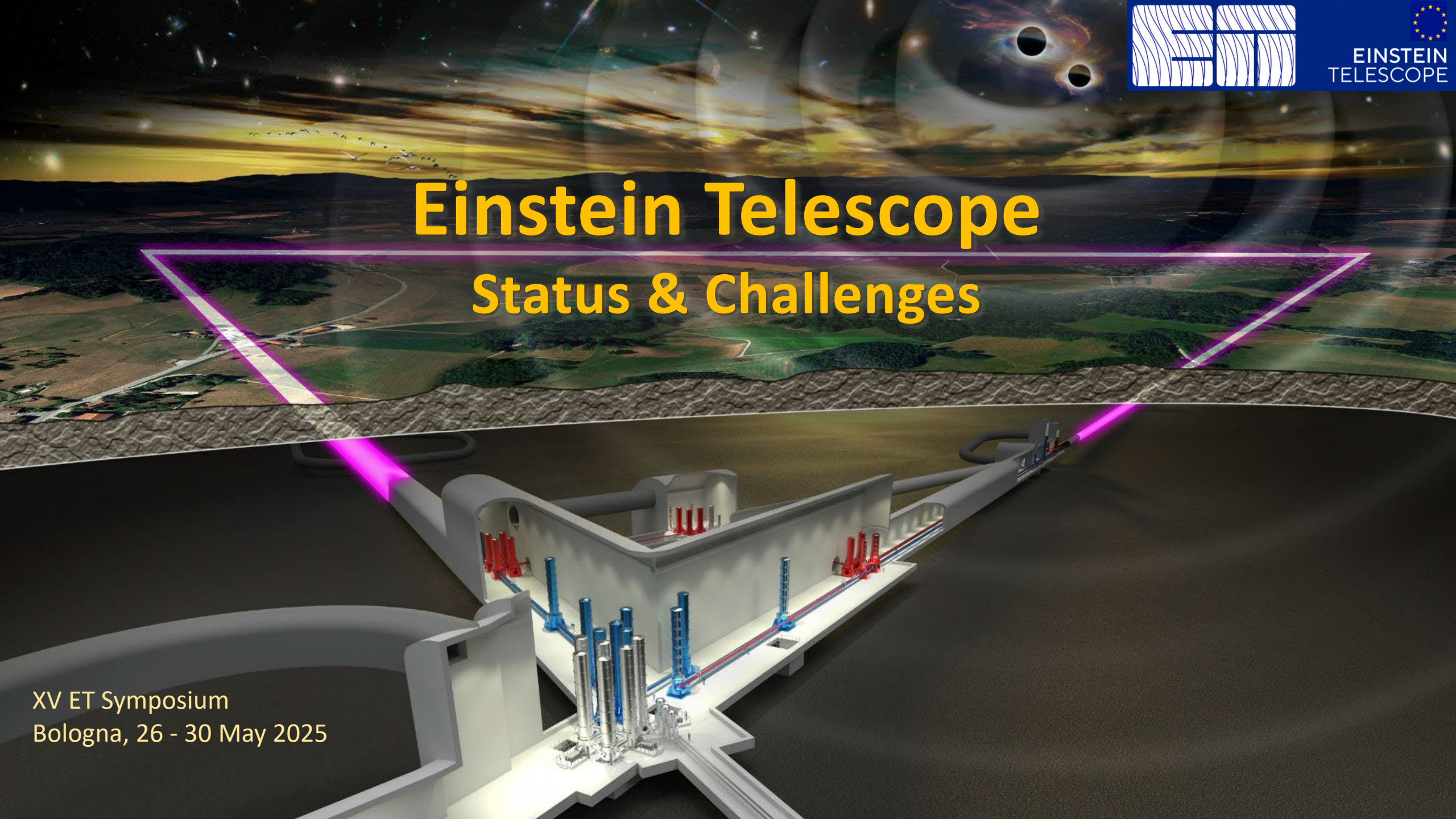


Einstein Telescope

Status & Challenges

XV ET Symposium
Bologna, 26 - 30 May 2025

ETO: ET Organization

ET Proto-Council

ESFRI Coordinators

Jorgen D'Hondt
A. Zoccoli

BGR
Board of Government Representatives

BSR
Board of Scientific Representatives

External Advisory Bodies

ET Project Directorate
A.Freise, F.Ferroni
(M. Martinez)

Admin. Offices

Communication Office
D. Rosińska

Engineering Department
P. Wernecke

Project Office
A. Variola

Preparatory Phase Projects

Infradev ET-PP
Implementationplan of ET Observatory
M. Martinez
(Managed by Project Directorate)

Design of ET Vacuum Pipe
P. Chiggiato
(CERN Coordination)

Civil Engineering
(CERN advisory)

