# Technical Handbook

# CheckPoint:Body™

Body Contamination Monitor

# TwoStep™-Exit

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D300081

www.mirion.com

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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 Technical Handbook will be made any time without announcement.

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

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# Imprint


| | |
|---|---|
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| D300081 | 07/2009 | New manufacture name | Zu |

# Contents and update

# Register 1

# 1 General

# Table of figures

# 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.

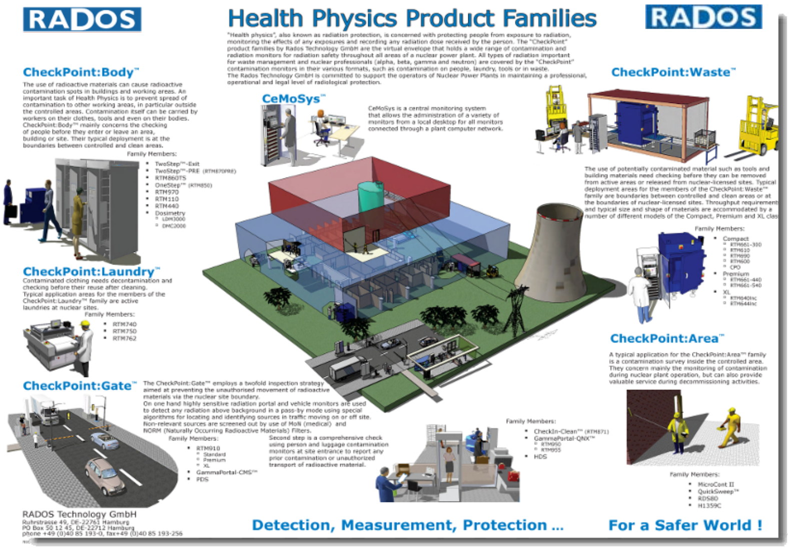



*Figure 1-1: RADOS Health Physics product family overview*

## CheckPoint:Body™ family:

The use of radioactive materials can cause radioactive contamination spots in buildings and working areas. CheckPoint:Body™ mainly concerns the checking 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** TwoStep™-Exit

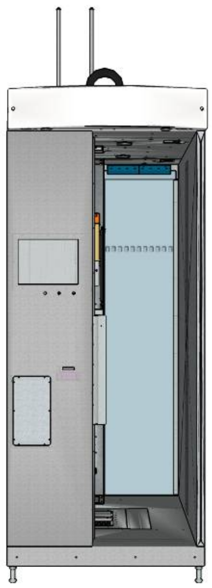


*Figure 1-2: TwoStep™-Exit design view*

The actual build of the CheckPoint:Body™ TwoStep™-Exit can be reached in Register 2 Technical Data.
Additional information on the CheckPoint:Body™ Family monitors, which are not part of this Technical Handbook, can be reached by the RADOS Service Team.

## 1.2 Type series description

The Health Physics product family for the applicable family member consists of different models (type series), which all support incorporation measurements. 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, with this documentation not referencing to the actual build type series.

**Type series members:**

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

| | | |
|---|---|---|
| ❶ | TwoStep™-Exit | Body Contamination monitor |
| ➲ | equipped with BetaFibre™ and/or GammaFibre™ detectors. | |

**Detector type list for use in in the family type series:**

| Abbr. | Name descr. | Type | Location | LxWxH |
|---|---|---|---|---|
| RFD | RADOS<br>Fibre<br>Detector | RFD485<br>RFD485A/B<br>RFD485G | head / foot / body<br>hand / forearm<br>small items box | 228x228x30 |
| | | RFD13/40 | Thorax body | 912x170x50 |
| | | RFD6/18 | Thorax body | 495x170x50 |
| | | RFD4.8/4.8 | head / foot | 228x228x30 |

## 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 **TwoStep™-Exit** types series are individually marked in this Technical Handbook.

The actual build of the CheckPoint:Body™ TwoStep™-Exit, which is briefly described in this Technical Handbook, can be reached in Register 2 Technical Data.
For Detailed Information on an enhancement of your CheckPoint:Body™ **TwoStep™- Exit** with options please consult the manufacturer with the address given in this handbook.

**NOTE**

The update of a CheckPoint:Body™ TwoStep™-Exit 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 Mechanical options

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

**Type series detector options:**

| | Detector options | Type | Series description |
|---|---|---|---|
| ❶ | Basic no wall | 1000x1180x2290 | no back wall with transport bars |
| ❷ | Basic monitor | 1000x1180x2290 | with back wall |
| ❸ | Basic cover | 1000x1180x2290 | with back wall and cover plate |
| ❹ | Basic colored | 1000x1180x2290 | metallic colored housing |

**Type series expansion options:**

| | Option | Type | Type series |
|---|---|---|---|
| ❶ | Head detector | fixed | CheckPoint:Body™ |
| ❷ | Head detector | manual movement | CheckPoint:Body™ |
| ❸ | Head detector | automatic travelling motion | CheckPoint:Body™ |
| ❹ | Back wall detector | RFD in back wall | CheckPoint:Body™ |
| ❺ | Glass sliding door | entrance/exit side | CheckPoint:Body™ |
| ❻ | Barrier | entrance/exit side | CheckPoint:Body™ |

| | | | |
|---|---|---|---|
| ❼ | Weight scale | foot | CheckPoint:Body™ |
| ❽ | Heigth control | head | CheckPoint:Body™ |

## Detector options:

| | Option | Type | Type series |
|---|---|---|---|
| ❶ | Basis version | RRD detectors | CheckPoint:Body™ |
| ❷ | Thorax option | RFD detectors | CheckPoint:Body™ |
| ❸ | Backwall option | RFD detectors | CheckPoint:Body™ |
| ❹ | Small items option | RFD detectors | CheckPoint:Body™ |

## Type series extension options:

| | Option | Number | Location |
|---|---|---|---|
| ❶ | Turnstile control | 1 | entrance/exit side |
| ❷ | External TFT display | 1 | LAN/ monitor area |
| ❸ | Card reader | up to 2 | entrance / inside |
| ❹ | Language selection | up to 4 | entrance side |
| ❺ | Protocol printer | 1 (local/LAN) | LAN/ monitor area |
| ❻ | UPS 1500 VA | 1 | electronic |
| ❼ | UPS 300VA | 1 | electronic |
| ❽ | Calibration button | radio controlled | monitor area |

## 1.3.2 Type series software options

As the technology used for release measurements is not just differentiated country to country 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 use over many years.
In addition, the clearance monitor provides many optional features that are provided on top of the standard configuration.

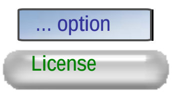
**Type series software options:**

| | Name | Specification |
|---|---|---|
| ❶ | Nuclide vectors | A nuclide vector impossible of activity contributions of defined nuclides in the total activity. |
| ❷ | Detector test | A reference measurement with a test dummy and a test source can be done for future checks of the detectors efficiencies. |
| ❸ | System check | The maintenance and test program. |
| ❹ | Dose rate calculation | Algorithm to calculate in dose rates (µSvH) |
| ❺ | $P^2$ module | measurement time optimisation |

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 TwoStep™-Exit 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 TwoStep™-Exit in the following two icons are added to demonstrate that special hardware- or software-options are needed to perform the described task.




- 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
- *.skd

For creating the design drawings a CAD-system is used:

- 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.

The data a disk used as standard data carrier is a CD-ROM.
The format for a CD-ROM 700MB.

## 1.5 Applied symbols and writing style conventions

**NOTE**

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

**CAUTION**

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

**WARNING**

**Caution and safety hints that have to be noted and complied to prevent injuries, damages or death.**

**DANGER**

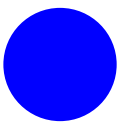
**Caution and safety hints that have to be noted and complied to prevent injuries, damages or death.**

**Note the operation instruction or the documentation.**

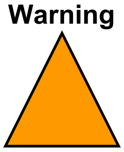
Applied principles in this document is the use of the following symbols are used:

**Prohibited action**

**Mandatory action**



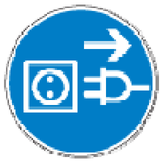
**Warning**



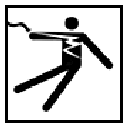
Example:

These symbols indicate processes or behaviours not allowed in the premises of the **TwoStep™-Exit**.

These symbols indicate special danger handling the **TwoStep™-Exit** that presents a risk of personal injury.



These symbols indicate important instructions accompanying the **TwoStep™-Exit** or special procedures with the **TwoStep™-Exit**.



These symbols should indicate the kind of danger precisely.

**Writing style conventions**

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

## 1.6 Product information

| | | |
|---|---|---|
| **Product name:** | Machine type: | CheckPoint:Body™ |
| | Model: | TwoStep™- Exit |
| | Serial number | |
| | Order number: | |
| | Date of manufacture: | 2009 |
| **Entries by customer:** | Inventory-no.: | |
| | location: | |
| **Address of manufacturer:** | Company name: | Mirion Technologies (RADOS) GmbH |
| | Street: | Ruhrstrasse 49 |
| | City: | 22761 Hamburg |
| | Telephone: | +49 (0)40 – 85 193-0 |
| | Fax: | +49 (0)40 – 85 193-256 |
| | E-mail: | Info@rados.de |
| **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: | D3.00.08.1 |
| | Date: | 07/09 |

# 1.7 Maintenance and safety

This chapter describes procedures necessary for keeping your **TwoStep™-Exit** operating reliably.
For troubleshooting problems, refer to the troubleshooting section of the Technical Handbook. Problems that cannot be solved need to be referred to your RADOS service team.

## 1.7.1 Safety notices

This **TwoStep™-Exit** 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

When there is a problem with the **TwoStep™-Exit** an error description and a suggested solution is 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 solve the problem over the phone and minimize downtime. If the problem cannot be solved by telephone, 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 **TwoStep™-Exit** when calling for assistance. Describe the problem and answer the questions from the service operator about the defects. Follow the instructions provided 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 **TwoStep™-Exit**.
- ⇨ Do not use aerosol cleaners. The use is not approved and may cause poor performance or could create a dangerous condition.

**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 to 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 odours.
- ⇨ The power cord is damaged or frayed.
- ⇨ A wall panel circuit breaker, fuse, or other safety devices are 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 **TwoStep™-Exit**.
- ⇨ 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 TwoStep™- Exit 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 TwoStep™- Exit:

- ⇨ Use the materials and supplies specifically designed for your TwoStep™- Exit only. 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 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

- non- consideration of content of this documentation
- wrong installation or operation
- not permitted removal of safety features

**Commissioning/Service**

**Operation**

**NOTE**

The commissioning of the monitor requires qualified expert personnel or RADOS service personnel.

The operation of the monitor requires trained personnel.

## 1.8.1 Electronics

| | WARNING |
|---|---|
| | **Life Danger**<br>If the monitor shows any errors, defects or if repairs are 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 in first. (refer to register 3 chapter 3.5 for details) |

**Marking**

## Marking of dangers and danger areas

| | | |
|---|---|---|
| Danger!<br>High Voltage | Electric shock | Label:<br>■ Discriminator (detector)<br>■ Mains terminal<br>■ Connection box |

**High voltage**

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


*Figure 1-3: Mains warning*

## 1.8.2 Marking by note signs

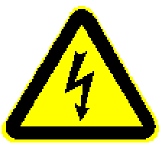
The gas supply for the monitor is mounted on the roof and marked with a sign for inlet and outlet valve. Following warnings are given on the label:

**Mains input**


*Figure 1-4: Label at the mains socket*

**Mains socket**


*Figure 1-5: Label at the mains input*



**CAUTION**

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

## 1.8.3 Name plate

The nameplate attached to the monitor is clearly visible.

