ORTEC®

radEAGLET-R

User Manual

Software 3.2.12r • Document 3.3.3b4o • 2020-11-18

AMETEK®
ADVANCED MEASUREMENT TECHNOLOGY

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ORTEC®
AMETEK®

ORTEC

📍 801 South Illinois Avenue
Oak Ridge, TN 37830
U. S. A.

📞 +1 865 482 4411

🖨 +1 865 483 0396

@ mailto:ortec.info@ametek.com

🌐 http://www.ortec-online.com/contactus/technicalsupport

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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 8.1.1, p. 121 and E.1, p. 153). 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 (8.4, p. 126).   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 8, p. 121 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. 143),

- a glossary of terms and technological background (Appendix B, p. 145 and C, p. 147)

- a trouble shooting guide (Appendix D, p. 151)

- an info pool (Appendix E, p. 153) with certificates, specification data etc.

✳ Several models of the RADEAGLET-R are available (see E.1, p. 153 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 $200\,\mu$Sv/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. 153).

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.

Front Cover

Spectrum Acquisition Status

Data Logging Status

Stabilization Status

GPS Status ✹

Current Time

Battery Status

Wi-Fi Status

Current Key Commands

Gamma Alarm LED

Neutron Alarm LED ✹

Battery Charging LED

ON Key

3-Button Keyboard with Status LEDs

Battery Failure LED

Handle with Vibrator

Neutron Detector ✹ in Handle

✹ Optional Feature

Figure 1: Annotated top view of the RADEAGLET-R instrument
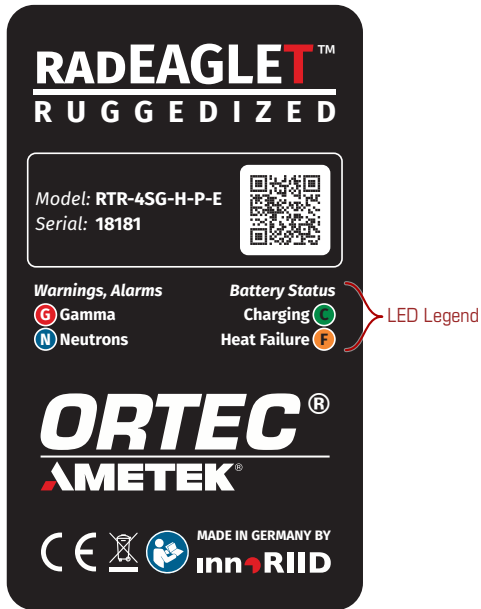
Figure 2: Name plate under the handle of the ʀᴀᴅEAGLET-R

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):

- (A) RADEAGLET-R instrument with (a) lanyard
- (B) KCl Calibration box (Only RADEAGLET-R models without internal source (see E.1, p. 153).)
- (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

Figure 3: The RADEAGLET-R in the watertight case

📋 Please make sure the delivered parts are complete.

1.5.4   Connectors

The ʀᴀᴅEAGLET-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. 4, p. 20) to connect your ʀᴀᴅEAGLET-R to a computer. All common operating systems like Microsoft Windows, MacOS or Linux are supported.

Magnetic USB Connector (Computer Connection)

USB-A Host Connector for Communication Dongles (Wi-Fi, Bluetooth, Ethernet, …)

Connector for Lanyard

Beeper

Plug Alignment Mark

Connector for Power Supply

Figure 4: Rear view of the ʀᴀᴅEAGLET-R

USB-A host connector at rear end

Use this plug (Fig. 4, 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. 4, 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. 4, p. 20).

Figure 5: Storage card behind front cover of the ʀᴀᴅEAGLET-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. 4, p. 20). To release the fastener press the button in the center (Fig. 6, p. 21) and pull the lanyard away from the instrument.

Figure 6: 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. 7, p. 23).
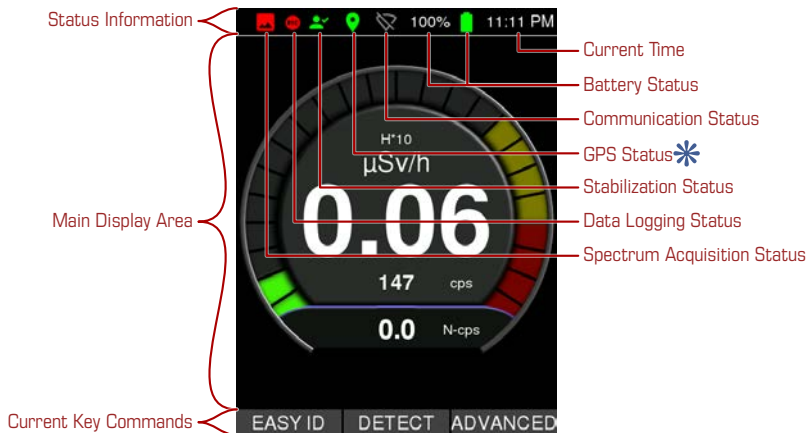
Figure 7: Anatomy of the RADEAGLET-R display

Top: Status Bar

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

5:56 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. 55)

💡 If the instrument's clock is completely off, you have to set it via the web interface (see 7.6, p. 113).

Battery Status

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

🔋 Full battery (100 %)

🔋 🔋 🔋 🔋 🔋 🔋 🔋 🔋 🔋

🔋 Empty battery

⚡ While the ʀᴀᴅEAGLET-R is powered by an external source (see 8.3, p. 123) providing enough power to charge the internal battery, the symbol is decorated by a bolt.

🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡ 🔋⚡

🔌 While the ʀᴀᴅEAGLET-R is powered by an external source (see 8.3, p. 123) 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 ʀᴀᴅEAGLET-R's USB-A port.
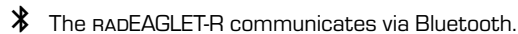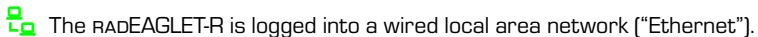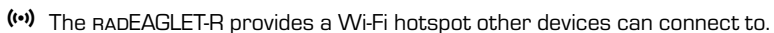
📶 The ʀᴀᴅEAGLET-R is logged into a Wi-Fi network.

((•)) The ʀᴀᴅEAGLET-R provides a Wi-Fi hotspot other devices can connect to.

🖧 The ʀᴀᴅEAGLET-R is logged into a wired local area network ("Ethernet").

✳ The ʀᴀᴅEAGLET-R communicates via Bluetooth.

🚫 Communication is off.

Ψ A USB mass storage device is available.

GPS Status ✳

This item is available for ʀᴀᴅEAGLET-R models equipped with a GPS receiver (see E.1, p. 153).
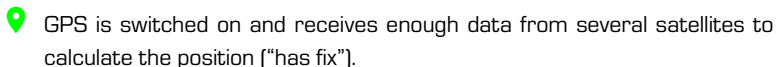
📍 GPS is switched on and receives enough data from several satellites to calculate the position ("has fix").
Location data is included whenever you save measuring results, for example, a spectrum.

📍 GPS is switched on but reception is (hitherto) insufficient.

📍 GPS is switched off.

Stabilization Status

The stabilization (see C.1, p. 147) 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. 151 for recommended remedies.
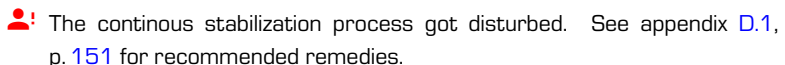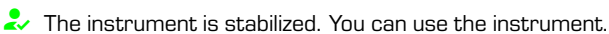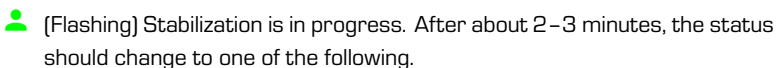
Data Logging

This symbol shows whether the ʀᴀᴅEAGLET-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. 19, p. 33), menus to choose from (Fig. 33, p. 48), alarms (Fig. 30, p. 44), or measurement results (Fig. 24, p. 38).

Bottom: Keyboard Legend

The labels in this area name the function currently associated with each of the RADEAGLET-R keys (Fig. 7, p. 23, Fig. 8, 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. 8, 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. 153).

🟢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 5.5, p. 57).

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. 8, 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).
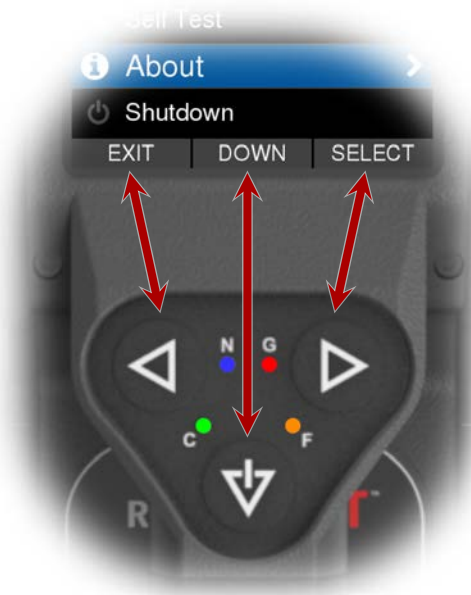
Figure 8: The current functions of keys shown along the bottom of the RADEAGLET-R display.

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. 9, p. 27).

Figure 9: 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. 10, 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.
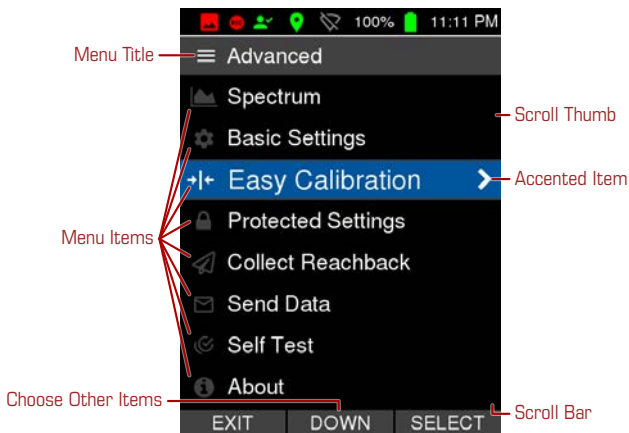
Figure 10: A menu with the third item accented

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. 10, 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. 11, p. 28.

You can toggle the state by simply pressing | Change |.
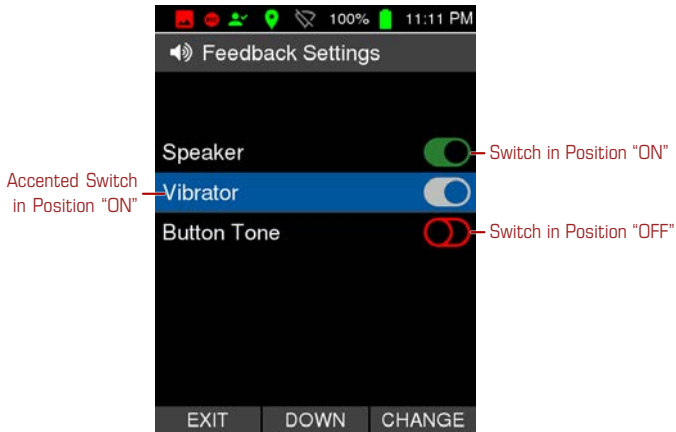
Figure 11: Changing switches

For other settings you can choose from a list of options, for example the screen brightness (see 5.4, p. 56). When you select the setting for change the list of valid settings is displayed (Fig. 12, p. 28).
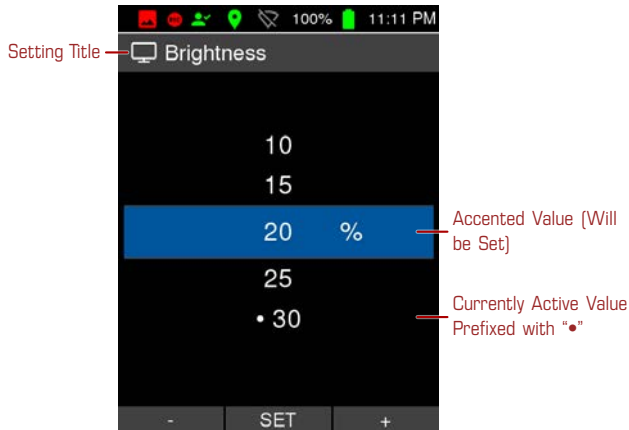
Figure 12: Changing values by choosing from a list

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 ʀᴀᴅEAGLET-R are locked behind a password. If you try to use these items, you will be prompted to enter the password (Fig. 13, p. 29).

📒 After successfull pasword entry, the RADEAGLET-R ist unlocked for about 10 min.
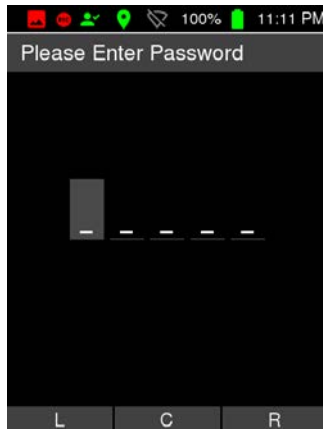
Figure 13: Entering the password

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 5.23, p. 85) after receiving the instrument to prevent unauthorized persons from manipulating the protected settings.

After pressing five keys the available commands change (Fig. 14, p. 29).
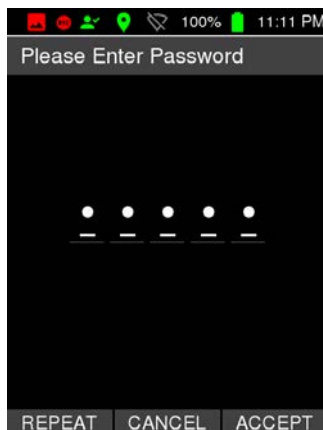
Figure 14: After entering the password

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 ʀᴀᴅEAGLET-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 ʀᴀᴅEAGLET-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. 15, 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`.
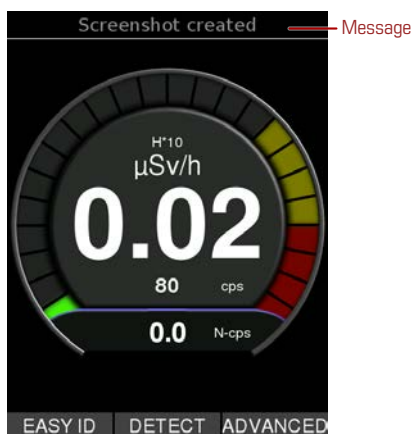
Figure 15: Status bar after saving a screenshot

For further processing screenshots, transfer them to your computer with, e.g., Storage Management in the Web interface (see 7.10, p. 118), or a USB flash drive (see 5.11.2, p. 67).

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. 16, p. 31) in front of the detector cap.

Figure 16: Box with potassium chloride (KCl) for stabilization and calibration (Only RADEAGLET-R models without internal source (see E.1, p. 153).)

2. Press and hold down the ⬢ key (Fig. 8, 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 with dots appearing from left to right (Fig. 17, p. 32).

5. The RADEAGLET-R begins an initial stabilization (Fig. 18, p. 32, see C.1, p. 147 for details).

6. When the stabilization source is identified it is shown (Fig. 19, p. 33).

7. After the stabilization the RADEAGLET-R switches to Dose Rate Mode (see 3.1, p. 35).

8. Watch the stabilization status icon on the screen (see 2.1, p. 23).

Figure 17: Starting the RADEAGLET-R
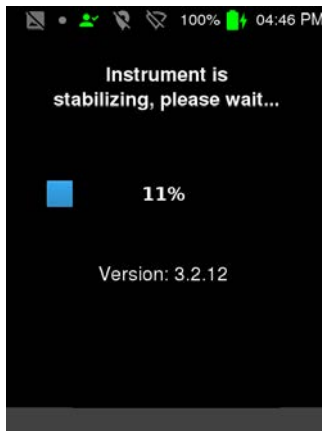
Figure 18: Initial stabilization
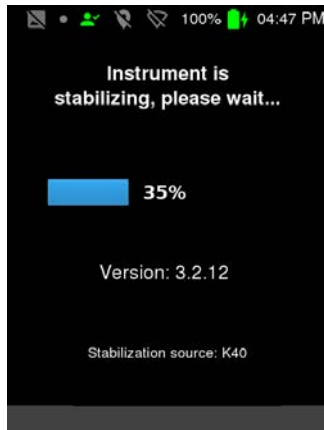
Figure 19: Initial Stabilization after identification of the stabilization source

2.4   Switching Off the ʀᴀᴅEAGLET-R

To switch off the instrument, navigate to the ⌈ Advanced ⌉ menu and select the
Shutdown command (see 5.29, p. 92). You will be prompted to confirm in case you
change your mind (Fig. 97, p. 93).

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

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. 38

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 20: Dose rate display

Several representations of the current ambient dose rate (H*10) are shown (Fig. 20, 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. 56.

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. 21, p. 36, Fig. 22, 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 5.17, 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.
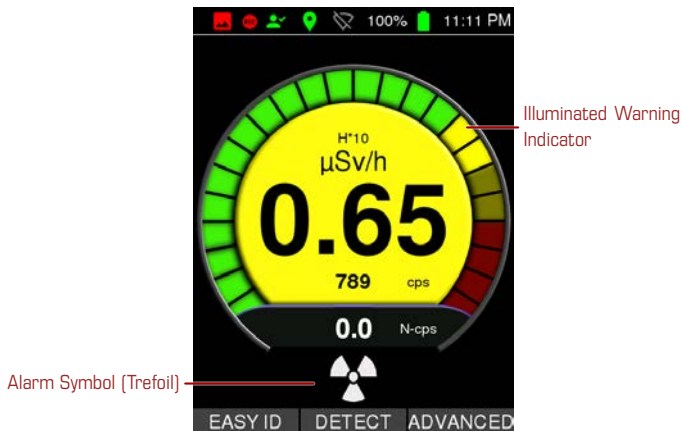
Figure 21: Dose rate display with gamma warning

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. 38.

