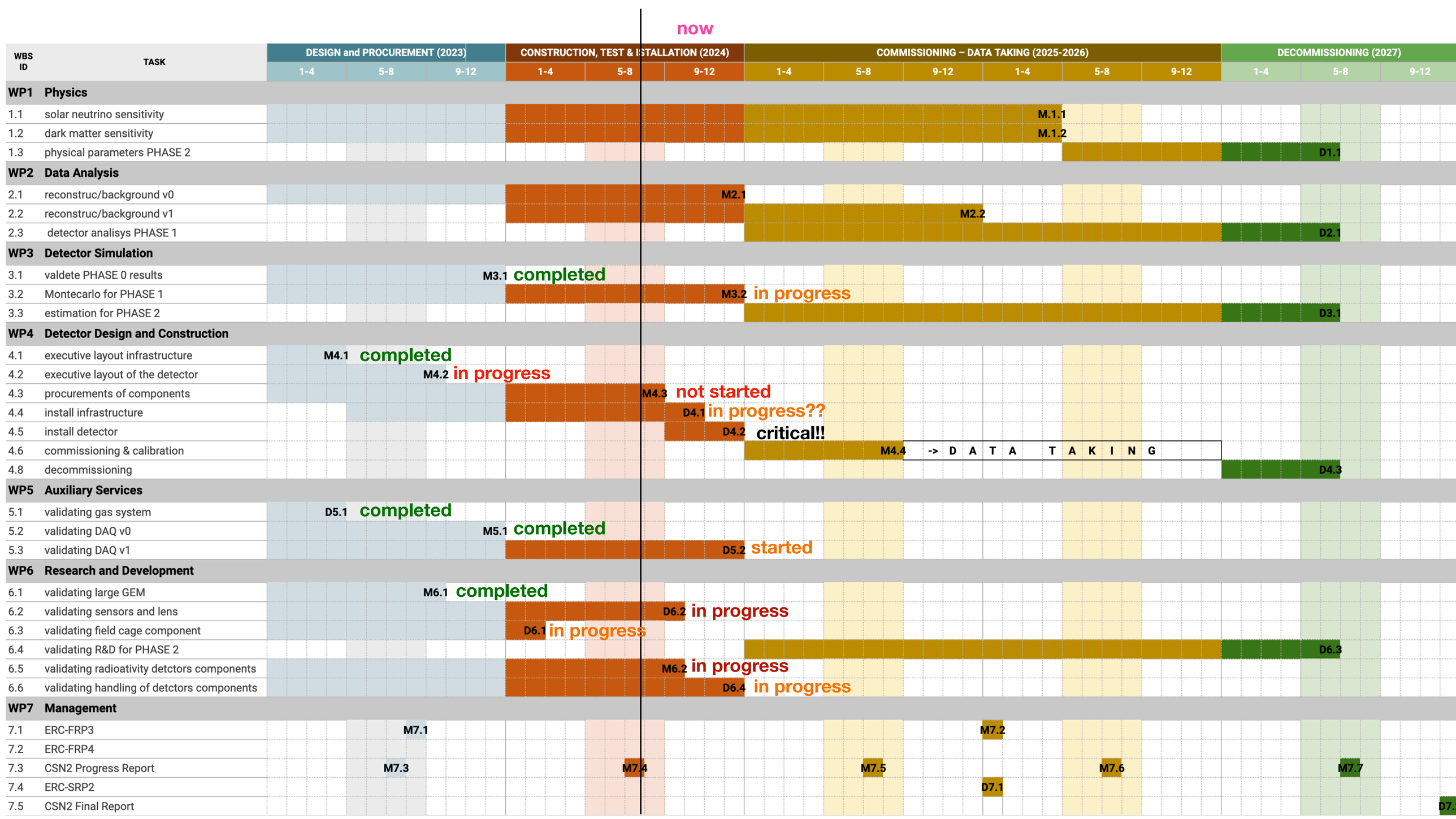
WP4 update

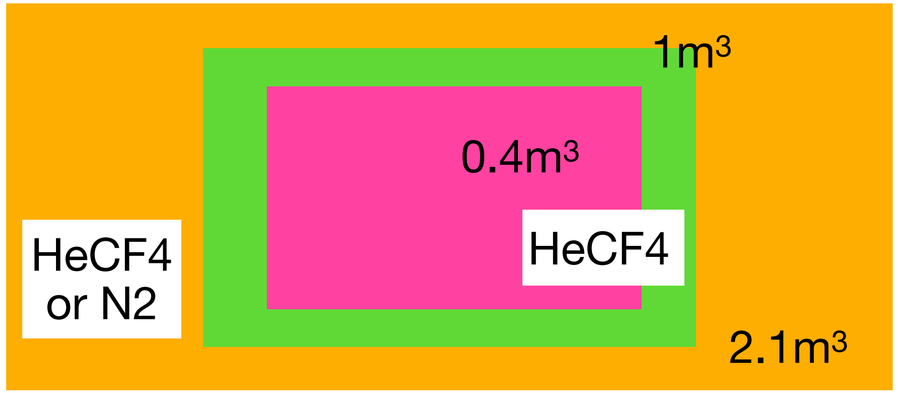
L. Benussi, S. Bianco, A. Biondi, C. Capoccia, A. Croce, M. Caponero, G. Dho, G. Maccarrone, G. Mazzitelli, E. Paoletti, L. Passamonti, D. Piccolo, D. Pierluigi, F. Rosatelli, A. Russo, G. Saviano, R. Tesauro , S. Tomassini and special guest D. Tozzi.

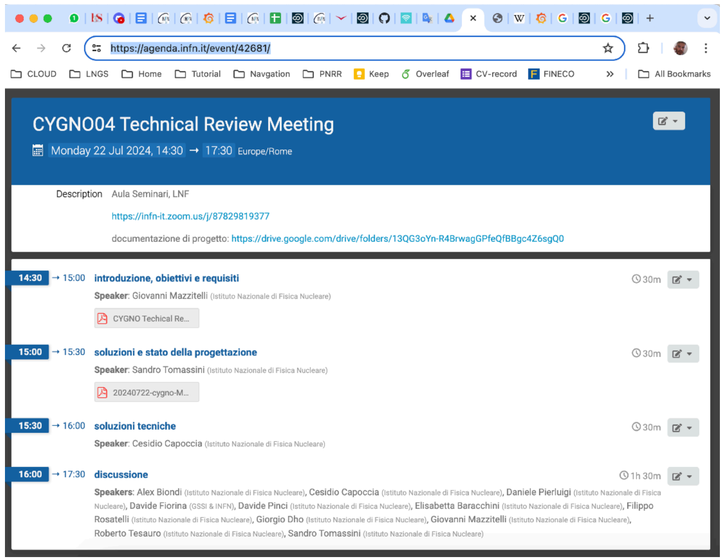
25/7/24 G. Mazzitelli


now
WBS ID
TASK
DESIGN and PROCUREMENT (2023)
CONSTRUCTION, TEST & ISTALLATION (2024)
COMMISSIONING – DATA TAKING (2025-2026)
DECOMMISSIONING (2027)
1-4
5-8
9-12
WP1 Physics
1.1 solar neutrino sensitivity
M.1.1
1.2 dark matter sensitivity
M.1.2
1.3 physical parameters PHASE 2
D1.1
WP2 Data Analysis
2.1 reconstruc/background v0
M2.1
2.2 reconstruc/background v1
M2.2
2.3 detector analisys PHASE 1
D2.1
WP3 Detector Simulation
3.1 valdete PHASE 0 results
M3.1 completed
3.2 Montecarlo for PHASE 1
M3.2 in progress
3.3 estimation for PHASE 2
D3.1
WP4 Detector Design and Construction
4.1 executive layout infrastructure
M4.1 completed
4.2 executive layout of the detector
M4.2 in progress
4.3 procurements of components
M4.3 not started
4.4 install infrastructure
D4.1 in progress??
4.5 install detector
D4.2 critical!!
4.6 commissioning & calibration
M4.4 -> D A T A T A K I N G
4.8 decommissioning
D4.3
WP5 Auxiliary Services
5.1 validating gas system
D5.1 completed
5.2 validating DAQ v0
M5.1 completed
5.3 validating DAQ v1
D5.2 started
WP6 Research and Development
6.1 validating large GEM
M6.1 completed
6.2 validating sensors and lens
D6.2 in progress
6.3 validating field cage component
D6.1 in progress
6.4 validating R&D for PHASE 2
D6.3
6.5 validating radioativity detctors components
M6.2 in progress
6.6 validating handling of detctors components
D6.4 in progress
WP7 Management
7.1 ERC-FRP3
M7.1
M7.2
7.2 ERC-FRP4
7.3 CSN2 Progress Report
M7.3
M7.4
M7.5
M7.6
M7.7
7.4 ERC-SRP2
D7.1
7.5 CSN2 Final Report
D7.

