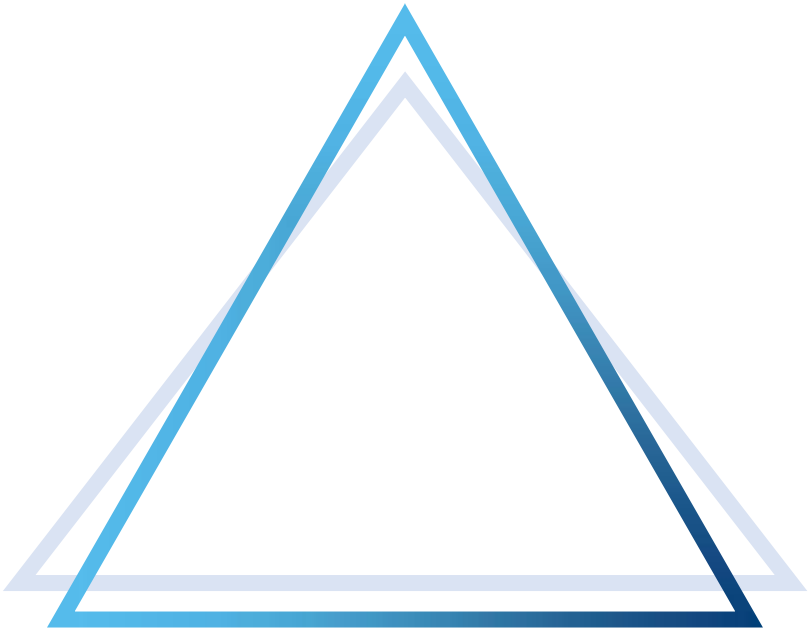
KU Leuven as ET-PP third party

Jonathan Menu, Institute for Theoretical Physics,
on behalf of KU Leuven

ET-PP Annual Meeting, Barcelona, June 12-13, 2023



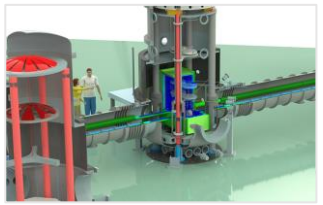
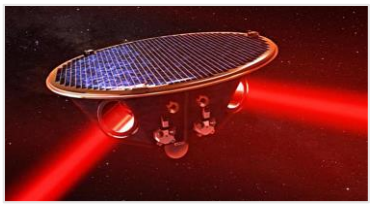
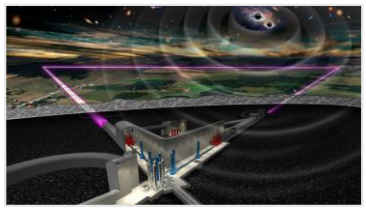
Gravitational Wave research at KU Leuven

9 departments involved

Physics & Astronomy, Mathematics, Chemistry, Earth & Environmental Sciences, Computer Science, Mechanical Engineering, Material Engineering, Electrical Engineering, Civil Engineering

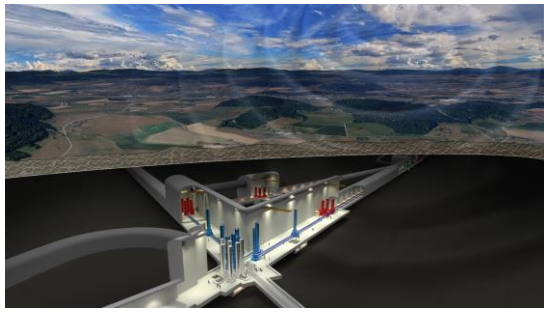
Key contributions to ET-related Interreg projects, ESA/NASA LISA mission, Flemish inter-university projects, …

Newest Flemish collaborative initiative: “Essential Technologies for ET”, led by KU Leuven + UAntwerp

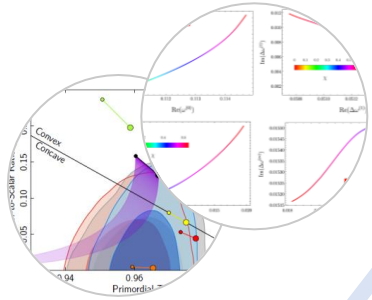
Essential Technologies for the Einstein Telescope

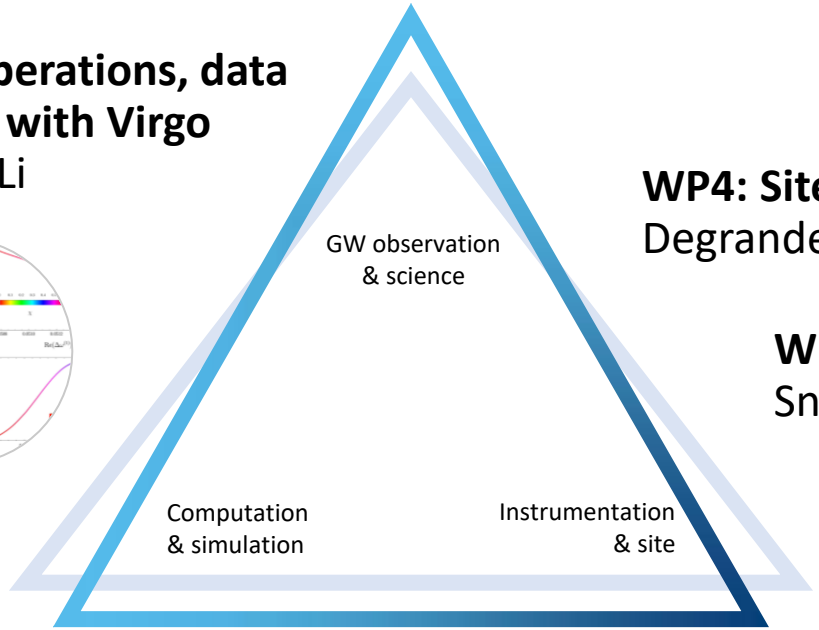
— International Research Infrastructure project (2023-2024, funded by Flemish Research Foundation)



