Research Result Presentation Meeting of the ICRR Inter-University Research Program 2021

Brief report on

A05: Data Taking, Calibrations, Measurements and Analysis with Super-Kamiokande and SuperK-Gd 200.000 ¥

B01: Development and testing of cost-effective, high-performance Photo-Detector anti-implosion covers for Hyper-Kamiokande 500.000 ¥

which are follow-ups of

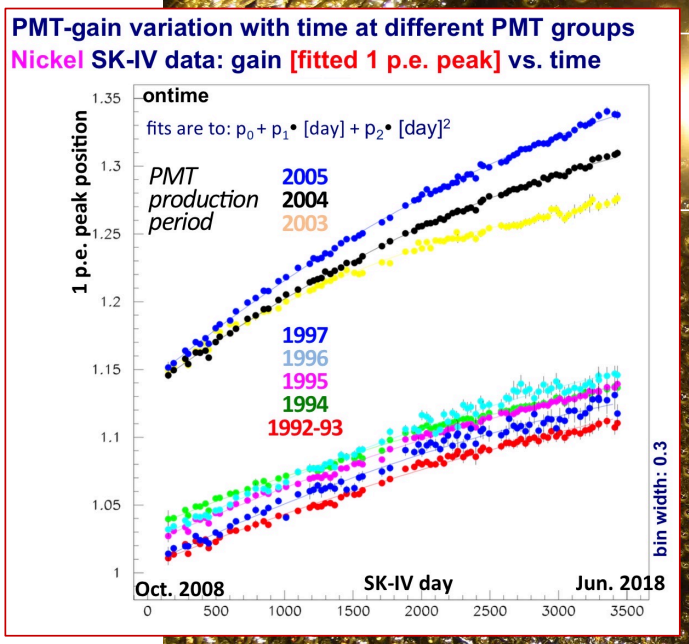
- two similar ICRR-IURP 2019 projects (the HK one had D. Bravo as IP)
- two similar ICRR-IURP 2020 projects

and hopefully predecessors of the two new ICRR-IURP 2022 projects just submitted

January 25th 2022

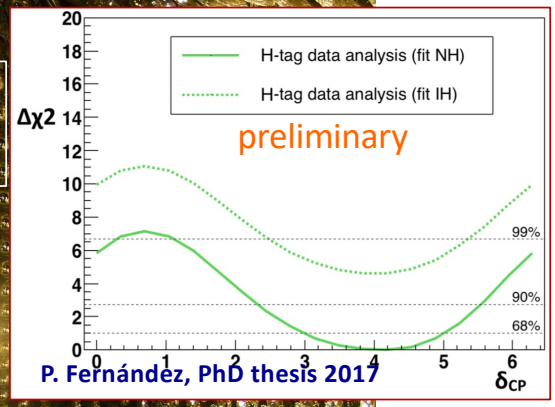
L. Labarga (University Autonoma Madrid, UAM)

UAM research in Super-K: some highlights at a glance



calibrations, detector evolution, etc.

neutron-tag in oscillation analyses



ICRR-IURP 2019: local travelling

ICRR-IURP 2020: materials for improvement of autoXenon system

ICRR-IUR 2021: Shipping SK-Gd T1.5 Gd samples to Canfranc for radio-purity investigations

Search for the Diffuse Supernova Neutrino Background

Radio-purity campaign for SuperK-Gd at Canfranc Underground Laboratory

(Units are mBq/kg, limits are at 95% CL)

