CYGNO_04 simulations
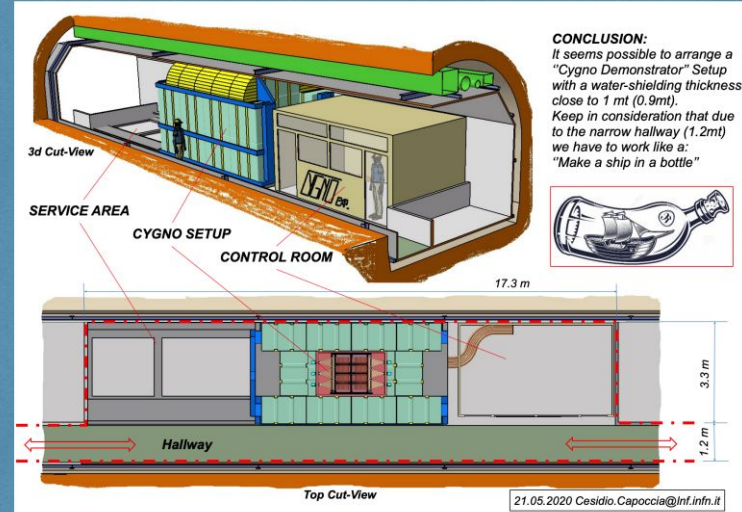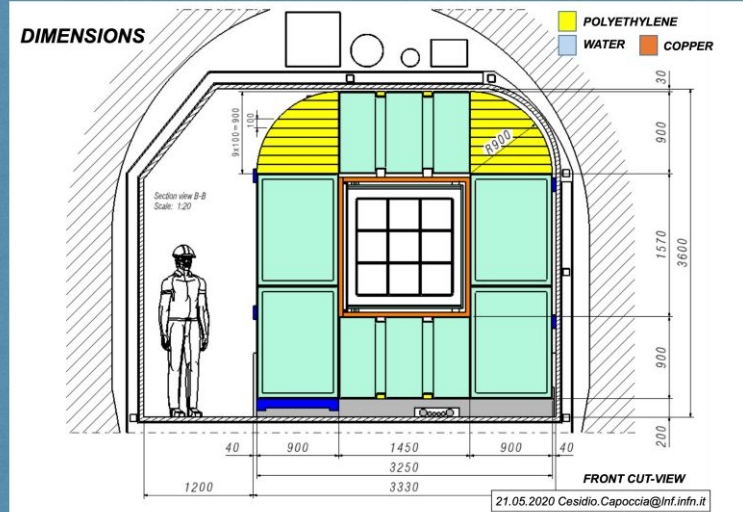
Giulia D'Imperio
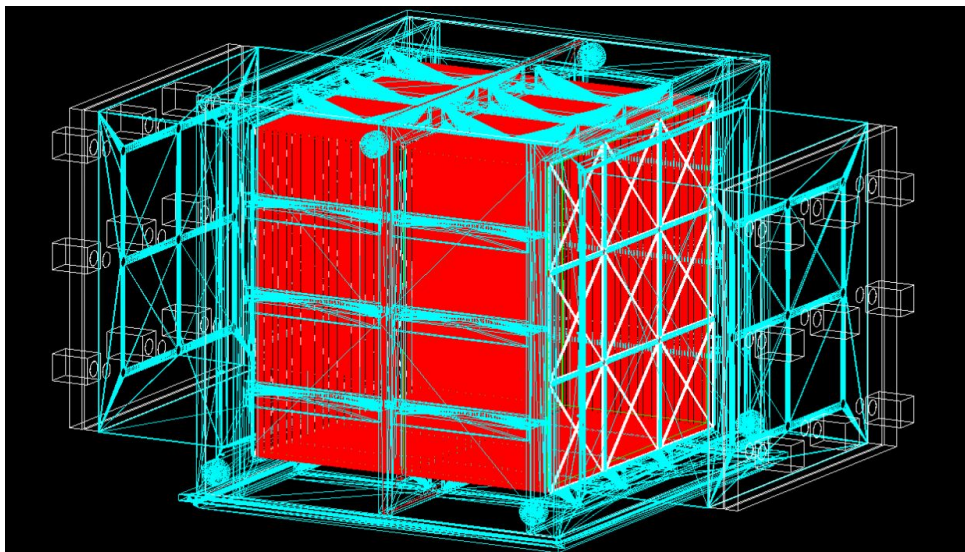
CYGNO simulation meeting 21/02/22

