

System Integration and Environmental Probe Networks

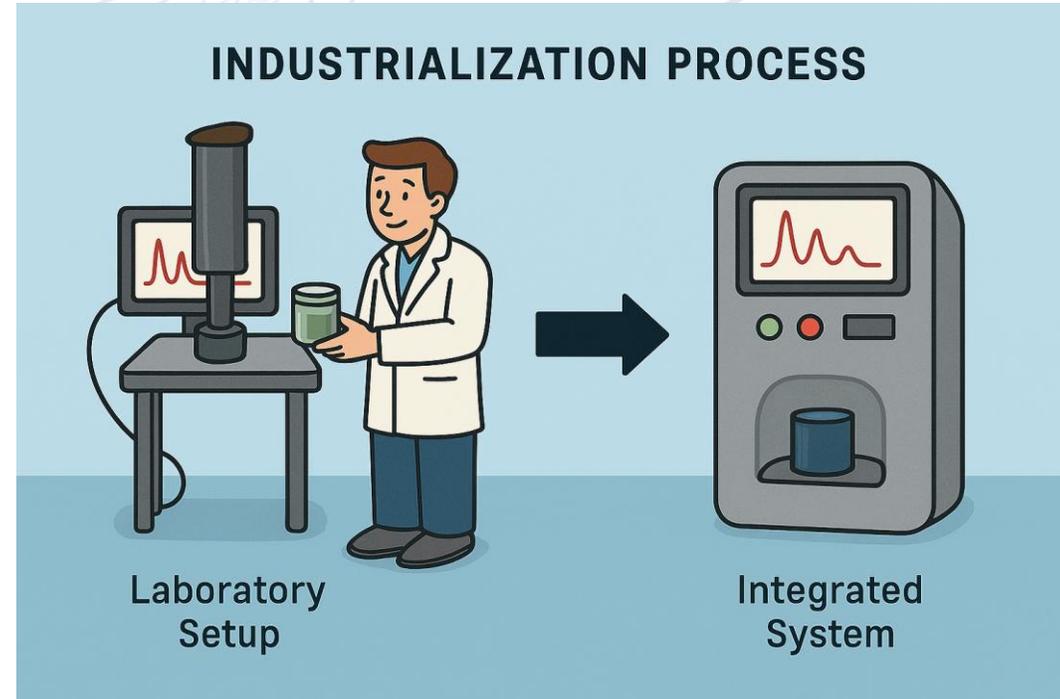
CAEN Winter School 2026

Viareggio, Italy, March 3rd, 2026

[Erica Fanchini](#)



- **CAEN Products**
- **From an idea to a system**
- **GAMON Platform**
- **Environmental probes:**
 - **GAMON-S &D**
 - **GAMON-DIVER**
 - **GAMON-DRONE**



**Electronics for science,
made by people**



CAEN *Team*



Pulse Processing Expertise

Signal Conditioning, Read-out Electronics - interface between the experiment and the scientist: from detector signals to visualization of data!

Power Supplies Expertise

High Voltage & Low Voltage Power Supplies for Particle Physics Experiments and Laboratories

POWER SUPPLY

- Universal Multichannel System
- VME - NIM Power Supplies
- Stand Alone Power Supply
- EASY (Embedded Assembly SYstem)
- Low Voltage Power supplies

MODULAR PULSE PROCESSING

- Analog
- Digital
- Digitizers
- Neutron Detection
- Read Out system
- Preamplifiers

DIGITAL SPECTROSCOPY

- Digital Multi Channel Analyzers
- Tube Base Multichannel Analyzers

CAEN electronics portfolio

A thousand of products in all necessary categorie to run experiments of fundamental physics:
From Power supply to MCA and stand-alone software for the signal analysis

CAEN SyS Portfolio

Tens of complete systems for the detection, identification and other radiologic investigations



Security Mobile Mapping Systems

Security Mobile Mapping Systems are advanced technologies used for mapping and surveillance in various environments. These systems are all focused on enhancing security through real-time data collection and analysis, offering valuable insights for monitoring and protection.



Fixed Radiation Monitoring Systems

Fixed Radiation Monitoring Systems (FRMS) are systems designed to continuously monitor radiation levels in a specific area, typically in industrial, nuclear, or environmental settings. These systems help ensure safety by providing real-time data on radiation exposure, enabling early detection of potential radiation hazards.



Special Nuclear Material and Nuclear Threat Identifier

Detection and localization of radioactive materials such as Special Nuclear Material (SNM) and Radiological Dispersal Devices (RDD), along with neutron source identification, play a critical role in enhancing national security, ensuring public safety.

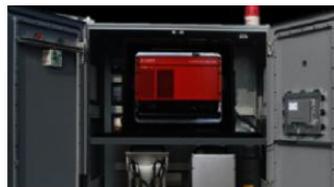
Our Mission

To provide our customers with innovative radiation detection instrumentation and systems, adding operational benefit and enhancing safety, safeguards, and security.



Radionuclide Identification (RID)

The DiscoverRAD is an ultra-compact, rugged, sensitive Radionuclide Identifying Device (RID). It provides superior usability by offering a wider energy range, enhanced detection capabilities, and real-time identification of radioactive materials, making it an ideal tool for rapid, on-the-ground assessments in both security and emergency response scenarios.



Gamma Spectroscopy

The UNATTENDED Special Nuclear Material (SNM) Remote Measurement System is designed to autonomously monitor and detect the presence of special nuclear materials with simultaneous gamma & fast neutrons measurements and without requiring constant human supervision.

What is the difference?

