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Behaviour of ^{222}Rn and its daughters in liquid nitrogen

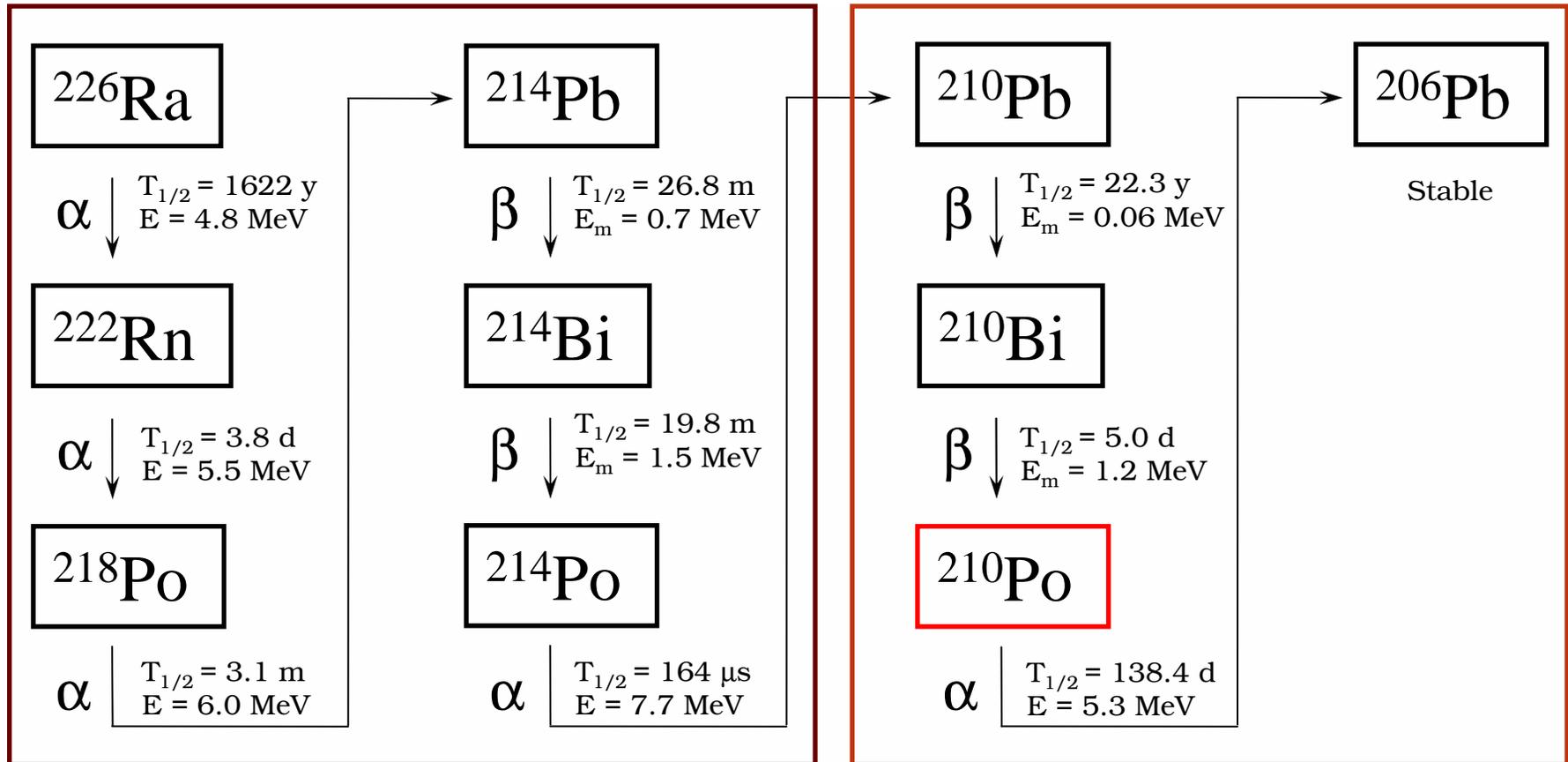
Marcin Wójcik, Nikodem Frodyma, Krzysztof Pelczar

GERDA Collaboration Meeting
Jagellonian University, Kraków 2008

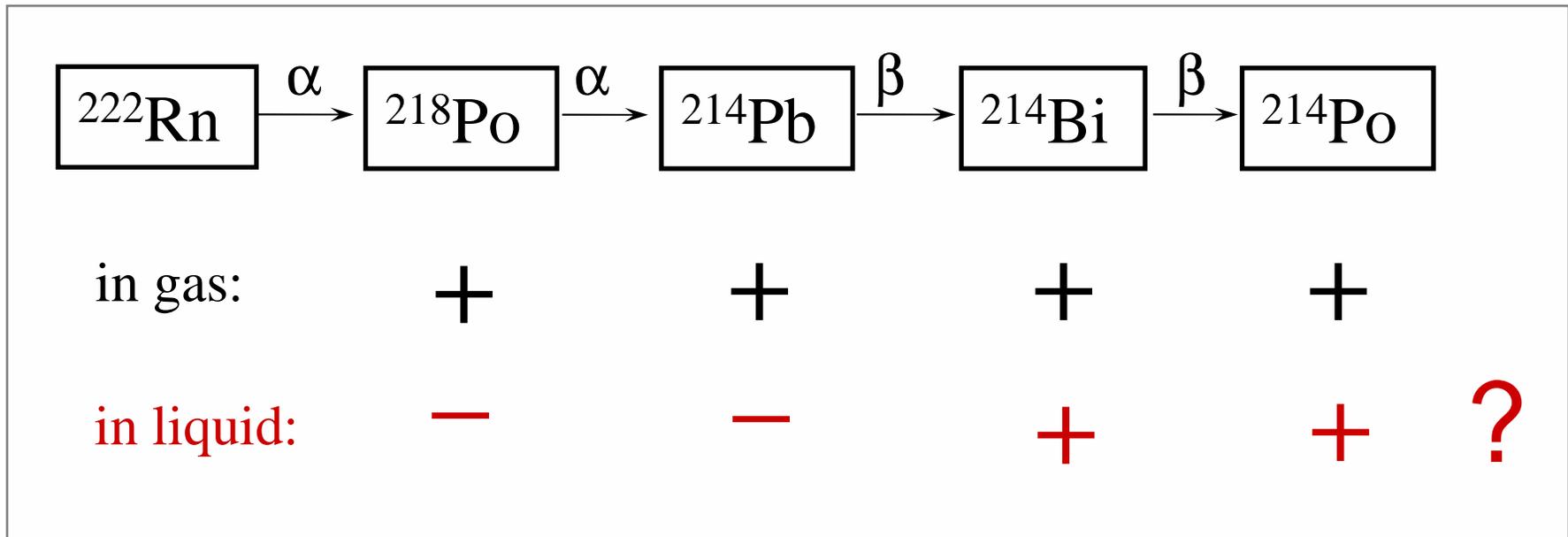
Problems and Questions

- ❑ Rn as a time-dependent background source in e.g. the GERDA experiment
- ❑ Rn and Rn-daughters location in cryostat with liquid gas
- ❑ Rn partition between liquid and gas phase
- ❑ Behaviour of Rn and its daughters in LN₂ in electric field

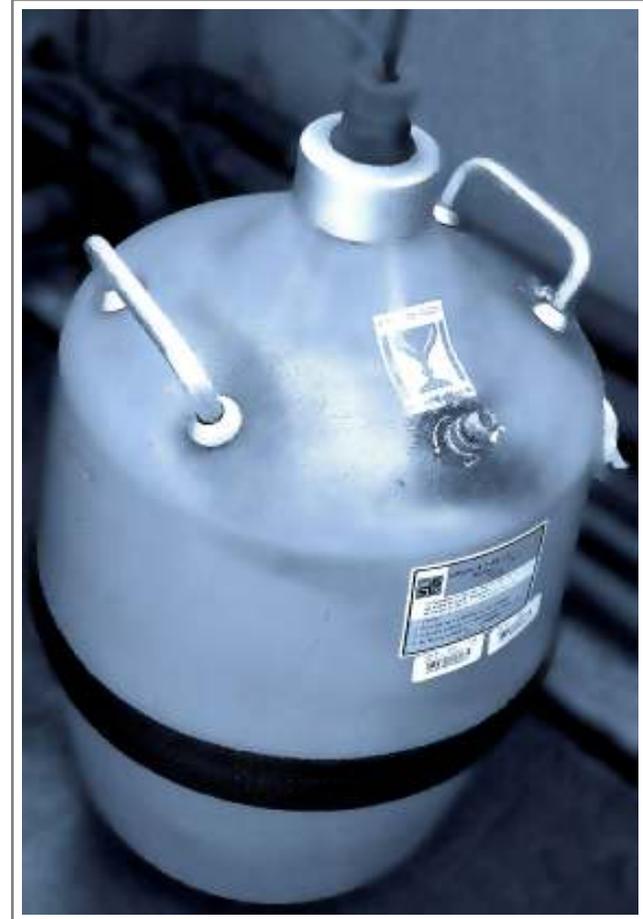
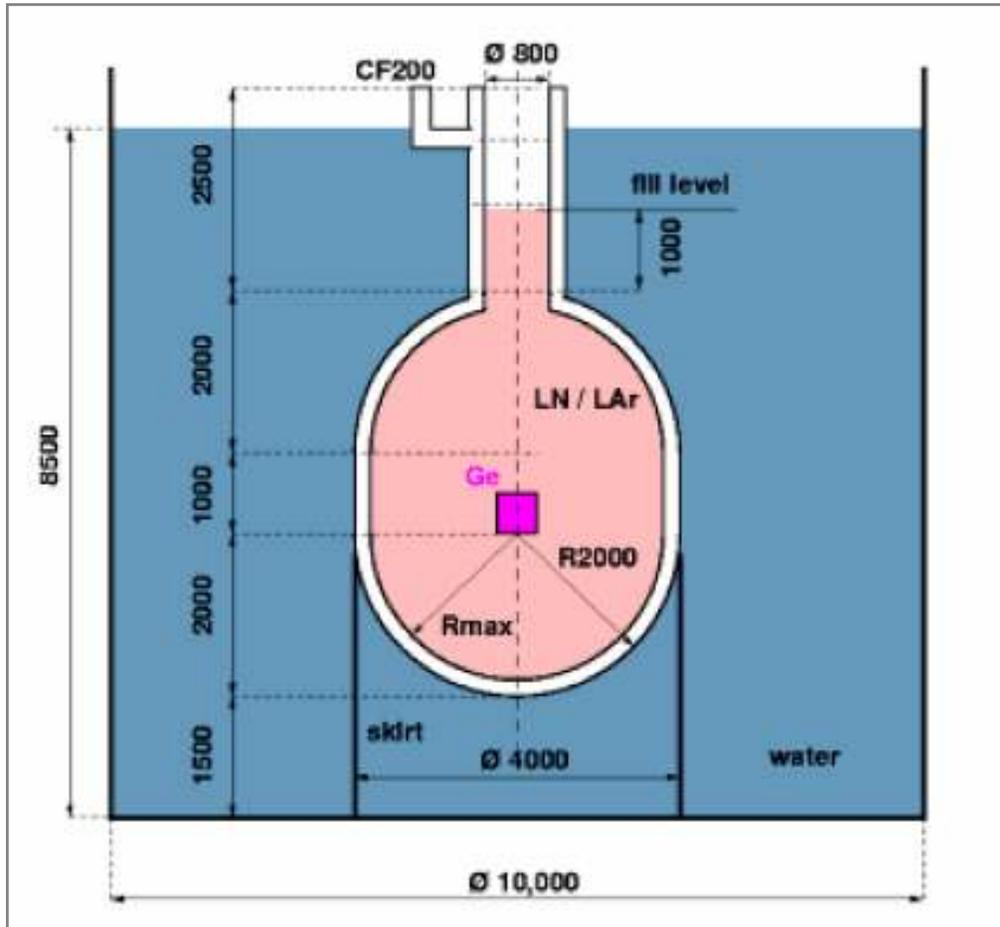
^{222}Rn and its daughters