Typ - type of monitor, e. g. TwoStep™- Exit

Nr. - serial number of the monitor
Baujahr - year of make, date of manufacture
Teilenr. - part number of the monitor
V + Hz - supply voltage, e. g. 230V/50Hz
A - power consumption

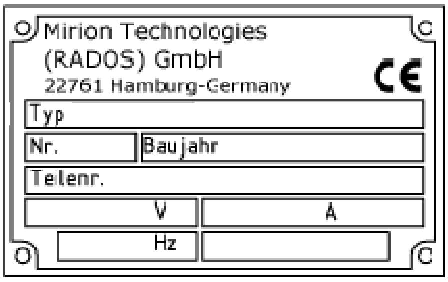



*Figure 1-6: Name plate TwoStep$^{TM}$-Exit*

# 1.9 Operating and User Software

**Software**

## 1.9.1 QNX 6.3x – operating system with runtime adaptation

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 RADOS 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.

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 work 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“, with which for instance databases or special hardware can be addressed.

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

The user surface can be realized on windows - surface capable of real time. It corresponds to the Open Look.

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+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 use 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.).

## 1.9.2 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 hours a day, 365 days a year, non-stop.

The QNX is, time-tested and field-proven, built on a 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. As no other commercial RTOS provides such a high level of fault containment and recovery.

But just as important, all components communicate via a single, well-defined form of communication: synchronous message passing. This message passing forms a virtual “software bus” that lets you plug in, or plug out, any component on the fly. 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 code 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 company (NYSE: HAR), is the industry leader in real time, embedded OS technology. The component-based architectures of the QNX Neutrino RTOS and QNX Momentics development suite together provide the industry's most reliable and scalable framework for building innovative, high-performance embedded systems. Global leaders, such as Cisco, Daimler Chrysler, General Electric, Lockheed Martin, and Siemens depend on QNX technology for network routers, medical instruments, vehicle telemetric units, security and defence systems, industrial robotics, and other mission or life-critical applications.

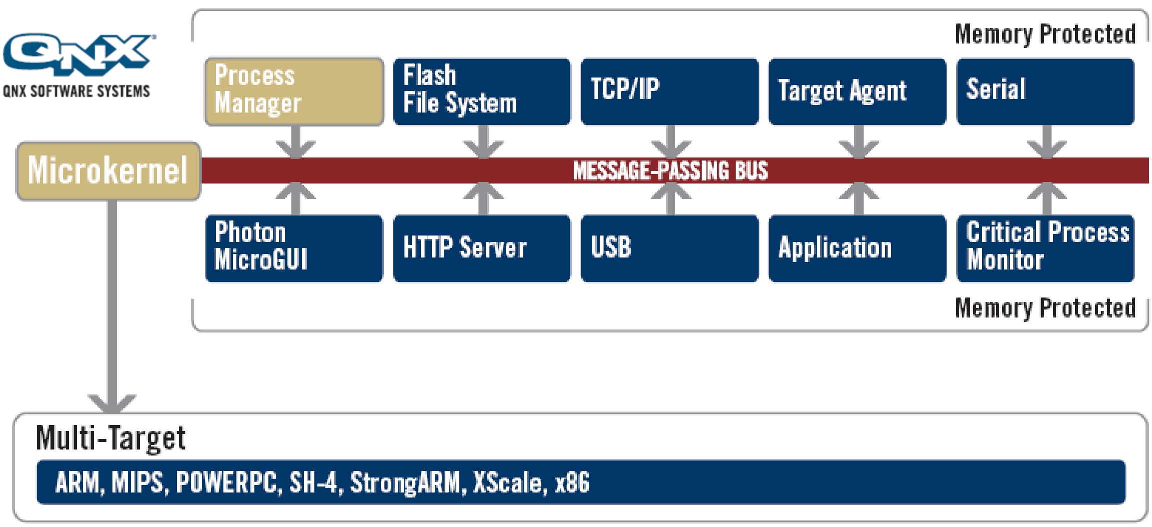



*Figure 1-7: QNX RTOS system overview (picture source: QNX Software systems)*

## 1.9.3 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 graphic display 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.
  Either the switched-on mode is displayed by a blue-collared rectangle or secondly as a pressed switch.
- Button: to start a specific program action
- Menu button: request to display a pull-down menu

## 1.9.4 General conventions of this documentation

This is a general description of the conventions, which are used in this documentation to operate in service 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, then the <Enter> is to be activated.

Mouse click:
The mouse pointer is positioned on the desired window element, and then the left mouse button is pressed.

*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 button with the label "*button*" is to be activated in the present window. (For operation of buttons refer to next paragraph ”button”).

## 1.9.5 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 mouse click on a menu button the pull-down menu appears. The presently selected menu mask is marked with a frame and can be called up with another mouse click.

It is also possible to select a menu via the keyboard by pressing the key combination <Alt> plus the underlined letter of the menu button. In the pull down menu the field can be selected by <Tab> and activated by <Enter>.

**Button**

The button is selected by positioning the mouse pointer on the desired button and clicking it. Then the requested program action is carried out.

**Lists**

List elements are selected with the mouse pointer and a mouse click. For selecting list elements not displayed, the sliding bar has to be used.

Scrolling in lists is done through the keyboard with the keys arrow <↑>, arrow <↓> or ↵ENTER.

Switches can be selected by <space bar>. Movement within a window is done by <TAB> or <SHIFT>-<TAB>.

## 1.9.6 CeMoSys Client, CeMoSys Server (OPTION)

CeMoSys stands for Central Monitoring System for RADOS Contamination Monitors. This application supplies the owner of RADOS contamination monitors with a browser based monitor overview. The possibility to view the measurement result database, the monitor status and to administrate the monitor builds the core use of this application.

Following RADOS Contamination monitor are prepared to work with CeMoSys using the CeMoSys Client in the operational Software:

| | |
|---|---|
| ■ CheckPoint:Body™ | TwoStep™-Exit, RTM860TS, TwoStep™-PRE, RTM110 |
| ■ CheckPoint:Laundry™ | RTM750 |
| ■ CheckPoint:Gate™ | RTM910, RTM911(i), CheckIn-Clean™ |
| ■ CheckPoint:Waste™ | RTM600, RTM610 |

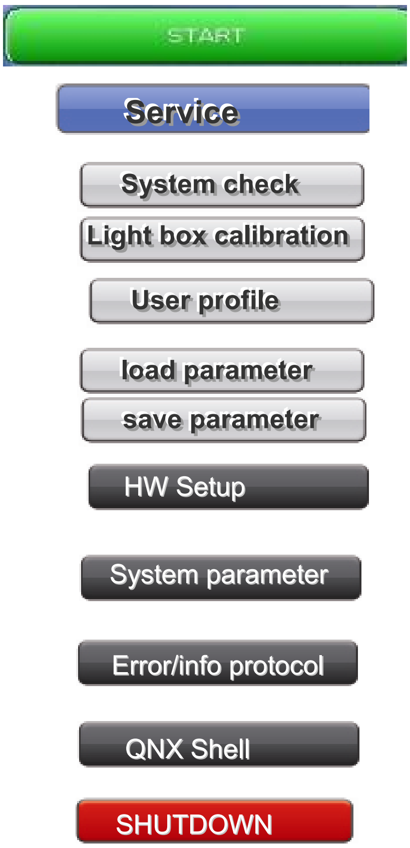
- More contamination monitor are planned to be embedded by RADOS

## 1.10 Start-up menu

The start-up menu is the central navigation tool for all TwoStep™-Exit software modules. Every software module can be reached with a click.


*Figure 1-8: 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 **utilities and programs** to perform for computer and detector administration.

the maintenance and calibration program for body contamination monitor (see Register 6).

a detector working point module (see Register 7)

user administration program (see Register 5)

enables the user to im- and export all TwoStep™-Exit parameter on a USB-stick(Register 10)

program to configured the hardware settings of the present TwoStep™-Exit (Register 10)

program to set i.e. the timestamp and screen resolution (Register 10)

list of the last system internal messages i.e. useful for troubleshooting

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

shutdown TwoStep™-Exit

## 1.10.1 User Software

The software functions of the monitor in the actual operational mode are briefly described in Register 3 for measurement and Register 4 for service operations of this documentation.

These modes are divided as follows:

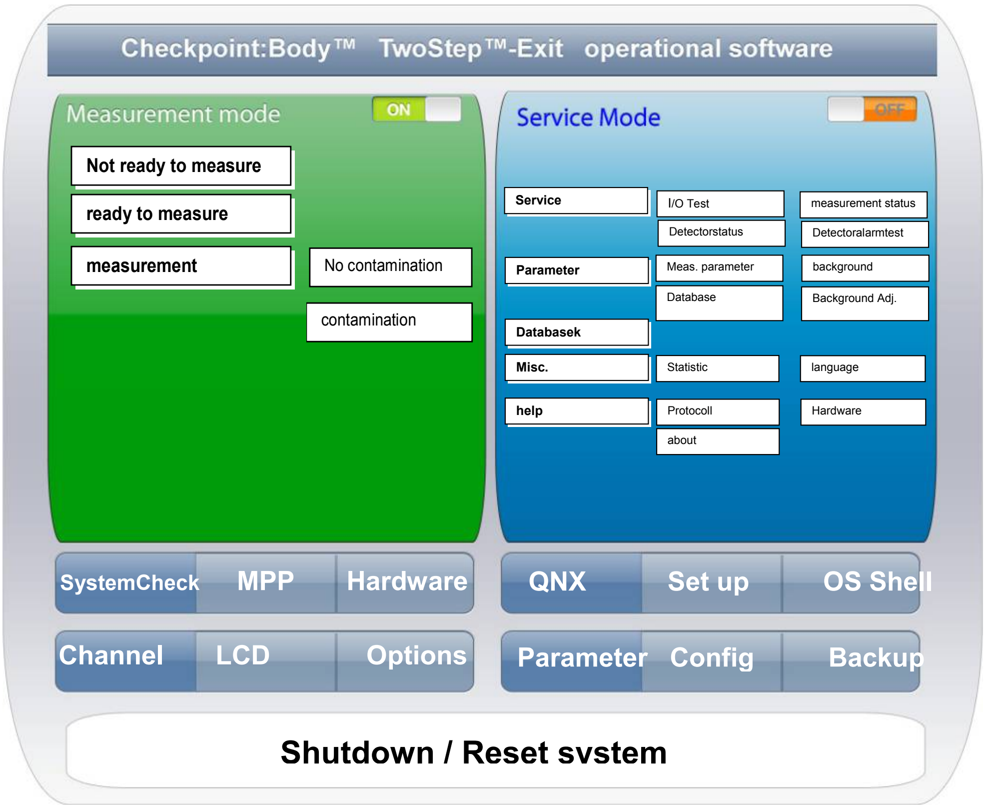



*Figure 1-9: Software overview*

The User software differentiates two main operation conditions:

***measurement mode*** and ***service mode***

#### 1.10.1.1 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 measurement“ 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 functioning and to measure the background.


service mode


measurement mode

*Figure 1-10: Service button*

#### 1.10.1.2 Service mode

The **“Service 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. In the service mode there are different sub-menus available to control the functioning of the monitor and to adjust all parameters influencing the measured value.

### 1.10.2 Operational submenu

The programmes from the operational submenu will be started in the **service mode** directly from the **start up** menu. This indicates that a **measurement operation** is <u>not</u> possible while performing the sub menu programmes.

