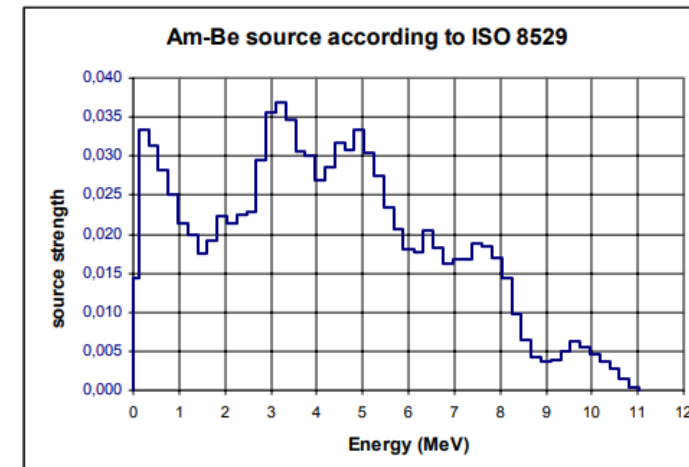
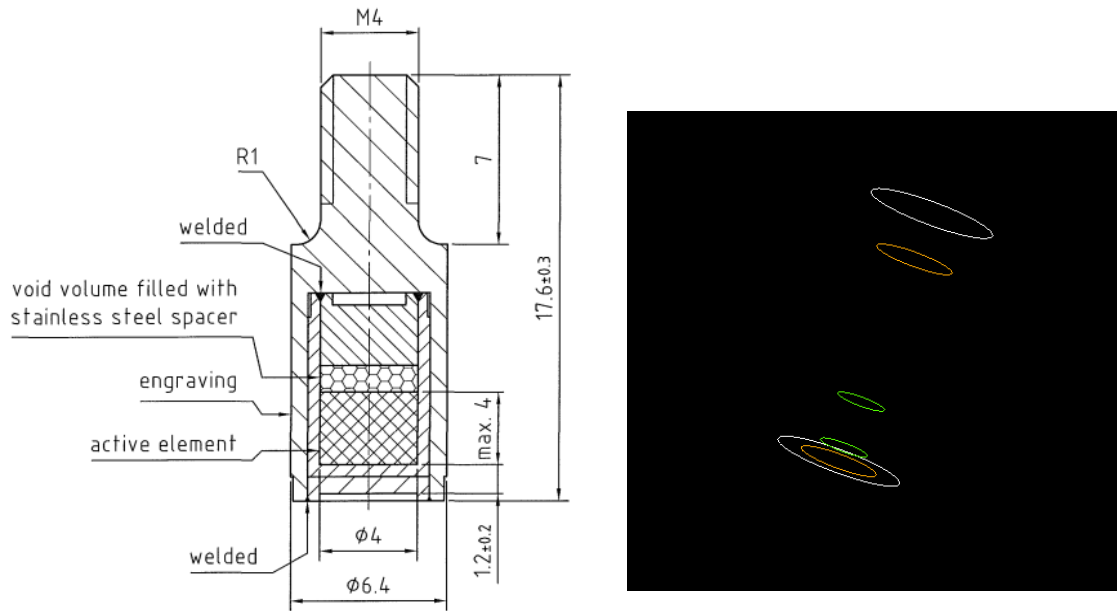


