

On solid ground

The German Centre for Astrophysics,
a centre for research, technology, and digitisation.

Michèle Heurs for a large team
CELLAR Workshop
28.11.2022, HZDR



Neutron star merger, AEI Golm

A competition historically unique in Germany

**ANNUAL BUDGET AFTER RAMP-UP PHASE 170 M€,
TOTAL VOLUME OF THE APPLICATION 1.4 B€**

Structural change

KNOWLEDGE CREATES PERSPECTIVES FOR THE REGION!

Two new large-scale research centres will be established in Lusatia in Saxony and in the Central German mining region. With "Knowledge creates perspectives for the region!", the BMBF and the Free State of Saxony are launching a competition for the establishment of the centres.

<https://www.bmbf.de/de/wissen-schafft-perspektiven-fuer-die-region-13122.html>

29. September 2022



Katharina Henjes-Kunst and Günther Hasinger in Görlitz



Michèle Heurs and Christian Stegmann in Cunnewitz

Who we are

The DZA is a joint initiative of German astronomy and astroparticle physics with the idea of creating a national and also international hub of astrophysics. The idea was born out of the need for cooperation, and it is supported by many research institutions, universities and partners.

A large team and many partners

FOUNDING PARTNER



MAX PLANCK
GESELLSCHAFT



HELMHOLTZ
SPITZENFORSCHUNG FÜR
GROSSE HERAUSFORDERUNGEN

Leibniz
Gemeinschaft



Fraunhofer



PART OF THE SUPPORTER NETWORK



HZDR
HELMHOLTZ ZENTRUM
DRESDEN ROSENDOF

KAT. Komitee für
Astro. Teilchen. Physik



OHB
DIGITAL

b.tu

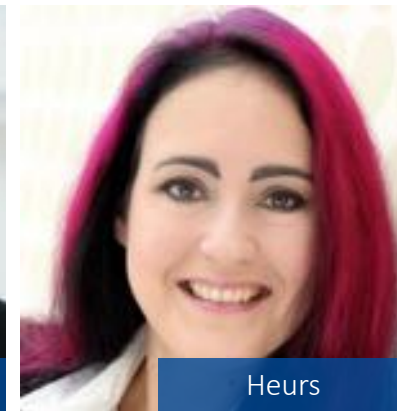
SKAO



SILICON
SAXONY
THE HIGH-TECH NETWORK



Hasinger



Heurs



Steinmetz



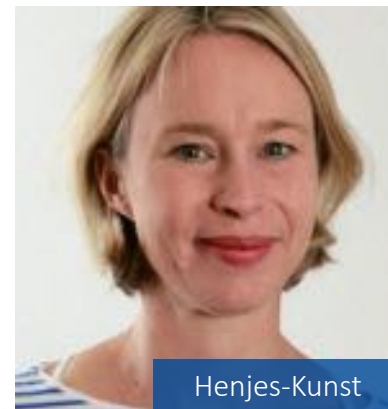
Nagel



Kramer



Hessling



Henjes-Kunst



Stegmann



Wagner

Astronomy was and is a high-tech science

"More than 40% of the world's gross national product is based on quantum mechanics and relativity."

Leon Lederman, Nobel Prize winner

Astronomy has always been a driver of progress



The astronomical clock in Görlitz (Scultetus 16th century)



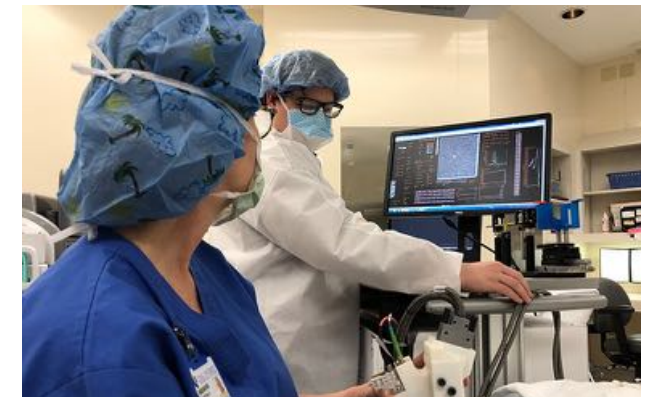
Wifi (Radio astronomy)



Progressive lenses (X-ray astronomy)

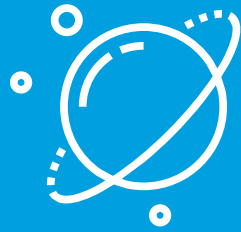


Zerodur (Optical Astronomy)



Adaptive Optics (Optical Astronomy)

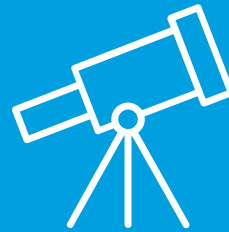
DZA concept : the challenges of astrophysics today



Astronomy

Square Kilometre Array
Observatory (SKAO)

Einstein Telescope
(Low Seismic Lab)



