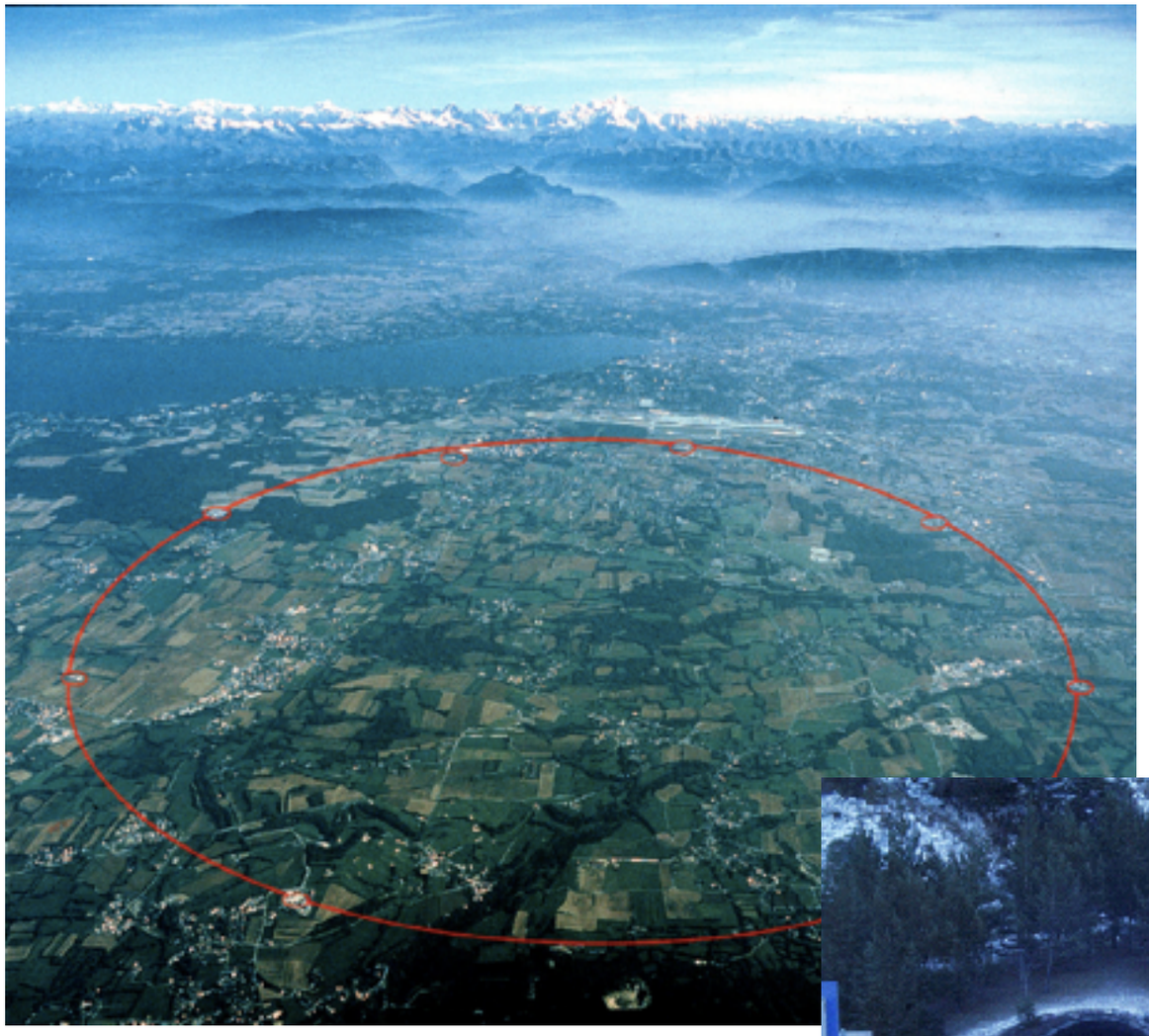
Radiation measurements around the Fukushima Daiichi nuclear power plant

Osaka University
NOMACHI, Masaharu

https://www.irasutoya.com is referred for the illustrations


Télescope
SXT (x2)
Banc optique fixe
pour les détecteurs
SXS et SXI
Télescope
HXT (x2)
Panneau
solaire
Banc optique
déployable
Détecteur
HXI
Senseur d'étoiles
Radiateur



A primer course of experimental physics

--- Advanced Technology Training Program in Osaka University ---

2011 08/September ~ 03/October
2010 12/July ~ 10/August
2009 20/February ~ 21/March

Participants

27 students

China	Beijing 4, Shanghai 3, Lanzhou 2
Philippine	Manila 2
Vietnam	Hanoi 3, Danang 2, Ho Chi Minh City 3
Malaysia	Kuala Lumpur 2, Johor Bahru 3
Indonesia	Bandung 2
Myanmar	Mandalay 2

3 young staff member from Hanoi and HMC as teaching assistant of the course.

2010 participants from ASEAN and China

Interview

1/March ~ 24/April in 11 cities. Two to four of organizers visit each city.
The number of candidates is **114**.

RCNP

大阪大学 OSAKA UNIVERSITY

JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE 日本学術振興会

SAKURA SCIENCE Exchange Program

Sakura Science Plan

大阪大学 OSAKA UNIVERSITY

International School on Radiation measurements in Osaka

1) 18 to 27 January 2015
2) 9 to 18 November 2015
3) 24 November to 3 December 2016
4) 8 to 17 November 2017
5) 31 October to 9 November 2018
6) 21 to 30 November 2019

RCNP

RENCONTRES DU VIETNAM
Orsay, France

Center for Theoretical Physics
Institute of Physics, VAST

The Abdus Salam ICTP

APCTP

Quy Nhon University

XVIII VIETNAM SCHOOL OF PHYSICS (VSOP-18)

Quy Nhon, 23 July - 4 August 2012

GENERAL INFORMATION

POSTER

The **18th Vietnam School of Physics** (VSOP), devoted to modern problems of **particle physics, astro-particle physics and cosmology**, specially, in the LHC era, will be organized in **Quy Nhơn**, the capital of Bình Định province, Central Vietnam, from **23 July – 4 August 2012** by *Rencontres du Vietnam* (RdV) and *Institute of Physics* (IOP), Hanoi, in cooperation with *Quynhon University*, Quy Nhon, and *Institut National de Physique Nucléaire et de Physique des Particules* (IN2P3), CNRS, France.

The school belongs to a series of schools originating from a school organized in 1994 by the initiative of RdV. It is also funded by the *Abdus Salam International Centre for Theoretical Physics* (ICTP), Trieste, Italy, and the *Asia-Pacific Centre for Theoretical Physics* (APCTP), Pohang, Korea, as an external activity.

All people are welcome to apply for the 18th VSOP. The school can accept upto 40 participants. Some **financial support** for participants who are from developing countries (with a priority given to young people, such as junior researchers, PhD- and master students, from the Asia-Pacific region), and who will attend the entire scientific program, may be possible.

For registration, the registration form should be completed and submitted by the deadline, **15 May 2012** (Tuesday).

OSAKA UNIVERSITY
European Center for Academic Initiatives

English 日本語

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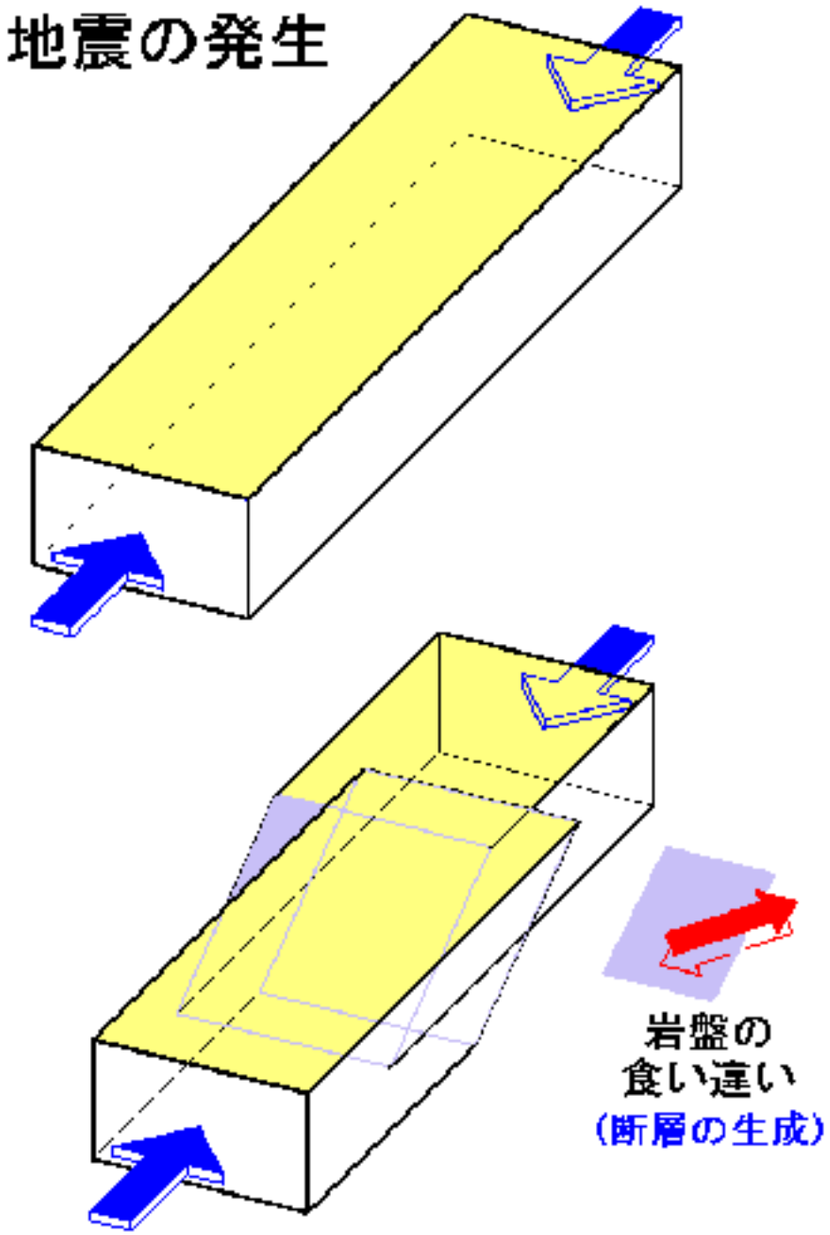
OSAKA UNIVERSITY
European Center for Academic Initiatives

3.11 2011

Earthquake 3.11 2011



Dislocation causes earthquakes

Energy of earthquake is (almost) proportional to the area of the fault.