Simulation of AmBe measurements with LIME @LNGS

CYGNO Simulation Meeting – 16 January 2023

F. Di Giambattista

AmBe neutron source



<https://rifj.ifj.edu.pl/handle/item/217>

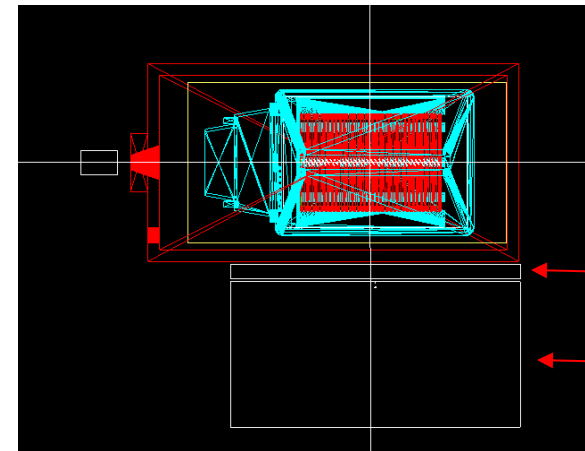
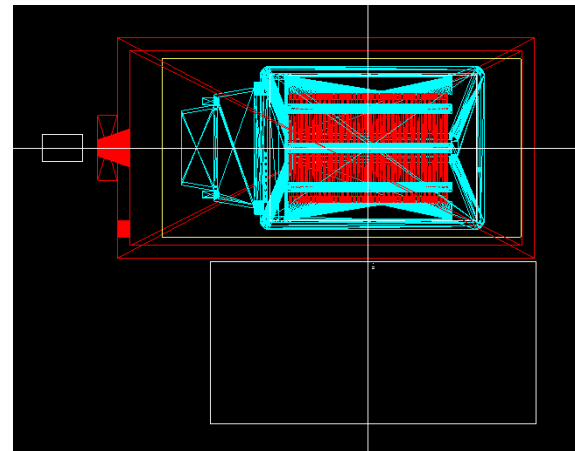
- Simplified geometry in GEANT4:
 - Capsule: stainless steel cylinder with 6.4mm diameter, 17.6mm height
 - AmBe source: cylinder made of homogeneous mix of AmO₂ and Be, 4mm diameter, 4mm height

- Neutrons generated from AmBe disk with standard ISO spectrum
- 59 keV gammas from ²⁴¹Am decay to ²³⁷Np (~10⁵ gammas per neutron)
- 4.38 MeV gammas from α + ⁹Be → ¹²C* + n (~58%)

<https://www.sciencedirect.com/science/article/abs/pii/S0969804307001200>

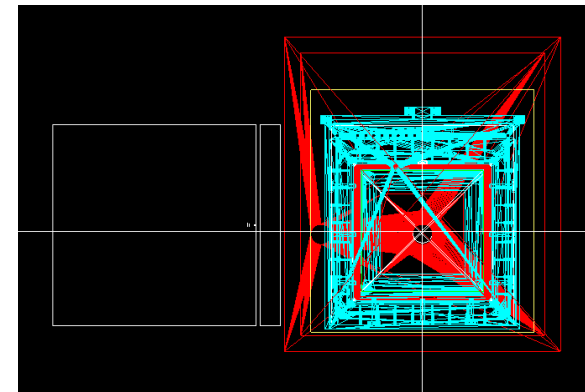
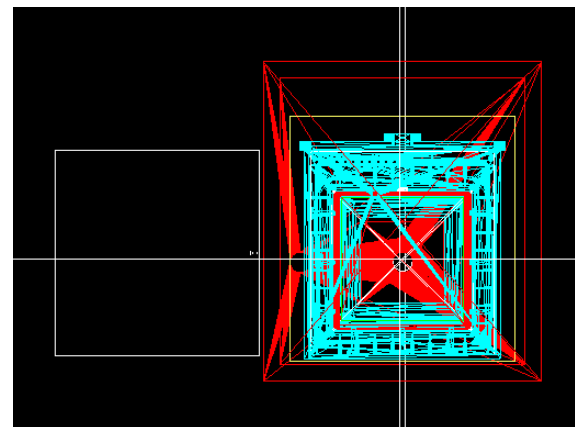
GEANT4 geometry setup

- Copper shielding, 4cm thickness on all sides
- 100x50x50 cm³ polyethylene box, with cylindrical hole on a side to accommodate the source capsule
- Tested both with or without a 5cm lead slab between LIME and the polyethylene box



