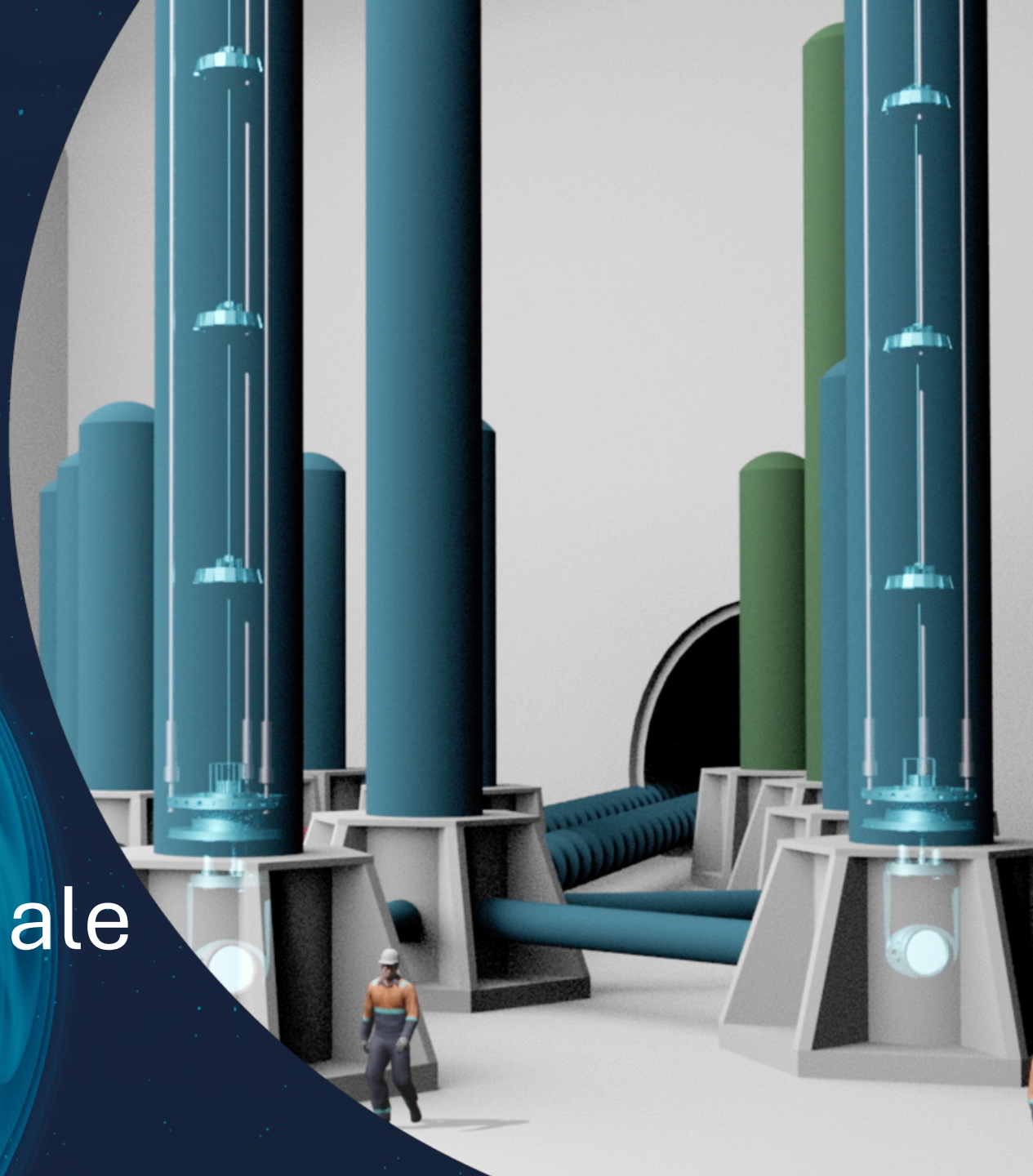
