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Development of a 3D highly granular scintillator neutrino detector for the T2K experiment

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The long baseline neutrino experiment T2K has launched the upgrade project of its near detector ND280, crucial to reduce the systematic uncertainty in the prediction of number of events at the far detector to less than 4%. An essential component of this upgrade is a highly segmented scintillator detector, acting as a fully active target for the neutrino interactions.
The baseline concept for it is a novel device, called SuperFGD (arXiv:1707.01785, 2018_JINST_13_P02006), with dimensions of ~200x180x60 cm^3 and a total mass of about 2 tons. It consists of about $2x10^6$ small scintillator cubes each of 1 cm^3. Each cube is covered by a chemical reflector and has three orthogonal cylindrical holes of 1.5 mm diameter. The signal readout from each cube is provided by WLS fibers (1.0 mm Kuraray Y11 multiclad fibers) inserted in these holes and connected to micro-pixel avalanche photodiodes MPPCs. We have demonstrated that this detector, providing three 2D projections, has excellent tracking performance, including a 4π angular acceptance, especially important for short proton and pion tracks. Moreover, with its data it will be possible to clearly distinguish between photon conversions and ν_e interactions. Interest in this detector has been expressed by groups of the DUNE and ESS-nu collaboration, proposing it as a component of their near detector complex.
A small prototype of this detector composed of 125 cubes was tested in a beam of charged particles at CERN in 2017. The detector response of this prototype, including the light yield, the cross-talk, and the time resolution has been measured and will be presented. The progress in the R&D of this detector, future plans and results of simulations will be also reported.

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