ORTEC®

RADEAGLE

User Manual

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AMETEK®
ADVANCED MEASUREMENT TECHNOLOGY

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1 Welcome

This chapter offers introductory information about this manual, some important advice for your safety and that of the instrument, and an overview of the radEAGLE, 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 radEAGLE.

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

The radEAGLE is not certified for use in explosive environments.

Do not unscrew the housing of the radEAGLE. There are no user servicable parts inside.

Various components inside the radEAGLE 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 nature of the application is such that objects you survey with the RADEAGLE could emit ionizing radiation with hazardous intensity.

1.3 Instrument Safety

The detector crystals built into in the RADEAGLE 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 30.0 °C (54.0 °F) in order to avoid damages.

1.4 Before First Use

We recommend charging the batteries of the RADEAGLE after unpacking prior to first time use (8.4, p. 116).

This is a good time to get familiar with the RADEAGLE by reading this manual.

Please read at least the rest of this chapter and those on basic operation (chapter 2, p. 21) before starting to experiment with the RADEAGLE.

Chapter 2, p. 21 explains the principles of operating the RADEAGLE.

The fundamental modes of operation of the RADEAGLE are detailed in chapter 3, p. 31, followed by explanations of the RADEAGLE alarms in chapter 4, p. 37.

A detailed reference on all the commands is given in chapter 5, p. 41, 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. 85.

Chapter 8, p. 107 details the power supply for the RADEAGLE and the handling of various battery types.

The appendix comprises

- information about the nuclides the RADEAGLE can identify (Appendix A, p. 119),
- a glossary of terms and technological background (Appendix B, p. 125 and C, p. 127)
- a trouble shooting guide (Appendix D, p. 131)
- an info pool (Appendix E, p. 135) with certificates, specification data etc.

✱ Several models of the radEAGLE are available (see E.1, p. 135 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 radEAGLE

The radEAGLE 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

✱ ^{3}He Neutron detector

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

✱ GPS Receiver

1.5.1 Detectors

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

1.5.1.1 Scintillation Detector

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

1.5.1.2 Geiger-Müller Detector

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

STOP 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 radEAGLE models with a neutron detector (see E.1, p. 135).

The ^{3}He neutron detector continuously runs and acquires the current neutron counts per second (cps) (→Neutron Detector).

1.5.2 Overview

Fig. 1, p. 14 shows a top view on the radEAGLE instrument. The radEAGLE features a 3.5 in (89 mm) color display presenting the various screens of the software.

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

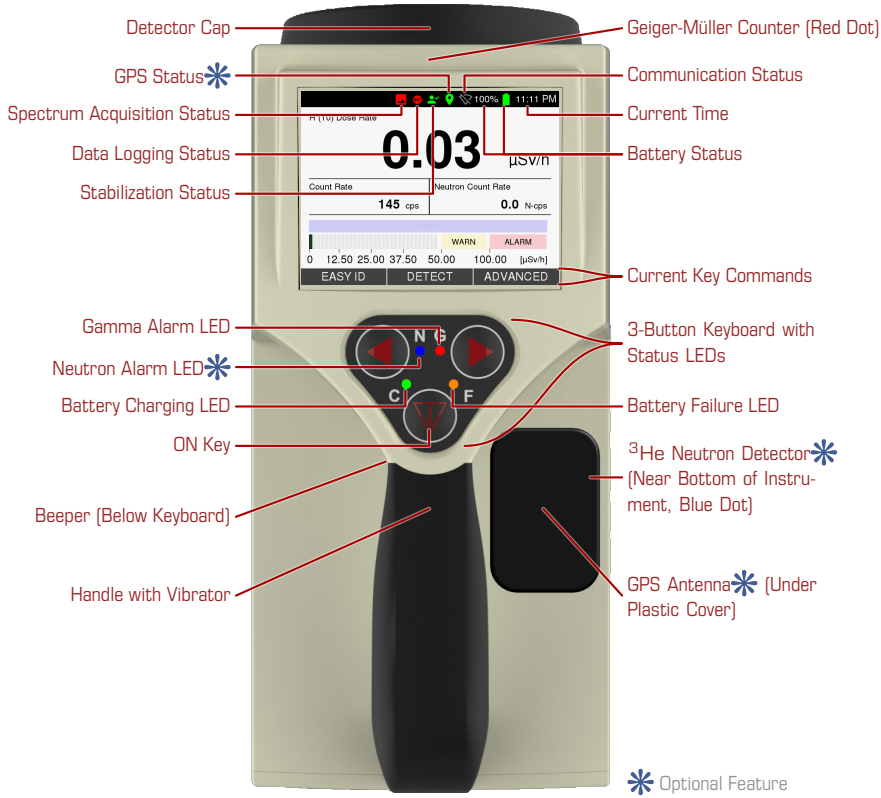


Figure 1: Annotated top view of the radEAGLE instrument

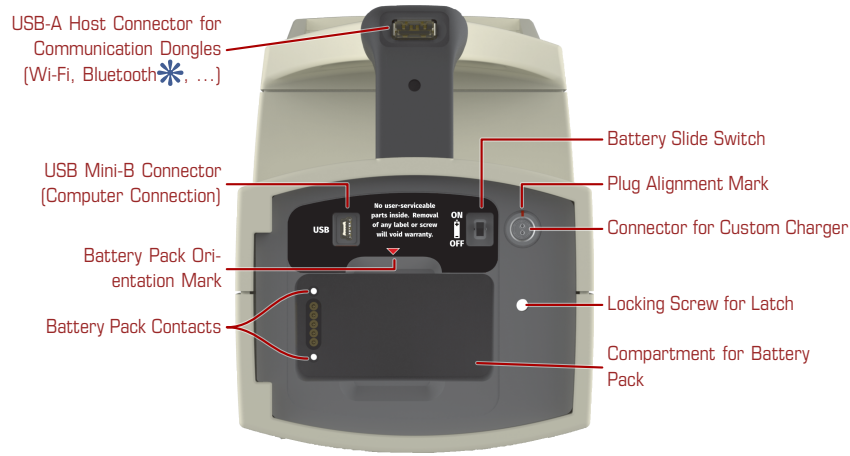


Figure 2a: Rear view of the RADEAGLE with open latch (standard housing)

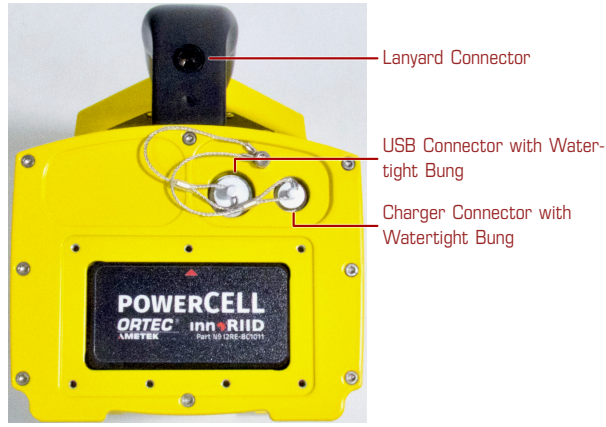


Figure 2b: Rear view of the RADEAGLE with open battery compartment (underwater housing)

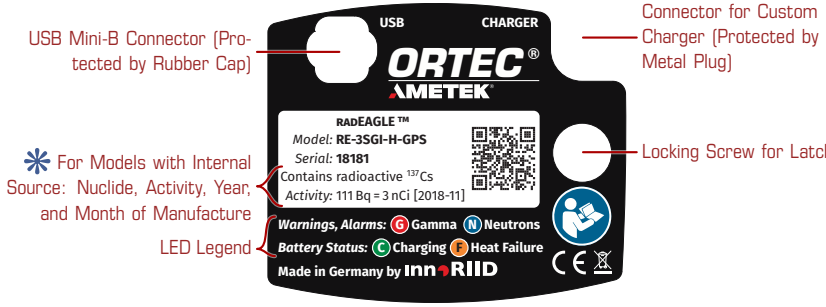


Figure 3: Name plate on the rear latch of the RADEAGLE

1.5.3 Hardware Accessories

The radEAGLE 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. 4, p. 16, Fig. 5, p. 17, Fig. 6, p. 17):

Figure 4: The radEAGLE in the standard case

- (A) radEAGLE instrument
- (B) KCl Calibration box
- (C) Charger with US or European plug
- (c) International adaptors for Charger (not with all instruments)
- (D) Power adaptor for cars (12 V)
- (E) Extra Battery pack for AA batteries (with screw driver)
- (F) USB cable for connecting the radEAGLE to a PC
- (G) Documents (manual, quick reference card, test sheet)
- (H) USB Stick

Please make sure the delivered parts are complete.

Figure 5: The radEAGLE in an optional watertight case

Figure 6: The radEAGLE with accessories

Figure 7: Standard (left) and optional watertight cases for the radEAGLE

1.5.4 Connectors

The RADEAGLE 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.

USB Mini-B at rear end

Use this plug (Fig. 2a, p. 15, Fig. 2b, p. 15) to connect your RADEAGLE to a computer. All common operating systems like Microsoft Windows, MacOS or Linux are supported.

USB-A host connector in the handle

Use this plug (Fig. 2a, p. 15) for Wi-Fi, Bluetooth, USB-to-Ethernet adaptors, or USB storage devices (all optional).

Power plug on back side

Please align the red dot on the charger cable to that of the plug when connecting (Fig. 2a, p. 15, Fig. 2b, p. 15, Fig. 140, p. 114).

2 Using the radEAGLE

The radEAGLE 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 radEAGLE Display

The radEAGLE displays information on a color LCD screen (Fig. 1, p. 14) divided into three principle areas (Fig. 8, p. 21).

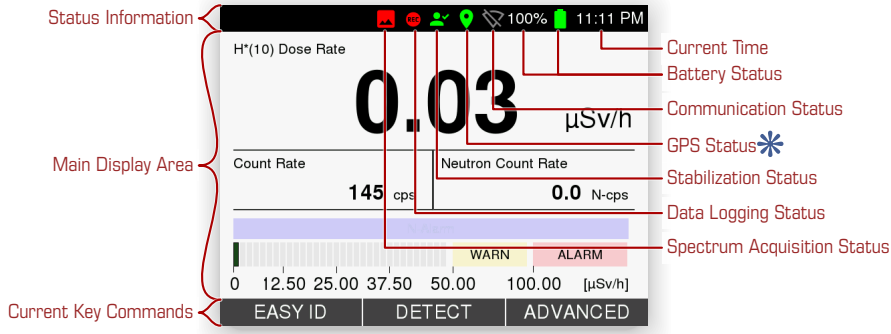


Figure 8: Anatomy of the radEAGLE display

Top: Status Bar

This area contains icons representing the status of several components of the radEAGLE.

3:17 pm

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

Please ensure the correct setting of the clock and your local time zone (see 5.3, p. 48)

If the instrument's clock is completely off, you have to set it via the web interface (see 7.6, p. 99).

Battery Status

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

- Full battery (100 %)

- Empty battery
- While the radEAGLE is powered by an external source (see 8.3, p. 113) providing enough power to charge the internal battery, the symbol is decorated by a bolt.

- While the radEAGLE is powered by an external source (see 8.3, p. 113) 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 radEAGLE's USB-A port.

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

GPS Status ✳

This item is available for radEAGLE models equipped with a GPS receiver (see E.1, p. 135).

- 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. 127) 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. 131 for recommended remedies.

Data Logging

This symbol shows whether the RADEAGLE logs data.

- The RADEAGLE 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 RADEAGLE currently acquires and records spectral data.

- The RADEAGLE 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 RADEAGLE. This may be status information after powering up the instrument (Fig. 20, p. 30), menus to choose from (Fig. 33, p. 42), alarms (Fig. 31, p. 38), or measurement results (Fig. 25, p. 33).

Bottom: Keyboard Legend

The labels in this area name the function currently associated with each of the RADEAGLE keys (Fig. 8, p. 21, Fig. 9, p. 24).

2.1.1 Status LEDs

Alarm and battery status LEDs are built into the keyboard of the RADEAGLE (Fig. 1, p. 14, Fig. 9, p. 24).

- G Gamma warnings and alarms
- N Neutron warnings and alarms *
  This item is available for RADEAGLE models with a neutron detector (see E.1, p. 135).
- 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 RADEAGLE Keys

You control the RADEAGLE with the three keys (Fig. 1, p. 14) 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. 50).

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

The meaning of every key changes depending on the circumstances. The current function of the keys is shown along the bottom of the screen (Fig. 9, p. 24) at all times. Almost, exceptions are: Switching on the RADEAGLE (see 2.3, p. 29) and taking screenshots (see 2.2.5, p. 28).

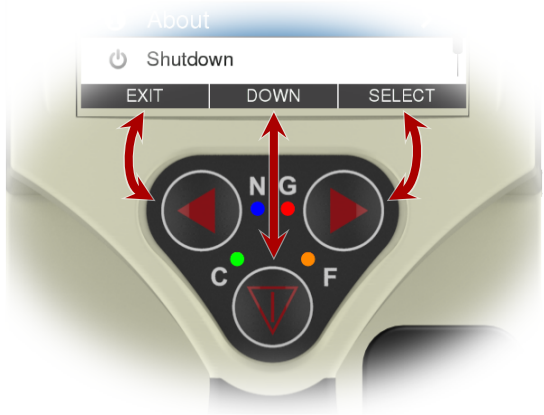


Figure 9: The current functions of keys shown along the bottom of the RADEAGLE display.

Chapter 5, p. 41 provides detailed descriptions of the different key functions under various conditions.

Some commands are available for a lot of the RADEAGLE'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 RADEAGLE cannot be used with only the three commands you can directly access via the three keys. All the available commands are grouped into pairs mapped to the keys ◀ and ▶, respectively.

The center key ▽ is mapped to the pseudo command Next, which cycles through the available command pairs (Fig. 10, p. 25).

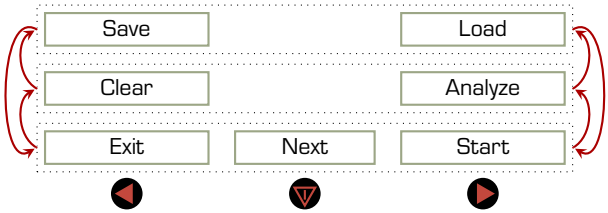


Figure 10: Cycling command pairs

2.2.2 Using Menus

A menu is a list of settings or operations you can choose from. It shows several items, one of which is accented with a distinct color (Fig. 11, p. 25).

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

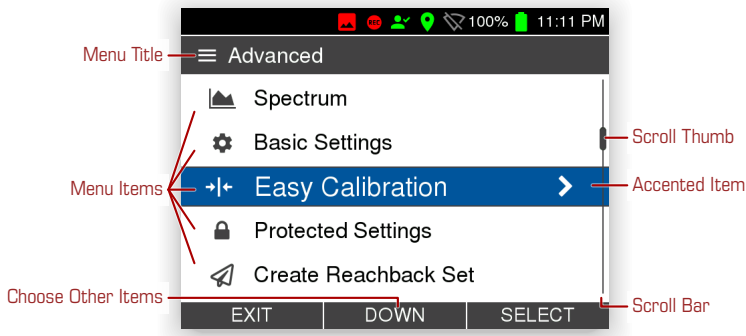


Figure 11: A menu with the third item accented

Some menus offer more items than fit on the screen simultaneously. This is indicated by a scroll bar with a thumb showing the relative position in the menu (Fig. 11, p. 25).

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 RADEAGLE to your needs by changing settings. Some settings are simple switches as shown in Fig. 12, p. 26.

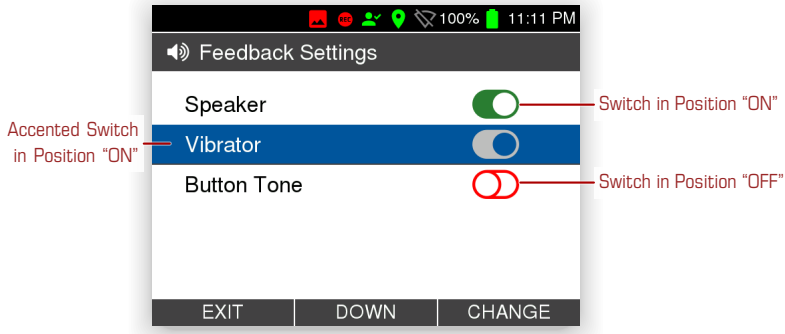


Figure 12: Changing switches

You can toggle the state by simply pressing Change.

For other settings you can choose from a list of options, for example the screen brightness (see 5.4, p. 49). When you select the setting for change the list of valid settings is displayed (Fig. 13, p. 26).

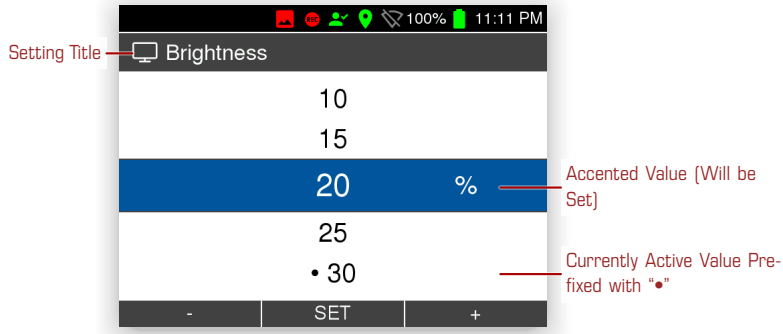


Figure 13: Changing values by choosing from a list

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

2.2.4 Entering the Password

Some settings and operations of the RADEAGLE are locked behind a password. If you try to use these items, you will be prompted to enter the password (Fig. 14, p. 27).

After successfull pasword entry, the RADEAGLE ist unlocked for about 10 min.

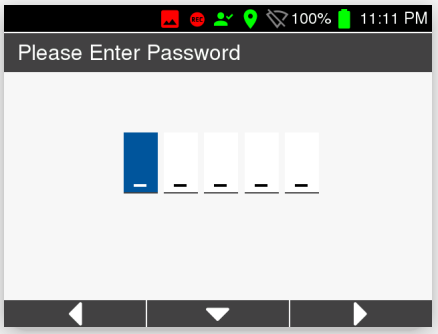


Figure 14: Entering the password

Use the keys ◀ for L, ▼ for C, and ▶ for R to enter the five-character password of L, C and R.

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

Change your password (see 5.23, p. 75) after receiving the instrument to prevent unauthorized persons from manipulating the protected settings.

After pressing five keys the available commands change (Fig. 15, p. 27).

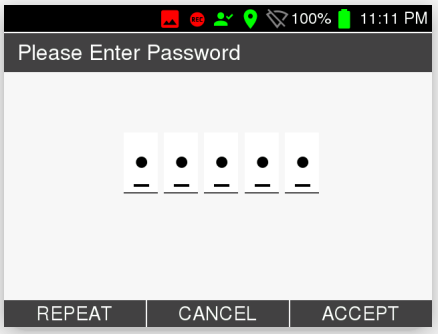


Figure 15: After entering the password

Settings and Commands

Repeat

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

Cancel

Cancel the password entry and quit accessing the protected settings.

Accept

Confirm your entry and have the radEAGLE 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 radEAGLE's display, for example, to document a certain result or for your inhouse training material.

➜ **To save a screenshot...**

1. Press and hold  .
2. Press  .

   You will be informed that a screen shot was saved in the status bar of the display (Fig. 16, p. 28). This message disappears after a moment.

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

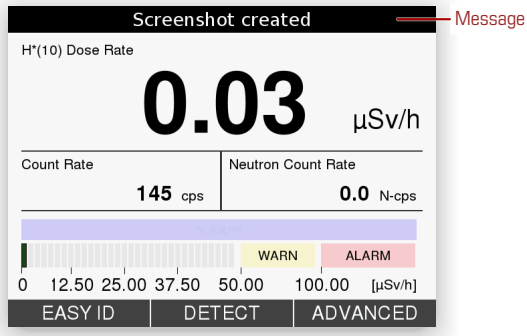


Figure 16: Status bar after saving a screenshot

For further processing screenshots, transfer them to your computer with, e.g., Storage Management in the Web interface (see 7.10, p. 104), or a USB flash drive (see 5.11.2, p. 59).

2.3 Starting Up the RADEAGLE

1. Position the instrument in a low-radiation environment.
2. Position the supplied KCl (pottasium chloride) box (Fig. 17, p. 29) in front of the detector cap if your RADEAGLE has no built-in source.

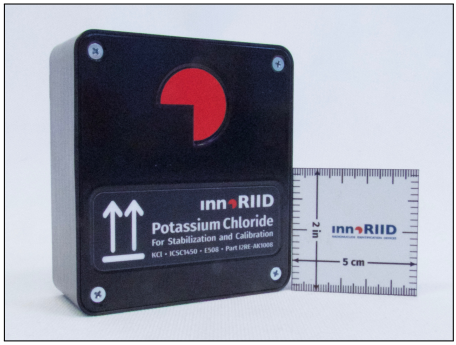


Figure 17: Box with potassium chloride (KCl) for stabilization and calibration

3. Press and hold down the key (Fig. 9, p. 24). (Ensure the battery slide switch behind the latch (Fig. 2a, p. 15) is in the top postion “ON”.)
4. After a couple of seconds the instrument begins to boot when the alarm LEDs (Fig. 1, p. 14) begin to flash.
5. You are welcomed by the start-up screen with dots appearing from left to right (Fig. 18, p. 29).

