



# Innovative Engineering for Citizen-based Radiation Measurement

Joe Moross

Bariloche, January 2016

# **SAFECAST:**

Tool for public information  
and engagement during and  
after nuclear emergencies

Azby Brown

RICOMET 2015  
BRDO Castle, Slovenia  
June 15, 2015



**March 11, 2011**

# From the point of view of average citizens:

After March 11, 2011:

- Fear, need to decide soon whether to flee
- Information vacuum
- Official sources deemed untrustworthy
- Social media paints more dire picture
- Even knowledgeable people can't find enough reliable and useful data



# **In Response:**

- We developed devices**
- We made a mapping system**
- We built a community of motivated citizen-scientists who want to measure radiation.**



**Evolving according to needs:**

***Early Phase: “Reality Check”***

***Transitional Phase: “Enablement”***

***Long-term: “Alternatives”***

# SAFECAST today:

- International, ad-hoc volunteer network
- Non-hierarchical (but with “centers of gravity”)
- Includes radiation experts, hardware designers, software designers, academics, tinkerers, hackers, entrepreneurs, housewives, drivers, students, etc.
- “Brain Trust” : Leaders in their fields
- We are neither pro- nor anti-nuclear.

We are Pro-Data !

# Funding:

- Individual donations
- Crowdfunding: Global Giving
- Kickstarter campaigns
- Support from private foundations
- In-kind support from manufacturers, etc.
- Most importantly, people donate their time

- Topic 1: The technical side
- Topic 2: The human side





Our first systems were bulky, but worked.





# Current workhorse:

## **bGeigie Nano**

- 7th-generation mobile detector
- Rugged
- Arduino-based
- GPS and data-logging
- LND 7317 2" pancake sensor
- OLED display
- Bluetooth and WiFi capable
- Open-source, open hardware, open data
- Designed to be sold as a kit, anyone can build it and upload data



# Devices:

- Primarily mobile to maximize coverage
- New fixed sensor network to log changes over time
- Iterative design, “agile and lean” development
- Open-source, open hardware, open data
- 7+ generations of devices in 2 1/2 years
- GPS, data-logging, tied to our API
- Emphasize ease of use, consistency, ruggedness, speed of deployment, cost-effectiveness
- Industry-standard 2” pancake GM tube (LND 7317) in most devices

# Deployment



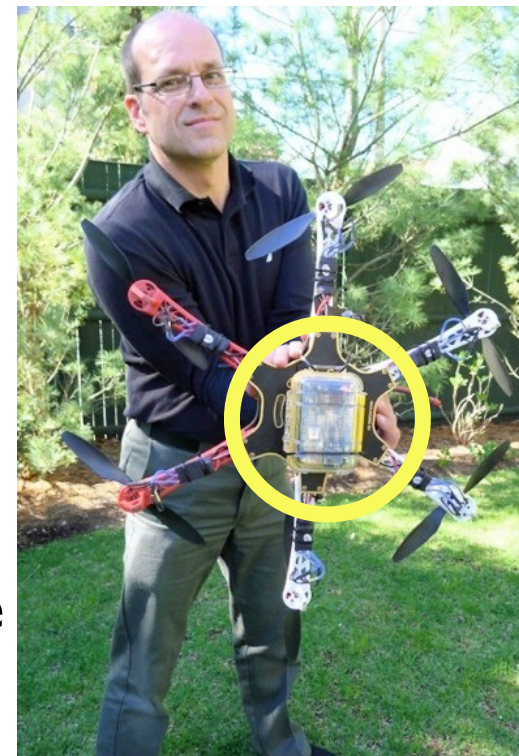
Automobile



Bicycle



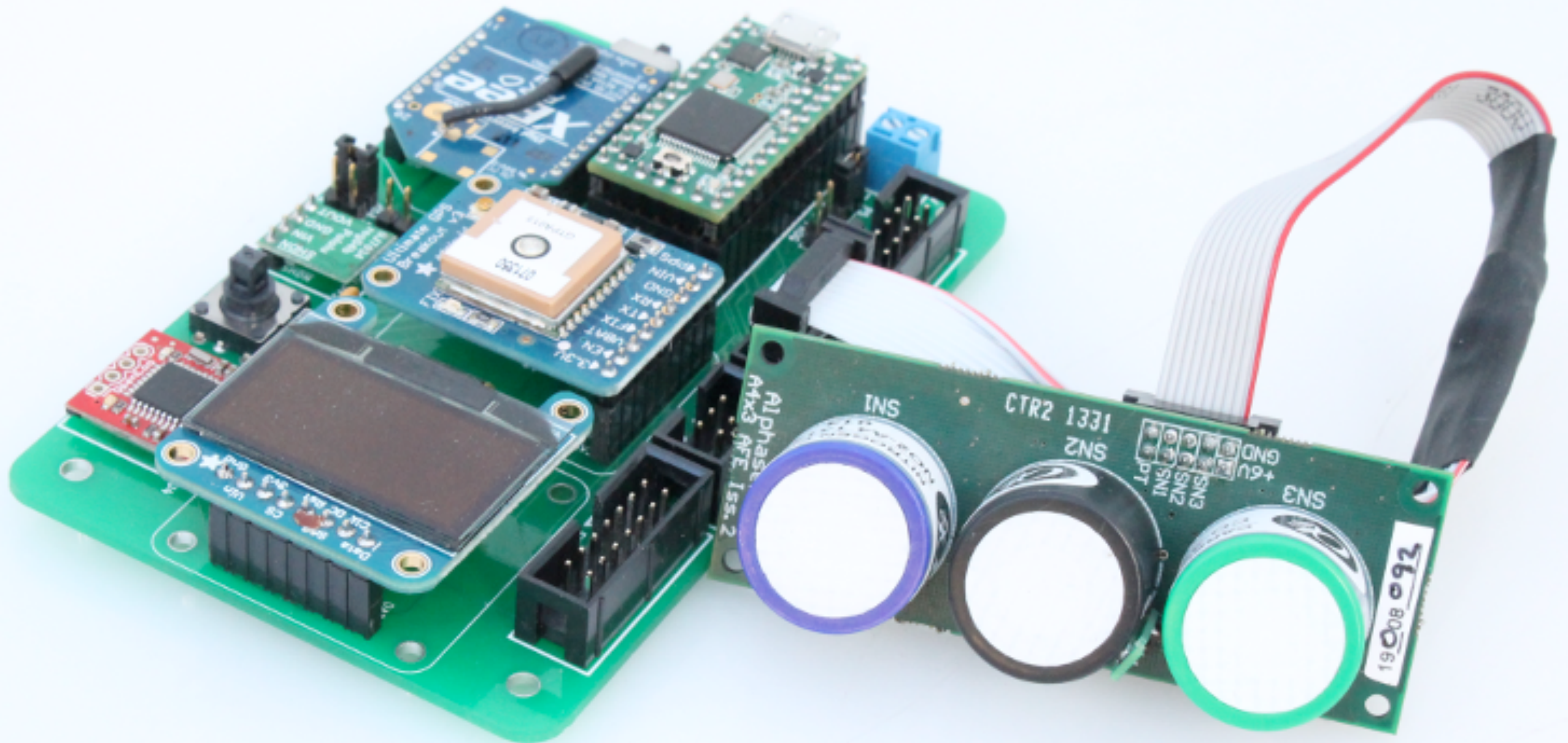
Hand-carry



Aerial drone  
(under development)

