Neutron Fluxes in Hall C @ LNGS

DS Material Meeting

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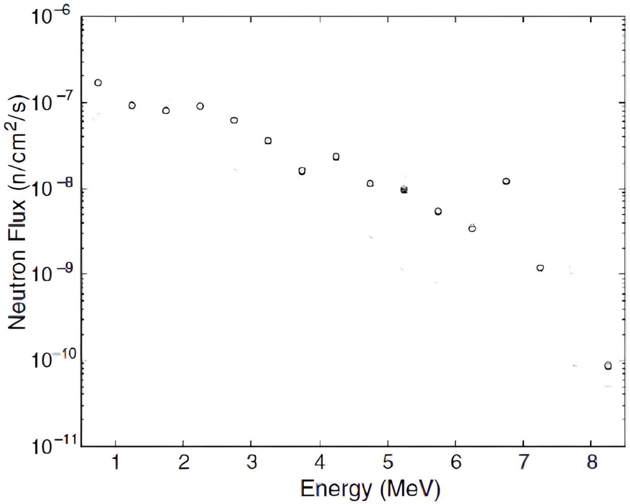
Neutron background from Hall C walls in DS-20k

Until now, the background in DS-20k caused by neutrons from the rock has always been calculated from the n flux estimated by Wulandari et al. :

- Hall C
  MC N-Particles Simulation
- Input neutron spectrum takes into account fission and (α,n) reactions
- Neutrons transported through the rock and concrete and scatter inside the halls
- Concrete with different humidity (dry, 8% of water in our case)



https://doi.org/10.1016/j.astropartphys.2004.07.005

Integrated flux in [0 - 10] MeV = 2.26 ± 0.49 · 10^{-6} n/cm2/s
Integrated flux in [0.5 - 10] MeV = 0.62 ± 0.13 · 10^{-6} n/cm2/s
Integrated flux in [1 - 10] MeV = 0.45 ± 0.13 · 10^{-6} n/cm2/s

(1.11 ± 0.05 ± 0.23) · 10^{-1} n in 10 y exposure (wo moderator)

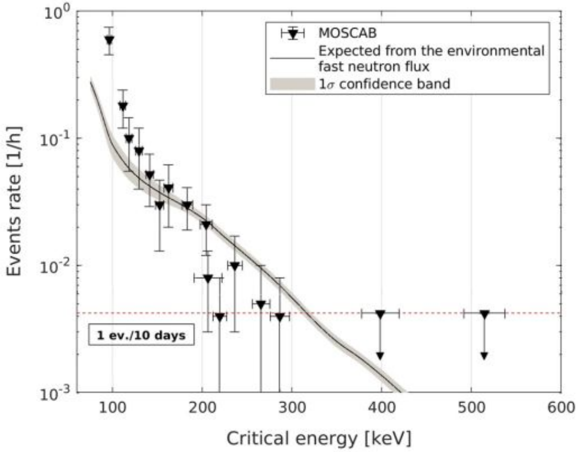
Input from measurements

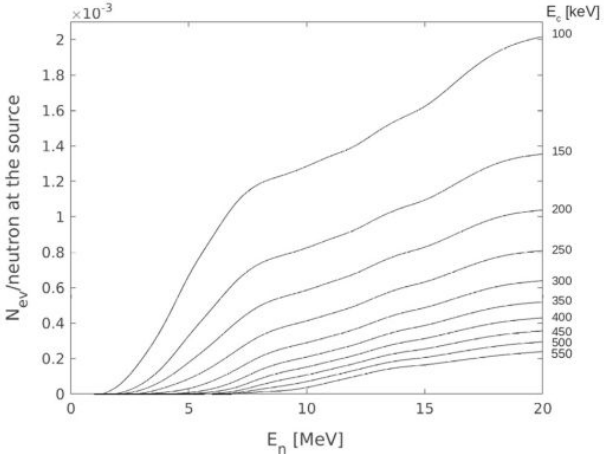
Bertoni et al., May 2023 (https://doi.org/10.1140/epjc/s10052-023-11522-x):

- MOSCAB (Materia OSCura A Bolle) bubble chamber (C_3F_8)
- Hall C (2018-2021)
- Sensitive to neutrons in [1, 20] MeV
- Flux obtained dividing rate by energy response of the detector

Integrated Flux in [1, 20] MeV= (0.38 ± 0.14) · 10^{-6} cm^{-2} s^{-1}

Compatible with Wulandari et al.



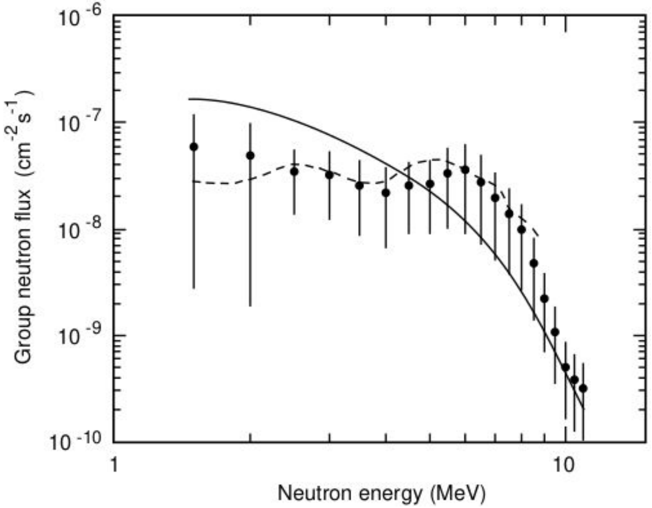


Input from measurements

Arneodo et al., 1999 (Il Nuovo Cimento):

- Hall C
- Proton recoil in an organic scintillator with a high hydrogen content

Energy interval (MeV)	Neutron flux (10^{-6} cm^{-2}s^{-1})	
	Ref. [3]	Present measurements
1.0– 2.5	0.38 ± 0.01	0.14 ± 0.12
2.5– 5.0	0.27 ± 0.14	0.13 ± 0.04
5.0–10.0	0.05 ± 0.01	0.15 ± 0.04
10.0–15.0	$(0.6 \pm 0.2) \times 10^{-3}$	$(0.4 \pm 0.4) \times 10^{-3}$



Flux in [1 - 10] MeV = $0.42 \pm 0.12 \cdot 10^{-6}$ n/cm2/s

Compatible with Wulandari et al.

Summary

Reference	Kind of Measurement	Location	Flux in [0, 10] MeV · 10^{-6} n/cm2/s	Flux in [1, 10] MeV · 10^{-6} n/cm2/s	Spectrum
Arneodo et al	Organic scintillator with high H content	Hall C	-	0.42 ± 0.12	Yes
Wulandari et al	Simulation	Hall C	2.26 ± 0.49	0.45 ± 0.13	Yes
Bertoni et al.	Bubble chamber (C_3F_8)	Hall C	-	0.38 ± 0.14	No

Conclusions

The measurements conducted so far in Hall C are consistent with the flux calculated by Wulandari et al. This confirms that the flux we have been using as input to calculate the external background in DS-20k is accurate and reliable.

The only difference lies in the energy range: Wulandari calculates the flux for energies <1 MeV, which are still important. We have seen from neutron simulations from the rock that the probability of
500 MeV neutrons contributing to the background
in DS-20k is non-zero

Initial energy of neutrons after cuts