WP update

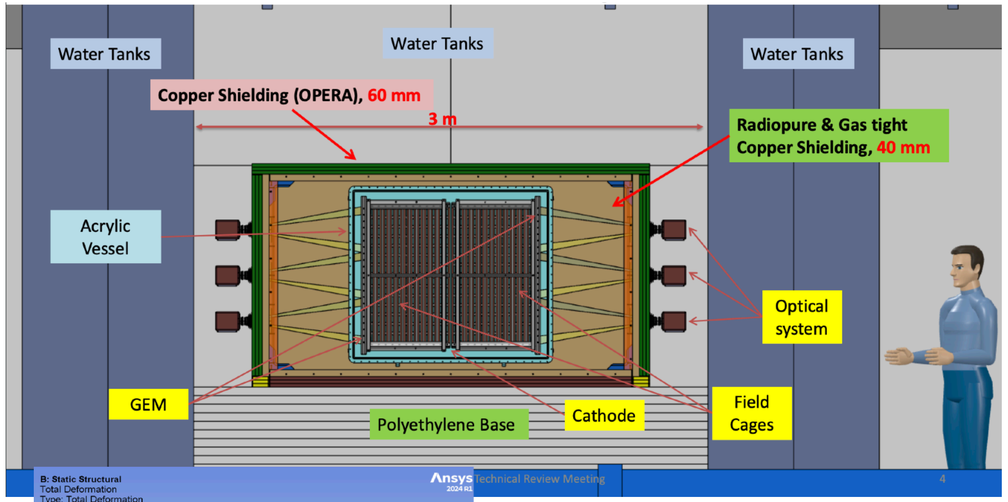
- design strategy https://agenda.infn.it/event/41522/
- detector components requirements vs specification https://docs.google.com/spreadsheets/d/1ldVnZN-t4iXgnNmQ8otjlN_2WeyrBTSeeFI_IVX8w14/edit?gid=2056996844#gid=2056996844
- 22/7 CYGNO04 technical review (A. Franceschi - CUORE/CUPD, T. Napolitano CUORE/CUPID, S. Gazana ex LNGS TM/LEGEND)

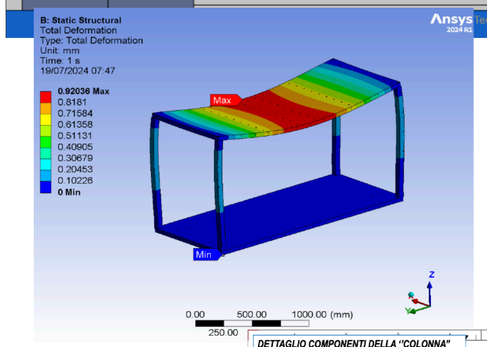


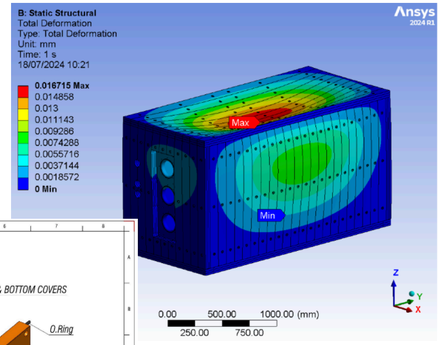


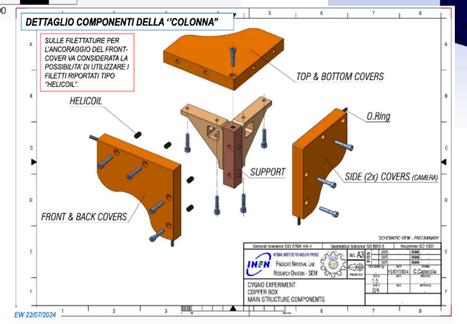
WP update

- Cu BOX finalising the layout
- Cu BOX mechanical simulation and study of the integration
- designing details (pillars) of Cu BOX in order to ensure mechanical stability and gas tightness
- designing a small prototype of the Cu BOX to test gas tightness
- FC FEM simulation and study of integration
- designing custom feed through