CHAIN	MAIN SUBCHAIN ISOTOPE	GOX-1510-D-001	GSF-1701-D-003	GSF-1705-D-001	GSF-1711-D-171111B	GSF-1711-D-171111A	GSF-1703-A-702142	GSF-1703 B-(RGD-OSF-005)	GOX-1603-B-237	GOX-1603-B-239	GOX-1603-B-236	GSF-1604-B-1	GSF-1611-B-003	GSF-1703-B-(RGD-OSF-005)	GSF-1703-B-(RGD-OSF-005)-b	GSF-1707-B-007	GSF-1604-C-160303	GSF-1707-B-007	GSF-1710-C-170901	GSF-1710-C-170902	GSF-1710-C-170903
^{238}U	^{238}U	1672 ± 122	< 45	< 11	< 52	< 168	< 13	< 13	< 68	< 130	< 36	< 25	< 13	< 10	< 19	< 10	< 20	< 10	< 9.7	< 12	< 11
	^{226}Ra	< 2.8	0.4 ± 0.2	4.3 ± 0.6	< 1.1	2.0 ± 1.4	0.7 ± 0.4	< 0.34	< 0.9	< 1.0	< 1.4	< 0.6	< 0.3	< 0.31	< 0.54	< 0.18	< 0.64	< 0.18	< 0.19	< 0.21	< 0.21
^{232}Th	^{228}Ra	259 ± 6	28.5 ± 1.1	12.2 ± 1.0	300 ± 7	778 ± 39	< 0.39	< 0.39	< 2.7	< 2.3	< 1.4	< 0.7	< 0.3	< 0.30	< 0.74	< 0.21	< 0.67	< 0.21	< 0.24	< 0.26	< 0.30
	^{228}Th	124 ± 3	6.3 ± 0.5	2.5 ± 0.4	31 ± 2	70 ± 3	1.7 ± 0.4	< 0.28	< 2.5	< 1.4	< 0.8	0.9±0.3	< 0.4	< 0.33	< 0.43	< 0.26	0.5 ± 0.2	< 0.26	< 0.28	< 0.31	< 0.30
^{235}U	^{235}U	28.7 ± 1.5	< 1.5	< 1.0	< 3	< 4	< 1.3	< 0.77	< 1.6	< 0.8	< 1.0	< 3.1	< 0.6	< 0.69	< 0.82	< 0.3	< 0.7	< 0.3	< 0.35	< 0.41	< 0.42
	^{227}Ac / ^{227}Th	< 14	< 5.5	3.4 ± 1.4	31 ± 5	46 ± 9	< 3.1	< 2.3	< 4.3	-	-	< 6.1	< 1.9	< 1.8	< 2.0	< 1.2	< 2.3	< 1.2	< 1.7	< 1.4	< 1.6
	^{40}K	21 ± 6	< 1.0	< 1.8	27 ± 3	57 ± 4	< 8.2	< 3.2	< 4.6	< 5.3	< 3.4	< 2.1	< 1.8	< 1.5	< 2.5	< 0.9	< 1.6	< 0.9	< 0.8	< 1.0	< 0.7
	^{138}La	< 3.2	< 0.25	< 0.36	< 2.4	< 2.4	< 0.29	< 0.29	< 0.6	< 0.7	< 0.7	< 0.5	< 0.3	< 0.29	< 0.31	< 0.20	< 0.3	< 0.20	< 0.09	< 0.05	< 0.14
	^{176}Lu	5.9 ± 0.4	26.5 ± 0.8	6.1 ± 0.4	< 1.2	4.3 ± 0.6	2.6 ± 0.3	< 0.29	< 0.8	< 0.7	< 1.6	0.4±0.3	0.4±0.1	< 0.46	< 0.41	0.4±0.1	< 0.4	0.8 ± 0.1	0.13± 0.03	0.11± 0.04	< 0.14
	^{134}Cs	-	-	-	-	-	-	-	< 0.24	< 0.4	< 0.23	< 0.24	< 0.09	< 0.09	-	< 0.06	< 0.1	< 0.06	< 0.08	< 0.06	< 0.07
	^{137}Cs	-	-	-	-	-	-	-	< 0.3	< 0.34	< 0.30	< 0.24	< 0.16	< 0.12	-	< 0.12	< 0.1	< 0.12	< 0.13	< 0.10	< 0.11

