

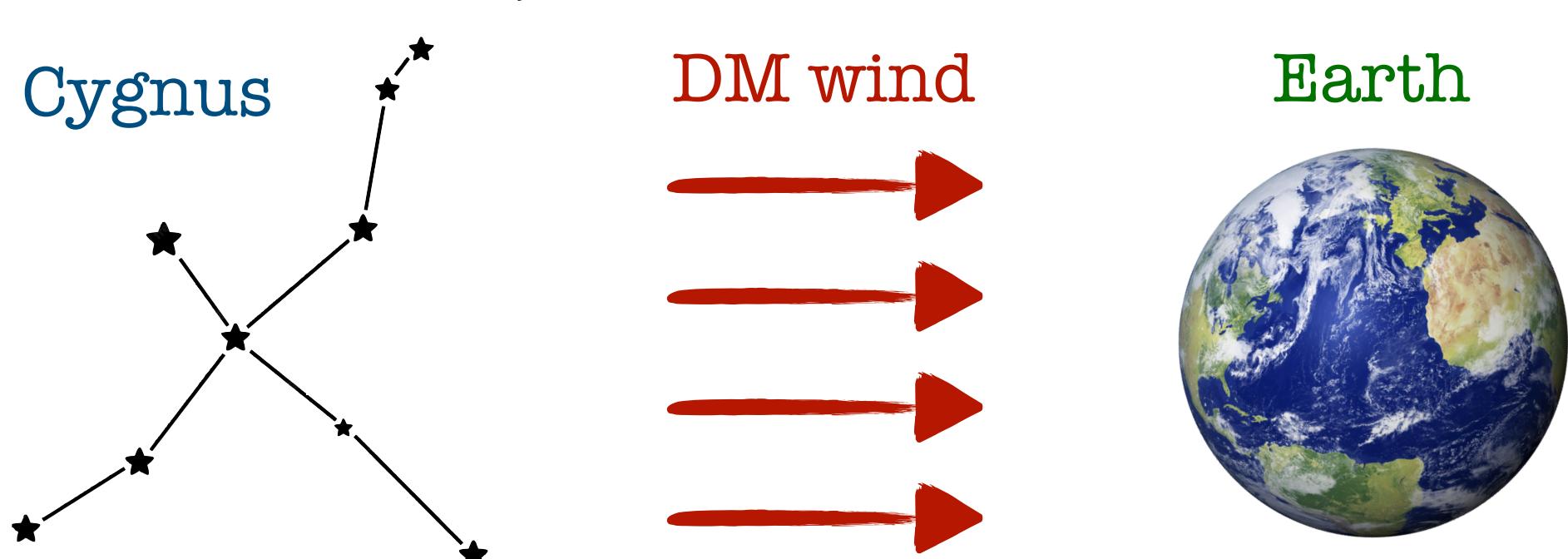
The CYGNO experiment

F. D. Amaro, E. Baracchini, L. Benussi, S. Bianco, C. Capoccia, M. Caponero, D. S. Cardoso, G. Cavoto, A. Cortez, R. J. de Cruz Roque, I. A. Costa, E. Dané, E. Di Marco, G. Grilli di Cortona, G. D'Imperio, G. Dho, F. Di Giambattista, R. R. M. Gregorio, F. Iacoangeli, H. P. Lima Júnior, G. Maccarrone, R. D. P. Mano, M. Marafini, G. Mazzitelli, G. Mc Lean, A. Messina, M. L. Migliorini, C.M.B. Monteiro, R. A. Nóbrega, A. Orlandi, I. F. Pains, E. Paoletti, L. Passamonti, F. Petrucci, S. Pelosi, **S. Piacentini**, D. Piccolo, D. Pierluigi, D. Pinci, A. Prajapati, F. Renga, F. Rosatelli, A. Russo, J.M.F. dos Santos, G. Saviano, A. da Silva Lopes Júnior, N. Spooner, R. Tesauro, S. Tomassini, S. Torelli



