Radon Vision 8

Software Manual

SARAD GmbH*

March 5, 2025

*info@sarad.de

Contents

List of Tables

List of Figures

1. Introduction

1.1. Functions

Radon Vision 8 is the application software for SARAD GmbH's radon measuring devices. It supports all devices of the device families:

- *Radon Scout*:
  - *Radon Scout 1* and *2*,
  - *Radon Scout PLUS*,
  - *Radon Scout Home* (*P*, *CO2*),
  - *Radon Scout Professional* (*P*, *CO2*),
  - *Thoron Scout*,
  - *Smart Radon Sensor*,
  - *Radon Scout eXpert*,
  - *Radon Scout Everywhere*,
- *DOSEman*:
  - *DOSEman*,
  - *DOSEman PRO*,

as well as the devices:

- *RTM 1688*,
- *RTM 1688-2*,
- *Analogue Radon Sensor*,
- *Analogue Progeny Sensor*,
- *Indoor Air Sensor*.

The app allows the following operations:

- Setting the measuring device, retrieving measurement data from the device:
  - for measuring devices connected locally to the PC via USB, RS-232 or RS-485,
  - for measuring devices connected via the ZigBee components of the *Net Monitors* family,

  - for measuring devices with integrated WiFi module,
  - for measuring devices that are connected via components of the *Aranea* family.

- Data management in binary files:
  - automatic creation of the directory structure
  - automatic assignment of file names
  - forced saving as a binary file prior to report generation as a quality assurance measure

- Interactive graphical display of measurement data in a diagram with:
  - selection of the measurement campaign to be displayed
  - multiple zoom
  - axis zoom
  - shifting the display along the axes
  - data cursor
  - diagram printout
  - saving in various file formats
  - copying to the clipboard
  - diagram editing

- Diagram display of the alpha spectrum (only for devices with spectrum measurement):
  - spectrum of individual measurement intervals
  - spectrum over selected time periods
  - diagram printout
  - saving in various file formats
  - copying to the clipboard
  - diagram editing

- Selection of measurement intervals for further analysis:
  - interactively with the mouse or
  - by importing an iCalender file,
  - restricting the selection by defining an evaluation window

- Calculations with the selected measurement intervals:
  - mean values with their statistical errors
  - exposure
  - dose calculation with adjustable dose conversion coefficient and equilibrium factor

- Switching between SI and US units
- Generation of a report as an Excel or LibreOffice file:
  - freely configurable template file for flexible layouts
  - inclusion of all measurement data in additional spreadsheets

Optionally activatable functions of older software versions:

- selective export of an Excel-compatible text file
- simple protocol printout with space for your own company sheet.

1.2. System requirements

- Windows operating system (tested with Windows 10 and 11)
- approx. 50 MB free drive capacity
- Minimum graphics requirements: 1024×768 pixels, 256 colours
- Mouse or other pointing device
- RS-232 interface (COM) or USB for reading out the measurement data

For the targeted temporal selection of measurement data files in iCalendar format (file extension ICS) are required, which can be created with common calendar apps such as *Calendar*, *Outlook*, with the calendar of *Thunderbird*, *Google-Calendar* or similar. can be created. One of these apps should be installed in addition to *Radon Vision 8*.

To be able to access measuring devices with *Radon Vision 8* the *SARAD Registration Server service* must be installed on the same PC.

2. Installation and Configuration

2.1. Installation of the SARAD Registration Server service

Insert the installation CD into the drive or download the installation file from the SARAD website and start `setup-regserver_service.exe`. The installation programme will guide you through the installation process.

If you want to connect measuring devices via USB, the USB driver for the FT232 from FTDI is also required on your PC. If your PC is connected to the internet when you first plug in a SARAD device, this driver will be installed automatically. For PCs that are permanently operated without an internet connection, you must install the driver manually. The latest driver and the corresponding installation instructions can be found on the website of the company FTDI Chip.

2.2. Installation of Radon Vision 8

Insert the installation CD into the drive or download the installation file from the SARAD website and start `setup-radon_vision-8.exe`. The installation programme will guide you through the installation process.

The Windows programme directory is suggested as the destination folder by default. You can change this as required. You can install *Radon Vision 8* in parallel to an earlier version of *Radon Vision* without any problems, but you should always select an installation directory that is different from that of the previous version.

2.3. Setup assistant

When *Radon Vision 8* is started for the first time, a setup wizard is started, allowing basic settings for the behaviour of the software.

The first thing to select is where *Radon Vision 8* shall save user data and store configuration settings (Figure 2.1).

There are two options here:

Standard *Radon Vision 8* stores user data in the Windows folder for application data (`%appdata%`), the configuration in the Windows registry.

User-defined Here, experienced users or administrators can also specify more exotic storage locations.

If you are unsure, select the first option!

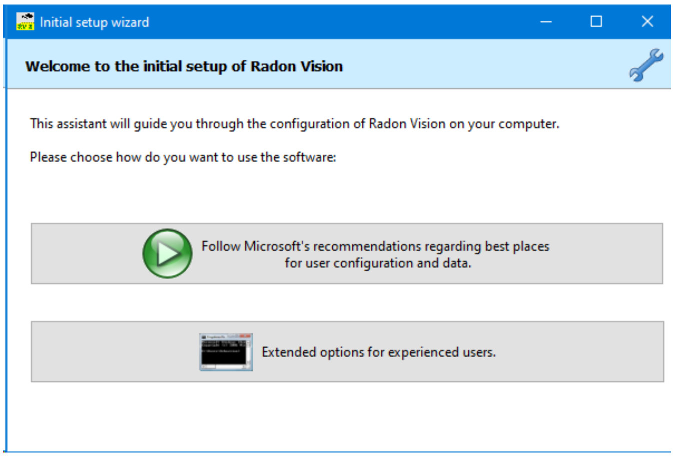


Figure 2.1.: Selection of storage locations for user data and configuration

In the next window (Figure 2.2) you can, based on the selection made previously, define the directory paths more precisely, the language of the user interface and the unit system to be used.

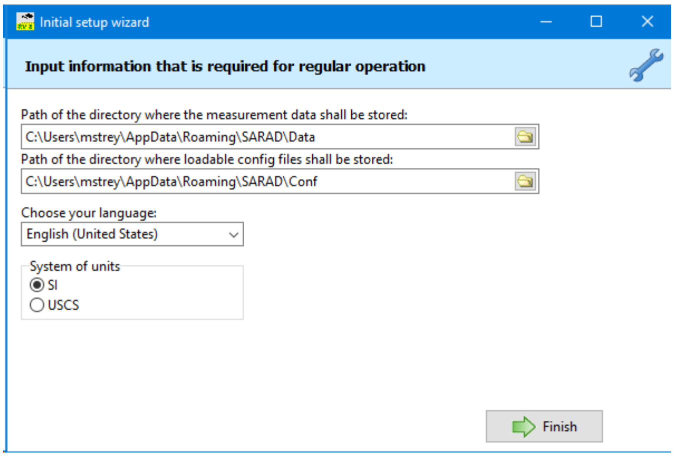


Figure 2.2.: Setting paths, language and unit system

3. Radon Vision 8 in a Nutshell

3.1. Terms: measurement campaign and measured value file

Measurement campaign A set of temporally related measurement data from the same measuring device, which are stored together in a measured value file. A measurement campaign begins with the start of the measurement on the instrument and ends when the measurement is stopped or when the measurement data is downloaded from the instrument. Measurement data downloaded from the instrument consist of at least one measurement campaign.

Measured value file Measurement data downloaded from the instrument can be saved as a file on the PC. The raw data (counts) of one or more measurement campaigns are saved in a binary file as they come from the instrument. This binary file in SARAD's proprietary RVX format is saved with systematic file name to a canonical place that has been set in the setup wizard (Figure 2.2). Measured value files can be provided with a comment when they are saved.

Radon Vision 8 displays the measurement campaigns of a measured value file individually or together in diagrams, but allows the measurement campaigns to be summarised in a measurement file using the filter functions. This makes it possible to analyse data recorded at one measurement location together, even though the measurement for example was interrupted by a battery change.

Figure 3.1 shows the diagram view of a measured value file with five, in this case unconnected, measurement campaigns.

With *Radon Vision 8* you can save measurement campaigns individually in RVX files, but also open several RVX files of the same measuring device at once, to analyse them together or to save them together in one RVX file.

3.2. Data storage and quality assurance

As binary files with a proprietary file format not disclosed by SARAD GmbH, the RVX files containing the raw measurement data are relatively tamper-proof. This means that they can also be used retrospectively as evidence, that a report created with *Radon Vision 8* has not been manipulated or completely invented.

In *Radon Vision 8*, the principle therefore applies: 'No report without binary raw data in RVX format.'

The programme therefore prompts you to save the measured values downloaded from the measuring instrument as soon as you want to generate a report (Figure 3.2).

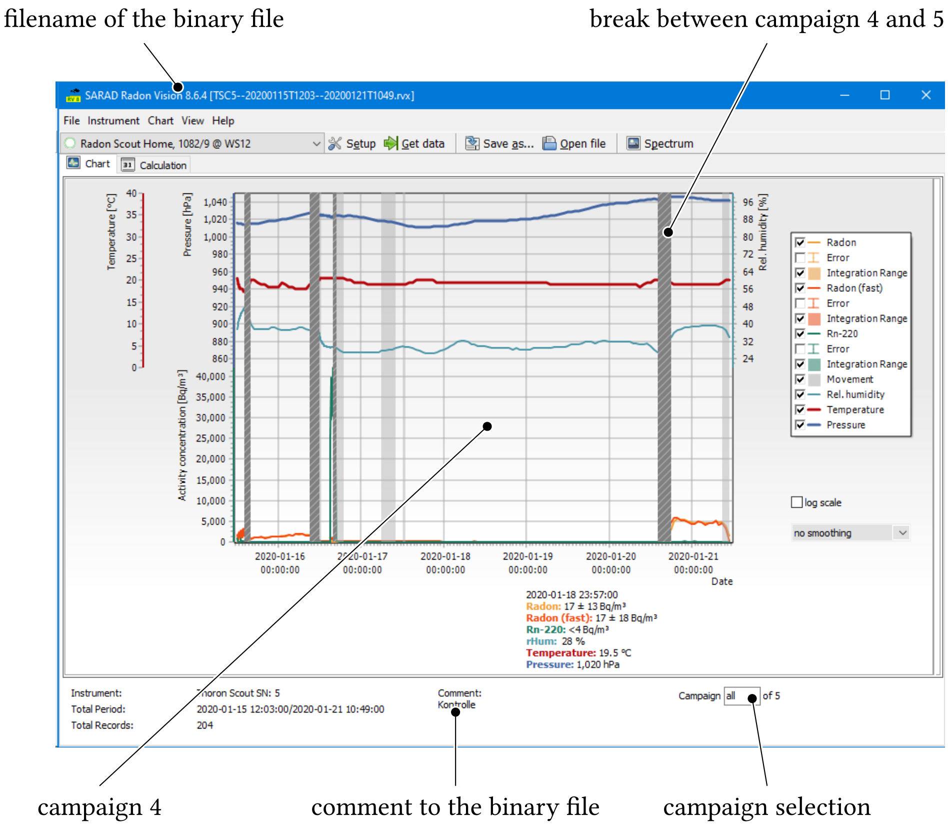


Figure 3.1.: Measured value file with five measurement campaigns

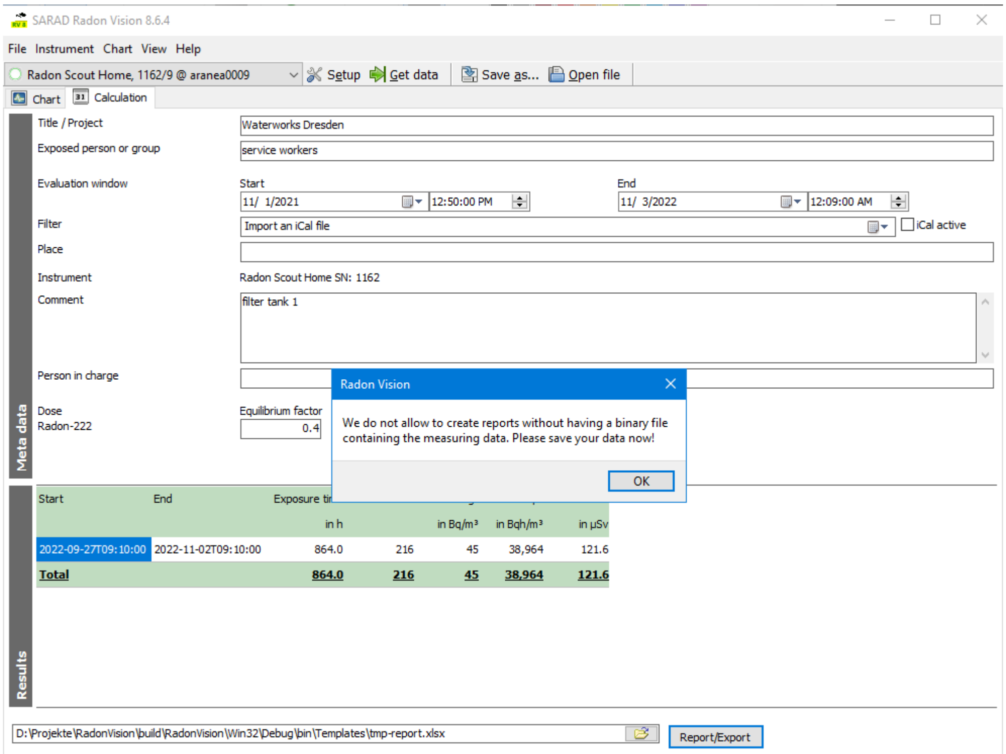


Figure 3.2.: Prompt to save as a binary file after clicking on *Report/Export*

The name of the binary file is included in every report generated by *Radon Vision 8* so that the report can be traced back to its source at any time.

