

LIME background simulation

CYGNO simulation meeting – 15/11/2021

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LIME internal background

- GEM – done and analysed
- Acrylic box – done and analysed
- Field cage – done and analysed
- Cathode – done and analysed
- Resistors – ongoing
- Camera body + lens – to do
- PMT, GEM supports, internal structure... – to do (?)

New geometry for the camera shielding to be included in GEANT4



Previous results on camera simulation:
35644 events/yr [0-20 keV]

Contribution	10 ⁵ (ER+NR)/yr (0-20 keV)	10 ⁵ (ER+NR)/yr (all)	NR/yr (0-20 keV)	NR/yr (all)
GEMs	0.69129±0.00002	3.83753±0.00004	311.62±0.09	17573.0±0.6
Acrylic Box	0.5245±0.0001	2.7054±0.0002	0	0
Field Rings*	0.049008±0.000005	0.32270±0.00001	2.665±0.004	121.84±0.03
Cathode*	0.033903±0.000001	0.081639±0.000002	0.4430±0.0006	69.400±0.008
TOTAL	1.2987	6.9473	315	17764

*Activity taken from TREX measurements multiplied by 10

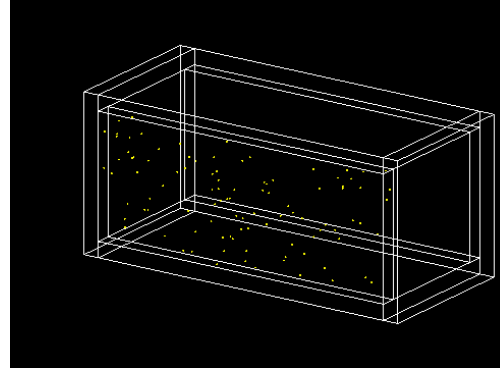
Track simulation

- **SRIM ion simulation**
 - SRIM simulation of He, C and F recoils at energies 1, 3, 6, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 35, 40, 45, 50, 55, 60, 100 keV - done
 - The computed ionization profiles are all uploaded on LNGS cluster
- **Digitization NR tracks** – 1000 ions, random drift, random direction
 - Digitization of He, C and F at all energies - done
 - Reconstruction done
 - I used the autumn21 reconstruction branch – seems to work well, 43% efficiency in reconstructing 1keV He recoils
 - Next: random energy sample
 - Post-reconstruction analysis ongoing

