ORTEC®

# RADEAGLET-R




## User Manual

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ADVANCED MEASUREMENT TECHNOLOGY

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# 1 Welcome

This chapter offers introductory information about this manual, some important advice for your safety and that of the instrument, and an overview of the RADEAGLET-R, its accessories, and applications.

## 1.1 Conventions Used in This Document

This document uses the following conventions to signify various kinds of text.

Ordinary Text

looks like this, sometimes **bold** or *italics* is used for emphasis.

`Constant Width`

is used for file names, path names, Internet links, or text you have to enter somewhere.




Indicates a specific danger to yourself, your data, or the instrument. Please make sure you carefully read these passages.



Information you should carefully consider before proceeding.



Important information you should pay attention to.



Suggested commands or procedures for advanced usage. You might skip these tips on your first pass through this document.



Information related to optional features not applicable to all models of the RADEAGLET-R.



If you read this document as a PDF file, you can click cross references, items in the table of contents, links into the Internet or similar, to immediately view the designated item.

## 1.2 Safety Warnings

The RADEAGLET-R is designed for outdoor use. When operated in accordance with the operating instructions, it should not present any hazard to the operator.




The RADEAGLET-R is not certified for use in explosive environments.



Do not unscrew the housing of the RADEAGLET-R. There are no user servicable parts inside.



Various components inside the RADEAGLET-R use high voltages posing a severe health risk for you.

The power adaptor is connected to line power. Normal care in handling such a line power device should be exercised. In particular this unit should not be connected to line power if it is wet.

The radEAGLET-R might contain lithium ion batteries (see 10.1.1, p. 139 and E.1, p. 179). Please comply with the relevant transport regulations especially for air cargo. If in doubt, ask your carrier.

The nature of the application is such that objects you survey with the radEAGLET-R could emit ionizing radiation with hazardous intensity.

## 1.3 Instrument Safety

The detector crystals built into in the radEAGLET-R are brittle. To enjoy a long-lasting performance of your instrument, avoid drops or other severe impacts.

Detector crystals may fracture under rapid temperature change. This could occur, for example, when transporting the instrument in a air-conditioned vehicle and unloading it in extremeley cold or hot environments. Sudden temperature change must not exceed 40 °C (72 °F) in order to avoid damages.

The rechargeable batteries of the radEAGLET-R should not be completely discharged. If you don't use the instrument make sure to charge the batteries at least once a year.

## 1.4 Before First Use

We recommend charging the batteries of the radEAGLET-R after unpacking prior to first time use (10.4, p. 145). Charging is also recommended after shipping the radEAGLET-R via air cargo because lithium ion batteries charged above 30 % are not allowed as air cargo.

This is a good time to get familiar with the radEAGLET-R by reading this manual.

Please read at least the rest of this chapter and those on basic operation (chapter 2, p. 23) before starting to experiment with the radEAGLET-R.

Chapter 2, p. 23 explains the principles of operating the radEAGLET-R.

The fundamental modes of operation of the radEAGLET-R are detailed in chapter 3, p. 35, followed by explanations of the radEAGLET-R alarms in chapter 4, p. 43.

A detailed reference on all the commands is given in chapter 5, p. 47, which you should read to know about all the features and possibilities in case you need them.

The web interface for monitoring, configuring and transferring data is detailed in chapter 7, p. 99.

Chapter 10, p. 139 details the power supply for the RADEAGLET-R and the handling of various battery types.

The appendix comprises

- information about the nuclides the RADEAGLET-R can identify (Appendix A, p. 163),
- a glossary of terms and technological background (Appendix B, p. 169 and C, p. 171)
- a trouble shooting guide (Appendix D, p. 175)
- an info pool (Appendix E, p. 179) with certificates, specification data etc.

✳ Several models of the RADEAGLET-R are available (see E.1, p. 179 for details), all of which are covered in this document. The few cases where a feature of a certain model differs from the main stream are marked in the text.

## 1.5 The RADEAGLET-R

The RADEAGLET-R is a new generation radio-isotope identification device (RIID). It consists of the following components:

- Scintillation detector using either a sodium iodide NaI(Tl), a lanthanum bromide $LaBr_3$(Ce), or a cerium bromide $CeBr_3$ crystal.
- Geiger-Müller detector

✳ Neutron detector

- Multi-Channel Analyzer (MCA) for spectral data readout of the scintillation detector
- Computational subsystem that includes LCD screen, keyboard, status LEDs, vibrator and speaker

✳ GPS Receiver

### 1.5.1 Detectors

Each component has a dedicated purpose. The scintillator is the primary detector of the instrument and would be used for multiple purposes including pulse height analysis and dose rates.

#### 1.5.1.1 Scintillation Detector

The scintillation detector is used to collect the pulse height spectrum of the gamma photons that interact with the scintillation crystal. The different radioisotopes each have specific decay schemes and some emit gamma photons that can be analyzed and used to determine the radiation source. (→Scintillation Detector)

#### 1.5.1.2 Geiger-Müller Detector

The dose rate is determined by either the scintillation detector or the internal Geiger-Müller tube. When the dose rate at the scintillator surface exceeds 200 µSv/h, the Geiger-Müller tube will perform the dose rate measurement. This tube is suited for measuring dose rates up to 1 Sv/h. (➞Geiger-Müller detector)




If the Geiger-Müller detector kicks in, you are already in an extremely dangerous level of radiation. You should increase distance and shielding between yourself and the source. Additionally, you should restrict the time you stay within this field to an absolute minimum.

#### 1.5.1.3 Neutron Detector



This item is available for radEAGLET-R models with a neutron detector (see E.1, p. 179).

The neutron detector continuously runs and acquires the current neutron counts per second (cps) (➞Neutron Detector).

### 1.5.2 Overview

Fig. 1, p. 17 shows a top view on the radEAGLET-R instrument. The radEAGLET-R features a 3.5 in (89 mm) color display presenting the various screens of the software.

The keyboard below the screen has 3 keys (  ) you can press with your thumb while holding the instrument.




Figure 1: Annotated top view of the RADEAGLET-R instrument

### 1.5.3 Hardware Accessories

The RADEAGLET-R is delivered with comprehensive accessories. The list of accessories may vary depending on what is ordered with the system. The transportation case should contain the following items (Fig. 3, p. 19, Fig. 4, p. 19):

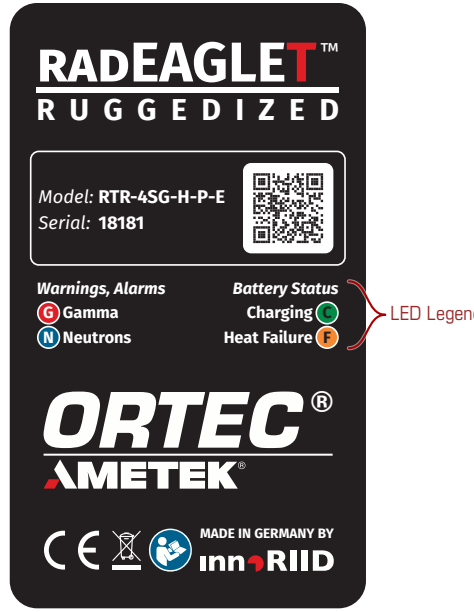



Figure 2: Name plate under the handle of the RADEAGLET-R

- (A) RADEAGLET-R instrument with (a) lanyard
- (B) KCl Calibration box (Only RADEAGLET-R models without internal source (see E.1, p. 179).)
- (C) Charger with US or European plug
- (c) International adaptors for Charger (not with all instruments)
- (D) Power adaptor for cars
- (E) Extra Battery pack for AA batteries
- (F) USB cable for connecting the RADEAGLET-R to a PC
- (G) Documents (manual, quick reference card, test sheet)
- (H) USB Stick

Please make sure the delivered parts are complete.




Figure 3: The RADEAGLET-R in the watertight case

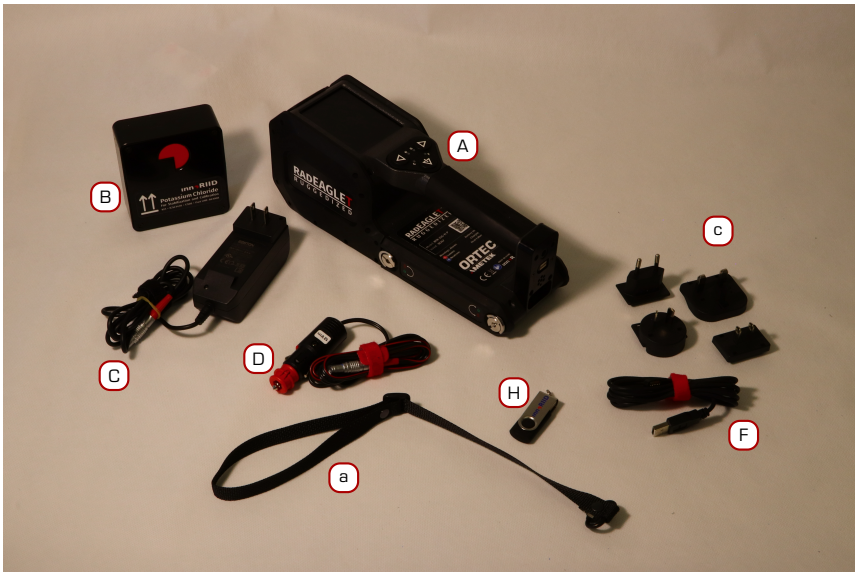



Figure 4: The RADEAGLET-R with accessories

### 1.5.4 Connectors

The radEAGLET-R has several connectors.

When operating under harsh conditions, keep the connectors clean and free of dust or sand. If you experience connection problems, clean the connector with a cleanser specialized for electronic components.

**Magnetic USB at rear end**

Use this connector (Fig. 5, p. 20) to connect your radEAGLET-R to a computer. All common operating systems like Microsoft Windows, MacOS or Linux are supported.

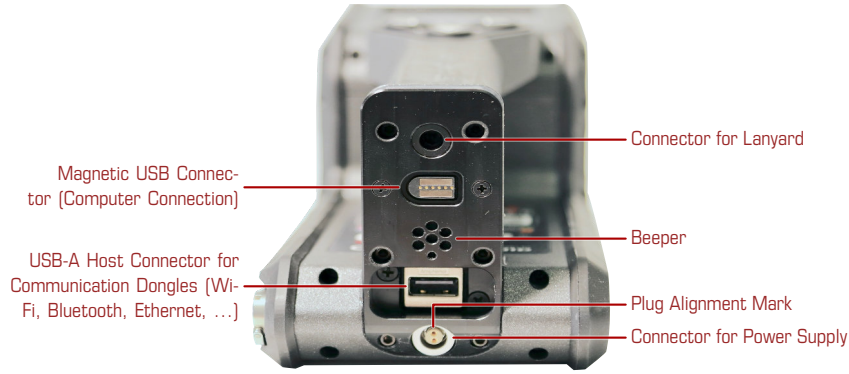



Figure 5: Rear view of the radEAGLET-R

**USB-A host connector at rear end**

Use this plug (Fig. 5, p. 20) for Wi-Fi, Bluetooth, USB-to-Ethernet adaptors, or USB storage devices (all optional).

**Power plug at rear end**

Please align the red dot on the charger cable to that of the plug when connecting (Fig. 5, p. 20) to an external power source.

**Micro SD storage card behind front cover**

All results of your measurements are stored on this card (Fig. 5, p. 20).



Figure 6: Storage card behind front cover of the radEAGLET-R

The SD card will be ejected by a spring, if you push it gently. To re-insert it, push the card until it snaps into place.

**Lanyard connector at rear end**

The lanyard of the radEAGLET-R snaps into the connector (Fig. 5, p. 20). To release the fastener press the button in the center (Fig. 7, p. 21) and pull the lanyard away from the instrument.




Figure 7: The lanyard connector of the radEAGLET-R

# 2 Using the radEAGLET-R

The radEAGLET-R is designed for single-hand operation. You hold the instrument by its handle and point the the detector to the object to be surveyed while observing the screen and pressing the keys with your thumb.

## 2.1 The radEAGLET-R Display

The radEAGLET-R displays information on a color LCD screen (Fig. 1, p. 17) divided into three principle areas (Fig. 8, p. 23).

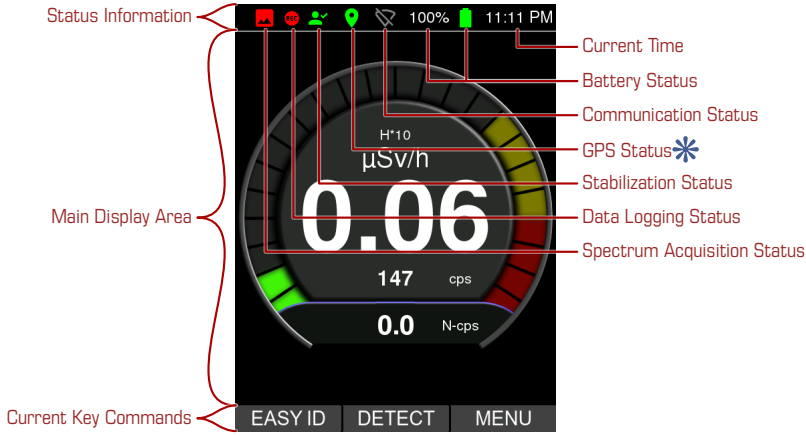



Figure 8: Anatomy of the radEAGLET-R display

**Top: Status Bar**

This area contains icons representing the status of several components of the radEAGLET-R.

**2:32 pm**

The hours and minutes of the current local time are shown. The date and time are read from the internal clock of the radEAGLET-R. Time stamps are written into all files saved by the radEAGLET-R, for example, spectra.

Please ensure the correct setting of the clock and your local time zone (see 5.3, p. 54)

If the instrument's clock is completely off, you have to set it via the web interface (see 7.5, p. 114).

**Battery Status**

The battery status is shown by a value and a symbol.

- Full battery (100 %)

- Empty battery
- While the radEAGLET-R is powered by an external source (see 10.3, p. 143) providing enough power to charge the internal battery, the symbol is decorated by a bolt.

- While the radEAGLET-R is powered by an external source (see 10.3, p. 143) and there is no or a non-rechargeable battery installed, this symbol is shown.

**Connectivity Status** ✳

This item is available while a communication dongle is plugged into the radEAGLET-R's USB-A port.

- The radEAGLET-R is logged into a Wi-Fi network.
- The radEAGLET-R provides a Wi-Fi hotspot other devices can connect to.
- The radEAGLET-R is logged into a wired local area network ("Ethernet").
- The radEAGLET-R communicates via Bluetooth.
- Communication is off.
- A USB mass storage device is available.

**GPS Status** ✳

This item is available for radEAGLET-R models equipped with a GPS receiver (see E.1, p. 179).

- GPS is switched on and receives enough data from several satellites to calculate the position ("has fix").

  Location data is included whenever you save measuring results, for example, a spectrum.
- GPS is switched on but reception is (hitherto) insufficient.
- GPS is switched off.

**Stabilization Status**

The stabilization (see C.1, p. 171) status is indicated by this symbol.

- (Flashing) Stabilization is in progress. After about 2–3 minutes, the status should change to one of the following.
- The instrument is stabilized. You can use the instrument.
- The continous stabilization process got disturbed. See appendix D.1, p. 175 for recommended remedies.

**Data Logging**

This symbol shows whether the radEAGLET-R logs data.

- The RADEAGLET-R logs data. You might want to stop logging, e.g., before you move to survey a different object or to save energy.
- Data logging is off.

**Spectrum Acquisition**

This symbol shows whether the RADEAGLET-R currently acquires and records spectral data.

- The RADEAGLET-R is currently recording a spectrum.
  You might want to stop spectrum acquisition, e.g., before you move to survey a different object or to save energy.
- Spectrum acquisition is off.

**Center: Variable Main Display**

The contents of this area change to the current mode of operation of your RADEAGLET-R. This may be status information after powering up the instrument (Fig. 21, p. 33), menus to choose from (Fig. 36, p. 48), alarms (Fig. 33, p. 44), or measurement results (Fig. 27, p. 39).

**Bottom: Keyboard Legend**

The labels in this area name the function currently associated with each of the RADEAGLET-R keys (Fig. 8, p. 23, Fig. 9, p. 26).

### 2.1.1 Status LEDs

Alarm and battery status LEDs are built into the keyboard of the RADEAGLET-R (Fig. 1, p. 17, Fig. 9, p. 26).

- G Gamma warnings and alarms
- N Neutron warnings and alarms ✳
  This item is available for RADEAGLET-R models with a neutron detector (see E.1, p. 179).
- C Battery charging, blinks when fully charged (“trickle charge”).
- F Battery failure: temperature not within the allowed range or battery completely discharged.

## 2.2 Using the RADEAGLET-R Keys

You control the RADEAGLET-R with the three keys (Fig. 1, p. 17) under your thumb while holding the instrument by its handle.

Pressing a key triggers a feedback tone which you can switch off (see 5.6, p. 58).

On the instrument, the keys look like this: ◁ ▽ ▷. In oral communication they are often called “left” “center”, and “right”.

The meaning of every key changes depending on the circumstances. The current function of the keys is shown along the bottom of the screen (Fig. 9, p. 26) at all times. Almost, exceptions are: Switching on the radEAGLET-R (see 2.3, p. 31) and taking screenshots (see 2.2.5, p. 30).

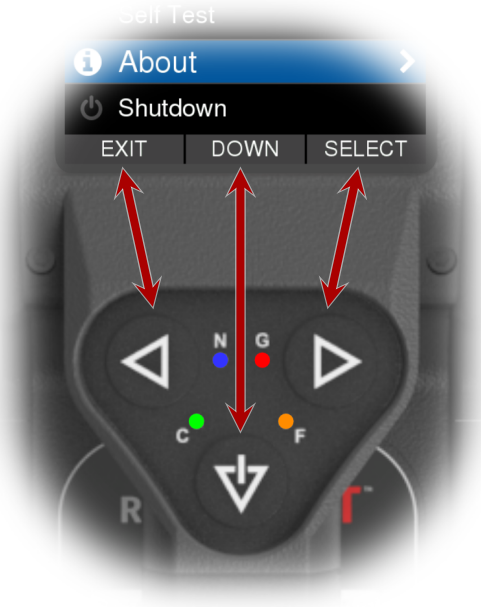



Figure 9: The current functions of keys shown along the bottom of the radEAGLET-R display.

Chapter 5, p. 47 provides detailed descriptions of the different key functions under various conditions.

Some commands are available for a lot of the radEAGLET-R's functions:

Down, Select, and Exit for navigating the functions and commands.

On • Off, + • -, Accept, and Cancel for changing settings or entering values.

### 2.2.1 Using Command Lists

Some sophisticated features of the radEAGLET-R cannot be used with only the three commands you can directly access via the three keys. All the available commands are grouped into pairs mapped to the keys ◁ and ▷, respectively.

The center key ▽ is mapped to the pseudo command Next, which cycles through the available command pairs (Fig. 10, p. 27).

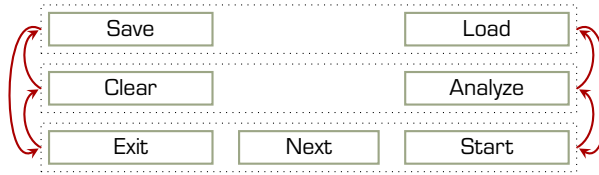



Figure 10: Cycling command pairs

### 2.2.2 Using Menus

A menu is a list of settings or operations you can choose from. It shows several items, one of which is accented with a distinct color (Fig. 11, p. 27).

After opening a menu, the top most item is chosen. You can choose other items with Down. After you reached the last item of the menu, the first item gets chosen again.

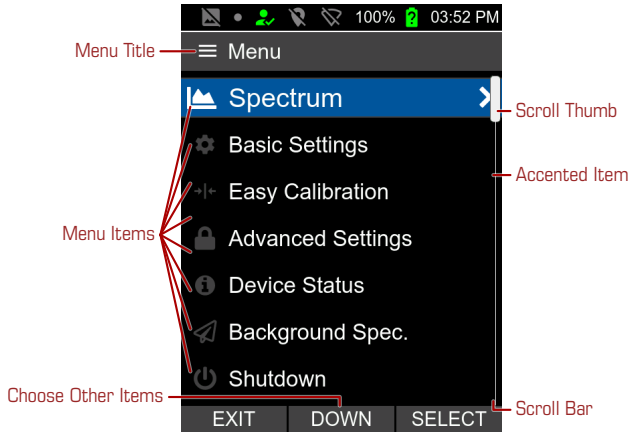



Figure 11: A menu with the third item accented

Some menus offer more items than fit on the screen simultaneously. This is indicated by a scroll bar with a thumb showing the relative position in the menu (Fig. 11, p. 27).

When the item you are interested in is accented, press Select to execute the associated command.

### 2.2.3 Changing Values

You can tailor the RADEAGLET-R to your needs by changing settings. Some settings are simple switches as shown in Fig. 12, p. 28.

You can toggle the state by simply pressing Change.

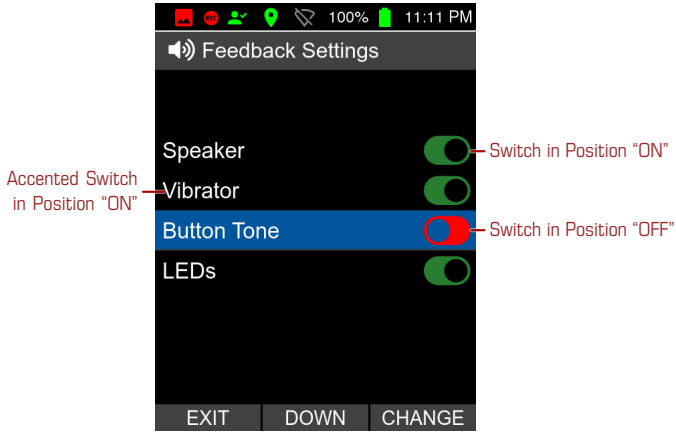



Figure 12: Changing switches

For other settings you can choose from a list of options, for example the screen brightness (see 5.4, p. 55). When you select the setting for change the list of valid settings is displayed (Fig. 13, p. 28).

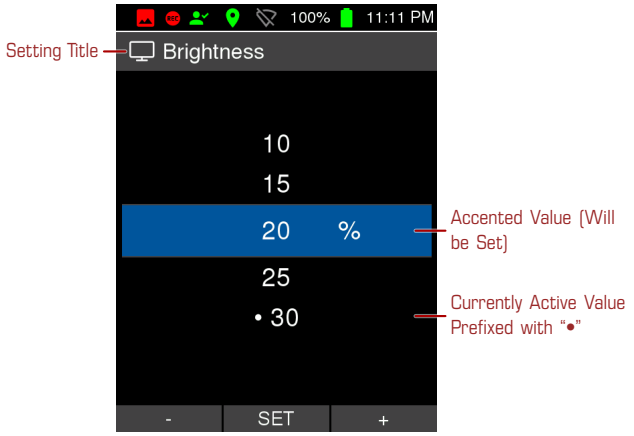



Figure 13: Changing values by choosing from a list

You can choose other values from the list with - or + and set the accented value with Set.

### 2.2.4 Entering the Password

Some settings and operations of the RADEAGLET-R are locked behind a password. If you try to use these items, you will be prompted to enter the password (Fig. 14, p. 29).

After successfull pasword entry, the RADEAGLET-R ist unlocked for about 10 min.

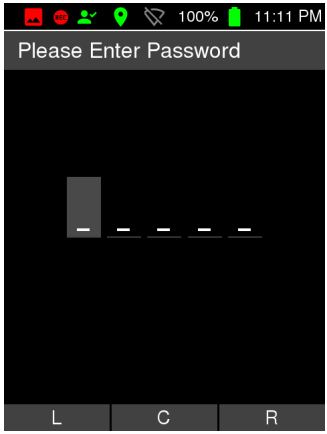



Figure 14: Entering the password

Use the keys ◁ for L, ▽ for C, and ▷ for R to enter the five-character password of L, C and R.

The factory password is always **L C R L C**.

Change your password (see 5.19, p. 78) after receiving the instrument to prevent unauthorized persons from manipulating the protected settings.

After pressing five keys the available commands change (Fig. 15, p. 29).

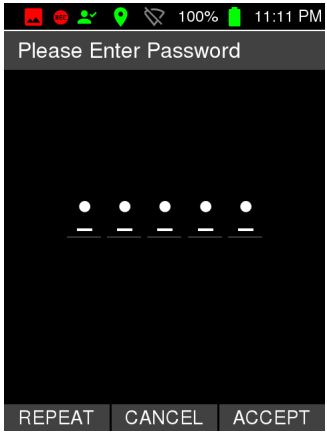



Figure 15: After entering the password

**Settings and Commands**

Repeat

Repeat the entry in case you are not sure whether you pressed they keys in the correct sequence.

Cancel

Cancel the password entry and quit accessing the protected settings.

Accept

Confirm your entry and have the radEAGLET-R check it for correctness. If your entry was incorrect, you will be notified and the password entry will start over.

### 2.2.5 Saving Screenshots

You can save the contents of the radEAGLET-R's display, for example, to document a certain result or for your inhouse training material.

→ **To save a screenshot**...

1. Press and hold .
2. Press .

   You will be informed that a screen shot was saved in the status bar of the display (Fig. 16, p. 30). This message disappears after a moment.

   The screenshot is saved as `*.png` image. The file name is is built from the technical name of the current screen and the current date and time in ISO format, for example `DoseRateScreen 20181018-231111.png`.

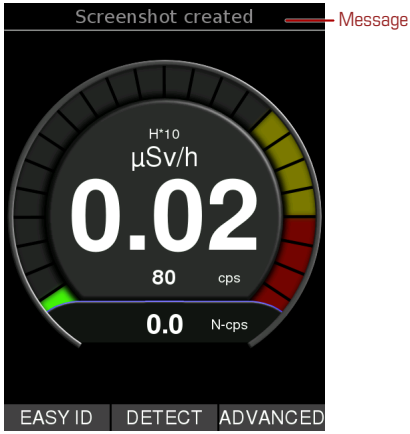



Figure 16: Status bar after saving a screenshot

For further processing screenshots, transfer them to your computer with, e.g., Storage Management in the Web interface (see 7.10, p. 123), or a USB flash drive (see 5.11.2, p. 68).

## 2.3 Starting Up the RADEAGLET-R

1. Position the instrument in a low-radiation environment.

✱ If your model is not equipped with an internal source, position the supplied KCl (potassium chloride) box (Fig. 17, p. 31) in front of the detector cap.

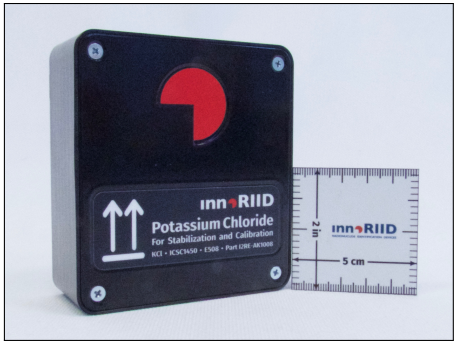



Figure 17: Box with potassium chloride (KCl) for stabilization and calibration (Only RADEAGLET-R models without internal source (see E.1, p. 179).)

2. Press and hold down the key (Fig. 9, p. 26).
3. After a couple of seconds the instrument begins to boot when the alarm LEDs (Fig. 1, p. 17) begin to flash.
4. You are welcomed by the start-up screen (Fig. 18, p. 32).
5. After a moment the instrument identifies itself by showing the type, serial number and software version (Fig. 19, p. 32).
6. The RADEAGLET-R begins an initial stabilization (Fig. 20, p. 33, see C.1, p. 171 for details).
7. If any sources are present, the instrument cannot perform the initial stabilization. This is indicated by a red text on the screen(Fig. 21, p. 33).
8. After the stabilization the RADEAGLET-R switches to Dose Rate Mode (see 3.1, p. 35) by default. You can also change the starting mode in the Startup Settings (5.5, p. 56).
9. Watch the stabilization status icon on the screen (see 2.1, p. 23).

⚠ If the initial stabilization could not be finished, due to a source nearby, the instrument constantly warns you in the status bar at the top of your screen. In this situation, it is highly recommened to get into a low radiation environment, prior to either restarting the instrument, or calibrating it (5.14, p. 72).




Figure 18: Starting the RADEAGLET-R

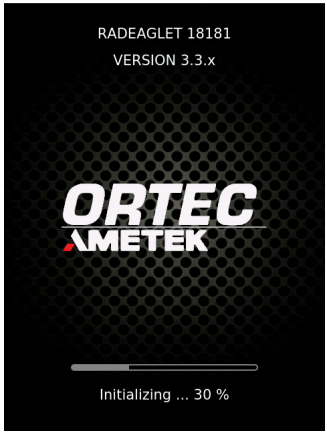



Figure 19: Identification screen

## 2.4 Switching Off the RADEAGLET-R

To switch off the instrument, navigate to the Advanced menu and select the **Shutdown** command (see 5.32, p. 92). You will be prompted to confirm in case you change your mind (Fig. 98, p. 93).

Another method to shut down is to hold ⏻ for 10 seconds or longer.

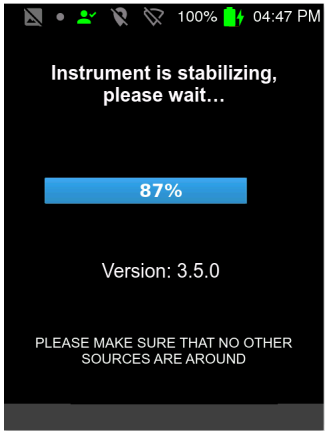



Figure 20: Initial stabilization

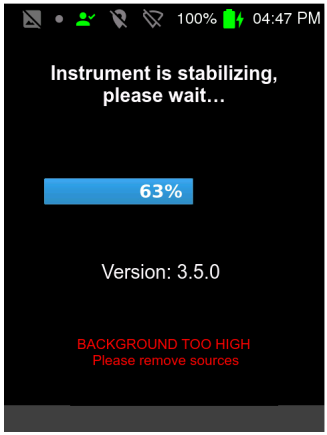



Figure 21: Initial Stabilization interrupted due to a source nearby

# 3 radEAGLET-R Measuring Modes

This chapter describes the essential measuring modes of your radEAGLET-R.

**Dose Rate Mode**

Observe the ambient radiation, see 3.1, p. 35

**Easy ID Mode**

Identify radiating nuclides quickly, see 3.2, p. 37

**Detect Mode**

Locate radiation sources, see 3.3, p. 39

Measuring modes might be overridden by warning and alarms, please refer to chapter 4, p. 43.

## 3.1 Dose Rate Mode

The Dose Rate Mode is the main measurement mode of the radEAGLET-R. It is active after starting up the instrument.

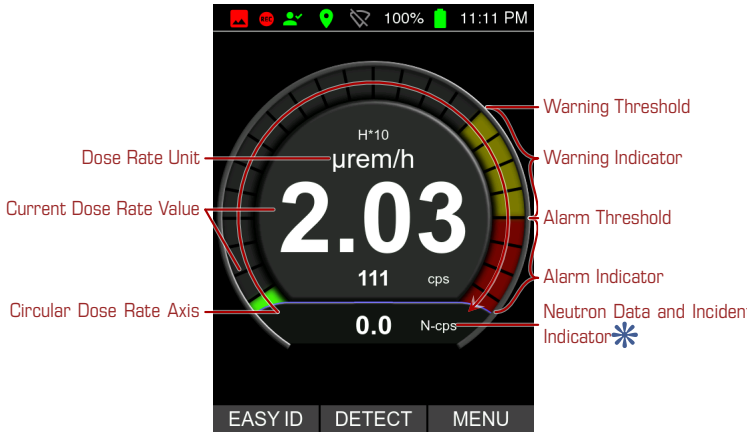



Figure 22: Dose rate display

Several representations of the current ambient dose rate (H*10) are shown (Fig. 22, p. 35):

**Digital**

Large digits show the current value and the unit. The unit adapts to the order of magnitude of the value: µSv/h, mSv/h, Sv/h. You can select a Sievert or a rem-based display, see 5.4, p. 55.

Additionally, the current gamma count rate is shown.

If your model is equipped with a neutron detector, the current neutron count rate ist shown.

**Analog**

A schematic chart modelled after a traditional LED chain shows the current dose rate along a circular axis divided into normal, warning and alarm sections.

Warning and alarm indicators are illuminated if the dose rate rises above the thresholds (Fig. 23, p. 36, Fig. 24, p. 37).

If your model is equipped with a neutron detector, the neutron data display switches to a blue background for neutron incidents according to the specified sensitivity, (see 5.16, p. 75).

Neutron sources are dangerous, they are always considered as threat. If the instrument indicates the presence of neutron radiation, move away from the source immediately.

