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Measurements and enhancement of the X-Arapuca light detection efficiency

The Photon Detection System (PDS) of the Deep Underground Neutrino Experiment (DUNE) will be based on the X-Arapuca (XA) technology to detect Liquid Argon (LAr) scintillation in the DUNE far detector. The PDS will be composed of 1,500 XA with approximate dimensions of 210 x 12 cm^2, located at the anode planes of the liquid argon time projection chamber (LArTPC). In the XA light trap device, the liquid argon scintillation light (with wavelength around 127 nm) is absorbed by a thin layer of para-Terphenyl (pTP) coated on a dichroic filter window and remitted at wavelength around 350 nm: next it is converted in the inner wavelength shifter plate (WLS plate) to higher wavelength around 430 nm. The dichroic filter cut-off is chosen to be 400 nm, in order to allow the pTP shifted light to enter in the X-Arapuca while trapping the fraction of photons escaping from total internal reflection in the WLS plate. An array of silicon photo-sensors (SiPM) coupled at the edges of the WLS plate collect the light. In this work, we present the first characterization of the photon detection efficiency of an X-Arapuca prototype sizing 20 x 7.5 cm^2 using an 241 Am source and the enhancement of the device efficiency of about +50% by replacing the baseline WLS with a newly developed WLS material. The resulting efficiency found is comparable with the first X-Arapuca single cell test performed in Brazil 2019-2020 with a natural uranium, 60Co source and cosmic muons.

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