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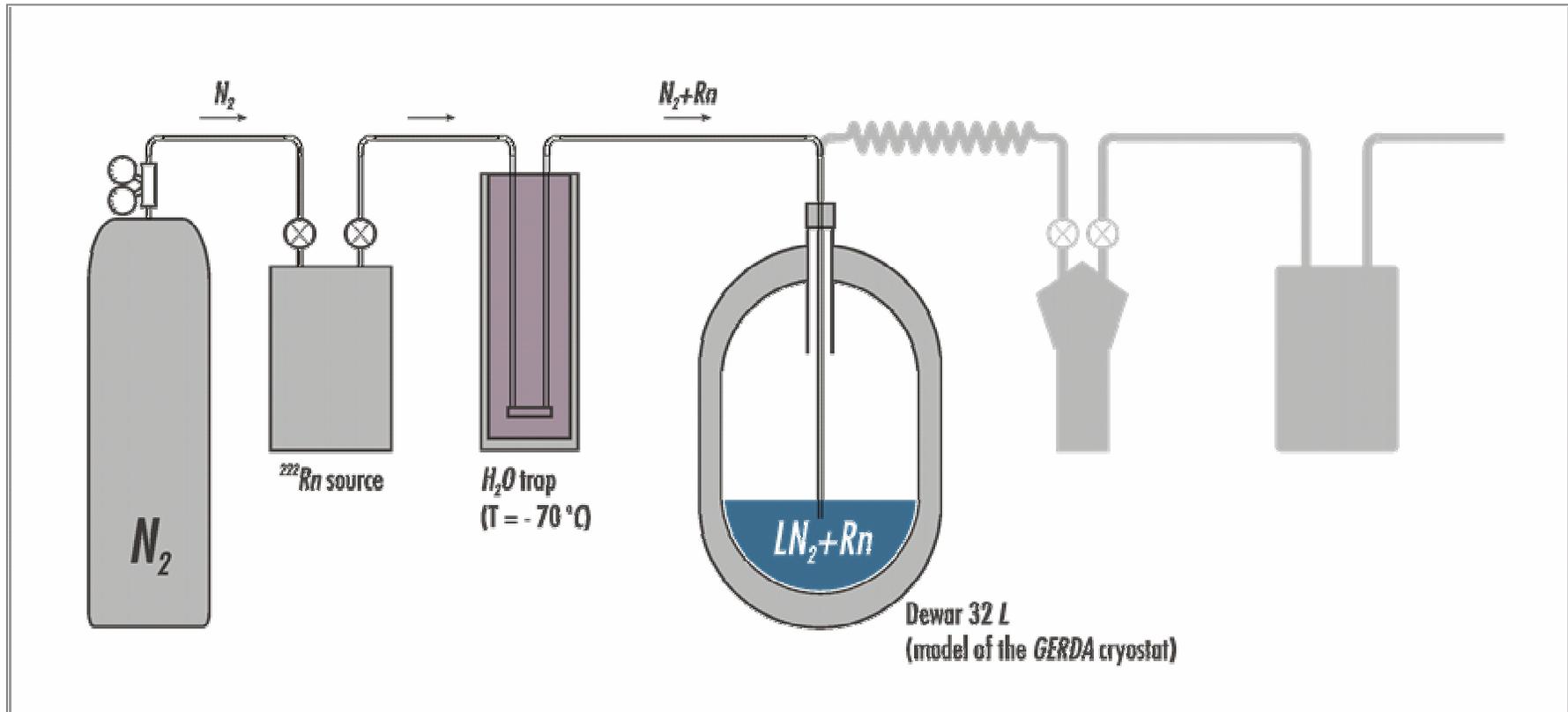


GERDA – model of the detector



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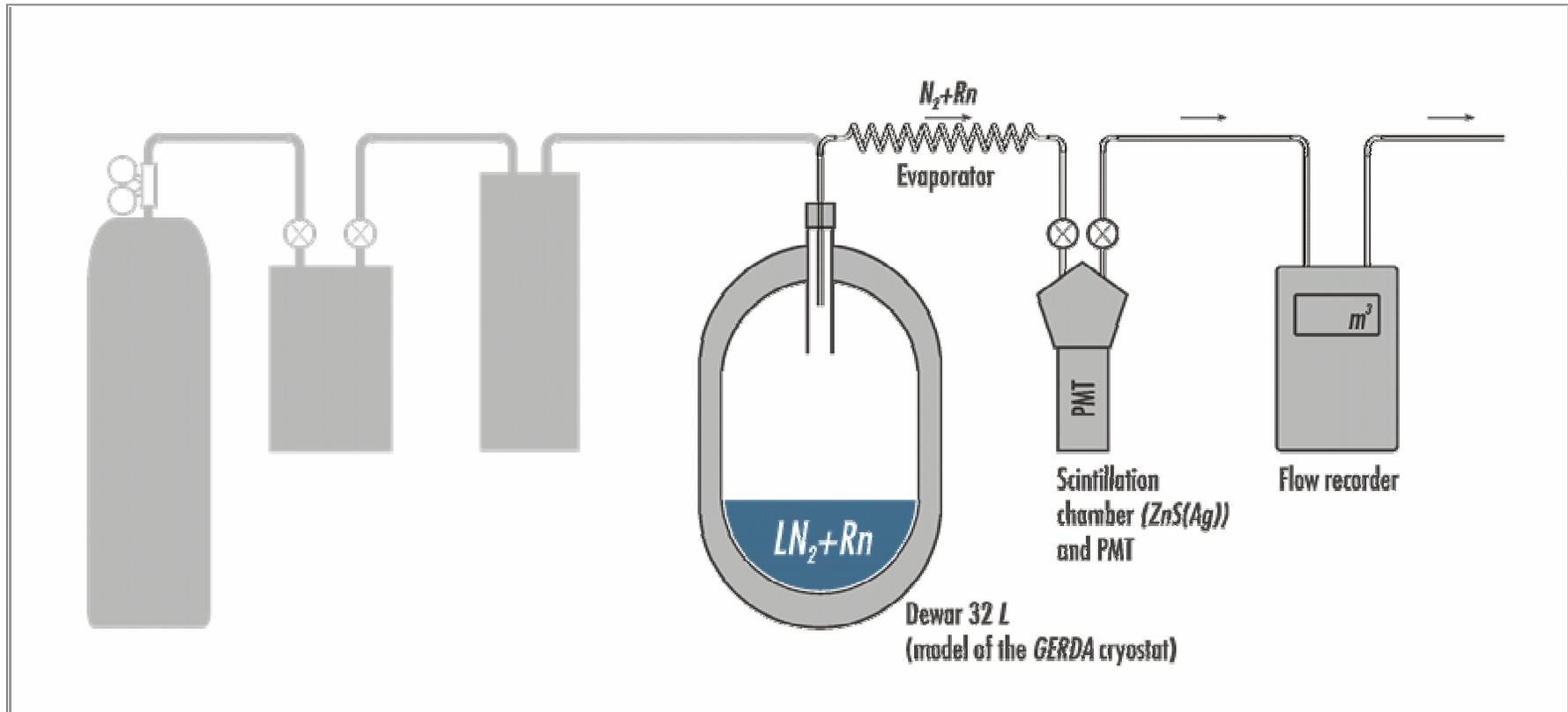
Rn dissolving in LN₂



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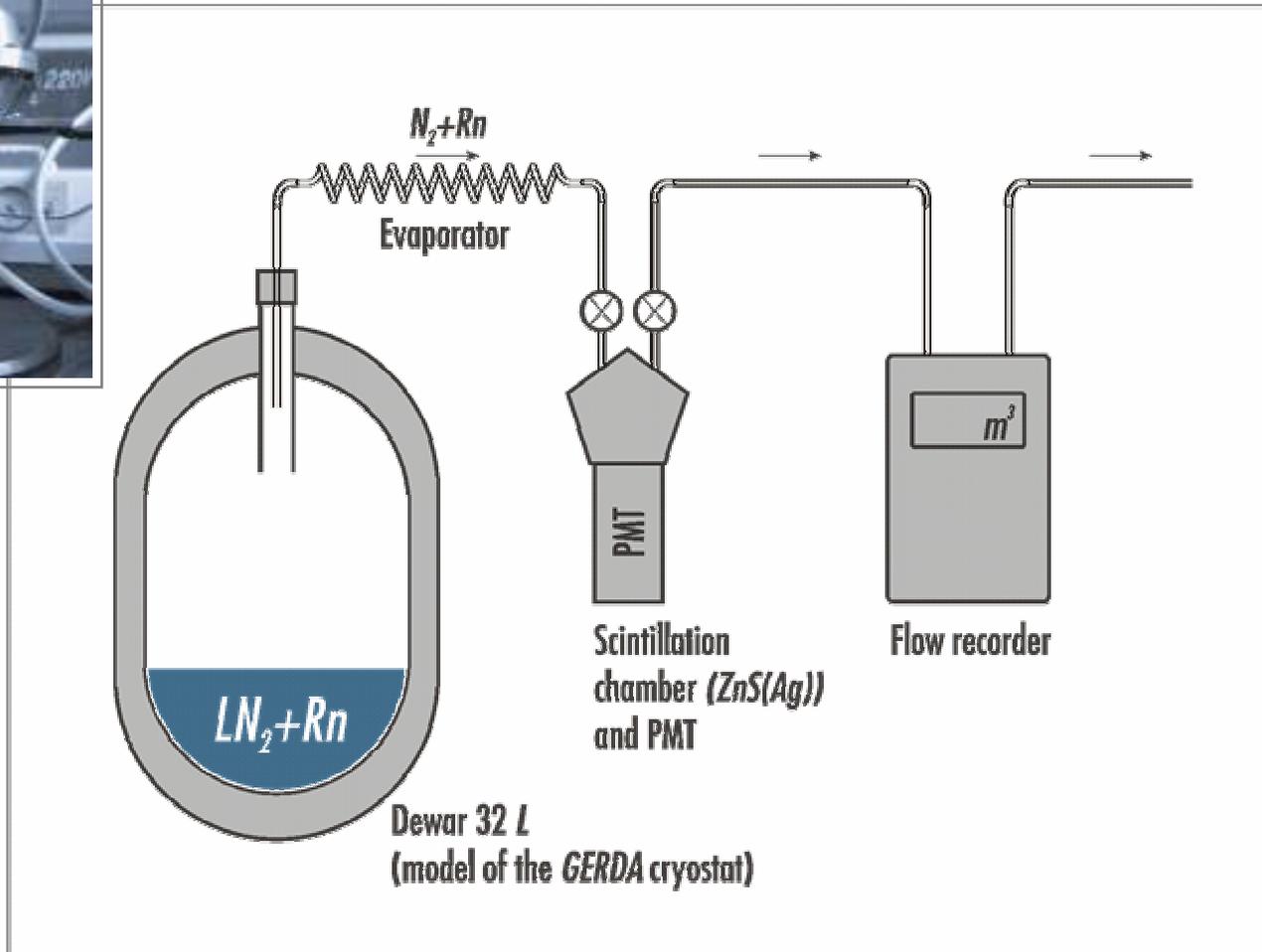
„Free evaporation” of LN_2 with Rn