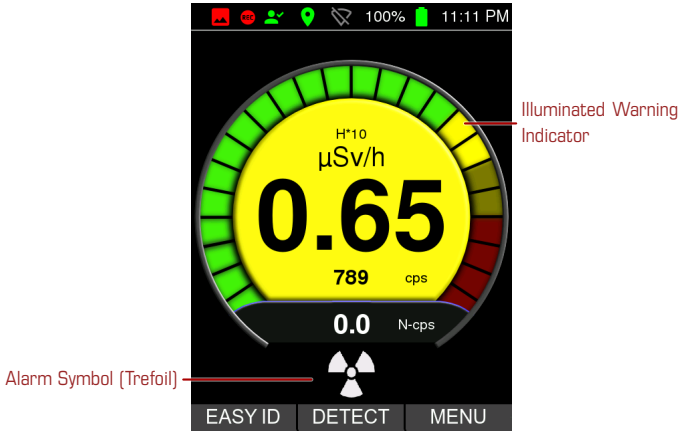



Figure 23: Dose rate display with gamma warning

**Settings and Commands**

Easy ID

Switch to the Easy ID mode, see 3.2, p. 37.

Detect

Switch to the Detect mode, see 3.3, p. 39.

Advanced

Open the menu for advanced operations, see 5, p. 47.

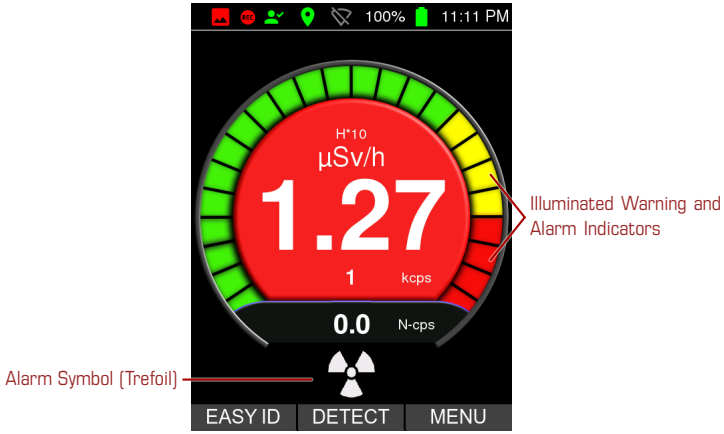



Figure 24: Dose rate display with gamma alarm

## 3.2 Easy ID Mode

The Easy ID measuring mode helps you to quickly identify radiating nuclides. Your RADEAGLET-R will acquire a spectrum for a preset duration (see 5.23, p. 81) and then analyze and save it.

When you enter the screen, you are asked which kind of measurement you want to take. Your choice will have an effect on the name of the resulting spectrum. The type of measurement is added to the spectrum name at the end, after the date and time.

During the acquisition, a chart (Fig. 26, p. 38) instructs you to find the best distance between the RADEAGLET-R and the source in question.

The nuclides identified will be displayed (Fig. 27, p. 39). The recorded spectrum and the analysis results are saved. The file name is composed of the current date and time followed by an index number.

### Settings and Commands

Reset

Reset the timer and clear the spectrum recorded so far.

Analyze

Initiate the analysis of the spectrum before the preset recording duration elapsed.

Continue

Continue with the Easy ID spectrum acquisition after an analysis. Sometimes, the preset duration was simply too short or the source is very weak, so extending the duration gives additional trust in the result.

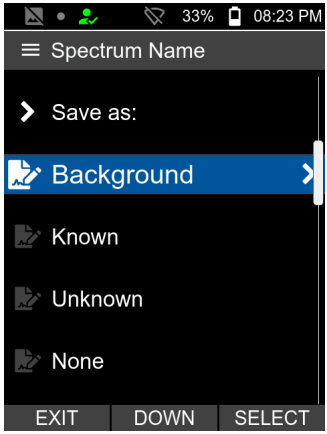



Figure 25: Determine the type of the measurement

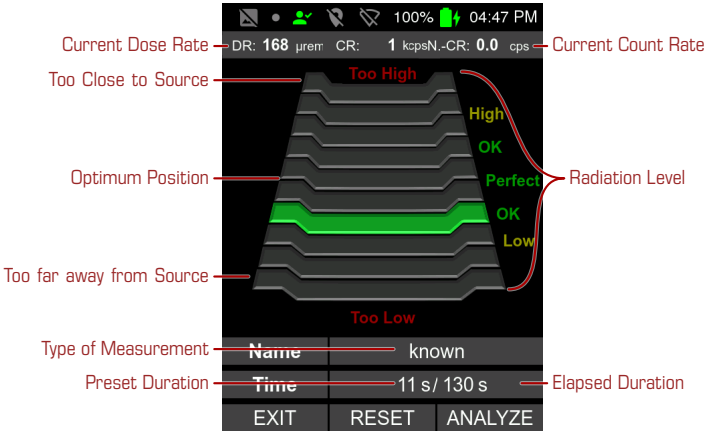



Figure 26: The Easy ID screen

Exit

Return to the superior screen.




Figure 27: The Easy ID results

## 3.3 Detect Mode

The Detect measuring mode is a tool to locate radiation sources by giving rapid visual and audio feedback to the changing dose rate of incoming radiation.

Detect Mode makes heavy use of the RADEAGLET-R's speaker. Make sure it is switched on (see 5.6, p. 58).

The tool starts with measuring the background radiation (Fig. 28, p. 39).

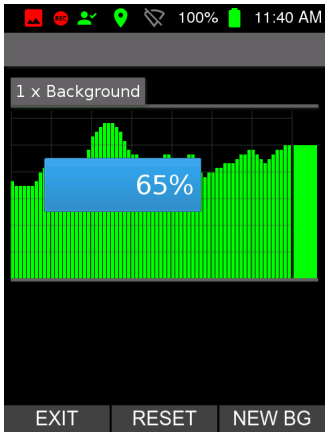



Figure 28: Detect mode background measurement

It is preferable to take the background in a low radiation environment. If you are in a facility with a high natural background or with multiple radiation sources present, the

detection capability adapts to this situation.

After finishing the background acquisition, the display shows a chart with colored bars representing the count rate history of the last couple of seconds (Fig. 29, p. 40).

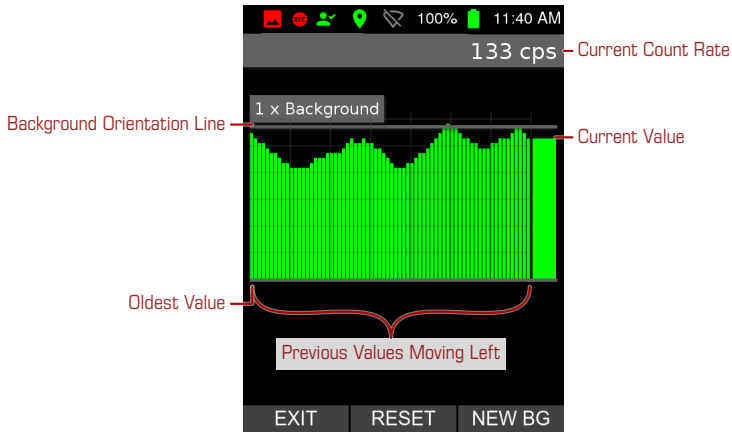



Figure 29: Detect mode chart

**Green Bars**

represent radiation levels close to the background.

**Red Bars**

represent increased radiation potentially caused by a source (Fig. 30, p. 40).

**Blue Bars**

represent neutron incidents, if any.

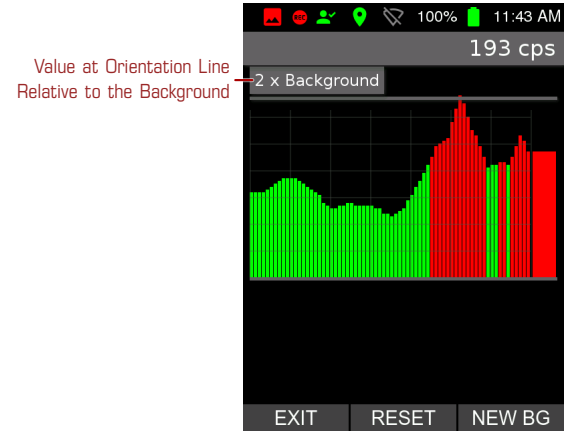



Figure 30: Detect mode: Approaching a source

If the radiation level increases, the chart will be rescaled to multiples of the background determined at the beginning (Fig. 31, p. 41).

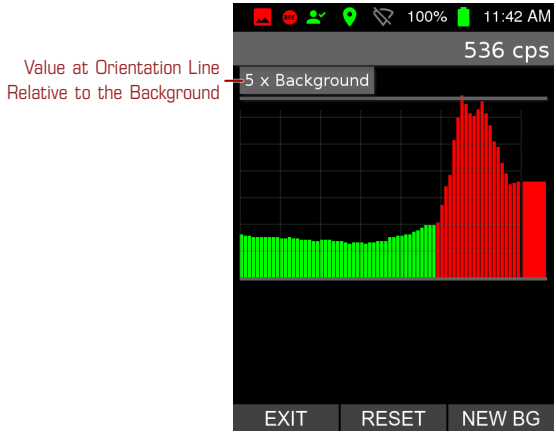



Figure 31: Detect mode: Close to a source

**Settings and Commands**

Reset

Reset the maximum scaling to the background, for example, to see more detail after moving away from a source.

New BG

Initiate a new background measurement. This might become necessary if you changed your measurement location or the background is suspected to have changed for whatever reason.

Exit

Return to the superior screen.

# 4 radEAGLET-R Warnings and Alarms

When the radEAGLET-R detects radiation above preset thresholds (see 5.16, p. 75), warnings and alarms are reported via several annunciators:

**Main Display**

Details of the alarm are shown on-screen, no matter which other activity was displayed when the alarm was raised.

The screen backlight will be switched on if it timed out before (see 5.4, p. 55).

The alarm details remain on the screen until you confirm them. You can turn off the confirmation, see 5.4, p. 55

**LED** The alarm LEDs (Fig. 1, p. 17) flash in several patterns.

**Speaker**

The speaker emits various sound patterns. You can switch the speaker on or off, see 5.6, p. 58. For the warning, the speaker emmits a constant beeping pattern, of equally long sounds. For the alarm, the sound is higher and the duration of the beeping sound alternates between a long and short beep.

**Vibrator**

The vibrator shakes the handle (and adds a little sound). You can switch the vibrator on or off, see 5.6, p. 58.

STOP Radiation sources are dangerous to you. When dealing with radiating material, you are strongly advised to:

1. Maximize your distance to the radiation source.
2. Minimize the time you are exposed to the radiation.
3. Put as much shielding between the source and you as possible.

STOP In addition to dangerous ionizing radiation, certain substances can pose a life-threatening risk to you, due to their chemical or biological effects. Plutonium, for example, is highly toxic, especially if ingested or inhaled. If the radEAGLET-R identifies plutonium (as WGPu or RGPu), you must not touch the source under any circumstances.

## 4.1 Gamma Warning and Alarm Display

The warning (Fig. 32, p. 44) and alarm (Fig. 33, p. 44) messages overlay all other activities of the radEAGLET-R.

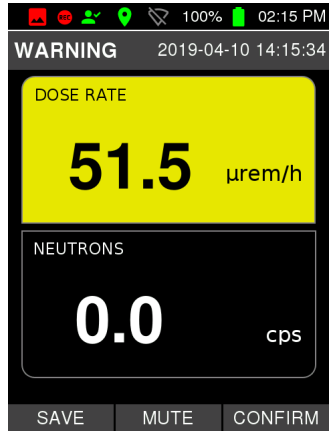



Figure 32: A warning reported on screen

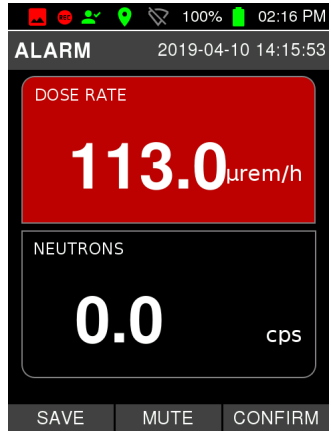



Figure 33: An alarm reported on screen

### Settings and Commands

Save

Save the Alarm in the RADEAGLET-R's database.

Mute

Switch off the beeper and vibrator for the current alarm. The next alarm, if any, reactivates them.

Confirm

Confirm the alarm. The beeper and the vibrator are switched off (see "Mute" above) and the screen returns to the content displayed before the alarm was raised.

An entry for the alarm is appended to the log file.

### 4.1.1 Neutron Alarm Display

This item is available for RADEAGLET-R models with a neutron detector (see E.1, p. 179).

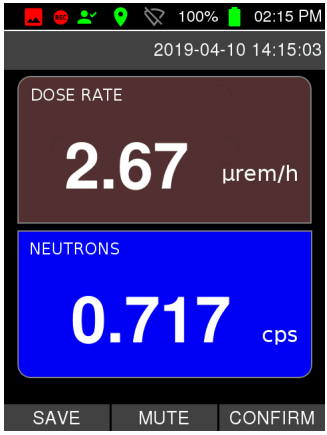



Figure 34: An neutron alarm reported on screen

## 4.2 Low Power Conditions

Visible (Fig. 35, p. 46) and audible warnings are triggered when the battery runs out of power. The first warning indicates 10 % of remaining power, the second 5 %.

You can always monitor the remaining power in the status bar, see 2.1, p. 23. Additionally, you can see the estimated remaining battery time in the Battery Informations, see 5.27, p. 85.

If you get this warning and want to continue working, replace the POWERCELL (see 10.2, p. 142) or connect the RADEAGLET-R to an external power source (see 10.3, p. 143).

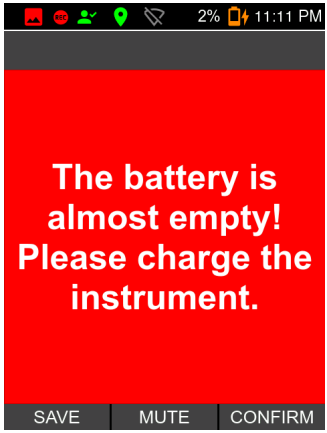



Figure 35: A battery warning reported on screen

# 5 radEAGLET-R Menu

This menu provides access to further operations of the radEAGLET-R. This includes, for example, a lot of settings you can change to adapt your radEAGLET-R to your personal needs and preferences, the spectrum with its comprehensive methods of analysis, communication with other devices, or collecting and transmitting data.

You can reach all options outlined below via the menu shown in Fig. 36, p. 48.


- Spectrum ..... see 5.1, p. 48
- Basic Settings ..... see 5.2, p. 53
  - Time and Date ..... see 5.3, p. 54
  - Display ..... see 5.4, p. 55
  - Startup ..... see 5.5, p. 56
  - Feedback ..... see 5.6, p. 58
  - Connectivity ..... see 5.7, p. 59
    - Wi-Fi ..... see 5.8, p. 59
    - Hotspot ..... see 5.9, p. 61
    - Bluetooth ..... see 5.10, p. 63
    - USB ..... see 5.11, p. 66
    - Services ..... see 5.12, p. 70
  - GPS ..... see 5.13, p. 71
- Easy Calibration ..... see 5.14, p. 72
- Advanced Settings ..... see 5.15, p. 74
  - Alarm Settings ..... see 5.16, p. 75
  - Administration ..... see 5.17, p. 76
    - Wireless Connection ..... see 5.18, p. 77
    - Set Password ..... see 5.19, p. 78
    - Factory Settings ..... see 5.20, p. 78
  - Calibration ..... see 5.21, p. 78
  - ID Settings ..... see 5.22, p. 80
    - Easy ID Settings ..... see 5.23, p. 81
    - Nuclide Library ..... see 5.24, p. 82
- Device Status ..... see 5.25, p. 84
  - System Information ..... see 5.26, p. 85

Battery Information ..... see 5.27, p. 85
Self Test ..... see 5.28, p. 87
Nuclide Information ..... see 5.29, p. 89
About ..... see 5.30, p. 91
Shutdown ..... see 5.32, p. 92

Spectrum ..... see 5.1, p. 48
Basic Settings ..... see 5.2, p. 53
Easy Calibration ..... see 5.14, p. 72
Advanced Settings ..... see 5.15, p. 74
Device Status ..... see 5.25, p. 84
Shutdown ..... see 5.32, p. 92

Figure 36: The Menu

**Settings and Commands**

Exit
: Return to the superior screen.

Down
: Highlight the next item. Cycles to the top item after you reached the last item.

Select
: Select the highlighted item.

## 5.1 Spectrum

The screen (Fig. 37, p. 49) shows a spectrum and provides access to commands to acquire and manage spectrum data and to influence the display and analysis of spectra.

**Settings and Commands**

Next
: Cycle through the commands available to work with the spectrum. This command is always available, the commands for the other two keys change.

Start • Stop
: Start or stop the acquisition of spectrum data. The current status is shown in the chart (Fig. 37, p. 49).

If you start recording data, the current spectrum is not cleared. To record a pristine spectrum, use Clear (see below) before Start.

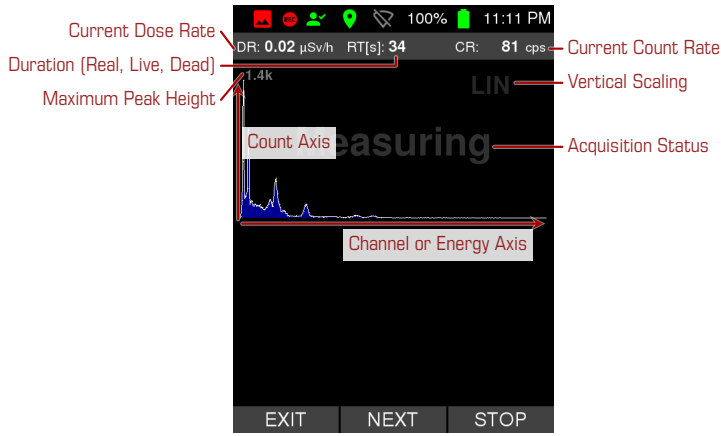



Figure 37: The spectrum screen

Clear

Clear the current spectrum.

Analyze

Let the RADEAGLET-R apply its identification algorithm to the current spectrum. The result is superimposed on the screen for a few seconds (Fig. 38, p. 49).

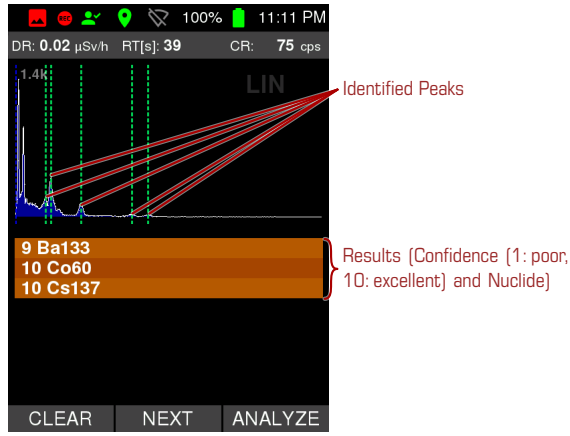



Figure 38: Result of a spectrum analysis

Cursor Right

Move a cursor into the spectrum diagram from lower to higher energies along the horizontal axis.

The cursor is a vertical line (Fig. 39, p. 50) labeled with the energy, the channel number, and the number of counts at this position in the spectrum.

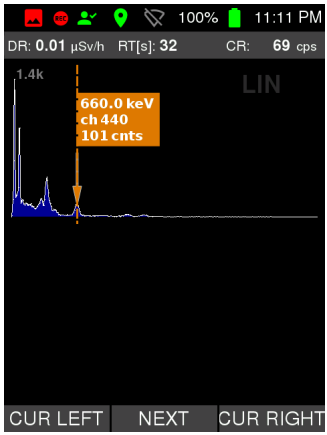



Figure 39: Spectrum with cursor

If you move the cursor beyond the left or right end of the spectrum, it wraps around to the opposite end.

Cursor Left

Move the cursor (see above) towards the low-energy end of the horizontal axis.

Zoom + • Zoom -

Zoom into the spectrum in multiple steps. The command is available only while you moved a cursor into the spectrum (see above) and the zoomed diagram will be centered around the cursor position.

The current zoom state is shown in the diagram (Fig. 40, p. 51)

ROI Left • ROI Right • Clear ROI

Specify a Region Of Interest, a part of a spectrum for closer inspection. Move the cursor (see above) to the low-energy end of the region, set it as left end of the ROI, move the cursor again and set the right end. The RADEAGLET-R fits a peak to the ROI and displays the centroid energy and the number of counts for the ROI (Fig. 41, p. 51).

Save

Save the current spectrum in the RADEAGLET-R database. You can load saved spectra for further analysis later (see below) or transfer them to a computer for further perusal.

The file names of saved spectra are composed of the current date and time followed by an index number. They will be shown after saving (Fig. 42, p. 52).

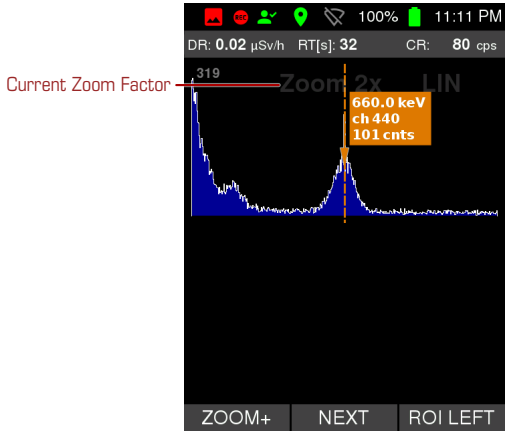



Figure 40: Zoomed spectrum with cursor

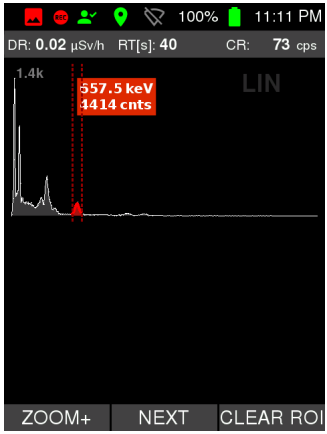



Figure 41: Spectrum with Region Of Interest

**Load**

Load a saved spectrum for further processing. Choose a from a list of files saved before (Fig. 43, p. 52). The spectrum saved most recently is listed on top.

**Load**

Load the highlighted spectrum file.

**Down**

Highlight the next item. Cycles to the top item after you reached the last item.

**Cancel**

Cancel the current command.

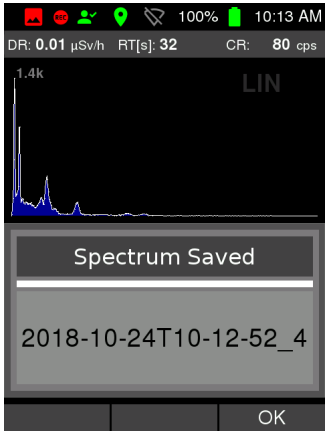



Figure 42: Info about a saved spectrum's file name

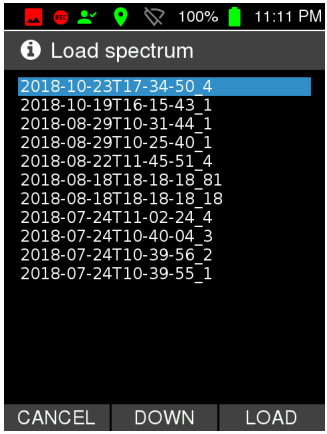



Figure 43: Spectrum files available for loading

LT • DT • RT

Cycle through the time and duration info displayed along the spectrum (Fig. 37, p. 49):

LT - Live Time

The duration of data acquisition as live time.

DT - Dead Time

The dead time as a percentage of the real time.

RT – Real Time

The duration of data acquisition as real time.

The current setting is shown along the spectrum, the command indicates the setting you will get after pressing the corresponding key.

For additional information refer to appendix C.7, p. 174.

LOG • SQRT • LIN

Change the vertical scaling of the spectrum diagram (see C.8, p. 174).

LOG Logarithmic scaling.

SQRT Square Root scaling.

LIN Linear scaling (the default).

The current scaling is shown at the top of the diagram (Fig. 37, p. 49). The command indicates the setting you will get after pressing the corresponding key.

Auto ID

Switch to a waterfall display, let the instrument collect a spectrum and analyze it (Fig. 44, p. 53).

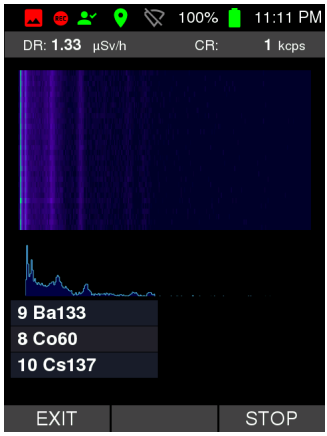



Figure 44: The Auto ID Waterfall display

Start • Stop

Control the acquisition of data for the Auto ID waterfall diagram.

These data are live data, independent of the spectrum you might have acquired or loaded in the spectrum screen.

Exit

Return to the superior screen.

Exit

Return to the superior screen.

## 5.2 Basic Settings

You can access the basic settings of the RADEAGLET-R via this menu (Fig. 45, p. 54). You can change these settings without entering a password.

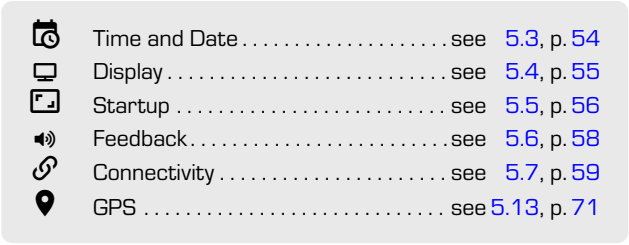



Figure 45: The basic settings menu

**Settings and Commands**

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Select

Select the highlighted item.

## 5.3 Time and Date

This screen (Fig. 46, p. 55) shows the current date and time of the RADEAGLET-R. It also offers the possibility to switch betwenn 12h mode and 24h mode.

The date and time affect many other important points. Spectra are typically saved with a filename based on the time and date so it is important to keep this as accurate as possible (Web interface, see 7.5, p. 114).

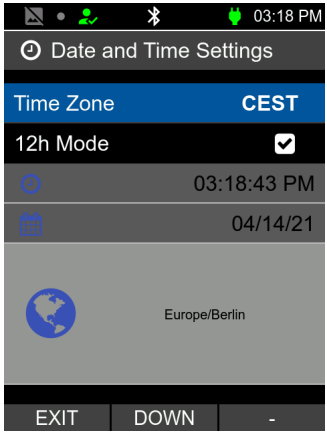



Figure 46: The clock settings

## 5.4 Display

This screen (Fig. 47, p. 55) groups several options for the display of your RADEAGLET-R.

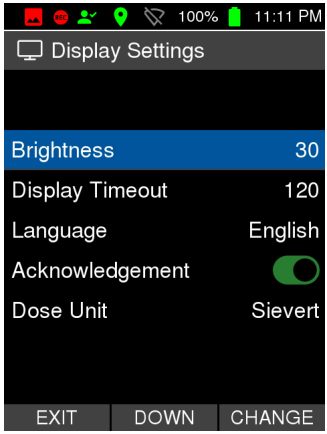



Figure 47: The display settings

### Settings and Commands

**Brightness**

Specify the brightness of the display's backlight.

If you want to avoid light emission from the RADEAGLET-R or are working in bright sunlight, you can reduce the brightness to zero.

**Display Timeout**

Specify the duration of user inactivity after which the display backlight is dimmed to save energy.

The backlight draws a significant amount of power, you should let it time out while running on batteries.

After the backlight times out, you can reactivate it by briefly pressing any key. The usual functions of short key presses are ignored in this case.

**Language**

Choose a language to be used for the display.

**English**

English with American spelling

**Deutsch**

German

***other***

*more languages which might be installed on your instrument*

Ensure you understand enough of the language you are changing to. It may be difficult to change back if you do not understand the menu language.

**Acknowledgement**

Specify whether you want to explicitely confirm warning and alarm messages or have the messages dissappear after the warning or alarm conditions are gone.

Alarms are saved in the log file only while this setting is “On”.

**Dose Unit**

Specify the unit for the display of dose values in all measuring modes or other operations of the radEAGLET-R.

**Sievert**

Sievert is a derived unit according to the International System of Units and the legally prescribed unit in many jurisdictions.

**rem** Röntgen equivalent in man. Sievert is the acknowledged international unit, but many users are familiar with doses stated in rem, mrem, µrem.

1 Sv = 100 rem

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Change

Edit the highlighted setting.

## 5.5 Startup

This screen lets you specify the behaviour of your radEAGLET-R after you switched it on.

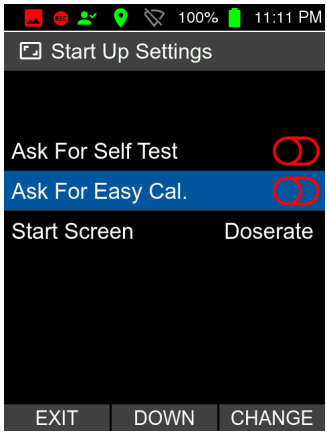



Figure 48: The startup settings

### Settings and Commands

**Ask for Self Test**

Specify whether your RADEAGLET-R shall offer a Self Test (see 5.28, p. 87) at the end of the system startup (see 2.3, p. 31) before activating the Start Mode specified below.

The factory setting is ON.

**Ask for Easy Calibration**

Specify whether your RADEAGLET-R shall offer an Easy Calibration (see 5.14, p. 72) at the end of the system startup (see 2.3, p. 31) before activating the Start Mode specified below.

The factory setting is ON.

**Start Mode**

The mode (see 3, p. 35) the RADEAGLET-R should activate after the system start (see 2.3, p. 31) is complete.

The factory setting is Dose Rate Mode.

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Change

Edit the highlighted setting.

## 5.6 Feedback

This screen (Fig. 49, p. 58) groups several options for the annunciator of your RADEAGLET-R. To switch off all the annunciators simultaneously, a password is required. That password is the same as needed for the Advanced Settings.

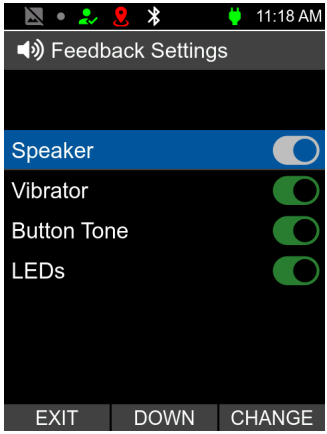



Figure 49: The feedback settings

### Settings and Commands

**Speaker**
Switch the speaker on or off. This affects warning and alarm reporting.

**Vibrator**
Switch the vibrator on or off. This affects warning and alarm reporting.

**Button Tone**
Specify whether the RADEAGLET-R should echo all your key presses with a beep.

**LED**
Switch the LEDs on or off. This affects warning and alarm reporting.

Exit
Return to the superior screen.

Down
Highlight the next item. Cycles to the top item after you reached the last item.

Change
Edit the highlighted setting.

## 5.7 Connectivity

This menu (Fig. 50, p. 59) provides access to settings for various connection devices plugged into the USB-A host adaptor (Fig. 5, p. 20) of your RADEAGLET-R.

Items in this menu depend on the connected device. If a device is not available at a given moment, the item is dimmed (grayed). Usually only one connectivity method can be used at a given time.

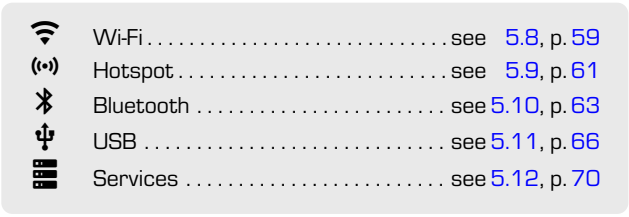



Figure 50: The connectivity menu

### Settings and Commands

Exit
: Return to the superior screen.

Down
: Highlight the next item. Cycles to the top item after you reached the last item.

Select
: Select the highlighted item.

## 5.8 Wi-Fi Settings

✱ This item is available while a Wi-Fi dongle is plugged into the RADEAGLET-R's USB-A port AND wireless communication is allowed, see 5.18, p. 77.

This screen groups settings and status information to connect your RADEAGLET-R to other devices via Wi-Fi (Fig. 51, p. 60).

⚠ The Wi-Fi hardware can be used for either connecting to an existing network or establishing a hotspot network but not both at the same time.

### Settings and Commands

Wi-Fi
: Switch the Wi-Fi dongle on or off.

