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Characterisation of a Novel Photodetector Configuration for Water Cherenkov Detectors

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We present the development and experimental characterisation of a novel photodetector configuration designed for water Cherenkov detectors, aimed at future use in high-energy gamma-ray observatories. The design consists of a small-area photomultiplier tube (PMT) coupled with a wavelength-shifting (WLS) plate, which aims to increase the effective light collection area by converting and guiding absorbed Cherenkov photons toward the PMT's photocathode edge. This approach offers a cost-effective alternative to large-area PMTs traditionally used in water Cherenkov detectors, as a means for background hadronic rejection.
To evaluate its performance, the detector was installed in a dedicated water tank at the University of Leicester and paired with a custom-built muon telescope to measure coincident triggers from atmospheric muons. The response of the WLS plates was measured and compared to that of a stand-alone 3-inch PMT. We report on the light yield, time response, and detection efficiency of the PMT with WLS plates. These results demonstrate the feasibility of using WLS-enhanced compact photodetectors in large-scale Cherenkov arrays and their potential integration into next-generation high-energy gamma-ray observatories.

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