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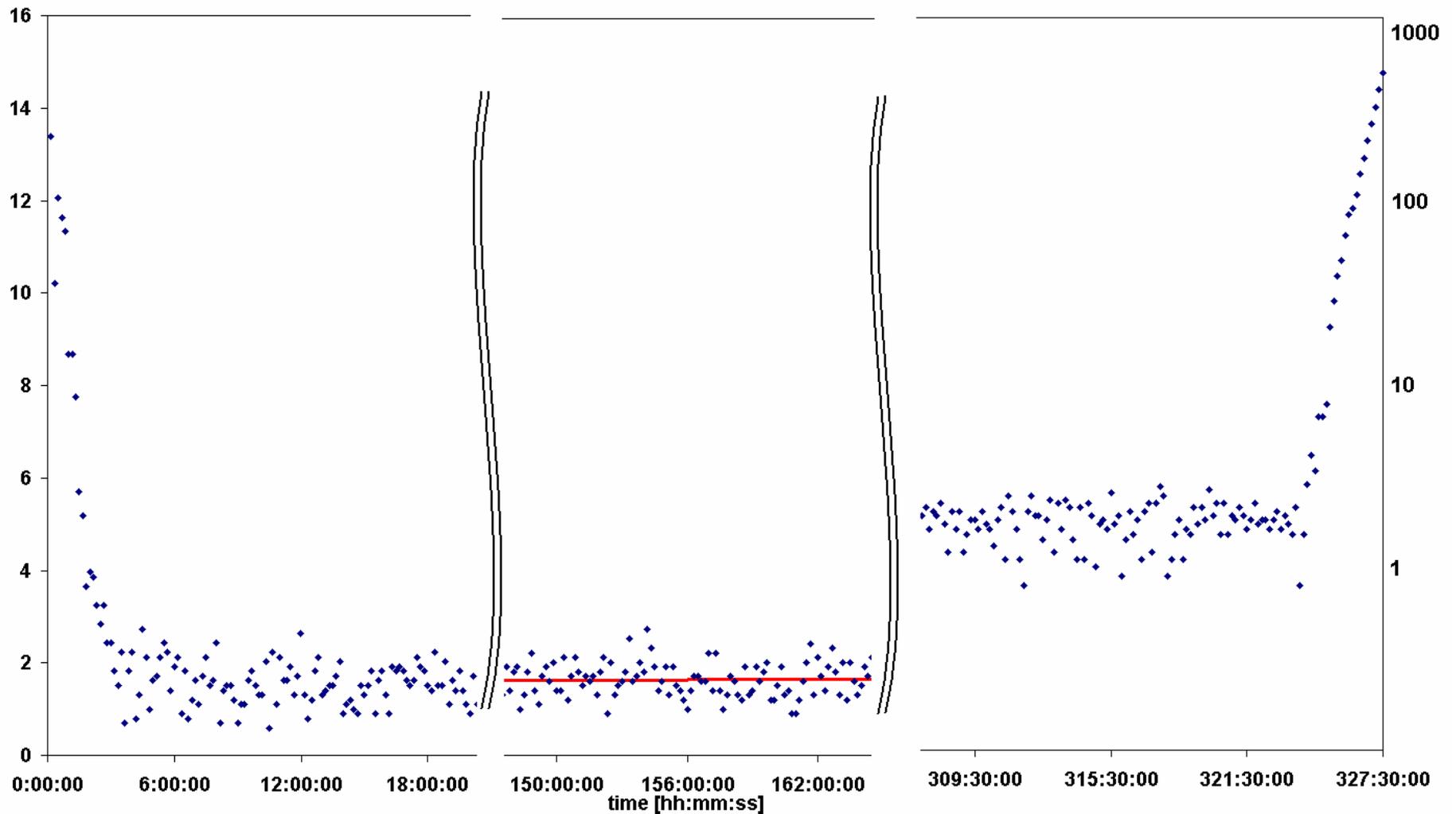
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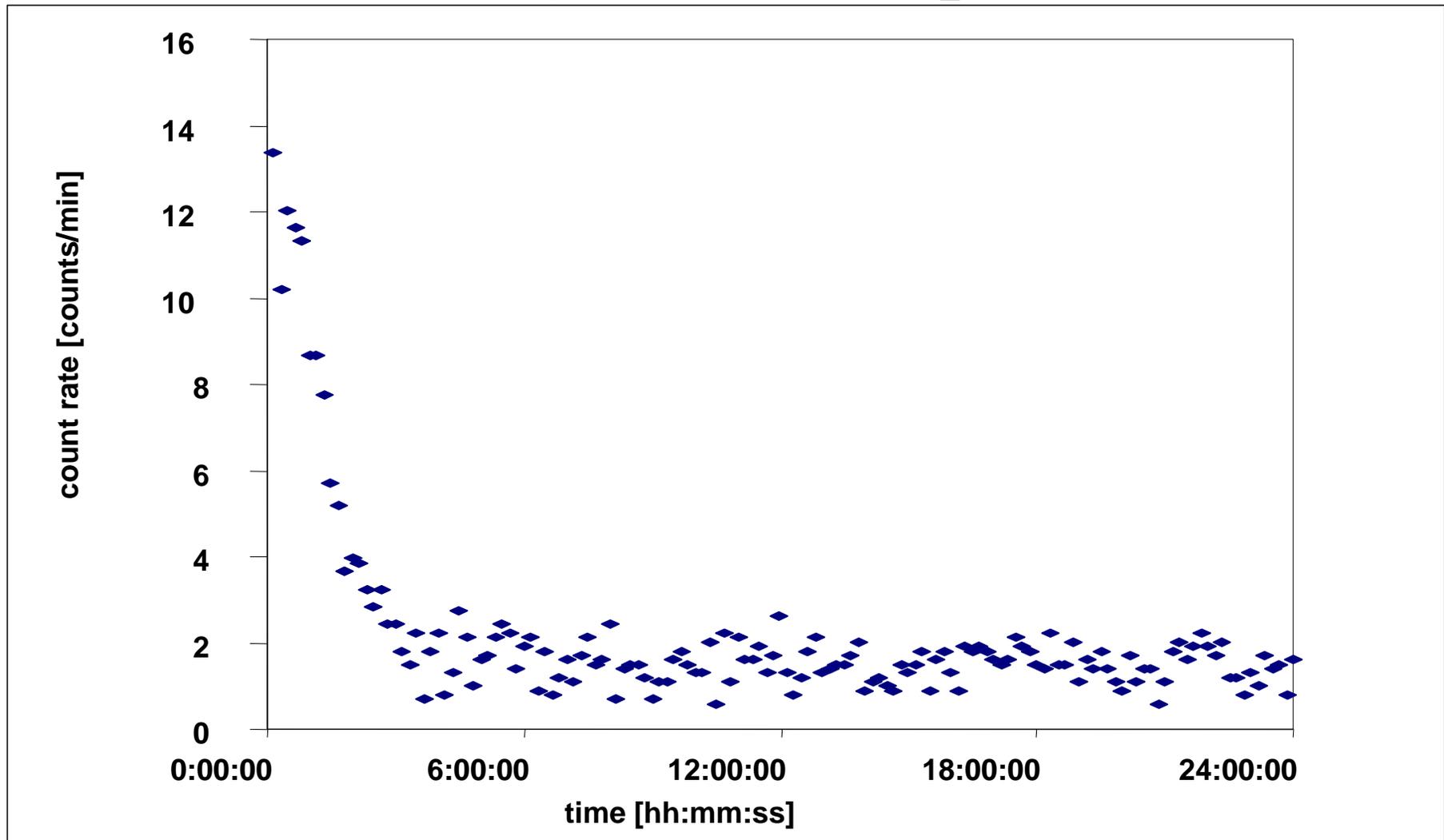
„Free evaporation” of LN₂ with Rn



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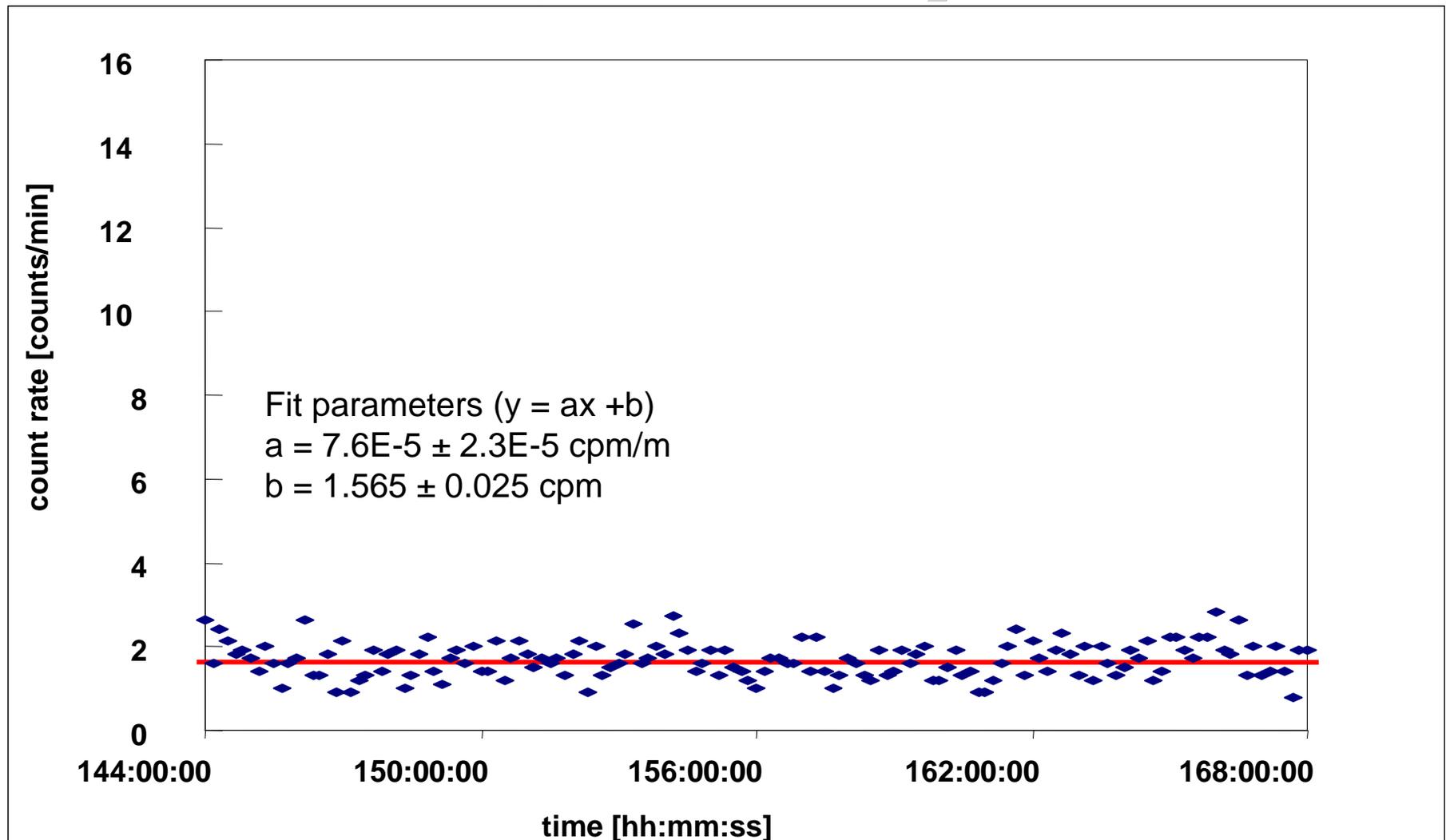
„Free evaporation” of LN₂ with Rn



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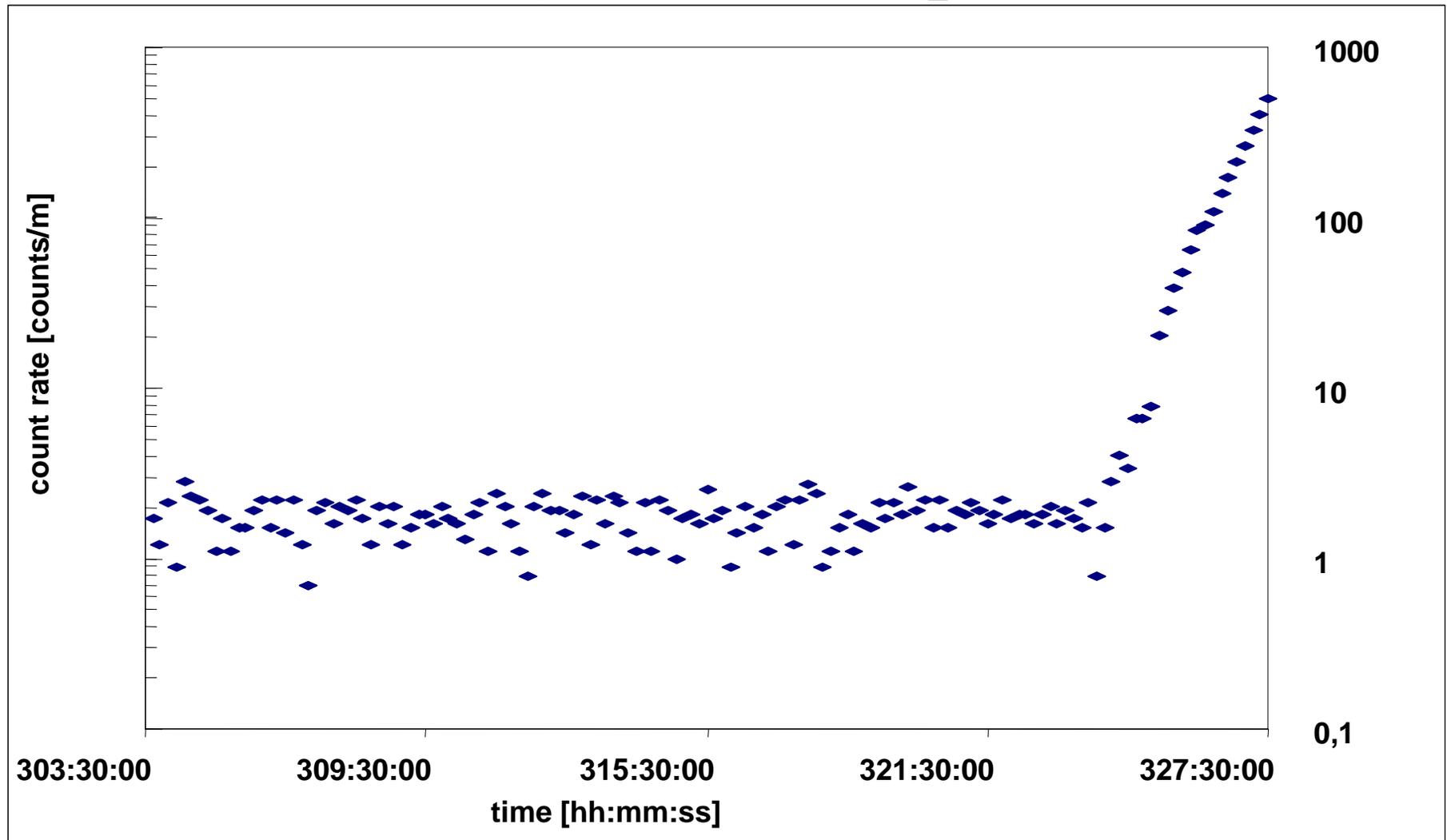
„Free evaporation” of LN₂ with Rn



