

Preliminary simulations of AmBe in LIME

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CYGN simulation meeting

AmBe source

- AmBe source is made of $^{241}\text{AmO}_2$ and ^9Be
- ^{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 ^9Be
 $\alpha + ^9\text{Be} \rightarrow ^{12}\text{C} + n$ (~42%),
 $\alpha + ^9\text{Be} \rightarrow ^{12}\text{C}^* + n$ (~58%),
 $^{12}\text{C}^* \rightarrow ^{12}\text{C} + \gamma$ (4.38 MeV)

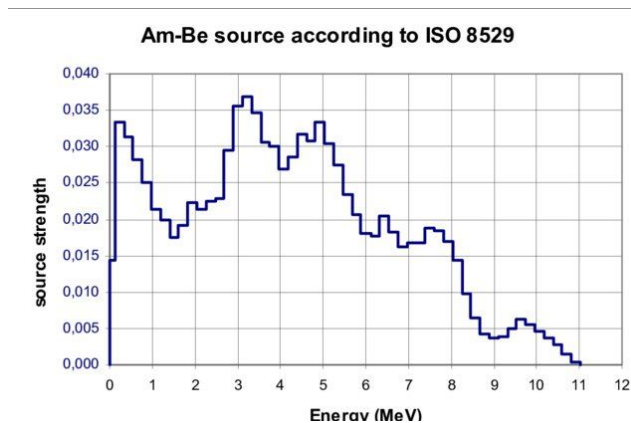
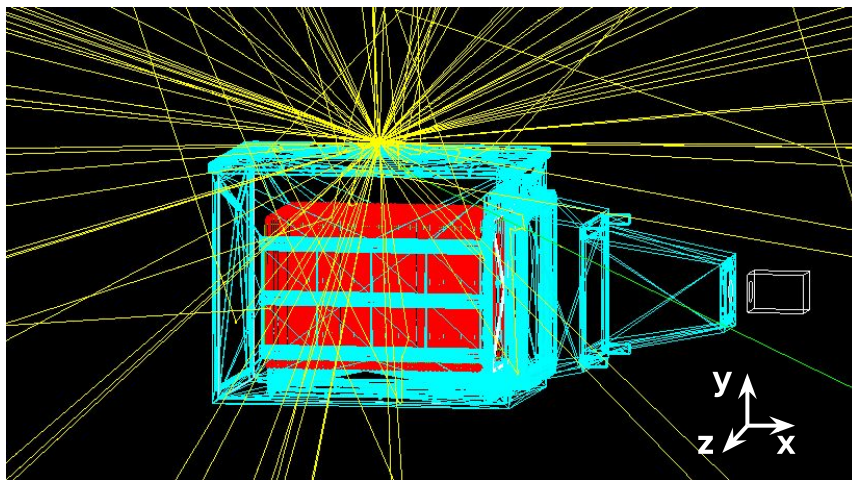


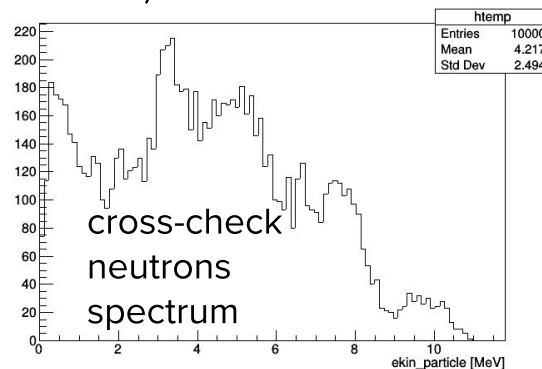
Fig. from
<https://rifj.ifj.edu.pl/handle/item/217>

AmBe simulation in LIME

- LIME simulation code <https://github.com/CYGNUS-RD/CYGN0-MC/tree/lime>
- Added macros in the macro directory to simulate separately:
 - neutrons with spectrum from figure in previous slide
 - 4.438 MeV gammas
 - ^{241}Am decay (mostly gammas at 59.5 keV)
- Position of the source about 4 centimeters above the LIME box

