Contribution ID: **27** Type: **not specified**

Development of the high-rate capable DLC-RPC based on the current evacuation pattern

Tuesday 15 October 2024 15:20 (25 minutes)

The DLC-RPC, a thin resistive plate chamber based on diamond-like carbon (DLC) electrodes, is being developed for further background suppression in the MEG II experiment. The detector should have ultra-low mass (\(< 0.1~\%~X_0\)) and high-rate capability (up to \(3~\rm{MHz/cm^2}\)) due to high-intensity (\(7 \times 10^7~/\rm{s}\)) and low-momentum (\(28~{\rm MeV/}c\)) muon beam passing through it. Additionally, the detector must have high efficiency (\(> 90~\%\)) for MIP particles to identify background events efficiently. The DLC-RPC consists of thin polyimide films as the substrate to minimize the material budget and spacing pillars (\(\sim 350\)nbsp;mu;\(\rm m\)nbsp;thick) formed by photolithographic technology. The prototype detector was verified to have a rate capability of up tonbsp;\(1~{\rm MHz/cm^2}\)nbsp;using an actual muon beam. We have developed the DLC-RPC with low resistivity (\(\sim 10 {\rm M\Omega/sq}\)) and strip-shaped current evacuation patterns to improve the rate capability. However, discharges tend to occur near the evacuation patterns due to the lower quench of the resistive electrode as the current path shortens. We have studied the discharge phenomena near the evacuation patterns with low-resistivity DLC in parallel plate geometry using the prototype DLC-RPC electrode, produced by the CERN Micro-Pattern Technologies workshop. We have also investigated the design of protection covers on the evacuation patterns to mitigate these discharges.

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Session Classification: Session 7