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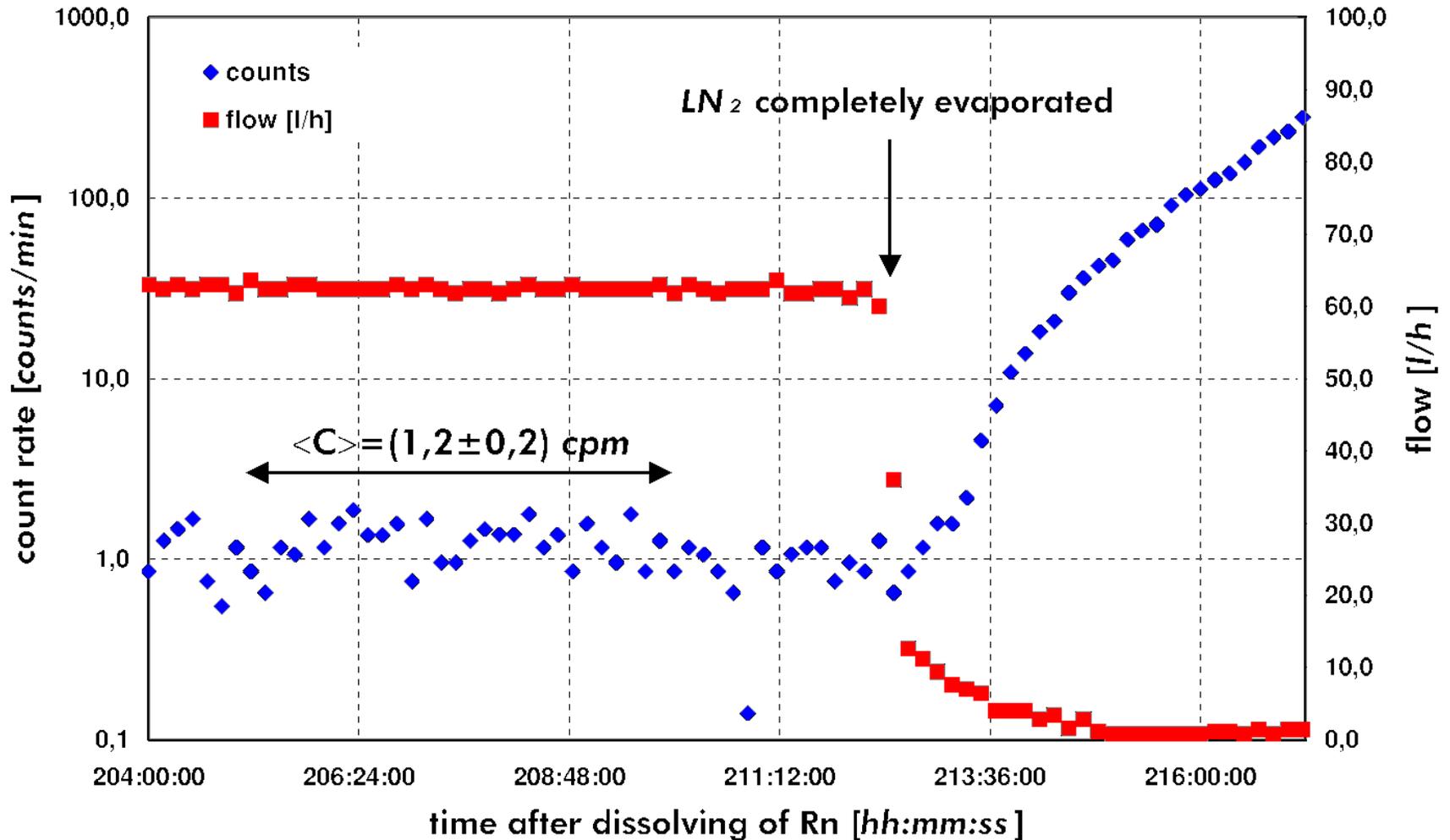
„Free evaporation” of LN₂ with Rn



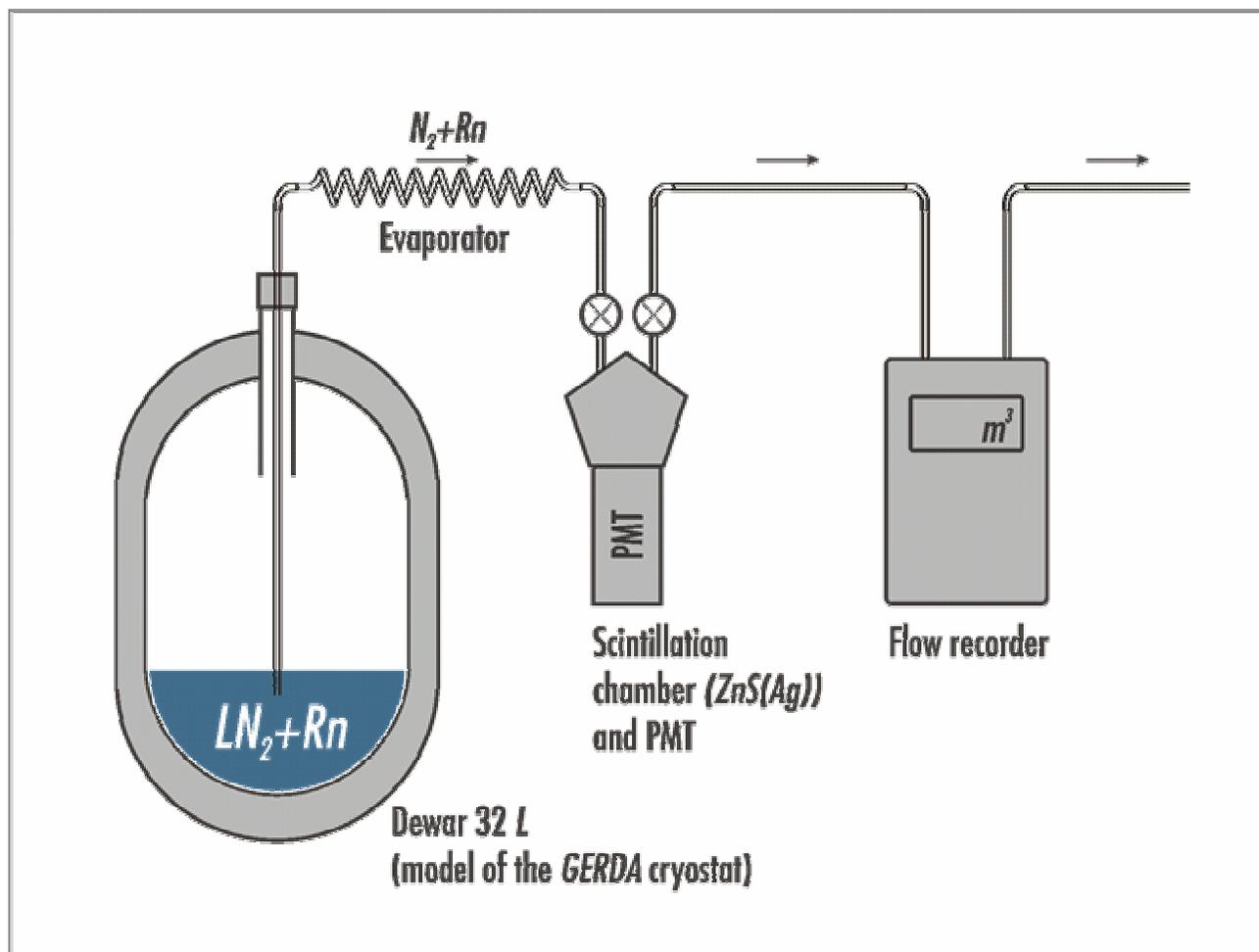
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Rn count rate growth after LN₂ evaporation

