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Performance of the MCP-PMTs for the TOP counter in the Belle II experiment

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We developed the micro-channel-plate (MCP) PMT for the Time-of-Propagation (TOP) counter, which is a novel Cherenkov counter to be used for particle identification in the Belle II experiment. The developed MCP-PMT has excellent performance for single photon detection; a timing resolution of about 40ps (sigma, including readout jitter), a nominal gain as high as 2×10^6 , and a position sensitivity of about 5mm with 4 x 4 anode. In the Belle II TOP counter, 512 MCP-PMTs are used under a magnetic field of 1.5T. The performance details were inspected with and without the magnetic field. The gain on each anode was found to vary up to a factor of two over the 16 anodes in some of the MCP-PMTs. We will discuss on this issue. The gain was dropped by 20-80% in a 1.5T magnetic field. The reason is considered that the secondary electrons can be localized and the electron amplification can be saturated. The rate of the gain drop seems to have a correlation with the high-voltage applied to obtain the nominal gain. We will discuss on the gain drop and its rate. The photon detection efficiency was also measured in a 1.5T magnetic field. The results on about 300 MCP-PMTs will be reported. Regarding the lifetime of the MCP-PMT, we succeeded in extending the lifetime significantly by introducing the atomic layer deposition technique on MCP coating. The results of the lifetime measurements will be reported.

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