@秋田大学　1998年10月3日

スーパーカミオカンデでのラドン測定

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他　スーパーカミオカンデ Collaboration

URL: http://www-sk.icrr.u-tokyo.ac.jp/

OUTLINE

- Introduction
- High sensitivity Rn detectors
- Rn measurement
- Rn-run
- Super sensitivity Rn detector

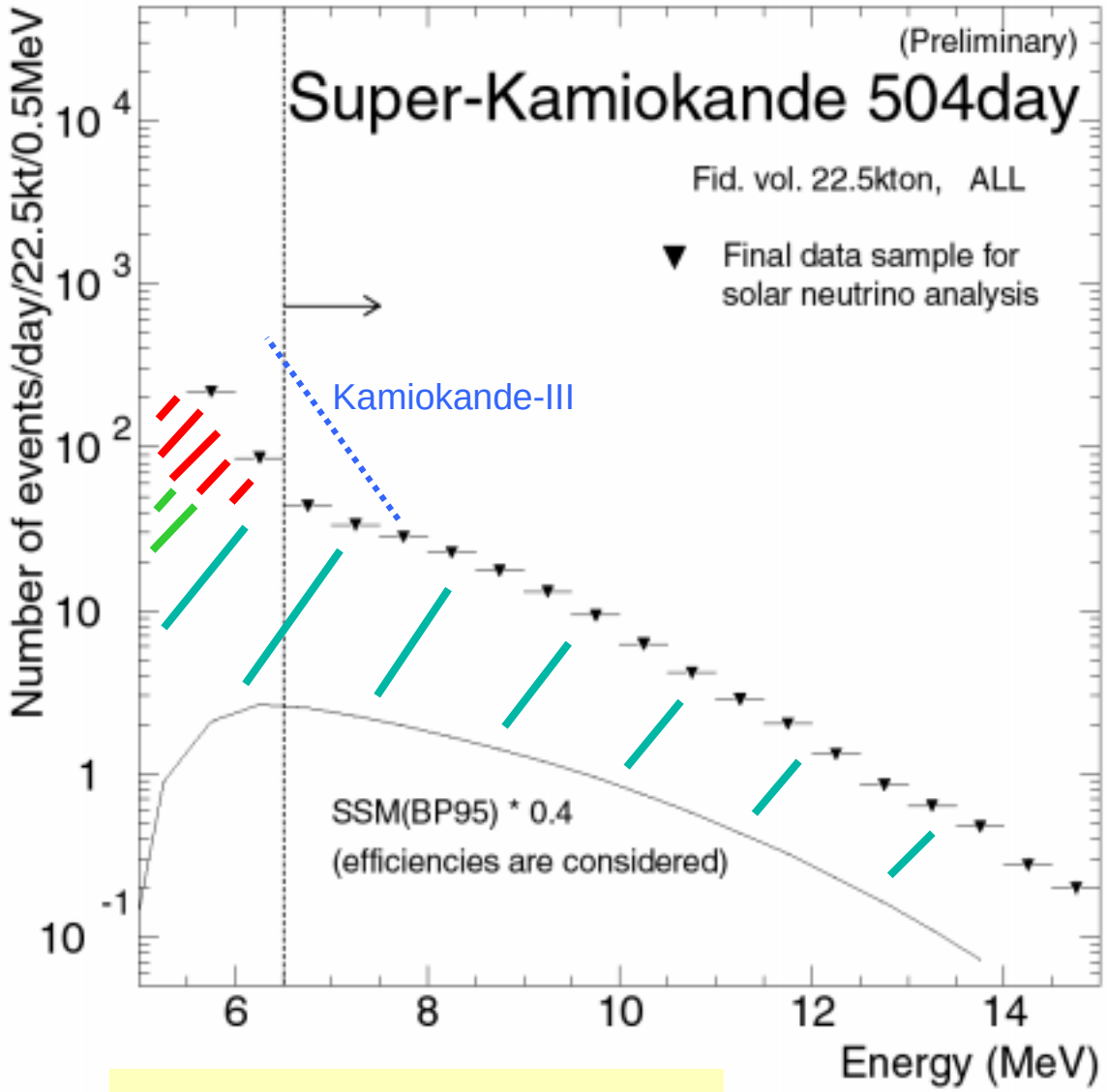