ETC: ET Collaboration

Spokesperson: M. Punturo
Deputy: H.Lück

CB
Collaboration Board
E. Coccia

FNR
Forum of National Representatives

EB
Executive Board
Punturo, Lück

SSB
Standard & Services Board

ISB
Instrument Science Board
S. Hild, J. Harms

EIB
E-Infrastructure Board
S. Bagnasco, P. Verdier

OSB
Observational Science Board
M. Branchesi, A. Gosh, M. Maggiore

SPB/SCB
Site Preparation/ Characterization
D. D'Urso, W. Walk
A. Rietbrock

National Host Teams

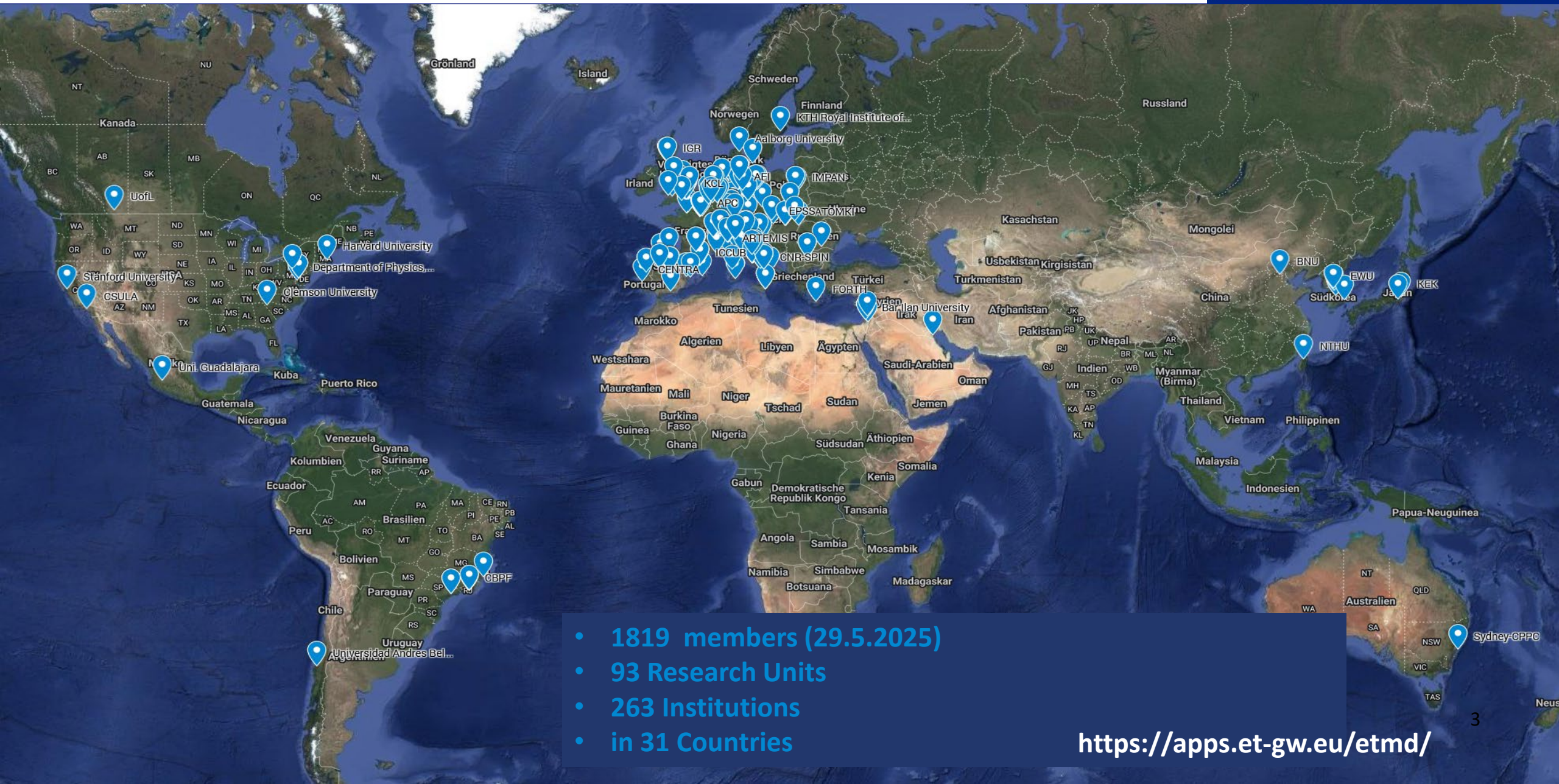
EMR Host Team

Sardiniaa Host Team

Lusatia Host Team

Private Companies

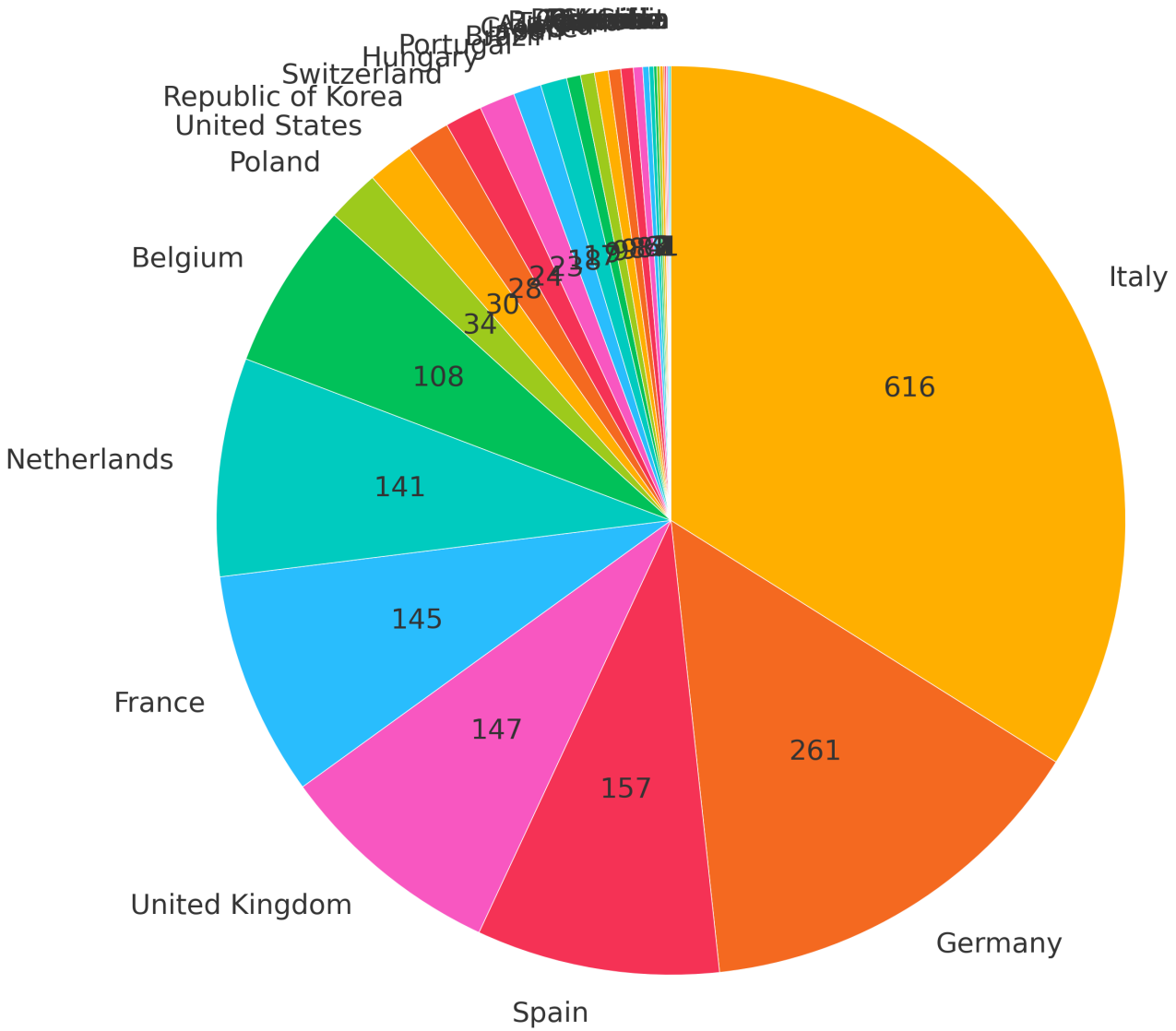
ET Collaboration Member‘s Affiliation Map



- 1819 members (29.5.2025)
- 93 Research Units
- 263 Institutions
- in 31 Countries

https://apps.et-gw.eu/etmd/

Distribution of Members by Country (27.5.2025)



Service and Standards Board (SSB)

As listed in the ETMD (https://apps.et-gw.eu/etmd/?c=6)

Standards and Services Boards (SSB)

Project Program Committee (PPC)

PPC Chair
Ettore Majorana

PPC Member
Takayuki Tomaru
Jerome Novak
Lluisa Mir
Katharina Henjes-Kunst
Alberto Gennai
Rosario De Rosa
Gianpietro Cagnoli

Early Career Scientists Support Committee (ECSS)

ECSS Chair
Anna Green

Member Conduct and Ethics Committee (EMCC)

EMCC Chair
Monique Bossi

Speakers and Awards Committee (SAC)

SAC Chair
Luca Naticchioni

Editorial Committee (EC)

EC Chair
Paola Leaci

EC Member
Jishnu Suresh
Alicia M Sintes
Silvia Piranomonte
Nicolas Leroy
Jonathan Gair
Julia Casanueva Diaz

Election, Voting and Membership Committee (EVMC)

EVMC Chair
Mariafelicia De Laurentis

Meetings and Symposia Committee (MSC)

MSC Chair
Jessica Steinlechner

Communications and Education Committee (CEC)

CEC Chair
Susanne Milde

Bylaws Updating Committee (BUC)

