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Two-phase Cryogenic Avalanche Detector with electroluminescence gap and THGEM/GAPD-matrix multiplier

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Two-phase Cryogenic Avalanche Detectors (CRADs) with THGEM multipliers have become an emerging potential technique for rare-event experiments. In this work the current status of the two-phase CRAD prototype in Ar, with electroluminescence (EL) gap and combined THGEM/GAPD-matrix multiplier, is described. The low threshold and high energy resolution of the detector is provided by the EL gap, optically read out in the VUV using compact cryogenic PMTs. The high spatial resolution of the detector is provided by the double-THGEM charge multiplier combined with a 5x5 matrix of Geiger-mode APDs (GAPDs), optically recording THGEM-hole avalanches in the Near Infrared (NIR). Proportional electroluminescence in EL gap in argon, with a minor (50 ppm) admixture of nitrogen to liquid Ar, has for the first time been systematically studied at cryogenic temperatures in the two-phase mode. The overall EL amplification parameter and the EL threshold measured in this work were in accordance with those predicted by the theory. The result on the EL threshold is particularly relevant to DarkSide and SCENE dark matter search-related experiments, where the operation electric field was thereby on the verge of appearance of the S2 signal. We also present the results on nuclear recoil detection in liquid Ar, using the two-phase CRAD and DD neutron generator, relevant in the field of energy calibration of rare-event detectors for dark matter search and coherent neutrino-nucleus scattering experiments.

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