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PORFIDO: OCEANOGRAPHIC DATA FOR NEUTRINO TELESCOPES

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Abstract

PORFIDO (Physical Oceanography by RFID Outreach) is a system designed to be installed in the optical modules of the NEMO experiment and possibly, in future underwater neutrino telescopes to gather oceanographic data with a minimum of disturbance to the main project and a very limited budget. The system gathers oceanographic data (temperature, etc.) from passive RFID tags (WISPs) attached to the outside of the NEMO optical modules with an RF reader situated inside the glass sphere, without the need of connectors or penetrators, which are very expensive and offer low reliability. Ten PORFIDOs will be deployed with the NEMO Phase 2 tower in 2011.

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1 INTRODUCTION

Gathering oceanographic data from a neutrino telescope installation can greatly benefit both oceanography and neutrino physics, if it can be carried out without adding to the reliability problems of the main installation and if the budget can be contained.

Continuous data from the bottom of the sea is a very rare achievement for oceanography. Data are traditionally obtained by dropping instruments to the bottom of the sea and recovering them a few months later, when batteries are exhausted.

Neutrino underwater telescopes need a very fast connection to onshore electronics, with a bandwidth several orders of magnitude higher than needed for oceanographic data.

If we could install sensors in the optical modules of a neutrino telescope we would obtain a lot of information that could be sent to the shore station without disturbing the photomultiplier data, and that could be easily contained in the "Slow Controls" data stream.

It is not feasible to propose additional connectors on the optical modules glass spheres, because of high cost and low reliability. Therefore we decided to take advantage of the RFID technology to read data by an RF signal through the glass wall from passive sensors that do not use batteries, but derive power directly from the reader RF signal.

2 THE RFID TAG - WISP

The RFID technology has reached a high grade of robustness and is widely used for access control. Several types of passive tags are available on the market with very low prices and reading ranges that go up to 10 m distance. However these tags only allow reading an identifier and have no capability to support sensors.

We found what we needed at the Intel Research center in Seattle[1)]. They have developed a tag called WISP that is passive, has a thermometer and an accelerometer installed, and is designed with an open architecture to include new sensors. It takes advantage of the EPC C1GEN2 Protocol, that includes the possibility of sensors in RFID tags.

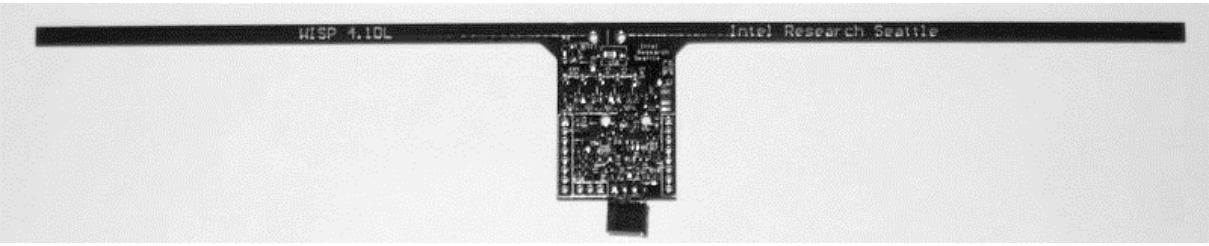

Fig 1: The WISP.

We need the tag to work at 4000 m depth, so we potted a WISP in a shell of two components epoxy, with a thickness of one cm. Several tests have been conducted in the framework of the NEMO experiment in LNS, Catania, and the results are very

encouraging for the possibility of standard electronic components to withstand a very high pressure. We will test the WISP under a pressure of 400 atm in the near future at LNS.

3 THE READER

We need an RFID Reader to put inside the optical modules, which has to be small, not very powerful and cheap. Several firms offer such instruments, and we have chosen CAEN RFID S.r.l.[2)] for its small footprint and general ease of use. We have tested several types of antennas and obtained the best results from a small PC Board antenna installed under the reader.

