TG11: overview and γ ray screening

W. Hampel (MPIK Heidelberg) for Task Group 11

- Material screening and purification results for GERDA

  γ ray screening results from Hades and LNGS

  Radon emanation results → ~~G. Zuzel~~ H. Simgen

  Radon in Argon → H. Simgen

- Low-level instrumentation for material screening in GERDA

  NPL Proficiency Test Exercise 2007

  News from MPIK, Baksan, Hades and LNGS

  Status of GeMPI 3 and GeMPI 4 → M. Laubenstein

  Status of the Radon Monitor → J. Kiko

γ ray screening measurements for GERDA in the last four months

Note: no samples screened at Baksan and MPIK in this period because of renovation works

Detector	Sample description	Type of equipment / used for	Mass
LNGS-GeMPI	Axon Ag plated Cu wire 50 Ω	Coax cable 50 Ω	80 g
	Vaqtech 1-CC-0712 50 Ω	Coax HV cable 50 Ω	106 g
	Habia Ag plated Cu alloy wire	Coax cable 50 Ω	3.158 kg
	Cuflon (with protective cover)	Teflon covered with Cu	1.074 kg
	Vaqtech 1-CC-0710 *)	Coax HV cable 50 Ω	
	Cuflon (without protective cover) *)	Teflon covered with Cu	
LNGS-GeMi	Concrete drilling piece #1	Concrete GERDA foundation	163 g
	Concrete drilling piece #2	Concrete GERDA foundation	116 g
LNGS-GePV	Mapei Ultraplan Maxi	Self-leveling floor GERDA foundation	139 g
HADES	PFA-PTFE 5 kV	HV cable	295 g
	NOMEX 464 yarn	for cables in cryostat	167 g
	Transistors	for LArGe setup	9 g
	Welding rods sample #1	for cryostat welding (not used)	4.043 kg

*) measured and under analysis

Screening in HADES of steel plates for cable chain

Status after 11 days => "Guideline values" measurement still ongoing

	Massic Activity mBq/kg	Uncertainty mBq/kg
Ra-226	0.76	0.2
Ra-228	0.6	0.3
Th-228	0.35	0.2
K-40	1.64	0.61
Co-60	10.7	0.6
Cr-51	4.3	0.9
Co-58	0.14	0.06
Mn-54	1.1	0.1

from Mikael Hult

Screening in HADES of welding rods sample #2
(actually used in the cryostat welding)

Status after 15 days => "Guideline values" measurement still ongoing
Measured without prior cleaning

	Massic Activity mBq/kg	Uncertainty mBq/kg
Ra-226	0.91	0.3
Ra-228	< 0.3	
Th-228	< 0.5	
K-40	< 1.6	
Co-60	2.0	0.2
Co-57	0.22	0.08
Co-58	0.25	0.06
Mn-54	0.90	0.11

for comparison:

^{228}Th and ^{60}Co specific activities of welding rod sample #1:

6.7 ± 1.2 mBq/kg

131 ± 3 mBq/kg

from Mikael Hult

γ ray screening results for cable materials

Cable sample	Detector	Specific activity [mBq/kg]							
		^{228}Th	^{228}Ra	^{238}U	^{235}U	^{226}Ra	^{40}K	^{108m}Ag	^{110m}Ag
Cuflon	**G**	< 7.2	< 6.5	< 200	< 5	< 9.3	61 ± 16		
Teflon coated HV cable	**H**	6 ± 2	4.5 ± 1.5	< 9	< 3	< 1.3	58 ± 8	1.8 ± 0.3	7.0 ± 1.0
Atlas Axon	**G**	< 12	< 15	< 530	< 12	< 12	230 ± 60	6.6 ± 2.1	
Habia Teflon	**G**	< 4.7	< 6.9	< 59	< 1.4	< 1.8	400 ± 40	0.78 ± 0.24	1.3 ± 0.2
Caburn 1-CC-0712	**G**	< 11	< 8	< 350	< 8.4	< 11	610 ± 80	5.0 ± 1.2	
Caburn 1-CC-0710	**C**	< 11	< 15			< 12	< 100		
Kapton flat cable *	**G**	< 4.0				9 ± 6	130 ± 60		
Kapton pure (Dupont) *	**G**	1.4 ± 0.7	< 1.0	< 27	< 1.1	17 ± 8	< 5.4		

* earlier measurements, included for comparison

G measured with GeMPI at LNGS
C measured with GeCris at LNGS
H measured at Hades

Phase I: no problem (cable material not close to the crystals)