WBS official requirements vs specification

CBS/PBS

WBS

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		WBS NUMBER							DESCRIPTION		COMPONENT COST AT WBS LEVEL (kEuro)					CORE COST already covered	CORE COST to be covered	
	Ref.	1	2	3	4	5	6	7		Unit Cost	7	6	5	4	3	2	1	
4	GM	1							CYGNO/INITIUM Project								912.75		679.45	
5	GM	1	1						DETECTOR							752.75				
6	GM	1	1	1					TPC						268.20					
7	GM	1	1	1	1				GAS VOLUME											
8	ST	1	1	1	1	1			PMMA gas vessel	30.00										
9	ST	1	1	1	1	2			PMMA cameras cones	0.30										
10	ST	1	1	1	1	3			PMMA GEM frame holder	1.00										
11	DP	1	1	1	2				READOUT											
12	LB	1	1	1	2	1			GEM foil	3.00										
13	CC	1	1	1	2	2			GEM frame	0.20										
14	LB	1	1	1	2	3			GEM holder	0.20										
15	LB	1	1	1	2	4			GEM connectors	0.20										
16	DP	1	1	1	2	5			Cameras	32.00										
17	DP	1	1	1	2	6			Optics	2.20										
18	RO	1	1	1	2	7			Cameras holedrs mechanics	3.00										
19	DP	1	1	1	2	9			PMTs	0.80										
20	DP	1	1	1	2	10			Cable & connectors	0.50										
21		1	1	1	3				CATHODE											
22		1	1	1	3	1			Feed through	1.00										
23	CC	1	1	1	3	2			Cathode frame	1.00										
24		1	1	1	3	3			Cathode foil	15.00										
25		1	1	1	4				FIELD CAGE											
26	CC	1	1	1	4	1			Cu rings	0.10										
27		1	1	1	4	2			Resistors	0.01										
28	CC	1	1	1	4	3			PMMA box	2.00										
29	RO	1	1	1	5				CALIBRATION SYSTEM											
30		1	1	1	5	1			Calibration source	5.00										
31	RO	1	1	1	5	2			Mechanics	5.00										
32	RO	1	1	1	5	3			Stepper motors	5.00										
33		1	1	2					SHIELDING											
34	CC	1	1	2	1				Cu bricks	0.019										
35	CC	1	1	2	2				Water tanks	1.300										
36	CC	1	1	2	3				Frame (consumable/carpentry)	20.000										

A	B	C	D	E	K
WBS ID	WBS item	min. phys. requiremet	how to (minimal)	staus	Note
	item -subitem	ev/y, ecc	materiale, spessore, dimesioni, radiopurezza, ecc es Lomba cathode		
	cathode	xx ev/y	Cu, xx mm, 50*80	missing	
	cathode - frame		PMMA/N6	missing	
	cathode - connector			R&D	Lime connector male RS 888-4755 and female RS 811-2873 (M#4), RS 811-2851 (M3)
	cathode - feed through			R&D	
	cathode - cable			validated, design	we have a nime meter cable
	cathode - HV PS	50 kV	ISEG PS	ready	
	field cage side A/B	kapton appers better then PET		R&D	
	field cage- lenght and pitch	L=50 pitch=>25 Cu strip 10mm + 24 PET drift 10mm	kapton/PET PBC (serigroup)	R&D	
	field cage - drift from cathod	4 mm (10mm strip center) +1m PET	----	R&D	
	field cage - field	950 V/cm	----	R&D	
	field cage - drift to gem	4 mm (10mm strip center) +1m PET	----	R&D	
	field cage - field cage frame			R&D	
	field cage - field cage resistors			R&D	
	GEM side A/B	Best effort (no other option available)	Katpon/copper	ready	Extra washed with de-ionized water to remove ecthning chems leftover
	GEM resistors	Best effort (no other option available)	Nickel/ceramic https://it.farnell.com/multicomp/mc	ready	
	GEM internal frame		Nylon 6	validated, design	First prototype done with NYLON6. Next should be done by NYLON66
	GEM Stack instert		Brass	validated, design	
	GEM stack screws		Stainless steel	validated, design	
	GEM T-nuts	Best effort (no other option available)	Stainless steel	ready	
	GEM HV pins	Best effort (no other option available)	Copper/gold/nickel/stanless steel https://www.tme.i	ready	
	GEM HV cable	Best effort (no other option available)	Teflon coating and copper to power GEM foils via HV	ready	1.7 mm diameter HV cables. Total lenght max 2m
	GEM External frame	See Field cage BOX (approx 3 Kg weight)	PMMA	validated, design	To be evaluated if can be done in NYLON66
	GEM Pulling screws		Stainless steel	validated, design	
	GEM feed through signal			R&D	
	GEM feed through HV			R&D	
	side A/B - GAS feed through			R&D	