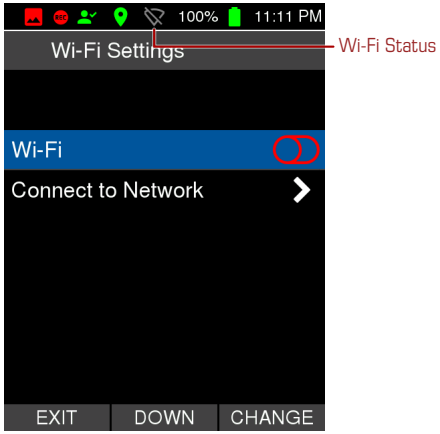



Figure 51: The Wi-Fi settings

If you RADEAGLET-R finds a wireless network you connected to before (see below), it will re-connect without asking for credentials.

### Connect to Network

Let the RADEAGLET-R search your site for available Wi-Fi networks.

After a moment the list of available access points is shown from which you can choose one to log in (Fig. 52, p. 60).

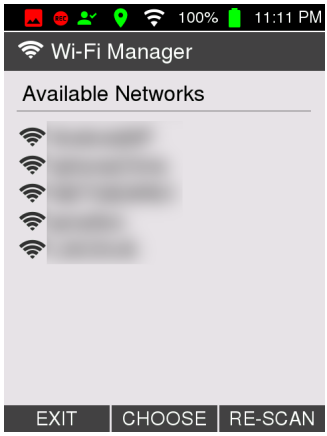



Figure 52: Available Wi-Fi access points

You will probably be prompted for a password. If in doubt, ask the administrator of the network you try to connect to.

After a moment you will be informed about the connection and the IP address the network assigned to your RADEAGLET-R (Fig. 53, p. 61).

You can use the displayed IP address to access the RADEAGLET-R's Web interface from a Web browser on any device in the same network.




Figure 53: Connected to a Wi-Fi network

Choose

Choose one of the available networks.

Re-Scan

Let the RADEAGLET-R scan for available networks again.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Exit

Return to the superior screen.

## 5.9 Hotspot Settings

This item is available while a Wi-Fi dongle is plugged into the RADEAGLET-R's USB-A port AND wireless communication is allowed, see 5.18, p. 77.

This screen groups settings and status information to let your RADEAGLET-R provide a Wi-Fi access point (Fig. 54, p. 62).

The Wi-Fi hardware can be used for either connecting to an existing network or establishing a hotspot network but not both at the same time.

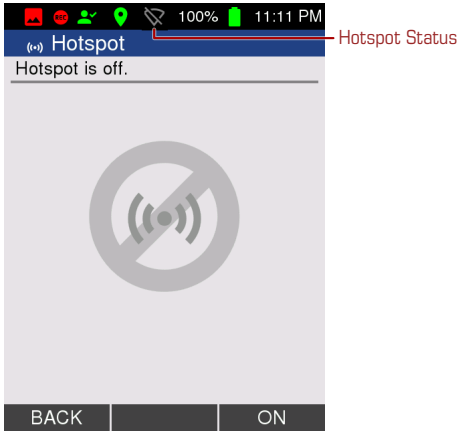



Figure 54: Hotspot is off

### Settings and Commands

On • Off

Switch the Wi-Fi hotspot on or off. Any Wi-Fi-capable computer, tablet or smart phone can log into the WLAN created by your RADEAGLET-R.

HS-Info • Web-Info

Switch between information about the Web interface address (Fig. 55, p. 62) or that for accessing the hotspot (Fig. 56, p. 63). Both are shown as text and as QR codes for devices equipped appropriately.




Figure 55: Hotspot: Web interface info

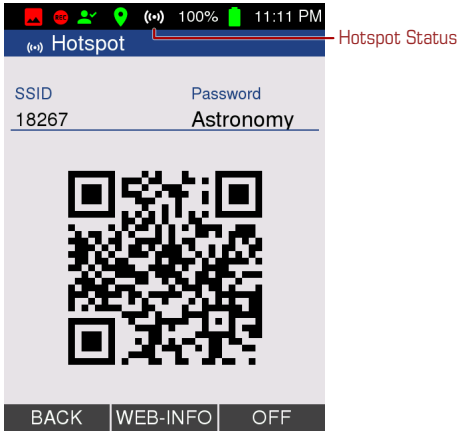



Figure 56: Hotspot: Access credentials

Exit

Return to the superior screen.

## 5.10 Bluetooth Settings

This item is available while a Bluetooth dongle is plugged into the RADEAGLET-R's USB-A port AND wireless communication is allowed, see 5.18, p. 77.

This screen groups settings and status information to pair your RADEAGLET-R with a Bluetooth equipped device like a smart phone to access the RADEAGLET-R's Web interface or to share the Internet connection. Additionally, you can pair bluetooth headphones with your RADEAGLET-R. You can switch Bluetooth on or off (Fig. 57, p. 64), start pairing with an external device and chose between known devices.

Initially the RADEAGLET-R knows no Bluetooth devices (Fig. 58, p. 64).

To add a Bluetooth device, switch it to paring mode and enter Bluetooth Pairing on you RADEAGLET-R. Follow the instructions displayed to initiate the pairing. The paired device will be shown and is ready for connection.

If allowed (see 5.18, p. 77), the RADEAGLET-R remembers all devices it has been paired to. If the foreign device is already known to the RADEAGLET-R, just chose it from the list. You can also delete devices from the list, by pressing REMOVE after choosing them. (Fig. 59, p. 65)

After a short while the MAC-adress of the Bluetooth device is displayed and you can click PAIR to establish the connection.

Finally the pairing information is shown, and the device is ready for connection. To connect,

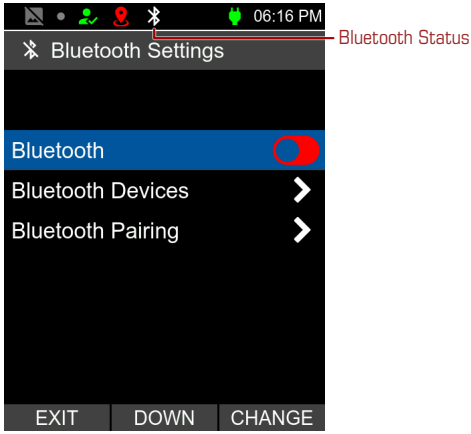



Figure 57: Bluetooth settings

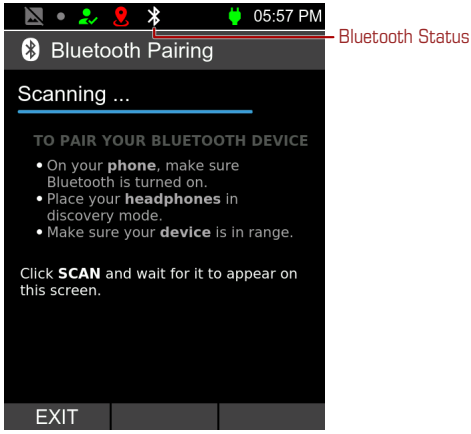



Figure 58: Bluetooth instructions on a pristine RADEAGLET-R

you can now switch to Bluetooth Devices, chose your device and press CONNECT. If you are paired to a phone, you can now share its internet connection.

### Settings and Commands

Scan, Pair

Start or stop the connection between the RADEAGLET-R and the Bluetooth device.

Remove

Remove a device from the list of known devices.




Figure 59: Connect to a known Bluetooth device

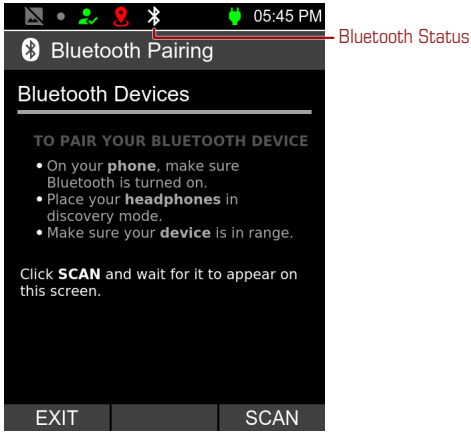



Figure 60: Scan for Bluetooth devices

Back

Go back to scan for new devices.

Exit

Return to the superior screen.

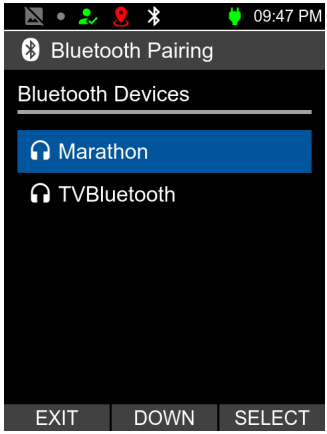



Figure 61: Press SELECT to start the pairing.

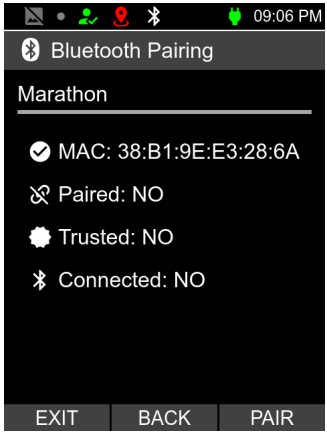



Figure 62: Press PAIR to finalize the pairing

## 5.11 USB Connections

This command depends on what is connected to the various USB ports of your RADEAGLET-R.

- A cable connects the magnetic USB port to a computer or similar device: see 5.11.1, p. 67
- A USB storage device (a.k.a. Stick) is plugged into the USB-A Port: see 5.11.2, p. 68
- A USB Ethernet adaptor is plugged into the USB-A Port: see 5.11.3, p. 69

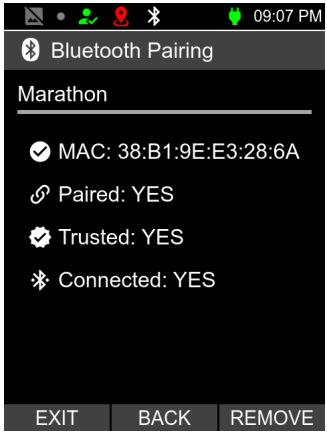



Figure 63: Bluetooth pairing established

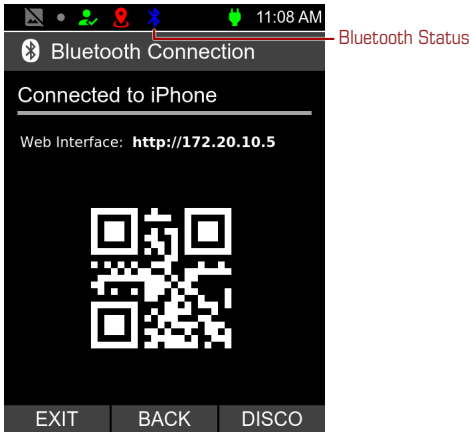



Figure 64: Web interface address for devices connected via Bluetooth

### 5.11.1 USB Cable to Host Computer

This item is available while a cable connects the RADEAGLET-R's magnetic USB port to the host computer or similar device.

This screen shows information about the status of the Web interface and the IP address to connect to from the Web browser (Fig. 65, p. 68).

#### Settings and Commands

On • Off

Switch the Web interface (see 7, p. 99) on or off.




Figure 65: USB cable connection information

Exit

Return to the superior screen.

### 5.11.2 USB Storage Device

This item is available while a USB storage device is plugged into the RADEAGLET-R's USB-A port.

Connect a USB mass storage device to your RADEAGLET-R and transfer data from the instrument to the device.

The RADEAGLET-R supports devices formatted as FAT32 without partitions.

#### Settings and Commands

Select

Copy all data (spectra, screenshots etc.) saved in the RADEAGLET-R's database to the USB mass storage device, that are younger than the chosen time frame.

The RADEAGLET-R overwrites files having the same name existing on the USB device without warning. As filenames usually contain date and time of their creation, however, it is highly unlikely that you loose data. If in doubt, make a backup copy of the USB device before using this feature.

You will be informed about the progress of the data transfer and after it finished.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Exit

Return to the superior screen.

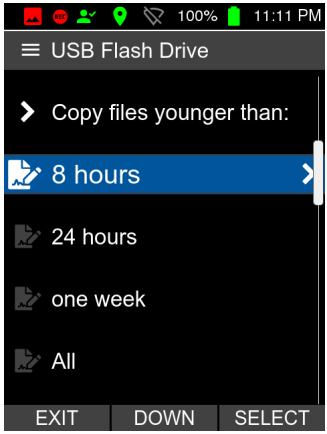



Figure 66: Data transfer to a USB mass storage device

### 5.11.3 USB Ethernet Adaptor

✳ This item is available while a USB to LAN (RJ-45 Socket) adaptor is plugged into the RADEAGLET-R's USB-A port.

The RADEAGLET-R connects to a Local Area Network and obtains an IP address from the network's DHCP server.

This screen shows information about the status of the Web interface and the IP address to connect to from the Web browser (Fig. 67, p. 69).

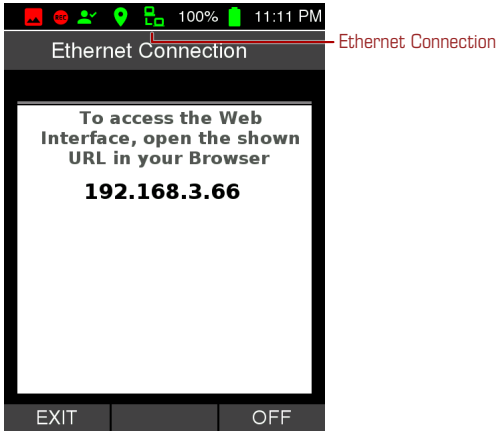



Figure 67: Ethernet LAN connection information

### Settings and Commands

On • Off
: Switch the Web interface (see 7, p. 99) on or off.

Exit
: Return to the superior screen.

## 5.12 Services

This screen shows information about the connectivity services your RADEAGLET-R provides and lets you switch them on or off (Fig. 68, p. 70). The PIN field is filled with the PIN provided by the innoLINK App, after connecting to it.

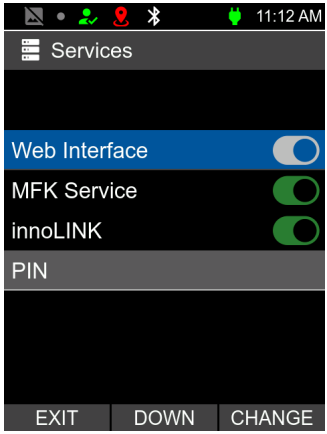



Figure 68: The services screen

### Settings and Commands

Web Interface
: Switch the Web interface (see 7, p. 99) on or off.

MFK
: Switch the MFK service (see 9, p. 127) on or off.

Down
: Highlight the next item. Cycles to the top item after you reached the last item.

Change
: Edit the highlighted setting.

Exit
: Return to the superior screen.

## 5.13 GPS

✳ This item is available for radEAGLET-R models equipped with a GPS receiver (see E.1, p. 179).

This screen (Fig. 69, p. 71) has the switch for the GPS receiver and shows your location, if available.

The current GPS status is indicated by a symbol in the status area (see 2.1, p. 23)

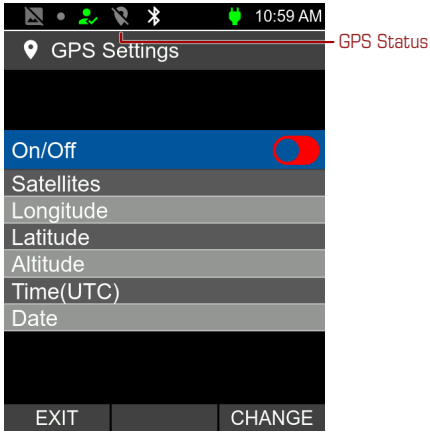



Figure 69: The GPS settings when GPS is off

When you switch on the GPS receiver, it starts to determine the location. For that it needs to receive data from a sufficient number off NAVSTAR satellites.

If the GPS receiver has sufficient data from enough satellites (“has a fix”), your location ist shown, see Fig. 70, p. 72. At the same time, the radEAGLET-R can update the system time, by synchronizing it to the GPS time, which is always correct.

### Settings and Commands

Change
: Edit the highlighted setting.

Sync
: Synchronize the internal clock with the GPS time.

Exit
: Return to the superior screen.

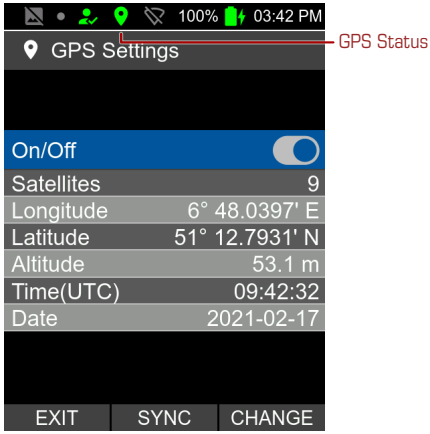



Figure 70: The GPS settings after determinig the location

## 5.14 Easy Calibration

This command lets you specify a calibration source and trigger a simple automatic calibration of the RADEAGLET-R.

An elaborate version of calibration is available too, see 5.21, p. 78.

For additional information refer to appendix C.2, p. 172.

If your model is not equipped with an internal source, place a suitable calibration source ($^{40}$K or $^{137}$Cs) in front of the detector before proceeding.

After you let the RADEAGLET-R know the calibration source (Fig. 71, p. 73), it will acquire data for a while and use it for calibration (Fig. 72, p. 73).

The acquired spectrum is shown, overlayed by the theoretical peak position of the selected source and the current peak fit of the measured spectrum.

Please stay away from any sources while using the Easy Calibration mode. Otherwise, the calibration will be stopped. Your RADEAGLET-R will show a red warning label on the screen, if any sources are nearby. (Fig. 74, p. 74).

A progress percentage is shown during the data collection (Fig. 73, p. 74), sometimes in several cycles, until the peak position of the calibration source is within ±0.5 % of the theoretical position.

### Settings and Commands

Exit

Return to the superior screen.

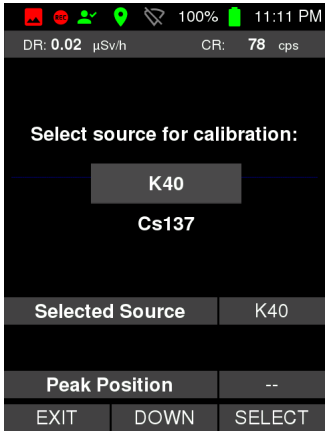



Figure 71: Selecting a source for easy calibration

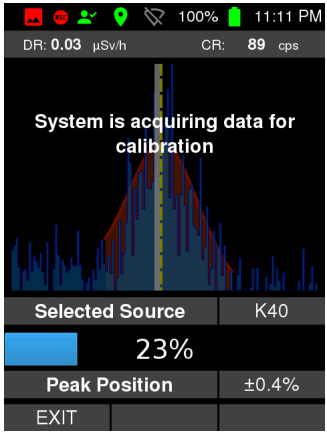



Figure 72: Easy calibration in progress

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Select

Select the highlighted item.

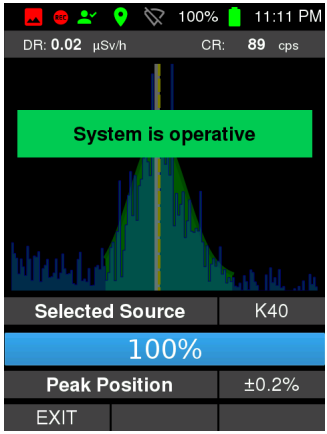



Figure 73: Easy calibration finished

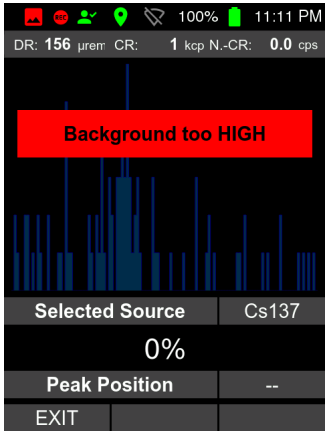



Figure 74: Easy calibration interrupted, due to present source

## 5.15 Advanced Settings

You can access the advanced settings of the RADEAGLET-R via this menu (Fig. 75, p. 75). Before accessing this menu you have to enter a password (see 2.2.4, p. 28).

### Settings and Commands

Exit

Return to the superior screen.

Alarm Settings . . . . . see 5.16, p. 75
Administration . . . . . see 5.17, p. 76
Calibration . . . . . see 5.21, p. 78
ID Settings . . . . . see 5.22, p. 80

Figure 75: The advanced settings menu

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Select

Select the highlighted item.

## 5.16 Alarm Settings

This screen (Fig. 76, p. 75) groups the settings for warnings and alarms.

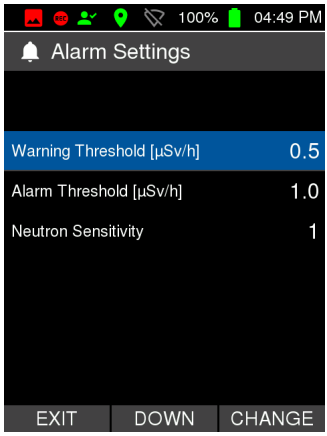



Figure 76: The alarm settings

These settings are designed for your personal safety. The alarm is intended to let you know you are exposed to dangerous radiation and may be accumulating a significant radiation dose. If you set the alarm levels or warning thresholds too high, this may pose a serious health risk to you.

You can set the unit used for these thresholds under 5.4, p. 55.

**Warning Threshold**

The dose rate threshold for warnings. The value must be lower than that for alarms.

**Alarm Threshold**

The dose rate threshold for alarms. The value must be higher than that for warnings.

**Neutron Sensitivity**

Set sensitivity for neutron alarms in several steps.

✱ This item is available for radEAGLET-R models with a neutron detector (see E.1, p. 179).

| Setting | Neutrons | Integration Duration |
|---|---|---|
| -5 | 4 | 4 sec |
| -4 | 4 | 10 sec |
| -3 | 4 | 15 sec |
| -2 | 4 | 20 sec |
| -1 | 4 | 30 sec |
| Default ±0 | 4 | 40 sec |
| +1 | 4 | 80 sec |
| +2 | 4 | 100 sec |
| +3 | 4 | 140 sec |
| +4 | 4 | 180 sec |
| +5 | 4 | 220 sec |

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

## 5.17 Administration

You can access general settings of the radEAGLET-R via this menu (Fig. 77, p. 76).

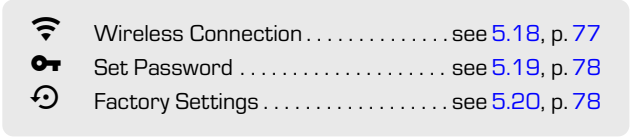



Figure 77: The Administration menu

### Settings and Commands

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Select

Select the highlighted item.

## 5.18 Wireless Connection

This screen (Fig. 78, p. 77) groups general settings for the wireless connections of your RADEAGLET-R. These settings affect all wireless communication like Wi-Fi (see 5.8, p. 59 and 5.9, p. 61) or Bluetooth (see 5.10, p. 63).

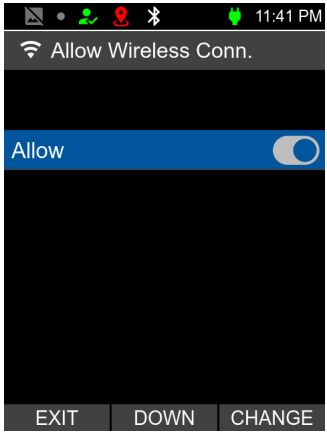



Figure 78: The Wireless Connection Settings

### Settings and Commands

Allowed

Specify whether your RADEAGLET-R is, in principle, allowed to use wireless communication channels.

✱ To actually use wireless communication, an appropriate adaptor must be plugged into the RADEAGLET-R's USB-A port.

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Select

Select the highlighted item.

## 5.19 Set Password

You can (and should) change the password of your RADEAGLET-R to prevent unauthorized changes of advanced settings.

After you confirmed that you want to set a new password (Fig. 79, p. 78) just enter the new password as described in 2.2.4, p. 28.

STOP Make sure to remember your changed password. Passwords cannot be deciphered at the factory.

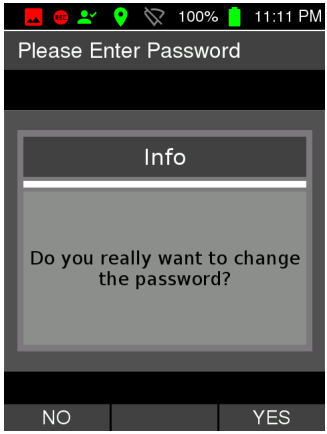



Figure 79: Setting the password

## 5.20 Factory Settings

This command re-establishes the factory settings of your RADEAGLET-R. You have to confirm this command (Fig. 80, p. 79).

Reset

Discard all your changes to the settings of the RADEAGLET-R and re-establish the factory settings.

⚠ This includes the password for the advanced settings (see 2.2.4, p. 28).

Exit

Return to the superior screen.

## 5.21 Calibration

This screen (Fig. 81, p. 79) shows a partial spectrum and some additional information you can use to inspect and trigger the calibration of your RADEAGLET-R.




Figure 80: Reset to factory settings

For additional information refer to appendix C.2, p. 172.

A simpler version of calibration is available too, see 5.14, p. 72.

If your model is not equipped with an internal source, place a suitable calibration source ($^{40}$K or $^{137}$Cs) in front of the detector before proceeding.

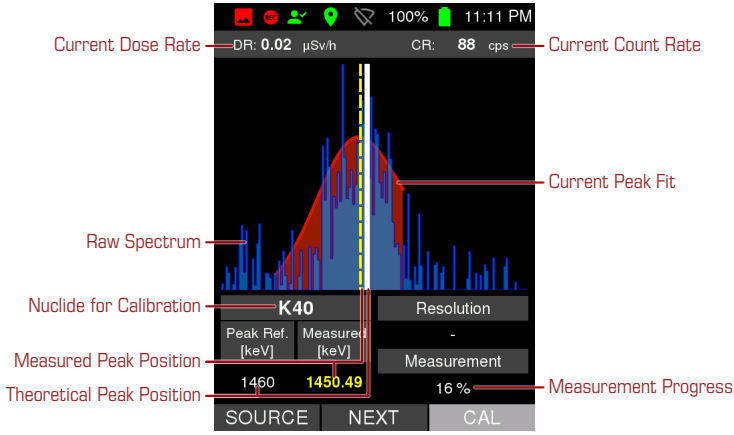



Figure 81: The calibration screen

### Settings and Commands

Next

Reveal the next available command for the left key.

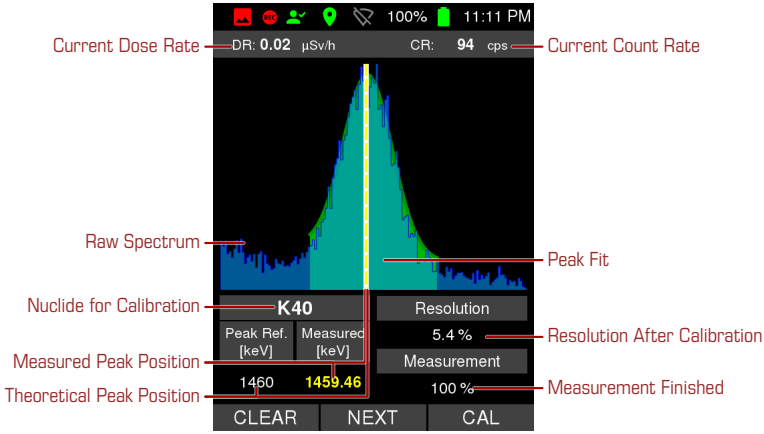



Figure 82: The calibration screen after measurement

**Source**

Specify the source to be used for calibration. Available are $^{40}$K and $^{137}$Cs.

**Clear**

Clear the spectrum acquired hitherto and restart data collection.

**Default**

Reset the gain to the factory default. The spectrum will be cleared and the instrument will start recalibration from the beginning.

**Calibrate**

Save the fine gain value determined by the calibration procedure and have it used for future measurements. (Only available after enough data for a calibration have been collected, see Fig. 82, p. 80).

Exit

Return to the superior screen.

## 5.22 ID Settings

You can access the identification settings of the RADEAGLET-R via this menu (Fig. 83, p. 80).

Easy ID Settings . . . . . see 5.23, p. 81
Nuclide Library . . . . . see 5.24, p. 82

Figure 83: The ID settings menu

### Settings and Commands

Exit
: Return to the superior screen.

Down
: Highlight the next item. Cycles to the top item after you reached the last item.

Select
: Select the highlighted item.

## 5.23 Easy ID Settings

This screen (Fig. 84, p. 81) groups the settings for the Easy ID mode.

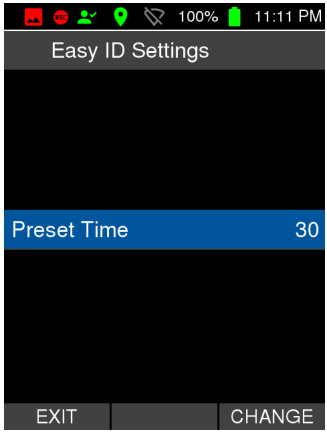



Figure 84: The easy ID settings

### Settings and Commands

**Preset Time**
: Specify the measurement duration in seconds for the easy ID mode (see 3.2, p. 37). The same time applies to the background spectrum.

Exit
: Return to the superior screen.

Select
: Select the highlighted item.

## 5.24 Nuclide Library

This screen (Fig. 85, p. 82) groups information about the nuclides your RADEAGLET-R knows about.

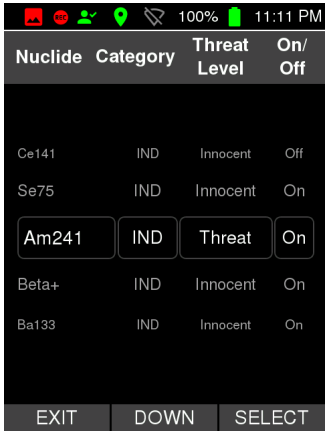



Figure 85: The nuclide library ready for selecting a nuclide

Several properties are associated with each nuclide known to the instrument:

**Name**

The simplified name of the nuclide

**Category**

The category a nuclide belongs to:

**NORM** Naturally Occurring Radioactive Material

**IND** INDustrially used material

**MED** MEDically used material

**SNM** Special Nuclear Material

**Threat Level**

The severity of the nuclide:

- Innocent
- Suspicious
- Threatening

**On, Off**

Should the RADEAGLET-R consider this nuclide during analysis and identification procedures.

You can change these properties for every nuclide in the list. The available nuclides are shown as a revolving list with one nuclide highlighted in the center.

When you enter the settings screen, $^{241}$Am is highlighted (Fig. 85, p. 82).

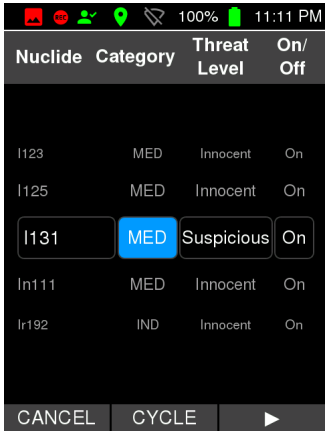



Figure 86: The nuclide library with $^{131}$I selected for editing its category

### Settings and Commands

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Up

Highlight the nuclide above the one currently highlighted. (Not available while $^{241}$Am is highlighted.)

Select

Select the highlighted nuclide for editing. One of the properties is even more highlighted for changing (Fig. 86, p. 83).

Cycle

Cycle through the options for the highlighted setting. (Only available when a nuclide is selected for editing, Fig. 86, p. 83.)

▶

Highlight the next property of the nuclide. (Only available when a nuclide is selected for editing, Fig. 86, p. 83.)

Accept

Make your changes to the highlighted nuclide permanent. (Only available when the On/Off property of a nuclide is highlighted for editing, Fig. 87, p. 84.)

Cancel

Discard your changes, if any, to the highlighted nuclide. (Only available when a nuclide is selected for editing, Fig. 87, p. 84.)

Exit

Return to the superior screen. (Only available while $^{241}$Am is highlighted.)

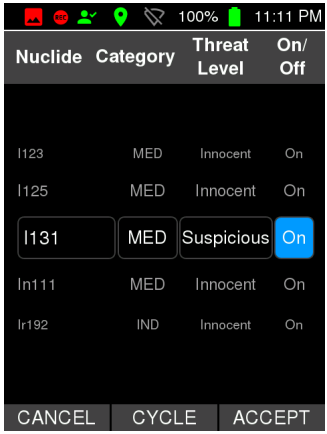



Figure 87: The nuclide library with $^{131}$I selected for editing its On/Off property

## 5.25 Device Status

You can inspect the status of various components of the RADEAGLET-R via this menu (Fig. 88, p. 84).

