Radon reduction & monitoring in Super-Kamiokande

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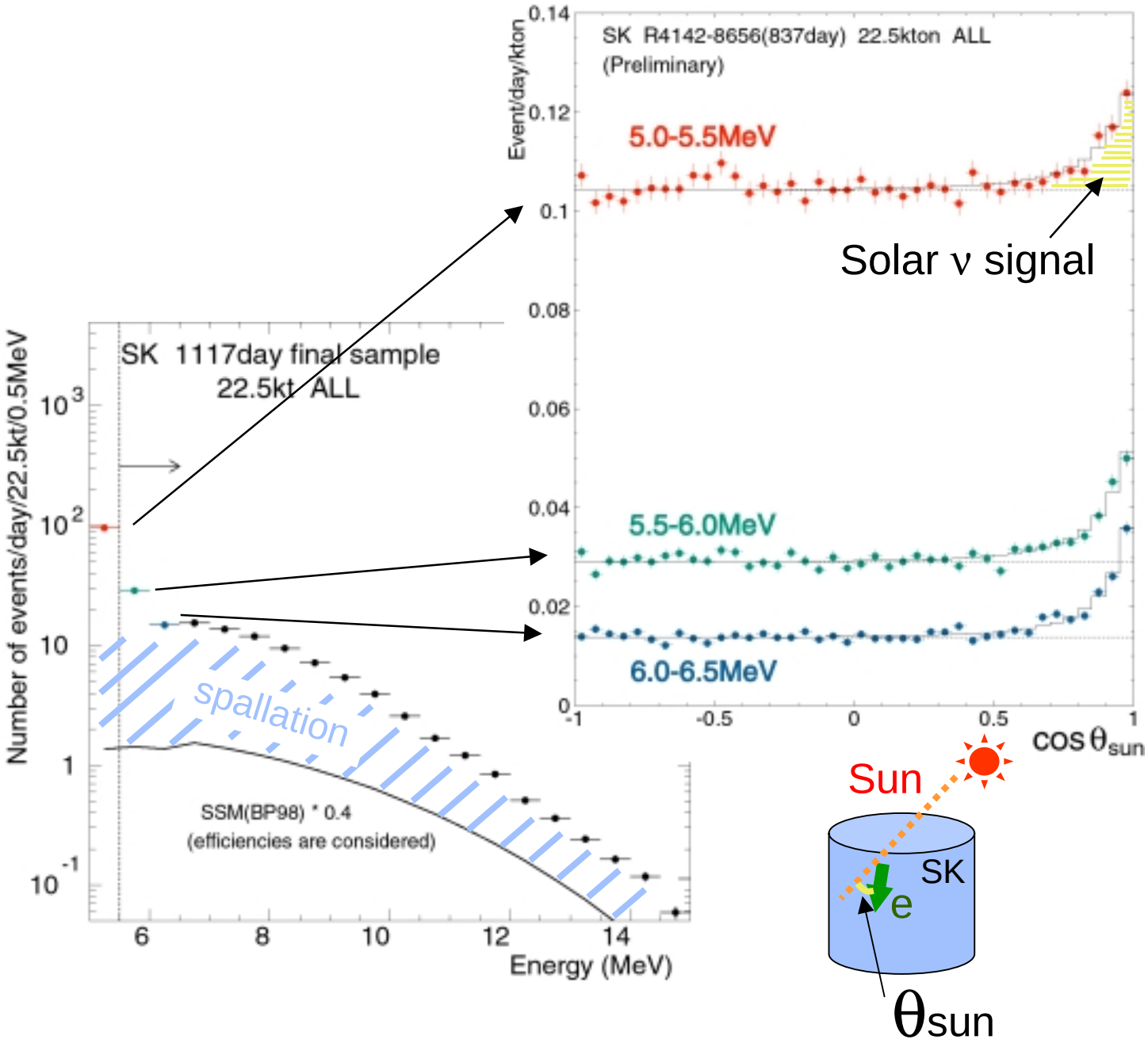
OUTLINE

- Low-energy final data sample
- SK site overview
- Rn detector
  - 70L for air & for water
  - 950L for water
- Rn-less-air supply system
- Water purification system
- Membrane degassing module test
- Summary

This presentation is available at
http://www-sk.icrr.u-tokyo.ac.jp/~takeuchi/radon/

Low-energy final data sample



Current composition (SK 1117d, 5.0-5.5MeV, 22.5kt)

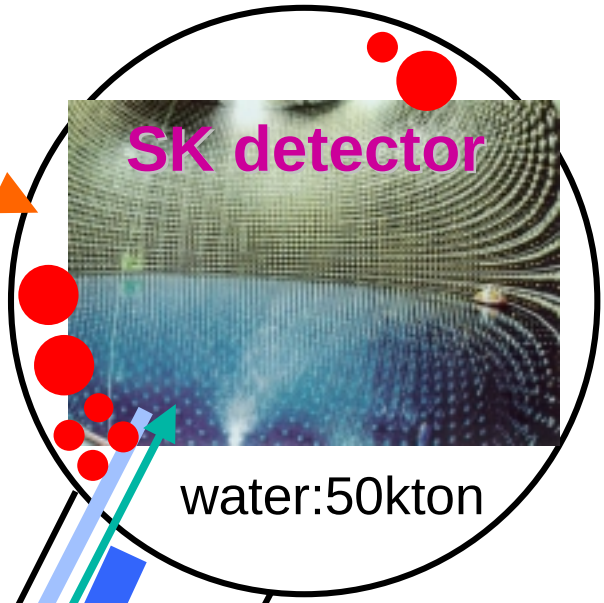
(rough estimation)

- Water supply origin (=Radon) **~40%**
- Internal origin (Ra->Rn?, γ from PMT, etc.) **~60%**
- Solar neutrinos ~2%

➡ **Need further radon reduction!**

SK site overview

•Covered with MINEGUARD
•supply fresh air from outside mine (～10m³/h)



Membrane vacuum degasifier test-bench

Control room

～60m between SK and water system

air-tight door

KamLAND

30t/h

mine tunnel
40～1000Bq/m³

Atotsu entrance (～3km)

