ETpathfinder

An introduction for Nikhef Theory

27th of March, 2026

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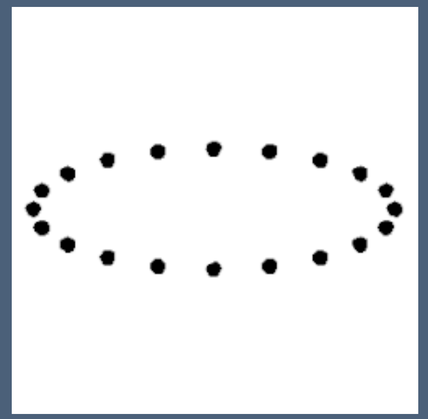
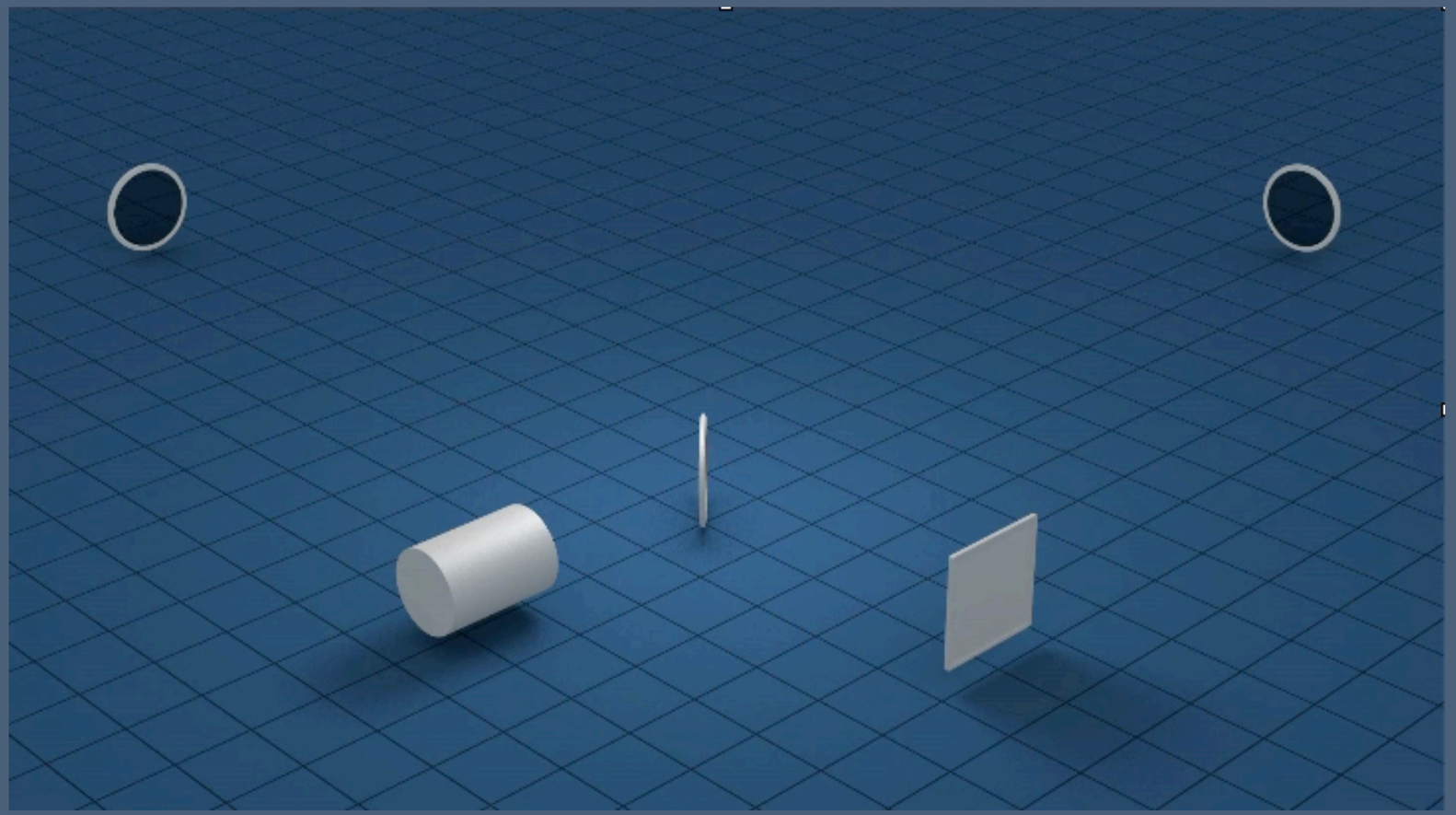
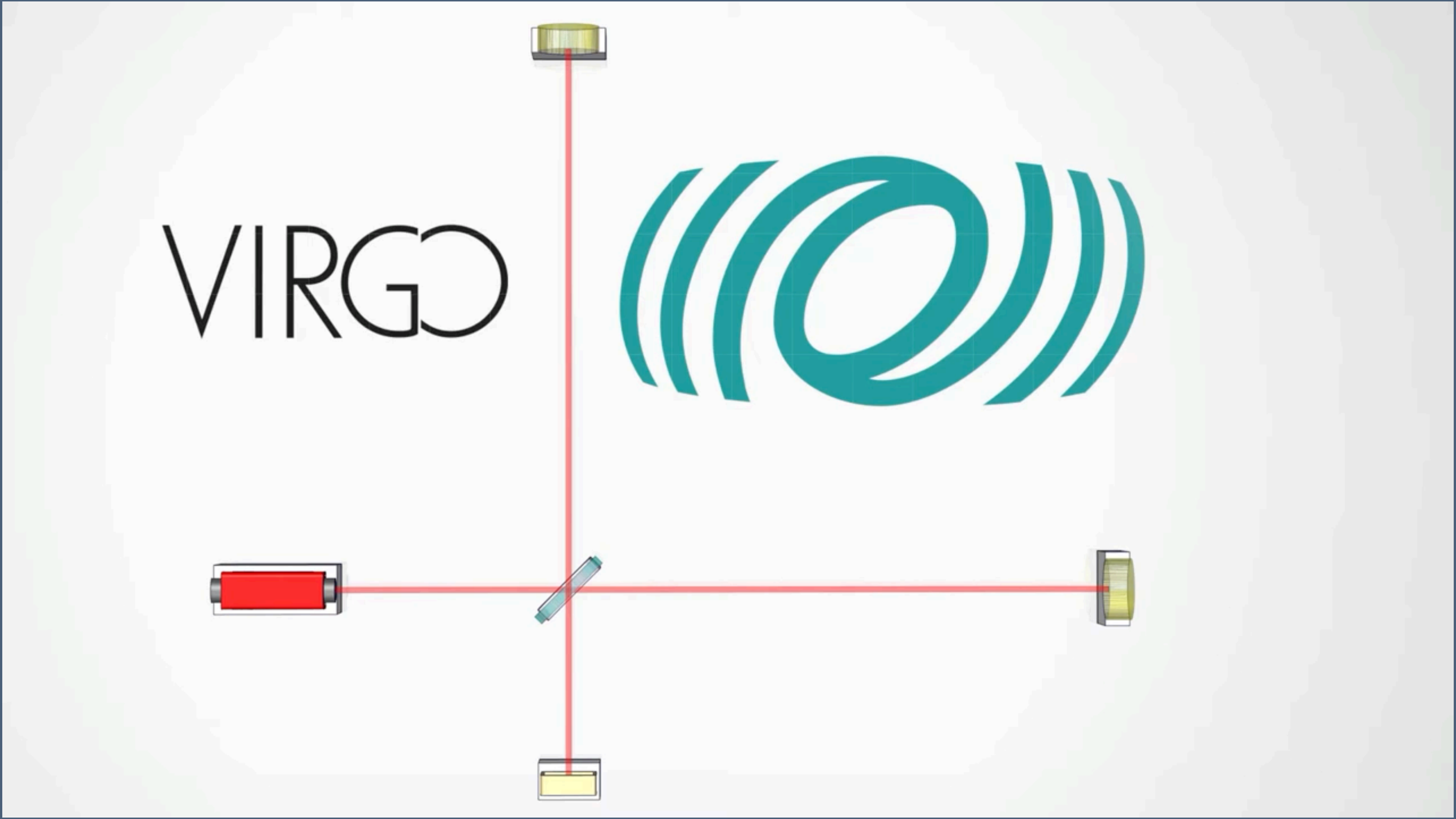
Maastricht University

