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Terrestrial Magnetic Field Effects on Large Photomultipliers

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The influence of the Earth's magnetic field on candidate large PMTs for a cubic-kilometer-scale neutrino telescope was studied within the framework of the KM3NeT design study. In particular, this study was aimed at deciding whether the use of a magnetic shield could be avoided, thereby reducing cost and simplifying optical sensor module assembly. Measurements were performed for three Hamamatsu PMTs: two 8-inch, R5912 types; one with standard and the other with super-bialkali photocathode, and a 10-inch R7081 type with a standard bialkali photocathode. The various characteristics of the PMTs, such as transit time, transit time spread, gain, peak-to-valley ratio and charge resolution, were measured while varying the PMT orientations with respect to the Earth's magnetic field, both with and without mu-metal cage magnetic shielding. Detection efficiency and the rates of spurious pulses were also investigated. In the 8-inch PMTs the impact of the magnetic field was found to be smaller than on the 10-inch PMT. With a mu-metal cage, the 10-inch PMT had a similar response as the 8-inch PMTs without a cage. The increased quantum efficiency in the 8 super-bialkali PMT almost compensates its smaller detection surface compared to the 10"PMT. No significant effects of the Earth's magnetic field were measured upon transit time and the rates of spurious pulses.

Summary

The influence of the Earth's magnetic field on candidate large PMTs for a cubic-kilometer-scale neutrino telescope was studied within the framework of the KM3NeT design study. Measurements were performed for three Hamamatsu PMTs: two 8-inch, R5912 types; one with standard and the other with super-bialkali photocathode, and a 10-inch R7081 type with a standard bialkali photocathode. The various characteristics of the PMTs were measured while varying the PMT orientations with respect to the Earth's magnetic field, both with and without mu-metal cage magnetic shielding. In the 8-inch PMTs the impact of the magnetic field was found to be smaller than on the 10-inch PMT. With a mu-metal cage, the 10-inch PMT had a similar response as the 8-inch PMTs without a cage. The increased quantum efficiency in the 8 super-bialkali PMT almost compensates its smaller detection surface compared to the 10"PMT.

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