Figure 18: Starting the RADEAGLE

6. The RADEAGLE begins an initial stabilization (Fig. 19, p. 30, see C.1, p. 127 for details).
7. When the stabilization source is identified it is shown (Fig. 20, p. 30).

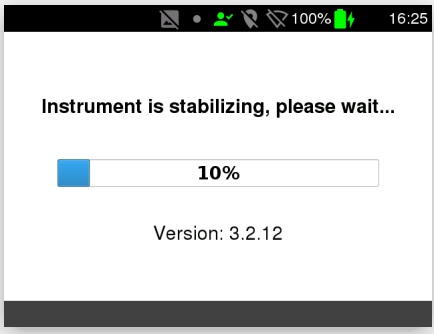


Figure 19: Initial stabilization

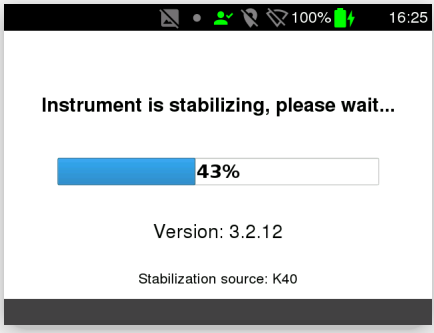


Figure 20: Initial Stabilization after identification of the stabilization source

8. After the stabilization the radEAGLE switches to Dose Rate Mode (see 3.1, p. 31).
9. Watch the stabilization status icon on the screen (see 2.1, p. 21).

2.4 Switching Off the radEAGLE

To switch off the instrument, navigate to the Advanced menu and select the **Shutdown** command (see 5.29, p. 82). You will be prompted to confirm in case you change your mind (Fig. 97, p. 82).

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

3 radEAGLE Measuring Modes

This chapter describes the essential measuring modes of your radEAGLE.

Dose Rate Mode

Observe the ambient radiation, see 3.1, p. 31

Easy ID Mode

Identify radiating nuclides quickly, see 3.2, p. 33

Detect Mode

Locate radiation sources, see 3.3, p. 34

Measuring modes might be overridden by warning and alarms, please refer to chapter 4, p. 37.

3.1 Dose Rate Mode

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

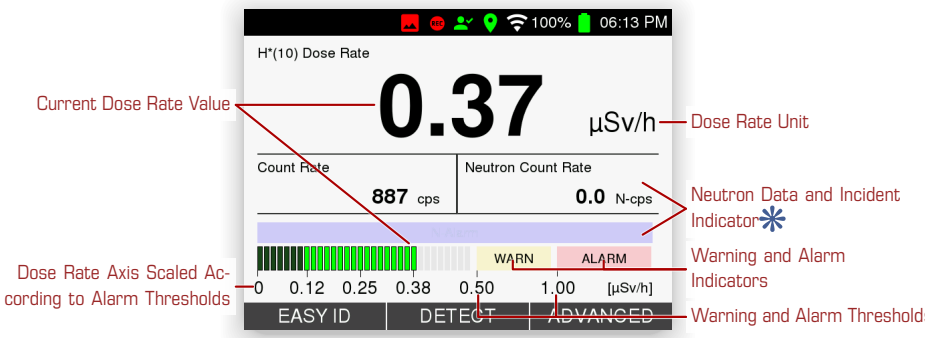


Figure 21: Dose rate display

Several representations of the current ambient dose rate (H*10) are shown (Fig. 21, p. 31):

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. 49.

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. A horizontal scale along the chart reflects your current warning and alarm thresholds (see 5.17, p. 66).

Warning and alarm indicators are illuminated if the dose rate rises above the thresholds (Fig. 22, p. 32, Fig. 23, p. 32).

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. 66).

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.

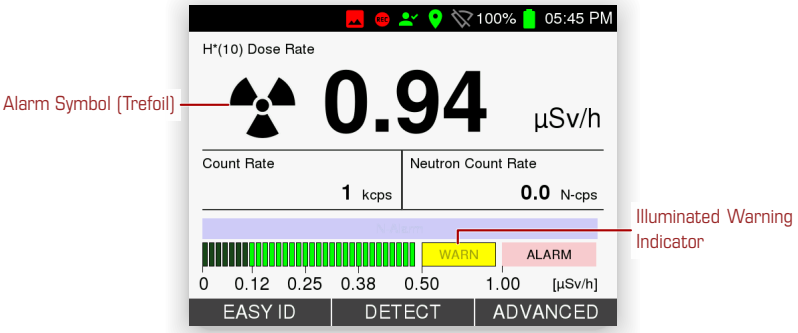


Figure 22: Dose rate display with gamma warning

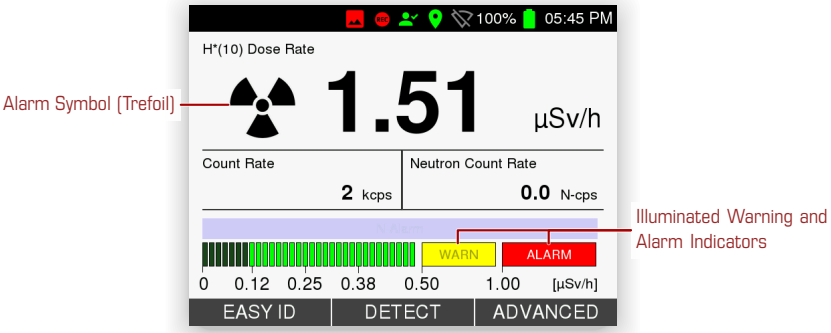


Figure 23: Dose rate display with gamma alarm

Settings and Commands

Easy ID

Switch to the Easy ID mode, see 3.2, p. 33.

Detect

Switch to the Detect mode, see 3.3, p. 34.

Advanced

Open the menu for advanced operations, see 5, p. 41.

3.2 Easy ID Mode

The Easy ID measuring mode helps you to quickly identify radiating nuclides. Your RADEAGLE will acquire a spectrum for a preset duration and then analyze and save it.

During the acquisition, a chart (Fig. 24, p. 33) instructs you to find the best distance between the RADEAGLE and the source in question.

The nuclides identified will be displayed (Fig. 25, p. 33). 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.

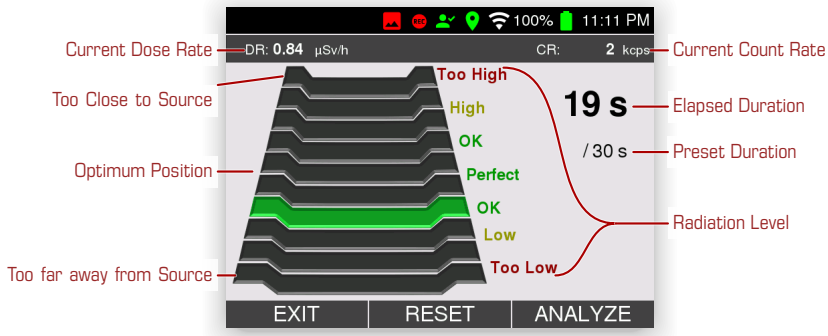


Figure 24: The Easy ID screen

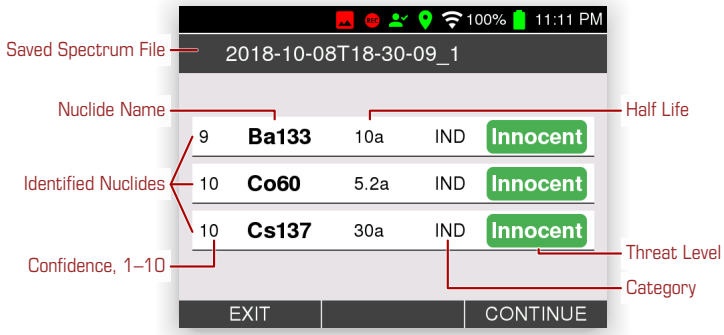


Figure 25: The Easy ID results

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.

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.

The tool starts with measuring the background radiation (Fig. 26, p. 34).

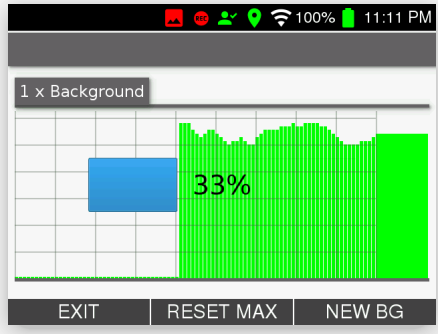


Figure 26: Detect mode background measurement

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. 27, p. 35).

Green Bars
: represent radiation levels close to the background.

Red Bars
: represent increased radiation potentially caused by a source (Fig. 28, p. 35).

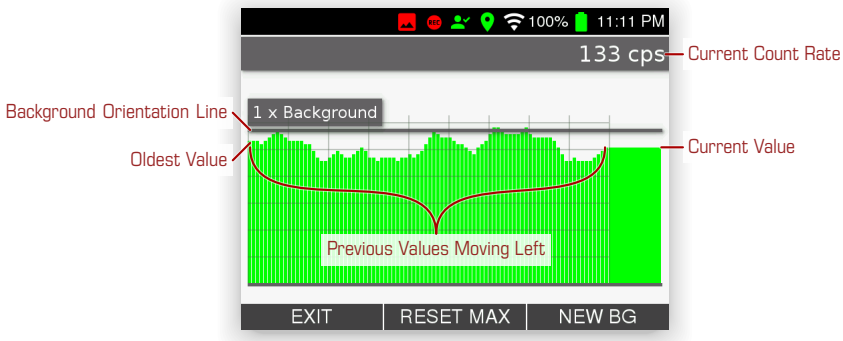


Figure 27: Detect mode chart

Blue Bars

represent neutron incidents, if any.

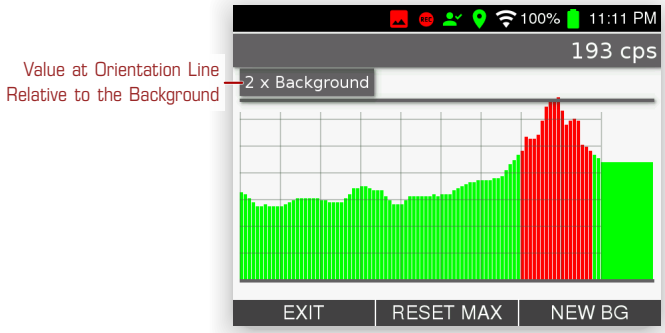


Figure 28: Detect mode: Approaching a source

If the radiation level increases, the chart will be rescaled to multiples of the background determined at the beginning (Fig. 29, p. 36).

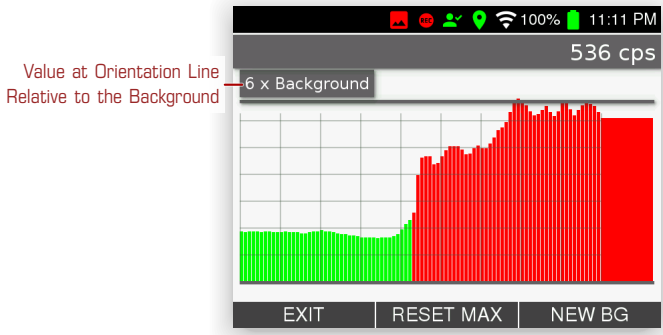


Figure 29: Detect mode: Close to a source

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 radEAGLE Warnings and Alarms

When the radEAGLE detects radiation above preset thresholds (see 5.17, p. 66), 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. 49).

The alarm details remain on the screen until you confirm them. You can turn off the confirmation, see 5.4, p. 49

LED The alarm LEDs (Fig. 1, p. 14) flash in several patterns.

Speaker

The speaker emits various sound patterns. You can switch the speaker on or off, see 5.5, p. 50.

Vibrator

The vibrator shakes the handle (and adds a little sound). You can switch the vibrator on or off, see 5.5, p. 50.

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 radEAGLE 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. 30, p. 38) and alarm (Fig. 31, p. 38) messages overlay all other activities of the radEAGLE.

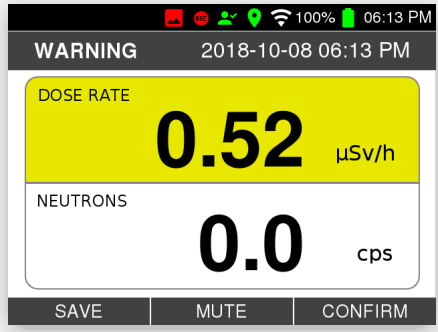


Figure 30: A warning reported on screen

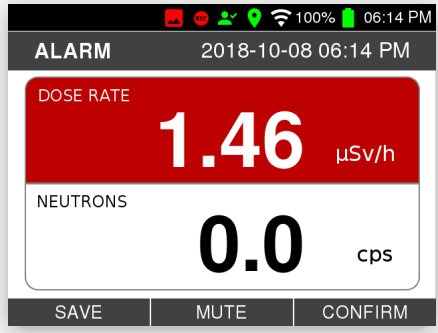


Figure 31: An alarm reported on screen

Settings and Commands

Save

Save the Alarm in the radEAGLE's database.

Mute

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

Confirm

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

4.1.1 Neutron Alarm Display

This item is available for RADEAGLE models with a neutron detector (see E.1, p. 135).

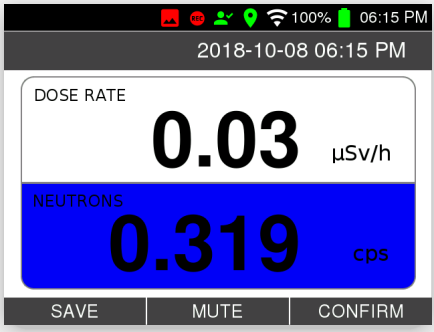


Figure 32: An neutron alarm reported on screen

5 radEAGLE Advanced Menu

This menu provides acces to advanced operations of the radEAGLE. This includes, for example, a lot of settings you can change to adapt your radEAGLE 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. 42.

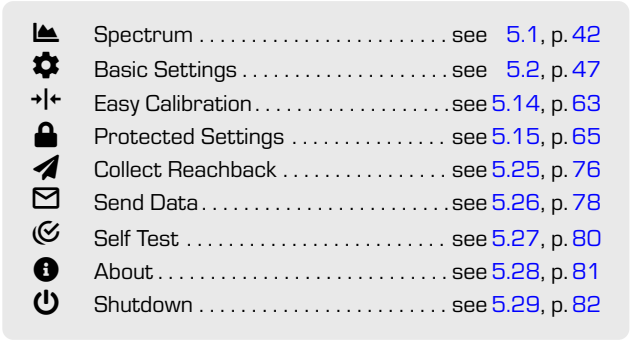


Figure 33: The advanced operations menu

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. 43) 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. 43).

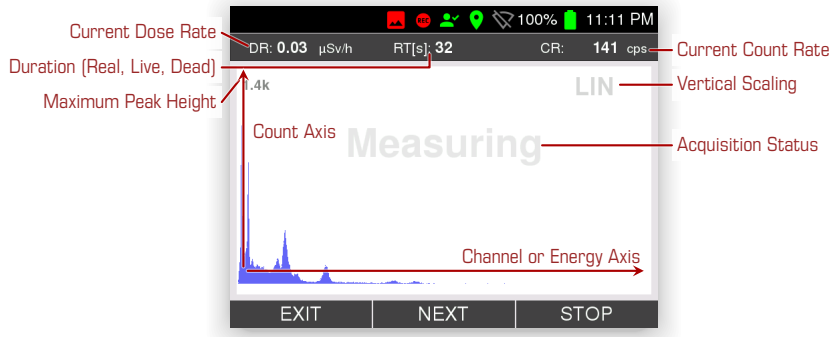


Figure 34: The spectrum screen

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 RADEAGLE apply its identification algorithm to the current spectrum. The result is superimposed on the screen for a few seconds (Fig. 35, p. 43).

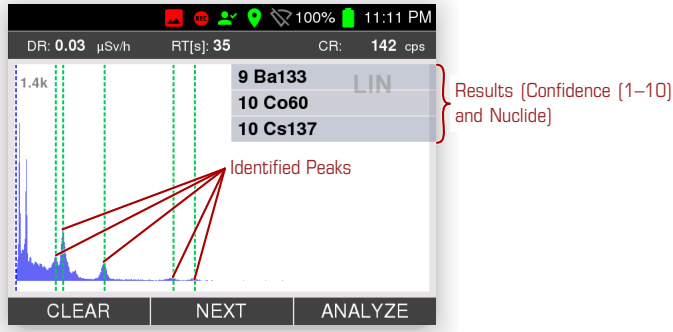


Figure 35: Result of a spectrum analysis

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

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

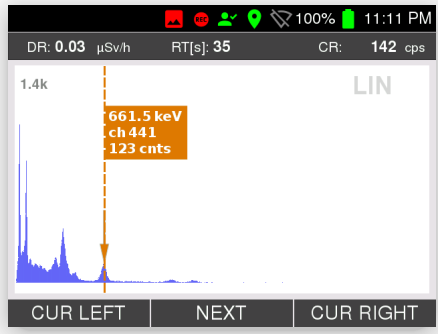


Figure 36: Spectrum with cursor

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.

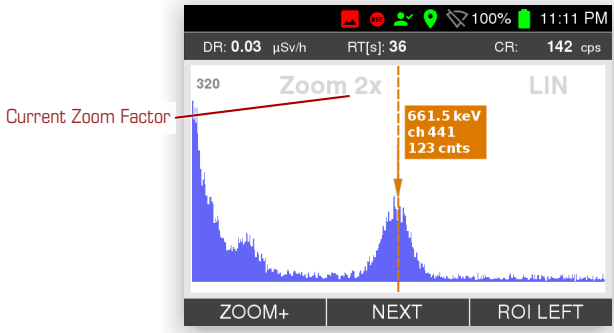


Figure 37: Zoomed spectrum with cursor

The current zoom state is shown in the diagram (Fig. 37, p. 44)

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 RADEAGLE fits a peak to the ROI and displays the centroid energy and the number of counts for the ROI (Fig. 38, p. 45).

Save

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

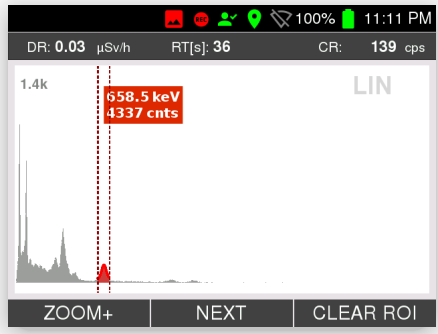


Figure 38: Spectrum with Region Of Interest

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. 45).

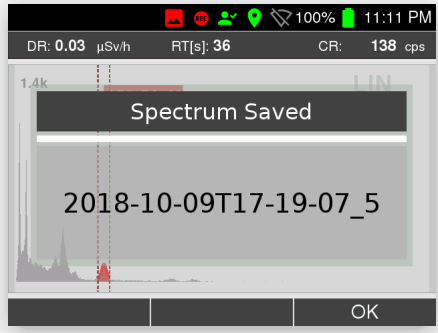


Figure 39: Info about a saved spectrum's file name

Load

Load a saved spectrum for further processing. Choose a from a list of files saved before (Fig. 40, p. 46). The spectrum saved most recently is listed on top.

Load

Load the highlighted spectrum file.

Down

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

Cancel

Cancel the current command.

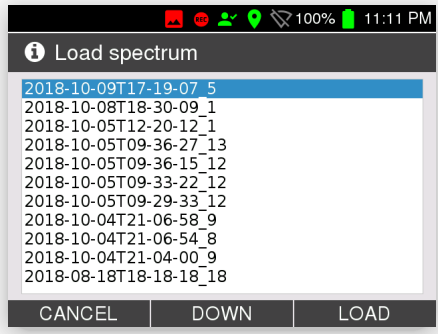


Figure 40: Spectrum files available for loading

LT • DT • RT

Cycle through the time and duration info displayed along the spectrum (Fig. 34, p. 43):

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. 130.

LOG • SQRT • LIN

Change the vertical scaling of the spectrum diagram (see C.7, p. 130).

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. 43). 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. 47).

Start • Stop

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

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

Exit

Return to the superior screen.

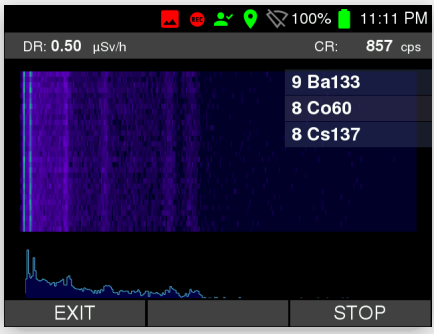


Figure 41: The Auto ID Waterfall display

Exit
Return to the superior screen.

5.2 Basic Settings

You can access the basic settings of the RADEAGLE via this menu (Fig. 42, p. 47). You can change these settings without entering a password.

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. 48) groups settings for the clock handling of your RADEAGLE.

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. 99).

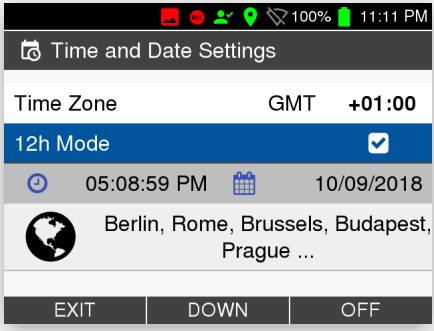


Figure 43: The clock settings

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. 49) groups several options for the display of your RADEAGLE.

