



RadiaCode

RADIACODE

10X SERIES

Nuclear Radiation Detector
and Spectrometer

ANDROID APP USER MANUAL

RADIACODE LTD

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Chapter

1

1 Introduction

This section contains introductory information about the application. **RadiaCode** and its joint use with the device **RadiaCode-10X**.

1.1 Safety engineering

Read the instructions before using the device.

[Safety warning](#)

[Precautionary measures](#)

1.1.1 Safety warning

- **Store the device out of the reach of children and pets.** To avoid accidents, keep the device and accessories out of the reach of children and pets.
- **Do not use the device in a potentially explosive or flammable environment.** Keep the appliance switched off at refueling points and near containers of flammable liquids. Do not store or carry flammable liquids, gases, or explosives in the same compartment as the device, its parts, or accessories.
- **Have the device repaired by qualified personnel only.** Do not disassemble it yourself.

1.1.2 Precautionary measures

- Read the operating instructions before using the device.
- Protect your device from extreme temperatures (below -20 °C or above 45 °C). Too high or too low temperatures reduce the storage capacity and shorten its service life.
- Do not use defective chargers.
- Do not grip the device strongly in your hand, press the buttons lightly.
- Avoid getting the appliance wet. Moisture can cause serious damage to the device. Moisture penetration into the device will void the manufacturer's warranty.
- Do not use or store the device in dirty areas.
- External shocks and rough handling can seriously damage the electronics of the device.
- The action of the electromagnetic field can damage the device. Avoid exposing the device to strong electromagnetic fields.
- Electronic and household appliances, cordless telephones can interfere with the operation of the device.
- If you brought the package with the device from frost to a warm room, leave it warm for two hours without opening. Otherwise, moisture condensation may cause malfunction of the device.
- Handle the device with care, the display is made of glass and can be broken if not handled carefully.
- Do not disconnect the device from the computer while the firmware is being updated. An attempt to disrupt the download process may lead to a malfunction of the device, which must be rectified only at the service center.

1.2 Developer information

RADIACODE LTD

3 Thaleias Street
3011 Limassol, Cyprus

Phone No.: +357 94 207 695 / +357 99 020 336

<https://radiacode.com>

e-mail: support@radiacode.com

Chapter



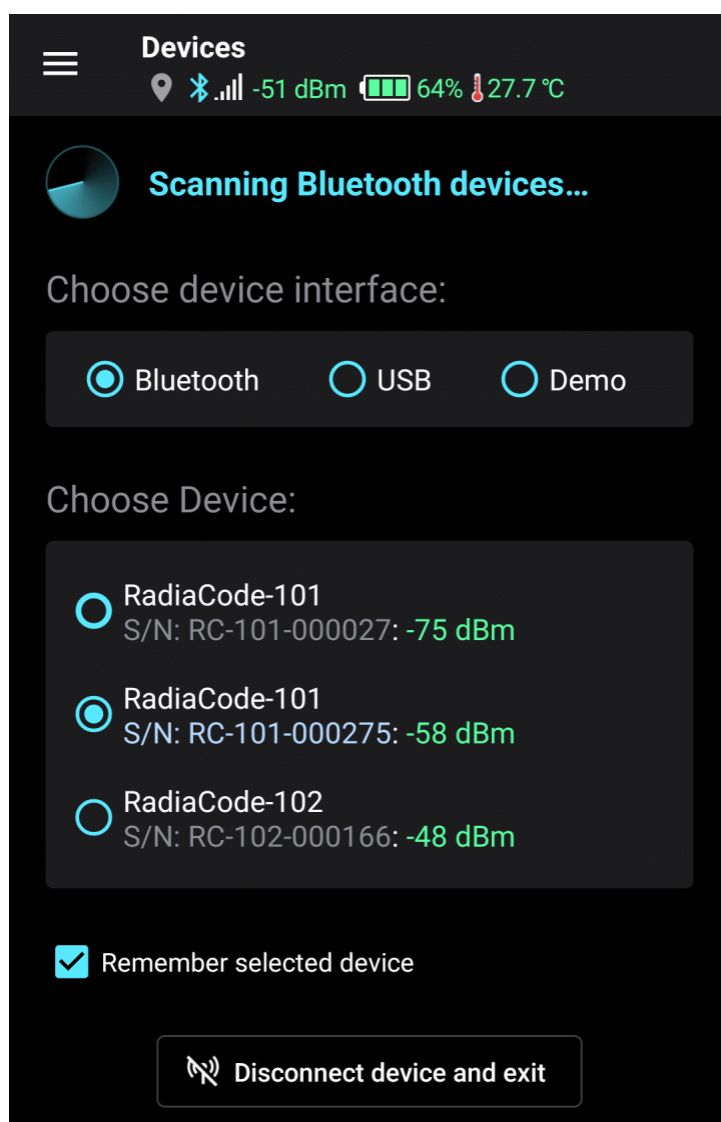
2 Quick start

Connecting the application to the device RadiaCode

Before starting to work with the device, make sure that the power of the device is turned on.

When you start the application for the first time, it will automatically open [device selection dialog](#). You can connect to the device via Bluetooth and USB interfaces. To connect the device to a phone/tablet via USB, you need to use an On-The-Go (OTG) cable.

Warning! To connect the RadiaCode device to your smartphone via Bluetooth, you do not need to perform the device pairing procedure via your smartphone's Bluetooth settings. You do not need to enter any connection codes either.

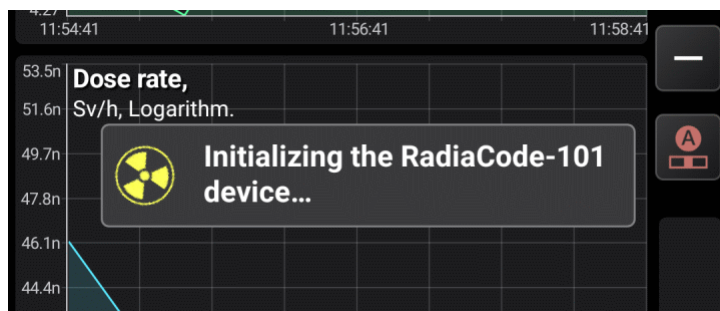


Tap the “Bluetooth” label. If Bluetooth is not enabled in your phone, the application will ask you to enable it. Confirm that you allow the app to turn on Bluetooth. If your phone does not support Bluetooth version 4.0 (Android OS version is less than 6), a corresponding message will be displayed. The device cannot be operated with such a telephone via the Bluetooth interface.

Additionally, the app requires location access permission to function. This is a requirement of the Android OS to work with Bluetooth Low Energy.

Soon, the device name will appear in the “Choose device” field. “RadiaCode-10X”. This means that the application has found the device via the Bluetooth interface. Detection may take some time. Leave the “Remember selected device” checkbox enabled, and subsequently the application will connect with the device automatically. If the application does not find the device for a long time, try following [these recommendations](#).

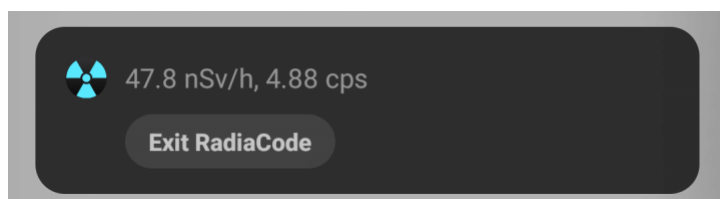
Tap the “OK” button at the bottom of the screen. Will open [app home screen](#). Communication with the device will be established and the device will be initialized, which will take a few seconds.



Once initialized, the application will continuously receive data from the device, even if there is another application in the foreground. The activity of the application is indicated by the icon in the notification area of the phone/tablet:

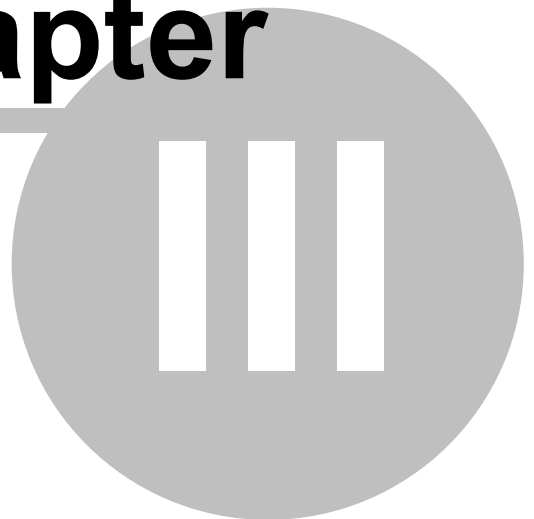


If you lower the notification curtain, you can see that the current values of the count rate and dose rate are displayed in the information field of the device:



Tapping this field in the curtain opens the application RadiaCode.

Chapter



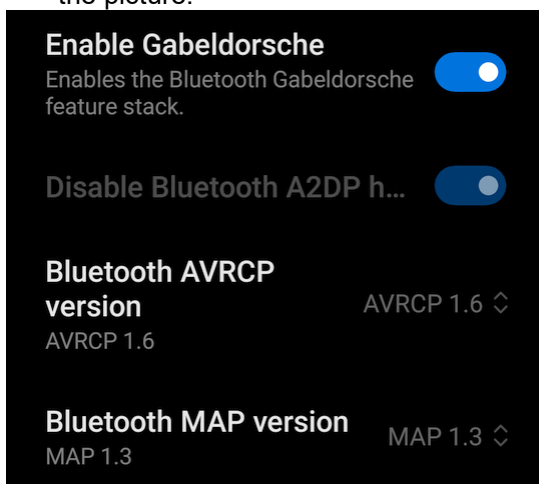
3 If the application cannot find the device...

There may be situations, when the application cannot connect with the device via Bluetooth or the connection with the device is unstable. In this case:

- Make sure that the RadiaCode app is allowed to access the location **in any mode**. This is a requirement of the Android system for Bluetooth Low Energy (BLE) to work in the background.
- If the app reports that it needs all the permissions requested, even though permissions have already been granted, restart your smartphone.
- Turn off Bluetooth in your smartphone and turn it on again.
- Turn off Bluetooth in the device via its menu and turn it on again:



- Reportedly, some models of smartphones may have interference between Bluetooth and Wi-Fi modules, so you can try turning off Wi-Fi in your smartphone. The effect appears in particular on the Xiaomi Redmi Note 10.
- If other Bluetooth devices are connected to your smartphone, disconnect them.
- If possible, check the operation of the application with the device on another smartphone. According to our statistics, connection problems most often occur on Huawei smartphones and related models.
- Check the power-saving settings for the RadiaCode app in your smartphone settings.
- If the app says that it needs to provide all the permissions, even though they are already provided, restart your smartphone.
- There are reports that on later versions of the Android system, communication with the device may be temporarily interrupted at intervals of about 10 minutes. If this is the case, you can try the following:
 - ✓ Turn on developer mode in the smartphone settings. You can find how to do this on the Internet.
 - ✓ Go to the "For Developers" settings, find there the following settings and set them as shown in the picture:

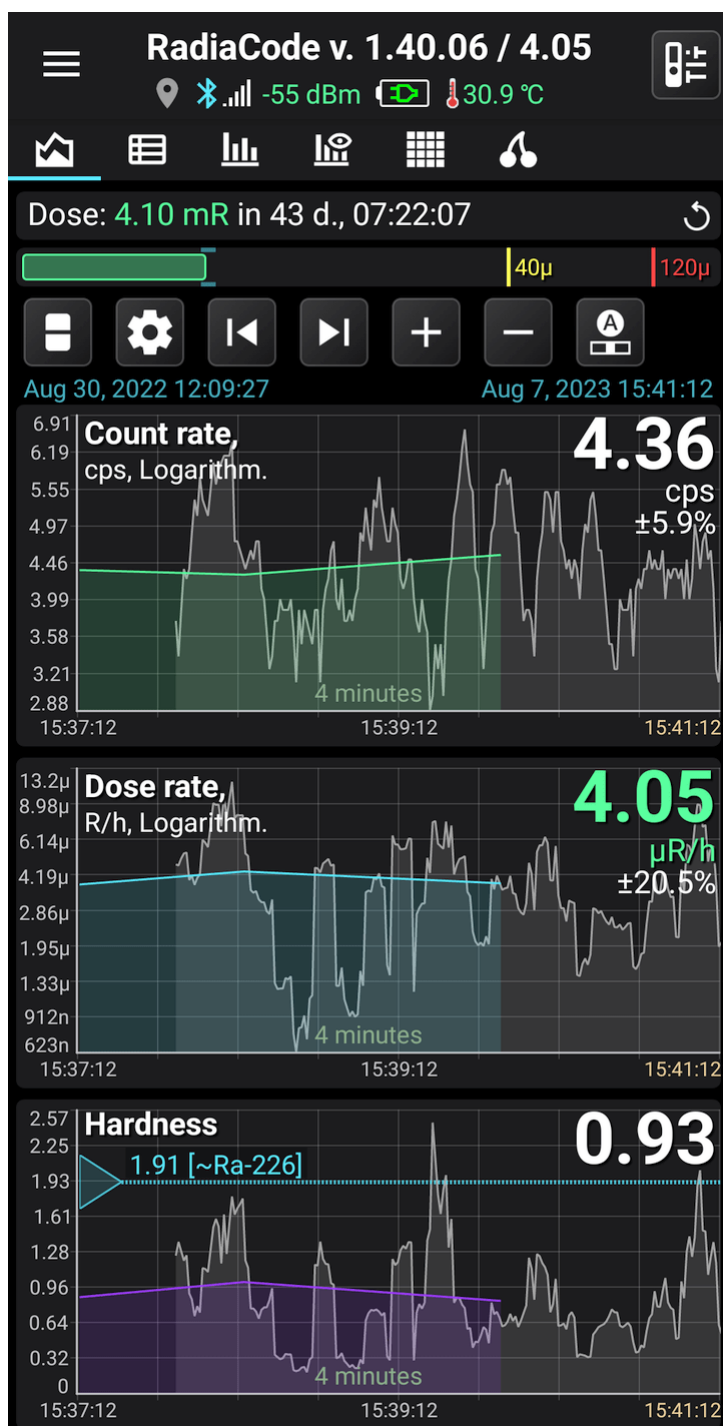


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IV

4 Main Screen



Screen fragments:

RadiaCode v. 1.40.05 / 4.04

The application name, its version and the version of the device firmware, if it is connected. If an app update is available on GooglePlay, the version number will be displayed in yellow.

If the device firmware requires an update, the firmware version number will be displayed in yellow. The device firmware is included in the application itself, so the application knows both the device firmware version and the firmware version for which the application is designed.

It is possible that the device has a newer firmware version than the one for which the application is designed. This happens when the device firmware has already been updated via RadiaCode for Windows and the app hasn't been updated yet. In this case, the firmware number is displayed in red and the application should be updated to GooglePlay, otherwise the correct operation of the application with the device is not guaranteed.

The main menu item "About RadiaCode" gives information about the version of the application and firmware, as well as their correspondence to one another.



Current status of the device and application: location, status and strength of the Bluetooth signal, temperature of the device.

If the location icon is gray, then the application does not write the current location to the database, either because this option is disabled in the application settings, or because it is impossible to determine the location.



Tapping this icon opens the main menu of the application.



This button at the top of the screen opens a dialog for quick settings of the device - control of sound, light indication, vibration, etc.



This button at the top of the screen becomes visible and blinks when the alarm threshold is exceeded, if the device sounds are enabled. Tapping this button mutes the alarm until either an alarm of a higher level occurs, or the alarm ends and reappears. The same is done by pressing the round button on the device body.

Charts Log Spectrum View Spectrogram Act

Application page switcher. In addition to the main page, there is also a page for viewing [measurement log](#), page to display [photon energy spectrum](#) and [spectrum view page](#) from [spectra libraries](#). Pages can be switched by tapping the page title.

