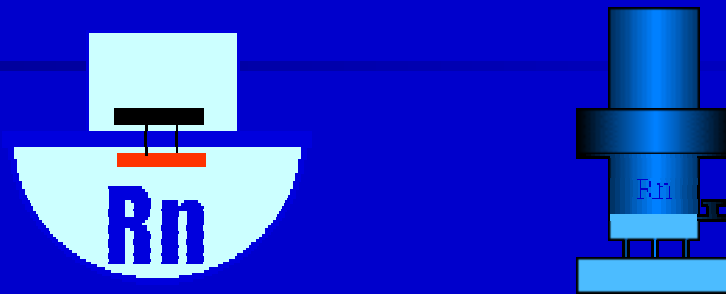


Development of the Groundwater Radon Detector

Japan-Taiwan International Workshop on
Hydrological and Geochemical Research for Earthquake Prediction

Date : Sep.-24,2002 Place : AIST (Tsukuba)



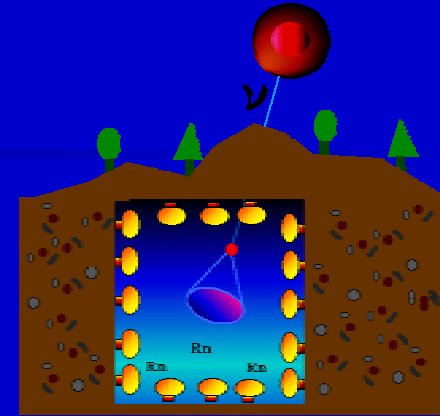
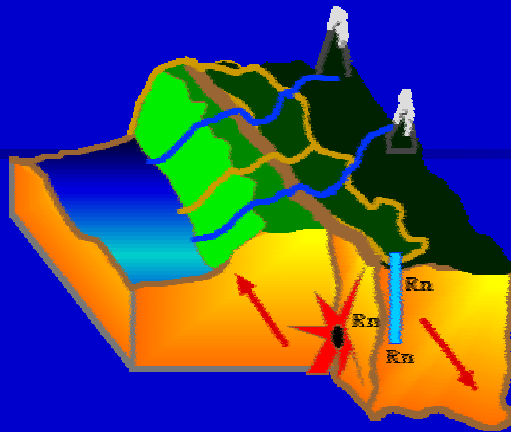
Educational Research Center for Lifelong Learning, Gifu University

Shigeki TASAKA

<http://www.ercll.gifu-u.ac.jp/~tasaka/>

E-mail: tasaka@ercll.gifu-u.ac.jp

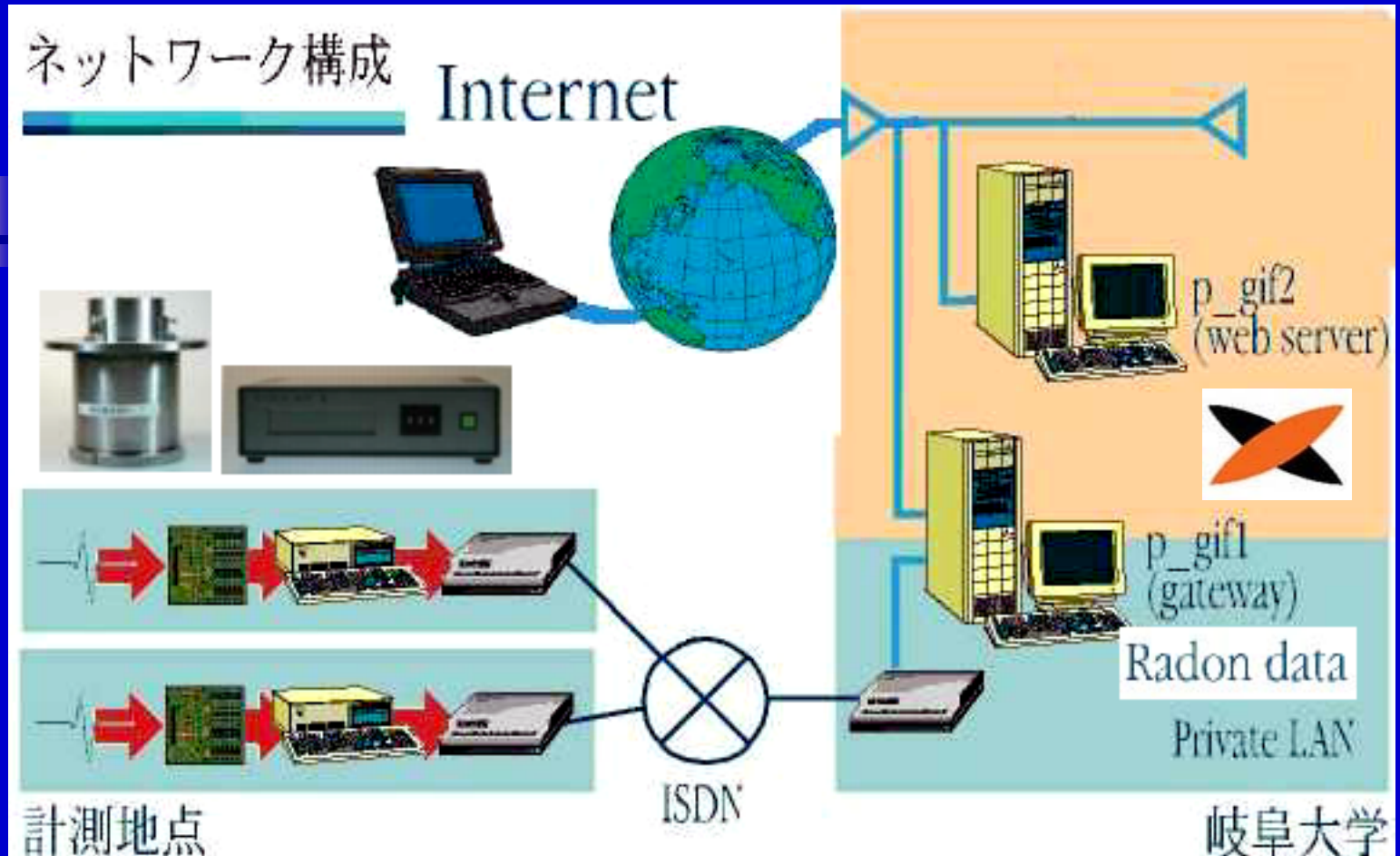
Application Research by Water Radon Detector



