Radon Vision 7

User Guide

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1. Introduction

1.1. Features

Radon Vision 7 is the application software for the radon measuring devices from SARAD GmbH. 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,*

- *DOSEman*:
    - *DOSEman,*
    - *DOSEman PRO,*

as well as the devices:

- *RTM 1688,*

- *RTM 1688-2,*

- *Analog Radon Sensor,*

- *Analog Progeny Sensor,*

- *Indoor Air Sensor.*

The app allows the following work:

- Setting the measuring device, fetching the measuring data from the device:
    - for instruments connected locally to the PC
    - for remote instruments connected over a switched connection via modems

- Data management in binary data files:
    - automatic generation of folder structure

- – automatic generation of file names
- – for quality assurance, constrains to save a binary data file before a report can be generated

- Interactive graphical display of measuring data in a chart with:
  - – selection of measuring campaign to be displayed
  - – multiple zoom
  - – axes zoom
  - – shifting of display along the axes
  - – data cursor
  - – printing of chart
  - – saving in various file formats
  - – copying to clipboard
  - – editing of chart

- Histogram of alpha spectrum (only for instruments capturing the spectrum):
  - – spectrum of single measuring period
  - – spectrum over marked intervals

- Tagging of measuring intervals for further evaluation:
  - – interactively with mouse or
  - – with the import of an iCalender file,
  - – Restriction of the selection by defining an evaluation window

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

- Switching between SI and US units

- Generating a report as an Excel or LibreOffice file:
  - – freely configurable template file for flexible layouts
  - – optional inclusion of all measurement data in additional spreadsheets

Functions of older software versions that can be activated optionally:

- selective export of an Excel-compatible text file

- simple report printing with space for your own company form.

1.2. System requirements

- Windows operating system (tested with Windows 7, 8 and 10)

- approx. 50 MB free drive capacity

- minimum graphics requirements: 1024 × 768 pixels, 256 colors

- mouse or other pointing device

- RS-232 interface (COM), USB or modem 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 *Thunderbird* extension *Lightning*, *Google Calendar* or similar. One of these apps should be installed in addition to *Radon Vision 7*.

2. Installation and configuration

2.1. Installation

Insert the installation CD into the drive or download the installation file from the SARAD website and start `setup-radon_vision-7.exe`. The installation program will guide you through the installation process.

As the target folder, as shown in Figure 2.1, the Windows program directory is suggested by default. You can change this as required. *Radon Vision 7* can also be portable installed on a USB stick or network drive (see section 2.2). You can install *Radon Vision 7* in parallel to an earlier version of *Radon Vision*, but you should definitely choose an installation directory that is different from that of the earlier version.
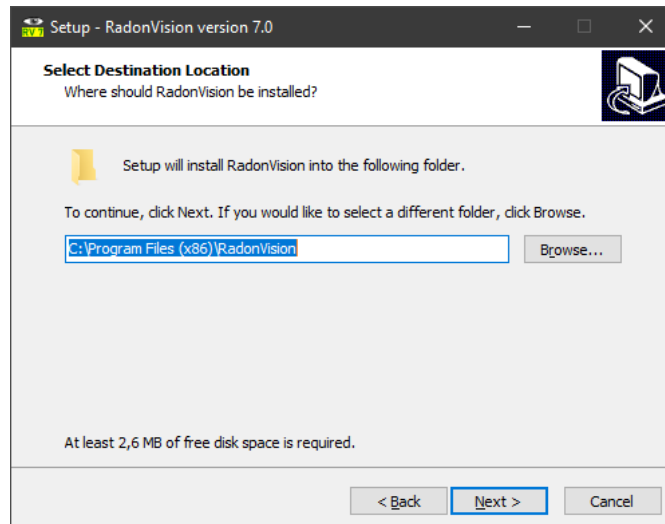
Figure 2.1.: Enter the target folder for the installation

The input mask for the selection of the software components to be installed can be seen in Figure 2.2. As a rule, the compact installation is sufficient, in which only the basic software *Radon Vision 7* is installed. The FTDI drivers required for data transfer from the measuring device via USB are normally automatically installed by Windows as soon as a SARAD instrument is connected to the PC via USB — provided there is an internet connection.
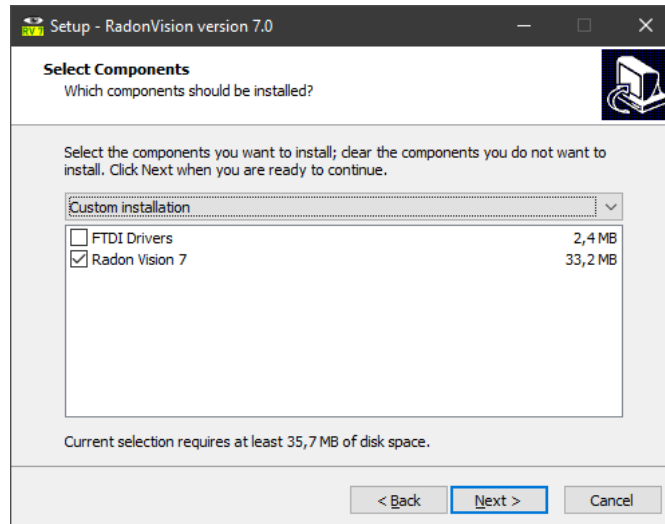
Figure 2.2.: Selection of software components to be installed

2.2. Setup wizard

When *Radon Vision 7* is started for the first time, a setup wizard is started with which basic settings for the behavior of the software can be made.

The first thing to choose is where *Radon Vision 7* should save user data and save configuration settings (Figure 2.3).

There are three options here:

Standard *Radon Vision 7* saves user data in the Windows folder for application data (`%appdata%`) and the configuration in the Windows registry.

Portable User data go into subdirectories of the program directory, the configuration in an ini file.

Custom Experienced users or administrators can also set more exotic locations.

If you are unsure, choose the first option!

In the next window (Figure 2.4) you can, based on the selection made previously, specify the directory paths more precisely, the language of the user interface and the unit system to be used.

You can also set whether *Radon Vision 7* should only consider devices connected directly to the computer or connected via modem when searching for connected measuring devices.
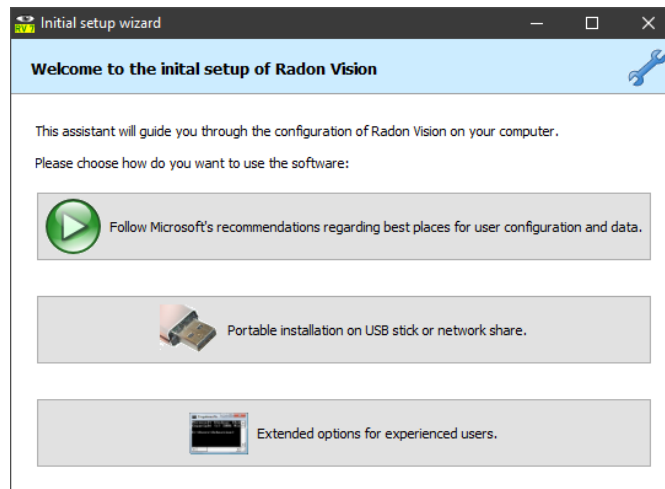
Figure 2.3.: Selection of storage locations for user data and configuration
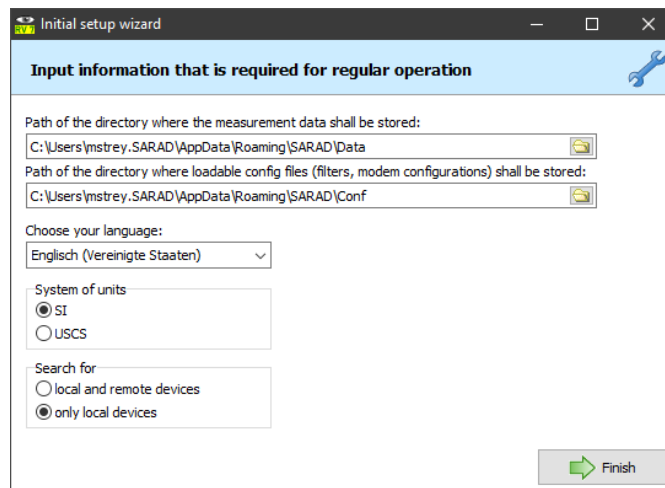
Figure 2.4.: Setting of paths, language and unit system

3. Getting started

3.1. Terms: measurement campaigns and measurement data file

Measurement campaign A set of measurement data from the same measuring device, which are located together in a measurement value file. A measurement campaign starts with the start of the measurement on the instrument and ends with the stop of the measurement or with the download of the measurement data from the instrument. Measurement data downloaded from the instrument consists of at least one measurement campaign.

