Engaging with local stakeholders: Some lessons from Fukushima for recovery

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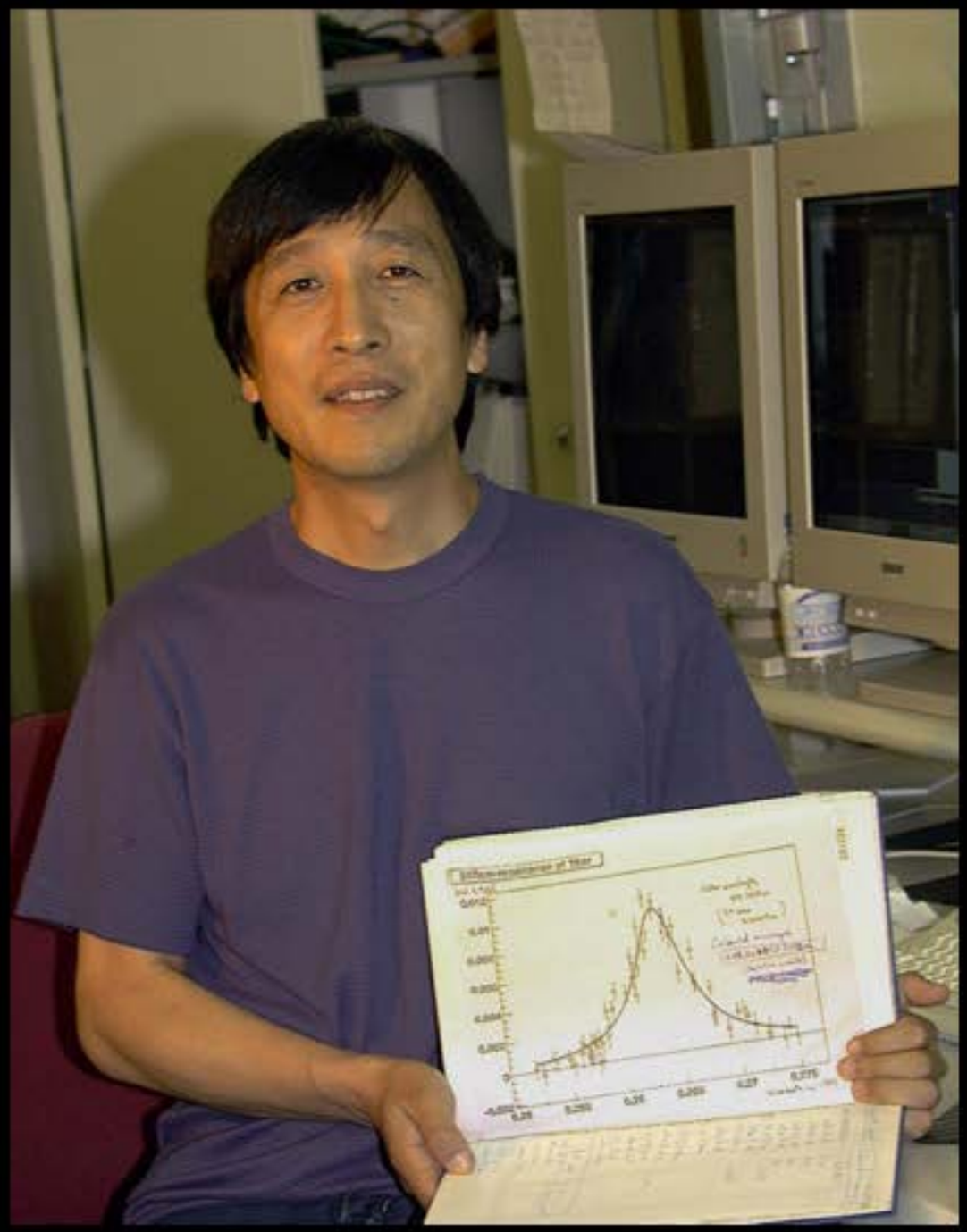
Oct 23, 2013, ICRP2013

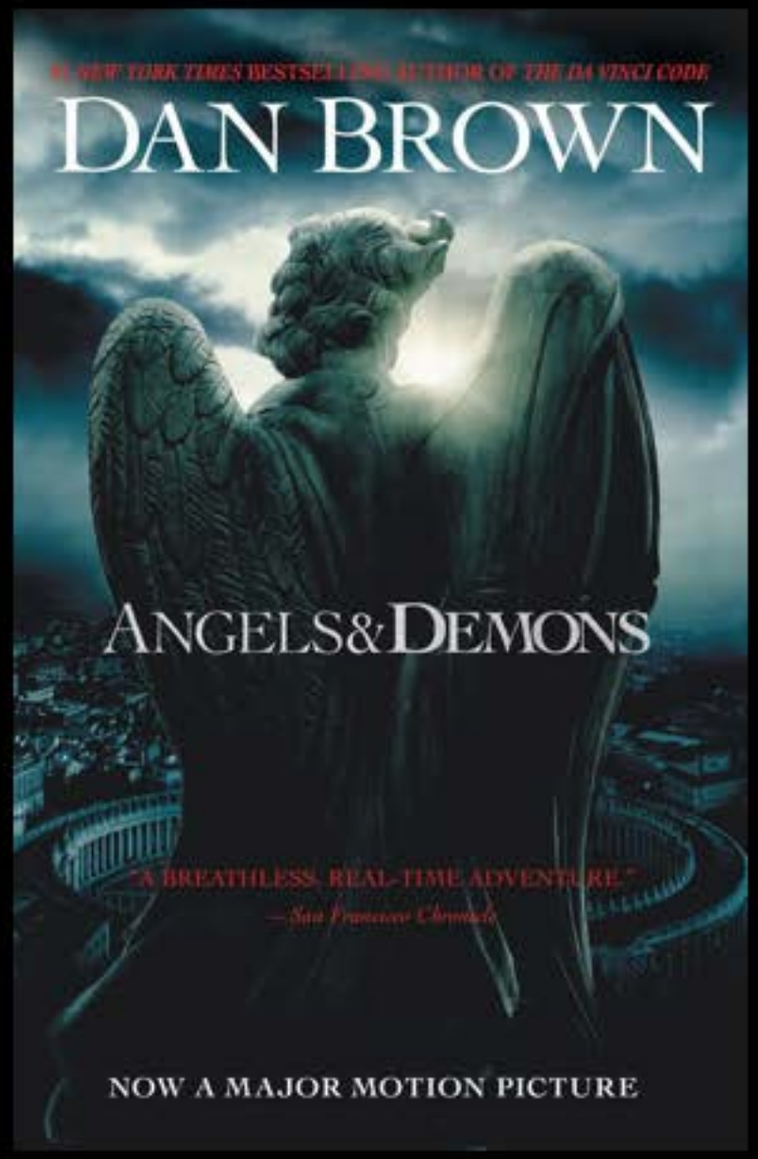
twitter hayano

Part 1

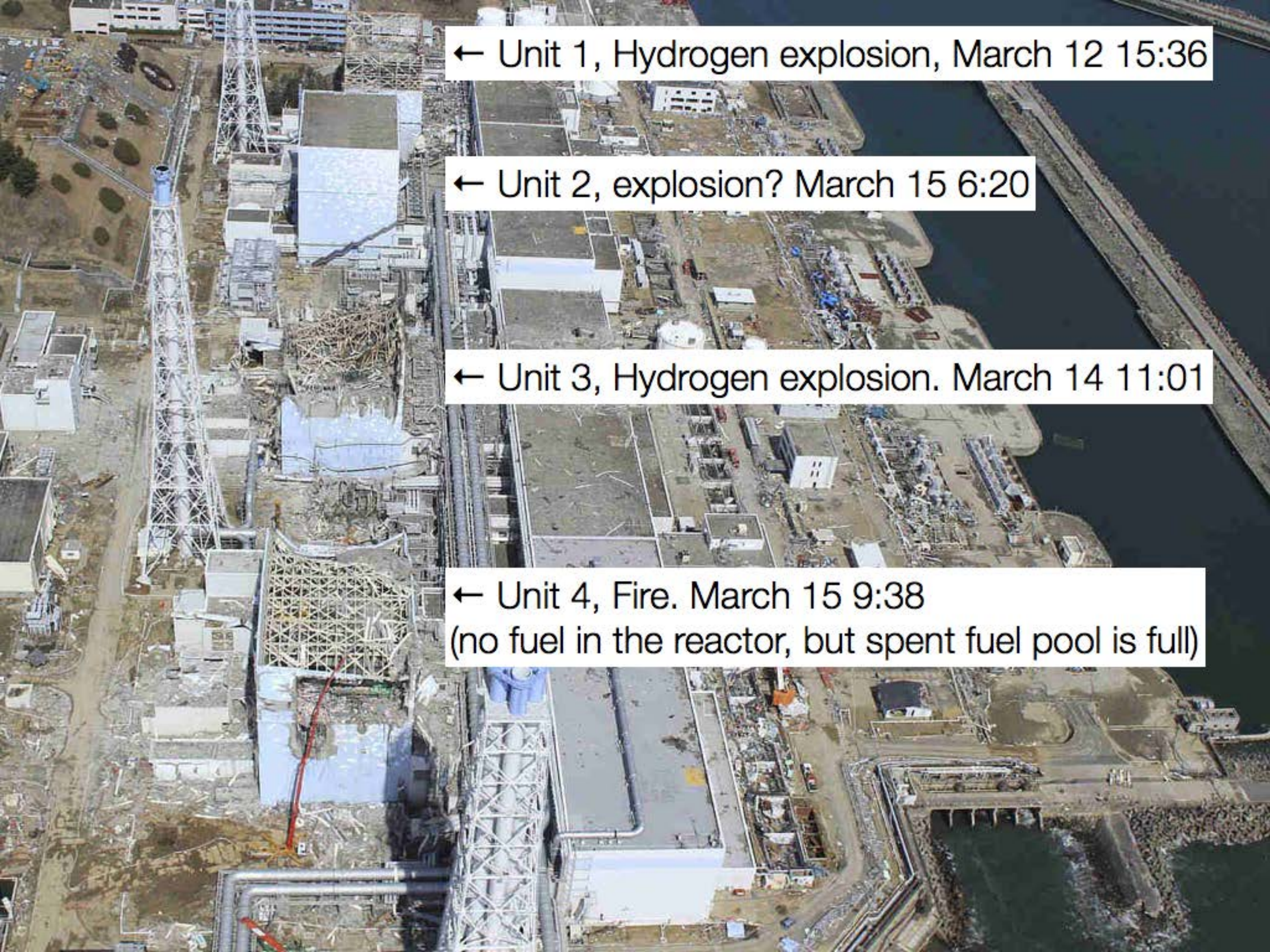
Why am I here today?

Before the accident
studying “antimatter” at CERN



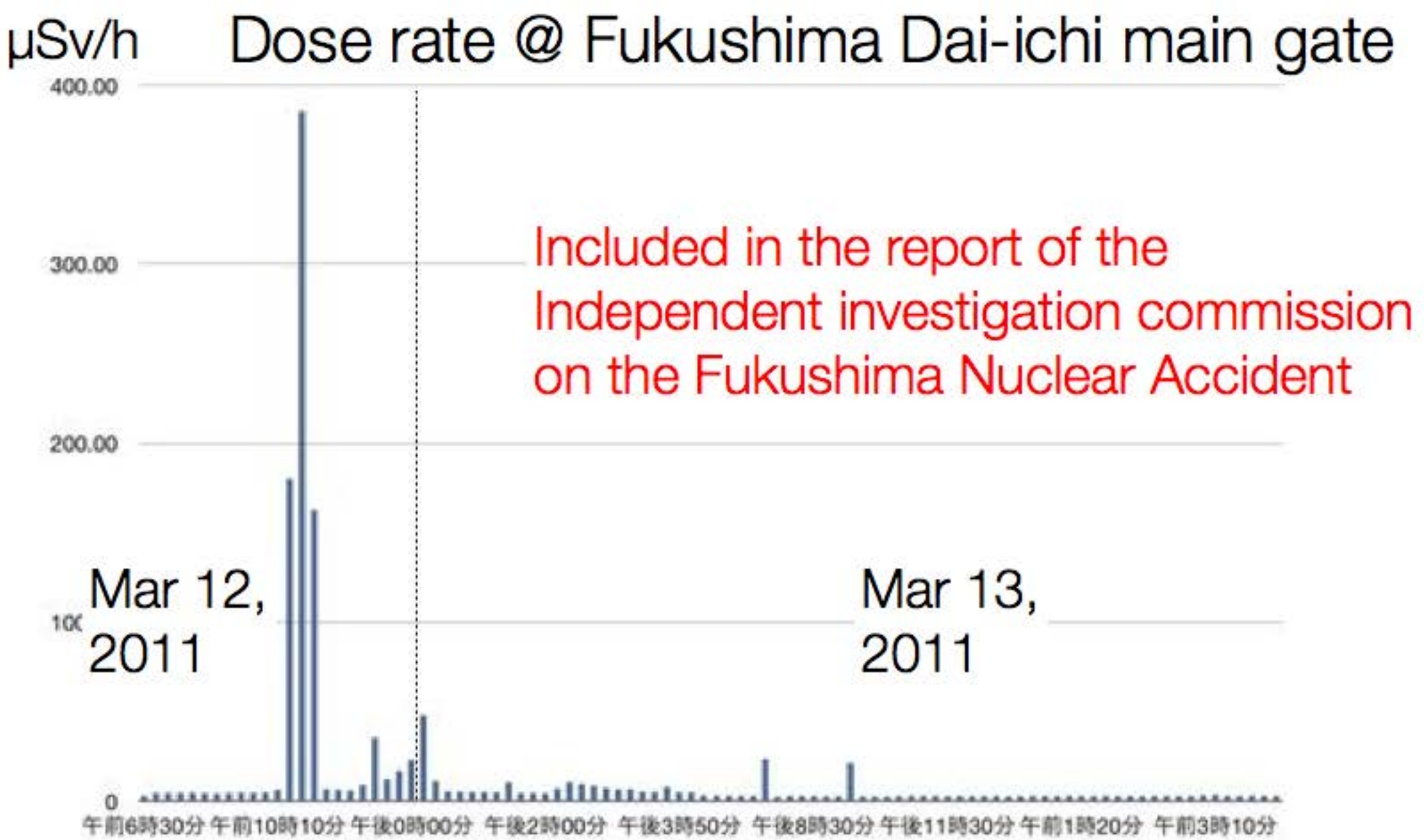


March 11, 2011, Tokyo University (was a physics department chair)


← Unit 1, Hydrogen explosion, March 12 15:36
← Unit 2, explosion? March 15 6:20
← Unit 3, Hydrogen explosion. March 14 11:01
← Unit 4, Fire. March 15 9:38
(no fuel in the reactor, but spent fuel pool is full)

My first graph: Mar 13, 2011, 07:49

twitter hayano



Ranked 7th
among the most influential twitter accounts

リツイートされたユーザーに対するトレンド分析 †

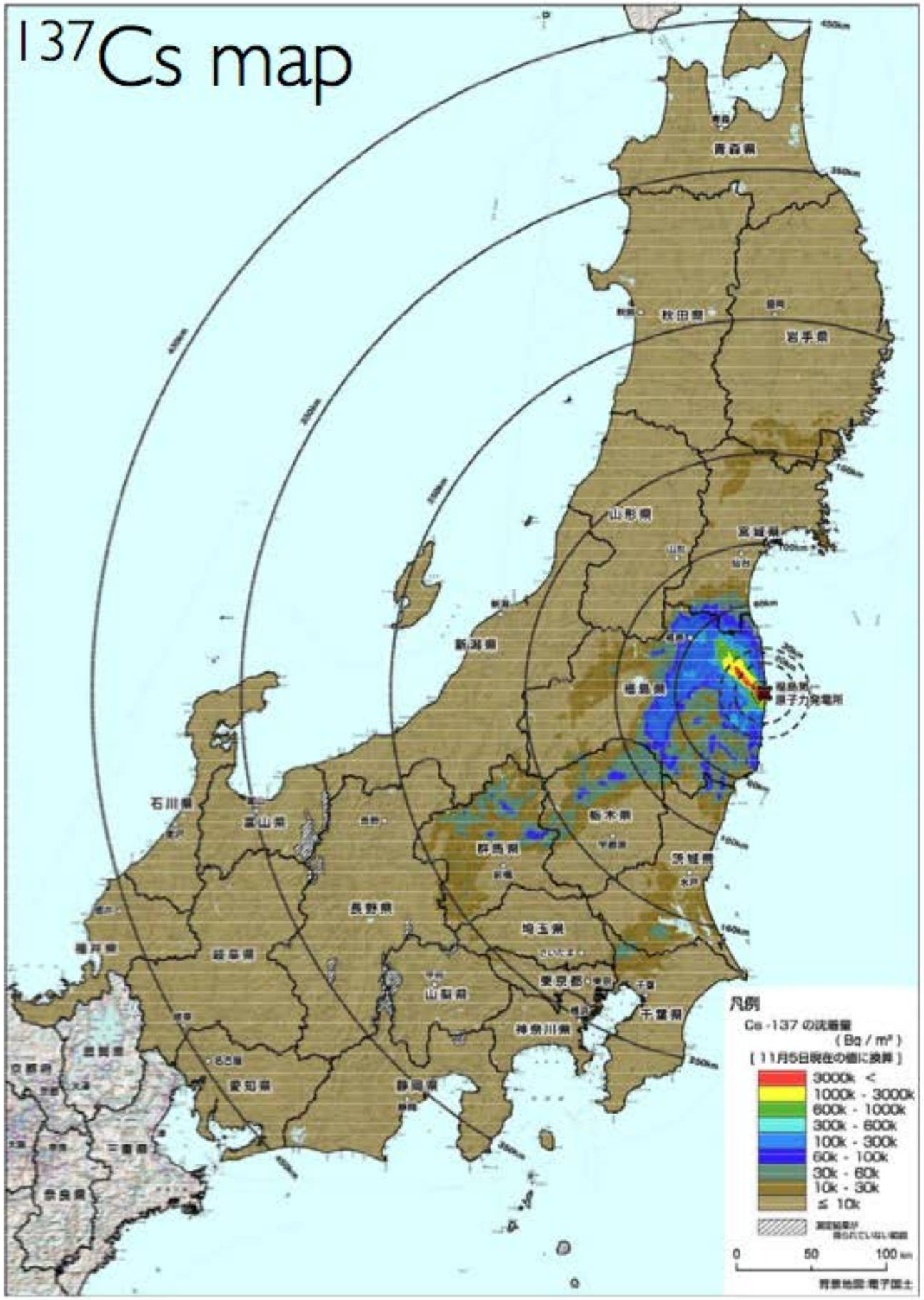
- データの中でリツイートされた頻度が高いユーザーのトップ100:
  http://www.cl.ecei.tohoku.ac.jp/prj311/trend/rteduser/top100.html

順位	ユーザ	被RT回数
1	@NHK_PR	630459
2	@nhk_seikatsu	304824
3	@Asahi_Shakai	279259
4	@nhk_news	209515
5	@nhk_HORIJUN	173995
6	@tsuda	165434
7	@hayano	145436
8	@nhk_kabun	127916
9	@earthquake_jp	114806
10	@touhokujishin	112592

source, Tohoku Univ.

twitter is a

bi-directional media



Summer, 2011

contamination maps &
various monitoring results
became available -

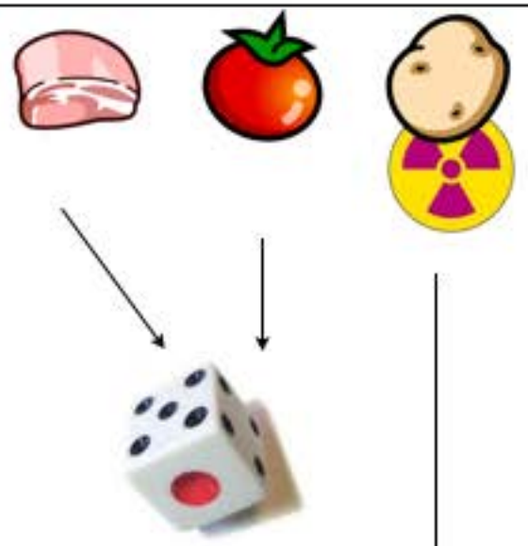
but

what about food safety?

what are kids eating?