- Timeline of the company: 1979 Opening of CAEN s.p.a., CAEN SyS in 2016
- Totally a new market,
- System integration development
- Complexity (customization) of the applications

CAEN is a medium enterprise and acts like a large laboratory prototype able to customize and design new products in an industrial environment

All products are qualified

- CE
- ROHS



Company project and manufacturing process :
Certified ISO 9001:2015



What we have here:

- Design
- Software development
- Test & characterization
- Quality check
- Maintenance and support service
- Commercial area



- It is a commercial product (reproducibility, certification, manual, etc.)
- It is a system designed and produced to satisfy a specific market need (it is not a custom system, it is designed based on commercial and technical analysis)
- Based on the commercial report about market needs, experts identify the key measurement points, evaluate requirements and propose a solution
 - Identification of the detection system (detector, electronics for data acquisition and signal analysis)
 - Identification of all non radiologic sensors (GNSS, LTE, batteries, CPU, rain sensor, WIFI antenna, LORA, temperature sensors, position sensors, PLC, actuators, custom PCB, etc..)
 - Other mechanical elements (shielding, moderator, neoprene, bumpers, heat dissipators, etc...)
 - Design of the mechanics (probe mechanics, structural elements, material selection etc...)
 - Software design and development with the integration of specific data analysis (GUI, database, connectivity, alarm-reachback, backend, etc...)
- Characterization, calibration and certifications (if required) for each probe

CAEN has some advantages:

- It designs and produces electronics for fundamental physics
- It has a lot of knowledge on radiologic sensors
- It has a lot of experience on algorithms and data analysis for physics

GAMON platform allows to choose between different spectroscopic or dosimetry systems with temperature compensation of the energy spectra and high-rate compensation.

These systems are designed for different use cases depending on their enclosure type (underwater, vehicle mountable, IP68...) and can be easily combined in a network configuration to be deployed in radioprotection or emergency scenarios.



STATIC ENVIRONMENTAL NETWORK



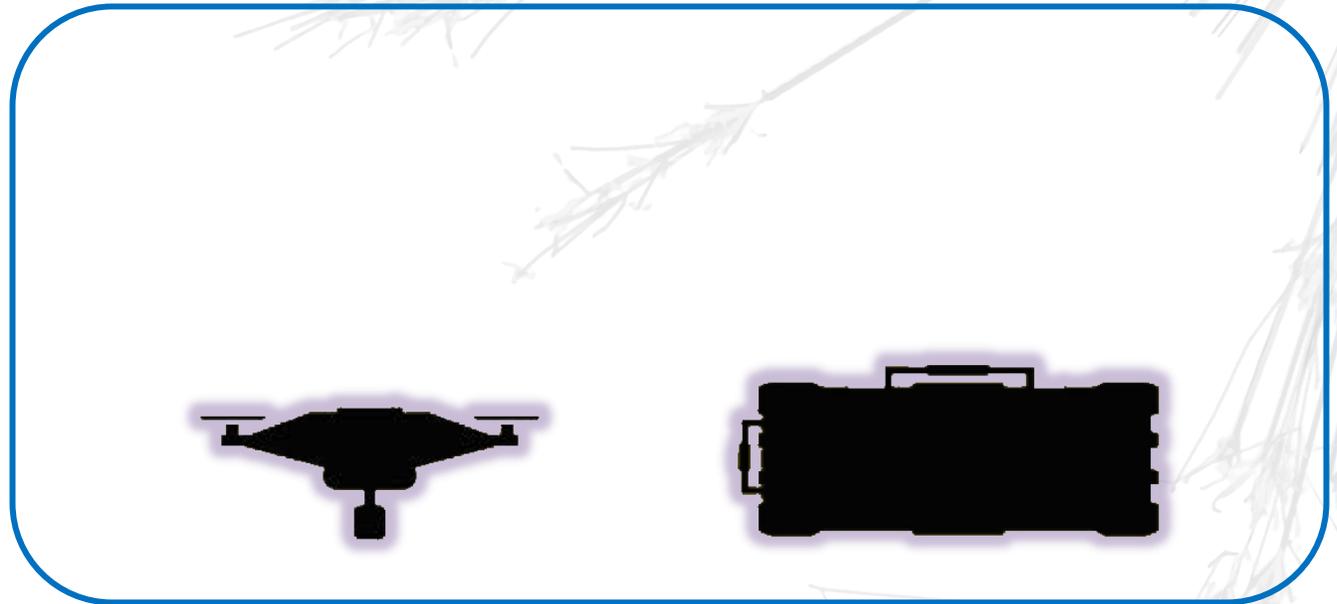
GAMON-S

GAMON-D

GAMON-DIVER

Radiation measuring stations for environmental monitoring network and continuous survey

DYNAMIC MONITORING NETWORK



GAMON-Drone

GAMON-Mobile

Mobile measuring units for first emergency response, prompt intervention and homeland security

