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Innovative means of operation of optical readout Time Projection Chamber

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We are going to present the R&D developed within the CYGNO/INITIUM projects towards innovative means of operation of optical readout Time Projection Chamber (TPC) for lower energy threshold and improved tracking performances. CYGNO goal is to develop an high precision TPC with an He:CF4 gas mixture at atmospheric pressure readout by scientific CMOS cameras and PMT, in order to achieve 3D tracking with head tail capability and particle identification down to O(keV) energy for directional search of Dark Matter and solar neutrino spectroscopy [1]. The ERC Consolidator project INITIUM aims at realising Negative Ion Drift operation at atmospheric pressure within CYGNO optical readout approach.
We are going to illustrate the possibility of enhancing the light yield (hence effectively lowering the energy threshold) up to a factor 10 without degrading the tracking performances in He:CF4 gas mixtures by means of luminescence of non-ionising electrons drifted beyond the amplification stages [2]. We are going furthermore to discuss TPC Negative Ion Drift operation at atmospheric pressure with He:CF4:SF6 optically readout by both CMOS camera and PMT. Negative Ion Drift operation is a peculiar modification of the TPC principle by which, thanks to the addition of an highly electronegative dopant to the gas mixture, anions act as image carriers rather than electron, reducing down to the thermal limit the diffusion during drift [3]. This characteristics allows for the use of longer drift distances, combined with improved tracking.
Each of these features can significantly boost the performances of any experimental approach that requires high precision imaging TPCs, such as, among the others, X-ray polarimetry, neutron spectroscopy, neutrinoless double beta decay searches, Migdal effect measurements and tracking in high energy physics.

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