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Investigation for Pixel-Based Accelerated Aging of Large Area Picosecond Photo-Detectors

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Abstract : Micro-channel plate photo-multiplier tubes (MCP-PMTs) have become ubiquitous and are widely considered potential candidates for next generation High Energy Physics experiments due to their picosecond timing resolution, ability to operate in strong magnetic fields, and low noise rates. A key factor that determines the applicability of MCP-PMTs in their lifetime, especially when they are used in high event rate experiments. We have developed a novel method for the investigation of the aging behavior of an MCP-PMT on an accelerated basis. The method involves exposing a localized region of the MCP-PMT to photons at a high repetition rate. This pixel-based method was inspired by earlier results showing that damage to the photocathode of the MCP-PMT occurs primarily at the site of light exposure and that the surrounding region undergoes minimal damage. One advantage of the pixel-based method is that it allows the dynamics of photo-cathode damage to be studied at multiple locations within the same MCP-PMT under different operating conditions. In this work, we use the pixel-based accelerated lifetime test to investigate the aging behavior of a 20 cm x 20 cm Large Area Picosecond Photo Detector (LAPPD) manufactured by INCOM Inc. at multiple locations within the same device under different operating conditions. We compare the aging behavior of the MCP-PMT obtained from the first lifetime test conducted under high gain conditions to the lifetime obtained at a different gain. Through this work, we aim to correlate the lifetime of the MCP-PMT and the rate of ion feedback, which is a function of the gain of each MCP, and which can also vary from point to point across a large area (400 cm^2) MCP. The tests were made possible by the uniqueness of the LAPPD design, which allows independent control of the gain of the chevron stacked MCPs. We will further discuss the implications of our results for optimizing the operating conditions of the detector when used in high event rate experiments.

Keywords : electron multipliers (vacuum), LAPPD, lifetime, micro-channel plate photo-multipliers tubes, photoemission, time-of-flight
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