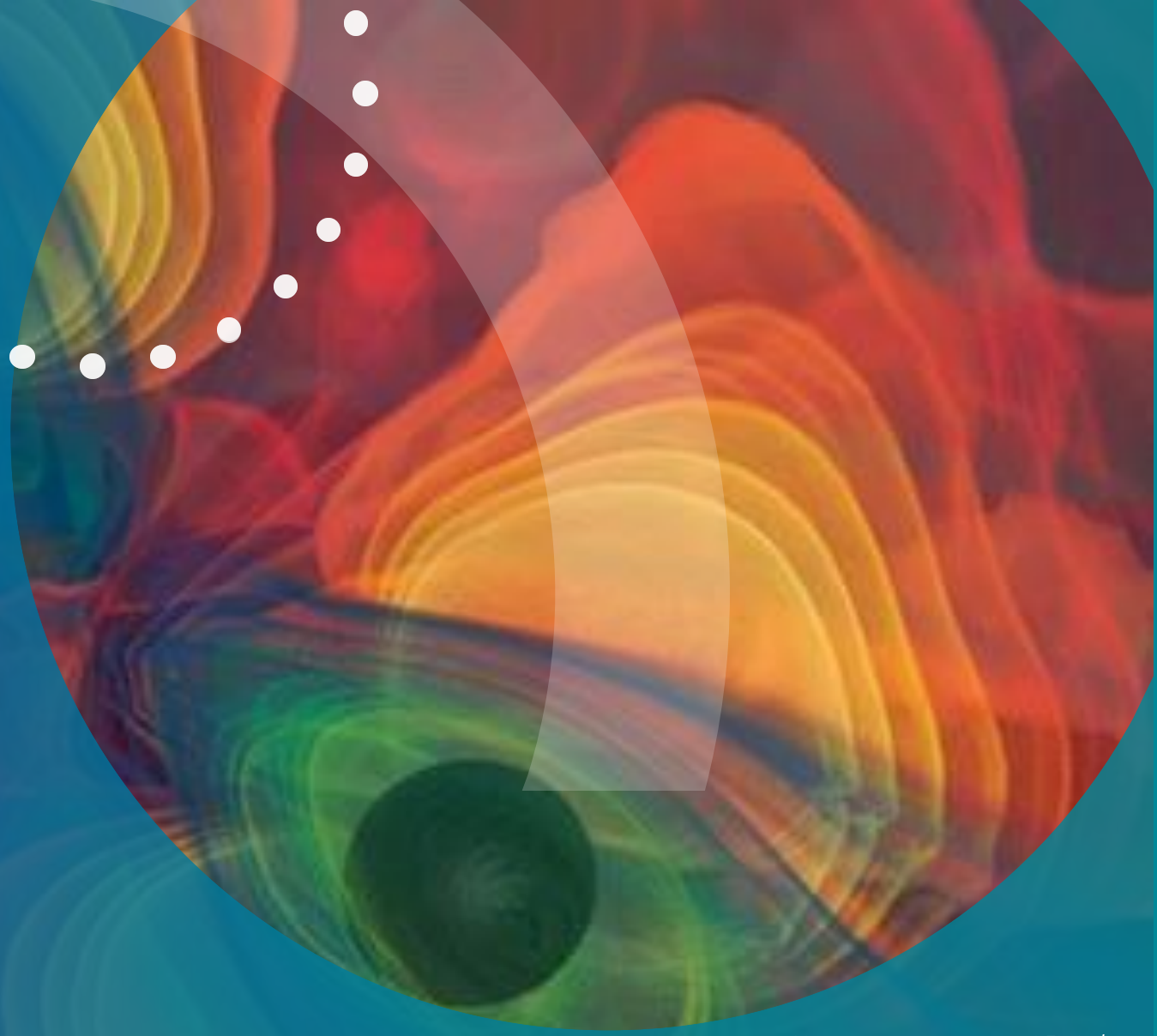
The German Centre for Astrophysics (DZA) and the Einstein Telescope