CYGNO_04 at LNGS

It's almost official that we are going to have hall-F for the demonstrator

From Davide's slides at the general meeting

CYGNO and CYGNO_04 geometry

- Actual CYGNO geometry in simulation: 3x3(x2) LIME modules
- Probable geometry for CYGNO will be 2x2(x2) modules: CYGNO_04
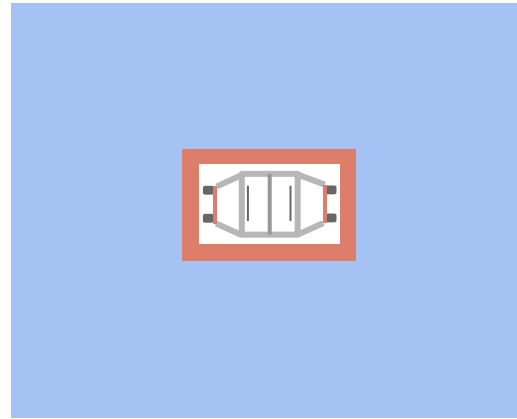

- Smaller active volume: 0.44 m³
- but also less material
  ➜ less radioactivity
- CYGNO_04 has similar sensitivity to CYGNO 1 m³
- Possible assigned area: Hall F @LNGS
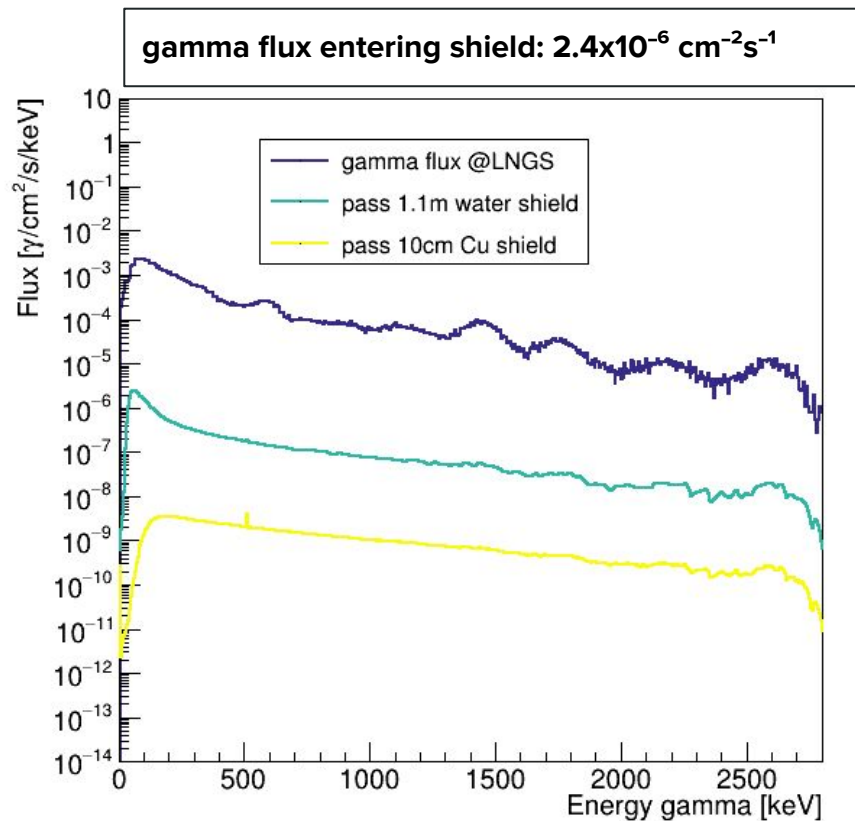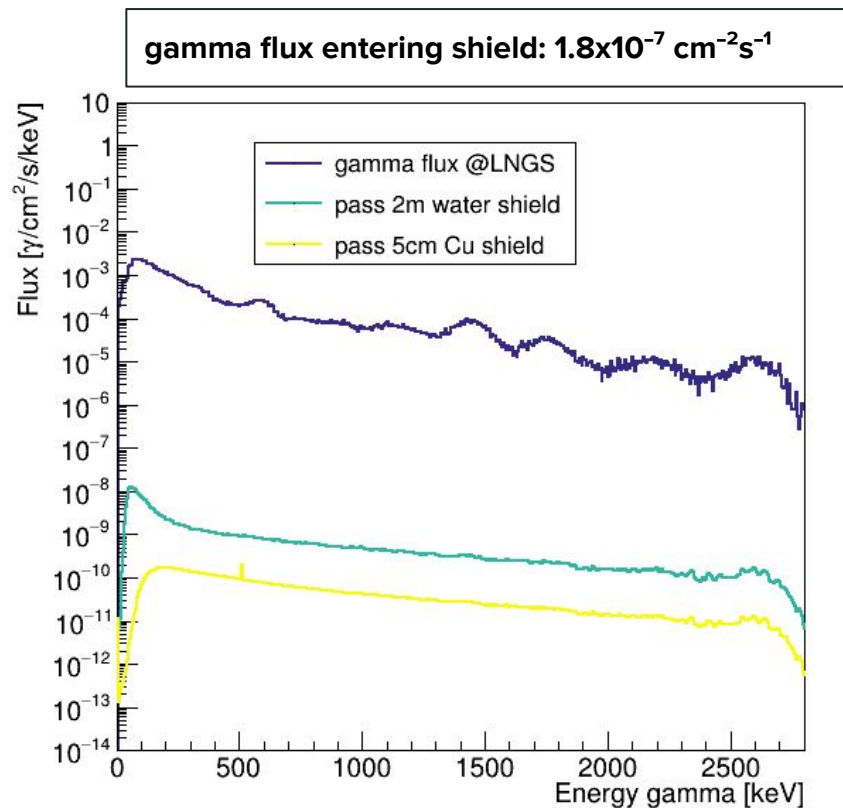
Shielding options studied for CYGNO

