

Interest of **Spanish** Groups in Hyper-Kamiokande

L. Labarga (UAM) [Spanish IBR representative]

Spain and the Japanese neutrino program:

- 🏆 **Kamiokande**, ~ 1983 → 1996
- 🏆 **Super-Kamiokande**, ~1996 →
 - *ν s are massive,*
 - *search for p -decay*
 - *search for SN relic neutrino **SuperK-Gd***

UAM joins in 2008

- **next: Hyper-Kamiokande**, ~ 2026 →
 - *Origin of ν mass, anti-/matter asymmetry*
 - *ν astrophysics: Supernovae, DSNB, others*
 - *proton decay, Grand Unification*

UAM since beginning

- ✓ Strong contribution from Canfranc U. Laboratory
- ✓ Possibility to increase participation in future

- DIPF (San Sebastián) “confirmed”
- USC (S. Compostela), IFAE (Barcelona), ...? “maybe”

with neutrino beams:



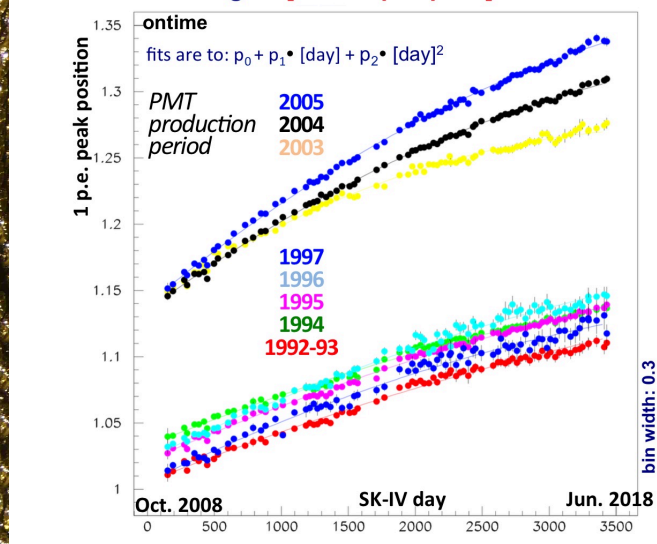
Spain & Super-Kamiokande: since 2008

funding mostly from EU, UAM, Japan

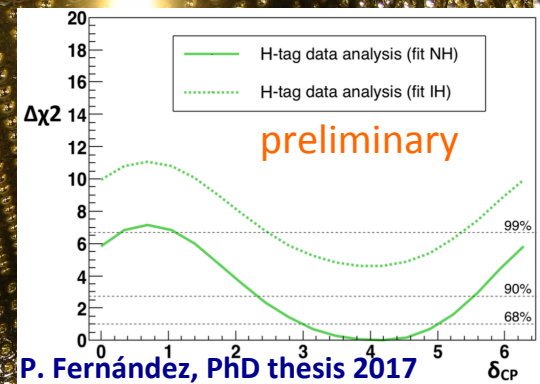
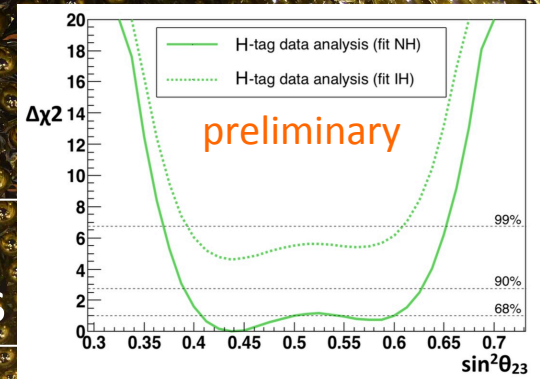


calibrations,
detector evolution, etc

PMT-gain variation with time at different PMT groups
Nickel SK-IV data: gain [fitted 1 p.e. peak] vs. time

