

Measurement of T-violating Transverse muon Polarization in $K^+ \rightarrow \mu^+ \pi^0 \nu$ Decay at J-PARC

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As a precision-frontier experiment at J-PARC, we are now proposing a search for time reversal invariance violation by measuring the transverse muon polarization (P_T) in the $K^+ \rightarrow \mu^+ \pi^0 \nu$ ($K_{\mu 3}$) decays which constitutes a T-odd observable. This observable is one of the few test of T-invariance and the corresponding CP violation in non-neutral meson sector and is sensitive to direct CP violation. At J-PARC, we aim to improve the precision of this measurement by a factor of 20 comparing with the best result from our own KEK-PS-E246 experiment, and reach a limit of $\Delta P_T \sim 10^{-4}$.

The final state interaction contributions in the SM descriptions are significantly smaller than the sensitivity of this experiment. On the other hand, several exotic models inspired by Multi-Higgs mechanism etc. predict sizable P_T values within the sensitivity attainable to us. Thus, this experiment is likely to find new source of CP violation, if any of these models are viable. Since it will certainly constrain the parameter space of the candidate models, the sensitivity of this experiment is comparable or superior to that of the proposed new neutron EDM experiment and other rare decay processes. The physics potential in terms of discovery of new physics along with the power to constrain the exotic model is shown to be competitive with other experiments being planned or prepared.

It is pointed out that the improved sensitivity will be achieved thanks to the new J-PARC facility beam quantities, namely, the newly designed low-momentum K^+ beam line. The experiment will use a stopped K^+ beam in conjunction with the upgraded E246 setup. Major changes of the detector system are 1) improved charged particle tracking by incorporating the state-of-the-art GEM detectors, 2) new readout of the CsI(Tl) calorimeter with APD, 3) introducing active polarimeter for the e^+ measurement from muon, and 4) a new magnet to hold the muon spin polarization. This arrangement with increased K^+ beam intensity and a runtime of 10^7 seconds will improve the E246 result by a factor of 20, bringing the discovery potential to $\Delta P_T < 2 \times 10^{-4}$ in our quest for new physics.