



Environmental Radiation Monitoring

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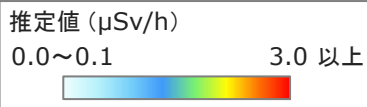
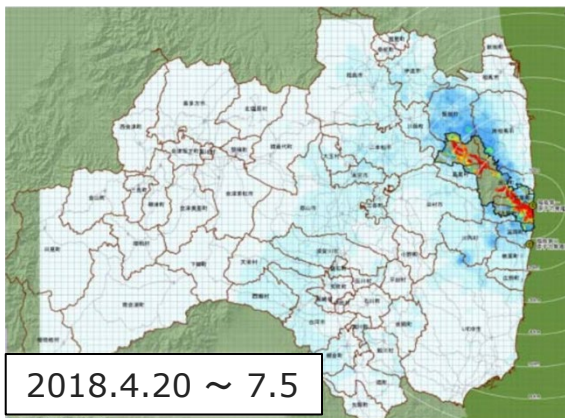
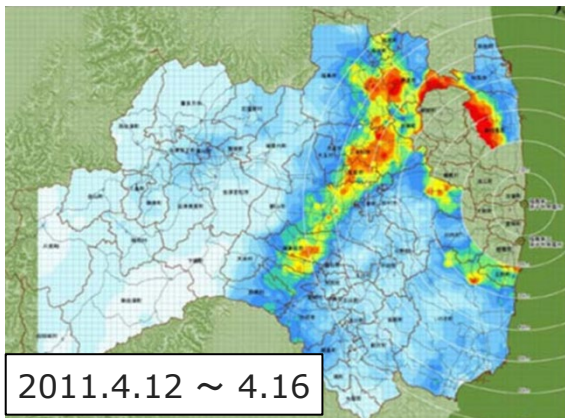
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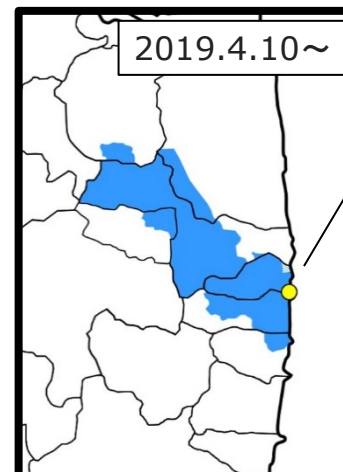
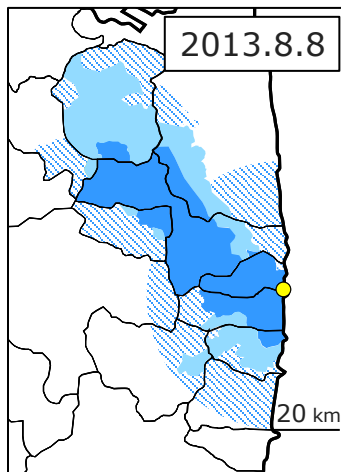
1. Fukushima Now

Air dose rate



※福島県「ふくしま復興のあゆみ(第26版)」をもとに作成

Evacuation Zone

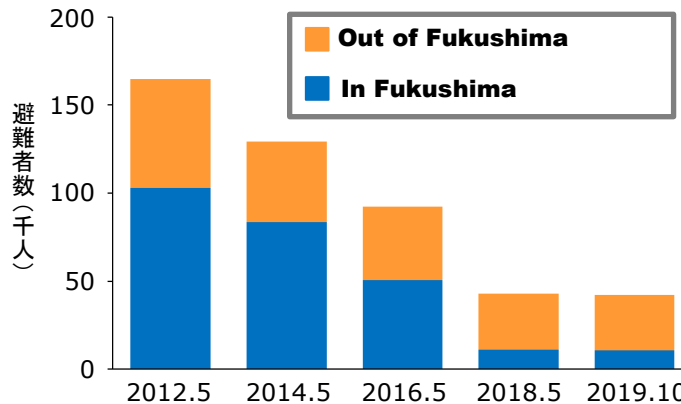


Fukushima Daiichi Nuclear Power Station

- Areas where Returning is Difficult
- Habitation Restricted Areas
- Preparation Areas for Lift of Evacuation Order

経済産業省「これまでの避難指示等に関するお知らせ」(2013年8月7日及び2019年4月10日)をもとに作成 (http://www.meti.go.jp/earthquake/nuclear/hinan_history.html)

Evacuee (Including Self Evacuee)



2012.5

164,865

2019.10

42,122

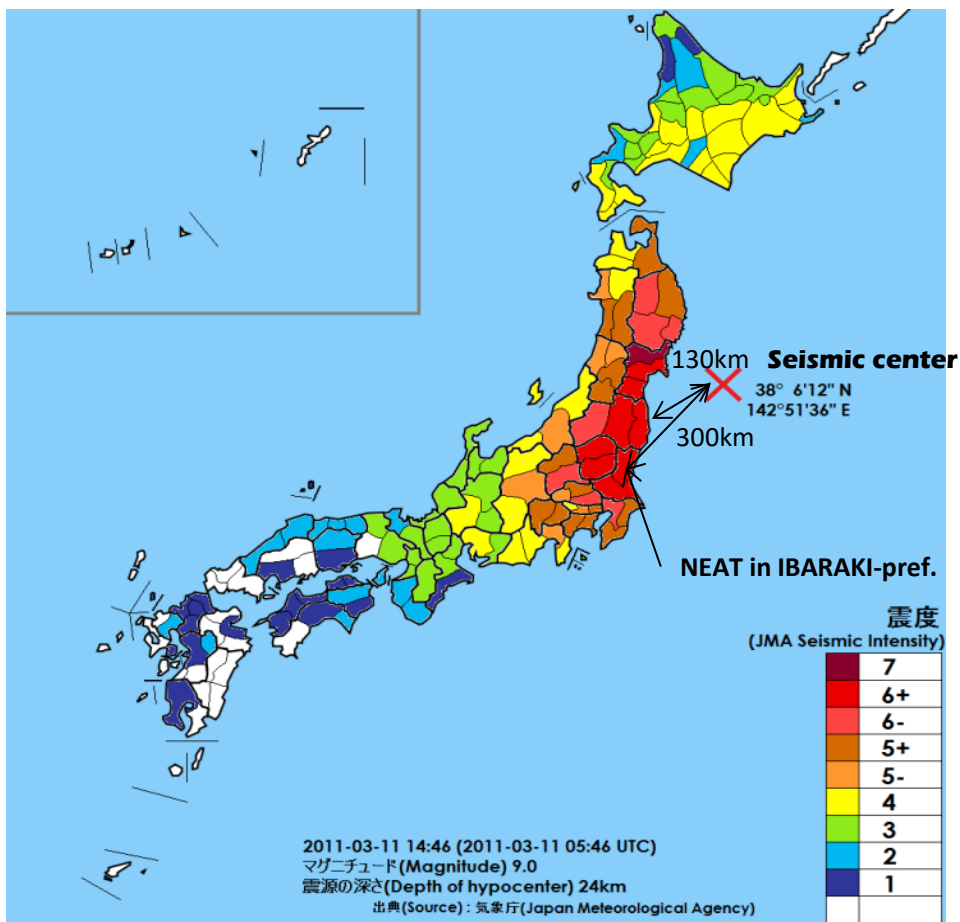
※福島県「ふくしま復興のあゆみ(第26版)」及び最新の被害状況即報(2019.10.7)をもとに作成

2. Great East Japan Earthquake

14:46, 11, March, 2011



About Great East Japan Earthquake



The great east Japan earthquake was occurred In 2011 March 11 14:46.

