The LIME detector prototype for the CYGNO experiment

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The CYGNO experiment aims at the development of a large gaseous time projection chamber (TPC) operated at atmospheric pressure for the directional detection of rare events such as Dark Matter (DM) and solar neutrino interactions in the underground National Laboratory of Gran Sasso (LNGS). Gas electron multipliers (GEMs) are used for charge amplification, and the secondary scintillation light produced in the multiplication process in a He:CF_4 (60:40) mixture is read by high-granularity sCMOS cameras and photomultiplier tubes (PMTs). The camera captures the projection of the tracks on the plane parallel to the GEMs, while the PMTs can measure the track component along the drift direction, providing a 3D reconstruction of the events. This technique provides an accurate measurement of the energy with a O(1) keV threshold and good sensitivity to the directionality of the events.

In order to demonstrate the scalability of this design, many prototypes were built and tested, the largest of which is the 50 L active volume LIME, with 50 cm drift and readout by 4 PMTs and a single sCMOS imaging a 35×35 cm^2 area. The detector stability, energy response and energy resolution were tested overground at the National Laboratory of Frascati of INFN with different radioactive X-ray sources and cosmic rays.

LIME was installed and commissioned underground at LNGS in February 2022 with the purpose of demonstrating the technical feasibility of this technique and to validate the Monte Carlo (MC) simulations of the response of the detector to the natural background. With this purpose, layers of copper of increasing thickness are planned to be mounted as a shielding for gamma radiation, and in the final phase also a 40 cm layer of water tanks will be mounted to provide a shielding layer against the natural neutron flux, to finally test LIME operation in the low background conditions of a DM experiment.

I will show the overground performance of LIME and the preliminary results on the data taken underground and the comparison with MC simulations. I will talk about the future perspectives of this technique, which finds applications not only in the rare events search for the CYGNO experiment, but also in neutron detection, in the study of the Migdal effect and in X-ray polarimetry in space.