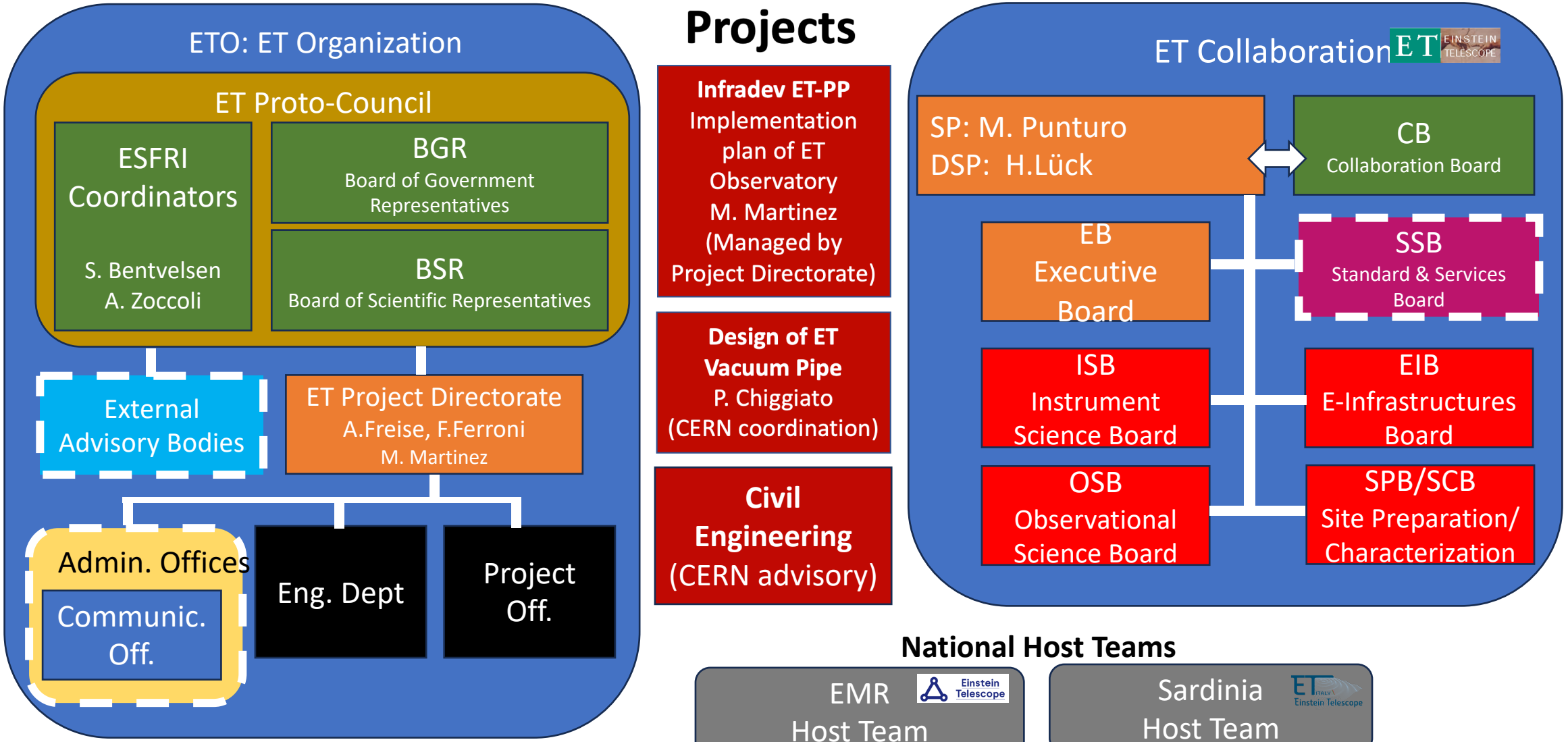
ET ITALY
Einstein Telescope