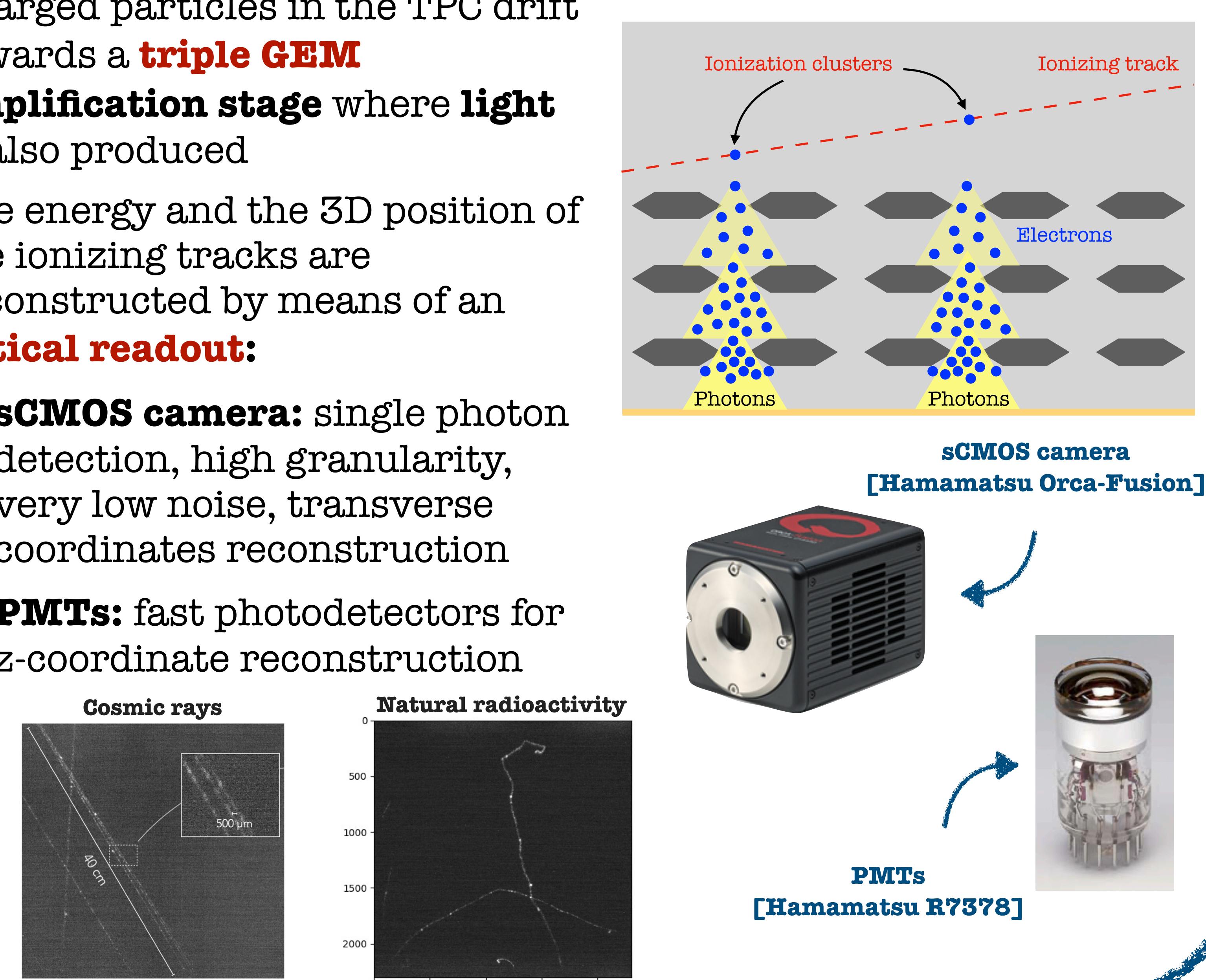
A TPC for directional DM searches

- The **CYGNO project aims** at a large detector for high precision **3D tracking of low energy** (down to **few keVs**) **nuclear recoils** from rare interactions (as for example WIMPs)
- A detector with **directional capabilities** would be crucial for a positive identification of a dark matter (DM) signal
- Experimental challenges:** rate $O(\text{evt/kg/day})$, background rejection, and energy threshold (keV)
- Strategy:** **high resolution pictures of nuclear recoils** in a (1 atm) He:CF₄ Time Projection Chamber (TPC) with a GEM amplification stage
 - low energy events in 1 atm gas \Rightarrow visible tracks
 - He and F in the mixture \Rightarrow sensitive to sub-GeV DM (He, F, possibly H) and spin dependent interactions (F, possibly H)
 - Allows the measurement of position, direction, total released energy, dE/dx (head/tail), PID

