

# Radiation risk assessment through citizen monitoring: challenges and opportunities.

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For the OpenRadiation consortium

# The origins of the OpenRadiation project

- During 90', citizen measurements of radioactivity was tested for the first time in settlements close to the Chornobyl exclusion area. Objective: to promote a practical radiation protection culture (CEPN 286 report)
- Principle of these actions: firstly, listen to inhabitants, then propose specific projects to answer their questioning

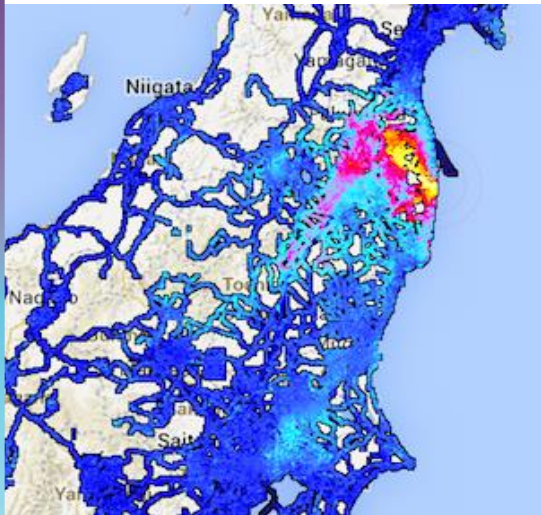


© CEPN, 2005



- The primary objective of citizen measurements of radioactivity is to render radioactivity visible
- The consequences are numerous:
  - Possibility to check the presence of radioactivity
  - Possibility to self evaluate its own risks, opening the way to radiation protection culture
  - Possibility to self-implement protective actions
- The most important consequence is the increased confidence in daily living conditions, which in turn decreases health consequences, especially psychosociological consequences (Lepicard et al, 2005)

# March 11, 2011: The Fukushima NPP accident



Safecast 2012

- Following the Fukushima NPP accident, several citizen initiatives have arisen rapidly to measure ambient radioactivity. The main motivation was a loss of confidence into national authorities.
- Moreover, new tools emerged during this period: interactive mapping of results, communication through social media, which resulted in large data sharing.
- The measurement of radioactivity in such a situation appears as a tool for adversarial debate. Radioactivity measurements turned then to a political object.
- However, the general objectives of citizen measurements remain the same:
  - Allowing everyone to self-evaluate its own risks
  - Providing field data in real time.
- Consequently, the ICRP recommend to include affected citizen into decision-making processes in post accidental situation and to support citizen initiatives of radioactivity measurements (ICRP 146, 2020)



# The beginning of OpenRadiation

- 56 major nuclear sites in France
- Environmental monitoring is made by experts (ASNR), and agreed laboratories from both licensees and their partners, and agreed laboratories from NGOs.
- Following the Fukushima accident, a public demand emerged in France for citizen radioactivity measurements in the vicinity of nuclear plants, powered by both health, educational, social or political reasons.
- The selected system should have some characteristics:
  - A portable apparatus, easy to handle, reliable and cheap
  - The possibility to share measurement results
  - Transparency in data publication and sharing
- A double challenge:
  - Operating such a system in a sustainable way even in the absence of any radiological issues
  - Being useful in case of nuclear or radiological emergency
- The solution : A collaborative approach with NGOs. Start of the work in 2013, official launch of the project in January 2017



## A partnership project:

**RISK**  
Summer  
School  
**2025**



In charge of public  
information about nuclear risk



Design and creation of connected  
tools



Education by and to  
science for pupils



Continuous education and  
public education to major risk  
prevention

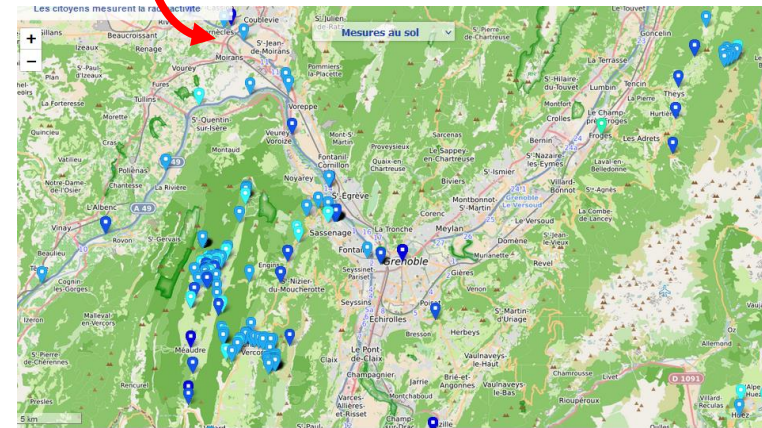
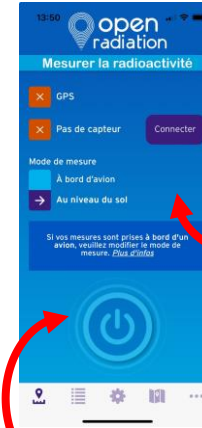