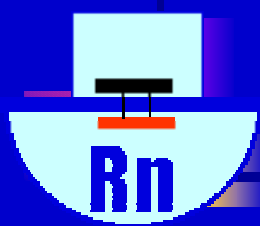
- Earthquake Prediction Research by Radon Observation of Groundwater.
- Monitoring the Pure Water radon concentration in the Super-Kamiokande solar neutrino detection Experiment , ICRR Univ. of Tokyo.
- Studies on the in-suit Method of Radon Measurement in Groundwater and Underground Structure Frontier Research in Nuclear Cycle Development Institute.

Radon Observation Network System

3



- Radon Concentration, Water Flow rate, Level and Temperature
- Data Logger, PC , Router
- → ISDN → Data Acquisition server → Web server → Internet
- anyone / always /anywhere: Web Page



Air Radon Detector



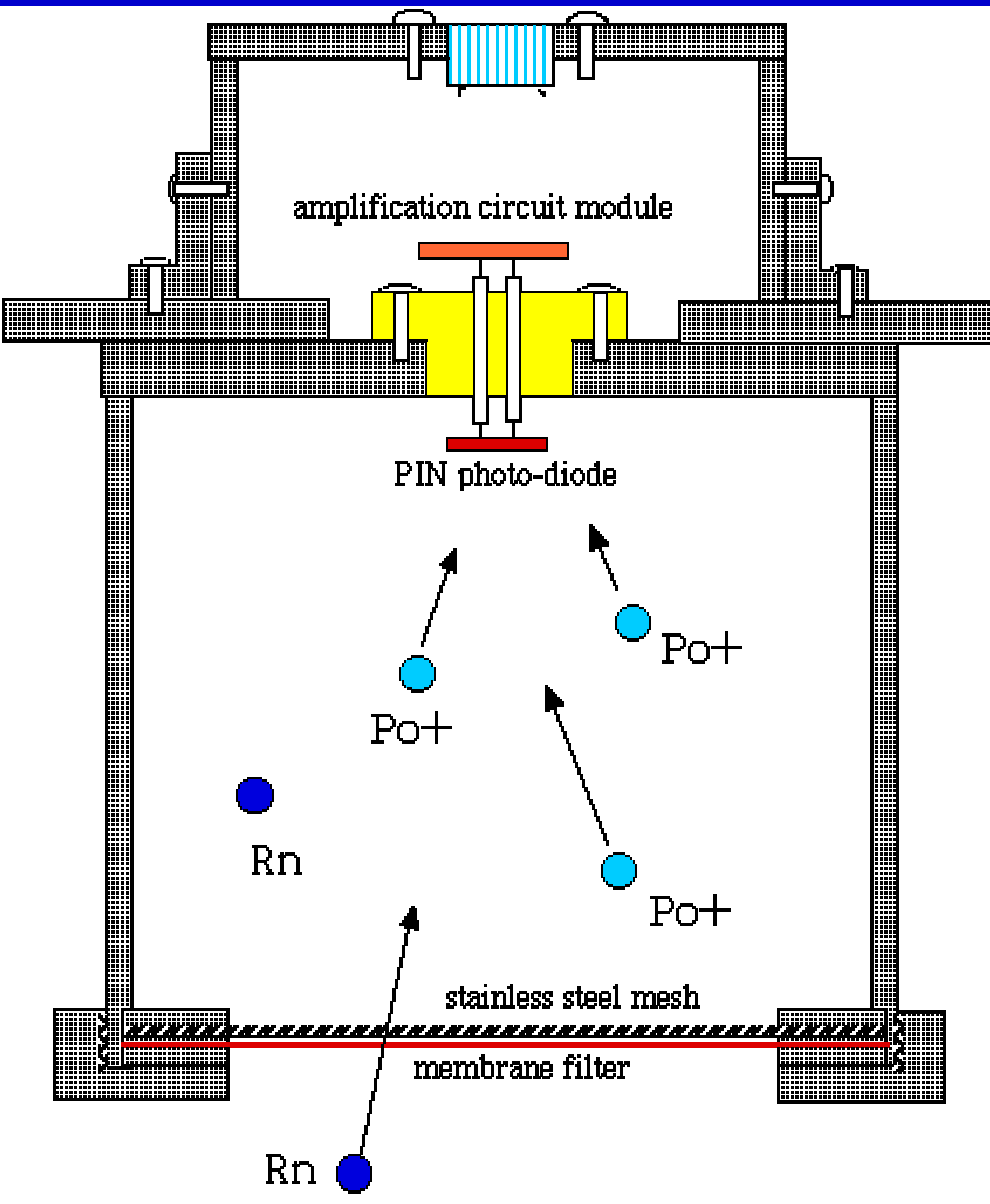
Volume: 1 liter
Detection limit: 1Bq/m^3



Volume: 70 liter
Detection limit: 5mBq/m^3

Structure of Air Radon Detector(1L)

