



FLYABILITY
ELIOS 2 RAD

USER MANUAL

VERSION 1.2
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1 Before starting

This manual focuses on the features of the dosimetry payload of Elios 2 RAD. It complements the following documents, which the Elios 2 RAD user must also read and understand fully:

- ELIOS 2 Original Instructions – certification compliance, safety guidelines and checklists
- ELIOS 2 User Manual – complete user guide
- ELIOS 2 Smart Battery Guidelines – safety guidelines

2 ELIOS 2 RAD System

The Flyability ELIOS 2 was developed explicitly as a flying platform capable of entering confined and cluttered environments. Elios 2 RAD is equipped with an additional dosimetry sensor.

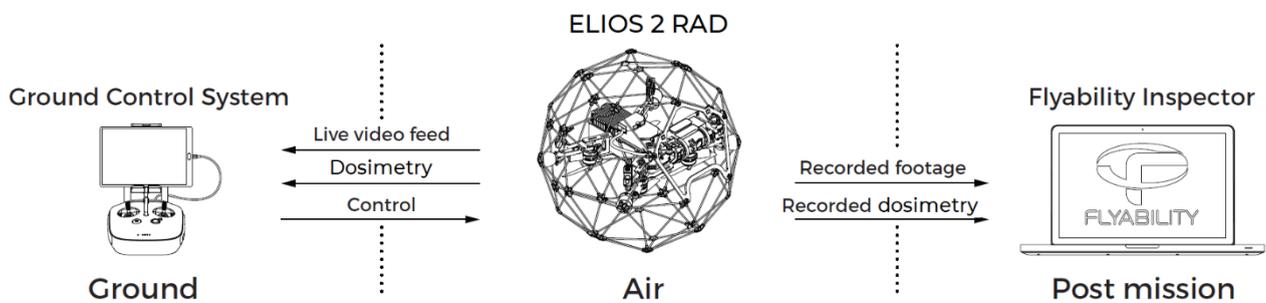
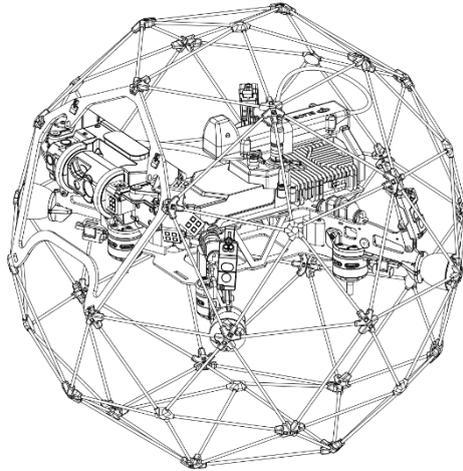


Figure 2.1: System overview

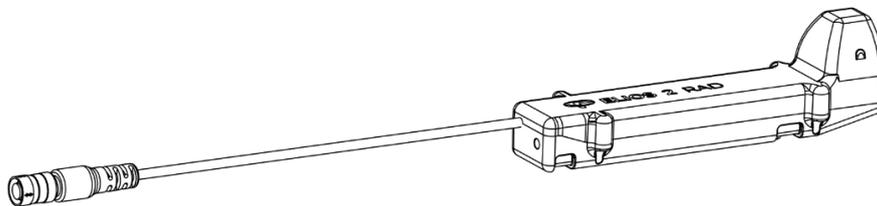
The operator will enjoy full control of Elios through the Ground Control System (GCS). A tablet allows the operator to monitor a live video feed and instantaneous dose rate transmitted by ELIOS 2 RAD. The Flyability Inspector post-mission analysis software provides a simple solution to visualize the recorded video, the thermal video and dosimeter data. Inspector 3.0 premium allows the user to recreate a 3D image of the flight environment to better visualize the dose rates measured in various locations.

3 Elios 2 RAD



Elios 2 RAD is a specially modified Elios 2 designed to carry a dosimetry detector module. Apart from the mounting bracket for the detector module, and the modified casing with a connector, all user changeable parts are compatible with a standard Elios 2. There is no significant change in flight behavior and collision resilience, though flight time is reduced slightly due to the added weight of the sensor module.