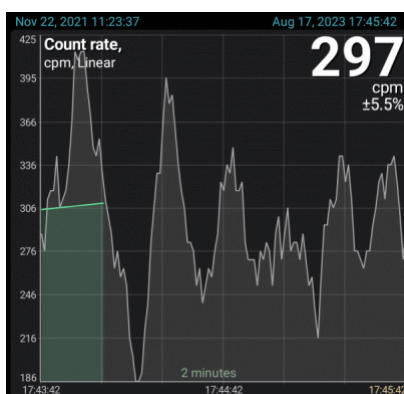
In [the application settings](#), you can choose whether to display text or icons as bookmark headers. The icons might be more convenient because they all fit on the same screen:



Dose: 32.1 μSv in 11 d., 21:22:07



The value of the emission dose accumulated over the specified time interval. On the right side of this field there is a button to restart the dose accumulation (the value of the accumulated dose is reset to zero).



Pulse count rate graph. The start and end date/time of the data section loaded into application memory from the database is displayed in blue at the top of the graph. This portion of the data is available for display in the graphs.

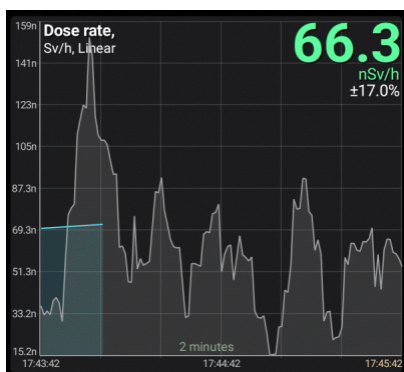
At the top right, the current value of the count rate is displayed - the number of emission pulses recorded by the device's sensor in one second or one minute, depending on the selected settings.

The time scale is displayed above the X-axis, on the graph it is 4 minutes. That is, the graph displays data for 4 minutes. The scale can be changed using the "+" and "-" buttons next to the graph, as well as the pinch gesture. For more details see [Graph displaying](#).

The X-axis displays the calendar time corresponding to the beginning and end of the graph. If the time corresponds to the current day ("today"), then the date is not displayed, otherwise the date will be displayed above the time.

If the graph displays the most recent data that correspond to real time, then on the right, in a lighter color, live data are displayed that have been read by the device from its sensor, but have not yet been processed (data processing and filtering algorithms require a certain amount of accumulated data for processing). Already processed and filtered values are displayed in green on the graph.

In [Graph settings](#), you can specify whether the application should always connect points on the graph with a line. You can set the time interval so that the points on the graph that are separated by a value greater than the interval will not be connected by a line, but will be displayed with gaps.

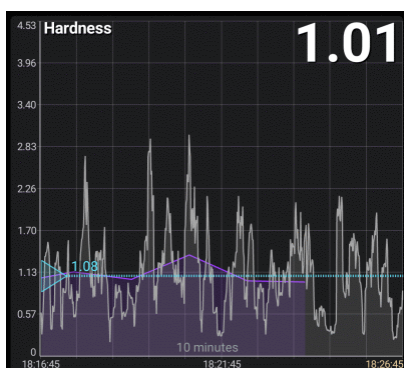


Dose rate graph. The units of measurement are selected in the device settings. When an alarm occurs, the dose rate value is displayed in the color corresponding to the alarm.

The alarm levels are displayed with horizontal colored lines.

Vertical colored lines with a circle at the top indicate when alarms occurred.

The dose rate graph is time synchronized with the count rate graph.



Graph of radiation hardness. It is formed from log data and operational data (gray zone), allows you to estimate the conditional radiation hardness for a specific device model. It is displayed as a dimensionless coefficient, which is calculated as $(\mu\text{rem/h})/(\text{cps})$.

The rigidity of the radiation characterizes which energies prevail on the spectrum, and allows you to focus on spectral changes, getting rid of the intensity component.

The hardness coefficient will be displayed correctly if the device firmware has version 3.0 or higher.

By moving the triangle at the left edge of the window, you can estimate which isotope approximately corresponds to the selected hardness.

See also: [Pseudo-determination of isotopes by radiation hardness](#).



Toggles the displayed graphs in various combinations. A long tap of this button opens a drop-down menu where you can select the desired combination of charts from the list. The same can be done through the graph settings dialog.



Opens the [graph settings](#).



Search for the previous/next piece of data after a break in time.

A long tap of the button moves to the very beginning or, respectively, to the very end of the graph.



Increase or decrease the time scale.

A long tap of the button increases the zoom to the maximum or decreases to the minimum.



Scaling mode indicator and return to the automatic scaling mode selected in the graph settings. See [Graph displaying](#).



Animated diagram of the current dose rate value with alarm levels. The blue zone shows the boundaries where the dose rate value was in the time interval specified in the [graph settings](#). If you select "Last minutes" option, the blue zone boundaries are updated every minute. If the real-time dose rate value coming from the device exceeds the current limits, the limits are updated according to the current value.

A long tap on the graph brings up a drop-down menu (if there is data in the database that matches the tapped point):

- Set a text comment for the selected point. Comment displayed in the [log](#).
- Show the selected portion in the log. Note that the log may not display the entry corresponding to the tap point due to the filters specified in the log settings.
- Open on the map [pseudo track](#) with data corresponding to the moment selected on the graph.

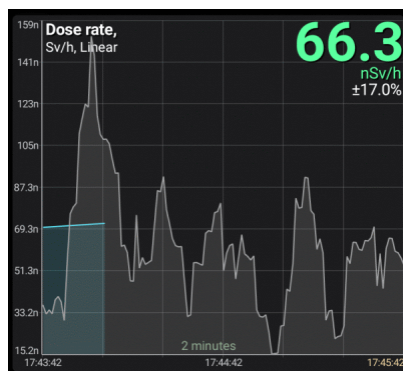
See also:

[Graph displaying](#)

[Graph settings](#)

4.1 Graph displaying

The count rate and dose rate graphs display data and are operated in the same way.



If the graph displays the most recent data corresponding to real time, then on the right, in gray, operational data is displayed that was read by the device from its sensor, but was not yet processed (data processing and filtering algorithms need to accumulate a certain amount of data). Already processed and filtered values are displayed on the graphs in green/blue. Live data is stored for the last 10 minutes.


One can control the live data filter that is displayed on the graph. You can set the width of the filtering window in the graph settings, i.e. the time over which the data is averaged. **Such averaging is performed by the device, serves only to display operational data** and is not related to data processing

by the device, as a result of which the values displayed by color graphs are calculated.

On the dose rate graph, vertical colored lines with a circle at the top show the moments when alarms occurred. These lines can be disabled in the graph settings.

Scale selection

The displayed data can be displayed in linear, logarithmic and quadratic scales. The current scale name is displayed at the top left of the graph; it is the square root in the example.

The scale can be changed either explicitly in [graph settings](#), which are called by the button , or by double-tapping the graph. You can set your own scale for each graph.

Y-axis zooming





By default, the displayed plot area fills the entire area visible in the window along the Y axis. The horizontal grid always has 8 cells, and the digitization values are calculated dynamically based on the displayed data. It should be borne in mind that two additional points are involved in determining the maximum and minimum values of the visible area: one beyond the left border of the area and one beyond the right.

You can select automatic scaling along the Y-axis both in the current visible area and in the entire range of data available to the application in the graph settings. Each graph (count rate, dose rate) has its own setting.

Graphs can be moved along the Y-axis (up/down) by swiping your finger across the screen. Initially, to switch from automatic scaling to manual scaling, you need to move the graph up or down vigorously enough (protection against accidental shift during paging). In this case, automatic scaling is disabled, and the graph can be precisely positioned with gestures in order, for example, to find out the values in peaks.



With the pinch gesture on the screen, you can stretch and shrink graphs both vertically and horizontally. When pinching vertically, the auto zoom mode is also disabled.

The “A” button is both an indicator of the current zoom mode and a means of returning to the last auto zoom mode selected. The icon on the button corresponds to the selected mode:



	Automatic scaling over the visible area.
	Automatic scaling over the entire data range.
	Manual zooming. Tapping the button returns to the last autoscaling mode selected in the settings.
	Both graphs are present on the screen and their scaling modes do not match. Tapping the button returns the last autoscaling mode selected in the settings for each graph.

In [graph settings](#), you can disable the transition to the manual scaling mode. In this case, attempts to shift the graphs and pinch along the Y axis are ignored, and the “A” button is highlighted in red.

X-axis zooming

Scaling of graphs along the X axis (time axis) is performed either by using the buttons  and , or a pinch gesture. A long tap of the button increases the zoom to the maximum or decreases to the minimum.

Scrolling

Scrolling graphs horizontally is performed by usual gestures, as well as buttons  and . The buttons search for the previous/next piece of data after a break in time.

A long tap of the button moves to the very beginning or, respectively, to the very end of the graph. The data is displayed in certain portions. When the limit is reached, a new piece of data is loaded from the database.

4.2 Pseudo-determination of isotopes by radiation hardness


The radiation hardness graph makes it possible at any time to estimate which energies predominate in the gamma-ray spectrum (low, medium, high). The application has a built-in table of hardness coefficients of reference values from ionizing radiation sources. Thanks to this table, it is possible to tell which isotope best corresponds to a particular hardness value.

The determination of isotopes is conditional. If, for example, the application has determined that the radiation hardness corresponds to the reference radiation hardness from, for example, caesium-137, then this only gives reason to assume that the radiation hardness is the same as that of the reference source of caesium-137.

Also, pseudo-determination of isotopes will not work if there are several radionuclides in the sample or gamma field.

In the graph settings, you can choose which isotopes from the table will participate in the pseudo-determination, and which will not. This allows you to disable the display of rare isotopes to reduce the likelihood of incorrect determination.

4.3 Graph settings

Graph settings are accessed with the button . The count rate and dose rate graphs have the same settings, individual for each graph.

Show charts: In the drop-down list, you can choose which charts to display.

The width of the window for averaging operational data, when displayed on graphs: time, over which the device averages operational data (operational data is displayed on the graphs in gray). *Such averaging is performed by the device, serves only to display operational data* and is not related to data processing by the device, as a result of which the values displayed by color graphs are calculated. An increase in the averaging time leads to a smoother, but less rapid reaction to changes in the radiation situation.

Y-Axis Scale: selection between linear, logarithmic and square root scales. You can also switch the scale by double-tapping the corresponding graph.

Y-axis zoom mode:

- *Across the entire range:* minimum and maximum values of the Y-axis data is calculated over the entire range of data available to the application. In this mode, the digitization of the Y axis does not change, when scrolling the graph horizontally.
- *By visible area:* minimum and maximum values of the Y-axis data is calculated from the plot of data shown on the graph. When scrolling through the graph, as well as when new data from the device is received, these values will change.
- *Disabled:* autoscale mode disabled. For autoscaling see [Graph displaying](#).

Display alarm events 1/2: One can turn off the display of vertical colored lines on the dose rate graph, which correspond to the moments when alarms occur.

Graph settings:

Graph line thickness: you can choose the thickness of the graph lines, in conventional units.

Values font size: you can select the size of the digits for the count rate and dose rate, in conventional units.

Indicator bar history: You can select the time interval for which the blue zone will be displayed in the dose rate/count rate indicator. The blue zone shows the boundaries where the rate value was in the given time interval. If you select "Last minutes" option, the blue zone boundaries are updated every minute. If the real-time dose rate/count rate value coming from the device exceeds the current limits, the limits are updated according to the current value.

The indicator bar shows: Select which value the indicator displays - dose rate or count rate.

Labels on graphs: You can choose where the values of the measured values, together with the units of measurement and the error, will be located on the graphs - on the right or on the left. If you disable the "**Show titles**" option, the application will not display the names of the measured values ("Dose rate", "Count rate"...).

Buttons and indicator bar: you can choose between two layouts of the page with graphs: on one layout the control buttons and the graphical dose rate/count rate indicator are on the right side of the graphs, on the other one - on top, which gives the graphs more horizontal space. This option works only for the portrait orientation of the screen, with the horizontal orientation the buttons are always displayed on the right side.

Disable scaling and shifting of graphs along the Y-axis: do not switch to the mode of manual scaling of graphs along the Y-axis, when trying to shift graphs up/down and scaling with a vertical "pinch".

Chapter



V

5 Log

This page displays the current and past measurement data in a table. As new meaningful data becomes available, it is added to the log.

Show: 824/1347484			
Interval: 1 month			
Date/Time	Data		
Aug 15, 2023 19:23:16	350 nSv/h $\pm 39.2\%$	66.0 cps $\pm 19.7\%$	
Aug 15, 2023 19:23:16	288 nSv/h $\pm 50.4\%$	46.0 cps $\pm 16.7\%$	
Aug 15, 2023 13:43:24	274 nSv/h $\pm 45.9\%$	13.1 cps $\pm 19.1\%$	
Aug 11, 2023 16:54:07	Battery charge end		
Aug 11, 2023 14:24:53	Battery charge begin		
Aug 11, 2023 12:21:34	Battery charge end		
Aug 11, 2023 12:01:15	Battery charge begin		
Aug 9, 2023 18:47:26	792 nSv/h $\pm 39.7\%$	121 cps $\pm 17.8\%$	
Aug 9, 2023 18:47:26	1.01 μ Sv/h $\pm 39.7\%$	134 cps $\pm 16.9\%$	
Aug 9, 2023 18:47:17	t = 27.5 °C Charge: 39%	23.1 μ Sv	
Aug 9, 2023	489 nSv/h $\pm 32.8\%$		

Above the table, there are icons for filter types of measurements and events and the current number of displayed records.

	Measurements made by the device in automatic mode.
	Device events - power on/off, reset of dose accumulation, battery discharge, etc.
	Current parameters of the device - temperature, battery charge, etc.











The letter **D** in the upper right corner of the entry indicates that the entry was made in demo mode of the application.

Tapping gear at the top of the screen opens the log display settings. In the settings, you can specify:

- What types of measurements to display;

- What types of device events to display;
- Whether to display all records or only those where there was any alarm;
- Whether to display only records with comments (a comment can be set by tapping the corresponding point on the graph of the count rate or dose rate);
- The sort order of records is descending or ascending date.

Tapping the record on the screen displays a dropdown menu:

	Aug 14, 2023 19:15:40	45.9 nSv/h $\pm 37.7\%$ 5.13 cps $\pm 10.8\%$	
	Aug 14, 2023 19:12:16	37.2 nSv/h 3.06 cps	Show on chart Show on map Edit comment... Delete record... Delete records in interval... Delete the entire log... Export csv...
	Aug 14, 2023 19:10:41	43.7 nSv/h 3.70 cps	
	Aug 14, 2023 19:09:05	41.0 nSv/h 3.57 cps	
	Aug 14, 2023 19:07:29	31.8 nSv/h 3.24 cps	
	Aug 14, 2023 19:05:53	43.3 nSv/h 3.51 cps	
	Aug 14, 2023 19:04:17	41.7 nSv/h 3.22 cps	
	Aug 14, 2023 19:02:41	35.6 nSv/h 2.96 cps	
	Aug 14, 2023 19:01:05	31.8 nSv/h 2.97 cps	
	Aug 5, 2023 19:21:51	33.8 nSv/h $\pm 32.6\%$ 4.38 cps $\pm 9.6\%$	

Show on the graph: Display the area corresponding to the selected record on the graph.

Show on the map: If the selected record is an automatic measurement or an alarm event and it has location information, then open on the map [pseudo track](#).

Paragraph **"Delete records in interval..."** makes it possible to select a time interval for deleting records.

Export to csv...: Share log file in Excel csv text format. You will be prompted to select the time interval for exporting records and the name of the csv file to export. Only the records that meet the conditions of the filters selected in the log settings, i.e. those that appear in the list, are exported.

Fields in a csv file are separated by semicolons. The values in the "Time stamp" field are decimal 64-bit numbers that represent time in Windows FILETIME format, i.e. the number of 100-nanosecond intervals since January 1, 1601. The time in the "Time stamp" and "Time" fields is local. Values in the "Dose accumulation time, sec." field is the dose accumulation time after the last reset, in seconds.

