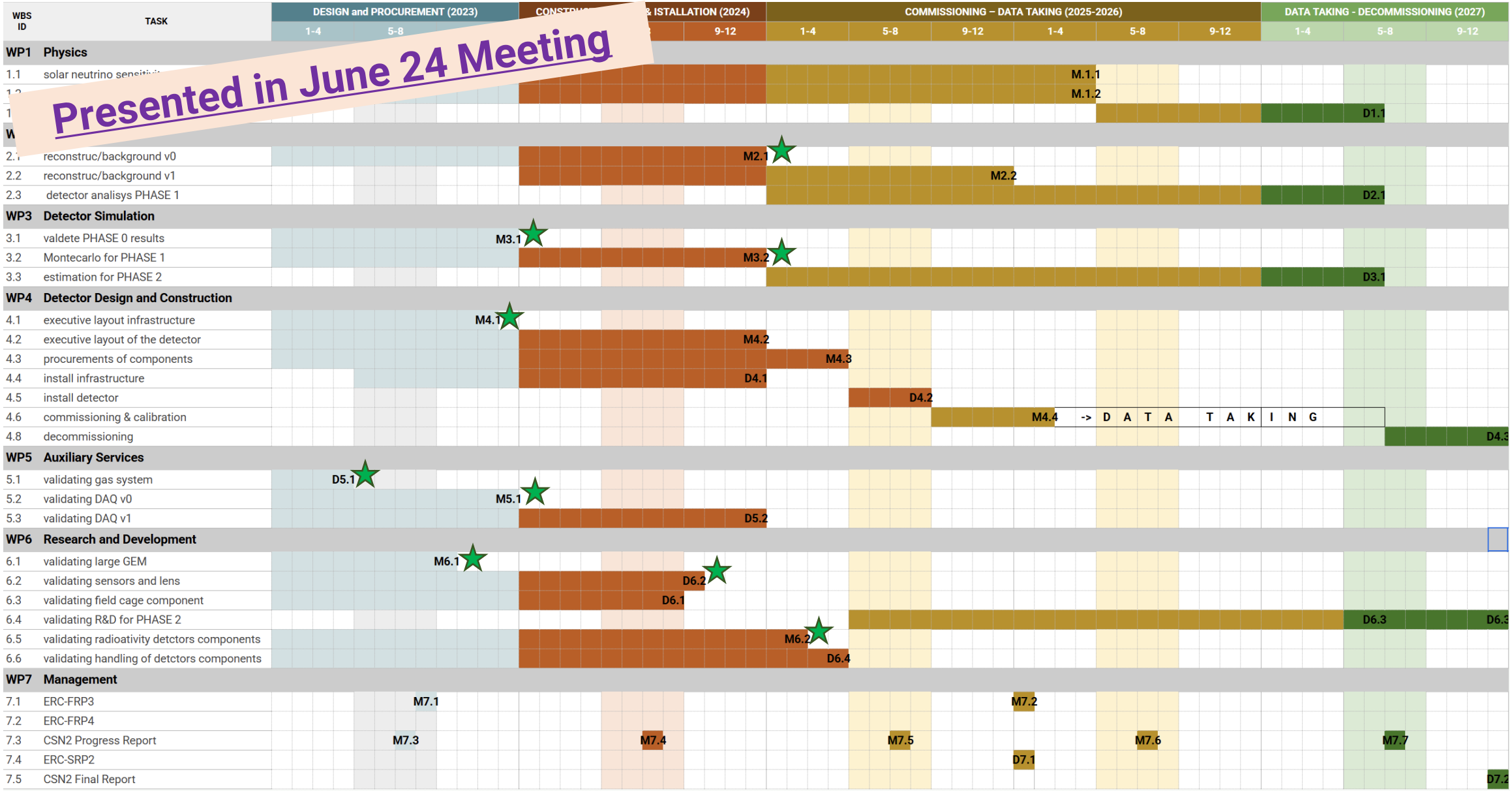
CYGNO04
Technical Coordinator Report

Davide Fiorina – GSSI & INFN LNGS

CYGNO04 Gantt



Presented in June 24 Meeting

CYGNO04 Gantt

CYGNO has been 6 months without a Technical Coordinator Apr-Nov 2024

→ Solved with a new nomination (Davide Fiorina)

With the new year and a stabilized situation, it has been clear that the assignations are incompatible with the realization of CYGNO04 among deadlines.

→ We obtained support from the LNGS design service (3 months/person)

→ The collaboration formed a task force (TC+SP+designer LNF+designer LNGS) with full decisional powers in matters of design and construction

We are now on the correct path to deliver the detector in the **first trimester of 2026**. Commissioning will last 6 months with one year of data taking, decommissioning is foreseen at the end 2027.

September 24

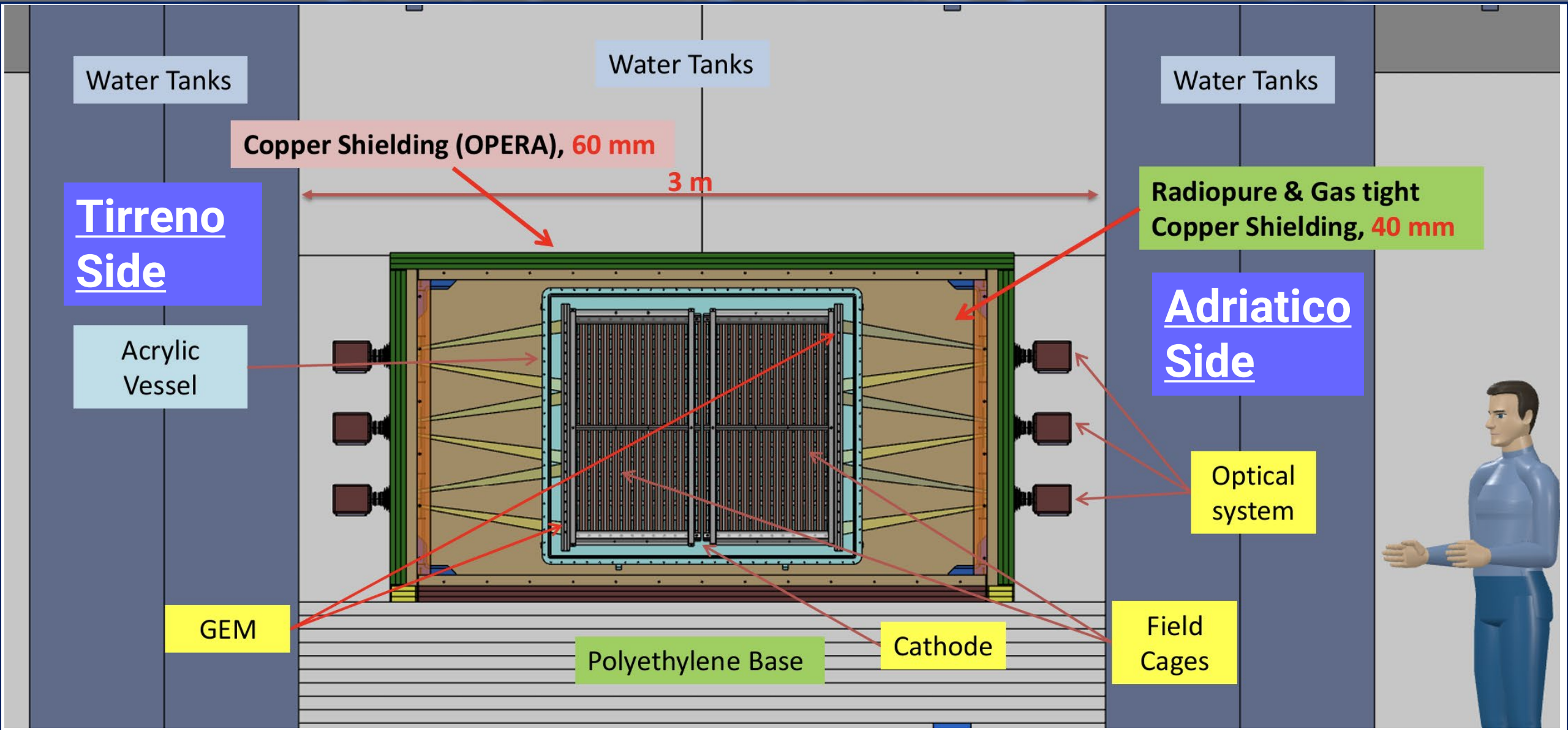
La commissione apprezza il lavoro di analisi compiuto dalla collaborazione su LIME ma invita la collaborazione a finalizzare la realizzazione di CYGNO-04 non oltre i primi mesi del 2026, recuperando, ove possibile i ritardi. La CSN2 raccomanda alla collaborazione un adeguato periodo di presa dati prima del *decommissioning* previsto nel 2027. La commissione inoltre puntualizza che la maggior parte delle spese di costruzione costruzione e caratterizzazione di CYGNO-04 devono essere sostenute su fondi ERC e si impegna a dare supporto all'esperimento secondo il piano finanziario esposto nel CDR a fronte del raggiungimento delle *milestone* di progetto, che saranno puntualmente verificate dai Referee.

HallF Infrastructure

VIA-VINCA: approved
Final project: approved

- Delay in the company preparation works → Delivery expected end of February
- Not a showstopper and not impacting the CYGNO04 timeline

Mechanical Layout

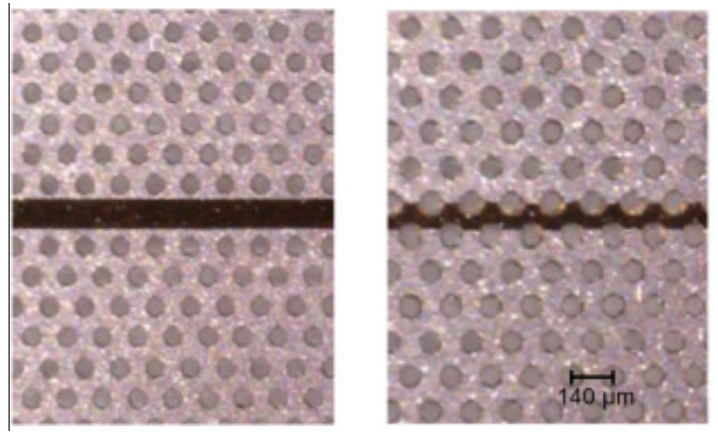


GEM foils

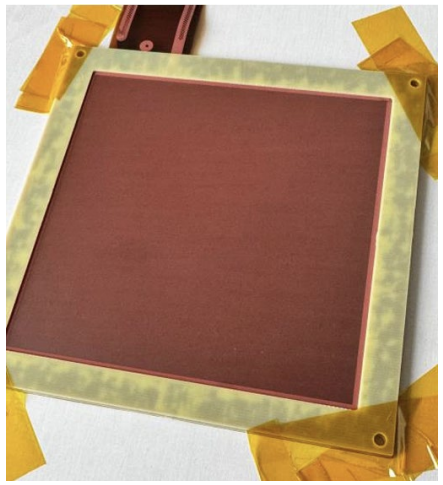
CYGNO needs 6 GEM foils, we bought 8 foils

