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How Robust Is the δ_{CP} Measurement?

Measuring the leptonic CP phase δ_{CP} and resolving the θ_{23} octant are primary objectives of DUNE and T2HK.

We show that two distinct effects can compromise the reliability of these measurements. First, the poorly constrained ν_e and $\bar{\nu}_e$ cross sections allow energy-dependent distortions that partially mimic the δ_{CP} -dependent spectral modulation, reducing DUNE's CP-violation sensitivity by up to $\sim 3\sigma$.

We demonstrate that the proposed ν SCOPE facility at CERN can recover this loss through percent-level measurements of σ_{ν_e} and the $\sigma_{\nu_e}/\sigma_{\nu_\mu}$ ratio.

Second, complex non-standard interactions (NSI) in propagation – motivated by the current $\sim 2\sigma$ NOvA–T2K tension – induce correlated biases in δ_{CP} and the θ_{23} octant when DUNE data are interpreted under the standard three-flavor hypothesis. Since T2HK is largely insensitive to these propagation effects, a $\sim 3\sigma$ discrepancy between the two experiments would constitute a clear diagnostic of BSM physics. These results highlight that both external cross-section constraints and baseline complementarity are essential to ensure a robust and unbiased determination of the oscillation parameters in the precision era.

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