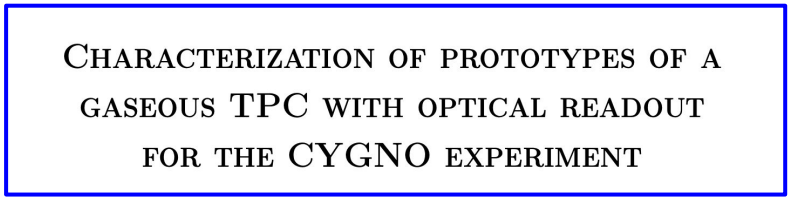
CYGNO-04 Materials bookkeeping: current status

Ernesto Kemp

SC mtg - 28/nov/2023

Data available right now

- Anna Calanca masters' thesis (2022-2023)



- A spreadsheet

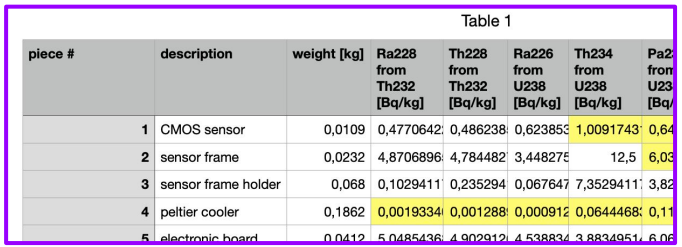
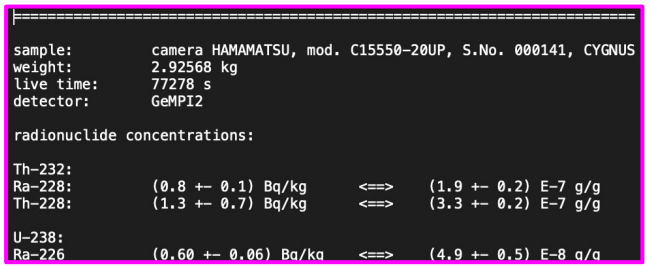


Table 1

piece #	description	weight [kg]	Ra228 from Th232 [Bq/kg]	Th228 from Th232 [Bq/kg]	Ra226 from U238 [Bq/kg]	Th234 from U238 [Bq/kg]	Pa2 from U23 [Bq/
1	CMOS sensor	0,0109	0,4770642	0,486238	0,623853	1,0091743	0,64
2	sensor frame	0,0232	4,8706896	4,784482	3,448275	12,5	6,03
3	sensor frame holder	0,068	0,1029411	0,235294	0,067647	7,3529411	3,82
4	peltier cooler	0,1862	0,0019334	0,001288	0,000912	0,0644468	0,11
5	electronic board	0,0412	5,0485436	4,902912	4,538834	3,8834951	6,06

- Matthias results (.txt files)



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sample:         camera HAMAMATSU, mod. C15550-20UP, S.No. 000141, CYGNUS
weight:         2.92568 kg
live time:      77278 s
detector:       GeMPI2

radionuclide concentrations:

Th-232:
Ra-228:         (0.8 +- 0.1) Bq/kg      <==>    (1.9 +- 0.2) E-7 g/g
Th-228:         (1.3 +- 0.7) Bq/kg      <==>    (3.3 +- 0.2) E-7 g/g

U-238:
Ra-226          (0.60 +- 0.06) Bq/kg    <==>    (4.9 +- 0.5) E-8 g/g
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Anna's thesis: measurements at LNF and STELLA facilities

- LNF: proved to be not enough accurate
- STELLA measurements:
  - camera:

Sample	Supplier	weight [g]	live time [s]	Ra-228	Th-228	Ra-226	Pa-234m
ccd , mod. C11440-52U, board only	Hamamatsu	225,5	1190529	1,03 ± 0,06	1,06 ± 0,06	1,15 ± 0,04	1,1 ± 0,2
PRIME-BSI EXPRESS	Teledyne	719,1	58484	1,3 ± 0,1	1,8 ± 0,1	1,00 ± 0,06	6 ± 2
orca-flash4.0, model C11440-22CU	Hamamatsu	4.08	83383	2,1 ± 0,2	2,1 ± 0,1	1,8 ± 0,1	7 ± 2
cMOS	Thorlabs Quantalux	264,6	644410	0,26 ± 0,02	0,63 ± 0,03	0,21 ± 0,01	3,0 ± 0,4

