Impact of the Fukushima disaster on Japanese fusion research

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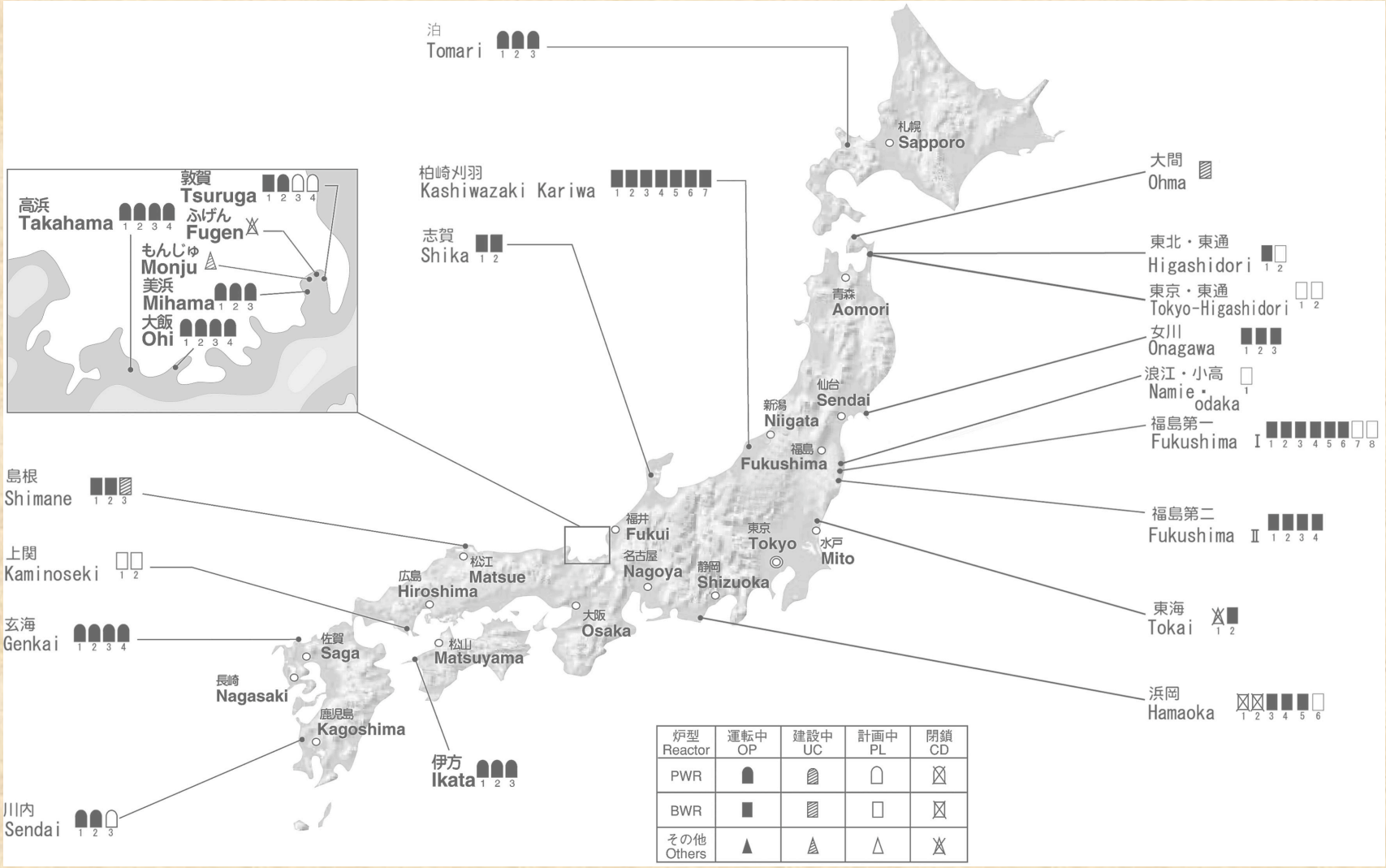
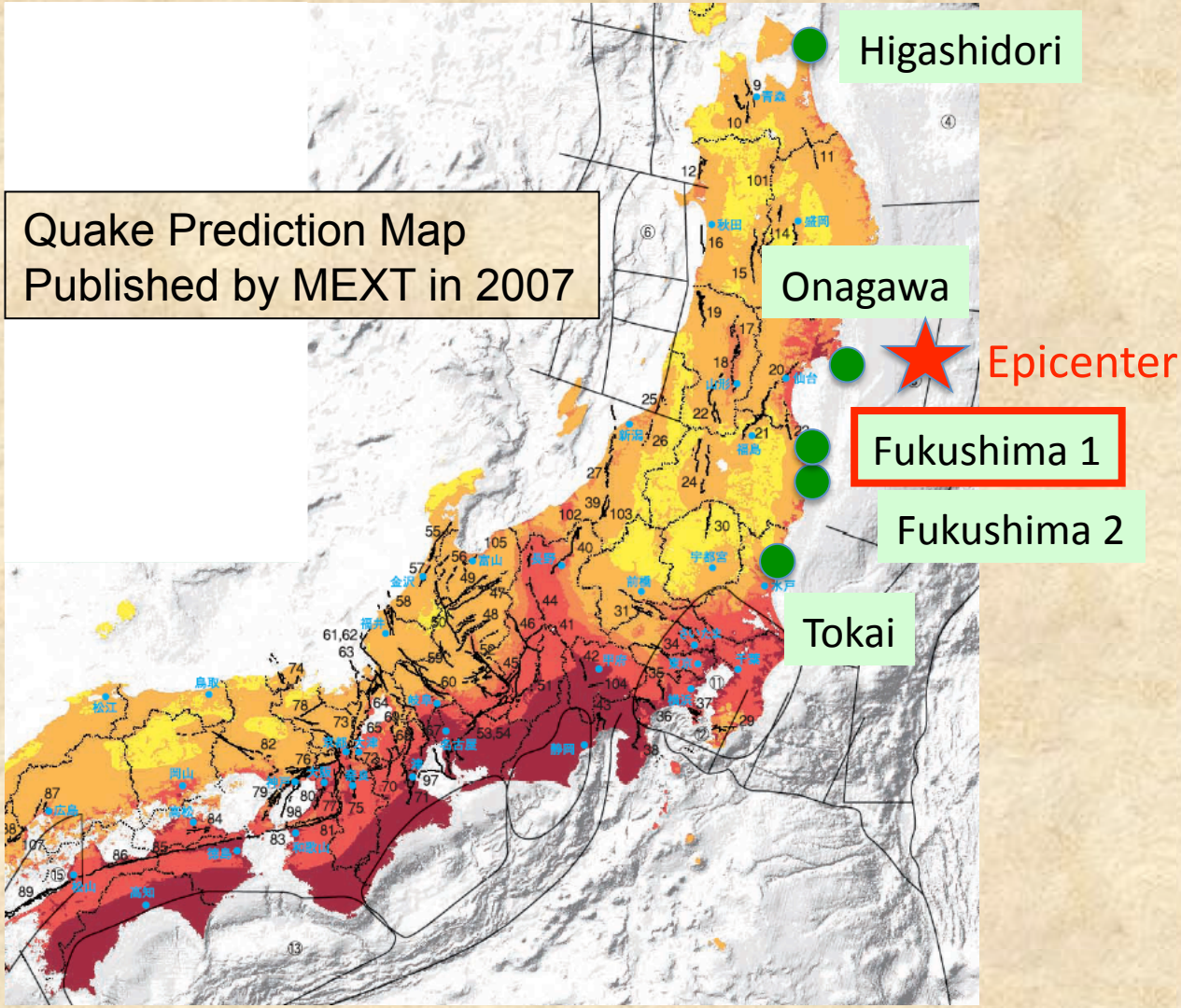
