CAEN SyS

CAEN Spectroscopy Division

COMPACT UGV/UAV MOUNTED UNIT FOR RADIONUCLIDES IDENTIFICATION

GAMON- Drone

APPLICATIONS AND SCENARIOS

GAMON-Drone is a light-weight gamma radiation spectroscopy system designed for the identification of radioactive isotopes with unmanned ground or aerial vehicles.

GAMON-Drone is used for monitoring inaccessible and radiologically hazardous areas. This system is provided with a high efficiency detector, to give a prompt alarm and statistically accurate measurement of the isotope related dose rate and activity.

Typical intervention scenarios are reported here below.

- In emergency and first response applications for a prompt control of the contaminated area
- For location survey and control before, during and after public events
- For the characterization of the NORM accumulated in Oil&Gas extraction and processing facilities, and pipes
- For the detection of orphan sources in scrap material of reprocessing plants.

DESCRIPTION

GAMON-Drone is a compact and light weight spectrometer specifically designed for UAV environmental radiation protection, inspection, and site remediation after the dispersion of radiological or nuclear material. The system can be used as a measurement device for first responders for the exploration of hazardous areas.

GAMON-Drone system is designed to offer the best combination of portability, low power consumption and performance. The unit is assembled in a lightweight enclosure that contains both the Scintillator Detector and the Digital Signal Processing Electronics.

GAMON-Drone is provided with the Horus-Quad UAV platform and uses the radio communication link of the UAV to send real time data to its ground station. Horus-Quad UAV provides 45 min continuous operation with its battery pack and Gamon-Drone payload, guaranteeing a communication range of 10 km in open line of sight.

GAMON-Drone can identify gamma-emitting radionuclides and differentiate them based on the category they belong to, distinguishing between NORM, medical and industrial.

GAMON-Drone runs spectrum analysis algorithms that can perform simultaneous identification of multiple radiological sources and provides quantitative measurements in terms of dose and activity per radionuclide with its built-in detector efficiency calibration.

The user can select the isotopes to be identified from the library and adjust the thresholds of the isotope related alarms. The spectrum stabilization can be obtained with the identification of natural occurring radionuclides as the ^{40}K, ^{232}Th, etc.

The gamma spectrometer is typically composed by an inorganic scintillation crystal of configurable volume. Standard system versions integrate NaI(Tl) 2”x2”, $CeBr_3$ 1.5”x1.5” or $CeBr_3$ 2”x2”, which are the best compromise between resolution and low background measurements. $LaBr_3$(Ce) and NaIL® detector can be integrated on request, where NaIL® detector can give the possibility of detecting neutrons.

Signal from scintillation detector is pre-amplified and the pulse is digitized by a 12 bit 62.5 MHz fADC. Digital signal shaping and pulse height analysis is performed by a digital MCA with 2048 channels.

The detector is configured to collect gamma interactions in the energy range from 30 keV to 3 MeV, providing statistically accurate dose rate measurements starting from 1 nSv/h.

GAMON-Drone features Ethernet and USB interfaces through waterproof connectors. It can be connected to its ground control station with wired interface as a portable spectrometer and can alternatively switch seamless to the wireless radio communication link of the provided drone.

The **GAMON-Drone** integrates an ARM based CPU that analyses data and stores the measures in an internal non-volatile memory of 32 GB. The **GAMON-Drone** is provided with an IP65 tablet that act as its ground control unit and is compliant with MIL-810G standards for drop and vibration resistance. Alternative custom defined ground control units can be provided on request. The ground control unit runs a web interface to allow the user to easily configure the data acquisition and the isotopic analysis.

MAIN FEATURES

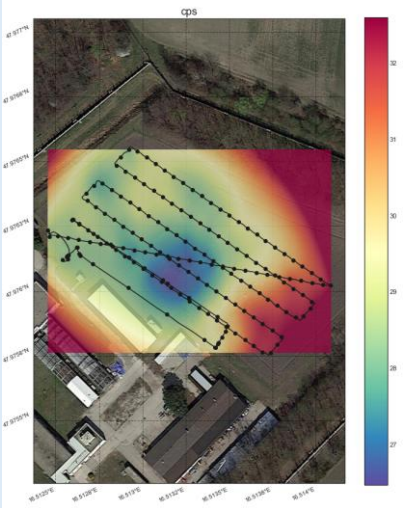
The GAMON-Drone is a UGV/UAV gamma radiation spectroscopy system designed to search for radiological materials.