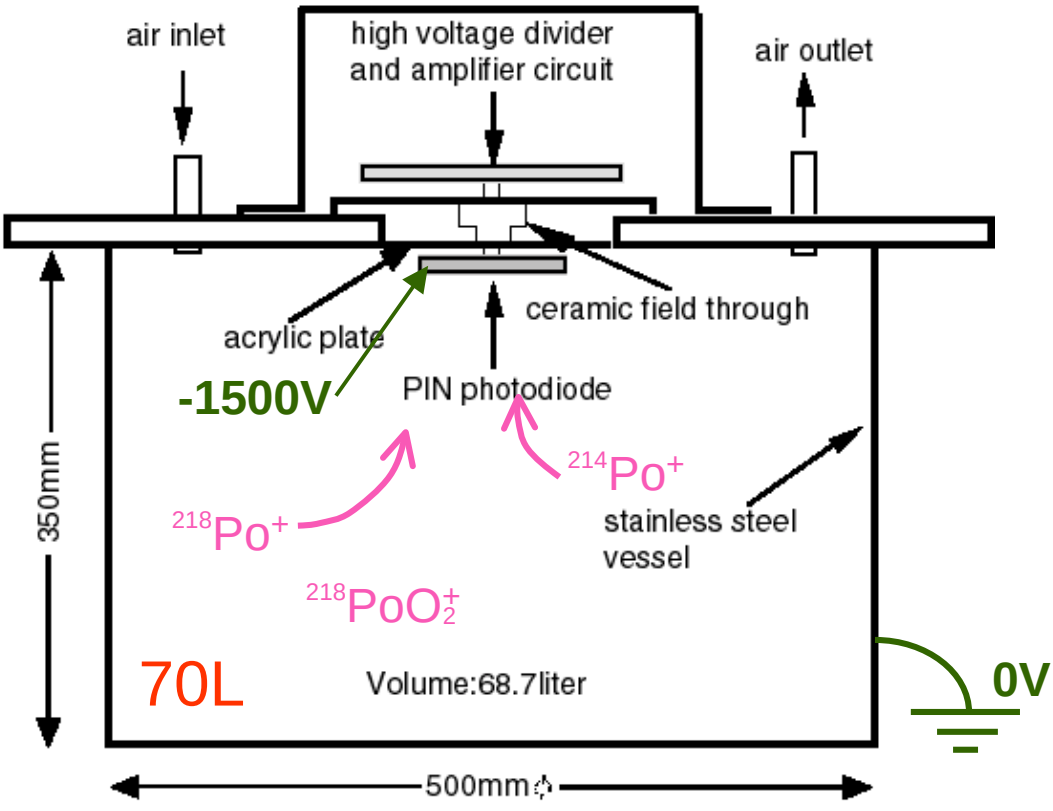
Rn-less-air supply system
15m³/h

950L Rn detector
70L Rn detector

70L real-time Rn detector for air

cf. Y.Takeuchi et al., NIM A421(1999)p334-341

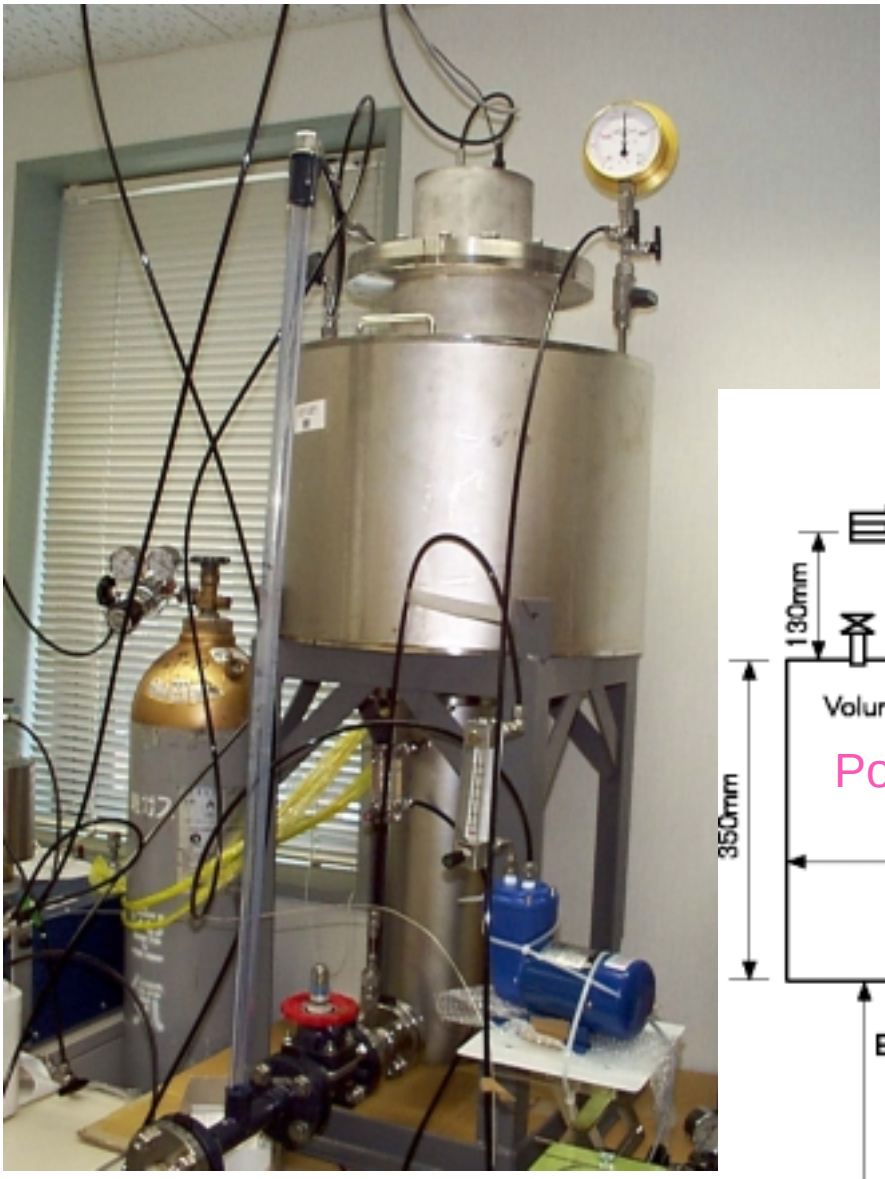
Method = PIN photodiode + Electrostatic collection