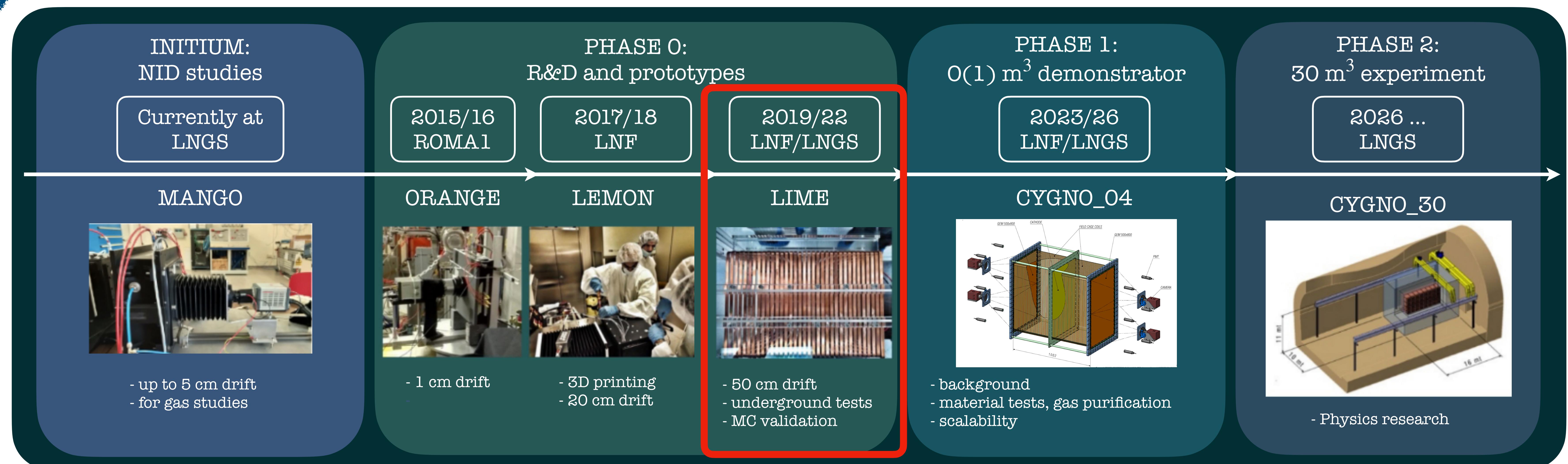


The optical readout

- Charged particles in the TPC drift towards a **triple GEM amplification stage** where **light** is also produced
- The energy and the 3D position of the ionizing tracks are reconstructed by means of an **optical readout**:
- sCMOS camera:** single photon detection, high granularity, very low noise, transverse coordinates reconstruction
- PMTs:** fast photodetectors for z-coordinate reconstruction



