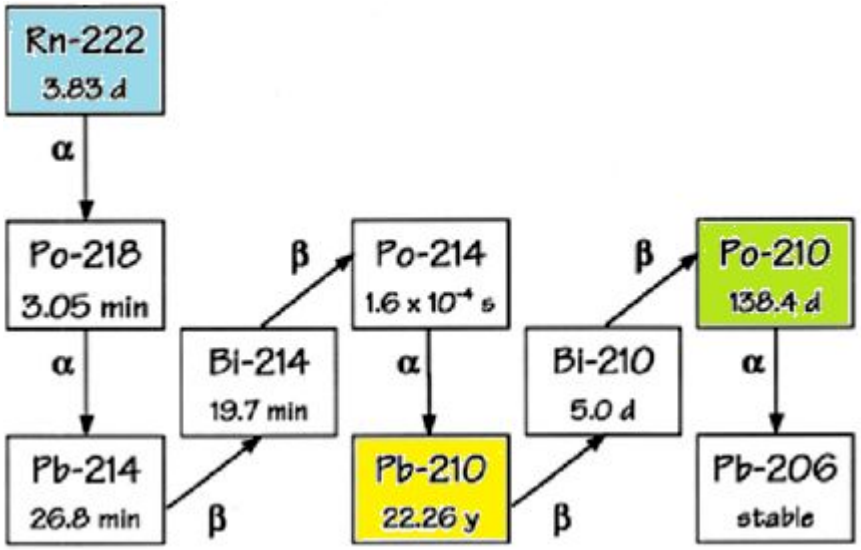
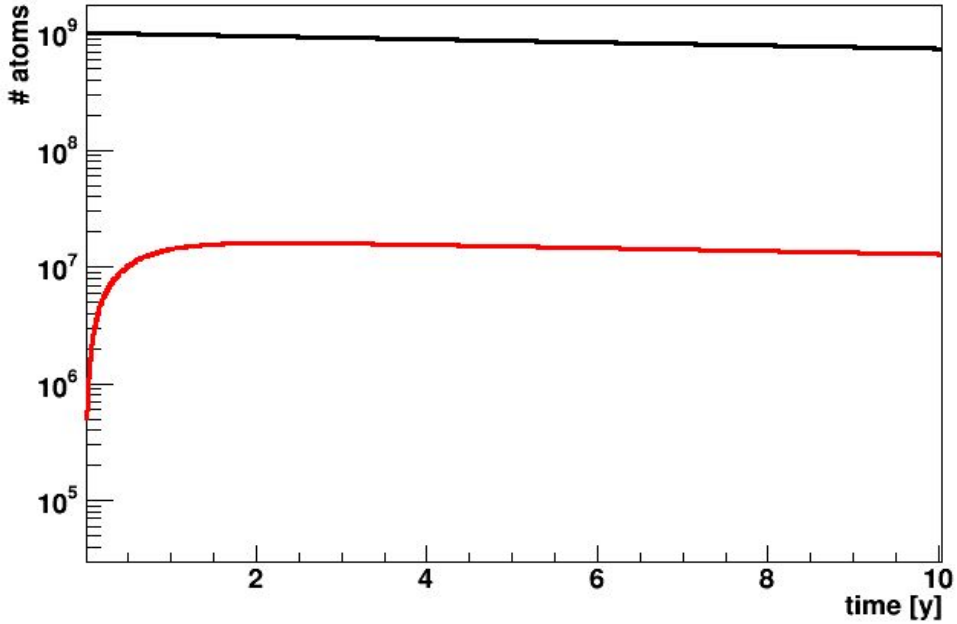
Surface contamination