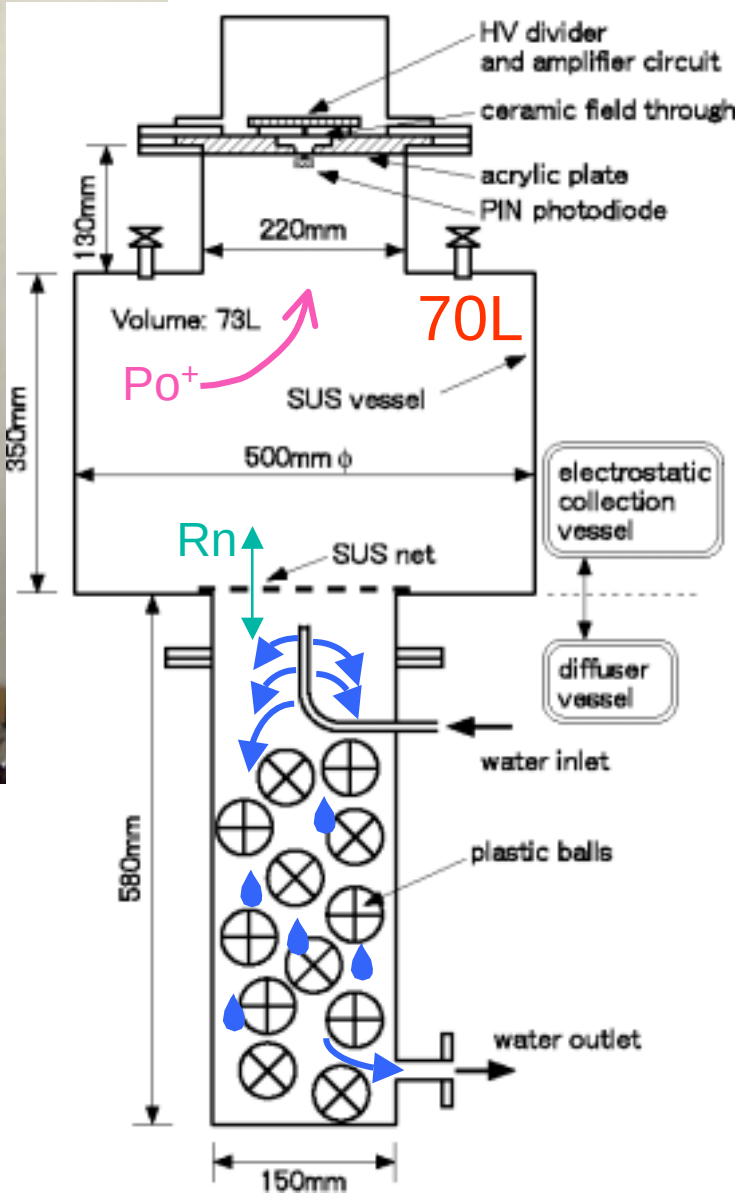


2.2±0.4 (^{214}Po count/day)/(mBq/m^3) @0.08gH_2O/m^3

0.9±0.2 (^{214}Po count/day)/(mBq/m^3) @11gH_2O/m^3

70L real-time Rn detector for water





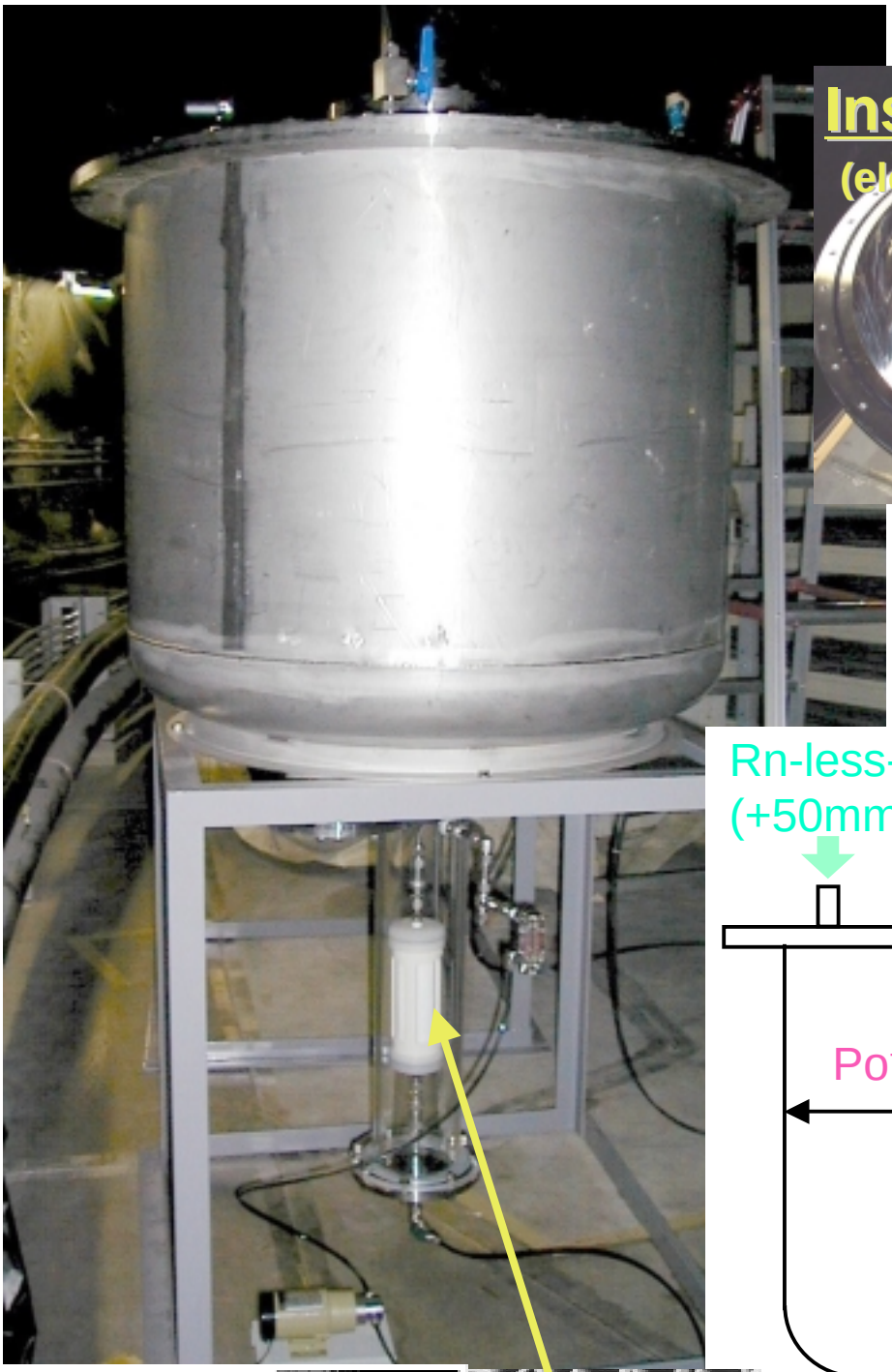
3.6±0.5 (count/day)/(mBq/m^3) for non-degasified water