https://drive.google.com/drive/folders/13QG3oYn-R4BrwagGPfeQfBBgc4Z6sgQ0

Cu NOSV vs OF

NOSV done!

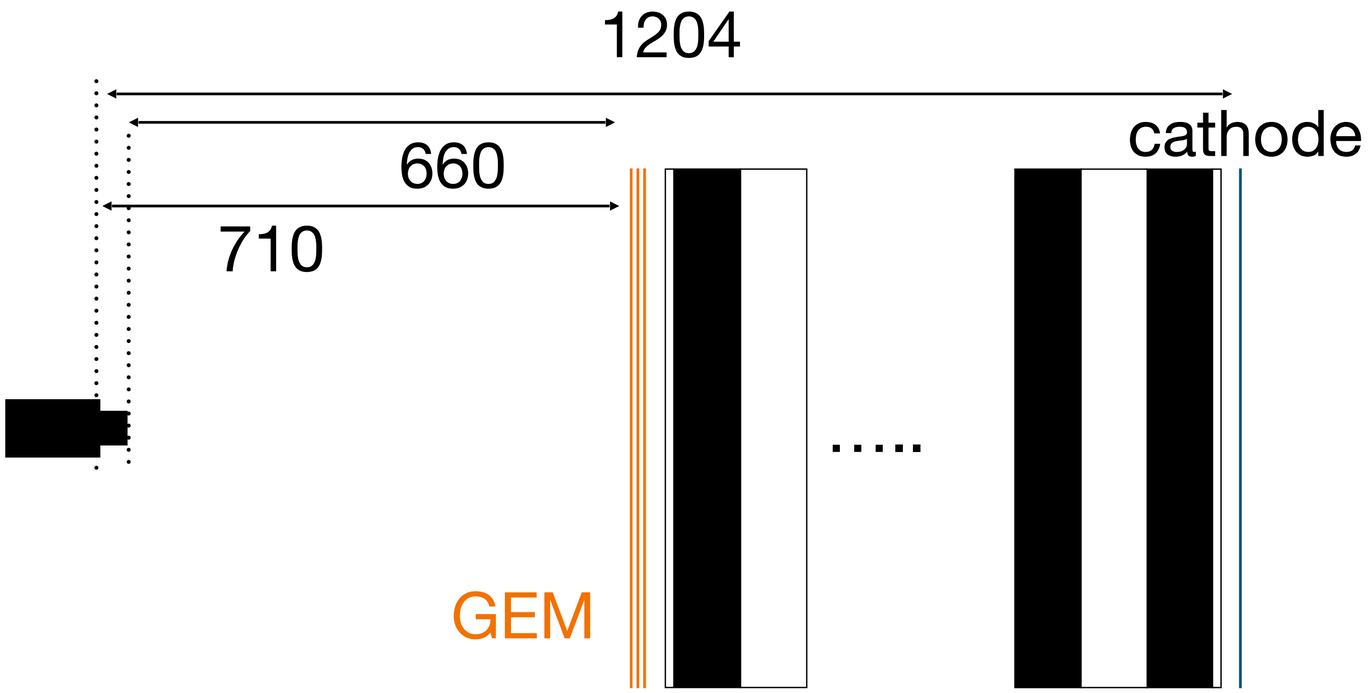
Oxygen-bearing copper															
Aurubis name	Standard				Chemical analysis							Physical properties			
	DIN EN 1976 Code	Number	UNS No.	US Standard ASTM	Copper in % min.	Oxygen in % min.	Oxygen in % max.	Silver in % min.	Silver in % max.	Phosphorus in % min.	Phosphorus in % max.	Conductivity in MS/m	Conductivity in % IACS	Recrystallization temperature in °C	Hydrogen-resistant
NO58	Cu-ETP	CR004A	C11000	B5	99.90 (Cu+Ag)	–	0.04	–	–	–	–	≥58.0	≥100	approx. 180	no
NORG	Cu-ETP1	CR003A	C11000	B5	99.99 (incl. O)	–	0.04	–	0.003	–	–	≥58.6	≥101	approx. 180	no
NORV	Cu-ETP1	CR003A	C11000	B5	99.99 (incl. O)	–	0.04	–	0.003	–	–	≥58.6	≥101	approx. 170	no
NOSV	Cu-ETP1	CR003A	C11000	B5	99.99 (incl. O)	–	0.04	–	0.003	–	–	≥58.6	≥101	(RRR* ≥400)	no
NG10 (NO58+Ag)	CuAg0.10	CR013A	C11600	B152	99.97 (Cu+Ag+O)	–	0.04	0.08	0.12	–	–	≥58.0	≥100	approx. 320	no
Oxygen-free copper															