Summary of Tables explaining the JMA Seismic Intensity Scale

0 Intense to none	1 Felt slightly by some people especially right after bedtime	2 Felt by many people especially right after bedtime	3 Felt by most people after bedtime
4	5 Lower	6 Lower	6 Upper
5 Upper	7		

If you fell a tremor **Remain calm, and secure your personal safety** **If you see/hear an Earthquake Early Warning**

- Protect your head and shelter under a table
- Don't rush outside
- Don't worry about turning off the gas in the kitchen
- Panic leads to injury
- When driving a car, turn on your hazard lights, then slow down smoothly
- Keep away from gates, walls, vending machines and buildings
- Leave immediately to highland when a strong shake has been felt on the seashore

Make residences earthquake resistant and fix furniture to prepare for earthquake

Ministry of Land, Infrastructure, Transport and Tourism
 Japan Meteorological Agency

The Fukushima Dai-ichi Nuclear Power Station Accident

- **14:46 Mar. 11** ; Earthquake and following tsunami struck the power Station
(**Magnitude 9.0, max height of tsunami: over 15 m**)
- **15:42** ; Loss of all electric power through unit 1 to 5 (without unit 6) , and data from 24 MPs around plant had been stopped.
- **19:03** ; *The Prime Minister declared “Nuclear Emergency”*
- **21:23** ; Residents evacuation within 3 km and shelter-in-place within 10 km,
23:00 ; **1.2mSv/h in front of the north door to reactor and turbine buildings of unit 1.**
- **5:44, Mar. 12** ; expanded evacuation within from 3km to 10km.
- **15:36** ; Hydrogen explosion occurred in the unit 1 reactor building.
- **18:25** ; Evacuation zone had been expanded within 20km.
- **11:01 Mar. 14**; Hydrogen explosion occurred in the unit 3 reactor building.
- **6:14 Mar. 15**; Hydrogen explosion occurred in the unit 4 reactor building.



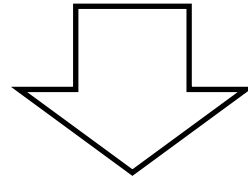


3. JAEA's Activities for Emergency



Nuclear Emergency Responses of JAEA/NEAT

The President of JAEA declared to organize an emergency disaster management headquarter on 11 March.



JAEA opened command office in Nuclear Emergency Assistance and Training Center (NEAT) in Hitachinaka.

Designated Public Institutions

Disaster Countermeasures Basic Laws
Armed Attack Situation Response Law

Nuclear Emergency
Response HQs of
National Government

Local Nuclear Disaster
HQs of National
Government

Local Disaster HQs
of Prefecture

Protection
of residents

Technical
Support



Joint Council for
Nuclear
Emergency
Response

Emergency Monitoring Center

Contamination
Screening

Dispatching
Experts

Environmental
Radiation Monitoring

Providing Disaster
Response Equipment

Nuclear Emergency Assistance
and Training Center (NEAT)





Dispatched specialists to Fukushima OFC

March 11 to 12, 2011



22:46 Mar. 11 ; Requested by MEXT(Ministry of Education, Culture, Sports, Science and Technology), JAEA gathered the 1st specialist team at the Operation Room of NEAT in IBARAKI pref.



06:00 Mar.12; Arrived at the monitoring center (Atomic center) next to Fukushima OFC in Okuma town

1:54 Mar. 12 ; The 1st team started from NEAT to Hyakuri Air Base, and moved to Fukushima OFC at Okuma town by a helicopter of JSDF.

Boarded a helicopter of Japan Self Defense Force(JSDF)



Brought radiation measuring devices



Dispatched a monitoring Vehicle



6:30 Mar.12; The 1st JAEA Team joined with emergency response meeting at Fukushima OFC

Environmental monitoring tools prepared for emergency



Personal dosimeter



Water, food, light



Environmental monitoring tools



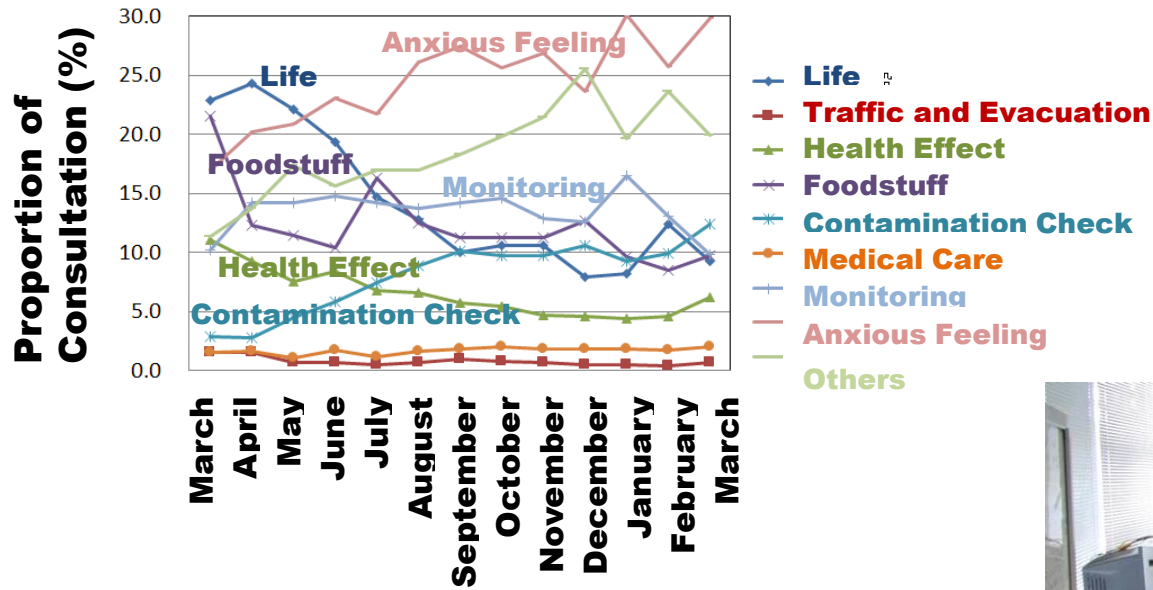
Air sampler for dust and iodine



Monitoring vehicle

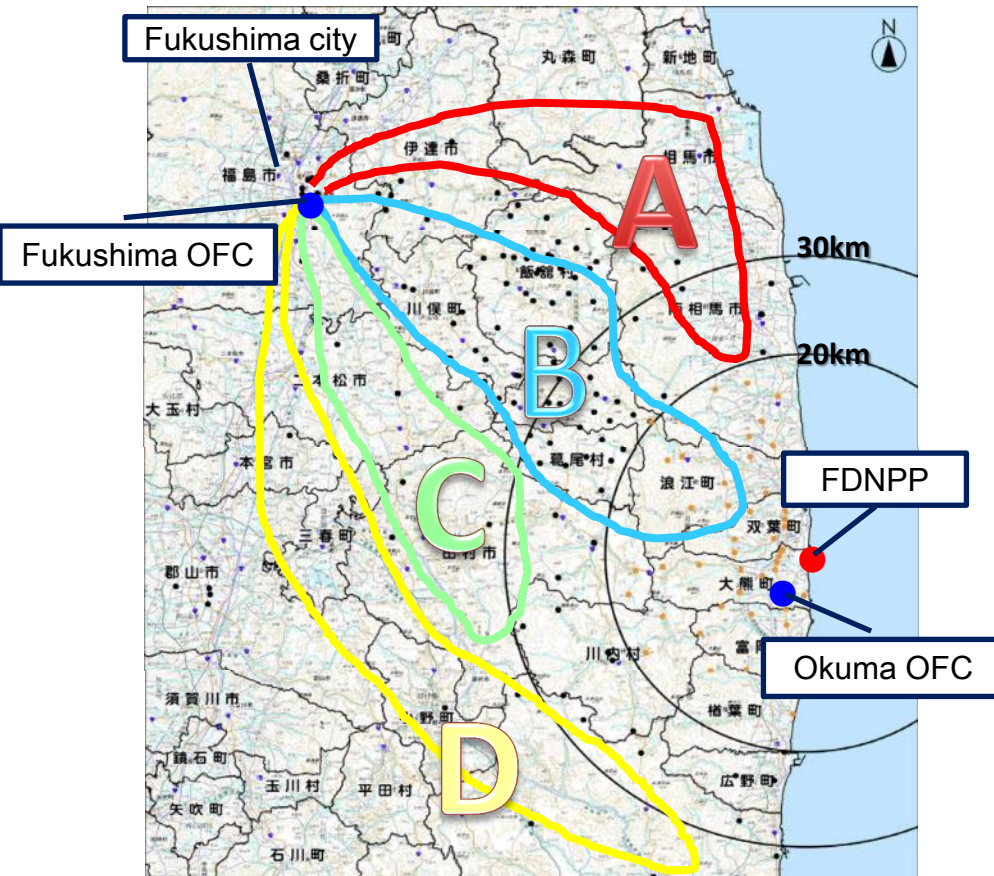
Telephone Consultation for Radiation at NEAT

34,581 Consultations
17 March 2011 - 18 September 2012



Changing of telephone consultation contents





Surface contamination monitoring

This monitoring has been continued with the Nuclear Regulatory Authority.