La Collaborazione ET Internazionale e Nazionale

D. D'Urso – ET National Representative

ET Project: Current Organization



Proto-council

ESFRI Coordinators
Stan Bentvelsen, Antonio Zoccoli

BGR (Board Governm. Represent.)

BSR (Board Scient. Represent.)

Policy & monitoring

Advisory Bodies
Scientific and Technical Advisory Committee
Program Advisory Board

Project Directorate
F. Ferroni, A. Freise
M. Martinez

monitoring / reporting

Deliverables:
Beam pipe vacuum
Site Preparation
Civil Infrastructure

INFRA-DEV
M. Martinez

- WP1 Coordination and Management
- WP2 Organization , Governance, Legal
- WP3 Financial Architecture
- WP4 Site Preparation
- WP5 Project Office/Engineering Dept.
- WP6Technical Design
- WP7Transfer of Technology
- WP8 Computing and Data Access
- WP9 Sustainable Development Strategy
- WP10 Education, Outreach, Citizen Engagement

monitoring / delivering

CERN
MOA CERN-INFN-Nikhef
P. Chiggiato

TDR ET Vacuum Pipe

Requirements & competences

Communication Office

Project Office

Engineering Department

setting

Strategy

ET Organization

ET Collaboration

Providing services

EB Executive Board

Policy proposals+ monitoring

Informing

CB Collaboration Board

managing

SSB Services and Standards Board

managing / reporting

advisory

FNR Forum of National Representatives

managing / reporting

SF Science Forum

Providing services

participating / supervisioning

ISB Instrument Science Board

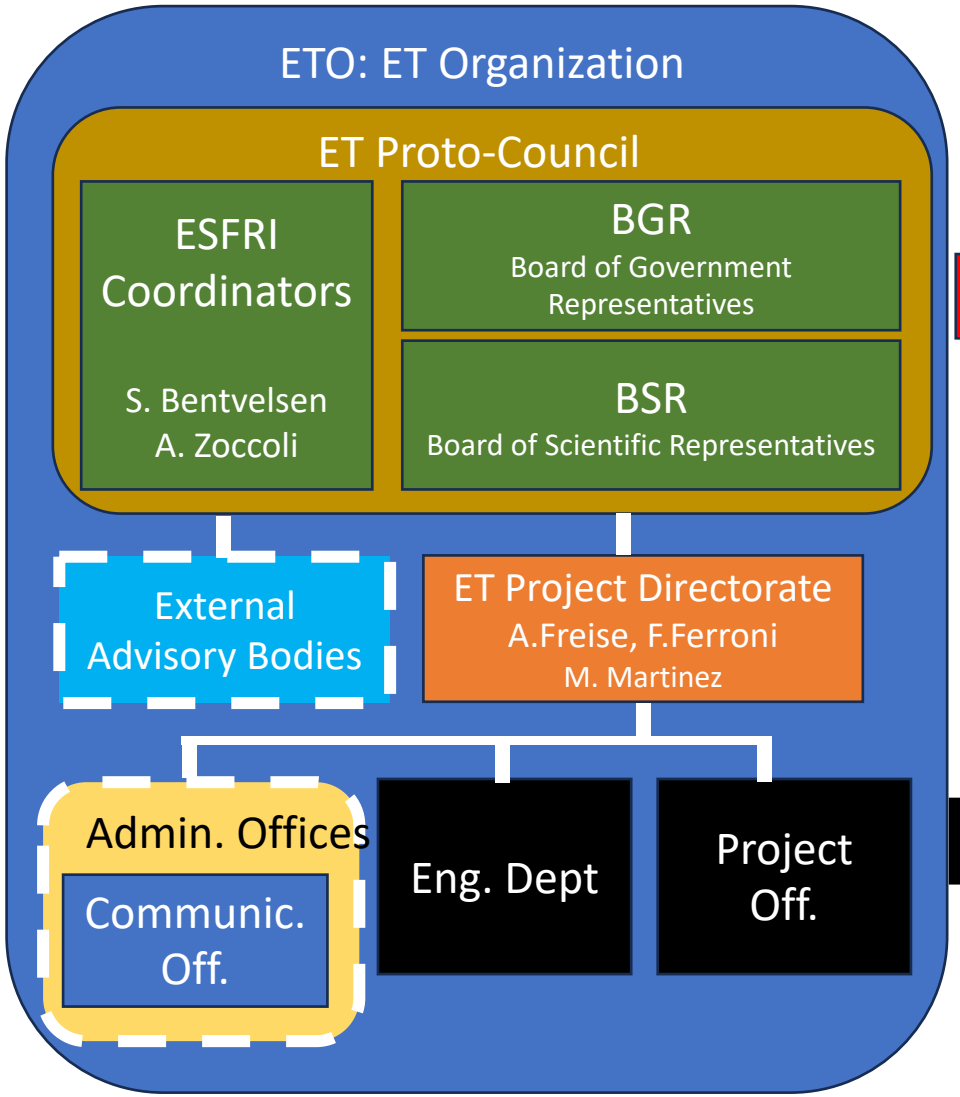
EIB Electronics/Computational Infrastructure Board