Organism bringing scientific and  
technical expertise to the project



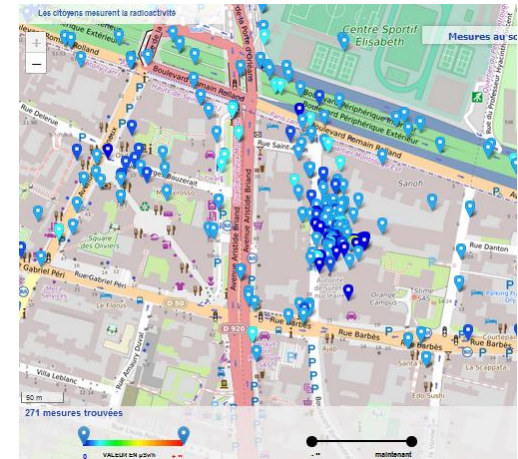
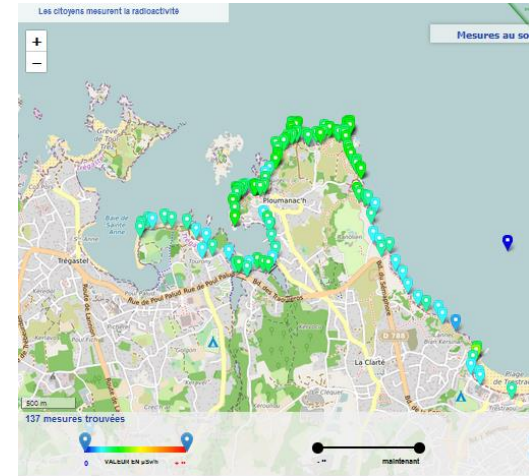
is made of three components:

- A connectable (Bluetooth) radioactivity detector
  - ➔ A Geiger-Müller tube
  - ➔ With an integrated calibration function
- A smartphone apps
  - ➔ To drive the detector, collect metadata and publish measurement results
  - ➔ Compatible with several models of detectors
- A website: [www.openradiation.org](http://www.openradiation.org)
  - ➔ To collect data, whatever the type of measurement and who made the measurements
  - ➔ To visualize the data and to make them available to the community
  - ➔ To facilitate exchanges between users, communication and project development.



# An overview on August 1<sup>st</sup>, 2025

- Source codes for the map and the apps are in **open source**
- All the measurement results are in **open data**
- Associated publications are (or will be soon) in **open access** (HAL)
- Possible loan of detectors to citizen
- **1,000,000** measurement results available on the interactive map, approximately 100,000 new results each year
- 350 active contributors, more than 1,000 people registered
- approximately 450 active detectors worldwide
- All the measurement results are published under the responsibility of the contributor
- None of the published result is removed: essential to keep confidence from contributors



# FAQ 1: What is the reliability of the detectors?

- The technology chosen, a Geiger-Müller tube, is a long-standing proven method and not prone to time shift
- GM tubes are tested before being used. The response tolerance is  $\pm 10\%$
- 50 counts have to be registered before the measurement can be stopped. The resulting maximal measurement uncertainty is  $\pm 15\%$
- Test of first-generation detectors (7 years of service): time shift less than 5%

But, but, but ...

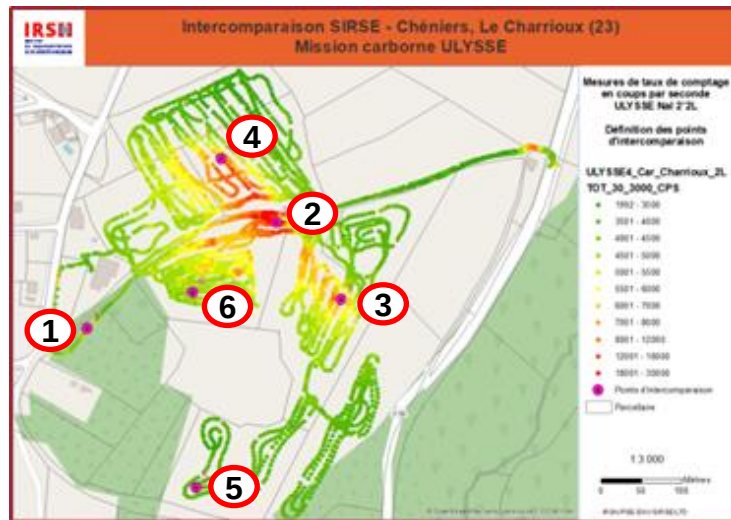
- For citizen, no duty to make their detector calibrated or simply tested with a reference source
- No scientific publication about intercomparison of citizen detectors vs. professional detectors