Instruments

Developments for future
astronomical experiments

Strong participation of
Saxon industry



Data Intensive Computing

Processing huge amounts
of astrophysics data from
all over the world

Innovative AI based and
Smart Green Computing

Interlocking of pillars → unique synergies

The German Centre for Astrophysics

2 Locations for research,
technology, digitalisation



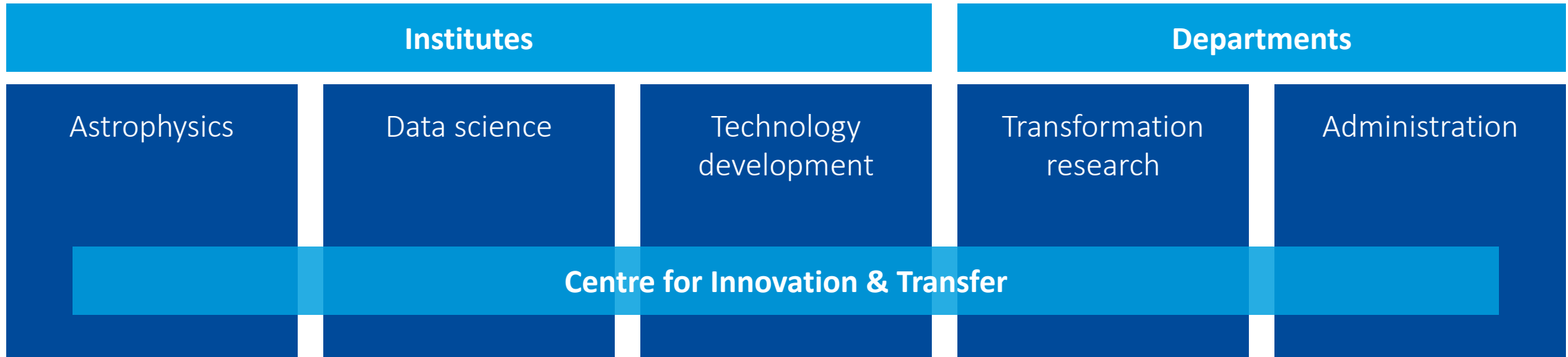
The Low Seismic Lab in
the granite of Lusatia



The DZA campus on the
Kahlbaum site in Görlitz



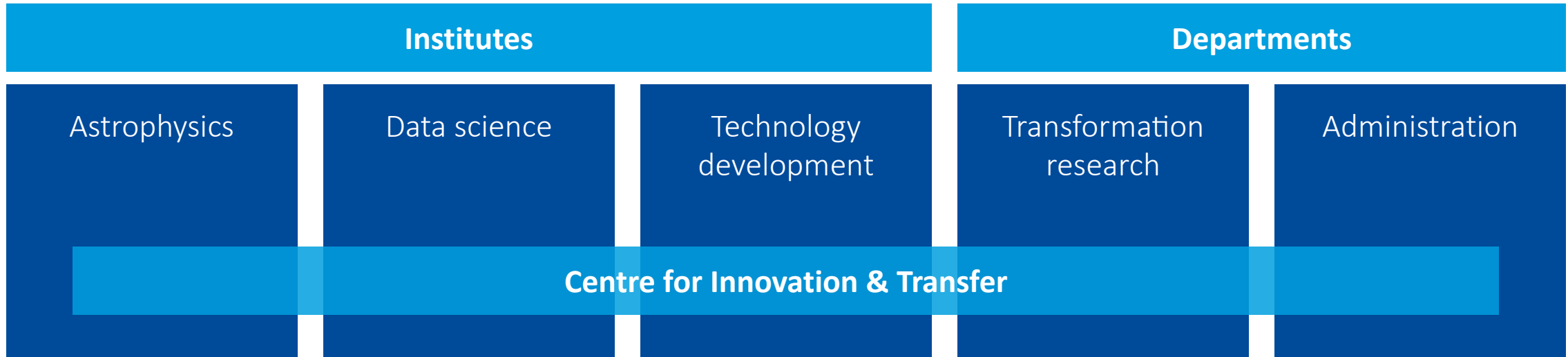
The Structure of the DZA



Think tanks for key technologies

- **Advanced materials** (silicon and semiconductor optics, photodetectors), **photonics**, **advanced manufacturing technologies**, ...
- **Digitisation** (hardware, algorithms and software)

