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The upgrade of the T2K Near Detector ND280

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Summary

In view of the J-PARC program of upgrades of the beam intensity, the T2K collaboration is preparing towards an increase of the exposure aimed at establishing leptonic CP violation at 3 σ level for a significant fraction of the possible δ_{CP} values. To reach this goal, an upgrade of the T2K near detector ND280 has been launched, with the aim of reducing the overall statistical and systematic uncertainties at the appropriate level of better than 4\%.

We have developed an innovative concept for this neutrino detection system, comprising the totally active Super-Fine-Grained-Detector (SuperFGD), two High Angle TPC (HA-TPC) and six TOF planes.

The SuperFGD, a highly segmented scintillator detector, acting as a fully active target for the neutrino interactions, is a novel device, (JINST 13 (2018) no.02, P02006; NIM A923 (2019) 134), with dimensions of ˜2x1.8x0.6 m3 and a total mass of about 2 tons. It consists of about 2x106 small scintillator cubes each of 1 cm3. Each cube is covered by a chemical reflector. The signal readout from each cube is provided by wavelength shifting fibers inserted connected to micro-pixel avalanche photodiodes MPPCs. The total number of channels will be ˜60,000. We have demonstrated that this detector, providing three 2D projections, has excellent PID, timing and tracking performance, including a 4π angular acceptance, especially important for short proton and pion tracks.

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. 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 appr. 1 cm2. The front-end cards, based on the AFTER chip, will be mounted on the back of the Micromegas and parallel to its plane.

The time-of-flight (TOF) detector will allow to reject events generated in the passive areas of the detector and improve particle identification. The TOF will consist of 6 planes with about 5 m2 surface area surrounding the SuperFGD and the TPCs. Each plane will be assembled with 2.2 m long cast plastic scintillator bars with light collected by arrays of large-area MPPCs from two ends. The time resolution at the bar centre is 150 ps.

In Summer 2018 we have tested prototypes of the SuperFGD, the resistive Micromegas and the TOF in a CERN PS test beam with excellent results.

We have recently completed the detailed TDR describing all the components of the ND280 Upgrade (arXiv:1901.03750). The project has been recently approved by CERN as part of the Neutrino Platform (NP07). In this talk we will report on the design of these detectors, their performance, the results of the test beam and the plan for the construction.

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