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GERDA

Behavior of ^{222}Rn and its daughters in N_2 and LN_2

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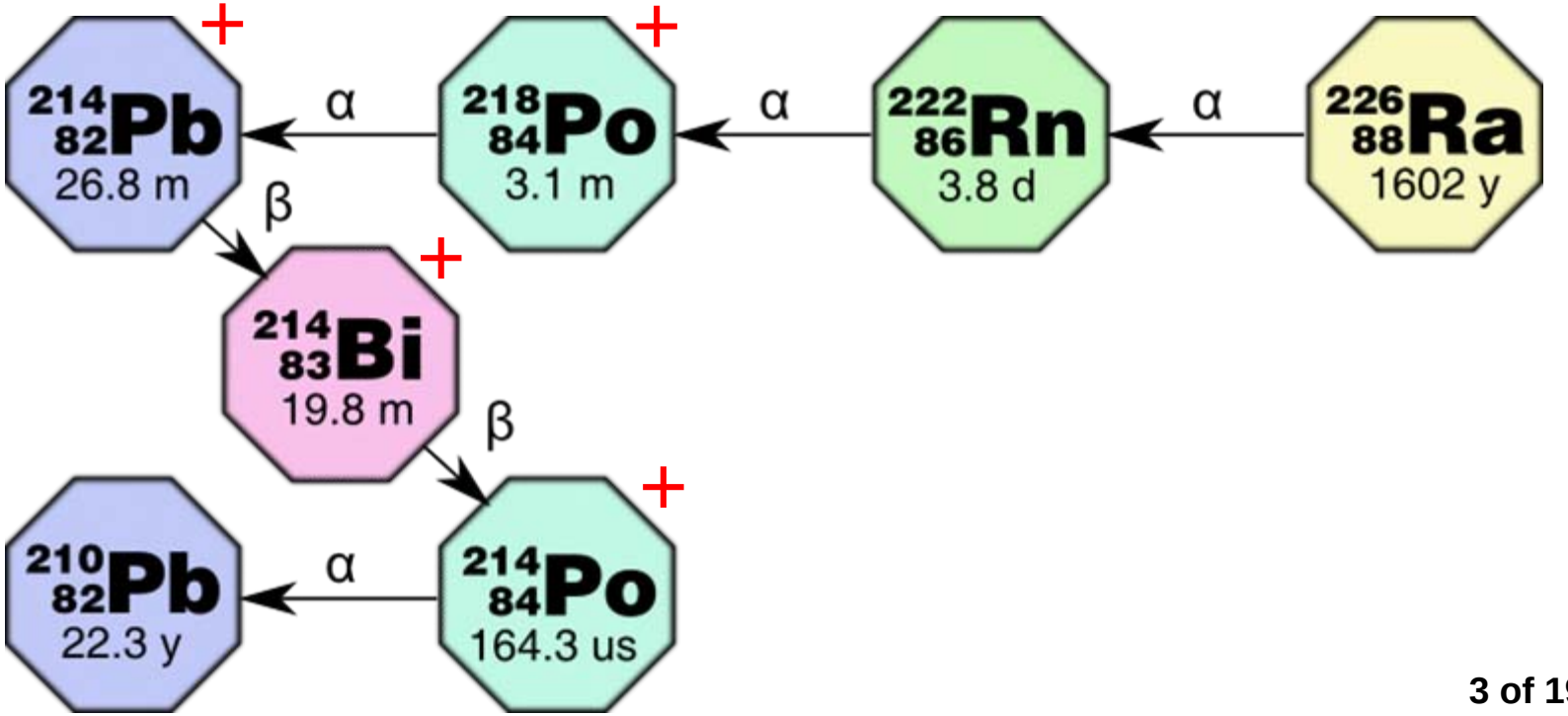
Outline

- Radon daughters in LN_2
  - Long term behaviour – influence of impurities
  - Simple model of the phenomenon
  - Test of the model
- Radon in gaseous N_2
  - Rn freezing out on the walls above the LN_2 surface
  - Rn daughters ”diffusion” into the liquid
- Summary

Rn daughters in LN_2 – long term behaviour

- Each created Rn daughter is positively charged right after the decay
- Electric field attracts the ions

