MIRION TECHNOLOGIES Health Physics Division

Technical Handbook

CheckPoint:Body™

RTM110

Hand-, Foot-, Clothing-Monitor

January 2011

D300051

www.**mirion**.com

RADOS

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All data in this manual takes place using best knowledge, but without guarantee. We reserve, in the interest of our customers, that improvements and corrections at hardware, software and documentation will be made any time without announcement.

We are grateful for suggestions and critic regarding this documentation or the RTM itself.

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Register 1	General		14.01.2011	Reg1.docx
Register 2	Technical data		14.01.2011	Reg2.docx
Register 3	Structure and description		14.01.2011	Reg3.docx
Register 4	Service		14.01.2011	Reg4.docx
Register 5	User administration		14.01.2011	Reg5.docx
Register 6	System check		14.01.2011	Reg6.docx
Register 7	MPP		14.01.2011	Reg7.docx
Register 8	Detector		14.01.2011	Reg8.docx
Register 9	Trouble shooting and repair		14.01.2011	Reg9.docx
Register 10	Maintenance		14.01.2011	Reg10.docx
Register 11	Nomenclature		14.01.2011	Reg11.docx
Register 12	Supporting documents		14.01.2011	Reg12.docx

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1 General

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1.1 Health Physics Product Families

“Health physics”, also known as radiation protection, is concerned with protecting people from exposure to radiation, monitoring the effects of any exposures and recording any radiation dose received by the person. The “CheckPoint” product families by Mirion Technologies (RADOS) GmbH are the virtual envelope that holds a wide range of contamination and radiation monitors for radiation safety throughout all areas of a nuclear power plant. All types of radiation important for waste management and nuclear professionals (alpha, beta, gamma and neutron) are covered by the “CheckPoint” contamination monitors in their various formats, such as contamination on people, laundry, tools or in waste.

Figure 1-1: RADOS Health Physics product family overview

CheckPoint:Body™ family:

The use of radioactive materials can cause radioactive contamination spots in buildings and working areas. The CheckPoint:Body™ mainly concerns the check of people before they enter or leave an area, building or site. Contamination itself can be carried by workers on their clothes, tools and even on their bodies.

Family Members applicable **RTM110**

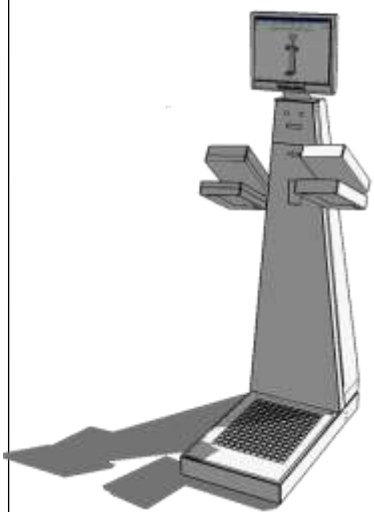


*Figure 1-2: **RTM110** design view*

	Additional information on the CheckPoint: Body™ Family monitors, which are not part of this technical handbook, can be reached by the manufacturer with the address given in this handbook.

1.2 Type series description

The Health Physics product family for the applicable family member consists of different models (type series).This documentation will cover all models from the series as listed below.

Not applicable references and text passage for all type series are individually marked.

The intention of this documentation is to instruct a user, who is skilled in monitor operation, with an easy reference to certain detailed questions. It must be assumed that it is not possible to give a complete knowledge about such a complex system with so many variations, in this documentation not referring to the actual build type series.

Type series members:

The Mirion Technologies (RADOS) GmbH contamination monitors are manufactured with different dimensions and detector configurations:

❶	**RTM110**	**Hand-foot-clothing monitor**
➲	Equipped with RADOS gas detectors.	
❷	**RTM110**	**Hand-foot-clothing monitor**
➲	Equipped with RADOS beta plast detectors.	

Table 1-1: Type series

Detector type list:

Abbr.	Name descr.	Type	Location	LxWxH (mm)
RBP	RADOS Beta Plastic Detector	RBP240 RBP240G RBP1050	hand clothing probe foot	275x162x39 275x162x39 442x342x39
RGZ	RADOS Gas Zähler (counter)	RGZ 270 Y RGZ 270 YG RGZ1100ZY	hand clothing probe foot	258x162x53 258x162x53 394x341x53

Table 1-2: Detector type list

1.3 Type series options

For a general overview all options are described briefly in this documentation although they are not applicable for all monitors.

Not applicable references and text passages for all **RTM110** types' series are individually marked in this technical handbook.

The actual build of the **RTM110**, which is briefly described in this technical handbook, can be reached in Register 2 Technical Data.
For detailed Information on an enhancement of your **RTM110** with options please consult the manufacturer with the address given in this handbook.

NOTE

The update of a RTM110 body contamination monitor with optional mechanic or software modules has no effect on the basic function as they are described in this handbook.

1.3.1 Type series mechanical options

To meet the customer's preferences the type series can be build with options.

Type series detector options:

	Detector options	Type	Family / Series
❶	Beta plast Version	RBP Detectors	**RTM110**
❷	Gas Version	RGZ Detectors	**RTM110**

Type series expansion options:

	Options	Number	Location
❶	Hand box	2	beside display
❷	Second foot sensor	1	for detector
❸	Display button	1	main frame
❹	CeMoSys	1	LAN
❺	Protocol printer	1 (local/LAN)	beside monitor/LAN
❻	Nuclide selection	1	main frame
❼	ID-card-reader	up to 2	main frame
❽	Control area button	1	main frame

1.3.2 Type series additional software features

As the technology used for release measurements is not just differentiated to country-specific particularities it is also subject to substantial changes in time. Continuously changing limits and changes in the philosophy of release measurements demand flexible design of the system software to guarantee efficient usage over many years.
In addition, the contamination monitor provides many optional features that are provided on top of the standard configuration.

<u>Type series software options:</u>

	Name	Specification
❶	PDF - print	Create protocol printout as a pdf-document. (Optional, per license)
❷	Network print	Use a network printer for protocol hardcopies. (Optional, per license)
❸	Detector test	A referenced measurement with a test dummy and a test source can be done for future checks of the detectors efficiency.

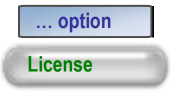
For a general overview all options are described briefly in this documentation although they are not applicable for all monitors.

Not applicable references and text passages for all **RTM110** types series are individually marked.

1.3.3 Type series technical handbook conventions

As this technical handbook is valid for all type series of the **RTM110** in the following icons are added to demonstrate that special hardware- or software-options are needed to perform the described task.

<u>Icons:</u>



- Optional hardware needed/missing
- applicable with adequate parameter setting or license only

- Additional Software license needed

1.4 Structure and subdivision

Text

This technical handbook has been created according to the guidelines of DIN EN 61187.

The texts are divided in up to 4 levels:

Level 1: script size of head line 22 pt, bold

Level 2: script size of headline 14 pt, bold

Level 3: script size of headline 12 pt, bold

Level 4: script size of headline 10 pt, bold

Script: Helvetica

Script size: for text 10 pt

1.4.1 Technical handbook systems and data carrier

Text- and CAD system

The text of this technical handbook is created with the word processing program Microsoft© Word© (from version 6.0) which is in common use at Mirion Technologies (RADOS) GmbH.

The drawing documents used in this technical handbook have been created with a CAD System and can be supplied in a common exchange format. These are:

- *.dwg
- For creating the design drawings a CAD-system is used:
- Auto-CAD©
- Auto-CAD©, Mechanical Desktop

1.4.2 Data carrier for text systems

Data carrier

In future Mirion Technologies (RADOS) GmbH intends to supply the technical handbook on data carriers.

The technical handbook is saved and supplied in Adobe Acrobat in *.pdf format.

For im- and export of data a standard USB-stick is used.

1.5 Applied symbols and writing style conventions

NOTE

Hints and valuable information for the user in the course of the description.

CAUTION

Always follow the basic precautions listed to avoid the possibility of damage to the instrument or other property.

WARNING

Always follow the basic precautions listed to avoid the possibility of physical injury, damage to the instrument or data loss.

DANGER

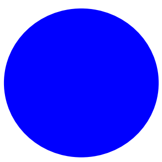
Always follow the basic precautions listed to avoid the possibility of serious injury or even death from electrical shock, short-circuiting, damages or other hazards.

Note the operation instruction or the documentation.

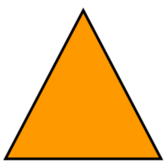
Applied principle in this document is the use of the following symbols:

Prohibited action

Mandatory action



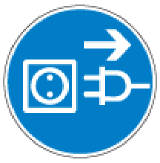
Warning



Example:

These symbols indicate processes or behaviors not allowed in the premises of the **RTM110**.

These symbols indicate special danger handling the **RTM110** that presents a risk of personal injury.



These symbols indicate important instructions accompanying the **RTM110** or special procedures with the **RTM110.**

These symbols should indicate the kind of danger precisely.

Writing style conventions

• **Bold type**	indicates the name of a button to press or touch.
• Underlining	is used to emphasize a word or term.
• *Italic type*	is used to indicate names, such as the chapter-, or screen names.
• *Figure X illustration*	Text referring to illustrations or screen samples is captioned below the image.

1.6 Product information

Product name:	Machine type:	CheckPoint:Body™ Hand- Foot- Clothing Monitor
	Model:	**RTM110**
	Serial number	SN612
	Order number:	110661
	Year of manufacture:	2011
Entries by customer:	Inventory-No.:	
	Location:	
Address of manufacturer:	Company name:	**Mirion Technologies (RADOS)**
	Street:	Ruhrstraße 49
	City:	22761 Hamburg
	Telephone:	+49 (0)40 - 85 193-0
	Fax:	+49 (0)40 - 85 193-256
	E-mail:	hamburg-info@mirion.com
Orders for spares and service:	Same as above:	
	Telephone:	+49 (0)40 - 85 193-187
	Fax:	+49 (0)40 - 85 193-165
Document data:	No. of document and operating manual:	D3.00.05.1
	Date:	01/11

1.7 Maintenance and safety

This chapter describes procedures necessary for keeping your **RTM110** operating reliably.
For troubleshooting problems, refer to the troubleshooting section (Chapter 9) of the technical handbook. Problems that cannot be solved need to be referred to your RADOS customer service.

1.7.1 Safety notices

This **RTM110** is designed and tested to meet strict safety requirements. These include safety agency approval and compliance to established environmental standards. Please read the following instructions carefully before operating the product and refer to them as needed to ensure the continued safe operation.

CAUTION

Any unauthorized alteration, which may include the addition of new functions or connection of external devices, may impact the product certification.
Please forbear from any unauthorized alteration.

1.7.2 Calling for service

If a problem with the **RTM110** occurs, an error description and a suggested solution will be displayed on the screen. Follow all steps in the suggested solutions until the problem is corrected.
If the problem still persists, call for assistance.

Follow the instructions below before calling for service.

1. Be prepared to provide a complete description of the problem to the service operator. Defining the problem accurately may help you and the operator to solve the problem over the phone and minimize downtime. If the problem cannot be solved by phone, a service representative will be dispatched to your site.
2. Record the displayed fault description.
3. Record the machine serial number.
4. If possible, use a phone near the ***RTM110*** when calling for assistance. Describe the problem and answer the questions from the service operator about the defects. Follow the instructions given by the operator.

1.7.3 Electrical safety

Use only the power cords and cable supplied with this equipment.

- Plug the power cords directly into a correctly grounded electrical outlet or outlets supplied by the **RTM110**.
- Do not use extension cords.

CAUTION
If you do not know whether or not an outlet is grounded, consult a qualified electrician. **You may incur a severe electrical shock if the outlet is not grounded correctly.**

- Do not place objects on power cords.
- Do not override or disable electrical or mechanical interlocks.
- Do not obstruct the ventilation openings.
  These openings prevent overheating of the machine.
- If any of the following conditions occur immediately switch off the power of the machine and disconnect the power cord from the electrical outlet.
  Call an authorized service representative to fix the problem.
- The machine emits unusual noises or odors.
- The power cord is damaged or frayed.
- A wall panel circuit breaker, fuse, or other safety device is tripped.
- Any part of the machine is damaged.

1.7.4 Maintenance safety

- Do not attempt any maintenance procedure that is not specifically described in the documentation supplied with your **RTM110**.
- Do not use aerosol cleaners. The use is not approved and may cause poor performance or could create a dangerous condition.

1.7.5 Operational safety

The **RTM110** equipment and supplies were designed and tested to meet strict safety requirements. These include safety agency examination, approval and compliance with established environmental standards.
Your attention to the following safety guidelines will help to ensure the continued safe operation of your **RTM110**:

- ⇨ Use only the materials and supplies specifically designed for your **RTM110**. The use of unsuitable materials may result in poor performance of the machine and possibly a hazardous situation.
- ⇨ Follow all warnings and instructions that are marked on or supplied with the machine.
- ⇨ Do not attempt to move any machine parts.

1.8 Disposal and recycling

1.8.1 Disposal and long time storage

The information of the section shall be used whenever the operator decides to stop the device from operation for a longer time period or for disposal.

Preparation tasks:

Task	Action
❶	Turn off power. Secure device against accidental re-activation by a third party.
❷	Remove and store all cables from device.
❸	Do not use airtight cover on storage sides, otherwise the corrosion of various parts will be increased.

⚠ WARNING

Risk of injuries caused by cuts!
The dismantling of the device conceals the risks of injury due to sharp edges and corners of the device housing.

Therefore, it is advised to use appropriate work gloves.

1.8.2 Recycling

The sign labeled on the product indicates that it is not allowed to use customer waste sides or bins for disposal.
The operator of the device is committed to use other waste material streams. Generally this is necessary to examine the issues of prevention, product recycling and materials recycling when evaluating individual electro scrap recycling options prior to final disposal.

The waste material stream for electro scrap is part of the public authorities.

Some materials, parts or subassemblies can be used for another purpose than that for which they were originally conceived (i.e. at a lower level).

The reuse is a part of the overall environmental protection. Please consult your local public waste management company for further information.

RECYCLING

In order to prevent possible environmental damage the following instructions must be followed carefully.
Even if an approved waste management company is performing the tasks the operator must ensure the proper task execution!
The disposal of all device parts must ensure that health and environmental damages are excluded.

Recyclable materials of the device:

Material	**Used in**
Copper	Cable
Plastic, rubber, PVC	Seals Hoses Cable Framework
Tin	Circuit board
Polyester	Circuit board

special waste:

Material	**Used in**
liquid-crystal display (LCD)	Display
Electro scrap	Circuit board, components

1.9 Safety precautions

The consideration of this documentation is a necessity for the trouble-free operation and the execution of possible guarantee claims. Please read the documentation carefully before starting to use this monitor, in order to secure a safe operation.

The documentation contains important notes for the service work. Therefore, it should be kept close to the monitor.

NOTE

All works necessary to operate the monitor as maintenance, transportation, storage, set-up, assembly and commissioning must be carried out only by qualified personnel with strict adherence to

- **circuit drawings and technical documentation**
- **warning and safety precaution signs**
- **safety notes and technical data sheets**

which are given in this documentation.

CAUTION

Severe personnel and material damage may occur because of

- **not considerating the content of this documentation**
- **wrong installation or operation**
- **not permitted removal of safety features**

Commissioning/Service

NOTE

The commissioning of the monitor requires qualified expert personnel or Mirion Technologies (RADOS) GmbH service personnel.

Operation

The operation of the monitor requires trained personnel.

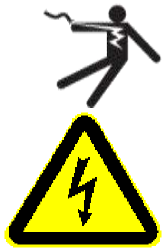
1.9.1 Electronics

Marking

WARNING

Life Danger

If the monitor shows any errors, defects or repairs have to be carried out; the monitor has to be disconnected from mains. Therefore the operation software has to be finished and the measurement computer has to be shut down first. (refer to register 3 chapter 3.5 for details)



Marking of dangers and dangerous areas

Danger!
High Voltage

Electric shock

Label:

- **Mains terminal**
- **Connectors**

Application:	**Electric voltage in working room** ■ **Switch room, electric distribution, detectors**
Attention!	Work to be carried out **only** by qualified service personnel or Mirion Technologies (RADOS) GmbH service personnel.
	Dangerous electric voltage.
Performance:	Works in the marked area are **only** to be carried out by: ■ Experts in electric or electro-technical trained personnel
To attach:	On voltage carrying components. ■ Clearly visible ■ Permanently visible
Possible consequences:	Danger of electric shock. ■ Death ■ Serious burnings

1.9.2 Gas connection

NOTE

1. **It must be ensured that sufficient air influx is provided.**
2. **The gas outlet should be connected to a ventilation system.**
3. **A semi-annual testing of all gas connections e. g. with the RADOS gas warning system is recommended.**

1.9.3 Flammable and non-flammable gases

Gas

WARNING

1. **Flammable:**
Methane 100% belongs to the group of gases that have an ignition range if mixed with air and under normal pressure. Such gases are called flammable in the sense of the **German Accident Protection Regulation VGB 61**. Due to the low portion of methane contained in P10 gas (ratio 90% Argon, 10% Methane), a danger in case of added fresh air in general can be excluded.
2. **Non-Flammable:**
A Mixture of Argon and CO_2 in the sense of the **German Accident Protection Regulation VGB 61** is characterized as non-flammable. According to any of the criteria, it cannot be related to flammability, health-threatening, fire-fostering, chemically instable and/or water-endangering

1.9.4 Marking by note signs

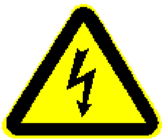
The gas supply for the monitor is marked with a sign for inlet and outlet valve. Following warnings are given on the label:

*Figure 1-3: Label gas **RTM110***

Mains

CAUTION

The mains connection of the monitors is marked with a sign (sticking label) "Pull mains plug before opening the monitor housing”.



1.9.5 Transport

The **RTM 110** is equipped with a handle and transport-wheels to ease the transport to the final destination.

Transport

Refer to register 10 for detailed information.

CAUTION

Please pay attention while moving the monitor.

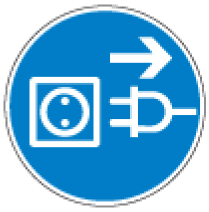
The monitor must be secured on transport as there is a danger of tipping for the monitor.

In case of transport the monitor has to be safeguarded against toppling!

WARNING

1. **If the monitor has to be moved, it is not allowed to use the clothing probe as a handle!**
2. **If the monitor is cautiously leant backwards by two people it is possible to move it on the carriage wheels. The main corpus of the monitor should be used as a handle**
3. **Please use extra care not to use the hand boxes or LC Display attachment to move the Hand foot clothing monitor!**

1.9.7 Connection to mains



The mains connection is prepared by a cable leading directly into the monitor. If it is necessary to change the mains use the country specific plug and the connecting has to be done in accordance to the monitor drawings.
For the connection values please refer to the technical data or to the type plate.

WARNING

The monitor **RTM110** has to be disconnected from mains prior any maintenance work.

Persons may be harmed by electric shocks!

1.9.8 Name plate

The nameplate attached to the monitor is clearly visible.

Typ	- type of monitor, e. g. **RTM110**
Nr.	- serial number of the monitor
Baujahr	- year/date of manufacture,
Teilenr.	- part number of the monitor
V + Hz	- supply voltage, e. g. 230V/50Hz
A	- Power consumption

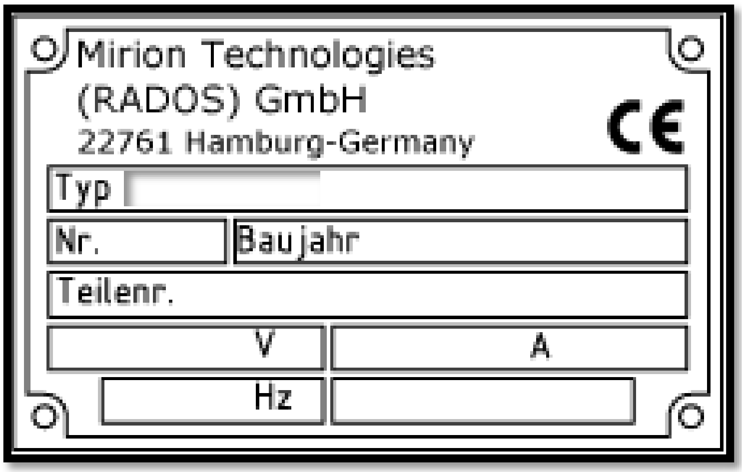


*Figure 1-4: Name plate **RTM110***

Software

1.10 Operating and User Software

Due to the new electronics and new PC 2010, the system is equipped with the latest development of QNX6.x operation system.

The new operation system supports most modern drivers for external equipment. It is therefore faster and more reliable.

1.10.1 QNX 6.4.x – operating system

In order to measure objects fast and reliable, many calculations of individual procedures have to run simultaneously. This requires a computer system that allows all operations with multi-task handling in real time, to measure the background continuously. For this aim Mirion Technologies (RADOS) GmbH has been using the operating system QNX for many years to carry out the different measurement tasks. The whole system is based on a very small and thus very fast core. This core is only responsible for the exchange of messages and the distribution of the computer capacity between simultaneously running programs.

All other functions of the operating system are available as independent programs and thus they can be used very flexibly.

Some of these functions are:

- The “Process Manager “for start-up, monitoring and finishing of all programs; in accordance with the POSIX standards 1003.1 and 1002.1b.
- The “File system Manager” for safe work with the different memory media with the file systems POSIX, DOS and ISO 9660 as well as the form of a memory medium of various hard disks, CD-ROM, ROM and Flash memory.
- The “Device Manager” for fast processing of all programs with the interfaces of the computer. These include the video monitor, terminals, modems as well as serial and parallel interfaces.
- The “Home Manager”, for addressing instance databases or special hardware.

Based on this architecture, extremely short task switches and reaction times are provided.

Network functions belong already to a standard part of the operating system. With different drivers any topologies can be used (e.g. Ethernet, Token Ring and FDDI). The TCP/IP– and NFS – protocol can also be used optionally thus allowing for a connection to all networks and large computers.

The modular design of the operating system makes it possible to employ computers of different capacity and size, depending on the task range to be accomplished. The computer capacity of the processors is made fully available to the user with the application of the 32 bit protected mode.

Due to the strict compliance with the UNIX and POSIX guidelines the source code is compatible to the world of UNIX systems (workstation, etc.).

1.10.2 Brief introduction to QNX6

Since 1980 many manufacturers have relied on QNX real time OS (RTOS) technology to power their mission critical applications. Everything from medical instruments and Internet routers to in car infotainment devices, nuclear monitoring systems and military communications has been build with the use of QNX. Small or large, simple or distributed, these systems share an unmatched reputation for operating 24/7 (24 hours a day, 7 days a week).

The time-tested and field-proven QNX is built on true micro kernel architecture. Under QNX every driver, application, protocol stack and file system runs outside the kernel, in the safety of memory protected user space. Virtually any component can fail and be automatically restarted without affecting other components or the kernel. No other commercial RTOS provides such a high level of fault containment and recovery.

But it is also important that all components communicate via a single, well-defined form of communication: synchronous message passing. This message passing form is a virtual ”software bus which provides ultra-reliable systems for the networking. Better yet, messages can flow transparently across processor boundaries, allowing your application to access any resource, anywhere on the network.

Engineered to the POSIX standard (1003.1-2001 POSIX.1), QNX gives you the power to port legacy and open-source UNIX, Linux and Internet codes with just a simple recompile. With standard APIs you can reuse application code, avoid costly delays and shorten your learning curve — accelerating development cycles and reducing time to market. In addition, QNX Neutrino provides pre-integrated, out-of-the-box support for a wide range of networking protocols, from traditional TCP/IP to next-generation stacks — all based on BSD and POSIX standards and optimized for interoperability.

QNX Software Systems, a **Harman International Industries Inc.** subsidiary (NYSE: HAR), is the industry leader in realtime, embedded OS technology. The component-based architectures of the QNX Neutrino RTOS and QNX Momentics development suite provides the industry's most reliable and scalable framework for building innovative, high-performance embedded systems. Global leaders, such as BMW, Mercedes, Cisco, General Electric, Lockheed Martin and Siemens depend on QNX technology for network routers, medical instruments, vehicle telemetric units, security and defense systems, industrial robotics and other mission or life-critical applications.

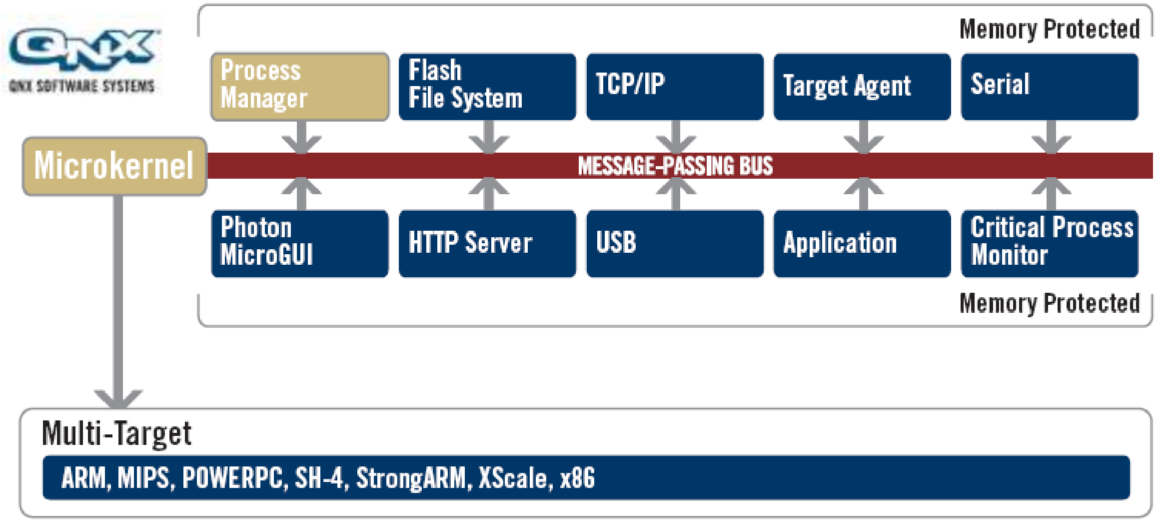


Figure 1-5: QNX RTOS system overview (picture source: QNX Software systems)

1.10.3 Operation of QNX6

The QNX provides a **G**raphical **U**ser **I**nterface for the operating system QNX. The complete operating is effected via menus and graphical symbols, so that the software and system functions are easy to handle.

The surface provides some graphical displays and input elements for communication with the user. These elements are introduced in short and it is described how they are operated.

- Selection switch: selection of one out of several options
- Input field: input of digits or characters
- Sliding bar: display of a digit in relation to a total
- Switch: Selection out of two possible modes. The switched-on mode is either displayed by a blue-collared rectangle or by a pressed switch.
- Button: to start a specific program action
- Menu button: request to display a pull-down menu

1.10.4 General conventions of this documentation

This is a general description of the conventions which are used in this documentation to operate in maintenance mode.

<key>:	Actuation of this key.
<Enter>:	Any user input (digits, letters) is acknowledged with this key.
<Alt>-<letter>:	After the "Alt" key has been actuated and kept pressed down, the stated letter is entered.
<Ctrl>**-**<Enter>:	After the <Ctrl> key has been actuated and kept pressed down the <Enter> key is to be activated.
Menu/Input in Menu:	An input in the menu has to be activated; for instance the meaning of service/ measurement status: there is a service menu, where the input "measurement status" has to be selected. (For operation of menus refer to next chapter” select menu”).
Button:	A with the label "button" is to be activated in the present window. (For operation of buttons refer to next paragraph ”button”).

1.10.5 Operation of window elements

Select menu

Basically the menu bar is positioned only in the upper part of an outer window frame. Behind the button of the menu there is a selection of program actions, which can be activated by the user. With a click mouse click on a menu button the select menu is shown. The presently selected menu mask is marked with a frame.

Button

The button is selected by positioning the cursor on the desired button and touching it. Then the requested program action is carried out.

1.10.6 CeMoSys™ Server (OPTION)

CeMoSys™ stands for Central Monitoring System for RADOS Contamination Monitors. This application supplies the owner of Mirion Technologies (RADOS) GmbH contamination monitors with a browser based monitor overview. It opens the possibility to view the measurement and the monitor status.

The following Mirion Technologies (RADOS) GmbH contamination monitors are prepared to work with CeMoSys™ in the operational Software:

CheckPoint:Body™	**TwoStep™–Exit, TwoStep™–Exit II OneStep™, RTM860TS, TwoStep™-PRE, RTM110 HandFoot-Fibre™, HandFoot-Fibre™–MED**
CheckPoint:Laundry™	RTM750, RTM740
CheckPoint:Gate™	CheckIn-Clean™, GammaPortal-CMS™, RTM910, RTM910N, RTM911i, FastTrack-Fibre™, D&D-Portal™
CheckPoint:Waste™	RTM600*, RTM610*, Tool&Object-Monitor TOM*, RTM661/300*, RTM661/440*, RTM661/540*;RTM644*

*only Measurement status is embedded

More contamination monitors are planned to be embedded by the **Mirion Technologies (RADOS) GmbH**.

For connection to CeMoSys™, every monitor needs to have a special CeMoSys™ client.

The CeMoSys™ Client is a software module, which is implemented and operating on RADOS contamination and clearance monitors, that gathers, stores, and transfers critical data to CeMoSys™ RTM user software. The tasks of the CeMoSys™ client are:

- Identification of new measurement results, test protocols or a monitor status change.
- Processing data and data storage of the respective measurement or parameter data in a data file.
- Transfer of data file to the CeMoSys™ database server using FTP.
- Intermediate storage of data file on RTMXXX local hard disk drive (if no network connection available) and automatic transfer of the stored data as soon as the network connection is available again.

1.11 Start-up menu

The start-up menu is the central navigation tool for all **RTM110** software modules. Every software module can be reached by touching the corresponding button.

Figure 1-6: Start-up menu

Software modules provided via the **Start-up Menu**:

Start	**starts the RTM user software the main program to perform contamination measurement (see register 3 and register 4)**
Service	Starts the **service** functions to perform the computer and detector administration.
System check	the maintenance and calibration program for body contamination monitor (see register 6)
MPP	Monitor Plateau Plotter (**Register 7**).
User profile	User administration program (see register 5)
load parameter save parameter	Enables the user to im- and export all **RTM110** parameter on a USB-stick
HW Setup	Program to configured the hardware settings of the present **RTM110**
System parameter	program to set i.e. the timestamp and screen resolution
Error/info protocol	list of the last system internal messages i.e. useful for troubleshooting
QNX Shell	Enables the user to get access to the local hard disk.
SHUTDOWN	shutdown the **RTM110**

1.11.1 Software functional sequence

In this chapter the functions of the monitor in the sequence of the actual operational mode are described.

These modes are divided as following:

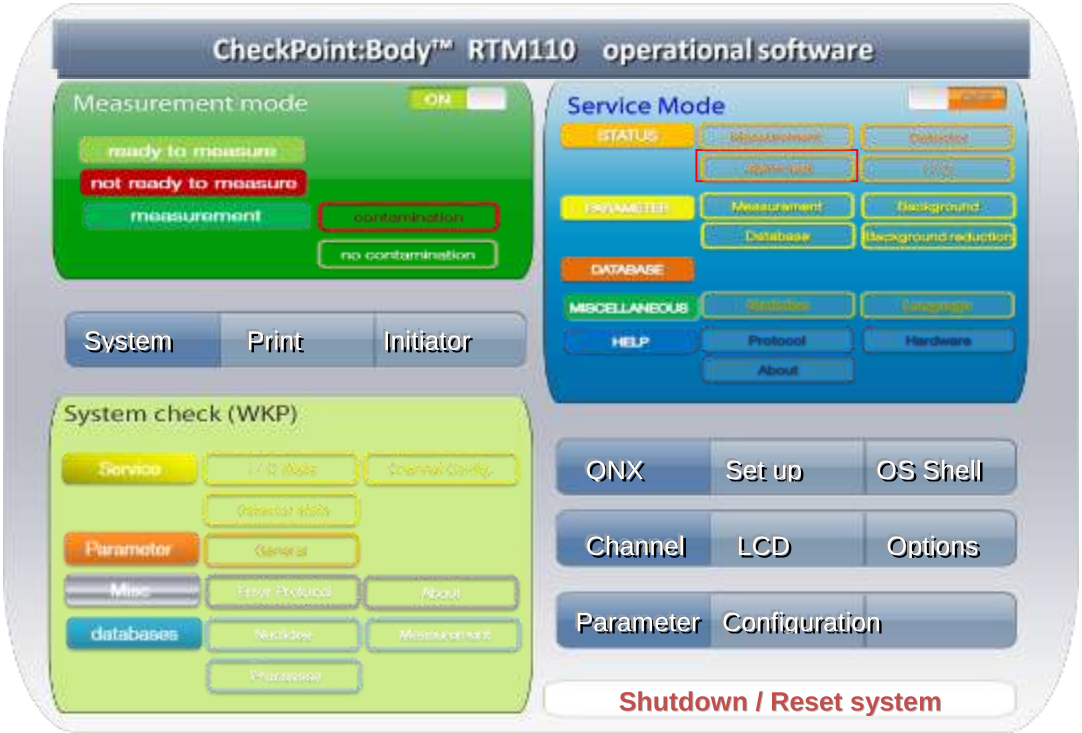


Figure 1-7: Software functional sequence

1.11.2 Operating conditions

The user software differentiates between two operation conditions:

Measurement mode

The **measurement mode** is the normal operational mode.
In this mode the measurement of objects is carried out.
The measurement mode is either in state of **contamination** or **ready to measure**. The monitor uses the phase **ready to measure**, i.e. the time period between the measurements, to check the connected detectors for their proper function and to measure the background.

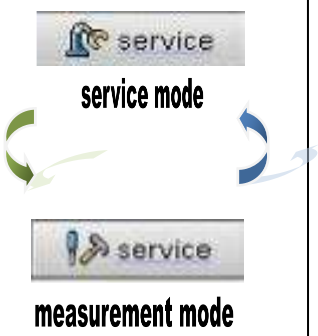


Figure 1-8: Service button

Maintenance mode

The **maintenance mode** is a very sensitive sector of the monitor and should therefore be accessible only to trained persons. This mode can only be entered via the respective button/key. In the maintenance mode there are different sub-menus available to control the function of the monitor and to adjust all parameters influencing the measured value.

1.11.3 Operational conditions submenu

The programs from the operational submenu will be started in the **maintenance mode** directly from the **start up** menu. This indicates that a **measurement operation** is not possible while performing the sub menu programs.

System check see register 6

The **system check** is a calibration tool to investigate quality changes over a time scale. The software is used to determine the detector efficiency and to manage the nuclides. Nuclide management comprises the acquisition, change and management of nuclide relevant information. By using these data, the efficiency of a nuclide relevant count rate measurement can be determined.

User administration see register 5

The **user administration** software is used to administer existing users, add new users, delete existing users or change the privileges of users operating software modules.

Load /Save configuration see register 10

The **load / save configuration** menu is used to save the operational parameter set to the **RTM110**. This utility is part of the data security policy for save and continuous operation. The configuration data can be stored to the local hard disk or a USB stick.

HW setup and system parameter see register 10

The **HW setup** program is designed to alter sensible monitor parameter after hardware changes are done to the **RTM110**.

The **system parameter** allows altering the QNX system settings like date, time and language or network environment.

QNX-Shell

The sub menu **QNX Shell** is placed in the startup menu to enable direct file access on the monitor hard disk. Usually this function will only be used by service personnel.

Print screenshot/protocol

Figure 1-9: Pictogram "printer"

The print screenshot function is functionally placed on a variety of menu screens. This enables the user to file actual displayed data even if a regarding print template is unavailable. The print screenshot function can easily be reached by the **printer** icon.

1.11.4 Exit user software

ATTENTION

The shutdown of the RTM110 (e.g. for maintenance) MUST follow this guideline to prevent any damages at the measurement computer or the electronic.

A damage of the RTM110 caused by ignorance of this guideline will lead to a loss of guarantee and warrantee by Mirion Technologies (RADOS) GmbH.

*Figure 1-10: **RTM110** close*

(1) Quit executing user software with ***close***.

(2) In the “start up- Menu” select the button ***shutdown*** to close operational software.

*Figure 1-11: **RTM110** shutdown*

(3) After select the button “***shutdown***” the display shows.

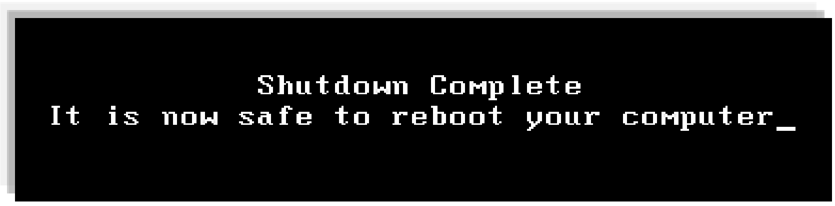


*Figure 1-12: **RTM110** shutdown complete*

(4) Use the mains switch to shut down the monitor, after the display shows the end of the shutdown process.

1.12 Authoritative regulations and guide lines

1.12.1 Guide line for machines

Before commissioning the **RTM110** monitor this documentation must be read in order to carry out a safe operation.

Changes

CAUTION

In case of unauthorized changes or supplementations of the machine the declaration of type conformity becomes void.

Caution and safety hints have to be duly noted and complied with.

Operation

CAUTION

The operation of the machine requires trained personnel.

1.12.2 Supporting documentation

Necessary supporting documentations are attached in register 12 of this technical handbook.

1.13 Copyright

Technical handbook

All data provided in this manual underlies best knowledge, but comprises no guarantee. In the interest of our customers we reserve the rights that improvements and corrections at hardware, software and technical handbook will be made any time without announcement.

Only with written consent from Mirion Technologies (RADOS) GmbH the contents of this technical handbook may be passed on to third persons. Especially procedure descriptions and explanations are not to be passed on to third persons.

Copying or multiplying for internal use is permitted.

We are looking forward for suggestions and critics regarding this technical handbook or the RTM itself.

1.14 User administration preset user

Every user belongs to one of five user groups with specific authorizations (in decreasing authority order):

Superuser	**Level 1**
Master	**Level 2**
Service	**Level 3**
User	**Level 4**
User_Low	**Level 5**

The authorizations of a higher user group include the ones from the user group below.
In order to ease the user administration and to provide the set-up process, default users, provided with the needed authorizations for administration, have been created.

NOTE

The CheckPoint:Body™ **RTM110** comes with following User and passwords as factory default setting:

Level	Password
Superuser	xxx
Master	xxx
S rvice	xxx
User	xxx

Explanations to the user authorizations in the individual user groups are stated in **Register 5**.

NOTE

When entering the user name and password, please pay attention to upper and lower case letters.

NOTE

We recommend to remove this page from the documentation or create new users and to delete the users described on this page, in order of save monitor operation in the customer environment.

2 Technical data / Circuit drawings

2.1 Technical data

RTM110 -Type-Series			
Type	Power;	rated current	fuse
	☑ 230V/50Hz;	0,5A	6.3 A mtr.
RTM110	☐ 110V/60Hz;	1 A	

General Data

	L x W x H
Dimensions	
Electronics housing with transport roller ☑ stainless steel	☑ 580 x 850 x 1700 mm
Weight	
Electronics housing	☑ approx. 70 kg

Options

☐ P^2	☑ hand box	☐ protocol printer
☐ display button	☑ second foot sensor	☐ CeMoSys activation
☐ nuclide selector	☐ extra relay	☐ other

PC

computer PC board	Soldered onboard Intel® Atom™ N270 1.6GHz CPU with 533MHz FSB
RAM	Soldered onboard 1GB DDR2-533 SDRAM
chipset	Intel® 945GSE + ICH7M
graphics	Integrated Intel® GMA950 GFx Core
I/O	1 x RS-232 ports with RJ-45 connector 2 x RS-232/422/485 RJ-45 connector USB Port 6 x USB 2.0 ports LAN 2 x RJ-45 ports for Gigabit Ethernet
HDD	1 x 2.5" drive bay for HDD/SSD
monitor	15” TFT - display
sound card	Audio Mic-in/Line-in/Line-out
keyboard	by customer Specification (order)

Software

Operating system	QNX 6.4x	
User Software	V: 4.xx	
	☐ System check	☐ User profile
	☐ CeMoSys activation	☐ PDF print
	☐ options	☐ Network print

Detector communication

Detector Module ☑ **RLC**

Two detectors are connected to one detector module (high voltage, discriminator) which itself is connected via twisted pair cable.

Technical data (continued)

Detectors

RBP	**Beta plast detectors**	
Type quantity	**Dimension** (mm)	**Location**
☐ **RBP240** ☐ 1 ☐ 3	275 x 162 x 39	hand
☐ **RBP240G** ☐ 1	275 x 162 x 39	clothing probe
☐ **RBP1050** ☐ 1	442 x 342 x 39	foot

RGZ	**Gas detectors**	
Type quantity	**Dimension** (mm)	**Location**
☑ **RGZ270Y** ☐ 1 ☑3	258 x 162 x 53	hand
☑ **RGZ270YG** ☑1	258 x 162 x 53	clothing probe
☑**RGZ1100ZY** ☑ 1	394 x 341 x 53	foot

Detector window	
Foil Area thickness and weight of detector foil	Aluminum-evaporated foil, Mylar 0,3 µm/ 0,4 mg 0,8µm/0,8 mg

Grid cover for sensitive detection area:

Grid	Gas detectors	Beta plast detectors
T88	RGZ270Y	RBP240
W5	RGZ270YG	RBP240G
No foil	RGZ1100ZY	RPB1050

Technical data (continued)

Gas supply		
flushing gas	☐ Chrysal ☑P10 (90 %/10 %) ☐ P 7.5 (92.5 %/7.5 %)	☐ Argon-CO^2 ☐ Argon-Methane ☐ Argon-Methane
gas flushing time ➔ Warm-up period	P10	approx. 2 h
	P7.5	approx. 4 h
	Ar/CO_2	approx. 4 h
flushing value	Approx. 5 l/h (the choker valve is complete open) After the warm-up period is finished the choke valve has to be closed until the gas flow meter shows a flushing value between 4 to 6 l/h.	
Permissible deviation limit	maximum 3 %	
Gas supply compression	Inlet 3 bar Outlet 50 mbar	
Gas Consumption	4 l/h Counting gas consumption if detector foil is not damaged	

Maintenance	
maintenance rate	1 year

Ambient conditions	
Operational temperature	0°C up to +45°C
humidity	relative humidity 75 % on annual average 95 % for 5 h no condensation
storage	The monitor is to be stored under dust-free conditions; otherwise it is necessary to cover the monitor with dust-protection wrapping.
storage temperature	-20 °C up to +75 °C
humidity	relative humidity 75 % on annual average, 95% for 5 h, no condensation
Operational temperature	0°C up to +45°C

CE conformity

This contamination monitor fulfills the required guidelines for electromagnetic compatibility and protection.

2.2 Response capability and MDAfor detectors

The Response capability is defined on the basis of the SSK recommendation
„Requirements of contamination control when leaving a controlled area“, no. 143a, released 03.08.02 (ISBN 0720-6100). The SSK (short for StrahlenSchutzKommision) is a national commission on radiological protection in Germany.

According to its constitution and in preparing its recommendations the SSK considers the fundamental principles and quantitative bases upon which appropriate radiation protection measures can be established, formulates the specific advices, codes of practice, or regulations that are best suited to the needs of radiation protection. The SSK acts as a consultant for the Federal Ministry for Environment, Nature Conservation and Nuclear Safety.

Protective grid: The hand detectors are protected by a fine honey comb grid.

Definition:

S(β)min	=	minimum attainable response capability
S(β)	=	response capability attained
k1min	=	smallest detectable contamination
N0	=	background
n	=	measured total count rate
$A_{aktuell}$	=	actual activity of source

Formalism:

$$k_{1,min} = \frac{3.3}{S} \cdot \left(\sqrt{\frac{2 \cdot N_0}{t^2}} \right)$$

$$S = (n - N_0) / A_{aktuell}$$

The calibration data of each detector is listed on a label at the detector surface. Due to different readout methods the labels at the back sites of a detector may differ for the values for background counts and efficiencies to the values in the monitor.

2.2.1 Minimum detectable activity (MDA)

RTM110				
Parameter / settings	Sigma		BG	Meas. Time
	1.65 + 1.65		0.1 µSv/h	5 s
Type of detector	Gas detector RGZ		Betaplast detector RBP	
source in contact to Rados Std.-grid	Hand	Foot	Hand	Foot
Sr-90 / Y90	10 Bq	15 Bq	12 Bq	25 Bq
Cl-36	15 Bq	28 Bq	20 Bq	35 Bq
Co-60	25 Bq	40 Bq	40 Bq	68 Bq
C-14	35 Bq	75 Bq	95 Bq	310 Bq
I-131	20 Bq	30 Bq	45 Bq	80 Bq
Am-241	25 Bq	50 Bq	45 Bq	310 Bq
Am-241	5 Bq	8 Bq	RGZ discriminated	

2.3 Circuit drawings

Description	**Drawing number**
Complete monitor	3E0602-1
Computer unit PC2010	3215PC201000
Connection for loudspeaker	4E0271F1
Foot sensor left	4E0310-1
Detector cables RBP	3E0604-1
Detector cables RGZ	3E0603-1

3 Structure and measuring operation

Table of figures

3.1 Total view RTM110

Figure 3-1: ***RTM110*** *view*

Description	Drawing number
Total view with 4 hand detectors	3M1278…
Total view with 2 hand detectors	3M1709....

3.2 General

This technical handbook has been worked out according to the DIN EN 61187 guidelines. It shall provide the user with the functions of the monitor and shall get him acquainted with its specific features. In this relation, a number of basic physical connections are described and explained in detail where it is necessary.

NOTE

This documentation will explain the "maximum version" of the body contamination monitor RTM110 .
All possible options and extensions will be shown and explained.
The description of optional Items will be indicated with the word "OPTIONAL" in parenthesis.
In case of options not present in your RTM110, please, jump to the next paragraph.

The absence of optional functions will not impair the correct work of the RTM110 ..

If you are interested in upgrading your RTM110 .with options please feel free to contact the RADOS customer service with the address given in register 1.

A definition of terms will be given in the "Glossary" of the technical handbook, which makes it easier for users to understand this terminology which often includes more than the term given.
The RADOS Customer Service would be glad to receive your advice for further improvement of this technical handbook or even the monitor.

3.2.1 Measuring task

The **RTM110** body contamination monitor is used in any place where the surface contamination of persons has to be monitored for a certain limiting value. This could happen at the exit of operational areas for surface contaminations of tools, clothing, hands and foots.

It is the measurement task of the body contamination monitor to detect a person's surface contamination above the limiting value with a high statistical reliability. In contrast, based on a high statistical reliability, no contamination alarm shall be given when there is a non-contaminated person. The contamination measurement shall be performed within the shortest possible period of time to achieve a maximum throughput of people.

It is the function of the RADOS hand-, foot-, clothing monitor (called **RTM110**) to control the observance of the limiting values of the Radiation Protection Regulation.

3.2.2 Further efficiency considerations

The detection limits as well as the maximum surface activity to be measured are influenced by a number of parameters.

These are in particular:

- the efficiency of the large-area proportional detectors, referred to the measured nuclide
- the intensity of the background radiation
- the statistical detection safety
- the statistical safety against false alarms caused by the background
- the measurement time and
- the time for the background measurement.

The monitor measures contamination by use of large-area flow proportional detectors. The efficiency of these detectors in contact is approximately 35 per cent for a strontium radiation emitter (related to the ^{90}Sr nuclear parent). The efficiency in this respect does not only depend on the kind and energy of particles, but it is largely influenced by the structure of the safety guards, the detector frame and the distance between the radiation emitter and the detector window. These aspects have to be taken into consideration when you study this value.

An activity of - for instance - 370 Bq provides a pulse rate of about 130 cps in addition to the background, which is determined by the natural terrestrial and cosmic radiation. At an ambient radiation of 0.1 µSv/h and by the use of detectors having an effective detector area of 300 cm², this background is about 16 cps. The normal ambient radiation is between 0.06 µSv/h and 0.2 µSv/h depending on the natural environment i.e. rocks with Radon and decaying Radon products. – detector-spezifisch

Therefore, a warning threshold shall be set in such a way that - on the one hand - it is not released by the background radiation, but on the other hand it shall react with a safe reliability for an activity of 370 Bq, for example.

Now, if the background radiation is changing, the warning threshold shall also be altered in relation.

If the warning threshold is not adjusted, the monitor is going to produce error alarm signals if the background increases and if it decreases the activity limit value cannot be detected safely. The background may be changed - for example - if there is a radiation emitter within the close vicinity of the monitor. This value may also be influenced by the gaseous state of the detectors.

Therefore, the warning thresholds of all connected detectors of the RADOS monitor are automatically adapted to a changing background.

For the microprocessor-controlled monitor this is done by the "background-subtraction". The actual background is constantly measured and stored during the measuring breaks.

3.2.3 Background subtraction

When the monitor is in operation, the principal function procedure is divided into "ready to measure" and "contamination measurement".

In "ready to measure" stage, the time between the contamination measurements the correct functioning is monitored and the background is constantly measured.

The detector signals generated by the background gamma radiation are called background. Measured over an integration time this measuring effect is called ‘count rate’. This effect may be superimposed by contaminated detectors.

The procedure chosen is mainly characterized by the fact that defective or contaminated detectors are recognized via special measuring routines. They would simulate an increased background value during background measurement. With these detectors, a personnel contamination would not be detected reliably. These measuring and testing routines are performed automatically in the background during the monitor's operation. This guarantees a continuous measuring operation and provides reliable personnel measurements.

In the following, the background measurement is also called 'the learning stage'.

When the monitor has at least finished the first learning stage, i.e. all detectors are working normally, the stage "ready to measure" is reached and the monitor can be entered for personnel measurements.

The person to be measured operates the initiators (hand, foot and handle) that activate the "measuring phases".

The user is requested to activate the monitor correctly and to take up a correct position of the body. When the instructions have been observed, the measurement begins. After the front is measured, the person to be measured turns around and then the back measurement is performed.

After the integration period is over, the counts given by the individual detectors are calculated to get the corresponding count rate. It is called gross count rate. From this gross count rate, the background value of the respective detector is subtracted. The Fig. of the resulting net count rate is compared to the value of the alarm threshold, which can be specifically pre-adjusted for each detector.

If the threshold is exceeded, an existing contamination will release an alarm signal. Apart from the warning of the audio-response operator, there is a graphical display of the contaminated area. This area is marked in red. Additional the message "CONTAMINATION" is shown on the screen.

3.2.4 Background measurement

Radioactive rays are constantly emitted from the earth into the environment, as well as from the space. This radiation is called "background radiation" or "background".
The detector also measures these radioactive rays. The following requirements are set to achieve a reliable measurement of the background:

High preciseness:	error of a result shall be so small that it can be neglected.
Short measuring time:	an ideal case would be to take a "snapshot" of the actual background before the body measurement begins. This would guarantee that the following measurement and evaluation of the current background at the time of the personal measurement could be used.

The determination of the background for both kinds of radiation, α- and β-radiation, cannot be executed in the same way. Whereas the normal background for β-radiation is caused by terrestrial and cosmic radiation, the reason of the α-background is to be seen in the electronic noise. This statement is only valid, if there is no industrial radioactive source present.

For the β-radiation the background is calculated on the basis of the Poisson statistics, the α-background does not comply with any statistical distribution as long as there is a minimum of electronic noise.

In case of an increased background due to contamination, the α-background is comprised by the measuring effect caused by the electronic noise and the measuring effect caused by the inherent radiation. Thus, two different mathematical distributions have to be taken into account.

To differ between contamination and non-contamination, it is required to determine the current background as precisely as possible. Simultaneously, fast changes shall be taken into account as long as they apply to the background, but not a previous measuring effect.

The world of statistics understands the term 'precise measurement' to be extended measurements, or continuously repeated measurements. But if there would only be extended measurements, no fast changes could be taken into consideration. The desired accuracy will not be achieved, since an accidental or non-accidental alternation of the background would not be taken into account. The alternative to these contradictory behaviours is a procedure where a long-time background and a short-time background are determined. It will be decided by another mathematical procedure, which of the two backgrounds is actual in use.

Statement of the background measurement time

Normal background measurement: calculation of median with 100 values

Fast background measurement: calculation of median with 30 values

Measurement result every 1 s ➔ background measurement = 100s normal
30s fast

3.2.4.1 Median calculation and sigma tube

For the fast background calculation the incoming count rates are averaged over a range of 30 values. That means a median from the previous 29 measurements and the current measurement is calculated for each measuring cycle.

For the long time background, 100 mean values are involved step by step for median formation. That means the last 100 values are classified according to their size. The middle of this group is the median value.

The number of values involved in such a median formation is called 'the depth of the median filter'. These calculations are also done in such a way that the last 99 values from previous measurements and the current value are involved.

The depth of the median determines how the long-time background has been affected by the past. At a depth of 100 values, 50 should be significantly increased (or decreased), before they have any influence on the median value. Therefore, the median is very stable against temporary changes, but not indifferent.

Before each measurement time calculation - that means every second - the channel with the highest background is selected from the previous calculations. This channel shows the longest integration period to prove the detection limits set under consideration of the required reliability.

The procedure described proves the long-time background, but another procedure is required that makes it possible to substitute the long-time background by a short-time background.

For that purpose, the standard deviation to the current median value is calculated. This standard deviation is put around the median value as a multiple around the so-called sigma tube. The user can set this in the menu **service/parameters/background** as a multiple of sigma to adjust it to the normal situation at the respective place.

For each measuring cycle the system calculates, whether the value is within the sigma tube and the long-time background is used. If afterwards another 15 values are outside the sigma tube, the short-time background is taken into consideration.

If only one mean value falls back into the sigma tube, the measurement time is calculated again by the updated long-time background. The short time as well as the long-time background are constantly calculated, regardless which of them is the currently used background. The switching operation speed depends on the number of measured values. This explains the involvement of different median values.

For the short-time background, only the last 30 mean values are involved into the median calculation. It should take into account temporary changes, but not suddenly.

This procedure makes it possible to profit from the statistic advantage of a long-time measurement as long as the background radiation is not disturbed within a short time by any trouble effects.

If a person enters the monitor, both calculations of the backgrounds are interrupted as long as the monitor is used by the person. That means

- depending of the current background - different background values are taken into account during a contamination measurement and also different integration periods (time of measurement) are used to detect the observance of limits. According to the German DIN standard 25 482 the integration period is also a function of the background measurement time. Thus, each person is individually measured. The result is an increased measuring accuracy.

At first, the same procedure is used for the α-background as for the β-background, except that there are different time constants of the median values and a different determination of the sigma tube, since the normal background cannot be calculated as the standard deviation. The time constants of the median value formation are neglected in this description.

The calculation of the sigma tube is done only for the part of the background that is cleaned from electronic noise. That means 0.15 cps is subtracted from the measured background. This value is called *offset*. The result cannot be negative. The sigma value is determined from the remaining part based on the Poisson statistics. This sigma value and the offset are put around the median value as the sigma tube.

3.2.4.2 Alpha - background

A similar procedure is used for the α-background determination, except that there are different time constants of the mean values and a different determination of the sigma tube, since the normal background cannot be calculated as the standard deviation. The time constants of the mean value formation are neglected in this description.

As indicated above, the normal α-background is caused by electronic noise. That means, the detector does not always measure zero α-pulses. From time to time it is also possible that a 1 α-pulse is measured. Normally, the α-backgrounds are approx. 0.15 cps.

The calculation of the sigma tube - the term is also used in this consensus to achieve consistency, although the sigma calculation is limited - is done only for the part of the background that is cleaned from electronic noise. That means 0.15 cps is subtracted from the measured background. This value is called "offset". The result cannot be negative. The sigma value is determined from the remaining part on the basis of the Poisson statistics. This sigma value and the offset are put around the median value as the sigma tube. It is not multiplied again with any adjustable factor, because the offset has been already added and big α-backgrounds do not vary significantly for statistics.

It is not possible to perform a safe detection of contamination by use of detectors which are defect or contaminated very much. Therefore, the measured results are checked additionally for significant changes of individual measuring channels using the α- and β-maximum thresholds and the β-minimum threshold.

If individual channels are above or below these threshold values, they may be quitted in the service mode. Then, they are excluded from the measurement. If the threshold values are below or above the standard value by more than 50 per cent (rounded) of the measurement channels, a message is displayed. The monitor is not "ready to measure".

In the menu **- service/measuring status** the channels can be displayed with their current pulse rate and if necessary quitted.

If any of these quitted channels is back within the "allowed" range for more than 30 seconds (e.g. after cleaning), it will automatically be used again.

Background measurements may be interrupted at any time by a contamination measurement. The system stores the measured data until the end of this contamination measurement to continue with the background measurements.

When the **RTM110** is switched on, it performs a first background measurement immediately after the user software is started. Only when this measurement is finished, the monitor is ready for operation.

Furthermore, there are messages only provided for the commissioning, such as: service, error in sequence control, service not possible, not active.

If one of these messages appears during normal operation, please start the monitor again or contact the RADOS service department.

3.3 Calculation of measurement time

3.3.1 DIN 25482 measurement time calculation

The calculation of the measurement time is carried out automatically in accordance with the regulations from DIN 25482 part 1. In this DIN standard the calculation for the detection and the recognition limits for different measurement methods are given. The measurement time to be expected can be derived from the given safeties, the background and the alarm level (equal to the detection limit). The formula mirrors an approximation which is very close to the true value or leads to an overestimation of the measuring time. Please note that this is a theoretical value.

The measurement time itself is calculated from the equation for the detection limit. This assumes that the activity to be checked for corresponds to the detection limit and that the predicted values of the DIN correspond to the expected count rates.

