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DUNE and T2HK Complementarity: Unlocking Enhanced CP Violation Insights

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After the landmark discovery of non-zero θ_{13} by the modern reactor experiments, unprecedented precision on neutrino mass-mixing parameters has been achieved over the past decade. This has set the stage for the discovery of leptonic CP violation (LCPV) at high confidence level in the next-generation long-baseline neutrino oscillation experiments. In this work, we explore in detail the
possible complementarity among the on-axis DUNE and off-axis T2HK experiments to enhance the sensitivity to LCPV suppressing the $\theta_{23} - \delta_{\rm CP}$ degeneracy. We find that none of these experiments individually can achieve the milestone of 3σ LCPV for at least 75\% choices of $\delta_{\rm CP}$ in its entire range of $[-180^\circ, 180^\circ]$, with their nominal exposures and systematic uncertainties. However, their combination can attain the same for all values of θ_{23} with only half of their nominal exposures. We observe that the proposed T2HKK setup in combination with DUNE can further increase the CP coverage to more than 80\% with only half of their nominal exposures. We study in detail how the coverage in $\delta_{\rm CP}$ for $\geq 3\sigma$ LCPV depends on the choice of θ_{23}, exposure, optimal runtime in neutrino and antineutrino modes, and systematic uncertainties in these experiments in isolation and combination. We find that with an improved systematic uncertainty of 2.7\% in appearance mode, the standalone T2HK setup can provide a CP coverage of around 75\% for all values of θ_{23}. We also discuss the pivotal role of intrinsic, extrinsic, and total CP asymmetries in the appearance channel and extrinsic CP asymmetries in the disappearance channel while analyzing our results.

Working Group

WG 1: Neutrino Oscillation Physics

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