The Structure of the DZA



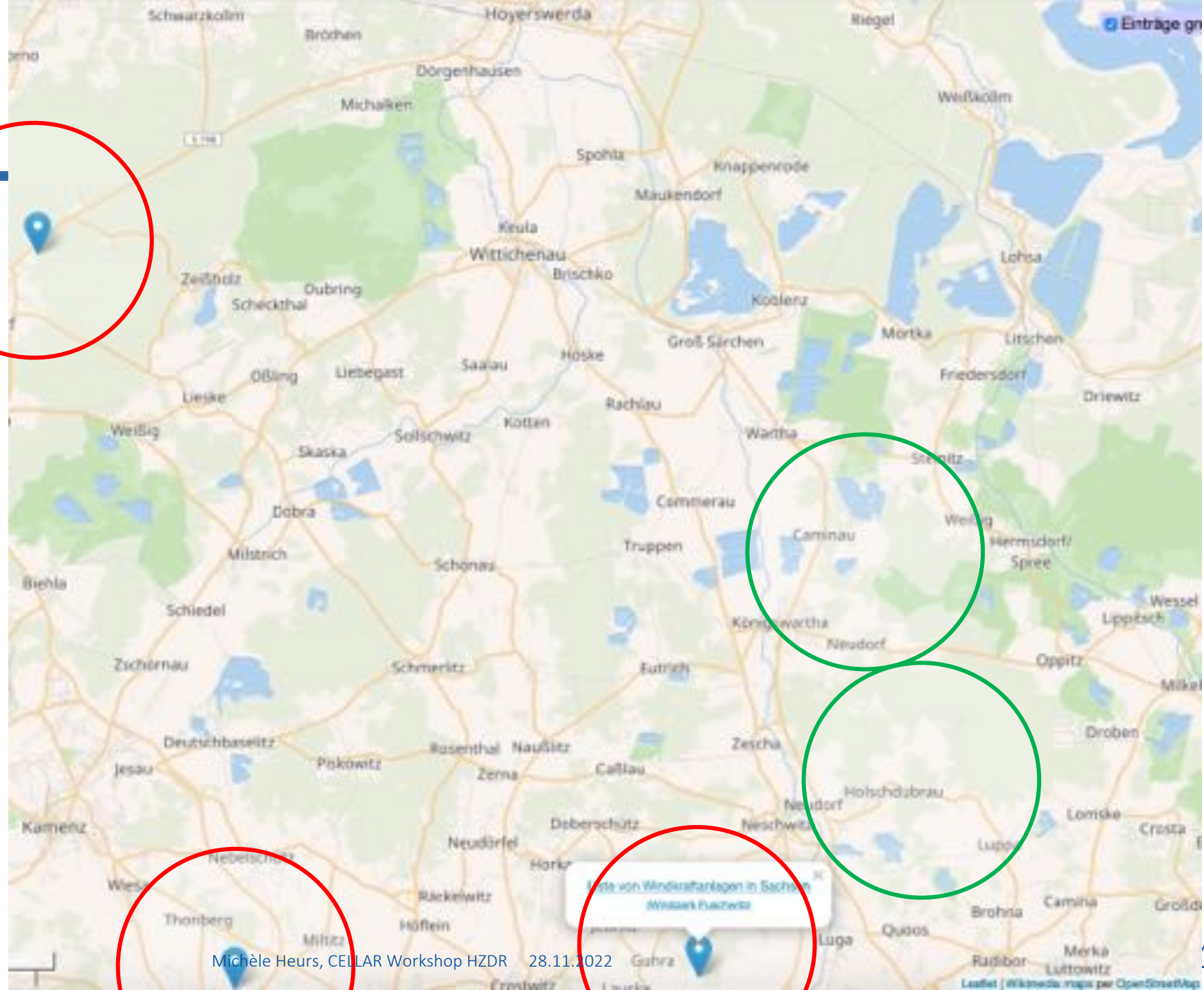
The Centre for Innovation & Transfer - the innovation engine

- Technology screening
- Promotion of spin-offs and start-ups
- Open Science & Transfer Policy
- Funding, project, network, IP and knowledge management