*⇒ A persistent doubt among professionals ...*

# An intercomparison study

- Made in 2019 by former IRSN
- Comparison of 9 citizen detectors with professional apparatus in an experimental area including high dose rate area

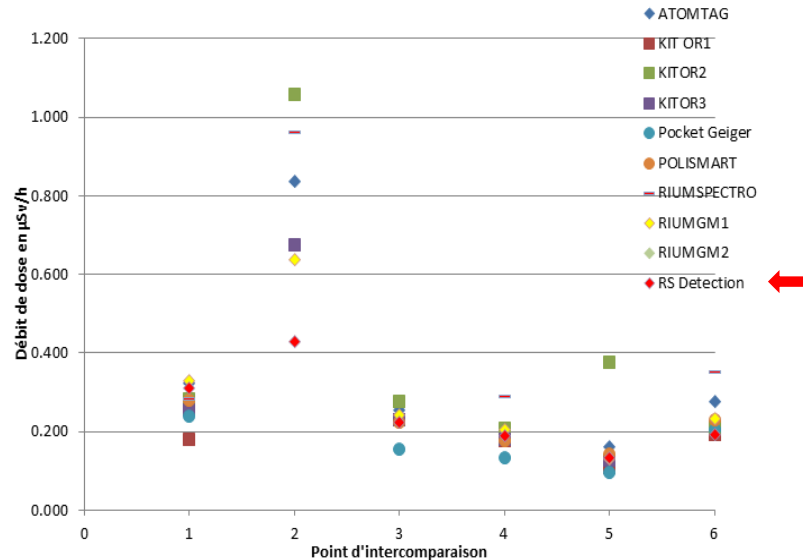
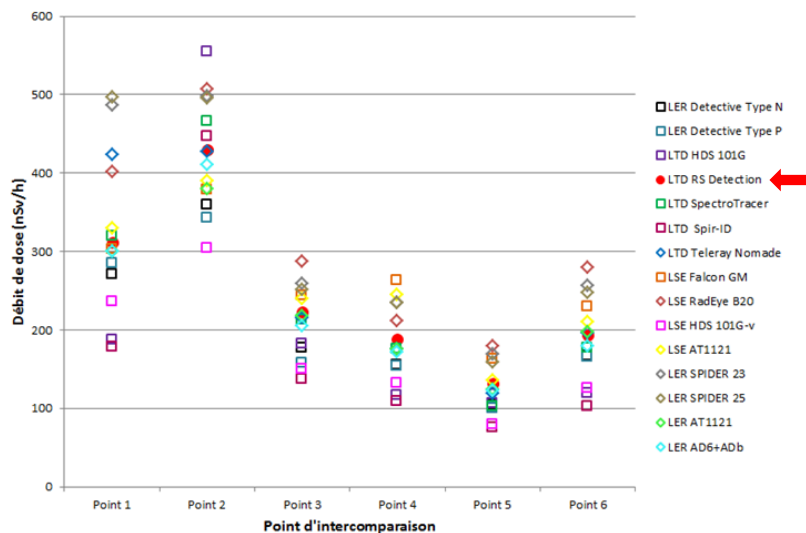
- The study area was first mapped with a high precision detector on a all-terrain vehicle
- 6 reference points were then defined and precisely measured with a reference apparatus



V. Bruno, ASNR, PSE-ENV/SIRSE

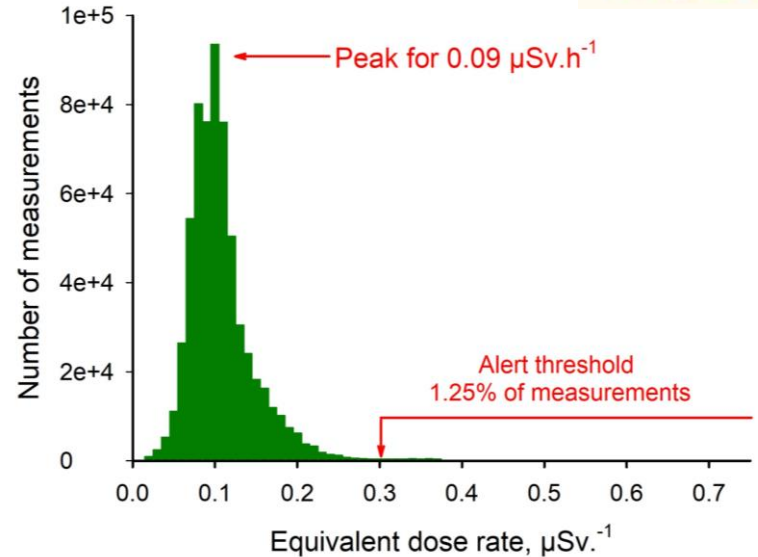
# An intercomparison study: results (1)

- Citizen detectors have a comparable response as compared to professional detectors
- However, a high sensitivity to internal temperature of citizen detectors



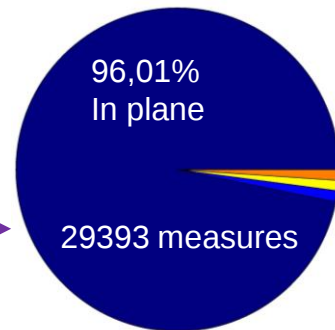
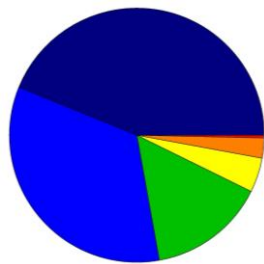
## FAQ 2: what about false positive results?

