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NESTOR Optical Modules blackening

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Abstract

The optical modules (OM) containing the photomultiplier tubes (PM) for a deep sea neutrino telescope must be protected them from direct sunlight. The problem has been solved using a heat shrink plastic sheet with very good optical and mechanical properties.

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1 – OPTICAL MODULES AND THE SUN

In a deep sea neutrino telescope the deployment process is a complex and time consuming process. This operation has to be carried out in good weather, so that the PMs end up being exposed to direct sunlight for many hours, if not days. This is a problem for photocathodes designed to be sensitive to single photons.

Therefore a method has to be devised to protect the PMs from direct sunlight, and the blackening cover has to be easily removable immediately before the deployment, without adding complicated and time consuming procedures to the process, whether on a ship bridge or directly in the sea water.

2 – NESTOR Bay Station

On July 28, 1998, the first deployment was carried out at the NESTOR Bay Station. This installation, situated on the west side of the Navarino Bay at a depth of 35 m, is intended as a long term test bed for underwater equipment of different kinds, and is connected to the Pylos Laboratory via a 4.5 km electrooptical cable carrying power and data.

The first item deployed was a NESTOR star with 14 PMs and the arms shortened to 5 m. This was intended as a long term test of the electronics and the general setup of a deep sea floor. However, since at 35 m depth the light of the sun is quite strong, the Optical Modules had to be very carefully blackened in order to be able to run the station 24 hours a day. Again the problem of PM blackening became important.

3 – OM BLACKENING

Initial tests carried out using black adhesive tape did not perform well, since the tape tends to come loose when put into sea water. Moreover a sheet of aluminized Mylar had to be used under the tape to prevent it from sticking directly to the glass, thus making it very difficult to remove.

The problem was solved using heat shrinking plastic

A sheet of heat shrink polyethylene strongly doped with carbon dust was extruded for us by a firm in Cassino(Rm) Italy.

The sheet is 2 m wide, 0.1 mm thick and can be shrunk using a heat gun by more than a factor of two in a single direction. Our optical modules have a diameter of 47 cm.

We covered an OM with three sheets of plastic: the first was 40 cm by 160 cm, and was wrapped around the circumference of the sphere. Two more pieces, 40 cm by 40 cm, were used to cover the top and bottom. This method was devised to minimize the superposition of several

layers of polyethylene, which make it difficult to distribute evenly the heat from the heat gun.

It must be mentioned that the heat shrink plastic will stick to itself when heated, so that the different pieces actually formed a single unit after heating. The same technique can be used if a hole or a cut occurs during the process of wrapping.

The OM contained a photomultiplier tube that was turned on after wrapping. The OM was illuminated by a strong light source. Only a very few leaks were detected, due either to irregularities in the material or to mishandling while wrapping.

Therefore, for the Bay Test, we wrapped the sphere twice, with the main plastic sheets at 90° from each other. For the deep sea deployment process it is probably sufficient to use a single sheet, since the PMs are not going to be powered before being submerged.

The wrapping process took about 15 min per optical module, including the double layers. The cost of the material was negligible, since the polyethylene was of the kind used for packing purposes, and not the much more expensive electronics stuff.

It is very easy to remove the plastic cover before deployment, using a cutter and discarding the plastic.

4 – CONCLUSIONS

The use of heat shrink plastic seems to be a very good answer to the problem of OM blackening, from the point of view of cost, efficiency of the wrapping and removal processes, and light tightness.

5 – ACKNOWLEDGMENTS

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