





Ambient Neutron Background in the Felsenkeller Underground Laboratory Thomas Hensel, Marcel Grieger et al.

Moderation and Detection System

- ³He proportional counters with 10 bar pressure [1,2]
- 8 polyethylene blocks of varying size, one with a 5 mm lead liner as neutron multiplier

Neutron Capture

Thermalization via elastic scattering inside PE

• **Neutron capture** inside the ³He:

- $^{3}\text{He} + n \rightarrow ^{3}\text{H} + p + 764 \text{ keV}$
- Measureable discharge by avalanche-like ionization

Background Elimination

- Signal/Noise ratio can be improved by **Pulse shape discrimination**
- electronic noise supression by factor 100
- α background supression by 25



Observed Count Rates

Calculated Detector Responses

Deconvoluted Spectra







Measured neutron counting rates Felsenkeller, underground.

Neutron count rates depend on the **detector response** *R* and the **flux** Φ :

 $\dot{N}_i = \int R_i(E) \frac{d\Phi}{dE} dE$

Highly underdetermined problem: 8 data points for a detailed spectral solution with 400 bins

Detector responses calculated with FLUKA using isotropic incident neutrons (M. Grieger).

- Unfolding codes like MAXED [3] used to find reasonable solutions with a **guessed spectrum**
- Initial guess from detailed Monte Carlo simulations of Felsenkeller
- Different starting spectra yield similar **results** - total flux variations less than 3%

Neutron flux obtained using the MAXED [3] algorithm for deconvolution.

Location (shielding)	Total neutron flux [m ⁻² s ⁻¹]
Bunker for activation exp. (40 cm concrete)	0.61 ± 0.03
Tunnel VIII (no special shielding)	2.19 ± 0.15

Comparison of selected Underground Laboratories

Neutron flux suppression by a **factor of 200** in Felsenkeller relative to surface

Total flux comparable to YangYang (South Korea)



Felsenkeller

- **48 meters** of rock overburden
- **9** connected tunnels of **former brewery**



References:

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[3] M. Reginatto et al., "Spectrum unfolding, sensitivity analysis and propagation of uncertainties with the maximum entropy deconvolution code MAXED", Nucl. Instr. Meth. Phys. A 476(1–2):242 – 246, 2002

[4] H. Park et al., "Neutron spectrum at the underground laboratory for the ultra low background experiment", Applied Radiation and Isotopes 81 (2013) 302 – 306

[5] D. Jordan et al., "Measurement of the neutron background at the Canfranc Underground Laboratory LSC". Astroparticle Physics 42, 1-6 (2013)

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