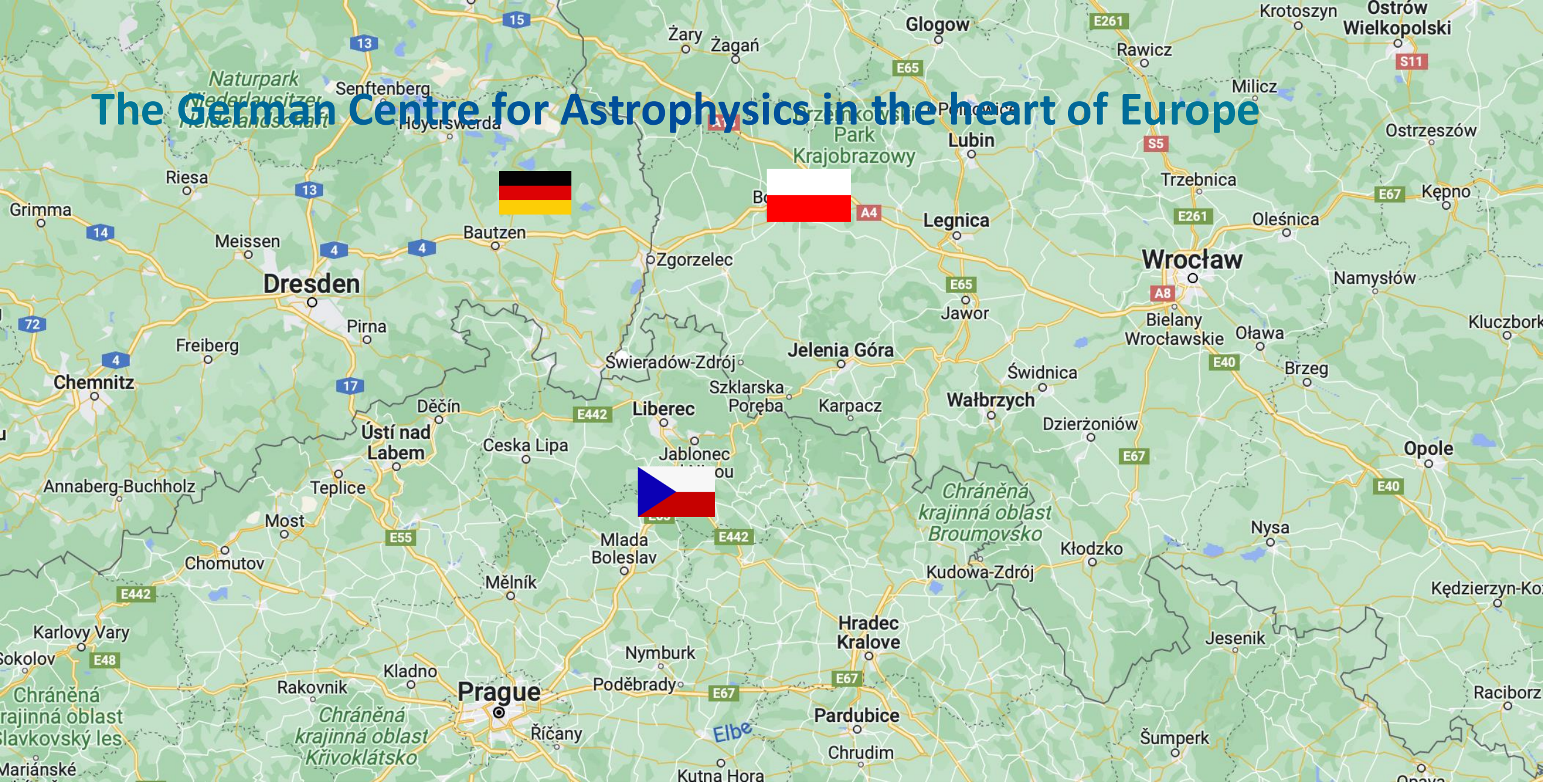
Christian Stegmann

PAiP, Warsaw, 19.2.25



Neutron star merger, AEI Golm

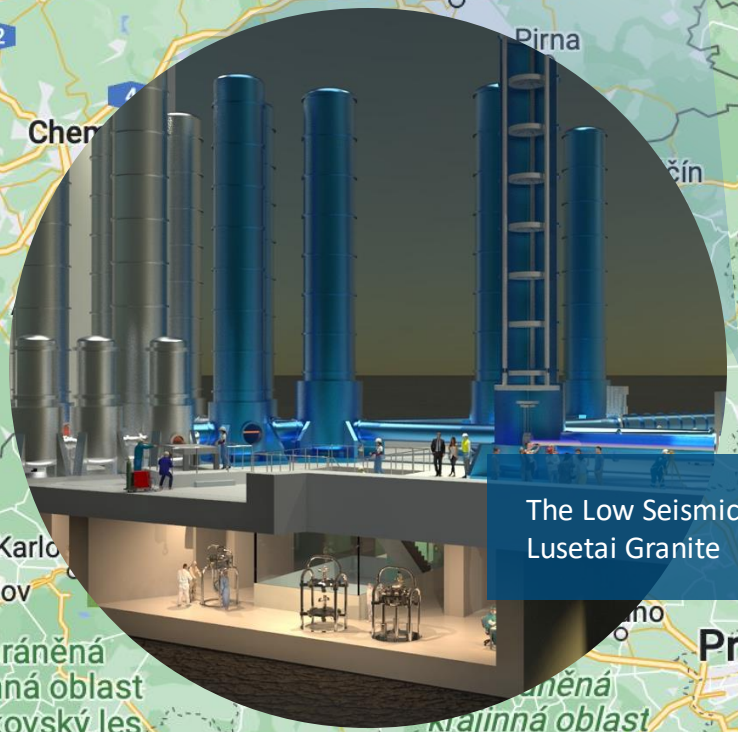
The German Centre for Astrophysics in the heart of Europe



The German Centre for Astrophysics in the heart of Europe

The DZA Campus on the Kahlbaum site in Görlitz

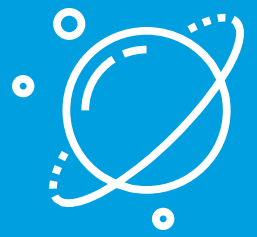
The German Centre for Astrophysics in the heart of Europe



The Low Seismic in the Lusetai Granite

The DZA Campus on the Kahlbaum site in Görlitz

Initial Key Strategic Priorities



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

The DZA on the Path to Becoming a Global Scientific Hub

2024 DZA in project phase

- No legal entity, project funding, interim HQ and technology lab in Görlitz, managed by TUD & DESY, Launch early gravitational wave and radio astronomy, technology development, and data science projects.
- End of 2024 already more than 60 people

2025/2026 Evaluation of project phase

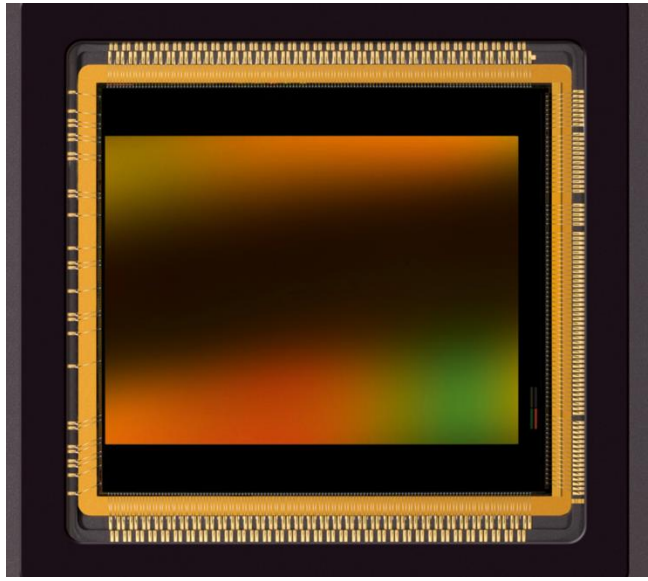
- independent legal entity
- start of initial 10-year period, launching projects, building an own campus.

2026-2035: Implementation of the DZA

- Eventually 1000 employees, annual budget 170 M€

Scientific topics of the DZA

- **Radio Astronomy**
  - enhancing capabilities of the Square Kilometer Array (SKA)
- **Optical Astronomy**
  - beyond the ELT, survey and time-domain projects will play a critical role
- **Technology development**
  - advancing CMOS technology, the likely successor of CCDs in astronomical cameras.
- **Data Science**
  - Managing unprecedented data challenges from SKA and other large-scale infrastructures.
  - Contributing to the SKA-Regional Centre network.



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."

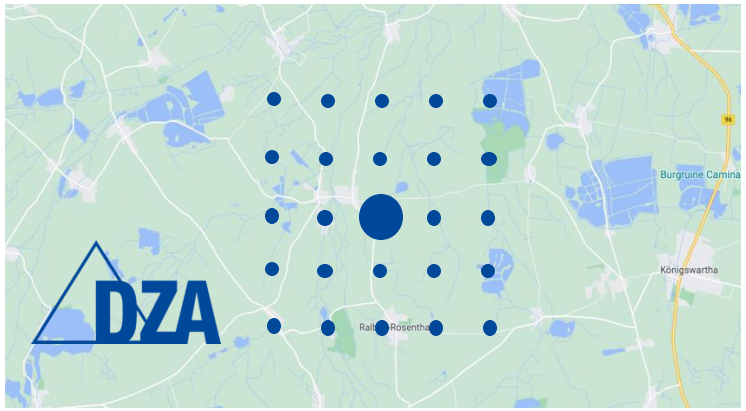
Dawid Statnik, Chairman Domowina, Association of Lusatian Sorbs

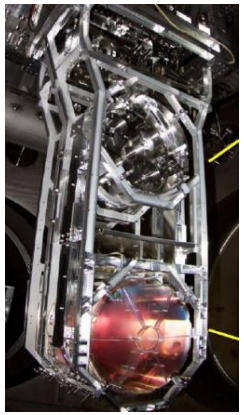
The Low Seismic Lab

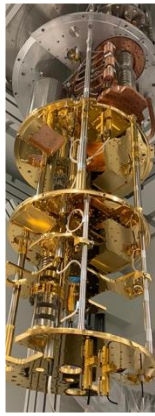
Innovation platform of approx. (40 x 30 x 30) m^3 in 200m depth in the Lusatian granite.

With a square kilometre 3D seismometer sensor array.