#### 1.10.2.1 System check

The **system check** is a calibration tool to investigate quality changes over a time scale. The software is used to determine the 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. (see register 6)

#### 1.10.2.2 User Profile

The **User Profile** software is used to administer existing users, add new users, delete existing users or change the privileges of users operating software modules. (see register 5)

#### 1.10.2.3 Load /Save configuration

The **load / save configuration** menu is used to save the operational parameter set to the TwoStep™- Exit, 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, a USB stick.

### 1.10.2.4 HW setup

The **HW setup** program is designed to alter sensible monitor parameter after hardware change done to the TwoStep™-Exit (see register 10)

### 1.10.2.5 System parameter

The **system parameter** allows altering the altering QNX system settings likes date, time, and language or network environment. (see register 10)

### 1.10.2.6 QNX-Shell

The sub menu “**QNX Shell**” is placed in the start up menu to enable direct file access on the monitor hard disk. This function will usually only be used by service personnel.

### 1.10.2.7 Print screenshot

The print screenshot function is functionally placed on a variety of menu screens. Ii 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” pictogram.

*Figure 1-11: Pictogram “printer”*

## 1.10.3 End User software

| **ATTENTION** |
|---|
| The shutdown of the **TwoStep™-Exit** (e.g. for maintenance) MUST follow this guideline to prevent any damages at the measurement computer or the electronic.<br><br>A damage of the **TwoStep™-Exit** caused by ignorance of this guideline will lead to a loss of guarantee and warrantee by RADOS. |

(1) Close running user software with ***close***.


*Figure 1-12: TwoStep™-Exit close*

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

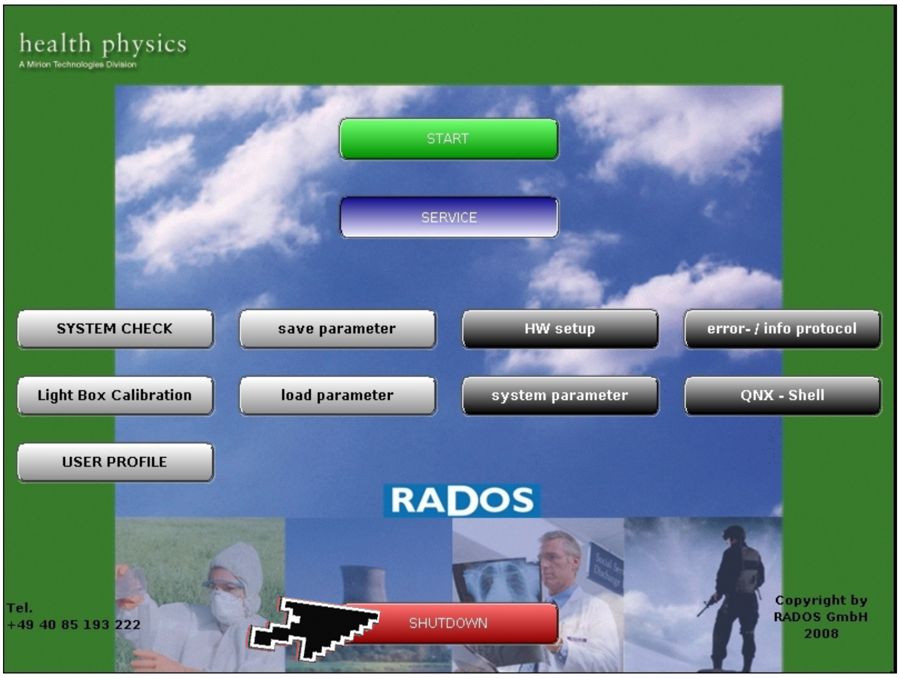



*Figure 1-13: TwoStep™-Exit shutdown*

(3) Wait for shutdown process to end.


*Figure 1-14: QNX shutdown*

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

# 1.11 Authoritative regulations and guide lines

## 1.11.1 Guide line for machines

Before commissioning the TwoStep™-Exit 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. |

## 1.11.2 Supporting documentation

Necessary supporting documentations are attached in Register 12 of this Technical Handbook.

# 1.12 Copyright

**Documentation**

The copyright protection claimed includes all forms and matters of copyrighted material and information now allowed by statutory or judicial law or hereinafter granted, including without limitation, material generated from the software programs that are displayed on the screen such as styles, templates, icons, screen displays, looks, etc.

All RADOS product names and product numbers mentioned in this publication are trademarks of RADOS Technology GmbH. Other company brands and product names may be trademarks or registered trademarks of the respective companies and are also acknowledged.

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.

Only with written consent from RADOS Germany the contents of this documentation 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 grateful for suggestions and critic regarding this documentation or the RTM itself.

## 1.13 Default-user

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.

1. Administration default-user
    - Name: Superuser
    - Password: Superuser
    - User group: Superuser

According to this scheme following users have been created

- Master
- Service
- User
- Default

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.**

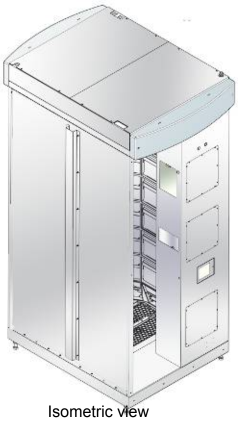
**NOTE**

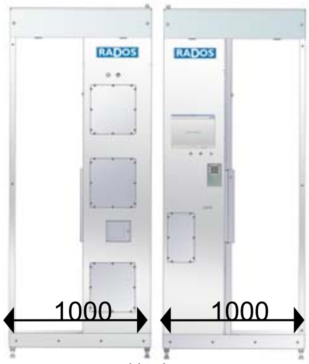
**We recommend to remove this page from the documentation or create new users and to delete the users described on this page, in order of save monitor operation in the customer environment**

# Register 2

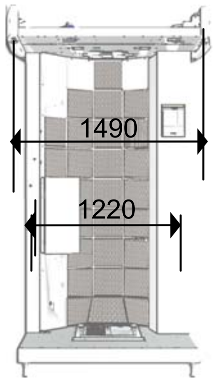
# 2 Technical data

## 2.1 Technical data

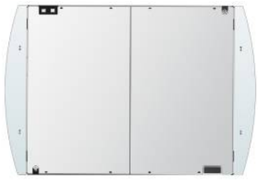

Isometric view

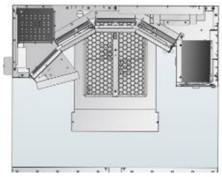


side view



inside view


Top inside view


top view

## TwoStep™-Exit -Type-Series

type

☑ **TwoStep™-Exit**

| Power; | rated current | fuse |
|---|---|---|
| ☐ 230V/50Hz; | 0.7A | 6.3 A mtr. |
| ☐ 110V/50-60Hz; | 1.5A | |

make

☐ Basic no wall
☐ Basic monitor
☐ Basic cover
☑ Basic colored

**Dimensions L x W x H** (in mm)

| | | |
|---|---|---|
| ☐ | 1000 x 1490 x 2490 | |
| ☐ | 1000 x 1490 x 2490 | with head detector |
| ☐ | 1000 x 1490 x 3099 | with moveable head detector |
| ☐ | 1000 x 1530 (1584) x 2490 | with door(s) / barriers |
| ☐ | 1000 x 1490 ((1530) (1584)) x 3099 | with head detector and door(s) / barriers |

### Weight — w/o shield

| | | | |
|---|---|---|---|
| Housing | ☐ stainless steel | ☐ approx. 430kg | ☐ approx. 500kg |
| with patented Split-Delta Geometry | ☐ painted steel | ☐ approx. 550kg | ☐ approx. 850kg |
| lead shielding gamma | ☐ approx.85 kg ☐ approx.137 kg ☐ approx. 137 kg | | |
| ☐ 10 mm ☐ 20 mm | ☐ approx.68 kg ☐ approx. 61 kg | | |

### Expansion Options

| | | | |
|---|---|---|---|
| ☐ head detector | ☐ movable | ☐ fixed | ☐ manual |
| ☐ glass sliding door | ☐ entrance | ☐ exit | |
| ☐ barrier | ☐ entrance | ☐ exit | |
| ☐ motorising | ☐ head el.-motorise | | ☐ interlock electromagnetic |
| ☐ backwall detectors | | | |
| ☐ small items box ☐ 1 ☐ 2 | ☐ 2 RFD | ☐ DIN A4 | |

### Extension Options

| | | |
|---|---|---|
| ☐ foot room monitoring | ☐ ID-card reader | ☐ protocol printer |
| ☐ language selection | ☐ UPS 1500 VA | ☐ UPS 300 VA |
| ☐ height control | ☐ weight scale | ☐ Turnstile control |
| ☐ radio controlled calibration | ☐ external TFT display | |

# Technical data (continued)

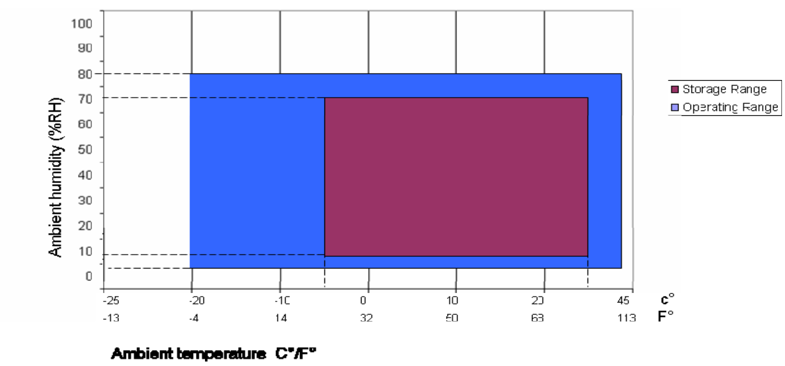
| | | |
|---|---|---|
| **PC** | | |
| computer PC board | Pentium | |
| *PCI FGA Plug-in board for detector communication and binary control | | |
| RAM | 256 MB; DDR-RAM DIMM 168-Pin PC100 | |
| interface | 2 x serial; 1 x parallel; 2x USB | |
| graphic display | VGA on board | |
| keyboard | by customer Specification (order) | |
| HDD | ≥ 40 GB | |
| CD-RW | Writer | |
| monitor | 15” TFT Display | |
| sound card | on board 16 Bit | |
| **Software** | | |
| Operating system | QNX 6.xx | |
| User Software | V: 6.xx | |
| | ☐ nuclide vectors | ☐ detector test |
| | ☐ CeMoSys activation | ☐ backup |
| | ☐ $P^2$ measurement time | ☐ dose rate |
| | ☐ system check | |

| | | | | |
|---|---|---|---|---|
| **RFD detectors** | | | **RADOS Fibre™ detectors** | |
| **Type** | | | | **location** |
| **RFD485** | | | hand/forearms | |
| **RFD485 A/B** | | | body front<br>back wall | |
| **RFD485 G** | | | | |
| **RFD13/40** | | | Thorax body | |
| **RFD6/18** | | | foot/forearms | |
| **RFD4,8/4,8** | ☐ 1 | ☐ 2 | small items<br>small items A4 | ☐ top ☐ bottom ☐ top + bottom |

| | |
|---|---|
| **Ambient conditions** | |
| Detector housing | |
| temperature | -20°C up to +45°C |
| humidity | outdoor conditions |
| Electronic rack | |
| temperature | 5 °C up to +45 °C |
| humidity | relative humidity 75 % on annual average,<br>95% for 5 h, no condensation |

**CE conformity**

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



## 2.2 Response capability

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.