- **21:43 Mar.14;** OFC had been moved to Fukushima city from Okuma town by occurring a hydrogen explosions.
- JAEA's environmental monitoring had moved to outside region of 20km radius from power plant since then.

Radiation Monitoring Routes (routine)

Dispatching Special Vehicles

Monitoring vehicle installed Ge spectrometer with shielding



- **Mar.14** : monitoring vehicle installed Ge detector was dispatched from NEAT-Fukui

Monitoring vehicle



- **Mar.15** : A monitoring vehicle was dispatched from NEAT-Ibaraki (Three monitoring cars had been worked in Fukushima from JAEA)

Whole-body counter (WBC) vehicle for Internal Exposure survey for occupational



- **Mar.12** : Dispatched from NEAT-Ibaraki
- **Mar.16** : Located at Fukushima Medical College.
- **Mar.21** : Located at TEPCO Onahama
- **May.30** : Another WBC vehicle was dispatched
- Internal doses were measured and evaluated for about 330 workers until April 25.



Surface contamination monitoring vehicle and decontamination vehicle



- **Mar.15** : Dispatched from NEAT-Ibaraki
- **Mar.16** : Located at Fukushima Medical College.



4. JAEA's Developments for Environmental Monitoring

Stick Type Monitoring Equipment "Gamma Plotter"

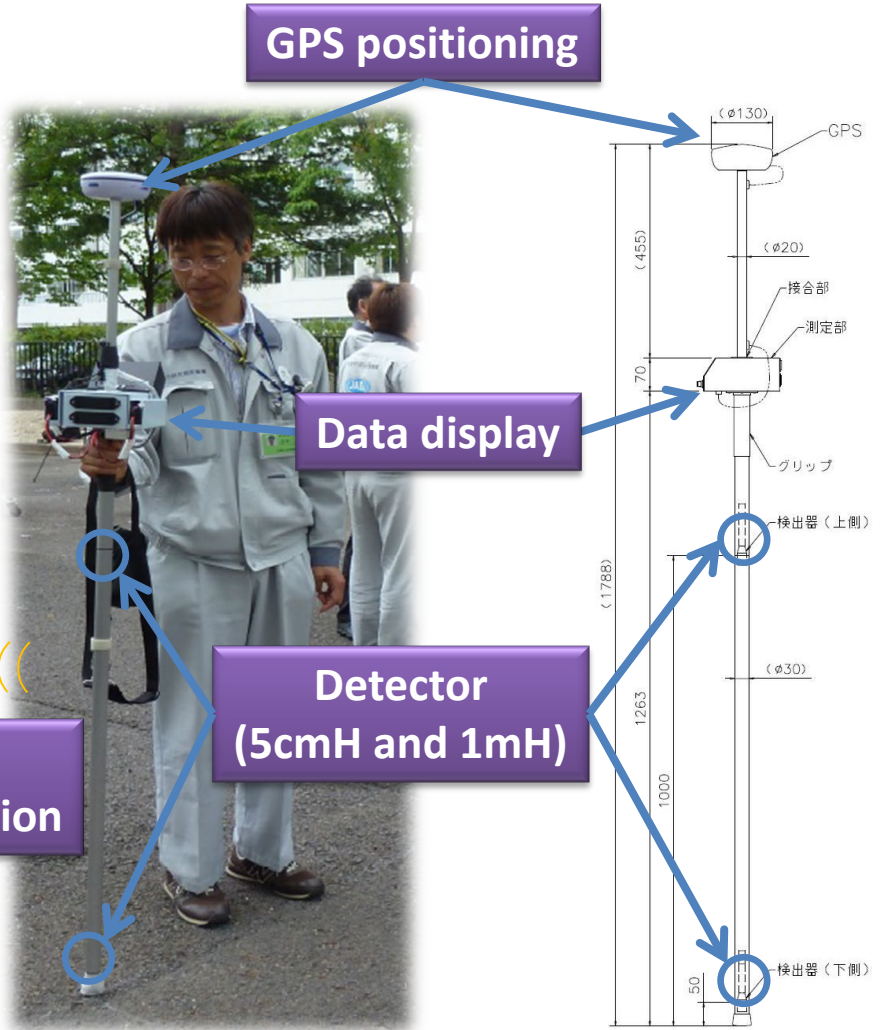
For Precision of the Monitoring Position

- ◆ GPS positioning
- ◆ Data transmitted to PC and processed to display the dose rate values on the Google earth maps.
- ◆ Two detectors installed on a 1.8m-stick, measuring radiation dose rates at different two heights.



Tablet PC

Radio transmission



GPS positioning

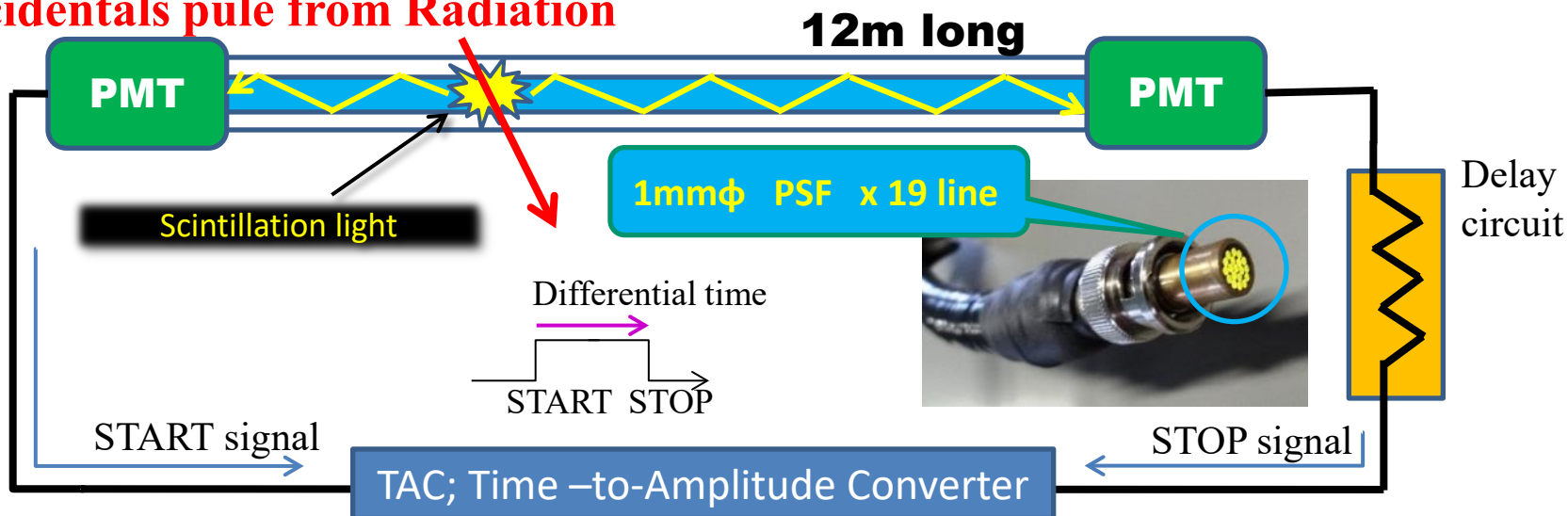
Data display

Detector (5cmH and 1mH)

