Radon emanation reduction of MPGD @ NEWAGE

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Dark matter search...

- Background reduction -> Need!
  - NITPC development
  - Low background detector development -> This talk
    - TPC inner BG: alpha-ray emission, radon…
  - Outer shield…
- Larger Volume -> Need!
  - ex. CYGNUS TPC

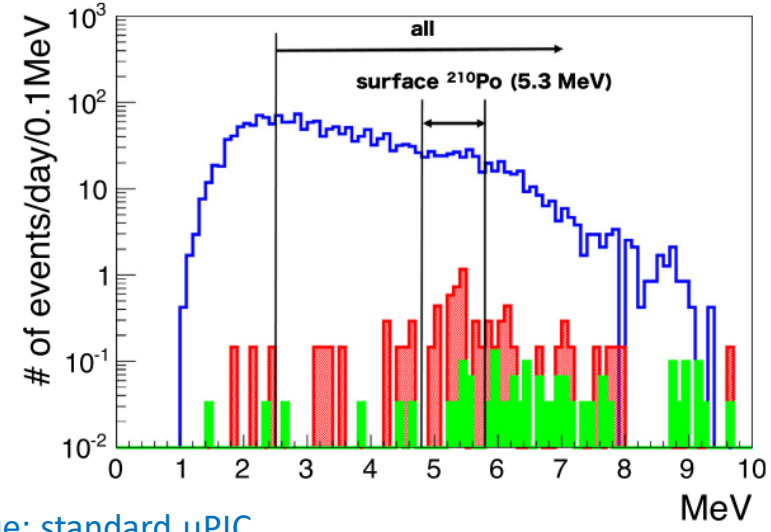
NEWAGE's MPGD – LAμPIC

- **LAμPIC** (Low alpha μPIC)
  - currently used in NEWAGE dark matter run
  - 30 x 30 cm^2 area, 400 um pitch, anode and cathode (both 768 chs)

PTEP 2021 063F01

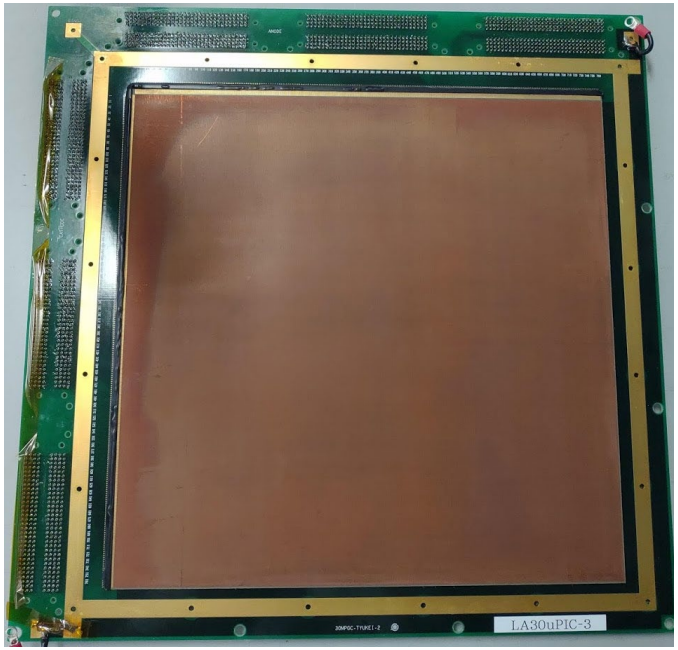
- **Achievement**
  - Changed surface material from standard μPIC (used before)

-> Surface alpha emission was reduced compare to standard μPIC !



