deep underground neutron background measurements for DIANA

not so much about (α, n)

2013 AARM collaboration meeting

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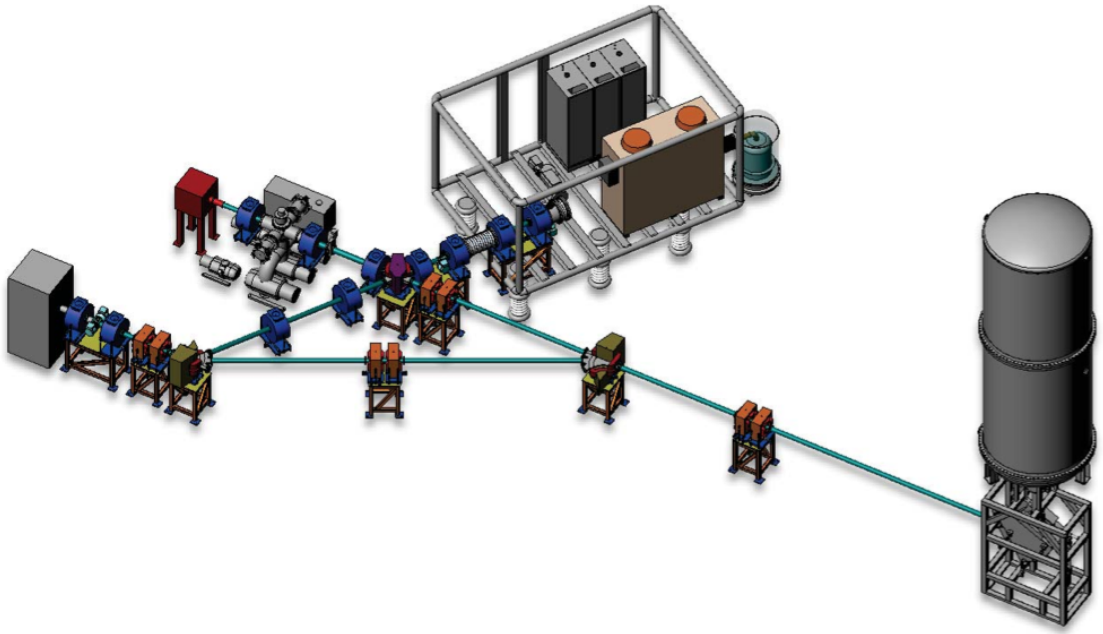
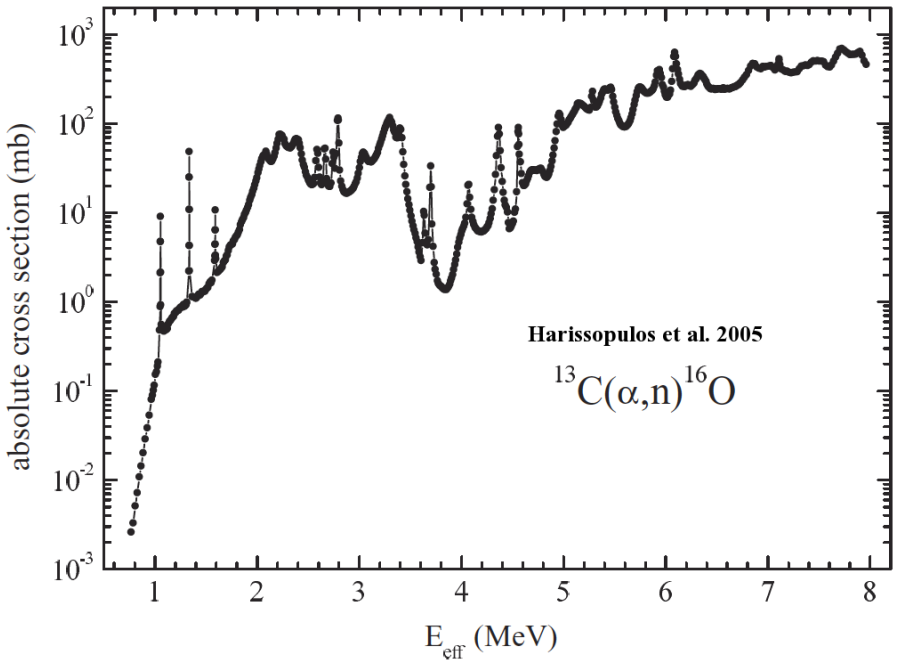
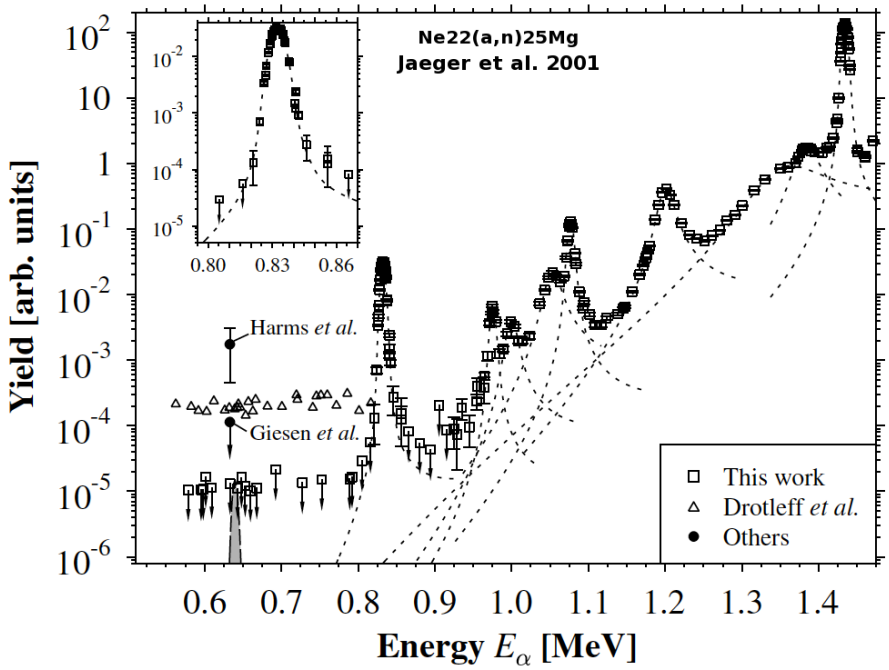