J. Pérez, PhD thesis 2017

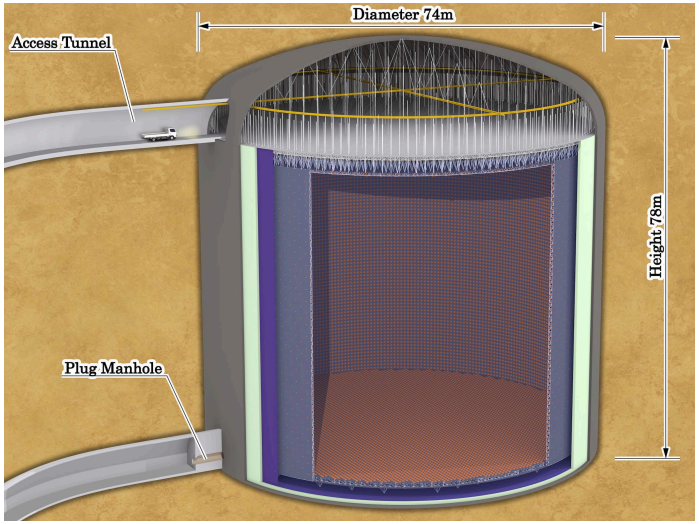
Excellent $Gd_2(SO_4)_3$ achieved, within specifications within experimental limits; Now preparing for mass production screening.

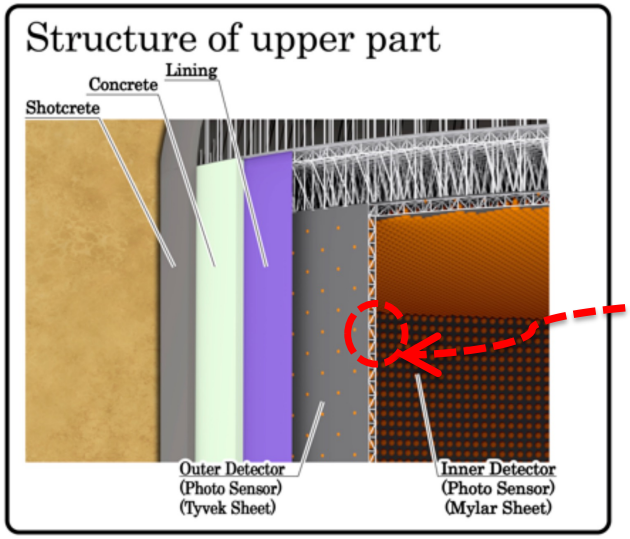
Name of Samples analyzed [MATerial*-date-Company-lot]

