



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008324 (ChETEC-INFRA).



TECHNISCHE
UNIVERSITÄT
DRESDEN

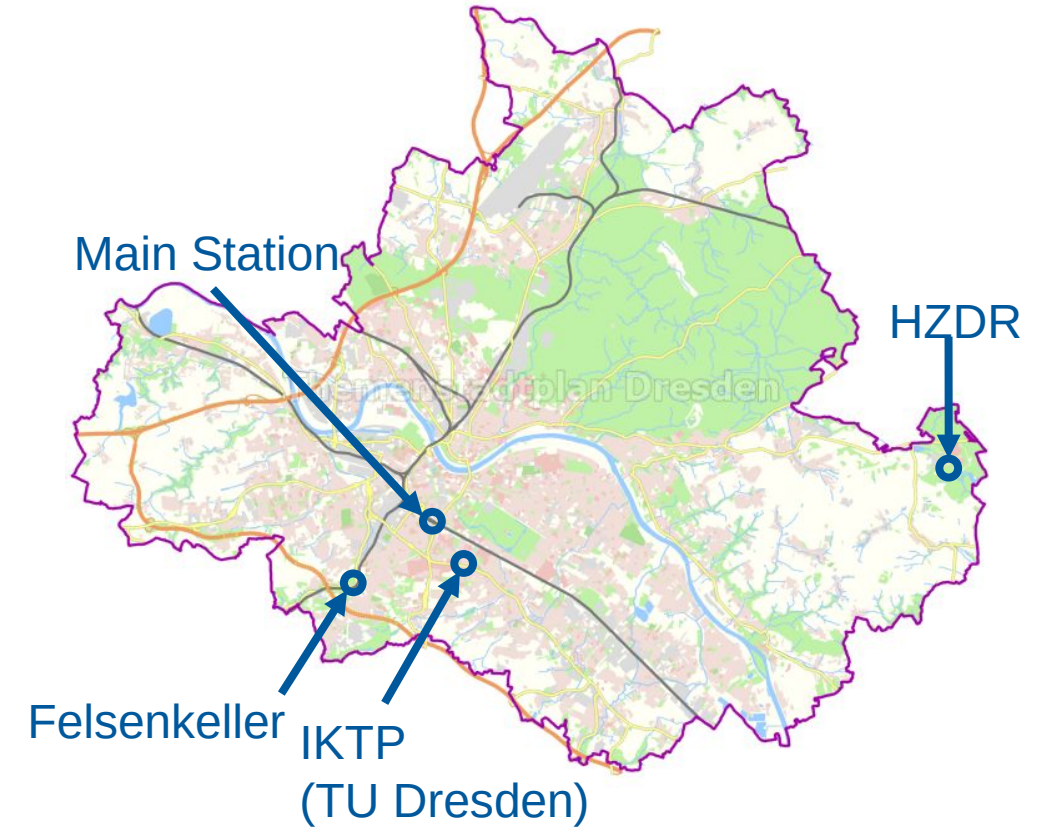
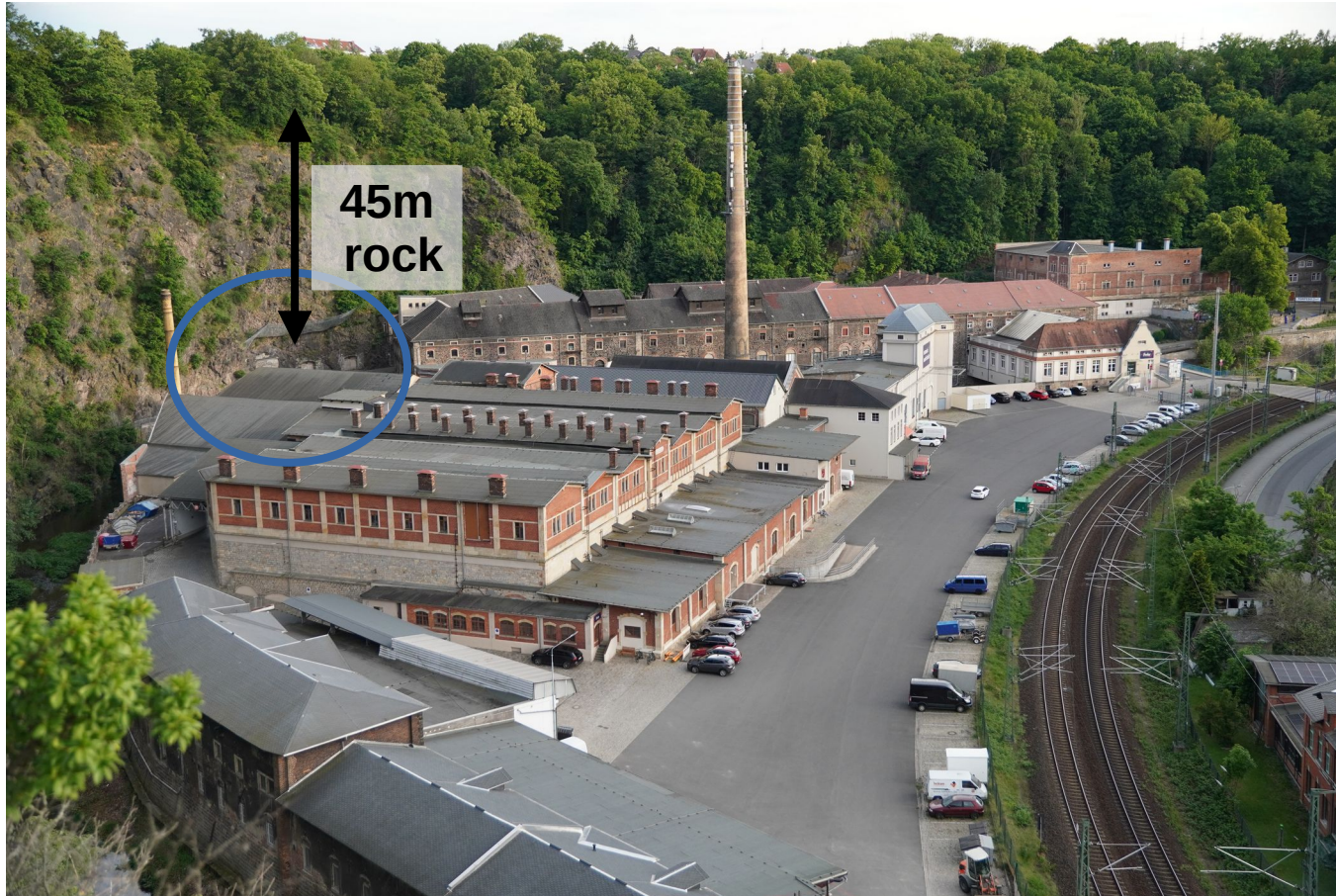
HZDR
HELMHOLTZ ZENTRUM
DRESDEN ROSENDORF

Status of Felsenkeller and perspectives of underground labs in Germany

HELIUM25 - Helium burning and perspectives for underground labs
July 22, 2025

Axel Boeltzig
Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

The Felsenkeller Laboratory: Location



The Felsenkeller Accelerator Laboratory: A Brief History

NEC 5MV Pelletron

SNICS ion source

Used from 1999 to 2012
in York (UK) for AMS
(^{14}C for pharmaceutical
research).