Measurement data 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 the proprietary RVX format from SARAD is saved in a central location specified in the setup wizard (Figure 2.4) with systematic file names. Measurement files can be provided with a comment when they are saved.

*Radon Vision 7* shows the measurement campaigns of a measurement value file individually or together in diagrams, but allows the measurement campaigns combined in a measurement value file to be evaluated together using the filter functions. This makes it possible to evaluate data recorded at a measuring location together, even though the measurement e. g. was interrupted by a battery change.

Figure 3.1 shows the diagram view of a measurement value file with five, in this case unrelated, measurement campaigns in *Radon Vision 7*.

3.2. Data storage and quality assurance

As binary files with a proprietary file format not disclosed by SARAD GmbH, the RVX files with the raw data of the measurement are relatively tamper-proof. In this way, they can also be used later as evidence that a report created with *Radon Vision 7* was not manipulated or completely invented.

The principle in *Radon Vision 7* therefore applies: "No report without binary raw data in RVX format."

The program 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).

The name of the binary file is in every report generated by *Radon Vision 7* so that the report can be traced back to its source at any time.
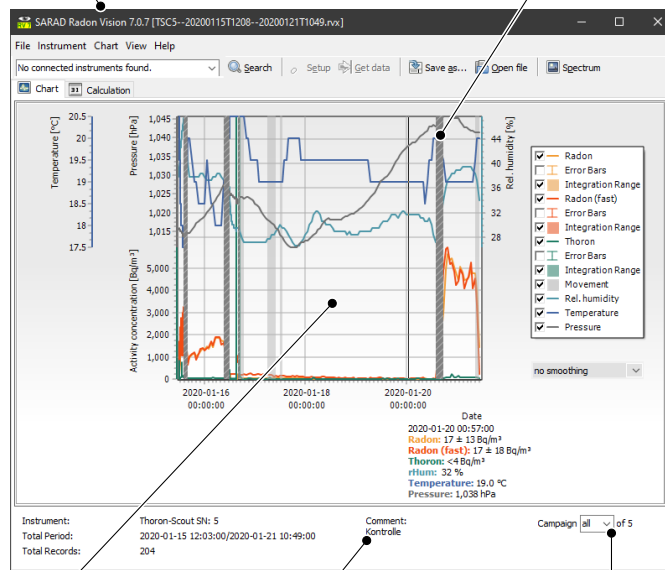
Figure 3.1.: Measurement file with five measurement campaigns
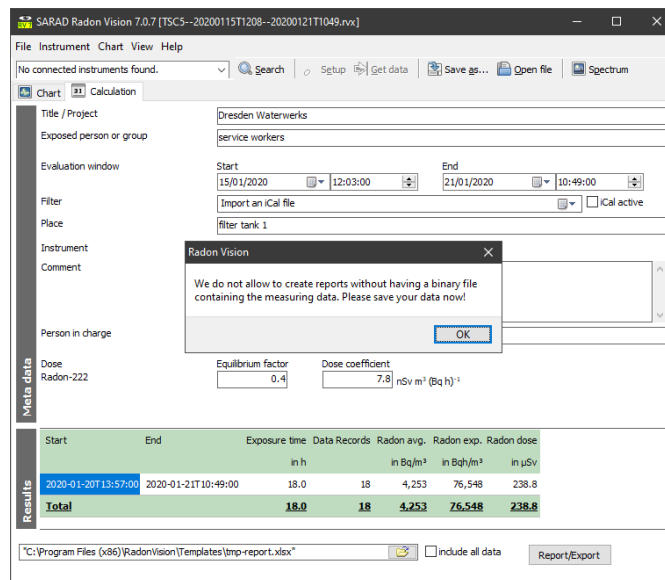
Figure 3.2.: Request to save as a binary file after clicking on *Report/Export*

3.3. Best practice

The following aspects must be considered when planning the measurement:

1. It takes a relatively long time to download many measurement data sets from the measuring instrument.

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

3. Data from different measured value files can be evaluated together in *Radon Vision 7*. However, it is not possible to split a measurement file.

4. The evaluation in *Radon Vision 7* is easier if all related data are in the same measurement campaign.

You generally will want to evaluate data from the same location together and, on the other hand, keep an overview of your data. This leads to the following tips:

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

2. Do not interrupt an ongoing measurement unnecessarily.

3. Delete the data from the instrument after downloading it with *Radon Vision 7* and saving it in an RVX file, unless you download the data of an ongoing measurement for an interim evaluation without closing the measurement to stop. Example: On the ground floor of an apartment, measurements are to be taken for six months to find an annual mean value for the radon exposure. You are curious and want a first overview after just a month. In this case, run the measurement, 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 for the interim evaluation.

4. Make meaningful comments when saving.

5. If you change the measurement location, stop the measurement and restart it at the new location to prevent measurement data from different measurement locations from getting into the same measurement campaign.

6. Always check the clock of the measuring instrument after each battery change and set it if necessary (see Figure 3.3)!
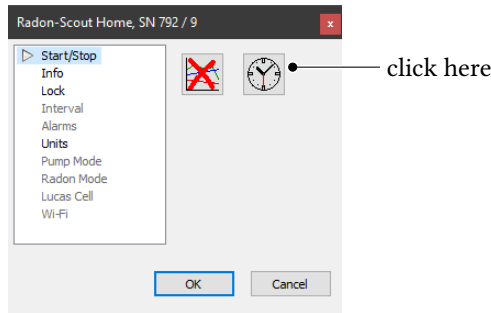
Figure 3.3.: Synchronization of the clock of the measuring instrument with the PC time

3.4. Calculation of mean values, exposure and dose

3.4.1. Marking integration intervals for calculating mean values, exposure and dose

Manually with the mouse

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

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

Hold Ctrl and drag the mouse over the marked intervals to undo the marking.

When marking, the mean values, exposures and dose values shown in the *Calculation* tab in the results table are automatically updated.

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

Rule-based by importing an iCalendar file

With a common calendar application such as *Microsoft Outlook*, the *Google Calendar* or the add-on *Lightning* for *Mozilla Thunderbird* a calendar can be created, that, exported as an ics file, can be imported in the *Calculation* tab of *Radon Vision 7*. The corresponding intervals appear immediately in the diagram and the values in the result table (Figure 3.5) are updated automatically.

iCalendar files can also often be exported from time recording systems or from software used for shift planning. This makes it possible to calculate the exposure of certain groups of people in a targeted manner.

