Contribution ID: **144** Type: **Poster**

Optimisation of gas composition and amplification stage for the CYGNO/INITIUM experiment

Wednesday, 10 July 2024 17:10 (20 minutes)

CYGNO is an international collaboration working on the development of a directional detector whose main goal is the direct detection of rare events, such as Dark Matter (DM) in the mass range below few tens of GeV/c2, by means of a gaseous detector. It exploits the expected directional anisotropy of the DM candidates by measuring the orientation of the track, in addition to the energy released in the active medium. It will consist in a Time Projection Chamber (TPC) filled with a He:CF4 gas mixture equipped with an amplification stage composed of a triple Gas Electron Multiplier (GEM) structure. Given the scintillating properties of the gas, the readout is optical, based on sCMOS cameras and fast photomultiplier tubes. A demonstrator of 0.4 cubic metre is under development and will be hosted at Laboratori Nazionali del Gran Sasso in 2024.
We will illustrate the ongoing activities of R&D whose goal is to improve the sensitivity and the performances of the future detector. Such studies include the optimisation of the gas mixture composition, with the possibility of adding hydrogen-rich compounds to enhance the DM sensitivity in the low mass range down to 500 MeV/c2, or of inserting electronegative molecules to exploit negative ion drift and obtain better tracking capabilities. Furthermore, the possibility of introducing a strong electric field below the GEM amplification structure to amplify the light output of the detector will be discussed.

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Session Classification: Poster session

Track Classification: Poster session: Direct detection