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



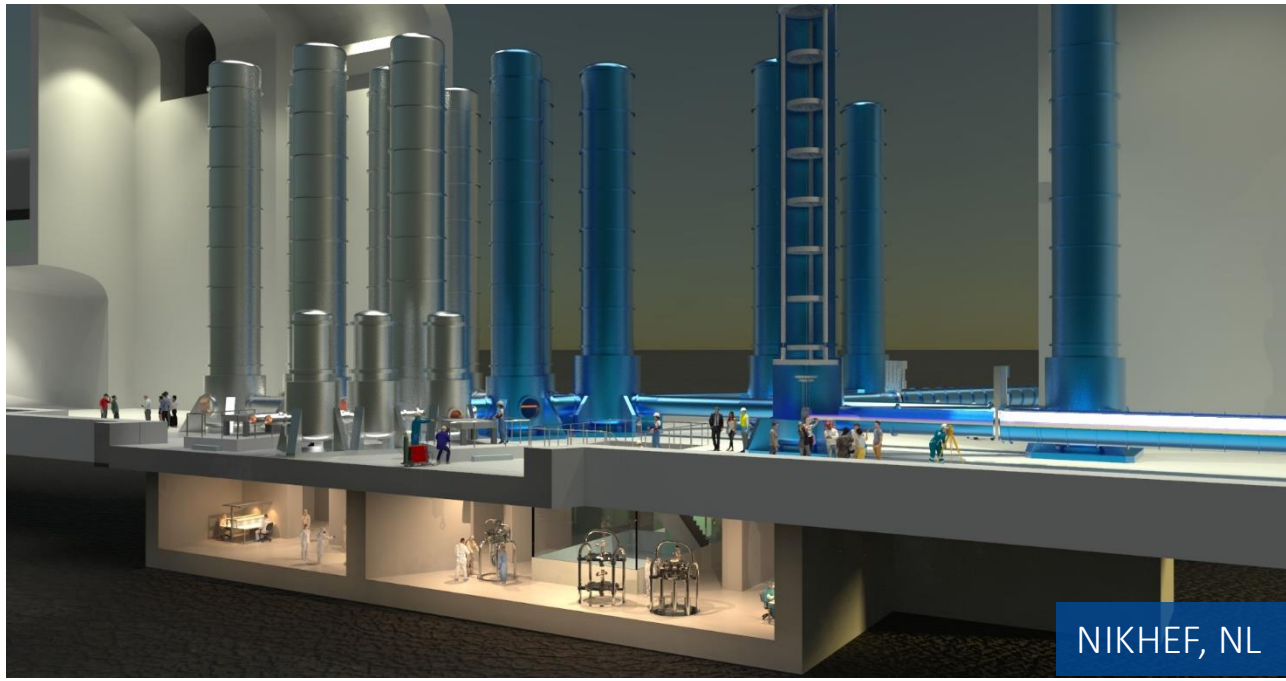




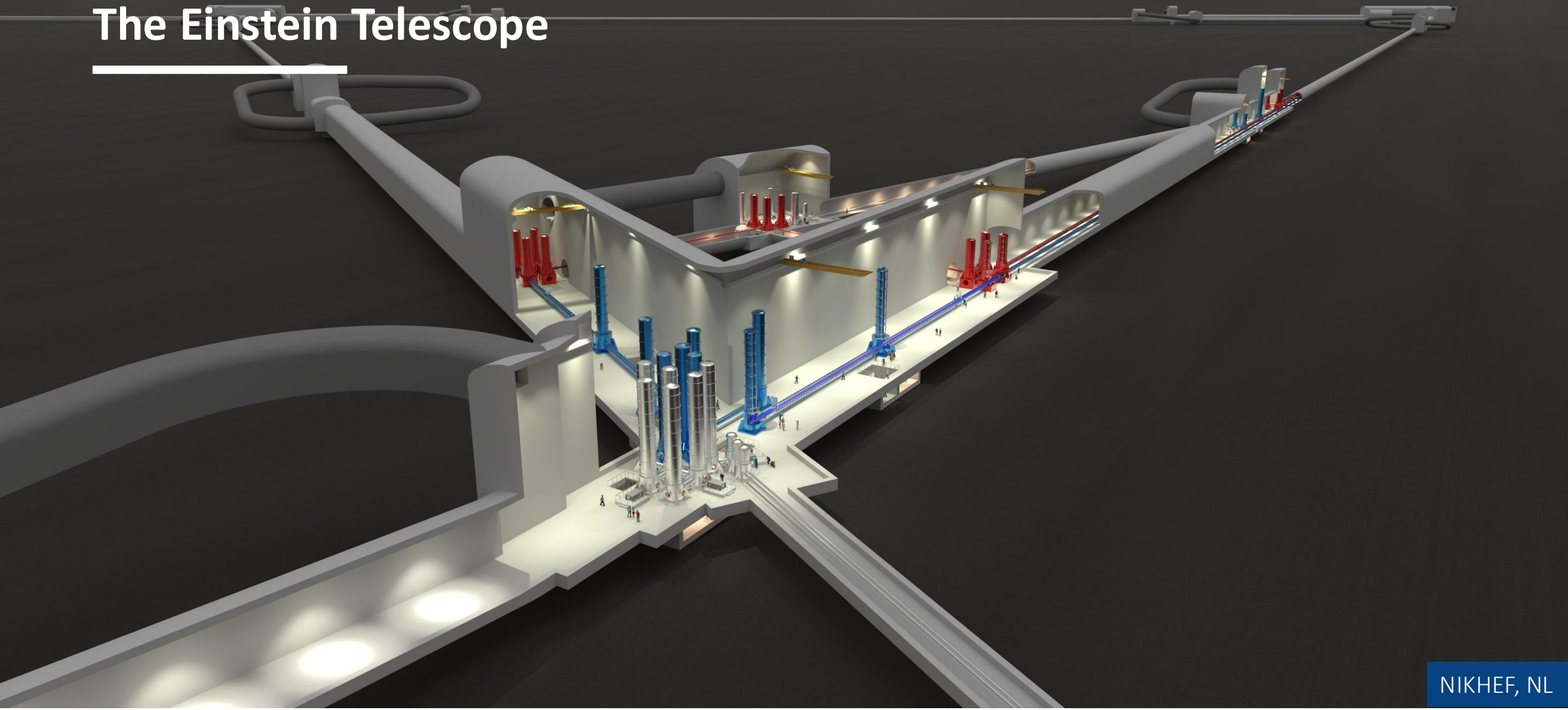
THE PLACE FOR FUTURE "DEEP TECH":

- Technology development for GW astronomy
- Adaptive seismic noise reduction
- Astrophysics with accelerators
- Low noise detector development

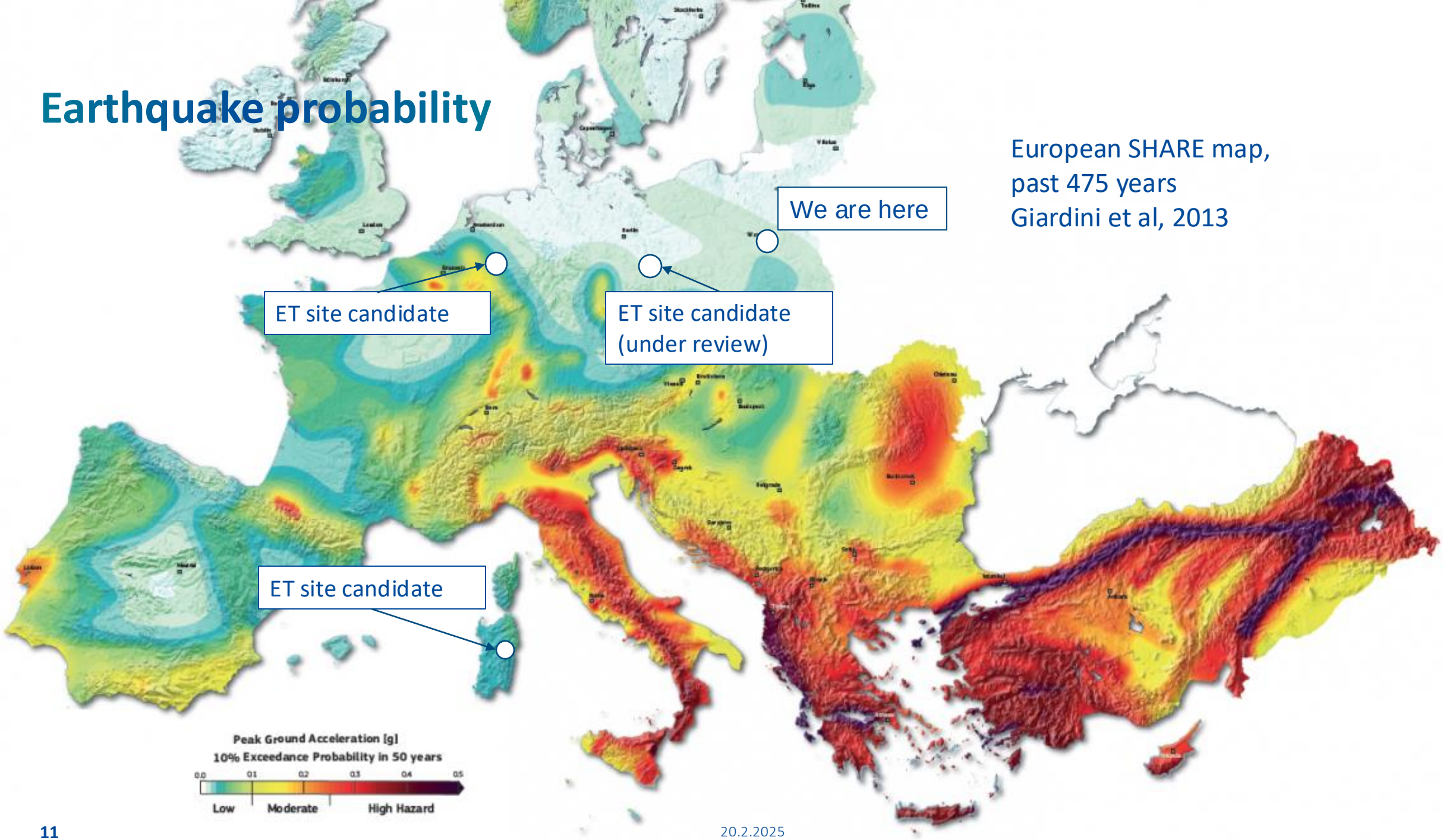
- Subnanometer microscopy and photolithography
- Quantum computing experiments