Proposed to MEXT vice minister, 2011/9/21
Funded by MEXT, JFY 2012 & 2013

三次補正予算 食品のサンプル検査



簡易検査機による
サンプル検査

イメージ図と
ご理解下さい
特定の機器を
示すものでは
ありません

すり抜けても
分からない
という 不安

新規提案 給食一食まるごと検査

子供が食べたのと同じ物を丸ごと

ミキサーにかけて
マリネリ容器に詰め

イメージ図と
ご理解下さい
特定の機器を
示すものでは
ありません

ゲルマニウム検出器で
精密測定

Fukushima school lunch, 18% of the ingredients are local (~35% before the accident)

県産食材、震災前の半分

県、新年度から促進策

県内の学校給食

県内学校給食の本年度の県産食材活用率は18・3%で、東日本大震災前のほぼ半分にまで落ち込んでいることが24日、県教委の調査で分かった。食材の流通段階や給食提供時の放射性物質検査体制ができた一方、東京電力福島第1原発事故に伴う放射性物質への根強い不安が色濃く反映された。この状況を踏まえ、県教委と県は新年度、給食に県産食材を取り入れる市町村への支援、保護者への理解を促す取り組みを始める。

本県学校給食の県産食材活用率の推移
※11年度は実施せず

県教委は、給食を調理している小、中学校、共同調理場などを対象に前期（6月）と後期（11月）の2回、給食で使っている県産食材の使用率を調査、平均値をまとめた。県産食材使用率は毎年度調査しており、2010（平成22）年度は36・1%、近年はおおむね35%前後で推移して全国的に比較的高い水準だった。昨年度は震災の影響で中止したが、この2年間での落ち込みは著しい。

本年度調査結果を食材ごとに見ると、全袋検査が行われているコメなど穀類で半分が地元産だったが、大比べれば半減した。豆類23・2%、玉ネギやキャベツなど緑黄色以外の野菜は20・5%。果実類は8・1%で1割を切った。キノコ類は3・4%、魚介類も1・2%と低さが目立つ。

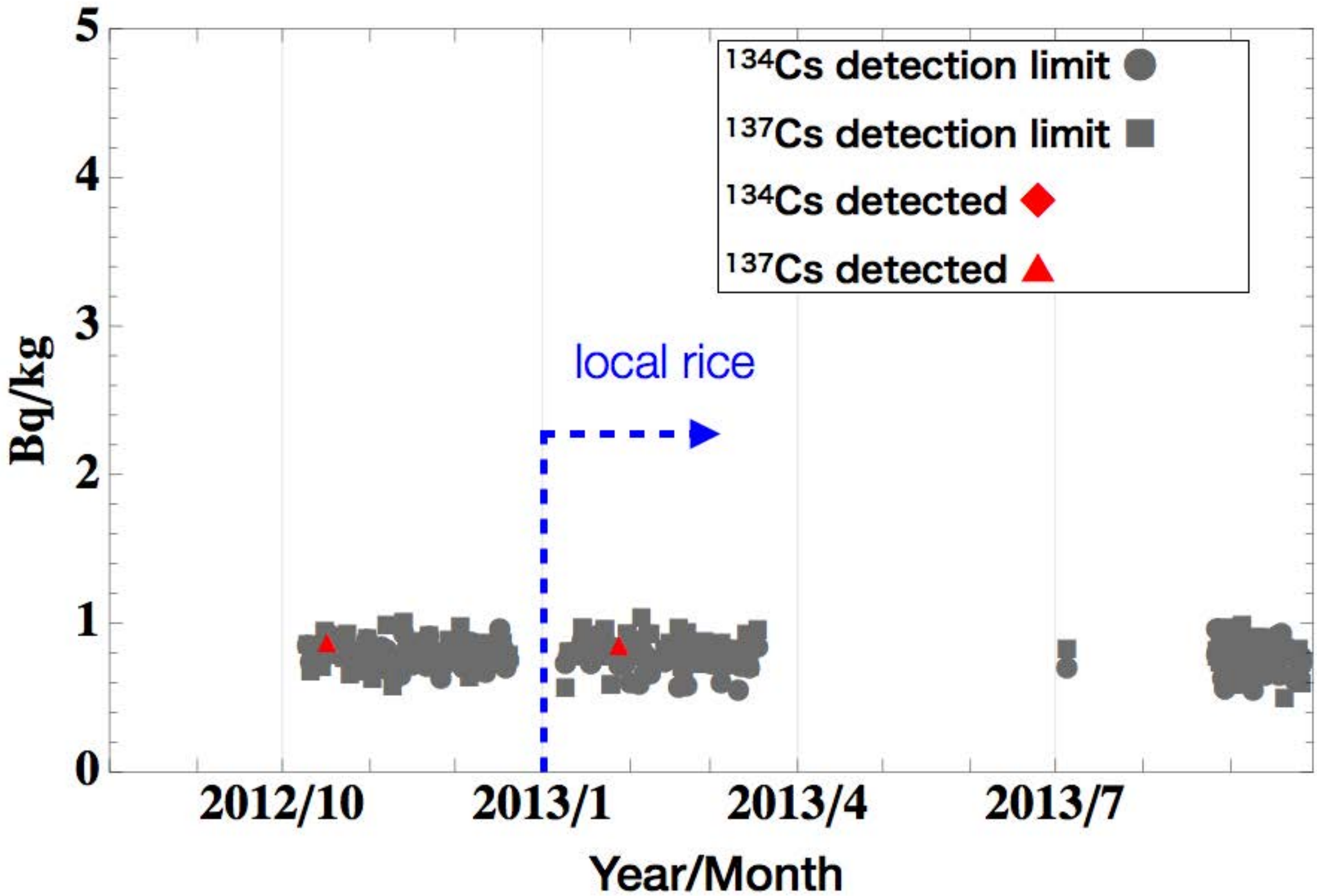
県教委によると、後期の県産使用率は20・1%で前期を3・5ポイント上回った。後期には、給食を提供する全市町村で、放射性物質検査体制が整備されたことが要因とみられる。

県が新年度、県産食材を給食に使う市町村に対し補助するのは食材購入費。各学期2回分を目標に補助する方針で、子どもたちに食材のルーツや育ち方などについての周知も図る。

また、県教委は授業参観などで保護者に、県産食材を使った給食メニューを紹介したり、食材の放射性物質検査を見てもらったりす

Feb 25, 2013
Fukushima Minyu
(Local paper)

^{134}Cs & ^{137}Cs in Fukushima city school lunch



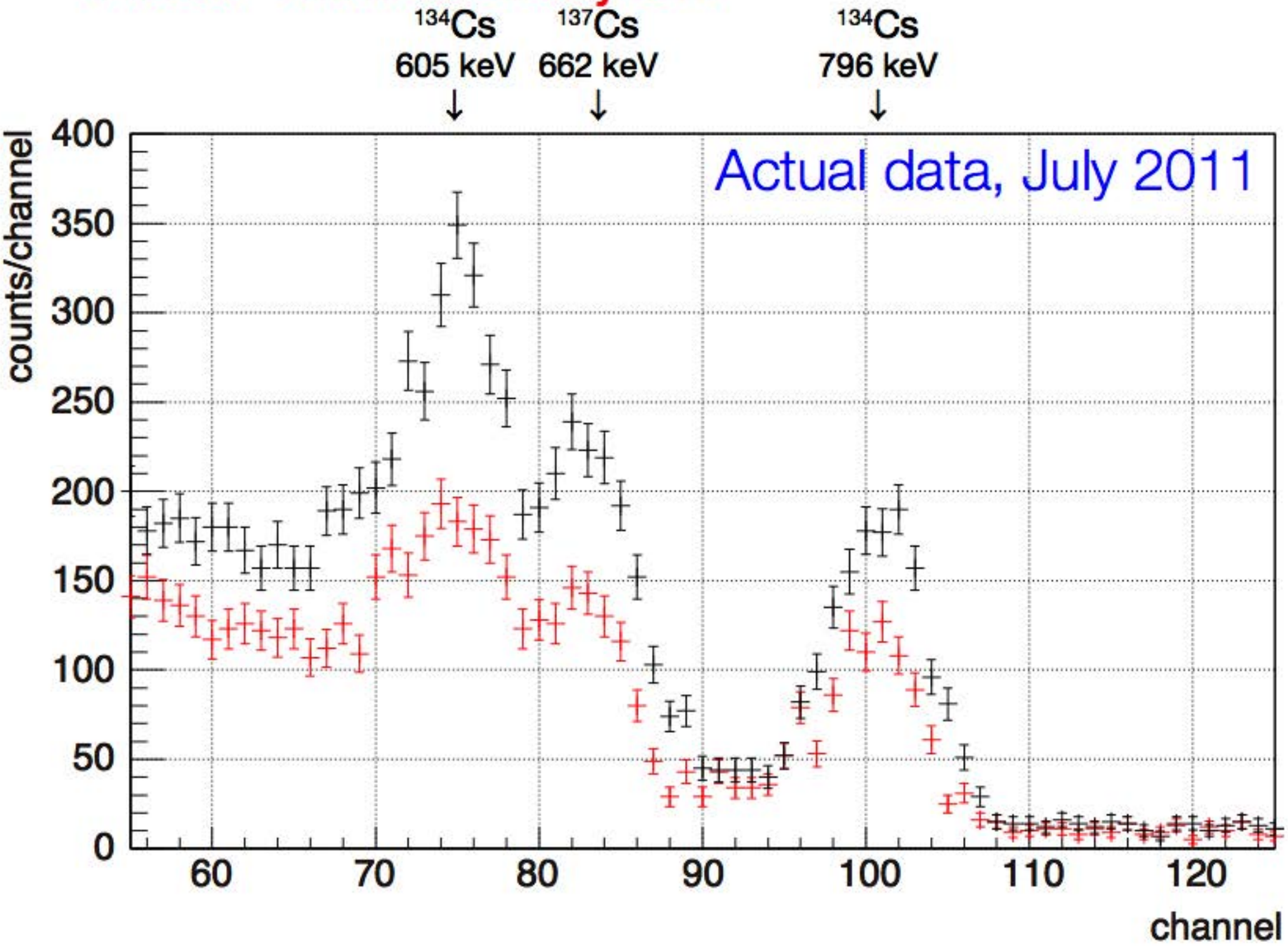
Helping MDs with WBC measurements (initially there were lots of confusions…)

The first WBC in Minami-Soma city hospital (23km north of Fukushima Dai-ichi) July 2011


南相馬
Minamisoma c.
福島第一
Fukushima
Dai-ichi
名取
名取川
岩沼
阿武隈川
上山
南陽
白石
角田
二王子岳
飯豊山
大日岳
米沢
伊達
相馬
西吾妻山
安達太良山
阿武隈川
二本松
本宮
田村
会津若松
沼沢湖
猪苗代湖
福島県
郡山
須賀川
旭岳
七ケ岳
那須岳
白河
阿武隈川
いわき
帝釈山
小名浜港
東北新幹線
13
6
49

Black: empty chair

Red: with a subject



Part 2

Internal Exposure
(daily ingestion of radiocesium)

Japanese radiocesium regulations

2011 Mar 17 ~

○ **Provisional regulation values for radioactive cesium[1]**

Category	Limit
Drinking water	200
Milk, dairy products	200
Vegetables	500
Grains	
Meat, eggs, fish, etc.	

Bq/kg

2012 Apr 1 ~

○ **New standard limits for radioactive cesium [2]**

Category	Limit
Drinking water	10
Milk	50
General Foods	100
Infant Foods	50

Bq/kg

Ministry of Health, Labour and Welfare

Fukushima soil : Cs - Sr - Pu ratio

Cs	Sr	Pu
10^7	**10^4**	**10**

Nuclides	Half life	max conc. *1 (Bq/m^2)
Cs-134	2 y	1.4×10^7
Cs-137	30 y	1.5×10^7
I-131	8 d	5.5×10^4
Sr-89	50 d	2.2×10^4
Sr-90	29 y	5.7×10^3
Pu-238	88 y	4.0
Pu 239+240	2.4x10^4 y	15.0
Ag 110m	250d	8.3×10^4
Te 129m	34d	2.7×10^6

*1：平成 23 年 6 月 14 日時点に

Fukushima c.
Pop. 290k

Koriyama c.
Pop. 340k

凡例
Cs - 137 の沈着量
(Bq / m²)
[11月5日現在の値に換算]
3000k <
1000k - 3000k
600k - 1000k
300k - 600k
100k - 300k
60k - 100k
30k - 60k
10k - 30k
≦ 10k
測定結果が得られていない範囲
0 10 20 km

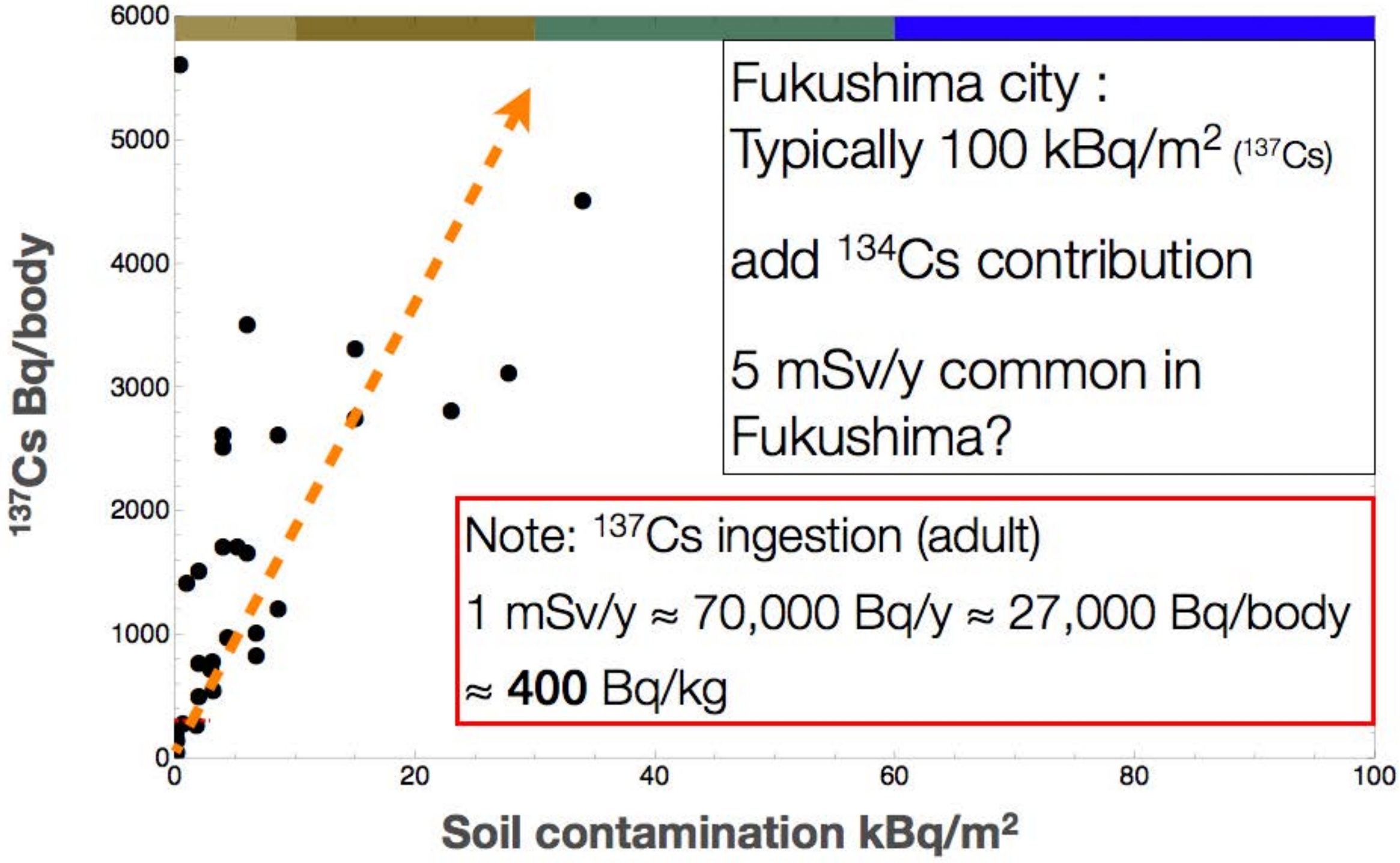
20km
30km

福島県

^{137}Cs deposition (2011/11/5)

3000k <
1000k - 3000k
600k - 1000k
300k - 600k
100k - 300k
60k - 100k
30k - 60k
10k - 30k
≦ 10k