- **D**ual **I**on **A**ccelerator for **N**uclear **A**strophysics
- 2 accelerators to cover 50 - 3000 kV with high beam current
- Gas-jet and solid target stations
- Low-background neutron detector and Ge array

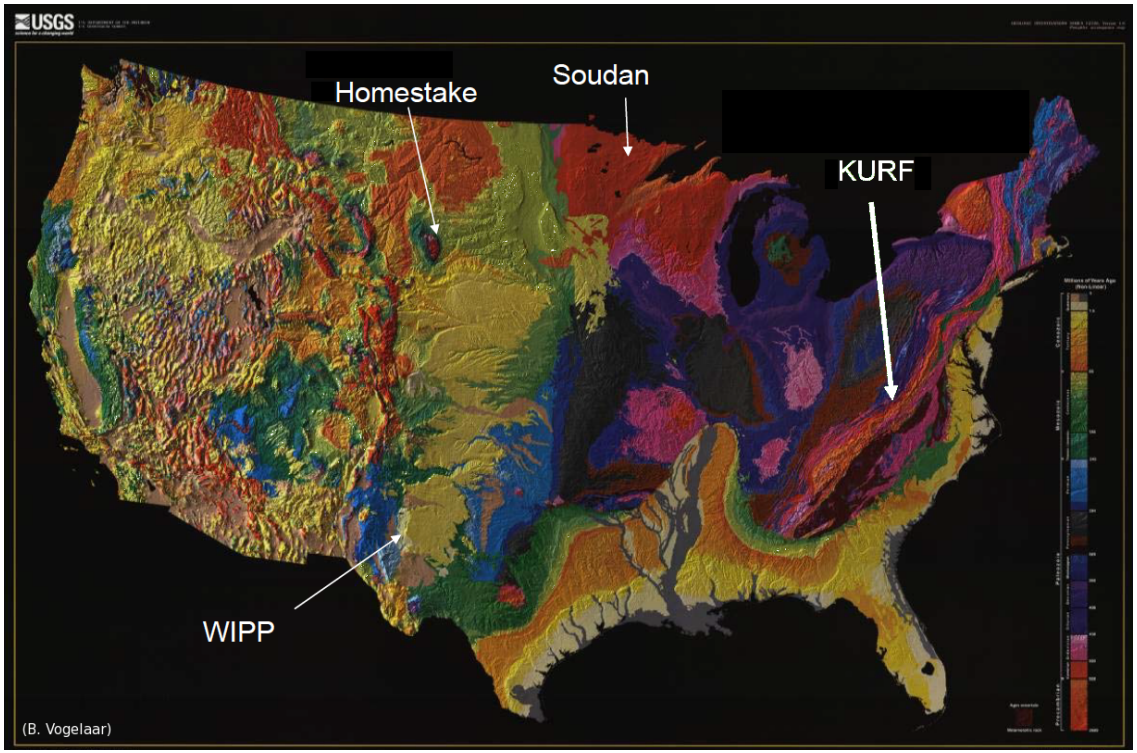
Why go underground?