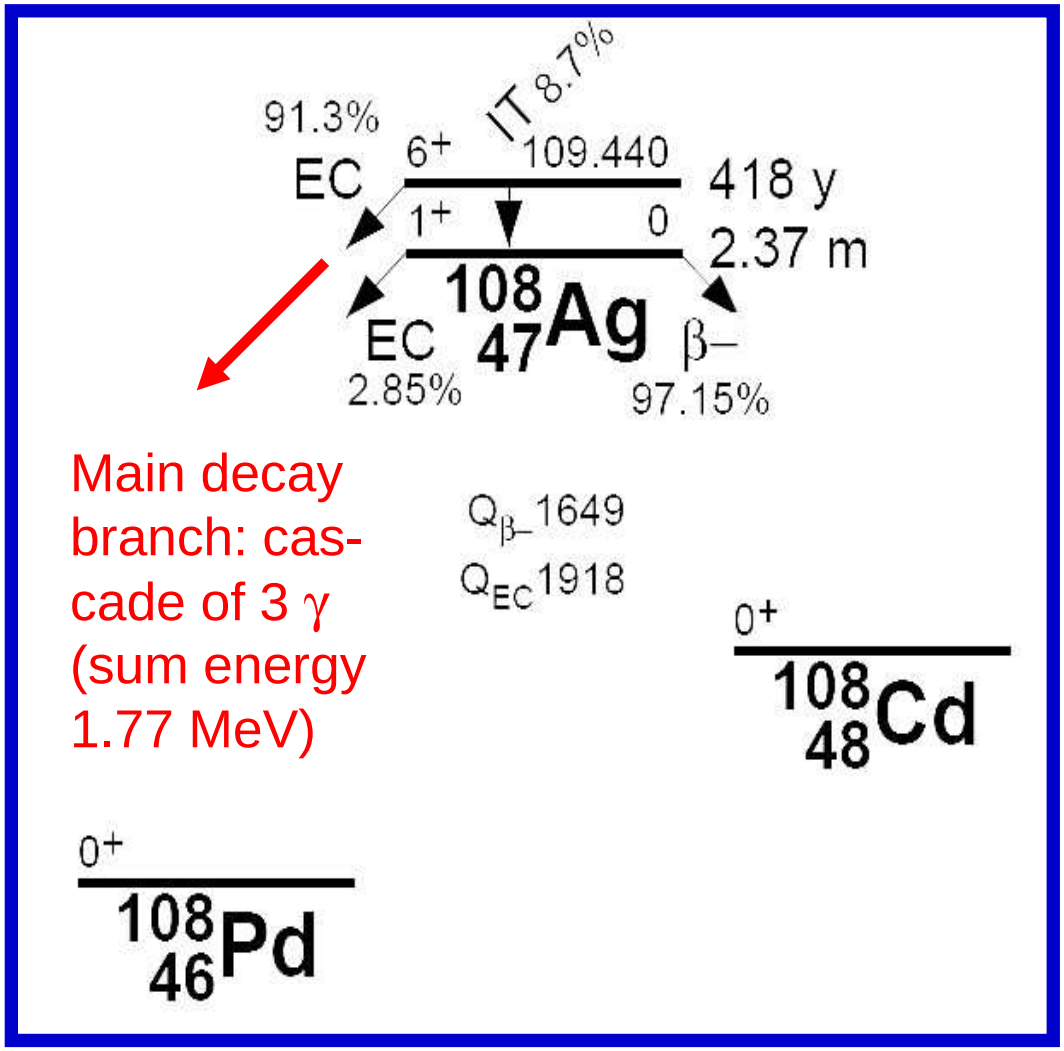
Phase II: 2 mBq/kg of both ^{226}Ra and ^{228}Th → BGI $(1.5–2.0)\cdot10^{-3}$

from Report GSTR-05-019 (K. Kröninger and X. Liu)

