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Fast-timing microchannel plate photodetectors: design, fabrication and characterization

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We report detailed design, fabrication and characterization of 6 × 6 cm^2 fast timing photodetectors based on next-generation microchannel plates (MCP). The whole assembly is made of low-cost borosilicate glass materials and hermetically sealed with a bialkali photocathode in a vacuum. The flexible photodetector design provides the potential of modifying individual components as well as the entire configuration to fit for different applications. A series of prototype MCP-photodetectors were fabricated following a step-by-step process including functionalization of glass capillary array through atomic layer deposition, MCP baking and scrubbing, photocathode deposition and hermetic thermo-compression sealing. The prototype MCP-photodetectors exhibit electron gains well beyond 107 level with excellent relative uniformity. The photodetectors present fast rise time of ~ 500 ps level and fall time of ~ 1.5 ns. Excellent timing resolution at single photoelectron mode of 20 ps and magnetic field tolerance up to 1.3 Tesla were achieved for photodetector with 10 μm pore size MCPs, comparing to that of 63 ps and 0.7 Tesla for the one with 20 μm pore size MCPs.

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