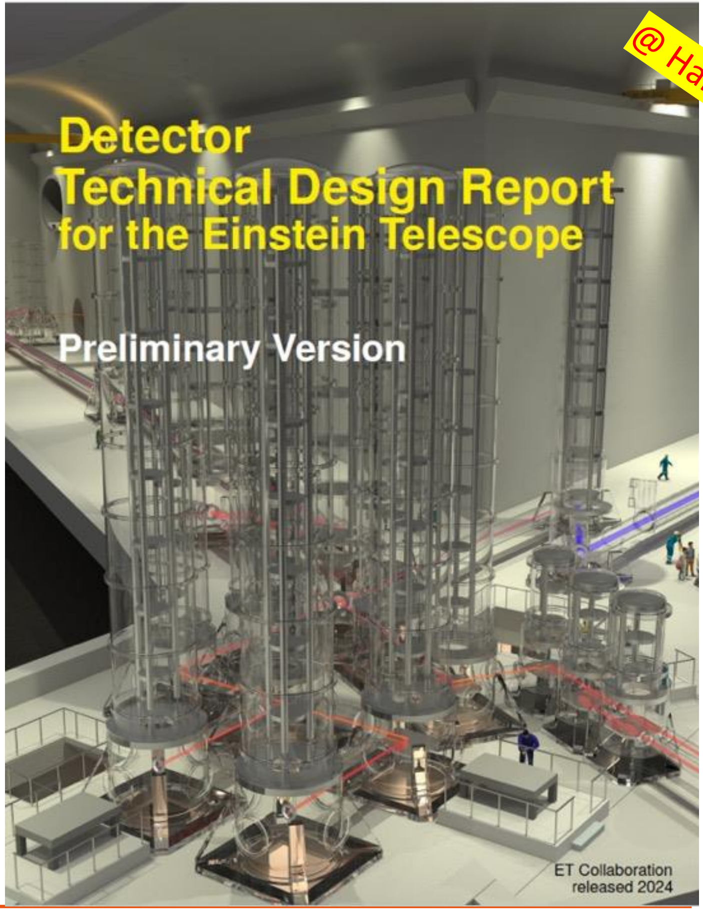
2025.

R&D Facilities in Europe

From the XIII ET symposium, an incomplete selection of thepresented large facilities



Preparing the ET TDR



@ Harald Lueck

@Michele Punturo

Vacuum pipe system

public TDS link: https://apps.et-gw.eu/tds/?call_file=ET-0005A25_ETPPDeliverable62VacuumPipeDes.pdf

ET Collaboration:

Vacuum Pipe Requirements Validation:

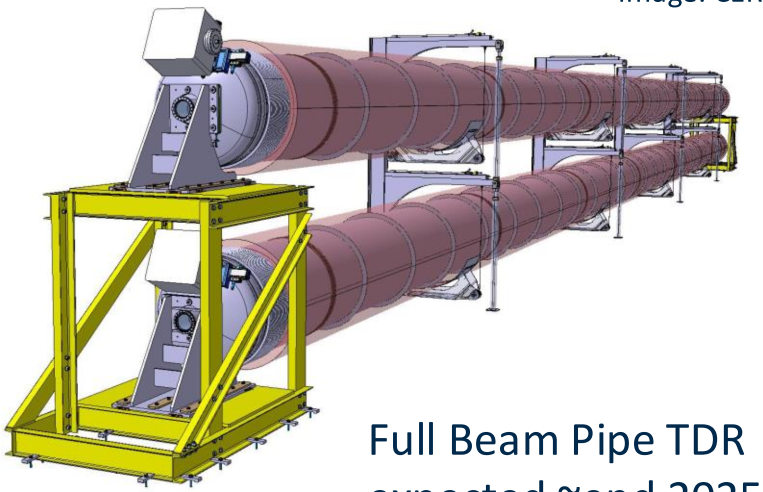
- Review of the design, materials, and requireme vacuum pipes.
- Coordination with external experts and review validate specifications.

