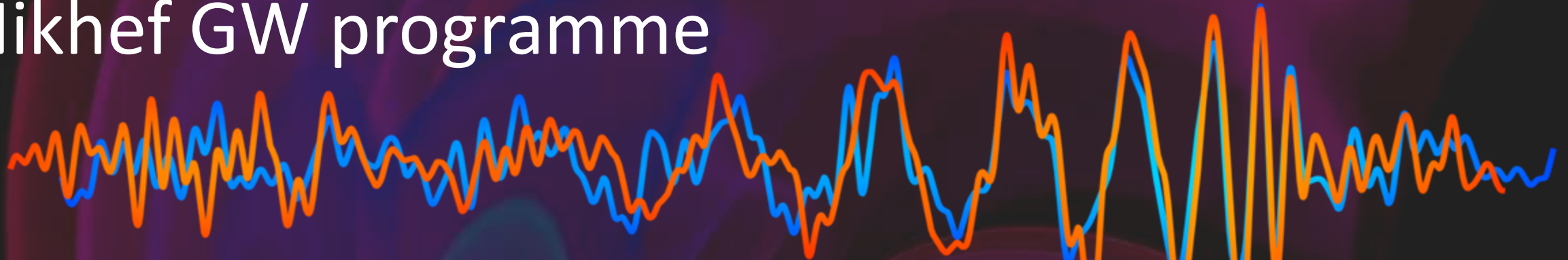


Nikhef GW programme



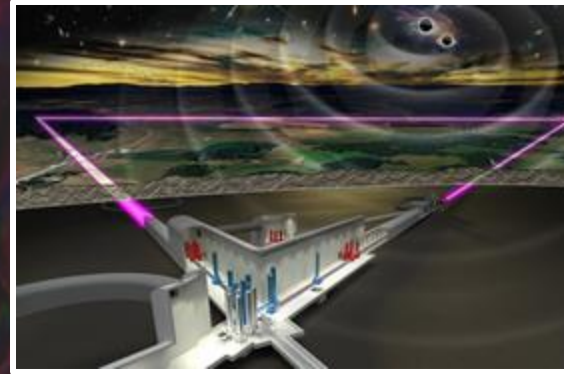
LIGO/Virgo/KAGRA



ETpathfinder



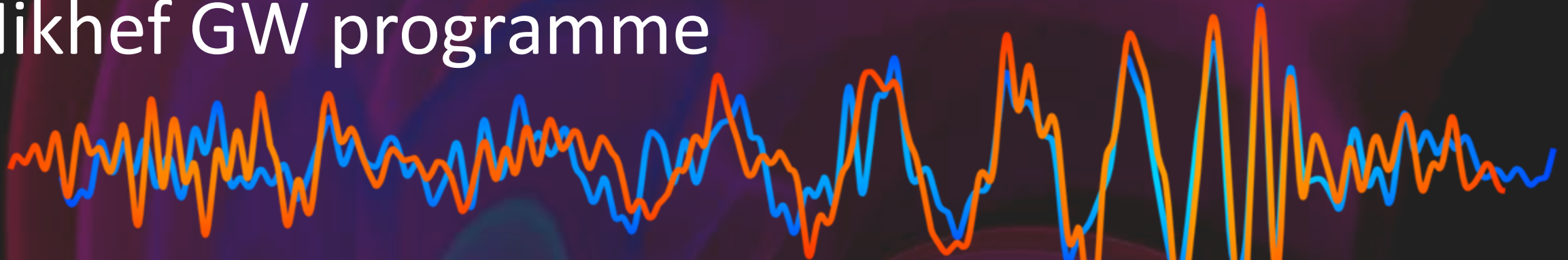
Einstein Telescope



LISA*



Nikhef GW programme



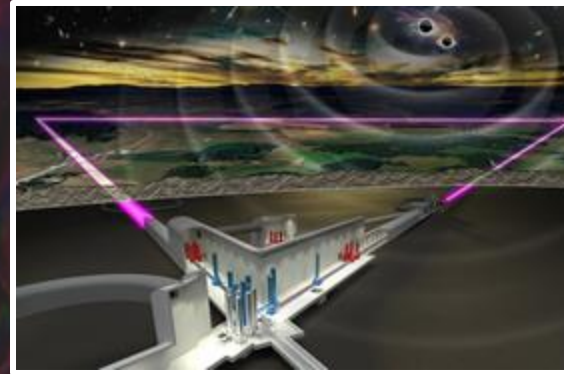
LIGO/Virgo/KAGRA



ETpathfinder



Einstein Telescope



LISA*



**ET-EMR
@Nikhef****



**ETO
@Nikhef****



Overview of the GW program

- **Key Mission: To detect and study gravitational waves (ripples in the fabric of space-time) that are produced by cataclysmic events in the universe.**
- 70 scientist: ~20 academics, ~20 postdocs and ~30 PhD students.
(EMR team and Nikhef ETO staff is not part of the GW programme)



Massive Tribute to Paul!