System Information . . . . . see 5.26, p. 85
Battery Information . . . . . see 5.27, p. 85
Self Test . . . . . see 5.28, p. 87
Nuclide Information . . . . . see 5.29, p. 89
About . . . . . see 5.30, p. 91

Figure 88: The Device Status menu

### Settings and Commands

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Select

Select the highlighted item.

## 5.26 System Information

This screen (Fig. 89, p. 85) shows information about your RADEAGLET-R's hardware status. Please have these data at hand when contacting our support.

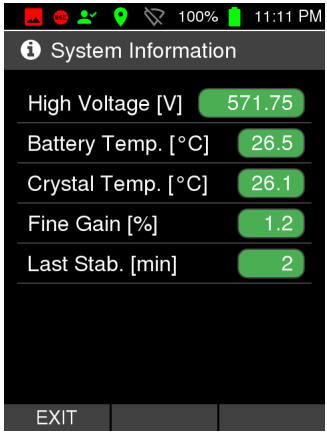



Figure 89: The hardware status

**High Voltage**

Typical values are between 500 V and 800 V.

**Battery Temperature**

The value should be between 0 °C and 50 °C.

**Crystal Temperature**

The value should be between -20 °C and 55 °C.

**Fine Gain**

The value should be ±10 %.

**Last Stabilization**

Time elapsed since the last successfull stabilization of the instrument (see C.1, p. 171).

Exit

Return to the superior screen.

## 5.27 Battery Information

This screen (Fig. 90, p. 86) shows information about your RADEAGLET-R's battery status.

**Status**

Can be FULL, CHARGING or DISCHARGING.

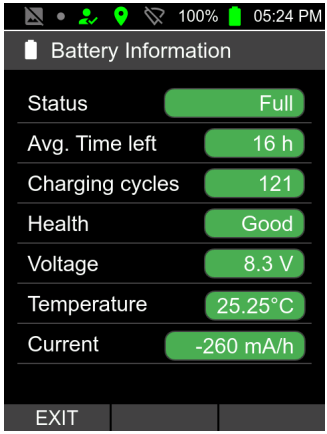



Figure 90: The battery status

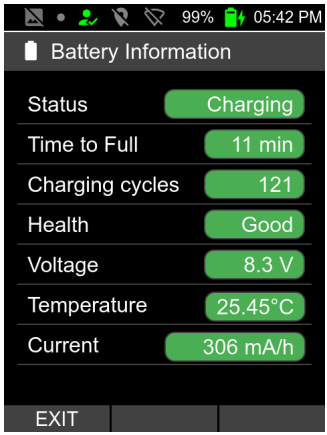



Figure 91: The battery status with charging batteries

**Average Time Left**

Time until the battery is empty. This is only displayed, when the instrument is currently discharging.

**Time to Full**

Time until the battery is fully charged. This is only displayed, when the instrument is currently charging.

**Health**

Battery health state. Can be GOOD (Battery is fine) or WEAK (Battery should be replaced soon)

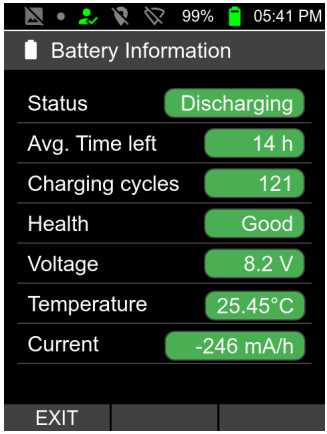



Figure 92: The battery status with discharging batteries

**Voltage**

Voltage provided by the battery. Decreases when the battery gets empty.

**Temperature**

Battery Temperature. Should be below 55°C.

**Current**

Battery Current. Is positive when the battery is charging and negative when it's discharging.

Exit

Return to the superior screen.

## 5.28 Self Test

This command initiates a test of several components of the RADEAGLET-R. The test is divided in several sections.

A summary is displayed after all tests are complete. Additionally a self test report is saved (Fig. 94, p. 89). It can be found in the SelfTestReports Folder within the user data.

The result are shown with symbols for each component:

✓ No problems detected.

✗ Problems detected. Please take a note of the circumstances and the displayed messages and contact our service department. See p. 2 for addresses.

**?** You should check the calibration of your instrument (see D.1, p. 175).

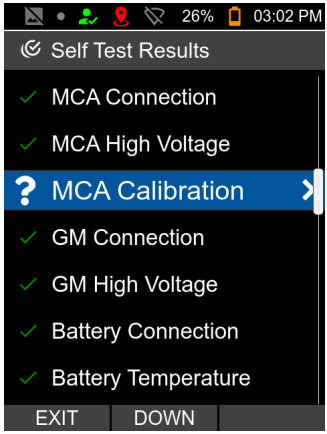



Figure 93: The self test screen

**Settings and Commands**

Scintillator and Multichannel Analyzer
: Connection, high voltage, calibration

Geiger-Müller Detector
: Connection, high voltage

Neutron Detector*
: Connection, high voltage,

Battery
: Connection, temperature, status

⚠ This test yields meaningful results only while a rechargable POWERCELL (see 10.1.1, p. 139) is mounted in the RADEAGLET-R. In case of a problem try replacing the battery (see 10.2, p. 142).

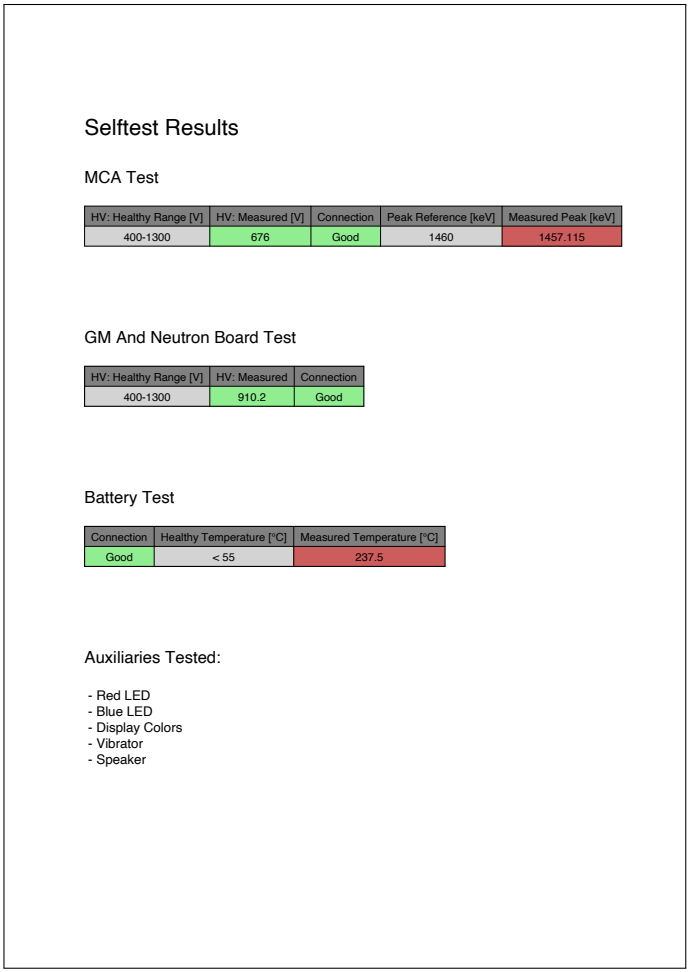
Display, LEDs, Vibrator, Speaker
: These tests activate the annunciators of the instrument and expose several visual and audible patterns.

Vibrator and speaker are activated regardless of your settings (see 5.6, p. 58).

Please verify that the annunciators of the RADEAGLET-R behave as announced.

If not: Please take a note of the circumstances and the displayed messages and contact our service department. See p. 2 for addresses.

Exit
: Return to the superior screen.



Selftest Results

MCA Test

| HV: Healthy Range [V] | HV: Measured [V] | Connection | Peak Reference [keV] | Measured Peak [keV] |
|---|---|---|---|---|
| 400-1300 | 676 | Good | 1460 | 1457.115 |

GM And Neutron Board Test

| HV: Healthy Range [V] | HV: Measured | Connection |
|---|---|---|
| 400-1300 | 910.2 | Good |

Battery Test

| Connection | Healthy Temperature [°C] | Measured Temperature [°C] |
|---|---|---|
| Good | < 55 | 237.5 |

Auxiliaries Tested:

- Red LED
- Blue LED
- Display Colors
- Vibrator
- Speaker

Figure 94: Report of a self test

## 5.29 Nuclide Information

This screen (Fig. 95, p. 90) shows information about the currently active nuclide library settings. An editable version of the library is accessible under the advanced settings, see 5.24, p. 82. Please refer to that chapter for the description of the nuclide attributes shown here.

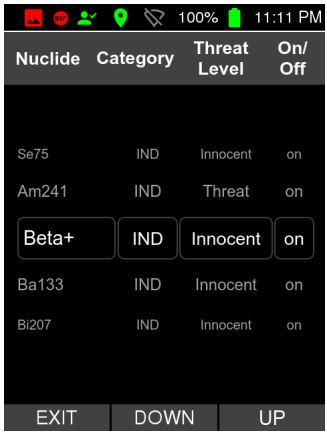



Figure 95: The nuclide information

### Settings and Commands

Exit

Return to the superior screen.

Down

Highlight the next item. Cycles to the top item after you reached the last item.

Up

Highlight the prevoius item. Cycles to the bottom item after you reached the top item.

## 5.30 About

This screen (Fig. 96, p. 91) shows information about your RADEAGLET-R. Please have these data at hand when contacting our support.




Figure 96: The instrument information

### Settings and Commands

Exit

Return to the superior screen.

## 5.31 Background Spectrum

This screen allows you to collect a new background spectrum. The duration for the background spectrum is the same duration set for the Easy-ID Mode. (see 5.23, p. 81)

### Settings and Commands

Next

Reveal the next available commands for the left and right key.

Start • Stop

Start or stop the acquisition of background spectrum data. The current status is shown in the chart. (Fig. 97, p. 92).

Extend

This option appears when a full background cycle is completed. Extend the background duration by another full cycle.

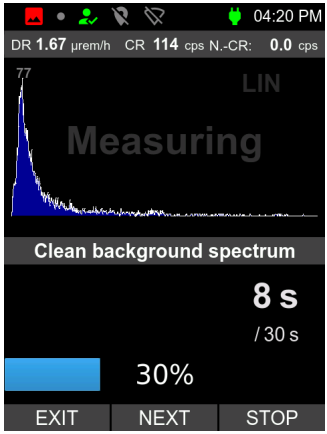



Figure 97: The background spectrum mode

Save

Save the current spectrum in the RADEAGLET-R database. The latest background spectrum is used whenever a new spectrum file is saved.

Clear

Clear the current background spectrum.

Exit

Return to the superior screen.

## 5.32 Shutdown

This screen (Fig. 98, p. 93) is shown when you switch off your RADEAGLET-R.

### Settings and Commands

OK

Shut down the instrument.

Cancel

Cancel the current command.

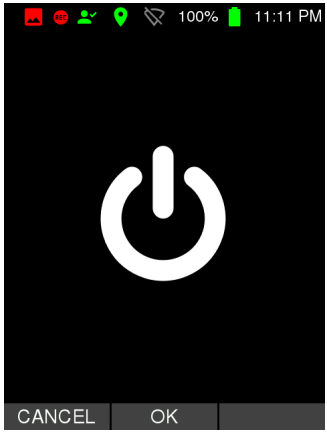



Figure 98: Shut down verification

# 6 Accessing radEAGLET-R Data

The radEAGLET-R can save a lot of your measurement results in its database, for example, spectra (5.1, p. 48), alarm logs (4, p. 43), or screenshots (2.2.5, p. 30).

## 6.1 Data Transfer

You can transfer data from the radEAGLET-R to other devices, usually computers, for printing, further processing, evaluation, or archival.

Data can be transferred directly via a connection to another device or indirectly with a removable storage medium.

### 6.1.1 SD-Card

An easy way to tranfer data from your radEAGLET-R to a computer is the usage of the micro SD-card. It is located under the front cap of the instrument. To extract the micro SD-card, push it gently so it springs back. Plug it into the micro SD-card port of your computer and copy the data. A micro-SD to SD adaptor might be needed - depending on the computer.

⚠ Yout radEAGLET-R can't save any data while the micro-SD card is not plugged into the instrument. Please make sure to put it back after transferring the data to your computer. As long as the SD-card is missing, the radEAGLET-R constantly warns you within the status bar at the top of the screen.

### 6.1.2 USB Cable Connection

Connect the magnetic USB connector of the radEAGLET-R (Fig. 5, p. 20) to a USB-A host connector of your device. Just hold the magnetic end of the cable close to the radEAGLET-R magnetic connector and it will snap into place. The radEAGLET-R provides several access methods:

**USB Mass Storage**
: A read-only drive should appear on your computer's desktop. It contains, for example, the documentation of the instrument.

**Network Device**
: A network connection is established and you can use your Web browser to access the instrument (6.2, p. 97).

You can check whether your computer recognizes the connected radEAGLET-R. The method depends on your computer's operating system.

Microsoft Windows

Information is available in the “Device Manager”. The method to open the device manager varies with the version of Windows (Vista, 7, 10, etc.). Please refer to the documentation of your Windows version for details. The RADEAGLET-R is listed as “Linux USB Ethernet/RNDIS Gadget” or “Remote NDIS Compatible Device” in section “Network Adapters”.

Apple MacOS

- The mass storage device named “INNODEVICE” should be shown under “About this Mac” in the  menu (Fig. 99, p. 96).

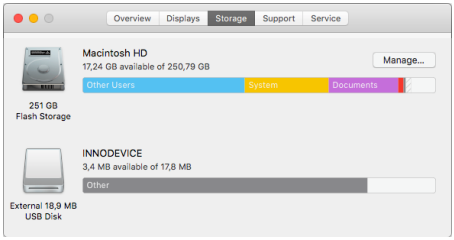



Figure 99: MacOS: The RADEAGLET-R mass storage

- The network connection “INNODEVICE” is shown in the “Network” panel of the “System Preferences” accessible via the  menu (Fig. 100, p. 96).

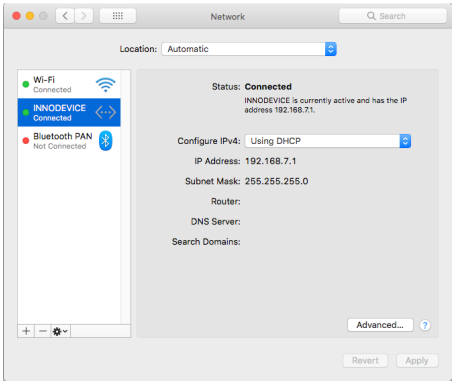



Figure 100: MacOS: The RADEAGLET-R network connection

Linux

Linux distributions differ much, so we can only provide general advice:

- The mass storage device named “INNODEVICE” should be listed as “Linux File-Stor Gadget” where (removeable) drives are listed.

- The network connection should be listed as “Ethernet” or “Linux Foundation Composite Gadget” with other network connections.

### 6.1.3 Wi-Fi Hotspot

Activate the Wi-Fi hotspot (5.8, p. 59), and use your device to log into the Wi-Fi network with the credentials shown.

This item is available while a Wi-Fi dongle is plugged into the radEAGLET-R’s USB-A port AND wireless communication is allowed, see 5.18, p. 77.

### 6.1.4 Wi-Fi Client

Log your radEAGLET-R into an existing Wi-Fi network (5.8, p. 59) with the credentials you received from that network’s administrator.

This item is available while a Wi-Fi dongle is plugged into the radEAGLET-R’s USB-A port AND wireless communication is allowed, see 5.18, p. 77.

This can be any type of Wi-Fi network, established by a traditional access point, as a hotspot established by your smart phone or a dedicated surf stick.

If allowed (see 5.18, p. 77), the radEAGLET-R remembers networks it has been logged into and reconnects automatically when they become available.

### 6.1.5 Bluetooth

Your radEAGLET-R can be paired with other devices, for example, smart phones, via Blootooth. You can access the Web interface and share the internet connection.

This item is available while a Bluetooth dongle is plugged into the radEAGLET-R’s USB-A port AND wireless communication is allowed, see 5.18, p. 77.

Internet sharing and Web interface access must be supported by the other device.

### 6.1.6 LAN Cable (RJ-45)

Connect the radEAGLET-R to a Local Area Network with a running DHCP server. It will automatically obtain an IP address.

This item is available while a USB to LAN (RJ-45 Socket) adaptor is plugged into the radEAGLET-R’s USB-A port.

## 6.2 Web Interface

While a device such as a desktop computer or a tablet is connected (6, p. 95) to the radEAGLET-R, you can access the Web interface of the radEAGLET-R.

Look up the IP address of the radEAGLET-R in the connection settings screen (5.7, p. 59) and point your browser to it.

You can browse and inspect saved spectra (7.3, p. 100) or manage or download all saved data to your device (7.10, p. 123).

# 7 radEAGLET-R Web Interface

The Web interface is available when you use a recent Web browser on your computer, tablet or smart phone to navigate to the IP address given in the connectivity settings (see 5.7, p. 59).

JavaScript is required for the radEAGLET-R Web interface and must be supported by the browser. Additionally, the web interface must be turned on in the connectivity settings 5.7, p. 59.

For the physical connection posibilities refer to section 6.1, p. 95.

The Web interface is divided into the sections shown in Fig. 101, p. 99. To navigate between sections open the menu by clicking the button ☰ (always available at the top, Fig. 102, p. 100).


Device Info . . . . . see 7.1, p. 99
Remote Screen . . . . . see 7.2, p. 99
Spectrum Browser . . . . . see 7.3, p. 100
Spectrum File Viewer . . . . . see 7.4, p. 114
Basic Settings . . . . . see 7.5, p. 114
Advanced Settings . . . . . see 7.6, p. 117
Software Update . . . . . see 7.8, p. 121
Documents . . . . . see 7.9, p. 122
Storage Management . . . . . see 7.10, p. 123


Figure 101: The menu overlay of the Web interface

The figures in this chapter illustrate the radEAGLET-R Web interface on a computer. The layout of the page content differs on mobile devices due to the smaller screen size. All features, however, are available on all devices.

## 7.1 Device Info

The device info section (Fig. 102, p. 100) of the Web interface shows general information about your radEAGLET-R and its status.

## 7.2 Remote Screen

The remote screen needs to be enabled in the Administration Settings of the instrument, which are located in the password protected area. By default, the remote

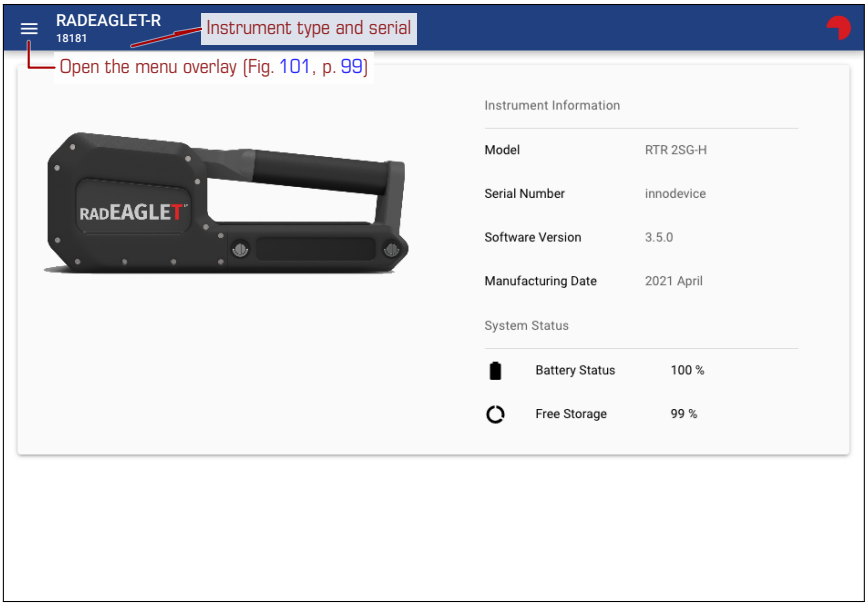



Figure 102: The device information in the Web interface

screen is switched off and can only be used after being switched on by authorized personnel.

This section (Fig. 103, p. 101) shows the current contents of your RADEAGLET-R's screen. The image changes when you operate the instrument.

You can control the instrument remotely by clicking the key descriptions in the Web interface.

⚠ If the RADEAGLET-R's screen is dimmed after a while of inactivity, your first click only restores the screen backlight. So if the instrument does not react after a moment, click again.

## 7.3 Spectrum Browser

This section (Fig. 104, p. 102) provides access to the spectra stored on the RADEAGLET-R. You can inspect, download or delete them.

The spectra are listed with several info columns:

- Record number
- File name derived from the recording date in ISO 8601 format
- Recording date and time in plain language

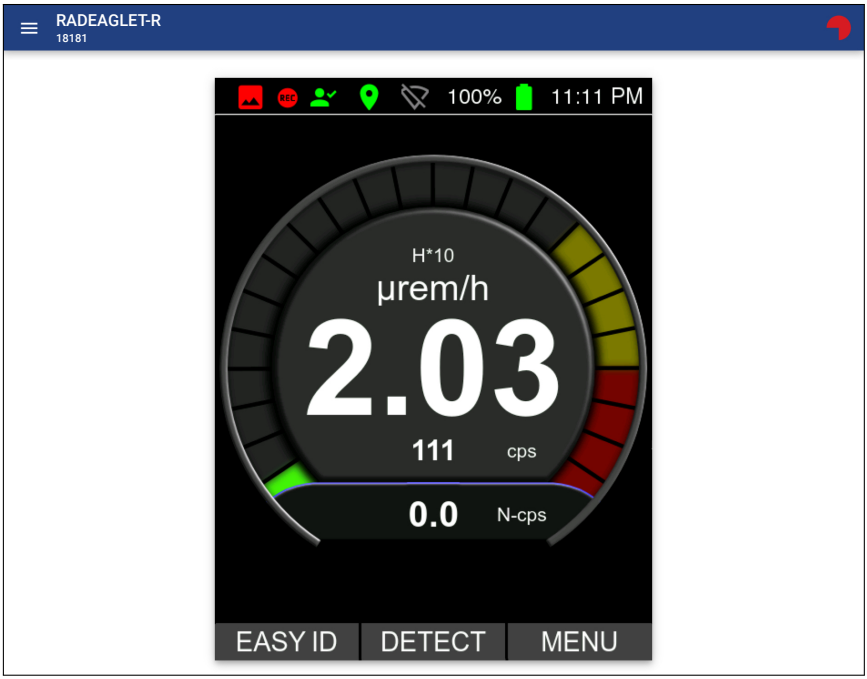



Figure 103: The remote RADEAGLET-R's screen in the Web interface

Initially **all** records are listed by ascending record numbers.

→ **To change the sorting criterion**...

1. Click the column title.
2. Click again to switch between ascending and descending order.

→ **To filter the list**...

1. Type part of the file name or part of the date into the box next to 🔍.
   The list shows only records matching that criterion in any of the columns.

You can browse the list page by page with ‹ or › and change the length of the list to accomodate your screen size with ▾.

Several commands are available for the individual records:

- Inspect the spectrum plus a lot of additional information (see 7.3.1, p. 102).
- Download the record.
- Delete the record.

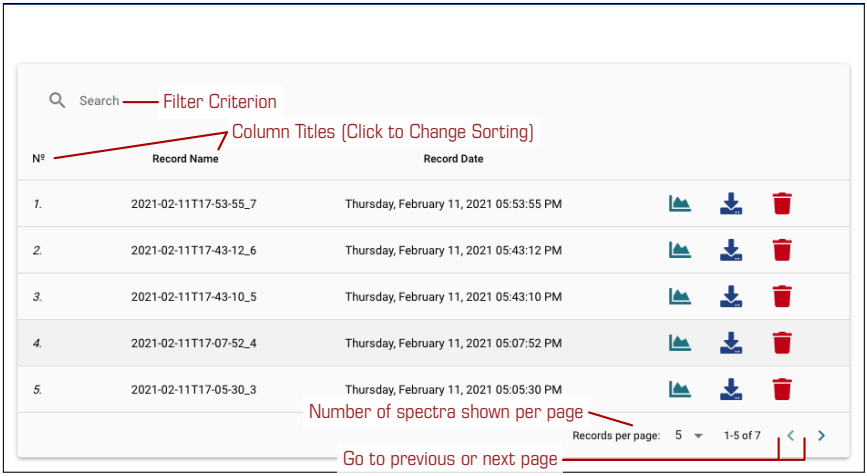



Figure 104: The spectrum browser in the Web interface

### 7.3.1 Spectrum Inspector

The spectrum inspector shows a spectrum diagram for visual inspection (see 7.3.1.1, p. 102), offers various methods for peak analysis, and provides several additional details about the spectrum data.

You can access the features with buttons along the top:

- Download the spectrum.
- Delete the spectrum.
- Manual peak analysis, see 7.3.1.2, p. 105.
- Automatic peak analysis, see 7.3.1.3, p. 105.
- PDF report, see 7.3.1.5, p. 112.
- Spectrum details, see 7.3.1.4, p. 108.

#### 7.3.1.1 Spectrum Diagram

→ **To see coordinates of a specific position**...

1. Move the pointer within the chart area and watch the coordinates of the current position shown above the chart (Fig. 105, p. 103).

→ **To zoom into a region of interest**...

1. Click and hold at one end of the ROI.
2. Drag to the other end of the ROI. The region will be accented (Fig. 106, p. 104).
3. Release the mouse button. The enlarged region shows up (Fig. 107, p. 104)

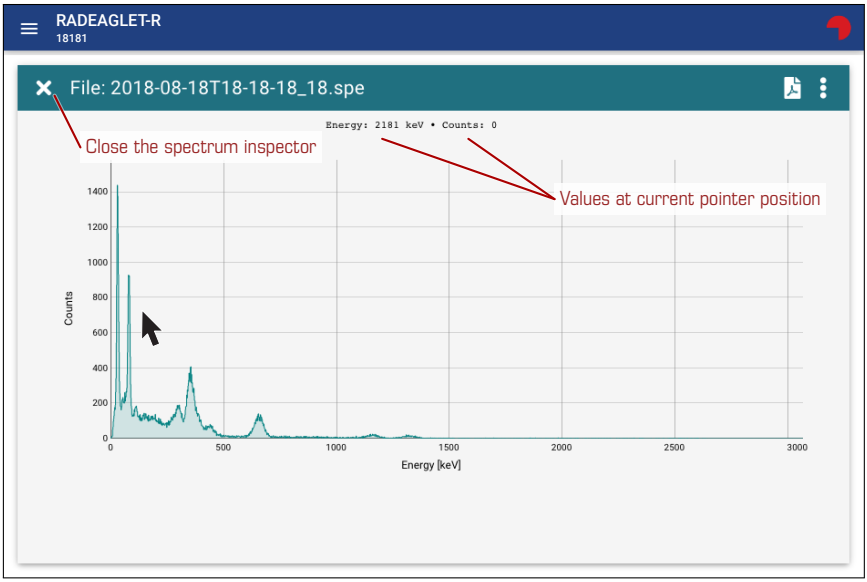



Figure 105: Spectrum diagramm in the Web interface

→ **To return to the complete spectrum**...

1. Double-Click in the chart area.

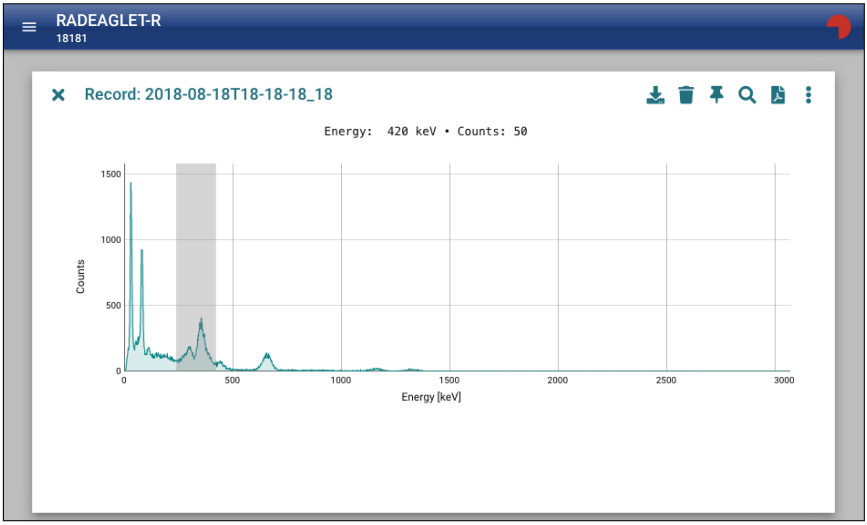



Figure 106: Zooming into the spectrum

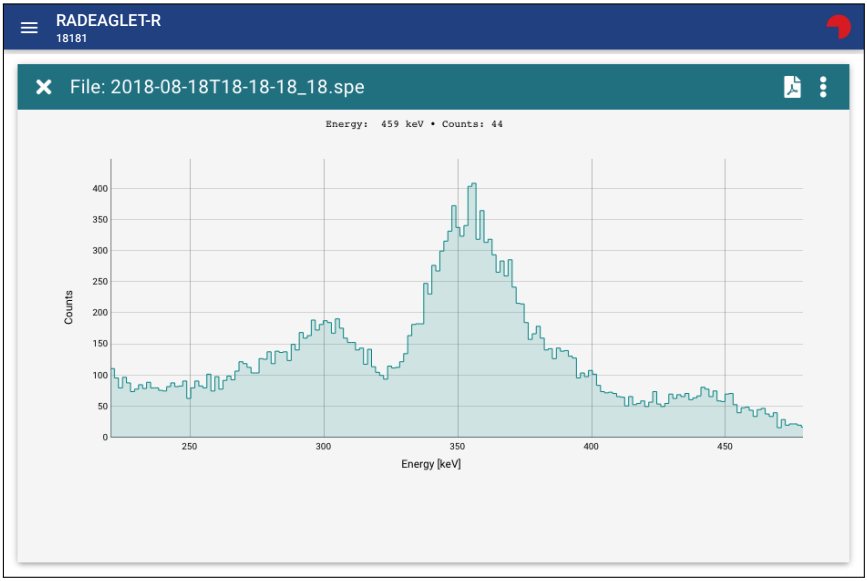



Figure 107: Enlarged part of the spectrum

#### 7.3.1.2 Manual Peak Analysis

→ **To analyze a peak**...

1. Click 📌.
2. Click and hold at one end of the peak.

   This also works in the zoomed diagram (see 7.3.1.1, p. 102).
3. Drag to the other end of the peak. The region will be accented (Fig. 108, p. 105).

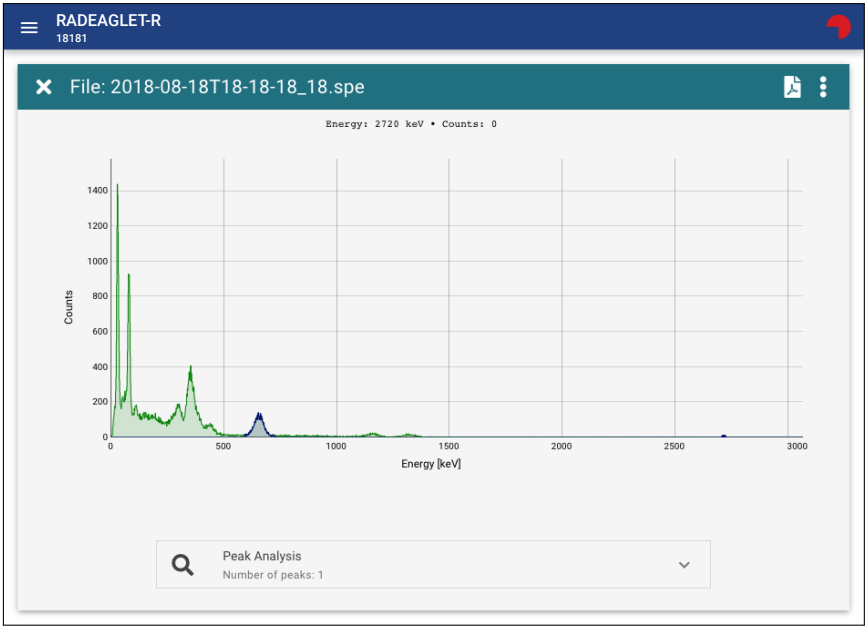



Figure 108: Marking a peak for analysis

4. Release the mouse button. The peak is colored in the diagram and the analysis results are shown below it (Fig. 109, p. 106).

#### 7.3.1.3 Automatic Peak Analysis

→ **To trigger an automatic peak analysis**...

1. Click 🔍.

   The spectrum will be scanned and all recognized peaks are accented in color. Details for the peaks will be shown below the diagramm (Fig. 110, p. 107).