3.3. Best practice

The following aspects must be taken into account when planning the measurement:

1. Downloading many measurement data sets from the measuring instrument takes a relatively long time.

2. All the measurement data stored on the instrument is always downloaded and then saved in the same measured value file.

3. The evaluation in *Radon Vision 8* is easier if all related data is not only in the same measured value file but also in the same measurement campaign.

As a user, you generally want to analyse data from the same measurement location together and also keep an overview of your data. This results in the following tips:

1. Plan the length of the measurement campaign according to your measurement objective.

2. Do not interrupt an ongoing measurement unnecessarily.

3. Delete the data from the instrument after you have downloaded it with *Radon Vision 8* and saved it in an RVX file, unless you are downloading the data of an ongoing measurement for an interim evaluation without stopping the measurement.

   Example: The ground floor of a flat is to be measured for six months to find an annual average value for radon exposure. You are curious and want an first overview after just one month. In this case, you let the measurement run, download the data and leave it on the instrument. At the end of the six-month period, the measurement campaign is completed by stopping the measurement, the complete data is downloaded from the instrument, saved on the PC as an RVX file and deleted from the instrument. For the sake of good order, delete the RVX files of the interim evaluation.

4. Assign meaningful comments when saving.

5. If you change the measurement location, stop the measurement and restart it at the new location to avoid measurement data from different measurement locations ending up in the same measurement campaign.

6. It is **necessary** to check the clock of the measuring instrument after every battery change and to set it if necessary (see Figure 3.3)!

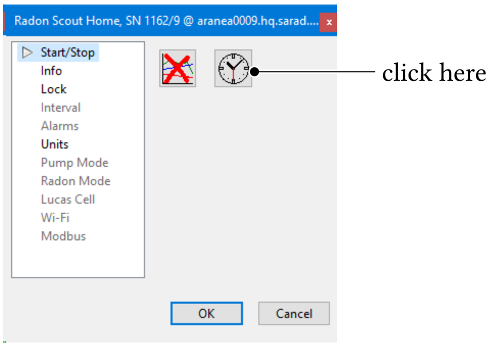


Figure 3.3.: Synchronisation of the clock of the measuring instrument with the PC

3.4. Calculation of averages, exposure and dose

3.4.1. Marking of integration intervals for calculating averages, exposure and dose

Manually using the mouse

Hold down ⇧ and move the mouse over the diagram to mark integration intervals.

ATTENTION: The integration intervals are only displayed in the diagram if *Integration Range* is selected in the legend.

Hold down Ctrl and drag the mouse over the selected intervals to deselect them.

When selected, the averages, exposures and dose values displayed in the results table of the *Calculation* tab are automatically updated.

Figure 3.4 shows campaign 5 from the measured value file shown in Figure 3.1. All measured values for the calculation of exposure and dose are marked here. Figure 3.5 shows the corresponding result.

Rule-based through the import of an iCalendar file

Using a common calendar application such as *Microsoft Outlook*, the *Google Calendar* or *Mozilla Thunderbird*, a calendar can be created which can then be exported as an ics file and imported into the *Calculation* tab of *Radon Vision 8*.

The corresponding intervals appear immediately in the diagram and the values in the results table (Figure 3.5) are updated automatically.

ICalendar files can also often be exported from working time recording systems or from software used for shift planning.

This makes it possible to specifically calculate the exposure of certain groups of people.

3.4.2. Setting the equilibrium factor and dose conversion coefficient

With *Radon Vision 8* you can calculate the local dose at the location of the measuring instrument. In the *Calculation* tab, you can set the equilibrium factor and the dose conversion coefficient required for this calculation. In the *DOSEman* family of devices designed as personal dose

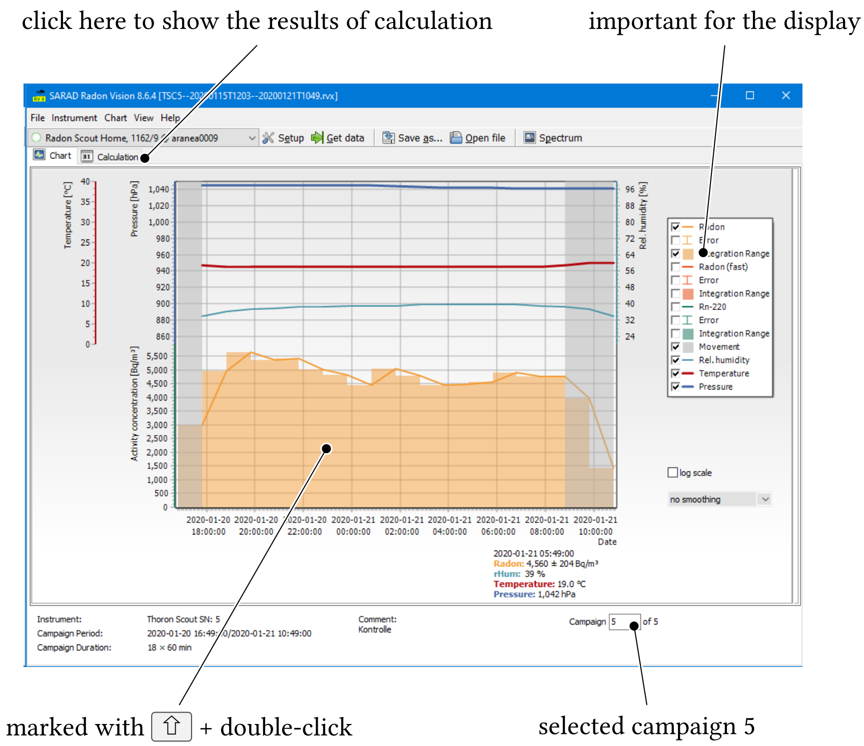


Figure 3.4.: Campaign 5 with active integration interval

meters, these factors are already part of the device configuration. With these devices, these factors are therefore downloaded from the measuring instrument when the measurement data is read out and automatically entered in the corresponding fields in the *Calculation* tab. For all other devices, the fields are filled with the usual default values.

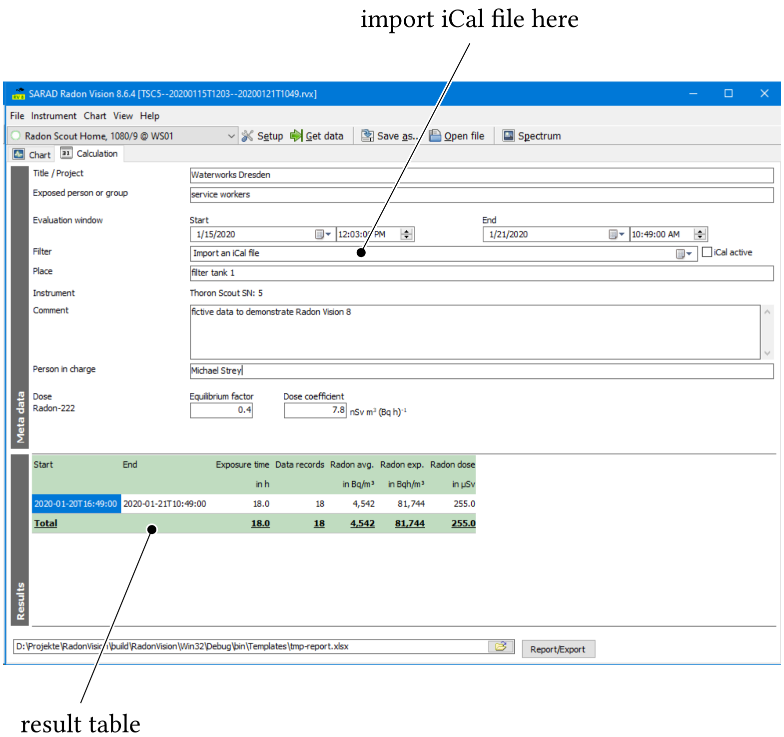


Figure 3.5.: *Calculation* tab with the results of the calculation

4. Application examples

4.1. Example: Assessment of the radon situation in living spaces

Scenario The landlord of a residential building would like to know whether the legal reference value of 300 Bq m^{-3} as an annual average value is complied with in his rental property.

At the start of the heating season, the building biologist commissioned with the investigation sets up a *Radon Scout Home* in each of two rooms on the ground floor which, in his experience, could be particularly exposed. He asks the residents to take a look at the devices from time to time, but not to change their locations and not to interrupt the measurement. Before starting the measurement campaign, he inserted fresh batteries—while still in his office—and connected the two instruments to his PC using the USB cable supplied, started *Radon Vision 8* and set the time and deleted old measurement data using the Instrument » Setup dialogue (Ctrl + E).

After three weeks, he comes back for an initial interim evaluation and reads out the measurement data on his laptop without interrupting the measurement. To do this, he connects the instrument to his laptop using the USB cable supplied, starts *Radon Vision 8* and presses Ctrl + G to download the measurement data. In the displayed diagram, he marks the entire measurement period with ⇧ + double-click to mark the entire measurement period. In the *Calculation* tab, he reads the average radon value.

The building biologist can already recognise from the mean value and the curve whether (a) there is no radon problem, (b) there is a massive radon problem or (c) the radon concentration is within the limits of the legal reference value. While in case (a) he may stop the investigation and in case (b) he can already start researching the entry pathways, in case (c) the building biologist will continue the measurement over a longer period of six months or even a year. For all further interim analyses, he can proceed in the same way as for the first and continue the measurement campaign.

If the measurement runs for several months, a battery change will be necessary, during which the measurement campaign is usually ended and a new measurement campaign is started. In *Radon Vision 8*, the interruption between two measurement campaigns is shown as a hatched area over the entire height of the diagram, which in this example degenerates into a dark grey dashed line in the overall view over such a long period of time. To include the measured values from both campaigns in the averaging, the building biologist must mark both campaigns, to the left and right of the interruption, one after the other with ⇧ + double-click. To warn him that two measurement campaigns are now being integrated or averaged, which generally have nothing to do with each other, *Radon Vision 8* displays an orange warning icon next to the *Report/Export* button. As both measurement campaigns belong together in the example, this warning can be ignored.

At the latest at the end of his investigation, our building biologist will save the measured values with File ≫ Save as... (Ctrl + A) to save the measured values on his PC. Afterwards he can use the *Report/Export* button to generate a report in Excel format, which also contains the complete measurement data in additional worksheets.

The building biologist is not yet satisfied with the report generated in this way. The report bears the SARAD logo in the top right-hand corner. He would like to have his own company logo there. The texts before the entries should also appear in German and not in English. To achieve this, the building biologist edits the Excel template under `<programme directory>` ▸ `Templates` ▸ `tmp-report.xlsx` and saves it under a new name in a directory of his choice. With this new template, he can easily create future reports in German and with his logo. In the same directory, he also finds the file `tmp-report_advanced_example.xlsx`, from which he learns how to use a little trick to further calculate the results and how to include a comparison with legal limits in the report. *Radon Vision 8* remembers the last template used with its directory and automatically offers it as the default template the next time it is exported.

4.2. Example: Determination of radon exposure in a school building

Scenario At a school in a town with a known high concentration of soil radon, the actual exposure of pupils and teachers is to be determined. Because the radon problem is well known due to the mining history of the area and those responsible know that the radon concentration normally rises during the night, the school caretaker has for some time had the task of opening all the windows every morning in order to ventilate thoroughly. The school building is empty at night, at weekends and on weekdays after 4 pm. Only the gymnasium is used on Mondays, Wednesdays and Fridays until 9 pm.

The engineering firm commissioned with the investigation set up a total of five *Radon Scout Professional*: two on the ground floor of the school, one in the basement room used for handicraft lessons, one on the first floor and one in the gymnasium. The measurements are taken during the heating period, so that the results can be analysed after just three months, during which the measuring system is left alone.

Each of the five devices is analysed individually. The result of the evaluation should be an average value comparable to the legal reference value of $300\,\mathrm{Bq\,m^{-3}}$, in which, however, the times when the room in question is not used are faded out.

Radon Vision 8 uses calendars in the standardised iCalendar data format for data filtering. These are files with the file name extension '.ics', which can be exported from practically all common calendar apps, such as *Microsoft Outlook*, *Google Calendar* or the email client *Thunderbird*. In addition, iCalendar files can also often be exported from software applications for shift planning and from working time recording systems.

The employee responsible for the evaluation uses *Thunderbird* to create a calendar for the school building in general, the gym and the workroom in the basement. He uses the possibility of his calendar to repeat appointments based on rules. For the school building, he goes to the last Monday before the start of his measurement campaign, enters a date from 7 a.m. to 4 p.m.

and specifies 'weekdays' as the repetition rule. It is not necessary to specify the end date, but it doesn't hurt either. For the autumn holidays, which fall within the measurement campaign, he must define an exception. To do this, he marks all dates in the holiday week and deletes them. He exports the calendar as `cal-school.ics`. He proceeds in the same way with the calendar for the gym, adding the period from 4 p.m. to 9 p.m. on Mondays, Wednesdays and Fridays. He uses a user-defined recurring appointment for this.