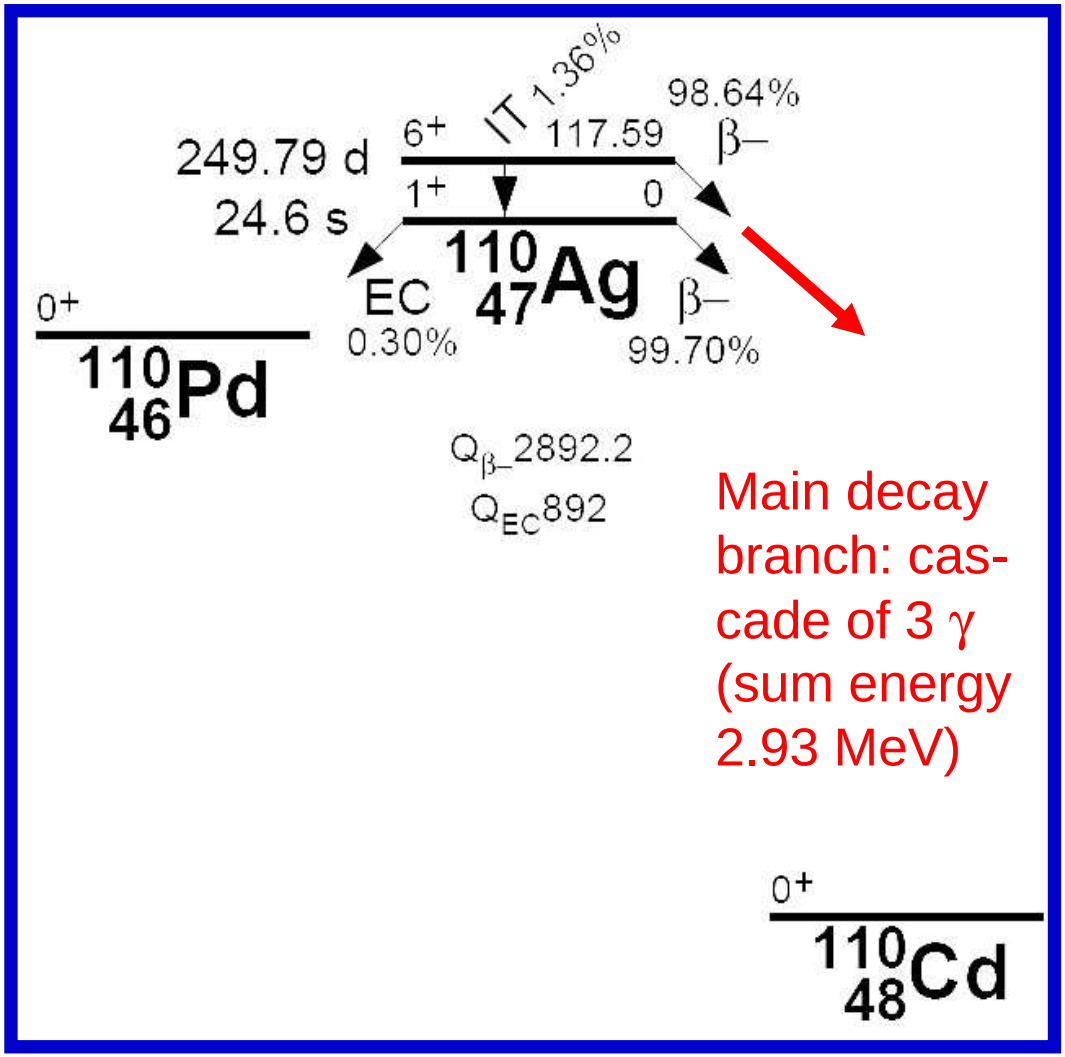
→ not far away from final goal

Two long-lived silver isomers: ^{108m}Ag (halflife 418 years)

^{110m}Ag (halflife 250 days)



Main decay branch: cascade of 3 γ (sum energy 1.77 MeV)



Main decay branch: cascade of 3 γ (sum energy 2.93 MeV)

Production of ^{108m}Ag and ^{110m}Ag by thermal and epithermal cosmic ray neutrons

Reaction	Halflife of product	Cross section	Resonance integral
		thermal	epithermal
^{107}Ag (n,γ) ^{108m}Ag	418 a	1.0 barn	not known
^{109}Ag (n,γ) ^{110m}Ag	250 d	4.4 barn	69 barn

Measured at LNGS (outside the tunnel):

Thermal neutron flux (< 0.3 eV) $1.4 \cdot 10^{-3}$ neutrons/cm^2·s

Epithermal neutron flux (0.3 – 300 eV) $6.9 \cdot 10^{-3}$ neutrons/cm^2·s

} A. Rindi et al. NIM A272(1988)871

→ Specific saturation activity ^{108m}Ag : > 4 mBq/kg Ag

^{110m}Ag : ~ 1300 mBq/kg Ag

Measured ^{108m}Ag and ^{110m}Ag activities in cables can be explained if the Ag content in some samples is of order 1 % (and if the resonance integral of ^{107}Ag is at least similar to that of ^{109}Ag).

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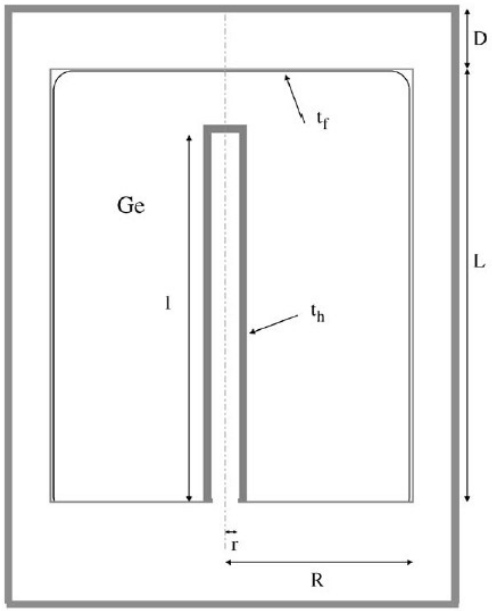
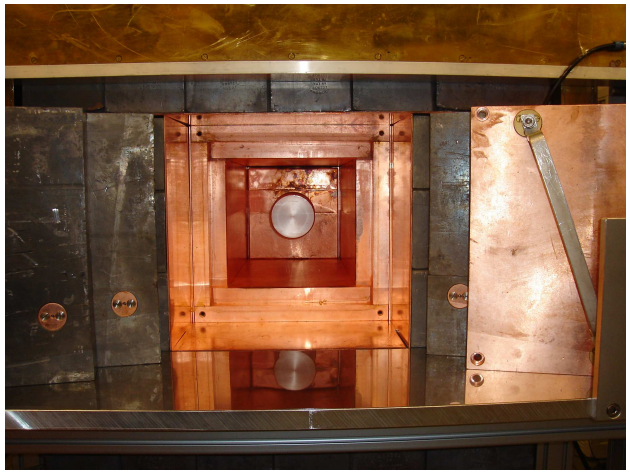
NPL National Physical Laboratory

Counting efficiency determination for γ ray sample screening:
mostly based on MC simulations of detector and sample geometry



Needed for such MC simulations

(1) outer dimensions of the Ge crystal
(2) size and location of the inner hole
(3) thickness of the dead layer
(4) position of the crystal within the cryostat