Introduction

ラドン（の娘核）は太陽ニュートリノ解析の低エネルギー領域での主要なバックグラウンド源である。

^{214}Bi: β 崩壊、E_{max} = 3.26 MeV

↳ ラドン除去、ラドン濃度測定を進めている

c.f. 0.5Bq/m^3 at Kamiokande-III

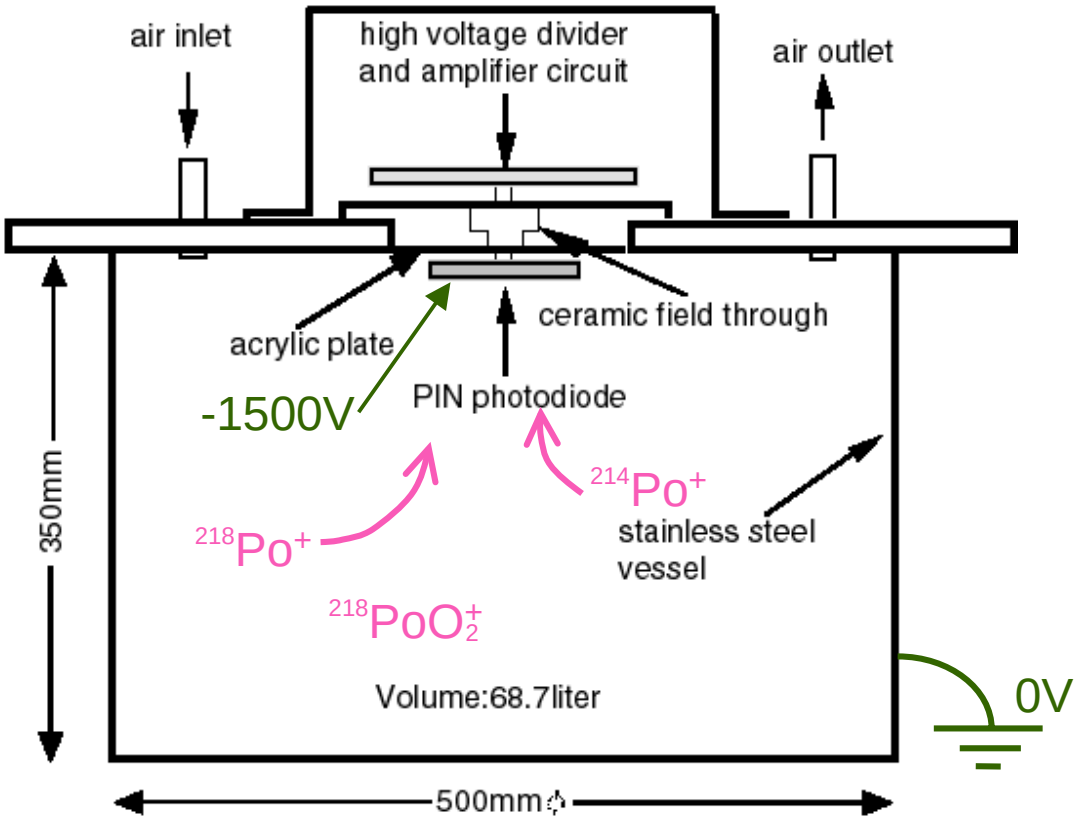


主要なバックグラウンド源

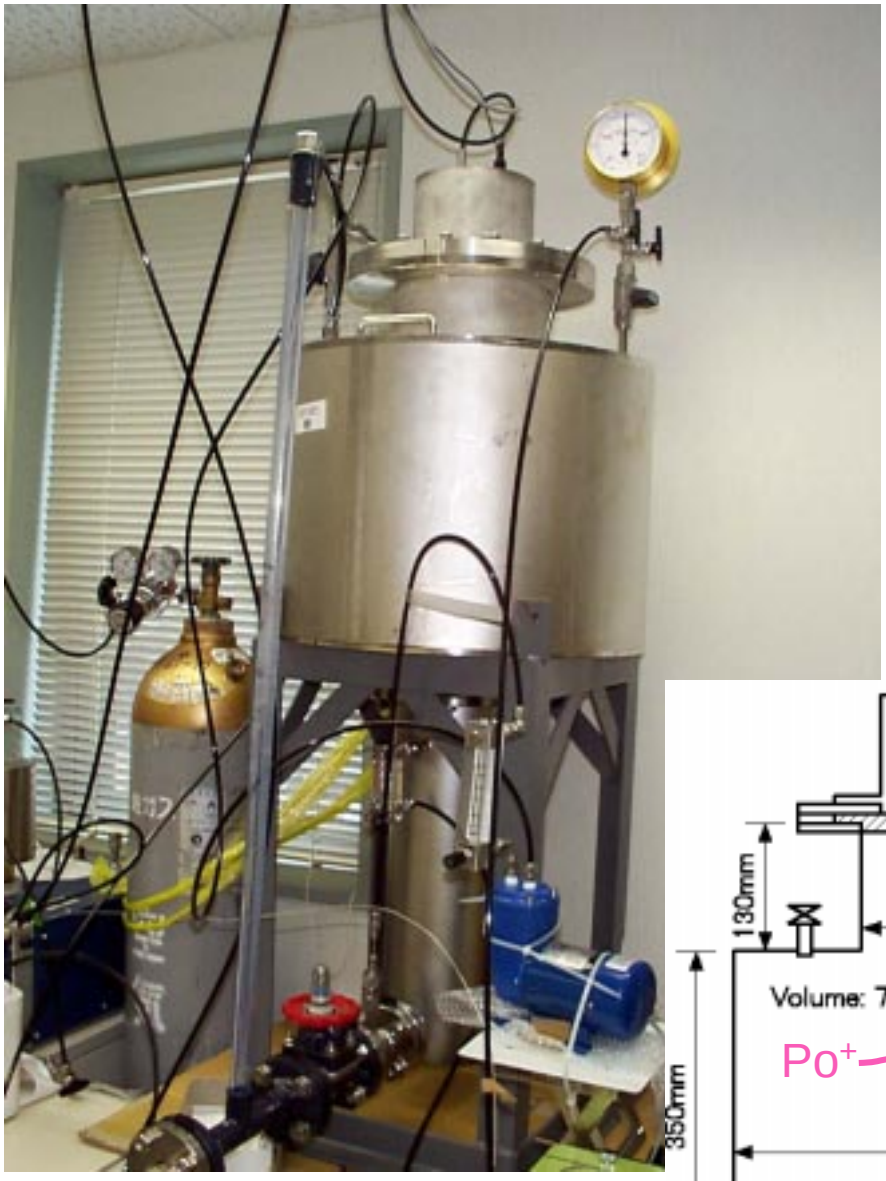
- Radon
- Spallation products
- External gamma-rays

