Contribution ID: **37** Type: **Poster**

R&D of Fast Timing MCP-PMT with PbF2 Window

Monday, September 15, 2025 3:50 PM (1 hour)

The timing performance of photodetector is a critical parameter for the development of Radiation Imaging Detectors based on Time Of Flight (TOF) technique, notably in applications like TOF Positron Emission Tomography (TOF-PET). The small size Microchannel Plate Photomultiplier (MCP-PMT), also referred to as Fast timing MCP-PMT (FPMT), is a popular candidate photodetector of TOF-PET for its high gain, good detection efficiency, single photon detect ability, magnetic field resistance, ultimately its good time resolution.
Using the Cherenkov radiator as the light window directly can eliminate the optical interface between the radiator and conventional MCP-PMT, and Cherenkov light will be directly converted into photoelectrons, thus improving the CTR of Cherenkov TOF-PET.
PbF2 is a favoured Cherenkov radiator for its high refractive index, high density and pure Cherenkov radiation. Starting from 2020, the MCP-PMT workgroup has completed the development of FPMT from Glass window FPMT (Glass-FPMT) to Pb Glass window FPMT (Pb-FPMT), and ultimately advanced to PbF2 window FPMT (PbF-FPMT). The structure of the PbF-FPMT was optimized to achieve a Rise Time (RT) less than 300 ps and a Transit Time Spread (TTS) of 30 ps under single photon mode. The direct use of PbF2 as the optical window eliminate the optical interface between the radiator and the detector, significantly enhances the number of Cherenkov photons and the multi-anode structure enables a great spatial resolution. The CTR of the first version of PbF-FPMT prototypes can reach 129.2±1.6 ps, and the improved ones will be used for this test later.

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Session Classification: Poster Session

Track Classification: Technological aspects and applications of Cherenkov light detectors