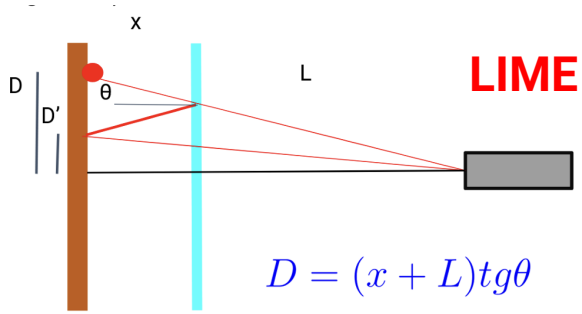
- 4 foils with random segmentation (one is oxidized)
- 4 foils with standard segmentation (one is oxidized)

Random segmentation should reduce the dead area while maintaing the operational stability (tested by CMS-GEM)



Oxidized GEM made by corrugation of copper plus deposition of O(nm) copper polymer makes the GEM opaque avoiding reflection of large light emission on hte PMMA window as observed in LIME



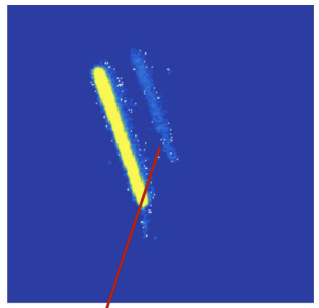


LIME

$$D = (x + L)tg\theta$$

$$D - D' = 2xtg\theta$$

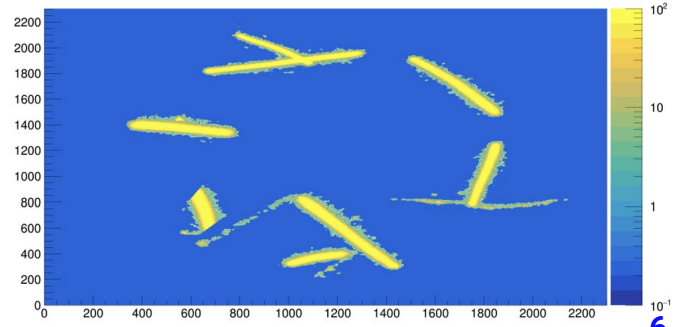
Distance of the shadow



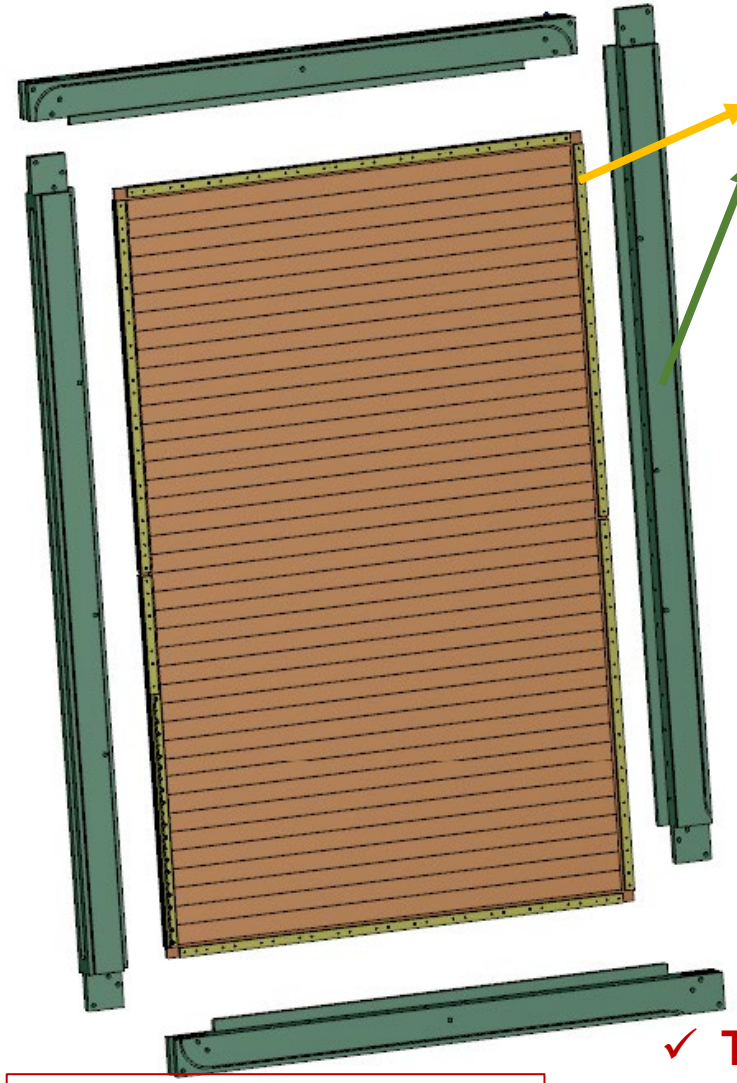
Theory and measurement agree

GIN- Frascati Proto

Oxided GEM large light



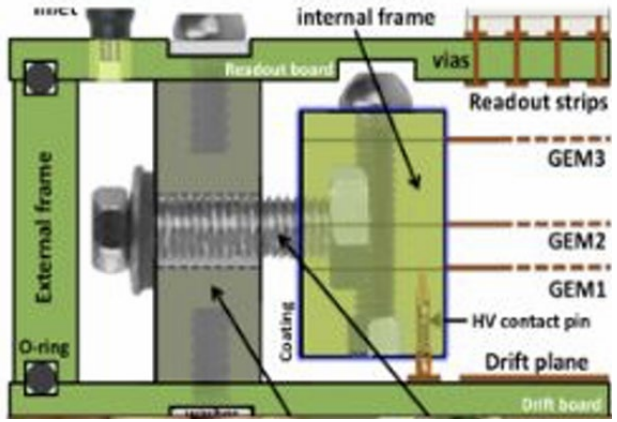
GEM Frame

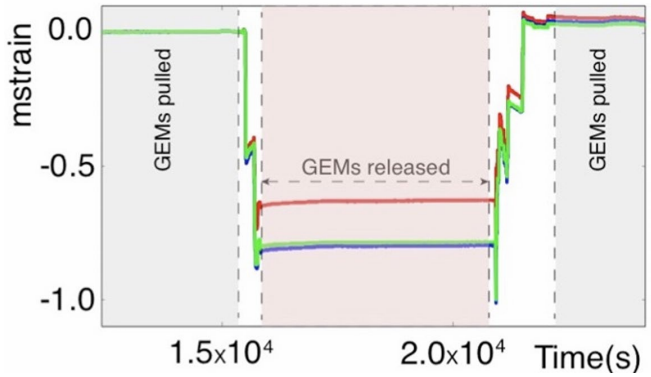


Work Carried out by LNF GEM foils are mounted à-la CMS

- Stretching system and HV powering through pogo-pins on the internal frame
- External Frame guarantees the tensile strength and it is part of the detector structure
- Both frames in Nylon66
  - Non-igrospoic (different from Nylon6)
  - Good mechanical proprieties
  - Lower background wrt PMMA

External Frames may host Fiber Bragg Grating (FBG) for tensile deformation monitoring



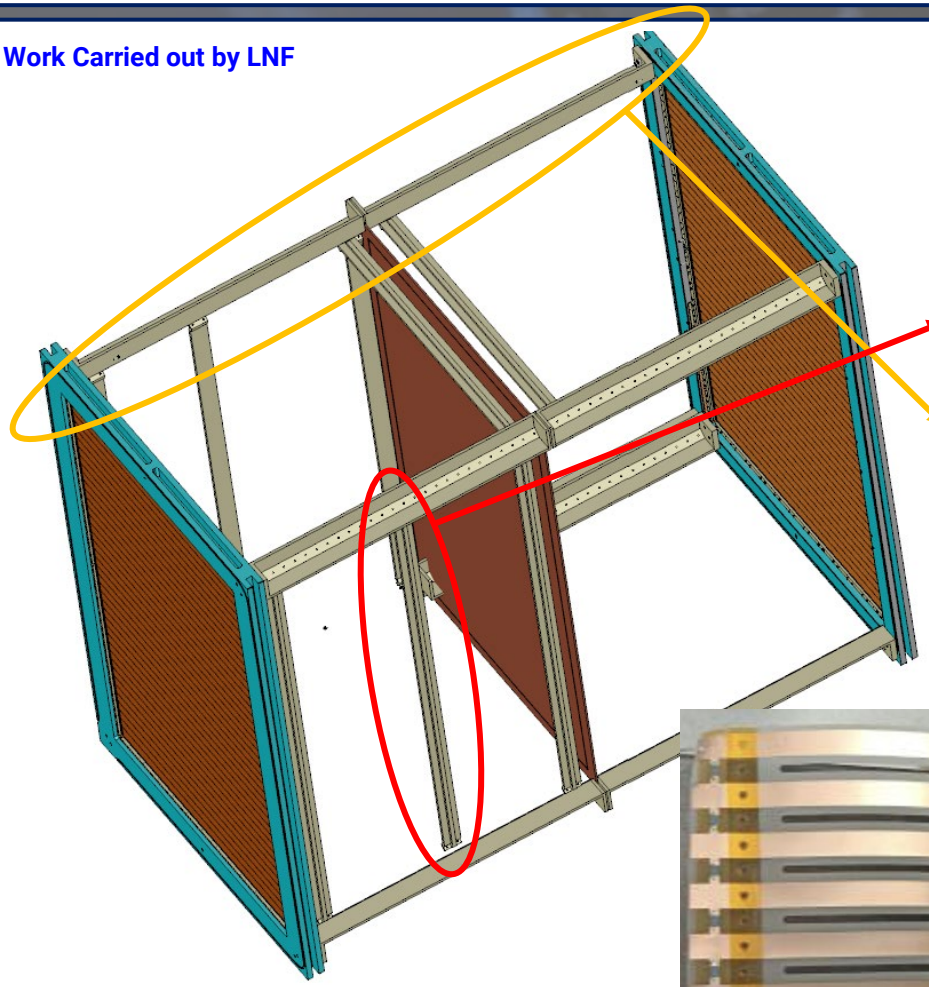


To be integrated in the 3D model

- ✓ **The two GEM frames are in production (1 month delivery+1 month GEM stack conditioning and test)**
- ✓ **Integration in the 3D model ongoing**

Field Cage and Cathode

Work Carried out by LNF

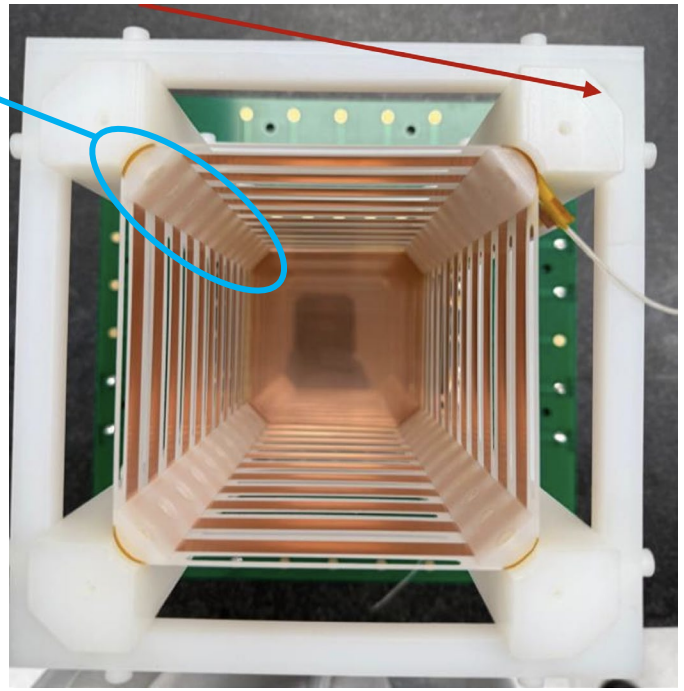


The cathode will be a Kapton foil copper clad on both sides (50um+5um)