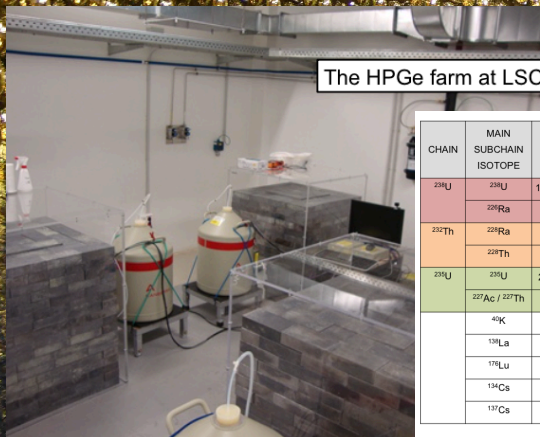


neutron-tag in
oscillation analyses



P. Fernández, PhD thesis 2017

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



The HPGe farm at LSC

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	²³² 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	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	¹⁷⁶ Lu	5.9 ± 0.4	28.5 ± 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	< 0.1	< 0.24	< 0.23	< 0.24	< 0.24	< 0.24	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.07
¹³⁷ Cs	¹³⁷ Cs	-	< 0.3	< 0.34	< 0.30	< 0.24	< 0.16	< 0.12	-	< 0.12	< 0.12	-	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.11

J. Pérez, PhD thesis 2017

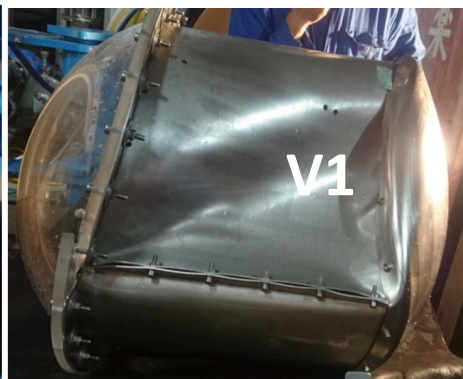
Excellent Gd₂(SO₄)₃ achieved, within specifications within experimental limits; Now preparing for mass production screening.

Name of Samples analyzed
[MATerial]-date-Company-IoI
*Gsf: Gd₂(SO₄)₃; GOX: Gd₂O₃

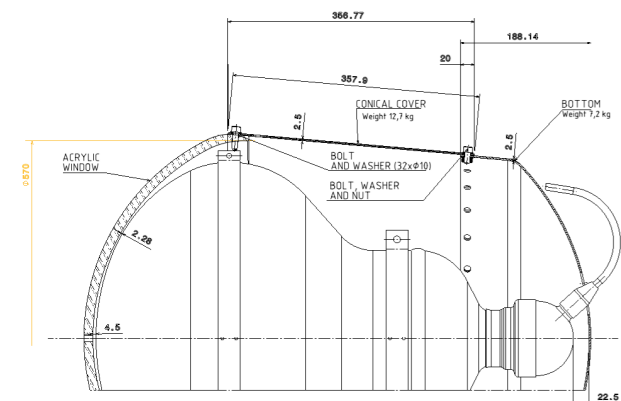
Current activities of Spain in Hyper-Kamiokande

funding from EU, UAM, Japan

- Relatively large UAM contribution to project proposal just approved
- working on simpler/cheaper approach to **anti-implosion covers for the PMTs**
- Already V1, V2 designed, prototypes made in Spain; tested in Spain & Japan



→ go to V3, it implies as well acrylic window modification



Potential Action Items for Spain in Hyper-Kamiokande

- short-medium term:
 - ✓ to **continue our R&D on low cost PMT cover** (*T. Aratz ...*)
 - now: iterations to optimize flangeless acrylic dome designs, fabricated in Japan and/or Italy (*Kuraray Tr. Co., Evonik ...*) .
 - summer 19: 3rd testing campaign (V3) in Spain and Japan
 - Near future: refinement of flangeless, lower-weight and lower-complexity stainless steel cover body
 - ✓ **radio-purity screening** campaigns at **Canfranc Underground Laboratory**, LSC (large experience with SK-Gd)
 - ✓ R&D on **attachment system PMT-Cover-Structure**
 - ✓ Exploring **low-radioactivity glass providers** in Europe, through Spanish glass-makers and screening facilities in the LSC. Option to build the PMT bulbs too?
- mass production; in all cases is **XY000** items (maximum ~40000):
 - ✓ anti-implosion cover for PMT
 - ✓ ancillary mechanical parts for PMT-Cover-Structure
 - ✓ DAQ etc. electronic boards (for the time being only production)