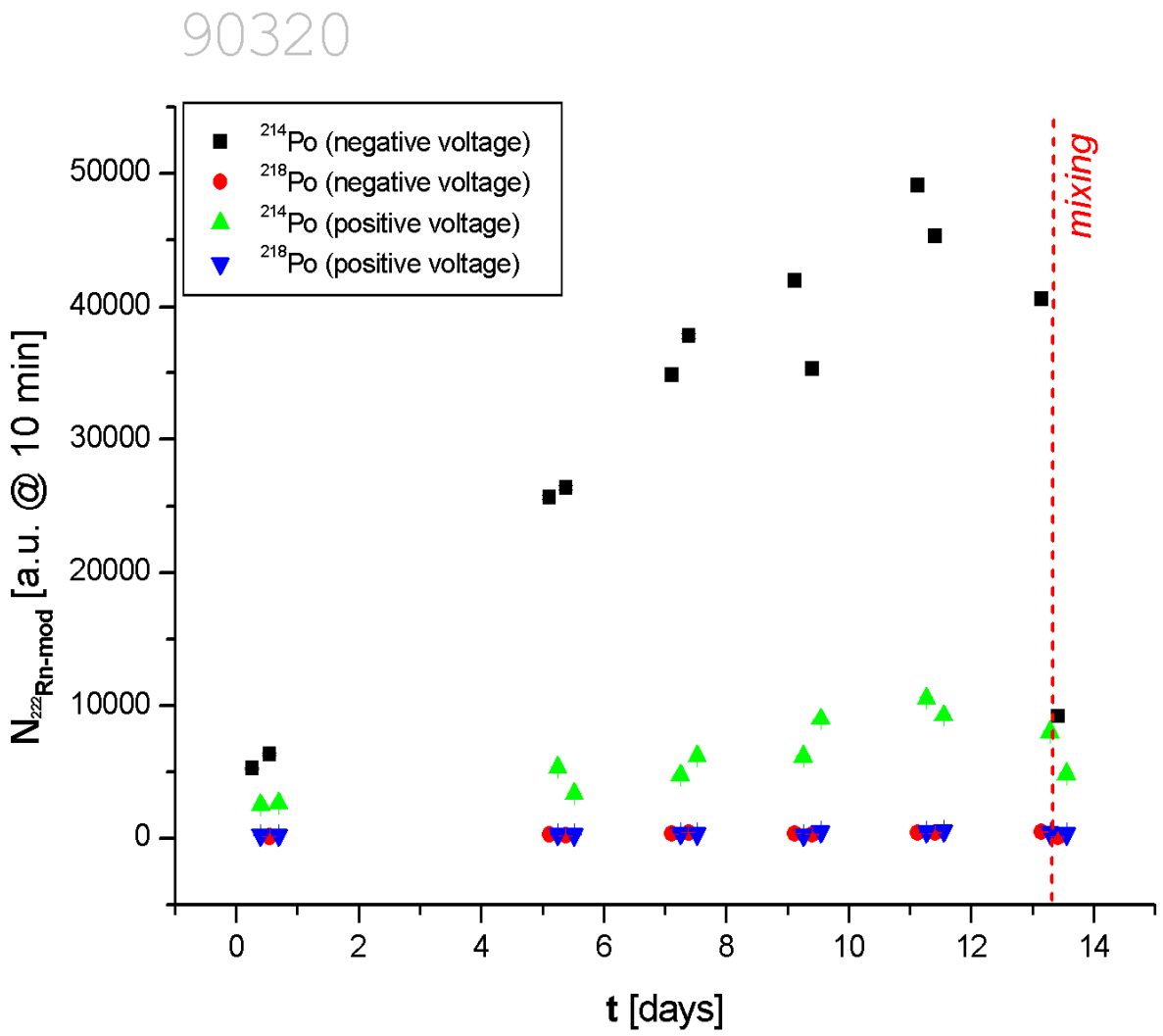


Rn daughters in LN_2 – long term behaviour

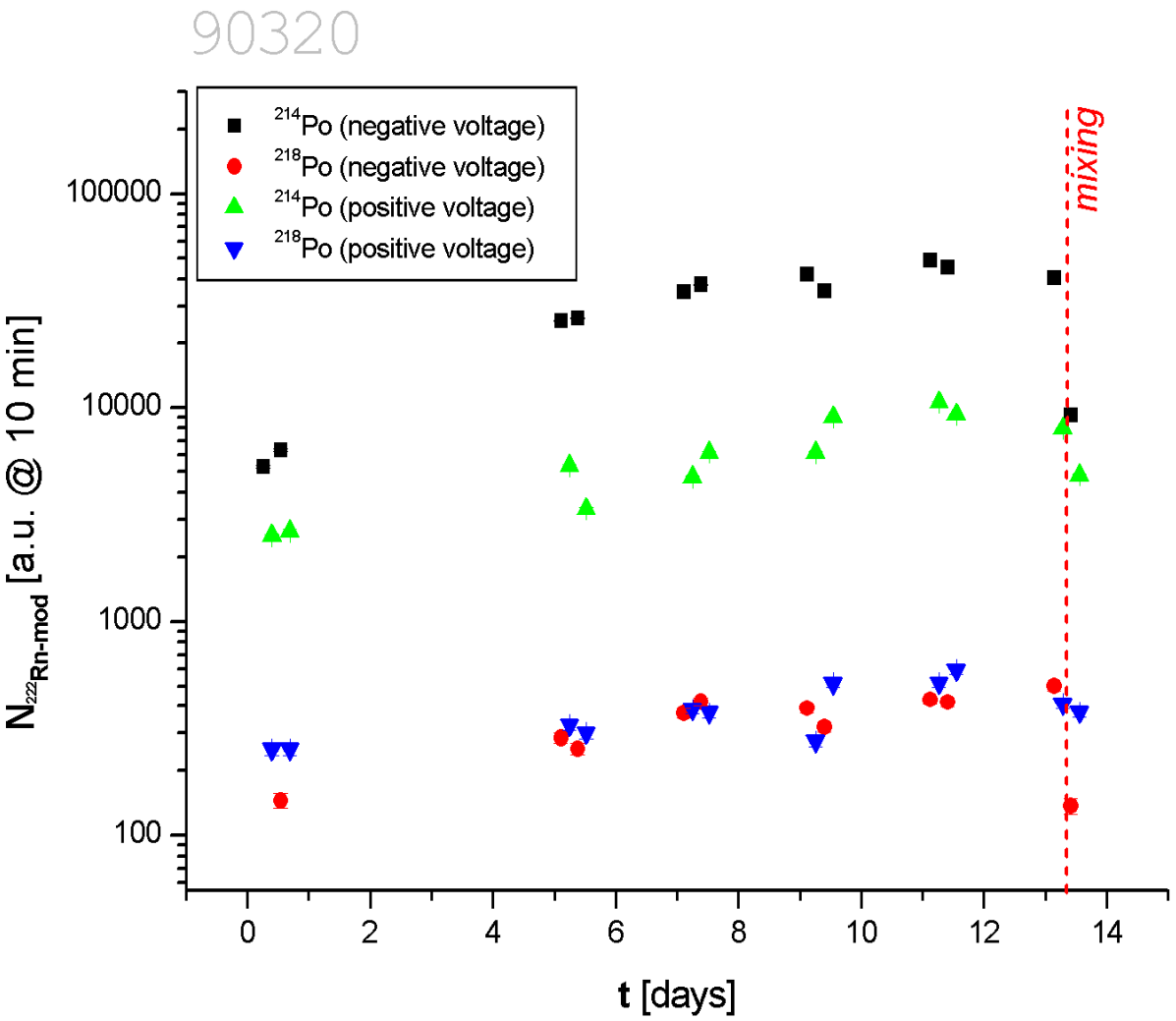
- Positive ion remains charged due to differences in ionizing potentials of the surrounding atoms and the ion

	1st [eV]	2nd [eV]
Ar	15.76	27.63
N	14.53	29.60
Rn	10.75	
Po	8.41	
Pb	7.42	15.03
Bi	7.29	16.69

