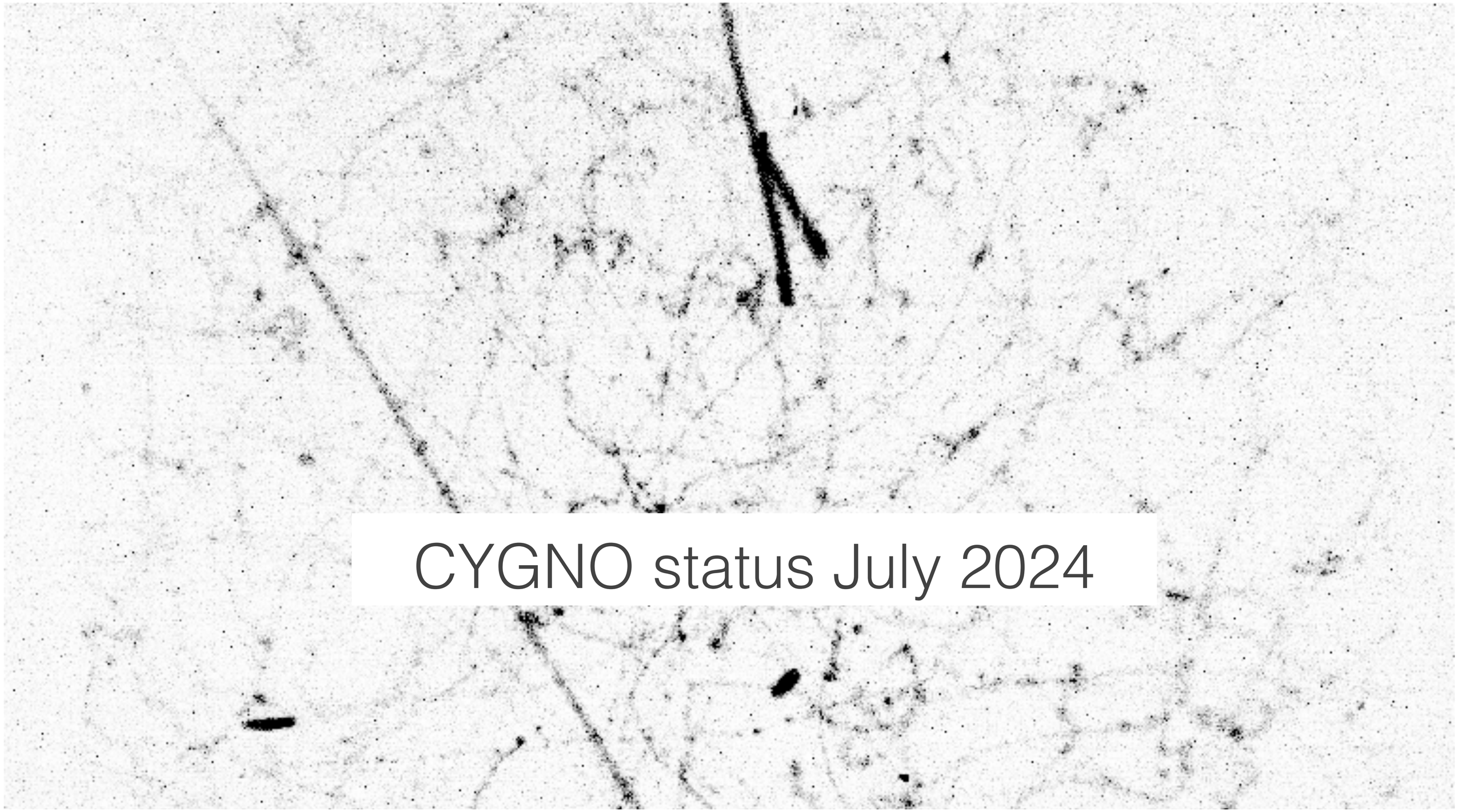
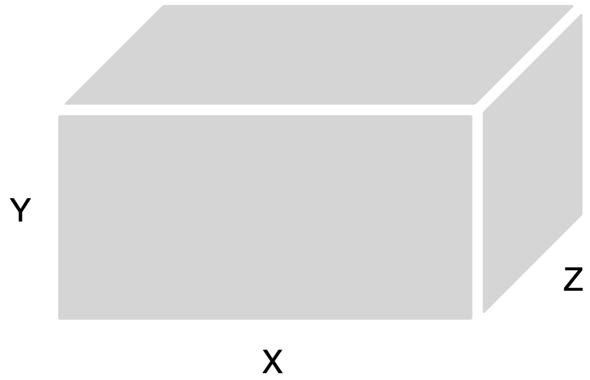


