Einstein Telescope in the Carpathian Basin

Why should we build a gravitational wave detector?

Péter Lévai, MTA Wigner RCP, Budapest

9 July 2018
Prag, Czech Rep.

9th Einstein Telescope Symposium: 'Birth of the ET collaboration'

chaired by Michele Punturo, Harald Lueck

from Thursday, 19 April 2018 at **09:30** to Friday, 20 April 2018 at **17:30** (Europe/Rome)
at **European Gravitational Observatory (EGO) (Auditorium)**
Via E. Amaldi 56021 S. Stefano a Macerata - Cascina (PI) Italy

Description

The 9th ET Symposium is hosted by European Gravitational Observatory, Cascina (Italy). The focus of the meeting is the creation of the ET collaboration, the definition of the strategy for the submission of the ET proposal to the 2020 update of the ESFRI roadmap. We will discuss the future of the GW astronomy and astrophysics.

International committee: J. van den Brand, S. Hild, S. Katsanevas, H. Lueck, M. Punturo, S. Rowan
Local organising committee: M. Punturo, E. Morucci

Support erika.morucci@ego-gw.it

Go to day

Thursday, 19 April 2018

09:30 - 10:30 Registration

10:30 - 11:00 Welcome and Motivations

Welcome talks and "instructions" for the meeting

10:30 **Welcome** *10'*

Einstein Telescope Collaboration

Kick-off meeting:
Cascina, 19 April 2018

Letter of Intent:
http://www.et-gw.eu/index.php/letter-of-intent

July 2018:
589 signature

Hungary: 53

Czech Rep.: 1

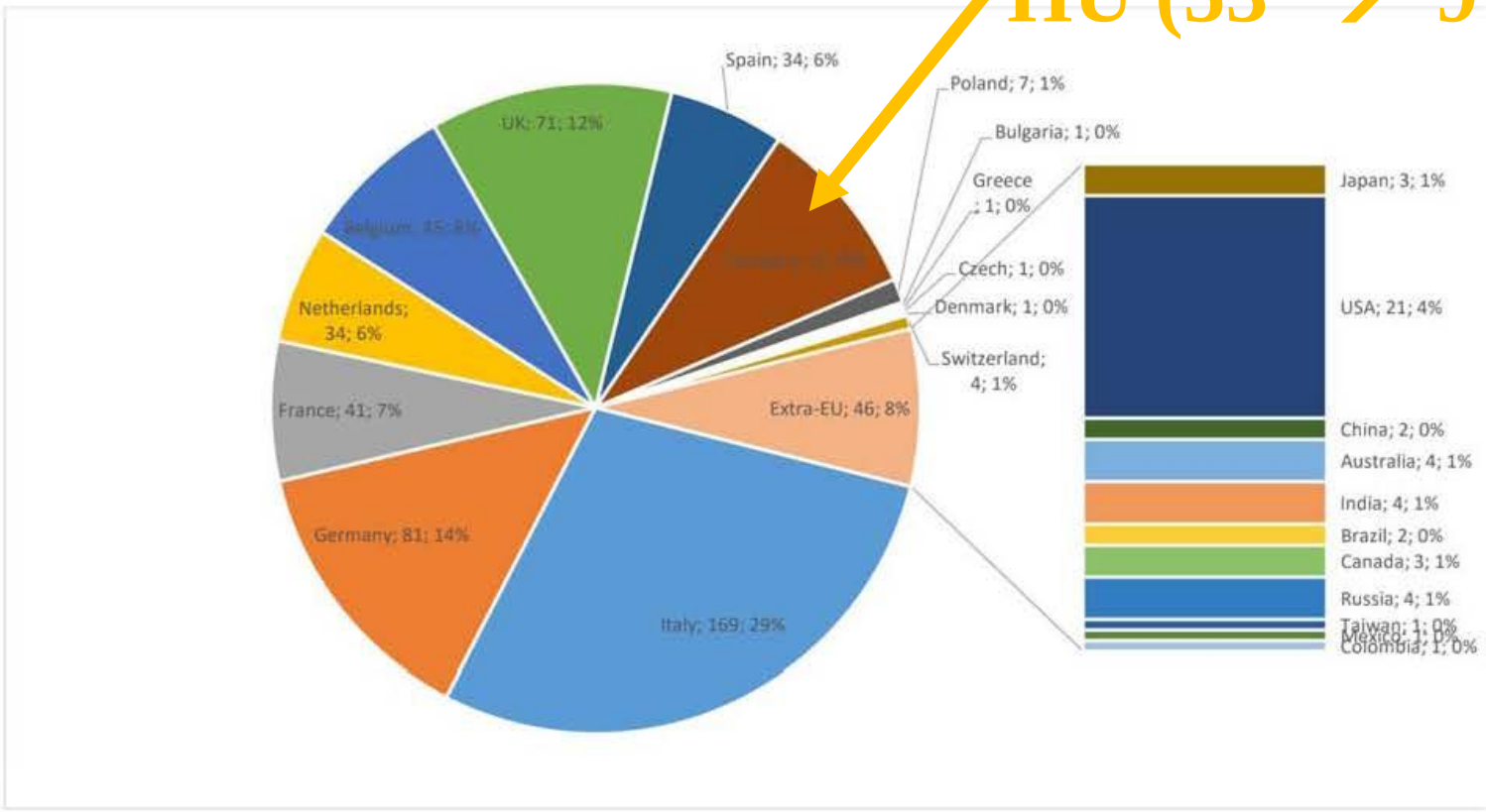
(Georgios Loukes-Gerakopoulos, ASU CAS)

Einstein Telescope (ET) Letter of Intent (LOI) signatures

This document reports the signatures of the ET LOI collected by the online system at the date 01/07/2018 18:54:00. Please, note that some of tl
declared to belong to more than one country; this info is stored in the database, but the output is created selecting just one of the two or more

Currently there are 589 valid signatures.

HU (53 → 9%)

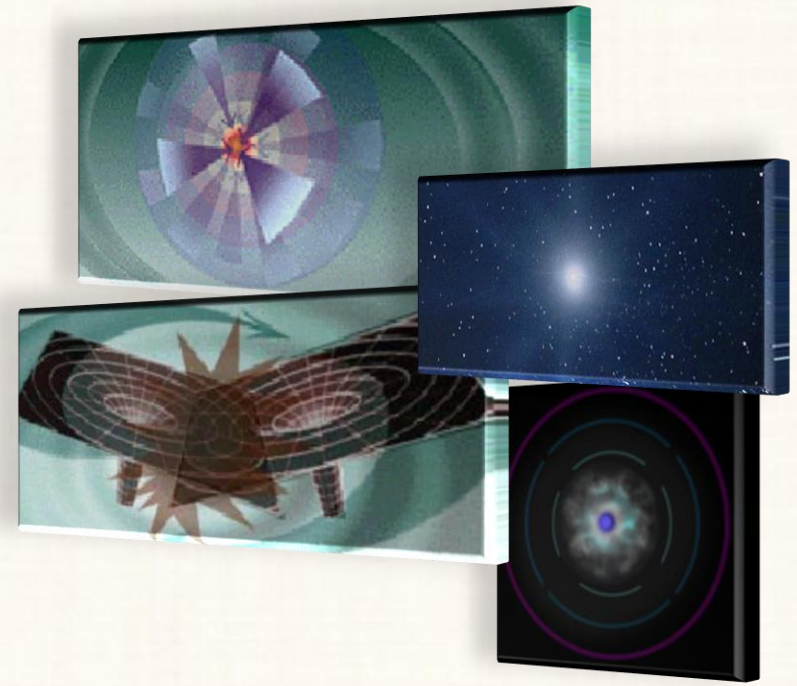


Recent supporters of the ET Collab. 01/07/2017

Could you/we increase the Czech interest ?

