Development of ultra-low material RPC for background identification in MEG II experiment

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New physics will be searched via the lepton flavor violating $\mu^+ \to e^+\gamma$ decay in the MEG II experiment, where the sensitivity to the μ^+ branching ratio is expected to reach 6×10^{-14} level. The two body decay will be searched using stopped μ^+ on a muon stopping target and the signal is identified by the kinematics of the emitted e^+ and γ; their energy (E_{e^+}, E_γ), relative angle ($\Theta_{e^+\gamma}$) and relative timing ($t_{e^+\gamma}$) are $E_\gamma = E_{e^+} = 52.8\,\mathrm{MeV}$, $\Theta_{e^+\gamma} = 180°$ and $t_{e^+\gamma} = 0$ respectively for the signal events.

As well as conducting the experiment with high μ^+ stopping rate, background suppression is crucial to achieve high sensitivity for the search. The dominant background source in this search is accidental coincidences of e^+ and γ entering the signal region; the positron comes from Michel decay $\mu^+ \to e^+\nu\bar{\nu}$ and the photon comes from radiative muon decay (RMD) $\mu^+ \to e\nu\bar{\nu}\gamma$ or positron annihilation in flight $e^+e^- \to \gamma\gamma$. To identify background-photons coming from RMD, dedicated detectors will be installed in the MEG II experiment, which detects e^+ accompanying RMD with the energy ranging typically between 1-5 MeV.

Background identification detectors will be installed to two sites, downstream and upstream of the muon stopping target. While the downstream identification detector has already been developed, the upstream one still remains to be developed due to difficulties specific to the upstream. The difficulties to be solved for the upstream identification detector are two-fold, both of which are caused by the ∼21 MeV muon beam passing through the upstream background identification detector:

- So as not to degrade the muon beam, the material budget cannot exceed $0.1\,\%X_0$.
- To deal with high rate muon ($100\,\mathrm{M}\,\mu^+/\mathrm{s}$ in total), corresponding rate capability and radiation hardness are required

In addition, timing resolution of $\sim$ 1 ns and detection efficiency of $\sim 90\,\%$ or better is required for the positron detection. By meeting all these requirements and installing the upstream background identification detector, the sensitivity of MEG II experiment is estimated to improve by $\sim 10\,\%$.

Our study aims to develop the upstream background identification detector. To accomplish this goal, Resistive Plate Chamber (RPC) with a novel design is under development as a hopeful candidate. In our RPC, the resistive electrodes are made of thin Diamond Like Carbon (DLC) enabling the reduction of material budget. In order to investigate the feasibility of the new-design RPC for MEG II experiment, the performance is evaluated using a prototype. The measured performance of our prototype RPC will be presented with the fabrication process of the detector.