Simulation update

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CYGNO general meeting 16/07/20

Simulation activities ongoing

- MC simulations with Geant (ER) and SRIM (NR) (Fabrizio, Giulia, Davide)
- MC digitization and reconstruction (Fabrizio, Emanuele)
- PMT and CMOS simulations (Rafael, Mariana)
- Machine learning to analyze CMOS analysis (Gustavo)
- Background simulations for CYGNO and LIME (Giulia, Andrè)
- Sensitivity study (Giorgio, Andrea+Stefano)
- Solar neutrino with CYGNO (Elisabetta)

Camera and lens background in LIME

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

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

	Counts [0-20] keV
Total	35644

Close to the goal 10^4 events/year

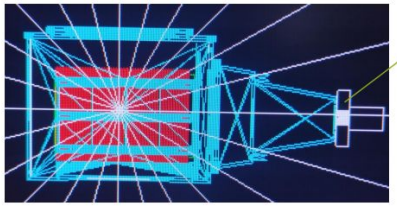
Roughly scales as expected O(100) less than CYGNO (only 1 camera and ~20 times smaller active mass)

Camera body shield

Preliminary results (Pa-234 decay missing* - files were corrupted)

- Simplistic approach used.

*updated values with ^{234m}Pa



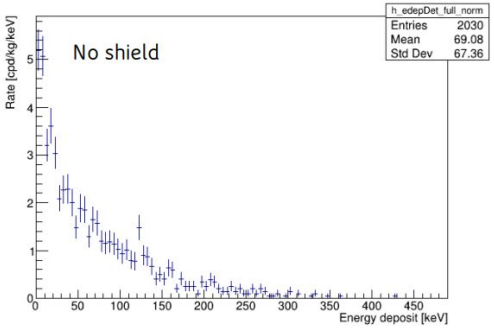
Cu Shielding with opening for the camera lens

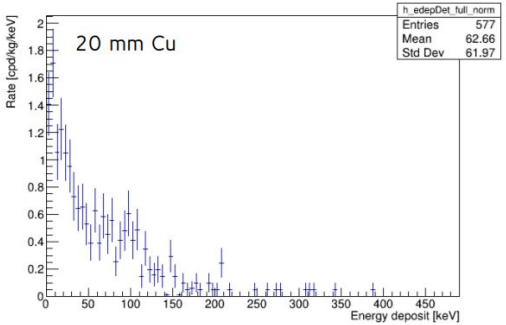
- 20 mm
- 45 mm (aprox.)

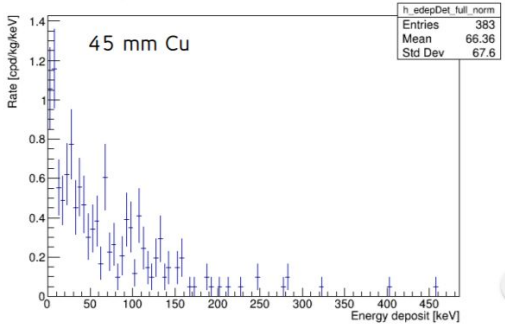
Note: shielding for the lens not included here.

	Counts [0-20] keV*		Attenuation Factor	
No Shield	2139	8300*	1	
20 mm Cu	676	900*	3	9*
45 mm Cu	378	512*	5	16*

Note: mPa-234 corresponds to about 75% of the events detected coming from Camera body.







- In CYGNO the shield attenuation to camera background (45 mm copper) is about ~10
  CAVEAT: we considered only the most intense gamma emitter in U and Th chain (214Bi, 214Pb, 228Ac, 212Pb, 206Tl)
- For LIME this may be sufficient, for CYGNO a low-radioactivity camera is needed

GEM radioactivity

From “Background assessment for the TREX dark matter experiment”
https://link.springer.com/article/10.1140/epjc/s10052-019-7282-6