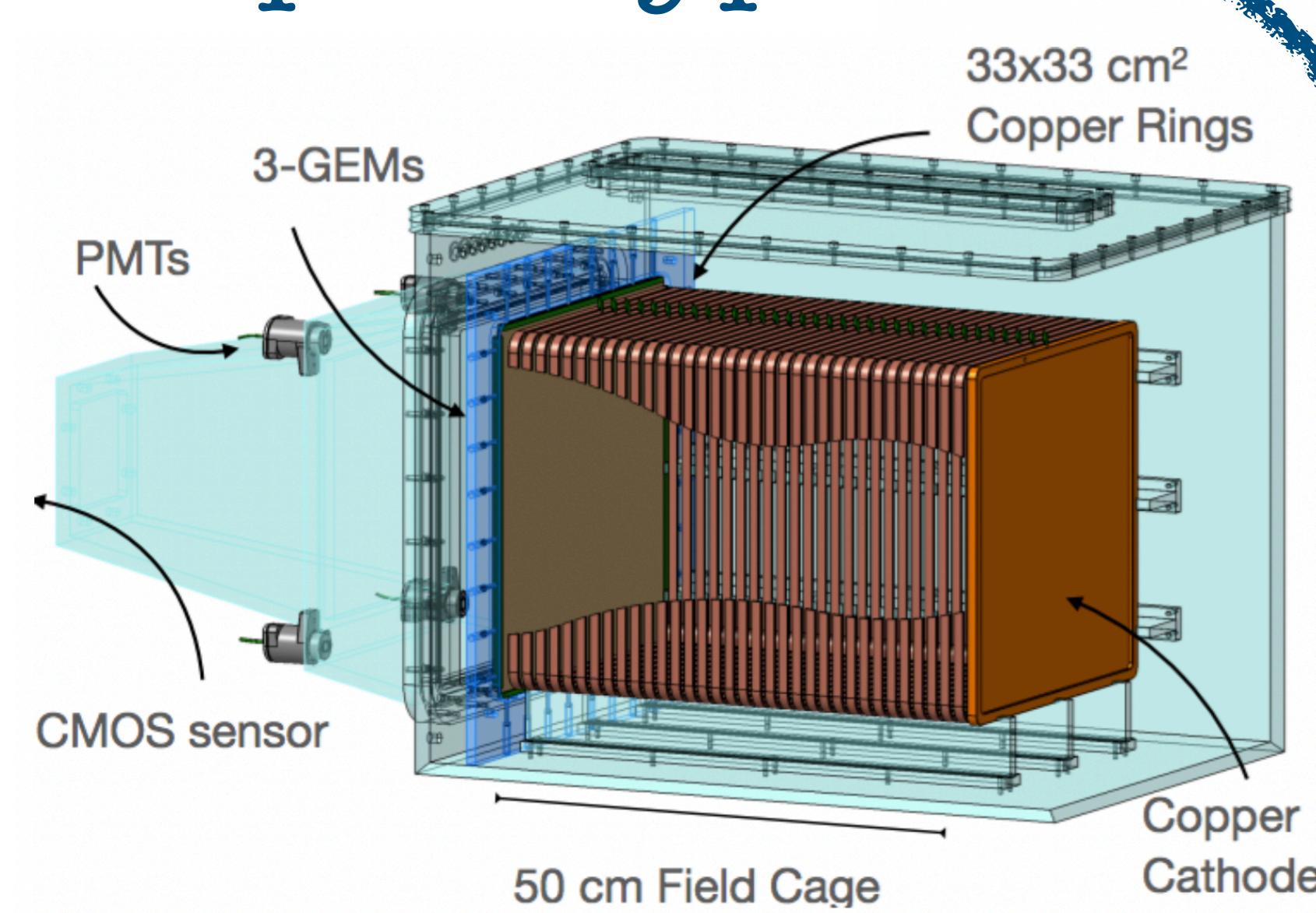
The CYGNO project



Instruments 6 (2022) 1, 6 - JINST 15 (2020) P10001 - JINST 15 (2020) 12, T12003 - 2019 JINST 14 P07011 - JINST 15 (2020) P08018
NIM A 999 (2021) 165209 - Measur.Sci.Tech. 32 (2021) 2, 025902