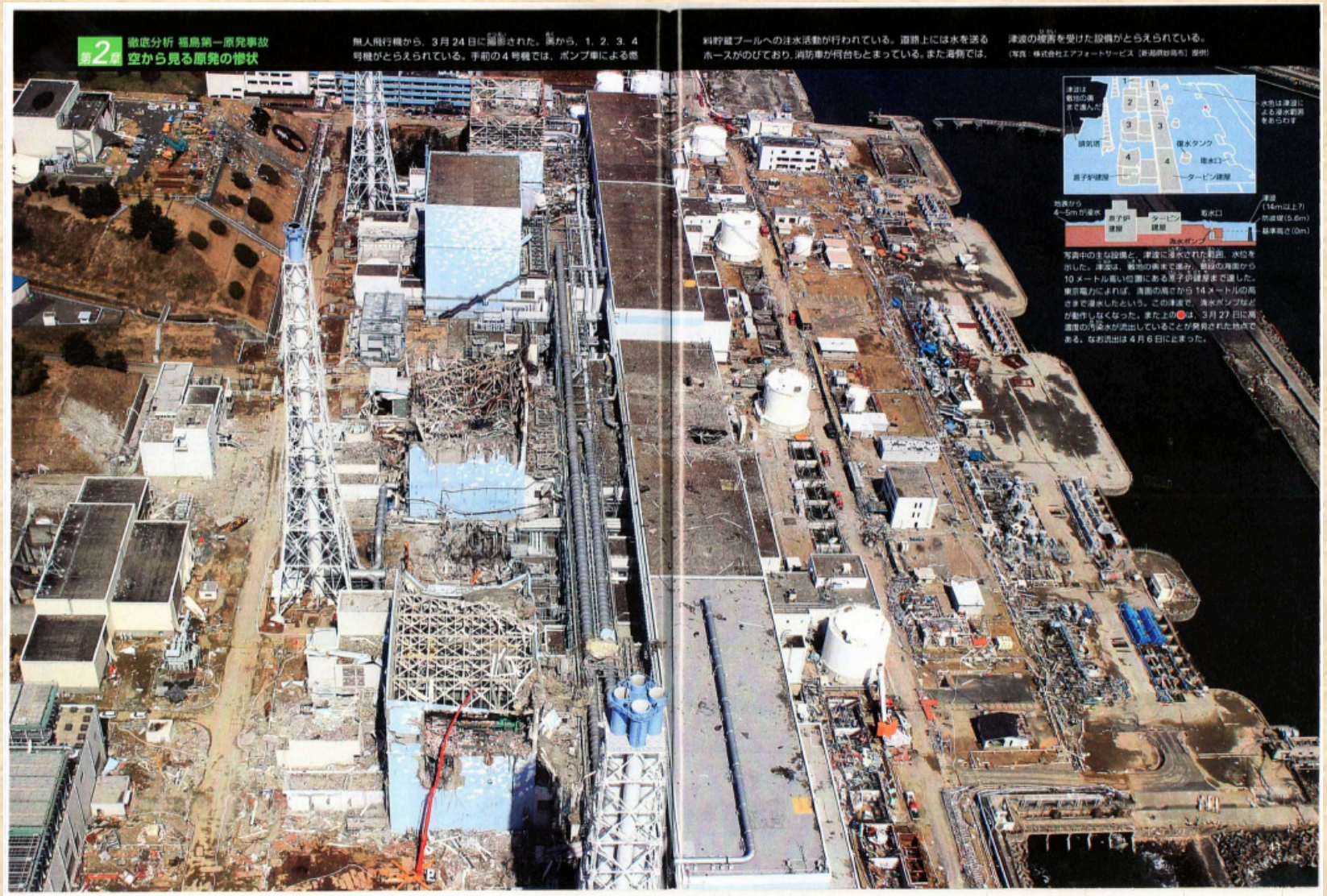
54 Nuclear Power Plants before 3.11



