

Radon emanation and removal measurement using 5A-type zeolite.

220523

Cygnus gas meeting

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(CST, Nihon-U)

- This results are additional experiment of the radon emanation and removal using 5A-type zeolite which was developed by Nihon-U.
 - Already tested by Rob (Sheffield-U) and Satoshi (Kobe-U).
- Reference gas : Argon.

RI activity for developed MS (2nd production) :

Sample name	²²⁶ Ra (mBq/kg)	²³² Th (mBq/kg)
4AMS (powder)	40.4+/-11.4	63.4+/-10.6
5AMS	14.2+/-7.0	58.8+/-8.6

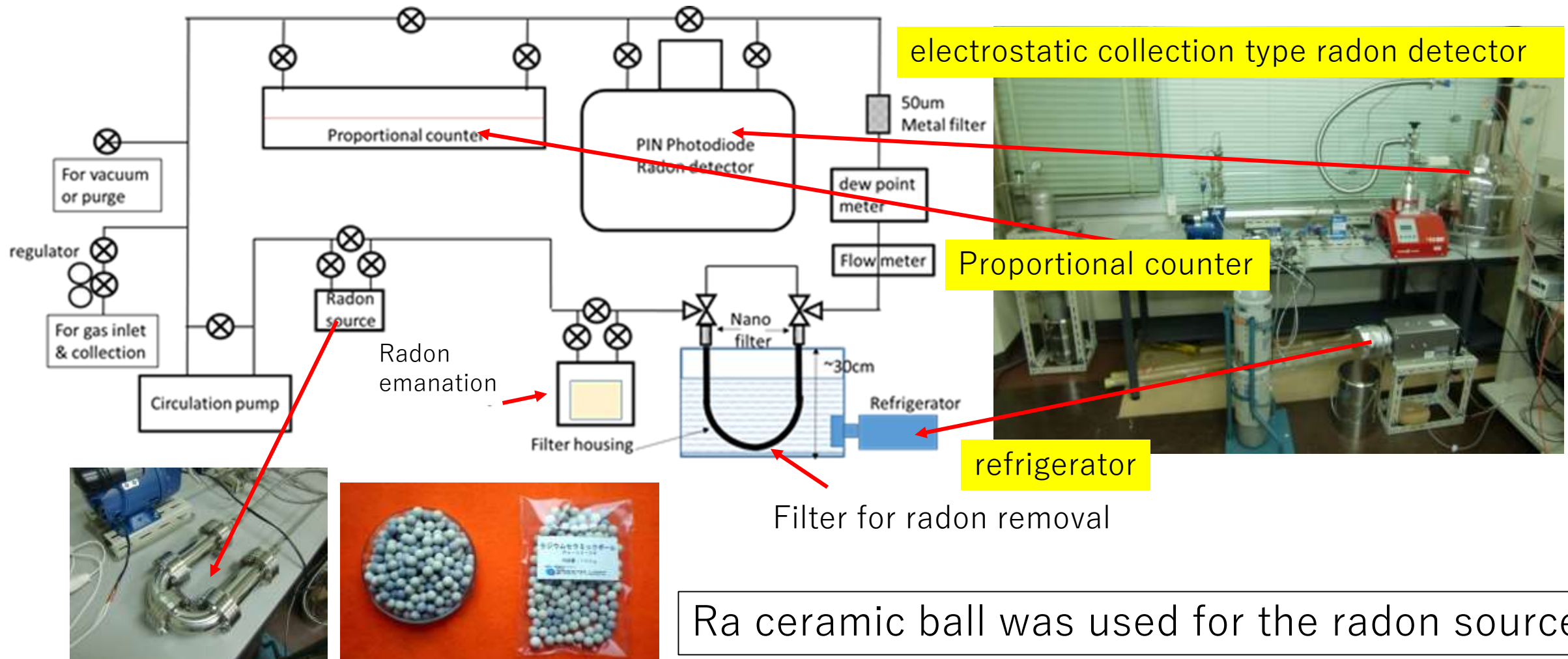
- 5AMS reaches around 1ppb (~ 12mBq / kg for Ra) in U conversion.
- We sent ~ 100g of this 5AMS to Kobe University and Sheffield University for radon removal test.
- (new) Radon emanation & removal test in CST Nihon-U.



