Research Report
ICRR Inter-University Research Program 2021

Research Subject:

Seal, mechanical and functional tests on the mPMT prototype for external vessel optimizzations

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Summary of Research Result：

In this fiscal year (Apr. 2021-Mar. 2022), the mPMT assembly was tested at the INFN labs, in Naples (Italy). The first mPMT prototypes were made without electronic components and cable. The gel filling was tested too, on the base of the method of the KM3NeT experiment.

As regarding the component assembly, the matching with the HPDE cylinder was not excellent. This was due to some inevitable deformations of the material. In spite of all our precautions planned with the company, there was an ovalization of the cylinders of about 2 mm in its diameter and this does not fit with an easy assembly, in particular with the acrylic dome and stainless-still clamping ring. In any case, even with these problems, two mPMTs were assembled.

A first mPMT was only with external component, and with inside an Arduino device to acquire some data during some planned pressure tests; a second mPMT was made with the external components and 18 not-good 3" PMTs by Hamamatsu, placed in a PMT support and with the Elastosil-604 optical gel.

Apart from the mentioned matching issues, the assembly was good and the gel filling test was good enough. Although there were some small detachments from the dome, they were probably due to two reasons: 1) a too much thick layer of gel; 2) because the dome was tested different times with the gel before the final assembly, so that its surface was dirty. As a solution, a new design of the PMT support has been designed for the next prototype and a new dome will be used directly without further

intermediate gel tests.

In September 2021, the two prototypes were tested at the Resinex company, in Italy, with a pressure test until about 1.3 MPa. Both prototypes successfully passed the test and their sealing was excellent.

In March 2022, at the Old JAMIC microgravity experimental laboratory, in Hokkaido, some important tests were done on the mPMT. The second prototype (with not-good PMTs and gel) was shipped to Japan for an installation test and the anti-implosion tests of the 20"-PMT covers.

These tests were passed successfully too. The mPMT was installed by the Japanese colleagues, the support team of the anti-implosion tests, and the Spanish colleagues of the HK collaboration.

After installation, the mPMT staid for many anti-implosion tests and it survived also when there was the implosion chain (i.e., when the 20"-PMT covers did not contain the shock wave generated by the caused implosion of the 20" PMT). Some 3" PMTs inside the mPMT were destroyed, but the external components and mPMT connections connected to the mock-up frame totally resisted.

Unfortunately, because of Covid-19 restrictions, nobody directly involved in the mPMT task could go to Japan. Colleagues in Hokkaido installed the mPMT to the mock-up frame only by written instructions. It means that the instructions were clear and easy to follow in the procedure (and real thanks to all colleagues that helped in these tests!).

The Covid and the post Covid pandemic have caused (and are causing still) many delays and some tests have been postponed. A long pressure test will start in Prague in the end of July 2022. I am using a prototype instrumented with an updated Arduino device to monitor the mPMT for the whole time of the long pressure test. In this prototype, a cable has been installed and it goes out from the mPMT to send data to a computer and monitor deformations, temperature, pressure and humidity in real time.

Finally, because of the mentioned matching problem and deformations of the HDPE cylinder, a new prototype will be made with a cylinder in POM-C material. This material is more expensive than HPDE, but no deformations after manufacturing should occur. POM-C is difficult to find in this period and the first cylinder will be ready in the end of September 2022 for a first check. This last mentioned prototype could be close to the final version and, after all these tests and updates, it will be instrumented to have the first functional mPMT prototype.

No.