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A photomultiplier tube model for the water Cherenkov detectors of the LAGO

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The Latin American Giant Observatory (LAGO) is an international experiment spanning over 10 Latin American countries and Spain. LAGO scientific objectives include the study of gamma-ray bursts and space weather phenomena using water Cherenkov detectors (WCDs) deployed at different latitudes and altitudes. Large area (8-9 inches) photomultiplier tubes (PMTs) sense the Cherenkov radiation produced by secondary particles, induced by primary cosmic particles in the atmosphere, crossing the WCDs.

We present a photomultiplier model applied to the Hamamatsu R5912 tube used in the LAGO' WCDs. The ARTI simulation framework, developed by the LAGO collaboration, can incorporate it. The model depends on the number of dynodes, the bias voltage, the number of incident photons, the photodetection efficiency, and the bias network. The model implementation includes a simulation of the LAGO's front-end, allowing the system linearity evaluation under different conditions.

The model was validated with data recorded by the MuTe-Chitagá (Bucaramanga, LAGO-Colombia) and Nahuelito (Bariloche, LAGO-Argentina) WCDs. The ARTI simulation chain estimates the number of Cherenkov photons arriving at the detector's PMT. We compare the anode/dynode pulse amplitude ratio predicted by the model with detector measurements. We also contrast the estimated and measured vertical equivalent muon signal. The estimated vertical-muon charge (321.6 UADC) differs by 4% from the measured by the MuTe WCD (333 UADC).

Keywords

photomultiplier tube; mathematical model; water Cherenkov detector; front-end electronics

Collaboration

other Collaboration

LAGO

Subcategory

Experimental Methods & Instrumentation

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