OF01	Cu-OFE	CR009A	C10100	B170	99.99	–	≤0.0003	–	0.003	–	0.0003	≥58.6	≥101	approx. 200	yes
OF02	Cu-OF	CR008A	C10200	B170	99.95 (Cu+Ag)	–	0.001	–	–	–	–	≥58.0	≥100	approx. 210	yes
OS10 (OF02+Ag)	CuAg0.10 (OF)	CR019A	C10700	B152	99.99 (Cu+Ag+O)	–	0.001	0.08	0.12	–	–	≥58.0	≥100	–	yes
Phosphorus deoxidized copper															
BEEL	Cu-PHCE	CR022A	C10300**	B379	99.99	–	–	–	0.003	0.001	0.006	≥58.0	≥100	approx. 230	yes
BEAL	Cu-HCP	CR021A	C10300**	B379	99.95 (Cu+Ag)	–	–	–	–	0.002	0.007	≥57.0	≥98.3	approx. 260	yes
BE57	Cu-HCP	CR021A	C10300**	B379	99.95 (Cu+Ag)	–	–	–	–	0.002	0.007	≥57.0	≥98.3	approx. 260	yes
BE58	Cu-PHC	CR020A	C10300**	B379	99.95 (Cu+Ag)	–	–	–	–	0.002	0.007	≥57.0	≥98.3	approx. 260	yes
BG10 (BE57+Ag)	CuAg0.10P	CR016A	C10700**	B152	99.97 (Cu+Ag+P)	–	0.001	0.08	0.12	0.001	0.007	≥58.0	≥98.3	approx. 320	yes
Phosphorus-bearing copper															
DLP	Cu-DLP	CR023A	C12000	B379	99.90 (Cu+Ag)	–	–	–	–	0.005	0.015	(54.0 – 57.0)***	(93.1 – 98.3)***	approx. 280	yes
DHP	Cu-DHP	CR024A	C12200	B379	99.90 (Cu+Ag)	–	–	–	–	0.015	0.040	(48.0 – 52.0)***	(82.7 – 89.7)***	approx. 280	yes