New Academics in the Group



Marco Vardaro

Hired by Nikhef
as ETpathfinder
Technical Coordinator



Anna Green

Hired by Maastricht (UD)
Expert in Optical
Simulations and Inter-
ferometry



Alex Amato

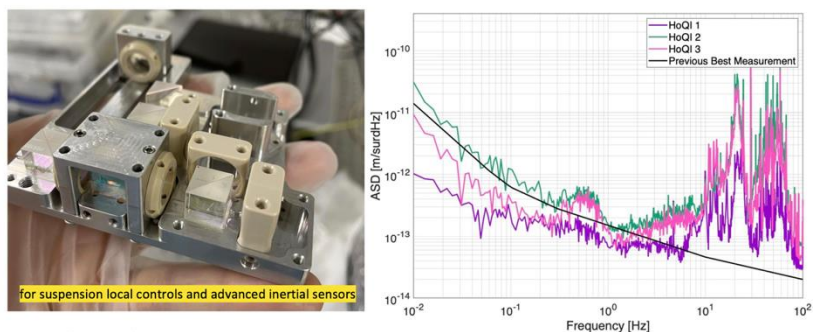
Hired by Maastricht (UD)
Expert in Materials and
optical Coatings

Overview of the GW program

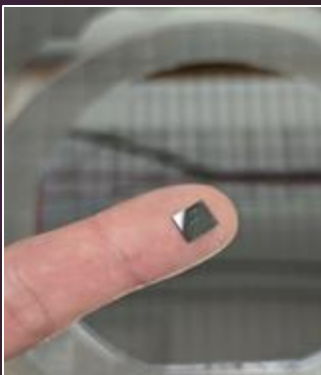
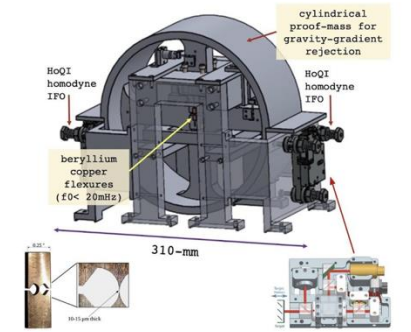
- **Key Mission: To detect and study gravitational waves (ripples in the fabric of space-time) that are produced by cataclysmic events in the universe.**
- 70 scientist: ~20 academics, ~20 postdocs and ~30 PhD students.
(EMR team and Nikhef ETO staff is not part of the GW programme)
- Large portfolio of grants including:
 - Personal grants (ERC Adv, ERC Consolidator, ERC starter, NWO Vici, NWO Vidi (2x), NWO Veni, Humboldt etc)
 - Consortium grants (NWO Infrastructure for Virgo, NWO XL – ET, Dutch Black Hole Consortium, ET-PP, LISA/ET roadmap etc)
 - 6x Industry Consortia for developing ET technologies
 - Specials: ET NGF (42 + 870), ETnext (Prinsjesdag announcement)

Loads and loads of innovative R&D

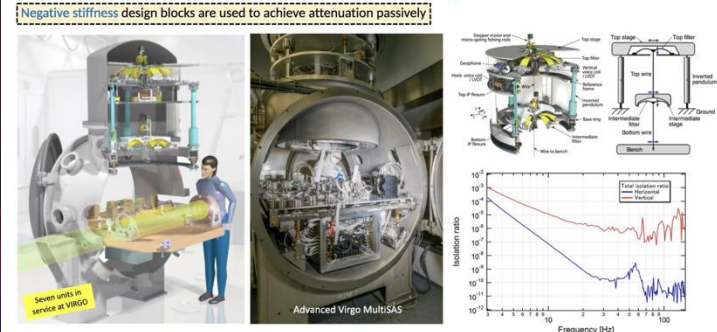
Homodyne Quadrature Interferometer (HoQI) displacement sensors



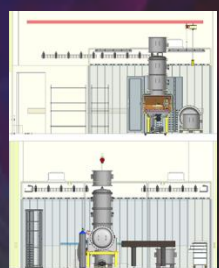
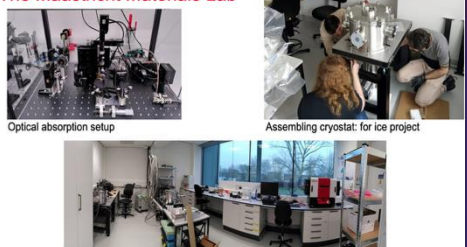
Tackling ground rotation noise



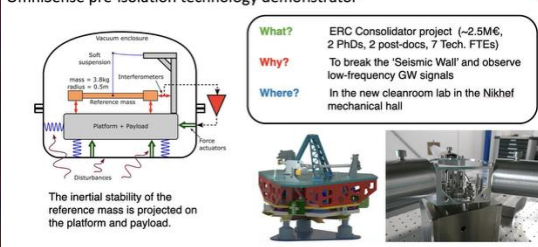
Vibration isolation for ET / VIRGO legacy



