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

Local Highlights: Felsenkeller Laboratory

ChETEC-INFRA General Assembly, Dresden, September 18, 2025

Konrad Schmidt, Helmholtz-Zentrum Dresden-Rossendorf, konrad.schmidt@hzdr.de, chetec-infra.eu

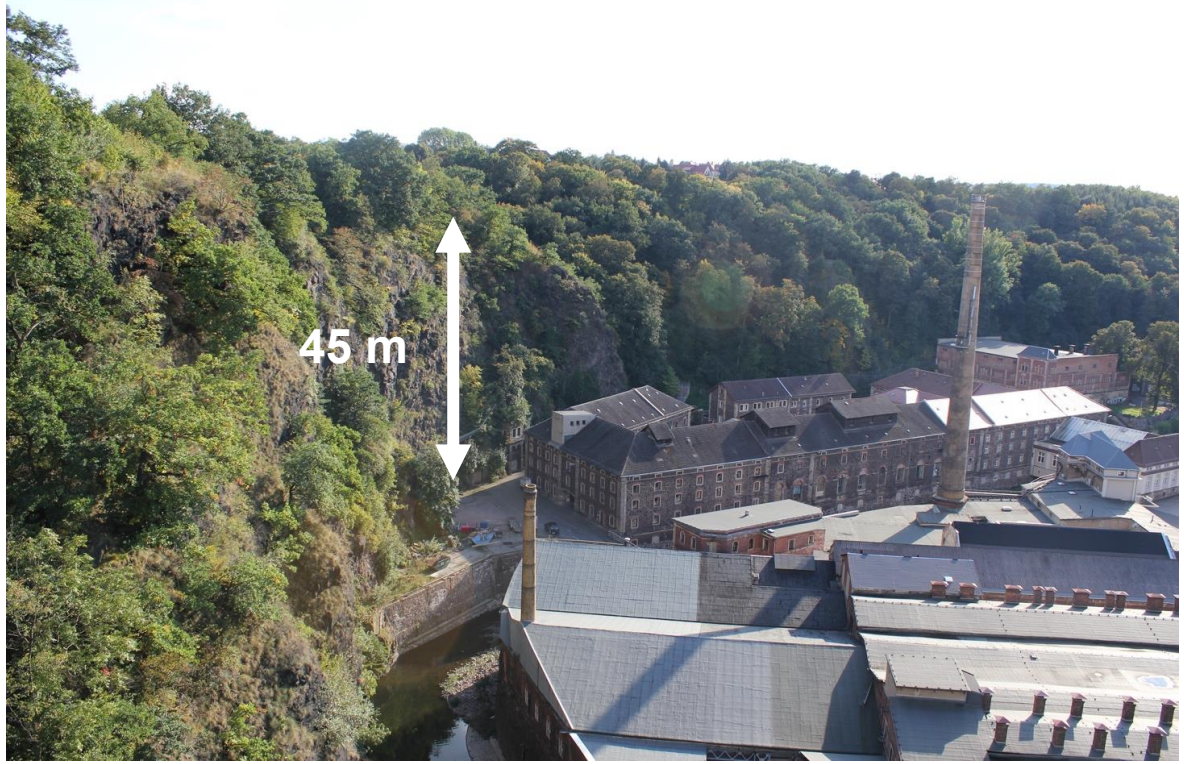
Dresden Felsenkeller underground lab, below 45 m of rock

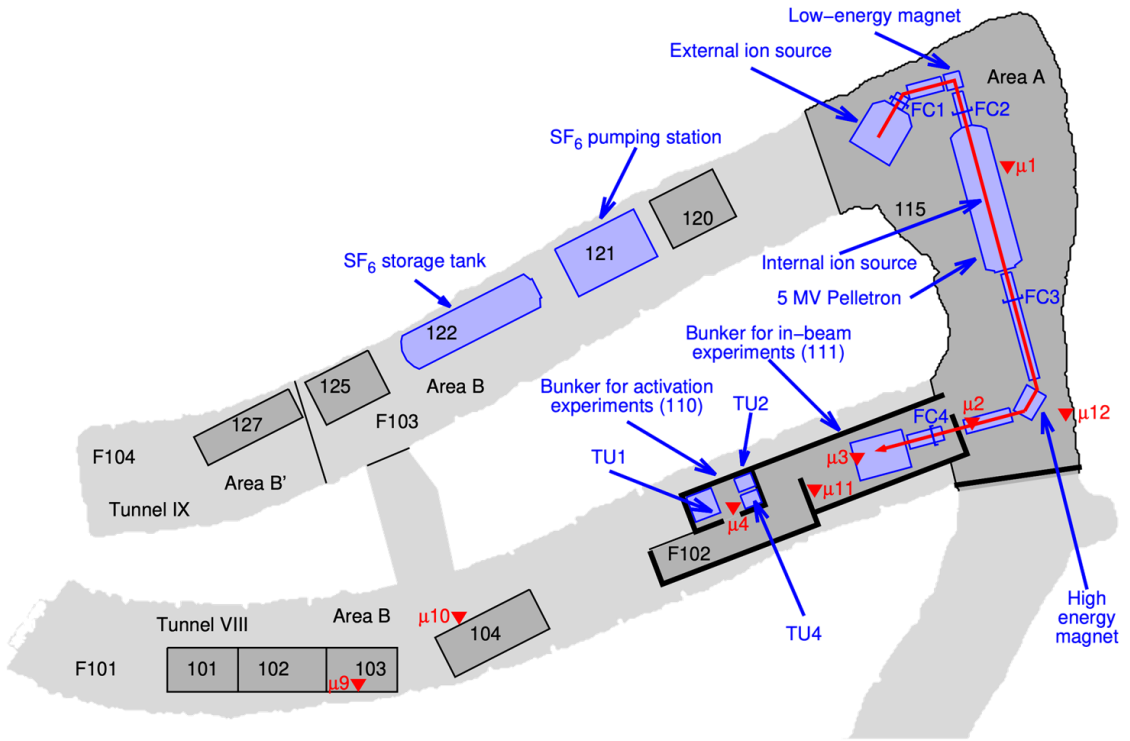
Joint effort HZDR – TU Dresden

- Investment by TU Dresden (Kai Zuber *et al.*) and HZDR (Daniel Bemmerer *et al.*)
- Day to day operations by HZDR

Two main instruments

- **HZDR:** 5 MV Pelletron, 30 µA beams of $^{1}H^{+}$, $^{4}He^{+}$, $^{12}C^{+}$, ...
- **TU Dresden:** 163% ultra-low-background HPGe detector for offline radioactivity measurements