CORRADO detector

For the CORRADO detector
at MPIK Heidelberg:
(2) and (3) not well known

→ Measure low and high energy γ ray sources and compare results with MC calculations varying the parameters of (2) and (3) until a good fit was obtained

Dusan Budjás

Environmental Radioactivity Proficiency Test Exercise 2007

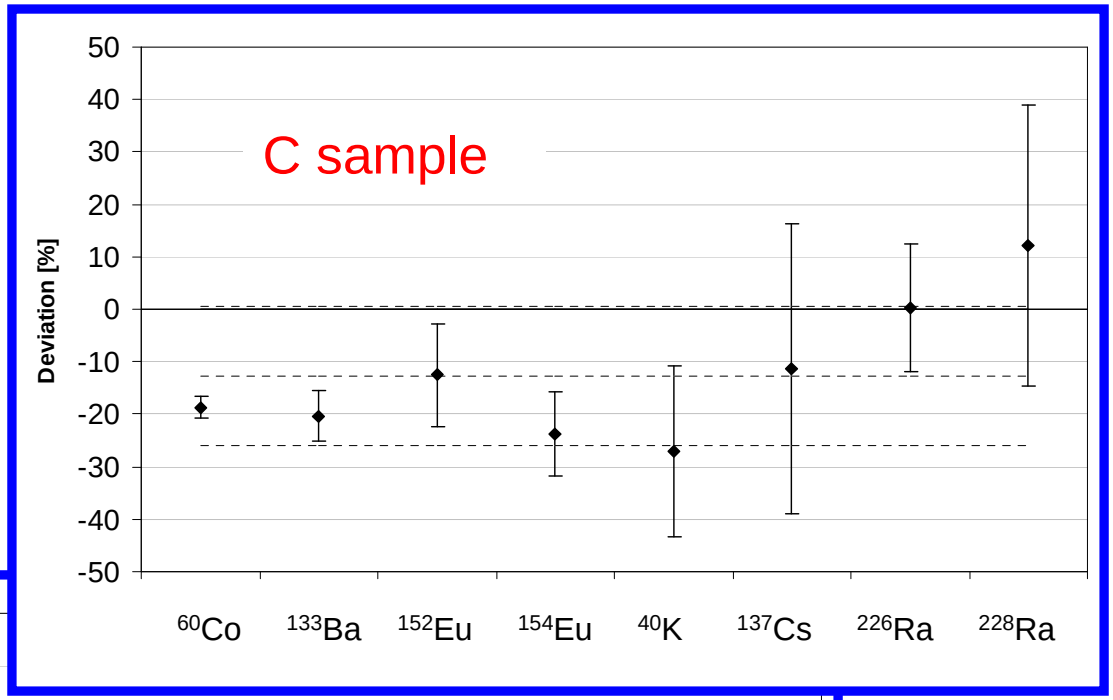
'C' sample: crushed concrete from dismantled nuclear power-plant

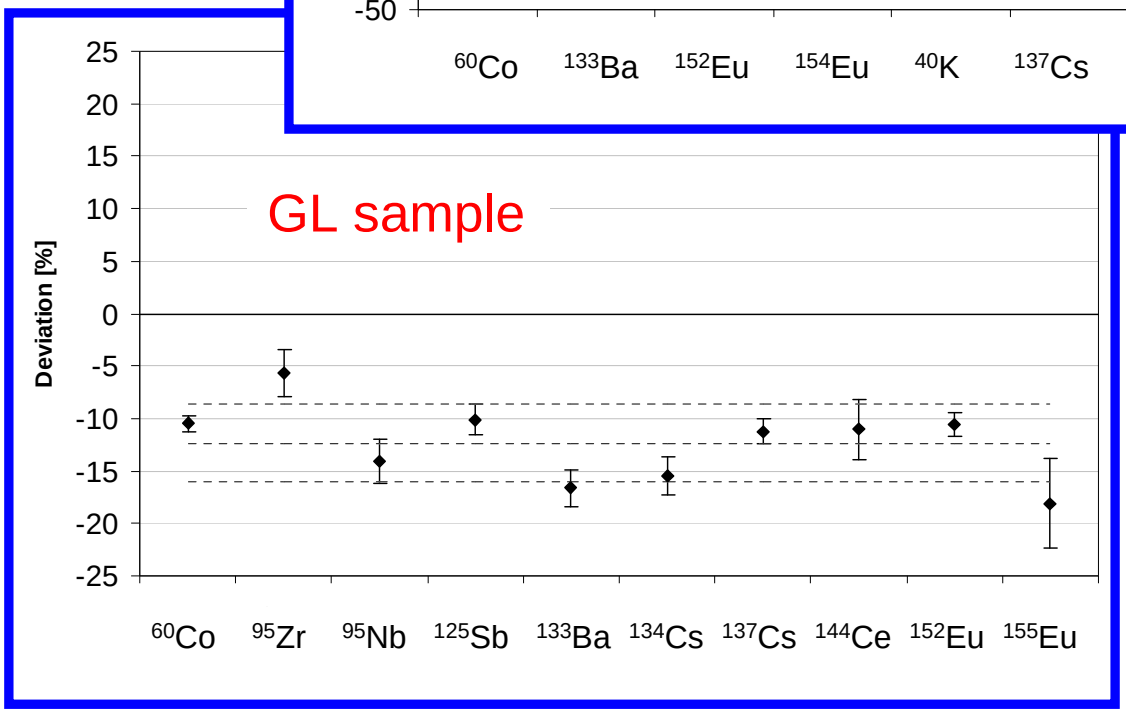
'GL' sample: low-radioactivity liquid solution consisting of 10 γ-emitting radionuclides