- Mobile system for radiological search and monitoring purposes
- Automatic radionuclides analysis with configurable library
- Embedded gamma dose rate and spectrometry measurement units
- Programmable isotope based and dose rate alarms
- Web page for an easy system configuration and visualization of the measurements
- Georeferenced and real time data visualized by the operator
- Compatible with alternative scintillation detectors, e.g. NAIL™ and $LaBr_3$(Ce)
- Internal database for an easy handling of the acquired data
- Count rate alarm and alarm reporting to the operator directly on the tablet
- Embedded Gain stabilization of the detector
- Ethernet, USB communication interface (WiFi optional)
- Embedded low power CPU

USE CASES

Typical applications of the GAMON-Drone system through UAV surveys cover:

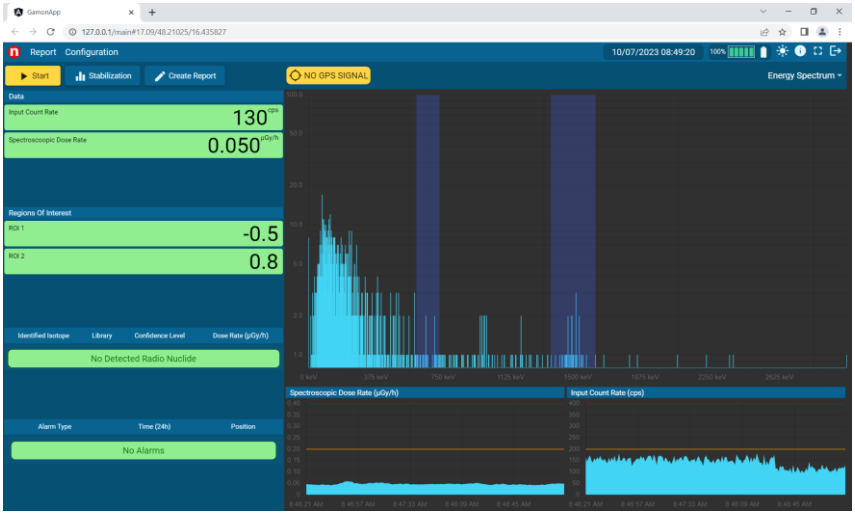
- Survey system for radiological search and monitoring purposes
- Large area survey and control for public events
- Emergency and first-response application for an easy control of the area
- Georeferenced measurements for radioactive mapping for creation of Activity Map and Dose Rate map of NORM



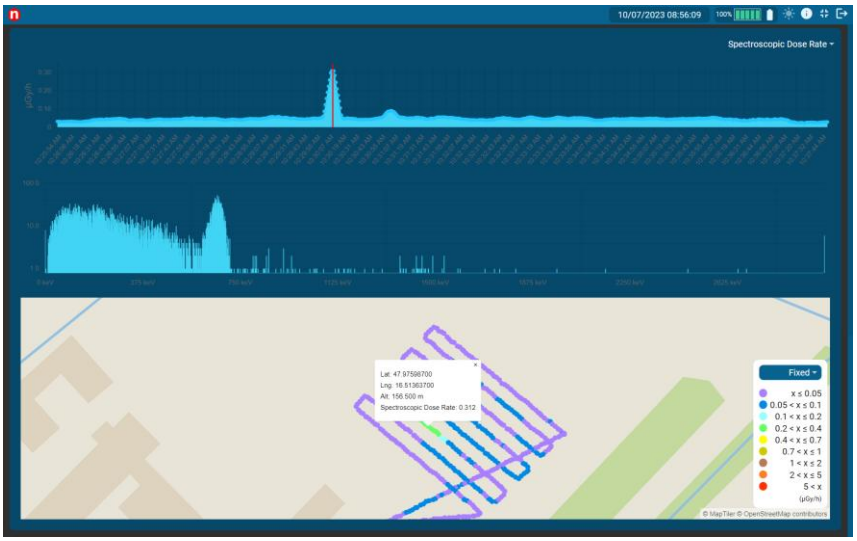
- Access point monitoring
- Typical detection capability with a NaI 2”x2”: alarm and identification of 9 MBq Cs-137 source at 5 m altitude, 1 m/s speed

The GUI of the software is a web interface reachable by a common browser. Security level of the web interface can be configured by the user to avoid unauthorized setting changes.