STATIC ENVIRONMENTAL NETWORK

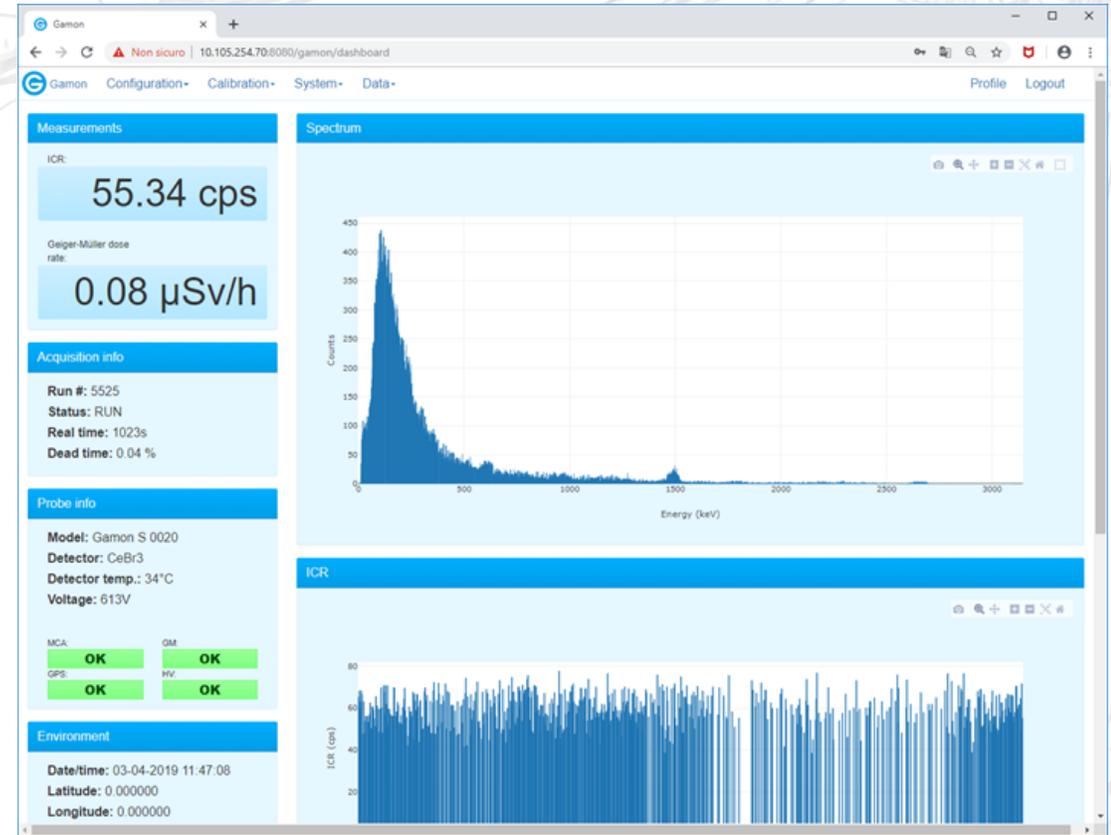
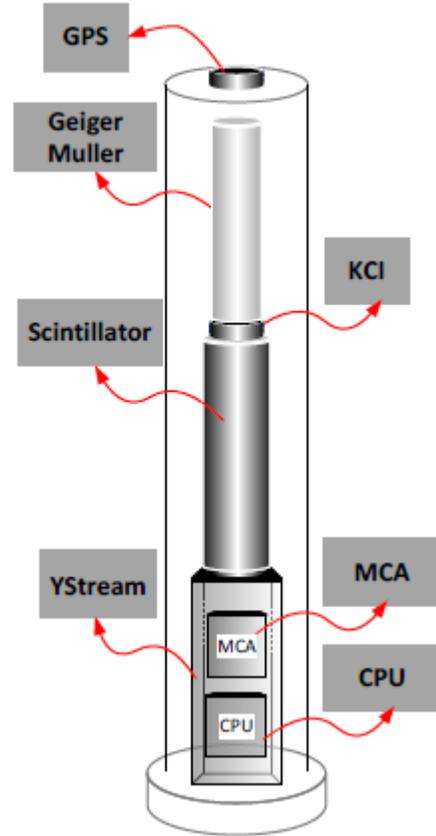
- Radiation measuring stations for environmental monitoring network and continuous survey
- Probes installed in the field in fixed position, biased and data managed with specific protocol to transmit data to a central server
- Each probe is an individual system working 7d a week and 24 h/day, reporting with a certain frequency or in case of emergency



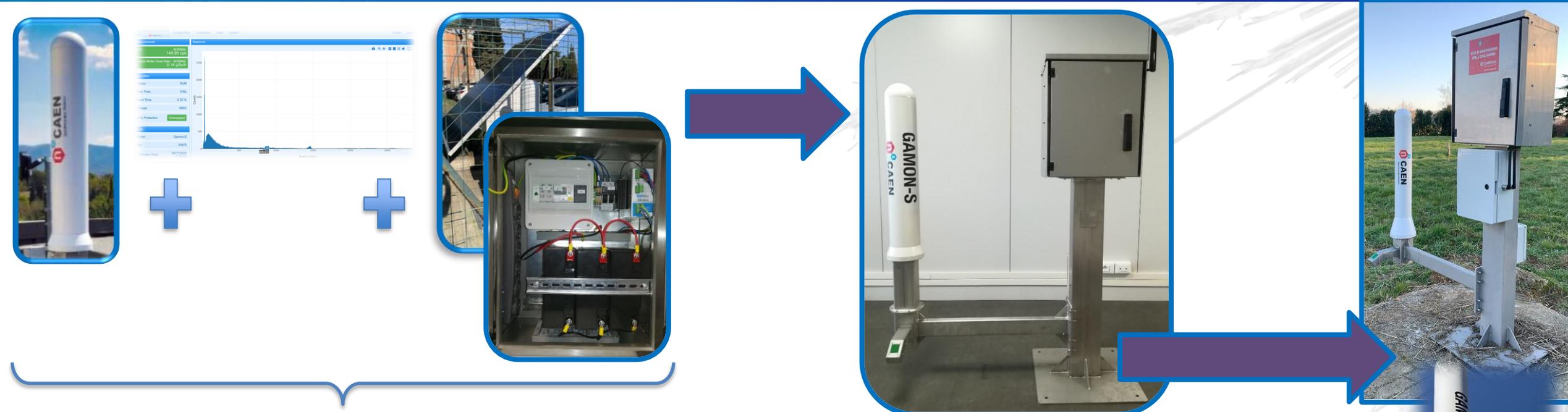
What is it important?

- Reliability
- Stability
- Continuous monitoring
- Temperature compensation (inorganic scintillator)
- Data transmission
- Extremely low failure rate
- Easy handle software for expert and non expert operators
- Reduce to the minimum the manual intervention (also on the analysis)