3.4.2. Setting the equilibrium factor and dose conversion coefficient

With *Radon Vision 7* you can calculate the local dose at the installation site of the measuring instrument. In the *Calculation* tab you can set the equilibrium factor and the dose conversion coefficient necessary for this calculation. With the devices of the *DOSEman* family designed as personal dose meters, these factors are already part of the device configuration. With these

click here to see the calculation results   important to display
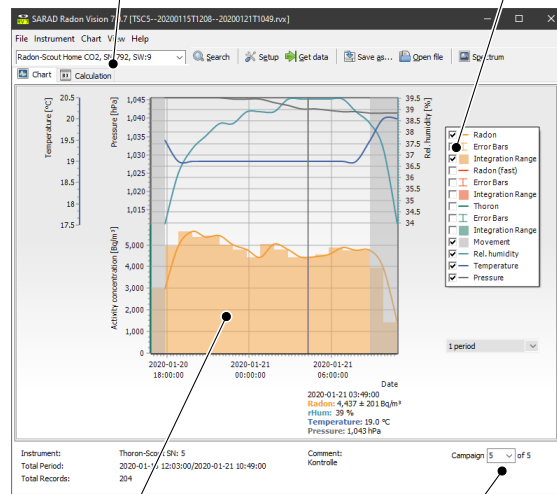
marked with ⇧ + double-click   campaign 5 selected

Figure 3.4.: Campaign 5 with an active integration area

iCal file can be imported here
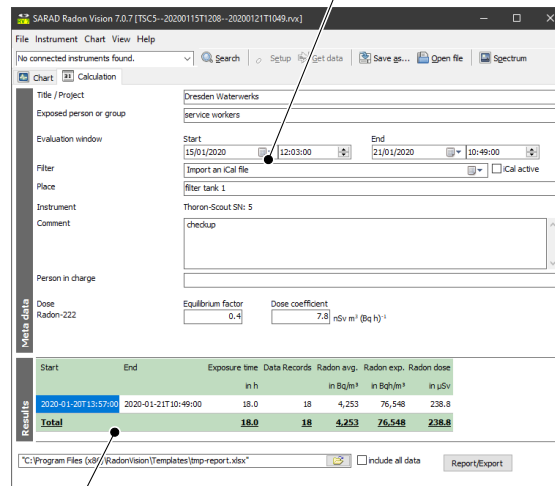
result table

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

devices, these factors are therefore downloaded from the measuring instrument when reading the measurement data and automatically entered in the corresponding fields in the *Calculation* tab. For all other devices, the fields are filled with the usual standard values.

4. Examples of use

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

Scenario The landlord of a residential building wants to know whether the legal reference value of $300\,\mathrm{Bq\,m^{-3}}$ is maintained as the annual average in his rental property.

At the beginning of the heating season, the construction biologist commissioned with the investigation installed one *Radon Scout Home* in 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 still had fresh batteries in his office and connected the two instruments to his PC using the supplied USB cable, started *Radon Vision 7* and used the `Instrument` ≫ `Setup` dialog (`Ctrl`+`E`) to set the time ⏱ and to delete old measurement data ✖.

After three weeks he takes a look at the first interim evaluation and reads the measurement data with his laptop without interrupting the measurement. To do this, he connects the instrument to his laptop using the supplied USB cable, starts *Radon Vision 7* and presses `Ctrl`+`G` to download the measurement data. In the displayed diagram, he marks the entire measurement period with `⇧` + double-click. In the *Calculation* tab he reads the radon mean.

Based on the mean value and the course of the curve, the construction biologist can already recognize whether (a) there is no or (b) a massive radon problem or whether (c) the radon concentration is within the limit of the legal reference value. While in case (a) he may stop the examination and in case (b) may already start researching the entry paths, in case (c) the construction biologist will continue the measurement over a longer period of six months or even a year. For all further interim evaluations, he can proceed as for the first one and keep the measurement campaign running.

If the measurement runs for several months, a battery change will be necessary, which usually ends the measurement campaign and starts a new measurement campaign. In *Radon Vision 7* 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 gray dashed line in the overall view over such a long period of time. In order to incorporate the measured values of both campaigns into the averaging, the building biologist must mark both campaigns one after the other, left and right of the interruption, 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 7* shows an orange warning sign ⚠ 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 examination, our construction biologist will save the measurement values on his PC with `File` ≫ `Save as...` (`Ctrl`+`A`). Then he can use the *Report/Export*

button to generate a report in Excel format, which will be supplemented with the complete measurement data when the box next to it is selected.

The construction biologist is still not satisfied with the report generated in this way. The report bears the SARAD logo in the top right. He would like to have his own company logo there. Moreover he wants to appear the describing texts before the entries to appear in Spanish and not in English. To achieve this, the construction biologist processes the Excel template under `<program 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 generate future reports in Spanish 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 continue calculating with the results and how to include a comparison with legal limit values in the report. *Radon Vision 7* remembers the last used template with its directory and automatically offers it as the default template for the next export.

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

Scenario At a school in a place with a known high soil radon concentration, the actual exposure of the pupils and teachers should be determined. Because the radon problem is known due to the mining history of the place and those responsible know that the radon concentration usually rises at night, the school's caretaker has had the task of opening all windows every morning to ventilate properly. The school building is empty at night, on weekends and on weekdays after 4 p.m. Only the gym is used until 9 p.m. on Mondays, Wednesdays and Fridays.

The engineering firm commissioned to carry out the investigation installed a total of five *Radon Scout Professional*: two on the ground floor of the school, one in the basement used for woodwork/metalwork classes, one on the first floor and one in the gym. The measurement takes place in the heating period, so that the evaluation can take place after only three months, in which the measurement arrangement is left alone.

The evaluation is done individually for each of the five devices. The result of the evaluation should be a mean value comparable to the legal reference value of $300\,\mathrm{Bq\,m^{-3}}$, but at which the times in which the room in question is not used are hidden.

Radon Vision 7 uses calendars in the standardized iCalendar data format for data filtering. These are files with the file extension ".ics", which can be exported from practically all common calendar apps, such as *Microsoft Outlook*, *Google Calendar* or the calendar add-on *Lightning* of the email client *Thunderbird*. In addition, iCalendar files can also often be exported from software applications for shift planning and from time recording systems.

The employee responsible for the evaluation uses *Lightning* and thus creates three calendars, one for the school building in general, one for the gym and one for the workroom in the basement. He uses the option 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 an appointment from 7 a.m. to 4 p.m. and specifies "weekdays" as the repetition rule.

It is not necessary to set the end date, but it does not harm either. He still has to make an exception for the autumn holidays that have fallen into the measurement campaign. To do this, he marks and deletes all appointments in the holiday week. He exports the calendar as `cal-schoolhouse.ics`. He does the same with the calendar for the gym, adding the period from 4 to 9 p.m. on Mondays, Wednesdays and Fridays. To do this, he uses a user-defined repetition rule for the appointment.

When creating the calendar for the workshop, the evaluator must consult the timetable. He's lucky: the school office maintains the timetable and substitution schedule, which also includes the daily use of the classrooms, with shift planning software that directly records the actual times of use of the workshop as an iCalendar file, `cal-workshop.ics`.

During the evaluation, the measured value files of the five measuring instruments are combined with the three iCal files, so that finally five reports are created in which the effective radon mean value for the area in question is displayed in the total line:

- basement with `cal-workshop.ics`,

- ground floor 1 and 2 as well as upper floor, each with `cal-schoolhouse.ics`,

- gym with `cal-gym.ics`.

4.3. Example: Local dosimetry in a waterworks

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

Radon levels are not so high that the effort to equip each employee with a personal dosimeter seems justified. Instead, the person responsible for occupational health and safety decided to set up a *Radon Scout Professional* in the room with the cascade aerator where the radon exposure is highest and to take the measured values of this one device as a reference for all operating rooms in which well water flows or stands in open bassins.

The measuring instrument is read out at least once a month. The data is deleted from the device in order not to unnecessarily extend the next readout process. *Radon Vision 7* allows several measurement data files of the same measuring instrument to be opened at the same time and evaluated together.

An electronic time recording system is used to record the times when the employees are in the exposed areas. Every employee holds his company or visitor ID card at the reader at the entrance when entering or leaving an operating room. The time recording system software allows an iCalendar file to be created for each employee, which, in the form of appointments, contains all the periods in which the employee in question was active in one of the exposed areas.

> **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 ID card readers, then this is possible e. g. with the software *AFS time recording*, which offers various options (terminal, smartphone app, PC) for recording the times.
>
> If you can be sure that the time of stay corresponds exactly to a duty or shift schedule, software for shift and duty planning, such as the online app *ShiftJuggler* can be used, which supports the iCalendar export of rosters.