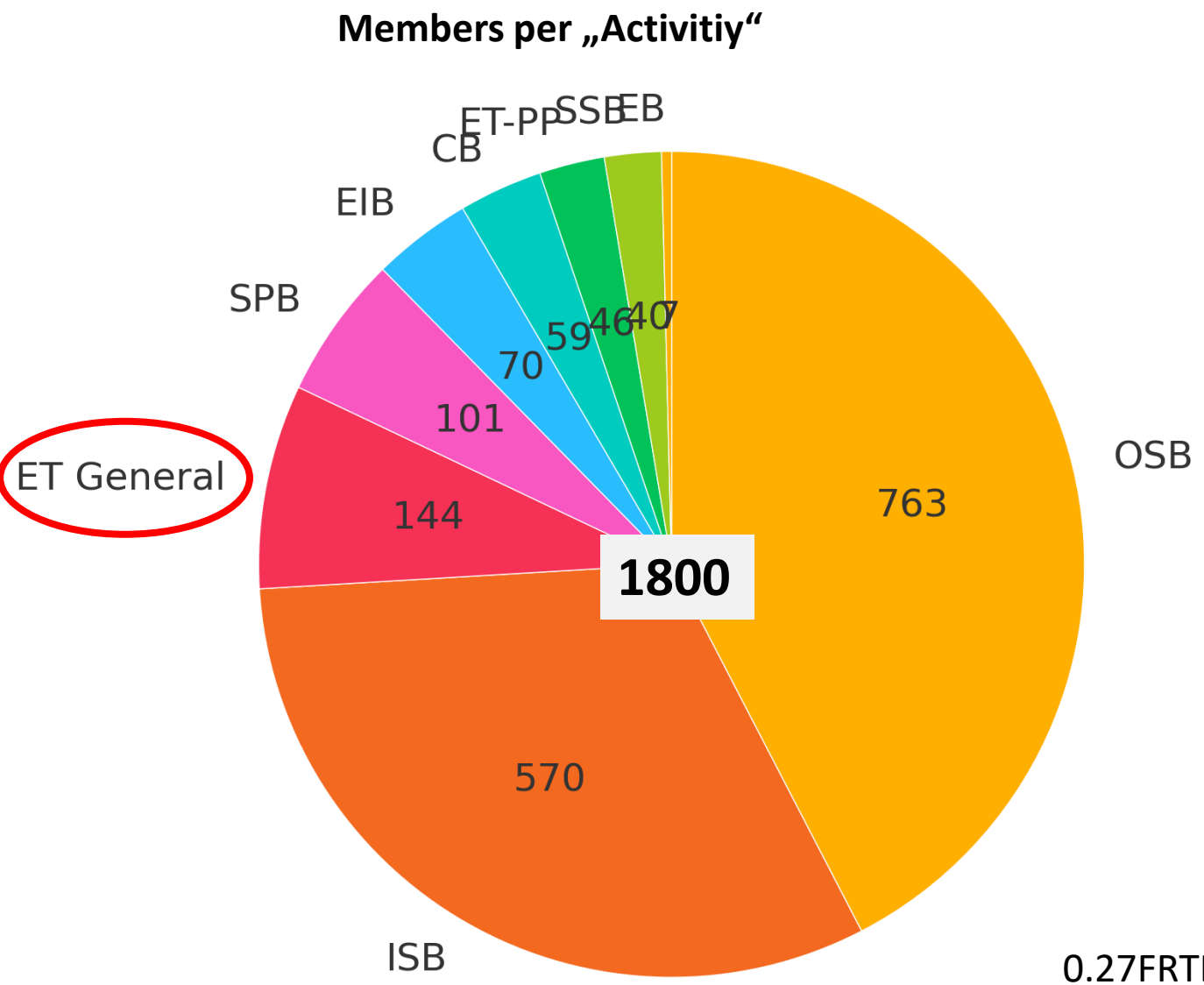
BUC Chair
Harald Lück

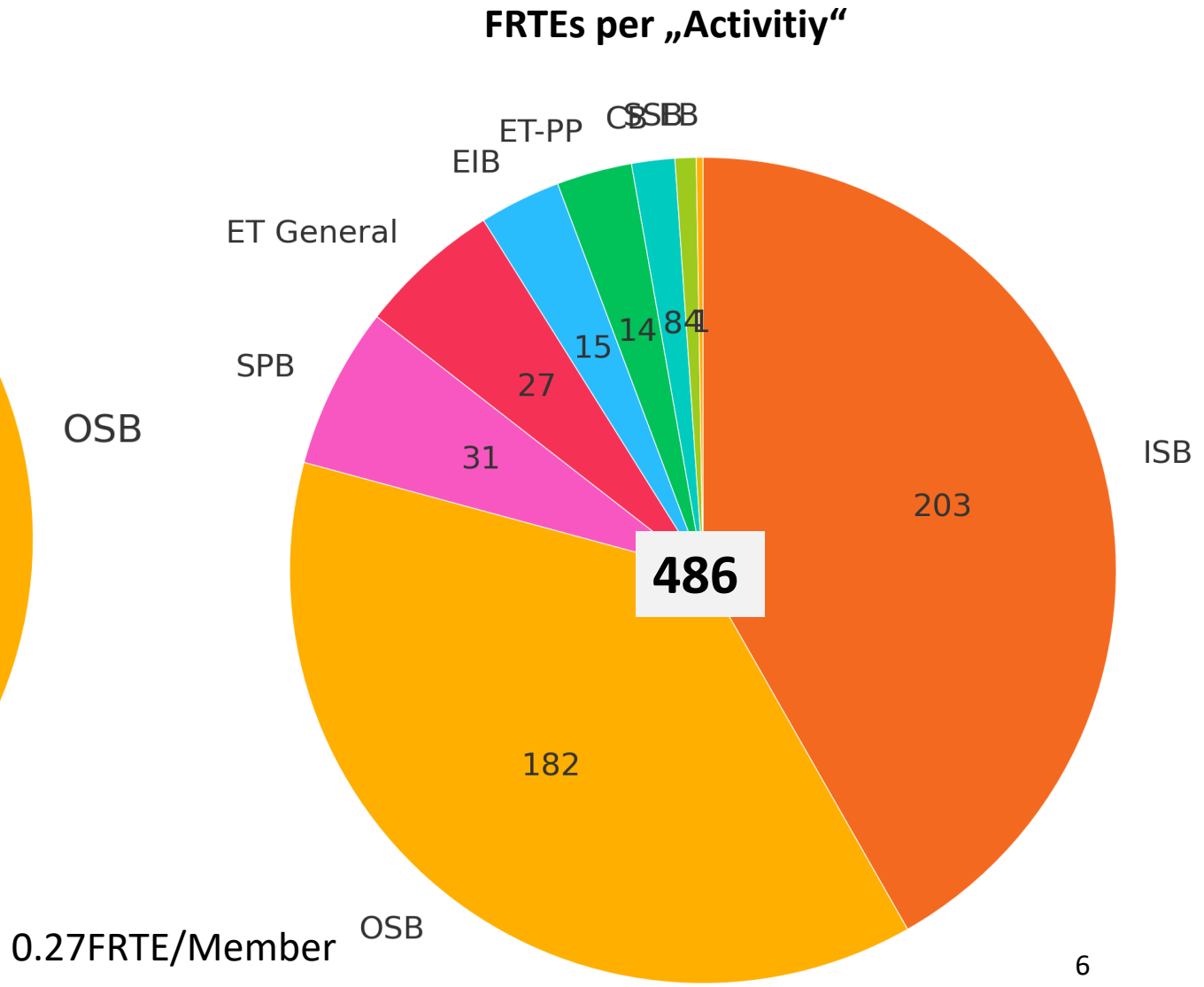
BUC Member
Patrice Verdier
Mario Spera
Michele Punturo
Samaya Nissanke
Viviana Fafone
Eugenio Coccia
Fabrizio Barone
Maria Celeste Artale

Committees have been formed and most have taken up work

Needs more Coordination → SSB Chair(s)

Activities of Collaboration members (27.5.2025)

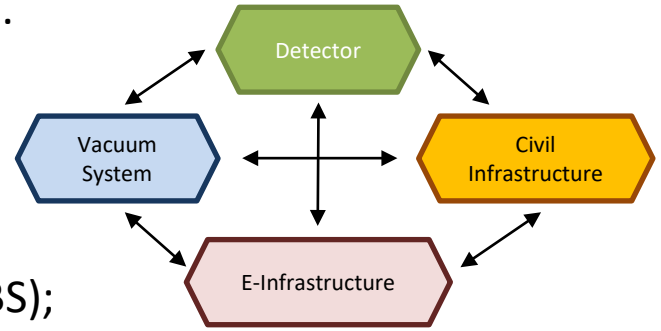




0.27FRTE/Member

From the PBS to the Detector TDR

Detector TDR is an ET-PP deliverable.
Due date for draft was Sept. 2024
→ Postponed to end of 2025



Three inputs needed:

- Product Breakdown Structure (PBS); with parameter tables
- Optical layout
- Detector layout

PBS (Product Breakdown Structure)

- ISB together with PO/Technical Coordinator
- PBS final structure is completed
- Parameter table submission incl. description field (23786 parameters)
- Transfer to ET PBS Database & Json File
- Convert database content → latex files

→ Pre-TDR: Check availability of descriptive reports
→ Compose writing team
(asap; discussing logic of TDR structure)

Preliminary Detector TDR ET-PP milestone Feb. 2026

Contents

ET PBS Database

HOME | PBS ELEMENTS (V1 2025) | ALL PARAMETERS | PROF

ALL | ALL HFI | ALL LFI

EXPORT | FILTRES | COLUMNS

not in system_subsystem_element_description

id	element_name	wbs_name	parent_id	level	description	system_subsystem_element_description	PBSCODE	Review	Actions
1827	Einstein Telescope			1			1		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1828	HF instrument		1827	2			1.1		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1829	Suspensions		1828	3			1.1.1		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1830	Suspension chain		1829	4	Passive isolation stages betw...		1.1.1.1		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1831	Filter-0		1830	5	First vertical low natural frequ...		1.1.1.1.1		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1832	Standard Filter		1830	5	Passive isolation chain main b...		1.1.1.1.2		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1833	Payload Interface Filter		1830	5	Last passive filtering stage of ...		1.1.1.1.3		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1834	Sensors and actuators		1830	5	Sensors and actuators for all F...		1.1.1.1.4		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1835	Inductive sensors and actuators		1834	6	LVDT and voice coils		1.1.1.1.4.1		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE
1836	Fishing rods		1834	6	Step motor driven auxiliary spr...		1.1.1.1.4.2		CHILDREN PARAMETERS REQUIREMENTS CHANGE REQUE

Rows per page: 10 1-10 of 1290

TRLs and R&D in ET

Need better knowledge of technological readiness levels (TRLs) and required lead times to readiness of **all subsystems and elements**

Which R&D activities are going on where? **Quite good knowledge in WGs, but complete picture needed**

Which topics are not covered?
Launched survey in 2023 (moderate success),
Need to redo in a well-organised, centralised manner.
Can start from PBS database. **Decide on proper tools**

→ **Solid planning of R&D needed to build ET, leaving NO gaps**
And only desired redundancies

R&D Facilities:
https://wiki.et-gw.eu/ISB/R_and_D_facilities

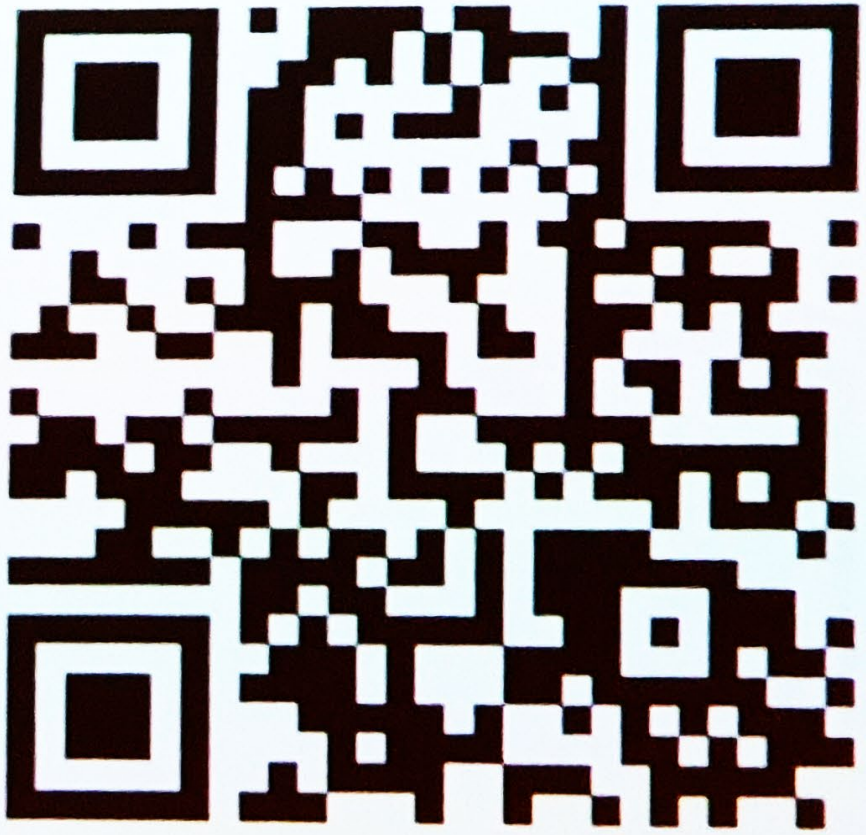
Slide from ISB Session yesterday…

Einstein Telescope

ET R&D roadmap

To be a bit provocative: Everybody things about something different when it comes to what the purpose of an R&D roadmap is:

- Identifying gaps in R&D
- Allow new-comers to find topics they can contribute to.
- Coordination and avoiding too much duplication.
  - Too much duplication is waste of resources
  - no duplication at all leads single point of failures and high risk.
  - what is the right level of duplication
- Distinguish between something that earns one 'ET-reward' (e.g. authorship or not)
- "Splitting up the cake", e.g. who (country, group, …) does what.



- What is ET R&D (claimed by others in front of funding agencies? „ET Plagiarism")

Beam Tube Pre-TDR done by CERN (ET-PP Del.)

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 requirements for vacuum pipes.
- Coordination with external experts and review panels t validate specifications.

