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Towards robust PICOSEC Micromegas precise timing detectors

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The PICOSEC Micromegas detector is a precise timing gaseous detector based on a Cherenkov radiator coupled to a semi-transparent photocathode and a Micromegas amplifying structure. First single-pad prototypes, equipped with a non-resistive Micromegas and a Cesium Iodide (CsI) photocathode, demonstrated a time resolution below = 25 ps. However, to make the concept appropriate to physics applications, several developments are required. The objective of this work is to improve the PICOSEC Micromegas detectors robustness aspects, including the integration of resistive Micromegas and robust photocathodes, while maintaining high time resolution. New prototypes are being tested in the laboratory and successfully operated with an 80 GeV/c muon beam. Studies on resistive Micromegas are being performed to limit the destructive effect of discharges and achieve stable operation in intense pion beams with a resistive anode. Preliminary results from a single-pad device equipped with a resistive Micromegas of 292 kΩ/□ and a CsI photocathode showed a time resolution of = 24.1 ps. CsI photocathode, although characterised by its high quantum efficiency, can be easily damaged by ion back flow. Detailed measurements of alternative robust photocathodes including Diamond Like Carbon (DLC), Boron Carbide (B4C) and nanodiamonds are ongoing. Additionally, a detector with a thinner 12 μm thick steel wires mesh is considered to be tested in order to achieve more uniform electric fields in both drift and amplification gaps. Finally, the excellent timing performance of the single-pad proof of concept is expected to be transferred to a new 100-channel PICOSEC detector with 10×10 cm2 resistive Micromegas and an anode with surface resistivity of 20 MΩ/□, making the device more suitable for large-area experiments in need of detectors with high time resolutions.

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