Photo: Bernd Rimarzig / HZDR.

The Felsenkeller Accelerator Laboratory: A Brief History

Accelerator transport to HZDR, work on control system and added internal ion source.



Delivery & installation
at Felsenkeller,
spring 2017.



Photos: Felix
Ludwig, Bernd
Rimarzig, Oliver
Killig / HZDR.

The Felsenkeller Accelerator Laboratory: A Brief History

Topping out ceremony,
June 2017.



Photos: Robert
Lohse / TU Dresden.

The Felsenkeller Accelerator Laboratory: A Brief History

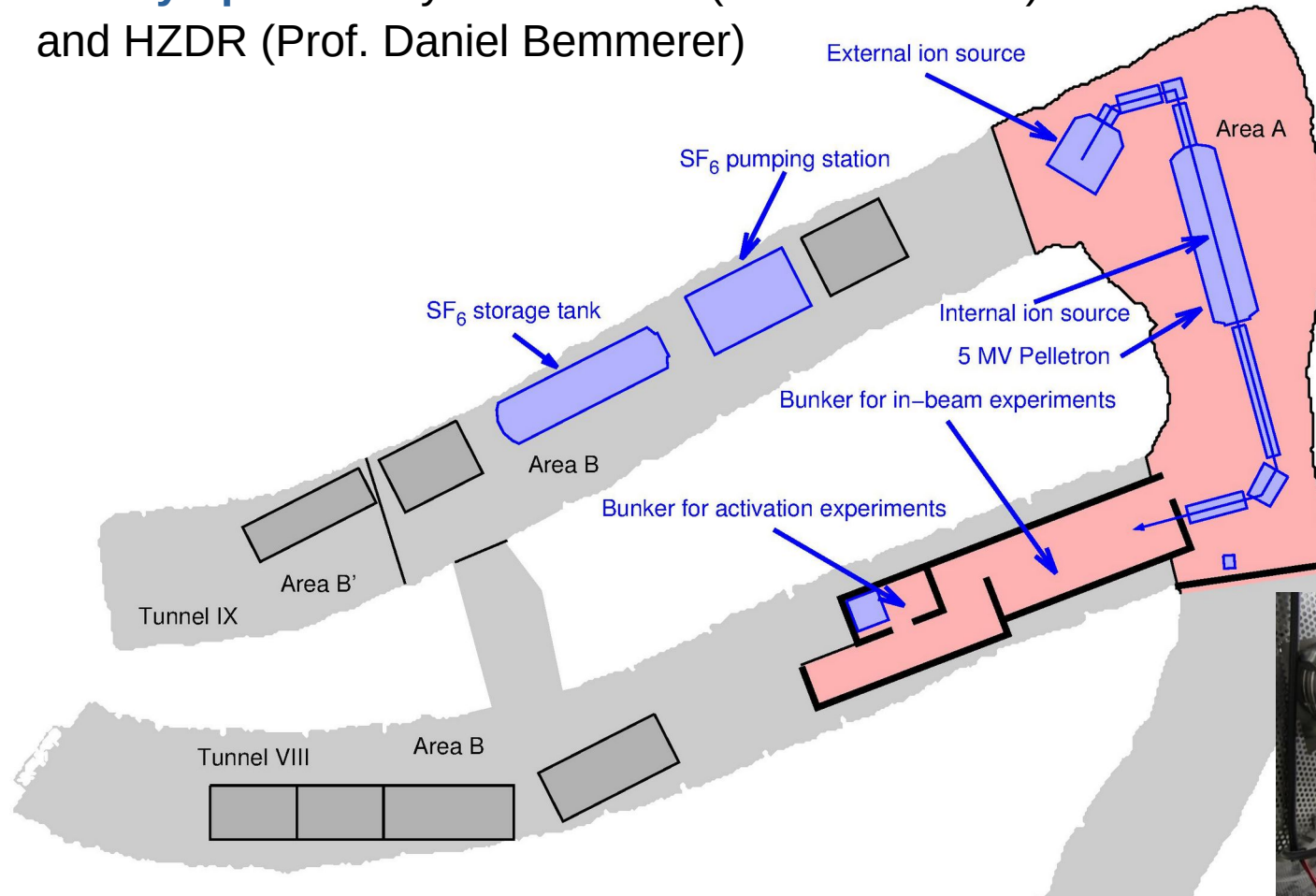
Ceremonial start, July 4, 2019.



Photos: André Wirsig / HZDR.

The Felsenkeller Laboratory

Jointly operated by TU Dresden (Prof. Kai Zuber)
and HZDR (Prof. Daniel Bemmerer)



External Sputter Ion Source

e.g. $^{12}\text{C}^{1+,2+,3+}$, ^{16}O

Internal RF Ion Source

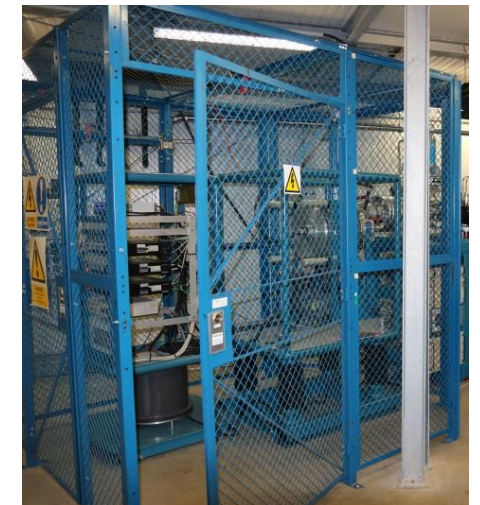
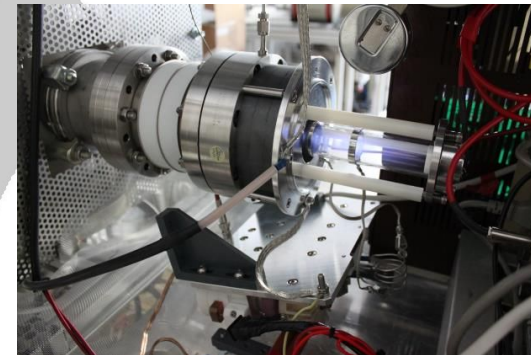
Higher intensities of H^+ , H_2^+ , He^+