When creating the calendar for the workroom, the evaluator has to consult the timetable. He is in luck: The school secretariat maintains the timetable and substitution plan, in which the use of the classrooms is also updated on a daily basis, with shift planning software that can output the actual times of use of the workroom directly as an iCalendar file, `cal-workroom.ics`.

During the evaluation, the measured value files of the five measuring instruments are combined with the three iCal files, resulting in five reports in which the effective radon average value for the area in question is shown in the totals line:

- basement with `cal-workroom.ics`,
- ground floor 1 and 2 and upper floor, each with `cal-school.ics`,
- gymnasium with `cal-gymnasium.ics`.

4.3. Example: Local dosimetry in a waterworks

Scenario In a waterworks there are areas with increased radon concentrations. The operator of the plant is obliged to provide evidence of the radiation exposure as a dose both for his own employees and for employees of external companies who are temporarily present in these areas. Exposure and dose should be reported on a monthly basis.

The radon exposure is not high enough to justify the expense of equipping every employee with a personal dosimeter. Instead, the person responsible for occupational health and safety has decided to set up a *Radon Scout Professional* in the room with the ventilation cascade where the radon exposure is highest and to use the measured values from this one device as a reference for all operating rooms in which well water flows or stands open.

The measuring instrument is read out at least once a month. During this process, the data is deleted from the device so as not to unnecessarily prolong the next readout process. *Radon Vision 8* allows several measured value files of the same measuring instrument to be opened at once and analysed together.

An electronic working time recording system is used to record the times when employees are in the exposed areas. Each employee holds their company ID card up to the reader at the entrance when entering or leaving a workroom. The software of the time recording system allows an iCalendar file to be generated for each employee, which contains all the periods in which the employee concerned was working in one of the exposed areas in the form of appointments.

Excursus

An example of a pure smartphone app for time recording with iCalendar export is *timeEdition*.

If time recording is to be carried out via terminals with badge readers, this is possible e. g. with the software *AFS-Zeiterfassung*, which offers various options (terminal, smartphone app, PC) for recording times.

If you can rely on the fact that the attendance times correspond exactly to a duty or shift plan, you can also use shift and duty planning software such as the online app *ShiftJuggler*, which supports the iCalendar export of duty plans.

When storing the measured value files, *Radon Vision 8* automatically suggests meaningful directories and file names. By default, the RVX file ends up in the directory path `%appdata%` ▸ `SARAD` ▸ `data` ▸ `Year-YYYY` ▸ `DevNo-nnnn` ▸ and corresponds to the naming scheme `<type><serial number>--<start time>--<end time>.rvx`. As everywhere in *Radon Vision 8*, the start and end times are specified in accordance with ISO 8601, i.e. in the form `YYYYMMDD` *T* `hhmm`, so that the files in the directory are automatically sorted correctly.

In our example, all measured value files end up in the same directory. At the beginning of each month, the health and safety officer is now faced with the task of creating the monthly report with the radiation dose of the previous month for the employee concerned from the measurement data collected and the iCalendar file available for each employee. To do this, she goes to the file open dialogue in *Radon Vision 8* with Ctrl + O and simply marks all files for opening. She then switches to the *Calculation* tab (Figure 3.5) and enters the heading for the report and the measurement location. Because the report should show the radiation exposure per month, she enters the following data under *Evaluation window* for March 2020, for example: "Start: 2020-03-01 00:00:00", "End: 2020-04-01 00:00:00".

Now she only has to enter the employee's name and the iCalendar file for each employee and create the report by clicking on the *Report/Export* button. Only in the first report of this series she is urged to store the measured values from several measurement files in a new RVX file by the hint shown in Figure 3.2. She stores this file, because of the better overview, in the same directory that she is using to store the reports. Thus she doesn't confuse the original measurement files with the combined one.

Hint

In principle, it is not a problem if the combined measurement files are together in a directory with the original measurement files. If multiple files are marked to open, *Radon Vision 8* will automatically check if the measured values are double and import each measured value only once.

5. Operation of Radon Vision 8

5.1. Overview

The Figures 5.1 and 5.2 show the two main views of *Radon Vision 8* with the following operating and display elements:

1. dropdown list of the connected measuring instruments with device name, serial number, firmware version and the host name by which the device is connected in the network,
2. *Setup* button to set the device settings of the selected instrument,
3. button to download the measurement data from the instrument,
4. button to store the measured data into a binary file,
5. button to open a binary measured value file,
6. button to display the alpha spectrum,
7. active range within the evaluation window,
8. inactive range outside of the evaluation window,
9. legend with checkboxes for the parmeters to be displayed,
10. docking area for the alpha spectrum,
11. track for thoron with shown error bars for the standard deviation,
12. switch to logarithmic scale,
13. dropdown list for the length of the smoothing period,
14. display of measured values on the position of the cursor line,
15. selection of a campaign—the values between start and stop of a measuring,
16. comment stored in the binary measured value file,
17. start and end time of the measured value file or of the measurement campaign resp.,
18. total number of all sets of values in the measured value file or number of sets and measuring interval in the currently shown measurement campaing resp.,

19. device type and serial number of the instrument that was used to record the displayed values[1],
20. lower part of the chart used for the measured values of the radiation sensor,
21. selection of the integration interval for the calculation of averages, exposures and dose,
22. upper part of the chart used for the environmental parameters,

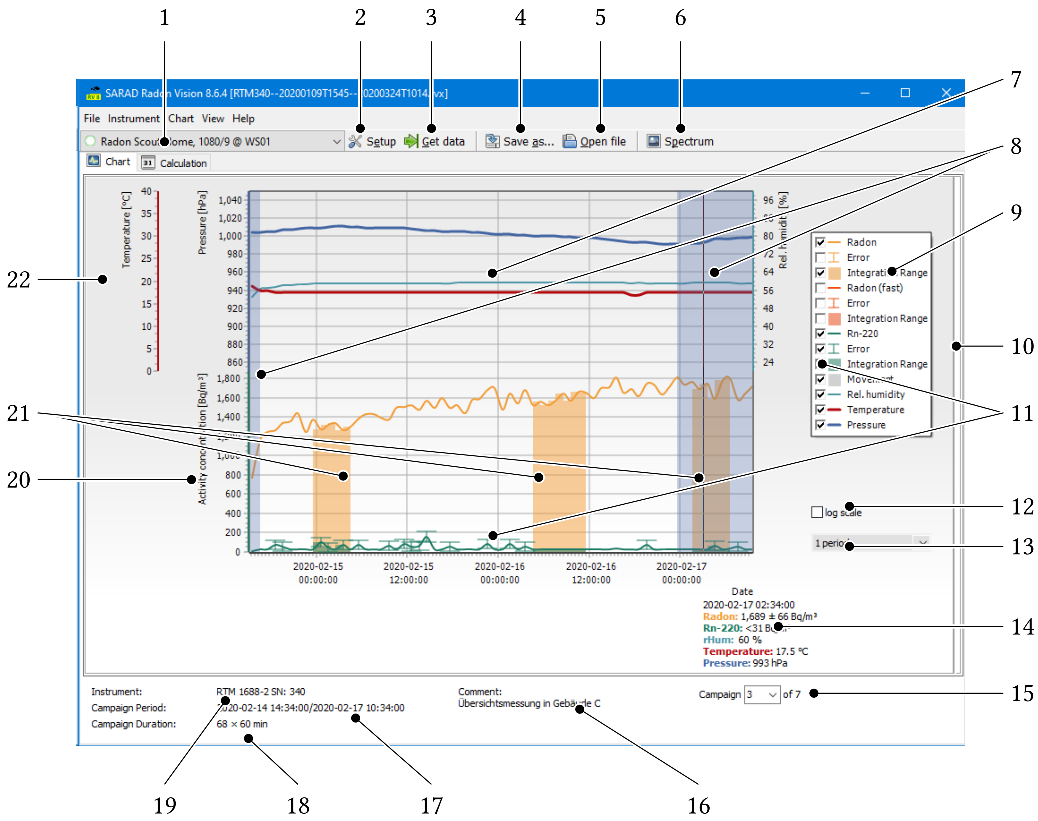


Figure 5.1.: Operating and display elements in the *Chart* tab

23. headline to be used in the report,
24. person or group of persons who has stayed at the place of measurement during the period considered,
25. limitation of the period considered in addition to the filter. This setting is used if exposure and dose are to be indicated on a weekly or monthly basis in the report.

[1]The measured data shown is from a measurement file recorded with *RTM 1688-2* and is not related to the *Radon Scout Home* in the list of connected devices (1).

26. iCalendar file that shall be used to filter the measured values in the calculation of averages, exposures and dose,

27. the iCalendar file can be disabled if the time filter in the diagram is to be set manually.

28. place of the measurement,

29. type and serial number of the measuring instrument that was used in the measuring—will be filled in automatically,

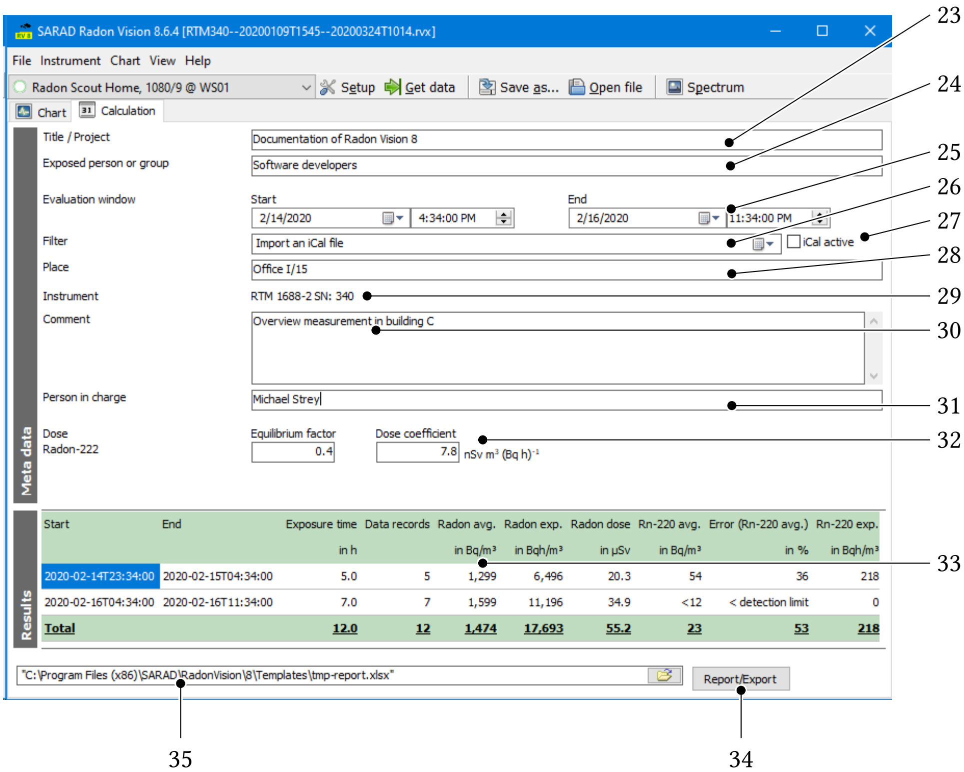


Figure 5.2.: Operating and display elements in the *Calculation* tab

30. multiple-line comment to explain the circumstances of the measurement,

31. the person who will sign the report,

32. equilibrium factor and dose conversion coefficient for dose calculation. The values in these fields usually do not need to be changed.

33. result table with one line for each integration interval considered,

34. start button to create the report. The report will be opened automatically with Excel or LibreOffice Calc if one of these programs is installed on your computer.

35. template to be used to create the report. You can adjust it to your own needs (see section 5.6).

5.2. Connecting the measurement instrument

For *Radon Vision 8* to connect to a measuring instrument, the *SARAD Registration Server service* must be installed (see section 2.1).

Most of the current measuring instruments of the company SARAD can be easily connected to the PC on which *Radon Vision 8* is running via the supplied USB cable. Alternatively, some devices allow the use of their RS-232 connection via the supplied cable with 9-pin D-sub connector. This requires that your PC still has a physical RS-232 interface (COM port). The devices *DOSEman* and *DOSEman PRO* use an infrared adapter for data exchange. *Radon Vision 8* supports both the older types with RS-232 connection and the current USB version.

In any case, the *SARAD Registration Server service* ensures that the dropdown list of the connected devices is automatically kept up to date. If this is not the case with devices connected directly via RS-232 or the infrared adapter, then you can select from the contextual menu of the dropdown list Scan for local devices and order the *SARAD Registration Server service* to search all available local interfaces for connected SARAD devices.

5.3. Device configuration

With Ctrl+E or with a click on the button *Setup* (3 in Figure 5.1) you open one of the dialogs for the configuration of your measuring instrument as shown in Figure 5.3 or 5.4 respectively. *Radon Vision 8* supports a large number of devices, all of which have different properties, so that, differing from device to device, there is always only part of the setting options described below.

5.3.1. Radon Scout family devices, Thoron Scout and RTM 1688-2

Start/Stop All settings related to starting or ending a measurement campaign:

- Deletes all measurement data stored in the device's memory. When the measurement is running, the current interval is aborted and restarted with the preset integration time.
- Sets the real time clock of the device to the system time of the PC. This can be done while the measurement is running.
- Starts a new measurement campaign.
- Ends an ongoing measurement campaign.