**R E M A R K**

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: fine mesh stainless steel net welding grid 8 x 8 mm, transparency 77% (hand, body, head), 71% (foot).

Definition:

| | | |
|---|---|---|
| $S(\beta)_{min}$ | = | minimum attainable response capability |
| $S(\beta)$ | = | response capability attained |
| $S(\alpha)_{min}$ | = | minimum attainable response capability |
| $S(\alpha)$ | = | response capability attained |
| $k_{1min}$ | = | smallest detectable contamination |
| $N_0$ | = | background |
| n | = | measured total count rate |

Formalism:

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

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

## 2.3 Efficiencies for detectors

The calibration data of each detector is listed on a label at the detector surface.

Example:

| | |
|---|---|
| **Measurement Values (cps)** | |
| Nulleffekt | **4,6** |
| **AM 241** | **128** |
| **C 14** | **15,8** |
| **CO 60** | **175** |
| **CL 36** | **192** |
| **Efficiency (%)** | |
| **AM 241** | **13,5** |
| **C 14** | **1,3** |
| **CO 60** | **6,8** |
| **CL 36** | **16,4** |
| **Activity act. (Bq)** | |
| **AM 241** LH959 | 916 |
| **C 14** FF 634 | 855 |
| **CO 60** MG 843 | 2495 |
| **CL 36** GI 525 | 1140 |
| | |
| **tested by** | JR 06 |
| **date** | 09.10.2006 |

### 2.3.1 Minimal detectable activity (MDA)

Measurement parameters for detection measurement

| | | |
|---|---|---|
| $t_0$ = | 1.65 | Sigma |
| t = | 10 s | measurement time |
| h = | 0.1 μSv/h | background during measurement |
| l = | 0 | distance to source [cm] (in contact) |

**BetaFibre™ Detectors**

| source | kind | Plastic grid | 81% transparency | 66% transparency |
|---|---|---|---|---|
| 241Am | α | 20 Bq | 25 Bq | 30 Bq |
| 14C | β | 250 Bq | 300 Bq | 350 Bq |
| 60 Co | β | 50 Bq | 70 Bq | 80 Bq |
| 36 Cl | β | 25 Bq | 30 Bq | 40 Bq |
| 90Sr | β | 15 Bq | 20 Bq | 25 Bq |
| 137Cs | β | 35 Bq | 45 Bq | 50 Bq |

**GammaFibre™ Detectors**

| Source | kind | distance [cm] Source – detector | Sum channel | |
|---|---|---|---|---|
| 60 Co | μ | 5 | < 600 Bq | center of detector |
| 137Cs | μ | 5 | < 2 KBq | center of detector |

## 2.4 Circuit drawings

| Description | Drawing number |
|---|---|
| Complete monitor | 3E0514A1 |
| LED-illumination | 3E0453-1 |
| MOWIN SWITCH | 4E0209-1 |
| Connection for loudspeaker | 4E0195-2 |
| Service- illumination | 4E0148K1 |
| Schottky-diode | 4E0134B1 |
| | |
| Computer unit | 3215PC200500 |
| | |
| Control unit exit door and head | 3E0515B1 |
| | |

# Register 3

# 3 Description and operation

# Table of figures

# 3.1 Total view Checkpoint:™Body TwoStep™-Exit


*Figure 3-1: TwoStep™-Exit View*

| description | drawing number |
|---|---|
| Total view of the TwoStep™-Exit | 3M2627. .. |

## 3.2 Measuring task

This Technical Handbook has been worked out according to the DIN EN 61187 guidelines. It shall provide the user with the functioning of the TwoStep™-Exit 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 necessary.

**NOTE**

This documentation will explain the "maximum version" of the body contamination monitor TwoStep™-Exit.
All possible options and extensions, like drive control, System check, MPP and so on 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 TwoStep™-Exit, please, jump to the next paragraph.

The absence of optional functions will not impair the correct work of the TwoStep™-Exit.

If you are interested in upgrading your TwoStep™-Exit with options please feel free to contact the RADOS Service Team with the address given in register general.

A definition of terms will be given in chapter *Glossary* of the Technical Handbook.

The RADOS team would be glad to receive your advice for further improvement of this Technical Handbook or even the monitor.

The TwoStep™- Exit body contamination monitor is used in any place where the surface contamination of persons has to be monitored for a certain limit value. This could happen at the exit of controlled areas, for example in nuclear facilities.

It is the measurement task of the TwoStep™-Exit body contamination monitor to detect a person's surface contamination above the limit under 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 to achieve a maximum throughput of people.

It is the function of the Mirion Technologies (RADOS) body monitor (called TwoStep™-Exit), to control the observance of the limiting values of the Radiation Protection Regulation.

## 3.3 Measurement basics and efficiency considerations

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

These are in particular:

- the efficiency of the RFD485- Beta Fibre™- detector, referred to the measured nuclide
- the efficiency of the RFDXX-Gamma Fibre™- detector, 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 TwoStep™-Exit measures contamination by use of Beta Fibre™-detectors. The efficiency of these detectors in contact is 35% for $^{90}$Sr (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 protection grids, the detector frame and the distance between the source and the detector window.

An activity of - for instance - 370 Bq provides a count rate of about 130 cps in addition to the environmental background, which is caused by the natural terrestrial and cosmic radiation. At an ambient radiation of 0.1 µSv/h (when using detectors having an effective detector area of 485 cm$^2$), this background is about 3 cps. The normal ambient radiation is between 0.06 µSv/h and 0.2 µSv/h depending on the rock quality (Radon and decaying Radon products).

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

Now, if the background radiation is changing, the alarm threshold shall also be changed.

If the alarm 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 alarm thresholds of all connected detectors of the monitor from the Mirion Technologies (RADOS) GmbH product family Checkpoint:Body™ is 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.

### 3.3.1 Background measurement

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 measurement of the background 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 body contacts) that activate the "measuring phases".

The user is requested by an audio-response operator to activate the body 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 Figure 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.

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".

Obviously, these are also measured by the detectors. 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 make a "momentary shot" or 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 radiation for α-, β- and γ - radiation, cannot be executed in the same way. Whereas the normal background for β- and γ - radiation is caused by terrestrial, cosmic or artificial radiation, the reason of the α- background is to be seen in the electronic noise. This statement is only valid, if there is no contamination.

Whereas 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. The background can also be artificially increased by a contaminated object located close to the monitor.

If there is an increased background caused by contamination, the α-background is comprised by the measuring effect caused by the electronic noise and the one resulting of the inherent radiation. Thus, two different mathematical distributions have to be taken into account. The β-background can still be calculated with the Poisson statistics.

The measurement result (contamination or not) depends on proper background determination. Simultaneously, flash background changes shall be taken into account. These changes shall not rely by a previous measurement.

The world of statistics understands the term 'precise measurement' to be extended measurements, or repeated measurements over and over again. Nevertheless, if there would only be extended measurements, no flash changes could be taken into consideration. The desired accuracy will not be achieved, since an accidental or non-accidental change of the background would not be taken into account. The alternative to these contradictory behaviors 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 the right one to measure the background.

**<u>Statement to the background measurement time</u>**:

| | |
|---|---|
| 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

### 3.3.2 Median calculation and sigma tube

In fast mode, the incoming count rates are averaged over a range of 30 values. That means a mean value 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 mean 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 mean values from previous measurements and the current mean 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 mean value is within the sigma tube and the long-time background is used. If afterwards another 15 mean 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 again calculated 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 mean 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 $\alpha$-background as for the $\beta$-background, 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.

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.

## 3.3.3 Background reduction

The person to be measured shields a portion of the background count rates of the gamma detectors (if installed).

Depending on the morphology of the person, the kind and direction of the background radiation, the shielding can be up to more than 10 % of the background count rate. This corresponds to a certain amount of activity, which will not be recognized. The TwoStep™-Exit monitor can take the reduction as a percentage (%) of the background value into the calculation and reduce the subtracted background by this amount. The factor can be set for each gamma channel and gamma sum channel.

RADOS recommends conducting intensive test with persons to determine the local background shielding factor with the best compromise. To test and optimise the background shielding factor, calculate the difference in percentage between current background rate and background rate reduced by the person inside the monitor. Therefore please use the menu “detector status” with its mean value function in the service mode. The background shielding factors in percentage can be adjusted in the menu “background reduction”. The software corrects the background rate due to the adjusted shielding factor.

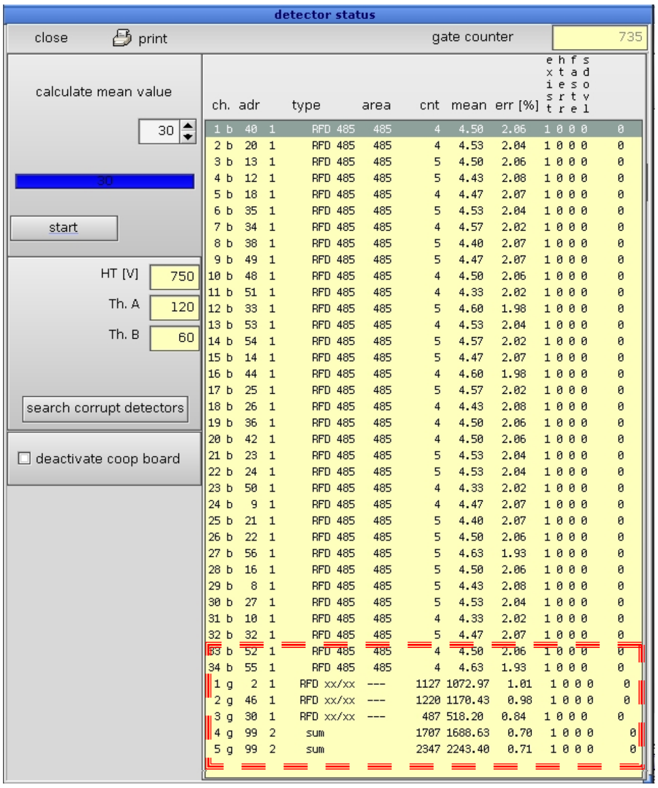



*Figure 3-2: Suitable body size*

| NOTE |
|---|
| **Refer parameter setting description in register 4 chapter “background reduction”, where this option is located as a menu-item in the service/measurement parameter-menu.** |

## 3.3.4 Automatic background reduction factors [Option]

height control option

The automatic background reduction factor setting is available if the TwoStep™-Exit monitor is equipped with an automatic scales and a body size measurement system. The dynamic calculation of the individual background reduction factors for all gamma channels will be initiated through measurement of the weight and height of the user.

The size and weight of the user is measured directly before the contamination measurement starts. From both values the background reduction parameter set is selected according the following table:

| **Size in cm →**<br>**Weight in kg↓** | **< 165** | **165 - 180** | **> 180** |
|---|---|---|---|
| < 60 | 1 | 2 | 3 |
| 60 - 75 | 4 | 5 | 6 |
| 75 - 90 | 7 | 8 | 9 |
| 90 - 105 | 10 | 11 | 12 |
| **> 105** | **13** | **14** | **15** |

*Table 3-3: Automatic background reduction factors*

The size and weight will be used only to determine the background reduction parameter set, both values will not be stored or printed.

**NOTE**

**Refer to parameter setting description in register 4 chapter “background reduction”, where the altering of background reduction factors for all gamma channels and sets is briefly described:**

## 3.3.5 Monitoring of the gamma background

gamma detector

The gamma background (if gamma detectors are present) is monitored during the contamination measurement, if the function is activated in the menu **service/background parameter**.