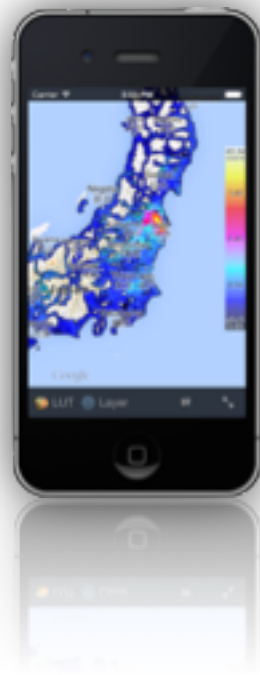


# SAFECAST Air



Prototype, 2015

# iOS



# OS X

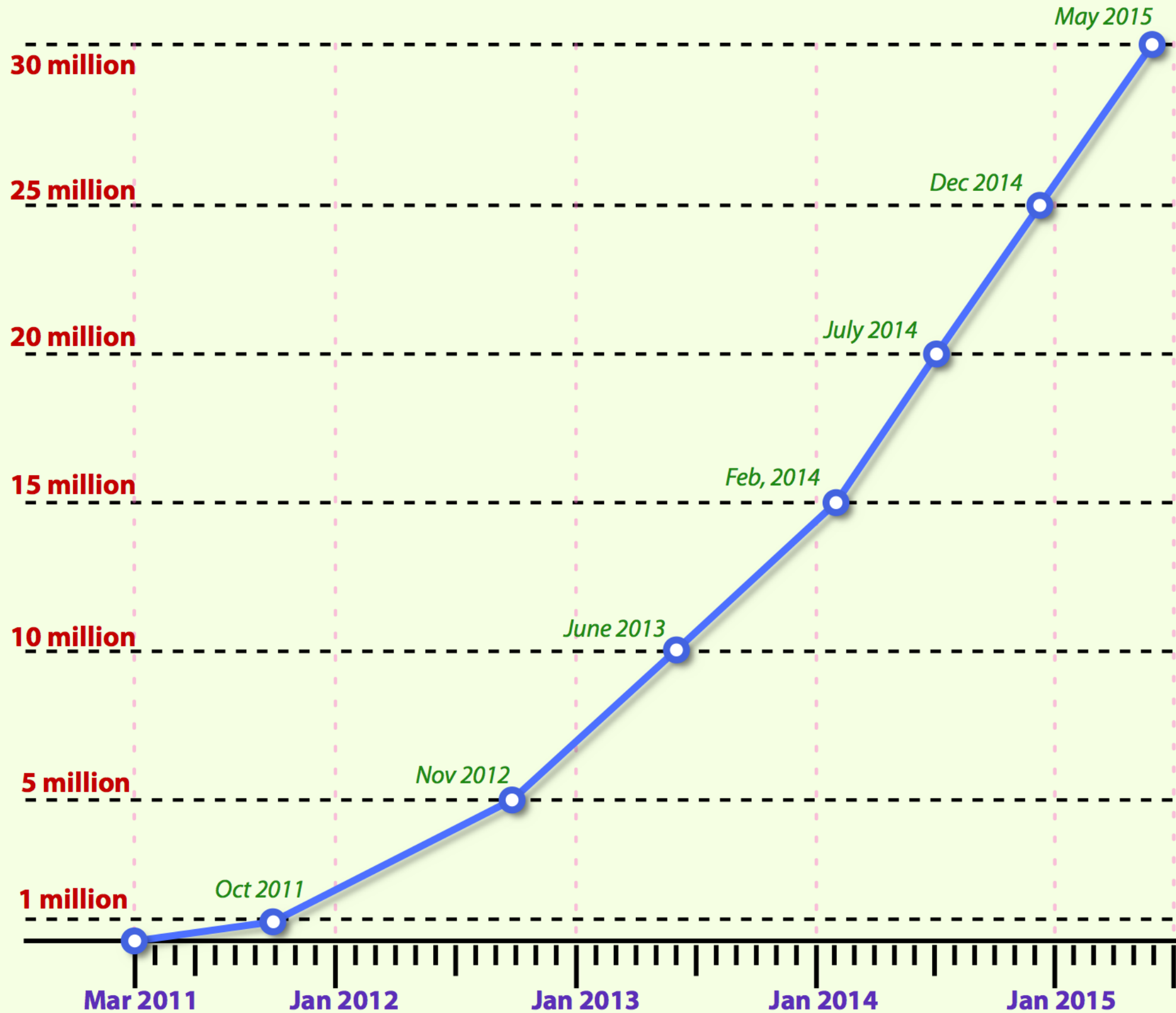


# Web

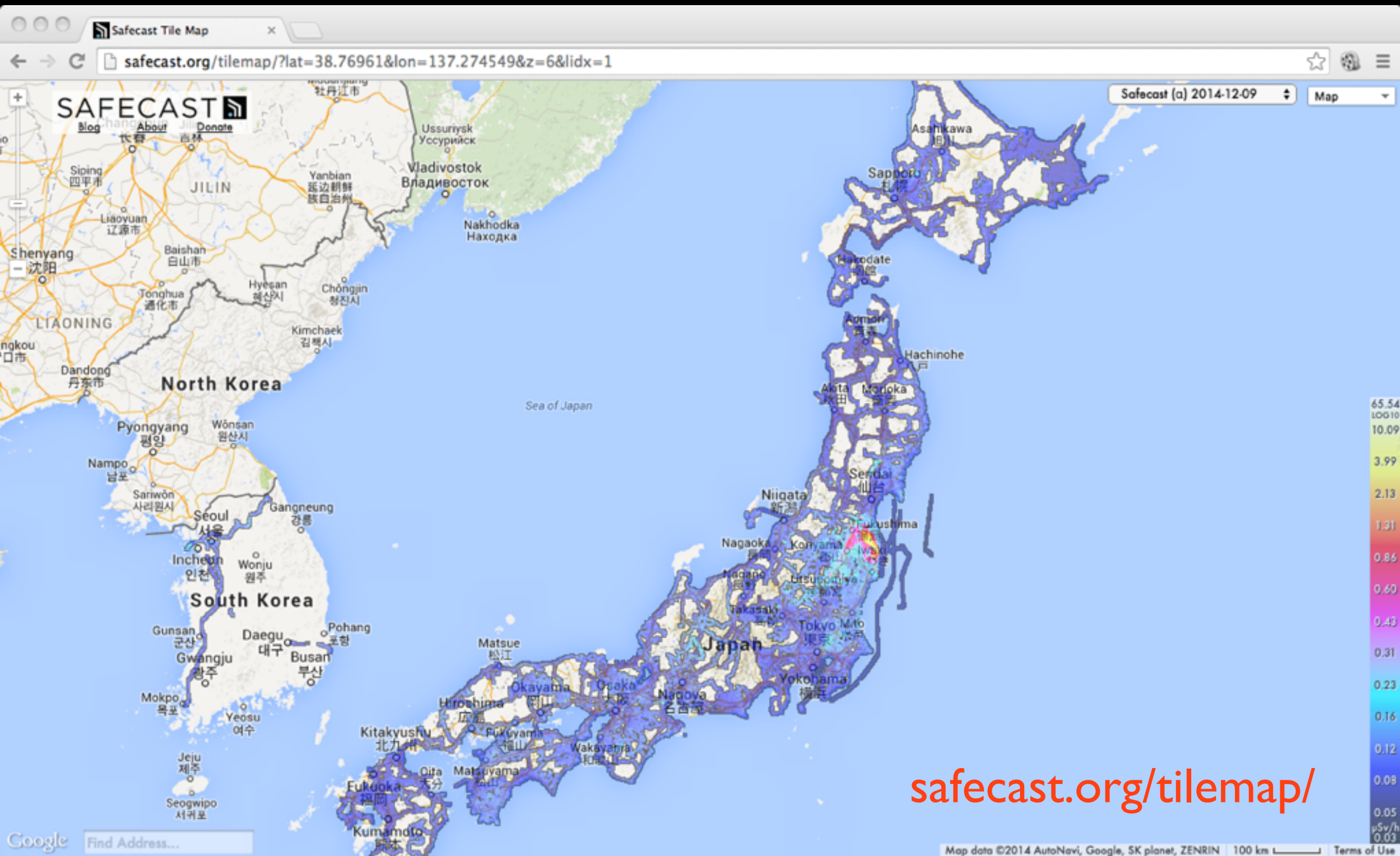
# Map system:

- Database updated daily, now approx 10GB
- Both server-fed webmaps and smart-client iOS and OSX apps
- API with query/filtering by time, location, device, etc.
- Approx 360 volunteers have uploaded data.  
But 90% is contributed by the most active 10%.
- Data and system are open-source (Creative Commons CC0 license). Anyone can download the data, and we encourage independent efforts based on our dataset.

# Growth of SAFECAST dataset

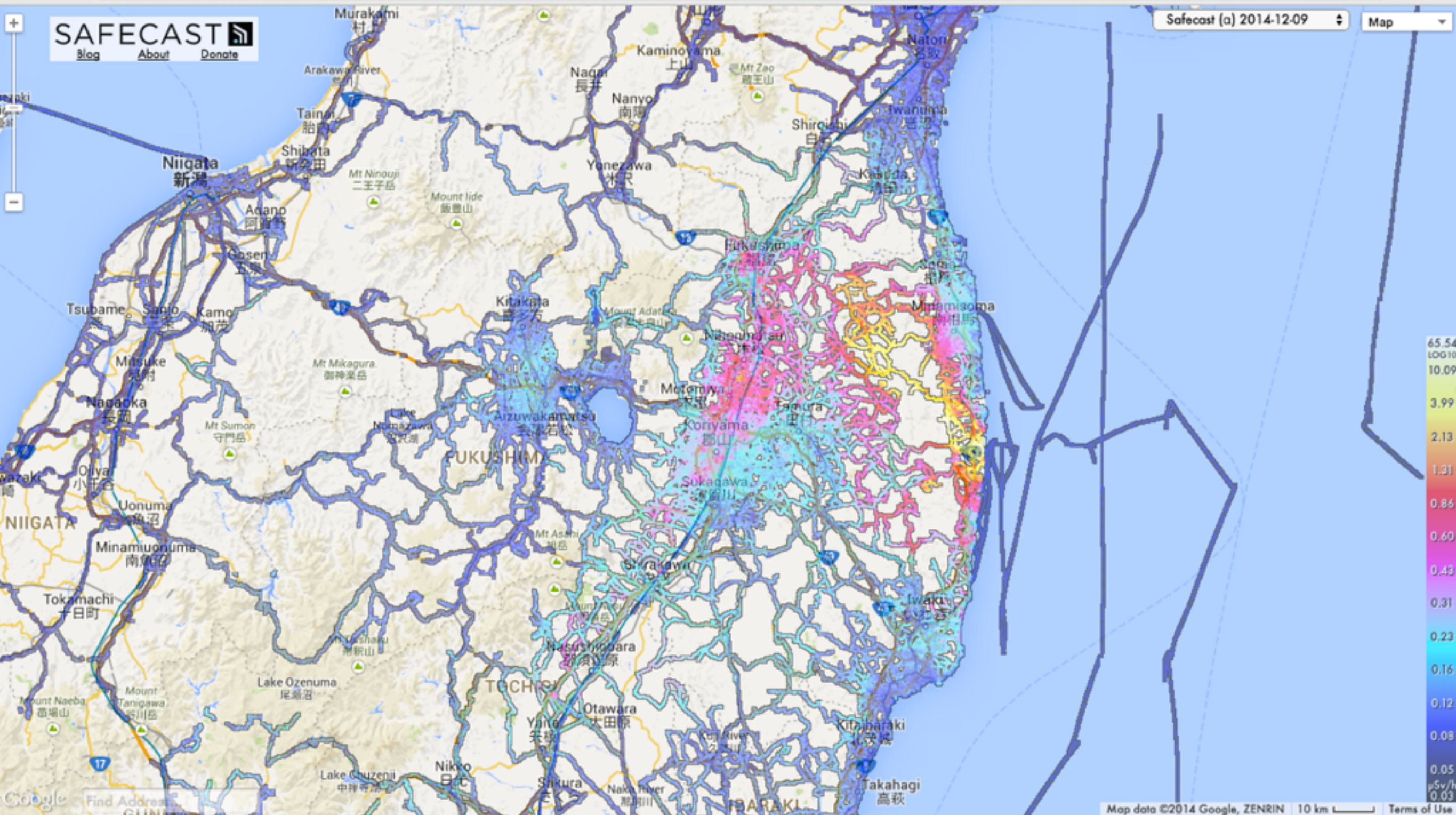




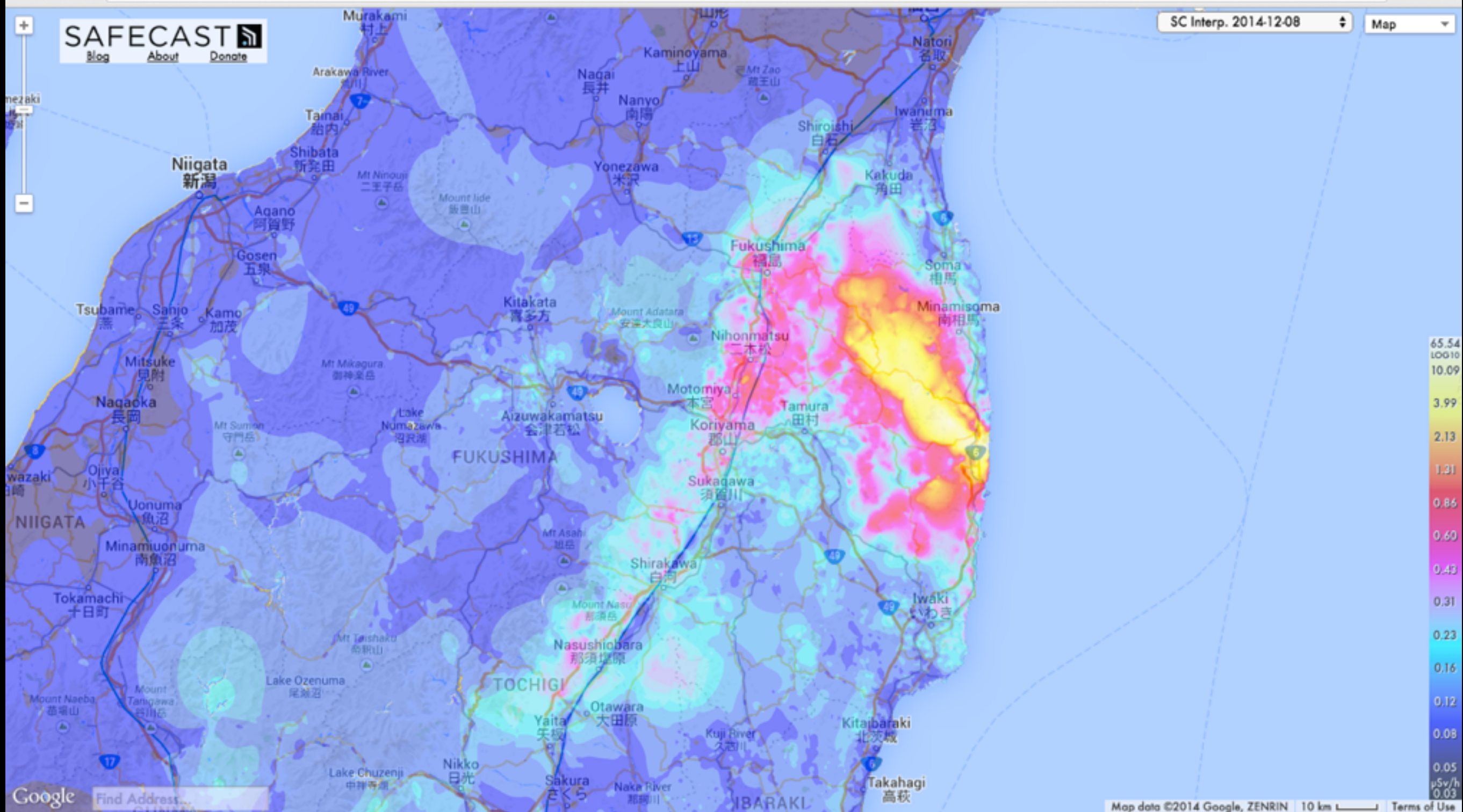


[safecast.org/tilemap/](http://safecast.org/tilemap/)