The measurement time t_b for a personnel measurement is calculated according to:

$$t_b = \frac{t_0}{t_0 \cdot \left(\frac{2}{\kappa_{1-\alpha} + \kappa_{1-\beta}} \cdot \left(\sqrt{R_{E0} + R_{En}} - \sqrt{R_{E0}} \right) \right)^2 - 1}$$

t_0	= background measurement time
R_{E0}	= expected value of the background
R_{Eb}	= expected value of the gross measurement effect
R_{En}	= expected value of the net measurement effect
$k_{1-\alpha}$	= Quantile error type I = false alarm safety
$k_{1-\beta}$	= Quantile error type II = detection safety = $k_{1-\gamma/2}$

NOTE

The expected net measurement value is calculated from the minimal measurable activity value AN (e. g. 50 Bq 60Co) and from the corresponding detector efficiency values for this nuclide effDetector i.

REn = AN * effDetector i

The measurement time calculation is carried out for each channel separately. The longest resulting time defines the total measurement time for the monitor. Thus, the implementation of this formula is proceeded in a strong conservative manner.

The confidence interval of the measurement values is defined:

$$R_{En} - \kappa_{1-\gamma/2} \cdot \sqrt{\frac{R_{E0}}{t_0} + \frac{R_{Eb}}{t_b}} \leq R_{En} \leq R_{En} + \kappa_{1-\gamma/2} \cdot \sqrt{\frac{R_{E0}}{t_0} + \frac{R_{Eb}}{t_b}}$$

The left side of the equation corresponds to the net alarm limit automatically calculated by the monitor whereby the software sets $K_{1-\gamma/2}$ (quantile of error of the third kind) equal to the quantile of the second kind. The manufacturer can revoke this coupling, if desired.

The error of the first kind (probability against false alarms) and the error of the second kind (detection safety) are employed as quantile of the Gaussian distribution. Deriving from the recommended value of 5 % for both errors, given by the SSK, it results in a value of 1.65 sigma.

In the following list, there are some examples of connection between the errors and respective quantiles.

Frequency of false alarms	***Probability against false alarms***	***Quantile [sigma]***
0.01%	99.99 %	3.72
0.1 %	99.9 %	3.09
0.5 %	99.5 %	2.58
1 %	99 %	2.33
2 %	98 %	2.05
3 %	97 %	1.88
4 %	96 %	1.75
5 %	95 %	1.65
6 %	94 %	1.55
7%	93 %	1.48
8 %	92 %	1.41
9 %	91 %	1.34
10 %	90 %	1.28

The user can determinate a minimum and a maximum time value to limit the calculated measurement time (see chapter measurement *parameter*).

3.3.2 MDA measurement time calculation

In aberration to the above described method to calculate the measurement time, alternatively the calculation can be done using the MDA method. The characteristically limits according to this method are defined in international standards and rules.

The MDA (short for **m**inimal **d**etectable **a**ctivity) detects the amount of nuclide activity which can securely be detected in 95 from 100 measurements while it will only be detected on 5 from 100 measurements on not contaminated objects.

Following parameter will influence the MDA:

- the counting rate of measurements,
- the detector size,
- the measurement geometry,
- the gate time,
- the photon energy E and the probability of absorption,
- the transition probability P for the gamma line used for the proof.

The measurement time t_b for the MDA method is according to ISO 11929 calculated with:

$$t_b = \frac{R_{E0}}{\left[\frac{eff \cdot MDA}{k_{1-\alpha} + k_{1-\beta}}\right]^2 - \frac{R_{E0}}{t_0}}$$

with

t_0	= background measurement time,
R_{E0}	= expected background value,
eff	= efficiency,
MDA	= minimal detectable activity,
$k_{1-\alpha}$	= Quantil 1. error,
$k_{1-\beta}$	= Quantil 2. error.

P² - the measurement time optimizing tool

Mirion Technologies (RADOS) GmbH has developed a program tool to reduce measurement times in the field of personnel contamination: **P**robability **P**ropagation, **P²** (Optional), a measurement procedure based on conditional probability according to DIN 25482/1.

The basic idea of the procedure is to activate an early measurement time abortion of the measurement if there is no contamination. This is the case for about 90 % of all personnel measurements, and it results in a cumulative measurement time reduction per day, if the monitor is used frequently, e. g. during outage times.

First of all a measurement time calculation according to DIN 25482/1 is carried out. During the measurement a remaining probability for the occurrence of the exceeded limit value is determined after each measurement cycle. Depending on the settings of the monitor and the radiation relevant ambient conditions, measurement time reductions of up to 30 per cent for non-contaminated people can be attained. In case of low contamination, which is below the limit value, the measurement time automatically gets near to the DIN measurement time; in case the limit values are exceeded, the DIN measurement time is applied in full length. All calculations run in real time. Therefore there are no changes in the measurement procedure if the P² procedure is activated.

<u>Example measurements with P² active</u>

According to DIN, the measurement time shall be 10 seconds. A non-contaminated person is already asked to leave the monitor after 7 to 8 seconds. For a lightly contaminated person the measurement time is approximately 9 seconds whereas a person with more than 60 % of the limit value is measured for the full measurement time, in this case for 10 seconds.

P² is a feature of the Checkpoint: Body™ software. It can be activated or de-activated in the mode **automatic measurement time calculation**.

3.3.2.1 The optimizing procedure

In the RADOS body contamination monitors the required measurement time for the body contamination measurement can either be set by the operating company or can automatically be calculated by the monitor (automatic mode). In the latter case according to DIN 25482/1 the measurement time for each detector (channel) is calculated from the variable parameters, such as background value, count rate and efficiency, as well as from the set parameters, such as detection safety and probability against false alarm. The longest measurement time (T_{max}) that may result from this from e. g. one of the 34 channels (in case of the TwoStep™-Exit II) supplies the standing time of person inside the monitor for each side of the body. The total pass-through time thus is calculated by two times T_{max} plus the times for entering, leaving and turning inside the monitor. In between the body measurement times, the background count rate is constantly checked and if it changes, an automatic adaptation of the measurement time to the current situation is carried out.

If the *P² Accelerator* is actuated a remaining probability is calculated for each channel and measurement cycle (in this case one second) which shows the probability for the set limit values still to become exceeded. The prerequisite for this is the assumption that during the measurement no changes of the radioactivity of the measurement material, i. e. of the person will take place.

The remaining probabilities are calculated with the help of the Gaussian Integral based on the total events per channel:

$$p(n) = 0{,}5 - \frac{1}{\sqrt{2\pi}} \int_0^{\kappa} e^{-0{,}5x^2} dx$$

The Integration limit κ depends on the required statistical safety as well as on the standard deviation and the mean value of the normalized Gaussian distribution of the measurement values, which accuracies increase with the rising number of measurement cycles n. The total probability P(n) for exceeding the limit value in the remaining measurement cycles N – n, is then calculated as follows:

$$P(n) = p(n) * (N - n)$$

Whereby N means the number of required measurement cycles (gross measurement time) according to DIN.

In this calculation a channel is considered “free” (=>exceeding of the limit values not possible anymore) if the set probability of the confidence level has not been reached two times in sequence of P (n). The two times query for this not reaching the set limit has been introduced, in order to cover for non-statistical deviations of count rates. Therefore, if all channels report “possible contamination below set probability of the confidence level”, the measurement is aborted.

Due to the double query of the release message per channel as well as the "waiting" for the channel with the longest measurement time there are already two safeties integrated into the procedure. For further safety, the software automatically excludes a measurement time reduction of more than 50 per cent of the measurement time calculated according to DIN.

3.3.2.2 Results by experiments

The procedure has been tested by simulations inside the company. The functionalism has been confirmed by the testing. There have been no malfunctions observed. The efficiency i. e. the shortening of the measurement times for measurements with 0 Bq average amounted to 30 %. Furthermore, the procedure was tested under real conditions in a field test. The test object was a RTM860TS PRE monitor which was tested in the months May and June 2000 in a German nuclear power station. During 36 days 26976 measurements, corresponding to 13488 passes through the monitor were carried out. A part of this test phase fell into the "outage time". The average measurement time according to DIN was 9.9 seconds per body side, the average time saving due to the P^2 accelerator consisted of 27.9 %. This equals an average of 375 passes through the monitor per day and a saving of 34 minutes per day and monitor!

Faulty releases due to the P^2 procedure have not been observed.

After evaluation of the field-test data it has been unambiguously proven that the P^2 accelerator also attains the measurement time saving which have been predicted by the simulations during the real application. Despite of the considerable time saving there have been no malfunctions (faulty releases) thus the appropriateness of the procedure has unambiguously been proven.

3.3.3 Alarm triggering

The triggering of an alarm takes place at the end of an alarm measurement, if the calculated net effect reaches or increases the actual chosen alarm threshold.

The measurement mode „*fixed measurement time*“ the set alarm threshold parameter will be used.

To ensure the detection safety is reached the alarm threshold for the measurement mode „*automatic measurement time*“ will be calculated using following formula

$$R_t = R_n - k_{1-b} * \sqrt{\frac{R_0}{t_0} + \frac{R_n}{t_n}}$$

with

R_t	=	actual alarm threshold	[cps]
$R_{\mathbf{n}}$	=	set alarm threshold	[cps]
k_{1-b}	=	detection safety (error second quantile)	[sigma]
R_0	=	background count rate	[cps]
t_n	=	measurement time for person	[s]
t_0	=	measurement time for background	[s]

3.4 The monitor

*Figure 3-2: **RTM110** (with hand box) parts*

The housing is made of high-quality steel. For dimension see dimensioned sketch in register 2.
With respect to measurement technique the **RTM110** consists of six parts:

① hand box (optional with one or two detectors)

② Foot plinth

③ Clothing probe

④ LC Monitor

⑤ Measurement electronics

⑥ USB port

To be connected to the monitor as an OPTION:

- card reader
- push-button for nuclide selection
- push-button to switch the display
- second foot sensor

Gas flow proportional or beta plastic scintillation detectors are used according to the version of the monitor. These detectors are hermetically-sealed. The kind of detectors does not influence the functional principle of the monitor.

<u>The operating elements of the monitor:</u>

① TFT-LCD colour
Graphical resolution of 800*600 pixels

② **Option:** push-button for nuclide selection and display switch

③ Infrared responder for keyboard

④ Gas flow meter (if RGZ detectors used)
Central behind the service door is a gas flow meter to check the gas supply

⑤ Service flap with keyboard (lockable)

⑥ Mains input
Gas connection
Printer - USB port

⑦ Foot sensor

⑧ **Option:** second foot sensor

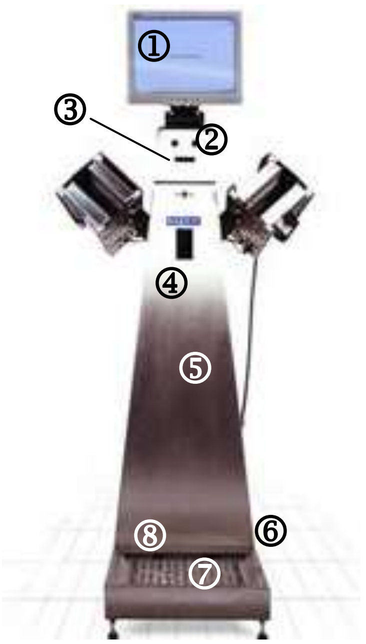


*Figure 3-3: **RTM110** parts*

3.4.1 RTM110 measurement

For a contamination measurement the user steps on the foot plinth facing the display. By triggering foot plinth the monitor recognizes that the user wants to carry out a measurement and thus the background measurement is interrupted. Then the last measured background value applies for the following measurement. There is an option available to equip the monitor with a second foot light barrier. That allows checking the correct positioning of both feet.

To measure the hands there is one hand box with a detector at each side of the monitor. In a two-phase measurement the top and the palm of the hand are measured. If there is a pair of detectors for the left and the right hand each (OPTION), then the hands are measured in one phase.

In order to obtain optimum positioning of the hands, the light barriers at the rear part of the detector must be interrupted. If one of these light barriers is released during the measurement, the measurement process is interrupted and the monitor requests the user to reposition the hands.

The clothing probe for measuring contamination on the garment is positioned at the right side of the monitor. If the clothing probe is taken out of its compartment, an acoustical amplifier is automatically switched on. In this way the decays can be "heard". Of course, the exact count rates can also be seen on the display.

CAUTION

The clothing probe must be used in upright position.
For the measurement it is also important that the probe is as close as possible to the measuring surface. Move the probe slowly during measurement.

At this point we like to remind you that every measurement in this field is meant for user radiation protection. Therefore it should be in the personal interest of every user to operate the monitor properly.

For easy detector decontamination in the foot plinth, a special foil can be placed over the detector window area.
One roll of this foil is supplied with the monitor.

NOTE

In the case that for the foot detector a hostaphan foil is used for protection of the foot detectors, it has to be considered that the foil will have an influence to the efficiency. The performance will drift depending on which nuclide is used. A calibration for the specific nuclides have to be carried out before the monitor is switched back into operation.

NOTE

The monitor is automatically measuring the time while the calculationis measured according to MDA and the parameter.

NOTE

If α-sensitive detectors are used, it has to be considered that an additional foil will make it almost impossible to measure α-particles.

3.4.2 RTM110 detector allocation

standard	*Gas flow detectors*
1	**RGZ270Y** Hands
2	**RGZ270YG** Clothing probe
3	**RGZ1100ZY** foot
option	*Beta plastic detectors*
1	**RBP240** Hands
2	**RBP240G** clothing probe
3	**RBP1050** foot

*Figure 3-4: **RTM110** with hand box detector allocation*

3.5 Measurement computer and electronic

In the following the minimum requirements of the the PC hardware and the operating system QNX in brief are described. As the PC components are developed very fast nowadays, it is also possible that components with higher capacities can be employed.

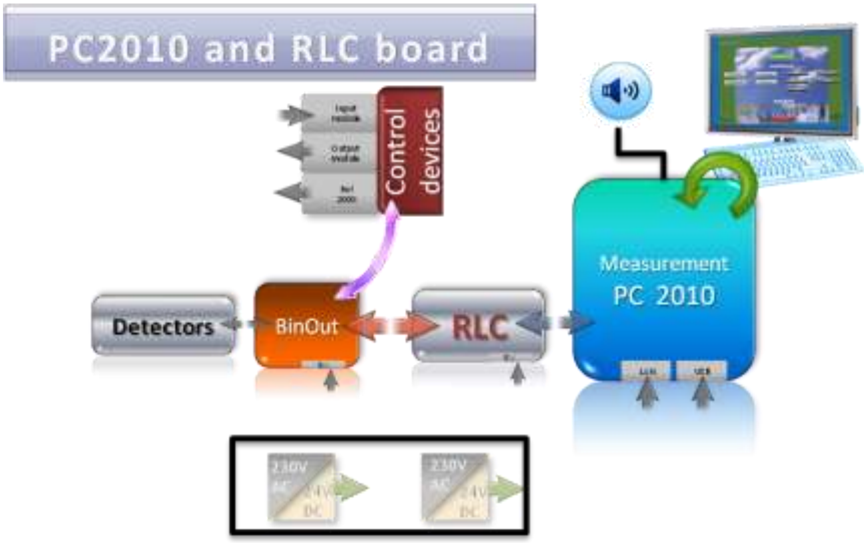


Figure 3-5: ***RTM110*** *RLC and extension boards Integration*

3.5.1 RLC Rados LAN Converter

The main change for the standard monitors which formerly was the AT2000 card is the RLC (Rados LAN converter) which takes the functions of the AT2000 now. The RLC is a new separated communication board connected to the PC by LAN and is been integrated into the system between the PC and the chain of detectors- In general this is only possible for BINOUT Modules or detectors which already communicated with ATEWIS before.

The hardware will be available by addressing the same protocol as the ATEWIS2000.

Computer conditions:

1. PC 2010 with 2 LAN connectors
2. Programmed RLC Module
3. QNX operating system as of QNX V6.4
4. Voice SW as of V 1.38

User Software is appropriate to the RLC process (device-specific).

3.5.2 Rados PC2010 system computer

The new industrial RADOS PC2010, with ATOM processor, is integrated in the monitor housing and includes the following features

- Ultra low power embedded system computer
- Fan less design
- Wide range DC power input
- Wide operating temperature
- Ultra low profile enclosure
- Rugged resign for shock/vibration protection
- Easy installation/maintenance
- 3 x RS-232 serial ports (over RJ45 connector)
- 6 x USB 2.0 ports

2x integrated network card (one used by RLC board)

The communication to the **R**ADOS **L**an **C**onverter board RLC is realized by a TCP/IP Network connection.

RADOS PC2010 system computer	
CPU	Intel Atom
Cooling fan	No
Power supply	10-28 VDC
Hard disk	2,5“
USB port	6
Parallel port	0
Serial port	3
ATEWIS PCI	No
FILICO or RLC	Yes

Table 3-6: RADOS PC2010

3.5.3 Operation system

In order to measure objects fast and reliably, many calculations of individual procedures have to run simultaneously. For instance, in order to measure the background continuously, a computer system is required that allows all operations in multi-tasking handling, in real time. For this aim Mirion Technologies (RADOS) GmbH has been using the operating system QNX for many years to carry out the different measurement tasks. The whole system is based on a very small and thus very fast core. This core is only responsible for the exchange of messages and the distribution of the computer capacity between simultaneously running programs.

All other functions of the operating system are available as independent programs and thus they can be used very flexibly.

For detailed information on the QNX operating system refer to register 1.

3.5.4 RADOS RLC electronic

The RADOS RLC electronic concept is the successor of the improved AT2000 system.
At least due to the measurement task the number of in and outputs on the extension board was enhanced.
The electronic concept supports the following functions:

- Communication port to the measurement PC
- Communication port for the detector board
- Communication ports for installed extensions (I/O port)
- Voice output control

The RADOS RLC board concept includes a wide number of customer specific in- and outputs which can be integrated on customer choice.

3.5.5 Measurement computer

The complete hardware electronics, including the PC, is located in the central part of the housing and can be reached by opening the front door.

The computer system used in the **RTM110** is composed of a single board industrial computer. The computer is placed in computer housing ②, please refer to Register 10 for detailed information on measurement of computer setup and maintenance. A keyboard for operational inputs to the operating software system is located inside the front door.

For quick and reliable computation of the measured values and simultaneous operator control, the QNX 6 operating system is used. According to the optional equipment the computer includes the respective RTM user software.

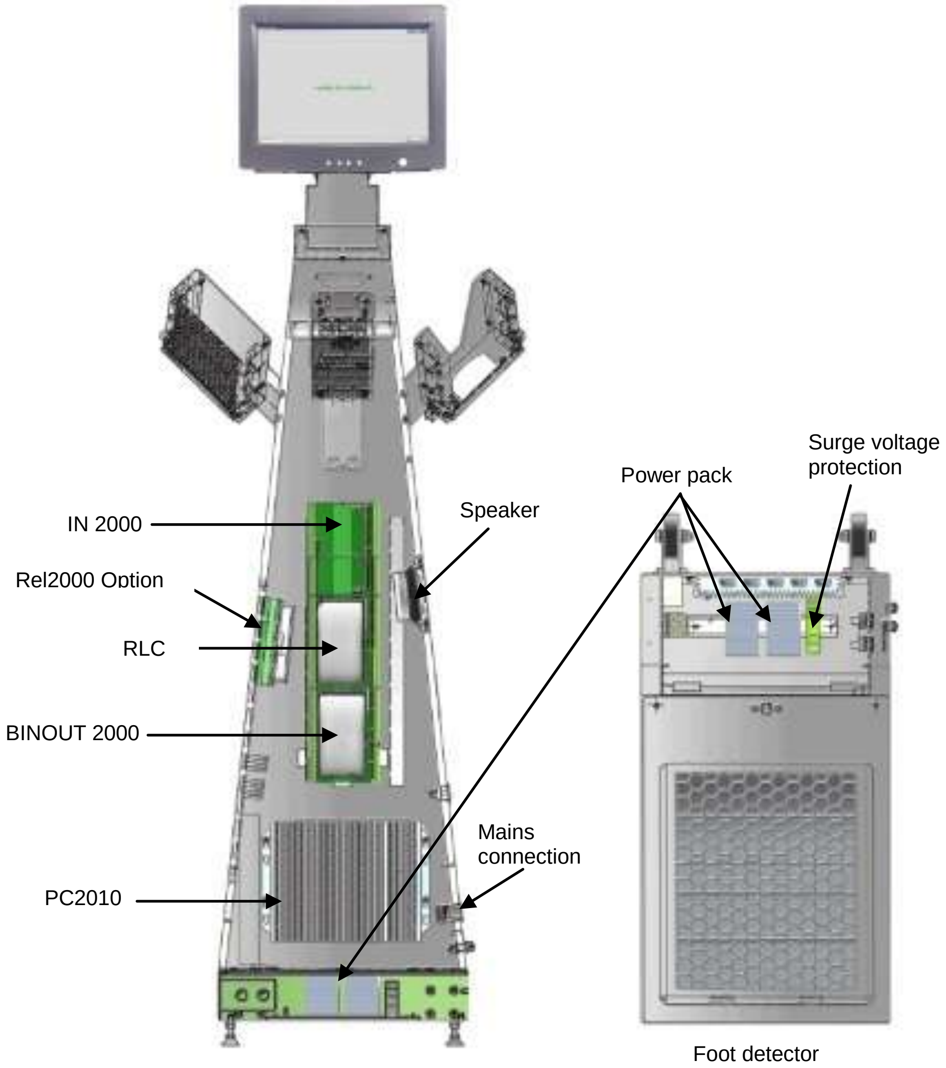


*Figure 3-7: **RTM110** RGZ with open service door*

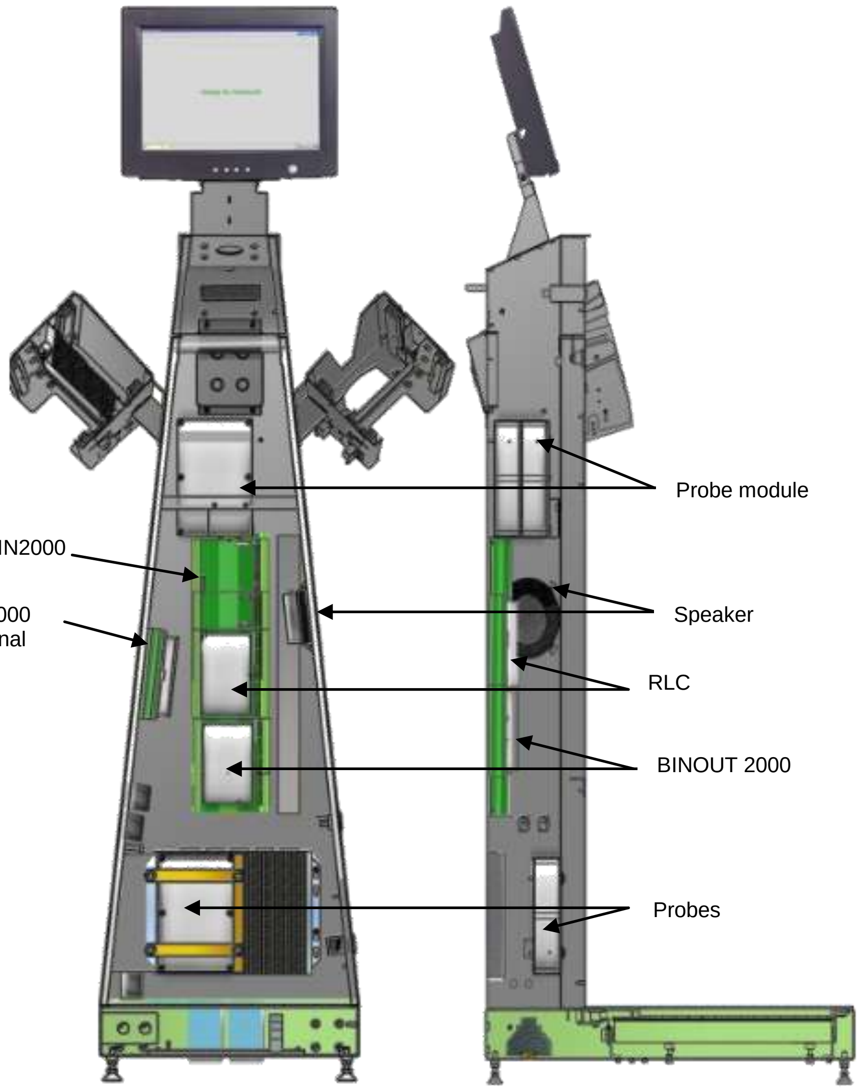


Figure 3-8: ***RTM110 RBP*** *with open service door*

3.7 User software

In this chapter, the software functions of the monitor in the actual operational mode are briefly described. More detailed Information can found as referenced in this documentation.

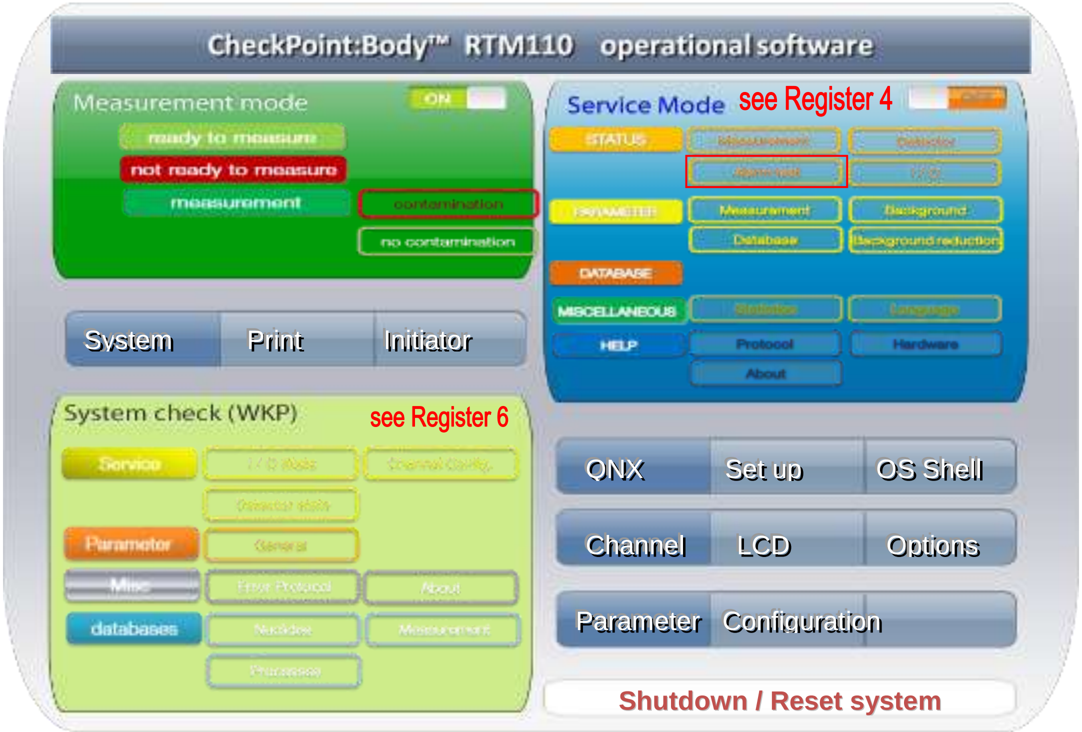


Figure 3-9: Software functional sequence

3.7.1 Operating conditions

The user software differentiates two operation conditions:

Measurement mode

The **measurement mode** is the normal operational mode.
In this mode the measurement of objects is carried out.
The measurement mode is either in state of **contamination** or **ready to measure**. The monitor uses the phase **ready to measure**, i.e. the time period between the measurements, to check the connected detectors for their proper function and to measure the background.

Figure 3-1: Service button

Maintenance mode

The **maintenance mode** is a very sensitive sector of the monitor and should therefore be accessible only to trained persons. This mode can only be entered via the respective button/key. In the maintenance mode there are different sub-menus available to control the function of the monitor and to adjust all parameters influencing the measured value.

3.7.2 Start-up menu

The monitor has different graphical and entry elements for the user communication. A detailed description of the operation is given in chapter "Computer system QNX".

Figure 3-10: Start-up menu

Software modules provided via the **Start-up menu**:

starts the **RTM user software** the main program to perform contamination measurement
(see register 3 and register 4)

starts the **utility** programs to perform for computer and detector administration.

Shutdown the **RTM110**

3.7.3 Graphical User Interface

The Graphical User Interface of the **RTM110** Software consists of 5 main parts:

① Monitor status line (possible states are)
- not ready to measure
- ready to measure
- measurement
- no contamination
- contamination

② Measurement time and - method

③ Service mode button

④ Detector allocation view

⑤ Service and information menu

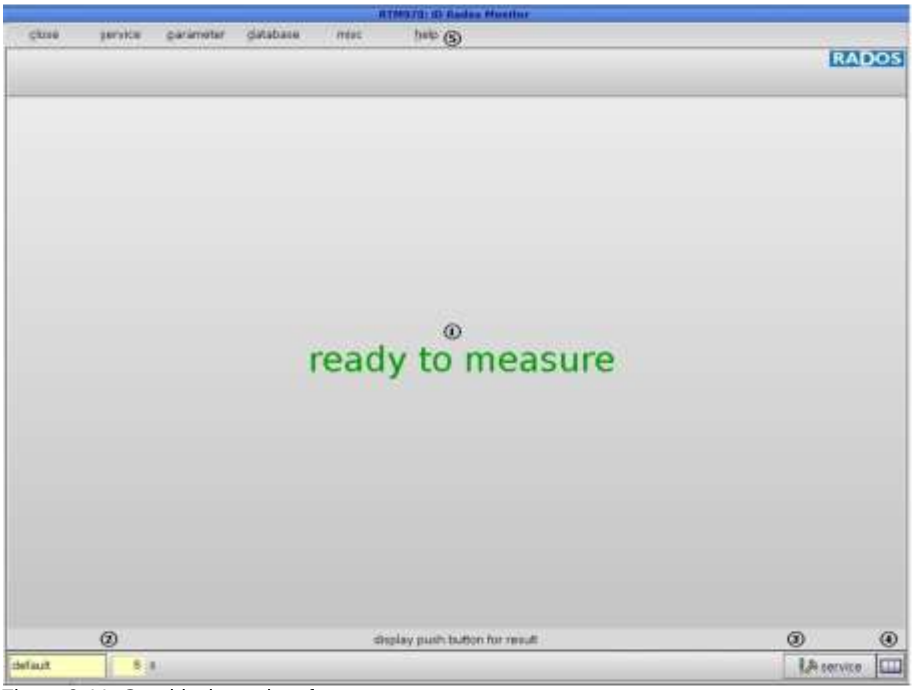


Figure 3-11: Graphical user interface

3.7.4 Measurement mode

The measurement mode is the usual operation of the monitor. For this reason it starts automatically after the monitor has been switched on. In this mode the users can carry out contamination measurements.

In this aspect, the **RTM110** distinguishes between a person measurement and a clothing measurement. The exact differences regarding the mode of operation and evaluation are described in the following chapters.

If there is no safe measuring operation possible due to any trouble, further contamination measurements will be stopped. Additionally, the screen provides a short description of the causes of malfunction. Possible reasons causing the trouble and the way to remove them will be described in the following.

The initiation of operation in the measuring state is done by light barriers. It is not necessary to feed any data through the keyboard. The user is guided by the graphical display and voice sequences. The measurement result is shown on the screen and/or via speech sequences.

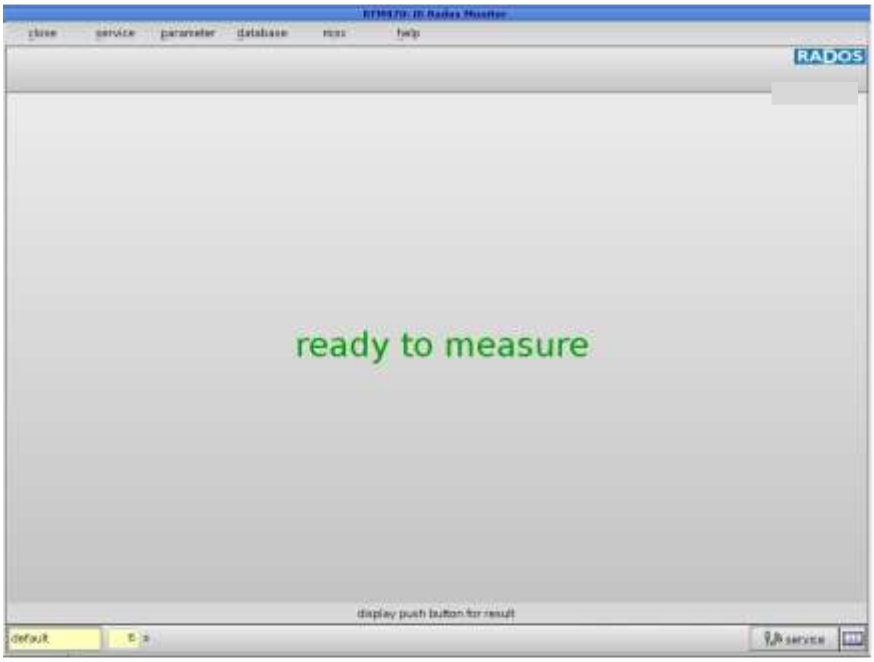


Figure 3-12: Example of the RTM user software - ready to measure

3.7.5 Person measurement

A person measurement can be carried out when the monitor displays "ready to measure". The measurement routine starts by stepping on the foot plinth.

The measurement itself is started as soon as the user has correctly positioned his hands and feet. Both, hands and feet, have to be placed such that they trigger the light barrier.

If this is not done immediately, you will hear following request:

- "WELCOME"
- "POSITION FEET"

If the feet are placed correctly at the foot plinth the monitor will request to:

- "INSERT HANDS"

Figure 3-13: Hand detector

> **NOTE**
>
> **The requests to position are controlled by initiators so the person to be measured will be requested on the base of his movements. If the positioning request will not be fulfilled in a defined time the measurement will be aborted.**

Figure 3-14: Display "measurement aborted"

> **NOTE**
>
> **The hands must be positioned so close to the detector that they trigger the light barriers in the rear part.**

Request for position screen displays:

Figure 3-15: Display "insert hands"

Figure 3-16: Display "position feet"

Figure 3-17: Display "insert right hand"

Figure 3-18: Display "position right foot"

Figure 3-19: Display "insert left hand"

Figure 3-20: Display "position left foot"

If the above mentioned conditions are fulfilled, the monitor begins with the measurement.

Version with one detector per hand

If the monitor is equipped with only one detector per hand, the measurement is carried out as described before. The difference to the version with two detectors lies in the fact that the hands are measured in two phases.

Thus after the first measurement phase (measurement of the hand palms) an acoustic signal is given and on the display appears the message:

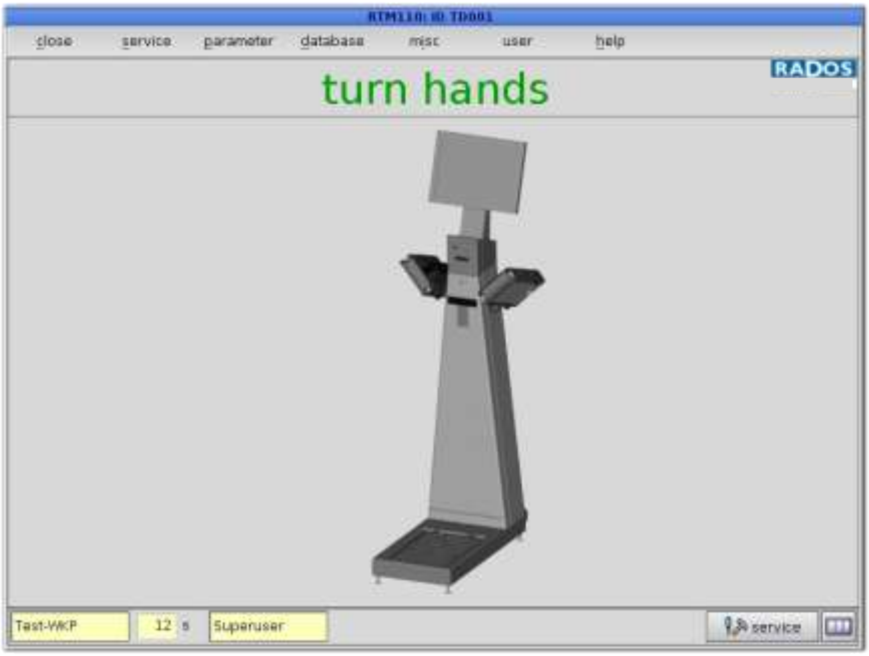


Figure 3-21: Display "turn hands"

- "TURN HANDS"
- "POSITION HANDS"

At the end of the measurement the result is shown at the display. The information displayed remains until the user has completely left the monitor. If no contamination was measured a respective message appears on the display and the user will be kept informed by a voice massage:

- "THANK YOU - NO CONTAMINATION"
- “GO BACK” / “STEP OFF”

3.7.6 Clothing measurement

If the clothing probe is removed from its holder in the status "ready to measure" clothing measurement is started. Any person measurement currently running is interrupted. It is therefore of no significance whether the user is standing on the foot plinth or at the side of the monitor.

Information about the current measurement result automatically appears on the display.

If RGZ-detectors are used and an α-license is installed, the net count rates shown are distinguished between α- and β-impulses. The pulse rates are displayed graphically up to the alarm level. Beside the graphics there are the exact numerical values. Additionally, the last determined backgrounds are numerically displayed.

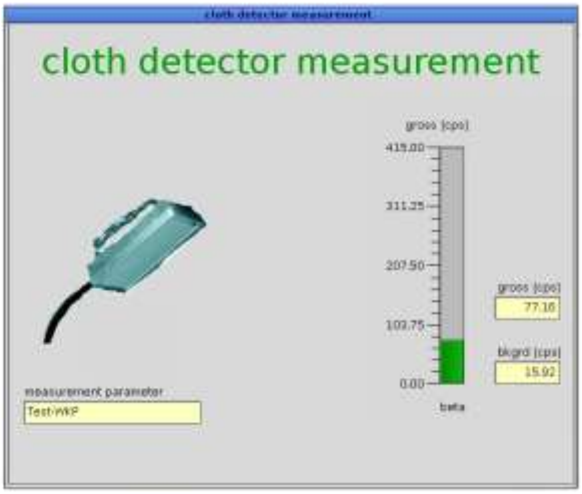


Figure 3-22: Pulse rate graphics

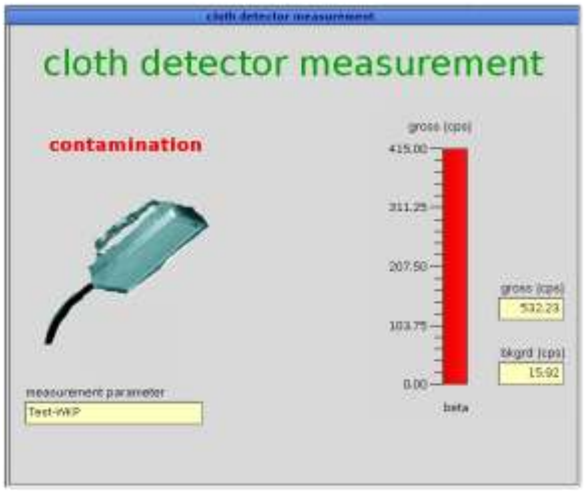


Figure 3-23: Pulse rate graphics with contamination

The name of the used parameter set is also shown. The parameter set defines, what alarm limits are used and states if a nuclide-specific efficiency calculation is carried out. If a nuclide selection switch is available the parameter set can be exchanged during the clothing measurement.

After the clothing probe is hung in the holder again, the monitor is ready for further measurements. During this time the adaptation of the background value is automatically continued.

3.7.7 Measurement

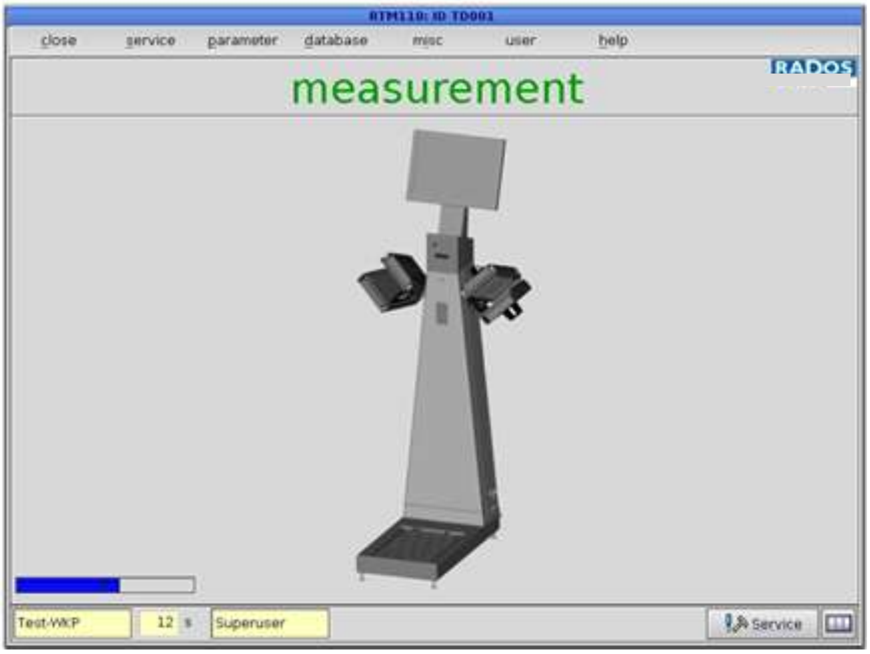


*Figure 3-24: Measuring **RTM110** with hand boxes*

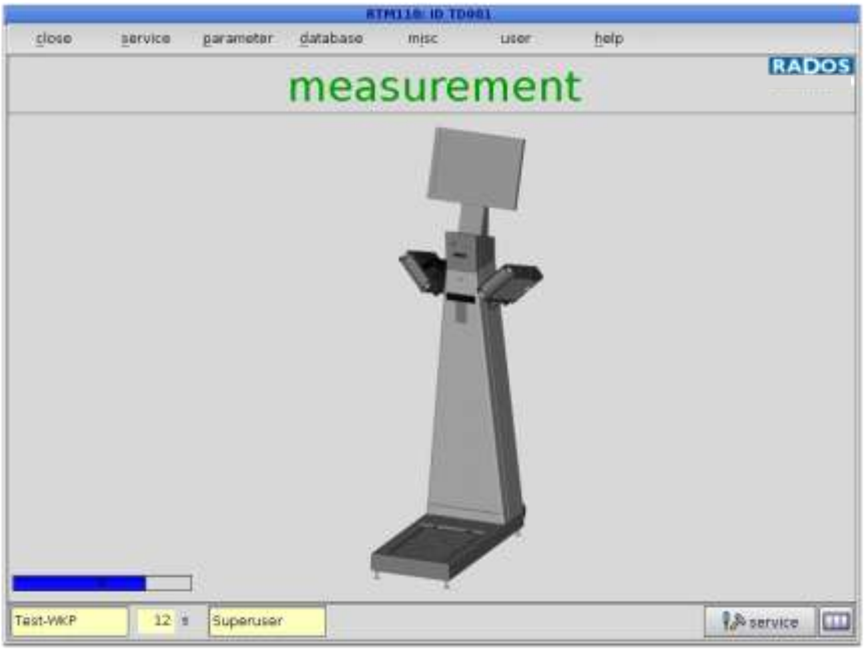


*Figure 3-25: Measuring **RTM110** without hand box*

If the automatic measurement time adaptation has been switched on (see chapter – **Measurement Parameter**) the calculation is now stated. In this case the measurement time and the alarm limits are adapted to the background value measured at last. The calculation does not perceptibly delay the start of the measurement.
During the measurement, the total measurement time (numeric value) and the remaining time (bar graph) are displayed.

During this time it is necessary to keep the measurement position. If the measurement position is left, the person measurement is interrupted. In this case the display shows the message asking the person to correct the position of hands or feet. If the hands or feet are repositioned the measurement is continued.
A complete leaving of the monitor leads to a stop of the measurement.

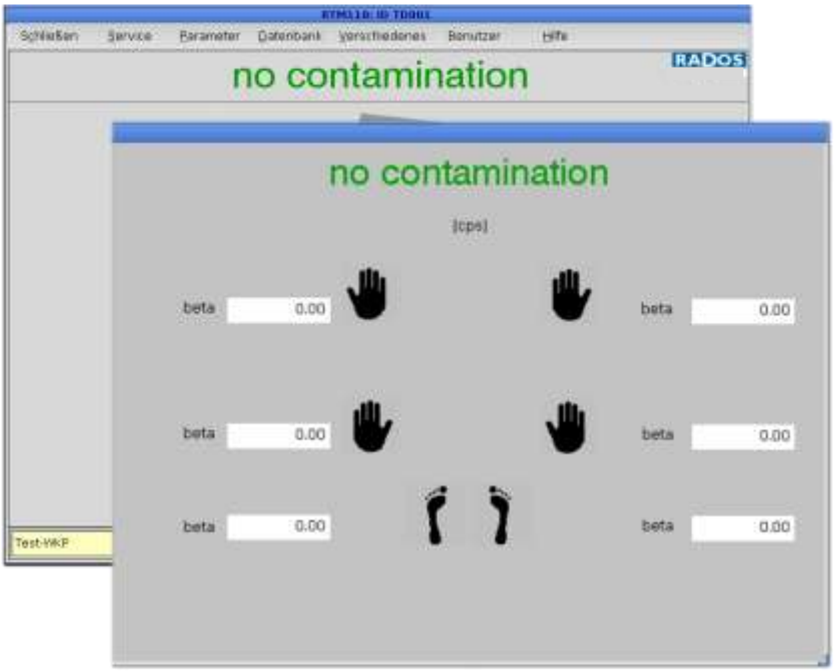


Figure 3-26: No contamination

If a contamination has been measured, the fields with the measurement values of all detectors involved are marked with a colour. So it is possible for the user to locate the position of the contamination.

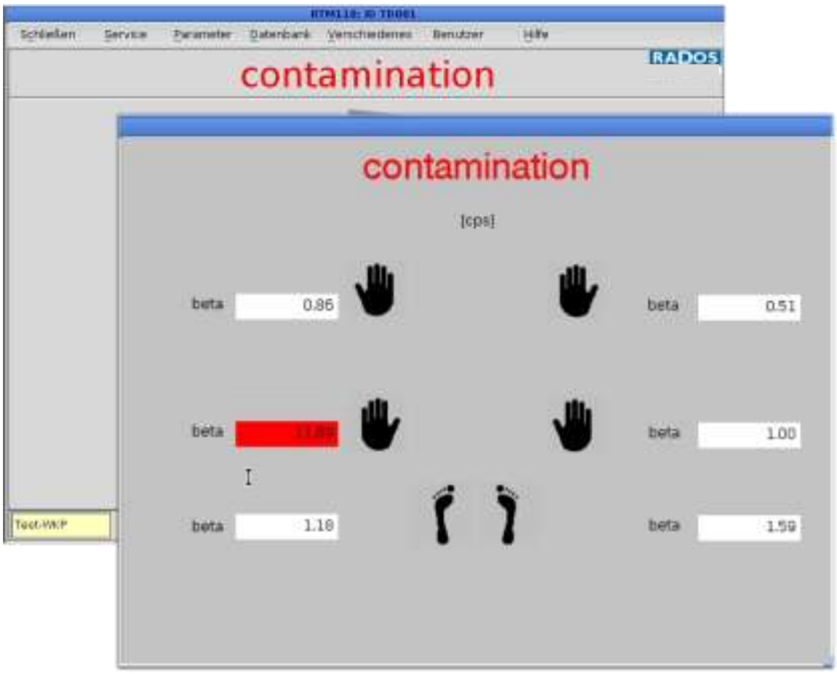


Figure 3-27: Contamination

If in the service mode an automatically print out is selected a protocol is now created.

After the user has left the monitor, it is now ready for further measurements. At this time the adaptation of the background is automatically continued.

3.7.8 Not ready to measure

If reliable measurement operation is not guaranteed, further measurements are prevented. The disturbances which lead to the interruption of the measurement operation are displayed. Additionally, the progress of the continuously running background determination is displayed in a percentage rate.

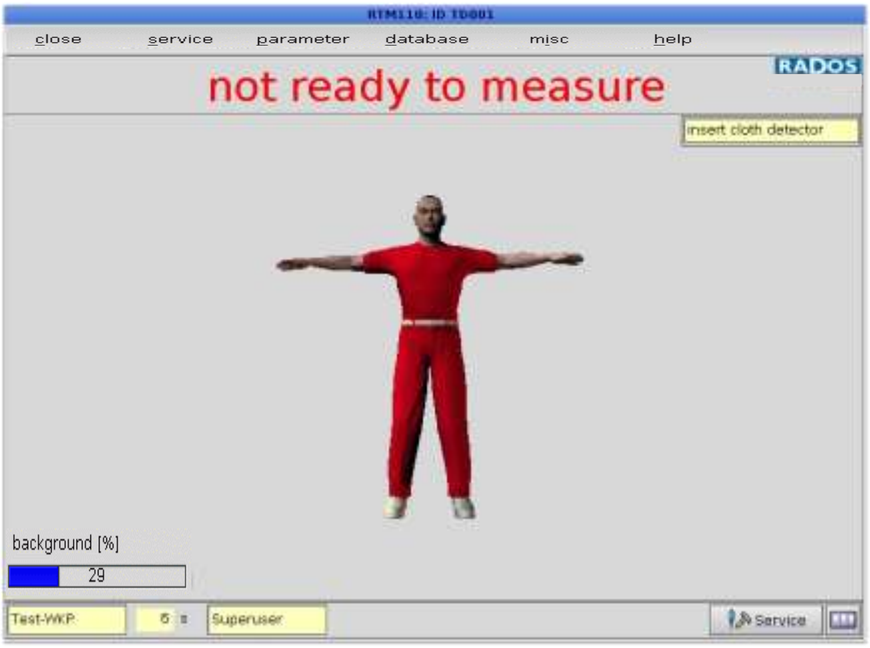


Figure 3-28: Not ready to measure

NOTE
Refer to register 10 Trouble shooting and repair (diagnostic and rectify of equipment faults) for detailed information.

3.7.9 Channel configuration

With the  button the current channel configuration of the monitor can be displ

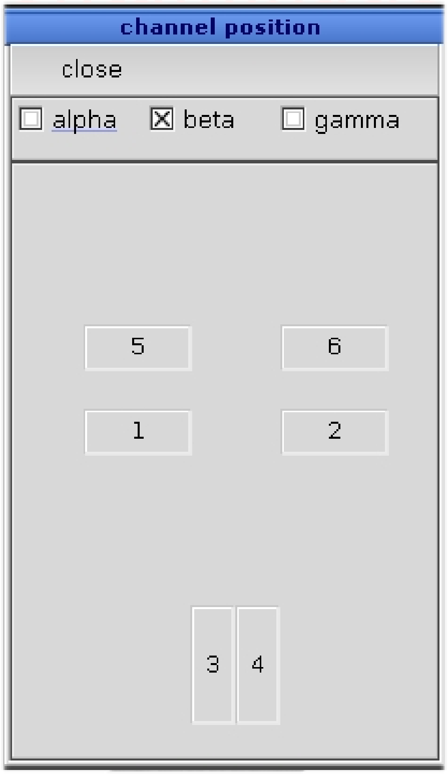


Figure 3-29: Channel configuration

4 Service

Table of Figures

4.1 Service

4.1.1 Prefix

The Body Contamination monitor family with the monitor **RTM110** has different graphical and entry elements for the user communication. A detailed description of the operation is given in chapter "Computer system QNX".

The service mode is opened and carried out by using the key switch **service** (see also the following chapter).

CAUTION

To shutdown the RTM110 it is absolutely necessary to follow the shutdown process given in Register 1 to prevent the RTM110 from any damages.

Figure 4-1: Start-up menu

Software modules provided via the **Start-up Menu**:

used to call the **RTM user software** the main program to perform contamination measurement
(see Register 3 and Register 4)

used to call the **utility** programs to perform for computer and detector administration.

Enables the user to get access to the local hard disk.

shutdown **RTM110**

Service

Following service functions are provided in the service main menu and can be called by using the service key:

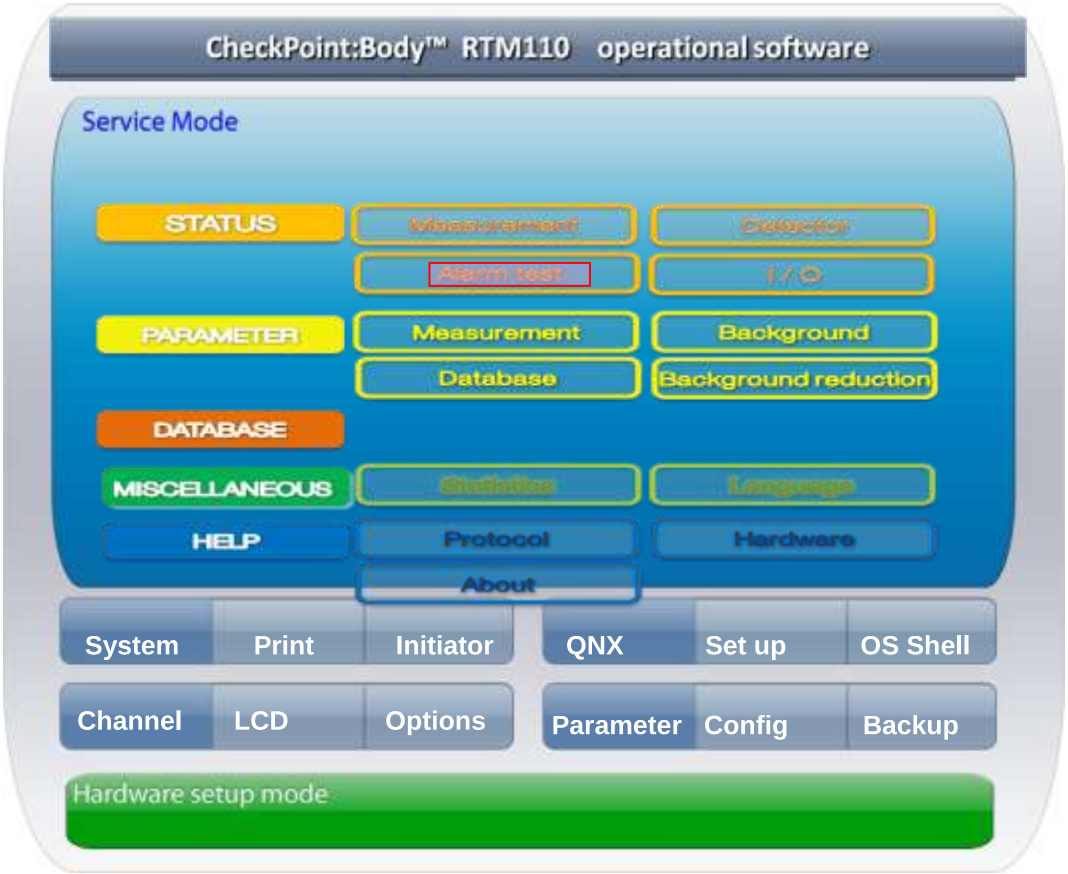


Figure 4-2: Service menu overview

4.1.2 Service main menu

The following picture shows the service main menu from which service functions and the monitor's parameter settings are accessible:

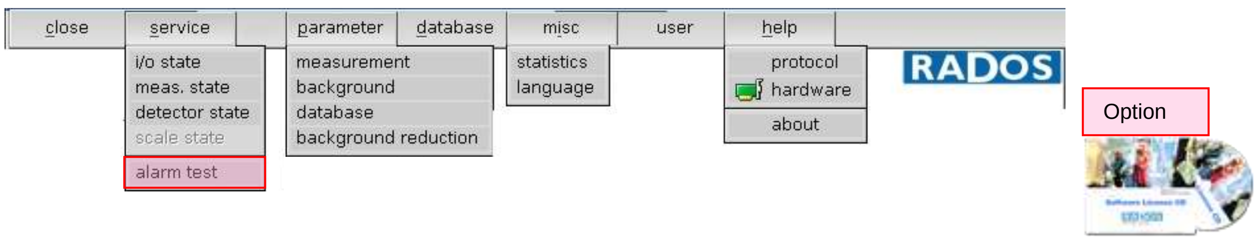


Figure 4-3: Service main menu

4.1.3 Service general

CAUTION

This operation mode requires qualified expert personnel or the RADOS Customer Service.

NOTE

The entries shown white colored fields can be edited to meet user premises. The fields colored in yellow are firmly set by the monitor software or are for information only.

CAUTION

The values displayed in this documentation are simulated data that should not be compared to real measurements.

Service

4.2 Service (enter and exit)

When the button, called ***"service"***, at the bottom of the display is actuated the “service cart” is visible and the service menu is accessible. In case of an activated user logon the password has to be entered. The monitor is **<u>not</u>** in the measurement mode any longer.

By actuating the service functions, the background measurement stops. From this menu the desired service functions may be chosen.