CYGNO status July 2024

News: Detector simulation

Acrylic box - dimensions



X = 1164 mm

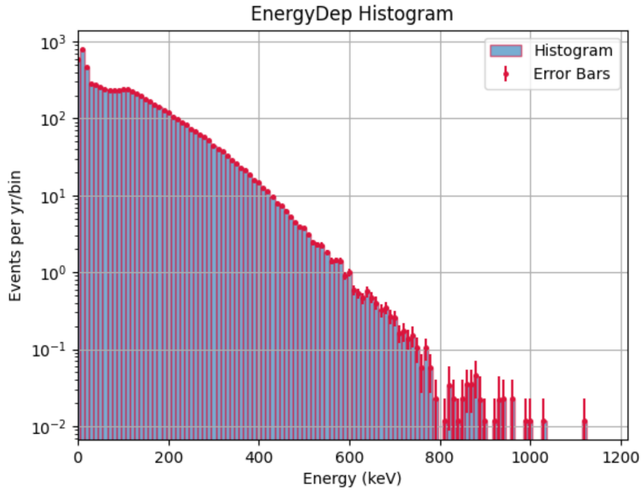
Y = 1000 mm - a bit less than TDR to avoid overlaps

Z = 735 mm

Thickness = 20 mm

LIME acrylic is 3 times worst;