UNSCEAR 1988:
100kBq/m² → 2 mSv/y internal exposure



Fukushima city :
Typically 100 kBq/m² (^{137}Cs)

add ^{134}Cs contribution

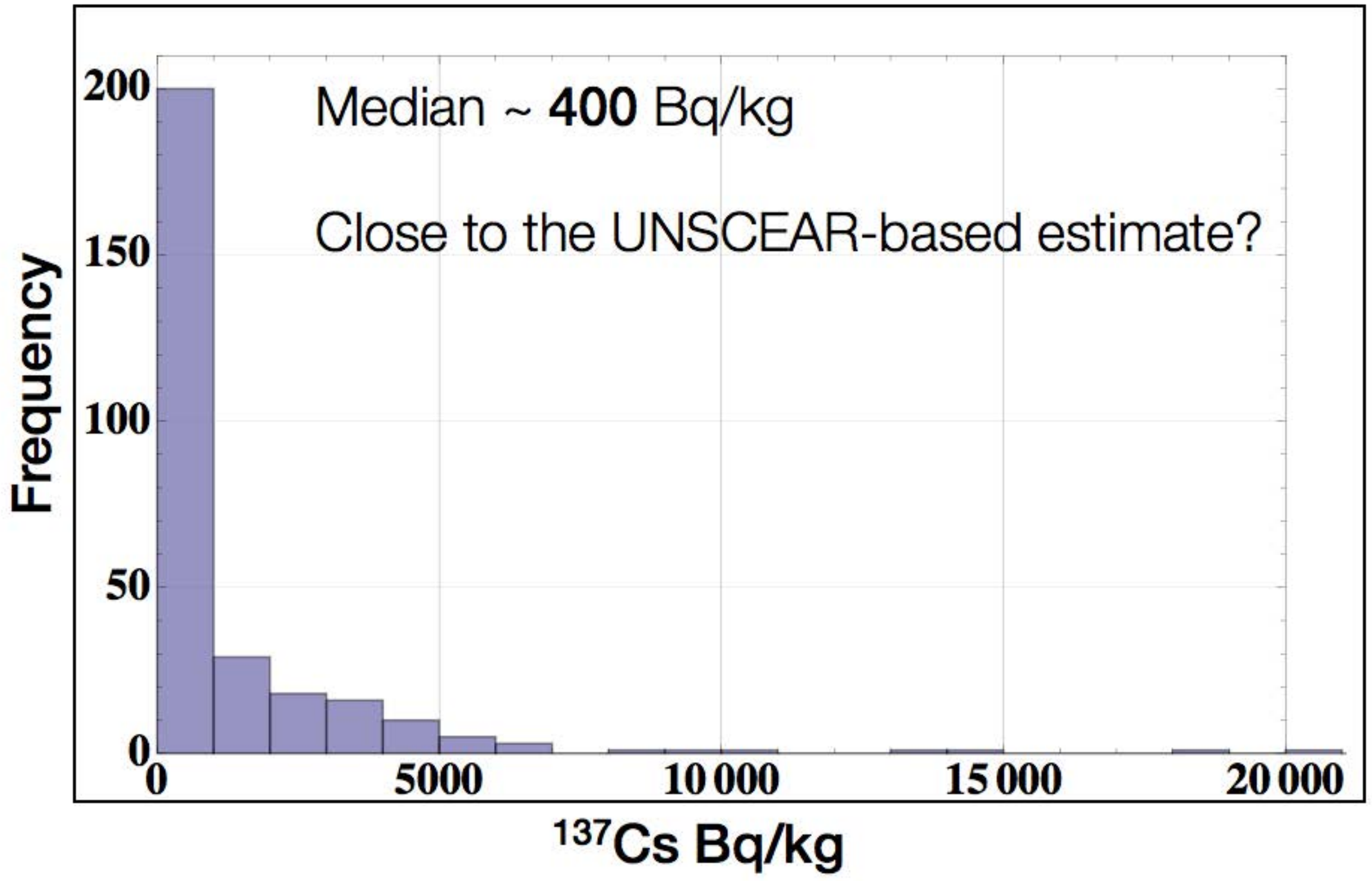
5 mSv/y common in Fukushima?

Note: ^{137}Cs ingestion (adult)

1 mSv/y ≈ 70,000 Bq/y ≈ 27,000 Bq/body

≈ **400** Bq/kg

Wild boar in Fukushima (2011-2013)



Internal radiocesium contamination of adults and children in Fukushima 7 to 20 months after the Fukushima NPP accident as measured by extensive whole-body-counter surveys

By Ryugo S. HAYANO,[*1,†] Masaharu TSUBOKURA,[*2] Makoto MIYAZAKI,[*3] Hideo SATOU,[*4] Katsumi SATO,[*4] Shin MASAKI[*4] and Yu SAKUMA[*4]

(Communicated by Toshimitsu YAMAZAKI, M.J.A.)

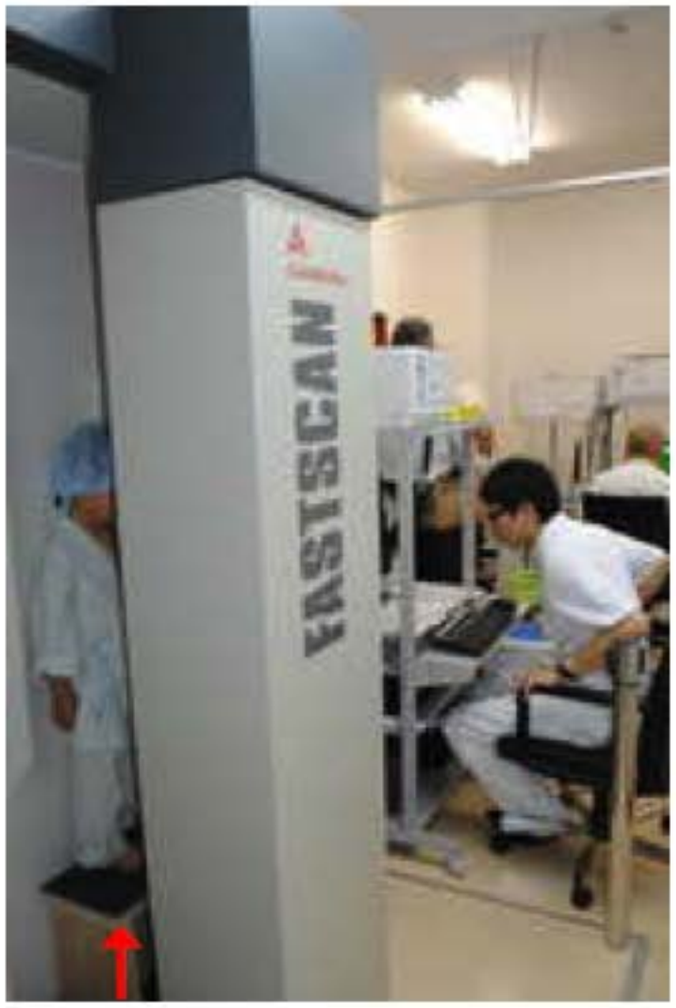
Abstract: The Fukushima Dai-ichi NPP accident contaminated the soil of densely-populated regions in Fukushima Prefecture with radioactive cesium, which poses significant risks of internal and external exposure to the residents. If we apply the knowledge of post-Chernobyl accident studies, internal exposures in excess of a few mSv/y would be expected to be frequent in Fukushima.

Extensive whole-body-counter surveys ($n = 32{,}811$) carried out at the Hirata Central Hospital between October, 2011 and November, 2012, however show that the internal exposure levels of residents are much lower than estimated. In particular, the first sampling-bias-free assessment of the internal exposure of children in the town of Miharu, Fukushima, shows that the ^{137}Cs body burdens of all children ($n = 1{,}383$, ages 6–15, covering 95% of children enrolled in town-operated schools) were below the detection limit of 300 Bq/body in the fall of 2012. These results are not conclusive for the prefecture as a whole, but are consistent with results obtained from other municipalities in the prefecture, and with prefectural data.

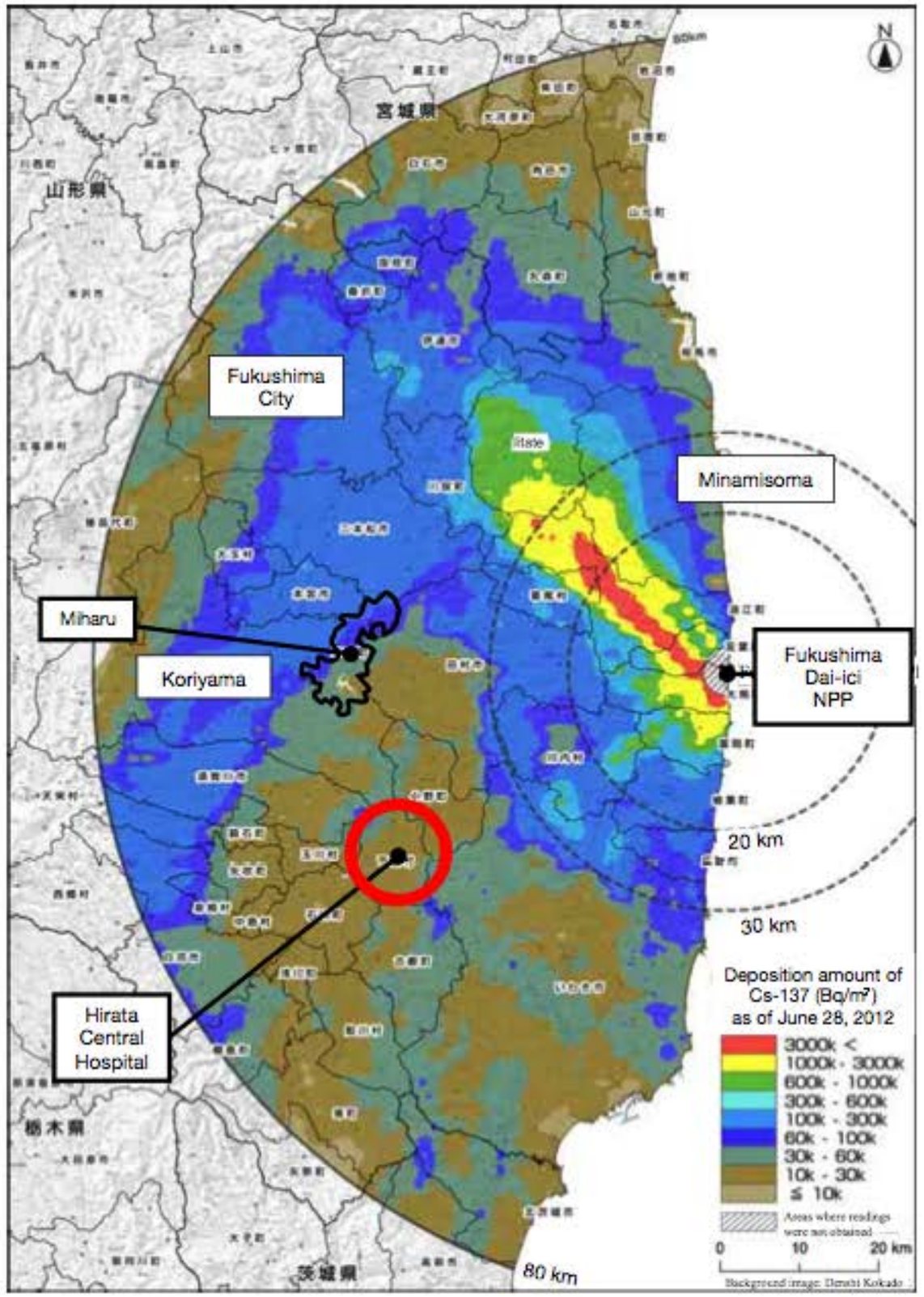
Keywords: Fukushima Dai-ichi NPP accident, radioactive cesium, whole-body counting, committed effective dose

WBC measurement at Hirata Central Hospital

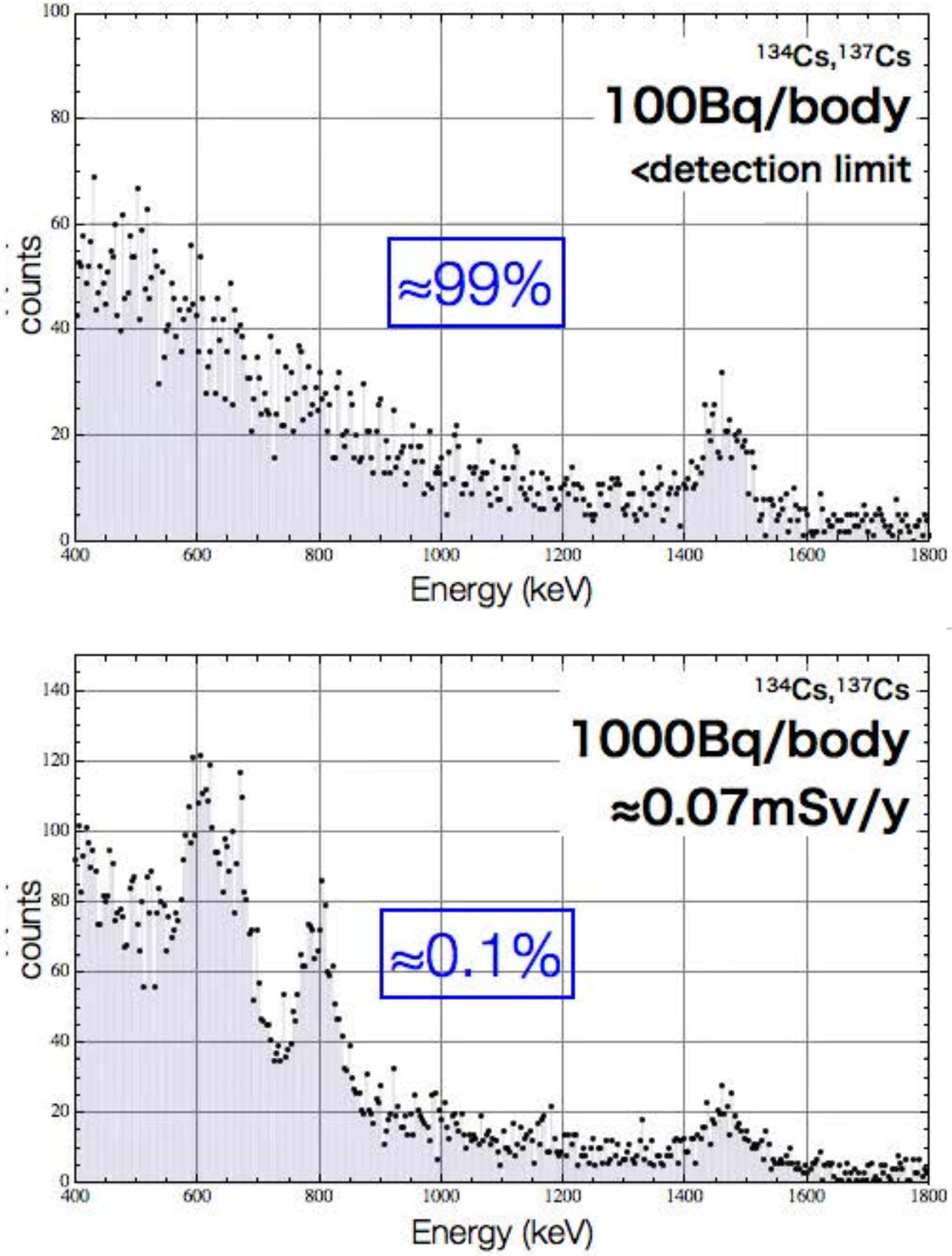
- FASTSCAN (2-min)
- Detection limit 300 Bq/body
  ≈0.02mSv/y ≈ 10% of ^{40}K
- Use step (for children)

