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Measurements and analysis of the single photon timing performance of single and multi-anode MCP-PMTs

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Microchannel plate (MCP) based photomultiplier tubes (MCP-PMT) provide state-of-the-art timing performance for both analog and single photon detection in many fields such as plasma diagnostics, high energy physics, and Time-of-Flight Positron Emission Tomography. While intrinsic properties and limitations of these devices as used in analog mode have been well studied, detailed studies of intrinsic performance and limitations in single photon detection have been lacking. In this paper we present measurements of two MCP-PMTs using two independent test set-ups. The first MCP-PMT is a Photek PMT210 having 10 mm diameter active area, impedance matched single anode, and two 3 μm pore MCPs, with measured single photon transit time spread of 30 ps FWHM using a short pulse laser, a vacuum photodiode timing reference, and a high-speed oscilloscope. The second MCP-PMT is a Photek MAPMT253 having 53 mm × 53 mm active area, a 16 x 16 array of 3.3 mm × 3.3 mm anodes, and two 6 μm pore MCPs, with measured single photon transit time spread of < 60 ps FWHM per anode using the same test set-up as the PMT210. These data are compared with an independent test set-up using a femtosecond laser, a vacuum photo-triode timing reference, and a high-speed oscilloscope. In-depth measurements and analysis of the impact on timing performance of bias voltages, MCP pore size, and readout electronics configuration will be presented.

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