Summary of CYGNO background simulations

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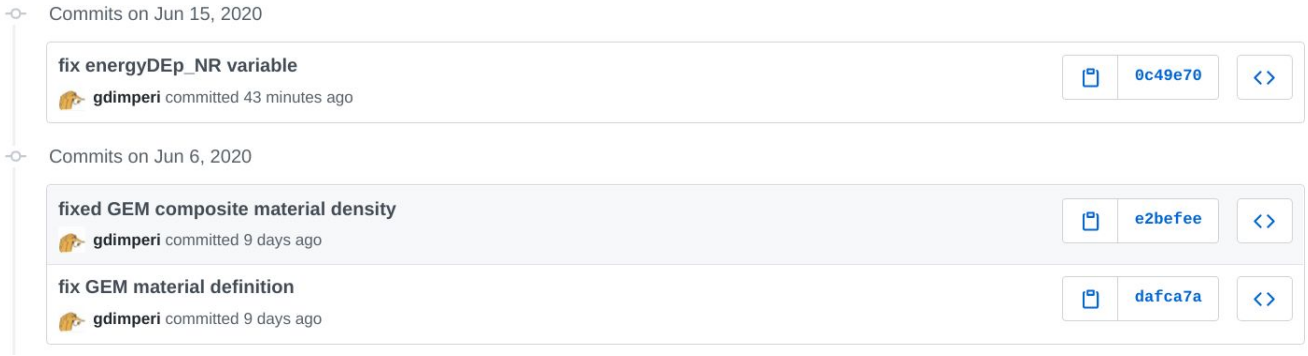
15/06/20
CYGNO Analysis & Simulation meeting

Update of the repository

- Fixed GEM composite material:
  - 5 um copper + 50 um kapton + 5 µm copper, 70 µm diameter holes with 140 µm pitch
  - average density 2.14 g/cm3
- Fixed a bug in the filling of energyDep_NR (energy deposit of nuclear recoils)

➜ repository has been updated

  - This could affect the neutrons simulations, probably necessary to repeat the simulations for the most interesting shielding options in LIME and CYGNO
  - I expect NR rates after the fix lower than past calculations



GEM radioactivity

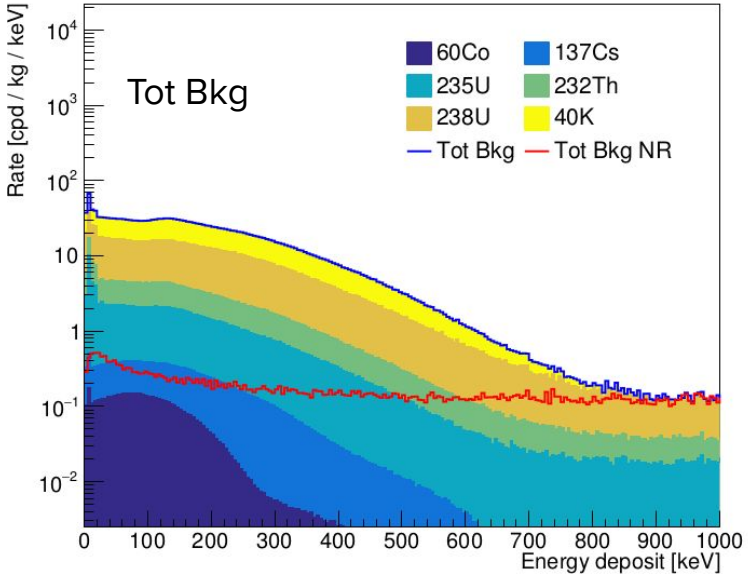
GEM radioactivity measured at LNGS, 12.3 g in 2 pieces
(each one about 20 x 20 cm2)

