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The T2K Near Detector Upgrade

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Neutrino oscillation physics has now entered the precision era. In parallel with needing larger detectors to collect more data with, future experiments further require a significant reduction of systematic uncertainties with respect to what is currently available. In the neutrino oscillation measurements from the T2K experiment the systematic uncertainties related to neutrino interaction cross sections are currently the most dominant. To reduce this uncertainty a much improved understanding of neutrino-nucleus interactions is required. In particular, it is crucial to better understand the nuclear effects which can alter the final state topology and kinematics of neutrino interactions in such a way which can bias neutrino energy reconstruction and therefore bias measurements of neutrino oscillations.

The upgraded ND280 detector, that will consist in a totally active Super-Fine-Grained-Detector (sFGD), two High Angle TPC (HA-TPC) and six TOF planes, will directly confront our naivety of neutrino interactions thanks to its full polar angle acceptance and a much lower proton tracking threshold. Furthermore, neutron tagging capabilities in addition to precision timing information will allow the upgraded detector to estimate neutron kinematics from neutrino interactions. Such improvements permit access to a much larger kinematic phase space which correspondingly allows techniques such as the analysis of transverse kinematic imbalances to offer remarkable constraints of the pertinent nuclear physics for T2K analyses.

The SuperFGD, a highly segmented scintillator detector, acting as a fully active target for the neutrino interactions, is a novel device with dimensions of ~2x1.8x0.6 m3 and a total mass of about 2 tons. It consists of about 2 million of small scintillator cubes each of 1 cm3. The signal readout from each cube is provided by wavelength shifting fibres connected to MPPCs. The total number of channels will be ~60,000 and the cubes have already been produced and assembled in X–X layers.
The HA-TPC will be used for 3D track reconstruction, momentum measurement and particle identification. These TPC, with overall dimensions of 2x2x0.8 m3, will be equipped with 32 resistive MicroMegas (ERAM). The thin field cage (3 cm thickness, 4% rad. length) will be realized with laminated panels of Aramid and honeycomb covered with a kapton foil with copper strips. The 34x42 cm2 resistive bulk Micromegas will use a 500 kOhm/square DLC foil to spread the charge over the pad plane, each pad being ~1 cm2. The electronics is based on the AFTER chips.
The time-of-flight (TOF) will consist of 6 planes with about 5 m2 surface area surrounding the SuperFGD and the TPCs. Each plane has been assembled with 2.2 m long cast plastic scintillator bars with light collected by arrays of large-area MPPCs from two ends.

In this talk we will present the status of the construction of the different subdetectors towards their installation at J-PARC, expected for the first half of 2023 and we will describe the expected performances of this new detector.

In-person participation

Yes

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