When storing the measured value files, *Radon Vision 7* automatically suggests useful directories and file names. By default, the RVX file ends up in the directory `%appdata%` ▸ `SARAD` ▸ `DATA` ▸ `Year-YYYY` ▸ `DevNo-nnnn` and corresponds to the naming scheme `<type><serial number>-<start time>-<end time>.rvx`. The start and end time are, as everywhere in *Radon Vision 7*, according to ISO 8601, so in the form `YYYYMMDD` *T* `hhmm`, so that the files in the directory are automatically sorted correctly.

In our example, all measurement files end up in the same directory. At the beginning of each month, the person responsible for health and safety 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 collected measurement data and the iCalendar file available for each employee. To do this, she goes to the file open dialog with Ctrl + O and simply marks all files there to be opened. Then she changes to the *Calculation* tab (Figure 3.5) and enters the heading for the report and the measurement location there. Because the report is supposed to show the radiation exposure per month, she enters the following data under *Evaluation window*, for example for March 2020:

Start 2020-03-01 00:00:00

End 2020-04-01 00:00:00

Now she only has to enter the name of the employee and his iCalendar file for each employee and to generate the report by clicking on the *Report/Export* button. Only in the first report of this series is it necessary with the note shown in Figure 3.2 to save the measured values combined from several measured value files in a new RVX file. For the sake of clarity, she stores them in the same directory in which she also stores the reports. This means that the original measurement files do not get mixed up with the summarized ones.

> **Hint**
>
> Basically, it is not a problem if the summarized measurement files are together with the original measurement files in one directory. If several files are marked for opening, *Radon Vision 7* automatically checks whether there are duplicate measurement sets and imports each measurement set only once.

5. Operation of Radon Vision 7

5.1. Overview

The Figures 5.1 and 5.2 show the two main views of *Radon Vision 7* with the following operating and display elements:

1. Dropdown list of connected measuring instruments,

2. *Search* button to search for newly connected instruments,

3. *Setup* button to set the device settings of the selected instrument,

4. Button to download the measurement data from instrument,

5. Button for saving the measurement data in a binary file,

6. Button for opening a binary measurement file,

7. Button for displaying the alpha spectrum,

8. Active area within the evaluation window,

9. Inactive area outside the evaluation window,

10. Legend with checkboxes for marking the parameters to be displayed,

11. Docking area for the alpha spectrum,

12. Diagram line for thoron with displayed error bars for the simple standard deviation,

13. Dropdown list for the length of the smoothing period,

14. Selection of a campaign — a number of measuring sets between the start and stop of a measurement,

15. Display of the measurement values under the pointer,

16. Comment stored in the binary file,

17. Start and end time of the measurement file,

18. Total number of all measured value sets in the measured value file,

19. Device type and serial number of the measuring instrument with which the displayed measured values were acquired [1],

20. Lower diagram area for the measured values of the radiation sensors,

21. Marking of the integration areas over which the mean as well as the exposure and dose are calculated,

22. Upper diagram area for environmental parameters,
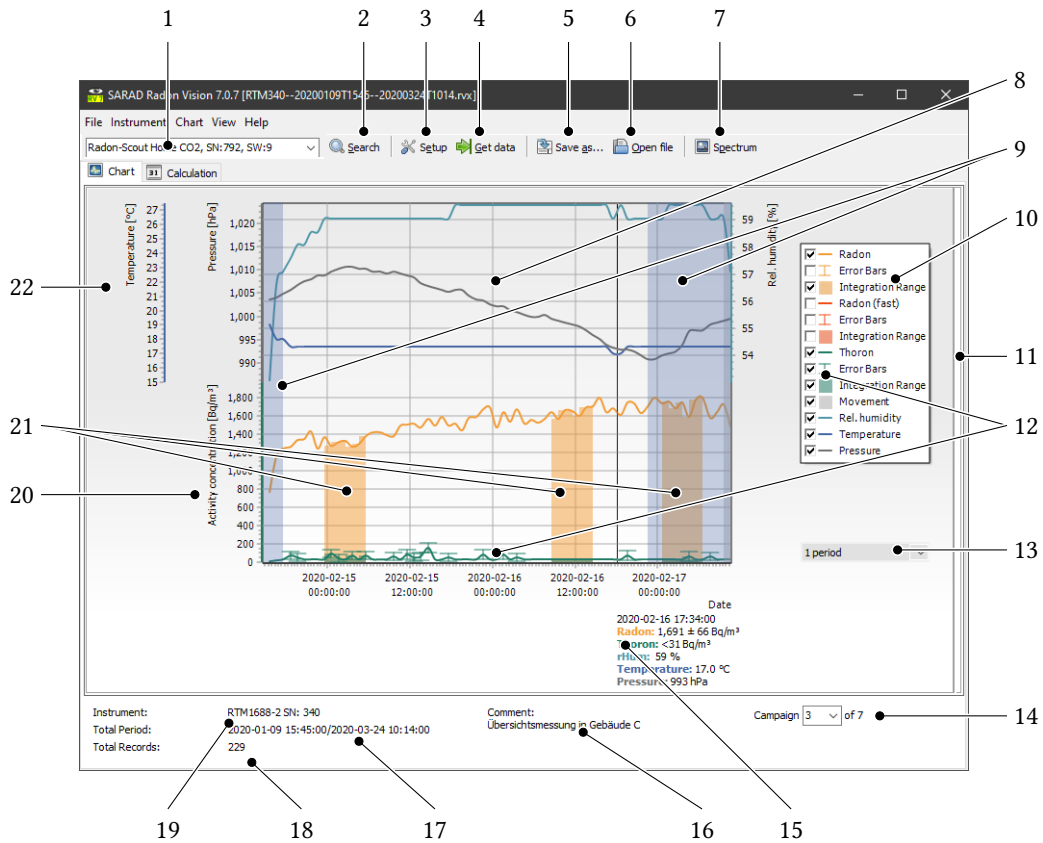
Figure 5.1.: Control and display elements in the *Chart* tab

23. Heading under which the report should be placed,

24. Person or group of people who was at the measurement location during the period under consideration,

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[1] The displayed measurement data come from a measurement value file recorded with a *RTM 1688-2*, so they have nothing to do with the *Radon Scout Home* in the list of connected devices.

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

25. Restriction of the period under consideration in addition to the filter. This setting is used if exposure and dose are to be shown in the report e. g. on a weekly or monthly basis.
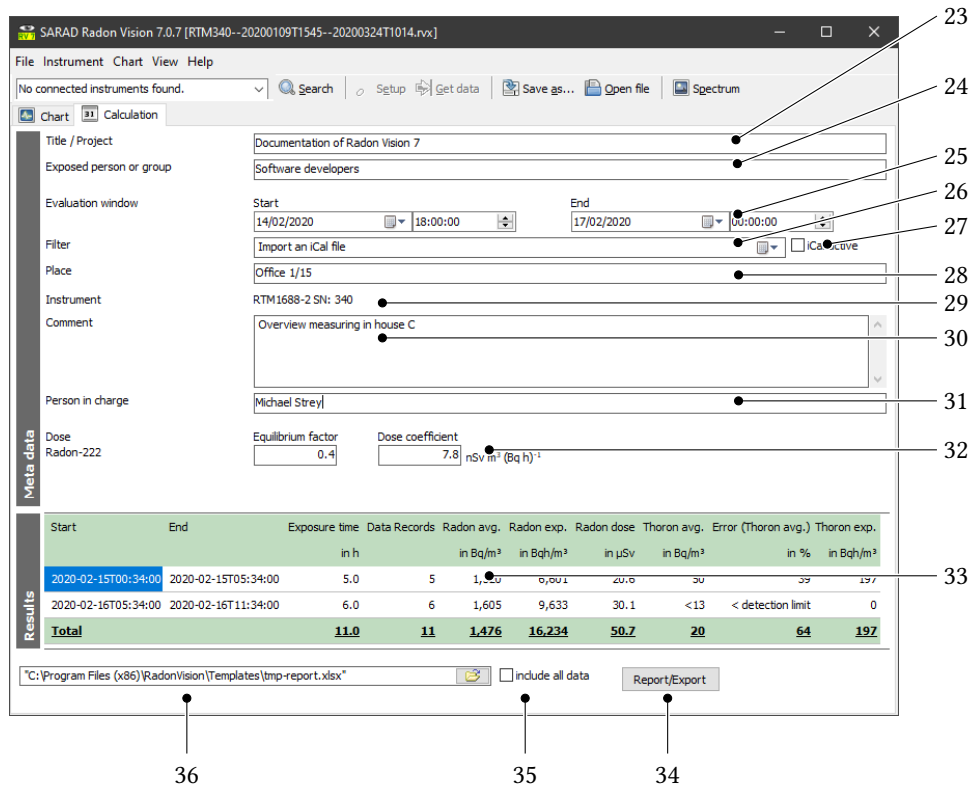
26. iCalendar file to be used to filter the measured values over time when calculating mean values, exposure and dose.

