Update on the environment background simulation for a 10-kg LMO prototype

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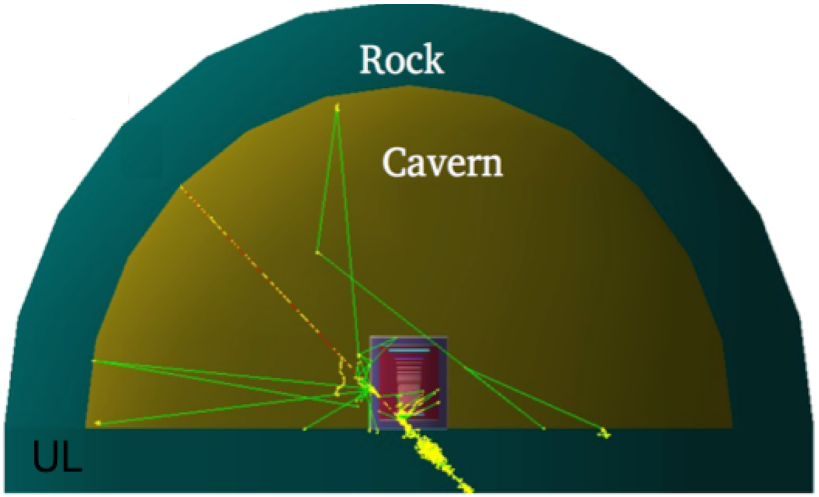
Environment γ/n background simulation

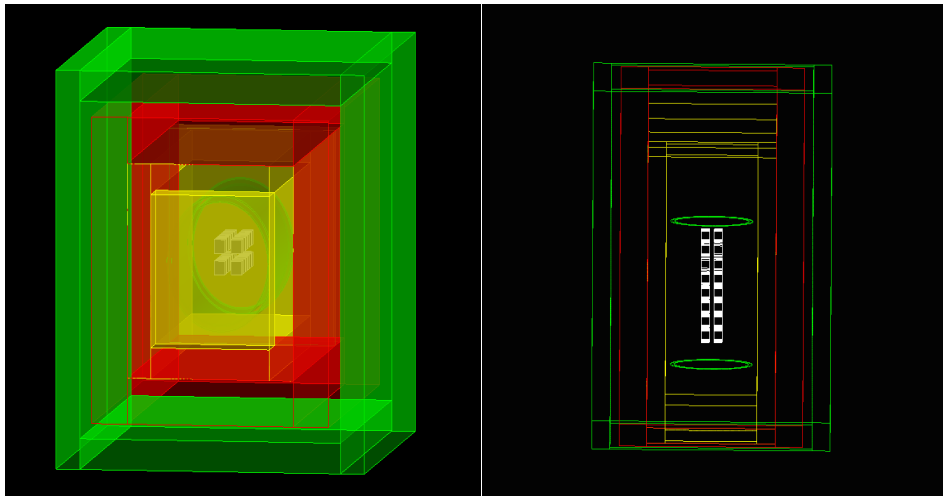
- Source generated based on the experimental measurements
- Randomized initial position and incident angle
- Using livermore_EM / QGSP_BERT_HP Physics-Lists for gamma/neutron process (compared with Standard_EM)

Background counting rates measured by the HPGe detector in this work and those estimated for the two HPGe detectors proposed in JUNA project Y. P. Shen, et al. Sci. China-Phys. Mech. Astron. October (2017)

Energy	This work		JUNA
	no shielding (per day)	shielding (per day)	shielding (per day)
>3 MeV	46.1 ± 1.3	2.35 ± 0.25	16.7 ± 1.8
6-8 MeV	1.45 ± 0.22	0.23 ± 0.08	1.64 ± 0.57