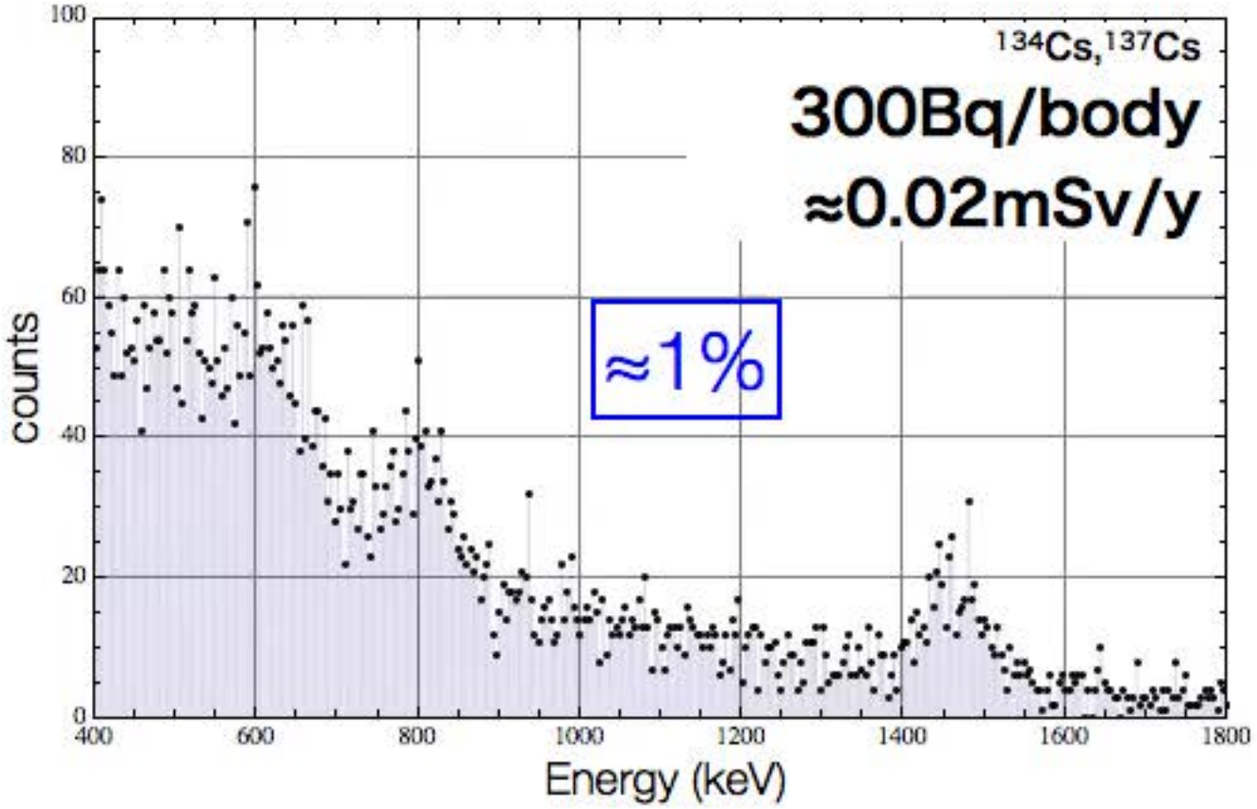


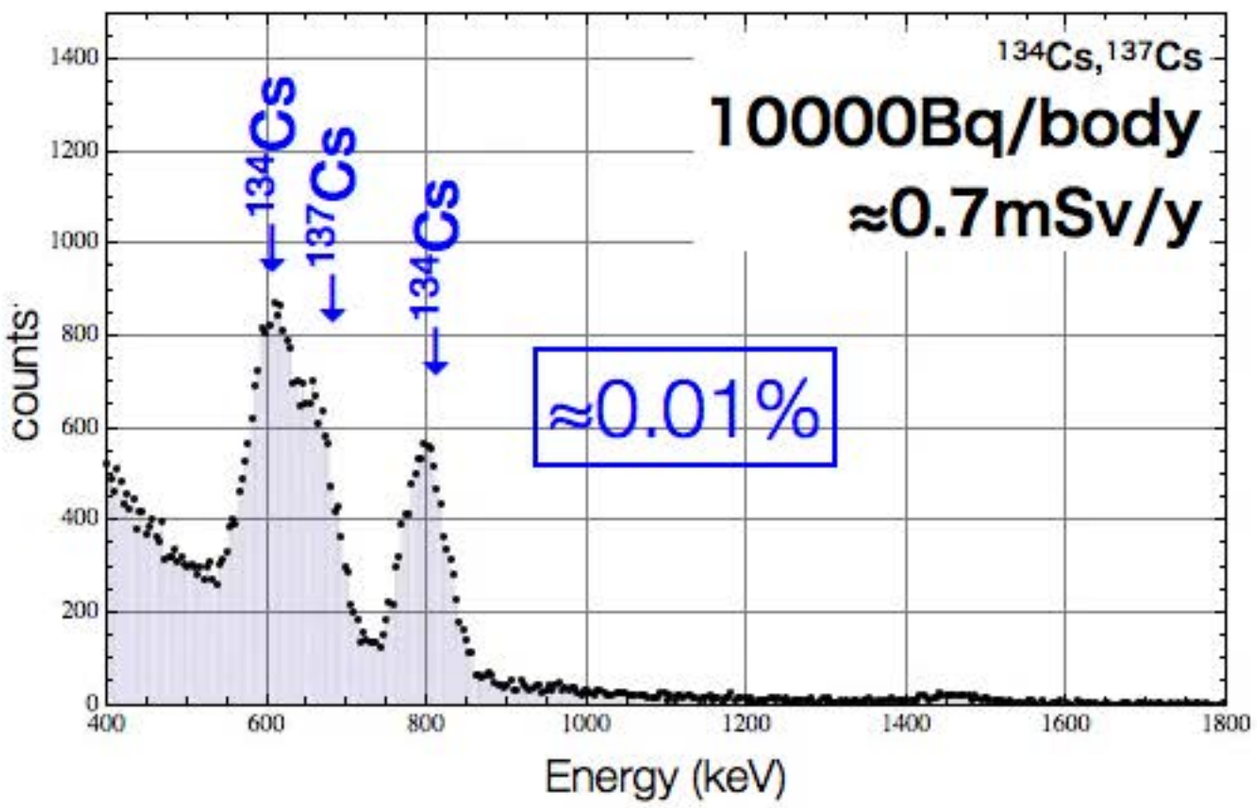
step



WBC spectra (simulations based on actual data)

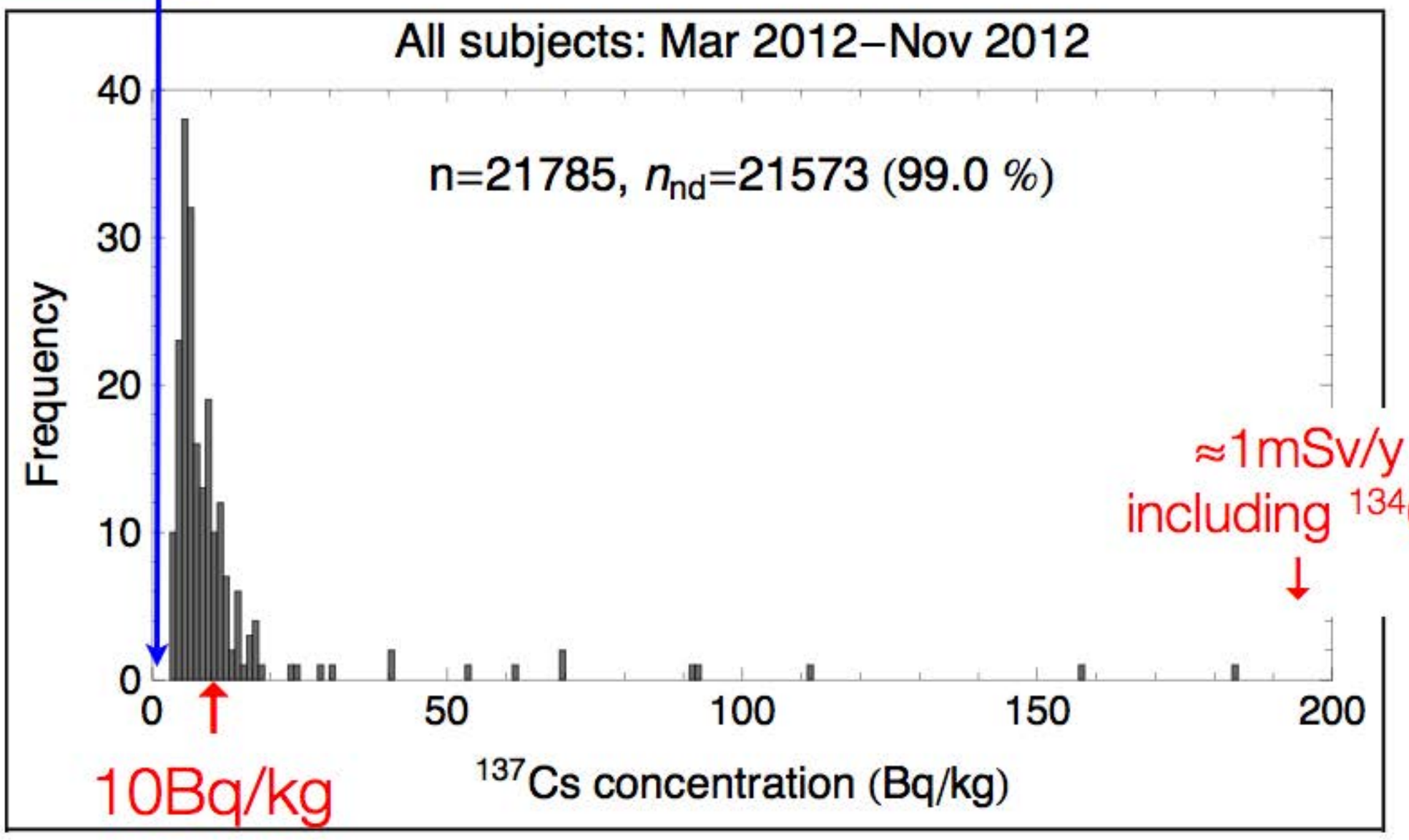




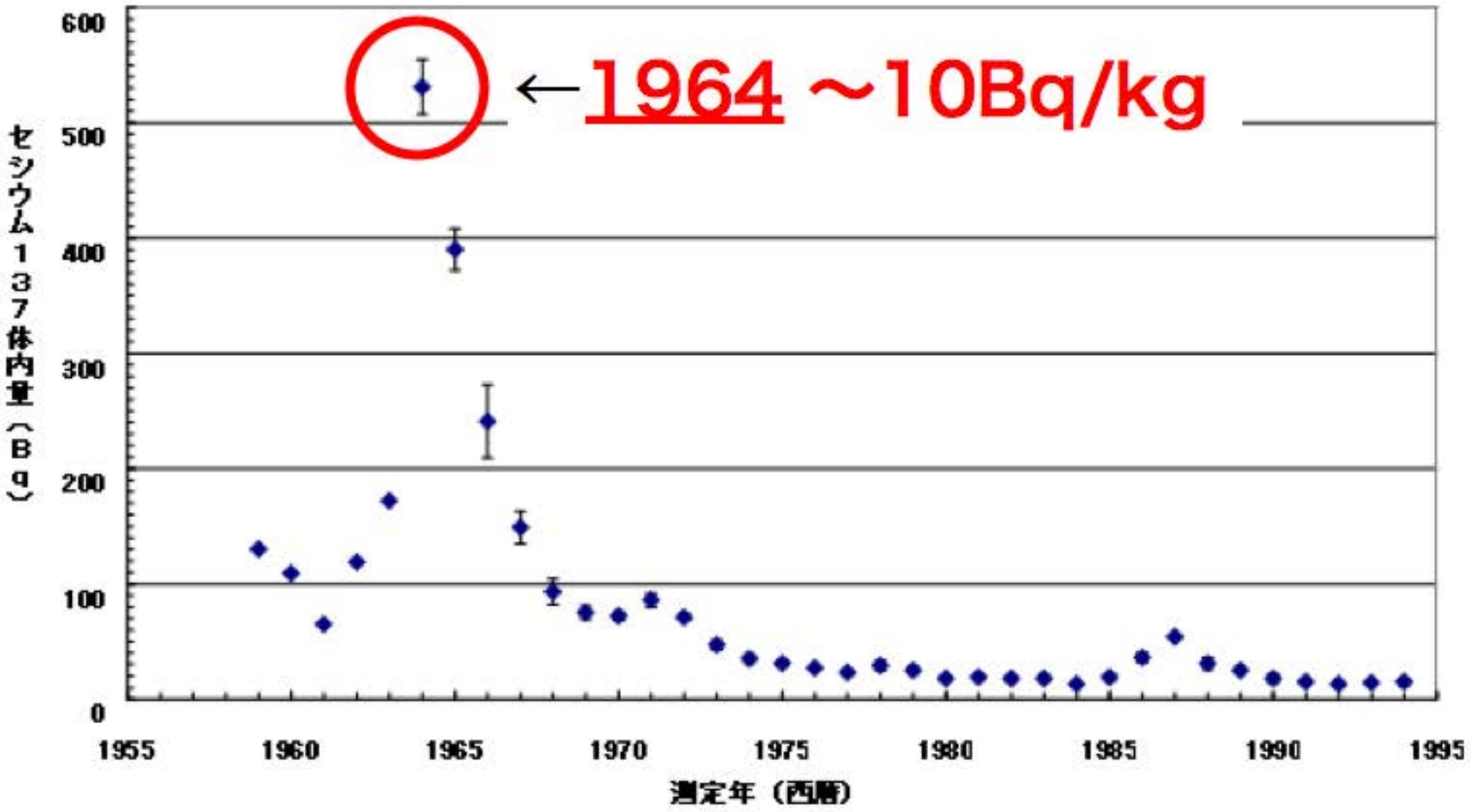


^{137}Cs concentration (Bq/kg) after March 2012

99% were ND



^{137}Cs in Japanese adult male, 1959-1994



（1959－1994）

Health Physics 71, 322 （1996）

Fukushima City

Iitate

Minamisoma

Miharu

Koriyama

Fukushima Dai-ici NPP

Hirata Central Hospital

20 km

30 km

Deposition amount of Cs-137 (Bq/m^2) as of June 29, 2012

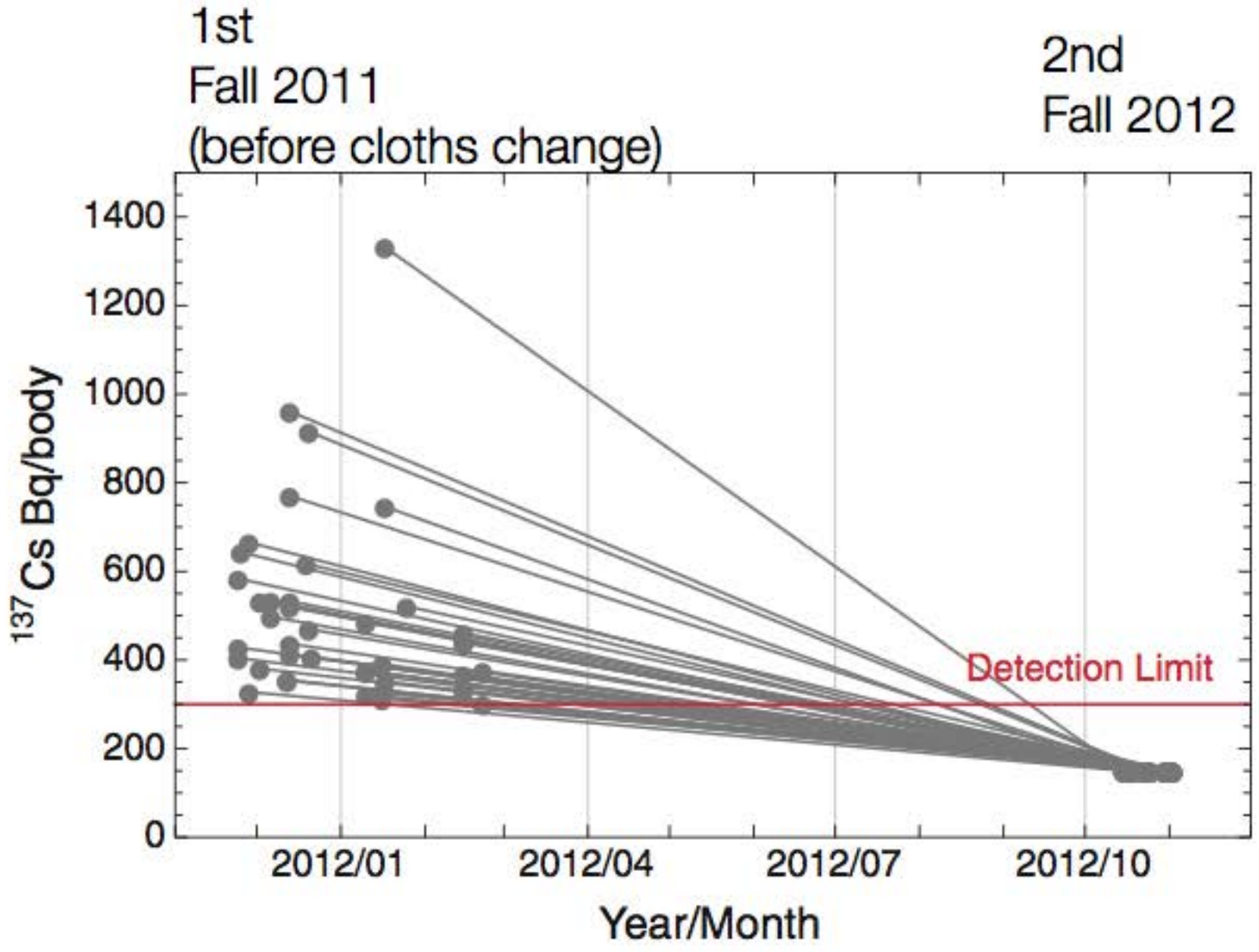
3000k <

1000k - 3000k

Miharu-town school children

data without “sampling bias”

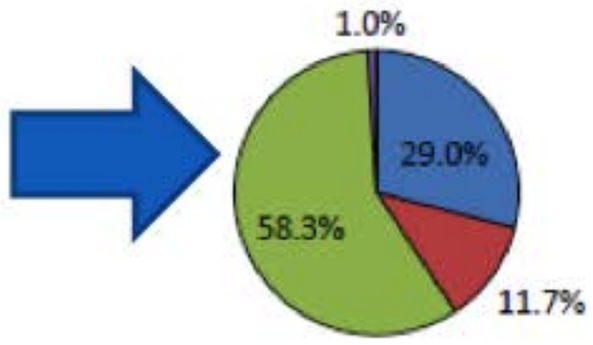
Enrolled in August 25, 2011	Measured in Winter 2011	Coverage	^{137}Cs detected	Enrolled in April 1, 2012	Measured in Fall 2012	Coverage	^{137}Cs detected
1,585	1,494	94.3%	54	1,456	1,383	95.0%	0



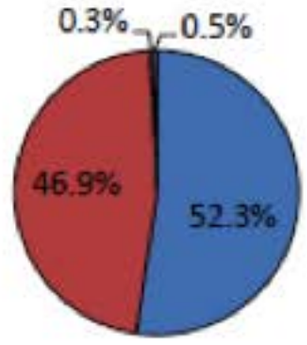
Miharu-town children are eating local rice & vegetables