1) 200 cm water shield
   + 5 cm copper shield
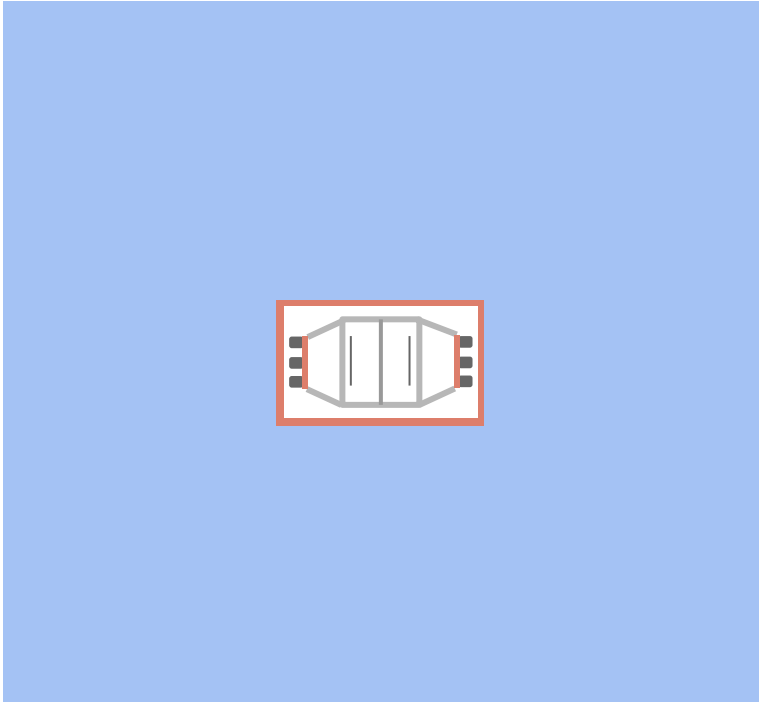
2) 110 cm water shield
+ 10 cm copper shield
CYGNO_04 (could fit Hall F space)