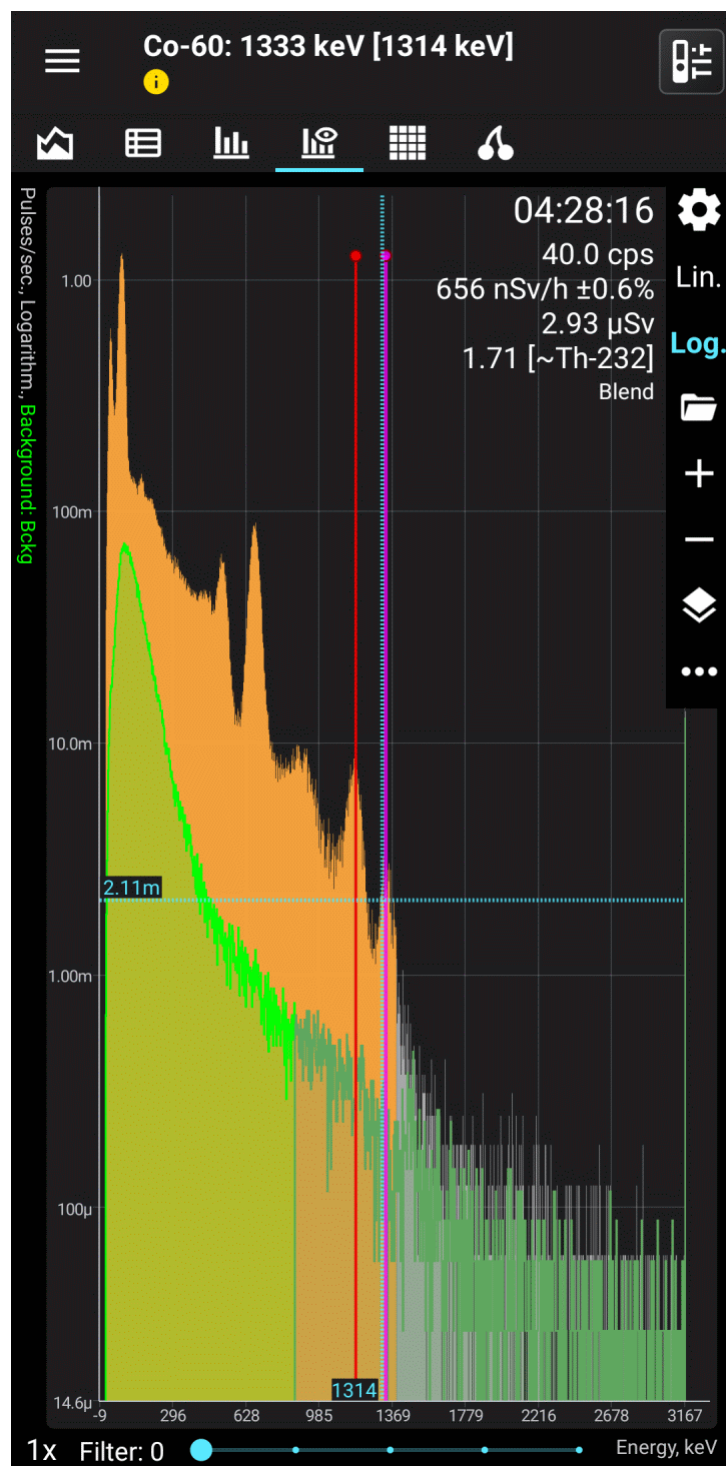
Chapter



VI

6 Spectrum

This window displays the energy spectrum of the photon (gamma and X-ray) radiation, typed by the device over a certain period of time. When you connect the device to the smartphone, the app reads the spectrum data from the device. Subsequently, the spectrum graph is updated either automatically at the interval specified in the settings, or manually.



At the top right of the graph you can see:

- the time for which the spectrum data was accumulated, in the format HH:MM:SS.
- The average pulse count rate, i.e. the sum of the number of pulses for all channels, divided by the time of data accumulation.
- Average dose rate of X-ray and gamma radiation over the time of spectrum accumulation.
- X-ray and gamma radiation dose over the accumulation time of the spectrum.
- The way the graph is updated, or, for [the "View Spectrum" window](#), the name of the spectrum.

In the mode of displaying the graph of difference between spectrum and background the values of count rate and dose rate will be equal to the difference of these values for spectrum and background. The accumulated dose will be calculated by the formula $(D_s - D_b) * T_s$, where D_s is the spectrum dose, D_b is the background dose, T_s is the spectrum accumulation time. In difference mode, spectrum information is displayed in italics as a reminder.

The display of each item except the last is controlled by the corresponding setting. Unnecessary data can be turned off to save screen space.





The part of the graph in which the shape of the spectrum should be considered unreliable due to the small volume of events accumulated there is drawn in gray.

Depending on the settings, the X-axis can display either channel numbers or photon energy. The Y-axis can display either the number of pulses or the count rate. The Y-axis scale can be linear or logarithmic.



Opens the settings related to the spectrum plot. In the settings you can choose:

- **Scale of the Y-axis** - linear or logarithmic. Fast scale switching - with icons "Lin." and "Log."
- **Units of the Y-axis** - the number of pulses or the count rate.
- **X-axis units** - channel number or photon energy.
- **Graph update**: either automatically at a preset interval or manually with the button ↻.
- **Displayed channels**: You can select how many channels to display on the graph, starting from zero (more precisely, from channel number 2, since channels 0 and 1 are service ones and are not displayed). This can be useful if the events in the older channels are not interesting.
- **Show last channel**: Turn on/off the display of the last channel data. The counter of the last channel includes not only the data of this channel itself, but also all data outside the range displayed on the graph, so it may not always be interesting to look at the last channel.
- **Drawing the graph**: You can choose to fill the spectrum graph with color (fill) and stroke with a line, or one of these options.
- **Drawing the background**: You can set the background to fill the graph with a color (fill) and stroke with a line, or one of these options.
- **Displaying the background**: cm. [Using the background](#).
- **Display isotope information**: In the application window title bar, display information about the characteristic gamma line of the isotope and decay chain, and display an icon to go to a website for more information. Disabling this option also disables the display of all isotope lines.
- **Display the position of the gamma lines**: Draw turquoise clue lines corresponding to the position of isotope energies.
- **Display the intensity of the gamma lines**: Draw red clue lines corresponding to the positions and intensities of isotope energies.

	<ul style="list-style-type: none"> • Draw markers on the lines of intensity: Display the gamma line intensity amplitude as red dots on the isotope lines. • "Spectrum Information" group: You can select which spectrum information to display in the upper right corner of the graph. • Show the amplification slider: Below the spectrum graph you can see the slider that adjusts the "amplification" of the histogram, see below. • Show the filter slider: Below the spectrum graph you can see the slider that adjusts the degree of filtering (smoothing) of the histogram, see below. • Gaps between bars in the "Fill only" mode: Draw bars with gaps between them, rather than a solid graph contour line, if the selected scale allows it and the "Draw a polyline instead of a histogram" option is disabled. • Draw a polyline instead of a histogram: instead of rectangular bars (histogram), draw a polyline that connects the midpoints of the tops of the bars. The graph is not entirely "true", because the accumulation of the spectrum is still discrete for each channel. In this mode, the option "Gaps between bars in the "Fill only" mode" has no meaning and is ignored. • Do not display negative values in the spectrum-background difference mode: Display only the top of the spectrum versus background difference plot that corresponds to positive difference values. Negative values will be displayed as zero. • Automatically scale the Y-axis: When the scale is more than 1, automatically select the scale of the Y axis in accordance with the maximum value of the data in the displayed area of the graph. • Export format: Choose in which format export the spectrum. • csv Export separator: you can specify which symbol to use when exporting the spectrum to a text file with the .csv extension (comma or semicolon). • Calibration coefficients: a page opens where you can specify the calibration factors a_0, a_1 and a_2. <p>Spectrum calibration is performed to convert the number of the spectrum channel to the value of the emission energy in keV using a polynomial of the 2nd degree of the form:</p> $E = a_0 + a_1 \cdot x + a_2 \cdot x^2,$ <p>where</p> <p>x is the channel number;</p> <p>a_0, a_1, a_2 are calibration coefficients.</p>
Lin.	Select the linear scale of the Y-axis.
Log	Select the logarithmic scale of the Y-axis.
.	
	Refresh spectrum data. The application reads the current data from the device and updates the graph regardless of the update method selected in the settings (manual or automatic).
	Open spectra library .
	Enlarge the graph (zoom in). The graph can be scrolled horizontally. Long press of this button increases the zoom to the maximum. The current scale value is displayed in the lower left corner of the screen.
	Zoom out. Long press of this button decreases the scale to one.

Open the dropdown menu. Actions are available in the menu:

- **Restart accumulation of** spectrum data. Confirmation is requested before restarting.
- **Share spectrum:** Export spectrum data to a text file with the .csv or .xml extension ([export](#)) and "share" this file, i.e. save it in the smartphone memory, send it by mail or via messenger.
- **Save spectrum to library:** Save spectrum to database. In the future, the spectrum can be used as a background, shared, etc. If the "Set as current background" option is left enabled in the spectrum saving request window, the saved spectrum is selected as the background to be displayed together with the spectrum. The background name is displayed in the vertical text box along the Y-axis.
- • • **Spectrum Information:** A window will open with detailed information about the spectrum, background and the difference between them.
- **Isotope info:** Show detailed information about the isotope that corresponds to the tapping point on the plot.
- **Attach the selected isotope:** Plot the lines of the currently displayed isotope or decay chain on the graph. The lines will be displayed in their places when moving the pointer, zooming and flipping the graph, etc., until the lock is explicitly released by the "Unlock selected isotope" menu item.
- **Detach the selected isotope:** Unlock the isotope or decay chain lines set by the "Attach the selected isotope" command.
- **Device Calibration:** Perform the [calibration procedure for the energy scale of the device](#).

Tapping the graph at a display scale of x1, displays the cursor lines. The vertical line corresponding to the position on the X-axis can be moved by tapping the screen at the desired point or moving your finger across the screen. The horizontal line is automatically positioned to the position of the pointer on the X-axis.

To display marker lines at a scale greater than x1, do **long tap on the screen**, then marker lines will appear. Move the vertical line left and right without lifting your finger from the screen.

Quick double tap toggles the display mode between linear and logarithmic.

At the bottom of the spectrum window there is a slider that controls "**enhancement**" of a histogram. A curve of the following type is superimposed on the graph:



This allows subtle peaks to appear on the graph. For each channel, the value is calculated by the formula $V_n = V_n A_n F + 1$, where:

n - channel number

V_n - spectrum value (number of pulses or count rate) in channel n

A_n - the value at the corresponding point of the amplifying curve

F - gain factor, which is set by the slider, from 0 to 5.

In amplification mode with $F \geq 1$, the digitization of the Y axis is not displayed.

Filter Engine applies a smoothing algorithm to the spectrum graph. The higher the filter value, the more the graph is smoothed.

The spectrum graph is also available as a [widget](#).

[Background Usage and Spectra Library](#)

[Displaying isotope information](#)

[View tab](#)

[Export and import of spectra](#)

[Calibrating the energy scale of the device](#)

6.1 Background Usage and Spectra Library

In the application RadiaCode it is possible to display on the graph not only the spectrum of accumulated emission, but also to compare the spectrum with the previously measured background spectrum. One can display spectrum and background graphs at the same time in the overlay mode, or display a graph of the difference between the values of the current spectrum and the background.

To use a background, you first need to measure this background with the device over a period of time. Then you need to save the resulting spectrum to the spectrum library. To do this, tap the local



menu call button in the spectrum window:

Select “Save Spectrum to Library” from the dropdown menu. You will be prompted to name the spectrum. The spectrum will be displayed with this name in the library list. If you leave the “Set as Current Background” option enabled, then after saving the spectrum will be displayed on the graph as a background. You can also select the background from the spectra library in future.

There are two modes for displaying spectrum and background. In the overlay mode, the background graph is drawn on top of the spectrum graph - the spectrum is drawn in orange, the background in green. In the second mode, the difference between the spectrum and the background is displayed, the color of the graph is purple.

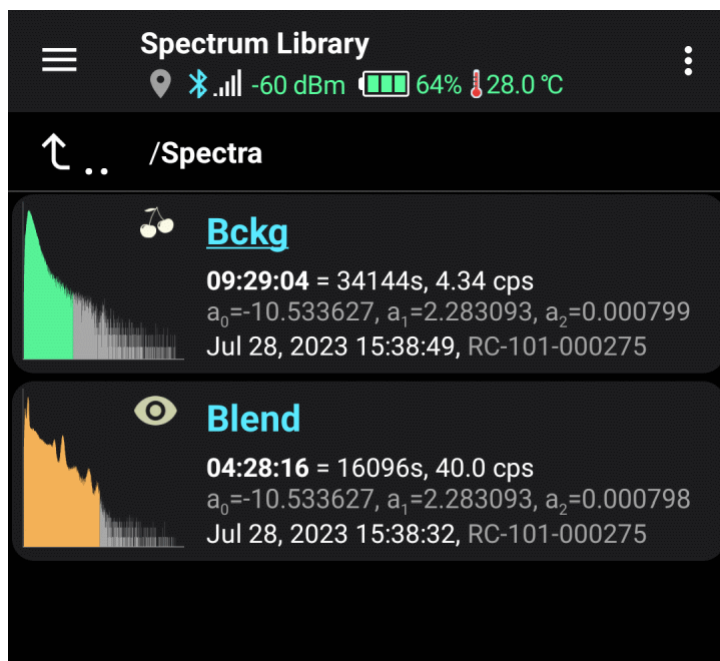
In the mode of displaying the difference between the spectrum and the background, the difference in the count rate is displayed, since the background and the current spectrum always have different accumulation times and it makes no sense to subtract the number of accumulated pulses.

If using spectrum and background from different devices for superposition RadiaCode-10X, it should be borne in mind that different devices have different calibration factors. When overlaying spectra graphs, the application compares them per channel (the first channel with the first channel, the second channel with the second channel, etc.). Different devices have different emission energies corresponding to the same spectral channels, therefore, when the graphs from different devices are superimposed, differences in the positions of the peaks corresponding to the same emission energy will appear.

If the application detects such a situation, it issues an appropriate warning. Device RadiaCode-10X is identified by its serial number.

Spectra library

The spectra library is called by the item “Spectra Library” of the local menu. The list of saved spectra is displayed:



The graph of the spectrum selected for display is shown in green. For [8-bit spectra](#) created by a device with firmware version less than 4.00, an orange marker with the number 8 is displayed in the lower right corner.

For each saved spectrum, its graph in the logarithmic scale, name and accumulation time are displayed.

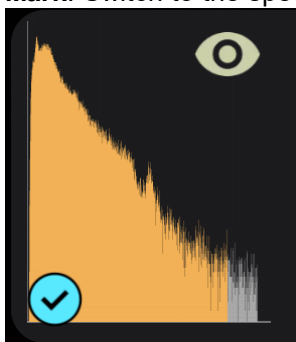
It is possible to create [folders](#) for more convenient organization of the library. You can manage folders through the options menu, which is accessed by tapping the three-dot icon in the top right corner of the screen. The options menu also contains:

- **Search:** An input line appears where you can enter part of the spectrum name. Only spectrum names containing the entered substring will remain on the screen. The search is performed within the displayed folder, i.e. this function essentially works as a filter. To find a spectrum located in a folder, you need to switch the display to "Simple list without folders" mode through the same options menu before searching.
- **Import spectrum:** The system tool for selecting an .xml or .csv file opens. You can import a file that was previously exported by an application into the library RadiaCode on your smartphone or computer.

Tapping a line opens a dropdown menu:

- **Set as current background:** Select a spectrum to display as background.
- **Load to view:** Load spectrum to view in ["View" tab](#).
- **Share spectrum:** [Export spectrum data](#) to text file with the extension .xml or .csv and "share" this file.
- **Rename spectrum:** Set a new name for the spectrum.
- **Edit comment:** Set or edit a comment for the spectrum. A comment is an arbitrary text that is displayed for the spectrum in the library in blue.
- **Edit calibration factors:** A dialog window opens where you can set calibration factors for the selected spectrum. This can be useful if the device, with which the spectrum was taken, was recalibrated.
- **Delete spectrum:** Remove spectrum data from the library.

