CYGNO simulations update

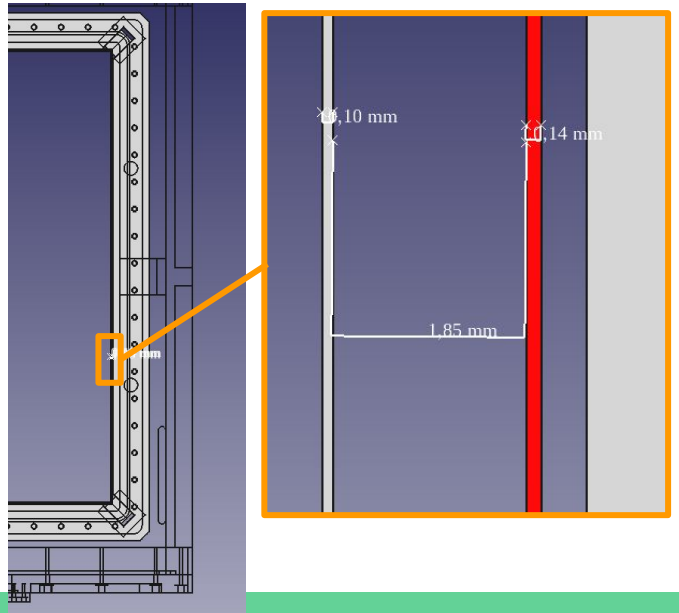
CYGNO simulation working group

29/07/24

Field cage

Two options, both consisting in a thin layer of plastic + Cu glued/pressed:

- Cu on PET (HPGe data analyzed ➜ see database)
- Cu on kapton (HPGe data not yet analyzed)

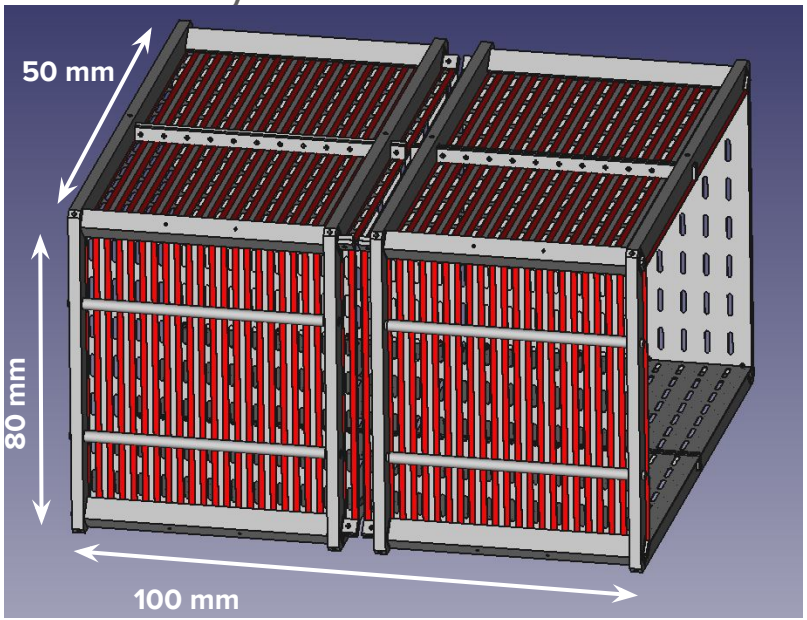


Implemented in CAD as a plastic layer of 100 um + 140 um thick Cu coils with a gap of 1.85 mm ➜ ?