lead

polyethylene

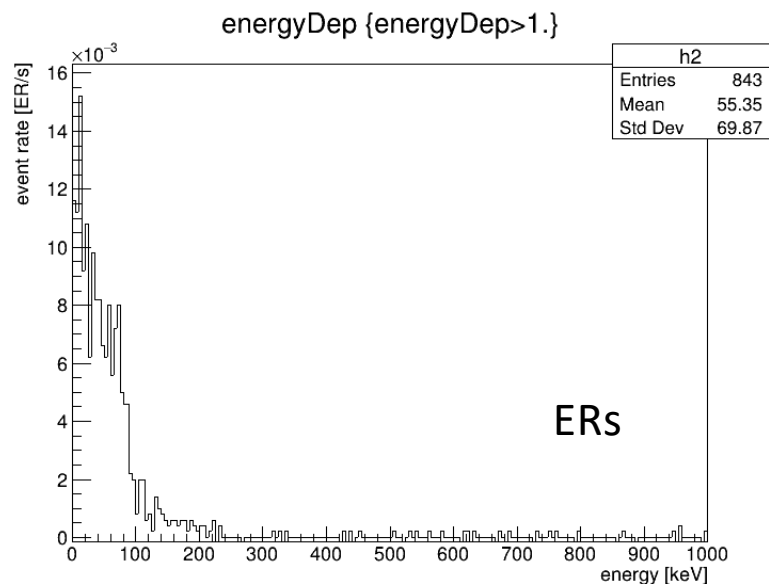


Without lead

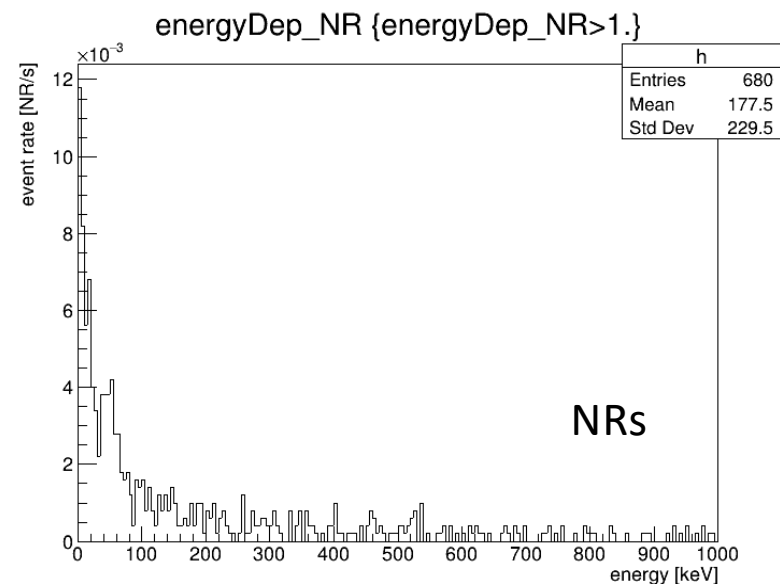
With lead

Neutron simulation

- Simulated neutrons in the no-lead configuration
- Neutron rate: 200 n/s



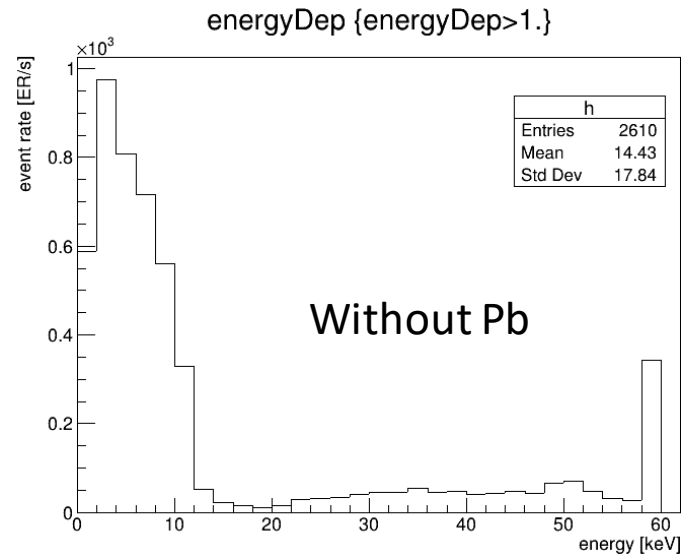
0.171 ER/s above 1keV
0.124 ER/s above 20keV



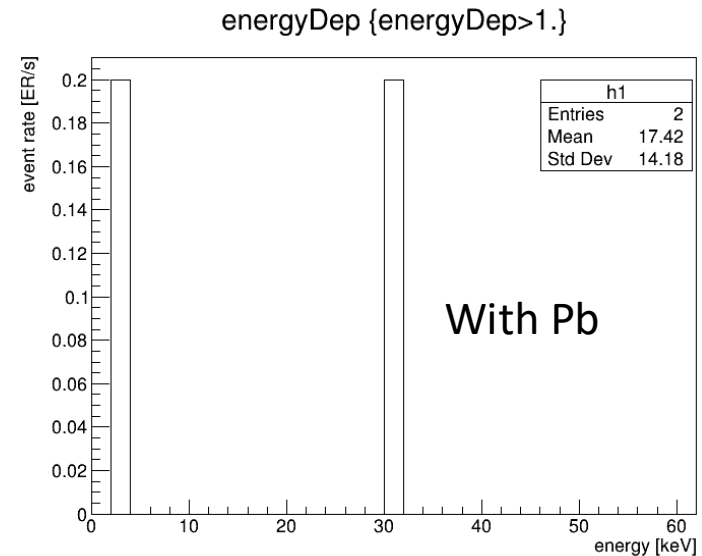
0.136 NR/s above 1keV
0.104 NR/s above 20keV