* RRR: residual resistivity ratio, ratio of electrical resistivity at 300 K to electrical resistivity at 4 K
** deviates from standard
*** reference value

noi per CUORE abbiamo scelto il rame NOSV principalmente per il suo alto RRR e il suo basso quantitativo di idrogeno, due caratteristiche essenziali per essere usato a bassa temperatura. Ma l'abbiamo usato solo per la parte a 10 mK. **A temperature più alte abbiamo scelto del rame OFE perché aveva delle caratteristiche meccaniche migliori e radiopurezza equivalente.** Quindi ti direi che non è strettamente necessario per voi comprare il NOSV anche se, se ricordo bene, il costo degli altri tipi dipendeva non tanto dal tipo ma dai formati e dalla resistenza meccanica. (C. Bucci CUORE/CUPID)

detector layout

validating components assembly



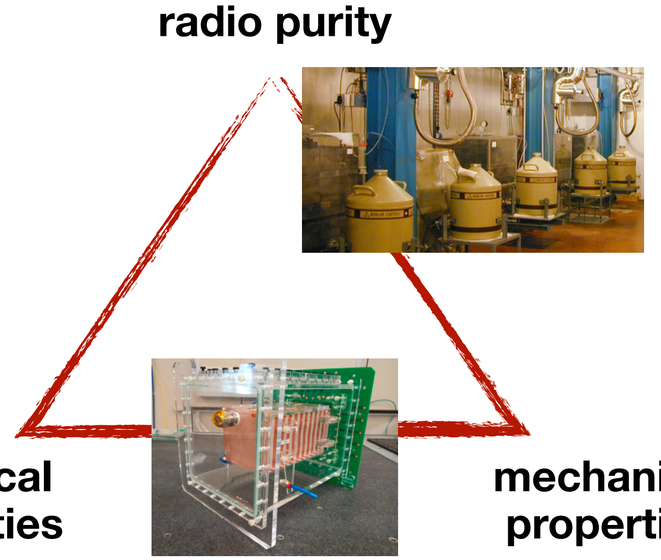
item	Relative distance (mm)	Absolute distance from cathode
cathode	0	
drift	4	5
drift FC PET	1	
drift FC Cu	10	495
drift FC PET	10	
.....*23	450	
drift FC PET	10	
drift FC Cu	10	
drift FC PET	1	500
GEM1	4	
GEM2	2	502
GEM3	2	504
OPTICS (ONYX)	660	1164
BODY	50	1214
—>		**1214**
total length		**2428**

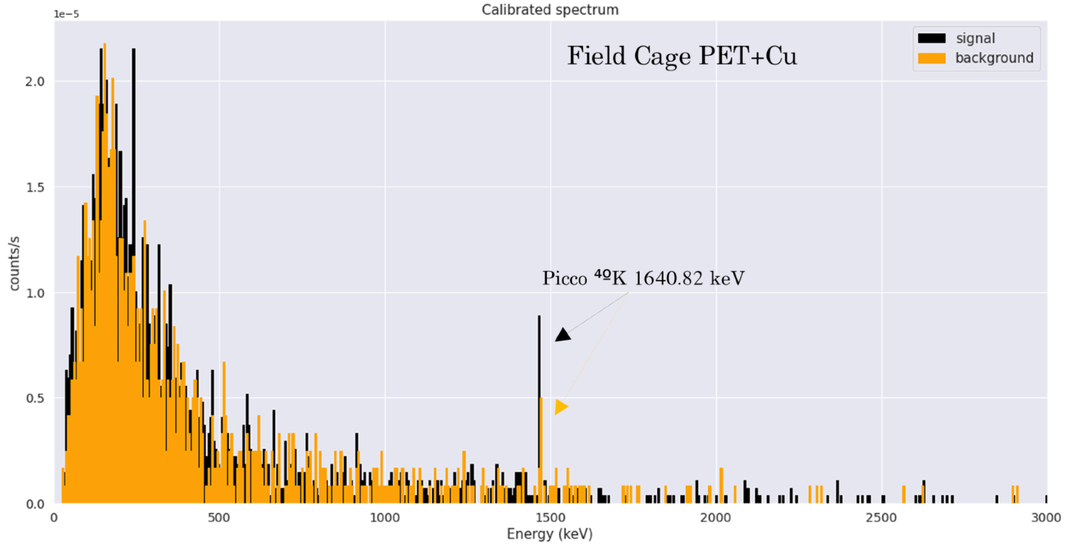
Absolute distance of camera body is independent of lens

validating materials for detector components

WP6 (coordinated by RM1)

- **scouting of candidate materials** is ongoing in parallel with electromechanical and gas tests
- defining of **procedure to handle materials** is on going
- a scouting of the **company that can provide** us materials started
- most of the **constraints** came from the availability of the **LNGS facility to test sample** of materials