How to send a probe in the field



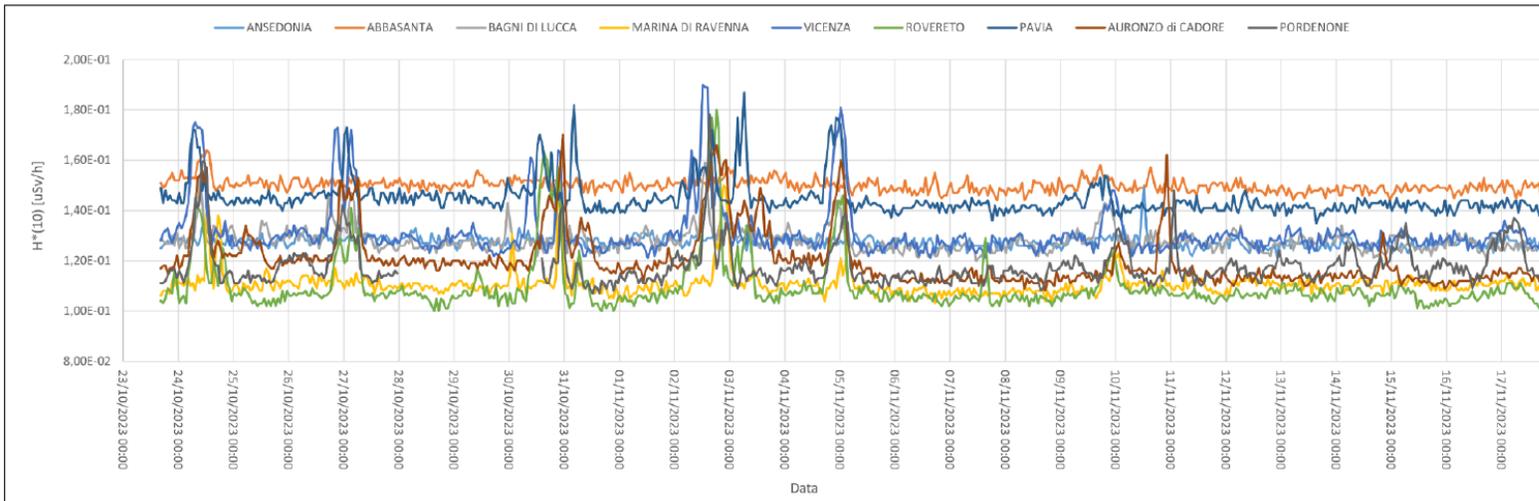
- Probe(s) selection
- Software analysis options
- Selection of the accessorize

- Production
- Calibration
- Testing

- Installation
- SAT
- Training
- Maintenance

ISIN (Italian National Inspectorate for Nuclear Safety and Radiation Protection) gamma grid:

- 33 dosimetric probes
- 30 spectroscopic probes

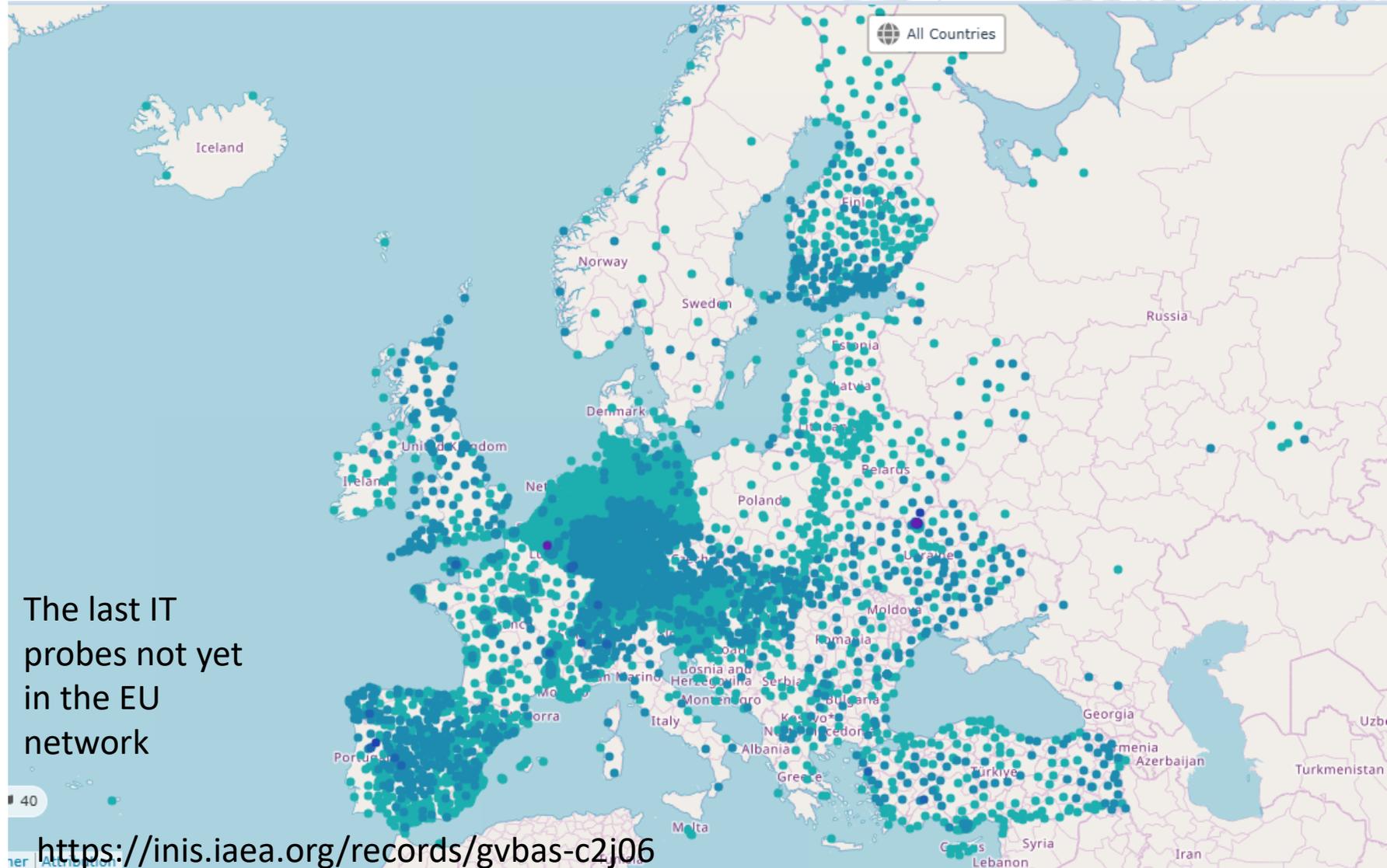


The **European Radiological Data Exchange Platform (EURDEP)** consists of data exchange mechanism and presentation website for radiological monitoring data which is collected and shared by 39 participating countries in almost REAL TIME.

EURDEP is the EU's official tool for the exchange of radiological data during an emergency but data is exchanged constantly and automatically so that it is available at all times and extra effort in case of an emergency can be minimised.

Data collected essentially reflects the current natural radiation background during normal operations.

