THE TECHNOLOGICAL (AND OTHER) CHALLENGES OF ET

Gianluca Gemme

INFN Genova

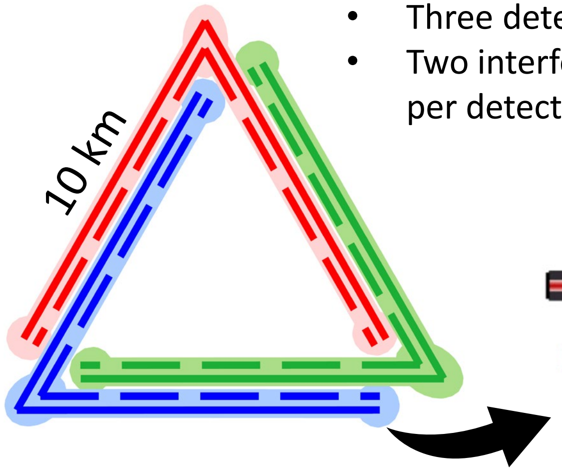
on behalf and with the contribution of
the ET Instrument Science Board

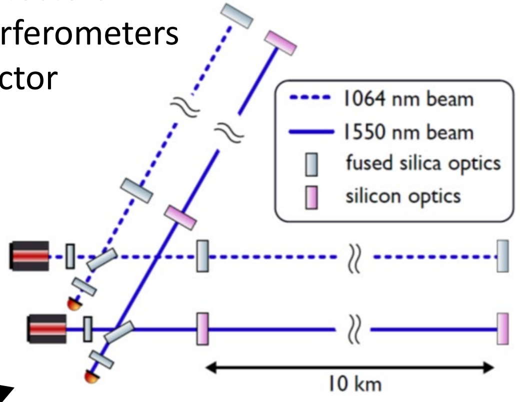
XII ET Symposium

Budapest, 7/6/2022

THE ET CONCEPT

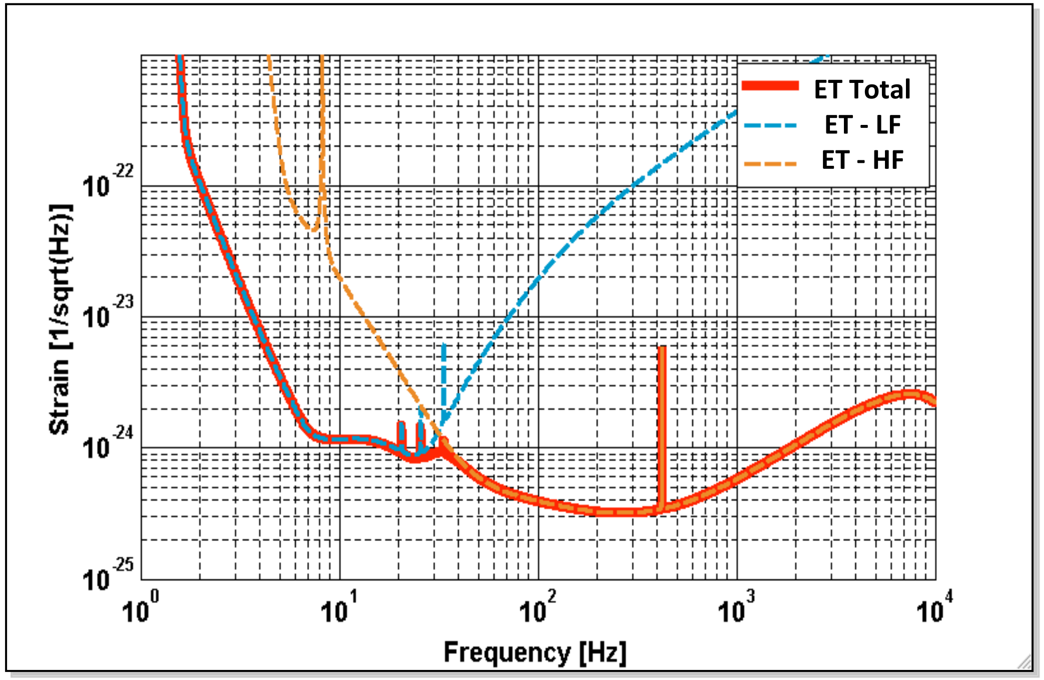
- Three detectors
- Two interferometers per detector

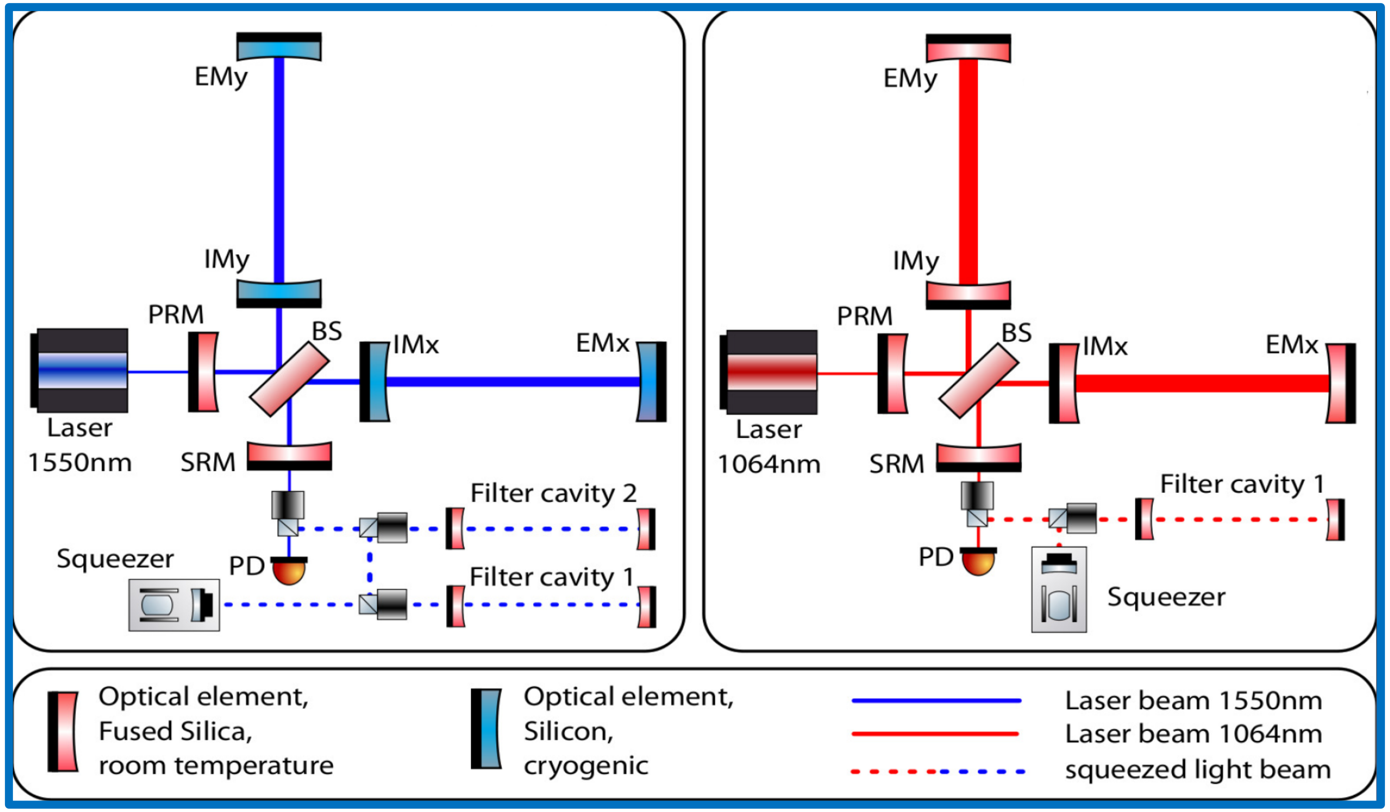


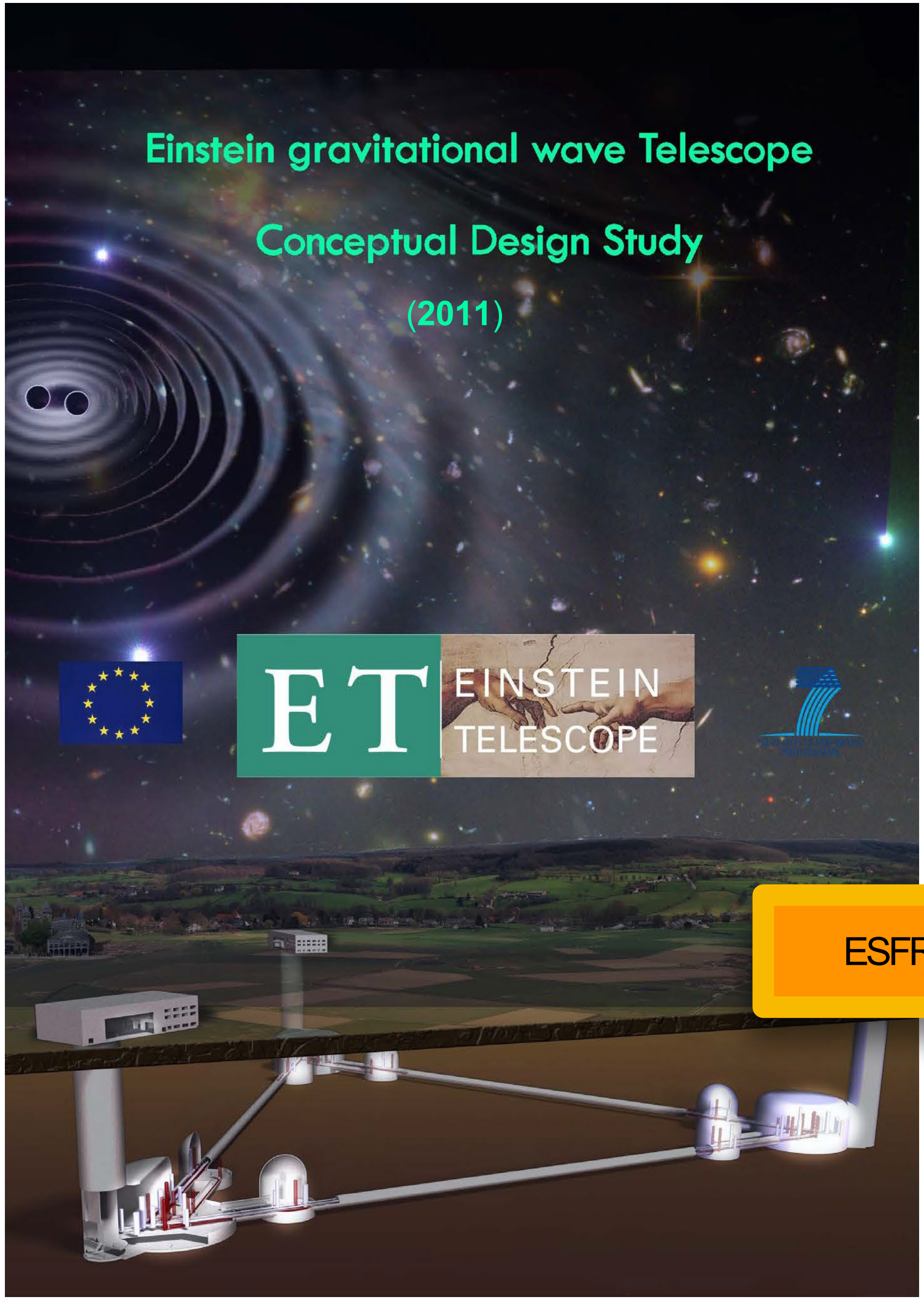


- ET - Low Frequency (LF): large cryogenic (10 - 20 K) silicon test masses, seismic suspensions, new wavelength, FDS, ..
- ET - High Frequency (HF): high power laser, high circulating light power, thermal compensation, large test masses, FDS, ..