The Einstein Telescope



Earthquake probability



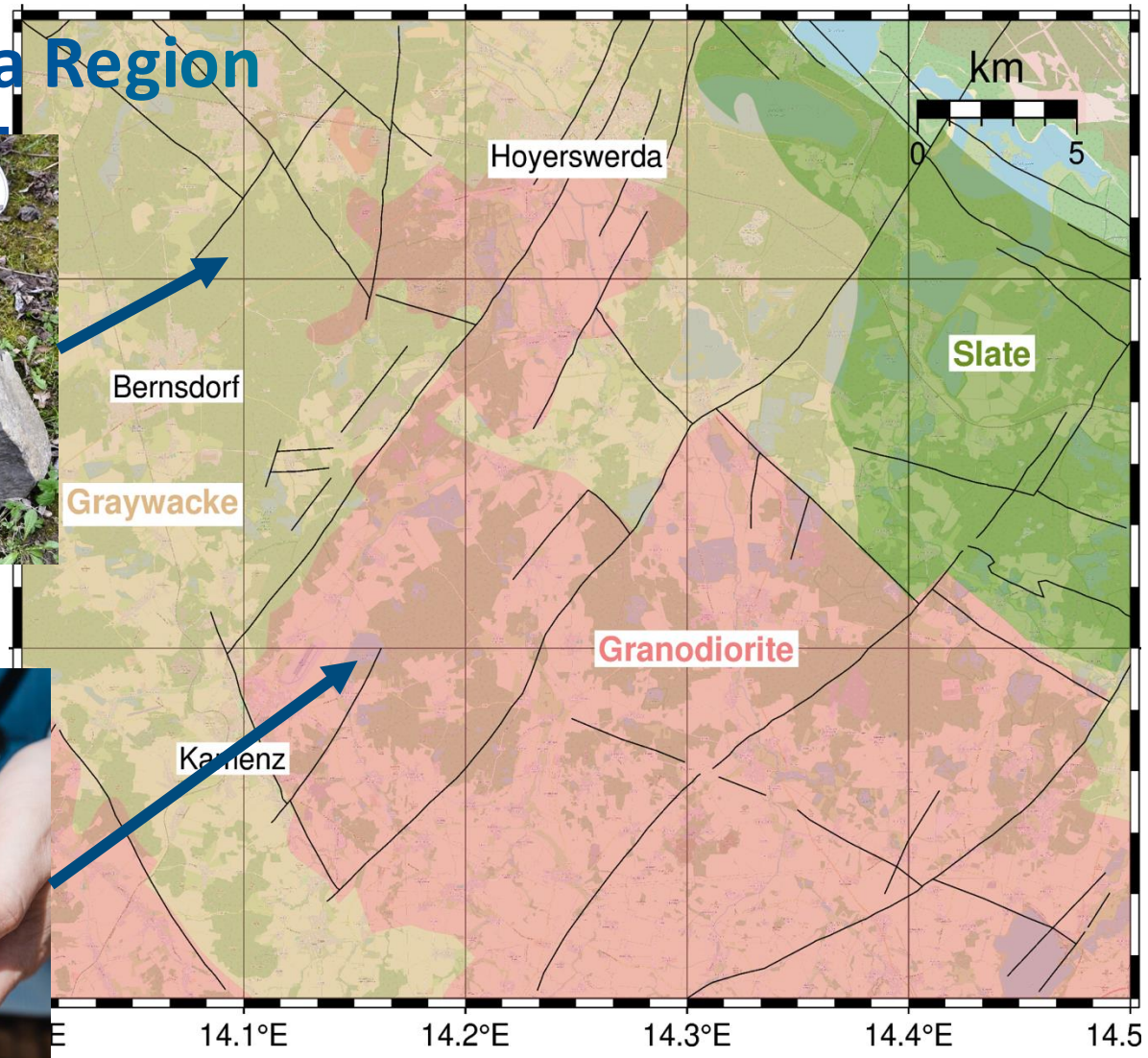
European SHARE map,
past 475 years
Giardini et al, 2013

A site for ET?

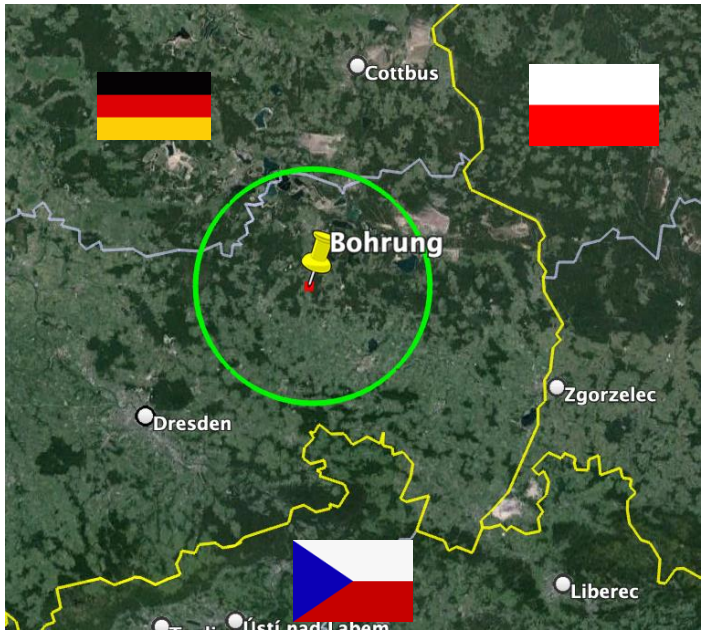
Several ciriteria are relevant for the site decision and can be roughly divided into four categories

Category	Lusatia
1. Can the scientific programme be carried out by ET at this location?	promising
2. Can ET be built at this site cost-efficiently and with calculable risks?	It's being investigated.
3. Can ET be operated at this location for decades?	It's being investigated.
4. Is there political support and financial commitment for the site?	Yes, for the site studies (no commitment yet for the construction from Germany for any of the sites)