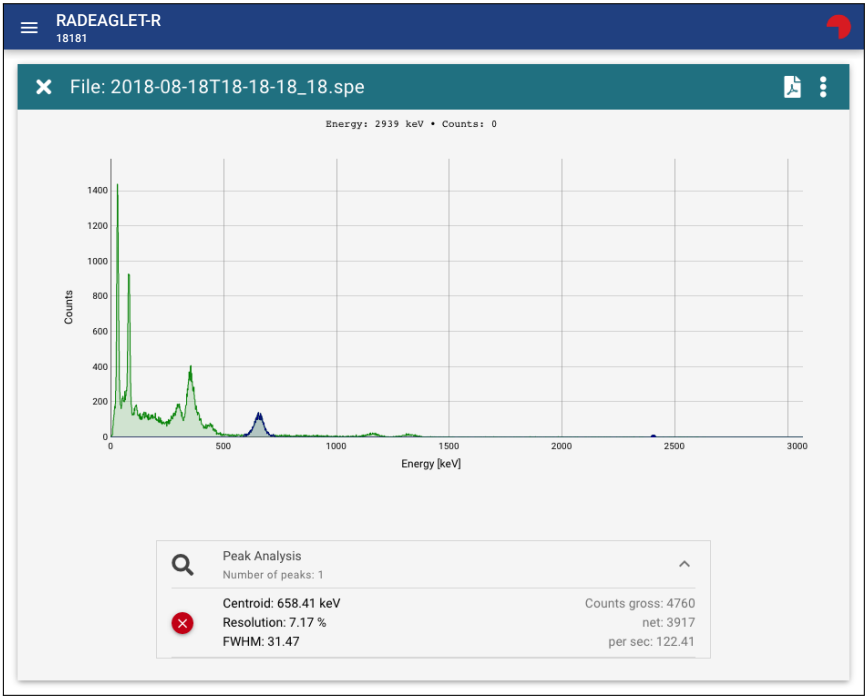



Figure 109: Results for a manually marked peak

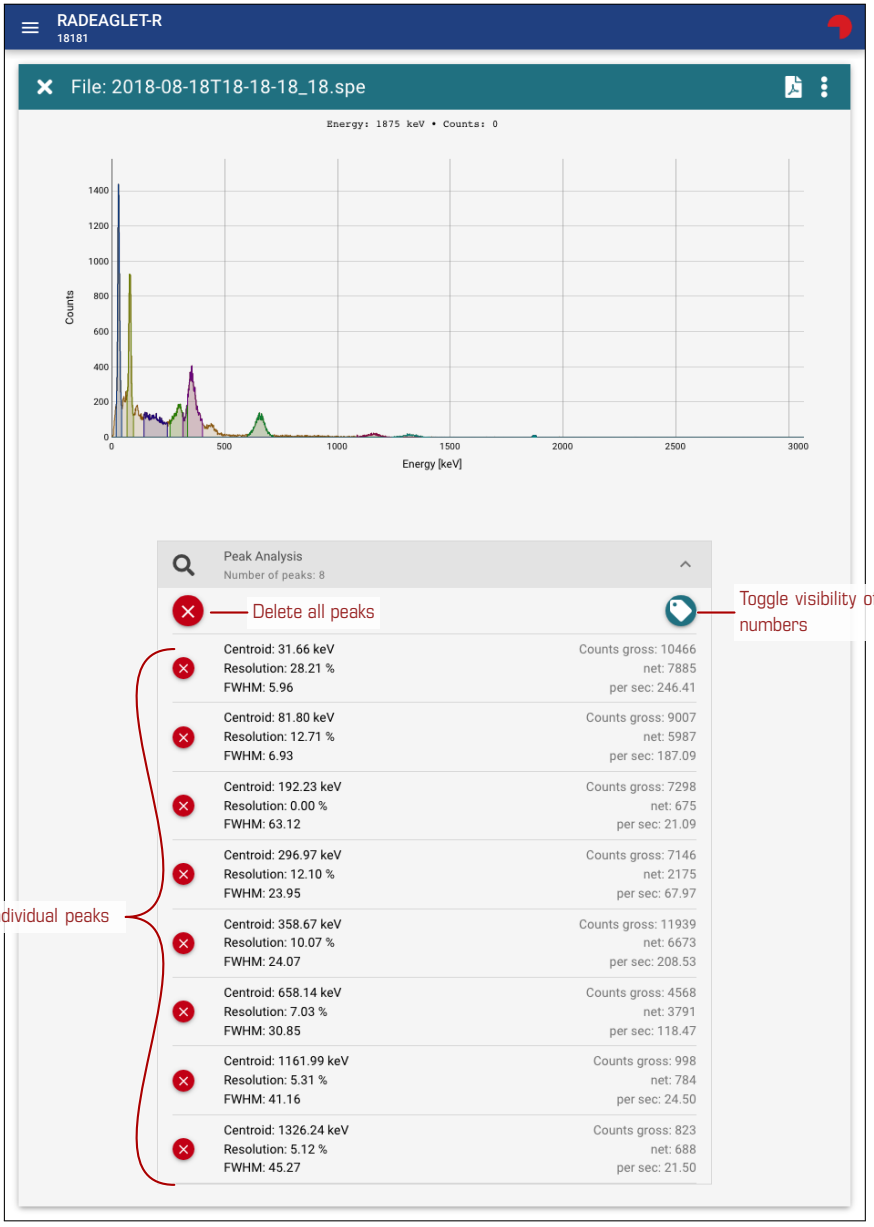



Figure 110: Results of an automatic peak analysis

#### 7.3.1.4 Spectrum Details

→ **To show detailed information for the spectrum**...

1. Click ⋮. Details will be shown in several subsections below the diagramm.
2. Click the triangles to expand or collapse subsections. (Fig. 111, p. 108, Fig. 112, p. 110).

You can change the vertical scaling of the spectrum diagram.

LIN Linear scaling (the default).

SQRT Square Root scaling.

LOG Logarithmic scaling.

The current scaling is accented below the diagram (Fig. 111, p. 108).

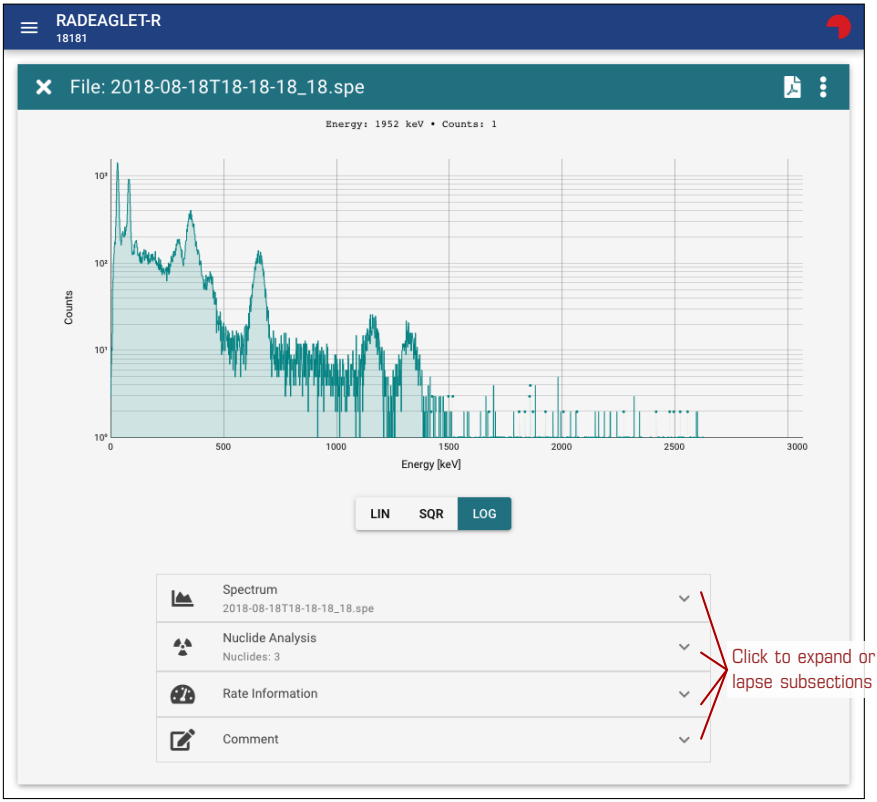



Figure 111: Spectrum with scaling methods and detail overview

You can add a comment to the spectrum in the last subsection (Fig. 113, p. 111). This comment will be appended to the PDF report (see 7.3.1.5, p. 112).




The comment is not saved with the spectrum permanently. It is lost when you leave the spectrum inspector.

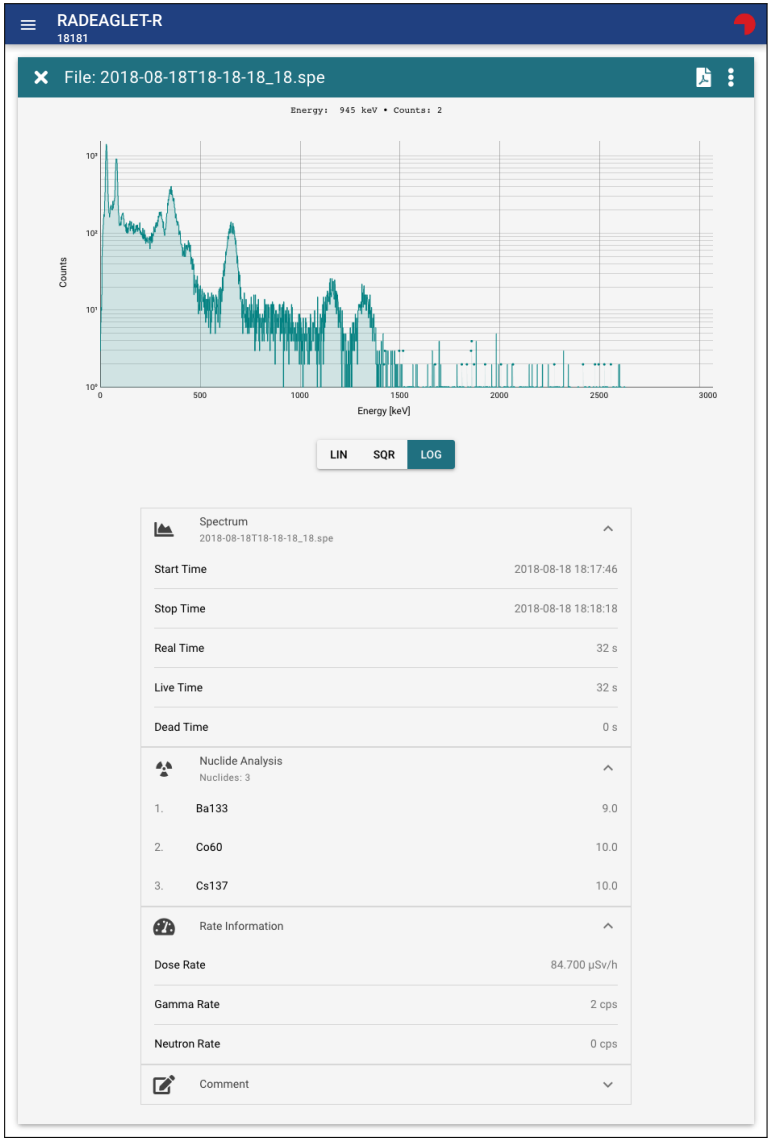



Figure 112: Spectrum with expanded detail information

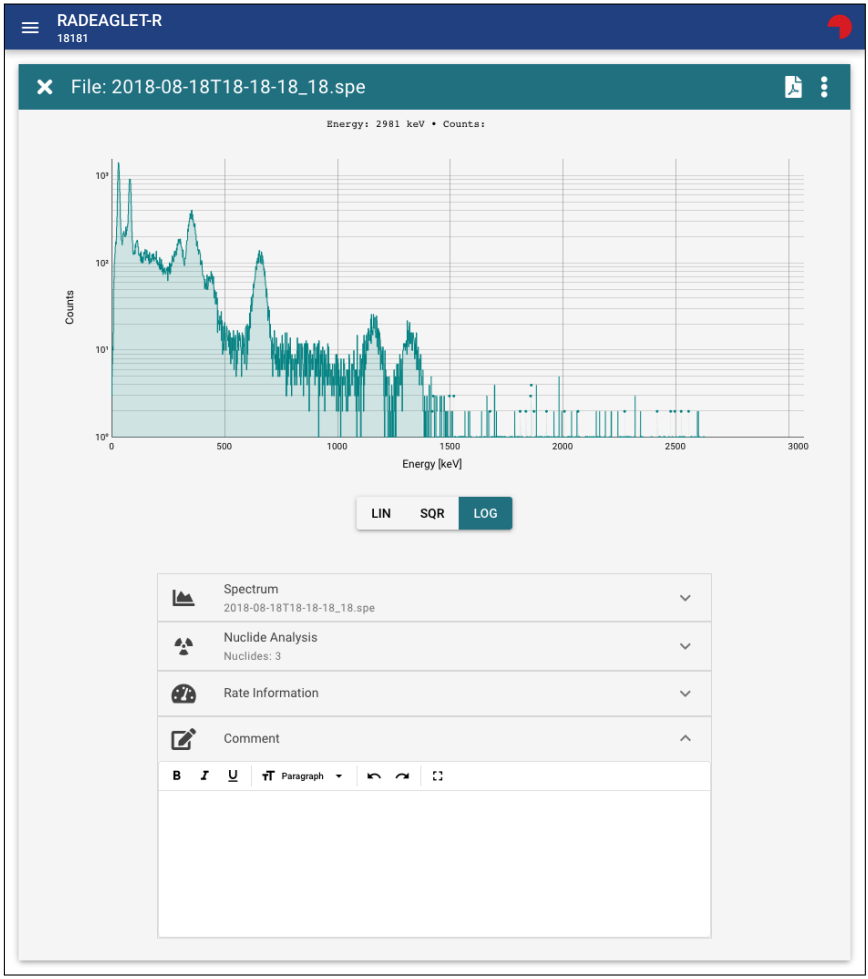



Figure 113: Comment subsection of spectrum details

#### 7.3.1.5 PDF Report Creation

→ **To create a PDF report...**

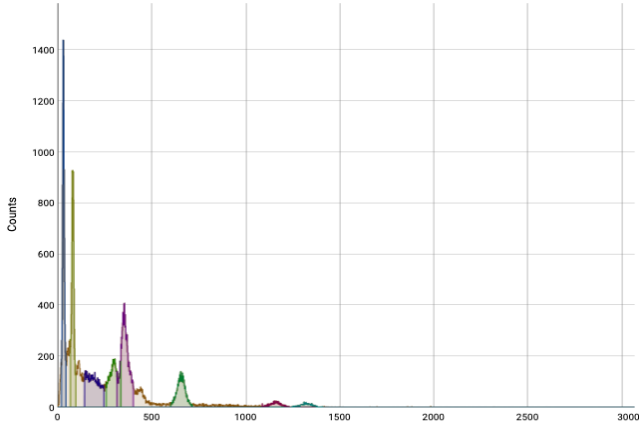
1. Click . Depending on your Web browser configuration, the pdf document will be opened in the browser or downloaded into the usual location for downloads.

   An example is shown in Fig. 114, p. 113.

Instrument Report: 2018-08-18T18-18-18_18.spe

ORTEC AMETEK

| | |
|---|---|
| **Report Date** | 15.02.2021 08:30:04 |
| **Model Name** | RADEAGLE |
| **Model** | RE 3SG-H-GPS |
| **Serial Number** | 18181 |




**Spectrum Information**

| | |
|---|---|
| Start Time | 2018-08-18 18:17:46 |
| Stop Time | 2018-08-18 18:18:18 |
| Real Time | 32 s |
| Live Time | 32 s |

**Rate Information**

| | |
|---|---|
| Dose Rate | 84.700 µSv/h |
| Gamma Rate | 2 cps |

**Nuclide Analysis**

| Nuclide | Confidence |
|---|---|
| Ba133 | 9.0 |
| Co60 | 10.0 |
| Cs137 | 10.0 |

**Peak Analysis**

| Centroid | Resolution | Gross | Net | counts/sec. |
|---|---|---|---|---|
| 31.66 keV | 28.21 % | 10466 | 7885 | 246.41 |
| 81.80 keV | 12.71 % | 9007 | 5987 | 187.09 |
| 192.23 keV | 0.00 % | 7298 | 675 | 21.09 |
| 296.97 keV | 12.10 % | 7146 | 2175 | 67.97 |
| 358.67 keV | 10.07 % | 11939 | 6673 | 208.53 |
| 658.14 keV | 7.03 % | 4568 | 3791 | 118.47 |
| 1161.99 keV | 5.31 % | 998 | 784 | 24.50 |
| 1326.24 keV | 5.12 % | 823 | 688 | 21.50 |

Figure 114: PDF report of a spectrum

## 7.4 Spectrum File Viewer

This section (Fig. 115, p. 114) provides access to the spectrum inspector (see 7.3.1, p. 102) for RADEAGLET-R spectra not saved in the RADEAGLET-R but on your PC, tablet or similar.

You can either drop a spectrum file on the page or click the "+" button to choose a spectrum with the standard file selection method of your computer.

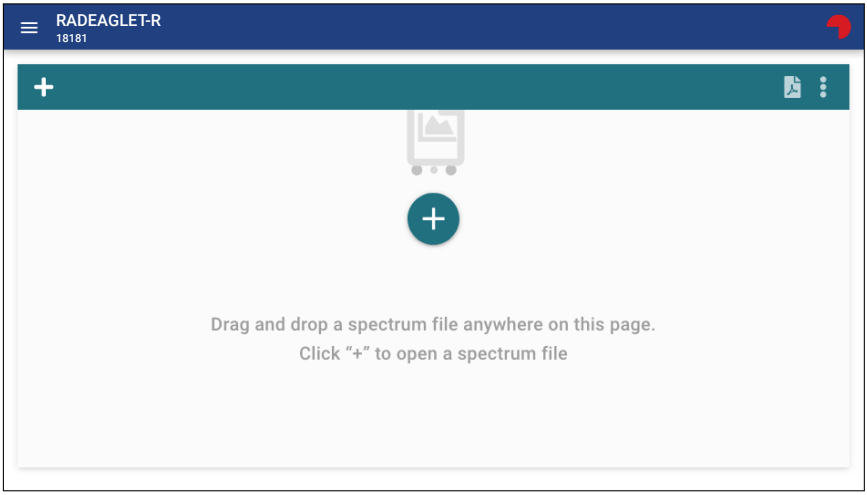



Figure 115: The spectrum file viewer in the Web interface

## 7.5 Basic Settings

This section (Fig. 116, p. 115) provides access to the basic settings of your RADEAGLET-R. Changes you make here are transferred to the instrument. The settings are the same ones available in the Basic Settings of the instrument (see 5.2, p. 53). These include:

- Language
- Date and Time (see 5.3, p. 54)
- Display Settings (see 5.4, p. 55)(Fig. 117, p. 115)
- Feedback Settings (see 5.6, p. 58)(Fig. 118, p. 116)

Additionally, you can change the theme of the web interface and chose between a dark and a light theme.

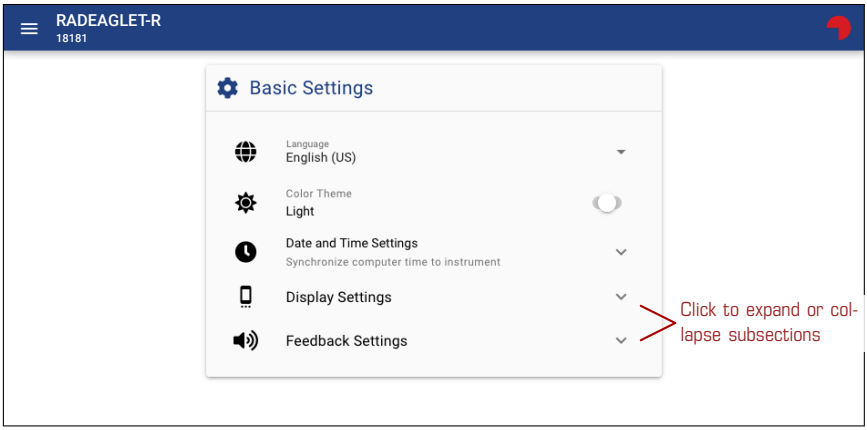



Figure 116: The RADEAGLET-R basic settings in the Web interface

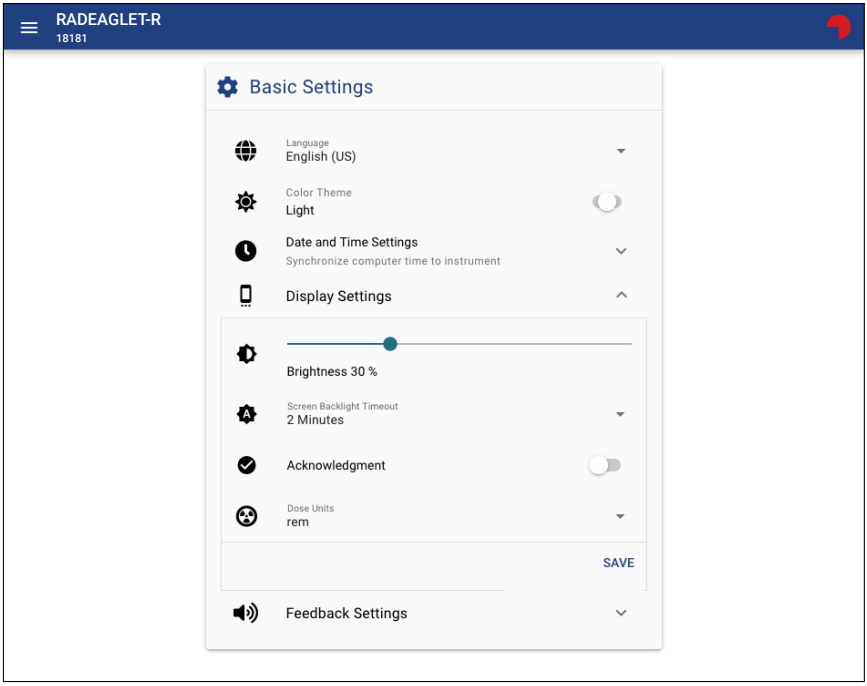



Figure 117: The RADEAGLET-R display settings in the Web interface

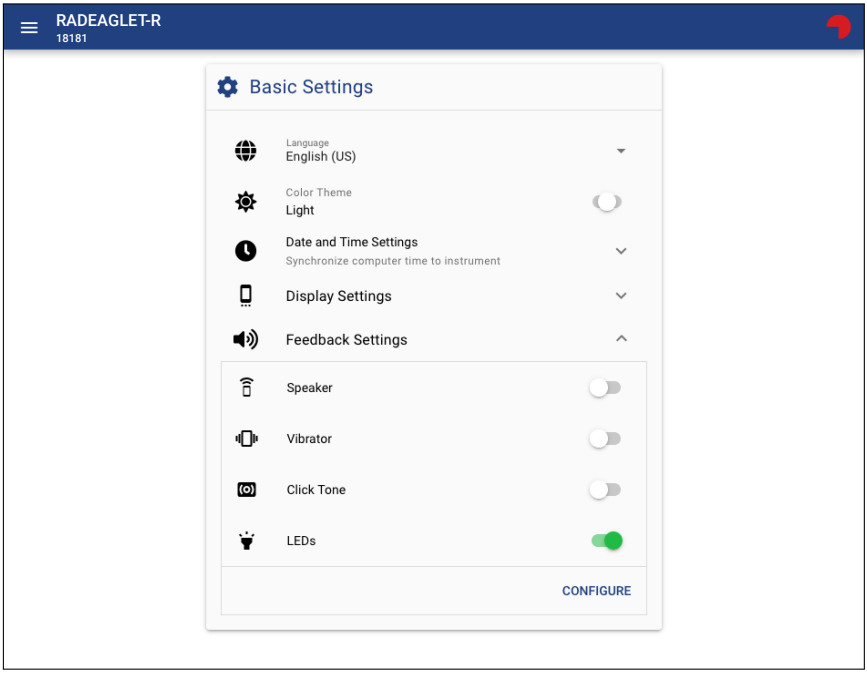



Figure 118: The RADEAGLET-R feedback settings in the Web interface

## 7.6 Advanced Settings

This section (Fig. 119, p. 117) provides access to further settings of your RADEAGLET-R. It is password protected, with the **default username 'user' and default password 'Astronomy'**. If you press CANCEL, when asked for the password, you can still access the settings. However, you won't be given the permission to change any of them. Amongst further options, the settings available here are the same Advanced Settings as in the instrument.
These include:

- Easy-ID Time (see 5.22, p. 80)(Fig. 121, p. 119)
- Nuclide Library (see 5.24, p. 82)(Fig. 121, p. 119)
- Alarm Settings (see 5.16, p. 75)(Fig. 120, p. 118)

Additionally, the import and export of configuration files is located here, as well as the possibility for software updates(see 7.8, p. 121).
You can also change the password for the Advanced Settings of the web interface and reset the password for the advanced settings within the instrument to factory defaults (Fig. 122, p. 120).

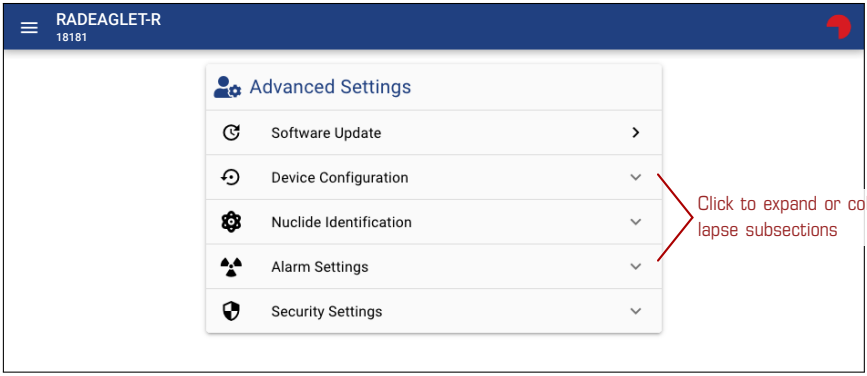



Figure 119: The RADEAGLET-R Advanced settings in the Web interface

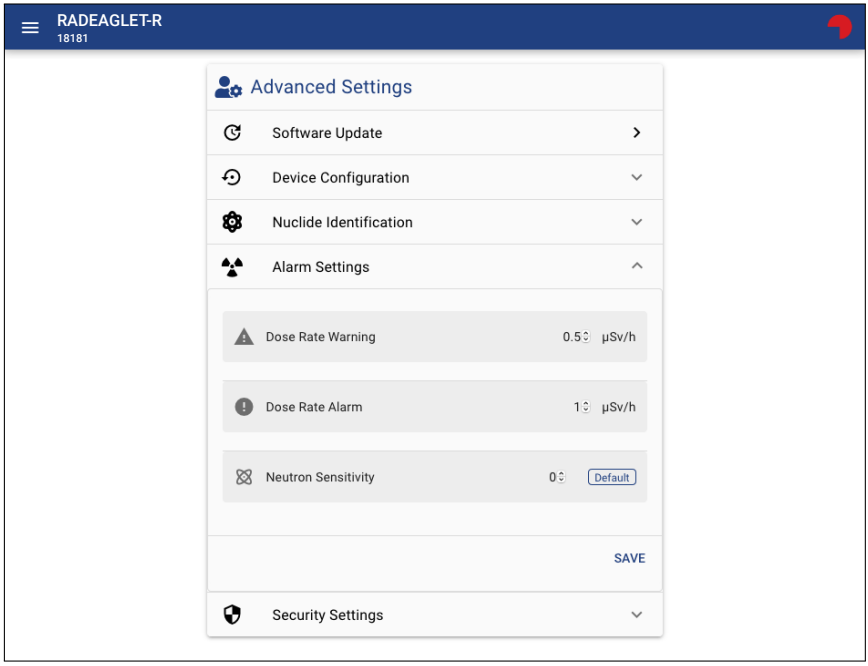



Figure 120: The RADEAGLET-R alarm settings in the Web interface

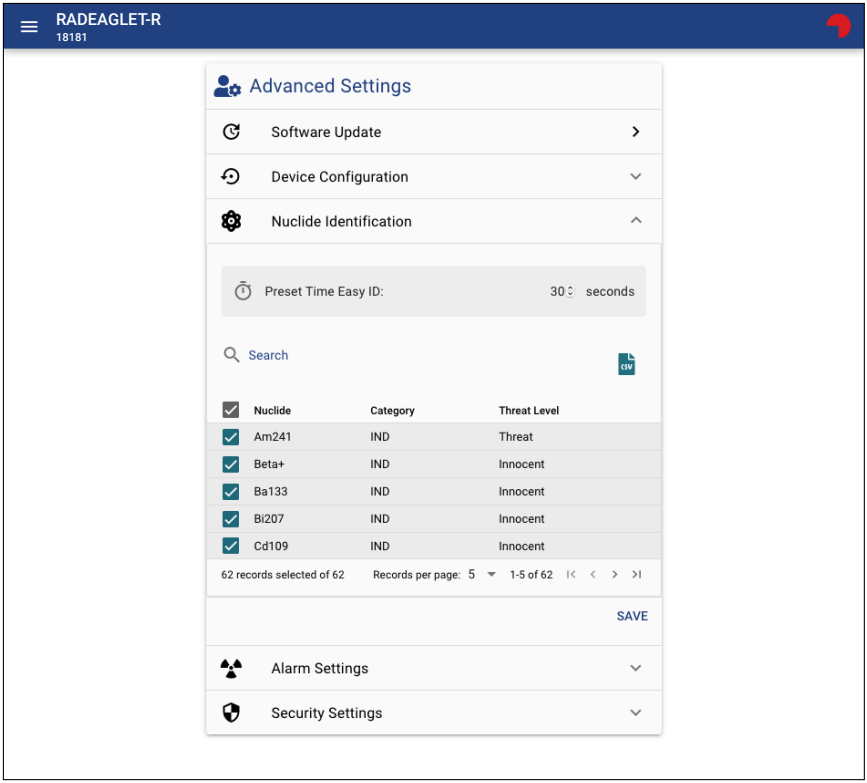



Figure 121: The RADEAGLET-R nuclide ID settings in the Web interface

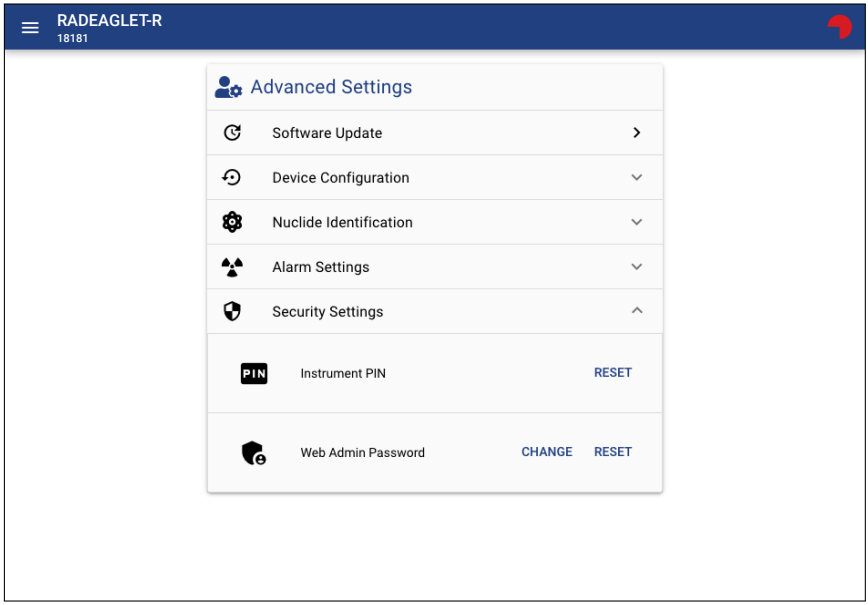



Figure 122: The RADEAGLET-R Security settings in the Web interface

## 7.7 Device Configuration

This section provides the possibility to EXPORT your configuration, i.e. the settings of the instrument. By clicking on IMPORT, you can also apply an already existing configuration onto the instrument.

⚠ Your old configuration will be overwritten. It is recommended to export your old configuration, prior to importing a new one.

## 7.8 Software Update

You can upload updates or additional software to your RADEAGLET-R in this section of the Web interface.

You can either drop an appropriate file on the page or click the button to choose a file with the standard file selection method of your device.

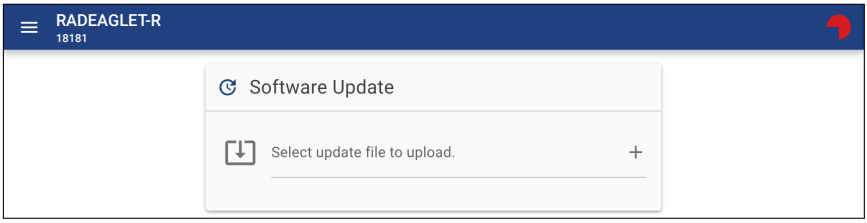



Figure 123: Update software on the RADEAGLET-R in the Web interface

The file will be transferred to the RADEAGLET-R, checked and prepared for installation (Fig. 124, p. 121).