Measurement Principle

From source to detector

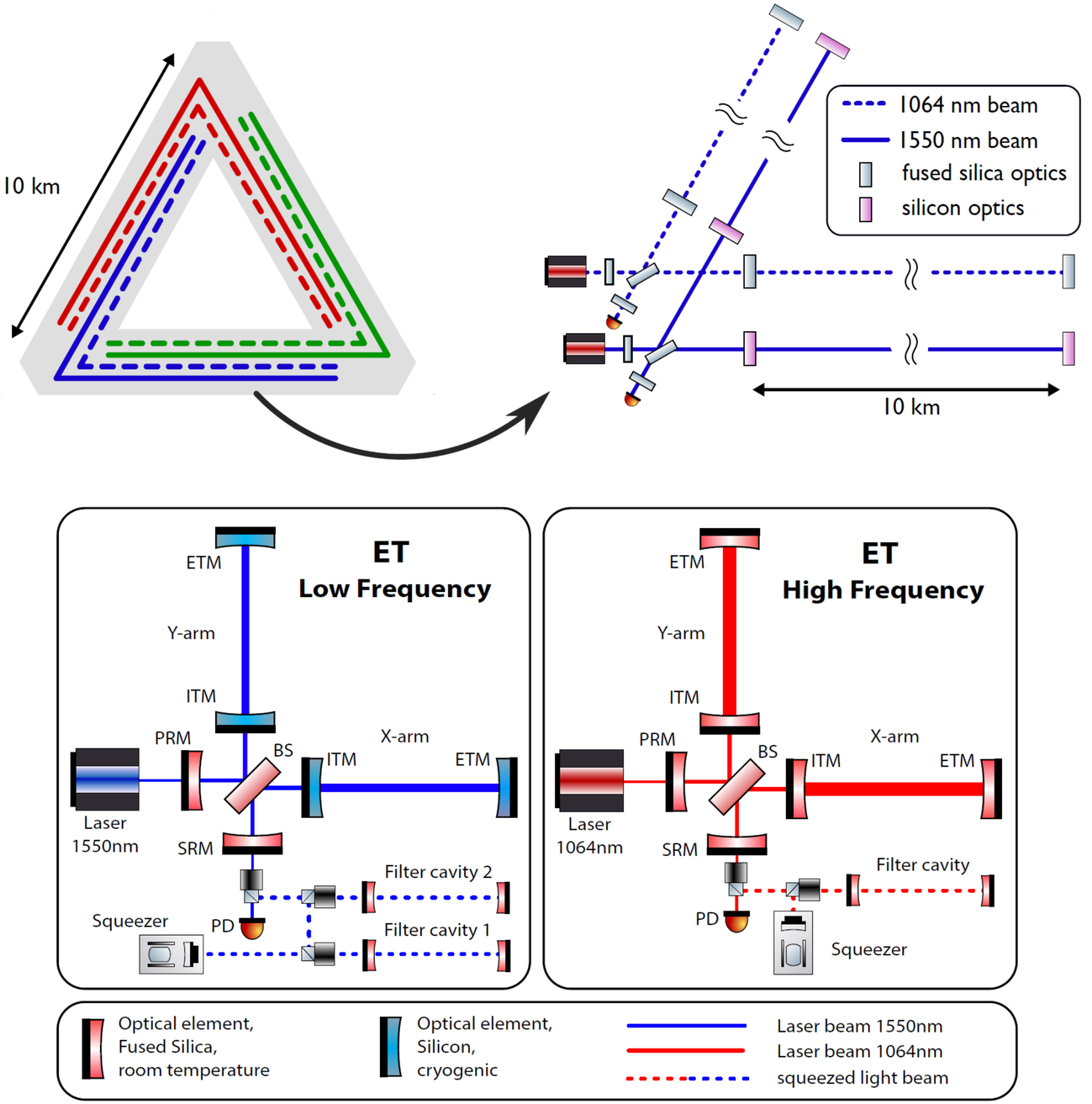





VIRGO

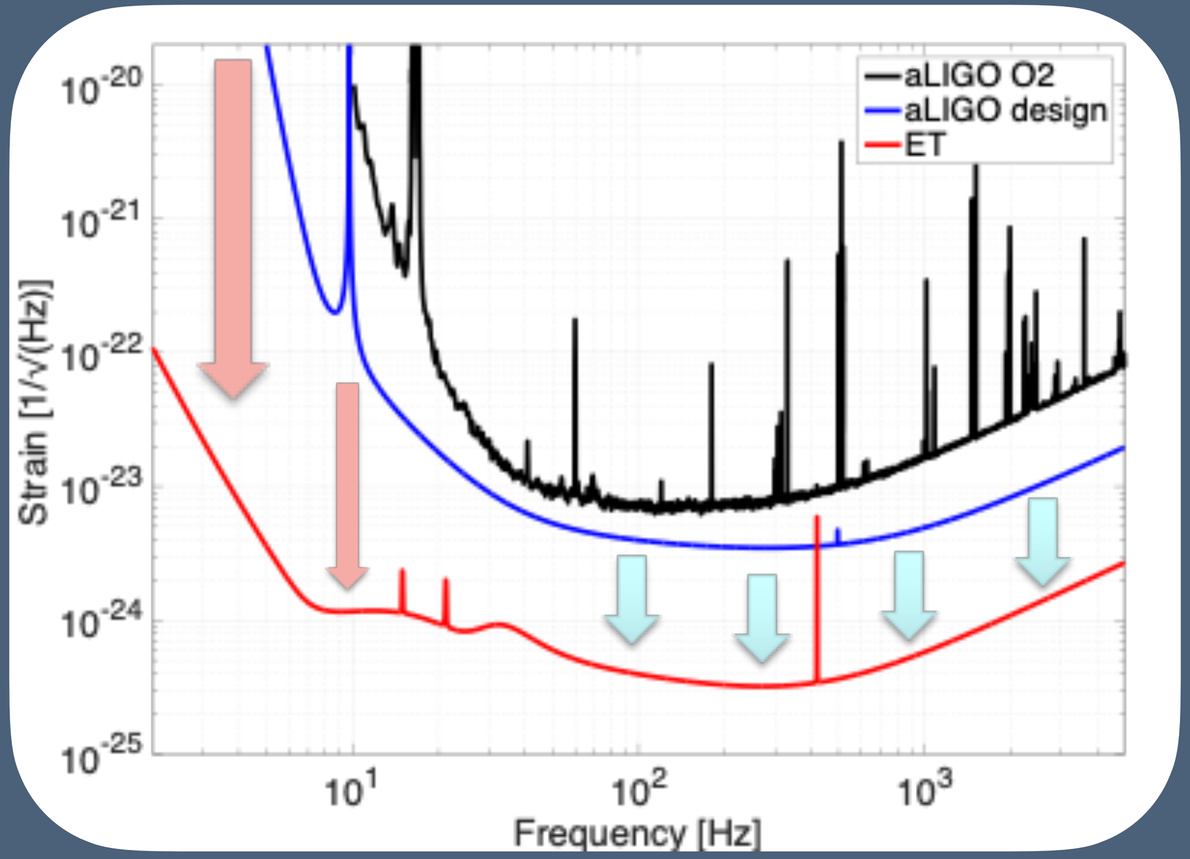
Einstein Telescope design

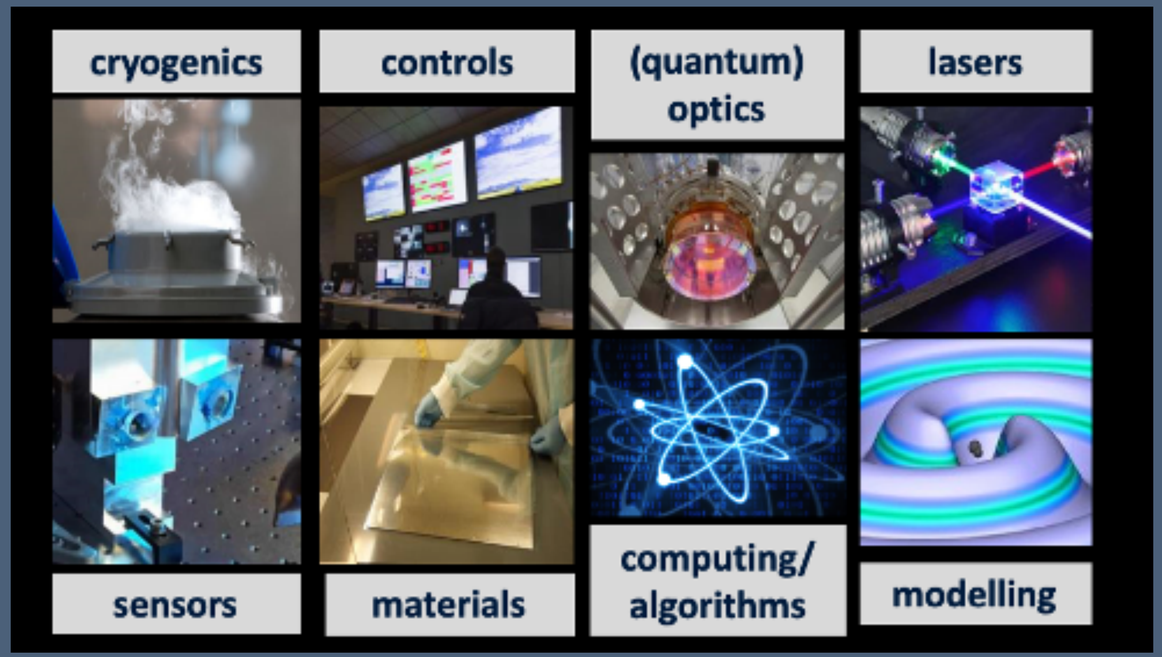
Parameter	ET-HF	ET-LF
Arm length	10 km	10 km
Input power (after IMC)	500 W	3 W
Arm power	3 MW	18 kW
Temperature	290 K	10-20 K
Mirror material	fused silica	silicon
Mirror diameter / thickness	62 cm / 30 cm	45 cm/ 57 cm
Mirror masses	200 kg	211 kg
Laser wavelength	1064 nm	1550 nm
SR-phase (rad)	tuned (0.0)	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



New technologies for Einstein Telescope

The low-frequency challenge





This has to be tested!


