LIME Simulations – Internal Background

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OUTLINE

- Objectives
- Simulation Results – Internal Background
    - Camera body
    - Camera lens
- Conclusions and Future work

Objectives

Test technology underground with some shielding to verify we can supress the background as much as possible for the CYGNO 1 m3 detector -> **Zero events inside the detector**

Test the technology with some small shielding to have a significant number of neutrons interacting inside the detector, but with very few gammas -> **Measure the neutron flux**

From last presentation we've seen that...

Due to practical reasons (space availability at LNGS) this might be a problem (depending on the internal background, in particular of the camera).

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Simulations focused on the camera radioactive background which is the major source of unavoidable natural radioactivity.

LIME Internal Background

LIME Internal Background

- Internal background of the camera body and lens measured at LNGS.

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sample:         camera, Hamamatsu, orca-flash4.0, 2.1275 kg, CYGNO
number:         1
live time:      83383 s
detector:       GeMPI

radionuclide concentrations:

Th-232:
Ra-228:         (2.1 +- 0.2) Bq/pc
Th-228:         (2.1 +- 0.1) Bq/pc

U-238:
Ra-226          (1.8 +- 0.1) Bq/pc
Pa-234m         (7 +- 2) Bq/pc

U-235:          (0.4 +- 0.1) Bq/pc

K-40:           (1.9 +- 0.3) Bq/pc

Cs-137:         (0.09 +- 0.03) Bq/pc

Co-60:          < 0.012 Bq/pc   @ start of measurement: 12-JUL-2018

upper limits with k=1.645,
uncertainties are given with k=1 (approx. 68% CL);

Ra-228 from Ac-228;
Th-228 from Pb-212 & Bi-212 & Tl-208;
Ra-226 from Pb-214 & Bi-214;
U-235 from U-235 & Ra-226/Pb-214/Bi-214
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sample:         objective of Hamamatsu orcaflash4.0, 213.5 g (with plastic cap), CYGNO
number:         1
live time:      504104 s
detector:       GePaolo

radionuclide concentrations:

Th-232:
Ra-228:         (0.077 +- 0.009) Bq/pc
Th-228:         (0.078 +- 0.006) Bq/pc

U-238:
Ra-226          (0.41 +- 0.02) Bq/pc
Pa-234m         (0.9 +- 0.3) Bq/pc

U-235:          (0.031 +- 0.008) Bq/pc

K-40:           (11 +- 1) Bq/pc

Cs-137:         < 0.0057 Bq/pc

Co-60:          < 0.0099 Bq/pc  @ start of measurement: 10-JUL-2018

La-138:         (0.52 +- 0.04) Bq/pc

upper limits with k=1.645,
uncertainties are given with k=1 (approx. 68% CL);

Ra-228 from Ac-228;
Th-228 from Pb-212 & Bi-212 & Tl-208;
Ra-226 from Pb-214 & Bi-214;
U-235 from U-235 & Ra-226/Pb-214/Bi-214
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Main contributions identified.

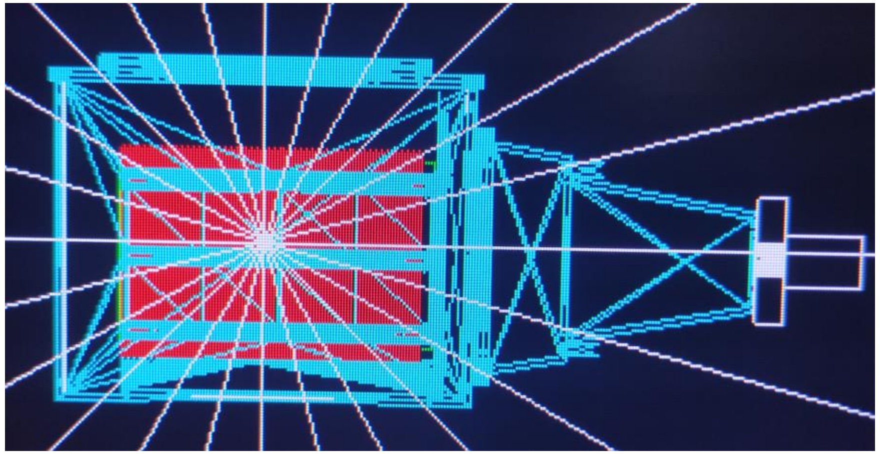
LIME Internal Background

- Internal Background Camera Body is originated mainly by:
  - Th-232 (0.98 Bq/kg)
  - U-238 (18.72 Bq/kg)
  - U-235 (0.188 Bq/kg)
  - K-40 (0.893 Bq/kg)