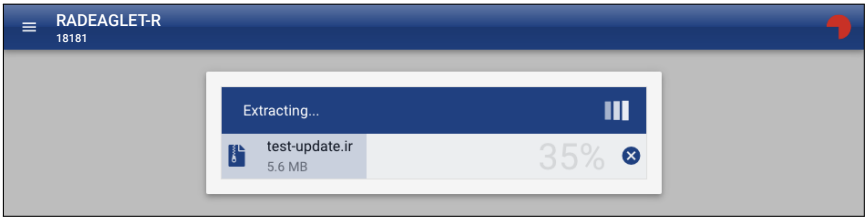



Figure 124: Transfer software to the RADEAGLET-R in the Web interface

After the file is checked and identified, you have to launch the installation by clicking → (Fig. 125, p. 122).

You will be informed about the result (Fig. 126, p. 122) and the the instrument will be restarted if necessary.

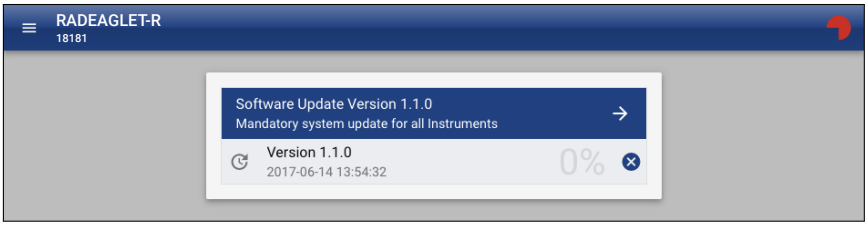



Figure 125: Ready to install the transferred software

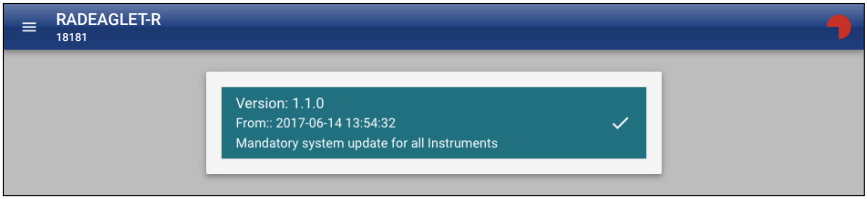



Figure 126: Successful installation of the software

## 7.9 Documents

This section (Fig. 127, p. 122) provides access to documents available on your instrument, for example, this manual in several languages.

Click an entry to access the document. Depending on your Web browser configuration, the pdf document will be opened in the browser or downloaded into the usual location for downloads.

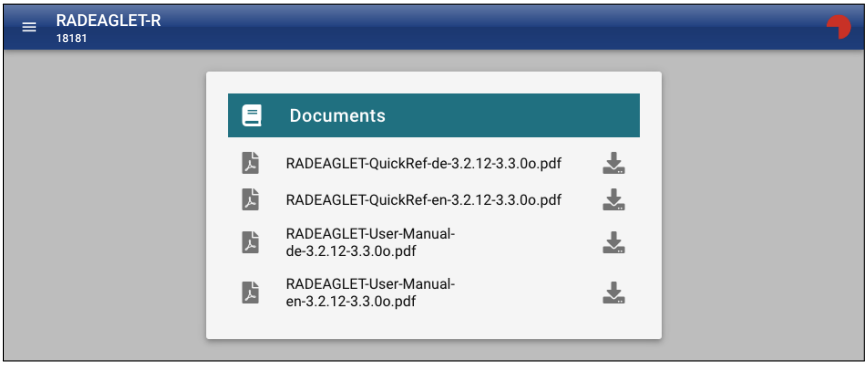



Figure 127: Documents available on your RADEAGLET-R

## 7.10 User Data

This section (Fig. 128, p. 123) provides access to all the data you saved in the RADEAGLET-R's database during your surveys.

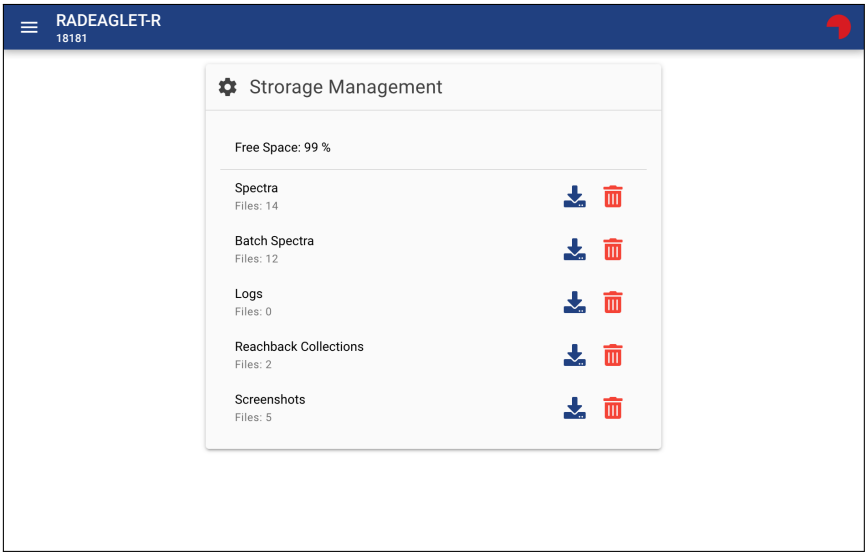



Figure 128: Managing the storage in the Web interface

The remaining storage space for more data is displayed above subsections for every type of data showing the number of stored files and the following commands:

- Download all records of this type compressed into a single `*.zip` archive.
  The filename of the archive comprises the type of data and the current date and time, for example `spectra-20180818-181818.zip`.
- Delete all records of this type. You will be asked to confirm this command.
  Use this command in case you need space or to maintain data confidentially before you pass on the instrument to another user.

# 8 The RadSync Application

The RadSync Application is a mobile phone application suitable to communicate and support some functions of your RADEAGLET-R. It can be downloaded from both 'Google Play Store' on Android devices and the Apple 'App Store' on Apple devices. The application can be found by using one of the following two links.
`https://play.google.com/store/apps/details?id=com.innoriid.innolink`
`https://apps.apple.com/us/app/radsync/id1568500244`

RADsyncThe RADsync App allows you to connect your RADEAGLE, RADEAGLET or RADEAGLET-R instrument(s) to your iOS device via Bluetooth. This free app serves as a repository for collected measurement from mu...apps.apple.com The connection is established via Bluetooth, which means that the Bluetooth dongle must be plugged into your RADEAGLET-R, to use it with the application. Additionally, to be able to connect, Bluetooth needs to be switched on in the Bluetooth Settings (5.10, p. 63) and the application needs to be activated in the Services Settings(5.12, p. 70).

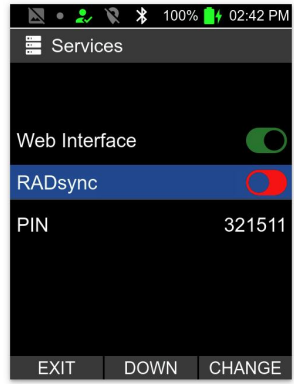



Figure 129: The Application is switched off

## 8.1 Connecting to the application

Switch on the Application in the Services Settings (5.12, p. 70). Open the application and press 'Scan'. Your RADEAGLET-R will show up in the list of available devices. Chose your instrument and pair. You will be asked to enter a six digit PIN code. This PIN is shown next to the 'PIN'-tag on the screen of your RADEAGLET-R. (Fig. 130, p. 126)

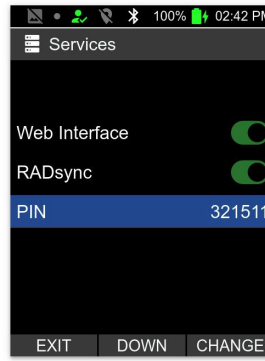



Figure 130: The Application is switched on

# 9 The MFK service

The MFK service is a REST-based API, used for communication with and remote control of your radEAGLET-R. It can be activated and disabled in the Services Settings (5.12, p. 70). This chapter is intended for users who are familiar with such APIs. For other users, the information provided here may not be easily accessible.

## 9.1 Requests

All request can be formulated via a URL, which needs to be typed into a web-browser of your choice. The URL format includes a version number to assure structural stability and account for extensability, endpoint changes, field deprecations and more. The structure is always as follows:
`http://<ip-address>/remote/v1/resource-path`
The API requests are using: GET, POST, PUT and DELETE HTTP methods. When submitting a POST or PUT request, the Content-type header should be set to `application/json` and the charset=UTF-8 (Optional).
An example request could look similar to this:

**`http://192.168.7.2:8888/remote/v1/instrumentStatus`**

## 9.2 Response

All the API responses are sent in a JSON format. The response uses standard HTTP status codes, to indicate the success or failure of API calls. Each API response is wrapped in a standard payload that contains the results of the API call. In some cases, it may contain some additional information and metadata. Here is an example of successful response:

```
{
        --- JSON payload ---
}
```

## 9.3 Resources

The resource is based on the following functionality parts: system information, live data access and remote control.

## 9.4 System Information

**GET http://<ip-address>/remote/v1/instrumentInformation**

This request returns the instrument information record. The response will look similar to this:


```
{
   "InstrumentInformation": {
    "Manufacturer": "innoRIID GmbH"
    "ModelName": "RADEAGLE",
    "ModelDescription": "3SG",
    "SerialNumber": "123456789",
    "SoftwareVersion": "1.7.2",
    "HardwareVersion": "1.33",
    "ProbeTypes": [
      "NaI_3x1",
      "He3",
      "GM"
    ]
   }
}
```


All available information is shown in the following table:

| Name | Type | Example | Comments |
|---|---|---|---|
| **Manufacturer** | String | Ortec/innoRiid | |
| **ModelName** | String | | |
| **ModelDescription** | String | 3SG, 3SG-N | |
| **SerialNumber** | String | | |
| **SoftwareVersion** | String | | |
| **HardwareVersion** | String | | |
| **ProbeTypes** | Array | | Contains all sensors in the device |

## 9.5 Status

**GET http://<ip-address>/remote/v1/instrumentStatus**

This request returns the status record.
The response will look similar to this:


```
{
   "InstrumentStatus": {
     "DateTime": "2000-02-01T12:11:33"
     "Battery": 75.0,
     "Error": [false],
     "SpectrumModeActive": true,
     "CrystalTemperature": 22,
     "Coordinates": [
       51.11513,
      6.650806,
      ]
  }
}
```


All available information is shown in the following table:

| Name | Type | Example | Comments |
|---|---|---|---|
| **InstrumentStatus** | Object | | |
| **DateTime** | String | | |
| **Battery** | Float | 75.0 = 75% | If > 100, charging of Battery is active |
| **Error** | [Boolean, String] | [True, "Description of the problem"] | If false, Array length is 1 |
| **SpectrumModeActive** | Boolean | | If true, a spectrum is currently taken |
| **CrystalTemperature** | Float | | Unit is °C (Degrees Celsius) |
| **Coordinates** | [Float,Float] | | [Latitude, Longitude] |

## 9.6 Live Data Access

**GET http://<ip-address>/remote/v1/measurement/doseCountRate**

This request shows Dose Rate and Count Rate values of the instruments' detectors.

The response will look similar to this:


```
{
   "Measurement": {
     "CountDoseData": [
     {
        "DetectorType": "Gamma",
        "Detector": "NaI_3x1",
        "Alarm": true,
        "AlarmDescription": "Alarm",
        StartTime": "2000-02-01T12:11:33",
        "Remark": "Maximum",
        "DoseRate": [
          {
            "value": 66.0,
           "unit": "uSv/h"
         },
         {
            "value": 6.6,
            "unit": "mrem/h"
          }
        ],
          "CountRate": {
            "value": 35424.0,
            "unit": "cps"
          }
        },
     {
        "DetectorType": "Gamma",
        "Detector": "NaI_3x1",
        "Alarm": false,
        "StartTime": "2000-02-01T12:11:33",
        "Remark": "Minimum",
        "DoseRate": [
         {
           "value": 2.0,
           "unit": "uSv/h"
```

```
    },
    {
      "value": 0.2,
      "unit": "mrem/h"
    }
  ],
  "CountRate": {
    "value": 1524.0,
    "unit": "cps"
  }
 },
 {
   "DetectorType": "Gamma",
   "Detector": "NaI_3x1",
   "Alarm": true,
   "AlarmDescription": "Warning",
   "StartTime": "2000-02-01T12:34:06",
   "Remark": "Current",
   "DoseRate": [
     {
       "value": 10.0,
       "unit": "uSv/h"
     },
     {
       "value": 1.0,
       "unit": "mrem/h"
     }
   ],
   "CountRate": {
     "value": 5524.0,
     "unit": "cps"
   }
 },
{
   "DetectorType": "Neutron",
   "Detector": "He3",
   "Alarm": true,
   "AlarmDescription": "Alarm",
   "StartTime": "2000-02-01T12:11:33",
   "Remark": "Maximum",
   "CountRate": {
```

```
            "value": 5.3,
            "unit": "cps"
          }
        },
        {
          "DetectorType": "Neutron",
          "Detector": "He3",
          "Alarm": false,
          "StartTime": "2000-02-01T12:11:33",
          "Remark": "Minimum",
          "CountRate": {
           "value": 0.0,
           "unit": "cps"
          }
        },
        {
          "DetectorType": "Neutron",
          "Detector": "He3",
          "Alarm": false,
          "StartTime": "2000-02-01T12:11:33",
          "Remark": "Current",
          "CountRate": {
            "value": 0.0,
            "unit": "cps"
          }
        }
      ],
      "MeasurementLocation": {
         "Coordinates": [51.11513, 6.650807]
      }
}
```


All available information is shown in the following table:

| Name | Type | Example | Comments |
|---|---|---|---|
| **Measurement** | Object | | |
| **CountDoseData** | Array | | Contains up to 6 Objects with DoseRate and CountRate information with the tags below. |
| **DetectorType** | String | Gamma, Neutron | |
| **Detector** | String | NaI_3x1, He3 | |
| **Alarm** | Boolean | True, False | If false, no alarm description is available. |
| **AlarmDescription** | Warning, Alarm | | |
| **StartTime** | String | Time | |
| **Remark** | String | Minimum, Maximum, Current | Minimum = minimum of the measured values since last call, Maximum = maximum of the measured values since last call, Current = current of the measured values since last call. |
| **DoseRate** | Array | [Object, Object] | DoseRate array contains two objects. One with uSv/h and value, the second with mrem/h and the value. |
| → Value | Float | | |
| → Unit | String | µSv/h, mrem/h | |
| **CountRate** | Object | | CountRate contains the value and the unit cps. |
| → Value | Float | | |
| → Unit | String | cps | |
| **MeasurementLocatio** | Object | | |
| → Coordinates | Array | [Latitude, Longitude] | |

## 9.7 Spectrum

**GET http://<ip-address>/remote/v1/measurement/spectrum**

This request return the spectrum.
The response will look similar to this:


```
{
    "Measurement": {
      "Spectrum": {
          "DetectorType": "Gamma",
          "LiveTime": "PT7.000000s",
          "RealTime": "PT8.000000s",
          "Type": "PHA",
          "SourceType": "Item",
          "Detector": "NaI_3x1",
          "StartTime": "2000-02-01T12:11:33",
          "ChannelData": [0, 2, 5, 2, 15, 56, 245, 134, 4, 4, ...]
       },
       "AnalysisResults": {
          "NuclideAnalysis": {
            "AlgorithmDescription": "innoRIID_Elija",
            "Nuclides": [
             {
               "Nuclide": {
                 "NuclideName": "Co-60",
                 "NuclideType": "SNM",
                 "NuclideIDConfidenceIndication": "0.9"
               }
             },
             {
               "Nuclide": {
                 "NuclideName": "Cs-137",
                 "NuclideType": "SNM",
                 "NuclideIDConfidenceIndication": "0.9"
               }
             }
            ],
            "AlgorithmVersion": "2.0.0"
          },
          "ThreatDescription": "innocent"
      },
```

```
      "MeasurementLocation": {
        "Coordinates": "[51.11513, 6.650807]"
      }
    }
}
```


| Name | Type | Example | Comments |
|---|---|---|---|
| **Measurement** | Object | | |
| **Spectrum** | Object | | |
| **DetectorType** | String | Gamma | |
| **LiveTime** | PT7.000000s | | |
| **RealTime** | PT8.000000s | | |
| **Type** | String | | |
| **SourceType** | String | | |
| **Detector** | String | NaI_3x1 | |
| **StartTime** | String | | |
| **ChannelData** | Array | [float, float,...] | Length up to 2048 |
| **AnalysisResults** | Object | | |
| → **NuclideAnalyis** | Object | | |
| **AlgorithmDescription** | String | | |
| **Nuclides** | Array | | Length up to 5, contains nuclide - objects |
| → **NuclideName** | Object | "Cs-137", "Co-60" | |
| → **NuclideTypes** | String | SNM, IND, ... | |
| → **NuclideIDConfidenceIndication** | Float | [0,1] | |
| **AlgorithmVersion** | String | | |
| **ThreatDescription** | String | Innocent, Suspicious | |
| **MeasurementLocation** | Object | | |
| → **Coordinates** | Array | [Latitude, Longitude] | |

## 9.8 Calibration

**GET http://<ip-address>/remote/v1/calibration**

Returns the calibration information.

The response will look similar to this:


```
{
"CalibrationType": {
   "EquationModel": {
      "Coefficients": [
         0,
         1.5
      ],
      "Model": "Polynomial"
   },
   "Unit": "keV",
   "Type": "Energy"
   }
}
```


| Name | Type | Example | Comments |
|---|---|---|---|
| **CalibrationType** | Object | | |
| **EquationModel** | Object | | |
| **Coefficients** | Array | | |
| **Model** | String | Polynomial | |
| **Unit** | String | keV | |
| **Type** | String | Energy | |

The Calibration node is describing the relation between the spectrum index in the measurement spectrum node and their representing energy. Without this relation, no expert will be able to analyze a recorded spectrum. The 'CalibrationType' describes a channel $\rightarrow$ energy function. The energy unit is in 'keV'. The function is a polynomial function

$$f(\text{channel}) = a_0 + a_1 * \text{channel} + a_2 * \text{channel}^2 \ldots$$

The coefficients $[0, 1.5]$ are describing the polynomial coefficients $a_0$, $a_1$. The relationship between channel index and its energy is fix for each detector and therefore it is sufficient to read once.

## 9.9 N42 Spectrum

```
GET http://<ip-address>/remote/v1/n4242
```

This request returns a spectrum in N42.42 file format.

## 9.10 Remote Control

With these commands you can remote control the acquisition of a spectrum. There are three different options:

Start the spectrum acquisition:

```
PUT http://<ip-address>/remote/v1/remote/acq/start
```

Stop the spectrum acquisition:

```
PUT http://<ip-address>/remote/v1/remote/acq/stop
```

Clear the spectrum:

```
PUT http://<ip-address>/remote/v1/remote/acq/clear
```

## 9.11 Workflow

This section describes a possible workflow with the MFK interface.

### 9.11.1 System Initialization

1. GET http://<ip-address>/remote/v1/instrumentInfomation
2. GET http://<ip-address>/remote/v1/instrumentStatus
3. GET http://<ip-address>/remote/v1/calibration

### 9.11.2 Dose and Count Rate Mode

1. GET http://<ip-address>/remote/v1/instrumentStatus
2. GET http://<ip-address>/remote/v1/measurement/doseCountRate
3. Pause for some time and start with 1. again

### 9.11.3 Start Spetrum Mode

1. GET http://<ip-address>/remote/v1/instrumentStatus
   - If the spectrum mode is currently not active:
     - PUT http://<ip-address>/remote/v1/remote/acq/clear

     Else:
     - PUT http://<ip-address>/remote/v1/remote/acq/start
     - PUT http://<ip-address>/remote/v1/remote/acq/clear
2. GET http://<ip-address>/remote/v1/instrumentStatus
3. GET http://<ip-address>/remote/v1/measurement/doseCountRate
4. GET http://<ip-address>/remote/v1/measurement/spectrum
5. Pause for some time and restart with 2.

# 10 Powering the radEAGLET-R

The standard power source of the radEAGLET-R is a rechargeable black powerCELL (10.1.1, p. 139) installed behind a locked cover on the left bottom (Fig. 131, p. 139) of the instrument.

To increase the field operation time you can swap the battery pack (10.2, p. 142) even while using the radEAGLET-R.

You can connect the radEAGLET-R to an external power source to run it and to charge the installed standard battery (10.3, p. 143).

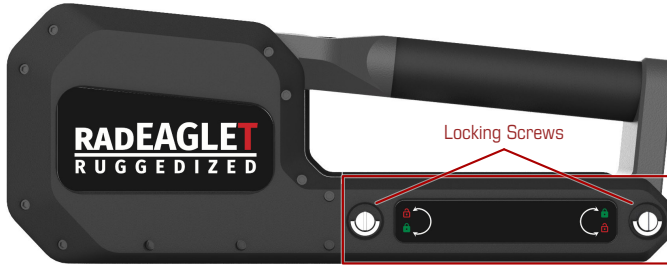



Figure 131: Position of the battery compartment cover of the radEAGLET-R.

## 10.1 radEAGLET-R Battery Packs

The radEAGLET-R comes with two different battery packs.

Additional battery packs in both variants are sold separately.

Batteries must be handled and disposed of properly as required in your jurisdiction.

### 10.1.1 Rechargable powerCELL

The rechargable powerCELL (Fig. 132, p. 140) is a sealed box containing rechargeable cells. They are recharged within the instrument whenever it is connected to external power.

A rechargable powerCELL-L containing Lithium Ion cells is installed in the instrument when it leaves the factory.

If you don't want to use Li-Ion cells, you can order your radEAGLET-R with Nickel–metal hydride cells (NiMH) with a very low self discharge (LSD).

Refer to the Battery section in Appendix E.1, p. 179 for details on operating and charging durations.




Figure 132: The standard rechargeable powerCELL of the radEAGLET-R.

Rechargeable batteries should not be completely discharged. If you don't use them for a while, make sure to charge it periodically as specified in Appendix E.1, p. 179.

Do not unscrew the reachrgable powerCELL. There are no user servicable parts inside.

→ **To check the status of a powerCELL...**

1. Press the marked button on the contact side of the powerCELL (Fig. 133, p. 140).
2. Observe the LED. It flashes in a pattern proportional to the current status:
   - No light: Empty
   - Continuous light: Full

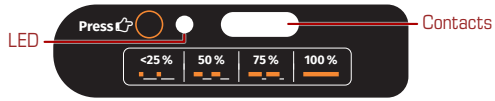



Figure 133: Status check of the powerCELL of the radEAGLET-R.

### 10.1.2 Non-rechargable POWERCELL

The non-rechargable POWERCELL (Fig. 134, p. 141) is a box for batteries you supply. You can fill it with six common batteries of size “AA” (a.k.a “Mignon” or “R6”).




Figure 134: The non-rechargable POWERCELL for common batteries

→ **To install batteries in the non-rechargable POWERCELL**...

1. Open the pack by removing the three screws on the left side with a Phillips PH 1 screw driver (included with the RADEAGLET-R.)
2. Insert six batteries.

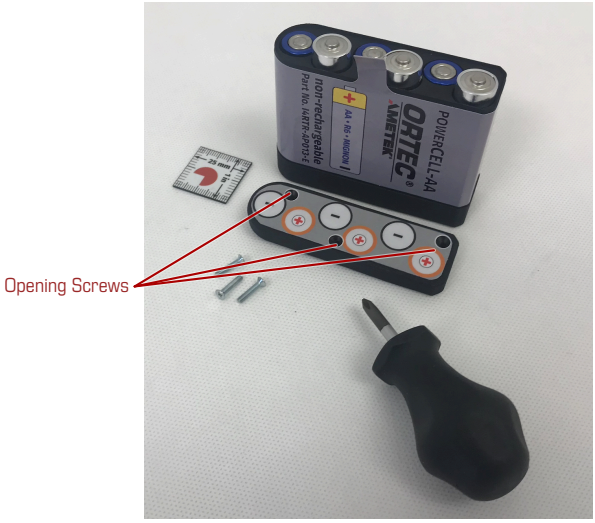



Figure 135: The non-rechargable POWERCELL filled with batteries

⚠ Observe the polarity (Fig. 136, p. 142). The correct orientation is sketched on the pack’s cover.

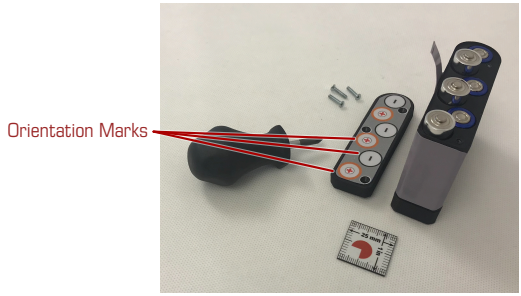



Figure 136: Orientation of AA batteries in the non-rechargable powerCELL (shown without cover).

3. Put the cover in place and fasten it with both screws.

   Please make sure to tightly screw the cover back on. The two parts need to align seamlessly (Fig. 137, p. 142).

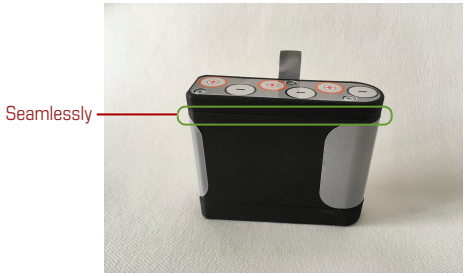



Figure 137: Alignment of the two parts of the non-rechargable powerCELL

Remove the AA cells if you don't want to use the instrument for a longer while.

You can fill the pack with rechargeable batteries, however, they won't be recharged in the instrument.

## 10.2 Replacing Batteries of the radEAGLET-R

You can replace the powerCELL of the radEAGLET-R.

You can replace powerCELL while the radEAGLET-R is running. An internal buffer provides power for at most 30 minutes. It is recharged automatically.

→ **To remove the powerCELL...**

1. Unscrew both locks of the cover by turning them counter-clockwise. You can use the attached bracket or, for example, a coin.

⚠ You don't need to remove the screws completely, just turn them until the cover loosens.

2. Remove the cover (Fig. 138, p. 143).




Figure 138: POWERCELL in compartment with cover removed

3. Grab the flap and pull the POWERCELL out of the instrument.

→ **To install a POWERCELL...**

1. Slide the POWERCELL into the compartment, contact side ahead.

   The case of the POWERCELL is asymmetric. It fits into the compartment in the correct orientation only.

2. Put the cover on the compartment.
3. Lock the cover by turning both locking screws clockwise.

## 10.3 External Power Sources

You can connect the RADEAGLET-R to external power sources via the connector on the rear side of the instrument Fig. 5, p. 20.

Included with the RADEAGLET-R are:

- Wall power supply (10.3.1, p. 144)
- Car adaptor

While the RADEAGLET-R is powered by an external source providing enough power to charge the internal battery, the the battery symbol (Fig. 1, p. 17) is decorated by a bolt.

➔ **To connect an external power source...**

1. Remove the protective cap from the connector.
2. Insert the plug.

⚠ Observe the orientation mark. The red marker on the plug must face upwards.

⚠ Always grab the plug when handling the connection.Do not pull at the cable behind the plug.

### 10.3.1 Wall Power Supply

Every power supply shipped with the RADEAGLET-R can handle common international AC voltages and frequencies.

Some models come with a fixed plug for a certain country. You can use a common traveler's kit to mechanically adapt the plug to various international wall outlets.

Other models feature swappable adaptors for several international wall outlet standards (Fig. 139, p. 144).

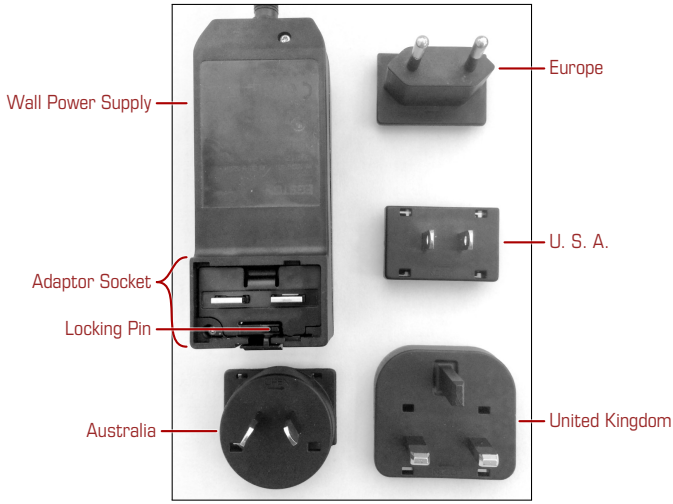



Figure 139: Wall power supply with international adaptors

➔ **To swap the international adaptor...**

1. Press the lock and slide the current adaptor to the side out of its socket (Fig. 140, p. 145).
2. Insert the desired adaptor into the socket and move it until it snaps into place (Fig. 141, p. 145).

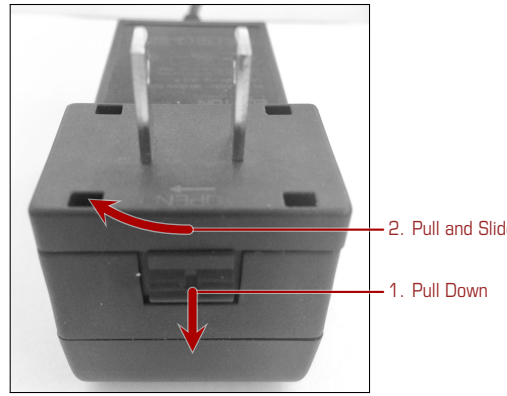



Figure 140: Removing an adaptor from the wall power supply

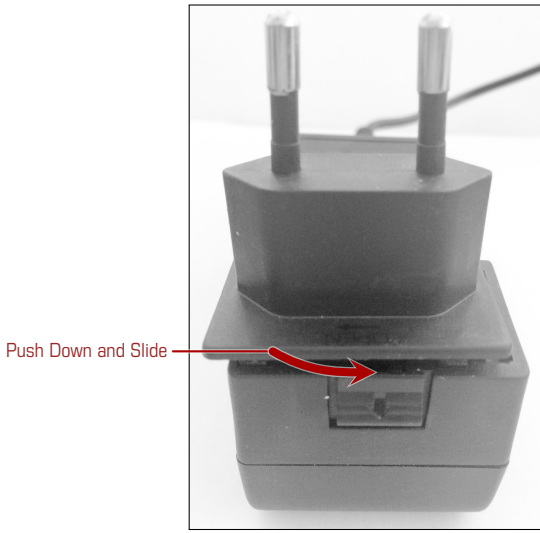



Figure 141: Mounting an adaptor to the wall power supply

## 10.4 Charging the powerCELL

While your radEAGLET-R is connected to an external power source (see 10.3, p. 143) an installed black powerCELL (see 10.1.1, p. 139) will be charged.

Charging is reported by a green LED (see 2.1.1, p. 25, Fig. 1, p. 17), which goes off when the battery is fully charged.

Refer to the Battery section in Appendix E.1, p. 179 for details on typical charging durations.

## 10.5 Energy Saving Tips

If you need to save energy, especially when running the radEAGLET-R from battery power, you can optimize a few settings to reduce power consumtion.

This section lists power-demanding features which you might not need all the time or for certain type of applications, beginning with the more energy-demanding features.

**Screen Brightness and Timeout**

The backlight of the screen draws a significant amount of power. Reduce the backlight brightness (see 5.4, p. 55) to what you really need in your environment.

Let the backlight time out after the shortest period of inactivity (see 5.4, p. 55) convenient for your workflow.

**Wi-Fi**

Switch off the Wi-Fi hotspot while you not using it to communicate (see 5.8, p. 59).

**USB Devices**

Disconnect any USB devices while you are not transferring data.

**GPS Receiver**

Switch off the GPS receiver (see 5.13, p. 71) if you don't need coordinates to be saved with, for example, identification results or spectra.

Switch off the GPS receiver while you work at places with poor or no GPS reception (inside buildings, underground, etc.).

**Detect Mode**

The detect mode causes high-volume data transfer between the components of the radEAGLET-R. Switch to another mode while not using the detect mode.

