Safecast – a Citizen Science project for ambient dose rate mapping

Quality assurance issues

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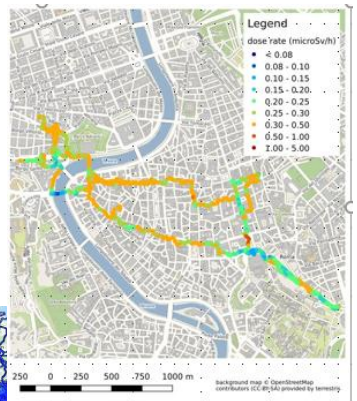
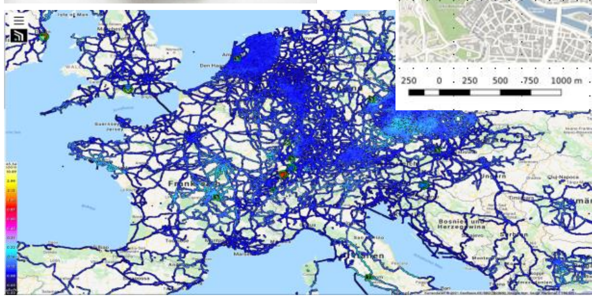
SAFECAST bGeigie Nano

mobile monitoring&mapping for public





educative! facilitates understanding ambient radiation, measurement and radiation protection

QA issues – partly still to be solved

!!! Lack of awareness about importance of QA issues can result into severe misinterpretation !!!

Uncertainty of a result
- has significant influence on its interpretability
- may destroy reliability of conclusions and decisions based on it

CALIBRATION: **count rate** [CPS] **=> ambient dose rate** [nSv/h] depends on

- **Detector properties:** sensitivity, energy response, linearity, etc
- **Conditions of measurement:** standardised measurement protocol
- **Device variability:** variability between individual devices
- **Detector handling:** abide conditions of measurement

QUALITY ASSURANCE (QA)

- **Characterization of the detector**
  by manufacturer and/or user verified by certified laboratory;
- **Measurement protocol -** the difficult and non-conventional part!
  deviation from standard protocol leads to additional uncertainty;
- **Uncertainty budget** - different sources
  - systematic - counting statistics, uncertainties from calibration, etc.
  - random - not keeping measurement protocol

EGU General Assembly 2021

vEGU21: Gather Online | 19–30 April 2021

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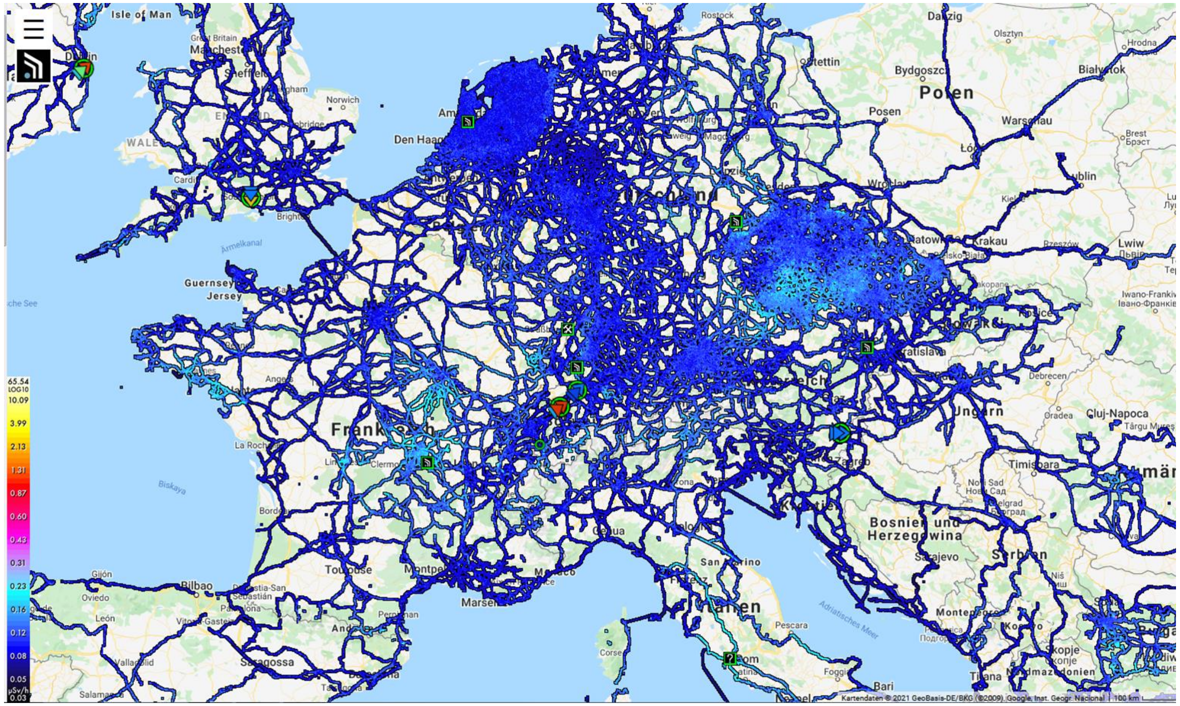
About SAFECAST