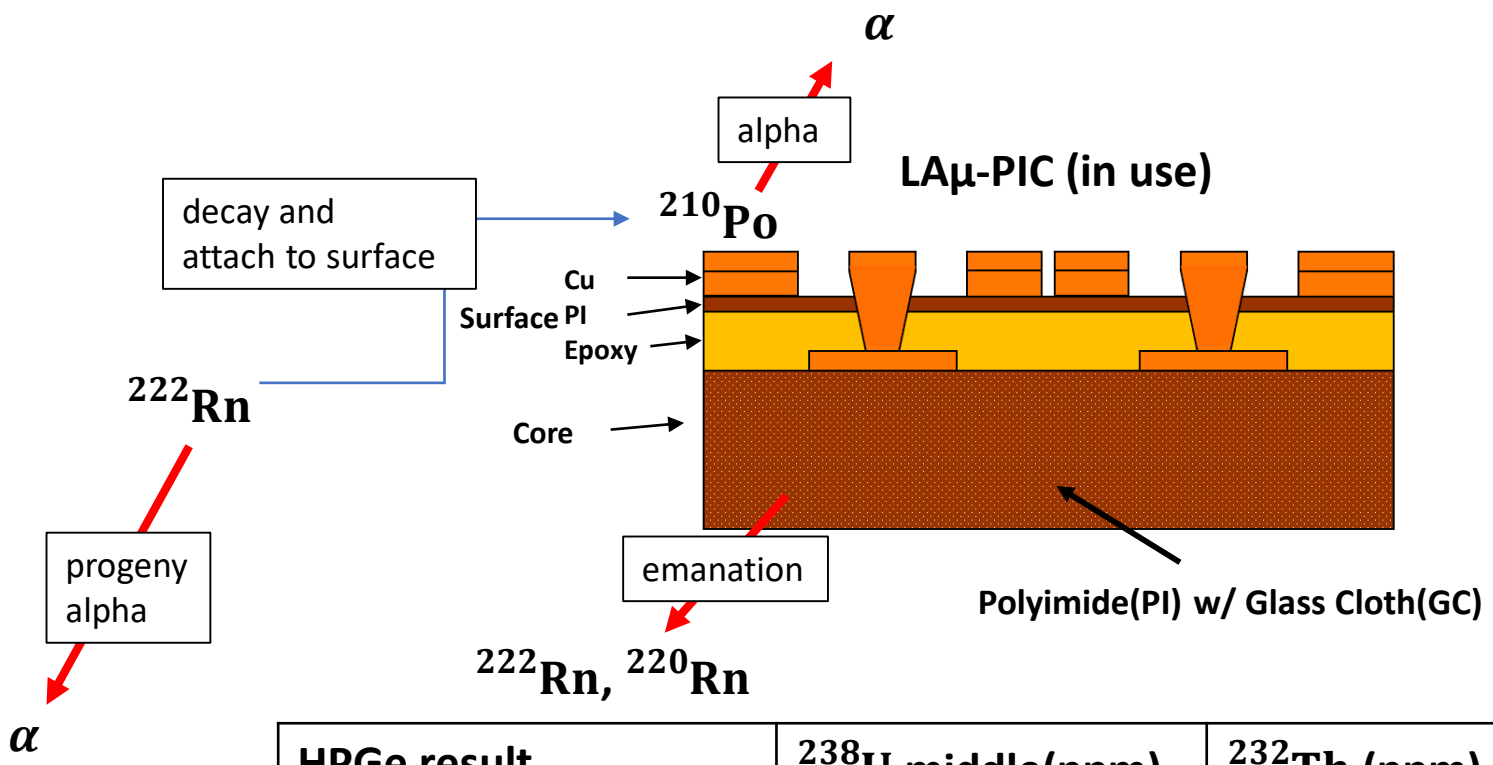
Blue: standard μPIC
Red: LAμPIC
Green : silicon wafer

