medusa Radiometrics

25 years

Gamma-ray sensors for topsoil mapping

Walk, drive or fly. Collect high-resolution gamma data with a lightweight, rugged and easy-to-use sensor.

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Medusa's aim is to make gamma-ray sensing easier

Scientific heritage

Medusa Radiometrics was founded in the Netherlands more than 25 years ago as a spin-off from the University of Groningen and the KVI – the Nuclear Physics Accelerator Institute. We builds on decades of expertise in gamma-ray physics and environmental sensing. What began as a research initiative has grown into an international provider of instruments and software for mapping in geoscience, nuclear applications, precision agriculture, and environmental monitoring.

R&D collaborations

We combine our scientific heritage with close links to practical field operations through R&D collaboration with our geosurveying sister companies, Medusa Explorations and Medusa Geoservices, which brings extensive operational experience. Additional innovation is driven by cooperation with international partners and end-users, integrating hardware, firmware, and data analysis into a single, cohesive system.

What sets us apart

Medusa sensors are designed for practical use in outdoor conditions. They are rugged, simple to operate, and equipped with onboard data processing, allowing results to be generated directly in the field. Their excellent weight-to-performance ratio makes them suitable for a wide range of survey platforms, including handheld, vehicle-mounted, drone-borne and airborne systems.

Mission and approach

Medusa's aim is to make gamma-ray sensing easier. Radiometric instruments and analysis of the results are often complex, but Medusa focuses on robust and intuitive systems that can be operated by both specialists and non-specialists, in research as well as in daily fieldwork.

02

About **Gamma-ray mapping**

Origins and applications

Gamma-ray sensing for geophysical applications developed as a method in the mid-20th century and gained momentum in the second half of the last century, when researchers demonstrated that natural radioactivity could be used to study soil and rock properties. Since then, it has become a well-established technique in mineral exploration, soil-texture mapping, precision agriculture and contamination mapping.

Natural radioactivity as a signal

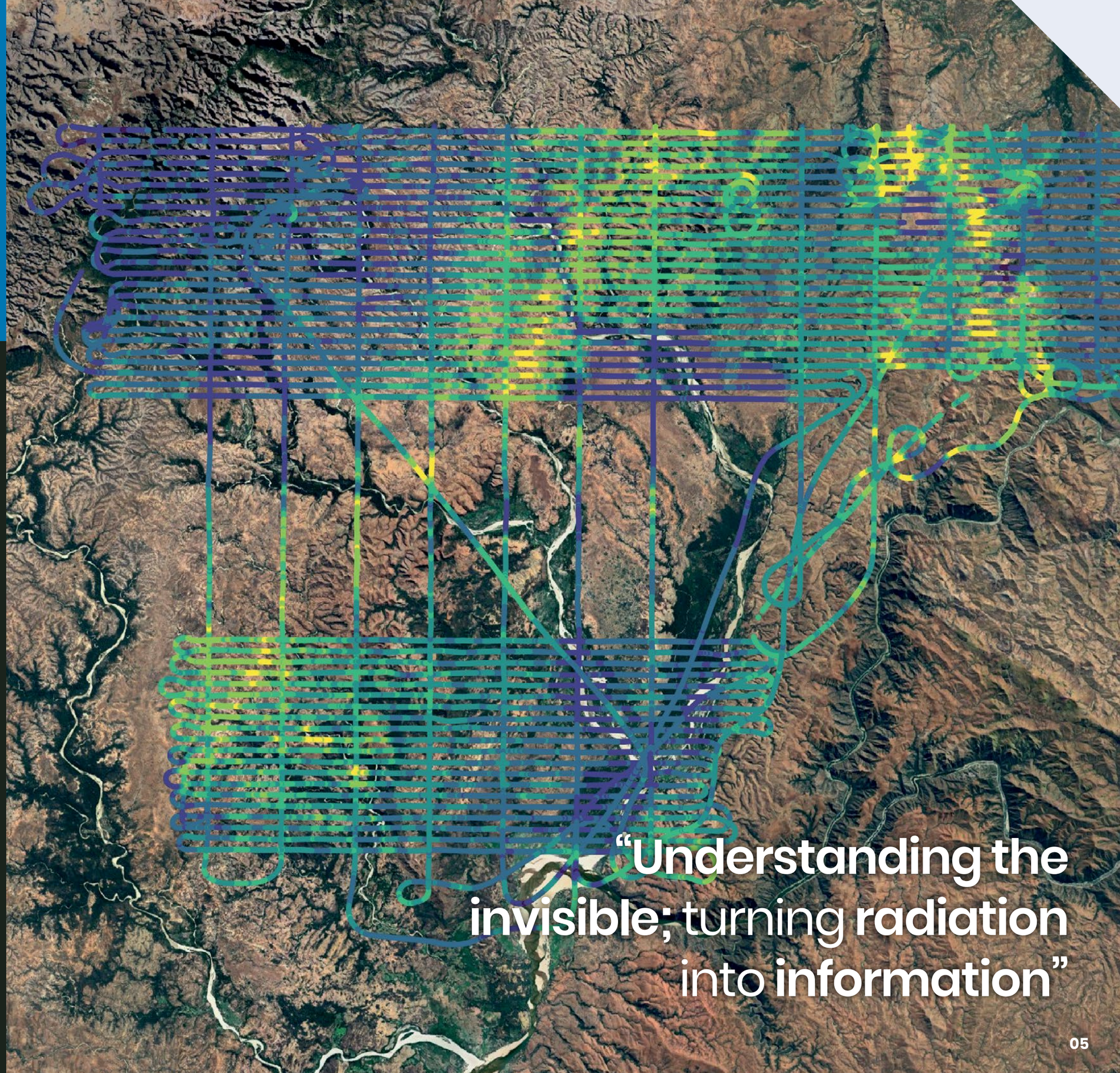
Soil contains small amounts of gamma-emitting potassium (K), uranium (U), and thorium (Th). As these elements decay, they emit gamma radiation. Variations in their distribution are linked to soil type and geological processes, making gamma-ray measurements a practical indicator of surface composition and geological history.