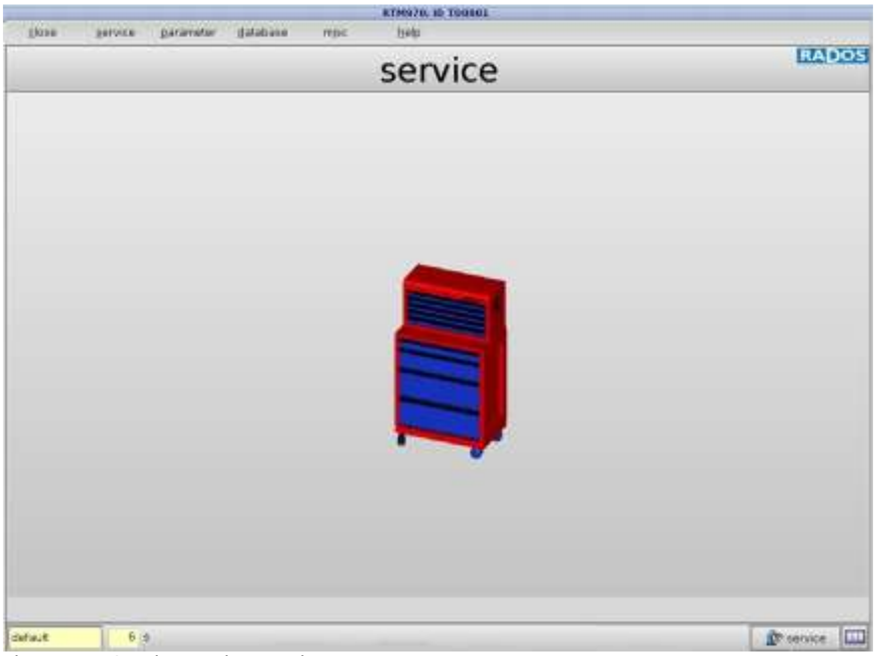


Figure 4-4: Service mode - service

The following submenus are available in service mode of the user software.

Figure 4-5: Service mode - button

If the button ***"service"*** is clicked, the service button icon changes from "robot arm" to "tool kits". The service menu remains active and the monitor turns into measurement mode.

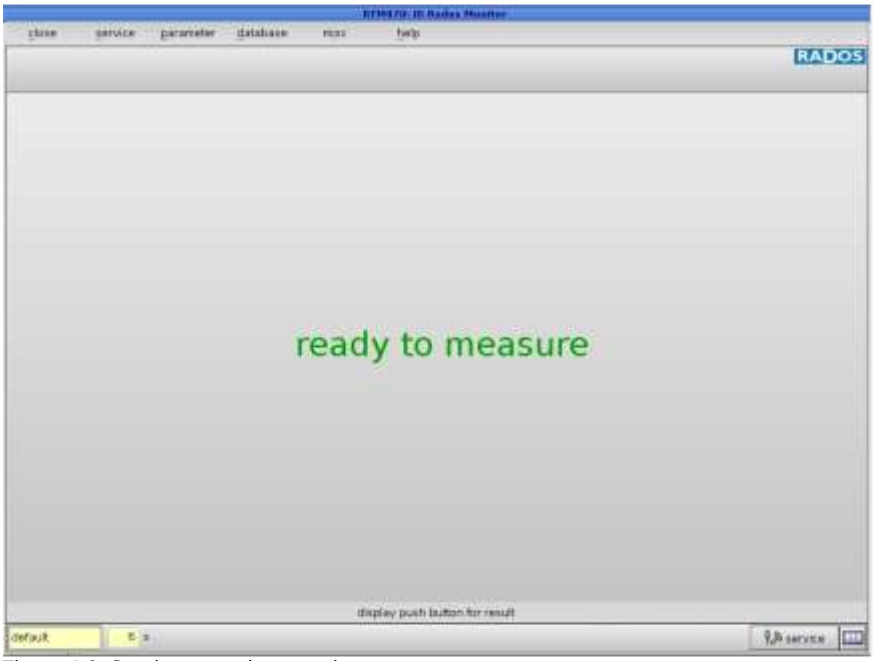


Figure 4-6: Service operation - ready to measure

If the button ***"service"*** is actuated again, the display returns to the service mode again (no measurement operation).

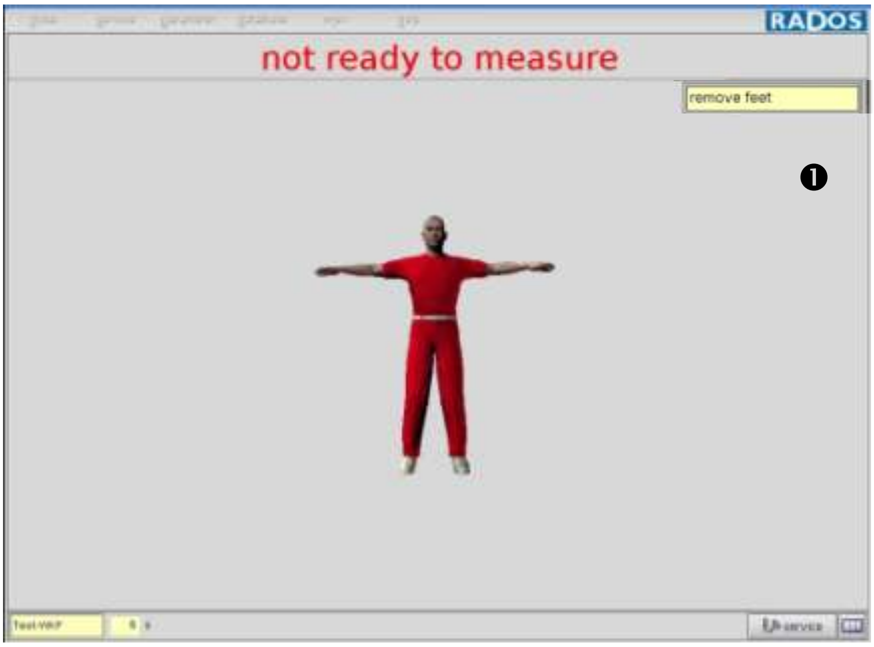


Figure 4-7: Not ready to measure

Should an error occur during the start, an error message appears on the main window ❶. When all error messages have been cleared message disappears.

The service mode is left by resetting the key switch or by actuating the button ***"service"***.

4.3 Service I/O test (input and output test)

The call-up of input and output test can only be effected during the running service mode via the menu ***service / I/O-test***.

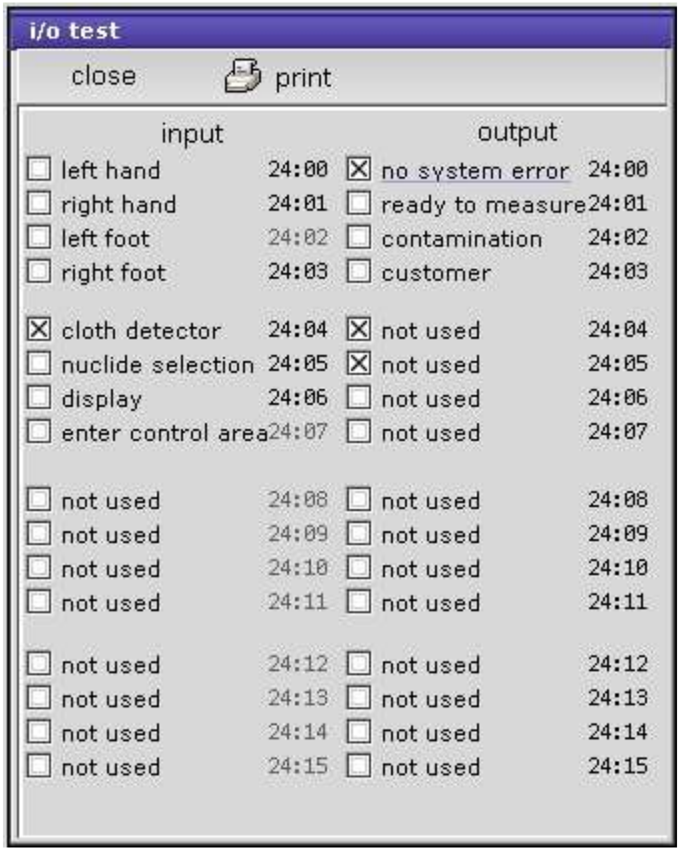


Figure 4-8: I/O test

All digital inputs are continuously controlled and the states are displayed on the video monitor.

The user can enter the states of the digital outputs via the keyboard. When they have been entered, the outputs are set immediately. By leaving the service mode, all outputs are reset to their original values.

With the button **close** the I/O menu is left.

4.4 Measurement status

The measurement status is called up via the menu ***service/meas. status***.

This **Service Point** is separated in two areas:

❶ Measurement status of the monitors

❷ Measurement status of each measurement channel, separated in windows for α-, and β- channels

4.4.1 Measurement status of the monitors

The monitor may have following states of measurement:

- ready to measure
- conditionally ready to measure
- not ready to measure

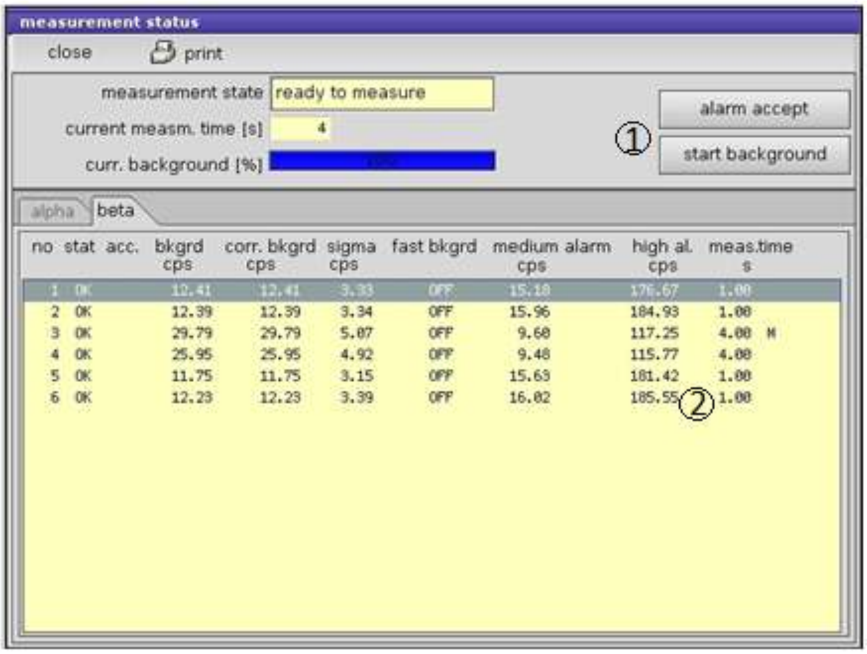


Figure 4-9: Measurement status

The state "**ready to measure**" demonstrates the availability of all channels for the measurement process. The duration of a measurement is shown in the field "**current measm. Time [s]**". It is calculated from the set parameters and the current background. If some channels should not attain the status **"OK"**, they can remain without consideration for the measurement by pressing the button ***"alarm accept"***.

This is only possible if at least half of the detector channels have attained the status **"OK"**. If some channels have been accepted, the monitor can only attain the state "**conditionally ready to measure**". If the monitor shows the status "**not ready to measure**" then a measurement operation is not possible any more.

4.4.2 Measurement status of each measurement channel

A list with following information, separated into respective windows α-, and β-detectors, is displayed for each channel:

A list with following information, separated into respective windows for β-detectors, is displayed for each channel:

no	- number of the measurement channel
stat	- status of the channel
acc	- quitting (Q: channel was quitted, otherwise no entry)
Bkgrd	- background value [cps]
corr. Bkgrd	- background value [cps] corrected by the respective shielding factor.
sigma	- width of the sigma tube [cps]
fast Bkgrd	- OFF or ON
medium alarm	- calculated alarm threshold for medium contamination [cps]
high al.	- calculated alarm threshold for high contamination [cps]
meas. time	- duration of the measurement (set parameters and bgd)

A measurement channel can be in following status (St):

OK	the channel is ready to measure
CHG	the status has just been changed
MIN	the value is beyond the minimum limit of the background
MAX	the maximum limit of the background has been exceeded

Additional information under automatic calculation of measurement time:

MB(eta**)**	Statement about measuring time determining channel

The used time of the first background measurement in per cent is shown at this place. By actuating the button (*start background*) a new background measurement starts.

4.5 Detector status

The detector status is called up in the menu - **service/detector state**.

This service menu is separated in three areas:

- ❶ Calculation of mean values
- ❷ Channel adjustment information
- ❸ Display detector type and channel information

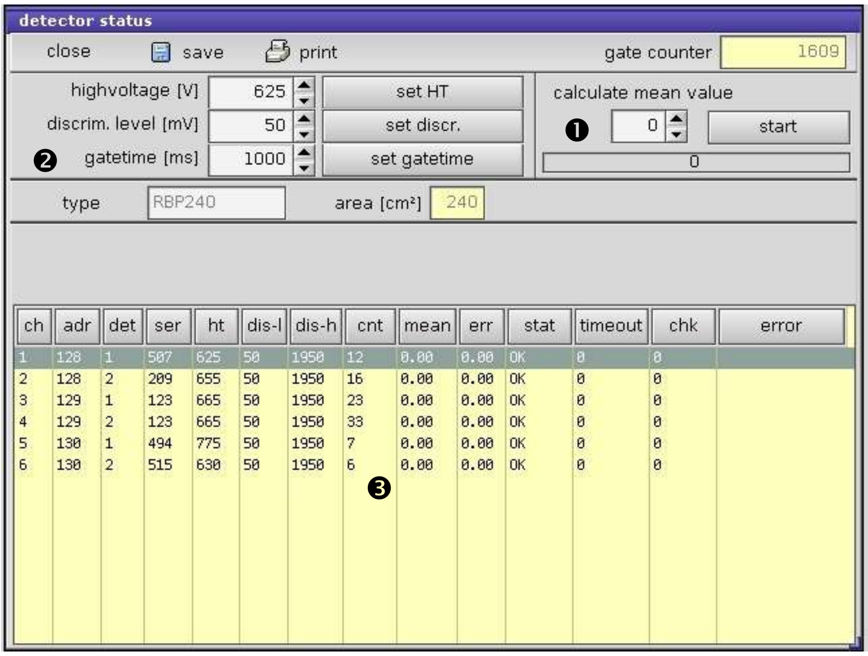


Figure 4-10: Detector status

4.5.1.1 Calculation of mean value

A new creation of the mean value is started via the button ***"start"***. The field above the ***"start"*** button shows the number of gate times which are used to measure the mean value. The user can change this value at any time. The end of the mean value calculation is given by an acoustic signal. The value "0" results in a permanent mean value creation of the count rates, while “60” would stand for a mean formation of 60 gate times á 1000 ms (a mean value for one minute).

4.5.1.2 Channel information

The following information of the measurement channels from the detector electronics is displayed for user information and service purposes only. The information is firmly set in the electronic and cannot be changed by user.

4.5.1.3 Display of detector type and channel information

The following information from the detector electronics are displayed for the channels:

ch	adr	det	ser	ht	dis-l	dis-h	cnt	mean	err	stat	timeout	chk	error
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭

ch.	① the number of channel within the monitor
adr	② address of the detector (firmly set via a DIP switch)
det	③ detector - type
ser	④ serial - number of the detector
ht	⑤ currently set high voltage [Volt] [1]
disl (mV)	⑥ low discriminator threshold [mV] [1 2]
dish (mV)	⑦ high discriminator threshold [mV] [1 2]
cnt	⑧ current net count rates per gate time
mean.	⑨ calculated mean value of the last 100 values count rates
err. (%)	⑩ default deviation in % referred to the current mean value

Status of channel ⑪

1. exist - module is located by ATEWIS2000 and attached
2. hterr - status bit shows HT-error. Target / actual voltage for detector to high
3. eeerr - status bit shows EEPROM-checksum-error
4. htinv - status bit shows HT-invalid-value-error
5. timeo - status bit shows timeout-error
6. chkee - status bit shows checksum-error

--

7. faste - status bit shows HT-fast-disable-error. HT-fast-disable active
8.diser - status bit shows discriminator-invalid-value-error
9.htmse - status bit shows HT-adjustment-error
10. sdovl - status bit shows counter-overflow-error.
11. synce - status bit shows RNET2000-bus synchronisation-error. Invalid module
12. gateo - Status bit shows gate time-errors

Timeout	⑫ Status bit shows Timeout-Error
chk	⑬ Status bit shows Checksum-Error
Err	⑭ Number of transfer errors since the last switching on

Often a detector consists of two physical channels, which belong to each other. They have the same manufacture-specific information.

The count rates are continuously determined. This is the number of measured counts per measurement period (gate time). The mean measurement values are determined from the last 100 count rates with their corresponding default deviation.

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Formula 4-1 standard deviation

The user is able to change the high voltage and the discriminator value for each detector. To do so, please select a channel and modify the values in the respective fields (white colored). Then press the button at the right side from the fields.

Altering the gate time, it does so for all channels at the same time.

When the menu is closed, the user is asked whether the changes should be written into the EEPROM or not. If this is confirmed, the detectors will operate with the new settings permanently.

4.6 Detector alarm test (Optional)

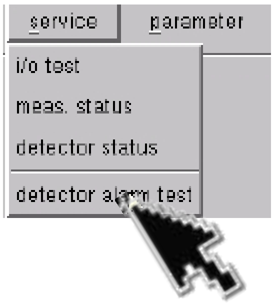


Figure 4-11: Service menu

The detector alarm test was developed to provide the user with a software tool to check the correct function of the entire measurement channel with the actual measurement parameter setting of the monitor.

Additional the detection of a source during a normal measurement this scenario can be tested for every measurement channel. To perform this test a source with an activity near the medium alarm level has to be placed in front of the detector.

To increase usability the detector alarm test is voice guided.

The detector test can be directly selected from the service mode menu, while the RTM user software is running.

The test results can be printed at the end of the test.

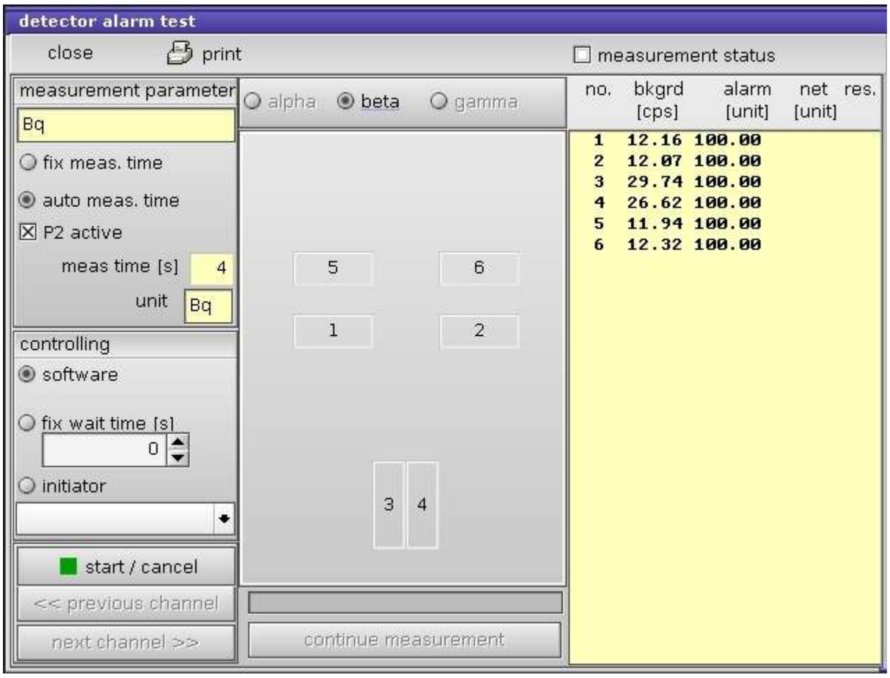


Figure 4-12: Detector alarm test (screenshot for illustration only)

NOTE

The test does not require any changes on RTM110 measurement parameter, therefore the personnel required to perform this task must not be enabled or skilled to change parameter.

4.6.1 Use of the detector alarm test

The detector alarm test is designed with the principle of measurement process in measurement mode, which means the **RTM110** has to be in "ready to measure" or "conditionally ready to measure" mode before entering the service mode and performing the detector alarm test. This ensures that the measurement parameters are active and the background is measured and known.

It is also important to know that the background reduction factor (if activated) does have an impact on the results. If the background reduction is activated the test user has to perform the measurement inside the **RTM110** following the announcements during the whole test.

A test source is needed to carry out the detector alarm test. Every channel has to be measured with direct contact to the test source in front of the detector.

4.6.2 Detector alarm test process

To start the detector alarm test, change from the measurement mode into the service mode using the service key. The detector alarm test can be chosen, if a license is purchased and installed directly from the service menu (**service/detector alarm test**).

NOTE

If the menu detector alarm test **is shown in light grey in the service menu there is no license activated on the RTM110 and the** detector alarm test **cannot be performed. Please feel free to contact the RADOS Customer Service for assistance on this matter.**

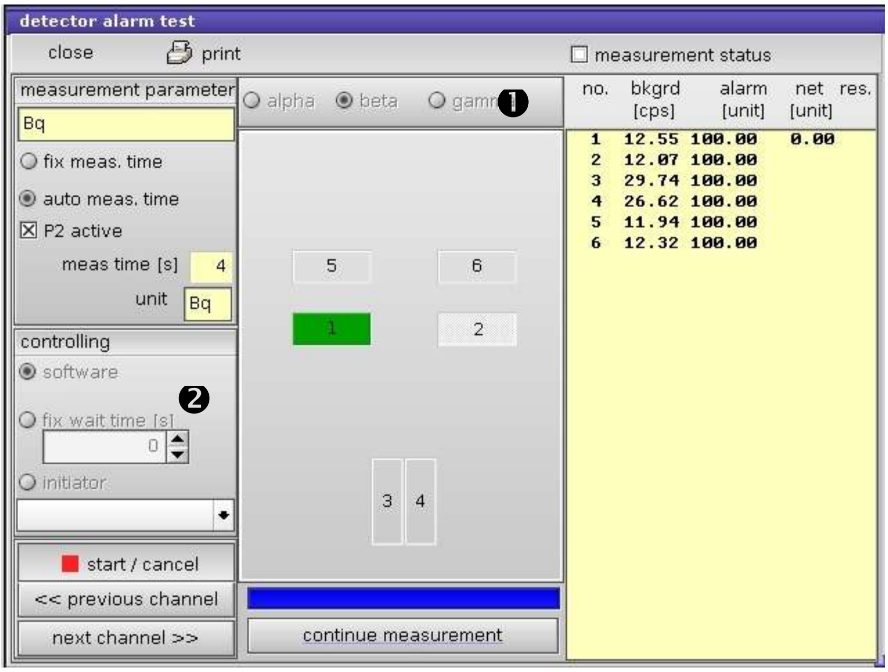


Figure 4-13: Detector alarm test settings (beta)

The measurement parameters are automatically set according the monitor parameter settings and the present monitor features.

Depending on the monitor design, different detectors types (alpha, beta, gamma detection) can be set in the middle of the screen ❶.

There are different possibilities under “test control by” ❷ to acknowledge the detector positions.

button acknowledge by mouse, to acknowledge every step, click on the button “**next>>**”

fix wait time select the button “fix wait time [s]” by clicking on the little box and give a waiting time in seconds with aid of the arrows. The next step will automatically delay for the set time. To start the detector test press by mouse the button “**next>>**”

initiator select the button “initiator” by clicking on the little box before and select an initiator for acknowledge the next step.

The measurement itself will start with channel 1 and will follow up to the last physical channel of the chosen of detector type. After the measurement of the single channels, the calculation of the sum channels S0-Sx is carried out.

NOTE

The test operator must have knowledge about the detector position (see chapter 3.3.4 channel configuration).

For usability purposes each process step is accompanied by a voice controlled count down.

The position of all channels and the measurement result will be displayed on the detector alarm test windows during the test. The test results can be printed using the **print** button.

The whole process of the detector test can be controlled by the keyboard (**start, stop, abort, continue, last channel, next channel**).

4.6.3 Test results

The results of the measurement are shown in the detector position drawing and in the table on the right side of the display.

Depending on the state of a channel, the detector channels will show a different background color. The next actual channel that is to be measured has a grey background and the field looks pressed down (see channel 15 in figure 4-11).

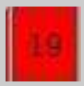
If the counts of a measurement were below the set threshold, than the fields are in white color (see channel 5 for example) and the voice output “no contamination” is sounded.

If the counts were more than the medium threshold, the background change into red color and the voice output is resounded “contamination” (see therefore channel 6 for example).

If the background color of a channel changes into pink, the high threshold was exceeded (see therefore channel 2 for example). Also in this case the voice output is resounded “contamination”.

Channels with counts higher than the medium threshold are also shown red colored in the table on the right side of the display.

<u>Caption of used colors</u>

	**next channel to be tested**
	**Measured values are below alarm threshold announcement: „no contamination“**
	**Measured values are above alarm threshold announcement: „contamination“**
	**Measured values are above high alarm threshold announcement: „contamination“**

CAUTION

If an error interrupted the detector alarm test (for example “error on detector”) the actual measurement will be stopped and an error message will be displayed.
Abort the detector alarm test and restart it after solving the problem. To control the state of the measurement there is a control box in the upper right corner with the caption “measurement status” ❸.This state will change into “red” if an error occurs.

4.7 Parameters (setting)

4.7.1 Calculation of measurement time

The calculation of the measurement time is carried out automatically in accordance with the regulations from the DIN 25482 part 1. In this DIN paper the calculation for the detection and the recognition limits for different measurement methods are given. From these given safeties, the background and the measurement time to be expected can be derived. This is not an exact function but rather a proximity value, which is however very close to the true value or leads to an overestimation of the measuring time. Please note that this is a theoretical value too.

More to "measuring time calculation" can be read in Register 3 of the documentation.

4.7.2 Measurement parameters

The parameters can only be displayed and modified if the operator is in the service mode via the menu **parameter/measurement**.

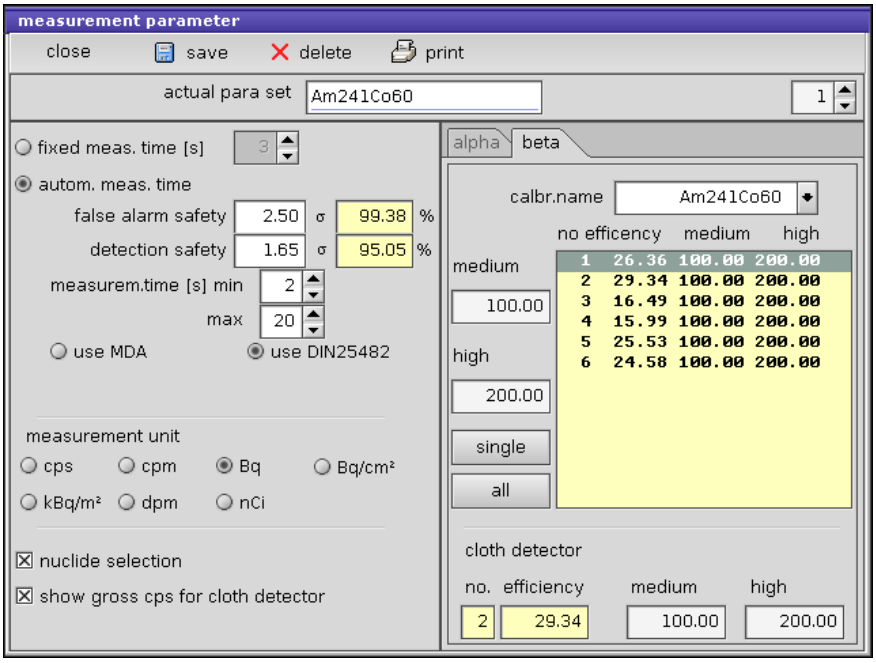


Figure 4-14: Setting of parameters

This point of the service program is to be used for the display as well as the input of parameters which are relevant for the procedure of the person measurement. The settings will do by using the keyboard (numbers, letters). The mouse pointer has to be positioned on the desired input element. Alternatively it is possible to move to the relevant element by using the tab key (shift + tab). In order to invert a switch, a mouse or space bar click is required if the focus is on the element. Press the button ***"save"*** if modified parameters shall be taken over, otherwise use the button ***"close"*** in order to ignore all parameter changes.

Up to 15 different parameter sets can be created. For identification purposes each parameter set is provided with a name in the field *"actual para set"*. With the arrow keys <arrow up> and <arrow down> the previous or the following parameter set can be selected.

Every parameter set contains following parameters, which are shown in the window on the left side:

- fixed or automatic measurement time (body measurement)
- duration of the fixed measurement time [s]
  safety against false alarm and safety of detection (only for automatic measurement time)
- Min. and max. measurement time (only for automatic measurement time)
- selection of the measurement unit
  - cps (counts per second)
  - cpm (counts per minute)
  - Bq (Becquerel)
  - Bq/cm² (Becquerel per cm²)
  - kBq/m² (kilo Becquerel per m²)
  - dpm (decay per minutes)
  - nCi (nano Curie)
- nuclide selection (optional)

  This is activated/deactivated only in case of a built-in nuclide selection switch.
- show gross cps for cloth detector

  If this button is selected, the measurement result of the cloth detector is shown as a gross value

At the right side there is an additional window for the respective alpha- and beta, gamma alarms. Furthermore, a nuclide can be selected via a list that can be folded up.

- calibr. name (only for nuclide-referred measurement)

  From a fold-up list the desired calibration with a special nuclide can be chosen. The nuclide and its efficiencies are automatically taken over from SYSTEM CHECK (WKP) for each channel.
- Alarms

  Here the alarm values for the respective set of parameters are defined. The values can be individually set for each channel.

  - medium contamination of the channel
  - high contamination of the channel

If the button ***"individual"*** or ***"all"*** are activated, the altered alarm values for the individual channel or for all channels are used in the measurement mode.

4.7.3 Background

The background parameters can only be modified in the running service mode via the menu **parameter/background**. For the α- and β background parameters it is necessary to open separate folders for their settings in this window.

4.7.4 Min.- max.- alarm - alpha and beta

The entered alarm limits are always based on 750 cm². That means the real alarm limit will be automatically calculated for each detector channel according to the individual area.
If the measured background is outside of the range, a faulty or contaminated detector is assumed. Thus the monitor is not ready to measure.

<u>Alpha</u>

- α - max. alarm [cps/750cm^2] (optional)
- number of background slots

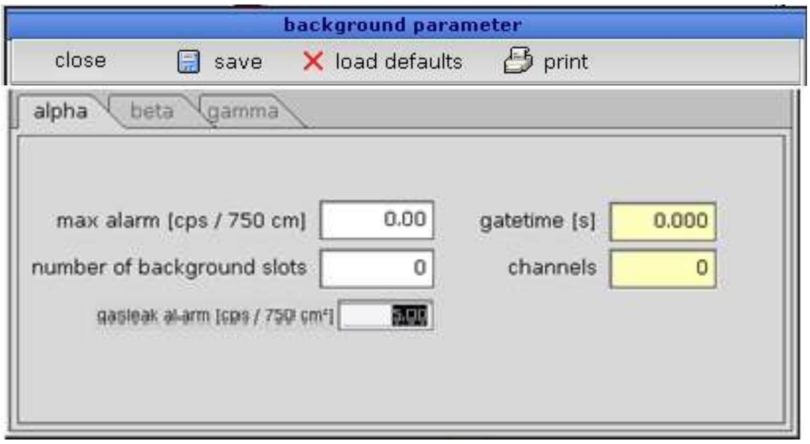


Figure 4-15: Alpha background parameters

Beta

- β - min alarm [cps / 750 cm²]
- β - max alarm [cps / 750 cm²]
- β - backgr. level off [σ]
- β - backgr. interr. [τ]
- β - gasleak alarm [cps / 750 cm²]

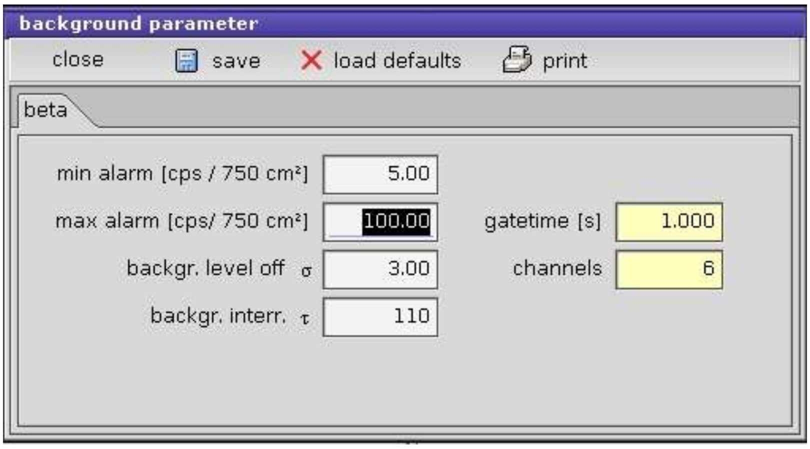


Figure 4-16: Beta background parameters (Gas)

4.7.5 Gas leak alarm

The parameter ***"gas leak alarm"*** is to be stated in "**cps**" for β -channels. This value refers to a detection area of 750 cm.

The set alarm level is automatically detector-specific calculated for each channel. It is proportional to the respective detection area.

The value should always be above the minimum alarm limit for the background.

In case of an active gas alarm the display will show the message: "**suspected gas leak: 3**".

The number "**3**" stands for the quantity of faulty channels.

To find out which detector channel is involved, please look at the measurement status.

4.7.6 Background reduction

Local background radiation might be shielded and thus the count rates are lowered due to measurement material or people being very close the detectors. The shielding depends on a large number of parameters, fundamentally however of the mass of the object (person) and the kind and the direction of the background radiation. If these remain unconsidered or possibly unrecognized, the detection limit of individual detectors of the monitor may increase. Therefore, in the RADOS body contamination monitors, a background shielding feature is default in the software.

This enables to state an individual shielding value H_i in percentage for each channel i – and furthermore a global factor G can be set. Multiplied with the current background count rate R_0 this results in the corrected background count rate R^i_0 as follows:

$$R^i_0 := R_0 * (1 – G * H_i)$$

Normally the global factor is set to 100 per cent, i. e. the stated shielding per channel is applied in full. A setting of 10 per cent corresponds to an actual shielding as stated in the right hand column. With the factor G an existing shielding profile can also be adapted to local conditions without changing the profile as a whole.

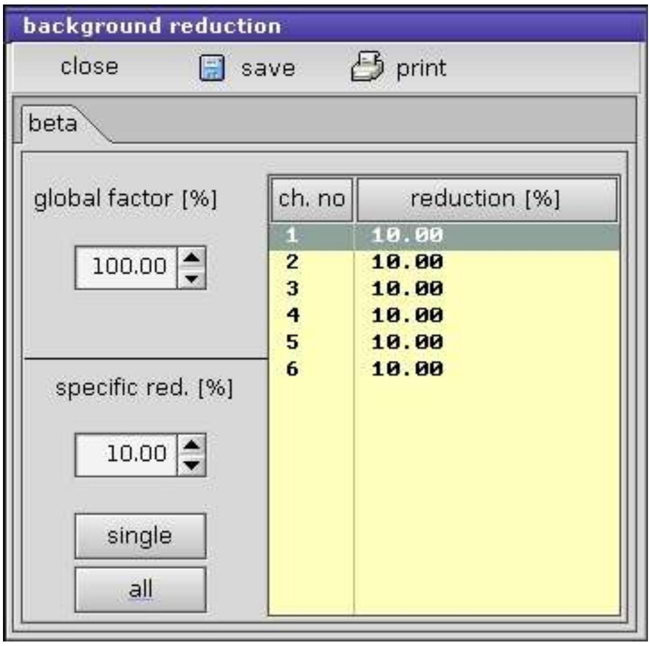


Figure 4-17: Background reduction

4.7.7 Database

4.7.7.1 Database parameters (general)

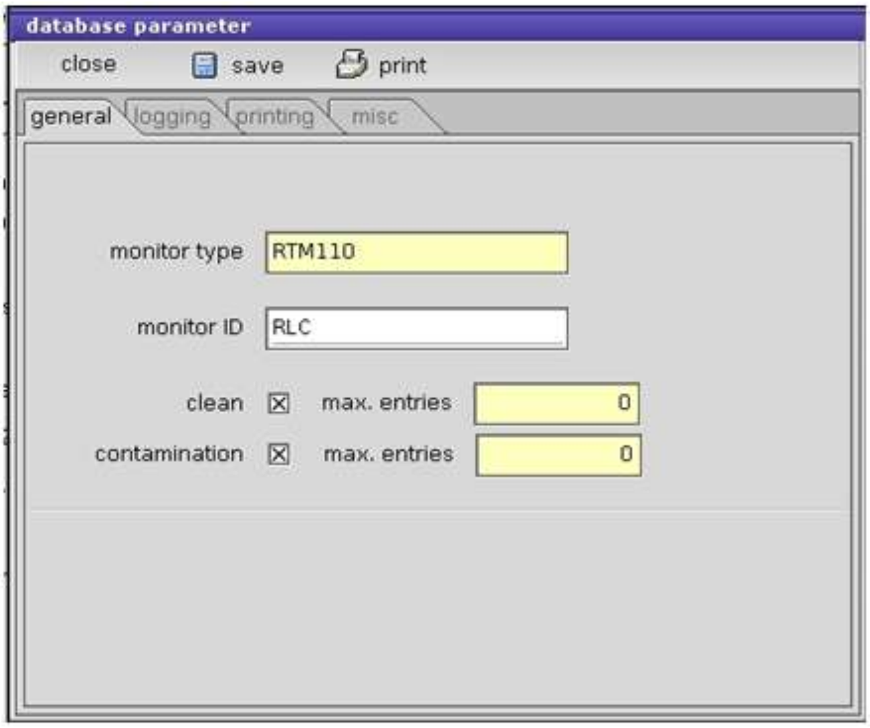


Figure 4-18: Database entries (general)

- Clean/Contamination:
  By activating the fields "**clean**" or "**contamination**" the respective measurement results will be saved into the database.

- Monitor ID:
  In this field an unequivocal name for the monitor can be entered (i.e. serial no.).
  The entry is freely selectable and is used for the identification of the monitor. The monitor ID is shown on the display and on the printout of the records. It is also used for the preparation of the logbook.

- Max. entries:
  The number of maximum measurement results, which can be saved in the database, is stated in this field. The highest number is set to 2000 results. If the provided quantity is exceeded, the oldest measurement results are automatically deleted.

4.7.7.2 Database entries (logging)

All contamination measurements can be saved in a log file and can later be copied to storage medium. Due to the special format of this file (each measurement is stored in exactly one line: the individual measurement results are separated by a semi-colon) the results of the measurements are easy to read in other programs (such as MS EXCEL) and can be further processed.

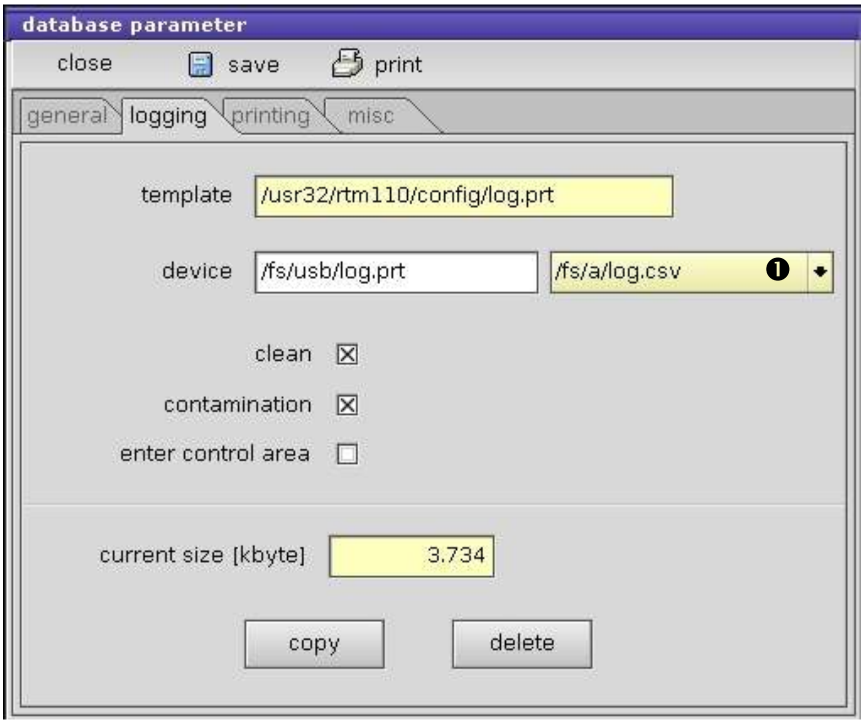


Figure 4-19: Database entries (logging)

The field **current size [Kbytes]** shows the current size of this log file. It is possible to decide if contamination measurements should be entered in the log file or not (**contamination** button).

If "**copy**" is selected, the current log file is copied to a storage medium. The kind of storage medium (i.e. USB Stick or compact disc) has to be chosen in reference to the log file size. In the field **device** the interface to which log template should be saved is stated. The device can be changed using the listings window ❶ next to the device field.

After saving (copy) the measurements, the log file should be erased from the monitor with "**delete**" in order to avoid an unlimited growth of this log file.

Figure 4-20: Select data storage

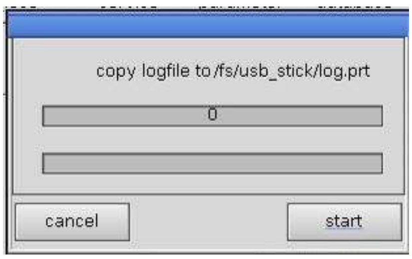


Figure 4-21: Progress window for data copy

4.7.7.3 Further processing of CSV-files

For further processing of the CSV file data RADOS recommends the use of MS EXCEL©.
The process steps for data import in MS EXCEL© are:

(a) Open MS EXCEL©

(b) Select Data **-> Import external Data -> Import Data** ❶ from menu.

(c) Select the CSV-File with the file selector ❷

(d) Confirm selection with **OK** ❸

(e) The following data import assistant of MSEXCEL© has to set with following inputs: (see Fig. below)

1. activate: **delimited**, start from row **1**, file origin: **Windows (ANSI)**❹
2. Delimiters: **Semicolon** ONLY, Text qualifier: **None** ❺
3. Data format column: **Text** ❻
4. Decimal limiter:. (dot) ❼

(f) Confirm data import with mouse click on **OK**❽

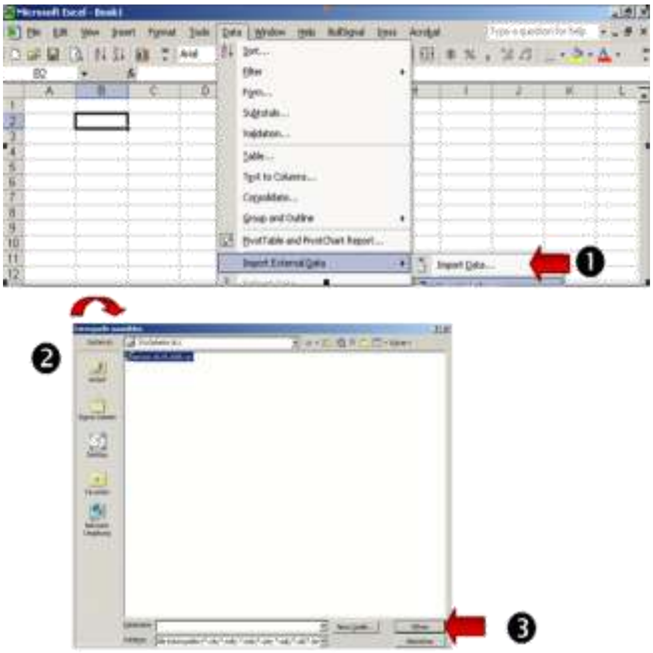


Figure 4-22: Data import to MS-Excel©

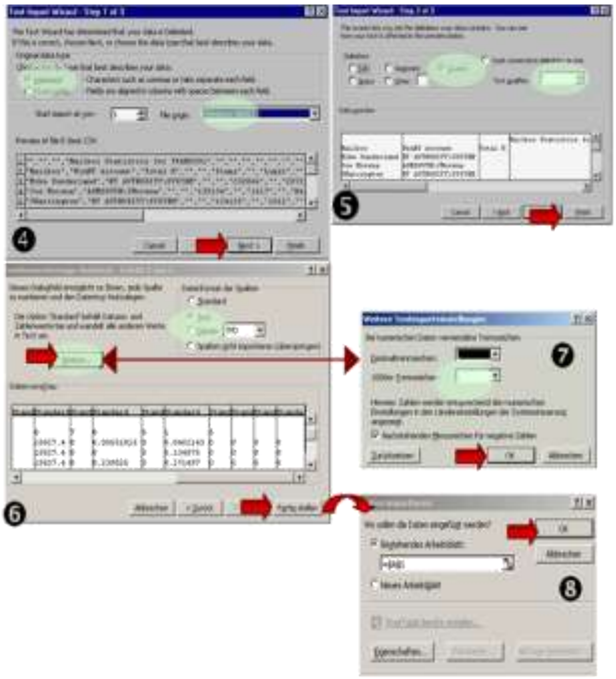


Figure 4-23: Data import assistant in MS-Excel©

4.7.7.4 Record printout (printing)

These parameters allow an automatic printout for certain measurement results (free and/or contamination).

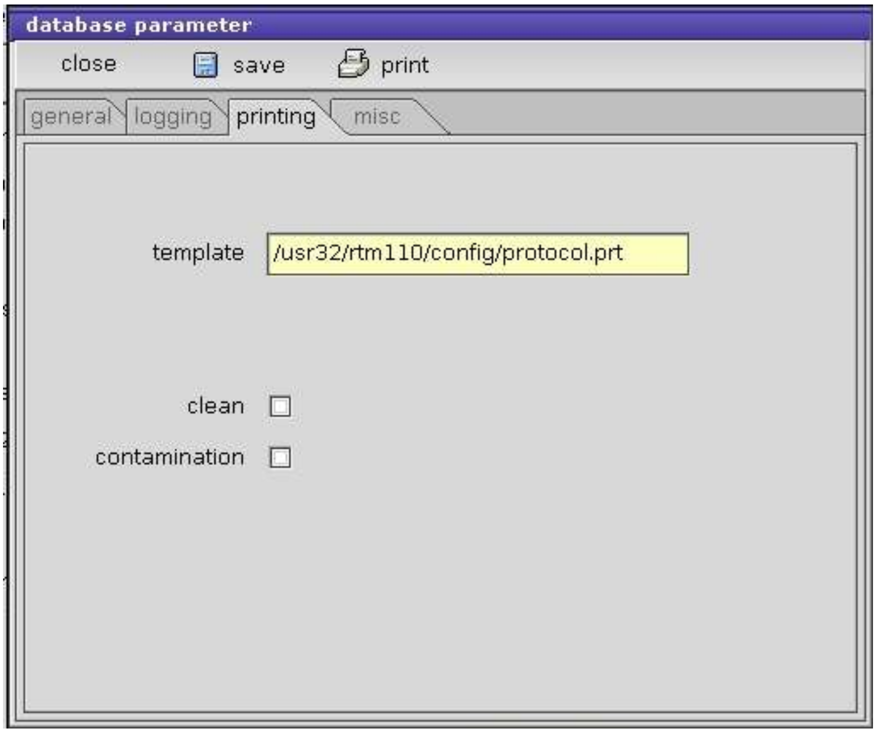


Figure 4-24: Database entries (printing)

By changing the value for "**measurements / page**" it can be set how many measurements will be printed on one page. The value 0 in this case allows the printing on endless paper.

The field "**device**" states the interface to the connected printer.

In the listings window the output interface is allocated:

Parallel interface 1:	/dev/par1
Serial interface 1:	/dev/ser1
USB-Stick:	/dos/USB-stick/{file name}.prt
No interface - no possible printout:	/dev/null

4.7.7.5 Misc

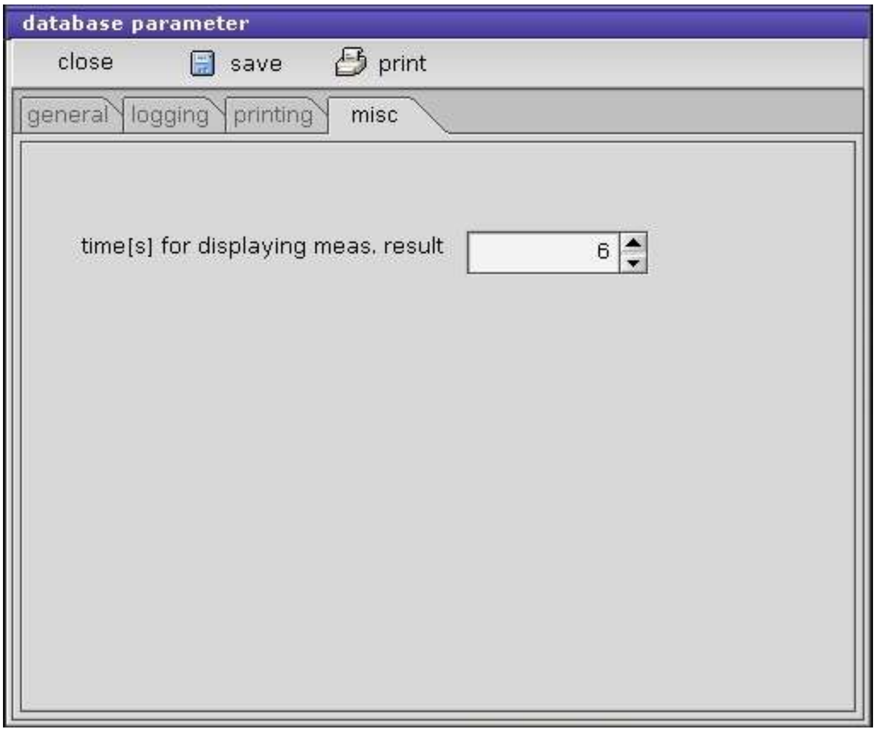


Figure 4-25: Database entries (misc)

- Time [s] for displaying meas. results:

The parameter defines the duration a measurement result is shown on the display after the person with a measured contamination result has left the monitor.

4.8 Database

The window shows the measurement results saved in the database.

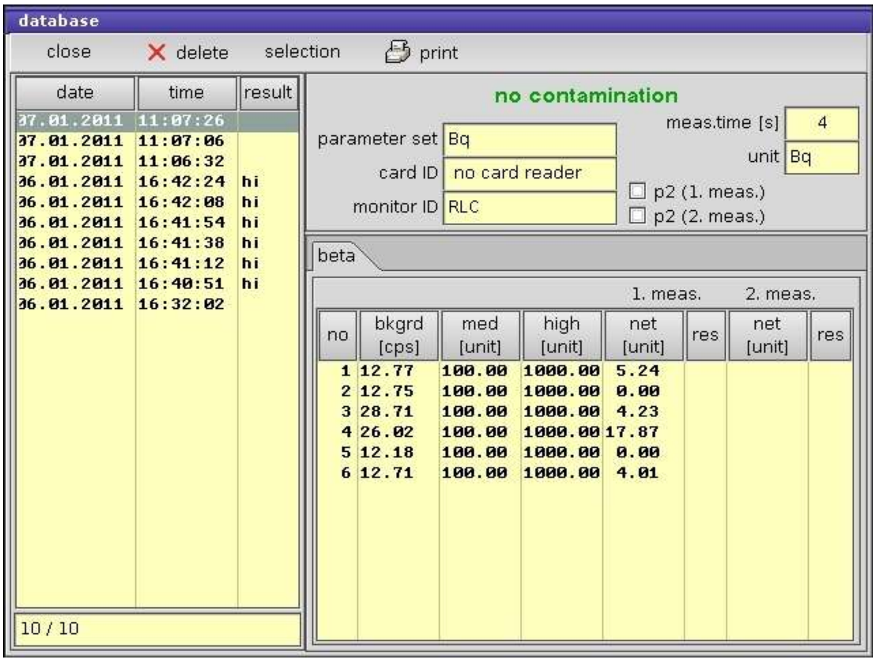


Figure 4-26: Setting database

In the left window all measurements are displayed with their time and a mark (little star) if radiation was detected.

If the cursor is moved within this window, the measurement values of the individual channels in the list at the right hand side are displayed.

It is possible to delete database sets selectively by clicking the button ***"delete"***.

Selection criteria

It is possible to select which results of the database are displayed in the listing.

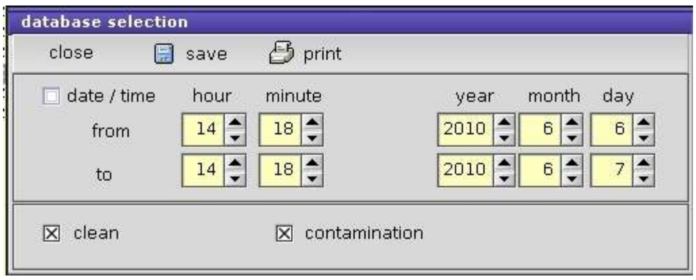


Figure 4-27: Database selection

4.9 Misc

4.9.1 Statistics

The statistic is called up in the running service mode via the menu **misc/statistics**.

Some important characteristics for the operating time of the monitor are displayed. They are separated in two windows. The upper window shows the operating time since the last start and the bottom window shows the total operating time since set up of the monitor.

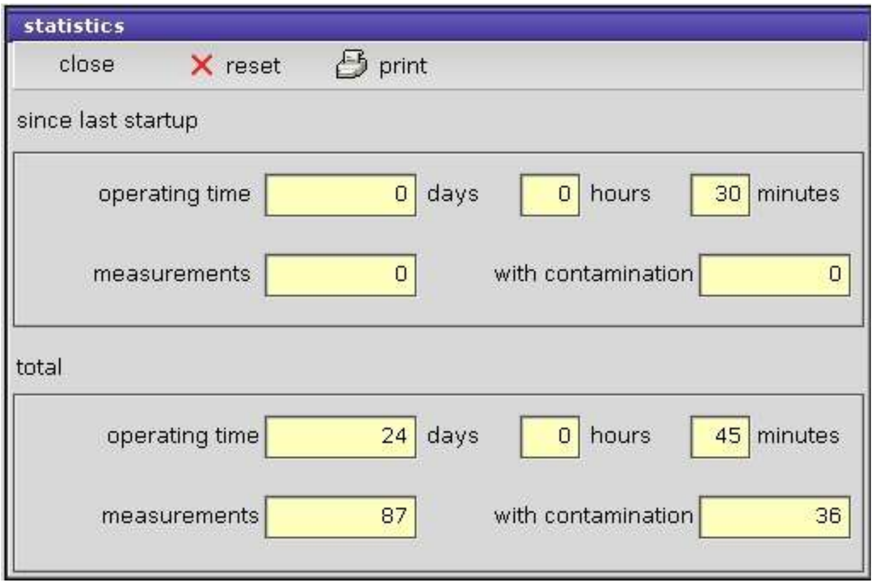


Figure 4-28: Setting statistics

Duration of the operation:

- ☐ Days, hours, minutes

Number of measurements since the last start or since the set up

- ☐ Measurements
- ☐ Measurements with contamination

With the button ***"reset"*** the data *"since last startup"* are set back to "0".

The "total" data (since the set up) can't be set back to "0".

4.9.2 Language

The call-up for the language setting is done in the running service mode via the menu **misc/language**.

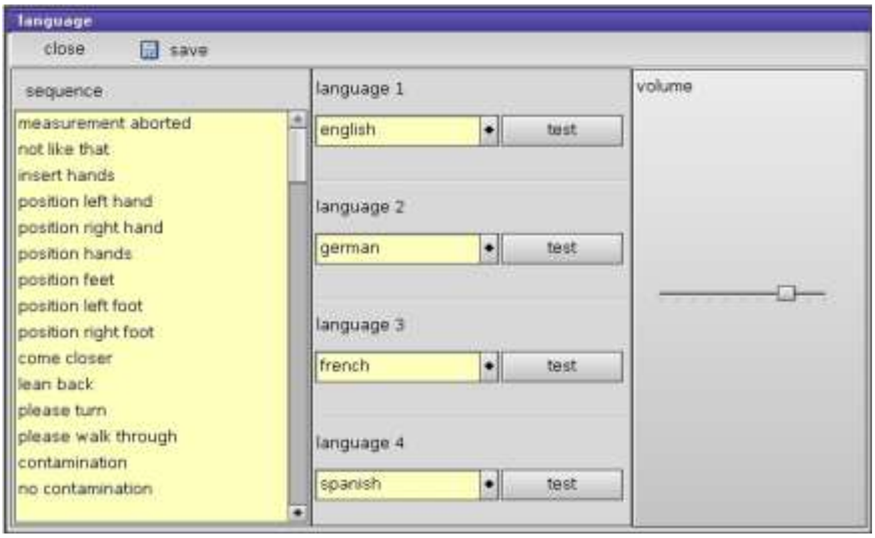


Figure 4-20: Setting language

With the first language it is determined in which language the user menus will appear. For the language display the respective audio-files have to be installed.

The available audio files can be tested for each language.

Additionally the loudness and volume of the audio support can be set via a slide control.