# 11 Tutorial

This chapter guides you through an exemplary survey with the RADEAGLET-R. A typical scenario is to survey objects for radioactive radiation, to locate and identify the radiation source, to document the results, and to share them with your team or supervisor. Common practice might include the following steps:

1. Turn on the RADEAGLET-R (see 11.1, p. 147).
2. Survey the environment (see 11.2, p. 150).
3. Locate a radiation source (see 11.3, p. 153).
4. Identify the Radiating Nuclide (see 11.4, p. 155).
5. Transfer Results (see 11.5, p. 158).
6. Turn off the RADEAGLET-R (see 11.6, p. 161).

The steps listed above include those outlined in chapter 5.6.2 of the "ANSI N42.34-2015" standard.

Your organization or institution probably has its own standard operation procedures (SOP). If available, you should adhere to those SOP.

Before you go through this chapter, you should should familiarize yourself with the RADEAGLET-R (1.5.2, p. 16) and its accessories (1.5.3, p. 17) and the principles of operation described in chapter 2, p. 23.

This chapter is not a complete description of the RADEAGLET-R but outlines just one of the many possible workflows.

Detailed descriptions of **all** the functions and commands are provided in the other chapters, mainly chapter 5, p. 47. The steps mentioned here contain precise cross references to the corresponding sections.

## 11.1 Turn on the RADEAGLET-R

→ **To turn on the RADEAGLET-R...**

1. Position the instrument in a low-radiation environment.
2. If your model is not equipped with an internal source, position the supplied KCl box (Fig. 17, p. 31) in front of the detector.
3. Press and hold down the key.
4. After a couple of seconds the alarm LEDs flash and the instrument begins to boot.
5. You are welcomed by the start-up screen with dots appearing from left to right.

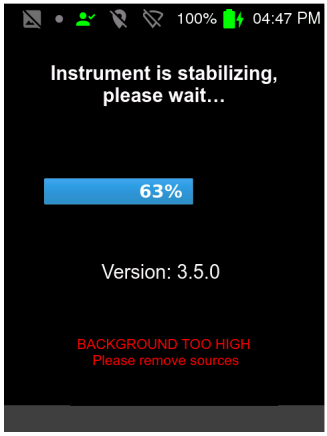



Figure 142: Initial Stabilization during instrument start

6. The radEAGLET-R begins an initial stabilization (Fig. 142, p. 148).
7. After the stabilization the radEAGLET-R switches to Dose Rate Mode (3.1, p. 35).

You can adjust the backlight brightness of your radEAGLET-R's LCD display to the lighting conditions of your surrounding (see 5.4, p. 55). The lower the backlight brightness, the longer the battery lasts.

### 11.1.1 Check the Status of the radEAGLET-R

After startup the radEAGLET-R is ready for use. The top of the screen (Fig. 143, p. 148) always shows the status of important features of the instrument, e.g., stabilization or battery power. For a detailed description of the status bar see chapter 2.1, p. 23.

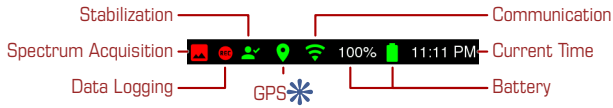



Figure 143: Status bar along the display's top edge

Several commands are available to inspect other status information. They are listed in Fig. 144, p. 149.

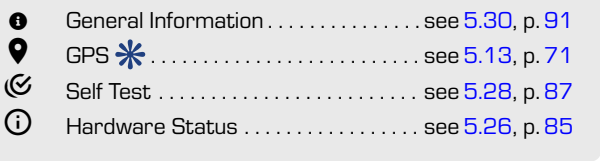



Figure 144: Commands for status information

### 11.1.2 Calibrate the RADEAGLET-R

Usually the calibration and stabilization of the RADEAGLET-R happens during startup and continuously while using it. If you want to explicitly start a calibration with a reference nuclide, several methods are available. A more elaborate method is described in chapter 5.21, p. 78. Here we use an automated calibration procedure.

For additional information refer to appendices C.1, p. 171 (stabilization), C.2, p. 172 (calibration), and D.1, p. 175 (red stabilization icon).

→ **To calibrate the RADEAGLET-R...**

1. Move to a low-radiation environment.
2. If your RADEAGLET-R has no calibration source built-in, place a source in front of the detector, for example, the KCl box included with the instrument.
3. Open the Advanced menu.
4. Scroll down to **Easy Calibration** and Select it.
5. Specify to the calibration nuclide and Select it.
6. The instrument displays progress in percent (%) during the process (Fig. 145, p. 150).
7. Wait until the RADEAGLET-R displays “System is operative” (Fig. 146, p. 150).
8. Finish the calibration with Exit.

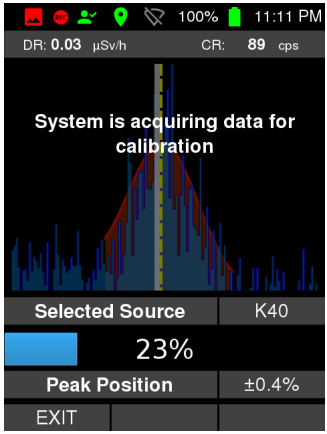



Figure 145: Easy calibration in progress

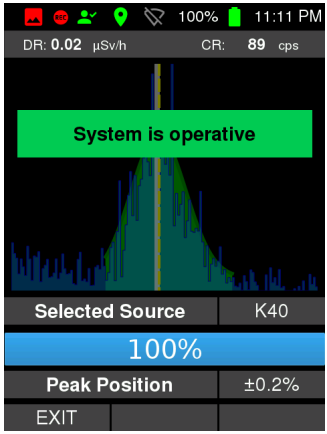



Figure 146: Easy calibration finished

## 11.2 Survey the Environment

The Dose Rate Mode (3.1, p. 35) is the main measurement mode of the RADEAGLET-R. The display shown in (Fig. 147, p. 151) appears after starting up the instrument.




Figure 147: The RADEAGLET-R in dose rate mode

### 11.2.1 Gamma Radiation

→ **To survey for gamma radiation...**

1. Move the RADEAGLET-R around (Fig. 148, p. 151) and observe the display.




Figure 148: Surveying an object for gamma radiation

The current dose rate is shown in a chart and with large digits (Fig. 147, p. 151).

You can change the dose rate unit, see (see 5.4, p. 55).

2. The radEAGLET-R always compares the current dose rate with the thresholds specified for warnings and alarms (see 5.16, p. 75) and reports values above the thresholds (Fig. 149, p. 152).

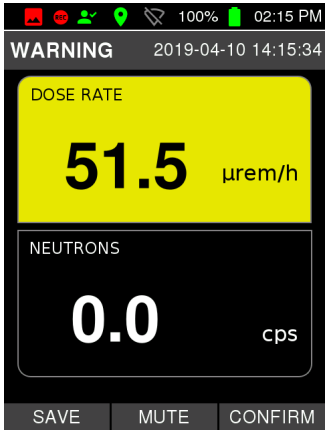



Figure 149: A gamma warning as reported on screen

Press Confirm to dismiss the message. Please refer to chapter 4, p. 43 for details.

### 11.2.2 Neutron Radiation

This item is available for radEAGLET-R models with a neutron detector (see E.1, p. 179).

The radEAGLET-R's neutron detector can detect slow a.k.a. thermal neutrons.

Fast neutrons need to be slowed down by a moderator, for example, ordinary water or substances containing lots of hydrogene.

→ **To survey for neutron radiation**...

1. Increase the sensitivity for unmoderated neutrons by holding the radEAGLET-R so the neutron detector is close to your body (Fig. 150, p. 153).
2. To detect neutrons regardless of your position relative to the source turn yourself around.
3. Observe the screen. Neutron incidents are shown and counted (Fig. 151, p. 153).
4. If the neutron counts exceed the adjustable alarm threshold (see 5.16, p. 75) a neutron alarm is triggered (see 4.1.1, p. 45).

For unmanned neutron detection a moderator must be used additionally. See Appendix E.4, p. 186 for details.




Figure 150: Recommended posture for neutron moderation




Figure 151: Dose rate display with neutron incidents

## 11.3 Locate a Radiation Source

If your survey of the environment indicates the presence of a radiation source, you can detect its position with the RADEAGLET-R's Detect Mode (see 3.3, p. 39).

This method acquires a spectrum of the background gamma radiation and then shows a chart and emits sound based on the fast comparison of the current radiatioon against the background.

This procedure is most useful with the RADEAGLET-R's speaker switched on. So we begin with checking the beeper setting.

→ **To locate a gamma radiation source**...

1. Ensure the Dose Rate screen is shown. If it isn't, press Exit until it is.
2. Open the Advanced menu.
3. Scroll down to **Basic Settings** and Select it.
4. Scroll down to **Feedback** and Select it (5.6, p. 58).
   Make sure the speaker is on (Fig. 152, p. 154).

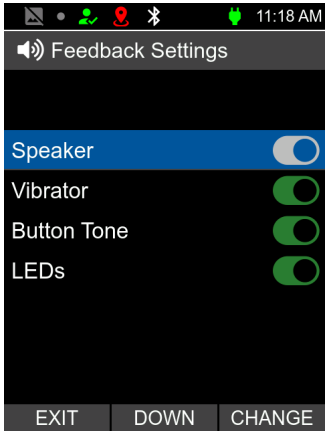



Figure 152: Checking the speaker switch

5. Ensure the Dose Rate screen is shown. If it isn't, press Exit until it is.
6. We recommend to move to a low-radiation position for the background measurement.
7. Press Detect.
   The RADEAGLET-R starts collecting background data (Fig. 153, p. 155).
8. When the background measurement is complete, move the instrument around.
   The display shows a bar chart representing the count rate history (Fig. 154, p. 155).

   The RADEAGLET-R beeps with higher frequency the closer the instrument is to the source. You can move around looking for the source without observing the display but listening to the beeps.

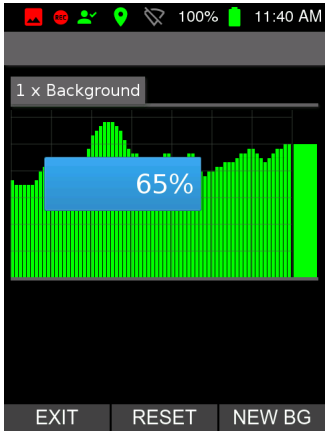



Figure 153: Collecting background data in Detect Mode with progress percentage.

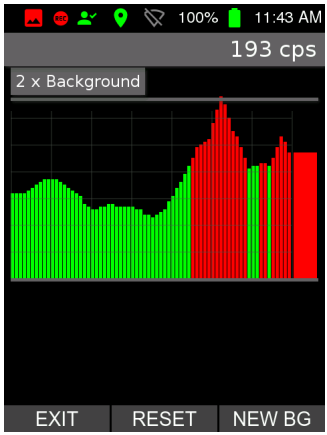



Figure 154: Detect mode chart when approaching a radiation source

## 11.4 Identify the Radiating Nuclide

Once you know about the position of a radioactive source, you can use your RADEAGLET-R's Easy ID mode (3.2, p. 37) to identify the nuclide causing the radiation. This procedure compares an acquired spectrum against information on known nuclides.

We start with the inspection of the nuclides the RADEAGLET-R knows and then continue with the identification procedure.

### 11.4.1 Nuclide Library

For the identification of nuclides the RADEAGLET-R refers to an internal collection of information about nuclides called the Nuclide Library. The library lists the name and some properties of all the nuclides the instrument knows about.

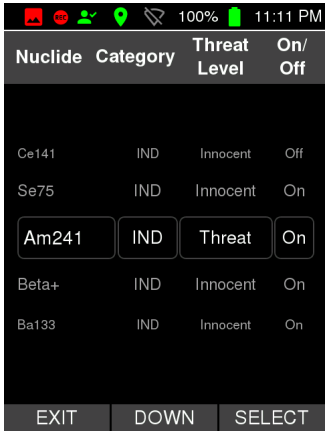



Figure 155: The nuclide library

Changeable properties are the nuclide's category, its threat level, and whether it should be considered at all by the identification algorithm (5.24, p. 82).

→ **To inspect the nuclide library**...

1. Ensure the Dose Rate screen is shown. If it isn't, press Exit until it is.
2. Open the Advanced menu.
3. Scroll down to Protected Settings and Select it.
4. Enter the 5-character password to access the protected settings, for details see 2.2.4, p. 28.
   The factory password is ◁ ▽ ▷ ◁ ▽.
5. Finish the password entry with Accept.
6. Scroll down to ID Settings and Select it.
7. Scroll down to Nuclide Library and Select it.
8. Browse the list (Fig. 155, p. 156) with Down or Up and watch the settings for the nuclides.
9. To finish your inspection scroll to the first listed nuclide $^{241}$Am (`Am-241`).
   The Down button changes to Exit and you can return to the superior menus.

### 11.4.2 Identification

The Easy ID procedure (3.2, p. 37) acquires a spectrum, compares it to the nuclide library and shows results.

➔ **To identify radionuclides**...

1. Ensure the Dose Rate screen is shown. If it isn't, press Exit until it is.
2. Switch to Easy ID mode.

   The RADEAGLET-R acquires a spectrum for a preset duration (see 5.23, p. 81). A chart with a colored bar (Fig. 156, p. 157) helps you to find the best distance between instrument and source.

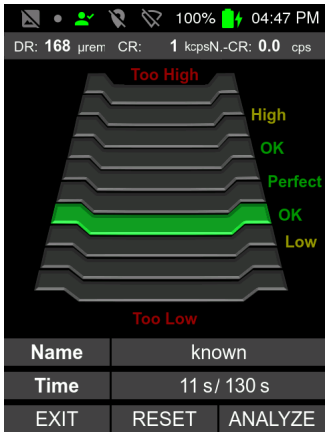



Figure 156: The Easy ID spectrum acquisition

3. If you need some time to find the best distance, press Reset to clear the spectrum recorded as yet and to restart the timer.
4. After the preset duration elapsed, the RADEAGLET-R analyzes the recorded spectrum and displays the result (Fig. 157, p. 158).

   The spectrum and the results are saved in the RADEAGLET-R's database under a name shown on the screen. It is composed of the current date and time (in ISO 8601 format) and an index number.

   If you want to have your position saved with the results of your survey, make sure GPS is switched on and receives enough satellite data. See chapter 5.13, p. 71 for details.

   This item is available for RADEAGLET-R models equipped with a GPS receiver (see E.1, p. 179).

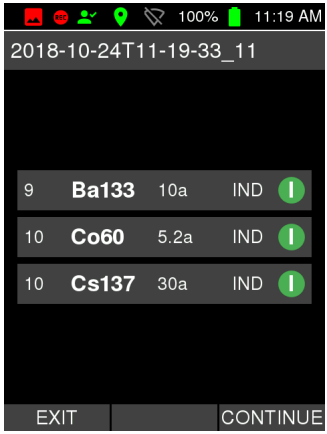



Figure 157: The Easy ID results

5. If the spectrum is insufficient for the identification of nuclides, a corresponding message is displayed. This could, for example, happen with a weak source or a too short acquisition duration. Press Continue to add the preset duration again and collect additional data for the spectrum. You can press Continue as often as needed.

6. If you are not satisfied with the confidence of the result, you can try to enhance it with Continue as described in the previous step.

## 11.5 Transfer Results

You can access measurement results and settings of your RADEAGLET-R with other devices such as computers or mobile phones. In this guide, we connect the RADEAGLET-R to a computer via cable. Various other methods are supported for the physical connection between the devices, see chapter 6.1, p. 95 for details.

→ **To connect the RADEAGLET-R to a computer**...

1. Start up the RADEAGLET-R and the computer.

2. Connect the USB connector of the RADEAGLET-R to a USB host connector of the computer with the included cable.

3. You can verify the connection on your computer, see 6.1, p. 95 for details.

   ⚠ Usually you don't need to install additional software on your computer. If in doubt, refer to section 6.1, p. 95.

### 11.5.1 Transfer to a Local Computer

You can use any reasonably modern Web browser on your computer to communicate with the RADEAGLET-R.

JavaScript is required for the RADEAGLET-R Web interface and must be supported by the browser.

→ **To acess the RADEAGLET-R from a computer**...

1. Ensure the Dose Rate screen is shown. If it isn't, press Exit until it is.
2. Open the Advanced menu.
3. Scroll down to **Basic Settings** and Select it.
4. Scroll down to **Connectivity** and Select it.
5. Scroll down to **USB** and Select it (5.11.1, p. 67).
6. The RADEAGLET-R shows information about the status of the Web interface and the IP address to connect to from your computer's Web browser (Fig. 158, p. 159).




Figure 158: USB cable connection information

7. Open the given IP address with the Web browser on your computer.

   Usually the IP address is always the same. You don't have to check it each time your connect the RADEAGLET-R to a computer. You might want to set a bookmark in your browser.

   You should see a page similar to Fig. 159, p. 160 with general information about the connected RADEAGLET-R.
8. Click ☰ at the top to reveal the menu of the web interface (Fig. 160, p. 160).
   Find a full description of all the options in chapter 7, p. 99.

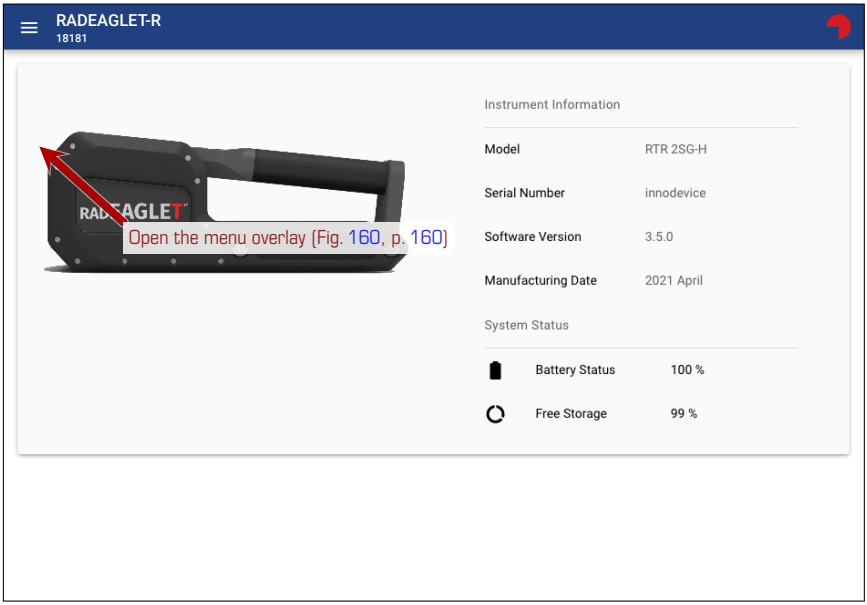



Figure 159: The device information in the Web interface

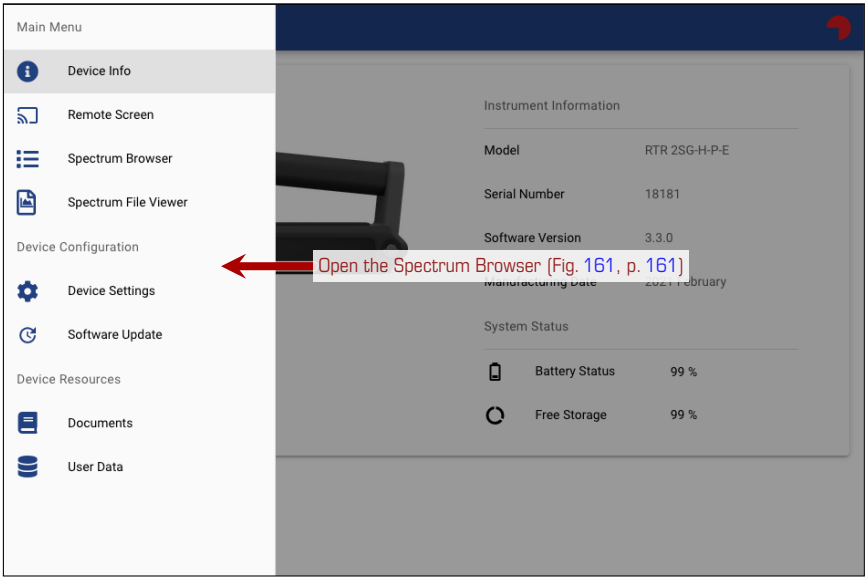



Figure 160: The menu of the Web interface

→ **To inspect data saved on your RADEAGLET-R...**

1. Get a list of saved spectra by clicking "Spectrum Browser" in the menu (Fig. 160, p. 160).
2. Look for the spectrum you saved after the identification in section 11.4.2, p. 157 above (Fig. 157, p. 158).

   Change the sequence of the listed spectra by clicking the column title (Fig. 161, p. 161). Multiple clicks on the same column toggle between ascending and descending order.

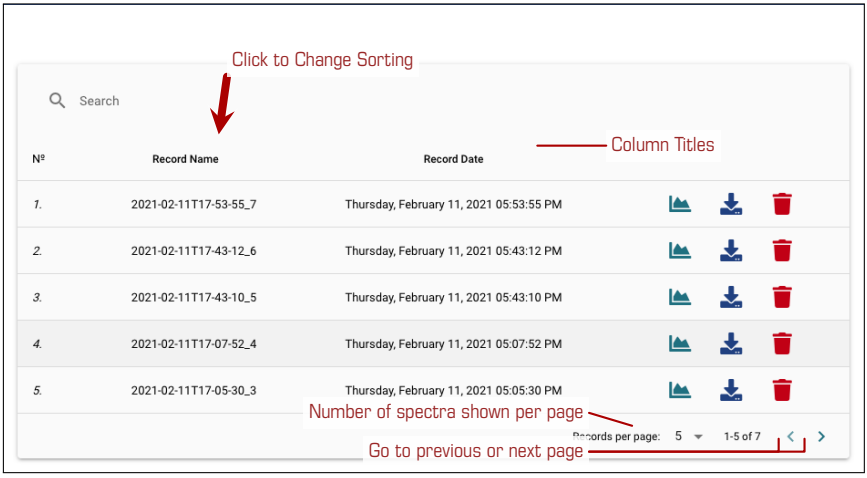



Figure 161: The spectrum browser in the Web interface

3. Click ⬇ to download the spectrum to your computer.

   What happens now depends on your Web browser and its settings. Often, the file will be saved in the standard "Downloads" folder of your computer.

   The spectrum is downloaded as a standard `*.zip` archive containing the data in both `*.spe` and `*.n42` format suitable for further analysis by many pertinent software programs.

   Refer to chapter 7.3, p. 100 to learn about the other features of the Spectrum Browser.
   Chapter 7.10, p. 123 explains how to downlaod all stored spectra in one go.

## 11.6 Turn off the RADEAGLET-R

After you finished all your measurements and data transfers, you should shut down the RADEAGLET-R.

→ **To switch off the radEAGLET-R...**

1. Ensure the Dose Rate screen is shown. If it isn't, press Exit until it is.
2. Open the Advanced menu.
3. Scroll down to **Shutdown** and Select it.

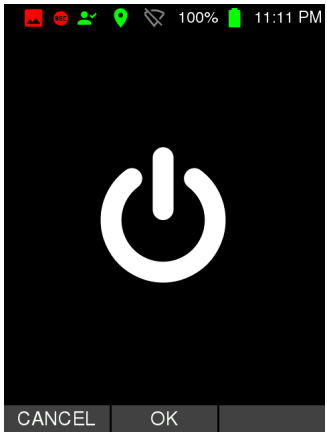



Figure 162: Shutting down the radEAGLET-R

4. Press to confirm the command (Fig. 162, p. 162).

Store your radEAGLET-R in its case (Fig. 3, p. 19) while not in use.

# A Nuclide Library

The following nuclides are included in the RADEAGLET-R standard library. Depending on the equipment of your RADEAGLET-R and custom orders, the actual library in the instrument can exceed this list significantly.

| Nuclide | Usage, Severity, Half Life | Description |
|---|---|---|
| $^{241}$Am<br>Am241 | SNM<br>Threat<br>432 a | Americium has several isotopes and $^{241}$Am is a radioactive isotope. It is a typical companion found in various plutonium nuclide compositions and therefore it is regarded as threat. This nuclide can also be found in components of smoke detectors, where a small americium source acts as an ionizer. |
| $^{18}$F, $^{14}$O, $^{15}$O, $^{11}$C, $^{13}$N, $^{26}$Al, $^{22}$Na, $^{121}$I, *others*, + | IND, (MED)<br>Innocent | Several nuclides emit + particles. These particles may recombine with negative particles in the detector material, typically depositing a photo energy of 511 keV. Some of these isotopes are used for positron emission tomography (PET).<br>The RADEAGLET-R displays the identification result + when confronted with such a source because all sources share the 511 keV line and cannot be differentiated further (except $^{22}$Na). |
| $^{110m}$Ag<br>Ag110m | IND<br>Innocent<br>250 d | Isotope of the chemical element silver. It has industrial applications and may be found in scrap metals. |
| $^{133}$Ba<br>Ba133 | IND<br>Innocent<br>10.75 a | Barium is used in some industrial applications and may be used as test source. It has peaks relatively close to $^{239}$Pu. |
| $^{207}$Bi<br>Bi207 | MED<br>Innocent<br>32.9 a | Isotope that is a follow-up from the alpha decay of $^{211}$At. Sometimes found in medical applications, but mostly used in industrial context. |

*to be continued...*

*... continuation*

| Nuclide | Usage, Severity, Half Life | Description |
|---|---|---|
| $^{109}$Cd<br>Cd109 | IND<br>Innocent<br>463 d | Cadmium is an industrially used radiation source. |
| $^{57}$Co<br>Co57 | IND (MED)<br>Innocent<br>272 d | This isotope of cobalt is often found in medical applications to estimate the size of organs. In industry, it is used as low energy emitter. |
| $^{60}$Co<br>Co60 | IND<br>Innocent<br>5.3 a | A high energy emitting isotope that can be used for transmission or absorptions spectroscopy. Its industrial applications include sterilization of surgical equipment and food. Depending on end user conops, $^{60}$Co may be considered a threat. |
| $^{51}$Cr<br>Cr51 | IND<br>Innocent<br>27 d | Short living industrial source. Sometimes encountered in medical research on blood cells. |
| $^{134}$Cs<br>Cs134 | IND<br>Innocent<br>2 a | The cesium isotopes are fission products of nuclear reactors and are often encountered in fall-out following nuclear power plant accidents (Chernobyl, Fukushima). This specific nuclide is sometimes also used for leak detection. |
| $^{137}$Cs<br>Cs137 | IND<br>Innocent<br>30 a | Cesium $^{137}$Cs is perhaps the most prominent nuclide because it is used as a calibration or test source throughout the world. Like $^{134}$Cs, it is a direct fission product of nuclear reactors and, therefore, is also seen after a nuclear plant accident (fall-out) or a nuclear detonation. Depending on end user conops, $^{137}$Cs may be considered a threat |
| $^{152}$Eu<br>Eu152 | IND<br>Innocent<br>13.5 a | Europium $^{152}$Eu is a source with many photo peaks. In the past, this isotope was used within the control system of nuclear power plants. The multitude of peaks makes europium an ideal candidate for calibrations and specific spectroscopic experiments. |

*to be continued...*

... continuation

| Nuclide | Usage, Severity, Half Life | Description |
|---|---|---|
| $^{68}$Ga<br>Ga68 | MED<br>Innocent<br>68 m | Gallium is used in nuclear medicine as a generator of radio-pharmaceutical isotopes for positron emission tomography (PET) scanners. |
| $^{123}$I<br>I123 | MED<br>Innocent<br>13 h | Iodine isotopes are frequently applied in nuclear medicine. This specific isotope is used for diagnostics regarding thyroid functionality. |
| $^{125}$I<br>I125 | MED<br>Innocent<br>60 d | Medical isotope for diagnostics on hormone levels and cancer treatment. |
| $^{131}$I<br>I131 | MED<br>Innocent<br>8 d | Iodine $^{131}$I is widely used for thyroid diagnostics and treatment as well as kidney and liver studies. It is a fission fragment in nuclear reactors and may be expected after a reactor accident. |
| $^{111}$In<br>In111 | MED<br>Innocent<br>2.9 d | Indium is used for research on brain cells and for infection rate analysis. |
| $^{192}$Ir<br>Ir192<br>Ir192s | IND, (MED)<br>Innocent<br>74 d | Iridium $^{192}$Ir is used in different applications. It is a source for cancer treatment and it is also used for inspections of pipelines (to investigate the quality of their welding). Sometimes, the weld can have small fractures, posing a threat that the pipeline could leak. $^{192}$Ir sources are also used to detect such fractures and to perform thickness measurements. The radEAGLET-R has two possible indications for iridium, $^{192}$Ir and $^{192s}$Ir, the latter referring to shielded sources because safe industrial usage requires very heavy shielding, often using depleted uranium as a shield. |

to be continued...

*... continuation*

| Nuclide | Usage, Severity, Half Life | Description |
|---|---|---|
| $^{40}$K<br>K40 | NORM<br>Innocent<br>1.28 Ga | Potassium $^{40}$K is part of the naturally occurring radiation materials (NORM), yielding a very clear photo peak at 1460keV. This peak is commonly used for calibration without additional calibration sources.<br>The identification result K40 will appear when analyzing radiation of ceramics, tiles and fertilizer. You may also denote its presence when running a long-term acquisition with your radEAGLET-R. An identification result for this source is always possible and it is absolutely safe. |
| $^{54}$Mn<br>Mn54 | IND<br>Innocent<br>312 d | The amount of manganese in waste water can be estimated by analyzing this isotope. Therefore, it is a reliable predictor for heavy metal pollution in the water of mining activities. |
| $^{99}$Mo<br>Mo99 | IND<br>Innocent<br>2.8 d | Generator for technetium $^{99m}$Tc. |
| $^{22}$Na<br>Na22 | IND<br>Innocent<br>2.6 a | $^{22}$Na features a high energetic line beneath its + emission and is well-suited to investigate pipeline leakage or welding quality.<br>Some further applications are found in medicine.<br>The identification result for this isotope will display Na22 and additionally +Na22 because the + emission is a natural part of the isotopes radiation profile. |
| $^{237}$Np<br>Np237 | SNM<br>Threat<br>2.14 Ma | Neptunium is used to produce $^{238}$Pu. It is considered to be a major SNM threat, as are uranium and plutonium. |

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... continuation

| Nuclide | Usage, Severity, Half Life | Description |
|---|---|---|
| $^{239}$Pu WGPu, WGPu_HS, RGPu, RGPu_HS | SNM Threat 6560 a | Plutonium is a severely dangerous material. It is extremely poisonous and poses a deadly risk for humans. The radEAGLET-R distinguishes four mixtures of $^{239}$Pu with $^{240}$Pu. The abbreviation RGPu stands for reactor-grade plutonium (yielding a higher amount of $^{240}$Pu in the composition). Weapons-grade plutonium (WGPu) has a higher amount of $^{239}$Pu and a lower amount of $^{240}$Pu. The denotion "HS" marks a source with heavy shielding where only few or none of the lower energy gammas of plutonium may be found in the spectrum. It is common for both reactor-grade or weapon-grade plutonium to be accompanied by an ID of $^{241}$Am. |
| $^{226}$Ra Ra226 | NORM Innocent 1600 a | Radium is a specific stage in the decay of uranium which naturally occurs in the earth's shell. When it decays down, it becomes $^{226}$Ra. Radium is one of the most frequently encountered radiation signatures and is considered naturally occurring radiation. Tiles and rocks are very likely to receive radium identification results. Also, sources denoted as uranium ore are typically identified as $^{226}$Ra sources. |
| $^{99m}$Tc Tc99m | MED Innocent 6 h | Widely used and frequently applied medical radiation substance. Used for imaging of the heart, liver and kidneys. |
| $^{201}$Tl Tl201 | MED Innocent 3 d | Used for diagnosing arterial diseases and problems associated with blood flow. |
| $^{232}$Th Th232 | NORM Innocent 14.05 Ga | A naturally occurring material found in rocks. It is used in lantern mantles and welding rods. |
| $^{232}$U U232 | SNM Threat 69 a | |

to be continued...

*... continuation*

| Nuclide | Usage, Severity, Half Life | Description |
|---|---|---|
| $^{233}$U<br>U233 | SNM<br>Threat<br>160 ka | This is a fissile isotope of Uranium that was formerly used in nuclear weapons. Today this uranium isotope is used primarily in nuclear reactors. It is still considered a threat material. |
| $^{235}$U<br>U235 | SNM<br>Threat<br>704 Ma | $^{235}$U is a very important isotope of uranium used in commercial nuclear power reactors. Uranium used in reactors is typically 3-5% enriched (the $^{235}$U content). Low Enriched Uranium has <20% $^{235}$U content. Highly Enriched Uranium (>20% and sometimes as high as 90% or more) can be used in nuclear weapons and is an important threat material to detect. |
| $^{238}$U<br>U238 | SNM<br>Threat<br>4.468 Ga | $^{238}$U is the primary constituent of natural uranium (about 99.3%). Depleted uranium has an even higher $^{238}$U content. It is a threat because it may be used in nuclear weapons. |
| Unknown | —<br>Threat | The radEAGLET-R can have a nuclide is unknown. This will appear when a) a nuclide is found that is deactivated in the current library of the instrument or b) whenever a source is measured whose spectrum does not match any of the references. Unknown sources are considered to be a threat. |
| Neutron Source | SNM<br>Threat | A neutron source is identified whenever the neutron detector detects the presence of neutrons. Neutron sources are very dangerous and should be treated with extreme care. |

# B Glossary

The glossary contains key technical terms used throughout this manual.