15 Nuclear Power Plants at 5 Sites were attacked by Tsunami on 3.11



Fukushima Site 1 after Hydrogen Explosions

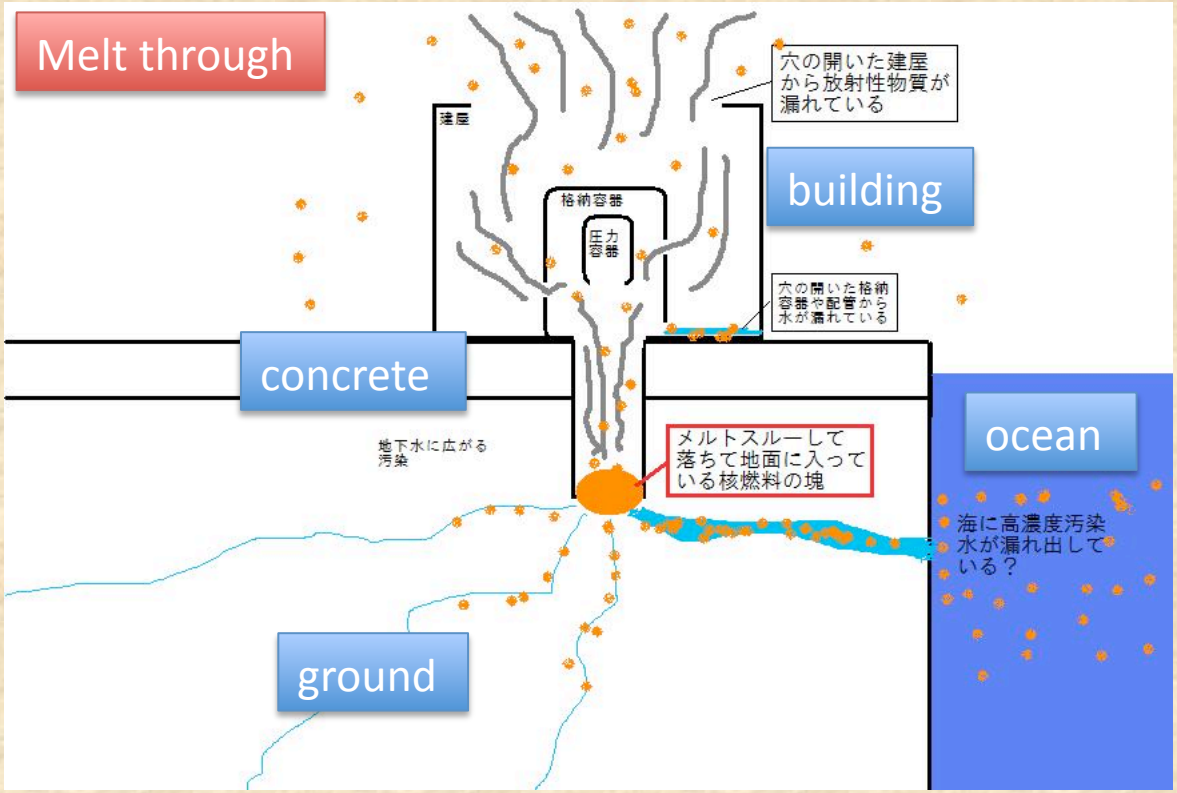


Newton　2011年6月号

Melt Down and/or Melt Through

Melt down

Melt through



http://housyanou.com/bbs/index.cgi?mode=view&no=142

http://yulanatume.blog60.fc2.com/blog-entry-177.html

Release of Radio Activities from Fukushima 1

	Inventory	Fraction Released	
137-Cs	408 kg	4.7 kg	0.011
90-Sr	253 kg	n.a.	
131-I	1.2 ~ 2.5 kg	0.035 kg	0.01~0.03

I assumed the following;

