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Constraining Systematics at T2K with Near-Detector Fits

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T2K is a long baseline neutrino oscillation experiment designed to make precise measurements of the parameters governing neutrino oscillations. A muon (anti-)neutrino beam is produced at the Japan Proton Accelerator Research Complex (J-PARC) on the east coast of Japan, and is aimed towards the Super-Kamiokande (SK) detector 295km away near the west coast. In this analysis, Markov Chain Monte Carlo is used to fit the Monte Carlo prediction to data from the near detectors, ND280 and INGRID, which measure the neutrino flux and interaction cross-sections before oscillation. The flux and interaction models are parameterised using external data and T2K beam line monitoring measurements to set the prior values and uncertainties. The fit to ND280 data incorporates the prior knowledge, further constraining the uncertainties and adjusting the parameters. Several updates have been made to the data samples and cross-section model used for the 2019 oscillation analysis to maximise the constraint on these systematics, and reduce the impact they have on oscillation results. After the near detector fit, the central values and uncertainties of the parameters are used in the prediction of SK data for the full oscillation fit. Typically the near detector fitting process reduces systematic uncertainties from 12-14% to 2-4%, allowing world-leading oscillation parameter measurements to be made at T2K.

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