External gamma flux

gamma flux entering shield: 1.8×10^{-7} cm^{-2}s^{-1}

gamma flux entering shield: 2.4×10^{-6} cm^{-2}s^{-1}
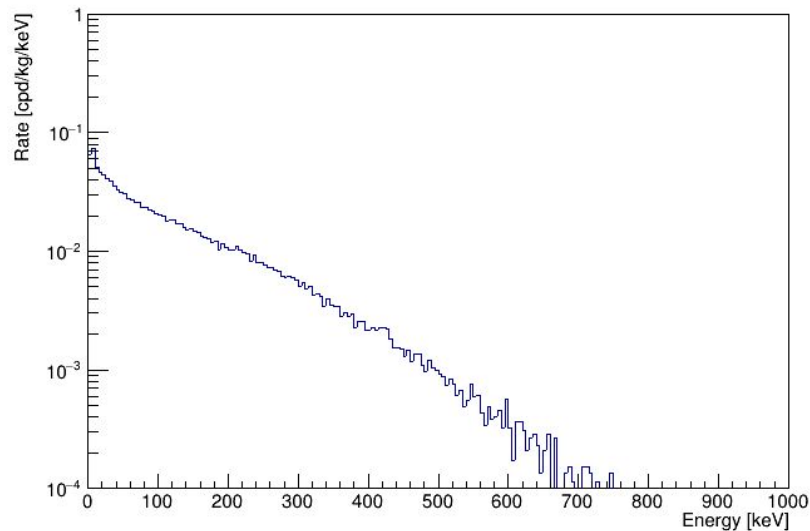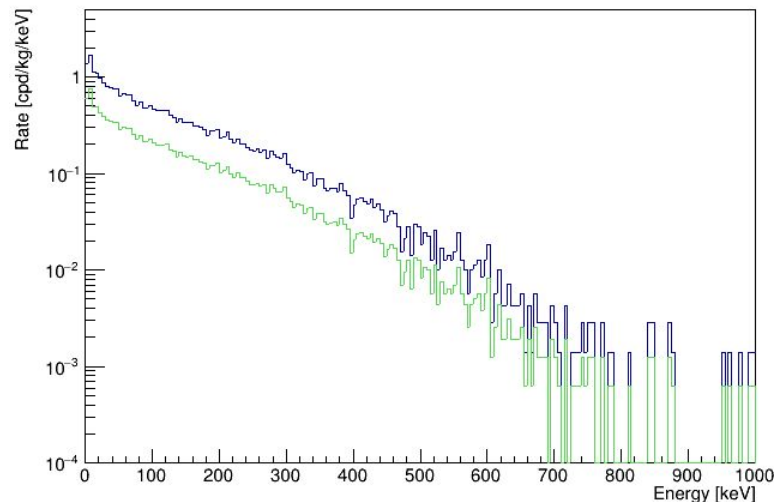
G. D'Imperio - CYGNO simulation meeting - 21/02/22

External gamma background

- **Rate [1-20] keV = 650 cts/yr**

- **Rate [1-20] keV = 1.4x10^4 cts/yr (CYGNO)**
- **Rate [1-20] keV = 6.4x10^3 cts/yr (CHINOTTO)**

* Rates for CYGNO_04 are obtained scaling from CYGNO numbers

Radioactivity assumptions for CYGNO simulations

- camera body: measurements @LNGS by Laubenstein
- camera lens:
  1) measurements @LNGS by Laubenstein

  2) fused silica
- acrylic box:
  1) measurements @LNGS by Laubenstein

  2) acrylic from SNO
- field cage: clean copper from TREX
- cathode: clean copper from TREX
- GEM:
  1) measurements @LNGS by Laubenstein

  2) clean GEMS from TREX

Summary of internal backgrounds

Summary Table	CYGNO		CHINOTTO*		Reference
	NR/yr 1-20 keV	ER/yr 1-20 keV	NR/yr 1-20 keV	ER/yr 1-20 keV	
GEM (LNGS)	5.07E+03	5.09E+05	1.00E+03	1.01E+05	Laubenstein@LNGS
GEM (TREX)	4.27E+03	3.61E+05	8.44E+02	7.14E+04	T-REX GEM
AcrylicBox (LNGS)	6.07E+03	3.61E+05	1.56E+03	9.32E+04	Laubenstein@LNGS
AcrylicBox (SNO)	7.67E+01	1.17E+04	1.98E+01	3.02E+03	SNO acrylic
CameraBody	0.00E+00	4.46E+05	0.00E+00	8.81E+04	Laubenstein@LNGS
CameraLens (LNGS)	0.00E+00	1.07E+06	0.00E+00	2.12E+05	Laubenstein@LNGS
CameraLens (fused silica)	0.00E+00	6.68E+01	0.00E+00	1.32E+01	Haereus "Suprasil"
Cathode (Cu)	8.58E-01	3.63E+02	1.69E-01	7.18E+01	T-REX copper
Field Cage (Cu)	1.51E+00	2.00E+03	2.99E-01	3.96E+02	T-REX copper
Total (LNGS)	1.11E+04	2.39E+06	2.57E+03	4.94E+05	
Total (low rad)	4.35E+03	8.21E+05	8.64E+02	1.63E+05	