- Safecast was initiated 2011 after Fukushima
- standard instrument bGeigie Nano: GM counter + GPS, measurements in log file on SD card

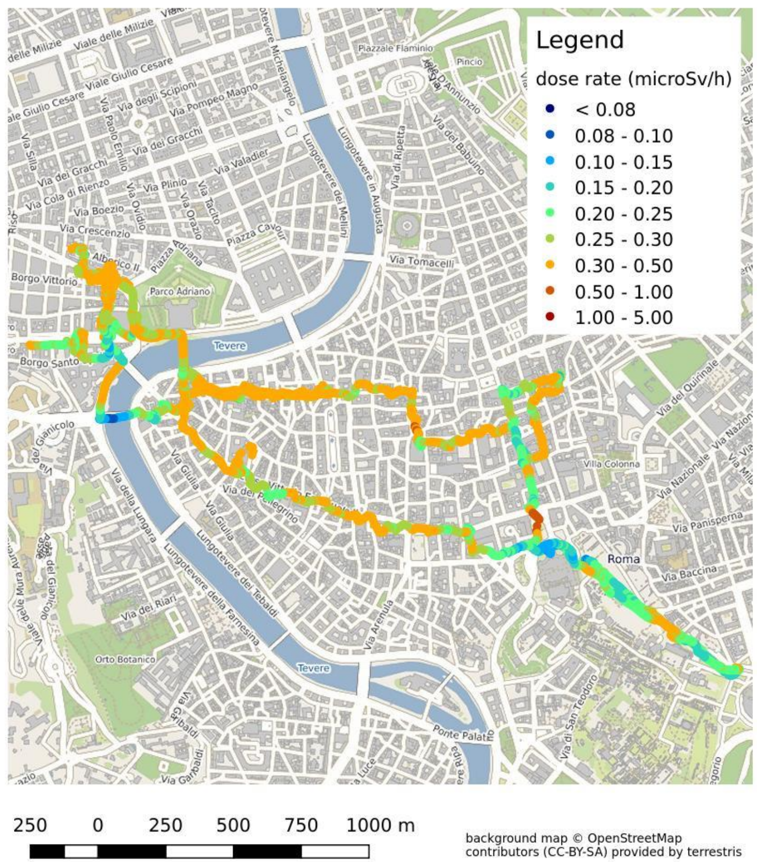
SAFECAST



https://safecast.org/

bGeigie Nano benefits

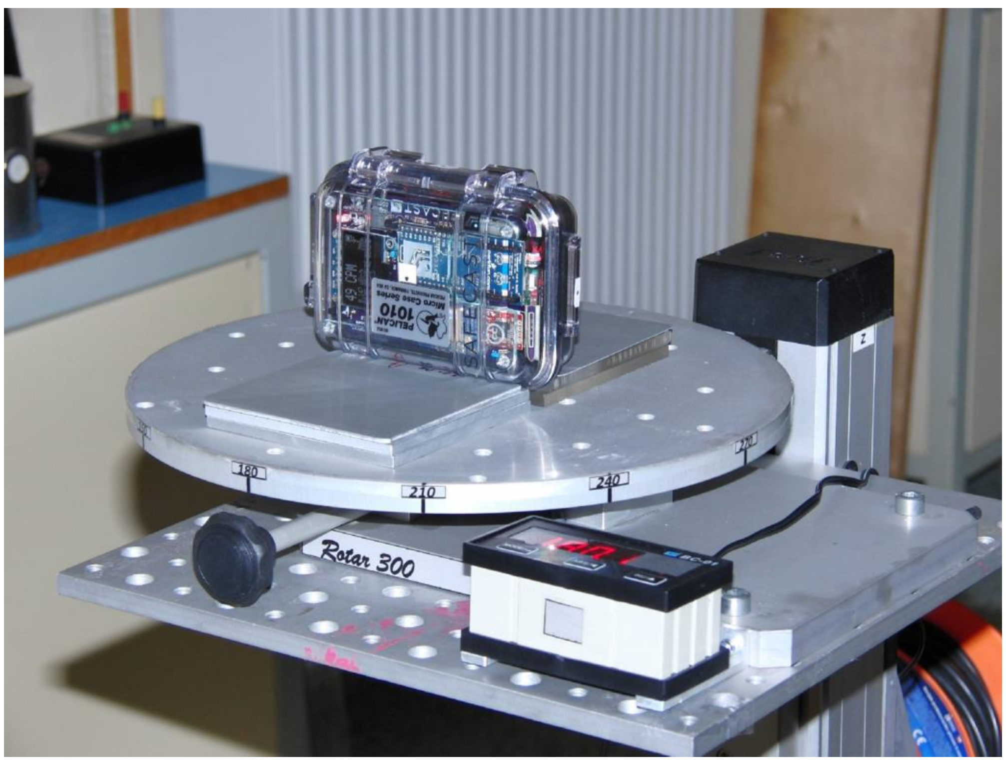
- easy handling; allows acquisition of large amounts of data, more than professional institutions can usually achieve;
- educative! - facilitates understanding ambient radiation, radiation measurement and radiation protection.