https://www.hinet.bosai.go.jp/about_earthquake/part1.html

Earthquake 3.11 2011

Energy of earthquake ∝ $1000^{M/2}$

M7 is 1000 times bigger than M5

32 x 32 = 1024

M7 is 32 times bigger than M6

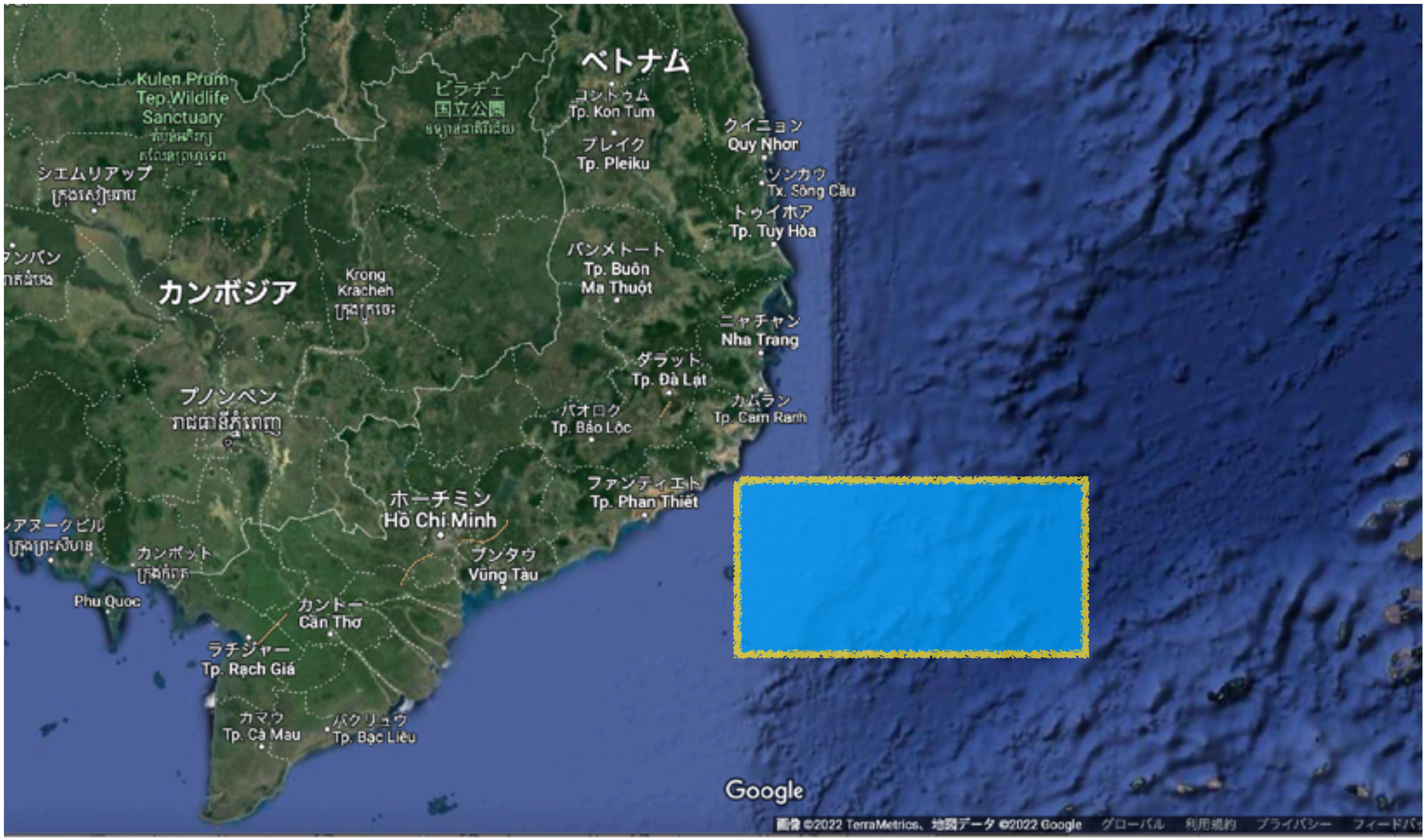
https://www.hinet.bosai.go.jp/about_earthquake/part1.html

M5 : 3.2 km long move 16cm

M5.0 - 5.9　～1300 /year in the world by USGS

M7 : 32 km long move 1.6 m

M7.0 - 7.9　～ 17 /year in the world by USGS



M9 : 320 km long move 16 m

Only 5 earthquake more than M9 since 1900.

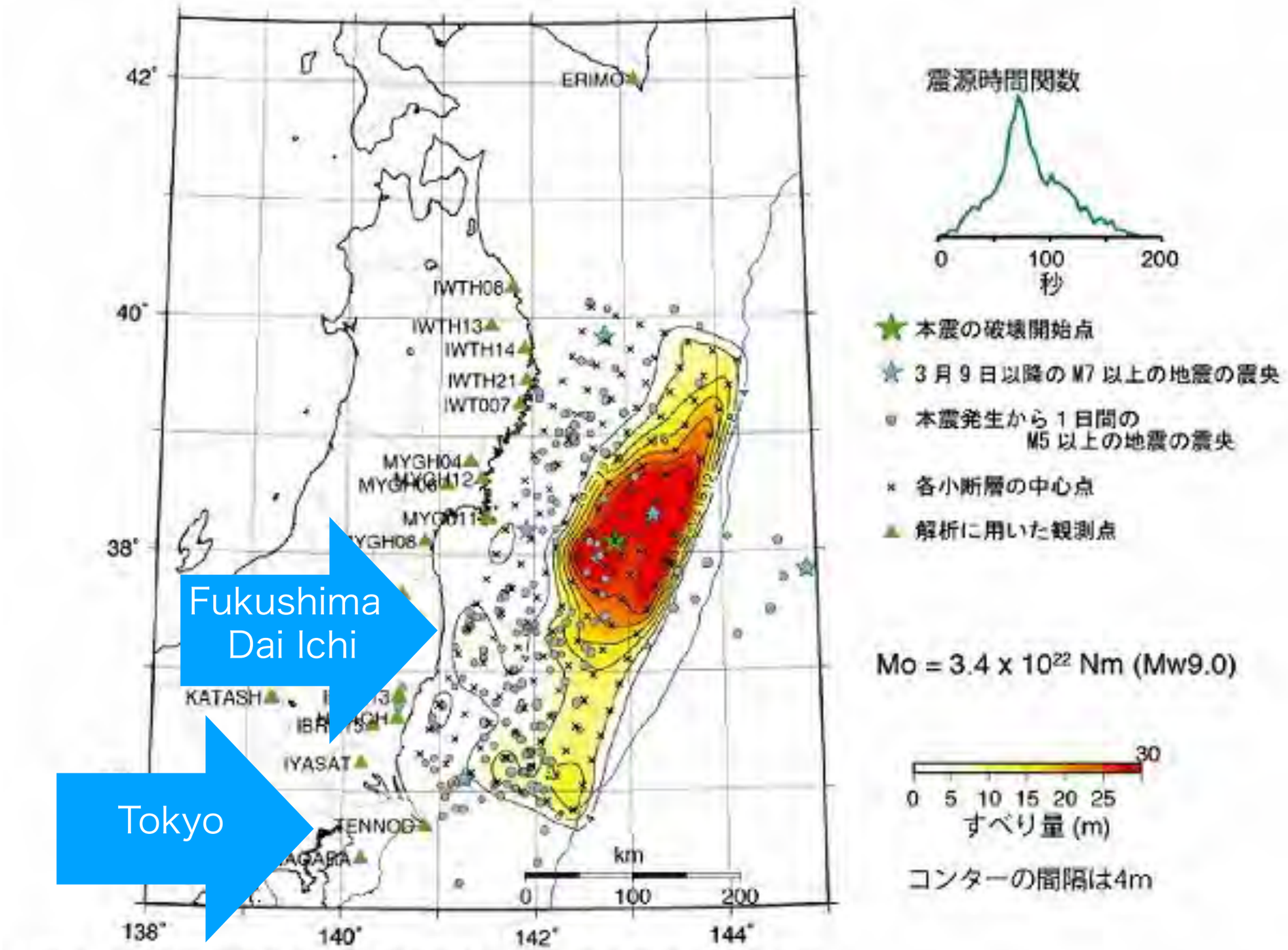


図１　震源過程解析から推定された、断層面上のすべり量分布

(引用：気象庁気象研究所作成資料)

