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STAR Institute

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Sciences Appliquées

GW-related activities at ULiège

LIGO, Virgo, ETest, ET

J.R. Cudell Oct. 23, 2020

with G. Baltus, V. Boudart, P. Char, C. Collette, M. Fays, F. Nguyen

The first two Belgians in LIGO-Virgo are at ULiège

CARDIFF UNIVERSITY → The University Of Sheffield. → LIÈGE université

LSC LIGO Scientific Collaboration

VIRGO

Data analysis Unmodeled signals

- Chair of the long-duration-burst analysis group
- Co-chair of the machine-learrning group.

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LSC LIGO Scientific Collaboration

Active damping of vibrations

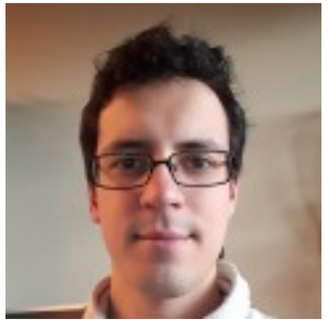
- Coordinator of the protoype part of E-TEST
- ERC SILENT: Seismic IsoLation of Einstein Telescope

Virgo in Liège

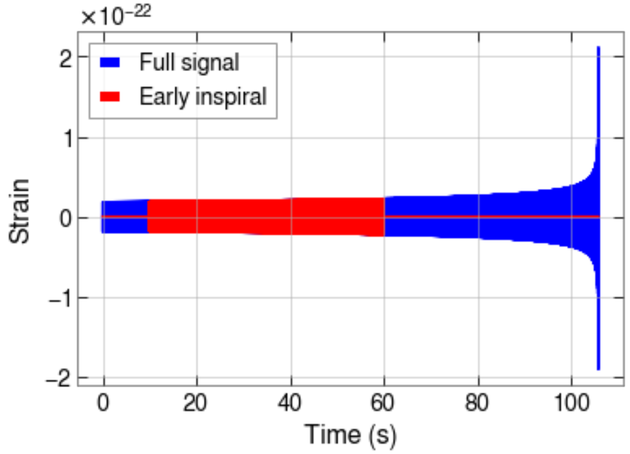
Data analysis: machine learning, bursts, binary coalescences; neutron stars