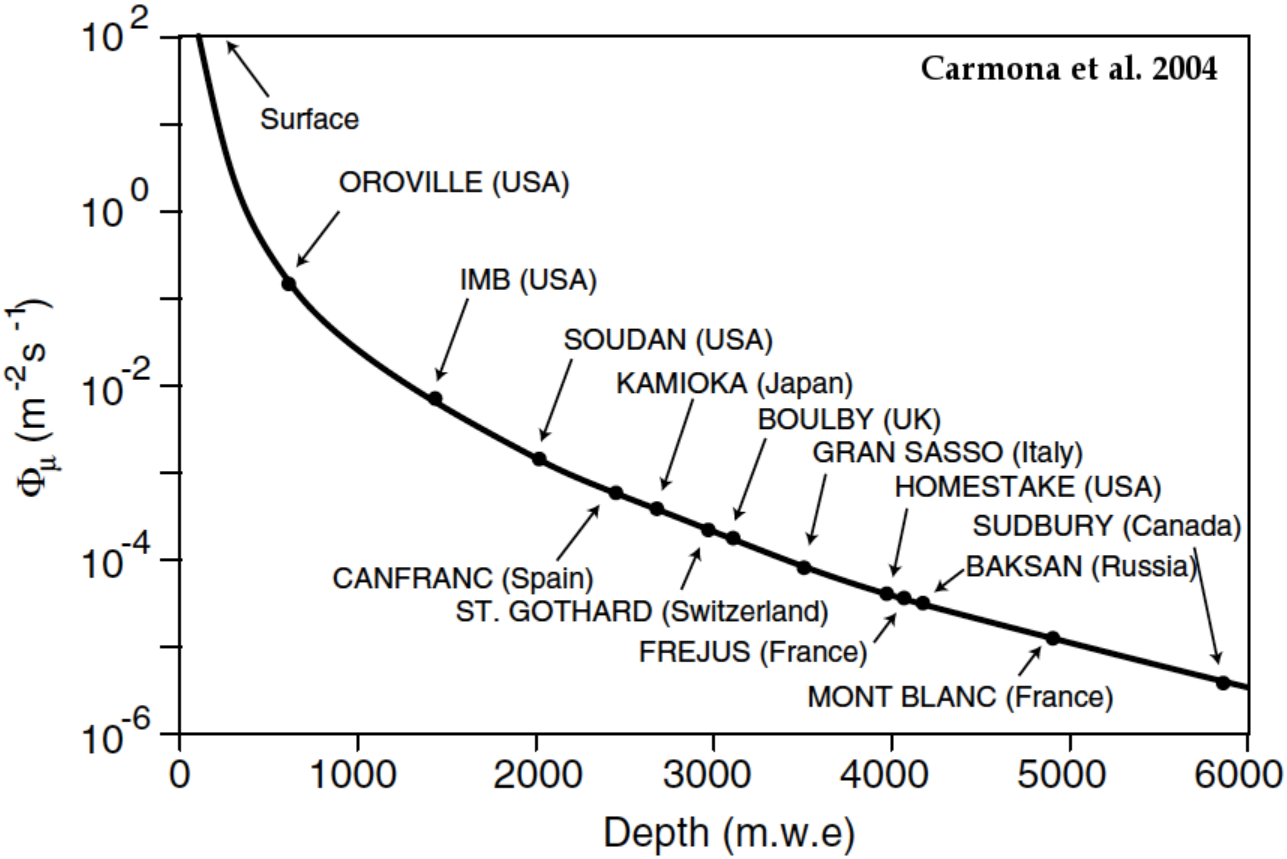
- Location of Gamow peaks:
  - $^{13}C(\alpha, n)$: $E_{cm} \approx 190$ keV
  - $^{22}Ne(\alpha, n)$: $E_{cm} \approx 540$ keV
  - $^{17}O(\alpha, n)$: $E_{cm} \approx 600$ keV
- Improvement by a few orders of magnitude opens up stellar energy range
- Cross section drops exponentially, need drastic background suppression