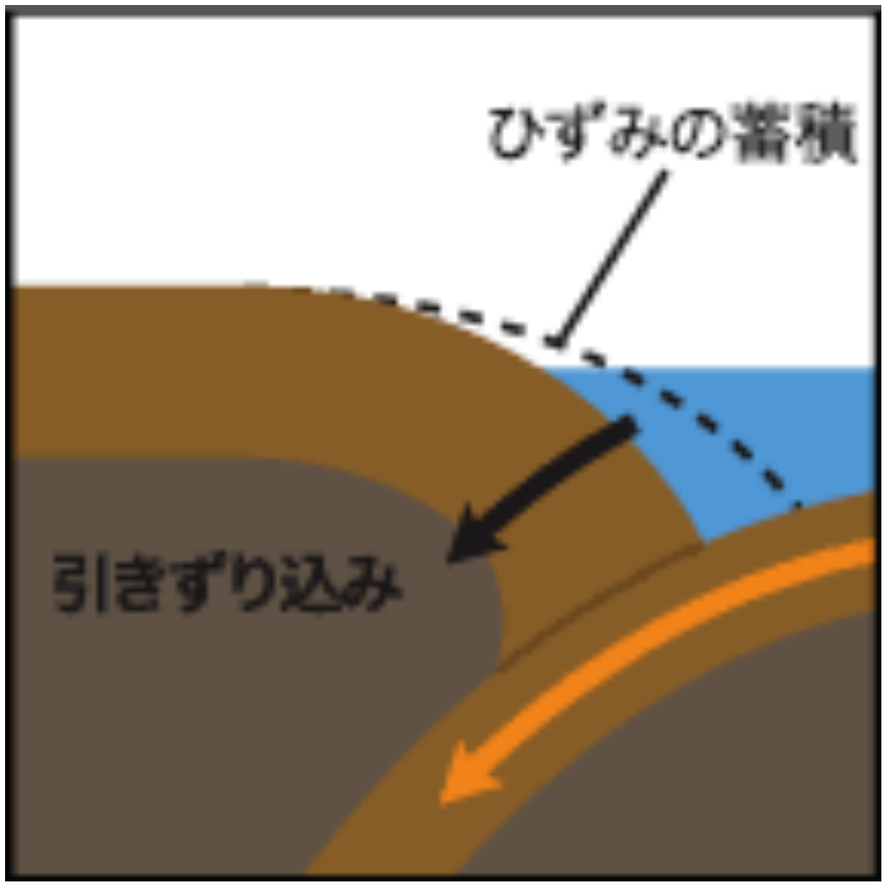
図 2.4　すべり量分布図

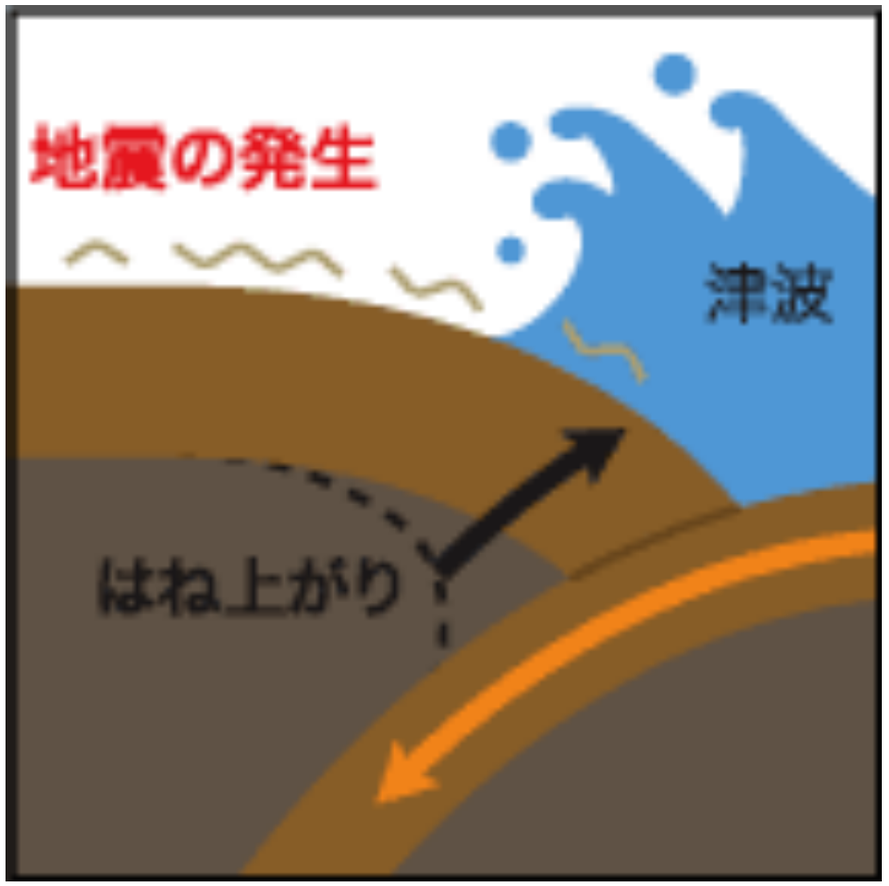
At Earthquake
The reactors “Stopped” safely
No damage has been reported.

But
Power line got damage.

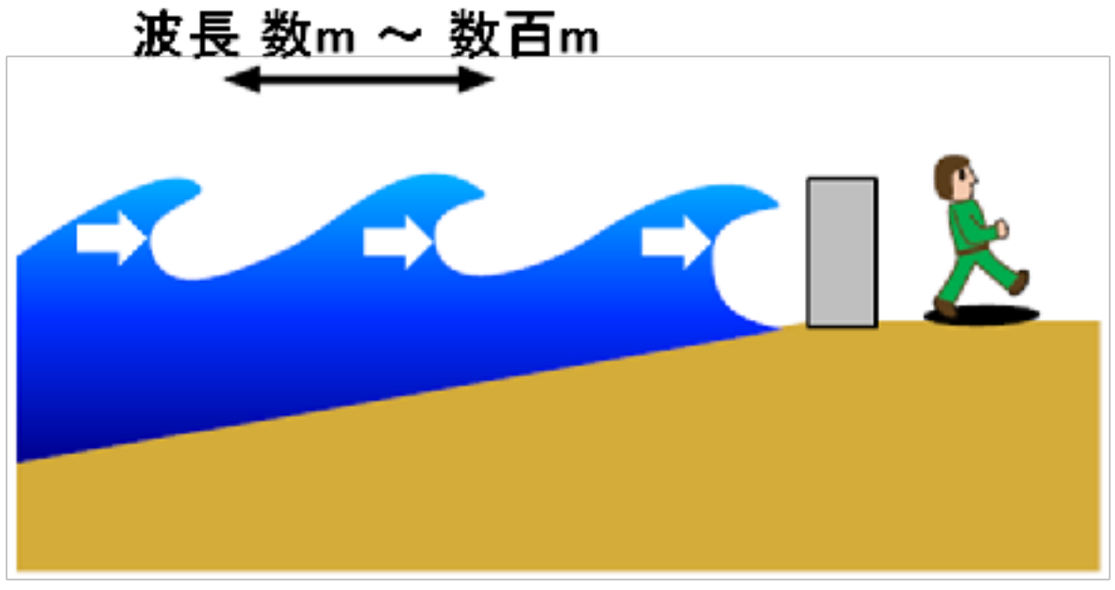
External power is necessary for cooling.
Instead of external power,
power generators take over.

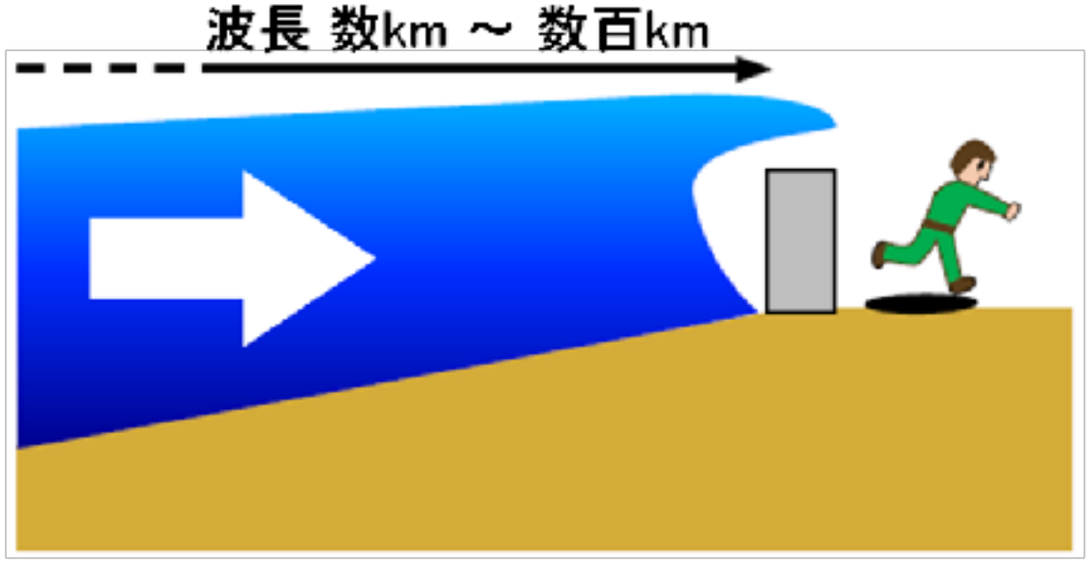
Earthquake 3.11 2011





https://www.bousai.go.jp/kohou/kouhoubousai/h21/05/special_02.html





https://www.city.miyako.iwate.jp/kikaku/koho/higashinihondaishinsai_miyako-shi-no-kiroku/kirokuphoto_1.html

https://www.jma.go.jp/jma/kishou/know/faq/faq26.html

Instead of external power,
power generators take over.

At Tsunami
It damaged power generators.

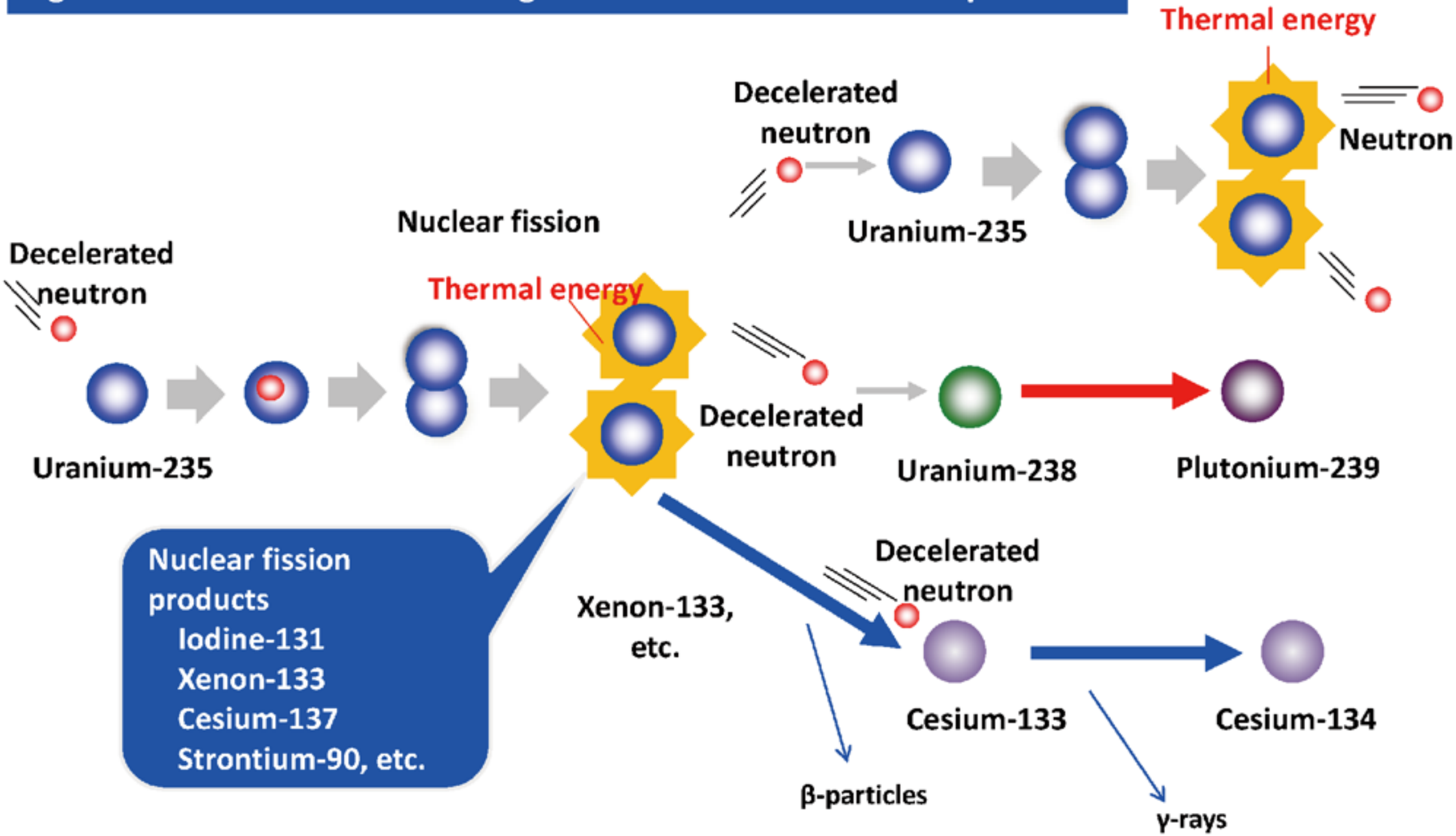
… No cooling.