Overview of KU Leuven-specific activities and WP leads
Funding: €3.6M (€6M in total)

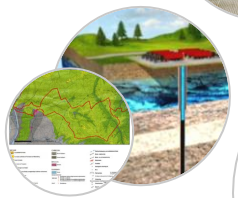
WP1: Operations, data analysis with Virgo
Hertog, Li



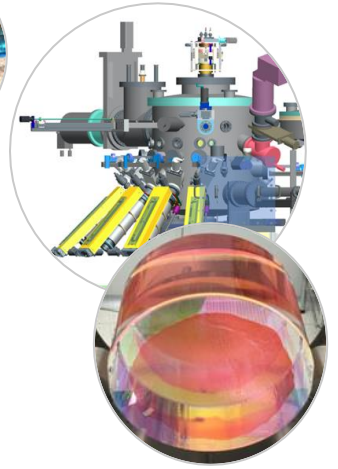


WP4: Site, Science, Infrastructure
Degrande, François, Hertog, Li

WP9: Geology
Snellings, Swennen

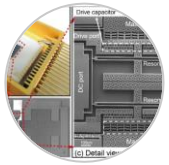


WP2: Mirror substrates, coatings
Glorieux, Locquet, Seo



WP5: Exascale computing
Li, Sana

WP3: Cryogenic Chips
Tavernier

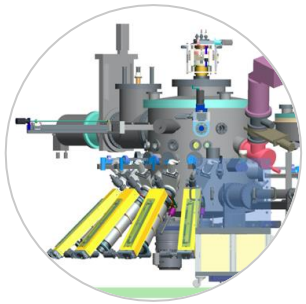


Partners: UAntwerpen, UGent, VUB, UHasselt, Imec

Image credits: Marco Kraan (Nikhef), Euridice

Essential Technologies for the Einstein Telescope: WP highlights

Mirror coatings



New molecular-beam epitaxy system @ KU Leuven Nanocentre

Addressing coating thermal noise (large impact on mirror performance):

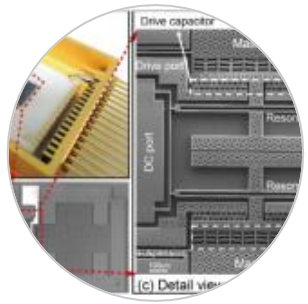
— Noise of state-of-the-art amorphous coating is major performance limitation in current GW detectors

— KU Leuven ambition: high-quality single-crystal oxide mirror coatings

Goal: structural, optical, mechanical loss characterization tools

Link with E-TEST, ETpathfinder

Cryogenic chips



MEMS accelerators with Cryogenic CMOS

Chip design for extreme environments

Main focus: sensor readout in cryogenic environments

Challenge: lack of transistor models valid at cryogenic temperatures

→ simulations + experimental validation

Essential Technologies for the Einstein Telescope: WP highlights

Tunnels, underground constructions

Hades tunnel (Euridice)

Low-frequency noise:

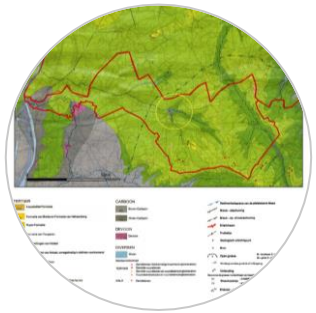
— Identification/characterisation of vibration sources in built environments (measurements + simulations)
Road, railway, industry, construction, wind turbines, low-amplitude seismic events

— Site response, dynamic soil-structure analysis of tunnels/shafts, using predictive models

— Structural health monitoring using digital twins

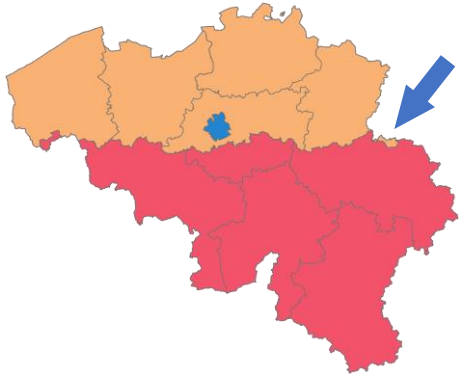
Experimental setup at underground laboratory (East-Belgium)

Geology



Voeren, Belgium

Voeren: Flemish municipality in East-Belgium, within EMR region of interest



Characterization geology:

— Drilling 2 boreholes, logging, core analysis

— Hydrogeological study

— Extrapolation, subsurface geological modelling

ET-PP third-party participation KU Leuven (EoI)

Commitment from KU Leuven:

- 3 FTEs for next 3 years
- €600k for site selection
- contribute to socio-economic, educational, outreach

WP (ET-PP)	Contribution	Details
3: Financial architecture	1 FTE	Financial expert: architecture for construction + operation
4: Site preparation	€600k	Drilling 2 additional boreholes in Flanders (as part of EMR)
5: Engineering dept.	1 FTE	Civil engineer dynamic soil-structure interaction
5: Project office	1 FTE	Project manager: operational management for ET, R&D landscape Belgium