OSB Observational Science Board

SCB Site Characterisation Board

Specific Boards

ET Current Organisation



Temporary groups, working towards becoming the ET governing body, such as a Council. **Our most important link to governments and funding agencies** (Austria, Belgium, France, Italy, Netherlands, Poland, Spain, UK are members with Germany as observer).

An small but active organisation with the formal responsibility to realise ET. **A future legal entity for ET would be based on this structure.**

Credits: A. Freise

ET Current Organization

Projects

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

- Main activities:
  - Structuring the ET legal entity
    - Defining its governance
    - Defining its technical bodies
  - Define the financial aspects of ET
  - Manage the relationship of the ET project with the European Commission framework (ESFRI)

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

- More than 120km of vacuum pipes
  - Define the technical design of the vacuum pipe with a clear target in the cost reduction
  - Propose innovative materials and solutions
- Joint developments with CERN involving ET and CE

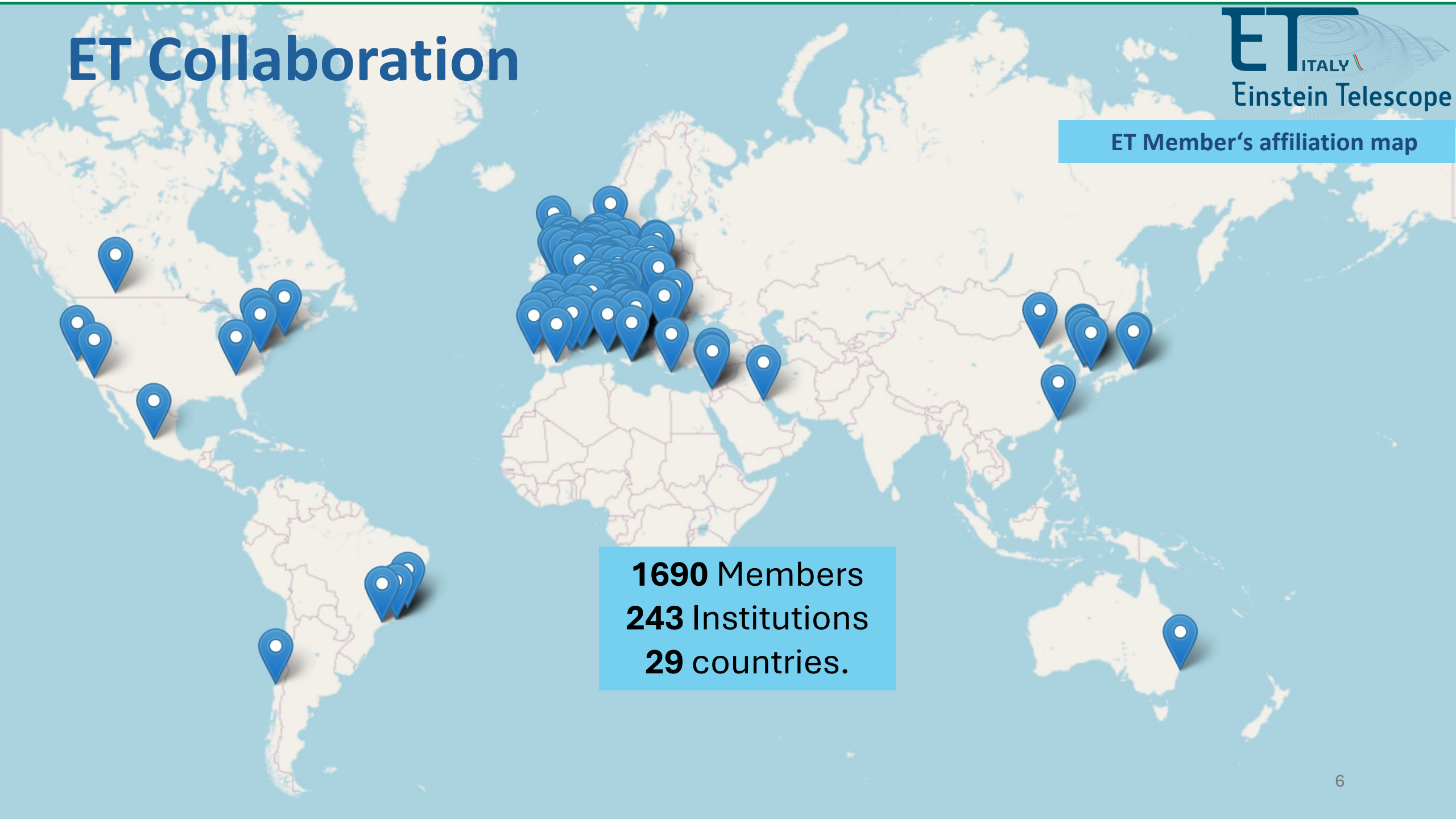
Civil Engineering
(CERN advisory)

