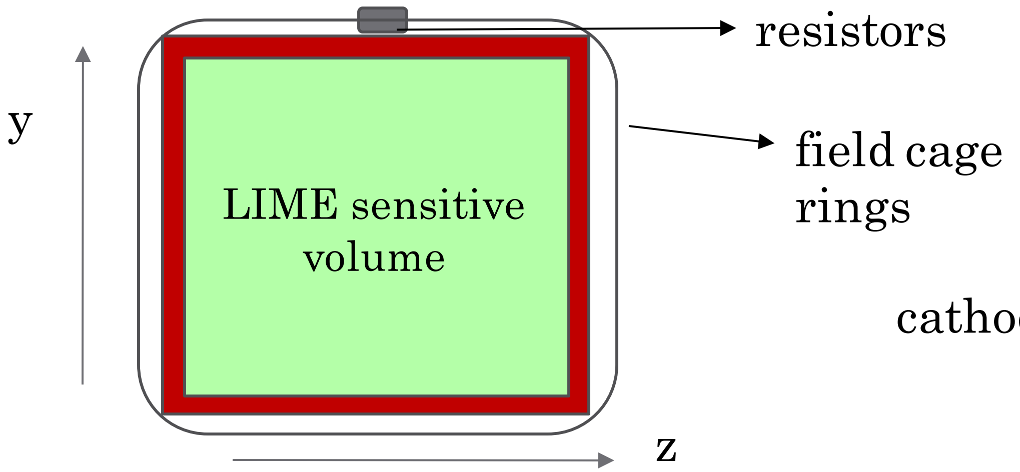
LIME background simulation

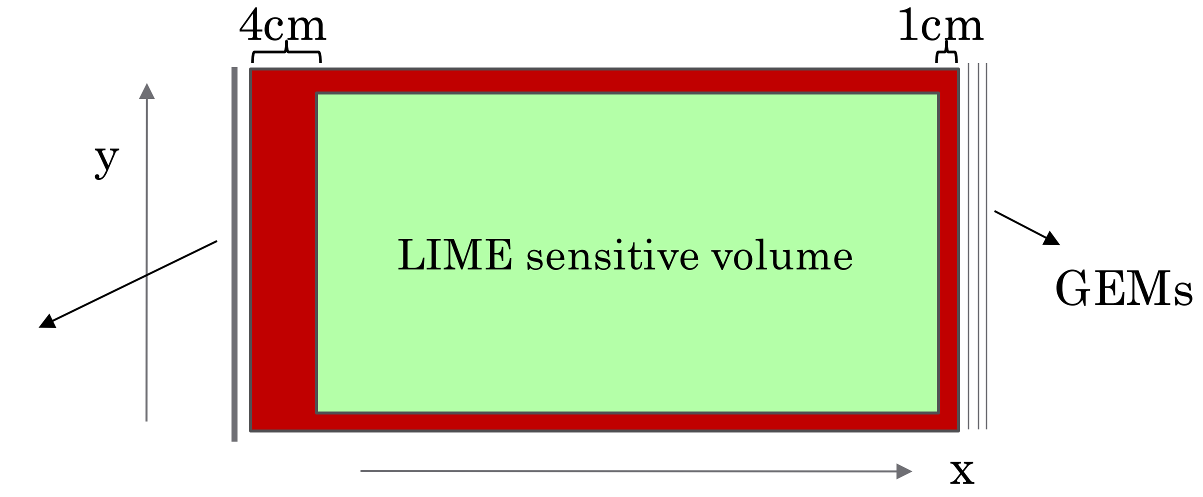
CYGNO simulation meeting – 19/09/2022

F. Di Giambattista

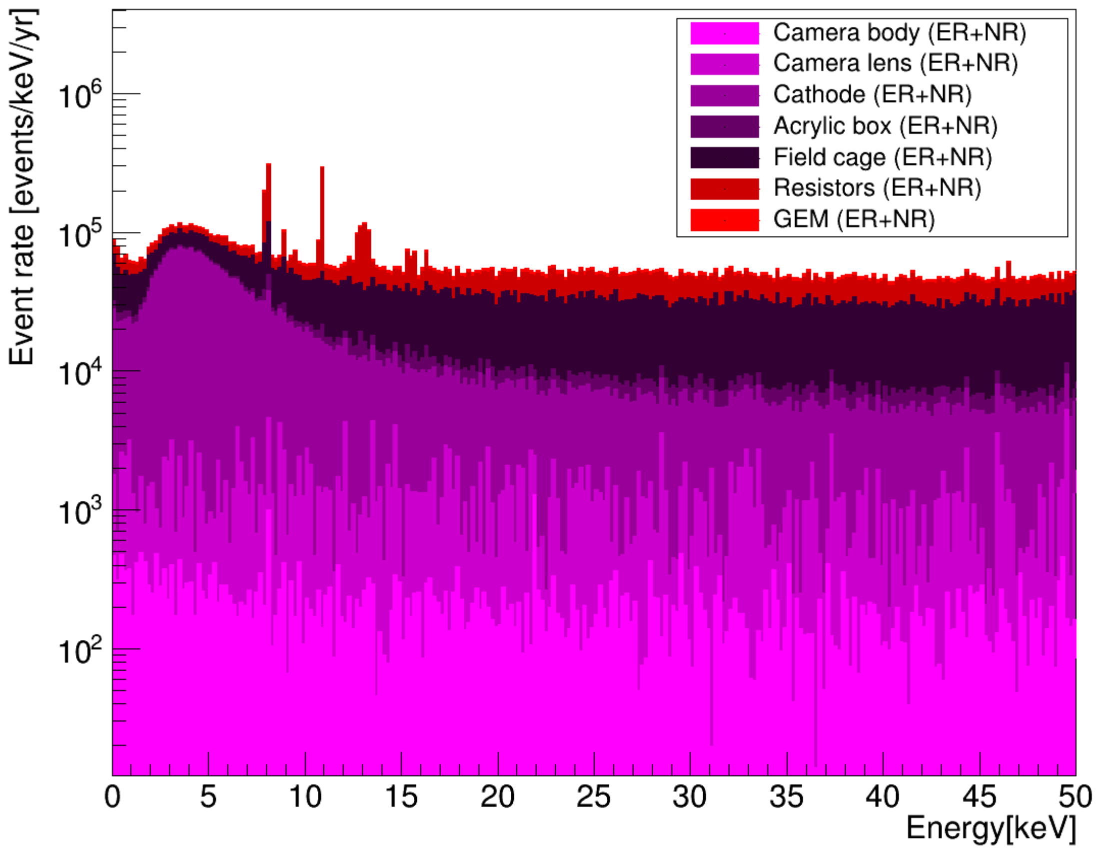
Finalizing LIME background

- Simulation of LIME underground background was done with new shielding geometry
- 4cm Cu, 6cm Cu, 10cm Cu
- External background: gammas, neutrons
- Internal background: radioactivity of detector components
- Shielding radioactivity (Bi210)
- Radiogenic neutrons (from alpha decay and spontaneous fission in shielding)
- Cosmogenic background (muon-induced neutrons)
- I applied some simple cuts to check how much we could improve
    - Cuts will be optimised: digitization of tracks from expected energy and spatial distribution in sensitive volume