Virgo

Early detection via convolutional neural network

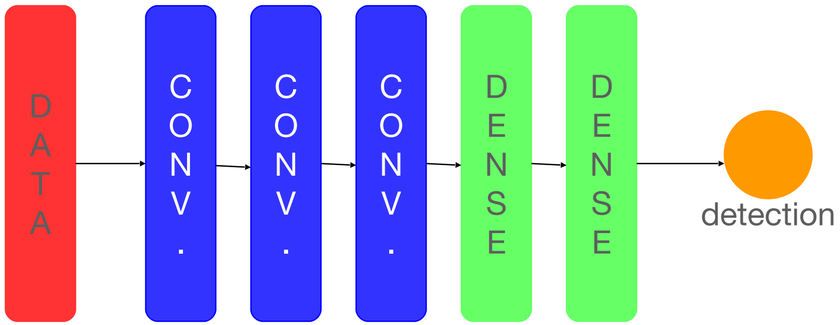


Grégory Baltus

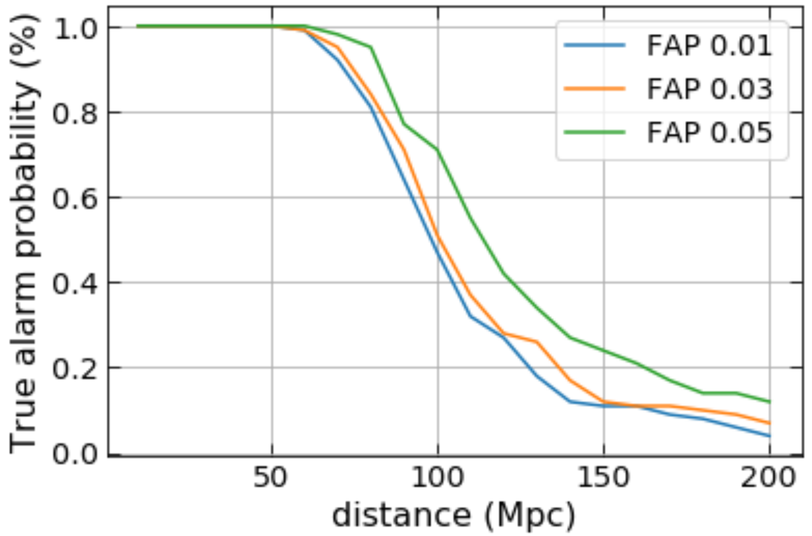


- long signal (binary neutron star, ET)
- multi-messenger astronomy (100-1000 faster than matched filtering)