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

28. Place where the measuring instrument was installed,

29. Type designation and serial number of the measuring instrument with which the measurement was carried out — is determined automatically,

30. Multi-line comment to explain the circumstances of the measurement in more detail.

31. The person who signs the report,

32. Equilibrium factor and dose conversion coefficient for the dose calculation. As a rule, the values in these fields do not have to be changed.

33. Results table with one row for each integration interval under consideration,

34. Button for starting report generation. The report opens automatically with Excel or LibreOffice Calc if one of these programs is installed on your computer.

35. With a tick in this field, you can ensure that not only the report but also all measurement data appear in the form of additional spreadsheets in the exported file.

36. Template to be used in the preparation of the report. You can adapt these yourself according to your needs (see section 5.6).

5.2. Connecting the measuring instrument

Most current measuring instruments from SARAD can easily be connected to the PC on which *Radon Vision 7* is running using the USB cable provided. As an alternative, some devices allow the use of their RS-232 connection via the supplied cable with a 9-pin D-Sub connector. This presupposes 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 7* supports both the older types with RS-232 connection and the current USB version.

In any case, *Radon Vision 7* automatically searches for all connected measuring instruments at the start and enters them in the drop-down list of the connected devices. If you only connected your measuring instrument after starting *Radon Vision 7*, you can add to the dropdown list by clicking on the *Search* button.

5.3. Device configuration

With $\boxed{\text{Ctrl}}$ + $\boxed{\text{E}}$ 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 7* 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.

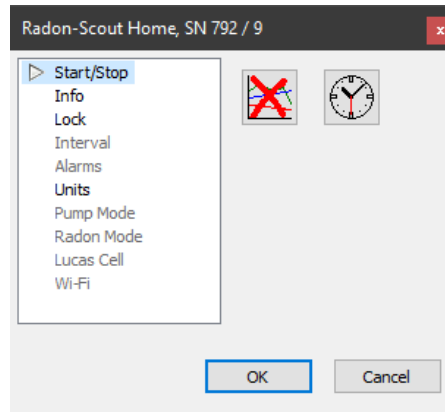### 5.3.1. Radon Scout family devices, Thoron Scout and RTM 1688-2

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

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.

  📋 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 Polonium-216 atom is signaled by a short tone.

>> **Po-216/Po-218** In addition to the Polonium-216, the signal tone is also generated when Polonium-218 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 7* 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 Polonium-218 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 Polonium-218 and Polonium-214 are used to calculate the radon concentration. Due to the longer half-lives of the intermediate nuclides Pb-214 and Bi-214, 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.

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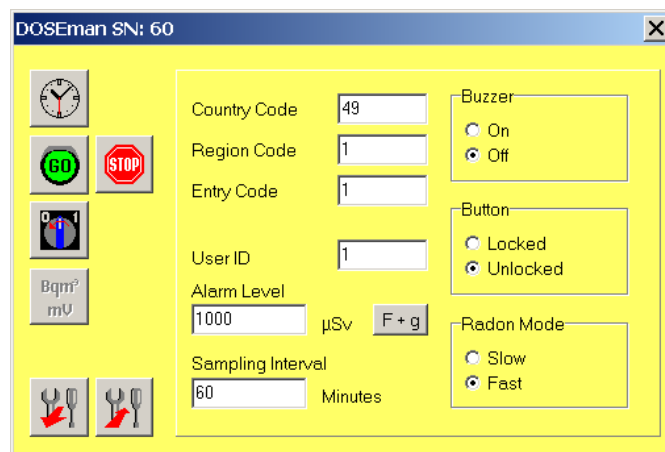
Figure 5.4.: Dialog for the device settings of the instruments of the *DOSEman* family

 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 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 s. section Dose calculation for *DOSEman* and *DOSEman PRO*

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 Polonium-218 and Polonium-214 are used to calculate the radon concentration. Due to the longer half-lives of the intermediate nuclides Pb-214 and Bi-214, 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 Polonium-218 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 $\boxed{F + g}$ opens the dialog for setting the coefficients shown in Figure 5.5.
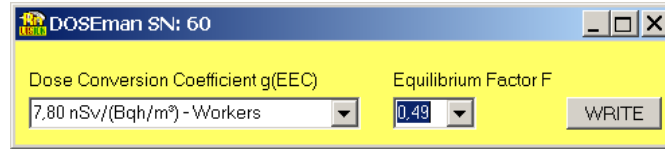
Figure 5.5.: Dialog for the setup of the coefficients for dose calculation

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:

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

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

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

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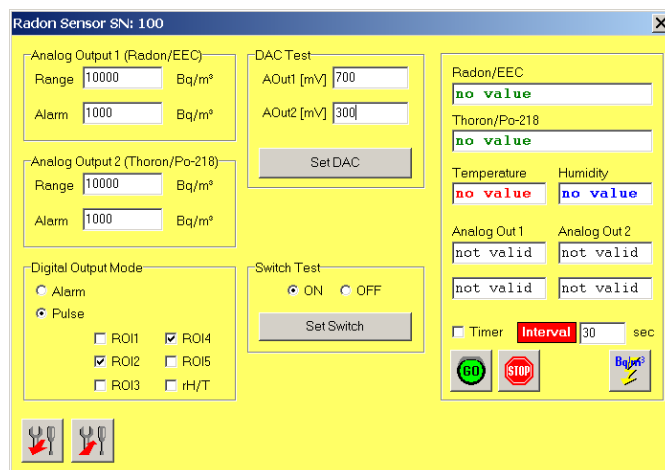
Figure 5.6.: Additional setting options for the *Analog Sensors*

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 $25\,000\,\mathrm{Bq\,m^{-3}}$ leads to 0 V at $0\,\mathrm{Bq\,m^{-3}}$ and 1 V at $25\,\mathrm{kBq\,m^{-3}}$).

> **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 $\boxed{\text{Set DAC}}$.

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.

5.4. Displaying and analyzing the measurement data

5.4.1. Fetching the measurement data

With a click on the button *Get data* (4 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 are 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 37.

When opening a measured value file, the start and end values of the y-axes are always set automatically so that all values are shown in the diagram. When changing the campaign, the manually changed zoom state of the y-axes and the start and end values of the y-axes are retained.

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 7* has the functions listed in Table 5.2 for the exclusive display of individual campaigns in the diagram.

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

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.

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 7* 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.

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.