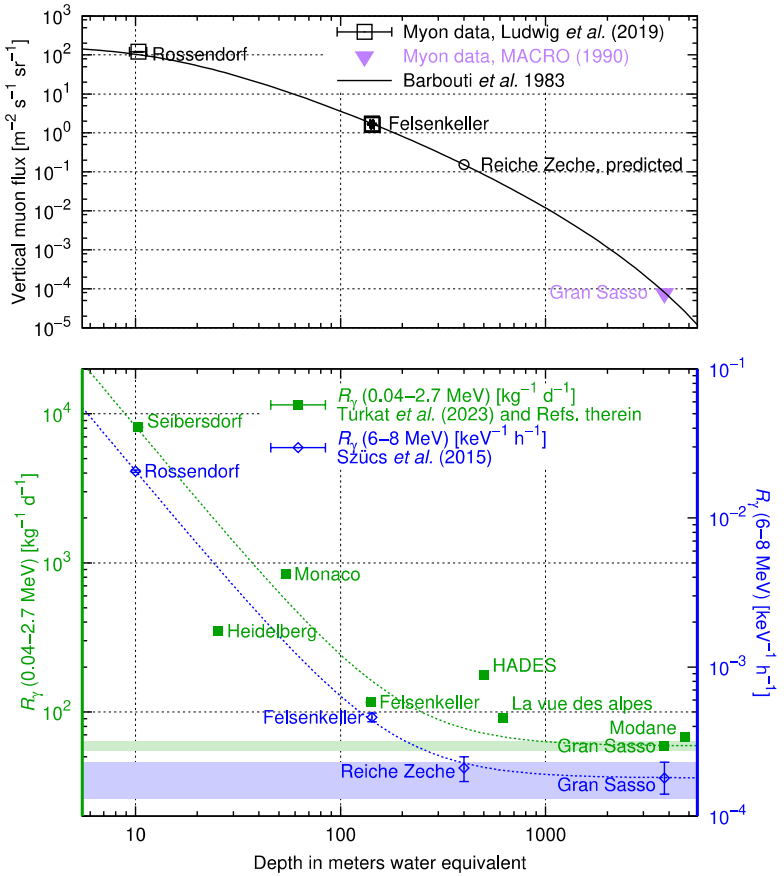




Felsenkeller: Studying low cross sections with low background

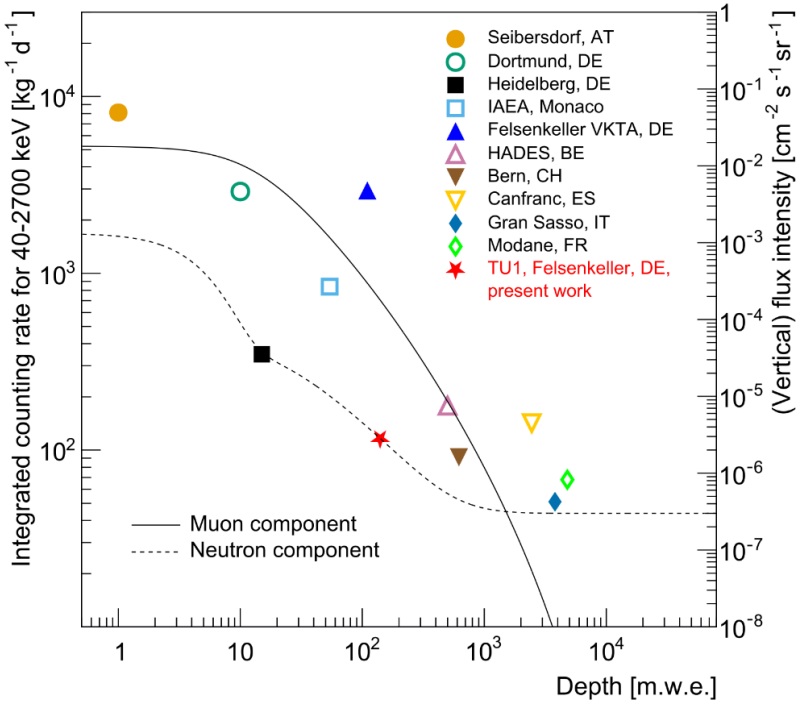
40× lower muon background

Astropart. Phys. 112, 24 (2019)



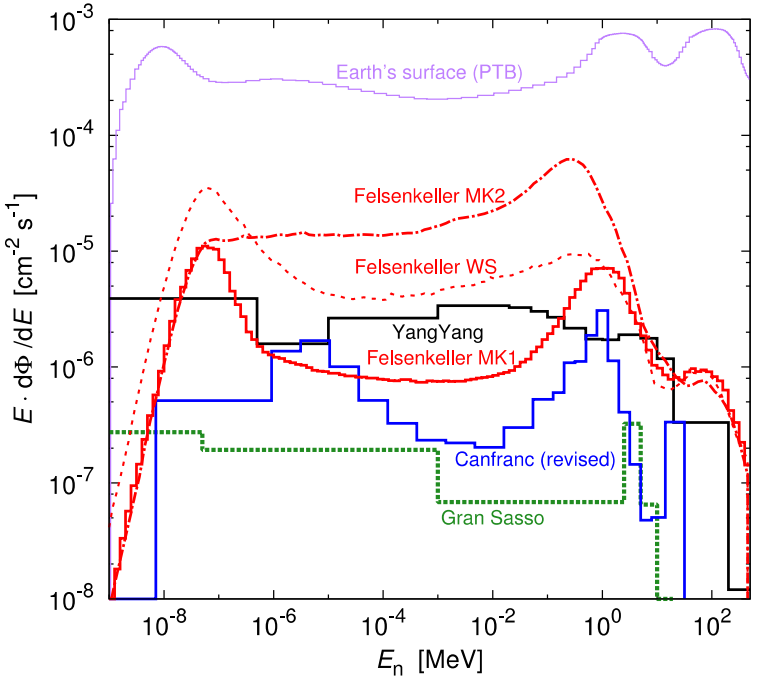
100× lower γ-background

Eur. Phys. J. A 51, 33 (2015)
Astropart. Phys. 148, 102816 (2023)
Eur. Phys. J. A 61, 19 (2025)



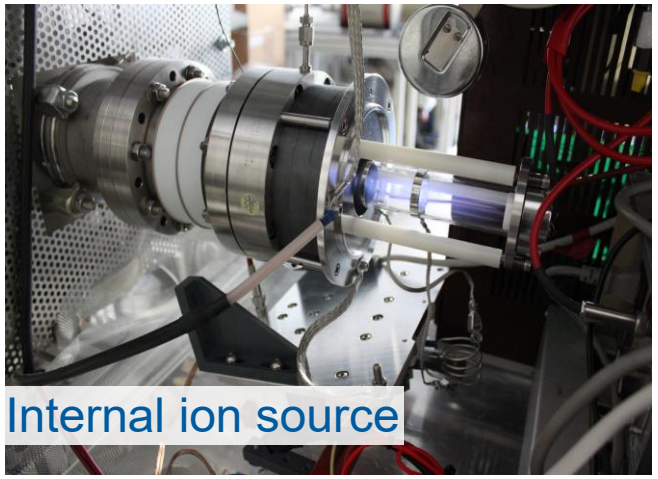
200× lower neutron background

Phys. Rev. D 101, 123027 (2020)