- Integration ongoing, the design of the support/frame will follow the same as the GEM one
- Backup solution, full copper plate

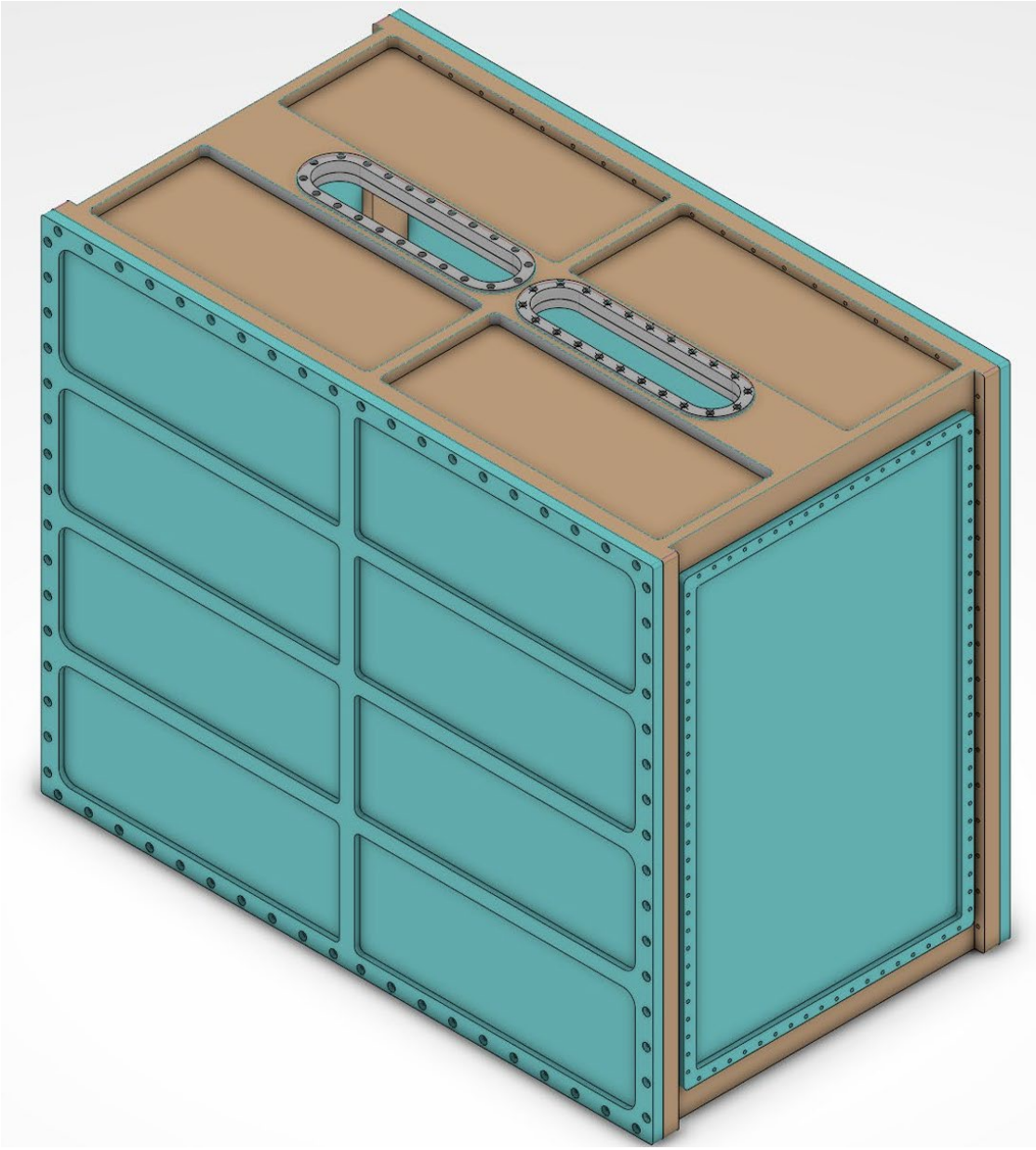
Field Cage Structure in Nylon66

- Probably no need for supporting structures (structural checks to be done)
- Field rings made by copper strips on Kapton (PET as backup)
- Resistors soldered on one side
- Field Cage held by countersink N66 screws. Tests indicate no need to use an additional N66 strip



To be integrated in the 3D model

PMMA vessel

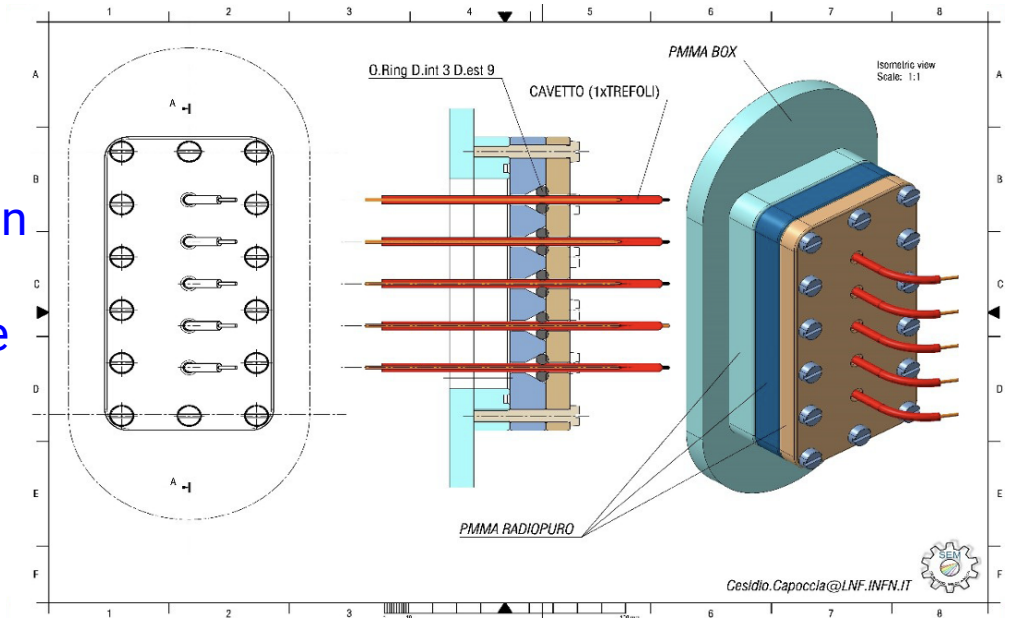


PMMA vessel

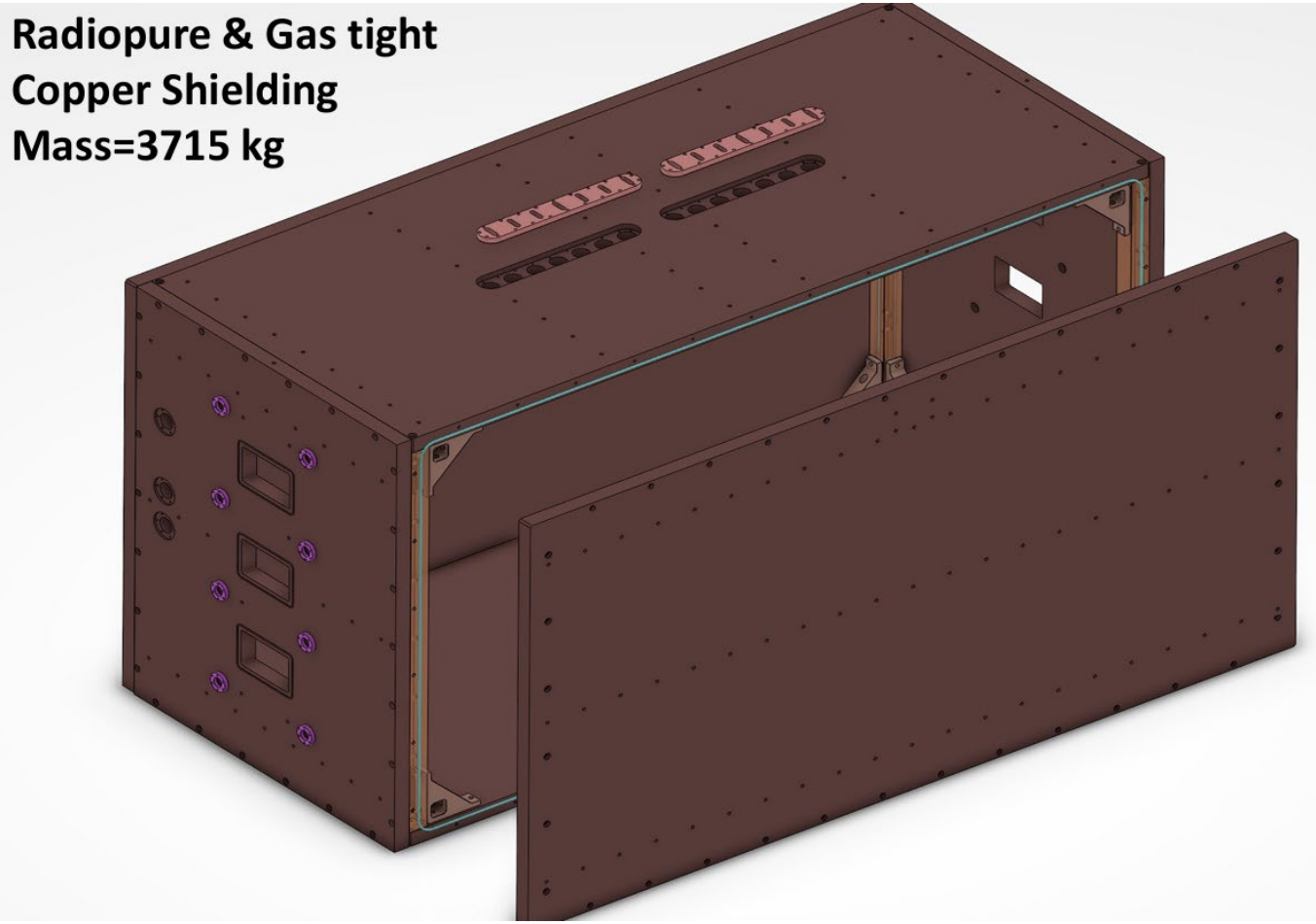
- Sizes defined, around 100kg
- Windows for Calibration source with flange and ETFE/Tedlar thin window
- Gas Tightness with O-rings and custom cables feedthrough, usable also for gas pipes
- PMMA supplier and company to machine it already available
- Need integration of GEM frames and Field cage to proceed