5 MV Pelletron

single-ended or tandem operation

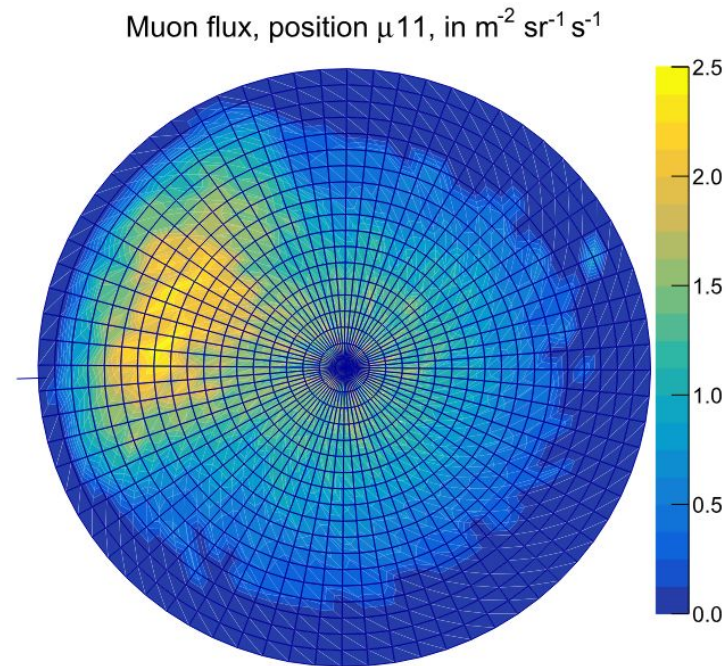
Target Station / In-Beam Bunker

Bunker for Offline Spectroscopy



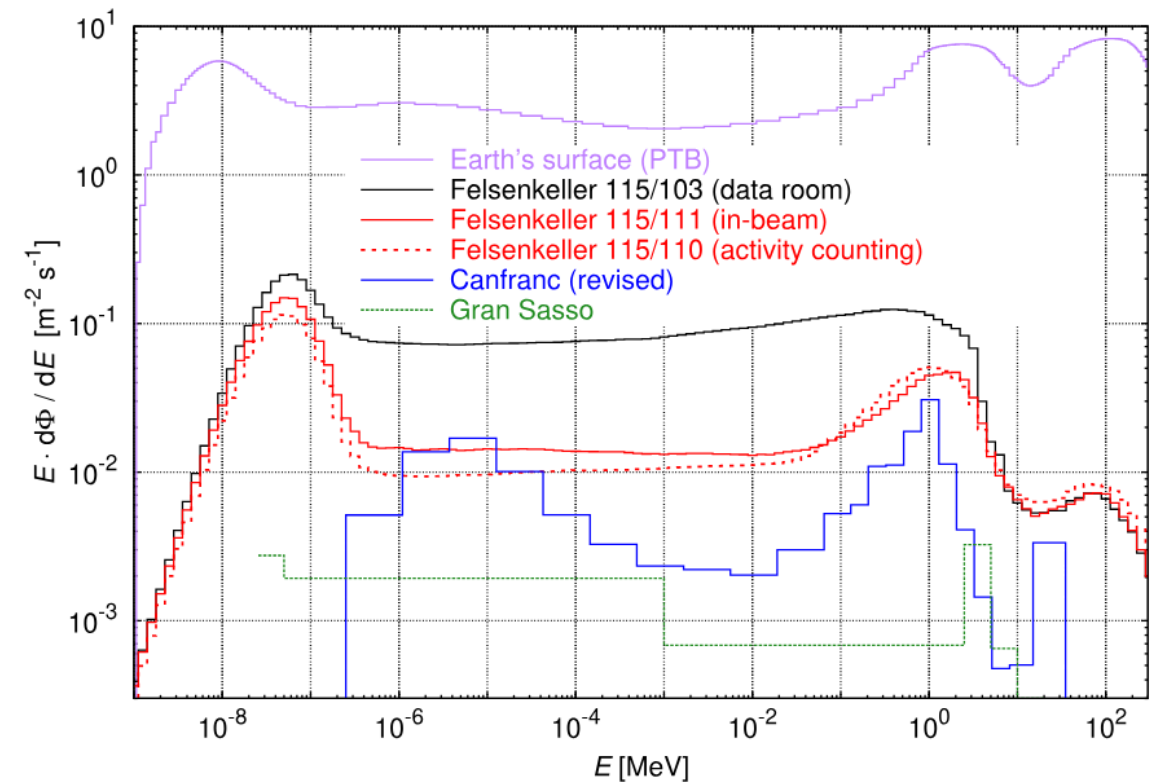
The Felsenkeller Laboratory: Backgrounds at 140 m.w.e.

Muons, suppressed by ~40



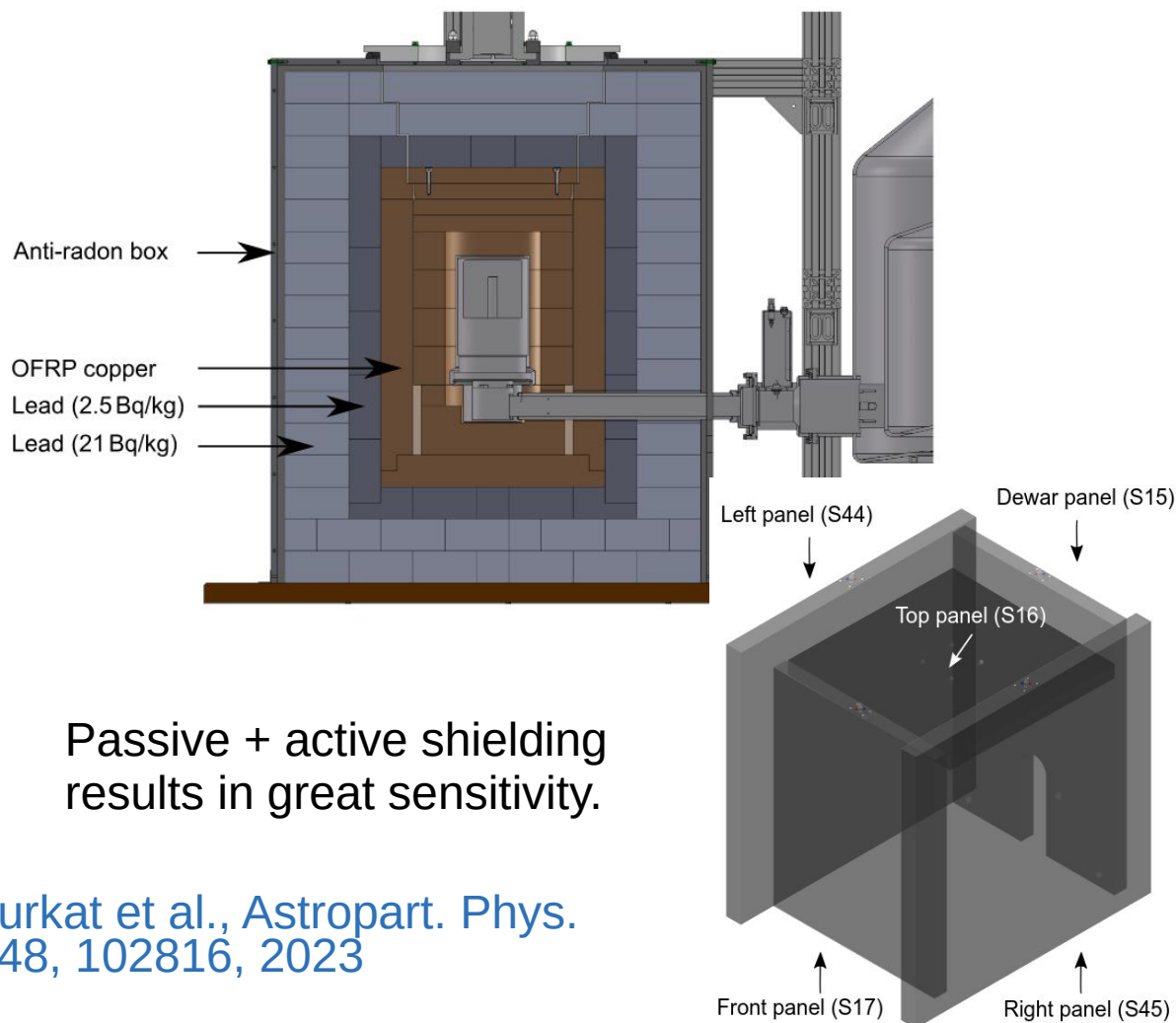
Bemmerer et al., Eur. Phys. J. A, 61:19 (2025)
Ludwig et al., Astropart. Phys., 112, 24-34 (2019)