Felsenkeller 5 MV underground ion accelerator


Accelerator


Internal ion source


External ion source

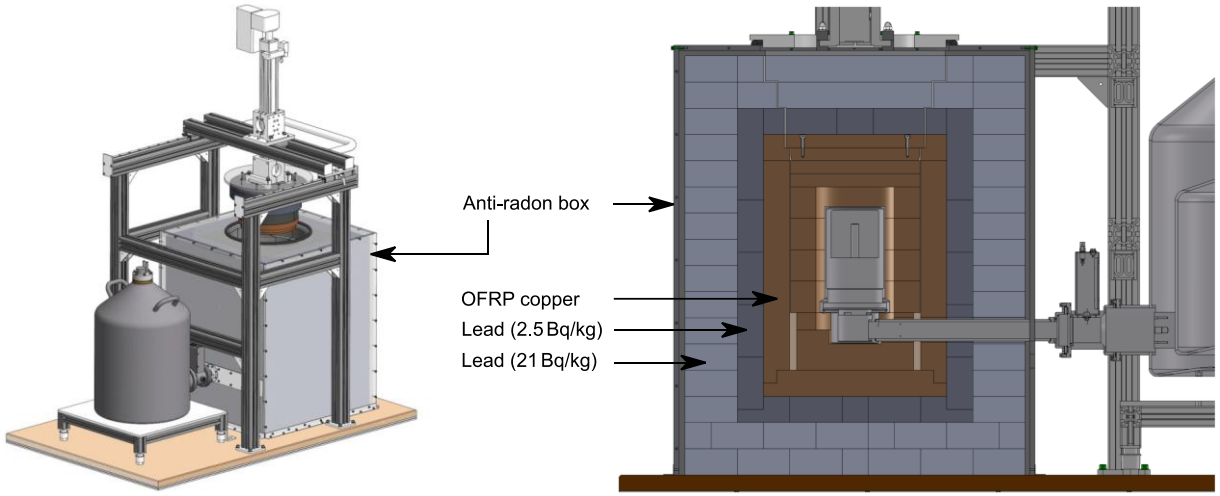

Irradiation station with 20+ HPGe crystals

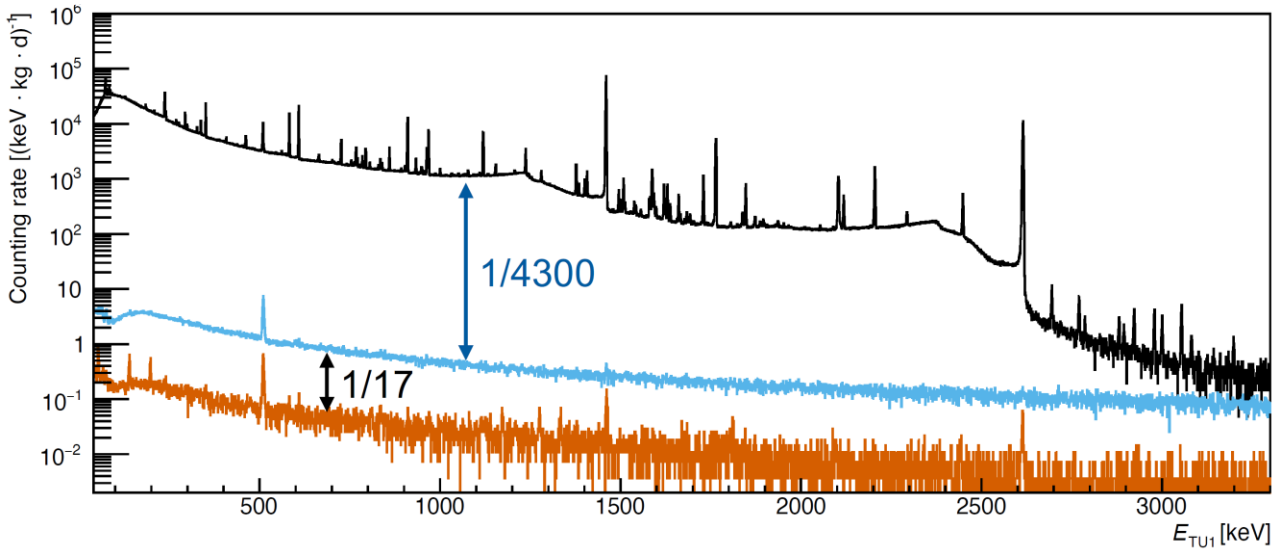
5 MV accelerator (0.4-3.8 MV), two alternative ion sources

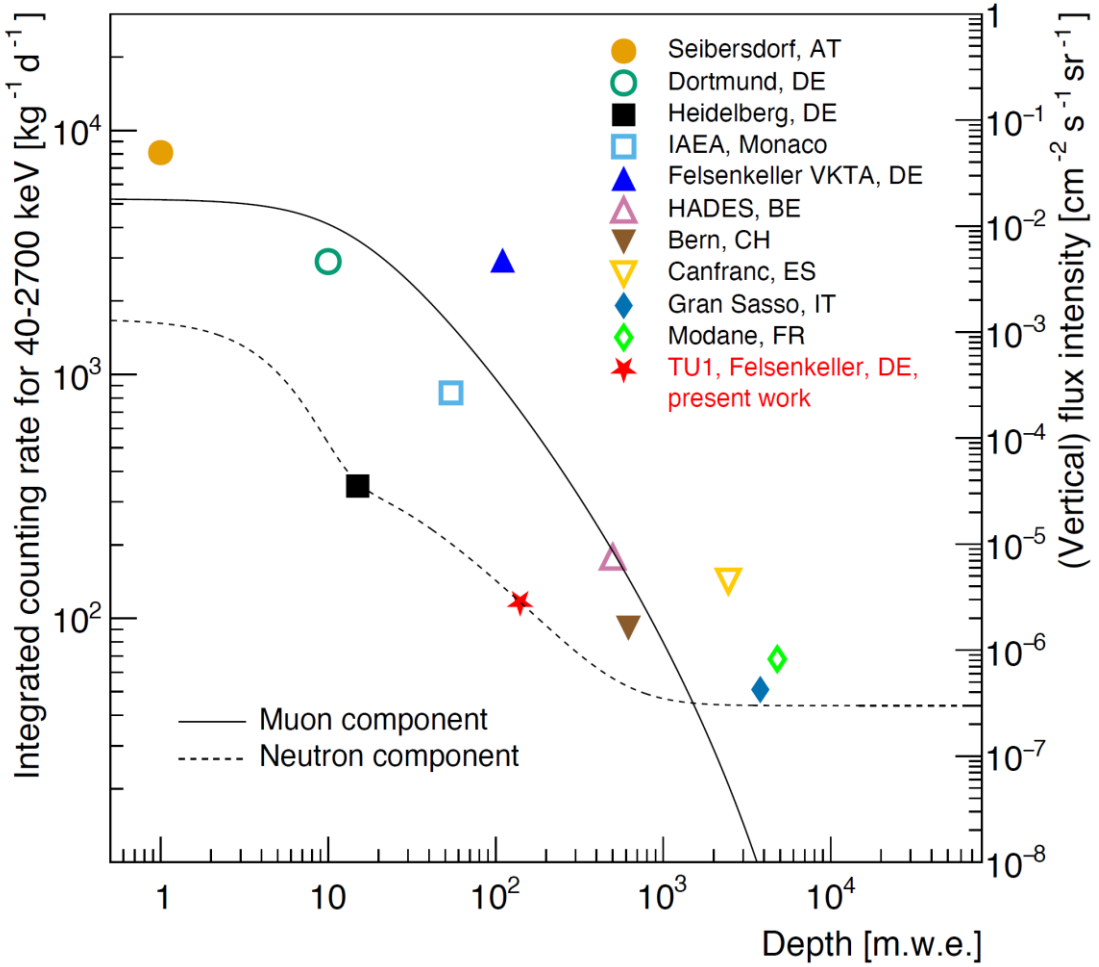
- Internal RF ion source: 30 µA ^{1}H, ^{4}He
- SNICS sputter ion source: 30 µA ^{12}C, …

- 24 hour operation permitted even without operator
- Personnel is allowed at target while beam is on
- Control and counting rooms at surface
- EU-supported transnational access available

Germany‘s most sensitive radioactivity measurement setup “TU1”

