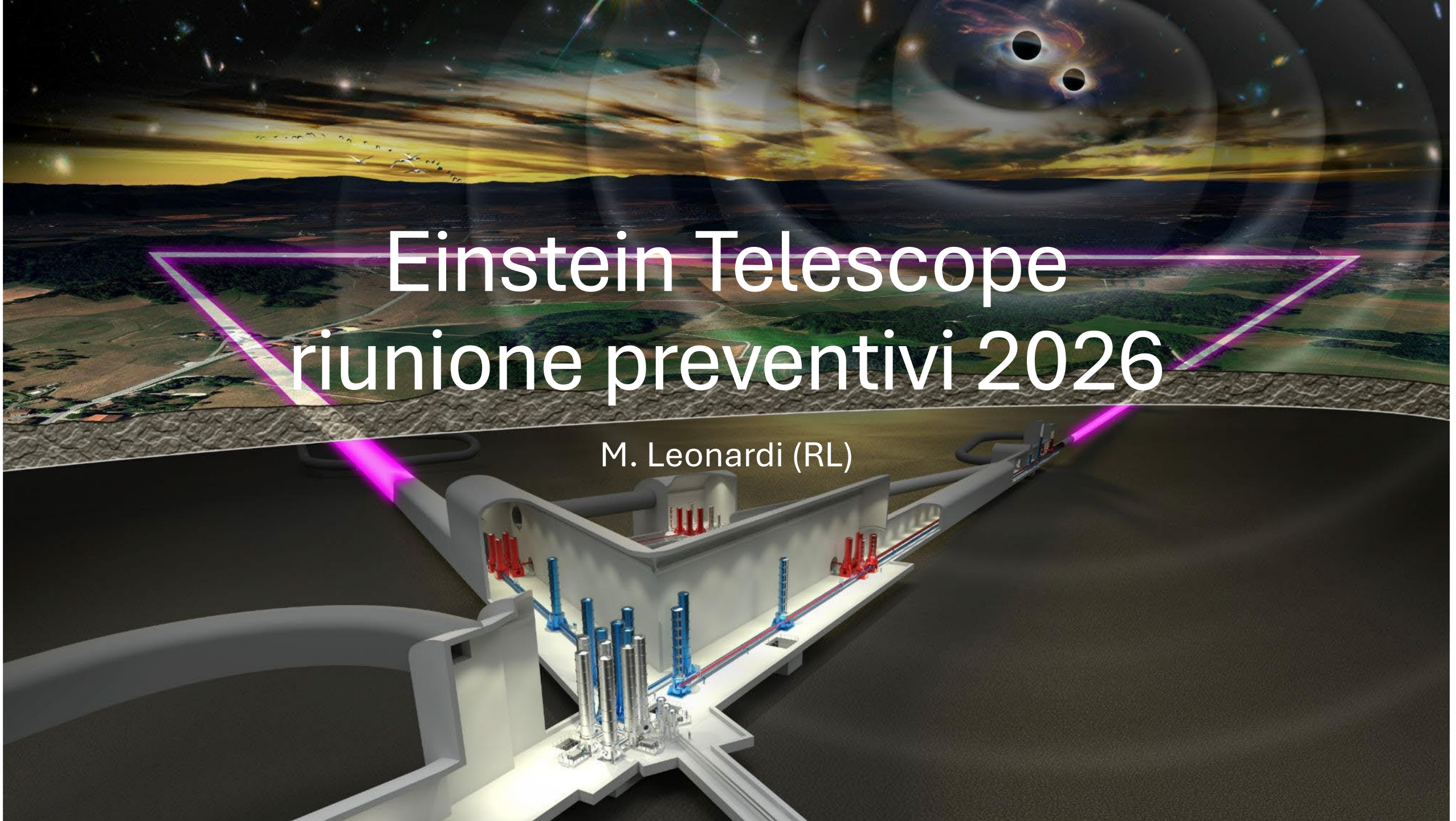
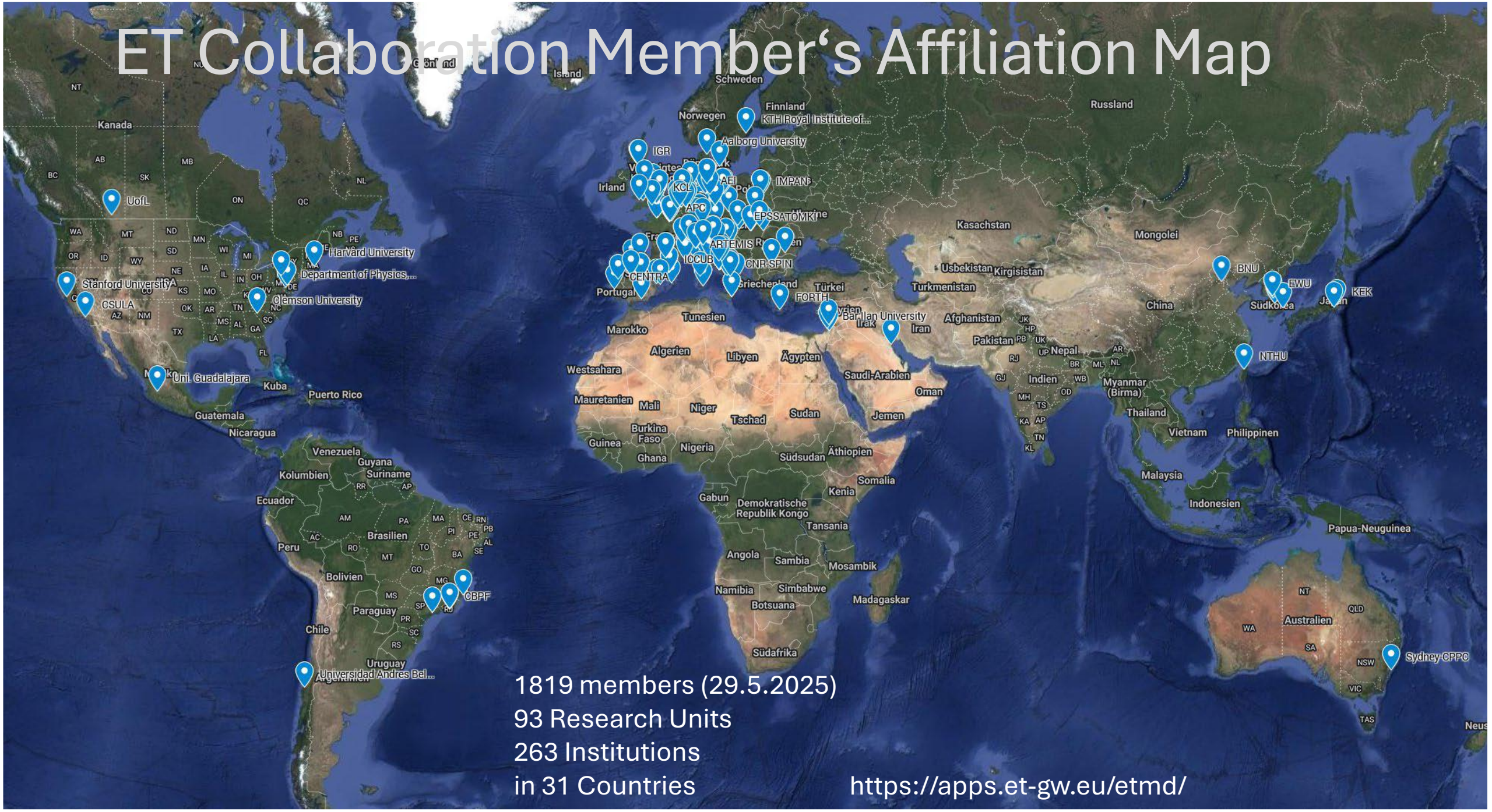