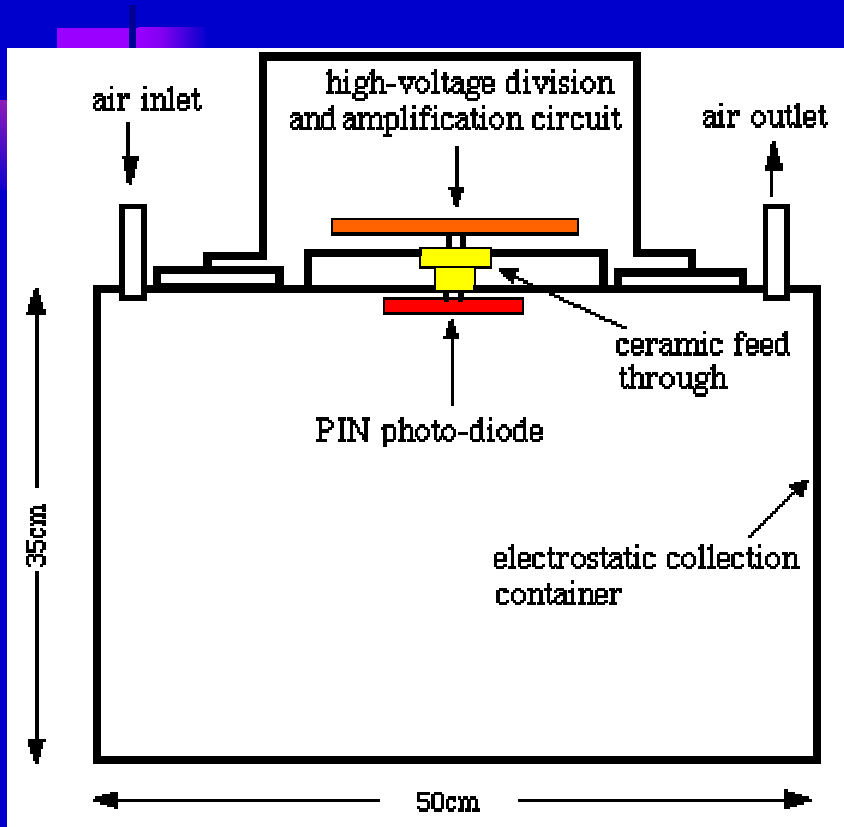
5



- “Rn” is a 222-Radon, “Po⁺” is Polonium ion of radon daughter nuclide.
- Amplification circuit module and a PIN photo-diode was used in detector.
- The bottom part is equipped with the membrane filter and stainless steel mesh.
- This vessel was installed inside of water radon detector.

Calibration Factor:
 $7.4 (^{214}\text{Po}/\text{d}) / (\text{Bq}/\text{m}^3)$

Structure of High Sensitivity Air Radon Detector(70L)⁶



- It was developed in order to measure the low radon concentration of Super-Kamiokande experiment.
- The capacity of the electrostatic collection container made from stainless steel is 70 liter
- The PIN photo-diode for newly developed radon measurement with an area of 18x18mm is used for a detection part.
- The newly developed high-voltage division circuit and the amplification circuit module are attached in the amplifier board.
- The negative high voltage -1500V is supplied to the p-layer of PD.
- In order to achieve a low background level, the inside of the vessel is electro-polished after the welding.
- It can measure on real time, to low radon concentration 5mBq/m³.