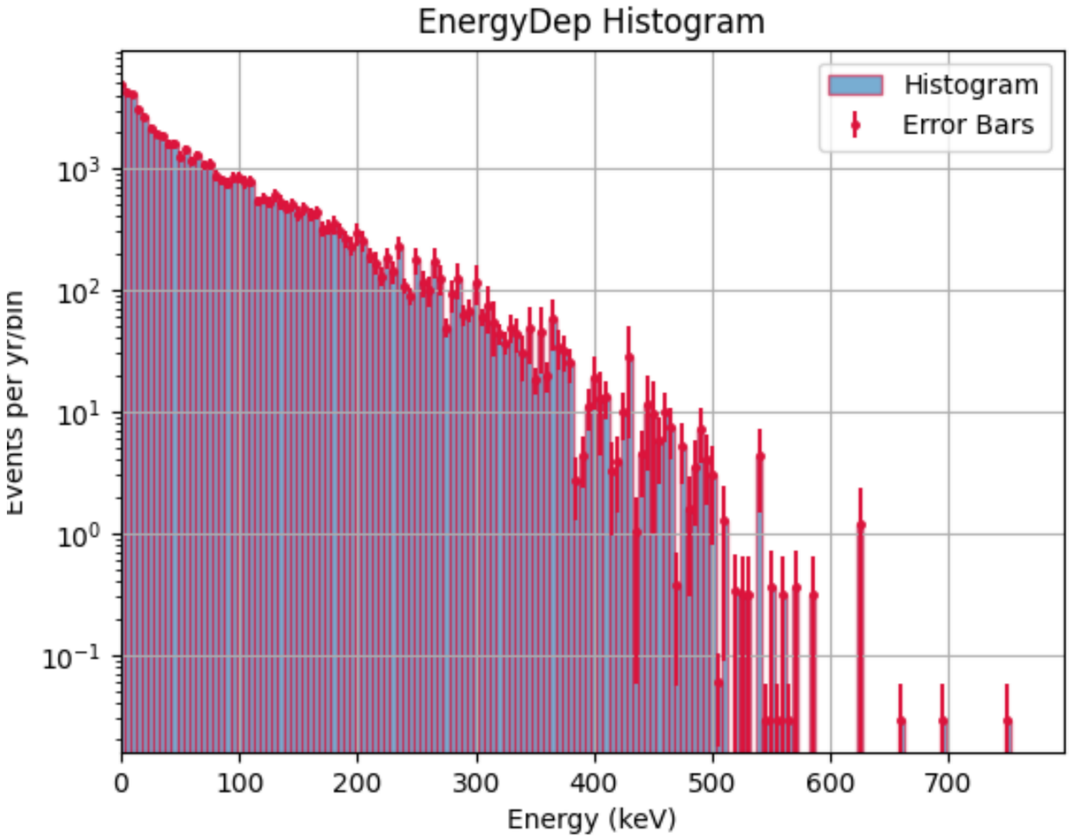
Acrylic box - SNO reference



ISOTOPE	ACTIVITY [Bq/kg]
^{238}U	2.96E-04
^{232}Th	5.69E-05
^{40}K	7.12E-05

Total Rate for events within the energy interval [1, 20] keV from all detectors: 13701 ± 43 events per year

News: Detector simulation

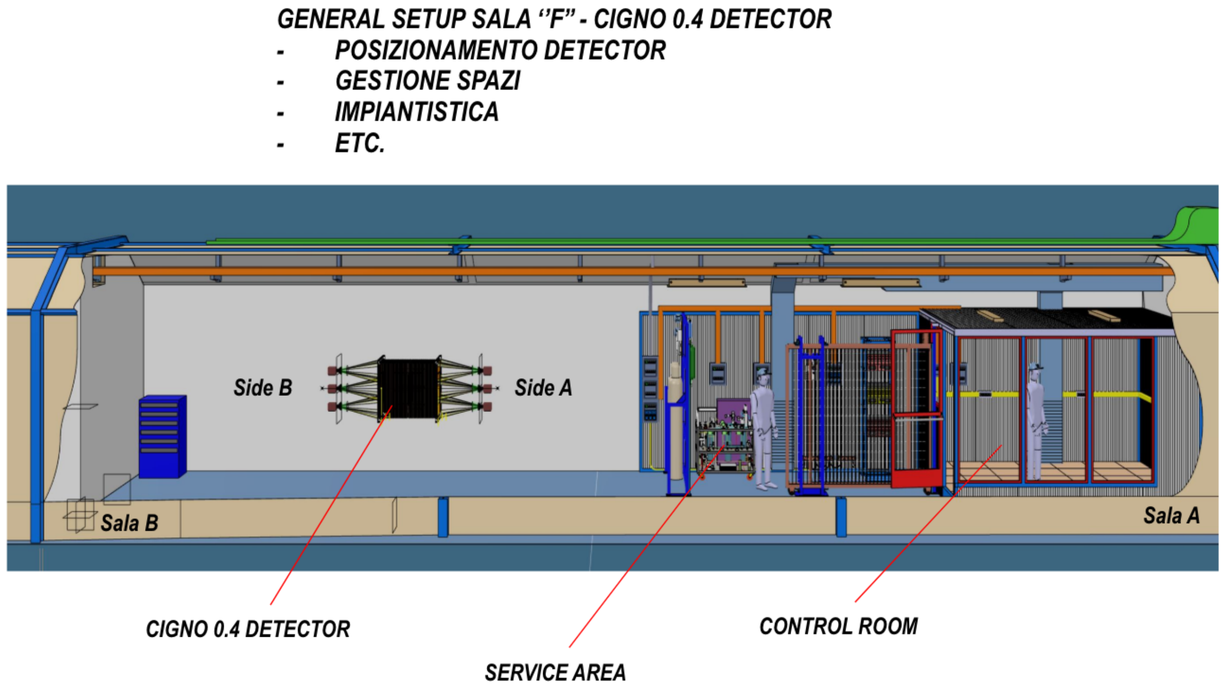


	0 [months]	12 [months]
Layer_0 [events per year]	72695 ± 1941	56791 ± 1874
Layer_1 [events per year]	15772 ± 795	11082 ± 749
Layer_2 [events per year]	4711 ± 344	4641 ± 339
Layer_3 [events per year]	2278 ± 244	2242 ± 240
Layer_4 [events per year]	967 ± 165	952 ± 163
TOTAL	96423 ± 2145	75708 ± 2067

NB: these are upper limits, in order to get the real numbers different technics measurements are going to be performed.