Rn daughters in LN_2 – long term behaviour



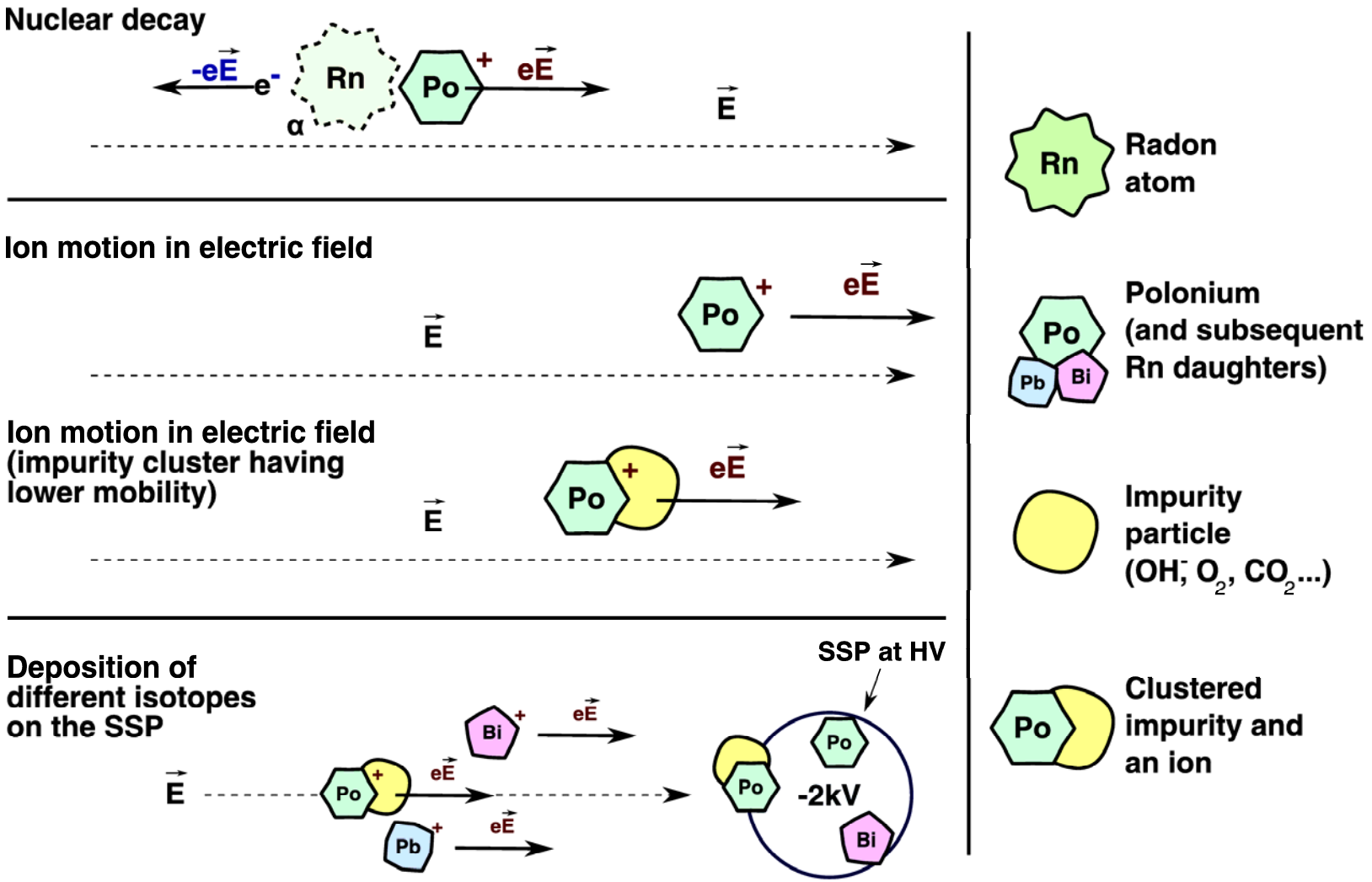
Rn daughters in LN_2 – long term behaviour



Rn daughters in LN_2 – simple model of the phenomenon

- Rn is inert and uniformly distributed in the volume
- Each decay positively charges the atom
- Ions lifetime related to impurities concentration
- Impurities concentration drops down in time
- Ions move in electric field $\mathbf{E}(\mathbf{r})$ with constant mobility μ_{LN2}: $d\mathbf{r} = \mu_{LN2}\mathbf{E}(\mathbf{r})dt$