Site overview



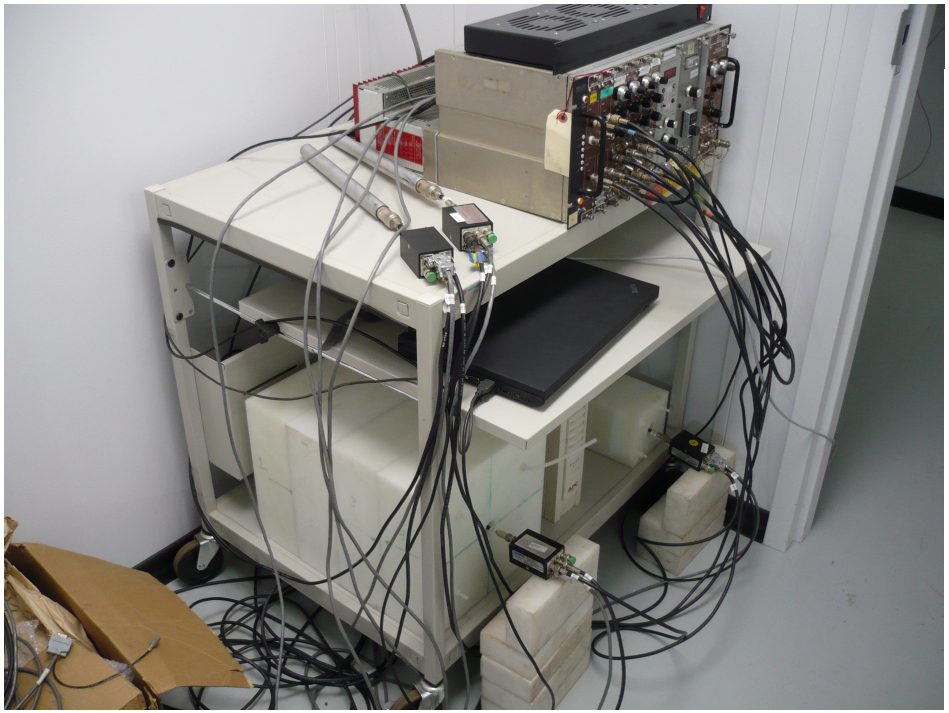
	WIPP	Soudan	KURF	SURF
Type of mine	Salt	Iron	Limestone	Gold
Depth [m]	655	780	500	1500
Equivalent depth [mwe]	2000	2090	1400	4300
muon flux [10^{-7} s^{-1} cm^{-2}]	4.8	2	≈ 20	0.04