- All results are published without restriction and none of them are removed.
- However, it is possible to obtain elevated results whatever the origin is.
- An alert threshold is set at a dose rate of 0,3  $\mu\text{Sv.h}^{-1}$  (1,25% of published measurements)
- All alerts are treated with a search for an explanation and a comment is published on the measurement.
- Less than 0,02% of published results remain unexplained



# Study of alerts received during April to December 2024

75 506 published measures



DR > 0,3  $\mu\text{Sv/h}$ ?

Yes: 30613 measures

user's tag

Non: 44 893 measures  
No comment

Yes: 9

No: 1211 measures remaining

Altitude > 3 000 m?

1220 measures remaining

Yes: 738

0,3 < DR < 0,8  $\mu\text{Sv/h}$ ?

No: 473

Possible origins:

- 1- Geologic, including radon
- 2- Urban objects
- 3- Unknown origin
- 4- Travel in Japan
- 5- Tests with sources
- 6- Technical defects

**Contacts with contributors**

Possible origins:

- 1- Tests with sources
- 2- Travel in Japan
- 3- geologic, including radon
- 4- Urban objects
- 5- Unknown origin
- 6- Technical defects
- 7- Manual registering

# Study of alerts received during April to December 2024 (2)

Analysis of the 1211 remaining measures:

- 2 manual reporting, with the use of a hand-made calibration function: false results.
  - 2 calibration studies by 4 contributors. 979 measurements  $>0,3 \mu\text{Sv.h}^{-1}$
  - 63 measures made in Japan, in the vicinity of the Fukushima NPP and ISF
  - 128 measures with a geologic origin (coherence with the environment when looking at the map)
  - 22 measurements of hot spots with either a geologic origin or a human origin
  - No case of technical defect identified
  - 17 measurements with an unknown origin
- 
- In this temporal series,  $<0,002\%$  of measurements remain unexplained
  - A part of these (11/17) is due to anonymous measurements. No way to contact and discuss with the contributor

|            | 0,3<DR<0,8 | DR>0,8 |
|------------|------------|--------|
| N measures | 738        | 473    |
| Manual     | 0          | 2      |
| N contrib. | 24         | 14     |

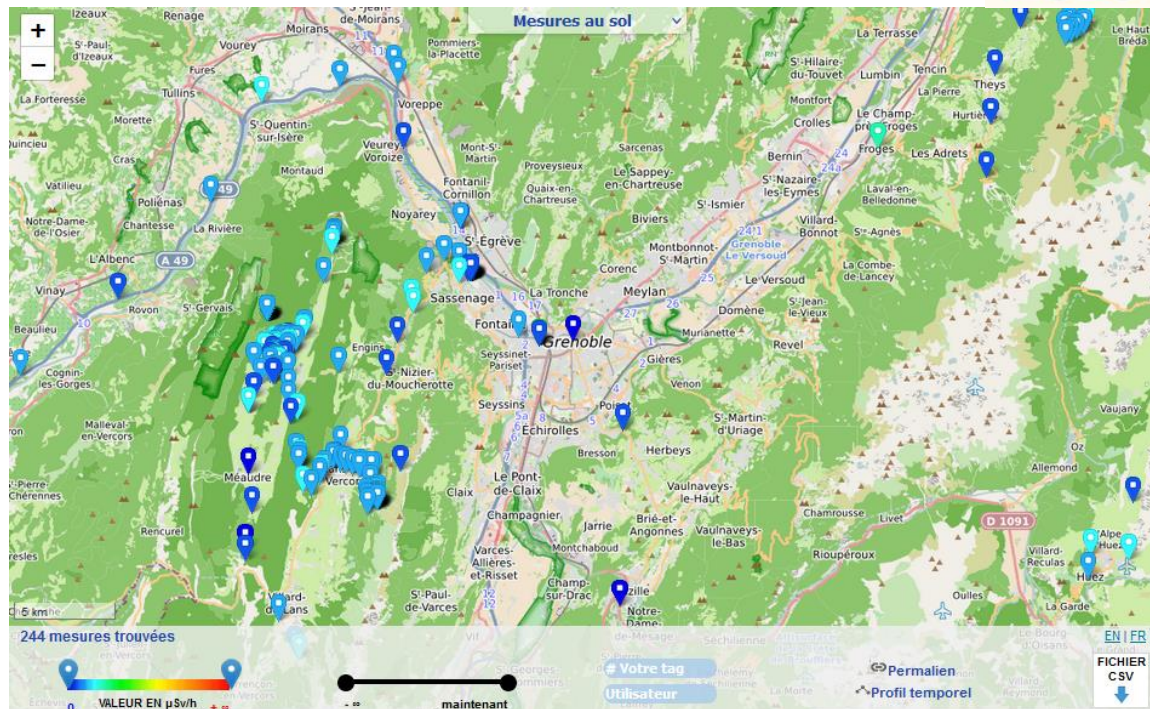
Geologic?

