Preliminary simulations of AmBe in LIME

Stefano Piacentini

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Recap: the AmBe source

Slide by Giulia

- AmBe source is made of $^{241}AmO_2$ and ^{9}Be
- ^{241}Am decay:
  - Radioactive ^{241}Am has a half-life of 432.2 years and decays via α emission (five different energies averaging 5 MeV) to ^{237}Np.
  - The dominant energy of the resulting background gamma-rays from the decay of the intermediate excited states in ^{237}Np is 59.5 keV.
  - Fast neutrons are produced when the decay α particles interact with 9Be.
- (α ,n) reaction with ^{9}Be

  α +9Be → 12C+n (~42%),

  α +9Be → $12C^*$ +n (~58%),

  $12C^*$ → 12C+γ (4.38 MeV)

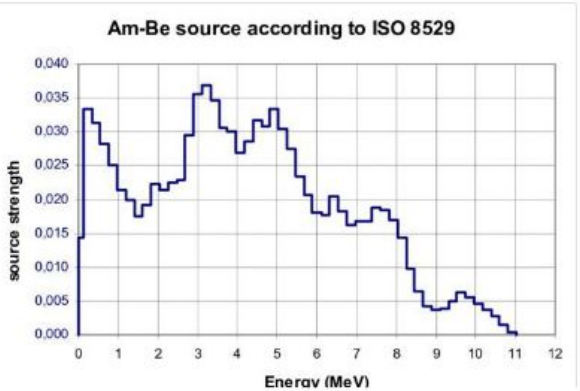
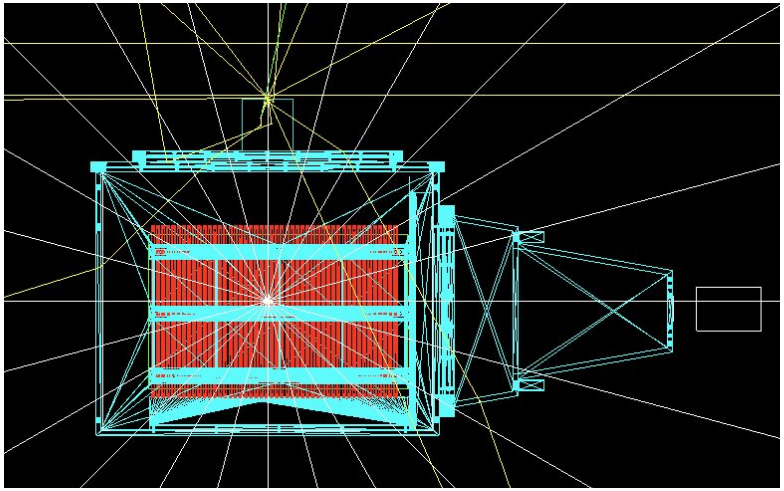


Fig. from https://rifj.ifj.edu.pl/handle/item/217

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

Simulation details

- The source emits in an isotropic way
- There's a lead cube of 10x10x10 cm^3 between the source and the detector



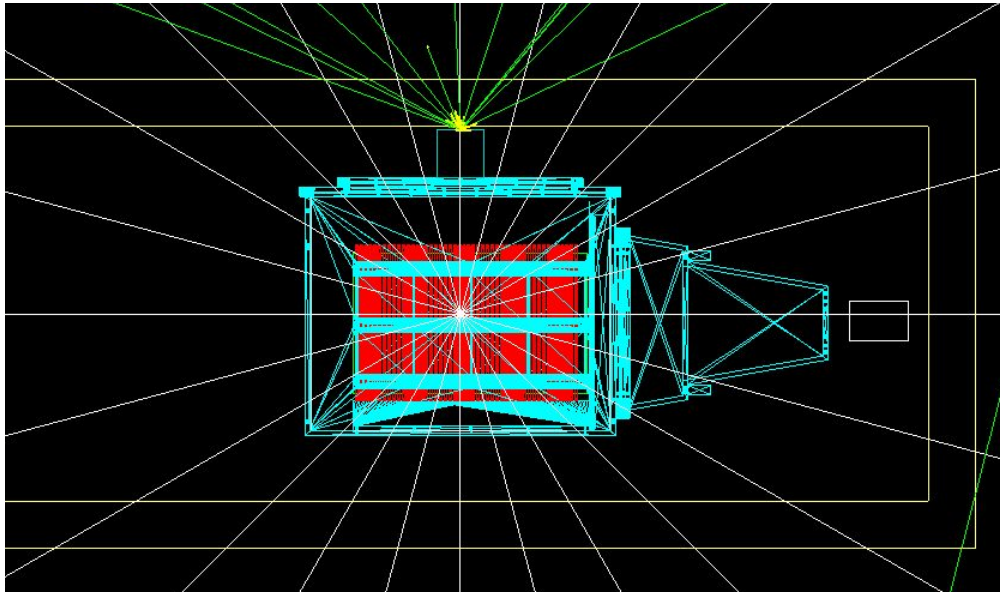
With respect to the last presentation, some runs with higher statistics have been performed:

- 10^7 neutrons with the spectrum of the last slide ---> 4.6×10^3 events produced
- 10^5 gammas @ 4.38 MeV ---> 2.2×10^4 events produced
- 10^6 ^{241}Am decays ---> 0 events produced

^{241}Am simulation

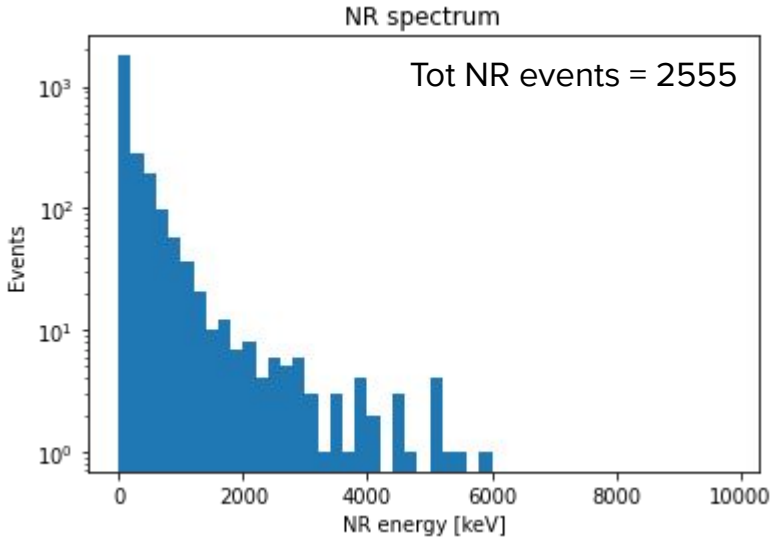
The simulation of the ^{241}Am decay produced 0 events.

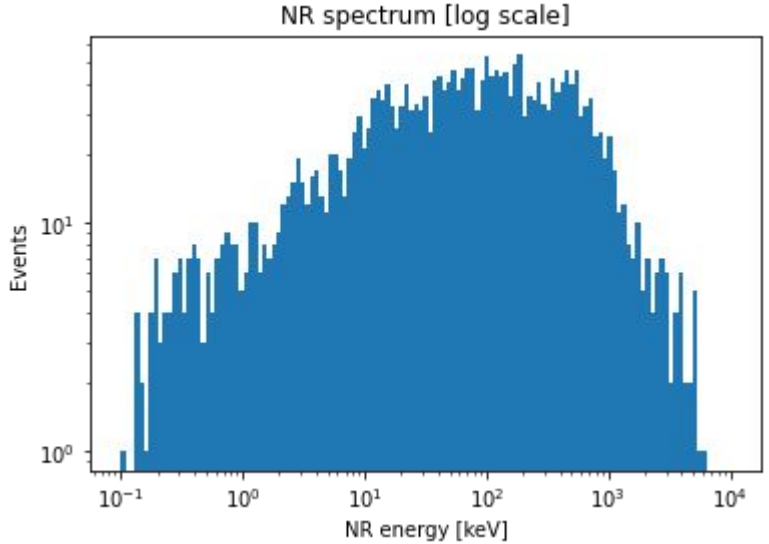
The reason is that the lead block completely shields these particles (mostly gammas @ 59.5 keV).