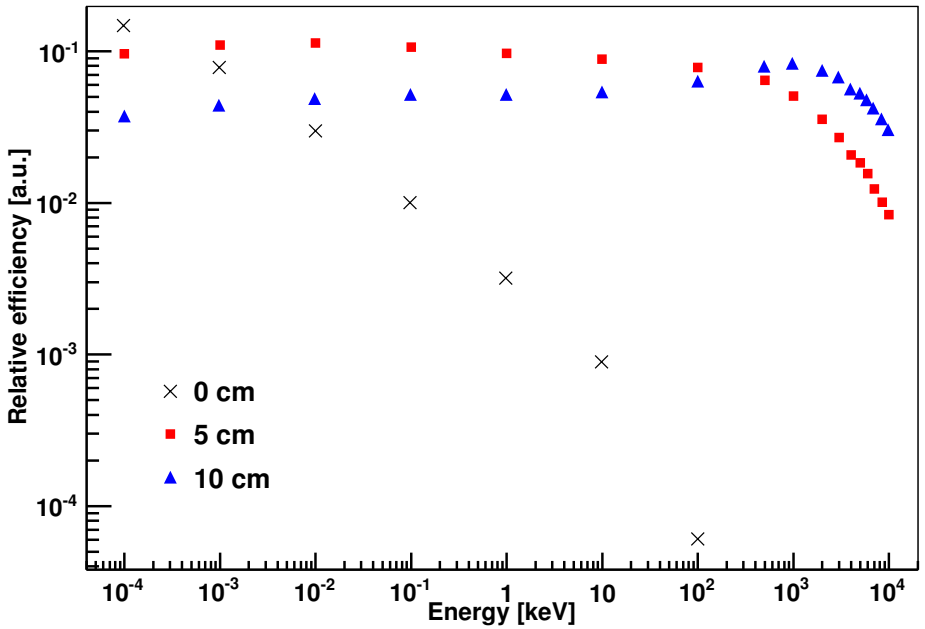
Background conditions



- Neutrons on surface: cosmic-ray muon induced, $\approx 10^{-3}$ cm^{-2} s^{-1}
- "No" muons underground $\rightarrow 10^{-6}$ cm^{-2} s^{-1} from (α, n) and ^{238}U

