FLYABILITY

ELIOS 3 RAD

USER MANUAL

Version 1.0
25.07.2023

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Before starting

This user manual focuses on the usage of the RDS-32 WR detector with Elios 3. As the product will evolve, it is possible to find some minor differences between this user manual and a further version of the product.

More detailed information on Elios 3 can be found in its specific User Manual available at: https://knowledge.flyability.com.

Additionally, a full comprehensive user manual dedicated to the RDS-32 WR detector can be found on the manufacturer website[1]

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[1]https://www.mirion.com/products/technologies/health-physics-radiation-safety-instruments/portable-radiation-measurement/handheld-health-physics-instruments/rds-32-radiation-survey-meters

Elios 3 RAD System description

The Elios 3 RAD system comprises the RDS-32 WR detector, along with an interface cable and mount designed specifically for Elios 3. This integrated system allows for real-time transmission and visualization of radiation data, including dose rate and cumulated dose, directly on Cockpit interface. Furthermore, the detector data is stored within the drone, ensuring seamless integration with Flyability Inspector for comprehensive post-flight analysis, review, and reporting.
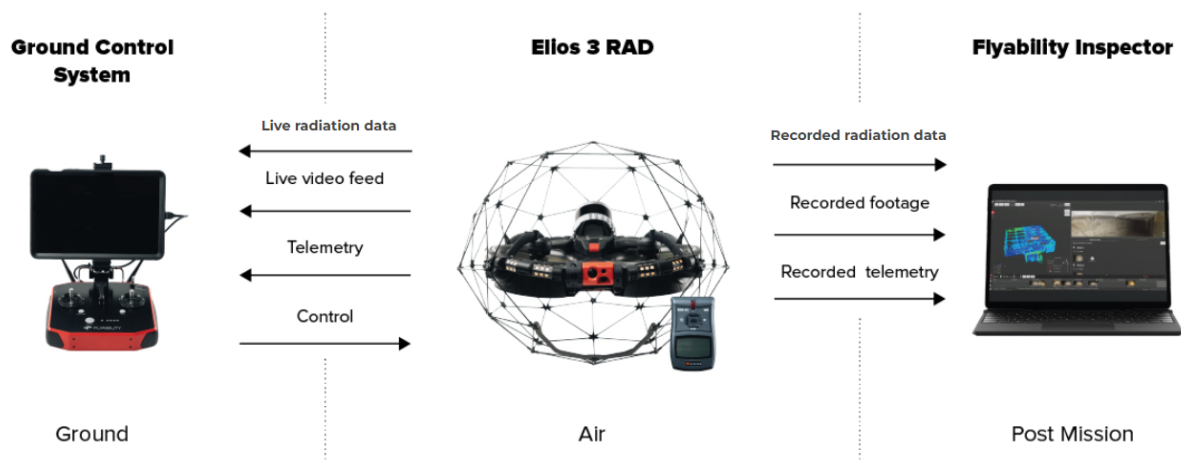
RDS-32 WR specification

The provided radiation dosimeter, the RDS-32 WR, is a product of MIRION TECHNOLOGIES. It is designed to detect both gamma radiation and X-rays. The device utilizes two distinct sensor types: a Geiger-Müller (GM) tube for low-level radiation detection, and a Silicon Diode (Si) for broader measurement capabilities. The detector transitions from the GM tube to the Si diode when radiation levels rise above 30 mSv/h and reverts back to the GM tube when levels fall below 10 mSv/h.

While the RDS-32 WR device is capable of integrating other probes to detect Alpha, Beta, and neutron radiation, these additional probes are not compatible with the Elios 3 drone.

The RDS-32 WR complies with the IEC 60846 standard, ensuring reliable and accurate measurements. The sensor is calibrated using a Cs-137 source, energy 662 keV.