Einstein Telescope riunione preventivi 2026

M. Leonardi (RL)

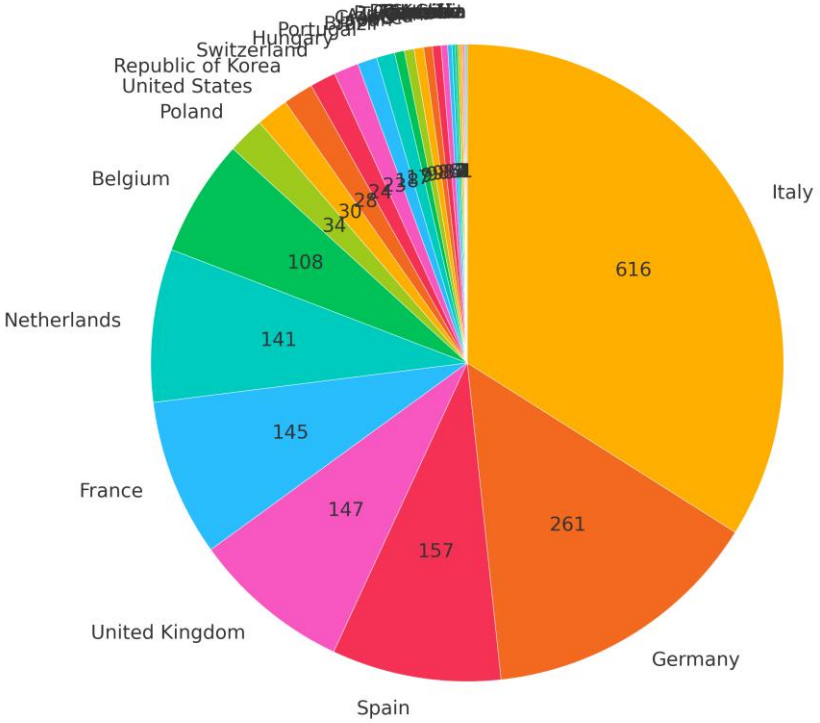
ET Collaboration Member‘s Affiliation Map



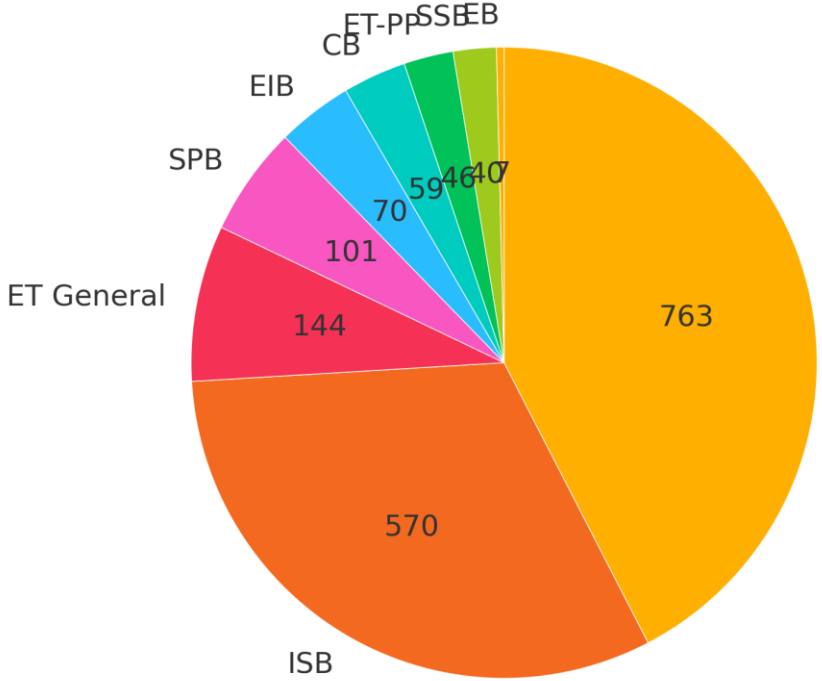
1819 members (29.5.2025)
93 Research Units
263 Institutions
in 31 Countries

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

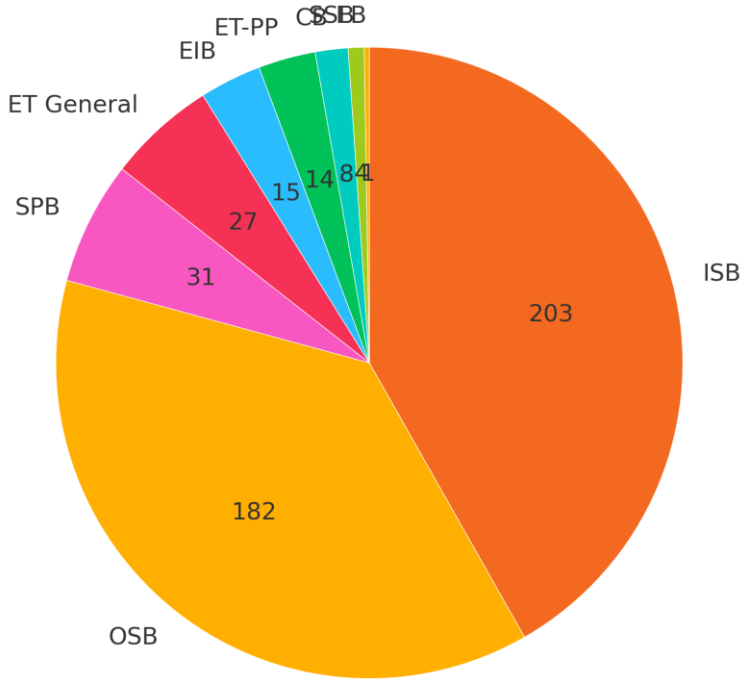
Distribution of members



Members by country



Members per “activity”



FRTEs per “activity”