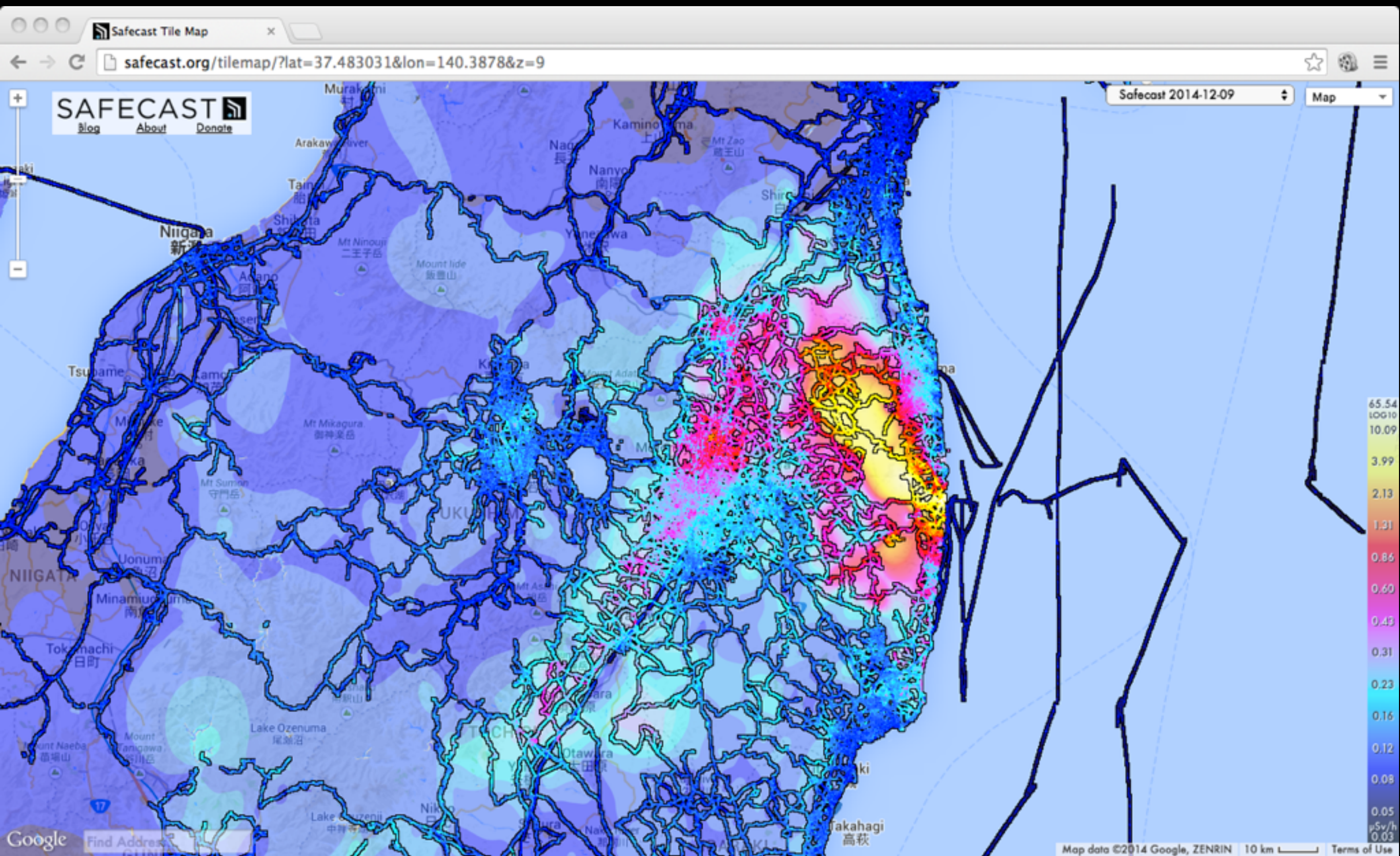




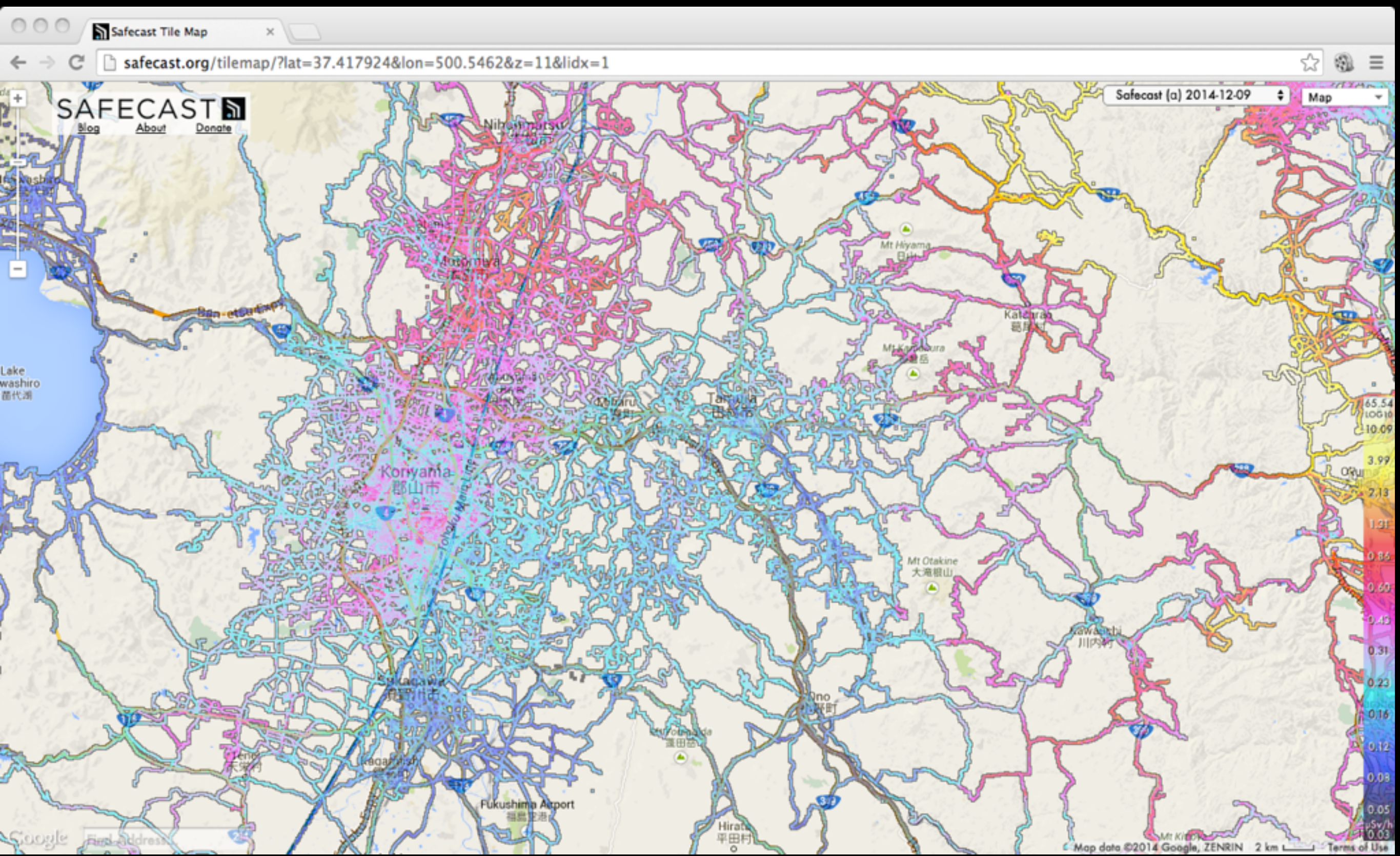




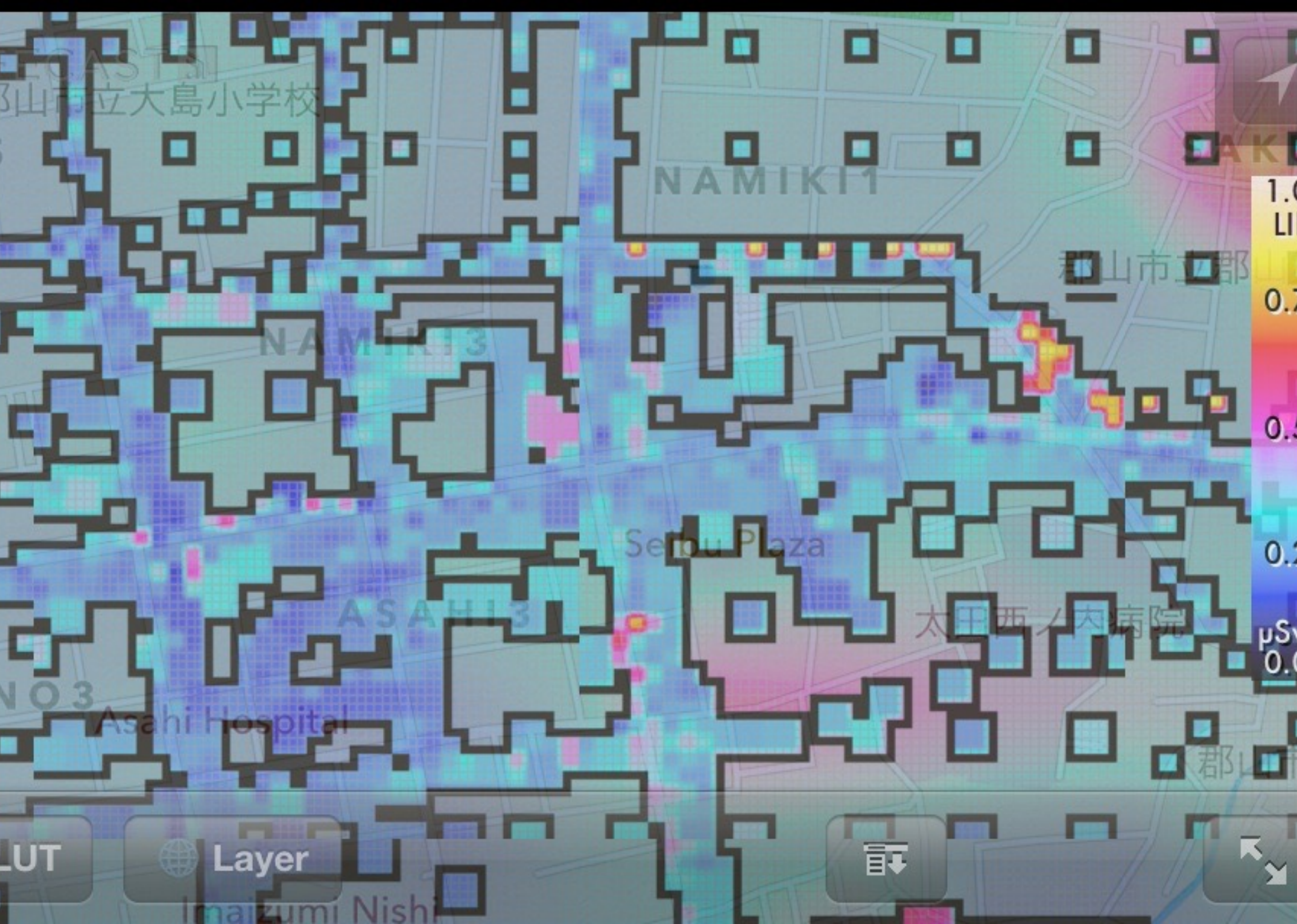




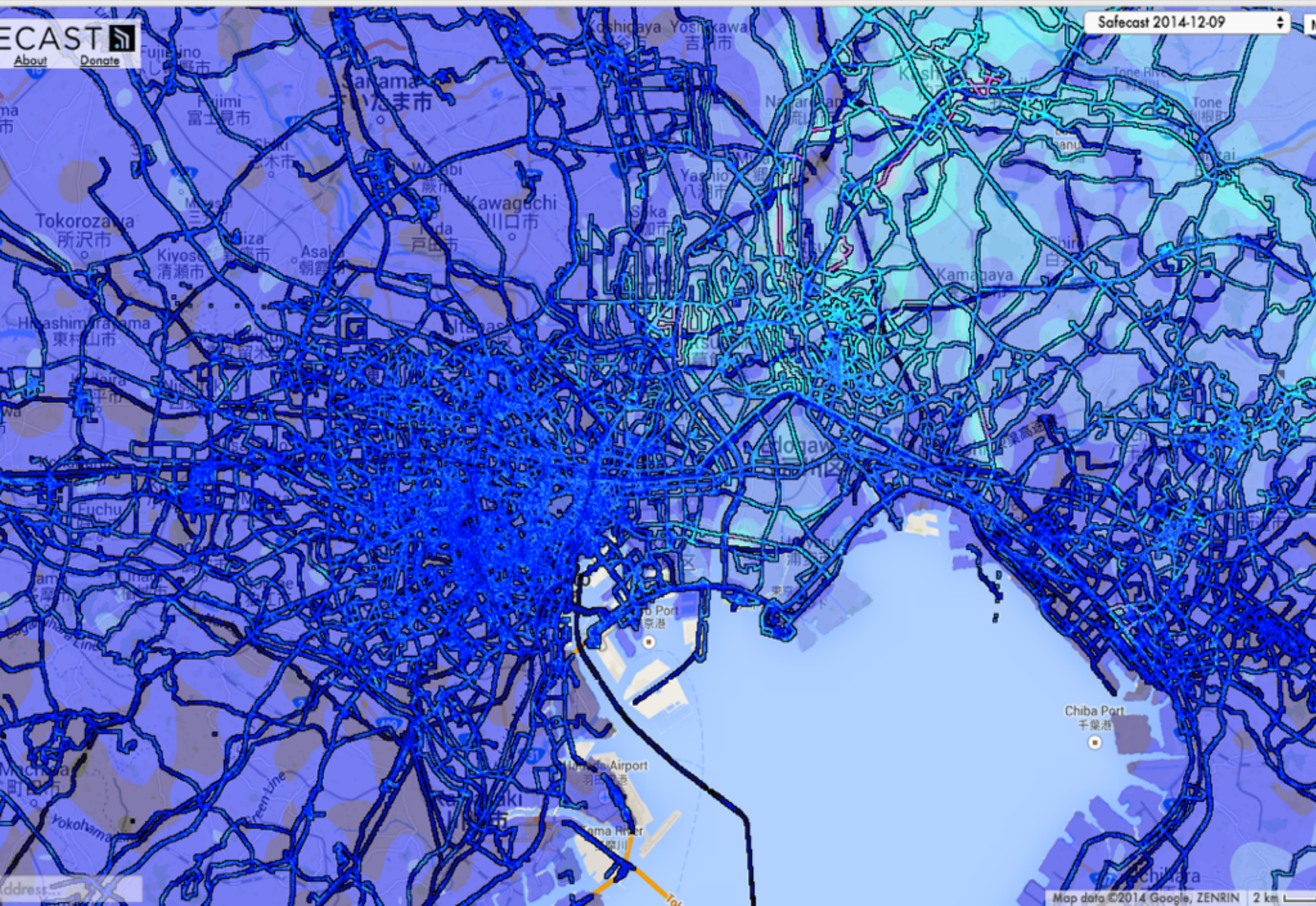




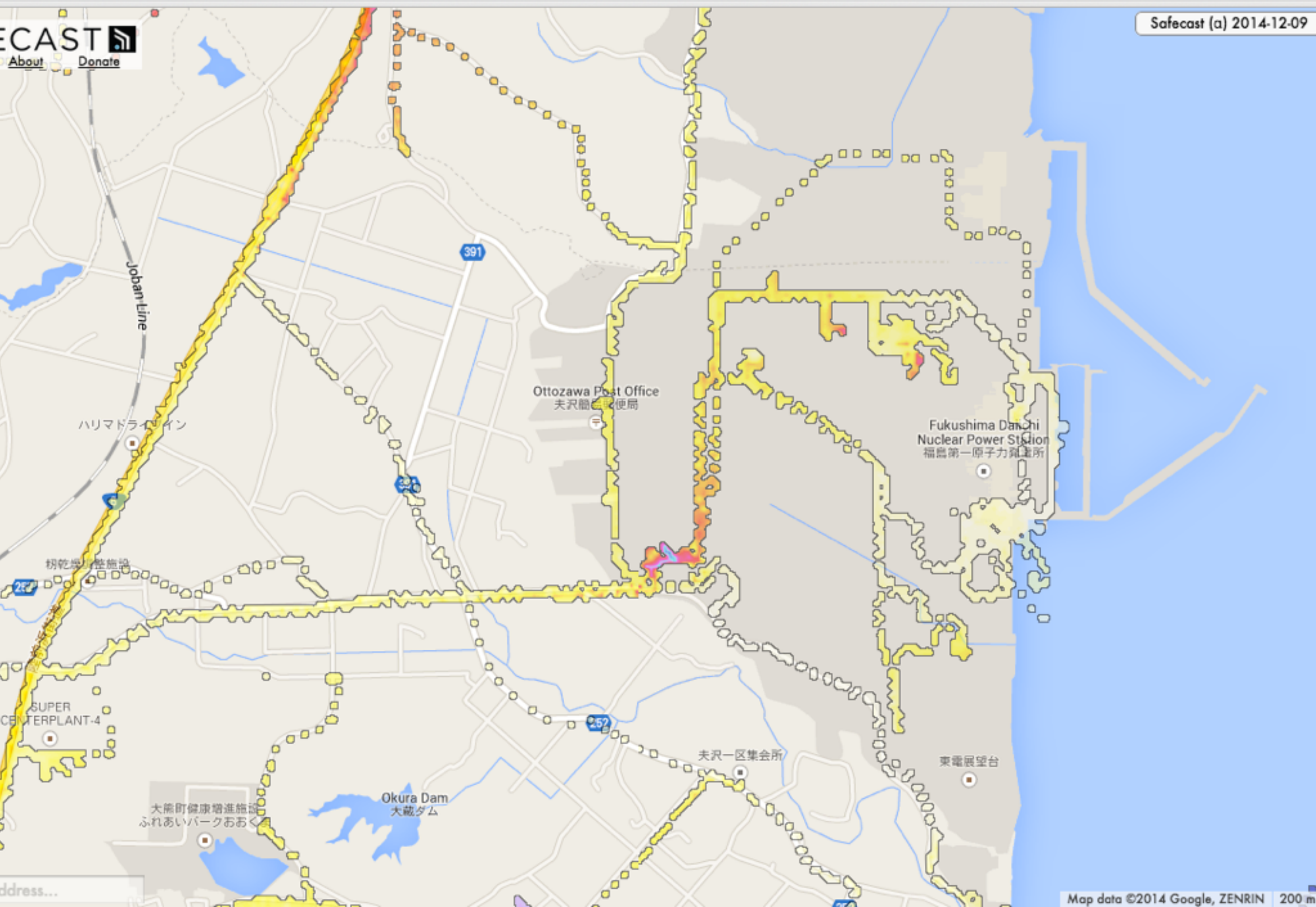








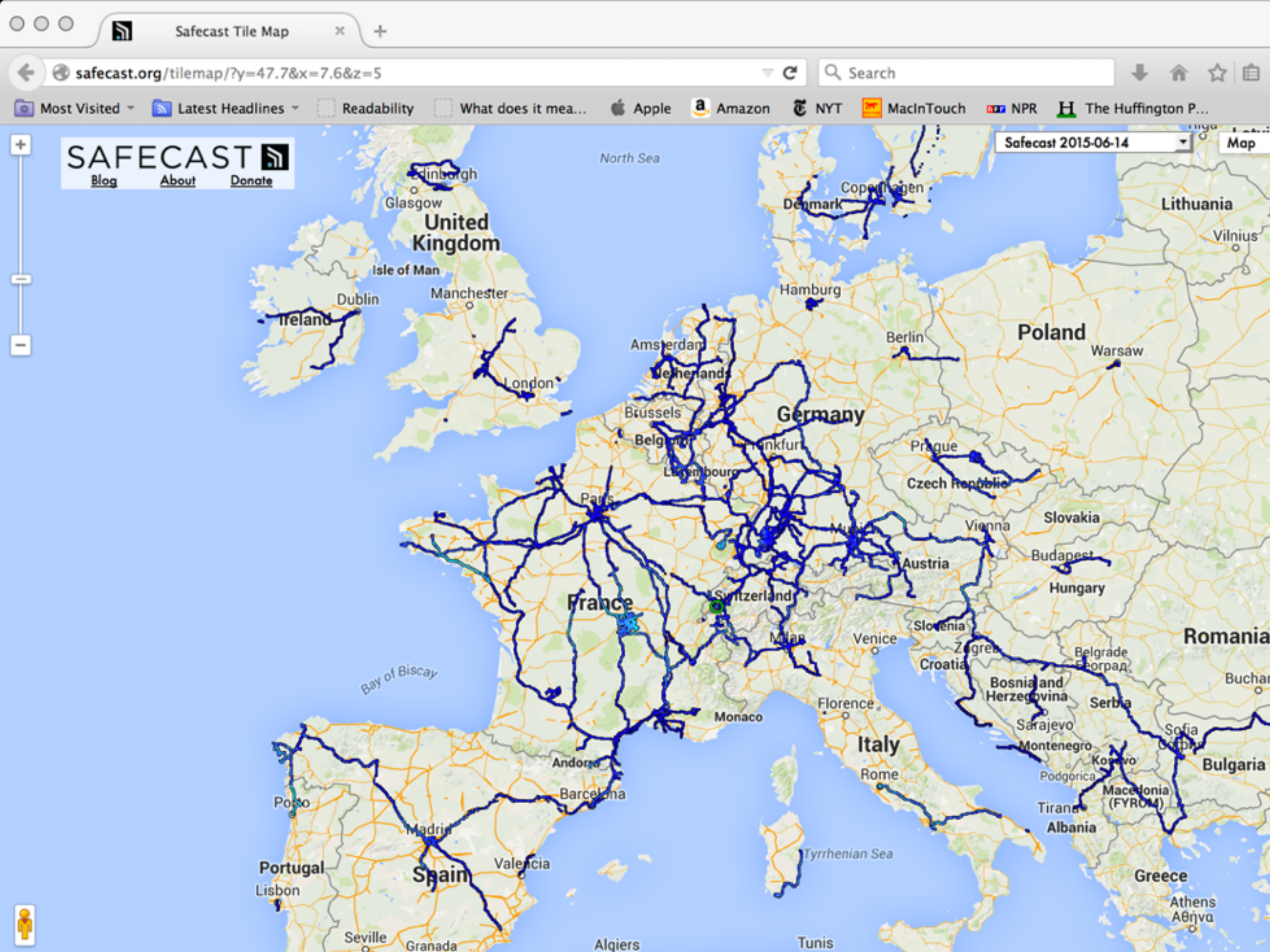


















Dashboard

Safecast Api

Users

Measurements

bGeigle Imports

Devices

# The Safecast API

Query and add to the Safecast dataset with your own application.

## API Endpoint

<https://api.safecast.org/en-US>

GET <https://api.safecast.org/.json>

JSON

HTML

## Available Resources

|                                 |                              |
|---------------------------------|------------------------------|
| <a href="#">Users</a>           | Add and view user accounts   |
| <a href="#">Measurements</a>    | Add and view measurements    |
| <a href="#">bGeigle Imports</a> | Add and view bGeigle Imports |
| <a href="#">Devices</a>         | Add and view Devices         |

## Users

|                              |   |
|------------------------------|---|
| Get a list of Safecast users | GET <a href="/users.json">/users.json</a>         |
| Add a new user               | POST <a href="/users.json">/users.json</a>        |
| View a user                  | GET <a href="/users/334.json">/users/334.json</a> |

## Measurements

|                            |   |
|----------------------------|---|
| Get a list of Measurements | GET <a href="/measurements.json">/measurements.json</a>                   |