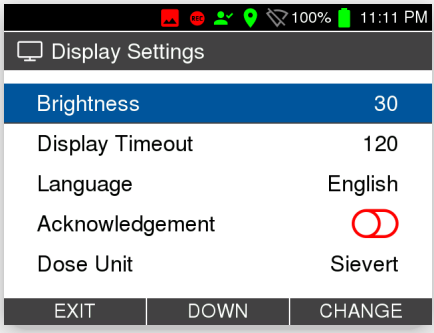


Figure 44: The display settings

Settings and Commands

Brightness

Specify the brightness of the display's backlight.

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*

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

Acknowledgement

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

Dose Unit

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

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. 50) groups several options for the annunciator of your RADEAGLE.

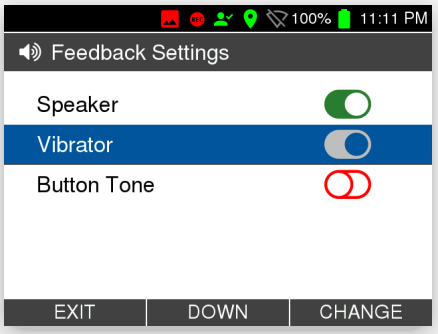


Figure 45: The feedback settings

Settings and Commands

Speaker

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

Vibrator

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

Button Tone

Specify whether the RADEAGLE 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.

5.6 Reachback

This screen (Fig. 46, p. 51) groups settings for a reachback SOP (5.25, p. 76). Please refer to 6.4, p. 84 for details.

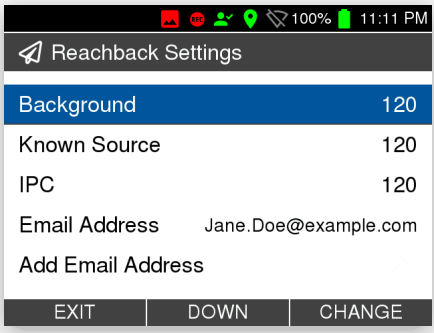


Figure 46: The reachback settings

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 RADEAGLE.

⚠ 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. 100).

Add Email Address
: Add an address to the list of addresses saved in your RADEAGLE.

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. 52) provides access to settings for various connection devices plugged into the USB-A host adaptor (Fig. 2a, p. 15) of your RADEAGLE.

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

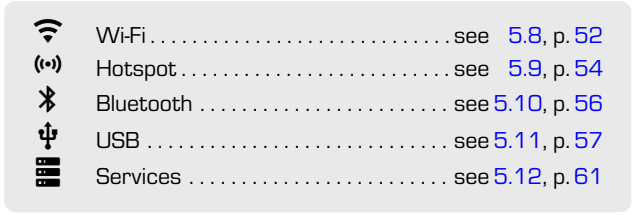


Figure 47: The connectivity menu

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 RADEAGLE's USB-A port.

This screen groups settings and status information to connect your RADEAGLE to other devices via Wi-Fi (Fig. 48, p. 53).

⚠ 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.

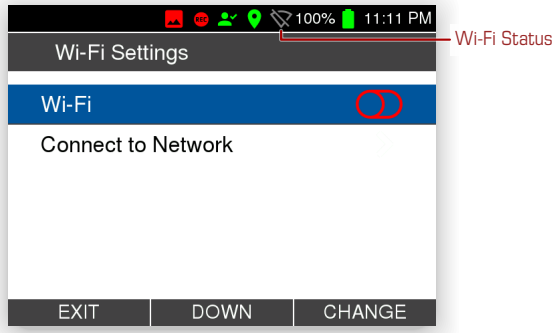


Figure 48: The Wi-Fi settings

Settings and Commands

Wi-Fi

Switch the Wi-Fi dongle on or off.

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

Connect to Network

Let the RADEAGLE 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. 53).

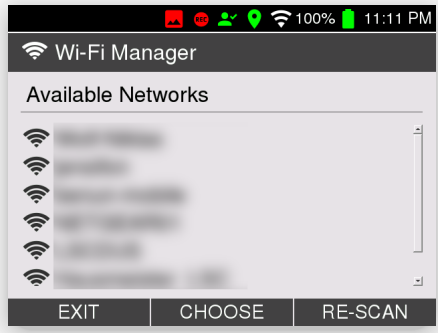


Figure 49: Available Wi-Fi access points

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 RADEAGLE (Fig. 50, p. 54).

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

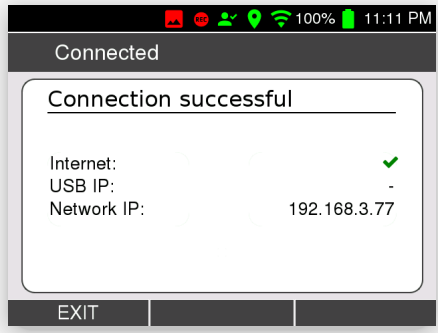


Figure 50: Connected to a Wi-Fi network

Choose

Choose one of the available networks.

Re-Scan

Let the RADEAGLE 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 RADEAGLE's USB-A port.

This screen groups settings and status information to let your RADEAGLE provide a Wi-Fi access point (Fig. 51, p. 55).

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

Settings and Commands

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 RADEAGLE.

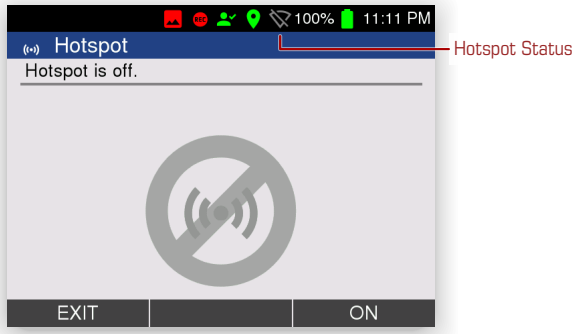


Figure 51: Hotspot is off

HS-Info • Web-Info

Switch between information about the Web interface address (Fig. 52, p. 55) or that for accessing the hotspot (Fig. 53, p. 56). Both are shown as text and as QR codes for devices equipped appropriately.

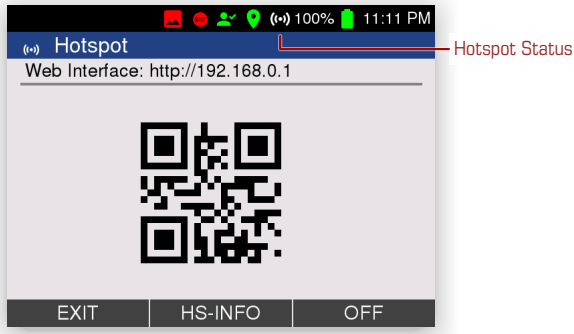


Figure 52: Hotspot: Web interface info

Exit

Return to the superior screen.

Figure 53: Hotspot: Access credentials

5.10 Bluetooth Settings

This item is available while a Bluetooth dongle is plugged into the RADEAGLE's USB-A port.

This screen groups settings and status information to pair your RADEAGLE with a Bluetooth equipped device like a smart phone to access the RADEAGLE's Web interface or to share the Internet connection.

You can switch Bluetooth on or off (Fig. 54, p. 56) and start pairing with an external device.

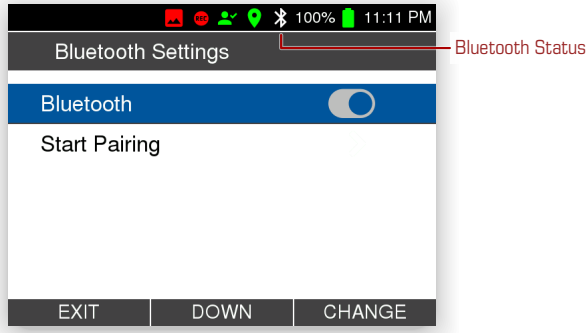


Figure 54: Bluetooth settings

Initially the RADEAGLE knows no Bluetooth devices (Fig. 55, p. 57).

Follow the instructions displayed to initiate the pairing. The paired device will be shown (Fig. 56, p. 57) and is ready for connection.

The RADEAGLE remembers all devices it has been paired to. If your desired device is already known, just choose it from the list.

After the connection is established, the IP address to access the Web interface is shown (Fig. 57, p. 58) as text and as QR code for devices equipped appropriately.

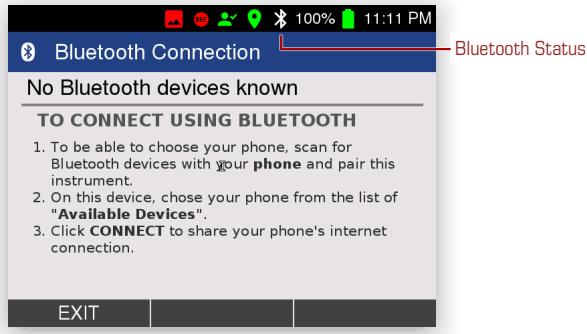


Figure 55: Bluetooth instructions on a pristine RADEAGLE

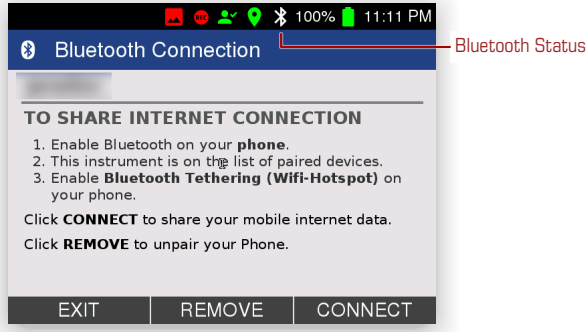


Figure 56: Connect to a known Bluetooth device

Settings and Commands

Connect, Disconnect

Start or stop the connection between the RADEAGLE 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 RADEAGLE.

- A cable connects the USB Mini-B port to a computer or similar device: see 5.11.1, p. 58
- A USB storage device (a.k.a. Stick) is plugged into the USB-A Port: see 5.11.2, p. 59
- A USB Ethernet adaptor is plugged into the USB-A Port: see 5.11.3, p. 60

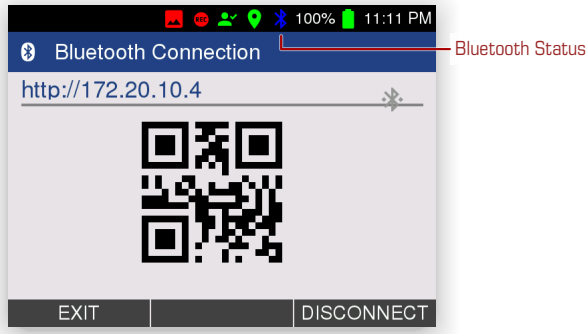


Figure 57: Web interface address for devices connected via Bluetooth

5.11.1 USB Cable to Host Computer

This item is available while a cable connects the RADEAGLE's USB Mini-B 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. 58).

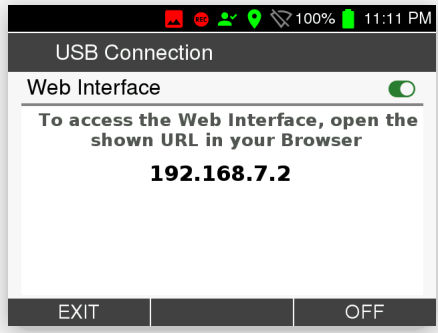


Figure 58: USB cable connection information

Settings and Commands

On • Off
Switch the Web interface (see 7, p. 85) 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 RADEAGLE's USB-A port.

Connect a USB mass storage device to your RADEAGLE and transfer data from the instrument to the device.

The RADEAGLE supports devices formatted as FAT32 without partitions.

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

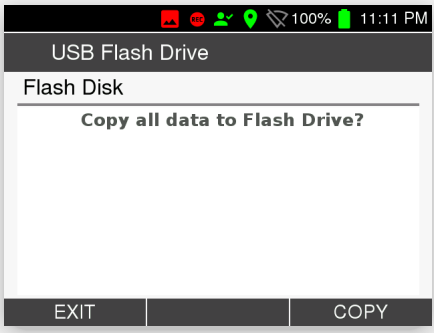


Figure 59: Data transfer to a USB mass storage device

Settings and Commands

Copy

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

The RADEAGLE 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. 60).

Exit

Return to the superior screen.

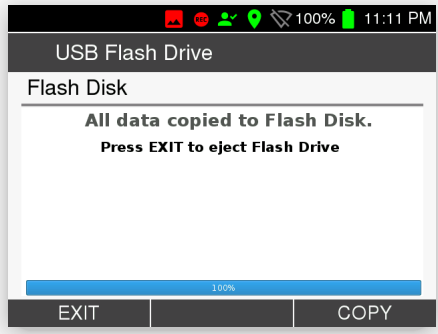


Figure 60: Data transfer complete

5.11.3 USB Ethernet Adaptor

This item is available while a USB to LAN adaptor is plugged into the RADEAGLE's USB-A port.

The RADEAGLE 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. 60).

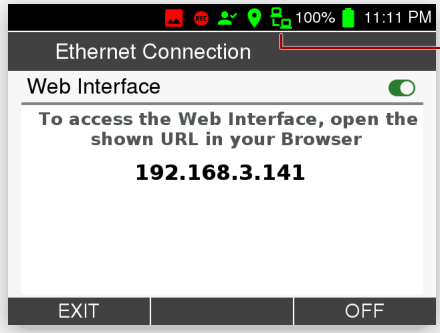


Figure 61: Ethernet LAN connection information

Settings and Commands

On • Off

Switch the Web interface (see 7, p. 85) on or off.

Exit

Return to the superior screen.

5.12 Services

This screen shows information about the connectivity services your RADEAGLE provides and lets you switch them on or off (Fig. 62, p. 61).

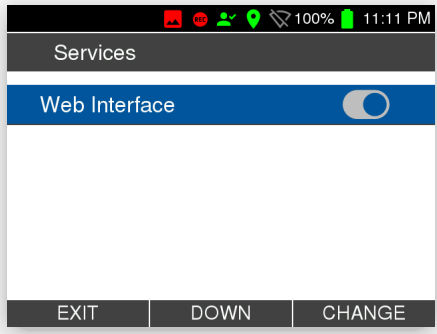


Figure 62: The services screen

Settings and Commands

Web Interface
Switch the Web interface (see 7, p. 85) 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 RADEAGLE models equipped with a GPS receiver (see E.1, p. 135).

This screen (Fig. 63, p. 62) 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. 21)

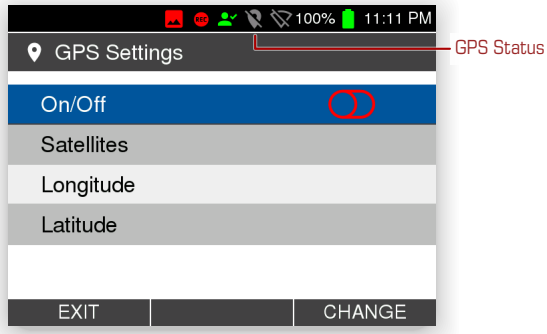


Figure 63: The GPS settings when GPS is off

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. 62, and increases after some time, see Fig. 65, p. 63.

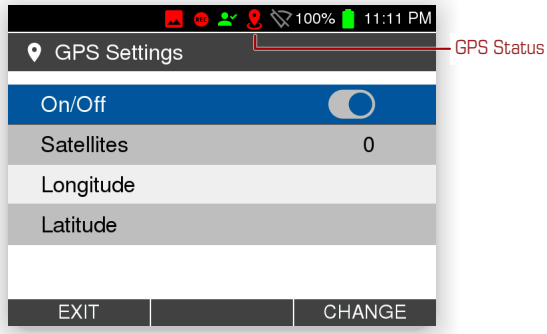


Figure 64: The GPS settings immediately after switching on GPS

If the GPS receiver has sufficient data from enough satellites (“has a fix”), your location ist shown, see Fig. 66, p. 63.

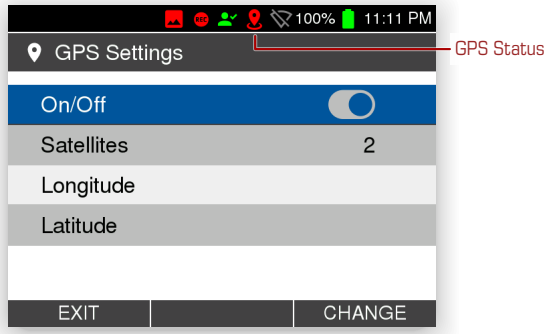


Figure 65: The GPS settings while searching satellites

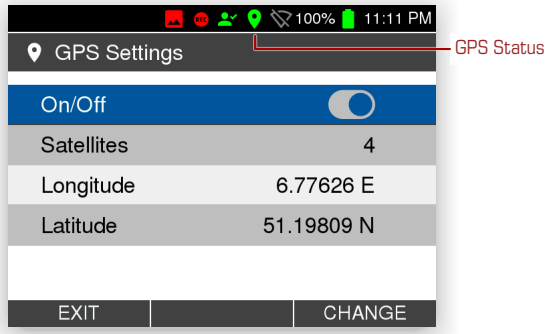


Figure 66: The GPS settings after determinig the location

Settings and Commands

Change
: Edit the highlighted setting.

Exit
: Return to the superior screen.

5.14 Easy Calibration

This command lets you specifiy a calibration source and trigger a simple automatic calibration of the RADEAGLE

An elaborate version of calibration is available too, see 5.18, p. 68.

For additional information refer to appendix C.2, p. 128.

Please place a suitable calibration source (^{40}K or ^{137}Cs) in front of the detector before proceeding.

After you let the RADEAGLE know which calibration source is in front of it (Fig. 67, p. 64), it will aquire data for a while and use it for calibration (Fig. 68, p. 64).

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

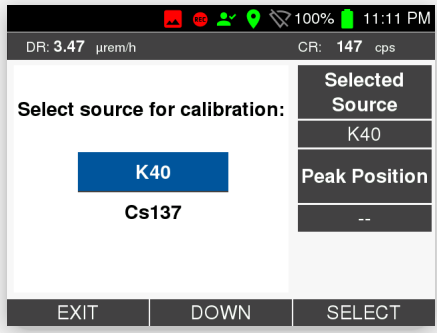


Figure 67: Selecting a source for easy calibration

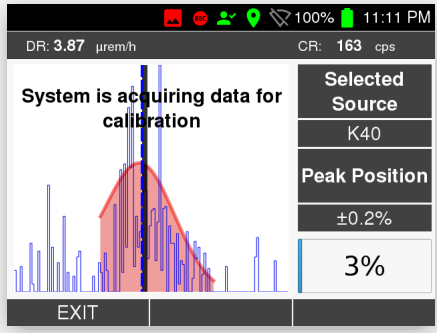


Figure 68: Easy calibration in progress

A progress percentage is shown during the data collection (Fig. 69, p. 65), sometimes in several cycles, until the peak position of the calibration source is within ±0.5 % of the theoretical position.

Settings and Commands

Exit
: Return to the superior screen.

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

Select
: Select the highlighted item.

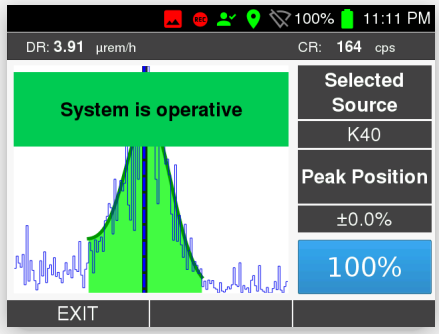


Figure 69: Easy calibration finished

5.15 Protected Settings

You can access the protected settings of the RADEAGLE via this menu (Fig. 70, p. 65). Before accessing this menu you have to enter a password (see 2.2.4, p. 26).

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. 66) shows information about your RADEAGLE's hardware status. Please have these data at hand when contacting our support.

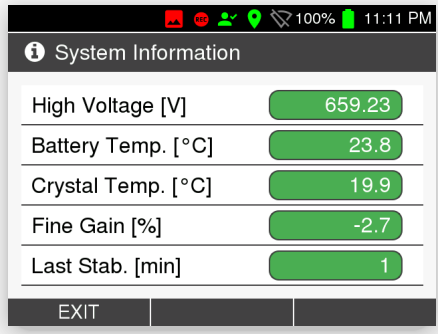


Figure 71: The hardware status

High Voltage

Typical values are between 500 V and 800 V.

Battery Temperature

The value should be between 0 °C and 50 °C. (Available only only for the black POWERCELL, see 8.1.1, p. 107).

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. 127).

Exit

Return to the superior screen.

5.17 Alarm Settings

This screen (Fig. 72, p. 67) groups the settings for warnings and alarms.

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. 49.

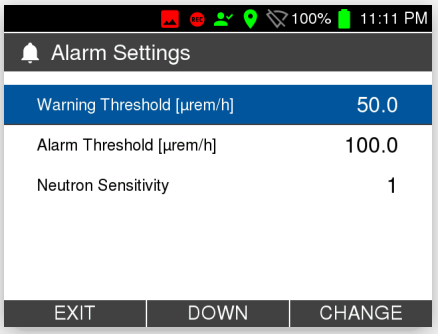


Figure 72: The alarm settings

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 RADEAGLE models with a neutron detector (see E.1, p. 135).

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. 68) shows a partial spectrum and some additional information you can use to inspect and trigger the calibration of your RADEAGLE.

For additional information refer to appendix C.2, p. 128.

A simpler version of calibration is available too, see 5.14, p. 63.

Please place a suitable calibration source (^{40}K or ^{137}Cs) in front of the detector before proceeding.