Info Displays the device status and the last measured values:

- ? Measures the voltage of the batteries. The state of charge can be estimated according to the type used. For measuring instruments with mono cells, the cell voltage is displayed, for all other devices the total voltage of the battery is displayed.

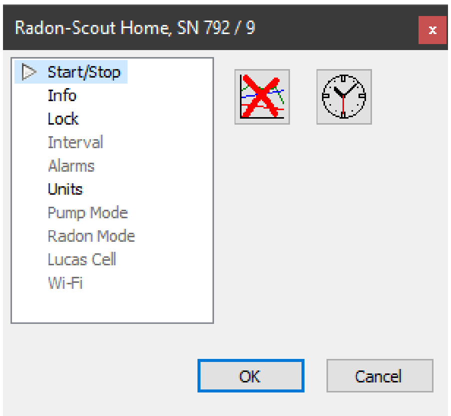


Figure 5.3.: Device-specific dialog for the device settings of the instruments of the Radon Scout family

Opens a window with a list of values from the last measurement interval. The prerequisite is that the first integration interval has already been completed.

Lock You can block the end of an ongoing measurement campaign with the switch or button on the device and the measured value display on the software. This setting is also possible when the measurement campaign is running.

Allows the start and end of a measurement campaign on the device. The measured values are shown on the display.

Locking the slide switch or button. The measurement can only be started once and cannot be interrupted afterwards. The measured values are not displayed.

Interval Sets the integration interval for calculating the radon concentration. The integration interval can also be changed while a measurement is already in progress.

interval = 3 h. If changes occur during the measurement, the 1-hour interval that has already started is extended to three hours.

interval = 1 h. If more than one hour of the current 3-hour interval has expired, the current 3-hour interval is completed and then switched to the 1-hour cycle. If less than an hour of the current 3-hour interval has elapsed, the current interval is the first 1-hour interval.

Measuring interval Length of the integration interval in minutes

Alarms Settings for devices with visual or acoustic alarming:

Alarm Level Threshold value for triggering an alarm on the measuring instrument.

Buzzer

Off The built-in acoustic signal generator is always switched off.

Alarm If the set alarm threshold is exceeded, a four-second beep is generated every minute, which can be deactivated by pressing the button once. If the measured value again exceeds the alarm threshold, the process is repeated.

Po-216 Every registered decay of a ^{216}Po atom is signaled by a short tone.

Po-216/Po-218 In addition to the ^{216}Po, the signal tone is also generated when ^{218}Po decays are registered.

Units Here you set the unit of measurement system used to display the measurement data on the display of the measuring instrument. The representation of the values in *Radon Vision 8* is independent of this setting.

Pump Mode Working regime of the pump installed in the *RTM 1688-2*:

Continuous The pump runs during the entire measuring time.

Interval The pump runs during the first 5 minutes of an integration interval. If the set integration interval is less than or equal to 5 minutes, the pump will run continuously.

Radon Mode This setting is only relevant for the display on the device. When the data series are displayed later on the computer or in the generated text files, the values of both calculations appear.

Fast only the decays of the ^{218}Po are used to calculate the radon concentration. The full measured value is reached after only 15 minutes. The sensitivity is compared to the setting *slow* halved, so that the statistical error increases.

Slow The decays of the ^{218}Po and ^{214}Po are used to calculate the radon concentration. Due to the longer half-lives of the intermediate nuclides ^{214}Pb and ^{214}Bi, the response time increases to approx. 150 minutes until the full measured value is reached. The sensitivity doubles compared to the setting *fast*. The statistical error is reduced accordingly.

Lucas Cell In *Radon Scout PMT*, depending on the application, scintillation chambers (Lucas cells) of different sizes can be used. Since the sensitivity depends directly on the chamber volume, four different calibration factors are saved in the device. These are assigned to the chamber sizes S, M, L and XL. By setting the appropriate chamber size, the *Radon Scout PMT* is instructed to use it to calculate the radon value. It is therefore always important to ensure that this parameter is set correctly in accordance with the chamber actually used. The chamber sizes are located on the outer surfaces of the Lucas cells.

WiFi With *Smart Radon Sensor* with built-in WiFi module, the WiFi access data and the connection data to a server serving as a relay station can be entered here.

SSID The SSID of your WiFi.

Password Your WiFi password. With a right-click you can switch the display to make the password string visible.

IP Address The IPv4 address of the server acting as relay station.

Port The port number of the server acting as relay station (typically 50002).

configure and restart Press this button to send the WiFi settings to the WiFi module. The module will be restarted.

Modbus With *RTM 1688-2* und *Smart Radon Sensor*, the serial interface can be switched so, that instead of the proprietary SARAD protocol the Modbus RTU protocol will be used. For more information on the modbus functionality, see our application note AN-009 [3].

Bus address If the devices are connected as a daisy chain along a RS-485 line in series, then the bus address can be used to set the node address at which the device can be reached.

Baudrate You can chose between 9600 bit s^{-1} and 19 200 bit s^{-1}.

5.3.2. Devices of the DOSEman family, RTM 1688 and Analog Radon Sensor

The setup dialog (Figure 5.4) is only accessible with these measuring instruments if the device is in the operating mode *Stand by*.

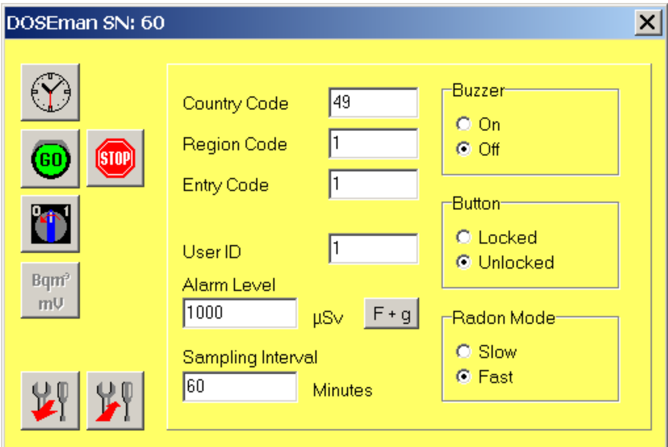


Figure 5.4.: Dialog for the device settings of the instruments of the *DOSEman* family

Sets the real time clock of the device to the system time of the PC.

All data stored in the device's memory are deleted and a new measurement campaign is started.

Ends an ongoing measurement campaign.

Turns off the device. No new measurement may be started beforehand. Switching on is only possible by pressing the device button. This function is not active for the Analog Sensors.

Opens the dialog window shown in Figure 5.6 for the advanced setup and test functions of the Analog Sensor.

Country Code, Region Code, Entry Code Freely usable numbers for the local assignment of the measurement data. The range of values is 0 to 255.

User ID Freely usable number for personnel assignment of the measurement data, such as e. g. personnel number. The range of values is 0 to 65 535.

Alarm Level Defines the limit value, above which an acoustic alarm is issued. The limit is to be specified in the range of 0 µSv to 20 000 µSv (for the dose calculation see section 5.3.2 Dose calculation for *DOSEman* and *DOSEman PRO*).

Sampling Interval Setting the integration interval. Defines the time interval between the individual points of the recorded series of measurements. The setting range is 1 min to 255 min.

F + g see section 5.3.2

Buzzer Switches the key tone at *DOSEman* and *DOSEman PRO* on or off.

Button

- **Locked** The measurement can only be started or stopped via the software. This prevents accidental switching off while the measurement is running. This mode should be set for every longer measurement, since the device switches itself off when the battery is discharged and pressing the button twice, unintentionally, can lead to a restart of the measurement and loss of the previously saved data. It will still be possible to switch the display at the push of the button.

- **Unlocked** The measurement can be started with a short push of the button and the device can be switched off by pressing the button for approx. five seconds.

Radon Mode This setting is only relevant for the display on the device. When the data series will be displayed later on the computer, the values of both calculations will appear.

- **Slow** The decays of the ^{218}Po and ^{214}Po are used to calculate the radon concentration. Due to the longer half-lives of the intermediate nuclides ^{214}Pb and ^{214}Bi, the response time increases to approx. 150 minutes until the full measured value is reached. The sensitivity doubles compared to the setting *fast*. The statistical error is reduced accordingly.

- **Fast** only the decays of the ^{218}Po are used to calculate the radon concentration. The full measured value is reached after only 15 minutes. The sensitivity is compared to the setting *slow* halved, so that the statistical error increases.

Transfers the parameters set in the device to the PC.

Transfers the changed settings to the device.

Dose calculation for DOSEman and DOSEman PRO

For the devices *DOSEman* and *DOSEman PRO*, an equivalent dose is calculated from the radon progeny concentration using a dose conversion coefficient g. Clicking on F + g opens the dialog for setting the coefficients shown in Figure 5.5.

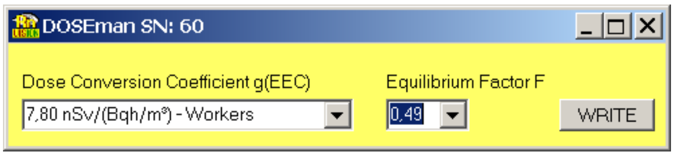


Figure 5.5.: Dialog for the setup of the coefficients for dose calculation

Since the dose calculation is always based on the exposure to the daughter products, the equilibrium factor F must be specified for the *DOSEman*. It determines the relationship between radon gas and its daughter products. If the equilibrium factor is unknown or not specified, select it with 0.4.

The selection list contains the currently valid coefficients g for occupationally exposed persons (*workers*) and the general population (*public*). Different values can be entered in the text field, if special regulations require it.

The equivalent dose E is then calculated from the exposure P_{Rn} as follows:

$$E = P_{Rn} \cdot F \cdot g_{EEC} \text{ with } [g_{EEC}] = \frac{\mathrm{Sv}}{\mathrm{Bq\,h\,m^{-3}}}$$

For the *DOSEman PRO*, where the concentration of the decay products is measured directly, the following applies accordingly:

$$E = P_{PAEC} \cdot g_{pot} \text{ with } [g_{pot}] = \frac{\mathrm{Sv}}{\mathrm{J\,h\,m^{-3}}}$$

Hint

With the *DOSEman* the product $F \cdot g_{EEC}$ is combined into one factor and saved in the device. When the dialog is opened, the currently set factor is loaded from the device. Since the combination of F and g_{EEC} no longer allows conclusions to be drawn unambiguously, the default setting "worker" is assumed and the associated equilibrium factor is calculated and displayed.

When using different dose conversion coefficients, the dose conversion coefficient must always be set first and then the equilibrium factor.

Due to the device's internal data format, rounding errors can occur when reading back the coefficients.

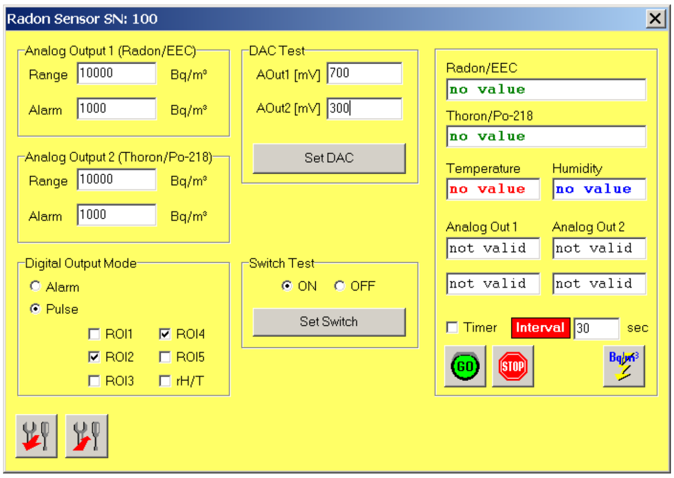


Figure 5.6.: Additional setting options for the *Analog Sensors*

Additional setup and test functions for Analog Sensors

Analog output 1, Analog output 2

Range defines the measuring range for which an output voltage of 0 V to 1 V is generated. (ex. the setting of 25 000 Bq m^{-3} leads to 0 V at 0 Bq m^{-3} and 1 V at 25 kBq m^{-3}).

Alarm defines the measured value from which the digital output, if configured as an alarm output, is activated.

Mode digital output

Alarm digital output configured as alarm output

Pulse digital output configured as pulse output

ROI1 ... ROI5 specified energy ranges, which are taken into account for the pulse formation at the digital output for the pulse formation

rH/T If the digital output was configured as a pulse output, the two analog outputs are assigned the measured values for temperature and humidity. Otherwise the radon concentration is output in parallel as an analog value.

DAC Test This option offers, when the measurement is stopped, a test option for the correct functioning of the analog outputs. The voltages entered in the input fields in the range of 0 mV to 1000 mV can be measured at the analog outputs by clicking on Set DAC.

Switch Test switches the digital output for test purposes. The measurement must be stopped.

Current measured values To check the error-free operation of the Analog Sensor, the measurement can be started and stopped within the dialog. Current measurement data can be read from the device while the measurement is running.

 Deletes existing data and starts a new measurement.

Ends a current measurement.

Click to load the current data. The prerequisite is that the first integration interval has already been completed. The data is displayed in the output fields above. In addition to the calculated concentrations as well as temperature and humidity, the analogue output values are also displayed in accordance with the range settings made.

Timer, Interval If the *Timer* field is selected, the current data is automatically fetched from the device at intervals defined by the *Interval* field.