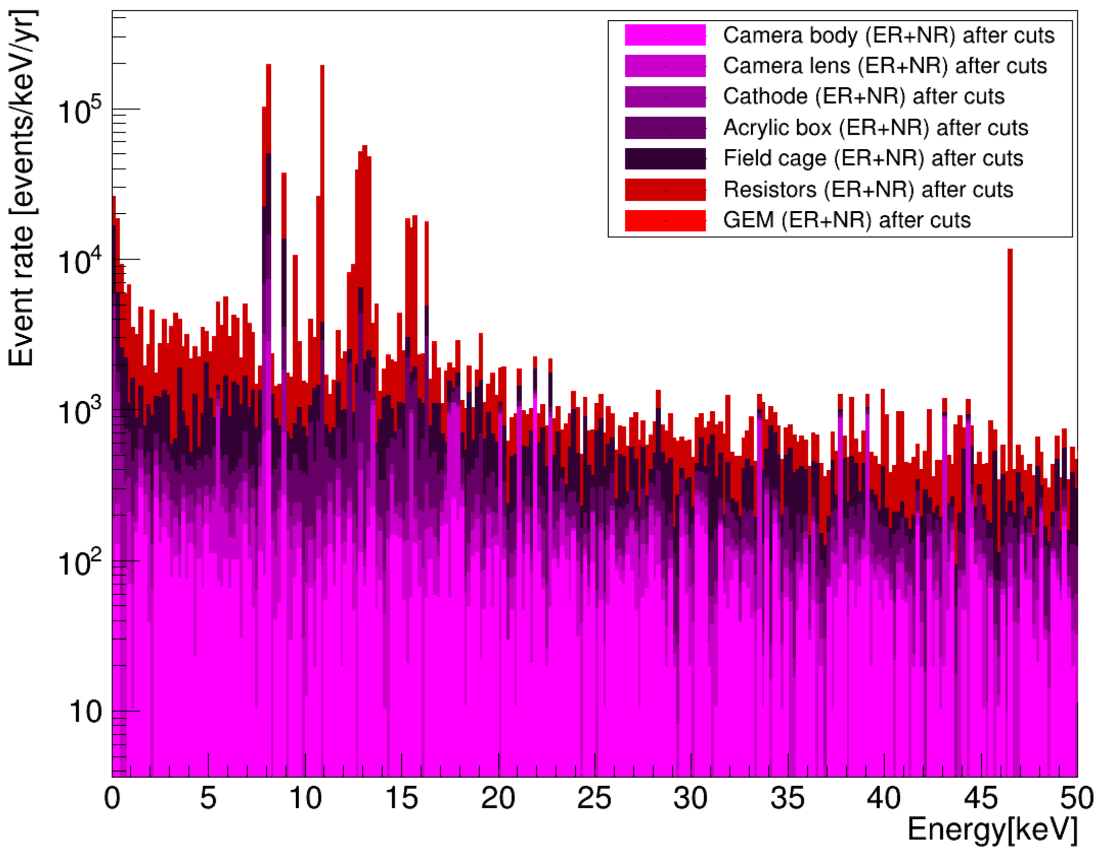




Internal background

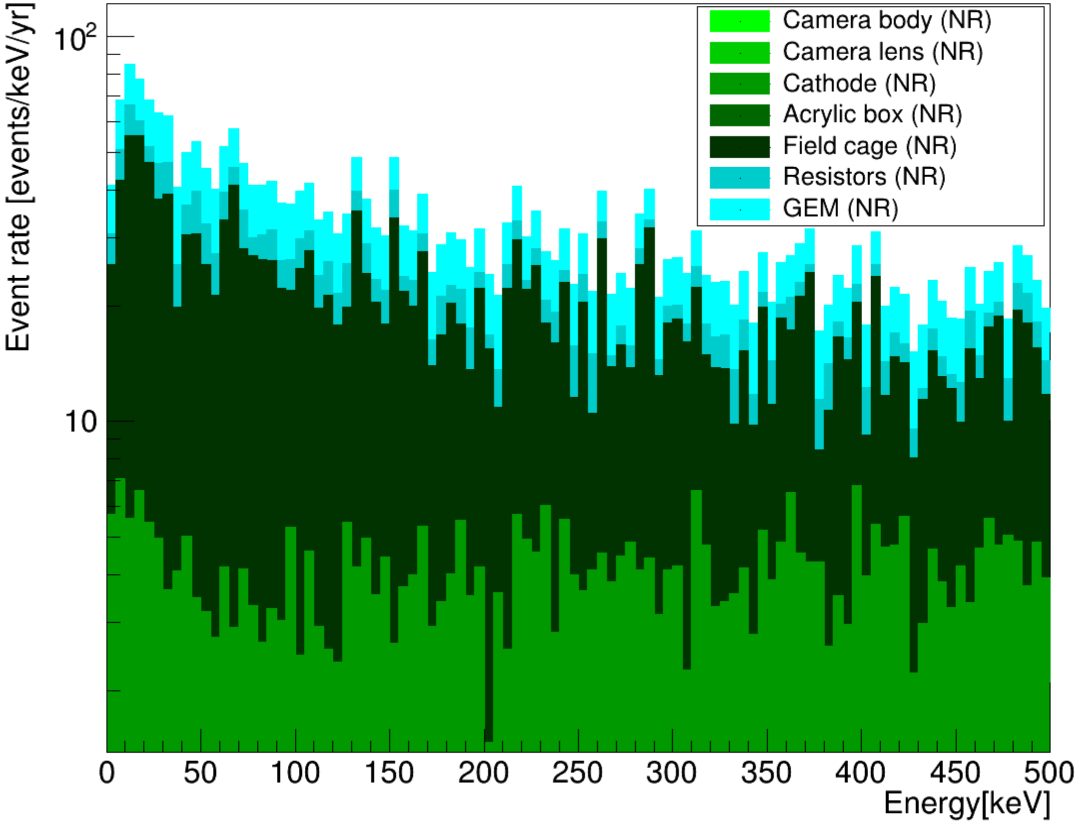


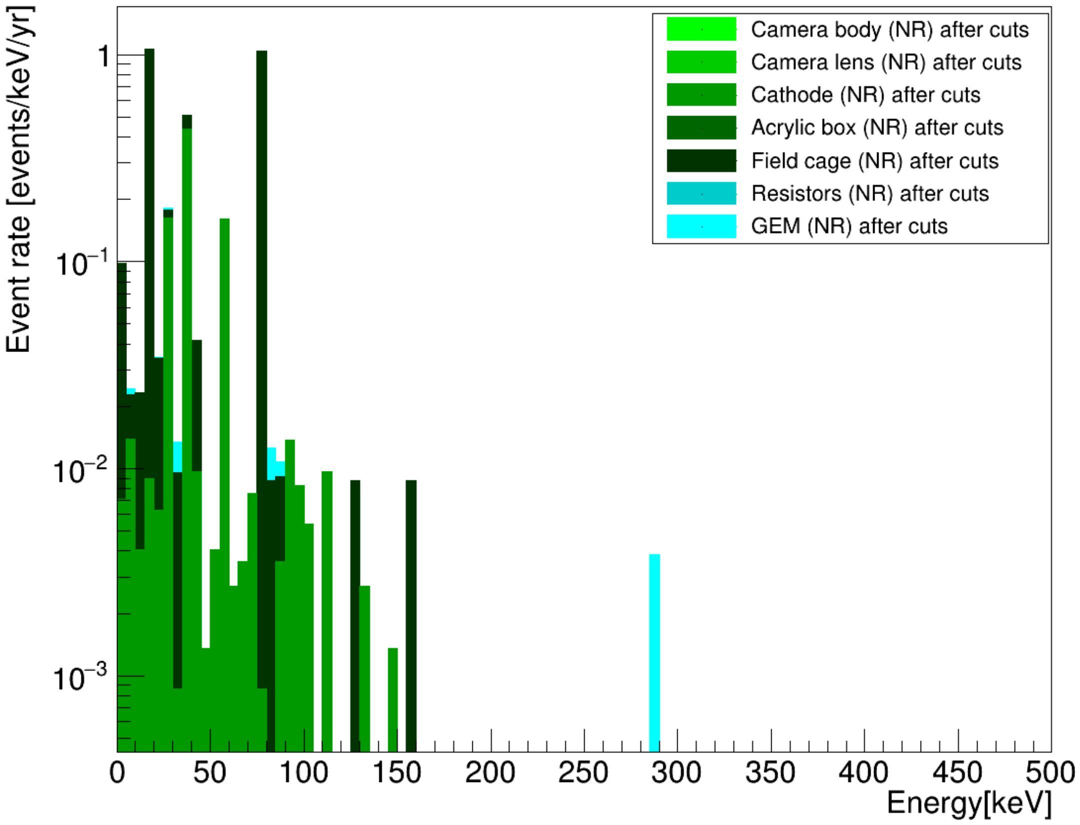
7.4e6 events/yr in whole range
7.3e6 events/yr above 1 keV
5.7e6 events/yr above 20 keV



2.8e5 events/yr in whole range
2.6e5 events/yr above 1 keV
5.2e4 events/yr above 20 keV

Internal background





6.1e4 events/yr in whole range
6.1e4 events/yr above 1 keV
6.0e4 events/yr above 20 keV