What will happen?

Nuclear Disaster

Products in Nuclear Reactors

Light-water nuclear reactor and generation of nuclear fission products



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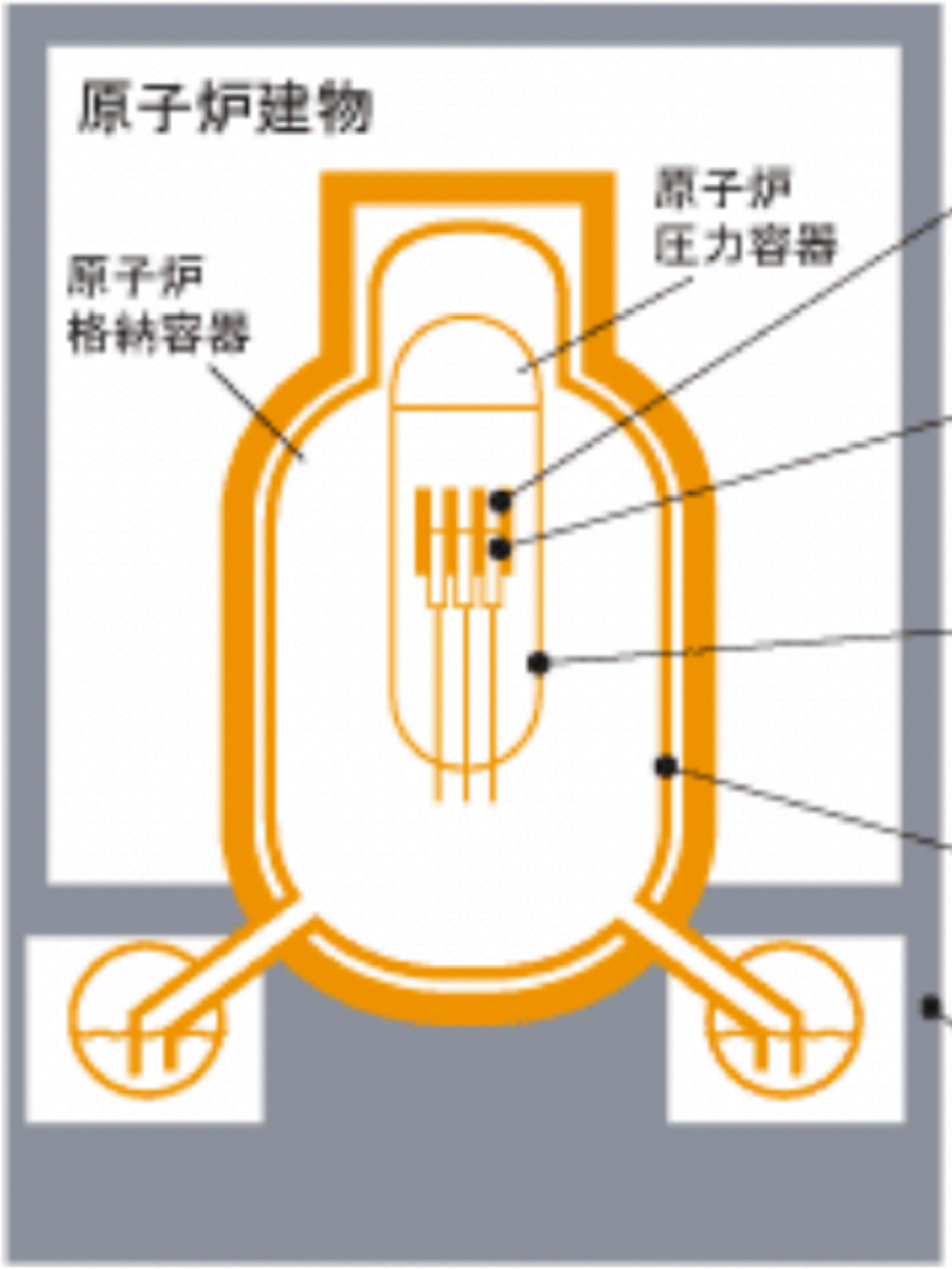
Government of Japan



fuel pellet

fuel rod

Pressure vessel

Containment vessel

Reactor Building

… No cooling.

What will happen?

chemical energy

Battery voltage is related to the chemical interactions.

Alkaline manganese battery (1.5V)

$$MnO_2 + H_2O + Zn \rightarrow Mn(OH)_2 + ZnO$$

Ni-Cd battery (1.2V)

$$2NiOOH + Cd + 2H_2O \rightleftharpoons 2Ni(OH)_2 + Cd(OH)_2$$

Thermal Energy

Energy of gas molecular is proportional to the temperature.

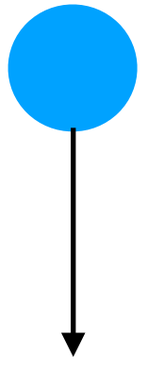
$$E = kT$$

k is Boltzmann constant $8.6171E^{-5}$ eV/K

at room temperature, it is about 26 meV = 0.03 eV

It is much lower than the ionization energy

Gravitation



Free fall of 1 kg from 1m high

$mgh = \sim 10\ J = 6 \times 10^{19}\ eV$

It is large energy but each nucleon may get …

$6 \times 10^{19}\ eV / (1000 \times 6 \times 10^{23}) = 1 \times 10^{-7}\ eV = 100\ neV$

Compare to other Energy, it is several order smaller.

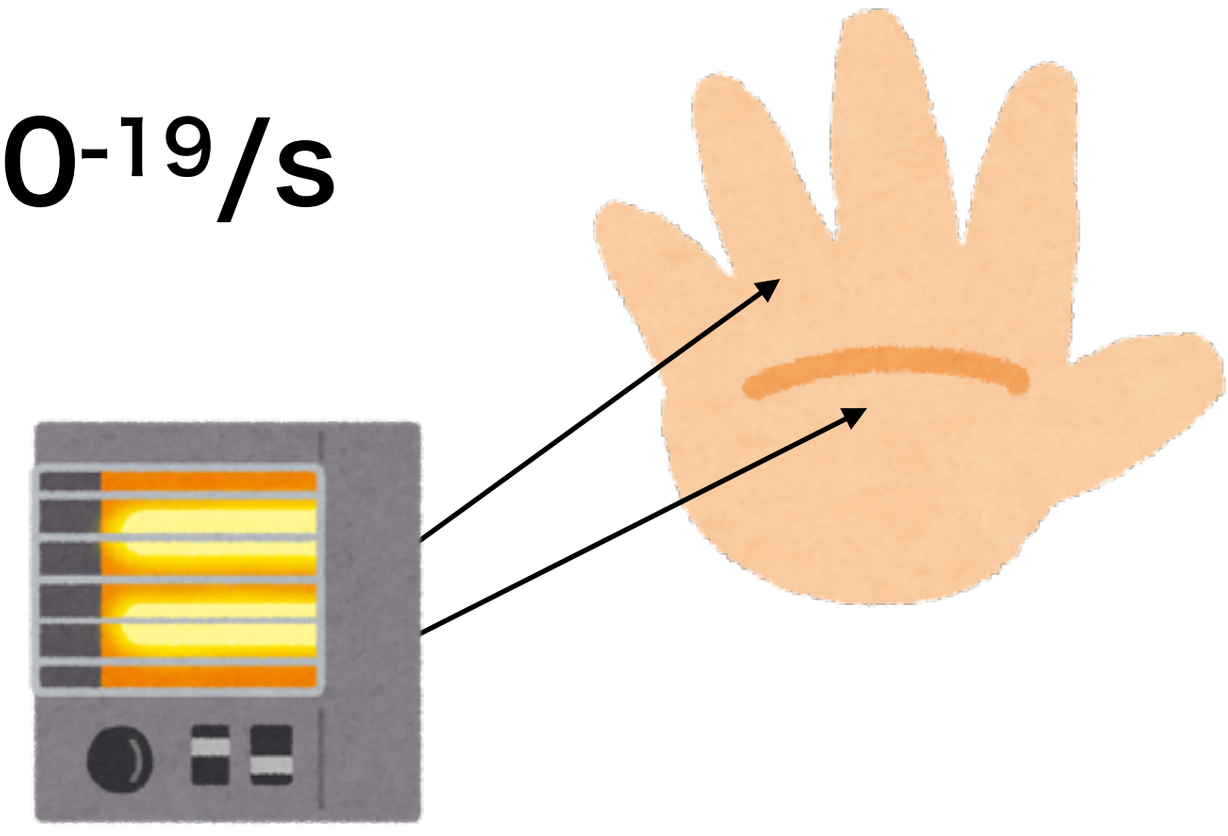
How much eV?

