Development of a novel 3D SuperFGD neutrino detector

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The long baseline neutrino experiments T2K has obtained a first hint on CP violation in neutrino oscillations and excluded CP conservation at the 95% confidence level. To strengthen this result the T2K collaboration is expected to collect the full exposure of $7.8×1021$ protons on target, thanks to planned upgrades to the J-PARC and the neutrino beamline. An upgrade of the T2K near detector ND280 has a goal to reduce a systematic uncertainty in the prediction of number of events at the far detector of less than 4%. The project includes the development of a new highly granular fully active scintillator neutrino detector as a neutrino target. This detector will allow us to obtain a much better uniformity of acceptance as a function of polar angle, to reduce the threshold for detection of charged particles, to improve the localization of the neutrino interaction vertex, and to effectively separate electrons from the neutrino interaction and background photons. The baseline concept of a novel highly granular fully active detector with dimensions of ~200x180x60 cm3 and a total mass of about 2 tons will represent an array of about 2x106 small scintillator cubes each of 1 cm3. Each cube covered by a chemical reflector has three orthogonal cylindrical holes of a 1.5 mm diameter. The signal readout from each cube is provided by inserted in these holes three 1.0 mm Kuraray Y11 multiclad WLS fibers which connected to micro-pixel avalanche photodiodes MPPCs. A prototype of this detector comprised of about 10000 cubes was tested in a beam of charged particles (electrons, muons, pions, protons) at CERN in 2018. Obtained parameters of the prototype: the light yield, cross-talk, and time resolution will be presented. The progress in R&D of this detector, future plans to construct the full scale detectors and results of simulations will be also reported.

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