Ca. 1980


January 2020


April 2020


Summer 2020

Autumn 2020

Summer 2021


Nikhef

Official Opening, Nov 2021

Toespraak minister Van Engelshoven bij opening ETpathfinder

Toespraak | 08-11-2021

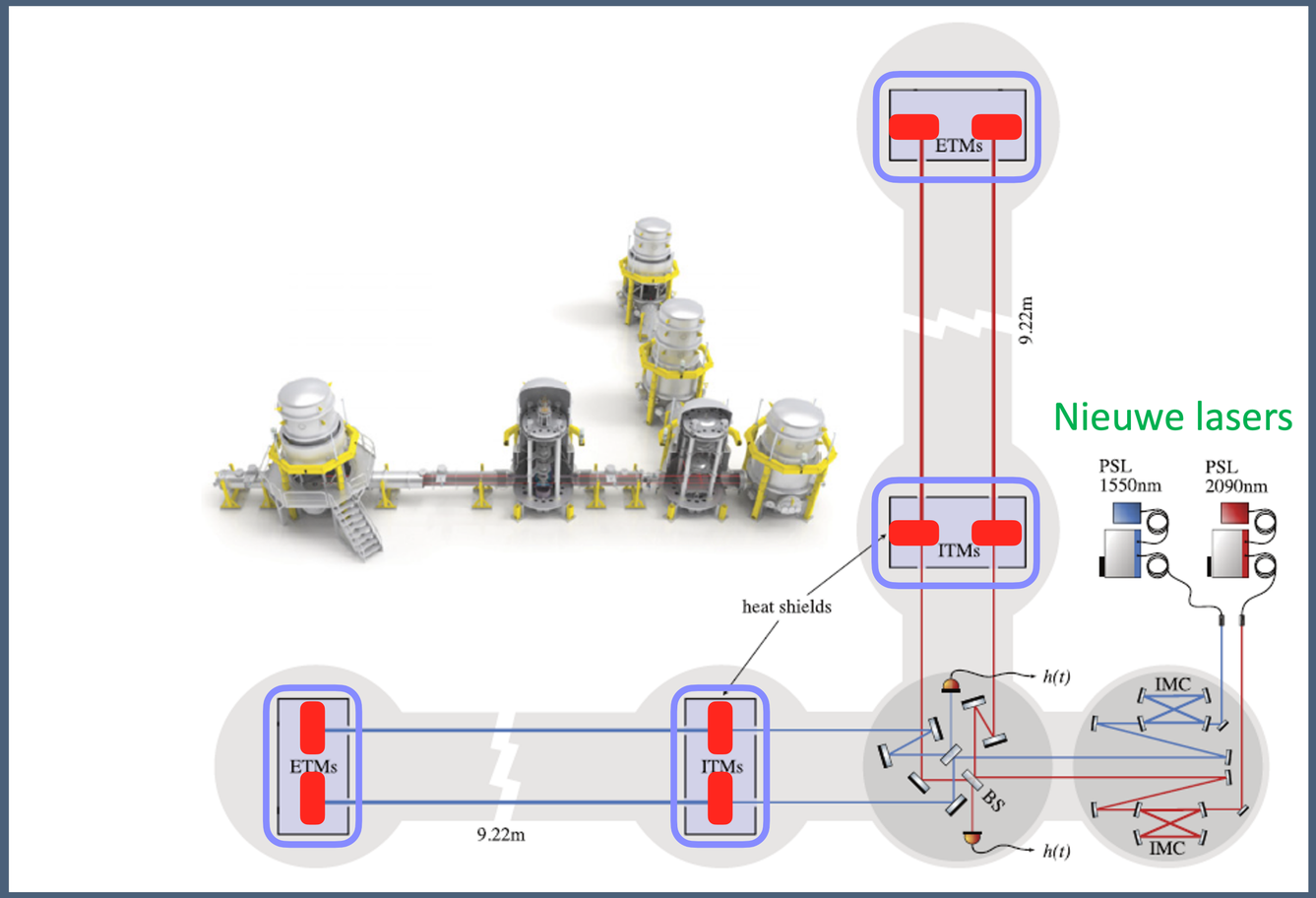
Today, we are taking a big step towards realizing this project. Because today, here in Maastricht, after years of hard work involving a great many people, we are opening ETpathfinder. A remarkable and significant milestone. For the Province of Limburg, for the Netherlands, and for Europe.

Whether we will succeed in bringing the Einstein Telescope to Limburg remains to be seen. What I do know for certain, is that ETpathfinder represents a giant step in the right direction. It's a wonderful achievement, one that will bring us all kinds of benefits for many years to come.