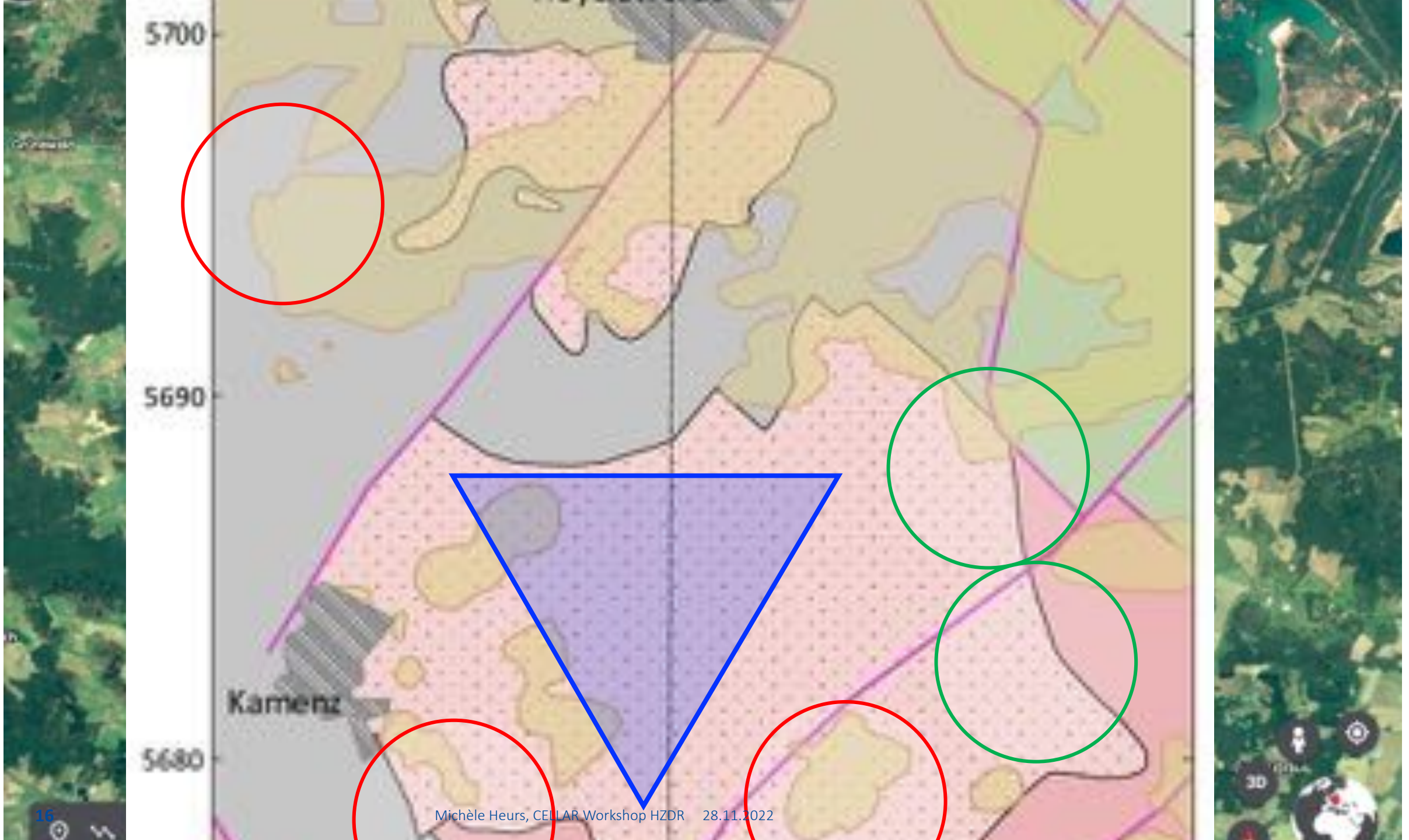
Research in the treasure of Lusatia

"The Lusatians are proud of their granite treasure, and it is a fascinating approach to let this treasure grow into a large number of long-term stable jobs in the whole range from crafts to science."

Dawid Statnik, Chairman Domowina, Association of Lusatian Sorbs







Measurements in the Treasure of Lusatia

Seismometer on
the surface

Test drilling in
Cunnewitz





Probebohrung

Probebohrung
für den Bereich Zentrum der Antropolyka



Die nachfolgende Tabelle zeigt die zum Ende der Prüfung 2011 ermittelte Anzahl der Teilnehmerinnen und Teilnehmer an der Prüfung. Die Teilnehmerinnen und Teilnehmer sind in die Kategorien der Teilnehmerinnen und Teilnehmer, die die Prüfung bestanden und die Teilnehmerinnen und Teilnehmer, die die Prüfung nicht bestanden, unterteilt. Die Teilnehmerinnen und Teilnehmer, die die Prüfung nicht bestanden, sind in die Kategorien der Teilnehmerinnen und Teilnehmer, die die Prüfung nicht bestanden, unterteilt.

Die Bewertung der Dokumente ist nach Möglichkeit möglich.
Bei Unklarheiten sind herzlich willkommen wir für eine Frage
an leicht zu erreichen. Kontakt: info@kita.de

Probowe

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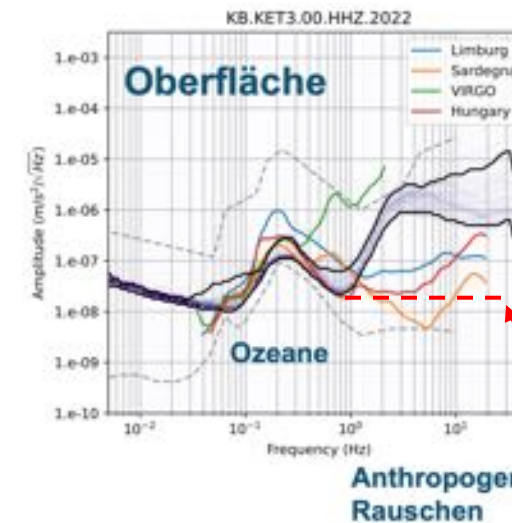
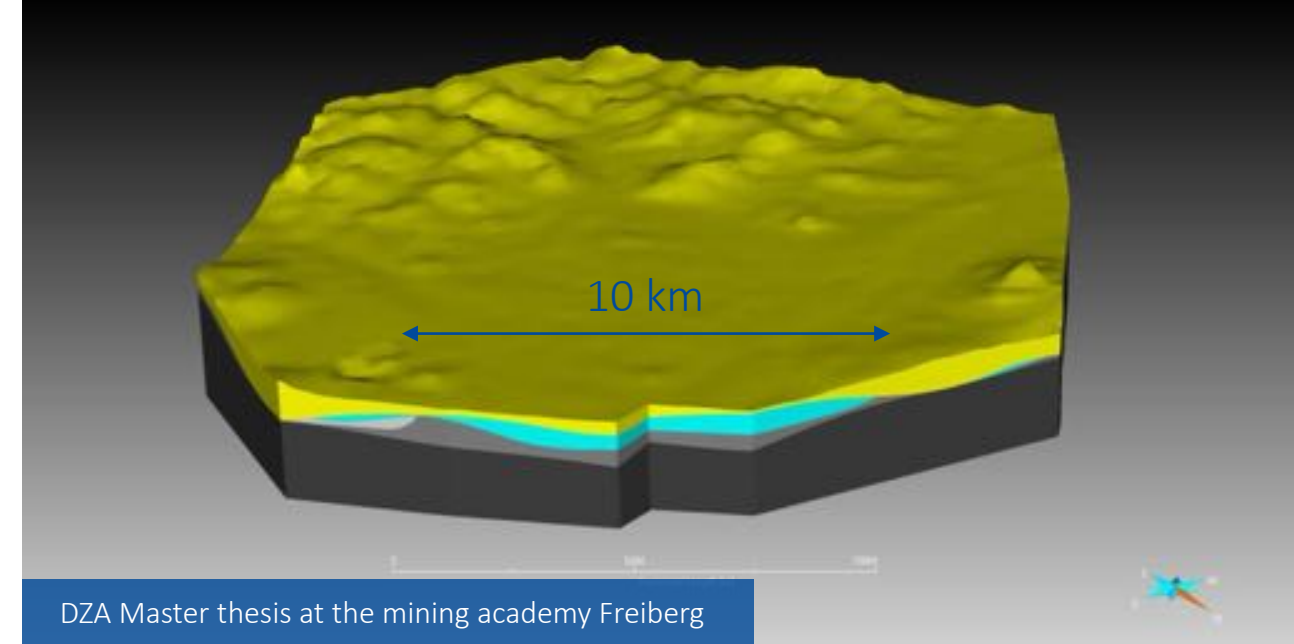