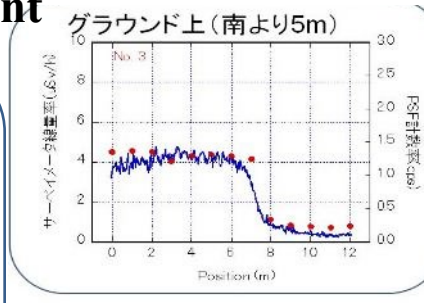
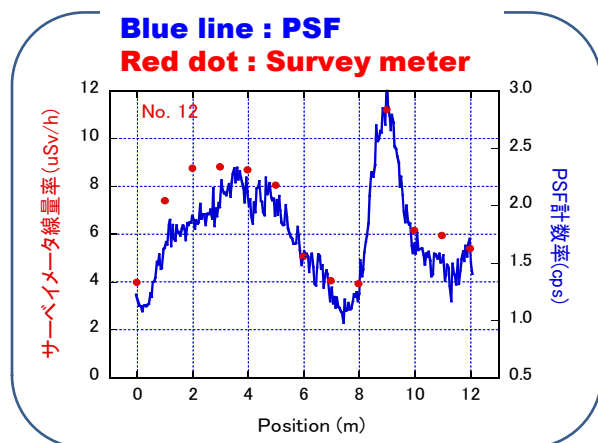
Plastic Scintillation Fibers (PSFs) Detector

For broad monitoring Area

Incidentals pule from Radiation



Examples for field measurement



Correlation of PSF and survey meter

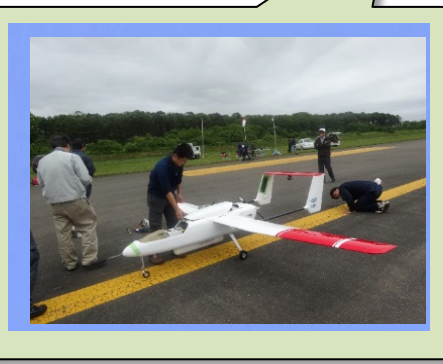
For broad monitoring Area

Range	Large area >100 km	Semi large area >10 km	Middle area >1 km	Small area ~ 100 m
Aircraft	Helicopter	UARMS	UAH	Micro UAV
Altitude	~ 300m	~ 150m	~ 50m	<10m



Helicopter

Using for Large area monitoring



Autonomous air plane

- Range: 100km
- Speed: 100km/h
- Operation: 6hour
- Use: For emergency

On the developing with JAXA



Autonomous helicopter

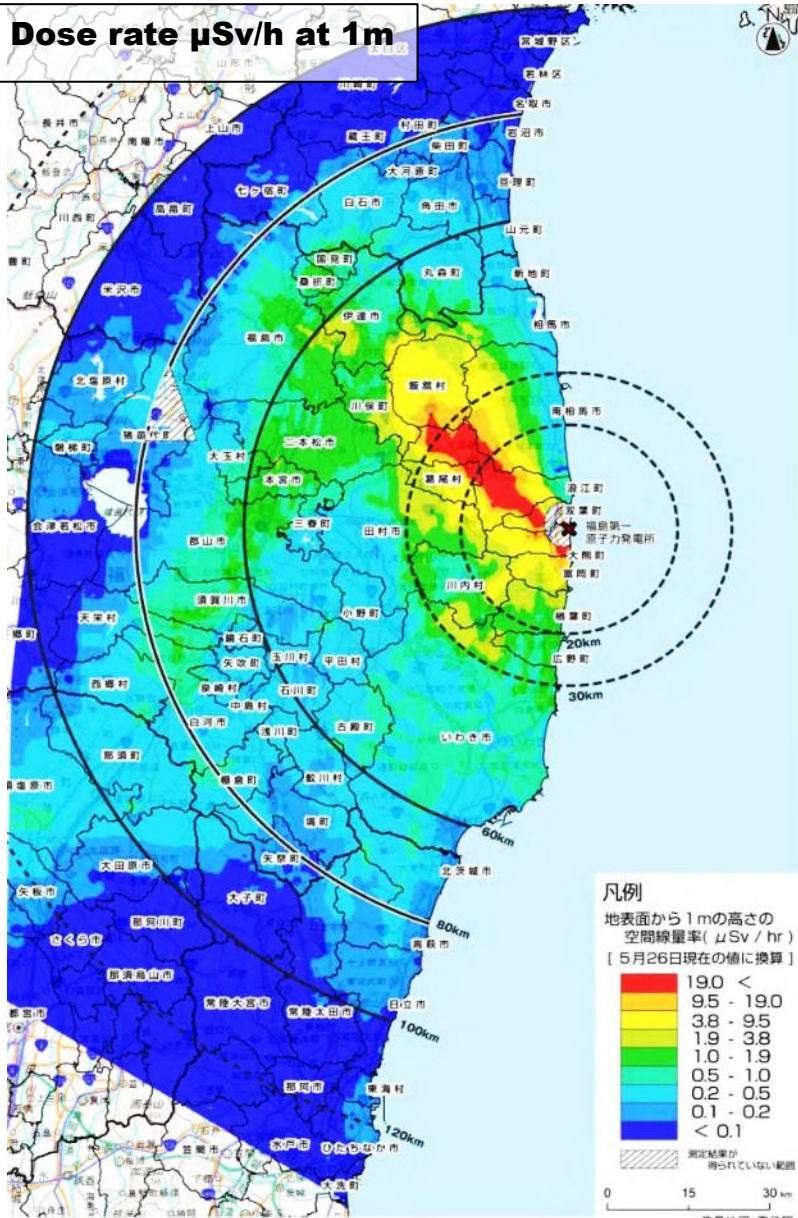
For precise distribution mapping;
Using for mapping inside of 5km around FDNPP/farm land/along river



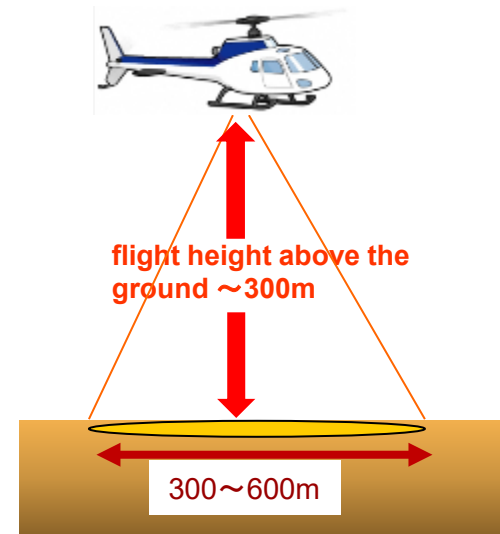
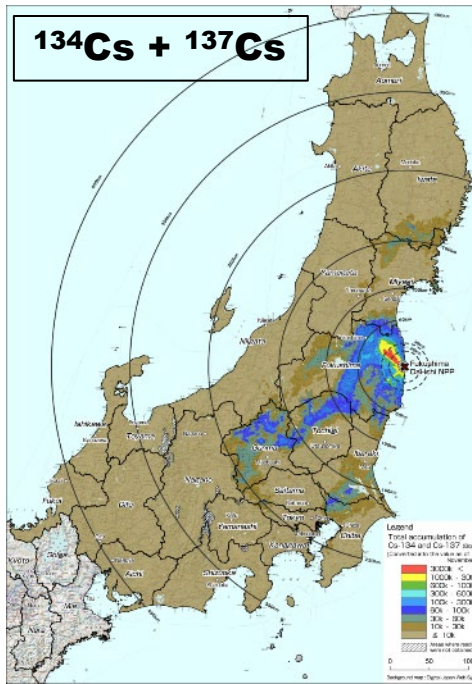
Micro UAV