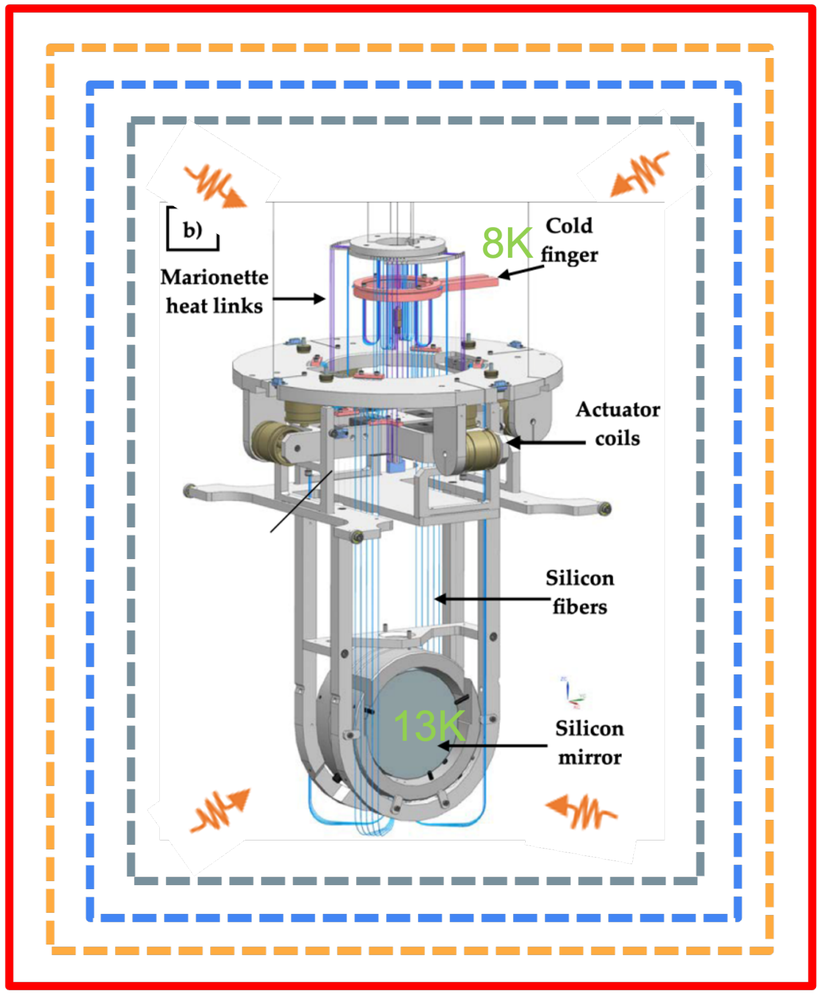

ALTMANN - 2 x 2 to
Summer 2022

ETpathfinder

- Goal: Testing ET technologies in an interferometer setup with minimal noise
- Cryogenic technologies
- Silicon Mirrors and coatings
- “New” laser wavelengths (1550nm, 2090nm)
- 20 partners from NL/B/G/FR/SP/UK



Radiative cooling with thermal shields



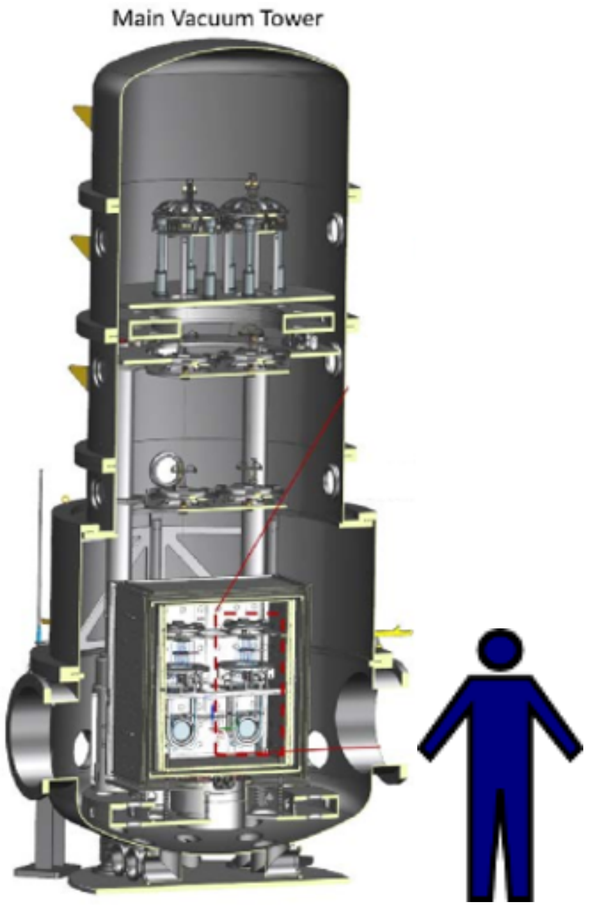
300K (kamertemperatuur)