- Profit of the CERN expertise in large civil and technical underground research facilities
- Develop together, in collaboration with external companies, the design of the ET facilities

ET Collaboration

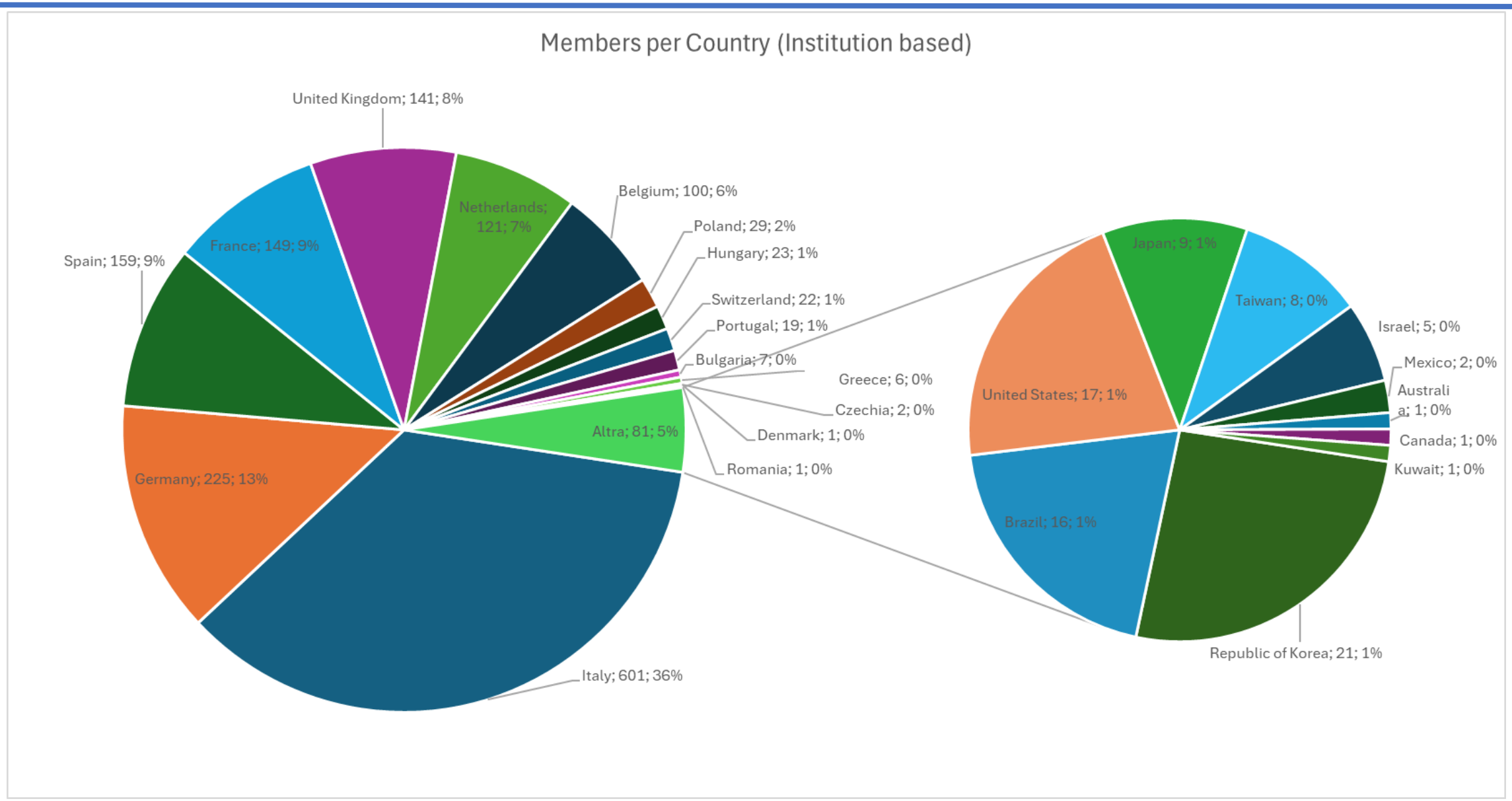
ET Einstein Telescope ITALY

ET Member's affiliation map



1690 Members
243 Institutions
29 countries.

ET Collaboration Demography