Feedthrough

- Following the implementaion of LIME HV cathode cable



Copper Vessel



Feedthrough similar as PMMA

Gas Thigh Radiopure Vessel

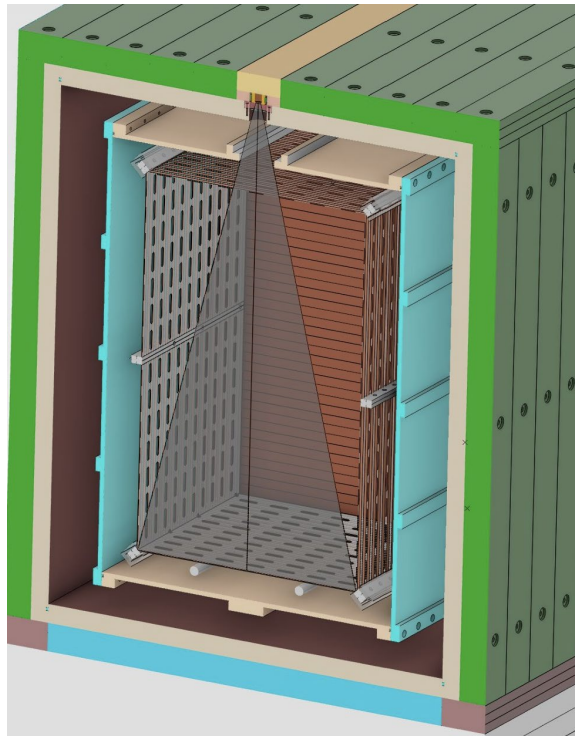
- Function as a second gas volume
- Feedthough and details still to be integrated
- 4cm radiopure copper slabs already purchased

→Slab dimensions are the strongest constraint of CYGNO04 realization

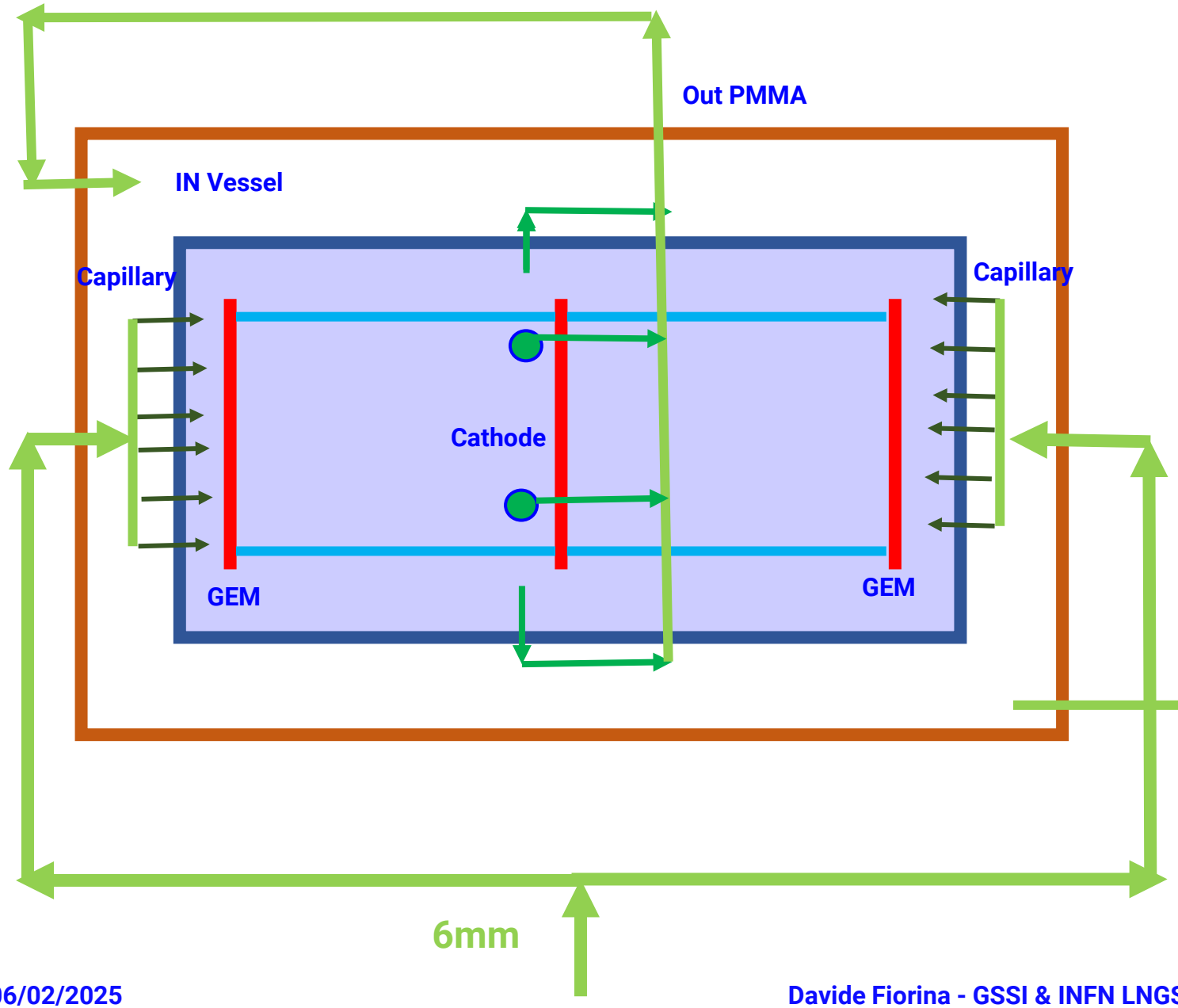
- Company to machine the slabs individuated (to be contacted)

55Fe source positioned on top

- Like LIME: detector calibration and response at different z positions on both sides of the TPC
- Additional gaseous 87Rb source is foreseen to be used



Gas distribution

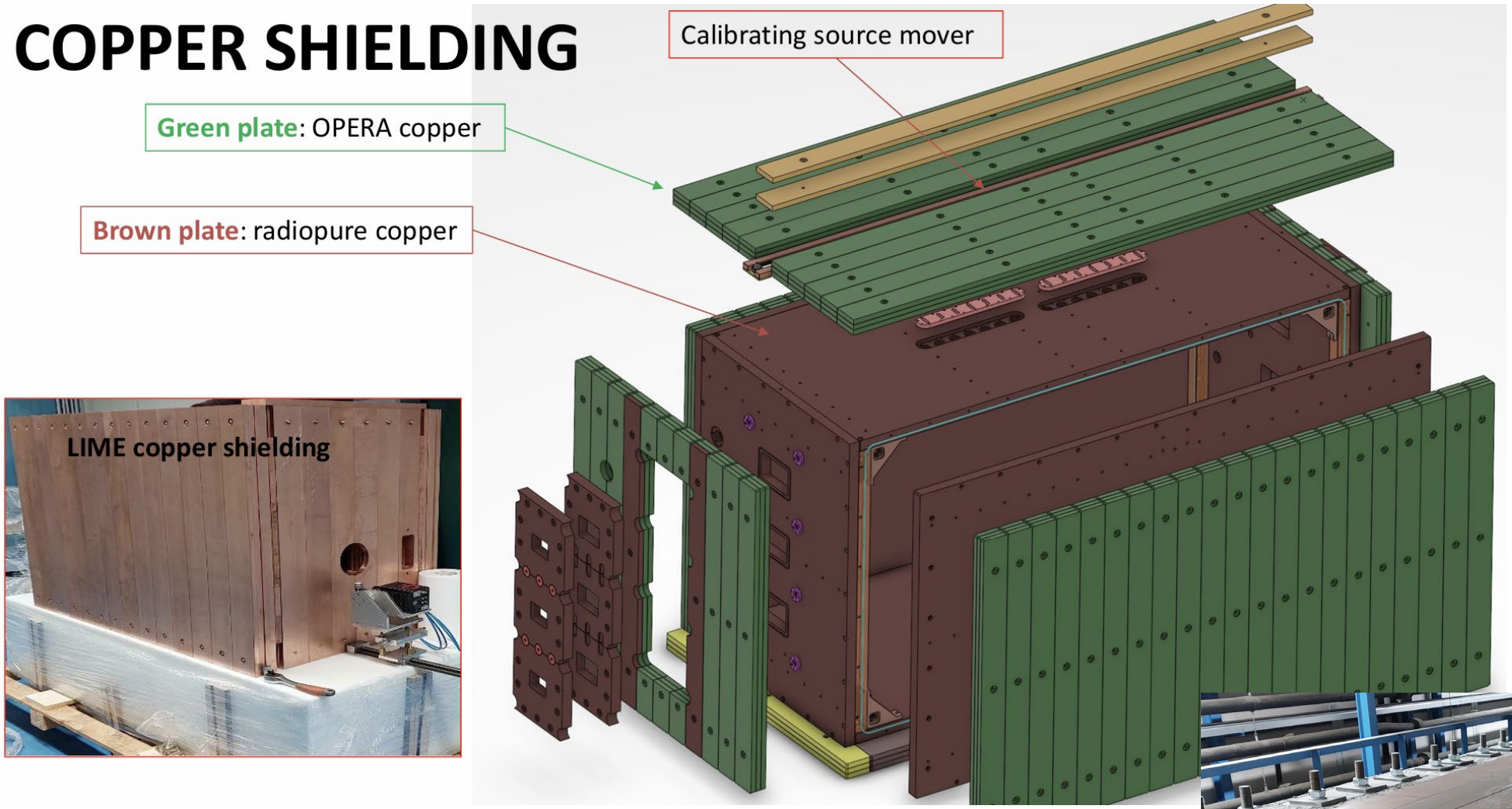


Gas System

- The core of the gas system is the one from LIME (built for CYGNO04)
- All pipes in SS or eventually copper
- Main gas line 12mm inside the copper vessel splitting in 12 (6 per side) 6mm pipes supplying the PMMA vessel on the 2 GEM sides
- Return placed in the center of the PMMA vessel 6x 6mm pipes converging outside the vessel in 1x 12mm pipe
- Main 12mm pipe is flushing the copper vessel cavity and then returning

To be integrated in the 3D model

Copper shielding



OPERA Copper
87 bars (flat 100x20) 2945 mm long weighing approximately 52 kg each for **4.5 tons.**