DS-Mat

Pb-210 and Po-210 contamination

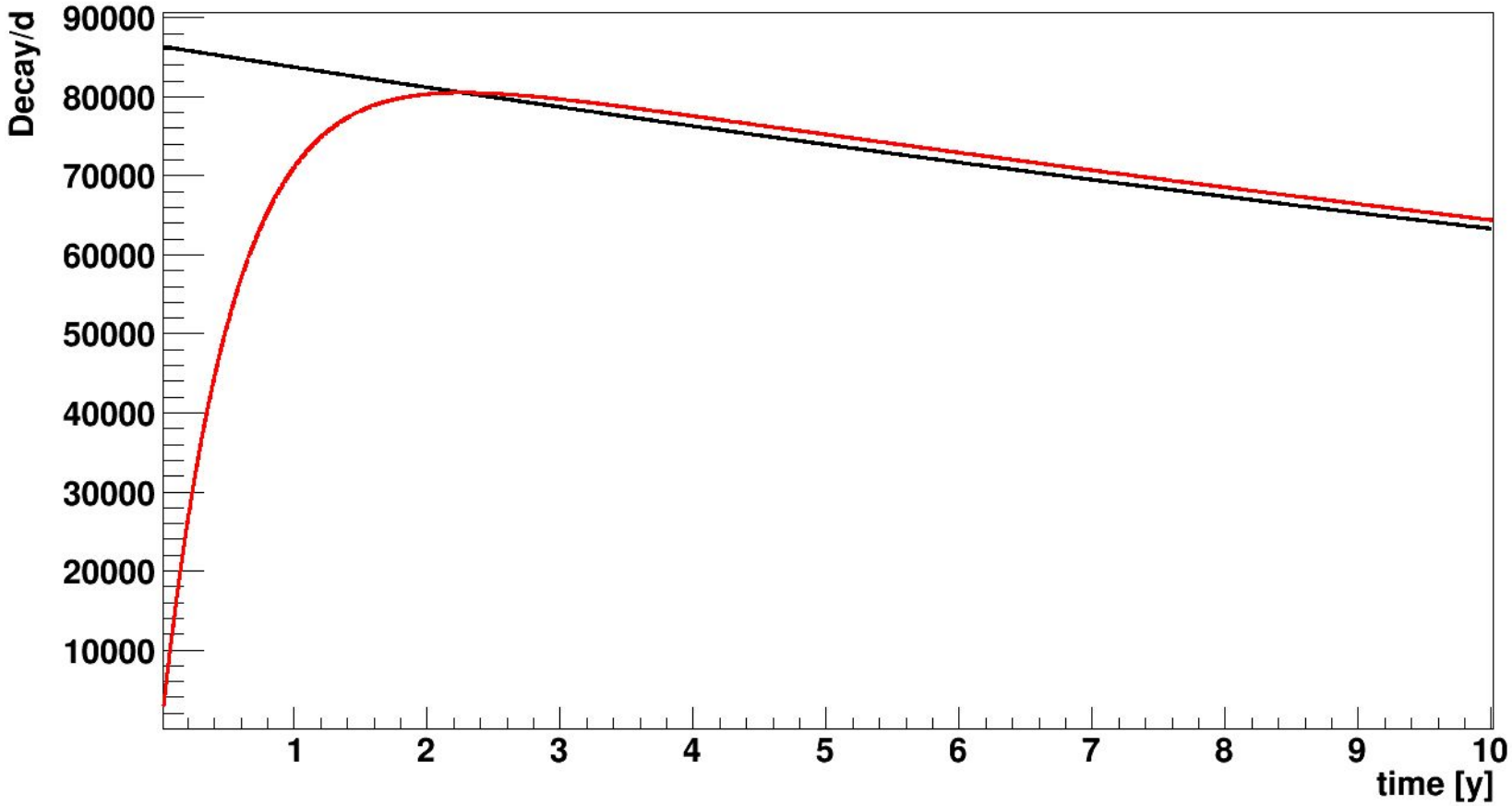


Pb-210 main source of Po-210

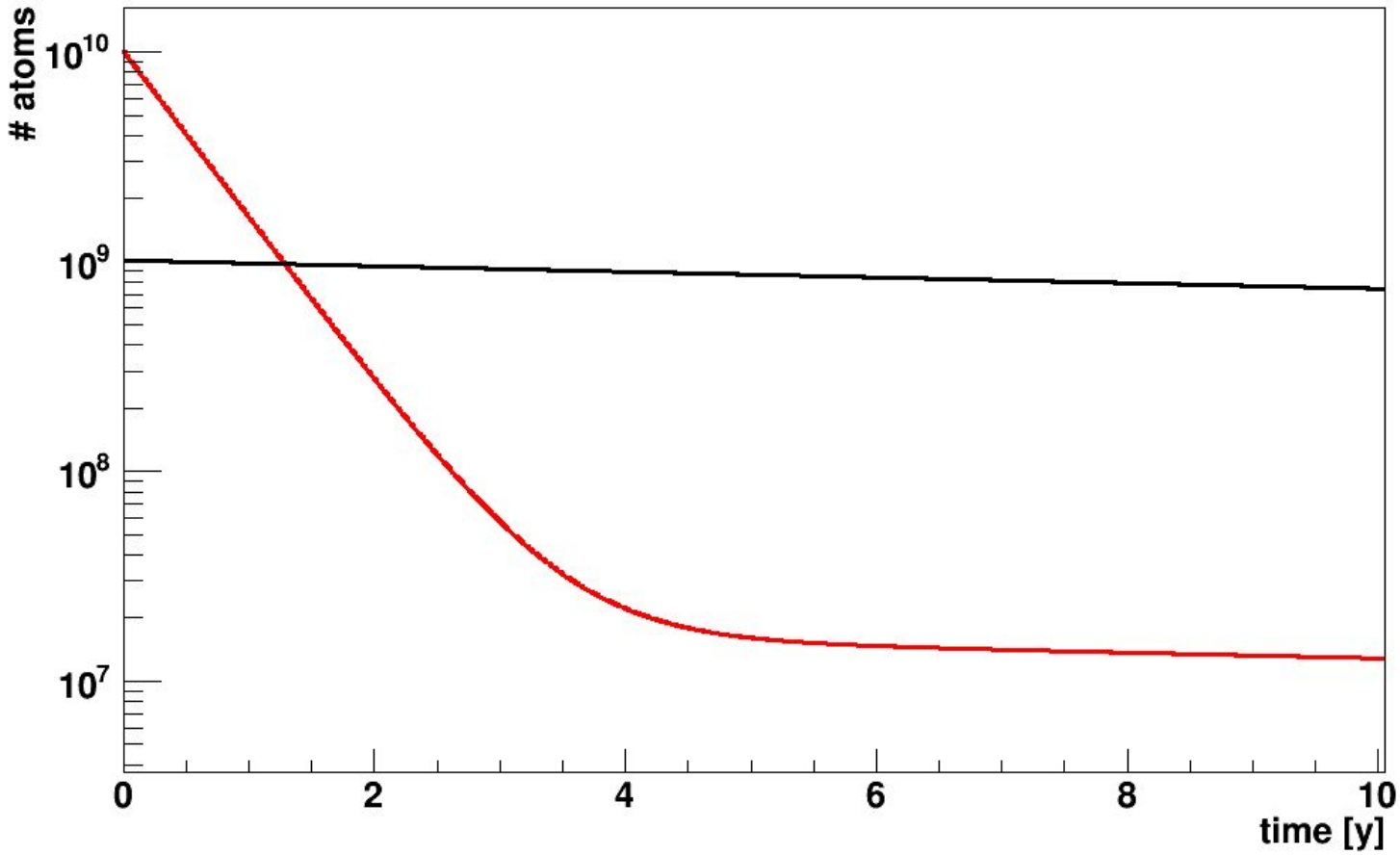


1 Bq Pb-210 -> 1.015253e+09 atoms

1 Bq Po-210 -> 1.725140e+07 atoms


Decay/d
90000
80000
70000
60000
50000
40000
30000
20000
10000
1
2
3
4
5
6
7
8
9
10
time [y]