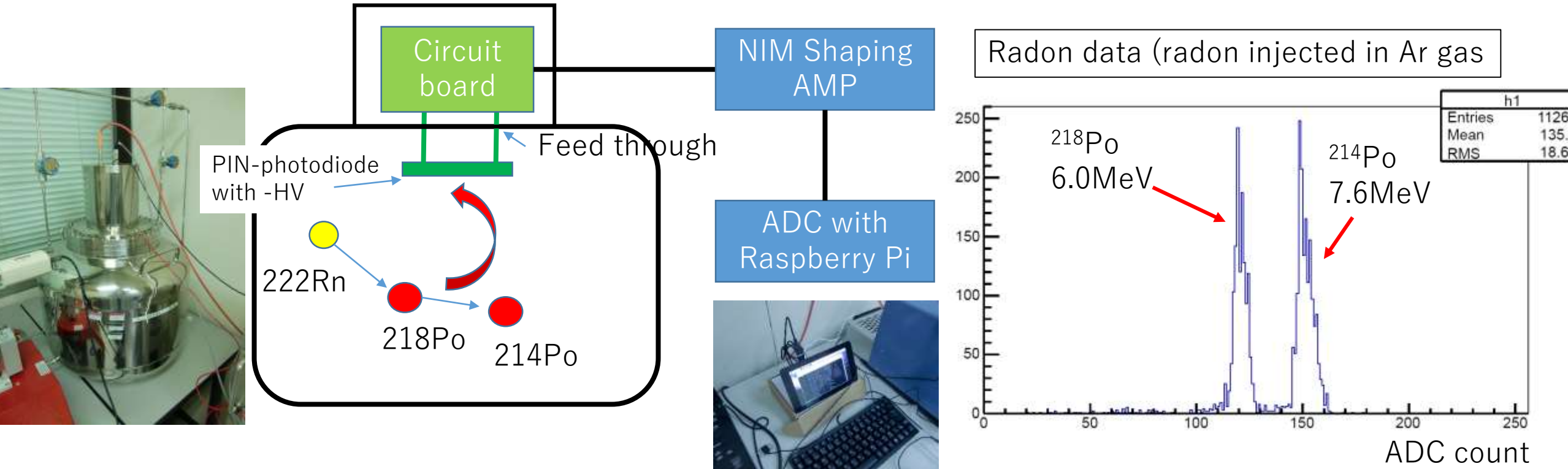
HPGe measurement @ ICRR Kamioka

Experimental setup : RI measurement system.

- Installed in CST Nihon University.
- Circulate gas with a pump.
- RI measurement by electrostatic collection type radon detector and proportional counter