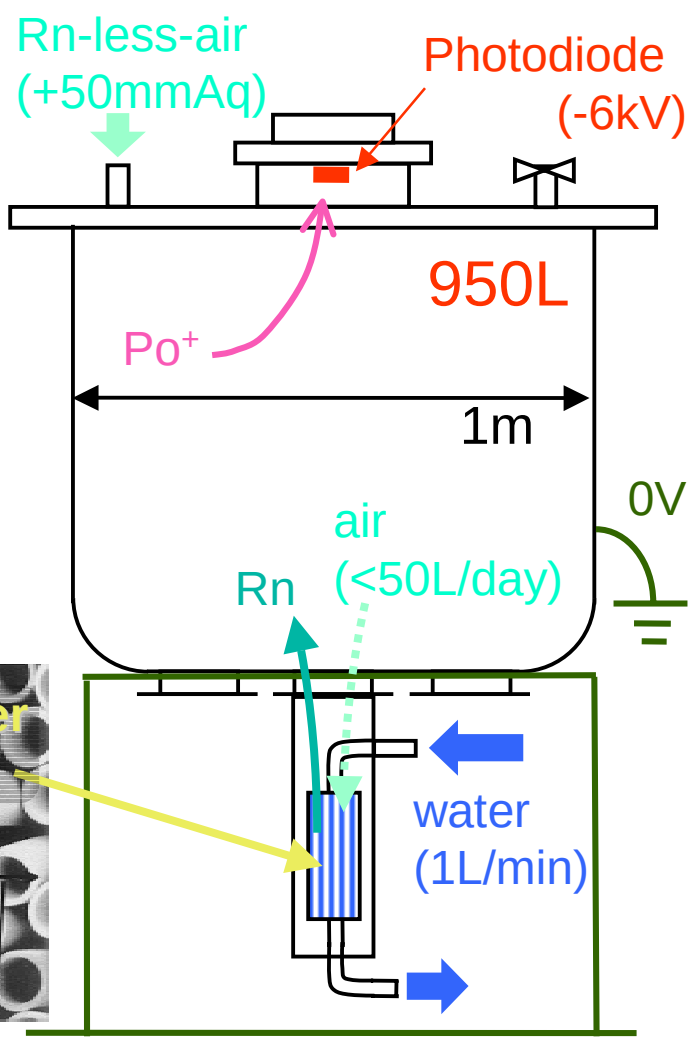
～0.7 (count/day)/(mBq/m^3) for degasified water

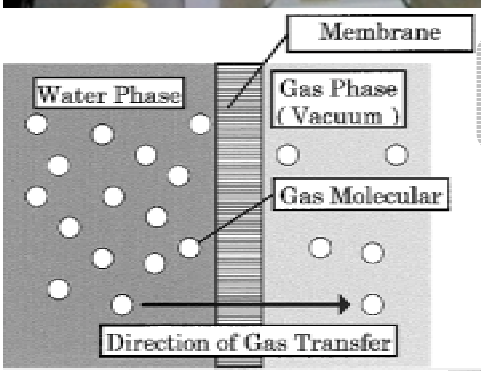
(re-estimated, preliminary)

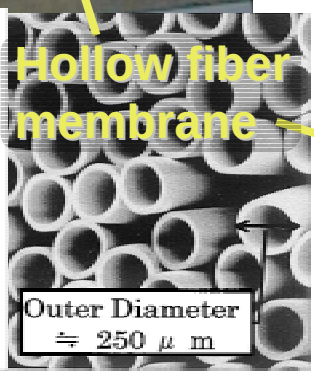
950L real-time Rn detector for water

(under development)









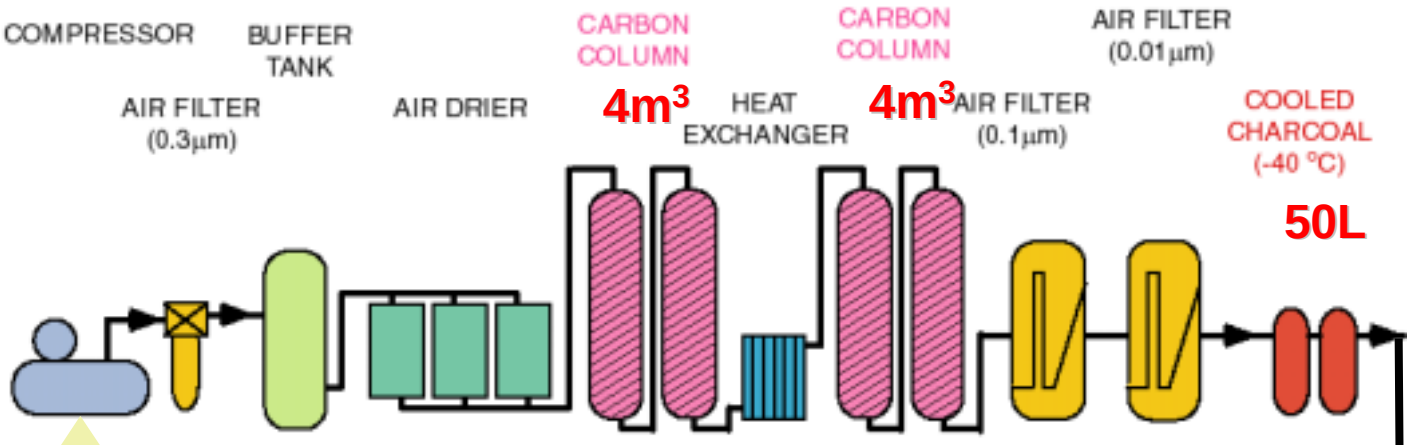
http://www.dic.co.jp/tech/prod0311/index.html

~8 (count/day)/(mBq/m^3) for degasified water

(under calibration, preliminary)

