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Integration-Level Testing of Sub-Nanosecond Microchannel Plate Detectors for Use in Time-Of-Flight HEP Applications

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Microchannel plate photomultiplier tubes (MCP-PMTs) are compact imaging detectors, capable of micron-level spatial imaging and timing measurements with resolutions well below 10 picoseconds. The Large Area Picosecond Photodetector Collaboration (LAPPD) is developing techniques for fabricating 20cm-square, thin planar glass-body MCP-PMTs at costs comparable to traditional PMTs. A major component of the project is a cross divisional effort at Argonne National Laboratory (ANL) and University of Chicago to fabricate and characterize the amplification and read-out stages of these MCP detectors. The gain structures are made by coating passive, porous glass substrates with high secondary electron yield (SEY) materials using atomic layer deposition (ALD), a well-established industrial batch process. Transmission-line readout with waveform sampling on both ends of each line allows the efficient coverage of large areas while main- taining excellent time and space resolution. Individual channel plates made by this process have already demonstrated gains larger than 10^5 and promising time resolving capabilities. Work between the High Energy Physics Division and the Advanced Photon Source at Argonne has produced an advanced channel- plate testing facility for studying the time response of MCPs using a pulsed laser capable of sub-picosecond pulses. The MCPs are tested in stacks of one or two plates with a simple photocathode and coupled to a microstripline anode board. These measurements will guide the systems-level optimization of LAPPD detectors and the development of reconstruction algorithms. Predictions made by the LAPPD simulations group based on material properties measured by the characterization group are compared with these tests to help further our understanding of MCP performance.

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