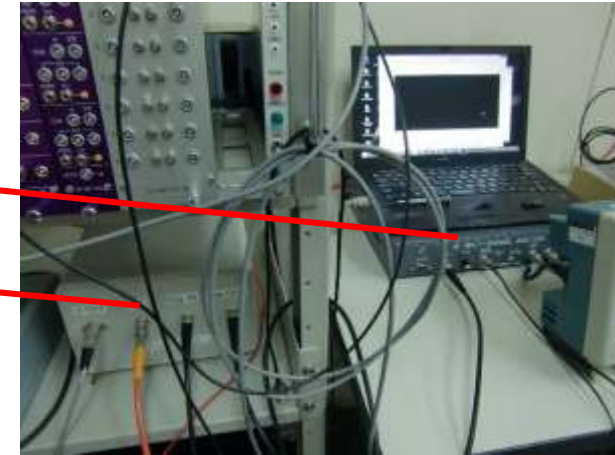
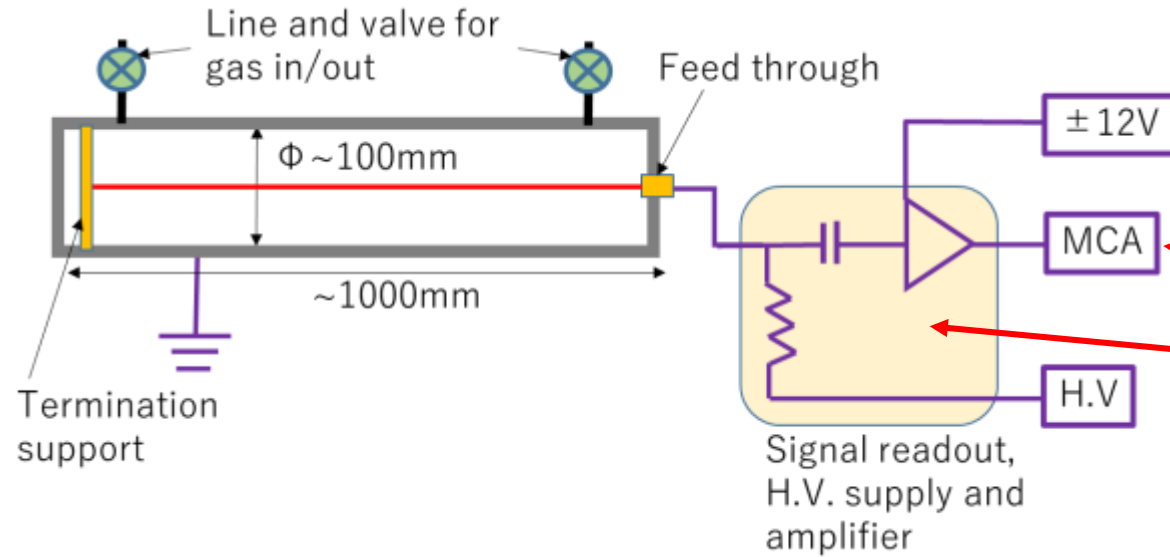
electrostatic collection type radon detector



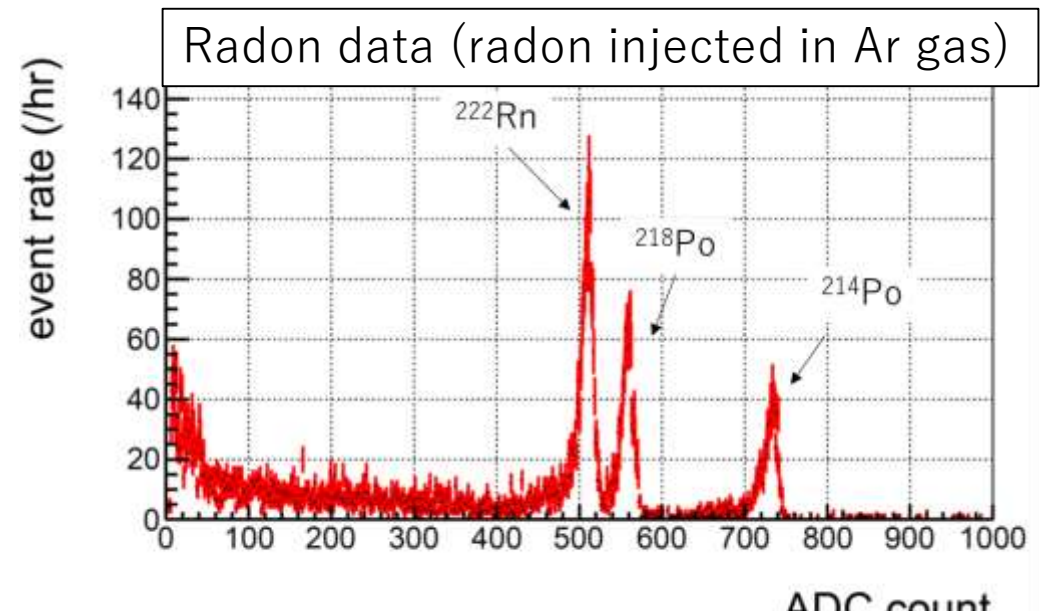
- Alpha-ray from the radon daughter was collected by - 500V electric field and detected by PIN-photodiode.
- SUS vessel, volume $\sim 80\text{L}$, low BG by electrolytic polishing.
- Radon detection sensitivity : $\sim 1\text{mBq}$
- G Pronost et. al, PTEP (2018) 9, 093H01

- Convert the amount of radon from the number of ^{214}Po measurements
 - $\sim 1\text{cpd} / (\text{mBq} / \text{m}^3)$
- Depends on electric field and humidity.