This (preliminary) optimized geometry of the CORRADO detector at MPIK was used in order to evaluate measurements of two NPL samples:

Result: on the average: -12% difference to the reference values for both samples was obtained

→ still a better characterization of the CORRADO detector is needed and is currently under way





from Dusan Budjás

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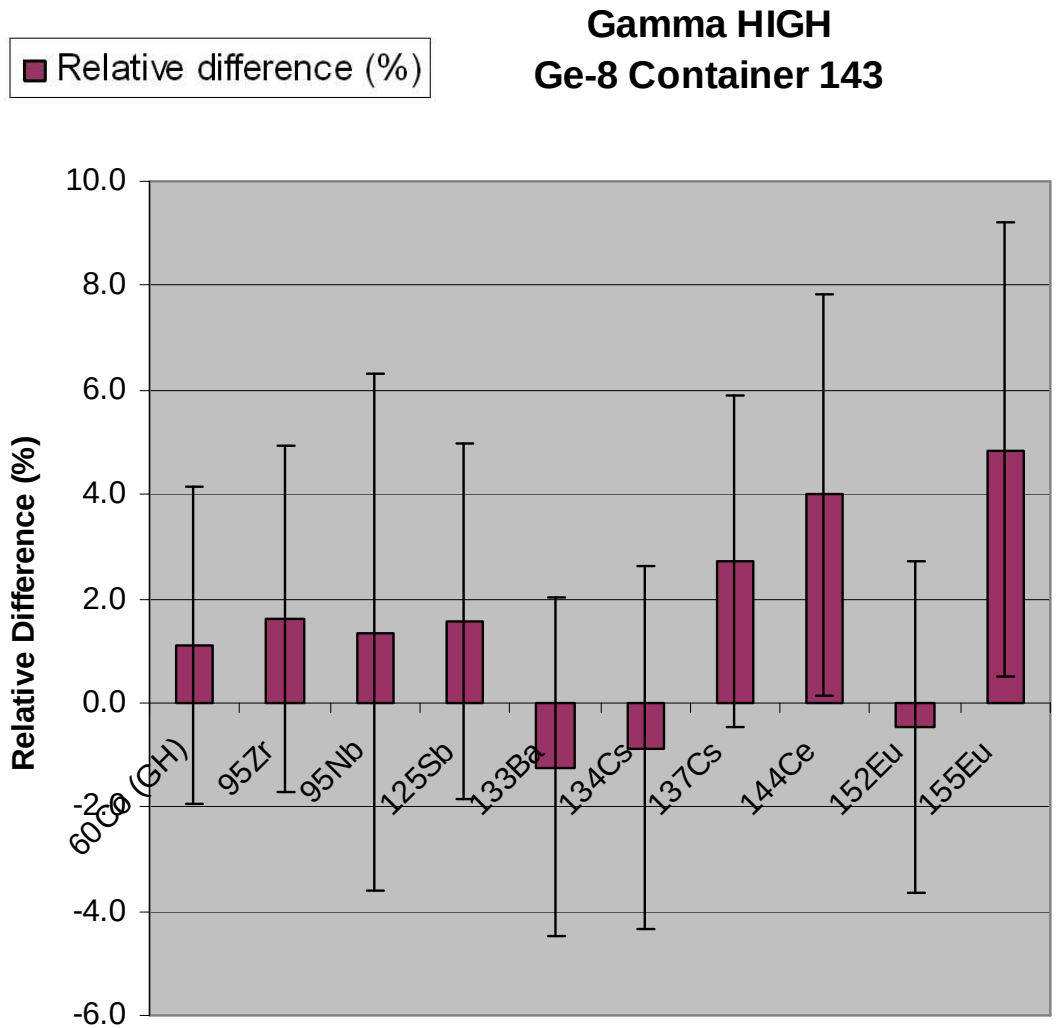
IRMM results



- Average deviation: +1.5%
- 8 out of 10 overlap with reference value using coverage factor 1
- All overlap with reference value using coverage factor 2
- All radionuclides correctly identified

Measured in HADES on Detector Ge-8,

The Eu-155 and Ce-144 results drive the average difference up. These two values are high since the detector used has a thin deadlayer and this means that he coincidence summing effect with low-E γ-rays and X-rays is significant. This was not properly corrected for since those two decay schemes are not yet incorporated in computer models.

