TG11 summary
- Material screening -

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Activities since Tübingen meeting

- Database created
- Further gamma spectroscopy screening measurements
- ^{222}Rn emanation measurements started
- Surface contamination studies (^{222}Rn daughter deposition)
- ICP-MS measurements
- ^{222}Rn monitoring in air
- Nitrogen purity measurements

Database

- Two tables have been created:
  - Results
  - Queued samples
- Available on restricted area of MPIK-GERDA homepage:

www.mpi-hd.mpg.de/ge76/internal/tg11_internal/Screening_Results.pdf

- If you have new input please send e-mail to *Wolfgang.Hampel@mpi-hd.mpg.de* or *Hardy.Simgen@mpi-hd.mpg.de*

Some remarks about the database

- Results (in particular upper limits) are not (yet) given in an uniform way!
  - Column „Remarks“ provides explanation
- Please spend some time to understand the meaning of the numbers!
- Colour code for the results:
  - In blue: Actually measured numbers
  - In red: Calculated numbers assuming secular equilibrium

Extraction from the database

Material Description	Sample weight [kg]	Method Laboratory	Date	Counting time [d]	Remarks	Activity/concentration			
						Isotope [mBq/kg]		Element [g/g]	
PMT glass (low background) from ETL	0.15	γ-Bruno MPIK	Jan 2006	7.72	U.L.(=D.T.): k = 1.645 Errors: k = 1	^{226}Ra	1990 ± 190	U	(161 ± 15) · 10^{-9}
						^{228}Th	1330 ± 110	Th	(328 ± 26) · 10^{-9}
						^{40}K	11900 ± 2400	K	(383 ± 77) · 10^{-6}
						^{60}Co	≤ 39.5		
Teflon coaxial cable	0.106	γ-GeCris LNGS	Jan 2006	16.28	Upper limits + confidence intervals: C.L. = 90% (frequentist approach)	^{226}Ra	(2.2, 11.3)	U	(0.17, 0.91) · 10^{-9}
						^{238}U	≤ 170	U	≤ 13 · 10^{-9}
						^{235}U	≤ 6.8	U	≤ 12 · 10^{-9}
						^{228}Th	≤ 3.4	Th	≤ 0.84 · 10^{-9}
						^{228}Ra	≤ 2.1	Th	≤ 0.52 · 10^{-9}
						^{40}K	(640, 880)	K	(22, 28) · 10^{-6}
						^{60}Co	≤ 3.2		
						^{137}Cs	(1.8, 7.1)		
Teflon extruded	28.06	γ-GeMPI LNGS	Dec 2005	64.33 (ongoing)	Upper limits: Decision threshold C.L. ˜ 95% (k = 1.69) Errors: C.L. ˜ 95%) (k = 2)	^{226}Ra	0.072 ± 0.046	U	(5.9 ± 3.7) · 10^{-12}
						^{238}U	≤ 1.6	U	≤ 130 · 10^{-12}
						^{235}U	≤ 0.052	U	≤ 92 · 10^{-12}
						^{228}Th	≤ 0.051	Th	≤ 13 · 10^{-12}
						^{228}Ra	≤ 0.045	Th	≤ 11 · 10^{-12}
						^{40}K	0.57 ± 0.26	K	(18.4 ± 8.4) · 10^{-9}
						^{137}Cs	≤ 0.023		
						^{7}Be	0.44 ± 0.30 (at start of measurement)		

γ–spectroscopy measurements

- PTFE:
  - 28 kg of high purity material from Elring-Klinger
  - Long measurement with GeMPI (finished)
  - Will be used for phase I detector holder
- Super-insulation foil
  - 2 clean samples identified in HD at 10 mBq/kg level
  - Preferred one (from Austrian Aerospace) presently measured by GeMPI

γ–spectroscopy measurements

- Kapton
  - Measurements done in Hd, LNGS, Geel
  - Sufficiently clean Kapton cable not yet identified (1 mBq/kg sensitivity required)
  - Search for alternatives: (Cuflon, ...)
- Participation on NPL (UK National Physical Laboratory) environmental radioactivity comparison exercise.
  - Results will be presented next time
- Activities in Baksan: → Talk of A. Smolnikov

^{222}Rn emanation measurements

- Stamped copper foil (200m x 0.3m x 100μm)
  - get a clue for typical ^{222}Rn emanation rates for Cu
  - Test purification procedures

Stamped copper foil

^{222}Rn emanation measurements

- Stamped copper foil (200m x 0.3m x 100μm)
  - get a clue for typical ^{222}Rn emanation rates for Cu
  - Test purification procedures
- Result for untreated foil:

  (1.6 ± 0.1) μBq/m^2
- First purification test started: Copper foil has been flushed with quartz-distilled water and dried again.