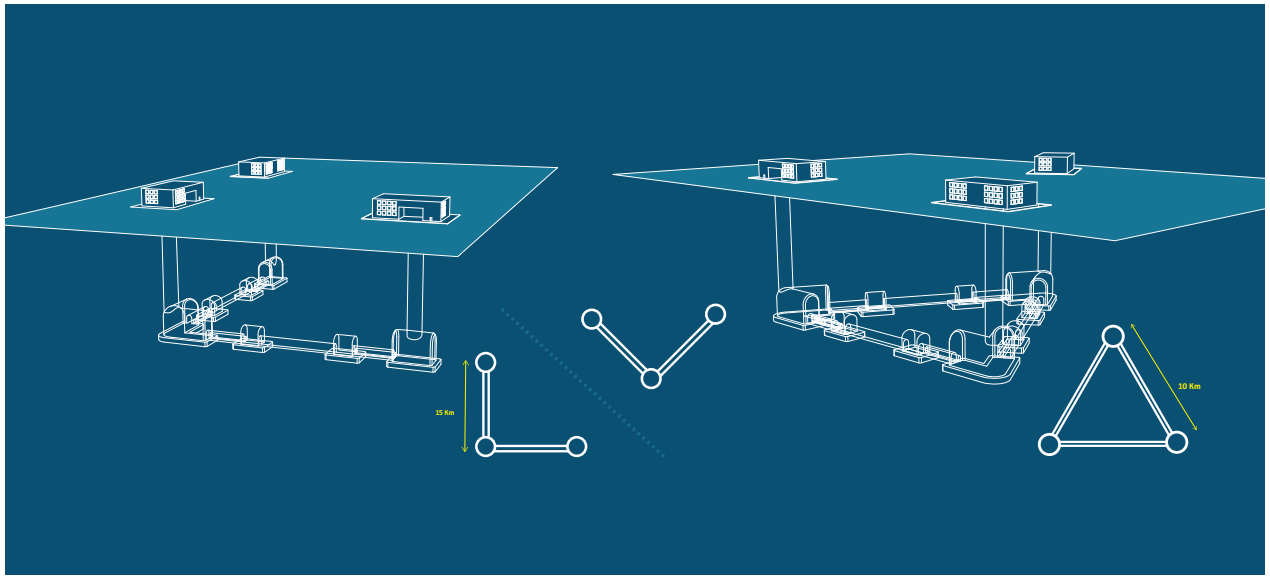


Current Main Activities

- **Updating the ET science case Δ or 2L**
- **Defining the key elements of the ET detector** (TDR)
- **Realizing a European network of R&D infrastructures**
- **Developing the design of the ET governance, civil and technical infrastructures, evaluating their costs**
- **Preparing the bidbook for the candidature of the sites**