17 events/yr in whole range
16 events/yr above 1 keV
11 events/yr above 20 keV

Camera shielding

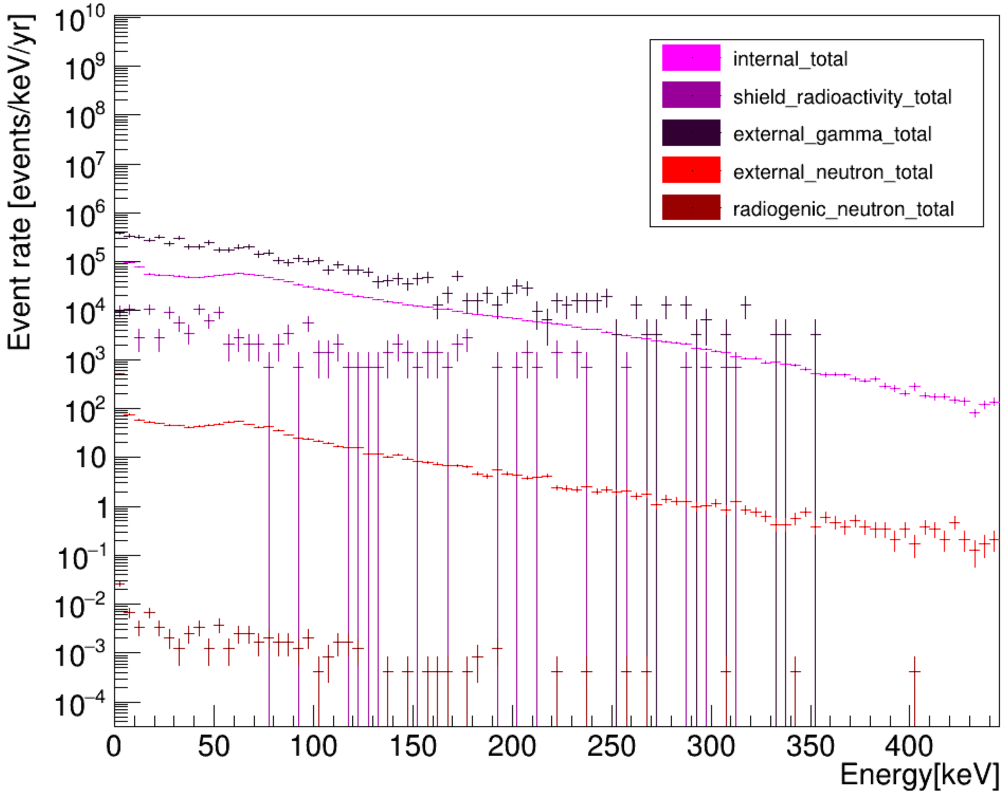
No shielding (camera+camera lens)	6cm of copper (camera+camera lens)
2.4(1)e4+1.52(5)e5 events/yr in whole range	2.1(2)e4+1.33(4)e5 events/yr in whole range
2.4(2)e4+1.50(9)e5 events/yr above 1 keV	2.1(2)e4+1.32(7)e5 events/yr above 1 keV
1.9(2)e4+1.24(7)e5 events/yr above 20 keV	1.6(2)e4+1.08(6)e5 events/yr above 20 keV

