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Results from the T2K Near Detector Analysis Fit and Prospects from Near Detector Upgrade Data

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T2K is a long-baseline experiment based in Japan and focused on oscillations of neutrinos and antineutrinos. (Anti-)neutrinos from J-PARC are first characterised in the Near Detector (mainly ND280) and, after travelling 295 km, measured in the Far Detector, Super-Kamiokande, in order to extract neutrino oscillation parameters, including the CP-violating phase, within the standard PMNS three-flavour mixing framework. The Near Detector data plays a key role in constraining flux and neutrino interaction models, significantly reducing systematic uncertainties at the Far Detector and therefore having a major impact on the precision of oscillation parameter measurements. To ensure the robustness of these constraints, two independent fitting frameworks are employed to tune the MonteCarlo predictions against the data: the semi-frequentist GUNDAM fitter and the Bayesian MaCh3 fitter, providing cross-validation of the results. For the most recent analysis, new samples covering a wider kinematics phase space, including high angle and backward going tracks, as well as new cross-section parameters have been introduced to improve sensitivity to low and high momentum transfer interactions. Fake data studies are performed in order to test the limits of the T2K interaction and systematics models and to evaluate potential biases in oscillation parameter measurements through fits to alternative interaction model scenarios. These studies are used to estimate possible biases arising from imperfect interaction modelling and to assess whether the current systematic uncertainties adequately cover these effects. In this talk, we will review the latest developments in the T2K Near Detector analysis also in view of the integration of ND280 Upgrade samples into the oscillation framework.

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