- **Mark:** Switch to the spectra marking mode. A check mark appears at the bottom left of the graph:



Select by tapping all spectra, with which the group operation will be performed, and tap the symbol with three vertical dots in the upper right corner of the screen:



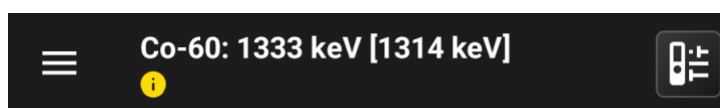
A dropdown menu will appear:

- **Select all:** Mark all spectra in the library.
- **Invert selection:** Make unmarked spectra marked and marked ones unmarked.
- **Combine selected:** Perform the operation of channel-by-channel addition of the data of the selected spectra. Only spectra obtained with the same device can be combined. RadiaCode-10X. A new spectrum is created, you are prompted to enter its name for saving in the spectra library. The number of pulses of each channel of the combined spectrum is the sum of the number of pulses in the corresponding channels of the combined spectra. The accumulation time is calculated in the same way.
- **Edit calibration factors:** A dialog window opens, where you can set the calibration factors for all selected spectra. This can be useful if the device, with which the spectra were taken, was recalibrated.
- **Delete selected:** Delete marked spectra after confirmation.
- **“Cancel”:** Unselect all spectra and exit the mode. The same is done with the “Back” button on the smartphone.

See also: [Export and import of spectra](#)

6.2 Displaying isotope information

When you tap the graph and move your finger across the screen, the application header displays information about the radioactive isotope, the energy of which corresponds to the cursor position:



The name of the isotope, the corresponding energy is displayed, in square brackets - the energy corresponding to the cursor line on the spectrum graph. The name of the decay chain for the isotope is displayed below.

To see examples of spectra of common isotopes, tap [here](#).

In case the option "Display gamma line position" is enabled:

The pink line marks the position of the isotope energy line. If the isotope has accompanying lines, then they are displayed in turquoise ([see the figure in the “Spectrum” topic](#)). The dotted lines correspond to the X-ray lines.

If there are several isotopes with close energies, then information about that isotope is displayed, the energy line of which is closest to the value of the energy corresponding to the cursor.

If the "Display gamma lines intensity" or "Draw markers on intensity lines" option is enabled, red lines/markers corresponding to the intensity of gamma radiation lines, relative to the activity of the parent nuclide, are drawn over or instead of turquoise isotope lines.

6.3 View tab

The “View” tab is intended for static viewing of spectra from [spectra libraries](#). The functionality of the tab and control is the same as on the main “Spectrum” tab, except that the update button is replaced with a button for switching to the spectrum library, and the name of the spectrum is displayed instead of information about the update.

To load a spectrum for viewing, you need to open the spectra library, tap the desired spectrum and select “Load to view” in the dropdown menu.

The preview displays the same background as in the main Spectrum tab.

6.4 Export and import of spectra

Spectra **are exported** with the command “Share”, which is called through the dropdown menus



in the “Spectrum” and “View” tabs, as well as the window of the spectra library.

Two formats are supported: .xml (default) and .csv. Both formats are supported by the popular Becquerel Monitor software. You can select the export format in the spectrum settings.


A file in xml format can simultaneously include a spectrum and a background and contains all information about them - names, number of channels, spectrum accumulation time, calibration factors and the serial number of the device on which the spectrum and background were taken. This format is self-sufficient and does not require additional steps from the user when importing; xml files can be imported directly from instant messengers like WhatsApp and Telegram.

A csv file is a text file with a .csv extension that can be used not only with the Becquerel monitor, but also with other applications due to the simplicity of its format. Only pairs of values “channel number, number of pulses” are written to the file. In the spectrum settings, you can choose which separator to use - comma or semicolon. The file name is formed as “Spectrum_<Current date/time>_<Accumulation time in seconds>s.csv”, for example, [Spectrum_2021-05-12_13-53-55_1426s.csv](#). When importing csv file into application RadiaCode a window is displayed where it is proposed to enter the spectrum name, the accumulation time (if it was not possible to determine it from the file name), as well as the serial number of the device, on which the spectrum was taken, and the calibration factors. It is possible to indicate to the application that the imported spectrum was taken with the currently connected device - for this there is a special button “Copy factors and serial number from the device”.

For spectrum and background overlapping from different devices RadiaCode-10X read [here](#).

Importing a spectrum to the library

Application RadiaCode is registered in the smartphone as a handler for files with the .xml and .csv extensions. When tapping a file with the .xml or .csv extension in any other Android application, for example, in WhatsApp or Telegram, the application RadiaCode will be in the “Open with...” list. If you open the file with RadiaCode, the spectrum will be imported into the spectrum library, you will be prompted to set the import parameters for the spectrum.

You can also import a spectrum using the button . The system file picker opens.

6.5 Calibrating the energy scale of the device

Calibrating the energy scale of the spectrum is necessary to accurately determine the energy of the gamma lines of the spectrum by the channel number. The devices undergo a calibration process at the factory, but detector parameters may change over time, necessitating a calibration update. It would require sources with known isotopic composition and energies in advance. The calibration points are the vertices of the peaks on the gamma spectrum. The result of the calibration is the values of the calibration factors, which are used by the device to convert the spectrum channel number into the radiation energy value in keV using a polynomial of degree 2 kind:

$$E = a_0 + a_1 \cdot x + a_2 \cdot x^2,$$

where

x is the channel number;

a_0 , a_1 , a_2 are calibration coefficients.

Spectrum energy scale calibration procedure

The calibration is performed at three points, which ensures sufficient linearity over the entire range of energies under study. To perform the calibration, the user will need a spectrum containing mono-energy lines, preferably located at the beginning, middle and end of the energy scale. For example, the following isotopes produce such lines:

- K-40 (1461 keV);
- Am-241 (59 keV);
- Lu-176 (202, 307 keV);
- Cs-137 (32, 662 keV);
- Th-232 (238, 583, 2614 keV);
- Ra-226 (78, 351, 609 keV);

Caution! You are solely responsible for any potential legal consequences and potential health risks associated with the acquisition, storage, and handling of radioactive materials. Please ensure that while working with radioactive materials, you do not violate local laws and regulations, and observe all safety precautions when handling them.

The most convenient and simple for calibration is Th-232, a naturally occurring element. In most countries around the world, small quantities of Th-232 are legal and available for purchase in local stores, for example, in the form of welding electrodes WT-20.

More details are explained in this instructional calibration [video](#).

You can also use alternative sources or their combinations for calibration. For example Cs-137 and K-40. It is not necessary to collect the spectrum with both sources at once, you can collect two separate spectra and memorize the channels where the lines are located during calibration. For example, after collecting the spectrum of Cs-137, remember that on channel 3 there was a peak with an energy of 32 keV, and on channel 66 there was a peak with an energy of 662 keV. And after collecting the K-40 spectrum, by selecting these channels, enter the appropriate energy (32, 662, 1461 keV).


For three-point calibration with a single source, it is best to use Th-232-based sources, but a certain peculiarity must be taken into account: the first line is better chosen at the low-energy level, the X-ray fluorescence line. If the source is a thoriated electrode, the X-ray fluorescence energy will be about 65 keV, but if the source does not contain heavy elements, the line will have an energy of about 88 keV.

After calibrating the device, it is desirable to test it on sources with a different isotopic composition. Also, because of the nonlinearity introduced by the discreteness of the channel step, the lines may not always fall exactly into the channel where they are supposed to be. This is especially true at the beginning of the spectrum.


If a rough calibration without a source is necessary, the K-40 isotope is recommended. It is necessary to dial the background spectrum, where the peak at 1461 keV or potassium fertilizer will be clearly visible, and the peak should be completely colored in yellow. Then, entering the settings, change the calibration factor A1 in increments of 0.1 until the top of the peak is at 1461 keV.

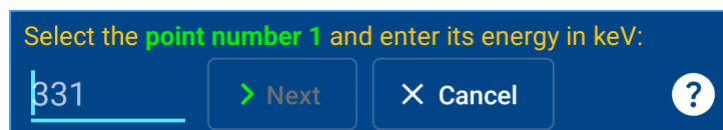
Calibration procedure

1) Place the device and the reference source to be measured as close as possible to each other. The detector should be placed with a "+" sign on the source or, if the source is powerful, pointed in its direction with a "+" sign. It is desirable that the count rate should not exceed 500 cps during calibration.

2) In the "Spectrum" tab, reset the spectrum by clicking on  and select "Restart Accumulation" from the drop-down menu.

3) Having determined the choice of reference points, wait until all spectral lines (Gaussians), on which the calibration will be carried out, are colored yellow, which will indicate sufficient statistical reliability of the spectrum data.

4) Tap on  and select "Energy Scale Calibration" from the drop-down menu. At the top of the tab, you will be prompted to enter the energy value:



5) Touch the graph and, by moving the marker lines, select the first point on the graph. Enter the energy corresponding to the point next to the "Next" button. Tap the "Next" button.

6) Repeat this manipulation twice and select the "Done" button.

7) The application will check the channel number values for validity. If the values are invalid, a diagnostic message about it will be displayed. If the values are acceptable, a window will be displayed with a table with energy values and corresponding spectrum channel numbers, and under the table the calculated values of the calibration factors:

Initial values for calculating calibration coefficients:


	Energy, keV	Channel #
Point 1	<u>1134</u>	<u>61.95</u>
Point 2	<u>1085</u>	<u>418.48</u>
Point 3	<u>2371</u>	<u>812.42</u>


Calculated values of calibration coefficients:

a0: -10.6180267

a1: 2.2851436

a2: 0.0007956

 Save coefficients

 Program coefficients into the device

Invalid values of calibration factors are displayed in red. The application blocks the ability to write such values to the device.

You can manually correct the table data, and changing energies and/or channel numbers will cause automatic recalculation of the factor values.

8) Tap the "Program factors to device" button to complete the calibration. If the calibration was initiated from the View tab, the button will save the spectrum open for viewing to the library with new coefficients.

If you need to return the factory calibration of the device or correct the calibration factors manually, you can use the "Calibration factors" button in the ["Device settings" dialog box](#) dialog box.

6.6 1024 spectrum channels instead of 256

Device firmware version 4+ supports 1024-channel spectra. Earlier firmware versions supported 256-channel spectra.

The number of spectrum channels is determined by the digit capacity of the ADC used, which digitizes the signal of the device's scintillation detector. The higher bit rate, i.e. 10 bits instead of 8 bits, allows 1024 channels of spectrum. This provides a clearer separation of the spectrum peaks in the low energy region of radiation. The transition to 10-bit spectra became possible due to

application of special algorithms and techniques of signal processing at the ADC output. These algorithms minimized the effect of the nonlinearity of the ADC characteristic on the shape of the spectrum.

Application RadiaCode works with 10-bit spectra. When loading from the spectra library and importing old 8-bit spectra (256 channels) from files, they are converted to 10-bit spectra (1024 channels). It should be kept in mind that:

- When converting spectra from 8-bit to 10-bit, the values of calibration coefficients are recalculated: the value of a_0 does not change, a_1 decreases by a factor of 4, a_2 decreases by a factor of 16.
- In the spectra and spectrogram library, 8-bit spectra are labeled with an orange circle with the number 8 in the lower right corner. Calibration coefficients are displayed as converted for a 10-bit spectrum.
- The 1024-channel spectra and spectrograms are always stored in the spectra and spectrogram library and exported.
- Drawing and processing of large spectrograms may be slower due to the increased number of channels.
- The application will work normally with a device that has firmware version less than 4.00 that produces 256-channel spectra. However, it is recommended to update the firmware to the latest version.
- Earlier versions of the application designed to work with 256-channel spectra will not work correctly with a device that has firmware version 4+.

Chapter

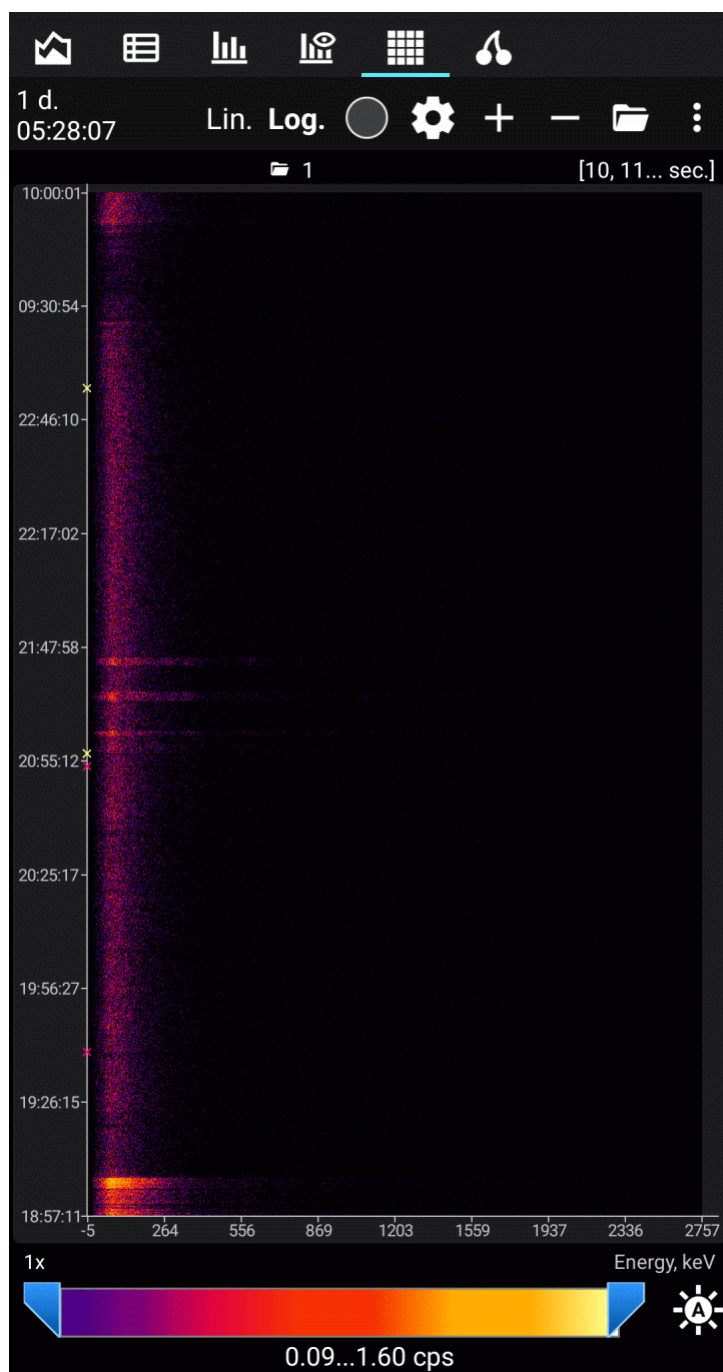


VII


7 Spectrogram

A spectrogram is a visual representation of the energy spectrum of photon (gamma and X-ray) radiation varying with time.

The Spectrogram tab displays a plot of either the spectrogram currently being recorded or the spectrogram loaded from the Spectrogram Library. There is no separate tab for viewing spectrograms, as there is for viewing spectra.



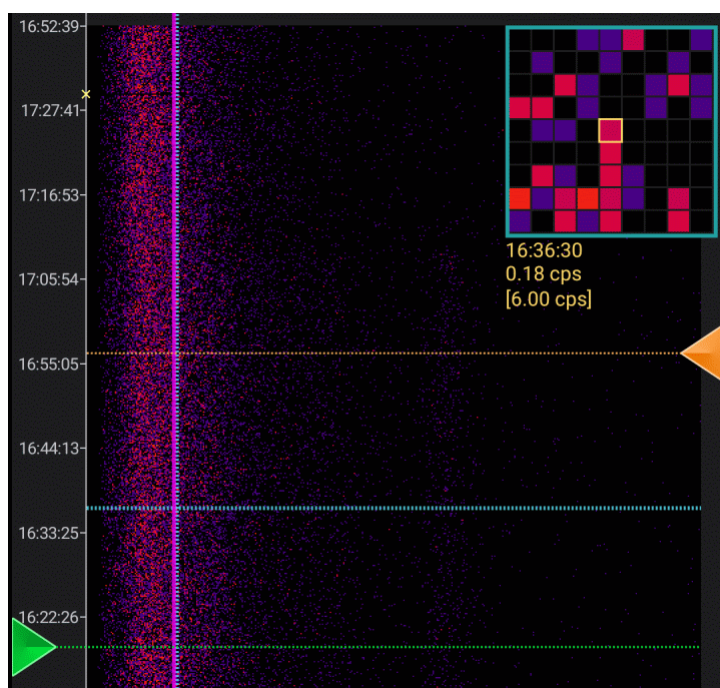
Each line on the vertical (Y scale) is a separate spectrum typed in the "Capture Interval". The size of the interval can be set in the settings. The horizontal (X scale) shows either spectrum channel numbers or photon energy calculated by analogy with the Spectrum tab. The count rate in each individual channel (Z scale, similar to the Y scale in the Spectrum and View tabs) is converted to a

brightness or color scale, which can be zoomed using the sliders below the spectrogram. By pressing the  the scale is automatically zoomed by the minimum and maximum values of the recorded or selected from the library spectrogram.