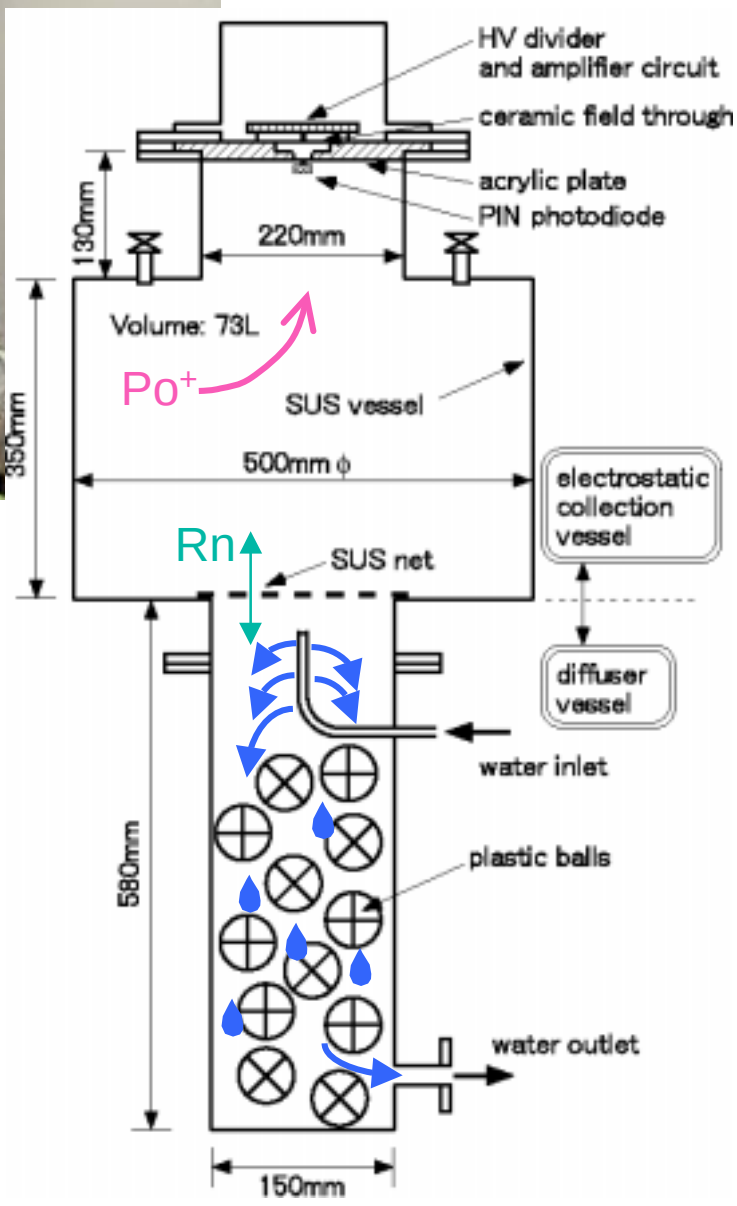
70L Rn detector for air

Method = PIN photodiode + Electrostatic collection



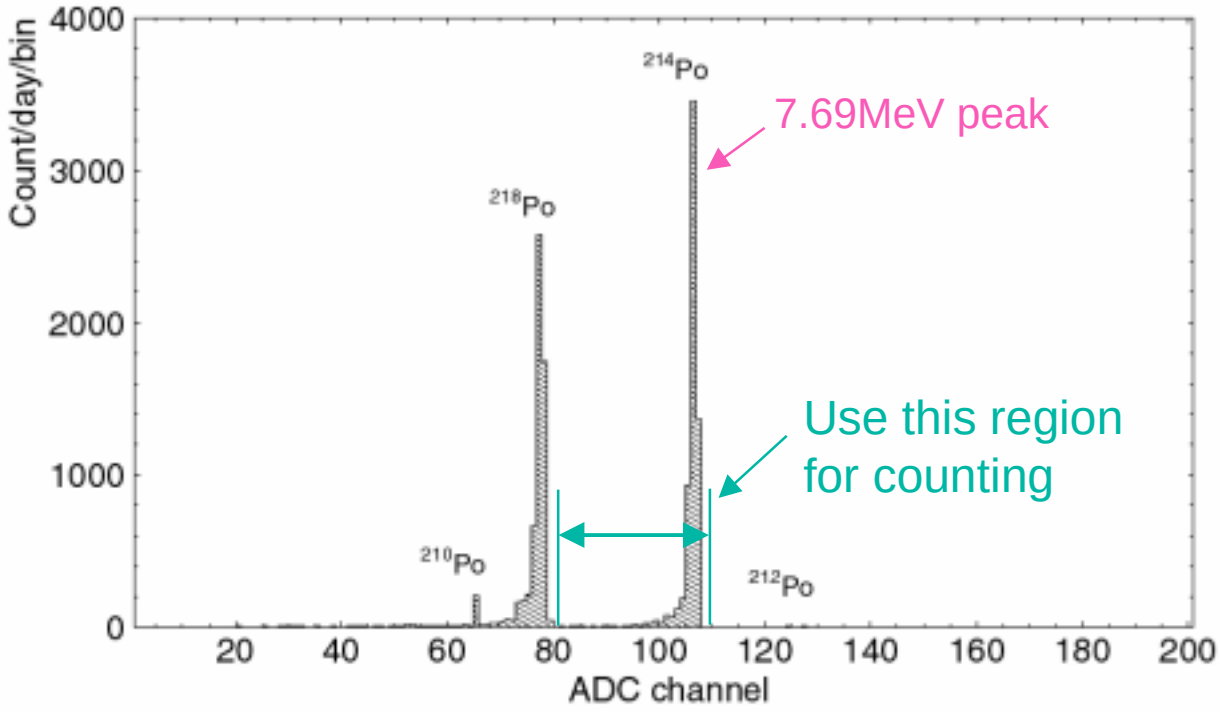
70L Rn detector for water





Calibration of 70L Rn detector

Typical response for 3Bq/m^3 Rn in air



Calibration Factor (preliminary)

$$\text{Calibration Factor} = \frac{\text{count /day}}{\text{mBq/m}^3}$$

70L Rn detector (air)

2.2±0.2(syst.+stat.) ± 0.4 (unknown syst.) @0.08g/m^3

0.86±0.06(syst.+stat.) ± 0.2 (unknown syst.) @11g/m^3

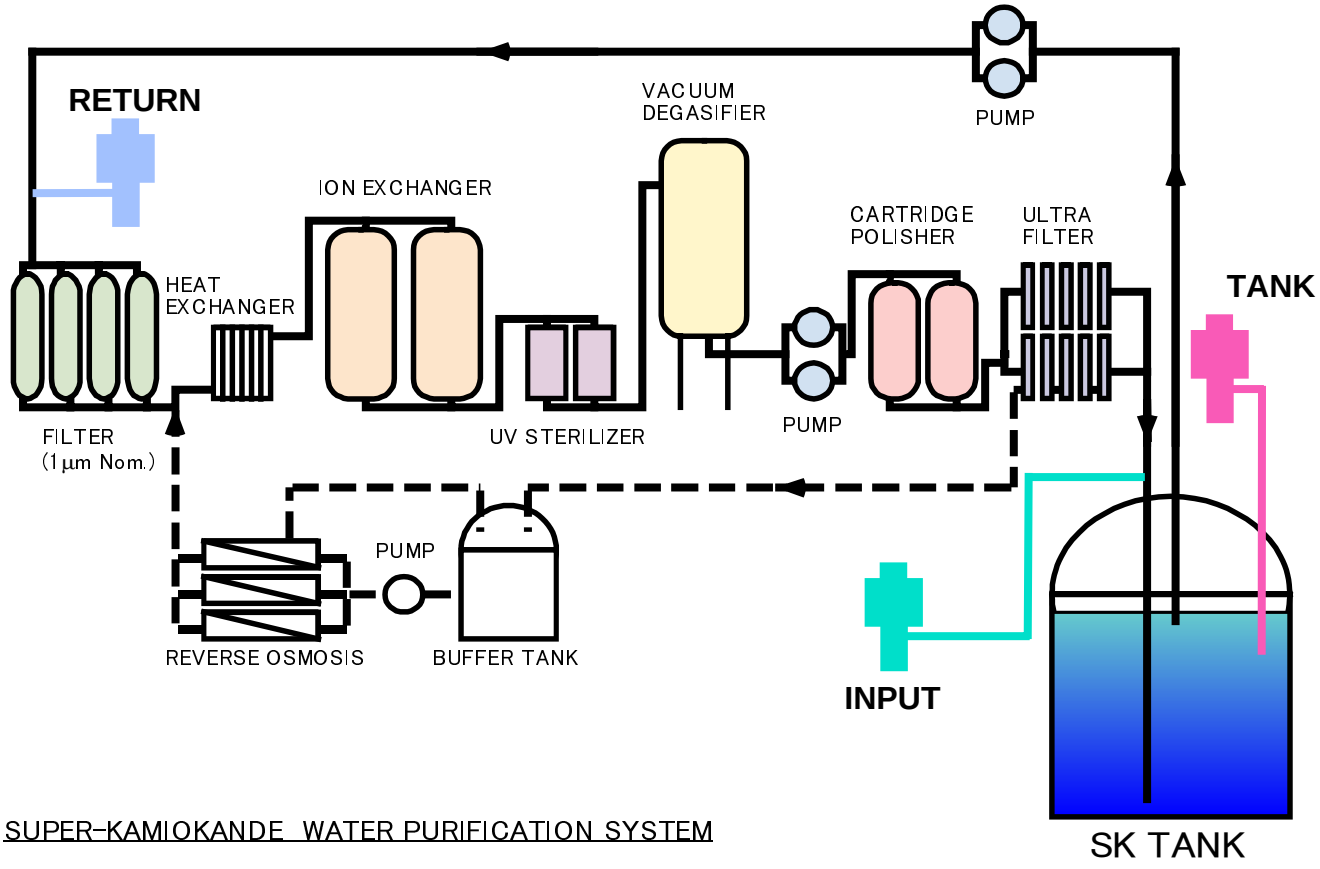
70L Rn detector (water)

3.6±0.5(syst.+stat.)