4.10 Help

The button ***"help"*** leads to the sub-menus:

- Protocol
- Hardware
- About (Info)

4.10.1 Protocol

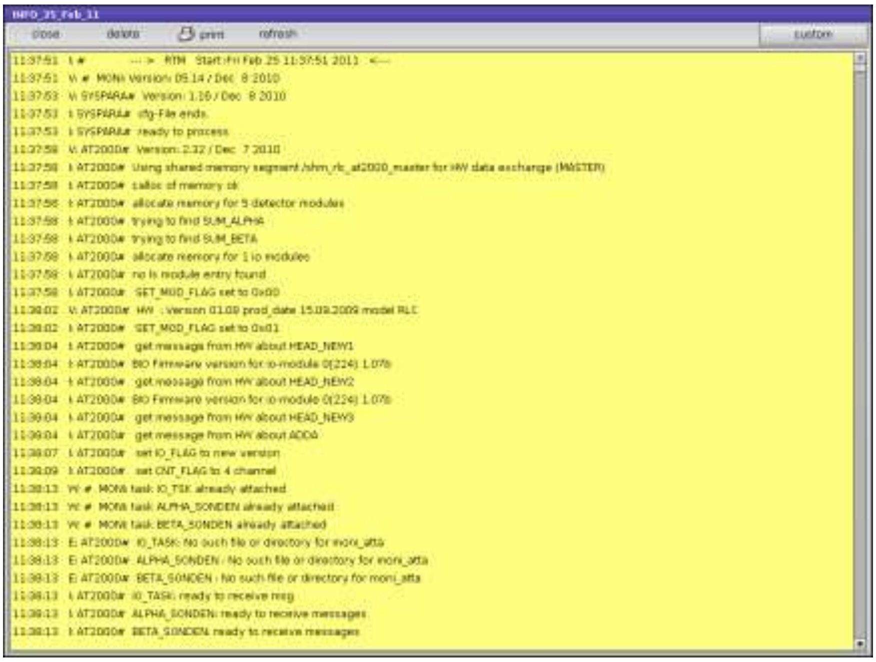


Figure 4-29: Protocol

Before entering the RTM user software a protocol manager is started. This manager records the start routine of the RTM user software.

In the protocol:

- Info messages
- Warning messages
- Error messages

are recorded, which occur during the start and the programme sequences.

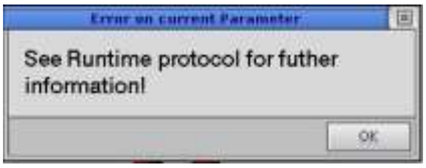


Figure 4-30: Possible error message on start

In the field "**directory**" the local path for storing messages is displayed. The left-hand window shows a listing of all available protocol files. There is an automatic delete function, so that only the protocols of the last 12 days are displayed in the list.
With the button ***"print"*** it is possible to make a printout of all recorded data in the selected protocol file.
With the button ***"delete"*** it is possible to remove a selected file manually.
With the button ***"close"*** you can return to the start menu.

4.10.2 Hardware

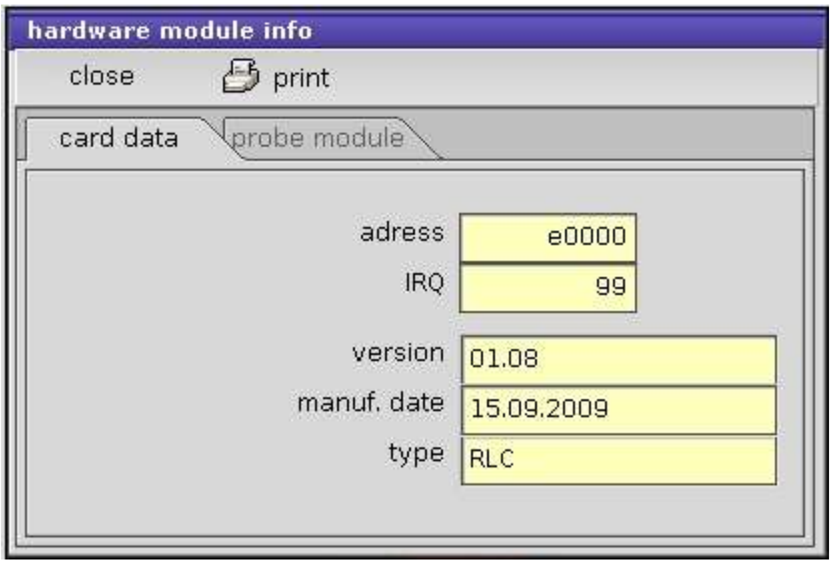


Figure 4-31: Hardware info ISA card

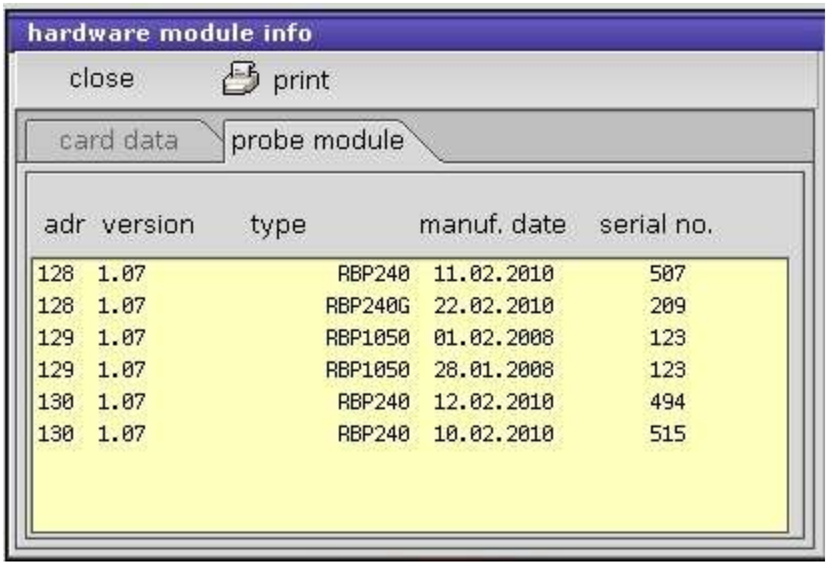


Figure 4-32: Hardware info counter modules

The button ***"close"*** leads to the start menu.

4.10.3 About (Info)

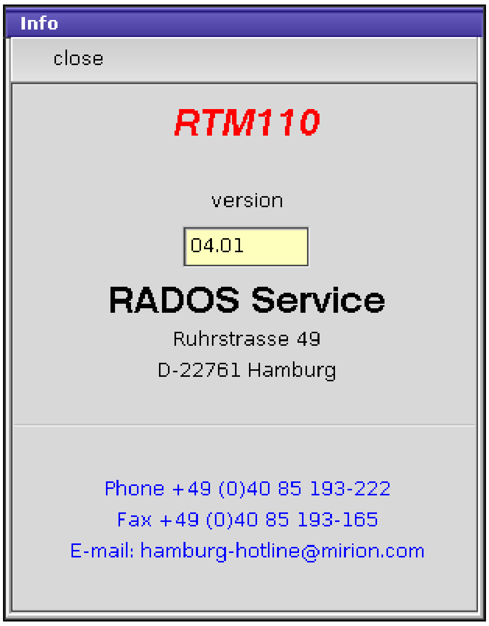


Figure 4-33: About (Info)

In the info window the current monitor name (**RTM110**) and its current user software version, with which the monitor is operated, are displayed.

With the button **close** return to the start menu.

4.11 Quit (exit program)

With the button ***"close"*** you quit the program and return to the start menu.

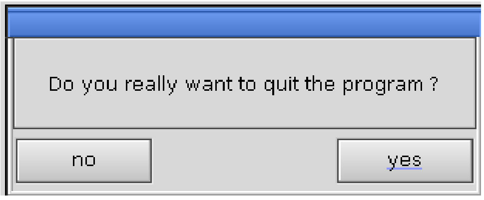


Figure 4-34: Quit program

5 User administration

Table of figures

5.1 User administration

In the **user administration** group authorizations for each user in different subprograms and modules can be defined. With the aid of **user administration** global authorizations can be given to all user software modules.

5.1.1 Prefix

The **RTM110** monitor has different graphical and entry elements for the user communication. A detailed description of the operation is given in chapter "Computer system QNX".

In order to start the **user administration** it is necessary to close the user software. Close the measurement mode by entering the maintenance mode in the user software and select menu-item **close**.
Regarding the case you are logged in as a **default** user please change your login authorization to the user group **user** at minimum to get access to the menu item **close**.

The **user administration** is opened and carried out using the **service -** and afterwards the **user profile** button in the start up menu. To get into the menu you need to logon as **superuser**.

Figure 5-1: Start-up menu

Used to call the **RTM user software** the main program to perform contamination measurement (see Register 3 and Register 4)

the user administration for Body contamination monitors.

5.1.2 User Groups

Every user belongs to one of six user groups with specific authorizations (in decreasing authority order):

Superuser	**Level 1**
Master	**Level 2**
Service	**Level 3**
User	**Level 4**
User_Low	**Level 5**
Nobody	**Level 6**

The authorizations of a higher user group include the ones from ones below.

The **superuser** is needed to edit data in the **user administration**. The user group **default** is only used as a *login-user* in order to prevent that every user can exit the measurement mode.

If a program module is quit, the authorizations in the module will be reset.

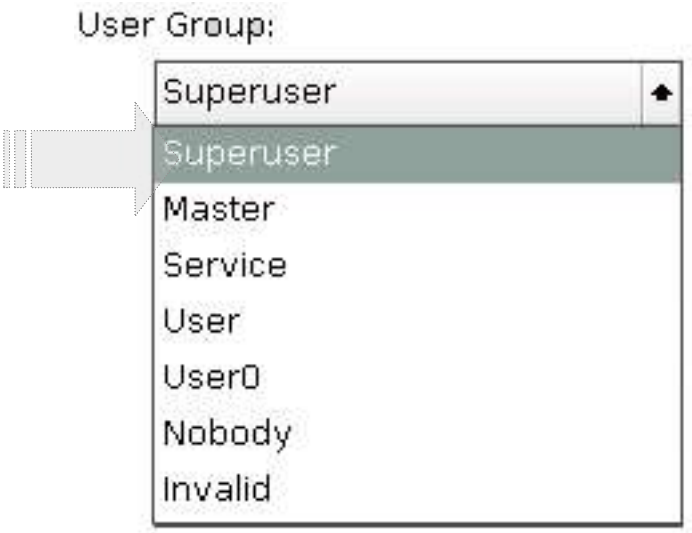


Figure 5-2: User administration – user authorization selection

5.1.3 User administration general

The device software for the contamination monitors from the **CheckPoint: Body™** family is a multiuser environment and is equipped with a user administration.
The device software user access follows hierarchical structures. The user access for respective user is stored and managed by a selection of user groups. The authorization of a user is defined by username and password.
The **superuser** (administrator) is defined as user level 1 and enables working with all rights. A user with the user Level 6 (**Nobody**) has respectively the fewest rights.
If a user does not have the appropriate rights in a software module the software module or display is hidden from view or is write protected.
The **user profile** organizes the user authorization in the user- software. With the aid of the **user profile** one can generate a **login-user**. Select this function with a click on the box **login-user** 1 **.**
The user software will now start with the corresponding group-authorization.
If there is no login-user defined, the system will automatically start with the group right user.

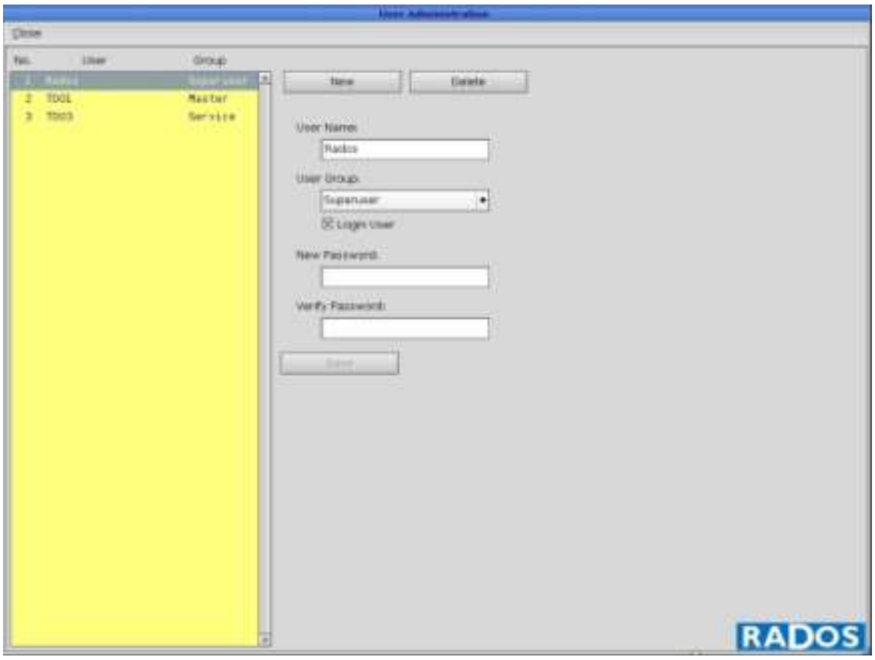


Figure 5-3: User administration –Start menu

> **NOTE**
>
> **If the login-user is defined with the group- right Master, the user profile will be deactivated in the measurement software. Therewith you can enter the service mode by using the maintenance key lock button.**

5.1.4 Authorizations in RTM User Software

The **user profile**, defined in the special user groups, will also organize the authorizations in the User Software. With the aid of the **user profile**, a login_user can be defined. The System will start with the defined authorizations of the login_user.

If there is no login_user defined, the system will start automatically with the authorizations of the “user” group.

Authorization needed to operate functions in the User Software:
(higher authorization by password query):

Function	**Minimum authorization**
End application ➲Menu	User
Change IO ➲ Service/ IO-Test ➲ Misc/language	Service
Measure background ➲ (Service/Meas.-status)	Service
Quit Channel ➲Service/Meas.-status	Master
High- / Discriminator changes (temporally) ➲ Service/Detector status	Superuser
Parameter changes ➲Parameter/Meas. parameter ➲Parameter/database ➲Parameter/BKG ➲Misc/statistic ➲Misc/language	Master
High-/Discriminator changes ➲Service/Detector status	Superuser
Parameter view ➲ Service	User_Low
System function ➲Change Date/Time ➲Hardware-Setup ➲QNX-Shell ➲Parameter load/save	Master
Contamination measurement	Nobody

The users and the “login_user” should be accounted according their tasks and respective authorizations in the **user profile** program.

CAUTION

If the “login_user” is defined for anybody with the group- authorizations Master, the user profile will be deactivated in the measurement software. So the sub menu “user” will not be shown in the User Software.

5.1.5 Authorization in System check

Authorization needed to operate functions in the System check module: (higher authorization by password query):

Function	Authorization
Perform Working Processes ➲ View Parameter, Nuclides and Results. ➲Printing	User
View Results ➲ Add Working processes ➲ Parameter changes.	Service
All Authorisations	Master

Table 5-4: Authorization System Check

The users should be accounted according their tasks and respective authorization in the **user profile** program.

User administration

5.2 Start of the user profile program

Start the **user profile** by selection in the start-up menu.

A protocol manager will be started first to save the start routine events of the **user profile** program.

The **user profile** program itself is secured with a password. You need to enter the username and the password for the superuser group. Regarding the case that **no** superuser is set, no password will be requested and each user with service key and keyboard is enabled to create new user accounts, change or even delete existing user accounts. If a superuser account exists, the work with the **user profile** program is allowed to these users only.

Figure 5-5: Log in user profile program

After login all present user accounts are visible in the opening main menu.

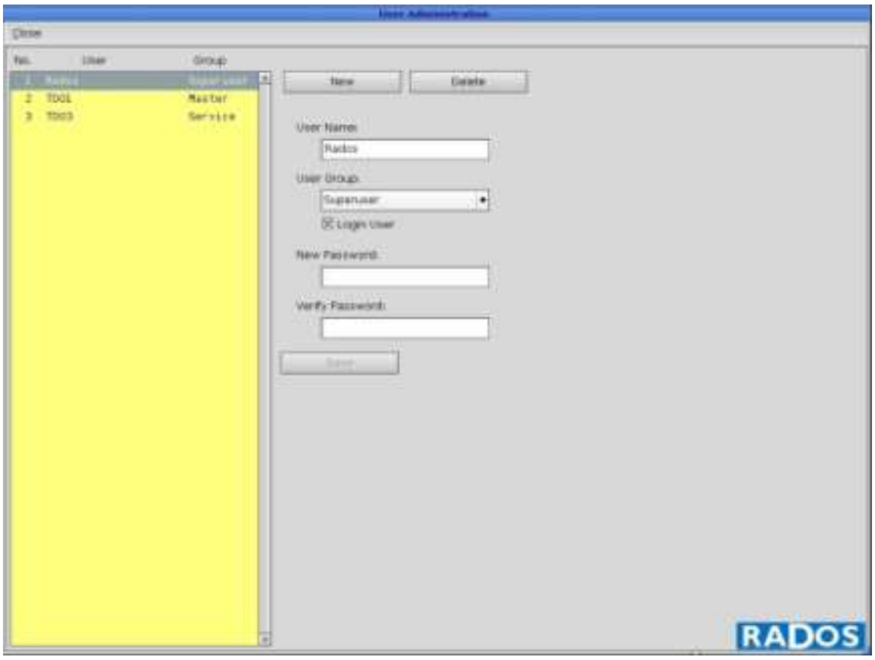


Figure 5-6: Main menu user profile

To simplify the first set-up user accounts for all groups are preinstalled.

Start of the user profile program

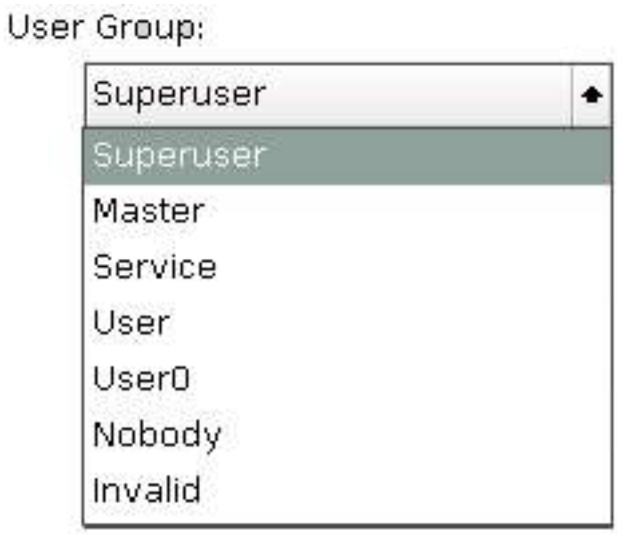


Figure 5-7: User group selection

	NOTE
	The preinstalled “superuser” account values can be found in chapter 1. of this documentation. **This Chapter is being advised to be removed from the manual, after first setup.**

	NOTE
	While entering user name and password attention has to be paid for capital and small letters. **The items in the white fields (in the running program) can be modified. However the items in the yellow fields are fixed.**

5.2.1 Installation of a new user profile

To install a new **user profile** you need to click on *new* (1) at the menu panel. The white fields (2) are used to open an account for a new user.

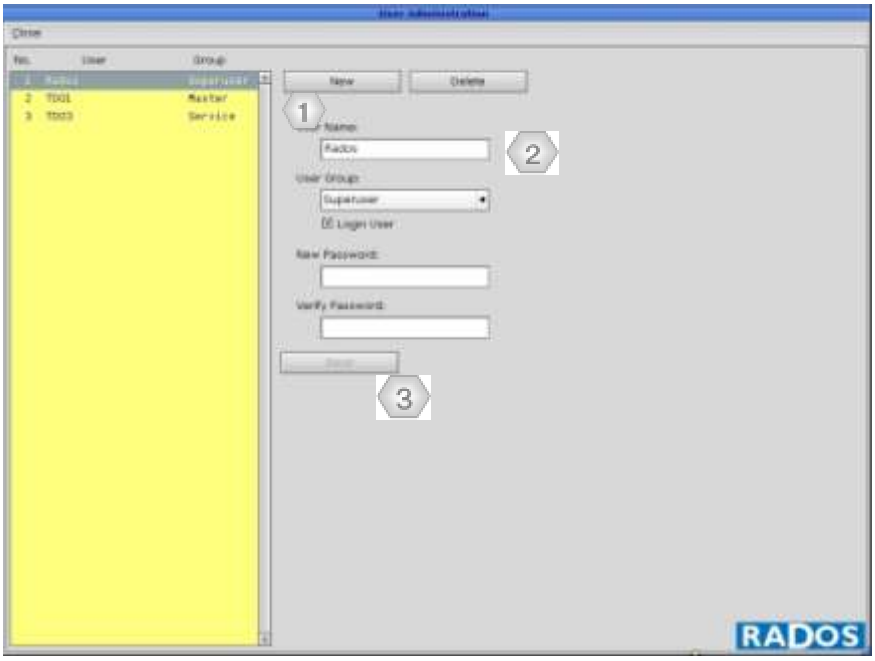


Figure 5-8: Installation of a new user profile

If no password is chosen for the **user profile** no password will be requested for the login.

The new **user profile** needs to be confirmed/saved with a click on *save* (3) at the menu panel. The new **user profile** is displayed in the left window include a consecutively number.

5.2.2 Modify a user profile

To modify a **user profile** one need to select a user 1 from the menu panel. The white window is used to modify 2 the **user profile**. The change is confirmed with *save* 3.

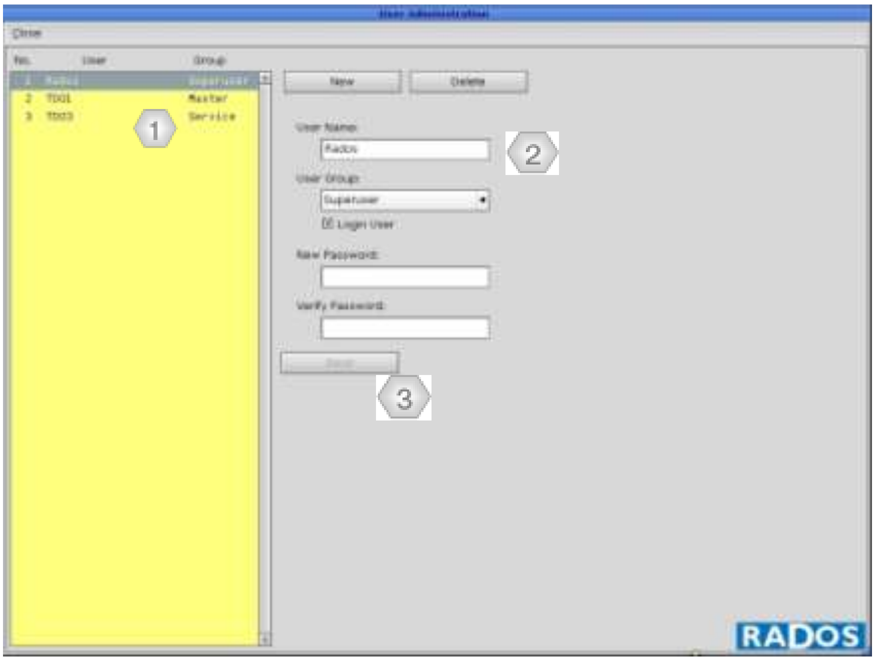


Figure 5-9: Modify a user profile

5.2.3 Login_user

The **user profile** also organizes the user authorization in the - User-Software. With the aid of the **user profile** one can generate a Login_user. Select this function with a click on the box “login_user”.

Figure 5-10: Login_user activation

The User Software will now start with the corresponding group-authorization.

If there is no login_user defined, the system will automatically start with the group right “user”.

CAUTION

If the “login_user” is defined with the group-right Master, the user profile **will be deactivated for RTM110 measurement software and the sub menu “user” will not be shown in the User Software.**

5.2.4 Delete a user profile

To delete a **user profile** one needs to click on the entry of the user in the left list 1 to mark it and click on *delete* 2 at the menu panel. A second window will appear with the inquiry *“Do you really want to delete the record”* 3 . The user is requested to confirm this step to avoid the accidental erasure of datasets.

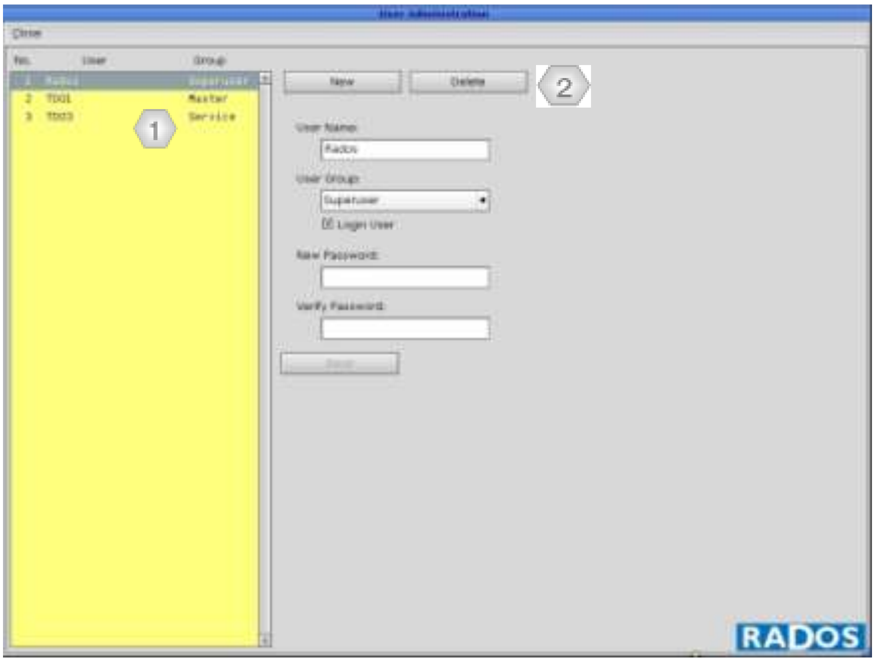


Figure 5-11: Modify a user profile

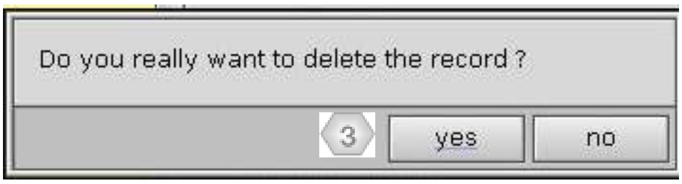


Figure 5-12: Delete a user profile

5.2.5 Close the user profile program

To close the **user profile** program one clicks at *close* at the menu panel.

6 System check

Figure

6.1 Startup menu

The Body Contamination monitor family with the monitor **RTM110** has different graphical and entry elements for the user. A detailed description of the operation is given in chapter "Computer system QNX".

In order to start the calibration tool **system check** it is necessary to close the user software. To close the measurement mode enter the service mode in the user software and select menu-item **close**.
Regarding the case you are logged in as a **default**-user please change your login-authorization to the user- group **user** at minimum to get access to the menu-item **close**.

The **system check** module is opened and carried out using the **service -** and afterwards the **system check** button in the startup-menu.

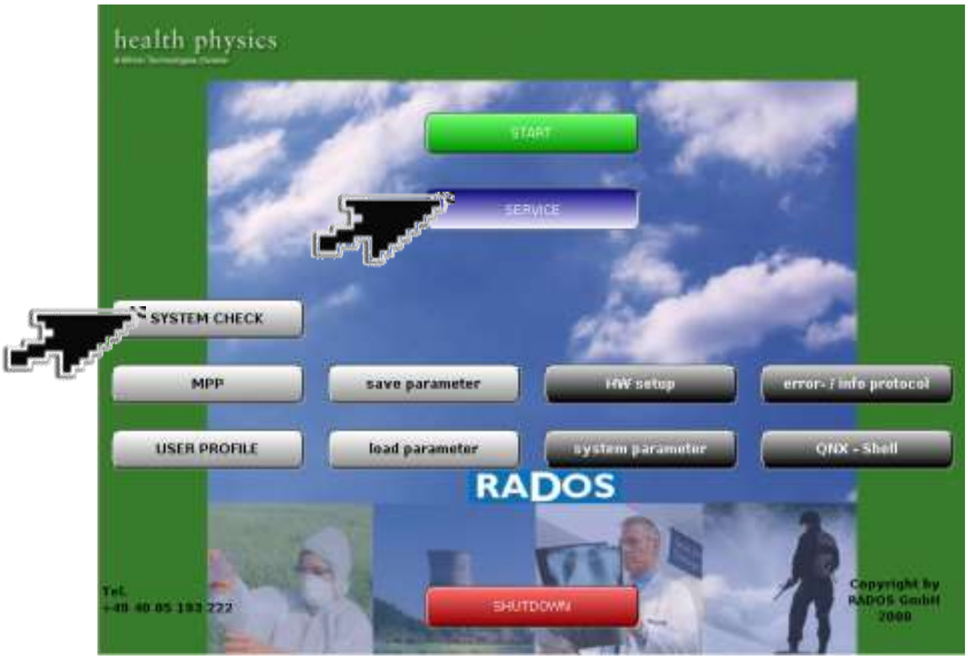


Figure 6-1: Start-up menu

Software modules provided via the **Start-up Menu**:

Used to call the **RTM user software** the main program to perform contamination measurement

Opens and reduces the full menu screen(see Register 3 and Register 4)

The maintenance and calibration program for body contamination monitors.

6.2 System check

The **System check**-module is used to

- Access and admin the nuclide database
- Perform in- and output tests
- Define working processes for detector calibration
- Carry out a working process for detector calibration
- Print out of working processes for detector calibration
- Define the validity of detector calibrations
- Im- and export of measurement data like results, nuclide database and working processes

The nuclide administration comprises the record, change and administration of test sources. Based on this data the efficiency of a measurement channel can be determined. If compared to a reference measurement a tendency of the physical development of a measurement channel with respect to its efficiency can be realized.

To start working with the **system check** module at first a *working process* needs to be defined. Such a working process either contents a new calibration, a protocol calibration or a follow-up calibration.
Additionally the binary in- and outputs can be checked in this procedure.

It is necessary to install the nuclides to be used in the nuclide database before starting a new working process. Furthermore, a reference is a prerequisite for a protocol or a follow-up calibration.

A calibration (determination of the efficiency) is done with these steps: (Some of the steps are only to be proceeded in the first use of the software).

- Background measurement
- Measurement of channels; successively measuring is possible for different types of radiation
- Test of the binary in/outputs in the main menu

When setting up new work steps

  - Creation of the test sources in the nuclide database
  - Set-up of a working process below database in the main menu; beta- or gamma test sources can be as well selected as multi sources
  - Setting of parameters
  - Selection of source or protocol

6.3 General mathematical calculations

Different calculations are to be effected according the selected measurement and nuclide parameters. Below the mathematical formulas applied are listed and their meanings are explained.

6.3.1 Current activity

Based on the radioactive decay the activity of a source diminishes during increasing life.

formula 6-1: current activity

$$A = A_0 \, e^{-\frac{\ln 2 \, \Delta t}{T_{\frac{1}{2}}}}$$

A	=	current activity [Bq]
A_0	=	initial activity [Bq]
$T_{\frac{1}{2}}$	=	half life [days]
Δt	=	time elapsed [days]

6.3.2 Efficiency

The ratio of measured counts per seconds [cps] and the radioactivity of the measurement source are called efficiency and are used as measure for the quality of the measurement channel.

formula 6-2: efficiency

$$\eta = \frac{N - N_0}{A}$$

η	=	efficiency
N	=	mean gross count rate [cps]
N_0	=	mean background count rate [cps]
A	=	current activity [Bq]

The efficiency is frequently stated as a percentage rate. In this case a multiplication with 100 has to be carried out to receive a percentage value.

6.3.3 Default deviation

The formula below is used to determine the determination of the mean deviation.

formula 6-3: default deviation

$$\sigma_n = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}$$

σ_n	=	default deviation
n	=	number of measurements
x_i	=	i^{th} measurement value
$\bar{x}$	=	mean value of all measurements

Considering only distribution processes this default deviation refers to the law of statistics. For nuclear decay the Poisson distribution has to be applied.

6.3.4 Error propagation net count rate

The mean net count rate is derived from the difference of the mean background count rate and the mean gross count rate. As both measurement values are subject to faults this is also true for the calculated value:

formula 6-4: net count rate

$$\sigma\left(N - N_0\right) = \sqrt{\sigma_N{}^2 + \sigma_{N_0}{}^2}$$

$\sigma(N-N_o)$ error of individual measurements
σ_N default deviation of the mean gross count rate [cps] or [cpg]
σ_{N0} default deviation of mean background count rate [cps] or [cpg]

6.3.5 Error propagation of efficiency

The error expansion for efficiency is described as:

formula 6-5: error propagation of efficiency

$$\sigma(\eta) = \sqrt{\frac{1}{A^2}\left(\sigma_N{}^2\right) + \frac{(N\text{-}N_0)^2}{A^4}\sigma_A{}^2 + \frac{1}{A^2}\left(\sigma_{N_0}{}^2\right)}$$

$\sigma(\eta)$	=	mean error of efficiency
A	=	current activity [Bq]
N	=	mean gross count rate [cps] or [cpg]
N_o	=	mean background count rate [cps] or [cpg]
σ_A	=	error of current activity
σ_N	=	default deviation of mean gross count rate [cps] or [cpg]
σ_{No}	=	default deviation of mean background count rate [cps] or [cpg]

6.4 Start

First a protocol manager is started, which records the start routine the system check module. The start-up menu of the System check program will appear automatically.

NOTE
It is assumed from now on that the login for the System check was done under the “Master” authorization (refer to 5.2.2. User profiles to get knowledge about administration of user login)

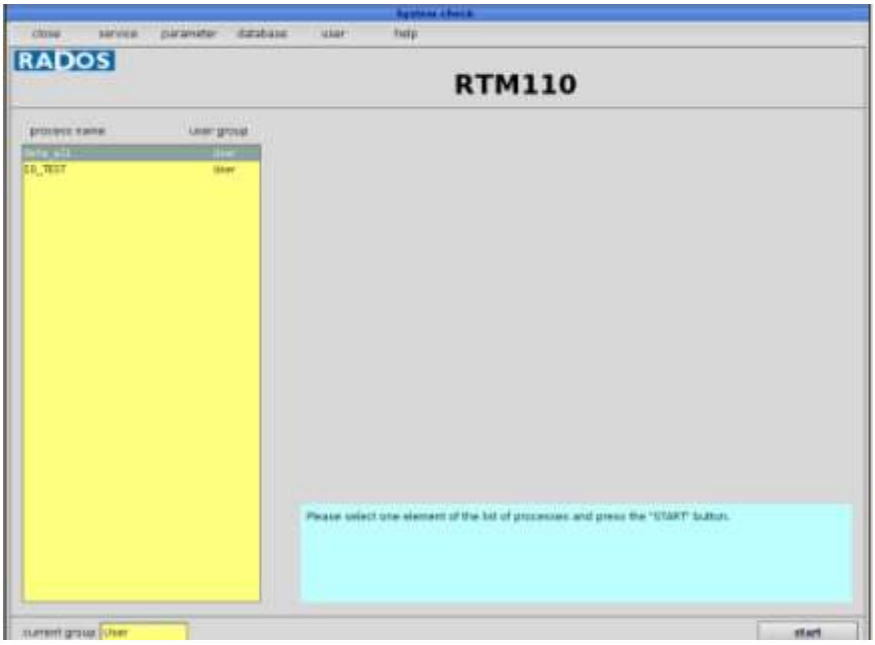


Figure 6-2: Start menu System check

This menu is the gate to the submenus:

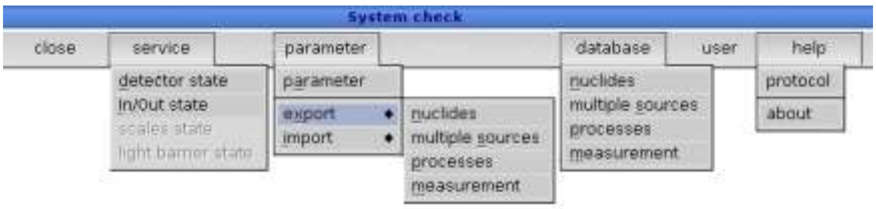


Figure 6-3: System check menu item overview

NOTE
Menu items displayed in light grey could not to be chosen in this RTM110.

6.4.1 Service general

	CAUTION
	This operation mode requires qualified expert personnel or the RADOS Customer Service.

	NOTE
	The entries shown $\boxed{\text{white}}$ colored fields can be edited to meet user premises. The fields colored in yellow are firmly set by the monitor software or are for informational purposes only.

	CAUTION
	The values displayed in this documentation are simulated data that should not be compared to real measurements.

6.5 Start of a working process

Dependant on login authorization all or just selections of installed processes appear at the main window of the **System check** -Software. A *"master"* process is not visible for *user* or *service* account holders. The calculation of the detector efficiency is nuclide specific and specific to the kind of radiation, respectively. After selecting a working process the measurement will be done for all selected detectors / multiple sources and the efficiency is calculated automatically. Provided that the sources are set and the work steps are prepared. The protocol and follow-up calibration allows due to its reference (existing protocol) an estimation and evaluation of the detector quality.

The selected working process is activated with the *START button*. Every process will be started in this way, either new, protocol or follow-up calibration.

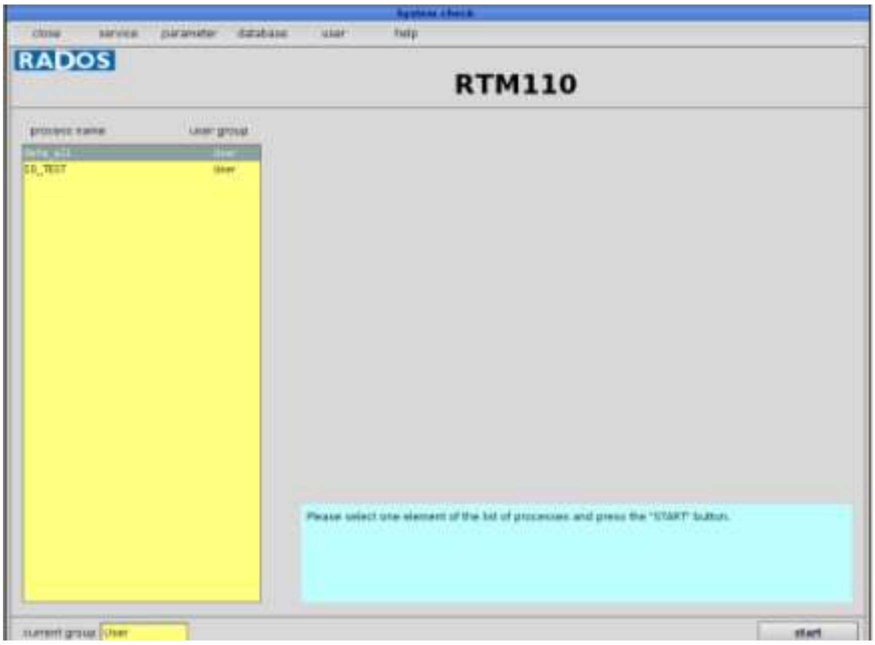


Figure 6-4: Start System check

6.5.1 Background measurement

Each process begins with a background measurement. If more than one radiation type is to be measured, these can be done without updating the background.

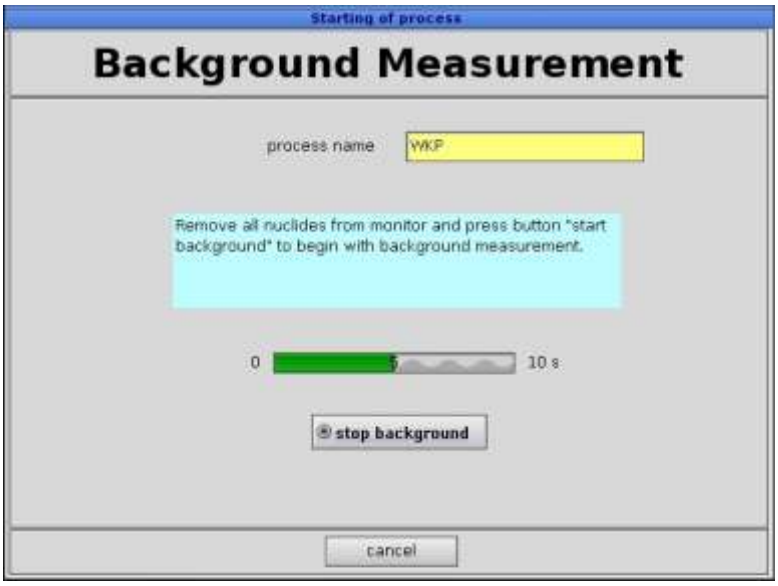


Figure 6-5: Background measurement

The result of the background measurement will be displayed for the activated beta and/or gamma channels.

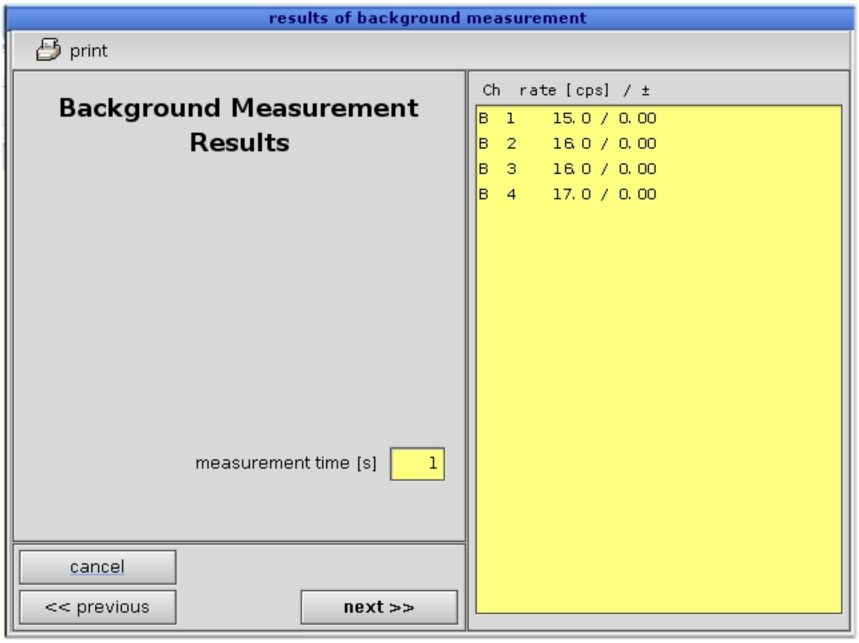


Figure 6-6: Result of background measurement

If the background is extremely unstable during the background measurement it is possible to repeat this measurement
Click ***<<previous*** for a restart.

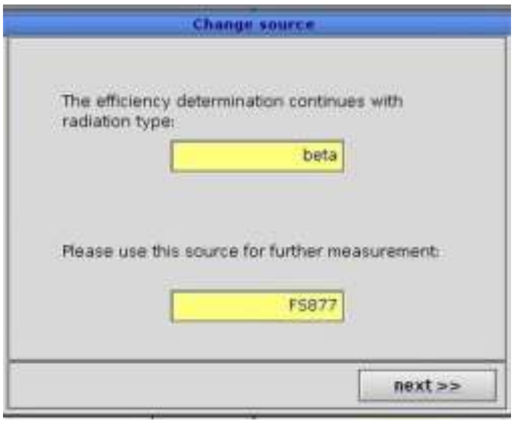


Figure 6-7: Change source

Select and place the correct source for the calibration.

6.6 Determination of channel efficiency (calibration)

The calibration measurement is necessary to determine the channel efficiency. For calibration three different modes are available:

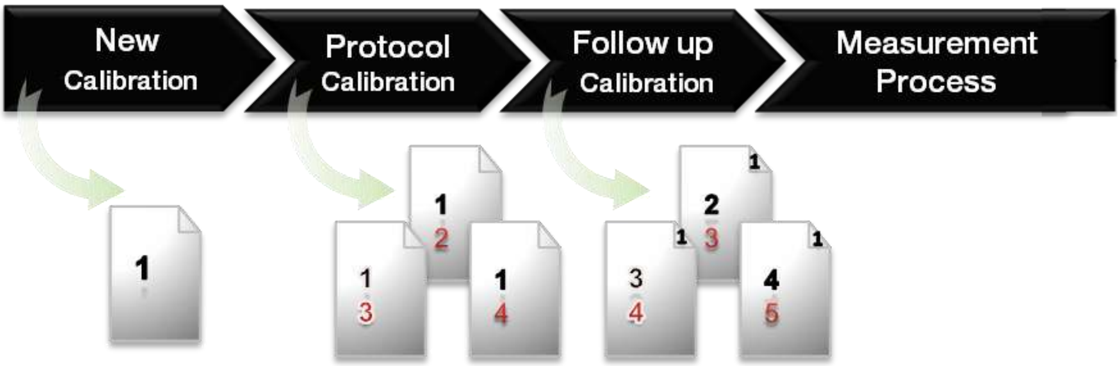


Figure 6-8: Calibration modes

New Calibration	**Chapter 6.6.1**

First efficiency calibration: The efficiency will be saved in a reference calibration. The calibration report can be viewed and printed in the ***Measurement results/Details*** menu.

Protocol Calibration	**Chapter 6.6.2**

This efficiency calibration process is identical with the new calibration. But one has to select a performed „new“ calibration as reference for the protocol calibration to perform an efficiency deviation calculation. The deviation will be quoted in per cent. It is not necessary to perform a protocol calibration on all channels.
The protocol calibration is useful for the efficiency deviation of the **RTM110** after factory acceptance.

Follow-up Calibration	**Chapter 6.6.3**

The follow-up calibration process is equal to the new calibration. The efficiency measured in the calibration will be compared to the last calibration performed (protocol calibration). This enables the user to monitor the deviation between each calibration and to update the calibration reference.

6.6.1 New calibration

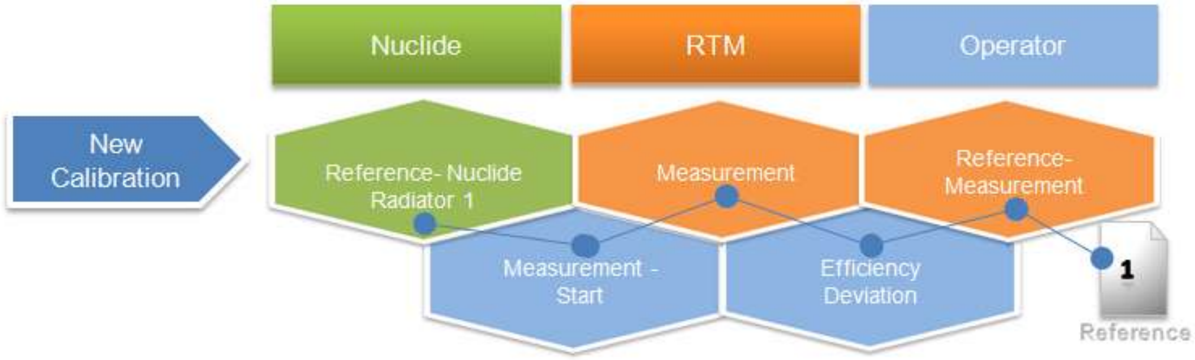


Figure 6-9: New calibration process

After the background determination, all channels a ready for measurement. Click therefore on button ***start meas***. For a better understanding, the location and name of the channels are displayed.

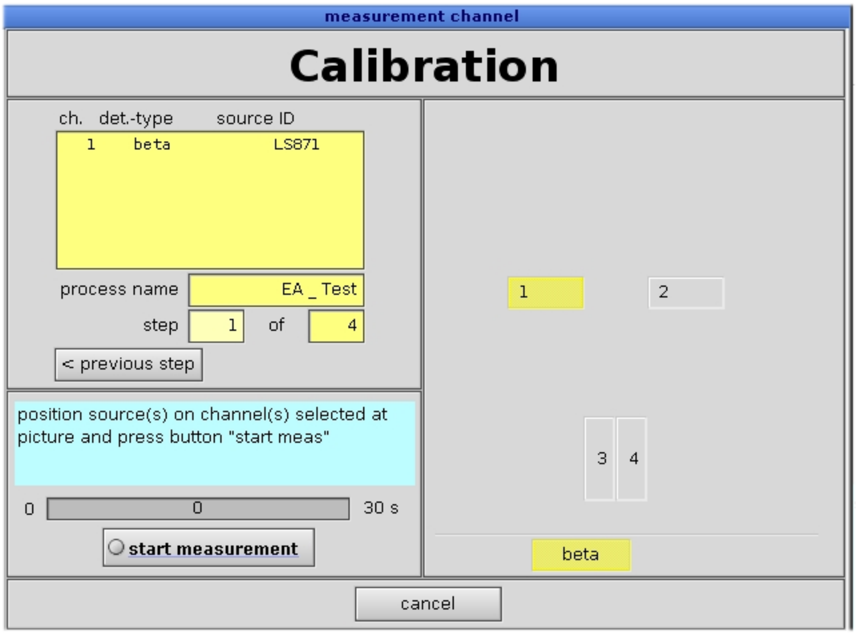


Figure 6-10: Calibration of all channels

Measurement results are displayed as:

- channel no.
- measurement time [sec]
- high voltage [volt]
- background count rate [cps] (standard deviation)
- gross count rate [cps] (standard deviation)
- net count rate [cps], error (see chapter error propagation net count rate)

- efficiency [%] (for error see chapter error propagation of efficiency)

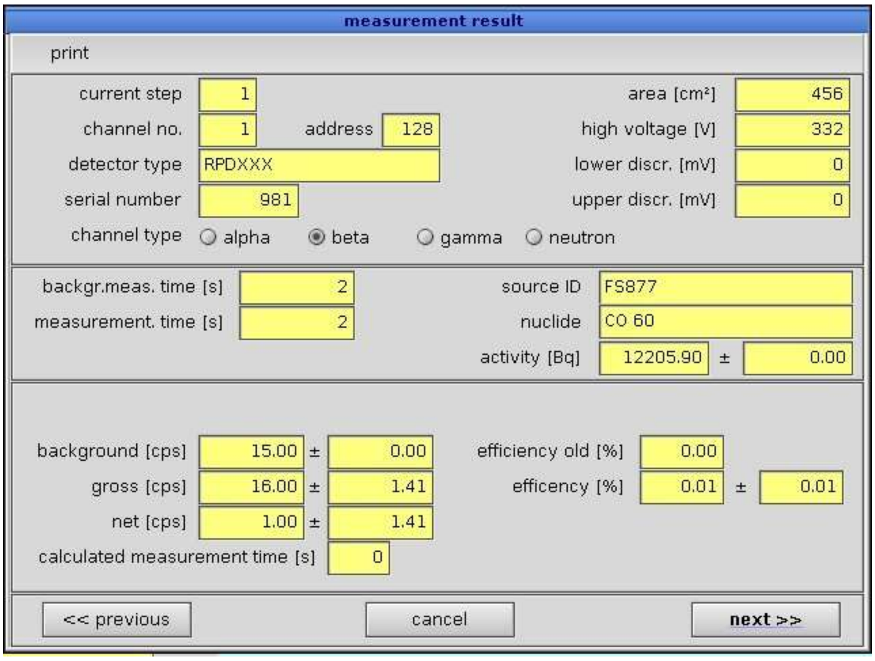


Figure 6-11: Measurement result (Channel measurement)

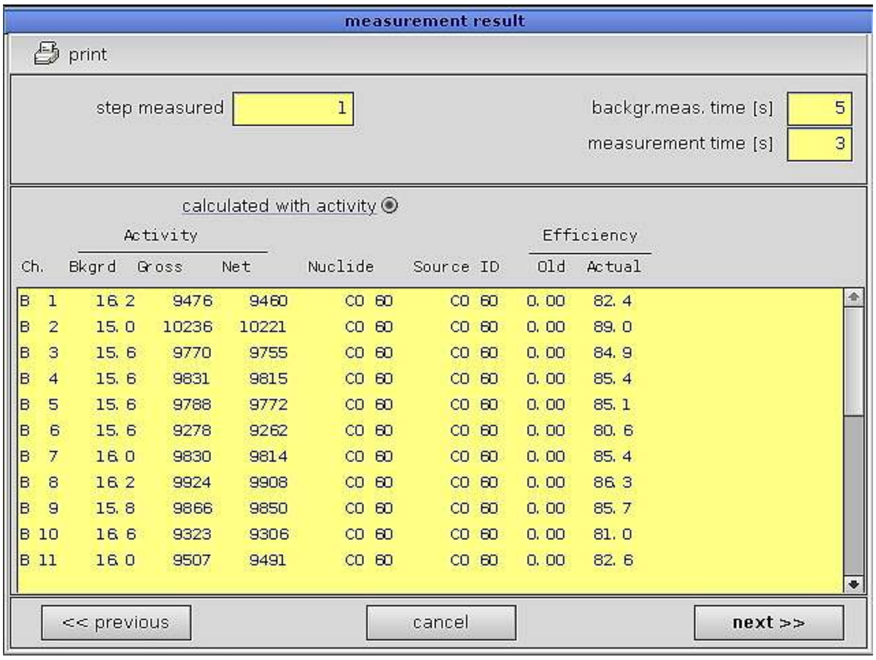


Figure 6-12: Measurement result (OneStep™ measurement example)

If necessary the measurement of a channel can be repeated. That will be necessary, when the source was displaced. Click therefore ***<<previous***.

After the last channel measurement the binary in- and outputs will be checked or the measurement results will be immediately displayed, just according to the working process.

6.6.2 Protocol calibration

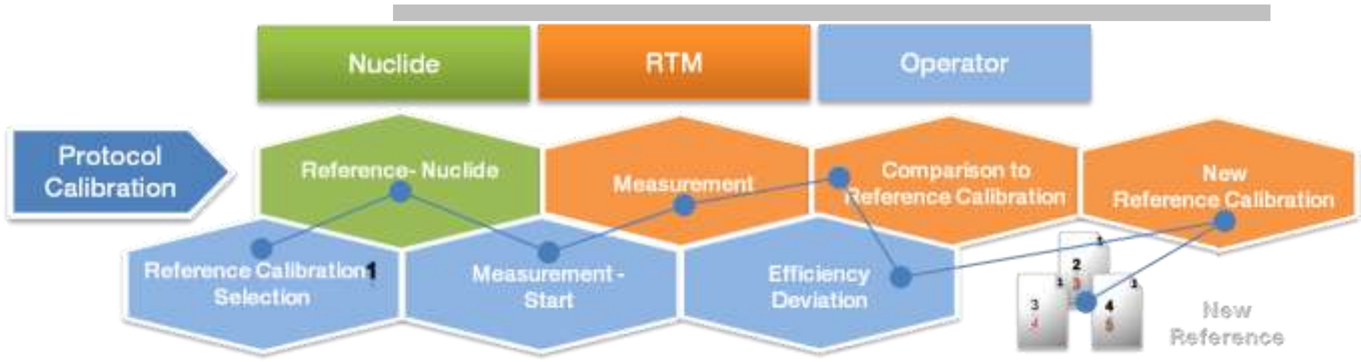


Figure 6-13: Calibration protocol process

The procedure of efficiency determination is identical to the previous described new calibration. In difference to a new/single calibration, an already existing calibration will be used as a reference. All measured efficiencies are stored; the current and former efficiency is displayed in ***measurement result/details*** as well as the resulting deviation in percent.

Here, it is not necessary to measure all channels, but a selection can be made by the buttons ***<previous step*** and ***next step>***.

This tool is applicable, e.g., after the exchange of a detector; the new efficiency is stored into the measurement results. Of course, it is also possible to measure all channels.

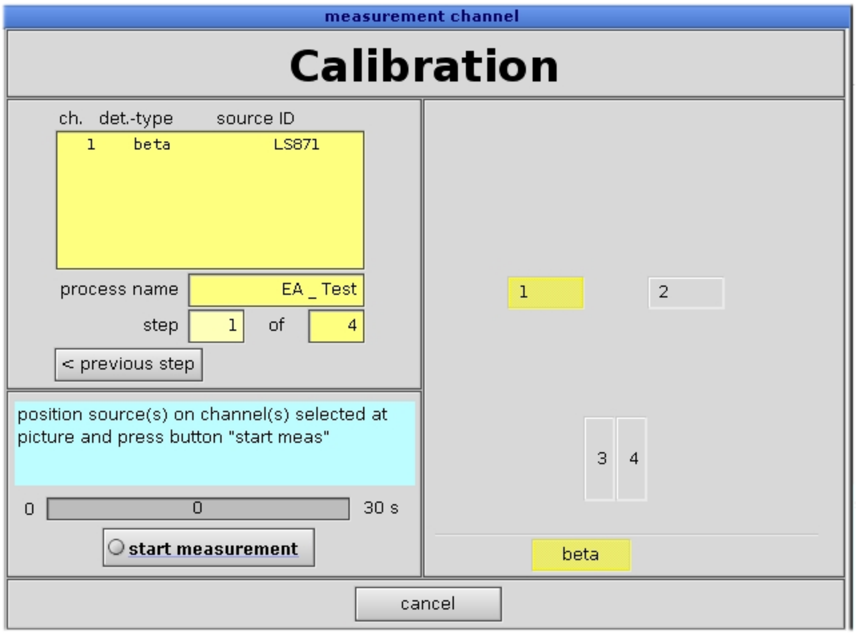


Figure 6-14: Efficiency determination calibration

After the last channel measurement the binary in- and outputs will be checked or the measurement results will be immediately displayed, just according to the working process.

6.6.3 Follow-up calibration

Figure 6-15: Follow-up calibration process

The efficiency determination for the ***sequence calibration*** will be performed like a ***new calibration***. The only difference is the basis as a reference calibration will be used.

The efficiency determination for the ***follow-up calibration*** will be reference calibration will be used.

Here, the current efficiency is always compared to the reference, defined in the set up of the working process. As a measurement result, the reference values are kept.

This task applies, when the monitor shall measure with the efficiency of the new calibration. The current test is used as control to check whether the variation is in the demanded tolerance limit.