4 ELIOS 2 RAD detector module



This module allows Elios 2 RAD to measure ambient radiation. At its core, the sensor module has an energy-compensated Geiger-Müller tube capable of detecting Cs137 and Co60.

The sensor module is removable for calibration but can only be installed on the specially modified Elios 2 RAD drone. To remove the sensor, undo the straps that hold it in place, and disconnect the cable that plugs into the body of the drone.

The detector unit should not be installed or removed while the drone is powered (battery connected). In case a disconnection is detected, Cockpit will show a warning: "Sensor error - restart your aircraft". In this case, the measurement of the flight shall be discarded.

Elios 2 RAD is shipped with one LOW dose detector model.

4.1 Detector Specifications

LOW LEVEL RADIATION DETECTOR

Detector technology	Energy-compensated Geiger-Müller
Types of radiation detected	Cs137, Co60
Calibration Energy (1)	Cs137
Full range	3.5uSv/h to 10mSv/h (2)

Sensor H*(10) dose rate accuracy error

with Cs137 with a calibration at 5mSv/h

- from 2 to 8 mSv/h (calibration 30s average) +- 15%
- from 1 to 10mSv/h (1sec sample rate) +-20%

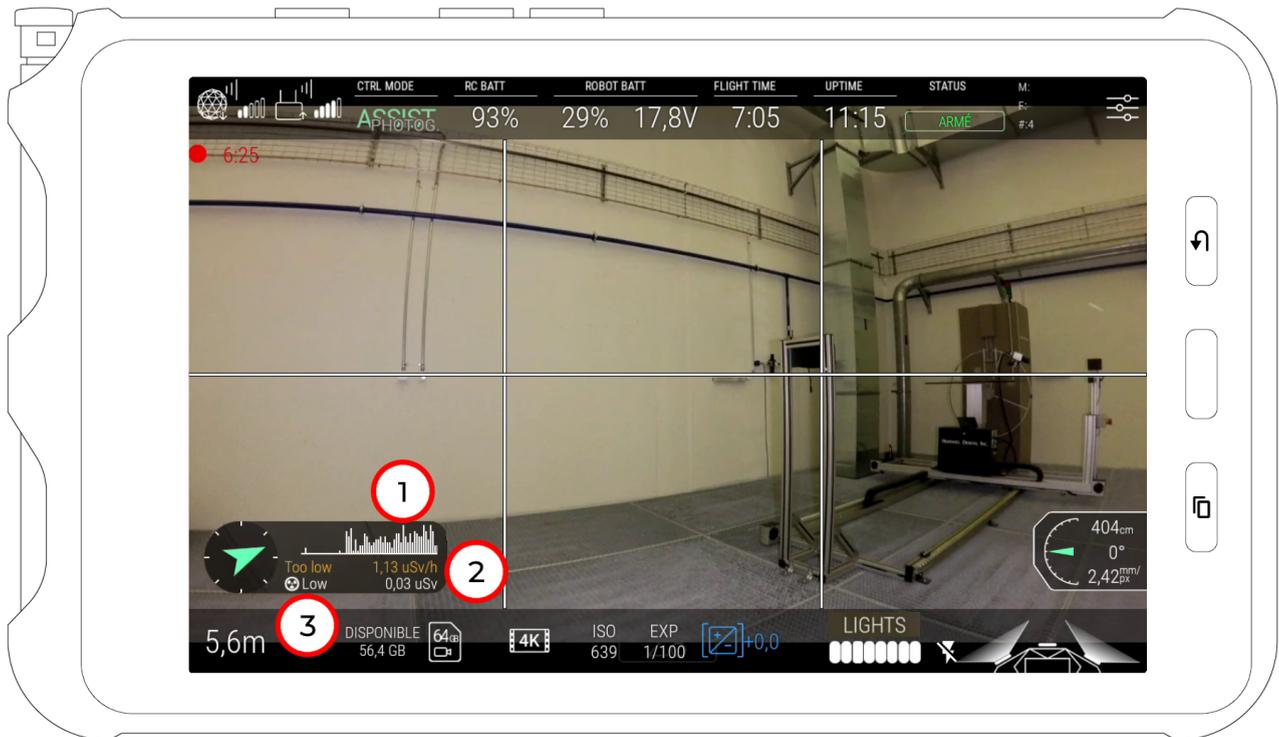
Sensitivity	3.5 uSv/h limit of detection H*10
Saturation detection	No

- (1) A calibration report is provided with the LOW dose detector
- (2) LOW dose Detector are delivered with a calibration at 5 mSv/h with a ¹³⁷Cs irradiation source to match below-mentioned specifications. The LOW dose detector can also be user recalibrated to work with lower dose rate (down to 3.5uSv/h). The range and linearity shall be assessed by the user.