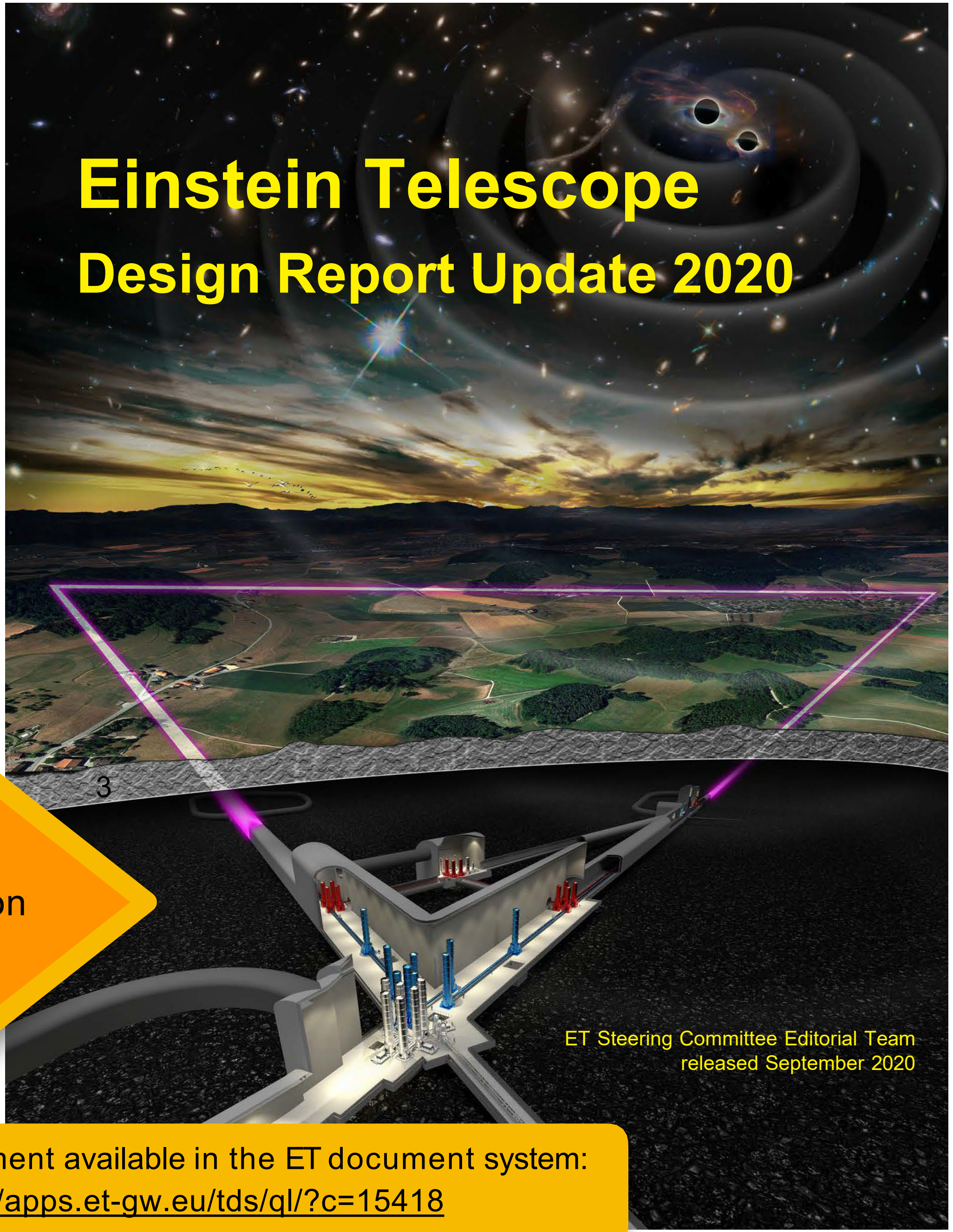
Sensitivity of ET (currently being updated)







ESFRI Application

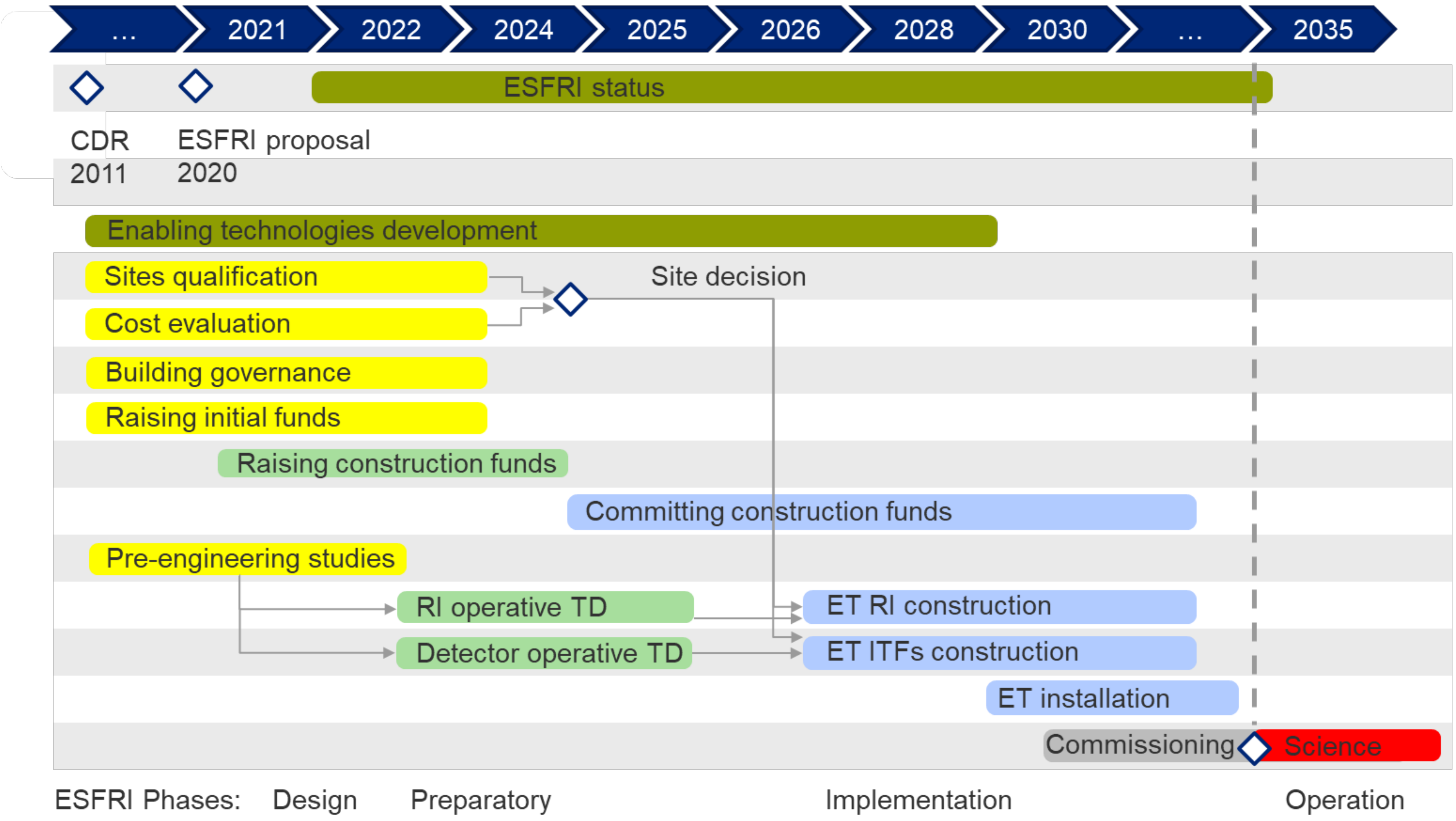


Document available in the ET document system:
https://apps.et-gw.eu/tds/ql/?c=15418

LIMITED CHANGES TO THE CONCEPTUAL DESIGN SO FAR

- The design update aimed at providing the same sensitivity curve with only small design changes that incorporate the state-of-the-art of instrument science in the field
- The new design document contains one baseline design, instead of several alternative design options from the conceptual design
- Design changes include:
  - Underground infrastructure uses several small caverns instead of single very large caverns at each corner
  - Filter cavities: removed from main tunnel, located in auxiliary tunnels, cavities are now shorter
  - Use of beam expander telescopes between beam splitter and input test mass. Noise model now correctly includes finite signal recycling cavity length
  - ET-HF does not use laser beams in a higher-order Gaussian mode, but the fundamental Gaussian mode. The thermal noise target can be achieved with A+ like coatings

TIMELINE (ESFRI)



EXCERPTS FROM THE ISB MANDATE

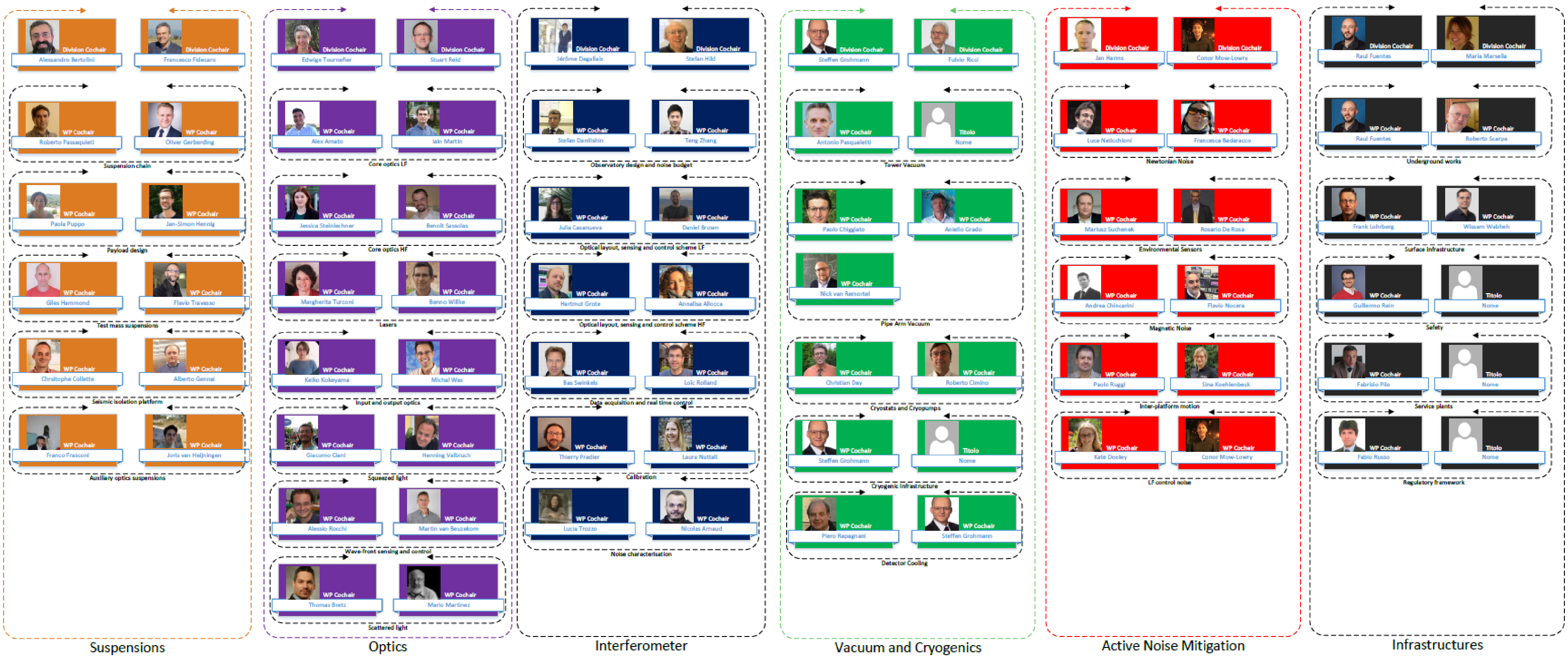
(ET-0085A-20, DEC 2020)

- The first objective of the team is to deliver the **ET Technical Design Report (ET-TDR)** of the infrastructure and of the detectors [...] in an iterative process. […]:
    - **By the end of 2022** (including costs evaluations) initial report:
      The level of detail of the design must be sufficient to allow the customization of the design for the two different sites, in order to prepare the site bids.
    - **By end of 2025** (including costs evaluation) for the Research Infrastructure:
      This activity will probably be transferred to (or shared with) an external company
    - **By the end of 2025** (including costs evaluations) for the detector

- **The timing is outdated. We are currently discussing an update of the timing and deliverables**

[...] If the technical solution is missing, they have to **highlight the need for R&D activity in this sector**. They are to coordinate the decision-making process to select between alternative design options that affect several work packages across divisions […]