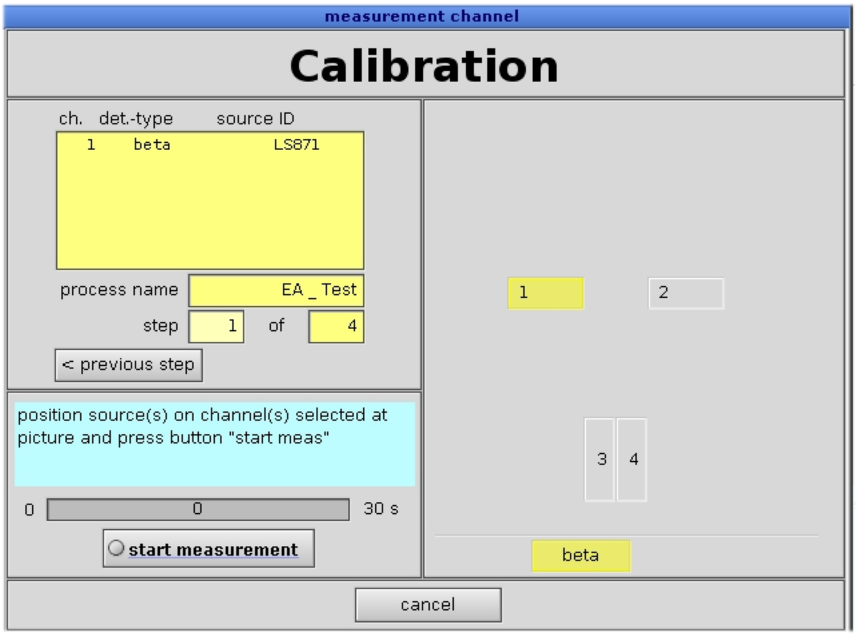


Figure 6-16: Efficiency determination follow up calibration

After the last channel measurement the binary in- and outputs will be checked or the measurement results will be immediately displayed, just according to the working process.

6.6.4 Check of binary in- and outputs

This test can be done either in the service menu or in line with a working process if defined when the working process was defined. To perform the binary ***Input test*** all initiators need to be activated. If the initiator is working properly a tick will be set next to the related field.

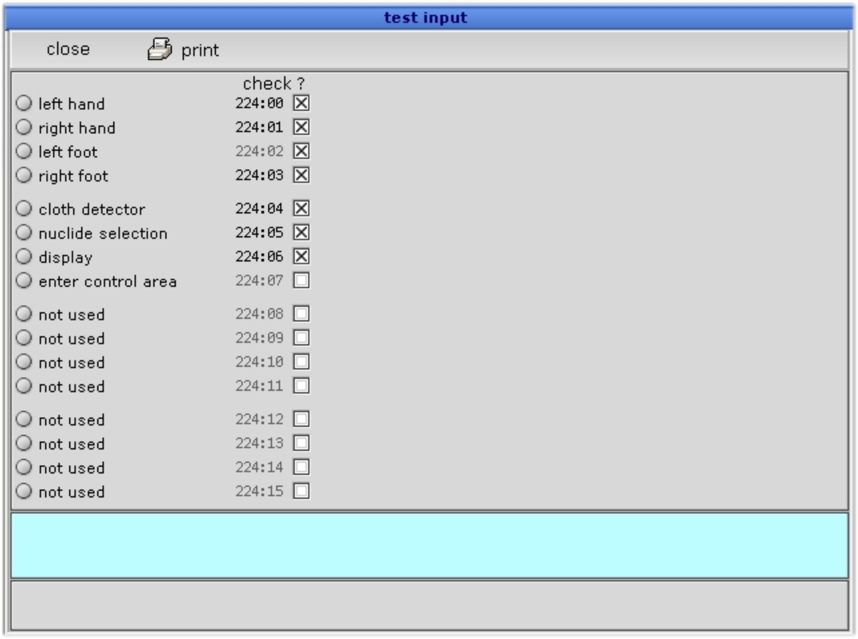


Figure 6-17: System check input test

Click on ***next>>*** to enter the binary output check.

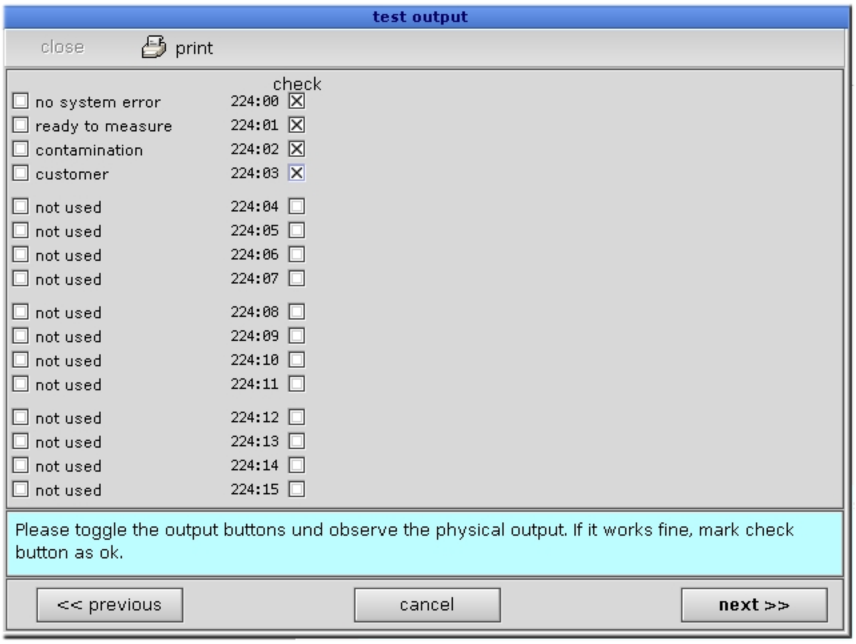


Figure 6-18: System check Output test

The binary outputs need to be checked manually on the related relays outputs. The output is activated by clicking the respective output with the mouse pointer. If the binary output is working properly the tick is added manually in the related fields. Click ***next>>*** to continue.

6.6.5 Total result of the efficiency determination

After all detectors have gone through the measurement process, the total result for each channel, separated in the respective windows, for beta or gamma detectors is displayed and a protocol can be generated (refer also to chapter Printing parameter):

--- Mirion Technologies (RADOS) GmbH ---

Protocol Date/time Page 1/x

Protocol-data

Current protocol No : 9 Reference No: 0

Date: Mon 10.07.06 15:30:22

Calibration name: Beta ALL
calibrated by TD0001
Remark :

Measurement time for background: 180s
Measurement time for channel al: 0s
Measurement time for channel be: 0s
Measurement time for channel ga: 120s

EXAMPLE
(excerpt of data)

GAMMA

No Bkgrd gross net nuclide source-ID activity time efficiency

……………………………………data…………………………

EXAMPLE
(excerpt of data)

INPUT OUTPUT TEST

No/Type status function

----

1 IN OK service key
......
4 IN OK measurement start
......
1 OUT OK ready to measure
......
4 OUT OK no contamination

--------------------- Signature 1 ----------------------- Signature 2

Figure 6-19: Protocol example

The measurement result can be named in the line “calibration name”. Additional information can also be given in the head in the white boxes.

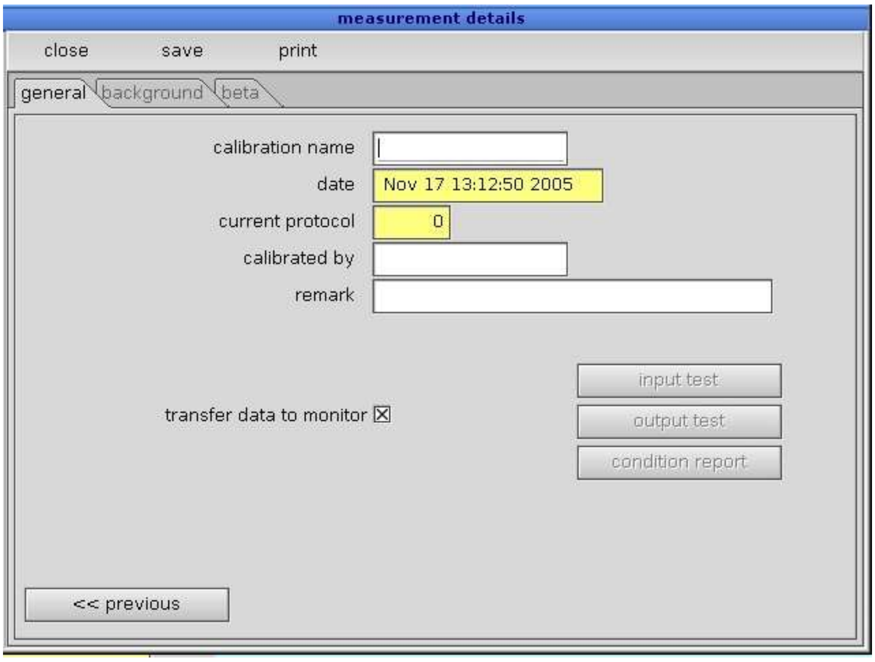


Figure 6-20: Measuring calibration result

Note

Menu item colored in light grey are referenced to software modules which are not built in the present RTM110.

The expiry time for calibration and the user alert can be individually defined to assure testers attendance for recalibration.

By opening an additional registry card the result of the background measurement is displayed for each channel.

Determination of channel efficiency (calibration)

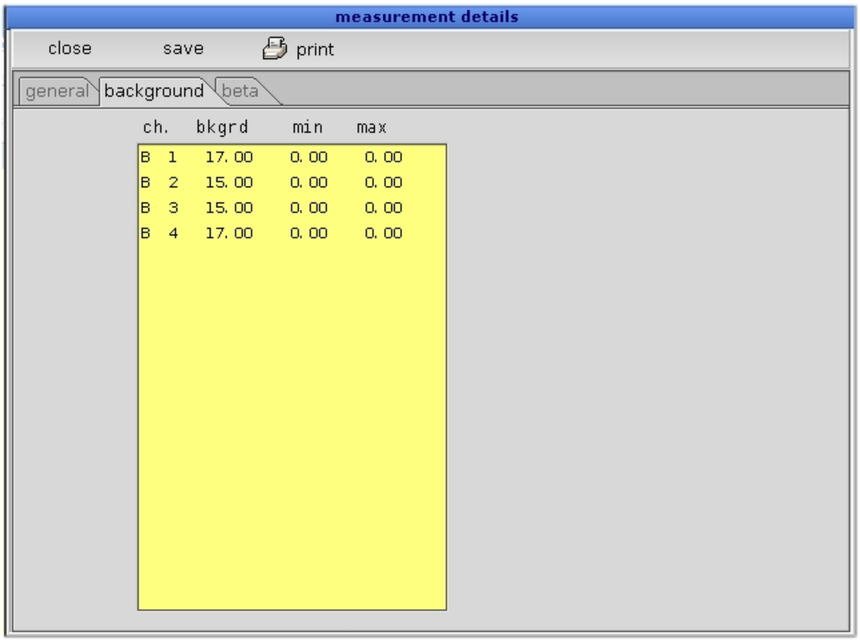


Figure 6-21: Background details

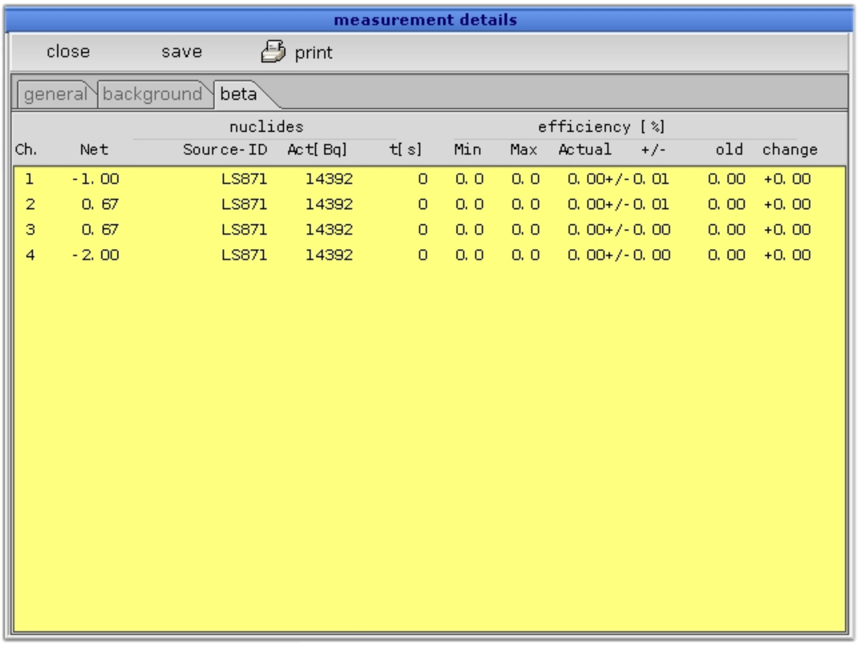


Figure 6-22: Channel details

If the binary in- and outputs were checked during the process, click on the registry card misc.

A click on ***Input*** shows the binary inputs.

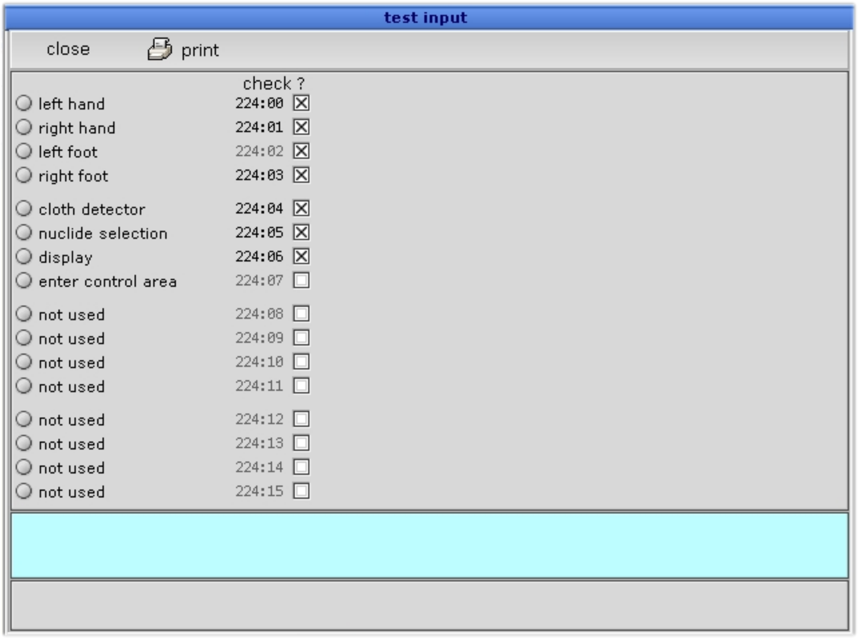


Figure 6-23: Input test

Click on ***Output*** to watch the binary outputs.

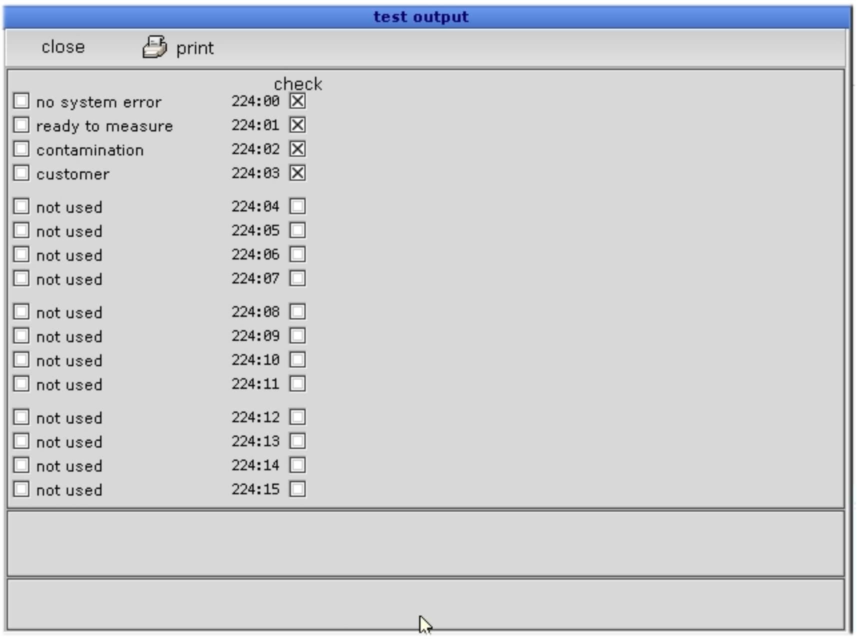


Figure 6-24: Output test

Results cannot be modified, but it is possible to ***save*** them into a protocol with the calibration name. They can be retrieved in the system check main menu under ***database/measurement***.

System check results can be printed as protocols directly via the printer interface with a click on ***print*** and the confirmation of the selected printer.

Clos(e)ing twice leads back to the main menu.

6.7 System check service mode

The **system check** startup window is the gate to all maintenance functions for the service menu.

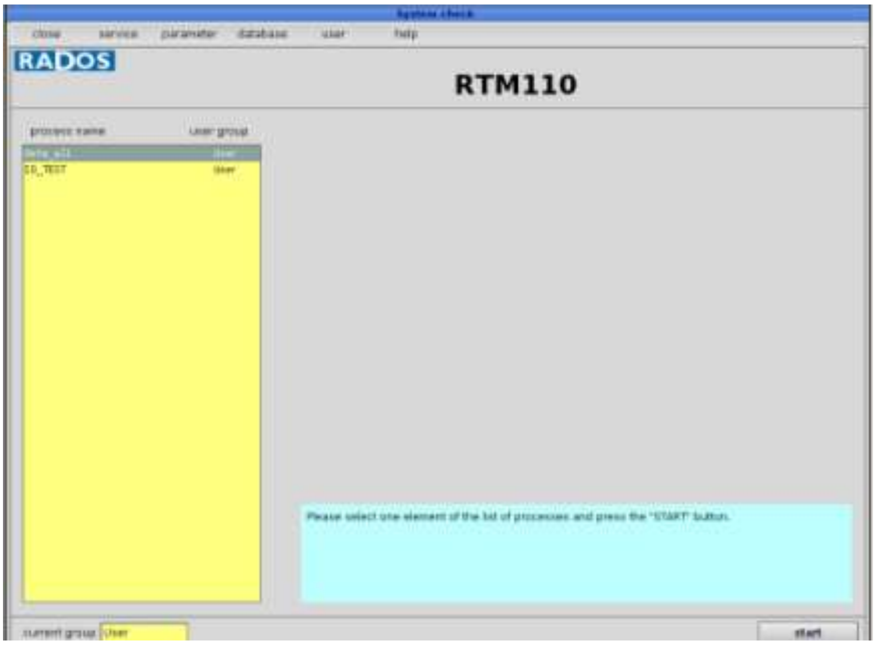


Figure 6-25: Start menu System check

Submenus overview:

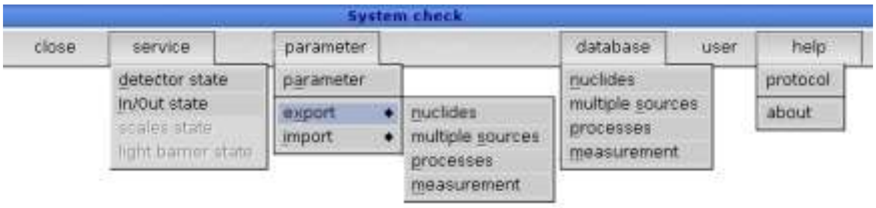


Figure 6-26: System check menu item overview

NOTE

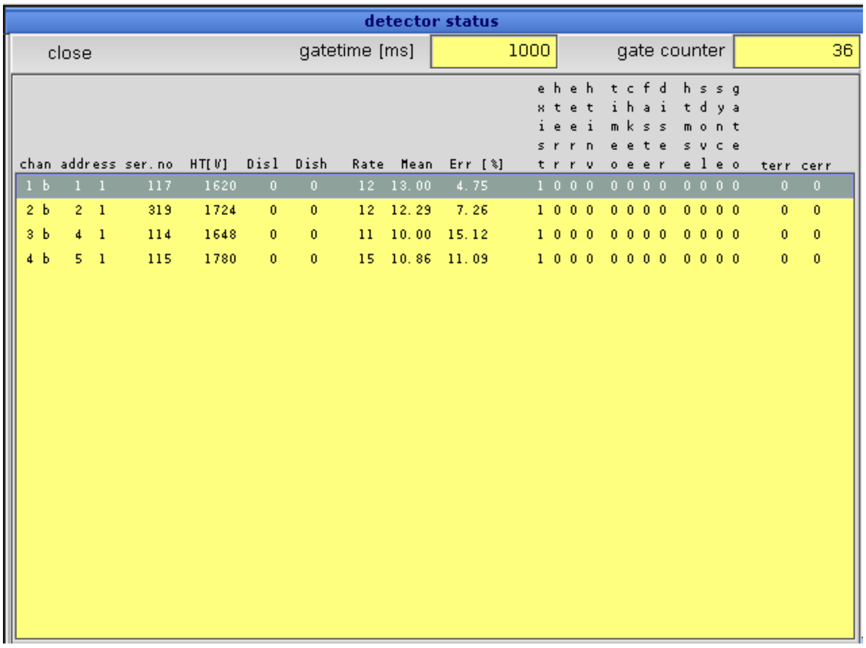
Menu items displayed in light grey could not to be chosen in this RTM110.

6.8 Menu area service

6.8.1 Detector status

The sub menu ***service/detector state*** is displaying the current status of each detector/channel. This window is exclusively used to inform about the current status of the detectors.

For more information see **Register 4 Service**.



detector status

close | gatetime [ms] 1000 | gate counter 36

chan	address	ser.no	HT[V]	Disl	Dish	Rate	Mean	Err [%]	exist	hterr	eeerr	htinv	timeo	chkee	faste	diser	htmse	sdovl	synce	gateo	terr	cerr
1 b	1 1	117	1620	0	0	12	13.00	4.75	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2 b	2 1	319	1724	0	0	12	12.29	7.26	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3 b	4 1	114	1648	0	0	11	10.00	15.12	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4 b	5 1	115	1780	0	0	15	10.86	11.09	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 6-27: Detector status

6.8.2 Binary In- and Outputs

The sub menu ***service/I/O state*** displays all binary in- and outputs of the monitor. Their functional testing will be explained later in line with defining a working process. In this chapter it has just informal character.

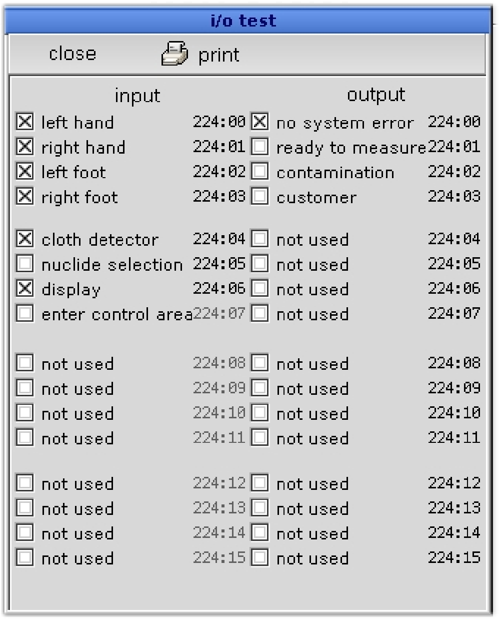


Figure 6-28: I/O state

6.9 Menu area user

After starting the System check-software the ***user*** is automatically logged in with the authorization User. Select the sub menu ***User*** to re-enter with another account/authorization.

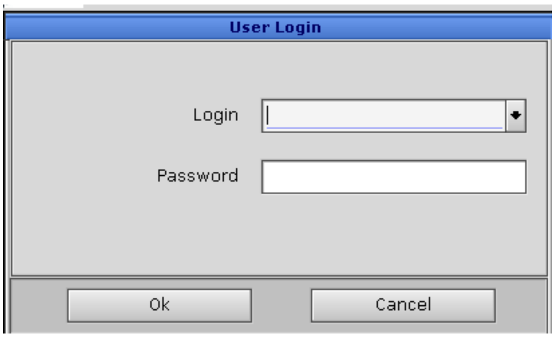


Figure 6-29: User

Every User belongs to a user group with specific authorization for using the program **System check**,

In general you can choose between four different user groups:

Superuser	all rights for the **System check** software incl. the installation of new accounts at the User profile management program
Master	all rights for the **System check** software
Service	working processes performance (**System check** software) incl. reading rights for measuring results
User	only work process performance
Default	only parameter view

6.10 Menu area parameter

Tab Global parameters

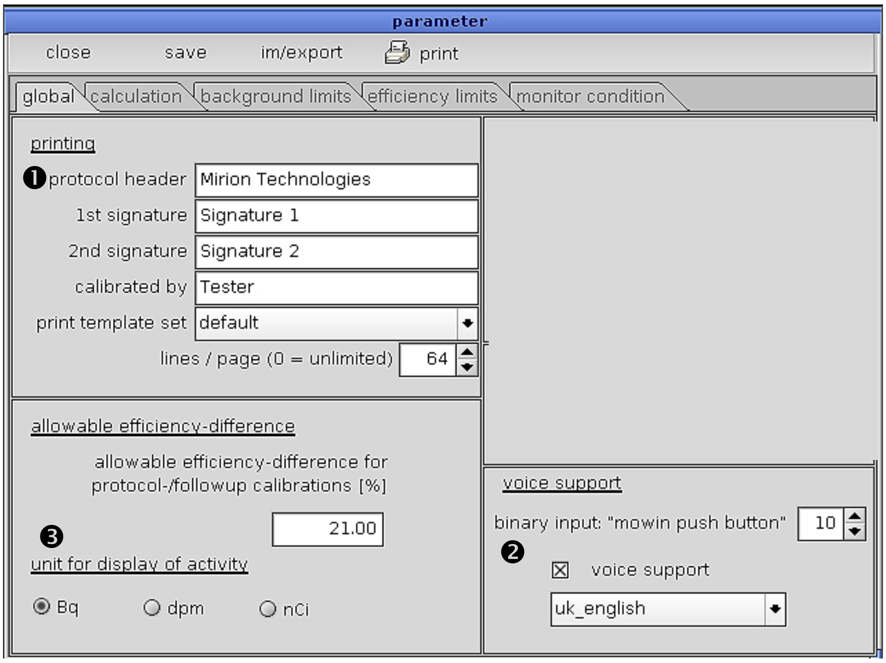


Figure 6-30: Parameter global

❶ Printing parameter

Modifications of measurements and record parameters are done in the menu ***parameter/parameter***. For a protocol hardcopy the layout is configurable as:

- ➲ Protocol header
- ➲ 1st signature
- ➲ 2nd signature
- ➲ calibrated by
- ➲ print template set
- ➲ lines / page (0=endless paper)

❷ Voice support

By selecting this function you're able to calibrate the detectors on your own. You also have to use an external measurement start push button, called MOWIN. This push button has a long cable, so that you are able to hold the source and start the measurement by the MOWIN-button. The voice support will guide you to the right detectors. The function of the push-button is to simulate the use of the enter-key on the keyboard and so the ok- key on the display.

❸ Basic calibration parameter

The measurement unit and the allowable efficiency difference is defined here.

Tab Calculation

With the appropriate parameters a theoretical measurement time is calculated for the each channel. The calculated time is displayed and stored in the measurement protocol.

For detailed information on measurement calculation time (DIN/MDA) refer to register 3.

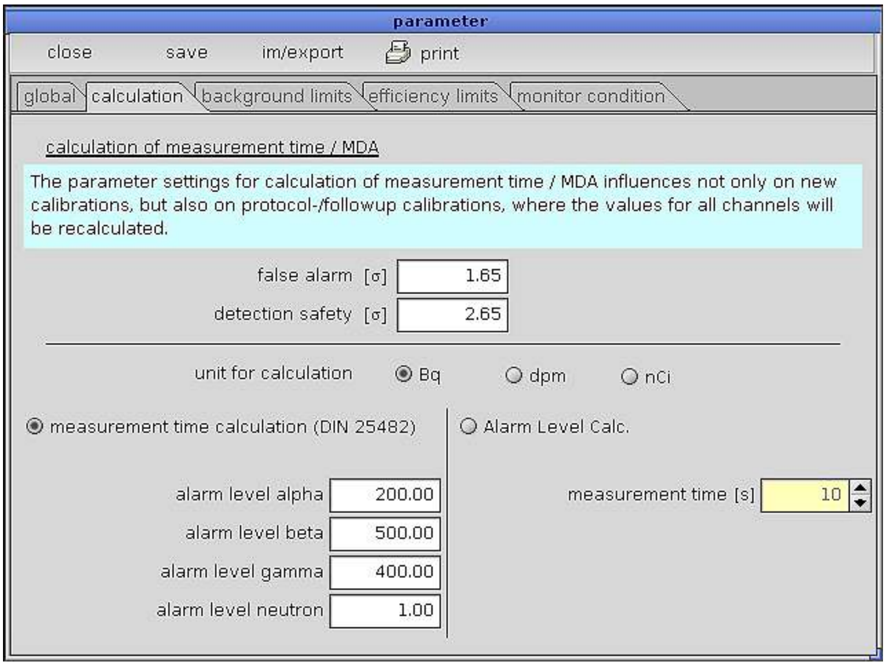


Figure 6-31: Parameter calculation

The calculation of measurement time can be used to indicate the channel which should be optimized to shorten body measurement time.
Indicators are:

False alarm
Detection safety
Calculation unit
- Bq (Becquerel)
- dpm (decays per minute)
- nCi (Nano Curie)

Measurement time according to DIN25482
- Alarm level Alpha
- Alarm level Beta
- Alarm level Gamma
- Alarm level (optional)

Alarm level calculation

NOTE
Detailed Information to measurement time calculation can be found in Register 3.

Tab Background limits

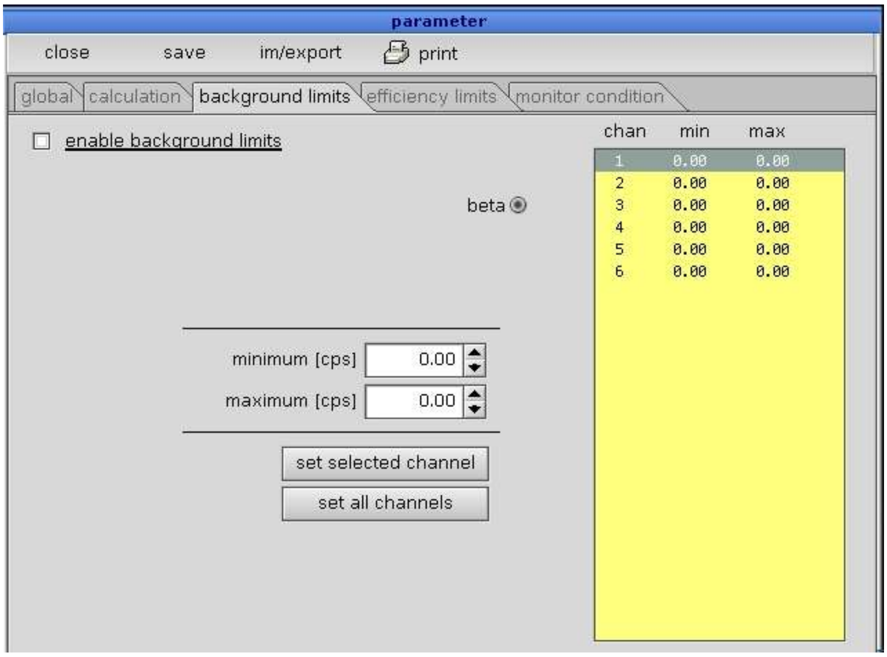


Figure 6-32: Parameter background limits

Within the parameter environment, background limits (in cps) can be set for each channel. Depending on the kind of radiation, a minimum and the maximum threshold for one or all channels can be entered. These are only valid for the **system check** program and can be found in the protocol.

This function can be activated/deactivated with the ***enable*** flag.

Tab Efficiency limits

Efficiency limits can be set for individual or all channels and per radiation type in the registry card of the same name. The entries are considered in the **system check** program and the resulting protocol.

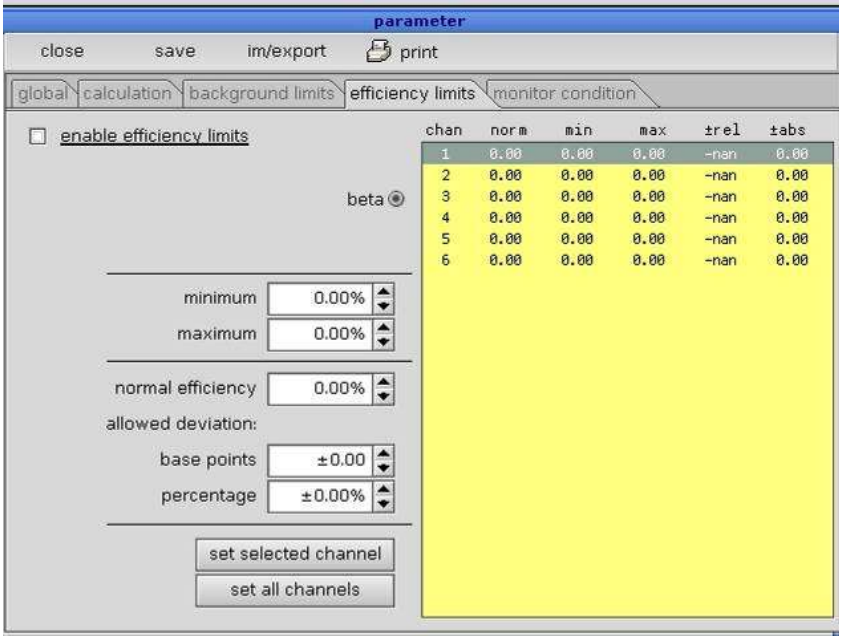


Figure 6-33: Parameter efficiency limits

This function can be activated/deactivated with the ***enable*** flag.

Tab Monitor status

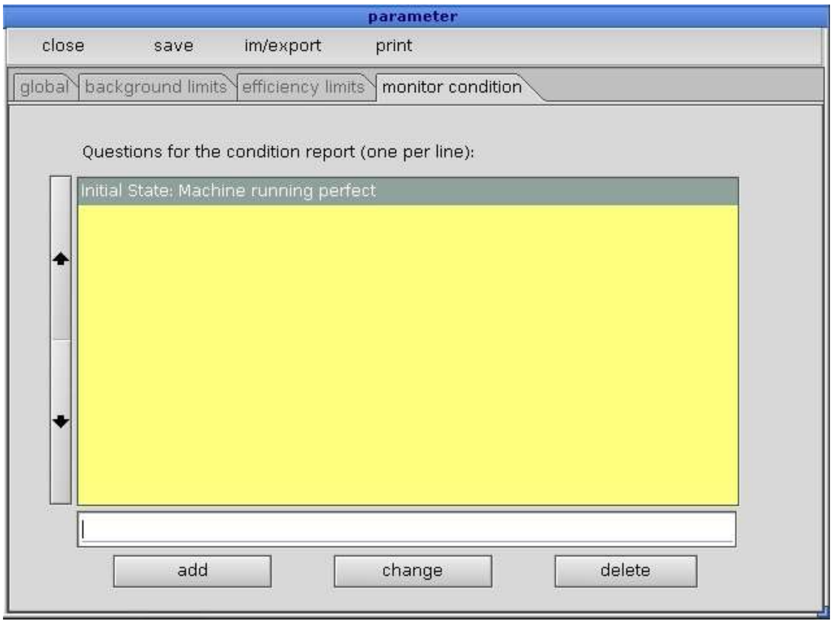


Figure 6-34: Parameter monitor condition

Specific questions about the monitor and/or the system check can be formulated in the “monitor status”. The questions are completely user defined and will come up at the end of the system check- process where they are to be answered. Questions and answers are then transferred into the protocol.

Administration of parameter sets

All parameter adjusted for the individual **RTM110** can be saved (export) on a destination (e.g. USB-stick or local hard disk) to be filed or to be stored in the **RTM110** again (import). For a detailed description the import – or export process refers to chapter 6.10.1 and 6.10.2.

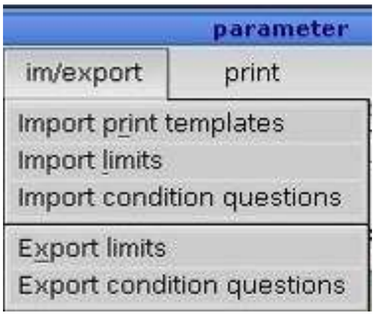
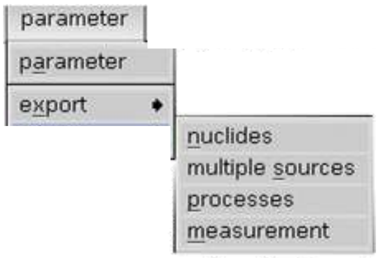


Figure 6-35: Parameter import and export

6.10.1 Export

To export, select in the main menu:



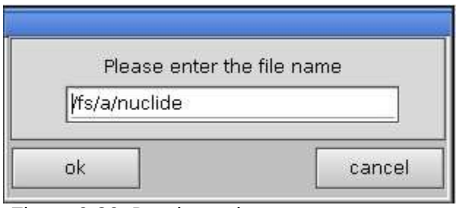


Figure 6-36: Database data export

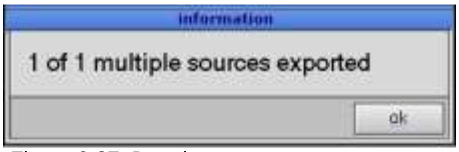


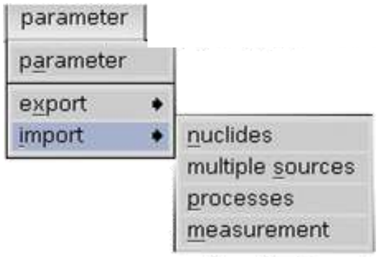
Figure 6-37: Data base export message

Since only raw-data can be exported, a dialog box opens directly for entering path and file name.

All data will be stored on an USB-stick or the local hard disk.
Measurement are called *.pdh,
sources are *.pdn,
multiple source are saved as *.pdp and
for the processes the extension is *.wkp.

6.10.2 Import

To import, select in the main menu:



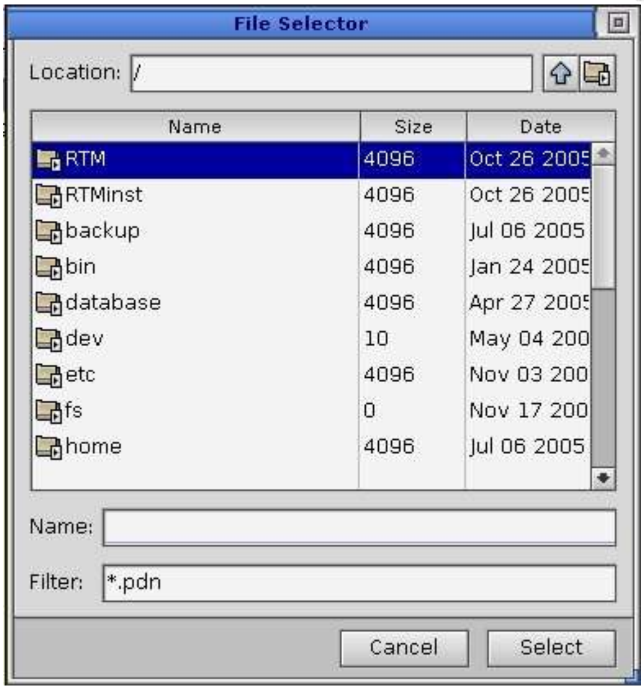


Figure 6-38: Import-file selector

Figure 6-39: Import warning

Just raw-data can be imported. Open therefore the file-selector window to enter the path and file name.

All data of the selected file will be saved in the database on the hard disk. If a file with the same name is already existent, an enquiry will appear on the display and ask whether the existing file should deleted or a rename of the data to be saved should be performed.

Attention has to be paid for the order of importation. First one needs to import the sources, then multiple sources followed by process and last measurements.

6.11 Menu area database

6.11.1 Nuclide database

The nuclide database is reached via ***database/nuclides***.

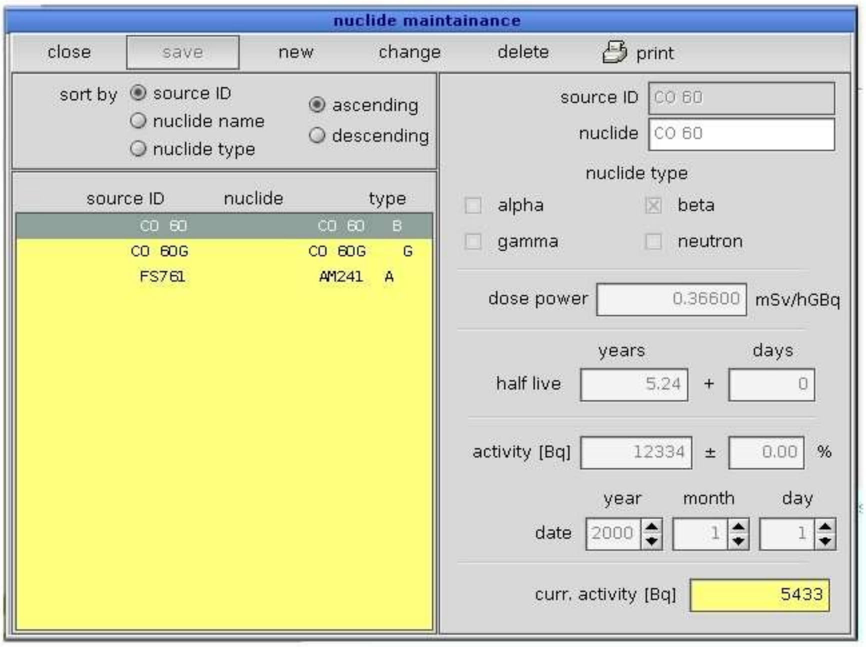


Figure 6-40: Nuclide maintenance

At the left-hand side of the display window all available nuclides are listed, while the data of the selected nuclide is inspect able at the right hand side.

The nuclide administration is left with the **close** button.

6.11.1.1 Nuclide data

Parameters connected to a test source are administrated as:

- source ID:
  User defined name administration purposes
- nuclide:
  nuclide name
- nuclide type:

  beta, gamma or neutron radiation
- Exposure rate constant (dose rate / dose power):
  The input of the exposure rate constant for one calibrated nuclide is only needed, if the exposure rate shall be calculated. Please consult the physical literature for the value of the constant (e.g. 60CO = 0.366).
- half-life:
  The duration can be stated in years as well as in days (it is also possible to have both entries). The entry in years is decimal units, i.e. 0.5 refers to half a year.

- activity:
  The activity of a nuclide at the date of the calibration certificate in Becquerel [Bq], as well as its deviance in percentage rate.
- date:
  date of the calibration certificate
- curr. activity:
  The current activity is calculated from the input parameters.

- Cascade decay of mother and daughter nuclides:
  The possible formation of daughter nuclides has to be considered before entering the actual activity value.

6.11.1.2 Nuclide data modification

Nuclide data are modified as:

- create a new test source **new**
- If a source is added to the nuclide administration for the first time or is modified, the data stated in chapter *nuclide data* have to be entered accordingly. (The current activity is automatically adjusted.)
- change data for an existing test source **change**
- remove data for an existing test source **delete**
- save and confirm the entered data **save**

Before deleting nuclide data an enquiry protects against accidental loss of information.

6.11.2 Multiple sources

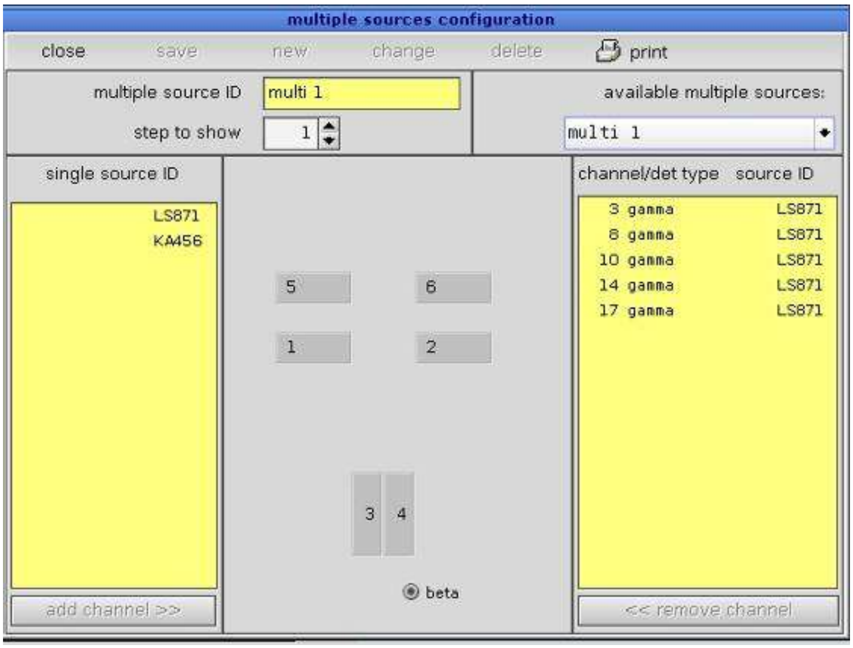


Figure 6-41: Multiple sources configuration beta

The function is used for the calibration with the aid of a special holder assembly for the test sources. It is possible to preset various nuclide sources for appropriate channels and working processes. Such, virtual multi-sources are generated.

The definition of multiple channels is done in the submenu ***database/multiple-sources***. After the multi-source got a name, the single sources are assigned to the respective channels and detector types as well as to working processes (according to the holder assembly). In one step, any user defined number of channels can be calibrated.

A working process is created with the defined multiple sources (same name). The calibration takes place with the activation of the start button in the main **System check** menu.

6.11.3 Working processes

The calibration and the inspection of the binary in- and outputs will be carried out during the working processes. The installation and administration of the work processes will be done at sub menu ***database/ processes.***

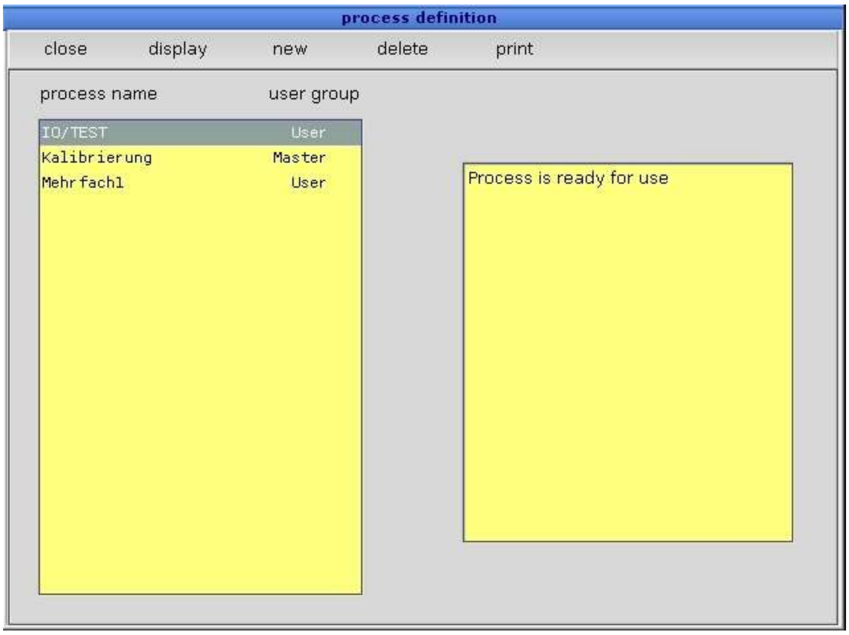


Figure 6-42: Overview processes

At the main menu an overview of all processes will be displayed. Also the user authorization needed to carry out the process is shown. If a working process is not defined correctly, it will be displayed as “not ready to use” and all definition- or process failures will be stated.

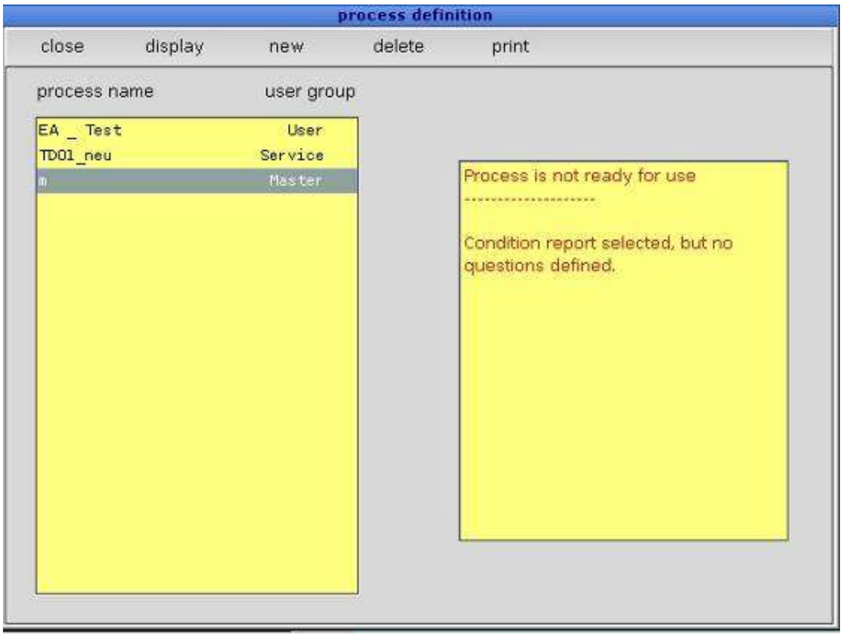


Figure 6-43: Overview processes

A process is deleted using the button *delete* at the menu panel.
Before deleting an enquiry protects against accidental loss of working processes.

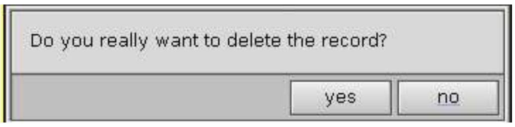


Figure 6-44: Delete a process

From the overview of all processes the detailed description of one process can be displayed using the button *display.* The process can be modified with the button *change or* printed with the button *print* at the menu panel.

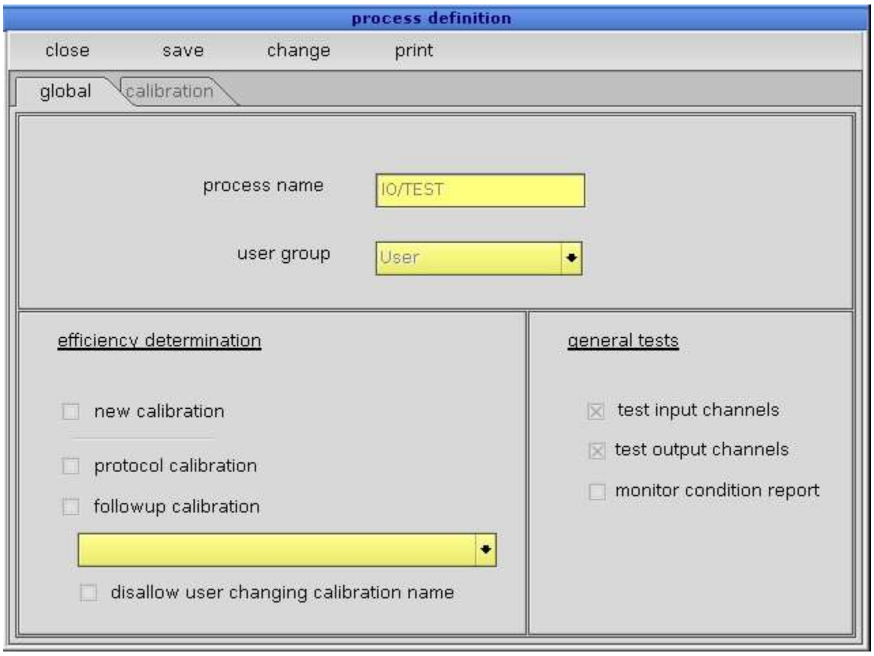


Figure 6-45: Modify a process

6.11.4 Installation of new processes

This menu is for the process definition. The global registry card includes the name of the process and user group. For efficiency determination various parameters are involved (next figure, left bottom part). Also, the binary in- and outputs can be checked within the global System check. The questionnaire for the monitor condition report is entered via the ***parameter/parameter/monitor condition*** menu. If a monitor condition report is selected in a working process the questions will appear after the calibration and will show up in the protocol printout.

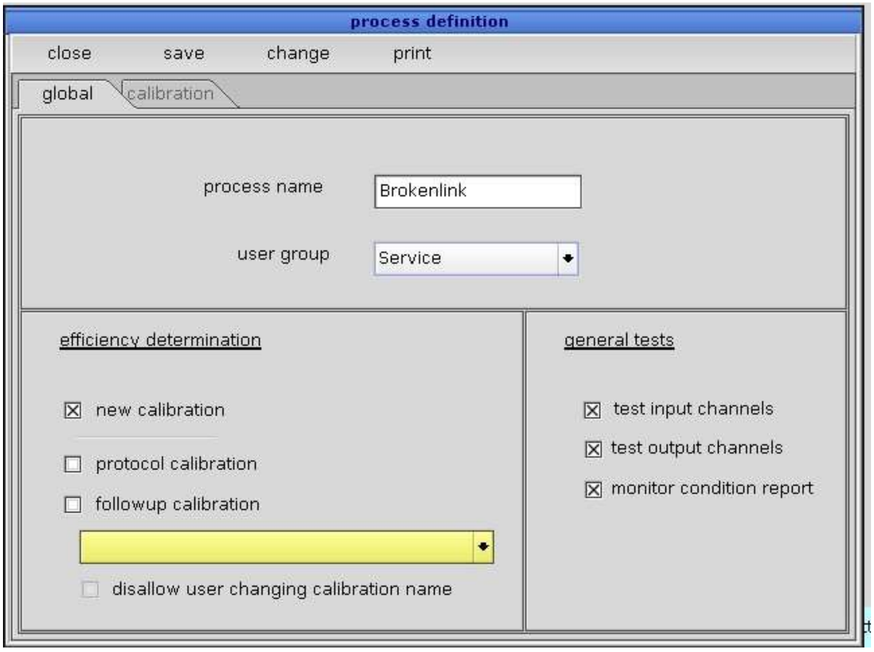


Figure 6-46: Installation of new processes

On the calibration registry card the duration for a measurement and a background determination for the channels are defined.

In case of a new calibration:
A source has to be chosen out of the nuclide database, whereas in case of a protocol or follow-up calibration a reference calibration has to be selected.

The difference between protocol and follow-up calibration is that the protocol calibration is connected to first (oldest) selected protocol, while the follow-up is connected to the latest reference protocol with same name. Before, it’s possible to choose a defined multiple source.

Menu area database

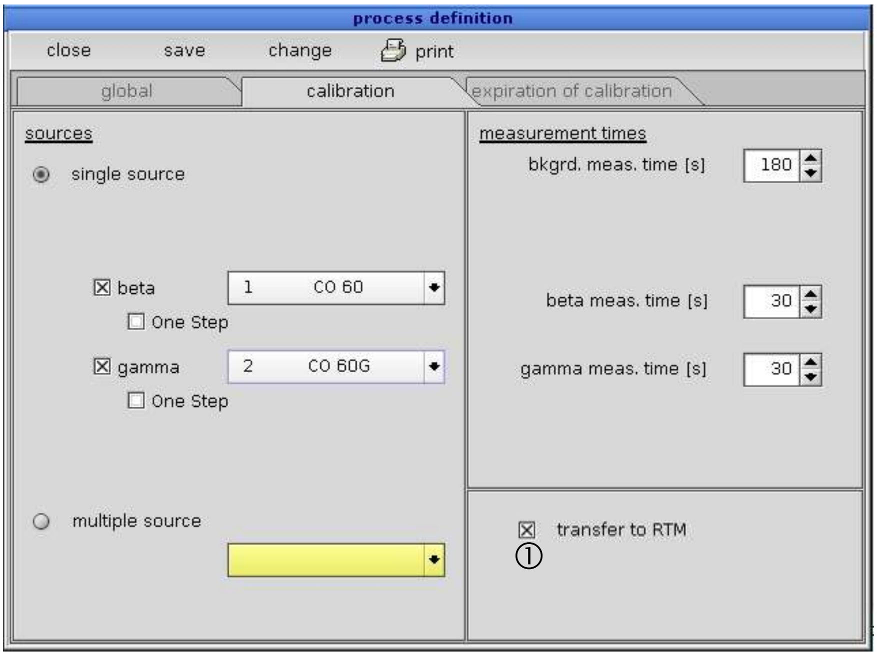


Figure 6-47: Installation of new processes, registry card calibration

Sources and measurement time can be individually defined to meet the users preferences.
To use the calibration results for the user software click on ***Transfer to RTM.*** ①

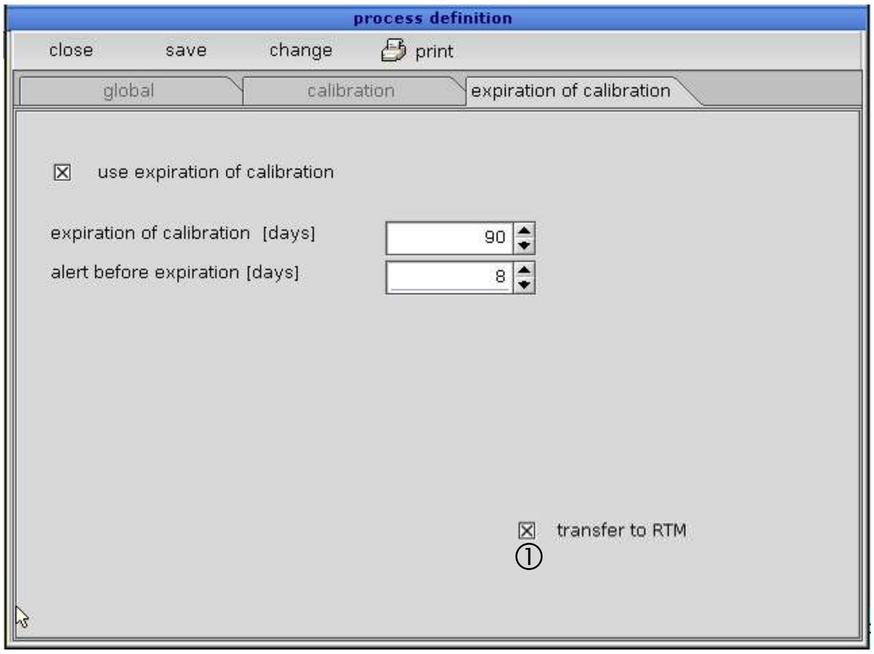


Figure 6-48: Installation of new processes, registry card calibration

The expiry time for calibration and the user alert can be individually defined to meet the user's preferences.
To use the calibration expiration in the user software click on ***Transfer to RTM.*** ①

6.11.5 Measurement database

The measurement database with all calibrations will appear after click on the sub menu ***database/measurement.***

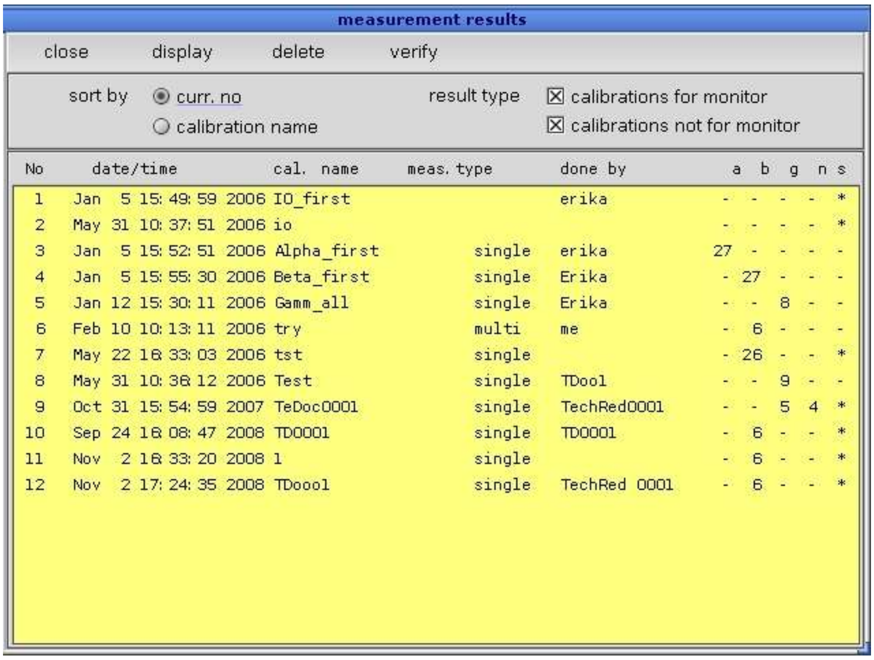


Figure 6-49: Measurement results

Each calibration can be selected with the mouse pointer from the provided menu and displayed and/or printed in detail and saved onto an USB stick or the local hard disk. It is not possible to modify a calibration.