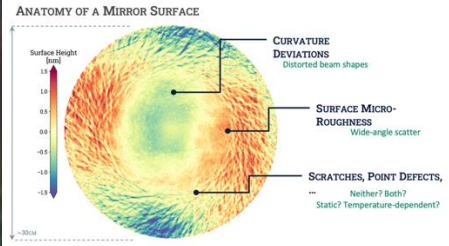
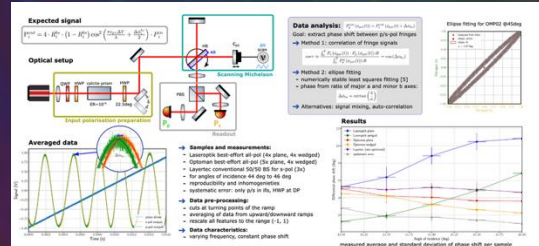
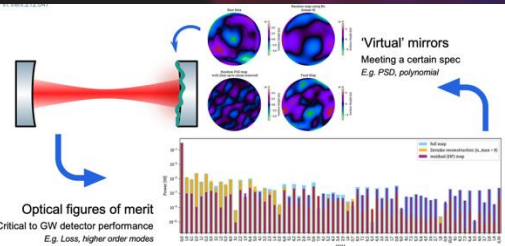
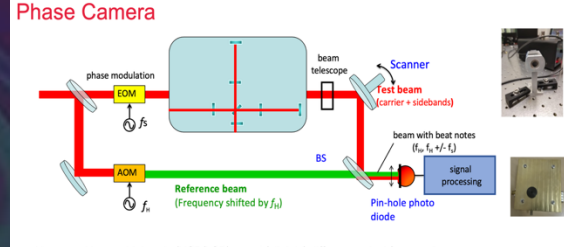
The Maastricht Materials Lab



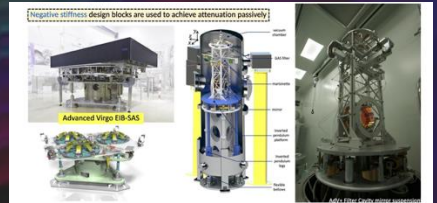
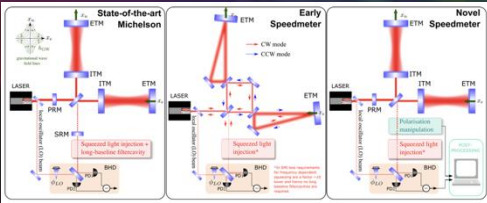
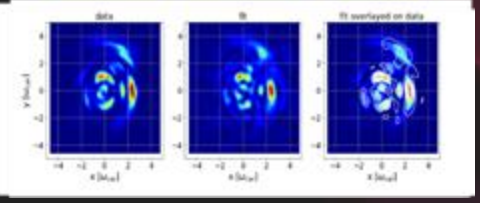
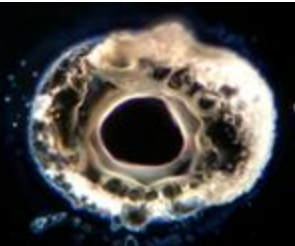
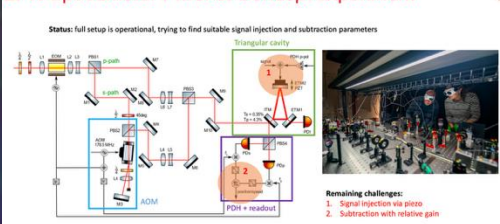
OmniSense pre-isolation technology demonstrator



Phase Camera

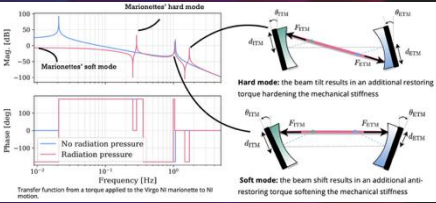


EPR Speedometer Proof of Concept experiment



NWO Vidi grant:

- Creating highly-stable laser light at 2090nm by nonlinear conversion of 1550nm light from a commercial fibre laser
- Investigate combination of 1550nm + 2090nm for controlling interferometers with silicon optics which are opaque for currently used light fields
- Conversion of 2090nm signals to near-infrared regime, where much better metrology is available



GW observations to date

- Currently in the fourth LIGO-Virgo Observing run
 - 200+ detections
 - First release of comprehensive results around August 2025
 - Events catalog, tests of general relativity, searches for gravitational lensing, ...
- Special event
 - Neutron star + very light black hole (?)
 - Further existence for compact objects
- Possibly further special observations to be announced...



OPEN ACCESS

Observation of Gravitational Waves from the Coalescence of a $2.5\text{--}4.5 M_{\odot}$ Compact Object and a Neutron Star

A. G. Abac, R. Abbott, I. Abouelfettouh, F. Acernese, K. Ackley, S. Adhicary, N. Adhikari, R. X. Adhikari, V. K. Adkins, D. Agarwal [▼ Show full author list](#)

Published 2024 July 26 • © 2024. The Author(s). Published by the American Astronomical Society.