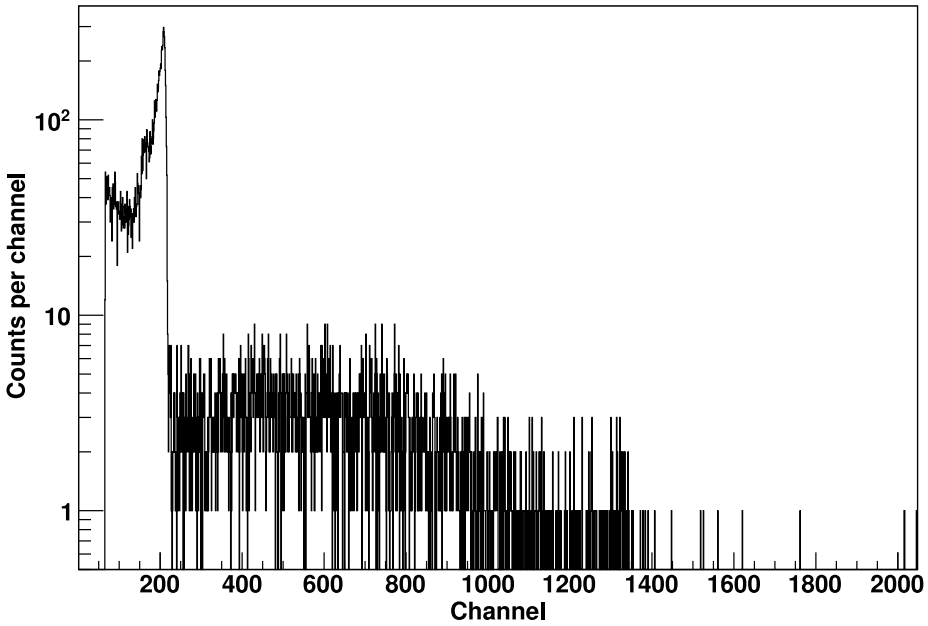
Underground neutron measurement setup

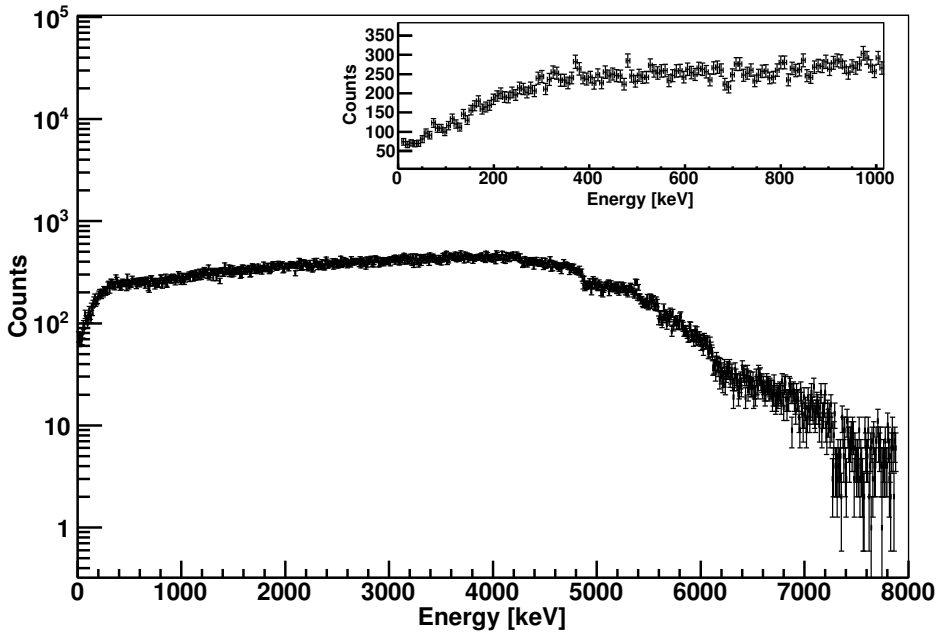




- 2 bare He counters, one in 2" PE, one in 4"
- Measured 1 month in KURF, 3 months at Soudan, 2 SURF (4100L), 5 WIPP
- Now back at SURF (4850L)