Neural network architecture



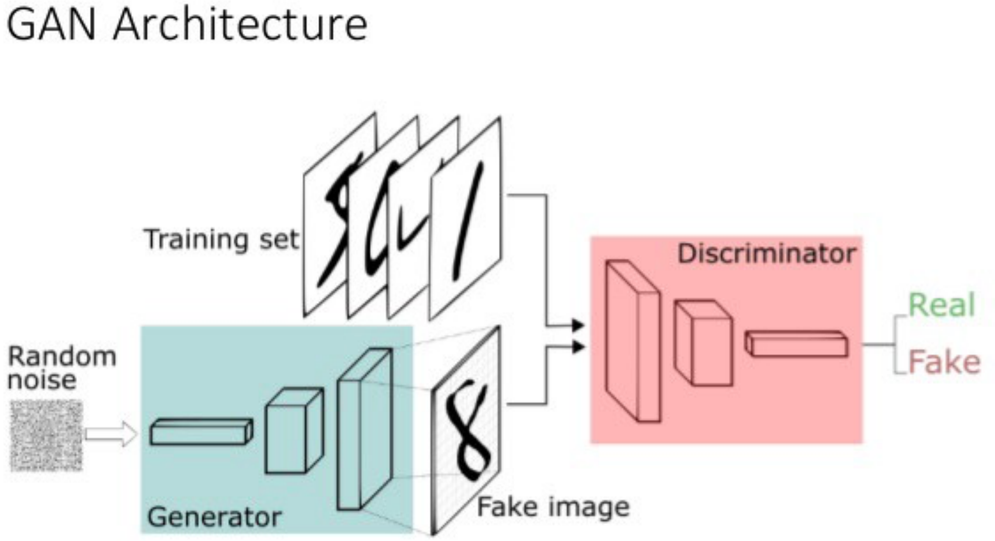
Efficiency on design noise



Virgo

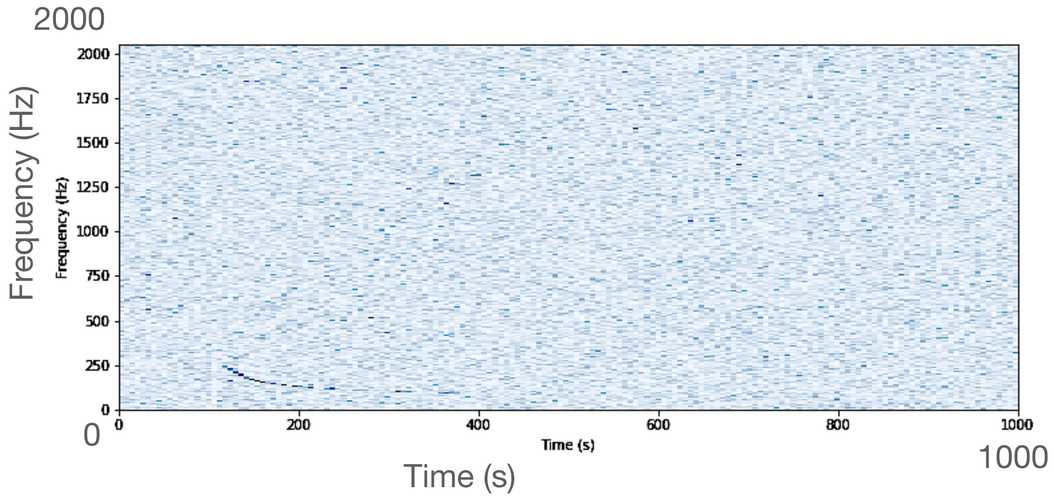
Anomaly detection via generative adversarial networks