ET Italia and local group

Progetto	Linea	Responsabili	Ricercatori (FTE)	Tecnologi (FTE)
VIRGO	Gravitational Waves, General and Quantum Physics	Giancarlo Cella	112.40	9.10
ET_ITALIA ET_ITALIA	Gravitational Waves, General and Quantum Physics	Domenico D'Urso	70.30	13.89
CTA	Radiation from the Universe	Riccardo Paoletti - Nicola Giglietto	56.52	5.80
DARKSIDE	The Dark Universe	Gemma Testera	45.42	18.50
KM3	Radiation from the Universe	Giacomo Cuttone	42.93	14.08

Name	FRTE
Damiano Avi (UniTN)	0.50
Giacomo Baldi (UniTN,INFN-TIFPA)	0.20
Sophie Bini (UniTN,INFN-TIFPA)	0.20
Giacomo Ciani (UniTN,INFN-TIFPA)	0.60
Gabriele Ferrari (UniTN,INFN-TIFPA)	0.20
Paul Lagabbe (UniTN,INFN-TIFPA)	0.60
Giacomo Lamporesi (INO-CNR,INFN-TIFPA)	0.20
Matteo Leonardi (UniTN,NAOJ) **(Research Unit Leader)**	0.40
Mirko Lobino (UniTN,INFN-TIFPA)	0.20
Andrea Miani (UniTN,INFN-TIFPA)	0.20
Albino Perego (UniTN,INFN-TIFPA)	0.20
Giovanni Andrea Prodi (UniTN,INFN-TIFPA)	0.25
Alessandro Zenesini (INO-CNR,INFN-TIFPA)	0.20
Research Unit totals	**3.95**

OSB activities: ~ 0.5 FRTE
ISB activities: ~ 2.4 FRTE (*squeezing*, *wavefront sensing and control, core optics and coating, stray light mitigation*)

A. Perreca is co-chair of the “Optical Layout, Sensing and Control of the ET HF Interferometer” WG (Interferometer division of the ISB)
G. Ciani was co-chair of the “Squeezed light” WG (Optics division of the ISB) until 16/04/2025 and currently is division co-chair of the optics division (of the ISB)
M. Leonardi is “ET-Italia R&D Squeezing” coordinator.
G. Ciani is “ET-Italia R&D Stray light mitigation” coordinator.

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:

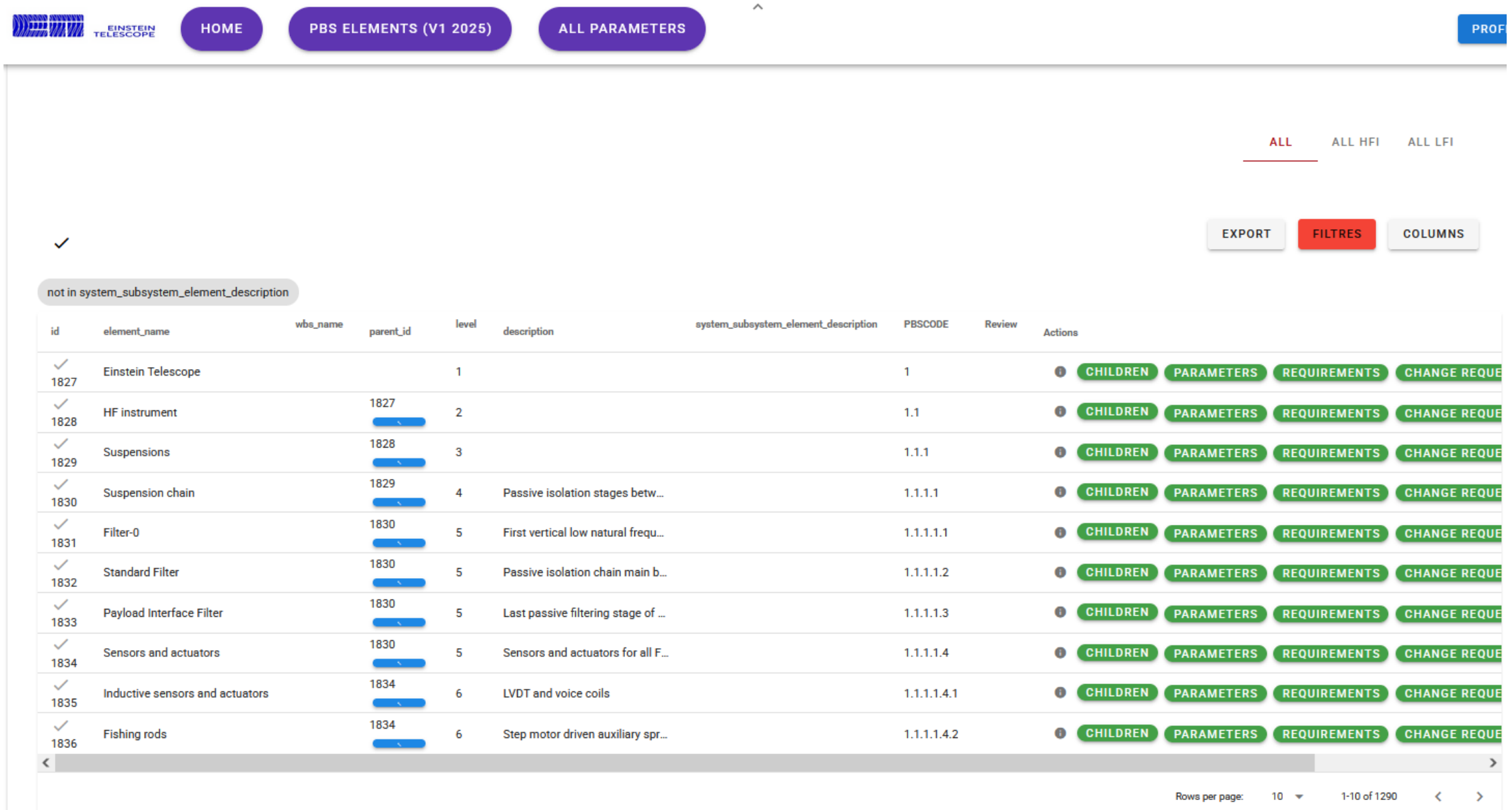
1. Product Breakdown Structure(PBS); with parameter tables
2. Optical layout
3. Detector layout

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 into latex files then Pre-TDR: Check availability of descriptive reports and finally Compose writing team (asap; discussing logic of TDR structure)

Preliminary Detector TDR ET-PP milestone Feb. 2026

ET PBS database



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 Cruciani	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)