Research in the treasure of Lusatia

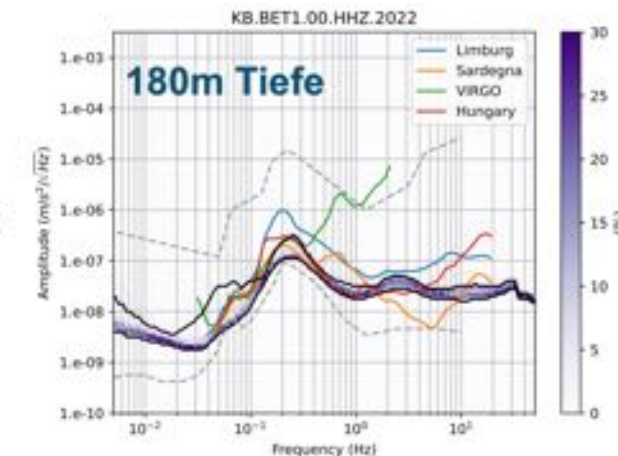


The tranquility at 250m depth

A unique monolithic and smooth granite block with an extension of at least 20 km with a homogeneous damping and seismic isolation layer!



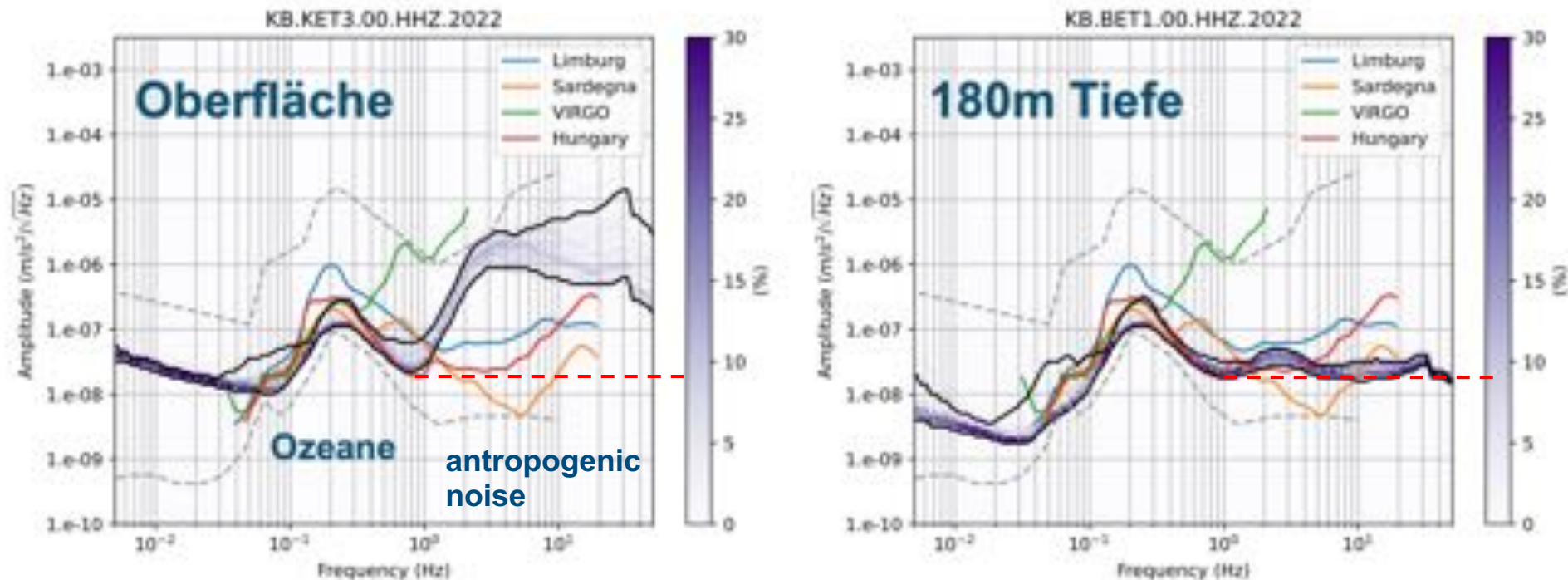
Surface measurement



In 180m depth

A. Rietbrock, KIT

First measurement of the low noise level already in 180m depth



“An important point to stress here is not to overestimate the overall noise levels due to:

- 1) The borehole was freshly cemented
- 2) The drill rig was still attached to the steel casing
- 3) The borehole seismometer was suspended from the drill rig
- 4) No thermal insulation at the top
- 5) The instrument was still adjusting to the surroundings