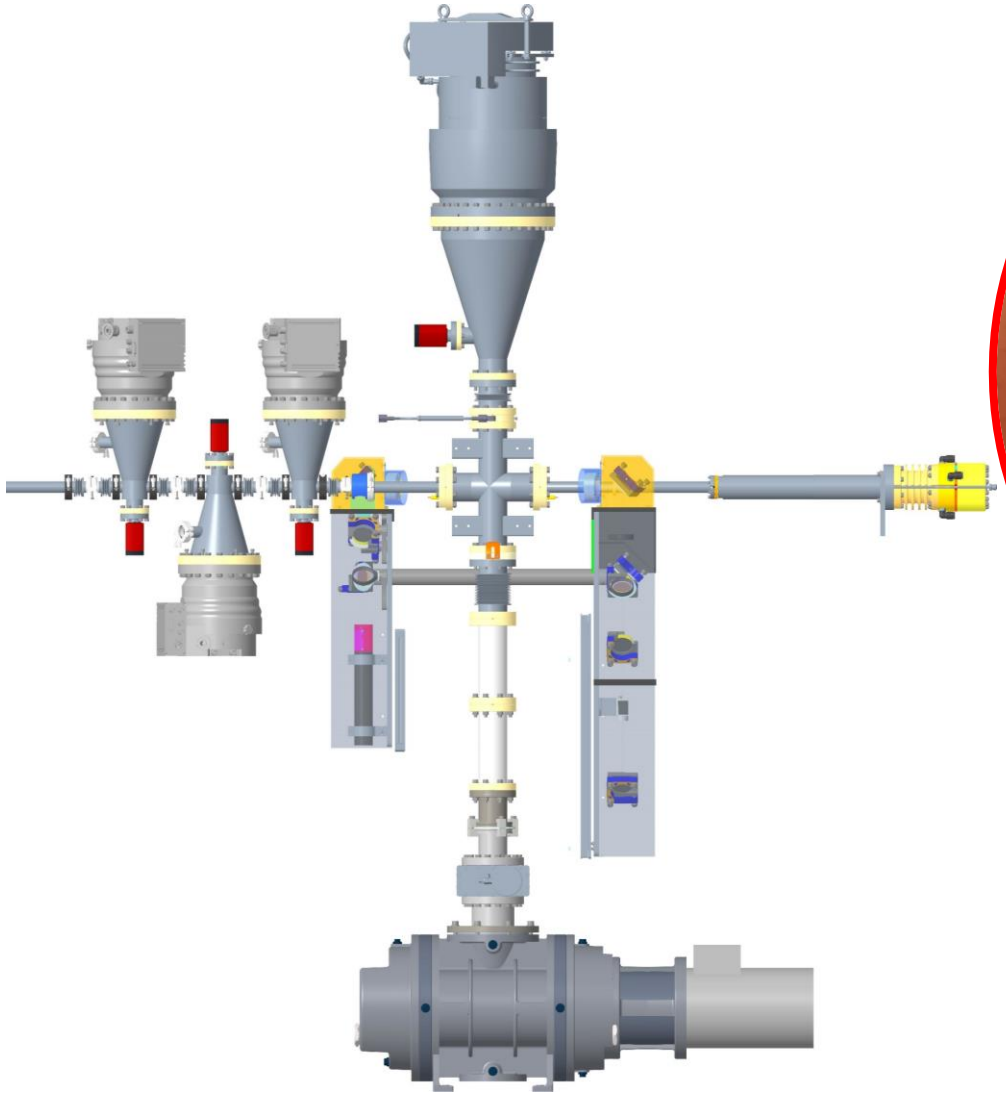


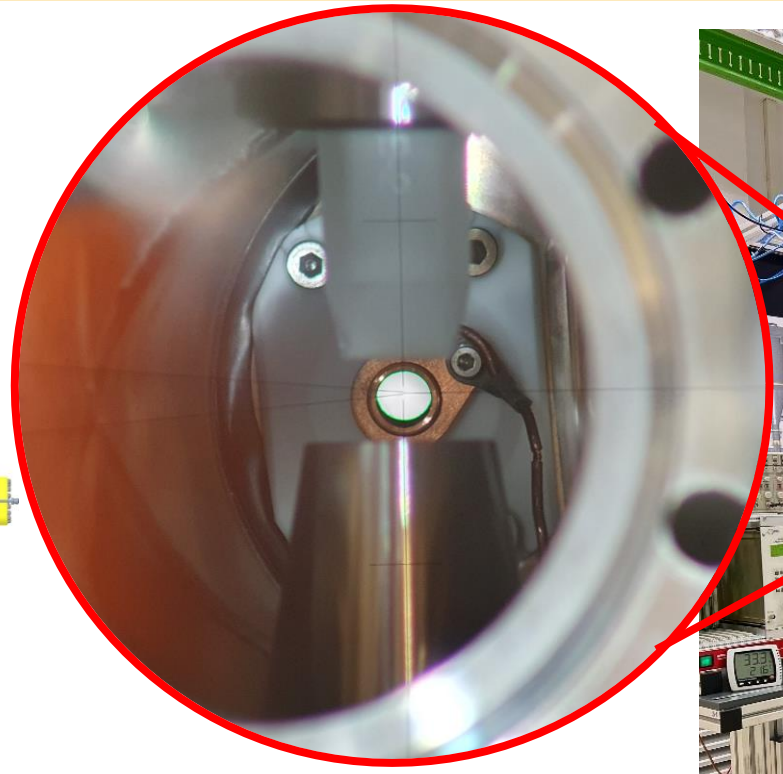




Steffen Turkat, Kai Zuber *et al.*, Astropart. Phys. 148 (2023) 102816

New Felsenkeller gas target setup operational in jet or static mode

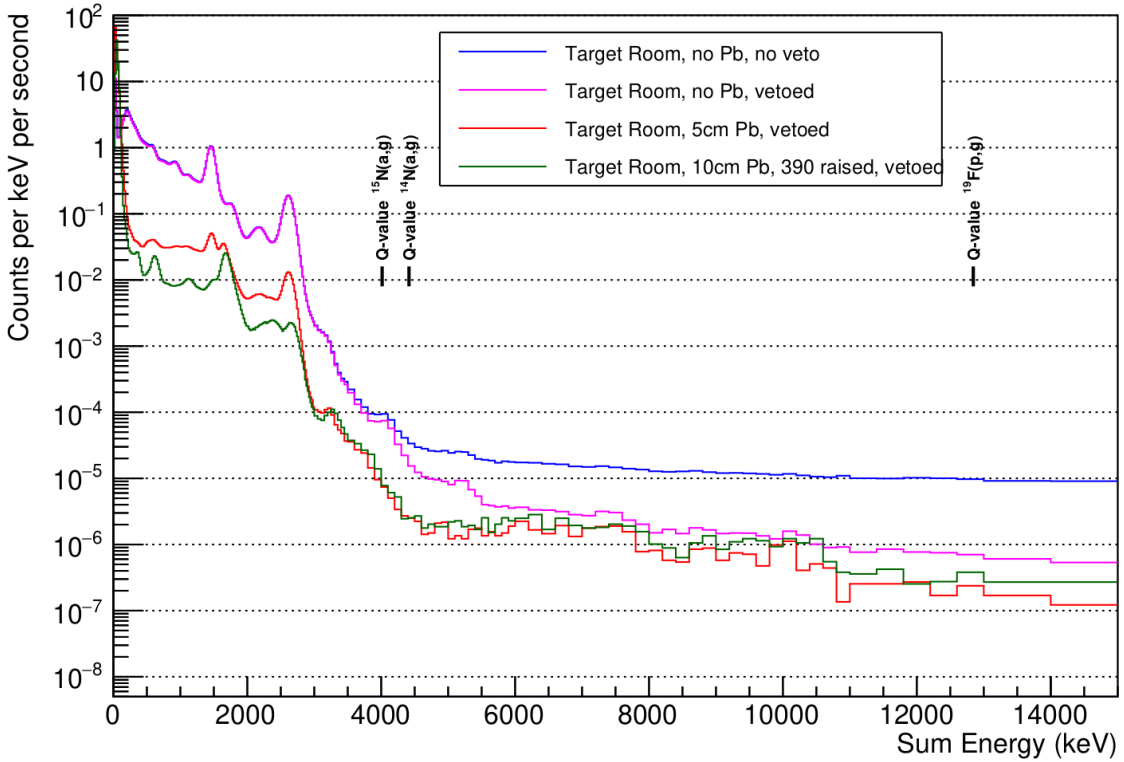


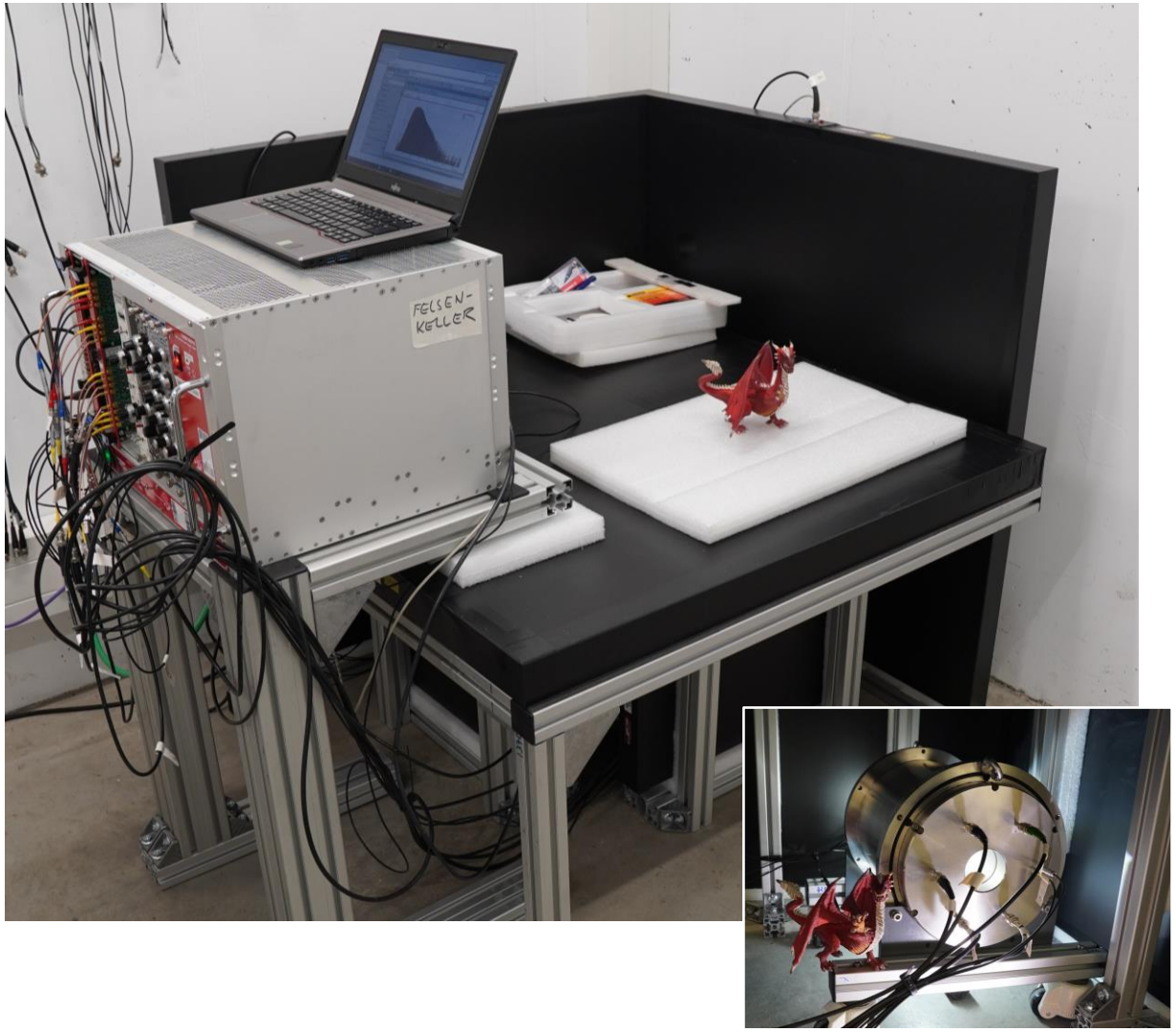


See talk by Anup Yadav

New 4π Summing Detector at Felsenkeller – FelICITAS