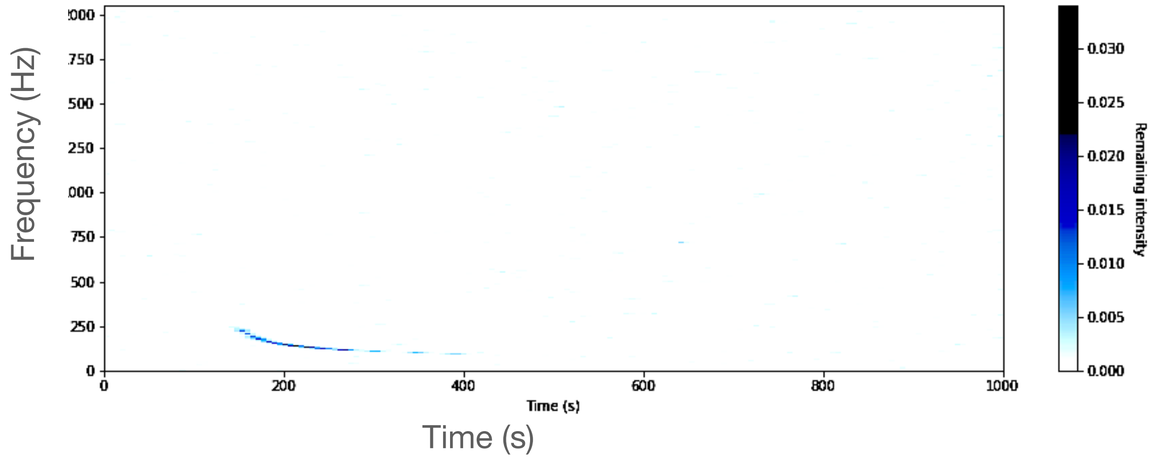
Vincent Boudart



noise matching by iterating in the latent space of the generator

noise subtraction





Virgo

Long burst detection

Maxime Fays

- Analysis Group co-lead & paper writing team : Long-Duration GW Burst Searches
- Development Group co-lead : Machine Learning Algorithms
- Development Team : X-pipeline (coherent signal from bursts) / X-SphRad (using spherical harmonics)/ **pyXel** (extension to long bursts)
- Development Team co-lead : iWave phase-locked loop to remove some glitches

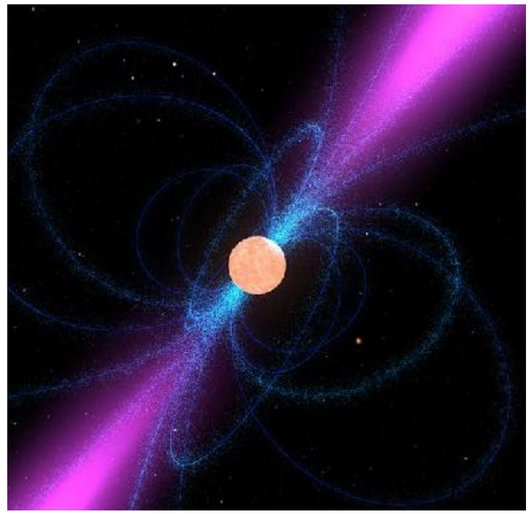
See Maxime's talk at 11:00

Virgo

Neutron stars as a probe of dense matter

Prasanta Char

- Mass ~ 1.5 M_{Sun} , Radius ~ 12 km,
- Density ~ 10^{4} - 10^{15} g cm^{-3}, from surface to core
- Magnetic field ~ 10^{12} G