Rn measurement

Water purification system

FILTER & ULTRA FILTER: DUST
ION EXCHANGER : Ra
CARTRIDGE POLISHER : Ra
VACUUM DEGASIFIER : Rn



SUPER-KAMIOKANDE WATER PURIFICATION SYSTEM

Rn concentration (averaged in Jan. 1998)

Input water : < **3.2mBq/m^3**
Return water : < **5.0mBq/m^3**
Tank water: < **5.7mBq/m^3**

Test run with Rn water (Rn-run)

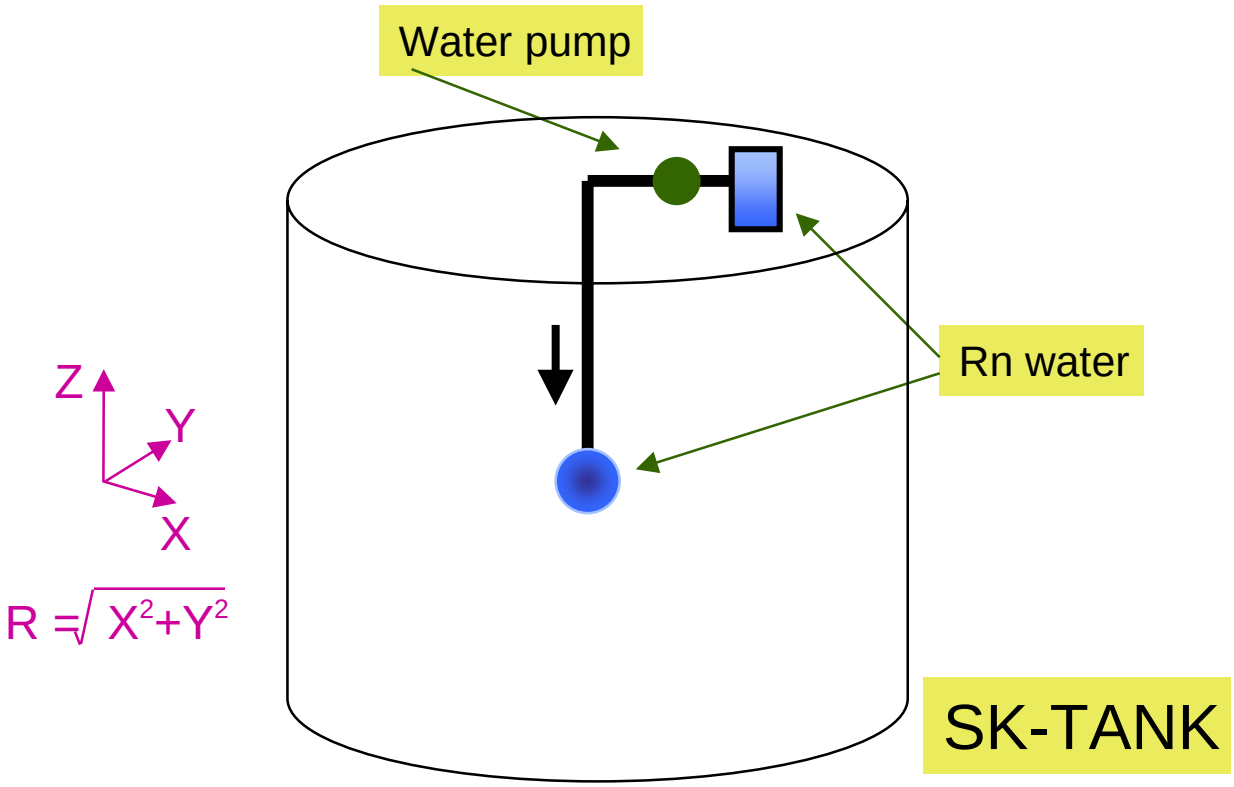
- Put 13Bq of Rn enriched water (Rn water) into the center of the SK detector.
  (@9:00a.m. on Dec.18, 1997)

- The Rn water was made by bubbling method.
  (10^4Bq/m^3 , 1.2 litter of Rn water)

- Water purification system was stopped during this test.

Run summary

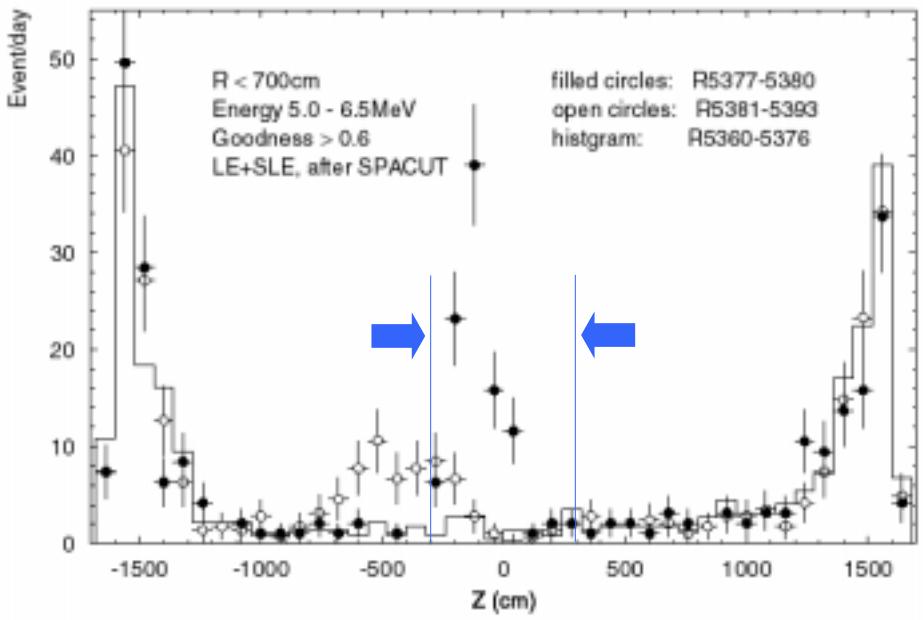
- Normal run: R5200-5333 (11/ 6-12/ 8) 15.4day
- BG-run1: R5334-5359 (12/ 8-12/15) 6.3day
- BG-run2: R5360-5376 (12/1512/18) 2.2day
- Rn-run1: R5377-5380 (12/18-12/19) 0.95day
- Rn-run2: R5381-5393 (12/19-12/22) 2.8day



Vertex & goodness distribution

(5.0~6.0MeV, after spallation cut)