ET Instrument Science Board (ISB) Organigram (ET-0033A-21) JULY 2021



Currently ~170 subscribers to et-isb-all mailing list

HIGHLIGHTS ON ISB ACTIVITIES

Regular weekly/bi-weekly meetings of ISB board/divisions/WGs

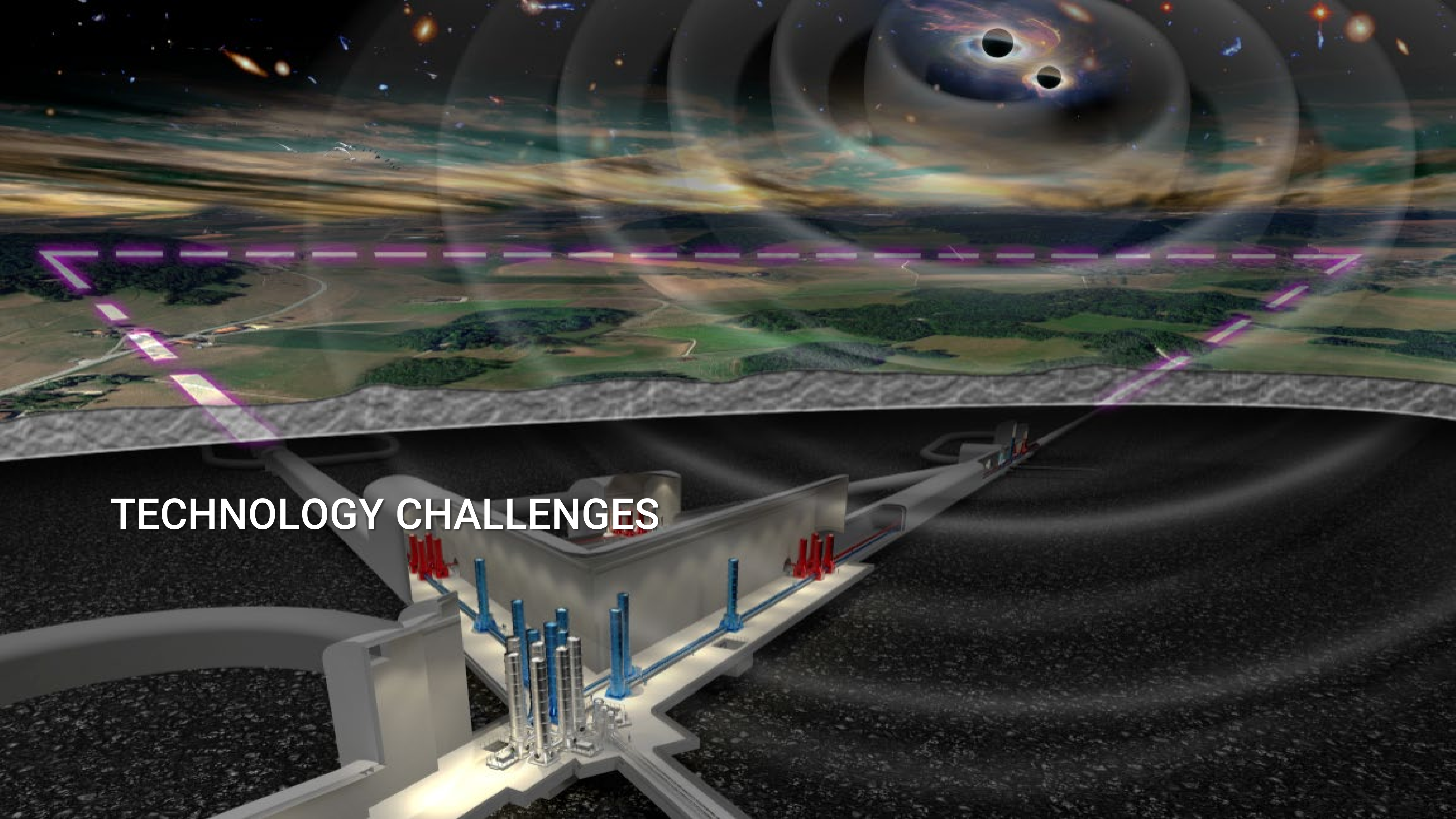
Topical meetings

- March 12 2021, Thermal noise workshop
- March 29-31, 2021 ISB Workshop (ET-LF mirror temp; LF noise; Facility limits)
- Sept 3/16 2021, ET-LF wavelength workshop
- Nov 24-26 2021, CoBA workshop
- Nov 24 2021 First ET-LF cryostat design meeting, Cascina
- May 12 2022, Recycling cavities design
- April 27-28 2022, Second ET-LF cryostat design meeting, Roma

Upcoming

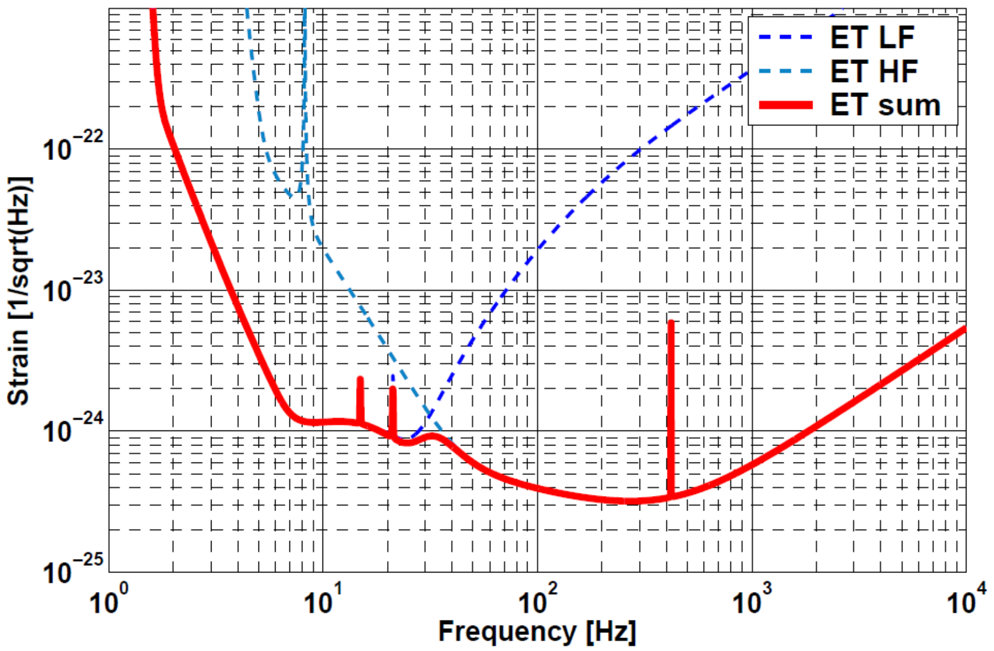
- July 2022, Meeting on noise in underground research infrastructure
- 29-30 Sept 2022, First Gravitational Wave Detector Vacuum workshop (GWDVac22), La Biodola (Isola d'Elba) Italy
- Fall 2022, ISB workshop
- Spring 2023 (TBC), Vacuum workshop, CERN

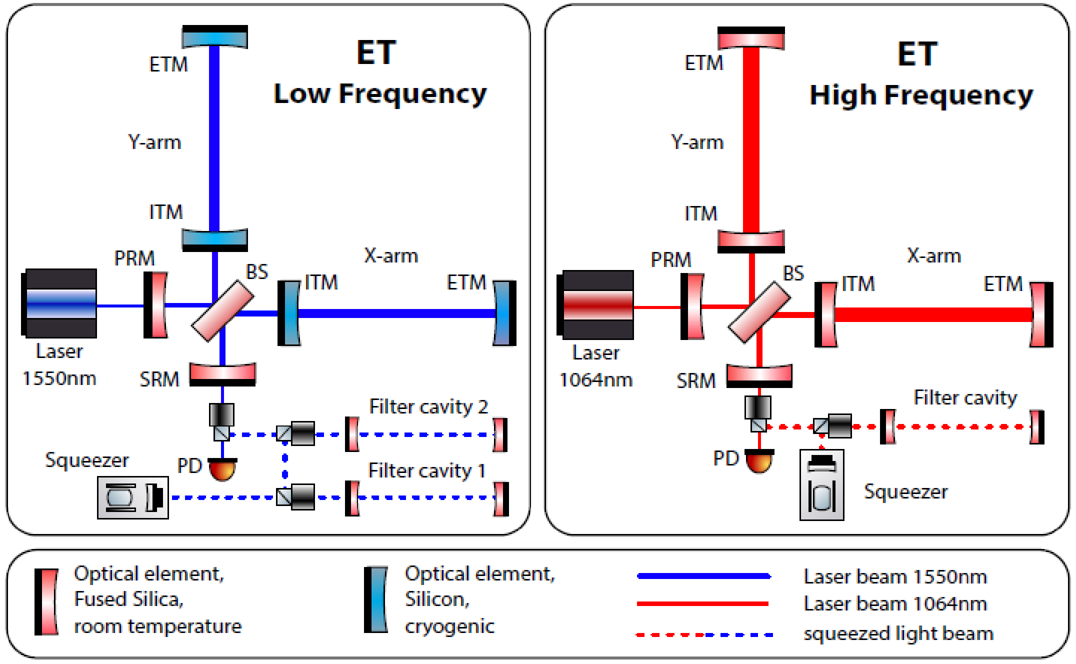
TECHNOLOGY CHALLENGES



ET BASELINE DESIGN

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 TECHNOLOGY (MAIN) CHALLENGES

Challenging engineering

New technology in cryo-cooling

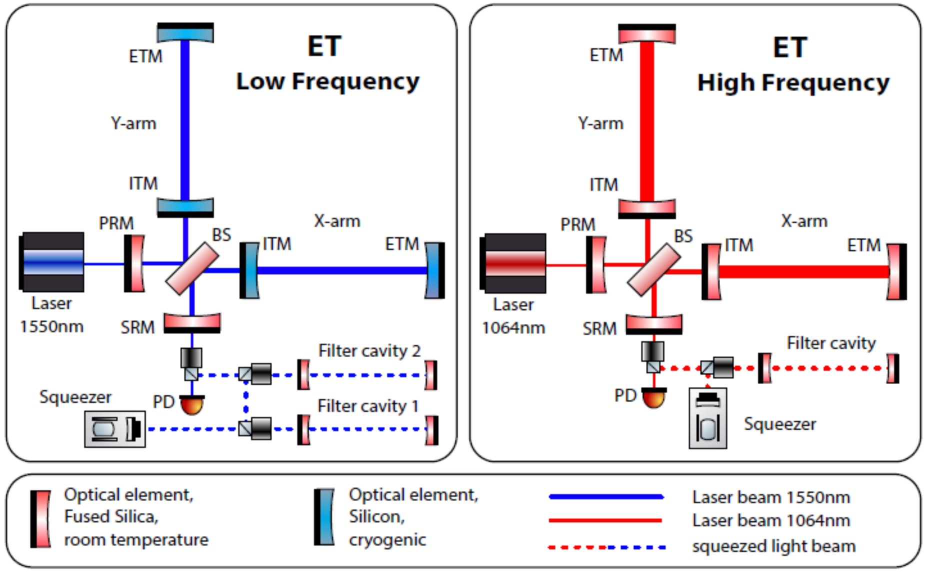
New technology in optics

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

- **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

LOW FREQUENCY NOISE

ET is not 10x better than 2nd gen detectors, it is million times better at 3Hz…

…and no gravitational wave detector to date has reached its design sensitivity at low frequencies

We need to systematically identify and mitigate LF noise

- RMS motion
- Achievable isolation
- Light scattering
- Angular controls
- Seismic platform and suspensions
- Environmental noise

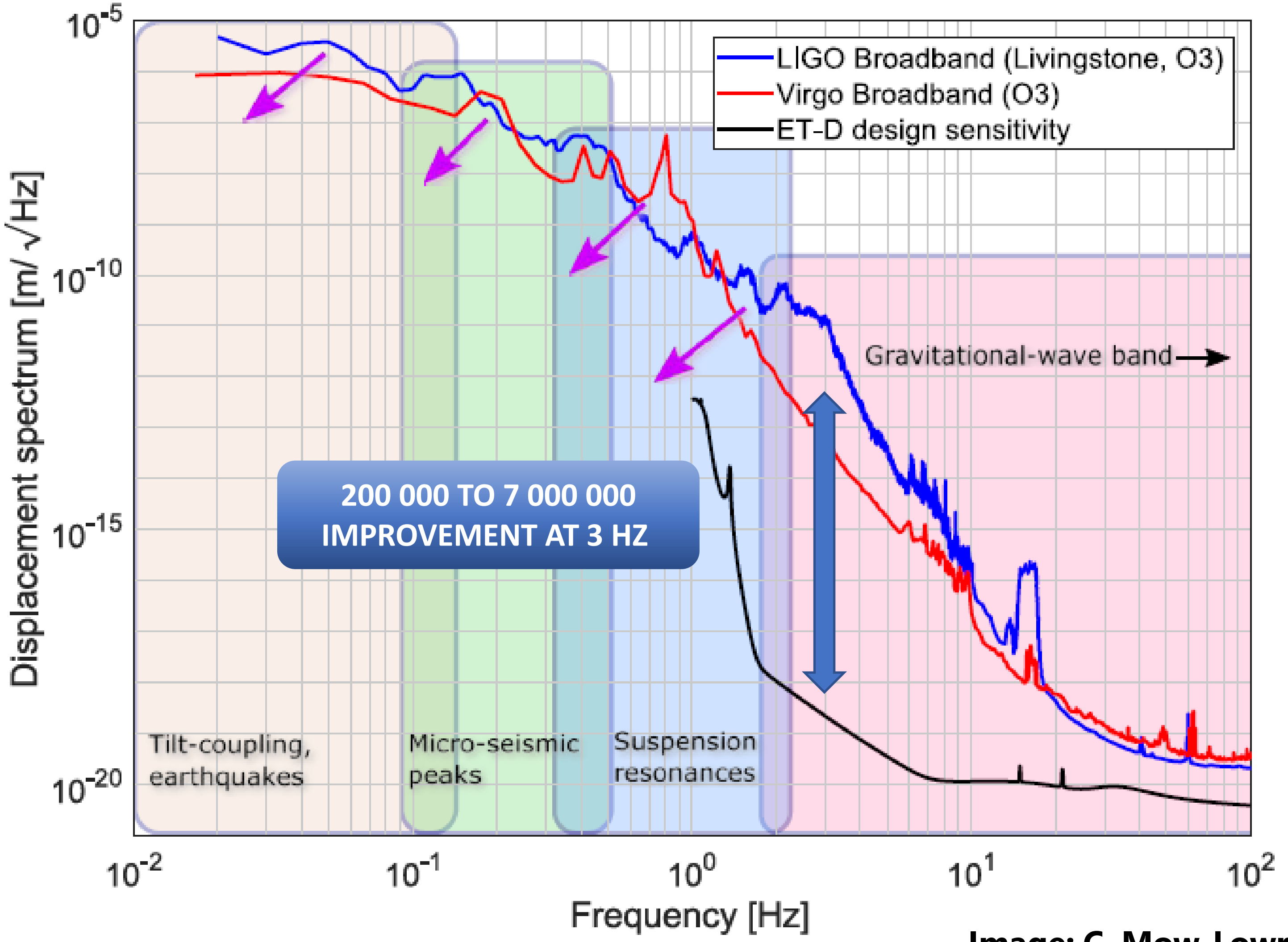
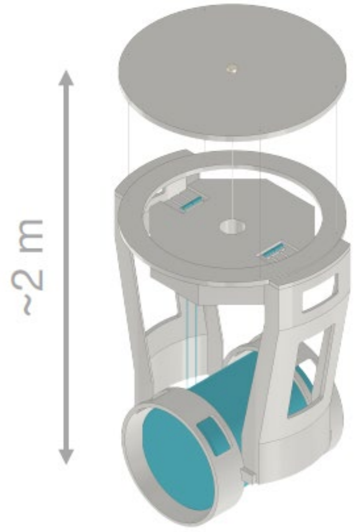
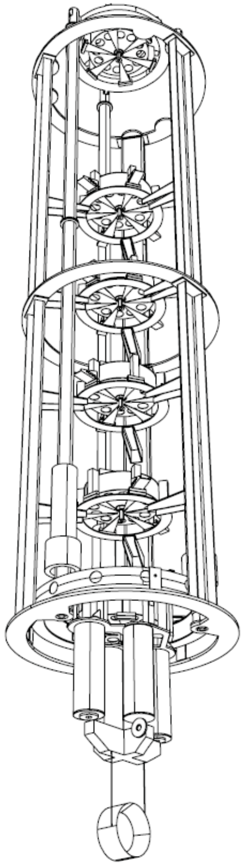