NOTE

The following error message indicates that no measurement data was marked in the list for a detailed view. Please repeat measurement data selection.

Menu area database

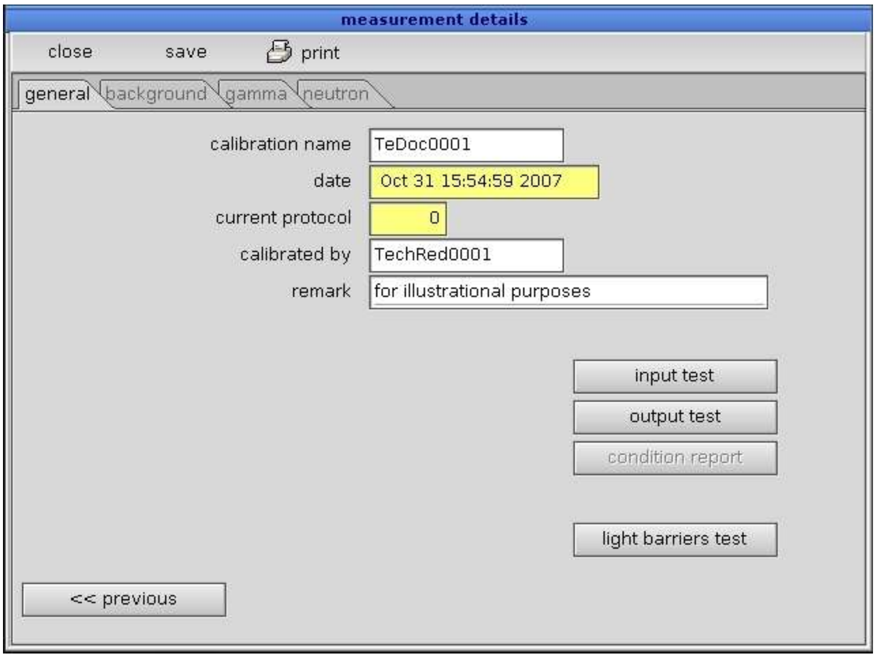


Figure 6-50: Measurement details I

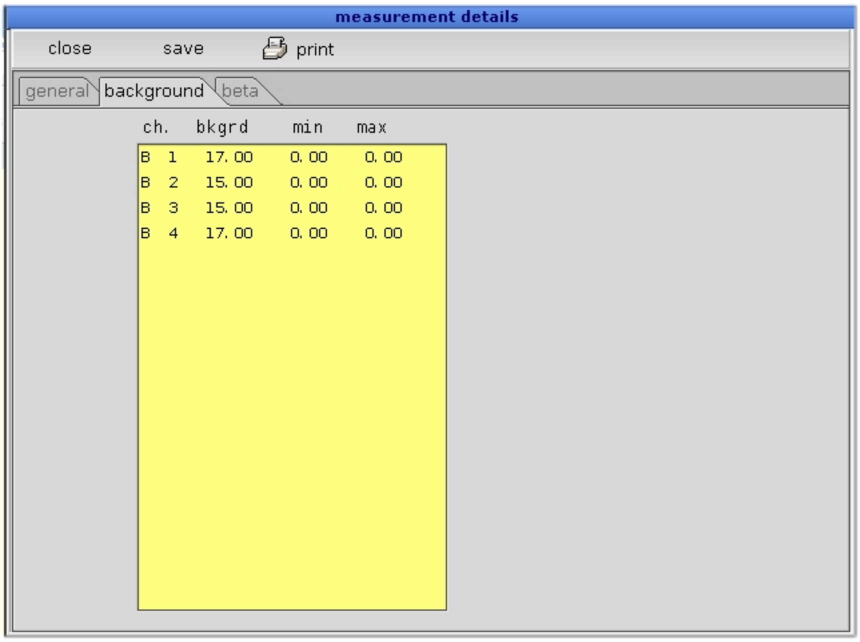
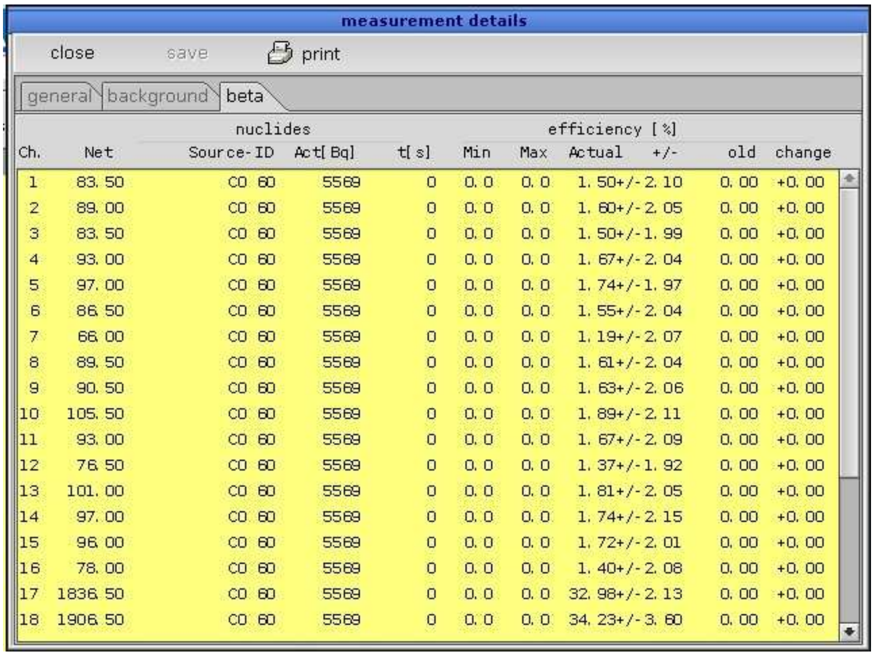


Figure 6-51: Measurement details II



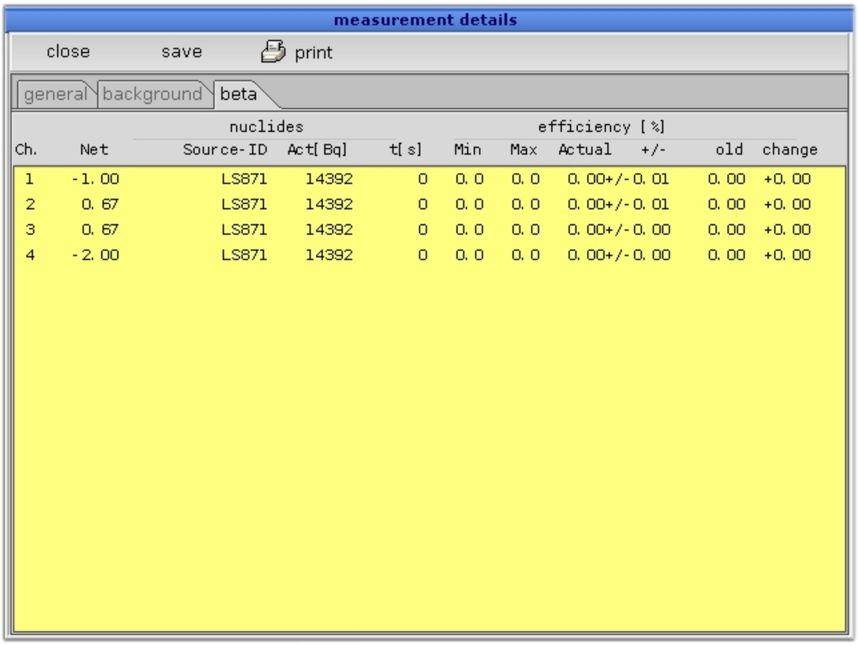
measurement details

close save print

general background beta

Ch.	Net	nuclides Source-ID	Act[Bq]	t[s]	efficiency [%] Min	Max	Actual +/-	old	change
1	83.50	CO 60	5569	0	0.0	0.0	1.50+/-2.10	0.00	+0.00
2	89.00	CO 60	5569	0	0.0	0.0	1.60+/-2.05	0.00	+0.00
3	83.50	CO 60	5569	0	0.0	0.0	1.50+/-1.99	0.00	+0.00
4	93.00	CO 60	5569	0	0.0	0.0	1.67+/-2.04	0.00	+0.00
5	97.00	CO 60	5569	0	0.0	0.0	1.74+/-1.97	0.00	+0.00
6	86.50	CO 60	5569	0	0.0	0.0	1.55+/-2.04	0.00	+0.00
7	66.00	CO 60	5569	0	0.0	0.0	1.19+/-2.07	0.00	+0.00
8	89.50	CO 60	5569	0	0.0	0.0	1.61+/-2.04	0.00	+0.00
9	90.50	CO 60	5569	0	0.0	0.0	1.63+/-2.06	0.00	+0.00
10	105.50	CO 60	5569	0	0.0	0.0	1.89+/-2.11	0.00	+0.00
11	93.00	CO 60	5569	0	0.0	0.0	1.67+/-2.09	0.00	+0.00
12	76.50	CO 60	5569	0	0.0	0.0	1.37+/-1.92	0.00	+0.00
13	101.00	CO 60	5569	0	0.0	0.0	1.81+/-2.05	0.00	+0.00
14	97.00	CO 60	5569	0	0.0	0.0	1.74+/-2.15	0.00	+0.00
15	96.00	CO 60	5569	0	0.0	0.0	1.72+/-2.01	0.00	+0.00
16	78.00	CO 60	5569	0	0.0	0.0	1.40+/-2.08	0.00	+0.00
17	1836.50	CO 60	5569	0	0.0	0.0	32.98+/-2.13	0.00	+0.00
18	1906.50	CO 60	5569	0	0.0	0.0	34.23+/-3.60	0.00	+0.00

Figure 6-52: Measurement details III



measurement details

close save print

general background beta

Ch.	Net	nuclides Source-ID	Act[Bq]	t[s]	efficiency [%] Min	Max	Actual +/-	old	change
1	-1.00	LS871	14392	0	0.0	0.0	0.00+/-0.01	0.00	+0.00
2	0.67	LS871	14392	0	0.0	0.0	0.00+/-0.01	0.00	+0.00
3	0.67	LS871	14392	0	0.0	0.0	0.00+/-0.00	0.00	+0.00
4	-2.00	LS871	14392	0	0.0	0.0	0.00+/-0.00	0.00	+0.00

Figure 6-53: Measurement details protocol message

NOTE

Before a measurement result from the database will be displayed an internal check of the saved data takes place.

Inconsistency or error in data will appear and been added with information for trouble shooting (see Figure 6-14).

6.12 Help

The button **help** leads to the submenu “About”.

Figure 6-54: About; System check-version

The window displays the version of the System check-Software.

6.13 Close (exit program)

By activating the **close** button, the program system check is quit and the startup menu comes up.

Figure 6-55: Close the program

7 Monitor Plateau Plotter (MPP)

Figure

7.1 Monitor Plateau Plotter (MPP) for gas detectors

A radiation monitor consists of at least one detector, which may contain up to two channels. Due to their physical nature and by using the respective detector and measurement electronics it is possible to measure the α- and β-radiation for each channel separately and simultaneously. This means that it is possible to acquire up to 4 measurement values from every detector.

The measurement values present the count rates acquired from the detector and thus present the measured activity. The efficiency (count rate per Becquerel) of the detector, among others, depends on the high voltage applied to the detector.

The main objective of the MPP-software is to measure the dependency of the efficiency of gas detectors to high voltage. For this reason a curve of the count rates at different high voltages is created for each detector channel.

	NOTE
	The MPP-software cannot be used to determine the optimum high voltage (working point) from beta and/or gamma plastic scintillation detectors. For these detector types the working point is determined by factory test and therefore the value is predefined.

For the semi-automatic drawing of the detector channel curves it is not necessary to remove the detectors from the monitor. It is only important to make sure that a sufficient high activity is available during the measurement.

The used source should be positioned in direct contact to the detector during the measurement.

The working point for a detector can be established with this program via a simple graphical determination. After this determination the respective high voltage can be permanently programmed into the electronics of the detector.

Using the database it is possible to save as many of such measurement curves as desired on the hard disk. One of these measurements can be marked as reference.

Furthermore it is possible to recognize damages and the wear off of a detector at an early stage. Also for this tool the program offers graphical support.

7.1.1 Service: Prefix

The Body Contamination monitor family with the monitor **RTM110** has different graphical and entry elements for the user communication. A detailed description of the operation is given in chapter "Computer system QNX".

In order to start the Monitor Plateau Plotter (**MPP**) it is necessary to close the user software. To close the measurement mode enter the service mode in the user software and select menu-item **close**.
Regarding the case you are logged in as a **default**-user please change your login-authorization to the user- group **user** at minimum to get access to the menu-item **close**.

The **MPP** module is opened and carried out using the **service -** and afterwards the **MPP** - button in the startup-menu.

Figure 7-1: Start-up menu

Software modules provided via the **Start-up Menu**:

Used to call the **RTM user software** the main program to perform contamination measurement

Opens and reduces the full menu screen (see Register 3 and Register 4

The maintenance program for body contamination monitors.

Following service functions are provided in the service main menu and can be called by using the service button:

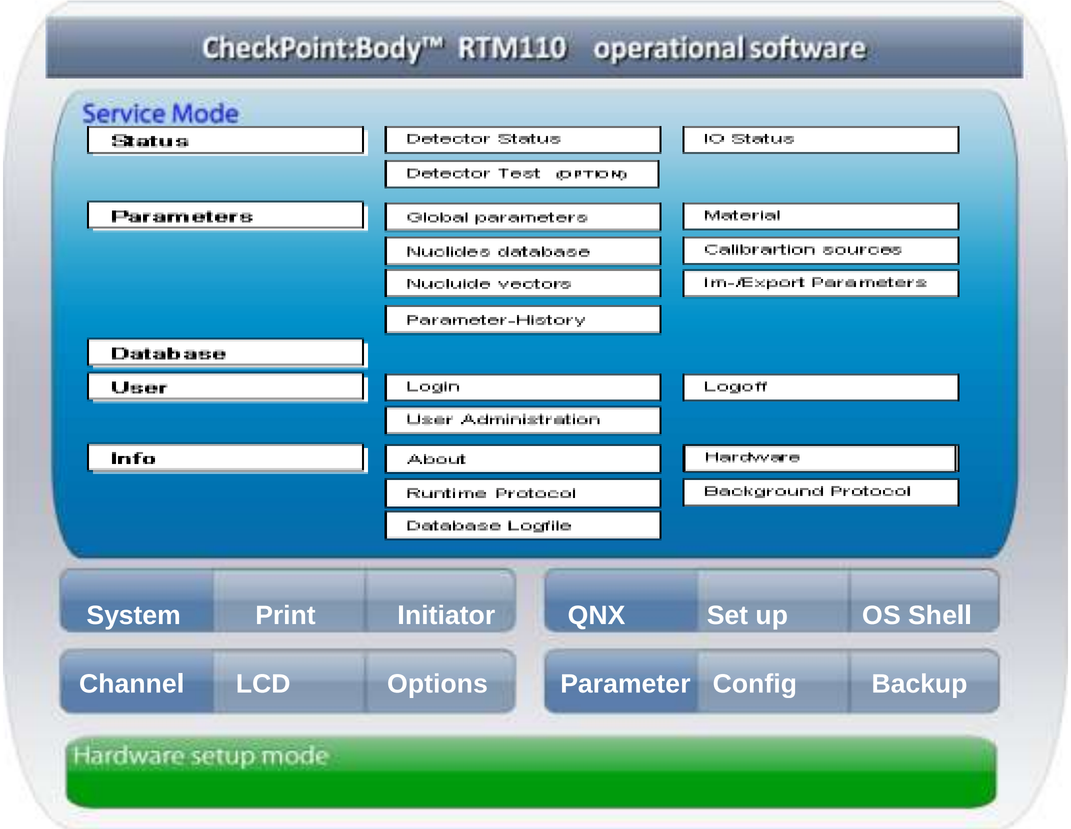


Figure 7-2: MPP menu overview

7.1.2 Service general

	CAUTION
	This operation mode requires qualified expert personnel or the RADOS Customer Service.

	NOTE
	The entries shown in white colored fields can be edited to meet user premises. The fields colored in yellow are firmly set by the monitor software or are for information only.

	CAUTION
	The values displayed in this documentation are simulated data that should not be compared to real measurements.

7.1.3 Description of the plateau

The operation voltage of a detector is increased in defined steps while the count rate jam is measured. The resulting measurement curve is featured by a certain voltage range where the count rate gains its proximate constance.

This is called the 'plateau' or ´count range` of the detector, a unique characteristic different for each detector. A good plateau is qualified displayed by a curve as flat as possible with an incline of only a few percentage points. The curve of the plateau should also not be accompanied by too large deviations, as otherwise electrical overshooting has to be assumed.
To create a plateau in the triggering range, it is necessary that each primary ionization results in a triggering count and that this count has no further counts (tail counts). The formation of the discharge from the primary ionization is in accordance with the law of statistics.

There will practically always be a formation of discharge when the number of primary electrons is high. With a low primary ionization a not to be neglected probability still exists, that is individual electrons will run to the counting wire without creating an ionization avalanche. This probability mainly depends on the kind of gas and its pressure as well as on the location where the primary ionization is increasing detector voltage results in higher probability for ionization avalanche.

Even if a sufficiently high primary ionization is available, a perfect horizontal plateau course may not be obtained. As long as the plateau slope remains below certain limits, this occurrence is accepted as a fact. One of the reasons for this phenomenon lies in the inhomogeneity fields.

Last but not least the plateau width is a direct follow up of the detector design. The working point should be fixed by a minimum of 150 volts and may have up to several hundred volts. The working point is in general placed in the front range of the plateau to protect the components against too high fields. For special applications, however, especially for α and β simultaneous measurements, the working point may also be set in the centre range or even be moved close to the exponential increasing curve.

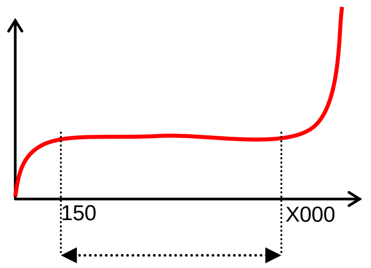


Figure 7-3: Length of plateau

7.2 Start

The MPP program starts with a protocol manager which records the start routine of MPP. This manager can be opened via the menu **help/protocol**. It will be described later in this chapter.

Afterwards, an internal check of the monitor and the connected detectors is carried out. In the start windows the every channel is displayed with the actual measurement and channel status. The position of the channel can be displayed using the button. To perform a quick measurement the automatic doors can be closed using the button in the footer. The catch detector button allows the user to view the actual status and measurement of a single channel.

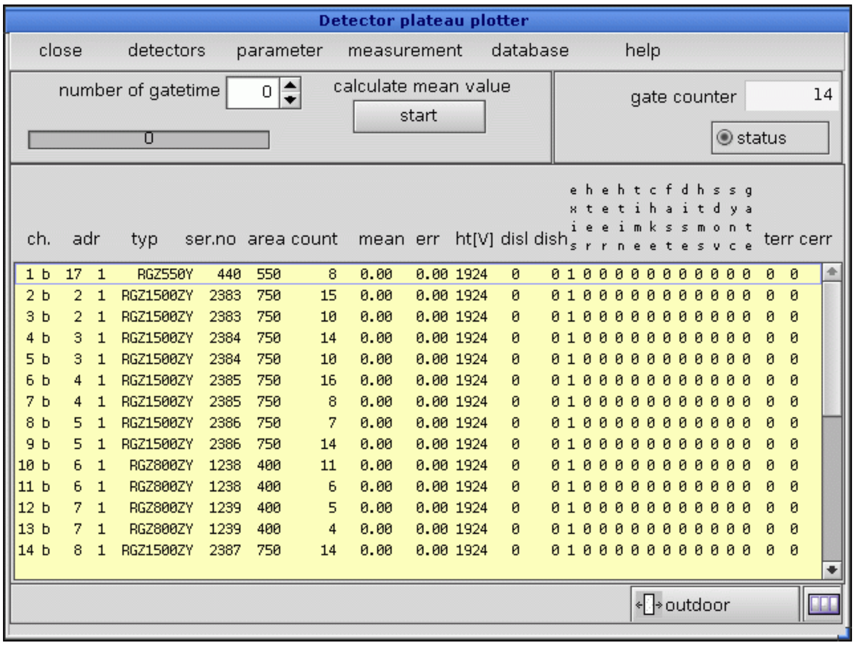


Figure 7-4: Start menus MPP

The information on this window for user information purposes, but it is also the gate to the following submenus:

Figure 7-5: Menus MPP

	CAUTION
	Should the monitor be turned off, the running RTM110 user software needs to be quit with: close. **Refer to Register 1 for a detailed advice on the shutdown procedure.**

7.2.1 Status window

All channels of the connected detectors are listed in the channel list. The list is grouped into α- (Option) and β-channels and the corresponding detectors (shown by their address). An overview of the count rates and their default deviations for all channels is given which allows a statement about the quality of the detectors.

Detector status

green OK
red Error
grey no connection

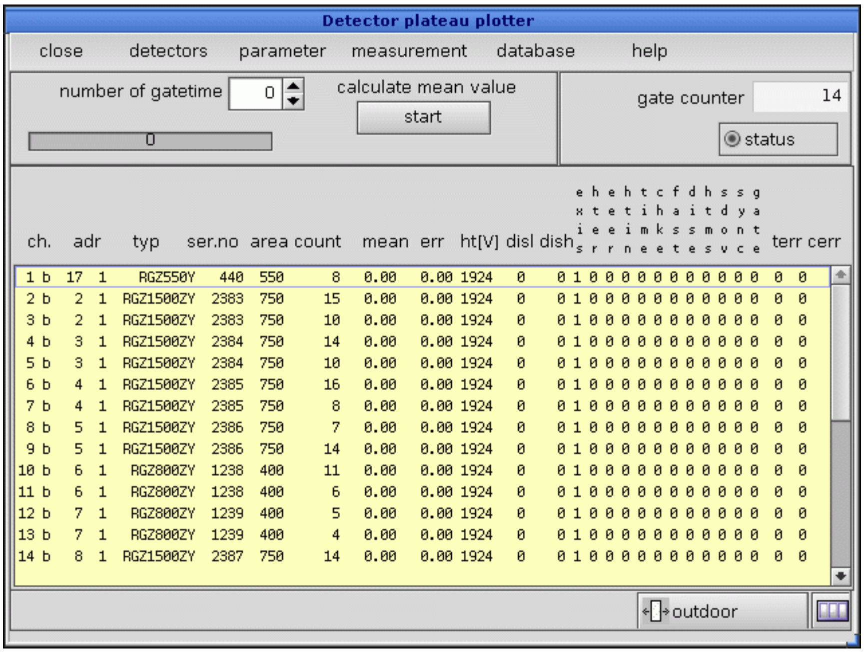
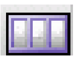


Figure 7-6: Channel list

7.2.1.1 Channel configuration

With the button  the current channel configuration of the monitor is displayed.

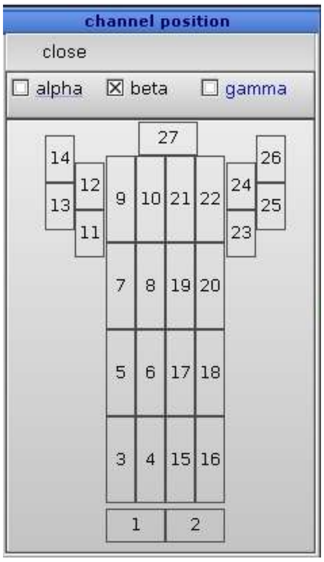
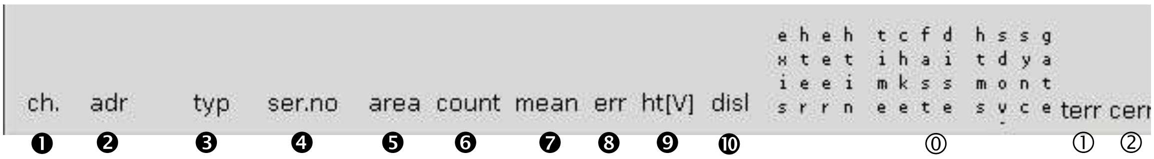


Figure 7-7: Example: Channel configuration

7.2.1.2 Channel Information



ch.	❶	the channel number within the monitor
adr	❷	address of the detector (firmly set via a DIP switch)
typ	❸	detector - type (RGZ, RXE ......)
ser.no.	❹	serial - number of the detector
area	❺	area of the channel [cm^2]
count	❻	current number of counts in the set gate time
mean.	❼	calculated mean value of the last 100 values count rates
err. (%)	❽	default deviation in % referred to the current mean value
ht (V)	❾	currently set high voltage [Volt] (can be modified by user)
disl (mV)	❿	discriminator threshold [mV]

Status of channel ⓪

exist	module is located by RLC module and attached
hterr	Status bit shows 1.HT-Error. target/actual high voltage level for detector 1 too high
hterr	Status bit shows 2.HT-Error. target/actual high voltage level for detector 2 too high
eeerr	Status bit shows EEPROM-Checksum-Error
htinv	Status bit shows HT-Invalid-Value-Error
timeo	Status bit shows Timeout-Error
chkee	Status bit shows Checksum-Error
faste	Status bit shows 1.HT-fast-disable-error. HT- fast-disable active
faste	Status bit shows 2.HT-fast-disable-error. HT- fast-disable active
diser	Status bit shows discriminator-Invalid-Value-Error
htmse	Status bit shows 1.HT- adjustment-error
htmse	Status bit shows 2.HT- adjustment-error
sdovl	Status bit shows counter-overflow-error. Counter 0...3
sdovl	Status bit shows counter-overflow-error. Counter 4...7
synce	Status bit shows RNET2000-Bus synchronisation-error. Individual module new.
Gateo	Status bit shows gate time-error.

Terr	①	Number of time out errors since last start
Cerr	②	Number of transfer errors since last start

7.2.2 Close (leave program)

With ***"close"*** the MPP program can be quit: it is possible to move back to the start menu. Before closing the MPP program the exit has to be acknowledged.

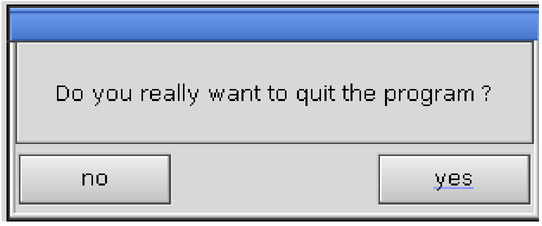


Figure 7-8: Finish program

If changes at the working voltage were previously made, e.g. in order to operate the detector with another working voltage which does not correspond to the values stored in the EEPROM, the user is at this point asked to write the new values into the EEPROM by clicking the button ***"save"***.

With the button ***"save"*** the program will be closed and all changes will be saved.

With the button ***"discard"*** the program will be closed and all changes that have not been explicitly saved will be lost. The values, which were set at the last saving, remain in the EPROM's.

With the button ***"cancel"*** the exiting procedure is aborted.

7.3 Detectors

For each detector firm values are stored in the EEPROM in order to identify every detector unambiguously. The figure shows the detector data stored in the EEPROM.

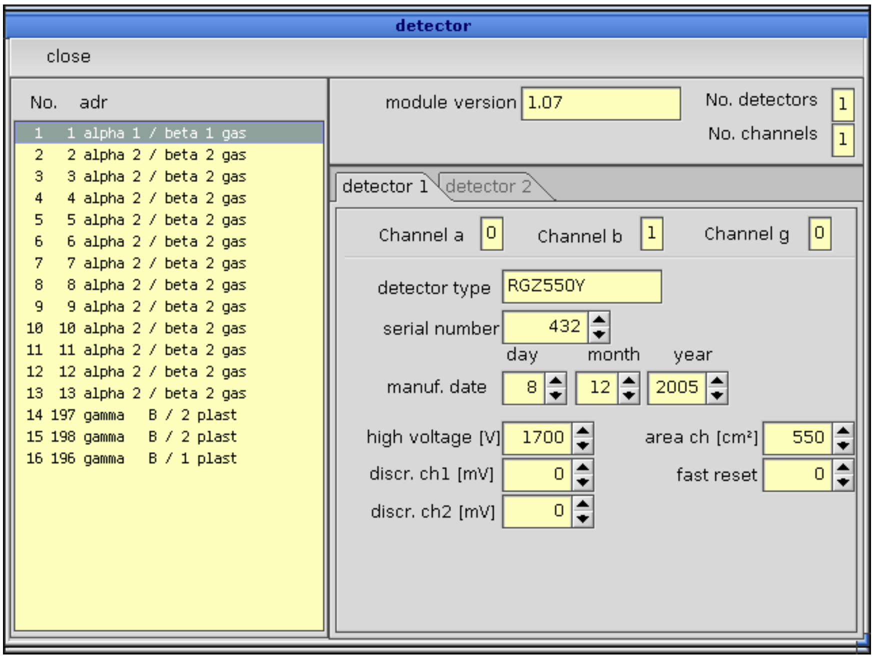


Figure 7-9: Detector data

The following entries are preset at the factory for every detector.
Following settings can be viewed:

Detector type	i.e. RGZ, RPD
Serial number	manufacture-specific serial number
Manuf. Date	date of manufacture of the detector
High Voltage	working voltage [V]
Diskr. Ch1 [mV]	lower voltage level on discriminator
Diskr. Ch2 [mV]	high voltage level on discriminator
Area ch. [cm²]	area of the individual channels
Fast reset	safety switch for shutdown on overload status

Data is also stored in electronics cannot be altered.
The display is for user information only.

Module version	Internal software version of electronics
No. of detectors	number of connected detectors to electronic
No of channels	number channel from detector
Channel [a], [b], [g]	type of detection of channel
No Adr	General Channel information

The button ***"close"*** escorts to the start menu.

7.4 Parameter

7.4.1 MPP: Setting of measurement parameter

Before the measurement starts, it is possible to open a dialogue window to set some common parameters for the measurement via the menu ***parameter***. In general these need not to be changed.

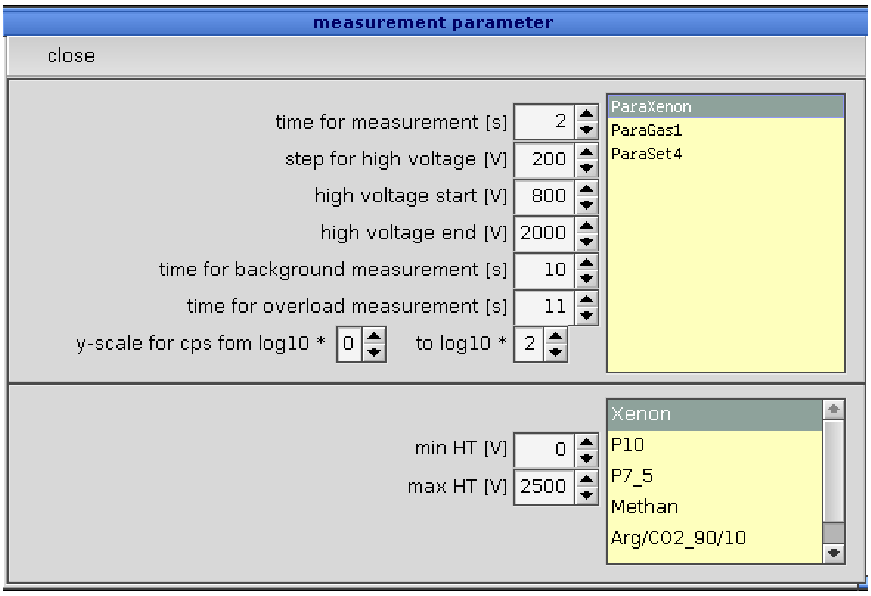


Figure 7-10: Measurement parameters

In the window at the right side there are selections for measurement parameter sets and gas types in order to choose the pre-set parameters for the detectors. These pre-set values for the measurements have proven very useful in the practice and are applicable without changes. These are:

Time for measurement [s]	Measurement time in seconds for each voltage value applied
Step for high voltage [V]	the electronics allow only steps of a multiple of 4 (4, 8, 12 ...) for the high voltage (min. 4.0 V up to max.100 V).
High voltage start [V]	The Plateau Measurement
High voltage end [V]	
Time for background measurement [s]	Measurement time in seconds for background measurement (without nuclides)
Time for overload measurement [s]	this field includes the time for the overload (cross talking) measurement of alpha channels
Y-scaling of log. 10*	The graphical display of the plateau measurement
Y-scaling up to log. 10*	

The button ***"close"*** escorts return to the main window.

7.4.2 Setting of nuclide parameter

In this dialogue ***measurement/parameter*** the respective channels are displayed. All available detectors can be marked either together or singularly. A gas from the gas list has to be allocated to the marked addresses. This is done with the button ***"<< add"*** (up).

For the marked addresses in the left window the channel assignment is simultaneously shown in the right window. For the selected channel a nuclide from the nuclide list and optionally a color for the display of the plateau curve can be assigned by clicking the button ***"add>>"*** (below). All channels to be measured must be provided with a nuclide.

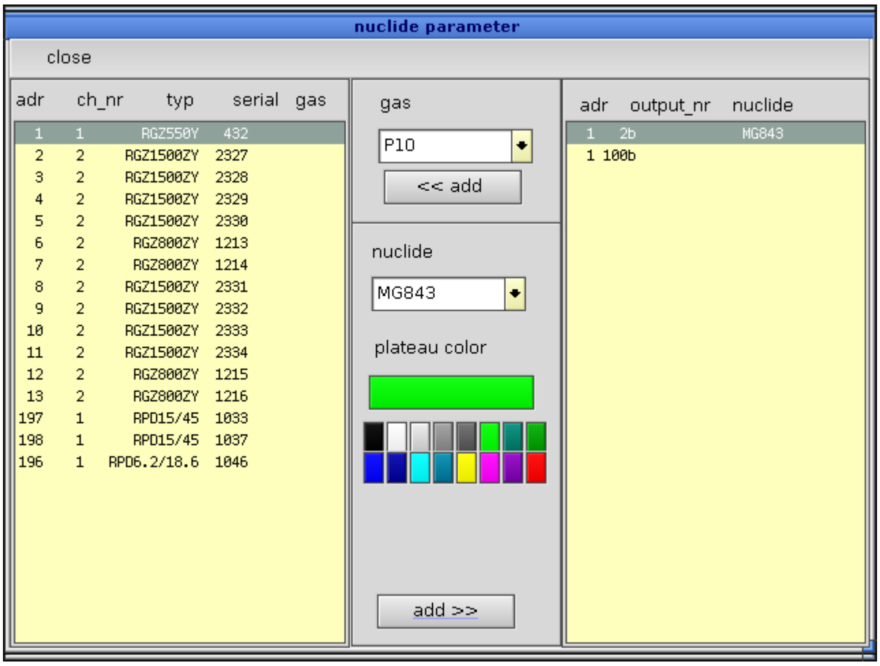


Figure 7-11: Nuclide parameters

Listing of the detectors and their data (left window):

Adr	Address of the detector
Ch_nr	Number of channels of a detector
Type	Detector Type, e.g. RGZ XXXX
Serial	Detector serial number
Gas	Kind of gas, e. g. P10, P7.5 Ar/Co^2 can be set with button ***"<<add"*** (up). This has no influence on the measurement but only on the protocol.

Listing of the detectors and their data (right window):

Adr	Address of the detector
output_nr	channel number and type of channel
nuclide	selected nuclide for measurement

The listed nuclides can be administered in the menu **database/nuclides**.

The button ***"close"*** escorts return to the main window.

7.5 Measurement

Before measuring, the sources to be used have to be positioned directly in front of the detectors in order to provide a yield as high as possible. In practice it has proven successful to use americium (^{241}Am) for the α-channel and strontium (^{90}Sr) for the β-channel. All channels of one detector can be measured simultaneously. For this reason, it is important to pay attention to the position of the nuclides. They must be fastened correctly in front of the detector during the measurement (see chapter - channel configuration). In case of a repeated test, however, it has to be noticed that ^{241}Am also influences the β-channel.

Clicking the button ***"start"*** initiates the measurement. The dialogue window shown below appears with the channels to be measured, which are displayed at the right hand side of this window. The measurement is carried out according to the data, which have been entered in the parameter menu (figure 6-7; measurement parameter). By actuating the button ***"start"*** (which changes into the ***"stop"*** button); the actual measurement starts with a time delay of approx. 10 seconds. The characteristic lines of all selected channels are automatically entered in the dialogue window.

Figure 7-12: Measurement of channels

7.5.1 Measurement

The high voltage of all participating detectors is set to start value (as stated in the measurement parameter). After the voltage has been set, the actual measurement can begin.

The obtained counts of a measurement are displayed in a plateau curve.

At the end of the measurement the computer opens up the window “overload“. Please continue with the button ***“start”***.

NOTE

In case of only beta detectors the section overload is skipped. By clicking on “background” and “start” the background measurement continues.

Overload (on Y-detector for simultaneously alpha/beta measurement only)

Here the counts from alpha radiation are measured with an applied beta radiation emitter. From this the cross-talking factor (max. 0.5 cps ϕ) is determined.

After the overload a check of the cross-talking values should be carried out. This is done via the menu - **results**. If the cross-talking value is too high, the procedure must be carried out again with a lower working voltage. If the value is ok, the menu window is left with ***“close”***.

At the end of the measurement the window “background” opens up automatically. Click the button ***“start”***.

7.5.2 Background

For measuring the natural background radiation, all sources in close proximity have to be removed.

After the background measurement for all channels has been carried out the dialogue window “**save results**” opens.

7.5.3 Save results

The results from the measurement, the overload and the background, are displayed with their values and can be saved after the name of the tester and a remark has been entered.

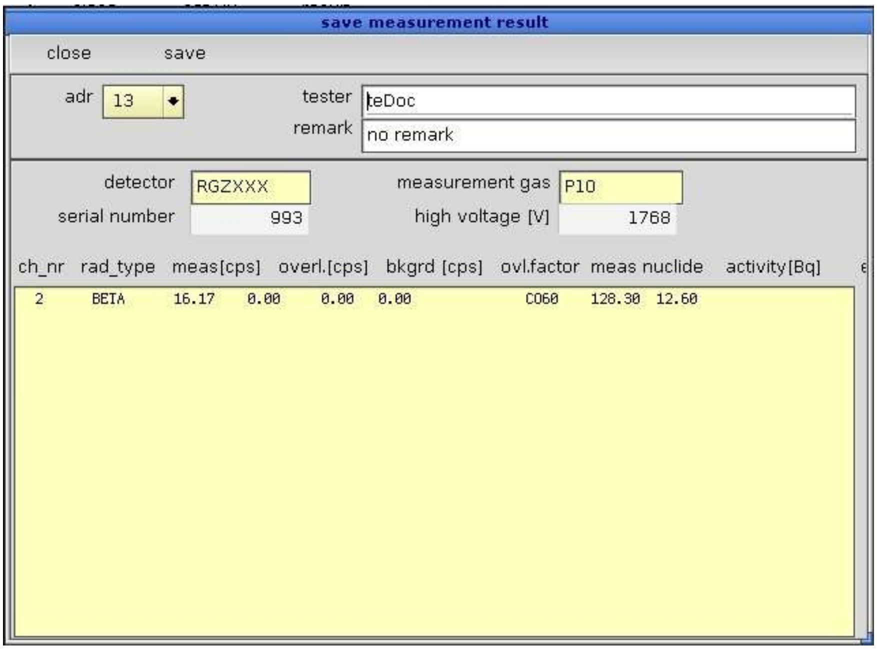


Figure 7-13: Save measurement result

tester	name of the tester
remark	comment to the measurement

With the button ***“close”*** the user gets back to the menu - **measurement**.

7.5.4 MPP: Adjust HV

An ideal working voltage can be set for each detector with the help of the measured plateau.

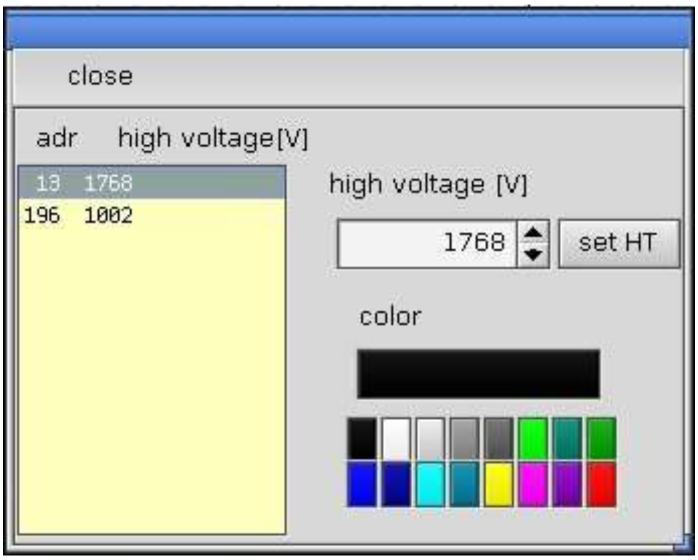


Figure 7-14: Adjust HV

A vertical line in the plateau displays the working voltage. It can be entered directly as a figure or changed with the arrow keys up/down at the corresponding address.

The working voltage should be within a range, in which all channels show a count rate, which is close to the horizontal line. (See figure below).

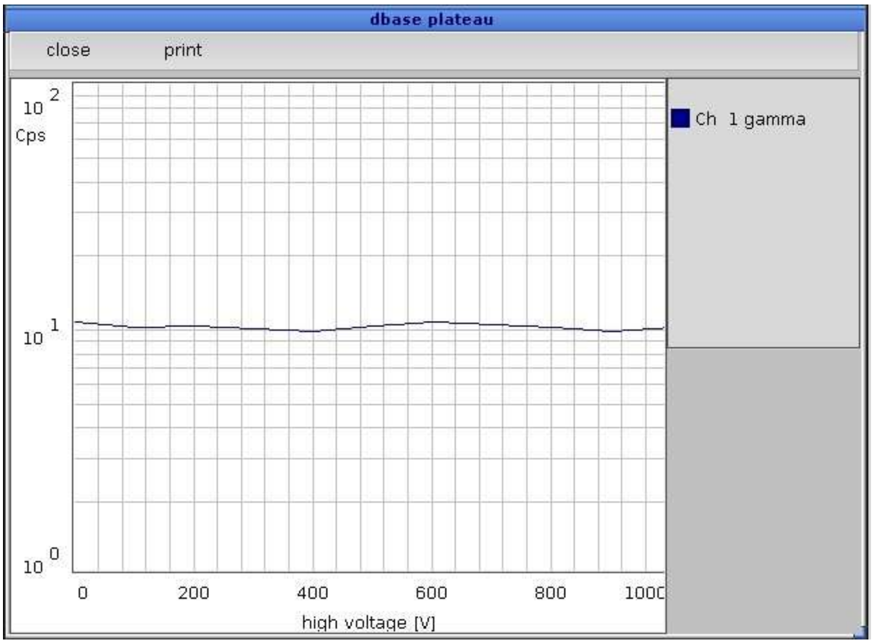


Figure 7-15: Plateau view

7.6 Database

7.6.1 Measurement

Each plateau is saved after the measurements and ordered into a database at the hard disk. This database is displayed in the left window via the menu **database/measurement**.

If a measurement result is selected from the database, all corresponding measurement data is displayed in the window below.

Even if a detector is (physically) exchanged, the original data of the initial detector is still available. This data is not automatically deleted from the database. It has to be deleted via the button ***"delete"***.

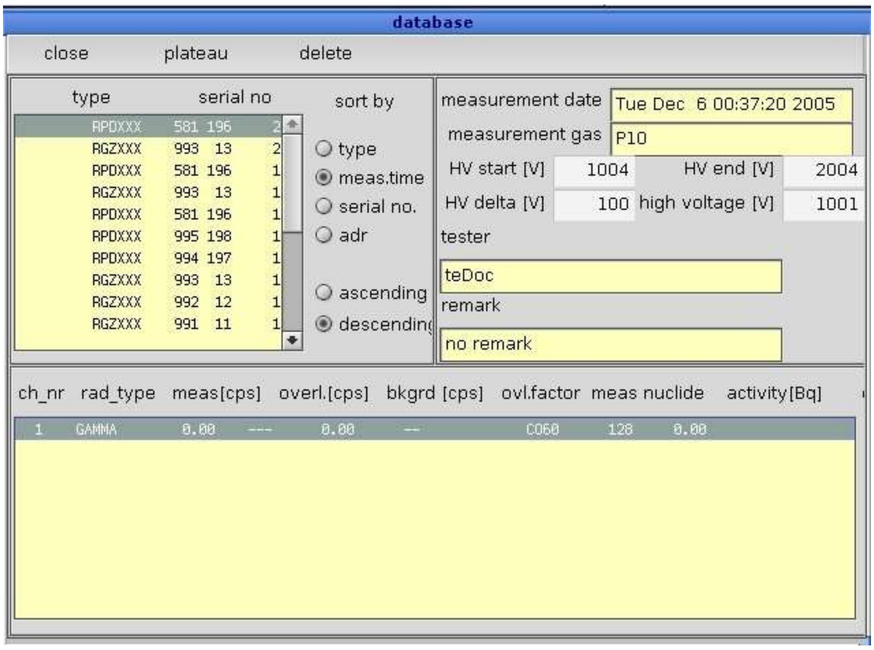


Figure 7-16: Menu database

Sort by

The database can be sorted via the check boxes ***"ascending"*** or ***"descending"***, according to the selected sort criteria:

type	detector type
meas. time	date of the measurement
serial no.	Serial number of the detector
adr	address of the detector

7.6.2 Plateau

The plateau of the selected detector is also available from the database. Via the button ***"plateau"*** it is displayed on the screen. Now the plateau can be printed out by a click on the button ***"print"*** and ***"print preview" to*** view results.

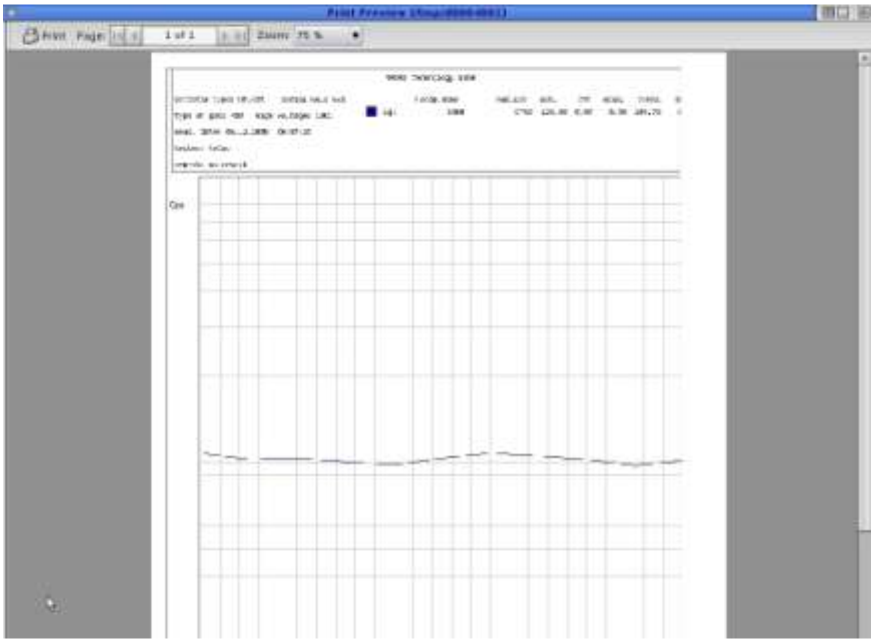


Figure 7-17: Print preview plateau

7.6.3 Print

In the menu - **select a printer** it is also possible to select other printers via scroll list "**Printer**".

Figure 7-18: Printer selection

7.6.4 Delete database

It is possible to work on the data set, which is displayed on the screen.

Furthermore, this is the only place where a data set can be deleted from the database. To use this function, please select a set of data and click at the command ***"delete"***.

7.6.5 Nuclide database

These data are called up via the menu **database/nuclide**.

On the left side of the display appears a list with all nuclides available. The data of the selected nuclide are displayed on the right hand side of the display.

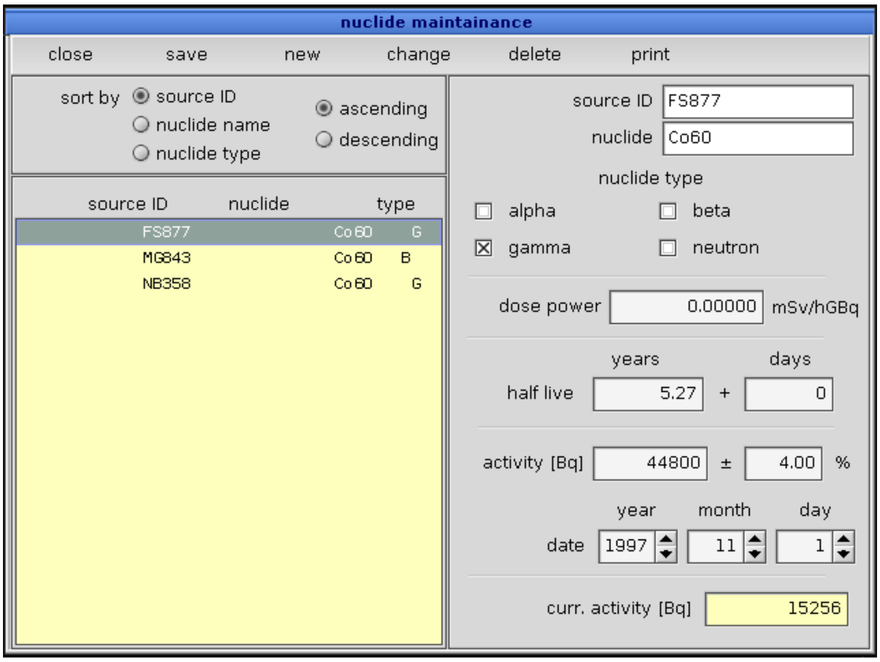


Figure 7-19: Nuclide maintenance

The nuclide administration is closed via the button **close**.

7.6.6 MPP: Nuclideadministration administration

Following data referring to a nuclide are administered in the system:

source ID any name for the radioactive source (reference name for the database)

nuclide name for the nuclide

nuclide type α-, β- ,γ- or neutron radiation can be selected alternatively

dose power The input of the dose power for one calibrated nuclide is only needed, if the monitor can and shall calculate the exposure rate. Please consult the physical literature for the value of the constant (e.g. ^{60}CO = 0.366).

half live The unit of time can be years or days (both entries are also possible). The entry of years is done to the base of 10; i.e. 0.5 corresponds to half a year.

activity [Bq] this field includes the radioactivity value of a nuclide at the time of the determination in Becquerel [Bq] as well as the error of this.

date determination date of the nuclide radioactivity

curr. activity [Bq] From the data given above the current activity [Bq] is calculated automatically and updated.

NOTE

Decay in several steps of mother and daughter nuclides:

If during the radioactive decay daughter nuclides arise these are to be considered during the entry of the activity.

7.6.7 MPP: Nuclide data modification

Possibilities to change the nuclide data:

- create a new nuclide **new**
- alter an already existing nuclide **change**
- remove an already existing nuclide **delete**

If a nuclide is created first time or is modified, the date stated in chapter "nuclide data" need to be entered or modified. (The current activity is automatically calculated and is not considered during the input).

A safety check protects against unintentional loss of data. Only if this check is confirmed with ***"yes"*** the nuclide data will be irrevocably lost.

An entry is acknowledged with the button ***"save"***.

7.6.8 Export

For the export of data please select the menu
database/ export/ measurement or
database/export/nuclide.

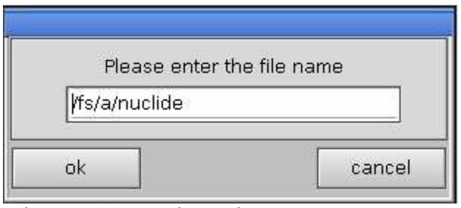


Figure 7-20: Database data export

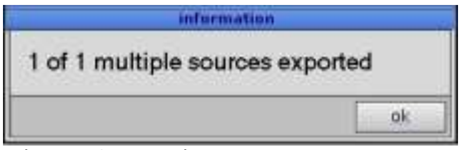


Figure 7-21: Data base export message

As it is only possible to export raw data, the dialogue window to enter the path and the file name are opened directly.

The files are exported to a USB-stick or the local hard disk. The data file extensions are
*.pdh (for measurement results) and
*.pdn (for nuclides).

7.6.9 Import database

For the import please select the menu

Database/import/measurement or

Database/import/nuclide.

Database

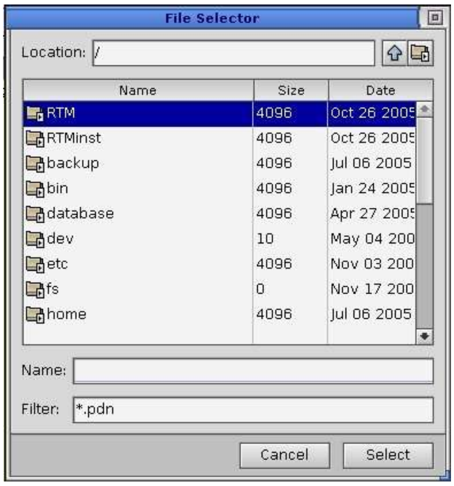


Figure 7-22: Import file selector

Figure 7-23: Import warning

As it is only possible to import raw data, the “file selector” window for the entry of the path and the file name is opened up directly.

The data of the named file is taken over on the hard disk. If a data set with the same characteristic data already exists, there is a query on the display to ask if the existing data set shall be overwritten.

7.7 MPP: Help

The menu **help** leads to the submenus:

- Protocol
- About

7.7.1 Protocol

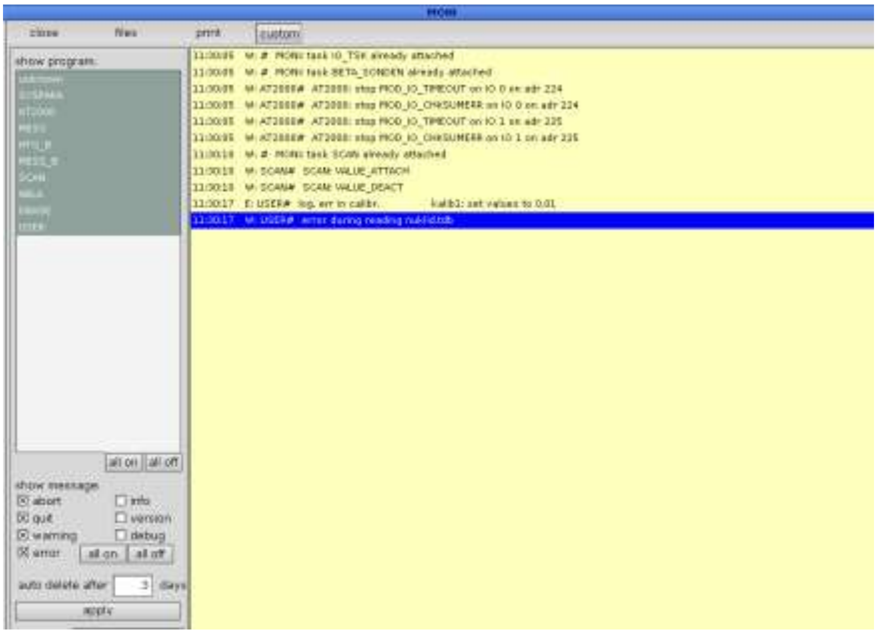


Figure 7-24: Protocol

Before entering the program MPP a protocol manager is started which records the start routine of MPP.