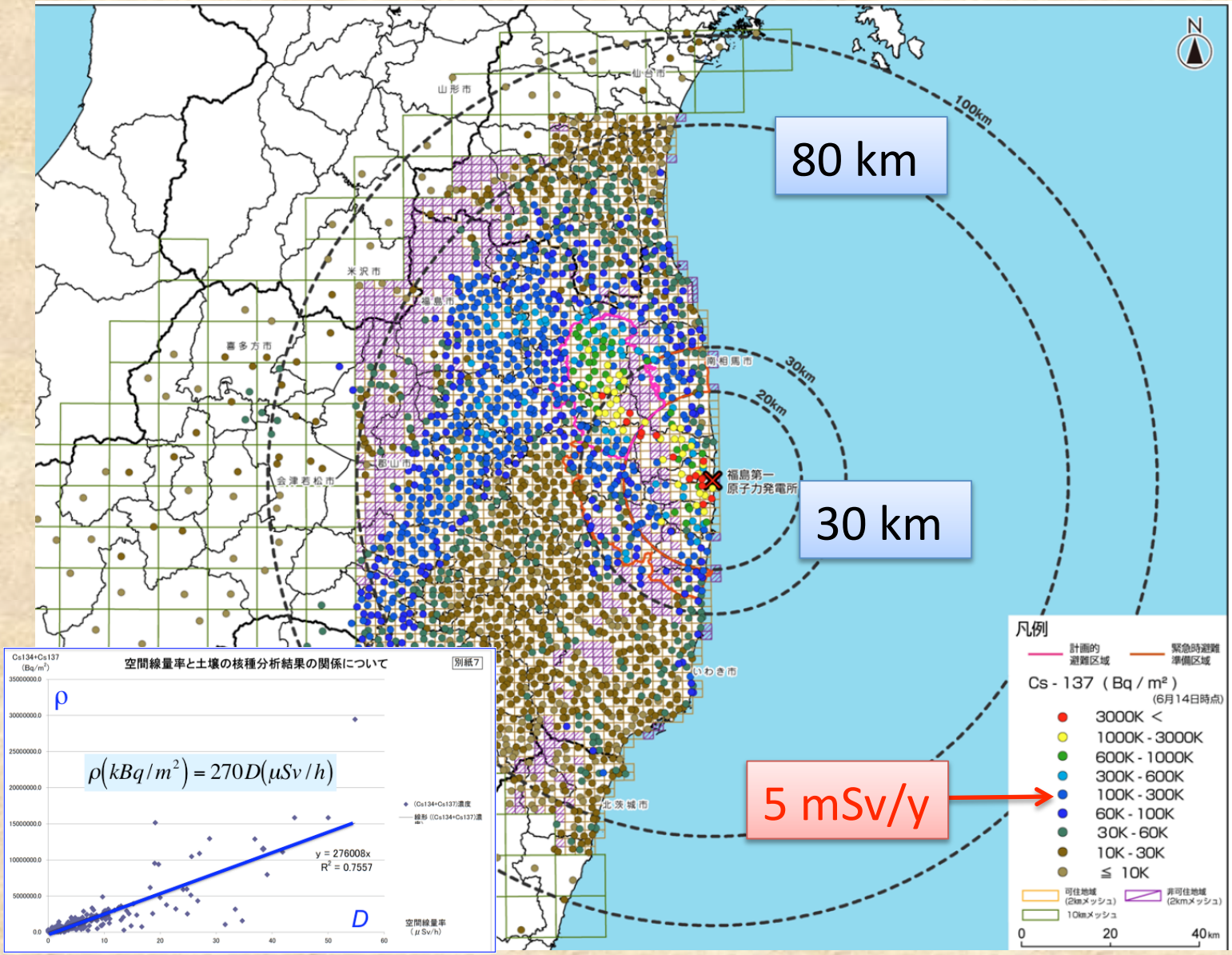
1 GWe-year operation consumes 1.2 ton of 235-U.
All fuels were burned at full power for one year.
The last two weeks operation contributed to 131-I production.

The Chernobyl accident

	Inventory	Mass & Fraction Released	
137-Cs	81 kg	27 kg	0.33
90-Sr	43 kg	2 kg	0.05
131-I	0.7 kg	0.4 kg	0.6

