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Investigation for pixel-based accelerated aging of Large Area Picosecond Photodetectors

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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 determining the applicability of MCP-PMTs is their lifetime, mainly when used in high-event rate experiments. We have developed a novel aging method to investigate the performance degradation of an MCP-PMT in an accelerated manner. The accelerated aging 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 voltage across 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, Micro-channel plate photo-multipliers tubes, Photoemission, Time-of-Flight.

Early Career

Yes

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