Proportional counter

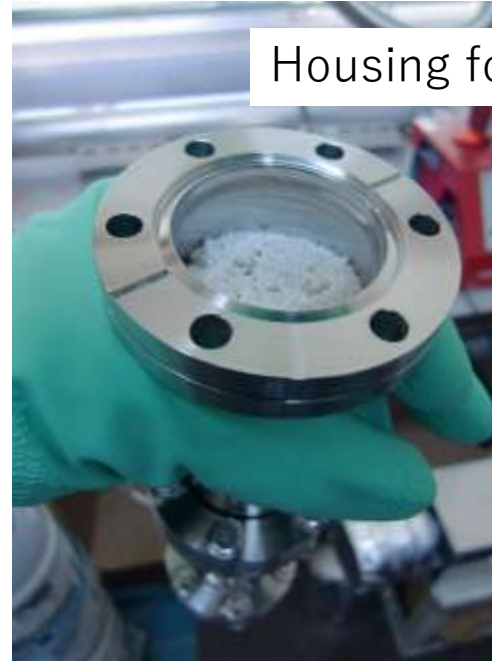


- Made of SUS, internal capacity 10L, low BG by internal electrolytic polishing.
- Alpha-ray from the ^{222}Rn can be observed directly.



Zeolite :

- Housing for emanation.
 - 172 g 5A zeolite
- filter for radon removal.
 - 39 g 5A zeolite
 - 1/2inch pipe x 64 cm
- Activation by 200°C in:
- 1) Constant temperature bath 2) with N₂ purge and 3) with vacuum.