Anyway these studies set the best configuration we can use;

News: Infrastructure installation



Infrastructure installation

- Final designs produced in November 23

- (Very) long **iteration** between GSSI (commissioner of works) and LNGS lead to an **official agreement in March 24**;

- Final designs translated in **executive designs in the meanwhile** and tender expected to be **issues in the next weeks**;

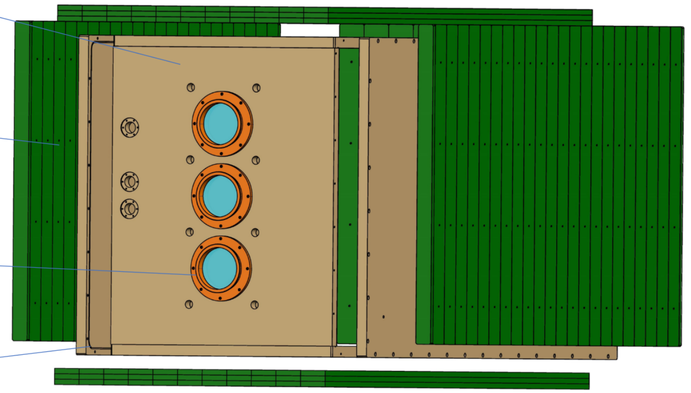
Material procurement and preparation by the **company in July**;

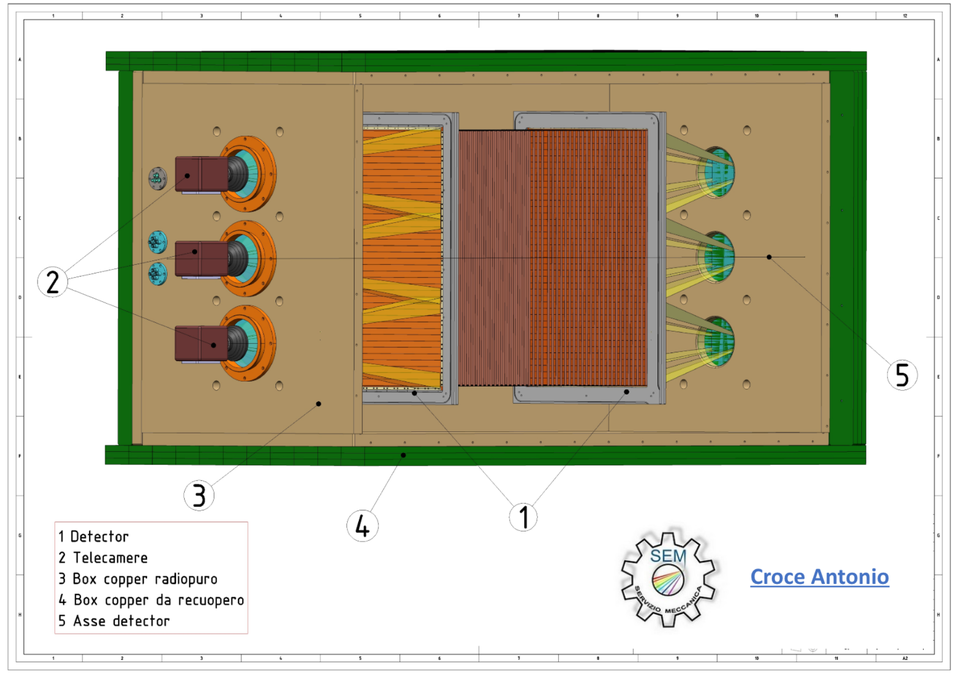
Works are then expected to **start after the summer** with a duration of **1-2 months**;

Hall-F is then expected to be **ready by the end of 2024**;

News CYGNO04 Design

- Box clean Cu (2260x900x1100)
- Box of Cu refurbished (OPERA).
- CAMERAs pass through
- O-Ring Cu for tightness