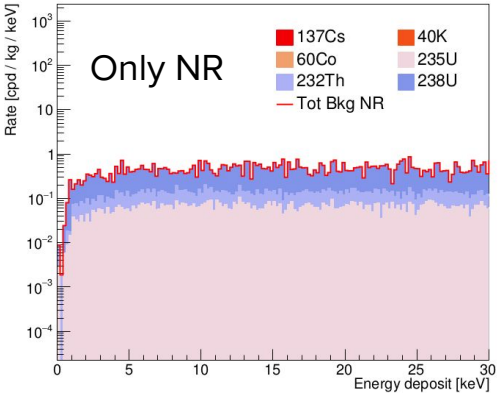
GEM isotopes	Limit/Meas	Activity (Bq/kg)	mass (kg)	Ngen	t_eq (year)	Activity (mBq/pc)	piece mass (kg)
U238 (Th234)	M	1.63E-01	0.7	1.00E+06	2.79E-01	1	0.00615
U238 (Ra226)	M	3.25E-02	0.7	1.00E+06	1.39E+00	0.2	0.00615
U235	L	1.58E-02	0.7	1.00E+06	2.87E+00	0.097	0.00615
Th232 (Ra228)	L	3.09E-02	0.7	1.00E+06	1.47E+00	0.19	0.00615
Th232 (Th228)	L	1.56E-02	0.7	1.00E+06	2.90E+00	0.096	0.00615
K40	L	3.58E-01	0.7	1.00E+07	1.27E+00	2.2	0.00615
Cs137	L	8.13E-03	0.7	1.00E+07	5.57E+01	0.05	0.00615
Co60	L	7.48E-03	0.7	1.00E+07	6.06E+01	0.046	0.00615

GEM background

GEM	Limit/Meas	ER/yr 1-20 keV	NR/yr 1-20 keV
238U	M	2.24E+05	3.60E+03
232Th	L	4.96E+04	7.41E+02
235U	L	5.79E+04	7.32E+02
40K	L	1.78E+05	0.00E+00
60Co	L	1.43E+03	0.00E+00
137Cs	L	2.83E+03	0.00E+00
GEM tot		**5.14E+05**	**5.07E+03**
GEM (only meas.)		**2.24E+05**	**3.60E+03**

Total background 5 x 10^5 cpy in 1-20 keV
NR background 5 x 10^3 cpy in 1-20 keV
(Same order of magnitude if we do not consider the limits)



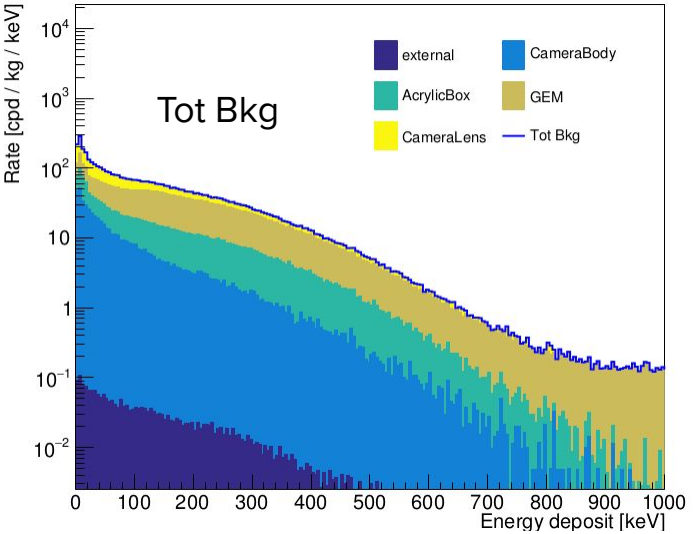


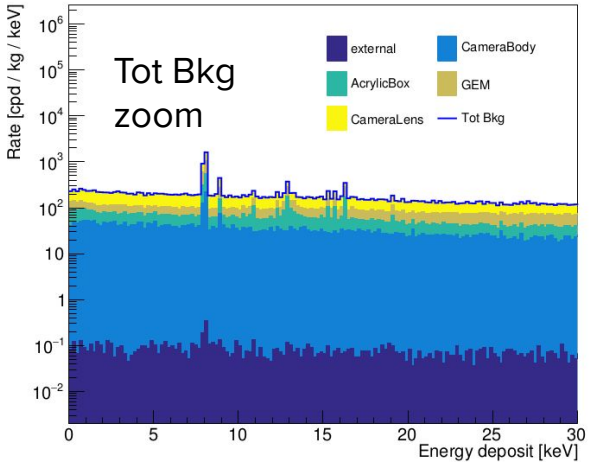
Summary

Total simulated backgrounds (up to now)