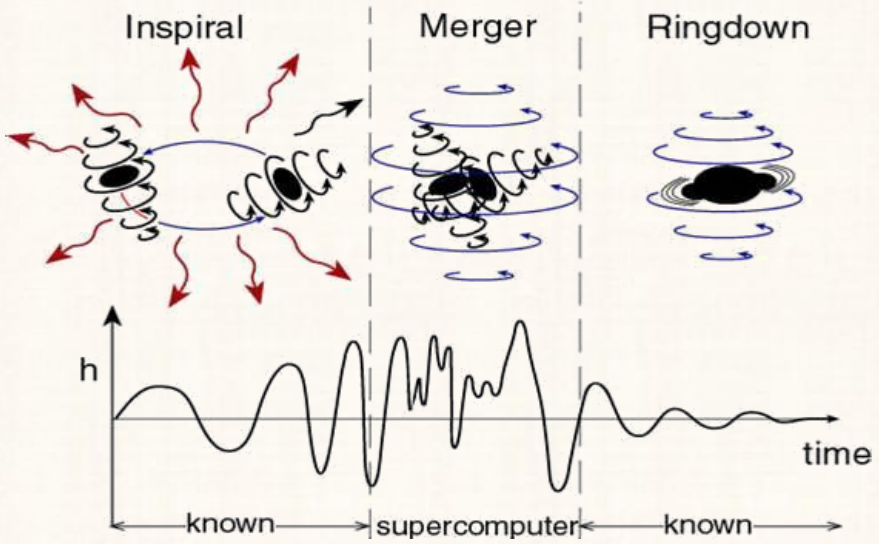
Sources of gravitational waves

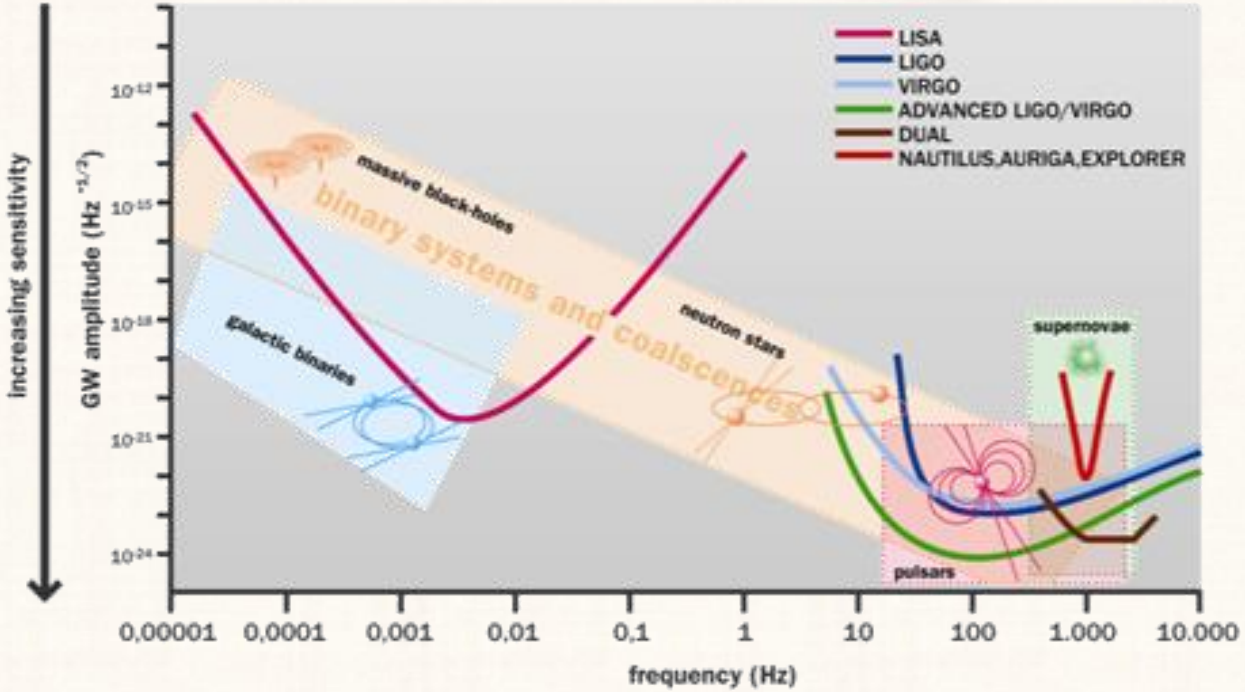
	Frequency
- Supernova explosion	1 KHz
- Spinning neutronstars	1 – 10 KHz
- Random cosmic events	
- Melting binary systems	200 Hz – 2 KHz
- Early stage of the Universe	0.1 – 10 Hz



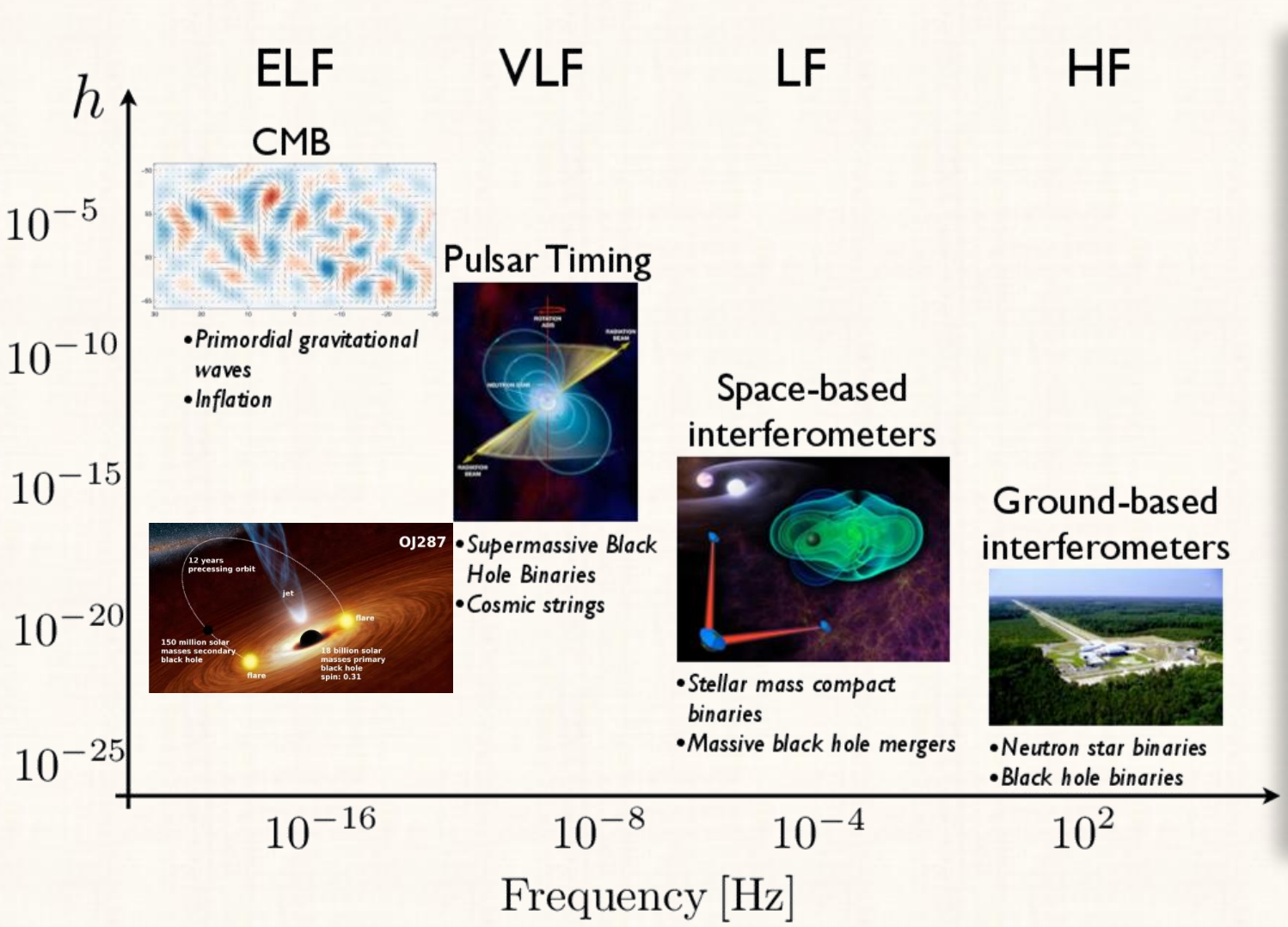
GW can be characterized by well-determined wave forms in the EARLY and the LATEsteges