- High-Efficiency Summing Detector: 28 x 7cm BGO. Scionix: 6x2-fold segmentation, SiPM readout
- Delivered January 2025. Commissioning and background measurements.
- First experiment on $^{15}N(\alpha,\gamma)^{19}F$ finished this summer

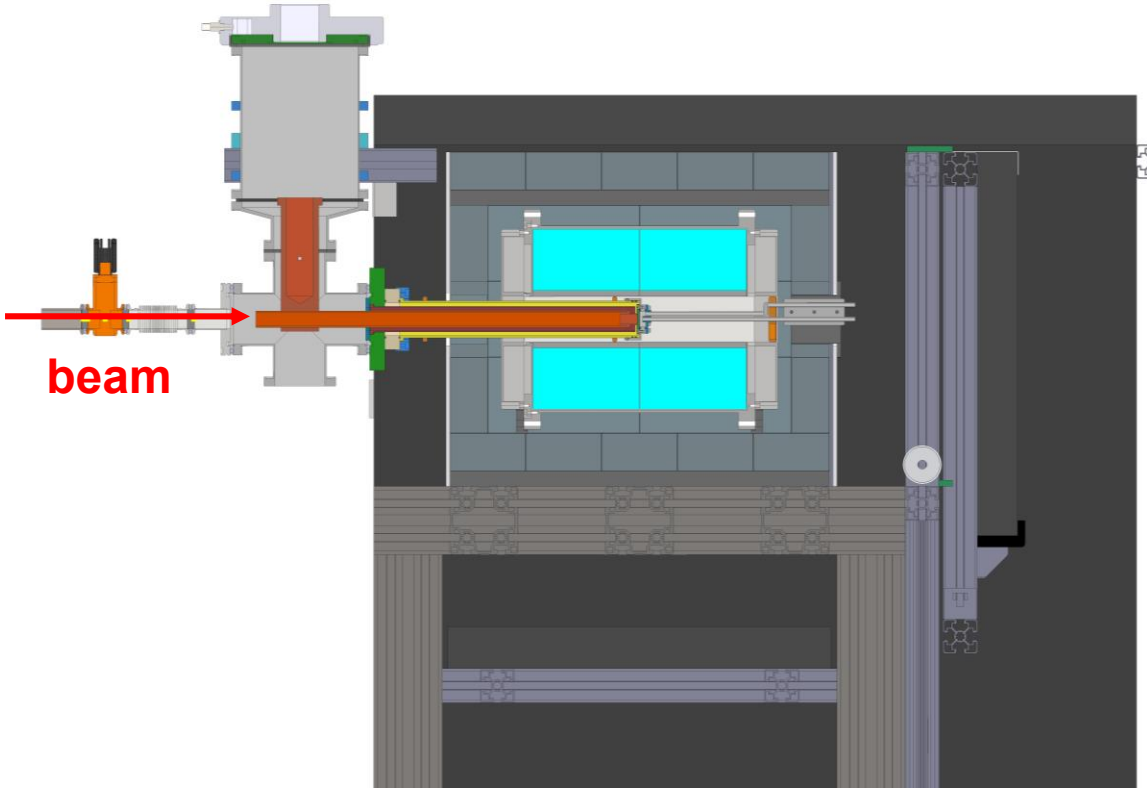


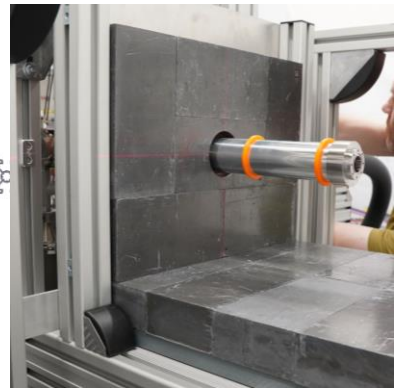


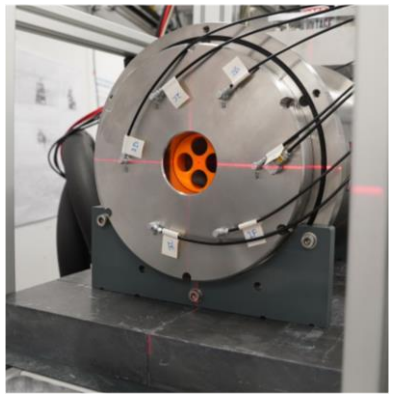
New 4π Summing Detector at Felsenkeller – FelICITAS