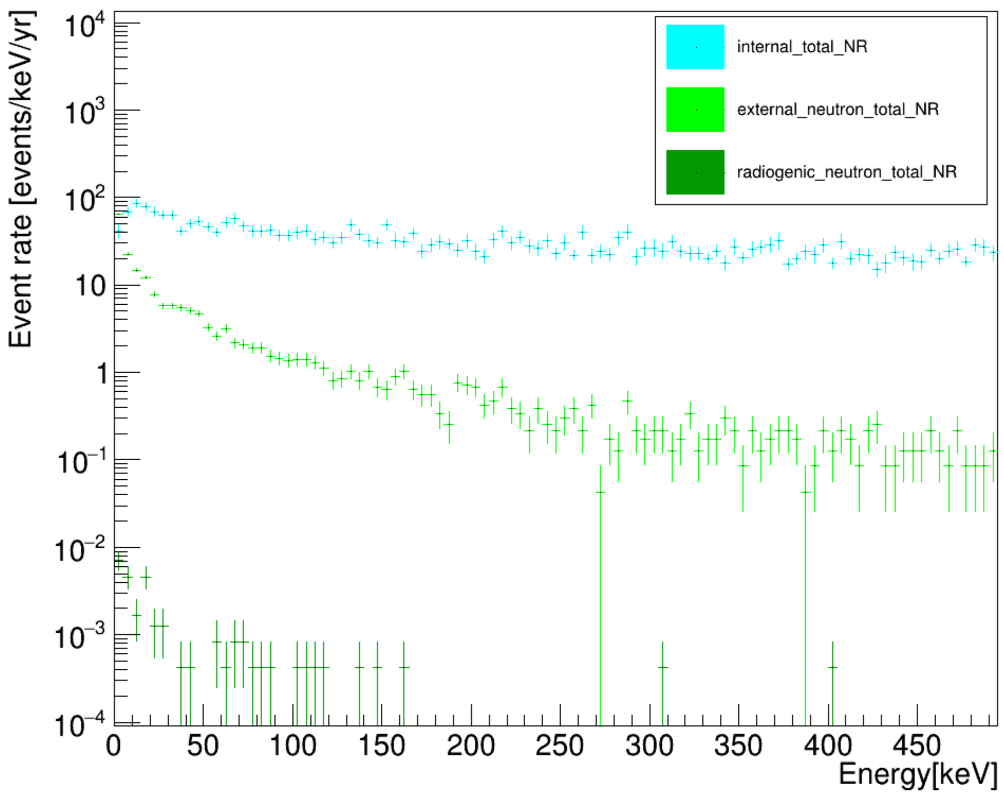
Events to be cut

1.8(1)e4+1.44(5)e5 events/yr in whole range	5.3(9)e3+1.7(1)e4 events/yr in whole range
1.8(2)e4+1.42(9)e5 events/yr above 1 keV	5.1(9)e3+1.6(2) events/yr above 1 keV
1.5(2)e4+1.20(7)e5 events/yr above 20 keV	3.8(9)e3+1.2(2)e4 events/yr above 20 keV