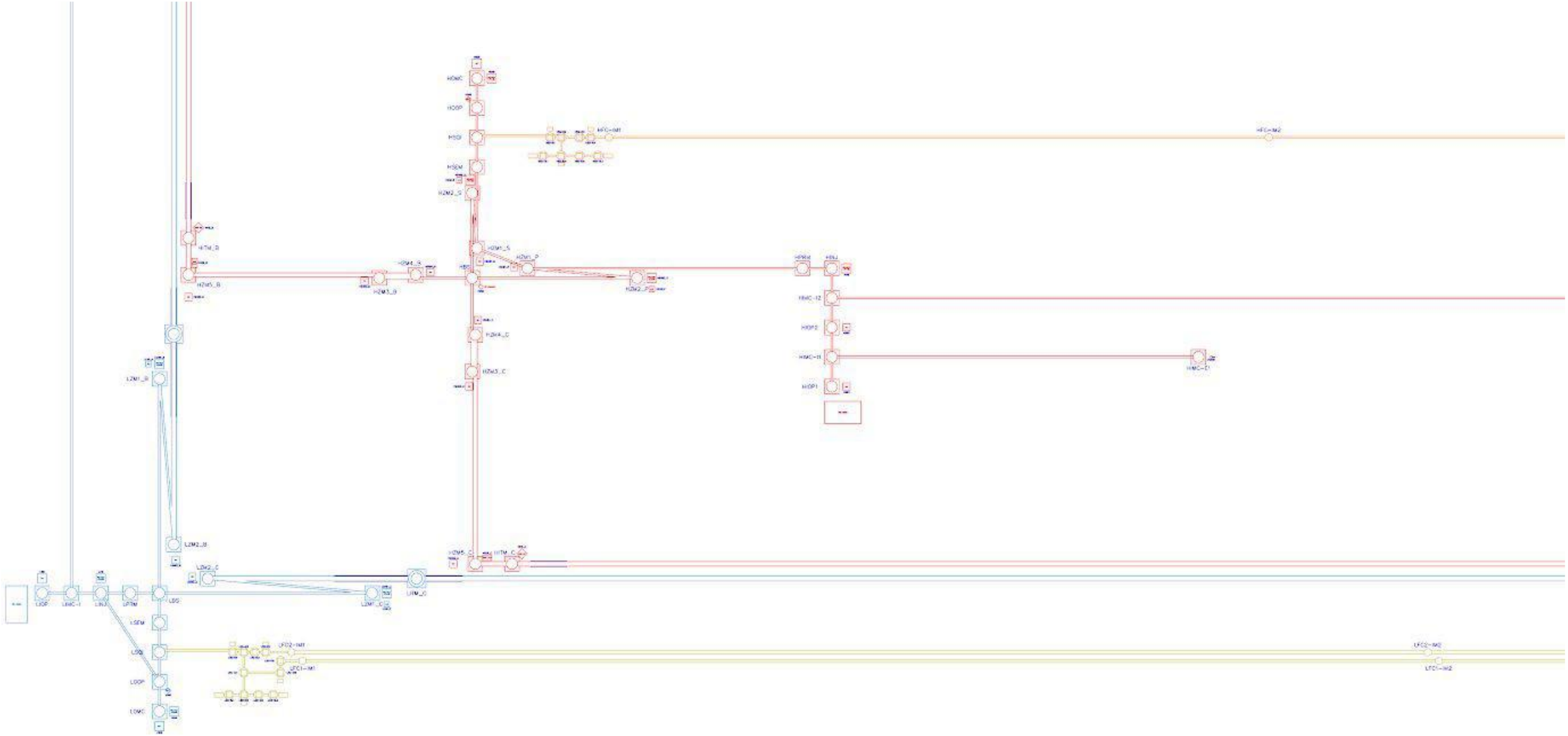
Name	Institution
Jerome Degallaix	LN2P3
Daniel Brown	Adelaide Uni
Giacomo Ciani	Trento University
Julia Casanueva	EGO
Sebastian Steinlechner	Maastricht University
Conor Mow-Lowry	Nikhef
Antonio Pasqualetti	EGO
Steffen Grohman	KIT
Ettore Majorana	Roma 1 University
Piero Rapagnani	Roma 1 University
Wissam 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

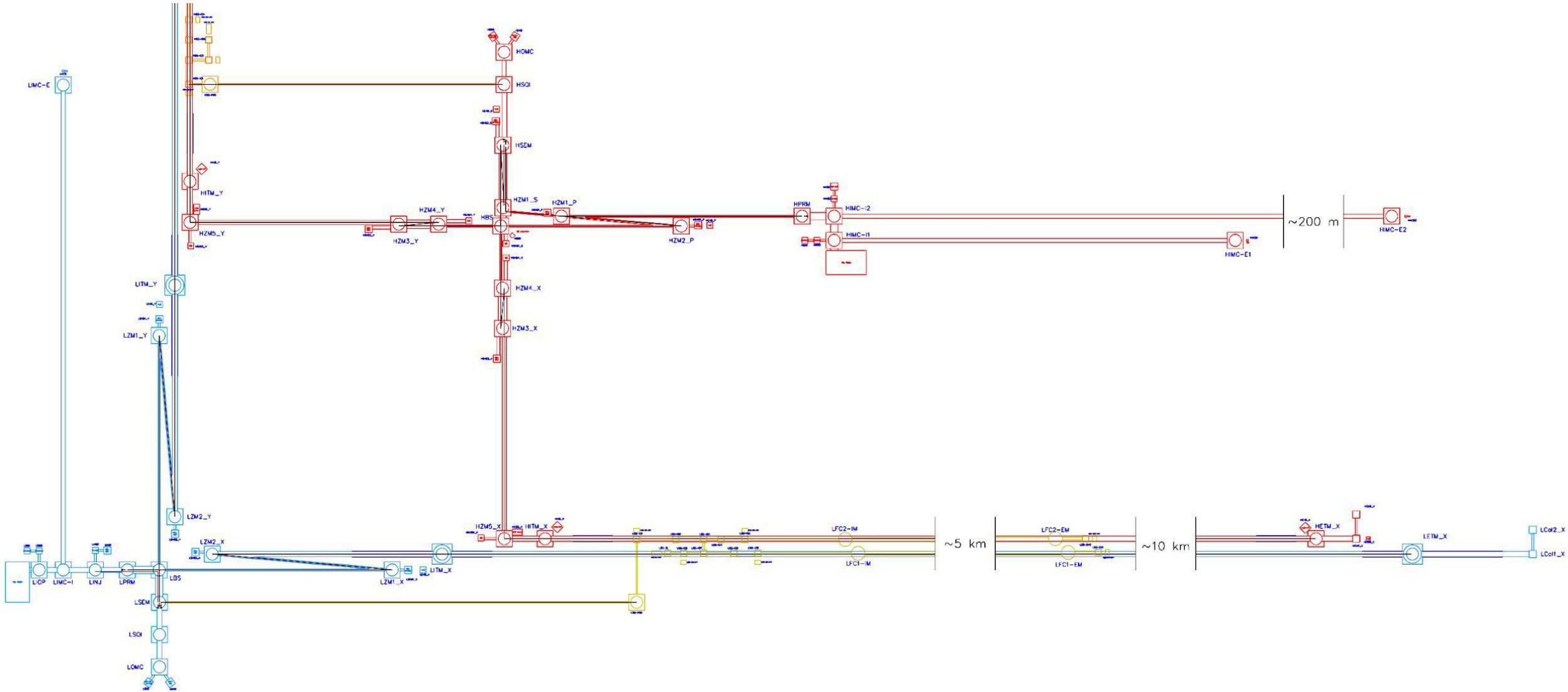
Summary of optical layout changes:

- 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



Optical Layout 2Ls 2025



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

ET Italia R&D activity at Trento

Trento RU is active in several ET Italia R&D WGs:

1. Core optics and Coating (E. Cesarini)
   - WP8: methodology
2. Quantum Enhancements (M. Leonardi)
   - WP1: development of integrated/fibered squeezed light source for ET LF
   - WP6: mismatch effects on squeezing
3. Wavefront sensing and control (A. Rocchi)
   - WP2: mode converter telescope, deformable mirror
4. Stray light mitigation (G. Ciani)
   - WP4: measurement of dust-scattering contribution in realistic setting and verification of predictive models

Budget 2025

Type	Description	Category	Request	Assegnato
Instr	WSC.2/ITS.4 - Infrared viewer: Necessario per allineare il fascio non visibile	WSC	5	5
Instr	WSC.2/RLA.3a - Laser a luce verde a baso rumore: Necessario il setup interferometrico per la misura del raggio di curvatura	WSC	7.5	7.5
Cons	WSC.2/RLA.3b - Ottiche e montaggi per la costruzione del setup di misura interferometrica	WSC	14	10
~~Software~~	~~Rinnovo licenza Comsol~~	~~OTHERS~~	~~6~~	
~~Instr~~	~~SQZ/SRC: FFT analyzer~~	~~QNR~~	~~16~~	

Mode mismatch measurement and correction on ET

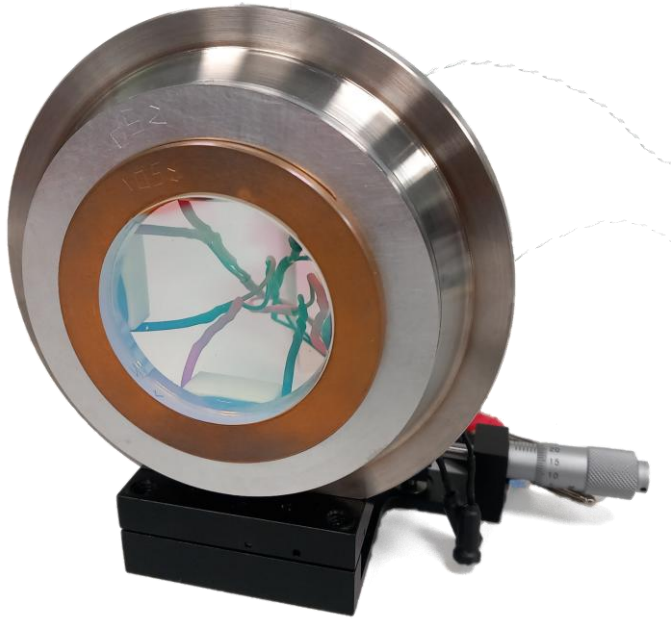
Mode-Mismatch measurement at 1550 nm

- Test cavity built and aligned at UniTn
- Cavity locked
- Measure lock stability and Unitary gain frequency of the lock control loop
- Measure the symmetrical and asymmetrical mode mismatch
  - Build mode-converter telescope
  - install quadrant photodiodes to measure MM

Mirror actuators, symmetrical and asymmetrical

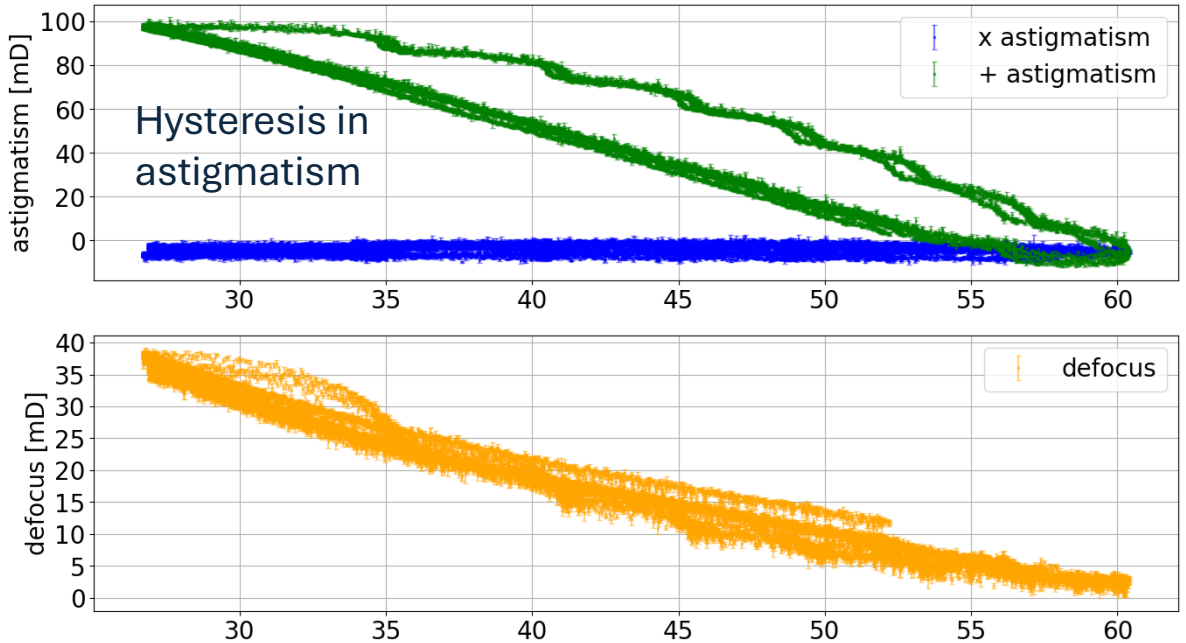
- Symmetrical actuator built and tested (same as Virgo)
- Two kinds of asymmetrical actuators designed: Bi-metallic and mono-metallic
  - Bi-metallic tested and still damage its mirror substrate→design to be improved
  - Mono-metallic asymmetrical actuator to be built and tested

(Future tasks)



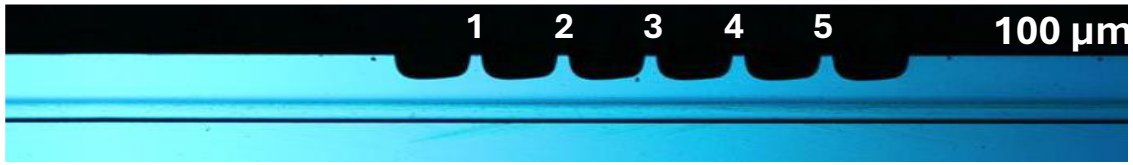
Picture of the bi-metallic asymmetrical actuator