Sample	Supplier	weight [g]	live time [s]	U-235	K-40	Cs-137	Co-60
ccd , mod. C11440-52U, board only	Hamamatsu	225,5	1190529	0,06 ± 0,01	4,3 ± 0,4	(7 ± 1)e-3	<1,2
PRIME-BSI EXPRESS	Teledyne	719,1	58484	0,27 ± 0,06	3,6 ± 0,5	<32 e-3	<17e-3
orca-flash4.0, model C11440-22CU	Hamamatsu	4.08	83383	0,4 ± 0,1	1,9 ± 0,3	0,09 ± 0,03	<0,012
cMOS	Thorlabs Quantalux	264,6	644410	0,12 ± 0,01	1,2 ± 0,1	<0,0023	<0,0055

  - copper shielding:

Sample	Sample weight [g]	live time [s]	Ra-228	Th-228	Ra-226	Th-234	Pa-234m	U-235
Copper frame	649	1751947	<0,35	<0,43	<0,42	<67	<25	<0,51
two pieces with pins of two copper frames	12,54	844883	0,23 ± 0,05	0,27 ± 0,05	0,23 ± 0,05	±0,90	<6,5	<56 e-3

Sample	Sample weight [g]	live time [s]	K-40	Cs-137	Co-60	Co-58	Mn-54	Pb 210
Copper frame	649	1751947	<1,9	<0,15	<0,18	0,3 ± 0,1	<0,14	–
two pieces with pins of two copper frames	12,54	844883	1,8 ± 0,5	<19 e-3	<52 e-3	<25 e-3	<23 e-3	75 ± 8

The spreadsheet: additional data from other parts / materials

- Camera: broken-down list ??

piece #	description	weight [kg]	Ra228 from Th232 [Bq/kg]	Th228 from Th232 [Bq/kg]	Ra226 from U238 [Bq/kg]	Th234 from U238 [Bq/kg]	Pa234m from U238 [Bq/kg]	K40 [Bq/kg]	U235 [Bq/kg]	Cs 137 [Bq/kg]
1	CMOS sensor	0,0109	0,4770642	0,486238	0,623853	1,0091743	0,6422018	321,100917	0,0834862	0,0385321100
2	sensor frame	0,0232	4,8706896	4,784482	3,448275	12,5	6,034482	3,44827586	0,2586206	0,0370689655
3	sensor frame holder	0,068	0,1029411	0,235294	0,067647	7,3529411	3,8235294	1,17647058	0,2205882	0,0147058823
4	peltier cooler	0,1862	0,0019334	0,001288	0,000912	0,0644468	0,112781	0,01396348	0,0010741	0,0002900107
5	electronic board	0,0412	5,0485436	4,902912	4,538834	3,8834951	6,067961	5,82524271	0,2184466	0,0485436893

- GEMs

22		in m2	mBq/pc							
23	GEM foil	0,048	0,19	0,096	0,2	1	5	2,2	0,097	0,05
24			Bq/m2							
25		48	0,0039583	0,002	0,004166	0,0208333	0,1041666	0,04583333	0,0020208	0,0010416666

- Lens / Window

27	old camera objective	0,2135	0,3606557	0,365339	1,920374		4,2154566	51,5222482	0,1451990	0,0463700234
28	Suprasil	0,220	0,0011	0,0013	0,00066	0,013	0,028	0,0015	0,00045	0,0054

STELLA: some more additional data

- PMTs: not in the spreadsheet!

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sample:          n. 8 PMT Hamamatsu, type: R7378A, CYGNUS
weight:          135.3 g (total)
live time:       488867 s
detector:        GePV

radionuclide concentrations:
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- To be done: double check STELLA data x Spreadsheet
  - consistency of different records
  - checksum camera parts x camera total

- Ongoing measurements: flexible PCB sheet
  - Delivered to Matthias on 25/oct/2023

- PMMA : perhaps we already have (D. Pinci is checking)

What do we need?

- To list missing parts / materials
  - Help from designers

- Design a Data Base (SQL)
  - steps: spreadsheet → DB
    A comprehensive DB is useful to assess the BKG contributions at any level:

  BKG breaking down:

  1. single parts
  2. subsystems
  3. position → CYGNO-04 modular design

  - Monte Carlo: BKG studies, sensitivity calculations, data validation
  - Data Analysis: systematics evaluation, cuts, etc..