Housing for emanation with zeolite

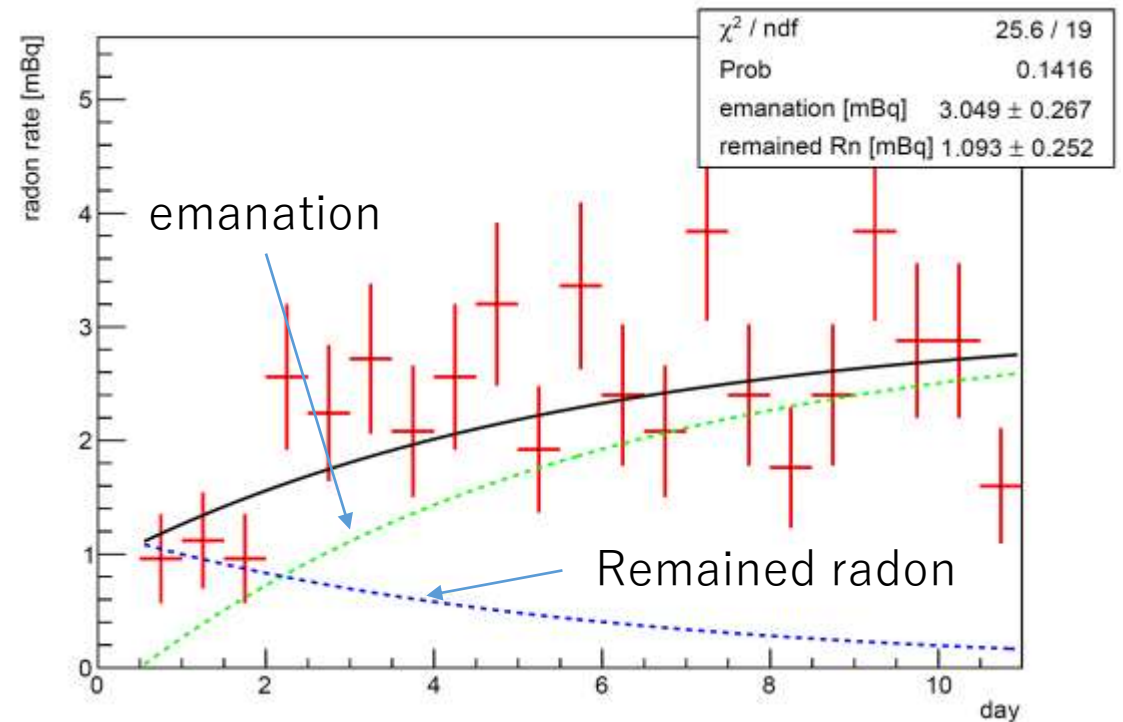
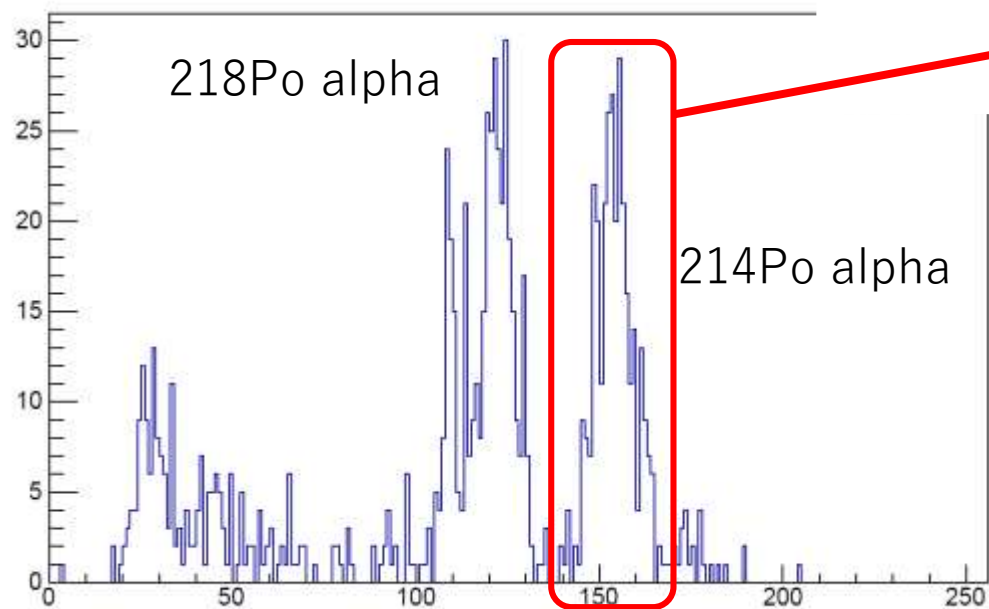