Advanced

Open the menu for advanced operations, see 5, p. 47.
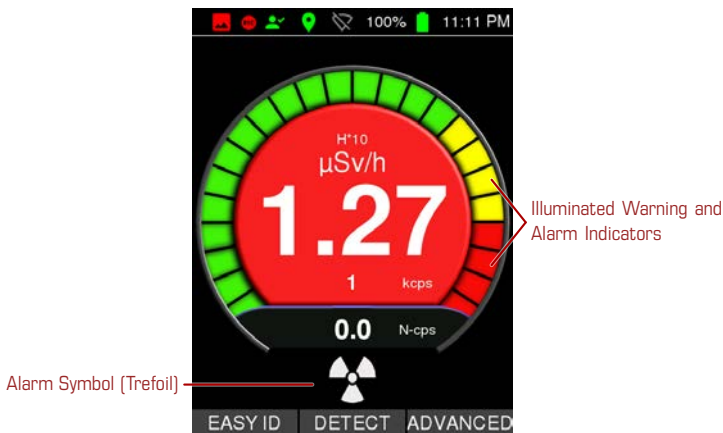
Figure 22: Dose rate display with gamma alarm

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 5.20, p. 78) and then analyze and save it.

During the acquisition, a chart (Fig. 23, p. 37) instructs you to find the best distance between the radEAGLET-R and the source in question.

The nuclides identified will be displayed (Fig. 24, p. 38). 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.
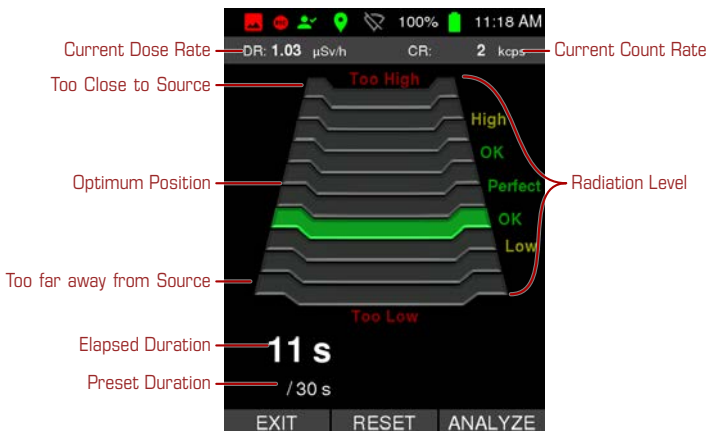
Figure 23: The Easy ID screen
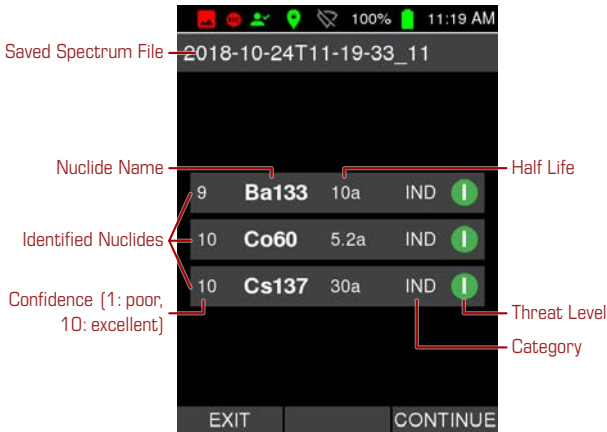
Figure 24: The Easy ID results

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.

Save

Save the recorded spectrum even if nothing was identified.

Exit

Return to the superior screen.

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 5.5, p. 57).

The tool starts with measuring the background radiation (Fig. 25, p. 39).
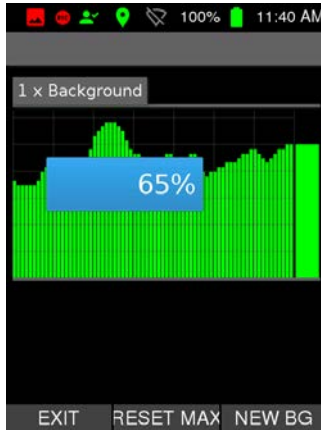
Figure 25: Detect mode background measurement

📋 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. 26, p. 39).
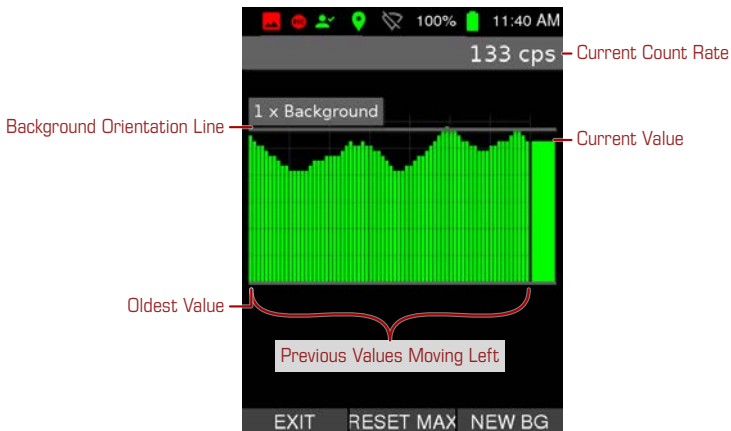
Figure 26: Detect mode chart

Green Bars

represent radiation levels close to the background.

Red Bars

represent increased radiation potentially caused by a source (Fig. 27, p. 40).

Blue Bars

represent neutron incidents, if any.

Value at Orientation Line
Relative to the Background
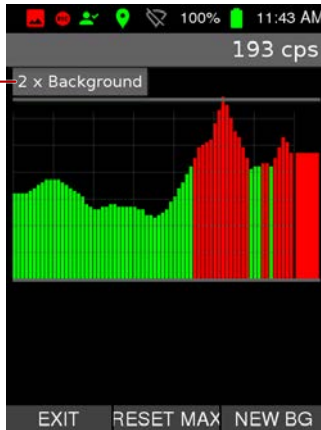
Figure 27: Detect mode: Approaching a source

If the radiation level increases, the chart will be rescaled to multiples of the background determined at the beginning (Fig. 28, p. 40).

Value at Orientation Line
Relative to the Background
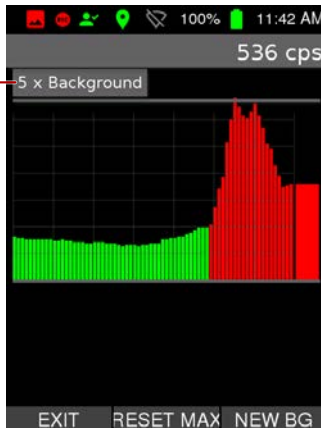
Figure 28: Detect mode: Close to a source

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 5.17, 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. 56).

> The alarm details remain on the screen until you confirm them. You can turn off the confirmation, see 5.4, p. 56

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 5.5, p. 57.

Vibrator

> The vibrator shakes the handle (and adds a little sound). You can switch the vibrator on or off, see 5.5, p. 57.

🛑 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.

🛑 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. 29, p. 44) and alarm (Fig. 30, p. 44) messages overlay all other activities of the RADEAGLET-R.

Settings and Commands

> Save

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

Figure 29: A warning reported on screen

Figure 30: An alarm reported on screen

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. 153).

Figure 31: An neutron alarm reported on screen

4.2   Low Power Conditions

Visible (Fig. 32, 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.

If you get this warning and want to continue working, replace the POWERCELL (see 8.2, p. 122) or connect the RADEAGLET-R to an external power source (see 8.3, p. 123).
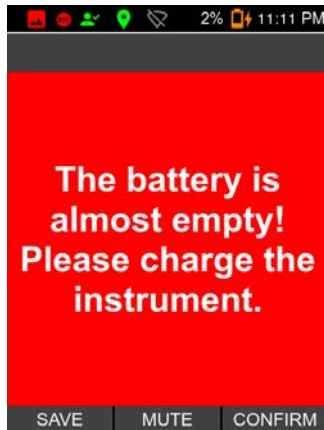
Figure 32: A battery warning reported on screen

5 RADEAGLET-R Advanced Menu

This menu provides acces to advanced 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. 33, p. 48.

Ⓒ Self Test . . . . see 5.27, p. 90

ⓘ About . . . . see 5.28, p. 92

⏻ Shutdown . . . . see 5.29, p. 92

📊	Spectrum . . . . see 5.1, p. 48
⚙	Basic Settings . . . . see 5.2, p. 54
→|←	Easy Calibration . . . . see 5.14, p. 71
🔒	Protected Settings . . . . see 5.15, p. 74
✈	Collect Reachback . . . . see 5.25, p. 86
✉	Send Data . . . . see 5.26, p. 88
Ⓒ	Self Test . . . . see 5.27, p. 90
ⓘ	About . . . . see 5.28, p. 92
⏻	Shutdown . . . . see 5.29, p. 92
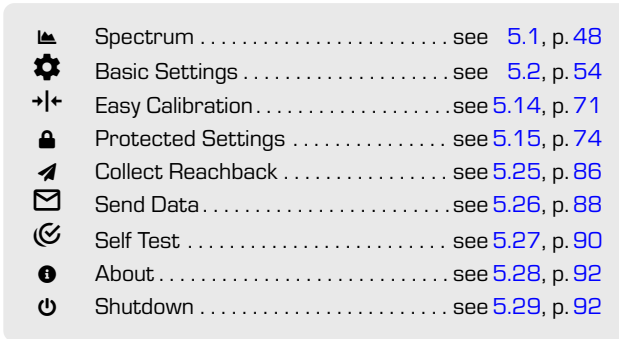
Figure 33: The advanced operations menu

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. 34, 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. 34, p. 49).
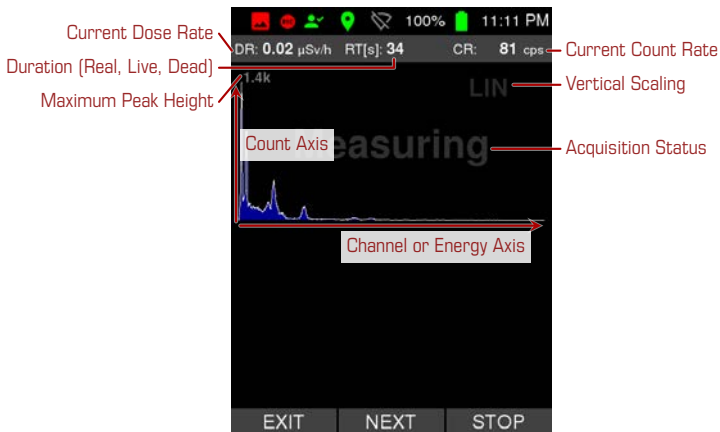
Figure 34: The spectrum screen

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

| 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. 35, p. 49).
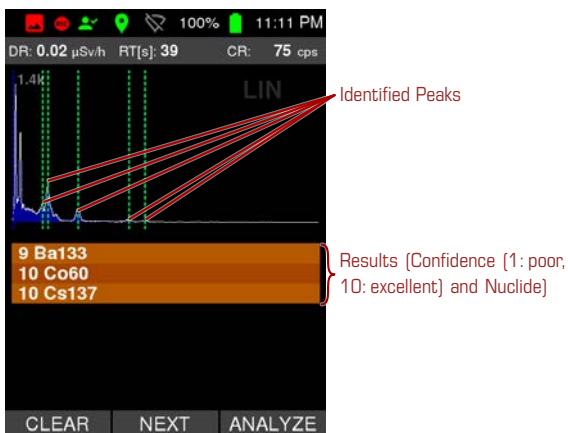
Figure 35: Result of a spectrum analysis

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. 36, p. 50) labeled with the energy, the channel number, and the number of counts at this position in the spectrum.

660.0 keV
ch 440
101 cnts

Figure 36: 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. 37, 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. 38, p. 51).

Current Zoom Factor
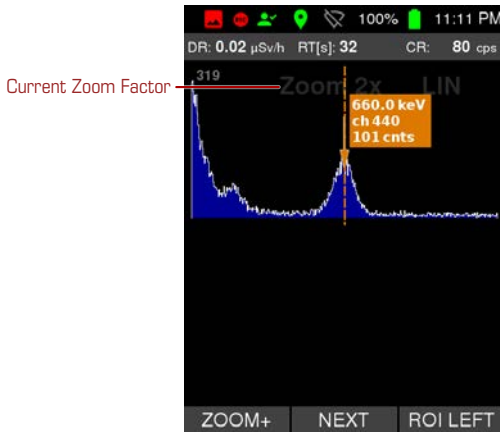
Figure 37: Zoomed spectrum with cursor

Figure 38: Spectrum with Region Of Interest

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. 39, p. 52).

Load

Load a saved spectrum for further processing. Choose a from a list of files saved before (Fig. 40, p. 52). The spectrum saved most recently is listed on top.
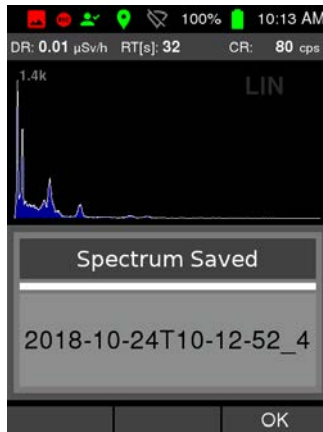
Figure 39: Info about a saved spectrum's file name
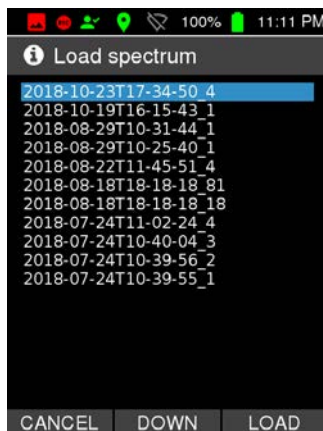
Figure 40: Spectrum files available for loading

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.

LT • DT • RT

Cycle through the time and duration info displayed along the spectrum (Fig. 34, 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.6, p. 150.

LOG • SQRT • LIN

Change the vertical scaling of the spectrum diagram (see C.7, p. 150).

LOG   Logarithmic scaling.

SQRT   Square Root scaling.

LIN   Linear scaling (the default).

The current scaling is shown at the top of the diagram (Fig. 34, 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. 41, p. 53).
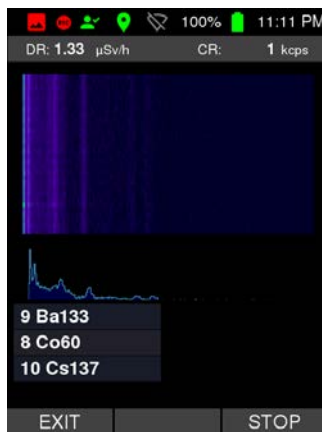
Figure 41: The Auto ID Waterfall display

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 ac-
quired 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. 42, p. 54). You can
change these settings without entering a password.

📅 Time and Date . . . . see 5.3, p. 55
🖥 Display . . . . see 5.4, p. 56
🔊 Feedback . . . . see 5.5, p. 57
✈ Reachback . . . . see 5.6, p. 58
🔗 Connectivity . . . . see 5.7, p. 59
📍 GPS ✳ . . . . see 5.13, p. 70
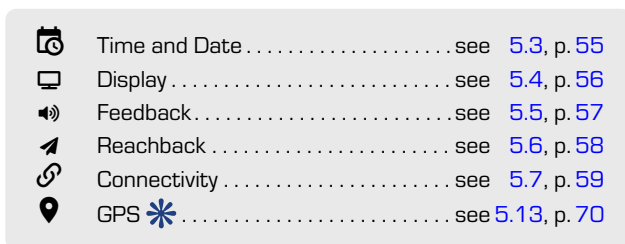
Figure 42: The basic settings menu

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. 43, p. 55) groups settings for the clock handling of your ʀᴀᴅEAGLET-R.

📋 The clock setting affects 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 7.6, p. 113).
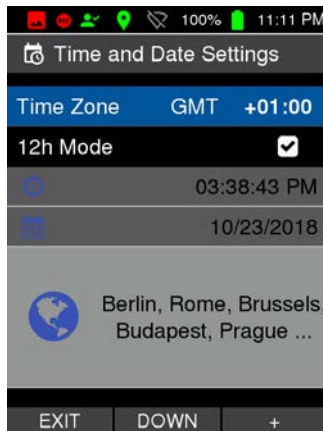
Figure 43: The clock settings

Settings and Commands

Time Zone

Specify your local time zone. To have the instrument handle daylight savings time correctly, you have to select not only the offset versus UTC, but also the correct collection of cities shown for a given offset.

12 h Display

Specify whether you want to have times shown in 12 or 24 hour format.

+

Change to the next time zone.

On, Off

Switch the setting on or off.

Exit

Return to the superior screen.

Down

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

5.4   Display

This screen (Fig. 44, p. 56) groups several options for the display of your RADEAGLET-R.
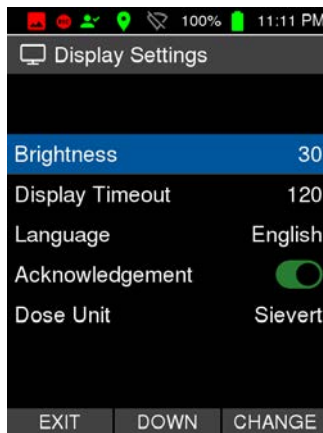
Figure 44: The display settings

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 explicitly 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 familar 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   Feedback

This screen (Fig. 45, p. 58) groups several options for the annunciator of your RADEAGLET-R.

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.

| 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.
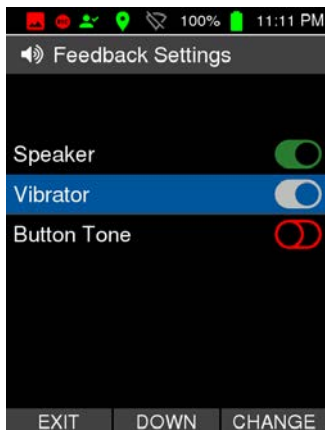
Figure 45: The feedback settings

5.6   Reachback

This screen (Fig. 46, p. 58) groups settings for a reachback SOP (5.25, p. 86). Please refer to 6.4, p. 97 for details.
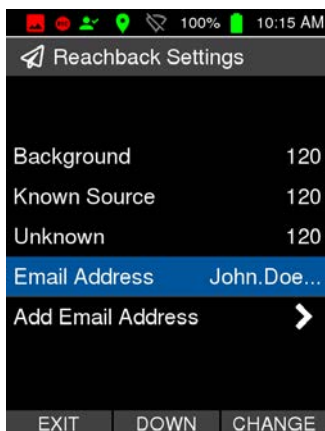
Figure 46: The reachback settings

Settings and Commands

Background

    Specify the default duration for a background measurement.