A subset of its specifications is presented below:

Detector supported	Mirion RDS-32™ WR
Technology	Energy-compensated GM tube and energy-compensated Si diode
IEC energy range	55 keV GM tube / 65 keV Si diode to 1.8 MeV
High energy response to Cs-137	4.4 MeV: GM tube 220%, Si diode 120% 6.7 MeV: GM tube 260%, Si diode 200%
Dose rate measurement range	0.05 µSv/h to 10 Sv/h
IEC dose rate measurement range	0.3 µSv/h to 10 Sv/h
Dose rate linearity[2]	-15% to +22% 0.3 µSv/h to 10 Sv/h

For the exhaustive list of specifications, please refer to the sensor's detailed documentation on the Mirion Technologies [website][3]

Airplatform specification

The flight specifications of Elios 3 are impacted by the extra weight of the radiation detector. The impacted specifications are found below:

Flight time[4]	7min30s w/ Lidar 9min45s w/o Lidar
Max operating temperature	45° C (113° F) w/ Lidar 50° C (122° F) w/o Lidar
Max wind resistance	4 m/s (13.1 ft/s) in assist mode 6 m/s (19.7 ft/s) in sport mode
Maximum altitude	2000 m (7,218 ft) w/ Lidar 3000 m (9,843 ft) w/o Lidar
Crashworthiness	Max 1 m/s for direct frontal contact on the sensor

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[2] The sensor will yield an attenuated dose rate result when the heavy components of the drone such as the battery or main body are aligned with the detector and radiation source
[3]https://www.mirion.com/products/technologies/health-physics-radiation-safety-instruments/portable-radiation-measurement/handheld-health-physics-instruments/rds-32-radiation-survey-meters
[4] In ideal flight conditions, with a new battery

Battery life	The additional weight of the payload results in increased power consumption by the battery, which may lead to accelerated battery wear. While the battery is still designed to function for 50 cycles, the maximum capacity, and hence flight time, may decline more rapidly when compared to flying without the payload

Data Integration

The dosimeter transfers to Elios 3 the current dose rate, sensor cumulated dose and status Flag at a rate of 0.5 Hz, or 1 measurement every 2 seconds. These data are integrated within Cockpit for live monitoring and Inspector for post flight analysis and reporting. The dose rate saturates at 10Sv/h.

Cockpit

Here's an overview of key data indicators you'll find on the Elios 3 user interface during the drone's operation with the RDS-32 WR detector
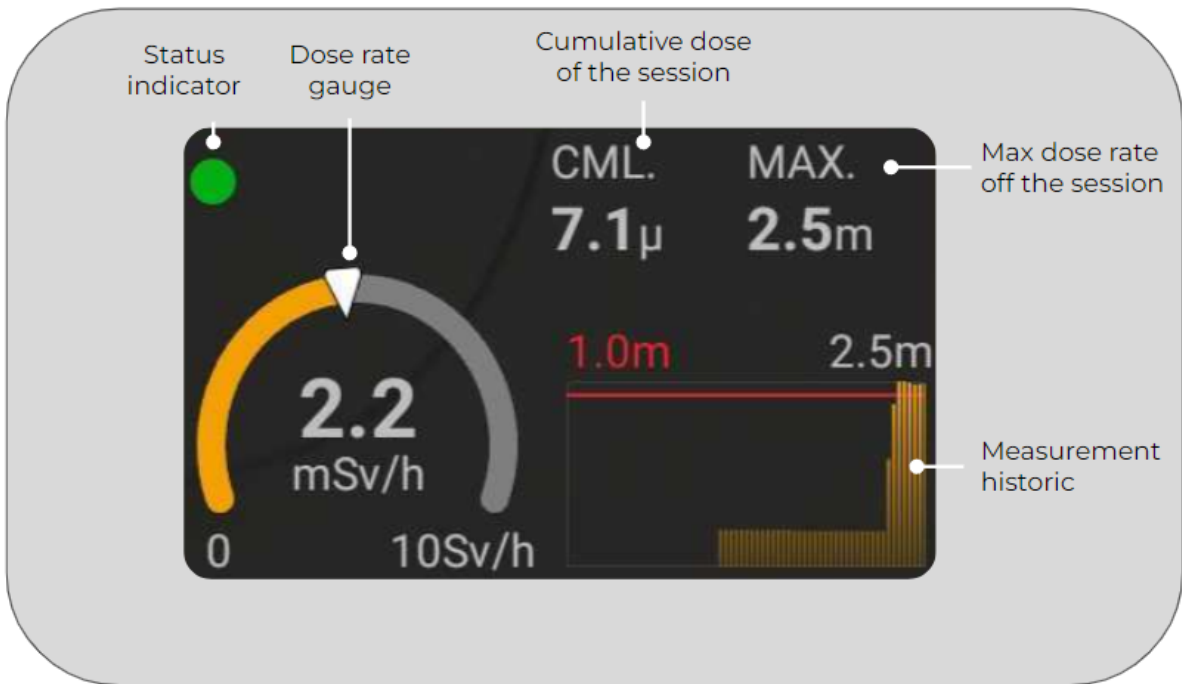
Dose rate gauge: This live indicator displays the current dose rate recorded by the detector. The units can be customized to REM or Sv in the 'Radiation' tab. Depending on the detected radiation, the value will automatically be displayed in either micro, milli, or standard units. If the radiation levels exceed 10 Sv/h, the green indicator will change to red, signaling detector saturation.