Water Radon Detector



Volume: 1 liter

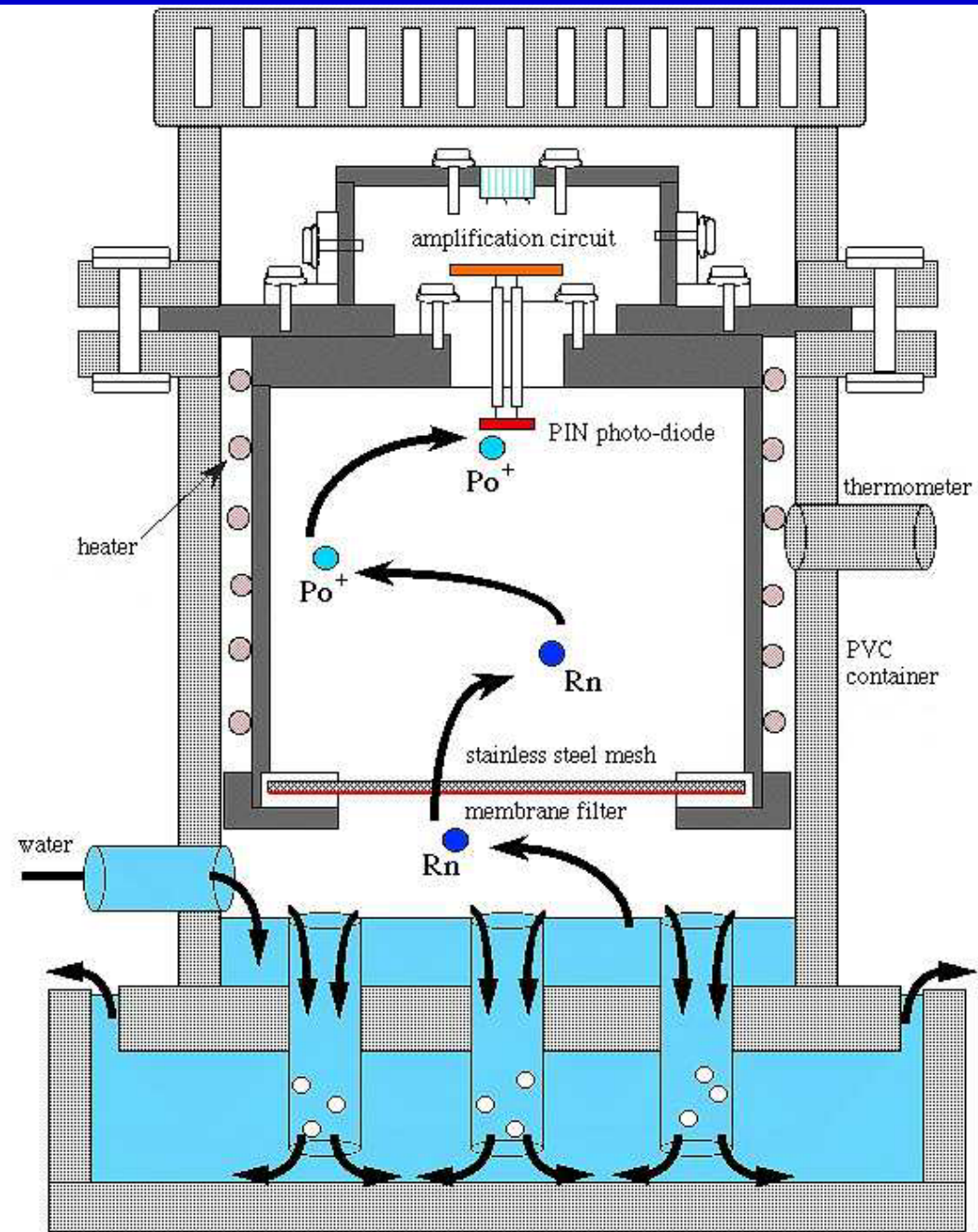


Volume: 70 liter

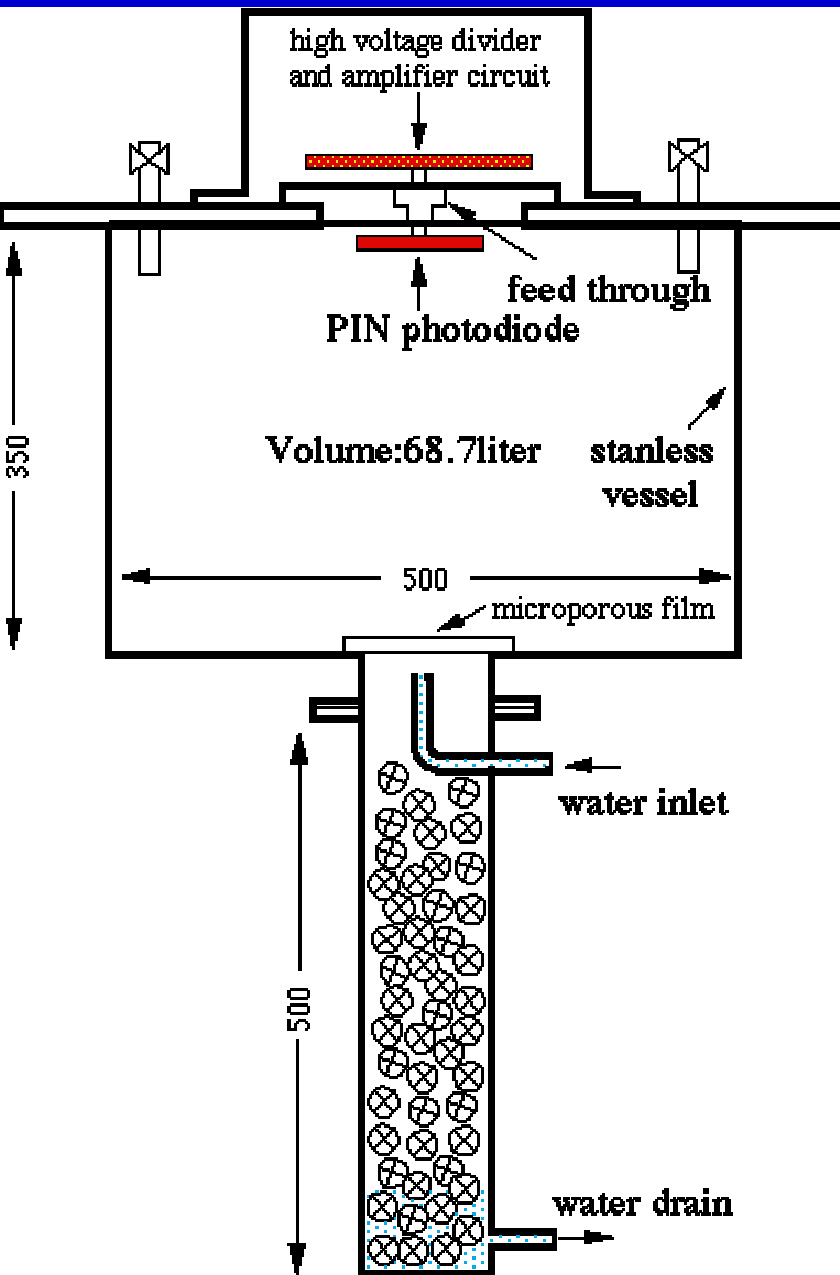
Structure of Water Radon Detector 8

Radon Detector

- Water is poured in the valve part of the airtight PVC container, and flows out of the detector lower part.