The Lusatia Region

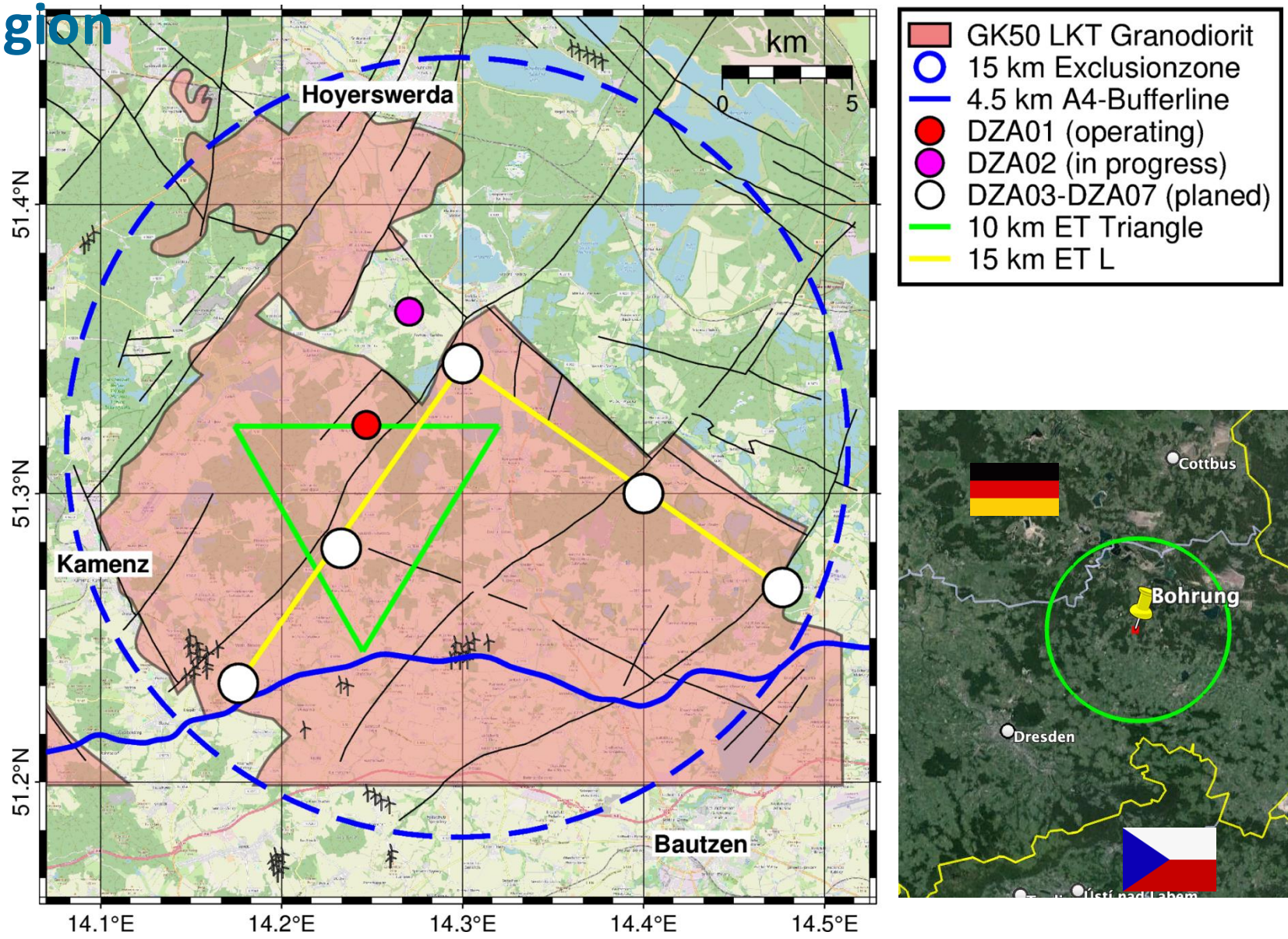


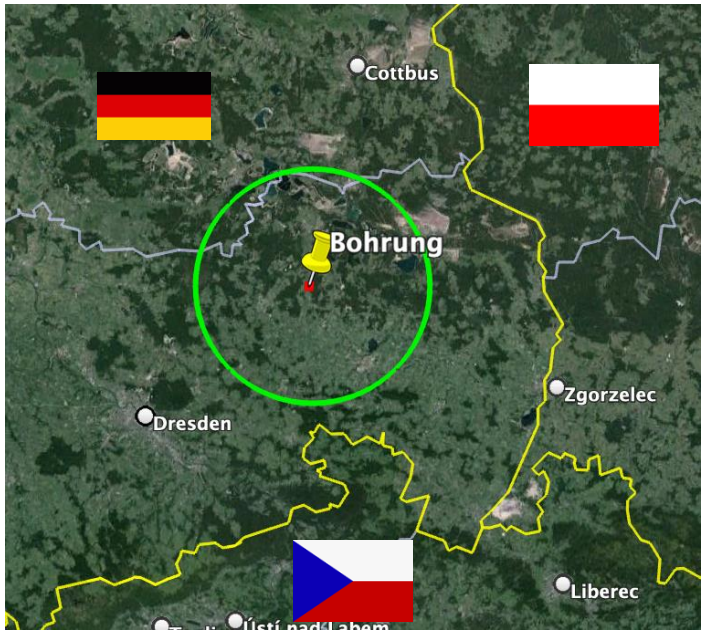
A largely monolithic and smooth granodiorite block with an extension of at least 20 kilometers