Z

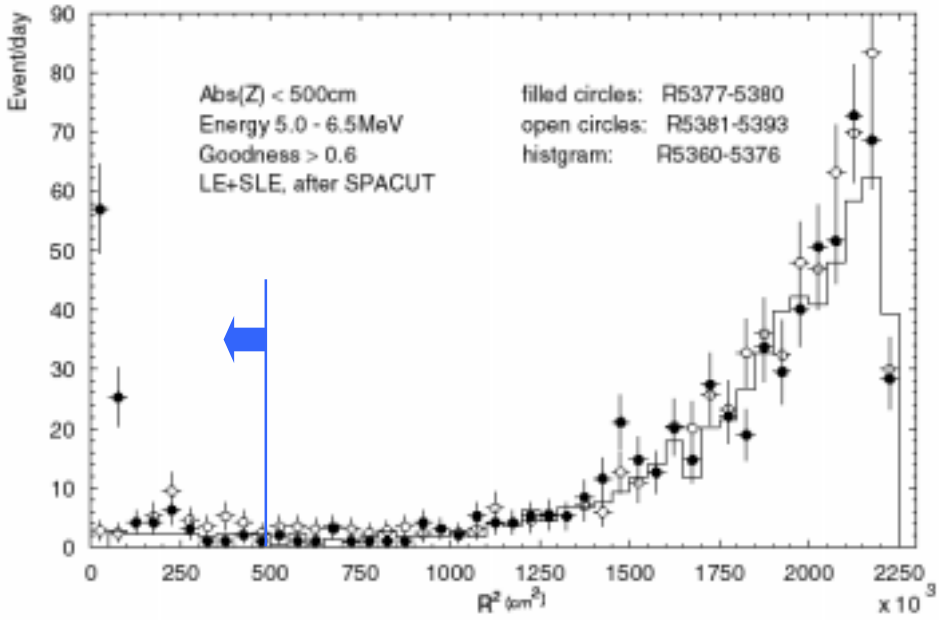


Rn-run1

Rn-run2

BG-run2

R^2

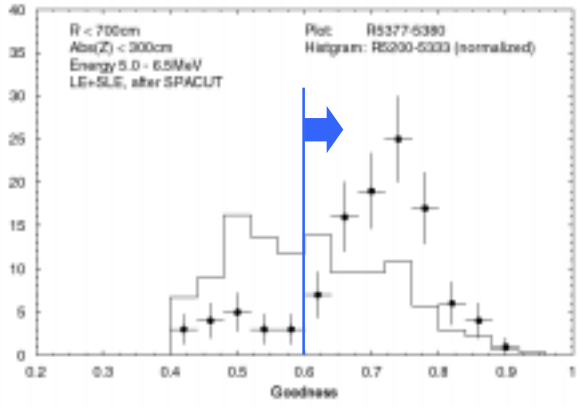


Rn-run1

Rn-run2

BG-run2

Goodness of vertex reconstruction



Rn-run1

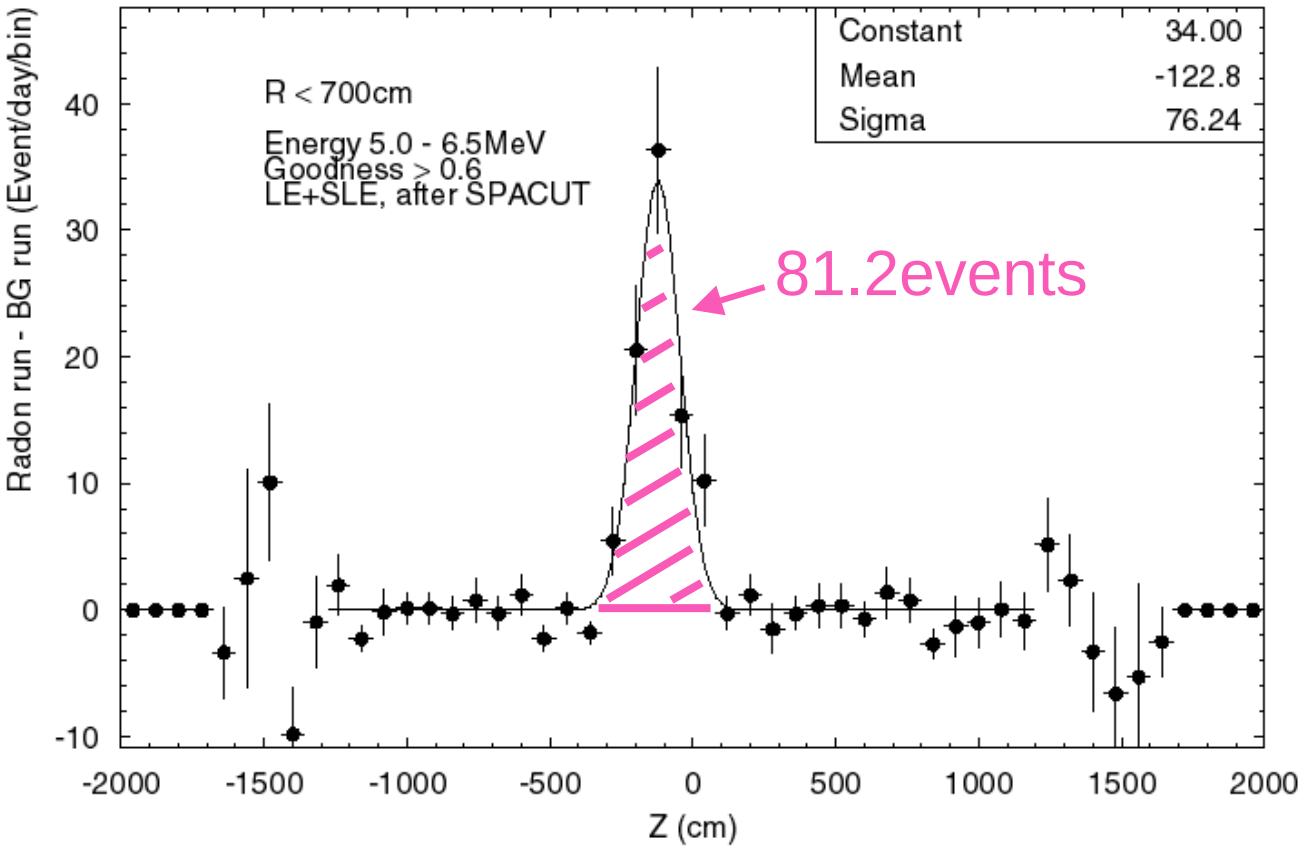
Normal run

Criteria for Rn events in Rn-run1

300cm < Z < 300cm, R < 700cm, Goodness > 0.6

Efficiency of the SK detector for Rn events

Z distribution: Rn-run1 - BG-run2



Rn-run1: Amount of Rn = 11.3 Bq
Livetime = 0.95 day

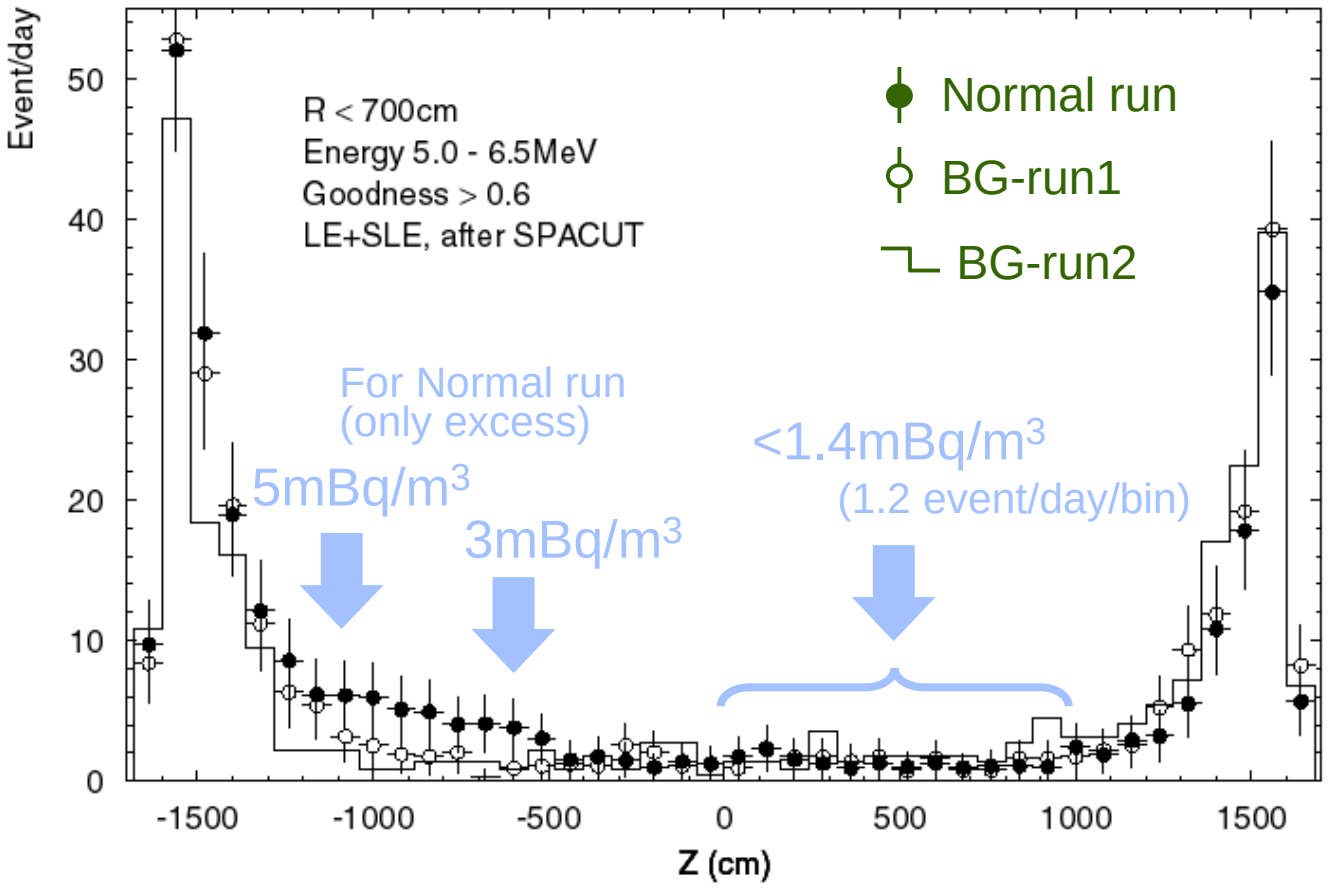
Efficiency = 8.3 x 10^{-5}

Energy = 5.0 ~ 6.5MeV
after spallation cut
goodness > 0.6
LE + SLE