Source?



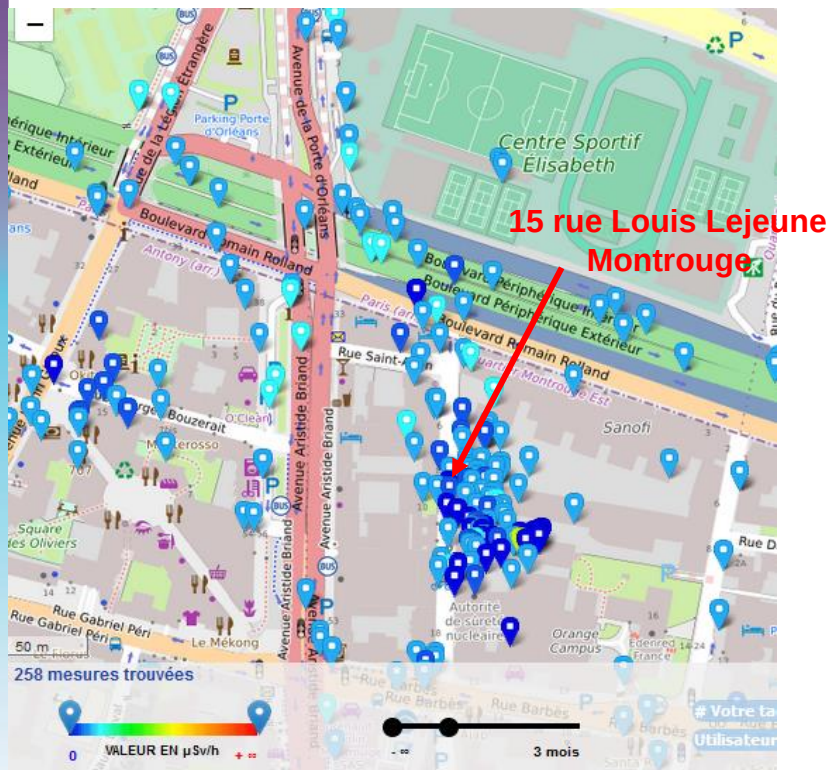
# A principle of auto moderation

- Contributors can interpret the data directly in the interactive map by themselves
- For that, some tools are proposed:
  - Selection of a range of values
  - Selection of a date range
  - Selection of a specific user
  - Selection of a specific project
  - Visualization of the temporal profile of measurement
  - Obtention of a CSV file with all the data displayed on the screen, limited to 400 last measurements