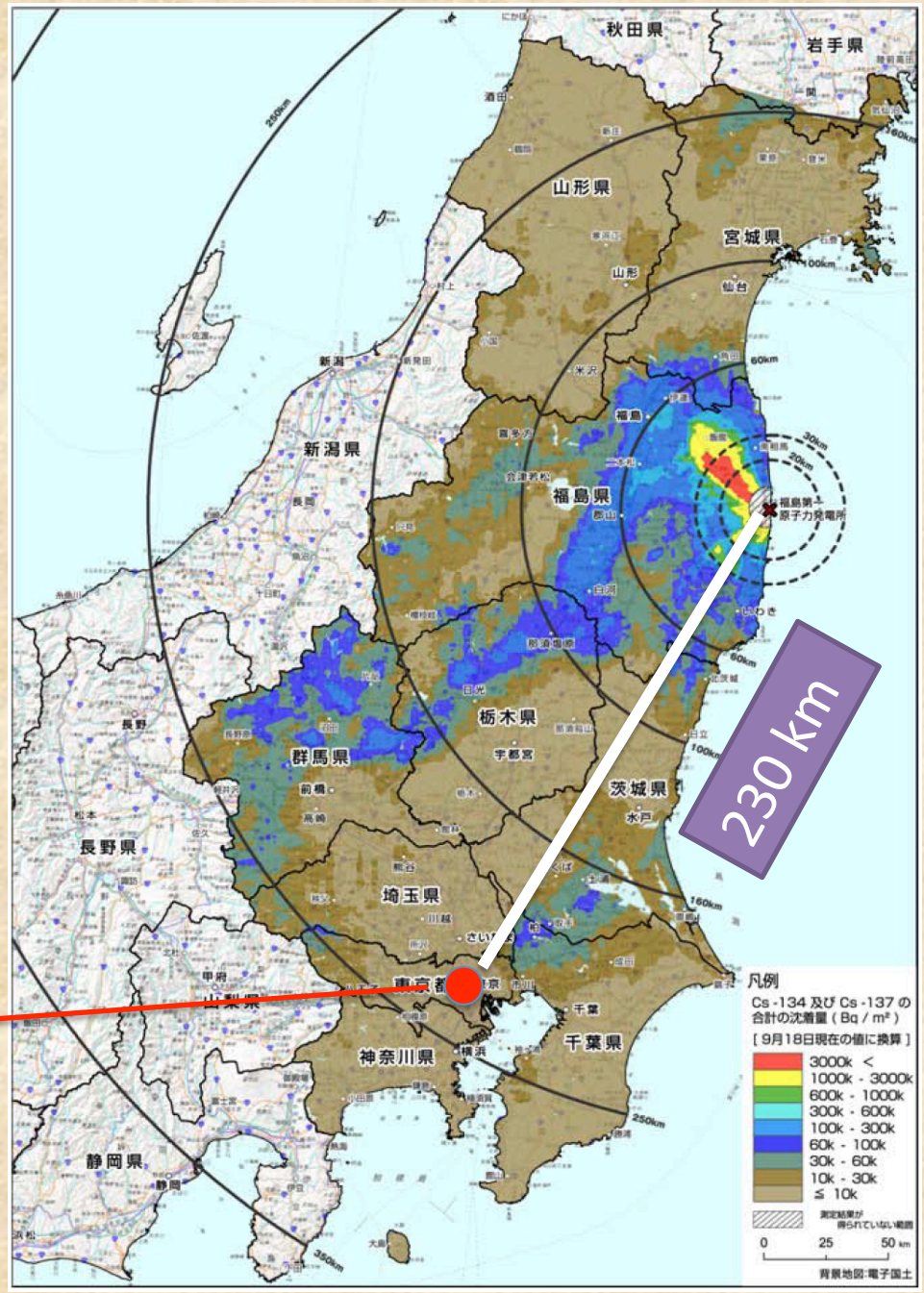
Map of Cs-137 Contamination in Soil

published by MEXT on 2011.8.30



Contamination of $^{134, 137}Cs$

MEXT on 2011.10.6



Events caused by the Fukushima disaster

- A large area contaminated with $^{134,137}Cs$ and ^{90}Sr
- Evacuation of thousands of residents
- A huge scale of decontamination work to 5~1 mSv/year.
- No place to store the contaminated soil and ash