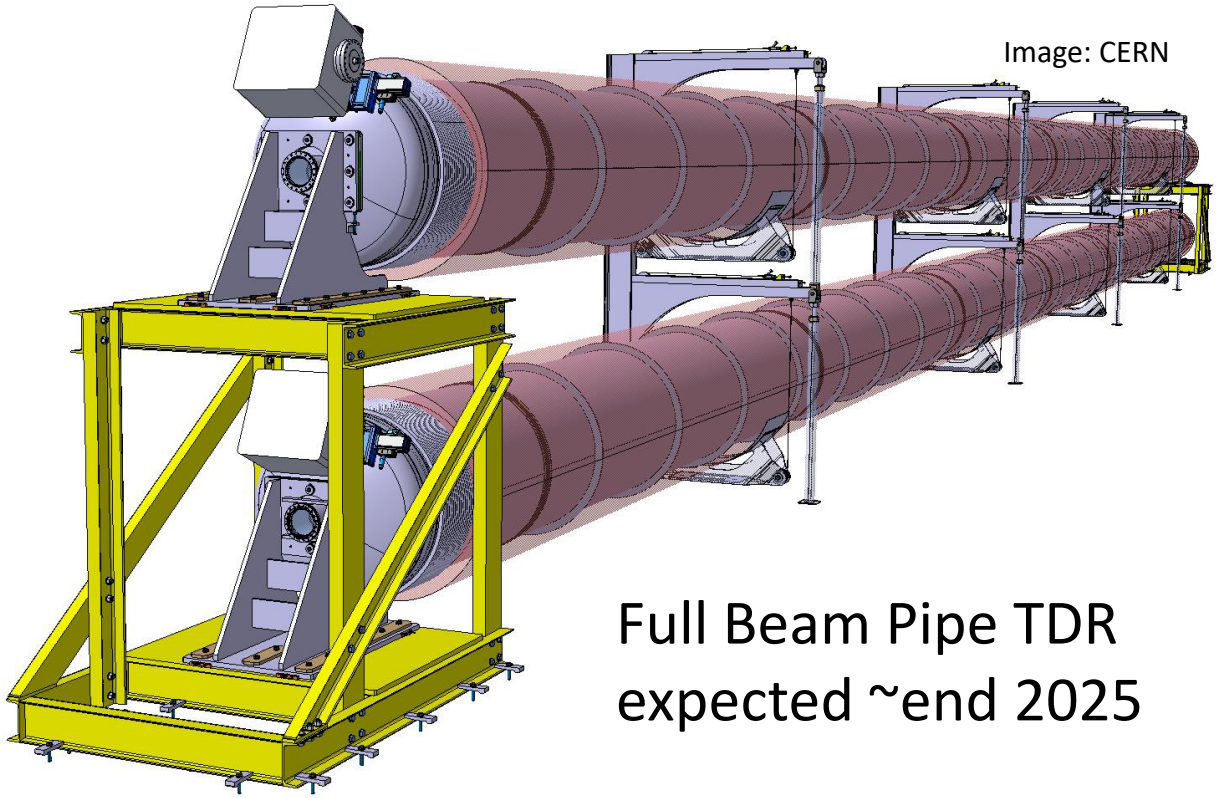


Image: CERN

Full Beam Pipe TDR expected ~end 2025

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)

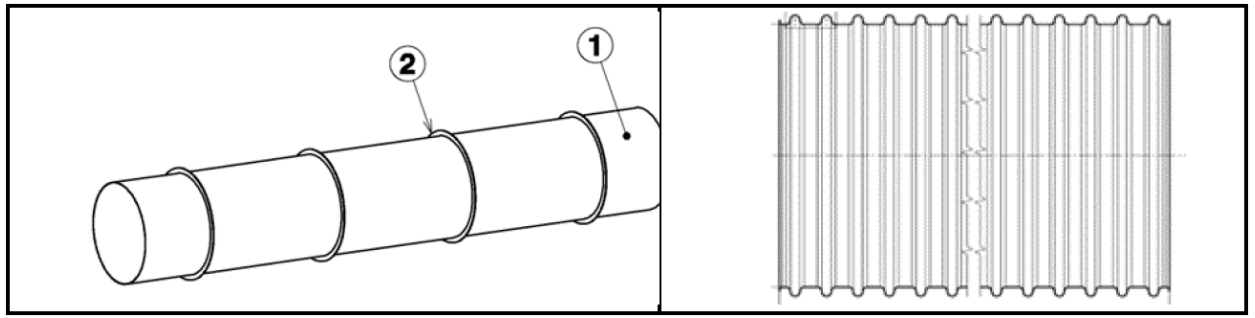


Image: CERN

ETO Task Force on detector layout

Chair: (Fiodor Sorrentino)

- **Two layers: core with full availability + consultants with high level expertise**
- Optical layout -> 2 + 2 (ISB)
- SQZ -> 1 + 1 (ISB)
- INJ -> 1 (ISB)
- ISC -> 1 (ISB)
- Suspensions -> 2 + 2 (ISB)
- Tower Vacuum -> 2 + 1 (ISB)
- Pipe vacuum -> 1 + 1 (ETO & CERN)
- Cryogenics -> 1÷2 + 2 (ISB)
- Civil engineering -> 1 + 1 (ETO)
- Technical engineering -> 1 + 1 (ETO)
- TETI local team liaison -> 1
- EMR local team liaison -> 1
- (Lausatia local team liaison? -> 1)
- Noise budget -> 1 (ISB)
- PO members -> 2 (ETO)
- + extra members if needed
- Secretary -> 1
- OSB liaison? *1*

Mandate: https://apps.et-gw.eu/tds/?r=19370:
provide new detector layouts for the Einstein Telescope.
The task force will source personnel and support from the ET Collaboration (ETC), ETO, the civil engineering specialists of the local teams, and from external projects or institutions as needed.
The task force should deliver the updated detector layouts to ETO three months after they start their task.

- Criteria
  - Good **expertise** in field
  - Good **knowledge** of
    - current **status** of design
    - main design **issues**
    - main design **options**
  - **Team** work ability
  - **Time** availability
    - frequent (live) meetings
    - intense work (computation, design, editing) between meetings
  - National diversity

Core team (24)

Name	Institution
Anna Green	Nikhef
Antonio Perreca	Trento Uni
Marco Vardaro	Nikhef
Nathan Holland	Nikhef
Leonardo Lucchesi	INFN Pisa
Antonino Chiummo	EGO
Francesca Spada	INFN Pisa
Paolo Ruggi	EGO
Julien Gargiulo	EGO
Henk Jan Bulten	Nikhef
Fulvio Ricci	Roma 1 Uni
Angelo Crucciani	INFN Roma 1
Jonathan Bratanata	Nikhef
Max Majoor	Nikhef
Mikhail Korobko	Hamburg Uni
Elena Licciardello	INFN-LNS
Romano Meijer	Nikhef
Ghada Mahmoud	APC
Benoit Tuybens	Nikhef
Fiodor Sorrentino	INFN
Ulyana Dupletsa	GSSI
Francesco Iacovelli	Geneve Uni
Patricia Lamas	Amberg Eng.
Tamara Bud	CERN

Advisors (23)

Name	Institution
Jerome Degallaix	LN2P3
Daniel Brown	Adelaide Uni
Giacomo Ciani	Trento University
Julia Casanueva	EGO
Sebastian Steinlechner	Maastricht University
Conor Mow-Lowry	Nikhef
Antonio Pasqualetti	EGO
Steffen Grohman	KIT
Ettore Majorana	Roma 1 University
Piero Rapagnani	Roma 1 University
Wissam Wahbeh	Roma 1 University
Maria Marsella	Roma 1 University
Patrick Werneke	Nikhef
John Osborne	CERN
Joseph Ickmans	EMR
Valeria Sequino	INFN
Andreas Freise	Nikhef
Riccardo de Salvo	n.a.
Marco Galimberti	EGO
Lucia Lilli	INFN Pisa
Archisman Ghosh	Gent University

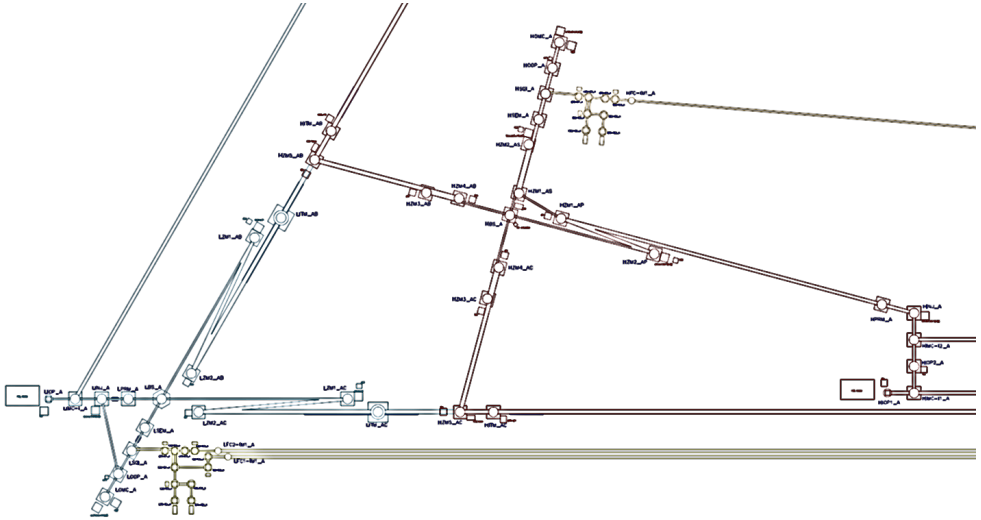
Optical Layout changes summarised

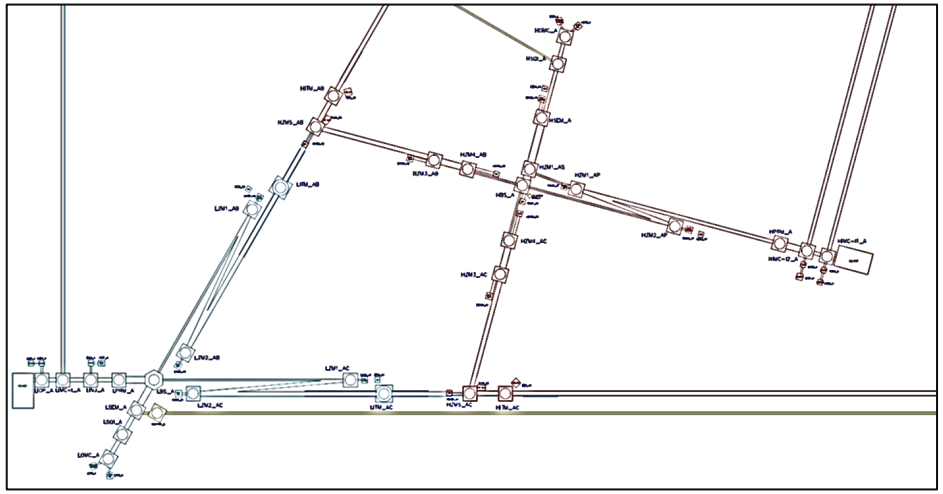
Slide: M. Majoor (modified)

ET-0676A-24/3194259

Summary of optical layout changes:

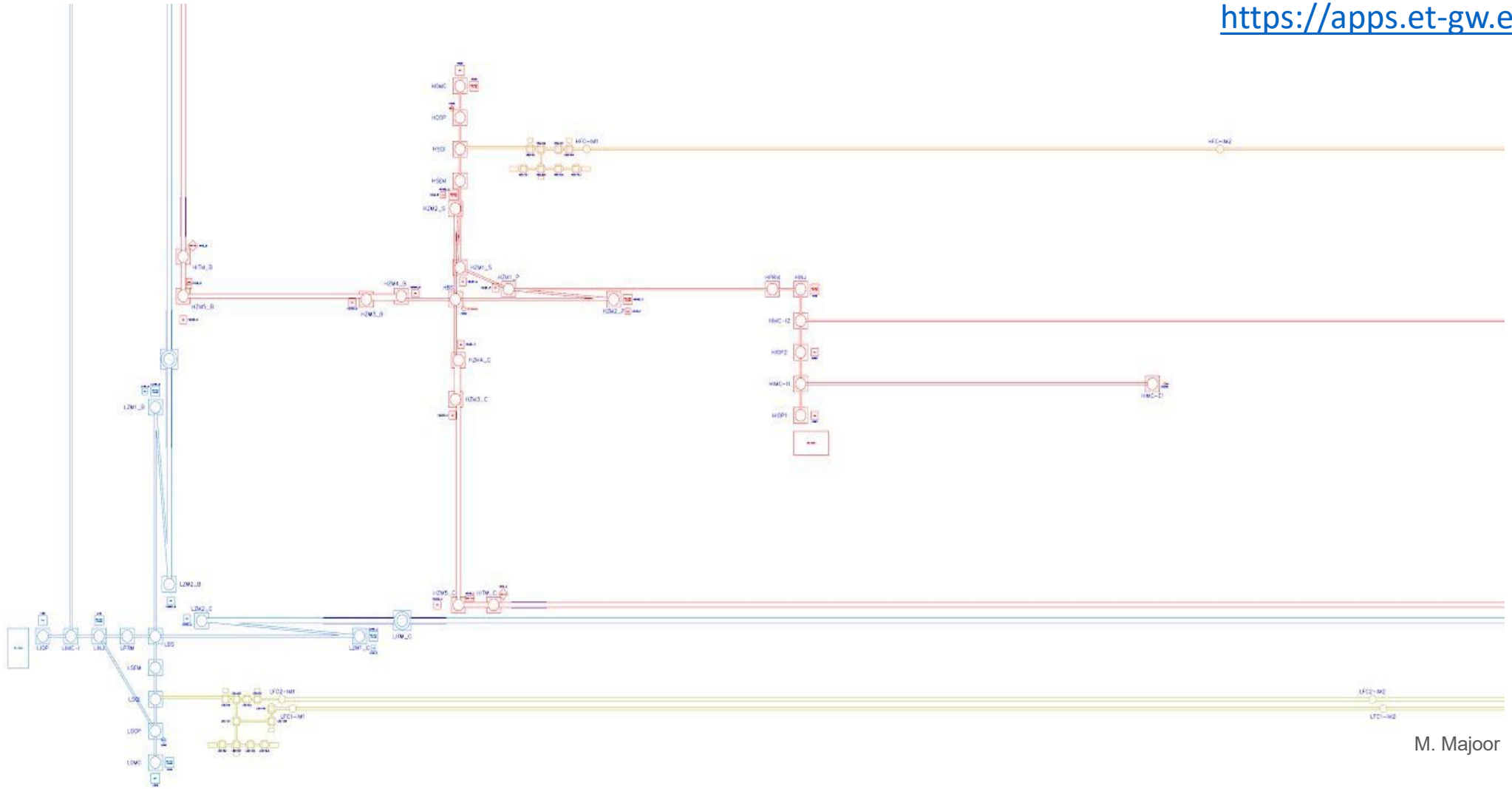
- LF filter cavities placed in the X / AC arm, with periscope coupling
- HF filter cavity relocated to the Y / AB arm with periscope coupling
- 2-mirror filter cavity design adopted, allowing reduced pipe diameter
- Shortened length of the LF input mode cleaner (IMC)
- HF IMCs merged into a single tunnel
- Beam routing for the Balanced Homodyne Detection (BHD) system passing through the beam splitter
- Additional reconfiguration of components, primarily by assuming that multiple major optics can be hosted in the same vessel ("tower merging")
- Re-assessment of auxiliary sensing systems, their requirements, and the implementation of these requirements, resulting in smaller, more accessible optical bench footprints.





Optical Layout 2Ls 2024

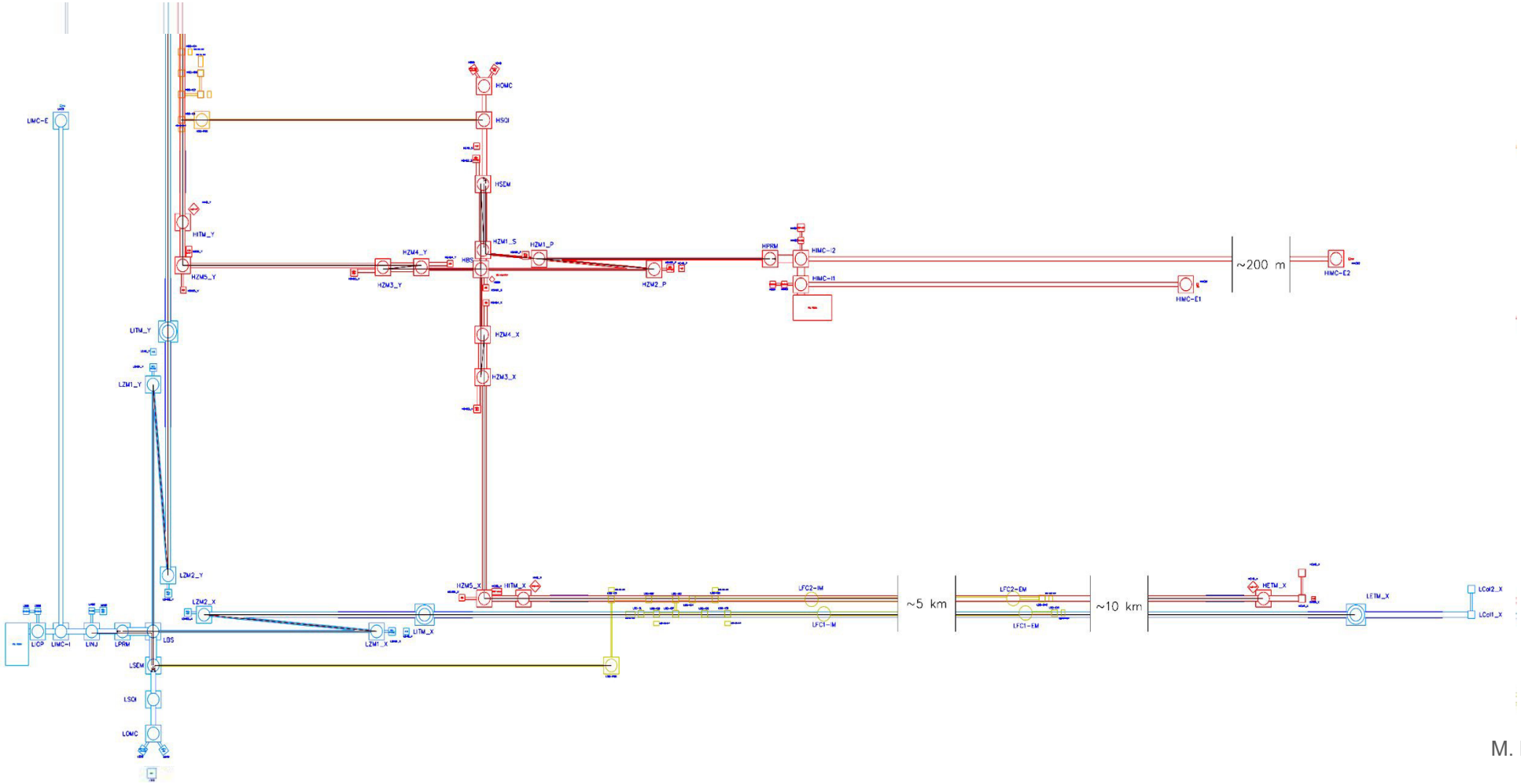
https://apps.et-gw.eu/tds/?r=19352
https://apps.et-gw.eu/tds/?r=19340