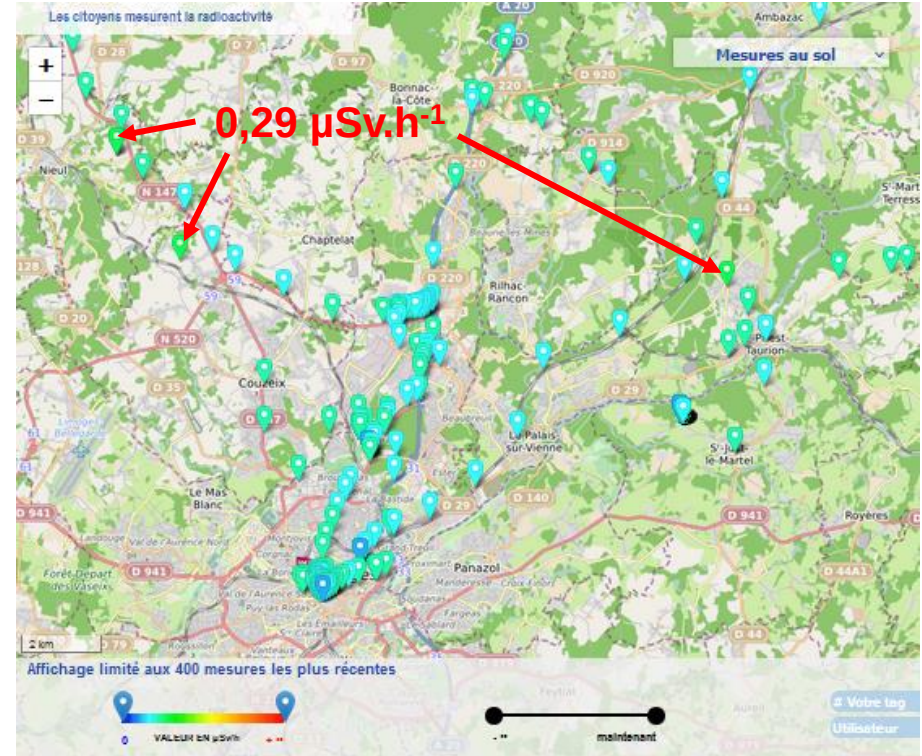
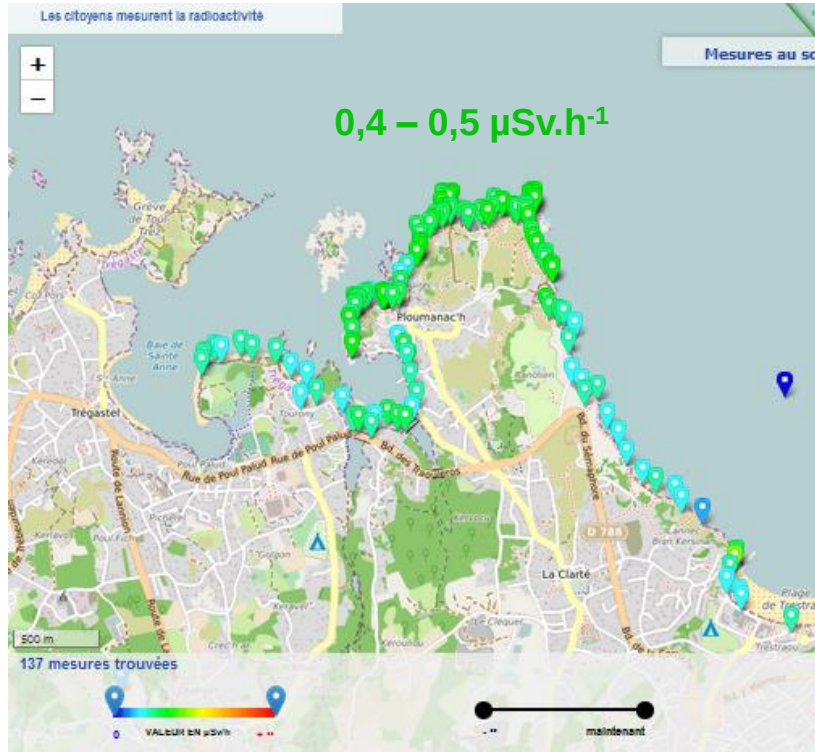
With these tools, contributors are able to distinguish between normal situations and abnormal situations without specific knowledge

# Some few examples of auto moderation (1)



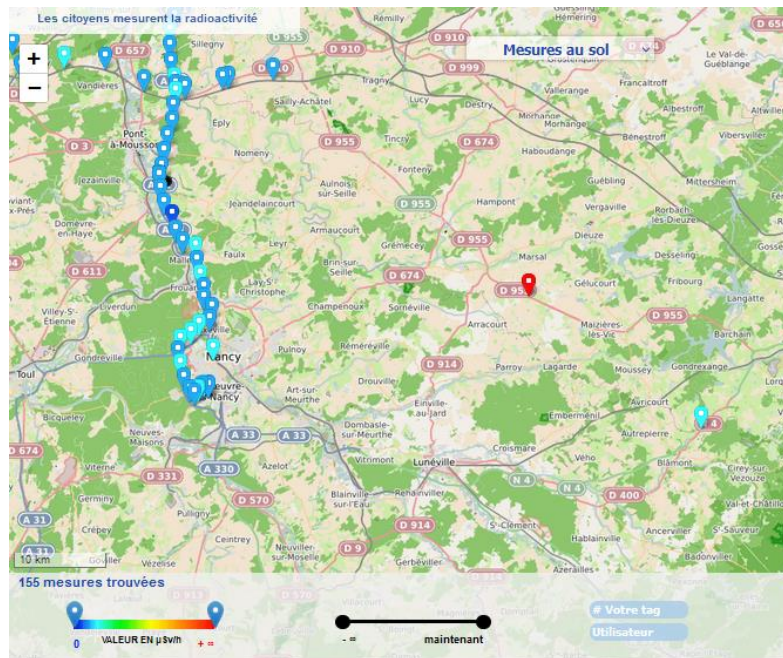
A single measurement abnormally elevated among numerous other measurements in a limited range of dose rate : who is right?

# Some few examples of auto moderation (2)



Some measurements naturally elevated with a geologic origin: a vision of a moderately elevated background area

# Some few examples of auto moderation (3)



210  $\mu\text{Sv}\cdot\text{h}^{-1}$ : a manual reporting with a false value

The measurement was commented to explain the mistake and to give a warning about manual reporting



A group of elevated values :

A reliability study of citizen detectors with a reference source.