For more precise distribution mapping;
Using inside forests and residential area such as around housing and building
On the developing

Dose rate $\mu\text{Sv/h}$ at 1m

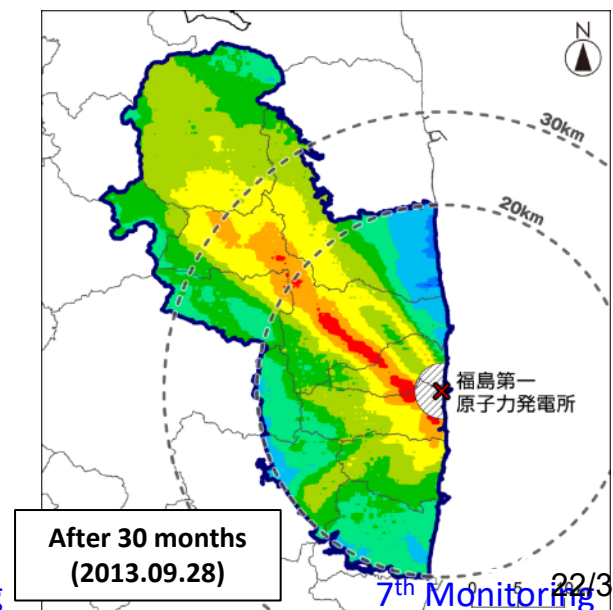
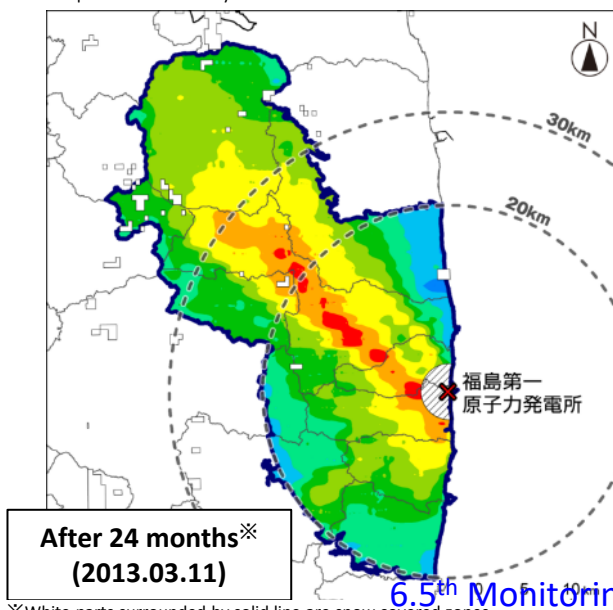
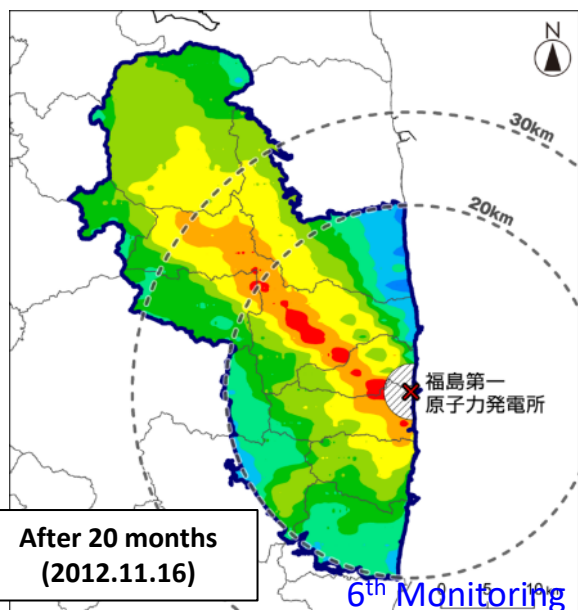
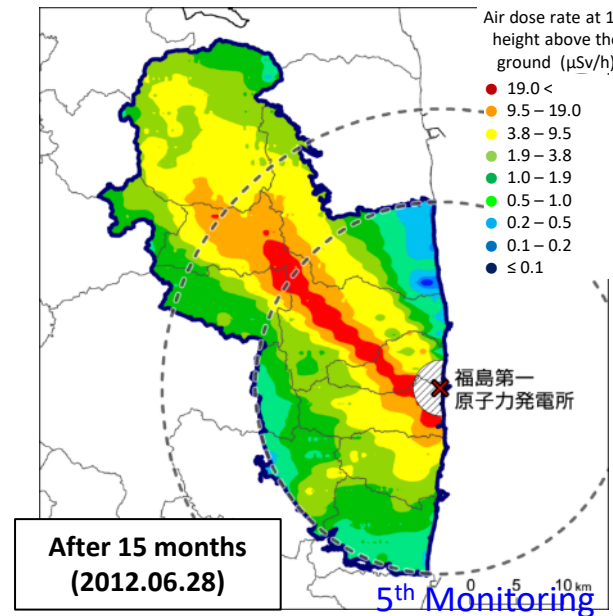
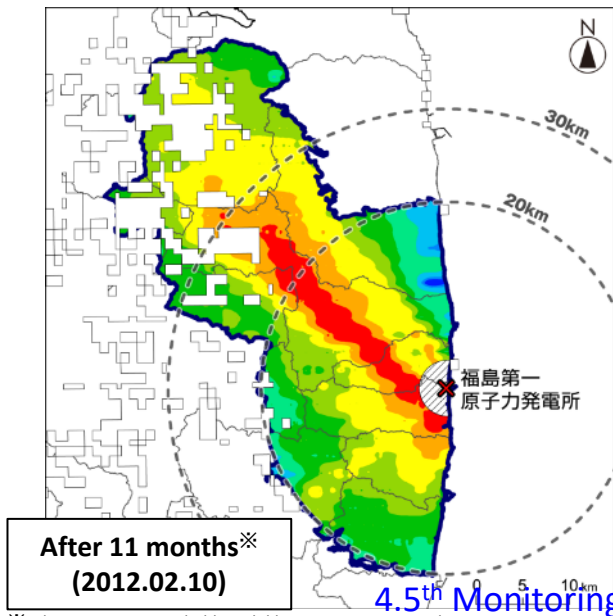
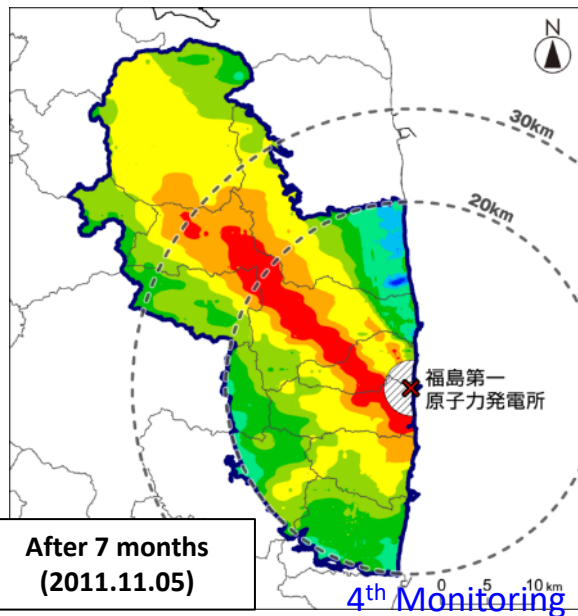


Det.size(inch), quantity	Energy range	Channel	Altimeter
16" \times 4" \times 2", 6 detector	0.02 - 3 MeV	1,024 ch	GPS



Dose Rate Distribution as a Passing Time

- by aircraft monitoring -



Air dose rate at 1m height above the ground ($\mu\text{Sv/h}$)