Known Source

    Specify the default duration for a measurement of a known source.

Unknown

    Specify the default duration for a measurement of an unknown source.

Email Address

    Specify the address the reachback data should be sent to. Choose from the list of addresses saved in your RADEAGLET-R.

    ⚠️ The complete setup for reachback mailings requires entering and editing a lot of text and thus is available and a lot more convenient in the Web interface (see 7.7, p. 114).

Add Email Address

    Add an address to the list of addresses saved in your RADEAGLET-R.

Change

    Edit the highlighted setting.

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.

5.7　Connectivity

This menu (Fig. 47, p. 59) provides access to settings for various connection devices plugged into the USB-A host adaptor (Fig. 4, 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 connectitvity method can be used at a given time.

📶	Wi-Fi . . . . see　5.8, p. 60
(•)	Hotspot . . . . see　5.9, p. 61
✳	Bluetooth . . . . see 5.10, p. 64
⎌	USB . . . . see 5.11, p. 66
▤	Services . . . . see 5.12, p. 68

Figure 47: 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.

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

⚠ The Wi-Fi hardware can be used for either connecting to an existing network or es-
tablishing a hotspot network but not both at the same time.
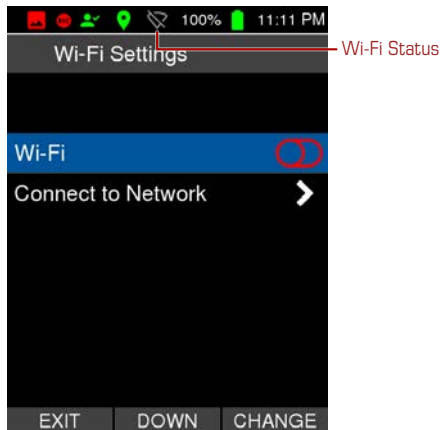
Figure 48: The Wi-Fi settings

Settings and Commands

Wi-Fi

> Switch the Wi-Fi dongle on or off.

> 📋 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. 49, p. 61).

Figure 49: 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. 50, p. 62).

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.

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.

Figure 50: Connected to a Wi-Fi network

This screen groups settings and status information to let your ʀᴀᴅEAGLET-R provide a Wi-Fi access point (Fig. 51, 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.
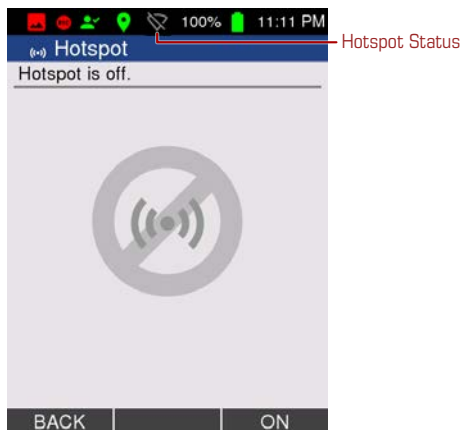
Figure 51: Hotspot is off

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 ʀᴀᴅEAGLET-R.

HS-Info • Web-Info

Switch between information about the Web interface address (Fig. 52, p. 63) or that for accessing the hotspot (Fig. 53, p. 63). Both are shown as text and as QR codes for devices equipped appropriately.
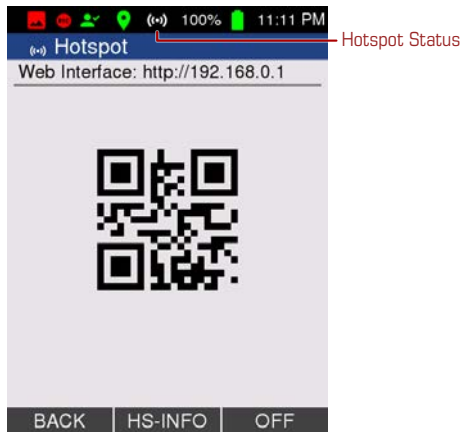
Figure 52: Hotspot: Web interface info
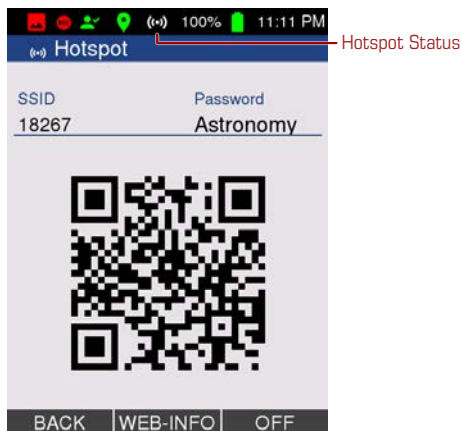
Figure 53: Hotspot: Access credentials

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.

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.

You can switch Bluetooth on or off (Fig. 54, p. 64) and start pairing with an external device.
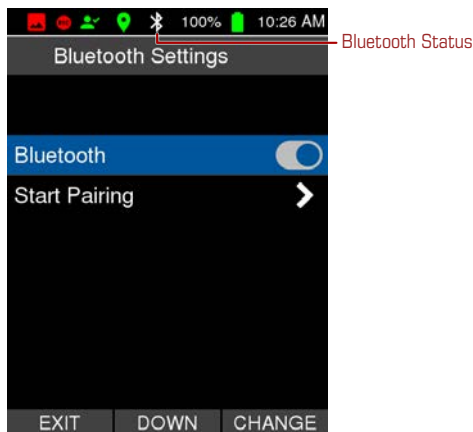
Figure 54: Bluetooth settings

Initially the RADEAGLET-R knows no Bluetooth devices (Fig. 55, p. 64).
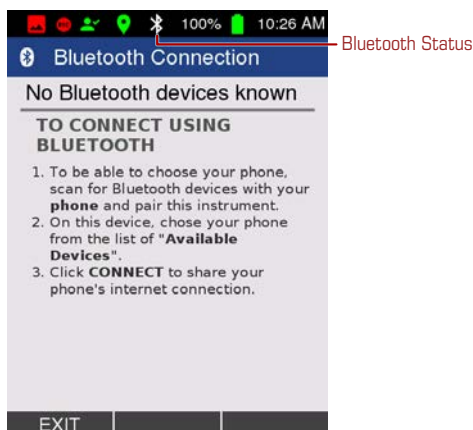
Figure 55: Bluetooth instructions on a pristine RADEAGLET-R

Follow the instructions displayed to initiate the pairing. The paired device will be shown (Fig. 56, p. 65) and is ready for connection.

💡 The RADEAGLET-R remembers all devices it has been paired to. If your desired device is already known, just choose it from the list.
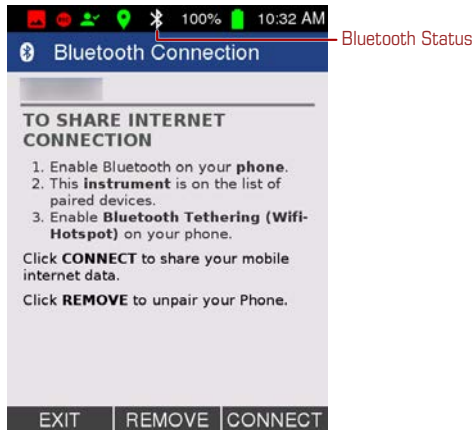
Figure 56: Connect to a known Bluetooth device

After the connection is established, the IP address to access the Web interface is shown (Fig. 57, p. 65) as text and as QR code for devices equipped appropriately.

Figure 57: Web interface address for devices connected via Bluetooth

Settings and Commands

| Connect, Disconnect |
Start or stop the connection between the RADEAGLET-R and the Bluetooth device.

| Remove |
Remove a device from the list of known devices.

| Exit |
Return to the superior screen.

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. 66

- A USB storage device (a.k.a. Stick) is plugged into the USB-A Port: see 5.11.2, p. 67

- A USB Ethernet adaptor is plugged into the USB-A Port: see 5.11.3, p. 68

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. 58, p. 66).

Figure 58: USB cable connection information

Settings and Commands

| On • Off |

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

| Exit |

> Return to the superior screen.

5.11.2   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.

You will be prompted to transfer data to the device or cancel the procedure (Fig. 59, p. 67).

Figure 59: Data transfer to a USB mass storage device

Settings and Commands

| Copy |

> Copy all data (spectra, screenshots etc.) saved in the RADEAGLET-R's database to the USB mass storage device.

> 🛑 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 (Fig. 60, p. 68).

Figure 60: Data transfer complete

Exit

Return to the superior screen.

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. 61, p. 69).

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. 62, p. 69).
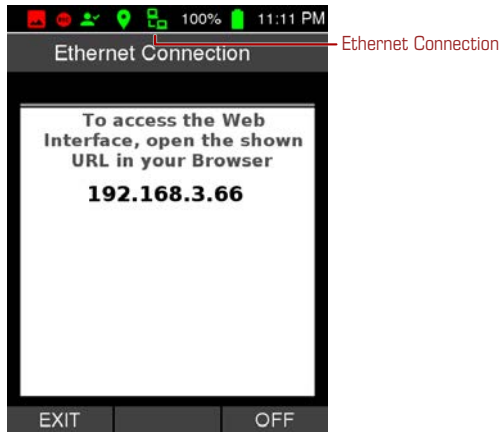
Figure 61: Ethernet LAN connection information
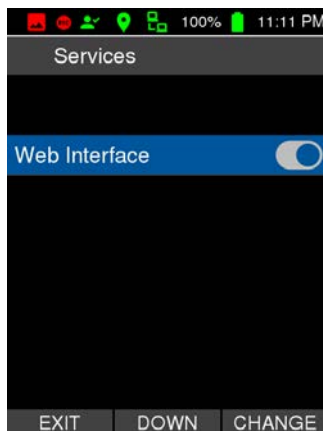
Figure 62: The services screen

Settings and Commands

Web Interface

> Switch the Web interface (see 7, p. 99) 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. 153).

This screen (Fig. 63, p. 70) 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)
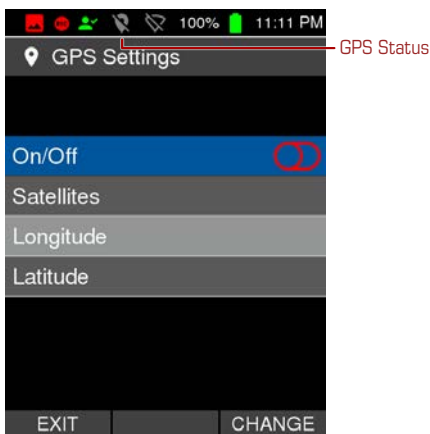
Figure 63: The GPS settings when GPS is off

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. The current number is shown, see Fig. 64, p. 71, and increases after some time, see Fig. 65, p. 71.

If the GPS receiver has sufficient data from enough satellites ("has a fix"), your location ist shown, see Fig. 66, p. 72.

Settings and Commands

| Change |

Edit the highlighted setting.

| Exit |

Return to the superior screen.
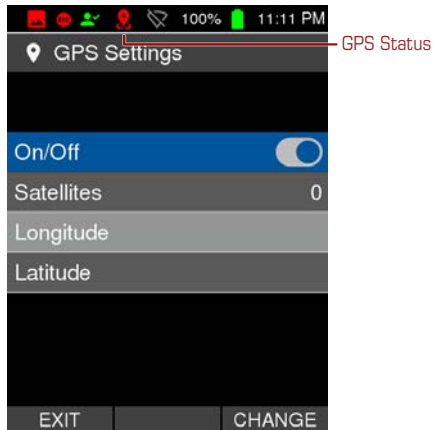
Figure 64: The GPS settings immediately after switching on GPS
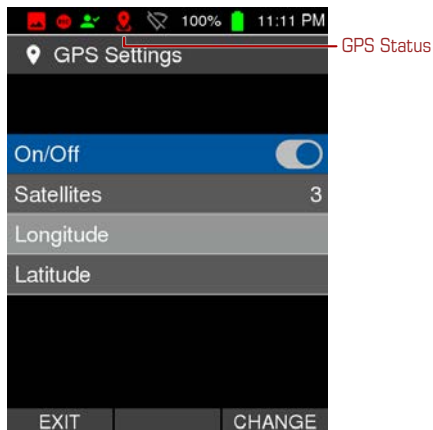
Figure 65: The GPS settings while searching satellites

5.14   Easy Calibration

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

An elaborate version of calibration is available too, see 5.18, p. 76.

For additional information refer to appendix C.2, p. 148.

✳ 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. 67, p. 72), it will aquire data
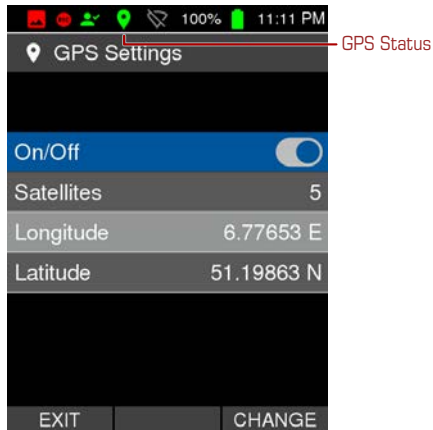
Figure 66: The GPS settings after determinig the location

for a while and use it for calibration (Fig. 68, 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.
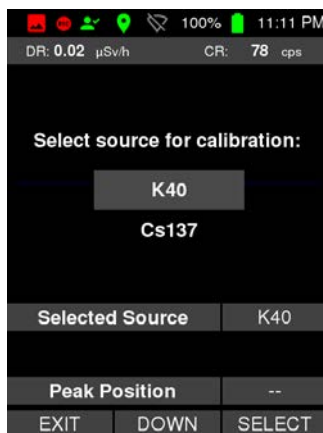
Figure 67: Selecting a source for easy calibration

A progress percentage is shown during the data collection (Fig. 69, p. 73), sometimes in several cycles, until the peak position of the calibration source is within ±0.5 % of the theoretical position.
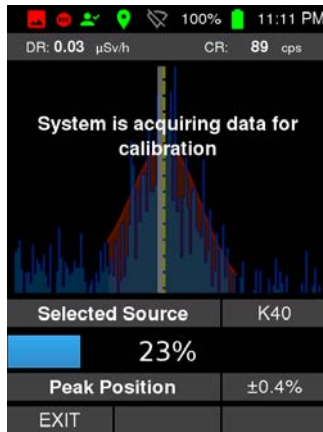
Figure 68: Easy calibration in progress
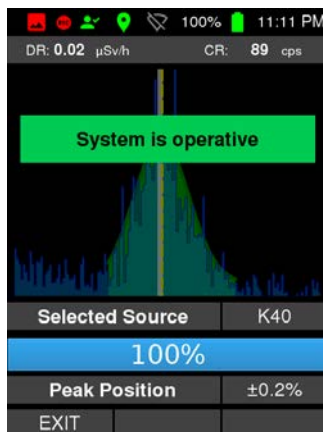
Figure 69: Easy calibration finished

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.

5.15   Protected Settings

You can access the protected settings of the radEAGLET-R via this menu (Fig. 70, p. 74).

Before accessing this menu you have to enter a password (see 2.2.4, p. 28).

ⓘ System Information . . . . see 5.16, p. 74
🔔 Alarm Settings . . . . see 5.17, p. 75
→|← Calibration . . . . see 5.18, p. 76
🗂 ID Settings . . . . see 5.19, p. 78
🗄 Storage Management . . . . see 5.22, p. 82
🔑 Set Password . . . . see 5.23, p. 85
🔄 Factory Settings . . . . see 5.24, p. 85
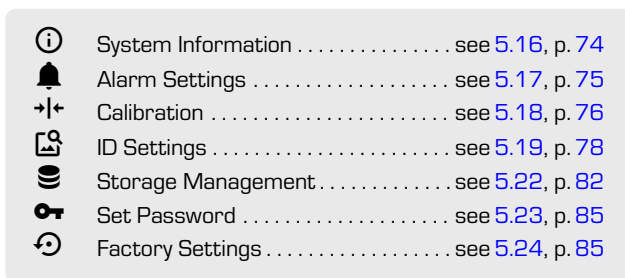
Figure 70: The protected settings menu

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.

5.16   System Information

This screen (Fig. 71, p. 75) shows information about your radEAGLET-R's hardware status.
Please have these data at hand when contacting our support.

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. 147).
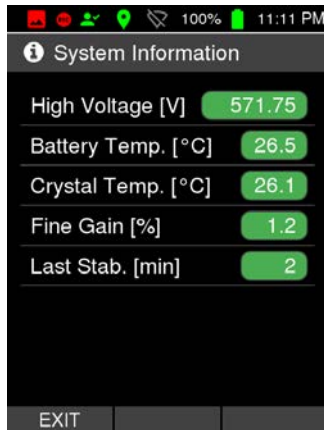
Figure 71: The hardware status

Exit

Return to the superior screen.

5.17   Alarm Settings

This screen (Fig. 72, p. 75) groups the settings for warnings and alarms.
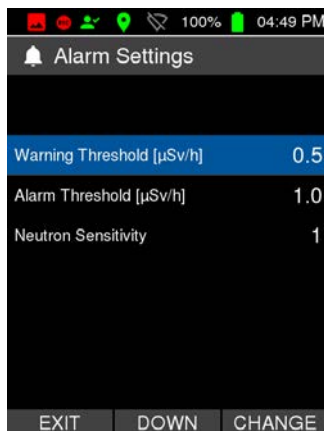
Figure 72: The alarm settings

🛑 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. 56.

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. 153).

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.

Change

Edit the highlighted setting.

5.18   Calibration

This screen (Fig. 73, p. 77) shows a partial spectrum and some additional information you can use to inspect and trigger the calibration of your RADEAGLET-R.

For additional information refer to appendix C.2, p. 148.

A simpler version of calibration is available too, see 5.14, p. 71.