http://www.town.miharu.fukushima.jp/soshiki/11/kensakekka-kouhyo.html

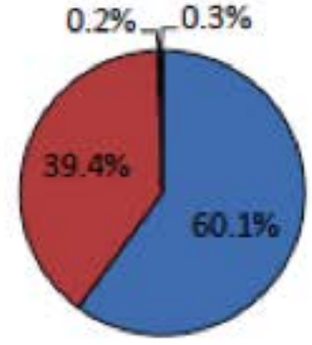
Rice



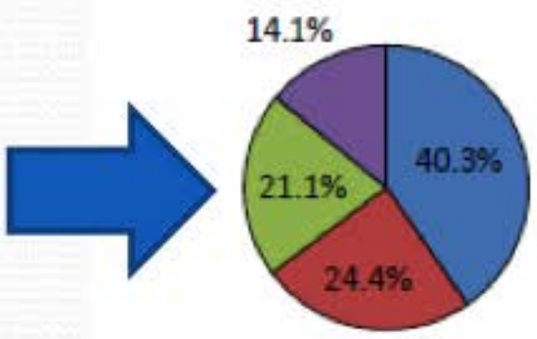
Meat



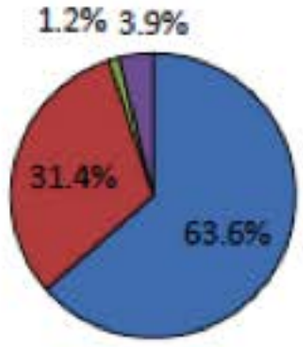
Fish



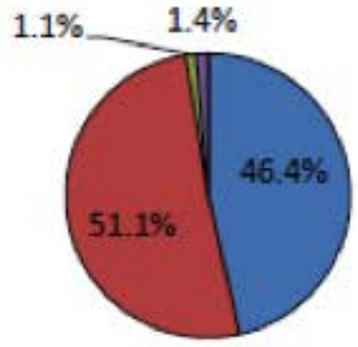
Vegetables



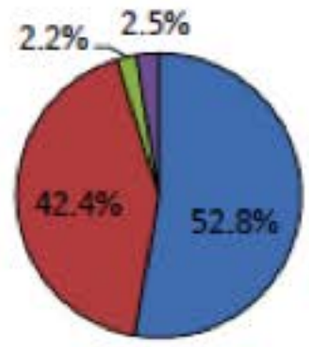
Mushrooms



Milk



Fruit



supermarket
avoid local food

supermarket
also buy local food

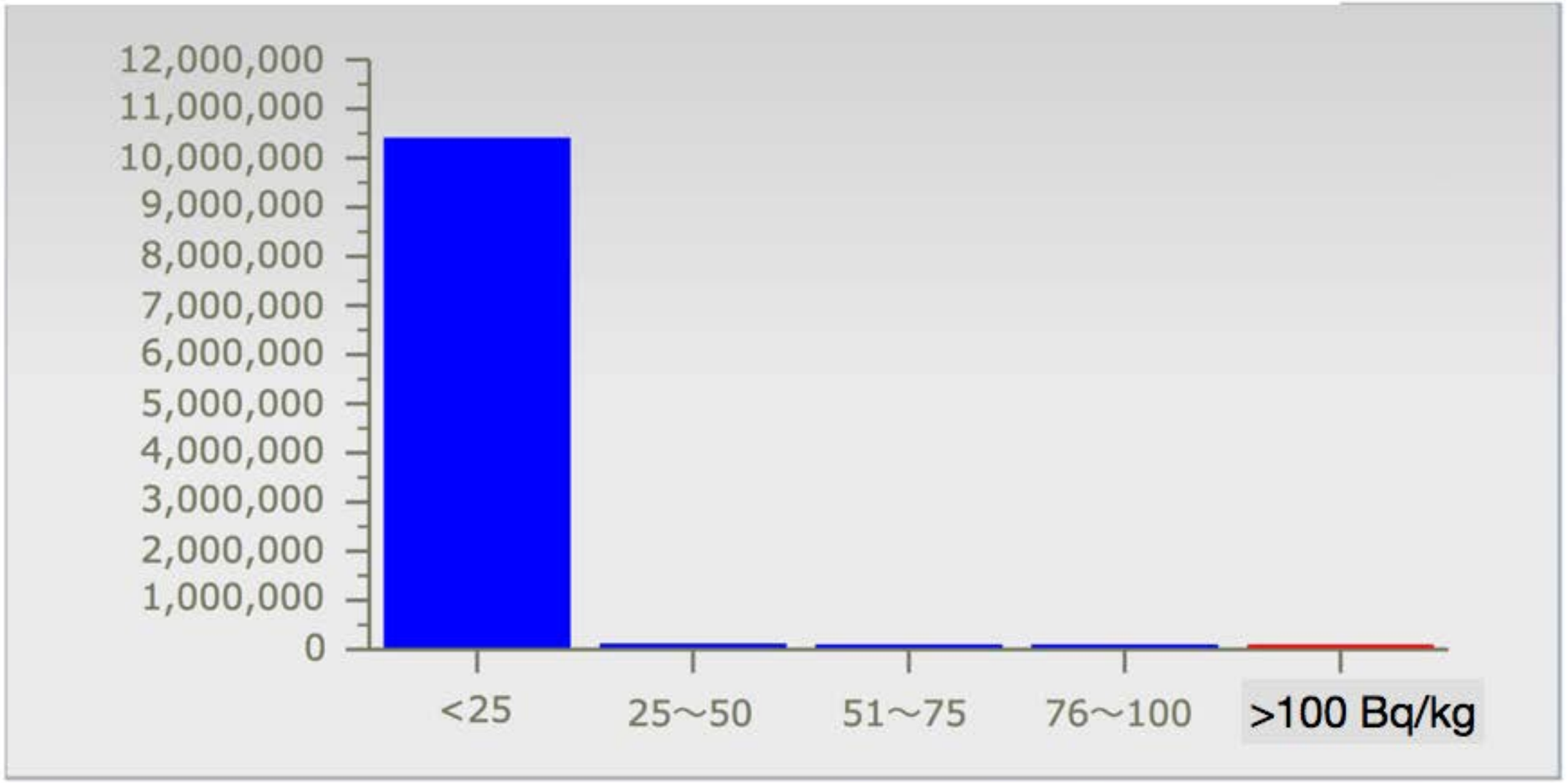
home-grown

other

Why?

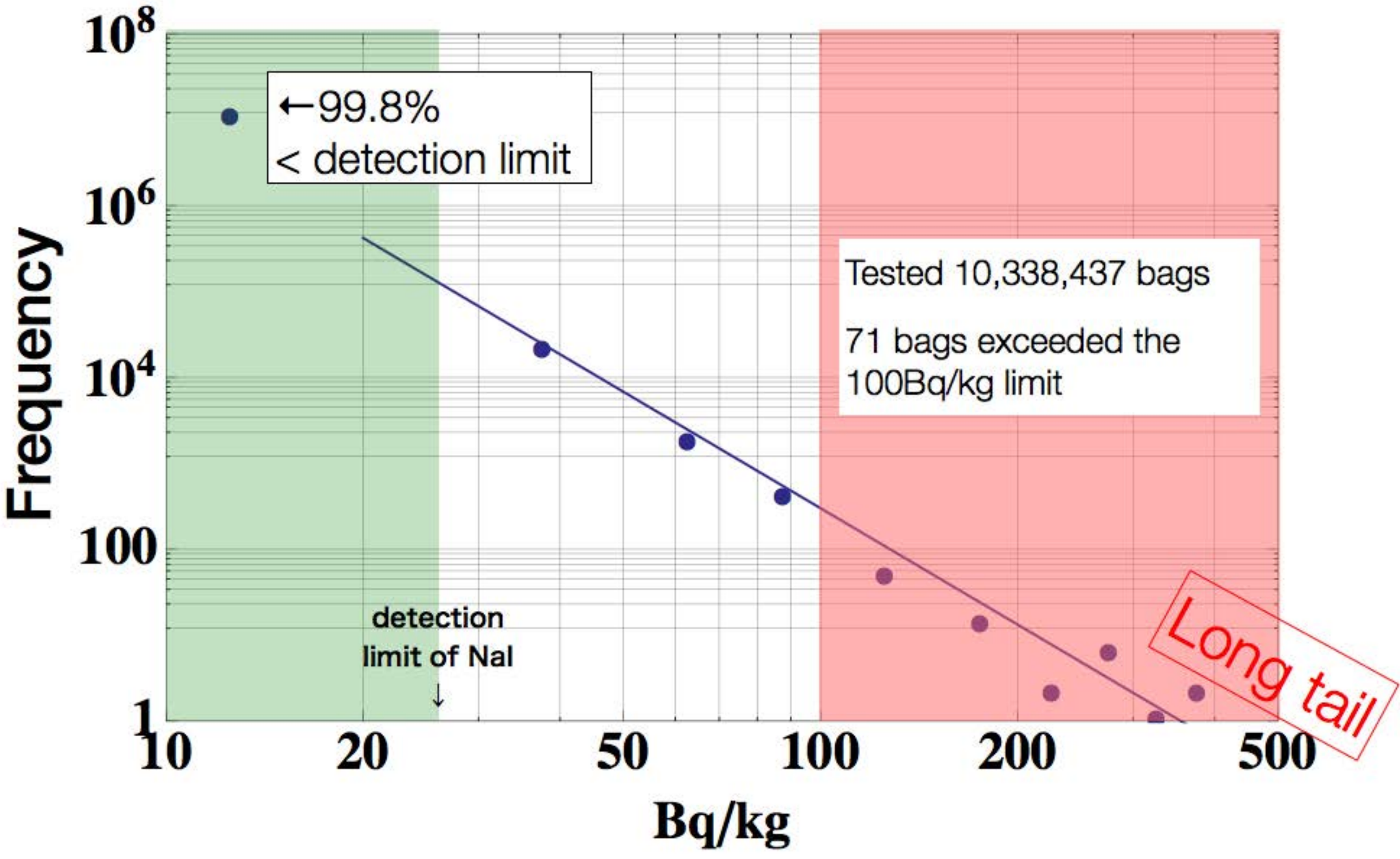
Every bag (30kg each) of brown-rice harvested in Fukushima in 2012 tested for radiocesium