59keV gamma simulation

- About 10^5 gammas per neutron emitted
- Gamma rate: 2×10^7 gammas/s



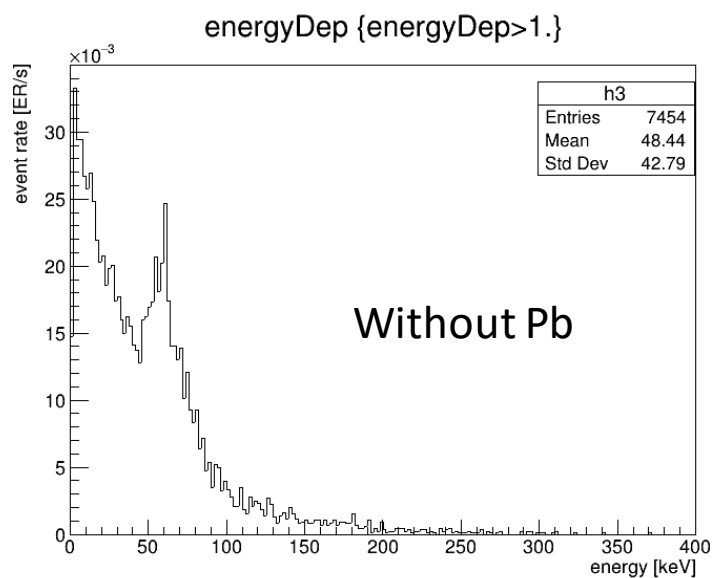
5220 ER/s above 1keV
1144 ER/s above 20keV



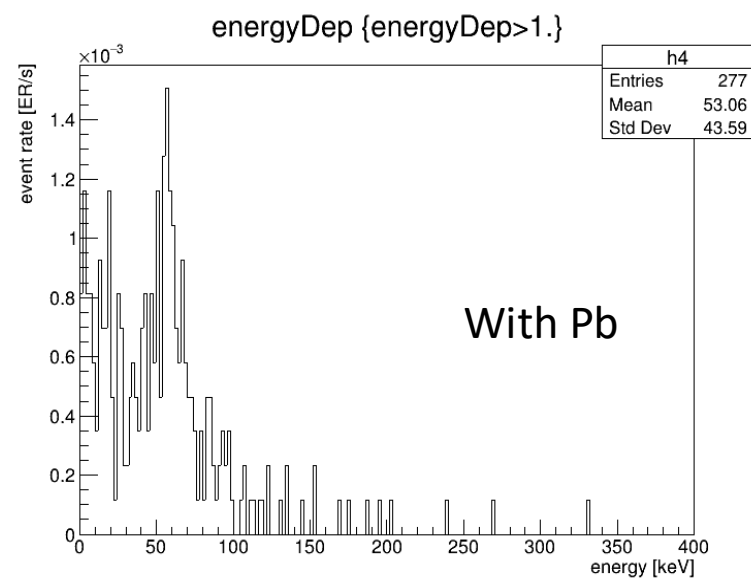
0.4 ER/s above 1keV
0.2 ER/s above 20keV

4.38MeV gamma simulation

- 0.58 gammas per neutron emitted (58% of decays in excited state of ^{12}C)
- Gamma rate: 116 gammas/s



0.86 ER/s above 1keV
0.61 ER/s above 20keV



0.032 ER/s above 1keV
0.024 ER/s above 20keV

Summary table

Shielding	External		Internal		Shielding radioactivity		Total	
	ER/yr	NR/yr	ER/yr	NR/yr	ER/yr	NR/yr	ER/yr	NR/yr
No shield	1.13e9	1450	7.26e6	6.11e4	-	-	1.14e9	6.25e4
4cm copper	2.64e7	850	7.26e6	6.11e4	6.7e5	0	3.43e7	6.19e4
6cm copper	9.40e6	980	7.26e6	6.11e4	6.4e5	0	1.73e7	6.21e4
10cm copper	1.95e6	915	7.26e6	6.11e4	5.7e5	0	9.78e6	6.20e4
40cm water + 10cm copper	5.09e5	2.0	7.26e6	6.11e4	5.7e5	0	8.34e6	6.11e4

Rates refer to events >1 keV