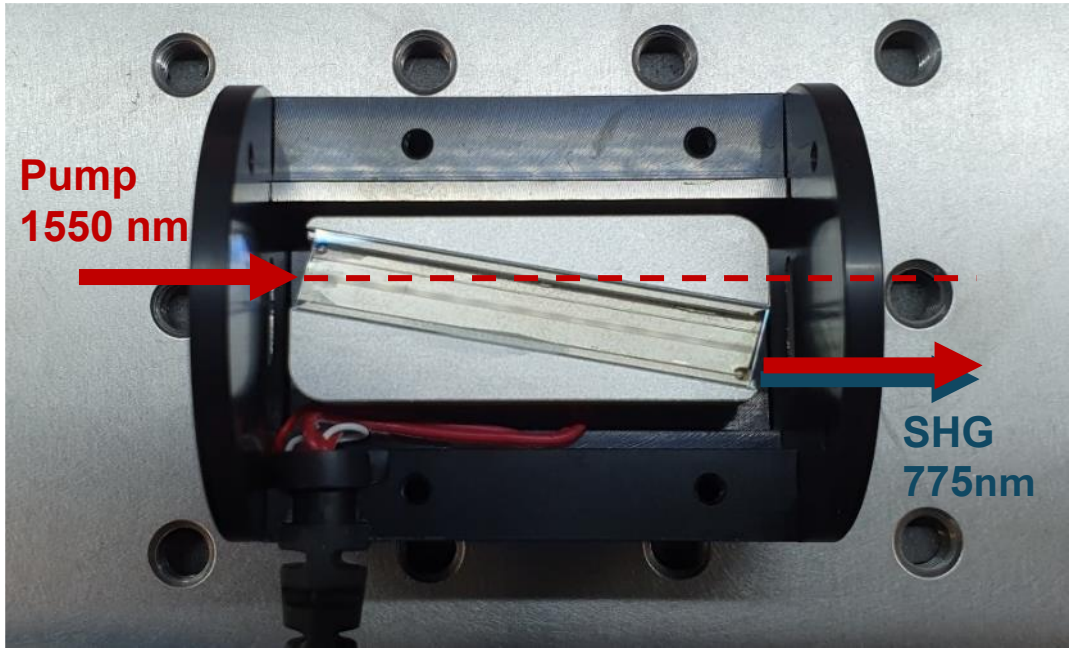
Diopter as function of temperature

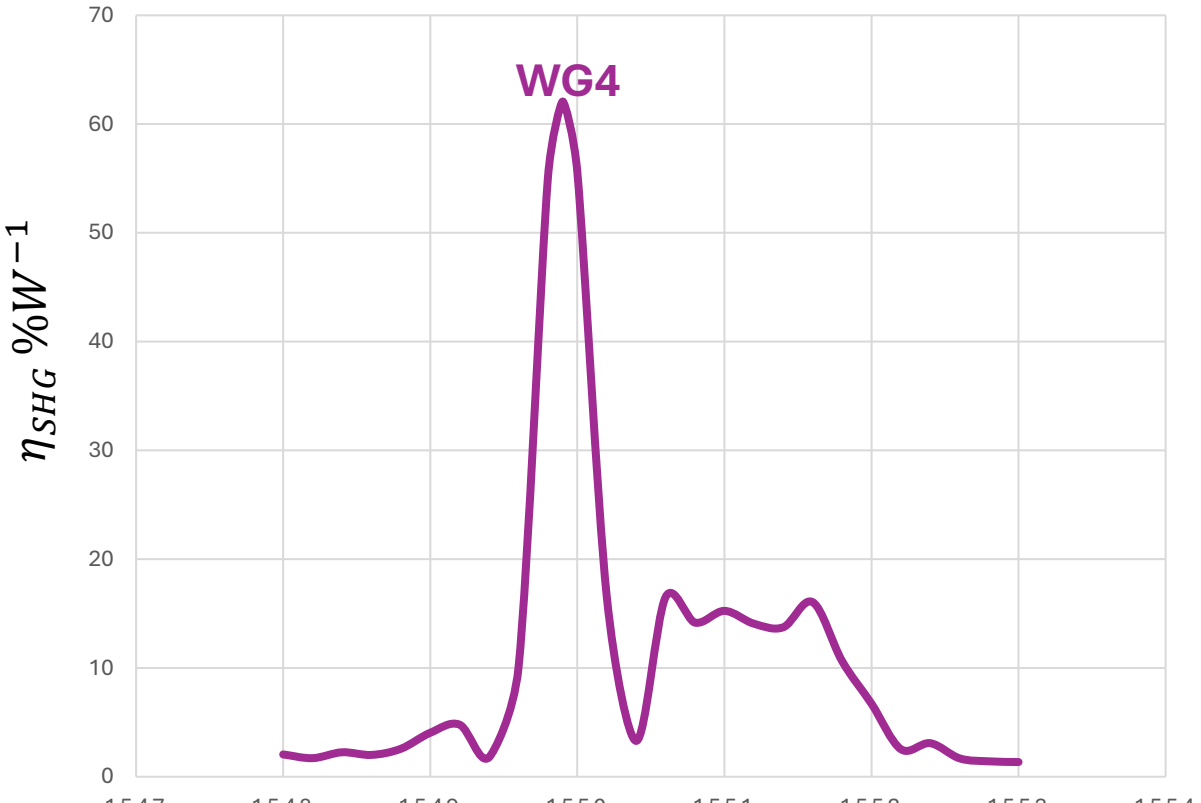


Squeezed light source for ET LF

No budget request related to this WP in 2025 due to the overlap with **CSN5** project “**SQUEEZE**”.