Rn-less-air supply system

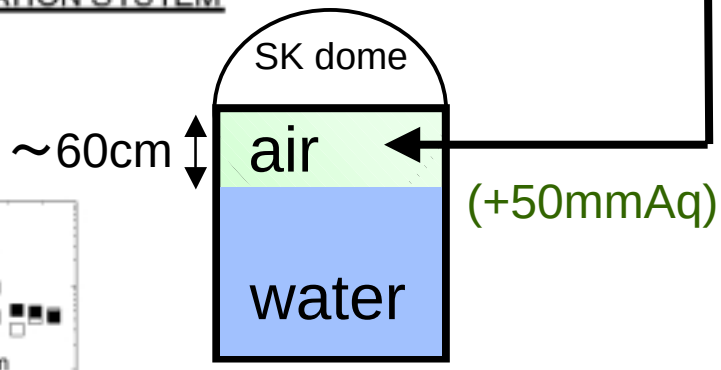
•Remove radon by (cooled) activated charcoal



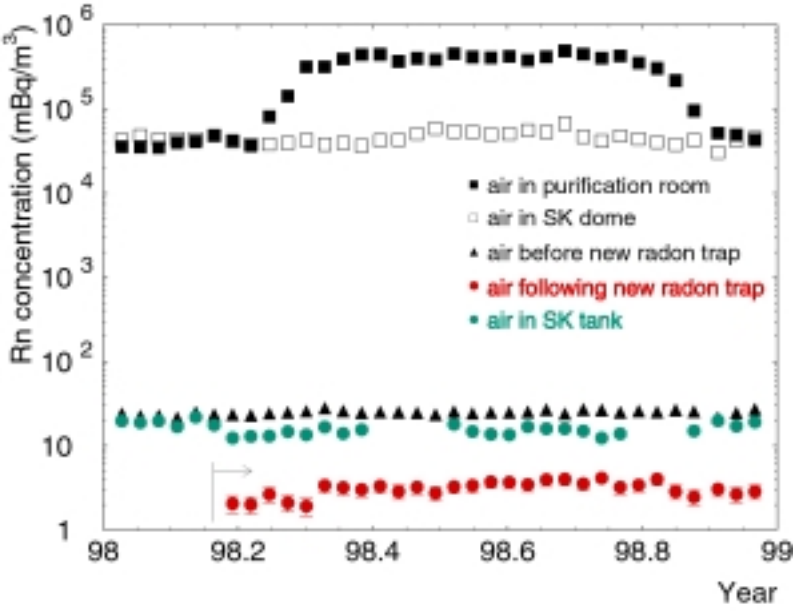
flow rate: ～15m³/h

SUPER-KAMIOKANDE AIR PURIFICATION SYSTEM

Mine air



SK tank (stainless steel)



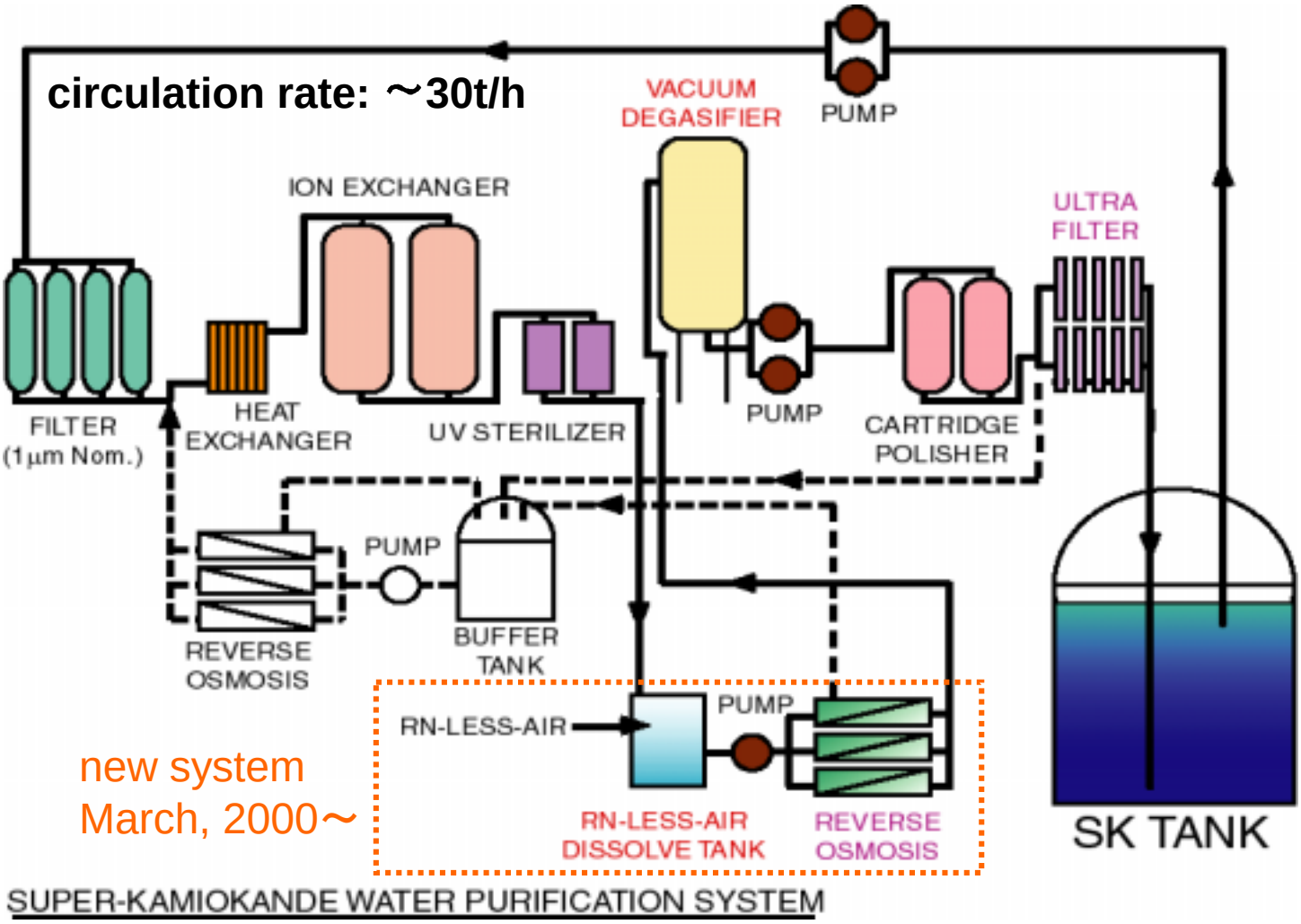
Radon concentration in

mine air:	～1000Bq/m³ (summer)
	～40Bq/m³ (winter)
purified air:	**2～3mBq/m³**
air in SK tank:	**10～20mBq/m³**