- 6) Many other things we have not thought off so far...”

A. Rietbrock, KIT

The Low Seismic Lab

Innovation platform of approx. $(40 \times 30 \times 30) \text{ m}^3$ in 200m depth in the Lusatian granite

With a square kilometre 3D seismometer sensor array.

→ Metrological validation of advanced seismic isolation concepts on a large scale

THE PLACE FOR FUTURE "DEEP TECH":

- Technology development for gravitational wave astronomy
- Adaptive seismic noise reduction
- Subnanometer microscopy and photolithography
- Quantum computing experiments
- Astrophysics with accelerators

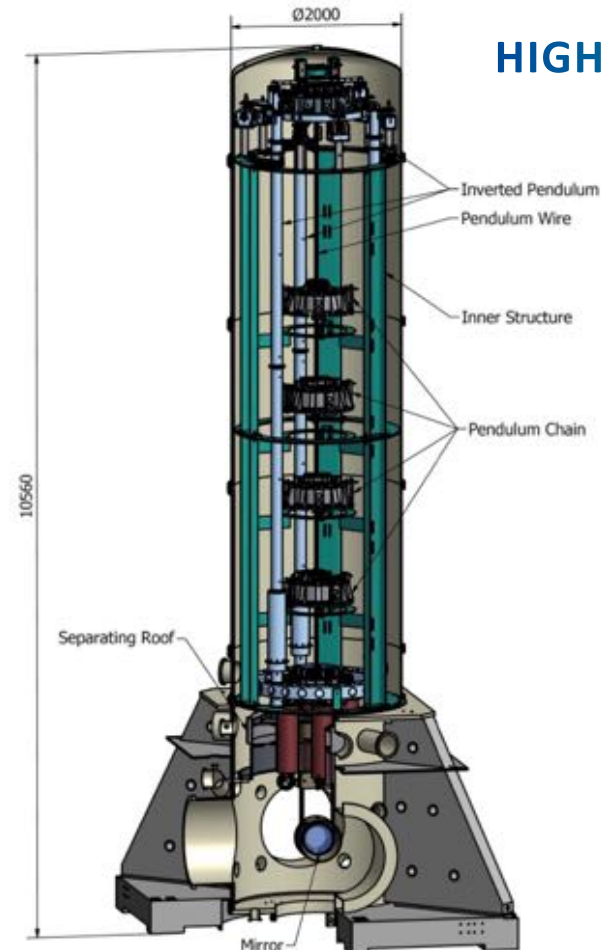


Example: Full-scale suspended test masses for next-gen. GWDs

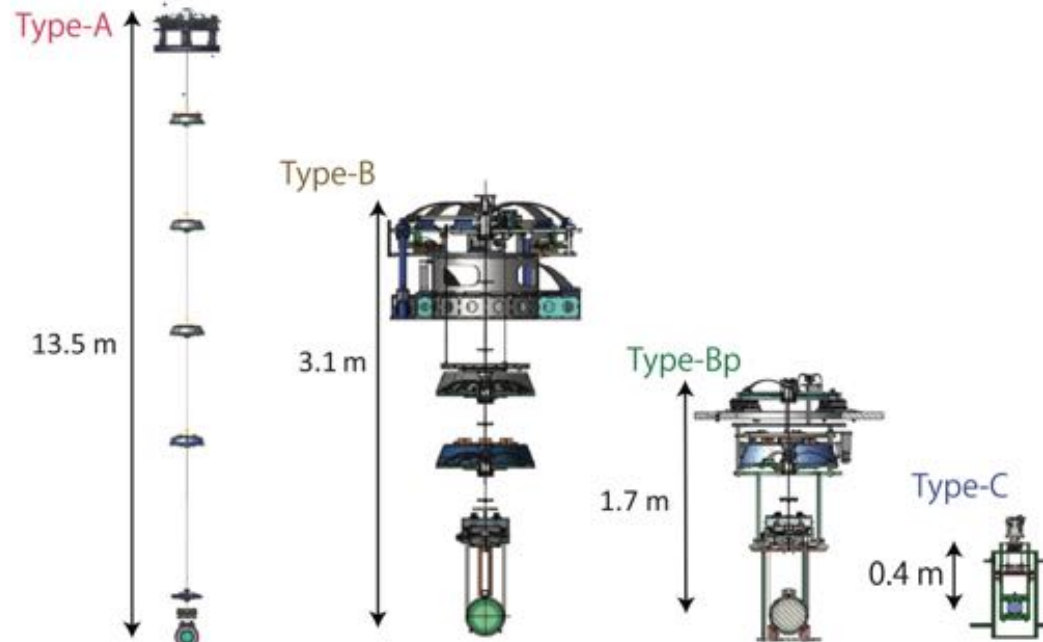
HIGHER?