In this protocol:

- Info messages
- Warning messages
- Error messages

are recorded, which might occur during the start and the program sequences.

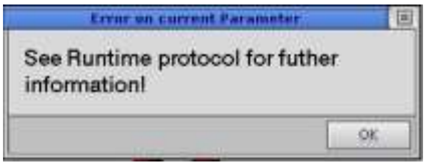


Figure 7-25: Error message on start

In the field "directory" the local path for storing messages is displayed.

The left-hand window shows a listing of all available protocol files. An automatic delete function is active, so that only the protocols of the last 12 days are displayed in the list.

With the button ***"print"*** it is possible to printout all recorded data in the selected protocol file.

With the button ***"delete"*** it is possible to remove a selected file manually.

The button ***"close"*** escorts you back to the start menu.

7.7.2 MPP: About (Info)

This window shows the current software version of the Monitor Plateau Plotter (MPP).

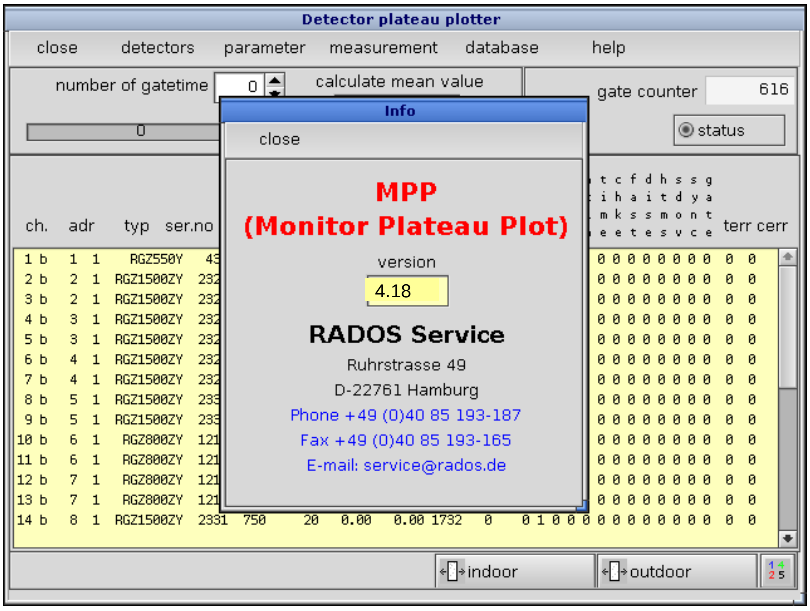


Figure 7-26: About; MPP-version

7.8 Quit (leave program)

With the button ***"close"*** you quit the program and return to the start menu.

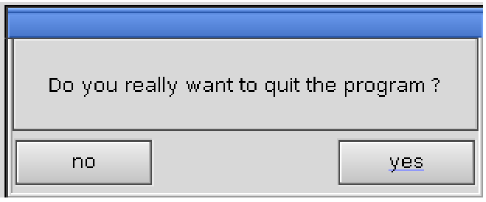


Figure 7-27: Quit program

8 Detector

Table of figures

NOTE

In this register only the type of detectors are mentioned and briefly described. A detector called RGZ xxxY for example will stand for a RADOS gas flow detector with xxx as a wildcard for the detector number (this number regards the size of the inlet window).

8.1 General

The detector location and the initiator location in the **RTM110** layout guarantees that the surface of person is optimal covered.

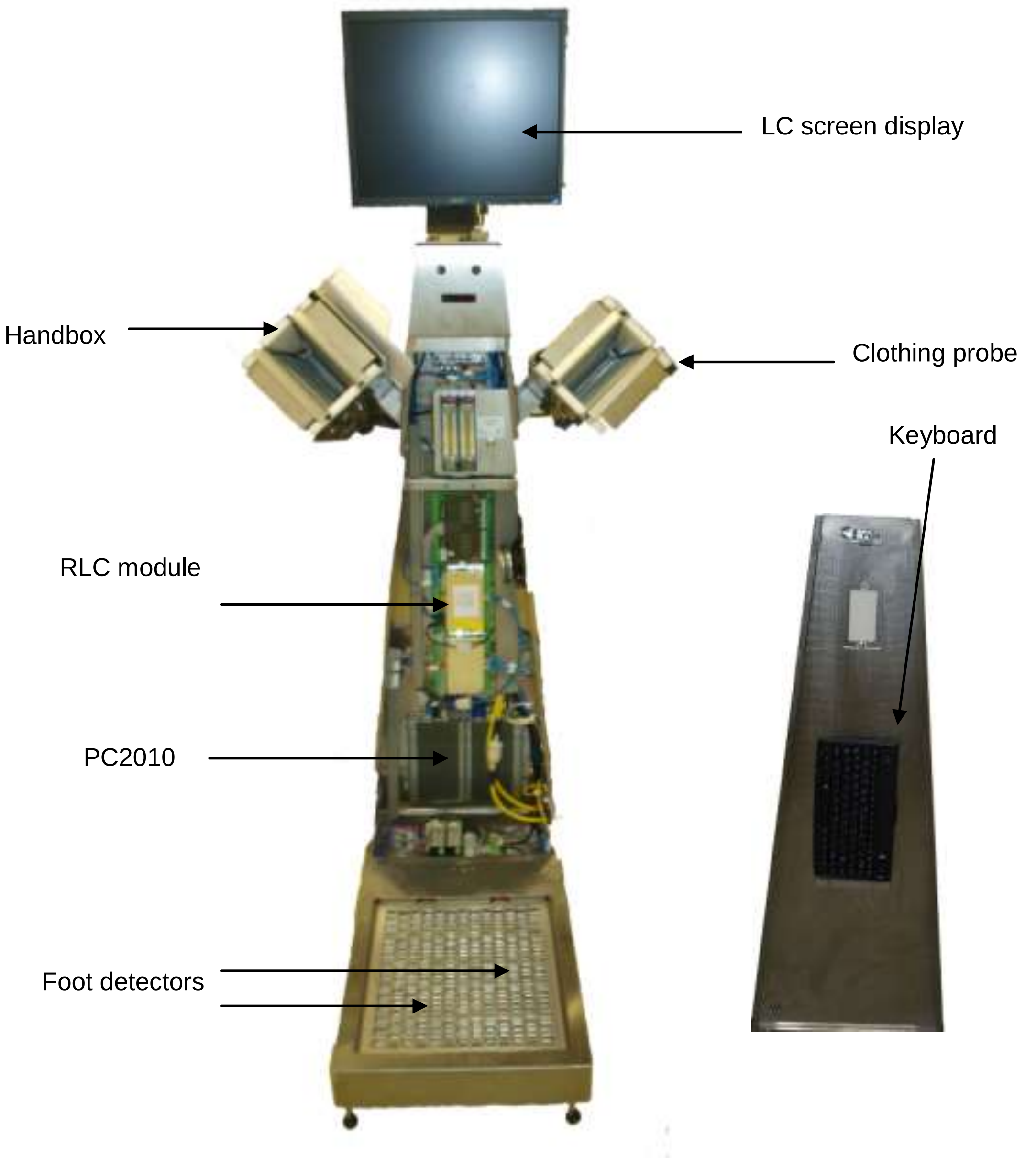


*Figure 8-1: **RTM110** component view*

8.1.1 Measurement computer and electronic

In the following the PC hardware applied, the operating system QNX in brief and the minimum requirements of the hardware are described. As the PC components are developed very fast nowadays, it is also possible that components with higher capacities will be employed.

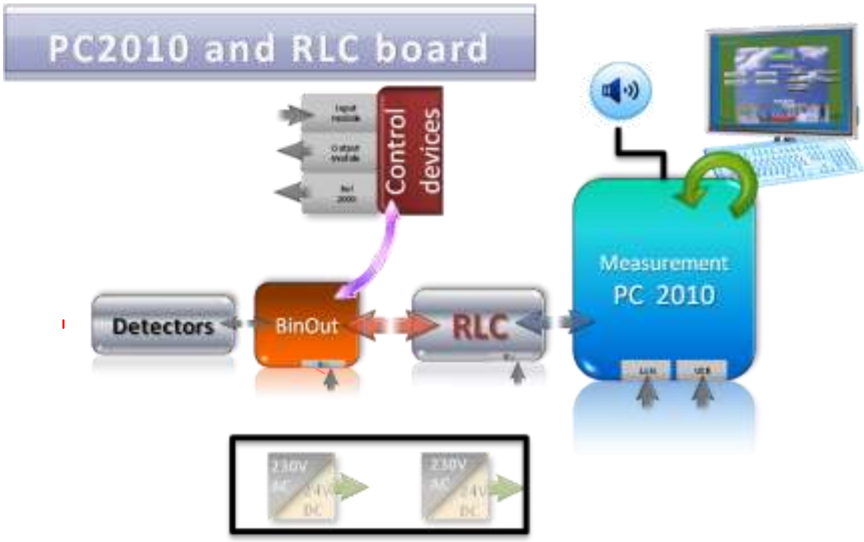


*Figure 8-2: **RTM110** RLC and extension boards Integration*

8.1.2 RADOS PC2010 system computer

The new industrial RADOS PC2010, with ATOM processor, is integrated in the monitor housing and includes the following features:

- Ultra low power embedded system computer
- Fan less design
- Wide range DC power input
- Wide operating temperature
- Ultra low profile enclosure
- Rugged resign for shock/vibration protection
- Easy installation/maintenance
- 3 x RS-232 serial ports (over RJ45 connector)
- 6 x USB 2.0 ports
- 2x Integrated network card (one used by RLC board)

The communication to the **R**ADOS **L**an **C**onverter board RLC is realized by a TCP/IP Network connection.

RADOS PC2010 system computer	
CPU	Intel Atom
Cooling fan	No
Power supply	10-28 VDC
Hard disk	2,5“
USB port	6
Parallel port	0
Serial port	3
ATEWIS PCI	No
FILICO or RLC	Yes

8.1.3 Operation system

In order to measure objects fast and reliably, many calculations of individual procedures have to run simultaneously. For instance, in order to measure the background continuously, a computer system is required that allows all operations in multi-tasking handling, in real time. For this aim Mirion Technologies (RADOS) GmbH has been using the operating system QNX for many years to carry out the different measurement tasks. The whole system is based on a very small and thus very fast core. This core is only responsible for the exchange of messages and the distribution of the computer capacity between simultaneously running program.

All other functions of the operating system are available as independent program and thus they can be used very flexibly.

For detailed information on the QNX operating system refer to register 1.

8.1.4 RADOS RLC electronic

The RADOS RLC electronic concept is the successor of the improved AT2000 system.
At least due to the measurement task the number of in and outputs on the extension board was enhanced.
The electronic supports following functions:

- Communication port to the measurement PC
- Communication port for the detector board
- Communication ports for installed extensions (I/O port)
- Voice output control

The RADOS RLC board concept includes a wide number of customer specific in- and outputs which can be integrated on customer choice.

8.1.5 Measurement position and sensory

The geometric and mechanical layout of the **RTM110** represents the optimal user position while the sensory is placed to control the person measurement position.

Sensory location on the RTM110:

*Figure 8-3: Sensory location on the **RTM110***

The foot-contact is used to recognize a person on the HFC-monitor (prepared for measurement).
The light barriers located in the hand boxes are used to guarantee that the person to measured places his hands deep enough to be fully covered by the detectors.
The correct positioning of the person takes places throughout the measurement process. Leaving this position will lead to a aborted measurement.
The contact for the clothing probe in the hand box and initiates the clothing probe measurement.

8.1.6 Detector and measurement channel

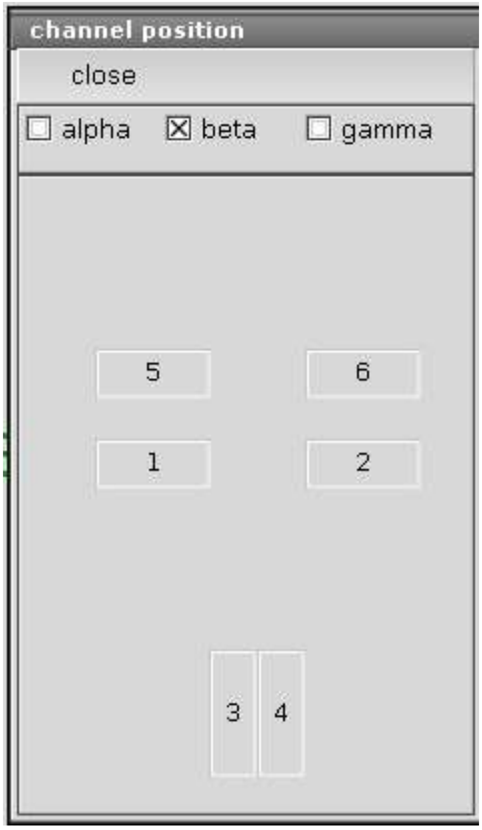


Figure 8-4: Channel configuration

The **RTM110** is equipped with 4 or 6 detectors in basic configuration.

No. of Detector	Position	Remark
1 5	Hand left	outer left hand inner left hand
2 6	Hand right	outer right hand inner right hand
2	Clothing probe	
3 4	Foot	

8.2 Detectors

8.2.1 RGZ - detectors

The large-area detectors RGZ are flow-proportional counters with a large and very thin radiation inlet window. They are used for the measurement of alpha and beta radiation. The sensitive areas of the detectors are covered by a protective grid.

The design of the housing provides the detectors with excellent features. They are rugged and can easily be decontaminated. The tensioned anode is located inside the detector, on Teflon insulators. It is made of 40 μm tungsten wire.

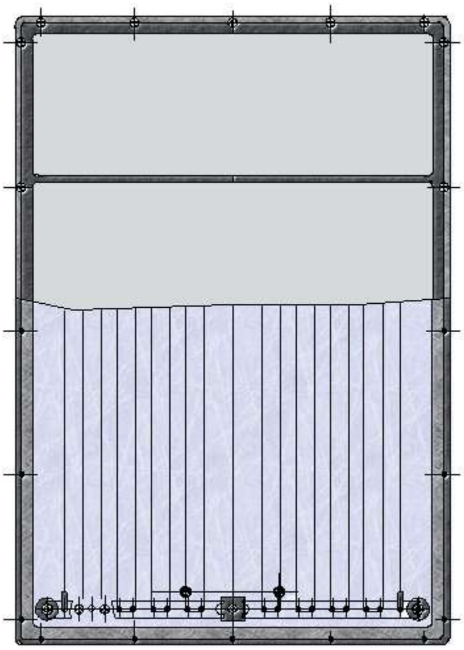


Figure 8-5: View inside the detector

Following mixtures are mainly used as counting gases for the detectors:

- P10 methane (10 %), argon (90 %)
- P7.5 methane (7.5 %), argon (92.5 %)
- Ar/CO_2 carbon dioxide (18 %, CO_2), argon (82 %)

DANGER

It is not allowed to use any flammable gas for the operating of detectors!

DANGER OF EXPLOSION!

- See also chapter "Gas Supply for RGZ-Detectors"

The setting for the operating voltage should be carried out according to the characteristics of the detector (see chapter - Monitor Plateau Plotter).

Plateau slope ≤ 5 % / 100 V (measured with simultaneous radiation from 20 nCi ^{241}Am and 10 nCi ^{90}Sr).

Detectors (RGZ____Y)

Gas supply	90% Argon - 10% Methane
Operating voltage	about 1.75 kV
Plateau length	about 400 V

CAUTION

For detectors with α-/β- separation, the high voltage is set individually according to the plateau characteristics.

Detector (RGZ____Y)

An electronic module on the detector housing is responsible for processing the detector counts. This has an amplitude discriminator, which transfers the detector counts into logical counts.

Furthermore, this component group contains a high voltage generator for producing the anode voltage. The transmission of data is done via a network register, with which the count rates can be read and the high Voltage (HV) can be set.

The detector-specific data, such as detector type, detector serial-no., HV, operating point, area value and date of manufacture are stored in an EEPROM, too.

The β-channel contains the α- and the β- signals, whereas the α-channel contains only the α-signals.

.

8.2.3 Gas supply for RGZ - detector

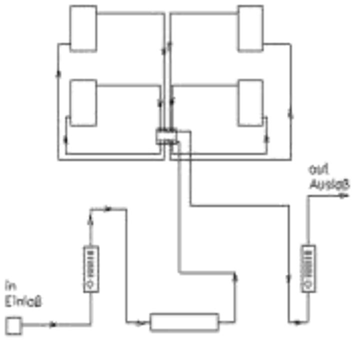


Figure 8-6: Layout diagram of gas supply

Various gases can be used for supplying the RGZ large-area proportional detectors. For safety reasons, gases are used which are non-inflammable or difficult to burn.

8.2.3.1 Usage of gas flow-proportional detectors

Permissible deviation limit for the gas composition are max. 3 %.

The gas supply pressure may be between 50 mbar and 3 bar.

The detectors are connected by hose in series in the **RTM110** monitor. The gas lines to the individual detectors are shown on a block diagram.

Two gas flow meters are situated in the monitor for checking the gas flow. The input gas flow meter is fitted with a needle valve on which the gas throughput in l/h should be set.

The outlet gas flow meter is used for checking the tightness. If the system is gas-tight and the warm-up period is over, then both gas flow meters should indicate almost the same throughput. It is important for a good functioning that all detectors are supplied with sufficient flushing gas, i.e. the outlet gas flow meter should indicate a flow.

8.2.3.2 Availability

Information about the warm-up period:

➔ Gas flushing time

P10	approx. 2 h
P7.5	approx. 4 h
Ar/CO_2	approx. 4 h

➔ flushing value

Approx. 5 l/h (the choker valve is complete open)

8.2.3.3 Flammable and non-flammable gases

CAUTION

1. *Flammable:*

   Methane 100 % belongs to the group of gases that have an ignition range if mixed with air and under normal pressure. Such gases are called flammable in the sense of the German Accident Protection Regulation VGB 61. However, due to the low portion of Methane contained in P10 gas (ratio 90 % Argon, 10 % Methane) a danger in case of added fresh air in general can be excluded.

2. *non-flammable:*

   Argon CO_2 in the sense of the German Accident Protection Regulation VGB 61 is characterised as non-flammable as, according to any of the criteria, it cannot be related to flammability, health-threatening, fire-fostering, chemically instable and/or water-endangering.

WARNING

1. **It must be ensured that sufficient air inlet is provided.**
2. **The gas outlet should be connected to a ventilation system.**
3. **A semi-annual testing of all gas connections, e. g. with the RADOS gas warning system is recommended.**

8.2.4 RGZ detector repair information

8.2.4.1 Detector foil

Hostaphan (Mylar) aluminum with an area-based weight of approx. 0.8 mg/cm² (6µm thick), is placed on both sides and used as detector foil. Genuine RADOS foil should also be used when exchange is needed.
A very simple, power voltage bounded gas tracing equipment for hydrocarbons has proved excellent for locating holes in the foil. (E.g. the RADOS Gas Warner Type I for methane and methane mixtures, order no. 0039GASWARN0).

Figure 8-7: Gas warning system

NOTE
The replacement of the foil should always take place in a dust-free room!

Process task:

CAUTION

Fine, hair-shaped pieces of lint are the most troublesome ones. They straighten up under the influence of an electrostatic field and lead to uncontrolled discharges.

- Do not touch anode wire with the fingers.
- Be careful of dust and lint particles!

It is recommended to blow out the detector with clean and dry compressed air.

1. Unscrew all screws in the window grid.
2. Lift the window grid and remove the old foil.
3. Ensure the wire is not broken otherwise rewire.
4. Place the new foil and window grid in position.
5. Penetrate the foil at the four corners and tightly pull the foil
6. Fix screws in the corner.
7. Penetrate the remaining holes, screw by screw
8. Simultaneously smooth the foil by alternately pulling it tight in different directions.
9. Do not over-tighten the screws.
10. Trim the excess at the edge of the foil.

8.2.4.2 Changing of the anode wire

It is also easy to replace a broken anode wire. In order to do so it is necessary to have the special wiring tool (Z 24 with 40 µm tungsten wire).

The wire is attached by using a soldering iron (50 W), which should not be too small, and a normal commercially available solder (Sn-60; Pb-38, Cu-4).

Here the wire is embedded in a relatively large solder droplet. The solder shrinks as it solidifies, gripping the wire as in a clamp. The wire is not soldered in the normal sense, because tungsten will not form an alloy with the solder that is used.

The excess at the end of the wire should be cut off immediately behind the solder spot. A protruding point inevitably leads to a corona discharge or to a direct sparking.

Figure 8-8: Examples: Anode wire I

Figure 8-9: Anode wire II

Figure 8-10: Anode wire III

8.2.5 RBP - detector

The large-area beta plastic scintillation detectors have been designed in such a way that there will be a low γ background value when the probability of count effects for β- and α-particles of relevant energy is optimal.
The detector is connected to a detector module, whereby one module can support up to two detectors. The position of a detector in the monitor is defined via the address jumper setting in the detector module. The jumper field of the electronics module has to be set in accordance with the list given in the chapter "*exchange of an electronic module"*.

One detector module includes the high voltage, the discriminator and the voltage divider for two detectors, plus a controller which transfers the data to the measurement electronics at a given time.

8.2.5.1 Detector unit

A detector unit consist of the beta plastic with the attached photo-multiplier, the primary electronics and the light-tight cover. It will be called RBP - detector for short.

The core of the detector electronics consists of a 16-Bit micro controller. The controller already comprises some useful basic functions, such as:

* flash-PROM 256kB to store the detector parameters, e.g. high voltage, discriminator threshold …
* 10-Bit A/D transformer to control the high voltage settings
* RJ-45 port as interface to the internal network
* 20 kB RAM

When choosing the detector material, we wanted to combine stability with solid physical features.

Therefore, a very thin scintillation material with a patented light-guide, in combination with a reflector system, results in this efficient β- and α-sensitive detector.

The10 stage photo multiplier, which reacts especially sensitive to the light spectrum of this scintillation material, is glued to the optical assembly. The photo multiplier collects the light output of the scintillation material and converts it to pulses. This is called photoemission, which means the photoelectrical process in the cathode and the secondary emission at the dynodes. It is merely a statistical process, which can comprise a large range. The statistical distribution is sufficient for the Poisson distribution.

The pulses are about 1 V depth and 25 ns width for ^{60}Co-quantums. The computer-controlled discriminator threshold, which must be set during the monitor set-up, separates the background noise of the electronics from the pulses, which are generated by the nuclear radiation.

When the pulses pass the set discriminator threshold they are digitised by the A/D transformer and transmitted to the PC via the AT-2000 network.

8.2.5.2 Dead time correctives

In the system described, a dead time corrective is not required, as no pulse rates are expected of such a magnitude that it would require a significant corrective. This becomes necessary only in case of an activity measurement of several hundred kBq with efficiencies of around 30 %.

8.2.5.3 Setting of high voltage

The photo multiplier has a similar function as a camera. The setting of the working point (high voltage ➔ abbr. HV) is an adjustment to the light conditions as it is done when taking photos, where normally the aperture is adjusted to the light conditions and the fine tuning is carried out via exposure time and film quality etc.

The fine tuning of the detector is carried out via the discriminator threshold and the selection of the material which is placed in front of the radiation (in this case the film material is equal to the packing of the plastic).

The photo multiplier must operate linear for the expected pulse rate (quantity of light). That means the output signal for all expected activities must be proportional to these activities. In practice, this means for the photo multiplier, which keep the adjustments very stable, to choose the HV as it is recommend by the producer.

The linearity can be controlled by two ways:

A) Measuring the counting rate by means of a source (activity of approx. 10.000 Bq) subject to different distance to the surface of the plastic. The clear result must be the inverse square law.

B) The source is fixed to the surface of the cabinet. Then the HV value changed by ± 50 volt and counting rate is measured for each HV value. The pulse rates which are determined in this way must show a linear behaviour in the logarithmic scale.

The HV can be set in the menu - **service/ det. status**. It is possible to set the HV from 400 to 1275 volt in steps of 2 volt. Before settings the HV values it must be guaranteed that the detector units are light-tight, otherwise there is the danger to destroy the photo multiplier.

NOTE
The optimal HV value is always pre set by the Mirion Technologies (RADOS) GmbH factory during the works testing. Normally it is not necessary for the user to change this value.

The adjustment of the HV is only needed when:

1. One single detector shows clearly a lower efficiency or higher background rate as given in the type test protocol.
2. The monitor shall be switched to another leading nuclide.
3. The whole monitor will be moved to a place with totally different background radiation (in intensity and/or energy spectra).

In case 1. the user can try to change the HV in steps of e.g. 10 Volts, in order to get back the nominal efficiency or background.

In case 2. and 3. it is worthwhile to make two measuring sessions. During each the HV will be switch in steps of 25 or 50 Volts over the whole range, e.g. 400 - 1200 V. In the first session only the background rate R_0 is measured. In the second session the count rate with the desired nuclide R_b is measured. The optimum high voltage is found when the following function, that means $F(U_i)$ reaches a minimum ($_i$ means the $_i$th detector):

$$F(U_i) = \frac{\sqrt{R_0}}{R_b - R_0}$$

The measurement could be carried out in the service menu "detector status".

CAUTION

Make sure that the total count rate will fulfill the desired statistically accuracy and that the detector will always work in a linear mode, as described above.

In general all calibration work should only be carried out by special trained persons or the Mirion Technologies GmbH Service.

8.2.5.4 Setting of the discriminators

In order to reach an optimal adjustment of the detector, the energy of the participating particles must be known. Normally this is the reference nuclide.

For low energy detection an upper energy window reduces the influence of high energy background into the low energy radiation measurement.

For this scope only two physical processes have to be considered for the radiation:

* the photoelectric effect
* the Compton effect

While for the photoelectric effect a more or less undistorted amplitude spectrum is measurable, there is a wide-spread spectrum with a strong edge - the Compton edge - from the Compton effect. With the choice of the discriminator threshold it is determined how much of the respective amplitude spectrum is registered by the process electronic. But the system also measures the background radiation, which consists of much different energy. Also for this reason an expanded spectrum is shown with many smaller and some larger distortions.

RADOS - detectors are always preset to the typical parameters for nuclear power stations or to customer specifications before they are delivered to the customer. The settings are optimized; therefore it is not necessary for the user to change the discriminator barrier afterwards.

8.2.6 RBP detector repair information

8.2.6.1 The detector foil

For a quick exchange of a damaged detector foil RADOS company offers already prepared foil frames for the different detector types. On this way the user is able to replace a frame with a damaged foil with a new one in a very short time, so that the **RTM110** is very fast ready to be used.

8.2.6.2 Dismounting and mounting of detector

CAUTION

The power must be switched off before any detector is removed from the **RTM110**. (refer to Register 3)

The monitor is only to be switched on again after the work has been completed!

CAUTION

The addressing of the detectors is designed differently (see chapter - Addressing of detectors).

Below the demounting and mounting of detectors in various locations is described.

8.2.6.3 How to change the detector foil

If the detector foil is damaged the use can replace the foil frame simply self. The user has to do the following steps:

1. Loosen screws at front frame of detector with Philips screwdriver.
2. Remove front frame and damaged foil frame from detector.
3. Position the new foil frame with RADOS label showing to the top and to the cable.

CAUTION

It is very important that the side from foil frame with adhesive tapes is positioned to the front of the detector (not to the inside of the detector).

4. Put the front frame on top with wide bar showing to the cable.
5. With a peaked tool first pierce the foil in the screw holes at the corners of the frame: e.g. with a soldering gun, a staple or a small screwdriver.
6. For positioning the frame, first the screws in the corner positions are tightened.
7. Then the remaining holes are punctured and the screws are screwed in.
8. Finally all screws are securely tightened once again.

8.2.6.4 Preparing a foil frame

If the user wants to prepare the foil frames for the beta plastic detectors by himself, please follow this instruction to guaranty that the detector will be light tight:

1. Between the screw holes of the foil frame and at the outer edge a strap of adhesive tape is affixed.

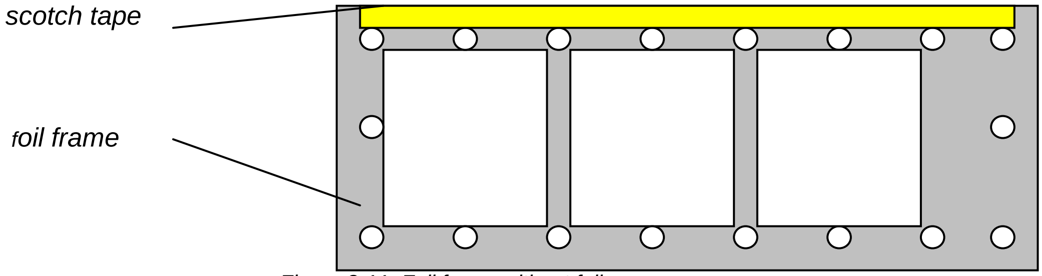


Figure 8-11: Foil frame without foil

2. Position foil frame with adhesive side down at the beginning of the foil sheet, which should have 3 µm. Foil, is fixed to the frame.
3. Now turn the frame until there are 2 layers of foil on each side
4. Cut off the foil in such a way that at two sides there remains a maximum fringe of 1 cm and on one side a fringe of 3 to 4 cm. (see Fig. below)

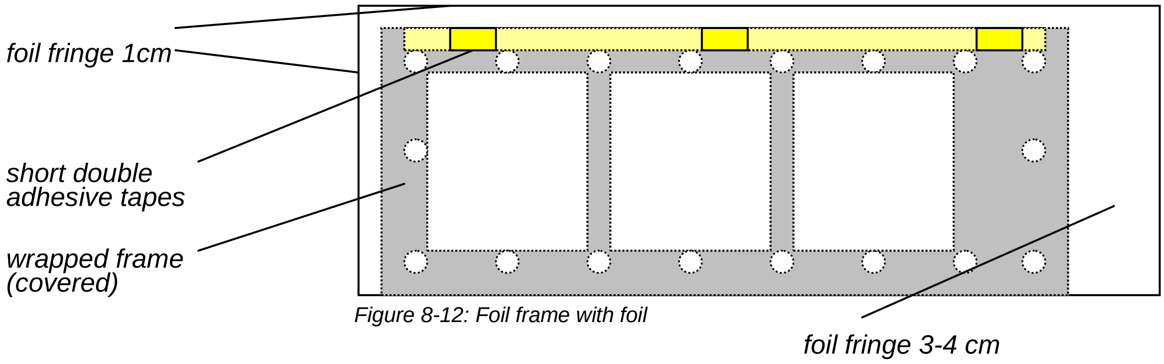
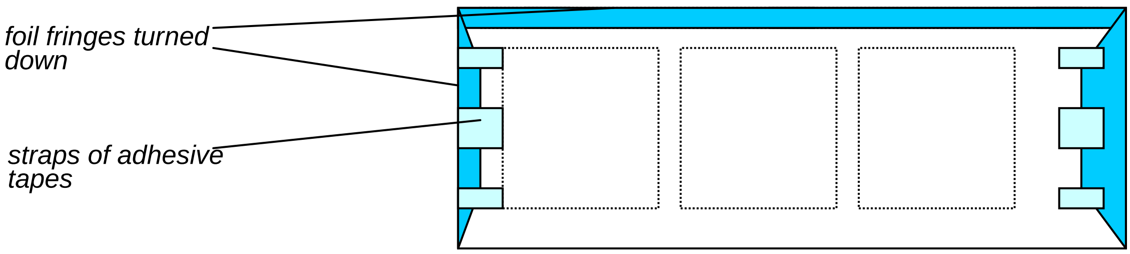


Figure 8-12: Foil frame with foil

5. Stick three short straps of double-adhesive tape directly on top of the foil along the long side of the frame and fix the protruding foil fringe.
6. Turn the foil down at the small sides and fix with short straps of adhesive tape.



8.3 Cabling of the components

8.3.1 Principal structure

Each detector module, light barrier module or binary component is a solitary unit. The modules have a common power supply of +5V DC.

The individual micro-controller modules contain a special network driver. It is possible to use cables of a length of more than 500 meters.

The cabling of the components take place with is an asynchronous network cables.
The RADOS development called RLC (RADOS LAN Converter) is used to connect the modules. The cables used are RJ45.

Each detector module, each light barrier module and each binary input and output module receives its individual address via which it is possible to exchange commands and data in the MASTER/SLAVE mode. In this case the RLC is used as the MASTER. Installed in the RLC Module is a ARM-Controller for the module communication and surveillance as well as an Ethernet controller for LAN communication. The RLC module is addressed via LAN to a determined IP address. The QNX-User Software communicates via LAN (Ethernet / TCP/IP) with the RLC Module.

The network structure installed on the CheckPoint:Body^{TM} enables a connection of all components with RJ-45 cables.

The last module in the RNET network structure is to be closed with a 120 Ohm resistor. This terminating resistor has to be connected with the according jumper in the module. Each module has its own binary address and is to be connected at the 8bit address button.

Following modules can be connected to the RADOS Network:

- detector module
- light barrier module
- binary module

8.3.2 RLC address at the detector module

Each module is a unit of its own. They have a common power supply of +5V DC. The individual micro-controller modules also contain a special network driver. They receive the individual address in the MASTER/SLAVE mode, which allows exchanging commands and data. In this case the PC electronics is normally used as MASTER and the individual components are used as SLAVE.

NOTE

The digits for Jumper S1 and S2 are given binary e.g. "00111100" has to set as shown in picture.

The addressing is carried out via an address switch in the module. The detectors are addressed by using the following table:

Unit / channel	**Address** (Software)	**Jumper** (module)	**Position**
Detector 1	128	10000000	left hand bottom
Detector 2			right hand bottom
Detector 1	130	10000010	left hand on top
Detector 2			right hand on top
Detector 1	129	10000001	left foot
Detector 2			right foot
Binary 1	224	11100000	binary module 1

Table 8-1: Addresses probe- and binary modules

The addressing is carried out via an address switch in the module.

8.3.3 Exchange of an electronic module

The integration into the network protocol RNET 2000 is the same for all electronic modules:

- One RJ-45 cable from the previous module or from the PC
- One RJ-45 cable to the next module, whereby the last module lacks it.
- An individual address, which can be set via an 8-Bit DIL counter.
- A +5V DC power supply.

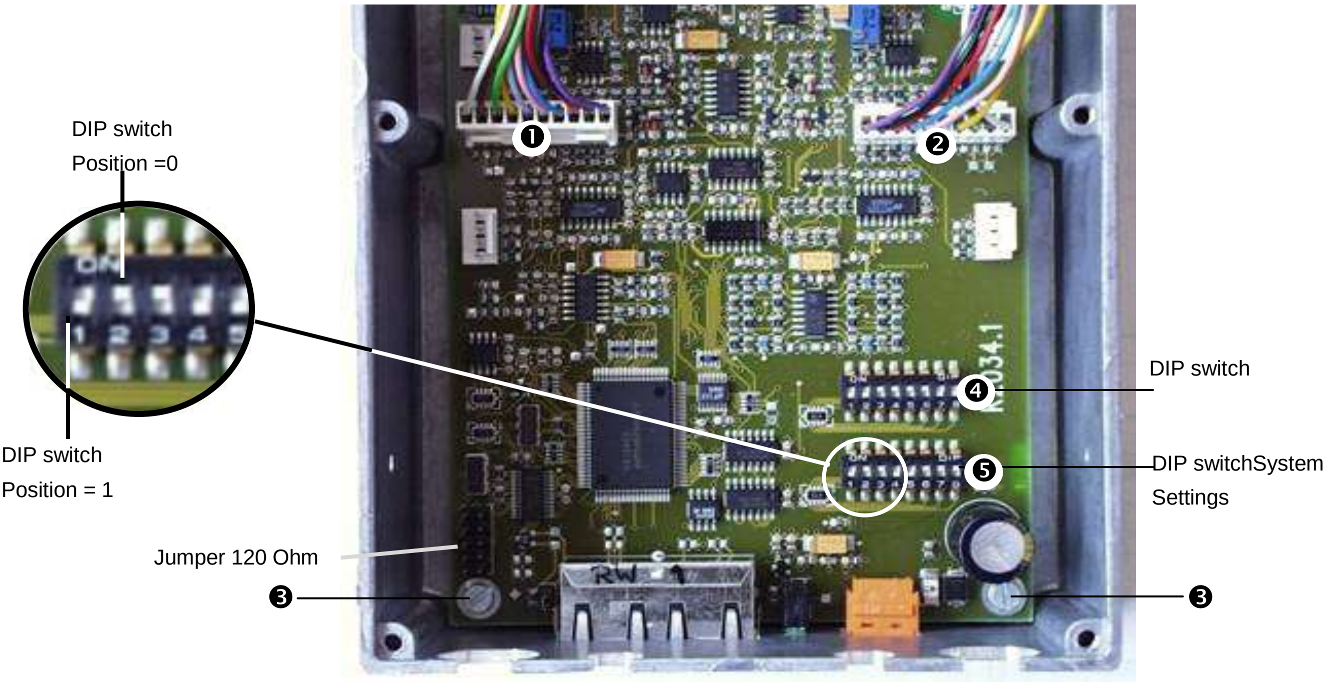


Figure 8-13: Detector module

<u>Exchange of a module:</u>

1. Remove the power cable, the RJ-45 cables and the detector connection cable (❶❷).
2. Open the cover of the module.
3. Dismantle the module.
4. Disconnect the module from the detectors.
5. Copy address and system switch settings from the old module.
6. Install new module.
7. Reconnect the cables.

	CAUTION
	The cable of the power supply has to be always the first one, which is removed in the beginning, and the last one, which is reconnected in the end during the exchange process.

8.3.4 Detector address

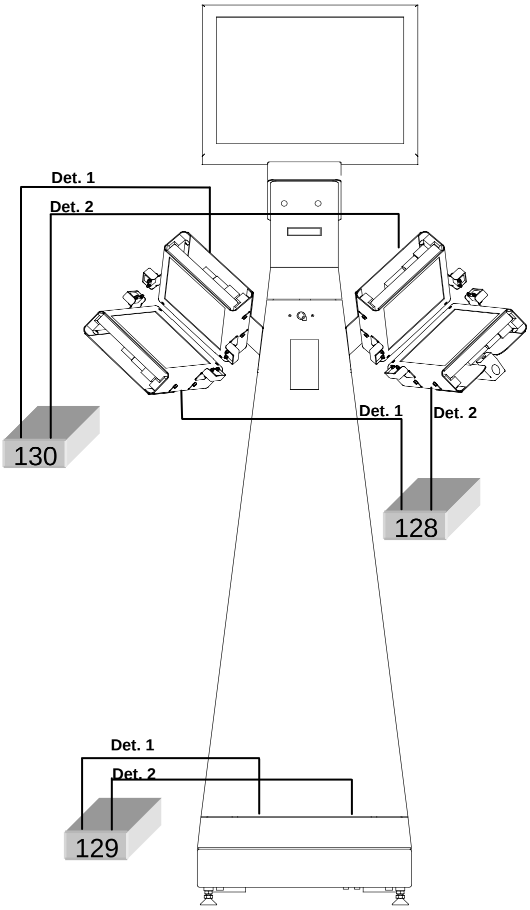


Figure 8-14: Detector address

8.3.5 RGZ Detectors

8.3.5.1 Preliminary work steps

Preparation for dismounting!

1. Disconnect the data cables and the supply plugs for mains and gas.
2. In order to pull off the gas hoses, the safety rings at the hose couplings are pushed backwards (away from the hose). Now the hoses can be taken out of the couplings.

NOTE

If it is not intended to build in a new detector immediately, we recommend connecting the interrupted gas supply with a bridging hose.

Thus the gas supply for the monitor is maintained. There is a bridging hose in the monitor. Hints and valuable information for the user in the course of the description

Working steps for mounting!

CAUTION

When mounting a detector it is important to ensure that the detector has been flushed with counting gas so that its operation after its mounting is not affected.

1. Please insert the detector into the detector fixture
2. Put the hoses into the detector plug-on connections. Please take care that the hoses are pushed deeply enough into the sealing, that is recognized by an increased push resistance.
3. Connect data cables and the supply plugs to the detector.
4. Pay attention to the correct position of hose and cable guides.

	⚠ **CAUTION**
	The gas must always flow from the bottom to the top, because the gas has a higher weight as air in area.

8.3.6 RGZ Foot detector

Turn-lock (square spanner)

The direction of the arrow shows position of the turn lock

▲ close
▶ open

Figure 8-15: Top view foot detector

Demounting and mounting

- Lift the foot grid and lay it down on the right hand side of the monitor.

	⚠ **CAUTION**
	The foot grid is connected to the monitor case via a ground strap. Before the foot grid can be taken away, it is necessary to turn the lock to the right!.

- Remove the protective foil
- Follow the working steps for demounting
- Take the detector out of the monitor
- Follow the working steps for mounting
- The protective foil is pulled over the detector, but before the dirty section of the foil being cut off with a shears.
- Carefully lay the foot grid over the detector

	NOTE
	If the detector is replaced, a setting of the detector addressing is not necessary, as the detector can only be used in this position

8.3.6.1 Hand detectors and clothing probe

Demounting and mounting

- Follow the working steps for demounting
- Pull off the detector holding camps
- Take off the detector
- **Important!** Mounting position of detectors (see also attachment of detectors and their mounting position).
- Position new or repaired detector at first in the hand box.
- **Important!** Protective grid must flush with the detector.
- Slide in detector holding clamps
- Follow the working steps for mounting

	NOTE
	For the setting of the detector addressing please refer to the attachment "addressing of the detectors and their mounting position"

8.3.6.2 Mounting of the detectors

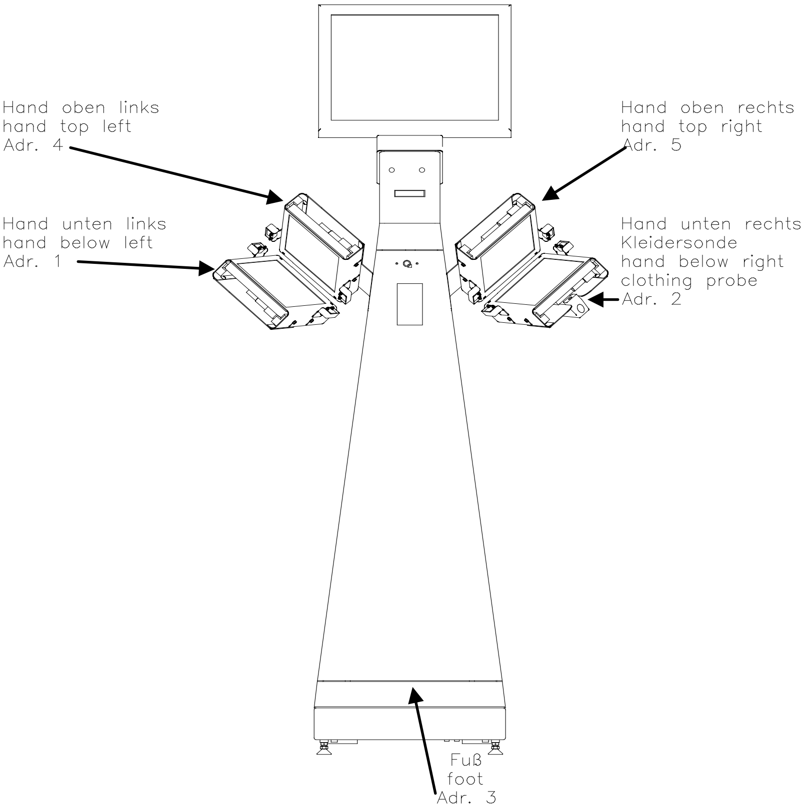


Figure 8-16: Detector view

8.3.6.3 Addressing the detectors

Protective cap

1. **Remove cable connections from module**
2. **Move protective cap up**
3. **Set addresses on the Dip-switch S2**
4. **Addresses of the detectors**
   (see listing in weld-in foil inside the monitor)
5. **Take back the counter module to the module and recover it with the protection cap**
6. **Reconnect cables to module**

Counter module

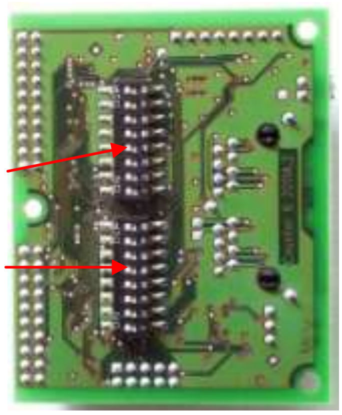


Figure 8-17: Detector module

View component side

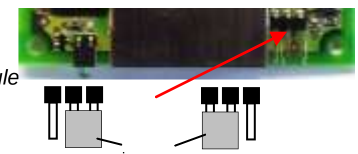


Figure 8-18: Counter module

8.3.7 RBP-detectors

In the following the disassembly and mounting of detectors in various locations is described.

8.3.7.1 Preliminary Work steps

In case of a problem with a detector, e.g. physical damage or error, it is often necessary to exchange the detector in a fast and simple way. For this reason every detector is connected to the monitor via a plug connection, which is easy to loosen.

NOTE

To guaranty that the detectors are connected in the right way to the monitor each detector plug and it is responsible socket is marked with a different colour.

The plug connection for the hand detectors is placed at the backside of the monitor.

Figure 8-19: Hand detectors - cable connection

Figure 8-20: Feet detectors - cable connection

The plug connection for the feet detector is placed under foot grid.

CAUTION

The main switch should be switched off before a detector cable is connected or disconnected, to prevent any damages to the detector electronics.

8.3.7.2 Foot detector

Preliminary steps for disassembly!

At first the data cables and the supply plugs are disconnected.
Now the detector can be taken away from the monitor.

Preliminary steps for mounting!

The data cables and the supply plugs have to be connected to the detector. Insert the detector into the detector fixture and pay attention to a correct position of the cable guides.

Turn-lock (square spanner)

The direction of the arrow shows position of the turn lock

- ▲ close
- ▶ open

Figure 8-21: Foot detector top view

Disassembly and mounting

- Lift the foot grid and lay it down on the right hand side of the monitor.

CAUTION

The foot grid is connected to the monitor case via a ground strap.

Before the foot grid can be taken away, it is necessary to turn the lock to the right!

- Remove the protective foil
- Follow the working steps for demounting
- Take the detector out of the monitor
- Follow the working steps for mounting
- The protective foil is pulled over the detector, but before the dirty section of the foil being cut off with a shears.
- Carefully lay the foot grid over the detector

8.3.7.3 Hand detectors and clothing probe

Disassembly and mounting

- Follow the working steps for demounting
- Pull off the detector holding camps
- Take off the detector
- **Important!** Mounting position of detectors (see also attachment of detectors and their mounting position).
- Position new or repaired detector at first in the hand box.
- **Important!** Protective grid must flush with the detector.
- Follow the working steps for mounting

NOTE

For the setting of the detector address please refer to the attachment "addressing of the detectors and their mounting position".

8.4 Calibration

After exchange of a detector the channel must be recalibrated, please refer to chapter **System check**.

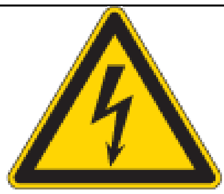
9 Trouble shooting and repair

Figures

9.1 Repair

9.1.1 Safety precautions

When carrying out service work at the personnel monitor, the main mains supply switch must always be switched off or, where applicable, the mains plug should be removed.

 ATTENTION! Caution!	 ATTENTION! HIGH VOLTAGE	 DANGER! Electric shock

WARNING

The main switch should be at OFF position before opening the detector covers.

9.1.2 General safety regulations

In any case, accident prevention regulations have to be obeyed during maintenance and repair work.

In addition, the following is to be taken into account:

- Working on electric systems is only to be done by adequately trained persons.
- Before working on electric systems, those parts, which undergo work, are to be switched off.
- This applies even if the repair seems to be trivial and the de-energization affects significant parts of the electric system.

9.1.3 Safety precautions

- Switch OFF automatic circuit breakers.
- Mark individual parts before disassembling.
- For all work use proper tools, which are in perfect condition.
- Replace gaskets and seals before reassembly.
- Pay special attention to perfect restoration of ground connections.

- Check unit after maintenance work for operational readiness.
- All operation, maintenance and repair work is to be carried out by personnel especially trained for the job.
- Before working the particular part of the electrical system must be switched off.
- The switching place(s) must be protected against unintentional switching on.

9.1.3.1 Cables

- In case of disconnecting cables, these must be protected against breaking. The cable ends have to be prevented by wrapping with insulating tape and PVC-foil.

9.1.3.2 Fuses

- It is forbidden to mend or bridge fuses and to use mended fuses.
- In case of replacing fuses only those of equal or smaller nominal current and characteristic (slow-acting, quick-acting, super-quick-acting) must be used.

9.1.3.3 Plugs and sockets

- Movable electrical equipment must only be connected and operated via the provided plugs and sockets.
- Use of adapters and plugs, which fit into sockets of different voltage, is forbidden.
- Plugs and sockets must not be pulled while energized.
- When replacing plugs and sockets, care needs to be taken of connecting in proper phase.

9.1.3.4 Cable accessories

- Cable clamps must be secured against shaking off by means of retainer washers and spring washers.
- When reconnecting cable connections to devices and systems, care needs to be taken of the cable-shields grounding (by means of grounding cone) and the cable inlet's tightness (according to the protective system of the respective device).

9.2 Guideline for troubleshooting

9.2.1 Troubleshooting general

Following good practices will be recommended by Mirion Technologies (RADOS) GmbH:

- Document solution
- Prepare for failures

- Keep spares
- Keep technical handbook
- Keep software
- Keep configuration info
- Back up data!

9.2.2 Troubleshooting process

- Gather information
  - define the problem
  - Ask questions
- Identify the kind of problem
  - Hardware failures
  - Percussive Maintenance
  - Thermals
- Try quick fixes
  - Look at recent changes
  - Check connections
  - Reboot the computer
- Isolate the problem
- Perform the repair

9.2.3 Trouble shooting

9.2.3.1 Distinction criteria

There are following classes of faults:

a) Detector faults:

- minimum level

- maximum level

b) Sensor faults:

- sensor does not trip

- sensor is constantly tripped

- sensor is insensitive

- sensor is unstable

c) Electronic faults:

- system faults

- various fault messages

The main goal is to conclude to the correct fault origin from the observed fault symptoms.

Trouble shooting on the **RTM110** is supported by comprehensive help functions in the service menu.

Fault messages, their possible causes and their correction are described in the following section.

NOTE

If the error or a rectification cannot be found. Please feel free to sent a copy of the runtime protocol to the RADOS Customer Service!

9.2.3.2 Trouble shooting examples

Measurement computer

Possible fault	Possible causes
Does the PC boot and start the user program?	- hard drive broken - bios settings lost - CPU battery down - no connection to main - Fuse broken - Hardware settings were cancelled - parameter settings - system check was not carried out right

Sensory

Possible fault	Possible causes
Is there dirt on the sensor?	- check the physical adjustment by sensor and I/O- menu. - pay attention for inverse sensors like nobody contact
Does the reflector exist or is there dirt	- check the cabling
LEDs: at the modules are blinking for BIN In, BIN out and A1	- check mains - check status of I/O‘s in the I/O menu or see runtime protocol

9.3 Detector fault messages and rectification

As an evidence for a contaminated or defective detector the in- or decrease of the minimum or maximum threshold of only one detector is to be adopted.

Rectification flowchart:

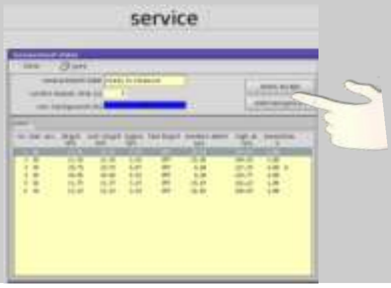
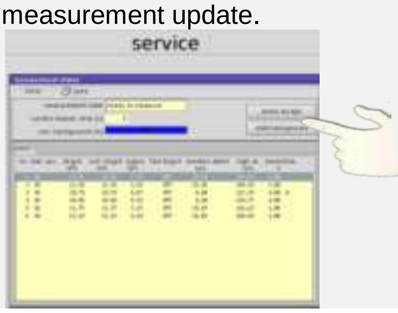
Message /fault	Chapter
In- or decrease of the minimum or maximum threshold of only one detector. 	**9.4.1 Software fault messages and rectification**
Change to **maintenance mode** and select **measurement status** menu. Press button **Alarm accept** for confirmation. 	**4.4.2 Measurement status**
The contamination monitor switches the **measurement mode** to conditionally ready to measure	**4.4.2 Measurement status**
Replace faulty detector 	**8.4.2.Detector mounting / unmounting**
Change to **maintenance mode** and select **measurement status** menu. Press button **start** to initiate a background measurement update. 	**4.4.2 Measurement status**
The contamination monitor switches the **measurement mode** to ready to measure	**4.4.2 Measurement status**
Re-calibrate the changed detector using the **System check** software.	**6.6.2 Detector efficiency calculation**

Figure 9-1: Detector- Rectification flowchart

9.4 Software fault messages and rectification

If a reliable operation is not guaranteed, further measurements are stopped. Troubles and faults that lead to the interruption of the measurements are displayed on the screen.

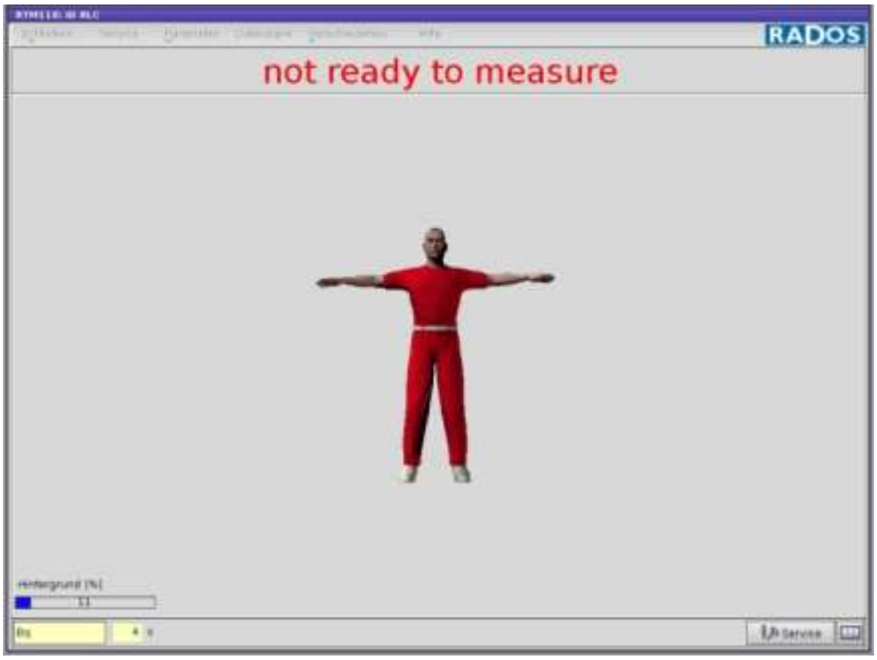


Figure 9-2: Failure - not ready to measure

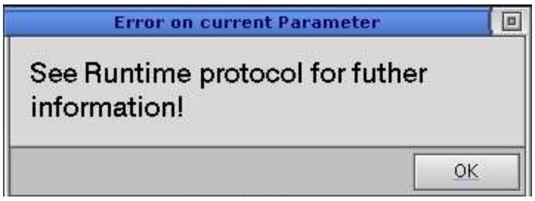


Figure 9-3: Error-message

NOTE

“call RADOS Customer Service ”

Please refer to Register 1 chapter “call for service”, if the rectification “call RADOS Customer Service” is mentioned in the following listing.

Service phone: +49 40 85 193- 222

9.4.1 On screen fault messages

Any possible messages and the causes for troubles and faults are described below:

Background

The progress of background determination is displayed. The value indicates the percentage to what extent the current measurement is finished. This value only appears when the background is completely determined anew. This will be done when the monitor is switched on, and on request in the service mode.

β or γ minimum level

At least one detector remained below the adjusted minimum threshold. The display of the measuring status (see Register- Service) shows which detectors are responsible for that.

α, β or γ maximum level

At least one detector has exceeded the maximum threshold set in the service mode. The display of the measuring status (see chapter - service) shows the detectors that exceeded it.

Detector fault

At least one detector does not deliver any data or delivers wrong data. If more than one detector is affected, it may be a fault in the electronics or a very high background. Otherwise, there may be a defect or contamination of the detector. More precise information can be taken from the "Detector status" (see service).

I/O fault

At least one sensor does not deliver correct values. It can be found out from the display of the I/O status (see also service) which sensors are affected.

Gas supply interrupted

For at least 4 minutes no gas flow was measured at the input gas pressure switch.

Supposition of a gas leak

At least one detector did not attain the gas alarm threshold set in the service menu. In the display of the measurement status (see chapter - service) it can be identified.

This is just a warning, which can only prevent a contamination measurement in connection with an exceeded minimum or maximum threshold.