| Add a new measurement      | POST <a href="/measurements.json">/measurements.json</a>                  |
| View a measurement         | GET <a href="/measurements/22684490.json">/measurements/22684490.json</a> |

api.safecast.org

[Dashboard](#)[Safecast Api](#)[Users](#)[Measurements](#)[bGeigie Imports](#)[Devices](#)Bgeigie Import #019-1112.LOG Processed[Download Original File](#)*If you don't see the map, please manually reload the page.*

1. Uploaded

2. Processed

3. Metadata Added

4. Submitted

5. Approved

6. Live

[Metadata](#)[Process Log](#)[Edit Details](#)

## Uploaded By

KM.AIZU

## Filename

019-1112.LOG

## Number Of Lines

6079

## Number Of

## Measurements

6079

## Metadata

|                    |  |
|--------------------|--|
| <b>Title</b>       | Route6 2014/11/12  |
| <b>Description</b> | Route 6<br>Return difficult district   |
| <b>Credits</b>     | Aizu radioactivity information center  |
| <b>Height</b>      | 1.3m   |
| <b>Orientation</b> | Facing Left  |
| <b>Cities</b>      | Koriyama,Hirata,Ono,Iwaki,Hirono,<br>Naraha,Tomioka,Okuma,Futaba,Namie<br>Minamisoma,Iitate,Kawamata,Fukushimaa,<br>Nihonmatsu,Motomiya,Inawashiro,Aizuwakamatsu |

[Delete this Import](#)

## MEASUREMENT

## Captured At

2014-11-12T10:27:28Z

Latitude 37.4701

Longitude 140.3621

CPM 72





[Dashboard](#)[Safecast Api](#)[Users](#)[Measurements](#)[bGeigie Imports](#)[Devices](#)Bgeigie Import #019-1112.LOG Processed[Download Original File](#)*If you don't see the map, please manually reload the page.*

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[Delete this Import](#)