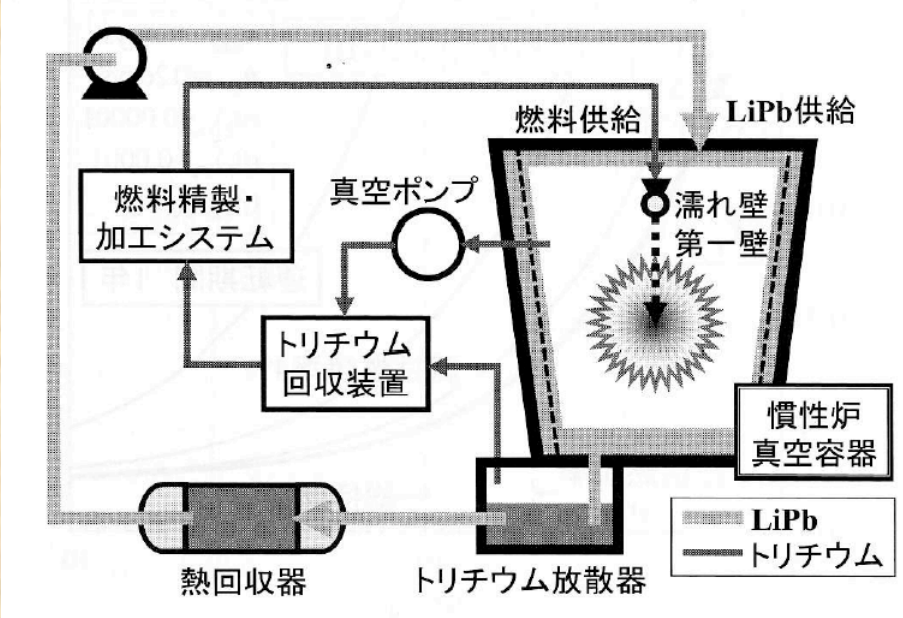
- Public opinion has turned to "anti-nuclear"

Safety

Tritium Inventory in Fusion Reactor

Electric Power Generation	1 GWe
Tritium Combustion per Day	0.4 kg
Inventory for 57 Days	23 kg = $8.2X10^{18}$ Bq

- Liquid LiPb Blanket for Inertial Confinement Reactor
- Solid State Blanket for Tokomak Reactor

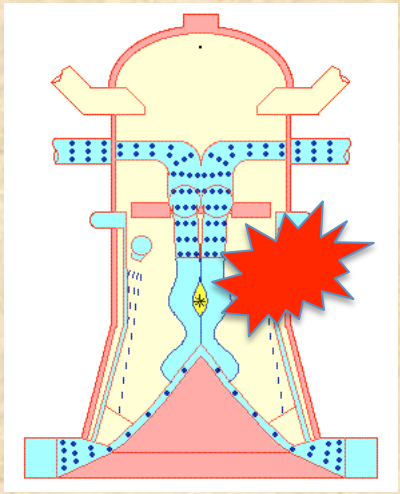


M. Nishikawa, J. Plasma Fusion Res. Vol.87, No.8 (2011) 503-511

Severe Accidents at Fusion Reactors

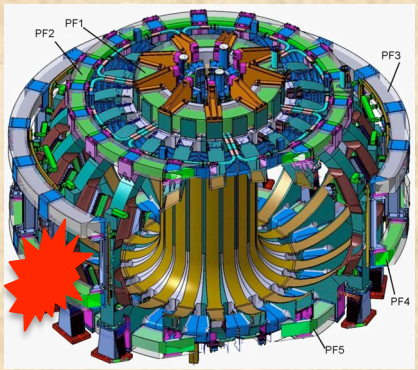
Safety

- Collapse of Reactor Vacuum Vessel
- Collapse of Tritium Breeding System
- Quenching of S.C. Magnet



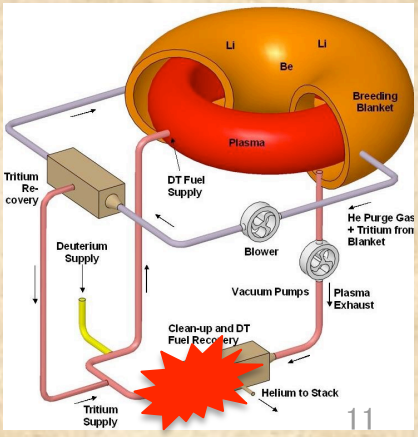
http://www.nuc.berkeley.edu/thyd/icf/IFE.html