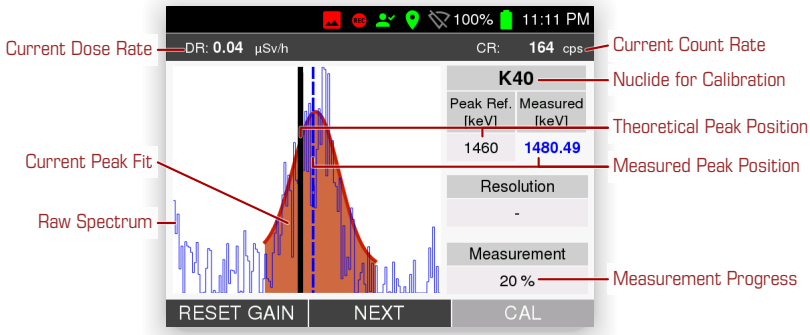


Figure 73: The calibration screen

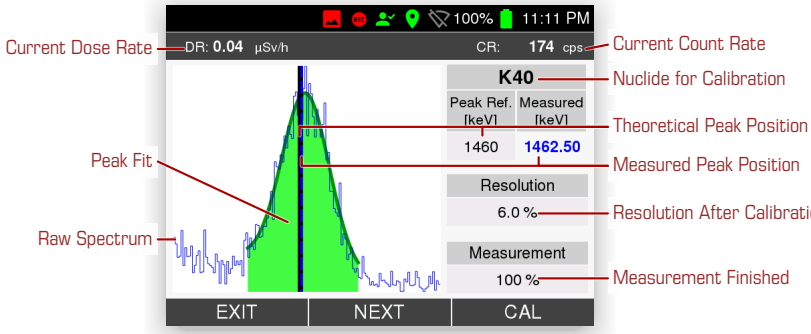


Figure 74: The calibration screen after measurement

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.

Place a calibration source containing the specified nuclide in front of the detector.

Clear

Clear the spectrum acquired hitherto and restart data collection.

Reset Gain

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. 68).

Exit

Return to the superior screen.

5.19 ID Settings

You can access the identification settings of the RADEAGLE via this menu (Fig. 75, p. 69).

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. 70) groups the settings for the Easy ID mode.

Settings and Commands

Preset Time

Specify the measurement time for the easy ID mode (see 3.2, p. 33).

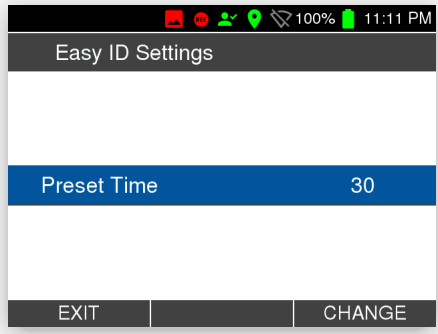


Figure 76: The easy ID settings

Exit
: Return to the superior screen.

Select
: Select the highlighted item.

5.21 Nuclide Library

This screen (Fig. 77, p. 70) groups information about the nuclides your RADEAGLE knows about.

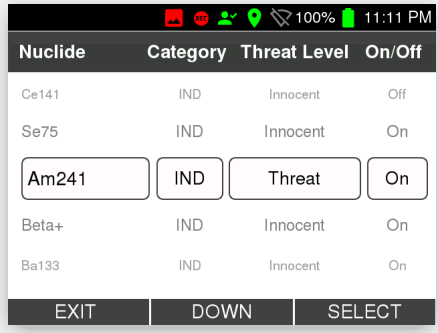


Figure 77: The nuclide library ready for selecting a nuclide

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 RADEAGLE 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. 70).

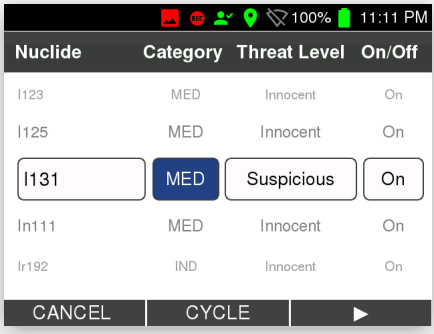


Figure 78: The nuclide library with ^{131}I selected for editing its category

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. 71).

Cycle

Cycle through the options for the highlighted setting. (Only available when a nuclide is selected for editing, Fig. 78, p. 71.)

▶

Highlight the next property of the nuclide. (Only available when a nuclide is selected for editing, Fig. 78, p. 71.)

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. 72.)

Cancel

Discard your changes, if any, to the highlighted nuclide. (Only available when a nuclide is selected for editing, Fig. 79, p. 72.)

Exit

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

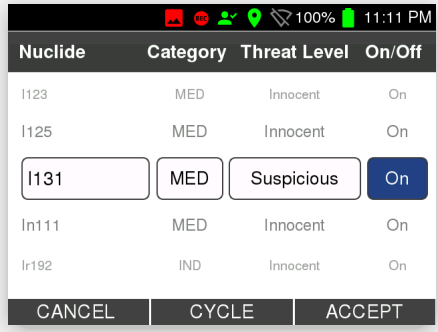


Figure 79: The nuclide library with ^{131}I selected for editing its On/Off property

5.22 Storage Management

This screen (Fig. 80, p. 73) provides an overview of all the data you saved in the RADEAGLE's database during your surveys.

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

A similar feature is available in the Web interface (see 7.10, p. 104).

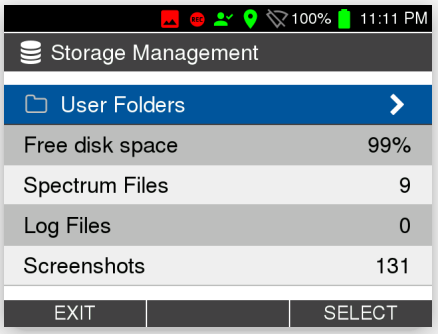


Figure 80: Storage management: Summary

Settings and Commands

User Folders

Show a list of folders containing various types of stored data (Fig. 81, p. 73) The number of files stored in each group is given in parentheses.

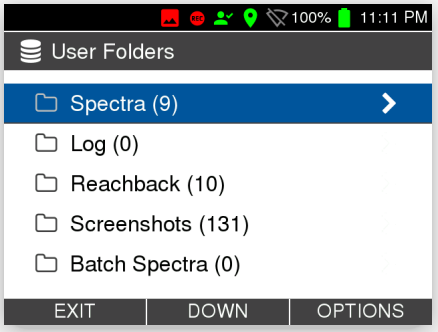


Figure 81: Storage management: List of folders with different types of data

data type

Open the commands available for every data type (Fig. 82, p. 74).

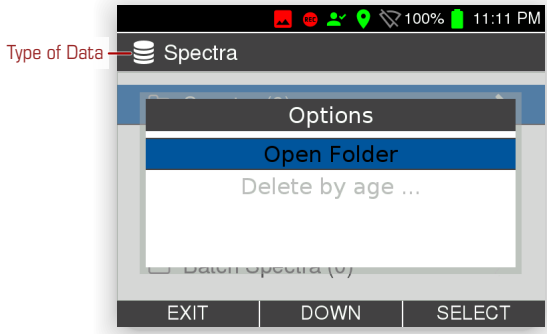


Figure 82: Storage management: Commands for a type of data

Open Folder

Open a list of all files in the group (Fig. 83, p. 74).

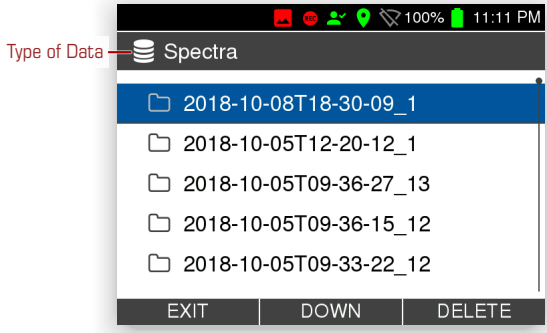


Figure 83: Storage management: List of files of a certain type

Delete

Delete the file highlighted in the list (Fig. 83, p. 74).

STOP The file is deleted immediately after you press the key. There is no additional warning.

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. 75).

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.

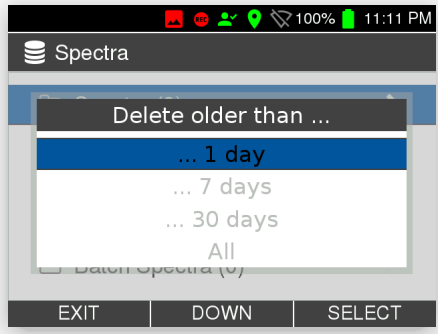


Figure 84: Storage management: Specify files to be deleted

5.23 Set Password

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

After you confirmed that you want to set a new password (Fig. 85, p. 75) just enter the new password as described in 2.2.4, p. 26.

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

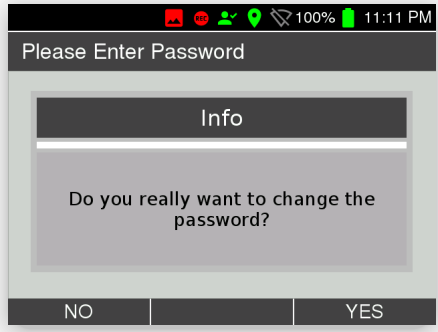


Figure 85: Setting the password

5.24 Factory Settings

This command re-establishes the factory settings of your RADEAGLE. You have to confirm this command (Fig. 86, p. 76).

Figure 86: Reset to factory settings

Reset

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

⚠ This includes the password for the protected settings (see 2.2.4, p. 26).

Exit

Return to the superior screen.

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 New to add a measurement.
2. Choose the type of measurement (background, known source, or unknown source, Fig. 87, p. 77).
3. Specify the duration of the measurement (To change default values see 5.6, p. 51).
4. Start the measurement. The elapsed time is shown during the measurement (Fig. 88, p. 77).
5. The name of the finished measurement file is appended to the collection.
6. Add more measurements ad libitum (Fig. 89, p. 78).
7. Press Finish to close the collection.

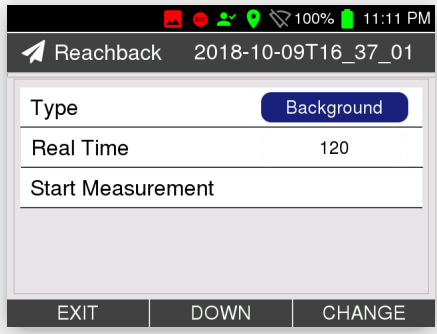


Figure 87: Settings for a new measurement

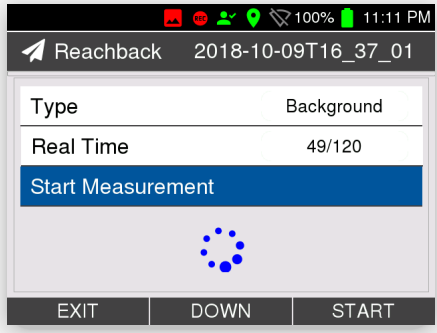


Figure 88: Collecting reachback data

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 RADEAGLE's database and can be accessed via the usual methods, for example, the Web interface (see 7.10, p. 104) or sent by mail (see 5.26, p. 78).

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.

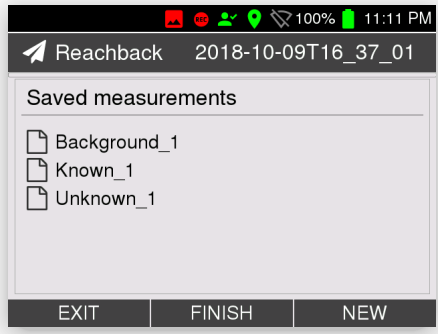


Figure 89: Collected measurements

5.26 Send Data

You can sent saved spectra (see 5.1, p. 44) or reachback data sets (see 5.25, p. 76) via e-mail with this command.

Sending mail is possible only while your RADEAGLE is connected to the Internet, so this is checked first, Fig. 90, p. 78.

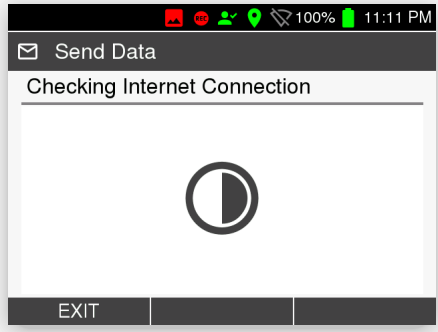


Figure 90: Checking the Internet connection

If there is no connection you are routed to the appropriate settings screens to configure a connection, Fig. 91, p. 79 (see 5.7, p. 52).

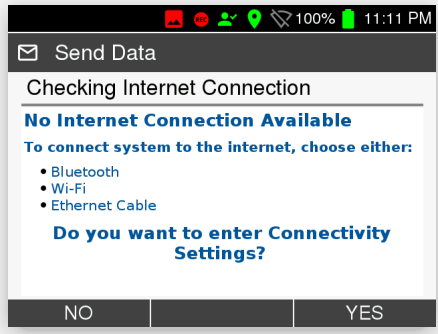


Figure 91: No Internet connection

If there is a connection, you can specify which type of files to mail (Fig. 92, p. 79).

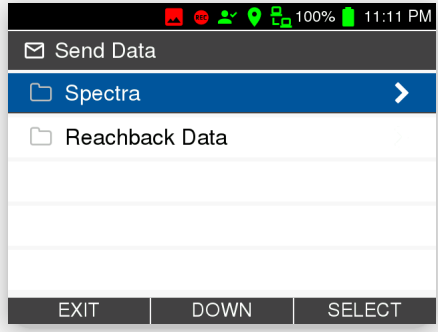


Figure 92: File types for mailing

From the list of available files you can select those to be included in the mail attachment (Fig. 93, p. 80).

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. 51). You have to confirm (Fig. 94, p. 80) and will be informed about success.

Select

Select the highlighted item.

Down

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

Exit

Return to the superior screen.

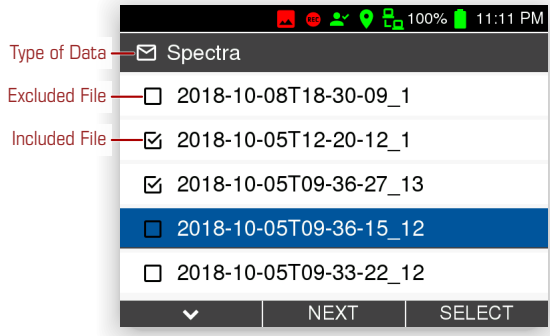


Figure 93: Selecting files

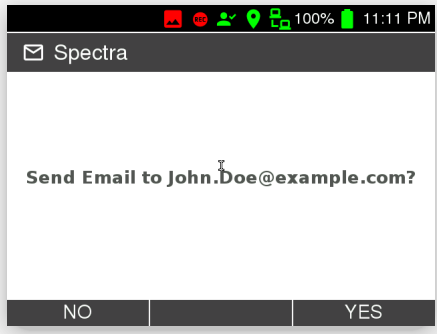


Figure 94: Ready to send files

5.27 Self Test

This command initiates a test of several components of the RADEAGLE. The test is divided in several sections (Fig. 95, p. 80).

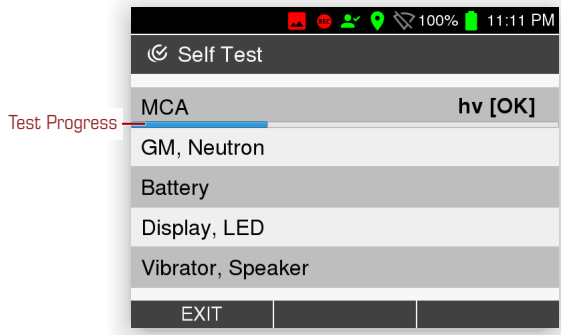


Figure 95: The self test screen

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 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. 131).

Battery

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

This test yields meaningful results only while a black powerCELL (see 8.1.1, p. 107) is mounted in the radEAGLE.

Passed

No problems detected.

Failed

Problems detected. Try replacing the battery (see 8.2, p. 109). Please take a note of the circumstances and 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. 50).

Please verify that the annunciators of the radEAGLE behaves as announced.

If not: Please take a note of the circumstances and 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. 82) shows information about your radEAGLE. Please have these data at hand when contacting our support.

Settings and Commands

Exit

Return to the superior screen.

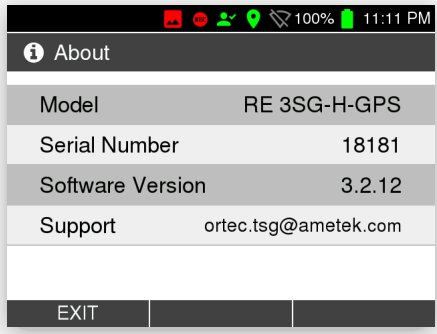


Figure 96: The instrument information

5.29 Shutdown

This screen (Fig. 97, p. 82) is shown when you switch off your RADEAGLE.

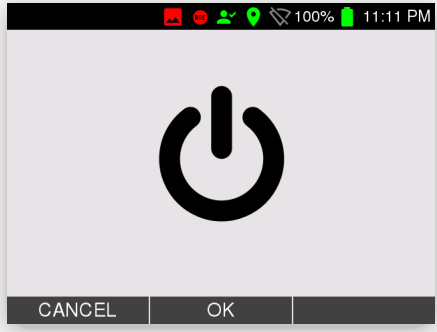


Figure 97: Shut down verification

Settings and Commands

OK
: Shut down the instrument.

Cancel
: Cancel the current command.

6 Accessing radEAGLE Data

The radEAGLE can save a lot of your measurement results in its database, for example, spectra (5.1, p. 42), alarm logs (4, p. 37), or screenshots (2.2.5, p. 28).

6.1 Storage Management

An overview of data stored on the radEAGLE ist available on the instrument (5.22, p. 72) or in the Web interface (7.10, p. 104).

6.2 Data Transfer

You can transfer data from the radEAGLE 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 radEAGLE and move or copy all available data to it (5.11.2, p. 59).

USB Cable

Connect the USB Mini-B socket of the radEAGLE (Fig. 2a, p. 15) 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 radEAGLE 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/`

Wi-Fi Hotspot

Activate the Wi-Fi hotspot (5.8, p. 52), 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 radEAGLE's USB-A port.

Wi-Fi Client

Log your RADEAGLE into an existing Wi-Fi network (5.8, p. 52) with the credentials you received from that network's administrator.

This item is available while a Wi-Fi dongle is plugged into the RADEAGLE'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 RADEAGLE remembers networks it has been logged into and reconnects automatically when they become available.

Bluetooth

Your RADEAGLE 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 RADEAGLE's USB-A port.

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

LAN Cable

Connect the RADEAGLE 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 adaptor is plugged into the RADEAGLE's USB-A port.

6.3 Web Interface

While a device such as a desktop computer or a tablet is connected (6, p. 83) to the RADEAGLE, you can access the Web interface of the RADEAGLE.

Look up the IP address of the RADEAGLE in the connection settings screen (5.7, p. 52) and point your browser to it.

You can browse and inspect saved spectra (7.4, p. 88) or manage or download all saved data to your device (7.10, p. 104).

6.4 Sending Data via E-Mail

While your RADEAGLE 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. 52 and 5.6, p. 51) or, more convenient, in the Web interface (7.7, p. 100).

For details about sending data refer to 5.26, p. 78.

7 radEAGLE 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. 52).

JavaScript is required for the radEAGLE Web interface and must be supported by the browser.

For the physical connection posibilities refer to section 6.2, p. 83.

The Web interface is divided into the sections shown in Fig. 98, p. 85. To navigate between sections open the menu by clicking the button ☰ (always available at the top, Fig. 99, p. 86).

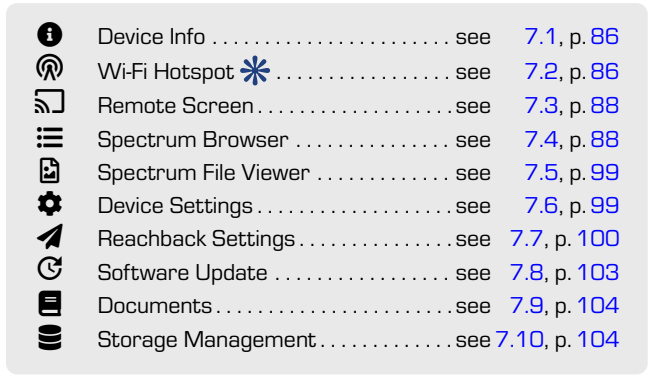


Figure 98: The menu overlay of the Web interface

The figures in this chapter illustrate the radEAGLE 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. 99, p. 86) of the Web interface shows general information about your RADEAGLE and its status.

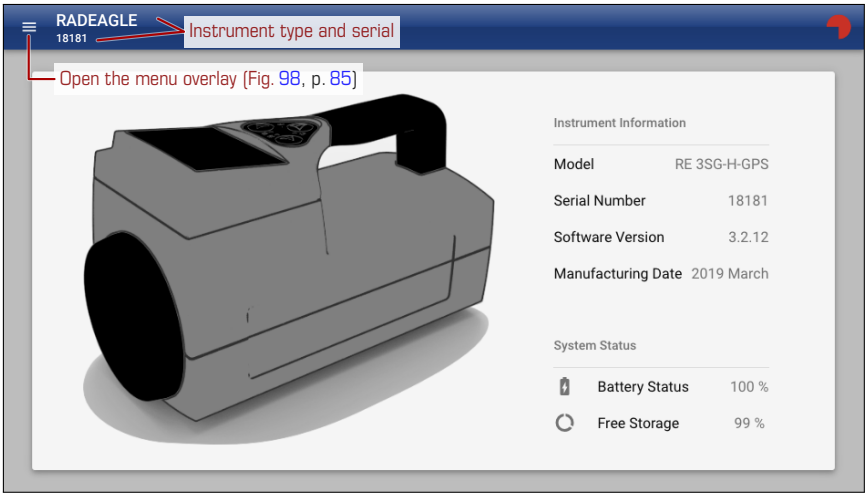


Figure 99: The device information in the Web interface

7.2 Wi-Fi Hotspot

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

This section (Fig. 100, p. 86) provides information about status, access path and credentials of the RADEAGLE's Wi-Fi hotspot.