seasonal variation is caused by different wind direction in mine tunnel

Water purification system

- Remove radon by Vacuum Degasifier
- Remove radium (in dust) by RO and UF



UF: ~100% remove for >100nm particles
RO: remove >0.1nm particles, but not 100%

→ complement

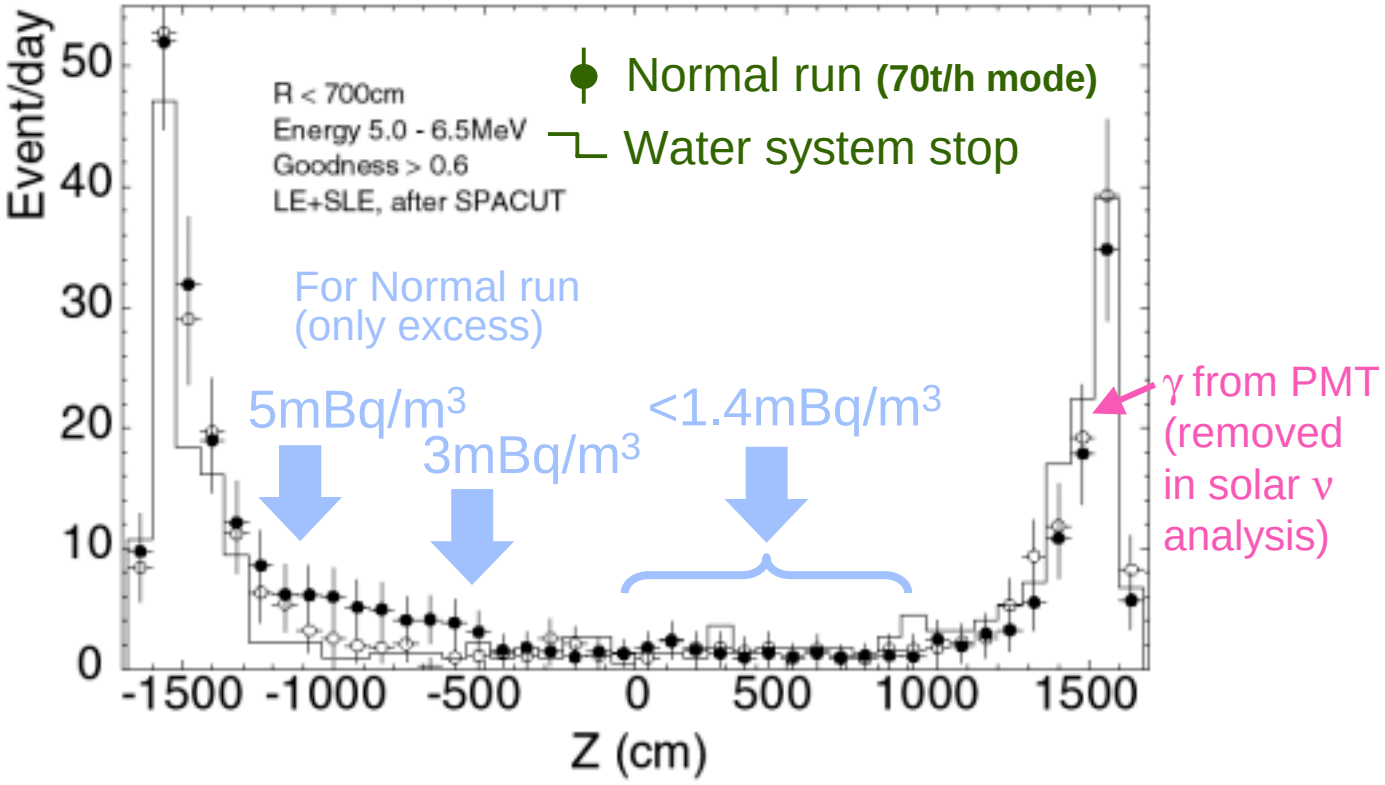
Radon concentration in

mine water:	~10000Bq/m^3
purified water:	**10~20mBq/m^3** **(re-estimated, preliminary)**
water in SK tank:	**1~2mBq/m^3** (upper half)
	~5mBq/m^3 (bottom part)

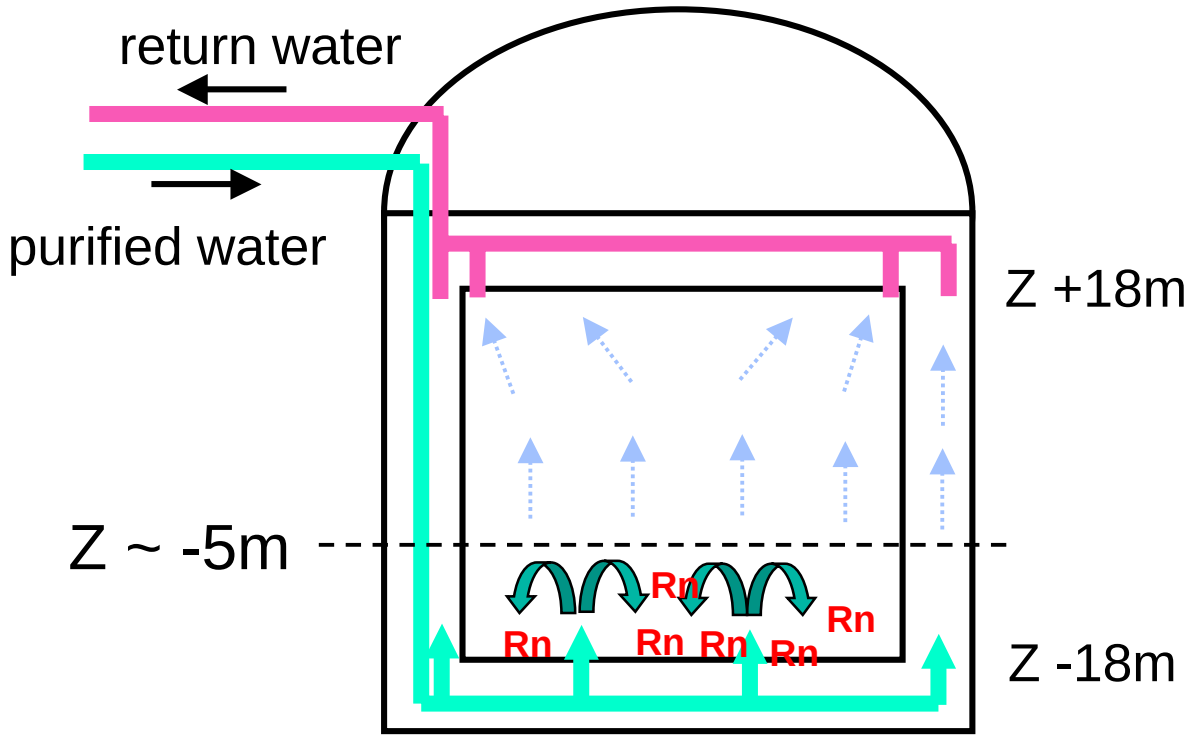
cf. Y.Takeuchi et al., Phys. Lett. B452(1999)p418-424