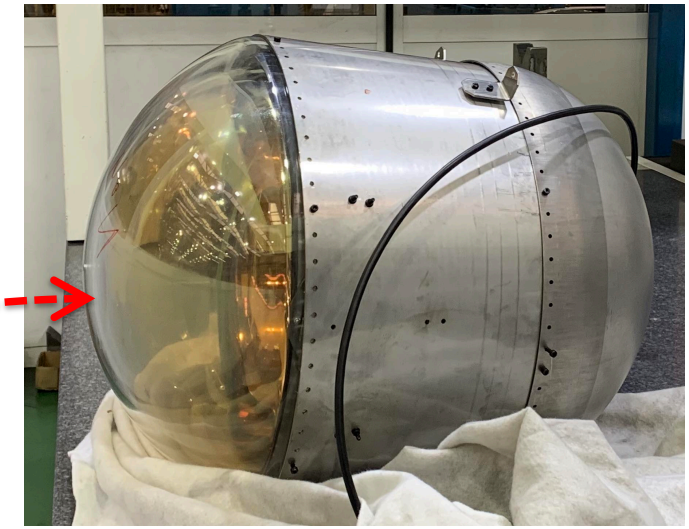
*GSF: $Gd_2(SO_4)_3$ GOX: Gd_2O_3

UAM research/works in Hyper-Kamiokande: two highlights

basic in HK are the photo detection system units

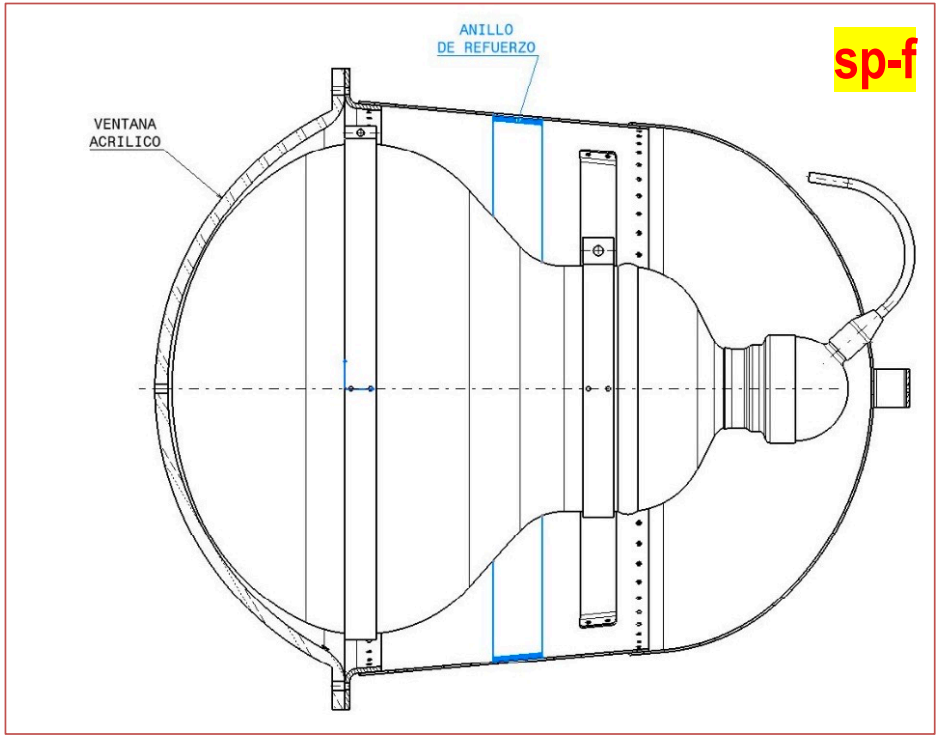






- fantastic PMT R12860-HQE **40.000** units at most
- problem with chain reaction after accidental implosion of one PMT: the case of SK
- need new implosion mitigation cover (SK: 40 m, HK: 70 m)
- careful dessign needed: efficiency, noise, safety etc.
- **UAM++ are working hard in making them a reality**

the proposed design of sp-nf, sp-f cover; general characteristics



- sp-nf is, probably, the simplest approach to a PMT anti-implosion capsule. It features flanged acrylic window and main attachments using rivets instead of bolts.
- sp-f differs sp-nf on the regular, flanged, acrylic window and the additional L-shaped corona as interface