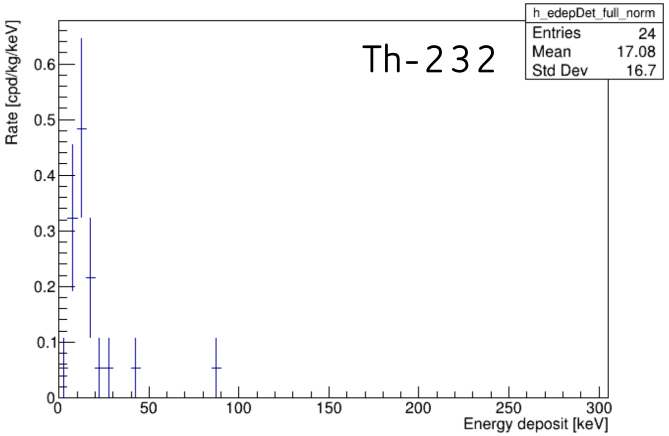
Simulations:

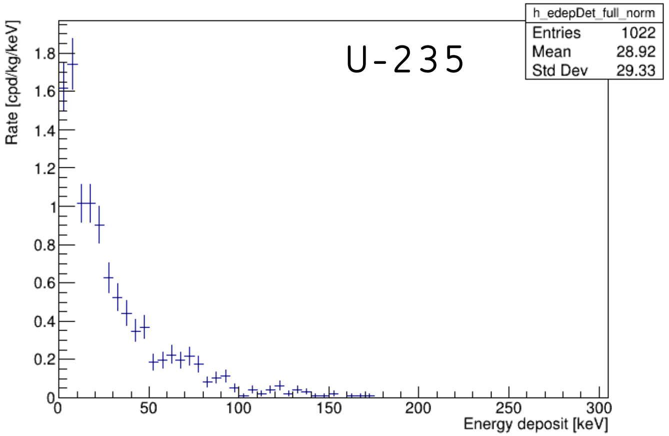
- 10M events per radioactive isotope
- Camera and Lens (treated separately)
- No shield

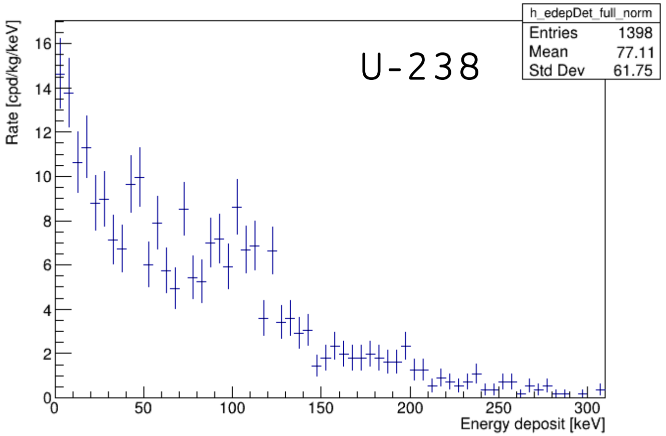
- Internal Background Camera Lens is originated mainly by:
  - Th-232 (0.726 Bq/kg)
  - U-238 (6.15 Bq/kg)
  - U-235 (0.145 Bq/kg)
  - K-40 (51.5 Bq/kg)
  - La-138 (2.44 Bq/kg)