...OR NESTED?

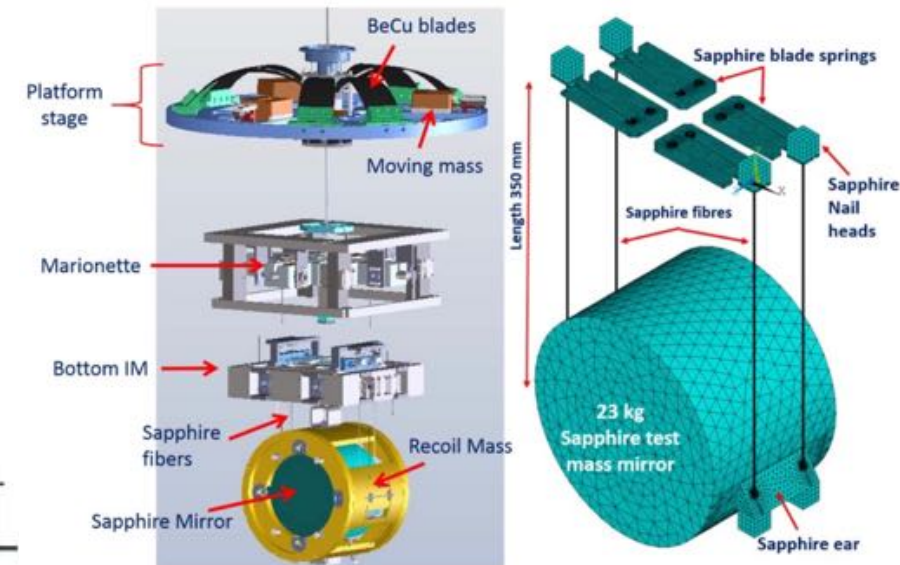
...AND CRYOGENIC?



[Source: T. Accadia et al., "Virgo: a laser interferometer to detect gravitational waves", JINST 7 P03012 (2012)]



[Source: T. Aki et al., "Vibration isolation system with a compact damping system for power recycling mirrors of KAGRA", Class. Quantum Grav. **36** (2019) 095015]



[Source: R. Kumar et al., "Status of the cryogenic payload system for the KAGRA detector", Journal of Physics: Conference Series **716** (2016)]

The role of the DZA in the Einstein Telescope

THREE POSSIBILITIES:

1. No ET

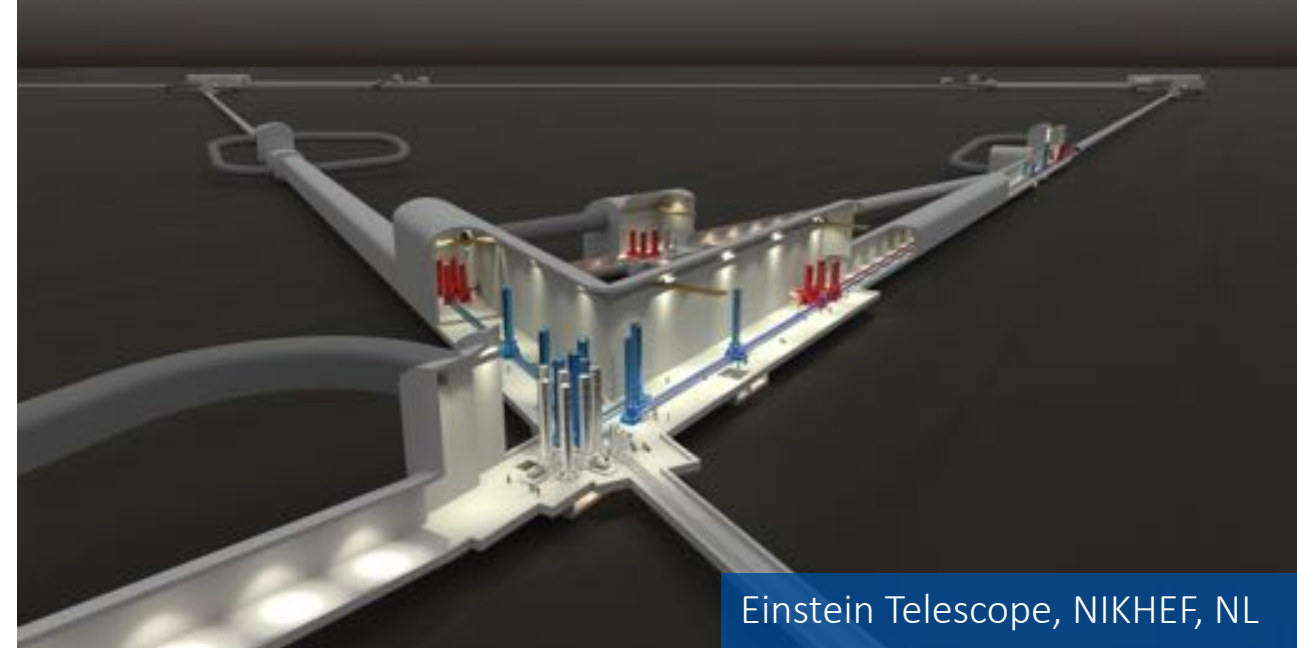
The DZA will participate in other international projects with the Low Seismic Lab (e.g. Cosmic Explorer, Advanced LIGO etc.).