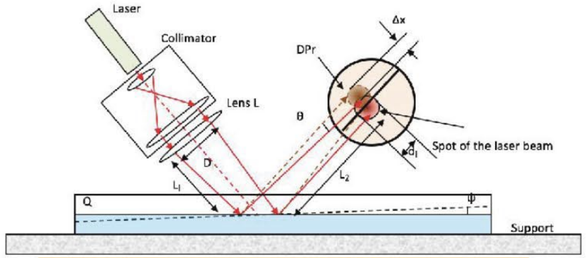
Image: C. Mow-Lowry

LOW FREQUENCY NOISE

- Underground infrastructure
- 17m tall seismic filtering suspensions
- Large impact on cavern engineering and costs
- Coupling with cryogenics
- R&D in active-passive filtering systems and seismic sensors

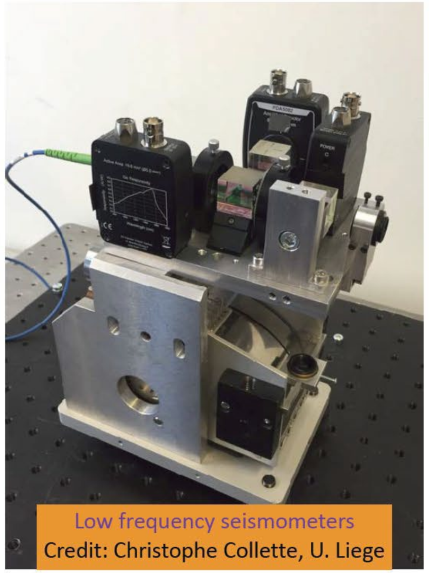




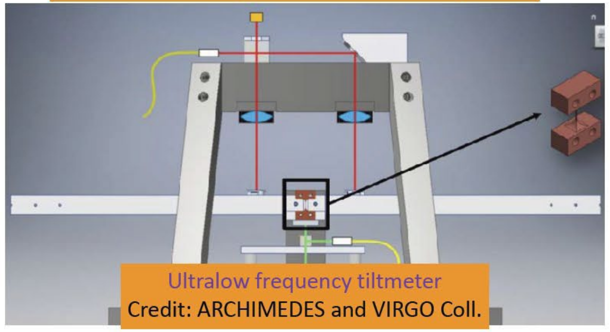


Laser inclinometer, Credit: B. Di Girolamo, CERN

6-D interferometric readout inertial sensor
Credit: Conor Mow-Lowry, VU Amsterdam



Low frequency seismometers
Credit: Christophe Collette, U. Liege



Ultralow frequency tiltmeter
Credit: ARCHIMEDES and VIRGO Coll.

LASER AND OPTO-ELECTRONICS

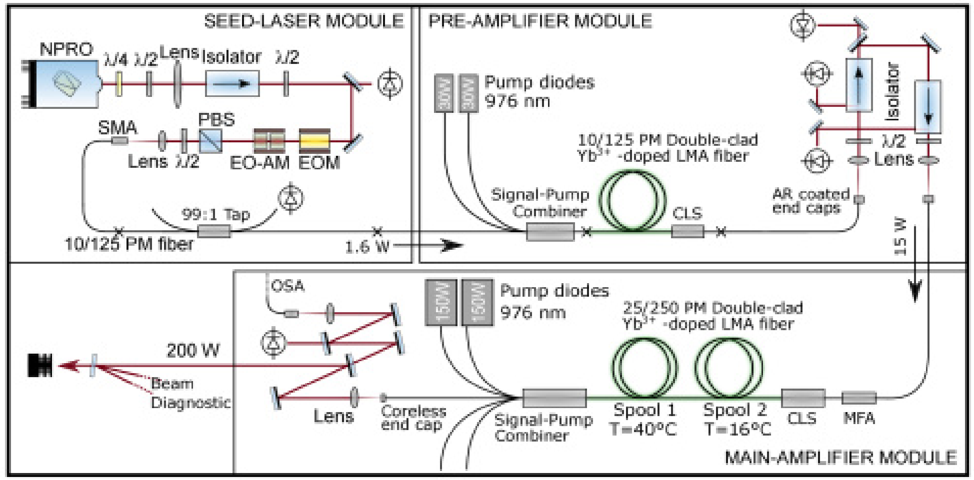
- Virgo and LIGO developed CW low noise lasers at 1064nm
  - ET-HF: evolution towards higher power
  - ET-LF: different wavelength, 1550nm (baseline) or 2000nm

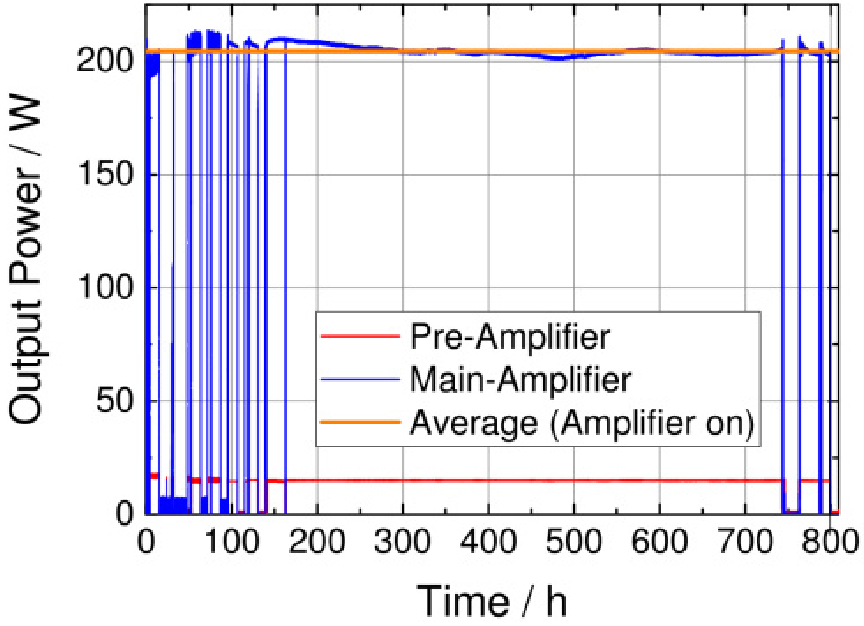
- Electro-optical components
  - High quantum efficiency photodiodes
  - Low absorption e.o.m.
  - Low dissipation faraday isolators

HIGH POWER LIGHT SOURCES

ET-HF Baseline: 700W laser power will be generated by a **coherent combination** of several **high-power laser-amplifier** stages

- Monolithic Fiber amplifier with outpower of 200w at 1064 nm was demonstrated @lzh
  - Yb^{3+}-doped Polarization-maintaining large-mode-area fiber
  - No sign of stimulated Brillouin scattering @ 200w
  - 94.8% fractional power in tem_{00} mode
  - Long-term test of more than 695 hrs

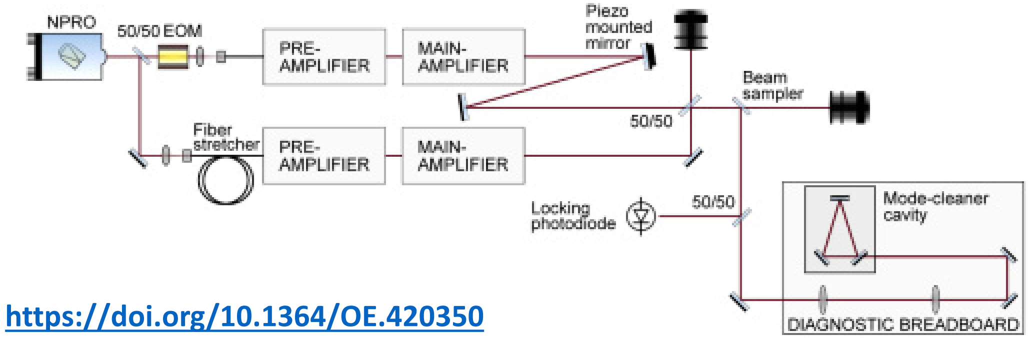




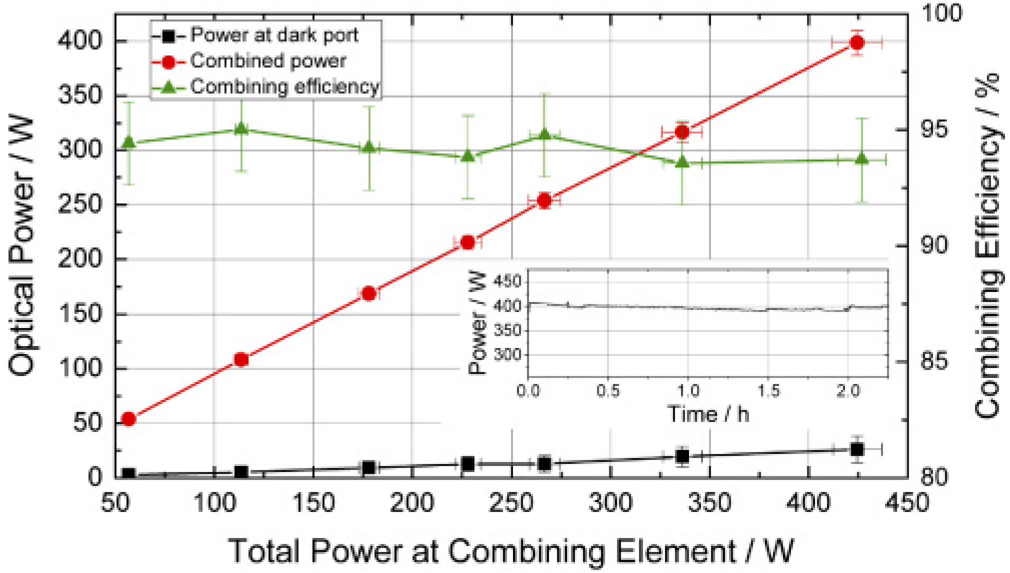
https://doi.org/10.1364/OE.27.028523

HIGH POWER LIGHT SOURCES

- Coherent beam combining of two fiber amplifiers
  - 370W in tem_{00} mode with combining efficiency >93%
  - The noise performance of the combined beam is comparable to the single amplifier noise



https://doi.org/10.1364/OE.420350



ET-LF LASER WAVELENGTH

Cryogenic mirrors and mirror suspensions can significantly reduce the thermal noise

- This requires a departure from the fused silica optics: alternative crystalline materials such as silicon and sapphire
- Silicon cannot be operated at 1 μm → change of wavelength is necessary (1.5-2 μm)
- Wavelength change impacts many aspects of the interferometer and depends on many technology developments
    - light sources
    - optical components
    - detectors