- 19.0 <
- 9.5 - 19.0
- 3.8 - 9.5
- 1.9 - 3.8
- 1.0 - 1.9
- 0.5 - 1.0
- 0.2 - 0.5
- 0.1 - 0.2
- ≤ 0.1

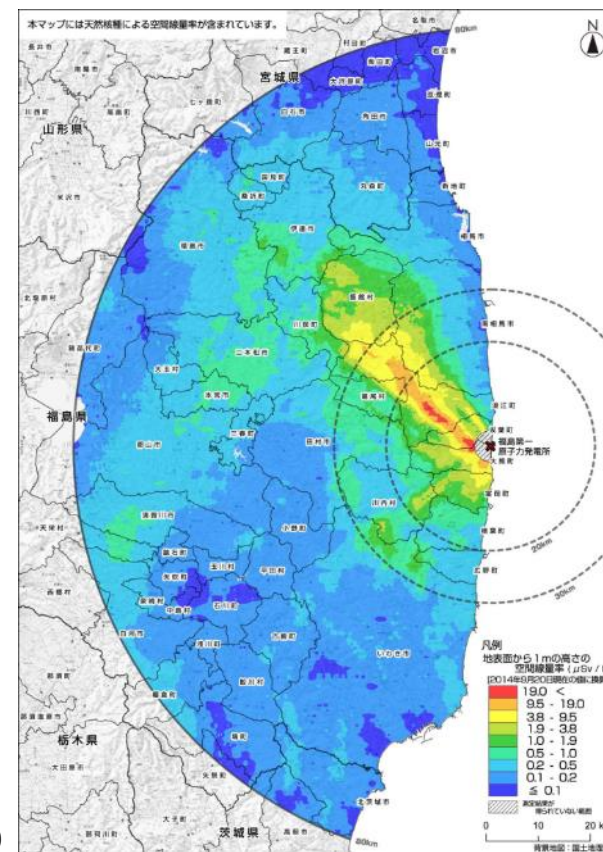
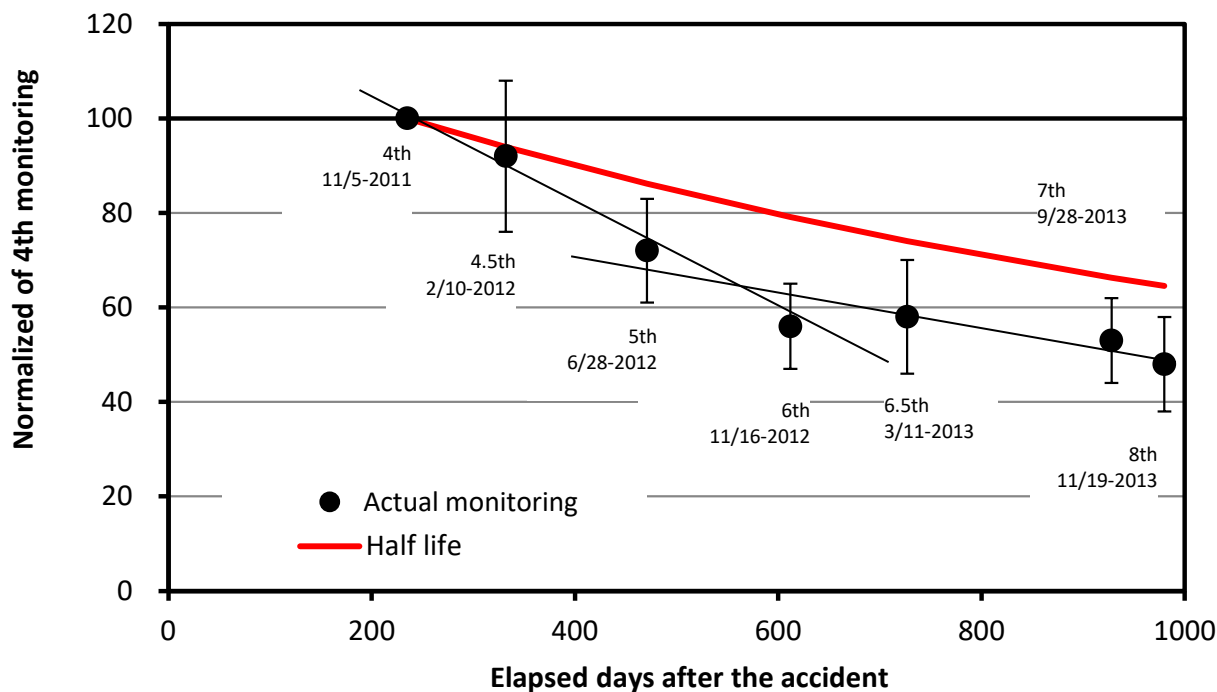
※White parts surrounded by solid line are snow covered zones

※White parts surrounded by solid line are snow covered zones

Dose rate variation with time based on airborne monitoring

FY	2011				2012				2013			
	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3
<80 km	1st	3rd	4th		5th		6th			7th		8th
>80 km	2nd *	East Japan 1st		West Japan and Hokkaido		East Japan 2nd		East Japan 3rd		East Japan 4th		

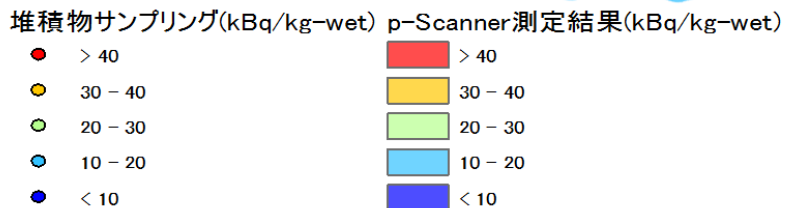
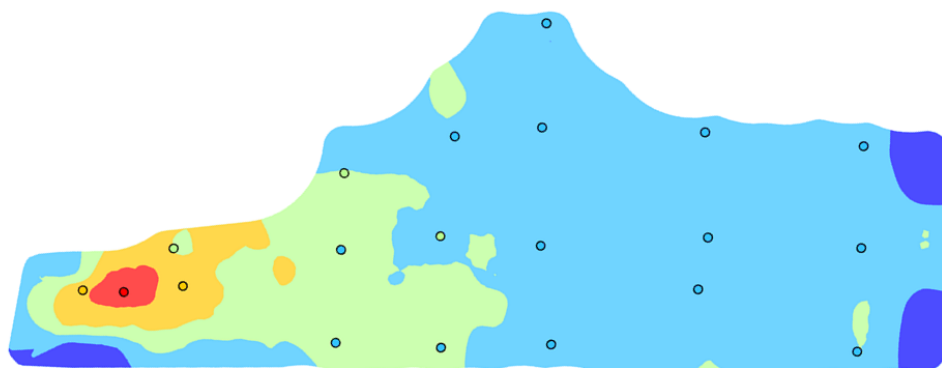
* Covering of a part of 100 - 120 km



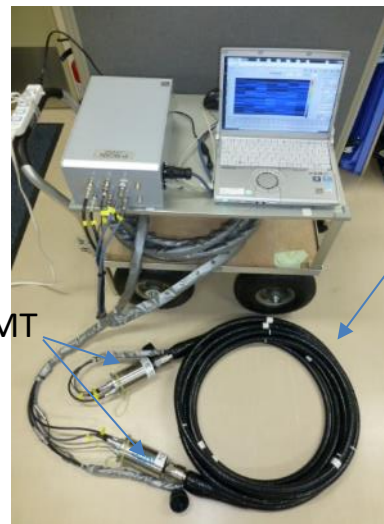
9th monitoring after 42 months (2014.09.20)