NIM A 977 (2020) 164285



LAμPIC

➢Surface alpha-ray BG : reduced at LAuPIC! But…

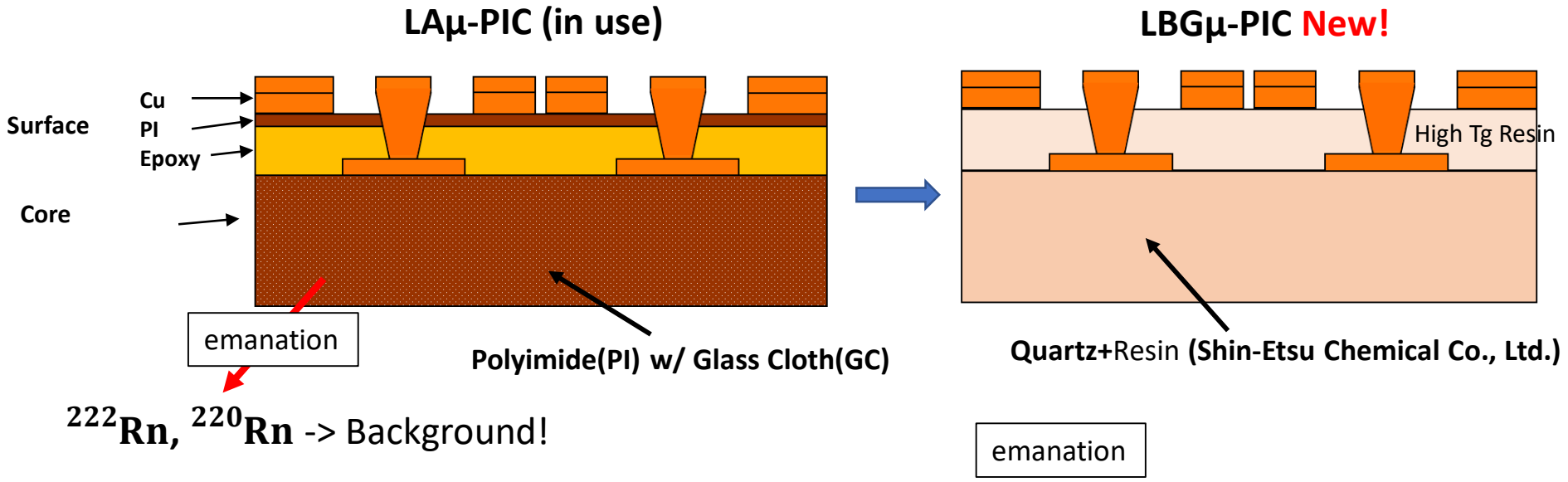


HPGe result	^{238}U middle(ppm)	^{232}Th (ppm)
LAμ-PIC core PI w/ GC	$(7.8\pm0.1)\times 10^{-1}$	3.42 ± 0.03

U/Th contamination is still here.

-> Could be serious background source via radon emanation !

Low Background μ-PIC(LBGμ-PIC)



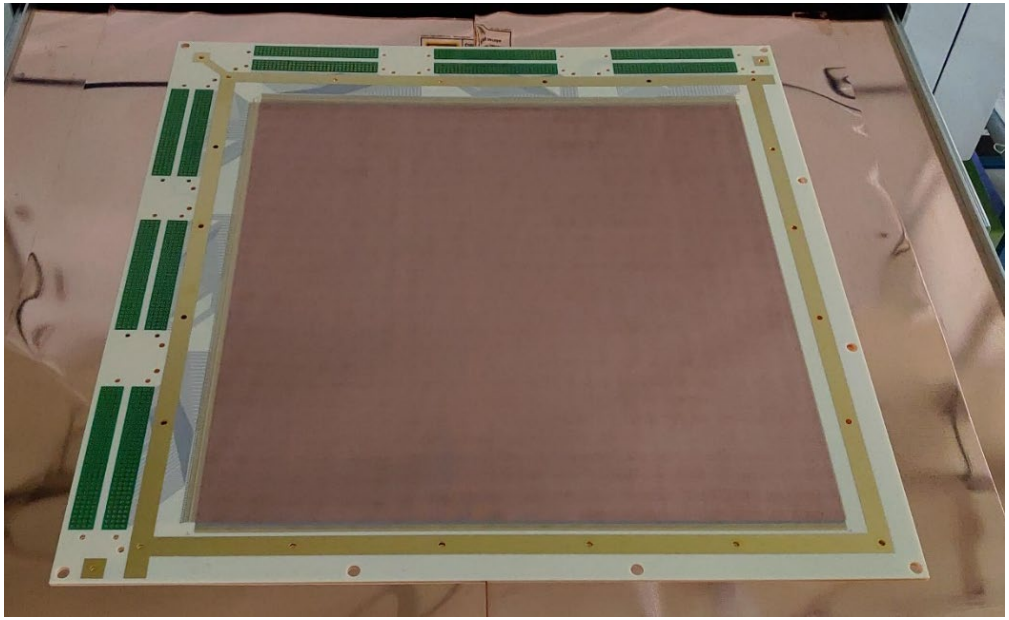
- Use low background material core (see Table)
- Reduce solder resist area (also BG)