1kW

= 100V x 10A

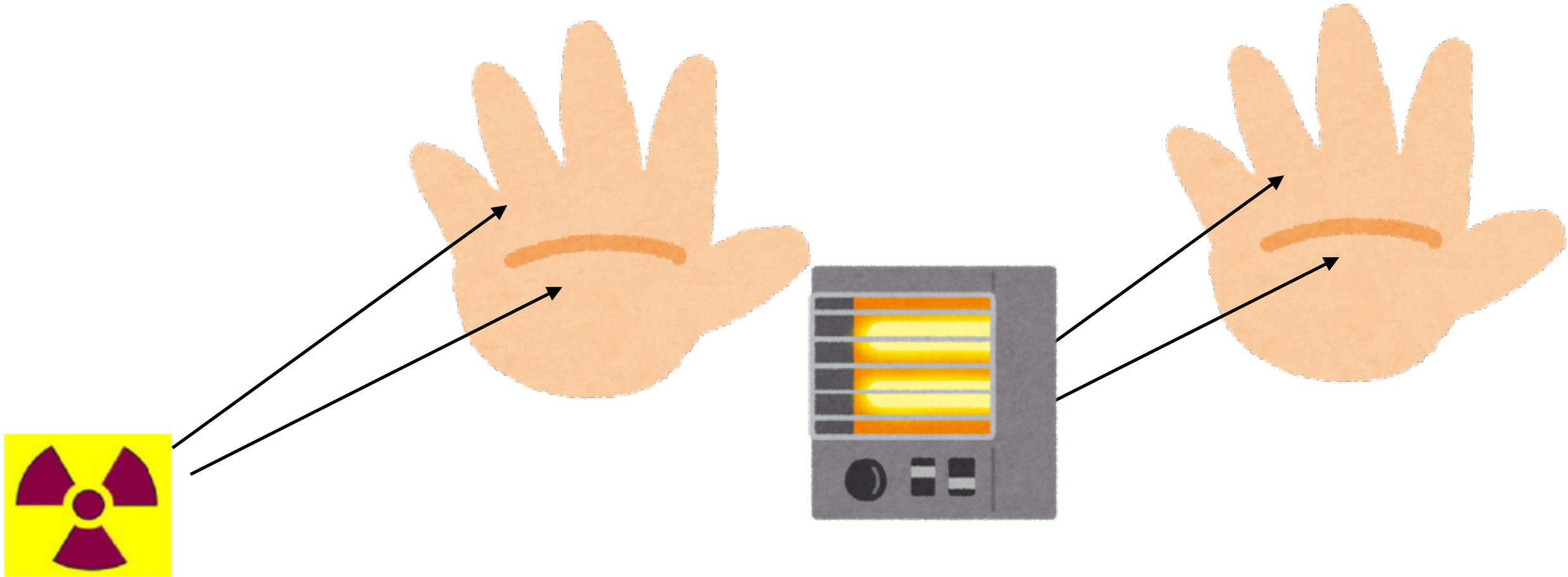
= 100eV x 10/1.6x10^{-19}/s

= 6 x 10^{21} eV/s



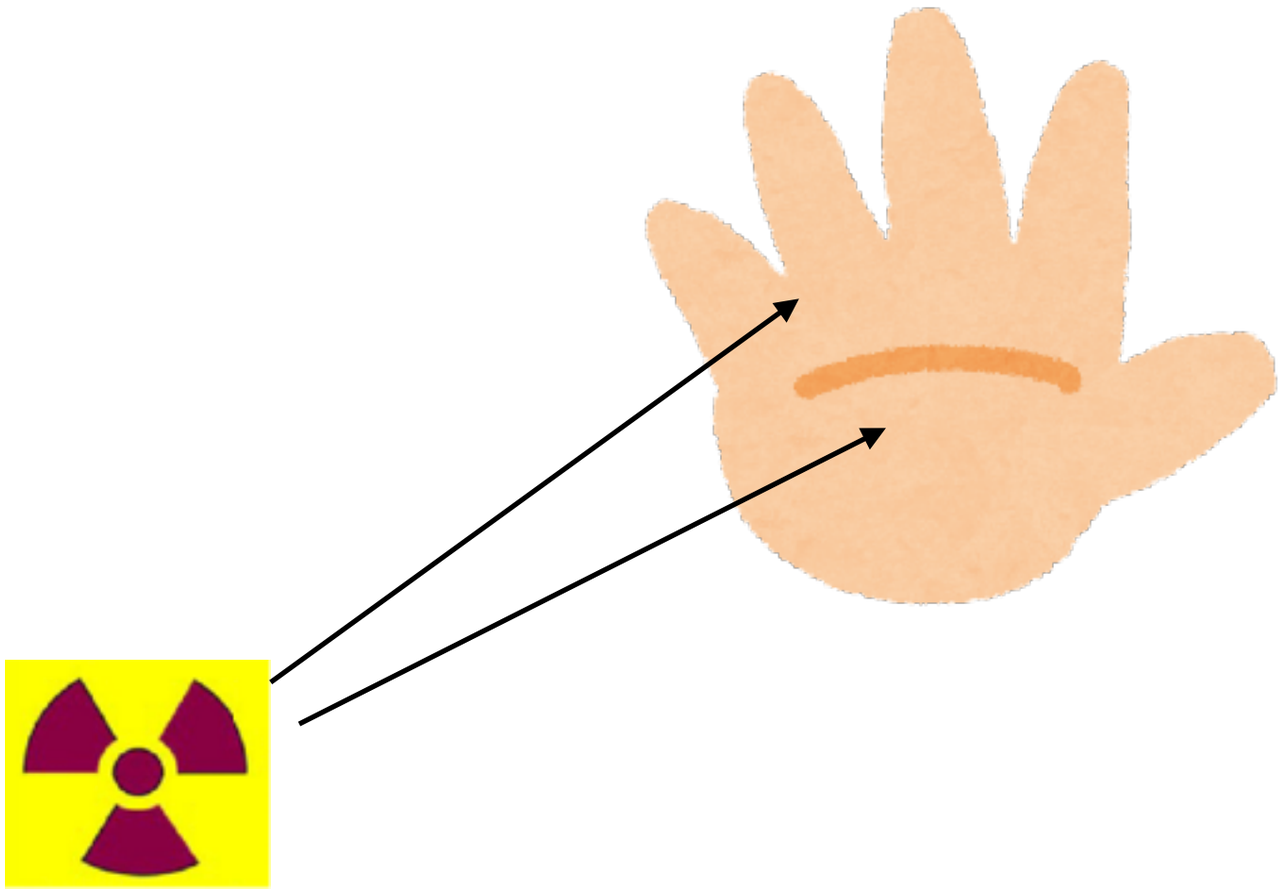
～1kW

Can you feel radiation?



~1 kW

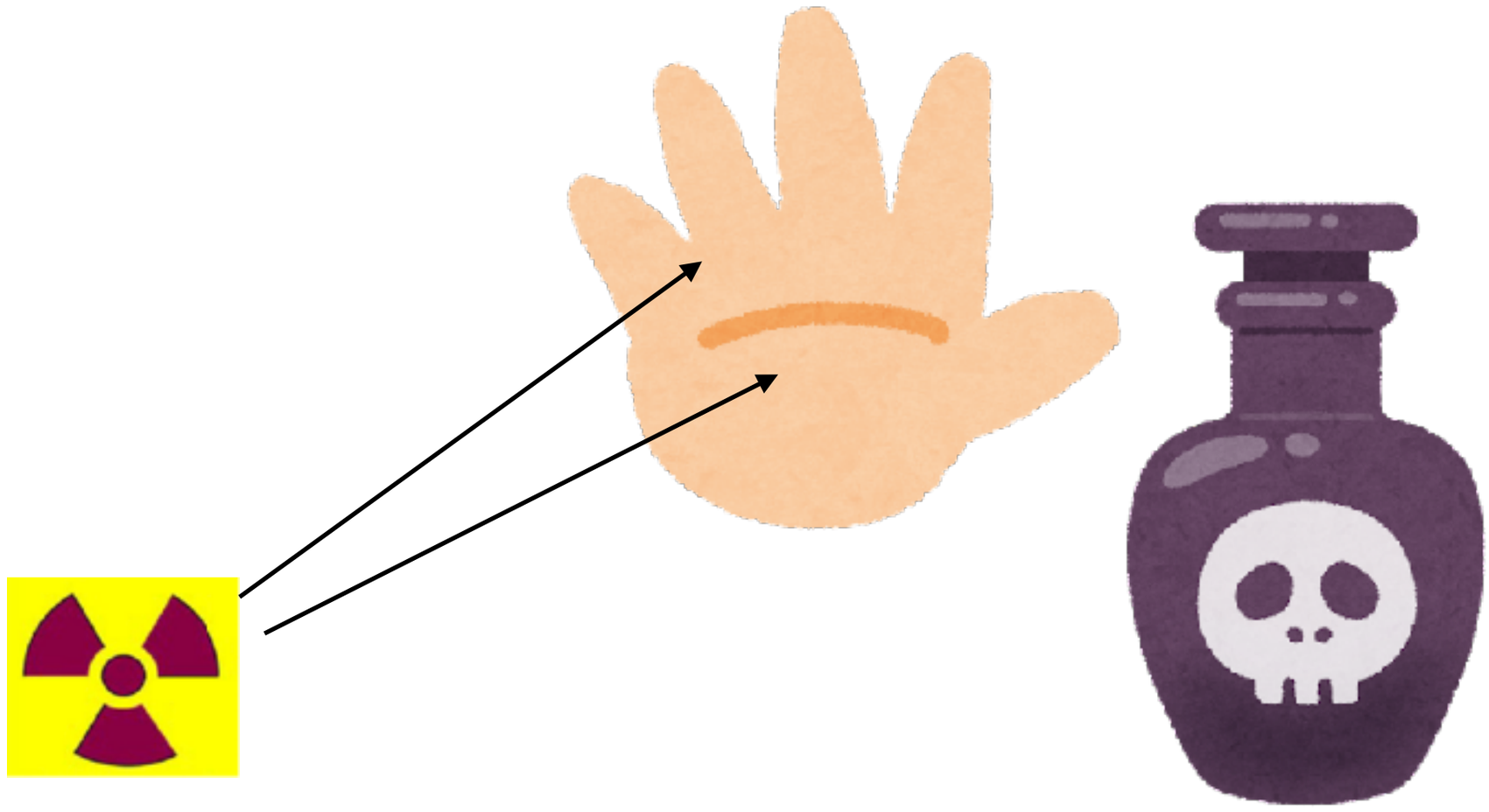
Can you feel radiation?



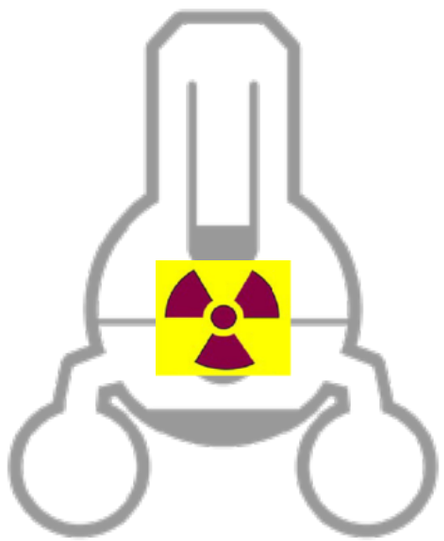
1 MBq x 1MeV = 1TeV/s

1TeV/s = 160 nW = 38nCal

Can you feel radiation?



$$1\ \mathrm{Sv} = 1\ \mathrm{J/kg} = 1\ \mathrm{W\ s/kg}$$



$10^{18}Bq/t \times 1MeV = 10^{24}eV/s/t$

$10^{24}eV/s/t = 1.6 \times 10^{5}J/s/t = 160kW/t$

In addition, we cannot switch off this heat

With cooling
Fission Products are remained in a capsule.
Without cooling, a capsule melts.

Zr generates Hydrogen at 900°C

ZrO2 melts at about 2,700°C

Melted fuel leaked from the pressure vessel into the inside of the containment vessel, and at the same time, cesium and other radioactive materials discharged from the fuel assembly was discharged within the containment vessel.

Additionally, under high temperature due to core damage, steam and zirconium of the fuel cladding reacted to generate hydrogen, which was discharged within the containment vessel from the damaged part of the pressure vessel together with steam.