80K vloeibaar stikstof

40K neon

15K waterstof

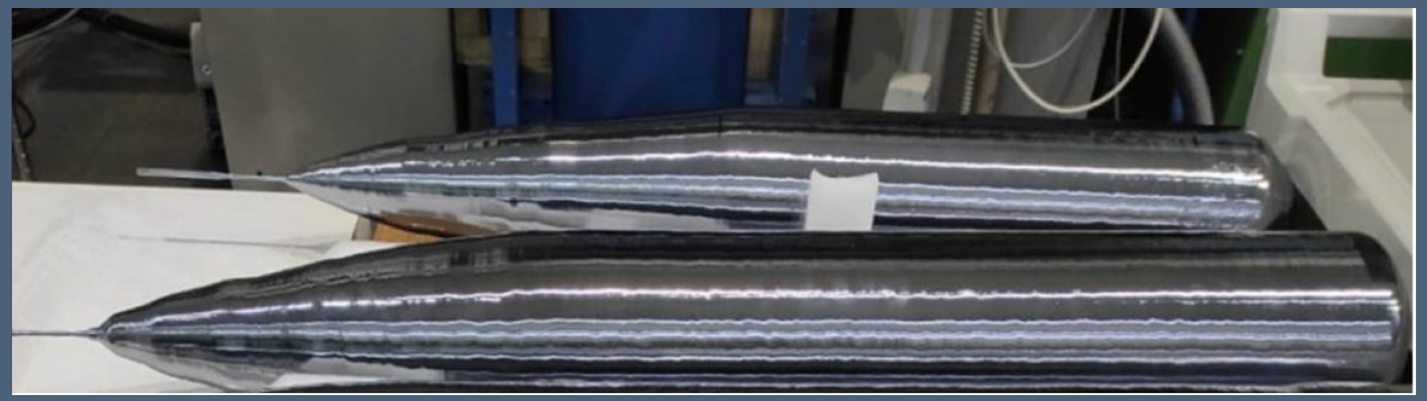
8K helium

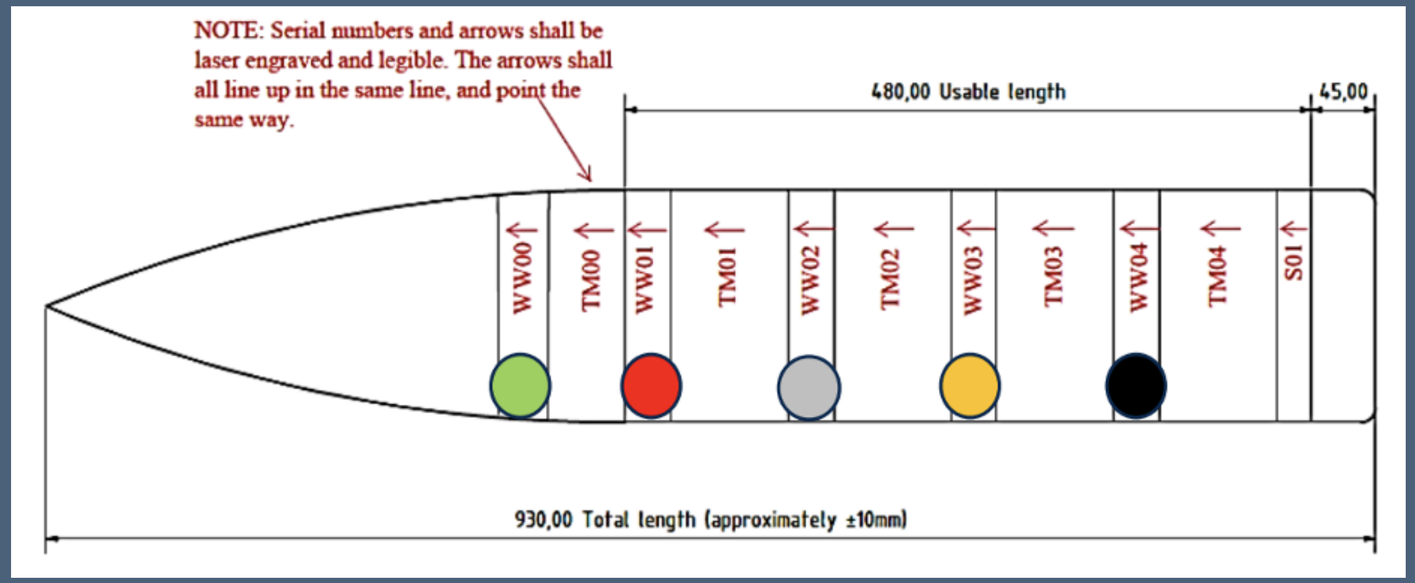


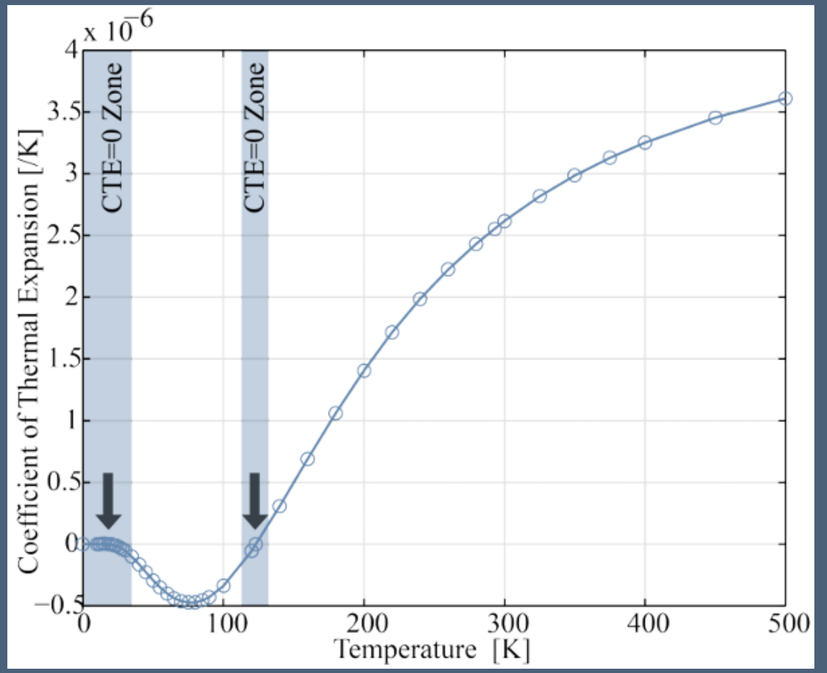
Stefan-Boltzmann law:

$$\frac{\mathrm{d}T_{\mathrm{pay}}}{\mathrm{d}t} = A\varepsilon\sigma\left(T_{\mathrm{pay}}^4 - T_{\mathrm{shield}}^4\right)$$