Neutrons, suppressed by ~200

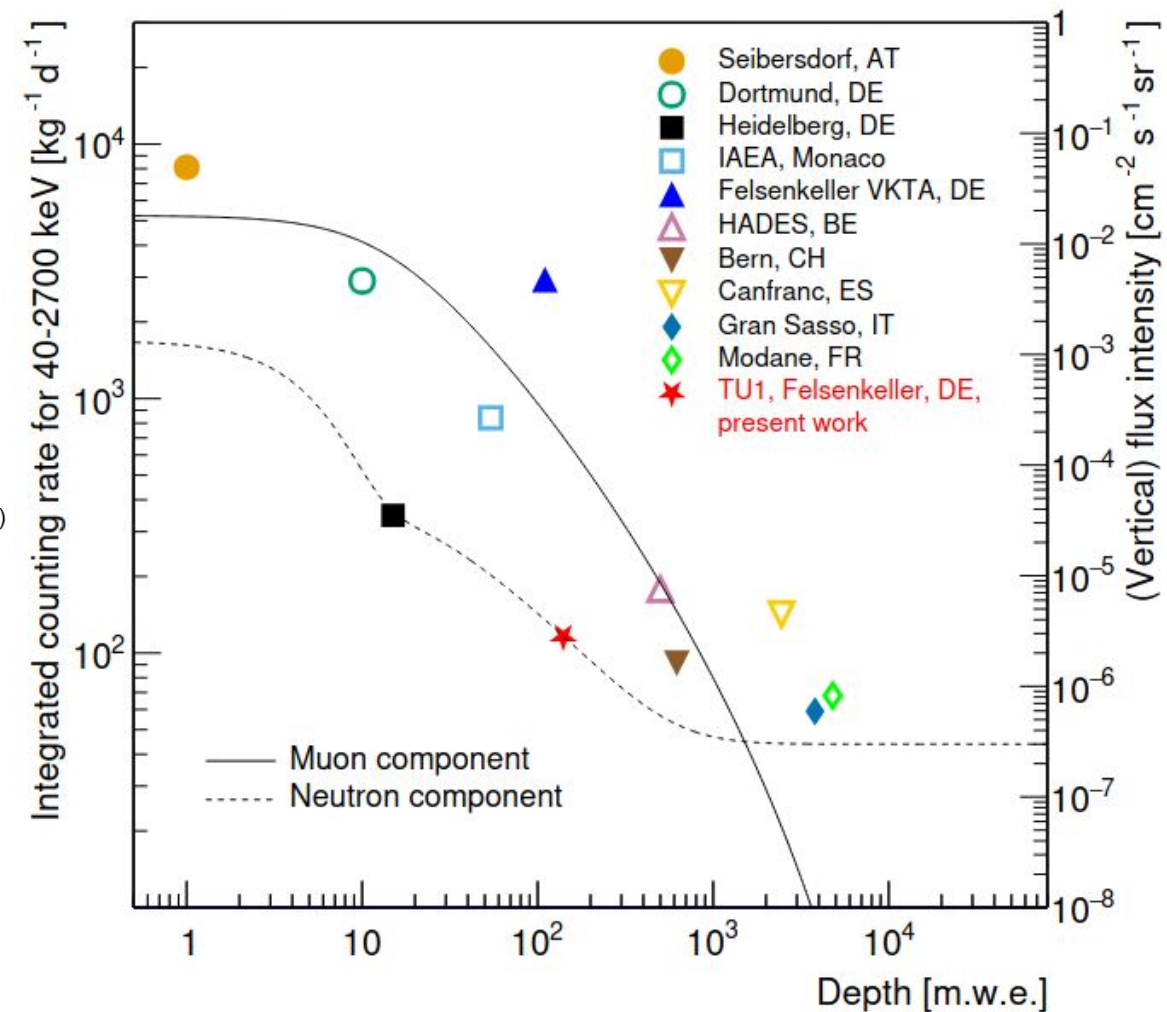


Bemmerer et al., Eur. Phys. J. A, 61:19 (2025)
Grieger et al., Phys. Rev. D 101, 123027 (2020)

Vetoed High-Sensitivity HPGe Counting with “TU1”



Turkat et al., Astropart. Phys.
148, 102816, 2023



The Felsenkeller Laboratory: Detectors and Measurements

Gamma-Ray Spectroscopy with HPGe Detectors

set of 20+ HPGe detectors (single + EuroBall clusters)
for absolute cross section measurements and angular
distribution measurements

Cross section + angular distribution measurements:

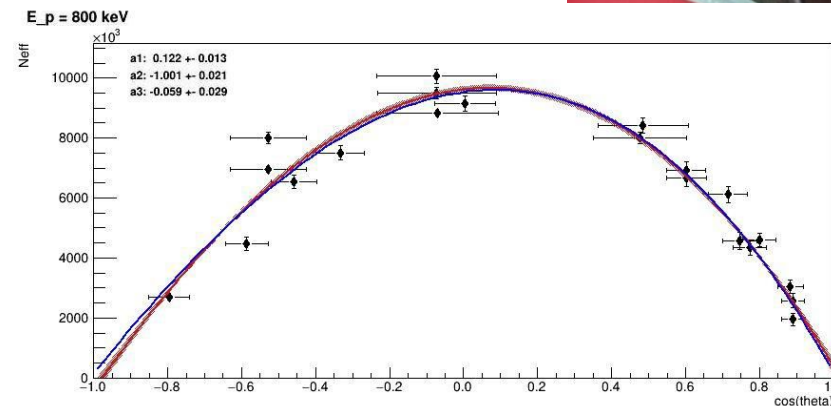
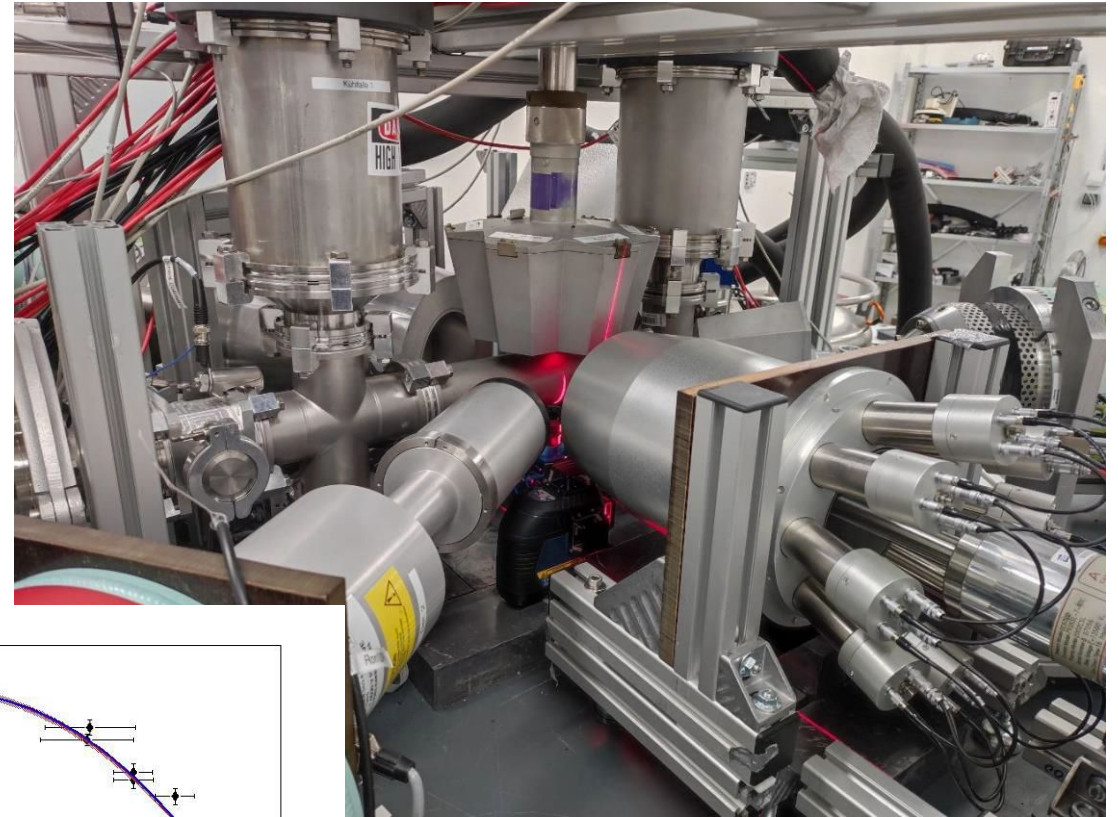
$^3\text{He}(\alpha, \gamma)^7\text{Be}$ (solid target, in-beam + activation counting)

$^{12,13}\text{C}(\text{p}, \gamma)^{13,14}\text{N}$

$^2\text{H}(\text{p}, \gamma)^3\text{He}$

$^{14}\text{N}(\alpha, \gamma)^{18}\text{F}$ (solid / gas target)

$^{15}\text{N}(\alpha, \gamma)^{19}\text{F}$



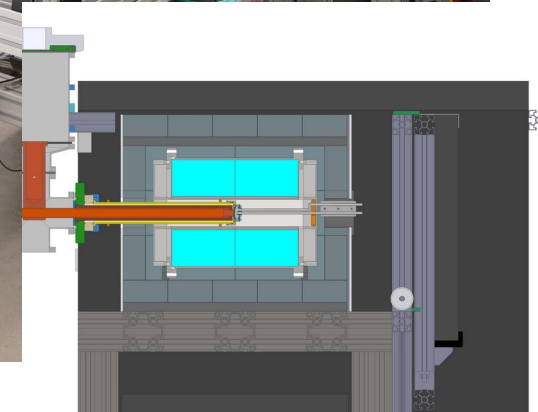
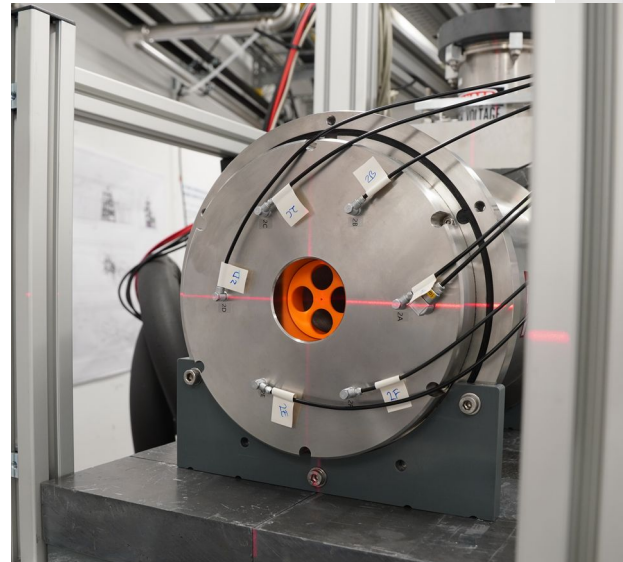
The Felsenkeller Laboratory: Detectors

Gamma-Ray Total Absorption Spectroscopy

new 4π BGO detector (dimensions cf. LUNA BGO),
High-efficiency, 12-fold segmentation, SiPM readout.

Delivered Jan. 2025, commissioned – measurements of
intrinsic and environmental backgrounds.

First solid target setup: 5cm Pb + active veto.
Measurement of $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ at low energies.



The Felsenkeller Laboratory: New (Jet) Gas Target

Jet Gas Target system:

Wall jet with densities up to 10^{18} atoms/cm²

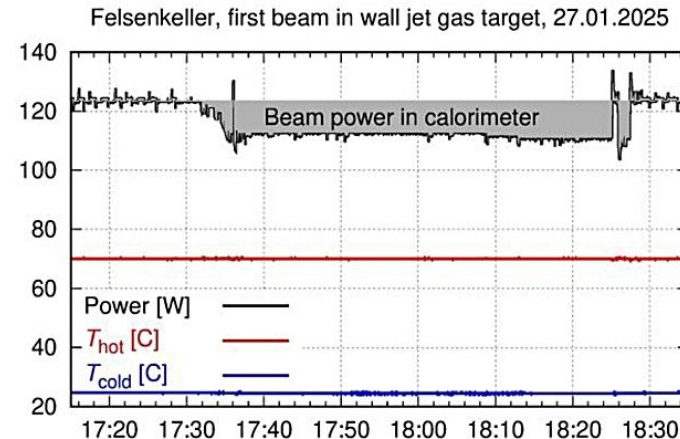
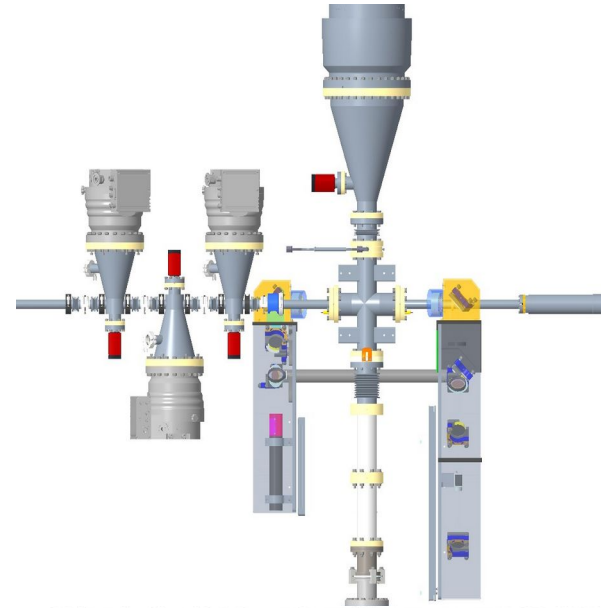
Developed and tested at HZDR