Water flow in SK tank

•Event excess in bottom region = Radon



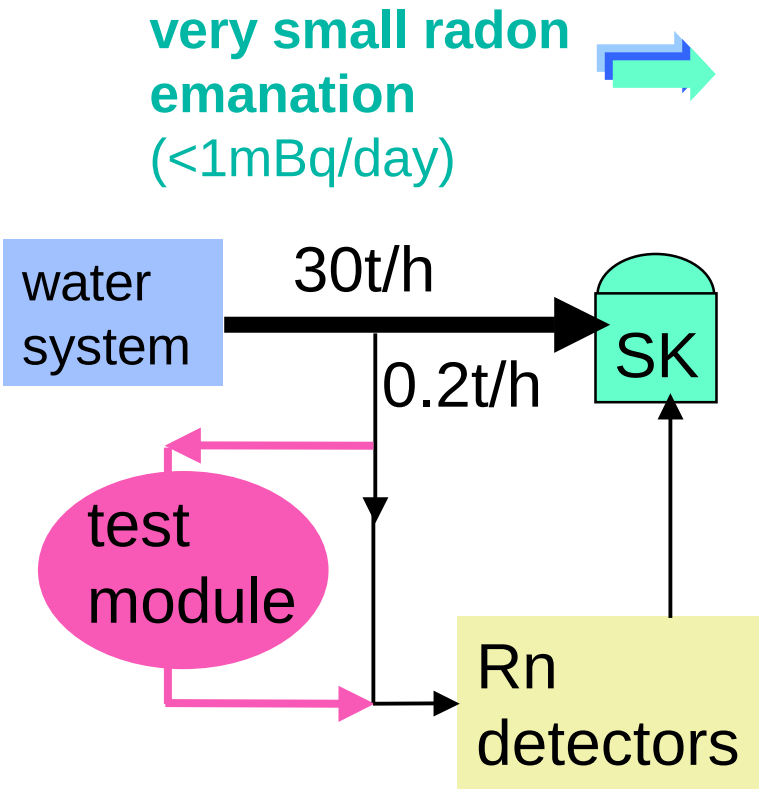
•Water flows stirs up radon emanated from PMTs and/or black sheets



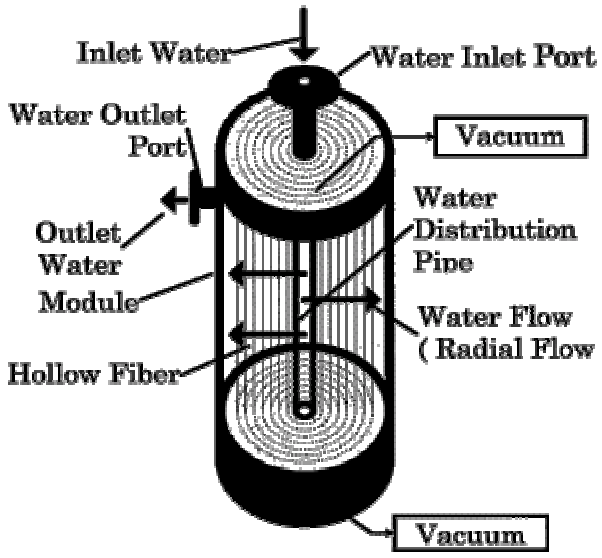
water inlet was moved to center

Membrane degassing module test (1)

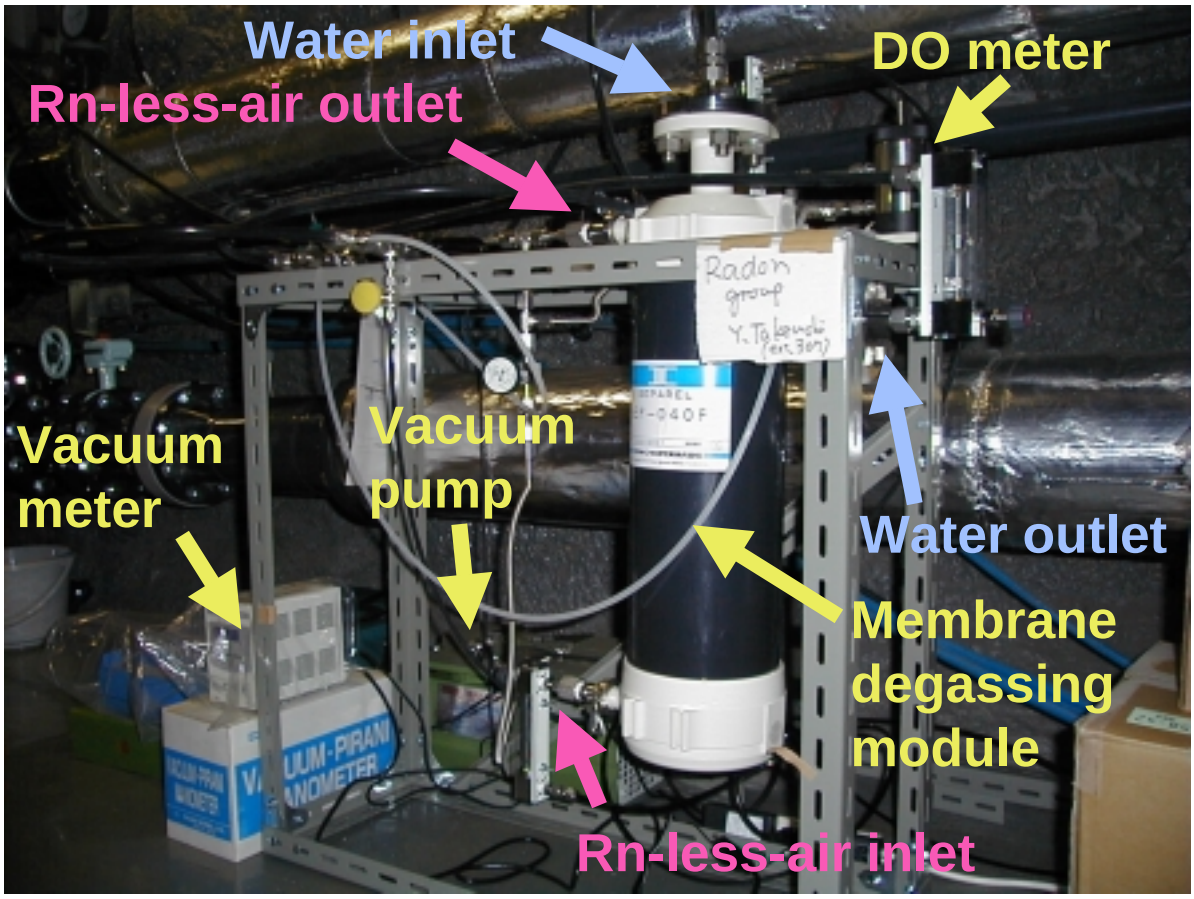
- We have to reduce radon in purified water (10～20mBq/m^3)
- Put a membrane degassing module just before SK-tank
- Monitor Rn concentration by a 950L radon detector