Max dose rate of the session (MAX): This value represents the highest dose rate transmitted by the detector to the drone since the drone was powered on.

Cumulative dose of the session (CML): This value represents the total accumulated radiation dose since the drone was powered on. It is calculated by subtracting the detector's initial dose from the current dose reading.

Cumulative dose of the drone: This value, displayed in the 'Radiation' tab of Cockpit, represents the total dose that the drone receives when plugged-in to a radiation payload.

Measurement historic: This logarithmic graph displays the dose rate values recorded over the last two minutes of the drone's operation.

Threshold Indicator: Within the 'Radiation' tab, you can set a dose rate threshold. If this threshold is reached during operation, it will be visibly marked on the 'Measurement History' graph with a red line. Additionally, a warning notification will be triggered.

Live radiation map: The drone trajectory is colorized according to the dose rate measured along the flight path.

Inspector

The Inspector application offers several features designed to display and analyze radiation data gathered by your Elios 3 drone equipped with the RDS-32 WR detector. Here's an overview of these features:
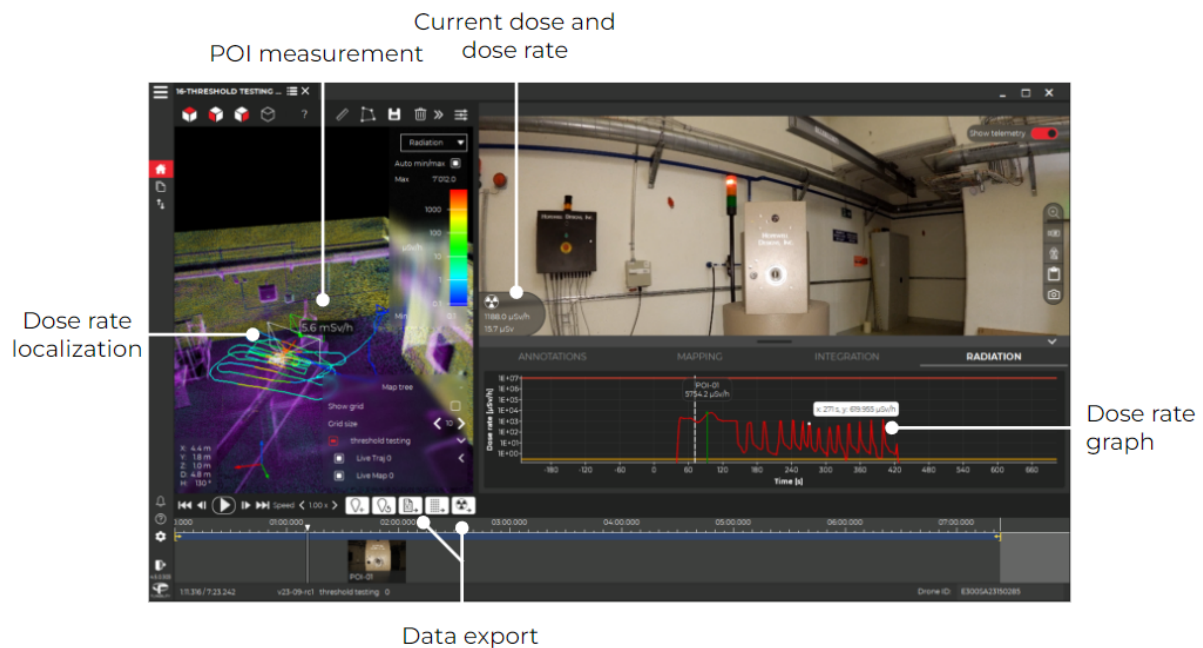
Current Dose and Dose Rate: This shows the cumulative dose of the session and dose rate at a selected point on the timeline. This allows you to pinpoint the exact radiation levels at a specific moment during the drone's flight. You can switch between Sv and Rem in Inspector settings

Dose Rate Graph: This feature plots the dose rate over time, with the measurements displayed in µSv/h. The graph starts at the moment the drone is armed (time 0). By right-clicking and dragging your mouse pointer along the graph, you can measure the cumulative dose over a specified period of time.