The energy lines on the spectrogram will look like vertical bands. The appearance of new bands will indicate a change in the spectral composition of the registered radiation. The Y-axis can display calendar time, spectrogram accumulation time or countdown number.


The total spectrogram accumulation time and capture interval are displayed at the top left.





A long tap on the chart displays the marker lines and a "magnifying glass" that enlarges the section of the chart at the intersection of the marker lines:



Under the magnifying glass the information about the spectrum channel that is in the center of the magnifying glass is displayed: its corresponding time or count number, count rate (number of pulses in this channel divided by spectrum accumulation time) and, in square brackets, total count rate for the spectrum (sum of pulses in all channels divided by accumulation time).

	<p>Start/stop recording of the spectrogram. Once stopped, recording can be resumed. When you exit the application, the spectrogram recording also stops. Every minute the recorded spectrogram is automatically saved in the library.</p>
	<p>Loading a spectrogram from the library does not stop the recording of the spectrogram, it continues in the background.</p>
	<p>Opens the settings related to the spectrogram plot. In the settings you can choose:</p> <ul style="list-style-type: none"> • Capture Interval: at what frequency the spectrum "snapshots" (counts) are taken. Each sample (spectrum) is shown on the plot by a number of horizontal squares. Acceptable values are from 1 to 600 seconds. Since the timer of the device is not synchronized exactly with the timer of the smartphone, the intervals of accumulation of spectra received from the device can have a scatter of ± 1 second.

- **Maximum number of samples:** Spectrogram buffer capacity. If the number of counts in the recorded spectrogram is equal to the specified value, the oldest count is deleted before adding a count. The maximum buffer capacity is 10,000 counts.
- **The minimum and maximum values of the scale:** the count rate limits for the engine at the bottom of the tab, which controls the brightness/palette of the plot. The squares of counts for which the count rate value is outside the specified values are displayed with border colors (start/end of the color scale).
- **Auto brightness: do not go beyond the boundary:** The minimum and maximum values of the scale can be automatically corrected by the application if the calculated values exceed the limits  the calculated minimum and maximum values are out of the limits specified in the settings. Setting these options blocks the values of the engine from exceeding the specified limits.
- **Scale:** If you select the logarithmic scale, the decimal logarithm is taken from the value of its count rate before calculating the brightness/color of the square. Quickly switch the scale - with the "Lin." and "Log." icons, as well as by double-tapping the plot.
- **Merge channels by:** To speed up rendering of large spectrograms, you can combine spectrogram channels by 2 or 4. When merging, the number of pulses in the adjacent 2 or 4 channels is summed. As a result, the displayed spectrogram has 512 or 256 channels, respectively.
- **Y-axis units:** you can select the calendar time (counted from the spectrogram recording start), spectrogram accumulation time (hours:minutes:seconds), count number (counts are numbered from zero), or disable the display to save screen space.
- **X-axis units** - channel number or photon energy.
- **Palette:** when selecting the "Brightness" option, only grayscale is used to display the count rate on the plot. The other two options are a choice between color palettes, the same ones used when rendering [tracks](#).
- **New data:** If new counts are added to the end of the chart, they will appear at the bottom of the chart. The oldest values will be at the top of the chart. Otherwise - new counts are added to the beginning of the chart.
- **Resume recording:** If automatic resumption of spectrogram recording is enabled, the action selected in the list will be performed when the application is launched and the device is connected. This option is triggered only if the spectrogram was recorded during the previous exit from the application.
- **Automatically colorize the spectrogram when recording:** When capturing the next count, automatically select the positions of the scale sliders at the bottom of the graph and, accordingly, color the spectrogram. *This happens only if the minimum or maximum value of the count rate in the captured sample exceeds the boundaries of the minimum or maximum value of the count rate for the entire spectrogram.*
- **Display isotope information:** draw vertical lines that correspond to the energy of this or that isotope at the point of the plot selected by tapping. The header of the application window will display text information about the isotope.
- **Draw the grid:** if the size of the squares is more than 3 pixels, then draw a black line grid for better perception of the plot.
- **Draw a graph of the count rate:** Display the count rate graph on top of the spectrogram. Since the time axis of the spectrogram is the Y-axis, the graph is rotated by 90° relative to the usual view.
- **Do not shift the initial boundary of the spectrum histogram range in the automatic end boundary shift mode:** Selects the dynamic or fixed interval of the displayed spectrum when the [spectrum histogram panel is enabled](#).

	<ul style="list-style-type: none"> • When recording a spectrogram, automatically save it in the library: The recorded spectrogram will be stored in the database every minute. After stopping the recording, the saved spectrogram will be visible in the spectrogram library.
Lin.	Select the linear scale of conversion of dose rate values to brightness/color.
Log	Select the logarithmic scale of conversion of dose rate values to brightness/color.
	Enlarge the graph (zoom in). The plot can be scrolled both horizontally and vertically. Long press of this button increases the zoom to the maximum. You can also use gestures to zoom.
	Zoom out. Long press of this button decreases the scale to one.
	Open the spectrogram library .
	<p>Open the dropdown menu. Actions are available in the menu:</p> <ul style="list-style-type: none"> • Share spectrogram: Export the spectrogram data to a text file with the extension .rcspg and "share" this file, i.e. save it in smartphone memory, send it by mail or via messenger. The .rcspg files can be imported through the spectrogram library. • Save spectrogram to library: Save the spectrogram in the database (spectrogram library). It is not necessary to stop recording to save the spectrogram. • Isotope info: Show detailed information about the isotope that corresponds to the tapping point on the plot. • Close spectrogram: Close the spectrogram, if it was selected from the library, and display a plot of the currently recorded spectrogram. • Spectrum histogram: Open or close the panel where the histogram of the spectrum corresponding to the selected interval in the spectrogram is displayed. • Load the spectrum to view: Open the spectrum, which is displayed in the spectrum histogram panel, in the "View" tab. • Save spectrum to library: Save the spectrum, which is displayed in the spectrum histogram panel, in the spectra library dialog box.


7.1 Spectrogram Library

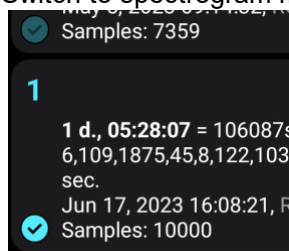
A list of saved spectrograms is displayed. For each spectrogram its name is displayed, which was set when saving, accumulation time, interval(s) of samples, date of recording start, serial number of the device and number of samples.

It is possible to create [folders](#) for more convenient organization of the library. You can manage folders through the options menu, which is accessed by tapping the three-dot icon in the top right corner of the screen. The options menu also contains:

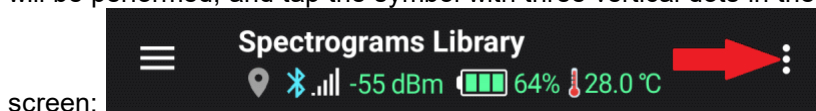
- **Search:** An input line appears where you can enter part of the spectrogram name. Only spectrogram names containing the entered substring will remain on the screen. The search is performed within the displayed folder, i.e. this function essentially works as a filter. To find a spectrogram located in a folder, you need to switch the display to "Simple list without folders" mode through the same options menu before searching.
- **Import spectrogram:** The system .rcspg file picker opens. You can import a file that was previously exported by an application into the library RadiaCode on your smartphone or computer.

Tapping a line opens a dropdown menu:

- **Open the spectrogram:** Load a spectrogram to view. If a spectrogram is currently being recorded, it continues in the background. To return to the graph of the recorded spectrogram, tap the button  on the "Spectrogram" tab and select "Close Spectrogram".
- **Share spectrogram:** Export the spectrogram data to a text file with the extension .rcspg and "share" this file, i.e. save it in smartphone memory, send it by mail or via messenger.
- **Rename spectrogram:** Set a new name for the spectrogram.
- **Edit comment:** Set or edit a comment for the spectrogram. A comment is an arbitrary text that is displayed for the spectrogram in the library in blue.
- **Delete spectrogram:** Delete spectrogram data from the library.
- **Mark:** Switch to spectrogram marking mode. A check mark appears at the bottom left of the



graph: Select by tapping all spectrograms, with which the group operation will be performed, and tap the symbol with three vertical dots in the upper right corner of the



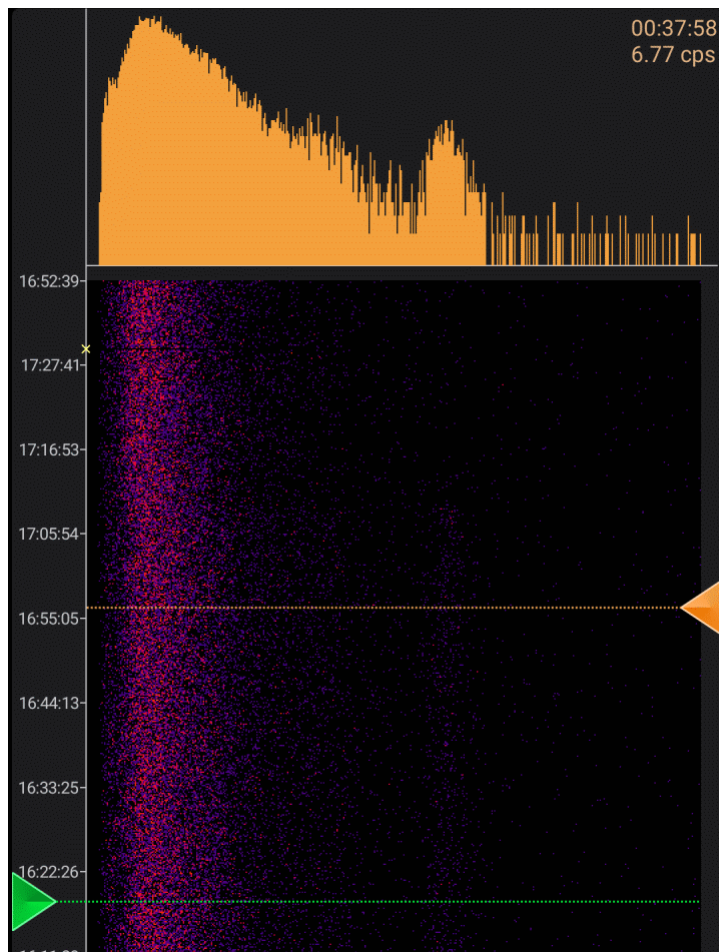
screen:

A dropdown menu will appear:

- **Select all:** Mark all spectrograms in the library.
- **Invert selection:** Make unmarked spectrograms marked and marked ones unmarked.
- **Delete selected:** Delete marked spectrograms after confirmation.
- **"Cancel":** Unselect all spectrograms and exit the mode. The same is done with the "Back" button on the smartphone.

7.2 Spectrum histogram

The menu command "Spectrum Histogram" in the tab "Spectrogram" opens the panel in which the spectrum corresponding to the interval selected in the spectrogram is displayed:



The interval is selected by dragging the triangles (markers). The scale of the spectrum (linear or logarithmic) corresponds to the scale selected for the spectrogram.

If the marker position is outside the spectrogram area displayed on the screen, the background of the marker will be semi-transparent.

A long touch of the marker sets its position to the corresponding extreme value. If, for example, you perform a long tap on both markers, the spectrum will be displayed for the entire spectrogram.

If during the recording of the spectrogram the corresponding marker is set to the extreme value, which corresponds to the most recent data, then when new data comes from the device, the marker will automatically move to the new extreme position, i.e. as if it "sticks" to the boundary. The behavior of the second marker in such a situation depends on the setting "Do not shift the initial boundary of the spectrum histogram range in the automatic end boundary shift mode". If this setting is enabled (default), the second marker stays where it was and the spectrum interval increases as new data is received from the device. If this setting is off, the second marker is moved so that the interval between the markers remains constant and the spectrum is displayed over the selected fixed interval.

Chapter

VIII

8 Activity

The “Activity” tab is designed to determine the absolute and specific activity of the Cs-137 isotope in various loose and watery materials (primarily in food) and the absolute activity of Cs-137 point sources. This isotope is one of the main pollutants after nuclear accidents and tests.



Measurement parameters

The upper part of the tab displays the parameters that shall be specified before starting the measurement:

Parameter name	Description
----------------	-------------

Geometry	<p>The parameter is selected from the list and determines the geometry of the sample in which the activity of Cs-137 is evaluated.</p> <p>If the sample dimensions are small (less than 5 mm), then the geometry should be selected “Point source 5 cm”. In this case, during the measurement, the sample is located at a distance of 5 cm from the “+” symbol on the back cover of the device and from the side of this symbol.</p> <p>If the sample is large enough (does not fit the description of the point source above), then one of the containers in the list should be selected. Containers are not included in the device delivery set and should be purchased separately.</p>
Product	Name of the sample material, selected from the list. The parameter if not entered if geometry is selected “Point source 5 cm” .
Weight	Numerical value of the sample weight in grams with an accuracy of 0.1 g. The parameter if not entered if geometry is selected “Point source 5 cm” .
Spectrum	Displays the spectrum name of the sample taken from the spectrum library, or “Current” if a new spectrum is being accumulated during the measurement process.
Background	Name of the background spectrum from the spectra library

Measurement results

The results are displayed below the measurement parameters and grouped into: **Activity/Specific**, **MDA/Specific** and **MPC**.

Result name	Description
Activity	Absolute activity of the sample minus the background, in becquerels.
Specific activity	Specific activity of the sample, based on the injected mass, in becquerels per kilogram. The parameter is not calculated if geometry is selected “Point source 5 cm” .
%	Estimation of the random error of the current values of absolute and specific activity. The error decreases with increasing the measurement time. At error values greater than 30%, the measured activity values are considered unreliable and are displayed in gray. If it is impossible to estimate the error, dashes are displayed.
MDA	Estimate of the minimum detectable activity, in becquerels. Calculated from the background spectrum and the sample spectrum, taking into account their random errors.
Specific MDA	Estimate of the minimum detectable specific activity calculated based on the MDA and the sample mass, in becquerels per kilogram. The parameter is not calculated if geometry is selected “Point source 5 cm” .
MPC	Exceeding the MPC level, in times. MPC is maximum permissible concentration, tabular values are taken for Russia. The parameter is not calculated if geometry is selected “Point source 5 cm” .

Spectrum

At the bottom of the “Activity” tab there is an area for displaying the histogram of the spectrum section, according to which the above estimates are calculated. In the center of the histogram, there is a region of the spectrum where the presence of a Cs-137 peak with an energy of 662 keV is assumed. The region with energies of 662 ± 100 keV is displayed in brighter colors. The criterion for the availability of cesium in the sample is the bell-shaped peak on the spectrum, which stands out above the background level, with a maximum in the middle of the graph. If such peak is not visible, then the measured values may be unreliable.

Start/stop button (combined) serves to start/stop the measurement. When starting a measurement, you can either continue the current measurement (if any) or start a new one. During the measurement, the current data is saved once a minute, the measurement will automatically continue after reconnecting the device and after restarting the application.

“Diskette” button serves to save the obtained spectrum to the spectra library.

“i” button serves to display extended information about the measurement.

“Gear” button opens the activity measurement settings dialog, where you can select the country for which the MPC standards apply, as well as configure the **“Offer to save the spectrum when stopping the activity measurement”** option: If the [activity measurement](#) is performed in several steps, this option can be disabled so that the application does not offer to save the accumulated spectrum each time the measurement is stopped.