✳ 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.
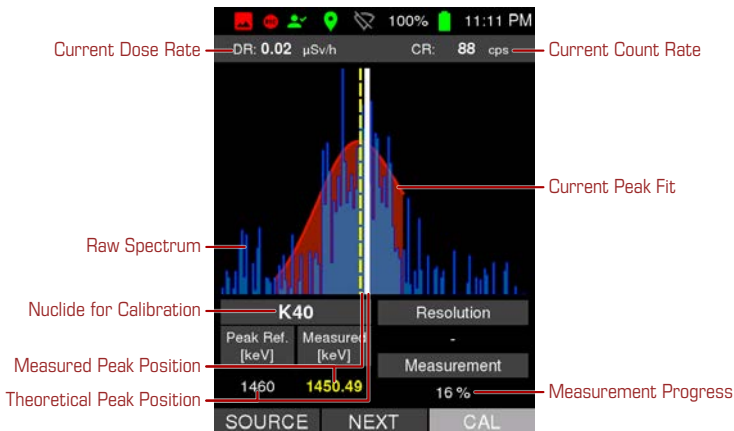
Figure 73: The calibration screen
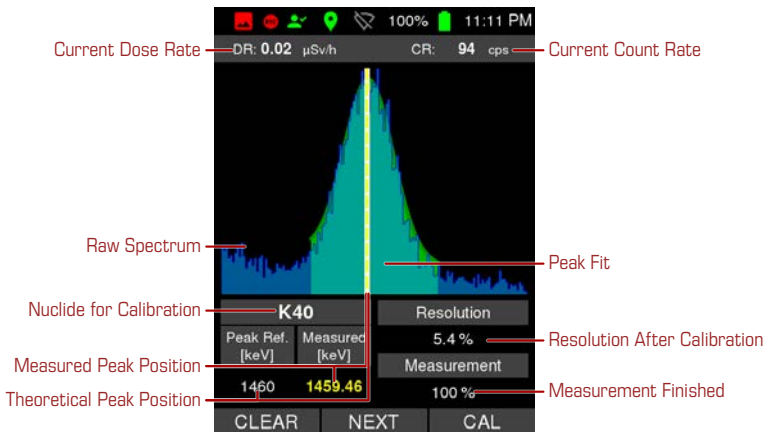
Figure 74: The calibration screen after measurement

Settings and Commands

Next

Reveal the next available command for the left key.

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. 74, p. 77).

Exit

>   Return to the superior screen.

5.19   ID Settings

You can access the identification settings of the RADEAGLET-R via this menu (Fig. 75, p. 78).

Figure 75: 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.

5.20   Easy ID Settings

This screen (Fig. 76, p. 79) groups the settings for the Easy ID mode.

Settings and Commands

Preset Time

>   Specify the measurement duration in seconds for the easy ID mode (see 3.2, p. 37).
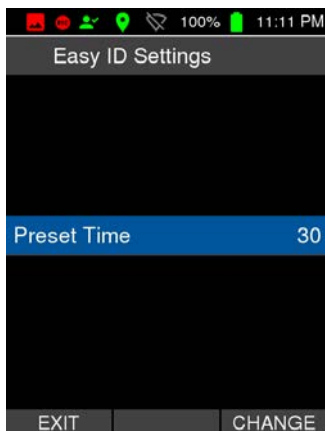
Figure 76: The easy ID settings

Exit

>   Return to the superior screen.

Select

>   Select the highlighted item.

5.21   Nuclide Library

This screen (Fig. 77, p. 79) groups information about the nuclides your RADEAGLET-R knows about.

Figure 77: 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. 77, p. 79).
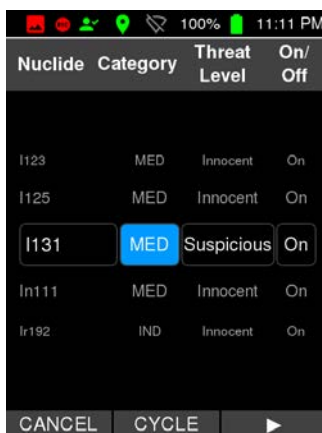
Figure 78: The nuclide library with ^{131}I selected for editing its category

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. 78, p. 80).

Cycle

> Cycle through the options for the highlighted setting. (Only available when a nuclide is selected for editing, Fig. 78, p. 80.)

▶

> Highlight the next property of the nuclide. (Only available when a nuclide is selected for editing, Fig. 78, p. 80.)

Accept

> Make your changes to the highlighted nuclide permanent. (Only available when the On/Off property of a nuclide is highlighted for editing, Fig. 79, p. 81.)

Cancel

> Discard your changes, if any, to the highlighted nuclide. (Only available when a nuclide is selected for editing, Fig. 79, p. 81.)

Exit

> Return to the superior screen. (Only available while ^{241}Am is highlighted.)
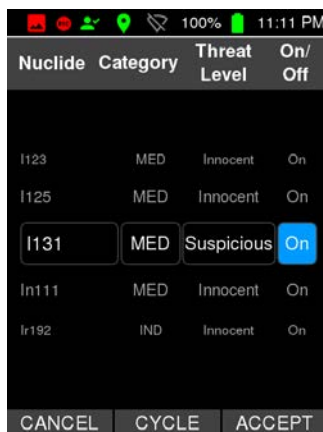
Figure 79: The nuclide library with ^{131}I selected for editing its On/Off property

5.22   Storage Management

This screen (Fig. 80, p. 82) provides an overview of all the data you saved in the RADEAGLET-R's database during your surveys.

Shown is summary about free space and the number of files in various file groups. You can delete data individiually or by their age.

💡 A similar feature is available in the Web interface (see 7.10, p. 118).
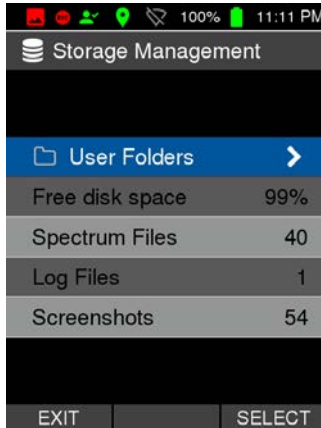
Figure 80: Storage management: Summary

Settings and Commands

User Folders

    Show a list of folders containing various types of stored data (Fig. 81, p. 83) The number of files stored in each group is given in parentheses.
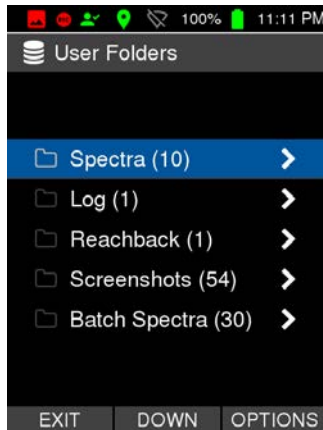
Figure 81: Storage management: List of folders with different types of data

data type

Open the commands available for every data type (Fig. 82, p. 83).
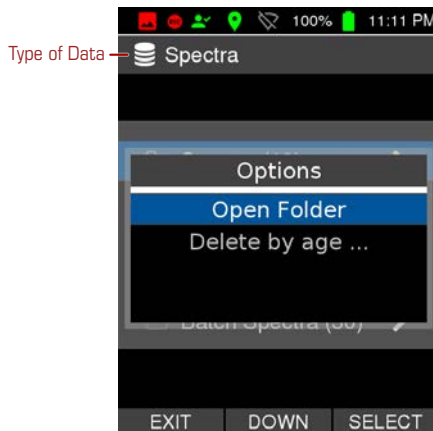
Figure 82: Storage management: Commands for a type of data

Open Folder

Open a list of all files in the group (Fig. 83, p. 84).

Delete

Delete the file highlighted in the list (Fig. 83, p. 84).

🛑 The file is deleted immediately after you press the key. There is no additional warning.
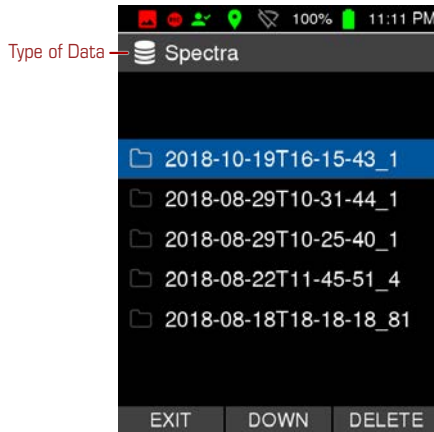
Figure 83: Storage management: List of files of a certain type

Delete by Age...

Open a menu and choose which files to delete. You can specify a minimum age or have all files deleted (Fig. 84, p. 84).
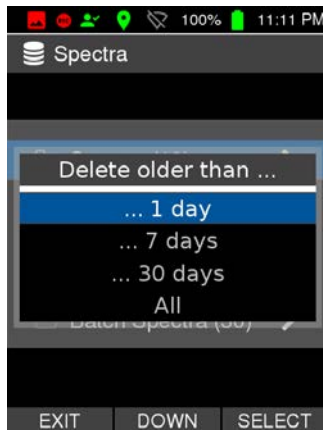
Figure 84: Storage management: Specify files to be deleted

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   Set Password

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

After you confirmed that you want to set a new password (Fig. 85, p. 85) just enter the new password as described in 2.2.4, p. 28.

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

Figure 85: Setting the password

5.24   Factory Settings

This command re-establishes the factory settings of your RADEAGLET-R. You have to confirm this command (Fig. 86, p. 86).

Reset

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

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

Exit

Return to the superior screen.

Figure 86: Reset to factory settings

5.25   Collect Reachback

This command initiates a collection of measurements for a reachback SOP. Initially, the collection is empty.

→ **To collect reachback data**...

1. Press $\boxed{\text{New}}$ to add a measurement.

2. Choose the type of measurement (background, known source, or unknown source, Fig. 87, p. 86).
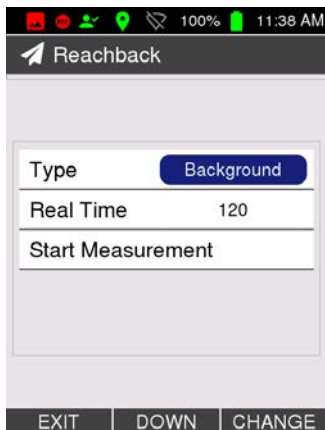
Figure 87: Settings for a new measurement

3. Specify the duration of the measurement (To change default values see 5.6, p. 58).

4. Start the measurement. The elapsed time is shown during the measurement (Fig. 88, p. 87).
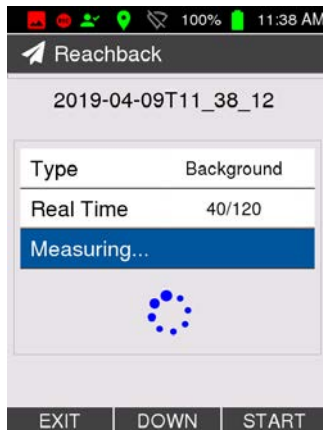
Figure 88: Collecting reachback data

5. The name of the finished measurement file is appended to the collection.

6. Add more measurements ad libitum (Fig. 89, p. 87).
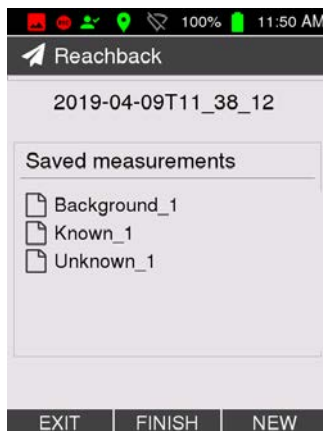
Figure 89: Collected measurements

7. Press │ Finish │ to close the collection.

All the listed measurements, both in *.spe and *.n42 format, will be combined into a *.zip archive named after the date and time of the measurement.

You will be informed about the saved collection.

📑 All measurements are stored in the RADEAGLET-R's database and can be accessed via the usual methods, for example, the Web interface (see 7.10, p. 118) or sent by mail (see 5.26, p. 88).

Settings and Commands

| 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.

5.26   Send Data

You can sent saved spectra (see 5.1, p. 51) or reachback data sets (see 5.25, p. 86) via e-mail with this command.

Sending mail is possible only while your RADEAGLET-R is connected to the Internet, so this is checked first, Fig. 90, p. 88.
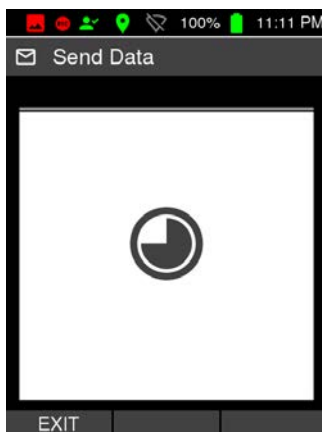
Figure 90: Checking the Internet connection

If there is no connection you are routed to the appropriate settings screens to configure a connection, Fig. 91, p. 89 (see 5.7, p. 59).
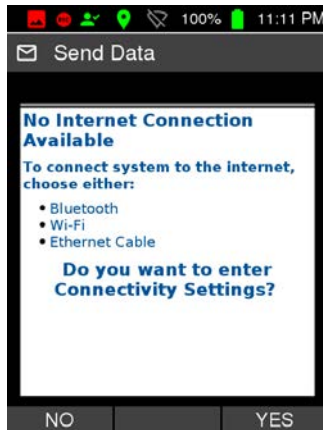
Figure 91: No Internet connection

If there is a connection, you can specify which type of files to mail (Fig. 92, p. 89).
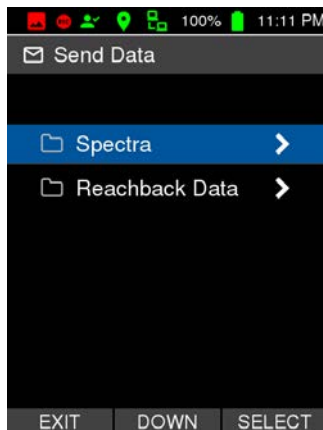
Figure 92: File types for mailing

From the list of available files you can select those to be included in the mail attachment (Fig. 93, p. 90).

Send

> Send the marked files. The files will be combined into a `*.zip` archive and sent as an attachment to the address you specified (5.6, p. 58). You have to confirm (Fig. 94, p. 90) and will be informed about success.

Select

> Select the highlighted item.

Type of Data —
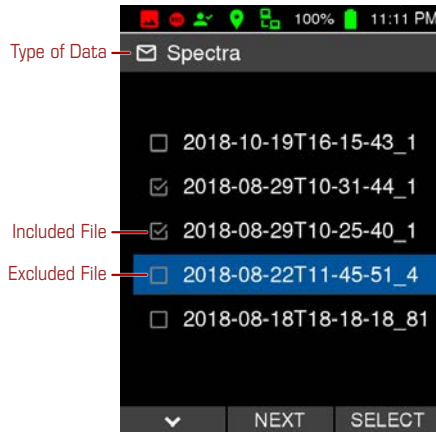
Figure 93: Selecting files

Included File —

Excluded File —
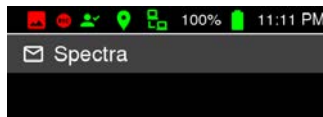
Figure 94: Ready to send files

Down

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

Exit

Return to the superior screen.

5.27   Self Test

This command initiates a test of several components of the rad EAGLET-R. The test is divided in several sections (Fig. 95, p. 91).
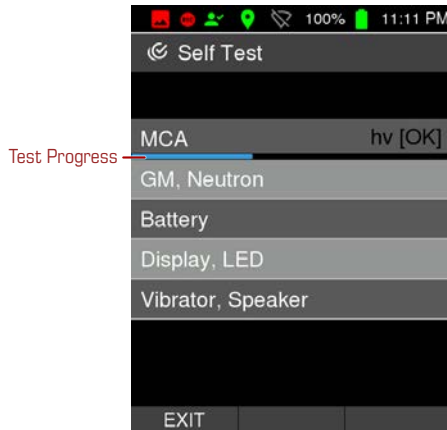
Figure 95: The self test screen

Multichannel Analyzer, Geiger-Müller Detector, Neutrondetector ✳

    Several features of these components are tested and the result is shown after a while:

    Passed

        No problems detected.

    Failed

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

    Check Calibration

        You should check the calibration of your instrument (see D.1, p. 151).

Battery

    The battery is checked and the result is shown after a while.

    Passed

        No problems detected.

    Failed

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

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 5.5, p. 57).

    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.

5.28   About

This screen (Fig. 96, p. 92) 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.

5.29   Shutdown

This screen (Fig. 97, p. 93) is shown when you switch off your RADEAGLET-R.

Settings and Commands

| OK |

     Shut down the instrument.

| Cancel |

     Cancel the current command.
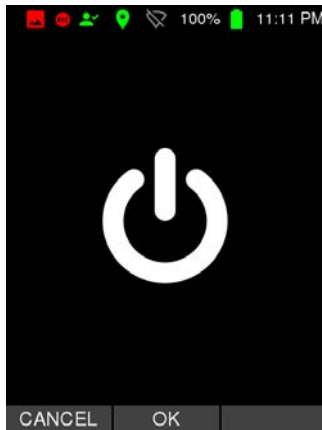
Figure 97: Shut down verification

6   Accessing ʀᴀᴅEAGLET-R Data

The ʀᴀᴅEAGLET-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   Storage Management

An overview of data stored on the ʀᴀᴅEAGLET-R ist available on the instrument (5.22, p. 82) or in the Web interface (7.10, p. 118).

6.2   Data Transfer

You can transfer data from the ʀᴀᴅEAGLET-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.

USB Mass Storage

You can connect a USB mass storage device, for example, a USB stick, to your ʀᴀᴅEAGLET-R and move or copy all available data to it (5.11.2, p. 67).

USB Cable

Connect the   magnetic USB connector of the ʀᴀᴅEAGLET-R (Fig. 4, p. 20) to a USB-A host connector of your device.

⚠️ For some computers or operating systems a special driver software is needed to connect to the ʀᴀᴅEAGLET-R via USB cable.