[The Astrophysical Journal Letters](#), Volume 970, Number 2

Citation A. G. Abac *et al* 2024 *ApJL* **970** L34

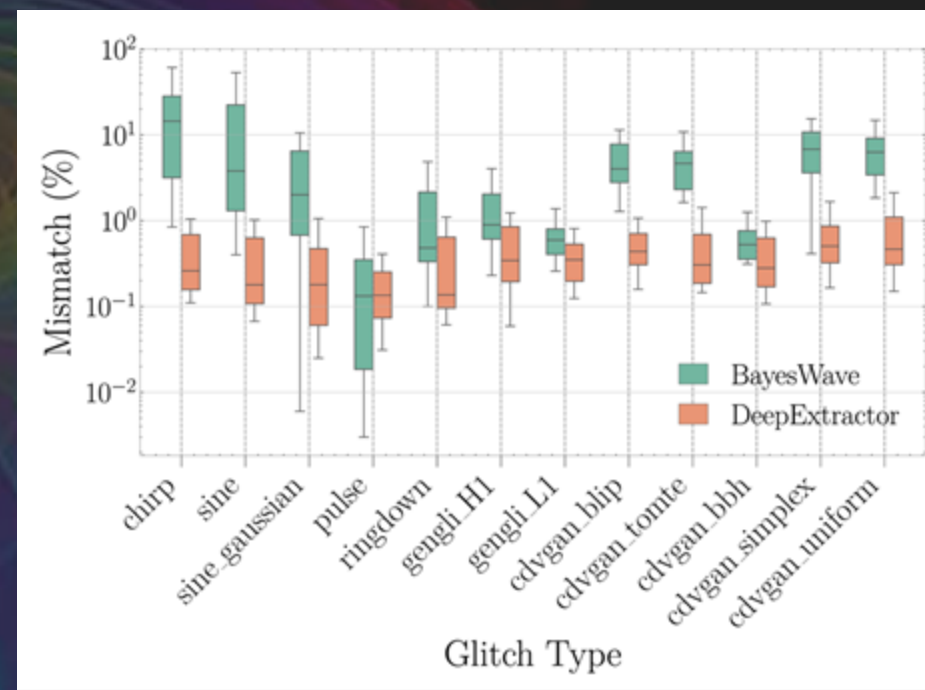
DOI 10.3847/2041-8213/ad5beb

Data analysis R&D: the power of Machine Learning

- Estimating the parameters of the source
 - Same accuracy as “classical” tools
 - Minutes (incl. training) rather than hours
 - Much more ecologically friendly
- Real-time instrumental glitch characterization
 - Seconds rather than hours
 - Sub-percent accuracy
- Towards data analysis methodology for Einstein Telescope and LISA
 - How to deal with long and overlapping signals
 - Glitch mitigation using the “null stream”

	kWh	CO ₂ [kg]	Trees [†]
JIM	34	11	0.55
PBILBY	3599	1180	59.02

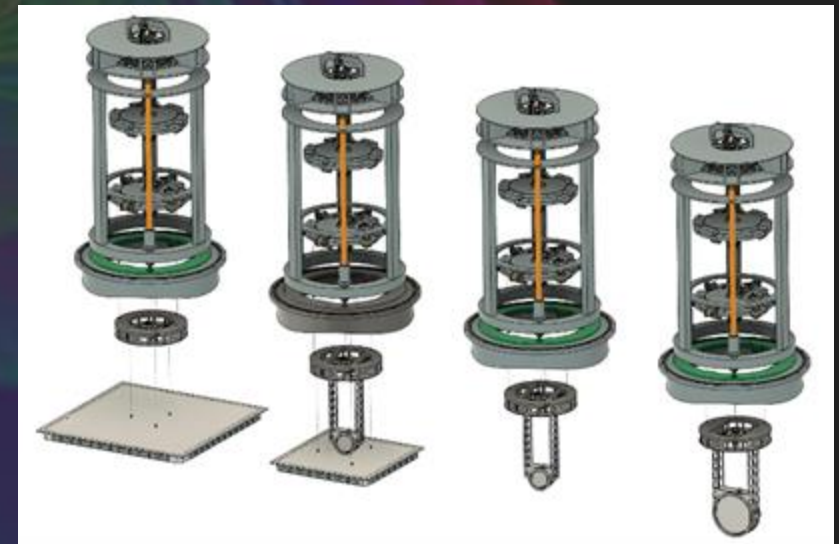
Wouters, Pang, Dietrich, Van Den Broeck, PRD 110, 083033



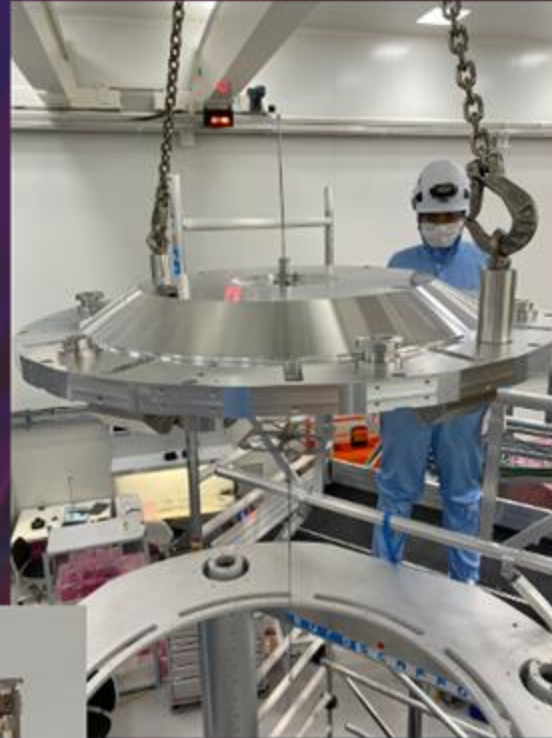
See talk by Harsh

Virgo overview

- Virgo is in a critical phase right now: Many changes ahead.
- 1) Reorganisation of Virgo itself ongoing.
- 2) Upgrade in preparation. If approved Nikhef will have to play a significant role.
- 3) LIGO/Virgo/KAGRA collaborations to dissolve by end of the year and form a single worldwide collaboration IGWN (International GW network)



ETpathfinder



ETpathfinder



BIG THANKS to all Nikhef people making ETpathfinder fun!