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It is not the explosion of the vessel.
Explosion in the building

In the meantime, core damage increased the temperature and pressure in the containment vessel and deteriorated its confinement function, causing gaps in such parts as the penetrator that extends to the outside of the containment vessel.

Radioactive materials discharged from such gaps to the outside of the containment vessel and diffused into the environment.

Hydrogen generated due to the reaction of the steam and metal of the fuel cladding leaked through the gaps into the reactor building and accumulated there, and led to a hydrogen explosion.

Nuclear Disaster

Radioactive Materials Derived from Nuclear Accidents

	H-3 Tritium	Sr-90 Strontium-90	I-131 Iodine-131	Cs-134 Cesium-134	Cs-137 Cesium-137	Pu-239 Plutonium-239
Types of radiation	β	β	β, γ	β, γ	β, γ	α, γ
Biological half-life	10 days *1 *2	50 years *3	80 days *2	70-100 days *4	70-100 days *3	Liver: 20 years *5
Physical half-life	12.3 years	29 years	8 days	2.1 years	30 years	24,000 years
Effective half-life (calculated from biological half-life and physical half-life)	10 days	18 years	7 days	64-88 days	70-99 days	20 years
Organs and tissues where radioactive materials accumulate	Whole body	Bones	Thyroid	Whole body	Whole body	Liver and bones

Effective half-life: Related to p.27 of Vol. 1, "Internal Exposure and Radioactive Materials"
Effective half-lives are calculated based on values for organs and tissues where radioactive materials accumulate as indicated in the table of biological half-lives.

*1: Tritium water; *2: ICRP Publication 78; *3: JAEA Technical Manual (November 2011); *4: Assumed to be the same as Cesium-137; *5: ICRP Publication 48

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Nuclear Disaster

Comparison of Estimated Amounts of Released Radionuclides between the Chernobyl NPS Accident and the TEPCO's Fukushima Daiichi NPS Accidents

Nuclides	Half-life[a]	Boiling point[b] °C	Melting point[c] °C	Release into the environment: PBq*		TEPCO's Fukushima Daiichi NPS/ Chernobyl NPS
				Chernobyl NPS[d]	TEPCO's Fukushima Daiichi NPS[e]	
Xenon (Xe)-133	5 days	-108	-112	6500	11000	1.69
Iodine (I)-131	**8 days**	**184**	**114**	**~1760**	**160**	**0.09**
Cesium (Cs)-134	**2 years**	**678**	**28**	**~47**	**18**	**0.38**
Cesium (Cs)-137	**30 years**	**678**	**28**	**~85**	**15**	**0.18**
Strontium (Sr)-90	29 years	1380	769	~10	0.14	0.01
Plutonium (Pu)-238	88 years	3235	640	1.5×10^{-2}	1.9×10^{-5}	0.0012
Plutonium (Pu)-239	24100 years	3235	640	1.3×10^{-2}	3.2×10^{-6}	0.00024
Plutonium (Pu)-240	6540 years	3235	640	1.8×10^{-2}	3.2×10^{-6}	0.00018

Ratio of radionuclides accumulated in the reactor core at the time of the accidents that were released into the environment

Nuclides	Chernobyl NPS[f]	TEPCO's Fukushima Daiichi NPS[g]
Xenon (Xe)-133	Nearly 100%	Approx. 60%
Iodine (I)-131	Approx. 50%	Approx. 2-8%
Cesium (Cs)-137	Approx. 30%	Approx. 1-3%

*PBq equals 10^{15}Bq.

Sources: a: ICRP Publication 72 (1996); b and c: Rikagaku Jiten 5th edition (1998); d: UNSCEAR 2008 Report, Scientific Annexes C, D and E; e: Report of Japanese Government to the IAEA Ministerial Conference on Nuclear Safety (June 2011); f: UNSCEAR 2000 Report ANNEX J; g: UNSCEAR 2013 Report ANNEX A

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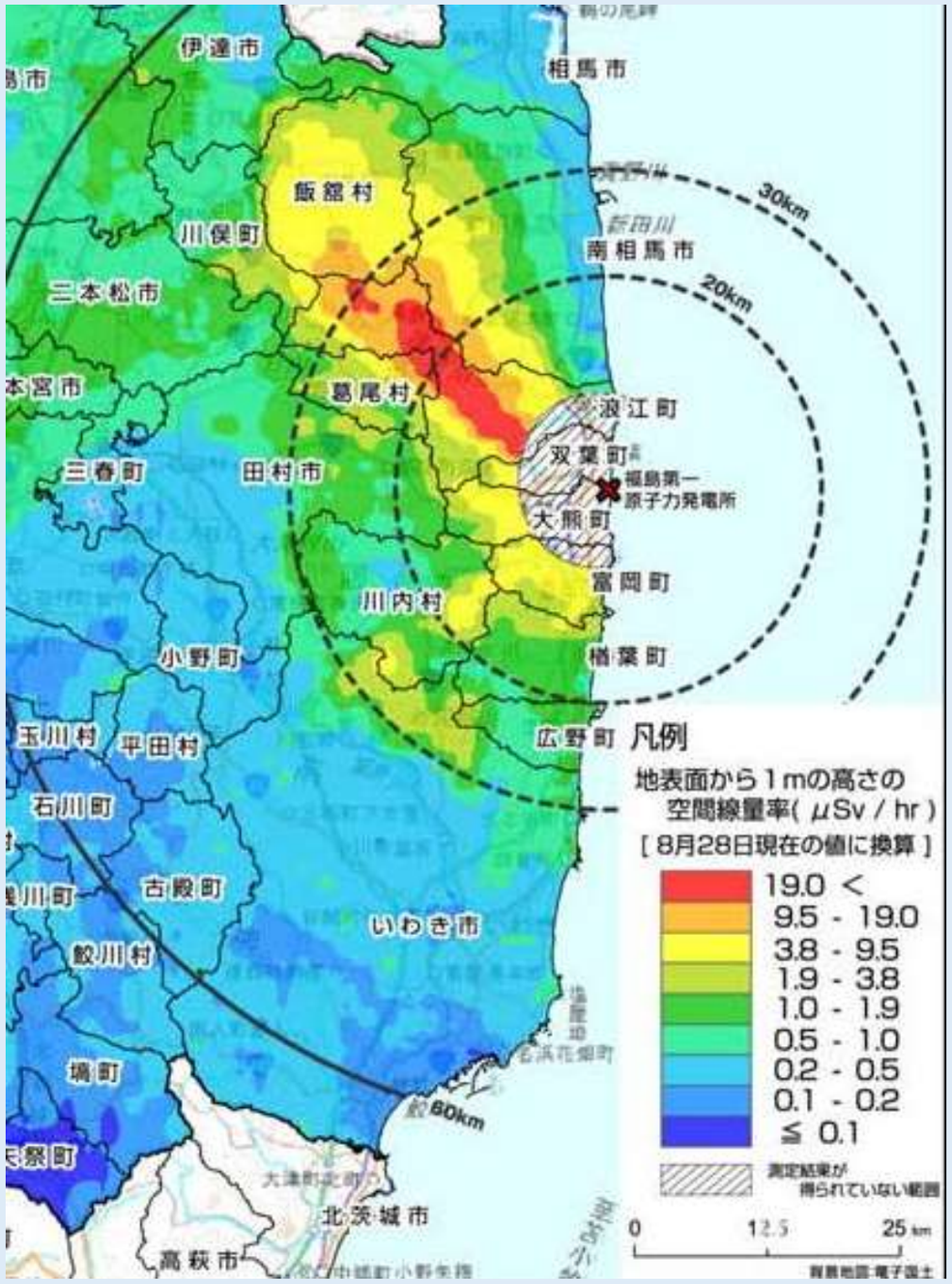
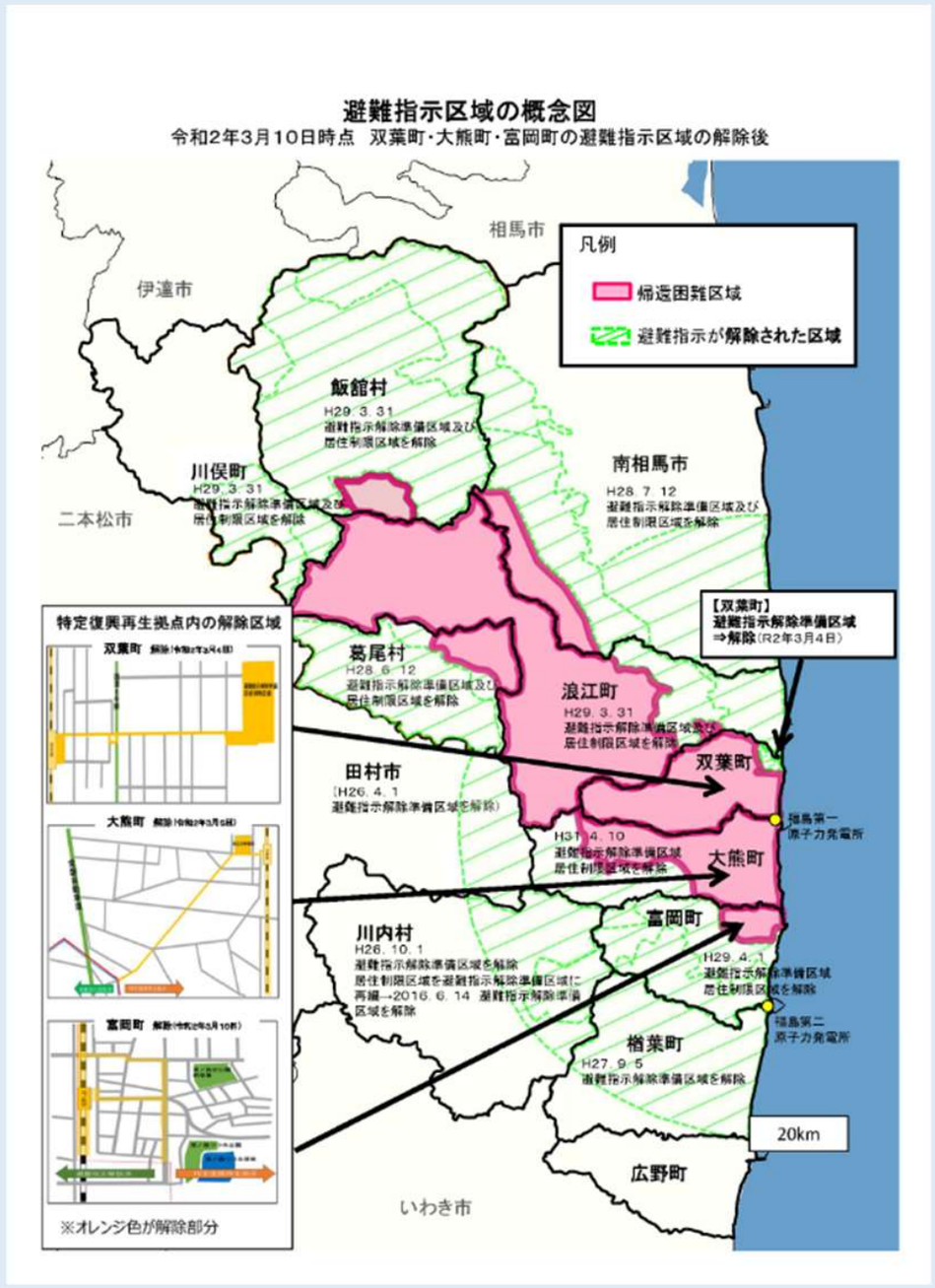
Government of Japan

Nuclear power plant accident then and now



http://www.imart.co.jp/fukushima-genpatu-houshasen-osen-zenkoku-map.html



https://www.pref.fukushima.lg.jp/site/portal/list271-840.html

soil sampling

The soil survey's gamma-ray radiation measurements were conducted in July and August, 2011, on soil samples collected in June and July, 2011, with the cooperation of many scientists in Japan.