- It is important to keep the air temperature about 5 higher than the groundwater temperature by heating cable.
- The temperature of water and air of inside detector are measured.



Calibration Factor:
 $9.6 (^{214}\text{Po}/\text{d}) / (\text{Bq}/\text{m}^3)$



Radon Extraction unit

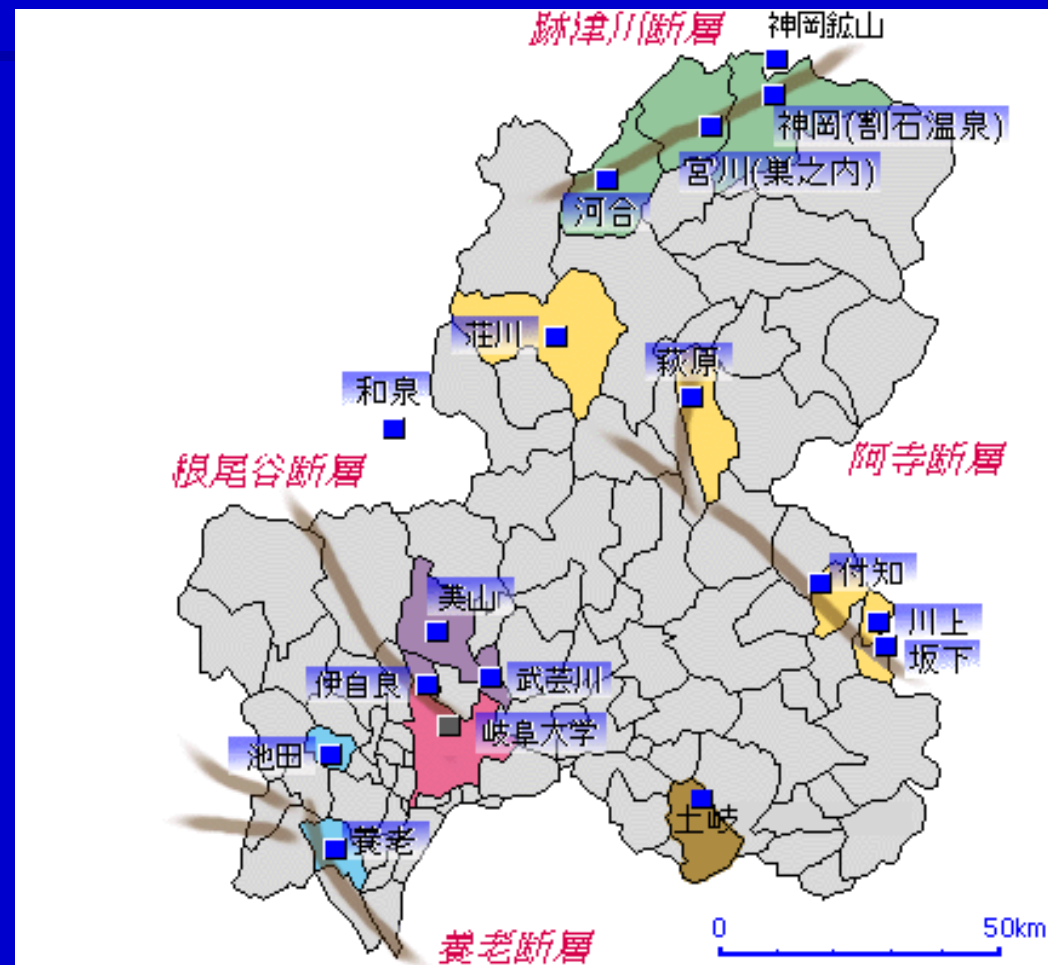
Structure of High Sensitive Water Radon Detector