Rn concentration in the SK-TANK

- Using the efficiency for Rn events and low-energy events of SK, the Rn concentrations in the SK-TANK are estimated.
- Event excess in the bottom region is due to Rn.

(The water inlet pipes are located on the bottom surface of the SK-TANK, and the water flow stirs up radon.
The origin of the radon is not yet determined.)



Rn concentration (from Rn-run & SK low-e events)

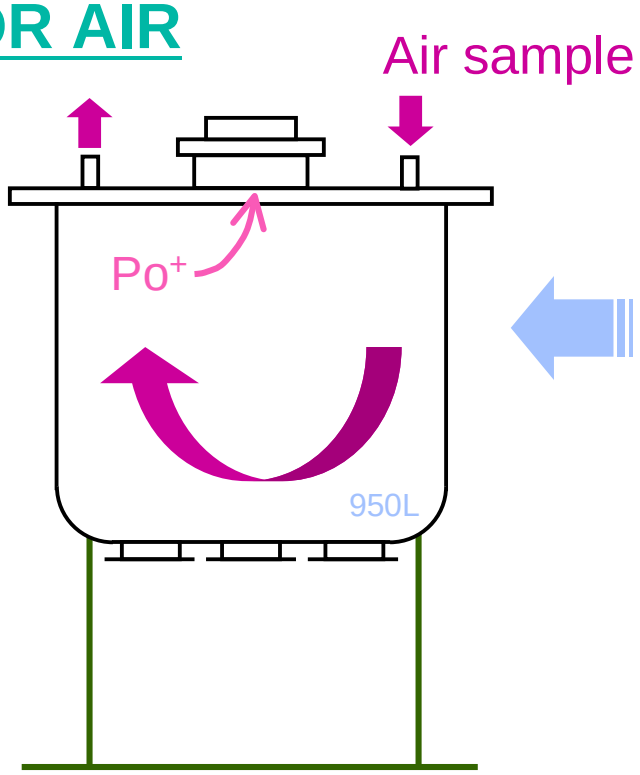
center	< **1.4mBq/m³**
bottom	**3~5mBq/m³**

Super sensitive Rn detector

Volume	70L	→	950L
Detection limit	~13		~1 (mBq/m^3/day)

(Stage 1)