implosion test in Hokkaido

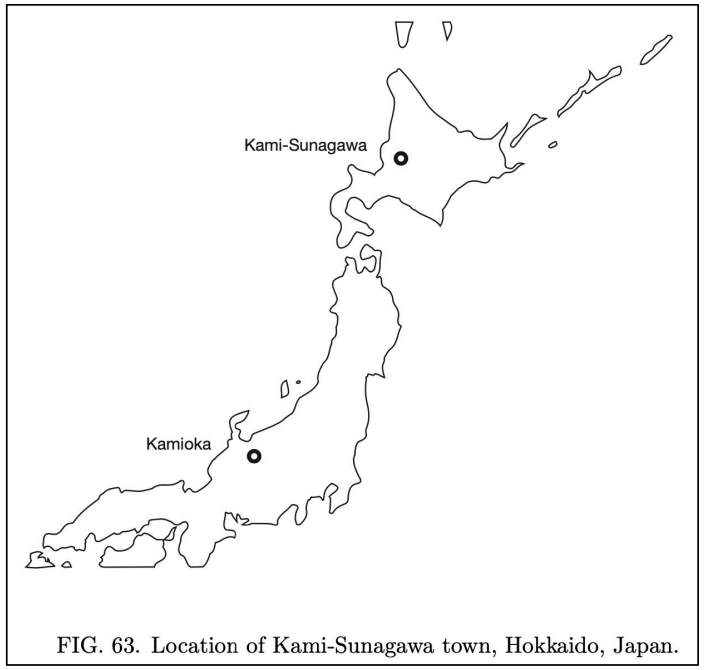
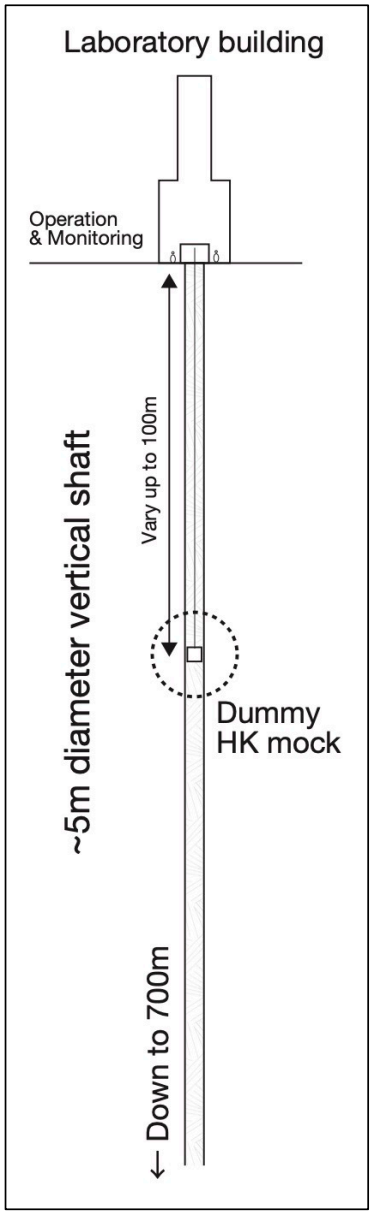
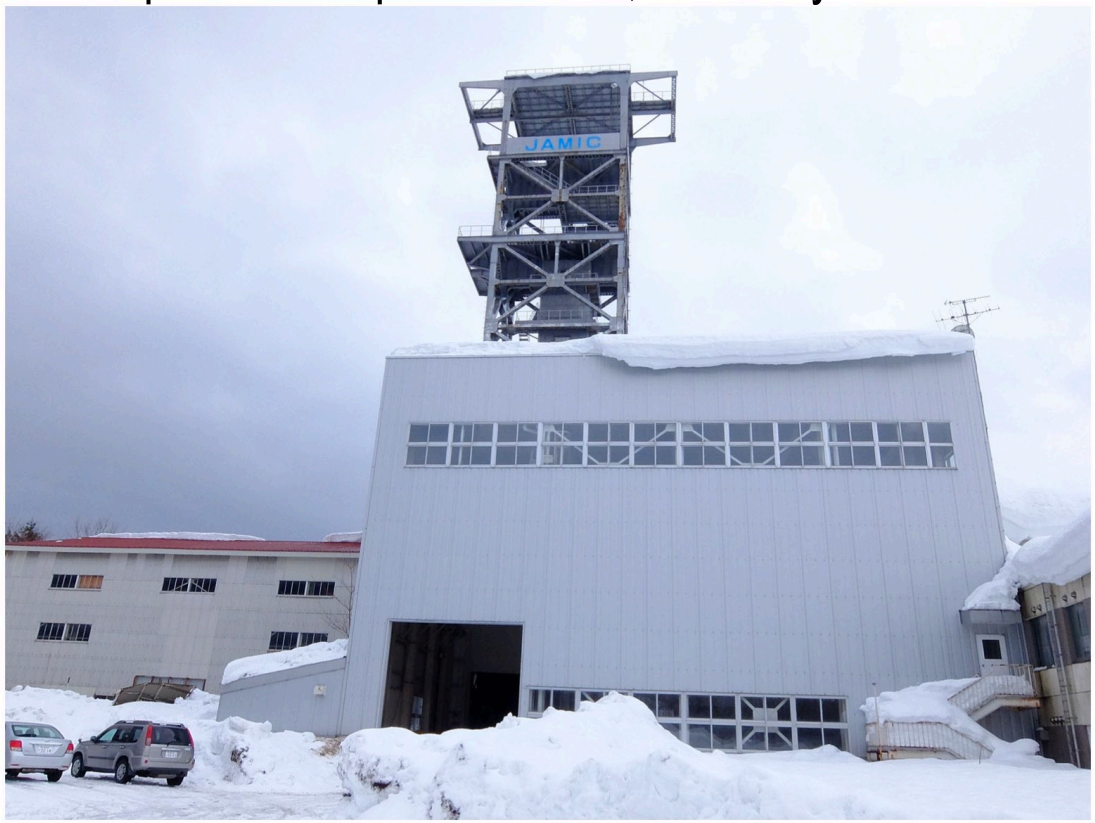