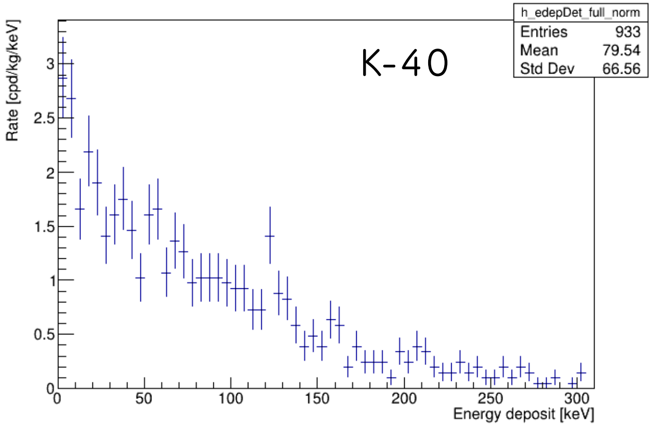


LIME Internal Background – Camera Body





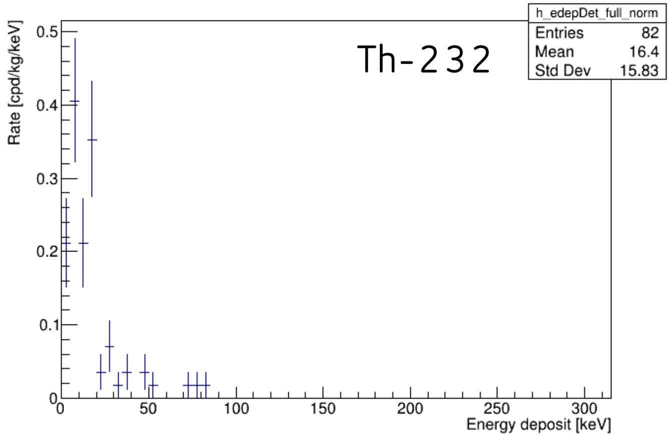


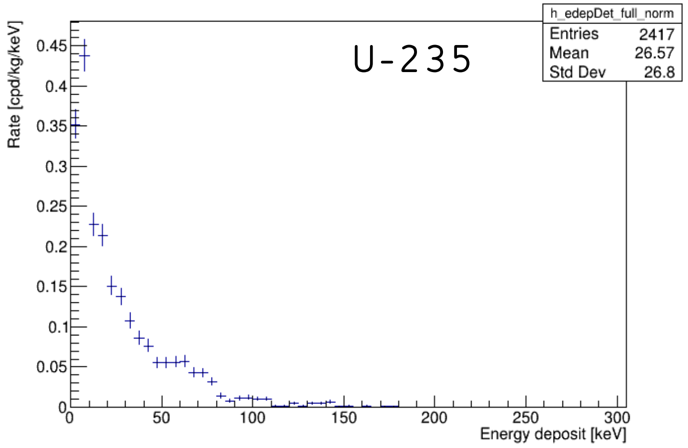


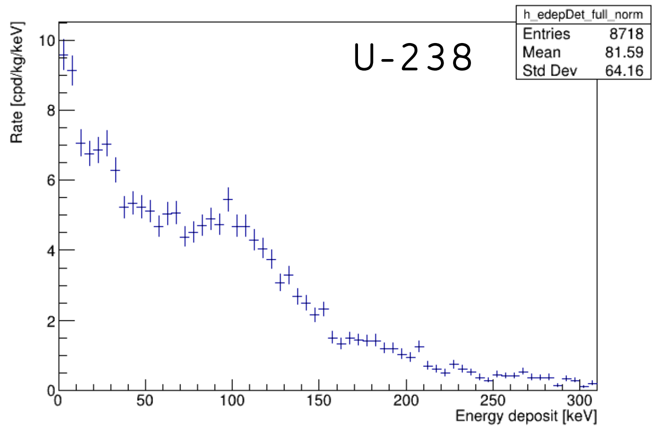
Camera body mass: 2.1272 kg

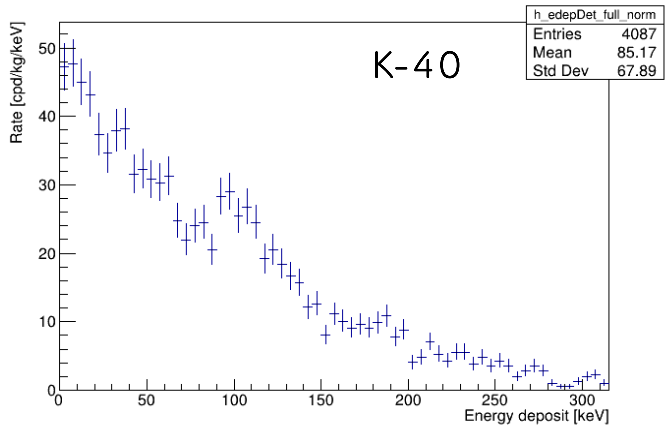
Isotope	Radioactivity	Counts [0-20] keV
Th-232	0.98 Bq/lkg	139
U-238	18.72 Bq/kg	6312
U-235	0.188 Bq/kg	676
K-40	0.893 Bq/kg	1178
Total	20.781 Bq/kg	8305