Correlation of actual monitoring and calculation of half live

Radioactivity monitoring for sediment in a pond using PSF and J-sub D



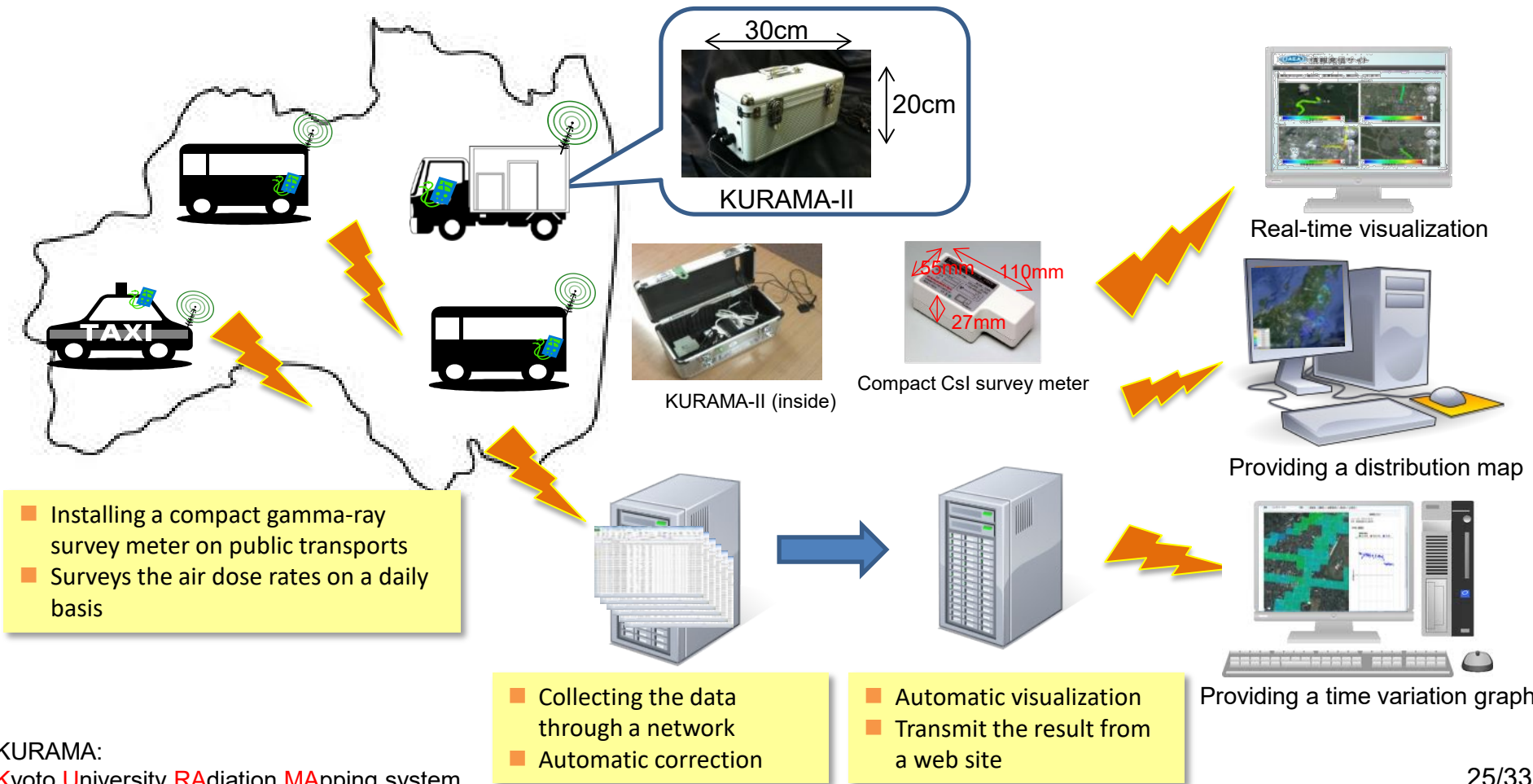
J-sub D:
Water proof LaBr3 spectrometer with skirt shape detection window



PSF: Plastic Scintillation Fibers (PSFs) Detector

PMT

- Real-time visualization of the distribution of air dose rates in Fukushima
- Providing visualized information on air dose rate distribution in residential areas on a daily basis.
- Installing a compact gamma-ray survey system on a public transport such as buses, trucks.
- Survey data are collected, corrected, and visualized automatically and opened to the public.



- Installing a compact gamma-ray survey meter on public transports
- Surveys the air dose rates on a daily basis

- Collecting the data through a network
- Automatic correction

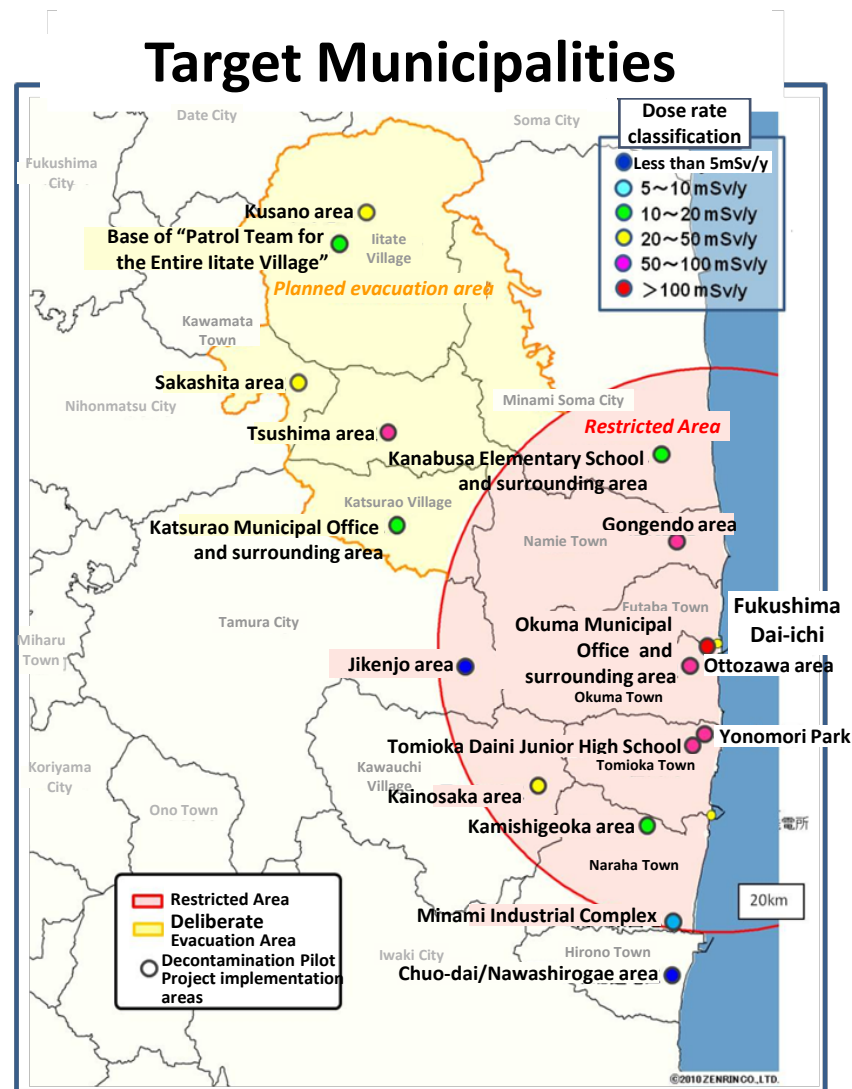
- Automatic visualization
- Transmit the result from a web site



5. Decontamination Pilot Project by JAEA

Decontamination Pilot Project (DPP) by JAEA



- JAEA was chosen by the Government to conduct decontamination pilot projects (DPP), including evacuation areas (Sept. 2011~June 2012)
- Main challenges to implement full-scale decontamination are lack of both real-world examples and also experience for planning and implementing decontamination technology
- Therefore, the decontamination pilot projects play a key role to support drafting of guidelines and manuals that can be used by the national government and local municipalities to optimize regional remediation work
 - Check the availability and efficiency of proven and new techniques
 - Investigate cost, work period, workforce, waste generated, and radiation exposure of workers
 - Establish waste management including volume reduction of wastes and treatment of the secondary waste
 - Secure workers' safety under radiation protection
 - Establish optimal radiation monitoring
 - Record the public communication



Futaba Town has advised us that they would not join the Decontamination Model Project as a target area.