Total 10,338,437 bags

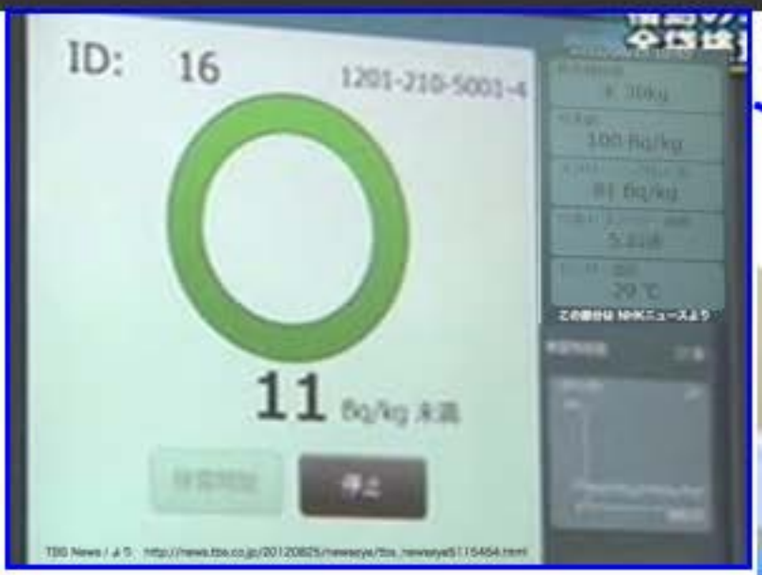


https://fukumegu.org/ok/kome/

Same data in log-log plot



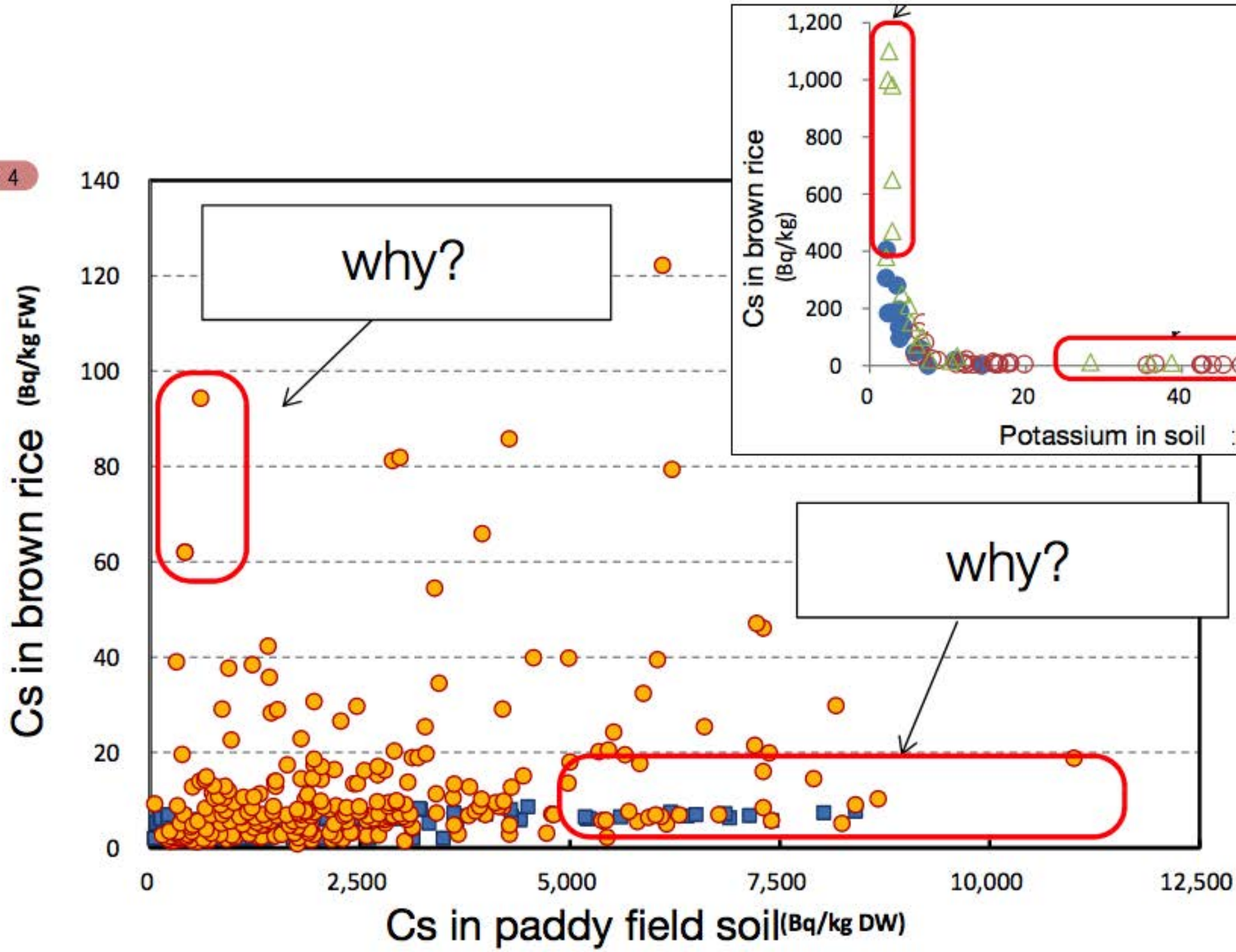
How the rice bags are measured



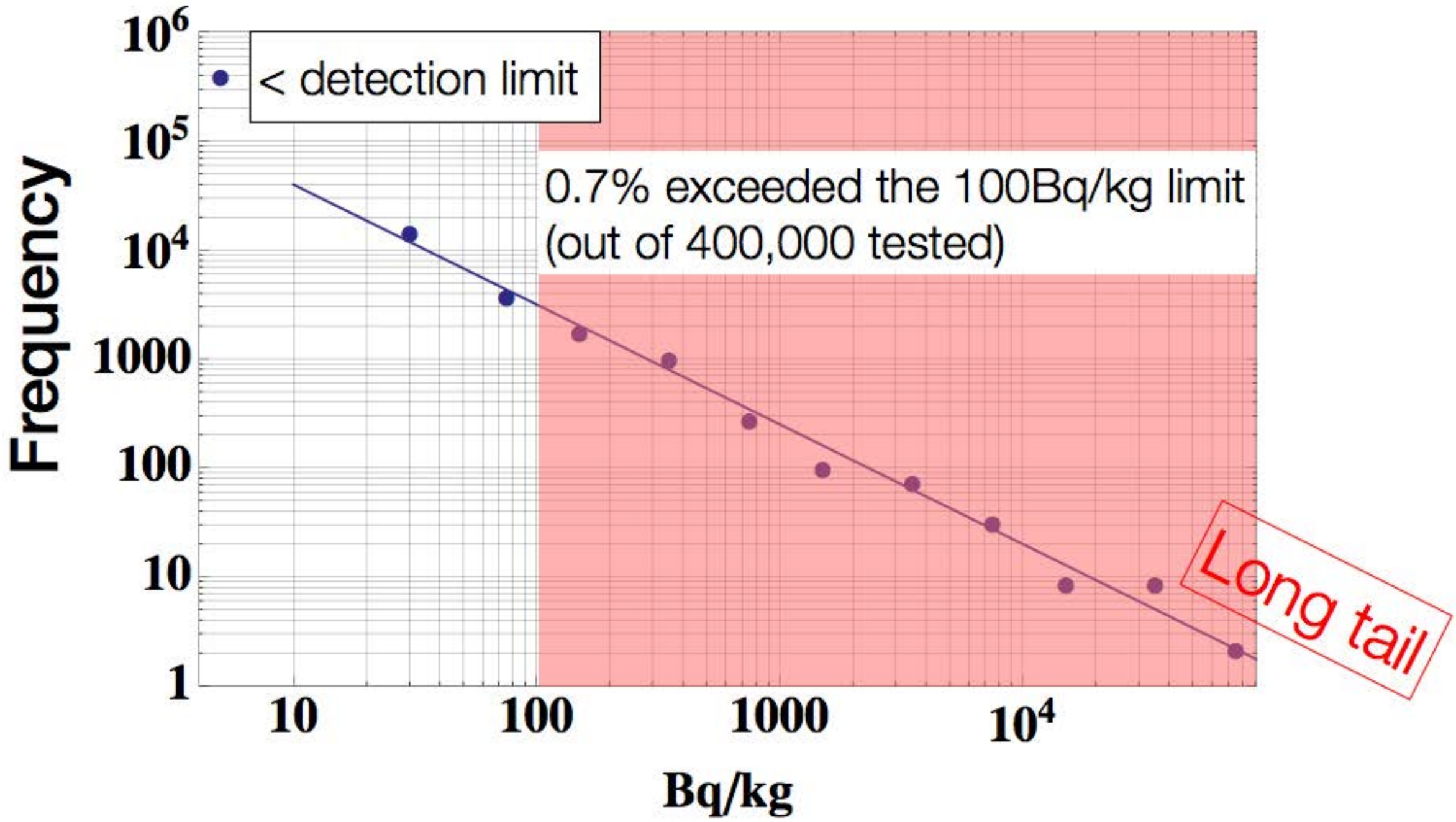
SHIMADZU
Excellence in Science

Soil → rice transfer factor

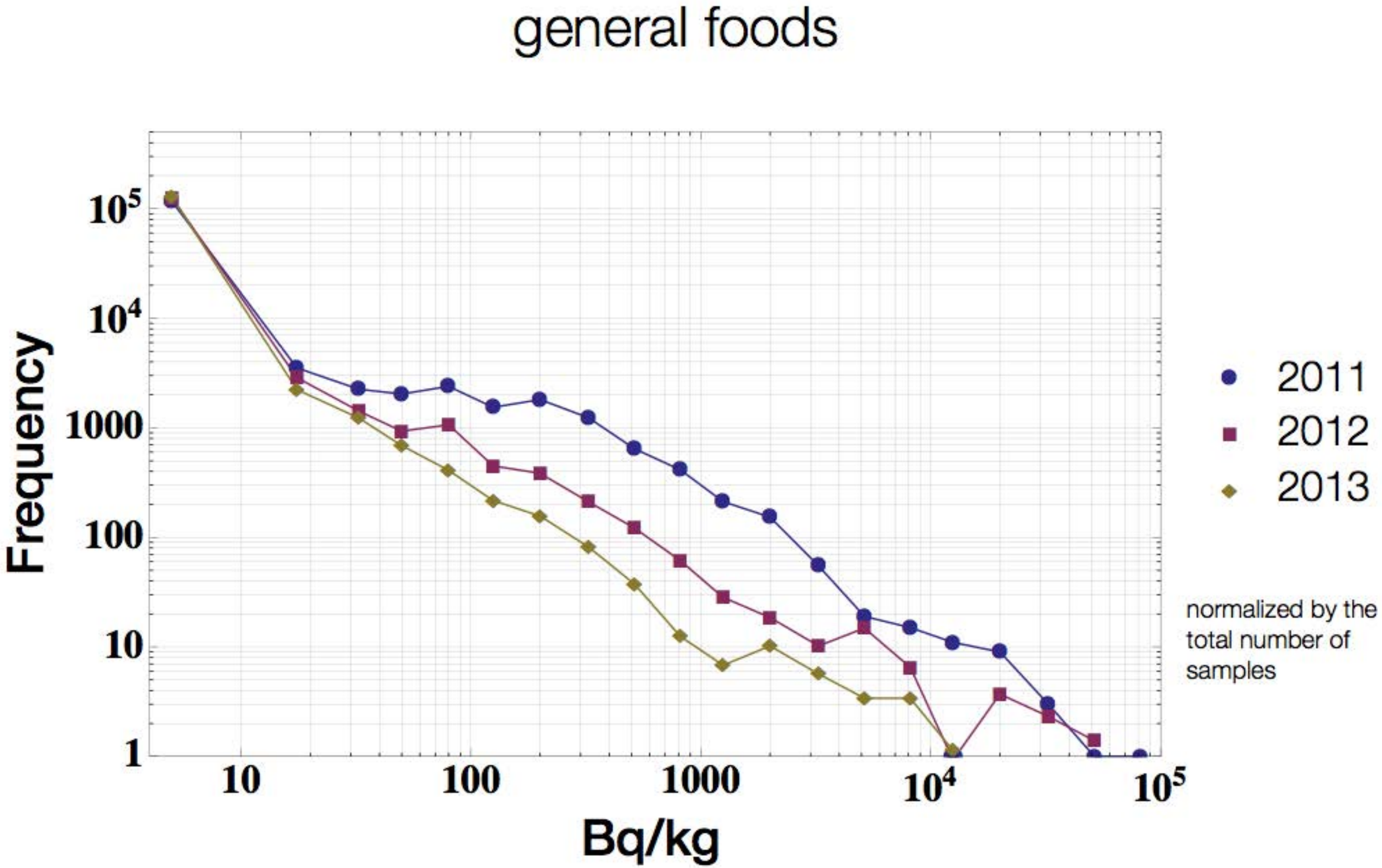
図 4



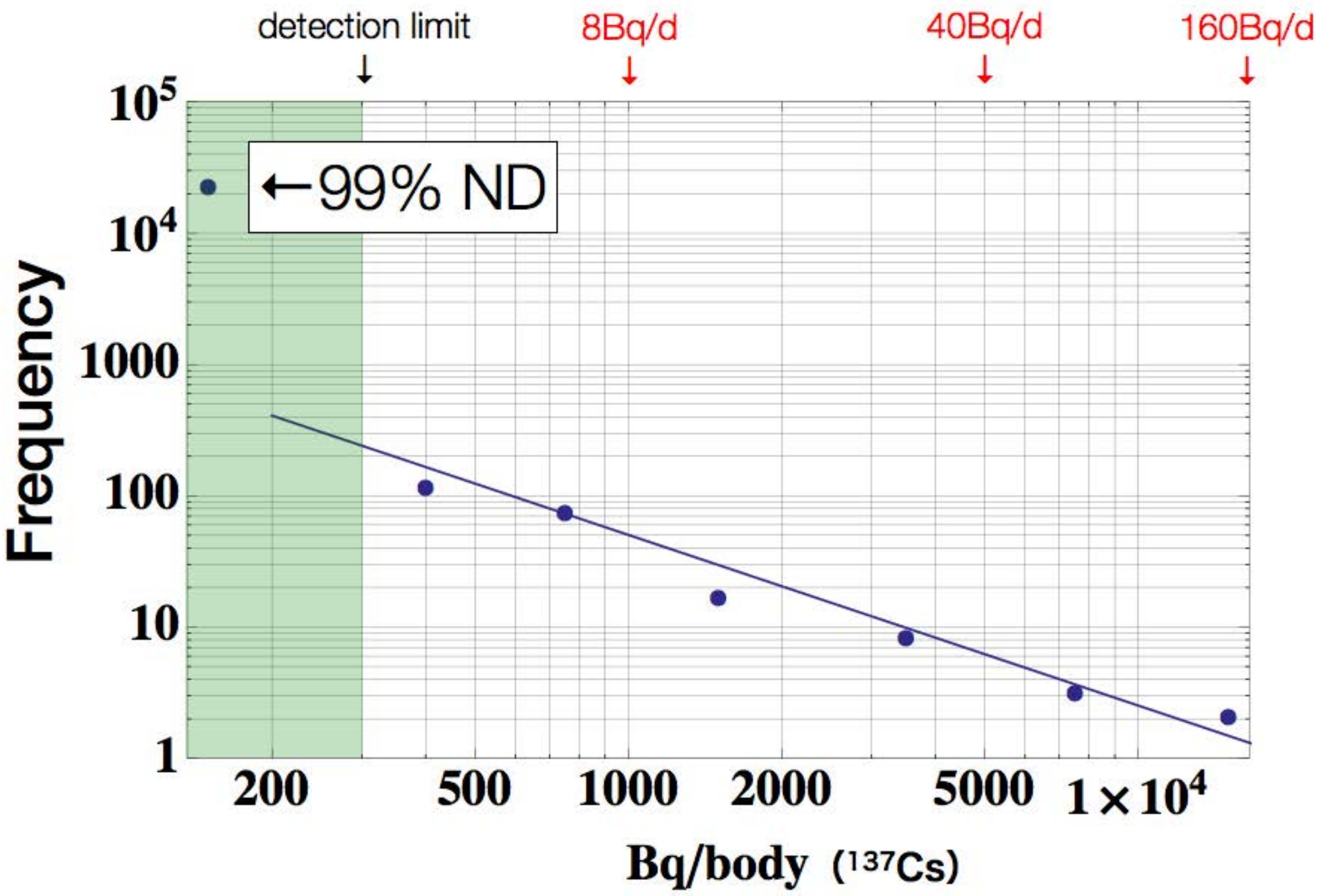
Test results of general foods
(2012 Apr ~ , pre-marketing tests)



The tail is getting shorter, 2011-2013

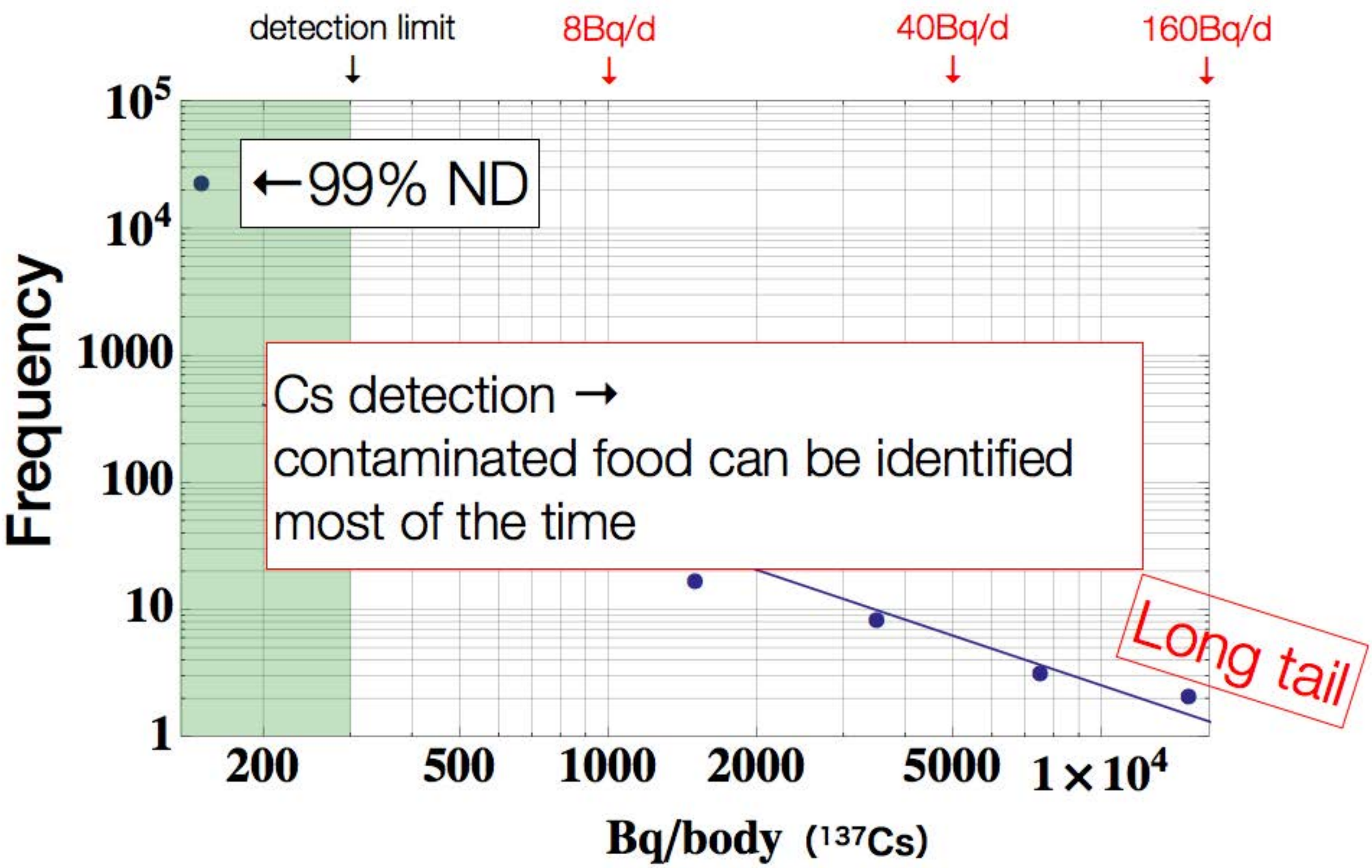


Hirata-hospital WBC results in log-log plot



Hayano et al.

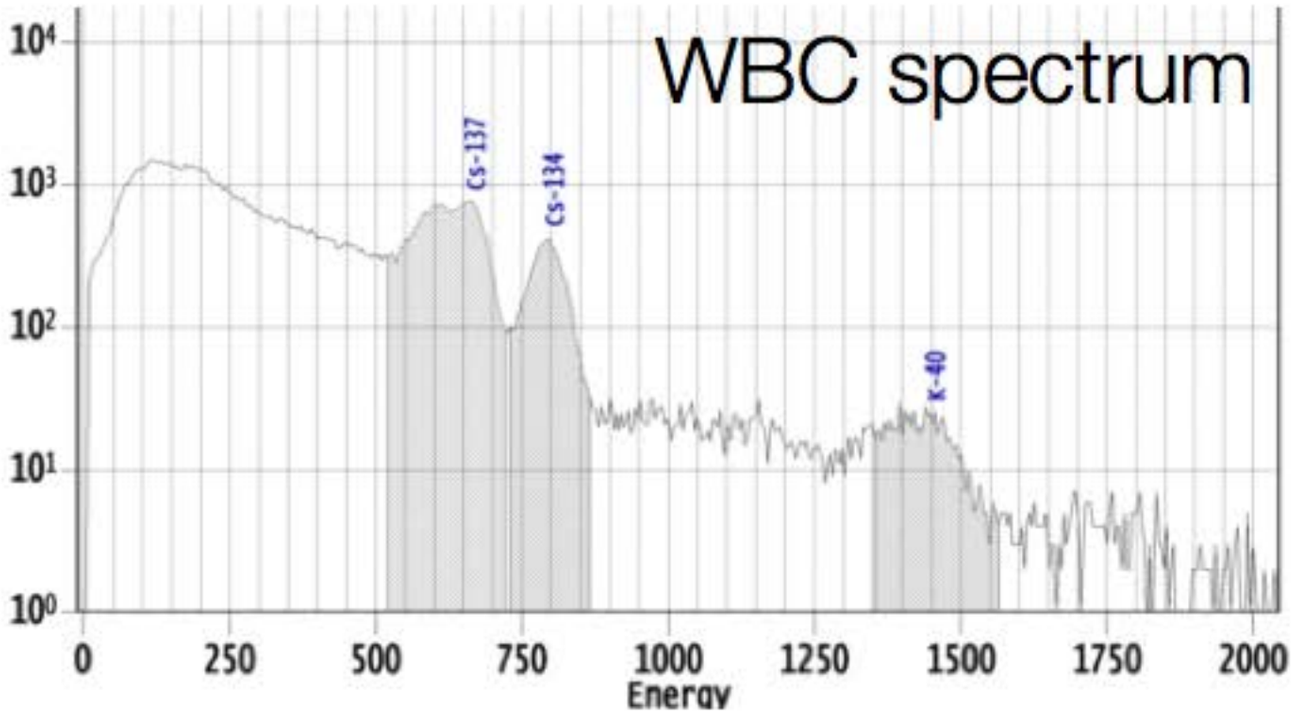
Hirata-hospital WBC results in log-log plot



Hayano et al.

70-male, 20,000Bq/body, 0.8mSv/y

140,000 Bq/kg mushroom was found in his pantry



Shiitake mushroom

Wild boar, wild mushrooms, …,

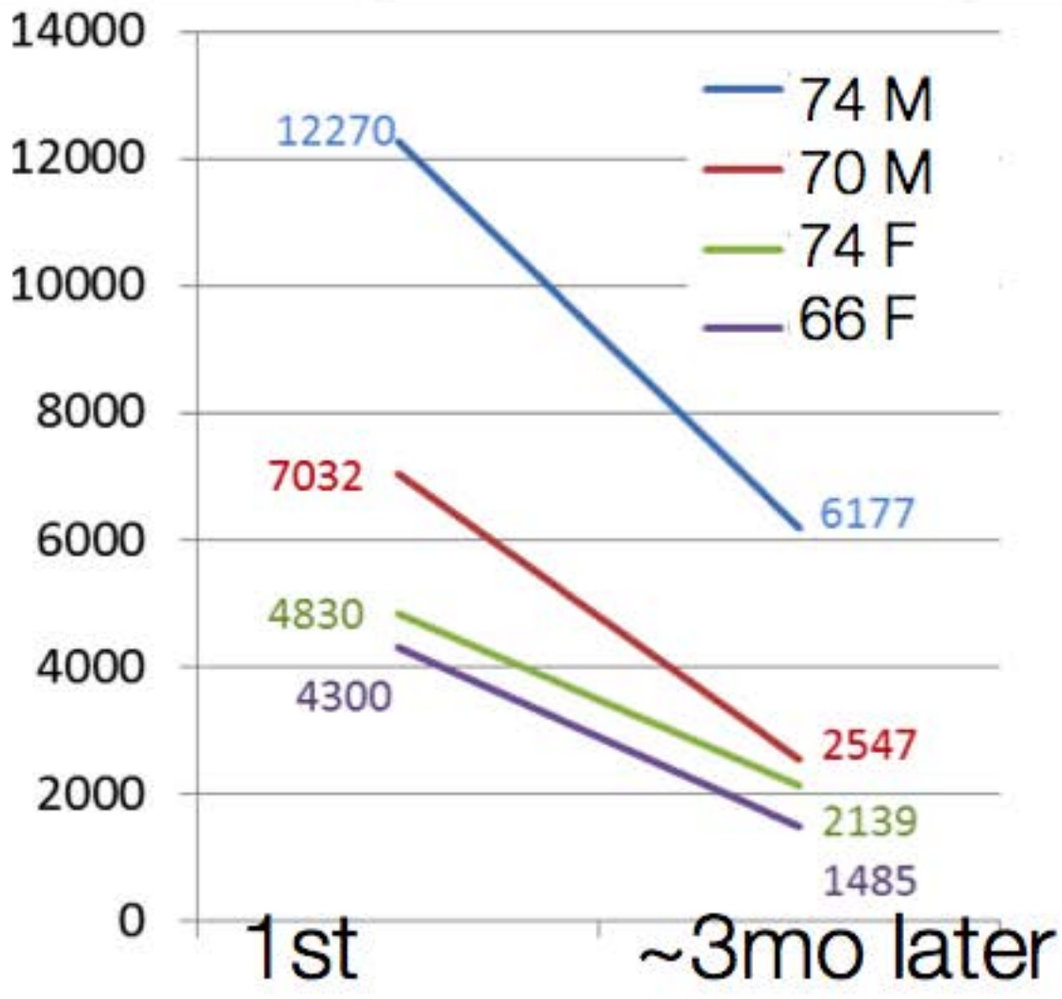
not from markets

not tested for radiocesium

consumed regularly

Such people are rare (~ 0.01%)

Age	Sex	Resident of	First measurement	^{137}Cs (Bq/body)	^{137}Cs (Bq/kg)
74	M	Nihonmatsu	2012.8	12,270	183.7
70	M	Kawamata	2012.7	7,032	111.6
74	F	Nihonmatsu	2012.8	4,830	69.4
66	F	Kawamata	2012.7	4,300	69.6