Silicon as cryogenic mirror material







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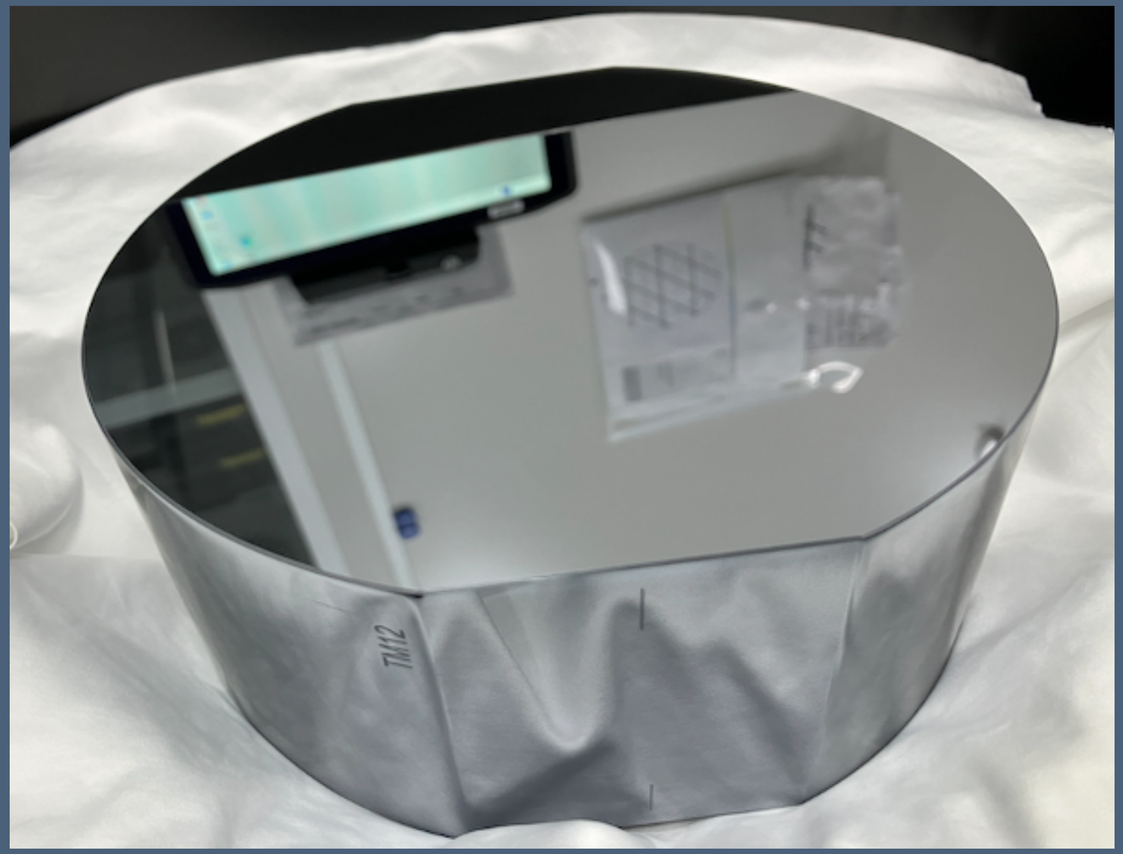

ETpathfinder Partners

Interreg
EUROPESE UNIE
Vlaanderen-Nederland
Europees Fonds voor Regionale Ontwikkeling

provincie limburg

Ministerie van Onderwijs, Cultuur en Wetenschap

Provincie Noord-Brabant

SMART HUB

Vlaamse Regering

VLAAMS-BRABANT
Met de steun van de provincie Vlaams-Brabant

Provincie Antwerpen

Ministerie van Economische Zaken

GHENT UNIVERSITY

Universiteit Antwerpen

VUB VRIJE UNIVERSITEIT BRUSSEL

IFAE Institut de Física d'Altes Energies

EXCELENCIA SEVERO OCHOA

LAPP Laboratoire d'Annecy de Physique des Particules

Nikhef

KU LEUVEN

UNIVERSITY OF BIRMINGHAM

Max-Planck-Institut für Gravitationsphysik Albert-Einstein-Institut

Maastricht University

Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

VU UNIVERSITY AMSTERDAM

ikz LEIBNIZ-INSTITUT FÜR KRISTALLZÜCHTUNG im Forschungsverbund Berlin e.V.

LIÈGE université

vito

RWTH AACHEN UNIVERSITY

University of Glasgow

TNO

Fraunhofer ILT

UHASSELT

UCLouvain

UNIVERSITY OF TWENTE.

KIT Karlsruher Institut für Technologie

Nikhef

Maastricht University

Nikhef

Maastricht University