All the measurements were commented

# FAQ 3: Which usefulness for OpenRadiation data ?

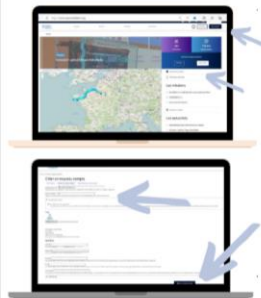
## *Mainly a pedagogic activity*



### Comment créer son compte ?

La création d'un compte OpenRadiation se fait depuis le site : [www.openradiation.org](http://www.openradiation.org)

L'inscription sur le site permet d'identifier et de récupérer facilement toutes vos propres mesures. De plus, être inscrit permet de créer ou de participer à des missions. Une mission rassemble les participants autour d'un objectif commun, à réaliser dans une durée définie. La mission est gérée par un chef de mission. Si vous souhaitez créer une mission, merci de contacter le webmaster en utilisant le lien de contact. Si vous souhaitez participer à une mission existante, veuillez contacter directement le chef de mission. Les missions peuvent être soit publiques (toutes les données sont accessibles au public), soit privées (accessibles uniquement aux participants).



Sur la page d'accueil du site OpenRadiation :

Cliquez sur « s'inscrire »

Remplissez votre adresse email et renseignez un nom d'utilisateur

Cliquez sur « créer un nouveau compte »

Un message de bienvenue contenant des instructions supplémentaires est envoyé à votre adresse e-mail :

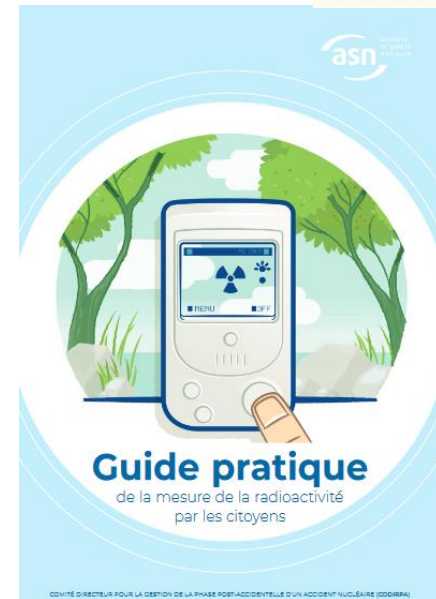
Cliquez sur le lien pour créer votre mot de passe sur le site.

Le lien n'est actif que pendant 24 heures et uniquement pour un usage

- Mainly towards scholarship public and dedicated publics (CLI for instance)
- A tool allowing to speak about radioactivity and to develop awareness-raising actions facing nuclear risks:

- Science day, disaster risk reduction day, “let’s know” festival, ...
- awareness-raising actions with CLI
- Provision of tools: tutorials, mounting notice, advice about measurement protocols, citizen measurement guide (in French ...)
- Community animation: newsletter, contributor’s day, events

*Not sufficient for the sustainability of the project*



*We have to make Openradiation evolving towards a true citizen science tool*

## FAQ 3: Which usefulness for OpenRadiation data ? (2)

- Citizen organize their measurements according to their personal interest:
  - Living places: home, garden, working place, school, ...
  - Ecological/health/political reasons
- Places measured by citizen are rarely the same as the ones measured by institutional environmental monitoring: notion of adversarial results
- However, these measurements are complementary
- In usual situation there is no radiological issue in our environment.
- Need to develop other functions to ensure the project's sustainability :
  - A tool for citizen science: SSH, environmental science, ...
  - A tool for environmental monitoring of radioactivity, complementary to the official monitoring: discovery of “hot spots”.
  - In case of emergency or post-accidental situations a supplementary dataset
- Whatever the planned function, absolute requirement to make a triage into the data
  - Contextualized and automated analysis
  - Collecting data according to the planned use
- Possibility of using a citizen science approach at all steps of any kind of project.



# An alert analysis flowchart

The analysis previously shown allows to detect abnormalities, but is limited by several points:

- Only if the published value is above the threshold alert
- Limited to available metadata

In most cases a plausible explanation can be found through either to a contact with the contributor or an examination of the geographical information on the map.

- Case of measures in Japan
- Case of detector working in an X-rays luggage controller
- Geological environment

Time consuming analysis!

Need for an automated, contextualized analysis using various sources of data

Ask for IA tools : A European funding demand is ongoing, for a citizen science project implicating our contributors.