The gross count rates of the first 3 seconds are averaged. During the following seconds of the continuing measurement, the gross count rates are checked against this average value. The measurement is aborted, if the gross count rates are outside the average +/- the value gross diff. max.

## 3.3.6 Calculation of measurement time

### 3.3.6.1 Calculation of measurement time according to DIN 25482

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. From the given safeties, the background and the alarm level (equal to the detection limit) the measurement time to be expected can be derived. 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 |
| $R_{E0}$ | = expectation value of the background |
| $R_{Eb}$ | = expectation value of the gross measurement effect |
| $R_{En}$ | = expectation 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 $A_N$ (e. g. 50 Bq $^{60}Co$) and from the corresponding detector efficiency values for this nuclide $eff_{Detector\ i}$.

$$R_{En} = A_N * eff_{Detector\ i}$$

**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, if desired, can revoke this coupling.

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*).

### 3.3.6.2 Calculation of measurement time according to MDA

In aberration to the above described method to calculate the measurement time, alternatively the calculation can be done using the MDA method. The characteristical limits according to this method are defined in international norms 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 and the resolving power of the detectors,
- 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 for the MDA method is calculated with:

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

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. |

### 3.3.7 P² - the measurement time optimizing tool

RADOS Technology has developed a program tool to reduce measurement times in the field of personnel contamination: **P**robability **P**ropagation, **P²**, 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.

As basis, a measurement time calculation according to DIN 25482/1 is carried out and during the measurement, after each measurement cycle a remaining probability for the occurrence of the limit value being exceeded is determined. 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, 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, for the user of the monitor there are no changes in the measurement procedure if the P² procedure is activated.

Example measurements with P² active

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**”.

### 3.3.7.1 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 38 channels (in case of the TwoStep™-Exit ) 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 *$P^2$ 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 $\kappa$ 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.

### 3.3.7.2 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 to 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 timesaving, 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.

## 3.3.8 Sum channel

If the monitor is equipped with gamma detectors, virtual sum channels are defined for nearby mounted detectors (see chapter 8.1.1). In this case the monitor has more measurement channel than build in detectors. The sum channels provide a more homogenous efficiency and a lower detection limit.

The sum channels are displayed in the **channel configuration**.

The detectors, from which sum channels are calculated, are marked with their own channel number and a sum channel number starting with S0. The sum channels are displayed in the **measurement status** (see chapter 4.5.1) as well.

Each sum channel has its own alarm level which it is set in the **measurement parameter** menu (see chapter 4.7.2). The sum channels are used in the automatic measurement time calculation in the same way as the real existing channels.

The sum is calculated as following:

$$R_{an} = (R_{eb1} + R_{eb1}) - (R_{e01} + R_{e02})$$

$R_{e0}$ = background
$R_{eb}$ = gross measurement effect
$R_{an}$ = net measurement effect

This net effect is compared to the set alarm level of the sum channel.

If the alarm level is set in Bq, Bq/cm² or kBq/m² the efficiency of the sum channel is used for measurements.

## 3.3.9 Quitting of channels

It is not possible to perform a safe detection of contamination by use of detectors, which are defect or highly contaminated. Therefore, the background and measured results are checked additionally for significant changes of individual measuring channels using the β-maximum thresholds and the β-minimum threshold.
These parameters can be set in the service menu of the user software building the min. and max. values for a functional detector type.

If individual channels are above or below these threshold values, they may be quitted or accepted 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% (rounded) of the measurement channels, a message is given to the screen display. The readiness for operation is discontinued.

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

If one of these quitted channels are within the "allowed" range for more than 30 seconds (e.g. after cleaning), it will automatically be used again to measure the background.

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

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

## 3.3.10 Alarm triggering

The triggering of an alarm takes place at the end of a 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] |
| $R_n$ | = | 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] |

## 3.3.11 UPS uninterruptible power supply [Option]

UPS EXPANSION

As an option the TwoStep™-Exit monitor can be equipped with an UPS to guarantee continuous operation during mains power fail.

There are two versions of UPS available:

- small version for backup of short breaks (30 s)
- large version for continuous full operation for 20 min.

During the mains power fail, the operation of the monitor is powered by the UPS. If the power returns, the system returns to normal operation automatically.

At the end of the UPS back up time, a running measurement is ended and the computer is brought into a safe shutdown mode before the UPS is disconnected. If the power returns, the system starts automatically up to normal operation.

## 3.3.12 Suitable body size

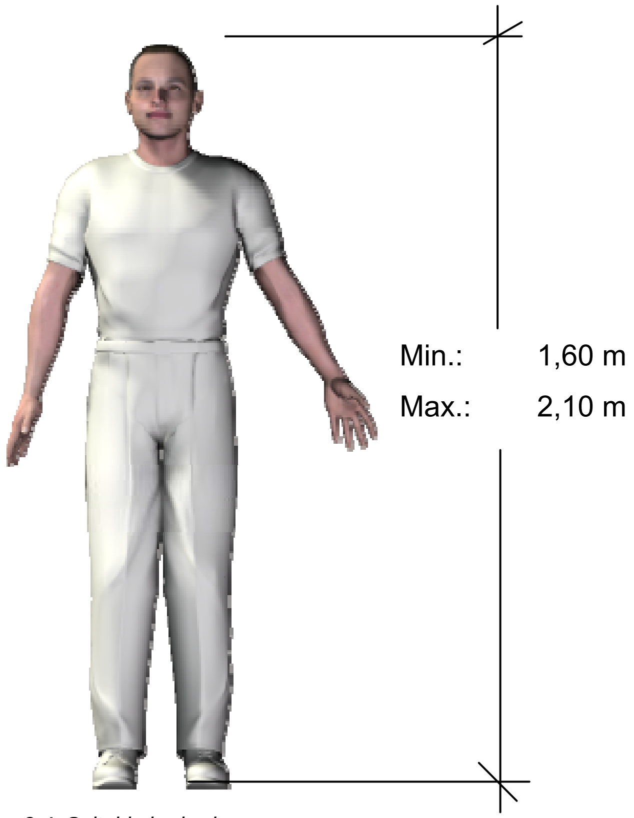



*Figure 3-4: Suitable body size*

The standard heights for persons using the TwoStep™-Exit is respective to the DIN33402 (Part2, Annex), between 1.60m and 2.10m

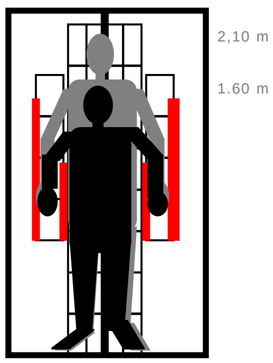



*Figure 3-5: User size and detector area*

An option structure alteration on the TwoStep™-Exit will enable the accurate measurement of smaller person. For this purpose, the guiding rods and the cable channel for the head detector have to be changed. So far, the structural alteration can only be applied to TwoStep™-Exit versions with moveable head detectors.

In general the TwoStep™-Exit offers different procedures for the measurement of “off standard body sizes” These can be adjusted in the **hardware setup** routine (refer to register 4 for details)

Following adjustments are possible in the TwoStep™-Exit software:

① Normal measurement with head position control for person larger than 1.60 m and without head position control for persons smaller than 1.60 m.

② Normal measurement with release of person larger than 1.60 m by TwoStep™-Exit software and no release for person smaller than 1.60 m.

③ Normal measurement for person larger than 1.60 m.
No measurement of person smaller than 1.60 m.


Figure 3-6: TwoStep™-Exit

## 3.4 The monitor

The housing is made of high-quality stainless steel. For dimension see dimensioned sketch 3M2627....

The following options are available:

- With back wall
- Without back wall
- Sliding door(s) ①and barrier(s)
  Entrance / Exit sliding door with a photoelectric barrier
  Entrance / Exit barrier with a photoelectric barrier
- head detector
  automatic moveable
  manual moveable
  fixed
- with hand detector box
- without hand detector box
- Small Items box

All combinations of above mentioned options are available, excepting the combination of entrance barrier with hand detector box.


Figure 3-7: Front side operating elements

If the body contamination monitor is equipped with automatic doors or barriers, there are up to 3 emergency-exit switch buttons ②
(refer to register 1).

The operating elements are on the left side, seen from the entrance side.

- VGA color LC display ④:
  graphical resolution of 800*600 pixels
- monitoring system status (on screen display ③):
  - ready to measure (green)
  - not ready to measure (red)
  - Service mode (see figure 3-5)
- Operating elements fixed in series:
  - Service switch - service and measurement ⑤
    The service switch is a key-operated switch, so that unauthorized persons will not be allowed to change significant settings and parameters.
  - Switch for display ⑥
  - free

Figure 3-8: Backside operating elements

- Infrared data interface (keyboard) ⑦
- Printer - interface for data output (USB-port)
- Mains flap (lockable) with mains switch
  (behind breakable glass for emergency use)

Figure 3-9: Infrared keyboard

Additional operating elements are located on the TwoStep$^{TM}$-Exit frame on entrance side to enable processing in open sliding door mode.

The measurement computer is placed behind a lockable but transparent service flap, which enables the user to perform a optical control of the signal lamps.


*Figure 3-10: Operational elements on side panel*

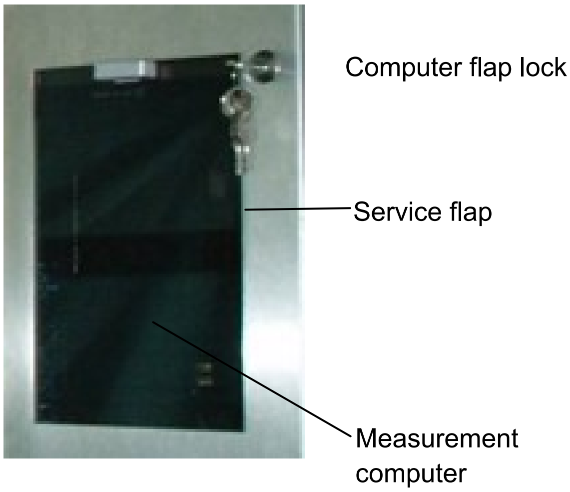



*Figure 3-11: Operational elements behind service flap*

# 3.5 TwoStep™-Exit Components

## 3.5.1 TwoStep™-Exit Elements

| *standard* | |
|---|---|
| 1 | **monitoring system status**<br>(on screen display)<br>not ready to measure (red)<br>ready to measure ( green) |
| 2 | **color LC - display** |
| 3 | **Mains disconnecting device** |
| 4 | **key switch**<br>service - measurement |
| 5 | **switch**<br>for display |
| 6 | **Service flap Measurement computer** |
| 7 | **IR-receiver keyboard** |
| 8 | **printer and USB connection** |
| 9 | **Emergency switch** |
| *option* | |
| 10 | **head detector**<br>fixed or moveable or automatic |
| 11 | **small items box** |
| 12 | **dosimeter box** |
| 13 | **UPS (1500VA/300VA)** |
| 14 | **weight scale** |
| 15 | **height control** |
| 16 | **Revision opening** |
| 17 | **IP Communication** |