5 Cockpit Interface

The dosimetry data is streamed directly to the ground station and can be monitored in real time on the Cockpit application.

5.1 Flight Display



DOSE RATE PLOT

A graphical representation of the dose rates measured over the past few seconds is displayed in the lower left corner (1).

DOSE RATE

The dose rate is displayed below the plot (2). On the left, an indicator shows if the value is out of the range of the detector (Too low in yellow or Saturated in red), see chapter 5.2 Out of range behavior).

TOTAL DOSE

The total dose absorbed by the drone since the battery is connected is displayed below the dose rate (2).

SENSOR

The type of sensor currently connected is indicated in the lower left corner of the plot area (3). This will indicate either: Low, medium, or High.

5.2 Out of range behavior

The Elios 2 RAD detectors will provide accurate readings within their specified range. Below the lower limit of the sensor, the dose rate value will be displayed in orange, and the message "Too low" will appear.

If the detector explicitly goes above the maximum range, the dose rate value will be displayed in red, and the message "SATURATED" will appear next to the value (see paragraph Saturation detection below)

If the detector type is not detected in the RAD panel menu, the out-of-range behavior will not be available.

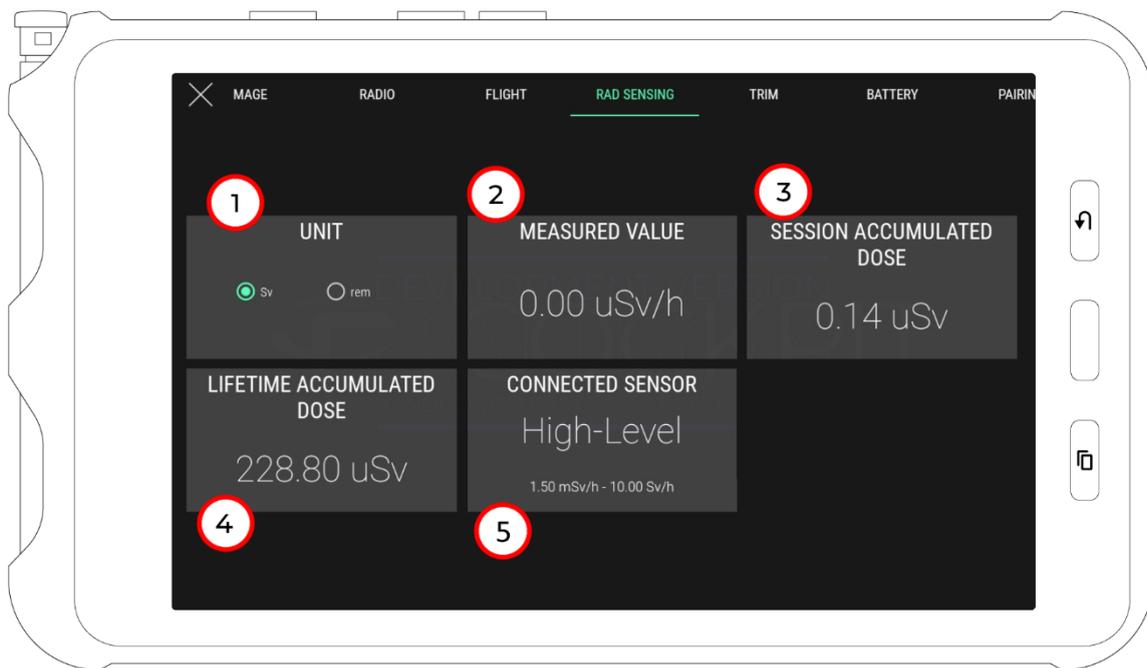
SATURATION DETECTION AND BEHAVIOR

The saturation is not detected by the detector.