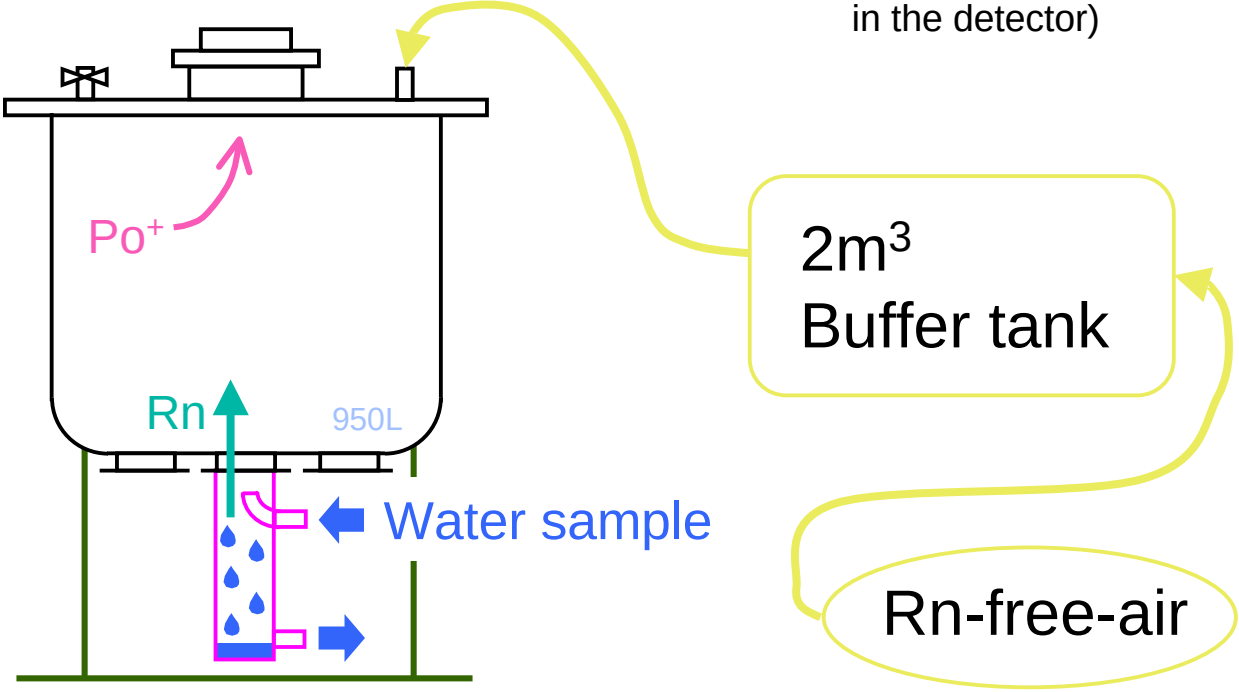
FOR AIR



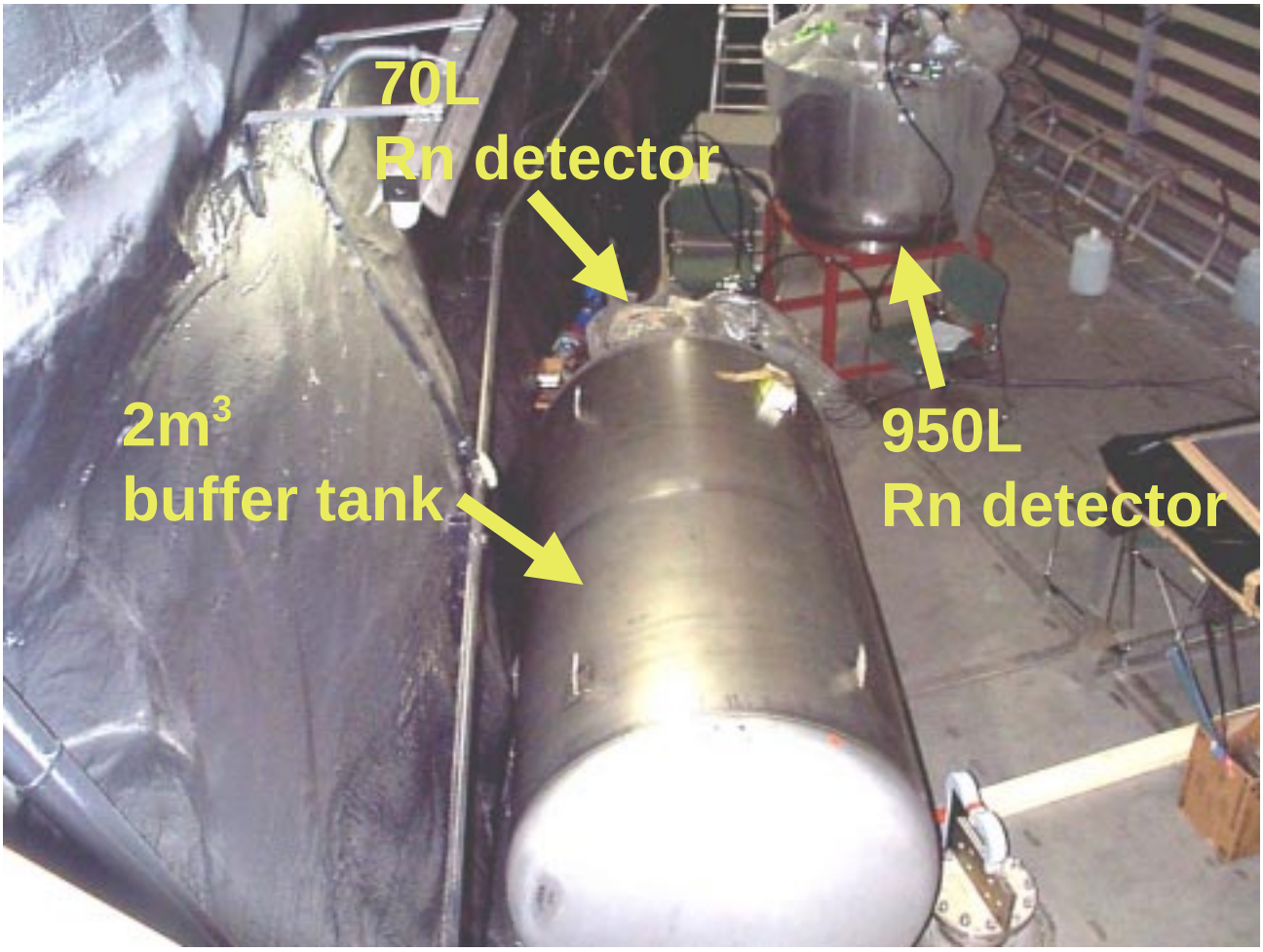
BG level and detection efficiency are studied with this setup

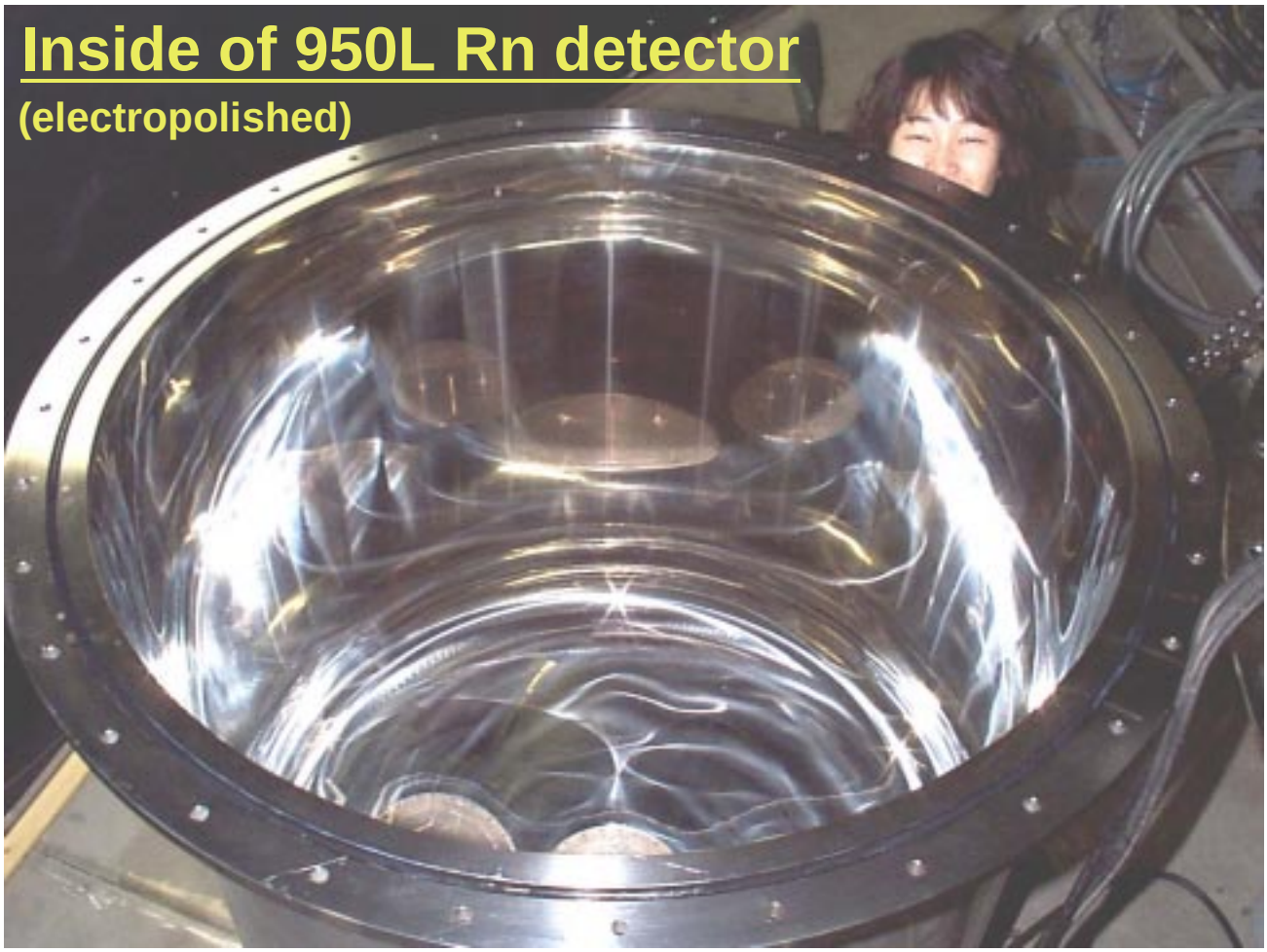
(Stage 2)