Measurement procedure

Use the following methods to assess the sample activity:

[Measurement of sample activity in a container](#)

[Point source activity measurement](#)

8.1 Measurement of sample activity in a container

Measurement procedure

IMPORTANT: To determine the activity of loose and watery materials, it is necessary to give them a standard shape by placing them in a special container (containers are not included in the device delivery set and are purchased separately). At the moment, the program calculates activity, when using multiple containers:



To measure the mass of the container and sample a balance with an accuracy of at least 1 g will also be required.

- 1) Charge the device to at least 50% capacity and using the [“Spectrum” mode](#) generate a background spectrum set. When obtaining the spectrum, the device shall always be in the same place where the activity measurement will be carried out. To improve the measurement accuracy, it is recommended to obtain spectra for at least 8 hours, and if possible - a day or more. Save the acquired spectrum to the [spectra library](#) with the name “Background Date/Location” or similar.
- 2) Open the **“Activity”** tab of the application and in the dropdown list of the **“Geometry:”** line select the container used.
- 3) In the dropdown list of the **“Product:”** line select the product type.
- 4) In the **“Weight:”** line enter the weight (net) of the sample. For this:
 - measure the weight of the empty container with the lid;
 - fill the container with the sample to capacity, having previously crushed, dried or pressed the sample;
 - close the lid and measure the mass of the container with the sample;
 - calculate the mass of the sample by the difference between the obtained values, and enter the result in the **“Weight:”** line (the program allows entering a value with an accuracy of 0.1 g).
- 5) In the **“Background:”** line select the previously obtained background spectrum.
- 6) Place the turned on device on the sample.
 - If a 60 ml container is used, place it on a horizontal surface with the lid up. Place the device on the container so that the “+” sign of the back cover of the dosimeter is located strictly above the center of the container lid. In this case, the other side of the device shall rest on some object of the same height as the container (for example, a second container of the same size).
 - If a Marinelli container is used, then place the device in the open cavity of the container with the USB connector facing out and the “+” sign inward.
- 7) At the bottom of the **“Activity”** tab, in the spectrum histogram display area, click the button with the triangle icon to start the measurement.
- 8) Perform measurements until the values of the minimum detectable activity (MDA), as well as the measurement error, reach the values that suit you.

8.2 Point source activity measurement

Measurement procedure

- 1) Charge the device to at least 50% capacity and using the [“Spectrum” mode](#) generate a background spectrum set. When obtaining the spectrum, the device shall always be in the same place where the activity measurement will be carried out. To improve the measurement accuracy, it is recommended to obtain spectra for at least 8 hours, and if possible - a day or more. Save the acquired spectrum to the [spectra library](#) with the name “Background Date/Location” or similar.
- 2) Open the **“Activity”** tab of the application and in the dropdown list of the **“Geometry:”** select **“Point source 5 cm”**.
- 3) In the **“Background:”** line select the previously obtained background spectrum.
- 4) Place the turned on device and the source at a distance from each other so that:
 - the “+” sign of the rear cover of the device was turned towards the source;
 - the geometric center of the source was located on the same line with the “+” sign, perpendicular to the rear cover of the device;

- the distance to the source, measured from its geometric center to the geometric center of the scintillator, was 5 cm (projections of the scintillator center on the side surfaces of the device are marked with marks, and the projection on the back cover is marked with a “+” sign).

5) At the bottom of the “**Activity**” tab, in the spectrum histogram display area, click the button with the triangle icon to start the measurement.

6) Perform measurements until the values of the minimum detectable activity (MDA), as well as the measurement error, reach the values that suit you.


Chapter



IX




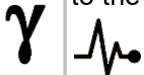



9 Map and tracks

Application RadiaCode equipped with functions of displaying the emission situation on a map in real time, as well as functions of recording routes ("tracks") and their subsequent download for view.

To access the map, select the "Map" item in the main menu, which is called by tapping the icon  top left. To record tracks, the app needs access to the location of the device. Also, the location function of the phone/tablet must be enabled.

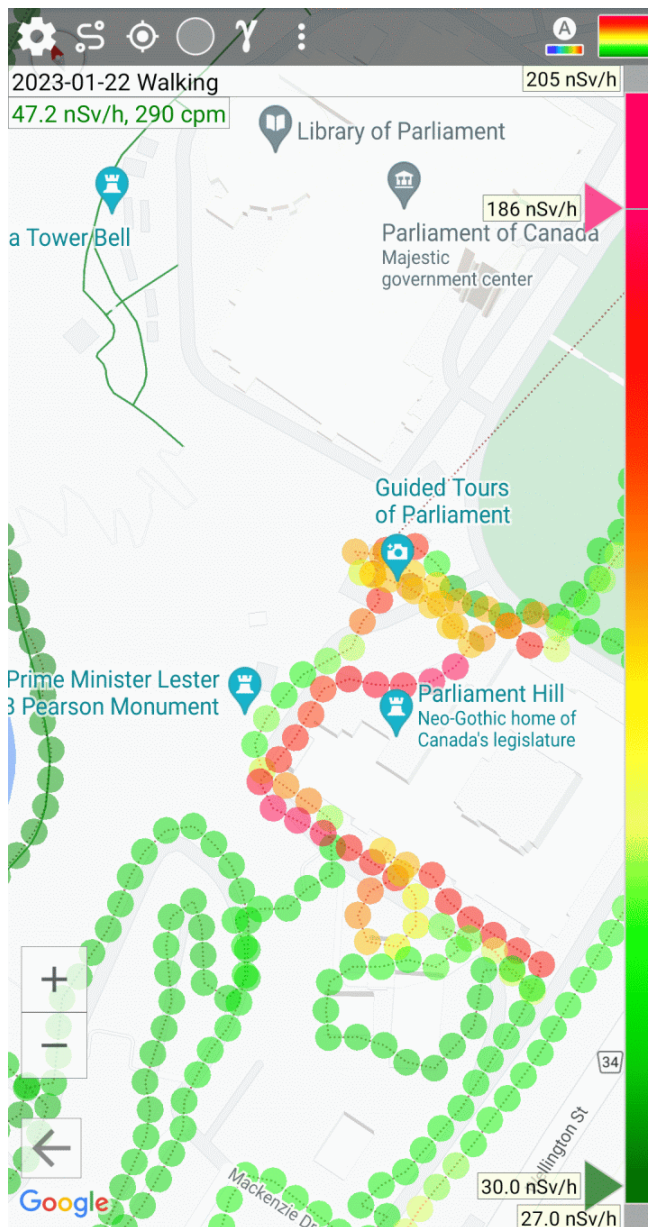


Opens [the settings related to the map.](#)


	Opens track library .
	Displays a point in the center of the map that corresponds to your current location.
	Starts or continues recording a track.
	<p>Indicates that marker colors are determined from dose rate values. When clicked, switches to the mode of marker coloring by count rate, and the icon on the button is replaced by this:</p> <p>This icon indicates that marker colors are determined by count rate values, and clicking on it switches to the mode of marker coloring by dose rate.</p>
	<p>Opens a dropdown menu:</p> <ul style="list-style-type: none"> • Mark: Enter marker flagging mode. In this mode, tapping a marker flags it for later deletion. The flagged markers are white and surrounded by a pink circle. • Delete selected...: After confirmation, delete the flagged markers from the track. Markers are permanently deleted and cannot be recovered.
	Automatically colors markers on the map in accordance with the minimum and maximum dose rate/count rate values. A long tap additionally automatically sets the minimum and maximum values of the displayed markers.
	Expands/hides the color bar graph.

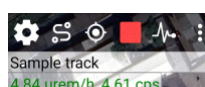
Tracks

When you record a track, each current location is marked with a circle on the map. The color of the circle corresponds to the emission level or count rate measured at this point, taking into account the color settings on the color scale.



The colors of the markers are determined by the dose rate values or, starting with application version 1.30.00, by the count rate values. The display mode is selected using the corresponding button on the toolbar. Tracks recorded with older versions of the software do not contain count rate information, so marker colors will appear the same in both modes. Tracks recorded by a device whose firmware did not yet support energy compensation essentially contain dose rate values that are directly proportional to the count rate.

To start recording a track, tap the icon  at the top left of the screen. You will be prompted to enter a track title. After that, recording will start, and the name of the track will be displayed at the top of the screen under the buttons:



New points appear on the map, and, accordingly, are remembered in the track only when the location changes. In [the application settings](#), you can set the minimum position accuracy. It should be borne in mind that the correctness of determining the location depends on many factors - the

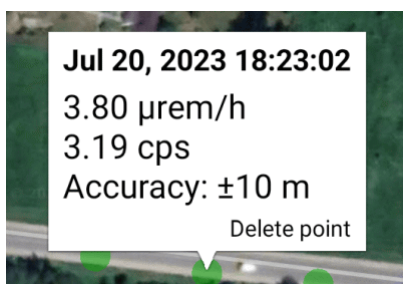
quality of the phone's GPS module, the interference situation, etc. In the absence of information from the GPS sensor, the smartphone can determine the location using other sources - cell towers and Wi-Fi networks.

When first displayed on the map in the dose rate mode, the marker is colored according to the current value of the dose rate transmitted by the device, and surrounded by a thick gray line. The operational value of the dose rate transmitted by the device lags behind the current calendar moment in time. The lag time depends on the rate of change in the radiation situation: with small changes in dose rate values, the lag can be tens of seconds; with sharp changes, the lag is reduced. As data arrives from the device, operational markers corresponding to the calendar time of the received values are repainted in accordance with the accepted value and acquire the status of permanent ones, the thick stroke disappears. You can turn off the thick outline of operational markers in the map settings. Hot markers are not stored in the database.

Track recording continues until it is explicitly stopped and as long as the application is in communication with the device. When the device is reconnected, track recording resumes automatically.

It should be borne in mind that in the track recording mode, the smartphone consumes a lot of energy and its battery will drain faster. If you do not need to, do not set too small a value for the positioning accuracy in the application settings.

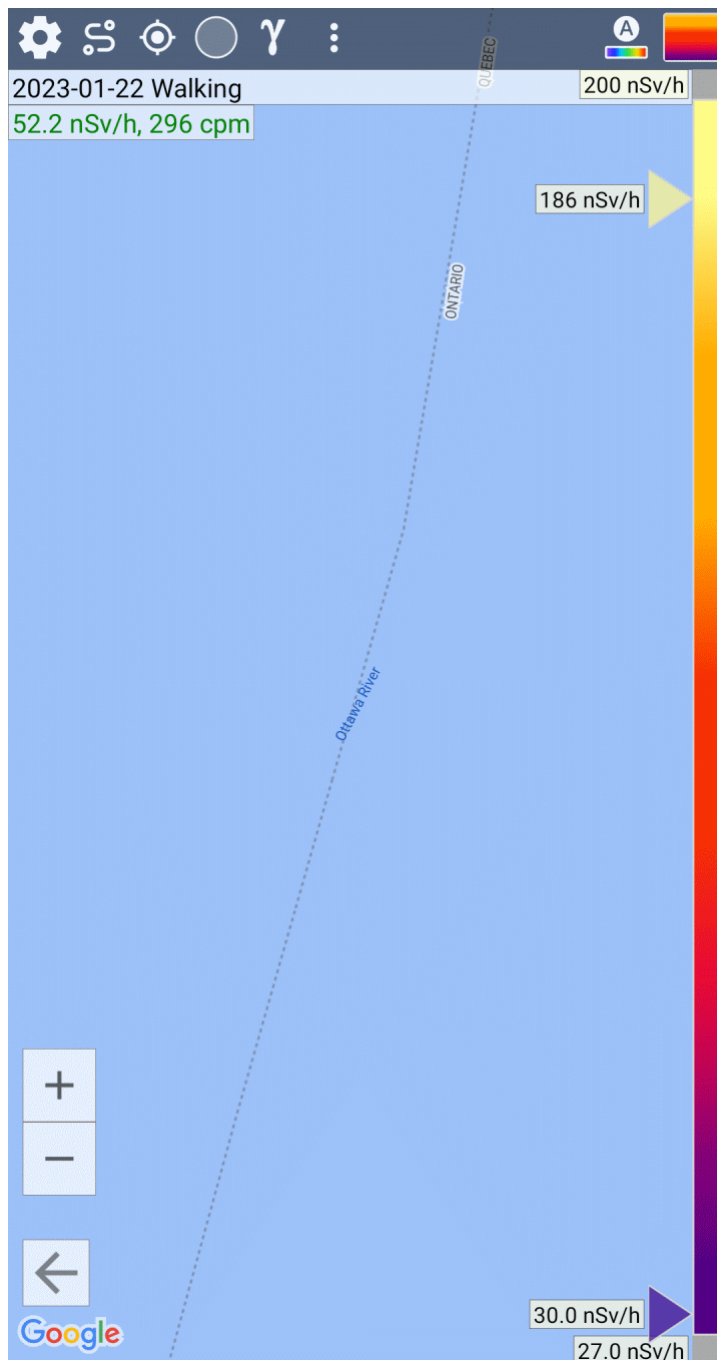
If you tap any circle (marker), information corresponding to this point will be displayed - date/time, measured emission level, count rate, and positioning accuracy:



Long tap of the window with information allows, after confirmation, to remove this point from the track.

Color scale

The color scale is a quick way to color the track points so that they clearly reflect the changing emission situation. By moving the scale sliders, you can set the minimum dose rate or count rate value, which corresponds to the violet color, and the maximum value, which corresponds to the red one:



This example shows that the entire range of measured values is approximately 40...77 $\mu\text{R/h}$. The purple slider is set to 40.5 $\mu\text{R/h}$, so all points with the same and lower dose rate level will be purple. The red slider is set to 77.2 $\mu\text{R/h}$, and all points with the same or higher level will be red. All points between 40 and 77 $\mu\text{R/h}$ will have intermediate colors, from violet to red. In the map settings, you can select a palette of colors to display markers.

In the map settings, you can turn on the function of automatic coloring of markers in accordance with the current maximum and maximum measured value.

See also:

[Map settings](#)

[Track library](#)

Pseudo tracks

9.1 Map settings

To open the map settings, tap  at the top left of the screen.

Maps API:

It is possible to choose the software platform that provides the maps and their rendering. The default is Google Maps. As an alternative map API you can choose the OpenStreetMap platform (<https://www.openstreetmap.org/>). OpenStreetMap is an open source project with the ability for users to add their own objects to the map.

Google Maps provides an opportunity to choose between the type of map - scheme, satellite photo or hybrid version and works only in online mode, ie, when displayed sections of the map are downloaded by the application from the Google server.

OpenStreetMap displays the map only as a diagram. You can choose between the online mode, when the map is downloaded as raster images-tiles from the servers of OpenStreetMap partner companies, and the offline mode, when preloaded files with vector maps are used for display (see below for details). OpenStreetMap draws markers much faster than Google Maps, so for very large tracks it is more convenient to use it.

Google Maps and OpenStreetMap settings are slightly different. The different settings are listed at [the end of the page](#).

Store location in the database:

Never: The coordinates of your smartphone's current location are not recorded in the database (log).

Only when recording a track: The coordinates of your smartphone's current location are only entered into the database during track recording. This allows you to partially recover a track from the base log as [a pseudo track](#).

Always: If enabled, the location is entered into the database along with the rest of the information. In the future, you can open on the map [pseudo track](#) and see the change in the radiation situation associated with the selected location. You should not enable this option unnecessarily, because location determination makes the smartphone consume a lot of power.

Coordinates are stored in the database only if location detection in the smartphone is enabled by the user. Android apps do not have the ability to turn location detection on and off on their own.

Location:

Location resolution and distance between markers on the map: If the location of the smartphone changes by more than the specified number of meters from the previous one, then in [track](#) a new point is recorded. Do not set too low values, since at the same time, the GPS module of the smartphone will work more intensively, while the number of track points will increase rapidly and the rendering of the track on the map will be slower.

Ignore a location if its measurement accuracy is worse than: If the accuracy of the position measurement is worse (greater than) the specified value, the application will ignore the system

message about the position change. For example, if you specify to ignore locations with a measurement accuracy worse than 20 meters, and the system reports that the location has changed, but the measurement accuracy is ± 22 meters, then this location change will be ignored.