#	Material,Supplier	Method	Unit	^{238}U	^{226}Ra	^{232}Th	^{228}Th	^{235}U	^{40}K	^{60}Co	^{137}Cs
26	Classical micromegas, CAST	Ge Paquito	$\mu Bq/cm^2$	< 40		4.6 ± 1.6		< 6.2	< 46	< 3.1	
27	Microbulk MM, CAST	Ge Paquito	$\mu Bq/cm^2$	26 ± 14		< 9.3		< 14	57 ± 25	< 3.1	
28	Microbulk MM, CAST	BiPo-3	$\mu Bq/cm^2$		< 0.134		< 0.097				
29	Kapton–Cu foil, CERN	Ge Paquito	$\mu Bq/cm^2$	< 11		< 4.6		< 3.1	< 7.7	< 1.6	
30	Cu–kapton–Cu foil, CERN	Ge Paquito	$\mu Bq/cm^2$	< 11		< 4.6		< 3.1	< 7.7	< 1.6	
31	Cu–kapton–Cu foil, CERN	BiPo-3	$\mu Bq/cm^2$		< 0.141		< 0.033				
32	Microbulk MM, CERN	Ge Latuca	$\mu Bq/cm^2$	< 49	< 0.70	< 1.2	< 0.35	< 0.22	< 2.3	< 0.14	< 0.13
33	Microbulk MM, CERN	BiPo-3	$\mu Bq/cm^2$		< 0.045		< 0.039				
34	Micromegas GEM, CERN	Ge Oroel	$\mu Bq/cm^2$	< 5.2	< 0.10	< 0.22	< 0.08	< 0.03	3.45 ± 0.40	< 0.02	< 0.02
35	Micromegas GEM 1^{st} cleaning	Ge Oroel	$\mu Bq/cm^2$	7.41 ± 0.81	< 0.21	0.19 ± 0.05	< 0.11	0.36 ± 0.04	0.84 ± 0.16	< 0.02	< 0.03
36	Micromegas GEM 2^{nd} cleaning	Ge Oroel	$\mu Bq/cm^2$	7.87 ± 0.89	< 0.17	0.14 ± 0.04	0.07 ± 0.02	0.36 ± 0.04	0.81 ± 0.15	< 0.03	< 0.02
37	Pyralux, Saclay	Ge Paquito	$\mu Bq/cm^2$	< 19	< 0.61	< 0.63	< 0.72	< 0.19	4.6 ± 1.9	< 0.10	< 0.14
38	Pyralux, Saclay	BiPo-3	$\mu Bq/cm^2$		< 0.032		< 0.036				
39	Isotac adhesive, 3M	Ge Paquito	$\mu Bq/cm^2$	< 18	< 0.45	< 0.43	< 0.22	< 0.18	< 2.3	< 0.10	< 0.14
40	Kapton–epoxy foil, CERN	BiPo-3	$\mu Bq/cm^2$		< 0.033		< 0.022				
41	Stainless steel mesh	Ge Paquito	$\mu Bq/cm^2$	< 53	< 1.5	< 1.7	< 0.9	< 0.6	< 8.7	< 0.3	< 0.5
42	Micromegas, CNM	Ge	$\mu Bq/cm^2$	< 462	< 10	< 11	< 6.3	< 4.5	< 61	< 3.8	< 3.7

GEM isotopes	Activity (μBq/cm^2)
U238 (Th234)	1.95E+00
U238 (Ra226)	3.91E-01
U235	1.89E-01
Th232 (Ra228)	3.71E-01
Th232 (Th228)	1.88E-01
K40	4.30E+00
Cs137	9.77E-02
Co60	8.98E-02

T-REX recent paper (2019), they did an extensive measurement campaign. Some improvement in 40K cleaning the GEMs, but this procedure increased 235U

Backup

Radioactivity measurements

Camera Body Orca Flash	Limit/Meas	Activity (Bq/kg)
U238 (Th234)	M	3.16E+00
U238 (Ra226)	M	8.13E-01
U235	M	1.81E-01
Th232 (Ra228)	M	9.49E-01
Th232 (Th228)	M	9.49E-01
K40	M	8.59E-01
Cs137	M	4.07E-02
Co60	L	5.42E-03

Camera Lens Orca Flash	Limit/Meas	Activity (Bq/kg)
U238 (Th234)	M	4.22E+00
U238 (Ra226)	M	1.92E+00
U235	M	1.45E-01
Th232 (Ra228)	M	3.61E-01
Th232 (Th228)	M	3.65E-01
K40	M	5.15E+01
Cs137	L	2.67E-02
Co60	L	4.64E-02
La138	M	2.44E+00

Acrylic Box	Limit/Meas	Activity (Bq/kg)
U238 (Th234)	L	3.50E-03
U238 (Ra226)	L	3.50E-03
Th232 (Ra228)	L	5.00E-03
Th232 (Th228)	L	4.50E-03
K40	L	3.50E-02

GEM	Limit/Meas	Activity (Bq/kg)
U238 (Th234)	M	1.63E-01
U238 (Ra226)	M	3.25E-02
U235	L	1.58E-02
Th232 (Ra228)	L	3.09E-02
Th232 (Th228)	L	1.56E-02
K40	L	3.58E-01
Cs137	L	8.13E-03
Co60	L	7.48E-03