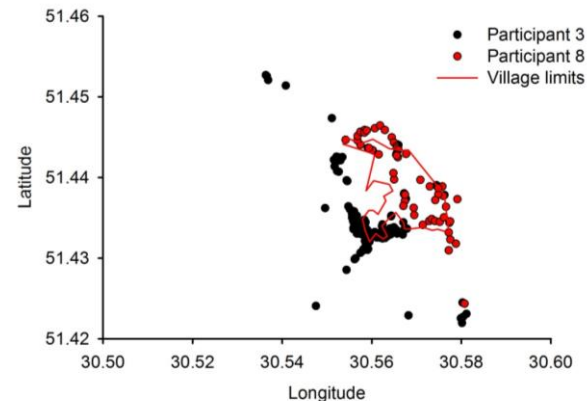
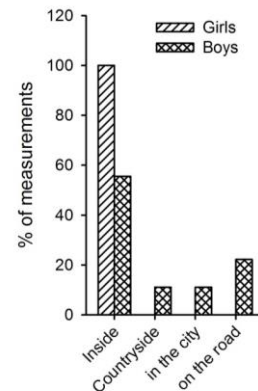


# The Territories project

- Measure of ambient dose rates by a group of pupils (between 14- and 17-year-old) in a village close to the Chernobyl exclusion zone
- Principle: Measure what you want, where you want, when you want
- Two advices:
  - If possible, make measurements 1m above the ground
  - Don't put yourself into danger!
- Data harvest, co-analysis and co-interpretation of the results
- Allowed to understand some behaviours
- Allowed to detect some hot spots and to explain them



First measurement

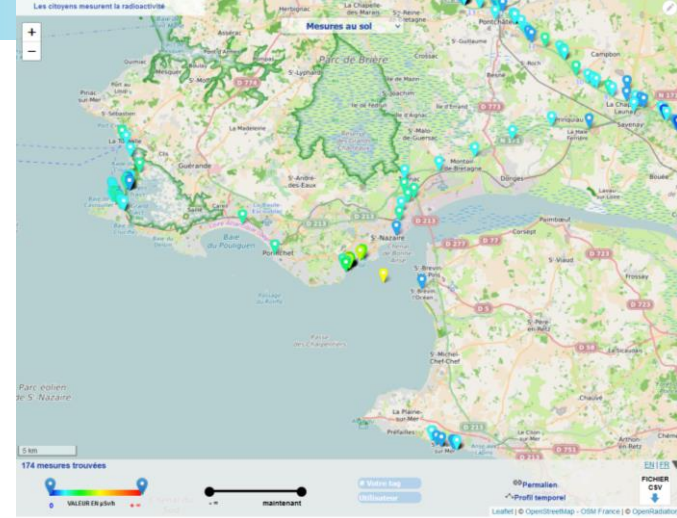


*A project in-between collective intelligence and participatory science*

# Environmental monitoring

- Ambient dose rates along the north bank of the Loire river more elevated as compared to what is observed in the countryside.
- Measurements from a contributor, made in May 2023.
- The highest dose rates are on the Trebezy beach, in the city of Saint Nazaire
- Confirmation of elevated ambient dose rates by an NGO (CRIIRAD) in September 2023, with a hotspot at 78,5  $\mu\text{Sv/h}$
- IRSN characterized the origin of this hotspot: presence of monazite, a naturally occurring mineral enriched in thorium and uranium
- No radiological threat for the population

*The discovery of a true hot spot*



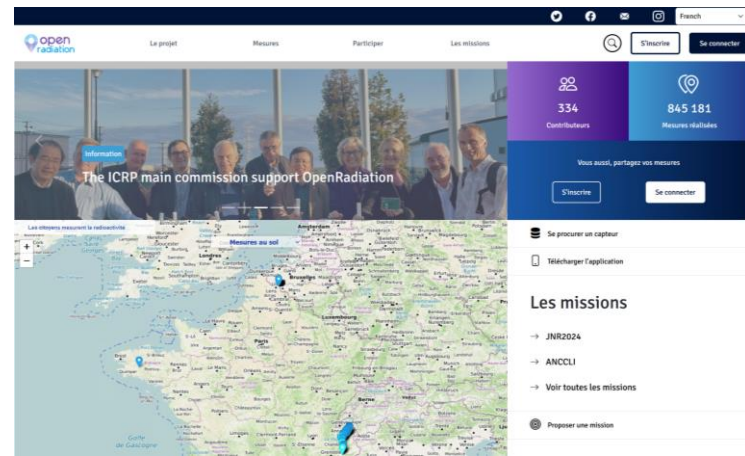
# The future ?

- Make Openradiation recognize, especially in the scientific community, but also in the radiation protection community and in the risk communication field
- Pursue the development of animations, especially towards scholarship public and people living close to NPP; scientific mediation actions, detector mounting sessions,
- Purse support to contributors: videos, tutorials, newsletter, discussion forum, etc.
- Making the website evolving, according to the needs of the contributors
- Launching new actions: survey study, participation to European projects, automated analysis of the data, etc.

*Collaborations and projects are welcome!*



**RISK  
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2025**





Thanks a lot for your attention !

*Questions? Wish to have a detector ?*

[contact@openradiation.org](mailto:contact@openradiation.org)

[openradiation@gmail.com](mailto:openradiation@gmail.com)

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