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

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 calculating the radon measurement variables — also called *regions of interest* or *ROI* — are represented by vertical lines with the respective nuclide, the range limits and the counting pulses contained therein. With *RTM 1688-2* and *Thoron Scout*, the spectrum is saved for each individual measurement set. Therefore, the spectrum view changes for these devices when you move the mouse over the main diagram. If integration intervals are marked, then the spectrum contains the sums of the counting pulses detected within the marked time ranges. With the devices of the *DOSEman* family, however, the total spectrum of the entire measured value file is always displayed.
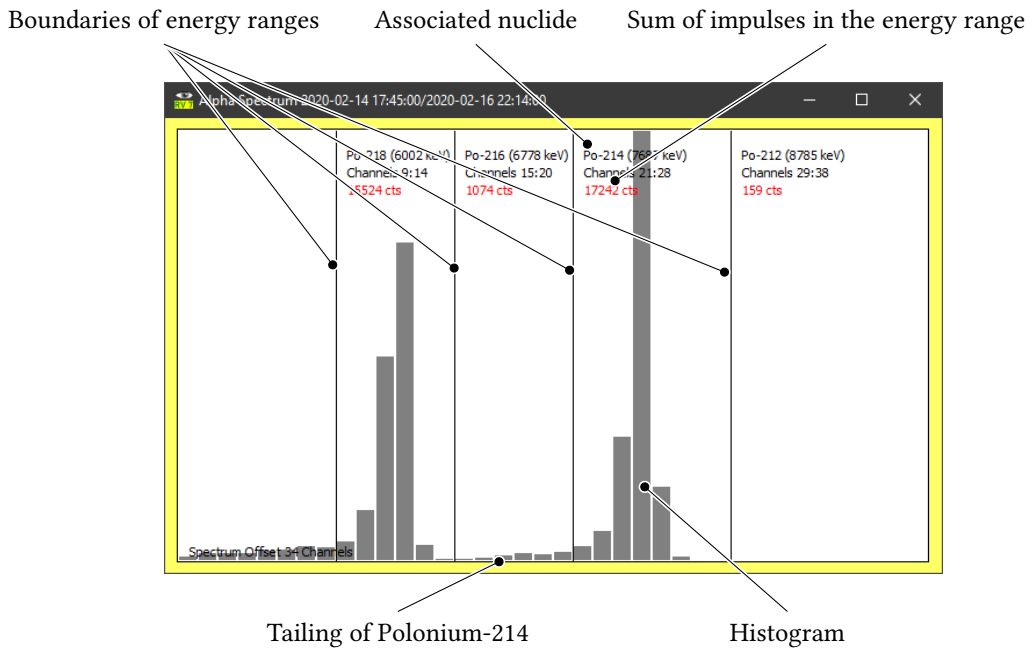

Figure 5.7.: Spectrum display

The window with the spectrum view can be dragged onto the docking area on the right edge of the *Chart* tab and thus placed firmly next to the main diagram (Figure 5.8).
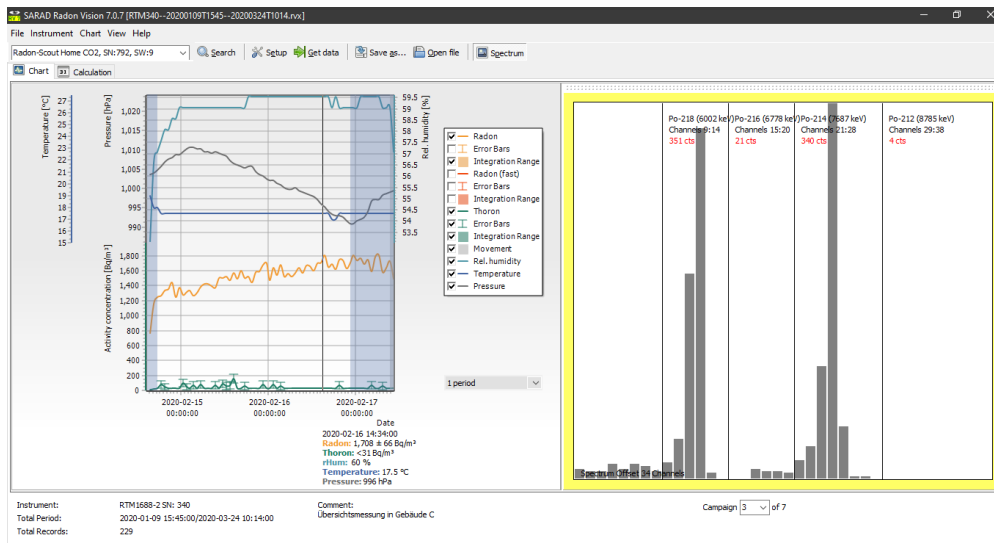
Figure 5.8.: Docked spectrum display and smoothing over one period

5.4.6. Changing the diagram view

Legend

In the legend (10 in Figure 5.1) you can define which of the measured parameters should be shown in the diagram.

Error bars and marked integration intervals (see section 5.4.4) can also be shown or hidden. The settings here also influence the content of the result 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 near the detection limit of a measuring device lead to strong statistical fluctuations in the individual values of a series of measurements. 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 measuring intervals (periods). Together with the smoothing function, an interpolating spline function is activated, which leads to the smoothing of the measured value lines. That is why you can already see an appropriately rounded curve with the setting *1 period*, in which the moving average is still identical to the course of the original data.

In principle, when choosing the smoothing parameter, you should note that short-term changes in concentration that are actually present are subject to smoothing as well as statistical fluctuations.

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

The environmental parameters shown in the upper part of the diagram are hardly affected by statistical measurement errors at the long measurement intervals that are typical for radon. For

this reason, no moving average is calculated for them when the smoothing function is switched on, but the spline function that 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.

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 5.17 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.

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.