Rn daughters in LN_2 – simple model of the phenomenon

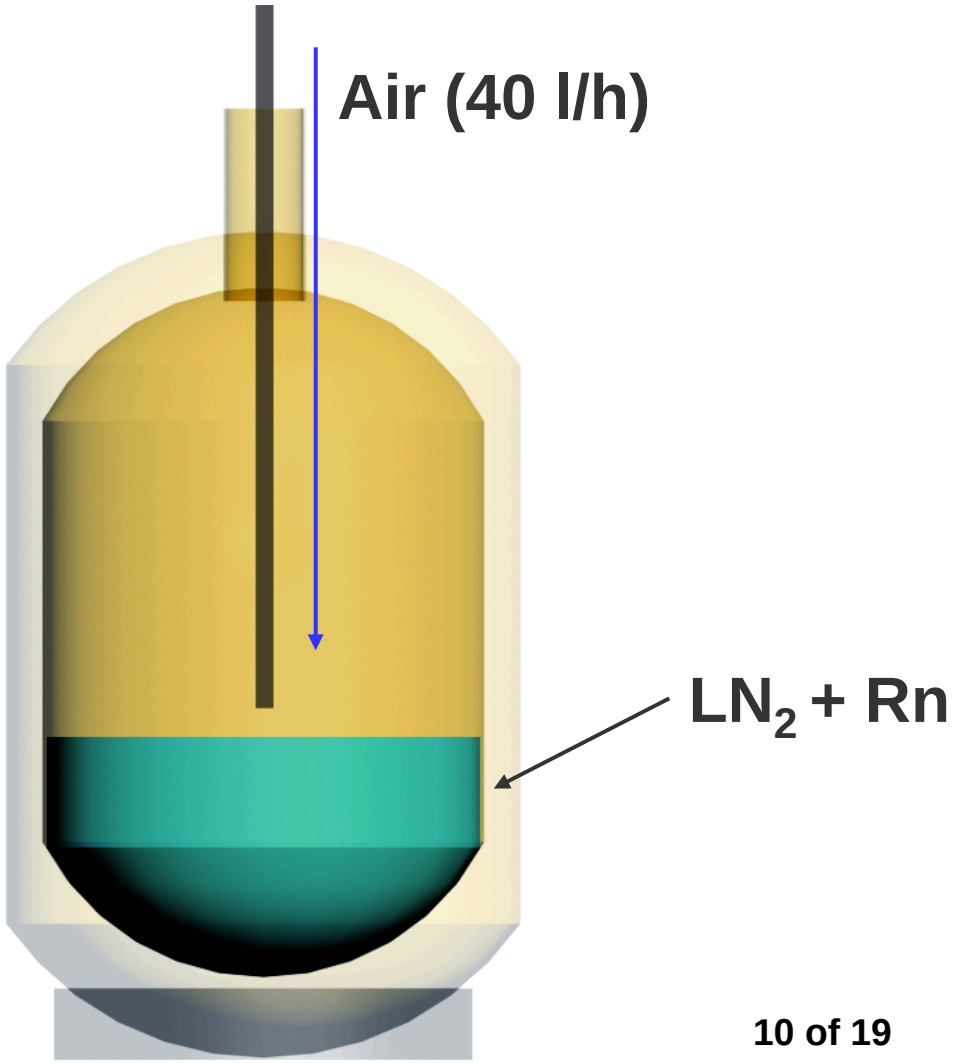


Rn daughters in LN_2 – simple model of the phenomenon

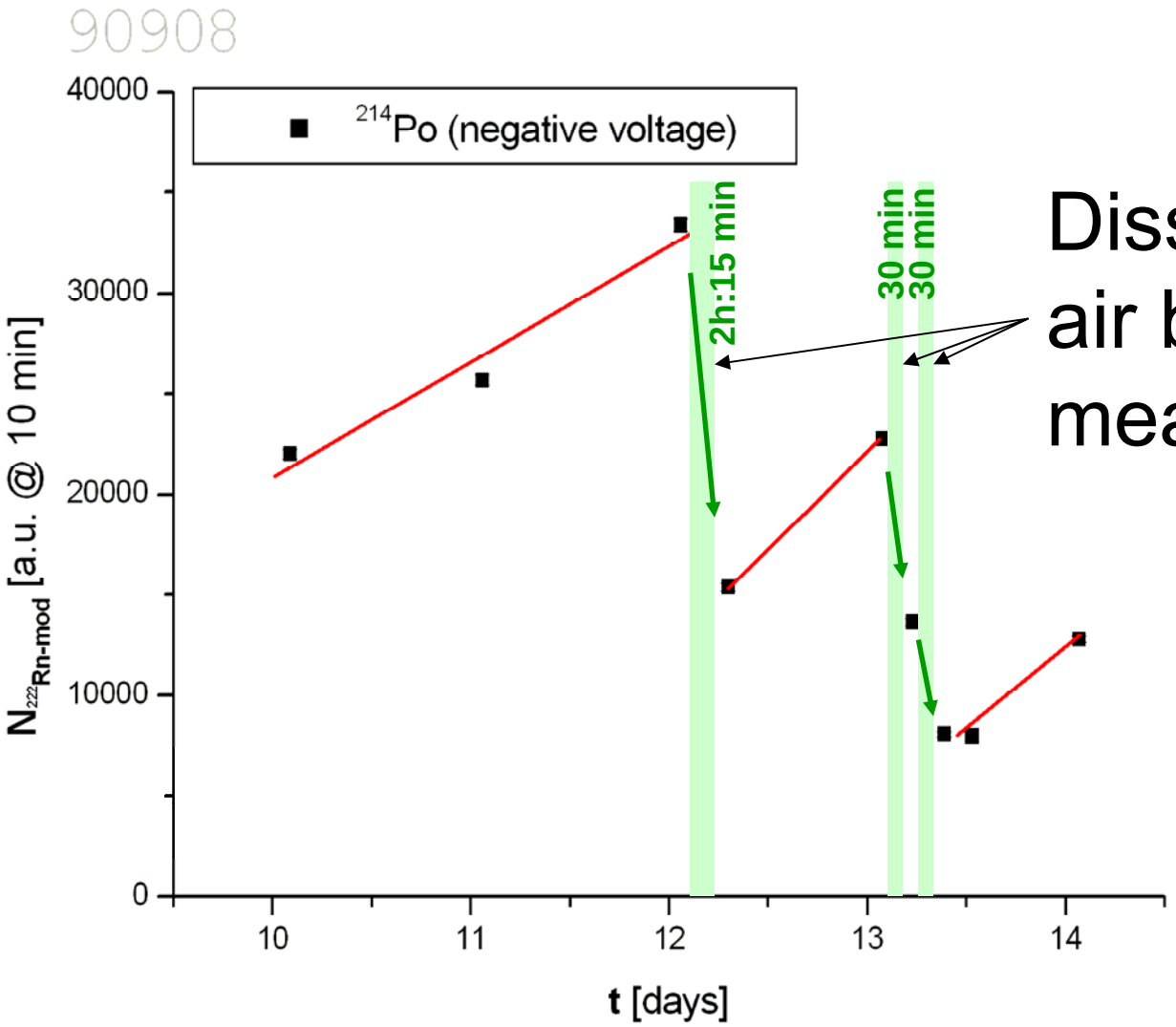
- Impurities are sticking to the walls of the dewar so the lifetime of ions grows
- Activity of Rn daughters collected on the plates grows as more ions approaches the plate (results are Rn-decay corrected)