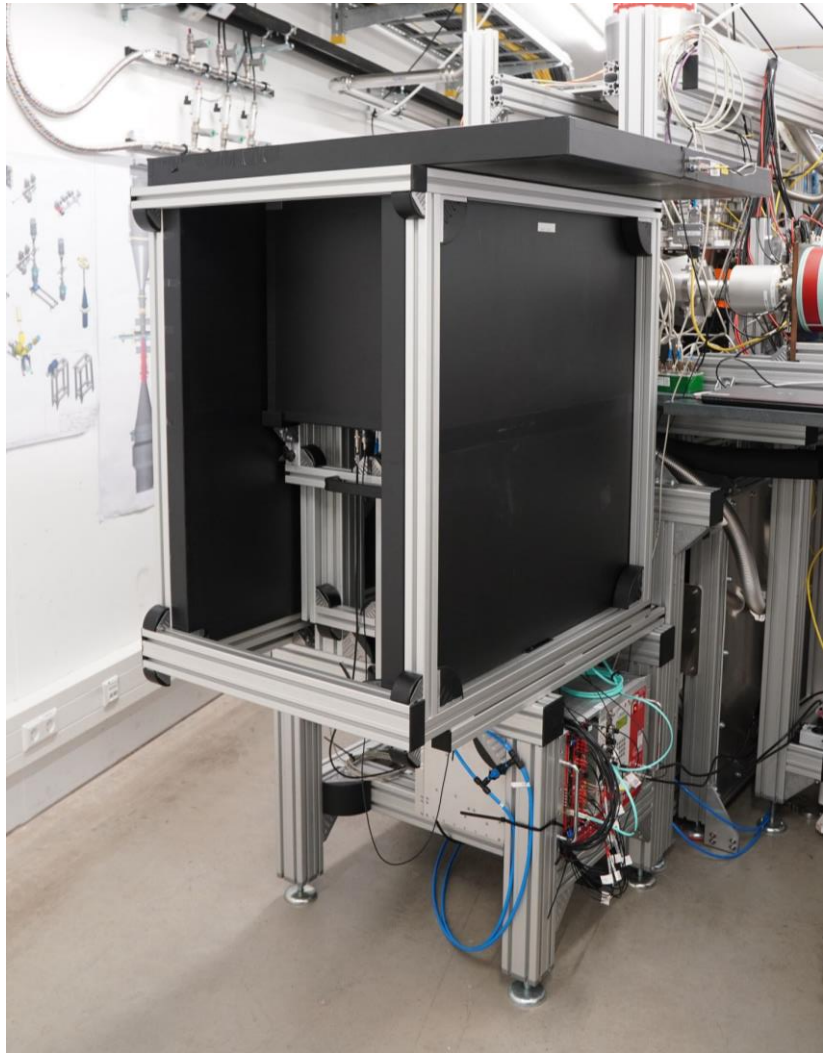
First **T**otal **A**bsorption **S**pectroscopy solid target setup at Felsenkeller

FelICITAS + 5cm of Pb shielding + 5 veto panels









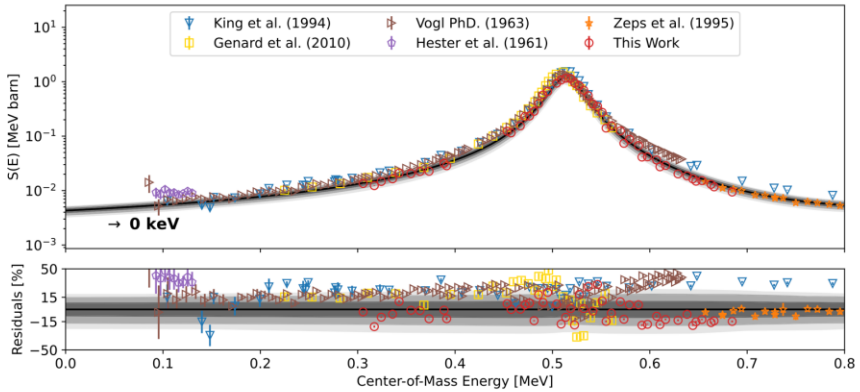
Science cases studied within ChETEC-INFRA TA (1)

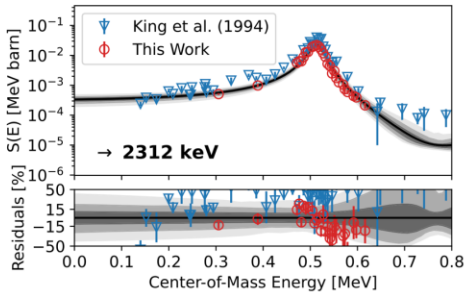
CNO cycle hydrogen burning

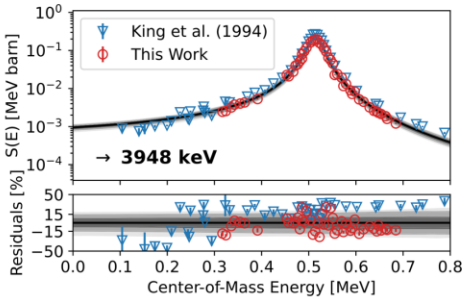
- $^{12}C(p,\gamma)^{13}N$ – Felsenkeller data published in
  J. Skowronski et al., Phys. Rev. C 107, L062801 (2023)
- $^{13}C(p,\gamma)^{14}N$ – Felsenkeller data published in
  J. Skowronski et al., Phys. Rev. C 111, 064611 (2025)

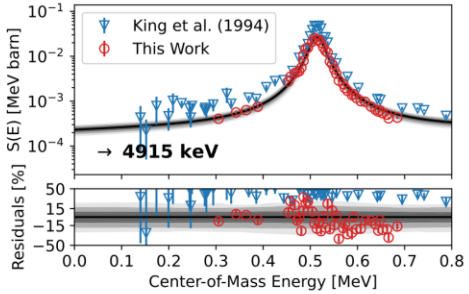
Relevance:

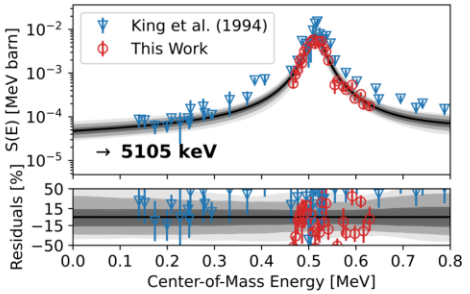
- ^{12}C / ^{13}C isotopic ratio
- Amount of ^{13}C available for the $^{13}C(\alpha,n)^{16}O$ s-process neutron source
- Radial profile of ^{13}N neutrino emission in the sun