ET:

Wilco Vink
Hans Frenaij
Gino Hoft
Mohammed van de Kraats
Guido Visser
Ruud Kluit
Roshan Bansropansingh
Michael Naafs
Marius Bouwman
Bas van der Heijden
Peter Jansweijer
Wim Gotink

CT

Wilco Baan Hofman
Daniel Kollmer
Karol Poplawski
Tristan Suerink
Bart van der Wal

MT:

Martin Doets
Kenny Lam
Mathijs Baars
Rogier Elsinga
Marco Kraan
Patrick Werneke
Berend Munnike
Martijn van Overbeek
Marije Barel
Stan Heijnen
Luuk van Nieuwland
Michiel Jaspers
Eric Hennes
Freek Sanders
Steven Lammers
Martin Adams
Robin Cornelissen

Maastricht technical:

Peter Cuijpers
Eliott Duvieusart
Dinesh Doerga
Roy van Kessel
Raymond Hodiamont

Nikhef Central:

Bram van der Gaag
Nico Rem
Rob van der Meer
Arjen van Rijn
Stan Bentvelsen
Muzaffer Pancar
Fred Bulten
Marieke Hopman
Frank Kayzel
Martine Oudenhoven
Jorgen d'Hondt

Maastricht support:

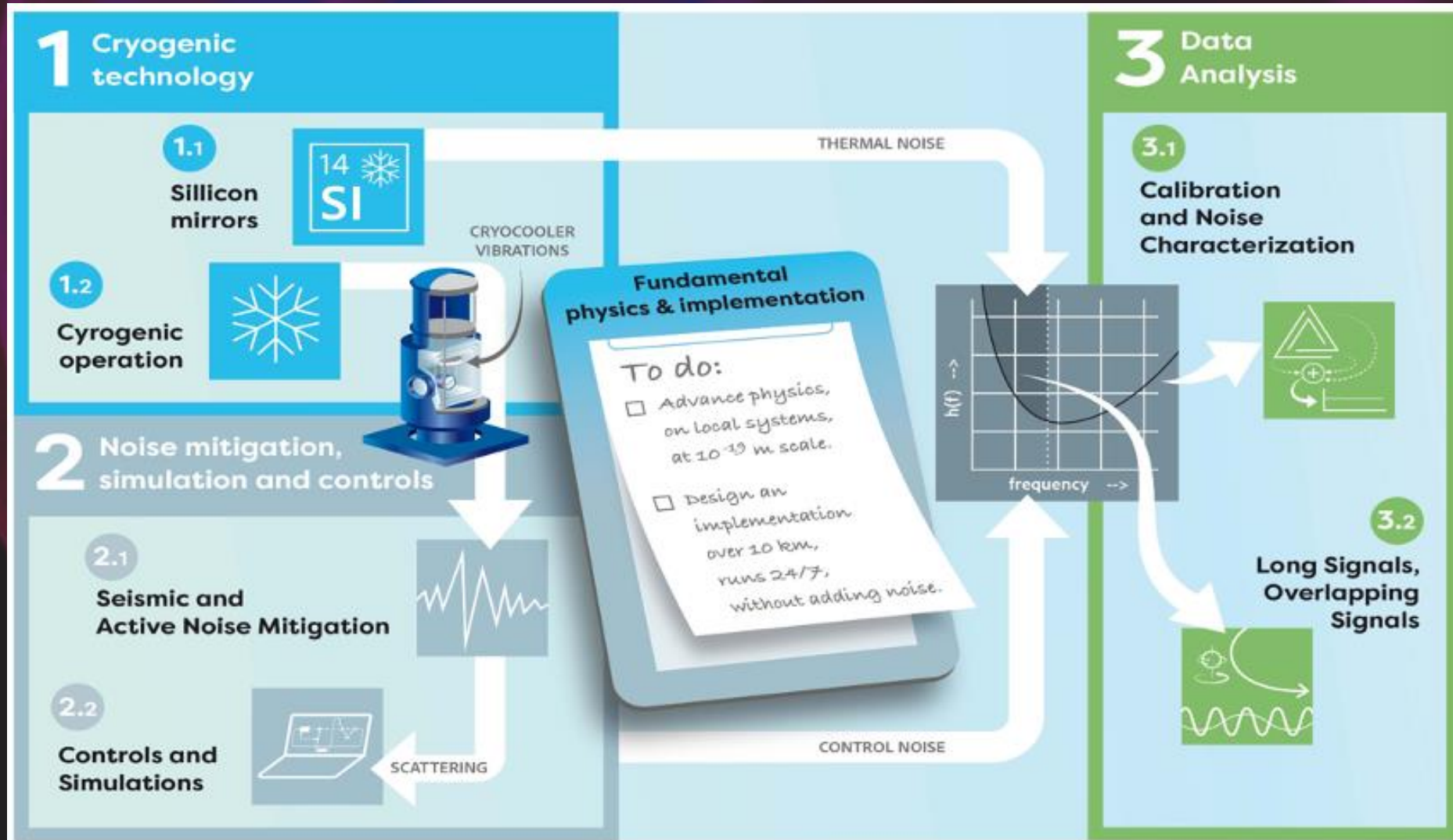
Sander Wolters
Tim Hiert
Bianca Mueller
Dylan Broepols
Daisy Blaauw
Bakir Bulic
Thomas Cleij
Job Ebisch
Jos Brouwers

GW program:

Jo van den Brand
Frank Linde
Paul Kuijer
Bas Swinkels
Henk Jan Bulten
Alessandro Bertolini
Matteo Tacca
Sebastian Steinlechner
Stefan Hild
Conor Mow Lowry
Andrei Utina
Enrico Porcelli
Joris van Heijningen
Andreas Freise
Marco Vardaro
Luise Kranzhoff
Guido Alex Iandolo
Elise van den Bossche
Jessica Steinlechner
Zeb van Ranst
Janis Woehler

Anna Green
Margot Hennig
Jan-Simon Hennig
Diksha Diksha
Yuefan Guo
Tobias Schoon
Niels van Bakel
Martin van Beuzekom
Jesse van Dongen
Daniela Pascucci
Teng Zhang
Vera Erends
Enzo Tapia
Stefan Danilishin
Viola Spagnuolo
Alex Amato
Luca Massaro

New ENW-XL grant: “Enabling ET”



ET NGF Industry consortia

Call 1 Vibration free cooling	Call 2 Vibration damping	Call 3 Optics	Call 4 - Thermal deformations	Call 5 Vacuum	
<div><div> </div><div></div><div></div><div><hr/></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div><hr/></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div><div> </div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div><div></div></div><div><hr/></div><div></div><div></div></div>	<div><div></div><div><div> </div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>

12 MEuro for 6 consortia

12 MEuro for 6 consortia

ETEC

Einstein Telescope Education Center



GW program vs ETO@Nikhef vs ET-EMR@Nikhef

ANNOUNCEMENTS – ETO @ NIKHEF

SLIDE CREDIT: JORGEN

From the 'outside' our Gravitational Waves activity and ET-activities in particular seem one big 'blob'. However, there is a need to make a distinction between the following ET-related activities:

1. The preparatory scientific activities, which are a 'regular' part of the GW-programme (group), headed by Stefan Hild; boosted by recently NWO funded ENW-XL project and the ET-'schaalsprong' initiative; ETpathfinder has a special position as an R&D- facility with international participation;
2. The activities for the feasibility study of hosting an ET in the Euregio Meuse Rhine (EMR), funded by the Dutch Growth Fund and partner countries, with head office in Maastricht; for this activity the group 'ET-EMR' exists within Nikhef; Stan Bentvelsen ('CSO') and Arjen van Rijn are part of the ET-EMR Project Office Directorate;
3. The activities for building up ETO: the European ET-Organization; Nikhef contributes a sizable share to this, mainly engineering and support, primarily funded by the ET-'schaalsprong' initiative; we decided to separate this into a dedicated group 'ETO' (@Nikhef) headed by Andreas Freise;

The Nikhef director oversees all these activities and is responsible for the internal [Nikhef] coordination.

All GW research happens inside GW program.

ET-EMR@Nikhef: project office for creating bidbook to host ET in EMR.

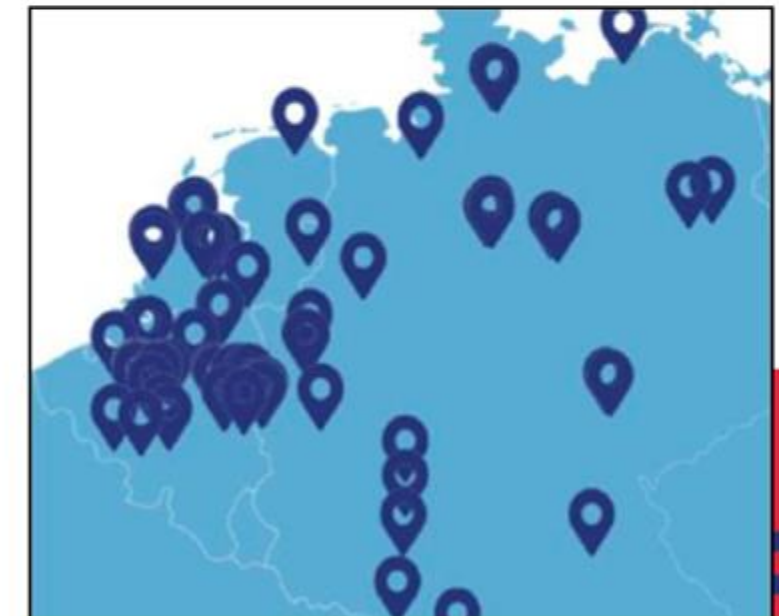
ETO@Nikhef: project within Nikhef to establish ETO.