Rn daughters in LN_2 – test of the model (dissolving of air in the LN_2)

- Dissolving of air for 30 min to 2 hrs before the measurement (stream above the surface of LN_2)
- Measuring of collected Rn – daughters activity in LN_2



Rn daughters in LN_2 – test of the model (dissolving of air in the LN_2)



Dissolving of air before the measurement

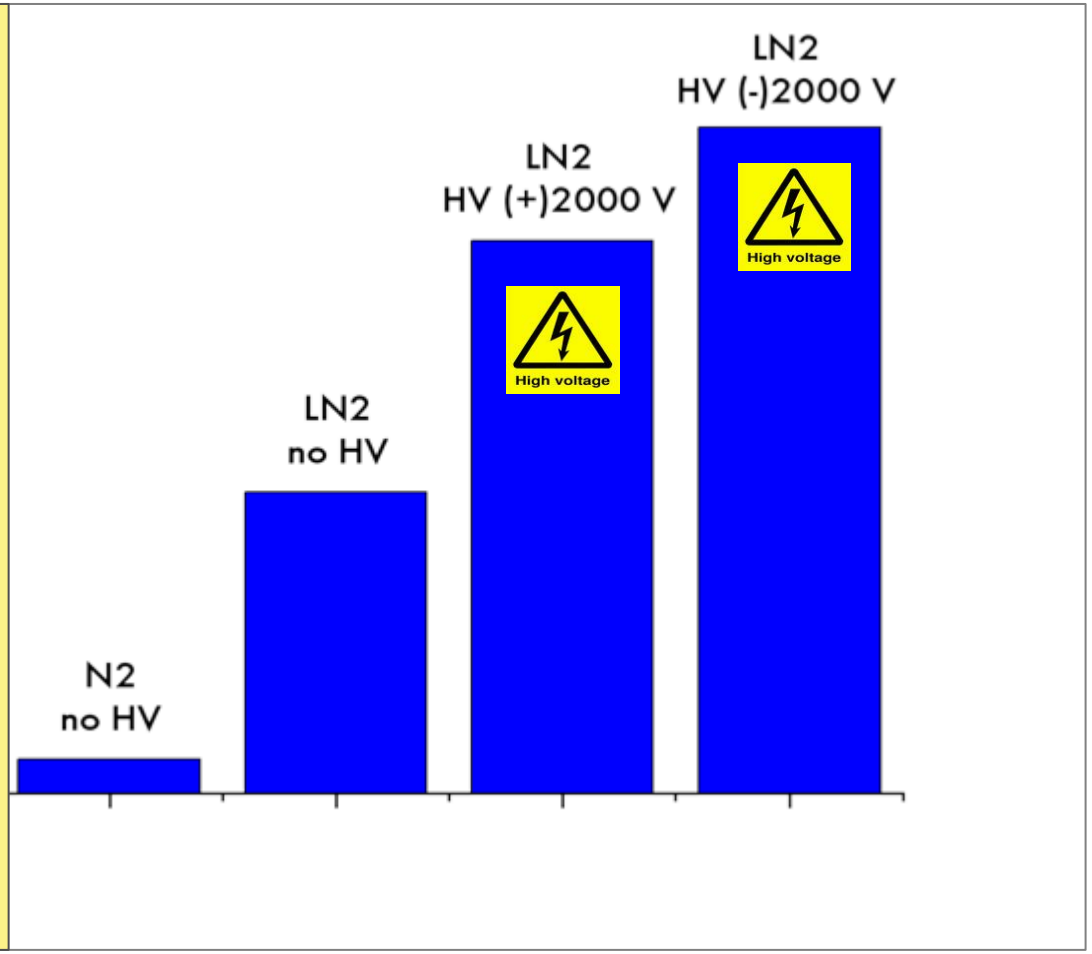
High voltage influence on counts of ^{214}Po