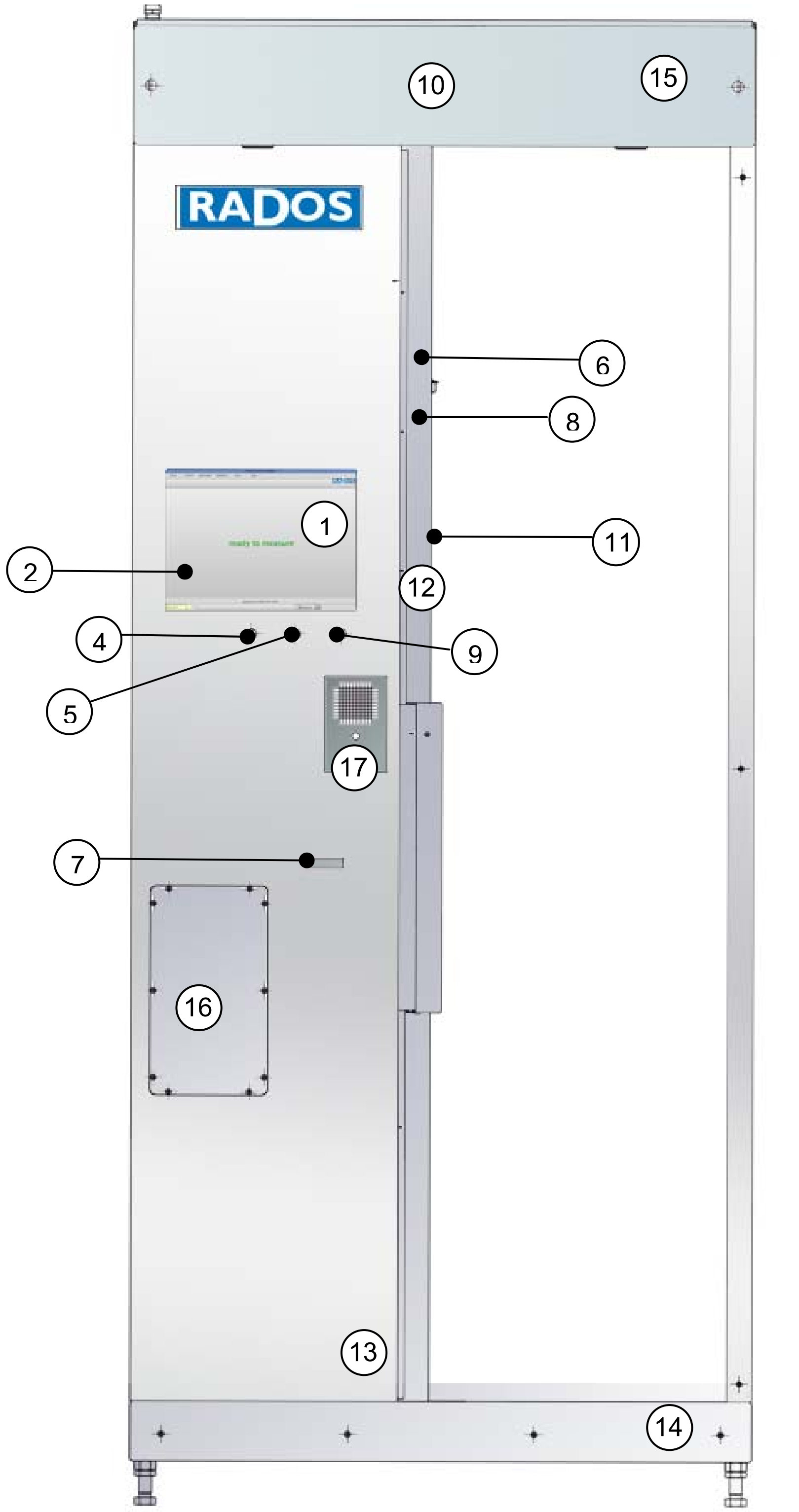



Figure 3-12: TwoStep™-Exit entrance view

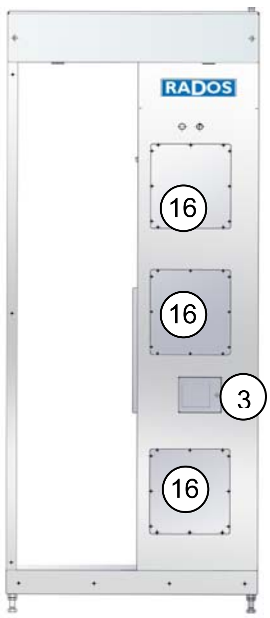



Figure 3-13: TwoStep™-Exit exit view

## 3.5.2 TwoStep™-Exit Beta Fibre™ detector allocation

Inside the monitor, there are the RFD detectors. They are Beta Fibre™ detectors having a large and very thin window where the radiation comes in. They are used to measure the beta emitters. The cabinet construction provides the detectors with excellent features. They are stable and can easily be decontaminated. Service door facilitate the access for possible repairs.

| *standard* | *detectors* |
|---|---|
| 1 | **RFD485**<br>body |
| 2 | **RFD485**<br>hand- and forearm measurement (back side) |
| 3 | **RFD485**<br>hand- and forearm measurement (front side) |
| 4 | **RFD485**<br>fixed head detector |
| 5 | **RFD485**<br>foot |
| 6 | **switch emergency passage** |
| 7 | **Measurement computer including USB and CD Devices** |
| *option* | |
| 4 | **head detector**<br>fixed<br>movable<br>automatic movement motion |
| 8 | **RFD485**<br>small items |

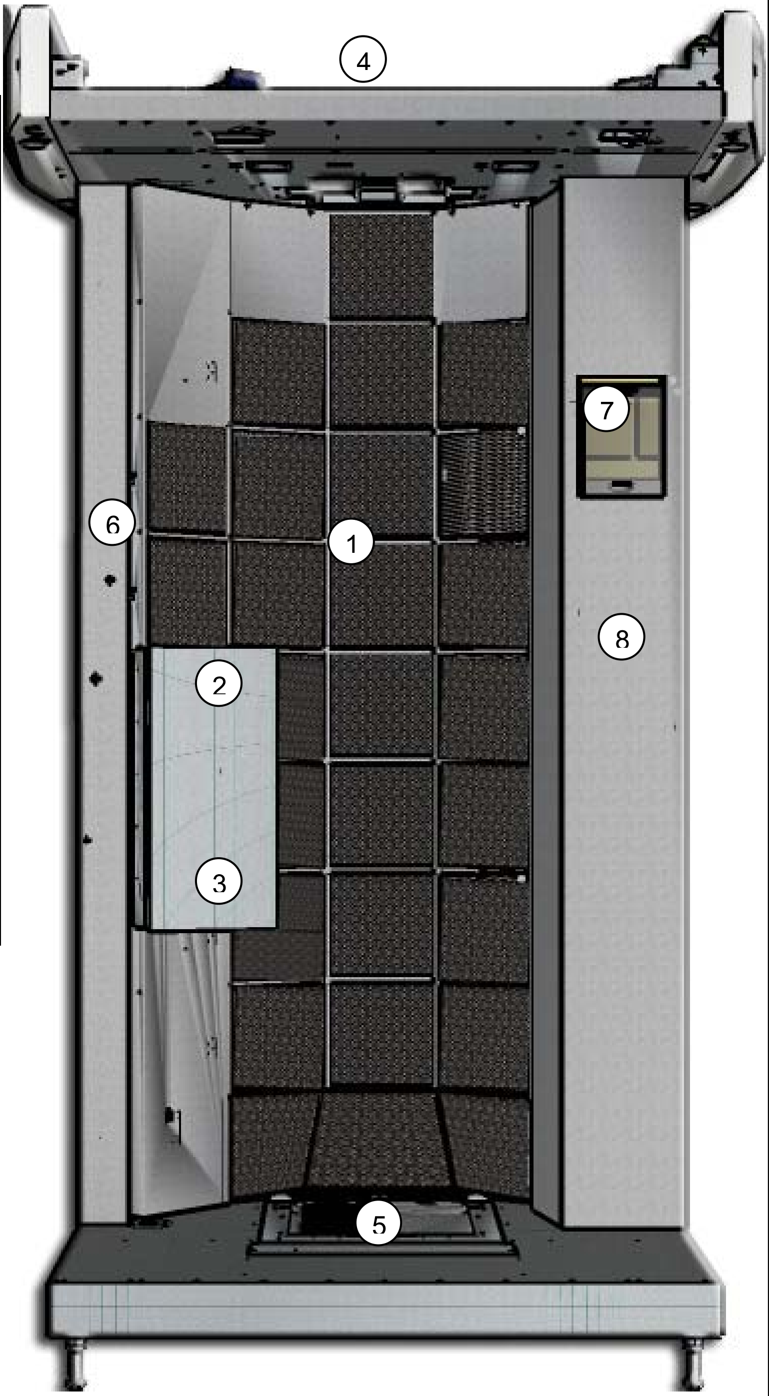



*Figure 3-14: TwoStep™-Exit beta detector allocation*

### 3.5.3 TwoStep™-Exit Gamma Fibre™ detector allocation

Inside the monitor the Gamma Fibre™ detectors are used to measure the gamma emitters. The cabinet construction provides the detector allocations with excellent features. They are stable and can easily be decontaminated. Service door facilitate the access for possible repairs.

| *standard* | *detectors* |
|---|---|
| 1 | **RFD13/40**<br>body |
| 2 | **RFD 6/18**<br>hand- and forearm measurement (back side) |
| 3 | **RFD 6/18**<br>foot |
| 4 | **switch emergency passage** |
| 5 | **Measurement computer including USB and CD Devices** |
| *option* | |
| 6 | **RFD4,8/4.8**<br>small items |

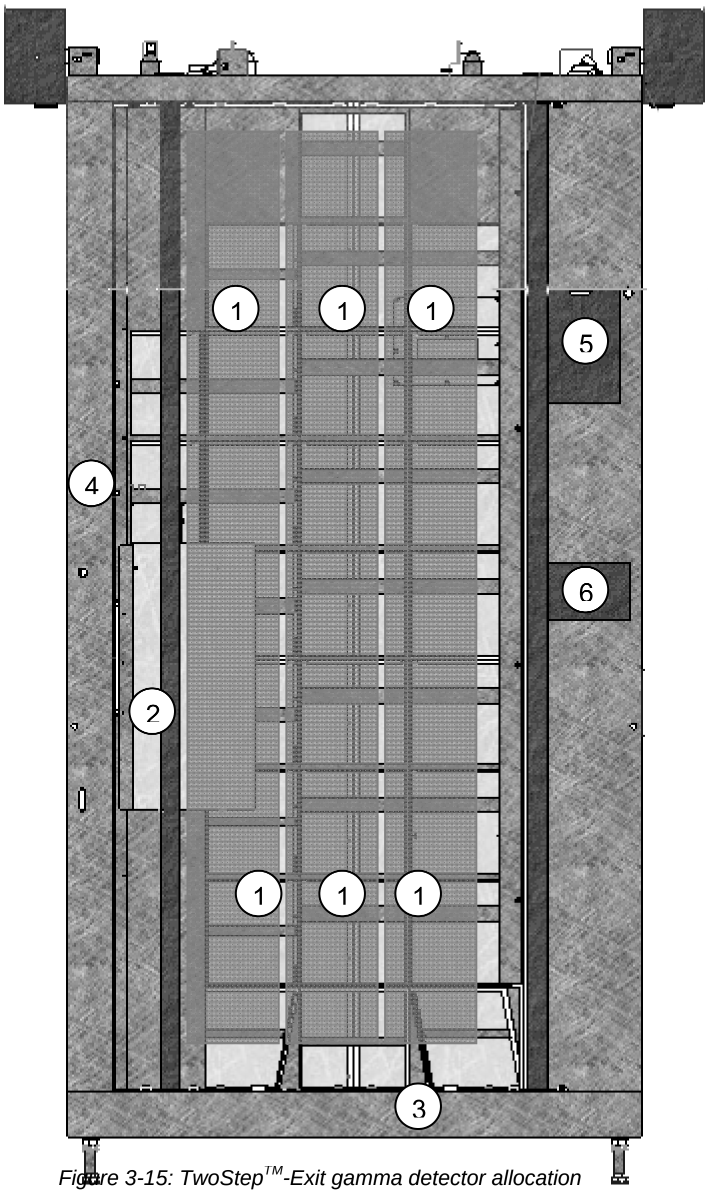



*Figure 3-15: TwoStep™-Exit gamma detector allocation*

## 3.5.4 Head detector

The TwoStep™-Exit is built with a fixed head detector. Alternative the TwoStep™-Exit have 2 options