Additional **3 tons** secured from the Ptolemy experiment

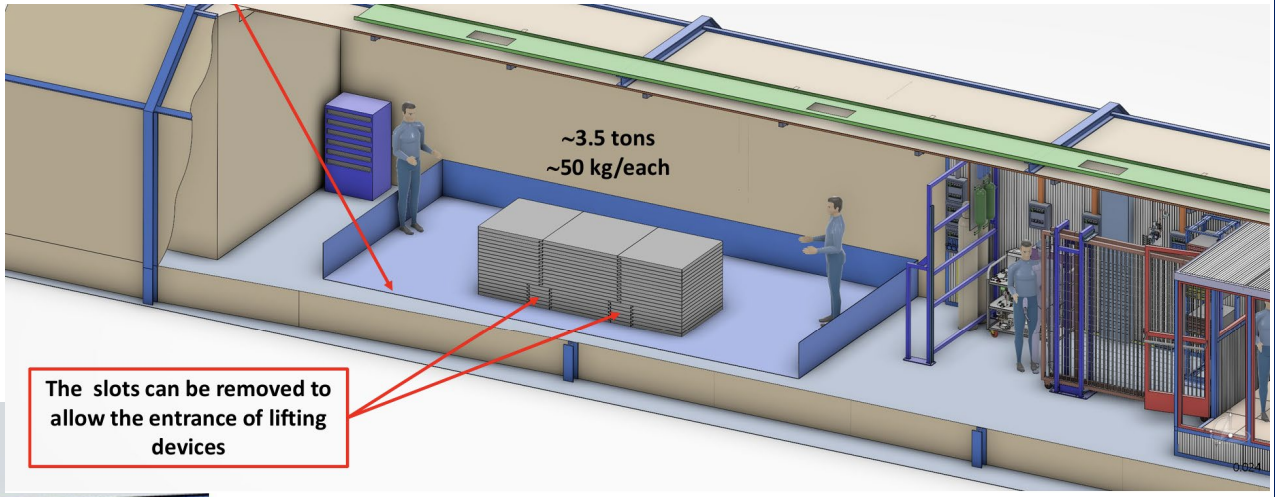
Company to machine Opera slabs available (same as LIME)

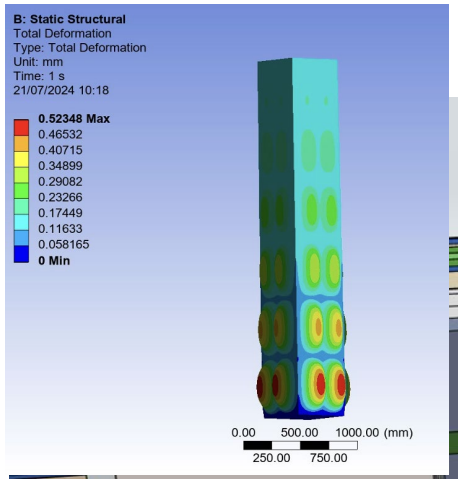
In principle no need to use LIME copper

Water shielding

Polyethylene base

- Wait for executive drawing to proceed with procurement

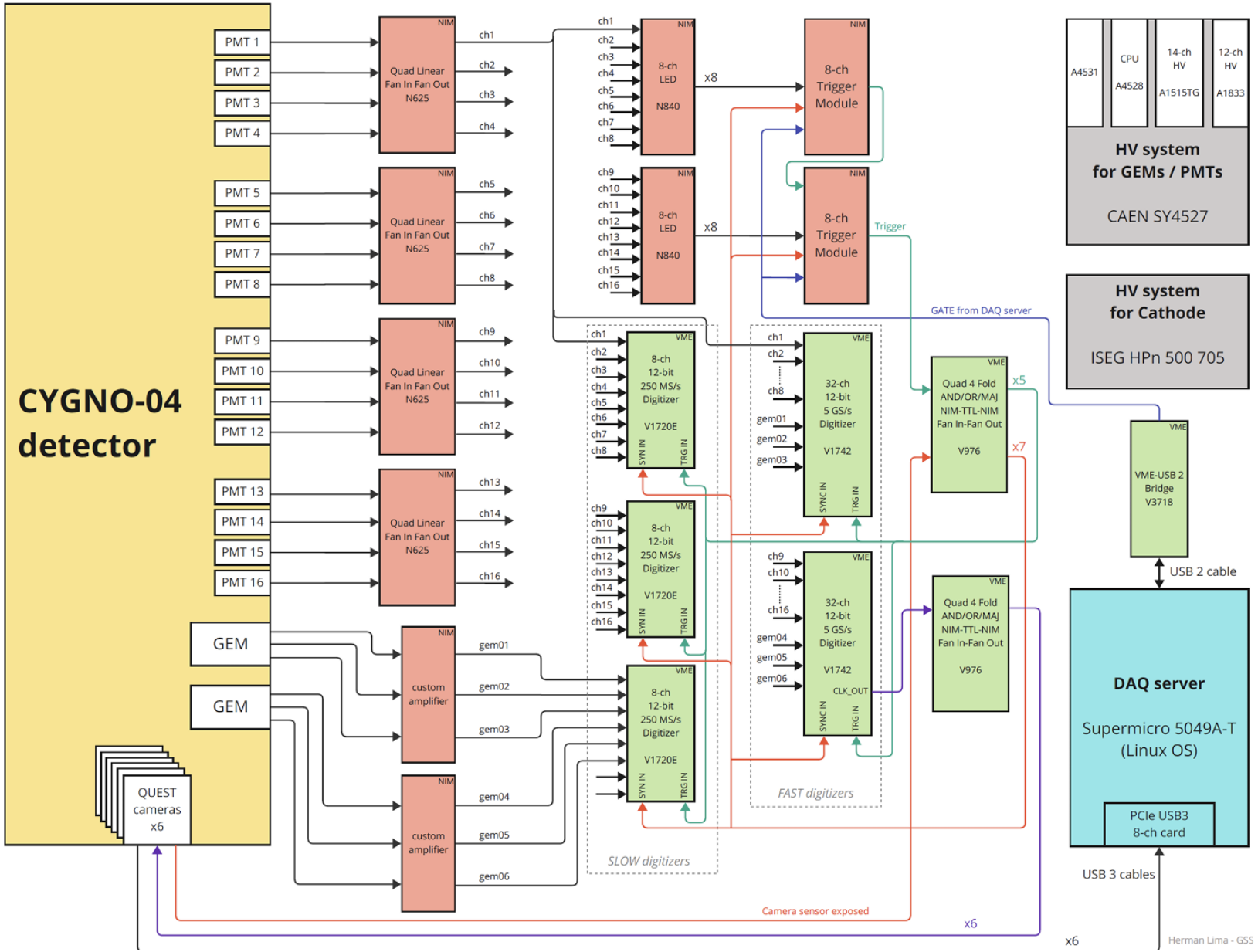




100cm Water Shielding

- Profiting from LIME experience the idea is already in place, but still to be integrated into the 3D model
- The same company is available to produce new boxes
- Hole foreseen for AmBe calibration
- **Safety Pool should be designed**

DAQ



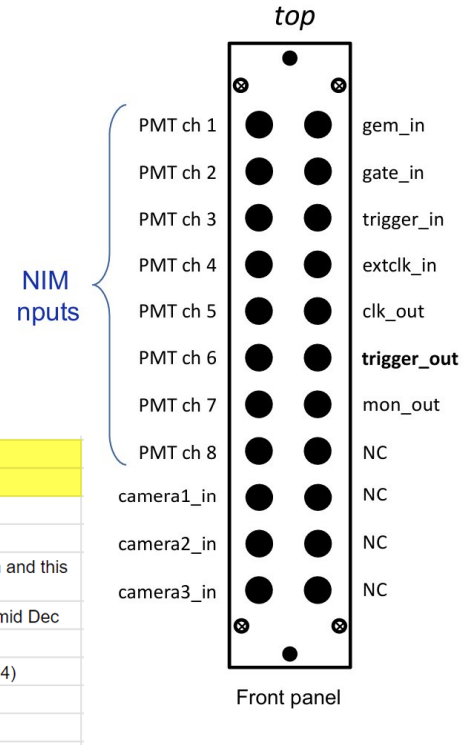
DAQ:

- 6 cameras and 16 PMTs to read
- Design two independent data acquisition paths that can run also in a ‘combined mode’.
- Wrt LIME change the camera operation mode from ‘software trigger’ to External Trigger mode
- One of the digitizers is the Master, sending a reference ext_trigger to the six cameras.
- Both the exposure and readout of the camera are made by the external trigger, reducing the deadtime.

DAQ

Version 1.0 of DAQ will inherit the same trigger logic of LIME using only the PMTs signals to trigger (version 2.0 discussed by Giorgio)

- Trigger will be generated by a custom made FPGA+rasperryPi module fully customizable
- All the necessary modules procured, just missing some cables and connectors



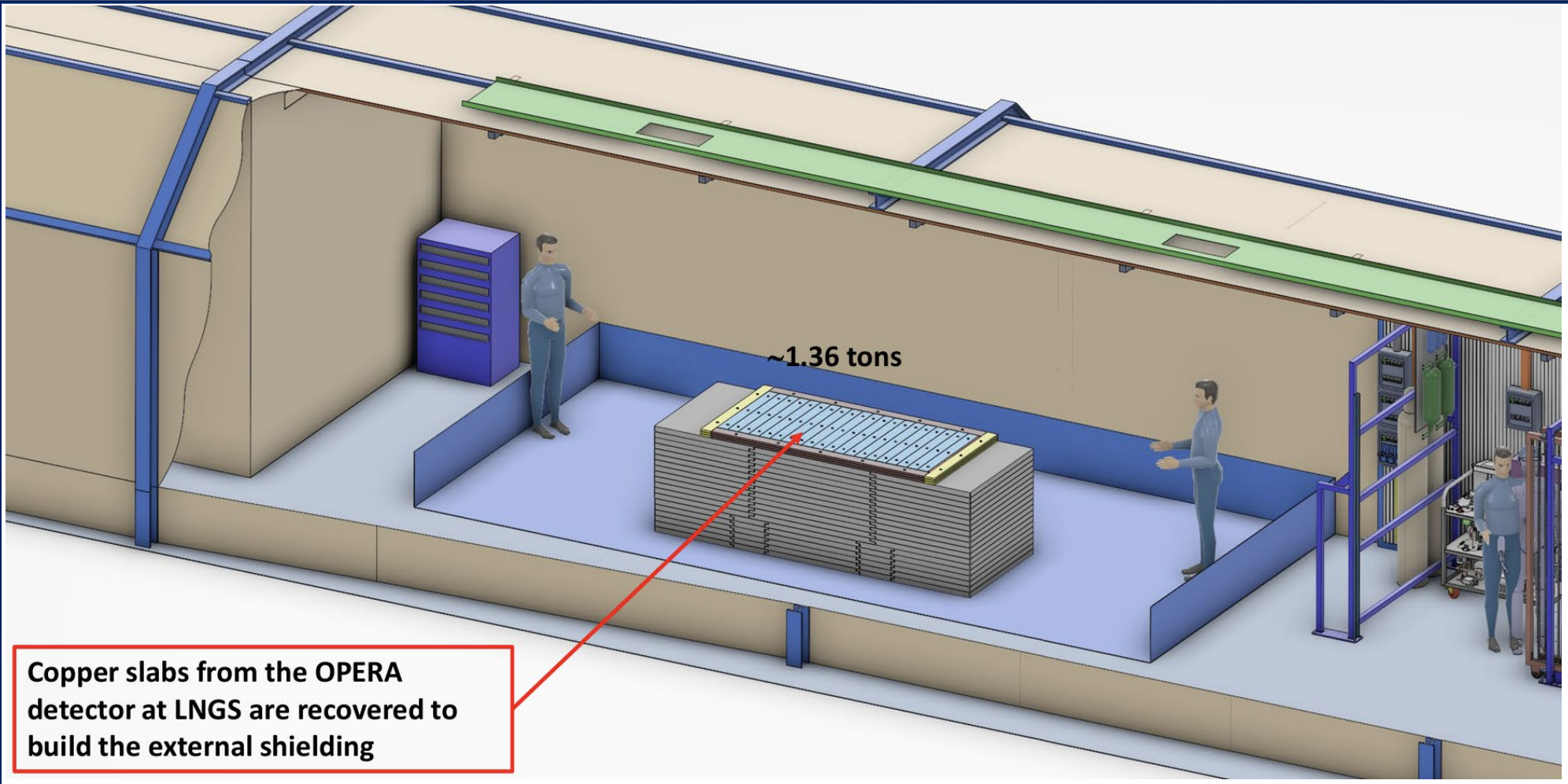
Front panel


Trigger Module v2 under development.