**Background** The term background refers to the ambient radiation present around the instrument. The background includes →Natural background and mixtures of perturbation sources surrounding the measurement site. Situations may arise, where the reduction of perturbation sources cannot be optimal, e.g. in laboratories operating with radiation sources.

**Centroid** Center of a peak. The centroid is used to measure peak position. Its numerical value is often generated by a peak fit routine. In the RADEAGLET-R, a peak fit is performed in the calibration screens, presenting you the centroid and resolution of the peak.

**Full-width-at-half-maximum (FWHM)** There are two points of the peak which have a height that equals half the height of the centroid position. One point on the left, another one right of the centroid. The distance between the energies of these two points is called the full-width-at-half-maximum abbreviated as FWHM. The FWHM divided by the centroid energy leads to the resolution.

**Geiger-Müller Detector (GM)** Secondary detector onboard the RADEAGLET-R. The GM detector consists of a pressurized tube filled with a radiation sensitive gas. Various gases can be used here, typically inert gases such as helium, argon, neon or xenon. Often these are mixed with an organic vapor or a halogen gas. GM tubes detect radiation utilizing an anode-cathode pair inside this gas. The cathode is the tube housing while the anode is a small wire in the center of the chamber. Radiation ionizes the atoms of the gas initiating a charge avalanche which drives a current towards the anode which generates a count. The number of counts is proportional to the strength of the radiation. GM detectors are non-spectroscopic.

**Natural Background** Natural background is the radiation around the instrument caused by natural processes. First, there are particles and photons coming from space, including the radiation of sun and cosmic rays. This type of natural background is called the cosmic background. There are certain materials in the earth land masses that are radioactive, such as uranium, thorium or potassium. This material is called naturally occurring radioactive material or NORM).

**Naturally Occurring Material (NORM)** Naturally occurring materials are, e.g., potassium $^{40}$K, thorium $^{232}$Th and uranium ore, which by now has arrived in its radium ground state and consequently is reflected by a radium $^{226}$Ra spectrum. NORM constitutes the terrestrial background radiation.

**Neutron detector** ✳ This item is available for radEAGLET-R models with a neutron detector (see E.1, p. 179).

Several neutron detector designs exist. The $^{3}$He-tube is the most efficient detector for its size. It is similar in size to the Geiger-Müller tube, but it utilizes $^{3}$He gas that is in limited supply. Due to this limited supply, the gas prices have risen and it became much more expensive in the past years.

**Scintillation detector** The primary detector for radiation used by the radEAGLET-R is the scintillation detector. The scintillation detector consists of a crystal coupled to a photomultiplier. Once radiation passes through the scintillation crystal, atoms of the crystal material become excited to higher energetic levels. Once they fall back onto lower energy levels, they emit light. This light is very weak and a source of light amplification is needed to see it. A photomultiplier is such an amplifier and it allows us to observe the light emitted inside the crystal. Additionally, the light also tells us which energy the incident radiation had. Analyzing the photopeak energies of the peaks in the spectrum with the radEAGLET-R's advanced algorithms provides the list of radionuclides measured.

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# C Technological Background, Limitations

## C.1 Stabilization

The primary spectroscopic detector of radEAGLET-R is the scintillation crystal. This crystal produces light pulses whenever gamma photons interact with the crystal material. The light pulses are very weak so they must be amplified. Therefore, the crystal requires a photo-multiplier tube (PMT) which is coupled to the crystal. This assembly allows the incident gamma photons to be digitized by the internal electronics, and the pulses (which are proportional to the energy of the incident gamma rays) form a histogram or gamma spectrum. This spectrum is stored in the embedded multi-channel analyzer.

The response of both the detector and the PMT may vary based on measurement conditions such as temperature or magnetic field. The peaks in the gamma radiation spectrum may shift due to these temperature variations. As temperature changes are encountered, modern scintillation based instruments must apply some means of stabilization. Shown below is the procedure the radEAGLET-R uses to correct for peak shifts and to adjust the peaks in the spectrum to their scientifically correct positions.

### C.1.1 Initial Stabilization

Each time the system is turned on, during the start-up the radEAGLET-R performs an initial stabilization. It runs temperature checks and searches for known peaks in the spectrum. It is strongly advised not to have check sources in the immediate area during this initial phase, because this can confuse the process.

### C.1.2 Continuous Temperature Monitoring

During the manufacturing process, each radEAGLET-R is tested in a climate chamber to learn the individual temperature dependencies of crystal and PMT. Both the absolute value of the temperature as well as the temperature gradients are used in this process. In the field, the instrument continuously monitors and adjusts the gain by measuring the temperature. It also distinguishes between slow temperature drifts and quick temperature shocks.

### C.1.3 Continuous Spectroscopic Adjustments

Although there is not always an actual source present, the natural background spectrum often contains valuable information. The radEAGLET-R uses the natural background peaks for an advanced stage of self-stabilization. When turned on, the radEAGLET-R is automatically taking background spectra and analyzing them. All this happens automatically in the

instrument, and is completely transparent to the user. Once the radEAGLET-R finds known radiation patterns and is sufficiently confident about the analysis result, it uses this information to make an automatic calibration adjustments. In many cases, the most prominent peak to do this is 1460 keV associated with natural potassium $^{40}$K. In addition to $^{40}$K, there are other peaks (natural and/or non-natural) used by this instrument to create a superior stabilization process.

## C.2 Calibration

The calibration has a tremendous impact on the measurement quality of the instrument. It determines the precision of the current calibration by locating the peak at the correct position. The radEAGLET-R has a dedicated screen to visually inspect the calibration quality when performing a calibration, see 5.21, p. 78.

The value for the resolution is generated by dividing the FWHM by the measured centroid energy.

### C.2.1 Checking the Calibration

The procedure for a visual inspection of the calibration when using a $^{137}$Cs calibration source:

1. Place a cesium $^{137}$Cs sample[1] in front of the detector.
2. Wait until a reliable fit of the peak is established. This can take several seconds. You can identify a good fit when the calculated values show up.
3. The difference between the target value E=661.6 keV of $^{137}$Cs and the calculated centroid is the calibration error.

The radEAGLET-R is a stabilized instrument and it is not expected that the peak positions will drift much. Sometimes a recalibration is still needed because environmental circumstances might be unfavorable for the background stabilization.

If you experience unusually high values in the resolution and/or a double peak phenomenon from a single peak source, this could indicate a small crack inside the NaI detector crystal. Please contact our service.

### C.2.2 Re-Calibrating Using the Calibration Mode

Begin with the visual inspection of the calibration state as explained above. If you experience a deviation between the target peak position and the actual position, you can perform a manual recalibration.

[1] Cesium $^{137}$Cs has a photo peak at the energy E=661.6 keV. It is a popular radionuclide for calibration purposes. It is available as a sealed button source (check source) from radionuclide suppliers.

After entering the calibration screen, it takes some time until the peak fit is established. The shown percentage value represents the progress of acquiring the minimum counts to establish the measured peak position. This depends on the strength of the calibration source you are using. Once the peak fit quality is sufficient and enough counts are contained in the spectrum, the Calibration button becomes active. You can press it to perform the manual recalibration and to definitively update the internal gain.

After recalibration, the calibration check acquisition is reset and you will get an updated view of the peak fit. You can now again inspect the results of the recalibration.

## C.3 Effective Range of Measurement

Detection and identification depend on the dose rate on the detector surface. This value can be defined by either varying the distance of the source and detector or by simply using stronger or weaker sources.

## C.4 Determination of the Full Width at Half Maximum

radEAGLET-R detectors have a specified FWHM, sometimes also denoted as resolution given in percentages relative to their peak position. Our usual reference is the $^{137}$Cs peak at 661.6 keV. It is the common peak to specify a resolution. The procedure used to determine this value is given as follows:

1. Acquire a background spectrum.
2. Acquire a $^{137}$Cs spectrum with at least 1 µSv/h at the detector surface.
3. Use a qualified background subtraction method to subtract the background from the cesium spectrum.
4. Perform a Gaussian fit on the peak data (using e.g. Matlab).
5. Locate both positions where the Gaussian curve reaches the half of its maximum.
6. Calculate the difference in terms of energy. The latter is the FWHM.

For sodium iodide based instruments, we specifiy a resolution better than 7.2 % at 661.65 keV which corresponds to a FWHM of 47.6 keV.

## C.5 Dose Rate Precision for the Geiger-Müller Counter

The integration time of the Geiger-Müller counter can take up to 30 seconds. Please keep that in mind, when referring to the dose rate.

The letters 'GM' are displayed on the screen in Dose Rate mode, when the GM tube is currently providing the shown Dose Rate.

## C.6 Over-Range Characteristics for the Scintillator and the Nuclide Identification

Nuclide identification results depend on the quality of the spectrum. For extremely high count rates, the scintillation spectrum degrades and for dose rates greater than 200 µSv/h at the detector surface, the radEAGLET-R switches off the scintillation subsystem and uses the fall-back GM tube for dose rate measurements.

A nuclide identification is possible in radiation fields up to 200 µSv/h. Though, a valid and precise ID is only given if the limits of the EASY-MODE ID are adhered to. Here, the instrument will clearly indicate, whether an over-range situation exists or not.

## C.7 Live, Real and Dead Times

The Multi-Channel Analyzer (MCA) component of radEAGLET-R is an advanced electronics component that deploys sophisticated signal processing algorithms for signal interpretation. The MCA and electronics have a short dead-time after each pulse where no signal will be seen. This is because the electronics cannot accept a new pulse to be processed while it is already processing a pulse. The higher the incident count rate, the higher the dead time. The dead-time accumulates with the measurement time and is dependent on the detector load in terms of counts per second (cps). Consequently, two acquisition times may be displayed: the real-time, which is the true time duration of the acquisition and the live-time, which is the acquisition time corrected by the above defined dead-time. The live time will always be shorter than or equalt to the real time.

## C.8 Scaling of the Vertical Spectrum Axis

Scintillation detectors have a certain energy-dependent sensitivity. Peaks at low energies (e.g. 59 keV of $^{241}$Am) have a higher sensitivity than peaks at the higher end of the spectrum (e.g. 1332 keV of $^{60}$Co). When observing this type of spectra and the y-axis has a linear scale, some peaks at higher energies might not be visible. To see a better display of the higher energy peaks, you might want to look at the spectrum either using a logarithmic scale or a square root scale for the y-axis. These different scales allow the user to visually equalize the peak heights so that a wide range of the spectra can be viewed without zooming.

# D Troubleshooting

The radEAGLET-R was developed using state-of-the-art quality standards for the system architecture and the stability of all components. Nevertheless, it may not be free of mistakes and there might exist situations that were not covered by our quality testing.

## D.1 The Stabilization Icon is Red

The stabilization icon turns red when the continuous stabilization fails. This does not necessarily mean the instrument is out of calibration, it simply means something is causing the routine stabilization from occurring properly.

Liklely causes are:

**Other radioactive sources in the vicinity of the instrument**

The best course of action is to remove any other sources from the room and perform a new stabilization by rebooting the system as described in section 2.3, p. 31.

Radioactive sources should not be used or stored near the instrument.

**Rapid change in temperature of the instrument**

The best course of action is to perform a new stabilization by rebooting the instrument (see 2.3, p. 31). After the instrument reboots, you should perform the Easy Calibration (see 5.14, p. 72) using a $^{137}$Cs source. This process typically takes less than a minute and ensures the instrument generates excellent identifications.

## D.2 Checking the Proper Function of the System

To ensure your radEAGLET-R is working properly, we will supply a short checklist for successful operation.

1. Check the status of the battery failure LED
   a) After some time, the booting screen of the radEAGLET-R should appear.
      - If the screen does not appear, check if the display has backlight. If not, there might be a problem with the battery. Power the instrument with external power and check whether the problem persists.
      - If the instrument boots with power cable connected, check the status of the battery switch in the rear battery chamber of the instrument.

   b) Is the orange battery fault LED on?
      - If yes, there might be charging problem or some other problem with the batteries. If it is running, turn off the instrument, and try charging the batteries.

2. System boot-up and welcome screen
    a) Self-checking routines run in the background of the boot process. If a self-check fails, a corresponding error message will appear on the device and give you further advice.
    b) Once started, the system should welcome you in dose rate mode. If no source is around, the ambient dose rate is expected to be between 0.01 µSv/h and 0.08 µSv/h.
    c) The count rate in cps should be greater than 0. There are always natural radiation counts.
    d) If you have a neutron detector, the neutron cps should be close to 0.00 cps. Sometimes values of about 0.05 might occur. If you observe a neutron count rate of 0.5 cps or greater, it is likely that a neutron source is nearby.
    e) If the battery was charged, the battery status bar should indicate fully charged status
    f) If the bar shows a low battery, this might point towards a problem with the batteries. Try charging the battery again.
3. Specific checks in spectrum mode
    a) Enter spectrum mode. Without a source, start a spectrum acquisition and observe the area around 1460 keV. After a few minutes, the natural potassium peak should appear at 1460 keV. You can use this peak to verify the correct positioning of the instrument even if no cesium calibration source is available. After fresh startup, the instrument should have at least a precision of around ±0.5 % of the line energy or a maximum deviation of ±7 keV around the 1460 keV line.
    b) After calibration, the instrument should have the potassium 1460 keV line well within ±0.25 (between 1457 keV and 1463 keV).
    c) Using an external cesium calibration source: Place the source in front of the detector at a minimum distance of 10 cm. Enter calibration check and wait for the threshold sum of the peak counts to be collected. The system will then show you the report of the peak properties. The resolution should not be greater than 7.3 %. The peak position deviation should not be greater than 0.5 % after startup, corresponding to a shift of ±3.3 keV around the target value of 661.6 keV.
    d) If the peak position deviates, press Cal to calibrate the instrument. Repeat the acquisition of the cesium reference in calibration mode and wait until new values for the peak assessment appear. The peak should be positioned well within 0.2 %, ±1.7 keV of the target peak position of 661.6 keV.
4. The Self Test (5.28, p. 87)
    a) Enter the self test and let it run.

b) Look at the results and prove if everything is okay.

c) If the calibration test shows a '?', recalibrate the instrument.

d) If any of the high voltages are out of range, the instrument needs to be send for repair.

e) If the MCA connection is bad, or the GM and neutron board connection is bad, that applies as well.

f) If the values for the battery are off, the battery might need replacement.

# E Info Pool

## E.1 radEAGLET-R: Specifications

Several models of this product are available.

(A) **radEAGLET-R 2SG**

Sodium iodide detector (NaI); Geiger-Müller tube

(B) **radEAGLET-R 2SG-E**

Sodium iodide detector (NaI); Geiger-Müller tube; embedded 111 Bq (3 nCi) $^{137}$Cs source

(C) **radEAGLET-R 2SG-N**

Sodium iodide detector (NaI); Geiger-Müller tube; neutron detector

(D) **radEAGLET-R 2SG-N-E**

Sodium iodide detector (NaI); Geiger-Müller tube; neutron detector; embedded 111 Bq (3 nCi) $^{137}$Cs source

(E) **radEAGLET-R 2SG-P**

Sodium iodide detector (NaI); Geiger-Müller tube; GPS receiver

(F) **radEAGLET-R 2SG-P-E**

Sodium iodide detector (NaI); Geiger-Müller tube; GPS receiver; embedded 111 Bq (3 nCi) $^{137}$Cs source

(G) **radEAGLET-R 2SG-N-P**

Sodium iodide detector (NaI); Geiger-Müller tube; neutron detector; GPS receiver

(H) **radEAGLET-R 2SG-N-P-E**

Sodium iodide detector (NaI); Geiger-Müller tube; neutron detector; GPS receiver; embedded 111 Bq (3 nCi) $^{137}$Cs source

Specifications relevant for certain models only are labeled with the model.

| | **Detectors** | |
|---|---|---|
| 1 | Gamma: NaI | Crystal size (Ø × L): 50.8 mm (2.00 in) × 25.4 mm (1.00 in) |
| 2 | Gamma (High Dose Rate) | Geiger-Müller detector |
| 3 | Neutrons: $^{3}$He Proportional Counter Tube (C) (D) (G) (H) | Size (Ø × L): 12.7 mm (0.50 in) × 52 mm (4.49 in); net: 9.4 mm (0.37 in) × 50 mm (3.94 in); 8 bar (116.03 psi) |

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| | | | |
|---|---|---|---|
| 4 | Neutrons: $Li_6ZnS$ | C D G H | Alternative to $^3$He tube |
| 5 | GPS | E—H | 66-channel MediaTek MT3339 receiver |
| | **Calibration** | | |
| 6 | External Source | A C E G | $^{40}$K; Startup time: 165 s |
| 7 | Embedded Source | B D F H | $^{137}$Cs; 111 Bq (3 nCi); Startup time: 115 s |
| | **Performance** | | |
| 8 | Energy Range | | Scintillator; 15 keV — 3 MeV |
| 9 | Energy Range | | Geiger-Müller detector; 45 keV — 1.5 MeV |
| 10 | Sensitivity ($^{137}$Cs): NaI | | >1500 cps per µSv/h |
| 11 | Gamma Spectrum | | 2048 channels |
| 12 | Dose Rate Range | | Total; 10 nSv/h — 1 Sv/h |
| 13 | Dose Rate Range: NaI | | Scintillator; 10 nSv/h — 450 µSv/h |
| 13a | Dose Rate Range: LaBr3 | | Scintillator; 10 nSv/h — 1 mSv/h |
| 14 | Dose Rate Range | | Geiger-Müller detector; >250 µSv/h — 1 Sv/h |
| 15 | Overload Threshold | | ≥1 Sv/h |
| 16 | Dose Rate Accuracy | | Scintillator; ±10 % ($^{137}$Cs, 662 keV); ±10 % ($^{241}$Am, 59 keV); ±10 % ($^{60}$Co, 1172 keV, 1332 keV) |
| 17 | Dose Rate Accuracy | | Geiger-Müller detector; ±30 % ($^{137}$Cs, 662 keV) |
| 18 | Thermal Neutron Sensitivity | C D G H | 1.6 cps/nv ±10 %; unmoderated; according to manufacturer's data |
| 19 | Nuclide Library | | $^{228}$Ac; $^{241}$Am; $^{133}$Ba; $^{140}$Ba; Beta+; $^{207}$Bi; $^{109}$Cd; $^{115}$Cd; $^{115m}$Cd; $^{141}$Ce; $^{57}$Co; $^{60}$Co; $^{51}$Cr; $^{134}$Cs; $^{137}$Cs; $^{152}$Eu; $^{155}$Eu; $^{67}$Ga; $^{68}$Ga; $^{123}$I; $^{125}$I; $^{131}$I; $^{132}$I; $^{111}$In; $^{192}$Ir; $^{40}$K; $^{140}$La; $^{176}$Lu; $^{54}$Mn; $^{99}$Mo; $^{22}$Na; $^{95}$Nb; $^{147}$Nd; Neutrons; $^{237}$Np; $^{144}$Pr; $^{238}$Pu; RGPu; RGPu-HS; WGPu; WGPu-HS; $^{226}$Ra; $^{103}$Ru; $^{125}$Sb; $^{75}$Se; $^{90}$Sr; $^{99m}$Tc; $^{132}$Te; $^{232}$Th; $^{201}$Tl; $^{232}$U; $^{233}$U; $^{235}$U; $^{238}$U; $^{131m}$Xe; $^{133}$Xe; $^{133m}$Xe; $^{135}$Xe; $^{95}$Zr |
| 20 | Nuclide Library | C D G H | $^{252}$Cf |
| | **Physical Properties** | | |
| 21 | Dimensions (W × D × H) | | 90 mm (3.54 in) × 280 mm (11.02 in) × 110 mm (4.33 in) |

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| | | | |
|---|---|---|---|
| 22 | Housing Material | | Powderpainted; Aluminum; fiber-reinforced plastic; polyoxymethylene; glass |
| 23 | Weight | A B | 1455 g (3.21 lb) including batteries |
| 24 | Weight | C D | 1505 g (3.32 lb) including batteries |
| 25 | Weight | E F | 1465 g (3.22 lb) including batteries |
| 26 | Weight | G H | 1515 g (3.34 lb) including batteries |
| | **Environmental** | | |
| 27 | Operation | | -20 °C — +55 °C (-4 °F — +131 °F); |
| 28 | Storage, Transport | | Recommended; +10 °C — +35 °C (+50 °F — +95 °F); |
| 29 | Storage, Transport | | -20 °C — +50 °C (-4 °F — +122 °F); |
| 30 | Temperature Change | | Sudden temperature change must not exceed 40.0 °C (72.0 °F) in order to avoid damage to the detector crystal. |
| 31 | Relative Humidity | | 10 % — 90 %, non condensing |
| 32 | Protection Rating | | IP65 according to IEC 60529 |
| 33 | Explosive Atmospheres | | NOT certified for use in explosive environments |
| | **Battery** | | |
| 34 | Type | | powerCELL; rechargeable; exchangeable; Li-Ion; LSD NiMH by request |
| 35 | Li-Ion: Capacity | | >3350 mAh; 7.2 V |
| 36 | Li-Ion: Operating Duration | | ≥12 h at 20 °C (68 °F) in dose rate mode with dimmed display back light and GPS switched off |
| 37 | Li-Ion: Operating Duration | | ≥7 h at -20 °C (-4 °F) in dose rate mode with dimmed display back light and GPS switched off |
| 38 | Li-Ion: Charging Duration | | 5 h at 20 °C (68 °F) when instrument off |
| 39 | Li-Ion: Storage | | Please recharge every 12 months |
| 40 | NiMH: Capacity | | >2700 mAh; 7.2 V |
| 41 | NiMH: Operating Duration | | ≥8.5 h at 20 °C (68 °F) in dose rate mode with dimmed display back light and GPS switched off |
| 42 | NiMH: Operating Duration | | ≥6 h at -20 °C (-4 °F) in dose rate mode with dimmed display back light and GPS switched off |
| 43 | NiMH: Charging Duration | | 5 h at 20 °C (68 °F) when instrument off |

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| | | | |
|---|---|---|---|
| 44 | NiMH: Storage | | Please recharge every 6 months |
| | **Display** | | |
| 45 | Type | | Transflective color TFT LCD |
| 46 | Size | | 3.5 in (88.9 mm); 480 pixel × 640 pixel |
| 47 | Central Luminance | | 250 cd/m² (typical) |
| | **Annunciators** | | |
| 48 | Red LED | | Gamma warning and alarm reporting; startup indication |
| 49 | Blue LED | (C) (D) (G) (H) | Neutron detection; alarm reporting; startup indication |
| 50 | Green LED | | Battery charging |
| 51 | Amber LED | | Battery temperature failure |
| 52 | Vibrator | | Warning and alarm reporting |
| 53 | Speaker | | Warning and alarm reporting (2000 Hz); battery alerts (4000 Hz); keyboard feedback (3400 Hz) |
| | **Memory** | | |
| 54 | Micro SD Card | | 16 GB; 12 GB available for the user |
| | **Input, Output** | | |
| 55 | USB | | USB 2.0; magnetic USB — USB-A; cable included; 1 m (3.28 ft) |
| 56 | USB Host | | USB 2.0; USB-A socket; Wi-Fi adaptor included; LAN (RJ-45) adaptor optional; Bluetooth adaptor optional |
| 57 | External Power | | LEMO Series K socket with bung |
| | **Software** | | |
| 58 | Embedded Software | | Linux Operating System |
| 59 | Web Interface | | Via USB cable connection; Via optional USB communication adaptors; Wi-Fi (included); Bluetooth; LAN (RJ-45) |
| 60 | Reachback and E-Mail Dispatch | | Via optional USB communication adaptors; Wi-Fi (included); Bluetooth; LAN (RJ-45); requires Internet connection |
| 61 | Download File Formats | | ANSI N42.42 (xml) and spe files compatible with third-party analysis software |
| | **Accessories** | | |
| 62 | Lanyard | | 27 cm (10.63 in) — 47 cm (18.50 in); Push & Go quick locking; polyamide |

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*... continuation*

| | | |
|---|---|---|
| 63 | Calibration Source (A) (C) (E) (G) | Box with potassium chloride (KCl); ICSC 1450; 400 g (14.11 oz); net: 200 g (7.05 oz); polyoxymethylene; Aluminium |
| 64 | DC Power Adaptor, Charger (International) | AC in: 100 V — 240 V; 620 mA; 50 Hz — 60 Hz; DC out: 12 V; 2.5 A; 235 g (8.29 oz) including adaptors; indoor; cable included; 150 cm (4 ft 11.1 in); CE; UL US |
| 65 | DC Power Adaptor, Charger (USA) | AC in: 100 V — 240 V; 620 mA; 50 Hz — 60 Hz; DC out: 12 V; 2.5 A; 170 g (6.00 oz); indoor; cable included; 150 cm (4 ft 11.1 in); CE; UL US |
| 66 | Car Power Adaptor, Charger | DC in: 12 V — 32 V; 80 g (2.82 oz); cable included; 150 cm (4 ft 11.1 in) |
| 67 | Replacement Battery | Polyoxymethylene box for 6 AA (Mignon, R6) batteries; 90 g (3.17 oz); with screw driver; 30 g (1.06 oz) |
| 68 | Documentation | Quick reference card; printed user manual; test report |
| 69 | Carrying Case | 400 mm (15.75 in) × 300 mm (11.81 in) × 168 mm (6.61 in); 1850 g (4 lb 1.3 oz); watertight; stackable; polypropylene; polyethylene |
| | **Standards** | |
| 70 | ANSI N42.34 2015 | Performance Criteria for Handheld Instruments for the Detection and Identification of Radionuclides |
| 71 | IEC 60529 | Degrees of Protection Provided by Enclosures (IP Code) |
| 72 | ANSI N42.42 2006 | Data format standard for radiation detectors used for Homeland Security |
| 73 | EMC - Directive 2014/30/EU | Regulations concerning electromagnetic compatibility |
| 74 | EN 61326-1:2013 | Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements |

## E.2 Detector Positions

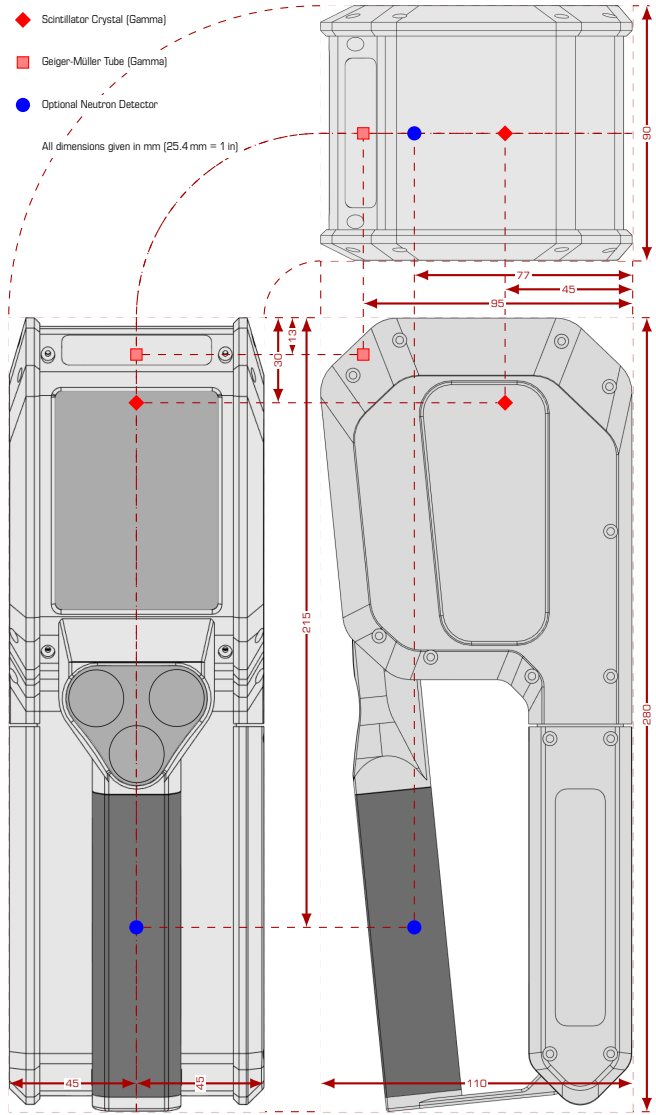



Figure 163: Position of the detector centers of the RADEAGLET-R (2 in×1 in NaI scintillator, drawn to scale)

## E.3 About Intrinsic Activity

Some models of the RADEAGLET-R contain an extremely low-activity radioactive source. Details are given in Appendix E.1, p. 179 and on the label attached to your instrument (Fig. 164, p. 185).

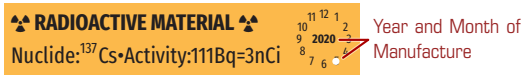



Figure 164: Label on the bottom side of a RADEAGLET-R with an embedded source

### E.3.1 General Rules for Handling Radioactive Material

The quantities of radioactive material contained in the RADEAGLET-R is extremely small and present no known radiation hazard. However, it is always a good practice to minimize exposure by following the basic principle of ALARA: **A**s **L**ow **A**s **R**easonably **A**chievable.

Decrease time and increase distance and shielding when handling these sources.

- Eating, drinking and smoking should be prohibited in areas where radioactive materials are used and/or stored.
- Radioactive materials should only be used by, or under the supervision of a responsible person in authorized areas.
- The regulations of your jurisdiction for disposal of radioactive material and electric devices must be followed.

### E.3.2 For the United States of America

- The radioactive material contained in the RADEAGLET-R is exempt from U.S. NRC and/or Agreement State licensing requirements.
- The radiation exposure rate at any point on the external surface of this product does not exceed 5 µSv/h (0.5 mrem/h)
- Radioactive Material — Not for human use — introduction into foods, beverages, cosmetics, drugs, or medicinals, or into products manufactured for commercial distribution is prohibited — Exempt Quantities Should Not be Combined.
- In accordance with the U.S. NRC regulations, these exempt quantity products may be disposed of in regular waste providing all radiation symbols and other identifying marks have been removed or defaced.

  For specific licensees the requirements of 10 CFR Part 20 apply where 10 CFR 30.18 is silent.

## E.4 Unmanned Neutron Detection Testing

This item is available for RADEAGLET-R models with a neutron detector (see E.1, p. 179).

For tests involving an un-moderated neutron source, an appropriate phantom of Polymethyl Methacrylate (PMMA, $(C_5H_8O_2)_n$, acrylic glass) or equivalent must be placed between the neutron source and the instrument to accurately simulate the moderation effects of field mission environments (which always provide moderation through surrounding material). Additionally, a moderator must be placed around the handle of the instrument as a replacement for the operators hand.

The neutron detector is placed inside the handle of the instrument.

## E.5 CE Certificate

**DECLARATION OF CONFORMITY**

CE

Radio Isotope Identifying Device (RIID)
Type: radEAGLET-R
Model: All
Serial Number: 20412 and up
Year of Manufacture: 2020

Herewith we declare, that the above stated instrument complies with the following EC-Directives:

EMC Directive 2014/30/EU

Furthermore, the European Standards IEC 61000-4, EN 61326-1:2013, and the US Standard ANSI N42.34-2006

Complete listing is included in the technical manual.
The above-stated device is defined for the analysis of gamma radiation.

Grevenbroich, 2020-05-20



Peter Henke
General Manager
innoRIID GmbH

## E.6 Warranty

ORTEC warrants that the items will be delivered free from defects in material or workmanship. ORTEC makes no other warranties, express or implied, and specifically NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

ORTEC's exclusive liability is limited to repairing or replacing at ORTEC by ORTEC to be defective in workmanship or materials within one year from the date of delivery. ORTEC's liability on any claim of any kind, including negligence, loss, or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall ORTEC be liable for special or consequential damages.

## E.7 Quality Control

Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

## E.8 Service

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing or by telephone, of the nature of the fault of the instrument being returned and of the model, serial, and revision numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped to the Repair Center designated by Customer Services. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty should follow the same procedure and ORTEC will provide a quotation for the repair costs.

## E.9 Damage in Transit

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage since the carrier is normally liable for damage in shipment. Packing materials, bills of materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

## E.10 Bibliography

Knoll, Glenn F. (1999[3]): Radiation Detection and Measurement.— ISBN 0-471-07338-5, John Wiley & Sons.