WP6 - report

Copper analysis with ICPMS

- After a standard surface cleaning, the copper we are studying for CYGNO04 shielding was measured with a Ge detector and with a more sensitive procedure based on Mass Spectrometer

- These are the **ICPMS results**

	Etching 2	**Etching 3**
	[pg * g^{-1}]	[pg * g^{-1}]
Th	9 ± 3	7 ± 2
U	5 ± 2	2 ± 1

^{58}Co has an half life of 70 days

^{54}Mn has an half life of 1 year

- These were the **Ge results**

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radionuclide concentrations:

Th-232:
Ra-228:          < 0.38 mBq/kg          <==>    < 9.3 E-11 g/g
Th-228:          < 0.20 mBq/kg          <==>    < 4.9 E-11 g/g

U-238:
Ra-226           < 0.44 mBq/kg          <==>    < 3.5 E-11 g/g
Th-234           < 17 mBq/kg            <==>    < 9.3 E-10 g/g
Pa-234m          < 11 mBq/kg            <==>    < 6.5 E-10 g/g

U-235:           < 0.37 mBq/kg          <==>    < 6.5 E-10 g/g

K-40:            < 3.2 mBq/kg           <==>    < 1.0 E-7 g/g

Cs-137:          < 0.14 mBq/kg

Co-60:           < 0.12 mBq/kg          @ start of measurement: 07-OCT-2022

Co-58:           (0.8 +- 0.1) mBq/kg    @ start of measurement: 07-OCT-2022

Mn-54:           (0.12 +- 0.05) mBq/kg  @ start of measurement: 07-OCT-2022
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- Upper limits on U and Th, 10 times larger than actual values

Copper Cathode

CYGNO-04 preliminary Based on **Ge** detector results

	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_vNOr5A9S34slWkOKHQgxg/edit?usp=sharing

- Quite large values, in particular for ^{40}K and ^{210}Pb

In Conclusion: radiopure copper seems a very good solution for cathode and shielding, while Opera-one is not

- By using the **ICPMS values**, a copper cathode would produce:
  - Total Rate in [1, 20] keV from all detectors: 11563 ± 302 events per year
  - Total Rate for NR events within the energy interval [1, 20] keV from all detectors: 46 ± 17 events per year
- These were the **Ge** results for the **Opera Copper**

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Radionuclide concentrations:
Th-232 chain:
Ra-228:          < 73 microBq/kg <==> < 1.8 E-11 g/g
Th-228           < 64 microBq/kg <==> < 1.6 E-11 g/g
U-238 chain:
Ra-226           < 0.10 mBq/kg <==> < 8.4 E-12 g/g
Pa-234m          < 1.9 mBq/kg <==> < 5.7 E-10 g/g
U-235            < 0.51 mBq/kg <==> < 9.0 E-10 g/g
K-40             (0.4 +- 0.2) mBq/kg <==> (1.4 +- 0.7) E-8 g/g
Cs-137           < 28 microBq/kg
Co-60            (31 +- 13) microBq/kg
Ag-108m          (0.25 +- 0.03) mBq/kg
Bi-207           (0.61 +- 0.06) mBq/kg
Pb-210           (7 +- 2) Bq/kg
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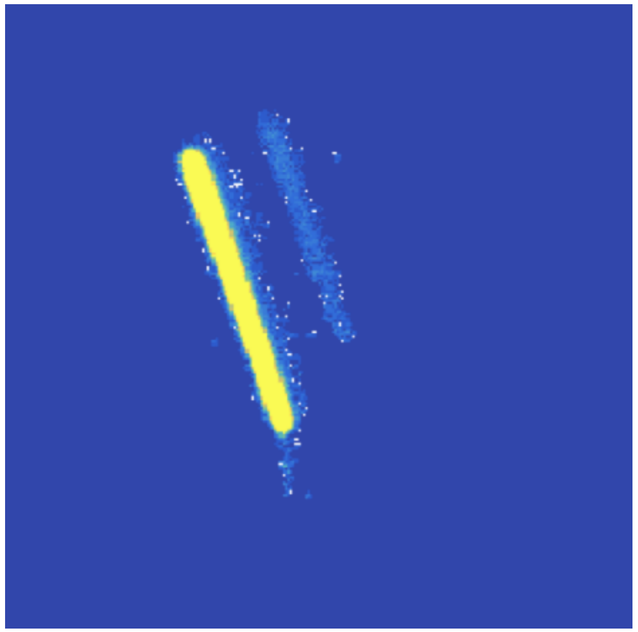
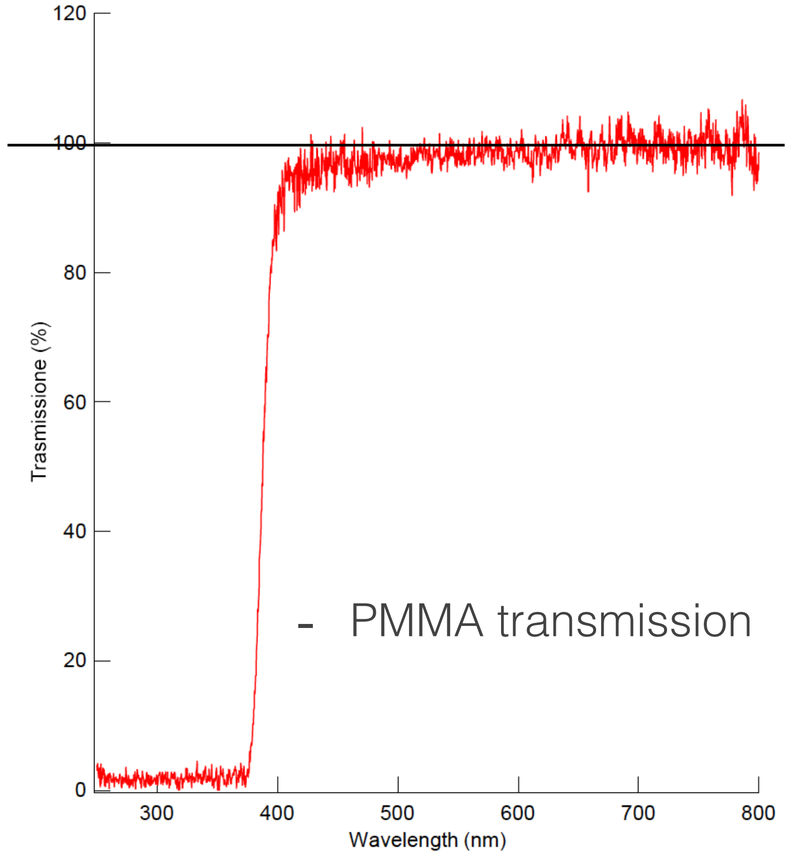
Optical windows

- PMMA has mechanical and radio purity good performance;
- Optical performance quite good except for a possible reflections visible on very bright tracks;



- While investigating other possibilities for the windows in the inner gas box (the PMMA one), we think a good solution for the external one, where, even if there are reflections, they are so out-of-focus to be not relevant;



- PMMA transmission