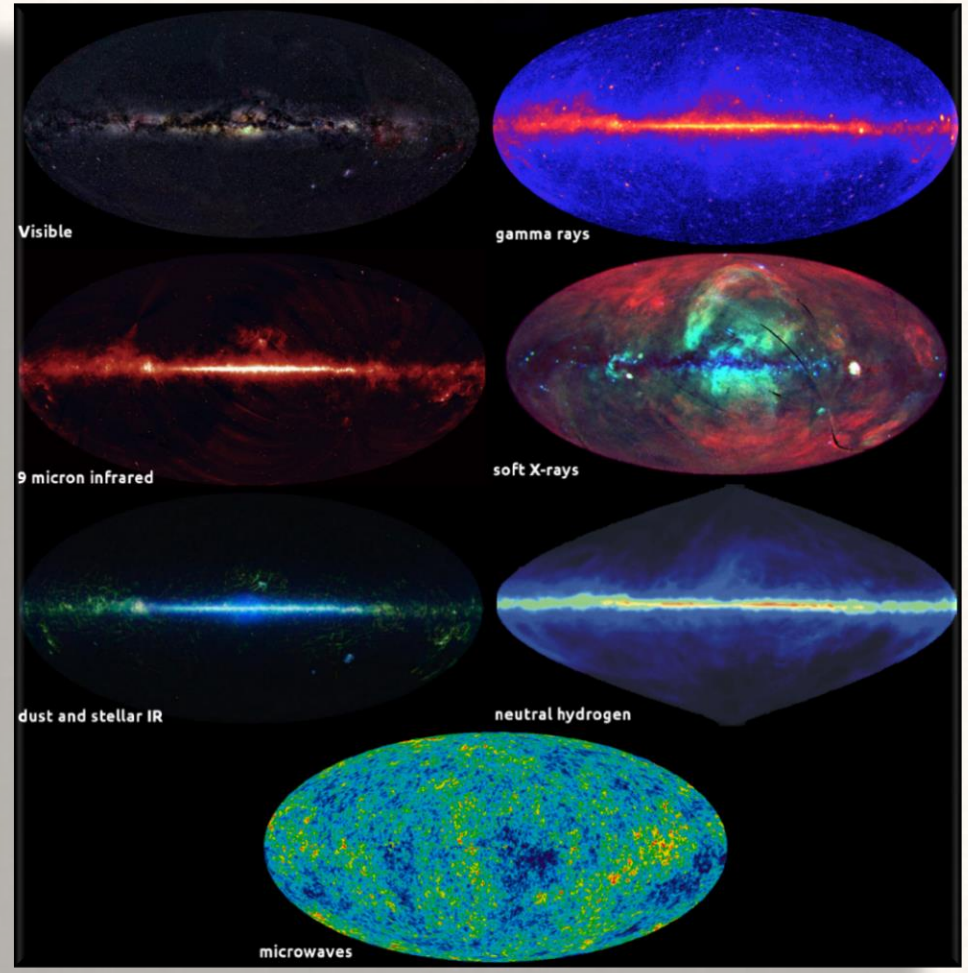
→ **precursor and forcast !!!!**





Gravitational waves + astronomy



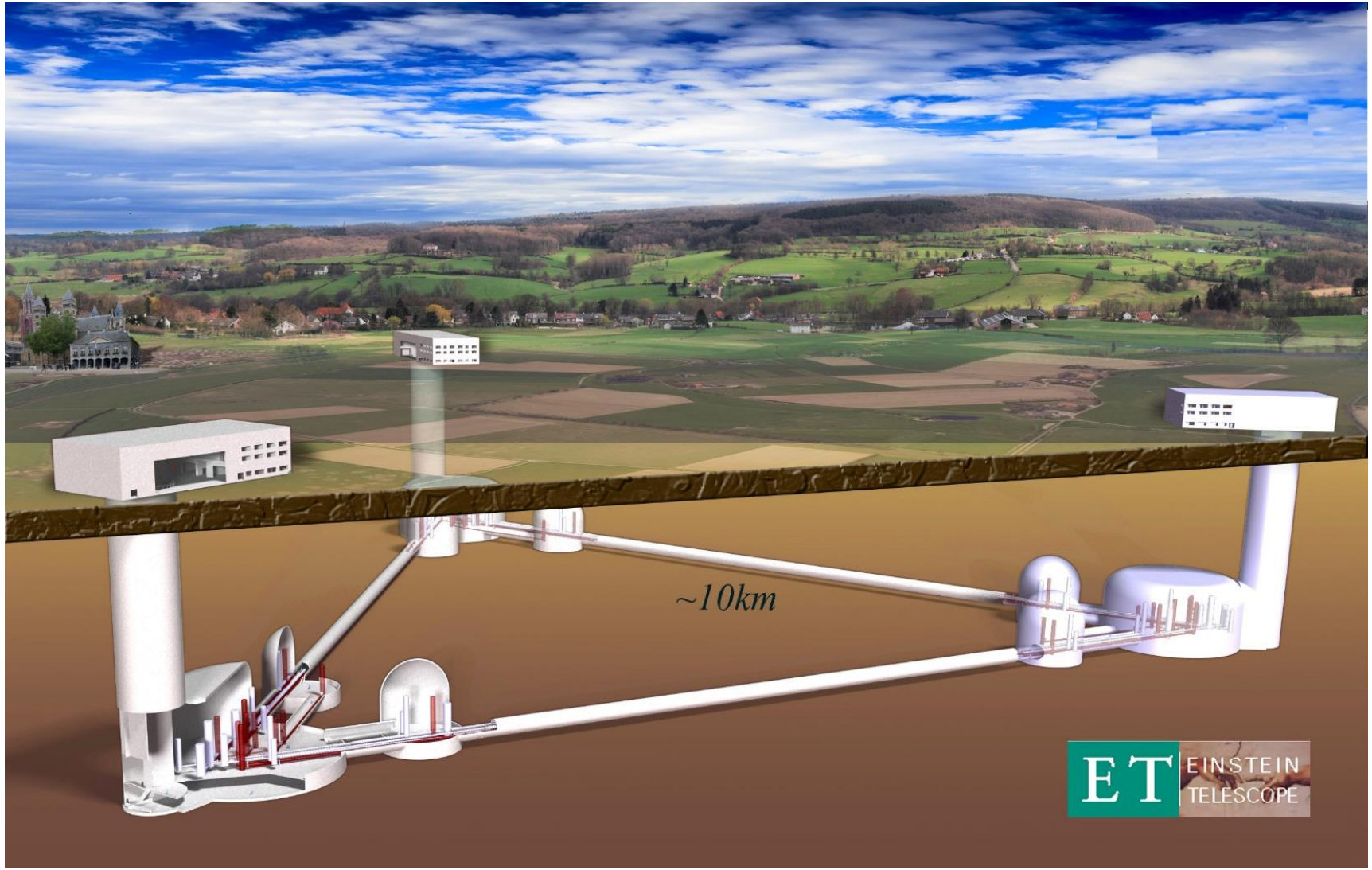


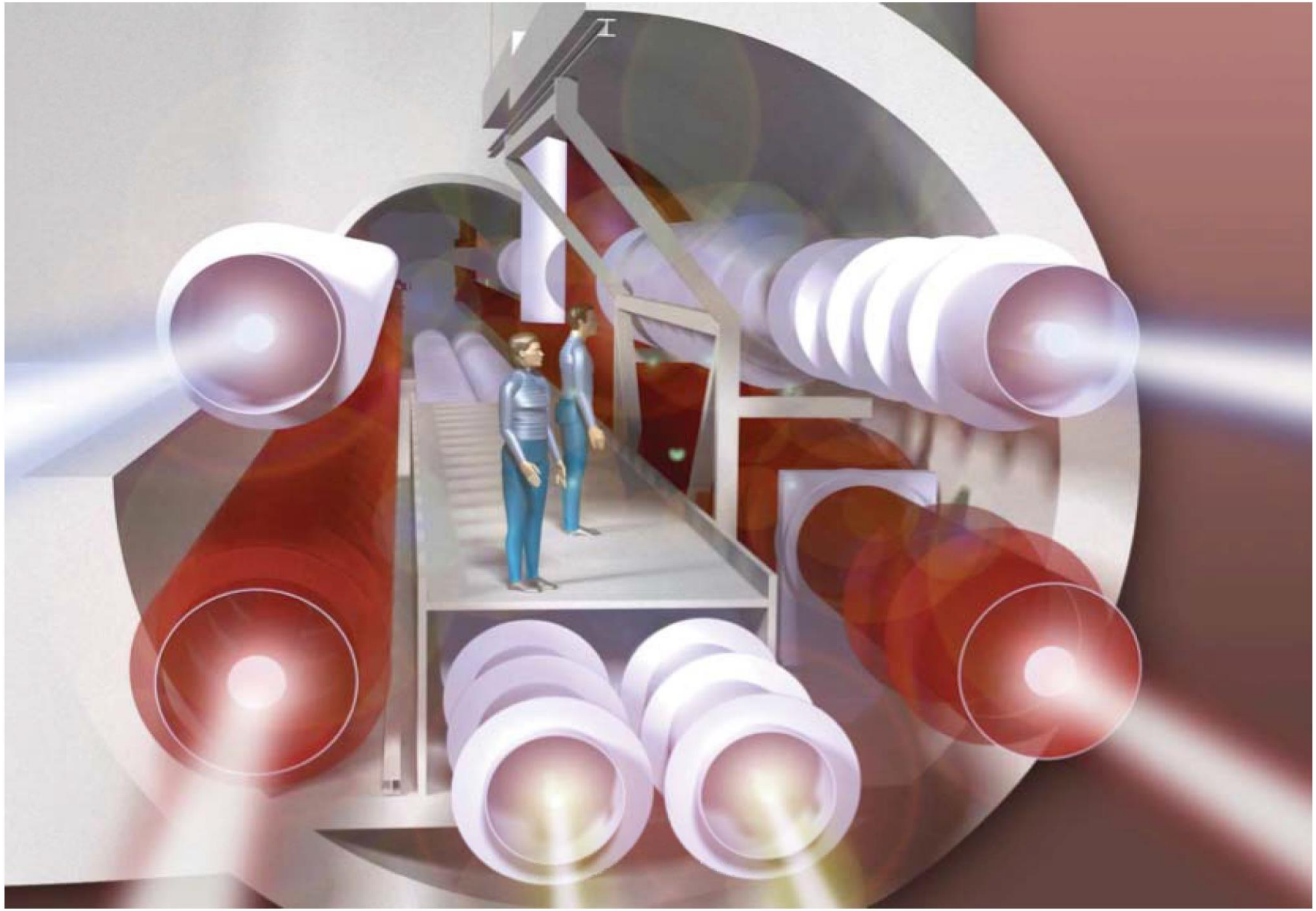
Combination of GW, CR & EM ►►►►► „Multi-messenger astrophysics”

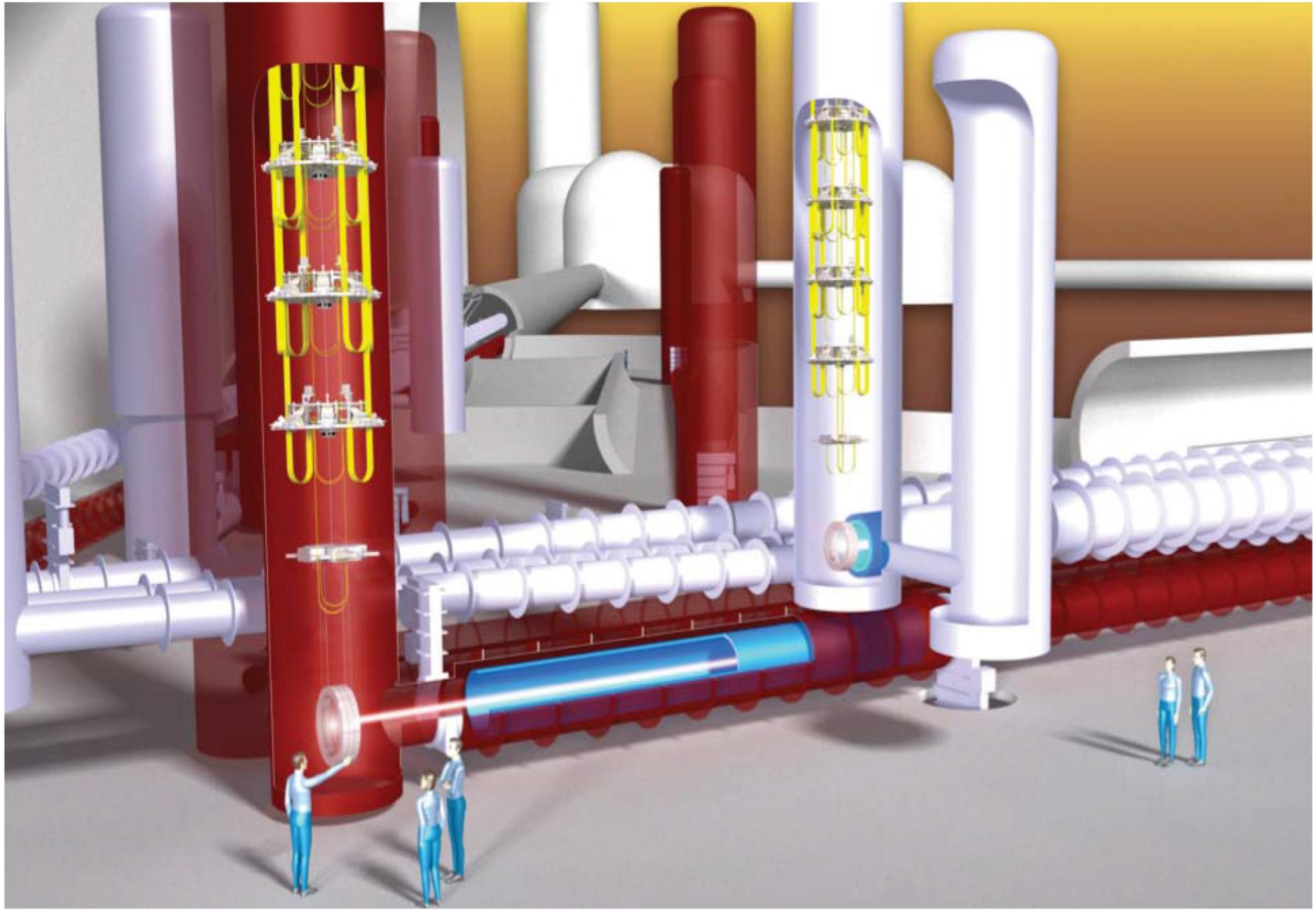
Worldwide Network of GW Observatories

Result: sky sectors for sources ►►►
forcast for optical observations !!!