- NR for the low-rad option mostly come from GEM � could be reduced with fiducialization
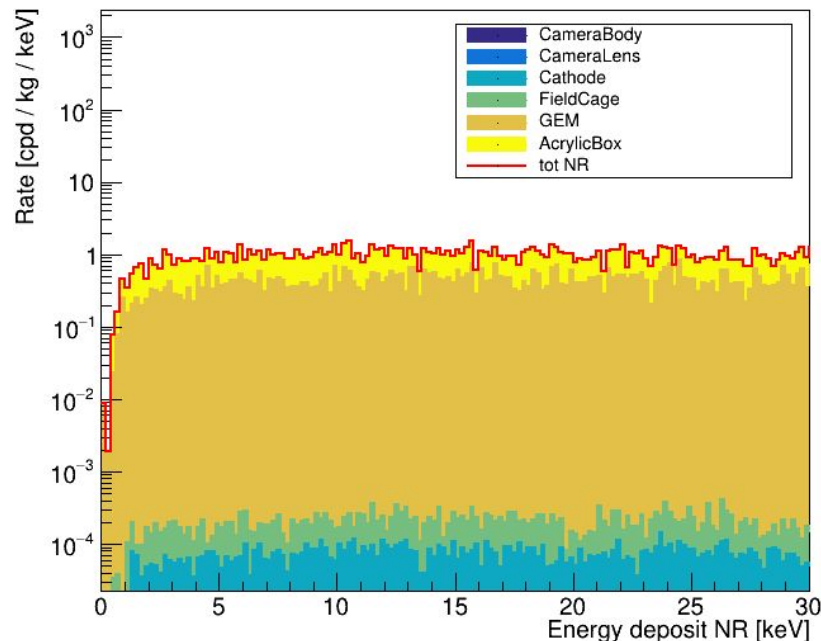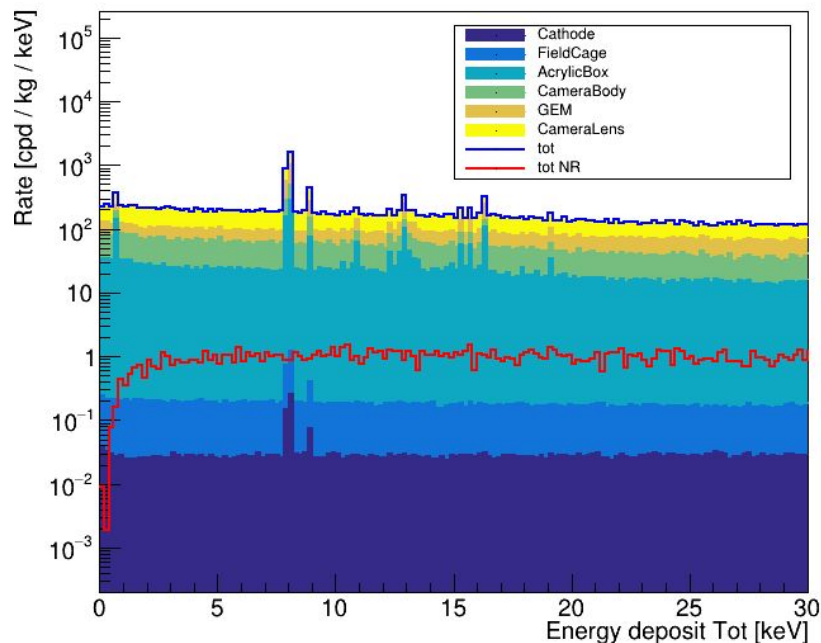- ER for the low-rad option mostly come from GEM and Camera body

* Rates for CYGNO_04 are obtained scaling from CYGNO numbers

Summary of internal backgrounds

- **CYGNO: ER rate [1-20] keV = 2.3×10^6 cts/yr**
- **CYGNO_04: ER rate [1-20] keV = 4.9×10^5 cts/yr**

- **CYGNO: NR rate [1-20] keV = 1.1×10^4 cts/yr**
- **CYGNO_04: NR rate [1-20] keV = 2.6×10^3 cts/yr**

Scaling procedure

- ## For external background
  - flux entering the shielding for CYGNO_04 option (110 cm water + 10 cm Cu)
  - energy deposits in the CYGNO gas 1 m^3
  - number of events is scaled by 0.44 (sensitive volume factor)

- ## For internal background
  - assign material radioactivity and calculate background for CYGNO 1 m^3
  - scaling for less material (approximately 0.44 factor)
  - scaling for sensitive volume factor 0.44

What we need for full CYGNO_04 sim

- Geometry file for CYGNO_04 to implement in Geant4
    - all internal parts
    - shielding geometry

- Radioactivity measurements for materials
    - baseline option (for example for camera, GEM, ecc)
    - radiopure option

- Radioactivity measurement for external background
    - gamma background may change in the different experimental halls (Hall F measurement not in literature)