- Based on the optimisation of copper shielding scheme, the demonstrator designs are being developed: **4 tons of radio-pure** copper for the **internal** layer and **7 tons for the external one**;

- After several check and discussion with involved WG, this proposal is to be considered as the current default layout

- Feed through and optical windows still under study;

- **field cage finalised**;

- cathode under studies;

Meeting with referees

In the past week we meet our INFN-referees and presented the status of CYGNO and our financial plan for the next 3 years

- Commissioning activity for CYGNO04 in the second half of 2025
- Start of data taking in Feb 2026 and half 2027 (16 months in total)
- Decommissioning of CYGNO04 in the second half of 2027

INFN - CSN2	2025	2026	2027
Gas Bottles	10	20	10
Gas Recovery	10	20	10
Consumables	30	10	20
R&D	30	20	0
Tot w/o Travels (k€)	80	70	40
Travels - Shift	28	20	10
Travels - Installation	28	10	30
Tot Travels (k€)	56	30	40
Tot (k€)	**136**	**100**	**80**

The progresses in the LIME operation, data analysis and simulation and all the work done for CYGNO 04 were very positively received

In order to go on with the procedure, they wants a quantitative evaluation of the results we can obtain with 1 year of data

Tentative updated CYGNO04 GANNT

Currently, from the ERC fundings, to cover the core costs of CYGNO04, there are **119 k€** available at **INFN** and **490 k€ at GSSI** for a t**otal of 609 k€**

Part of the equipment needed for CYGNO04 was already bought and is currently being used and validated on LIME:

- high voltage system;
- gas system;
- DAQ and trigger;

Item	Cost (k€)
Gas Vessel	35
Readout: GEM. cameras, PMT	146
Cathode	17
Field Cage	13
Calibration	10
Copper Shielding	180
Water Shielding	85
Polietilene Base	20
DAQ	11
Electric Services	20
Cooling and Conditioning	25
Safety: fire detection, gas monitors	35
Total	597

According to the latest quotations received, the **other costs** expected for the **construction** of CYGNO04 is of **597 k€**, therefore an expense that can **be fully covered with ERC funds**

The **total value** of **CYGNO04** is of about **910 k€.**

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Letter

Secondary scintillation yield from GEM electron avalanches in He-CF_4 and He-CF_4-isobutane for CYGNO — Directional Dark Matter search with an optical TPC

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Our paper on the use of hydrogenated has mixtures for the search of light DM was published on Physics Letter B

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ABSTRACT

CYGNO is an international collaboration with the aim of operating a 1 m^3 optical time projection chamber (TPC) for directional Dark Matter (DM) searches and solar neutrino spectroscopy, to be deployed at the Laboratori Nazionali del Gran Sasso (LNGS). A He/CF_4 (60/40) mixture is used, along with a triple Gas Electron Multiplier (GEM) cascade to amplify the ionisation signal. The scintillation produced in the electron avalanches is read out using a scientific complementary metal–oxide–semiconductor (sCMOS) camera. This solution has proven to provide very high sensitivity to interactions in the few keV energy range. The inclusion of a hydrogen-based gas will offer an even lighter target, resulting in a more efficient energy transfer in a DM particle collision, and consequently, a lower detection threshold. Additionally, longer track lengths of light nuclear recoils are easier to detect with a clearer direction. However, the addition of such gas will contribute to quenching the scintillation, jeopardizing the TPC performance. In this work, we demonstrate the feasibility of adding 1% to 5% isobutane to the He/CF_4 (60/40) mixture by measuring the respective absolute scintillation yield output. The overall scintillation produced in the charge avalanches is not drastically suppressed by quenching due to the isobutane addition. The presence of Penning transfer from excited He atoms to isobutane molecules increases the number of electrons in the avalanches, partially compensating for the loss of scintillation due to quenching. For the highest applied GEM voltage, the total number of photons produced in the avalanche per keV deposited in the absorption region presents a decrease of only a factor of about three, from $2.30(20) \times 10^4$ to $8.2(4) \times 10^3$

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