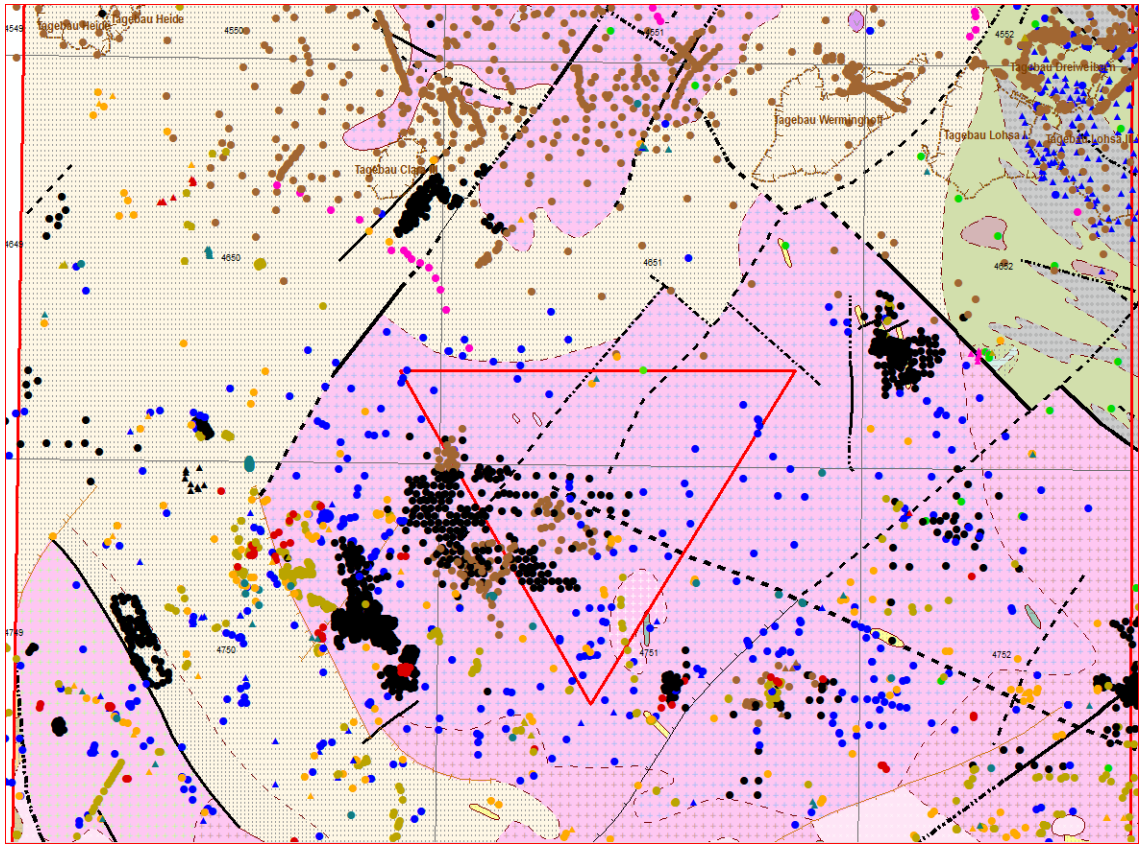
The Lusatia Region

Both topologies would fit

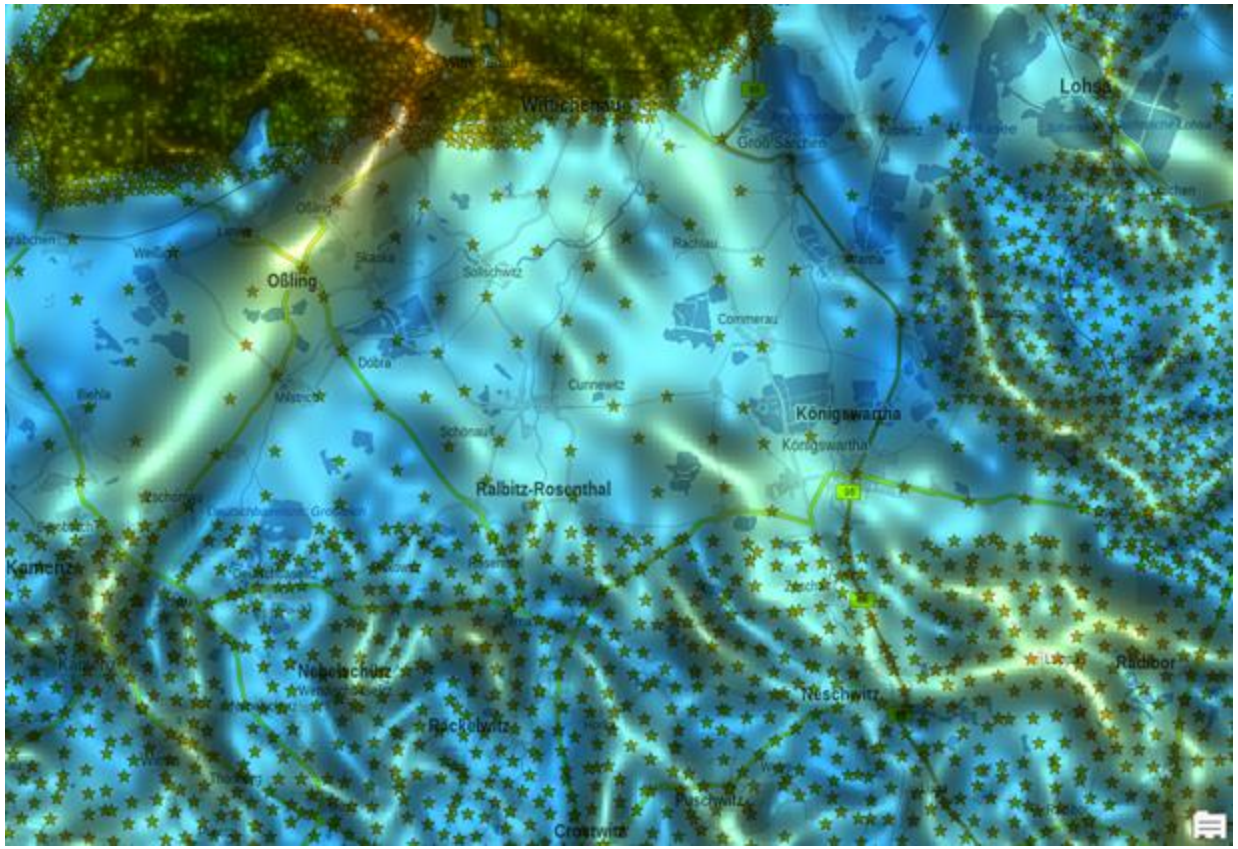




The Lusatia Region – well studied



- ca. 4000 documented drillings reaching top of basement (shown here)
- all available in digital form



- Complete gravimetric survey of the region with a point density of up to 400m

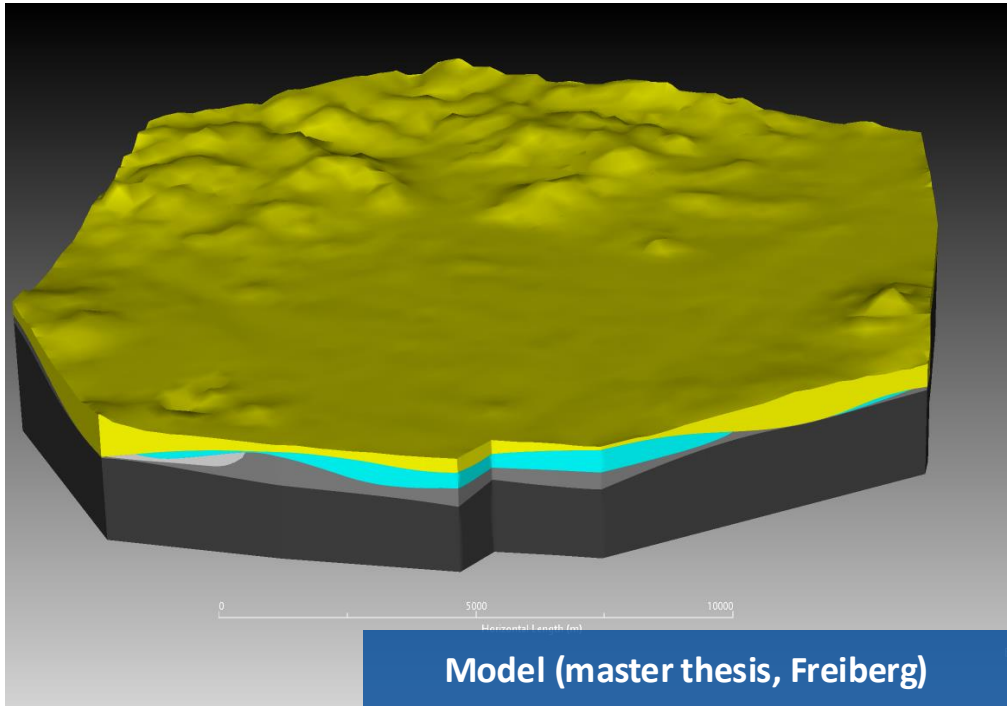
The drill site in Cunnewitz

250 m

180 m

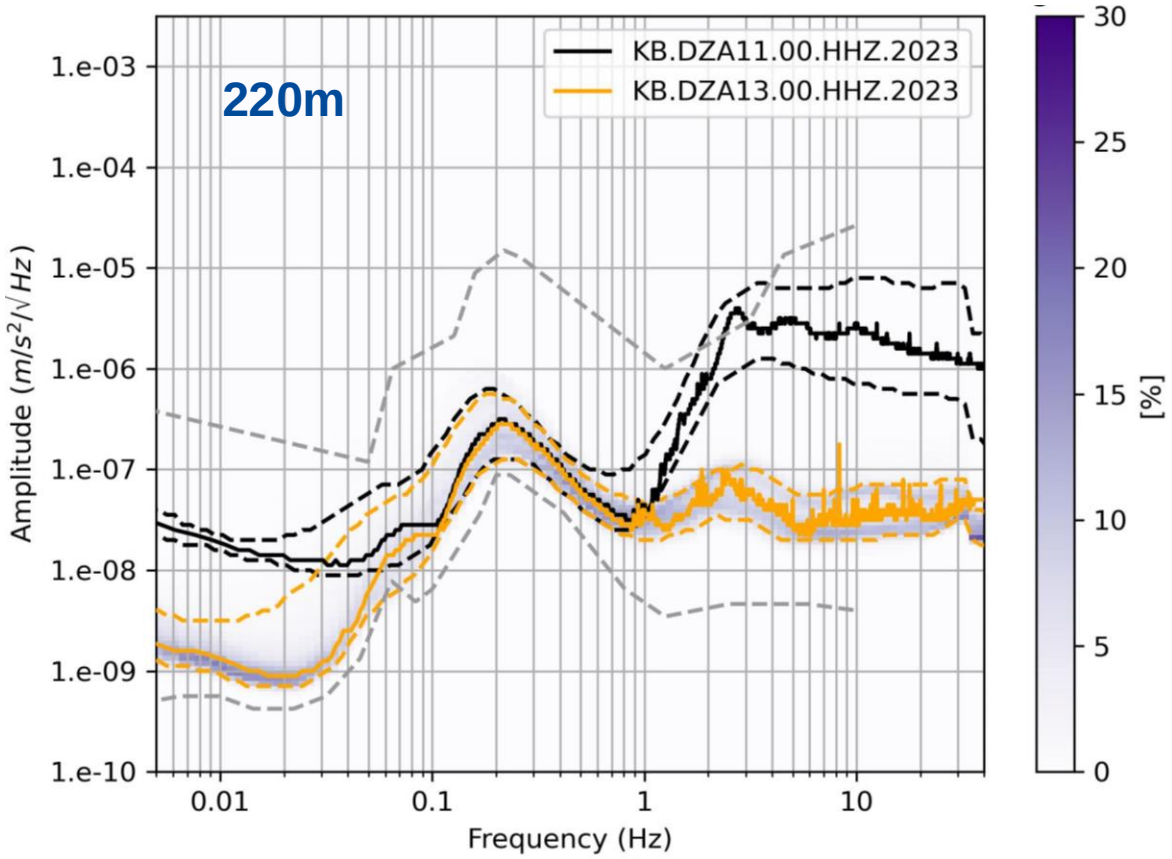
Seismometer in operation since over a year