By: Mikael Hult, Joël Gasparro, Gerd Marissens

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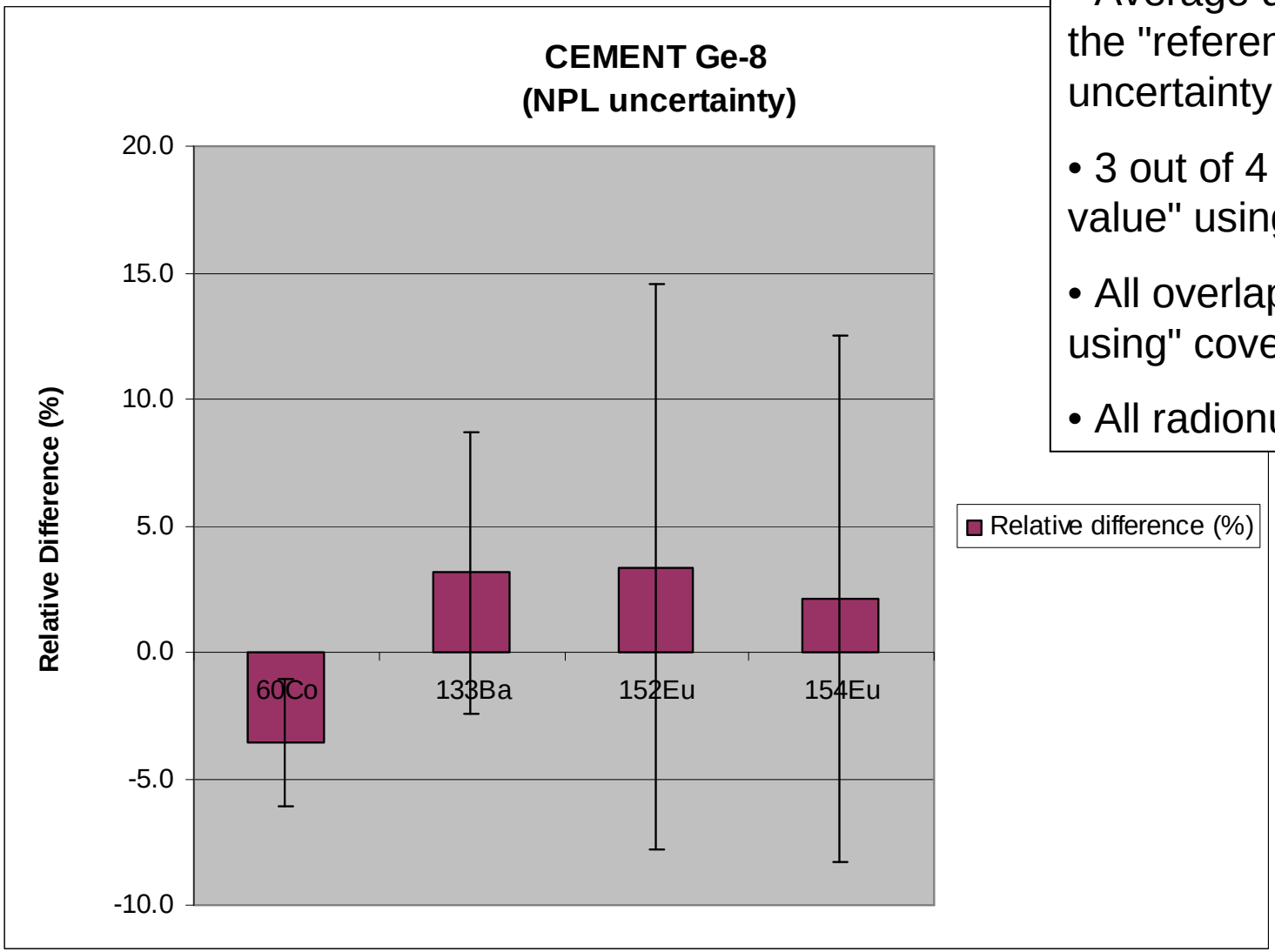
IRMM results



- Average deviation: +1.2% Note that the "reference values" have higher uncertainty than our reported values!
- 3 out of 4 overlap with "reference value" using coverage factor 1
- All overlap with "reference value" using" coverage factor 2
- All radionuclides correctly identified

By: Mikael Hult, Joël Gasparro, Gerd Marissens

News from γ ray screening at MPIK and Baksan

Good news from MPIK:

Renovation of the LLL almost completed. Resume γ ray screening at the beginning of December (as promised in Geel)

Bad news from MPIK:

Problems with DARIO, Liquid N_2 filling tube blocked, Detector thus has been warmed up. Must be removed from shielding.

Good news from Baksan:

As reported in Geel, the 4 HPGe setup has been renovated in the last few months. Currently a background measurement is running. γ ray screening for GERDA will be resumed shortly

News from γ ray screening at HADES

First sandwich measurements for GERDA coming up soon

Sandwich detector setup at HADES

Scheduled for sreening with the sandwich detector: electronic parts for the PMTs of LArGe

- **2 types of capacitors (small and large) and 1 type of resistors.**
- **For one PCB about 0.14 g of small capacitors, 2.5 g of large capacitors and 0.11 g of resistors will be used.**
- **Required sensitivity: ^{228}Th/^{228}Ra is 4 Bq/kg and about one order of magnitude more relaxed for ^{226}Ra and ^{40}K.**
- **The total mass of the available components is about 100 g.**