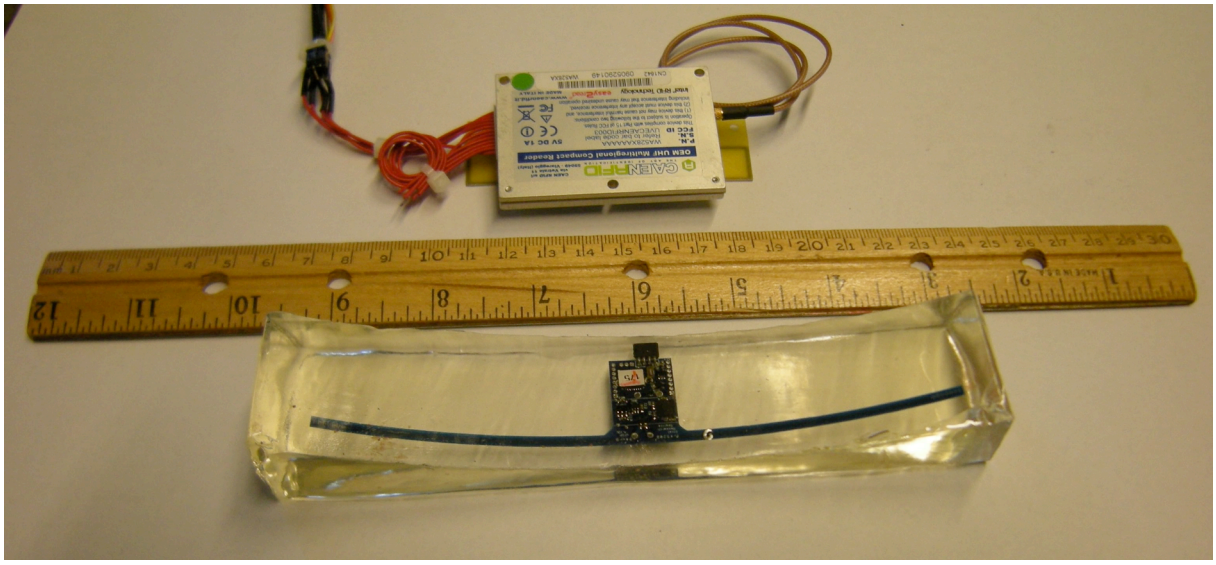

Fig. 2: The WISP potted in epoxy and the CAEN reader.

4 TESTS AND DEVELOPMENT

To test the system in a configuration as close as possible to the final we glued two potted WISPs to the outside of an optical module, we assembled the reader over the antenna with a 2 mm spacer and installed it inside the glass sphere. Finally, we immersed the bottom of the sphere in salt water simulating the sea. Using an RS/232 interface to a pc we were able to read both wisps more than once a second, which is high compared to the intrinsic time constant of oceanographic data. The immersion in salt water did not change the performance.

To prevent electromagnetic interference with the PMT assembly we will install an aluminum shield behind the reader.

In the near future we are planning to run pressure tests and to implement new sensors, starting with a measure of conductivity.

The NEMO group has approved the installation of 10 PORFIDOs on the Phase2 tower that will be deployed in 2011.

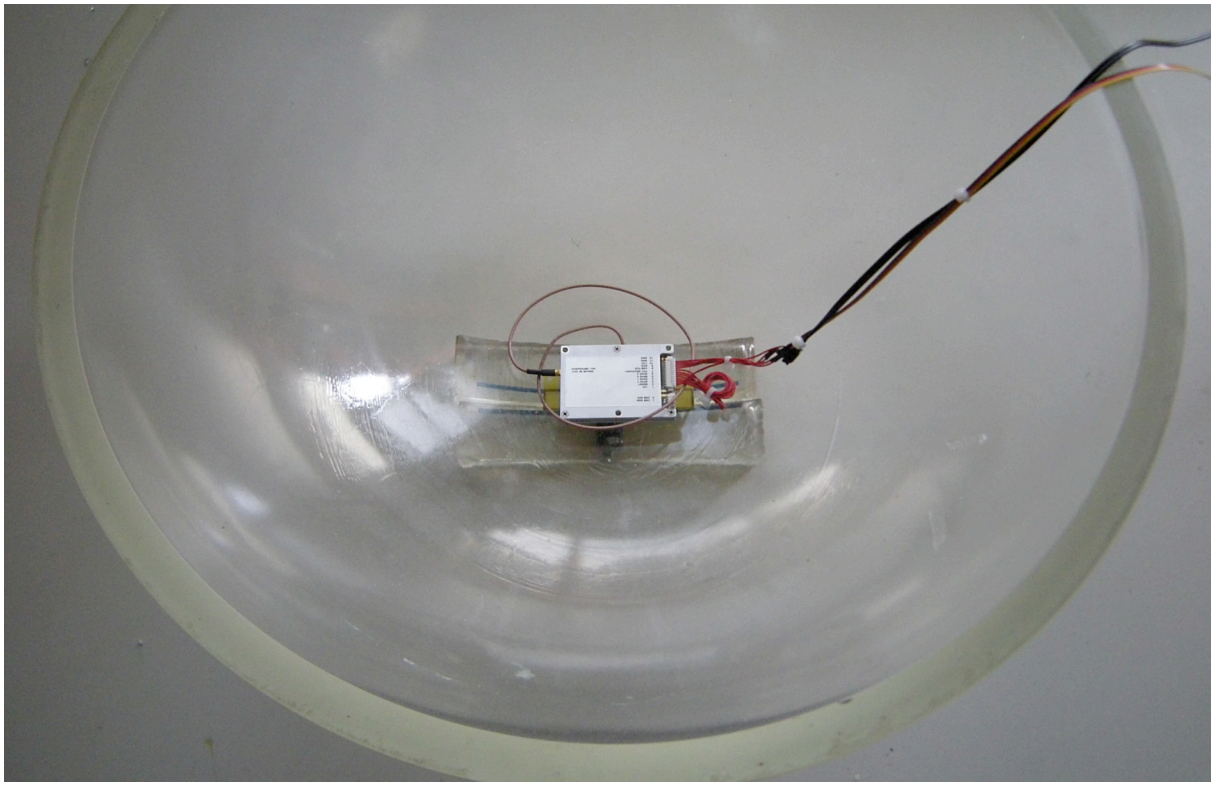

Fig. 3: Test setup.

5 ACKNOWLEDGEMENTS

We would like to thank Joshua R. Smith and the WISP team for continuing support.

We are grateful to the Catania components of the NEMO group who lent us a lot of essential support.

6 REFERENCES

(1) Design of an RFID-Based Battery-Free Programmable Sensing Platform Alanson P. Sample, Daniel J. Yeager, Pauline S. Powledge, Alexander V. Mamishev, Joshua R. Smith. IEEE Transactions on Instrumentation and Measurement, Vol. 57, No. 11, Nov. 2008, pp. 2608-2615.

(2) CAEN RFID - Via Vetraia 11, I-55049 VIAREGGIO - ITALY