- Detector consists of a upside electrostatic collection container and a lower extraction cylinder.
- Plastic ball (diffuser) is contained in the cylinder, is carrying out the duty which makes the extraction radon gas in the water into air.
- Water is continuous sent in a rate 1 L/m. While water reaches the bottom of a cylinder, the dissolved radon gas is extracted into air.
- Radon is diffused to electrostatic collection unit, and decay in Polonium.

Calibration Factor:
 $3.0(^{214}\text{Po}/d) / (\text{mBq}/\text{m}^3)$

Radon Observation in Groundwater, Gifu Prefecture, Central Japan

- The 16 groundwater observatories were made on the active faults in Gifu Pref.
- The groundwater observation results were displayed with the real time on the internet Web Page.
- Water Radon concentration, water flow rate, water level and water temperature



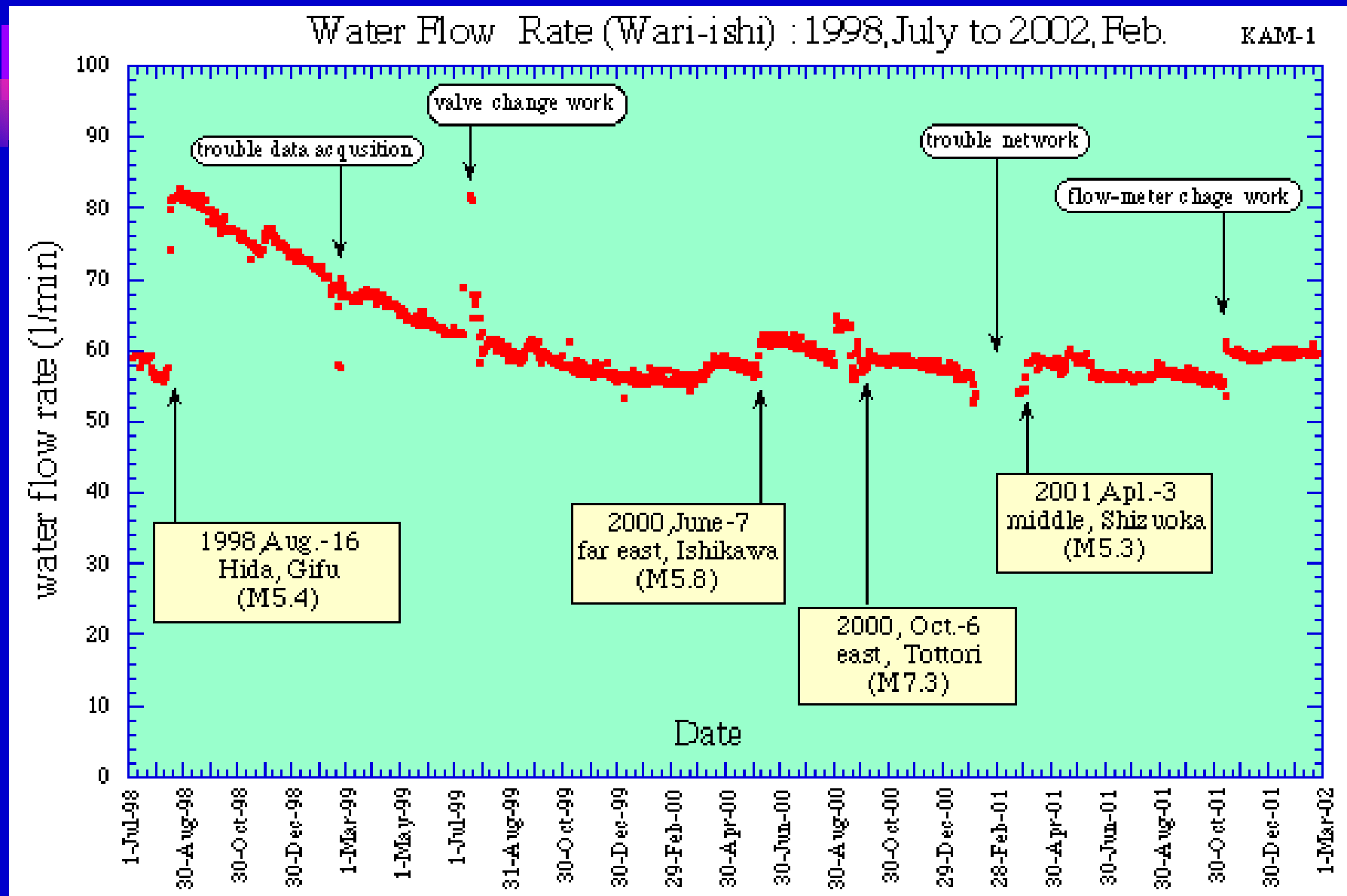
<http://ll.physics.gifu-u.ac.jp/>

Earthquakes with change of water data in 2000-2001

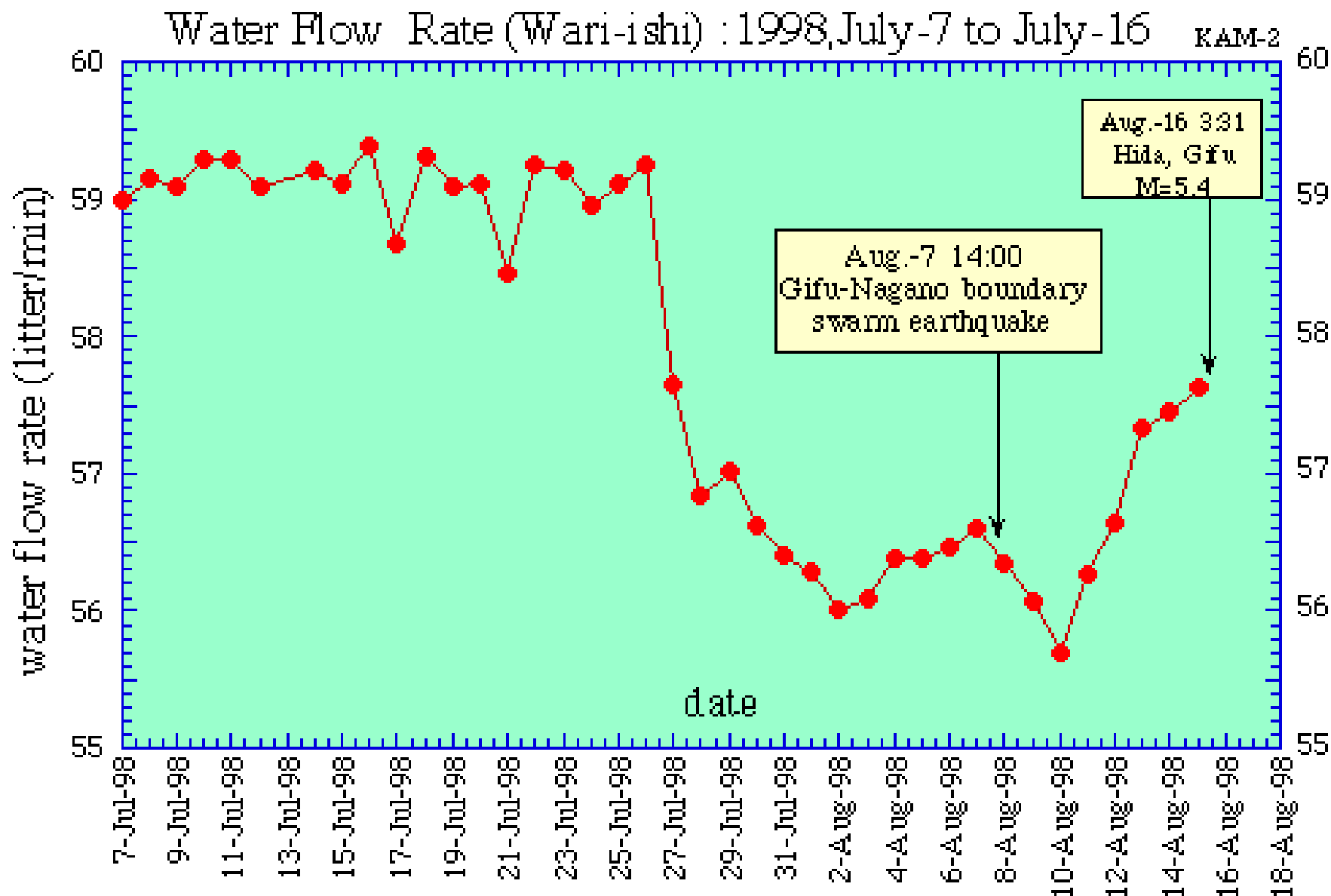
earthquakes with change of water data in 2000-2001	HEI	KAM	KAW	MUG	IJI	TAR	YOU	HAG	SAK	NIN
	F T R	F T R	L T R	L T R	L T R	F T R	F T R	L T R	L T R	L T R
(1) far east, Ishikawa 2000, June-7 6:16 D=10km M=5.8	⊙ ⊙ ×	○ ○ ×	○ × ○	× ○ ×	×	×	×	×	×	×
(2) east, Tottori 2000, Oct.-6 13:30 D=11km M=7.3	⊙ ⊙ ×	○ ○ ×	×	×	× ○ ×	○ × -	×	×	×	○ × ○
(3) south, Mie 2000, Oct.-31 1:43 D=40km M=5.7	○ ○ ×	×	×	×	× ○ ×	×	× × ○	×	×	×
(4) east Mino, Gifu 2001, Jan.-6 11:48 D=40km M=4.9	- ○ -	×	×	× ○ ×	× ○ ×	×	×	○ ○ ×	×	×
(5) middle, Shizuoka 2001, Apl.-3 23:57 D=30km M=5.3	×	○ ○ -	×	×	×	×	×	×	⊙ × -	×

F/L: water flow rate/water level, T: water temperature, R: Radon,
 ⊙:pre-seismic change, ○:co-seismic change,
 ×:no change, -:no data

Earthquake with change of water flow rate (KAM)