1. Click on Tools

Figure 5.9.: Limit line — step 1

2. Add

Figure 5.10.: Limit line — step 2

3. Color Line

4. Deselect   5. Add

Figure 5.11.: Limit line — step 3
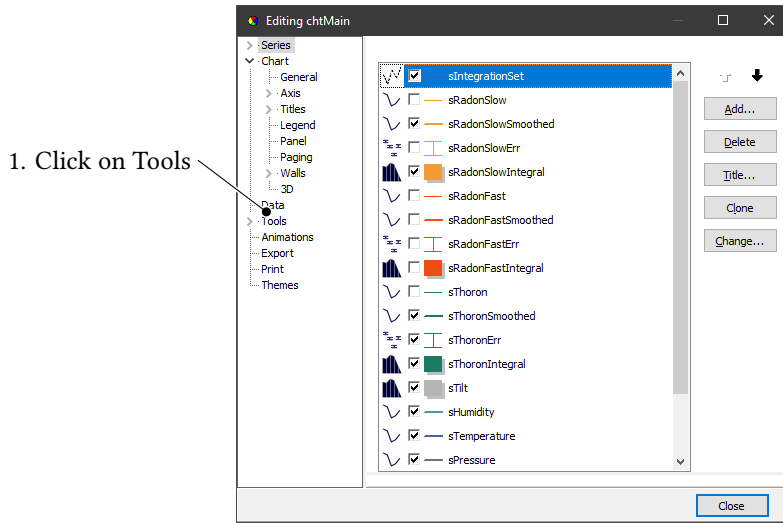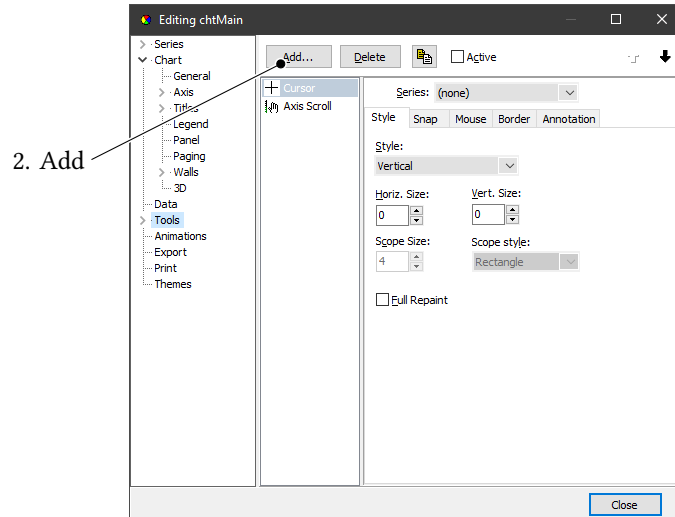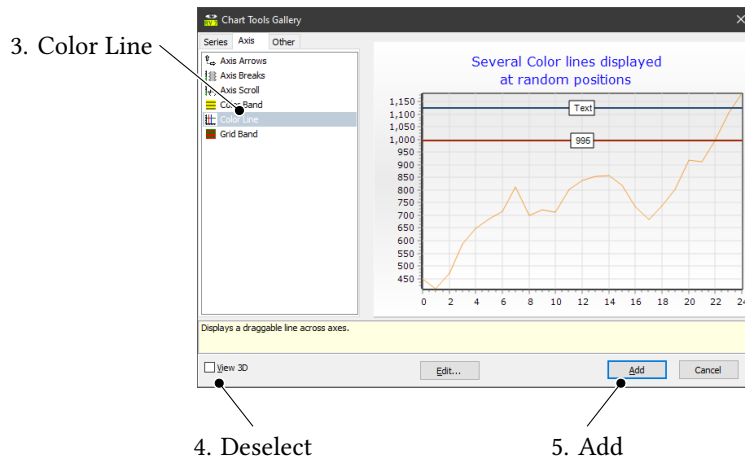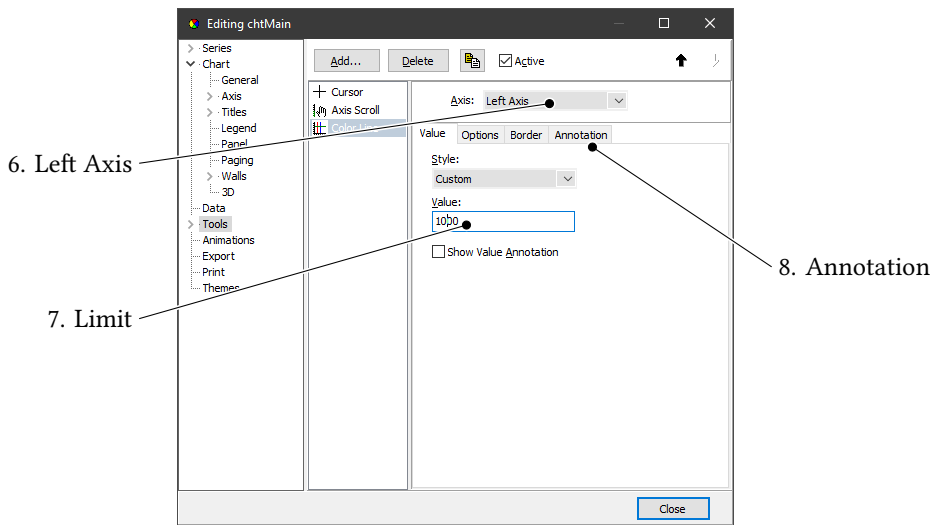