10cm of copper simulation is ongoing

First phase: 4 cm of copper

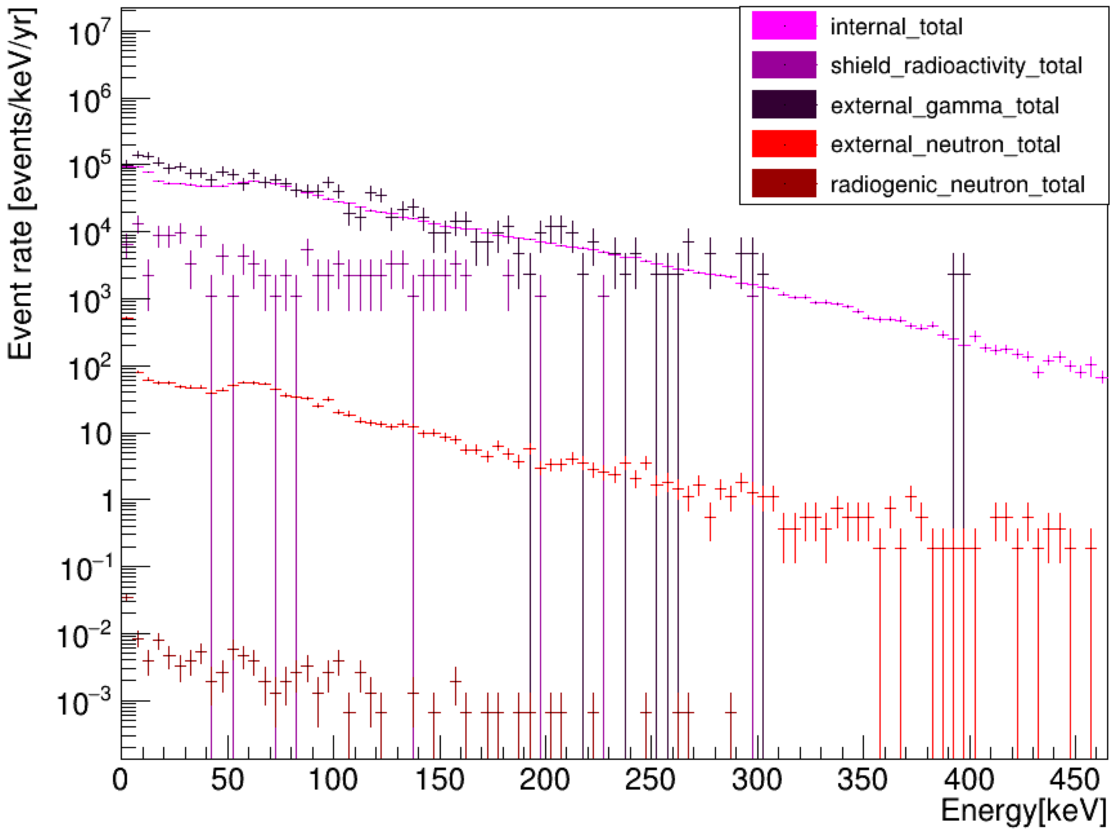


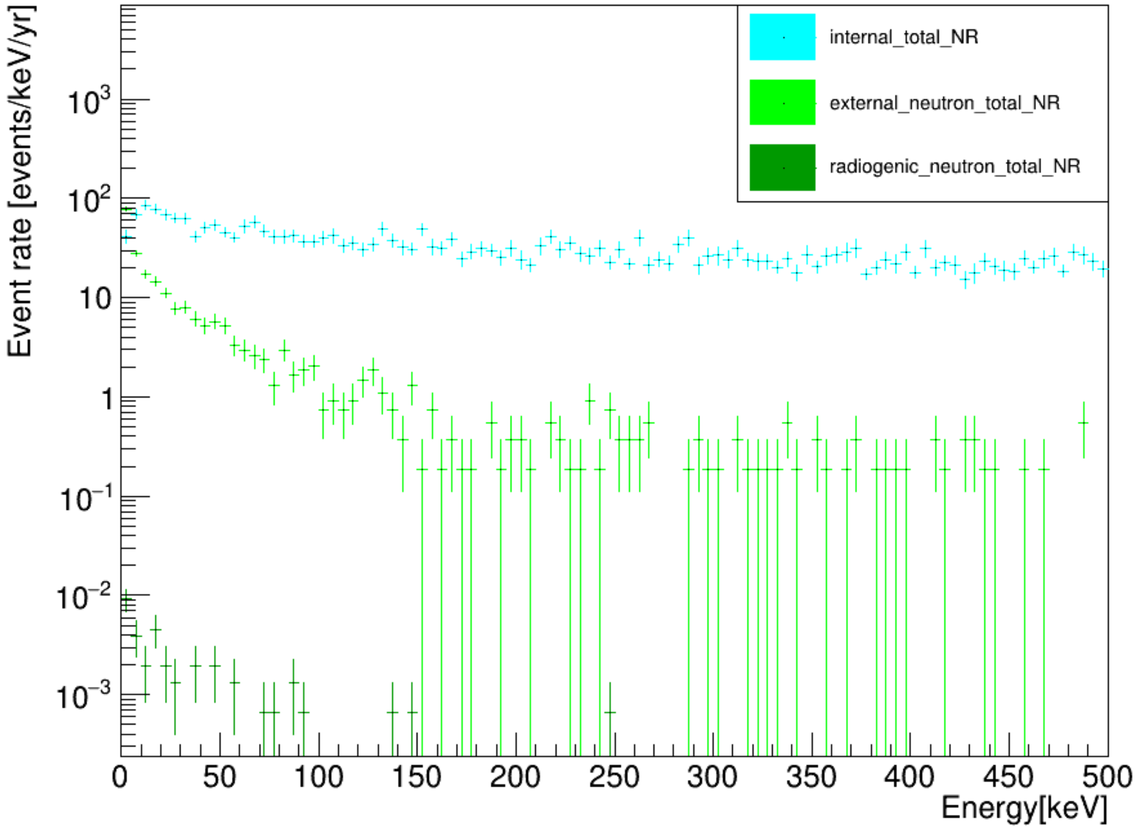


From external gammas: 2.68(6)e7 ER/yr
From shielding: 6.7(5)e5 ER/yr

From external neutrons: 1.02(1)e3 NR/yr
From radiogenic neutrons: 0.15(2) NR/yr

Second phase: 6cm of copper

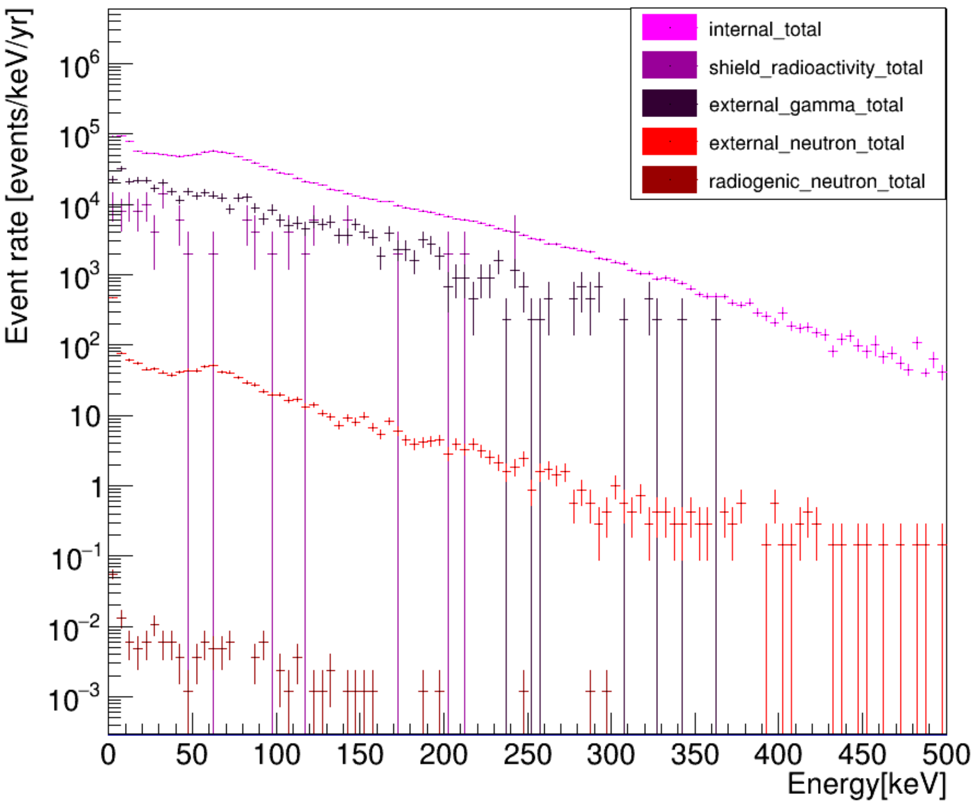


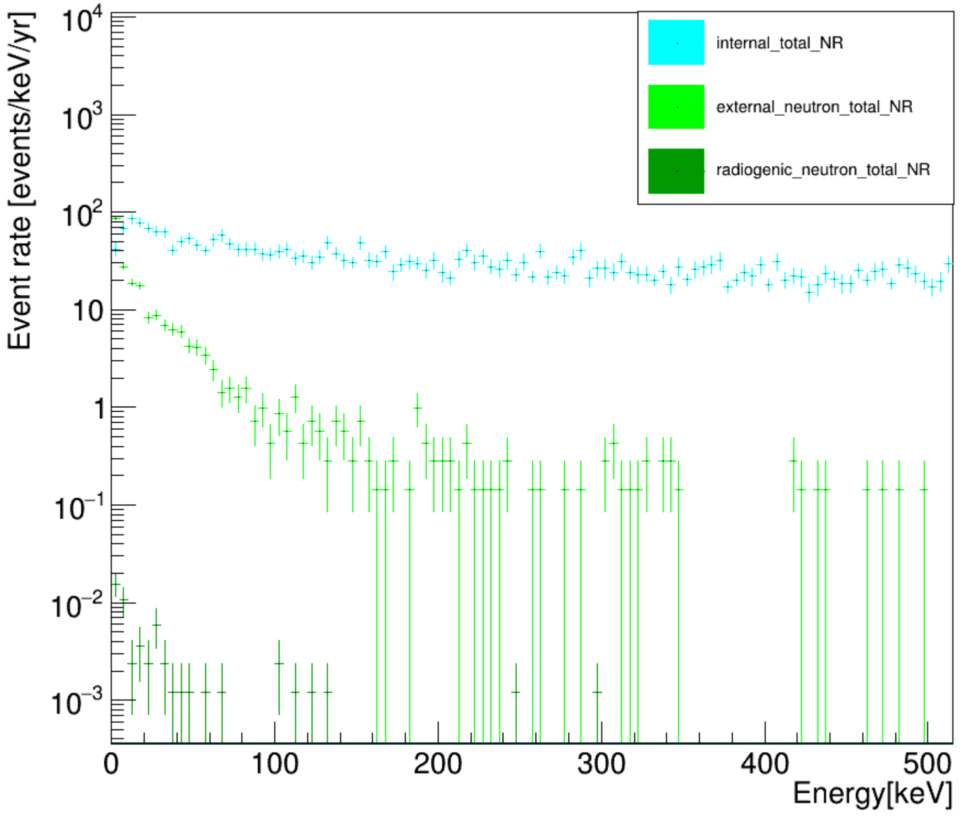


From external gammas: 9.5(3)e6 ER/yr