Shallow penetration, high relevance

Most of the signal originates from the top 50 cm of soil. This makes gamma-ray sensing especially suitable for topsoil analysis, land-use studies, exploration and environmental monitoring. Sensors can be mounted on vehicles, carried by hand, or integrated on drones, providing real-time spatial data without disturbing the ground.

From measurement to insight

Sensors record the gamma energy spectrum, which is used to determine elemental concentrations. The data is processed using full-spectrum analysis, and then corrected for factors such as altitude and background radiation. The results are detailed maps and datasets that reveal spatial patterns beyond what traditional soil sampling can show.



“Understanding the invisible; turning radiation into information”

03 Applications

Mineral exploration
Gamma-ray sensing is a well-established tool in mineral exploration. Variations in potassium (K), thorium (Th), and uranium (U) reflect geological structures, alteration zones and mineralization patterns. Radiometric surveys allow rapid coverage of large areas, helping geologists identify prospective targets and improve geological models with greater confidence.

Soil-texture mapping
Different soil textures are characterized by distinct concentrations of naturally occurring radioelements. Gamma-ray measurements provide continuous, high-resolution maps of sand, silt, and clay distribution. This offers an efficient alternative to labor-intensive sampling and supports land-use planning and environmental assessment.

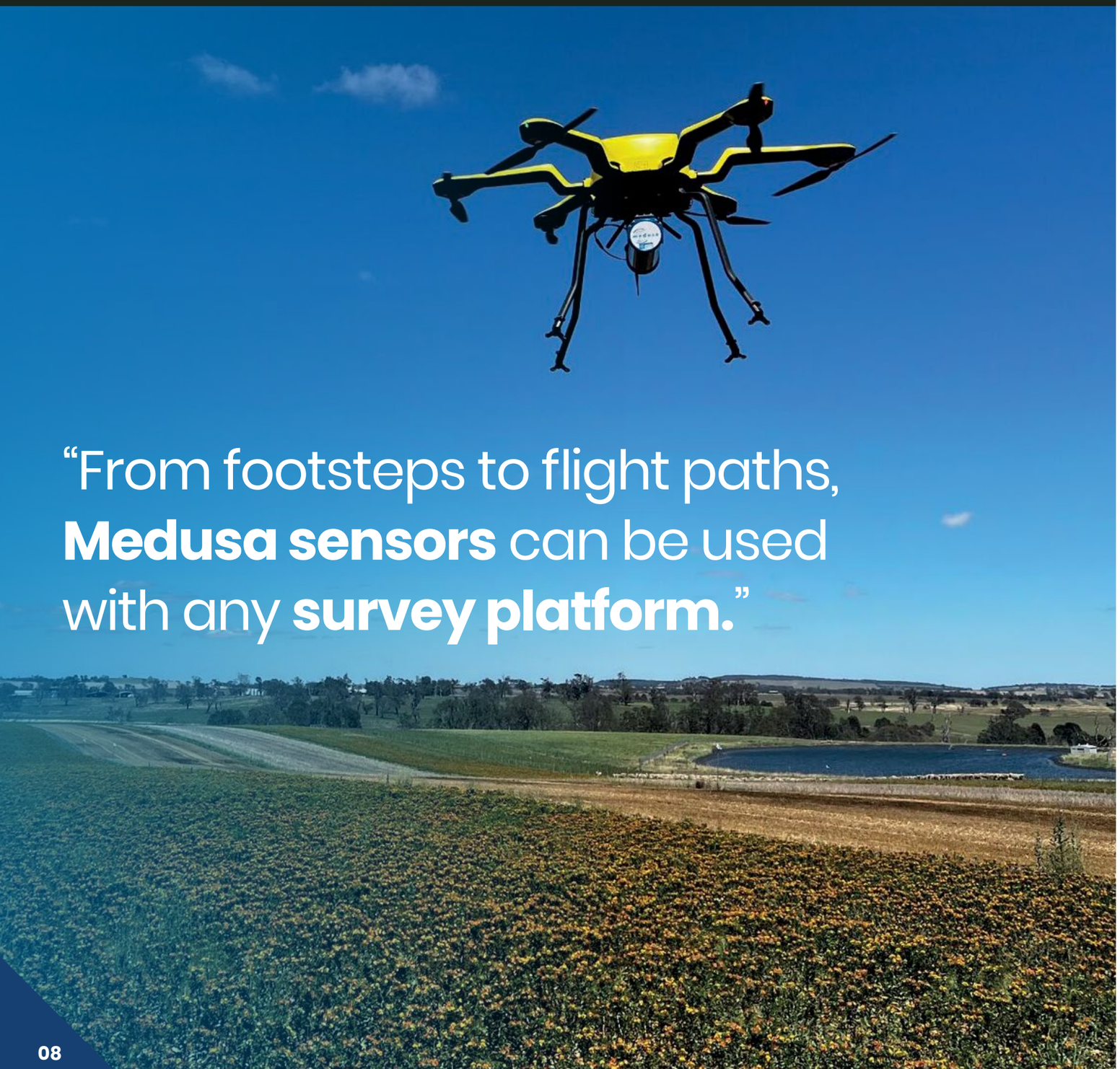
Precision agriculture
Radiometric data support fine-scale management zoning by resolving spatial variability in soil texture, nutrient-related properties, and moisture sensitivity. This information helps farmers optimize seeding, irrigation, and fertilization, improving crop performance while reducing input costs and resource use.

Soil moisture
Soil moisture slightly attenuates radiation. Hence, changes in gamma-ray intensity over time can be used to estimate soil moisture content. These measurements support applications in hydrology, geotechnical engineering, and environmental monitoring by enabling non-intrusive, large-area assessment of near-surface moisture conditions.

Contamination mapping
Gamma-ray sensors can detect radiometric anomalies linked to mine tailings, waste disposal sites, or elevated natural radioactivity. Their sensitivity and mobility allow fast delineation of affected areas, supporting targeted remediation and long-term environmental monitoring.