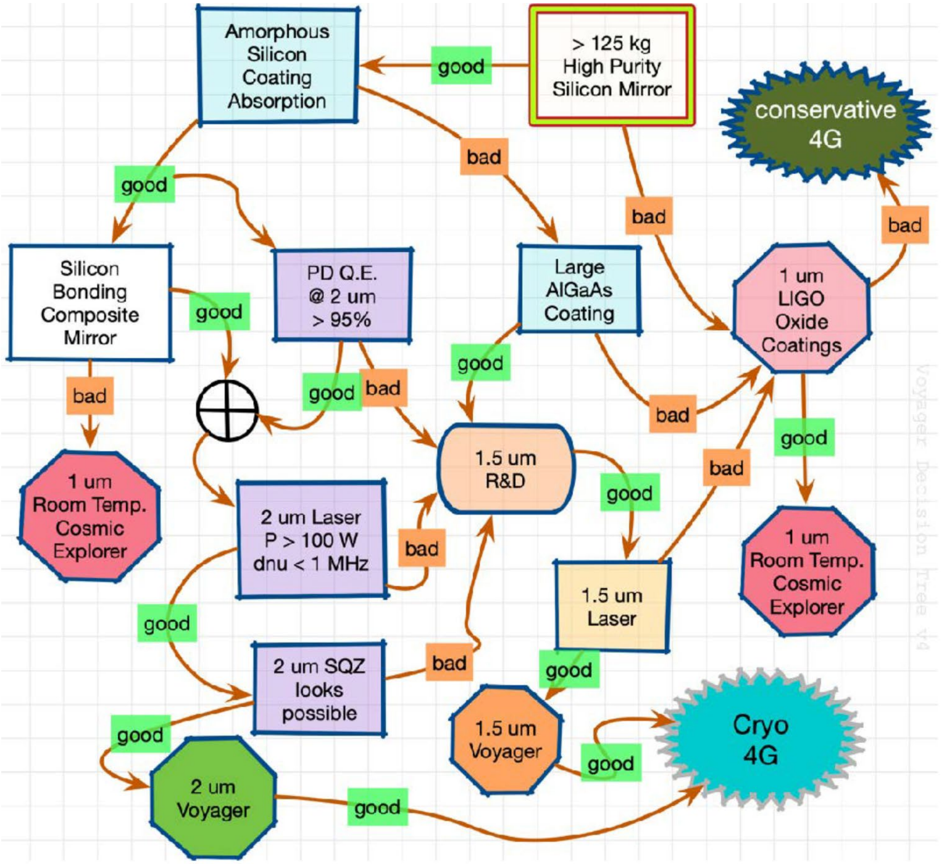


Image: Rana Adhikari GWADW 2018

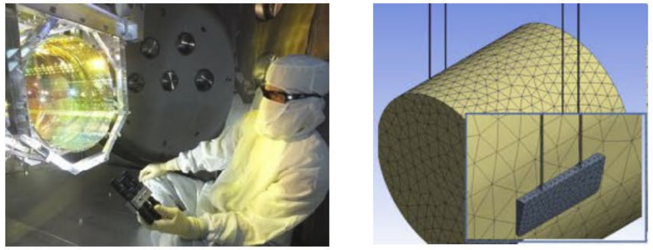
ET-LF LASER WAVELENGTH

- ET-LF wavelength workshop (3rd/16th September 2021) : https://wiki.et-gw.eu/ISB/Optics/ET-LFworkshop
  - Aim : weight pros and cons for possible wavelengths (1.06, 1.5 and 2.0 um) and establish the needed R&D
  - Participation of other Divisions (ITF, SUSP, VAC&CRYO), LIGO Voyager and KAGRA
  - Outcome: 1550nm is still the preferred choice but other options should be kept open as alternatives/upgrades
  - Summary document to be published on ET TDS (draft on Overleaf: https://www.overleaf.com/read/bffsvvfqdffy)

List of possible wavelengths: technologies, properties/known issues "decision matrix"

Wavelength	1064	1550	1950	1980/5	2050	2090	2128
Substrate (material and properties)	Sapphire Absorption (20-200pm/cm) still too high and not reproducible (devpt needed) issues= biref, polishing, cost	Silicon abs=5-10ppm/cm (T>50K) Large size devpt needed Issues = large size - biref??	Silicon abs=5-10ppm/cm(T>50K) Large size devpt needed Issues = large size? Biref? Low abs only in smaller segments -> composite mirrors?				
Coating (type, expected/known properties: absorption, loss,..)	Amorphous: no coating or mixed material design that will meet noise requirements? Yet... Crystalline: AlGaAs very promising (v. low abs & losses) but scaling issues. AlGaN is lattice matched to Al2O3 but not suitably developed.	Amorphous: mixed material designs (*e.g.* Craig *et al.*, Phys. Rev. Lett. 122, 231102, 2019) Crystalline: AlGaAs very promising but scaling issues. AlGaP?	a-Si likely good choice here (lower absorption than at 1.5)- possibly any shift to longer wavelength helpful? Low absorption could allow the increase of power (but depends also on radiation heat load which could be dominant) to compensate for optical losses (QE, FI,...) SiN? Amorphous: mixed material designs (*e.g.* Craig *et al.*, Phys. Rev. Lett. 122, 231102, 2019)				
Laser (technology, performances, issues...)	Power:OK Stabilisation: LF noise to be improved	Power:OK Stabilisation: LF noise to be improved	Power : development ongoing, lot of reliability studies to be done. Stabilisation: PSL components to be developed, low noise performances to be demonstrated				(OPO conversion of 1064.) For Power and stabilisation see left cell. Maybe some advantages coming from 1064nm pump.
Photodet and other optical elements	InGaAs QE>99%	InGaAs QE>99%	InGaAs, QE~80-85%, large 1/f noise - HgCdTe QE~92% - InAsSb QE~80% Development of low loss Faraday isolator needed Optical losses limit QN improvement above ~10Hz				
Losses and scattering	scattering losses -> FC cavity loss limits SQZ perf at LF More scattered light noise (cut off freq propto 1/lambda)						
Others or comments			Water vapor absorption: is it an issue for the laser components and for IOO?			Is fused silica absorption an issue (120ppm/cm at 2128) for BS?	

CORE OPTICS AND COATINGS

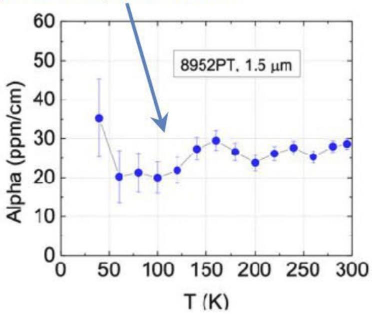


Advanced LIGO – 40 kg / ET 200 kg

Nikon SiO_2

Absorption of "best 45 cm" MCZ Si: 1.5um

Stanford/Glasgow/Berkeley/Caltech 2019



Substrates

- Substrate (ET-HF silica / ET-LF silicon) of 200 kg-scale, diam≥45cm, with required purity and optical homogeneity/absorption

Silicon

- Czochralski (CZ) method produced test masses could have the required size, but show absorption excesses due to the (crucible) contaminants
- Float Zone (FZ) produced samples show the required purity, but of reduced size (20cm wrt ≥45cm required)
- Magnetic Czochralski (mCZ) could be the possible solution (45cm + abs 20 ppm/cm)?

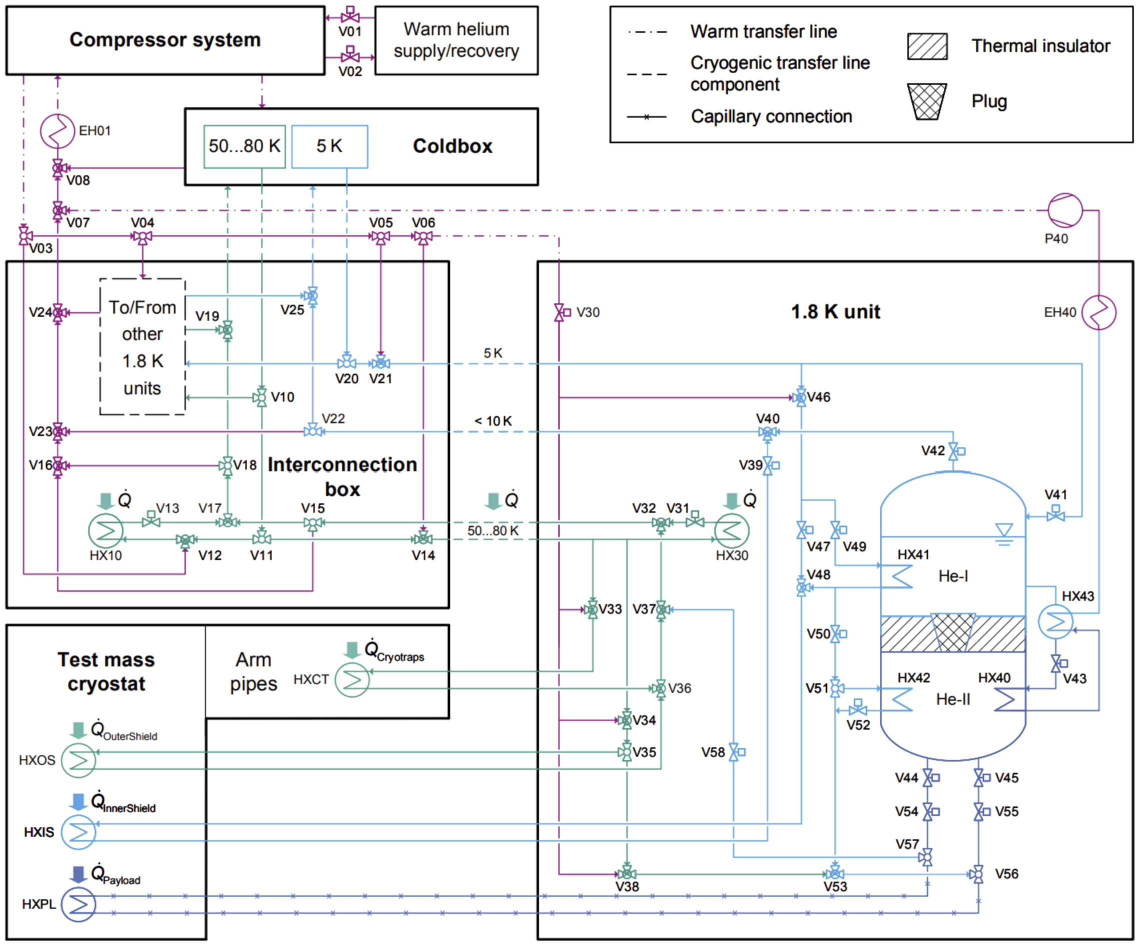
Coating

- Amorphous dielectric coating solutions often either satisfy thermal noise requirement (3.2 times better than the current coatings) **or** optical performance requirement (less than 0.5ppm) – not both
- AlGaAs Crystalline coatings could satisfy ET-LF requirements, but currently limited to 200mm diameter
- Crystalline oxides?

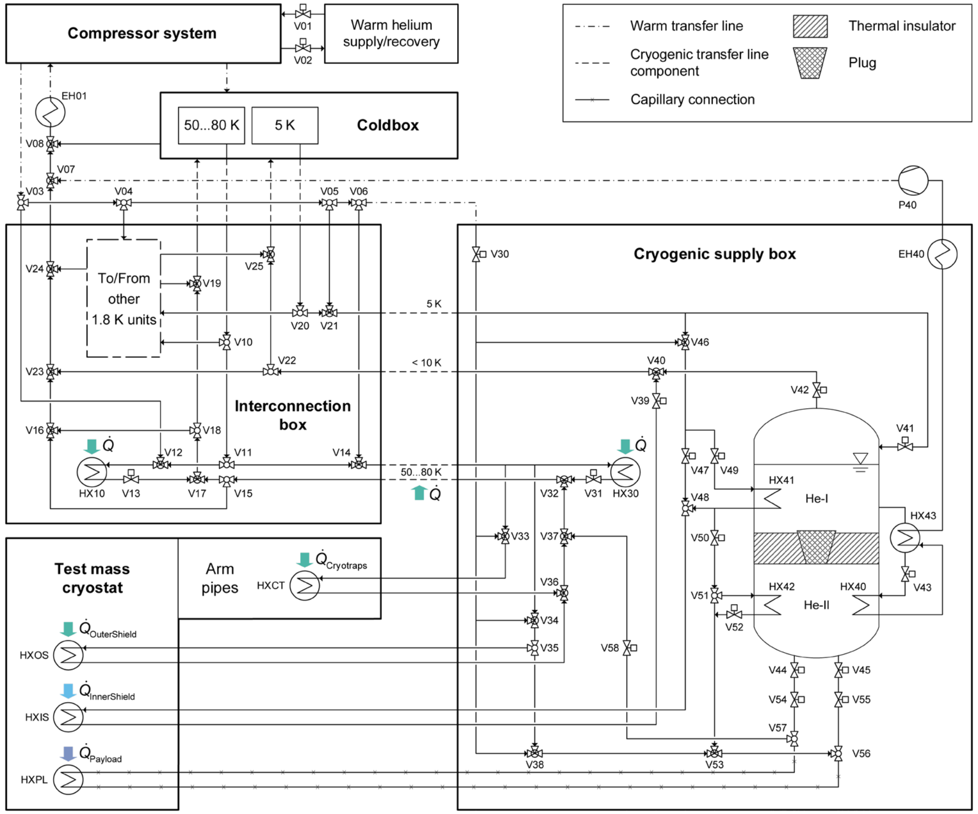
CRYOGENICS

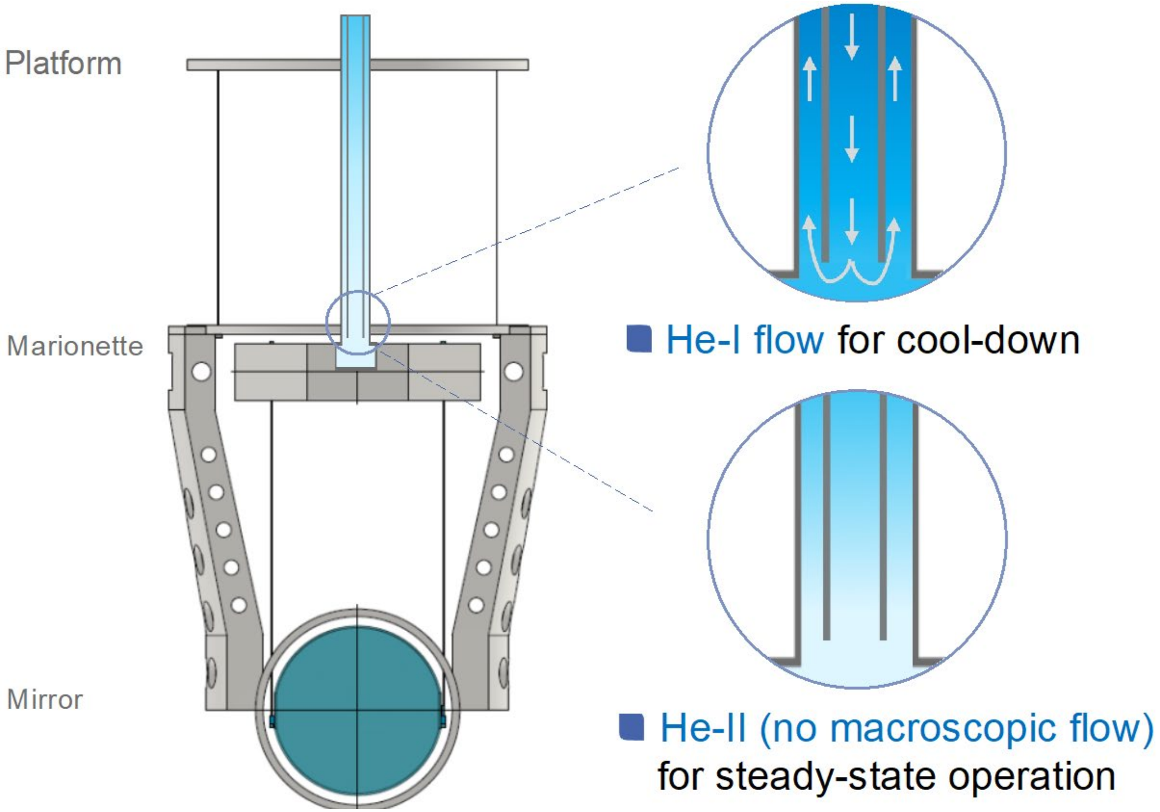
- ET-LF operating temperature ~10K

- Key issues:
  - Acoustic and vibration noises
  - Laser absorption and heat extraction
  - Cleanliness and contamination
  - Cooling time (large masses, commissioning time, …)
  - Infrastructures
  - Technology (gasses or cryo-coolers)
  - Materials
  - Safety