From shielding: 6.4(6)e5 ER/yr

From external neutrons: 1.19(3)e3 NR/yr
From radiogenic neutrons: 0.17(2) NR/yr

Third phase: 10 cm of copper

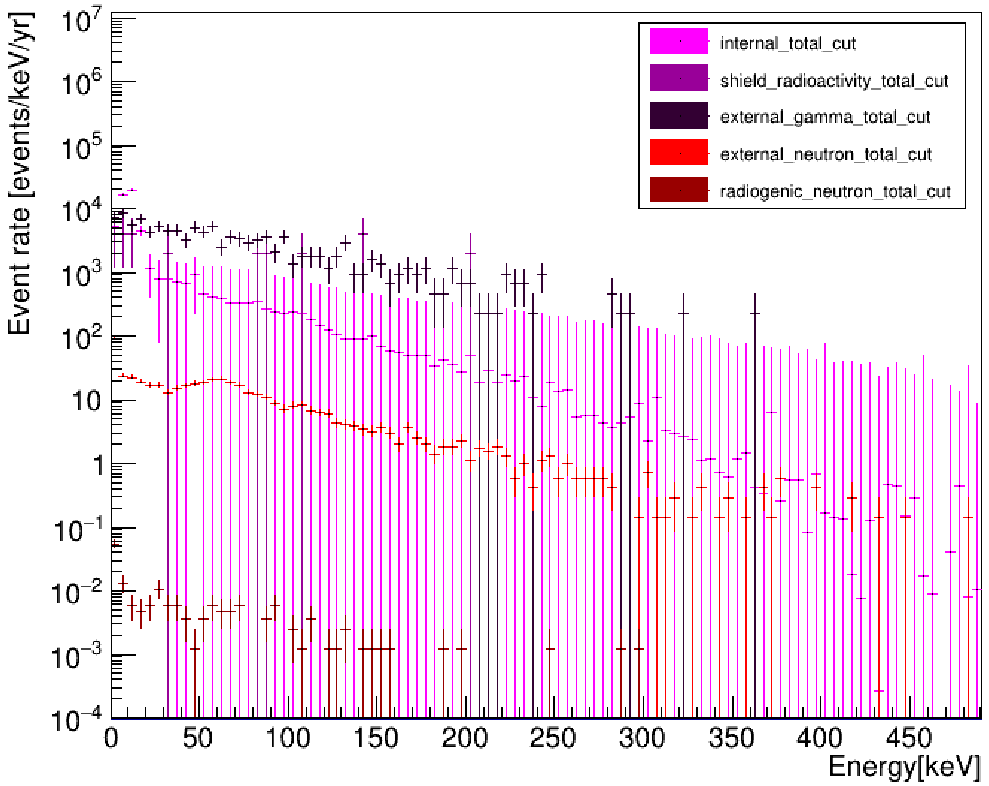


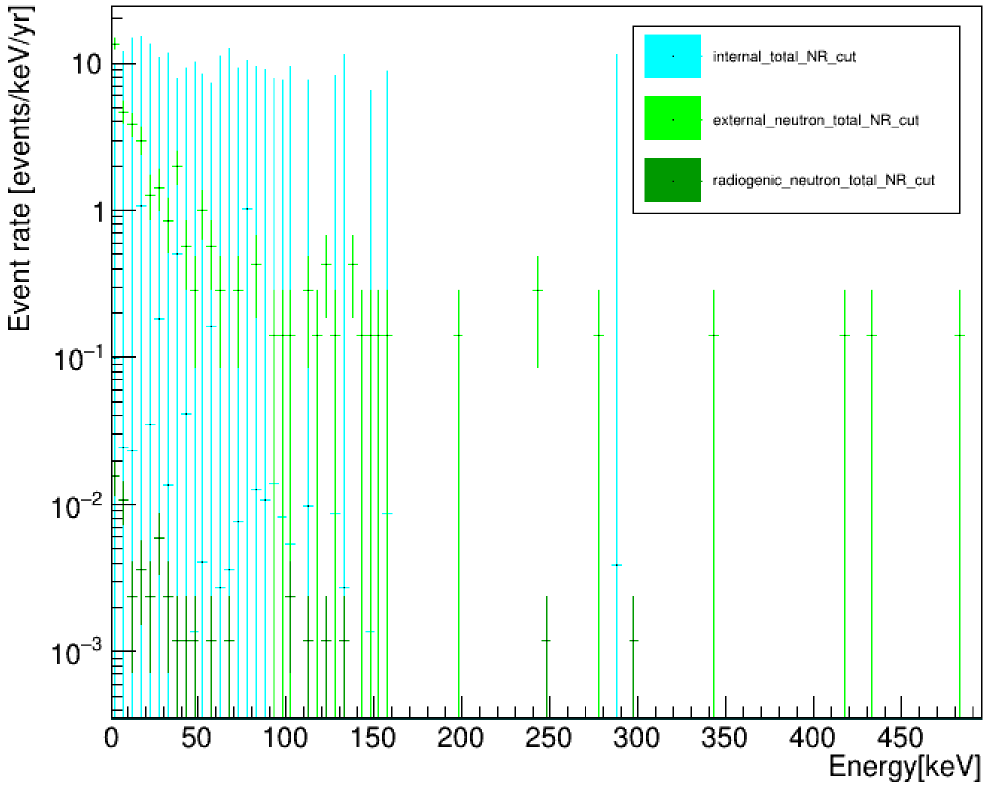


From external gammas: 1.98(5)e6 ER/yr
From shielding: 5.7(7)e5 ER/yr

From external neutrons: 1.13(3)e3 NR/yr
From radiogenic neutrons: 0.29(4) NR/yr

Third phase: 10 cm of copper

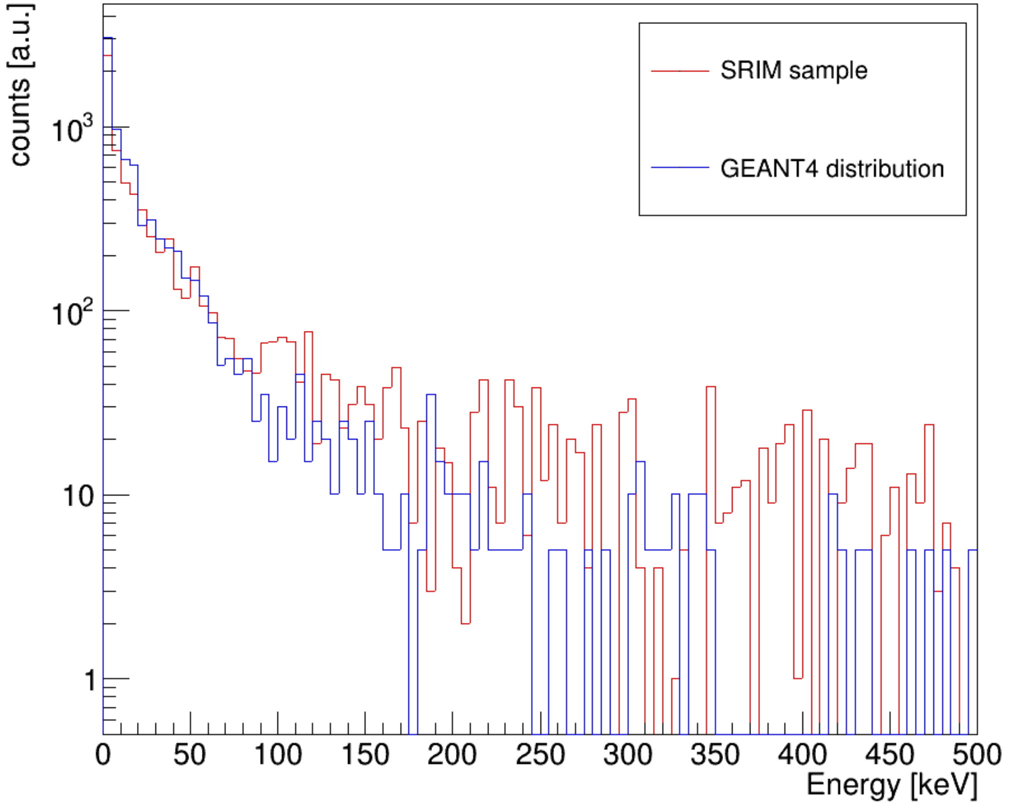




From external gammas: 1.4e6 ER/yr