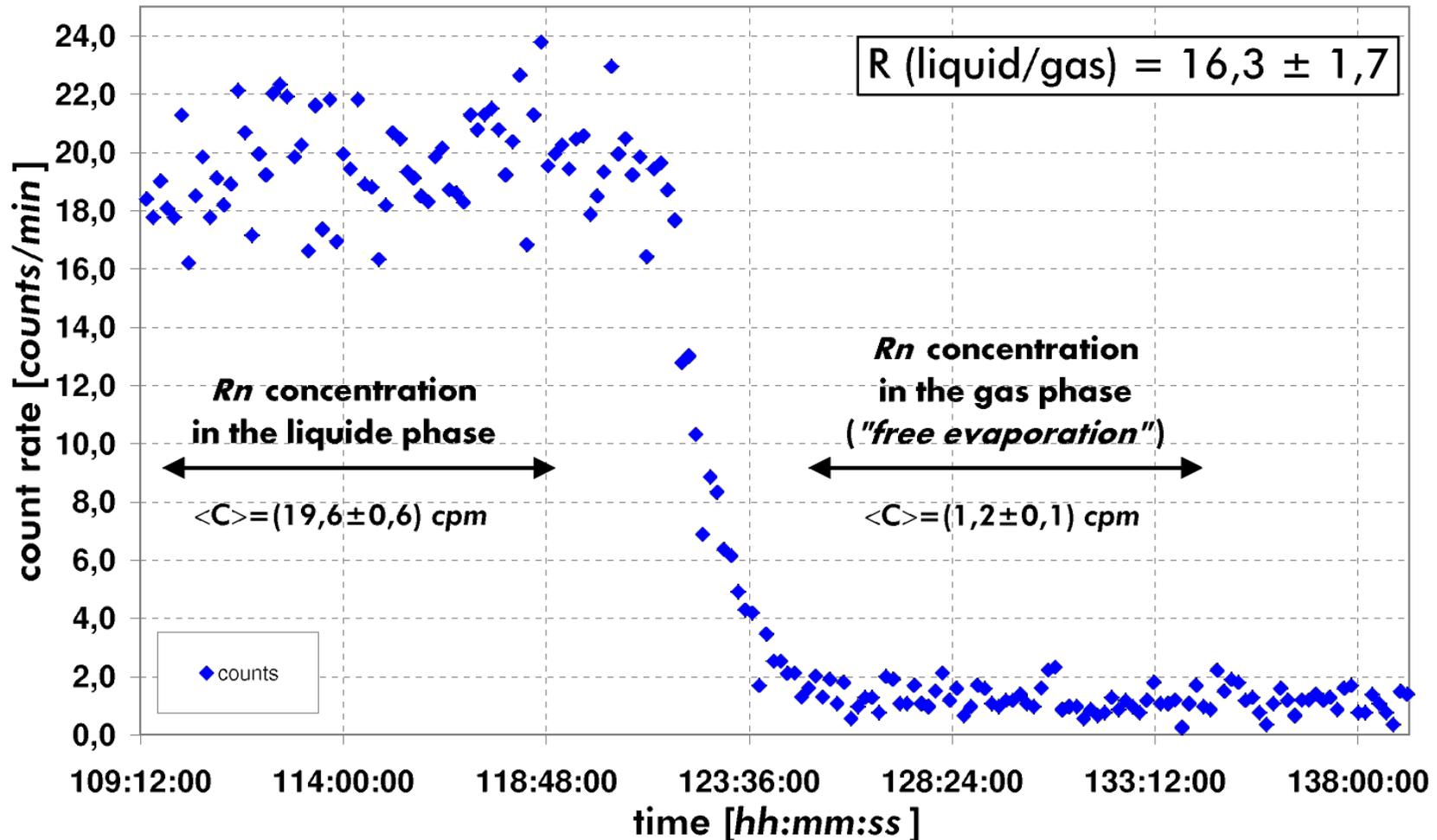


Measurement of the Rn concentration in LN₂



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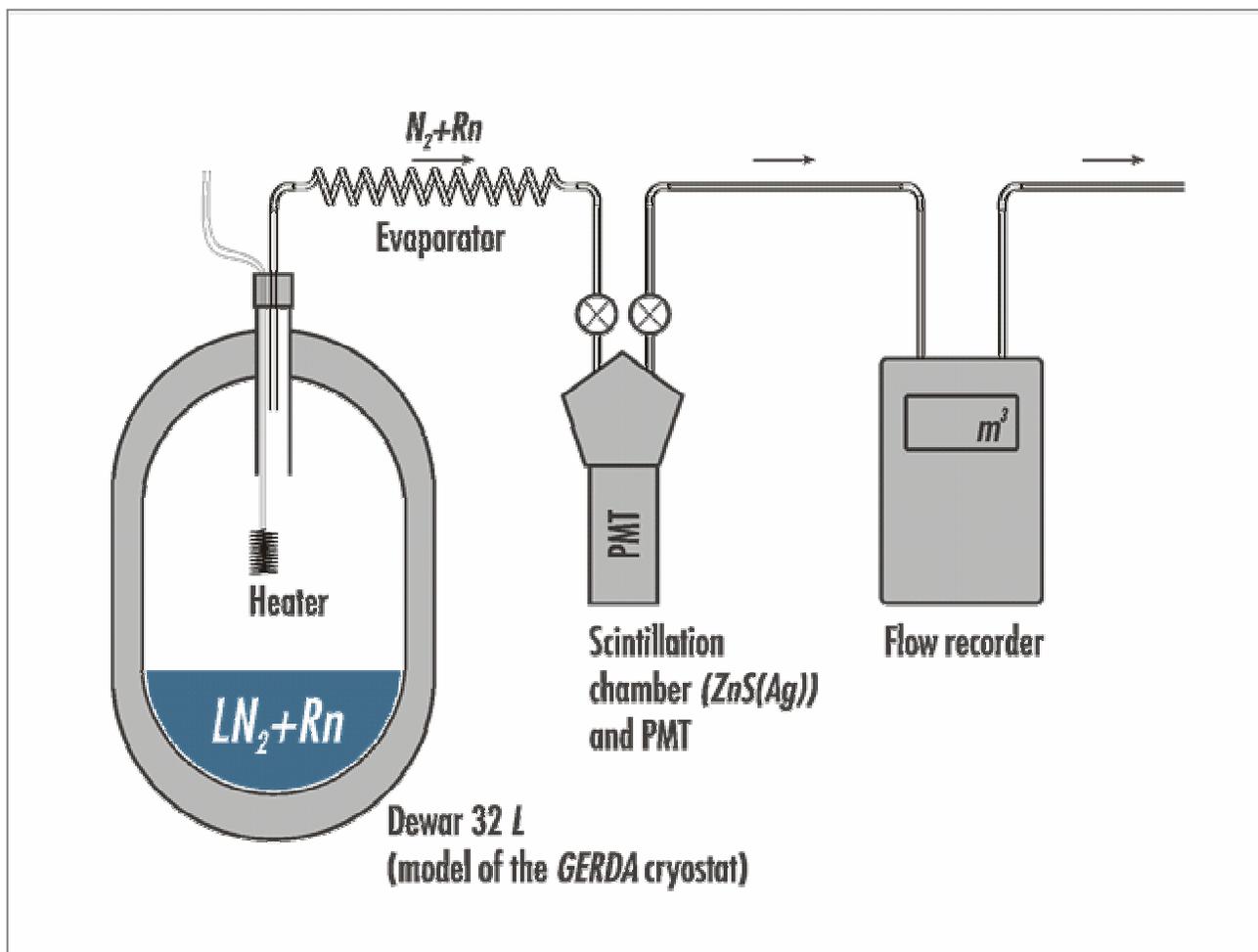
Rn concentration in liquid and gaseous nitrogen



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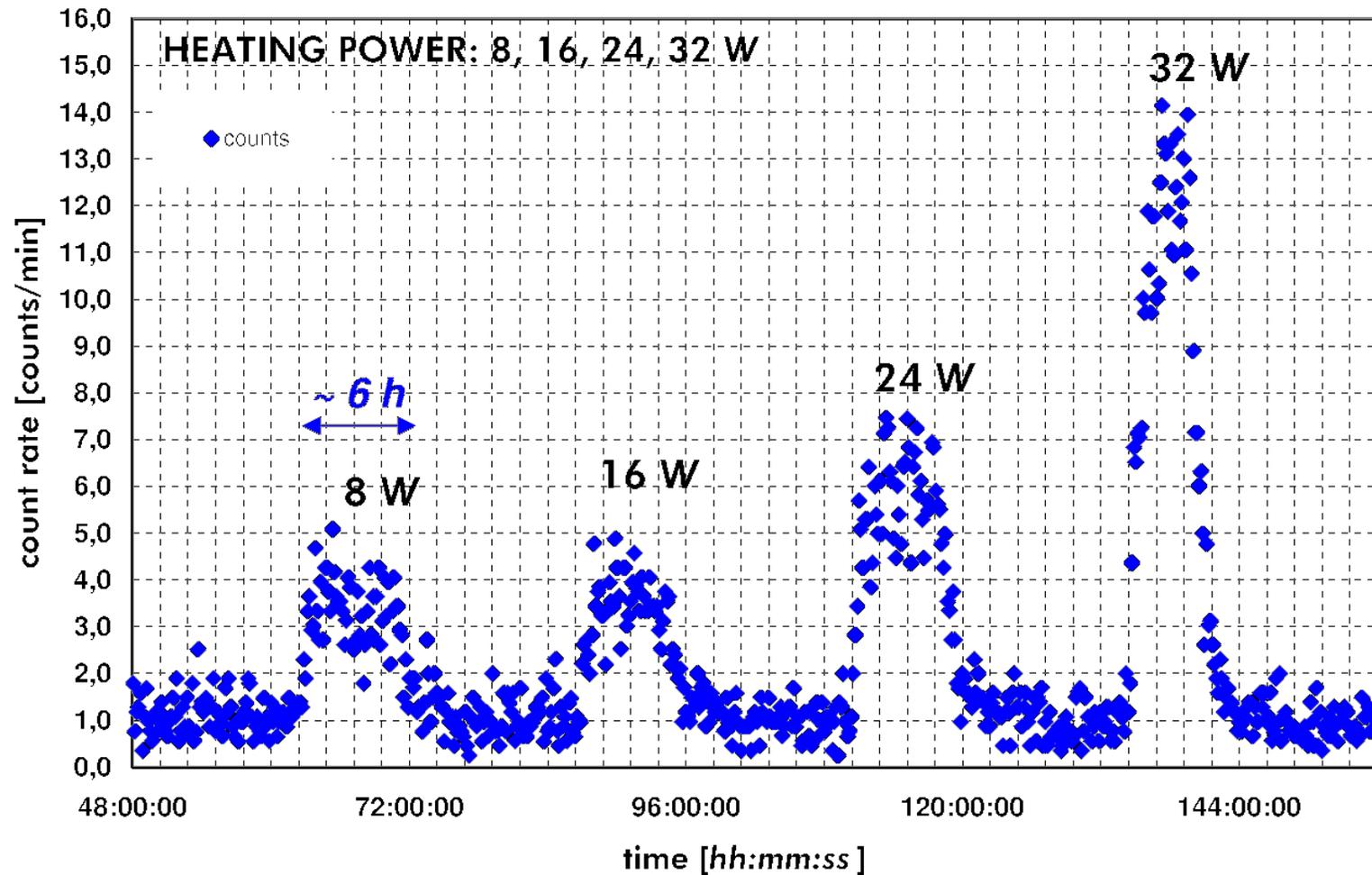
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Variable heating inside the Dewar



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Variable heating inside the Dewar



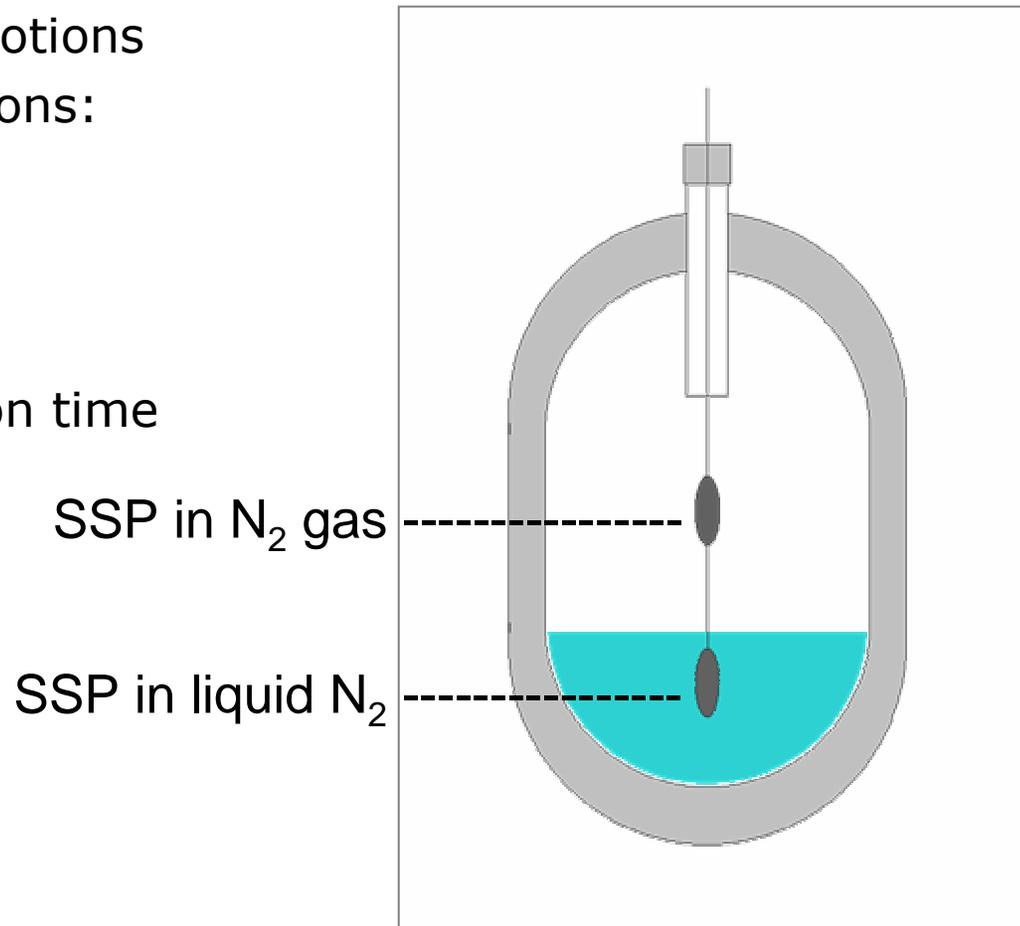
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Rn-daughters deposition on stainless steel plates (SSP) and alfa-spectrometry

SSP placed in different positions and under different conditions:

- Liquid nitrogen
- Gaseous nitrogen
- High voltage applied
- Long and short exposition time



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alfa-spectrometer

Alphas from ^{222}Rn (3.8235 d 3)

E_α (keV)	I_α (%)
5489.52 30	99.92 1
4987 1	0.078
4827 4	~0.0005

Alphas from ^{218}Po (3.10 m 1)