	ER/yr 1-20 keV	NR/yr 1-20 keV
GEM	5.14E+05	5.07E+03
AcrylicBox	4.34E+05	-
CameraBody (shield)	4.46E+05	-
CameraLens (shield)	9.83E+05	-
External Gammas (200Water + 5Cu)	9.75E+02	-
Total	**2.38E+06**	**5.07E+03**

Summary background spreadsheet:
https://docs.google.com/spreadsheets/d/1SKkd1C-zJoFzb0ZRkG0D9_vNOr5A9S34slWkOKHQqxg/edit?usp=sharing





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

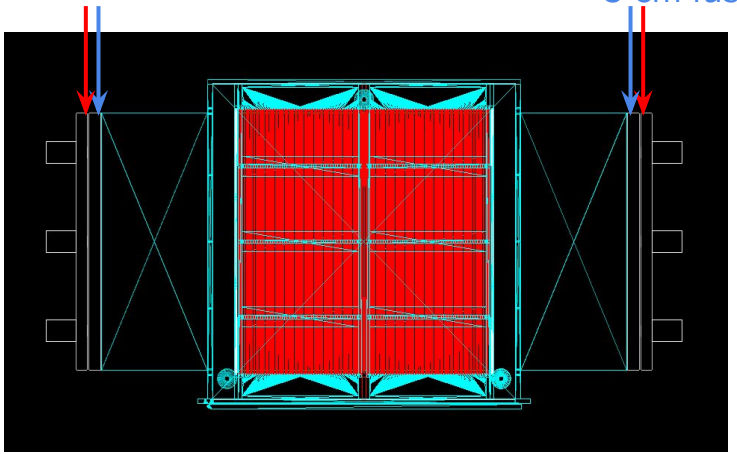
Acrylic Box	Limit/Meas	Activity (Bq/kg)
U238 (Th234)	L	3.50E-03
U238 (Ra226)	L	3.50E-03
Th232 (Ra228)	L	5.00E-03
Th232 (Th228)	L	4.50E-03
K40	L	3.50E-02

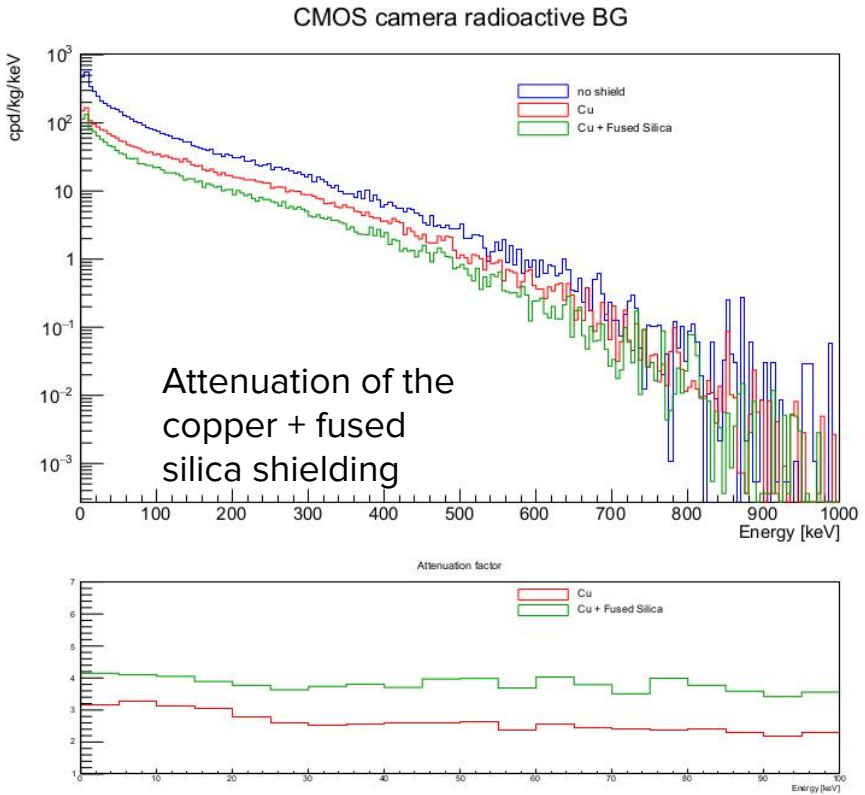
GEM isotopes	Limit/Meas	Activity (Bq/kg)
U238 (Th234)	M	1.63E-01
U238 (Ra226)	M	3.25E-02
U235	L	1.58E-02
Th232 (Ra228)	L	3.09E-02
Th232 (Th228)	L	1.56E-02
K40	L	3.58E-01
Cs137	L	8.13E-03
Co60	L	7.48E-03