## MEASUREMENT

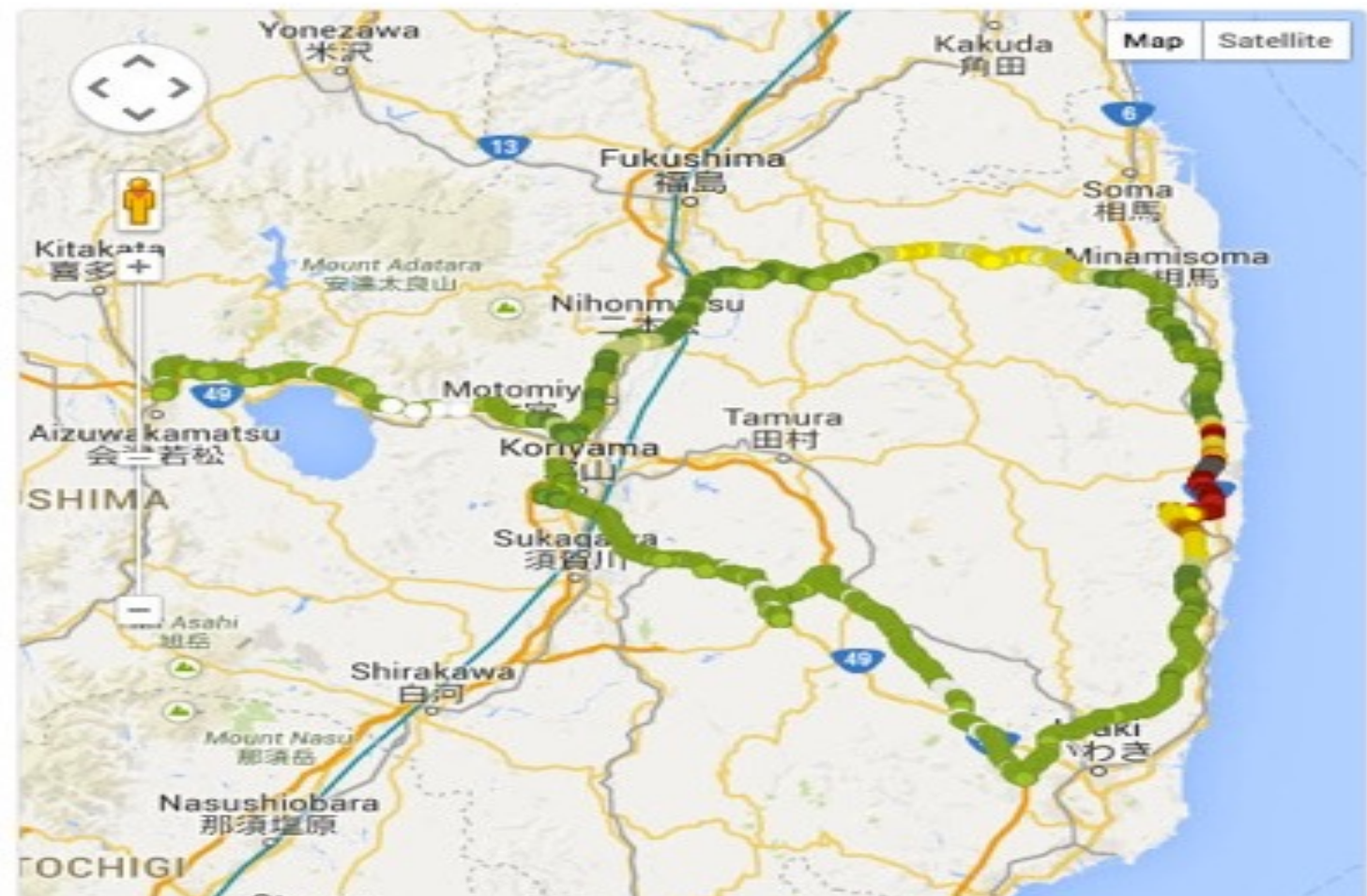
## Captured At

2014-11-12T10:27:28Z

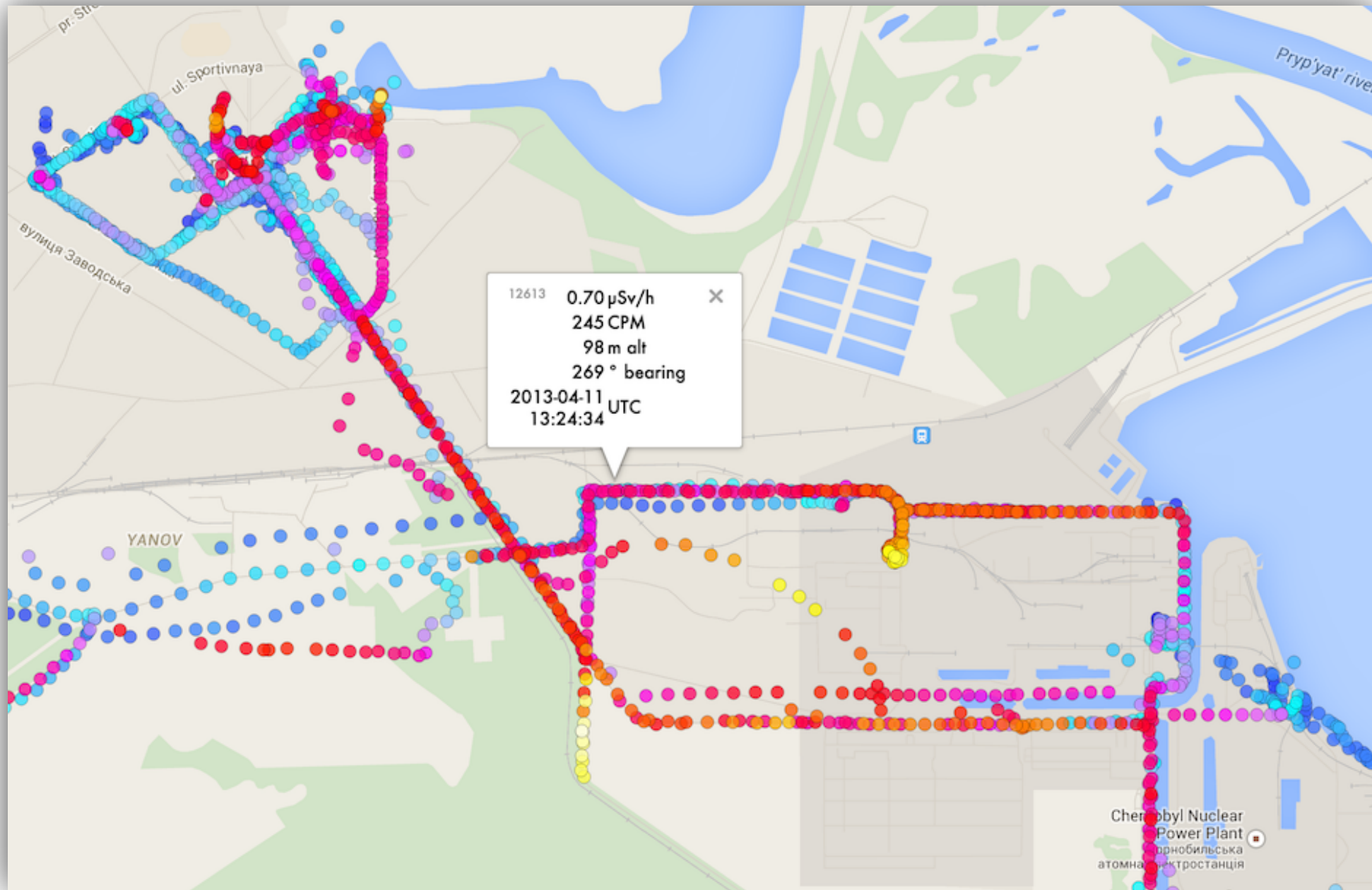
Latitude 37.4701

Longitude 140.3621

CPM 72

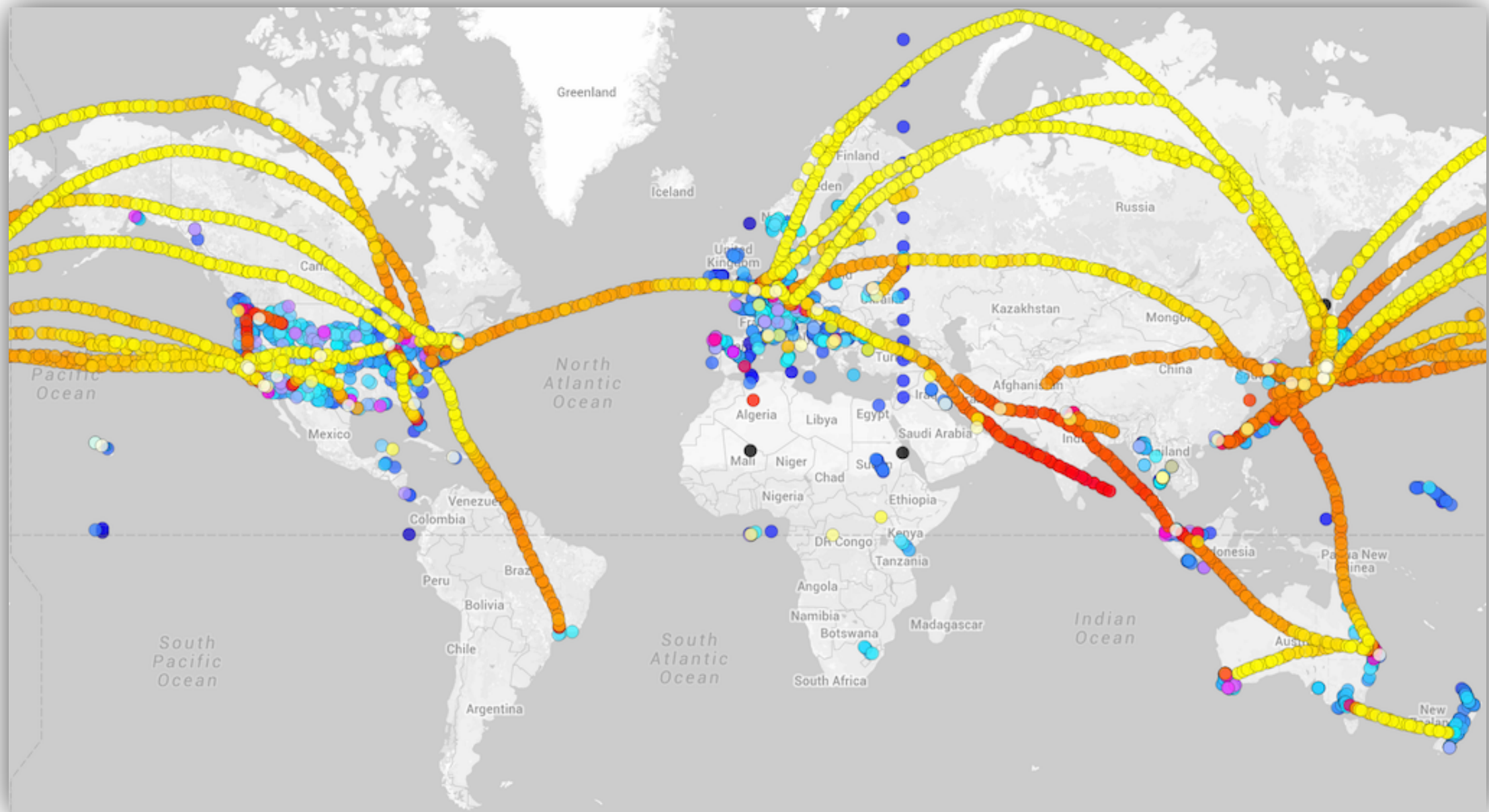
 $\mu$ sv 0.22

**We think it's very important  
to keep humans in the loop!**



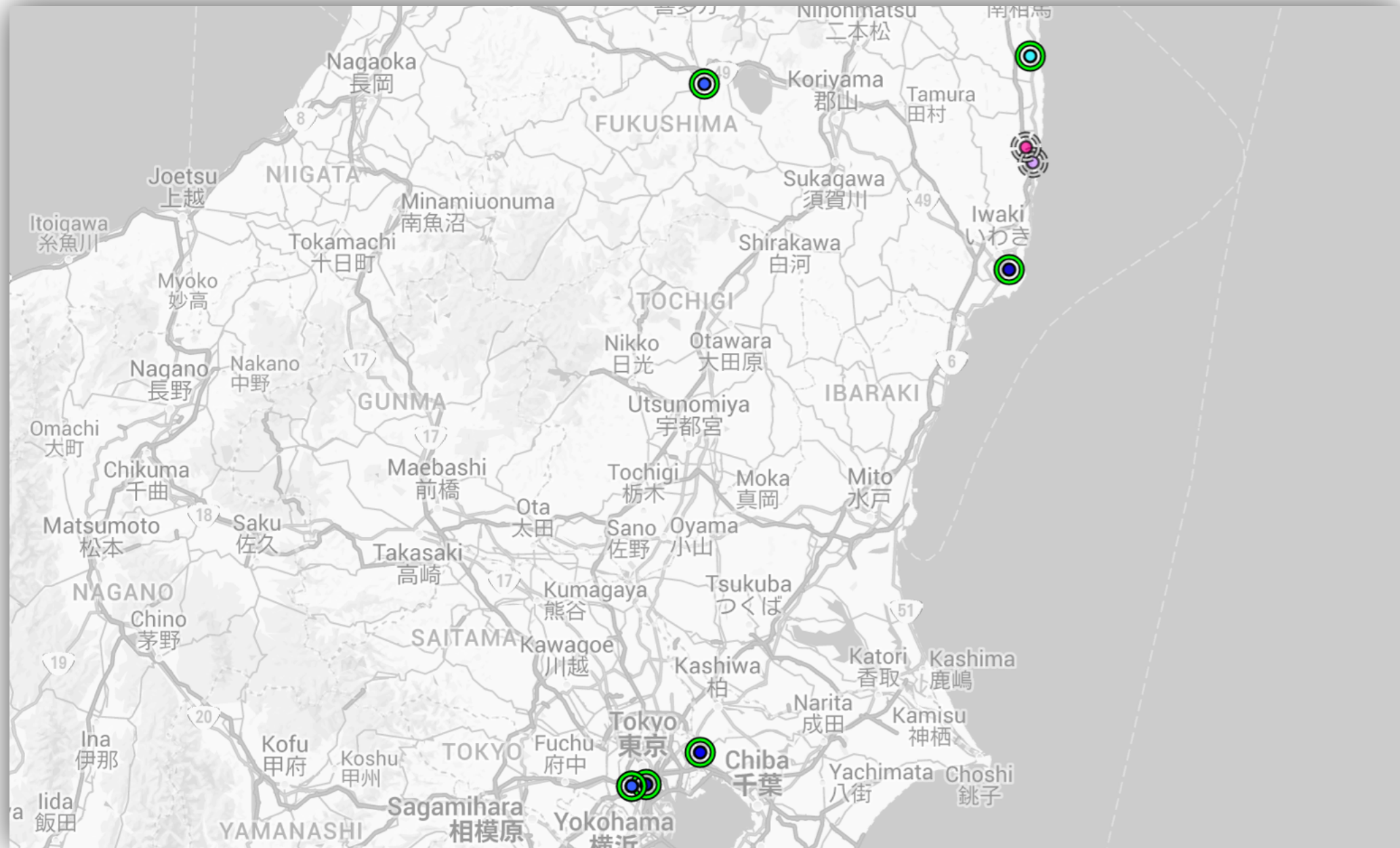
# bGeigie Log Viewer





# 5000+ bGeigie Logs

(In-flight radiation data can be uploaded, but is not included on our main maps)



# Realtime Sensors





Expanding network, new hardware deployment.