Filter for radon removal with zeolite



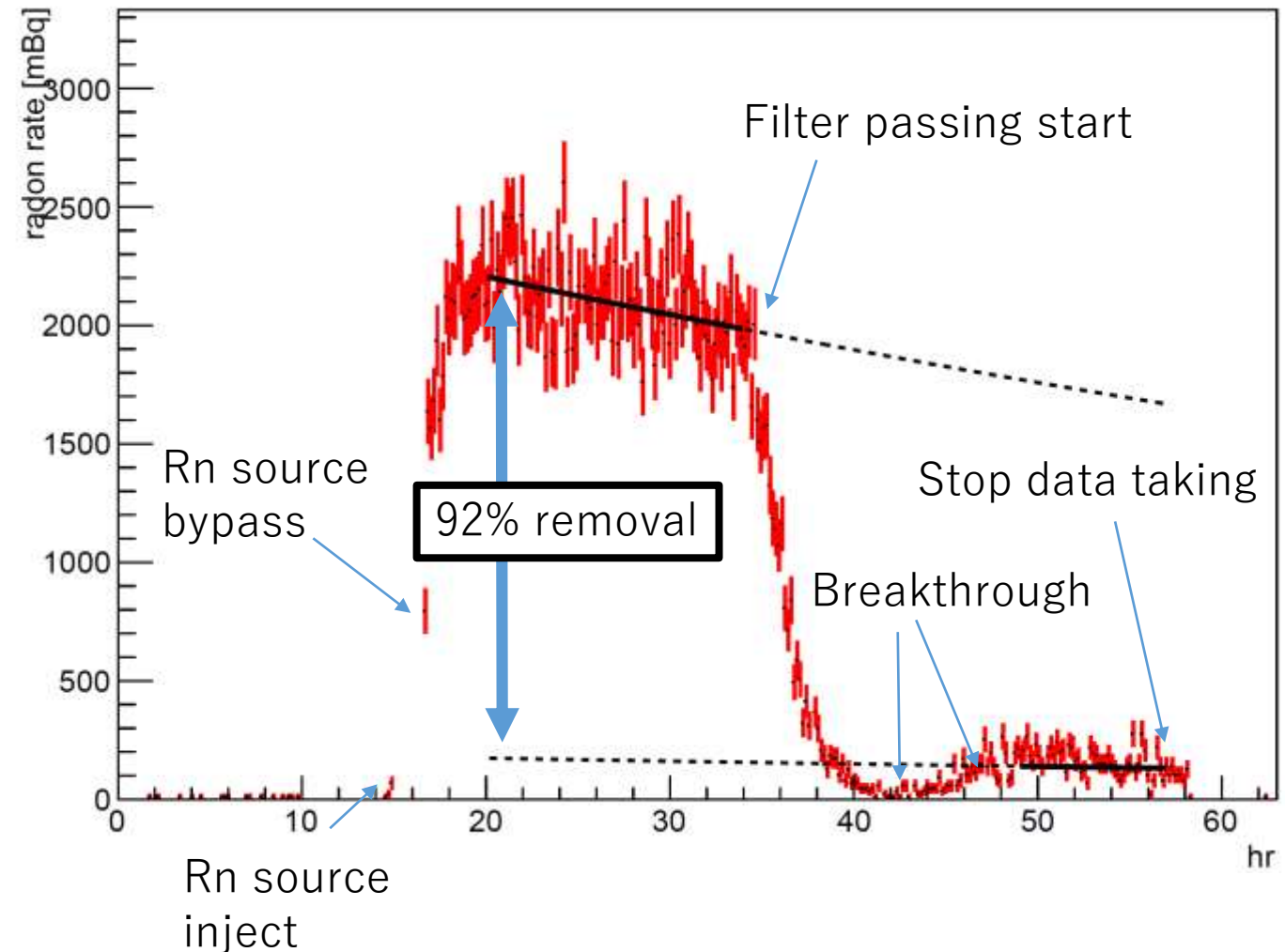
Results :

- Radon emanation :
 - 4/21- 5/2 2022
 - Ar gas was circulated with 0.8L/min.
 - Room temperature
 - electrostatic collection type radon detector was used.
 - Emanation : 3.0 ± 0.3 mBq/filter
 - Possibility : the circulation pump is not all metal type. It may increase the emanation rate.
=> Need to check the BG.