* An examination conducted by a committee appointed by JAEA

Recommended Clean-up Technologies

Land use classification		Comprehensive evaluation	
	Forest	◎Removal of leaf litter and humus layers (on flat ground and slopes), ○Removal of leaf litter, humus layers and topsoil (on flat ground), ▲Trunk washing, ○Branch trimming in the lower part (evergreen tree)	
	Farmland	◎Machine that strips off surface of soils, ○Backhoe (stripping off depth of 5 cm of the soil), ◎Reversal tillage (by tractor and plough), ○Ploughing to replace surface soil with subsoil (by backhoe)	
Residential area	Roof	▲High pressure water, ○Brushing, ○Wiping, ▲Apply a remover	
	Gutter	△High pressure water, ○Wiping	
	Wall	○Brushing	
	Topsoil	○Removal of topsoil	
	Rubble	○Washing of the rubble, ○Removal of the rubble	
	Turf	○Removal of the Turf	
	Garden tree	▲Clipping a garden tree	
Large structure	Interlocking block	△High pressure water	
	Concrete and Mortar surface	△Sanding machine with the dust-collection (Plane which scrapes concrete), ○Ultrahigh pressure water (Over 150MPa), ○High pressure water (10-20MPa), ○Iron shot blasting	
	Roof floor	Concrete surface	○High pressure water (including brushing)
		Waterproof coating surface	○High pressure water (including brushing)
		Downpipe	○High pressure water(Maximum 50MPa)
	Playing field	○Strips off surface of soils (Large mower+Sweeper), ○Strips off surface of soils (Road planers), ○Strips off surface of soils(Motor grader), ○Ploughing to replace surface soil with subsoil	
	Swimming pool	○High pressure water	
Turf	○Turf stripper		
	Paved road	▲Road cleaners + Riding style road sweepers, △High pressure water (About 15MPa)+Brushing, △Car of a functional recovery drainage pavement, ○Ultrahigh pressure water (120~240MPa),○Iron shot blasting, ○TS Road planers	



◎ : highly effective, ○ : effective, △ : moderately effective, ▲ : limited effect

6. Cooperation for National and Local Government

Cooperation for National and Local Government

Cooperation and Support for Special Decontamination Area and intensive Contamination Survey Area

① Special Decontamination Area

- Technical advices for decontamination
- Decontamination Pilot Project, Follow-up Monitoring

② Intensive Contamination Survey Area

- Support and Consulting for Decontamination
- About 4,100 –March 2019

Communication and Human resource Development

- Bidirectional communication about 23,000 at 259sites-March 2019
- Human recourse development for Students (Fukushima Univ. National Institute of Technology, Fukushima Collage, Nagaoka University for Technology・・)



Fukushima Health Management Survey

- Design and Evaluate of Internal Exposure monitoring
- 11 July 2011~31 March 2019
About 93,150 (Child 72,570、Adult 20,580) measured by JAEA





7. Environmental Monitoring Data Base

JAEA has released a database on website since 27 Mar 2015

<http://emdb.jaea.go.jp/emdb/en/>



Japan Atomic Energy Agency

Google™ Custom Search



日本語

Database for Radioactive Substance Monitoring Data

The Japan Atomic Energy Agency (JAEA) is collecting monitoring data related to the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi Nuclear Power Plant accident, including air dose rate, and radioactive concentration (ground surface, soil, seawater, marine soil, river water, river sediment, groundwater, and food). JAEA visualized these data and publicly released in this website so that users can comprehend information intuitively.

Environmental Monitoring Data

Radioactive substances released to the atmosphere by the Fukushima Daiichi NPP accident were eventually deposited on the land of Japan and contaminated ground soil, forests, ocean, and rivers. Data here are results of radioactive substance monitoring conducted by the various organizations including national government, local governments, and power companies to investigate the situation with regards to the dispersion of radioactive substances.

Dose Rate / Accumulated Dose

Measured air dose rate data, i.e. the amount of radiation per unit time in the air (nGy/h, or μSv/h). The air dose rate is continuously observed around the nuclear facilities to detect abnormality including radioactive substance leakage.

- » Survey Meter (1 cm dose equivalent rate)
- » Vehicle-borne Survey
- » Airborne Monitoring [air dose rate]
- » Monitoring Post (air absorbed dose rate)

Land Water

Measured data of radioactive substance in the water including river water, lake water, suspended sediment, river sediment, aquatic organisms, well water, and tap water.

- » River / Lake

Atmosphere

Measured data of radioactive substances in dust.

- » Dust
- » Monitoring Post (Dust Monitor)
- » Rainfall

Soil

Measured data of radioactive substances released to the environment by Fukushima Daiichi NPP accident including ground deposition, radioactive concentration of soil sample and environmental sample, and radioactive substance depth distribution.

- » Ground Measurement
- » Airborne Monitoring [cesium deposition density]
- » Soil / Environment Sample Analysis
- » Depth Distribution in Soil

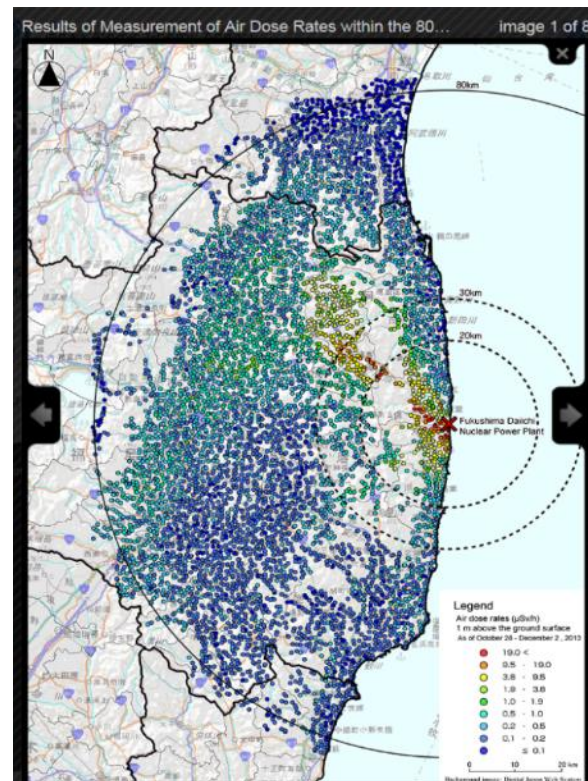
Food

Data of radioactive substances measured to maintain our safety and security of food including agricultural products, livestock products, fishery products, processed food, and drinking water.

- » Drinking Water
- » Food Item
- » Fishery Product
- » Game Meat

Marine Area

Measured data of radioactive substances released to the environment by Fukushima Daiichi NPP accident, including seawater, marine soil, air dose rate above the sea surface, and marine organisms.



Download File

Results of Measurement of Air Dose Rates within the 80 km Radius from Fukushima Dai-ichi NPP. (From June 2013 to July 2013)

KML

Miyagi (229 KB)	Yamagata (79.9 KB)	Fukushima (961 KB)	Ibaraki (119 KB)	Tochigi (79.4 KB)
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XML

Whole area (1.16 MB)	Miyagi (131 KB)	Yamagata (2.01 KB)	Fukushima (946 KB)	Ibaraki (26 KB)	Tochigi (1.54 KB)
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CSV

Whole area (186 KB)	Miyagi (24.1 KB)	Yamagata (669 Bytes)	Fukushima (154 KB)	Ibaraki (5.25 KB)	Tochigi (585 Bytes)
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Summary

- 1. Environmental Radiation monitoring has been carried out since 12 March 2011.**
- 2. New monitoring technologies have been developed from problems of actual monitoring fields.**
- 3. Drafting of guidelines and manuals of decontamination had been edited.**
- 4. Monitoring database on website had been released.**