FIG. 63. Location of Kami-Sunagawa town, Hokkaido, Japan.

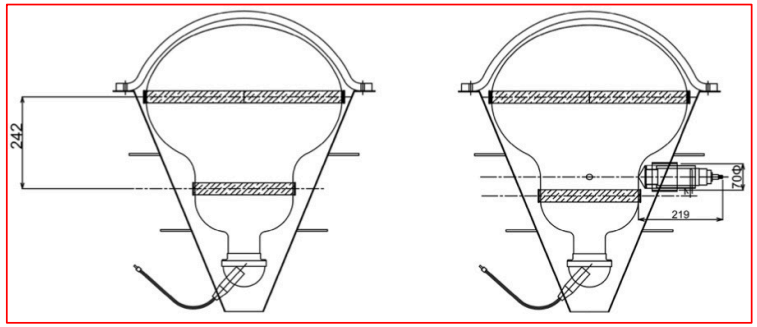


study implosion in real conditions: ~80 m depth

At previous implosion tests, February 2018:



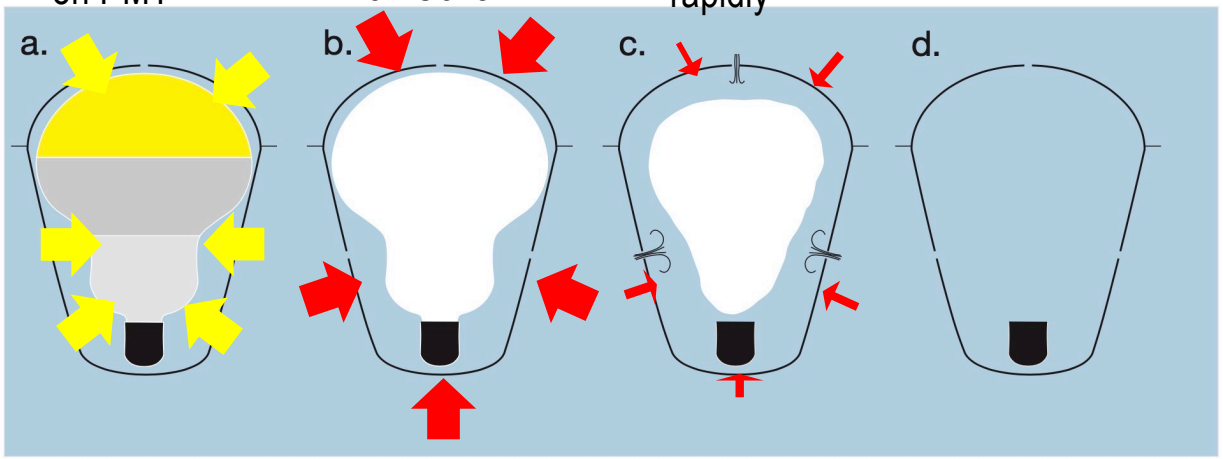
implosion test in Hokkaido

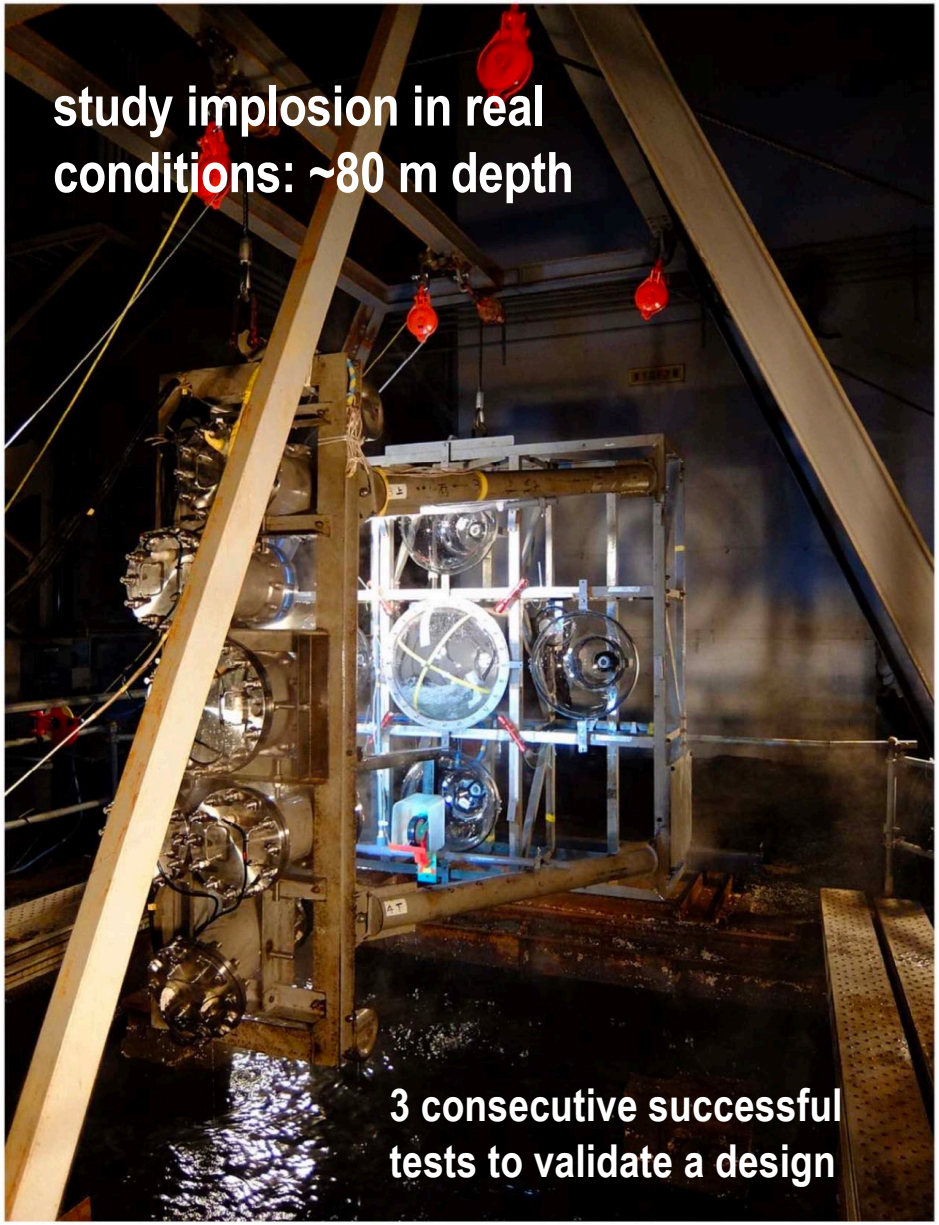


full constant pressure on PMT

full sudden pressure on Cover

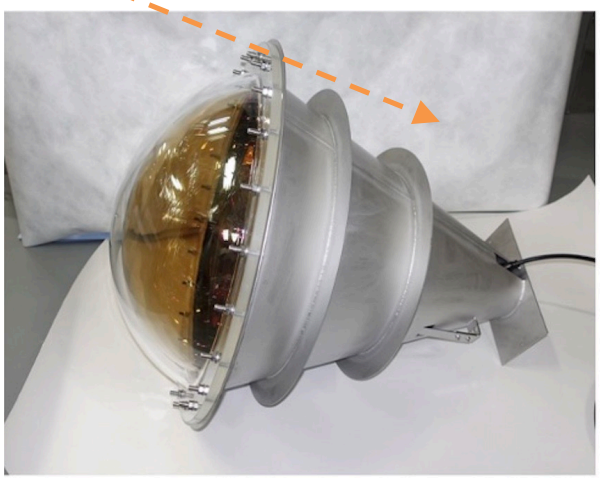
pressure reducing rapidly

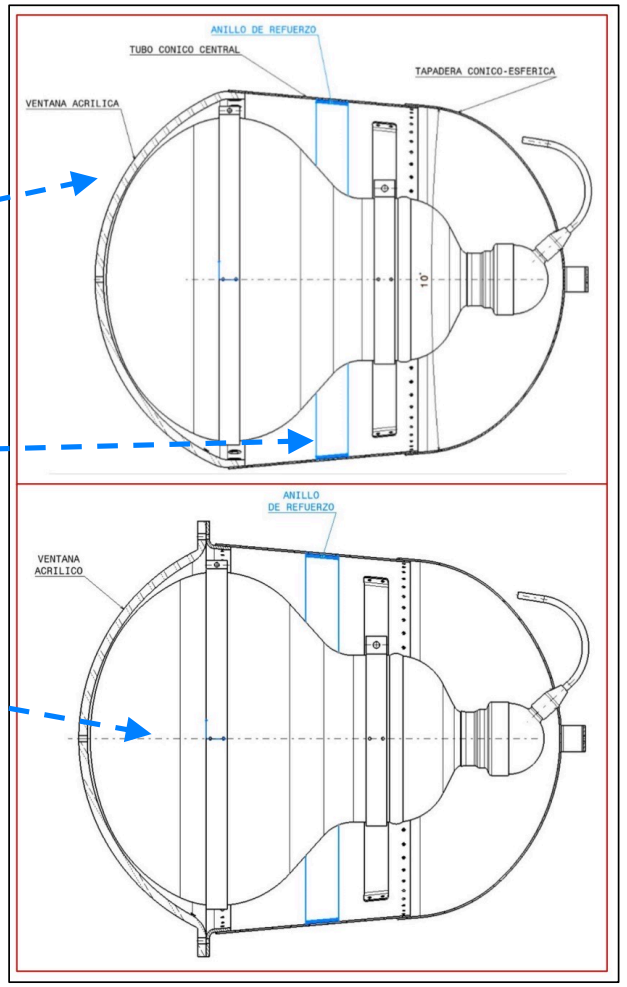




Implosion tests as certification process to propose the HK-cover design to HK [@ mid. March]

- 3 x **Sp**-nf (V3.2) units
- 3 x **Sp**-nf (V3.2) units+ reinforcement
