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Characterisation of the R8520-506 PMT and Its Long-Term Performance in Liquid Argon

The Hamamatsu R8520-506 PMT is an alternative photosensor candidate for small-scale liquid argon detector. A systematic characterization of seven Hamamatsu R8520-506 1-inch PMTs will be presented in this report, comparing their key performance parameters at room temperature and in the liquid argon environment, with a particular focus on their long-term operational stability through a two-week continuous test. As a result, the PMT gains at cryogenic temperatures are found to be approximately 20%-40% higher than those at room temperature, and the gain enhancement is accompanied by improved peak-to-valley ratios, better single photoelectron resolution and lower afterpulse rates. In contrast, the dark count rates exhibited non-uniform variation trends, with some PMTs showing increases while others showed decreases. Besides, The afterpulse time spectrum is also analyzed, in which three potential characteristic peaks attributed to He⁺, CH₄⁺ and Ar⁺ ions of residual gas are roughly identified. Overall, the R8520-506 PMT demonstrates stable and reliable performance at cryogenic temperatures, indicating its suitability for use in liquid argon detectors.

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