Osaka university and the Japan Atomic Energy Agency (JAEA) played a key of role in the collection of the soil samples. 409 scientists from 94 academic research institutions, and 3 private enterprises participated.

The university of Tokyo and Japan Chemical Analysis Center greatly contributed to gamma-ray measurements of the soil radioactivities. 340 scientists from 21 institutions collaborated for the gamma-ray measurements.

2011.8.3

N

1ｍ高さでの空間線量［μSv/h］

20
10
5
2
1
0.5
0.2
0.1

凡例

0 15 30 km

30 km
80 km
100 km

Restricted area

(Areas where Returning is Difficult)

The area more than 50mSv/year

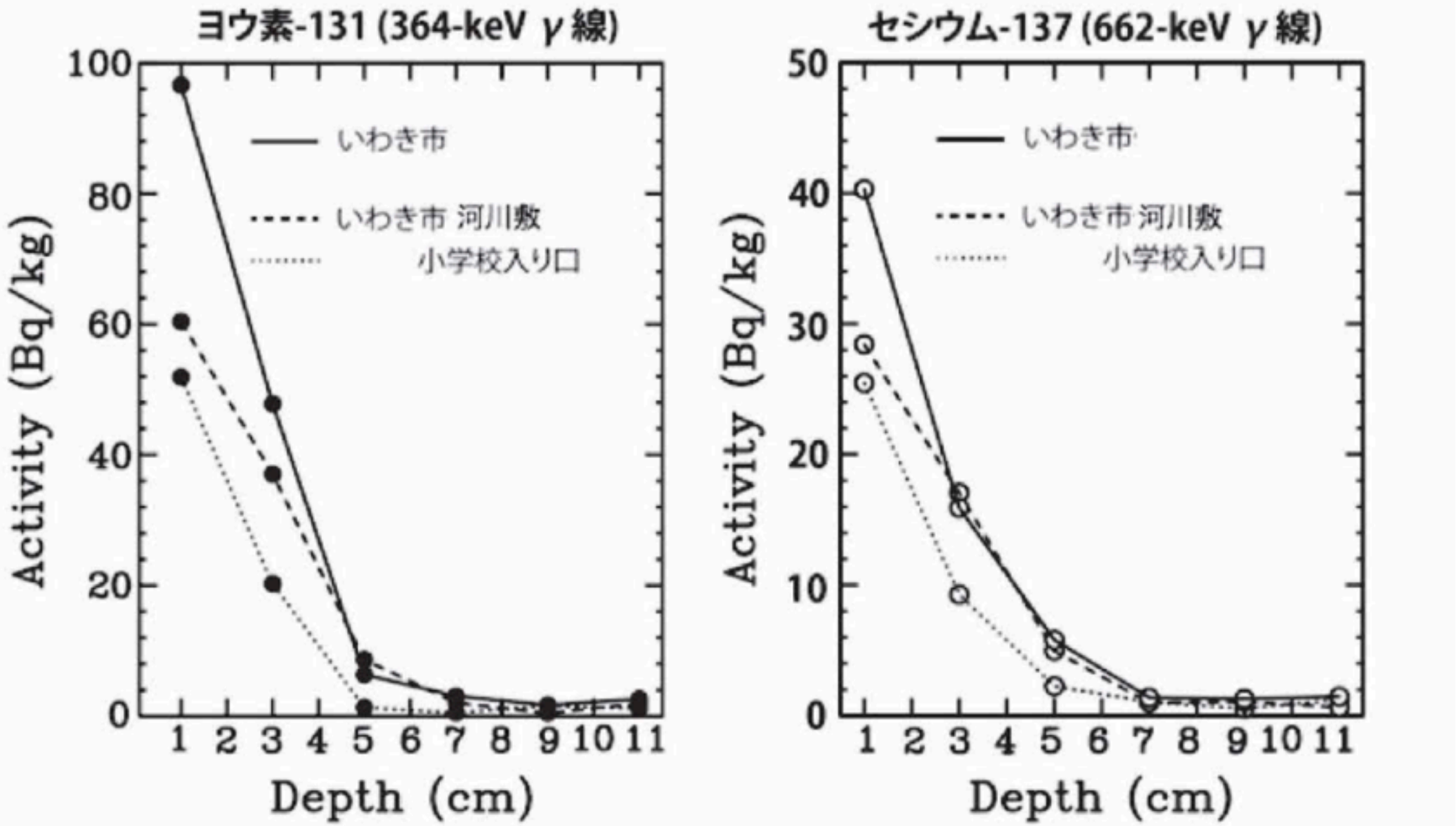


図2　パイロット土壌調査での深さ分布の測定の例

https://www.jstage.jst.go.jp/article/radioisotopes/62/10/62_724/_pdf

Education

Philosophy & Background

Educate them to develop problem-solving skills!

- The modern society has many problems that are difficult to solve by approaching them only from a single academic field.

- We hope that students will learn a balanced knowledge regardless of their field of study in order to understand the issues and gain the ability to lead society.

- We have designed a learning program centered on radiation to address the complex issue of "Fukushima reconstruction".

- Although the subject of this learning program is nuclear power and Fukushima reconstruction, we believe that the fundamental ideas and approaches to solutions can be applied to any problem.

Major of students (2021)

Science	15
Engineering / Agriculture	23
Literature	4
Economics	4
Law and Politics	5
Human Science	8
Medicine / Dentistry	5
Foreign Studies	11
Education	2
Tourism	4

The students has wide variety of background. It causes multidisciplinary view point on the discussion.

Most of them are the 1st year in Osaka University.
Some of students come from other University.

We don’t require any knowledge to the participants.