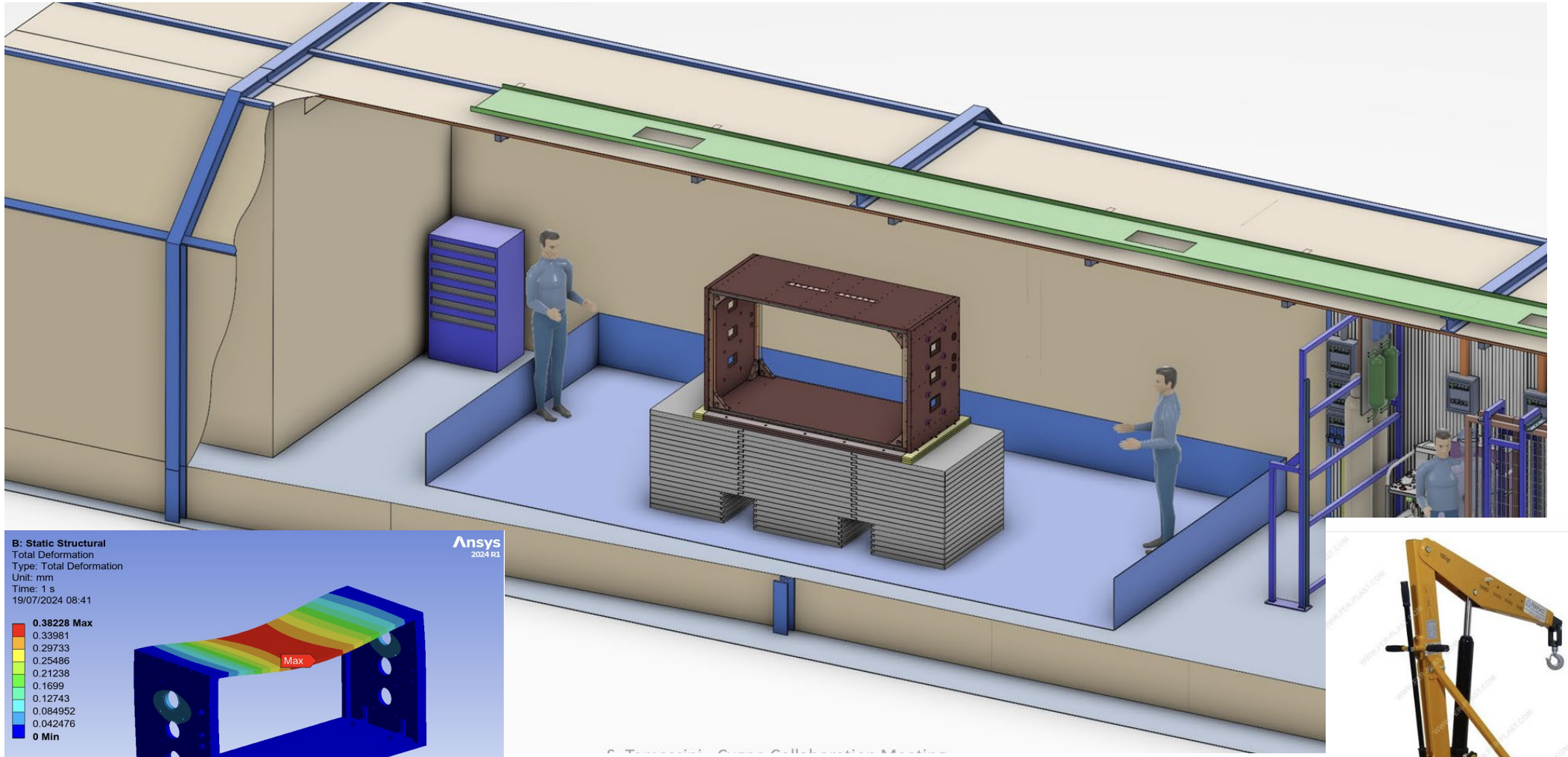
	GROUP	DESCRIPTION	Model	Manufact.	Need	Available	TO ORDER	Notes
1	NIM module	Quad Linear Fan In Fan Out	N625	CAEN	4	4	0	1 available at LNF and 2 ordered
2	NIM module	8-ch Discriminator	N840	CAEN	2	2	0	1 available at LNF
3	~~NIM module~~	~~4-ch Fast Amplifier~~	~~N978~~	~~CAEN~~	~~2~~	~~4~~	~~4~~	D. Pinci said there is a custom amplifier design going on and this module won't be used in CYGNO04 (21/10/24).
4	NIM module	8-ch Trigger Module	TM v2	GSSI	2	1	1	under development / estimated delivery of new comps. mid Dec
5	NIM crate	12-slots standard NIM crate		CAEN	1	3	-2	1 available at LNF and 1 at LNGS
6	VME module	8-ch, 250MSPS Digitizer	V1720E	CAEN	3	3	0	2 available, need 1 more because of the GEMs (28/10/24)
7	VME module	32-ch, 5GSPS Digitizer	V1742	CAEN	1	3	-2	1 available at LNF and 1 at LNGS
8	VME module	Quad 4 fold Logic, NIM-TTL-NIM	V976	CAEN	2	1	1	1 fanout of the Trigger signal and 1 Clock to cameras
9	VME module	VME-USB2 Bridge	V3718	CAEN	1	1	0	1 available at LNF (accord. to Francesco Renga)
10	VME crate	4U, 8 slots, VME64 std crate	VME8008B	CAEN	1	1	0	8 slots used / I said to D. Pinci that it is safer to replace by a 21-slot standard crate (21/10/24). Ex: CAEN VME8100
11	HV module	12-ch for the PMTs	A1833	CAEN	1	1	0	
12	HV module	14-ch HV for Triple-GEMs	A1515BTG	CAEN	1	1	0	
13	HV crate	Universal Multichannel Power Supply System	SY4527	CAEN	1	1	0	
14	HV system	AC/DC High-Voltage Power Supply	HPn 500 705	ISEG	1	1	0	
15	Computing	8-ch, USB3-PCIe interface card	PCIe-U308	ADLINK	1	0	1	1 unit ordered by GSSI / estimated delivery mid December
16	Computing	Graphics Processing Unit (GPU)	???	???	1	1	0	according to D. Pinci (21/10/24) one (maybe 2) GPU is already installed in LIME DAQ Server.
17	Computing	USB 2 cable (Type-A to Type-C connectors)			1	0	1	check if available at LNF
18	Computing	USB 3 long cable			6	0	6	
19	Computing	Xeon processor workstation (DAQ server - Linux)	5049A-T	Supermicro	1	1	0	
20	Computing	Computer (Windows OS)			1	1	0	
21	Sensor	Orca Quest qCMOS camera	C15550-20UP	Hamamatsu	6	1	5	5 new cameras ordered by GSSI (nov/24)
22	Sensor	Photomultiplier Tube (PMT)	R7378	Hamamatsu	16	4	12	ordered?
	** Minimum Requirements.*							

Software infrastucture work will start ASAP as the ORCA QUEST2 cameras are delivered.
DAQ v1 will be ready well in time before CYGNO04 installation