No-equilibrium ($N^0_{Po210} = 10 \times N^0_{Pb210}$)



High-activity case

Isotope	Activity reduction factors after etching/electropolishing			
			Germanium	
	Copper	Stainless steel	NPGe	HPGe
^{210}Pb	50 / 300	100 / 400	100 / –	700 / –
^{210}Bi	50 / 300	100 / 800	400 / –	800 / –
^{210}Po	1 / 400	20 / 700	1000 / –	100 / –

Copper

- etching: 5 min in (1% H_2SO_4 + 3% H_2O_2) and 5 min in 1% citric acid
- electro-polishing: 85 % H_3PO_4 + 5 % 1-butanol ($C_4H_{10}O$)

Stainless steel:

- etching: (20 % HNO_3 + 1.7 % HF) and 15 % HNO_3
- electro-polishing: 40 % H_3PO_4 + 40 % H_2SO_4 + 3 % CrO_3

Germanium:

- etching: CP4 solution (45.45 ml HNO_3 + 27.27 ml HF + 27.27 ml CH_3COOH + 0.5 ml Br for 100 ml solvent) done by Canberra-France in Lingolsheim in cooperation with MPP Munich

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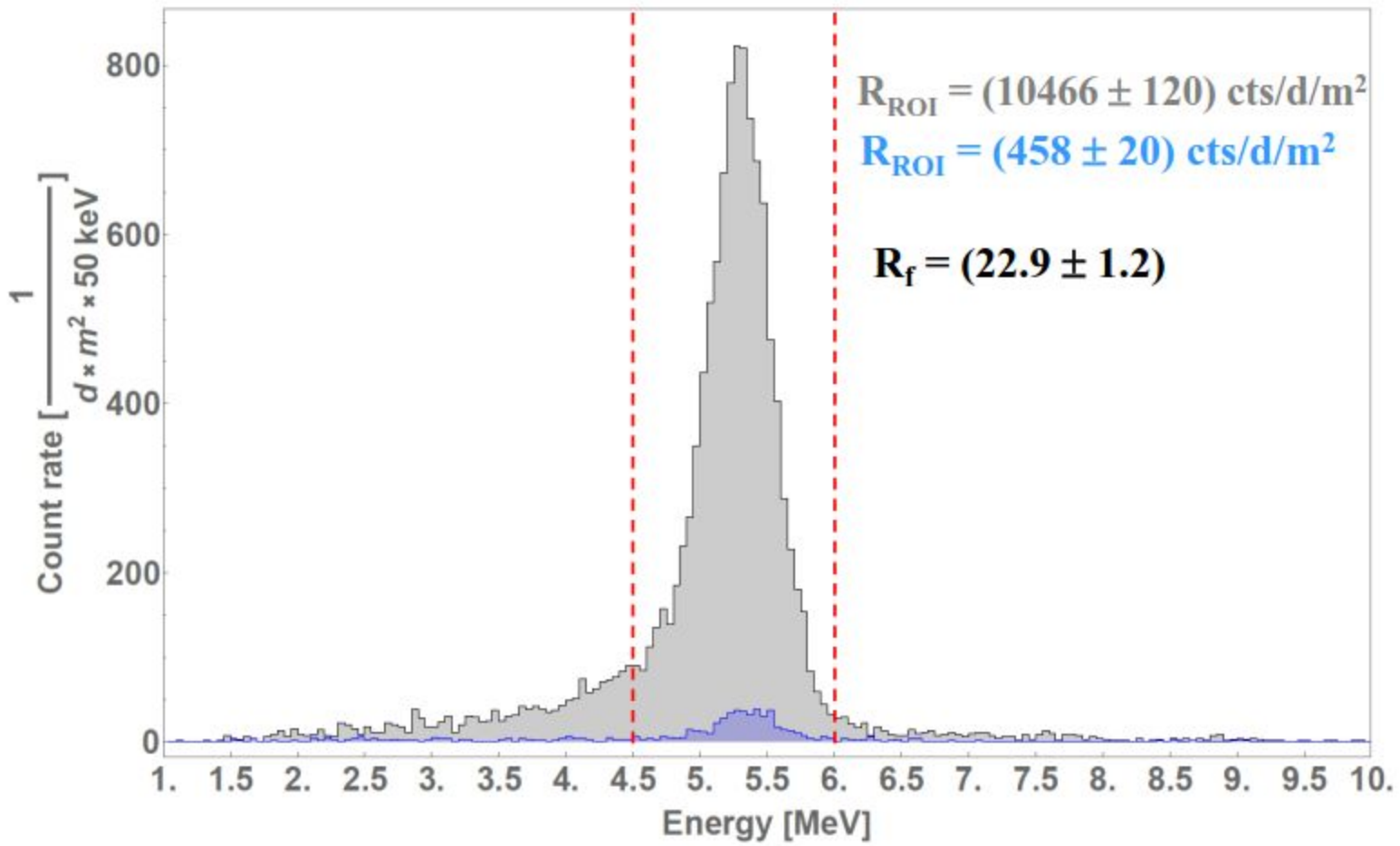
„Dynamic" etching