Above the maximum range the detector reaches its saturation point, above this value, the values will continue to rise but they will no longer be accurate. When the ambient dose rate largely exceeds the saturation level of the detector, the output measurement values will even decrease slightly. This fold-back effect is not automatically detected.

5.3 Settings Menu

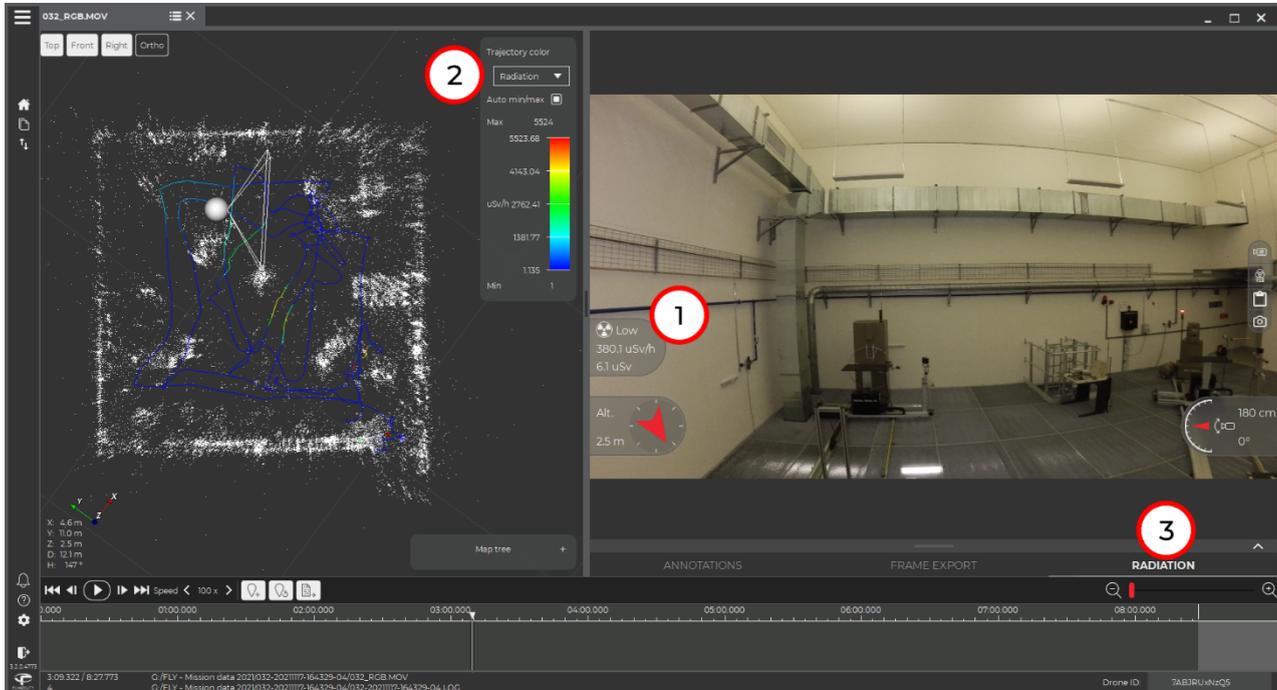
The cockpit settings menu contains the additional 'RAD SENSING' menu tab. This contains the following information and settings:



1. Unit, the unit in which the dose and dose rate are displayed, this can either be Sievert or Rem
2. Measured Value, the dose rate currently measured by the detector, updated every 2 seconds
3. Session Accumulated Dose, the total dose absorbed by the drone since the battery is connected
4. Lifetime Accumulated Dose, the total dose absorbed by the drone over its lifetime before this session
5. Connected sensor, this indicates the range of the detector currently connected.

6 Post flight analysis with Inspector 3

The flight data can be downloaded onto a PC using Inspector 3. The basic version allows the dosimeter data to be displayed alongside the video, while the premium version can re-create a 3D model of the flight environment, with the flight path being colored corresponding to the locally measured dose rate values.