M. Majoor

14

Optical Layout 2Ls 2025



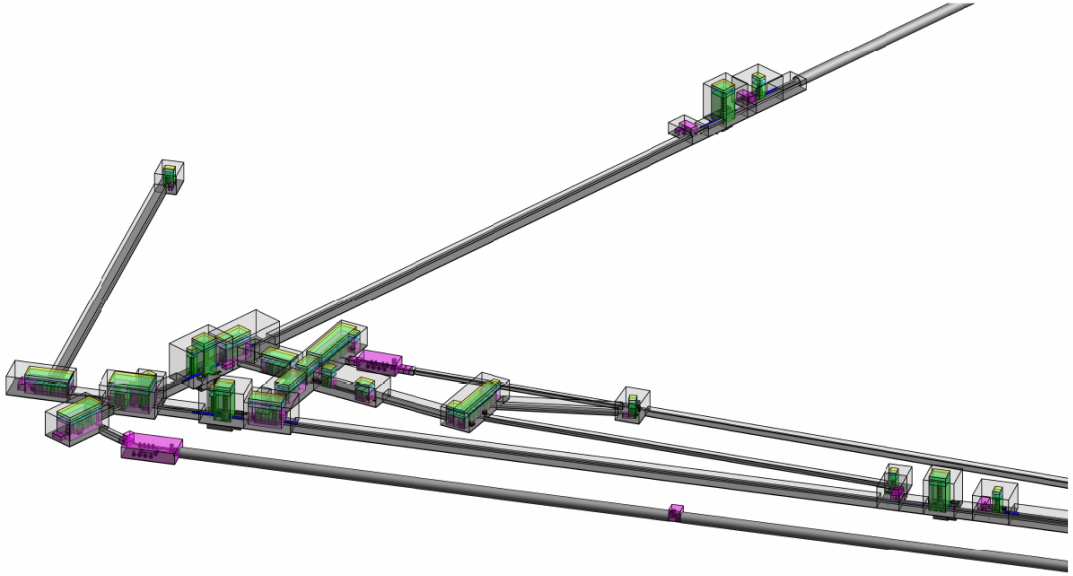
M. Majoor

15

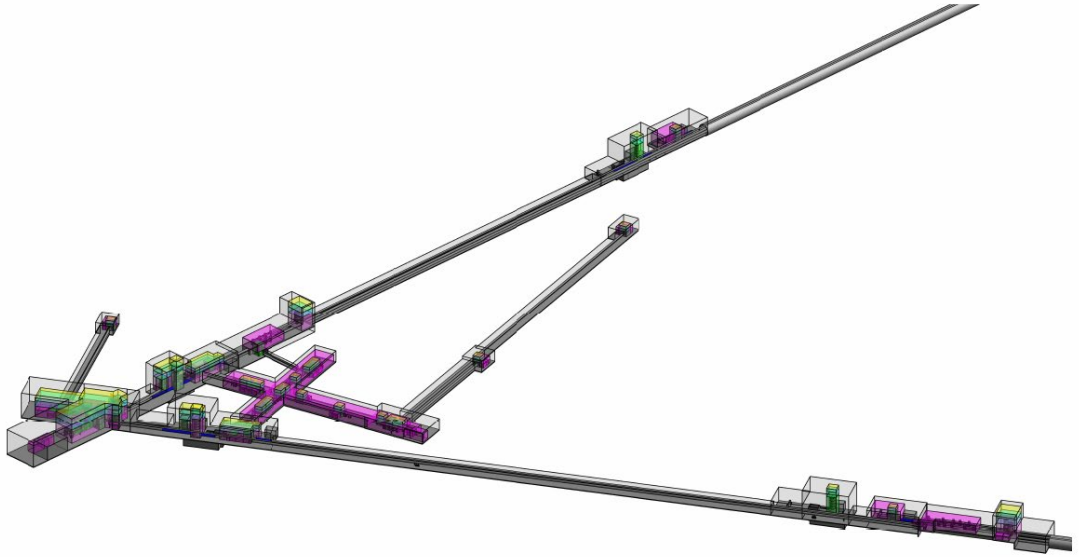
Detector Layout comparison (Δ)

Slide: M. Majoor (modified)

- 2024 reference



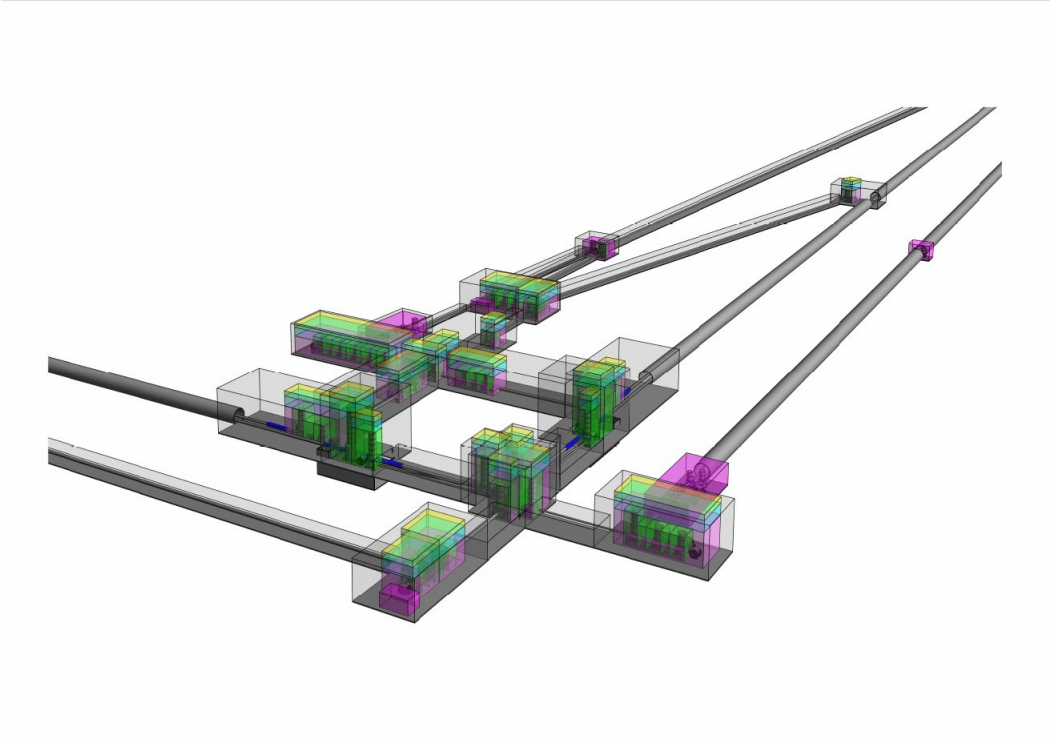
- New 2025baseline



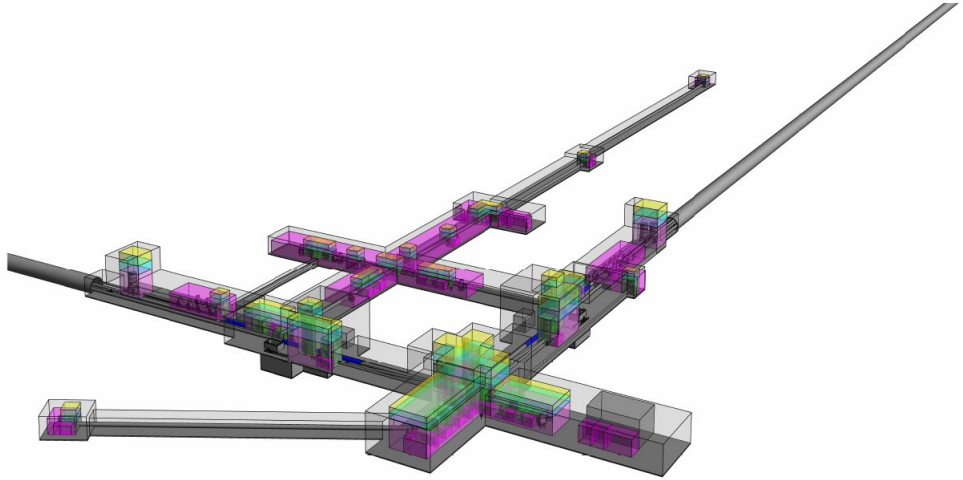
Detector Layout comparison (2L)

Slide: M. Majoor (modified)

- 2024 reference



- New 2025 baseline



Blue Book available on archive

General Relativity and Quantum Cosmology

[Submitted on 15 Mar 2025]

The Science of the Einstein Telescope

Adrian Abac, Raul Abramo, Simone Albanesi, Angelica Albertini, Alessandro Agapito, Michalis Agathos, Conrado Albertus, Nils Andersson, Tomás Andrade, Igor Andreoni, Federico Angeloni, Marco Antonelli, John Antoniadis, Fabio Antonini, Manuel Arca Sedda, M. Celeste Artale, Stefano Ascenzi, Pierre Auclair, Matteo Bachetti, Charles Badger, Biswajit Banerjee, David Barba-González, Dániel Barta, Nicola Bartolo, Andreas Bauswein, Andrea Begnoni, Freija Beirnaert, Michał Bejger, Enis Belgacem, Nicola Bellomo, Laura Bernard, Maria Grazia Bernardini, Sebastiano Bernuzzi, Christopher P. L. Berry, Emanuele Berti, Gianfranco Bertone, Dario Bettoni, Miguel Bezares, Swetha Bhagwat, Sofia Bisero, Marie Anne Bizouard, Jose J. Blanco-Pillado, Simone Blasi, Alice Bonino, Alice Borghese, Nicola Borghi, Ssohrab Borhanian, Elisa Bortolas, Maria Teresa Botticella, Marica Branchesi, Matteo Breschi, Richard Brito, Enzo Brocato, Floor S. Broekgaarden, Tomasz Bulik, Alessandra Buonanno, Fiorella Burgio, Adam Burrows, Gianluca Calcagni, Sofia Canevarolo, Enrico Cappellaro, Giulia Capurri, Carmelita Carbone, Roberto Casadio, Ramiro Cayuso, Pablo Cerdá-Durán, Prasanta Char, Sylvain Chaty, Tommaso Chiarusi, Martyna Chruslinska, Francesco Cireddu, Philippa Cole, Alberto Colombo, Monica Colpi, Geoffrey Compère, Carlo Contaldi, Maxence Corman, Francesco Crescimbeni, Sergio Cristallo, Elena Cuoco, Giulia Cusin, Tito Dal Canton, Gergely Dálya, Paolo D'Avanzo, Nazanin Davari, Valerio De Luca, Viola De Renzis, Massimo Della Valle, Walter Del Pozzo, Federico De Santi, Alessio Ludovico De Santis, Tim Dietrich, Ema Dimastrogiovanni, Guillem Domenech, Daniela Doneva, Marco Drago, Ulyana Dupletsa, Hannah Duval, Irina Dvorkin, Nancy Elias-Rosa et al. (385 additional authors not shown)

Einstein Telescope (ET) is the European project for a gravitational-wave (GW) observatory of third-generation. In this paper we present a comprehensive discussion of its science objectives, providing state-of-the-art predictions for the capabilities of ET in both geometries currently under consideration, a single-site triangular configuration or two L-shaped detectors. We discuss the impact that ET will have on domains as broad and diverse as fundamental physics, cosmology, early Universe, astrophysics of compact objects, physics of matter in extreme conditions, and dynamics of stellar collapse. We discuss how the study of extreme astrophysical events will be enhanced by multi-messenger observations. We highlight the ET synergies with ground-based and space-borne GW observatories, including multi-band investigations of the same sources, improved parameter estimation, and complementary information on astrophysical or cosmological mechanisms obtained combining observations from different frequency bands. We present advancements in waveform modeling dedicated to third-generation observatories, along with open tools developed within the ET Collaboration for assessing the scientific potentials of different detector configurations. We finally discuss the data analysis challenges posed by third-generation observatories, which will enable access to large populations of sources and provide unprecedented precision.