- Etching procedure: 5 x 1 min wash with a mixture of 1% H_2SO_4 + 3% H_2O_2
- Passivation with 1% citric acid at the end
- Washing in high-purity deionized water (18 MΩ×cm)

Impact of the surface 210Po contamination on the bkg budget

Assumptions:

- Rn plate-out rate (only): **250 atoms/day/cm^2** (based on SNOLAB measurement for 153 Bq/m^3). **INDEPENDENTLY of material.**
- Considered the plate-out rate proportional to Rn activity. No other effects.
- Surfaces (**m^2**) :

surface barrel = 41.244
surface caps = 10.4764
surfAcryTPC = 124.394
surfAcryVeto = 880
surfSS = 28
surfCuElec = 209.528
surfElec = 209.528
surfCuVeto = 248.787

Evolution of activity in time taken into account (10 y is a good fraction of 22.2 y)

Impact of the surface 210Po contamination on the bkg budget

Cases:

- Exposure
  - 1 day
  - 6 months

- Environment activity
  - 153 Bq/m^3
  - 0.1 Bq/m^3

Both are considered to have a linear effect.

Impact of the surface 210Po contamination on the bkg budget

Case 1 day + clean:

	Before CUTS			After CUTS		
nSource	Self pr.	Argon	Sum	Self pr.	Argon	Sum
AcryTPC	3.14E-3	5.76E-3	8.91E-3	2.26E-8	4.15E-8	6.41E-8
AcryVeto	2.22E-2	4.08E-2	6.30E-2	1.29E-8	2.37E-8	3.66E-8
SS_TPC	6.49E-4	1.30E-3	1.95E-3	4.35E-10	8.69E-10	1.30E-9
Cu_Elec	1.41E-3	9.71E-3	1.11E-2	1.02E-8	6.99E-8	8.01E-8
Cu_FC	1.68E-3	1.15E-2	1.32E-2	9.73E-10	6.69E-9	7.66E-9
Elec	6.62E-3	9.71E-3	1.63E-2	4.77E-8	6.99E-8	1.18E-7
TOTAL	3.57E-2	7.88E-2	1.15E-1	9.48E-8	2.13E-7	**3.07E-7**

Impact of the surface 210Po contamination on the bkg budget

Case 6 months + clean:

	Before CUTS			After CUTS		
nSource	Self pr.	Argon	Sum	Self pr.	Argon	Sum
AcryTPC	5.66E-1	1.04E+0	1.60E+0	4.07E-6	7.47E-6	1.15E-5
AcryVeto	4.00E+0	7.34E+0	1.13E+1	2.32E-6	4.26E-6	6.58E-6
SS_TPC	1.17E-1	2.34E-1	3.50E-1	7.82E-8	1.56E-7	2.35E-7
Cu_Elec	2.54E-1	1.75E+0	2.00E+0	1.83E-6	1.26E-5	1.44E-5
Cu_FC	3.02E-1	2.08E+0	2.38E+0	1.75E-7	1.20E-6	1.38E-6
Elec	1.19E+0	1.75E+0	2.94E+0	8.58E-6	1.26E-5	2.12E-5
TOTAL	6.43E+0	1.42E+1	2.06E+1	1.71E-5	3.83E-5	**5.53E-5**

Impact of the surface 210Po contamination on the bkg budget

Case 1 day + dirty:

	Before CUTS			After CUTS		
nSource	Self pr.	Argon	Sum	Self pr.	Argon	Sum
AcryTPC	4.81E+0	8.82E+0	1.36E+1	3.46E-5	6.35E-5	9.81E-5
AcryVeto	3.40E+1	6.24E+1	9.64E+1	1.97E-5	3.62E-5	5.59E-5
SS_TPC	9.93E-1	1.99E+0	2.98E+0	6.65E-7	1.33E-6	2.00E-6
Cu_Elec	2.16E+0	1.49E+1	1.70E+1	1.56E-5	1.07E-4	1.23E-4
Cu_FC	2.57E+0	1.76E+1	2.02E+1	1.49E-6	1.02E-5	1.17E-5
Elec	1.01E+1	1.49E+1	2.50E+1	7.29E-5	1.07E-4	1.80E-4
TOTAL	5.47E+1	1.21E+2	1.75E+2	1.45E-4	3.25E-4	**4.70E-4**

Impact of the surface 210Po contamination on the bkg budget

Case 6 months + dirty:

	Before CUTS			After CUTS		
nSource	Self pr.	Argon	Sum	Self pr.	Argon	Sum
AcryTPC	8.66E+2	1.59E+3	2.45E+3	6.23E-3	1.14E-2	1.77E-2
AcryVeto	6.13E+3	1.12E+4	1.74E+4	3.55E-3	6.51E-3	1.01E-2
SS_TPC	1.79E+2	3.57E+2	5.36E+2	1.20E-4	2.39E-4	3.59E-4
Cu_Elec	3.89E+2	2.67E+3	3.06E+3	2.80E-3	1.93E-2	2.21E-2
Cu_FC	4.62E+2	3.17E+3	3.64E+3	2.68E-4	1.84E-3	2.11E-3
Elec	1.82E+3	2.67E+3	4.50E+3	1.31E-2	1.93E-2	3.24E-2
TOTAL	9.84E+3	2.17E+4	3.15E+4	2.61E-2	5.85E-2	**8.46E-2**

Cleaning protocols (manipulation and packaging)

- Copper (this should be OK):
    a. Tumbling
    b. electropolishing
    c. Specific chemical etching (SUBU)
- Stainless Steel (similar protocol of Copper)
    a. Tumbling
    b. electropolishing
    c. chemical etching
- Acrylic (for small or fragile components)
    a. atmospheric plasma treatments

- Reflectors?
- Electronics (cable? components?)
- more?

Parylene coating ???

SS

- Electropolishing necessary? (bars? Entire Structure?)
- Dimensions and Welding details needed
- Welding Rn emanation: possible measurements

Electronics

- What is the possible impact?
- Total surface?
- a,n yield in worst scenario (entire 210Po contamination on the surface)

Conclusion:

Rn plate-out is a relevant source of n-bkg. It needs to be mitigated:

- We need to avoid exposure to Rn in all steps
- Materials have to be stored in Rn-free atmosphere
- We need to foresee surface cleaning protocols