Brought to and installed at Felsenkeller

First beam on target January 2025

Commissioning experiment: $^{14}\text{N}(\alpha, \gamma)^{18}\text{F}$

→ Talk by Anup Yadav



Access to Felsenkeller

ChETEC-INFRA, 2021-2025

EU-funded transnational access, supporting beam-time and travel/subsistence of users

Felsenkeller Scientific Advisory Board

beam time available to the international scientific community for the purposes of pure scientific research

free of charge and based on the recommendations by an independent scientific advisory board.



Affiliations of (co-)proposers of Transnational Access projects at Felsenkeller (ChETEC-INFRA)



Complementarity to Other Laboratories: Carbon(p, γ)

Low-Energy Measurements at LUNA-400

Skowronski, Boeltzig, Ciani et al., Phys. Rev. Lett. 131, 162701, 2023

Intermediate energy range at Felsenkeller

Skowronski, Masha, Piatti et al., Phys. Rev. C 107, L062801, 2023

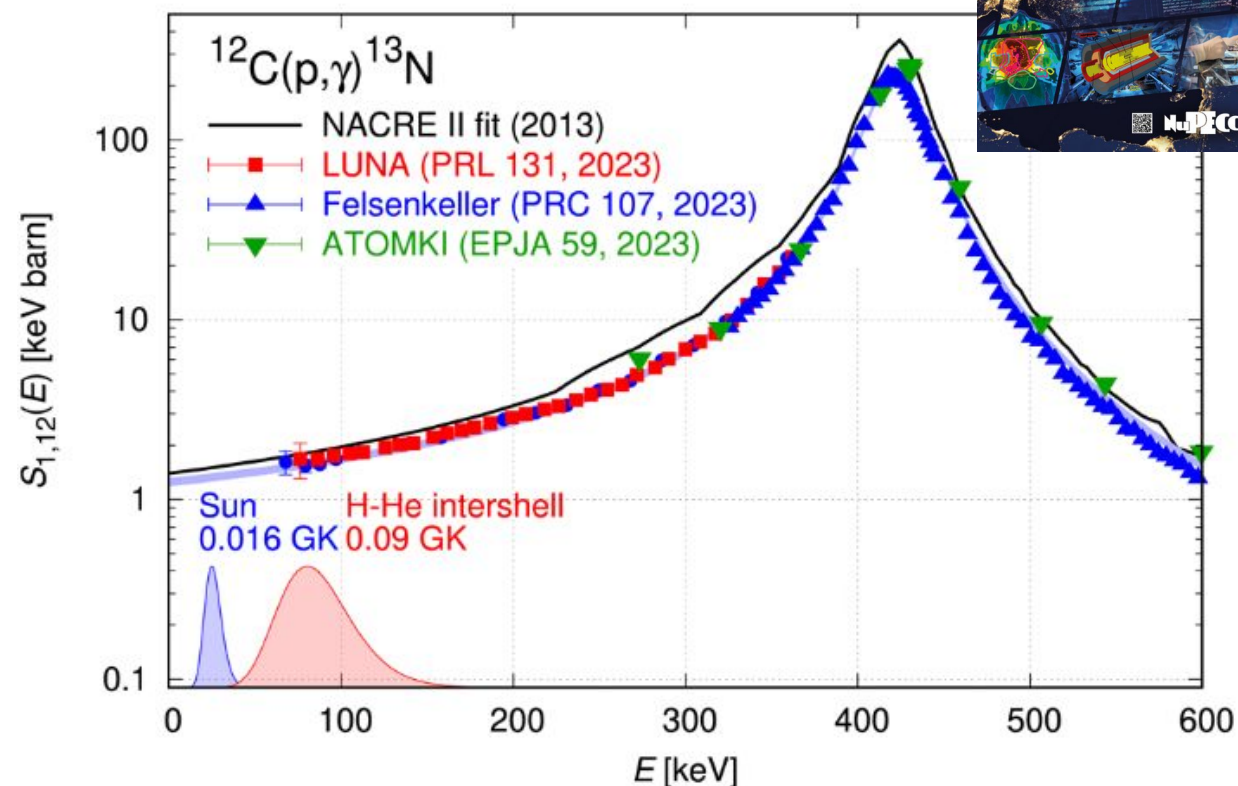
Skowronski, Masha, Piatti et al., Phys. Rev. C 111, 064611, 2025

Higher energy measurements on surface

Atomki: Gyürky, Cséregi et al., EPJ A 59(59), 2023

Notre Dame: Kettner et al., Phys. Rev. C 108, 035805, 2023
(and at other laboratories)

Exploiting complementary conditions between laboratories to obtain a comprehensive picture.