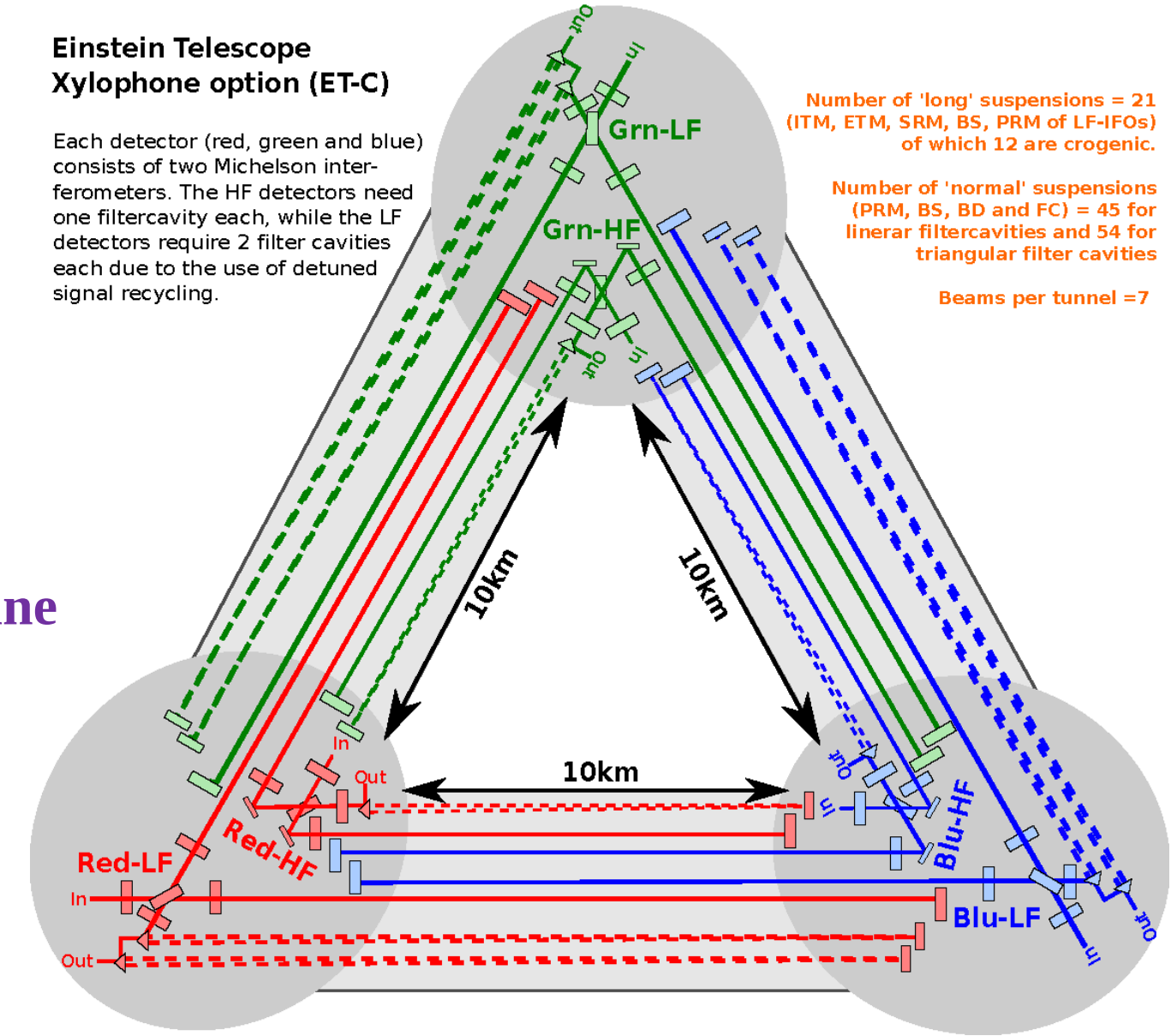
Einstein Telescope – TechDR from 2011







Az ET felépítése



Locations:

HU Mátra Mountine

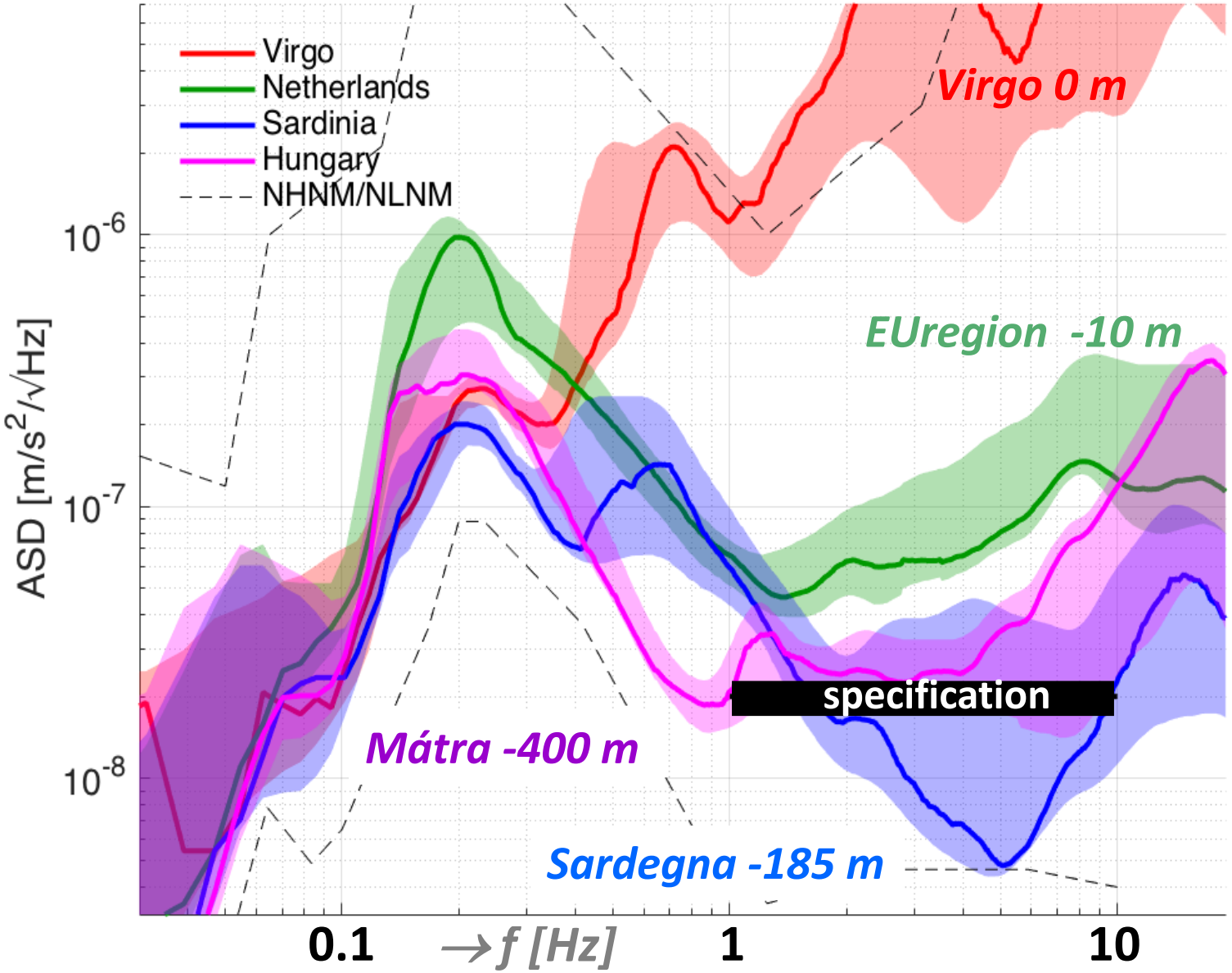
BE-NL-D Liege

IT Sardinia

ES Pireneus

…

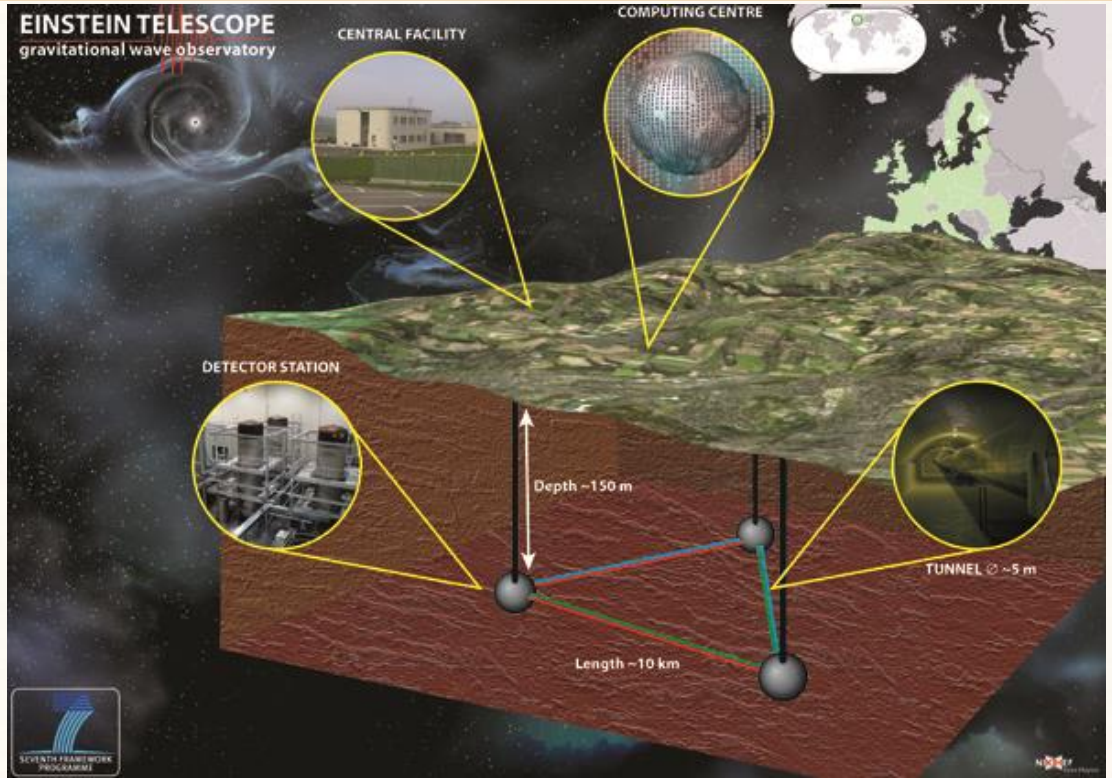
Adventage of underground location



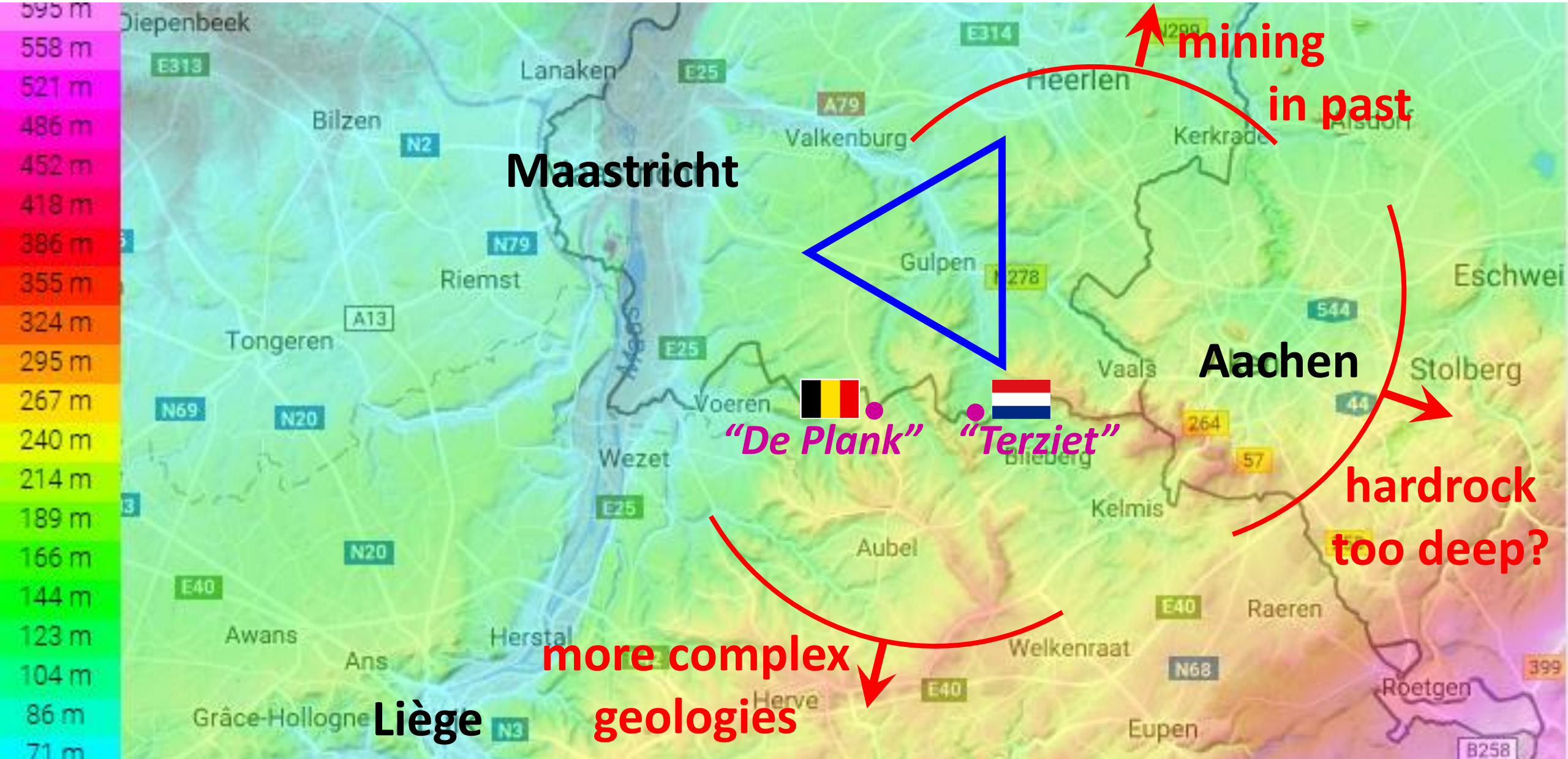
Masterplan: 3G-GW Detector construction in Europe !!!

- GW discoveries by 2G-GW detectors (LIGO/VIRGO – GW20150914, GW20151226, …)
- InternationalCollaboration for developing a 3G-GW detector facility
