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Photon Detection System in the far detector module of the DUNE experiment

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The Deep Underground Neutrino Experiment (DUNE) is a long baseline neutrino experiment for neutrino science and Beyond the Standard Model physics, aiming to resolve the neutrino mass hierarchy and measure CP-violation phase. DUNE will also have sensitivity to detect neutrinos from supernovae.
The experiment will make use of four far detector (FD) modules, 1300 km away from the beam line, installed 1.5 km deep underground. The FD modules will consist of Liquid Argon Time Projection Chambers with 17 kt of liquid argon each, the largest ever attempted.
Photon detection systems (PDS) are integrated in the liquid-argon neutrino detectors and are used to provide the timing information for an event, which is necessary for reconstructing the drift coordinates of ionizing particle tracks and can be effectively used for other purposes including triggering events, background rejection, and calorimetric energy estimation.
The PDS of the first FD module consists of light collector modules placed in the inactive space between the innermost wire planes of the TPC anode. The light collectors, the so-called X-ARAPUCAs, consist of cells acting as light trap and capturing wavelength-shifted photons inside boxes with highly reflective internal surfaces where they are guided to Silicon Photomultipliers by wavelength-shifting bars.
The first FD module will use X-ARAPUCAs based rectangular Photon Detection unit (Supercell) having dimensions 209×12×2 cm3. The 48 SiPMs on each X-ARAPUCA supercell are ganged together, and the signals are collected by FE electronics, mounted on the supercell. The second FD module will be equipped with Vertical Drift system, in which charge is drifted vertically toward the charge readout planes. In this case, a new design for X-ARAPUCA, called Megacell has been implemented in which the detector has square dimensions 600×600×8 mm3. In the present work the results in term of photon detection efficiency performances for X-ARAPUCA Supercell design and the test ongoing for the X-ARAPUCA Vertical Drift modules are reported.

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