EURDEP is not a rapid alert system carried out via the European Community Urgent Radiological Information Exchange system (ECURIE)



The last IT probes not yet in the EU network

<https://inis.iaea.org/records/gvbas-c2j06>

<https://remap.jrc.ec.europa.eu/Advanced.aspx>

GAMON DIVER – Underwater probe

Gamma spectrometer for the measurement of radioactive isotopes in water

GAMON-Diver shows in real time the progress of the count and radiological alarms in case of exceeding the preset thresholds

Considering a GAMON-S probe and a GAMON-Diver probe with the same type and dimension of scintillator:

- **Which are the main differences with a GAMON-S measurement?**
- **Which are the main differences and their impact on the measurement?**



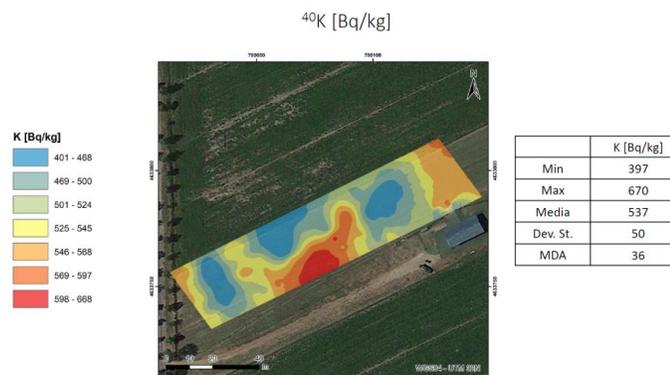
Is a light/weight spectroscopic system for uncrewed monitoring with aerial drones. It's also suitable for industrial application where a compact format is required.

Connected with WiFi and Ethernet connection.



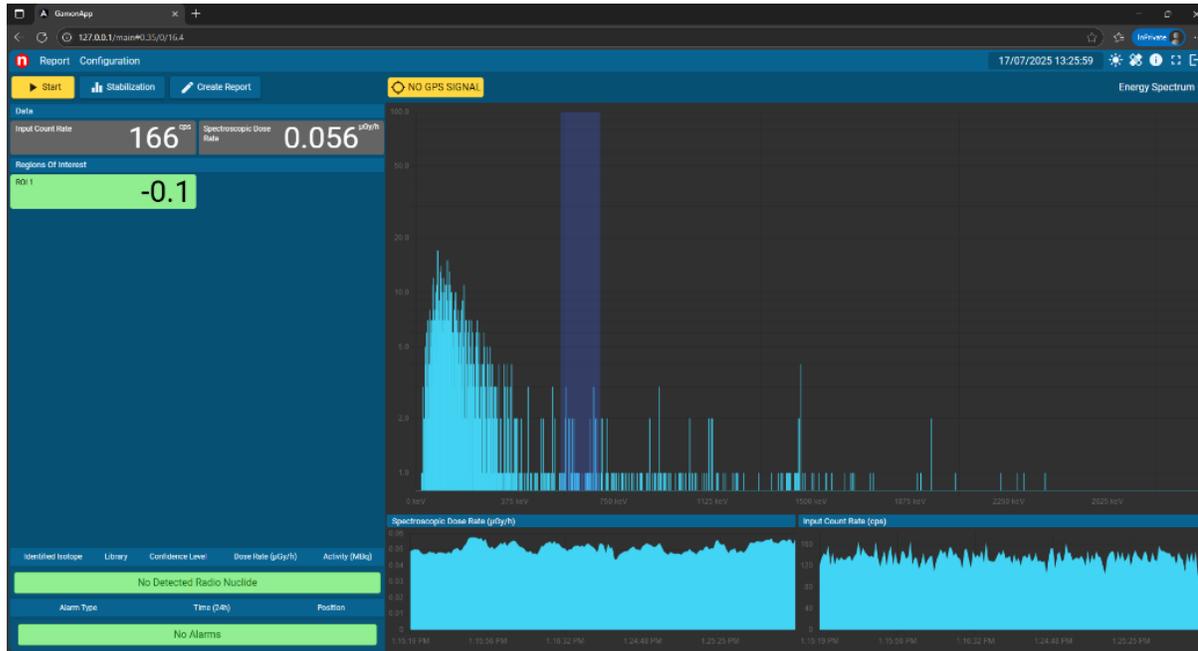
Highlights

- Gamma dosimeter
- Protection IP>65
- Rechargeable internal battery
- Internal GPS
- L x Ø = (46 x 10) cm
- Weight < 2.5 kg with NaI(Tl) 2"x2"
- Optional CeBr₃ , NaI, etc...





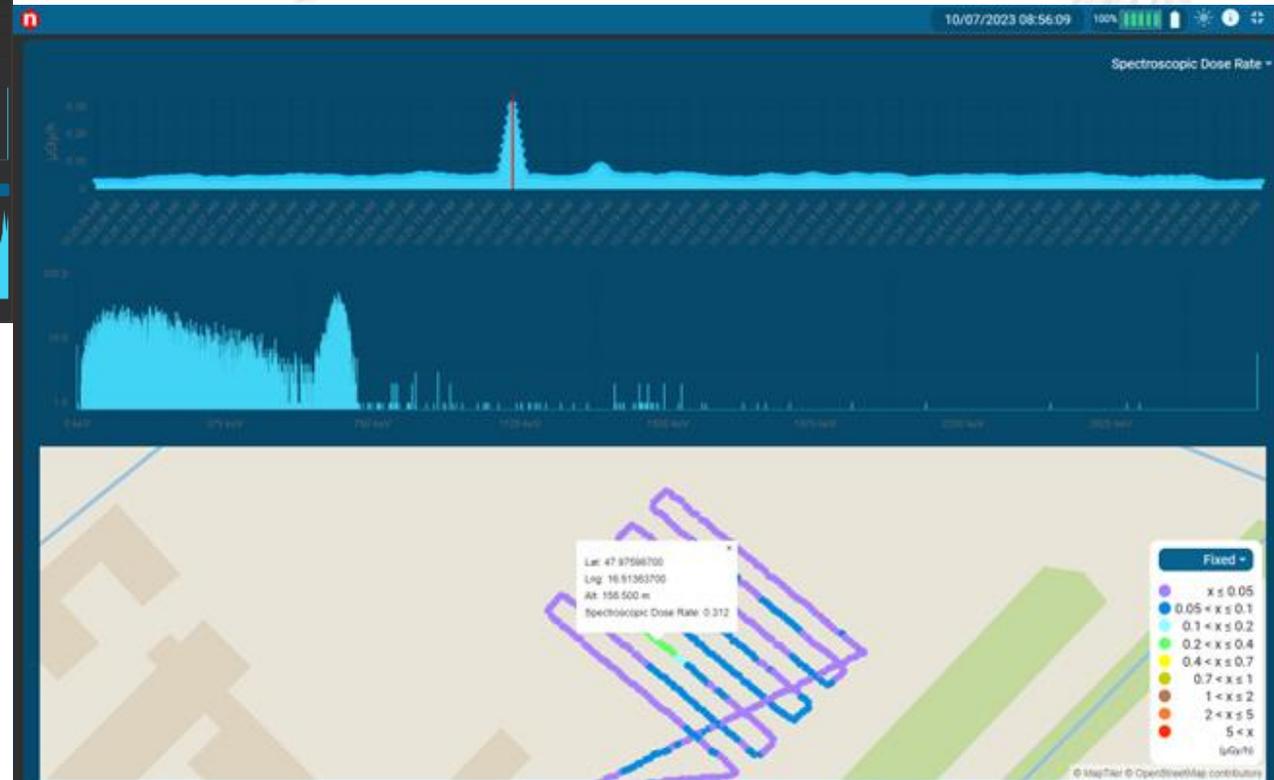
GUI (Graphical User Interface) for the operator