HPGe result	^{238}U middle(ppm)	^{232}Th (ppm)
LAμ-PIC core PI w/ GC	$(7.8\pm0.1)\times 10^{-1}$	3.42 ± 0.03
LBGμ-PIC core Quartz + resin	$(5.1 \pm 1.0) \times 10^{-3}$	$(1.2 \pm 0.4) \times 10^{-2}$
Reduced ratio	~1/150	~1/300

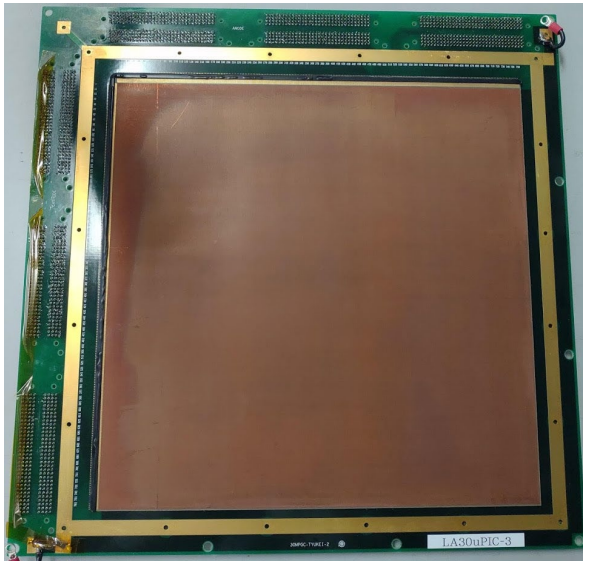
→ less than **1/100** **U/Th chain contamination!**

LBGuPIC

- Same size as LAμ-PIC
- Development : 2018 – 2020
  - Manufactured by DNP (Dai Nippon Printing.)