CRYOGENICS





- Cooling power supply for cryotraps, thermal shields and payload at various temperature levels
- Surface-located remote compressors
- Underground coldboxes and cryogenic distribution system

https://apps.et-gw.eu/tds/?content=3&r=17648

- Studies of ultra-low noise payload cooling for ET-LF
- Integration options for soft thermal links, noise budget
- Investigation of He-II-filled marionette suspension
- Thermal and vibrational studies on thermal shielding concepts

UNDERGROUND INFRASTRUCTURE

~30km of underground tunnels

- Safety (fire, cryogenic gasses, escape lanes, heat handling during the vacuum pipe backing)
- Noise (creeping, acoustic noise, seismic noise, Newtonian noise)
- Minimisation of the volumes, but preservation of future potential)
- Water handling, hydro-geology and tunnels inclination
- Cost

Large caverns

- In addition to the previous points:
- Stability
- Cleanliness
- Thermal stability
- Ventilation and acoustic noise

Huge work within the Infrastructure Division, so far mostly at local level in the two candidate sites

VACUUM SYSTEM

Vacuum systems for planned third generation detectors are likely to be the largest UHV systems built

Preliminary estimated cost ~560 Meuro
Beam pipe is its largest component (~1/2 of the system cost)
120 Km 1m diameter UHV tubes, total volume ~10^5 m^3

Exploit 2G detectors experience
Vacuum requirements: factor >5 more stringent than Virgo
10^{-10} mbar for H_2, 10^{-11} mbar for N_2 and <10^{-14} mbar for Hydrocarbons

Some open issues:

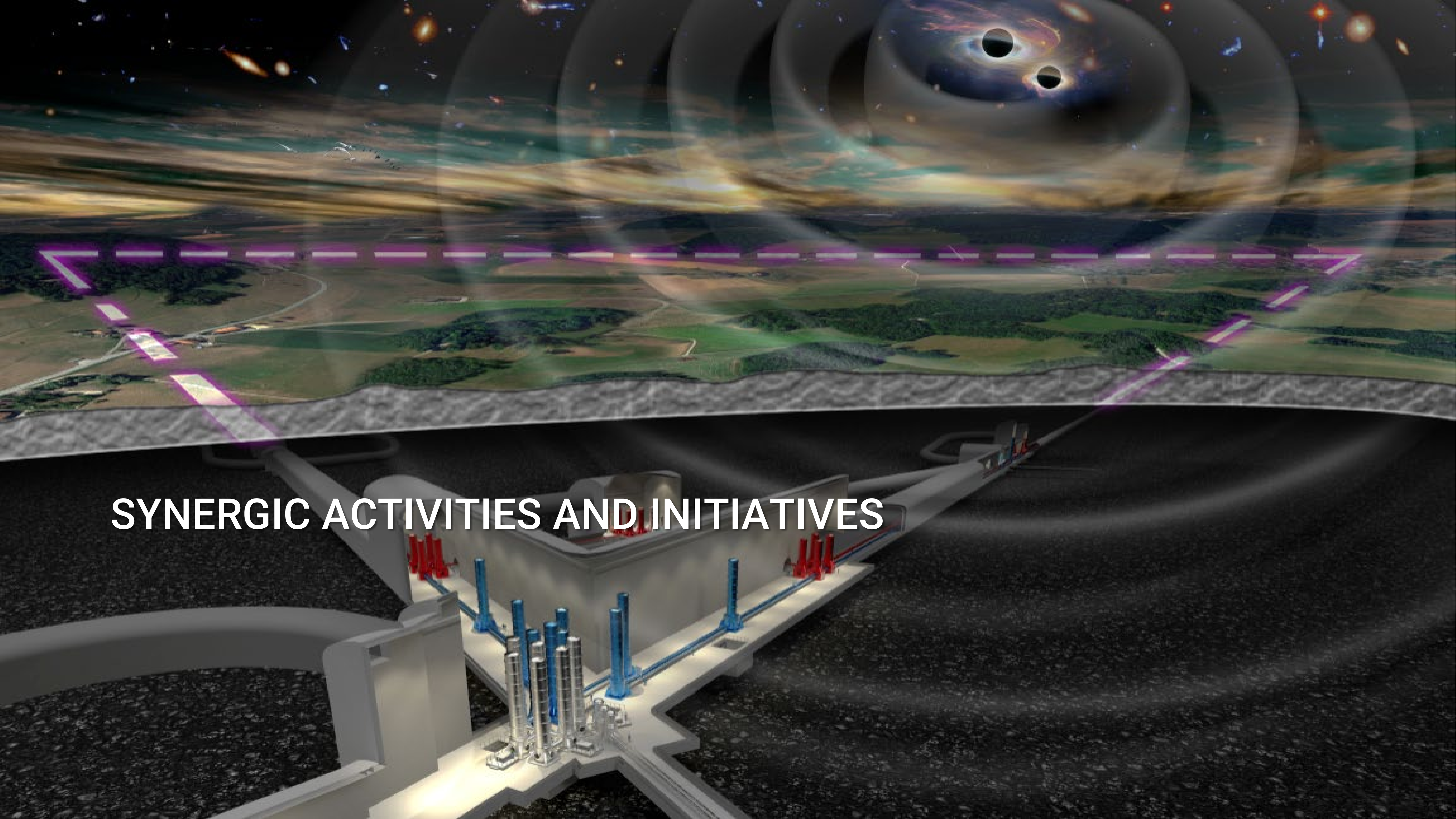
- **Envelope material other than stainless steel (**Mild steel, aluminum, …)
- **surface treatment and cleaning techniques** to reduce outgassing
- **new getter materials**
- optimal **vacuum tube diameters** (light scattering issues, vacuum conductance…)
  This will in turn influence **tunnel size and costs**

Joint development with CERN involving ET and CE (see later…)

OTHER CHALLENGES

- Low noise controls
- Auxiliary optics, adaptive optics and thermal compensation of optical aberrations
- Precision mechanics, alignment and positioning
- Computing (see talk by Stefano B. this afternoon)
- …
- **Governance & Organisation**

SYNERGIC ACTIVITIES AND INITIATIVES



VIRGO_nEXT

- Exploit the existing infrastructure up to its limits
- Be part of a further enhanced 2G+ network
- **Reduce the downtime between 2G and 3G**
- **Provide a risk reduction for ET-HF technologies**
- **Provide a risk reduction for ET-LF: mitigation of technical noise**

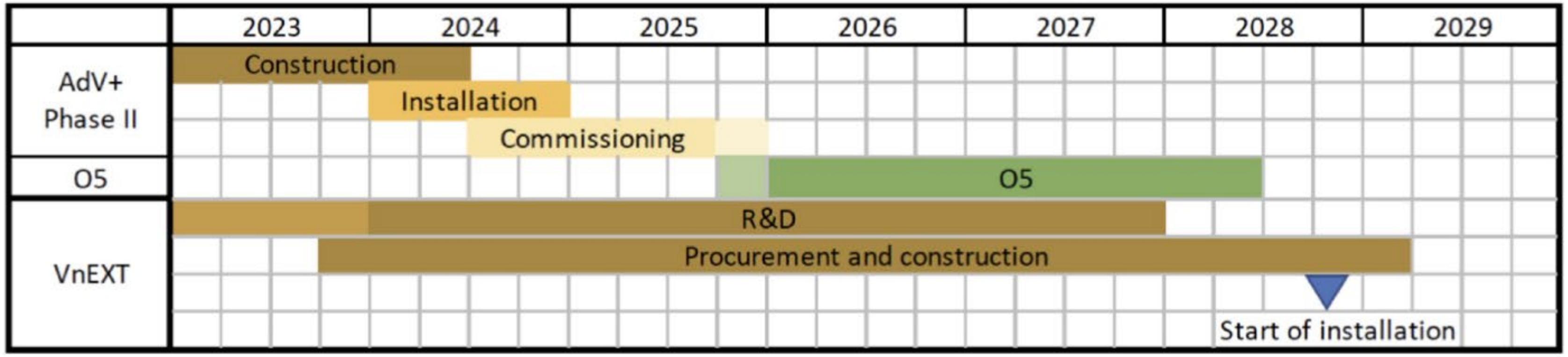
Parameter	O4 high	O4 low	O5 high	O5 low	post-O5low
Power injected	25 W	40 W	60 W	80 W	277 W
Arm power	120 kW	190 kW	290 kW	390 kW	1.5 MW
PR gain	34	34	35	35	39
Finesse	446	446	446	446	446
Signal recycling	Yes	Yes	Yes	Yes	Yes
Squeezing type	FIS	FDS	FDS	FDS	FDS
Squeezing detected level	3 dB	4.5 dB	4.5 dB	6 dB	10.5
Payload type	AdV	AdV	AdV	AdV	Triple pendulum
ITM mass	42 kg	42kg	42 kg	42 kg	105 kg
ETM mass	42 kg	42kg	105 kg	105 kg	105 kg
ITM beam radius	49 mm	49 mm	49 mm	49 mm	49 mm
ETM beam radius	58 mm	58 mm	91 mm	91 mm	91 mm
Coating losses ETM	2.37e-4	2.37e-4	2.37e-4	0.79e-4	6.2e-6
Coating losses ITM	1.63e-4	1.63e-4	1.63e-4	0.54e-4	6.2e-6
Newtonian noise reduction	None	1/3	1/3	1/5	1/5
Technical noise	"Late high"	"Late low"	"Late low"	None	None
BNS range	90 Mpc	115 Mpc	145 Mpc	260 Mpc	500 Mpc

- **ENABLE THE FORMATION OF A NEW GENERATION OF EXPERTS, THOSE WHO WILL RUN ET**

See Paola's talk tomorrow 9am

SYNERGIES WITH ET

- OPTICS
- SQEEZING
- HIGH POWER OPERATION
- CONTROLS, CALIBRATION, DETCHAR
- LF TECHNICAL NOISE



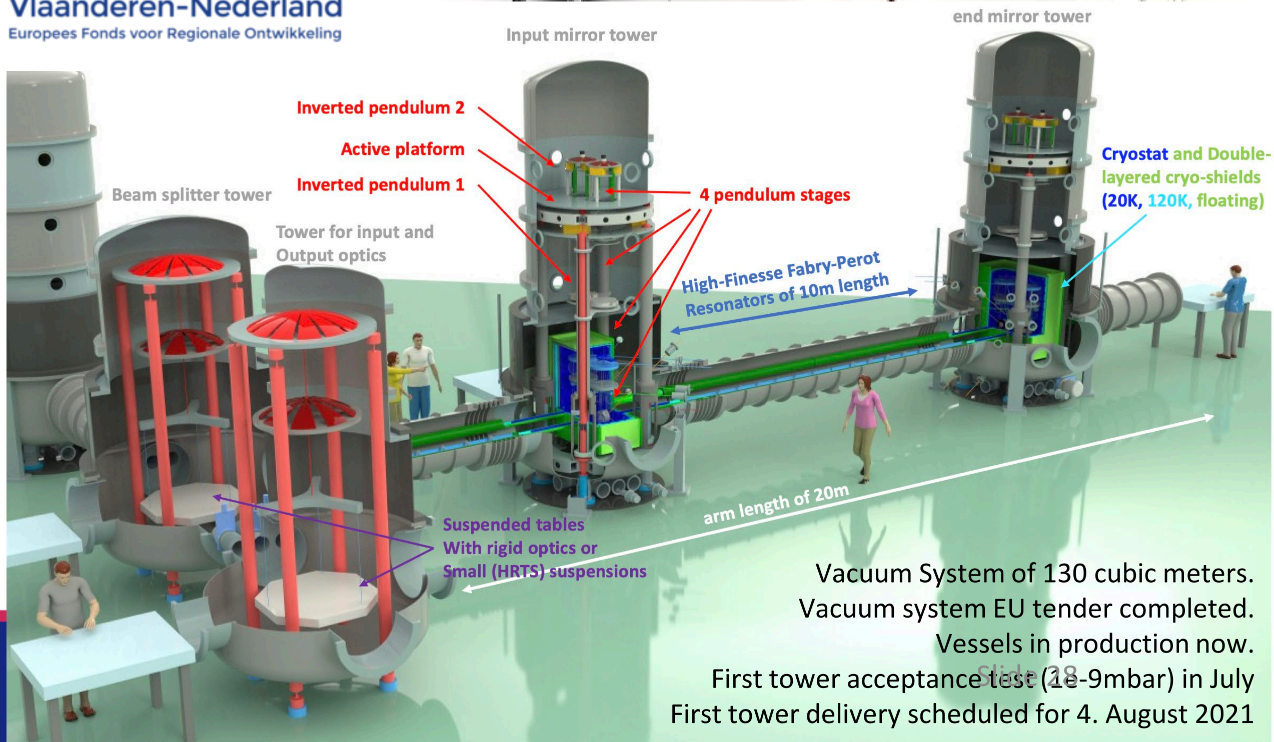
See Paola’s talk tomorrow 9am

ET-PATHFINDER

- New facility for testing ET-LF technology in a low-noise, full-interferometer setup
- Key aspects: Silicon mirrors (3 to 100+kg), cryogenics cryogenic liquids and sorption coolers, water/ice management), "new" wavelengths (1550 and 2090nm), coatings etc
- Start with 2 FPMI, one initially at 120K and one 15K (2022+)
- >20 partners from NL/B/G/FR/SP/UK
- Initial capital funding of 14.5 MEuro
- Detailed Design Report available at apps.et-gw.eu/tds/?content=3&r=17177
- **Open for everyone interested to join**
- For more information please see:

  www.etpathfinder.eu

Interreg Vlaanderen-Nederland
Europees Fonds voor Regionale Ontwikkeling



Vacuum System of 130 cubic meters.
Vacuum system EU tender completed.
Vessels in production now.
First tower acceptance test (1e-9mbar) in July
First tower delivery scheduled for 4. August 2021

CREDIT: S. Hild

AMALDI RESEARCH CENTER

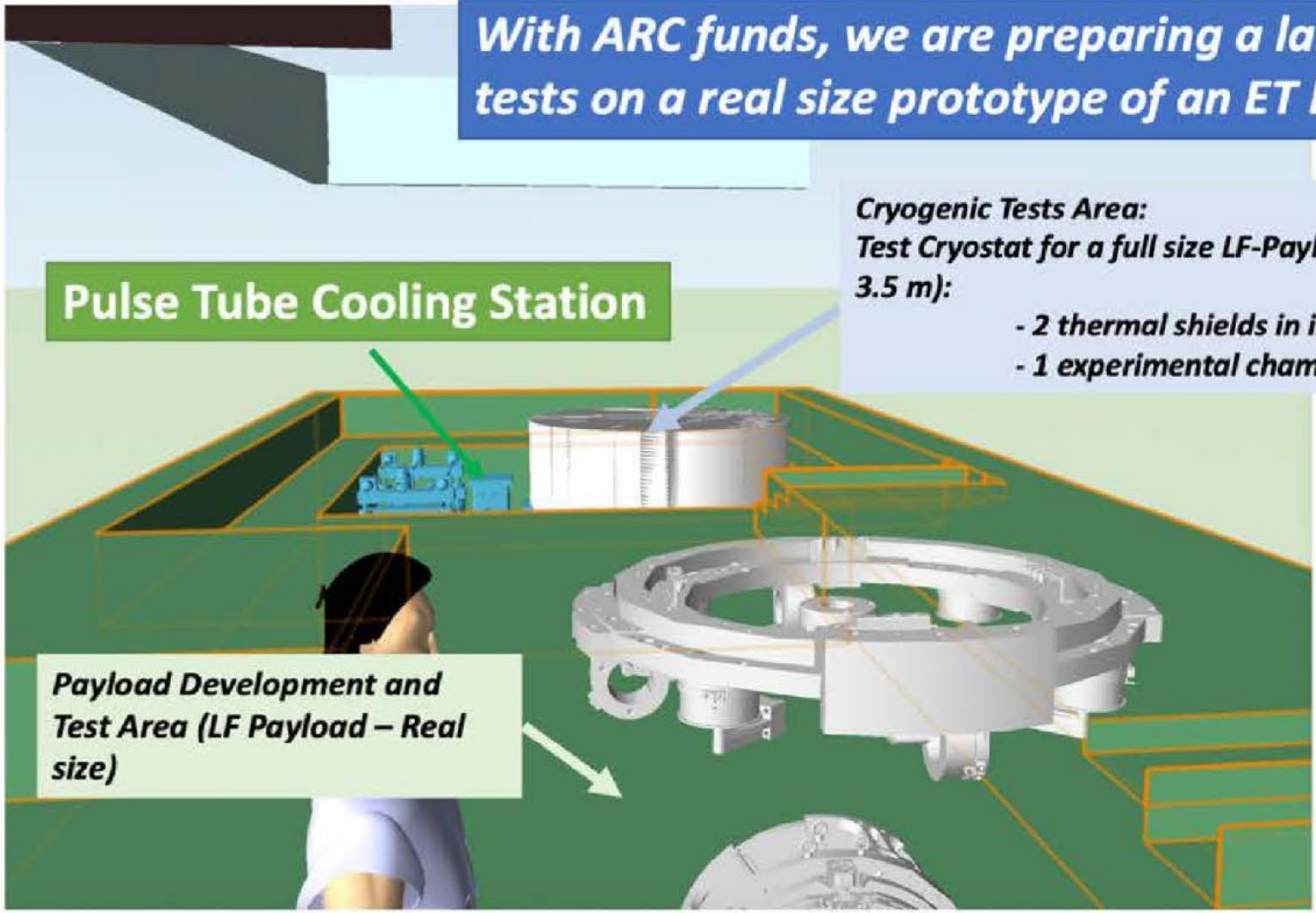
3G Gravitational-Wave Lab

MINISTERO DELL' ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

INFN ROMA Istituto Nazionale di Fisica Nucleare Sezione di Roma

AMALDI RESEARCH CENTER

With ARC funds, we are preparing a lab for low temperature tests on a real size prototype of an ET LF-Payload



The Rome1 ET Group:

From Virgo:

Sibilla	Di Pace	(Post Doc Researcher)
Ettore	Majorana	(Full Professor)
Valentina	Mangano	(Post Doc Researcher)
Luca	Naticchioni	(INFN Researcher)
Maurizio	Perciballi	(INFN Technician)
Paola	Puppo	(INFN Researcher)
Piero	Rapagnani	(Associate Professor)
Fulvio	Ricci	(Full Professor)

From CUORE:

Angelo	Cruciani	(INFN Researcher)
Antonio	D'Addabbo	(Post Doc Researcher LNGS)
Stefano	Pirro	(INFN Researcher)

From EGO:

Paolo Ruggi (EGO Researcher)

Dutch government funding for ET

- **42 M€ have been (conditionally) awarded** now (announcement 14.04.2022). Money can flow from 2023 and is dedicated to:
    - 19 M€: connections to industry for research and innovation: 'The aim of this programme is to **optimally position [...] in particular Dutch industry**, for R&D and orders relating to Einstein Telescope',
    - 23 M€: '**for the preparation and realisation of the underground infrastructure** [...]', project organisation and management
- **870 M€ have been reserved** for the construction of the ET infrastructure, if the EMR site is selected as the location of ET.

Het Nationaal Groeifonds

Resultaten tweede ronde

Onderzoek, ontwikkeling en Innovatie

De revolutie van de zelfdenkende moleculaire systemen	97
Duurzame MaterialenNL	220
Einstein Telescope	42 & (870)
NXTGEN HIGHTECH	450
Photondelta	471
Cellulaire agricultuur	60
CropXR	43
Groeiplan Watertechnologie	(135)
NL2120, het groene verdien-vermogen van Nederland	(110)
Werklandschappen van de toekomst	(26)
Biotech Booster	246
Oncode-PACT	325
PharmaNL	80
Toekomstbestendige leefomgeving	(100)
Groenvermogen II	500
Nieuwe Warmte Nu!	200
Digitaal Ecosysteem Mobiliteit en Smart City	(85)
Digitale Infrastructuur en Logistiek	51
Luchtvaart in Transitie	383
Zero-emissie binnenvaart batterij-elektrisch	50

Totaal € 4.544 mln

Kennisontwikkeling

Digitaal Onderwijs Goed Geregeld	34
Digitaliseringsimpuls onderwijs NL	560
Impuls Open Leermateriaal	78
Ontwikkelkracht	332
Collectief laagopgeleiden en laaggeletterden	51
Nationale LLO Katalysator	392
Opschaling publiek private samenwerking in het beroepsonderwijs	210

Totaal € 1.657 mln

Infrastructuur

Rail Gent-Terneuzen	105

Totaal € 105 mln

Toegekend:	€ 1.317 miljoen
Voorwaardelijk toegekend:	€ 3.663 miljoen
Gereserveerd:	€ 1.326 miljoen
Totaal NGF:	€ 6.305 miljoen

(100) : bedrag tussen haakjes = reservering

Welvaart van morgen begint vandaag

CREDIT: A. Freise

ETIC – Einstein Telescope Infrastructure Consortium

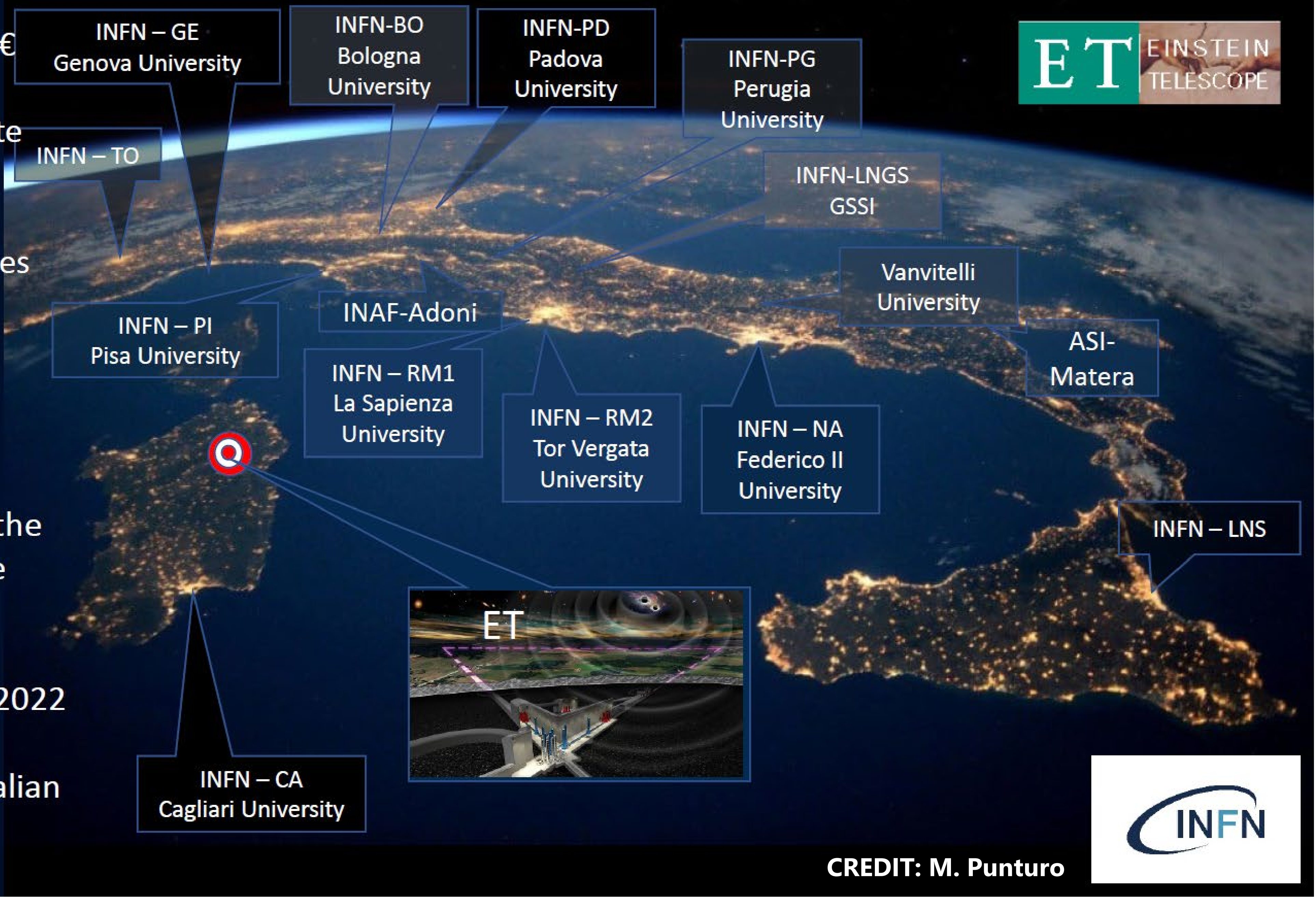
Next Generation EU
Investment proposed 100M€ focused on ET enabling technology and Sardinian site candidature support

