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Prototype Test of a Water Cherenkov Detector Designed Based on the SWGO Lake Concept

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This study presents the design and evaluation of a water Cherenkov detector (WCD) prototype based on the lake concept proposed in the SWGO framework. Aimed at future large-scale cosmic ray and gamma-ray observatories, the prototype uses a separate, stand-alone bladder structure made from lightweight materials. By using the natural buoyancy of water, the system removes the need for traditional mechanical support, providing a scalable and cost-effective solution for wide-field detector arrays. Its modular design allows for easy transportation and fast deployment, greatly reducing the need for complex infrastructure and lowering construction costs, especially in remote or challenging locations.

The prototype was first tested in a laboratory using cosmic-ray muons to systematically study its light response uniformity, time resolution, and detection efficiency. Field tests were then carried out by deploying a small detector array, consisting of water bladder units and LHAASO electromagnetic particle detectors (ED), on the artificial lake at the LHAASO site. The time response of the WCD was analyzed by calculating residuals with respect to the reconstructed shower front and comparing them with results from nearby ED detectors. Using coincidence-triggered data, the time synchronization performance of the WCD was thoroughly evaluated, demonstrating its potential for use in large-scale observatories.

With advantages in detecting low-energy electromagnetic particles and improving the timing accuracy of shower front measurements, the bladder-based WCD is well suited for next-generation experiments in the TeV–PeV energy range. Its strong scalability and ability to adapt to different environments make it a promising option for future observatories like SWGO and for possible upgrades to the LHAASO array, contributing to the development of low-cost, high-precision ground-based particle detection systems.

Collaboration you are representing

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