5.3.3. Setting the device clock

A correctly set device clock is essential if the measured values obtained are to be correctly categorised in terms of time. There are a few aspects to bear in mind:

1. SARAD measuring instruments generally do not have a dedicated real-time clock. Instead, the clock is realised by a counter in the processor. This generally means that the time is reset when the battery is changed.

2. Older versions of *Radon Vision* always set the device clock to PC time, i.e. to the currently valid local time. This is not always optimal, especially if the devices are running over a long period of time with a transition from daylight saving time to standard time or even in a large monitoring network spanning several time zones.

3. Older firmware versions of the Radon Scout family ignored the seconds when setting the device clock. As a result, the time can jump forwards or backwards by one minute when setting the clock.

To take these circumstances into account, the setting of the device clock in *Radon Vision 8* was delegated to the *SARAD Registration Server service* for the devices of the *Radon Scout* family. The devices of the *DOSEman* family, which are usually read out daily as personal dosimeters, are always set to local time in the traditional way.

The *SARAD Registration Server service* can be configured to set the device clock automatically whenever it detects the measuring instrument in question, i.e. if the measuring instrument is permanently connected, every time the *SARAD Registration Server service* is restarted (usually coincides with a computer restart) or when the measuring instrument is plugged in. In the configuration of the *SARAD Registration Server service* you can also specify the offset to UTC with which the clock should be set. This ensures that the clock is always set to UTC with the same fixed offset, regardless of whether this is initiated manually via *Radon Vision 8* or automatically. To prevent the minute jump with older firmware versions, the *SARAD Registration Server service* may wait until a full minute has been reached and only then set the clock. The device in question is blocked for other actions during this time, which is indicated by a red dot in front of the device in the drop-down list.

In the default setting, the UTC offset is set to zero and automatic clock setting is deactivated. To change these settings, please proceed as follows:

1. Open the directory `%programdata%\SARAD\RegServer-Service` in Windows Explorer (enter the character string in the address bar of the Explorer).

2. Copy the file `config.example.toml` to `config.toml`.

3. Open `config.toml` with a text editor.

4. The relevant lines are in the section `[usb_backend]`. Remove the comment character (#) in the lines `#set_realtime_clock = false` and `#utc_offset = 0`. Change the settings according to your requirements. For Central European Time `utc_offset = 1`, for Central European Summer Time `utc_offset = 2`.

5. Save the file and restart your PC.

5.4. Displaying and analyzing the measurement data

5.4.1. Fetching the measurement data

With a click on the button *Get data* (3 in Figure 5.1) or Ctrl + G you start reading out the measurement data from your measuring instrument. In the window that opens, the number of data records that have already been downloaded is displayed until the download is complete.

> **Hint**
>
> With the measuring instruments of the *DOSEman* family, the data transmission cannot be interrupted. It continues to run in the background even when the download window is closed. With these devices, the number of messages received by the measuring instrument is displayed instead of the downloaded measured value sets.
>
> For all other measuring instruments, you can cancel the download, which can take a long time with many saved measurement data, by closing the download window. In this case, only the data that has already been loaded is shown in the diagram.

5.4.2. Zooming and moving

Table 5.1 lists the simple options for changing the axis scaling and the position of the measured value lines in the diagram. In addition, there are the very extensive functions for changing the diagram described in the section 5.4.6 on page 38.

In the following cases the start and end values of the y axes will be set automatically to fit the span between extreme values:

- when opening a measured value file,
- after a doubl-click within the chart or on the y axis,
- when zooming the time axis.

Table 5.1.: Zoom and move in the diagram

Purpose	Operation with the mouse
Zoom In the timeline	a) Drag from left to right with the right mouse button
	b) Dragging at the end of the display area
Zoom Out the timeline	Drag from right to left with the right mouse button
Scrollen along the timeline	Drag on the chart or on the timeline
Zoom In the lower y-axis	Pull up on the axis
Zoom Out the lower y-axis	Pull up on the axis
Zoom In the y-axis	⇧ + click on the axis
Zoom Out the y-axis	Ctrl + click on the axis
Scroll the upper y-axes	Drag on the axis

When moving the time axis, the scaling of the y axis is maintained.

For the display of data sets with a large dynamic range, it is possible to switch to logarithmic axis calibration (12 in Figure 5.1).

In the upper diagram range (22 in Figure 5.1), the scaling of the y axes is not adapted to the current value range of the measured values. It is based on typical ambient conditions of temperature, humidity and air pressure. Thus the range of variation of these environment parameters can be easily noticed.

5.4.3. Selecting campaigns

A measurement campaign includes related measurement values between the start and end of a measurement (see section 3.1). Since the data of a measurement campaign should generally be evaluated together, *Radon Vision 8* has the functions listed in Table 5.2 for the exclusive display of individual campaigns in the diagram.

Table 5.2.: Select campaigns in the diagram and from the dropdown list

Purpose	Operation
Show single campaign	a) Double-click within the campaign in the diagram
	b) Select campaign from the dropdown list (14 in Figure 5.1)
Change campaign	Select campaign from dropdown list
Show all campaigns	Select *all* in dropdown list

Hint

If you have selected a campaign and select the same campaign again in the drop-down list or double-click in the diagram, the timeline is zoomed out completely and the campaign is displayed in full length.

With the F2 button, the focus is set on the drop-down list of the campaign selection, so you can then easily switch between the campaigns with up, down, pg up, pg down or direct input of the campaign number.

5.4.4. Marking integration intervals

For the calculation of mean values, exposure and dose, integration intervals must be marked with which it is determined over which areas along the time axis these calculations are to be carried out. In *Radon Vision 8* it is possible to define any number of such intervals. This can be done manually on the one hand, in the diagram using the functions listed in Table 5.3, on the other hand by importing an iCalendar file. The latter way is usually more sensible. It is described in detail in section 5.5.

Table 5.3.: Mark integration intervals in the diagram manually

Purpose	Operation with the mouse
Marking integration intervals	⇧ + move mouse over the area
Remove marker	Ctrl + move mouse over the area
Mark entire campaign	⇧ + double-click
Remove campaign marker	Ctrl + double-click

Hint

The integration intervals are only shown in the diagram if at least one *Integration Range* is marked in the legend (see Figure 3.4 on page 16). However, the integration intervals are still active, even if they are not shown in the diagram.

5.4.5. Spectrum display

For devices with integrated alpha spectroscopy, the acquired spectrum can be displayed in a separate window (Figure 5.7). The energy ranges defined for the calculation of the radon measurands—also called *regions of interest* or *ROI*—are represented by horizontal coloured bars indicating the respective nuclide, the decay energy resulting from its decay and the sum of the counting pulses in the ROI. With the *RTM 1688-2* and *Thoron Scout*, the spectrum is saved for each individual set of measured values. Therefore, the spectrum view of these devices changes when you move the mouse over the main diagram. If integration intervals are marked, the spectrum contains the sums of the counting pulses detected within the marked time ranges. In contrast, the devices of the *DOSEman* family always display the sum spectrum of the entire measured value file.

As in the main diagram, a context-sensitive menu with the items Edit diagram, Print preview, Copy to clipboard and Save diagram is also available in the spectrum view after right-clicking.

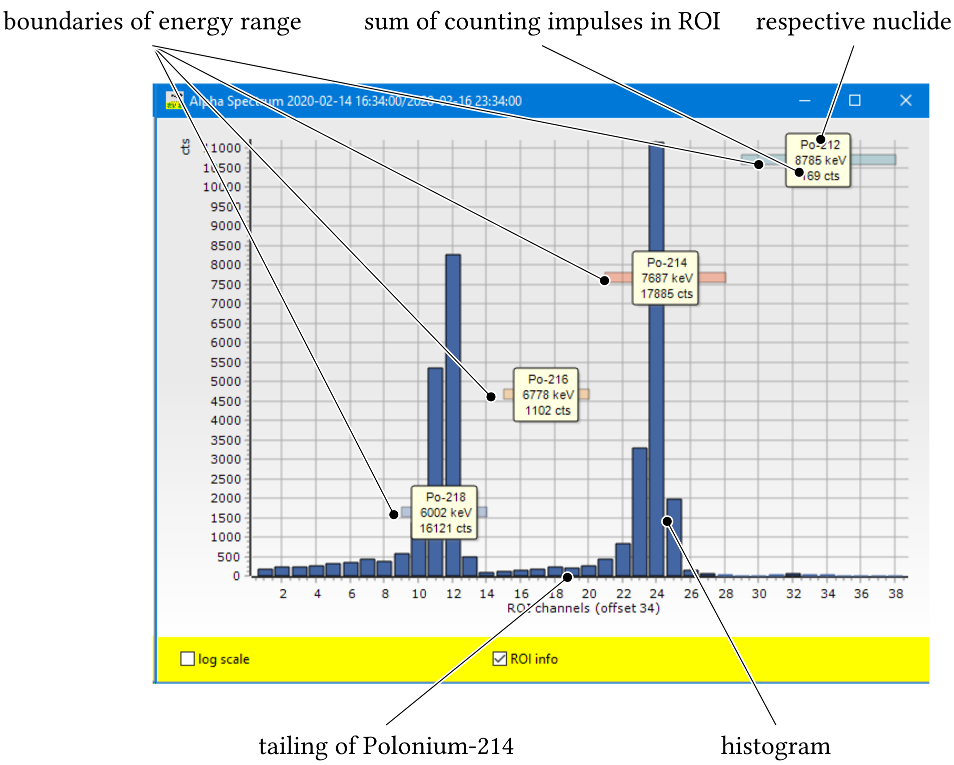


Figure 5.7.: Spectrum display

The window with the spectrum view can be dragged to the docking area on the right-hand edge of the *Chart* tab and placed firmly next to the main diagram (Figure 5.8).

Figure 5.8.: Docked spectrum display; logarithmic scaling in the line diagram and smoothing with a moving average over two periods. The ROI information in the spectrum histogram is switched off to make the ROI limits more visible.

5.4.6. Change chart view

Legend

In the legend (10 in Figure 5.1), you can specify which of the measured parameters are to be displayed in the diagram. In addition, error bars and marked integration intervals (see section 5.4.4) can be shown or hidden. The settings here also affect the content of the results table (33 in Figure 5.2) in the *Calculation* tab (see section 5.5). Only the parameters that can be seen in the diagram are displayed there.

Smoothing

Measurements in concentration ranges close to the detection limit of a measuring device lead to strong statistical fluctuations in the individual values of a measurement series. These can be reduced using the smoothing function (13 in Figure 5.1). The smoothing function forms a moving average over the set number of measurement intervals (periods). Together with the smoothing function, an interpolating spline function is activated, which leads to the smoothing of the measured value lines. For this reason, even with the setting *1 period*, where the moving average is still identical to the original data, you will see a nicely rounded curve.

In principle, when selecting the smoothing parameter, you should bear in mind that actual short-term changes in concentration are also subject to smoothing, as are statistical fluctuations.

The columns displayed in the marked integration intervals are based on the original measurement data even when smoothing is switched on.

The environmental parameters displayed in the upper part of the diagram are hardly affected by statistical measurement errors given the long measurement intervals that are usual for radon. Therefore, no moving average is calculated for them when the smoothing function is switched on, but the spline function, which rounds off the curve, is activated.

Complex editing functions

Via the main menu Diagram » Edit diagram or via the corresponding entry in the pop-up menu, which you open with a right click to the left or right of the diagram, you will get to a window (Figure 5.9), which opens up very extensive possibilities for you to change the diagram creatively.

The complete documentation of these functions would go beyond the scope of this manual. We therefore refer here to the documentation of the manufacturer of the software component used for the diagram display.

> **Warning**
>
> The menu item was marked with the note *(experimental)* for a good reason. You have all the options here to cause mischief. If necessary, restarting the app always helps to get back to a meaningful display.

Useful applications are e. g.:

- Changing individual colors
- Showing the unsmoothed curve in addition to the smoothed
- Changing the axis labels
- Changing the minimum and maximum values of the axes
- Adding a heading or footer
- Inserting a limit line

As an example of a sensible application, the Figures 5.9 to 5.15 explain how to create a horizontal line to mark a radon limit.