Nikhef

EMR site preparation

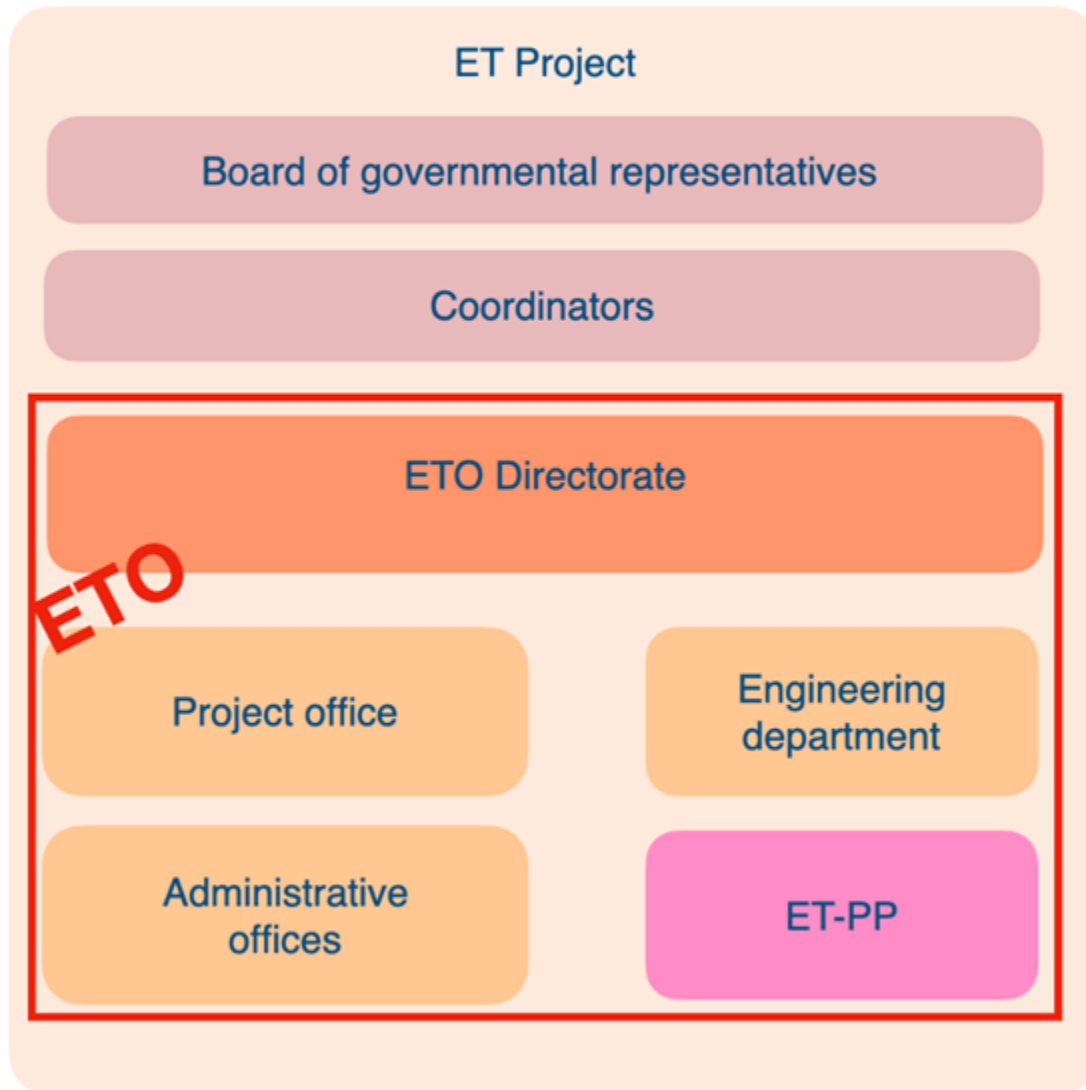
A Project Office Has been installed by all ministers in the EMR region

- Feasibility studies for the ET-EMR candidacy
- Dutch reservation for construction: 870 ME
- The project office is completely separate from the Nikhef programmes, but Nikhef hosts several of the people as Nikhef employees.



Many partners signed MoU
and actively support ET

ET Organisation (ETO): an novel organisation for realising the Einstein Telescope