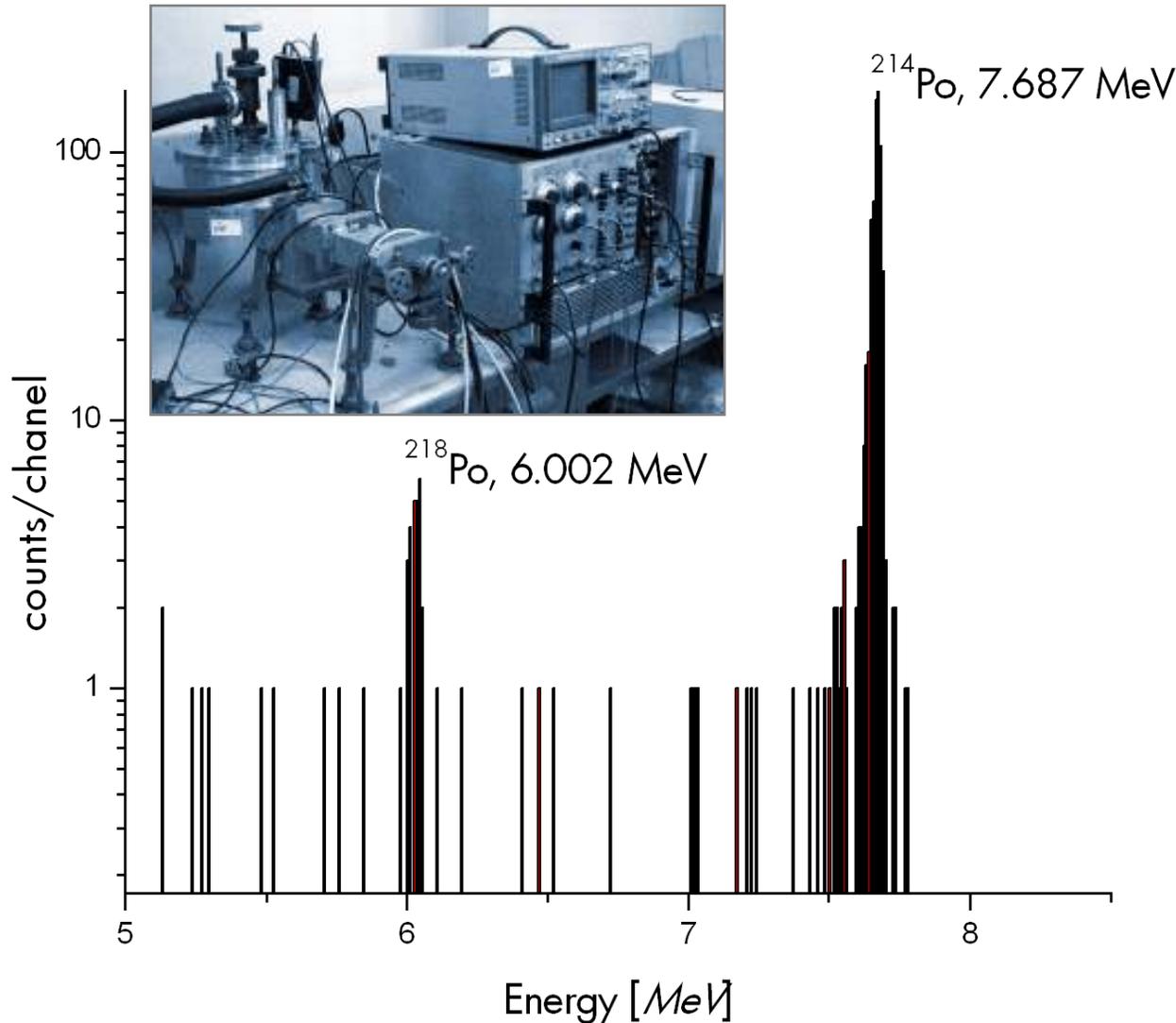
E_α (keV)	I_α (%)
6002.35 9	99.9989
5181 2	0.0011

Alphas from ^{214}Po (164.3 us 20)

E_α (keV)	I_α (%)
7686.82 7	99.9895 6
6902.1 2	0.0104 6
6609.9 10	6.0E-5 20

Alphas from ^{210}Po (138.376 d 2)

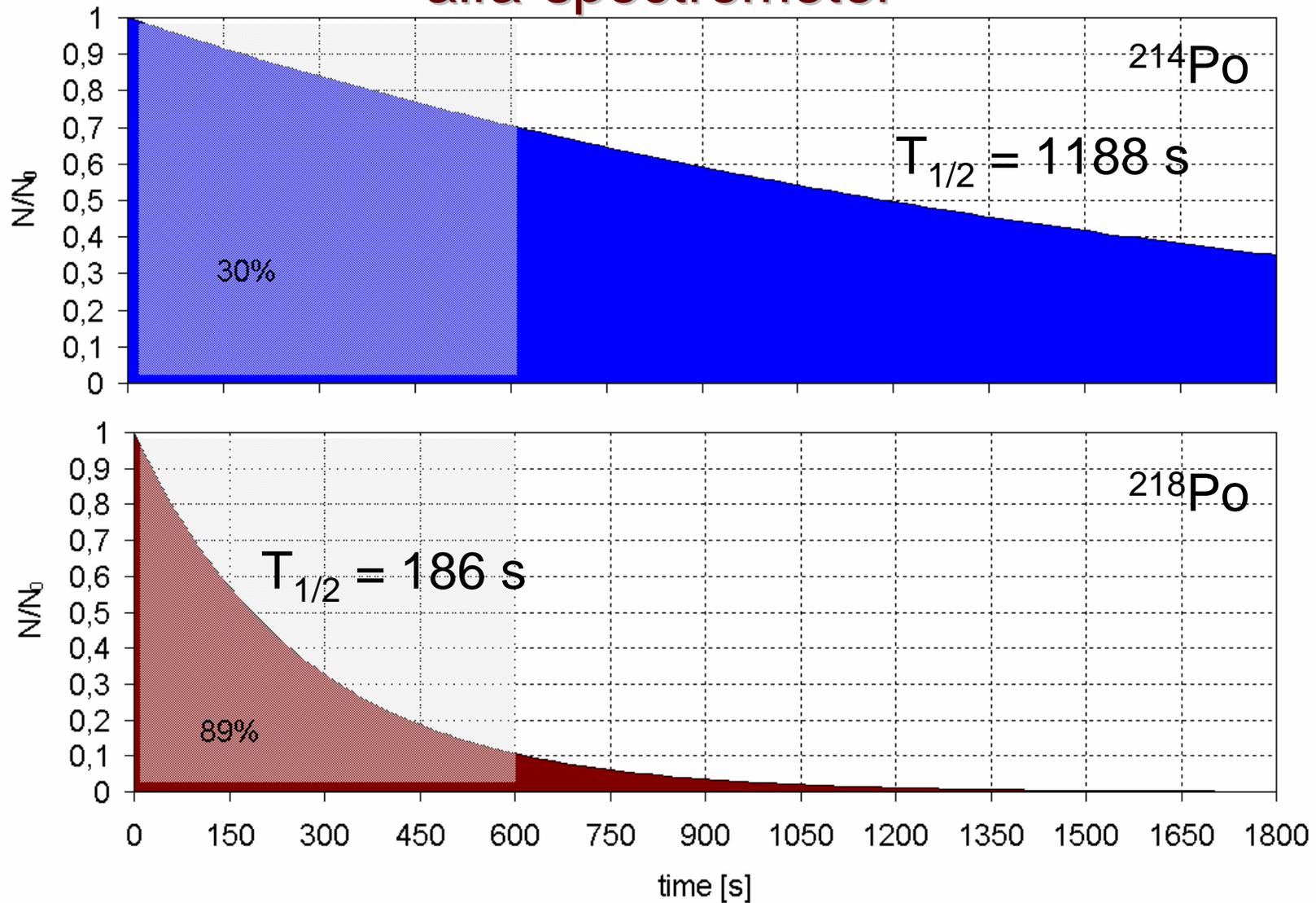
E_α (keV)	I_α (%)
5304.38 7	100
4516.58 9	0.00122 4



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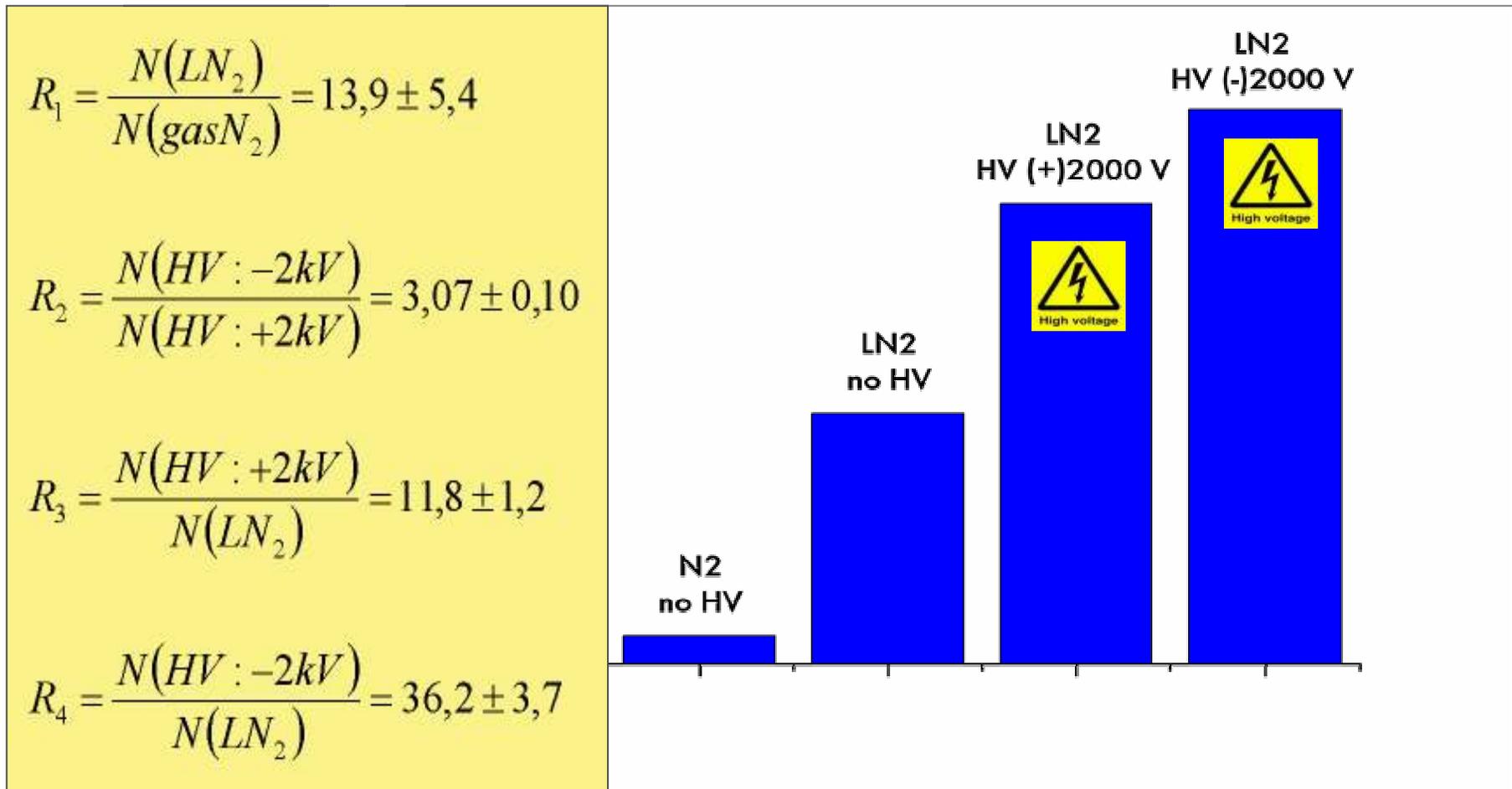
alfa-spectrometer