Comments: 880 pages, 203 figures

Subjects: **General Relativity and Quantum Cosmology (gr-qc)**; Cosmology and Nongalactic Astrophysics (astro-ph.CO); High Energy Astrophysical Phenomena (astro-ph.HE); Instrumentation and Methods for Astrophysics (astro-ph.IM); Nuclear Theory (nucl-th)

Report number: ET-0036C-25

Cite as: arXiv:2503.12263 **[gr-qc]**

(or arXiv:2503.12263v1 **[gr-qc]** for this version)

https://doi.org/10.48550/arXiv.2503.12263

ET-PP deliverable.

Opt-in possibility for ET Collaboration Members who did not participate in the writing directly but made significant contributions to ET.

OSB developing Post-BB visions & plans, e.g. wave modelling, MDCs, how to deal with Calibration uncertainties etc

E-Infrastructure Board

EIB Chairs: Stefano Bagnasco, Patrice Verdier

ET-PP WP8 Chairs: Achim Stahl, Nadia Tonello

- EIB mandate: ET E-Infrastructure board mandate.pdf (also in TDS: ET-0323A-21)
- Contact us :
  - EIB chairs and Division chairs: et-eib-chairs@et-gw.eu
  - All EIB Members: et-eib-all@et-gw.eu

Organization

- EIB Divisions definition and mandate EIB_Divisions.pdf

Division 1: Software, frameworks, and data challenge support - Chair: Andres Tanasijcsuk

Division 2: Services and Collaboration Support - Chair: Antonella Bozzi

Division 3: Computing and data model, Resource Estimation - Chair: Gonzalo Merino

Division 4: Multimessenger alerts infrastructure - Chair: Steven Schramm

TTG: Technology Tracking working Group - Chair Sara Vallero

ET E-Infrastructure

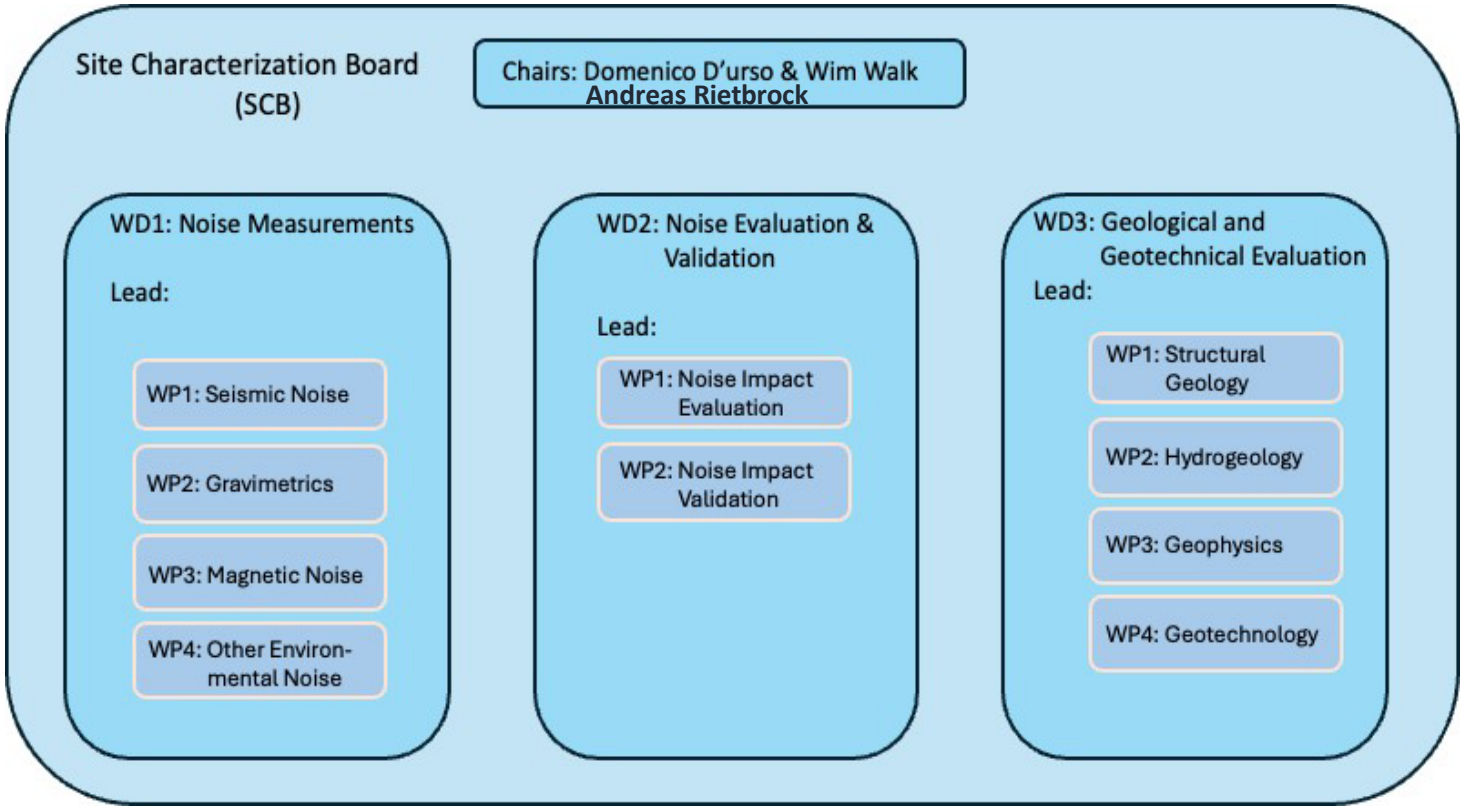
- **Data transfer and storage**
- **Software packaging and distribution**
- **Computing power**
- **Data distribution**
- **High-availability service management**
- **Data cataloguing and bookkeeping**
- **Job lifecycle management**
- **High-level workload management**
- **Monitoring and accounting**
- **Authentication, Authorisation and Identity management**

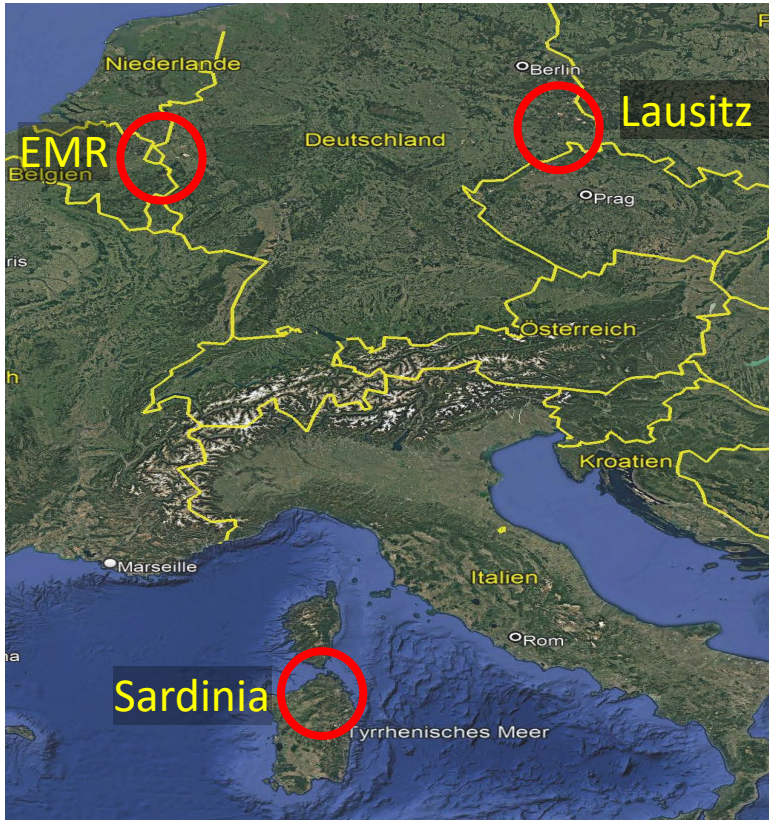
Urgency increased by the MDCs of OSB

Services and tools, e.g. clouds, for the Collaboration need to be centrally organized and homogenized

SCB: Site Characterization Board

- Site characterization at local sites: subsurface measurements moving full speed ahead (noise, geology, hydromodeling)
- Including Lausitz in SCB (Andreas Rietbrock)
- SCB revised organization and division leaders





- Discussing best way to validate measurements performed by local sites
- Aligning local timelines with WP4 milestones and deliverables, create single SCB timeline.

ESPPU Document (CERN Roadmap)

ET-0701A-24

Einstein Telescope - The future European Gravitational Wave Observatory

Synergies and complementariness with the High Energy Particle Physics

Contact person: Spokesperson of the ET collaboration: Michele Punturo (michele.punturo@pg.infn.it)

Deputy-Spokesperson: Harald Lück (harald.lueck@aei.mpg.de)

ETO Directors: Fernando Ferroni (fernando.ferroni@roma1.infn.it), Andreas Freise (a.freise@nikhef.nl)

Submitted: https://apps.et-gw.eu/tds/?r=19359

All submissions:

https://indico.cern.ch/event/1439855/contributions/

Other contributions:

- CSN2-Strategy-2024 ENG_v8.docx
- EPPS BE input.pdf
- ESPP_Statement_2025_submit.pdf
- ESPPU_2025_LVK_input.pdf
- INFN-National-Input.pdf
- KAT_statement_for_EPPSU_2025.pdf
- Netherlands_input_to_ESPP_2026.pdf
- PL4ESU_main_document_20250321.pdf
- SpainAstropaticleCommunity_updateESPP26.pdf
- UK_ESPPU_Input_2025_310325.pdf

ESFRI Questionnaire

ESFRI European Strategy Forum on Research Infrastructures

10 December 2024

GENERAL QUESTIONNAIRE FOR MONITORING OF PROJECTS 2021

This GENERAL QUESTIONNAIRE FOR MONITORING OF PROJECTS applies to the following eleven Projects 2021 – **EBRAINS** (DIGIT), **GGP** (SSH), **GUIDE** (SSH), **EIRENE RI** (H&F), **ET** (PSE), **EUPRAXIA** (PSE), **MARINERG-i** (ENE), **OPERAS** (SSH), **RESILIENCE** (SSH), **SLICES** (DIGIT), **SoBigData++** (DIGIT).
The monitoring addresses both the SCIENTIFIC CASE as well as the IMPLEMENTATION CASE following up on prior conclusions and recommendations.