“The ground holds countless stories worldwide; **radiometrics simply helps us read them.**”

04 Survey Platforms



“From footsteps to flight paths, **Medusa sensors** can be used with any **survey platform.**”

Walking surveys
Handheld or backpack-mounted systems offer flexibility for small areas, rough terrain, and detailed inspections. They are well suited for mineral exploration, contamination assessments, and research sites where precise positioning and low survey speeds are required.

Vehicle-borne surveys
Mounted on cars, tractors or ATVs, sensors can cover large areas efficiently. Vehicle platforms are commonly used in agriculture, geological mapping, and infrastructure monitoring, providing consistent and high-resolution datasets.

Drone-borne surveys
Lightweight sensors mounted on multirotor or fixed-wing UAVs allow surveys in difficult or hazardous locations. They provide uniform and repeatable coverage with no ground disturbance, making them useful in mining, hazard zones, and remote fieldwork.

Airborne surveys
Helicopters or small aircraft enable surveys over tens to hundreds of square kilometers. Airborne radiometrics is widely used in mineral exploration and regional geological mapping, combining large-area coverage with efficient data acquisition.

Stationary installations
Fixed systems monitor changes in gamma radiation over time, for example for soil moisture estimation or environmental baseline monitoring. These installations can operate autonomously for extended periods.

Sensor accessories
Planning to integrate a sensor on your own platform? We offer a wide range of accessories. Available options include: drone mounting plates, vehicle brackets, cables, antennas, altimeters, handles and backpack systems. Please contact us for more information.

05 The MS-system

A rugged core

The MS series is Medusa Radiometrics' family of field-ready gamma-ray sensors, built around the embedded Medusa Detector Operating System (mDOS application) and robust hardware. Designed for demanding environments, each unit operates fully autonomously and requires only a power supply to start measuring.

Consistent user experience

All MS models use the same interface and workflow for mapping operations. The main difference between models is detector size: larger detectors contain more crystal volume, which increases sensitivity and allows faster data collection. From the compact MS-100 to the high-performance MS-20K, operation is consistent across the entire series.

Intelligent hardware and embedded software

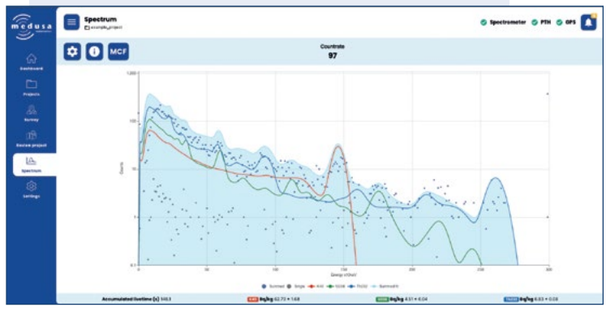
Onboard processing performs calibrations, corrections, analysis and quality checks in real time, while also storing all raw data for later analysis. The MS series is self-calibrating, supporting stable and repeatable performance during long surveys and varying field conditions.

Real-time monitoring

A built-in WiFi access point allows data to be viewed instantly on any browser-enabled device. The mDOS interface displays spectra, maps, and system status in real-time on tablets, laptops, or smartphones, both in the field and during setup.

Key features

- Stand-alone system
- Autonomous operation
- Accepts a wide input voltage range
- Self calibrating
- RTK-ready GPS inside
- Internal storage
- Embedded mDOS app
- Works with every tablet, pc or phone.
- Real-time mapping
- Live radionuclide viewer
- Soil-sample location advice



"A sensor built for the field, designed for ease of use and engineered for endurance."

06 The MS-series: overview

"Choose the detector that fits your platform, and the mapping speed that fits your mission."