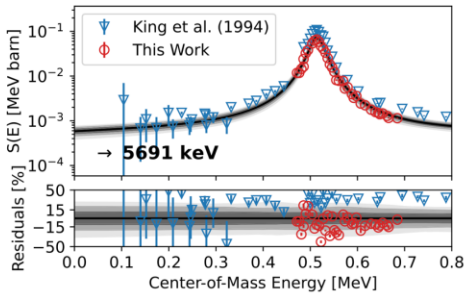


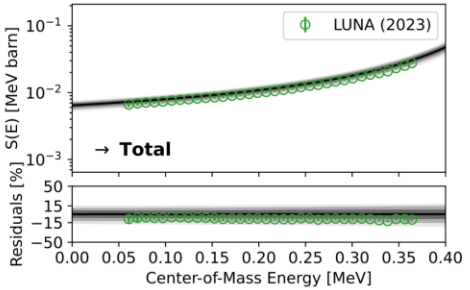












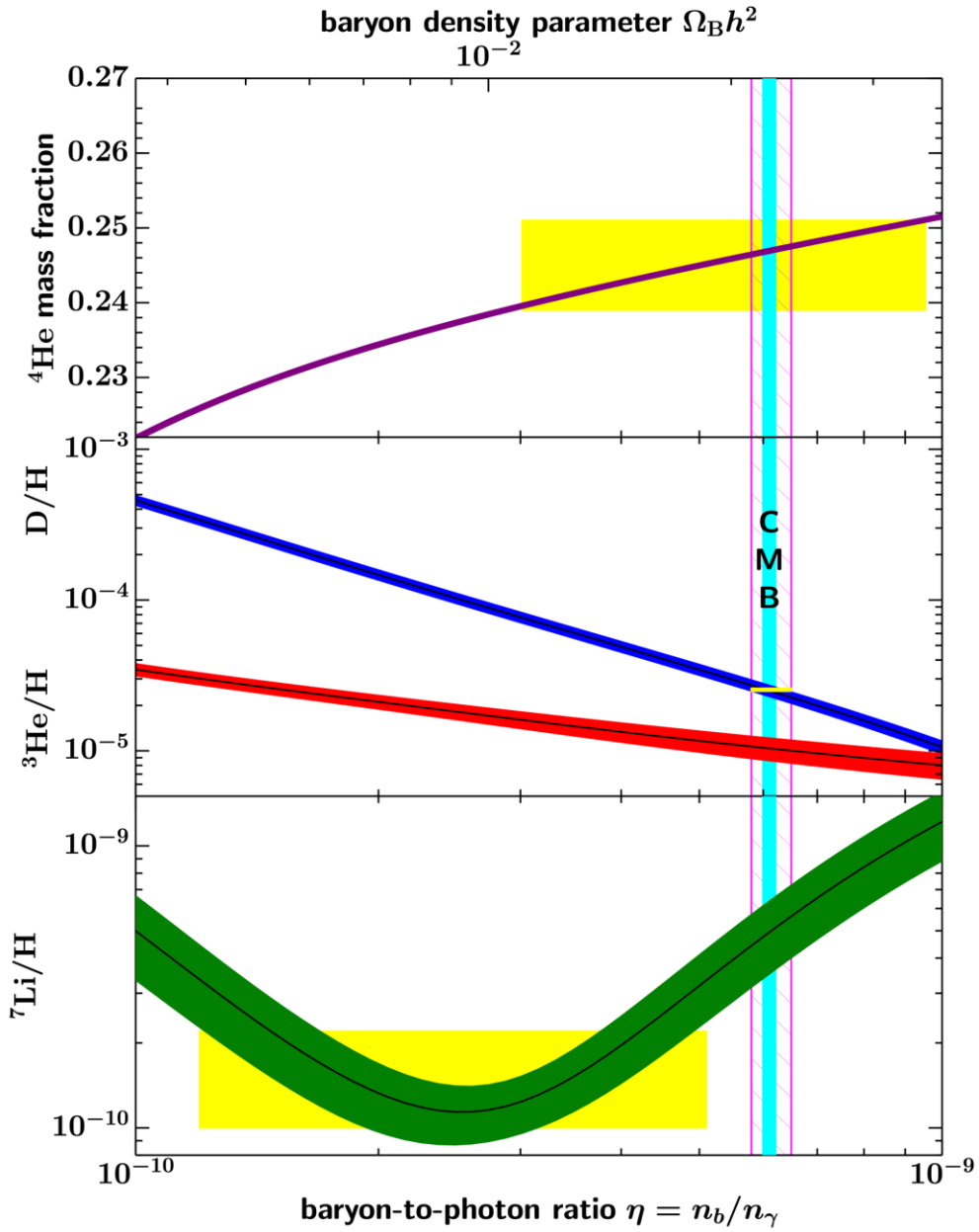
Konrad Schmidt, Helmholtz-Zentrum Dresden-Rossendorf, konrad.

Science cases studied within ChETEC-INFRA TA (2)

Big Bang nucleosynthesis

- $^{3}He(\alpha,\gamma)^{7}Be$ – measurement of the γ-ray angular distribution, analysis in collaboration with Ken Nollett (San Diego) and Xilin Zhang (MSU)
  - PhD thesis Steffen Turkat (2023)
  - PhD thesis by Peter Hempel (ongoing)
  - Paper draft is in the works
  - New measurements planned with gas target when gas recirculation will be available

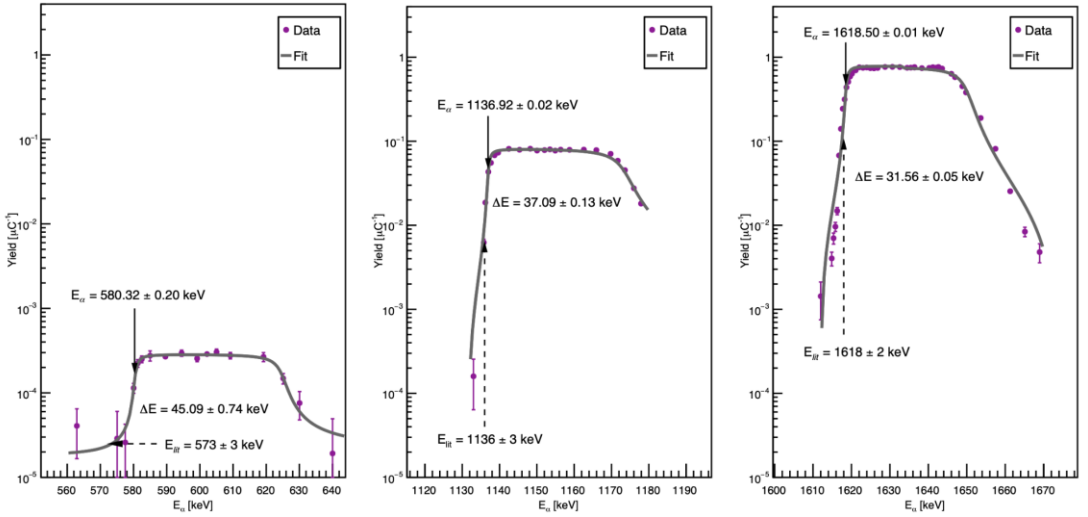
- $^{2}H(p,\gamma)^{3}He$ – measurement of the cross section and of the γ-ray angular distribution
  - Master Thesis by Maria Lukyanova (ongoing)
  - publication planned for late 2025



Science cases studied within ChETEC-INFRA TA (3)