From shielding: 4.37e5 ER/yr

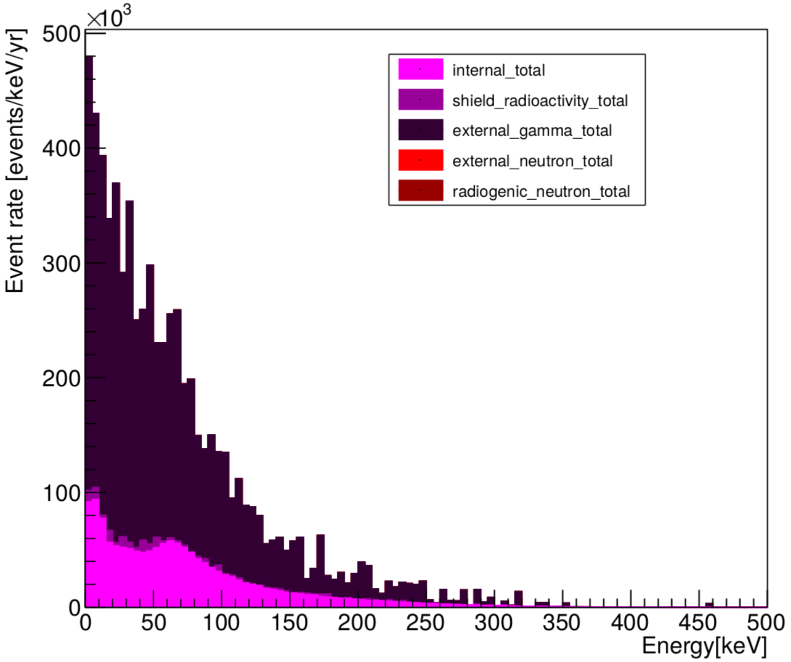
From external neutrons: 942 NR/yr
From radiogenic neutrons: 0 NR/yr

Cuts optimization

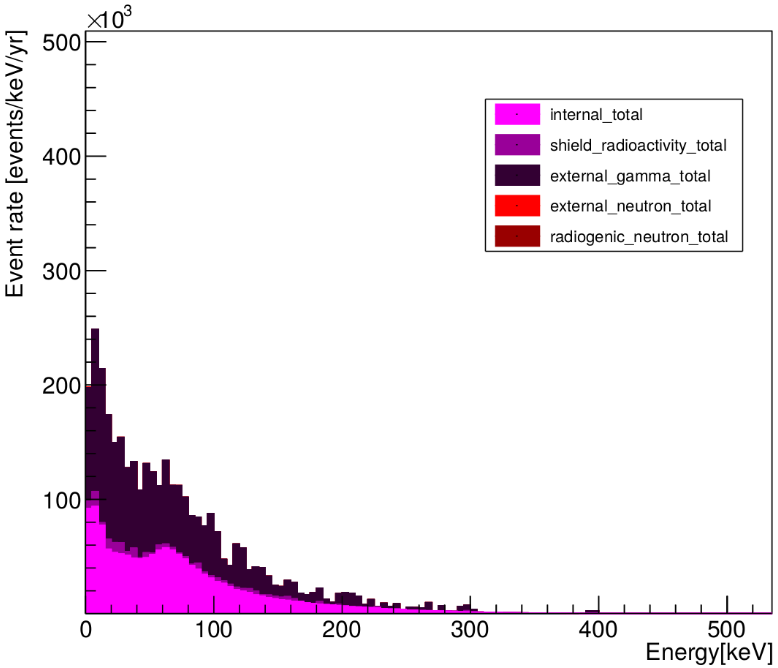


- Simulated with SRIM 8000 ions distributed according to the GEANT4 simulation (energy and atom)
- I am working on the digitization of the tracks to distribute them in x,y,z and angle according to the spatial and angular distribution taken from GEANT4