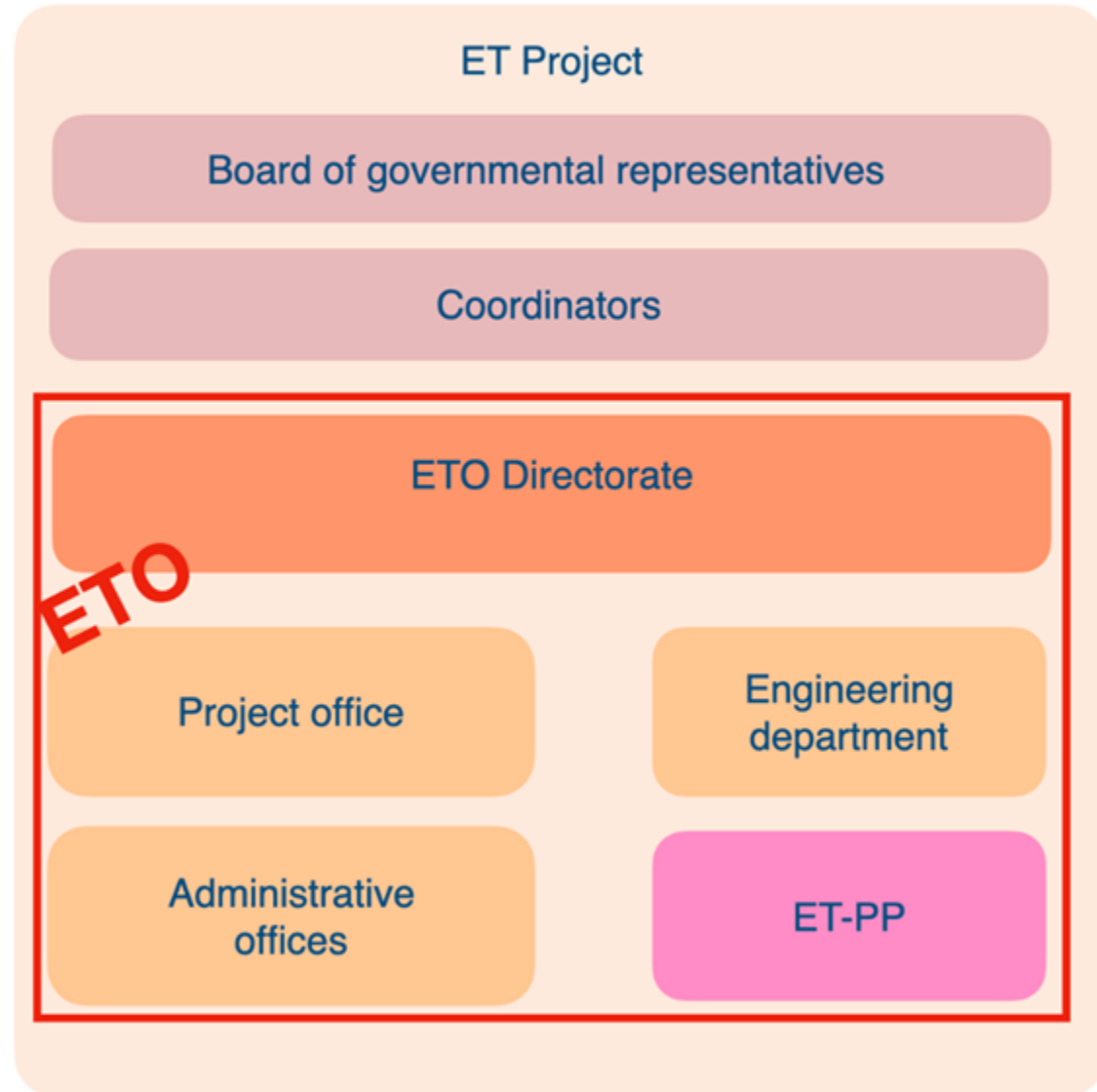


The problem: projects at this stage are usually run by scientists. Professional managers and engineers are only hired after the implementation phase is well underway. This creates a critical lack of expertise in the early phases and thus delays, also later on.

Based on experience from recent projects (CTA, SKA, KM3NET, etc), we decided to try something better, with a focus on:

- establishing direct governmental engagement
- creating a professional non-scientific organisation to coordinate and organise the ET Project.

People with key roles in ETO at Nikhef



Jorgen D'Hondt (ET Coordinator)

Andreas Freise (ETO Director)

Daniela Trani (Head of ETO Directorate)

Patrick Werneke (Head of Engineering Department)

Martine Oudenhoven (Head of Communication Office)

Daniel Nikolov (Strategy and Org Development Advisor)

Karin Matthesius (Executive and Management Support)

Jonathan Bratanata (Civil Engineering)

Max Majoor (Mechanical Engineering)

Romano Meijer (Systems Engineering)

Marije Yolande Barel (Vacuum Technology)

See talk by Romano
on Design Taks-force

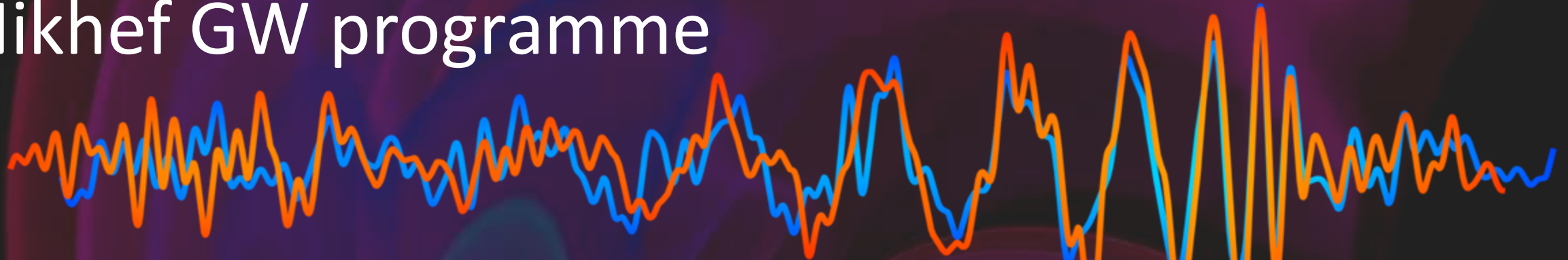
Good synergies and joint work with GW programme. e.g.
for the ET detector design.

The ETO Team – distributed and united



Photo from our ETO General Meeting in Rome, 27-28 November 2024
The next meeting will be in September 2025 on Elba

Nikhef GW programme



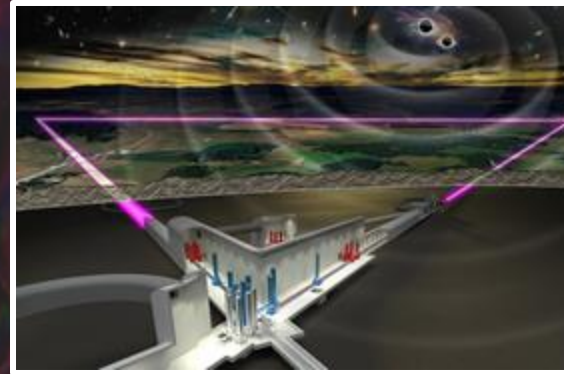
LIGO/Virgo/KAGRA



ETpathfinder



Einstein Telescope



LISA*



**ET-EMR
@Nikhef****



**ETO
@Nikhef****





We have quite some challenges
and tasks ahead of us



We have quite some challenges and tasks ahead of us

... but we have a fantastic team to tackle them. **Lets go!**