- 8% Human Resources
- 30% Scientific apparatuses
- 12% Distributed Infrastructures
- 28% ET design
- 12% Training

Additional 5M€ funding on the same framework for the site characterization

Feedback expected in June 2022

Discussion ongoing on an Italian share toward ET realization



German Centre for Astrophysics

Research | Technology | Digitisation

an initiative of German astronomy and astroparticle physics

The Contest

An open ideas competition to implement two large-scale research centres in Saxony with

an eventual annual budget of 170 M€, i.e. with about 1000 employees,

in total 1.4 G€ until 2038

The two scientific drivers

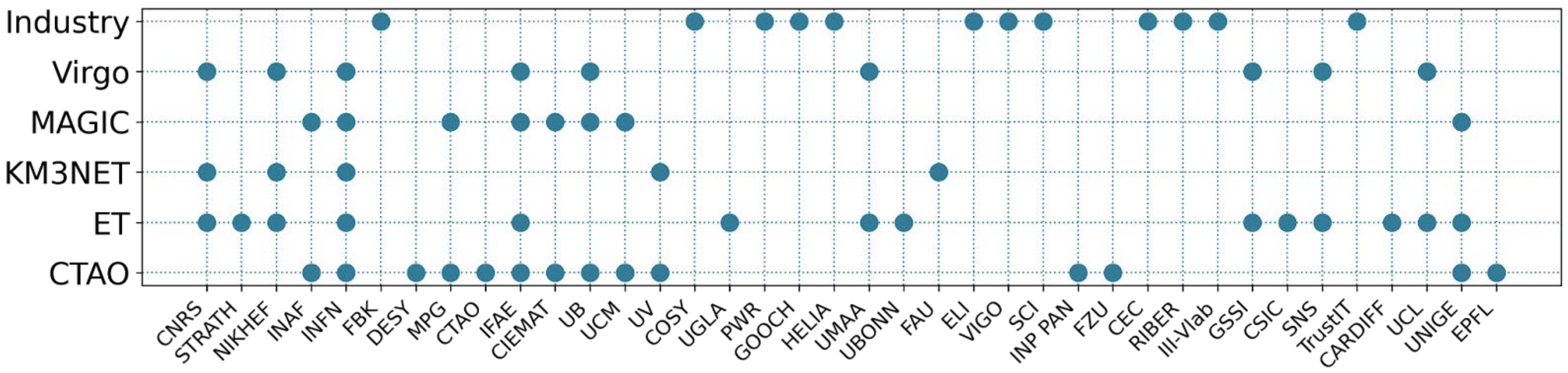
Radio astronomy with the Square Kilometre Array (SKA)

Gravitational wave astronomy with the Einstein telescope (ET)

CREDIT: K. Henjes-Kunst

M2TECH

- M2Tech (Horizon2020-INFRA-TECH):
  - Proposal submitted on April 20th
  - 10M€ + 1.8M€ (Swiss)
  - 39 beneficiaries among which 14 from ET + 12 industries
  - Proposed R&Ds for ET: coatings and substrates, photosensors, simulation (Digital Twins) and noise monitoring, timing (WR), computing and alert system
  - Decision expected in fall 2022, to start in Feb 2023 (duration: 4 years)



See Edwige’s talk tomorrow

CERN-INFN-NIKHEF AGREEMENT ON ET ARMS VACUUM

- Duration: three years from the formal signature of the agreement (expected soon)
- Coordinator: Paolo Chiggiato, CERN

- Main technical objectives
  1. Re-evaluate the baseline solution (Virgo/LIGO) with minor modifications imposed by the new requirements.
  2. Design and test technical solutions that fulfil the ET requirements and are less expensive than the baseline. The required technical infrastructure will be evaluated and optimized as well.
  3. Manufacture, assembly and test a pilot sector.
  4. Write the technical design report, including cost estimations

- Main coordination objectives
  1. Coordinate the effort of ET collaborators interested in the same technical objectives.
  2. Coordinate the contact and sharing of information with Cosmic Explorer in the field of vacuum technology.

CERN-INFN-NIKHEF AGREEMENT ON ET ARMS VACUUM

- **The first step of this collaboration is the definition and editing of the functional specifications, which comprise beam pipe requirements, and constraints with respect to infrastructures and services**

- The TDR will be the main outcome of this contribution
  - The TDR will be site independent
  - The TDR will include manufacturing, post-production treatments, installation, and commissioning procedures
  - The interfaces with the tunnel infrastructures and services will also be included in the TDR.
  - It will contain the manufacturing drawings necessary for the prototypes and the integration with the other vacuum systems (towers and cryogenic traps)

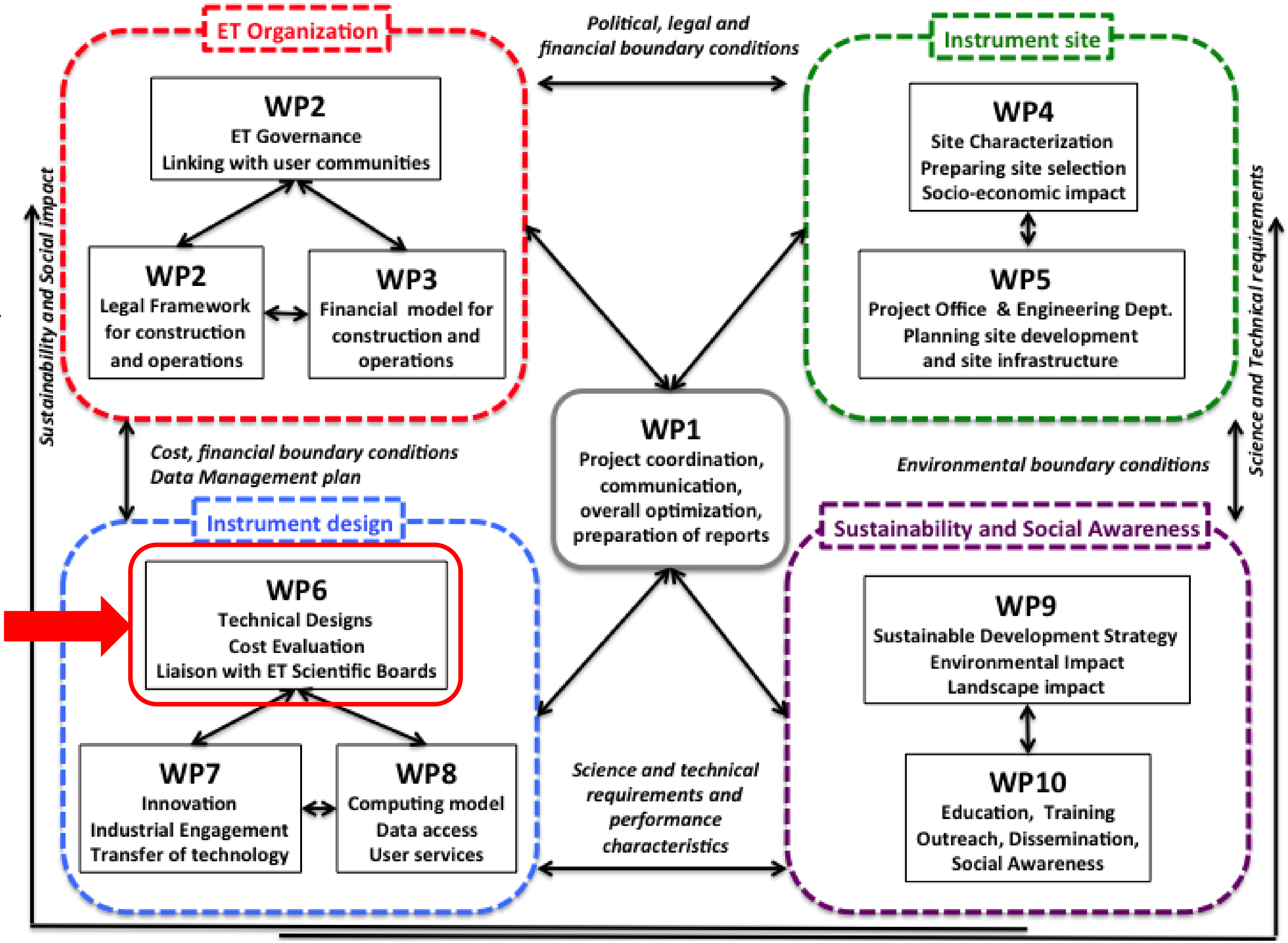
INFRA-DEV

- ET-PP INFRADEV has been accepted!

  3.5M€ for ET preparatory phase (2022-2026)

- WP6:
  - Scientific case
  - TDR of the RI
  - TDR of the detectors and facilities
  - Data management plan

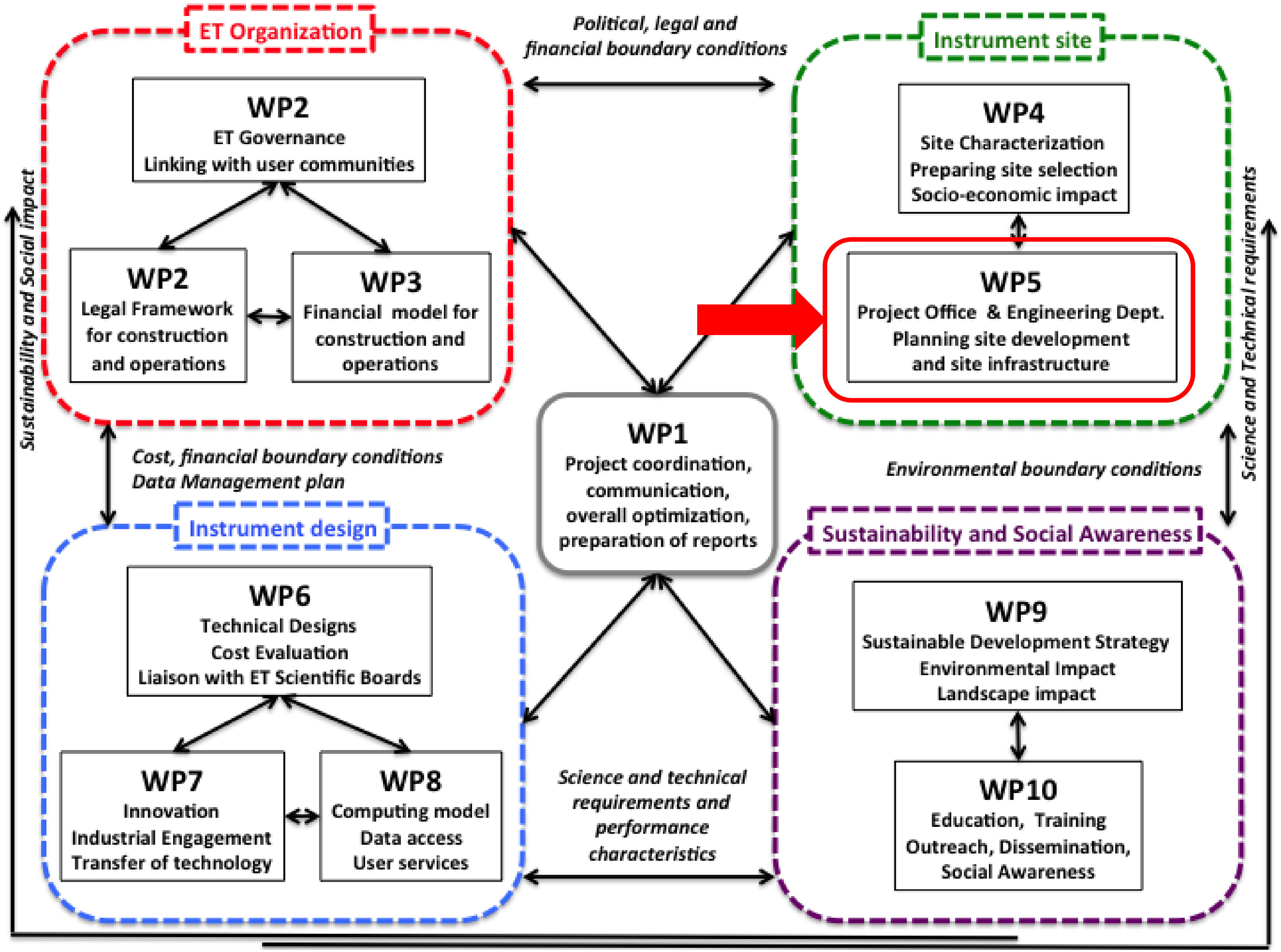
See Mario’s talk tomorrow



INFRA-DEV

- WP5
  - Establish the ET RI Project Office and the corresponding Engineering Dept.
  - Set-up a Project Management environment

- Kick-off meeting with ISB on May 20



See Mario's talk tomorrow

FINAL CONSIDERATIONS

- ✓ **In about one year the ISB has attracted a lot of interest, and many activities are started and proceeding with good pace…**

  …but there are disparities among the various activities

- ✓ **The number of people involved is growing…**

  …but on average the intensity of involvement is still medium/low
  (experience tells us that we systematically underestimate the time needed to achieve our goals)

- ✓ **Many initiatives that complement and support ISB goals are very positive and will help…**

  …but coordination among the various initiatives needs to be improved
  (e.g., agreeing on common and realistic timelines, interfaces, decision chain...)

There is a need for the community to find ways to harmonize the development goals of the 2G+ detectors and the start of the 3G to optimize the use of available resources

(especially human resources)