Point of Interest (POI) Measurement: This is the dose rate recorded at a designated Point of Interest. The measurement is shown in micro, milli, or standard Sv/h.

Dose Rate Localization: This feature colorizes the drone's 3D flight trajectory based on the measured dose rate values. This offers a visual representation of the radiation levels encountered throughout the flight, helping you identify areas of higher radiation more easily.

Data Export: The report feature automatically adds the POIs with dose rate to your report. Additionally, you can export the radiation data in a timestamped CSV file.

Limitation and good practice

In order to maximize the value of your radiation payload, some limitations and guidelines are provided below.

Measurement delay

The inherent characteristics of the Geiger-Müller tube mean that dose rate data may require a certain period to stabilize and accurately reflect the actual radiation level. The time needed for data convergence can vary based on multiple factors, including the dose rate value, its rate of change, and the direction of this change. The following table offers approximate convergence times under different conditions:

| Radiation Field	Convergence Time (Field Increasing)	Convergence Time (Field Decreasing)
<10mSv/h	1-10 seconds	5-20 seconds
10-30 mSv/h	1-5 seconds	5-10 seconds
>30mSv/h	1-5 seconds	1-10 seconds

When gathering radiation data with low radiation field, it is recommended to
1. Fly at a slow speed to get precise trajectory colorization based on the dose rate
2. Keep the drone steady for a few seconds to ensure the dose rate indicator converges while taking a Point of Interest.

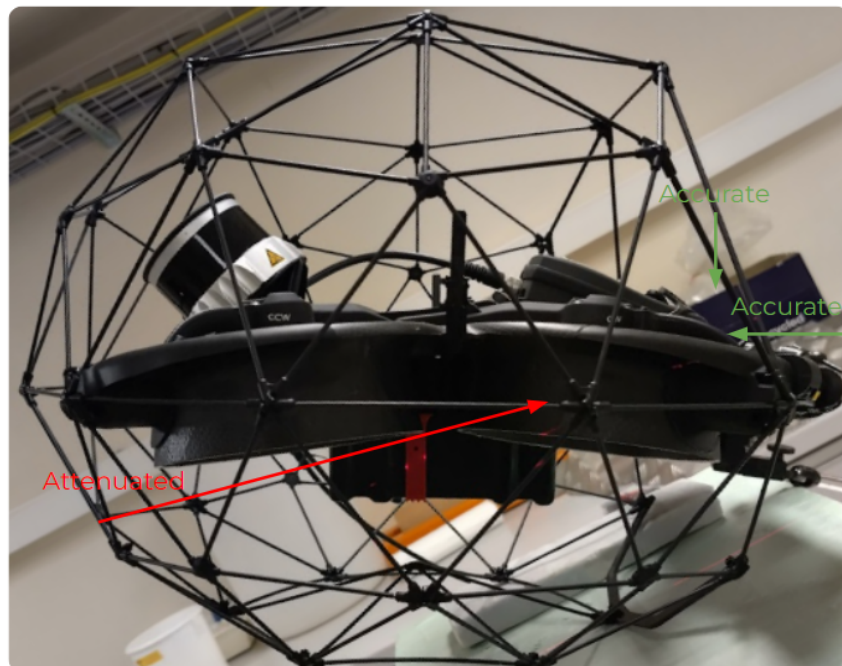## Angular response

The accuracy of radiation measurements can be affected by the drone's orientation relative to the radiation source for two reasons:

Geiger-Müller Tube Sensitivity: The RDS-32 WR geiger müller tube is inherently less sensitive when the radiation source aligns with its axis. This can result in lower measurement values in certain orientations.
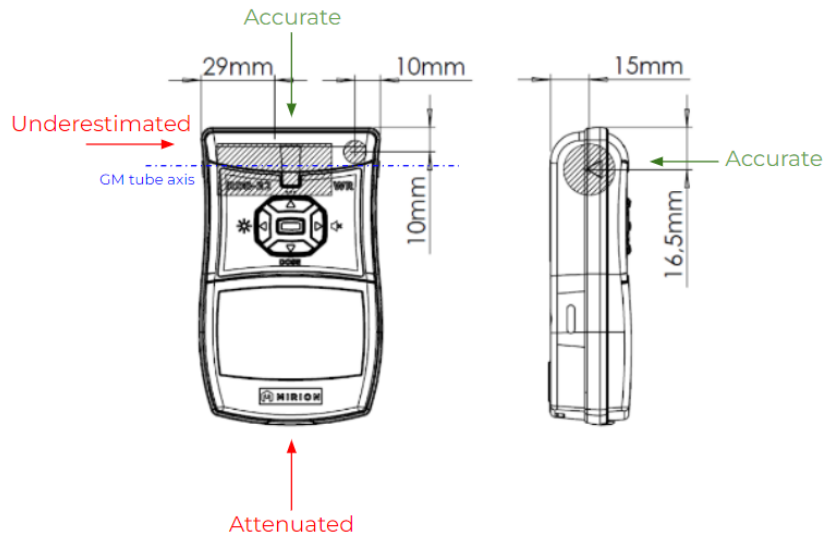
Attenuation in Heavy Components: Radiation particles passing through heavy components of the detector or the drone, such as the battery or LiDAR, may have their measurements underestimated due to attenuation in these materials.

For ambient radiation measurements where the radiation source is diffuse, the measurements remain accurate as most of the drone's angular response is not attenuated.

However, for hotspot measurements, it is important to align the front of the drone with the source of radiation emission to obtain accurate readings.
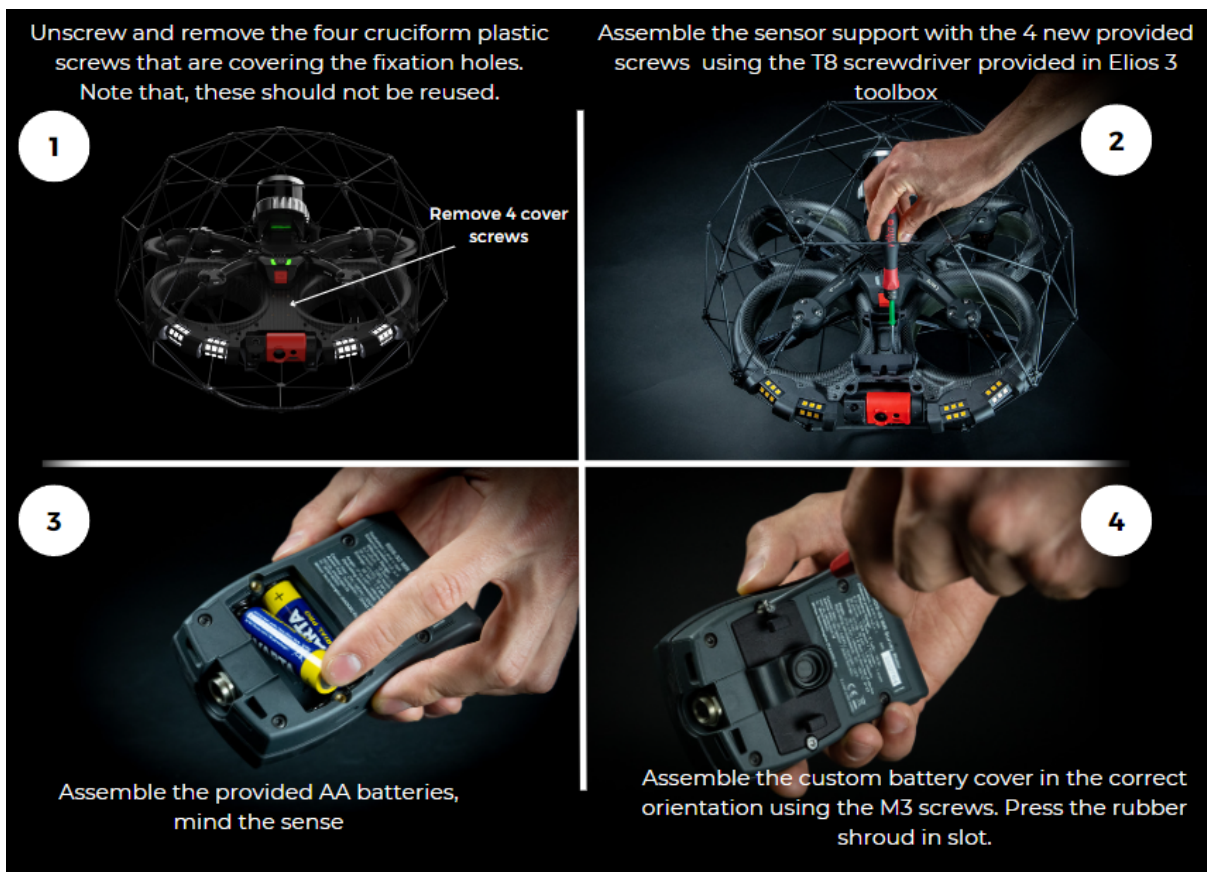
Installation