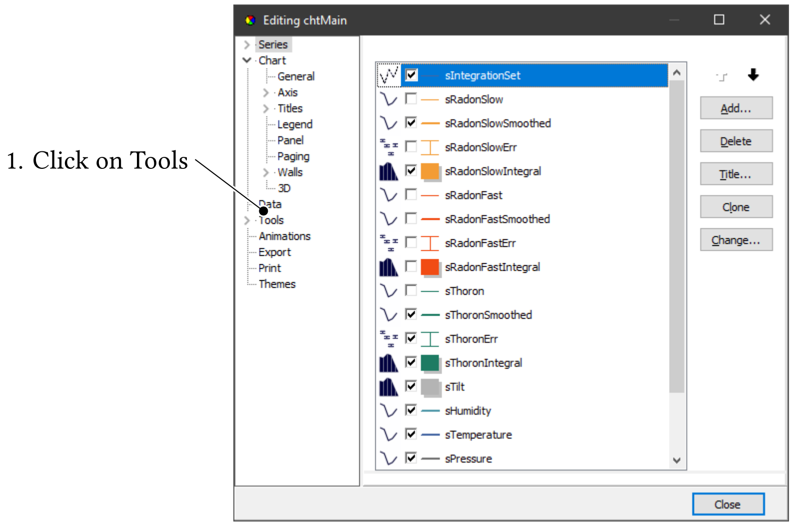


Figure 5.9.: Limit line — step 1

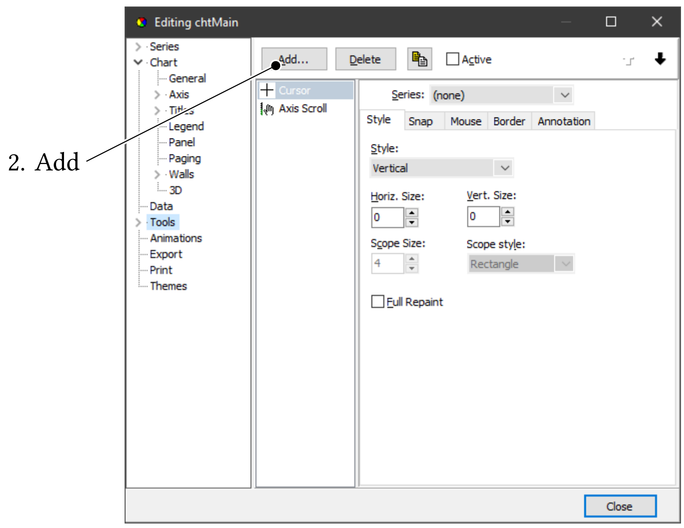


Figure 5.10.: Limit line — step 2

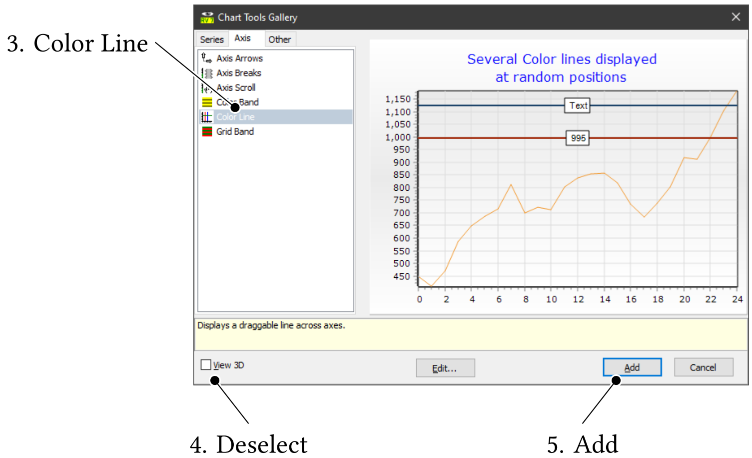


Figure 5.11.: Limit line — step 3

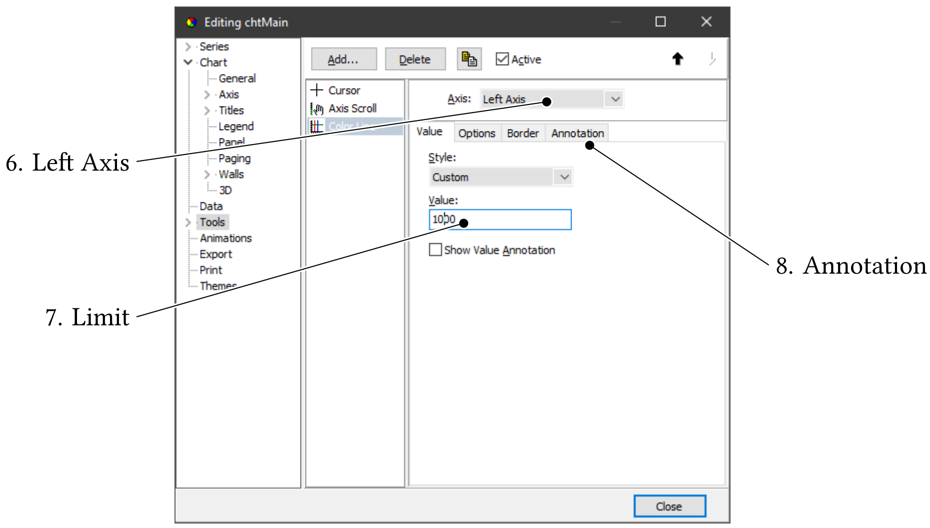


Figure 5.12.: Limit line — step 4

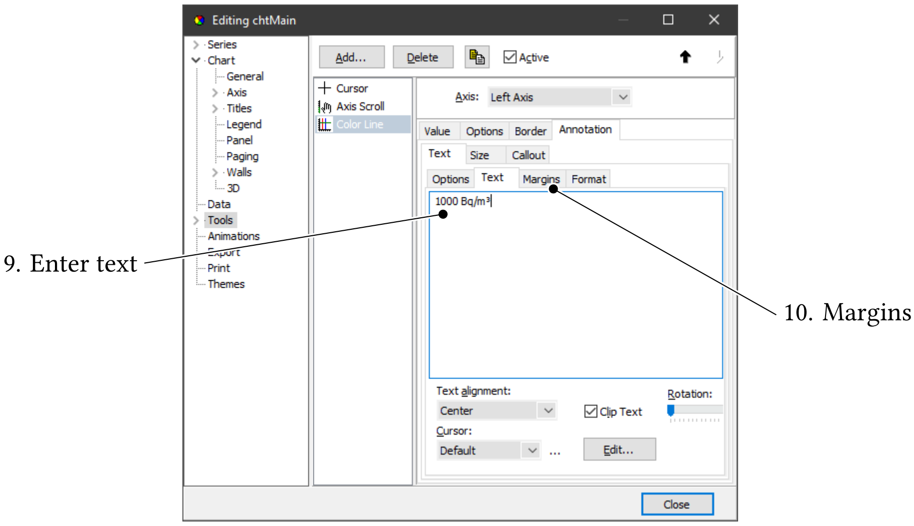


Figure 5.13.: Limit line — step 5

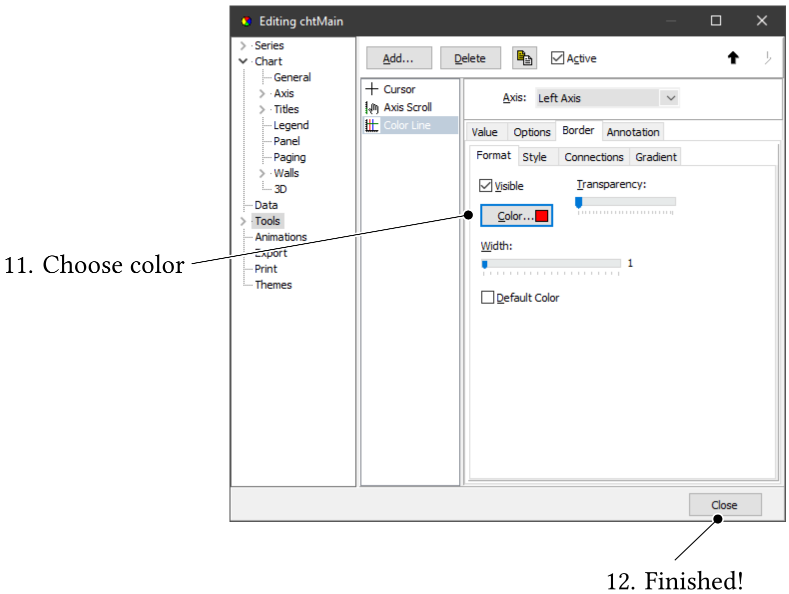


Figure 5.14.: Limit line — step 6

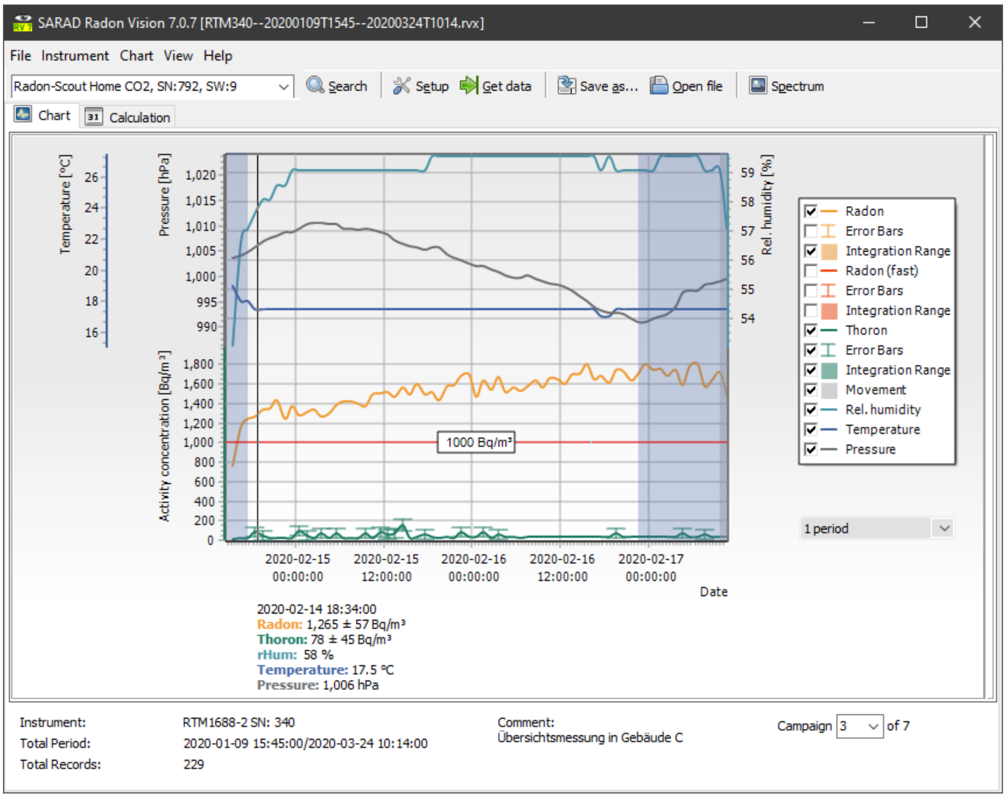


Figure 5.15.: Diagram with limit line

5.4.7. Print and export

In addition to the ways described in the previous section via the main and pop-up menus, there is a third way to access the functions for editing, printing, exporting and copying to the clipboard: Under View ⟩ Diagram Toolbar you can show an additional toolbar. Figure 5.16 shows all three options in one screen section.

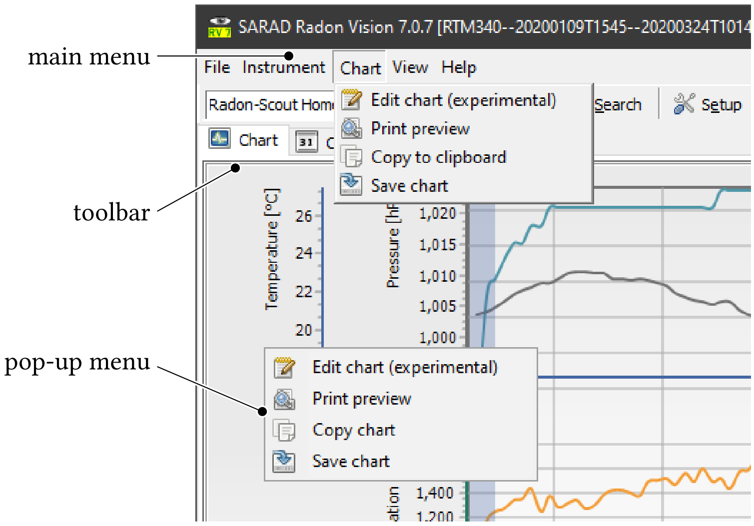


Figure 5.16.: Three types of access to chart functions

Figure 5.17 shows the preview for the diagram print. In addition to the alignment on the paper, margins and aspect ratio as well as the setting options common in every print dialog, you can also specify the level of detail of the printout.

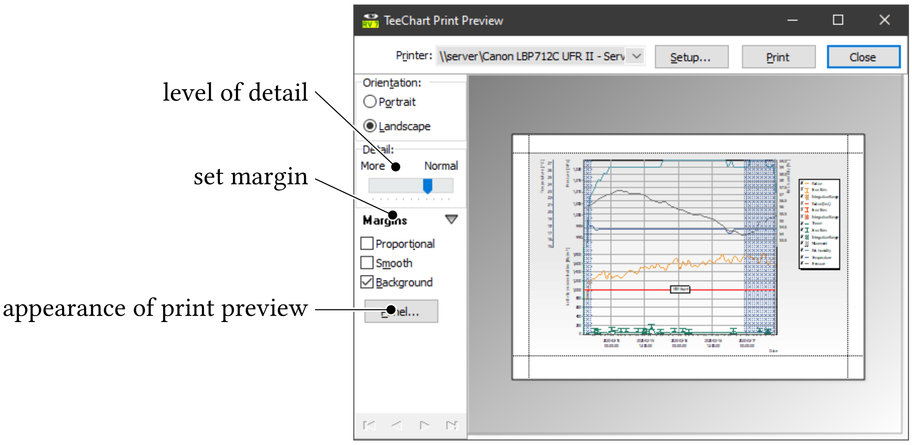


Figure 5.17.: Print preview

Under the menu item Save diagram you can save the diagram in the file formats EMF, WMF, BMP and JPG, under Copy diagram you can also copy it via the clipboard.