- Energy spectrum
- Spectroscopic Dose Rate
- Gamma Count Rate
- Map of the flight with dose rate info

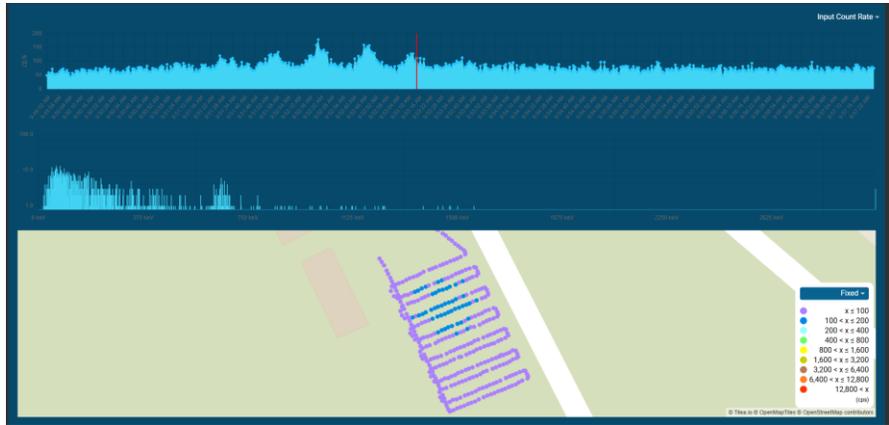
Definition of Region of Interest and Alarm threshold in the energy spectra