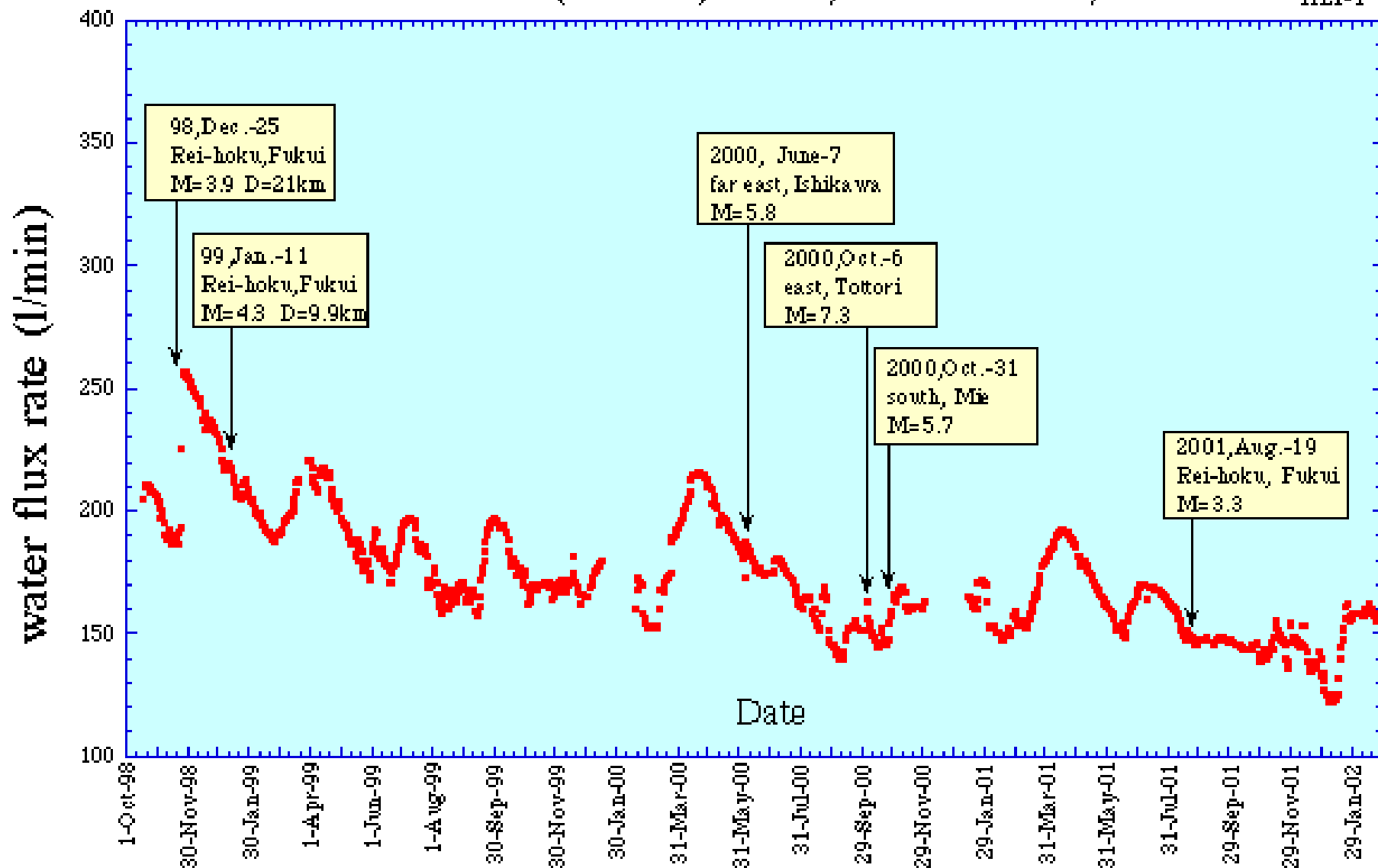
Pre-seismic change of water flow rate (KAM)



Earthquake with change of water flow rate (HEI)

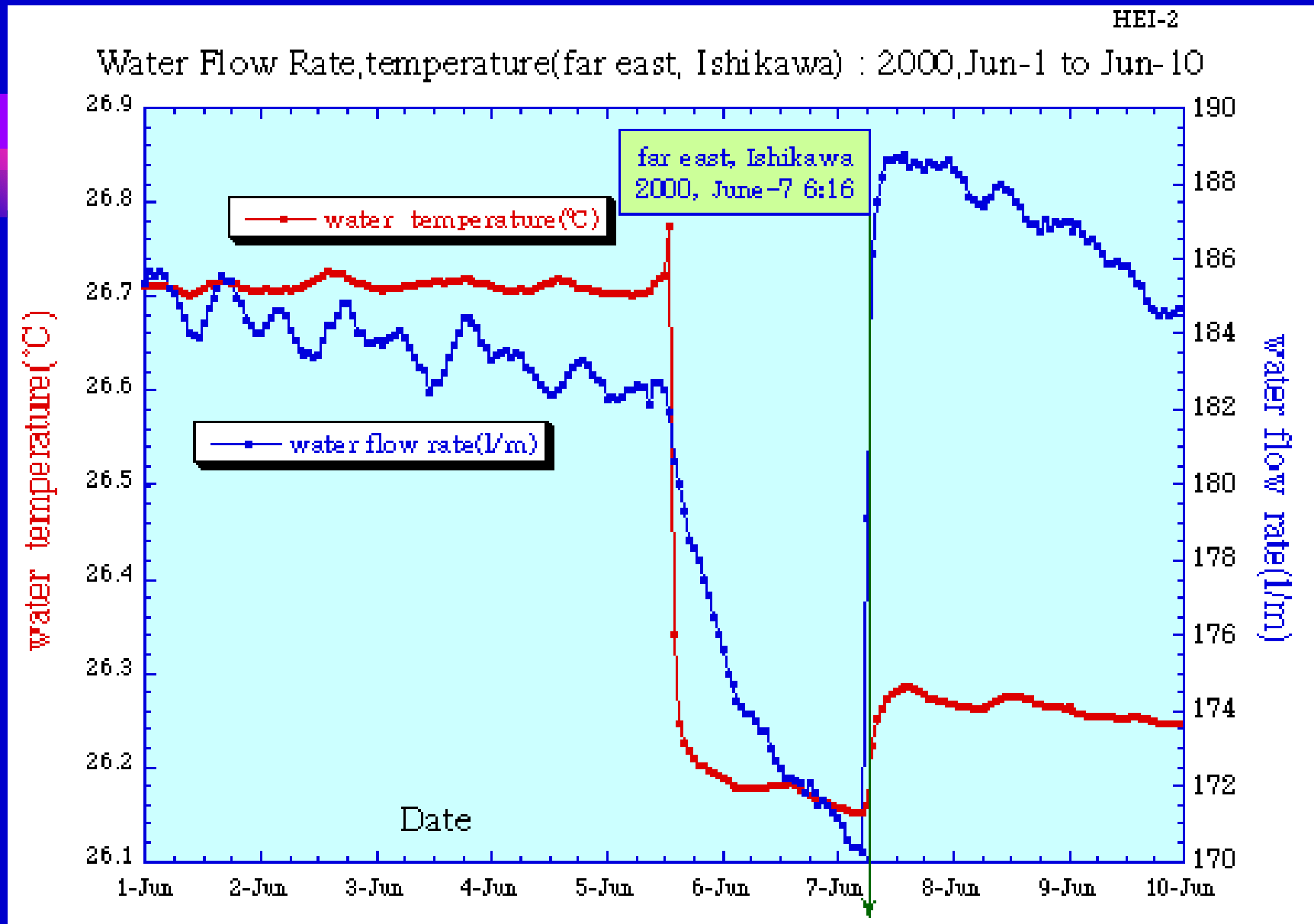
Water Flow Rate (Heisei): 1998, Oct. to 2002, Feb.