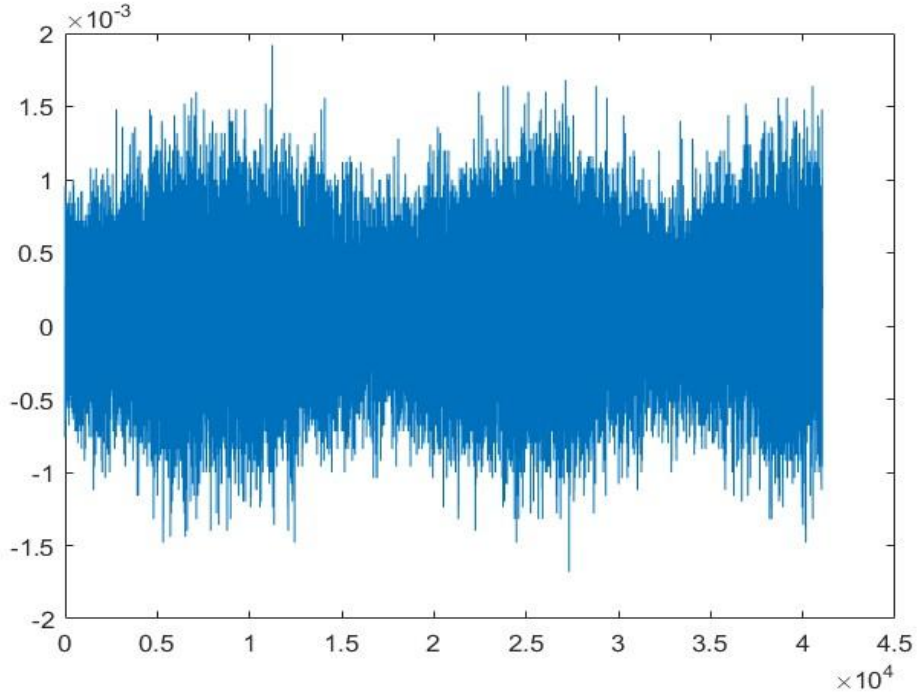


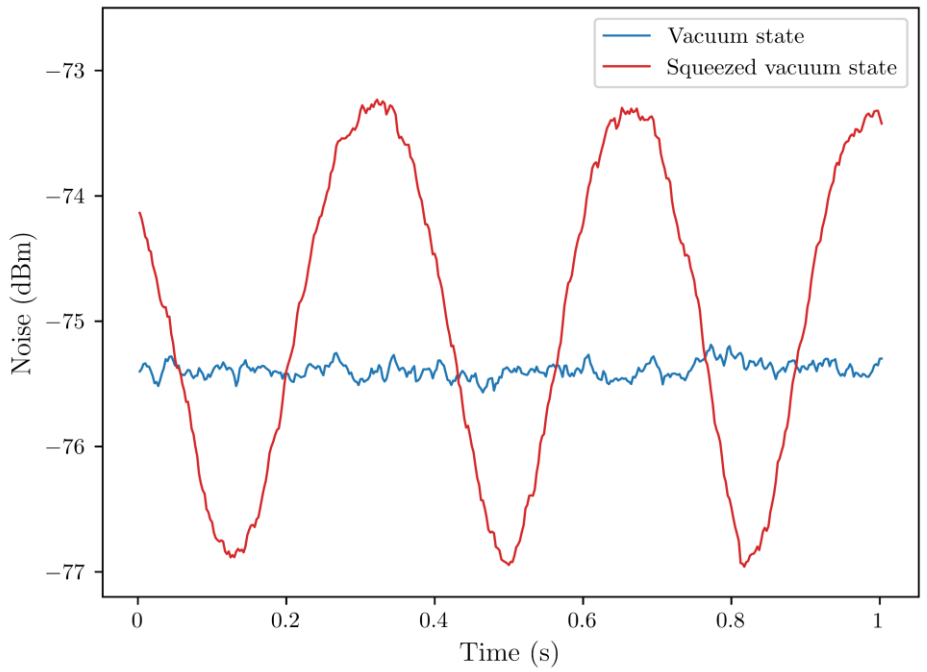




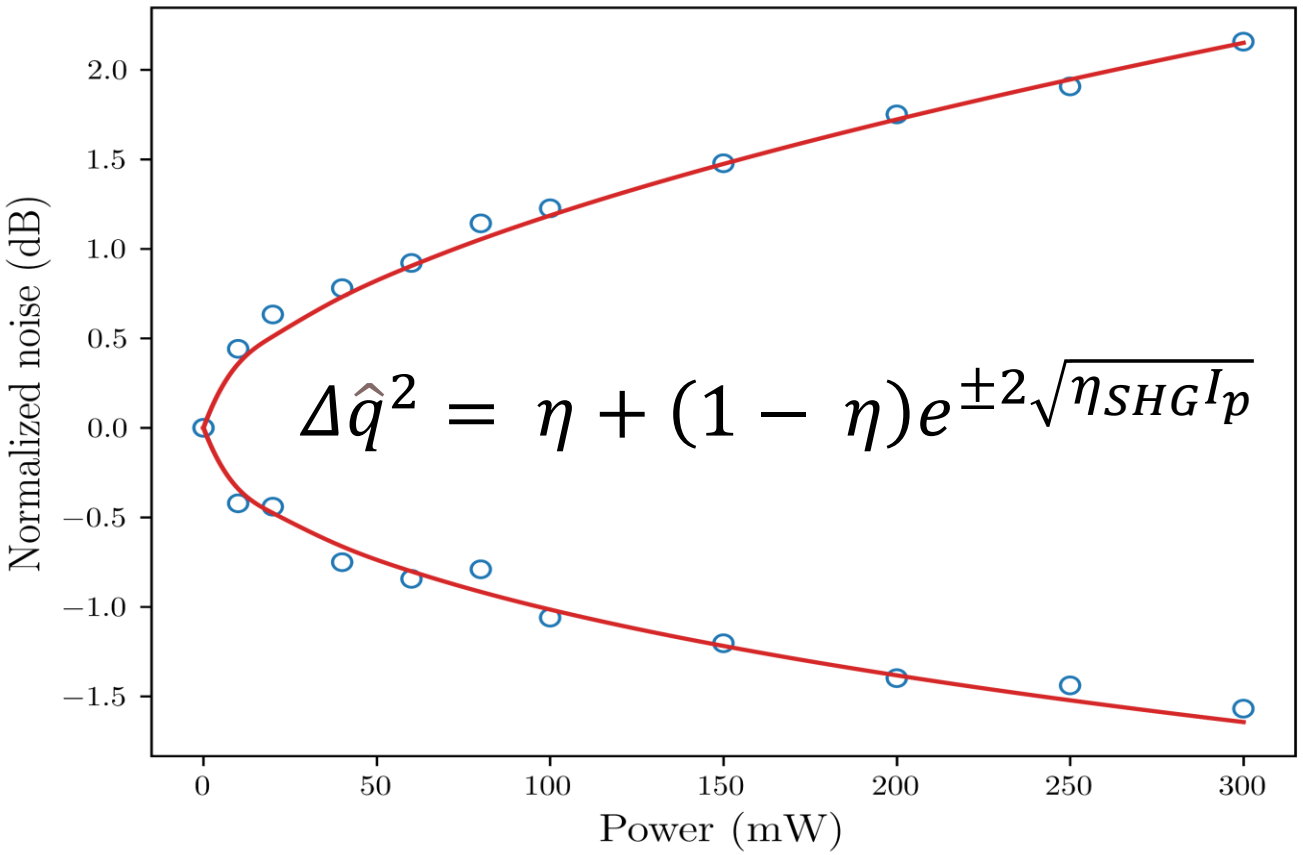
Squeezing measurement

The spatial overlap between squeezed light and local oscillator has been investigated by measuring the visibility (V=90 ±1 %).