$$R_1 = \frac{N(LN_2)}{N(gasN_2)} = 13,9 \pm 5,4$$

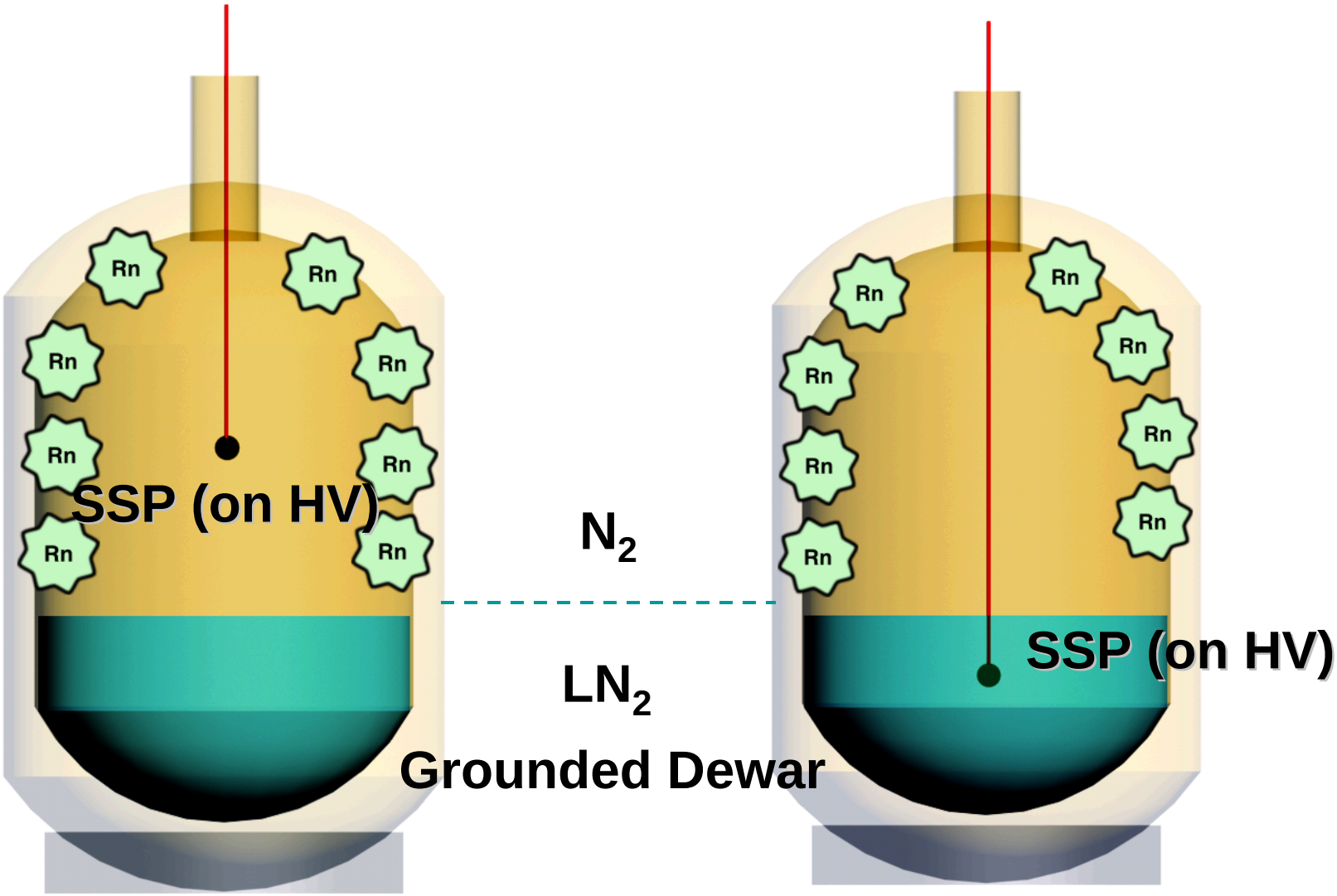
$$R_2 = \frac{N(HV:-2kV)}{N(HV:+2kV)} = 3,07 \pm 0,10$$

