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Scintillation light collection, production and propagation in the 4 tonne dual-phase demonstrator (data analysis and simulations)

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Summary

The Deep Underground Neutrino Experiment (DUNE) is a new generation long-baseline neutrino detector pursuing the goals of measuring neutrino oscillations, investigating the presence of CP-violation, performing neutrino astrophysics studies, and nucleon decay searches. DUNE planned to install four 10-kton Liquid Argon (LAr) Time Projection Chambers (TPC) using both single and dual-phase (DP) technology. The latter provides charge amplification before collection in the gaseous phase.

The photon detection system in these detectors is crucial to provide the trigger signal for rare non-beam events, an absolute time reference for the charge and to complementary calorimetry. The testing and design optimization of the DP technology up to DUNE modules is following a scaling approach. A DUNE DP prototype (ProtoDUNE-DP) is currently being constructed at CERN to demonstrate the operation of the DP technology at large scale (6x6x6 m3 LAr volume). In 2017 a DP 4 tonne demonstrator of 3x1x1 m3 volume took cosmic data and exhibited good performance in terms of charge extraction and light collection.

The ProtoDUNE-DP light detection system has been designed based on the results from the 3x1x1 performance. In the demonstrator, 5 cryogenic photomultipliers were installed with different configurations in terms of PMT base polarity and wavelength shifting methods. During the 4-tonne

demonstrator operation, scintillation light data have been collected during several months of operation in different drift and amplification fields configurations. In DP, on the top of the scintillation light produced in the liquid phase (S1 signal), a secondary light signal (S2) is generated in the gas phase during the charge amplification.

An overview of the 3x1x1 light detection system performance will be presented, confirming the good capability of the system to collect and characterize S1 and S2 signals, to monitor LAr purity, to measure the electron drift velocity and provide a trigger to the charge. The presence of external Cosmic Rays Taggers (CRT) allowed the reconstruction of the tracks in the fiducial volume and the study of the light signal also in absence of drift field. Data have been compared with MC simulations. The sensitivity to the LAr optical parameters not completely known such as Rayleigh scattering and light production mechanisms have been studied and will be presented in this poster.

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