Squeezing characterization



Squeezing level of
$\mathbf{-1.57 \pm 0.05 dB}$

Anti-squeezing level of
$\mathbf{2.16 \pm 0.07 dB}$

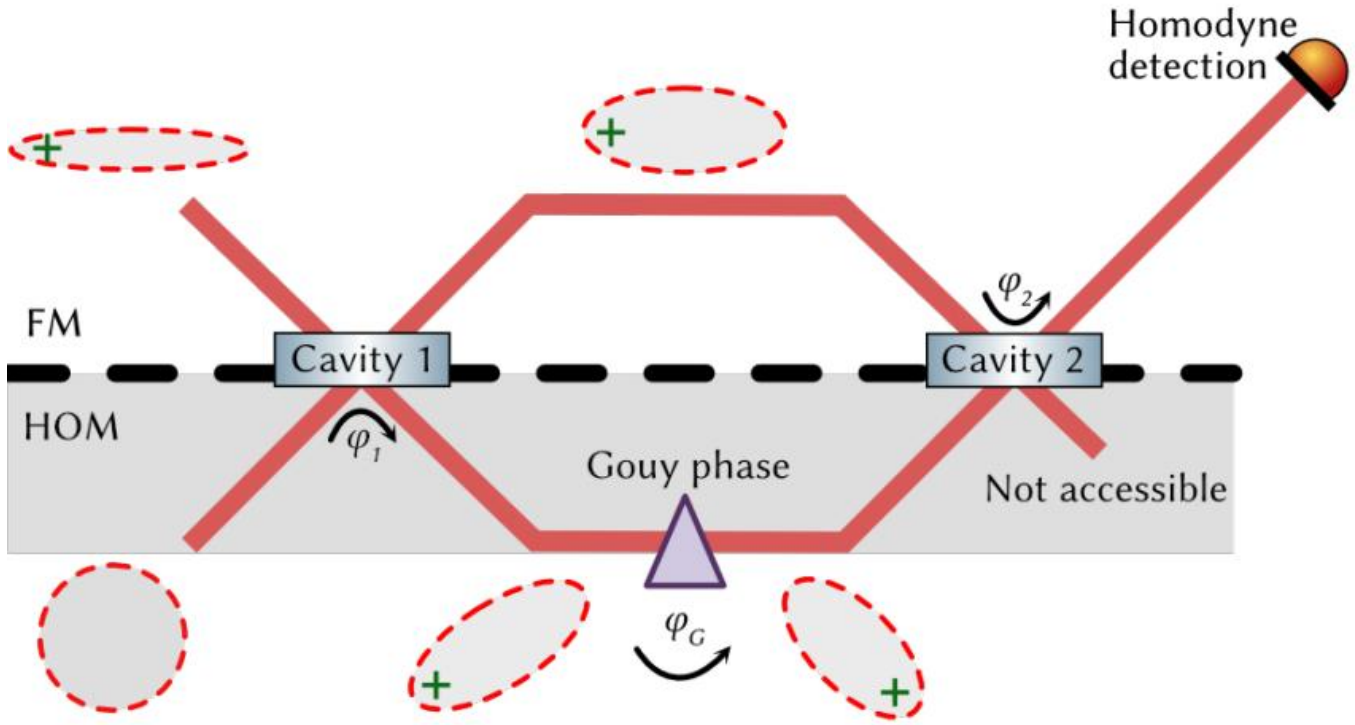
$\eta_{SHG} = 42\% W^{-1}$

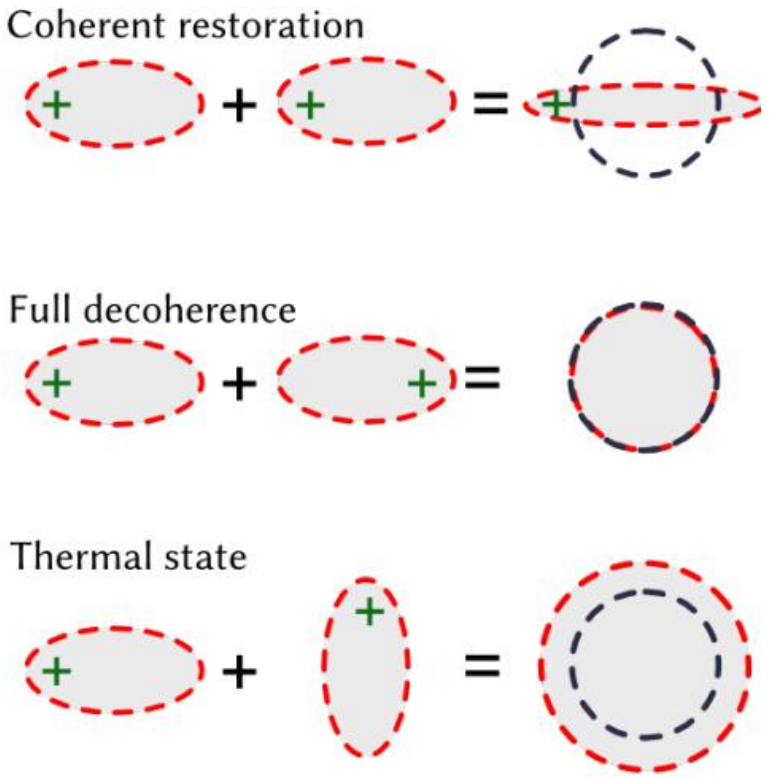
$losses\ \eta = 35\%$

Now that we demonstrated the capability of squeezing production, we will ask budget in 2026 to optimize this source for ET LF.

Budget request for 2026: approx. 35k

Mismatch effect on squeezing





Mismatch effect on squeezing, tabletop experiment

- Anno 1:
  - costruzione di una cavità triangolare stabile con loop di aggancio (PDH)
  - Implementazione di un sistema di Auto Allineamento

- Anno 2:
  - aggiunta di una seconda cavità gemella (o simile)
  - integrazione del fascio di squeezing

- Anno3:
  - misura e caratterizzazione degli effetti di dephasing in funzione del mismatch e della fase di Gouy

Budget request for 2026: approx. 23k

Sensore di polvere compatto UHV compatible

Progetto in collaborazione con la sezione di Padova.

Motivazione: monitorare la contaminazione da polvere i ET e altri ground-based detectors durante le operazioni.

Idea di base: foglio di luce con array di fotorivelatori e algoritmi di analisi del segnale congiunto.

Work packages:

- Generazione del foglio di luce (PD)
- Damping del foglio di luce (PD)
- Posizionamento dei rivelatori e analisi del segnale (TN)
- Sviluppo elettronica (PD)
- Ingegnerizzazione package (TN+PD)

TN ha uno studente di dottorato in visita dalla Cina dedicato per un anno a questo progetto.

Budget request for 2026: approx. 7k