The web interface shows the real time counting rate of the scintillator, the real time ambient dose equivalent rate, and the live spectrum by the scintillator, as moreover the map of the flight with real time point corresponding to the terrain radiological level. Counting and dosimetry trends of the last ten minutes are displayed in flow charts to help the user in the search of radiological dispersal device.



All the measurements are georeferenced by means of the high precision GPS of the UAV. Values are presented in a dynamic map both in real time acquisition and in the reports that are automatically generated. In the report, the selection of a point in the map highlights the corresponding value in the graph, and vice versa.



Scintillation Detector	NaI(Tl) Ø51 x 51 mm	$CeBr_3$ Ø51 x 51 mm	$CeBr_3$ Ø38 x 38 mm
Ordering Code	WSGDRONAABAA	WSGDROCBABAA	WSGDROCBAAAA
Energy Range	30 keV - 3 MeV	30 keV - 3 MeV	30 keV - 3 MeV
Resolution	7%	4%	4%
H*(10) Range	0.001 - 200 µSv/h	0.001 – 300 µSv/h	0.001 - 600 µSv/h
Total Efficiency to Cs-137	1850 cps/µSv/h	2000 cps/µSv/h	1050 cps/µSv/h
Peak Efficiency to Cs-137	360 cps/µSv/h	520 cps/µSv/h	190 cps/µSv/h

TECHNICAL SPECIFICATIONS

Scintillation Detectors

- 2”x2” NaI(Tl)
  - Energy range: 30 - 3000 keV
  - Energy resolution: FWHM @ 662 keV: 7.0%
- 1.5”x1.5” $CeBr_3$ and 2”x2” $CeBr_3$
  - Energy range: 30 - 3000 keV
  - Energy resolution: FWHM @ 662 keV: 4.0%
- Other scintillators size and types on request

Spectrometer dimensions and weight

- Diameter: 12.5 cm
- Height: 41 cm
- Weight: less than 2.5 Kg

Communication Interfaces

- Probe: Ethernet/USB
- Drone: radio communication link
- Remote: Wi-Fi

Environmental

- Temperature range -20 ÷ 50 °C

Sensors

- Internal temperature sensor for stabilization
- Integrated backup GPS (drone GPS used in standard data acquisition)

Data acquisition

- MCA depth: 2048 channels
- Digital signal processing

Embedded PC

- Low power ARM based CPU
- Linux based operative system
- 32 GB internal data storage

Software

- Integrated web interface
- Local database and data repository
- Nuclide analysis
- Configurable spectrum stabilization with natural background
- Configurable isotope library
- Adjustable isotope related alarms
- Installed and stand-alone GIS map server

Power supply

- Power consumption: 5 W
- 12 V powered from the UAV

Standard Military Tablet 10.1”

- IP65
- Temperature range -10 ÷ 50 °C (battery mode)
- Drop test resistance up to 1.2 m
- MIL-STD-810G shock, vibration and drop resistant

Ordering options WSGDRONAABAA, WSGDROCBABAA and WSGDROCBAAAA include:

- GAMON-Drone spectrometer
- Military Tablet 10.1”
- Preinstalled GIS map for 1 selected region
- All required cables
- Other Optional Tablets or Laptops under request

UAV Specification

- EASA Class C6 compliant
- Quadcopter configuration
- Completely foldable
- Frontal flight survey camera
- Optional 3D Gimbal with High resolution camera for photogrammetry
- High efficiency propellers 28.2"x9.2" carbon fiber foldable
- Batteries: 48 V, 28 Ah, LiPo
- Diagonal wheelbase (with propellers): 1805 mm
- Height: 575 mm

UAV Features

- Empty Operating Weight (EOW): 12 kg (including batteries)
- Maximum Take-Off Weight (MTOW): 18 kg
- Endurance EOW: 60 minutes
- Endurance MTOW: 30 minutes
- Endurance with GAMON payload: 45 minutes
- Maximum flight height: 120 m (limited by design)
- Maximum take-off wind speed: 20 - 28 km/h (5.5 - 7.9 m/s)
- Maximum drone speed: 3 m/s (limited by design)
- Maximum operating transmission range: 10 km

UAV Safety

- Fail-safe mode: this function allows the aircraft to return to the take-off point automatically.
- Emergency landing: system automatic monitoring of the battery voltage and activation of the controlled descent in case low voltage
- Collision Avoidance System: with a 2D Lidar sensor with 320° of angular range
- Flight Termination System: dedicated remote control independent from the primary command to be activated in case of UAV loss of control

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