LBGμ-PIC

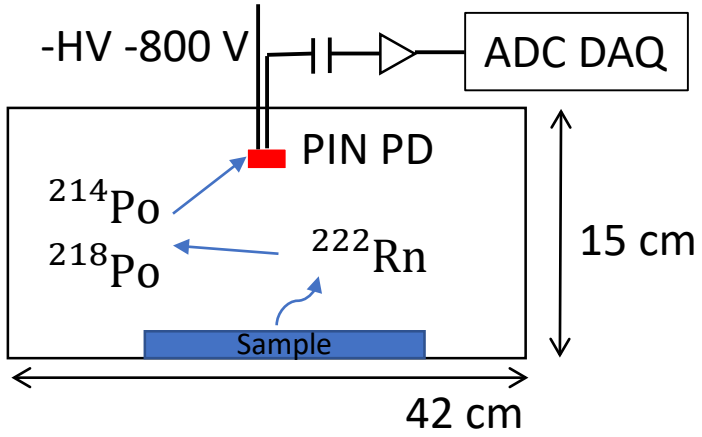


LAμ-PIC

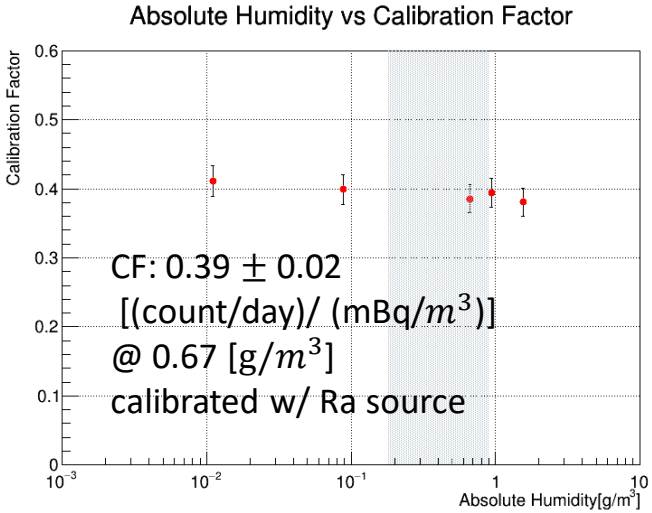
Radon measurement

➢Radon detector : constructed at Kobe Univ.

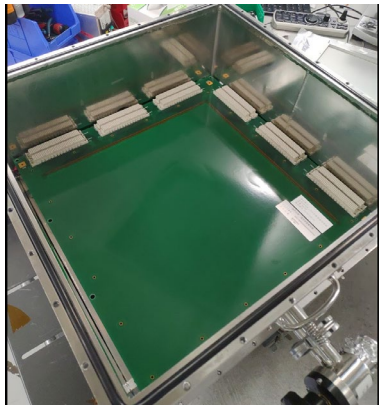
Radon detector
（used as TPC before）



Radon detector schematic



Calibration



Sample (LAuPIC)
in TPC

^{214}Po count rate [count/day]
-> Radon concentration [mBq/m^3]

Radon measurement result

➢LAuPIC, LBGuPIC, BG measurements were done.

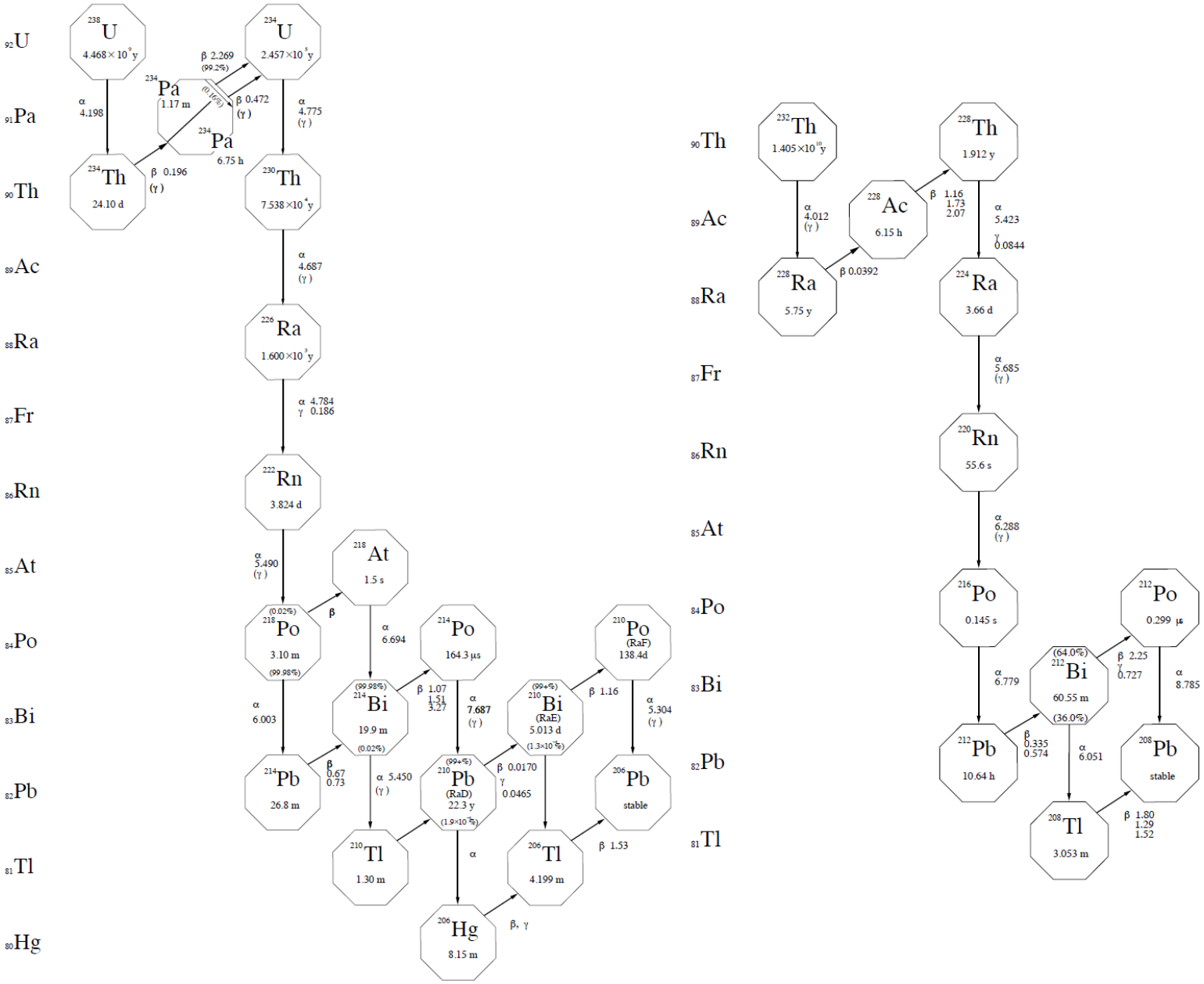
Sample	Measurement duration [days]	214Po count rate [count/day] (stat.)
LA μ-PIC	5 days	40.8 ± 4.9
LBG μ-PIC	5 days	7.0 ± 2.1
BG (no sample)	5 days	6.2 ± 1.9