ET science case: Δ or (two) L

- Since 2011 (CDS, triangle configuration) the situation drastically changed:
  - ❑ First detections, GTWC-3 catalog → BH population → new evolution models;
  - ❑ Science case developed;
  - ❑ Know-how with advanced (L) detectors;
  - ❑ International scenario (+ Cosmic Explorer in US);
  - ❑ Two candidate sites strongly supported (and a potential third site…).
- The Collaboration is analyzing both configurations: optimizing science return, differential risk assessment.
- First results on the science return published in Marica Branchesi et al JCAP07(2023)068:
- A preliminary differential risk analysis, provided by a specific committee, is under elaboration



The 2L 15 km geometry shows an improved science return in a relevant number of science targets

ET Enabling Technologies

Challenging engineering

New technology in cryo-cooling

New technology in optics

New laser technology

High precision mechanics and low noise controls

High quality opto-electronics and new controls

➢ The multi-interferometer approach asks for two parallel technology developments:

- **ET-LF:**
  - Underground
  - Cryogenics
  - Silicon (Sapphire) test masses
  - Large test masses
  - New coatings
  - New laser wavelength
  - Seismic suspensions
  - Frequency dependent squeezing

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)	$5 \cdot 10^{-10}$ m/f^2	$5 \cdot 10^{-10}$ m/f^2
Gravity gradient subtraction	none	factor of a few

- **ET-HF:**
  - High power laser
  - Large test masses
  - New coatings
  - Thermal compensation
  - Frequency dependent squeezing

Evolved laser technology

Evolved technology in optics

Highly innovative adaptive optics

High quality opto-electronics and new controls

ET ITALY Einstein Telescope

R&D

- National funds for R&D
- Common fund are current limited to vacuum and civil engineering studies (@CERN)
- R&D scenario and roadmap on going
  - DB of enable covered technologies
  - avoid duplication of efforts
  - R&D that can be offered to new RU
  - international R&D plan

ET Italia

- 605 members of 81 institutions for 27 RU
- **Site Characterization**
- **R&D enabling technologies**
- sinergia con altri progetti INFN
- Finanziamenti: nazionali (fondo Ferroni-Fedeli, PRIN), regionali (RAS) ed europei

R&D Research lines

- 3G Vacuum Systems and Cryogenics (VAC)
- Cryogenic payload (CPAY-LF)
- Suspensions and Seismic Isolation Systems (SUS)
- Active Noise Mitigation (ANM)
- Core Optics and Coatings (CRD)
- Wave front sensing and control (WSC)
- Quantum Noise Reduction (QNR)
- Stray light mitigation (SLM)
- Computing
- DAQ

Synergies with VIRGO

- Frequency dependent squeezing (10 dB)
- High power laser (1.5 MW intracavity power planned for VnEXT vs 3 MW planned for ET)
- Thermal compensation system
- Input and output optics
- Parametric instabilities mitigation
- Coatings
- Mirrors
- Payload
- Seismic superattenuator
- Scattered light mitigation
- Digital electronics and calibration

ET candidate sites

- Two sites officially candidate:
  - EMR EUregio, border region between Nederland, Belgium and Germany
  - Sardinia (Sos Enattos area)
- A third potential site is located in Saxony (Lusatia), still not official
- Overall site evaluation is a complex task depending on:
  - Geophysical and environmental quality
  - Financial and organization aspects
  - Services, infrastructures

Investments and Timing

INVESTMENTS FOR SITE DEVELOPMENT (ALREADY ALLOCATED)

total **109 million**

€3.5 million	€17 million	€4 million	€50 million	€2.5 + 12 million	€10 + 10 million
SAR-GRAV laboratory *by Autonomous Region of Sardinia*	ET Project *by MUR*	PRIN ET Tecnhologies *by MUR*	NRRP ETIC project *by MUR*	NRRP MEET and TERABIT *by MUR*	multidisciplinary laboratory Sos Enattos *by Autonomous Region of Sardinia and INFN, INAF, INGV*

INVESTMENTS FOR THE CONSTRUCTION OF THE LABORATORY IN SARDINIA

total **1.3 billion**

€350 million	€950 million
by Autonomous Region of Sardinia	by Italian Government