Observed in Radio, X-rays, γ-rays, Gravitational waves (GW)

Major Observations in recent years:

1. Observations of massive pulsars in Radio
2. Tidal deformability from Binary Mergers in GW at LIGO-Virgo
3. Simultaneous mass and radius measurements in X-rays by NICER

Constraints on the nuclear matter equation of state

Other periodic observations:

Glitch behavior of Pulsars

Superfluid nature of Nuclear matter

See Prasanta's talk at 16:30

Prototype

Christophe Collette, Jérôme Loicq

Geophysical studies for ET

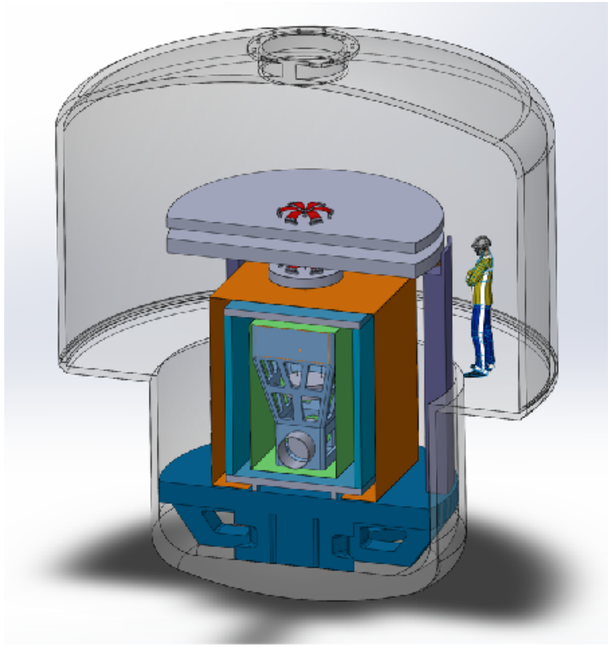
Frédéric Nguyen

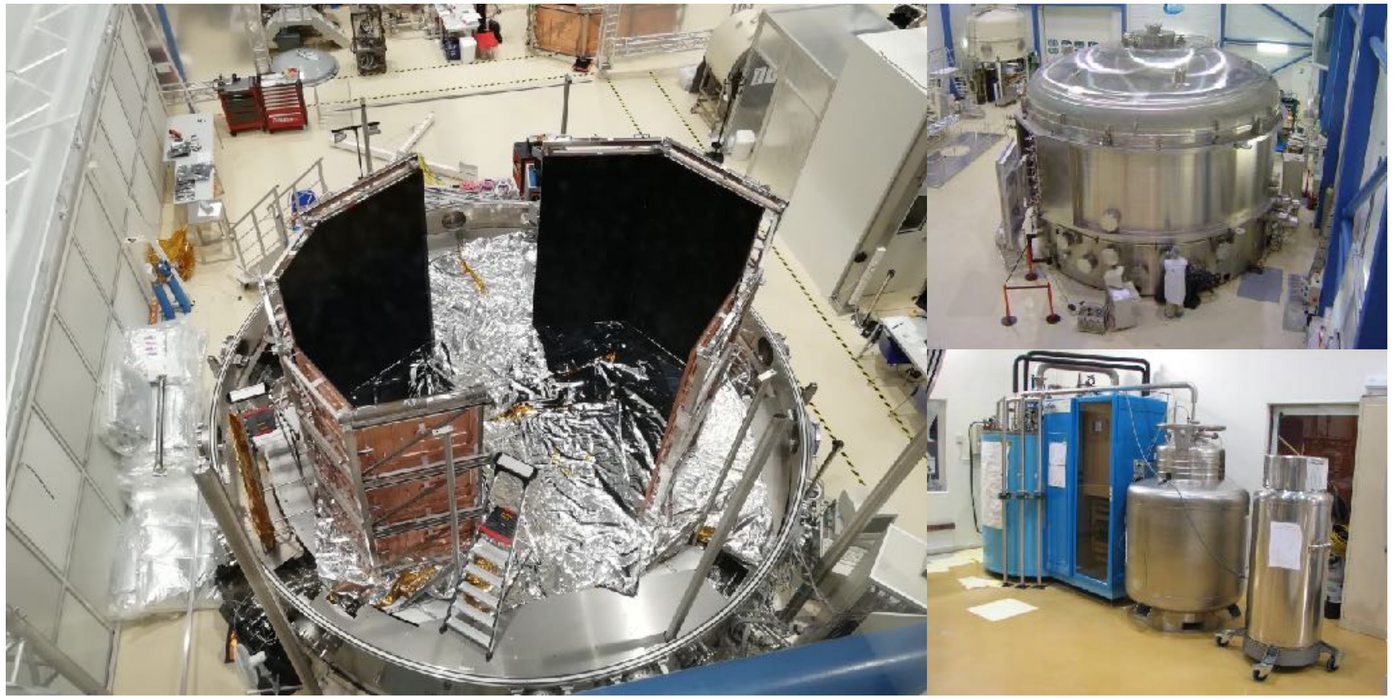
E-TEST : protoype

equipped with full-scale mirror and being built at Liège (CSL)

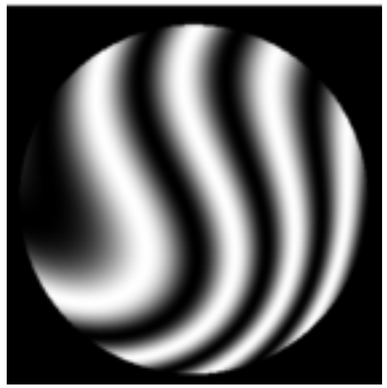
- Low frequency (<1 Hz) seismic isolation
- Large real-size mirror
- Cryogenic temperature (10-20K)

