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Performance of a prototype gaseous TPC with optical readout for rare events studies

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A gaseous Time Projection Chamber (TPC) with optical readout is proposed in the CYGNO project as an innovative technique to study rare events such as DM particle or solar neutrino interactions. 3D particle tracks can be reconstructed in the TPC volume, filled with He:CF4 at atmospheric pressure. The amplification stage exploits a stack of three Gas Electron Multipliers (GEM) stack where the ionisation charge is multiplied; photons are produced in the multiplication process which are in turn read out by sCMOS sensors and PMTs. The sCMOS camera guarantees a high readout granularity, a high sensitivity, and a low noise level. PMTs are used as well to measure the drift time of ionisation electrons to obtain the coordinate perpendicular to the camera plane. This technique allows the measurement of the particle energy with a O(KeV) threshold and, also, to have a sensibility to the direction of the events. This last characteristic is very relevant, especially for background discrimination.
A 50 L prototype (LIME) is the last and largest prototype built. It was operated at the Frascati National Laboratories (LNF) and was then moved underground at the Gran Sasso National Laboratories (LNGS) where it is still under test exploiting different shielding configuration to carefully measure internal and external backgrounds and to test reconstruction capability in realistic conditions.
Results on the measured performance of LIME overground using several radioactive sources will be presented, as well as the studies on the long-term stability and performances of the prototype both over and underground. The comparison of a Monte Carlo simulation of the detector response with measured data will be shown. Moreover, current R&D activities with the aim of optimizing the design of the O(1) m3 demonstrator to be hosted in Hall F of LNGS will be discussed.

Primary author: Prof. PETRUCCI, Fabrizio (University Roma Tre and INFN)

Presenter: Dr PRAJAPATI , Atul (GSSI)

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