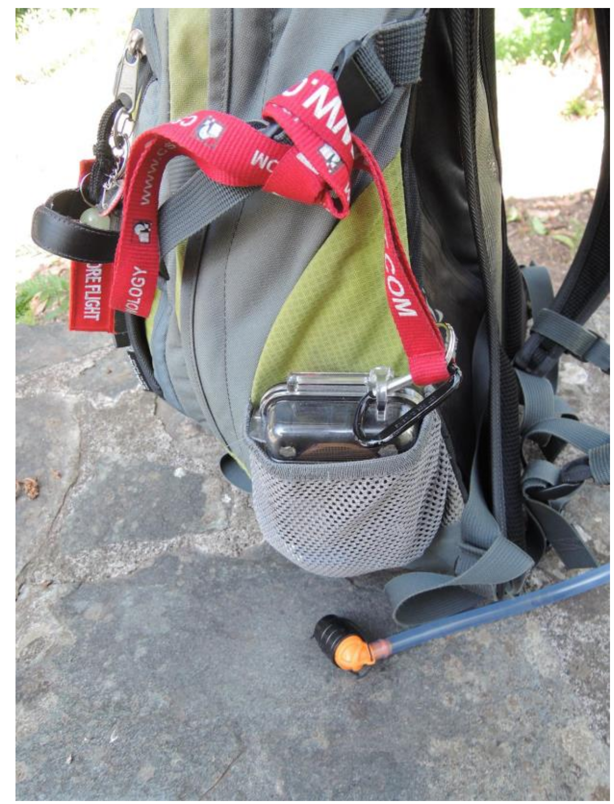
QA issues – partly still to be solved

- traditional metrology: characterization of the instrument in standard configurations/conditions, using **accredited** methods
- additional: citizen scientists are no trained metrologists

→ device handling **not assured**, measurement protocol often **not abided**, understanding uncertainty not deep