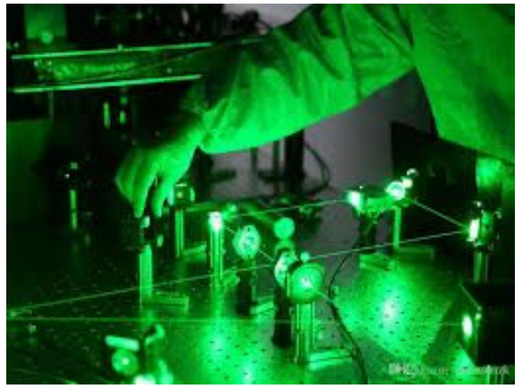
See next talk by Binlei Ding

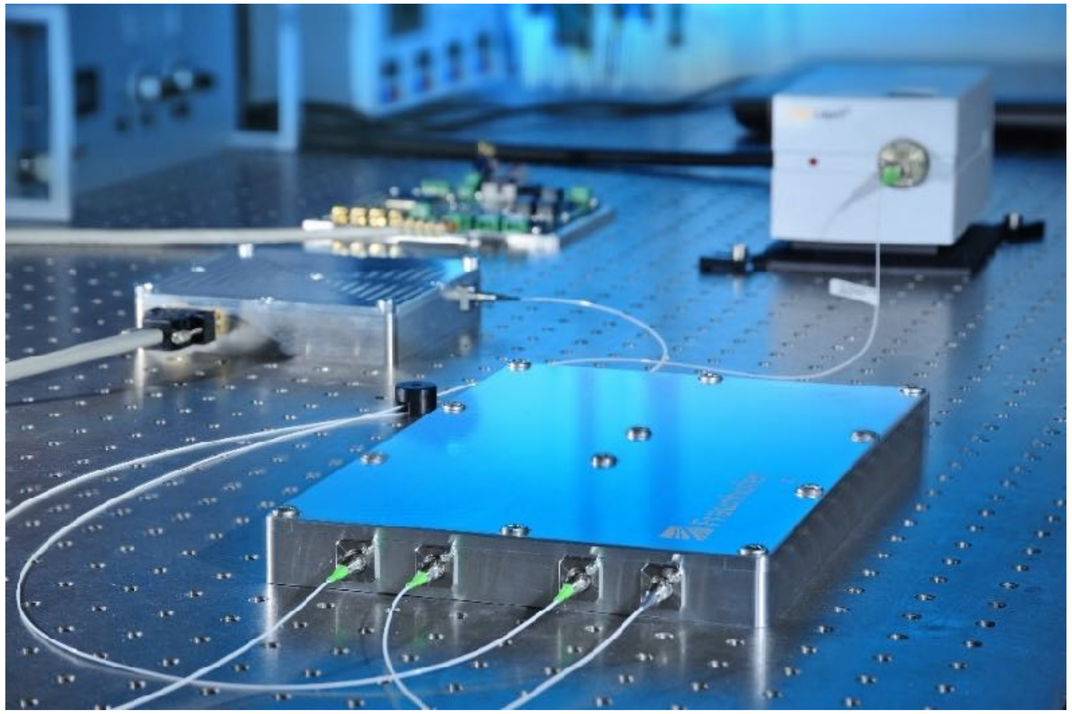


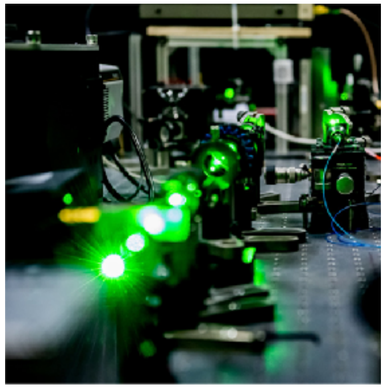


development of ultra-stable lasers at 2 µm

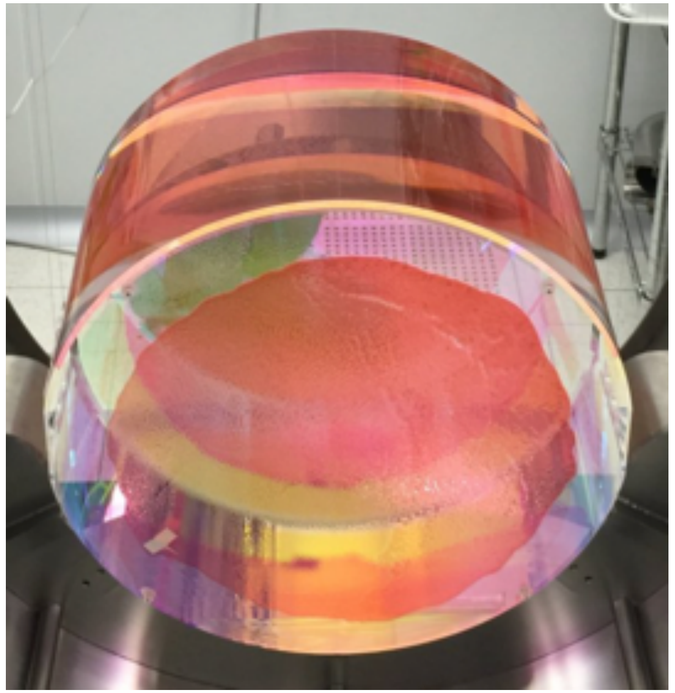






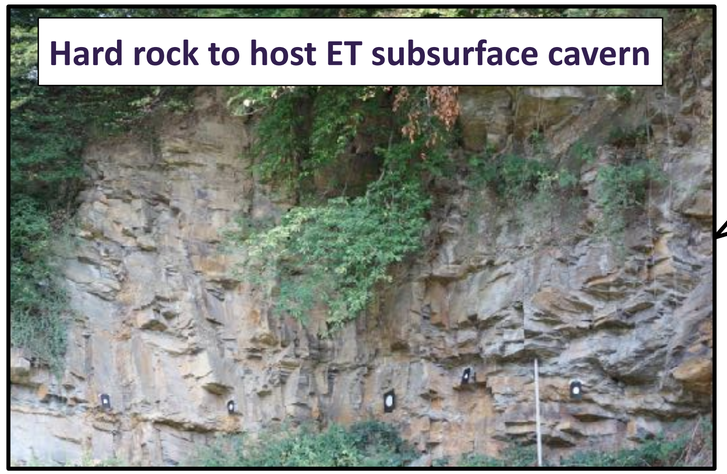


