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WArP R&D: Demonstration and comparison of photomultiplier tubes operation at liquid Argon Temperature

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A new generation, high Quantum Efficiency 3" photomultiplier tube (PMT) for cryogenic applications at liquid Argon temperature (LAr, T=87 K) has been recently developed by Hamamatsu Photonics (Mod. R11065). This issue is of interest in particular for direct Dark Matter searches with detectors adopting liquified Argon as nuclear targets for WIMP interactions and read-out of the corresponding scintillation light signals from nuclear recoil in the medium. Improvements in detector sensitivity down to low recoil energy thresholds can be primarily achieved by using these new PMTs with enhanced quantum efficiency.
Within the on-going R&D activity of the WArP Collaboration (WIMP Argon Program at the INFN GranSasso Lab), a first set of R11065 PMTs has been subject to a series of tests aiming at their characterization in reference working conditions. These were obtained by operating the PMTs immersed in the liquid and optically coupled to LAr cells of various size. A comparison of the R11065 Hamamatsu PMT with a former generation of cryogenic PMT (currently in use with the WArP-100 detector), has been also carried out with the two PMTs simultaneously operated and viewing a common LAr volume. From these tests the superior performances of the Hamamatsu PMT have been clearly demonstrated, showing that this new type of PMT is very well suited for experimental applications, in particular for new direct Dark Matter searches with LAr-based experiments.

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