Installation

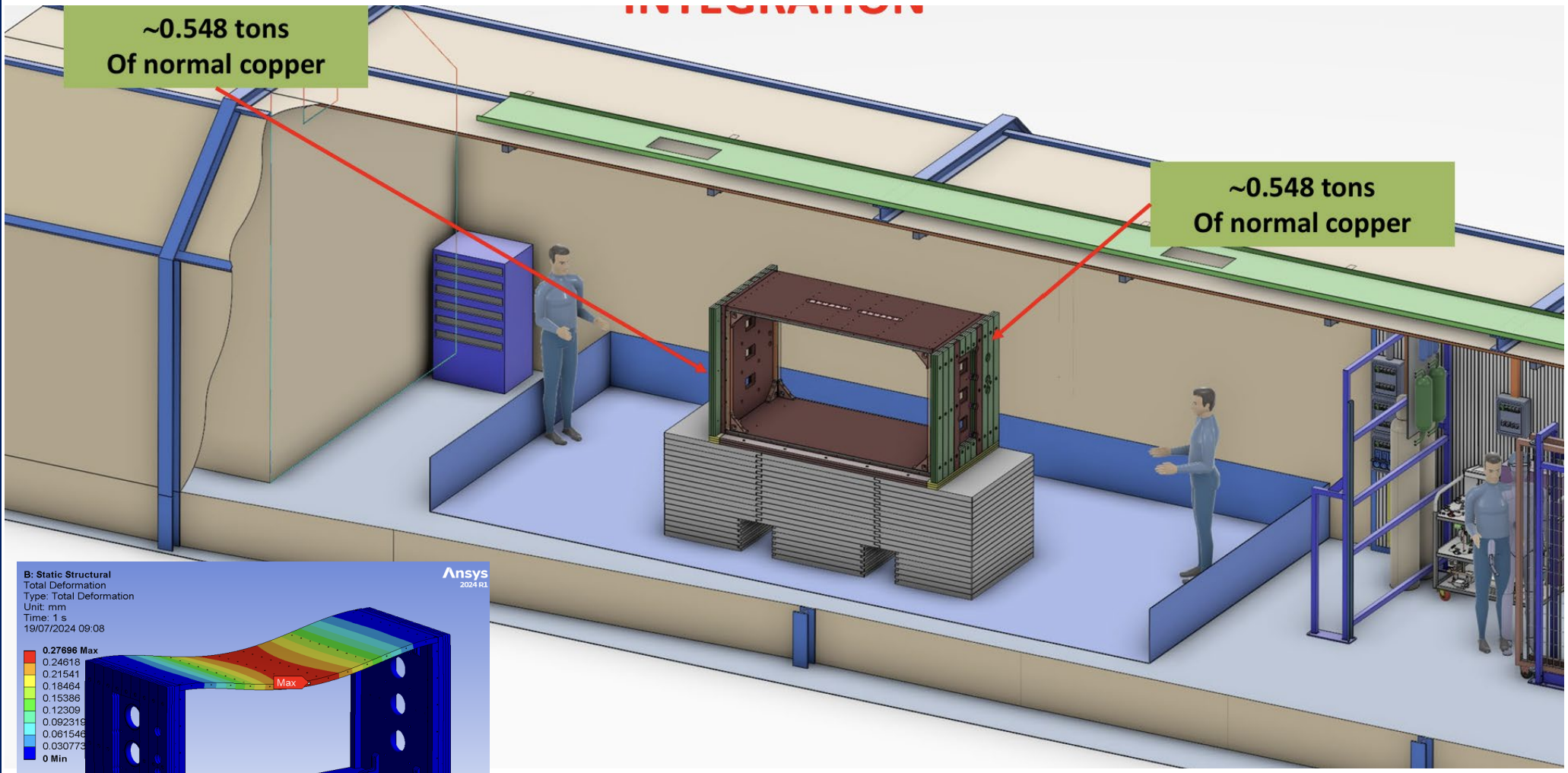


Installation

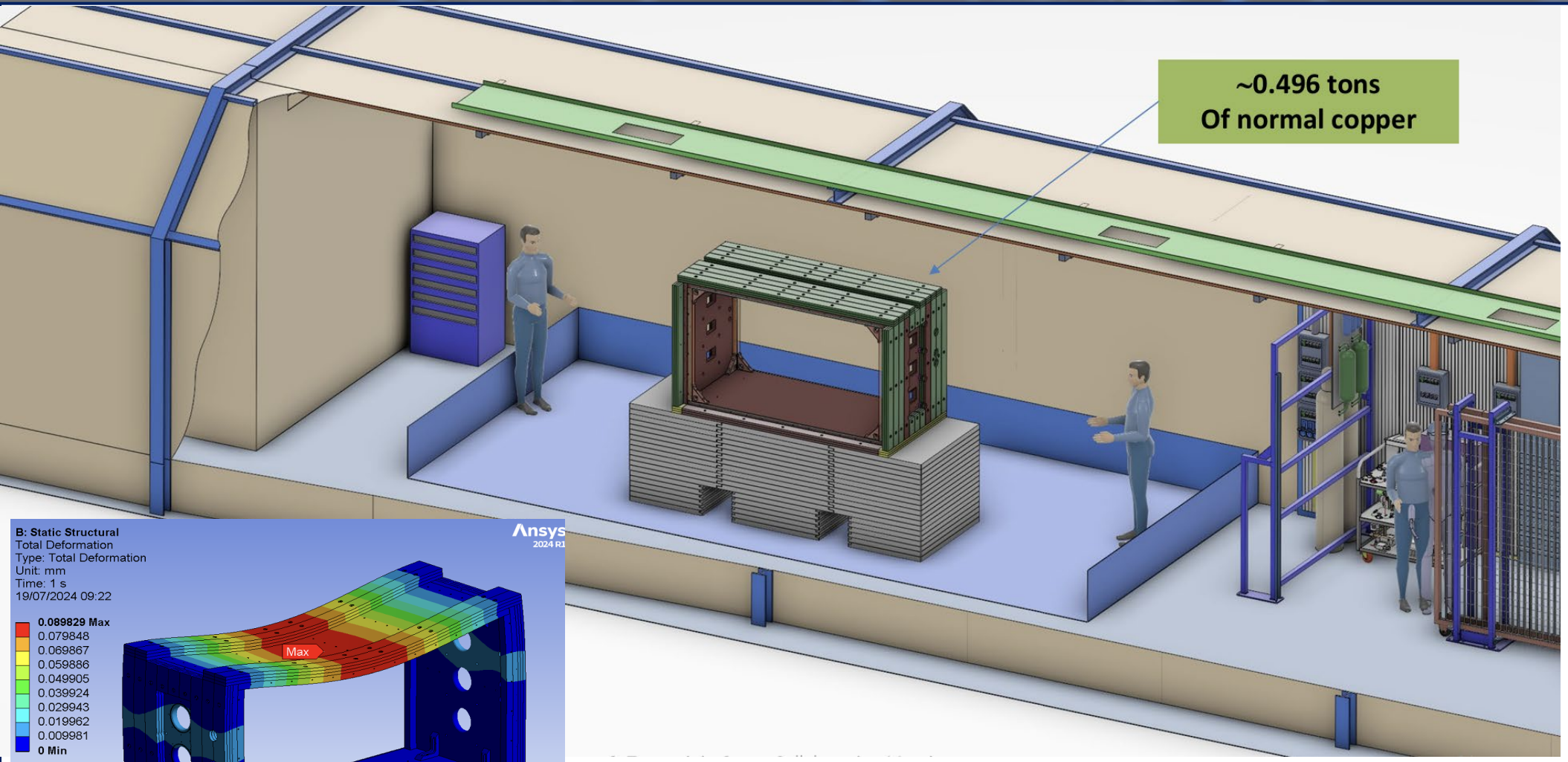


NELLA BASE DI POLIETILENE VANNO PREVISTE DELLE "NICCHIE" PER PERMETTERE ALLE RUOTE ANTERIORI DELLA GRU DI "ENTRARE" SOTTO LA COPPER BOX