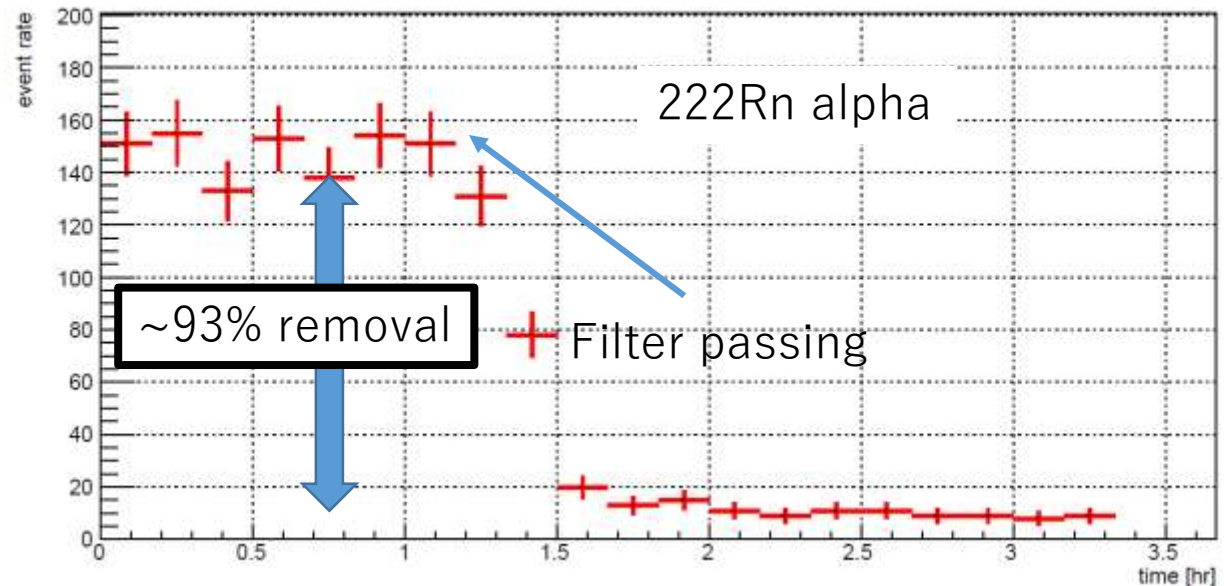
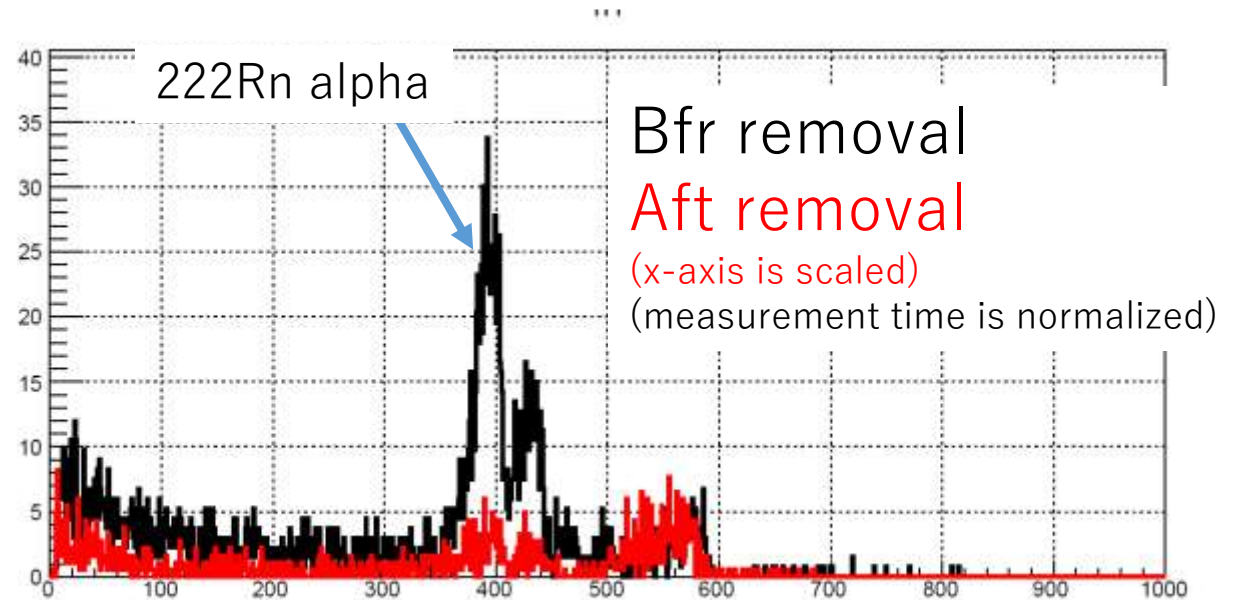