- *manual head detector*
  the height of the head detector can easily be adjusted by hand.
- *electric head detector control*
  control the head detector position in accordance to the measurement stages

Head detector characteristic:

- 1 moveable RFD485 detector in a plastic housing
- optional motor or manual driven from 1.6m to 2.10m
- integration in the measurement state sensory control
- optimized and increased detection with a light barrier attached to the detector
- integrated sensors for min and maximum position
- easy change of detector by fast open possibility of detector box
- light cables are secured in a dragchain
- motor driving unit is secured by slipping clutch
- special safety design for light barrier holder to stop head contact of detector

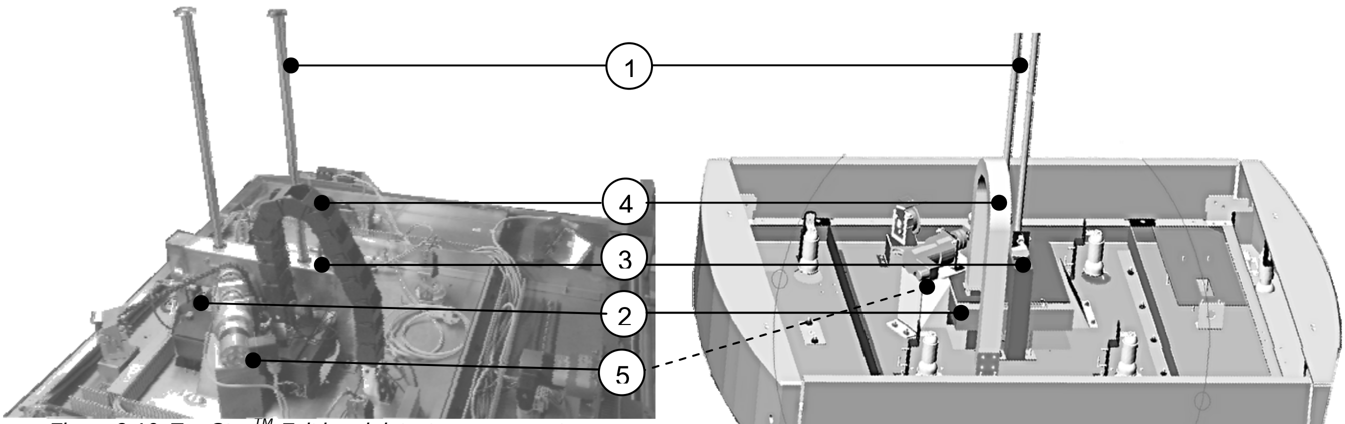



Figure 3-16: TwoStep™-Exit head detector components

| No | component |
|---|---|
| 1 | Stanchion |
| 2 | Head up sensor |
| 3 | Head down sensor |
| 4 | Dragchain |
| 5 | Motor (optional) |
| 6 | Light barrier holder |

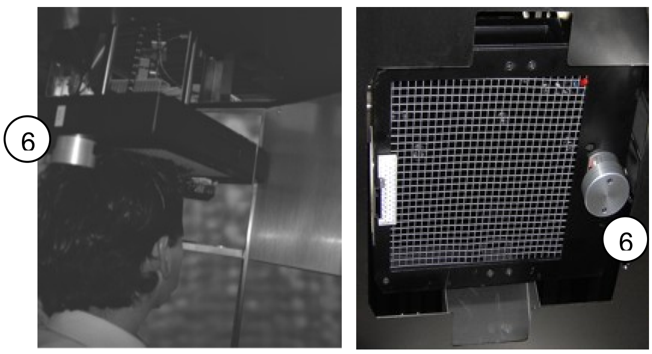



Figure 3-17: TwoStep™-Exit head detector inside view

# 3.6 Computer

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.

## 3.6.1 Function and design

The computer system consists of a single-board industrial PC. The industrial computer is compatible to any PC/AT standard.

## 3.6.2 System computer

The computer has a Pentium-type processor (industrial plug-in card) and serial interfaces for the scales and an optional label printer. The record printer may be connected by an USB or via a parallel interface (depending on the customer's configuration).

The memory must have at least 256 Mbytes RAM, of which about 2 MB are required for the operating system and for the graphical surface. The remaining memory capacity is required for the calculation programs, the service functions and the graphical display. At the hard disk there should be at least 40 GBytes available for the operating system and the necessary program. As hard disks with much larger capacities are used, the capacity should not be any problem.

USB device slots and CDR/W CD Burning drive for data exchange are available.

The displays appear via a VGA chip on the single-board computer and a VGA-LC color display with a resolution of at least 800 * 600 pixels.

## 3.6.3 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 RADOS 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.

## 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.

### 3.7.1 Software functional sequence

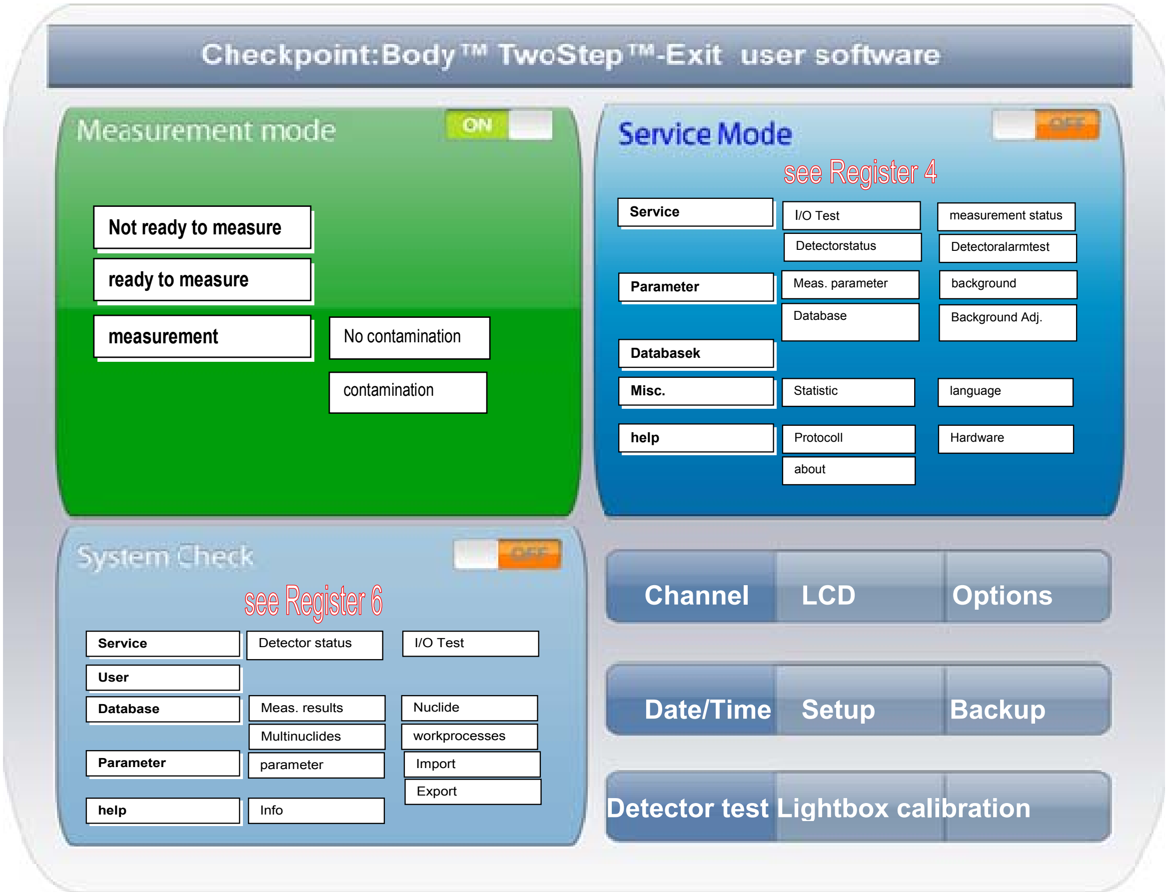



*Figure 3-18: Software functional sequence*

## 3.7.2 Operating conditions

service mode


measurement mode


*Figure 3-19: Service button*

The User software differentiates two operation conditions:

***measurement mode*** and ***service 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 measurement“ or “ready to measure“.

The ***service mode*** is very sensitive and should therefore be accessible to trained persons only as settings in different sub-menus allow changes on parameters responsible for the measured value.
This mode can only be entered via the respective button in combination with the service key.

## 3.7.3 Out of operation conditions


*Figure 3-20: out of service button*


*Figure 3-21: out of service button*


The User software differentiates following out of operation modes:

***Out of service*** and ***Emergency Exit***

The ***out of service*** mode allows the administrator of a contamination monitor to put the instrument out of service if outstanding maintenance or repair cannot be performed immediately.

The ***out of service*** mode can be activated by entering the service mode (use of service key) and pressing the out of service button. After turning the service key again, the monitor stays in the mode ***out of service***. It is is displayed on the screen ***out of service- do not use***.

The ***emergency exit*** mode enables the administrator of a contamination monitor to use the monitor as safe passageway in case of an emergency. The ***emergency exit*** mode is available for contamination monitors with door options only.