G4 Setup



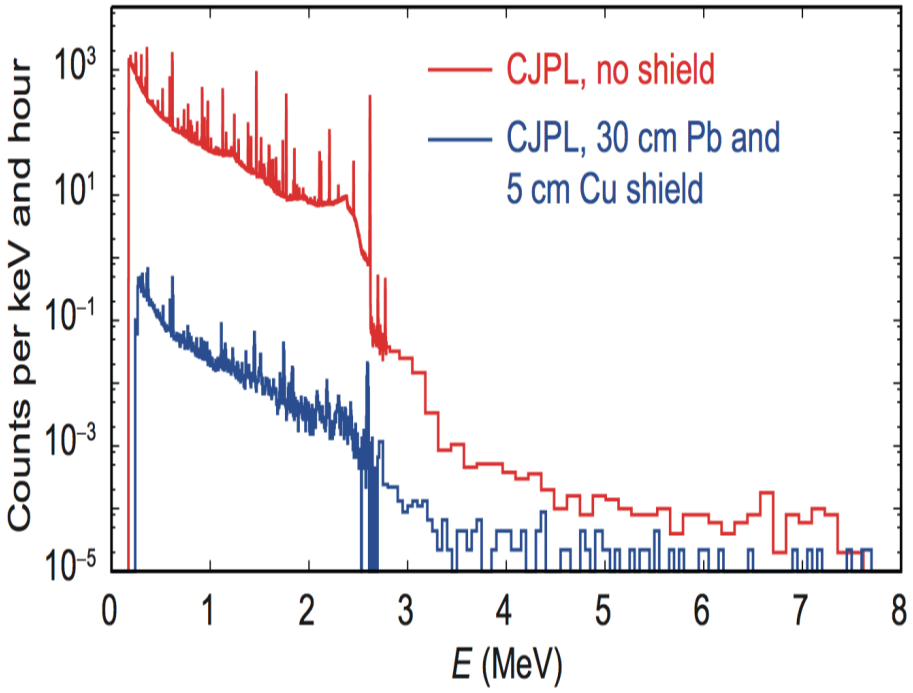


Cavern radius: 6 m
Crystal size: 4.5 x 4.5 x 4.5 cm^3
Crystal material: LMO (3.07g/cm^3)
Detector array: 4 x 9

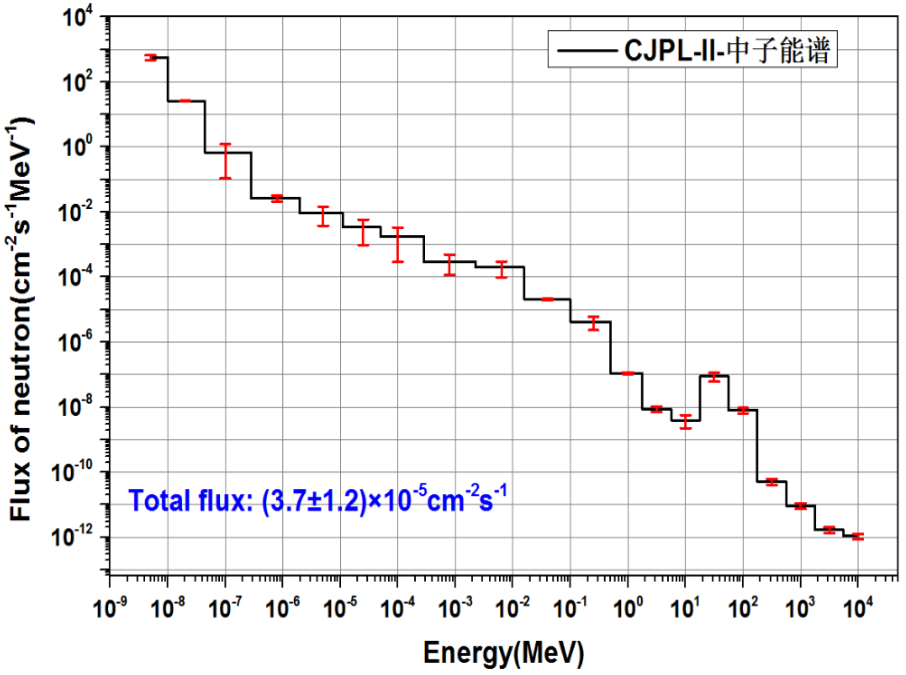
Shields	Thickness	Height
Lateral Copper	120mm	1200mm
(Lateral Lead)	100mm	1500mm
Lateral PE	150mm	1500mm
Top Copper	120mm	120mm
DR Vessels (3x)	2mm	600mm

