

Research Report

ICRR Inter-University Research Program 2020

Research Subject: Development and testing of cost-effective, high-performance Photo-Detector anti-implosion covers for Hyper-Kamiokande

Principal Investigator: Luis Labarga

Participating Researchers: Luis Labarga, Lluís Martí, Bryan Zaldivar

Summary of Research Result:

This grant was utilized with the aim of furthering the development of the “Spanish” (UAM-Aratz) design for the shockwave arresting “anti-implosion” PMT covers for the Hyper-Kamiokande project, in conjunction with internal funding from the Spanish institutions involved in the project (UAM, *Laboratorio Subterráneo de Canfranc* (LSC)). It succeeded in providing important funding for activities in Japan crucial in the continuing development of the covers, which have now reached a successful third iterative version (V3), building on prior development work in 2017-18 (V1-vV2.2). A crucial milestone crossed during the former IURP 2019 grant was the finalization of the acrylic flange-less dome design, the successful completion of the competitive bidding process between acrylic suppliers (bulk material and precision-forming technique), and the confirmation of the adequacy of said acrylic dome through precision testing. This V3 cover was successfully certified under nominal + margin static pressures during a hydrostatic testing campaign in Spain of full-scale, complete cover prototypes in 2019, as well as through static Finite Elements Modeling (FEM) computational testing in Japan, both with help of the antecessor IURP 2019.

During this IURP 2020, the grant directly allowed for the completion of several actions:

- The first version of attachment system cover/HK-structure was designed, and a prototype produced.
- A full V3 cover with the above system mounted was shipped to ICRR in Kashiwa campus for testing at the HK mockup structure. The test was reasonably successful; no showstoppers were found.
- After the above tests, the cover was transported to Kamioka for a Radon emanation measurement. It was performed in U. Kobe’s device at Hall G. The resulting $5.4 \pm 0.6 \text{ Bq/m}^3$ is considered large, however it is suspected that it might be due to the significant amount of dust that was left inside the cover that could not be removed for the measurement.

- The first version of attachment system PMT-cover was fully designed, and a prototype produced. No showstoppers were encountered.
- Two mechanical samples of HK PMT (no vacuum in the bulb) were purchased to Hamamatsu. One of them was shipped to Spain for practicing with the attachment systems. The other one was transported to Kamioka for future tests there.
- Four regular acrylic covers (with flange) were purchased to Hamamatsu to be used in the certification tests (hydrostatic and induced implosion) of the 2.3 version of the cover (as V3 but with an additional corona to be used with flanged acrylic domes). V2.3 is considered the backup “Spanish cover” should the nominal cover V3 does fail the certification program.
- Several soaking tests have been (or are being) performed on different components (rivets, deformed rivets, acrylic samples) to study their impact on the transparency of pure water. Also, several light transmission measurements on relevant materials have been made.
- Geometry mapping and thickness measurements have been also carried out on the produced acrylic domes, flangeless and flange-width. In all the cases the results were within specifications.

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