Requirements → CERN

Gas species	Maximum residual gas pressure [mbar]
H_2	1×10^{-10}
H_2O	5×10^{-11}
CO	10^{-11}
N_2	10^{-11}
C_xH_y with more than 100 amu	$< 1\times10^{-14}$

New material: AISI 304 or 316L (Austenitic Stainless Steel)
→ AISI 441 (Ferritic Stainless Steel)

Image: CERN



Full Beam Pipe TDR expected ~end 2025

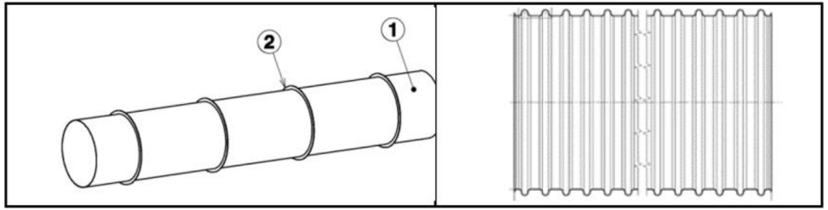
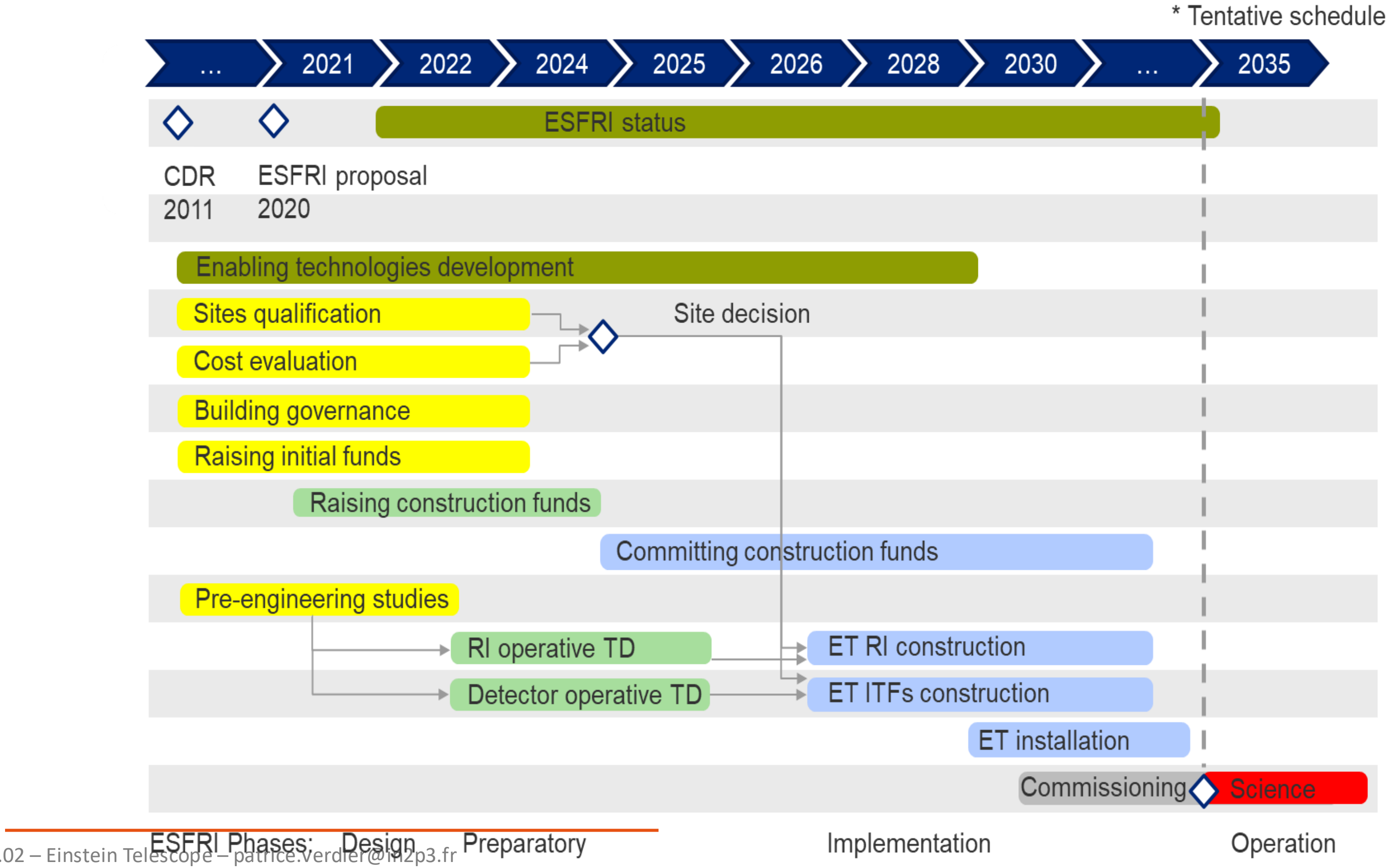