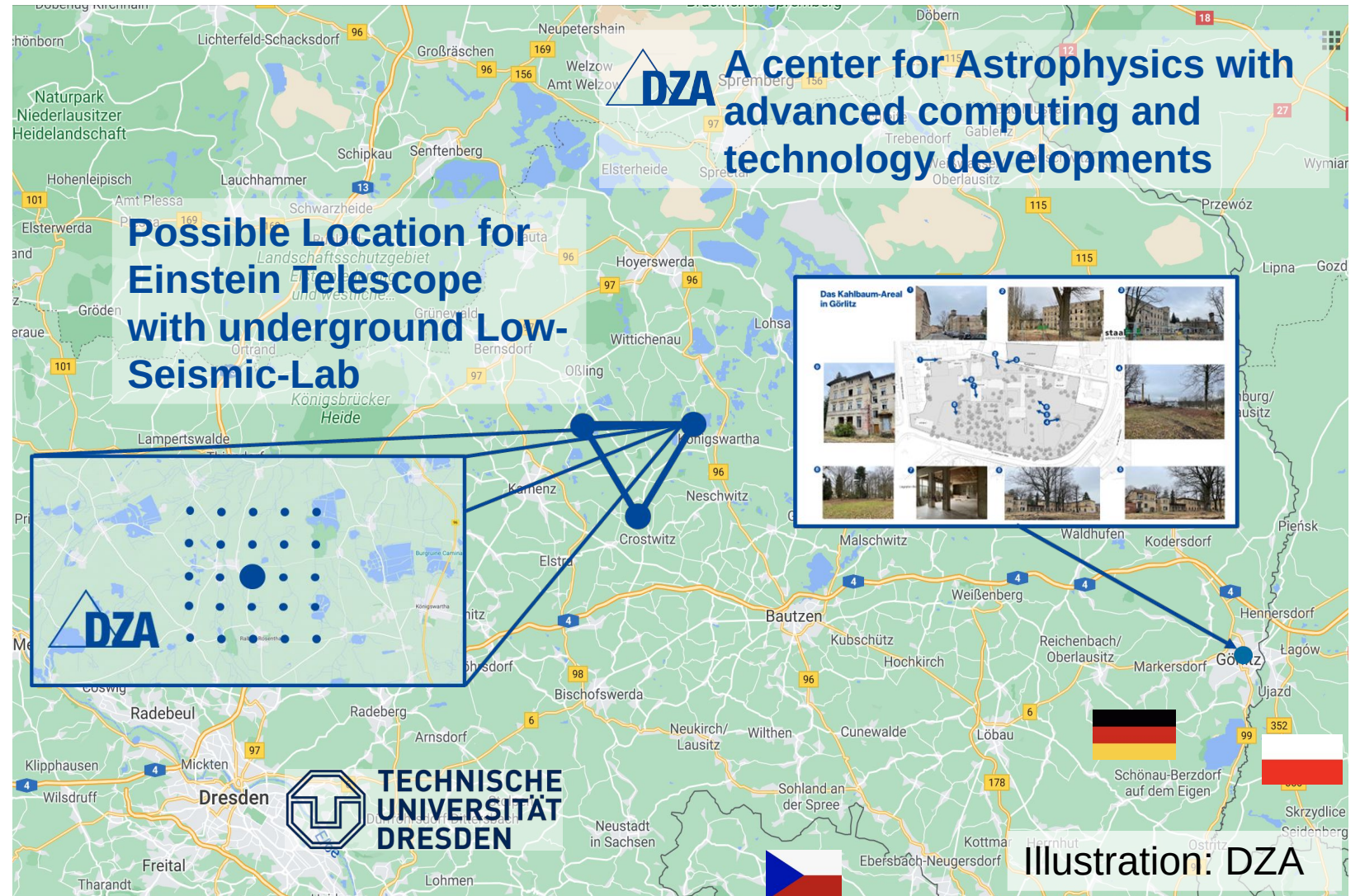
The German Center for Astrophysics (DZA)

Proposed as part of initiative “Wissen schafft Perspektiven für die Region” to address the **structural transformation** of the region away from surface coal mining.

September 2022: **DZA selected** as one of two funded projects.

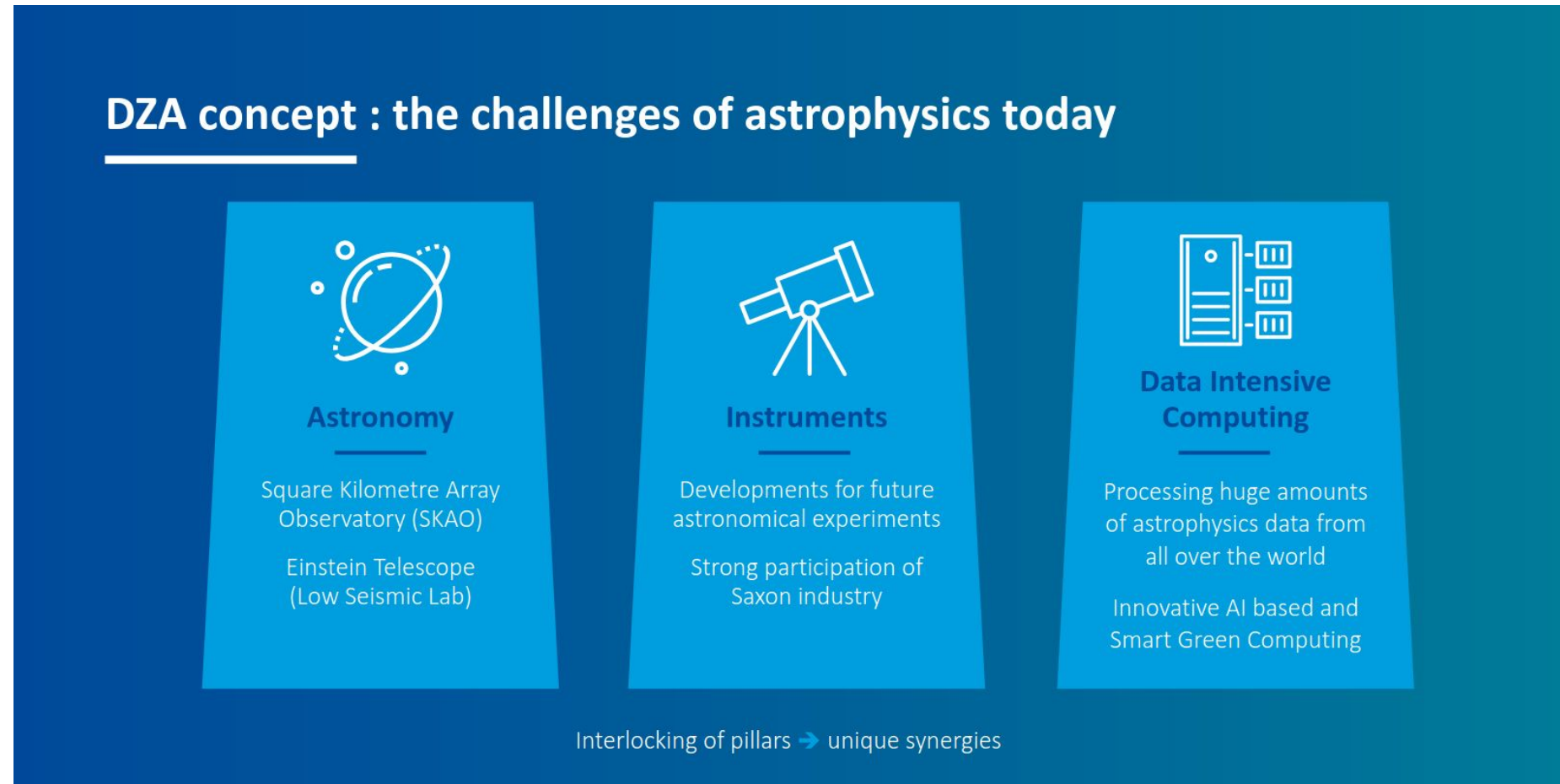
Approximately **EUR 1.1 billion in funding** from the Federal Ministry of Research, Technology and Space until 2038

Founding director: Prof. Dr. Günther Hasinger.



The German Center for Astrophysics (DZA)

Addressing challenges in modern astrophysics from very different angles



Slide: M. Heurs / DZA

https://indico.ego-gw.it/event/562/contributions/4900/attachments/2826/4963/ET_Symposium_DZA_Heurs_110523_PDF_version.pdf

The German Center for Astrophysics (DZA)

Unique geological conditions in Lusetia: a **possible location for the Einstein Telescope** for gravitational waves.