# Japan, Fukushima, Iwaki (sensor 41)

Online

6 mins ago

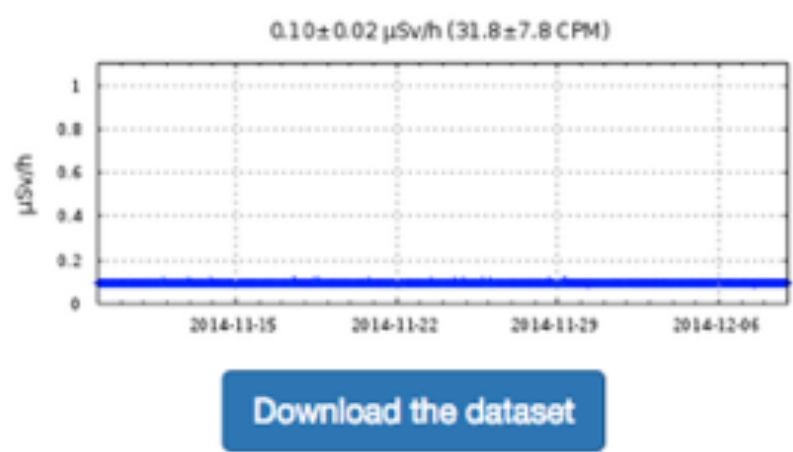
31<sub>cpm</sub>

0.093<sub>μSv/h</sub>

12 months ago

60<sub>cpm</sub>

<sub>μSv/h</sub>



Facebook Twitter Google+ + Share

## Leave a Reply

Name (required)

Email (will not be published) (required)

Website

Comment

37°00'37.8"N 140°55'31.1"E

Save

View on Google Maps

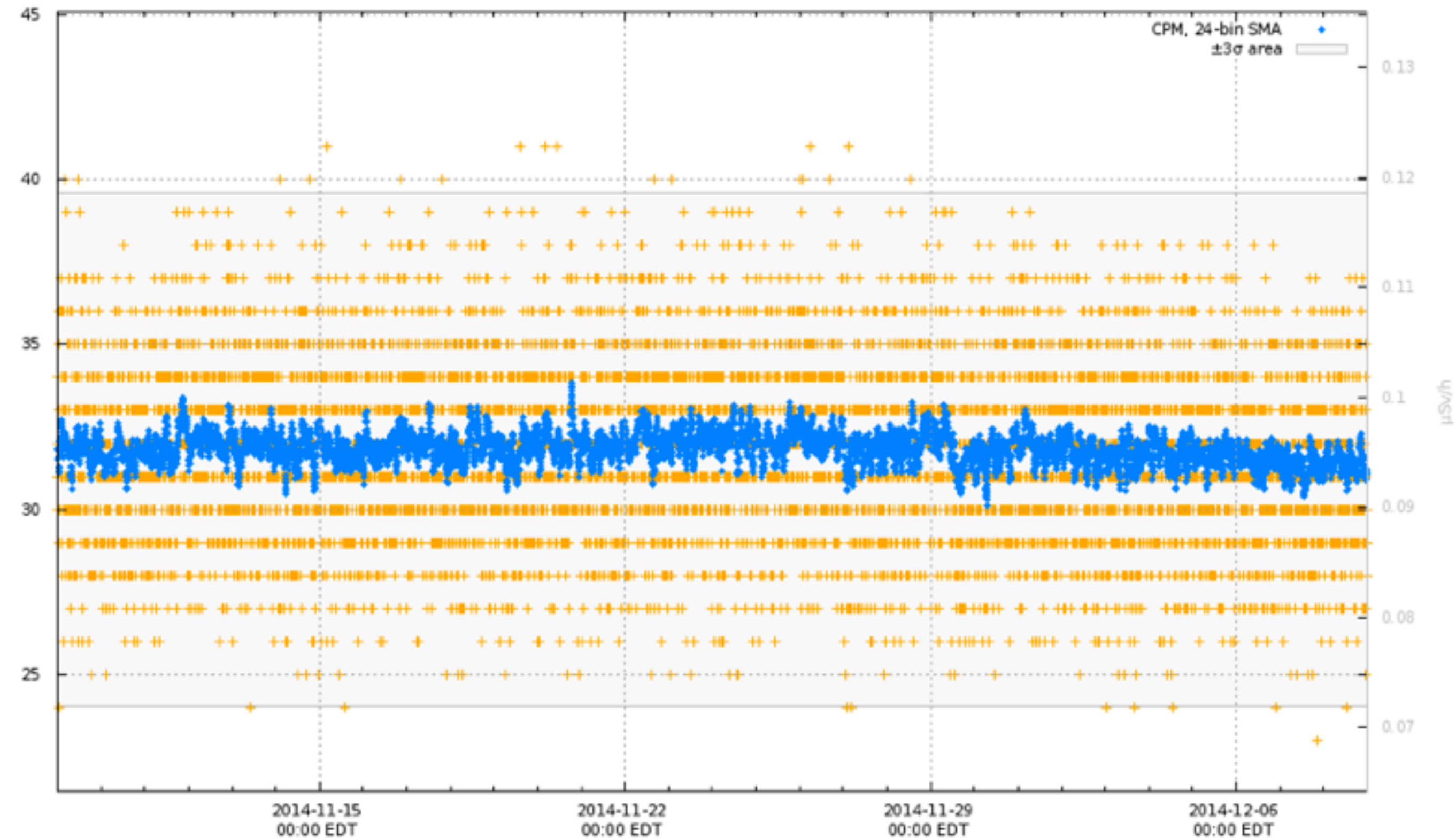
Google

©2014 Google - Map data ©2014 Google, ZENRIP

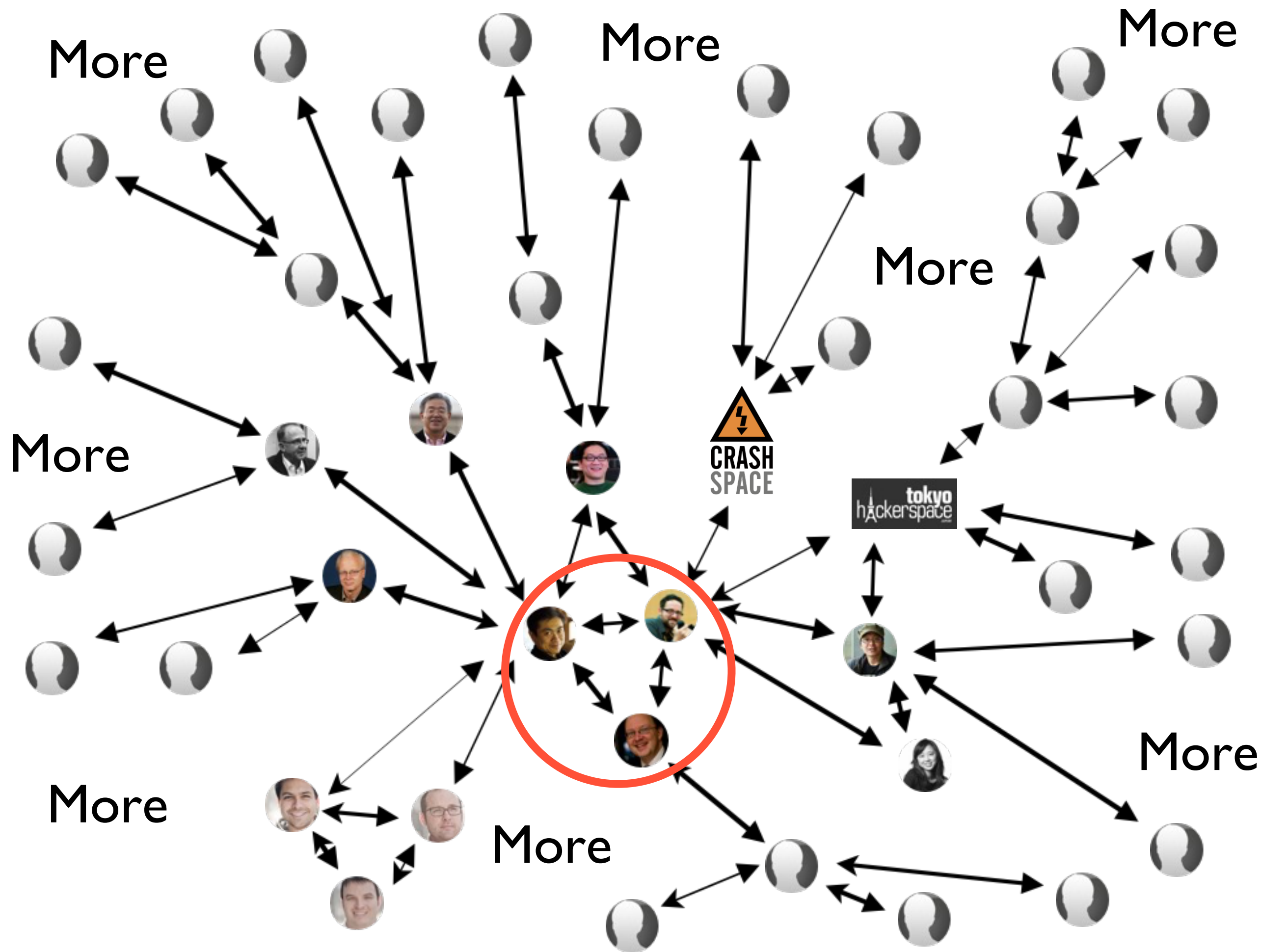
## Comments

- Rob Oudendijk on [Japan, Tokyo, Embassy of the Netherlands](#)
- ray ozzie on [USA, MA, Manchester](#)
- ray ozzie on [USA, MA, Manchester](#)
- Safecast on [USA, Massachusetts, Cambridge](#)
- Safecast on [USA, Massachusetts, Cambridge](#)



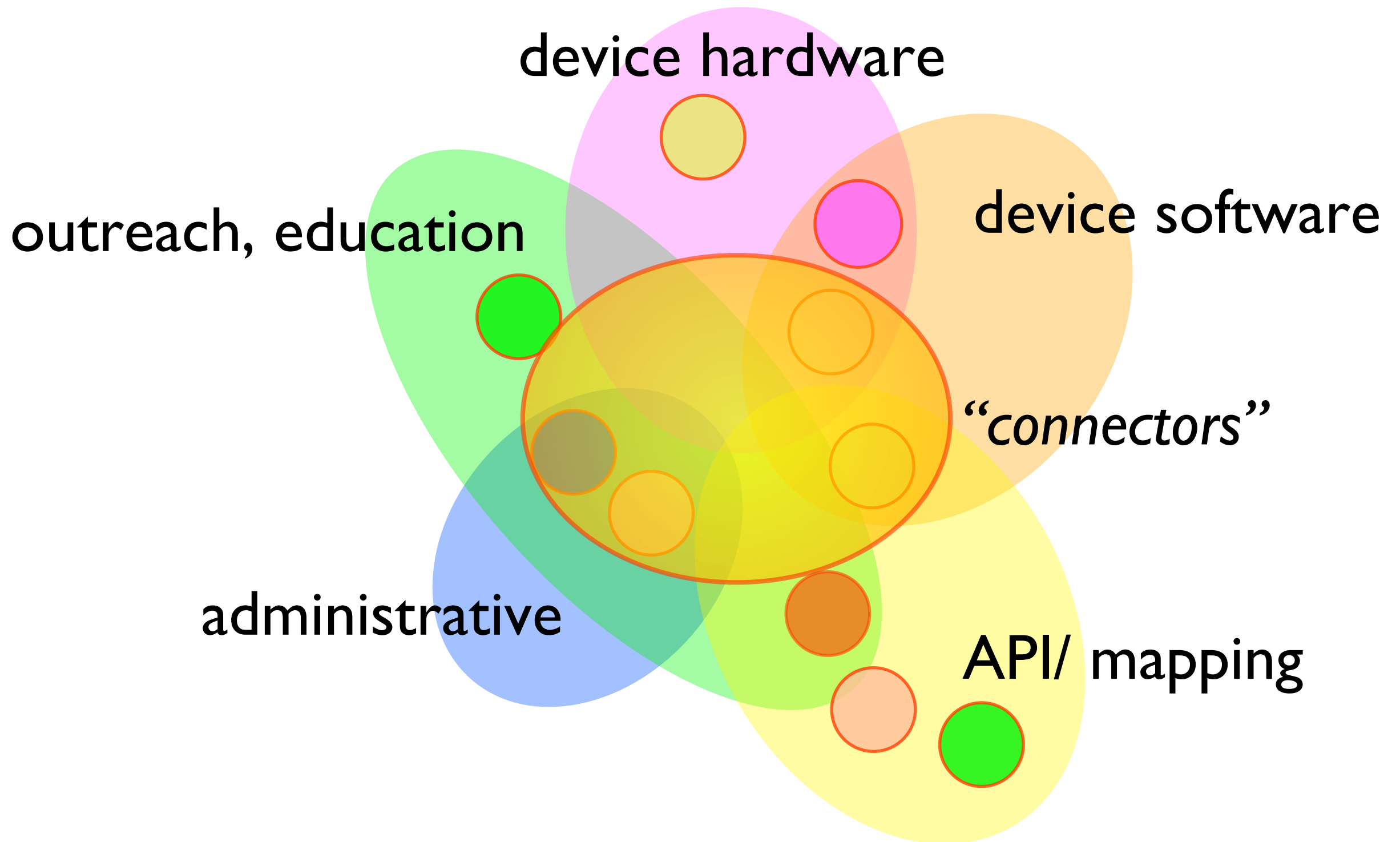
sensor=41, total 8387 records,  $31.8 \pm 7.8$  CPM ( $0.10 \pm 0.02$   $\mu\text{Sv/h}$ )

People





# Our Teams



*Lots of multitasking, multi-competence*







# Building Community

We want to encourage people to get involved.  
This requires skills in education and media.