SEPAREL EF-040P: DAINIPPON INK AND CHEMICALS, INC.

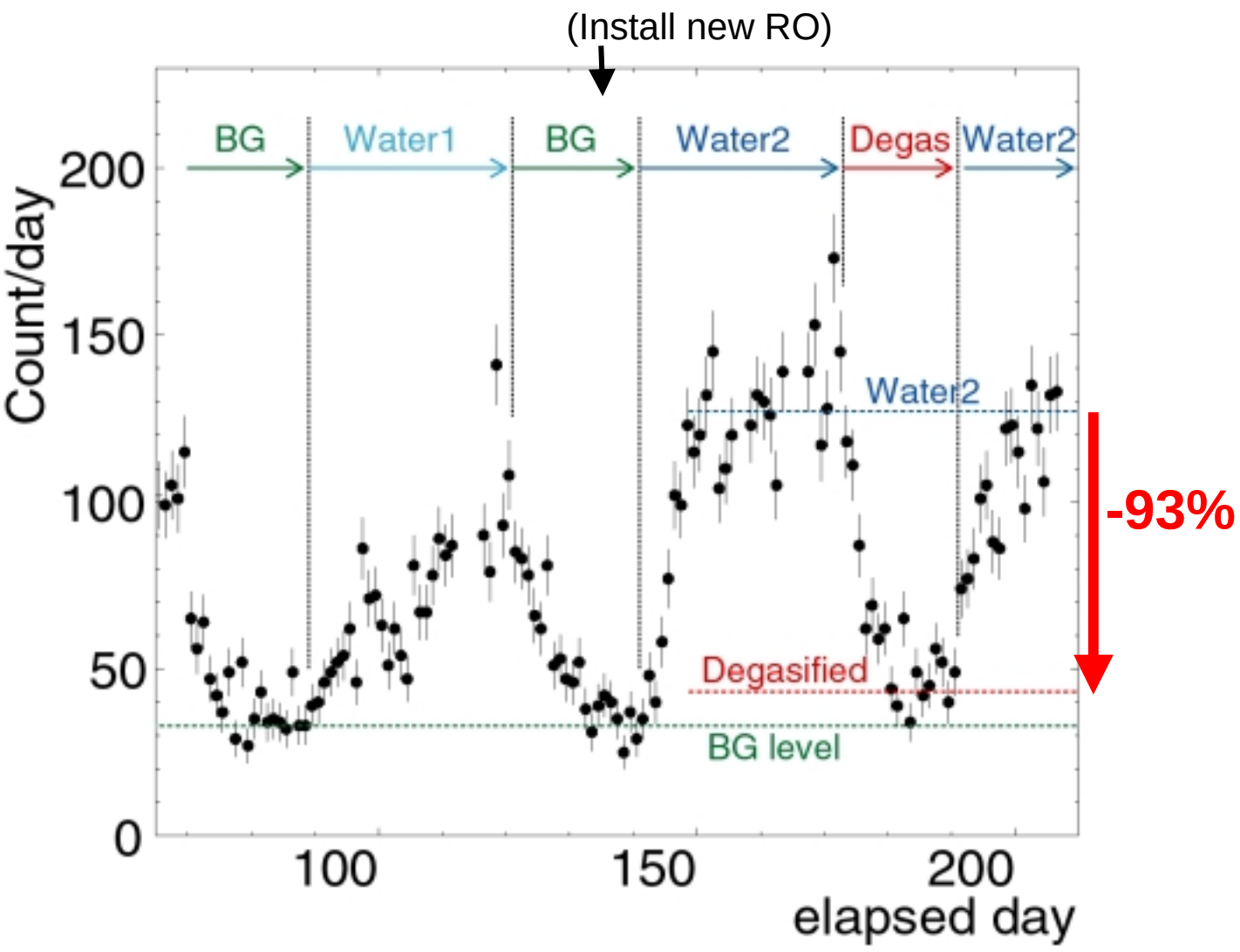


http://www.dic.co.jp/tech/prod0311/index.html



Membrane degassing module test (2)

Count rate by 950L Rn detector



Radon concentration in:

purified water	～12mBq/m^3
degasified water	**～1mBq/m^3**

(degassing parameters are not optimized yet)

➡ **Succeeded to remove radon by the test module!**

Summary

• Radon is a dominant BG for the current very low-energy solar ν data in Super-Kamiokande.

➡ **Need further radon reduction!!**

• Real-time Rn monitoring has been carried out at SK site by using several 70L and 950L radon detectors.

Radon concentration in

purified air: **2～3mBq/m^3**

purified water: **10～20mBq/m^3** **(re-estimated, preliminary)**

air in SK tank: **10～20mBq/m^3**

water in SK tank: **1～2mBq/m^3** (upper half)

～5mBq/m^3 (bottom part)

• In order to reduce radon in purified water, a hollow fiber membrane degassing module was tested.

➡ **Succeeded to remove ～93% of remaining radon by the test module**

Future plan

• Locate radon source in water purification system

(～summer, 2000)

• Install hollow fiber membrane degassing system

(～Dec., 2000)