Plans for ~200 meter underground **“low seismic laboratory”**.

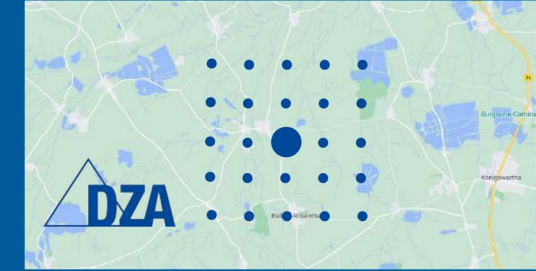
Potential for underground accelerator explored as part of the current phase.

The Low Seismic Lab

Innovation platform of approx. $(40 \times 30 \times 30) \text{ m}^3$ size at 200 m depth in Lusatia granite with square-kilometer 3D seismometer sensor array
→ Metrological validation of advanced full-scale seismic isolation concepts

THE LOCATION FOR FUTURE “DEEP TECH”:

- Technology development for gravitational wave astronomy
- Adaptive seismic noise cancellation
- Sub-nanometer microscopy and photolithography
- Quantum computing experiments
- Accelerator-based astrophysics



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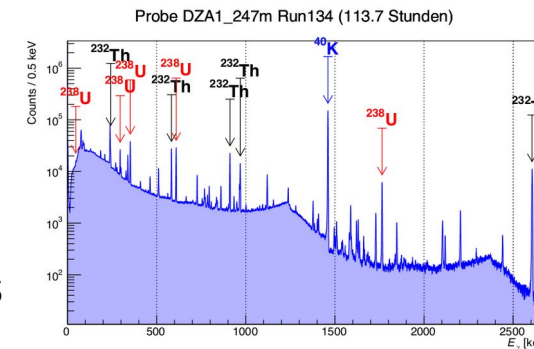
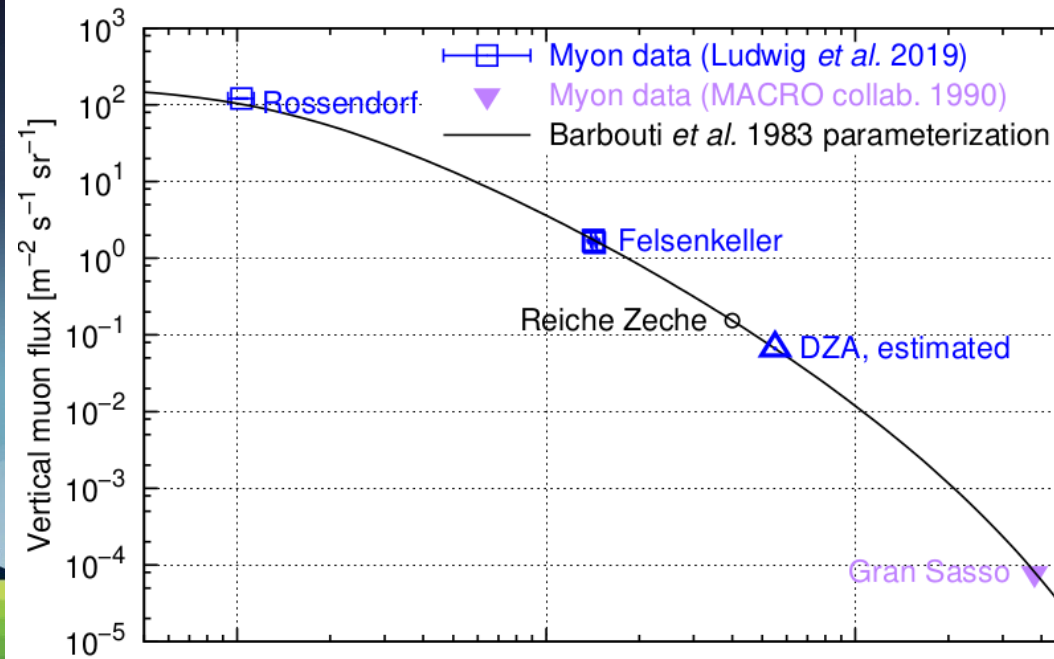
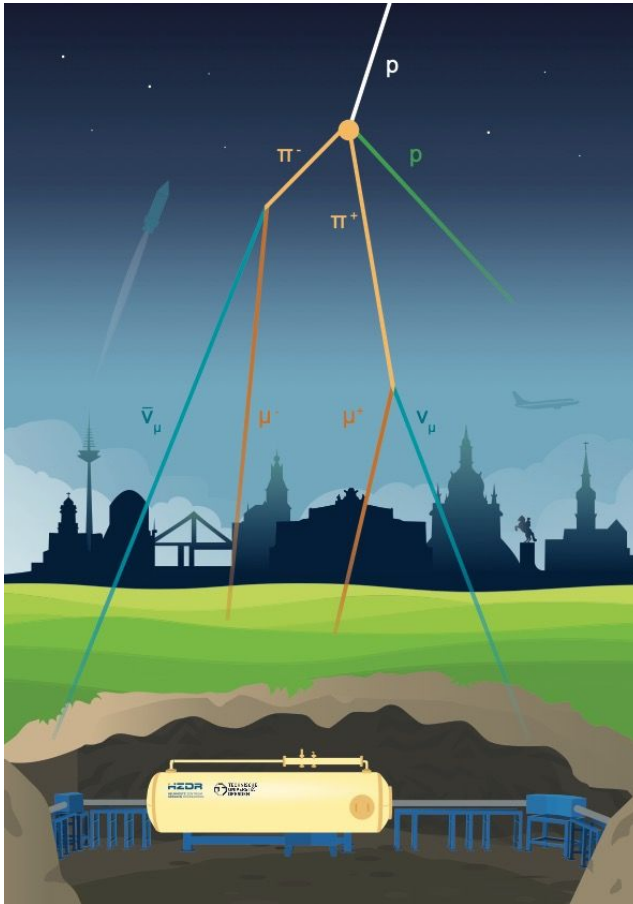
WFA Seminar Wrocław 07.10.2022



Slide: D. Blaschke, G. Hasinger / DZA

http://www.ift.uni.wroc.pl/files/seminars/WFA_Seminar_071022_compressed.pdf

The German Center for Astrophysics (DZA)



Gamma-spectroscopy of drill cores with TU1

Cooperation between HZDR and DZA on requirements / plans for an underground accelerator laboratory.

Summary

Felsenkeller is a **shallow-underground (145 m.w.e) accelerator laboratory** for nuclear astrophysics, with a 5MV accelerator + SNICS and RF ion source.

Solid and jet/extended gas target setups available. Proton, helium and carbon beams successfully used.

First beam 2019. First cross section data being published. **Many more under analysis / preparation. Stay tuned!**

Collaborations with groups underground and on surface. Laboratory is **open to user experiment proposals** (via a Scientific Advisory Board).

The new **German Center for Astrophysics (DZA)** in Lusetia will open exciting opportunities for astrophysics, including an underground low-seismic laboratory.



Acknowledgment



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