HEI-1



Pre-seismic change of water flow rate, temperature

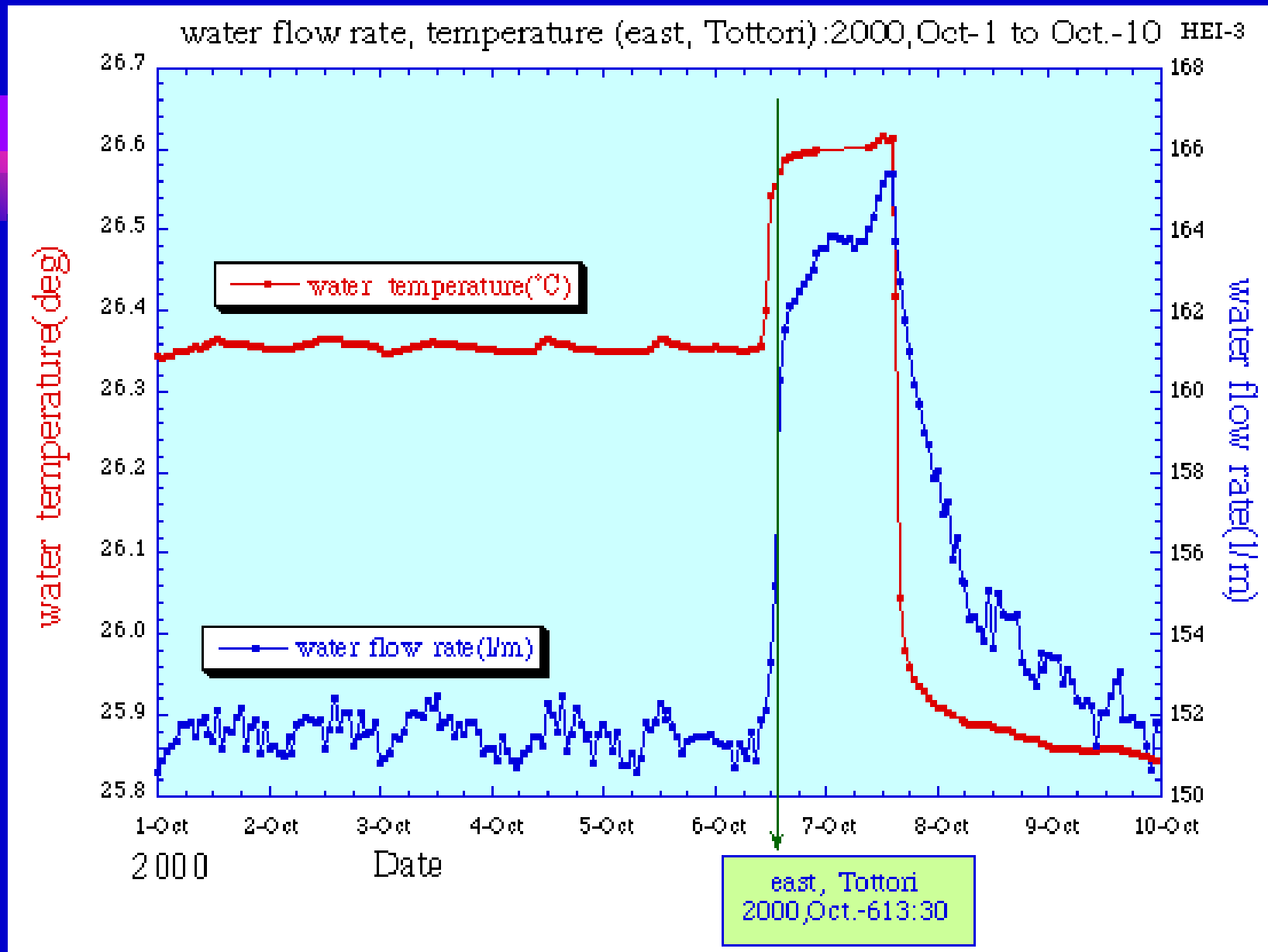
15



Far west Ishikawa: M=5.8 d=90km Water temperature/flow decreased before 1.5days

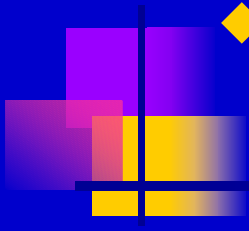
Pre-seismic change of water flow rate, temperature

16



West Tottori: M=7.3 d=270km Water temperature/flow increased before 2.5 hr

Summary

- 
- ◆ It is established that continuous observation have long time stability by using our groundwater radon detector.
 - ◆ Developed water radon detector was applied in the wide radon concentration ranges from 10^4 to 10^{-3} (Bq/m³).
 - ◆ It is established to watch groundwater data with real time for collaborator and citizen by our developed radon measuring and network systems.
 - ◆ We have observed many co-seismic and a few pre-seismic changing data of groundwater.