



ChETEC-INFRA - SNAQs

Measurement of the ³He(α , γ)⁷Be γ -ray angular distribution at the Felsenkeller shallow underground facility

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The Felsenkeller shallow underground laboratory

 \rightarrow A new underground lab for nuclear astrophysics



The ³He(α , γ)⁷Be reaction

 \rightarrow Investigating the BBN and solar fusion processes



Current campaign at Felsenkeller

 \rightarrow Setup, analysis and first results







The Felsenkeller shallow underground laboratory

- Located in Dresden/Germany
- Advantage: Proximity to city center and university
- 45m rock overburden (140m.w.e.)



Source: Google Earth



Source: Google Earth



https://stadtplan.dresden.de/





The Felsenkeller shallow underground laboratory



- External ion source
 - \rightarrow E.g. intense carbon beam (¹²C⁻)
- > 5MV Pelletron accelerator

➢ Interal ion source

 → H & He beam in single end mode

➢ Current experimental setup

 \rightarrow ³He(α,γ)⁷Be campaign







The S factor of the ³He(α , γ)⁷Be reaction since 2000







The ³He(α,γ)⁷Be reaction

Motivation

- Big Bang nucleosynthesis & stellar hydrogen burning
- Affects ⁷Be and ⁸B neutrino flux
- Affects abundance of primordial ⁷Li

Aim

- Connect LUNA data to others
- First measurement of angular distribution







Experimental campaign at Felsenkeller

- Targets: ³He in tantalum backing (~180 nm)
- Current energy: $E_{cm} = 807 \text{ keV}$
- \blacktriangleright Current on target: ~ 5 μ A







The ³He(α,γ)⁷Be reaction at Felsenkeller



Approach 1: Measuring the prompt γ -rays

- Inbeam measurement with 21 HPGe detectors
- Angular distribution for direct capture to ⁷Be
 - \rightarrow Search for both γ_0 and γ_1





Approach 2: Activation analysis of ⁷Be ($T_{1/2} = 53.22 \text{ d}$)

- Measurement on new underground counting setup
- Calculate activity of ⁷Be at end of irradiation





Approach 1: Measuring the prompt γ -rays

Highly preliminary data set

- Figure shows the summed data for one crystal (+ ACS)
- Currently only comparison to lab background
- Campaign on irradiation of backing still undergoing





Measurement of the ³**He** (α,γ) ⁷**Be** γ **-ray angular distribution** Schools on Nuclear Astophysics Questions - 13.10.2021 Steffen Turkat



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Approach 2: Activation analysis of ⁷Be

New counting setup at Felsenkeller

- HPGe with 163% relative efficiency
- Passive shielding:
 - \rightarrow 45 m rock (140 m.w.e.)
 - \rightarrow 40 cm low active concrete
 - \rightarrow N₂ flushed box
 - \rightarrow 15 cm Pb + 10 cm Cu
- Active shielding:
 - \rightarrow Five scintillation panels











Approach 2: Activation analysis of 7Be

Offline analysis of irradiated sample

- \succ t_{irr} ~ 1.6 d & t_{meas} ~ 5 d
- @800keV: t_{irr} of 20 min would've been sufficient for act. analysis
- @200keV: t_{irr} of 1d is already sufficient for act. analysis











Summary & conclusion



The Felsenkeller shallow underground laboratory

- → New underground lab for nuclear astrophysics
- \rightarrow 5 MV pelletron + sophisticated counting facility



The ³He(α , γ)⁷Be reaction

- → Reaction currently under investigation at Felsenkeller
- \rightarrow Main focus on γ -ray angular distribution



Benefits of underground laboratories

- \rightarrow Minimize background rate for measuring rare processes
- \rightarrow Enable low energy campaign
- \rightarrow Significantly decreases valuable beam time