		 gSMS-100	 MS-100	 MS-350	 MS-700	 MS-1000	 MS-2000	 MS-7300	 MS-4000	 MS-20K
Typical use	Application	Volumetric soil moisture monitoring	Antropogenic mapping	Soil-texture mapping Mineral mapping Agricultural mapping Contamination mapping	Soil-texture mapping Mineral mapping Agricultural mapping Contamination mapping	Soil-texture mapping Mineral mapping Agricultural mapping Contamination mapping	Soil-texture mapping Mineral mapping Agricultural mapping Contamination mapping	Soil-texture mapping Agricultural mapping Contamination mapping	Soil-texture mapping Mineral mapping Agricultural mapping Contamination mapping	Soil-texture mapping Mineral mapping Agricultural mapping Contamination mapping
	Survey platform	Stationary	Handheld, droneborne	Handheld, droneborne	Droneborne, handheld	Droneborne, vehicle borne	Vehicle borne	Vehicle borne	Airborne	Airborne
Gamma-ray spectrometer	Scintillation crystal	100 ml CsI	100 ml CsI	350 ml CsI	700 ml CsI	1000 ml CsI	2000 ml CsI	7300 ml EJ200 polymer	4000 ml CsI	5 × 4000 ml NaI (1 upward-looking)
	Max. recording frequency	5 hz								
	Radionuclide analysis	^{40}K, ^{238}U, ^{232}Th, ^{137}Cs	Conform ANSI N42.34-2021	^{40}K, ^{238}U, ^{232}Th, ^{137}Cs				^{40}K, ^{238}U (degraded), ^{232}Th	^{40}K, ^{238}U, ^{232}Th, ^{137}Cs	
Electrical	Input voltage	5 - 35 V					9 - 35 V			
	Power consumption	3 W (average), 6 W (max)								
	Power source	External								
GNSS	Type	n/a	uBlox ZED-X20P							
	Accuracy	n/a	1.5 m CEP							
	RTK accuracy	n/a	0.6 cm + 1 ppm CEP							
	Signals	n/a	All-band (L1/L2/L5/L6+ L-band) GPS, GLONASS, BeiDou, Galileo							
Mechanical	Dimension	100 (Ø) x 166 (L) mm	100 (Ø) x 166 (L) mm	100 (Ø) x 215 (L) mm	100 (Ø) x 295 (L) mm	100 (Ø) x 375 (L) mm	120 (Ø) x 605 (L) mm	175 (Ø) x 855 (L) mm	175 (Ø) x 706 (L) mm	495 × 750 × 280 (H) mm
	Weight	1.5 kg	1.5 kg	2.7 kg	4.7 kg	6.7 kg	11.0 kg	12.0 kg	28.0 kg	90.0 kg
	Operating Temperature	-20 to +65 °C								
	IP rating	IP65								IP64
Connectivity	Wi-Fi	2.4 and 5 Ghz								
	Ethernet	100 Mbps								
	Port	RS-232								
Data	Format	JSON, NMEA, CSV								
	Streaming	RS-232, ethernet and Wi-Fi								
	Sensors	Spectrometer, GPS, PTH								
	Internal storage	16 GB, 500 hours of data								
Included software	Onboard-processing	gSMS mDOS	Medusa detector operating system (mDOS) real-time analysis, survey planner, real-time radionuclide inspection, sample measurements							
	Post-processing	GammAn full-spectrum analysis (FSA) and window analysis (WA)								
	Support	Online support, an extensive library of support guides, and custom support are available								

All MS sensors share the same intuitive mDOS user interface. They differ in detector volume and recommended mapping speed.

07 Best **practices** for **surveying**

“Low and slow with the biggest sensor possible.”

Balancing sensor size and survey speed

Effective gamma-ray surveys start with selecting the right detector for the chosen platform. Larger sensors offer higher sensitivity and support faster mapping, making them suitable for wide-area surveys. Smaller sensors are better suited for platforms with limited payload capacity or for missions that require very low operating altitudes.

Altitude, spatial resolution, and line spacing

Survey height is an important factor determining spatial resolution: the lower the measurement, the sharper and more detailed the radiometric footprint. Line spacing should match the sensor footprint at the selected altitude, ensuring continuous coverage without gaps or excessive overlap. By adjusting altitude and line spacing together, users can balance data quality with operational efficiency.