9.4.2 Hardware faults

FAULT	ORIGIN	RECTIFFICATION
Monitor does not operate	a) power supply failure - no mains supply	a) service department - check wire and fuses - check mains connection - measure low voltages
Video display is blank	a) power supply failure - no mains supply	a) service department b) check wire and fuses - check mains connection - measure low voltages c) restart the monitor again - replace the video- monitor or LC-display - adjust contrast in BIOS of CPU
Light barrier failure **Continual request to leave the monitor**	a) the light barrier is continually active due to a tripped sensor b) the monitor cannot carry out first background measurement c) sensor is set too sensitively d) sensor defect	a) check all inputs in service menu "I/O- test" b) Without person in the monitor only the following input signals should be active: - body contact - service - gas - emergency passage - head detector is up - exit is closed c) sensor should be cleaned - Adjusted if necessary d) replace
Minimum limit	a) background – pulse rate <u>below</u> minimum limit b) high voltage set too low	a) turn to service menu - measurement status, look at MIN level of channels b) check high voltage (*detector status)* c) check sensors (menu I/O-test)
Maximum limit	a) background- pulse rate <u>above</u> maximum limit b) high voltage set too high c) contamination of monitor d) housing damaged	a) more exact evaluation in service menu “detector-status“ - check MAX-level of detectors c) check high voltage (*detector status)* d) decontaminate e) check housing for damages, - check for light tightness - remove detector and exchange

Software fault messages and rectification

FAULT	BE RESPONSIBLE FOR	RECTIFFICATION
	RGZ Detectors	
Gas supply fault Gas supply interrupted	a) The body contamination monitor has not been supplied with gas for more than 4 minutes	a) Is the monitor supplied with gas within a short time again, then there is no need for action b) If the monitor has been without gas supply for a longer time it is suggested to open the inlet gas flow meter completely for quick flushing c) Flush after the gas supply has been re-established again
Minimum level	a) No background count rate below minimum level b) Disturbed gas supply of the detector big hole in the detector foil c) Counting wire is broken d) High voltage set too low	a) Turn to service menu, measurement status look at MIN level of channels b) Check gas outlet valve for throughput check detector foil replace detector foil exchange detector c) Exchange the complete detector d) check high voltage (*detector status)*
Maximum level	a) No background count rate above maximum limit b) Disturbed gas supply of detector big hole in detector foil c) Counting wire broken d) High voltage set too high e) Contamination of detector or contamination of monitor	a) More exact evaluation in service menu "detector-status" b) check MAX-level of detectors c) Check gas outlet meter for throughput check detector foil exchange detector foil exchange detector d) Exchange detector e) Check high voltage (menu detector status) f) Take out detector with protective grid decontaminate
	RPD Detectors	
Minimum level	a) Background count rate below minimum level b) High voltage set too low	a) Turn to service menu, measurement status look at MIN level of channels b) Exchange detector c) Check high voltage (*detector status)*
Maximum level	a) Background count rate above maximum level b) Counting wire broken c) High voltage set too high d) Detector housing broken	a) More exact evaluation in service menu "detector-status" - check MAX-level of detectors b) Exchange detector c) Check high voltage (menu detector status) d) Examine detector on not luminescent state e) Exchange detector

ABLA MESSAGE	ORIGIN	RECTIFFICATION
"error on detector"	a) Detector data (rates) are out of range b) Detector defective	a) more exact evaluation in service menu “detector-status“ b) change detector settings c) Detector defective d) change detector call RADOS service
"error on parameter setting"	a) measurement data could not calculated	a) more exact evaluation in service menu “parameter“ b) - change monitor parameter to default parameter
"error on light barrier"	a) light barrier contacts are blocked or just one barrier is actuated several times	a) remove blocking and actuate light barrier by hand (simulate measurement) b) Switch to “service” mode and return to “measurement” mode to reinitialize io -module

9.5 Protocol

Before entering the RTM user software a protocol manager is started. This manager records the start routine of the RTM user software.

In this protocol:

- Info messages
- Warning messages
- Error messages

are recorded ❶, which occur during the start and the program sequences.

Figure 9-4: Protocol

The left-hand window shows a listing of all available protocol files. There is an automatic delete function, so that only the protocols of the last 12 days are displayed in the list.

With the button ***print*** it is possible to make a printout of all recorded data in the selected protocol file.
With the button ***history*** it is possible to view the log-file history.
With the button ***close*** you can return to the start menu.

Should one of these errors ❶ appear during running operation, please start the monitor again or contact the RADOS customer service.

Protocol fault messages

The Software procedures and failure messages are guided by the ABLA routine (ABLA is a short in German [**ABLA**ufsteuerung] what means sequential control) which will display following messages if a failure occurs.

Below any possible messages, causes for troubles and faults, are described.

ABLA MESSAGE	ORIGIN	RECTIFFICATION
"error on I/O module"	a) at start: ABLA could not locate AT2000 and /or the LS task b) in operational mode: AT2000 could not communicate or locate with in –or output channel	a) restart the monitor b) call RADOS Customer Service a) restart the monitor b) check camera and light barrier for proper function c) call RADOS Customer Service
"error on process control"	a) ABLA application was not initiated correctly	a) restart the monitor b) call RADOS Customer Service
"error on service key"	a) ABLA could not define input on io "service key"	a) restart the monitor b) call RADOS Customer Service
"gamma min alarm"	a) minimum rates on gamma channel are to low	a) turn to service menu - measurement status - look at MIN level of channels - change detector settings b) Detector defective - change detector - call RADOS Customer Service
"… max alarm"	a) background- pulse rate <u>above</u> maximum limit b) contamination of monitor	a) more exact evaluation in service menu "detector-status" - check MAX-level of detectors - change detector settings b) Source in direct detector contact during background measurement - Remove source - decontaminate detector c) Detector defective - change detector - call RADOS Customer Service
"process control not active"	a) Internal Fault of ABLA Application, data could not be retrieved	a) restart the monitor - call RADOS Customer Service
"mathematics not active"	a) Measurement data could not be retrieved during start of monitor	a) restart the monitor - call RADOS Customer Service
"i/o not active"	a) No AT2000 data received from ABLA at start	a) restart the monitor - call RADOS Customer Service

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ABLA MESSAGE	ORIGIN	RECTIFFICATION
error on detector	detector data (rates) are out of range detector defective	(1) more exact evaluation in service me nu “detector-status“ (2) change detector settings (3) detector defective (4) change detector call RADOS Customer Service
error on parameter setting	measurement data could not calculated	(5) more exact evaluation in service menu “parameter“ (6) - change monitor parameter to default parameter
error on light barrier	light barrier contacts are blocked or just one barrier is actuated several times	(7) remove blocking and actuate light barrier by hand (simulate measurement) (8) switch to maintenance mode and return to measurement mode to reinitialize I/O-module

9.6 Stock-keeping of spare parts / service department

Address:	**Mirion Technologies (RADOS) GmbH** Ruhrstraße 49 22761 Hamburg
Phone:	+49 - 40 85 193-222
Fax:	+49 - 40 85 193-208
e-mail	hamburg-hotline@mirion.com

10 Maintenance/Transport/Storage

Figure

10.1 Maintenance

Under normal conditions, the body contamination monitor **RTM110** does not need any maintenance. Nevertheless, it is advisable to perform some small repeat tests from time to time.

10.1.1 Start-up menu

The start-up menu is the central navigation tool for all **RTM110** software modules. Every software module can be reached with a click.

Figure 10-1: Start-up menu

Software modules provided via the **Start-up Menu**:

START	Used to call the **RTM user software** the main program to perform contamination measurement (see Register 3 and Register 4)
Service	used to call the **utility** program to perform for computer and detector administration.
System check	The maintenance and calibration program for body contamination monitor (see Register 6).
MPP	a detector working point module (see Register 7)
User profile	user administration program (see Register 5)
load parameter save parameter	enables the user to im- and export all **RTM110** parameter on a USB-stick
HW Setup	program to configured the hardware settings of the present **RTM110**
System parameter	program to set i.e. the timestamp and screen resolution
Error/info protocol	list of the last system internal messages i.e. useful for troubleshooting
QNX Shell	enables the user to get access to the local hard disk.
SHUTDOWN	Shutdown **RTM110**

10.1.2 Save/load Configuration

To enable the user with the feature of a central parameter backup, the import and export of all **RTM110** settings and parameter on data storage media (usually hard disk or USB-stick) was designed to be a part to the user software.

Figure 10-2: Start-up menu

Software modules provided via the **Start-up Menu**:

used to call the **RTM user software** the main program to perform contamination measurement (see Register 3 and Register 4)

parameter on a USB-stick.

To prevent an erroneously saving of data (or respective overwriting existing data) this service process starts with a safety inquiry.

After this inquiry the data storage media (usually hard disk, writeable CD or USB-stick) and the path to the data storage media has to be defined by the user.

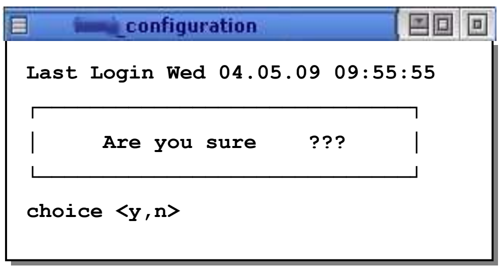


Figure 10-3: Safety inquiry

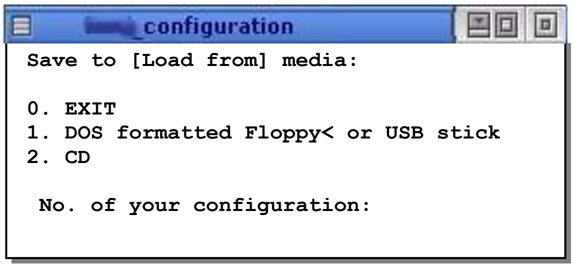


Figure 10-4: Data storage media

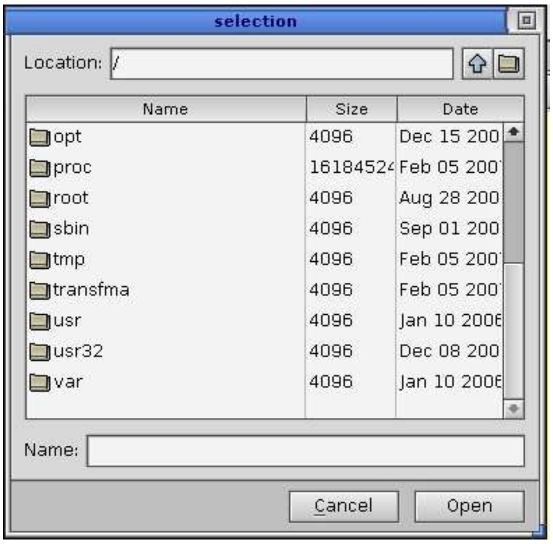


Figure 10-5: Data storage media path (save/load)

Regarding the case that backup data already exists on the chosen path, the following statements have to be given by the backup operator.

Figure 10-6: Data safety questions

<u>Save configuration</u>

To save the configuration data of the monitor the menu button "**save**" ❶ has to be actuated. The actual saved data ❷, the result of the saving process❸ (serviceable in case of errors) and an overall progress bar ❹ will be displayed throughout the saving process.

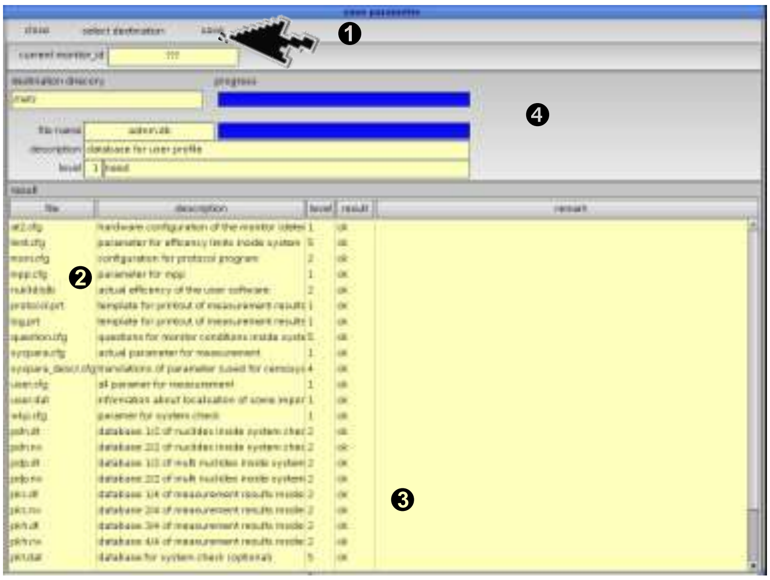


Figure 10-7: Save configuration menu

Load configuration

To restore a configuration in the monitor the menu button "**load**" ❶ has to be actuated. The actual restored data ❷, the result of the loading process❸ (serviceable in case of errors) and an overall progress bar ❹ will be displayed throughout the "load configuration" process.

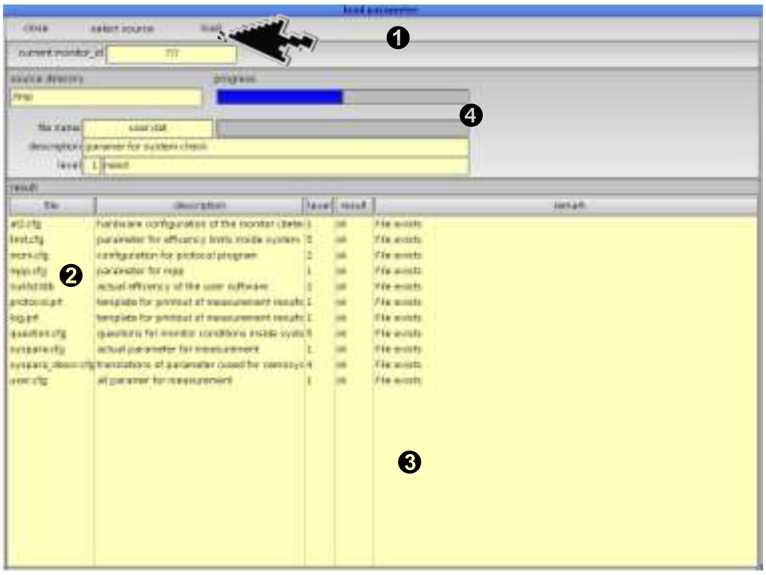


Figure 10-8: Load configuration menu

Note

The menu item "select source" is part of the save/load menu to change the path to the storage devices in the save or load menu.

10.1.3 System Configuration

The menu **system Configuration** enables the user to alter system internal settings.

Figure 10-9: Start-up menu

Software modules provided via the **Start-up Menu**:

used to call the **RTM user software** the main program to perform contamination measurement
(see Register 3 and Register 4)

alter System parameter

<u>In General:</u>

- A mouse click on **<<u>A</u>pply>** will apply the setting and the changed data will be stored in the **RTM110**
- A mouse click on **<save>** will store the settings to the **RTM110**.
- The monitor must be <u>restarted</u> to enable the settings.

NOTE

Please make sure that all RTM parameter are at hand or known prior altering system parameter. It is not advised or needed to change system parameter on RTM monitors.

10.1.3.1 Localization

The tab *system configuration* enables direct change of the screen resolution (in dependency to the used display, a resolution of 800x600 is mandatory) and the system immanent directories (use care changing the directories).

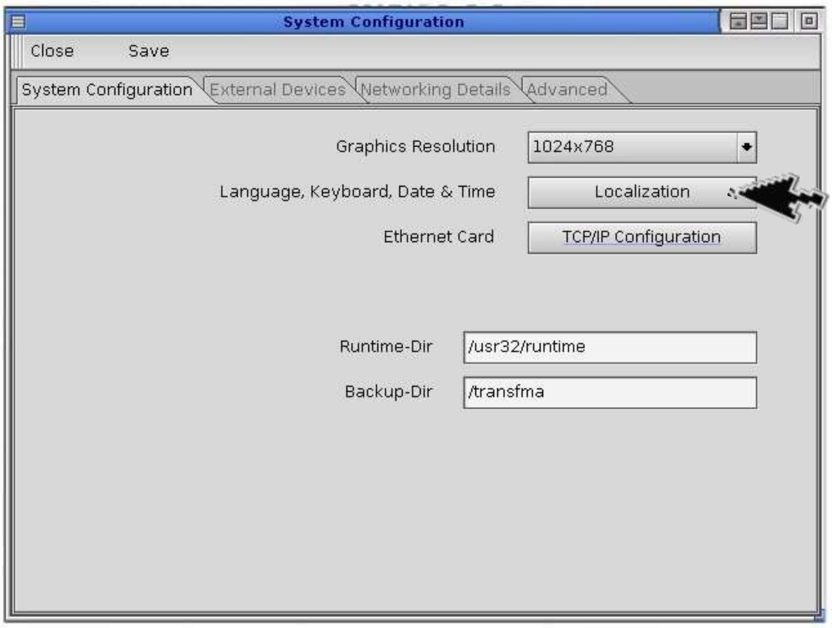


Figure 10-10: Localization

Select localization on tab System configuration.
The display user configuration starts with defining the time zone.

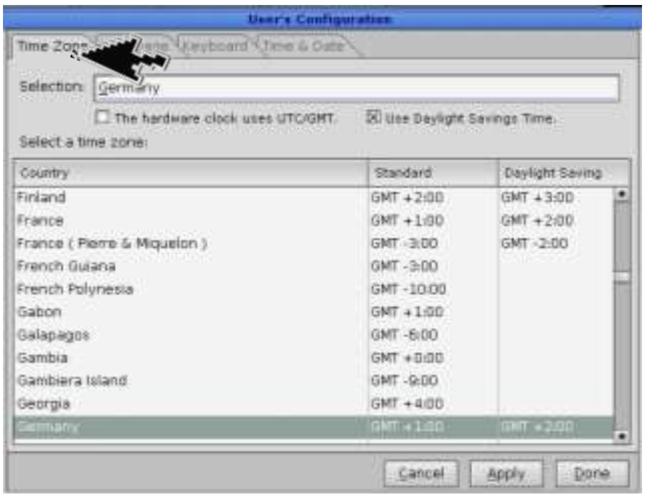


Figure 10-11: Localization Time Zone

The tabs *language* and *keyboard* will define the operation system language and the keyboard layout (especially used to access german "umlaute" or other national special character)

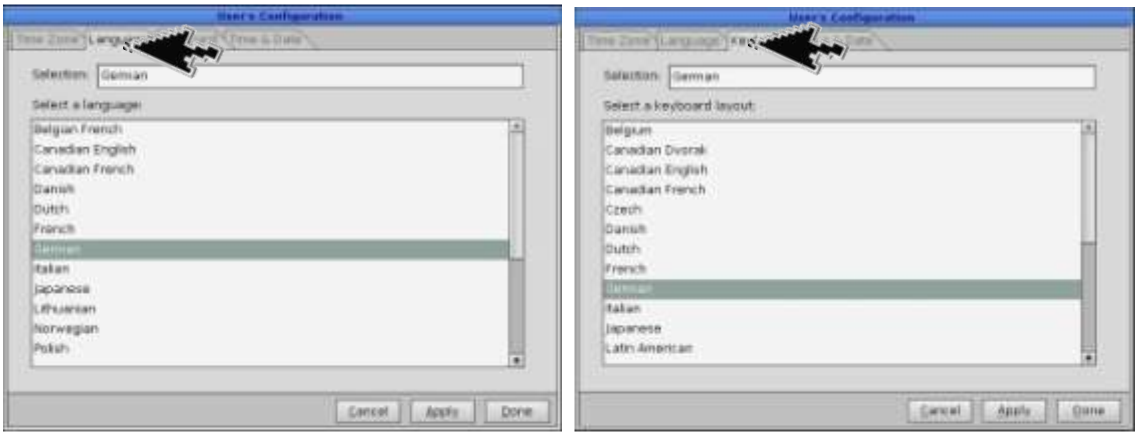


Figure 10-12: Localization language and keyboard

The display to set system time and -date lets the user change the date using the six throttles for hour, minute, second and for year, month, day.

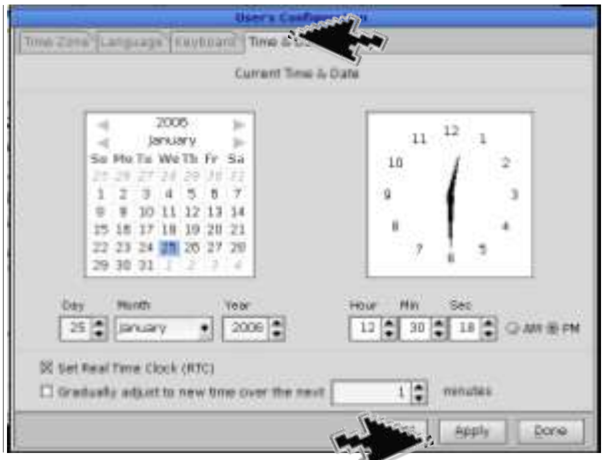


Figure 10-13: Date time

10.1.3.2 TCP/IP configuration

Select *TCP/IP configuration* on tab *System configuration* in order to alter network settings.

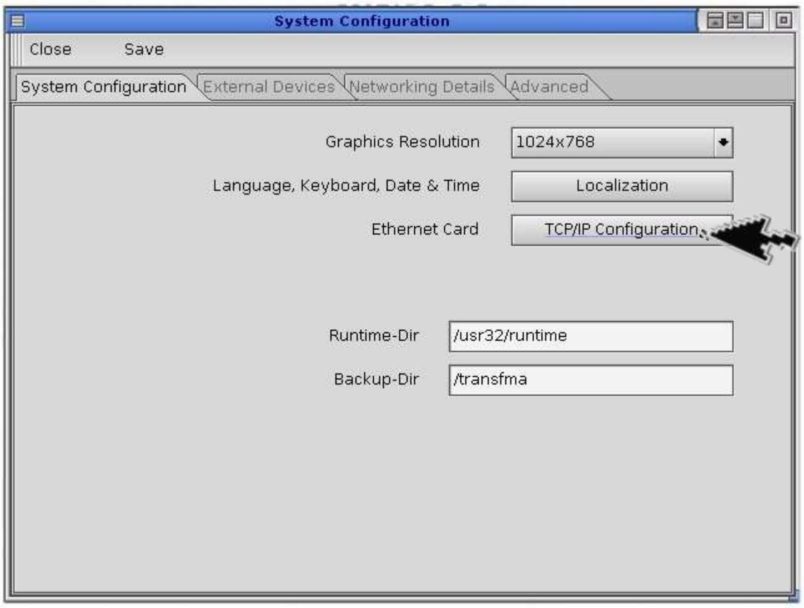


Figure 10-14: TCP/IP configuration

The display *TCP/IP configuration* starts with defining the *global network settings* on final destination.

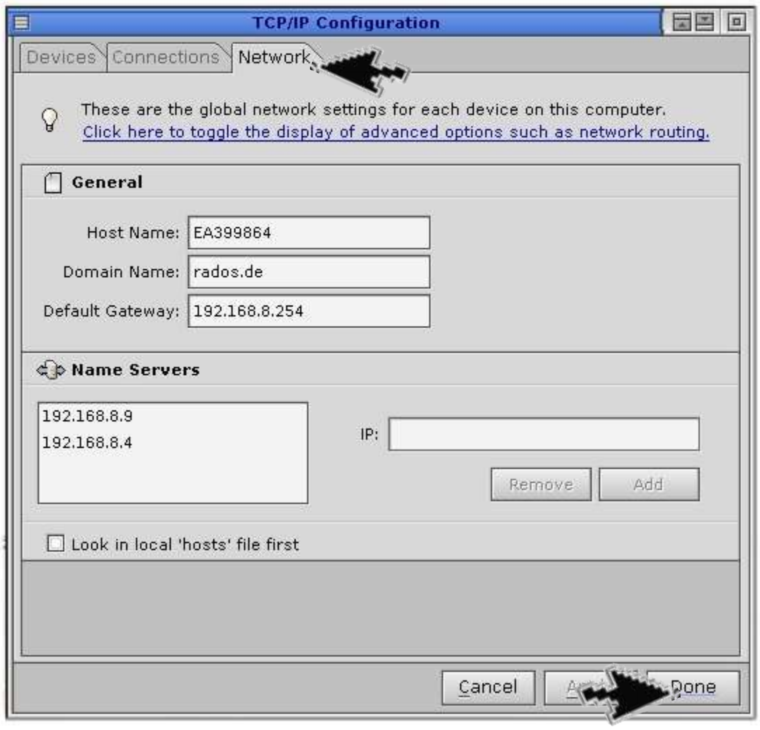


Figure 10-15: Network

The tab *connections* will display actual route connections of the device. While the tab *devices* allow the user to insert or alter network specifications like the applicable DHCP (*Dynamic Host Configuration Protocol*) Server in final network integration.

10.1.3.3 External devices

The tab *External Devices* enables altering the devices connected to the **RTM110** i.e. after weigh cell update or printer change.

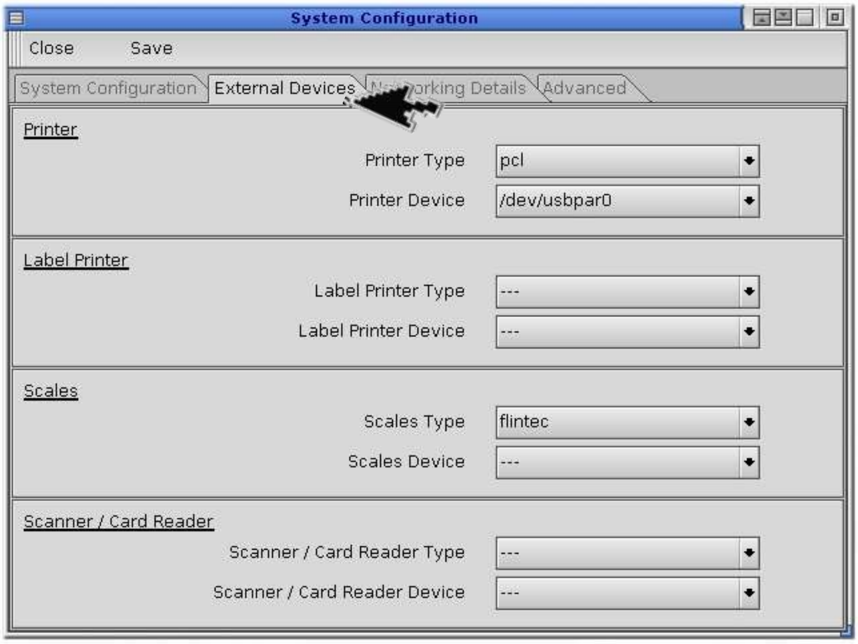


Figure 10-16: External Devices

NOTE

The devices selectable are shown in the drop down menu only and represent the recommended devices, which have been approved by Mirion Technologies (RADOS) GmbH.

Regarding the case other devices should be used, please contact the RADOS Customer Service to ensure the device can be supported by a software driver.

10.1.3.4 Networking details

The tab *Networking Details* allows the selection of additional network service protocols as well as enabling an optional modem device.

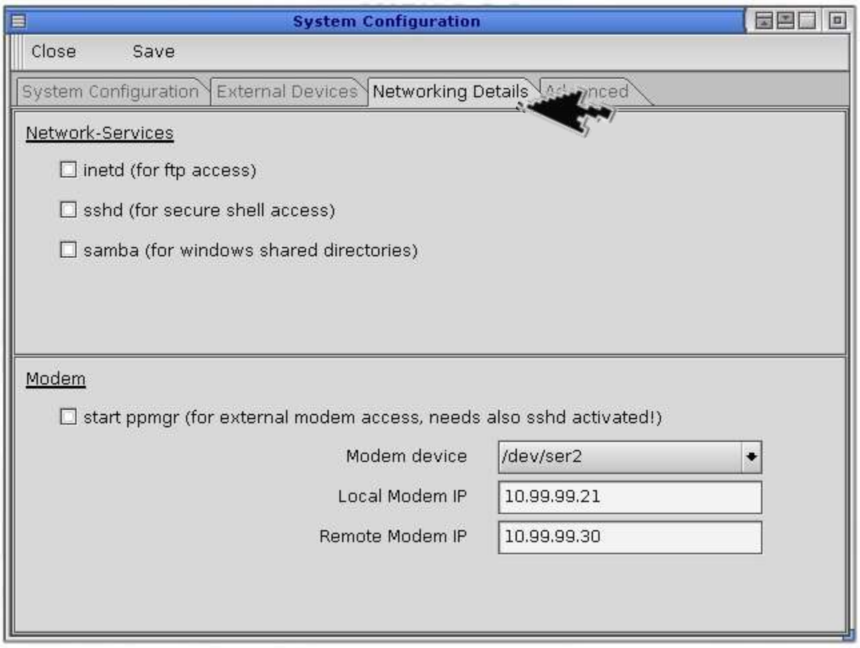


Figure 10-17: Networking details

NOTE

The modem device selectable is shown in the drop down menu only and represents the recommended devices, which have been approved by Mirion Technologies (RADOS) GmbH.

Regarding the case other devices should be used, please contact the RADOS Customer Service to ensure the device can be supported by a software driver.

10.1.3.5 Advanced settings

The tab *Advanced* allows the alteration of optional QNX services for printing and database.

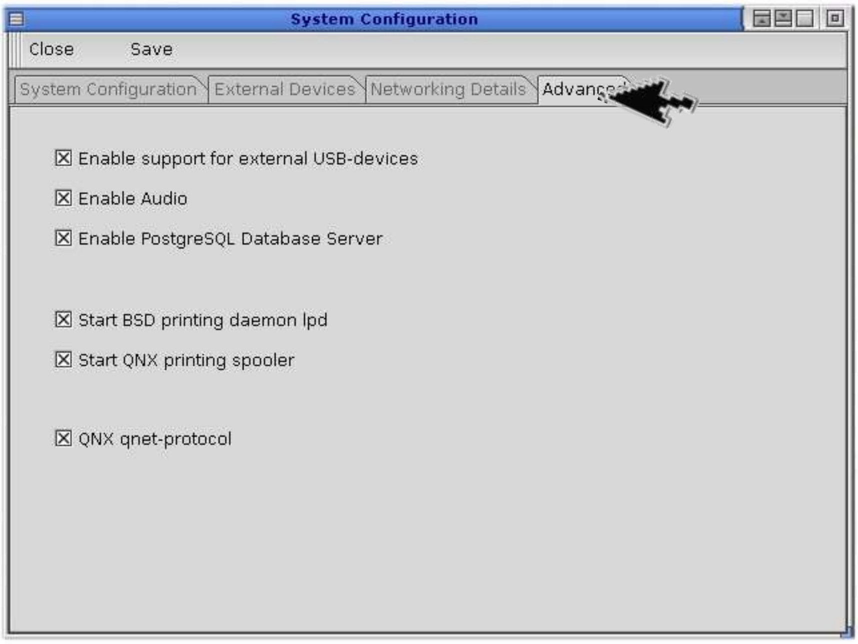


Figure 10-18: Networking details

10.1.4 HW Setup

The start of the **HW setup** is necessary after the peripheral equipment of the **RTM110** or the **RTM110** environment has been changed.
As the **HW setup** will address all possible **RTM110** configurations, this chapter will be the guide through the **HW setup** screens.

Figure 10-19: Start-up menu

Software modules provided via the **Start-up Menu**:

Used to call the **RTM user software** the main program to perform contamination measurement (see Register 3 and Register 4)

Alter monitor configuration

NOTE
Please be sure to obtain all necessary information before starting the HW setup **routine. It is important to be completely informed about the make and the hardware configuration of the present RTM110** before **starting the** HW setup**.**

WARNING

The HW setup program is designed to alter sensible monitor parameter. Therefore it is not allowable to cancel or discontinue the HW setup program, after it is once started.

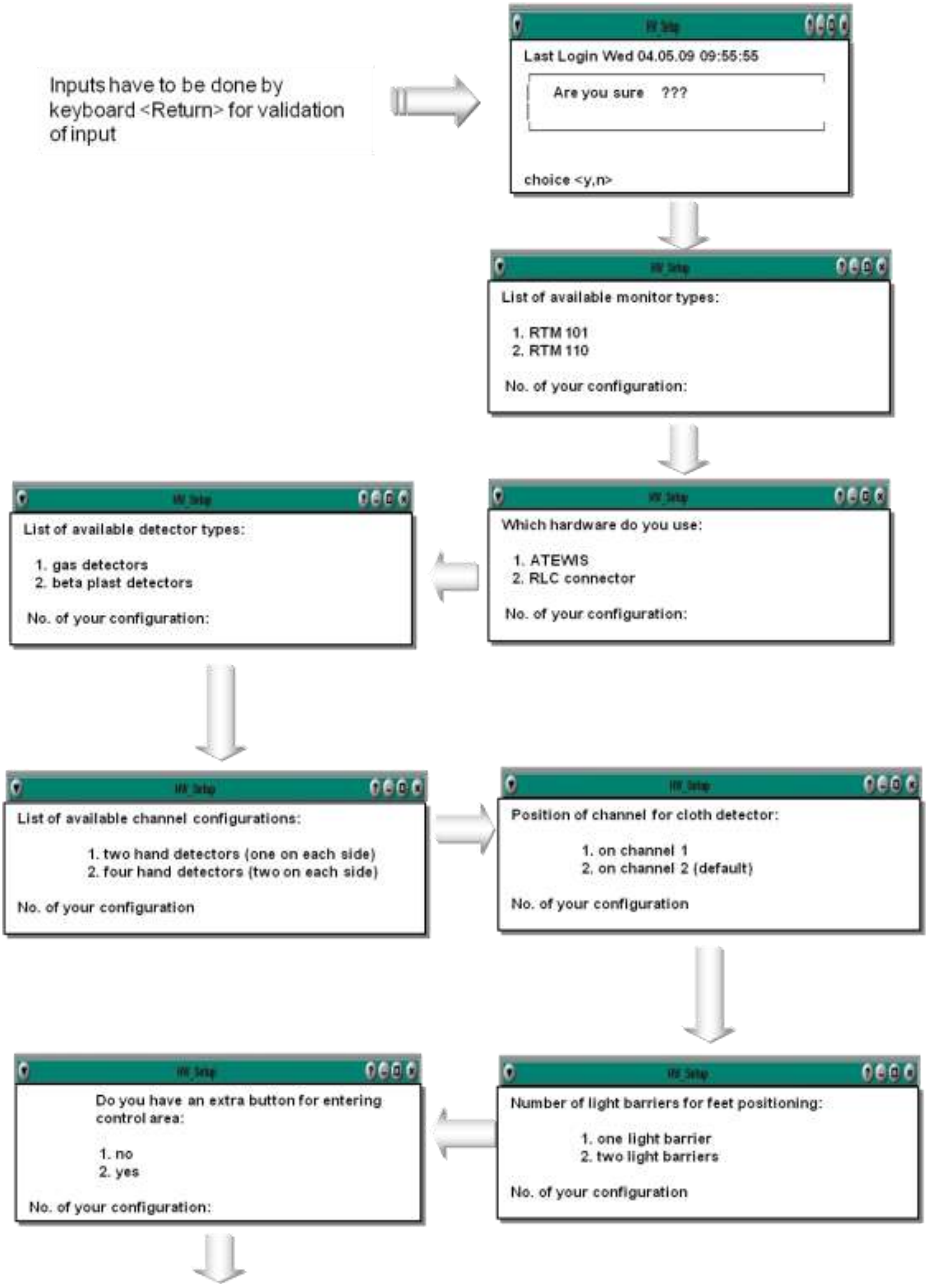
If the **HW setup** was stopped or cancelled during the setup process all menu items in the start menu will be inaccessible.

Please contact the RADOS Customer Service if the above described problem has been achieved.

HW setup start

As it is serious to change the internal hardware data the user is asked to confirm the start of the **HW setup**. The following query and decisions will be asked in a QNX shell. A printout of the factory settings is supplied within the copy of the factory test record.

10.1.5 HW setup in QNX shell



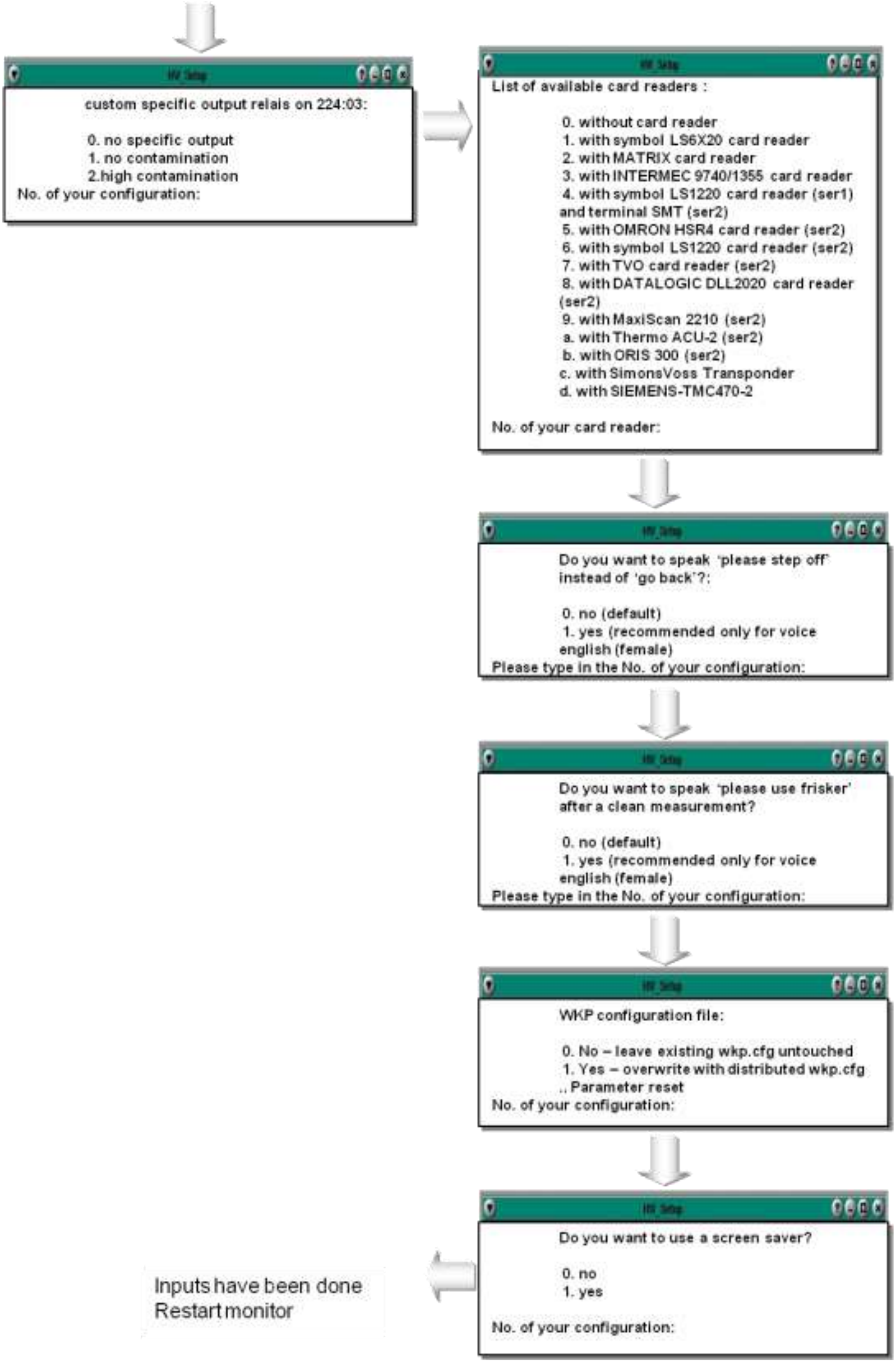


Figure 10-20: Hardware update in QNX Shell

10.2 License Setup

The license setup program enables the user to apply changed or updated user software provided by Mirion Technologies (RADOS) GmbH to the device.

This program always starts with the hardware setup or it appears automatically when installing new software,

Enter the program by activating the menu **HW setup** on the main window.

Figure 10-21: SW update –License setup

The user will be led to a black screen where a ‘y’ for yes needs to be entered to open the license setup.

License Setup

Figure 10-22: SW update –Welcome screen license setup

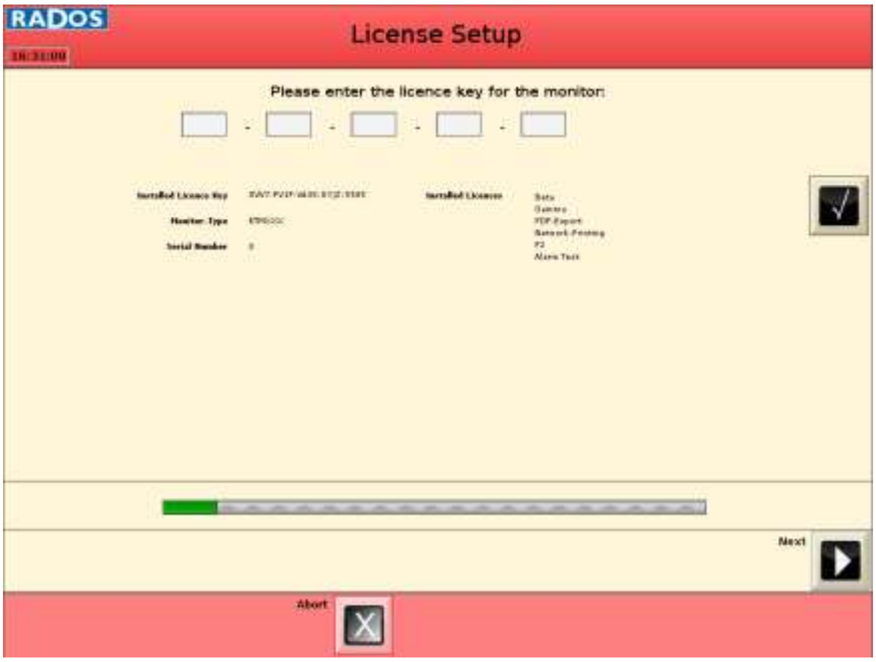


Figure 10-23: License setup – License key

Insert the correct license code and confirm the entry by pressing the upper right button. Activating the **Next** Button the installation process continues.

10.3 Cleaning

Cleaning your monitor and its components and peripherals helps to it in good working condition. Depending on the environment that your monitor operates in determines how often you should clean. The below lists are our recommendation and may change depending upon your environment.

10.3.1 General cleaning tips

General tips that should be taken in account when cleaning any of the components as well as tips to help keep a monitor clean.

1. Never spray or squirt any type of liquid onto any monitor component. If a spray is needed, spray the liquid onto a cloth and then use that cloth to rub down the component.
2. Operators may use a vacuum to suck up dirt or dust around the monitor surface and on keyboards. However, do not use a vacuum for the inside of your monitor as it generates a lot of static electricity that can damage the internal components.
3. Never get any component inside the monitor or any other circuit board damp or wet.
4. Be cautious when using any type of cleaning solvents.
   Some individuals may have allergic reactions to chemicals in cleaning solvents and some solvents can even damage the case. Always try to use water or a highly diluted solvent.
5. When cleaning, be careful not to accidentally adjust any knobs or controls. In addition, when cleaning the back of the computer unit, make sure not to disconnect any of the plugs.

10.3.2 Cleaning tools

Although many products are available to help improve the process of cleaning, please use water or a highly diluted solvent to clean.

- Cloth
  A cloth is the best tool used when rubbing down a component; although paper towels can be used, we recommend using a cloth whenever possible.
- Water or rubbing alcohol
  When moistening a cloth, it is best to use water or rubbing alcohol. Other solvents may be bad for the plastics used at the monitor.
- Portable Vacuum
  Sucking the dust, dirt, hair and other particles out can be one of the best methods of cleaning. Over time, these items can restrict the airflow and cause circuitry to corrode.
  Do not use a standard vacuum as it can generate a lot of static electricity that can damage your computer.
- Cotton swabs
  Cotton swaps moistened with rubbing alcohol or water are excellent tools for wiping hard to reach areas in any location.

- Foam swabs
  Whenever possible, it is better to use lint-free swabs such as foam swabs.

10.3.3 LCD cleaning

Dirt, dust, and finger prints can cause the computer screen to be difficult to read. Unlike a computer monitor, the LCD display is not made of glass, therefore requires special cleaning procedures.

When cleaning the LCD screen it is important to remember to not spray any liquids onto the LCD directly; do not use a paper towel as it may cause the LCD to become scratched.

To clean the LCD screen we recommend that you use a soft cotton cloth; if a dry cloth does not completely clean the screen, you can apply rubbing alcohol to the cloth and wipe the screen with the damp cloth.

10.3.4 Case cleaning

Information about keeping the appearance of the computer looking new. During cleaning, if ventilation locations are found, these can be cleaned helping the case keep a steady airflow to the computer, keeping components cool and in good working condition.

The plastic case that houses the PC components can be cleaned with a lint-free cloth that has been slightly dampened with water. For stubborn stains, add a little household detergent to the cloth. It is recommended that you never use a solvent cleaner on plastics.

It is safe to use a standard vacuum when cleaning the outside vents of a computer; however, if you need to clean the inside of the computer, use a portable battery powered vacuum to prevent static electricity.

10.3.5 Fuses

The two mains fuses (4 A M) are located on the mounting plate inside the terminal block. The mounting plate is accessible through the front wall (service door) of the main housing.

10.3.6 Protective plastic cover of the feet detector

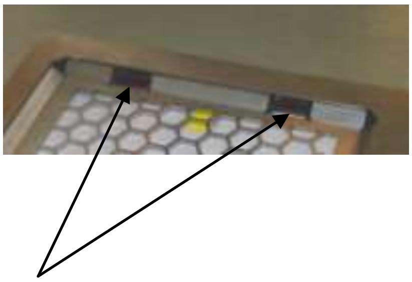
It is advisable to clean the foot area from time to time so that it will not be damaged by any impurities, little stones, etc.

In case this protective plastic cover is defective, it must be exchanged. It is available from RADOS under the stock number: 6995FRAPAN00. To exchange it, a suitable piece is cut out according to the size of the detector. When the foil is placed, be careful not to cover the light barrier.

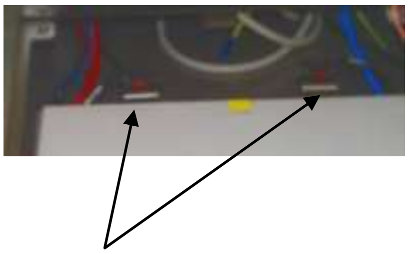
10.3.7 Photoelectric barrier

The foot light barrier is located in the foot area. Depending on the offer, one or two light barriers are integrated. In general a light barrier is mounted in front and in the rear part of the foot detector. The front light barrier is the transmitter to the rear barrier which functions as responder.

The protective plastic cover has to be pleated and placed under the detector in order not to disturb the contact between transmitter and responder.



Photoelectric barrier responder



Photoelectric barrier transmitter

10.4 Transport

Immediately after the delivery, please check the consignment for possible transportation damages. In that case, please inform both the Transport Company and Mirion Technologies (RADOS) GmbH. If necessary the commissioning should be carried out.

The feet of the monitor have to be aligned so that the monitor is horizontally leveled and does not wobble if there is weight put on it. For this alignment the monitor feet are equipped with screws that can be wound up and down.

If the monitor has to be moved, the clothing probe is not to be used as a handle! For small moves of the monitor there is a transport handle at the back side of the monitor. If the monitor is cautiously leaned backward, it is possible to move the monitor, which is equipped with two transport rollers, for short distance.

Please note that the monitor has a weight of about 70 kg. For larger distances a trolley or something similar should be used.

The monitor should not be operated in a humid or dusty environment.

CAUTION

The RTM110 must be moved only by trained expert personnel. The relevant safety rules must be observed!

Please pay attention that the RTM110 is let down gently

DANGER

Pay attention to the markings on the monitor to find the sufficiently supporting areas!

Ensure that the monitor is secured against toppling during transport!

In addition, all detectors should be covered with a protective cardboard.

Before setting-up, the transport safety features and the protecting caps should be removed.

Before set-up the transport safety features should be removed.

10.5 Installation location

To install your device properly it is important to consider about an adequate site. Due to the fact that the performance of the device is improved and its site is additionally stabilized the user can carry out the following preparations.

You have to ensure, that the background is as normal as possible, that implies

- a constant and stable level of background radiation,
- low directed radiation,
- the installation surrounding area shall be free of activity containing tubes or the like.

Arrangements to stabilize the installation location:

- providing the monitor with a lead shield
- Shielding by constructional measures like mounting additional shielding walls.

11 Nomenclature

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U

V

W

11.2 Glossary

As different terms are used for facts of this scope and as the common ISO standards are not completely introduced presently, we would like to give a brief definition of the used terms. We tried to comply with the standards and regulations as closely as possible for the generally binding terms. Additionally RADOS specific descriptions for special component names are integrated.

Name / Abbreviation	Description / Meaning
Activity (radioactivity)	Radioactive activity complies with the decays per second of a special material. The unit is Bq. The activity alone does not say anything about the danger of radiation.
Background	Background or also called underground radiation. Rock and other material emit radioactive radiation permanently to the environment. There is also permanent radiation penetrating from the space to the earth's surface. Usually, this radiation is also measured by a detector. In principle, this radiation is an unwelcome effect but it also can be used to control if the detectors still measure.
Background value	Measured value of the background without additional source of radiation.
Becquerel	Measurement unit of activity. The strength of the radioactivity is proportional to the number of decays per second 1 Becquerel (Bq). Whereby 1 decay per second refers to 1 Becquerel (Bq). The old name of the unit was Curie (Ci) 1 Bq = 27 * 10-12 Ci or 1 Ci = 37 * 109 Bq.
BINOUT2000	**Bin**ary **Out**put 2000 This Mirion Technology (RADOS) –development is a binary-output channel module to provide the information of optional added devices on RTM contamination monitors (like doors, barriers)
CeMoSys™	**Ce**ntral **Mo**nitoring **Sy**stem Mirion Technology (RADOS) –development for a intranet based contamination monitor overview with a SQL database
Channels	Detector unit including the evaluating electronics and software. If channels are mentioned, the signal processing has already been completed.
CMS	**C**ontrolling **M**icroelectronic **S**ystem A very small electronic circuit components for use in an integrated circuit or sometimes for use on their own as a general electronic component without PC use.
Coincidence	Measurement of several events which happen simultaneously

Name Abbreviation	**Description, Meaning**
Contamination	Pollution ➔ in this case with radioactive material or substance.
Compton-effect	Physical interaction where a photon is scattered at the nucleus. A free electron emerges
Coop	Coincident circuit Mirion Technology (RADOS) –development COOP is an electronic device with one output and two (or more) inputs. The output is activated only when signals are received within a time window accepted as at the same time and in parallel at both inputs. Successor of the CTS module for the TwoStep™–Exit
Cps	Counts per second ➔ can be linked directly with activity via the efficiency factor.
CTS	**C**ross **T**alk **S**election Predecessor of the Coop- module
Decay constant	The decay constant λ of a radioactive decay is equal to the reciprocal value of the average life period τ. The following relation exists between decay constant λ, average life period τ and half-life period T: $\lambda = \tau^{-1} = T^{-1} \cdot \ln 2$
Detector	Detection medium in the original form without electronic read-out.
Detector unit	Detection medium with appropriate electronics and housing.
Discriminator	Electronic component to discriminate the output counts of the photo multiplier.
Dose	Total absorbed energy in a mass unit. Physical unit is joule / kilogram. One J/kg is equal to the amount of energy, which develops when energy of 1 J is transmitted to matter with a mass of 1 kg by means of ionising radiation. 1 J/kg = 1 Gy (Gray) 1 Gy = 100 rad (old measurement unit: Radiation Absorbed Dose). Equivalent dose in Sv = Q * energy dose in Gy, Sv (Sievert) Quality factor Q = 1 Sv / Gy, expresses the characteristic of the radiation (source) the ionization density along the way of a charged particle. For x-ray, γ, β radiation Q is = 1 Sv/Gy, for α radiation Q is = 20 Sv/Gy
Efficiency	Common abbreviation is EF. Ratio between measured count rate and activity. The efficiency can be stated as fraction or percentage (*100).
EFISYS	Special algorithm for continuous determination of the background
Fibre Detector Test rig	Measurement arrangement for RFD detector tests
FILICO	**Fi**bre **Li**ne **Co**mmunicator Mirion Technology (RADOS) –development especially used for Fibre-technology

Name Abbreviation	Description, Meaning
Gamma quantum	Energy quantum of short-wave electromagnetic radiation
Gross effect	Measurement value of background and applied radiation.
H13xxx	**H**erfurth**13**… A detector development by the Herfurth company, the predecessor of Mirion Technology (RADOS).
Half life	Physical: the period of time, in which half of the cores of radio nuclide decay. The half-lives are in the range of 31 magnitudes from 10^{24} to 10^{-7}.
HGZ	**H**erfurth **G**as **Z**ähler A gas detector development (shift detectors) by the Herfurth company , the predecessor of Mirion Technology (RADOS).
Hot spot	Small constituent with a very high activity. Possible hot spots have the same capability to jump as fleas. Therefore it is very difficult to locate them.
HS-5620	A CPU Board used with the ATEWIS cards.
IN2000	**In**put 2000 This Mirion Technology (RADOS) –development is a binary-input channel module to provide the information of optional added devices on RTM contamination monitors (like doors, barriers)
Integral efficiency local dose	Efficiency factor for the whole unit.
IO-Board	**In**put 2000 This Mirion Technology (RADOS) –development is a binary-input-output channel module to communicate with the Light box, modules and computer in fibre- technology monitors.
IRMOS	**I**ntegrated **R**adiation **Mo**nitoring **S**ystem Predecessor of CeMoSys™.
KON-R	See Atewis
light box	Converts light fluctuations into current or voltage fluctuations. In use for fibre- technology monitors, available in with 64 and 6 channel.
lnc	**l**eading **n**uclide **c**orrelation
LPP	Labour Plateau Plotter Measurement arrangement for gas detector tests, Plateau detection.
MCII	MicroCont II A handheld device which carries out measurements for alpha, beta or gamma-radiation
Measuring effect	A value is measured which is significantly different from the background.
Median	The centre of a set of figures which are arranged by orders. The median separates a number set in two sub sets of equal size.

Name Abbreviation	**Description, Meaning**
Monitor	A device which carries out measurements independently within a period of time
MOWIN	**Mo**nitor **Wi**rkungsgrad **N**uklidverwaltung Predecessor of the System check module, the MOWIN switch is still in use for system check.
Net effect	Measured value after deduction of the background.
Nuclide	A nuclide is an atom characterised by its proton number, neutron number and its energy state. Presently more than 2500 different nuclides are known which are distributed to 109 known elements. More than 2250 of these nuclides are radioactive.
Option	Optional design of a RTM…
Partial efficiency	It's the efficiency of the individual detector.
PCI-Card	This Mirion Technology (RADOS) –development is used for computer connection is Fibre systems.
Photo multiplier	Converts light fluctuations into current or voltage fluctuations.
PIM	Person In Monitor → A Sensor to Stop the background and start personnel measurement in PCMs
Plast	Scintillation material, which is often called "plast" or "plastic" due to its material.
Operating point	Fixed setting of the high voltage at which all measurements are carried out.
Quantile	Numerical value which corresponds as multiple of a normalized standard distribution to a determined probability. In the co-ordinate system this means a value on the abscissa.
QNX **QNX4** **QNX6**	A microkernel-based, real-time, multi–tasking operating system. QNX is based on the idea of running most of the OS in the form of a number of small tasks, known as servers. This differs from the more traditional monolithic kernel, in which the operating system is a single very large program composed of a huge number of "parts" with special abilities. QNX4 – used until 2005 → QNX6 used since 2006
Radiation	Contrary to gamma radiation, which is a wave radiation, α and β radiation is a kind of particle radiation. α-particles are heavy particles. They have a very high binding energy. They are 2times loaded helium ions. In contrast to β-particles they are more difficult to measure, as they lose their starting energy rather quickly, while going through matter. α-particles ionise densely, β-particles however rather loosely. This difference is of great importance with respect to the damaging effect of the different kinds of radiation within the living tissue. β-particles are light-weight particles. They are electrons. Their average energy is by a factor 10 lower than the energy of the α-particles. (β energy lies in the range of 100 to 1000 keV, α particles in the range of 5 MeV).

Name Abbreviation	Description, Meaning
Radioactive substance	Also called radioactive source. Determined chemically unambiguous material, which emits radiation.
RadVision	Mirion Technology (RADOS) –development Truck Monitor product development.
RBP	RADOS Beta Plast Mirion Technology (RADOS) beta plast detector development
Reference nuclide	The most frequent nuclide which occurs in the plant.
RFD	RADOS Fibre Detector Mirion Technology (RADOS) Fibre™ detector development
RGZ	RADOS Gas Zähler Mirion Technology (RADOS) gas detector development
RLC	**R**ados **L**AN **C**onverter
RMF-55	RADOS Mylar Fix Mirion Technology (RADOS) development glue for RFD Mylar foil
RNET	RADOS Network Mirion Technology (RADOS) for network with coaxial cable.
RPD	RADOS Plast Detektor Mirion Technology (RADOS) gamma plastic detector development
RTM	RADOS Technology Monitor Short for Mirion Technology (RADOS) contamination monitor developments.
Sensitivity	The proportion of the radiation part which reaches the detector and the actually measured counts. Often the term efficiency is also used in this respect.
Sievert	Unit name for the equivalent dose (Sv). ➔ 1 Sv = 100 rem.
Sigma factor	Multiplier of the normalized standard deviation. ➔ quantile
Solid angle	Similar to the scale of a circle, it is possible to subdivide a sphere which is described as solid angle. The unit is steradian.
System computer	PC which is used for controlling and data acquisition and preparation.
Task-switch	Procedure switching via software.
Working point	Firm setting of the high voltage, at which all measurements are carried out.

12 Supporting Documents

12.2 Test protocol

12.3 Software / License

12.4 Conformity Documents

12.5 Third Party Documents