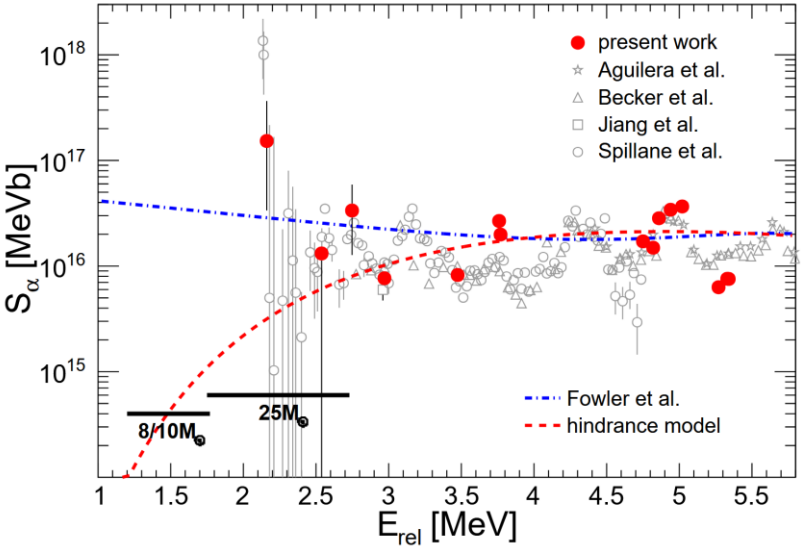
Helium burning

- $^{14}N(\alpha,\gamma)^{18}F$ – experiment with jet gas target and 14 HPGe detectors (April – June 2025)
  - **See talk by Anup Yadav** (PhD thesis)
  - Nucl. Inst. Meth. A paper submitted
  - Physics paper planned for late 2025
- $^{15}N(\alpha,\gamma)^{19}F$ – experiment with solid target and new **FeICITAS** 4π BGO detector (June - July 2025)



Carbon burning

- Target tests for $^{12}C+^{12}C$ campaign at LNGS Gran Sasso
  - Master thesis Annika Willer (2024)
- Long-term collaboration with STELLA group Strasbourg (Prof. Sandrine Courtin)
  - first experiment August-September 2024
  - Follow-up beam time September-October (now)
  - **See talk by Marcel Heine**



Scientific outlook

Solar fusion and hydrogen burning

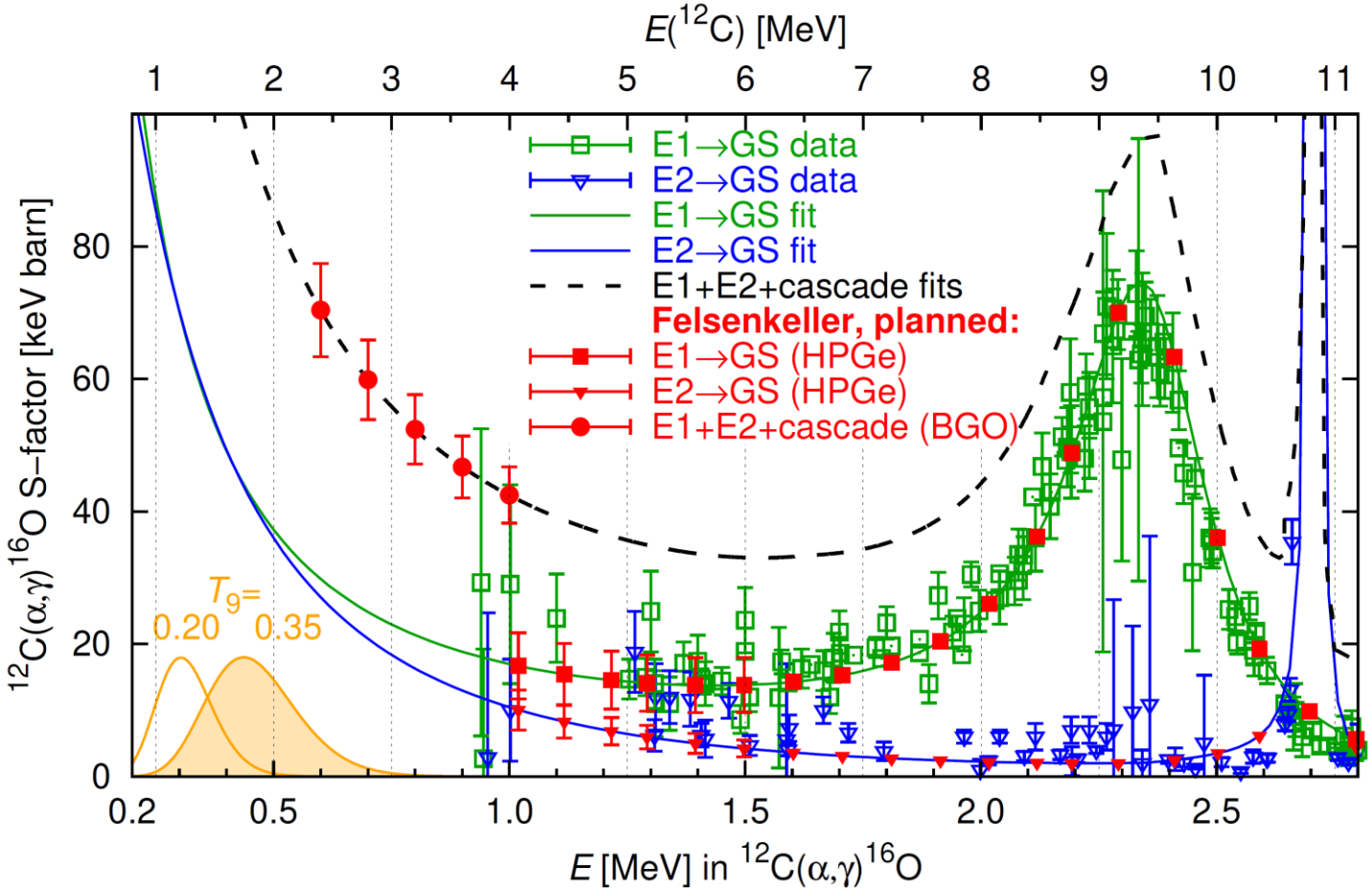
- $^{3}He(\alpha,\gamma)^{7}Be$ – with recirculating gas target
- $^{14}N(p,\gamma)^{15}O$ – over a wide energy range
- $^{19}F(p,\gamma)^{20}Ne$ – with new **FelICITAS** detector

Helium burning

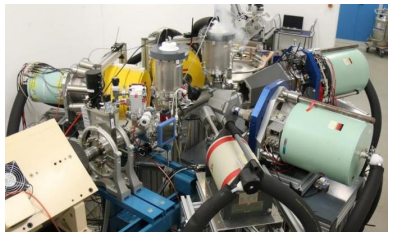
- $^{18}O(\alpha,\gamma)^{22}Ne$ – with solid target or ^{4}He target
- $^{12}C(\alpha,\gamma)^{16}O$ – in direct and in inverse kinematics, with HPGe and with **FelICITAS** detector

Carbon burning (collaboration with STELLA Strasbourg)

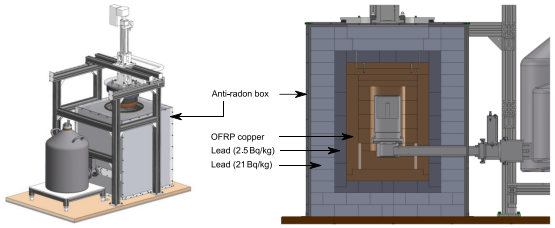
- Ongoing experiment
  - Focus on particle spectroscopy
  - Test York $LaBr_3$ array



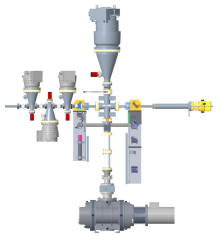
Summary



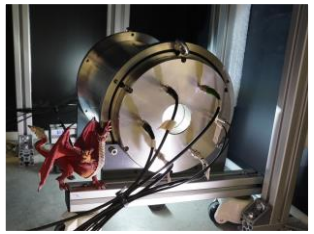
Felsenkeller demonstrated its capabilities with various experiments



Smallest activities, e.g., of irradiated samples can be analyzed with ultra-low background counting setup



Gas target enables long scale measurements without target degradation and beam-induced background



FelICITAS will enable measurements of even lower cross sections