from Mikael Hult

News from γ ray screening at LNGS

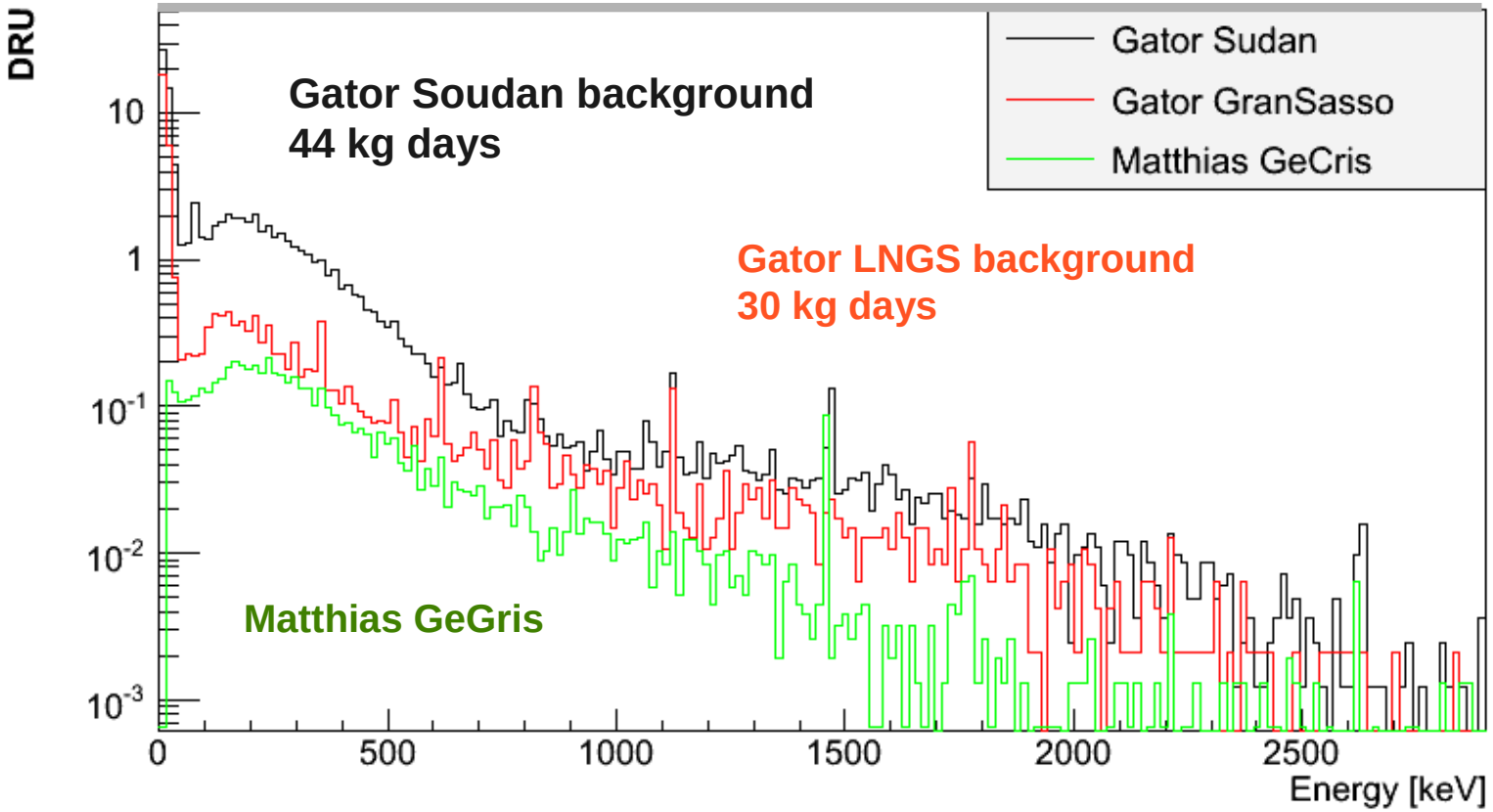
GATOR HPGe-Detector at LNGS

- **Ultra-low background, 100 % efficient (2.2 kg) HPGe-spectrometer**
- **Shield:** 5 cm of OFHC Cu from NA; 20 cm Plombum Pb (inner 5 cm: 3 Bq/kg ^{210}Pb), air-lock system and Nitrogen purge against Rn

from Laura Baudis

GATOR HPGe-Detector at LNGS

- **First background spectrum: < 1 event/kg d keV above 40 keV**
- Goal: screen XENON100 and GERDA materials



For comparison:

Gator	2.2	kg
GeCris	2.47	kg
GeMPI	2.15	kg

GeCris background:

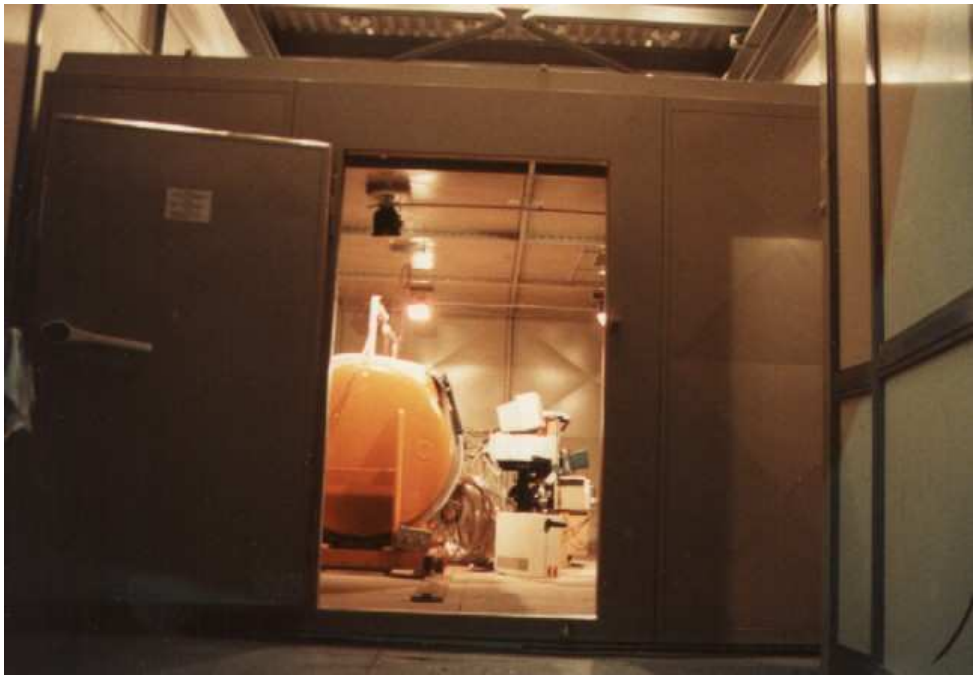
a factor of 3 higher than that of GeMPI

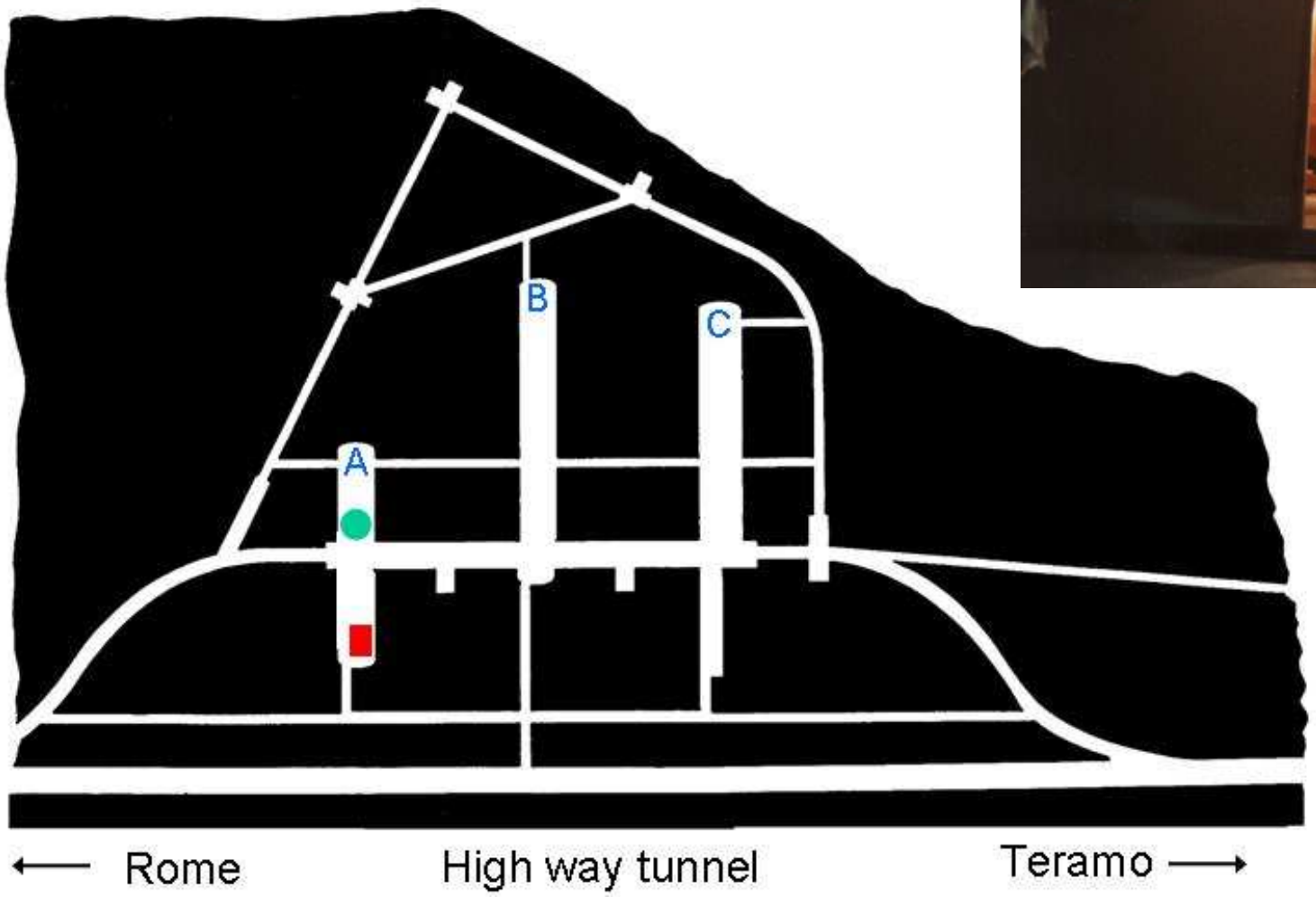
(40 – 2700 keV)

from Laura Baudis

Location of GATOR:

in the Faraday cage of the former GALLEX/GNO counting lab in hall A of LNGS





GERDA

former GALLEX/GNO counting lab

Paper in preparation

Measurements of extremly low radioactivity levels in stainless steel for the cryostat in GERDA

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