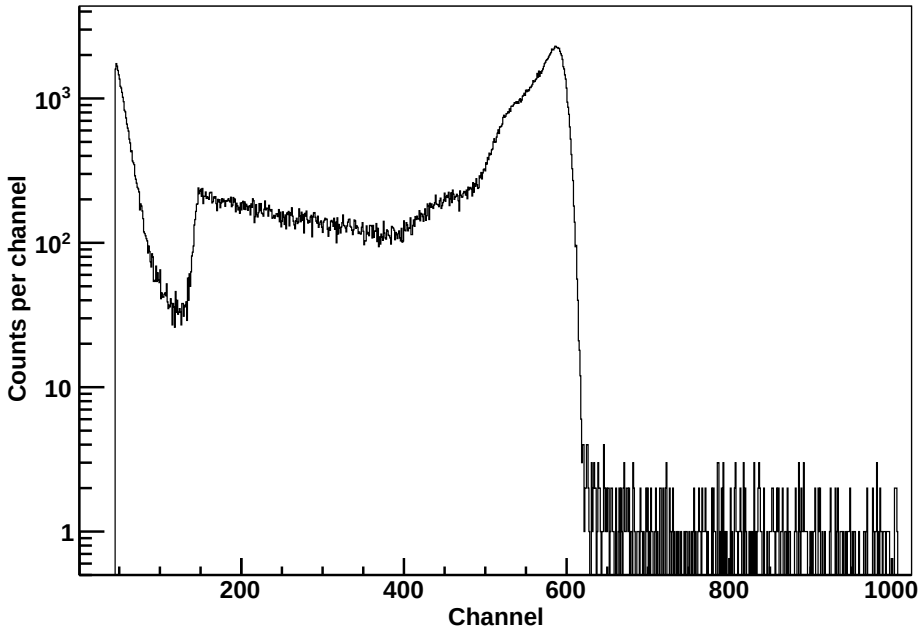
α background

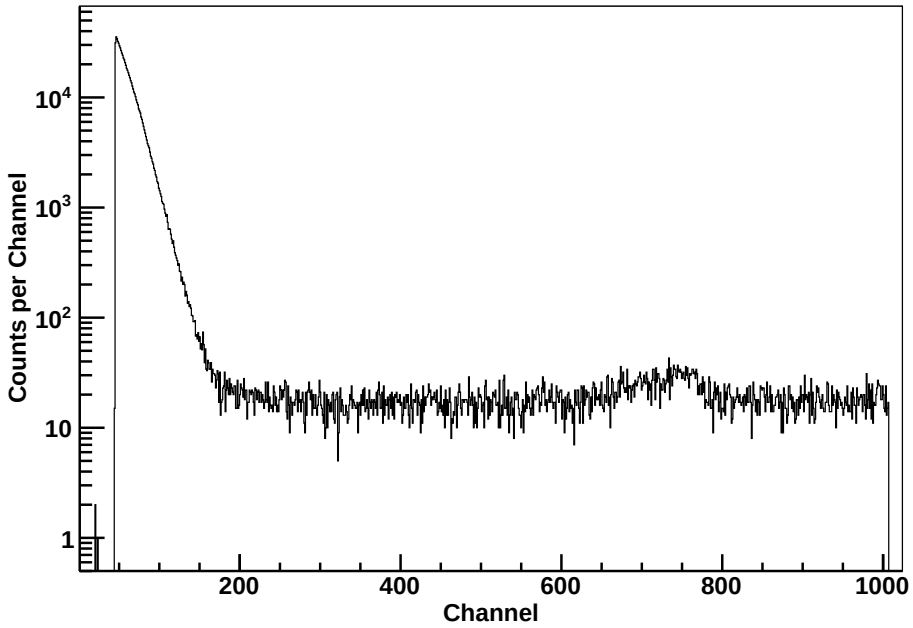




- U, Th in walls of counter
- Decay alphas major source of background
- Shape of spectrum doesn't change with varying U/Th