  Gravitational **W**ave **I**nternational **C**ommittee; EINSTEIN Telescope Consortium 2018/04/20 → LoI

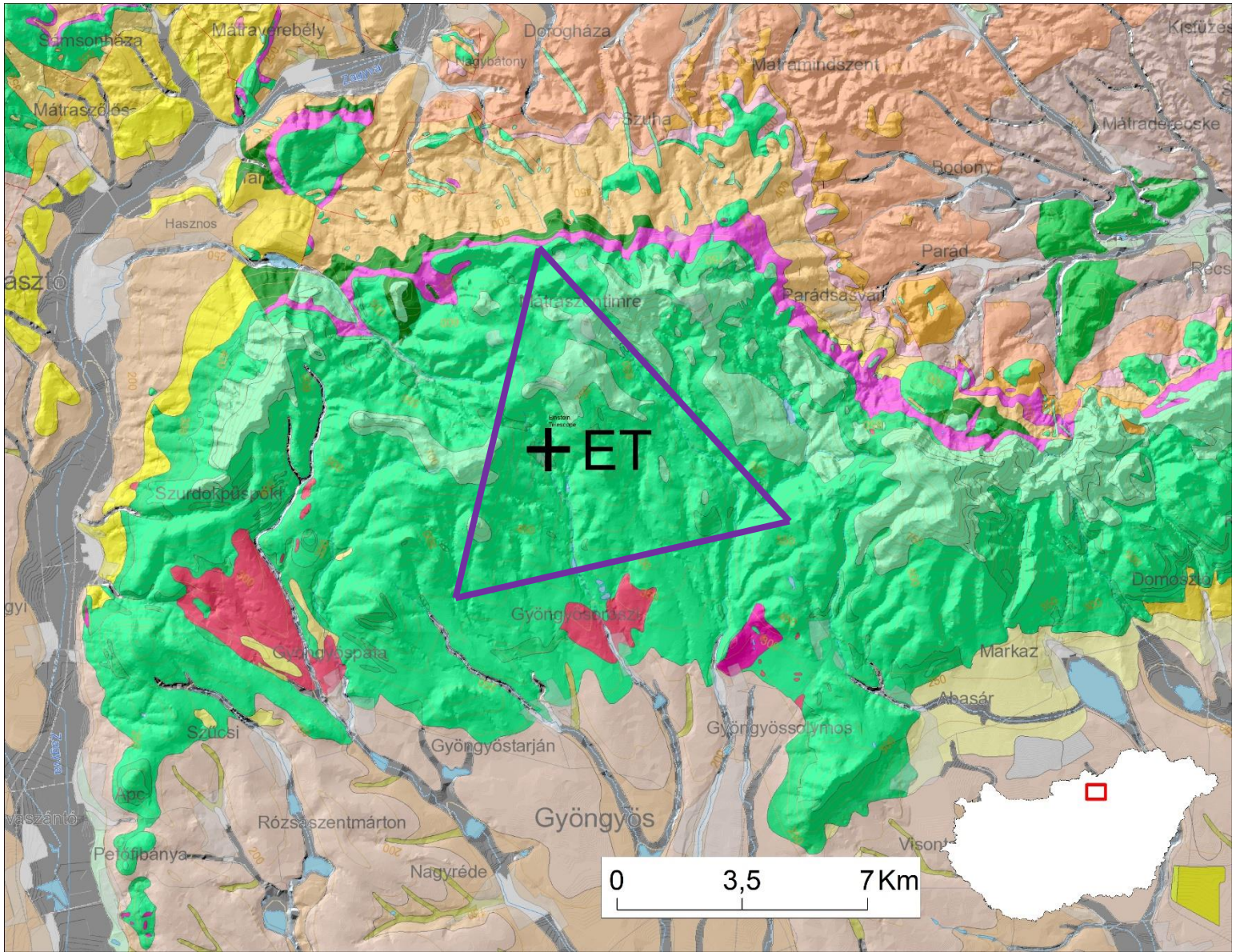
Observing run	Epoch	Duration (months)	aLIGO sensitivity	AdVirgo sensitivity
O1	2015–2016	4	Early	—
O2	2016–2017	6	Mid	Early
O3	2017–2018	9	Late	Mid
O4	2019	12	Design	Late
O5	2020+	–	Design	Design



Dutch-Belgian-German plan



Hungarian location for ET in the Mátra (10+10+10 km)



