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# TPC Particle Identification Performance and Systematic Uncertainties in the T2K Near Detector Before and After the Upgrade

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T2K (Tokai-to-Kamioka) [1] is a long-baseline accelerator experiment aimed at studying neutrino oscillations and searching for CP violation in the lepton sector. Reducing systematic uncertainties in the predicted event rates at the far detector Super-Kamiokande is essential for improving T2K's sensitivity to the CP-violating phase. The ND280 near detector plays a key role in this task by constraining neutrino flux and interaction model parameters using pre-oscillation data. The time projection chambers (TPCs) [2] provide key information for particle identification (PID) and the reconstruction of charged particle kinematics in ND280. The ND280 upgrade [3] introduced two high-angle TPCs (HA-TPCs), which, together with the three existing vertical TPCs, provide an extended angular acceptance for charged particles.

The TPC PID algorithm [4] is based on measurements of the ionization energy loss of charged particles traversing the TPC gas. The performance of the algorithm and associated systematic uncertainties are evaluated using control samples of muons, protons, and electrons produced in neutrino interactions. The work focuses on the studies of the TPC PID before and after the ND280 upgrade, as well as on the impact of the results and evaluated systematics on muon-candidate selection using the ND280 near detector data. This work is supported by Russian Science Foundation grant No. 26-72-00042.

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[2] N. Abgrall et al. (T2K ND280 TPC Collab.). Time Projection Chambers for the T2K Near Detectors, Nucl. Instrum. Meth. A 637 (2011) 25–46.

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[4] A. Dergacheva and A. Izmaylov. Evaluation of uncertainties associated with particle identification in the time projection chambers of the ND280 near detector of the T2K experiment, Physics of Atomic Nuclei 89, 4 (2026).

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