Realtime waypoint and mission report



Two examples

From Gamon software interface to Google Earth

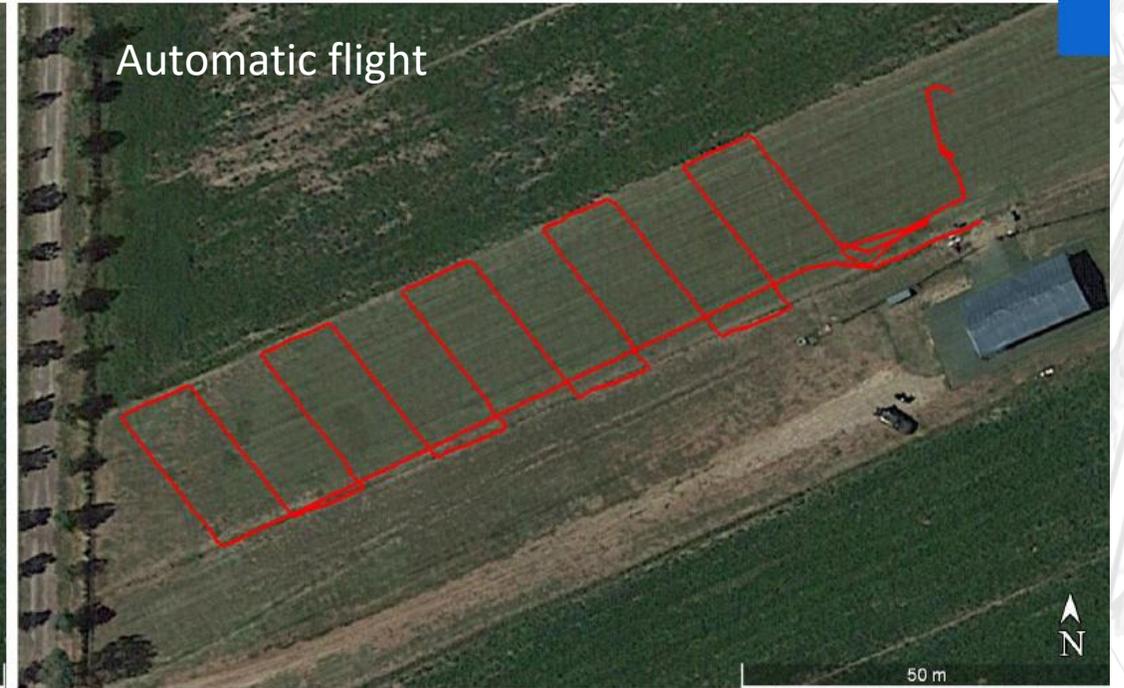


Flight over a 9 MBq ^{137}Cs source not shielded



Flight over a 500 MBq ^{137}Cs source, partially shielded

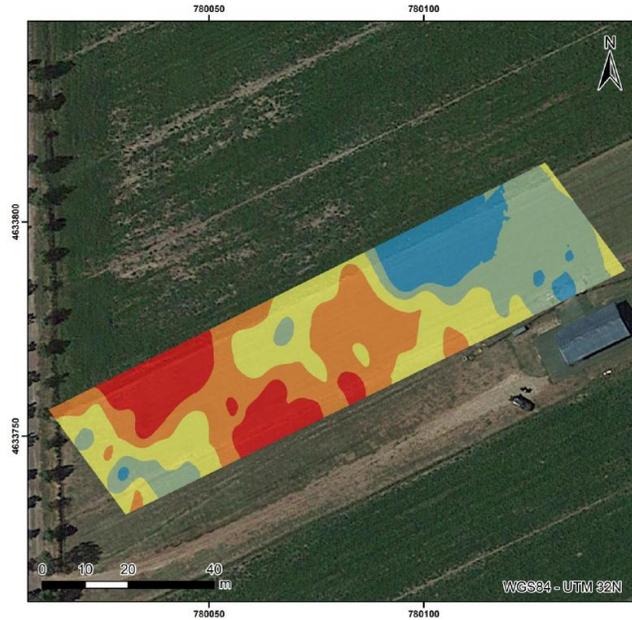
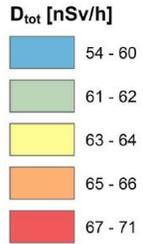




Spaziatura [m]	10
Lunghezza traccia [m]	507
Durata survey [min]	12
Area investigata [m ²]	3928
Numero di spettri	140

	Min	Max	Media	Dev. St.
Velocità [m/s]	0	1.5	0.7	0.4
Quota [m]	0	5.9	4.2	1.2

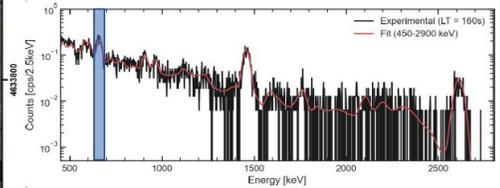
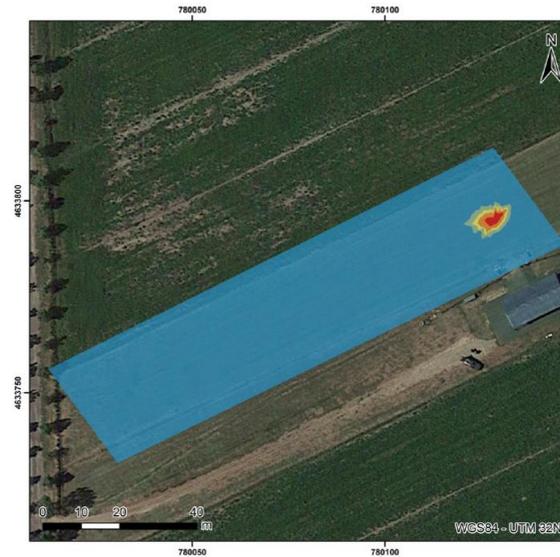
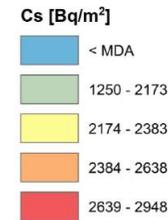
Dose [nSv/h]



	D _{tot} [nSv/h]
Min	54
Max	70
Media	62
Dev. St.	3

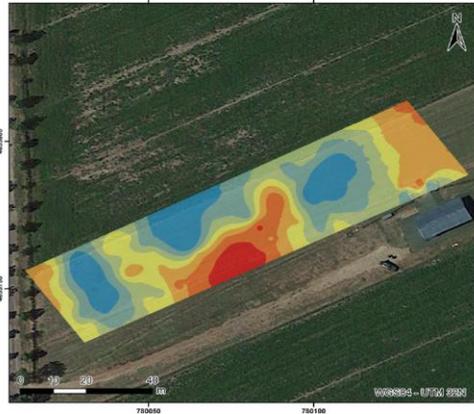
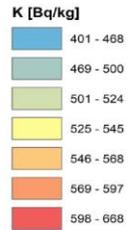
- What do you see?
- Is there a source?

¹³⁷Cs [Bq/m²]

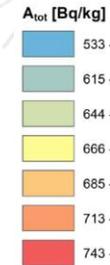


	Cs [kBq]
Sorgente calibrata	370
Valore stimato	285 ± 75
MDA	1.25

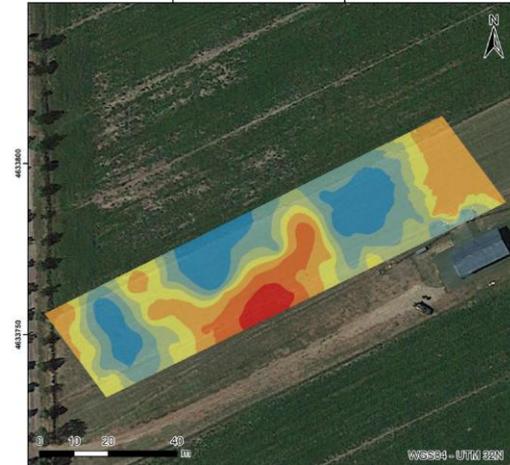
^{40}K [Bq/kg]



	K [Bq/kg]
Min	397
Max	670
Media	537
Dev. St.	50
MDA	36



Attività totale [Bq/kg]

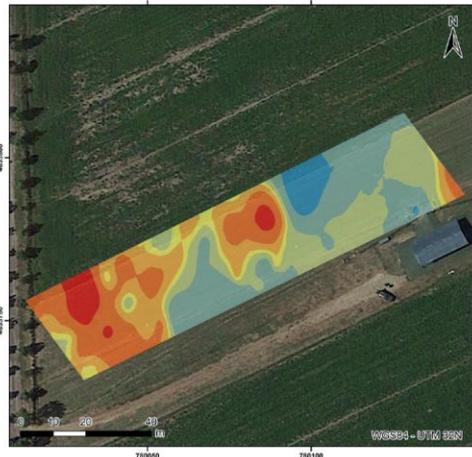
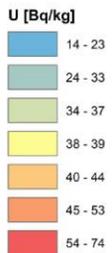


	Att _{tot} [Bq/kg]
Min	529
Max	805
Media	678
Dev. St.	49

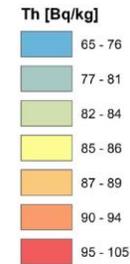
Activity Heat plot used for applications with radioactivity spread in a wide area.