(Preliminary) fluxes





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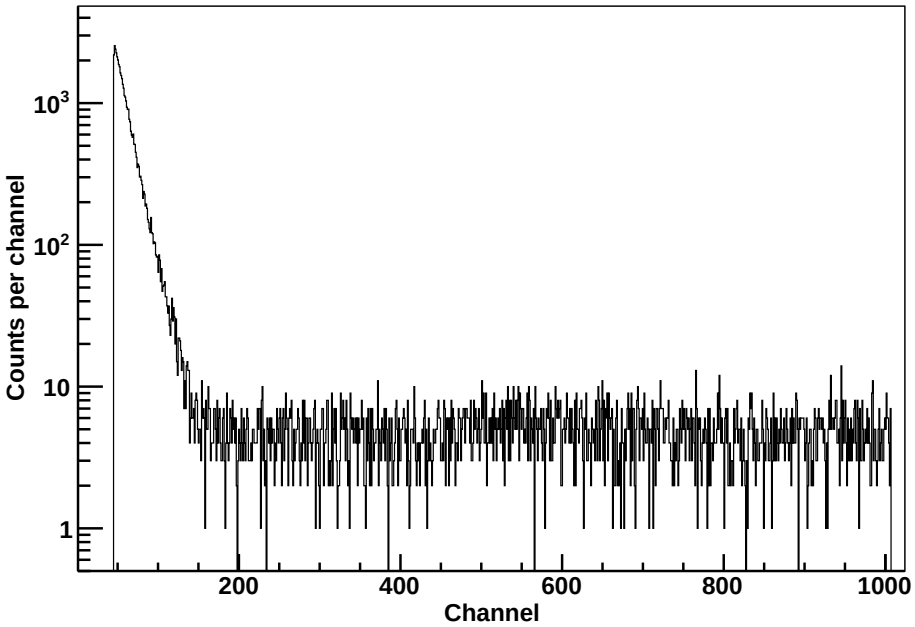
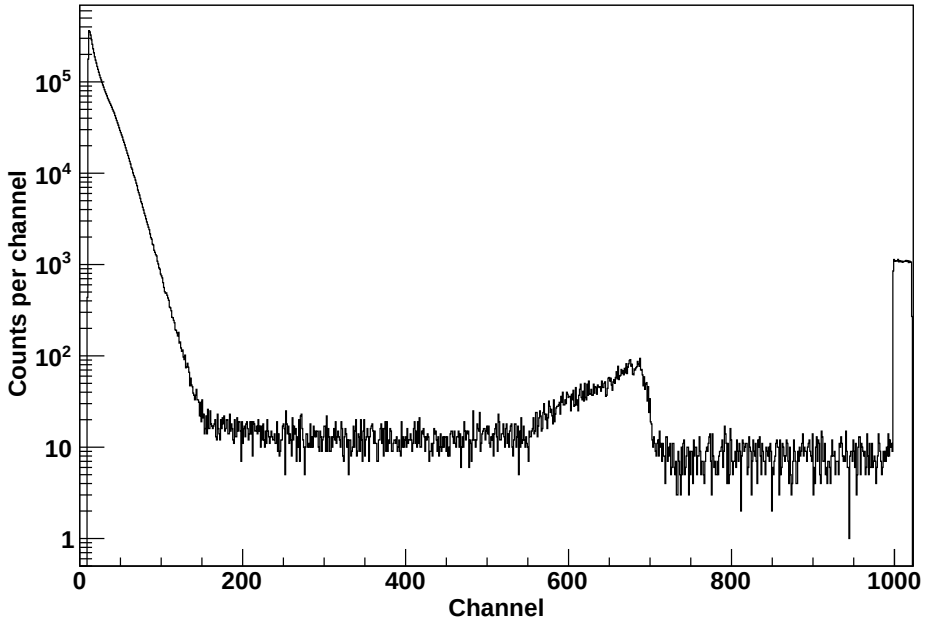
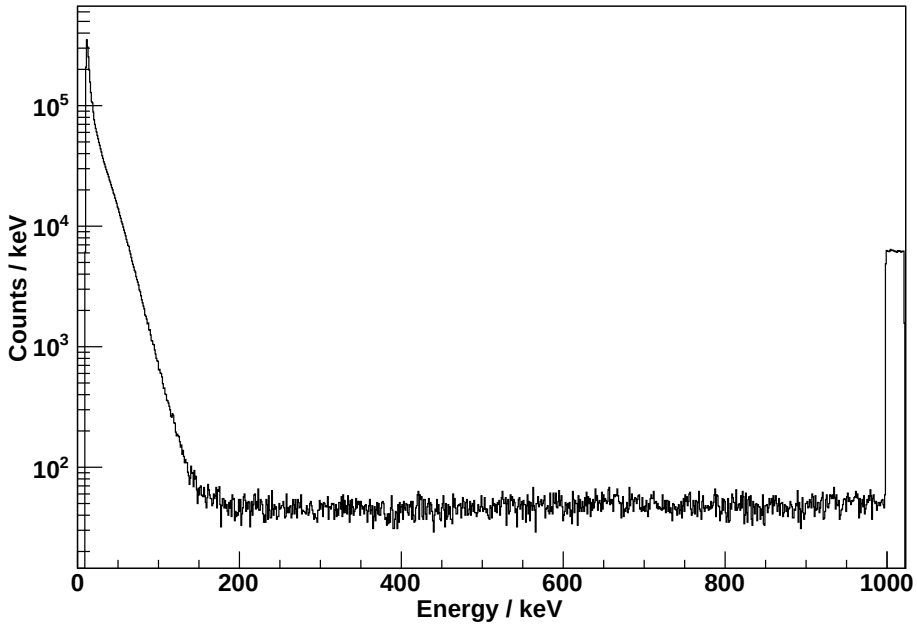




- KURF: $< 0.6 \cdot 10^{-6}$ cm^{-2} s^{-1}
- Soudan: $(0.5 \pm 0.1) \cdot 10^{-6}$ cm^{-2} s^{-1}
- SURF (4100L): $(7.9 \pm 0.2) \cdot 10^{-6}$ cm^{-2} s^{-1}
- WIPP: $1.3 \cdot 10^{-7}$ ($\pm$20%) (reported in 1997)

Hot new data



- 2×5 months of data
- Just came in 10 days ago, no number yet

Summary and Outlook

- Underground (α, n) measurements can approach stellar energy range
- Next-generation underground facility DIANA in design phase
- Neutron background characterisation underway
- Fluxes in all sites in reasonable range
- At SURF (4850L) right now