Typical survey parameters*

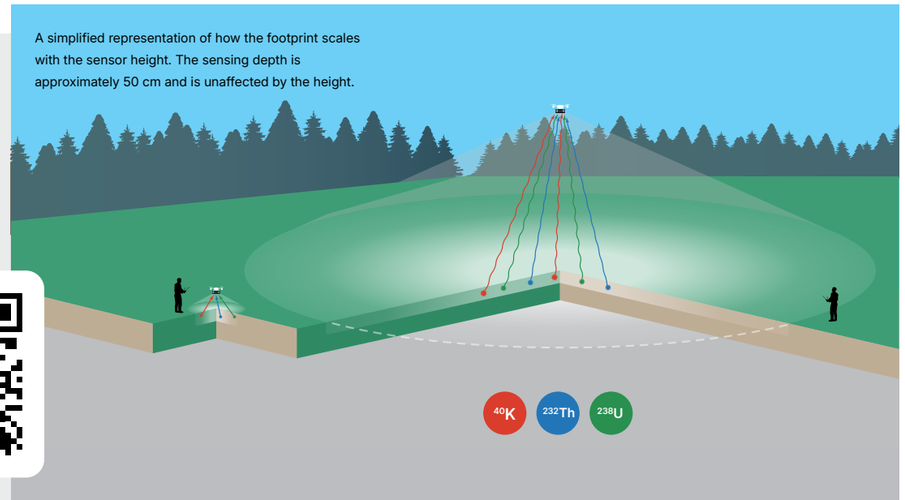
Sensor model	Platform	Height	Line spacing	Speed	Recording frequency
gSMS-100	Stationary	2-5 m	n/a	n/a	15 min
MS-100**	Handheld, droneborne	0-40 m	5-20 m	Up to 10 km/h (3 m/s)	0,3 hz
MS-350	Handheld, droneborne	0-25 m	5-25 m	Up to 15 km/h (4 m/s)	0,3 hz
MS-700	Droneborne, handheld	0-30 m	10-30 m	Up to 20 km/h (6 m/s)	0,5 hz
MS-1000	Droneborne, vehicle borne	0-40 m	10-40 m	Up to 30 km/h (8 m/s)	1 hz
MS-2000	Vehicle borne	0.8 m	5-20 m	Up to 45 km/h	1 hz
MS-7300	Vehicle borne	0.8 m	5-20 m	Up to 45 km/h	1 hz
MS-4000	Airborne	60-120m	100 m	Up to 90 km/h	5 hz
MS-20K	Airborne	60-120 m	250 m	Up to 120 km/h	5 hz

* Typical values. Outcome depends on terrain, platform, and required data quality.

** The MS-100 is dedicated to anthropogenic mapping only.

Explore real survey data

Scan the QR code to access example datasets, recommended workflows, and full survey examples for practical guidance.



08 gSMS: **The new soil moisture sensor**

“Compared to point sensors, the gamma soil-moisture sensor (gSMS) measures average soil moisture over a much larger volume, typically tens of cubic meters”.

Why traditional moisture systems fall short

Most soil moisture sensors rely on point measurements. This makes them sensitive to local effects such as stones, roots, air pockets, and installation errors. Furthermore, moisture variation is often highly heterogeneous on a meter scale. As a result, the data are difficult to scale from single points to entire fields or landscapes.

How gSMS addresses this

The Medusa Radiometrics gamma soil moisture sensor (gSMS) measures soil moisture over a volumetric footprint of several cubic meters, far beyond the reach of conventional probes. By capturing variability in radionuclide concentration within this volume, the gSMS provides stable, spatially averaged moisture estimates that accurately reflect field conditions.

The physics behind it

The presence of water in soil has a small effect on the measured gamma radiation. A stationary sensor can measure these small variations. As soil moisture increases, more gamma photons are absorbed before reaching the detector. By quantifying this attenuation and comparing it with a physically calibrated model, the gSMS system derives continuous and reliable estimates of volumetric soil moisture in the upper tens of centimeters of soil, in a diameter around the sensor in the range of tens of meters.

What you receive

A complete gSMS setup consists of an MS-100 sensor and access to the online gSMS portal for data visualization and long-term monitoring. Optional accessories, such as power modules, and mounting hardware, can be supplied for continuous field operation and automatic data upload, enabling real-time insight.

Section of the gSMS Portal Interface

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