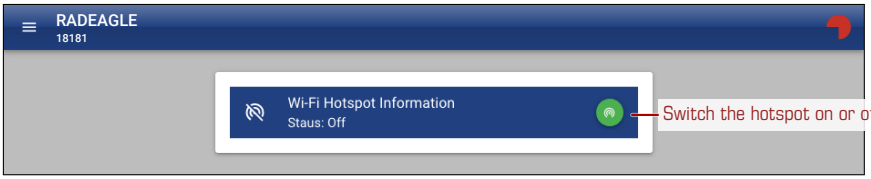


Figure 100: The Wi-Fi hotspot info in the Web interface (off)

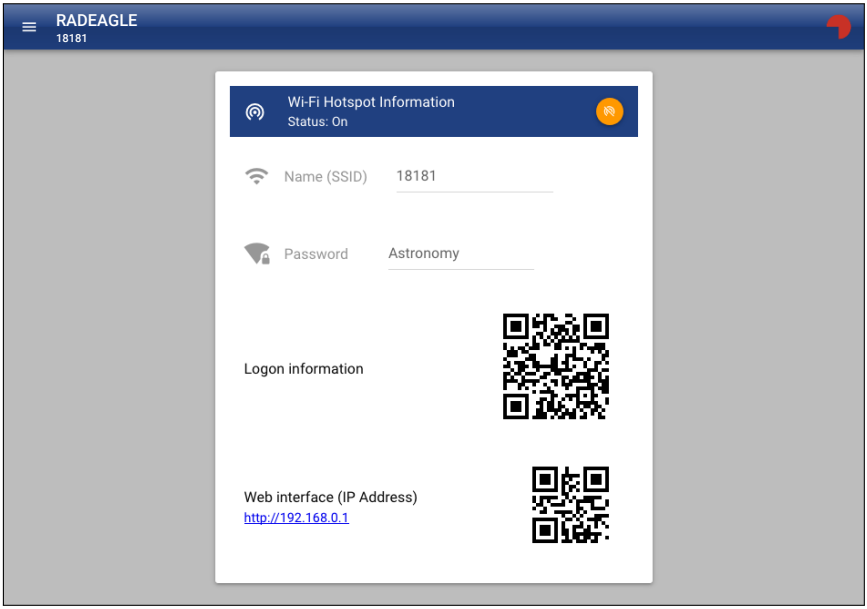


Figure 101: The Wi-Fi hotspot info in the Web interface (on)

7.3 Remote Screen

This section (Fig. 102, p. 88) shows the current contents of your RADEAGLE'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 RADEAGLE'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.

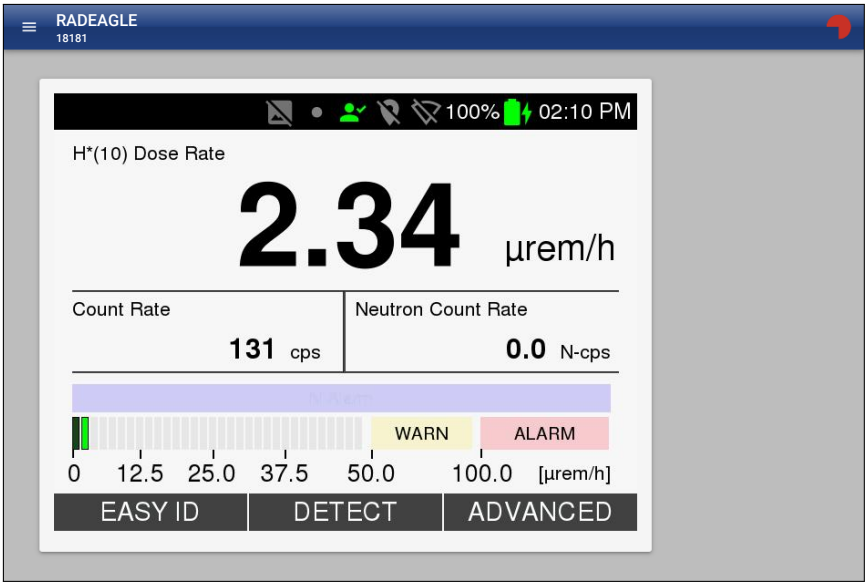


Figure 102: The remote RADEAGLE's screen in the Web interface

7.4 Spectrum Browser

This section (Fig. 103, p. 89) provides access to the spectra stored on the RADEAGLE. 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 ▾.

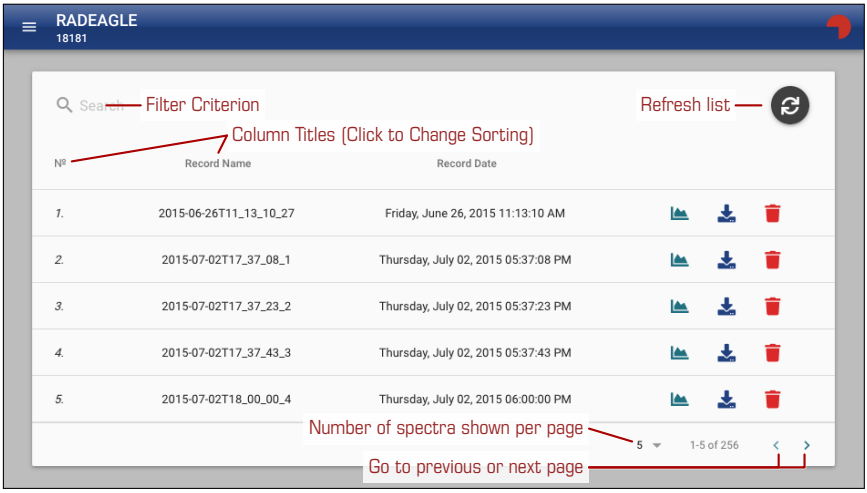


Figure 103: The spectrum browser in the Web interface

Several commands are available for the individual records:

- Inspect the spectrum plus a lot of additional information (see 7.4.1, p. 89).
- 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. 90), 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. 92.
- Automatic peak analysis, see 7.4.1.3, p. 92.
- PDF report, see 7.4.1.5, p. 97.
- Spectrum details, see 7.4.1.4, p. 95.

7.4.1.1 Spectrum Diagram

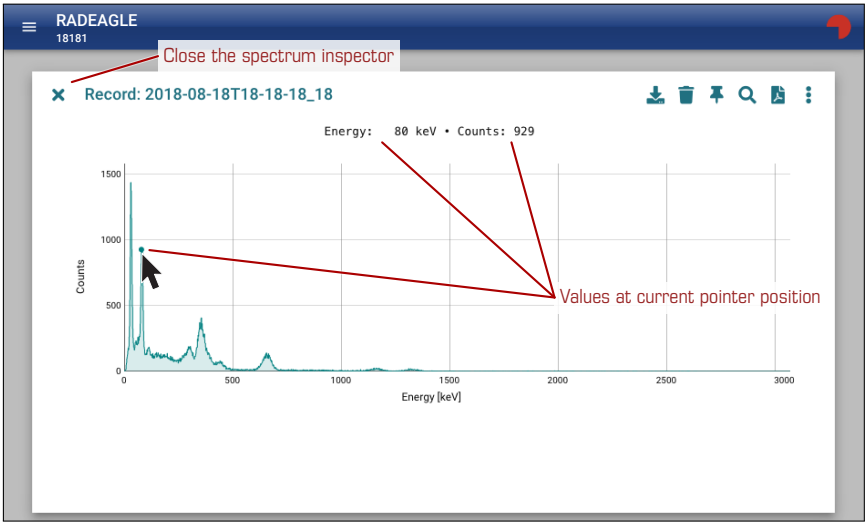


Figure 104: Spectrum diagramm in the Web interface

➜ **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. 104, p. 90).

➜ **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. 105, p. 91).

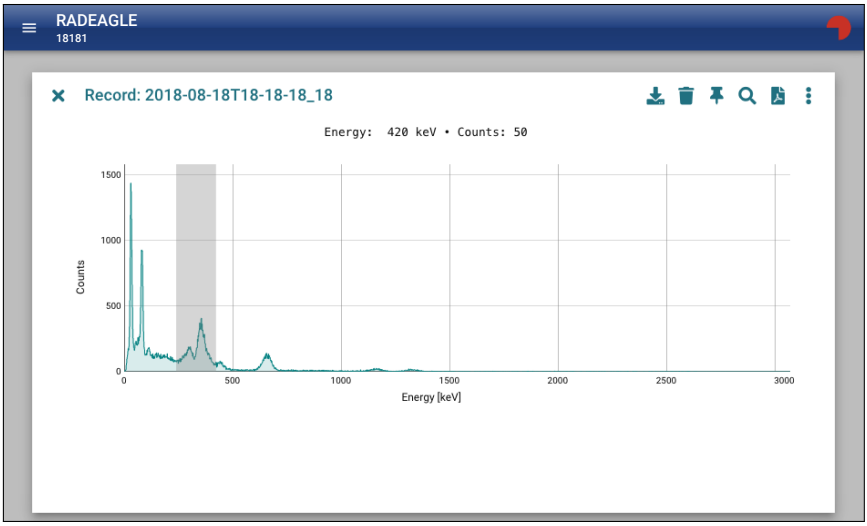


Figure 105: Zooming into the spectrum

3. Release the mouse button. The enlarged region shows up (Fig. 106, p. 91)

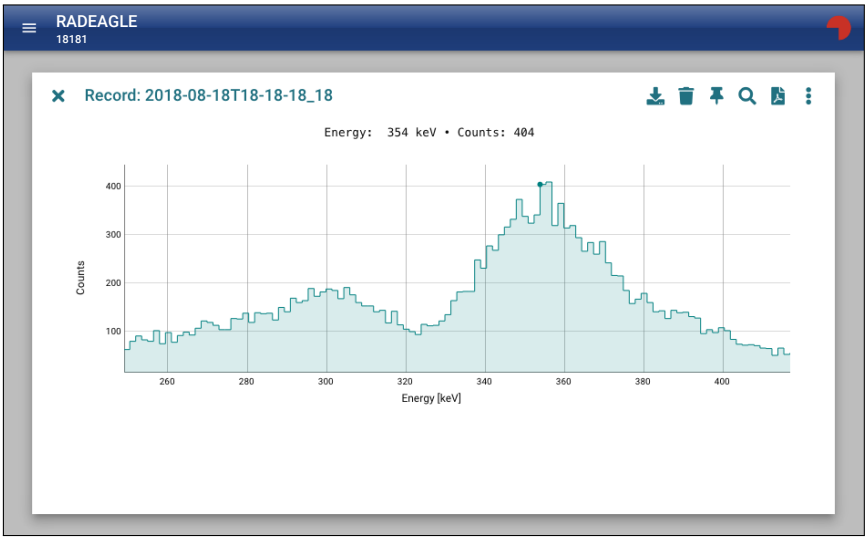


Figure 106: Enlarged part of the spectrum

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

1. Double-Click in the chart area.

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. 90).
3. Drag to the other end of the peak. The region will be accented (Fig. 107, p. 92).

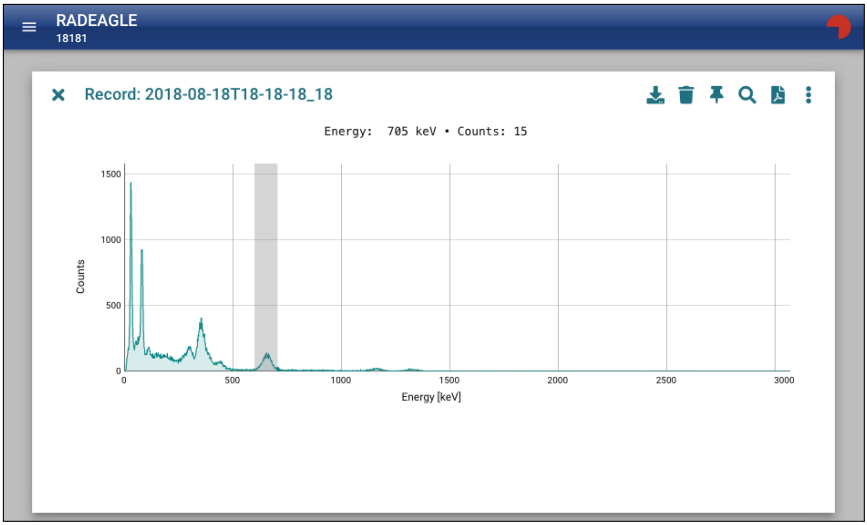


Figure 107: Marking a peak for analysis

4. Release the mouse button. The peak is colored in the diagram and the analysis results are shown below it (Fig. 108, p. 93).

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. 109, p. 94).

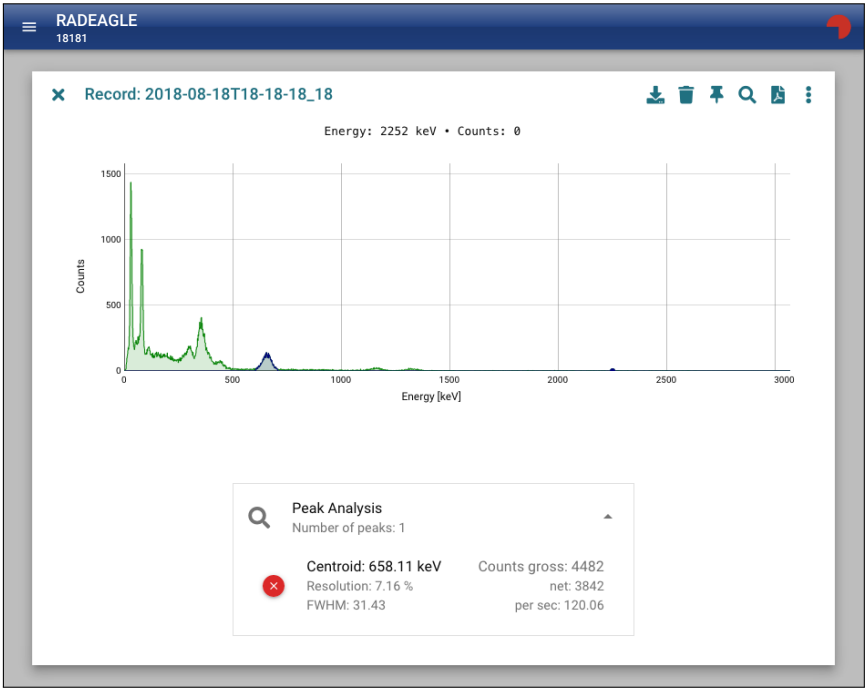


Figure 108: Results for a manually marked peak

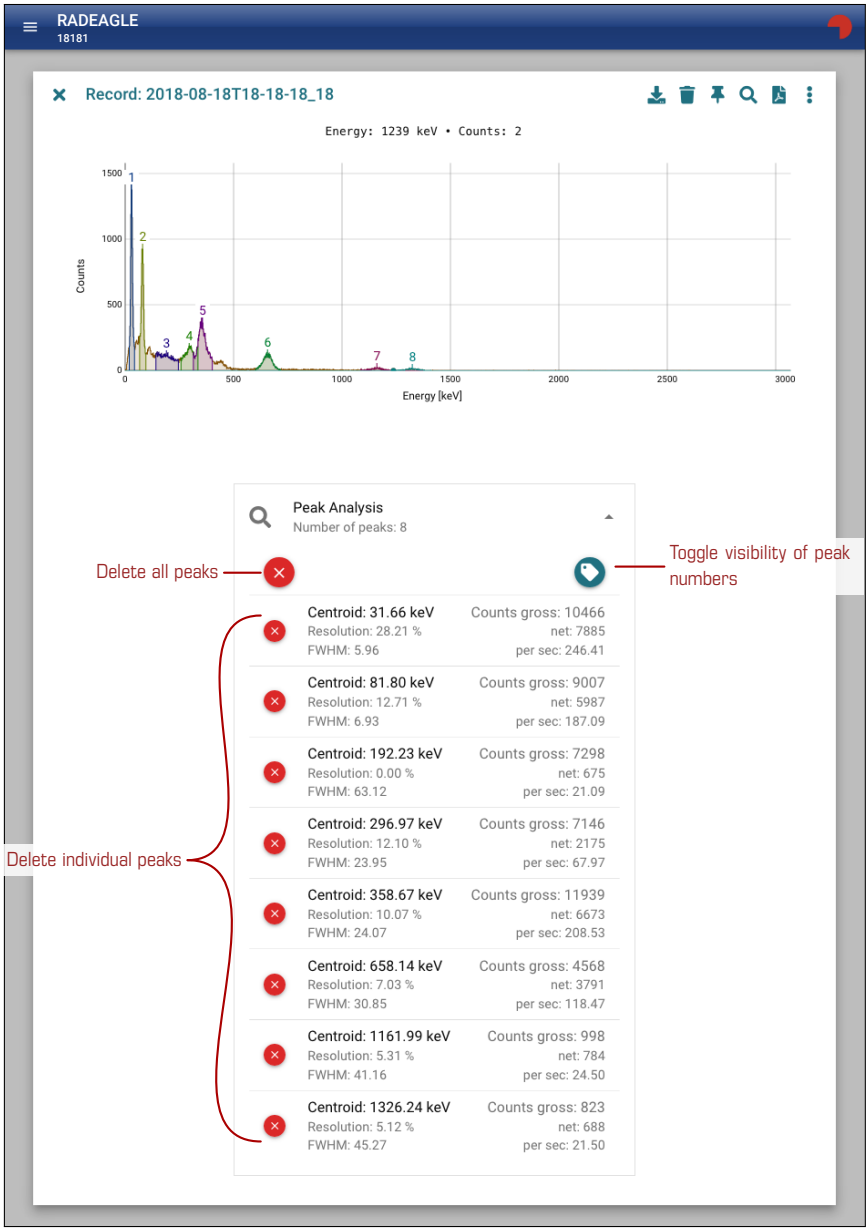


Figure 109: Results of an automatic peak analysis

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. 110, p. 95, Fig. 111, p. 96).

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. 110, p. 95).

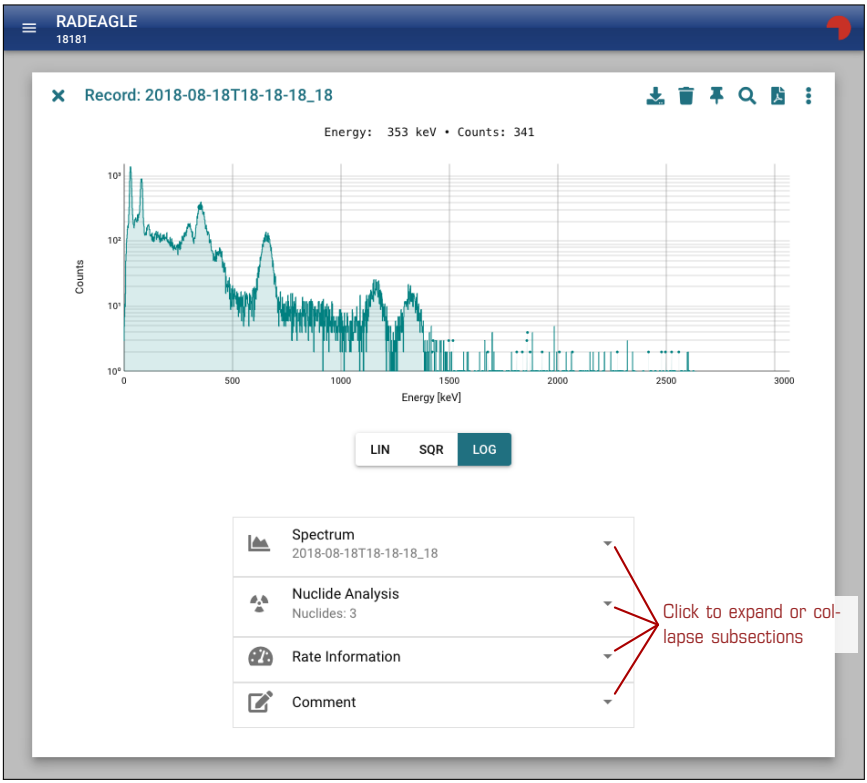


Figure 110: Spectrum with scaling methods and detail overview

You can add a comment to the spectrum in the last subsection (Fig. 112, p. 97). This comment will be appended to the PDF report (see 7.4.1.5, p. 97).

