GERDA Cryostat Rn emanation

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General remarks

- Tolerable rate: ~8 (14) mBq $\rightarrow$ 10^{-4} cts/(kg·keV·y) assuming homogenous Rn distribution (GSTR-07-020)
- The cryostat and the lock to be considered as a one system?
- Is the assumption on homogenous distribution justified in the presence of e.g. permanent heat transfer causing convection?
- What to do in case of high Rn emanation rate?
  - additional cleaning
  - testing emanation at low temperatures (adsorption)
  - Rn sweepers (M. Wojcik)

Measurement procedure

- Closing the cryostat using a metal-sealed (Helicoflex gasket) flange equipped with necessary ports
- Pumping down to min. 1 mbar (removal of air-born Rn) and filling with pure nitrogen (slight overpressure) twice
- Waiting ~1-2 weeks
- Adding cold and Rn-free nitrogen to mix the gas inside the cryostat
- Extracting two samples of some 10 m^3 and scaling the measured activity to the full volume
- Total time needed for a full test: **min. 14 days**

Measurement at SIMIC

- Nov. 2007 – mostly checking the „order of magnitude"
- After first cryostat cleaning. Outer vessel not yet ready
- No N_2 filling prior to the extractions (no gas mixing inside)
- Extracted samples send to HD for counter filling and counting

Unit	Description	Emanation rate [mBq]
PC storage tanks	V = 114 m^3 S = 140 m^2	TK2: 45 ± 8 TK4: 25 ± 3
EP North	V = 0.7 m^3	~ 25
Linde (HP)	V = 3 m^3	2.7 ± 0.3
SOL	V = 16 m^3	65 ± 6
Linde (GS)	V = 6 m^3	3.5 ± 0.2

Measurement at SIMIC

- 1st test (23 m^3 at STP)
  A_{tot} = (16.9 ± 1.6) mBq
- 2nd test (45 m^3 at STP)
  A_{tot} = (29.8 ± 2.4) mBq
- Since the second test seemed to be more representative we assumed the second result to be more realistic

$$A_{tot} \sim 30 \text{ mBq}$$

1st measurement at GS

- March 2008. After completion (IV + OV) and additional cleaning at SIMIC
- Cryostat prepared at SIMIC (filled with Rn-free N_2)
- Transportation time to GS used for Rn emanation (~1 week)
- Measurements were performed immediately after installation in Hall A

1st measurement at GS

- Cold and Rn-free N_2 added to the cryostat prior to the extractions (gas mixing inside)
- LAr used for cooling of the adsorption traps (much smoother extractions)
- Extracted samples processed and counted at GS

1st measurement at GS

- 1st sample (44 m^3 at STP):
  A_{tot} = (13.6 ± 2.5) mBq
- 2nd sample (40 m^3 at STP):
  A_{tot} = (13.7 ± 2.8) mBq

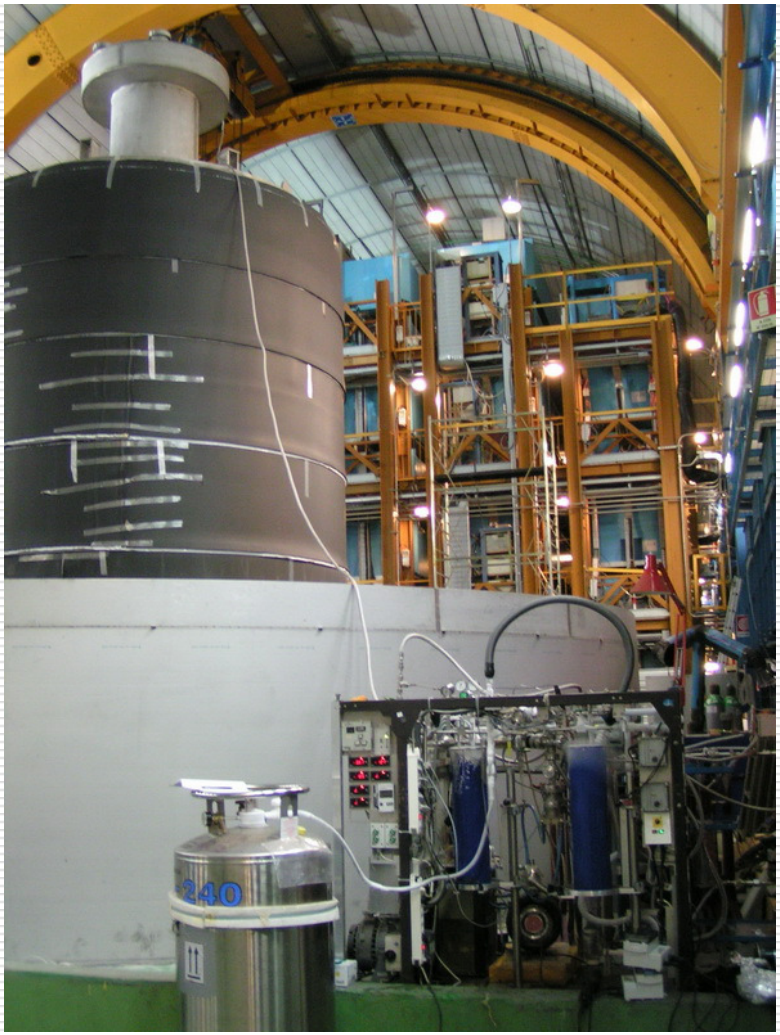
Average:

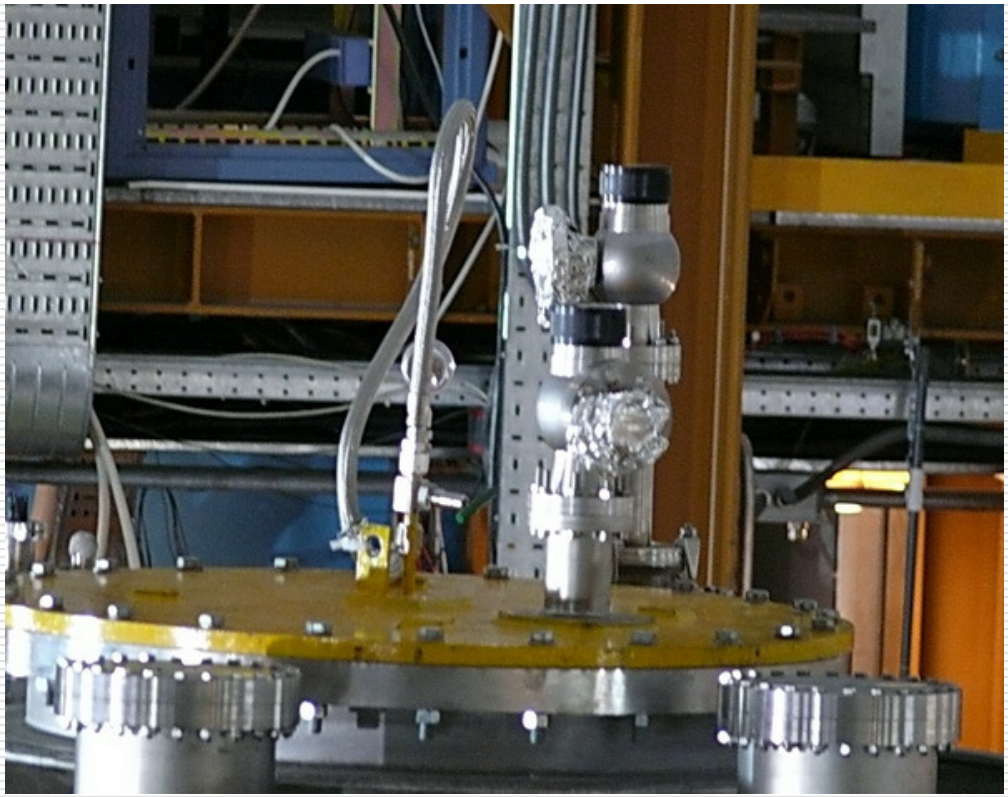
A_{tot} = (13.7 ± 1.9) mBq

2nd measurement at GS

- April 2008, preparation immediately after the evaporation test (following copper mounting) has been finished
- Top flange has been exchanged with the cryostat filled with nitrogen (neck covered with a plastic foil)
- Only 1 pumping cycle down to 1.6 mbar has been performed
- Extractions done 15 days later, after adding some cold and Rn- free nitrogen gas
- LAr used for cooling of the adsorption traps
- No access to the top flange – a 15- m full-metal flexible tube used for extractions was a part of the cryostat

2nd measurement at GS





2nd measurement at GS

- 1st sample (20 m^3 at STP):
  A_{tot} = (120 ± 5) mBq
- 2nd sample (26 m^3 at STP):
  A_{tot} = (121 ± 5) mBq

Average:

A_{tot} = (121 ± 4) mBq

Summary

Sample description	Single results [mBq]	Adopted value [mBq]	Comments
1st test, SIMIC in Nov. 2007	16.9 ± 1.6 29.8 ± 2.4	~30	Empty cryostat after cleaning, no N_2 mixing prior to extractions
2nd test, SIMIC/GS in March 2008	13.6 ± 2.5 13.7 ± 2.8	13.7 ± 1.9	Empty cryostat, additional cleaning performed at SIMIC
3rd test, GS in April 2008	120 ± 5 121 ± 5	121 ± 4	Cu shield inside, after evaporation test

Conclusions

- Increase of the Rn emanation rate by a factor of 9 after Cu installation
- Investigations of different parts used to fix the copper shield did not show any clear source of Radon → probably contamination with fine dust (see Hardy's talk for details)
- Residual Rn from the air cannot be completely excluded → an additional test is needed to definitively rule out that option
- How to proceed with cleaning and measurements → one of the construction and integration session topics (today afternoon)
- Checking if Rn is homogeneously distributed in the cryostat volume