DOSE RATE GAUGE (1)

This gauge will display the dose rate at the current point in the video, and the total dose absorbed until that point in the flight. The user can choose whether the value is displayed in Sievert or Rem in the settings menu.

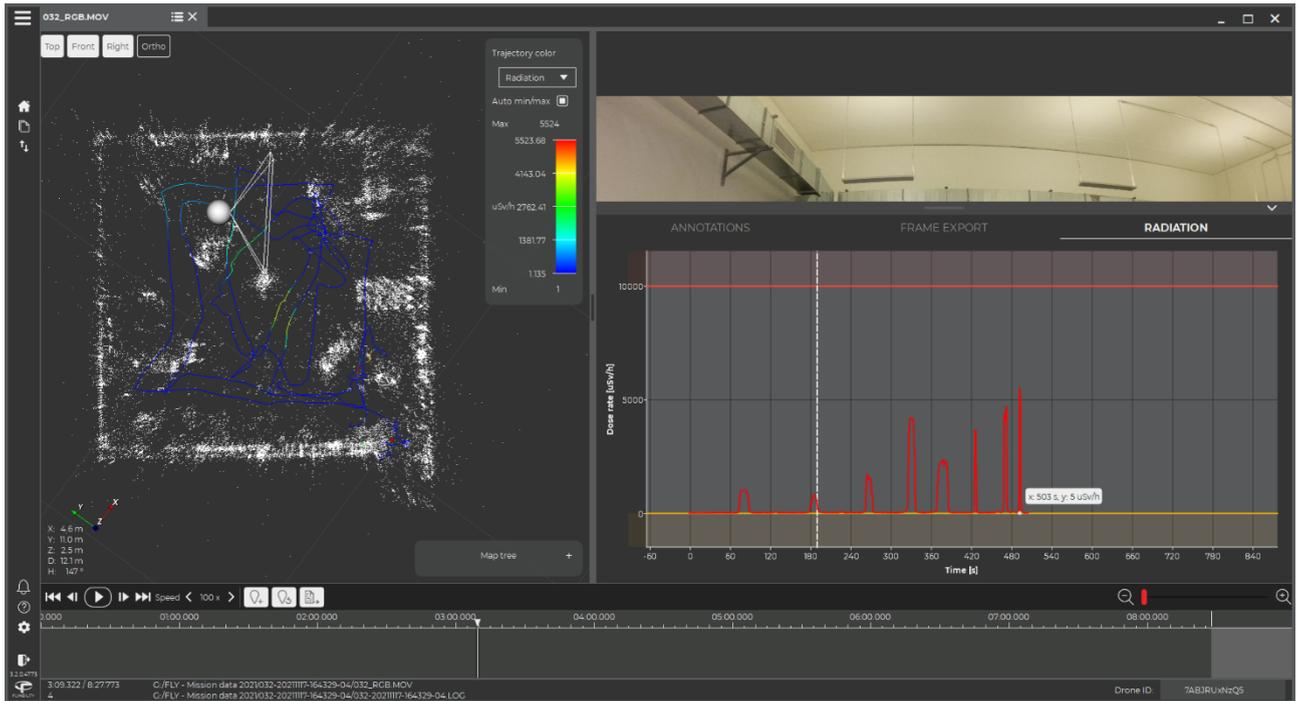
TRAJECTORY COLOR BAR (2)

This menu allows you to change the color mapping of the flight path line in the 3D model. By default, it will autoscale from the minimum to the maximum value.

RADIATION TAB (3)

Click on this tab to expand a plot of the measured dose rate throughout the flight, this allows you to quickly identify hotspots. The lower limit of the detector is indicated in orange and the upper (saturation) limit in red.

If a sensor disconnection was detected, the value will be equal to -1 in the graph



7 Calibration

When used in safety critical applications, you must calibrate the detector modules prior to first use and at least annually. Additionally, the detector units may become damaged due to rough handling during shipping and transport. Such defects, if any, shall be identified by verifying the calibration.

Additionally, you must verify the uncertainty below 15% by measurements at 20%, 50% and 80% of the global dose rate range regularly.