Study for camera shielding

Copper shielding to the camera body and a fused silica layer between lens and acrylic box

4.5 cm copper
5 cm fused silica



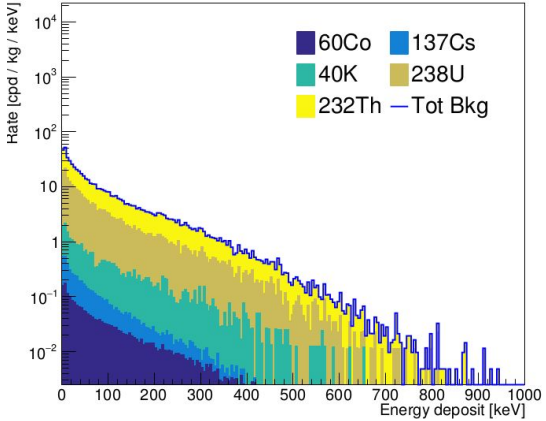


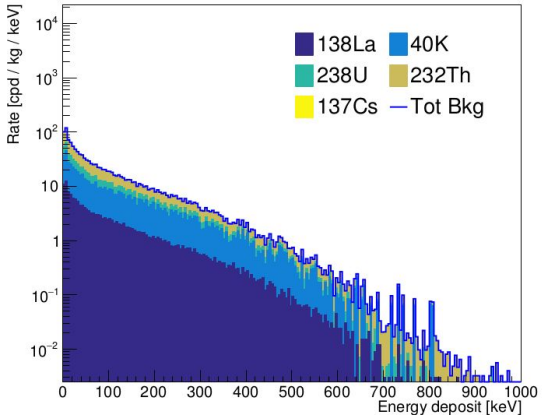
Total background in 0-20 keV 1.4 x 10^6 cpy
Total attenuation of the copper + fused silica shield factor ~4

Background from cameras (body + lens) with shield

Camera Body (shield)	Limit/Meas	ER/yr 1-20 keV
238U	M	1.71E+05
232Th	M	2.57E+05
235U	M	0
40K	M	1.37E+04
60Co	L	1.52E+03
137Cs	M	3.39E+03
Camera Body tot (shield)		**4.46E+05**

Camera Lens (shield)	Limit/Meas	ER/yr 1-20 keV
238U	M	1.74E+05
232Th	M	4.32E+05
235U	M	0
40K	M	2.69E+05
60Co	L	0.00
138La	M	1.07E+05
137Cs	L	9.76E+02
Camera Lens tot (shield)		**9.83E+05**





Background from acrylic box

Acrylic Box	Limit/Meas	ER/yr 1-20 keV
238U	L	1.34E+05
232Th	L	2.22E+05
235U	L	0
40K	L	7.83E+04
60Co	L	0
137Cs	L	0
Acrylic Box tot		**4.34E+05**