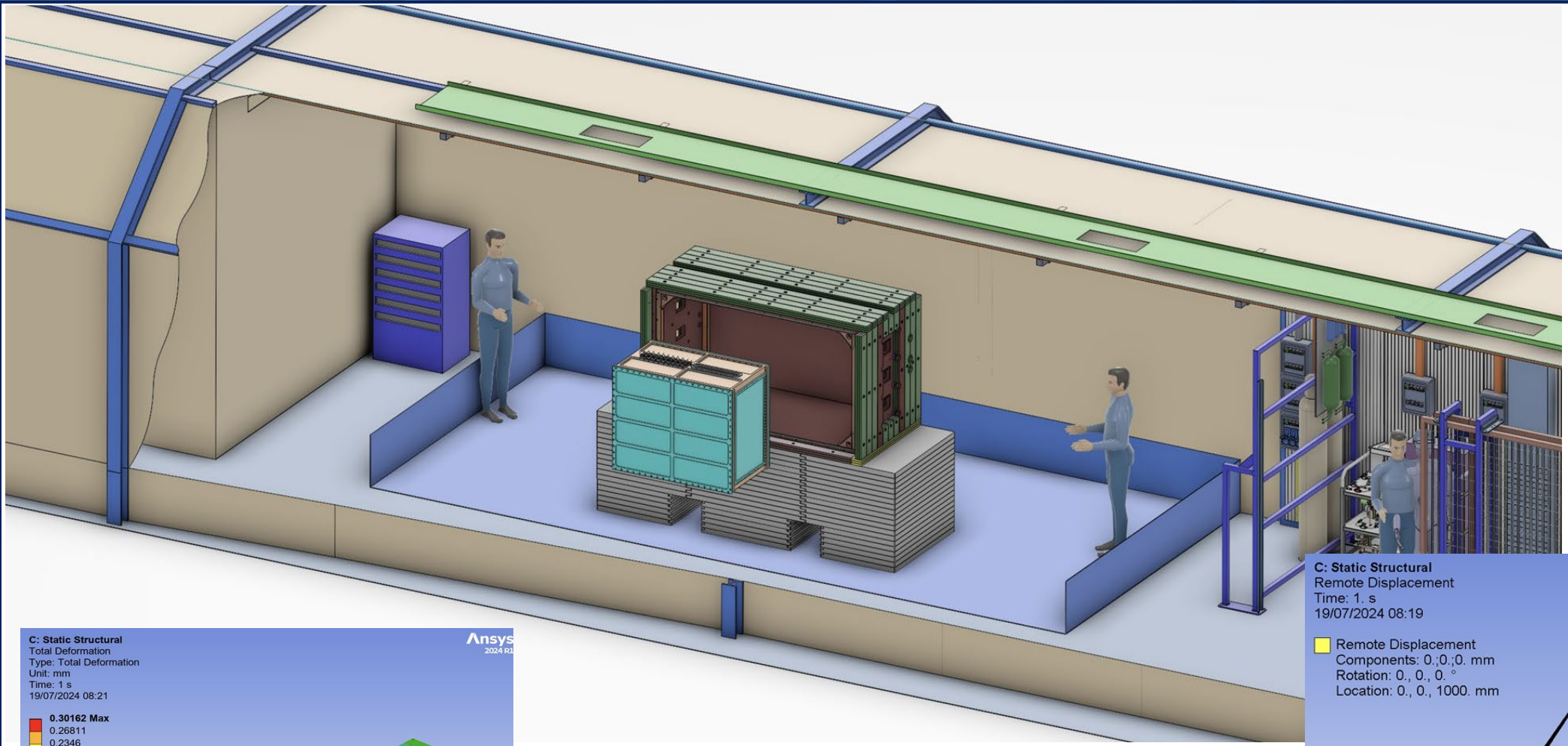
Installation

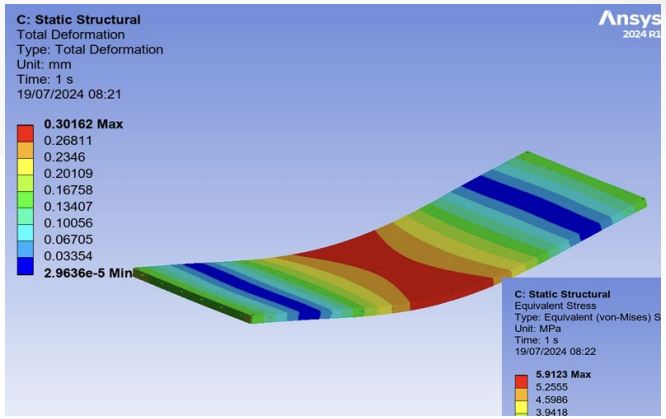


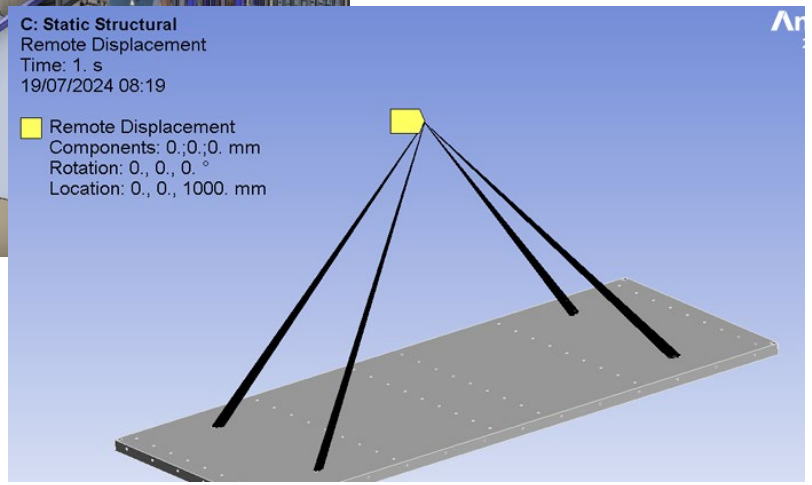
Installation



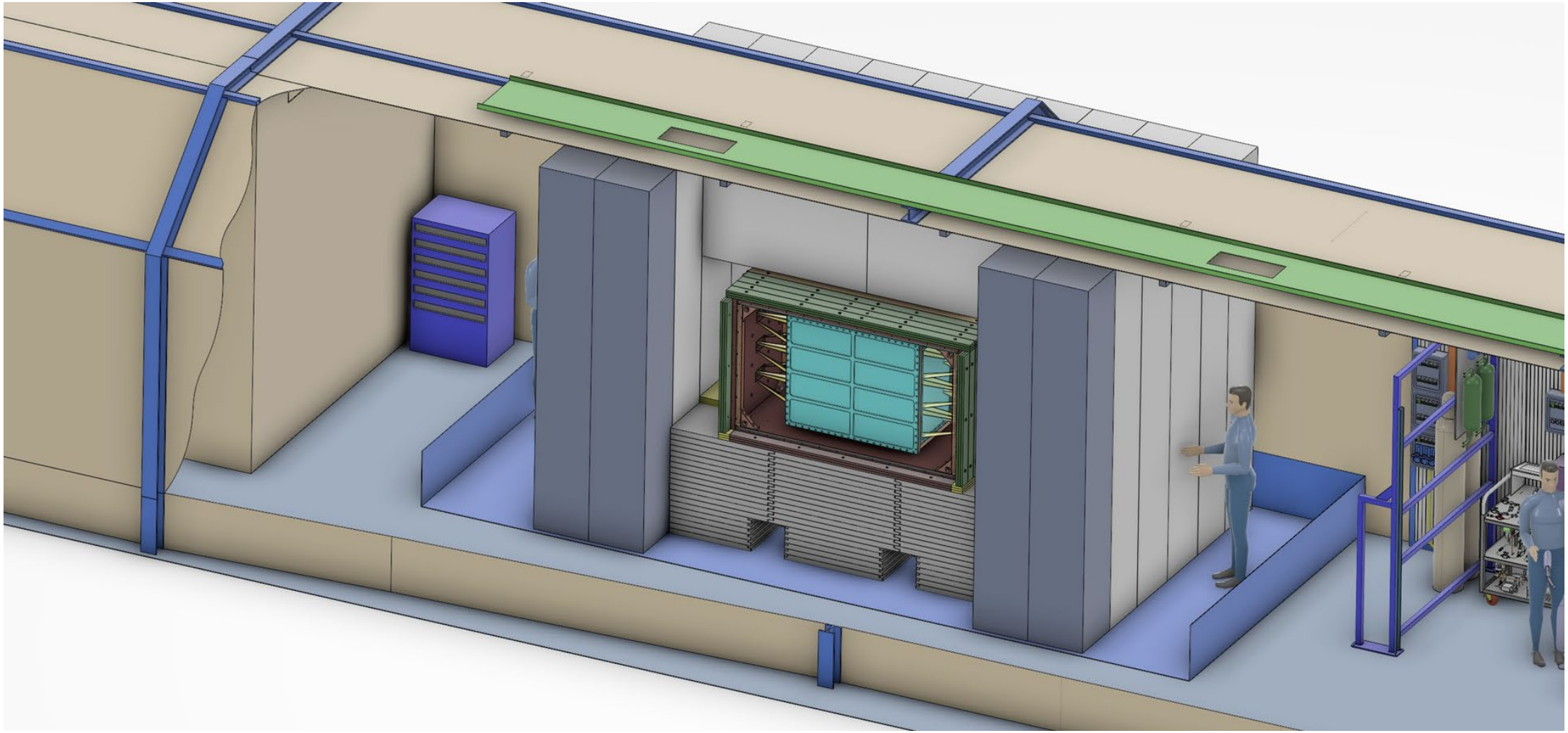
Installation





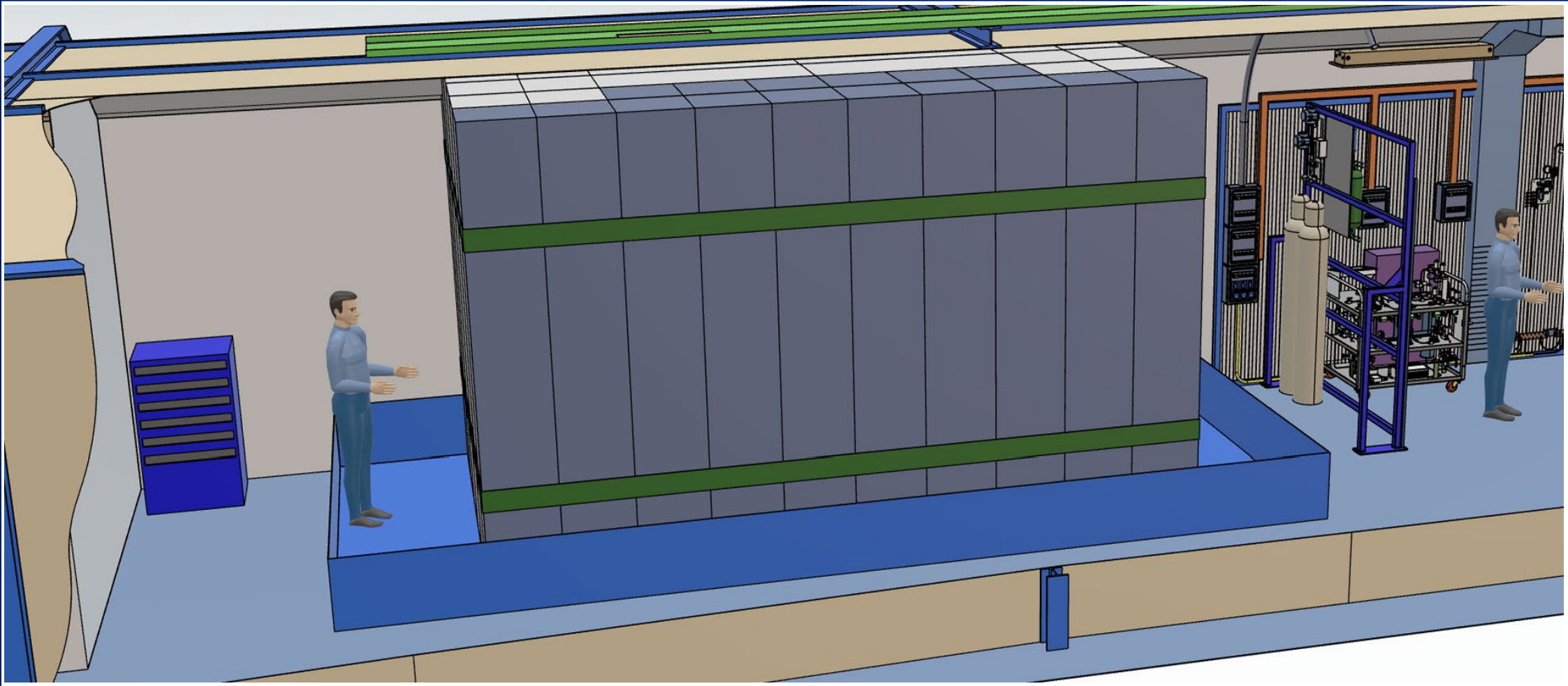


Installation



MAINTAINANCE CONFIGURATION

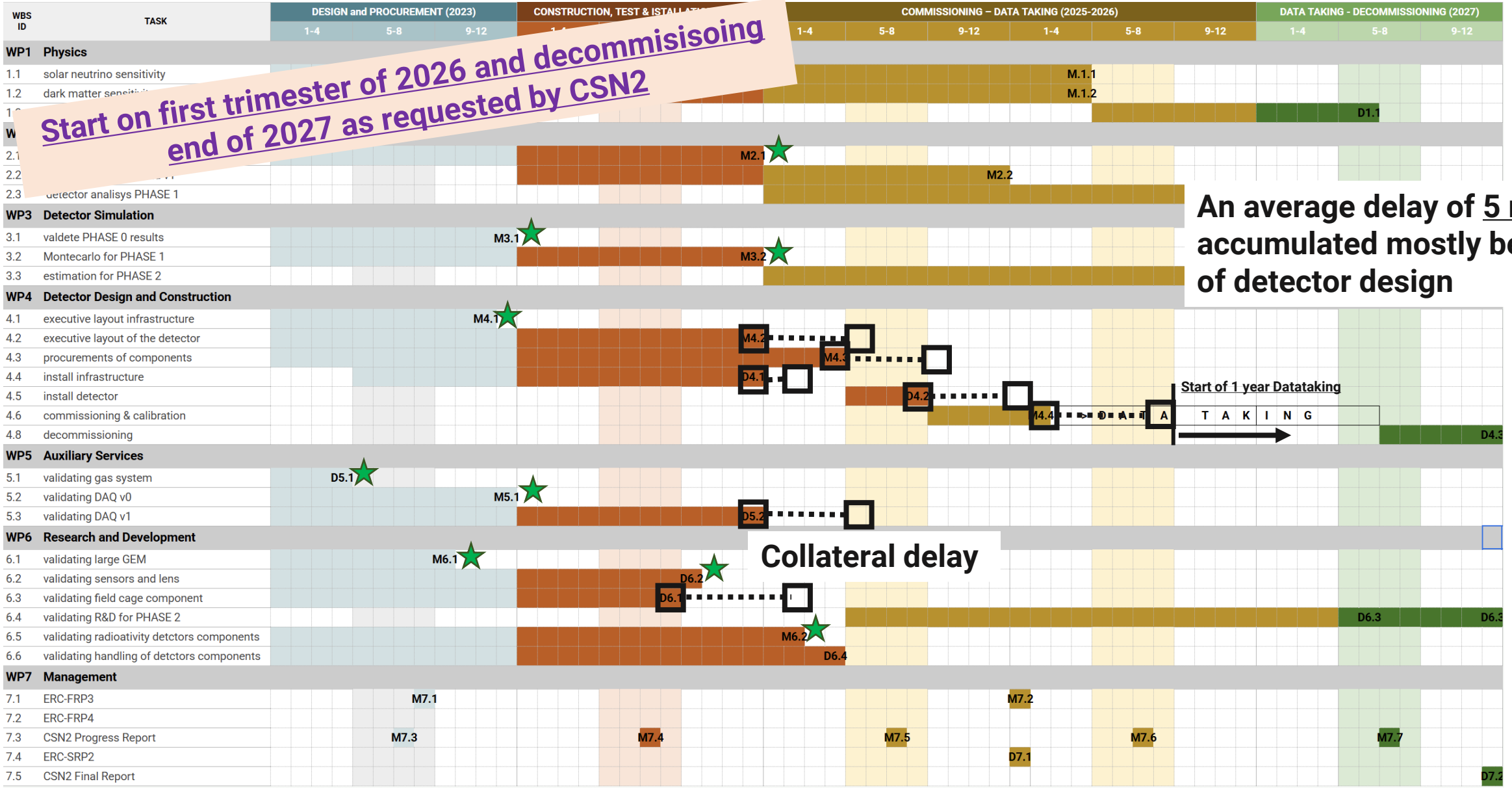
Installation



Data Taking Configuration

We should be able to swap from **Data taking** to **Maintenance** in ***O(1day)***

CYGNO04 Gantt



Start on first trimester of 2026 and decommisisoing end of 2027 as requested by CSN2

An average delay of 5 months accumulated mostly because of detector design

Collateral delay