The detector modules can be calibrated using the manufacturer's software by connecting the sensor module to a PC via the provided cable. The following software are required:

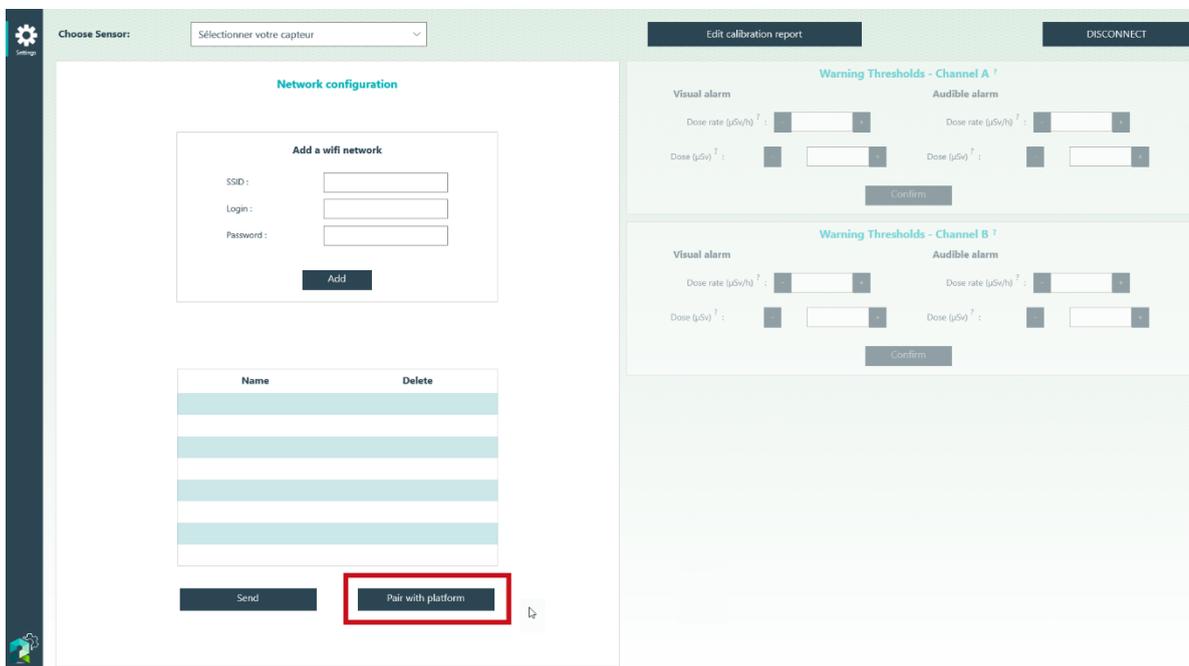
1. RIUMCONFIG calibration software, [available for free on the windows store](#)
2. The FTDI driver for the connection cable, [available here](#)

You will also need a license for the RIUMCONFIG software, this is a .csv file provided with the drone. If you do not have this file, then contact support@flyability.com and you will be given a new one free of charge.

7.1 Setting up RiumConfig

This software is developed by Icohup, the manufacturer of the detector unit. It can only be installed via the Windows Store. Follow the instructions to install it.

When launching the program, you will be given the option to create a password (mot de passe means password). This is not needed for the Elios 2 RAD sensor module, but we recommend you do it anyways, because otherwise it will just keep bothering you with it. You may encounter parts of the program that are not translated, to help you we show you the main translated parts here below.



To activate the license, click on “Pair with platform”. This will open a window where you can select your .CSV license file. Once you have done this, restart the program. You will notice that there is no exit button, so you must press Alt+F4 to terminate it.

Start the program again. A second “calibration” button will have appeared on the left hand bar. You have successfully installed and activated RiumConfig.