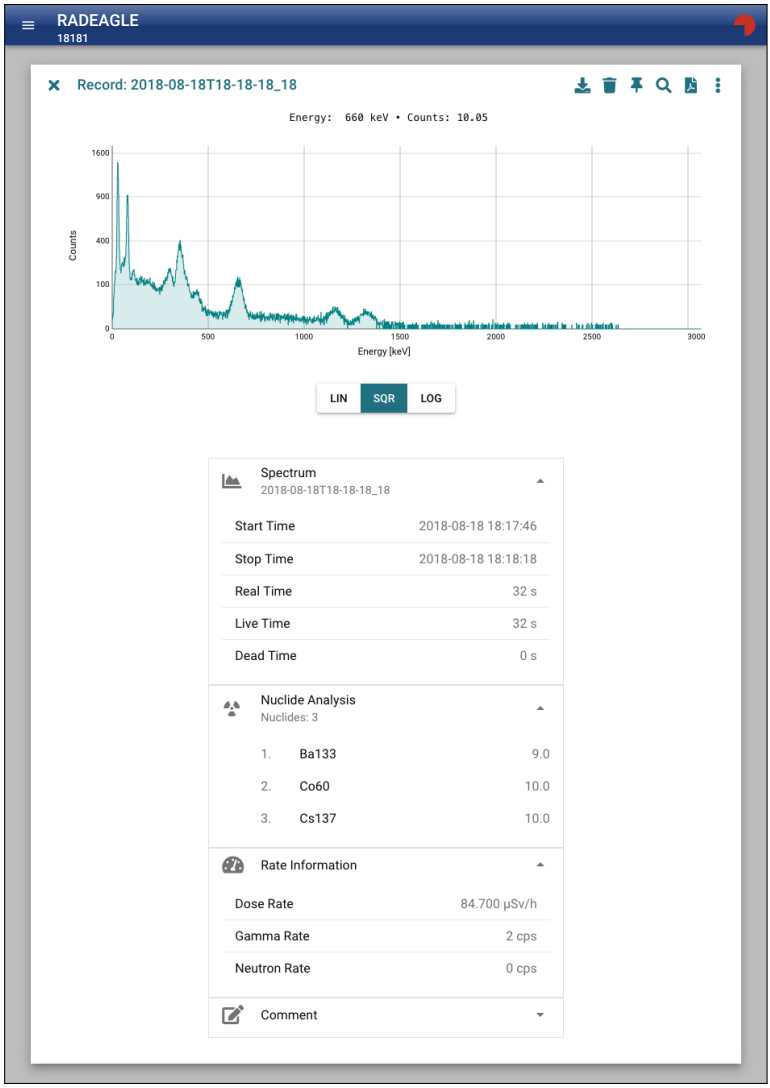


Figure 111: Spectrum with expanded detail information

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

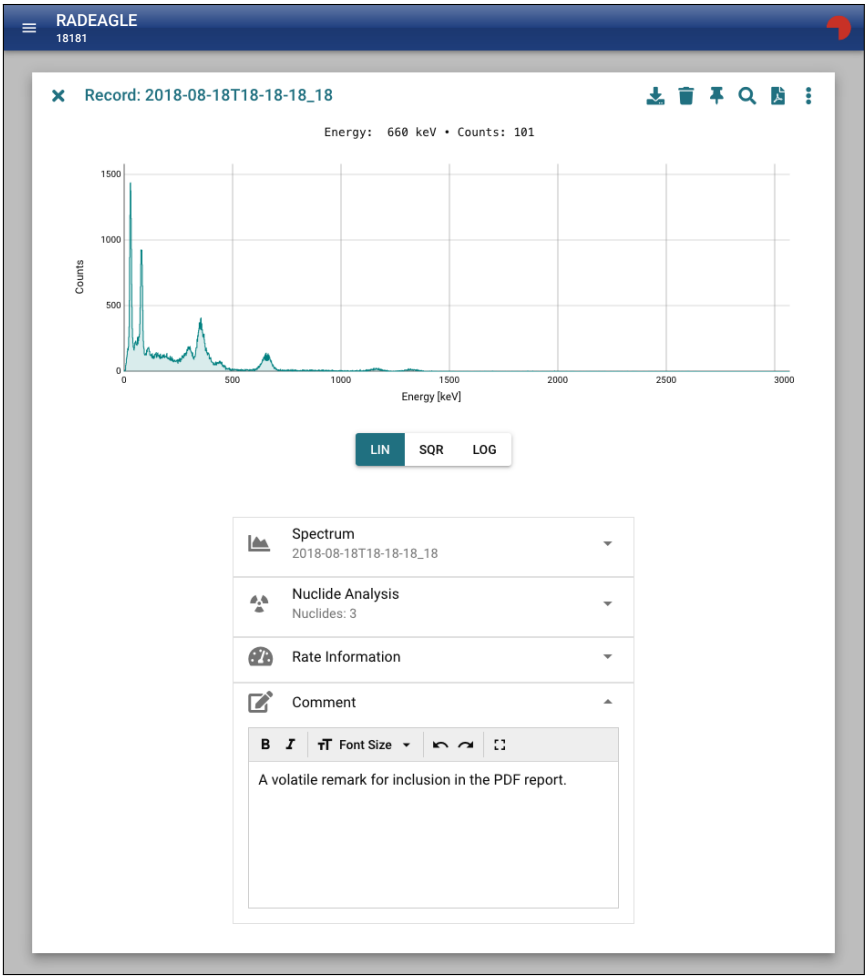


Figure 112: Comment subsection of spectrum details

7.4.1.5 PDF Report Creation

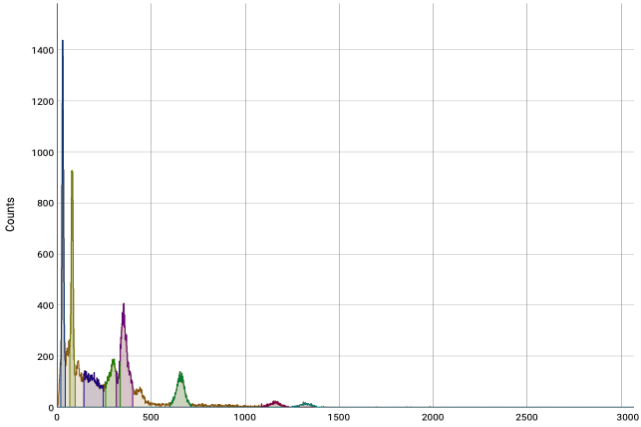
➜ **To create a PDF report...**

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. 113, p. 98.

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

ORTEC AMETEK

Report Date	26.02.2019 03:28:30
Model Name	RADEAGLE
Model	RE 3SG-H-GPS
Serial Number	18181



Spectrum Information

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

Rate Information

Dose Rate	84.700 µSv/h
Gamma Rate	2 cps

Nuclide Analysis

Nuclide	Confidence
Ba133	9.0
Co60	10.0
Cs137	10.0

Peak Analysis

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

Figure 113: PDF report of a spectrum

7.5 Spectrum File Viewer

This section (Fig. 114, p. 99) provides access to the spectrum inspector (see 7.4.1, p. 89) for RADEAGLE spectra not saved in the RADEAGLE 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.

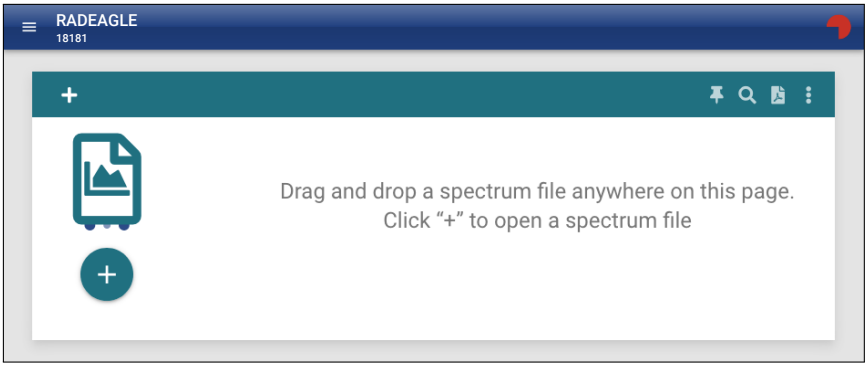


Figure 114: The spectrum file viewer in the Web interface

7.6 Device Settings

This section (Fig. 115, p. 99) provides access to some settings of your RADEAGLE. Changes you make here are transferred to the instrument.

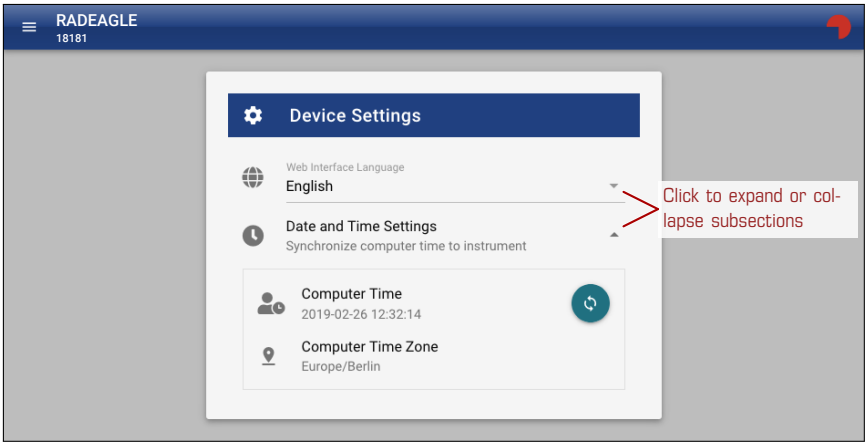


Figure 115: The RADEAGLE settings in the Web interface

7.7 Reachback Settings

This section (Fig. 116, p. 100) provides access to the settings for reachback methods described in see 6.4, p. 84. 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.

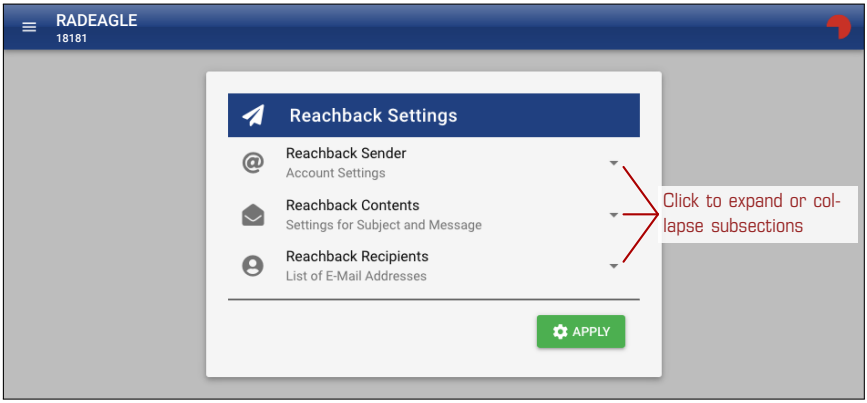


Figure 116: The reachback settings in the Web interface

The settings are grouped into subsections you can expand or collapse as needed (Fig. 117, p. 101).

You can send reachback messages to various recipients. The RADEAGLE 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. 118, p. 102).

The currently selected recipient is decorated with a checkmark (Fig. 117, p. 101). Click to select another recipient from the list.

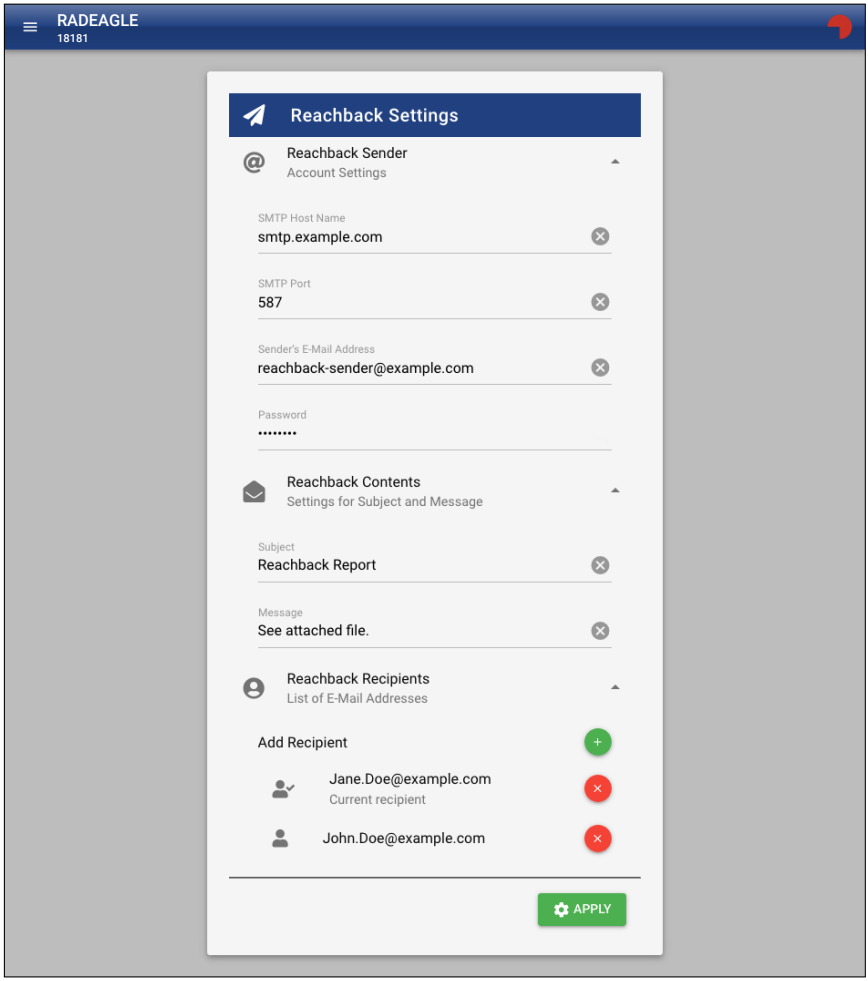


Figure 117: The expanded reachback settings in the Web interface

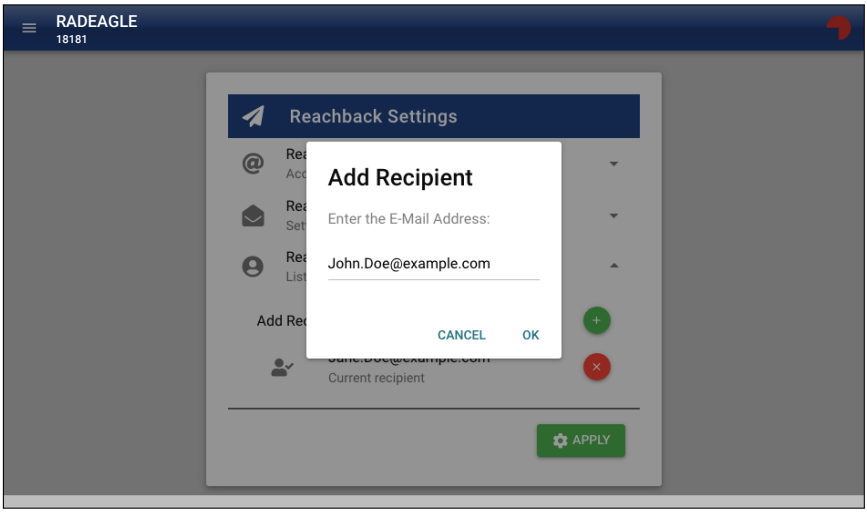


Figure 118: Adding a recipient for reachback messages

7.8 Software Update

You can upload updates or additional software to your RADEAGLE in this section of the Web interface (Fig. 119, p. 103).

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 119: Update software on the RADEAGLE in the Web interface

The file will be transferred to the RADEAGLE, checked and prepared for installation (Fig. 120, p. 103).

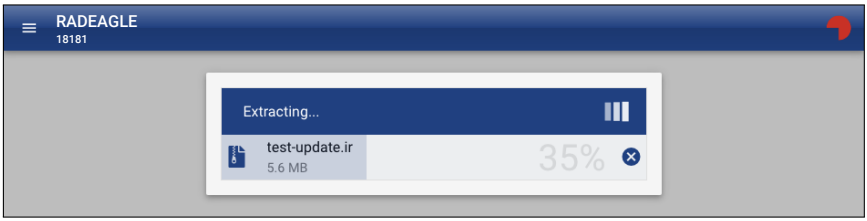


Figure 120: Transfer software to the RADEAGLE in the Web interface

After the file is checked and identified, you have to launch the installation by clicking → (Fig. 121, p. 103).

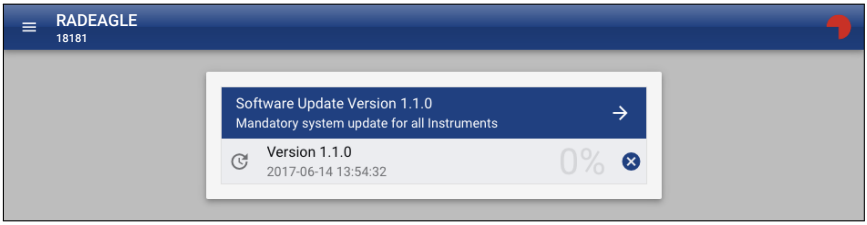


Figure 121: Ready to install the transferred software

You will be informed about the result (Fig. 122, p. 104) and the the instrument will be restarted if necessary.

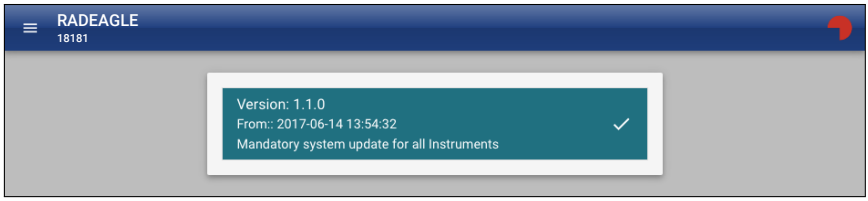


Figure 122: Successful installation of the software

7.9 Documents

This section (Fig. 123, p. 104) 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.

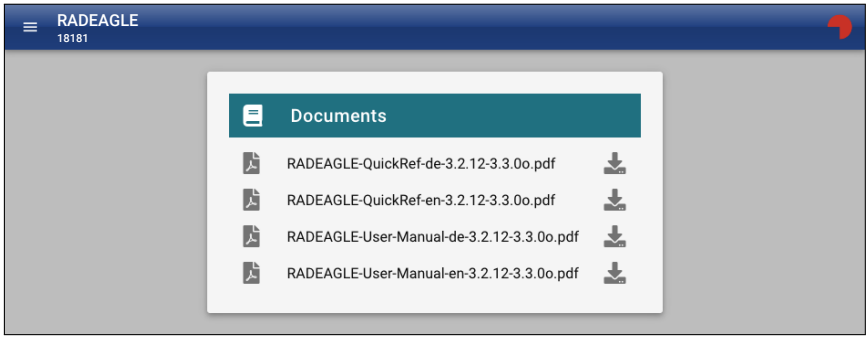


Figure 123: Documents available on your RADEAGLE

7.10 Storage Management

This section (Fig. 124, p. 105) provides access to all the data you saved in the RADEAGLE'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.

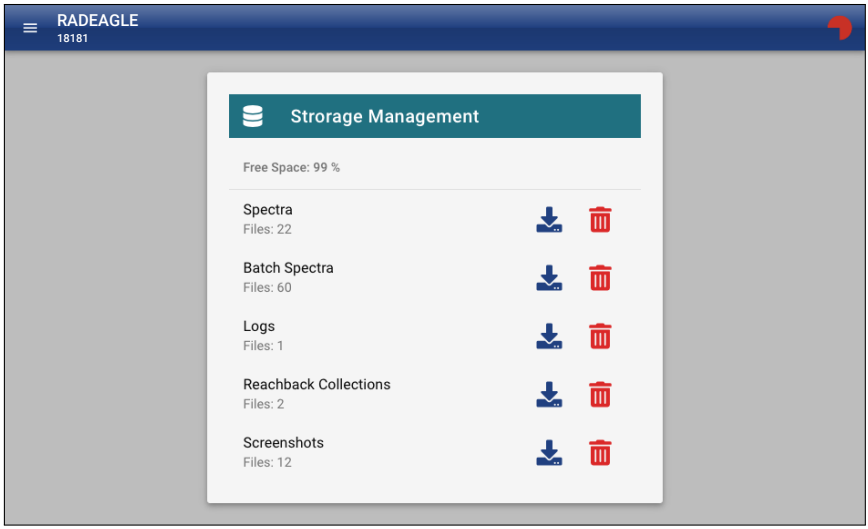


Figure 124: Managing the storage in the Web interface

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 radEAGLE

The standard power source of the radEAGLE is a rechargeable black powerCELL (8.1.1, p. 107) installed behind the rear latch (Fig. 2a, p. 15) of the instrument.

To increase the field operation time you can swap the battery pack (8.2, p. 109).

You can connect the radEAGLE to an external power source to run it and to charge the installed standard battery.

8.1 radEAGLE Battery Packs

The radEAGLE 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. 125, p. 107) is a sealed box containing rechargeable Nickel–metal hydride cells (NiMH) with a very low self discharge (LSD) over time. They are recharged within the instrument whenever it is connected to external power.

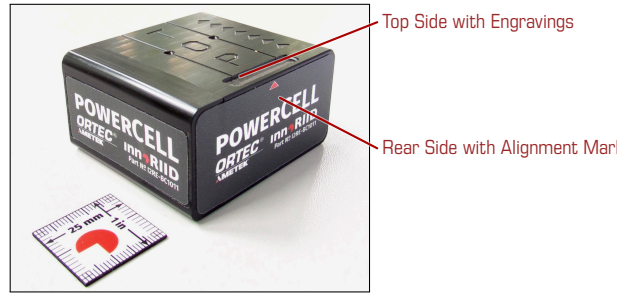


Figure 125: The standard black rechargeable powerCELL of the radEAGLE.

A black powerCELL is installed in the instrument when it leaves the factory.

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

8.1.2 Blue powerCELL

The blue powerCELL (Fig. 126, p. 108) is a box for batteries you supply. You can fill it with six common batteries of size “AA” (a.k.a “Mignon” or “R6”).

