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Low Power Multi_dynamics Front End for the Optical Module of a neutrino underwater telescope

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A proposal for a new front-end architecture intended to capture signals in the optical module of an underwater neutrino telescope is described. It concentrates on the problem of power consumption, signal reconstruction, charge and time precision. Preliminary test results on a demonstration board are shown.

Summary

The NEMO underwater neutrino telescope uses large area photomultipliers (PMTs) inside optical modules (OMs) to detect the Cherenkov light emitted by the muons generated by neutrinos in the seawater. The PMTs are put in a 17"glass sphere capable to stand more than 350 Atm external pressures. The signals at the output of the PMT must be suitably coded and sent on-shore. The OM contains the PMT and its base board, the front-end electronics, the data pack and transfer electronics, the slow control interface and a set of environmental sensors.

The work described in this paper is aimed at the development of a low-power front-end for the OMs of the NEMO submarine neutrino detector. A mini-tower equipped with 16 OMs (NEMO-Phase1 MiniTower) has been successfully deployed in December 2006 in front of the Catania harbour as a first prototype. The technological solutions adopted provided results in agreement with expectations. In the meantime, we have developed a solution which can fulfil all requirements of a km3-scale detector, in particular for what concerns power consumption, PMTs aging and signal dynamics. The final version of the presented front-end electronics will be employed in one of the 16 floors NEMOPhase2 Tower to be deployed at the end of 2008.

This solution is based on the use of an Application Specific Integrated Circuit (ASIC) for the fast sampling of the PMT signal, which is performed according to its shape classification made by another unit. Two other units, one ADC and a Field Programmable Gate Array (FPGA), provide digital encoding of the voltage sampled signals, the packing of the data and its transfer towards the shore station.

An electronic board containing the PMT interface and the mentioned units constitutes the OM front-end. By means of the FPGA, this board receives the slow control signals and transmits the measurements of environmental parameters such as temperature and humidity, together with the data.

A proposal for a system to capture signals from Optical Modules of an underwater neutrino telescope has been described, with focus on power consumption and dynamics considerations. All considerations regarding the signals and their acquisition are discussed, starting from the most general

hypothesis possible, so that they will be valid for any underwater Cherenkov neutrino telescope.
The development of the demonstration board to evaluate the advantages of the proposed architecture fitting the specifications of power dissipation, multi input dynamics, signal reconstruction, establishes the basis for the definitive design of the final front end board using the SAS chip. As soon as the chip will be available, the whole front-end will be tested together with the PMT.

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