^{222}Rn emanation samples

^{222}Rn emanation measurements

- Tooth belt (Polyurethane)

  (230 ± 30) μBq for complete belt

  (1.6 ± 0.2) mBq/kg

  (115 ± 15) μBq/m

- Next samples:
  - IGLIDUR: Sliding plastics
  - Big shut valve for top flange (Viton seal)
    - ^{222}Rn emanation of viton: (80-300) mBq/m^2
    - Critical! Do we need it?

Surface contamination studies

- Starting question: How should we treat the copper cryostat?
- Problem of ^{210}Pb (^{210}Bi) accumulation on copper
- Copper discs loaded with ^{222}Rn daughters in HD
- Measurements performed in Cracow by M. Wójcik
- Results: → Talk of G. Zuzel

ICP-MS measurements

- Cooperation with A. Gerdes (U Frankfurt) on standby
- Instead: ICP-MS measurements @ Gran Sasso
- Contact with E. Pernicka (U Tübingen, formerly MPIK, new laboratory in Mannheim) established
  - Is interested in collaboration
- Activities in Russia: → talk of V. Kornoukhov

^{222}Rn monitoring in air

- Big electrostatic chamber under development.
  - To be done: HV tests, cleaning, calibration
  - Design sensitivity: ~50 μBq/m^3

Electrostatic chamber

^{222}Rn monitoring in air

- Big electrostatic chamber under development.
  - To be done: HV tests, cleaning, calibration
  - Design sensitivity: ~50 μBq/m^3
- Sensitivity of Lucas cells: ~1 Bq/m^3
- R&D programm for simple setup with sensitivity of ~100 mBq/m^3 started.
  - Plan: Lucas cell with enlarged volume
  - Exploiting potential of VM2000 reflector foil

Latest results on nitrogen purity measurements

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What we know about ^{222}Rn in N_2

- N_2 can be purified from ^{222}Rn by cryo-adsorption on activated carbon.
- ^{222}Rn purity <0.5 $\mu Bq/m^3$ (STP) can be achieved at flux of 100 m^3/h (STP).
- Purification of liquid N_2 possible!
- Requirements for GERDA can be fulfilled by same purification plant as used in BOREXINO.

BOREXINO N_2 purification plant

The BOREXINO purification plant

- 2 identical purification columns:
  - 2kg of expensive (rare) activated carbon with very low ^{222}Rn emanation rate (0.3 mBq/kg).
  - Cooled with LN_2.
  - Equipped with heater (can be baked for regeneration).
- Maybe one column sufficient for BOREXINO (under investigation).

To purify or not to purify?

- Purification plant á la BOREXINO
  - is not cheap (One column: ~80 k€)
  - requires additional space
  - consumes a lot of N_2 for cooling (~30% of produced N_2)
  - needs operators/maintenance

- Is purification avoidable?

  → ^{222}Rn measurements of unpurified N_2 and of storage tanks required.

Storage tank measurements

- Standard cryo-tank for technical quality LAr/LN_2 (3.5 m^3 / Westfalen AG):

  180 mBq $\Rightarrow$ 75 μBq/m^3 (STP)

- Electropolished cryo-tank for highest purity LN_2 (3 m^3 / LINDE):

  2.7 mBq $\Rightarrow$ 1.3 μBq/m^3 (STP)

- Standard cryo-tank for highest purity LN_2 (16 m^3 / SOL):

  70 mBq $\Rightarrow$ 6 μBq/m^3 (STP)