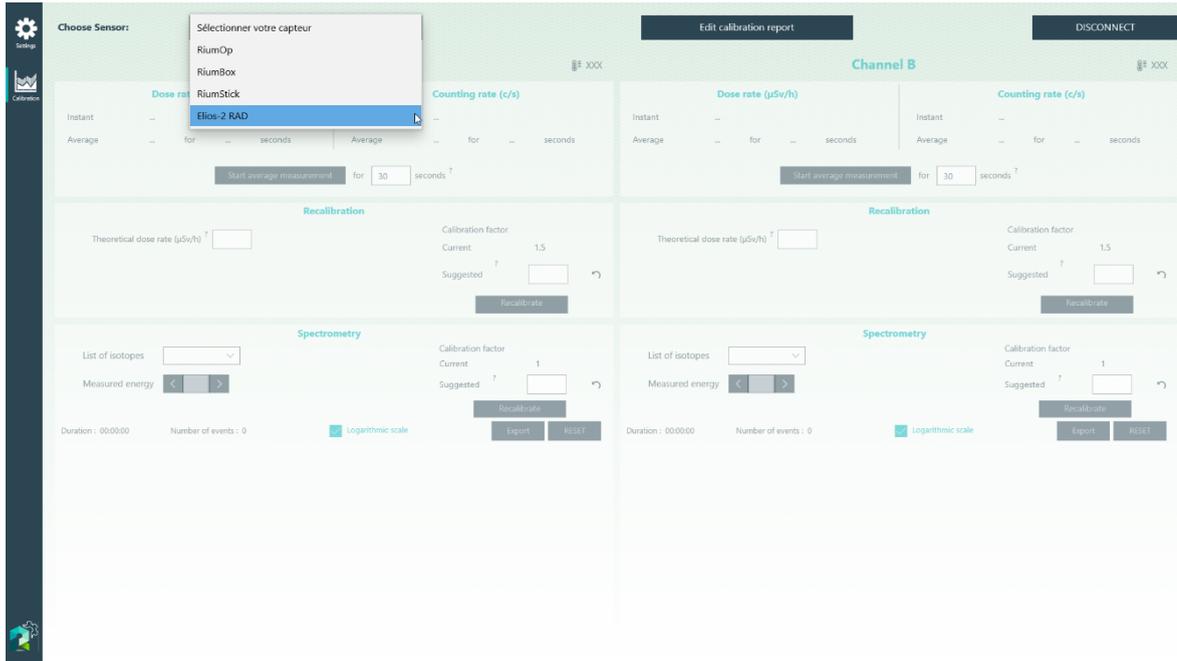
7.2 Calibrating the Elios 2 RAD sensor module

7.2.1 Connect the detector module to a windows PC

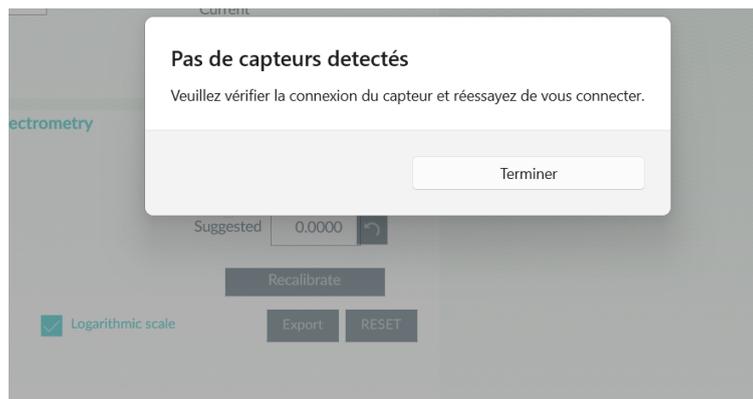
Use the provided USB adapter to connect the sensor module to your PC.

In RiumConfig, click on the “Calibration” tab on the bar to the left, then select it from the drop-down menu in the top left.

E2RAD is compatible with Elios 2-RAD type of detectors, which are named as follows in RiumConfig:
Low level = X