2. ET in Sardinia or Holland

With the Low Seismic Lab, the DZA will make essential contributions to the reduction of seismic noise, among other things.

3. ET in Lusatia

A potentially excellent scientific solution. Strengthening the lighthouse character for the region. Political support for financing is necessary.



Einstein Telescope, NIKHEF, NL

A EUROPEAN PROJECT

- Construction costs:
 - First phase 1.2 B€
 - Full scope 1.7 B€
- Construction time: 8 years
- Lifetime: 50 years
- Location decision: 2025

DZA Timeline

IN PROJECT PHASE (2023-2026):

„very little“ money flowing in first three years

RIGHT NOW: Further test drills and geological / seismic investigations to determine suitability of granite for LSL & ET

first hires (5 profs, 60 staff and support) + make all plans for:

IN "FULL FUNDING" PHASE (2026 ONGOING):

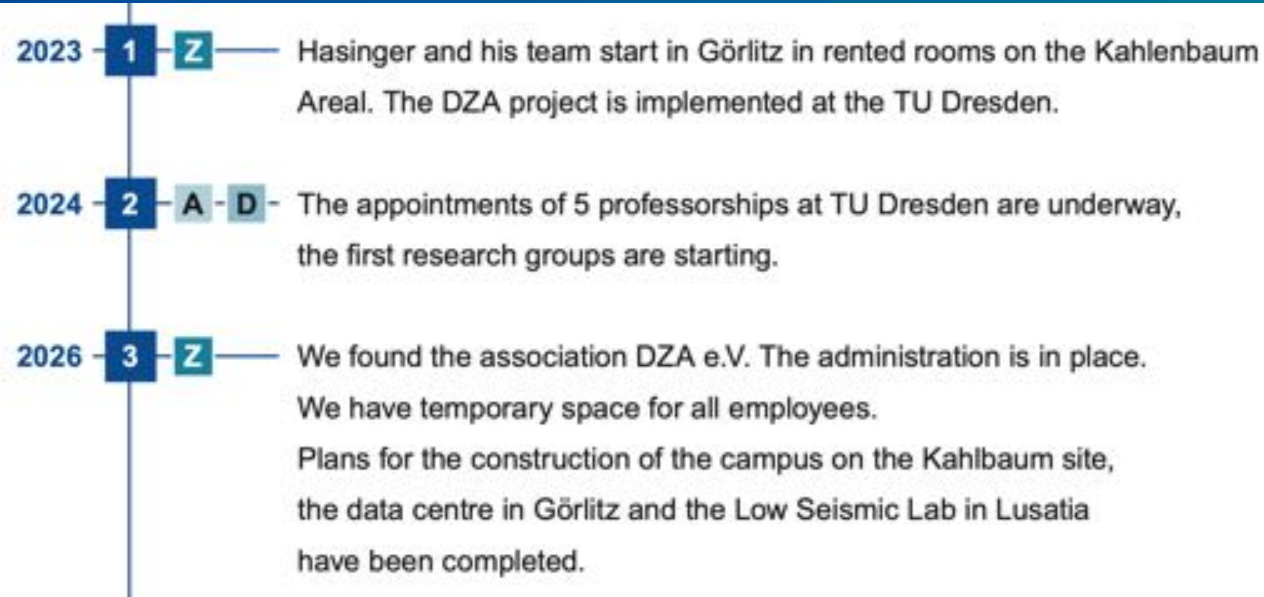
Buildings and underground lab construction, full ramp-up of personnel and research & science

IN ANY CASE:

- DZA will conduct technology development for gravitational wave astronomy and in particular for ET, and for e.m. astrophysics (e.g. SKA)

From DZA proposal:

For project phase (2023 – 2026):



The German Centre for Astrophysics in Lusatia

- National beacon with international visibility.
- Unique combination of research and development in digitalisation, sensor technology and materials research.
- Jobs with a future in many areas.
- Magnet for business and institutions, support for start-ups and spin-offs, transfer of knowledge.
- Education from nursery school to training and university.
- Prospects for young people in the region, securing the need for skilled workers.
- We attract people and prevent migration.