These drivers and installation instructions are availble via the Internet. Please refer to

https://beagleboard.org/static/beaglebone/latest/README.htm#step2

or visit our website to find current information on driver software under

http://www.innoriid.com/drivers/

You can check whether your computer recognizes the connected ʀᴀᴅEAGLET-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 ʀᴀᴅEAGLET-R

is listed as "Linux USB Ethernet/RNDIS Gadget" or "Remote NDIS Compatible Device" in section "Network Adapters" (Fig. 98, p. 96).
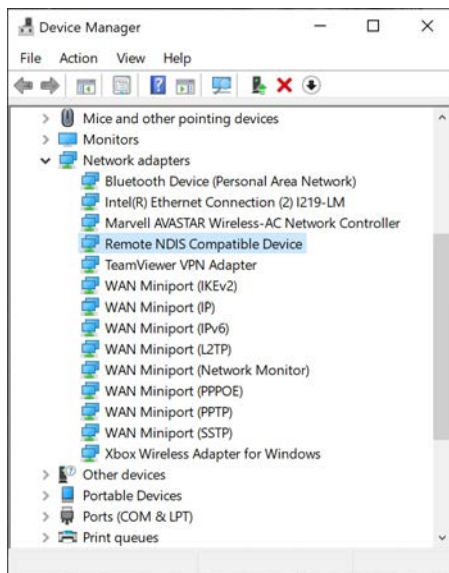
Figure 98: MS Windows 10: Check USB cable connection information

Apple MacOS

Information is available in the "Network" panel of the "System Preferences" accessible via the menu (Fig. 99, p. 96). The RADEAGLET-R is listed as "Beagle-Bone Black".
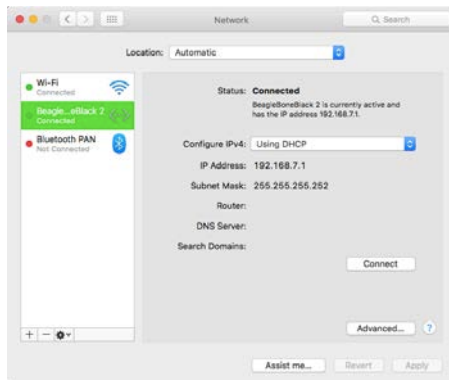
Figure 99: MacOS: Check USB cable connection information

Wi-Fi Hotspot

Activate the Wi-Fi hotspot (5.8, p. 60), 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.

Wi-Fi Client

Log your RADEAGLET-R into an existing Wi-Fi network (5.8, p. 60) 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.

📄 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.

📄 The RADEAGLET-R remembers networks it has been logged into and reconnects automatically when they become available.

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

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.

6.3   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 (7.4, p. 102) or manage or download all saved data to your device (7.10, p. 118).

6.4   Sending Data via E-Mail

While your RADEAGLET-R is, via cable or wireless, connected to a network with Internet access data can be transferred via email.

You can setup the connections and addresses on the instrument (see 5.7, p. 59 and 5.6, p. 58) or, more convenient, in the Web interface (7.7, p. 114).

For details about sending data refer to 5.26, p. 88.

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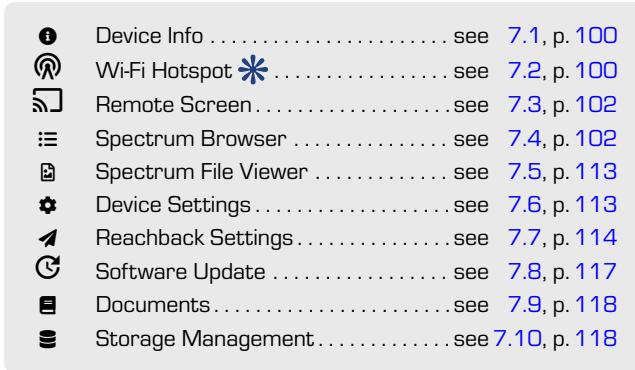
The Web interface is available when you use a recent Web browser on your computer, tablet or smart phone to navigate to the IP address given in the connectivity settings (see 5.7, p. 59).

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

💡 For the physical connection posibilities refer to section 6.2, p. 95.

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

❶	Device Info . . . . see	7.1, p.	100
ⓝ	Wi-Fi Hotspot ✳ . . . . see	7.2, p.	100
🔲	Remote Screen . . . . see	7.3, p.	102
≔	Spectrum Browser . . . . see	7.4, p.	102
🗎	Spectrum File Viewer . . . . see	7.5, p.	113
⚙	Device Settings . . . . see	7.6, p.	113
✈	Reachback Settings . . . . see	7.7, p.	114
⟳	Software Update . . . . see	7.8, p.	117
▤	Documents . . . . see	7.9, p.	118
⛁	Storage Management . . . . see	7.10, p.	118

Figure 100: 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. 101, p. 100) of the Web interface shows general information about your RADEAGLET-R and its status.

Figure 101: The device information in the Web interface

7.2   Wi-Fi Hotspot

✳ This item is available while a Wi-Fi dongle is plugged into the RADEAGLET-R's USB-A port.

This section (Fig. 102, p. 100) provides information about status, access path and credentials of the RADEAGLET-R's Wi-Fi hotspot.
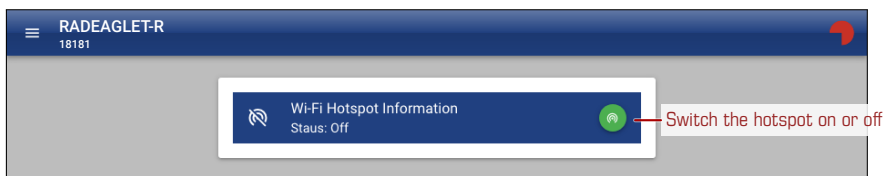
Figure 102: The Wi-Fi hotspot info in the Web interface (off)
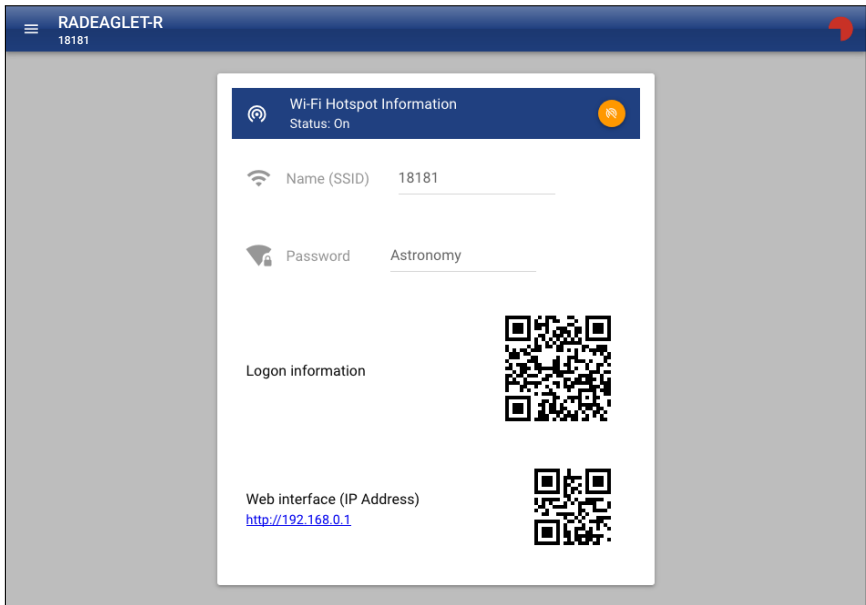
Figure 103: The Wi-Fi hotspot info in the Web interface (on)

7.3   Remote Screen

This section (Fig. 104, p. 102) 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.
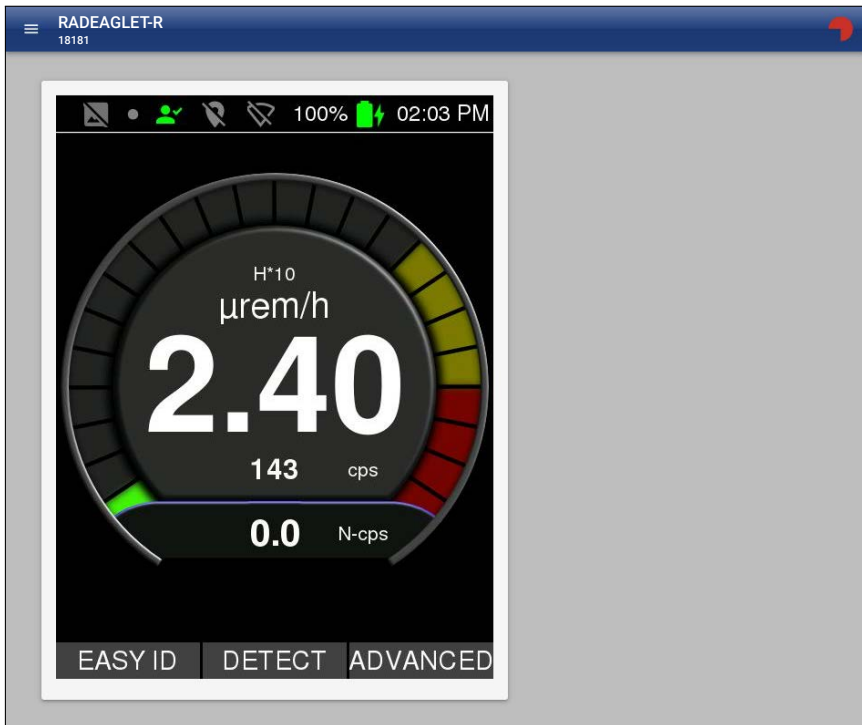
Figure 104: The remote RADEAGLET-R's screen in the Web interface

7.4   Spectrum Browser

This section (Fig. 105, p. 103) 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

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 ▾ .
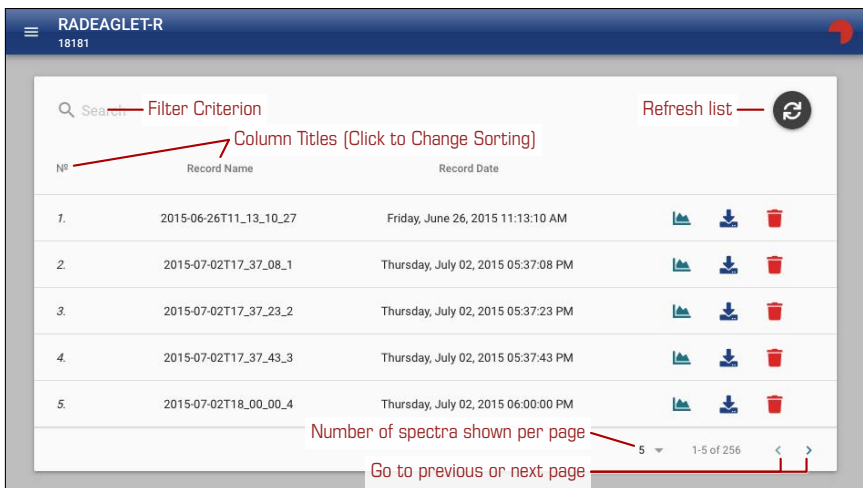
Figure 105: The spectrum browser in the Web interface

Several commands are available for the individual records:

- ⎙ Inspect the spectrum plus a lot of additional information (see 7.4.1, p. 104).

- ⬇ Download the record.

- 🗑 Delete the record.

7.4.1   Spectrum Inspector

The spectrum inspector shows a spectrum diagram for visual inspection (see 7.4.1.1, p. 104), 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 7.4.1.2, p. 106.

- 🔍 Automatic peak analysis, see 7.4.1.3, p. 106.

- ▤ PDF report, see 7.4.1.5, p. 111.

- ⋮ Spectrum details, see 7.4.1.4, p. 109.

7.4.1.1   Spectrum Diagram
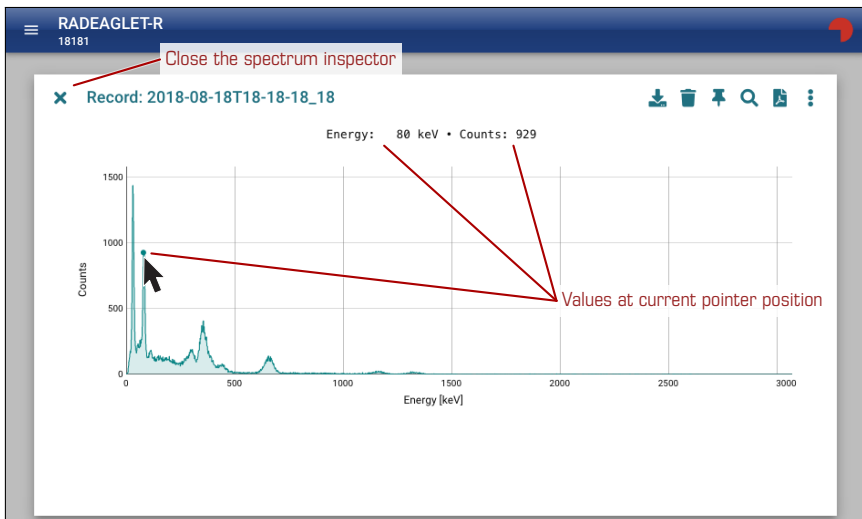
Figure 106: Spectrum diagramm in the Web interface

→ **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. 106, p. 104).

→ **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. 107, p. 105).
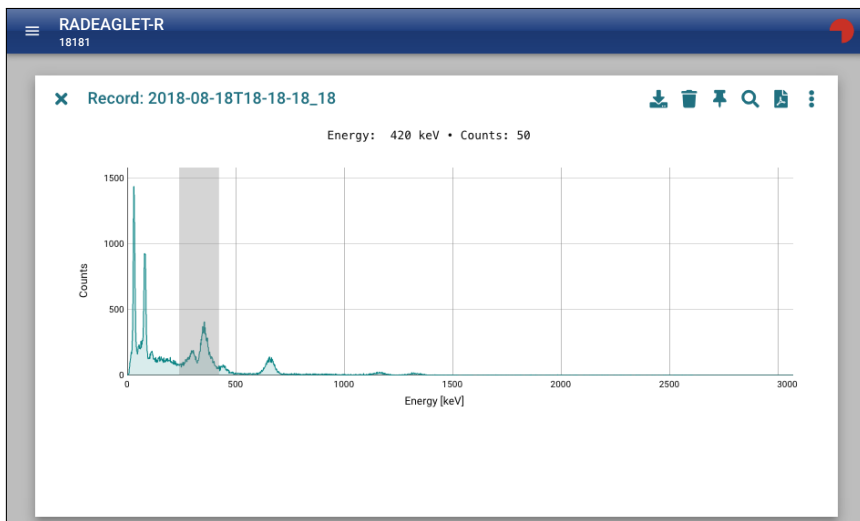
Figure 107: Zooming into the spectrum

3. Release the mouse button. The enlarged region shows up (Fig. 108, p. 106)

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

1. Double-Click in the chart area.
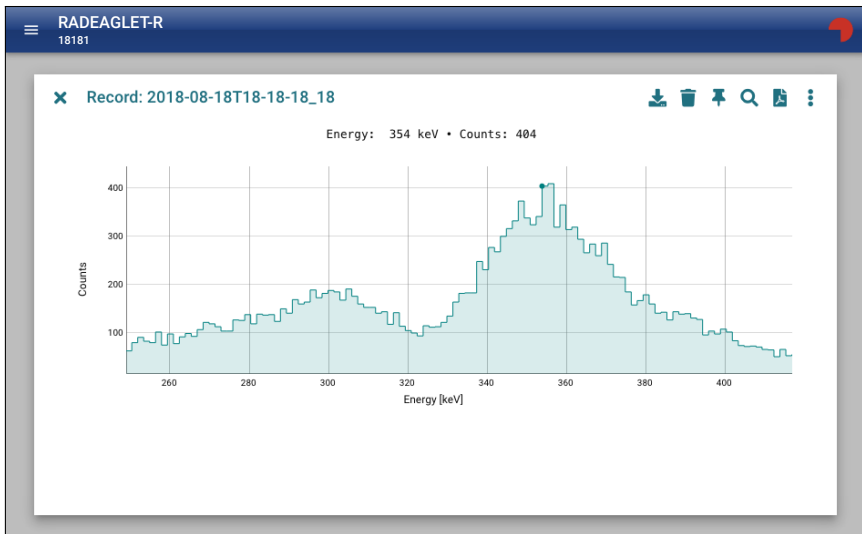
Figure 108: Enlarged part of the spectrum

7.4.1.2   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 7.4.1.1, p. 104).

3. Drag to the other end of the peak. The region will be accented (Fig. 109, p. 107).

4. Release the mouse button. The peak is colored in the diagram and the analysis results are shown below it (Fig. 110, p. 107).