Input gamma/neutron spectrum

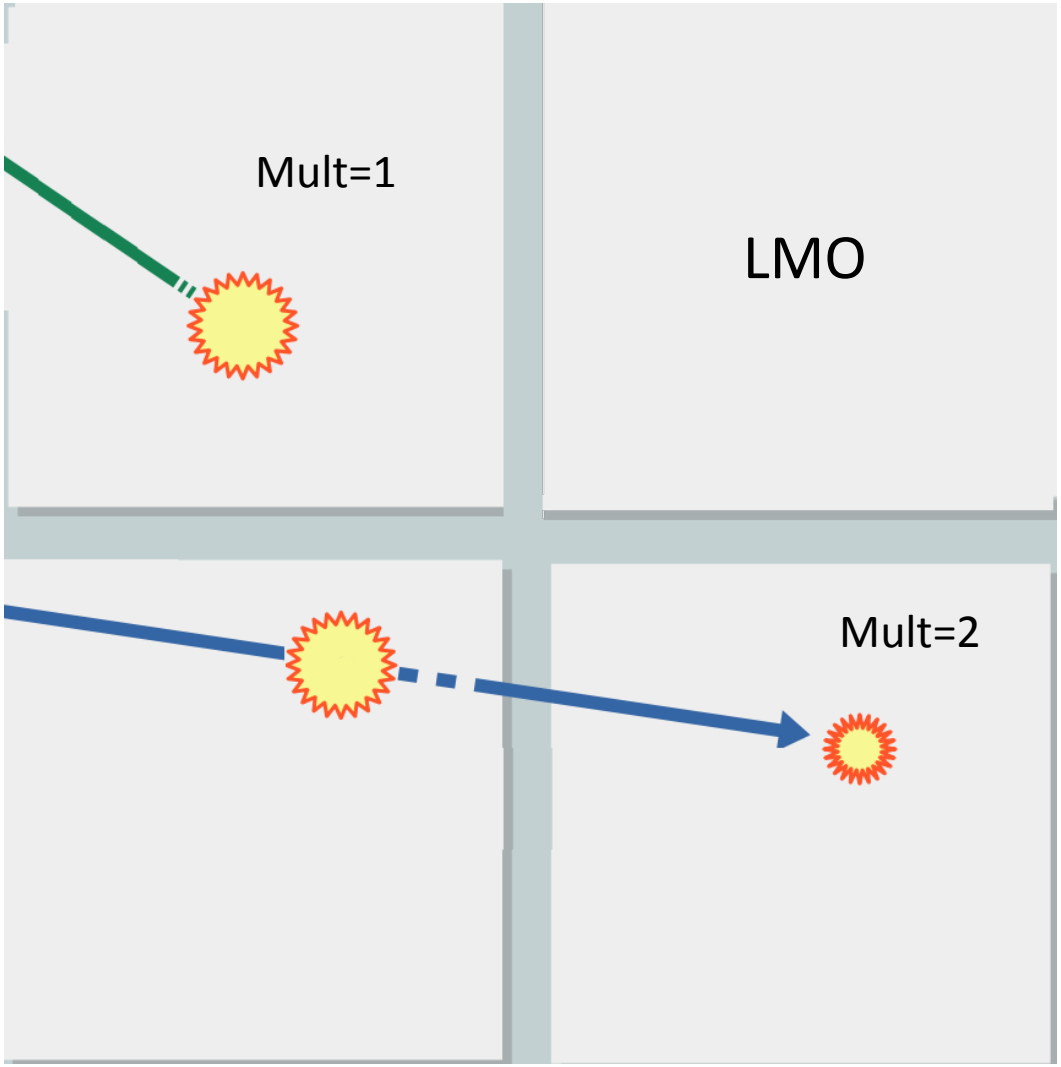
Gamma Spectrum



Neutron Spectrum

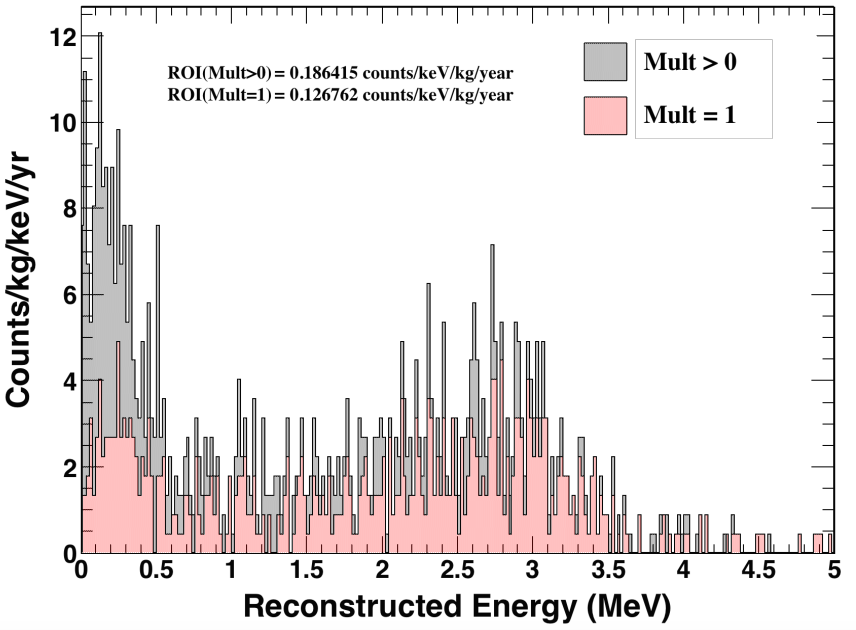


Single-site / Multi-site event

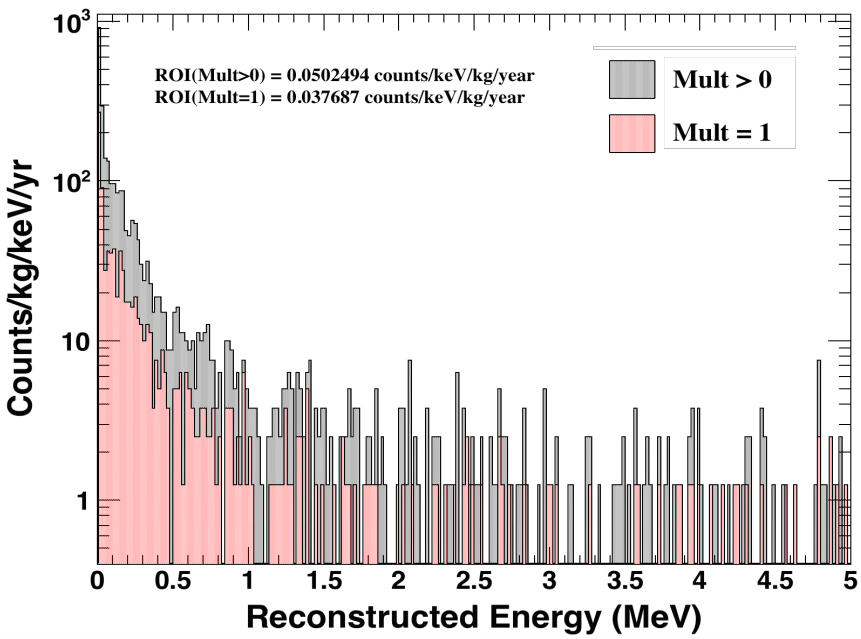


Gamma/Neutron background contribution

Gamma



Neutron



Cosmogenic background simulation

如果认为 R_i为放射性同位素 i 的产生率，那么它可以表示成以下公式：

$$R_i = \sum_j N_j \int \Phi_k(E)\sigma_{ijk}(E)dE$$

CRY　　Geant4

N_j：稳定的靶核 j 的数量

ϕ_k：宇宙射线 k 粒子的通量

σ_{ijk}:宇宙射线k粒子作用在稳定靶核j上产生放射性同位素i的反应截面

模拟过程：

- CRY产生宇宙射信息作输入
- Geant4模拟宇宙射线与物质的相互作用
- 统计宇宙线Neutron、 Proton 、 Muon 、 Gamma 入射情况下宇生放射性核素 产生率。