Image: CERN

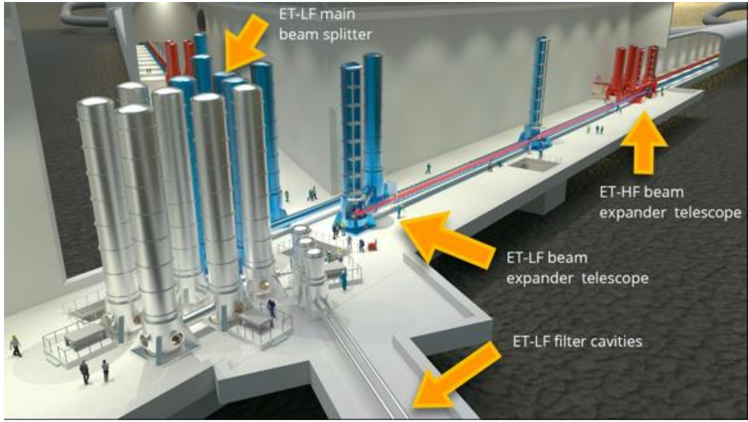
Schedule


* Tentative schedule
…
2021
2022
2024
2025
2026
2028
2030
…
2035
ESFRI status
CDR
2011
ESFRI proposal
2020
Enabling technologies development
Sites qualification
Site decision
Cost evaluation
Building governance
Raising initial funds
Raising construction funds
Committing construction funds
Pre-engineering studies
RI operative TD
ET RI construction
Detector operative TD
ET ITFs construction
ET installation
Commissioning
Science
ESFRI Phases: Design
Preparatory
Implementation
Operation

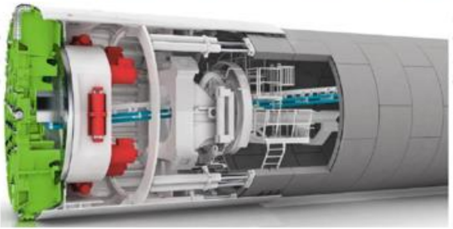
Infrastructure

@J. Degallaix

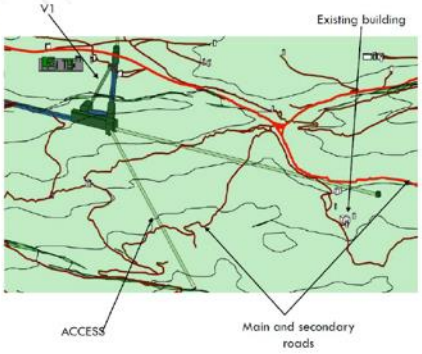
- stratégie pour la construction des tunnels et cavernes
- gestion infrastructure souterraine
- intégration dans l'environnement local



Taille, forme des cavernes ?



Méthode d'excavation ?



Installations existantes ?

+ Studies for the characterization of candidate sites in progress: drilling, ambient noise (seismic, wind turbine, magnetic ...)