BG subtracted	214Po count rate [count/day]	mBq/m^3	mBq/uPIC
LA μ-PIC	34.6 ± 5.3	86.6 ± 14.2	2.34 ± 0.39
LBG μ-PIC	0.8 ± 2.8	2.1 ± 7.1	**0.06 ± 0.19** < **0.41** (90 % C.L.)

→ Radon emanation is reduced!

For more precise measurement, BG and LBG run is ongoing…

U/Th chain


92U
91Pa
90Th
89Ac
88Ra
87Fr
86Rn
85At
84Po
83Bi
82Pb
81Tl
80Hg
238U 4.468×10^9 y
234U 2.457×10^5 y
234Pa 1.17 m
234Pa 6.75 h
234Th 24.10 d
230Th 7.538×10^4 y
226Ra 1.600×10^3 y
222Rn 3.824 d
218At 1.5 s
218Po 3.10 m (99.98%)
214Po 164.3 µs
214Bi 19.9 m (0.02%)
214Pb 26.8 m
210Tl 1.30 m
210Pb (RaD) 22.3 y
210Bi (RaE) 5.013 d
210Po (RaF) 138.4d
206Pb stable
206Tl 4.199 m
206Hg 8.15 m
α 4.198
β 2.269 (99.2%)
β 0.472 (γ)
β 0.196 (γ)
α 4.775 (γ)
α 4.687 (γ)
α 4.784 γ 0.186
α 5.490 (γ)
α 6.694
β 1.07 1.51 3.27
α 7.687 (γ)
α 6.003
β 0.67 0.73
α 5.450 (γ)
β 0.0170 γ 0.0465
β 1.16
α 5.304 (γ)
β 1.53
α
β, γ
90Th
89Ac
88Ra
87Fr
86Rn
85At
84Po
83Bi
82Pb
81Tl
232Th 1.405×10^10 y
228Th 1.912 y
228Ac 6.15 h
228Ra 5.75 y
224Ra 3.66 d
220Rn 55.6 s
216Po 0.145 s
212Po 0.299 µs
212Bi 60.55 m
212Pb 10.64 h
208Tl 3.053 m
208Pb stable
α 4.012 (γ)
β 1.16 1.73 2.07
β 0.0392
α 5.423 γ 0.0844
α 5.685 (γ)
α 6.288 (γ)
α 6.779
β 2.25 γ 0.727
α 8.785
β 0.335 0.574
α 6.051
β 1.80 1.29 1.52