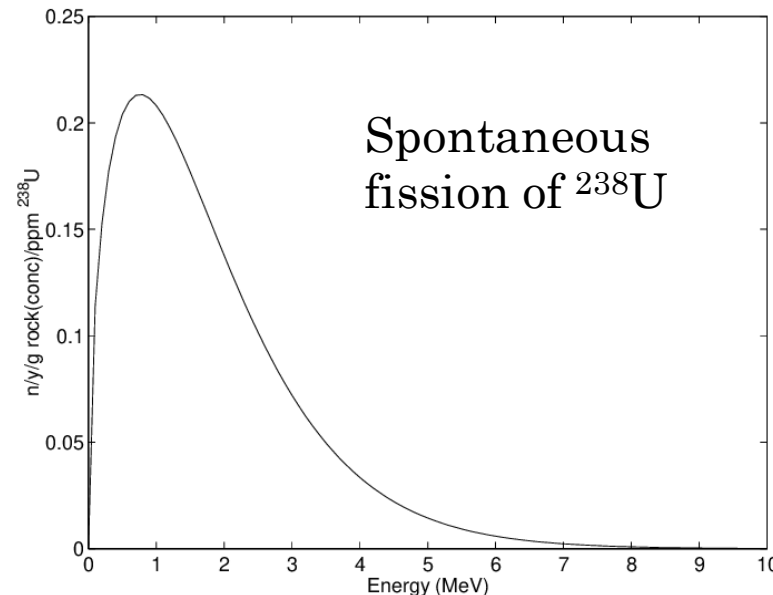
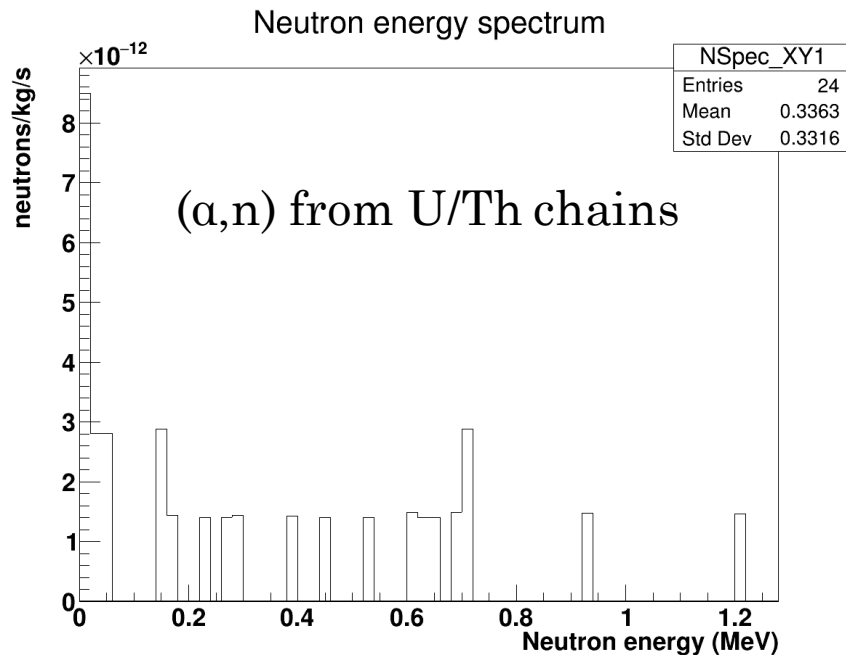
Additional neutron background

- **Radiogenic** and **cosmogenic** component of neutron background produced in detector material: (α,n) reactions + spontaneous **fission**, **muon** induced
 - **SOURCES4C** - A Code for Calculating (α,n), Spontaneous Fission, and Delayed Neutron Sources and Spectra
 - Fastest option for radiogenic component calculation – I'm having issues with the version I'm using, I'll soon get the latest version
 - **SaG4n** – GEANT4 tool for (a,xn) simulations <http://win.ciemat.es/SaG4n/>
 - Alternative to SOURCES4C: only (α,n), but based on GEANT4
 - Fission neutron yield could also be analytically computed, and the spectrum can be taken from measurements
 - **MUSUN** (MUon Simulations UNderground)
- In any case, a GEANT4 simulation of this additional neutron flux will be done to assess the NR rate

Neutron yield simulation



- I did a simulation with SaG4n to estimate the neutron flux from the Cu shielding
- 100M alpha events, with energies extracted from the energy distributions of all alpha emitters in natural radioactive chains, weighed with their relative content in OPERA copper
 - From (α,n) : 3.85×10^{-11} n/kg/s \rightarrow if all neutrons enter the gas: 4.13×10^{-12} n/cm²/s
- Fission neutron rate calculated as $R = \text{Activity} \times \text{B.R.} \times \text{yield}$
 - $R_{\text{fission}} = 2.14 \times 10^{-9}$ n/kg/s \rightarrow if all neutrons enter the gas: 2.29×10^{-10} n/cm²/s



- 4-6 orders of magnitude lower than external component, but needs to be assessed
- Also for CYGNO?
- Cosmogenic component can be 20 times larger than radiogenic

Conclusions

- Internal background simulation of LIME underground is ongoing; simulation of resistors and camera to be done
 - I need to modify the geometry of the detector implemented in GEANT4 to add the shielding for the camera
- Reconstruction of simulated NR is done with the autumn21 branch, I'm working on the post-reco analysis (with the new mango-gssi branch)
- Next step in track simulation: produce a sample with random energy
- Radiogenic and cosmogenic neutron contribution to the background must be assessed; from preliminary results it is subdominant