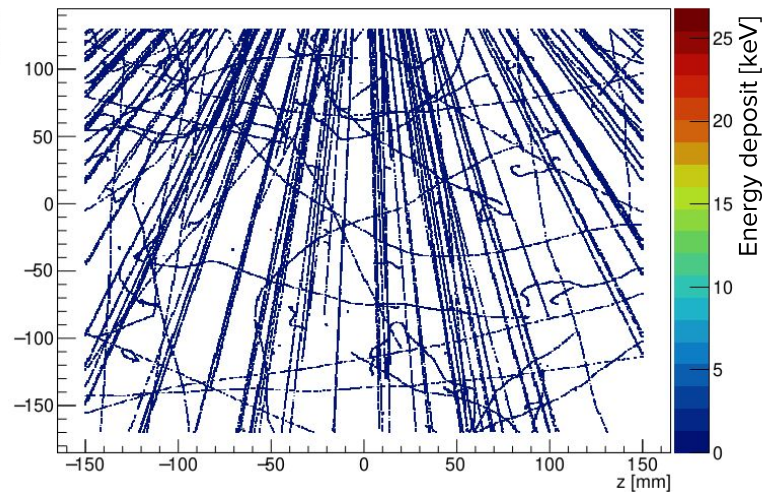
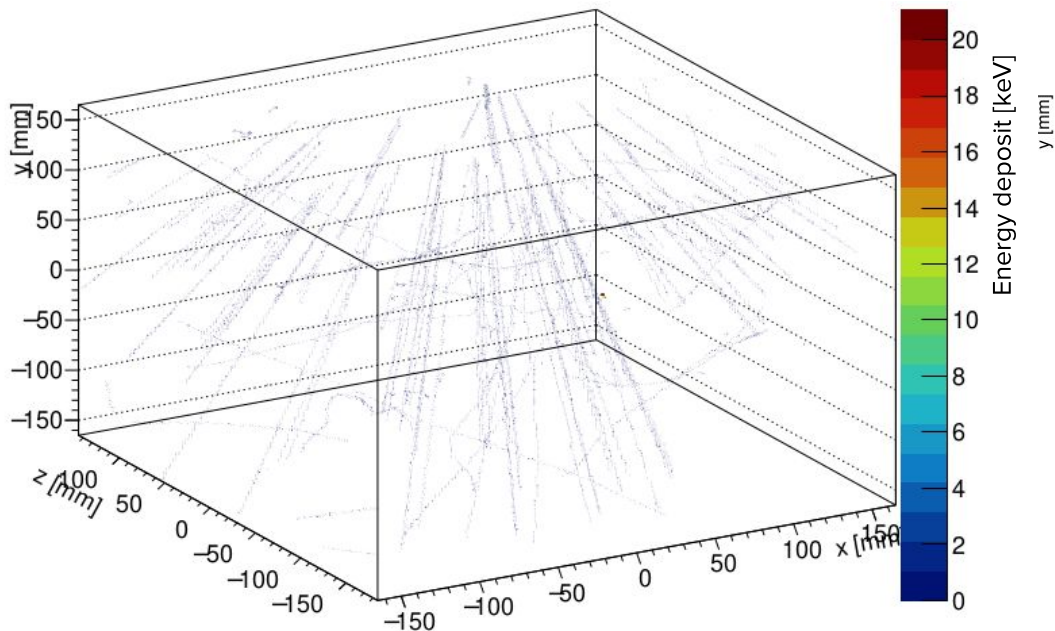


(no lead between source and detector)



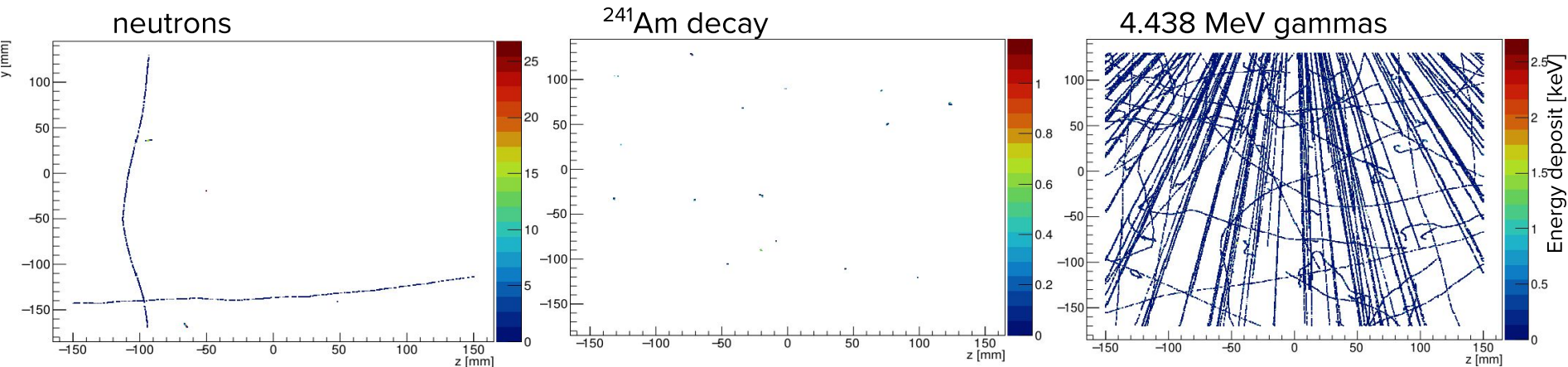
AmBe tracks in LIME

- 10000 generated neutrons → 6 tracks (4 NR + 2 ER)
- 10000 generated Am decays → 16 tracks
- 6000 generated gammas 4.438 MeV → 103 tracks



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- Note the scale in the color palette: nuclear recoils have more dense energy release
- Note that these are 10000 source events superimposed:
 - only in 58% of cases the events with NR have also a gamma of 4.438 MeV
 - in most cases only tracks from gammas and no neutron events

Summary and to do list

- Code and macros for AmBe simulations are ready (on github)
- Simple checks on few events look reasonable
- Need to produce more events for systematic studies:
 - study the energy spectrum of ER and NR
 - study source AmBe acceptance/source intensity needed for LIME measurements in order to study feasibility of Migdal effect with LIME
 - apply digitization + noise
 - study reconstruction performance on simulated images