SOL high purity N_2 tank

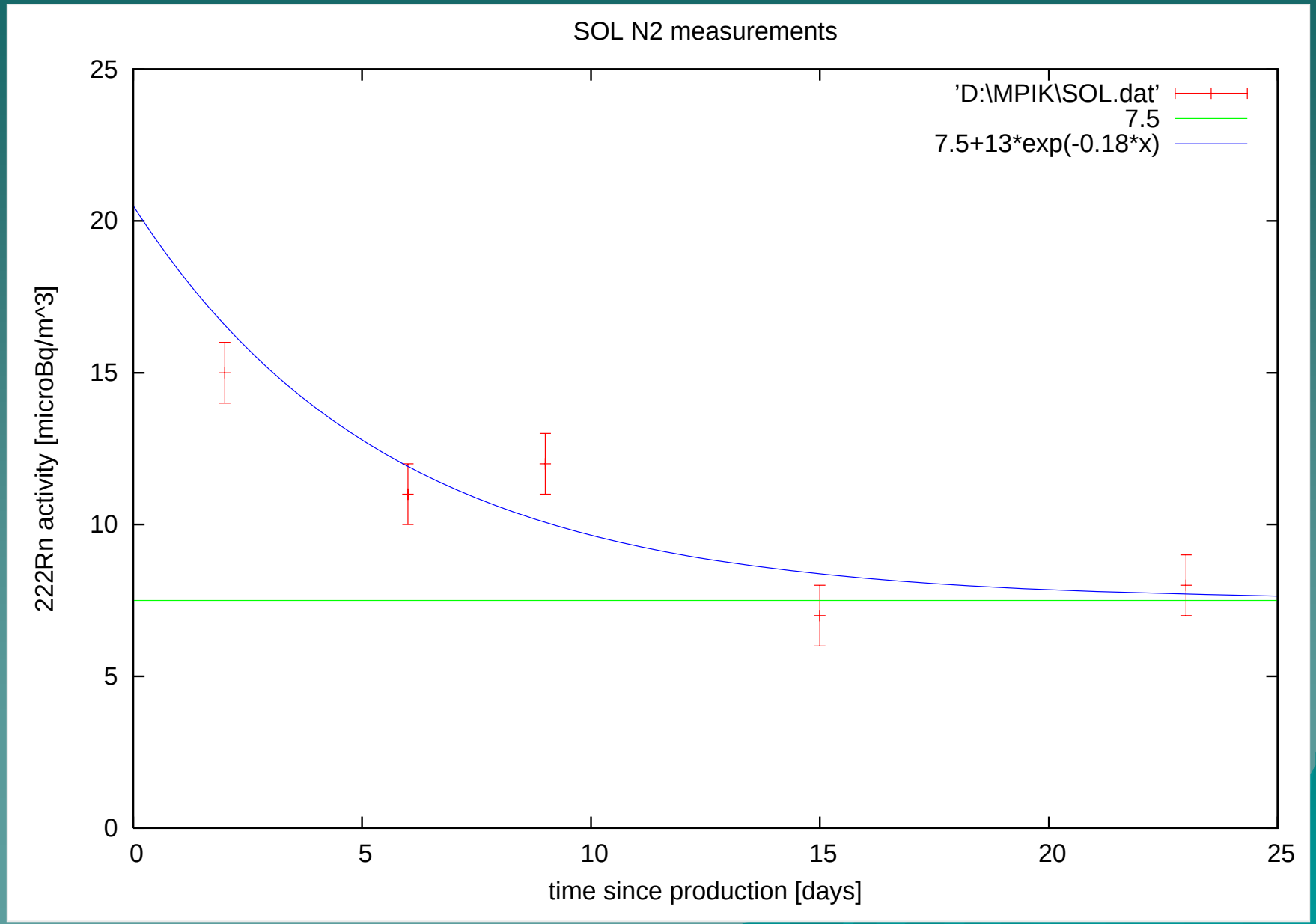
^{222}Rn in SOL nitrogen

- Nitrogen produced in Italy at 24.01.06

Date	Result
26.01.06	(15 ± 1) μBq/m³ (STP)
30.01.06	(11 ± 1) μBq/m³ (STP)
02.02.06	(12 ± 1) μBq/m³ (STP)
08.02.06	(7 ± 1) μBq/m³ (STP)
16.02.06	(8 ± 1) μBq/m³ (STP)

- Expectation (homogenous distribution) in equilibrium: 6 μBq/m³ (STP)

^{222}Rn in SOL nitrogen



Is SOL N_2 sufficiently pure for us?

- Requirement for GERDA:
  - MC simulation (see proposal):

    0.5 μBq/m^3 (STP) $\Rightarrow$ <10^{-4} cts/(kg·keV·y)
- 8 μBq/m^3 (STP) is OK for phase II
- Moreover: ^{222}Rn decays as soon as oustide of storage tank
- Purification probably avoidable
- Final ^{222}Rn level determined by emanation from cryostat and lock.

Conclusion

- N_2 can be purified from ^{222}Rn.
- It is desirable to avoid purification.
- SOL N_2 would be good enough for us.
- A possible scenario:
  - No purification for first filling
  - Wait for ^{222}Rn decay if necessary
  - For quick replacement of evaporated N_2 with ^{222}Rn-free N_2: Small scale purification column (150 g adsorber)
- No major differences for Ar expected.