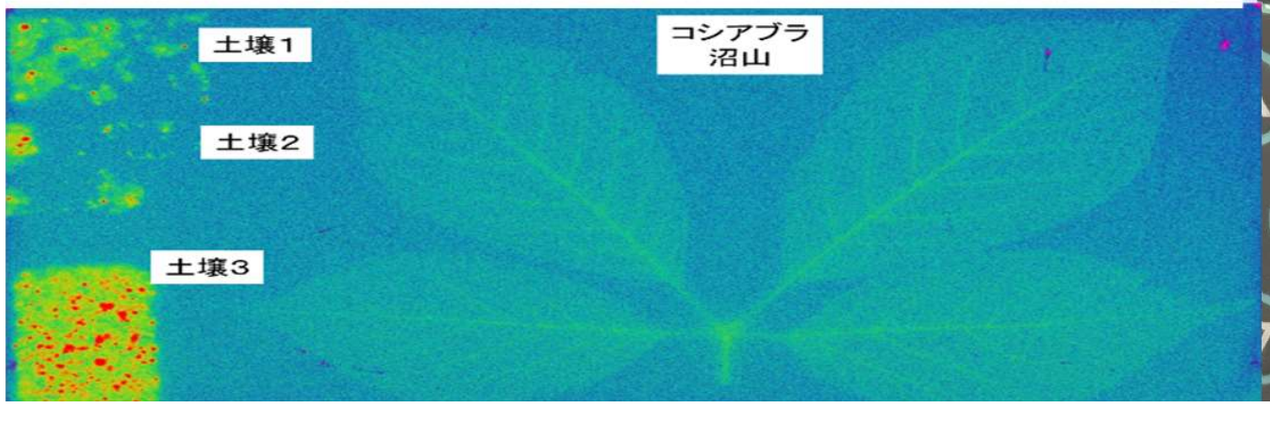
Sampling

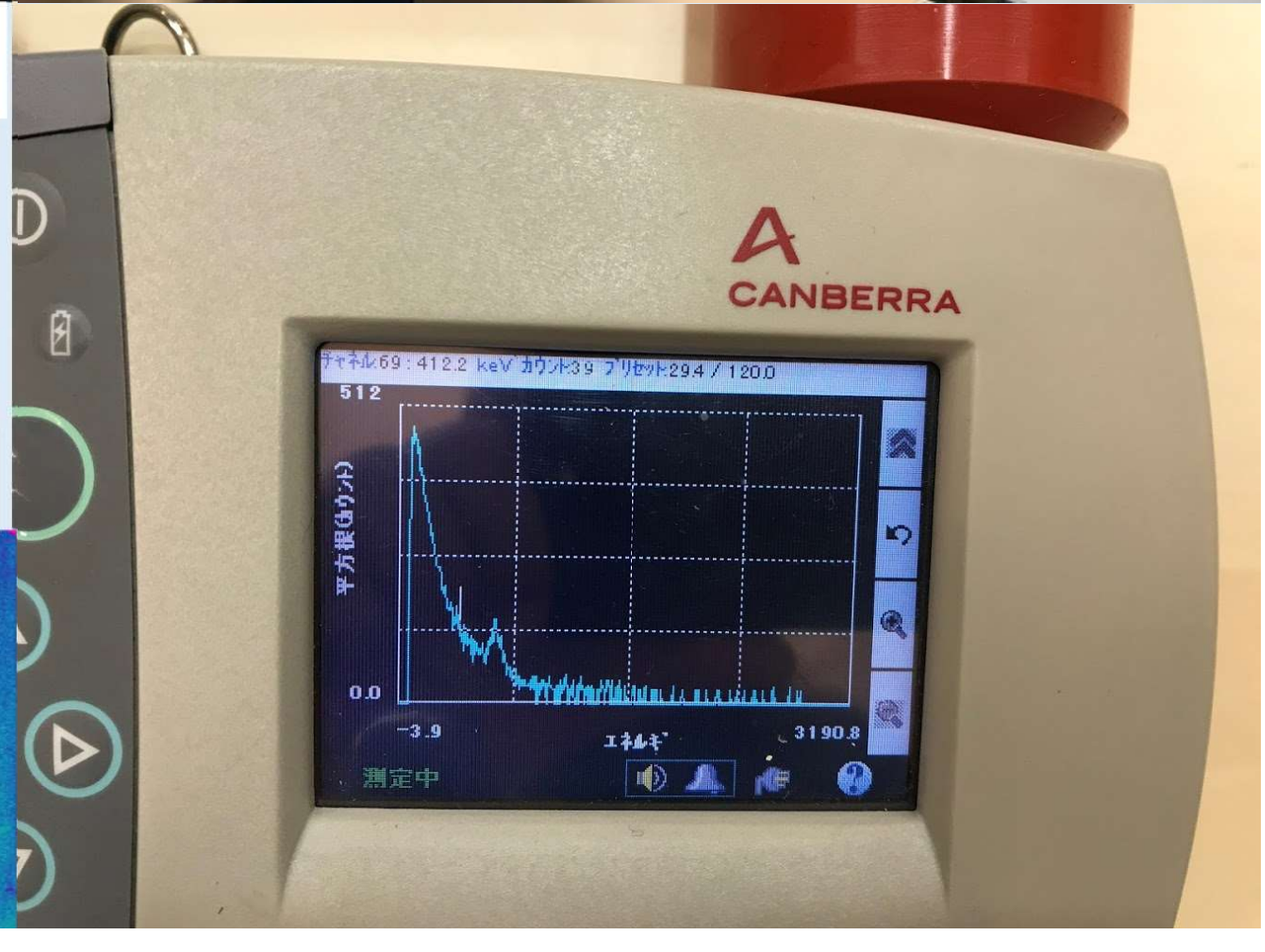
Sampling

Preparation for measurements

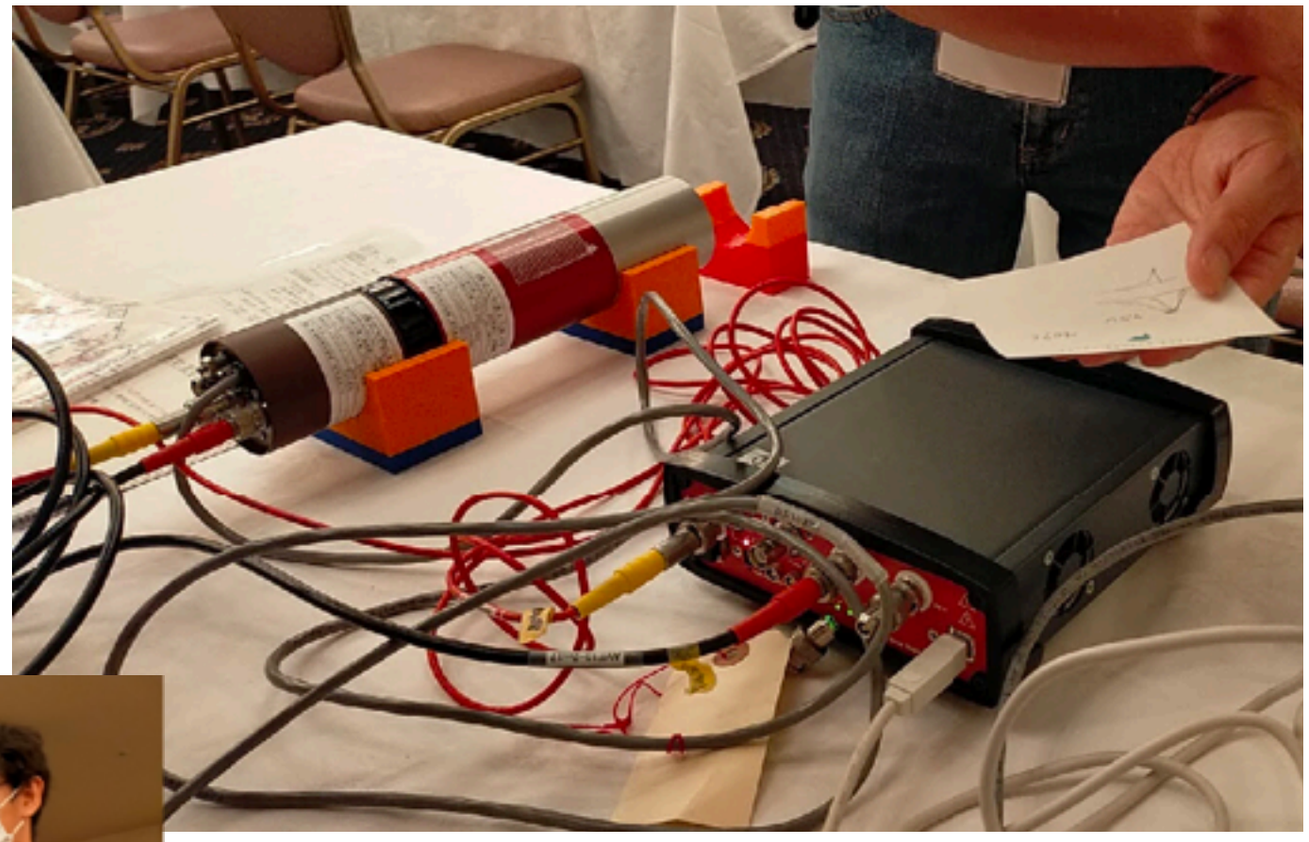

Sample processing


2018年9月2日　飯舘村放射線研修
土壌１
土壌２
土壌３
コシアブラ
沼山


土壌１
土壌２
土壌３
コシアブラ
沼山


CANBERRA
チャネル69：412.2 keV カウント39 プリセット294 / 1200
512
平方根(カウント)
0.0
-3.9
エネルギ
3190.8
測定中

Measurements



CAEN mc² Analyzer

File Tools View Help

Histogram

CAEN
Tools for Discovery

Counts

100
200
80
150
50
100
40
50
20

1000 2000 3000 4000
Channels

Properties

Board Model:
Serial Number:
Channel:
Name: C:\Users\sakura\Desktop\co
ADC Channels: 4096
Spect. Counts: 67320
Total Counts: 67406
Real Time: 300.848 s
Live Time: 300.060 s

ROI

Uncertainty:
Centroid:
FWHM:
Range:
Gross:
Net:
Net/Live:
Peak:

Spectra List

M- 0 counts

Name

ROI Editor

Range

Done Cancel

Region | First | Line | Centroid | FWHM | Resolution | Range | Gross | Net | Peak

Cursor

Cursor

Channel 0

Count 0

ReadOut Rate: 0.00 Hits/s | Acquisition | Not Connected

25°C Mostly cloudy 9:35 AM 9/7/2022

CAEN mc² Analyzer

File Tools View Help

Histogram

CAEN
Tools for Discovery

^{137}Cs
661 keV

^{134}Cs
795 keV

^{40}K
1460keV

Counts
200
150
100
50
1000
2000
3000
4000
Channels

Properties

Board Model:
Serial Number:
Channel:
Name: C:\Users\sakura\Desktop\ho...
ADC Channels: 4096
Spect. Counts: 67330
Total Counts: 67405
Real Time: 300.446 s
Live Time: 300.030 s

ROI

Uncertainty:
Centroid:
FWHM:
Range:
Gross:
Net:
Net/Live:
Peak:

Spectra List

M- 0

counts

Name

ROI Editor

Range

Begin | End | Unc. | Centroid | FWHM | Resolution | Range | Gross | Net | Peak

Cursor

Cursor

Channel 0

Count 0

ReadOut Rate: 0.00 MB/s | Acquisition | Not Connected

25°C Mostly cloudy

9:35 AM
9/7/2022

Local Social Event (2019)

Introduction to Discussion
held by Students only

- Knowledge based on experience gained through activities, not just knowledge gained from classroom lectures alone. Discussions based on both types of knowledge

- The knowledge gained today is put to use today.

- Students from different backgrounds come together to learn new perspectives and ways of thinking.

- The students who live together gradually come to understand each other, and this leads to the joy of being able to step up at the same time and to improve each other.

- Through repeated discussions with the same peers, students will be able to control how to conduct discussions, find landing points, assumptions, and so on.

Student Discussion

Study at Osaka University

For Prospective International Students 2021

Contact us at: info.groningen@overseas.osaka-u.ac.jp

Degree Programs in English

Undergraduate programs		
Schools	**Degree**	**Course/Program**
Human Sciences	Bachelor	Human Sciences International Undergraduate Degree Program
Science	Bachelor	International Undergraduate Program in Science *Initial years: English/Japanese mix Final years: primarily in Japanese

Graduate programs		
Graduate Schools	**Degree**	**Course/Program**
Science	Master/ Doctor	Special Integrated Science Course
	Master/ Doctor	International Physics Course
Engineering Science	Master/ Doctor	Special Program of "Engineering Science 21st Century"
Information Science and Technology	Master/ Doctor	Informational Technology Special Course in English
Engineering	Master/ Doctor	Biotechnology Global Human Resource Development Program for Industry-University Co-Creation
	Master/ Doctor	Chemical Science Course
	Master/ Doctor	International Priority Graduate Program on Applied and Engineering Physics
	Master/ Doctor	International Program of Mechanical Engineering
	Master/ Doctor	International Program of Materials and Manufacturing Science
	Master/ Doctor	Global Science and Engineering Course on Electrical, Electronic and Infocommunications Engineering
	Master/ Doctor	International Program of Sustainable Energy and Environmental Engineering
	Master/ Doctor	International Program of Maritime and Urban Engineering
Economics	Master/ Doctor	Sustainable Economy Program

Exchange Programs

FrontierLab

Places students in laboratories of the following schools: Science, Engineering Science, Engineering, Information Science and Technology

Duration: 3 to 12 months

Maple

Improve Japanese language skills, enhance knowledge of Japanese culture and society

Duration: 12 months (Sept. – Aug.)

OUSSEP

The Osaka University Short-term Student Exchange Program has been designed for 3rd/4th year students to take special academic lectures in English as a Special Auditor

Duration: 5 to 12 months

iExPO

Immersion Exchange Program Osaka allows students fluent in Japanese to freely choose classes and conduct research under the guidance of a professor

Duration: 3 to 12 months

OSAKA, KANSAI, JAPAN
EXPO2025

Students / International activity

Students × International exchange × Music

a-tune

go for EXPO 2025

Osaka University

Who are we ?

2025年大阪・関西万博にて、
世界中の人々と音楽で交流するイベントを開催することを目指し、
活動中の大阪大学公認の学生団体です。

We are a student group recognized by Osaka University.
In Expo 2025, We aim to hold an event interacting with people from all over the world through music.
We are an official student organization of Osaka University.

Fortune cookie