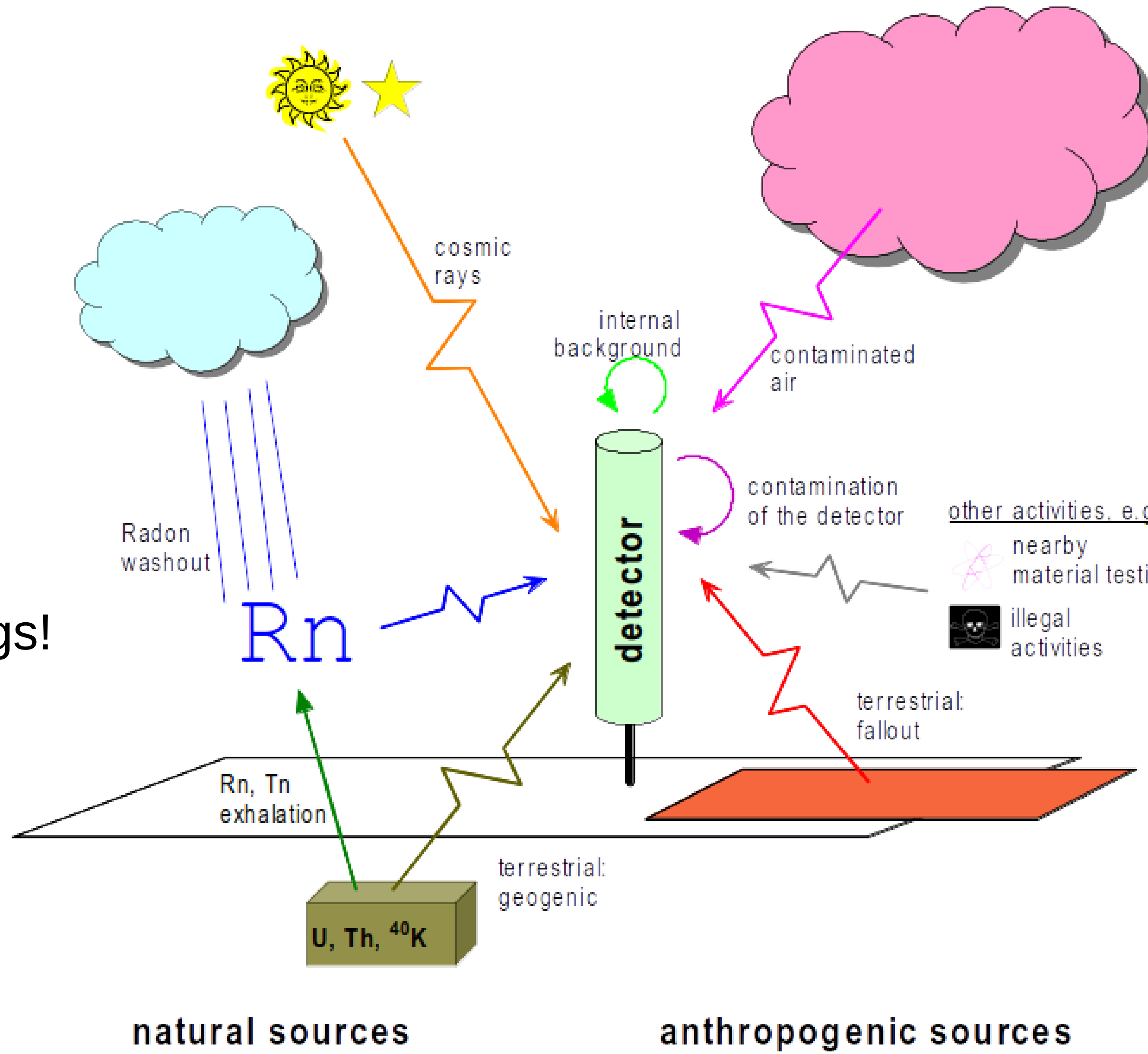
vs.



Physical origin of ambient dose rate

The signal recorded by a G-M counter is the sum of contributions from various sources.

Important to know for interpretation of readings!



(source: AIRDOS report; European Atlas of Natural Radiation)

Composition of the ADR signal

registered counts =	
internal background	radioactivity in detector components, electronic noise
+ cosmic radiation	mainly muons; neutrons almost not registered by G-M; intensity depends mainly on altitude above sea level and (minor effect) geomagnetic latitude
+ atmospheric gamma radiation	natural: • Rn progeny (^{214}Pb, ^{214}Bi) – usually 1-30 Bq/m³ ^{222}Rn, high temporal variability; 10 Bq/m³ ^{222}Rn → ca. 2.5 nSv/h. Thoron progeny usually much less. • Cosmogenic radionuclides ^{7}Be, ^{22}Na: very low ADR artificial: • can be substantial temporarily after releases, e.g. ^{132,131}I, ^{132}Te after Chernobyl • long term: resuspended fallout: very low ADR
+ terrestrial gamma radiation	natural: • ^{40}K, ^{238}U, ^{232}Th series γ radiating radionuclides in the ground; • Rn progeny washed to the ground after rain: can be substantial effect! artificial: Fallout from atmospheric bomb tests and accidents (Chernobyl); mainly ^{137}Cs

Calibration

Conversion of count rate, counts per second

→ ambient dose rate ADR, nSv/h

Conversion factor depends on

- Detector properties:
  - sensitivity
  - energy response
  - dose rate linearity
  - internal background
  - cosmic response (muon and γ response are different)
  - variability between devices

→ characterization of the instrument;
classical metrology, to be done in laboratories

- Detector handling:
  - height above ground,
  - angular orientation of detector against vertical
  - shielding (car, human body, etc.)

→ definition of measurement protocol,
to ensure reproducibility and repeatability

Quality assurance (QA)

- Characterization of the detector:
  by manufacturer or user, ideally verified by certified laboratory; follows established procedures
- Measurement protocol:
  - This is the difficult and non-conventional part!
  - Citizen scientists are usually no trained metrologists; therefore little aware of the influence of the protocol on the result.
  - Deviation from standard protocol leads to additional uncertainty; current work: through particular experiments involving intentional "mishandling" estimate this uncertainty component.
- Uncertainty budget:
  - different sources: counting statistics, systematic uncertainties (from calibration uncertainties)
  - Uncertainty of a result has very important influence on its interpretability and on the reliability of conclusions and decisions based on a measurement (or a set of measurements) !

Lack of awareness about importance of measurement protocol and uncertainty can lead to severe misinterpretation!

Bundesamt für Strahlenschutz

SÚRO

Thank you for your attention

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