Neutrons simulation: NR spectrum

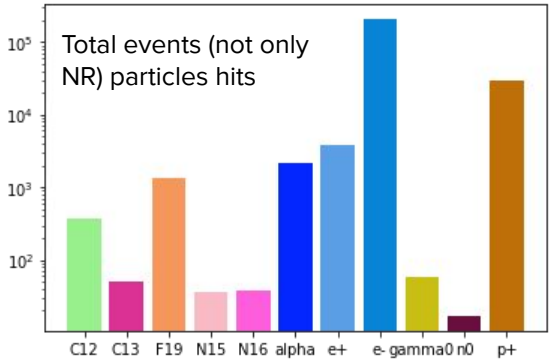
Selecting NR events is quite easy: there must be a nucleus and some NR energy deposit.

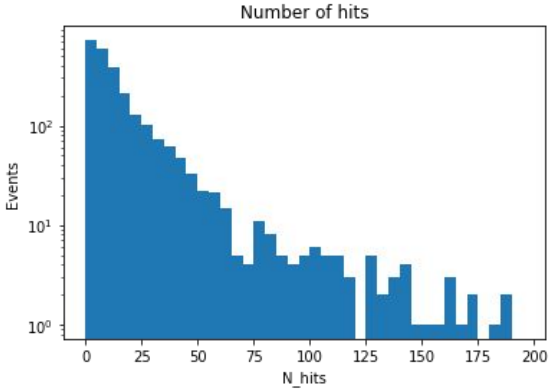


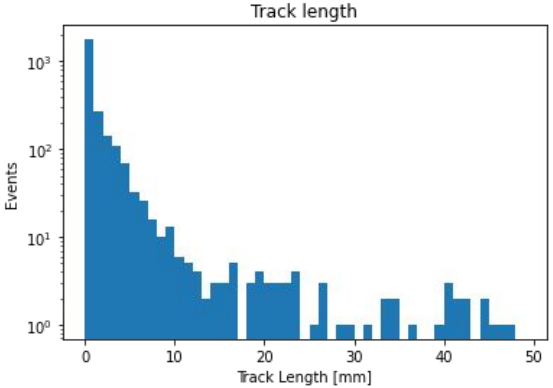


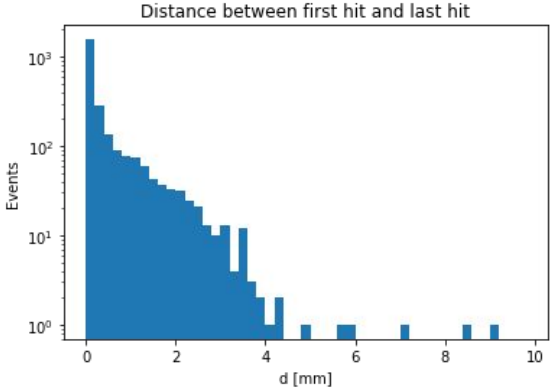
Tot neutrons generated / NR inside the detector = 0.2555 %

NR spectrum: events and dimensions









How to identify ER events [in progress]

Selection ER events is a bit more complex:

- There must be electrons
- There must not be positrons or ionizing particles like protons, etc.
- The track has to begin inside the detector active volume: otherwise how can be sure that the electron we are looking is not part of a pair produced by some photon?
- In the case of the gammas simulation, a single event can have multiple tracks, so one have to look at the single tracks to get the right energy spectrum.

To conclude: I’m currently trying to find out a way to select the ER events in a rigorous way.

Any suggestion at this point is very welcome.

Conclusions

- With respect to my last presentation, I did a bit of work on simulations with higher statistics.
- I obtained the NR spectrum resulting from a neutron source with an original spectrum consistent with the AmBe source expected one.
- I’m currently trying to find out what is the most rigorous way to select the ER events to get the ER energy spectrum.
- As a gas mixture I used the usual $HeCF_4$, but once I get the ER spectrum the next step will be to see what happens with $ArCF_4$.