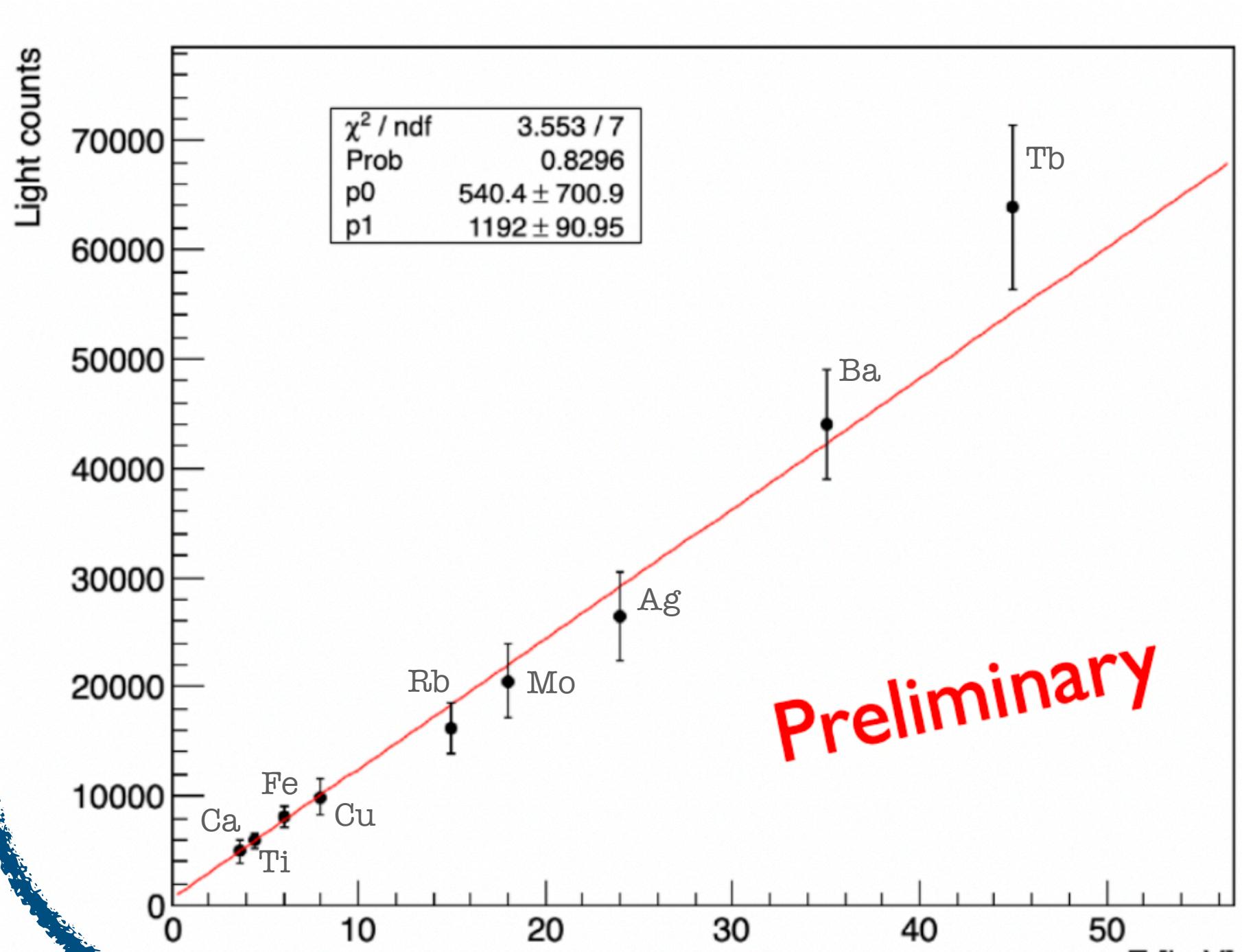
LIME: the current prototype

- Built and tested at **LNF**, now at **LNGS**
- He:CF₄ @ 1 atm
- Copper ring field cage, 50 cm drift
- 1 sCMOS sensor + 4 PMTs
- 3 GEMs for a $33 \times 33 \text{ cm}^2$ sensitive area



- Electronic recoil (ER) calibration with different X-ray sources

- ~ 13% energy resolution**
- good linearity** in the response



DM search: sensitivity projections

- CYGNO PHASE 2:** $\mathcal{O}(30\text{-}100 \text{ m}^3)$ detector for directional DM search in the $\sim \text{GeV}/c^2$ mass region
- Preliminary sensitivity projections. **Assumptions:**
 - Low energy **threshold**: 1 keV (0.5 keV)
 - Quenching Factor**: SRIM simulation
 - Observable**: angular distribution
 - Angular resolution**: 30°
 - Background**: different scenarios (isotropic background)