6. Left Axis

7. Limit

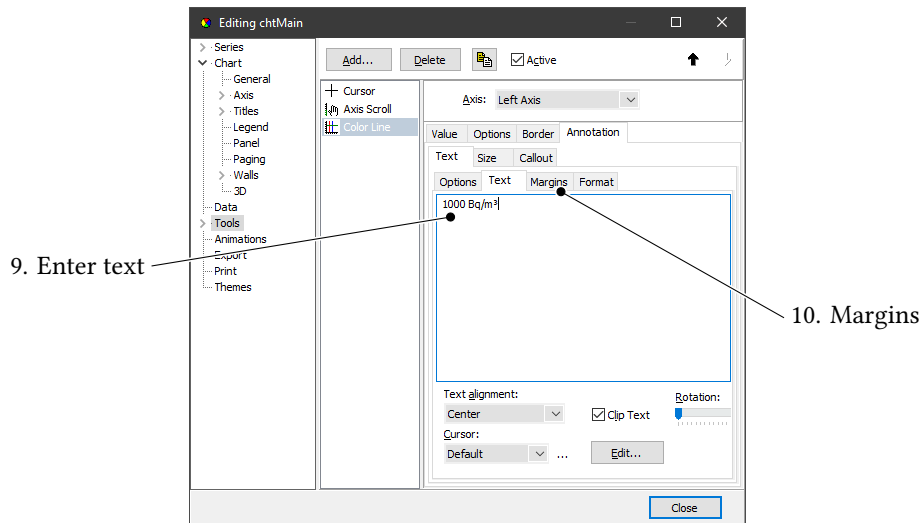8. Annotation

Figure 5.12.: Limit line — step 4

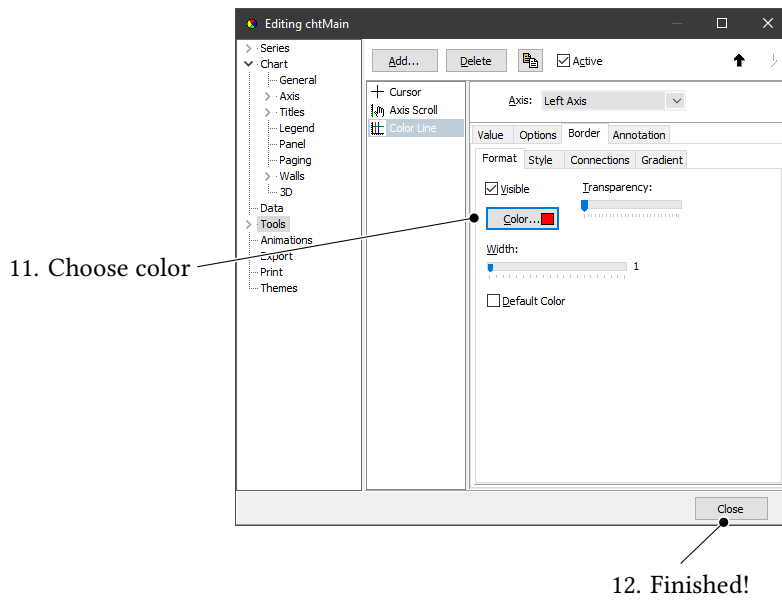Figure 5.13.: Limit line — step 5

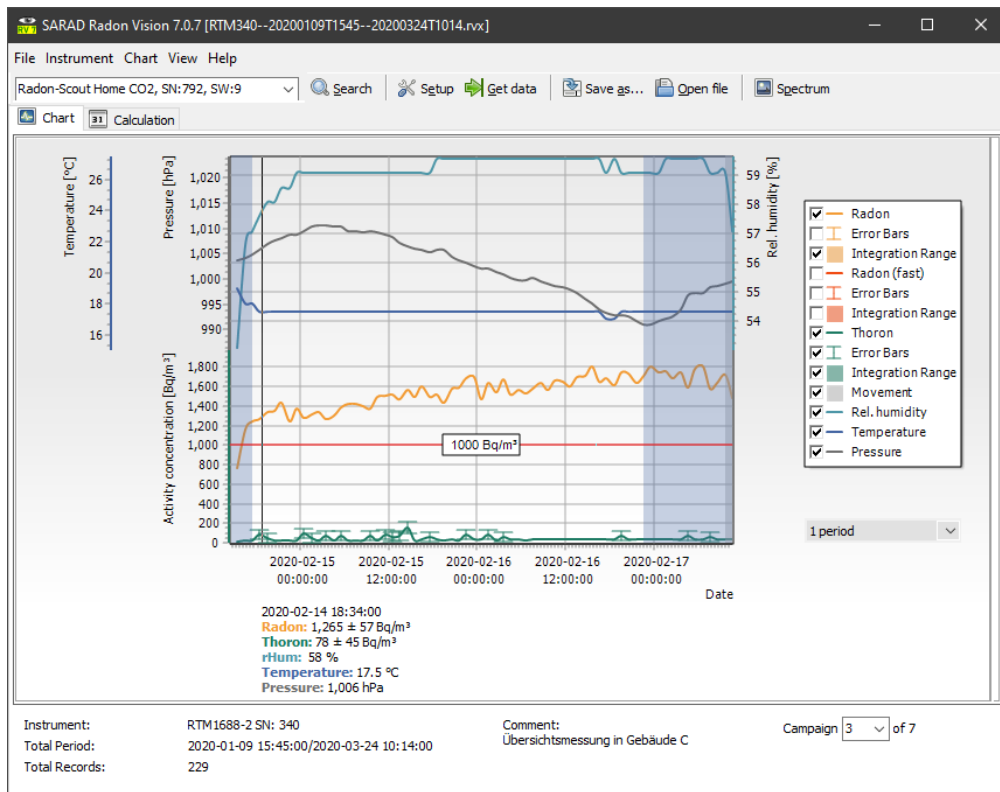Figure 5.14.: Limit line — step 6

Figure 5.15.: Diagram with limit line
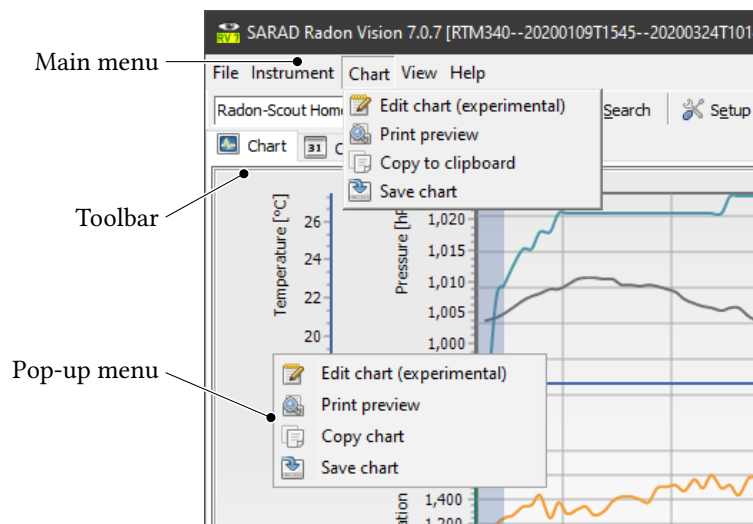
Figure 5.16.: Three types of access to chart functions
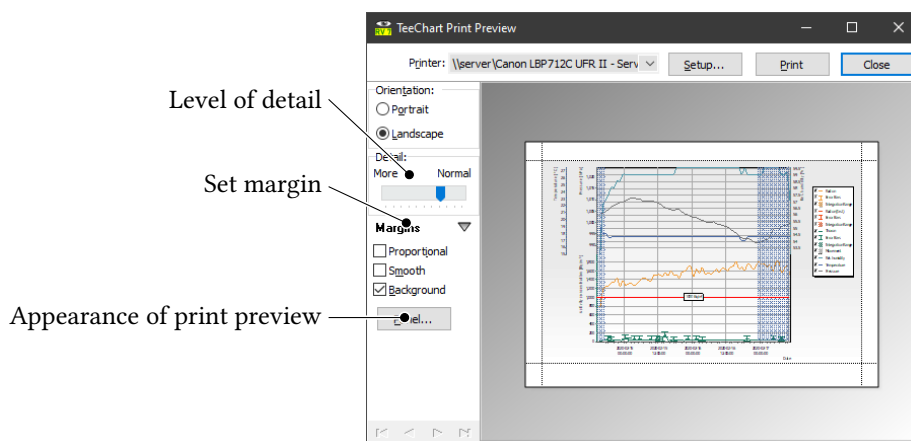
Figure 5.17.: Print preview

5.5. Calculation of exposure, dose and mean values

5.5.1. Display of the calculated values

To display the calculated average values, exposures and dose values, use the *Calculation* tab shown in Figure 5.2 on page 25. As soon as one or more areas in the diagram, as described in section 5.4.4, have been marked as integration intervals, the results table (33 in Figure 5.2) shows the corresponding values for each individual integration interval and for the entirety of all integration intervals. Only the parameters that are selected for display in the legend of the diagram are taken into account. For example, e. g. the average thoron 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 shown in the diagram. Finally, the relative error values only appear in the result 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" [2].

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 7* 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 7*, 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 7* 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 7 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 [1].

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 7 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 7* 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 7* 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, 9 in Figure 5.1).

5.6. Reports

As a professional tool for those responsible for radon protection and service providers, *Radon Vision 7* offers a flexible function for generating reports (34 to 36 in Figure 5.2).

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

The appearance of the report is largely determined by the template (36 in Figure 5.2), which you can customize yourself according to your needs. In the template file — the supplied templates can be found in the subdirectory `Templates` of the program directory — the placeholders for the values to be taken from the program are marked with a preceding `$` sign.

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

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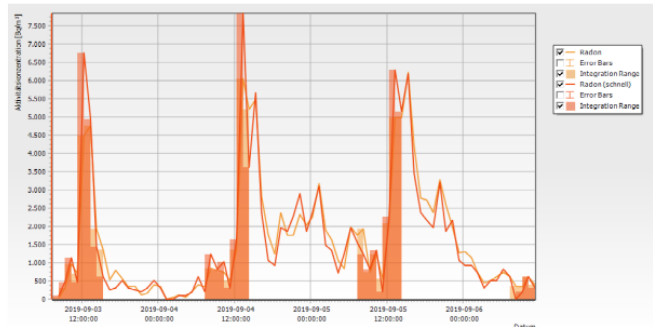
Start	End	Exposure time in h	Data records	Radon avg. in Bq/m³	Radon exp. in Bq h/m³	Radon dose in µSv
2019-09-03 07:30	2019-09-03 15:00	8,0	8	1823	14581	50,8
2019-09-04 07:00	2019-09-04 14:00	7,0	7	2218	15527	54,1
2019-09-05 07:30	2019-09-05 14:30	7,0	7	2364	16547	57,7
2019-09-06 07:00	2019-09-06 11:19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

Person in charge for this measurement   Thorsten Tennstedt

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Figure 5.18.: Report from standard template

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
$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

Variable	Meaning
`$ROW_220PAEC_MIN`	minimum of Potential Alpha Energy Concentration (PAEC) through ^{220}Rn progeny in the integration interval
`$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
`$TOTAL_222DOSE`	total dose by ^{222}Rn
`$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 change all other contents of the template file as you wish exchange, translate, move

or omit entirely.

> **Hint**
>
> *Radon Vision 7* searches for fields with the variables listed above when generating the report in the template and exchanges these **fields** with the value of the corresponding variables. Formulas in the template that contain variables therefore **do not work**.
>
> However, the template file `tmp-report_advanced_example` demonstrates a trick how you can still use these variables to calculate with the help of invisible fields.

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

A. List of keyboard shortcuts

Key combination	Function
Ctrl + O	File ⟩ Open file
Ctrl + A	File ⟩ Save as...
Ctrl + Q	File ⟩ Exit
Ctrl + S	Instrument ⟩ Search
Ctrl + E	Instrument ⟩ Setup
Ctrl + G	Instrument ⟩ Get data
Ctrl + P	View ⟩ Spectrum
Ctrl + T	View ⟩ Main toolbar

B. Known limitations and errors

1. The options for remote data transmission known from *Radon Vision 6* have not yet been implemented in *Radon Vision 7* except for the dial-up modem connection. For ZigBee and network connections via SARAD's *IP Box* you therefore have to use *Radon Vision 6*.

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

3. In Windows 10, the app flickers from time to time. This is a pure display problem in connection with updating other visual components in Windows. This does not limit the stability of the app. The effect occurs in particular when a slide show with changing background images is switched on on the desktop background.

4. 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.

5. 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.

6. If the Windows setting of the decimal separator does not match the language setting of *Radon Vision 7*, 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] *Ermittlung und Berechnung der Dosis aus der spezifischen Aktivität der Radon- und Radon-folgeprodukte.* URL: https://www.sarad.de/cms/media/docs/applikation/an-010_dose_calulation-de.pdf.

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

Glossary

PAEC Potential Alpha Energy Concentration.

PAEE Potential Alpha Energy Exposure.