Ignore location if the distance to the previous point is less than: If the distance between the previous point and the current point is less than the specified value, the application will ignore the system message about the location change. The combination of the last two options allows you to eliminate situations where the system reports small changes in geolocation coordinates measured with poor accuracy.

In a group “**Markers**” you can choose how the circle markers will be displayed on the map:

- **Minimum and maximum dose rate value for the marker** defines the range of values of the measured dose rate level displayed on the map. Points with a dose rate level outside the specified range are not displayed.

- **Automatically shift the minimum and maximum values:** if the marker added to the track has a dose rate value that exceeds the boundaries of the levels displayed on the map (“Minimum and maximum dose rate value for the marker”), then change the corresponding boundary so that the marker is visible. For example, if the maximum limit is set to 120 $\mu\text{R/h}$, and the dose rate of the next marker is 140 $\mu\text{R/h}$, the maximum displayed value will become 140 $\mu\text{R/h}$.

- **Immediately put a marker on alarm:** when an alarm occurs, immediately request a location from the system and put a marker when and if the system will provide this location. Marker is set on general grounds, all other settings and filters applicable to marker setting apply, *except the option “Ignore location if the distance to the previous point is less than...”, i.e. the option “Immediately set marker on alarm” only speeds up getting the current location from the system.*

- **Display markers where the dose rate value is out of bounds defined by color scale:** If this option is disabled, then only those points with the dose rate level between the values defined by the sliders will be displayed on the map. Points with values below the purple slider (for example, less than 40.5 $\mu\text{R/h}$) and above red (77.2 $\mu\text{R/h}$) will not be displayed.

- **Connect markers with a line:** Draw a dashed line connecting the markers. This helps to display the intended trajectory of movement if the markers are far apart, but slows down rendering.

- **Automatically set marker colors by min./max. dose rate values:** Set (including during the track recording process) colors so that purple corresponds to the minimum dose rate in the track, and red - to the maximum value. The triangles on the color bar will be set to their respective positions. ***If you move one of the triangles, then this option is disabled. It should also be borne in mind that the automatic coloring of markers with a significant number of points slows down the application.***

- **Enable the auto-coloring option when loading a new track:** If auto-coloring was disabled, for example, due to manual manipulations with the color scale, then auto-coloring will be automatically enabled when loading another track or starting recording a new one.

- **Disable live data marker stroke:** Do not stroke live markers (for which the dose rate value has not yet been transmitted by the device) with a thick gray line.

- **Marker size:** you can select the diameter of the circles.

- **Markers stroke:** Marker circles are outlined with a semi-transparent gray line, which allows you to visually perceive them as a set of circles, and not as a solid line if the markers partially overlap. At small map scales, the stroke masks the colors of the circles, so you can turn off the stroke or choose to turn it off automatically at small scales. The track is rendered slightly faster when the stroke is off.

- **Decimation of markers:** One can choose an additional criterion, taking into account which the markers are decimated when they are added to the map in order to speed up the rendering of large tracks. When adding a new marker, the application compares its parameters with the parameters of the previously added marker. The next marker is NOT added if the following conditions are simultaneously met: 1). The distance between this marker and the previous one is less than specified in the selected criterion (1/4 of the marker radius, 1/2 of the radius, or whole radius). 2). The difference in the dose rate of this marker and the previous one does not exceed 10% of the value of the dose rate of the previous marker.

Decimation of markers affects only their display on the map. This setting does not affect the process of recording a track; non-displayed markers are not deleted from the track.

- **Marker palette:** you can select the palette of colors that are used to draw the markers.

- **Automatically display the current position in the center of the map:** If in the process of recording a track you move the map to the side (for example, to view some other part of the map), then after the specified time the map will display in the center the position corresponding to the current location.

- **Ignore a point if the accuracy of determining its location is worse than:** When calculating the track length, ignore the points for which the positioning accuracy is worse than the specified one. This makes the calculation of the track length more accurate.

- **Display location accuracy and track length:** Display in the upper left corner of the map information about the accuracy with which the last location was determined, as well as the length of the track. This function works only if track recording is on. If the location was recorded in the track, then the color of the text in the window will be black, otherwise it will be red (the conditions for recording coordinates are not met).

- **Keep smartphone screen on when map is active:** The smartphone screen will not turn off if a map is displayed on the screen.

Some of the settings related to location are found in [the application settings](#).

You can import a track with the button . The system file picker opens.

Export settings (“Share”)

Application RadiaCode can export a track in several formats:

- in its own **rctrk** format, which is a text format and can be imported back into an application on another smartphone.
- in **gpx** format (a free text format for storing and exchanging GPS data). gpx files can be opened in a browser with a variety of viewing tools. When exporting the gpx file, the application specifies the dose rate value in micro-roentgen as the altitude above sea level.
- in **kmz** format (compressed .kml) for viewing in Google Earth (<https://earth.google.com/>) and in other programs that support the .kml/.kmz format.

When exporting a track in the .kmz format, one can set the following settings:

- **Marker size:** By default, Google Earth draws markers of some automatically selected size. This setting allows controlling the marker size in Google Earth.

- **Marker transparency:** One can choose the degree of transparency of the markers: 0% - opaque, 75% - almost transparent.

- **Decimation of markers:** Do not add a marker to the file if the distance in meters between it and the previous marker is less than the specified one, and the difference in dose rate values is not too large. This allows reducing the number of markers on the map. For decimation, the same algorithms are used as when drawing a track in the application.

- **HTML in point descriptions:** Each point is assigned a text string that is displayed in Google Earth when the marker is clicked - date/time, dose rate, location accuracy. Google Earth allows using an HTML markup in descriptions, which makes the text more readable. However, not all programs that work with the .kmz format understand HTML correctly, and for such programs, you can turn off HTML in the text.

Settings specific to Google Maps:

In field **"Map type"** you can choose how the map will look - a diagram, a satellite photo or a hybrid version.

Theme for Diagramthe "Scheme" mode: you can select a map theme: light (the default), dark or let the app select the theme according to the smartphone's light sensor. In the latter case, the theme switches automatically if the light level has changed and remains stable for 10 seconds. Due to the use of the ambient light sensor, the power consumption of the application may increase slightly.





Do not add markers to the map outside of the displayed area: This option can optimize the map performance when there are a lot of points in the track. If the number of points is more than 500, then when moving and scaling the map, all markers are deleted and only those that are within the map area visible on the screen are re-added. This causes track markers to blink, but the map is drawn faster due to the limited number of markers added. The effectiveness of this technology depends on the ratio of visible markers and their total number in the track (if the entire track is displayed on the map, then the efficiency will even be negative), as well as the speed of the smartphone.

Settings specific to OpenStreetMap:

OpenStreetMap map source: by default (online), the variant when the map is loaded as ready raster images-tiles from the servers of companies-partners of OpenStreetMap is applied. The second option is to work with maps in offline mode, i.e., no Internet connection is required for this. The source of maps are vector map files, which you need to download yourself from one of the sites listed on the page <https://download.mapsforge.org/> (it's more convenient to do it with a computer) and put it in the RadiaCode app folder on your smartphone named `/sdcard/Android/data/com.almacode.radiacode/files/Maps`.

When downloading maps, it is better to choose the format of version 5, maps of this format are in the folder with the name v5:

Index of /pub/Mirrors/download.mapsforge.org/maps

Name	Last modified	Size	Description
 Parent Directory		-	
 v3/	2018-01-09 08:59	-	
 v4/	2018-03-28 12:36	-	
 v5/	2018-10-08 07:41	-	
 world/	2020-05-05 03:28	-	

At the moment Mapsforge library does not support work with files given the restrictions on access to files that impose the rules of Android system versions 11+, so the map files must be placed in the folder whose name is given above.

In offline mode, map rendering, i.e. the conversion of vector information into a picture, is performed by the Mapsforge library, which is built into the application. This operation requires some smartphone processor resources. When you move the map around the screen and zoom in, the app will consume more power than in online mode.

Map theme: In offline mode, you can choose between two display options, which differ mainly in color palette.

Image scaling: In online mode, the application obtains images of areas of the map with a low resolution. On high-resolution smartphone screens, the inscriptions on such a map look too small, so the images have to be scaled. After scaling, the final image may look a little blurry, but you have to choose between image quality and inscription size. You can find the optimal ratio by using manual scaling. Offline mode does not have this problem, but you can still experiment with the scale.

Marker rendering optimization: In offline mode, you can select the way that the OpenStreetMap library will use to optimize marker rendering. If large tracks take too long to render, you can try changing this setting.

9.2 Track library

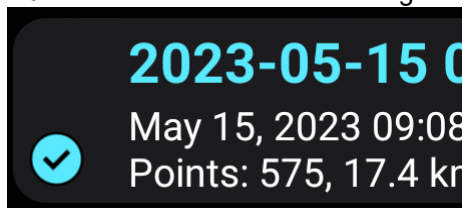
The list of saved tracks is displayed. For each track, you can see its name, which was set when you saved it, the date when you started recording, the time spent on the way, the number of points in the track and the total length of the track in kilometers. For tracks that were created by a device with firmware that does not support energy compensation, a yellow icon is displayed in the lower right corner.

It is possible to create [folders](#) for more convenient organization of the library. You can manage folders through the options menu, which is accessed by tapping the three-dot icon in the top right corner of the screen. The options menu also contains:

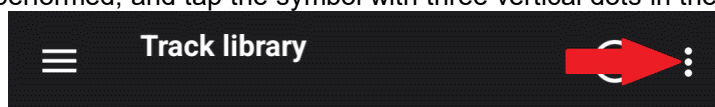
- **Search:** An input line appears where you can enter part of the track name. Only track names containing the entered substring will remain on the screen. The search is performed within the displayed folder, i.e. this function essentially works as a filter. To find a track located in a folder, you need to switch the display to "Simple list without folders" mode through the same options menu before searching.
- **Track import:** The system .rctrk file picker opens. You can import a file that was previously exported by an application into the library RadiaCode on the smartphone.

Tapping a line opens a dropdown menu:

- **Open track on the map:** Load a track to view.
- **Share a track:** Export the track data to a text file and "share" this file, i.e. save it in smartphone memory, send it by mail or via messenger. The file format can be selected in [the map settings](#).
- **Rename track:** Set a new name for the track.
- **Edit comment:** Set or edit a comment for the track. A comment is an arbitrary text that is displayed for the track in the library in blue.
- **Delete track:** Remove track data from the library.
- **Mark:** Switch to the track marking mode. A check mark appears at the bottom left of the graph:



Select by tapping all tracks, with which the group operation will be performed, and tap the symbol with three vertical dots in the upper right corner of the



screen:

A dropdown menu will appear:

- **Select all:** Mark all tracks in the library.
- **Invert selection:** Make unmarked tracks marked and marked ones unmarked.
- **Delete selected:** Delete marked tracks after confirmation.
- **"Cancel":** Unselect all tracks and exit the mode. The same is done with the "Back" button on the smartphone.

Tapping the plus icon allows you to add a new track and start recording it.

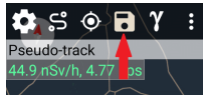
9.3 Pseudo tracks

A pseudo track is a track generated by the application based on the dose rate data that was written to the database when the option is enabled "[Save geographic coordinates of measurements in the database](#)".

To build a pseudo-track, select the desired point on the graph or the desired entry in the [log](#) and make a long tap on the screen. A dropdown menu will open. Select the **"Show on the map"** item in it (it will be available only if the above option was enabled during the measurement and the application received location data from the system). You will be prompted to select time limits for creating a pseudo track:

The map will open, it will display the markers that fall within the selected time interval. It should be taken into account that not operational, but already processed data are entered into the database, which come from the device with a frequency that depends on the current radiation situation. For small changes in dose rate values, data is received at a frequency of approximately 2 minutes, with sharp changes, data is received more frequently. When creating a pseudo track, all map settings are taken into account and the same decimation and filtering algorithms are applied as when building a regular track.

The pseudo track displayed on the map can be saved in the tracks library using the button on the toolbar:



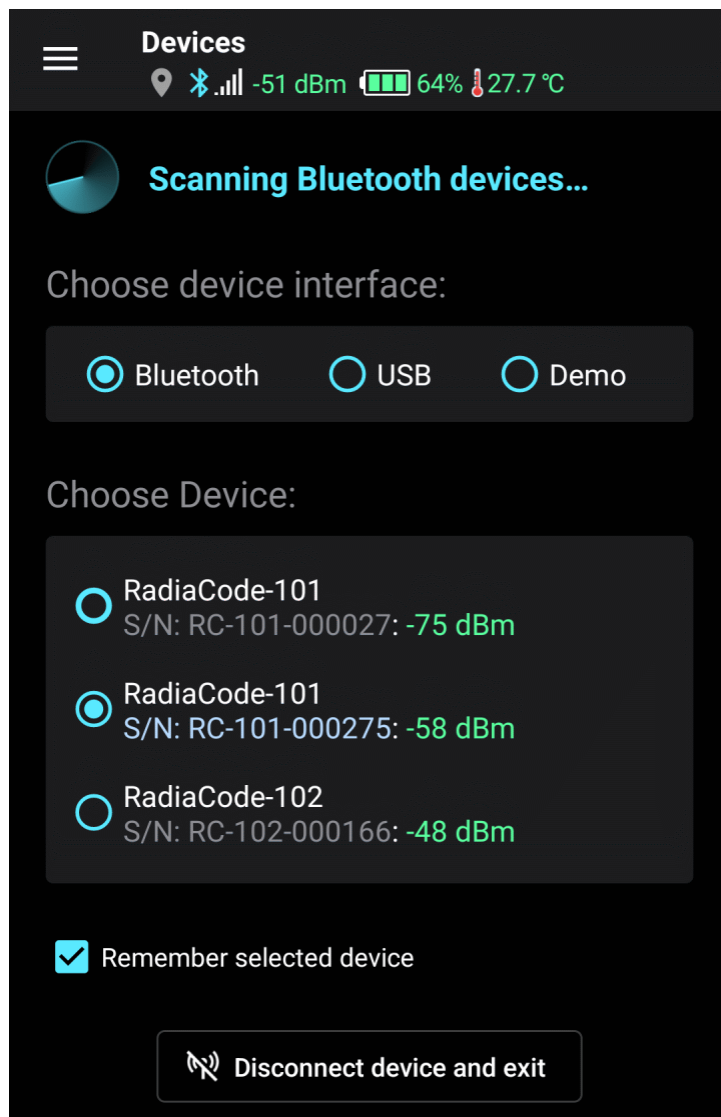
Chapter



X

10 Devices

Device selection is available through the navigation menu (icon in the upper left corner of the screen). The device selection page is displayed:



It supports operation with devices connected to a mobile device via Bluetooth and USB. By choosing “Demo”, you can get acquainted with the application operation in the demo mode - you do not need a device for this. In the demo mode, the application operates with a virtual device.

When you select an interface, the application scans the environment and detects devices available for connection. The “Choose Device” field displays a list of detected devices. In the “Demo” mode, the virtual device is always available.

If for a long time the application does not find the device via the Bluetooth interface, try following [these recommendations](#).

Option “**Remember selected device**” instructs the program not to display the device selection page before starting work, if the selected device is turned on and the program was able to detect it.


After connecting the device via Bluetooth, the application takes some time to establish connection with the device and initialize it.

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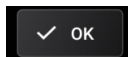


XI

11 Application settings

Application settings are available through the navigation menu (pictogram  in the upper left corner of the screen).

Please note that to save the settings, you need to tap the "OK" button at the bottom of the screen:



Application language: Tap to select the language of the application interface. The Russian language is available if it is supported by the mobile device.

Groups in the settings dialogs: Settings in dialogs are organized into groups. By default, all groups are collapsed, which gives them a compact appearance. To expand a group, tap it. If you select the "Always Expanded" setting, all settings groups in all dialogs will be displayed in expanded view. If the "Remember State" option is enabled, the application will remember which settings groups have been expanded and expand them the next time you enter the dialog. You can also enable group collapse/expand animation.

Measuring unit: Select in which units the information about the recorded radiation level is displayed: Roentgens (R), Sieverts (Sv) or Biological Rad Equivalent (rem). Rem is an obsolete unit of measurement of equivalent dose of ionizing radiation in the GHS system.