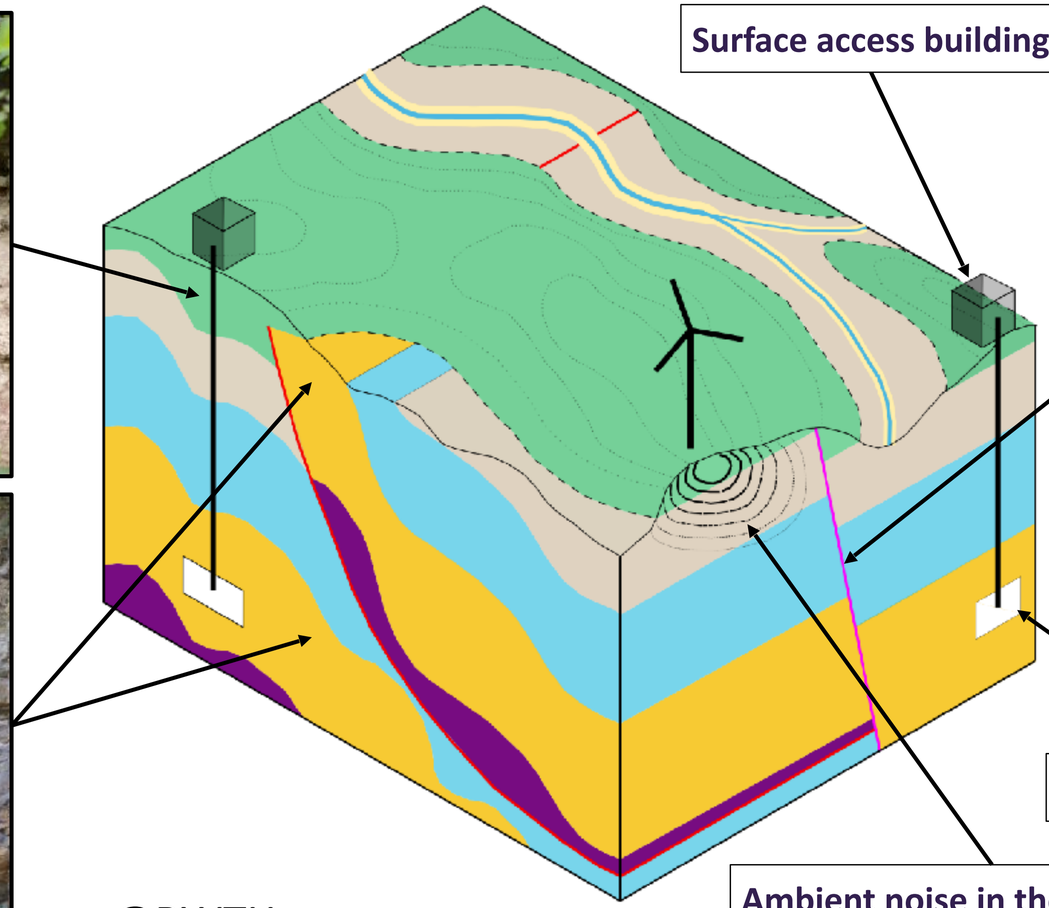
certification of mirrors



E-TEST : geophysics

Conditions for ET construction





@RWTH

Activities and deliverables

1. Open cross-border groundwater and seismic noise models
2. Hydrogeophysical observatory and monitoring public database
3. 3D cross-border geological model
4. ET-Design