Drill cores

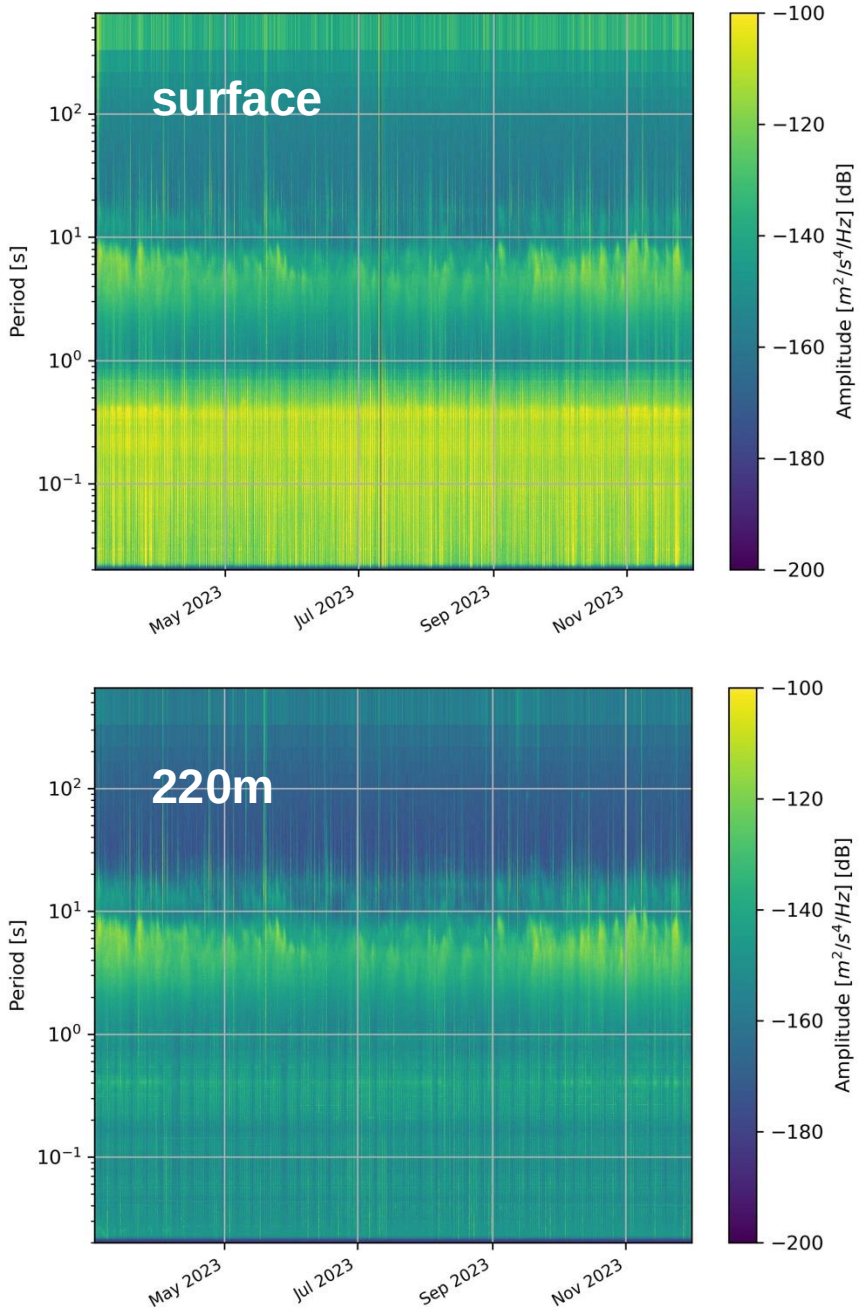


Model (master thesis, Freiberg)

Lusatia – comparison surface to borhole

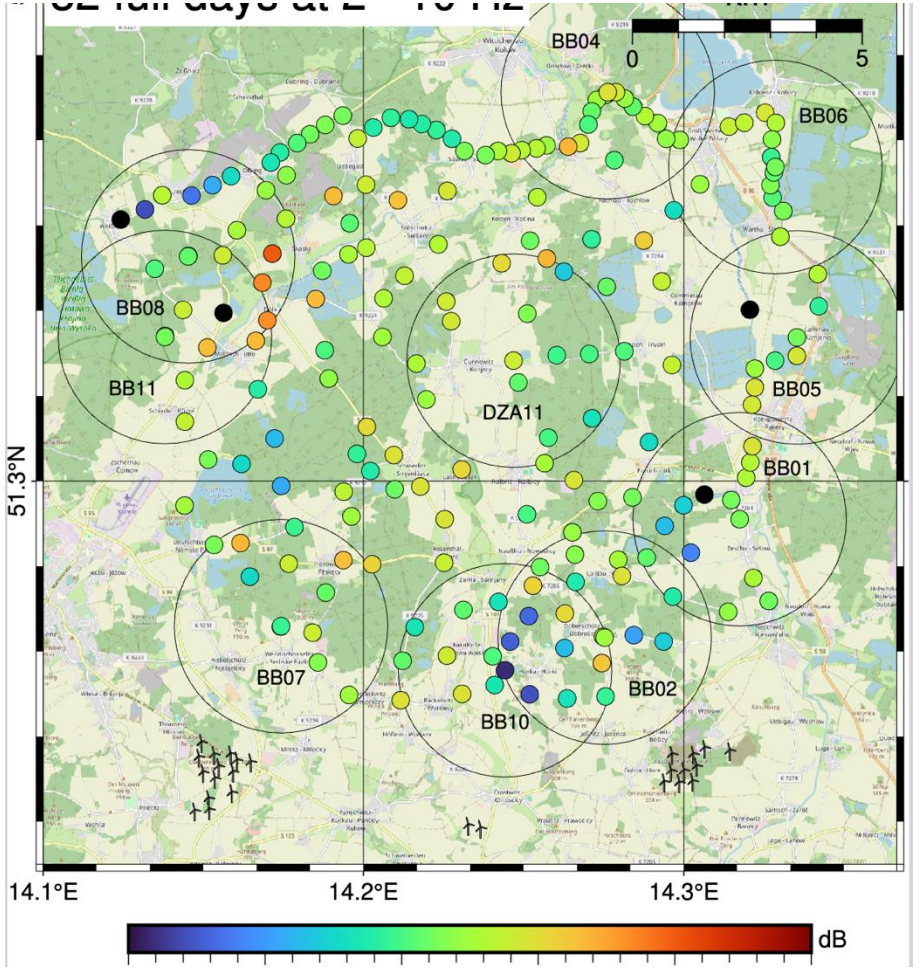


Courtesy Andreas Rietbrock



Extensive Investigations for the DZA's Low Seismic Lab are ongoing

- Passive seismological experiment for the determination of the 3D shear wave model
  - Deploy 100 seismic stations to measure the temporal variation of seismic noise and operated for at least 1 year.
- Conduct high-resolution 2D reflection seismic surveys of geological structures
  - Acquire 2 km long reflection seismic profiles and intersecting near the drilling location DZA-01 for calibration. Perform detailed studies at future drilling locations.
- Analysis of the physical parameters of the drill cores
  - focusing on the Lusatian granodiorite and tectonic structures.
- Update the geological/hydrological map of the granite stock
  - Develop a geological/tectonic model using data from the archive from the Lusatian Geological Survey.
- Measurement of seismic noise at three additional boreholes
  - to qualify the spatial and temporal noise level in Lusatia.
- 5 more drill holes into the granodiorite
- Integrated Lusatian subsurface model and characterization of seismic noise



Interim conclusion of the geological investigations

- A **site investigation team was established** between GFZ, TUBAF, LfULG, Frauenhofer, KIT, DZA, …
- There is a **wealth of geological drilling data**, collected in East Germany, all available in digital form.
- Geophysical/geological **site investigations are well under way**, first robust models later in the year.

"All exploration work done so far point out that the mapped granodiorite at depth is well suited for an Einstein Telescope" – Andreas Rietbrock, KIT

DZA

KIT Karlsruhe Institute of Technology

TU Bergakademie Freiberg · TUBAF Die Ressourcenuniversität. Seit 1765.

GFZ Helmholtz Centre Potsdam

Landesamt für Umwelt, Landwirtschaft und Geologie | Freistaat Sachsen

Fraunhofer IEG

…

Lusatia as a site for ET?

