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Calorimeter-Based EDM Analysis for the Fermilab Muon $g-2$ Experiment

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The muon electric dipole moment (EDM) is a sensitive probe of charge-parity (CP) violation and physics beyond the Standard Model. In the Fermilab Muon $g-2$ experiment, an EDM introduces an additional spin-precession component that produces a vertical oscillation in the decay-positron distribution that can be measured by the calorimeters. For a muon EDM smaller than the current limit set by the BNL Muon $g-2$ collaboration, this oscillation occurs at the anomalous precession frequency (ω_a). It's 90° out of phase with the horizontal oscillation induced by the muon magnetic dipole moment (MDM), providing a distinct signature for an EDM search. We present a preliminary calorimeter-based EDM analysis using the Fermilab Muon $g-2$ dataset. Geant4 simulations with a range of muon EDM values are used to extract the conversion factor that relates the amplitude of the EDM-induced vertical-position oscillation to the muon EDM magnitude. The same simulation approach is used to study systematic effects that could mimic EDM signals, including beam dynamics and detector-related effects. Preliminary results from these studies are presented, showing the impact of potential systematic contributions on EDM extraction. By combining the simulated EDM conversion factor with the expected statistical precision, we evaluate the projected sensitivity to the muon EDM and discuss prospects for improving constraints on CP-violating physics beyond the Standard Model.

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