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Performance of the High-Angle Time Projection Chambers in the T2K Near Detector Upgrade

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The T2K experiment in Japan is a long-baseline neutrino oscillation experiment searching for the CP violation in the leptonic sector. To improve the precision of measurements in \mathbb{Z} CP terms, the Near Detector complex (ND280) has undergone a significant upgrade, which includes the installation of new **High Angle Time Projection Chambers** (HA-TPCs). These new HA-TPCs are required to provide 4π acceptance of charged particles and to enhance particle tracking during neutrino interaction.

The HA-TPCs have a novel **lightweight composite field cage** that allows thinner walls while maximising the tracking volume and reducing the detector's material budget. Its readout system, **Encapsulated Resistive Anode Micromegas** (ERAMs), uses innovative resistive Micromegas technology, which enhances the detector's stability and robustness without compromising the spatial resolution. These technologies have been studied during several test beams and cosmic ray campaigns.

These detectors were installed in the 2023 Autumn and 2024 Spring at the J-PARC complex. Following a commissioning phase using cosmic rays and a neutrino beam, in June 2024, HA-TPCs began taking data with the fully upgraded ND280. Using the ND280 reconstruction software in T2K, these collected data are reconstructed, and the initial performance achieved by HA-TPC is studied.

The key performance results include measurements of *spatial*, *momentum*, *and energy resolution* and a comparison with MC simulation. These results demonstrate that the HA-TPCs meet the desired goals of the **ND280 upgrade** and have a strong potential for application in the Hyper-Kamioakande experiment. In addition to the performance results, ongoing studies on the *electric field homogeneity*, *alignment*, *and performance of ERAMs*, which confirm the robustness of HA-TPCs for long-term operation, are highlighted.

Secondary track

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