Advantages:

Uniform andesit

Hard/stiff stone

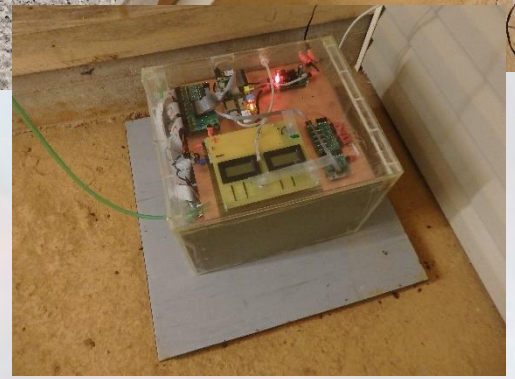
Low-level natural-noise

Well-understood region (samples)

Low citizen density

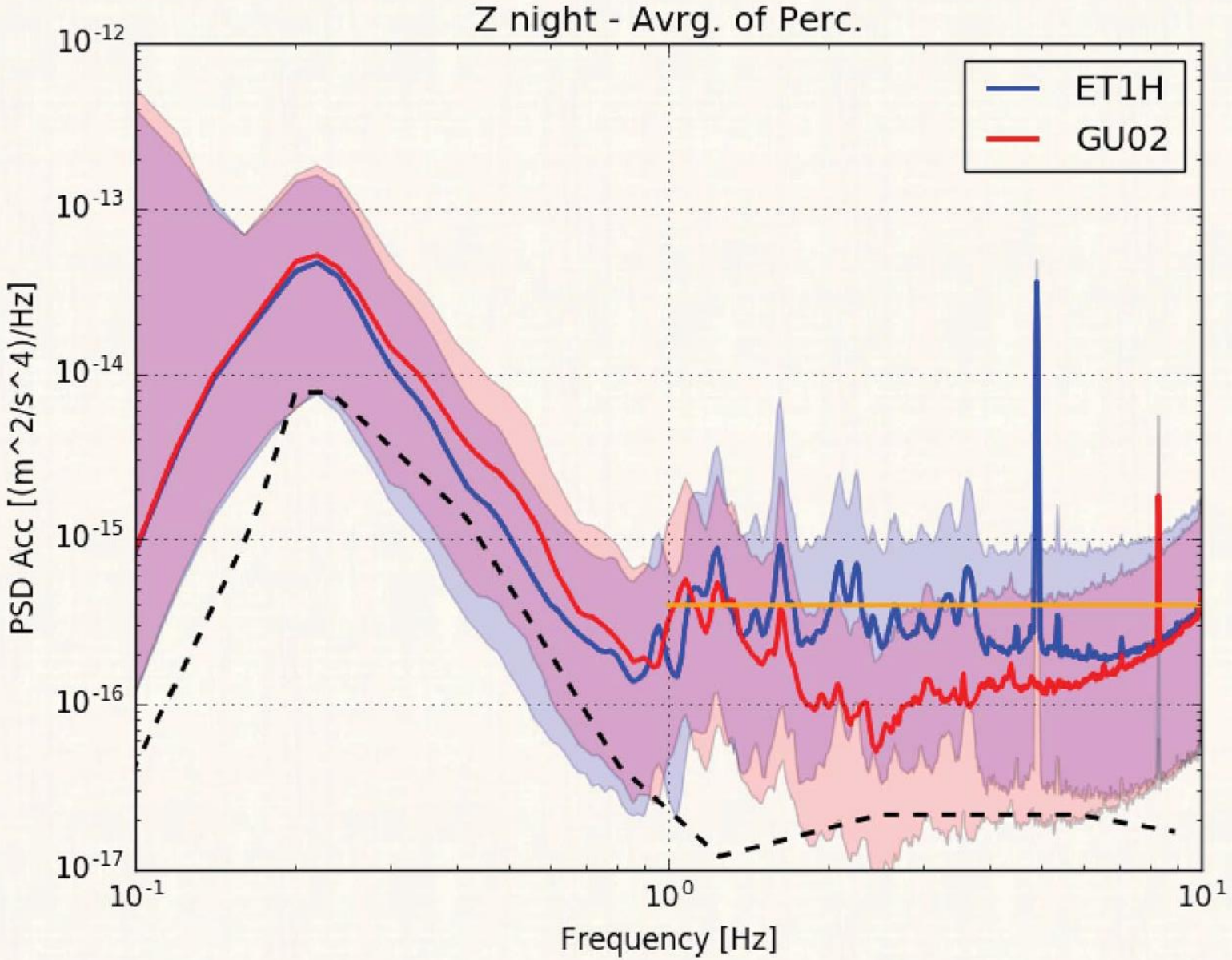
Low-level civilisation-noise

Matra Gravitation and Geophysics Laboratory (MGGL)



Conclusions

Summary of two years data collection in the MGGL Laboratory



TIMESCALE

	Virgo	AdV	aLIGO	ET
1985	R&D			
1990	White Paper, CDR (1989)			
1995	R&D Approval (1994) Final Design, TDR (1995) Beginning Infrastructure (1996)		R&D	
2000	Completion installation Detector (2003)	R&D	CDR (1999)	
2005	Scientific data taking (2007)	First AdV sensitivity projection (2004) AdV White Paper, CDR (2005)	R&D Funding (2006) Building (2008)	First Idea (2005) R&D
2010	Decommissioning (2011)	Approval (2009) First orders (2010) TDR (2012)	Installing completion (2014) Data taking (2015)	CDR (2011)
2015		Completion Installation (2016) First data taking (2017)		R&D
2020				TDR ?
2025				Construction ?

15 years

15 years

15 years

15 years

UNIVERSITY of GLASGOW

VIA VERITAS VITA

We made a start on the updating at the Glasgow workshop in Sep 2017

https://gilsay.physics.gla.ac.uk/dokuwiki/doku.php?id=et_update_2017:start

Stefan Hild

List of items to investigate

- Science case difference between 2Hz cut-off and 10Hz cut-off? Tomek, David
- Lessons learned from KAGRA so far in terms of materials?
- Lessons learned from KAGRA so far in terms of sensors and actuators?
- What do we lose if we abandon triangular footprint vs longer L?
- What do we lose if we abandon the xylophone (because might not be necessary in global network)? What cost reduction to we get? Stefan
- Tube diameter to small currently for proper scattering mitigation?
- Optimum arm-length? is there a sweet spot from beam divergence, mirror dimensions available, energy stored in suspensions?
- What an estimate for the classical noise budget of an 3G detector? (Useful for optimisation)
- Is it of any use if a single ET has good LF sensitivity but no other detector has similar sensitivity in this frequency range?
- Do we need sky localisation capability?

suspension:

- Unordered List Itemmodify to two floor design. Con: lose flexibility of infrastructure
- a-LIGO pre-isolation and compact SUS.
- Warm and cold sensors and actuators.
- up to date list of what is available in terms of materials (sapphire, silicon, composite masses?) today Giles,
- SPI: options for central ifo?
- improvement of seismic sensors, tiltmeters
- actuators for minimal cross-coupling (act only in the desired direction)
- violin mode sensors and dampers
- think about ALL modes of long suspensions Norna
- Need to look anew into cryo-suspension techniques. 1.5m last stage.
- SPI?

optical topology

- (Michelson vs speedmeter etc) what is the decision path? decision point can be late as they all fit into the same infrastructure
- LG33 availability of optics, TCS, do we need LG33 ? rely on better coatings? review investigations since ET DS. Jerome
- squeezing higher order modes
- coatings review Stuart, Peter
- substrates review of materials and performance Harald
- PIs Anna, Andreas, Daniel
- TCS: Better wavefront sensors, better actuators? Need for TCS in "voyager" design?
- alternatives to xylophone design? what do we need? what do we gain?
- update options for optics surface, surface figure, scatter. Derive cavity losses (10km) from this
- squeezing losses in FC. Actuating BW of FC. Actuating on surface figure of FC to reduce losses and improve MM.
- adaptive mode matching
- quantum noise of ET LF Haixing
- what parameters do we have to push to get to CE sensitivity? Haixing
- problems with increasing beam size

site and infrastructure

- derive site preference from geology and noise sources (cities)? Is it possible?
- minimum set of measurements for validating site. Improve understanding of damping of different materials at sites. Michele
- cryogenics. Cooling power -> disturbances. liquid He "from above". safety issue?
- self made seismic noise: level, counter-measures Nikhef
- Identify any potential cost savings on vacuum?
- facilities for producing large cryo substrates -> GWIC 3G R&D