7.4.1.3   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. 111, p. 108).
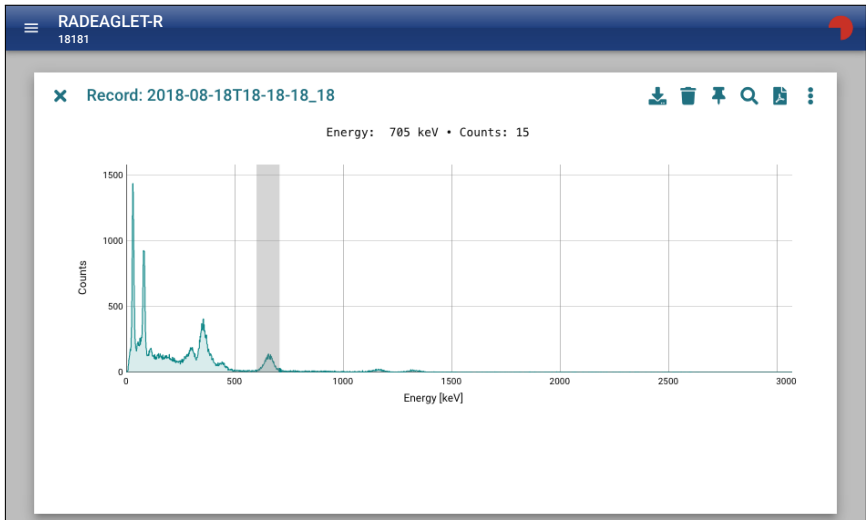
Figure 109: Marking a peak for analysis
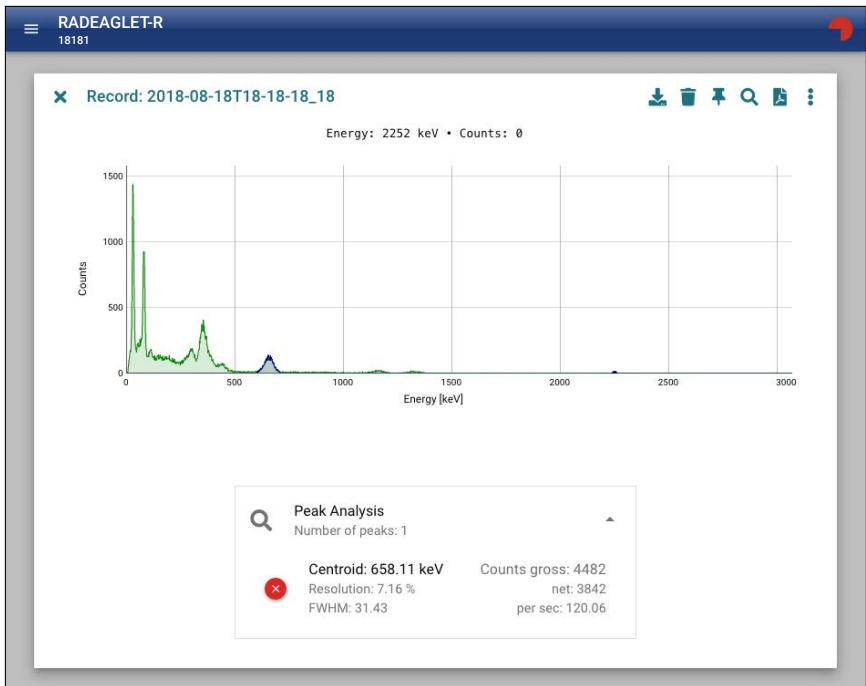
Figure 110: Results for a manually marked peak
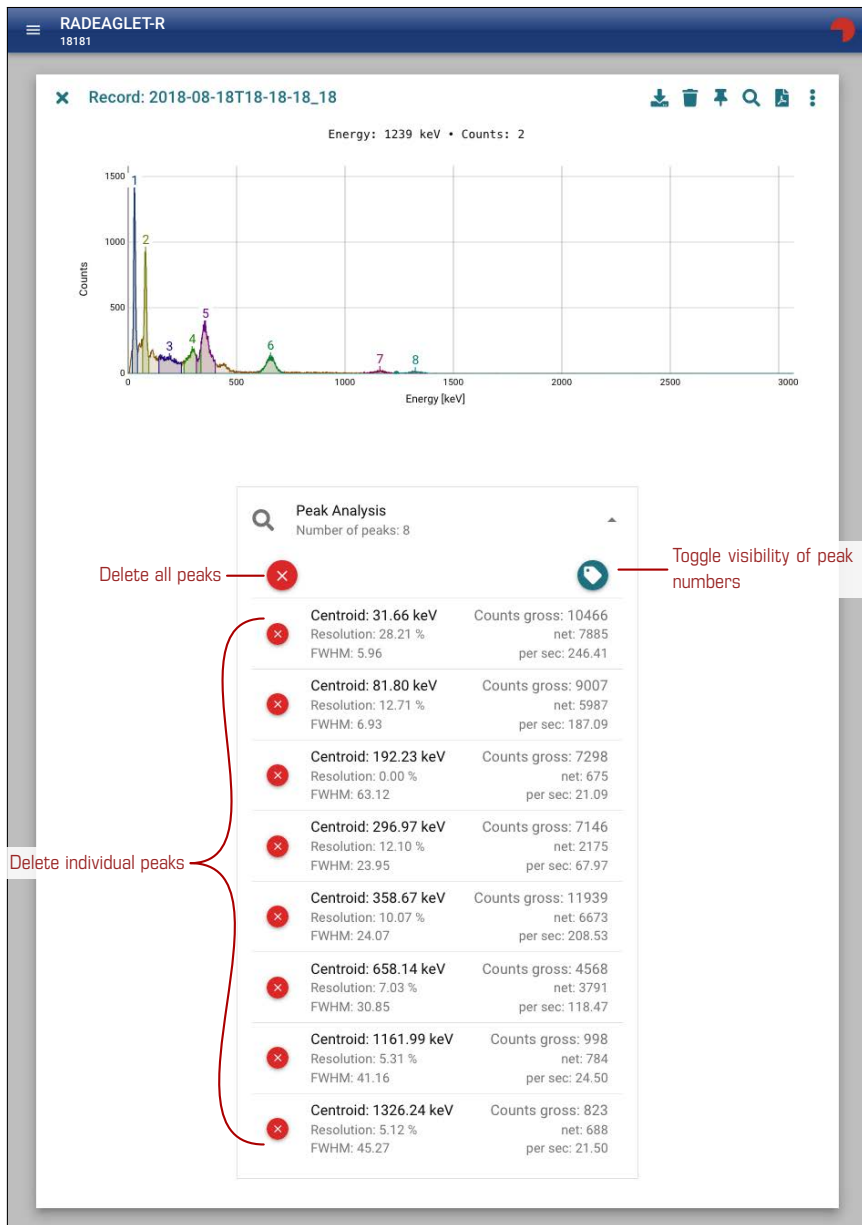
Figure 111: Results of an automatic peak analysis

7.4.1.4   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. 112, p. 109, Fig. 113, 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. 112, p. 109).
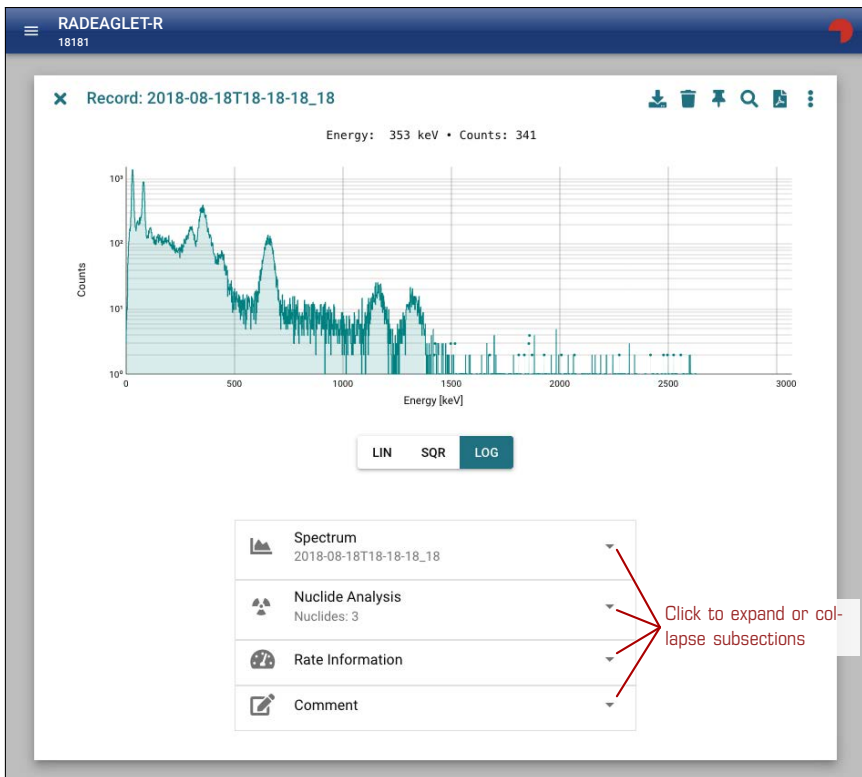
Figure 112: Spectrum with scaling methods and detail overview

You can add a comment to the spectrum in the last subsection (Fig. 114, p. 111). This comment will be appended to the PDF report (see 7.4.1.5, p. 111).
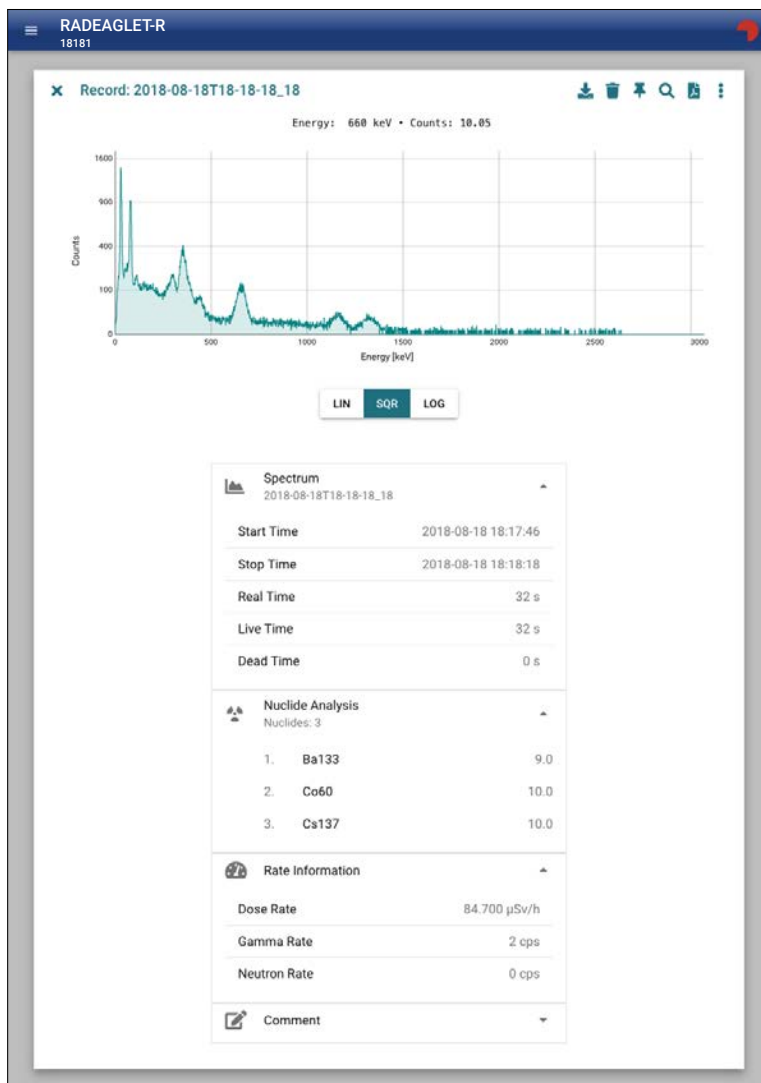
Figure 113: Spectrum with expanded detail information

🛑 The comment is not saved with the spectrum permanently. It is lost when you leave the spectrum inspector.
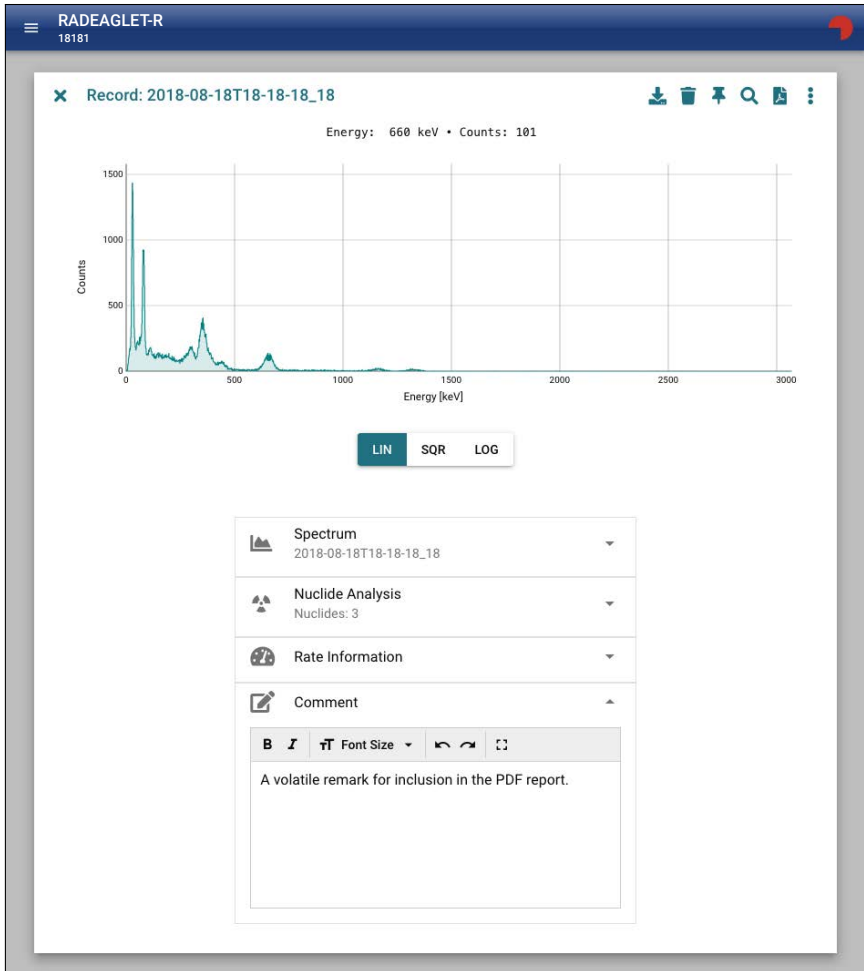
Figure 114: Comment subsection of spectrum details

7.4.1.5 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. .
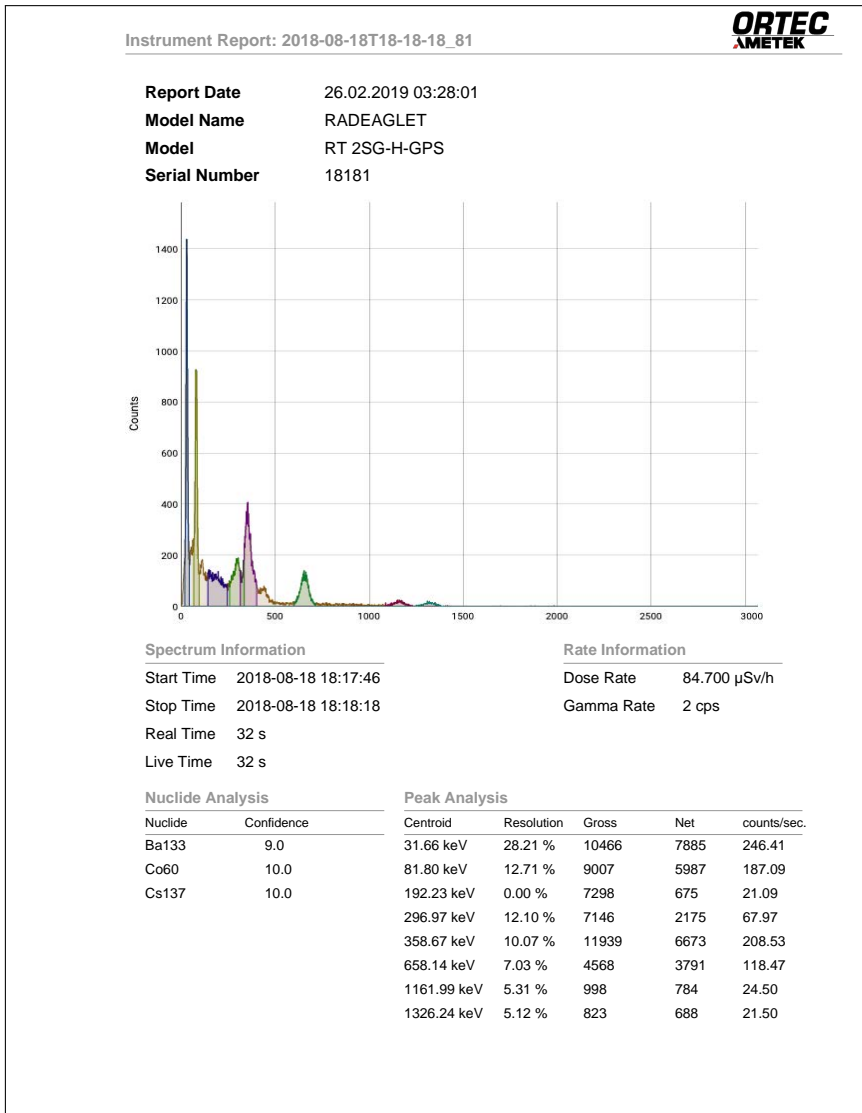
Figure 115: PDF report of a spectrum

7.5 Spectrum File Viewer

This section (Fig. 116, p. 113) provides access to the spectrum inspector (see 7.4.1, p. 104) 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.
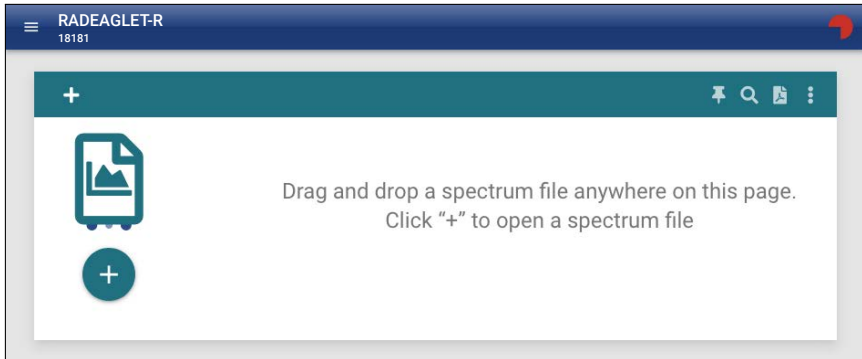
Figure 116: The spectrum file viewer in the Web interface

7.6 Device Settings

This section (Fig. 117, p. 113) provides access to some settings of your RADEAGLET-R. Changes you make here are transferred to the instrument.
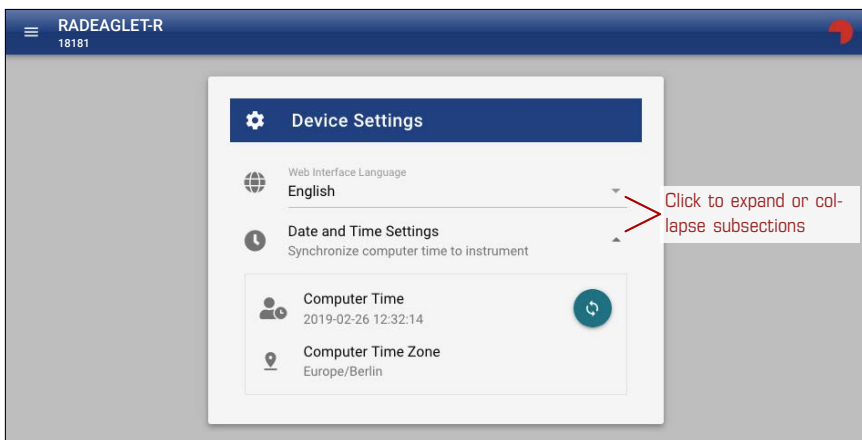
Figure 117: The RADEAGLET-R settings in the Web interface

7.7   Reachback Settings

This section (Fig. 118, p. 114) provides access to the settings for reachback methods described in see 6.4, p. 97. Entering addresses and passwords is way more convenient via the Web interface using a real keyboard than on the instrument itself.