5.5. Calculation of exposure, dose and mean values

5.5.1. Display of calculated values

The *Calculation* tab shown in Figure 5.2 on page 24 is used to display the calculated mean values, exposures and dose values. As soon as one or more areas have been marked as integration intervals in the diagram, as described in section 5.4.4, the results table (33 in Figure 5.2) displays the corresponding values for each individual integration interval and for the total of all integration intervals. Only the parameters that are selected for display in the diagram legend are taken into account. For example, the thoron mean value is not displayed if the thoron curve is hidden in the diagram. Exposure and dose are only displayed if the selected integration interval is also displayed in the diagram. Finally, the relative error values only appear in the results table if the error bars are shown in the diagram.

The dose is always displayed together with the exposure, even if the measuring instrument itself is not a dosimeter and cannot display a dose.

5.5.2. Detection limit and exposure calculation

For all measuring instruments that record the alpha spectrum and can thus differentiate between different nuclides as sources of alpha energy, the so-called *tailing* makes it difficult to differentiate between the radioactive nuclides in their mixture.

Figure 5.7 shows a spectrum that is typically formed by the decay products of ^{222}Rn. In the same picture the tail of the ^{214}Po distribution is marked, which to the left reaches into the *region of interest* (ROI) of the ^{216}Po that is important for the thoron measurement. The tailing of a high radon concentration will hide the peaks of a low thoron concentration in the spectrum. Decays are counted in the ROIs for thoron, but you cannot say whether and how much thoron was in the mixture. One can only say: “If thoron was in the mixture, the resulting decay pulses were definitely less than those that we counted in the thoron ROIs (and have to attribute to the radon).”

You can find a detailed look at this complex topic in our application note AN-004, “Thoron measurements with the RTM 1688-2” [5].

The masking by the tailing results in the *detection limit.* If the average activity concentration determined in an integration interval is below the detection limit, this is marked in the results table by a less-than sign and a corresponding note in the error column.

The *exposure* is the product of concentration (in $\mathrm{Bq\,m^{-3}}$) and length of stay (in h). The exposures given in the results table therefore always refer to a person who is assumed to have been in the vicinity of the measuring instrument during the entire integration interval.

Internally, *Radon Vision 8* calculates the exposure for each individual measured value and sums up the individual values within the marked integration interval. It can happen that the measured concentration for individual measured values is below the detection limit. For these periods, the exposure is assumed to be zero. As can be seen in Figure 5.2 on the thoron mean in the second line of the results table, even an entire integration interval can be below the detection limit. Regardless of this, individual measured values within this integration interval may well have been above the detection limit. For these periods, the exposure is of course greater than zero. It so happens that the exposure in the results table usually does not simply correspond to the product of the average and exposure duration.

5.5.3. Dose calculation

In *Radon Vision 8*, in addition to the exposure, a dose is always calculated and displayed in the results table, regardless of whether the measuring instrument used is a dosimeter or not. If dosimeters (*DOSEman*, *DOSEman PRO*) are used, the coefficients used in dose calculation in *Radon Vision 8* can also be different from the coefficients used on the device.

In principle, any radon measuring instrument that is small enough to be worn on the body and sensitive enough to deliver statistically significant measured values over the wearing period can be used as a dosimeter. In addition to the *DOSEman*, the *Radon Scout Professional* would be particularly suitable for this type of application. The evaluation to determine the *personal dose* is simple in this case. Before each use, all old measurement data are deleted from the device. The mission measurement file then contains only one campaign. As described in section 5.4.4, the entire campaign is marked with ⇧ + double-click and the dose appears in the results table. The preset coefficients *equilibrium factor* and *dose conversion coefficient* (32 in Figure 5.2) do not usually have to be changed.

If the measuring instrument was not carried around during the marked campaign, but was fixed in one place, the dose determined in this way is initially not a personal but a *local dose*. Nevertheless, this value can be used to estimate a personal dose if the person for whom the dose is to be determined was in the same room and thus experienced the same exposure as the measuring device. The residence times must therefore be combined with the measurement data for the evaluation.

Radon Vision 8 supports this indirect calculation of the personal dose by the possibility to import periods from a calendar in the form of iCalendar files. This is explained in more detail in the following section.

Further information on the theoretical basis for dose calculation can be found in our application note AN-010 [2].

5.5.4. Filtering with iCalendar files

iCalendar is a standardized data format for exchanging calendar content. The corresponding files typically have the file extensions `.ics` or `.iCal` and are supported as an export format by practically all calendar apps.

Radon Vision 8 can import such files. The calendar dates with their start and end times are used to form the integration intervals that are used in *Radon Vision 8* for dose calculation.

To calculate the personal dose for a person who was at a known time in a room equipped with a radon measuring instrument, proceed as follows:

1. Create a new calendar with any name in a calendar app of your choice.

2. Enter the times of stay as appointments. You do not have to bother to assign names to the appointments. *Radon Vision 8* treats all appointments in the calendar equally. You also do not have to enter each appointment individually. The calendar apps allow the convenient

creation of repetitive appointments and the setting of exceptions. This makes it easy to set regular working hours on weekdays and exceptions for vacation times, for example.

3. Export your calendar as an iCalendar file.
4. Download the measurement data from the measuring instrument or open the corresponding measurement value file.
5. Open the iCalendar file in the *Calculation* tab under *Filter* (26 in Figure 5.2). The integration intervals with their individual positions and doses and, in the last line, the total dose are displayed in the results table.

If you want to further restrict the selection because you have to generate reports on a weekly or monthly basis, you can do this with the *evaluation window* (25 in Figure 5.2, 8 in Figure 5.1).

5.6. Reports

As a professional tool for radon protection managers and service providers, *Radon Vision 8* offers a flexible function for generating reports (34 to 35 in Figure 5.2).

Click on the *Report/Export* button to generate a report in Excel, LibreOffice, CSV or HTML format, as shown in Figure 5.18.

The appearance of the report is essentially determined by the template (35 in Figure 5.2), which you can customise according to your needs. In the template file—the supplied templates can be found in the `Templates` subdirectory of the programme directory—the placeholders for the values to be transferred from the programme are marked with a `$` sign in front of them.

Table 5.4 lists all variables that can be used in report templates with their meaning.

Table 5.4.: Variables that can be used in report templates with their meaning

Variable	Meaning
`$TITLE`	title or heading of the report
`$PERSON`	exposed person or group of people
`$START`	start date and time of the evaluation window
`$END`	end date and time of the evaluation window
`$PLACE`	measuring location
`$INSTRUMENT`	type and serial number of the measuring instrument
`$COMMENT`	free comment
`$FILENAME`	file name of the binary measurement file
`$F222`	equilibrium factor for ^{222}Rn
`$D222`	dose conversion coefficient for ^{222}Rn
`$D220`	dose conversion coefficient for ^{220}Rn (thoron)
`$CHART`	diagram image
`$PIC`	person in charge for the implementation of the measurement
`$ROW_START`	start date and time of the integration interval
`$ROW_END`	end date and time of the integration interval
`$ROW_TIME`	duration of exposure in the integration interval
`$ROW_NO`	number of measured values in the integration interval

Continued on next page

Continued from previous page

Variable	Meaning
$ROW_222MIN	minimum of the ^{222}Rn activity concentration in the integration interval
$ROW_222MAX	maximum of the ^{222}Rn activity concentration in the integration interval
$ROW_222AVG	average of the ^{222}Rn activity concentration in the integration interval
$ROW_222AVG_ERROR	error of the ^{222}Rn average value
$ROW_222EXP	exposure through ^{222}Rn in the integration interval
$ROW_222DOSE	dose by ^{222}Rn in the integration interval
$ROW_222FAST_MIN	minimum of the ^{222}Rn activity concentration in the integration interval, calculated from the decay products with a short half-life
$ROW_222FAST_MAX	maximum of the ^{222}Rn activity concentration in the integration interval, calculated from the decay products with a short half-life
$ROW_222FAST_AVG	average of the ^{222}Rn activity concentration in the integration interval, calculated from the decay products with a short half-life
$ROW_222FAST_AVG_ERROR	error of $ROW_222FAST_AVG
$ROW_222FAST_EXP	exposure through ^{222}Rn in the integration interval, calculated from the decay products with a short half-life
$ROW_222FAST_DOSE	dose by ^{222}Rn in the integration interval, calculated from the decay products with a short half-life
$ROW_220MIN	minimum of the ^{220}Rn activity concentration in the integration interval
$ROW_220MAX	maximum of the ^{220}Rn activity concentration in the integration interval
$ROW_220AVG	average of the ^{220}Rn activity concentration in the integration interval
$ROW_220AVG_ERROR	error of the ^{220}Rn average value
$ROW_220EXP	exposure through ^{220}Rn in the integration interval
$ROW_220DOSE	dose by ^{220}Rn in the integration interval
$ROW_222PAEC_MIN	minimum of Potential Alpha Energy Concentration (PAEC) through ^{222}Rn progeny in the integration interval
$ROW_222PAEC_MAX	maximum of Potential Alpha Energy Concentration (PAEC) through ^{222}Rn progeny in the integration interval
$ROW_222PAEC	average of Potential Alpha Energy Concentration (PAEC) through ^{222}Rn progeny in the integration interval
$ROW_222PAEC_ERROR	error of $ROW_222PAEC
$ROW_222PAEE	exposure through ^{222}Rn progeny (Potential Alpha Energy Exposure) in the integration interval
$ROW_220PAEC_MIN	minimum of Potential Alpha Energy Concentration (PAEC) through ^{220}Rn progeny in the integration interval
$ROW_220PAEC_MAX	maximum of Potential Alpha Energy Concentration (PAEC) through ^{220}Rn progeny in the integration interval
$ROW_220PAEC	average of Potential Alpha Energy Concentration (PAEC) through ^{220}Rn progeny in the integration interval
$ROW_220PAEC_ERROR	error of $ROW_220PAEC
$ROW_220PAEE	exposure through ^{220}Rn progeny (Potential Alpha Energy Exposure) in the integration interval
$ROW_TOTAL_EXP	total exposure through ^{222}Rn and ^{220}Rn in the integration interval
$ROW_TOTAL_DOSE	total dose by ^{222}Rn and ^{220}Rn in the integration interval
$TOTAL_TIME	total duration of exposure
$TOTAL_NO	total number of measurement sets
$TOTAL_222MIN	total minimum of ^{222}Rn activity concentration over all integration intervals
$TOTAL_222MAX	total maximum of ^{222}Rn activity concentration over all integration intervals
$TOTAL_222AVG	total average of ^{222}Rn activity concentration over all integration intervals
$TOTAL_222AVG_ERROR	error of $TOTAL_222AVG
$TOTAL_222EXP	total exposition through ^{222}Rn

Continued on next page

Continued from previous page

Variable	Meaning
$TOTAL_222DOSE	total dose by ^{222}Rn
$TOTAL_222FAST_MIN	total minimum of ^{222}Rn activity concentration over all integration intervals, calculated from the decay products with a short half-life
$TOTAL_222FAST_MAX	total maximum of ^{222}Rn activity concentration over all integration intervals, calculated from the decay products with a short half-life
$TOTAL_222FAST_AVG	total average of ^{222}Rn activity concentration over all integration intervals, calculated from the decay products with a short half-life
$TOTAL_222FAST_AVG_ERROR	error of $TOTAL_222FAST_AVG
$TOTAL_222FAST_EXP	total exposure through ^{222}Rn, calculated from the decay products with a short half-life
$TOTAL_222FAST_DOSE	total dose by ^{222}Rn, calculated from the decay products with a short half-life
$TOTAL_220MIN	total minimum of ^{220}Rn activity concentration over all integration intervals
$TOTAL_220MAX	total maximum of ^{220}Rn activity concentration over all integration intervals
$TOTAL_220AVG	total average of ^{220}Rn activity concentration over all integration intervals
$TOTAL_220AVG_ERROR	error of $TOTAL_220AVG$
$TOTAL_220EXP	total exposure through ^{220}Rn
$TOTAL_220DOSE	total dose by ^{220}Rn
$TOTAL_222PAEC_MIN	total minimum of PAEC through ^{222}Rn progeny over all integration intervals
$TOTAL_222PAEC_MAX	total maximum of PAEC through ^{222}Rn progeny over all integration intervals
$TOTAL_222PAEC	total average of PAEC through ^{222}Rn progeny over all integration intervals
$TOTAL_222PAEC_ERROR	error of $TOTAL_222PAEC
$TOTAL_222PAEE	total exposure through ^{222}Rn progeny (Potential Alpha Energy Exposure) over all integration intervals
$TOTAL_220PAEC_MIN	total minimum of PAEC through ^{220}Rn progeny over all integration intervals
$TOTAL_220PAEC_MAX	total maximum of PAEC through ^{220}Rn progeny over all integration intervals
$TOTAL_220PAEC	total average of PAEC through ^{220}Rn progeny over all integration intervals
$TOTAL_220PAEC_ERROR	error of $TOTAL_220PAEC
$TOTAL_220PAEE	total exposure through ^{220}Rn progeny (Potential Alpha Energy Exposure) over all integration intervals
$TOTAL_EXP	total exposure
$TOTAL_DOSE	total dose

You can exchange, translate, move or completely omit all other contents of the template file as you wish.