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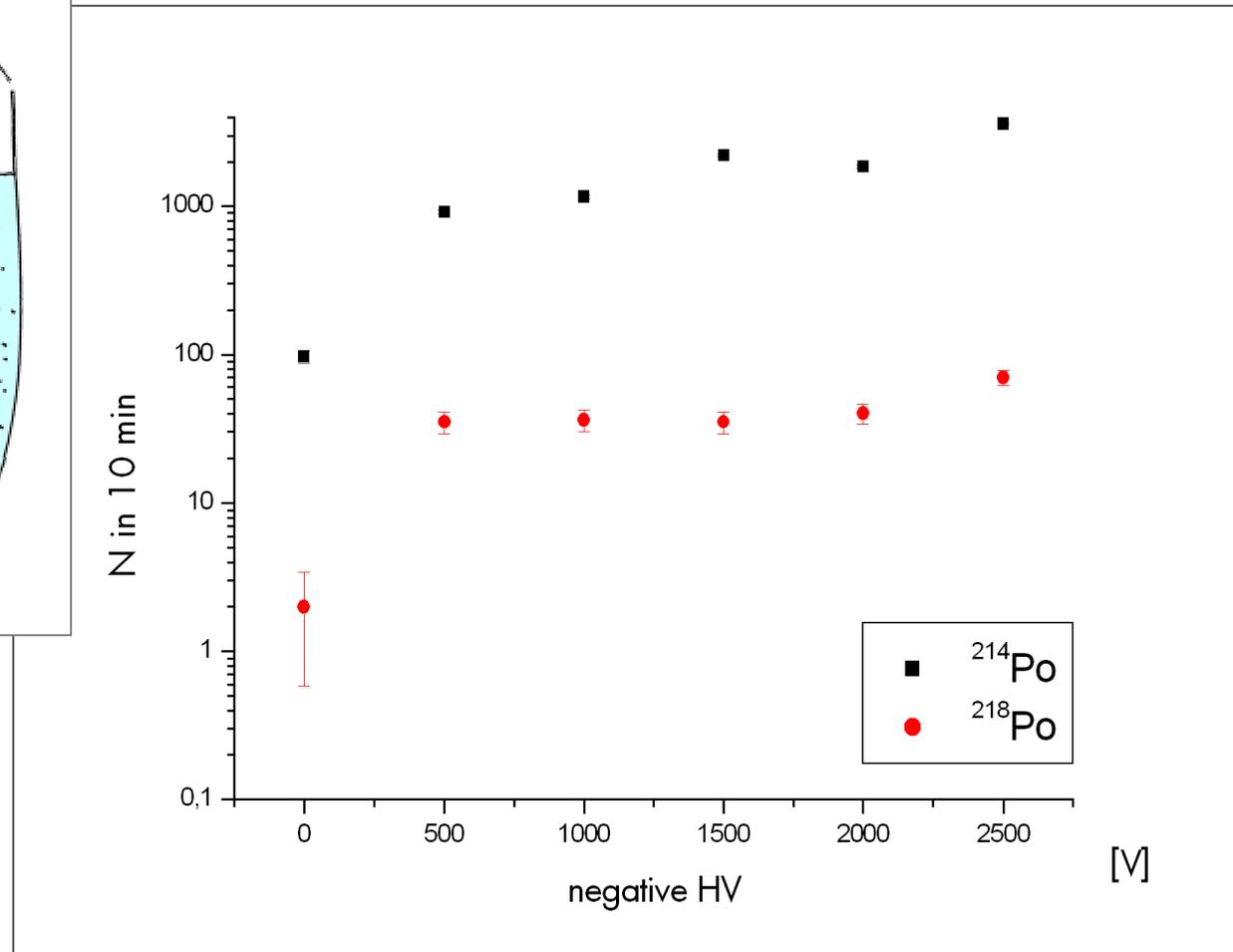
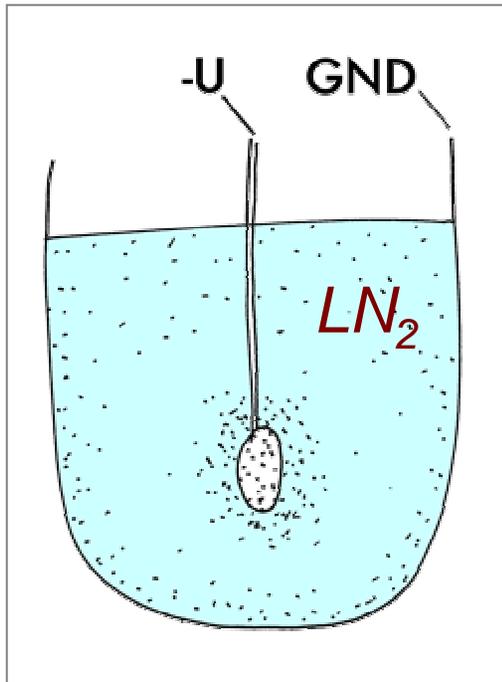
High voltage influence on counts of ^{214}Po



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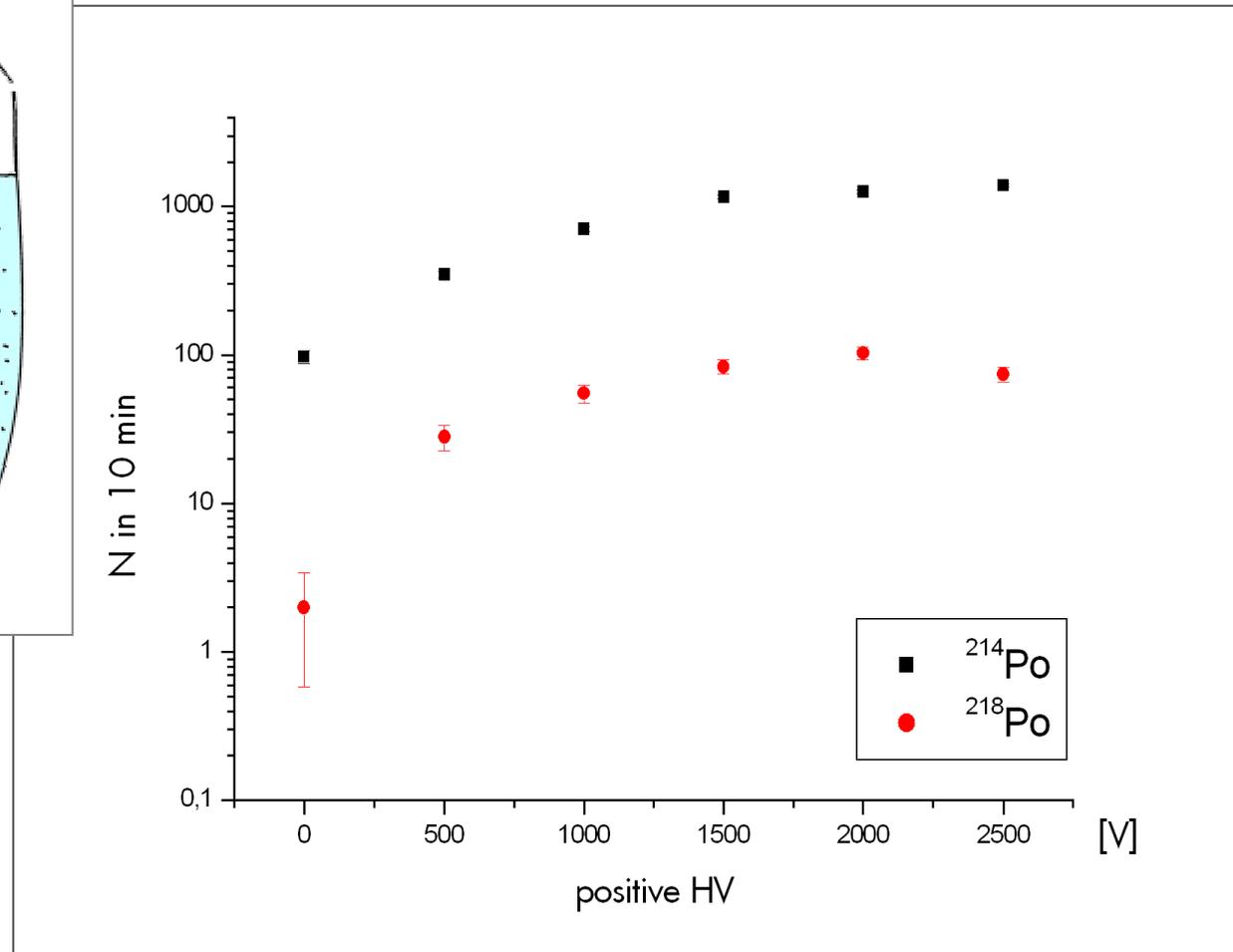
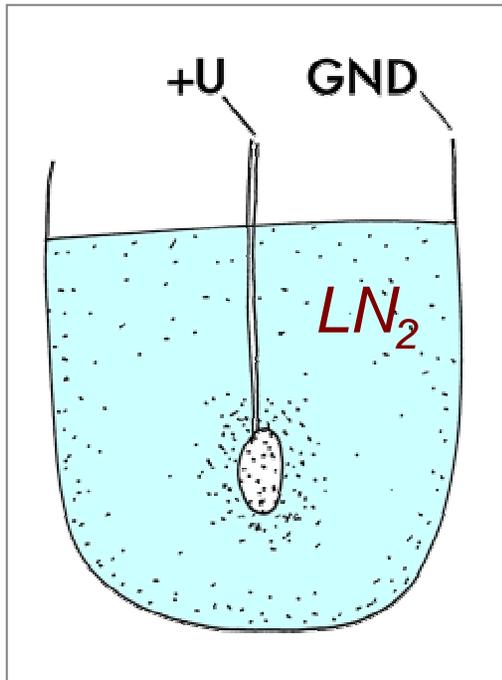
Counts of ^{214}Po and ^{218}Po vs applied voltage negative voltage



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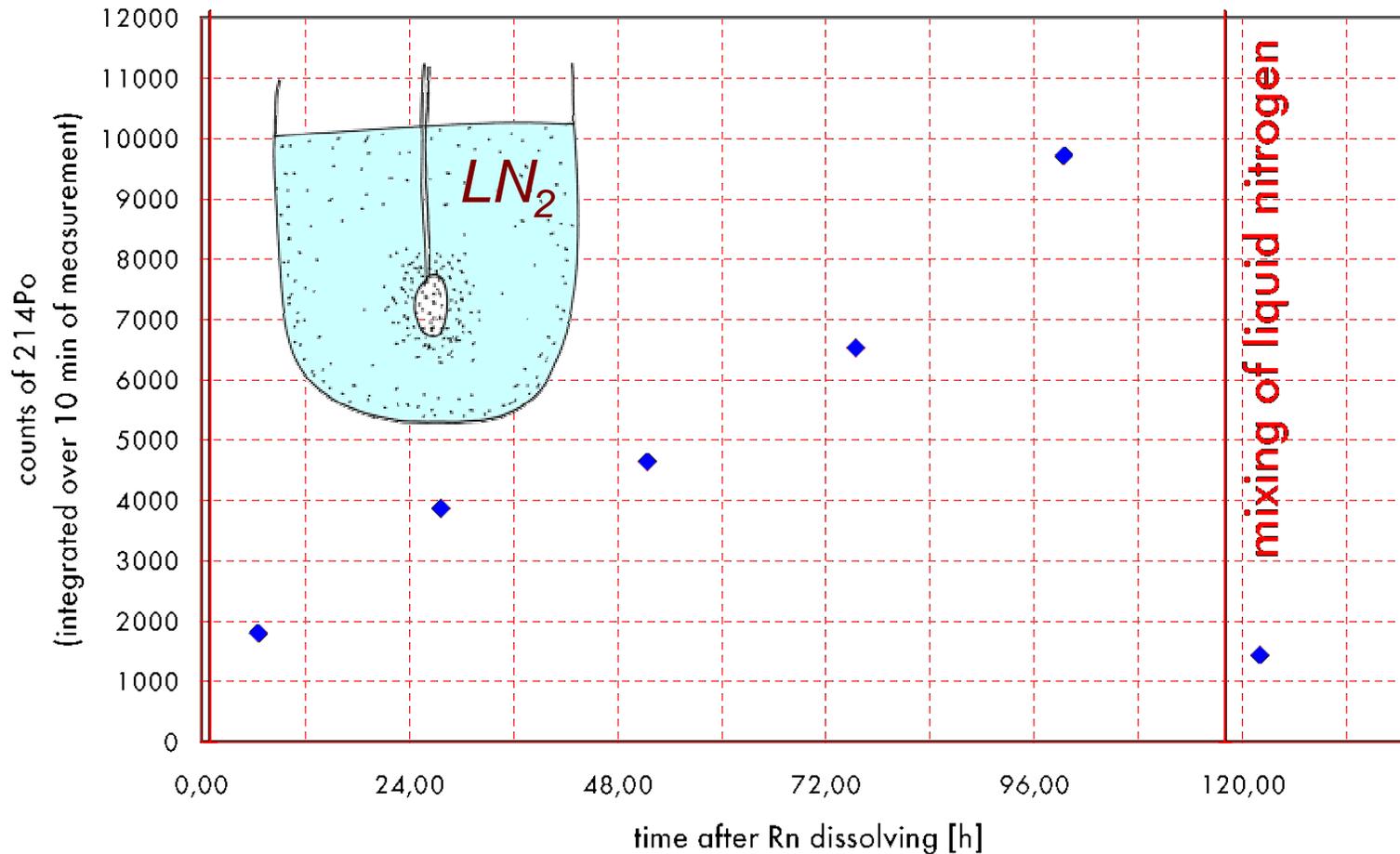
Counts of ^{214}Po and ^{218}Po vs applied voltage positive voltage