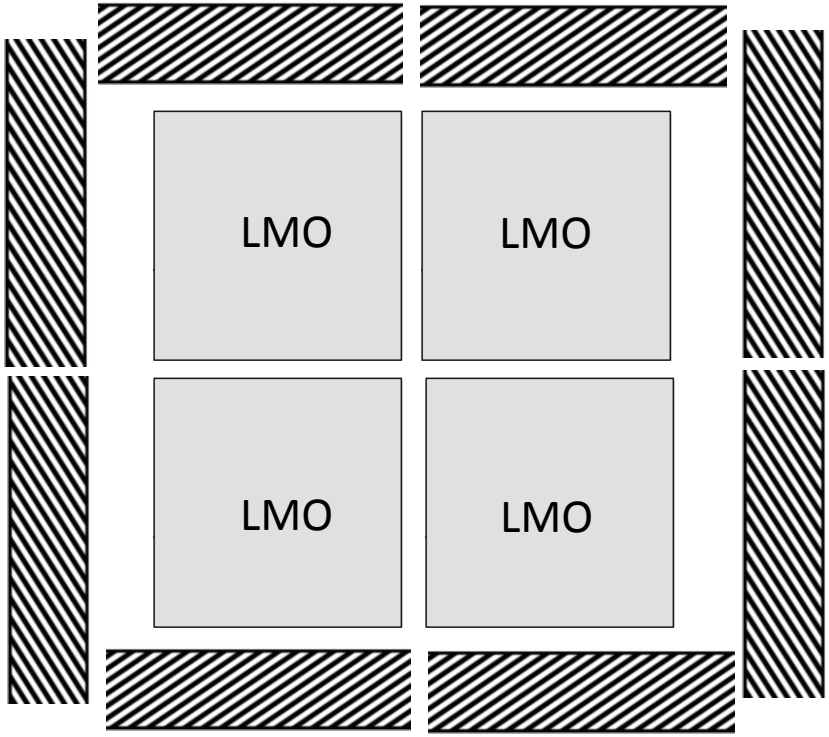
宇生核素	半衰期	衰变模式	衰变子体	产生率（北京）($day^{-1}kg^{-1}$)				
				中子	质子	μ子	伽马	总和
^{68}Ge	270.9 d	EC	^{68}Ga	73.30	5.41	0.31	4.03	83.05
^{68}Ga	67.7 m	EC or β^+	^{68}Zn	73.30	5.41	0.31	4.03	83.05
^{65}Zn	243.9 d	EC or β^+	^{65}Cu	35.14	3.64	1.23	0.46	40.47
^{63}Ni	101.2 yr	β^-	^{63}Cu	4.05	0.54	0.12	0.08	4.79
^{57}Co	271.7 d	EC	^{57}Fe	3.55	1.07	0.03	0.03	4.68
^{60}Co	5.3 yr	β^-	^{60}Ni	1.21	0.22	0.01	0.01	1.45
^{55}Fe	2.7 yr	EC	^{55}Mn	3.01	1.05	0.04	0.05	4.15
^{54}Mn	312.2 d	EC	^{54}Cr	0.67	0.24	0.01	0.02	0.94
^{49}V	330.0 d	EC	^{49}Ti	0.90	0.49	0.02	0.02	1.42
^{3}H	12.3 yr	β^-	^{3}He	18.33	4.82	0.33	0.20	23.68

From Hao Ma’s talk (CDEX)

Discussion

- Considerable environment BG contribution (at ROI)
- Additional lead shielding is necessary
- Muon induced BG in progress (cosmogenic radioactive isotope)

Background veto



NaI/CsI/natural abundance crystal