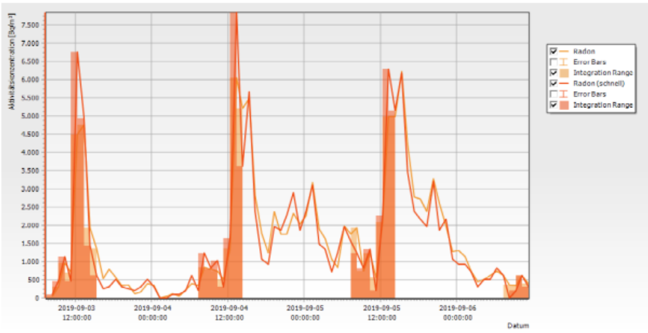
Hint

When generating the report, *Radon Vision 8* searches the template for fields with the variables listed above and replaces these **fields** with the value of the corresponding variable. Formulas in the template that contain variables will therefore **not** work.

However, the template file `tmp-report_advanced_example` demonstrates a trick that allows you to continue calculating with these variables using invisible fields.

In addition to the report, all raw data are also exported to the spreadsheet file as additional tables.

Title/Project Beispielbericht
Exposed person or group Arbeiter in einem Wasserwerk
Period
Start datetime: 2019-09-03 07:19
End datetime: 2019-09-06 11:19
Place Filterhalle Süd
Instrument DOSEman SN: 453
Comment Vielen Dank an Herrn Tennstedt von den Berliner Wasserbetrieben
Binary measuring data file name DM453--20190903T0719--20190906T1119.rvx
F_{222} 0,4
D_{EEC_222} 7,8 nSv·m³·(Bq·h)⁻¹



Start	*End*	*Exposure time in h*	*Data records*	*Radon avg. in Bq/m³*	*Radon exp. in Bq h/m³*	*Radon dose in µSv*
2019-09-03 07:30	2019-09-03 15:00	8,0	8	1823	14581	50,8
2019-09-04 07:00	2019-09-04 14:00	7,0	7	2218	15527	54,1
2019-09-05 07:30	2019-09-05 14:30	7,0	7	2364	16547	57,7
2019-09-06 07:00	2019-09-06 11:19	4,0	4	431	1725	6,0
Total		26,0	26	1861	48379	168,6

Person in charge for this measurement Thorsten Tennstedt

16.04.2020,rep-dosecalc-20190903--20190906.ods page1of1

Figure 5.18.: Report from standard template

6. Remote Data Transmission

6.1. The SARAD Registration Server service

SARAD instruments can be connected to the PC running *Radon Vision 8* in a variety of ways:

local connection The measuring instrument is connected directly to a USB, RS-232 or RS-485 cable connected to the PC.

ZigBee network One or more measuring instruments are connected via SARAD's ZigBee products of the *Net Monitors* family.

LAN Measuring instruments are connected via SARAD's *Aranea LAN*.

WiFi SARAD measuring instruments with a built-in or external WiFi module connect to the PC directly or indirectly via a server in the LAN.

via internet Measuring instruments are connected to the PC via Ethernet with *Aranea LAN* or via mobile radio with *Aranea LTE* or *Aranea Outdoor* via the *SARAD MQTT Broker*.

All these communication channels, which can also be combined with each other, are supported by the *SARAD Registration Server service*. All devices connected via it are listed in the drop-down device list (1 in Fig. 5.1) and can be used in exactly the same way as locally connected measuring instruments.

The *SARAD Registration Server service* is complex and highly configurable and is also used by other SARAD applications (*dVISION 4*, *ROOMS*). It is therefore documented in a separate manual [4]. The devices of the *Aranea* family, on which the *SARAD Registration Server service* runs on the device side, also have their own manual [1].

Therefore, only the basic functionality that is activated by default in *SARAD Registration Server service* and a few basic aspects that are essential to understand if something does not work as expected need to be discussed here.

6.2. A Windows service

The *SARAD Registration Server service* is a Windows service that is started immediately after installation, runs constantly in the background and is started automatically every time Windows is restarted. This service is configured so that it is terminated and restarted automatically in the event of an error.

You can see whether the service is running in the Windows program *Services*. With administrator rights, you can also stop or restart the service there.

A second way to check the function of the *SARAD Registration Server service* is to access the API of the service. To do this, visit the address `localhost:8008` with your web browser. If the API documentation appears at this address, then the *SARAD Registration Server service* is working correctly.

If you start *Radon Vision 8* without the *SARAD Registration Server service* running, you will receive the error message shown in Figure 6.1.

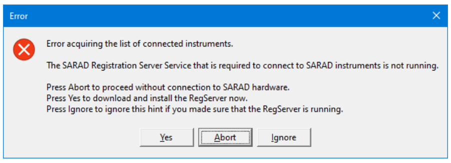


Figure 6.1.: Error message for missing *SARAD Registration Server service*

6.3. Configuration of the SARAD Registration Server service

All configuration options are managed in the `%programdata%\SARAD\RegServer-Service` directory in the `config.toml` file. This is a simple text file in TOML format [6], which you can edit with any text editor. After installation, there is only a template for this configuration file in the above-mentioned directory, which contains all configuration options and their default settings and briefly explains them. As long as no `config.toml` with different settings exists in this directory, the *SARAD Registration Server service* works with these default settings.

The *SARAD Registration Server service* must be restarted after each editing of `config.toml`. To do this, run the Windows system program *Services* as an administrator (Fig. 6.2) and restart the service via the pop-up menu that opens with the right mouse button (Fig. 6.3).

> **Warning**
>
> Pay close attention to the syntax when editing `config.toml`! If you make a mistake here, the service will stop immediately every time you try to restart it and will enter an endless loop of automatic restarts.

6.4. Locally connected devices

In the basic configuration, the *SARAD Registration Server service* assumes that a SARAD device could be connected to any existing RS-232 interface (COM1) or to any USB port.

At the USB ports, plugging in a device for the *SARAD Registration Server service* is the trigger for checking whether the new device is a SARAD measuring instrument. COM1, on the other hand, checks every 30 s whether a SARAD device is connected.

These default settings can be customized in the `[usb_backend]` section of the `config.toml` file.

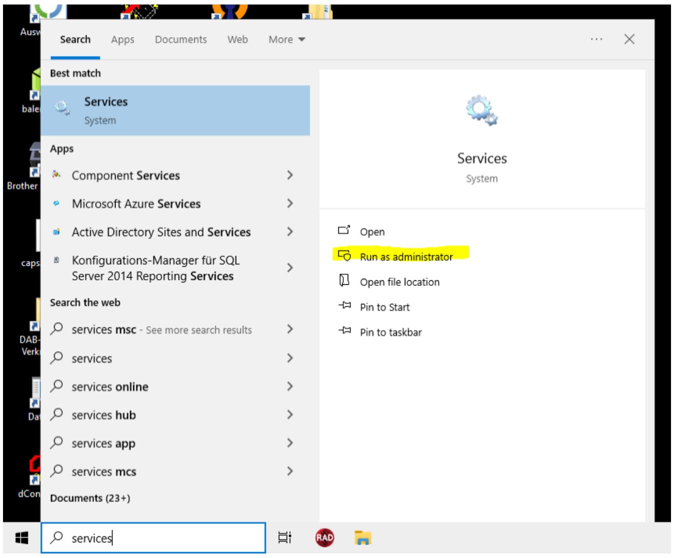


Figure 6.2.: Start *Services* via the Windows search function with win and enter 'Services'

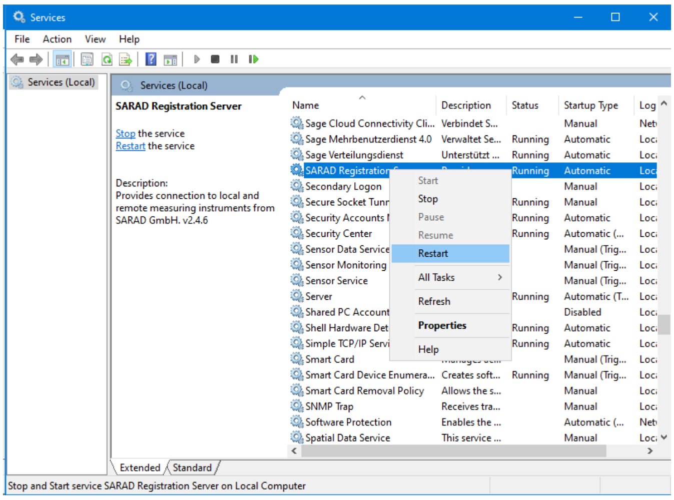


Figure 6.3.: Restarting the *service*

6.5. Devices in the local network

In the basic configuration, the *SARAD Registration Server service* installed on your PC sees the SARAD measuring instruments connected to other PCs in your LAN on which the *SARAD Registration Server service* is also installed. Conversely, your colleagues will also see the device connected to your PC in their device list in *Radon Vision 8*.

This behavior is configured in the sections `[frontends]` and `[backends]`. If you do not want other users to see the devices connected to your PC, set `mdns = false` in the `[frontends]` section. Conversely, if you do not want to see any devices from other workstations in your device list, then set `mdns = false` in the `[backends]` section.

6.6. Handling of device access conflicts

As mentioned in section 6.5, multiple users with *Radon Vision 8* can have access to one and the same measuring instrument. However, SARAD measuring devices are not capable of multitasking, i.e. they cannot communicate with several instances of *Radon Vision 8* at the same time. That's why a reservation mechanism ensures that access conflicts are avoided. The respective reservation status is indicated by a colored dot in front of the device name in the drop-down device list. With each access (z. B. with Instrument > Get data), the device is reserved and thus blocked for other users, which is indicated by a red dot in the device list. If you move the mouse over a device marked in this way, a tooltip shows who is using the device (Fig. 6.4). Once the setting or data download is complete, the device is released and the dot turns white again. If you are the person who has reserved the device, the dot is green.

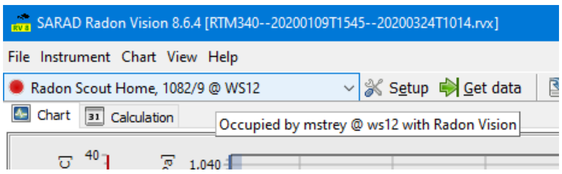


Figure 6.4.: Display of the reserving user with host name and application program

In an emergency, it is possible to take the device away from the other user by force. The context-sensitive menu of the drop-down device list contains the item Steal chosen device (Fig. 6.5). This immediately releases the device again and the other user receives an error message.

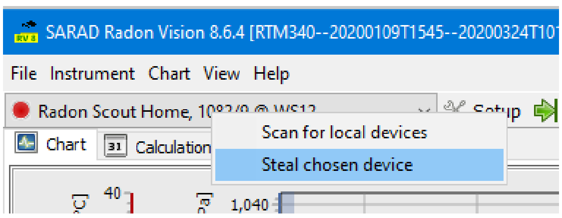


Figure 6.5.: Taking over a blocked device

A. List of Keyboard Shortcuts

Key combination	Function
Ctrl + O	File ≫ Open file
Ctrl + A	File ≫ Save as...
Ctrl + Q	File ≫ Exit
Ctrl + E	Instrument ≫ Setup
Ctrl + G	Instrument ≫ Get data
Ctrl + P	View ≫ Spectrum
Ctrl + T	View ≫ Main toolbar
F2	Sets focus on campaign selection
⇧ + mouse	Marks an interval for integration
Ctrl + mouse	Removes the marking
⇧ + double-click	Marks the complete campaign
Ctrl + double-click	Removes the marking of the campaign
⇧ + click	*Zoom Out* of y-axis
Ctrl + click	*Zoom In* of y-axis
Pulling	Scroll or *Zoom In* of the time line
Pulling on the y-axis	Scroll or *Zoom In* of the y-axis
Pulling with right mouse key	*Zoom In/Out* of the time line

B. Known limitations and errors

1. Exposures and doses are not calculated with US units and the entire *Calculation* tab is not displayed.

2. When marking a campaign from *DOSEman PRO* with ⇧ + double-click, access violations were observed on some PCs that no longer occur after switching one of the curves shown off and on again.

3. When calculating the thoron average values from *DOSEman PRO* data, the errors of the thoron average values are not calculated. The less-than signs, which normally indicate that the detection limits are not reached, should be ignored here.

4. If the Windows setting of the decimal separator does not match the language setting of *Radon Vision 8*, there may be problems with the representation of the equilibrium factor and dose conversion coefficient, which can also lead to incorrect calculation of the doses .

Bibliography

[1] *Aranea LAN/LTE/Outoor – Manual*. English. SARAD GmbH, 2025. *Aranea LAN/LTE/Outoor – Handbuch*. Deutsch. SARAD GmbH, 2023.

[2] *Ermittlung und Berechnung der Dosis aus der spezifischen Aktivität der Radon- und Radonfolgeprodukte*. URL: `https://www.sarad.de/cms/media/docs/applikation/an-010_dose_calulation-de.pdf`.

[3] *MODBUS RTU Protokoll für SARAD Geräte*. URL: `https://www.sarad.de/cms/media/docs/applikation/an-009-sarad_modbus_rtu_protocol-de.pdf`.

[4] *SARAD Registration Server service – Softwar Manual*. English. SARAD GmbH, 2025. *SARAD Registration Server Service – Softwarehandbuch*. Deutsch. SARAD GmbH, 2025.

[5] *Thoron Measurements with the RTM1688-2*. URL: `https://www.sarad.de/cms/media/docs/applikation/AN-004_Thoronmeasurements_EN_11-03-08.pdf`.

[6] *TOML*. URL: `https://toml.io/en/`.

Glossary

PAEC Potential Alpha Energy Concentration.

PAEE Potential Alpha Energy Exposure.