You can make your changes permanent with ✿APPLY. If you leave the reachback settings without doing so, your changes are dismissed.
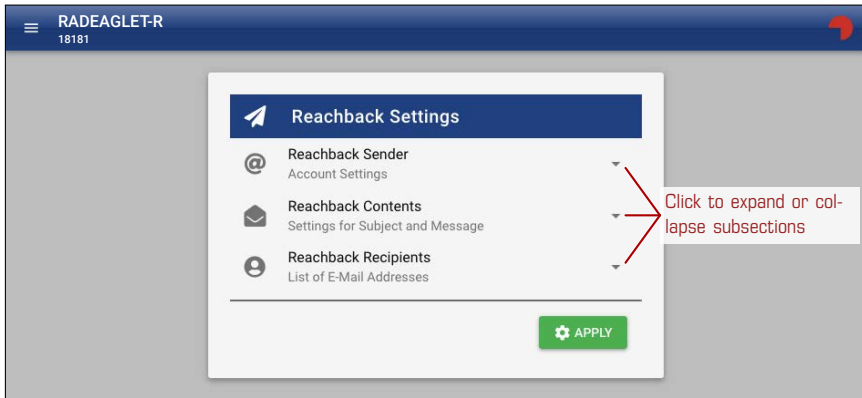
Figure 118: The reachback settings in the Web interface

The settings are grouped into subsections you can expand or collapse as needed (Fig. 119, p. 115).

You can send reachback messages to various recipients. The radEAGLET-R remembers a list of addresses so you don't have to enter them again and again but choose from the list. You can manage this list here by adding and deleting addresses (Fig. 120, p. 116).

The currently selected recipient is decorated with a checkmark ▲✓ (Fig. 119, p. 115). Click ▲ to select another recipient from the list.
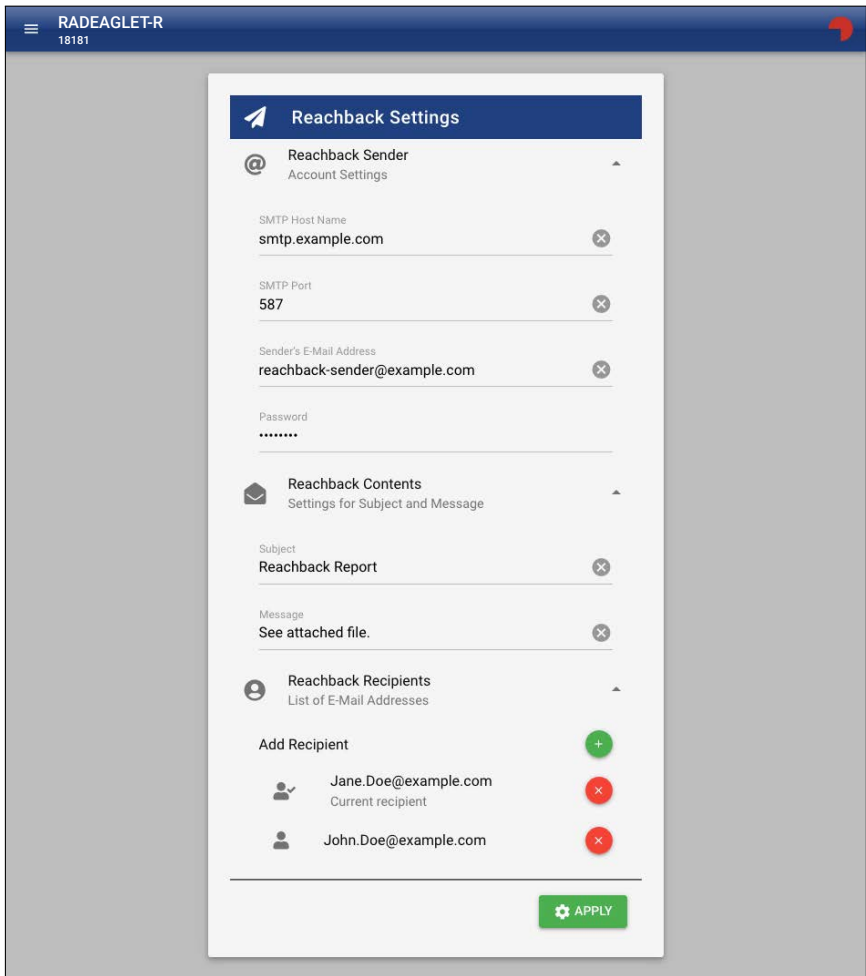
Figure 119: The expanded reachback settings in the Web interface
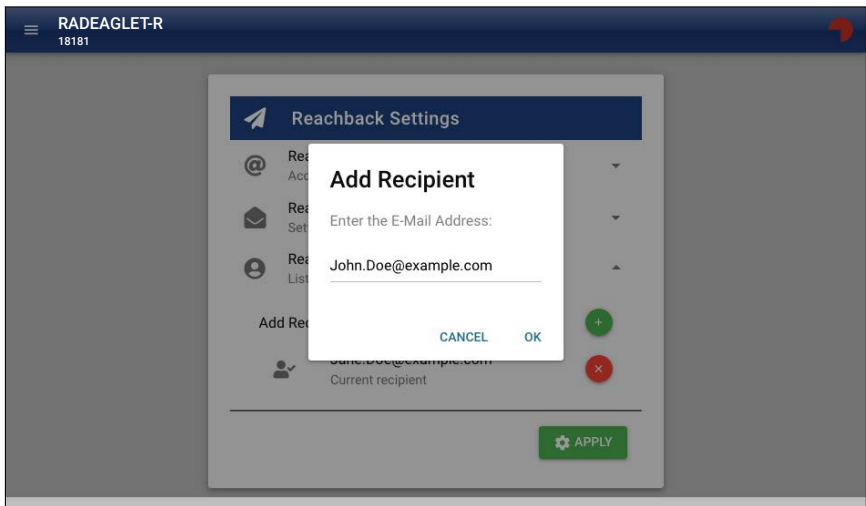
Figure 120: Adding a recipient for reachback messages

7.8 Software Update

You can upload updates or additional software to your RADEAGLET-R in this section of the Web interface (Fig. 121, p. 117).

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.
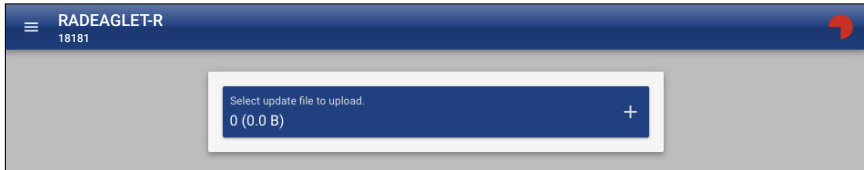
Figure 121: Update software on the RADEAGLET-R in the Web interface

The file will be transferred to the RADEAGLET-R, checked and prepared for installation (Fig. 122, p. 117).
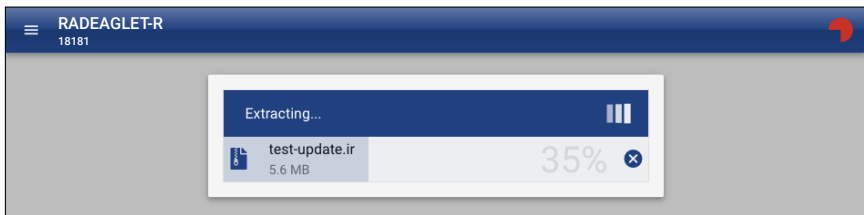
Figure 122: Transfer software to the RADEAGLET-R in the Web interface

After the file is checked and identified, you have to launch the installation by clicking ➔ (Fig. 123, p. 117).
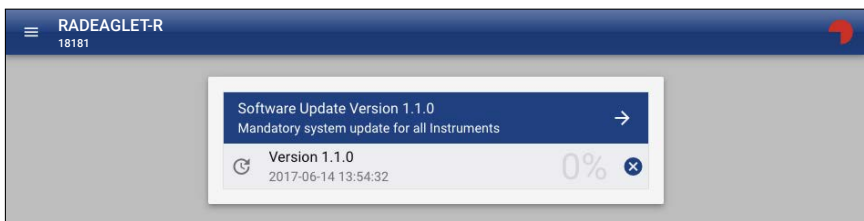
Figure 123: Ready to install the transferred software

You will be informed about the result (Fig. 124, p. 118) and the the instrument will be restarted if necessary.
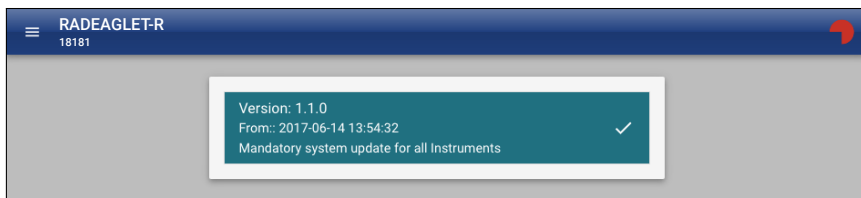
Figure 124: Successful installation of the software

7.9   Documents

This section (Fig. 125, p. 118) 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.
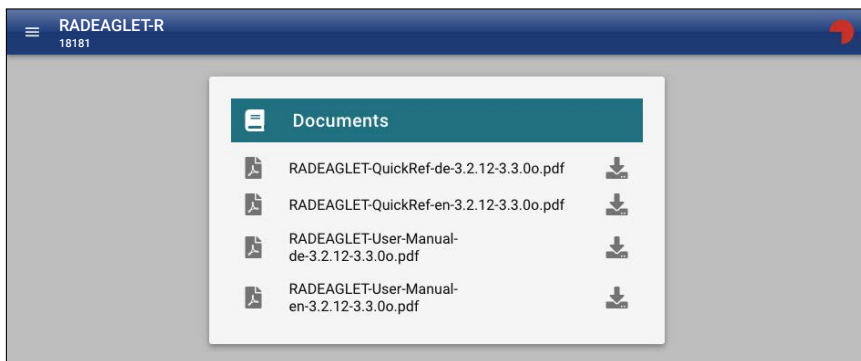
Figure 125: Documents available on your RADEAGLET-R

7.10   Storage Management

This section (Fig. 126, p. 119) provides access to all the data you saved in the RADEAGLET-R's database during your surveys.

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.
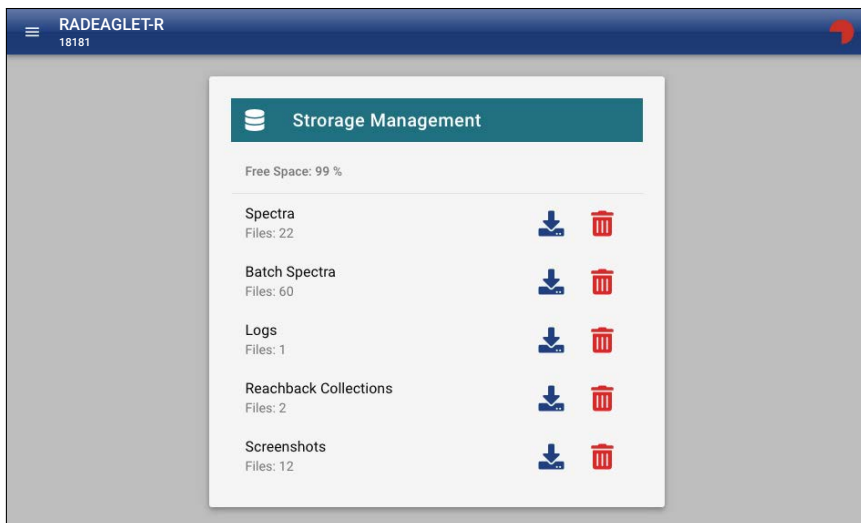
Figure 126: Managing the storage in the Web interface

Use this command in case you need space or to maintain data confidentially before you pass on the instrument to another user.

8 Powering the RADEAGLET-R

The standard power source of the RADEAGLET-R is a rechargeable black POWERCELL (8.1.1, p. 121) installed behind a locked cover on the left bottom (Fig. 127, p. 121) of the instrument.

To increase the field operation time you can swap the battery pack (8.2, p. 122) 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 (8.3, p. 123).

Figure 127: Position of the battery compartment cover of the RADEAGLET-R.

8.1 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.

8.1.1 Black POWERCELL

The black POWERCELL (Fig. 128, p. 122) is a sealed box containing rechargeable cells. They are recharged within the instrument whenever it is connected to external power.

A black 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. 153 for details on operating and charging durations.

Figure 128: The standard black rechargeable ᴘᴏᴡᴇʀCELL of the ʀᴀᴅEAGLET-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. 153.

🚫 Do not unscrew the black ᴘᴏᴡᴇʀCELL. There are no user servicable parts inside.

→ **To check the status of a black ᴘᴏᴡᴇʀCELL**...

1. Press the marked button on the contact side of the black ᴘᴏᴡᴇʀCELL (Fig. 129, p. 122).

2. Observe the LED. It flashes in a pattern proportional to the current status:

   • No light: Empty

   • Continuous light: Full
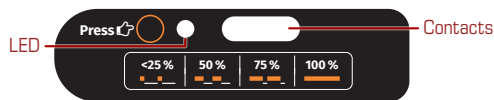
Figure 129: Status check of the black ᴘᴏᴡᴇʀCELL of the ʀᴀᴅEAGLET-R.

8.2 Replacing Batteries of the ʀᴀᴅEAGLET-R

You can replace the ᴘᴏᴡᴇʀCELL of the ʀᴀᴅEAGLET-R.

💡 You can replace ᴘᴏᴡᴇʀCELL while the ʀᴀᴅEAGLET-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. 130, p. 123).

powerCELL with Flap

Locking Screws

Figure 130: 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.

8.3   External Power Sources

You can connect the RADEAGLET-R to external power sources via the connector on the rear side of the instrument Fig. 4, p. 20.

Included with the RADEAGLET-R are:

- Wall power supply (8.3.1, p. 124)
- 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.

8.3.1   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. 131, p. 124).
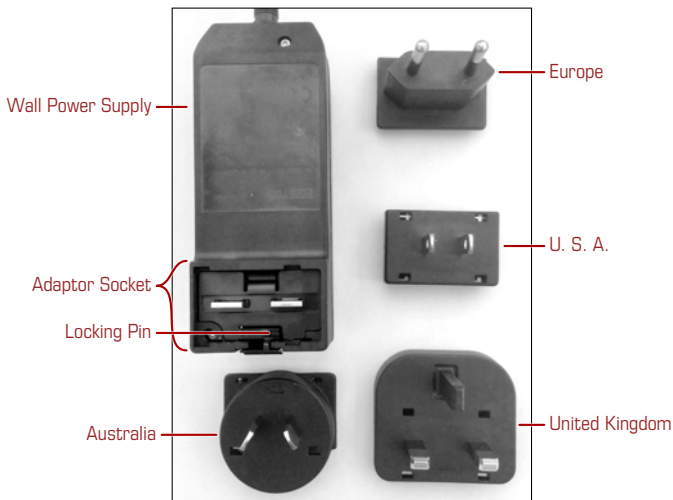
Figure 131: Wall power supply with international adaptors

→ To swap the international adaptor…

1. Press the lock and slide the current adaptor to the side out of its socket (Fig. 132, p. 125).

2. Pull and Slide

1. Pull Down
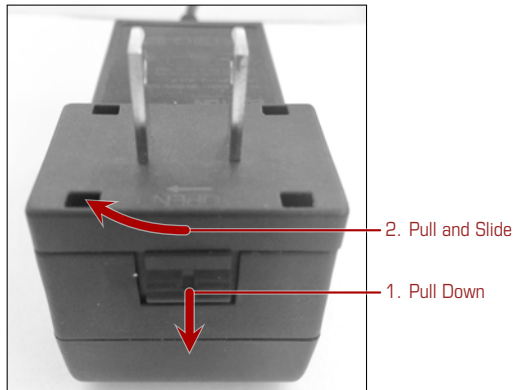
Figure 132: Removing an adaptor from the wall power supply

2. Insert the desired adaptor into the socket and move it until it snaps into place (Fig. 133, p. 125).

Push Down and Slide
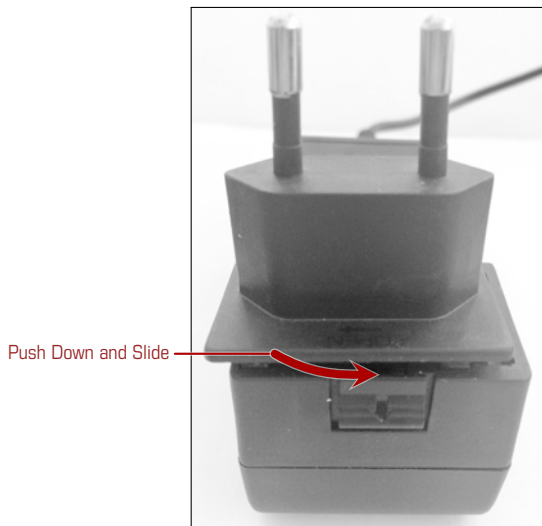
Figure 133: Mounting an adaptor to the wall power supply

8.4   Charging the POWERCELL

While your RADEAGLET-R is connected to an external power source (see 8.3, p. 123) an installed black POWERCELL (see 8.1.1, p. 121) 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. 153 for details on typical charging durations.

8.5   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. 56) to what you really need in your environment.

Let the backlight time out after the shortest period of inactivity (see 5.4, p. 56) convenient for your workflow.