- Release of Tritium and Other Radio Activities to Environment



http://www.iter.org/

http://www.iter.org/mach/magnets



Safety

Properties of Tritium

- A long half-life of 12 year
- A biological half-life of ~ 10 days for HTO*
- Difficult to detect because of low beta-energy of 18 keV
- High permeation through ferritic steel
  at operating temperature of 400°C<T<550°C**

  A refractory alloy (Nb, Ta, W) or SiC is required.**

* http://www.naka.jaea.go.jp/forum/aomori_sympo/ichimasa.pdf

** Issues of tritium migration and control in PbLi blankets, Brad Merrill, Idaho National Laboratory, June 11th, 2007

Safety

Release of Radio Activities

	Activity
H-3 (100% of Inventory) $T_{1/2}$=12 y	23 kg 8.2X10^{18} Bq
Cs-137 (Fukushima) $T_{1/2}$=30 y	4.7 kg 1.5X10^{16} Bq
I-131 (Fukushima) $T_{1/2}$=8 d	35 g 1.6X10^{17} Bq

$$\frac{dN}{dt} = -\frac{\ell n 2}{T_{1/2}} N$$

$$M(g) = \frac{A}{N_A} N$$

Resource of Rare Metals

Resource

	Reserve (10^6 ton)	Country
Li	4 ~ 11	Bolivia, Chile
Be	0.5 ~ 0.7	Brazil
Nb	4 ~ 5	Brazil
Ta	0.1 ~ 0.2	Brazil, Australia
W	3 ~ 6	China

Rare metal resources are unevenly distributed in limited countries.

The 3rd Science & Technology Basic Plan (FY2006-2010)

Polycy

1. Strategic research fields
   - Life science
   - IT
   - Environmental sciences
   - Nano-tech. & materials

2. National mission-oriented project
   - Super computer
   - X-ray FEL
   - FBR
   - Space transportation system
   - Marine & earth observation - exploration

Polycy

X-Ray FEL

- Successful oscillation on 7 June 2011
- The shortest wavelength in the world of 0.12 nm
- Service starts in FY2011

The 4th Science & Technology Basic Plan (FY2011-2015)

Polycy

1. Reconstruction from the Earthquake

2. Strategic promotion

- Green innovation
  - Low carbon energy supply
  - Highly efficient and smart use of energy
  - Greening of social infrastructure
- Life innovation
  - Innovative preventive care
  - New early diagnostic method
  - Safe & highly effective treatment
  - QOL of elderly/disabled persons and patients

3. National mission-oriented project

   none

Policy Changeover to Less Nuclear Energy, More Renewable Energy

Polycy

- Previous and current prime ministers have expressed

  "Nuclear energy is gradually reduced to zero."

  "Renewable energy is promoted to replace nuclear energy."

- Six plants at Fukushima site 1 are to be decommissioned.
- Four plants at Fukushima site 2 have no chance for resuming operation.

Financial Crisis in Japan

Budget

		$1X10^{12}$ ¥ (= 13 B$)	
A	National Debt of Japan	678	A/GDP =1.2
B	National + Local Debt of Japan	1145	B/GDP = 2.1
	GDP	547	

The Earthquake and the Fukushima disaster accelerates the debt.

Budget 2011 for Atomic Energy Field

Budget

	10^8 ¥ (~ M$)
Support for Nuclear Plant Location	1351 ↘ ?
Safety, Security, Safeguard	429
FBR	402 ↘ ?
Nuclear Waste Disposal	132
ITER	114
Human Resource Development	111
Fundamental Research	50
NIFS	44
JT-60	35
ILE Osaka	6 ?
Others	1615
Total	4289

Budget Trends for Research

Budget

- Renaissance of nuclear energy is over in Japan?

  Vested rights must be over.

- ITER program will continue to keep the int. agreement.

- Budget cut of several % every year may be applied to all fields of sciences.

  HIF and WDM is one of the general sciences.

  Is the ice age for the sciences coming in Japan?

Summary

We have to pay more attention to the following items.

Safety

- Severe accidents in fusion power system

Resource

- Resource of rare metals

Polycy

- Policy changeover to less “nuclear energy”

  Green innovation!! Life innovation!!

Budget

- Crisis of budget amplified by the Earthquake