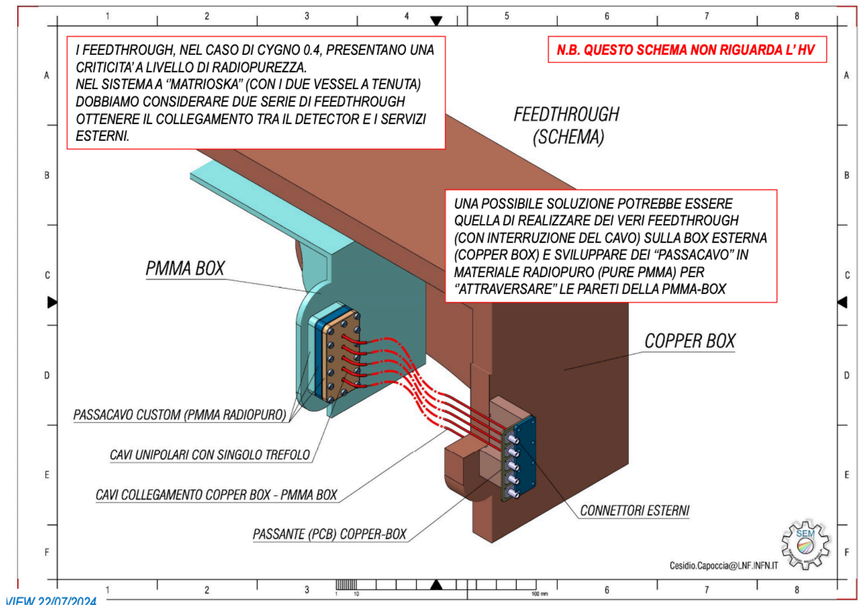




G. Mazzitelli, CYGNUS meeting 2023

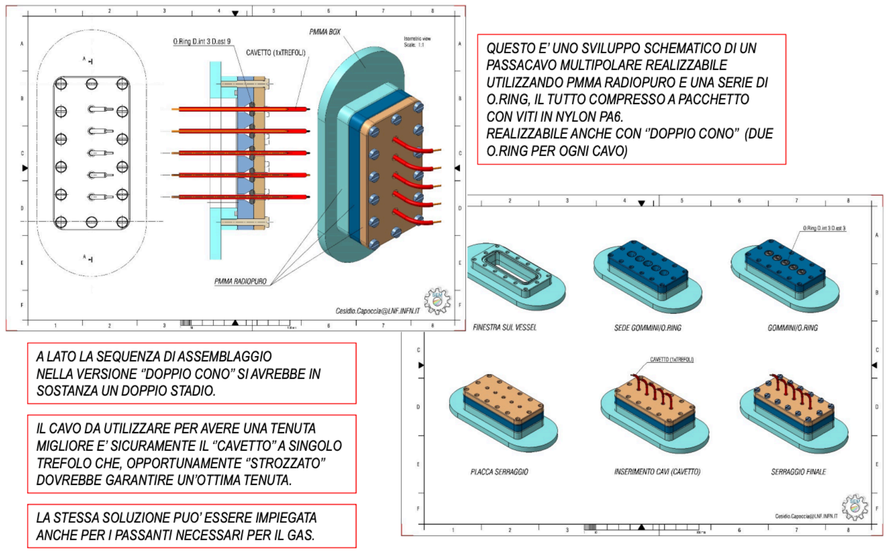
pre-experimental BOX missing requirements

- camera body (ORCA 2 or…)
- camera lens (95f or 85f)
- camera focus (measurements…)
- thickness of windows (experimental/pre-experimental) & materials (PMMA…)
- N2 or HeCF4 in the pre-experimental space
  (huge difference in terms: costs, maintenance, windows, PMTs, ecc)
- PMTs and PMTs windows
- source type/position & mouvements
- cables (numbers) and connectors, cable materials requirements
- feed through



experimental BOX missing requirements

- vessel PMMA thickness distributions (frame, etc)
- cathode Loomba/Cu thickness/HV validation
- FC kapton/PET validation
- optical window (PMMA?)
- source window (0.18mm PET? rad measure missing)
- feed through (R&D to do, rad measure missing)
- cable and connectors (rad metusure missing)



finalise before the summer

the main output of the review commette: buy raw materials!

- NOSV copper purchase O(140) ke —> slabs larger then the needed
- water tanks purchase O(60) ke —> spare tanks
- PMMA radiopure acquisition O(10) ke —> slabs larger then the needed
- safety missing system at LNGS O(10) ke
- clean room O(5) ke
- carpentry, tools and crane O(10) ke
- mass spectrometer (60) ke —> less simplify source design (only for light gain!)
- cathode, FC, mechanics for that ecc. (consumable) O(5) ke

what will be (for sure) missing

- copper processing O(30-50) ke (FANTINI)
  WARNING: Cu processing cost will be unfixed until we don't define specification on tools and cleaning procedure to apply.
- copper plasma cleaning/internal surface coatings O(?) ke
- PMMA processing O(10-30) ke (PALAZZI)
  WARNING: PMMA processing will be very risky until we don't have a samples of materials and specification on glue, tools, cleaning procedure to apply.
- …