- Safecast blog, discussion, Facebook, Twitter, etc
- Geiger-counter building workshops
- Talks and presentations
- Media interviews



[Development: Real-Time Interpolation](#) [Safecast OS X](#) [Updated Safecast Webmap!](#) [Safecasting DC](#) [Safecasting Iraq: Open](#) [Safecasting Japan](#)

## ABOUT SAFECAST

Safecast is a global project to empower people with data, primarily by mapping radiation levels and building a sensor network, enabling

[Learn More](#)

## OUR PROJECTS

Safecast is a global sensor network for collecting and sharing radiation measurements to empower people with data about their environments.

[Learn More](#)

## DONATE

Safecast is made possible entirely thanks to tax deductible donations from people like you. We are a registered US 501(c) 3 non profit

[Learn More](#)

## (日本語) BGEIGIE NANOの使用説明-YOUTUBE動画

Sorry, this entry is only available in 日本語.

© Posted on Saturday January 24th, 2015 07:16 PM

[Comment](#)



## HELLO BIKINI !

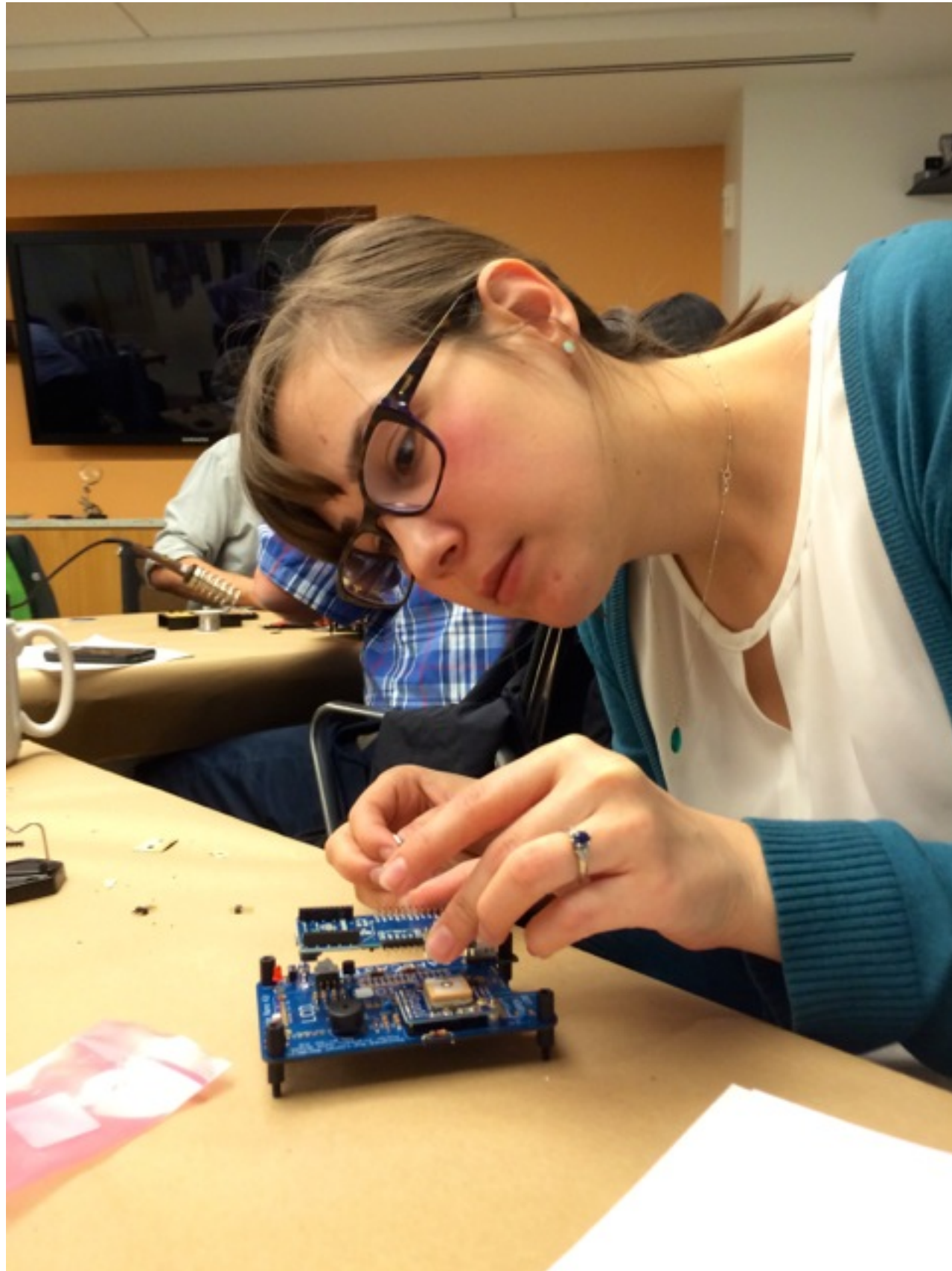
Above: Dr. Buesseler on the beach at Bikini. We recently got some unique uploads from Bikini and Enewetak Atolls, courtesy of Dr. Ken Buesseler, of the Woods Hole Oceanographic Institution OAS-IOB. Dr.

[Go](#)

Build your own  
bGeigie Nano







## **Recent workshops in:**

Tokyo

Fukushima

Kobe

Strasbourg

Taipei

Hong Kong

## **Upcoming workshops:**

Washington, DC

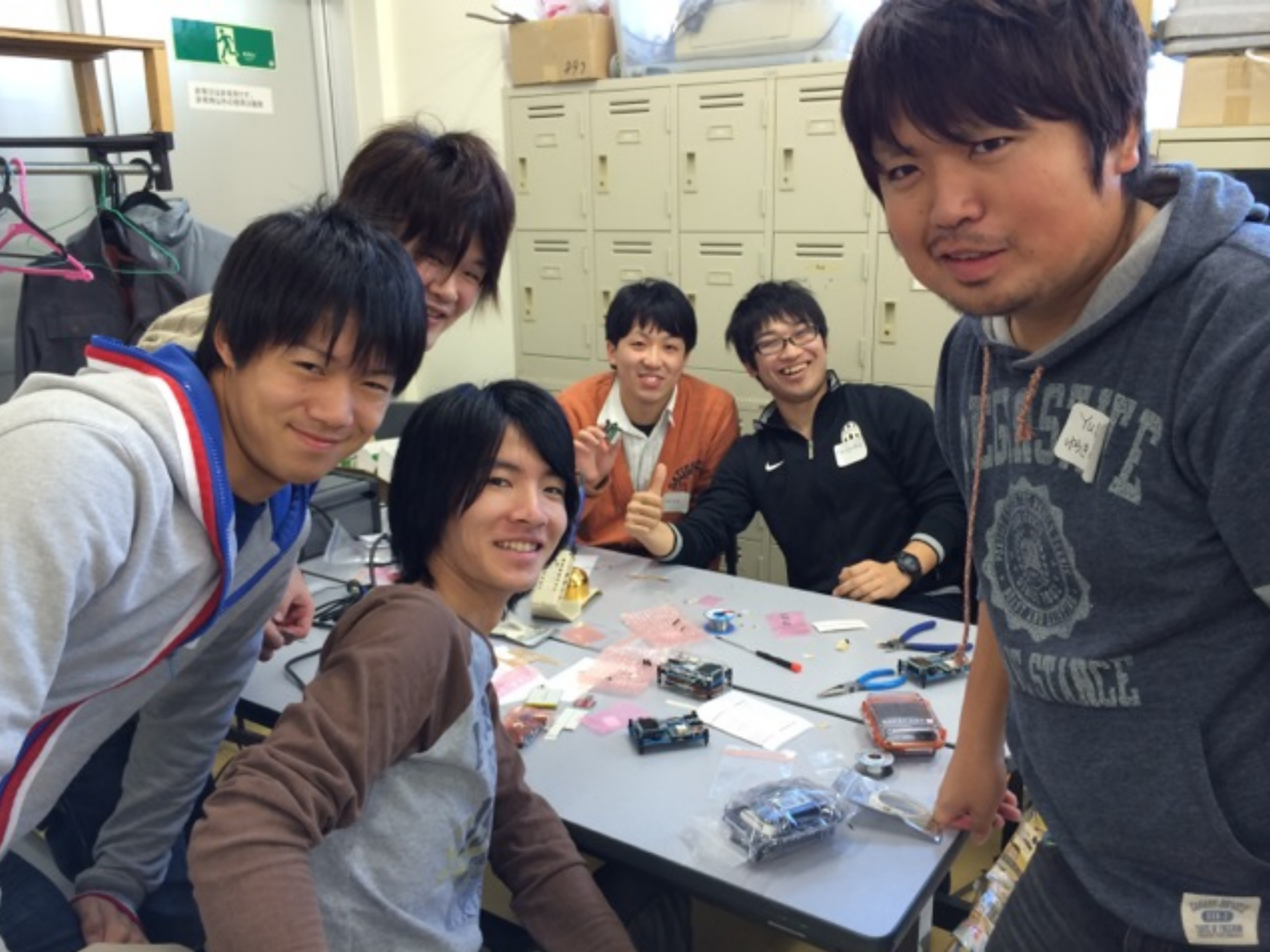
Trieste





Workshop with college students in Koriyama



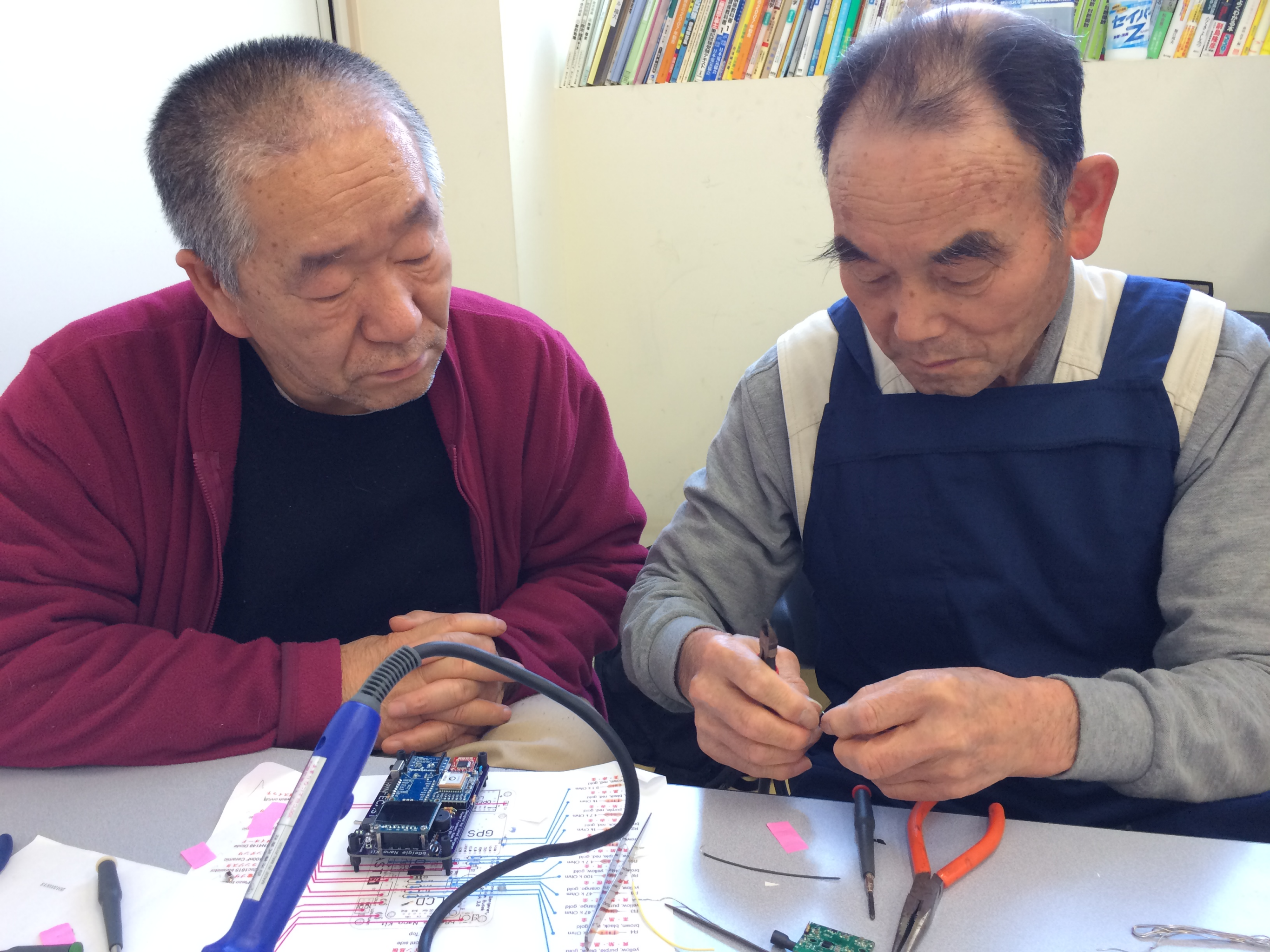






Testing 12 newly-built bGeigie Nanos in a nearby park.









