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Wavelength shift fiber enhancing PMT for the water Cherenkov detector prototype at very high energy Gamma-ray observatory

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The Southern Wide-field Gamma-ray Observatory (SWGO) is the proposal for a new ground-based gamma-ray observatory in the Southern Hemisphere, and an array of water-Cherenkov detectors (WCD) will be used to monitor the very-high-energies gamma-ray emission from the southern sky. In this report, we propose one fiber-PMT, small size photomultiplier tube (PMT) coupling with wavelength shift fiber bunch to enhance light collection efficiency, to be used as photosensor for these WCDs. This is a cost effective approach with respect to a large area PMT currently used in WCD. One WCD prototype has been built in our laboratory with this fiber-PMT, XP3960 PMT and Kuraray Y11 fiber bunch the structure of this fiber-PMT photosensor and the WCD will be introduced. The light yield and time resolution of this fiber-PMT WCD prototype has tested with cosmic ray muon, the single particle peak is clear visible with charge resolution 19% and time resolution less than 4 ns. The uniformity of this WCD is also tested with cosmic ray muon by changing the trigger prober position and direction. The simulation based on GEANT4 also is developed to optimize the performance of this detector, including the effect of detector area, water depth and fiber length. The optimized WCD design demonstrates the potential for improved performance while reducing costs and simplifying installation and maintenance processes.

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