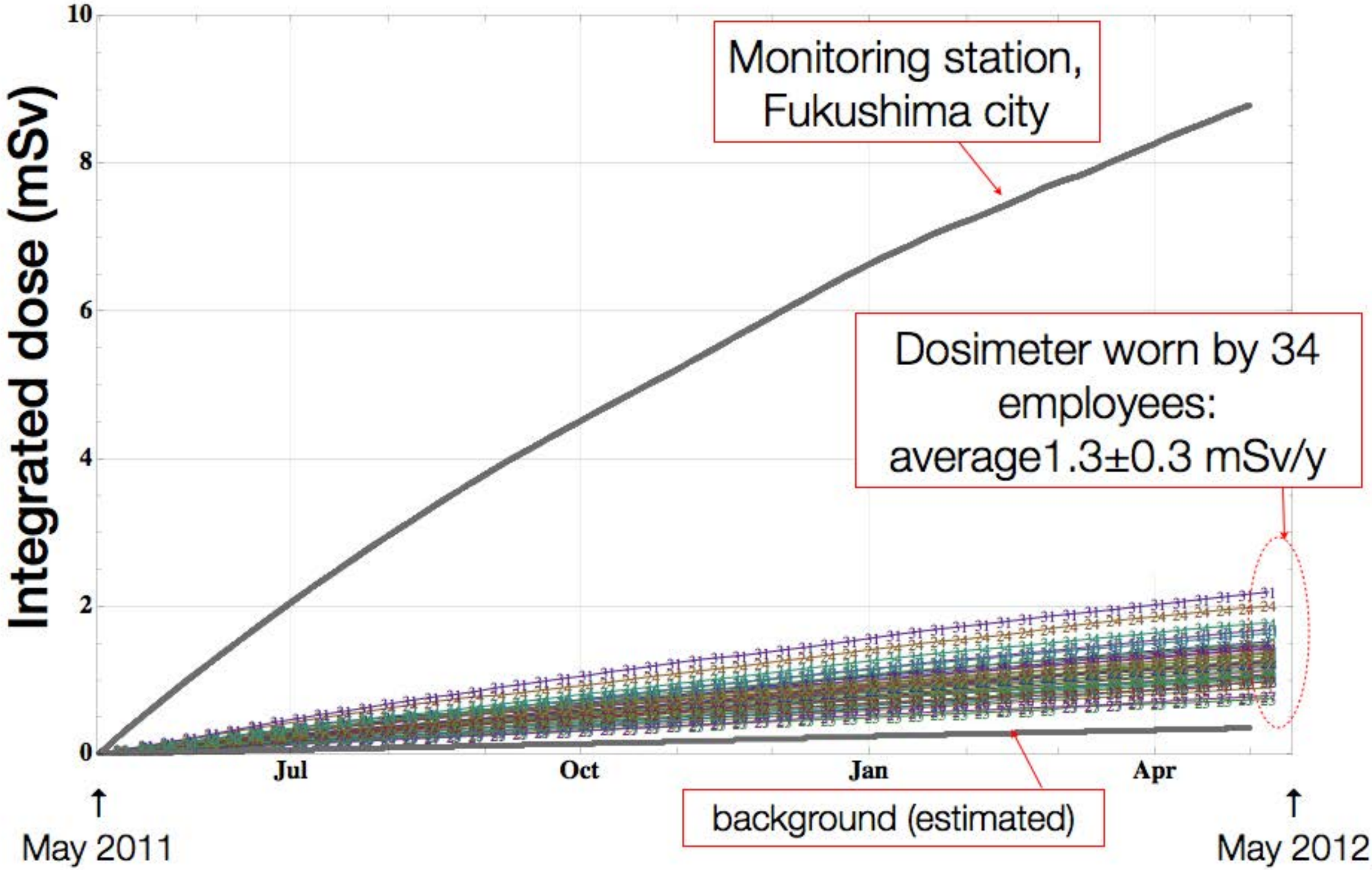


←after receiving advice, the Cs concentration decreased as expected

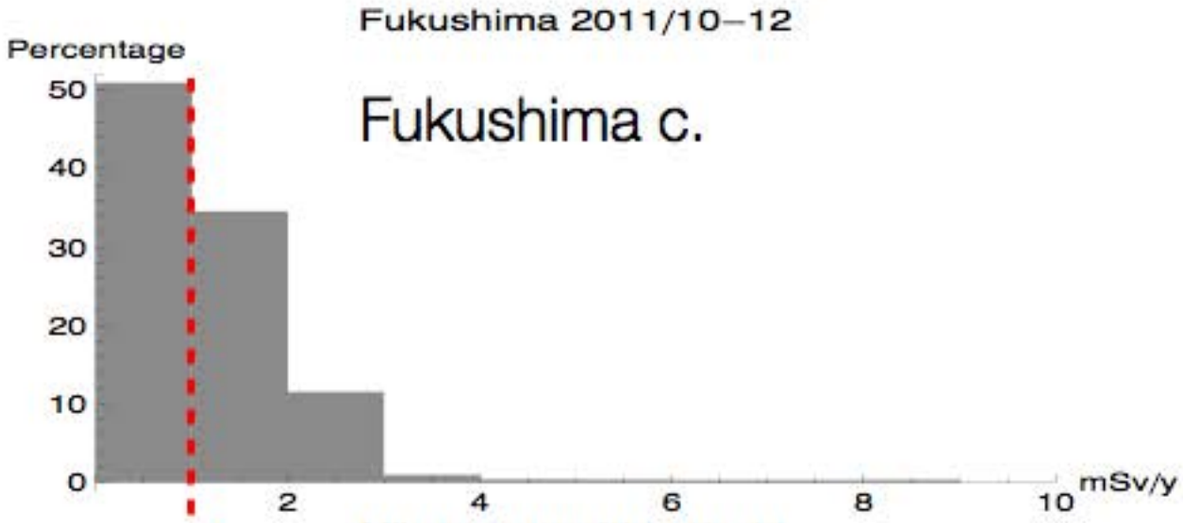
Part 3

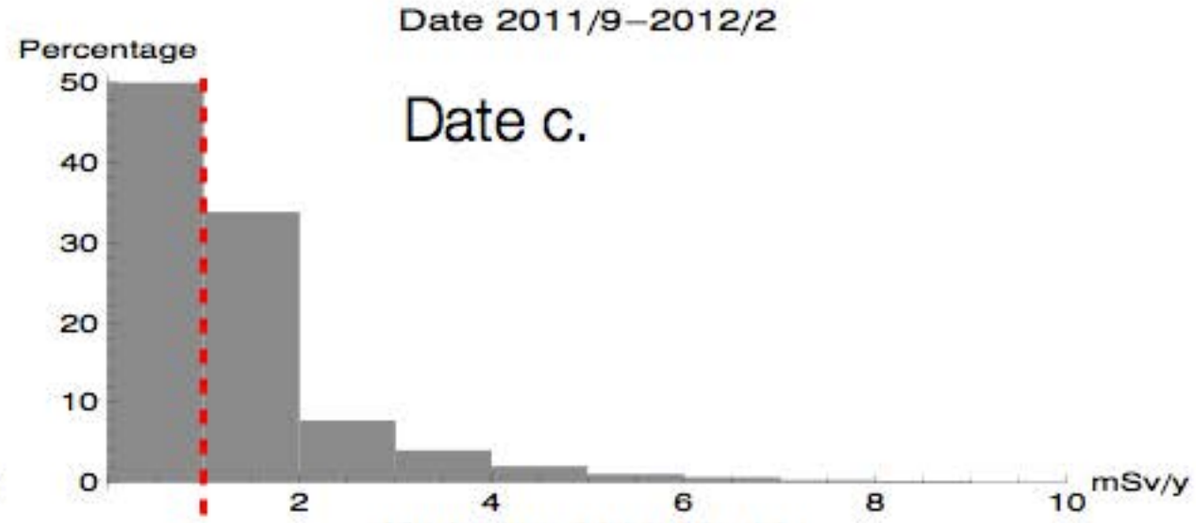
External Exposure

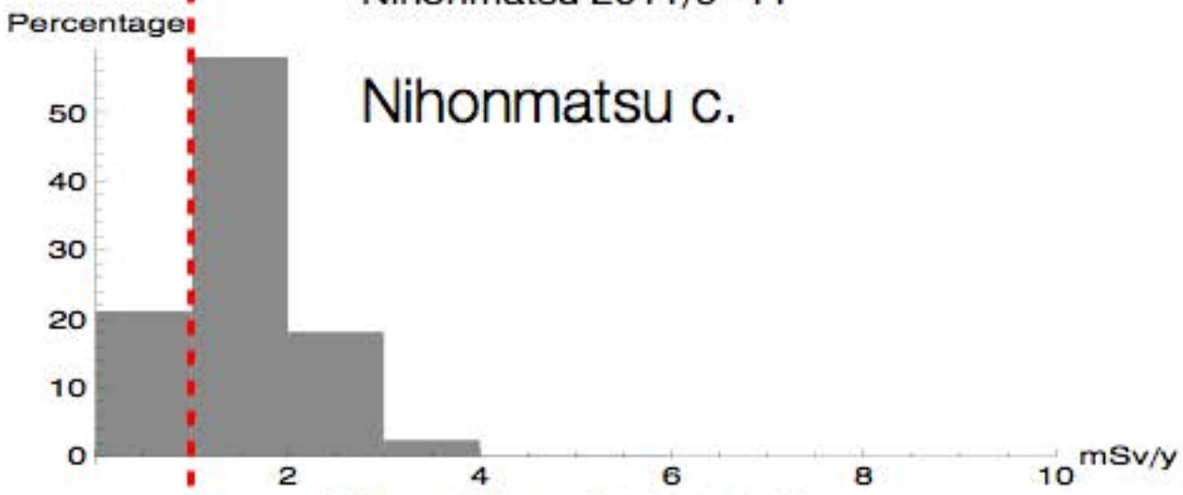
Personal dosimeter results May 2011-Apr 2012
Fukushima TV station employees