Wi-Fi

Switch off the Wi-Fi hotspot while you not using it to communicate (see 5.8, p. 60).

USB Devices

Disconnect any USB devices while you are not transferring data.

GPS Receiver

Switch off the GPS receiver (see 5.13, p. 70) 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.

9   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 9.1, p. 127).
2. Survey the environment (see 9.2, p. 130).
3. Locate a radiation source (see 9.3, p. 133).
4. Identify the Radiating Nuclide (see 9.4, p. 135).
5. Transfer Results (see 9.5, p. 138).
6. Turn off the RADEAGLET-R (see 9.6, p. 141).

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. 19) 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.

9.1   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. 16, 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.
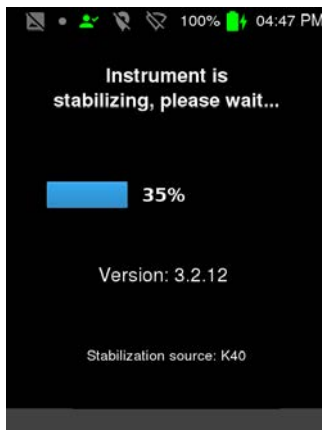
Figure 134: Initial Stabilization during instrument start

6. The RADEAGLET-R begins an initial stabilization (Fig. 134, p. 128).

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. 56). The lower the backlight brightness, the longer the battery lasts.

9.1.1 Check the Status of the RADEAGLET-R

After startup the RADEAGLET-R is ready for use. The top of the screen (Fig. 135, p. 128) 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 135: Status bar along the display's top edge

Several commands are available to inspect other status information. They are listed in Fig. 136, p. 129.

- ❶ General Information . . . . see 5.28, p. 92
- ❷ Available Memory . . . . see 5.22, p. 82
- ❸ GPS ✳ . . . . see 5.13, p. 70
- ❹ Self Test . . . . see 5.27, p. 90
- ❺ Hardware Status . . . . see 5.16, p. 74

Figure 136: Commands for status information

9.1.2   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 5.18, p. 76. Here we use an automated calibration procedure.

💡 For additional information refer to appendices C.1, p. 147 (stabilization), C.2, p. 148 (calibration), and D.1, p. 151 (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. 137, p. 130).

7. Wait until the RADEAGLET-R displays "System is operative" (Fig. 138, p. 130).

8. Finish the calibration with ⟨ Exit ⟩.
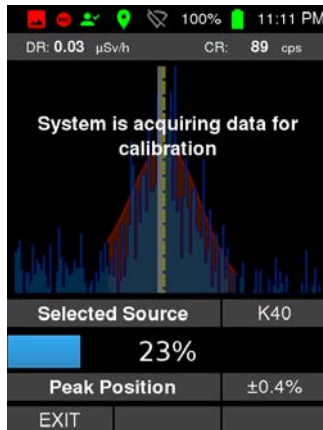
Figure 137: Easy calibration in progress
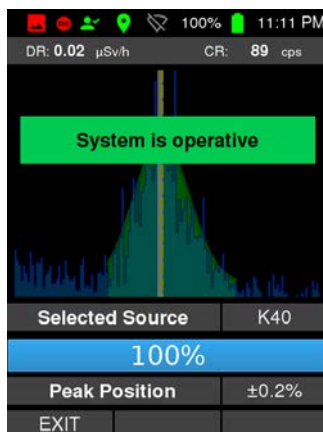
Figure 138: Easy calibration finished

9.2 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. 139, p. 131) appears after starting up the instrument.

Figure 139: The RADEAGLET-R in dose rate mode

9.2.1 Gamma Radiation

→ **To survey for gamma radiation**…

1. Move the RADEAGLET-R around (Fig. 140, p. 131) and observe the display.

Figure 140: Surveying an object for gamma radiation

The current dose rate is shown in a chart and with large digits (Fig. 139, p. 131).

💡 You can change the dose rate unit, see (see 5.4, p. 56).

2. The ʀᴀᴅEAGLET-R always compares the current dose rate with the thresholds speci-
fied for warnings and alarms (see 5.17, p. 75) and reports values above the thresholds
(Fig. 141, p. 132).

Figure 141: A gamma warning as reported on screen

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

9.2.2   Neutron Radiation

✳ This item is available for ʀᴀᴅEAGLET-R models with a neutron detector (see E.1,
p. 153).

The ʀᴀᴅEAGLET-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 sub-
stances containing lots of hydrogene.

➔ **To survey for neutron radiation**…

1. Increase the sensitivity for unmoderated neutrons by holding the ʀᴀᴅEAGLET-R so the
neutron detector is close to your body (Fig. 142, p. 133).

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. 143, p. 133).

4. If the neutron counts exceed the adjustable alarm threshold (see 5.17, p. 75) a neu-
tron alarm is triggered (see 4.1.1, p. 45).

💡 For unmanned neutron detection a moderator must be used additionally. See Ap-
pendix E.4, p. 160 for details.

Figure 142: Recommended posture for neutron moderation

Figure 143: Dose rate display with neutron incidents

9.3   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. 38).

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 (5.5, p. 57).
   Make sure the speaker is on (Fig. 144, p. 134).
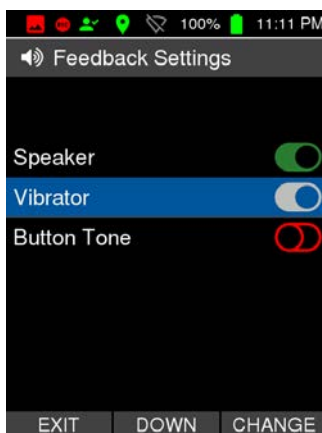
Figure 144: Checking the speaker switch

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. 145, p. 135).

8. When the background measurement is complete, move the instrument around.
   The display shows a bar chart representing the count rate history (Fig. 146, p. 135).

   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.
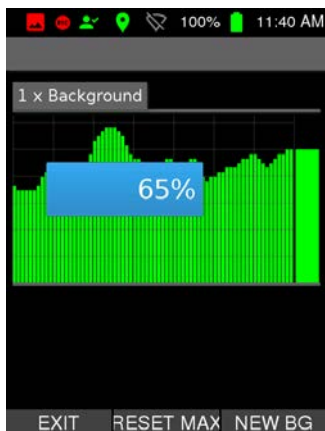
Figure 145: Collecting background data in Detect Mode with progress percentage.
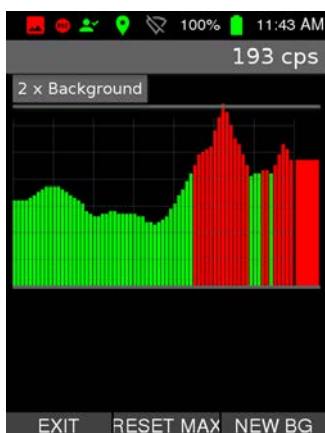
Figure 146: Detect mode chart when approaching a radiation source

9.4   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.

9.4.1   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 147: 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 (5.21, p. 79).

→ **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. 147, p. 136) 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.

9.4.2   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 5.20, p. 78). A chart with a colored bar (Fig. 148, p. 137) helps you to find the best distance between instrument and source.
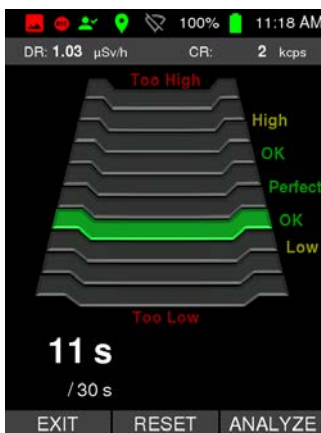
Figure 148: The Easy ID spectrum acquisition

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. 149, p. 138).

   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. 70 for details.

   ✳ This item is available for RADEAGLET-R models equipped with a GPS receiver (see E.1, p. 153).
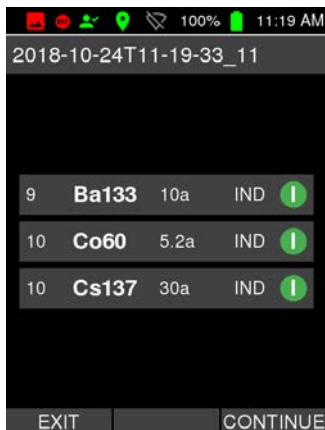
Figure 149: The Easy ID results

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.

9.5 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 6.2, 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 6.2, p. 95 for details.

⚠ Usually you don't need to install additional software on your computer. If in doubt, refer to section 6.2, p. 95.

9.5.1   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. 66).

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. 150, p. 139).

Figure 150: 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. 151, p. 140 with general information about the connected RADEAGLET-R.

8. Click ≡ at the top to reveal the menu of the web interface (Fig. 152, p. 140).
   Find a full description of all the options in chapter 7, p. 99.

Figure 151: The device information in the Web interface
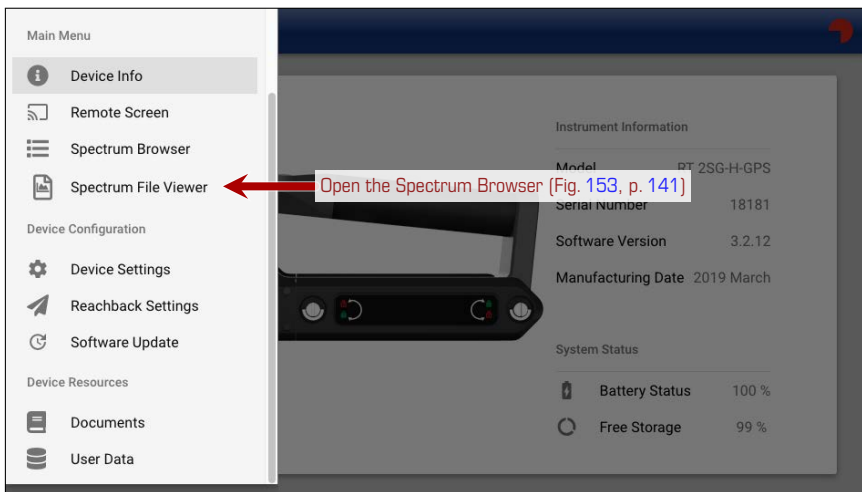
Figure 152: The menu of the Web interface

➜ **To inspect data saved on your ʀᴀᴅEAGLET-R**…

1. Get a list of saved spectra by clicking "Spectrum Browser" in the menu (Fig. 152, p. 140).

2. Look for the spectrum you saved after the identification in section 9.4.2, p. 137 above (Fig. 149, p. 138).

   💡 Change the sequence of the listed spectra by clicking the column title (Fig. 153,

p. 141]. Multiple clicks on the same column toggle between ascending and descending order.
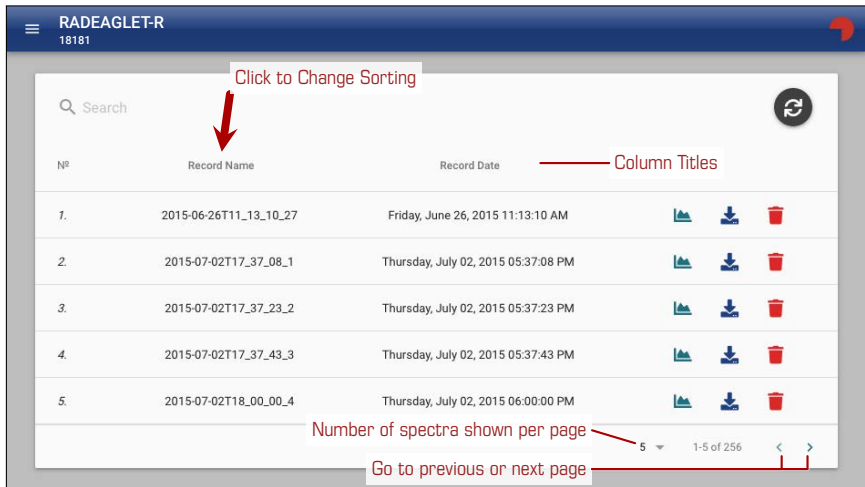
Figure 153: The spectrum browser in the Web interface

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 7.4, p. 102 to learn about the other features of the Spectrum Browser.

   Chapter 7.10, p. 118 explains how to downlaod all stored spectra in one go.

9.6 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.
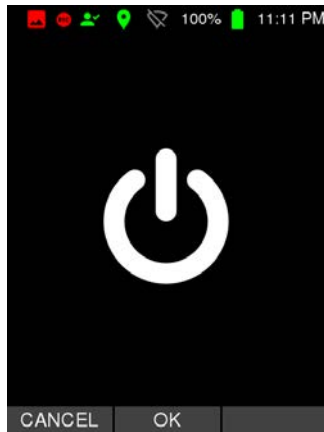
Figure 154: Shutting down the RADEAGLET-R

4. Press 🔽 to confirm the command (Fig. 154, p. 142).

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

A   Nuclide Library

to be defined

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. 153).

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.

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 5.18, p. 76.

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 $\boxed{\text{Calibration}}$ 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 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.6   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.7   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. 71) 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.

E   Info Pool

E.1   ɪɴɴᴏRIID ʀᴀᴅEAGLET-R: Specifications

Several models of this product are available.

(A) ʀᴀᴅEAGLET-R 2SG

Sodium iodide detector (NaI); Geiger-Müller tube

(B) ʀᴀᴅEAGLET-R 2SG-E

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

(C) ʀᴀᴅEAGLET-R 2SG-H

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

(D) ʀᴀᴅEAGLET-R 2SG-H-E

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

(E) ʀᴀᴅEAGLET-R 2SG-P

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

(F) ʀᴀᴅEAGLET-R 2SG-P-E

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

(G) ʀᴀᴅEAGLET-R 2SG-H-P

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

(H) ʀᴀᴅEAGLET-R 2SG-H-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) × 114 mm (4.49 in); net: 9.4 mm (0.37 in) × 100 mm (3.94 in); 8 bar (116.03 psi)

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4	Neutrons: Li$_6$ZnS (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: 145 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 — 250 µSv/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)	3.5 cps/nv ±10 %; unmoderated; according to manufacturer's data
19	Nuclide Library	*to be defined*
20	Nuclide Library (C)(D)(G)(H)	*to be defined*
	Physical Properties	
21	Dimensions (W × D × H)	90 mm (3.54 in) × 280 mm (11.02 in) × 110 mm (4.33 in)
22	Housing Material	Rustless; Aluminium; fiber-reinforced plastic; polyoxymethylene; glass
23	Weight (A)(B)	1420 g (3.13 lb) including batteries
24	Weight (C)(D)	1470 g (3.24 lb) including batteries
25	Weight (E)(F)	1430 g (3.15 lb) including batteries
26	Weight (G)(H)	1480 g (3.26 lb) including batteries
	Environmental	
27	Operation	-20 °C — +55 °C (-4 °F — +131 °F); >0.15 bar (2.18 psi)
28	Storage, Transport	Recommended; +10 °C — +35 °C (+50 °F — +95 °F); <2.1 bar (30.46 psi)

to be continued...

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29	Storage, Transport	-20 °C — +50 °C (-4 °F — +122 °F); <2.1 bar (30.46 psi)
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 % — 80 %, non condensing
32	Protection Rating	IP66 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
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

to be continued...

… continuation

49	Blue LED Ⓒ Ⓓ Ⓖ Ⓗ	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
63	Calibration Source Ⓐ Ⓒ Ⓔ Ⓖ	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

to be continued…

... continuation

| 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
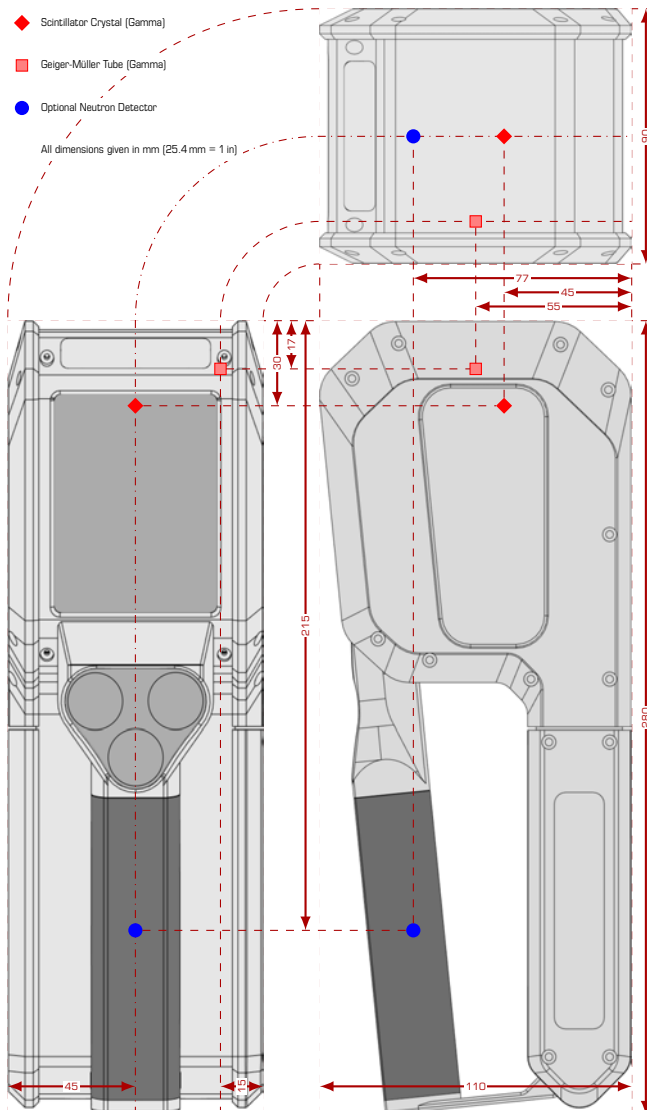
Figure 155: Position of the detector centers of the radEAGLET-R (2 in×2 in scintillator, drawn to scale)

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. 153 and on the label attached to your instrument (Fig. 156, p. 159).
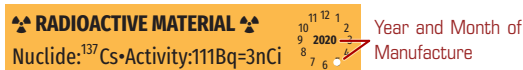

Figure 156: Label on the bottom side of a radEAGLET-R with an embedded source

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 Sv/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. 153).

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).

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.