- Once we have a sample of images with the right distribution of tracks, I will optimize the cuts

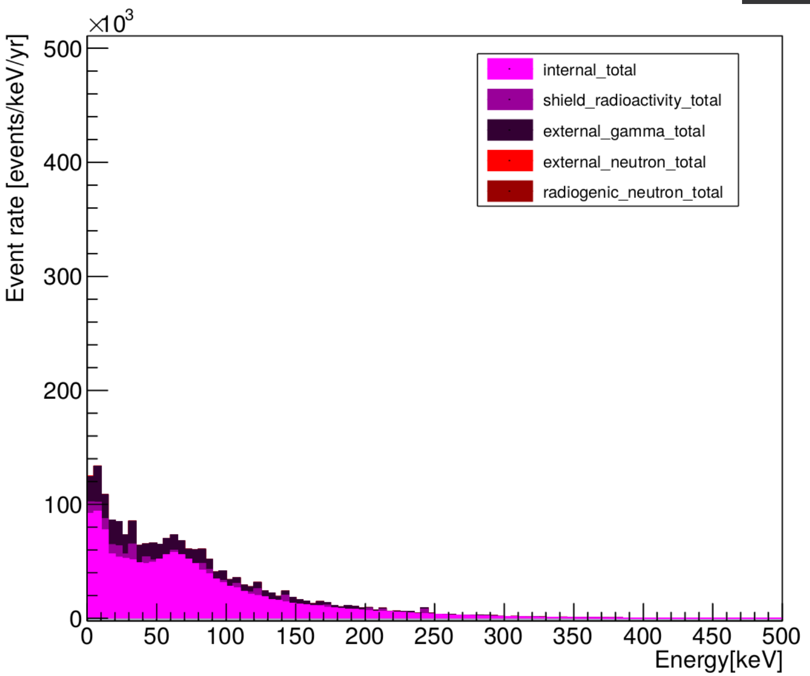
backup



4cm of copper



6cm of copper



10cm of copper

Cosmogenic neutrons (back of the envelope)

From cross section measurement of muon spallation on different targets, we can expect O(1e-3) n/mu/(g/cm3)

3e-10 n/s/cm3

Comparing to radiogenic neutrons: 1.876e-11

A NR rate 16 times larger than the radiogenic one would be of <10 NR/yr