Submitted!
https://apps.et-gw.eu/tds/?r=19523

ESFRI MoS
ESFRI Monitoring System

Strategy Report on Research Infrastructures

Project Report
Created at 2025-04-24

PROJECT COORDINATOR:
Michele Punturo

PROJECT NAME:
Einstein Telescope

Collaboration with CERN

https://home.cern/news/news/knowledge-sharing/cern-expands-its-collaboration-einstein-telescope

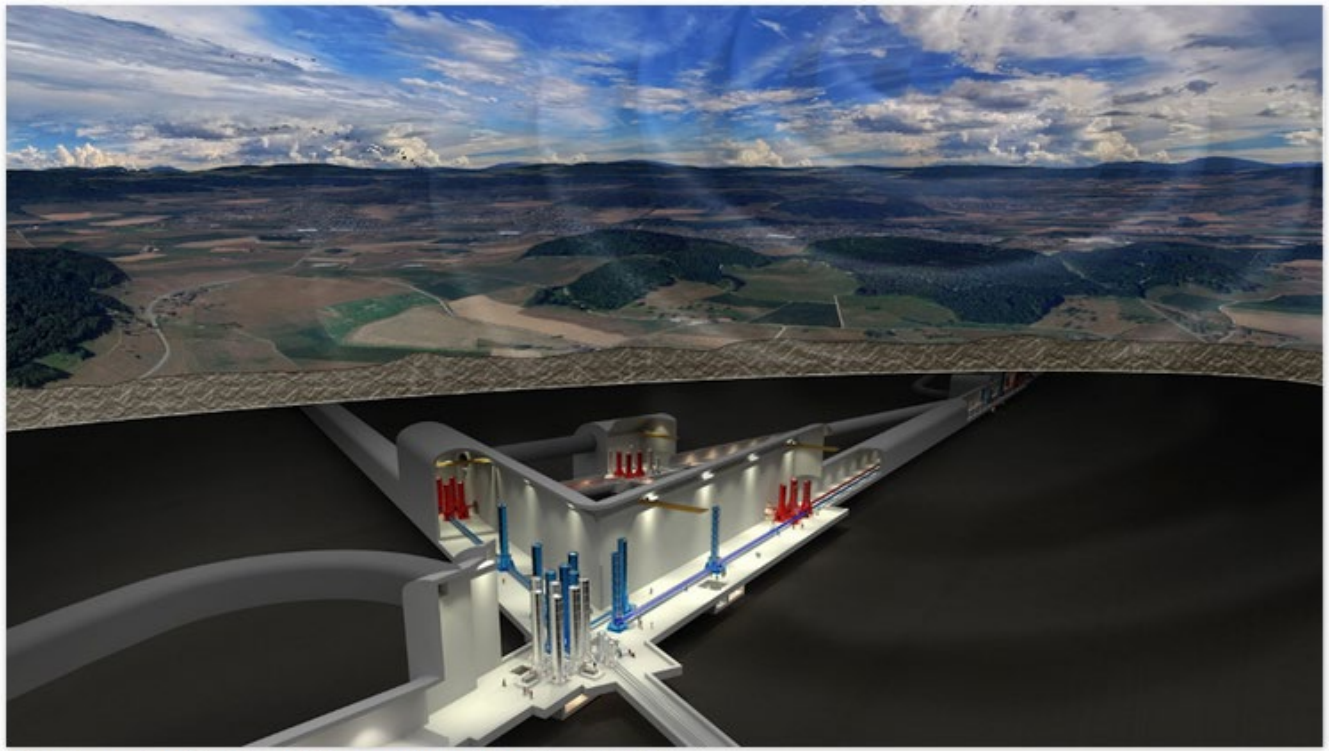
May 20, 2025

- **Technology Synergies with CERN**
  - Vacuum systems, materials, and surface treatments
  - Civil engineering and safety technologies
- **Collaboration Milestones**
  - Oct 2022: Agreement on vacuum & materials (Nikhef, INFN)
  - Sep 2023: Agreement on civil engineering
  - Mar 2025: Extension to engineering & safety
- **CERN Contributions**
  - Power distribution, signal & fiber-optic cabling
  - Cooling, ventilation, access & safety systems
  - Configuration management & project coordination
- **Mutual Benefits**
  - Knowledge transfer with the Future Circular Collider (FCC)
  - Shared solutions for underground infrastructure & safety

CERN expands its collaboration on the Einstein Telescope

CERN and the Einstein Telescope collaboration have signed a new collaboration agreement in the field of engineering and safety to advance Europe's next-generation gravitational-wave observatory

20 MAY, 2025 | By Chetna Krishna & Anaïs Schaeffer



Artist's impression of the Einstein Telescope. (Image: Marco Kraan/Nikhef)

SP, DSP, CB Chair timescales

SP, DSP Mandate ends: 22.3.2026
CB Chair. Mandate ends: 15.11.2025
We wish to have some overlap with the current people

Responsible ETC Unit: Election, Voting and Membership Committee (EVMC) chaired by Mariafelicia De Laurentis

Procedure detailled in the Bylaws:

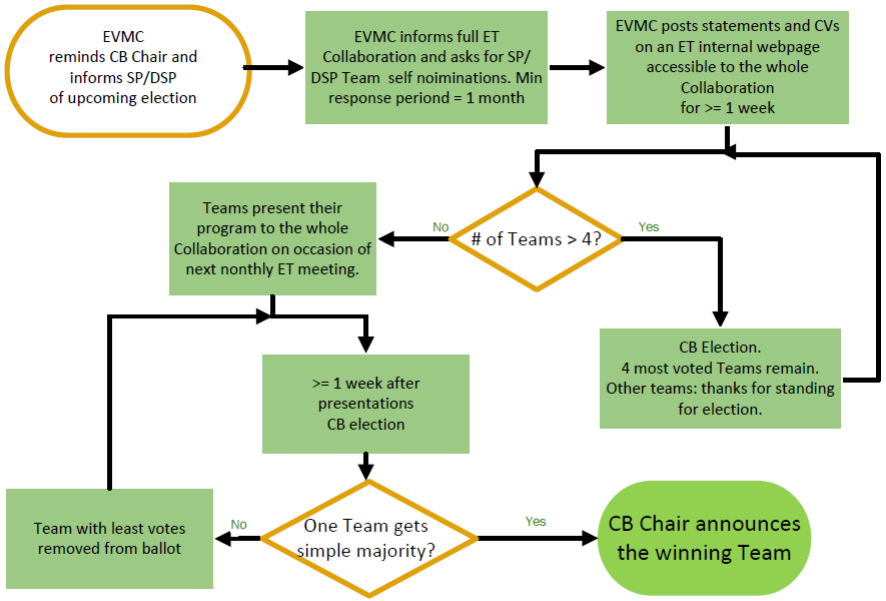


Figure 3: Spokesperson / Deputy Spokesperson election scheme

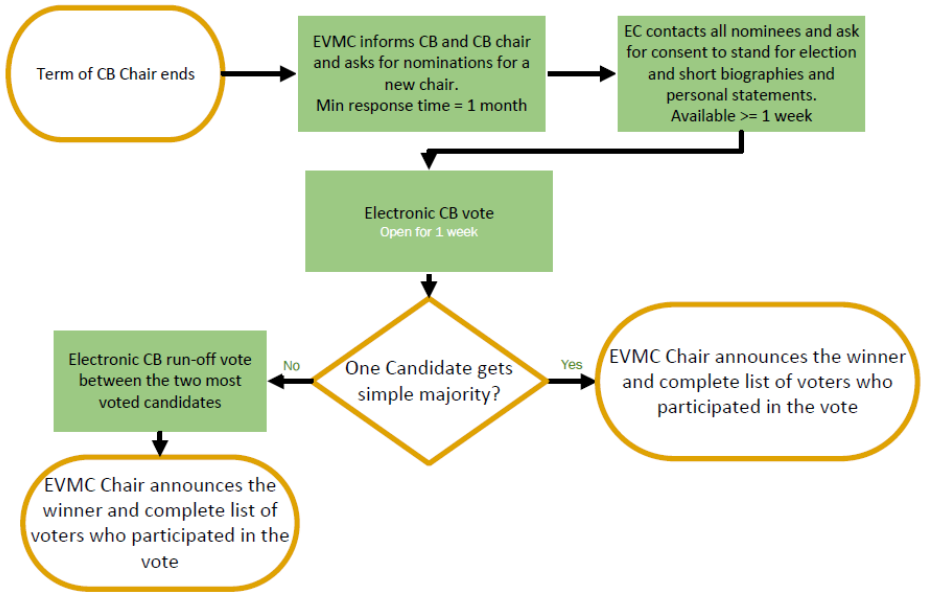


Figure 4: CB Chairperson election scheme

Upcoming ET Meetings

Stated goal:

announce the location **one year ahead** at the preceding respective meeting,
i.e. announce XVI ET Symposium now!

Annual Meeting 2025 (Proposal by Croatia, conditionally accepted by EB yesterday)

Symposium 2026: ???

LOC + Collaboration support by:
SSB Meetings and Symposia Committee (MSC) – chaired by **Jessica Steinlechner**

ET Annual Meeting 2025 candidature: Croatia

WELCOME TO RIJEKA

- [redacted]11.2025. Monday – Friday
  (4 days conference)
- **Booked through agency**
  GRAN HOTEL BONAVIA**** – 92 EUR
  HOTEL CONTINENTAL*** – 69 EUR
  HOTEL NEBODER*** – 64 EUR
- **One afternoon – visit to Istria with dinner**
- **Limit the number of participants (165) or displaced plenary**
- **Scientific organization**

Costs: 400€ (early bird) vs 450€ regular

UNIVERSITY

- 50 years
- Faculty of Physics
- Laboratory for nonlinear and quantum optics

ACCOMODATION

LOCATION

CLOSE TO MAJOR AIRPORTS
TRIESTE
ZAGREB