Count rate units: You can choose to display the count rate in pulses per second or pulses per minute (pulses per second multiplied by 60). The setting affects the entire application, including the spectrum.

Min. dose units of dose in Sievert: By default, the dose and dose rate are displayed in units that are automatically selected by the program: pico-, nano-, micro-, etc. If the unit of measurement in the device settings is set to Sieverts, this option allows you to select microSieverts as the minimum scale, as shown on the device display. **Temperature Units:** You can select whether the device temperature is displayed in Celsius or Fahrenheit.

Units of temperature: You can choose whether to display the device temperature in Celsius or Fahrenheit.

Duplicate alarm sounds and device vibration on the phone: When an alarm occurs, the smartphone will beep and vibrate in parallel with the device.

Sound indication of the counting speed (clicks): Issue sound of clicks with a frequency proportional to the count rate. To generate clicks, operational information about the count rate is used, which is issued by the device. You can select the volume of clicks and the type of click sound. The "**Mute click sounds on calls**" option forces the application to make an attempt to track incoming and outgoing smartphone calls, including messenger calls.

Phone signals: You can select the volume of the alarm sounds that your smartphone emits. Actual volume level depends on smartphone model and settings.

Connect/disconnect sounds: Give a signal when the connection between the control panel and the application is established or lost. You can set the volume of these signals. If the connection with the device is lost, the application tries to reconnect with it with an interval of about 30 seconds.

Push notification when communication with the device is lost: Provide a pop-up notification when communication with the device is lost. When the connection is re-established, the notification disappears.

Push notifications for alarms: You can instruct the application to issue pop-up notifications when device alarms occur, either always, or only when the application window is inactive. Pop-up notifications are issued regardless of whether the alarm sounds of the device are turned on or off and can be useful, among other things, for indicating alarms on any kind of Smart-watch connected to a smartphone. *In order for push notifications to appear, they should be enabled for the application RadiaCode in the "Application" settings of the smartphone.*

Device battery: You can tell the application to issue push notifications if the battery charge level of the device becomes less than the specified value, as well as in the case when the device itself turns off its power due to a complete battery discharge. A notification about a decrease in the charge level is issued once and does not repeat until the application is restarted or until the device's battery charge again drops from a higher value to the specified threshold.

Tab titles: Choose how to display the tab titles on the application screen - as text ("Home", "Journal", "Spectrum", ...) or as icons. When displayed as icons, icons of all the tabs always fit on the screen.

Start page: You can select which page (tab) will be active when the application starts. If the "Open map" option is set, the map will be opened after activating the [page](#).

Widgets: You can set the background transparency for the application widgets, and separately - the transparency of the text and graphs displayed in the widgets. Widgets are opaque by default.

Screen orientation: You can select one of the options to lock the smartphone screen in a preset position when the application is active.

Database Backups: Automatically create database backups when the application starts. You can choose how often to create backups and how many copies to keep. Backup copies of the database file are created in the Backup subfolder of the application's working folder and have names in the YYYY-MM-DD.db format, for example, 2023-12-08.db. The "Restore backup..." button displays a list of copies available for recovery. When restoring, the application is restarted.

Do not turn off the smartphone screen when the application is active: The smartphone screen will not turn off if an app is displayed on the screen RadiaCode.

An animation of the icon in the status bar when the device is connected: If this option is enabled, the app has established a connection with the device, and the app is inactive, the app icon in the smartphone status bar will change appearance every few seconds. This allows you to see if the device is connected to the app without activating the app.

Diagnostic Mode - enable extended information output to the application log file. When a crash occurs, the extended log can help developers figure out the cause of the crash.

See also [Expert settings](#).

11.1 Expert settings

Expert settings

Expert settings are for advanced users. Change them only at the direction of the technical support or developers.

Bluetooth scan time - the maximum time during which the application waits from the system for a response to a request to build a list of available Bluetooth devices. By default, it is 20 seconds. Under normal conditions, when the device is working properly, is near the phone and there is no interference, scanning for Bluetooth devices is much faster and there is no need to adjust the scan time.

Connection timeout: The time during which the application waits for a connection to the device. If the connection is unstable, you can try to increase this time.

Location request rate: The desired interval at which the application receives location information from the system. This time is an approximate one and the system can inform the application about the change in location either more often or less often than the specified interval. Increasing the interval saves battery life on your smartphone, decreasing the interval may make location determination more frequent (which can be important when traveling at high speeds), but it will drain the battery faster.

Use legacy Google Maps renderer: Google announced the availability of a new, improved map renderer. If you disable the "Use legacy Google Maps renderer" option, then the RadiaCode application requests the use of a new renderer. However, when using the new renderer, map rendering is often noticeably slower. *The effect of changing the value of this option appears only after restarting the application.*


“Debug” group settings are associated with debug information that is written to the application log file in diagnostic mode. The developers may ask you to enable this or that option in order to better understand the problem that has arisen. All of these options are disabled by default. enabling them significantly increases the size of the log file and can affect application performance. After enabling debug options, you need to restart the application.

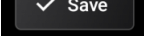
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XII



12 Device Settings

If the device is connected, then the device settings are available through the navigation menu (pictogram  in the upper left corner of the screen). The device settings displayed in the application are read by the application from the device and correspond to the settings available through the menu of the device itself.

Please note that to transfer the settings to the device, you need to tap the button  at the top right of the screen.

Measuring unit: You can choose microroentgens or Sieverts.


Device language: The language of inscriptions displayed on the device screen.

Dose Rate Alarms: Dose rate alarm thresholds can be set. If the registered emission level exceeds the specified values, then, depending on the settings  and , an audio signal and vibration are issued. In [the application settings](#), you can set the smartphone to repeat the device alarms through its speaker.

Dose Alarms: You can set alarm thresholds for the level of the accumulated emission dose.

Count Rate Alarms: Count rate alarm thresholds can be set.

Alarm signals mode:

Continuously: When an alarm occurs, the device will generate the specified signals (sound and/or vibration) at certain intervals until the user presses the button on the device body or mutes the alarm sound from the application with the button .

Once: Each time an alarm occurs, the device will issue the specified signals one time.

Display backlight: You can select the backlight operating mode of the device display.

Display rotation: You can select the mode of the image rotation on the device display. "Automatically" means that the device will itself determine the orientation of the image using the built-in accelerometer.

The "**Calibration factors**": the dialog box opens where you can manually adjust the values of the spectrum calibration factors, which are used by the device to convert the spectrum channel number into the radiation energy value in keV. In the application you can [calibrate the energy scale of the spectrum](#).

Device settings profiles

The device settings can be saved as profiles. All device settings and spectrum calibration factors are stored in the profile. To save a profile, tap the three dot icon in the upper right corner of the screen, select "Save Profile" and enter a name for the profile. Later on, you can load a profile from the profile library using the "Load Profile" menu item. **Note** that when you load a profile from the library, the settings are not automatically written to the device - to load the settings into the device, you must tap the "Apply" button at the bottom of the screen.

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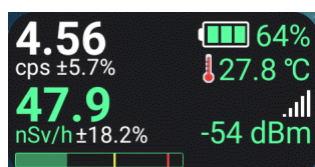
XIII

13 App widgets

If you don't know what a widget is and how to put it on your smartphone's desktop, look on the Internet for help.

Application RadiaCode app provides several widgets:

Indicators widget



This widget can only be resized horizontally. The right side with the battery, temperature and Bluetooth signal strength is only displayed if there is enough space for it. The red square in the lower left corner means that the [track is being recorded](#).

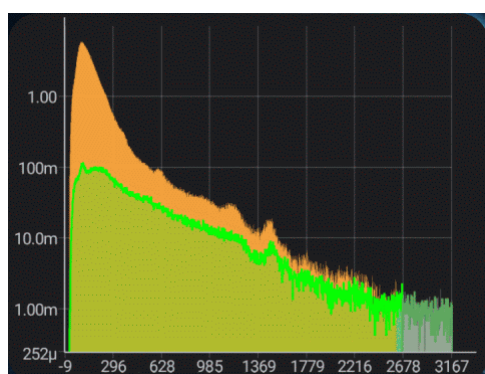
The indicator widget is updated approximately every two seconds.

Device screen widget



This is a screenshot of the device screen, which is updated every two seconds. When an alarm occurs, the widget can be updated more frequently. You cannot change the size of the device screen widget.

Spectrum widget



This widget displays the spectrum graph in the form that corresponds to the settings of the ["Spectrum" tab](#) in the app itself. The spectrum widget is updated at the interval specified for automatic spectrum updates in the application, but, unlike the application, the spectrum widget is always updated automatically. The size of the spectrum widget can be changed without restriction.

Remarks

Touching the widget launches the app RadiaCode.

When you exit the RadiaCode app normally, it notifies the open widgets that the device is disconnected from the smartphone, and the widgets display a corresponding inscription. If you exit abnormally, for example, when "swiping" an application in the screen of running smartphone applications, the RadiaCode app may not receive any notifications from the system. In this case, widgets will display the latest information received from the application, although the application is no longer in smartphone memory.

The RadiaCode widgets are updated quite often, which, by default, is not provided by the system. So far, no negative effects of frequent widget updates have been detected.

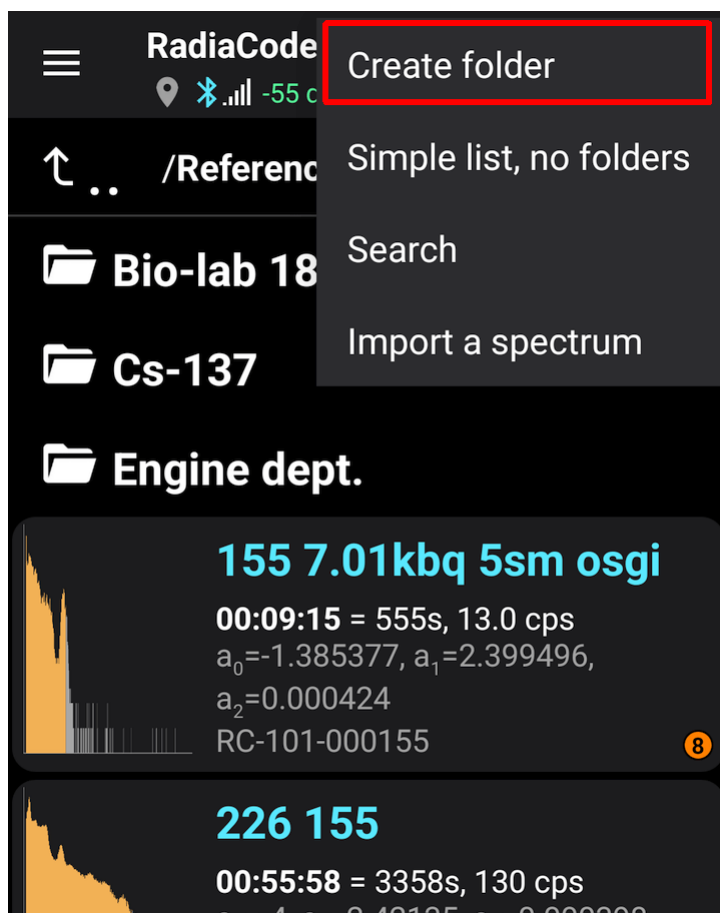
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14 Folders in the libraries

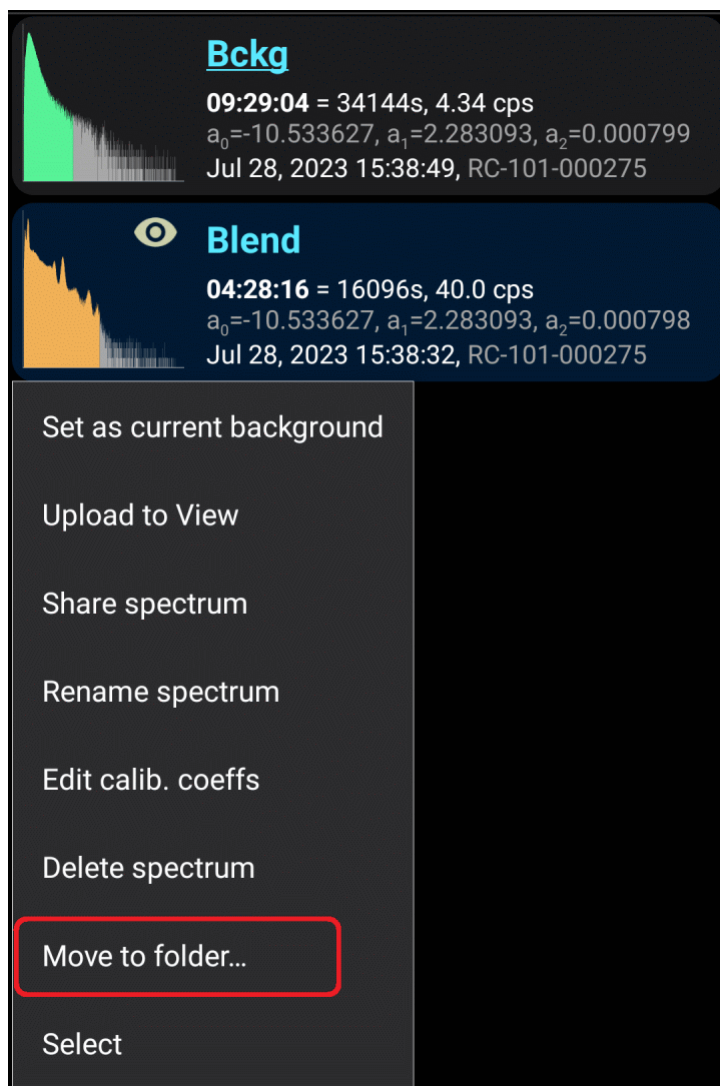
In the libraries of spectra, spectrograms, tracks and device profiles, you can place the contents in folders, just like in the file system. No folders are physically created on the smartphone and all folder information is in the application database file. File names must be unique within the entire library - the application will not let you save a file with an existing name, even if the existing file is in a different folder.

The interface associated with folders is the same in all the libraries listed, although the composition of the drop-down menus may vary slightly depending on the type of library. To create a folder, select the appropriate option from the toolbar's options menu:

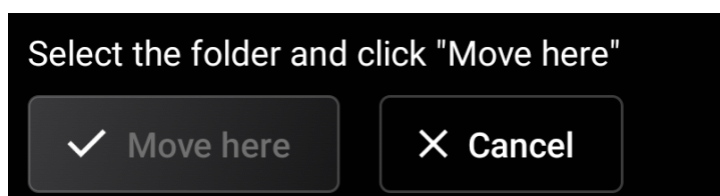


In the list, folders are always displayed before files. Touching a folder takes you to that folder. If the screen does not show the root folder, you can move up a level by touching the very first line with the arrow icon, as well as the "Back" button on your smartphone.

To move a file to a folder, tap it and choose "Move to Folder" from the drop-down menu:



At the bottom of the screen you will see a panel with explanatory text and buttons:



Navigating between folders, select the desired folder and click "Move Here".

To rename, delete or mark a folder, make a long tap on it and select an action from the drop-down menu. You can select multiple files and/or folders to move at the same time. The menu for actions with the marked files/folders is called "options menu" by touching the three-dot icon in the upper right corner of the screen.

It is possible to display all library files as a single list, so that you can see the entire contents of the library at a glance. To do this, select "Simple list without folders" from the options menu. In simple list mode, for each file, the path to its folder is displayed if the file is not in the root folder. To display the folders again, select "Show Folders" from the options menu.

Imported spectra, spectrograms and tracks go to the root folder.

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XV

15 Feedback

A form opens where you can send a letter with wishes to the developers or report bugs in the application. You need to enter your name and email, to which a reply will be sent, if requested. All the necessary technical information, including log files (logs), will be included in the report automatically.

If you want to report a bug in the application to the developers, then first make sure that [the “Diagnostic mode”](#) option is enabled in the settings. In the diagnostic mode, the application generates an extended log file that can help developers. After enabling the diagnostic mode option, you need to restart the application.

Button **“Add file”** allows selecting files on your smartphone, such as screenshots, that will be included in the archive sent to the developers.