

Research Report

ICRR Inter-University Research Program 2019

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

Principal Investigator: David Bravo-Berguño (Universidad Autónoma de Madrid, UAM)

Participating Researchers: Luis Labarga-Echeverría (UAM)

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-v2.2). The crucial milestone crossed during the grant’s validity period was the finalization of the acrylic 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 has been 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 during this period.

In particular, the grant directly allowed for the completion of several milestones:

- Covering the travel and lodging expenses in Japan related to meetings, workshops and business visits with industrial partners, necessary for the advancement of the cover design in general and the refinement of v3’s most innovative piece, the acrylic dome, in particular.
- Realizing a detailed subcontracted FEM analysis of the new design through the Nippon Marine Enterprises (NME) Ltd. company, certifying the superior performance and cost-effectiveness of the v3 “flangeless” design, acrylic dome and acrylic-to-steel cover interface, with respect to the previously-certified “flanged” design of v2.2.
- Performance of acrylic material compatibility testing in the Kamioka Underground Observatory facilities (soak testing and transmissivity analyses).
- Dissemination of the project’s research progress in collaboration meetings and international physics conferences.

This grant's funds were exhausted in December 2019, corresponding to the end of my contractual employment relationship with UAM and my direct involvement in the HK collaboration. During these ~8 months (April-December 2019) when the grant was employed to advance the status of the project, the v3 "Spanish cover" was brought from a conceptual, unproven concept that was regarded as having a backup role within the HK project at best (where the "flanged" v2.2 design was regarded as the prime design for the Spanish contribution), to being a mature and tested design tentatively regarded as having a superior potential to become the prime Spanish contribution. Several high-fidelity, realistic prototypes were constructed and partially tested. The project is nowadays moving towards its full certification through a dedicated implosion-testing campaign in the ex-JAMIC Hokkaido facilities, progressing through its optimization cycles in order to remove weight, complexity and cost while increasing robustness and reliability, as well as accommodate necessary structural refinements to simplify operational assembly and mounting procedures. The encouraging results obtained have also helped in obtaining further funding in Spain for continued project development.

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