We have set-up a study to comprehensively assess

- the **geological and geophysical conditions** in Lusatia (already underway),
- the feasibility and **costs of underground and surface structures** and infrastructure,
- the **socio-economic impacts**,
- the expected **operating costs of the infrastructure** and the **legal framework**

Expected results

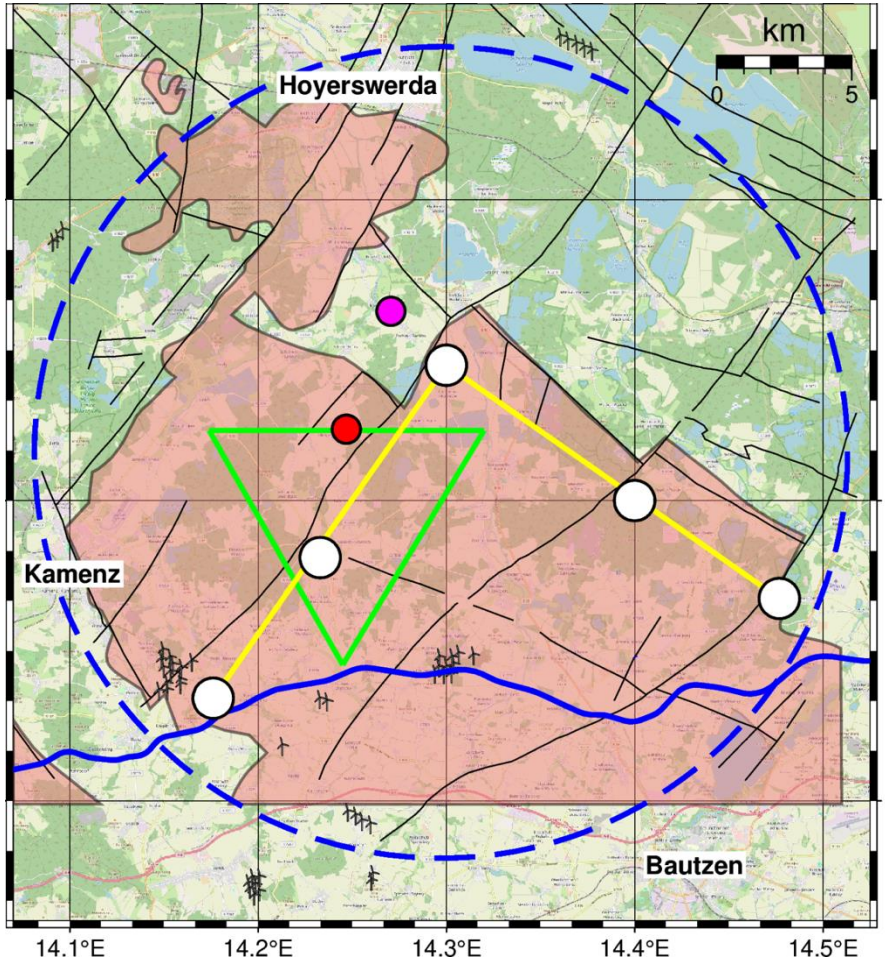
- **Geological report**: Comprehensive presentation of the geological conditions.
- **Technical report:** Detailed presentation of the construction and operating scenarios with complete cost analyses.
- **Economic and social impact report**: Comprehensive analysis of the regional impact.

Ready end of 2026

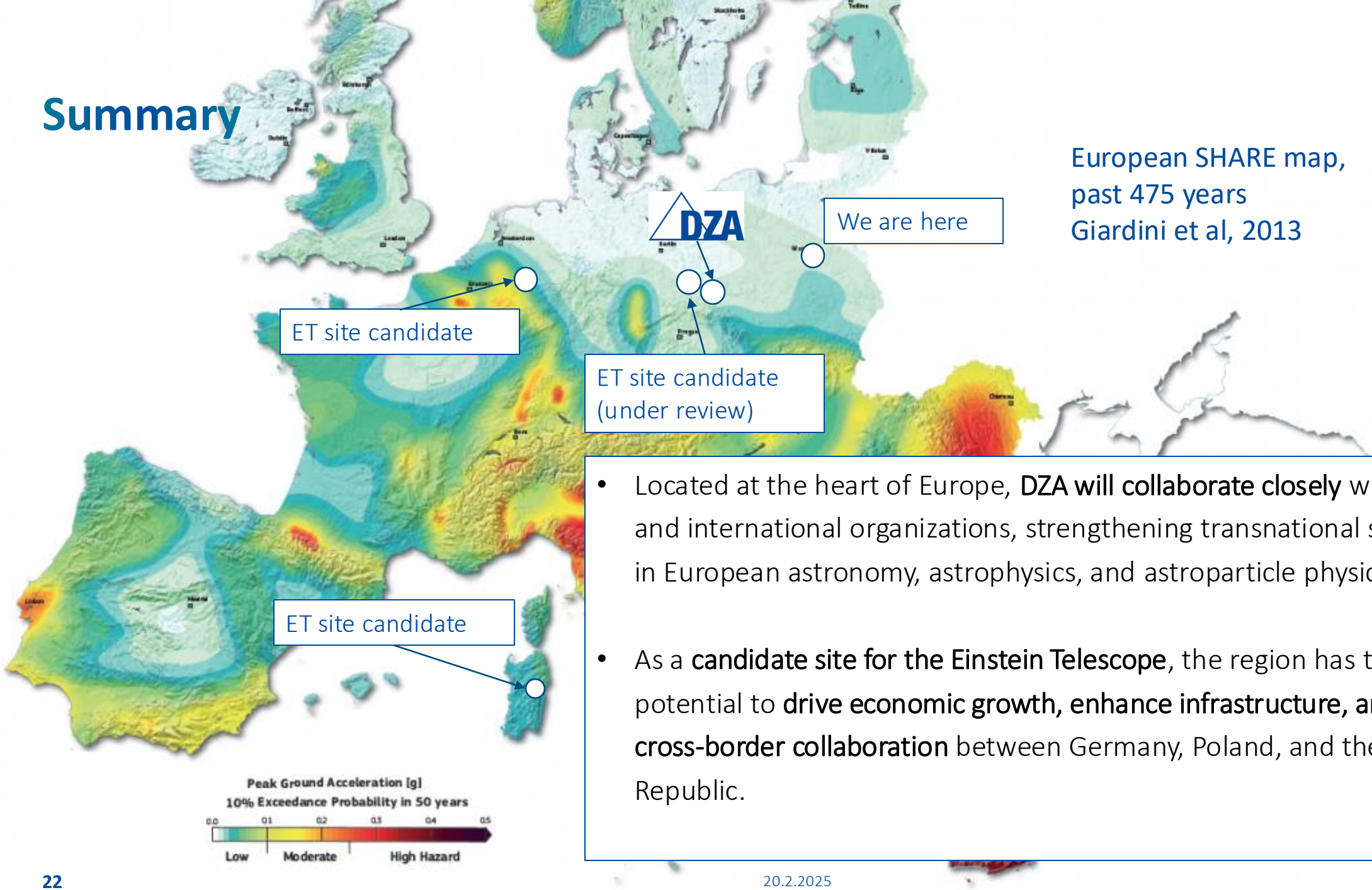
Supported by the Saxon state government.

Lusatia – proposed candidate site for the Einstein Telescope

- **Geological Suitability**: Stable granite massif with low seismic activity and extensive geological data supports ET's requirements
- **Scientific and Technological Hub**: Strong regional research network, especially with the new German Center for Astrophysics (DZA), which aligns with ET's goals in gravitational wave astronomy
- **Political and Community Support**: Firm support from Saxony's government.
- **Regional Development**: ET as a catalyst for economic growth, infrastructure improvements, and cross-border collaboration between Germany, Poland, and Czech Republic.
- **Ongoing Assessments:** seismic and geological studies underway, as well as tunnel and socio-economic studies, supported by Saxony to ensure decision readiness by the end of 2026.



Summary



European SHARE map,
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Giardini et al, 2013

- Located at the heart of Europe, **DZA will collaborate closely** with national and international organizations, strengthening transnational structures in European astronomy, astrophysics, and astroparticle physics.

- As a **candidate site for the Einstein Telescope**, the region has the potential to **drive economic growth, enhance infrastructure, and foster cross-border collaboration** between Germany, Poland, and the Czech Republic.