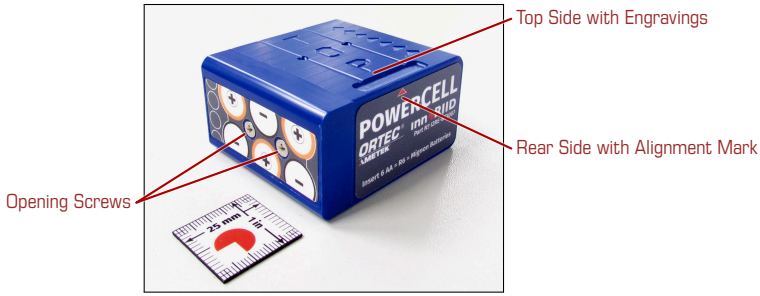


Figure 126: The blue POWERCELL for common batteries.

➜ **To install batteries in the blue POWERCELL...**

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

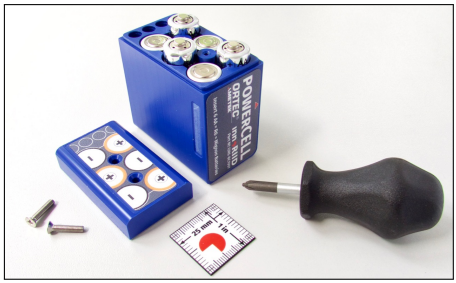


Figure 127: The blue POWERCELL filled with batteries.

⚠ Observe the polarity (Fig. 128, p. 108). The correct orientation is sketched on the pack's cover.

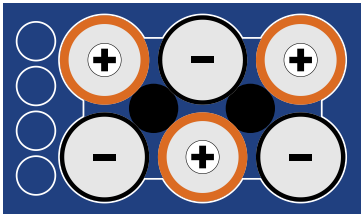


Figure 128: Orientation of AA bateries in the blue POWERCELL (shown without cover).

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

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

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

8.2 Replacing Batteries of the radEAGLE

The procedure of replacing batteries depends on the type of enclosure of your radEAGLE.

The following sections provide information about different enclosure types. Please refer to the section for the enclosure of your radEAGLE.

8.2.1 Standard Enclosure

➜ **To remove the powerCELL...**

1. Remove the USB and power cables, if any, from the instrument.
2. Pull the bung from the power connector plug (Fig. 129, p. 109).

Figure 129: Pulling the protection of the power connector

3. Unscrew the lock of the latch by turning it counter-clockwise (Fig. 130, p. 109).

   You don't need to remove the screw completely, just turn it until the latch opens.

Figure 130: Opening the rear latch of the radEAGLE

4. Open the latch.
5. Grab the powerCELL and pull it backwards from the battery compartment (Fig. 131, p. 110).

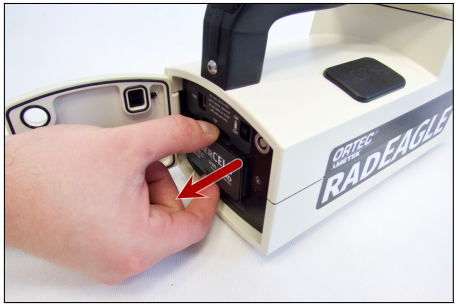


Figure 131: Removing the powerCELL from the radEAGLE

➜ **To install a powerCELL...**

1. Slide the battery pack into the compartment, contact side ahead (Fig. 132, p. 110).

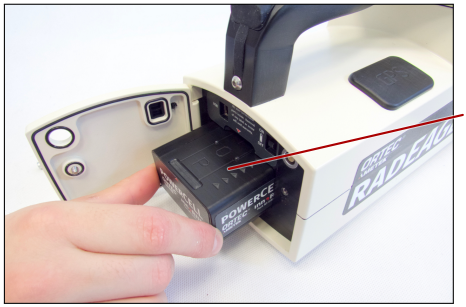


Figure 132: Inserting a powerCELL

⚠ Observe the orientation marks:

- "TOP" and arrows are engraved in the top side of the pack (Fig. 125, p. 107).
- The triangle at the back side of the powerCELL pack must align with that above the compartment in the instrument (Fig. 134, p. 111).

2. Push it lightly until it snaps into place (Fig. 133, p. 111).
3. Close the latch.
4. Close the lock by turning the screw clockwise.
5. Insert the bung to protect the power connector.

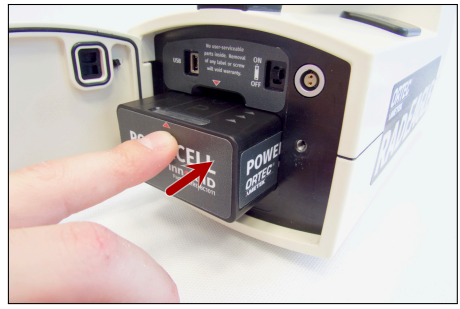


Figure 133: Snapping the POWERCELL into place

Figure 134: The POWERCELL correctly mounted in the RADEAGLE.

8.2.2 Underwater Enclosure

➜ **To remove the POWERCELL...**

1. Use a 2.5 mm hex key (aka "Allen" wrench) to loosen and remove the screws along the edge of battery cover plate on the rear side of the instrument.
2. Remove the cover plate (Fig. 135, p. 112).
3. Tilt the instrument so the POWERCELL slides out (Fig. 136, p. 112). You might need to carefully shake the instrument.

➜ **To install a POWERCELL...**

1. Slide the battery pack into the compartment, contact side ahead (Fig. 137, p. 113).

   ⚠ Observe the orientation marks:

   - "TOP" and arrows are engraved in the top side of the POWERCELL.

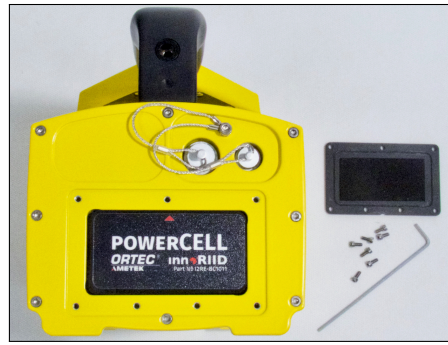


Figure 135: POWERCELL in the RADEAGLE after removing the cover

Figure 136: Removing the POWERCELL with gravity assistance

- The red triangle at the back side of the POWERCELL must point towards the top of the instrument.

2. Move the battery pack until it is completely in the compartment.
3. Check the cover plate, especially the O-ring surrounding the foam rubber, for dirt or damages (Fig. 138, p. 113).
4. Put the coverplate into place.

   Observe the orientation mark. The notch in the center of a long edge of the plate must point towards the bottom of the RADEAGLE (Fig. 139, p. 113).
5. Insert the screws into the holes of the cover plate and fasten them with a hex key.

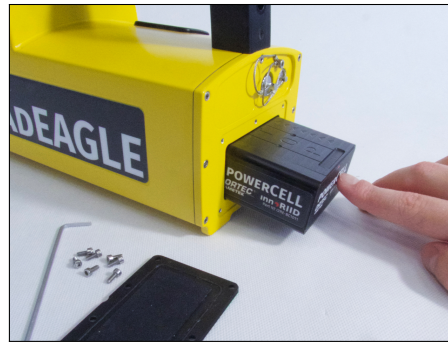


Figure 137: Inserting the powerCELL

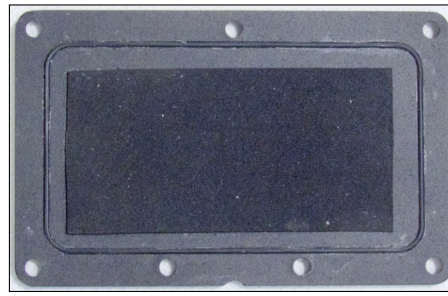


Figure 138: Correct placement of the O-ring seal on the inner side of the cover plate

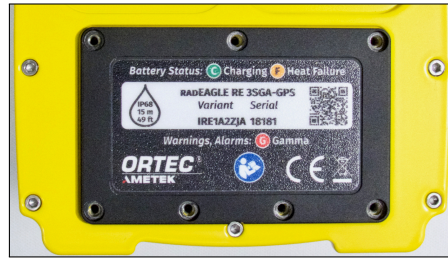


Figure 139: Correct placement of the battery cover plate

8.3 External Power Sources

You can connect the radEAGLE to external power sources via the connector on the rear side of the instrument Fig. 2a, p. 15.

Included with the radEAGLE are:

- Wall power supply (8.3.1, p. 114)
- Car adaptor

While the RADEAGLE is powered by an external source providing enough power to charge the internal battery, the the battery symbol (Fig. 1, p. 14) is decorated by a bolt.

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

1. Remove the protective cap from the connector (Fig. 129, p. 109).
2. Insert the plug (Fig. 140, p. 114).

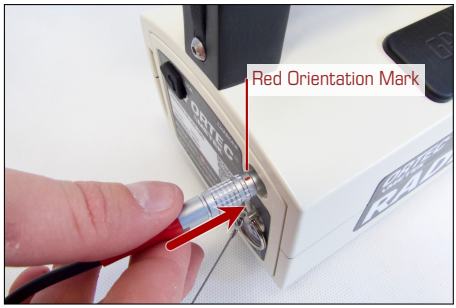


Figure 140: Inserting the external power plug

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

Always grab the plug when handling the connection (Fig. 141, p. 114). Do not pull at the cable behind the plug (Fig. 142, p. 115).

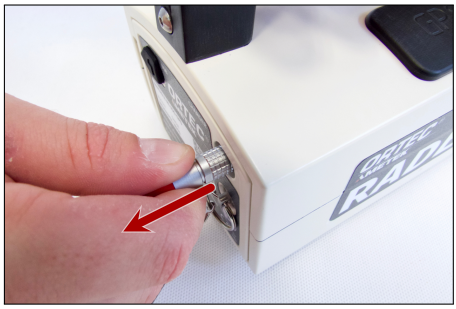


Figure 141: Unplugging the external power connection

8.3.1 Wall Power Supply

Every power supply shipped with the RADEAGLE 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.

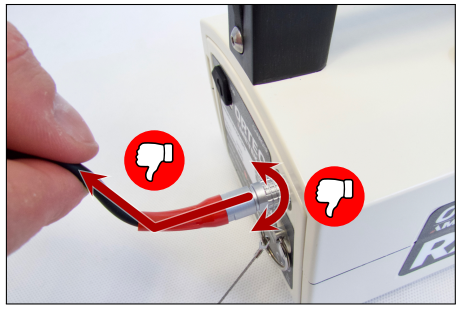


Figure 142: Do NOT rotate the connector, do NOT bend or pull at the power cable!

Other models feature swappable adaptors for several international wall outlet standards (Fig. 143, p. 115).

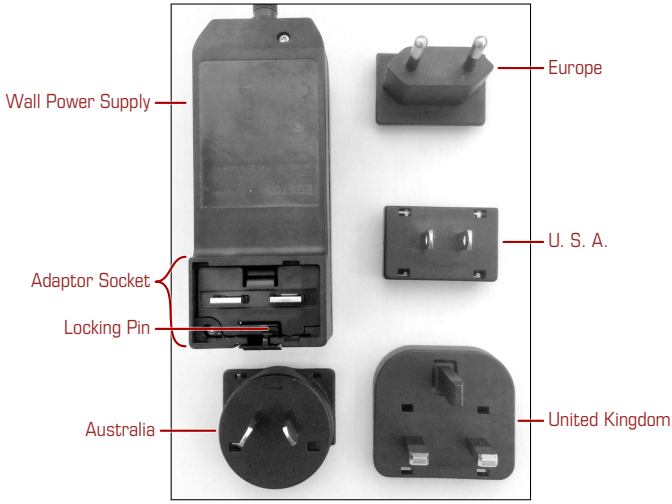


Figure 143: Wall power supply with international adaptors

➜ **To swap the international adaptor**...

1. Press the lock and slide the current adaptor to the side out of its socket (Fig. 144, p. 116).

2. Insert the desired adaptor into the socket and move it until it snaps into place (Fig. 145, p. 116).

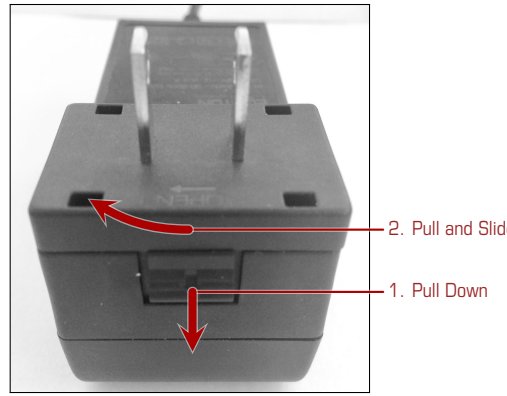


Figure 144: Removing an adaptor from the wall power supply

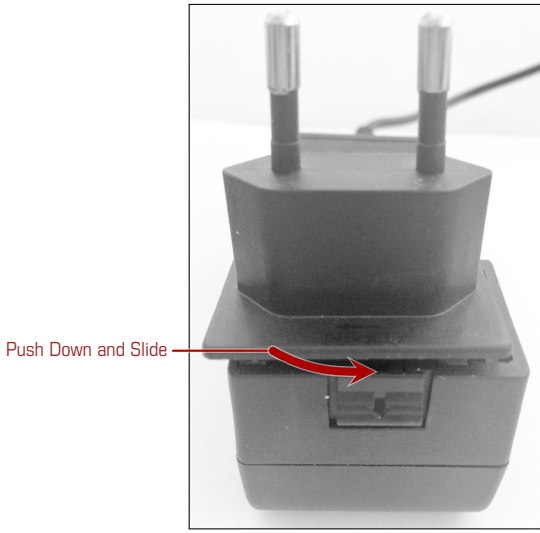


Figure 145: Mounting an adaptor to the wall power supply

8.4 Charging the powerCELL

While your radEAGLE is connected to an external power source (see 8.3, p. 113) an installed black powerCELL (see 8.1.1, p. 107) will be charged.

Charging is reported by a green LED (see 2.1.1, p. 23, Fig. 1, p. 14), which goes off when the battery is fully charged.

8.5 Energy Saving Tips

If you need to save energy, especially when running the radEAGLE 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. 49) to what you really need in your environment.

Let the backlight time out after the shortest period of inactivity (see 5.4, p. 49) convenient for your workflow.

Wi-Fi

Switch off the Wi-Fi hotspot while you not using it to communicate (see 5.8, p. 52).

USB Devices

Disconnect any USB devices while you are not transferring data.

GPS Receiver

Switch off the GPS receiver (see 5.13, p. 62) 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 radEAGLE. Switch to another mode while not using the detect mode.

A Nuclide Library

Nuclide	Usage, Severity, Half Life	Description
^{241}Am `Am241`	SNM Threat 432 a	Americium has several isotopes and ^{241}Am is a radioactive isotope. It is a typical companion found in various plutonium nuclide compositions and therefore it is regarded as threat. This nuclide can also be found in components of smoke detectors, where a small americium source acts as an ionizer.
^{18}F, ^{14}O, ^{15}O, ^{11}C, ^{13}N, ^{26}Al, ^{22}Na, ^{121}I, *others*, +	IND, (MED) Innocent	Several nuclides emit + particles. These particles may recombine with negative particles in the detector material, typically depositing a photo energy of 511 keV. Some of these isotopes are used for positron emission tomography (PET). The RADEAGLE displays the identification result + when confronted with such a source because all sources share the 511 keV line and cannot be differentiated further (except ^{22}Na).
^{110m}Ag `Ag110m`	IND Innocent 250 d	Isotope of the chemical element silver. It has industrial applications and may be found in scrap metals.
^{133}Ba `Ba133`	IND Innocent 10.75 a	Barium is used in some industrial applications and may be used as test source. It has peaks relatively close to ^{239}Pu.
^{207}Bi `Bi207`	MED Innocent 32.9 a	Isotope that is a follow-up from the alpha decay of ^{211}At. Sometimes found in medical applications, but mostly used in industrial context.
^{109}Cd `Cd109`	IND Innocent 463 d	Cadmium is an industrially used radiation source.

to be continued...

... continuation

Nuclide	Usage, Severity, Half Life	Description
^{57}Co Co57	IND (MED) Innocent 272 d	This isotope of cobalt is often found in medical applications to estimate the size of organs. In industry, it is used as low energy emitter.
^{60}Co Co60	IND Innocent 5.3 a	A high energy emitting isotope that can be used for transmission or absorptions spectroscopy. Its industrial applications include sterilization of surgical equipment and food. Depending on end user conops, ^{60}Co may be considered a threat.
^{51}Cr Cr51	IND Innocent 27 d	Short living industrial source. Sometimes encountered in medical research on blood cells.
^{134}Cs Cs134	IND Innocent 2 a	The cesium isotopes are fission products of nuclear reactors and are often encountered in fall-out following nuclear power plant accidents (Chernobyl, Fukushima). This specific nuclide is sometimes also used for leak detection.
^{137}Cs Cs137	IND Innocent 30 a	Cesium ^{137}Cs is perhaps the most prominent nuclide because it is used as a calibration or test source throughout the world. Like ^{134}Cs, it is a direct fission product of nuclear reactors and, therefore, is also seen after a nuclear plant accident (fall-out) or a nuclear detonation. Depending on end user conops, ^{137}Cs may be considered a threat
^{152}Eu Eu152	IND Innocent 13.5 a	Europium ^{152}Eu is a source with many photo peaks. In the past, this isotope was used within the control system of nuclear power plants. The multitude of peaks makes europium an ideal candidate for calibrations and specific spectroscopic experiments.
^{68}Ga Ga68	MED Innocent 68 m	Gallium is used in nuclear medicine as a generator of radio-pharmaceutical isotopes for positron emission tomography (PET) scanners.

to be continued...

... continuation

Nuclide	Usage, Severity, Half Life	Description
^{123}I I123	MED Innocent 13 h	Iodine isotopes are frequently applied in nuclear medicine. This specific isotope is used for diagnostics regarding thyroid functionality.
^{125}I I125	MED Innocent 60 d	Medical isotope for diagnostics on hormone levels and cancer treatment.
^{131}I I131	MED Innocent 8 d	Iodine ^{131}I is widely used for thyroid diagnostics and treatment as well as kidney and liver studies. It is a fission fragment in nuclear reactors and may be expected after a reactor accident.
^{111}In In111	MED Innocent 2.9 d	Indium is used for research on brain cells and for infection rate analysis.
^{192}Ir Ir192 Ir192s	IND, (MED) Innocent 74 d	Iridium ^{192}Ir is used in different applications. It is a source for cancer treatment and it is also used for inspections of pipelines (to investigate the quality of their welding). Sometimes, the weld can have small fractures, posing a threat that the pipeline could leak. ^{192}Ir sources are also used to detect such fractures and to perform thickness measurements. The radEAGLE has two possible indications for iridium, ^{192}Ir and ^{192s}Ir, the latter referring to shielded sources because safe industrial usage requires very heavy shielding, often using depleted uranium as a shield.
^{40}K K40	NORM Innocent 1.28 Ga	Potassium ^{40}K is part of the naturally occurring radiation materials (NORM), yielding a very clear photo peak at 1460keV. This peak is commonly used for calibration without additional calibration sources. The identification result K40 will appear when analyzing radiation of ceramics, tiles and fertilizer. You may also denote its presence when running a long-term acquisition with your radEAGLE. An identification result for this source is always possible and it is absolutely safe.

to be continued...

... continuation

Nuclide	Usage, Severity, Half Life	Description
^{54}Mn Mn54	IND Innocent 312 d	The amount of manganese in waste water can be estimated by analyzing this isotope. Therefore, it is a reliable predictor for heavy metal pollution in the water of mining activities.
^{99}Mo Mo99	IND Innocent 2.8 d	Generator for technetium ^{99m}Tc.
^{22}Na Na22	IND Innocent 2.6 a	^{22}Na features a high energetic line beneath its + emission and is well-suited to investigate pipeline leakage or welding quality. Some further applications are found in medicine. The identification result for this isotope will display Na22 and additionally +Na22 because the + emission is a natural part of the isotopes radiation profile.
^{237}Np Np237	SNM Threat 2.14 Ma	Neptunium is used to produce ^{238}Pu. It is considered to be a major SNM threat, as are uranium and plutonium.
^{239}Pu WGPu, WGPu_HS, RGPu, RGPu_HS	SNM Threat 6560 a	Plutonium is a severely dangerous material. It is extremely poisonous and poses a deadly risk for humans. The radEAGLE distinguishes four mixtures of ^{239}Pu with ^{240}Pu. The abbreviation RGPu stands for reactor-grade plutonium (yielding a higher amount of ^{240}Pu in the composition). Weapons-grade plutonium (WGPu) has a higher amount of ^{239}Pu and a lower amount of ^{240}Pu. The denotion “HS” marks a source with heavy shielding where only few or none of the lower energy gammas of plutonium may be found in the spectrum. It is common for both reactor-grade or weapon-grade plutonium to be accompanied by an ID of ^{241}Am.

to be continued...

