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Cryogenic setup for the characterization of novel optical amplification structures (MPGD-based) for Dark Matter searches

Compelling astrophysical and cosmological evidence for the existence of dark matter (DM) has led to numerous direct detection experiments, including DarkSide, XENON, LZ, etc., searching for particle DM candidates. These experiments rely on noble liquid detectors, in which vacuum ultraviolet (VUV) scintillation or scintillation and ionization, induced by elastic scattering of WIMPs on nuclei, is registered.
One of the main challenges in argon-based detectors is the relatively low efficiency of available VUV-optimized photosensors. This limitation makes light collection and detection of S1 and S2 light in liquid argon (LAr) challenging. Therefore, efficient wavelength shifter (WLS) materials are needed to enable light collection with standard photosensors.

Over the past decade a significant progress was observed in the development of new optical amplification structures, including new WLS materials and methods of applying these to new structures capable of enhancing scintillation light detection. As future experiments require much larger target masses (multi-ton scale) to improve current sensitivity limits, new optical amplification structures/technologies scalable to such sizes are mandatory to improve or even maintain the performance of these detectors. One such example is the recently developed WLS FAT-GEM (wavelength-shifting field-assisted transparent gaseous electroluminescence multiplier) that combines the characteristics of FAT-GEMs with reflecting and WLS coatings to maximize S2 light collection, which opens the possibility to the scale-up of future Dark Matter detectors.

In this work the plans for development of novel optical amplification structures, namely a floating FAT-GEM (Field-Assisted Transparent Gaseous Electroluminescence Multiplier) with wavelength-shifting capabilities (WLS FAT-GEM) will be discuss. A cryogenic setup, recently commissioned for studying new wavelength-shifting materials for optimised light collection in noble element radiation detectors, will be presented along with its first reasults and its new extension that enables the study of these MPGD-based structures, potentially interesting for rare-event searches.

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