**Safecast Volunteers and Koriyama City Officials**





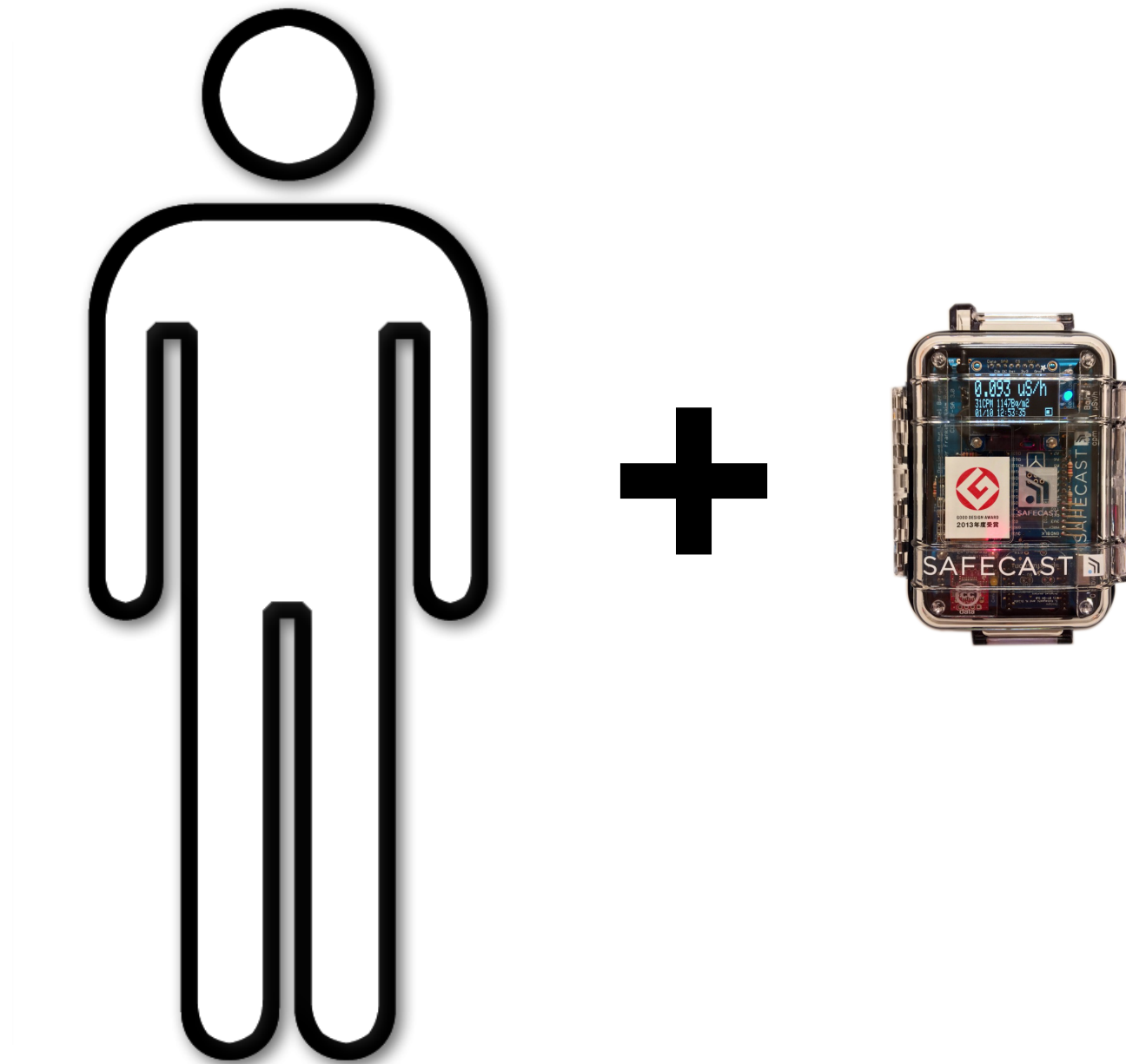
Ten bGeigies were delivered to Koriyama City





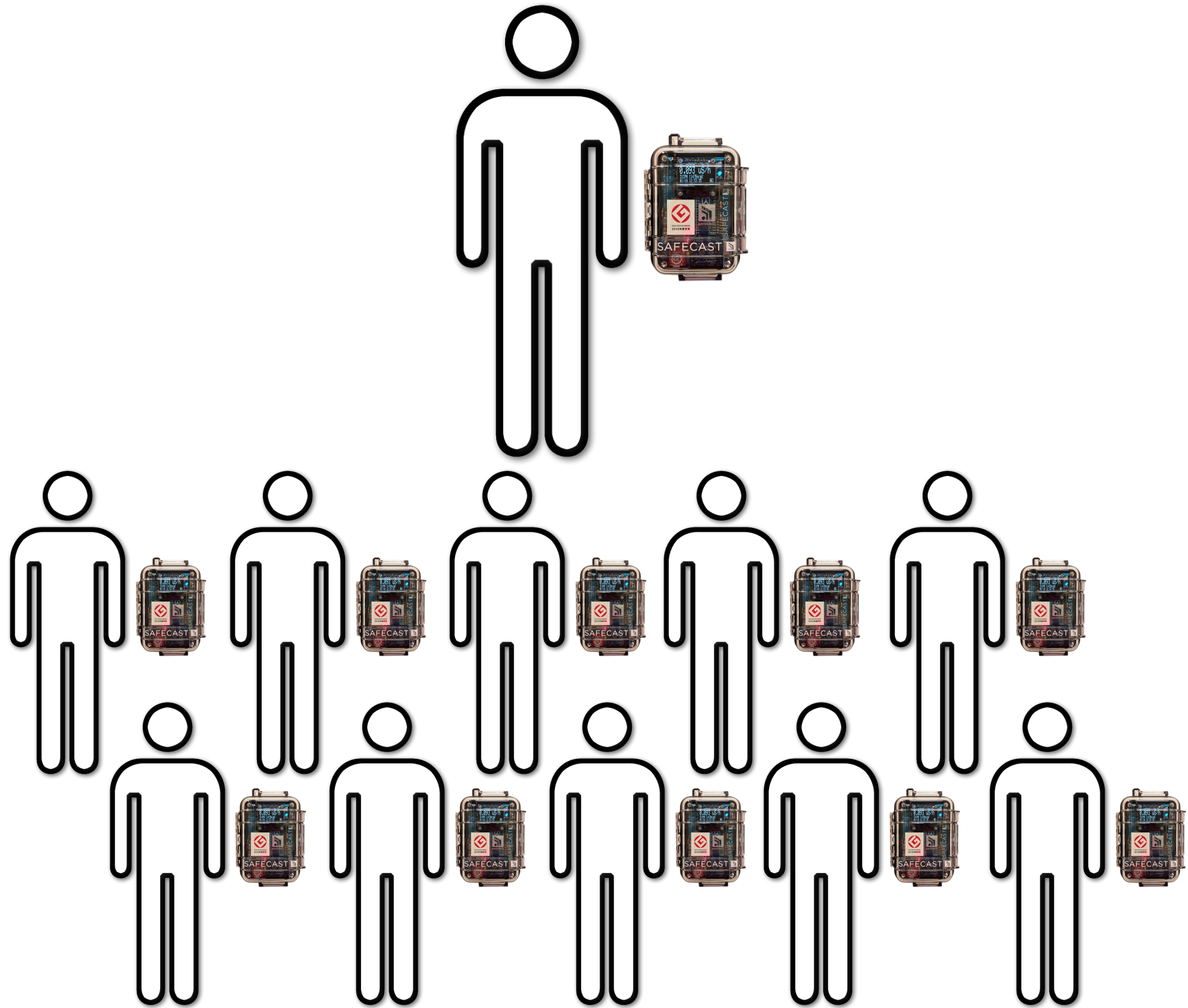
Mounted on postal delivery vehicles



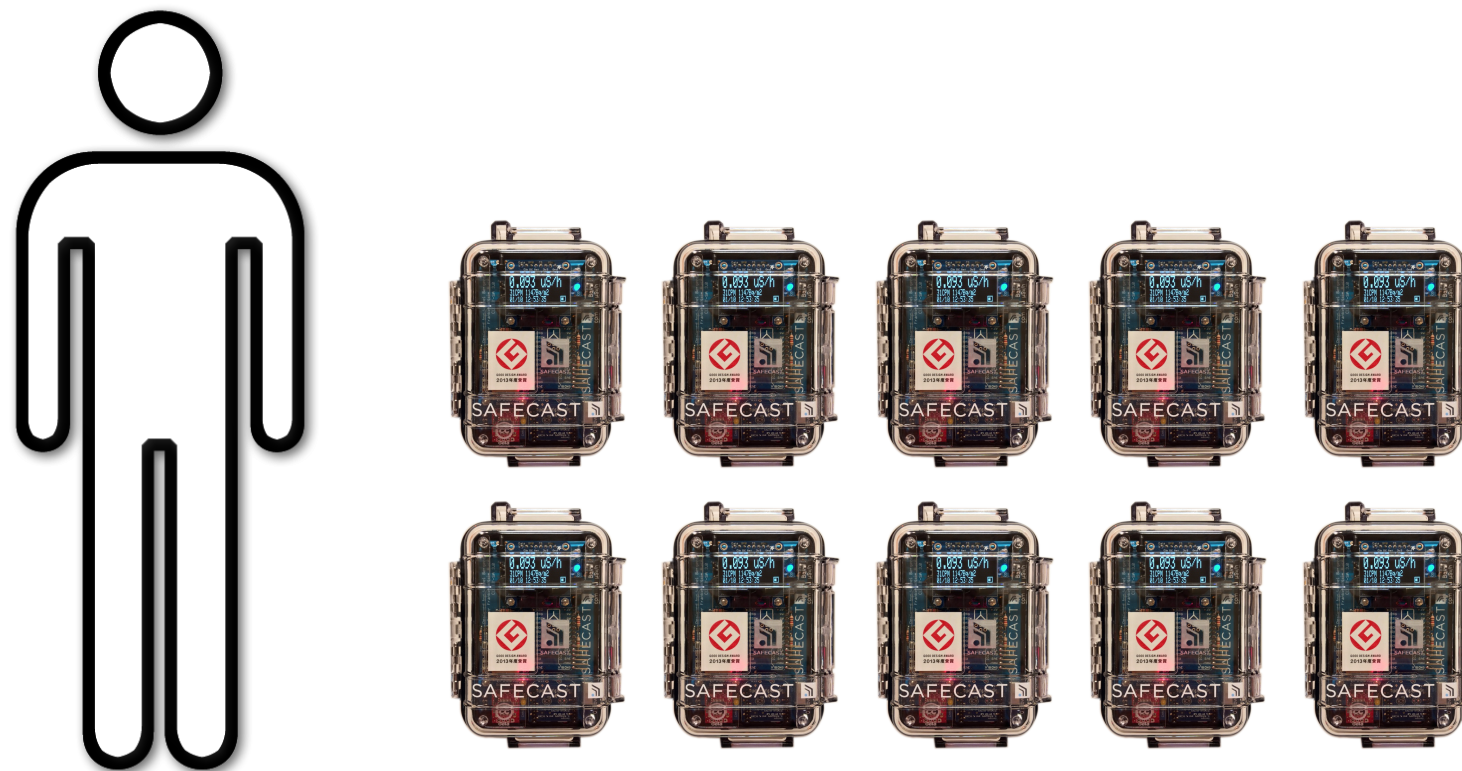


Our experience after Fukushima suggests that in the event of another large radiation emergency additional manpower will be needed.





One person can quickly teach ten others.



We have prepared “airlift crates” of devices that can be quickly sent to emergency areas anywhere in the world.





We've found it's necessary to educate media as well.



# THE SAFECAST REPORT

VOLUME 1 - MARCH, 2015



[www.safecast.org](http://www.safecast.org)



## **SUMMARY:**

Everything we do has been enabled by open hardware and software, new DIY fab tools, and social media.

It required putting into practice agile development and iterative design - “Deploy or Die”

Managing human networks is harder than managing technical systems.

Our credibility depends on our openness.

Govt. agencies are accountable for people's lives and well-being. We aren't, and that makes our work easier than theirs.





SAFECAST

SAFECAST





[www.safecast.org](http://www.safecast.org)