FOR WATER

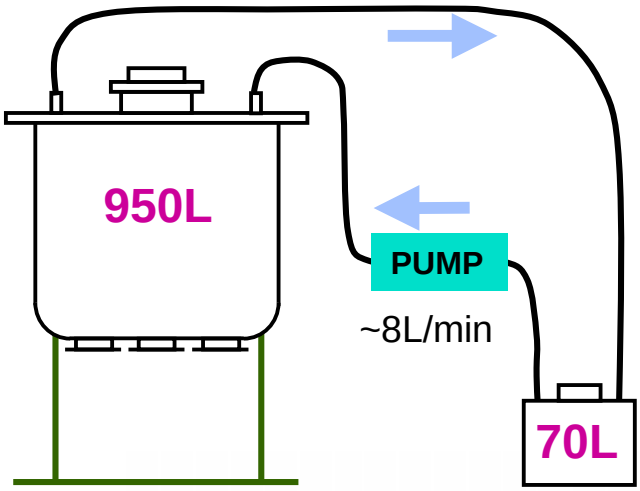


Super sensitive Rn detector

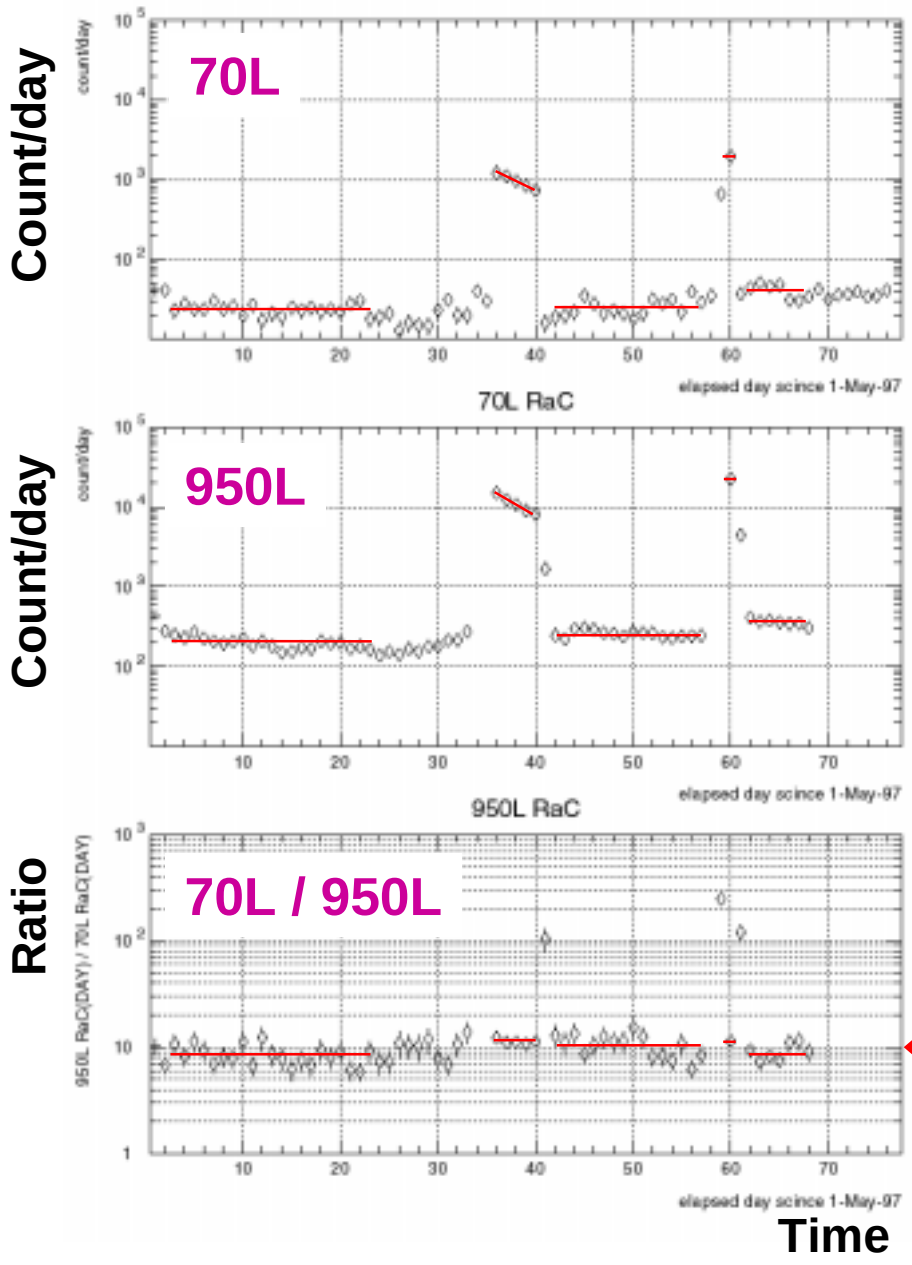




Comparison of detection efficiency



Connect 950L and 70L Rn detectors, then compare the count rates for each detector.



Factor 10

Efficiency@950L = Efficiency@70L x 10

SUMMARY

•Rn concentration in SK tank water

Rn-run

center < 1.4mBq/m^3

bottom 3~5mBq/m^3

70L Rn detector

Tank water < 5.7mBq/m^3

•Efficiency for Rn events

8.32×10^{-5} 5.0~6.5MeV
after SPACUT
Goodness>0.6
LE+SLE

•Development of a 950L Rn detector

The efficiency for 950L Rn detector is
10 times lager than 70L Rn detector.