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Rn (and daughters) concentration growth in time (with $-2000V$ applied)



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Plans for further measurements

- Germanium plates
- Liquid argon
- Dynamics simulations

Preliminary conclusions

- Large part of Rn is dissolved in LN₂
- The Rn concentration in evaporated gas is lower than in liquid gas and depends on the evaporating rate (heating power)
- High voltage forces Rn to concentrate around the SSP
- The polarity of HV is not meaningless
- The concentration of Rn depends on time of SSP exposure

Open questions

- Mechanism of Rn and Rn – daughters concentration



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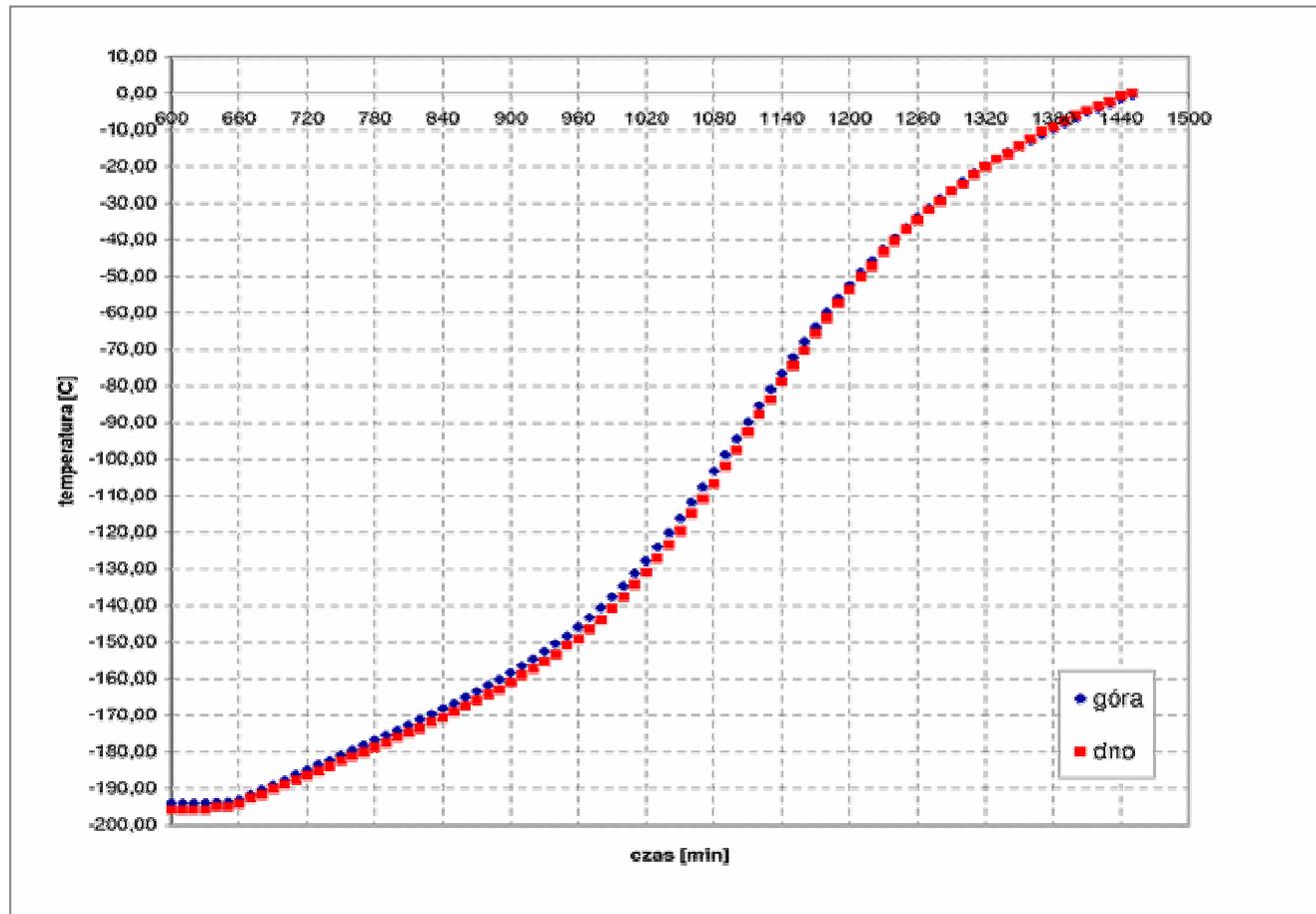


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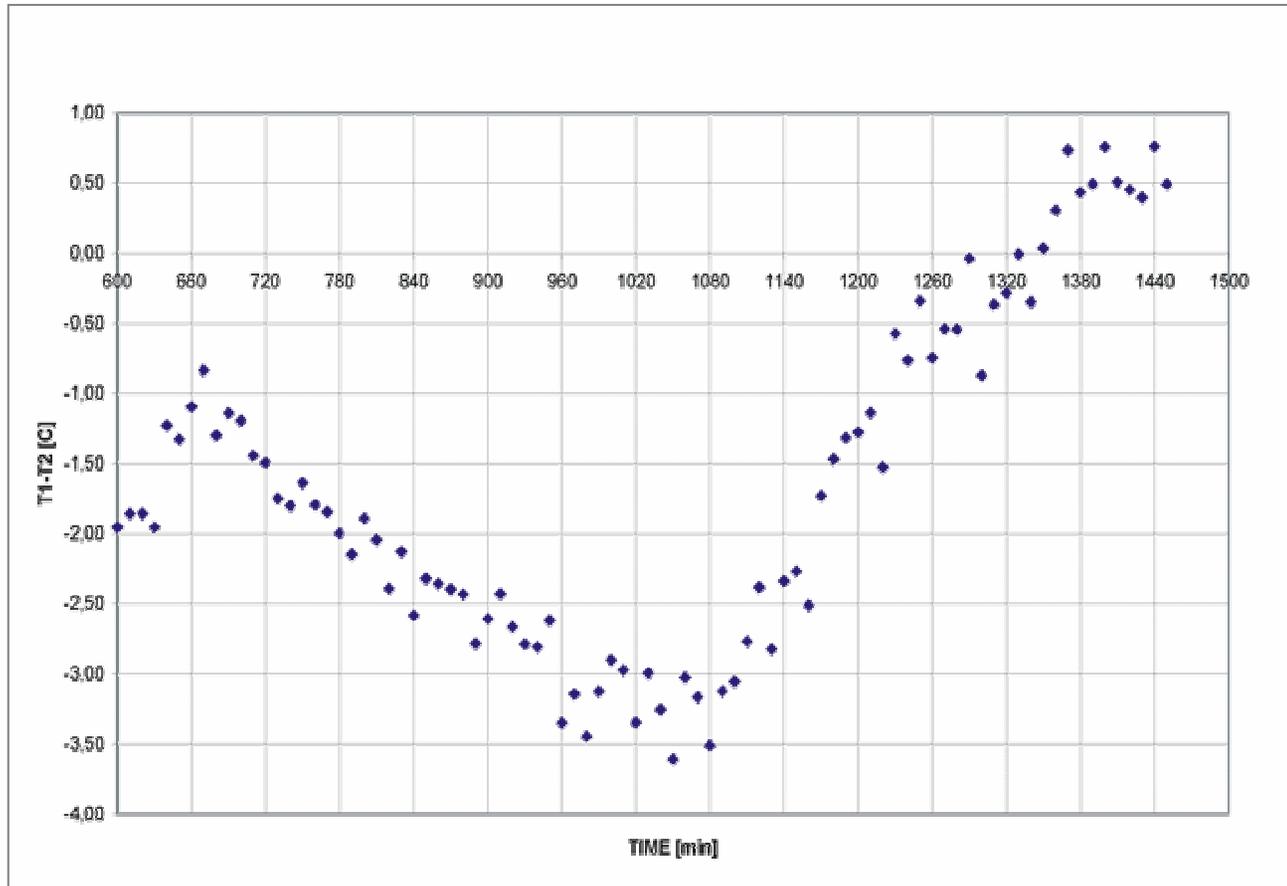
Temperature inside the dewar (top and bottom, after N₂ evaporation)



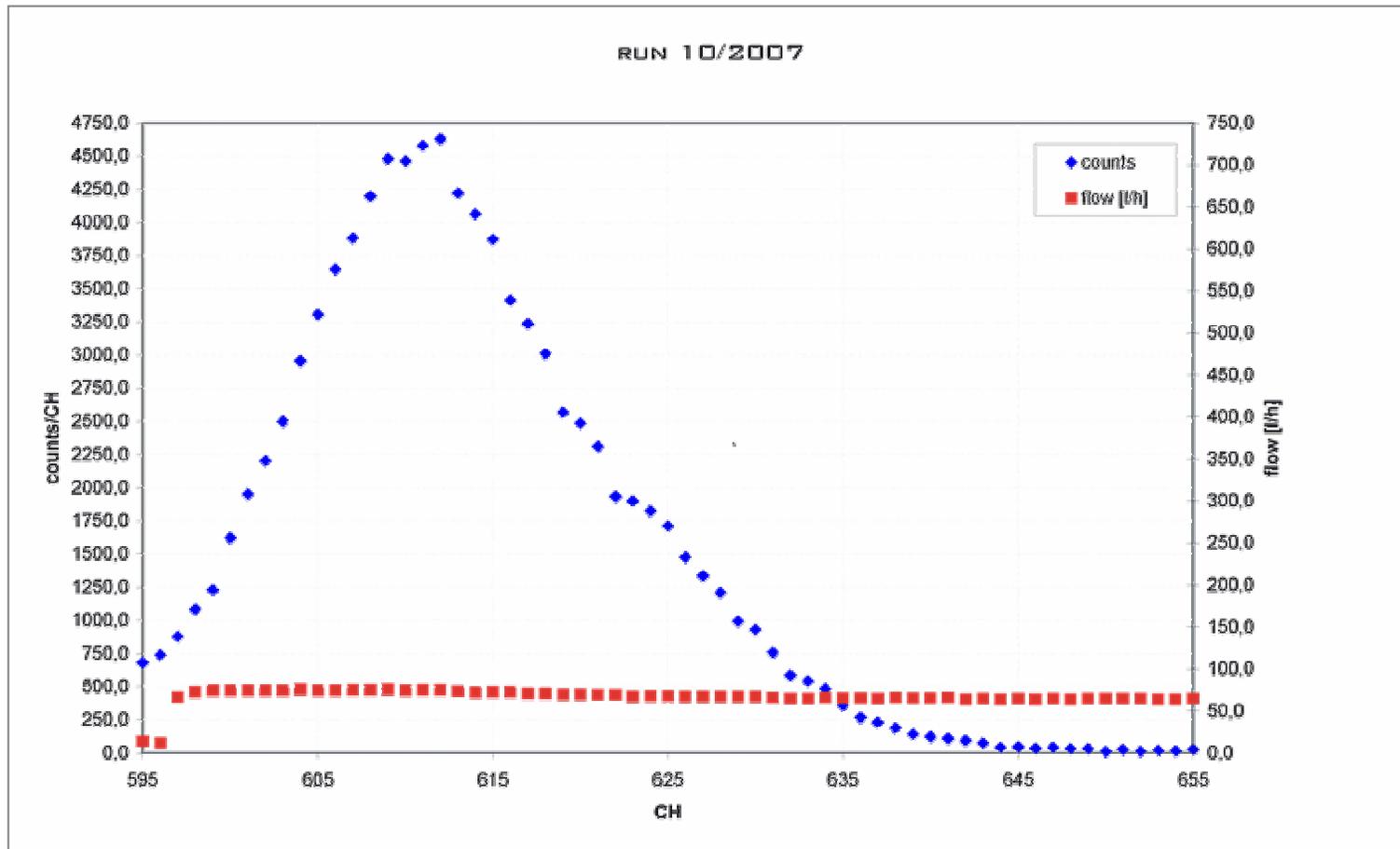
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Temperature difference between top and bottom wall of the dewar (after nitrogen evaporated)



Rn concentration growth (after LN2 evaporated) with constant flow rate



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