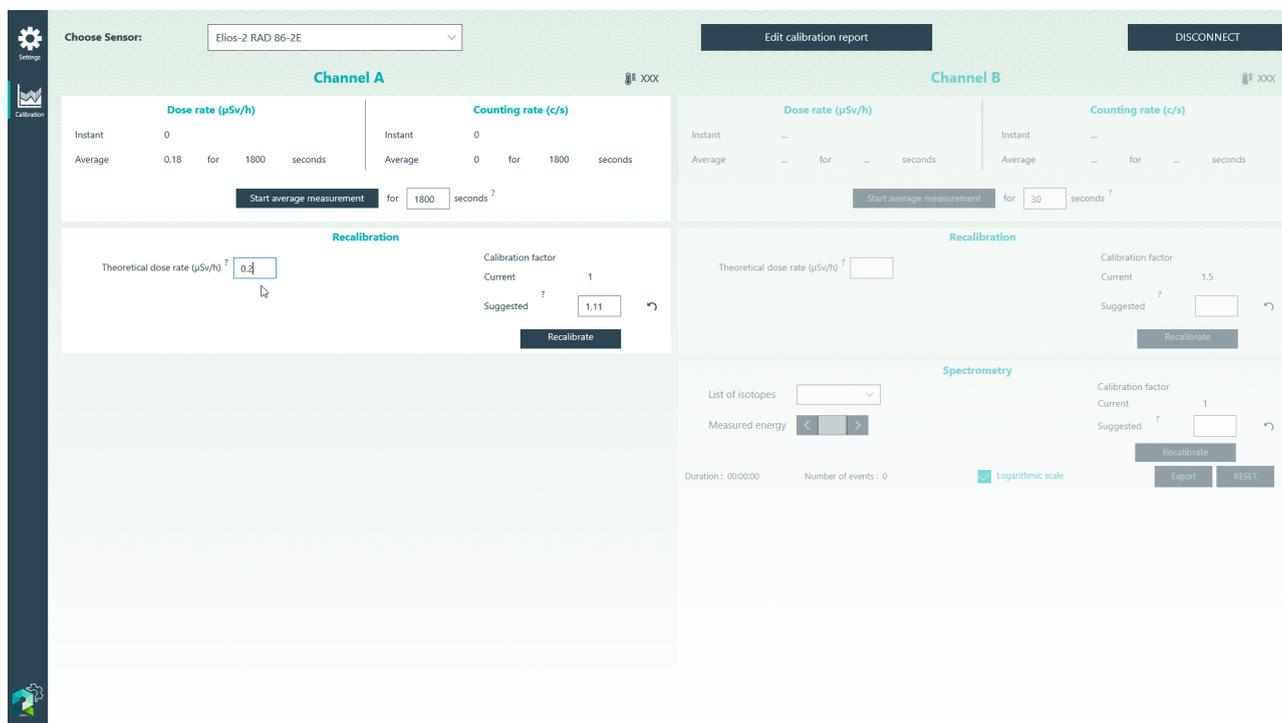
If the Elios 2 RAD sensor module is not connected to your PC at this point, then you will get this message



This message means: “No sensor, verify the connection and try again”. This can be due to a faulty connection, or due to the drivers not being installed correctly. Be sure that the FTDI drivers have been installed.

If the sensor module is successfully connected you will get a message saying “Confirmation de connexion”, click ‘Valider’ to continue.

You can now calibrate the E2 RAD detector unit by making an average measurement and comparing it with the theoretical value of a known reference source. A suggested value for the calibration factor will appear in the field when you enter the theoretical dose rate of the known reference source.



7.2.2 Irradiation type

Icohup recommended calibration by using an irradiator allowing a homogeneous irradiation field at least 3 times larger than the sensor.

7.2.3 Position

The sensors must be positioned as follow:

- the center of the field must fit with the center marks on the sensors. (see pictures)
- the depth of irradiation must fit with the center on the sensor. (see pictures)

The position of the center of detection is indicated by a gray dot on the casing, as shown in red on the image below.



7.2.4 Measurements

The manufacturer of the detector recommends calibration by using ^{137}Cs emitting 662keV gamma particles with a dose rate in the following range: from 3 to 6 mSv/h and 60 seconds irradiation time.

Once the calibration factor is adjusted, we suggest validating an uncertainty below 10% from measurements at 20%, 50% and 80% of the global dose rate range.

Irradiation duration must be adjusted in function of the dose rate to reach a sufficient counting statistic.

8 Updated Technical Specifications

AIRCRAFT

ADDITIONAL TAKE-OFF WEIGHT +75g RAD payload

MAX FLIGHT TIME Up to 9 min with RAD payload

NON-ROHS COMPLIANT Detector contains lead. Applications exempted from the restriction in Article 4(1) specific to medical devices and monitoring and control instruments.
DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

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