Package Contents

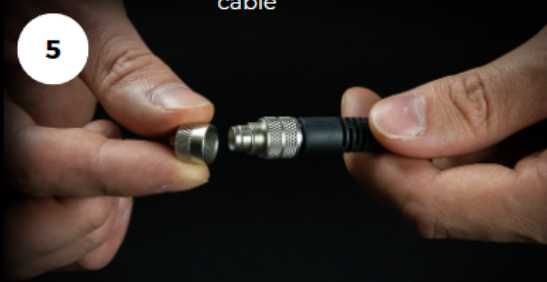The following components are part of the package:
- Transport box
- Detector box with calibration certificate
- Custom battery cover
- Sensor support
- Connection cable
- Screws and screwdrivers
- Quick start guide with activation card

Sensor mount installation and connection

1 Unscrew and remove the four cruciform plastic screws that are covering the fixation holes. Note that, these should not be reused.

Remove 4 cover screws

2 Assemble the sensor support with the 4 new provided screws using the T8 screwdriver provided in Elios 3 toolbox

3 Assemble the provided AA batteries, mind the sense

4 Assemble the custom battery cover in the correct orientation using the M3 screws. Press the rubber shroud in slot.

Remove the caps on both sides of the cable

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Carefully connect the cable to the RDS-32 WR, then fasten the ring to ensure it is secure
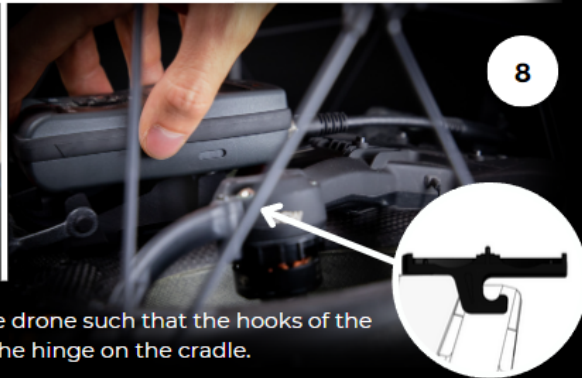
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Position the sensor on the front of the drone such that the hooks of the battery cover fit beneath the hinge on the cradle.

Secure the RDS-32WR to the sensor support using the rubber strap. Ensure proper positioning by aligning the strap to cover the "RDS-32" and "WR" markings on the sensor."

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Ensure the cable goes through the opening in the LiDAR mount. Carefully align the connector with the AUX port and gently push it in until you hear a click, indicating it's securely connected."

Starting-up

Follow these steps to get the system up and running:

1. Make sure you are using Cockpit 3.5 or further for the tablet and Avionics 23-09 or further for the drone software
2. Start by turning on the controller.
3. Open Cockpit application on the tablet.
4. Power on Elios 3 drone.
5. To activate the detector, perform a short+long press on the central button of the RDS-32 WR detector until the screen turns on. After a few seconds, the data transmission icon should start blinking, indicating that the detector is transmitting data to the drone.
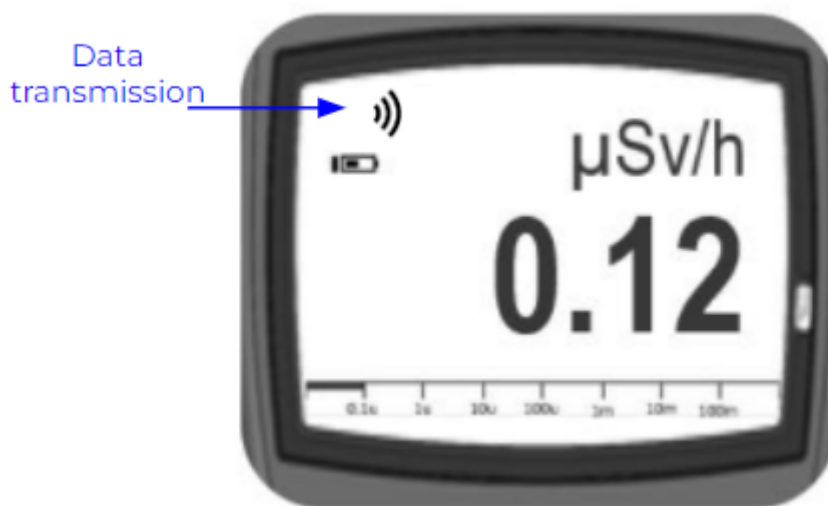
If your drone license is already activated for the radiation payload, you will notice the radiation widget appearing on the bottom left part of the Cockpit flight screen on the tablet.

Turning-off

To turn-off the detector, perform a short+long press on the central button until the screen turns off. You can do this either before or after turning off the drone.

Important: Remember to manually turn off the detector after the mission since there is no auto-shutdown feature. If you forget, the detector AA batteries will get drained after a few hours or days, and you will need to replace them.

License activation

License activation is a necessary step when starting up Elios 3 with the radiation payload for the first time. To activate the license, follow these steps:

1. Ensure that your tablet is connected to the internet through Wi-Fi or other.
2. Power on Elios 3 and the RDS-32 WR detector.
3. Upon starting Cockpit application, a pop-up will appear after connection to the drone, guiding you trough the radiation payload activation process. You'll need to log on your Flyability account.
4. Inside the quick start guide in the transport box, you will find a QR code required for the activation process.
5. Once the license activation is successfully completed, your drone will be fully activated, and you won't need to repeat these steps in the future.

It's important to note that the license is tied to the drone itself, not to the detector. So, even if you change or swap the detector, the drone will remain activated for the radiation payload, and there's no need to activate the license again.

RDS-32 WR configuration

The detector provided in the package will be already configured by Flyability. If you use a detector not provided by Flyability, it will require to be configured using the CSW-32 Configuration Software and USB cable-link (not provided, can be obtained from Mirion). Contact support@flyability.com to get explanations on the configuration steps.

Troubleshooting

Detector compatibility

The radiation payload is compatible with the RDS-32 WR from MIRION TECHNOLOGIES. Other versions exist such as the RDS-32, RDS-32ITx, RDS-32iTxWR and RDS-31. These versions may work if connected to Elios 3, it has however not been validated and we can't guarantee the compatibility of Elios 3. Thus, Flyability will offer no support related to these detectors.

Detector Not Turning On

1. Verify that the central button is being pressed correctly for the required duration (short+long press).
2. Check if the AA batteries are correctly inserted with the right polarity and have sufficient power.

No radiation data on cockpit

If no radiation widget is displayed on Cockpit flight screen when the radiation payload is plugged on the drone, try the following steps:

1. Check that the detector is turned on
2. Check that the data transmission icon blinks on the detector screen, if it is not the case, try to restart the detector. If the problem persists contact support@flyability.com
3. Verify that the drone and cockpit software version are updated by going to the INFO tab in Cockpit. It should be Avionics 23-09 or further, Cockpit 3..5 or further.
4. Check that the connection cable is correctly connected on the detector on one side and on the AUX port on the drone side.
5. Restart Cockpit, the drone, the remote control and the detector.
6. If the problem persists, contact support@flyability.com

No radiation data on Inspector

If no radiation features are displayed on Inspector when you upload a flight, try the following steps:

1. Check that you are using Inspector 4.5 or further
2. Remember if the flight was not done with a radiation payload connected and a radiation payload license activated. If not, Inspector will not display the radiation features.
3. Control that your drone has the radiation payload license activated. To do so, connect the detector to Elios 3, and start the full system.

a. If the radiation widget is displayed on Cockpit flight screen, the license is activated, contact support@flyabililty.com if the problem persists
b. If no radiation widget is displayed on Cockpit flight screen, follow the steps for the license activation.