- Radon removal
- 1) electrostatic collection type radon detector

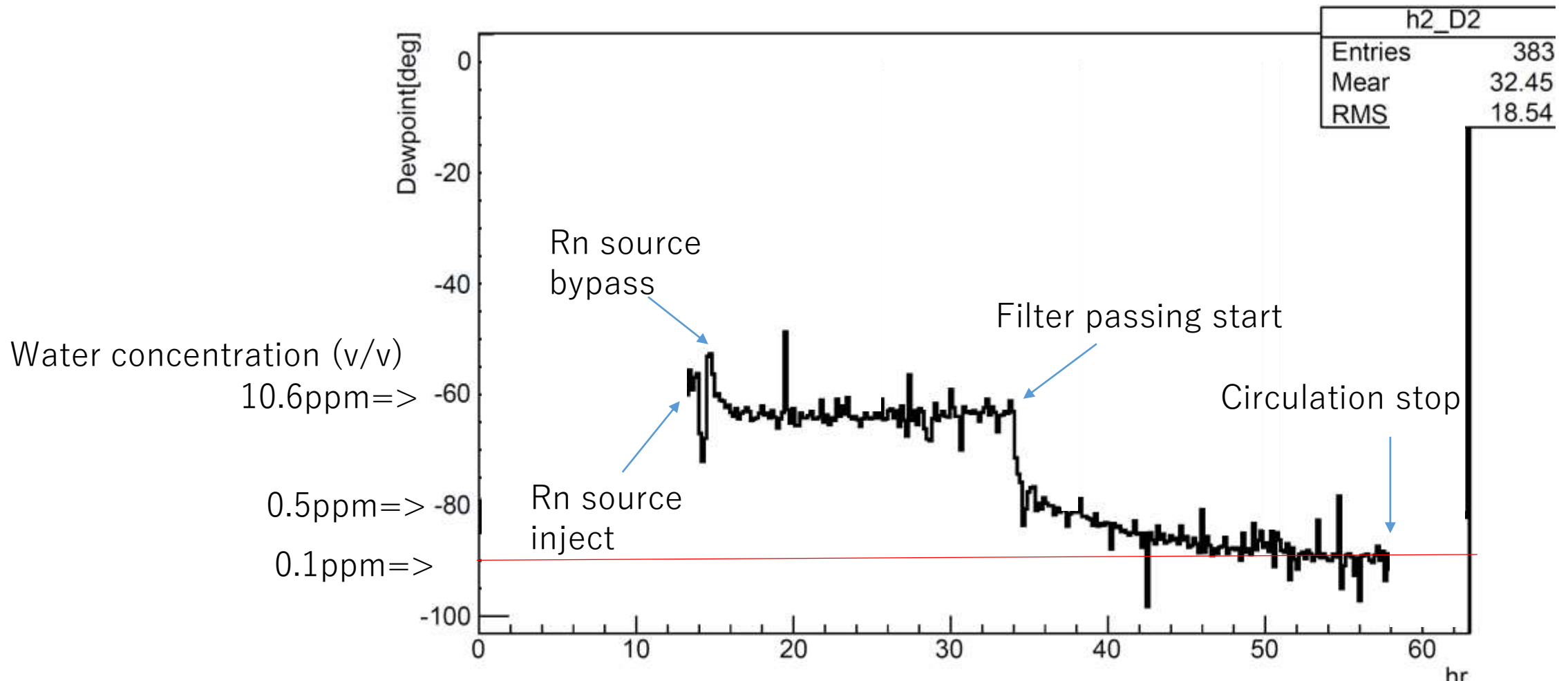
- 5/2- 5/4 2022
- Ar gas was circulated with 1.0L/min.
- Filter was cooled to -60 deg
- electrostatic collection type radon detector was used.
- Radon rate bfr/bft filter passing : 0.079 ± 0.003
 - $\Rightarrow$ 92% removal
- Breakthrough of radon was found.



- Radon removal
- (2) proportional counter
=> To see the radon atom removal directory.
- Ar gas was circulated with 1.0L/min.
- Filter was cooled to -60 deg
- Rn removal ~ 93%



- Water removal :
- Monitored by dewpoint meter.
- Ar gas was circulated with 1.0L/min.
- Filter was cooled to -60 deg
- Reducing of dewpoint is clearly found after filter passing.
 - Water concentration $\sim 10\text{ppm} \Rightarrow 0.1\text{ ppm}$



Conclusion

- We exam the radon emanation and removal test from Ar.
- Emanation : $3.0 \pm 0.3 \text{ mBq}$
- Removal efficiency : $>90\%$
- Also water removal was tested too using dewpoint meter.
- NU-developed 5A-type zeolite is low radon emanation and effective removal of radon (and water)
- Next :
 - Emanation BG measurement.
 - More fine ion exchange ratio for 5A-type to more effective radon removal.
 - Oxygen removal test.