



Contribution ID: 93

Type: **Parallel Presentation**

## **Performance Evaluation of MCP-PMT with an Active Ion Barrier**

*Wednesday, November 20, 2024 2:30 PM (15 minutes)*

We present results from the performance characterization of MCP-PMTs with an active metal grid between the photocathode and the MCP. The active ion barrier grids are intended to prevent the positive ions generated inside the MCPs during the electron multiplication process from reaching the photocathode and thus, increase the lifetime of the MCP-PMT. The potential applied on the grid redirects the liberated positive ions toward the MCP. Our results demonstrate that the ion feedback rate, measured using the after-pulses generated by the ions, reduces with the applied potential on the grid. Our results also show that critical performance parameters such as the timing resolution, gain, and pulse height distributions are not impacted by the applied potential on the active ion barrier. We complement these results with simulation of the ion trajectories in a model MCP-PMT with active ion barrier grid and demonstrate how potential on the ion grid improves the timing resolution. Our simulations also provide a framework to identify the nature of ions that are generated inside the MCP. These observations, the first of their kind, provide essential data necessary to design new MCP-PMTs geometries with prolonged lifespans.

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**Session Classification:** RDC 02 - Photodetectors Parallel Session

**Track Classification:** RDC Parallel Sessions: RDC2: Photodetectors