LIME Internal Background – Camera Lens







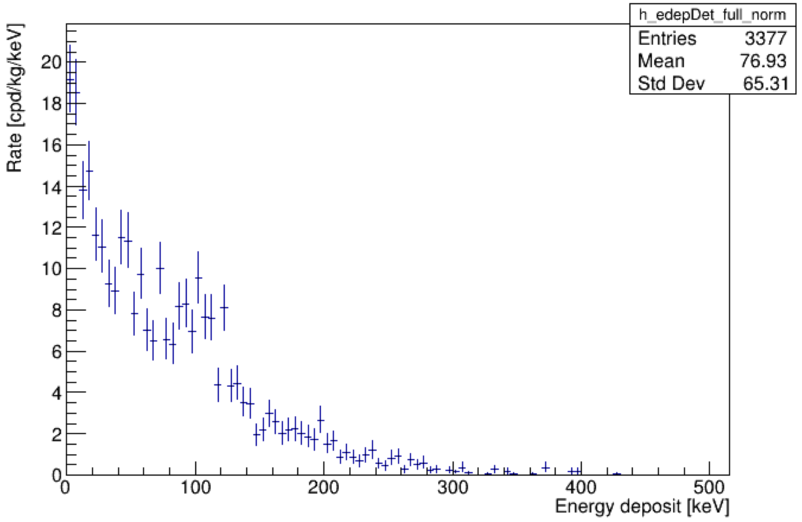


Camera ens mass: 0.2135 kg

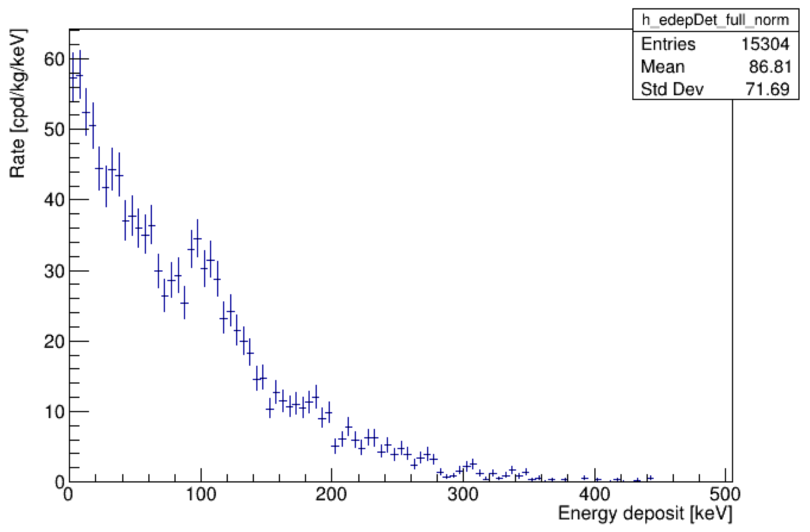
Isotope	Radioactivity	Counts [0-20] keV
Th-232	0.726 Bq/kg	148
U-238	6.15 Bq/kg	4076
U-235	0.145 Bq/kg	154
K-40	51.5 Bq/kg	22961
La-138	2.44 Bq/kg	0
Total	60.961 Bq/kg	27339

LIME Internal Background – Camera body + lens

Energy deposit rate (Camera body)

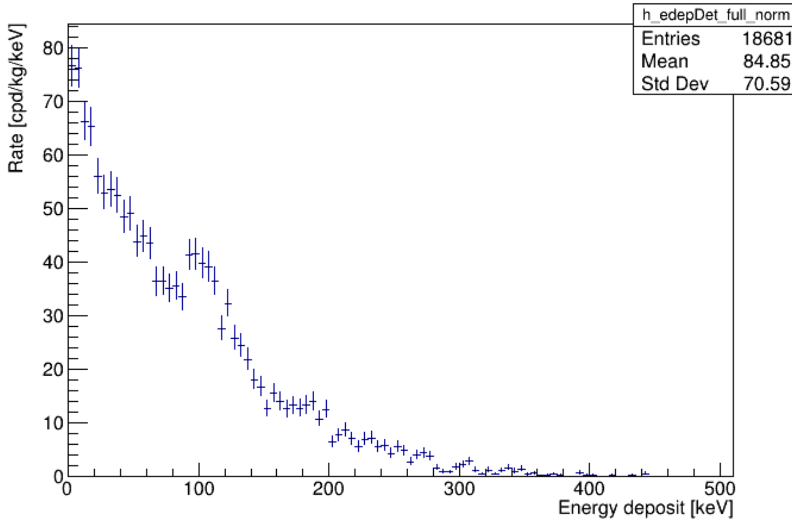


Energy deposit rate (Camera lens)



Major radioactive source from the camera.

Energy deposit rate (Full camera)



	Counts [0-20] keV
Total	35644

Close to the goal 10^4 events/year

Conclusions and Future work

- Simulation of LIME internal background started;
- First results for the camera background without shielding completed;
- Values obtained suggest that we are close to the objective (close to 10^4 events/year) full camera without shielding;
- Major source of the background is the camera lens (about ¾ of the entire background produced);
- Results seem to be in accordance with what is expected for CYGNO 1 m3 (about 10^6 events/year);
- Shielding for the camera body implemented for LIME;

- Re-do the simulation for the camera body with shielding (Cu) with different thicknesses
- Resume with the simulation of the GEM structure, field rings, cathode and support structures;
- Optimize the shielding considering the space available;

Thank you!