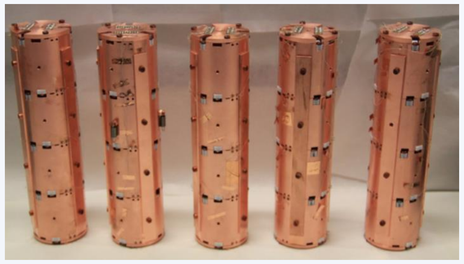
Calibration of $Li_2{}^{100}MoO_4$ bolometers with ^{56}Co sources for searches of $0\nu2\beta$ decay of ^{100}Mo

M.M. Zarytskyy on behalf of the CUPID-Mo Collaboration

Institute for Nuclear Research of NASU, 03028 Kyiv, Ukraine

CUPID-Mo EXPERIMENT

CUPID-Mo [1], located in the Modane underground laboratory (France), is a demonstrator for the future ton-scale double beta decay experiment CUPID [2]. CUPID-Mo uses an array of 20 ^{100}Mo-enriched $Li_2{}^{100}MoO_4$ (LMO) low-temperature scintillating bolometers in the 5 towers to search for neutrinoless double-beta decay ($0\nu2\beta$) of ^{100}Mo.



The detectors exhibit extremely high energy resolution (FWHM~6 keV for 2615 keV gamma-quanta) investigated with Th/U sources. However, a dirrect measurement of the energy resolution at Q-value of ^{100}Mo (3034 keV) is impossible with a Th/U source. It is crucial to cross check the calibration and the energy resolution by means of sources providing gamma peaks at energies higher than the range of interest of ^{100}Mo.

In order to improve the precision, we are going to use a ^{56}Co source, that has several gamma-quanta with energies in the region of interest, for the energy calibration of the detectors.

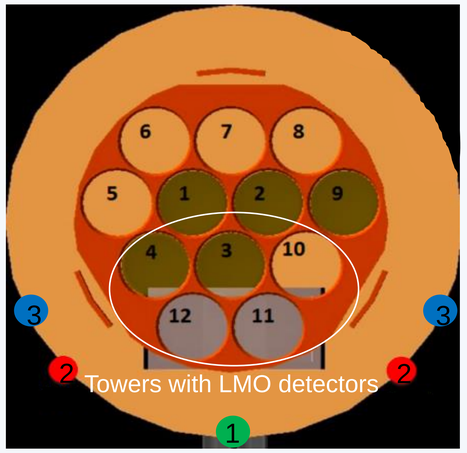
OBJECTIVES

The ^{56}Co sources is used for the calibration of LMO detectors in the range of interest at 3034 keV.

The detectors response has been simulated to optimize the position and activity of the sources so that the total counting rate does not exceed 1/6 Hz.

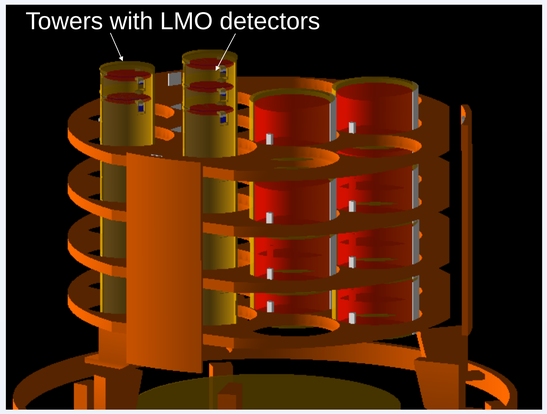
The next ^{56}Co calibration sources configurations were simulated:

1. One source
2. Two sources (where Th/U sources are placed)
3. Two sources shielded by Cu bars



MONTE-CARLO SIMULATIONS

The Geant4 [3] geometry implementation of CUPID-Mo detectors inside the EDELWEISS cryostat used for the Monte-Carlo simulations.