This plot helps the operator to verify the overall situation

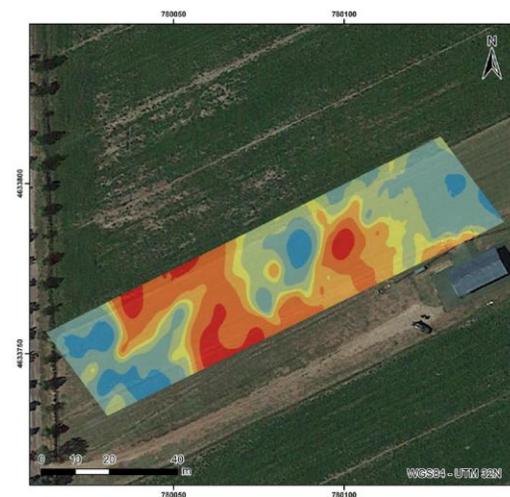
^{238}U [Bq/kg]



	U [Bq/kg]
Min	14
Max	73
Media	36
Dev. St.	9
MDA	14

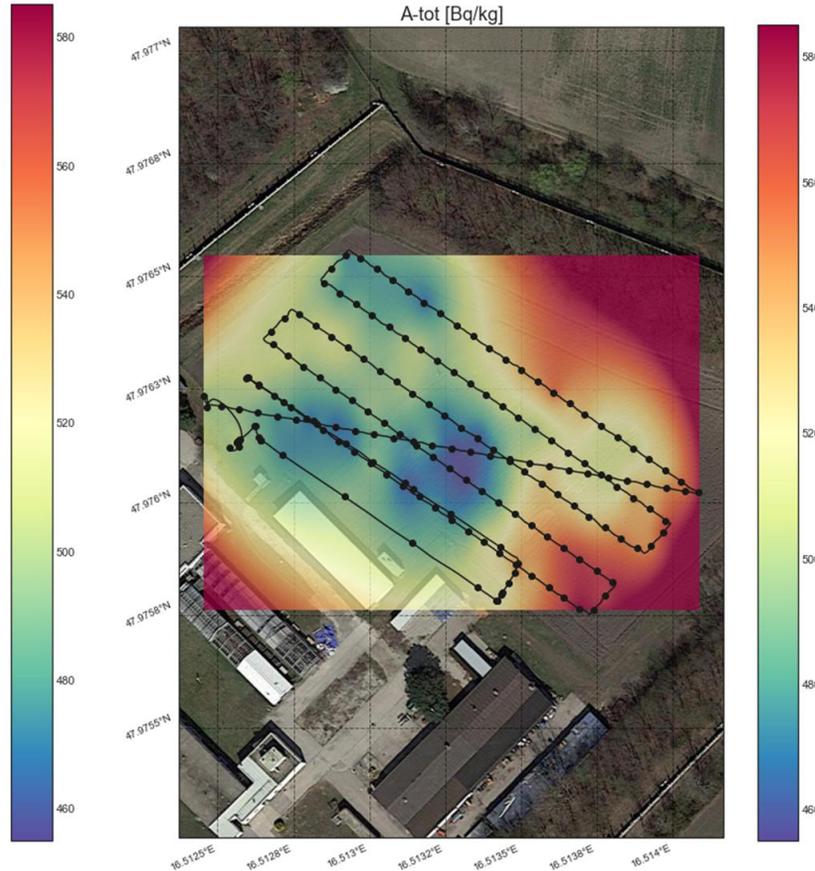
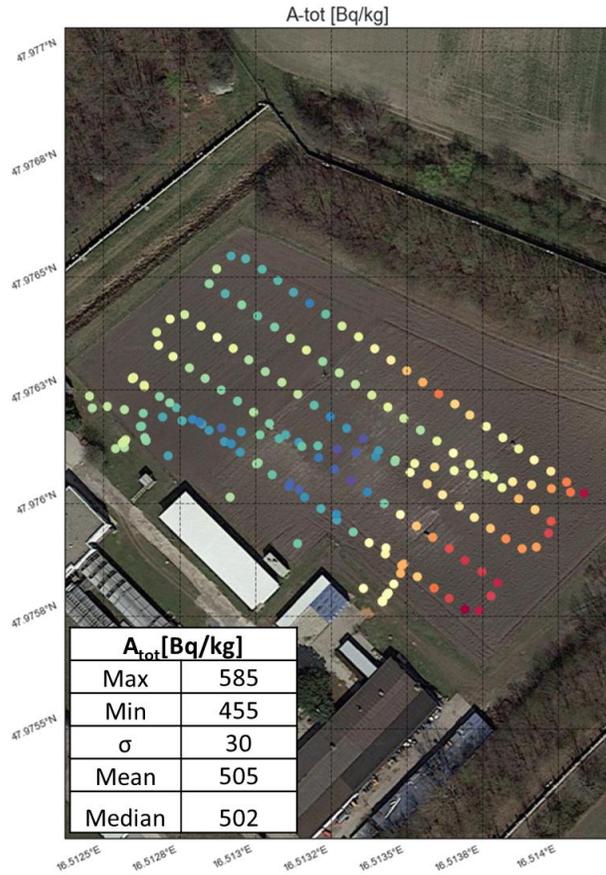


^{232}Th [Bq/kg]



	Th [Bq/kg]
Min	66
Max	103
Media	82
Dev. St.	7
MDA	9

Different radiation levels due to fertilizer



Interpolation of the points using the **Inverse Square Distance Weighting** method to create the heat map.

Can you list how many type of radiologic analysis are performed in the software described?

- **Temperature compensation** => temperature sensor and check on ^{40}K
- **Energy calibration check** => ^{40}K peak
- **Dose rate calculation** (for GM tube and spectroscopic) => pre calibration of each type and dimension of scintillator based on measurements performed in ACCREDIA labs (certified source and measurement procedures)
- **Gamma Spectroscopy**: gamma source identification from an unknown spectra (radionuclide library and id procedures)
- **Gamma spectrometry (at the end of the measurement)** => activity calculation of specific radionuclides
- **Procedure for a self energy calibration**

All the analysis are done in automatic and online (less than a second) without the intervention of a specialist.
Software development, characterization tests and optimization are all processes done internally to make everything working autonomously and without human intervention.
Physicist and engineers are working to make it possible.

Thank you for your attention!

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