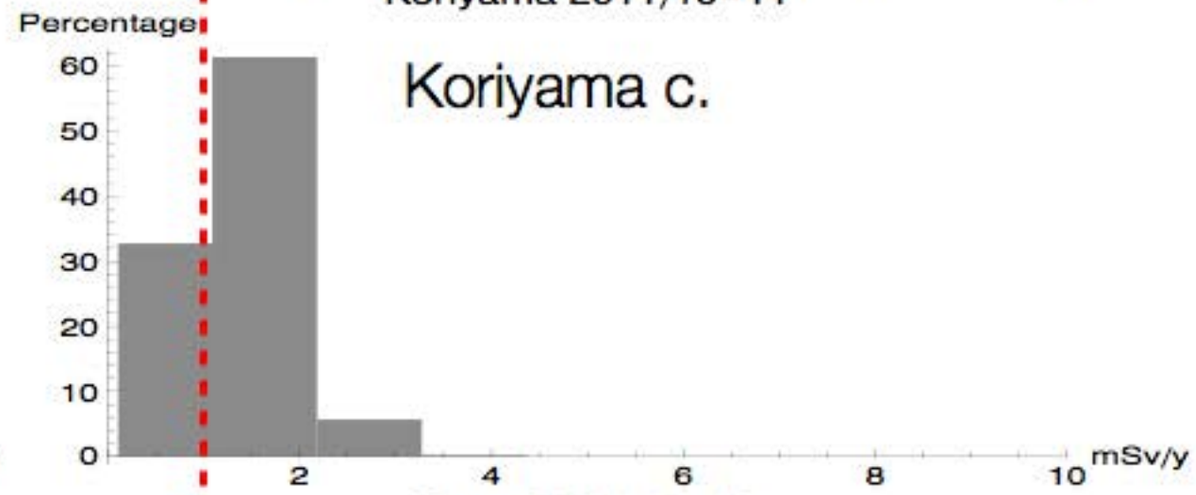


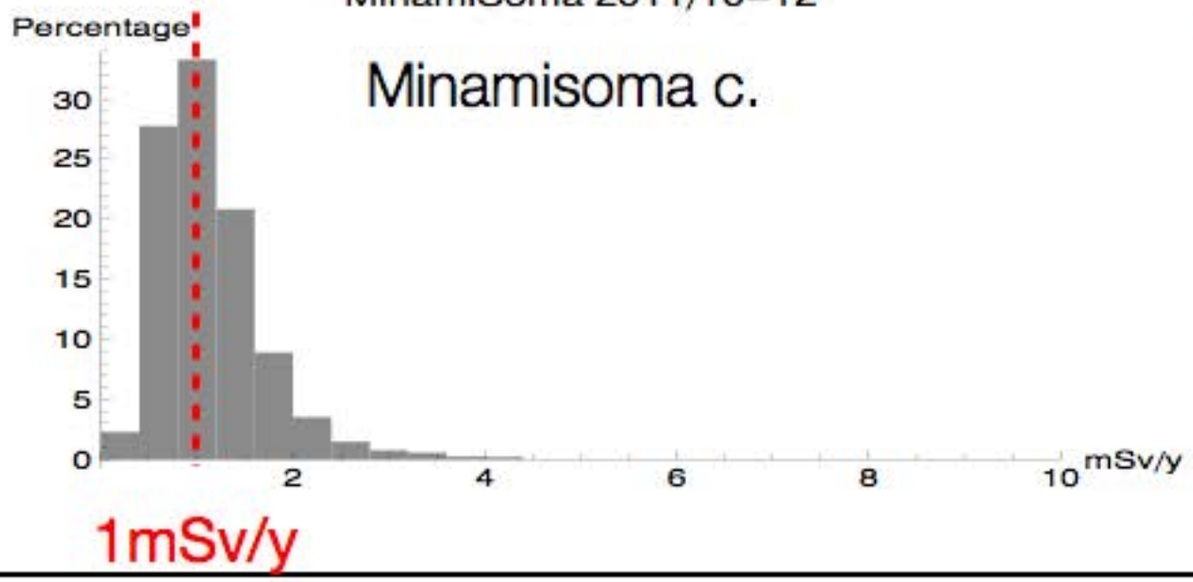
“Glass badge” results, winter 2011

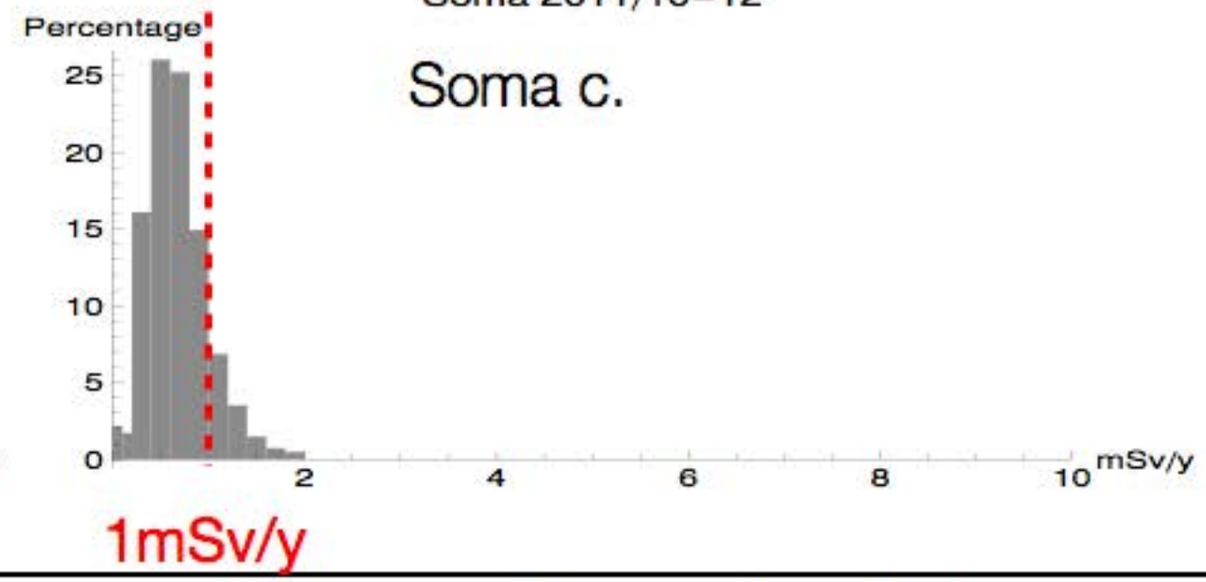






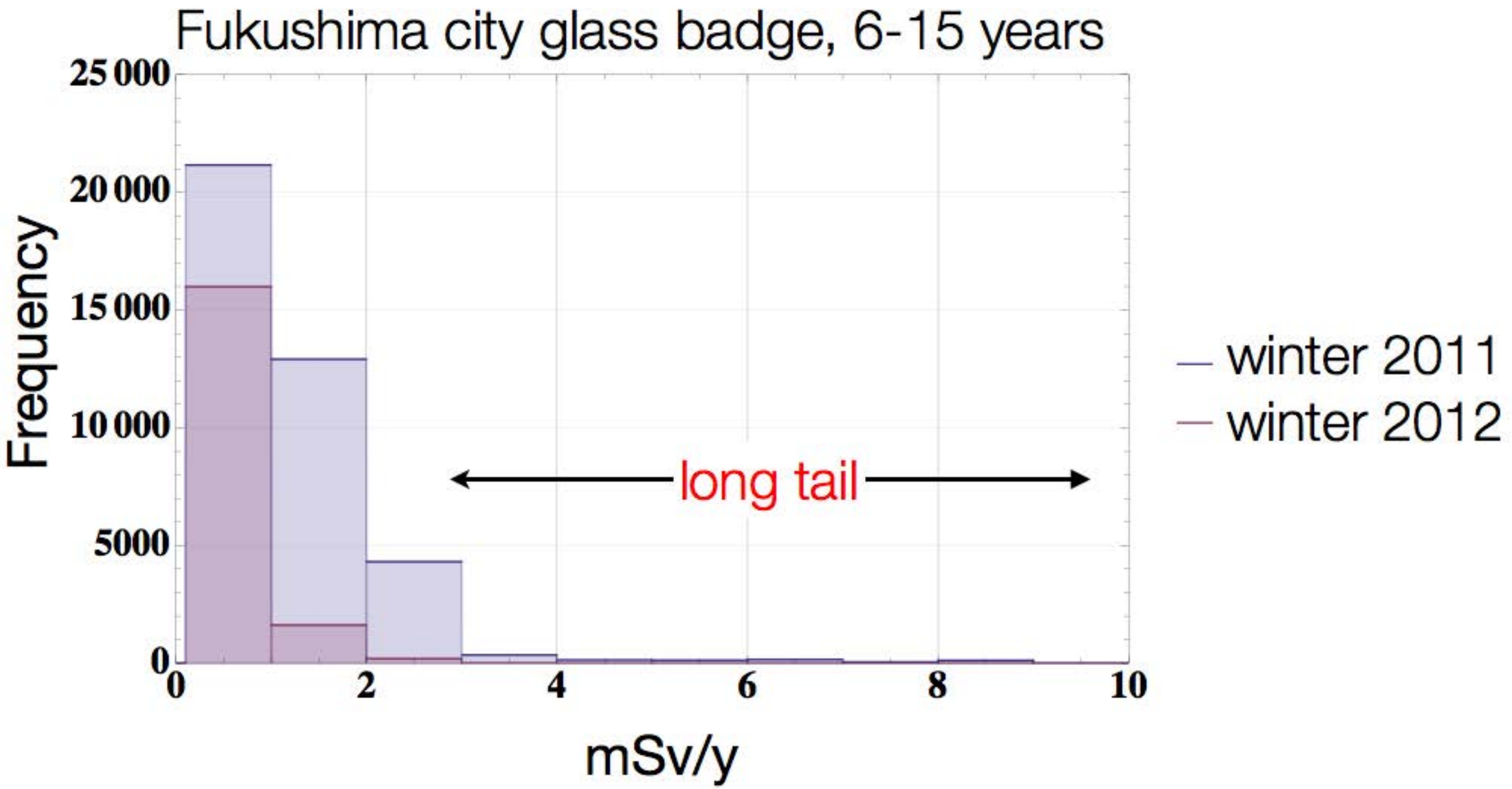






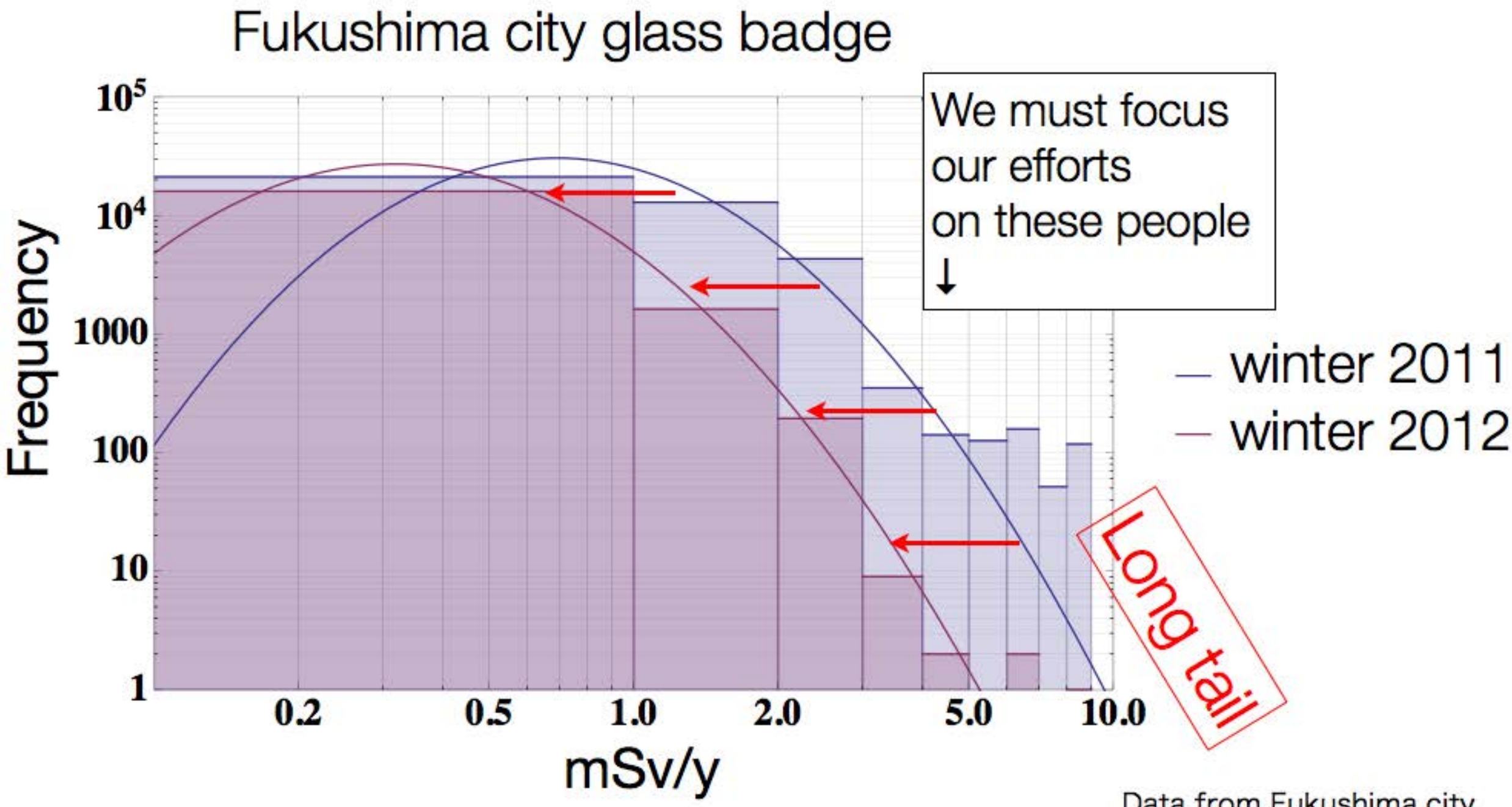
2~3 mo. results extrapolated to 1 year

Long tail of “glass badge” data



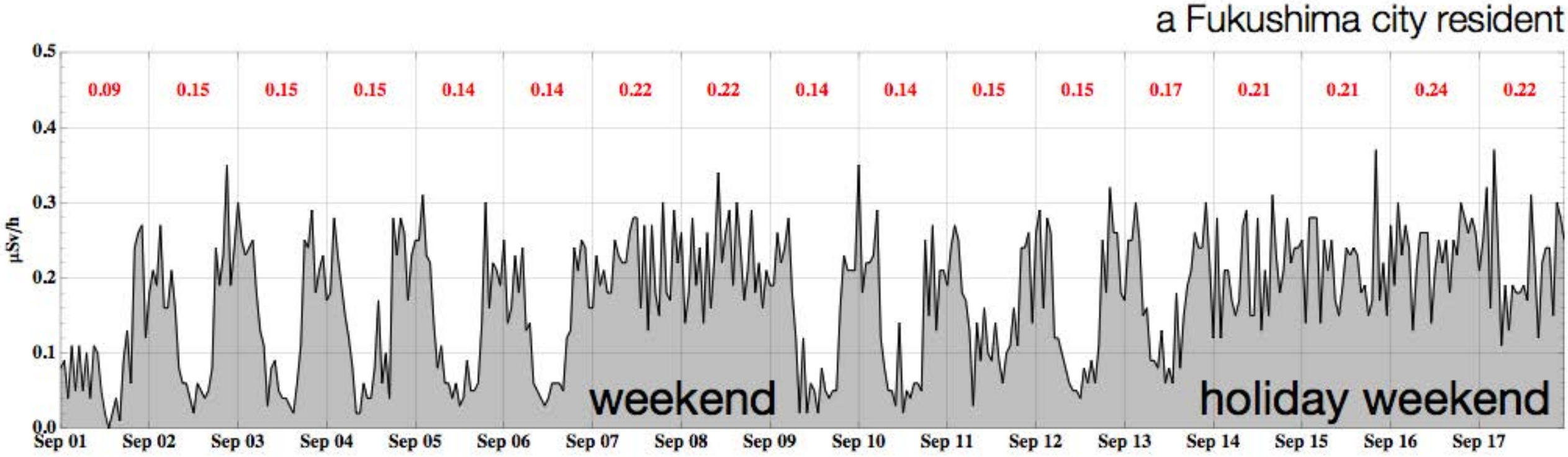
Fukushima city

Fukushima city glass badge data in log-log



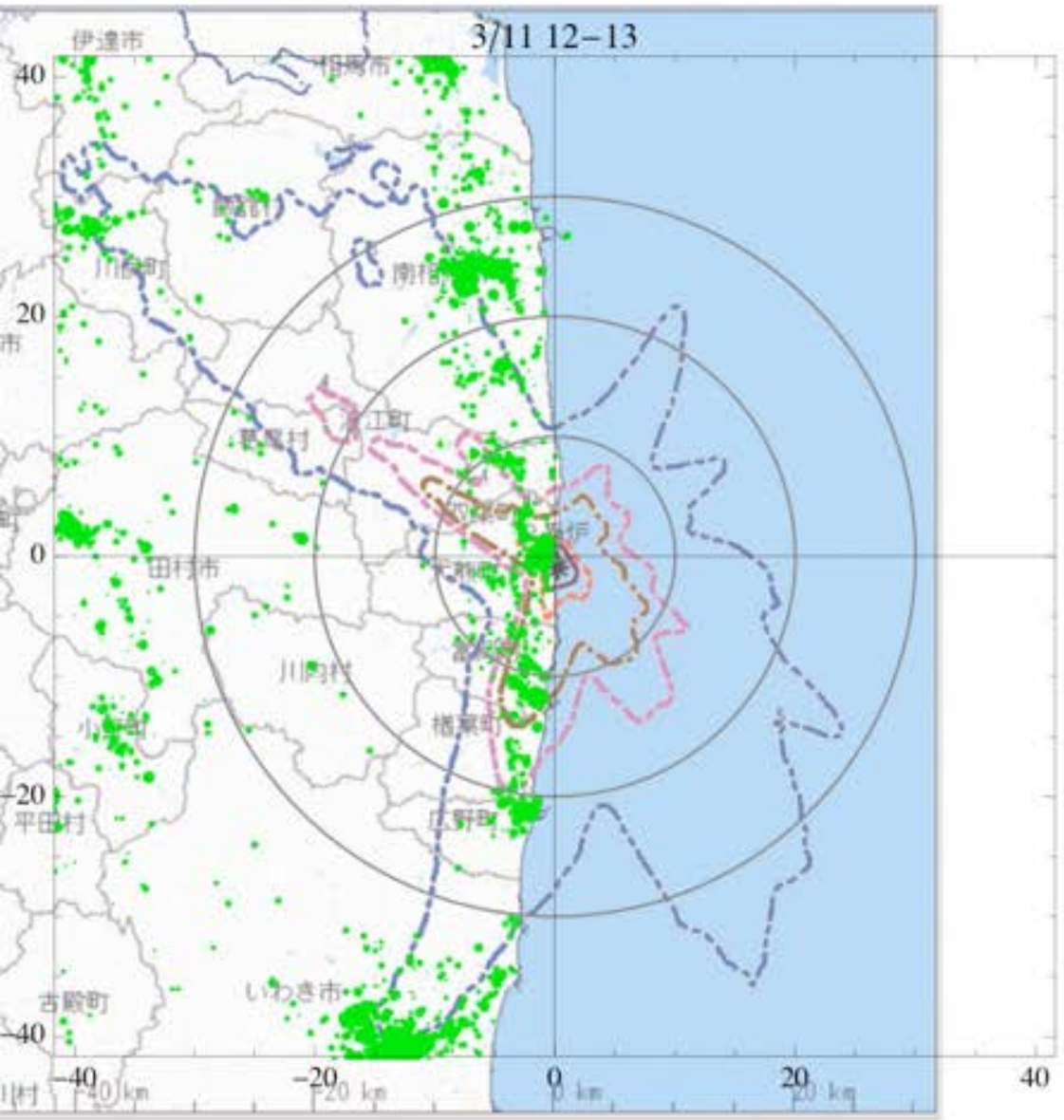
Data from Fukushima city

Personal dosimeter
with 1-hour integrated-dose readout



Our plan was to combine dosimeter & GPS-enabled phone

like I did in this paper →



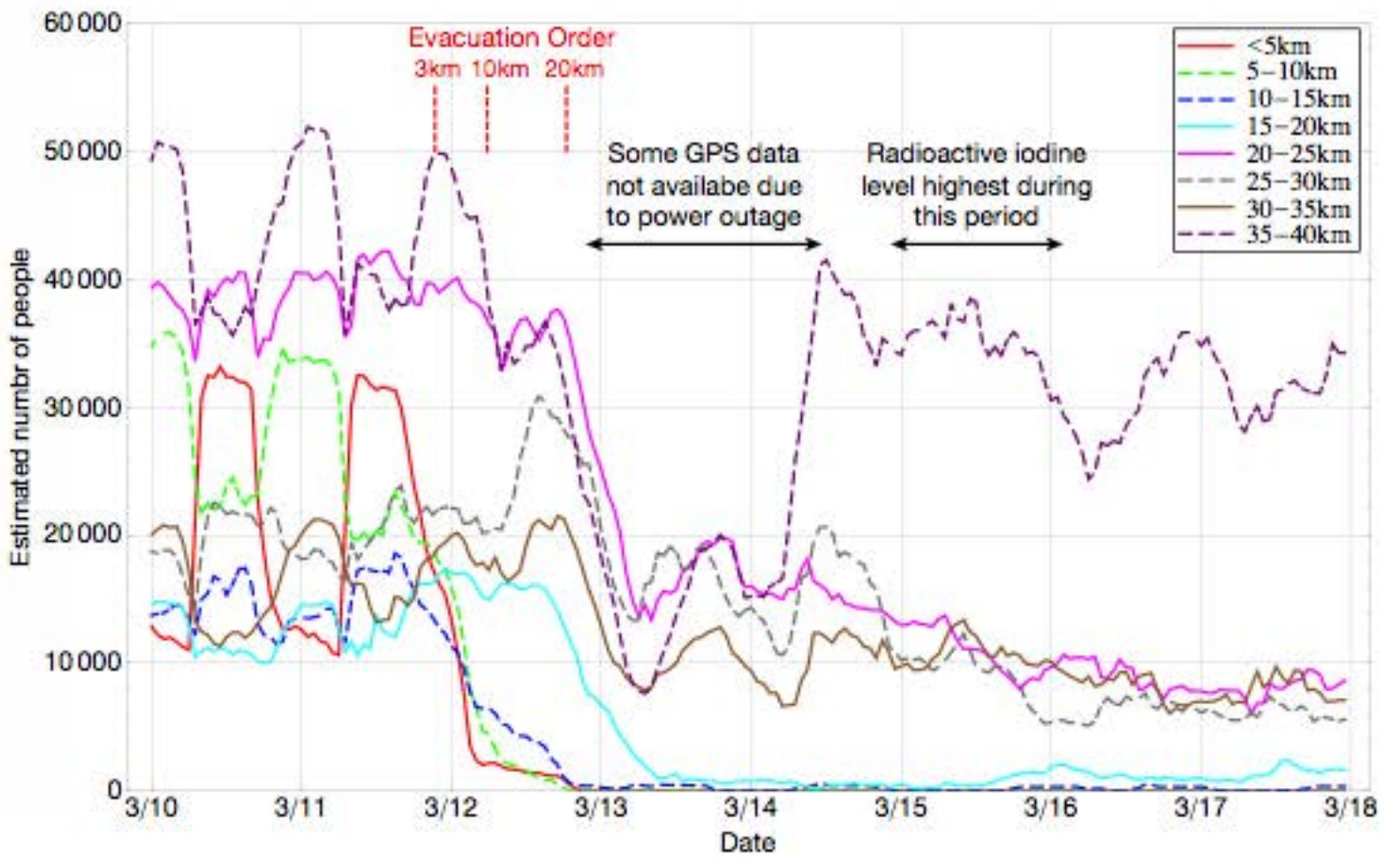
Estimation of the total population moving into and out of the 20 km evacuation zone during the Fukushima NPP accident as calculated using "Auto-GPS" mobile phone data

By Ryugo S. HAYANO*1,† and Ryutaro ADACHI*2

(Communicated by Toshimitsu YAMAZAKI, M.J.A.)

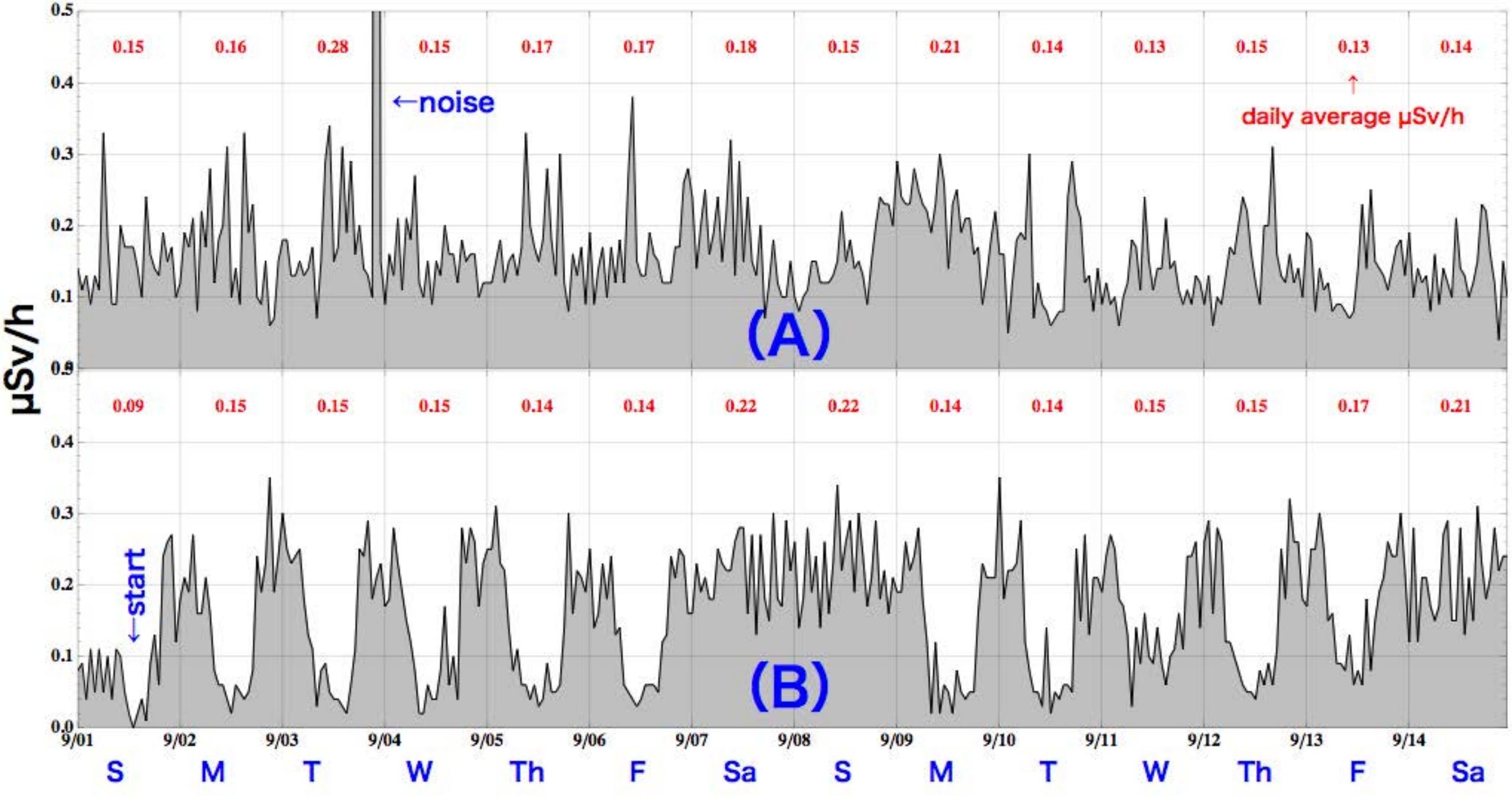
Abstract: The first objective data showing the geographical locations of people in Fukushima after the Fukushima Dai-ichi nuclear power plant accident, obtained by an analysis of GPS (Global Positioning System)-enabled mobile phone logs, are presented. The method of estimation is explained, and the flow of people into and out of the 20 km evacuation zone during the accident is visualized.

Estimated number of people around Fukushima Dai−ichi NPP



But it was not necessary.
the key is to share the data with people

A - farmer living in the ex-exclusion zone
B - office worker in Fukushima city



Summary

What have we learned in 2.5 years?

1. It is essential that we measure internal+external dose for each individual
2. Internal contamination is much much lower than initially feared
   for most people, <10% of K-40 dose
   but there is a long tail
3. The risk of external exposure is higher
4. “Long tail” is an important keyword
   1. Must measure many people
   2. Looking at the “average” is insufficient
   3. Important to find the people in the “tail”, explain, consult, devise effective measures to reduce their dose
   4. Fortunately, the number of such people is relatively few in Fukushima