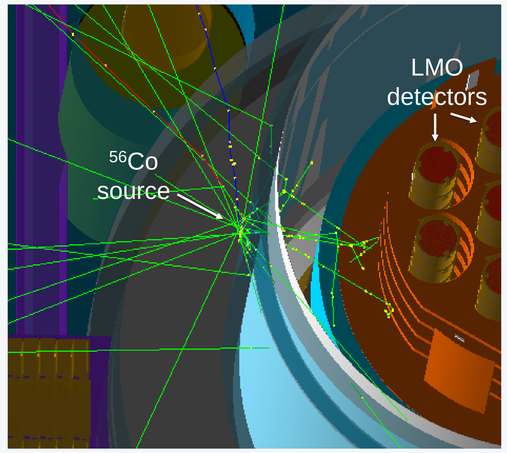


The ^{56}Co source volume represented with Ø 1 × 10 mm iron wire with the mass of 0.62 g.

The sources were placed in different configurations inside the lead shield facing the 300K screen. The wires height is centered with the respect to detectors positions.

For the ^{56}Co decay generation the Geant4 decay physics referenced to ENSDF database was used.

The visualization of 10 ^{56}Co decays inside the source volume of the configuration #1. The green lines are the tracks of gamma quanta.



RESULTS

Average overall gamma rate (10^{-3} counts per decay) for each tower

Configuration	Tower 10	Tower 11	Tower 12	Tower 3	Tower 4
1	1,476(7)	3,62(1)	3,59(1)	1,919(8)	1,45(7)
2	3,28(1)	4,74(1)	4,73(1)	3,14(1)	3,24(1)
3	3,050(7)	2,498(7)	2,488(7)	2,084(6)	2,989(7)

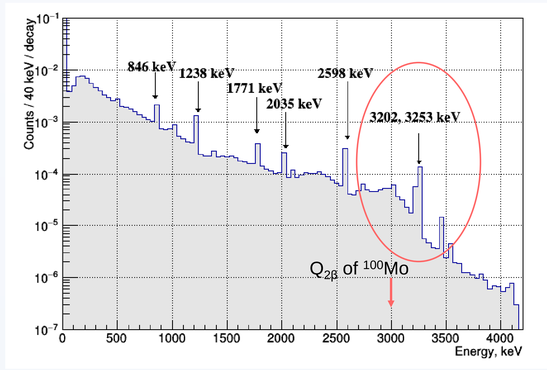
Average overall peak rate (10^{-6} counts per decay) at 3253 keV for each tower

Configuration	Tower 10	Tower 11	Tower 12	Tower 3	Tower 4
1	0,5(1)	1,4(2)	1,4(2)	0,6(1)	0,4(1)
2	1,2(2)	1,6(2)	1,8(3)	1,2(2)	1,2(2)
3	1.0(1)	0,8(1)	0,8(1)	0,7(1)	1.0(1)

According to the fact that the single detectors rates need to be below 1/6 Hz, the maximum activity of ^{56}Co source can be calculated using the highest overall gamma rate per detector. With this value the lowest peak rate per detector at 3253 keV can be estimated.

Configuration	Maximum source activity, Bq	Lowest peak rate, counts/week
1	42	10(2)
2	32	14(4)
3	51	19(3)

Simulated total energy spectrum of $Li_2{}^{100}MoO_4$ detectors for the ^{56}Co source configuration #3.



CONCLUSIONS

Three different configurations of ^{56}Co calibration sources were simulated to optimize the position and activity of the sources.

The Monte-Carlo simulations were performed using Gean4 toolkit with the geometry implementation of CUPID-Mo detectors inside the EDELWEISS cryostat.

The configuration of the source's position beside the Cu bars with the activity of ~50 Bq gives the highest peak rate at 3253 keV and does not exceed the total counting rate of 1/6 Hz.

This configuration is foreseen to be realized in the future calibration of $Li_2{}^{100}MoO_4$ detectors.

REFERENCES

[1] E. Armengaud et al. [CUPID-Mo collaboration], Eur. Phys. J. C, 80(1):44 (2020)

[2] CUPID pre-CDR, CUPID Interest Group, arXiv:1907.09376

[3] S. Agostinelli et al., Nucl. Instrum. Meth. A 506, 250 (2003)

CONTACTS

zaritsky96@gmail.com

CUPID-Mo POSTERS AT NEUTRINO 2020

#382 (T. Dixon)	#404 (D. Poda)	#418 (P. Loaiza)
#419 (B. Schmidt)	#448 (B. Welliver)	#525 (V. Singh)

Poster #374