HU-Technology contribution - 1: World-class IT

WIGNER Datacenter -- Csillebérc, MTA WIGNER RCP [4 MW]

2013/01/01: Start of the CERN TIER-0 extension [1300 km 3x100 Gbit/s]

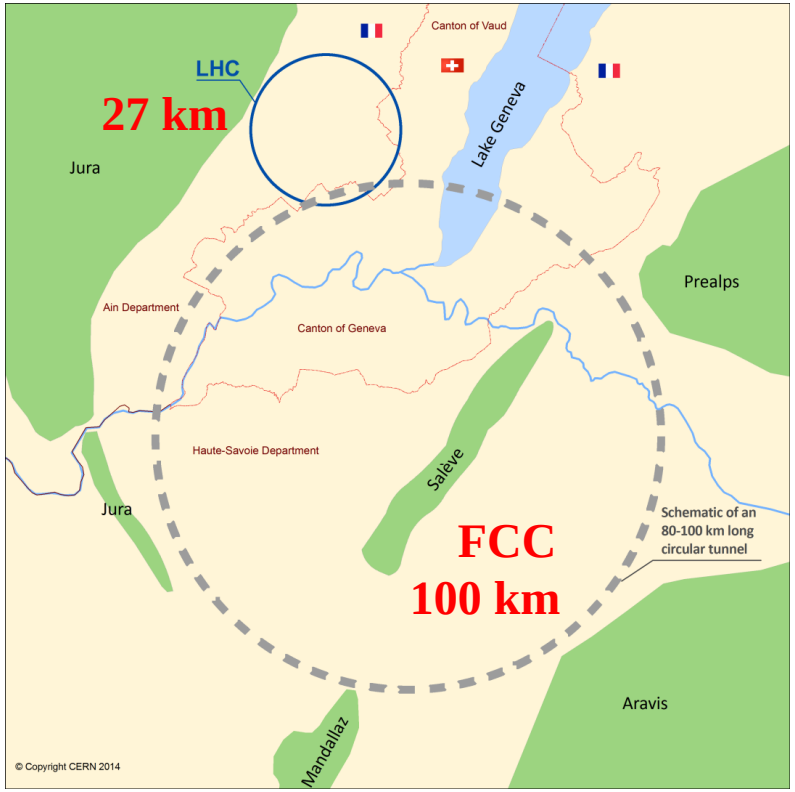
2016/07/01: Academy Cloud + Wigner Cloud (+ Integrated GPU)

Tier-0: 80 000 CPU-kernel, 90 PB HD, 240 TB RAM (+ GPU Club, CERN AIME events)

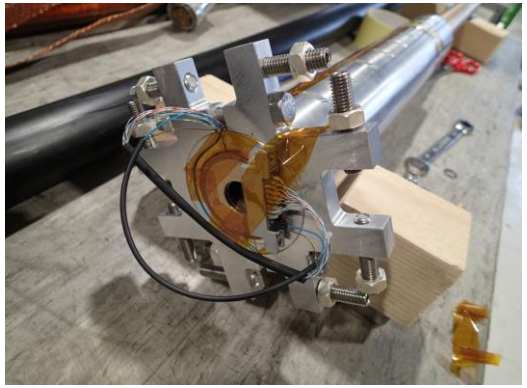
Academy Cloud: 2300 CPU-kernel, 2 PB HD, 15 TB RAM, 1.6 PB tape (+ 32 TFLOP GPU)

►►►► **IT-center for the ET Project**

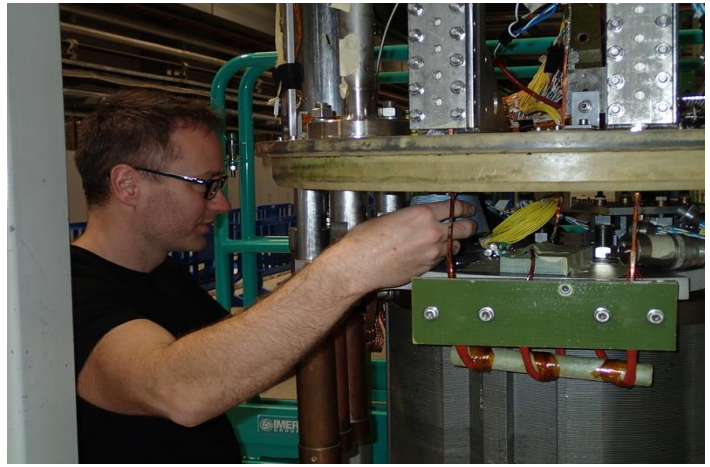
HU-Technology-2: criotechnology and connected test-facilities at liquid-helium temperature (CERN-WIGNER Collab.)



Large Hadroncollider (LHC)
Future Circulare Collider (FCC)
→ Many thousands superconducting dipol cooled down by liquid He



Superconducting structures.



Installing a test-bed
Dániel Barna (Wigner RCP)
Head of the SUSHI project

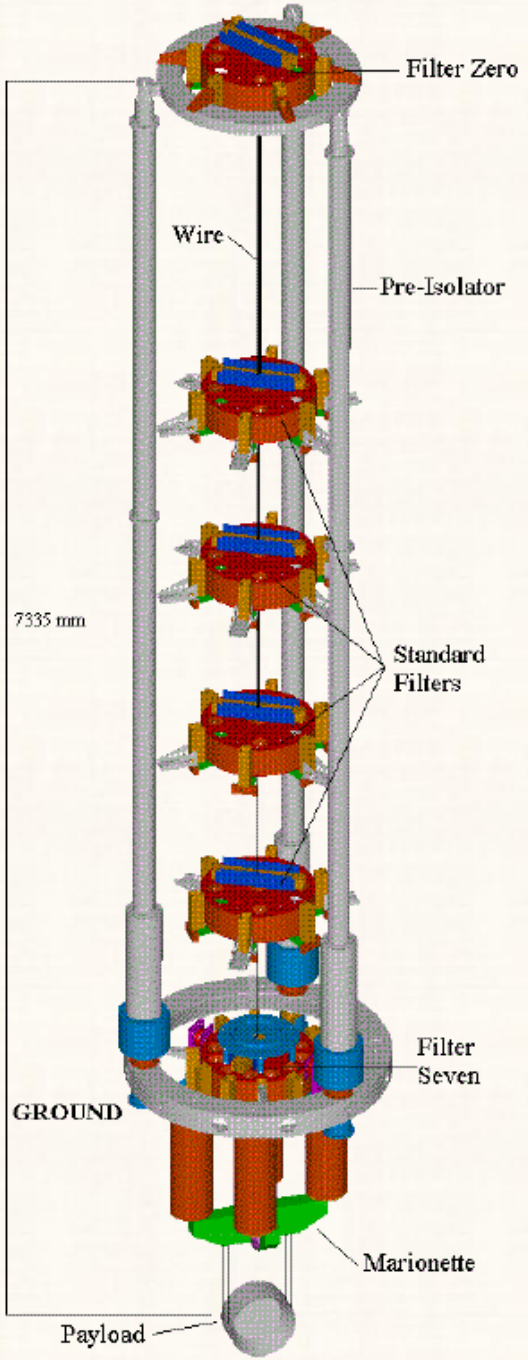
The test facility for superconducting structures and LHC magnets installed inside

HU-Technology-3: (Plan)

Insulation of Seismic noises

- Seismic noises yield unnecessary effects for earth-based GW-detectors
- VIRGO system has Super Attenuator for noise insulation under 100 Hz
- Hibryd systems (passive/active) rendszer
- Multistage insulation pendulum
  - Backward pendulum
  - 6 level of seismicfiltering
  - The weight of the mirror

BME, Budapest (plan)



Hungarian activities in 2018:

1. Joining to the European ET Collaboration (person, institute, country)
   Signing ET LoI (so far 53 HU-fun)
   Establishing HU-ET Collaboration
   (MTA Wigner RCP, MTA CSFK, MTAATOMKI, + Univs.

2. Feasability Study for the Matra site

3. Political Support for the ESFRI application (2019)

4. Financing backround (10 years!)
   National Gravitechnological Program

5. Further steps ►►►► ESFRI Roadmap 2020
   V4 Collaboration
   Bilateral technological collaborations
   Fostering interest in neighbour countries and institutes