- 3 x **Sp**-f (V2.3) units
- 3 x **Jp-sus** cover units
- 3 x **Jp-resin** cover units





9 flanged acrylic domes needed for the tests; used ICRR-IURP 2021 to purchase them

Summary

UAM has been granted with two ICRR-IURP 2021 projects:

A05: Data Taking, Calibrations, Measurements and Analysis with Super-Kamiokande and SuperK-Gd

B01: Development and testing of cost-effective, high-performance Photo-Detector anti-implosion covers for Hyper-Kamiokande

they are follow-ups of two similar ICRR-IURP 2019 projects (the HK one had D. Bravo as IP), another two 2020 … and hopefully predecessors of the two new ICRR-IURP 2022 projects just submitted

ICRR-IURP is an extremely useful program; it has helped UAM in its research with SK and HK by funding

- Research trips inside Japan
- Preparations of a new auto-monitoring system for Super-Kamiokande
- Finite Element Modeling of its design of an acrylic window without flange
- Acquisition of HK PMTs with no vacuum for mechanical tests
- **Acquisition of HK flanged acrylic windows for the final test program of the sp-cover**
- **Logistics transport of SK-Gd T1.5 Gd samples to Canfranc lab. for RI investigations**
- **…**

Thank you very much ICRR for your Science and your support !

Additional Slides