$$R_3 = \frac{N(HV:+2kV)}{N(LN_2)} = 11,8 \pm 1,2$$

$$R_4 = \frac{N(HV:-2kV)}{N(LN_2)} = 36,2 \pm 3,7$$



Radon in gaseous N_2 – Rn freezing out on the walls above the LN_2 surface



Radon in gaseous N_2 – Rn freezing out on the walls above the LN_2 surface

^{214}Po ^{218}Po	N_2	LN_2
No-HV	22 ± 5 9 ± 3	0 0
+ 2000 V	23 ± 5 5 ± 3	13 ± 4 0
- 2000 V	2717 ± 52 536 ± 23	44 ± 7 1 ± 1

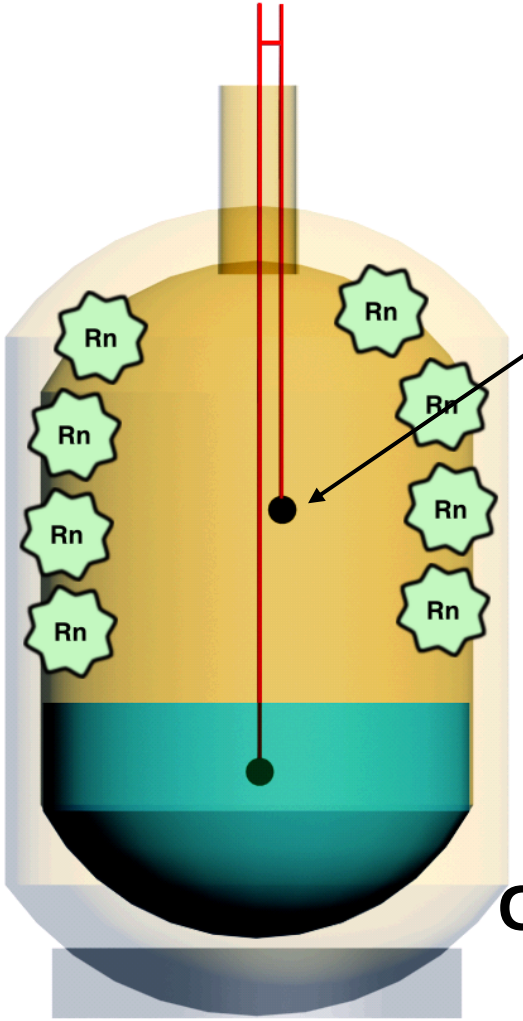
Radon in gaseous N_2 – Rn freezing out on the walls above the LN_2 surface

- Rn dissolved in the gas quickly froze out on the walls
- Boil-off cleans the volume of ~15 l above the LN_2 (60 l/h of gas) fast

Radon in gaseous N_2 – Rn freezing out on the walls above the LN_2 surface

- Electric field attracts Rn daughters from the walls
  - The same results for no field and positive field (decays of some Rn atoms close to the plate etc., no carriage particles for positive HV counts)

Radon in gaseous N_2 – Rn freezing out on the walls above the LN_2 surface



Ion attractor

Both SSPs at the same HV

N_2

LN_2

Grounded Dewar

Radon in gaseous N_2 – Rn daughters diffusion into the liquid

- Example of the detailed data *with* and *without* outer ion “attractor” (Rn daughters counts on the SSP immersed in LN_2)

^{214}Po **^{218}Po**	**with** attractor	**without** attractor
- 2000 V	**44 ± 7** **1 ± 1**	**92 ± 10** **1 ± 1**

Summary

- Impurities influence the Rn-daughters behaviour in LN_2
- Inlet of Rn from the lock system
  - Freezing out of Rn on the surfaces – **Good**
  - Low ”diffusion” of Rn-daughters – **Good**
  - **E** field attracts daughters (3 h of lifetime), but checked for low immersion depth (electric field relatively high) – **Bad**