... continuation

Nuclide	Usage, Severity, Half Life	Description
^{226}Ra Ra226	NORM Innocent 1600 a	Radium is a specific stage in the decay of uranium which naturally occurs in the earth's shell. When it decays down, it becomes ^{226}Ra. Radium is one of the most frequently encountered radiation signatures and is considered naturally occurring radiation. Tiles and rocks are very likely to receive radium identification results. Also, sources denoted as uranium ore are typically identified as ^{226}Ra sources.
^{99m}Tc Tc99m	MED Innocent 6 h	Widely used and frequently applied medical radiation substance. Used for imaging of the heart, liver and kidneys.
^{201}Tl Tl201	MED Innocent 3 d	Used for diagnosing arterial diseases and problems associated with blood flow.
^{232}Th Th232	NORM Innocent 14.05 Ga	A naturally occurring material found in rocks. It is used in lantern mantles and welding rods.
^{232}U U232	SNM Threat 69 a	
^{233}U U233	SNM Threat 160 ka	This is a fissile isotope of Uranium that was formerly used in nuclear weapons. Today this uranium isotope is used primarily in nuclear reactors. It is still considered a threat material.
^{235}U U235	SNM Threat 704 Ma	^{235}U is a very important isotope of uranium used in commercial nuclear power reactors. Uranium used in reactors is typically 3-5% enriched (the ^{235}U content). Low Enriched Uranium has <20% ^{235}U content. Highly Enriched Uranium (>20% and sometimes as high as 90% or more) can be used in nuclear weapons and is an important threat material to detect.

to be continued...

... continuation

Nuclide	Usage, Severity, Half Life	Description
^{238}U U238	SNM Threat 4.468 Ga	^{238}U is the primary constituent of natural uranium (about 99.3%). Depleted uranium has an even higher ^{238}U content. It is a threat because it may be used in nuclear weapons.
Unknown	— Threat	The radEAGLE can have a nuclide is unknown. This will appear when a) a nuclide is found that is deactivated in the current library of the instrument or b) whenever a source is measured whose spectrum does not match any of the references. Unknown sources are considered to be a threat.
Neutron Source	SNM Threat	A neutron source is identified whenever the neutron detector detects the presence of neutrons. Neutron sources are very dangerous and should be treated with extreme care.

B Glossary

The glossary contains key technical terms used throughout this manual.

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

Centroid Center of a peak. The centroid is used to measure peak position. Its numerical value is often generated by a peak fit routine. In the RADEAGLE, 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 RADEAGLE. 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 RADEAGLE models with a neutron detector (see E.1, p. 135).

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 RADEAGLE 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 RADEAGLE's advanced algorithms provides the list of radionuclides measured.

C Technological Background, Limitations

C.1 Stabilization

The primary spectroscopic detector of radEAGLE 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 radEAGLE 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 radEAGLE 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 radEAGLE 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 radEAGLE uses the natural background peaks for an advanced stage of self-stabilization. When turned on, the radEAGLE is automatically taking background spectra and analyzing them. All this happens automatically in the instrument,

and is completely transparent to the user. Once the RADEAGLE 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 RADEAGLE has a dedicated screen to visually inspect the calibration quality when performing a calibration, see 5.18, p. 68.

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

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

C.2.2 Re-Calibrating Using the Calibration Mode

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

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

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

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

C.3 Effective Range of Measurement

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

C.4 Determination of the Full Width at Half Maximum

radEAGLE 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 radEAGLE 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 radEAGLE 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 radEAGLE 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 ^{40}K 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 and using the ^{40}K box supplied with the instrument (see 2.3, p. 29).

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. 29). After the instrument reboots, you should perform the Easy Calibration (see 5.14, p. 63) using a ^{137}Cs source. This process typically takes less than a minute and ensures the instrument generates excellent identifications.

D.2 System Switches Back to Black Screen

Solution: Unplug all cables from radEAGLE. Open rear battery chamber and set the battery switch to “off”. Wait at least 10 seconds. Put the switch back to the “on” state. If the problem reappears, please contact our customer support.

D.3 System Keeps Running Although the Battery Switch is Set to Off

The battery switch activates or deactivates the current flow between battery and main board. If the main board is connected to USB, it will be powered via USB. The system may keep on running for a short time after the battery was removed.

Solution: Unplug the USB cable. This will shutdown the power to the mainboard.

D.4 Checking the Proper Function of the System

To ensure your radEAGLE 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 radEAGLE 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 innoRIID radEAGLE: Specifications

Several models of this product are available.

(A) **radEAGLE 3SG**

Sodium iodide detector (NaI); Geiger-Müller tube

(B) **radEAGLE 3SGI**

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

(C) **radEAGLE 3SG-H**

Sodium iodide detector (NaI); Geiger-Müller tube; ^{3}He tube

(D) **radEAGLE 3SGI-H**

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

(E) **radEAGLE 3SG-GPS**

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

(F) **radEAGLE 3SGI-GPS**

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

(G) **radEAGLE 3SG-H-GPS**

Sodium iodide detector (NaI); Geiger-Müller tube; ^{3}He tube; GPS receiver

(H) **radEAGLE 3SGI-H-GPS**

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

(I) **radEAGLE 3SG-A**

Sodium iodide detector (NaI); Geiger-Müller tube; underwater enclosure

(J) **radEAGLE 3SGI-A**

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

(K) **radEAGLE 3SG-A-H**

Sodium iodide detector (NaI); Geiger-Müller tube; underwater enclosure; ^{3}He tube

(L) **radEAGLE 3SGI-A-H**

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

(M) **radEAGLE 2LG**

Lanthanum bromide detector ($LaBr_3$); Geiger-Müller tube

(N) **radEAGLE 2LG-H**

Lanthanum bromide detector ($LaBr_3$); Geiger-Müller tube; ^3He tube

(O) **radEAGLE 2LG-GPS**

Lanthanum bromide detector ($LaBr_3$); Geiger-Müller tube; GPS receiver

(P) **radEAGLE 2LG-H-GPS**

Lanthanum bromide detector ($LaBr_3$); Geiger-Müller tube; ^3He tube; GPS receiver

(Q) **radEAGLE 3CG**

Cerium bromide detector ($CeBr_3$); Geiger-Müller tube

(R) **radEAGLE 3CG-H**

Cerium bromide detector ($CeBr_3$); Geiger-Müller tube; ^3He tube

(S) **radEAGLE 3CG-GPS**

Cerium bromide detector ($CeBr_3$); Geiger-Müller tube; GPS receiver

(T) **radEAGLE 3CG-H-GPS**

Cerium bromide detector ($CeBr_3$); Geiger-Müller tube; ^3He tube; GPS receiver

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

Detectors		
Gamma: NaI	(A—L)	Crystal size (Ø × L): 76.2 mm (3.00 in) × 25.4 mm (1.00 in)
Gamma: $LaBr_3$	(M—P)	Crystal size (Ø × L): 50.8 mm (2.00 in) × 25.4 mm (1.00 in)
Gamma: $CeBr_3$	(Q—T)	Crystal size (Ø × L): 76.2 mm (3.00 in) × 20.32 mm (0.80 in)
Gamma (High Dose Rate)		Geiger-Müller detector
Neutrons: ^3He Proportional Counter Tube (C) (D) (G) (H) (K) (L) (N) (P) (R) (T)		Size (Ø × L): 12.7 mm (0.50 in) × 64 mm (2.52 in); net: 9.4 mm (0.37 in) × 50 mm (1.97 in); 8 bar (116.03 psi)
GPS	(E—H) (O) (P) (S) (T)	66-channel MediaTek MT3339 receiver
Calibration		
External Source		^{40}K; Startup time: 150 s
Internal Source	(B) (D) (F) (H) (J) (L)	^{137}Cs; 111 Bq (3 nCi); Startup time: 130 s
Performance		
Energy Range (Gamma)		15 keV — 3 MeV
Throughput		>250 kcps

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Max. Input Count Rate		750 kcps
Sensitivity (^{137}Cs)	A–L	>2500 cps per µSv/h
Sensitivity (^{137}Cs)	M–P	>1800 cps per µSv/h
Sensitivity (^{137}Cs)	Q–T	>2500 cps per µSv/h
Gamma Spectrum		2048 channels
Dose Rate Range		10 nSv/h – 1 Sv/h
dto. Scintillator	A–L	10 nSv/h – 250 µSv/h
dto. Scintillator	M–P	20 nSv/h – 250 µSv/h
dto. Scintillator	Q–T	10 nSv/h – 250 µSv/h
dto. Geiger-Müller Detector		100 µSv/h – 100 mSv/h
dto. Overload		≥1 Sv/h
Thermal Neutron Sensitivity	C D G H K L N P R T	1.65 cps/nv ±10 %
Typical Resolution	A–L	<7.2 % FWHM at 661.6 keV (^{137}Cs) at 20.0 °C (36.0 °F) ambient temperature
Typical Resolution	M–P	<3.2 % FWHM at 661.6 keV (^{137}Cs) at 20.0 °C (36.0 °F) ambient temperature
Typical Resolution	Q–T	<4.2 % FWHM at 661.6 keV (^{137}Cs) at 20.0 °C (36.0 °F) ambient temperature
Nuclide Library		^{228}Ac; ^{241}Am; ^{133}Ba; ^{140}Ba; Beta+; ^{207}Bi; ^{109}Cd; ^{115}Cd; ^{115m}Cd; ^{141}Ce; ^{57}Co; ^{60}Co; ^{51}Cr; ^{134}Cs; ^{137}Cs; ^{152}Eu; ^{155}Eu; ^{67}Ga; ^{68}Ga; ^{123}I; ^{125}I; ^{131}I; ^{132}I; ^{111}In; ^{192}Ir; ^{40}K; ^{140}La; ^{176}Lu; ^{54}Mn; ^{99}Mo; ^{22}Na; ^{95}Nb; ^{147}Nd; Neutrons; ^{237}Np; ^{144}Pr; ^{238}Pu; RGPu; RGPu-HS; WGPu; WGPu-HS; ^{226}Ra; ^{103}Ru; ^{125}Sb; ^{75}Se; ^{90}Sr; ^{99m}Tc; ^{132}Te; ^{232}Th; ^{201}Tl; ^{232}U; ^{233}U; ^{235}U; ^{238}U; ^{238}U; ^{131m}Xe; ^{133}Xe; ^{133m}Xe; ^{135}Xe; ^{95}Zr
Nuclide Library	C D G H K L N P R T	^{252}Cf
Physical Properties		
Dimensions (W × D × H)		113 mm (4.45 in) × 245 mm (9.65 in) × 156 mm (6.14 in)
Weight	A B	2600 g (5 lb 11.7 oz) including batteries
Weight	C D	2800 g (6 lb 2.8 oz) including batteries
Weight	E F	2620 g (5 lb 12.4 oz) including batteries
Weight	G H	2820 g (6 lb 3.5 oz) including batteries
Weight	I J	2700 g (5 lb 15.2 oz) including batteries

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Weight	K L	2900 g (6 lb 6.3 oz) including batteries
Weight	M	2400 g (5 lb 4.7 oz) including batteries
Weight	N	2600 g (5 lb 11.7 oz) including batteries
Weight	O	2420 g (5 lb 5.4 oz) including batteries
Weight	P	2620 g (5 lb 12.4 oz) including batteries
Weight	Q	2800 g (6 lb 2.8 oz) including batteries
Weight	R	3000 g (6 lb 9.8 oz) including batteries
Weight	S	2820 g (6 lb 3.5 oz) including batteries
Weight	T	3020 g (6 lb 10.5 oz) including batteries
Housing Material		Aluminium; polyoxymethylene; glass
Environmental		
Operating Temperature		-20 °C — +55 °C (-4 °F — +131 °F)
Storage Temperature		+10 °C — +35 °C (+50 °F — +95 °F)
Temperature Change		Sudden temperature change must not exceed 30.0 °C (54.0 °F) in order to avoid damage to the detector crystal.
Relative Humidity	A—H M—T	10 % — 80 %, non condensing
Relative Humidity	I—L	≤100 %
Shock Resistance		50 × g
Protection Rating	A—H M—T	IP65 according to IEC 60529
Protection Rating	I—L	IP68 according to IEC 60529; 15 m (49.21 ft)
Explosive Atmospheres		NOT certified for use in explosive environments
Battery		
Type		powerCELL (LSD NiMH, rechargeable); exchangeable
Capacity		>2700 mAh; 7.2 V
Operating Duration		≥8.5 h at 20 °C (68 °F) in dose rate mode with dimmed display back light and GPS switched off
Operating Duration		≥6 h at -20 °C (-4 °F) in dose rate mode with dimmed display back light and GPS switched off
Charging Duration		3.5 h at 20 °C (68 °F) when instrument off
Display		
Type		Transflective color TFT LCD
Size		3.5 in (88.9 mm); 640 pixel × 480 pixel
Central Luminance		250 cd/m² (typical)
Annunciators		
Red LED		Gamma warning and alarm reporting; startup indication

to be continued...

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Blue LED	C D G H K L N P R T		Neutron detection; warning and alarm reporting; startup indication
Green LED			Battery charging
Amber LED			Battery temperature failure
Vibrator			Warning and alarm reporting
Speaker	A—H	M—T	Warning and alarm reporting; keyboard feedback
Memory			
Data Storage			16 GB internal memory; 12 GB available for the user
Input, Output			
USB	A—H	M—T	USB 2.0; Mini USB-B — USB-A; cable included; 80 cm (2 ft 7.5 in)
USB		I—L	USB 2.0; LEMO Series T connector — USB A; watertight; cable included; 80 cm (2 ft 7.5 in)
USB Host	A—H	M—T	USB 2.0; USB-A socket; Wi-Fi adaptor included
Wi-Fi		I—L	Embedded behind display; reduced range
Software			
Embedded Software			Linux Operating System
Web Interface			Via USB cable connection
Web Interface	A—H	M—T	Via optional USB communication adaptors; Wi-Fi (included); Bluetooth; LAN
Reachback; E-Mail	A—H	M—T	Via optional USB communication adaptors; Wi-Fi (included); Bluetooth; LAN; requires Internet connection
Download File Formats			ANSI N42.42 (xml) and spe files compatible with third-party analysis software
Accessories			
Carrying Case			390 mm (15.35 in) × 310 mm (12.20 in) × 192 mm (7.56 in); 1.8 kg (3.97 lb); stackable; polypropylene; polyethylene
Optional Carrying Case			400 mm (15.75 in) × 300 mm (11.81 in) × 223 mm (8.78 in); 2020 g (4 lb 7.3 oz); watertight; stackable; polypropylene; polyethylene
Calibration Source			Box with potassium chloride (KCl); ICSC 1450; 400 g (14.11 oz); net: 200 g (7.05 oz)
DC Power Adaptor, Charger			AC in: 100 V — 240 V; 620 mA; 50 Hz — 60 Hz; DC out: 12 V; 2.5 A
Car Power Adaptor, Charger			DC in: 12 V

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Replacement Battery	Polyoxymethylene box for 6 AA (Mignon, R6) batteries; with screw driver
Standards	
ANSI N42.34 2015	Performance Criteria for Handheld Instruments for the Detection and Identification of Radionuclides
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
ANSI N42.42 2006	Data format standard for radiation detectors used for Homeland Security
EMC - Directive 2014/30/EU	Regulations concerning electromagnetic compatibility

E.2 Detector Positions

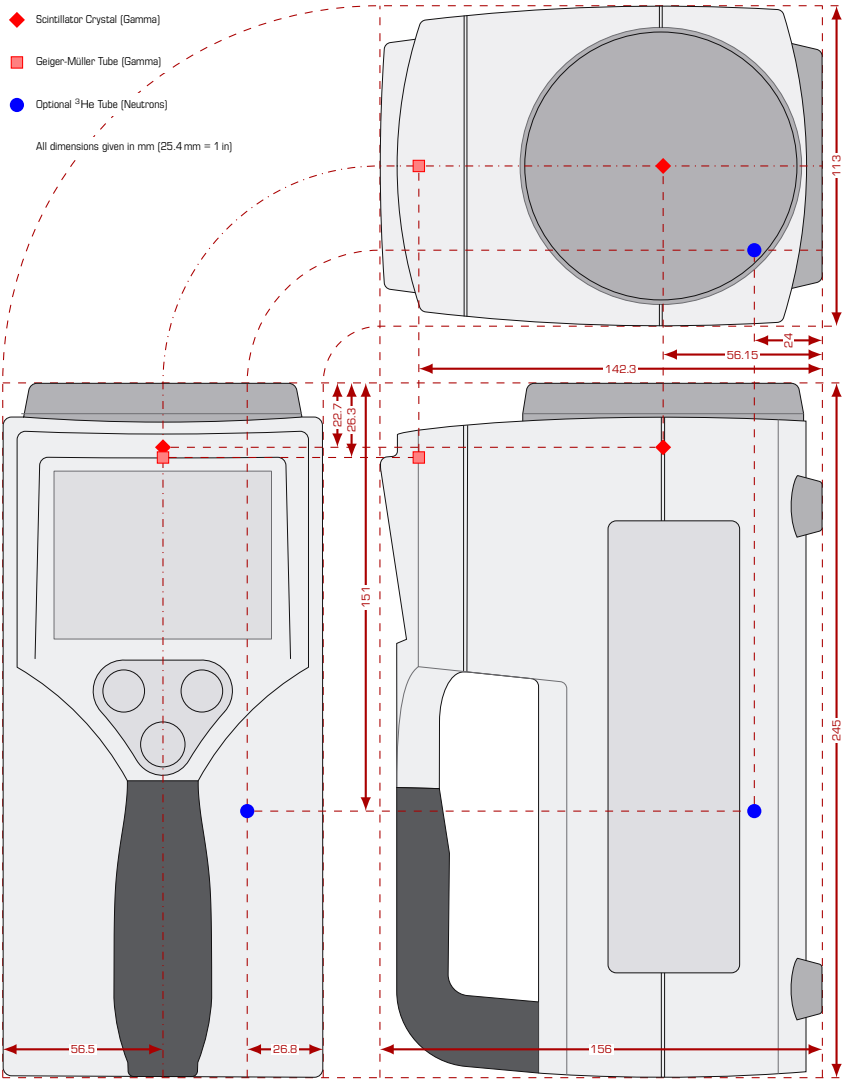

Figure 146a: Position of the detector centers of the RADEAGLE (2 or 3 in×1 in scintillator, drawn to scale)

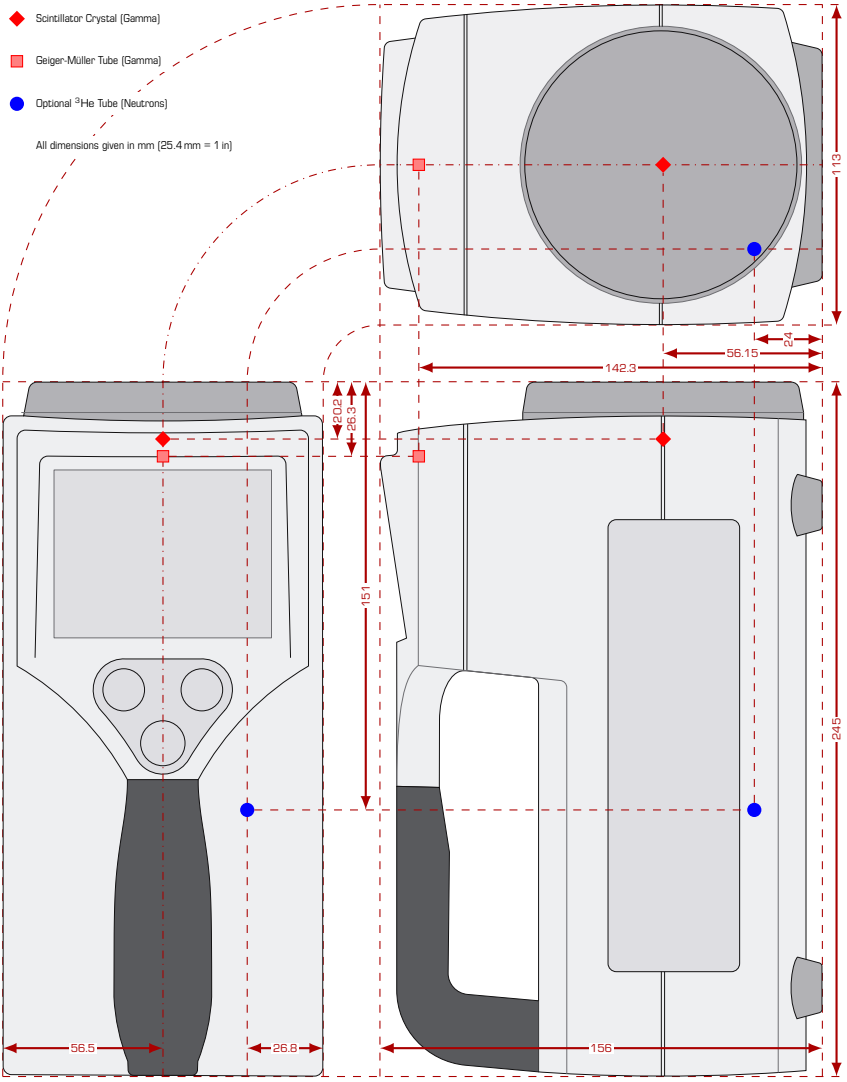

Figure 146b: Position of the detector centers of the RADEAGLE (3 in×0.8 in scintillator, drawn to scale)

E.3 About Intrinsic Activity

Some models of the radEAGLE contain an extremely low-activity radioactive source. Details are given in Appendix E.1, p. 135 and on the name plate attached to your instrument (Fig. 3, p. 15).

E.3.1 General Rules for Handling Radioactive Material

The quantities of radioactive material contained in the radEAGLE 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 radEAGLE 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 radEAGLE models with a neutron detector (see E.1, p. 135).

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: radEAGLE
Model: All
Serial Number: 15001 and up
Year of Manufacture: 2015

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

EMC Directive 2014/30/EU

Furthermore, the European Standard IEC 61000-4 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, 2015-08-27

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.