Field Cage (PET+Cu)	Reference	Limit/Meas	Activity (Bq/kg)
238U (226Ra)	Laubenstein @LNGS	L (<)	9.20E-03
238U (234Th)	Laubenstein @LNGS	L (<)	6.40E-01
238U (234mPa)	Laubenstein @LNGS	L (<)	4.50E-01
235U	Laubenstein @LNGS	L (<)	2.20E-02
232Th(228Ra)	Laubenstein @LNGS	L (<)	2.90E-02
232Th(228Th)	Laubenstein @LNGS	M (=)	3.00E-02
40K	Laubenstein @LNGS	M (=)	2.10E-01
137Cs	Laubenstein @LNGS	L (<)	1.20E-02

Field cage

- Simple way to implement in Geant4 is to simulate a sheet with right dimensions and a mix of materials with correct materials ratio and correct density



- Thickness 100 um
- Total surface (2x0.8+2x0.5)x1.0 m2= 2.6 m2
- Density (from database) 2.625 g/cm3
- PET density = 1.38 g/cm3
- Cu density = 8.96 g/cm3

Calculate weight fractions and tot mass:

- f_Cu = 0.12
- f_PET = 0.88
- FC mass = 682.5 g

Field cage

- Rescaling from previous simulations (CYGNO-1m3) using the mass of new FC Cu+PET calculated before (682.5 g), and sensitive volume ratio
- Isotope-based rescaling to take into account the broken equilibrium in Uranium chain

Field Cage (Cu on PET)		evt/yr 1-20 keV	NR/yr 1-20 keV	ER/yr 1-20 keV
238U	L	2.10E+04	1.22E+02	2.09E+04
232Th	M	2.07E+03	1.35E+02	1.93E+03
40K	M	3.55E+03	0.00E+00	3.55E+03
137Cs	L	1.61E+02	0.00E+00	1.61E+02
Field cage tot		**2.68E+04**	**2.56E+02**	**2.65E+04**

Should be more accurate than previous scaling presented in July (7.14E+04 ev/yr)

Cathode

- Rescaling from previous simulations (CYGNO-1m3) using the mass of new copper cathode 2.5 m thick
- Cathode dimensions: 0.5 m (W) x 0.8 m (L) x 2.5 mm (T)
- Cathode mass 8.96 kg

Cathode (copper Schrieber)		evt/yr 1-20 keV	NR/yr 1-20 keV	ER/yr 1-20 keV
238U	L	1.22E+04	1.36E+02	1.21E+04
232Th	L	3.03E+05	3.37E+03	3.00E+05
40K	L	2.19E+04	2.44E+02	2.17E+04
60Co	L	2.94E+00	3.27E-02	2.91E+00
137Cs	L	2.54E+01	2.82E-01	2.51E+01
Field cage tot		**3.37E+05**	**3.75E+03**	**3.34E+05**

Numbers presented in July assumed a cathode of 50 um thickness (old CAD), so scaling by mass gives very different result (old: 9.20E+03 ev/yr)

CYGNO-04 preliminary

	CYGNO-04			
Summary Table	**NR/yr 1-20 keV**	**ER/yr 1-20 keV**	**Reference**	**Comment**
GEM (TREX)	1.10E+03	9.27E+04	T-REX GEM	scaled from CYGNO-1m3
AcrylicBox (SNO)		1.37E+04	SNO acrylic	CYGNO-04 sim
CameraBody		5.19E+04	Laubenstein@LNGS	scaled from CYGNO-1m3
CameraLens		9.35E+04	Laubenstein@LNGS	scaled from CYGNO-1m3
Cathode (Cu)	3.75E+03	3.34E+05	Schrieber Cu (2.5 mm)	scaled from CYGNO-1m3
Field Cage (Flex)	2.56E+02	2.65E+04	Cu+PET	scaled from CYGNO-1m3
Cu Shielding		7.57E+04	4 cm Schrieber + 6 cm OPERA Cu	CYGNO-04 sim
Total (internal)	**1.49E+03**	**3.23E+05**		
External Gamma		1.00E+04	SABRE gamma flux @LNGS	
External Neutrons	7.50E+00	3.41E+00	CUORE n flux @LNGS	
Total (external)	**7.50E+00**	**1.00E+04**		
Tot	**5.11E+03**	**6.22E+05**		

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