## 3.7.4 Sensory functional sequence

The operational sensory functions are integrated as shown in following flowchart:

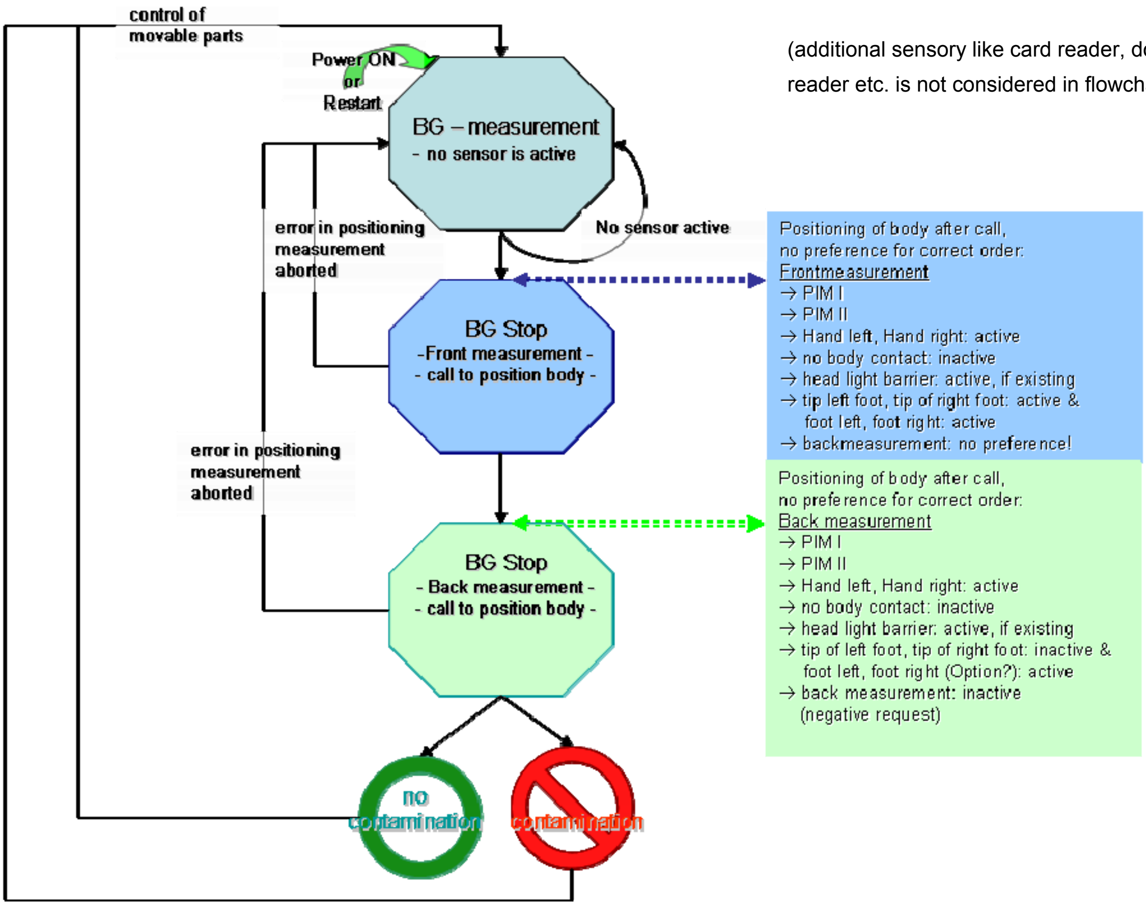



*Figure 3-22: TwoStep™-Exit simplified flowchart of foot sensory*

### View of foot frame and light barriers - lengthwise

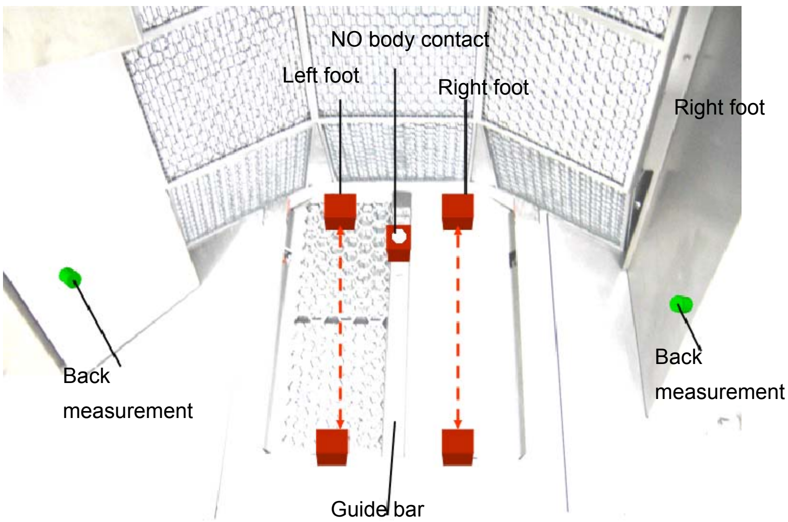



*Figure 3-23: TwoStep™-Exit s foot frame and light barriers (lengthwise)*

## 3.8 Measurement mode

The measurement mode is the standard state of the monitor. For this reason, it starts automatically after the monitor has been switched on. In this mode the users can step inside for a contamination measurement.

In this aspect, the TwoStep™-Exit differentiates in the measurement mode between the states of "***contamination measurement***" and "***ready to measure***". The exact differences regarding the mode of operation and evaluation are described in the following chapters.

If there is no correct operation possible due to any faults, further measurements will be prevented. Additionally, the screen provides a short description of the cause of malfunction.

Any operations done in the measuring state are initiated by light barriers. Data inputs via the keyboard are not necessary. The user is guided by the graphical display and voice sequences. The measurement result is shown on the screen and/or via speech sequences.

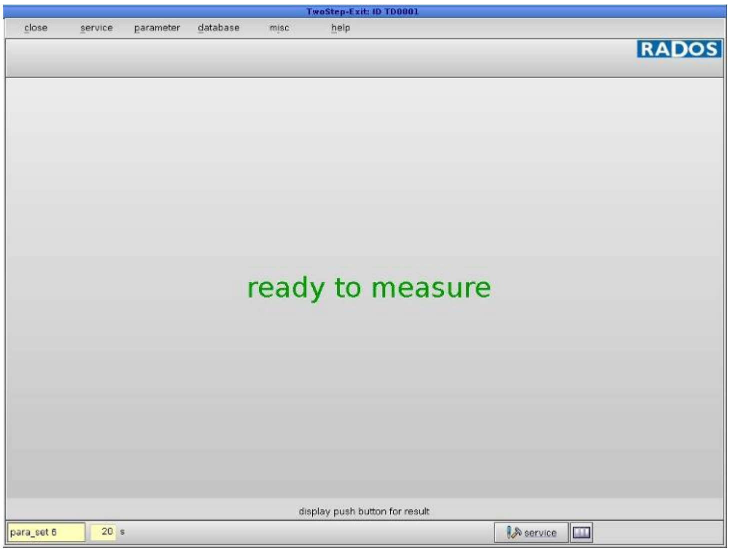



*Figure 3-24: User Software - ready to measure*

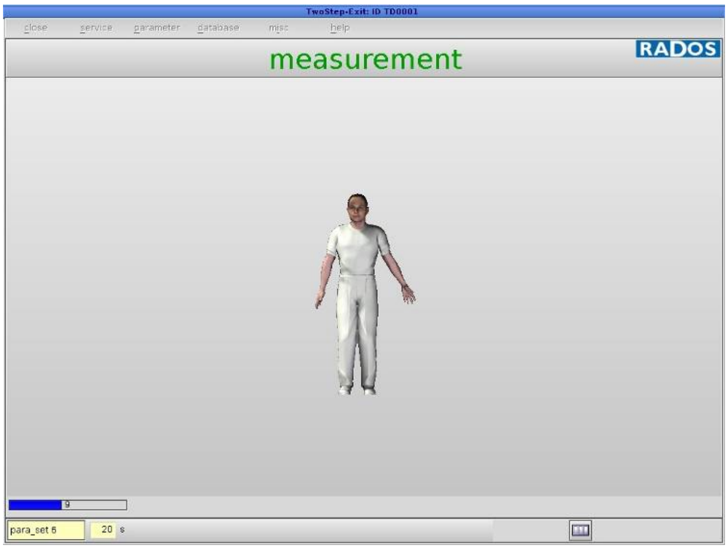



*Figure 3-25: User Software – measurement*

| | |
|---|---|
| | **NOTE** |
| | **As shown in the sensory functional sequence the afterwards described positioning aid via vocal announcements will come only, if the position of person in accordance to the initiators has to be changed. Practiced persons will therefore not be announced to position body. However the contamination result will always be announced.** |

### 3.8.1 Personnel measurement

If the state **"ready to measure**" is displayed, a person may enter the monitor to be measured for contamination. A light-reflex switch (PIM sensor- **P**erson **I**n **M**onitor) indicates that a person has entered the monitor. The person is requested by a voice to take up a correct position of the hands, the feet and the body.

| NOTE |
|---|
| Based on the installed foot sensory (lengthwise or abeam) the announced vocal audio prompts will differ.<br><br>**The following will show audio prompts for lengthwise only sensory in a text capture like "*FRONT MEASUREMENT*"<br>for abeam sensory in a text capture like "FRONT MEASUREMENT" and prompts for both like "FRONT MEASUREMENT".** |

The barcode reader is linked to the personnel measurement process.
The barcode reader is activated after the PIM indicates person entering the monitor and a continuous vocal request to "INSERT CARD" comes up. The contamination measurement starts after the dosimeter is successful memorized to the system. The dosimeter data information is stored in connection with the measurement data in the database.

After identification via dosimeter the person is requested by a voice recorder to take up a correct position of the hands, the feet and the body. The user has to turn towards the detectors and the feet have to be positioned in the middle of the punched foot grids. If this is not done properly, the vocal audio aid starts and „POSITION LEFT FOOT" and „POSITION RIGHT FOOT" is requested. Further on more detailed Information about positioning will be announced in the abeam sensory version with the prompts „MOVE RIGHT FOOT SLIGHTLY BACK" or "POSITION LEFT FOOT CLOSER".
The prompts will be repeated until the feet are placed properly on the foot grids.

The user has to place his left hand as deeply as possible into the hand box. The left arm should be lightly stretched and placed near the proximity sensor, while the right must be stretched and touch the body initiator ①. If this is not done immediately, the prompt "POSITION LEFT HAND" or "POSITION RIGHT HAND" comes up. This prompt will be repeated until the hand is placed properly in the hand box and the body initiator ① is activated.

In the presence of an automatic head detector, it lowers down as soon as the set connection from the set-up menu is fulfilled, e. g. after the hands, and feet are positioned correctly.

In order to achieve an optimum measuring sensitivity, the person shall contact the body detectors as close as possible. This position for the person is pre designed by the position of the initiators and sensors, if the person is not close enough the signal "COME CLOSER" is announced.


*Figure 3-26: Example front measurement*

Only if all of the above mentioned conditions are fulfilled, the monitor begins with the front measurement (with the prompt “*FRONT MEASUREMENT*” in the lengthwise sensory version). If - during the parameter setting - the automatic adjustment of the integration period was switched on, the computation starts now. The integration period and the alarm thresholds are adjusted to the last measured background. The computation has no severe impact to the beginning of the measurement severely.

The user will be kept informed on the remaining integration period by the voice recorder announcing every second.

After the front measurement is finished, the movable head detector will move upwards (if the monitor is equipped with this option) and the signal "TURN PLEASE" is announced.
To execute the back measurement, the person shall turn his back towards the detectors. If the monitor is equipped with an entrance door, this door will close before the back measurement is started. This will however take place after the person has positioned properly.

*Figure 3-27: Example of back measurement "position hands"*

In correspondence to the front measurement, first the right foot has to be positioned on the foot grid and then the left foot. The vocal audio aid will start again with *„REMOVE LOWER LEG FROM LIGHT BARRIER"* or „POSITION RIGHT FOOT (CLOSER)" and „POSITION LEFT FOOT(CLOSER)" if the positioning is found incorrect by the initiators.

As already performed by the user during the front measurement (but inverse), the left hand has to touch the body initiator while the right hand is placed in the hand box.

Only if the conditions are fulfilled in all aspects, the monitor starts to measure the backside (the lengthwise sensory version will additionally prompt "*BACK MEASUREMENT*").
The remaining integration period is announced to the user by a voice recorder secondly.

During the back measurement, the entrance door closes.

When the respective integration periods are over, the counted detector counts are computed including the current background (background subtraction). Then they are compared to the alarm threshold that could be separately set for each measuring channel (detector) before.

If no contamination was detected, the message "THANK YOU; NO CONTAMINATION; WALK THROUGH PLEASE" is announced. If there is an exit door, it opens and remains in this position until the person has left the monitor. Only after the exit door is closed, the entrance door opens and the monitor is ready for the next measurement.

It is not possible to enter the monitor if there still is a person inside, since the exit door will not close (only applies to the version with two sliding doors).

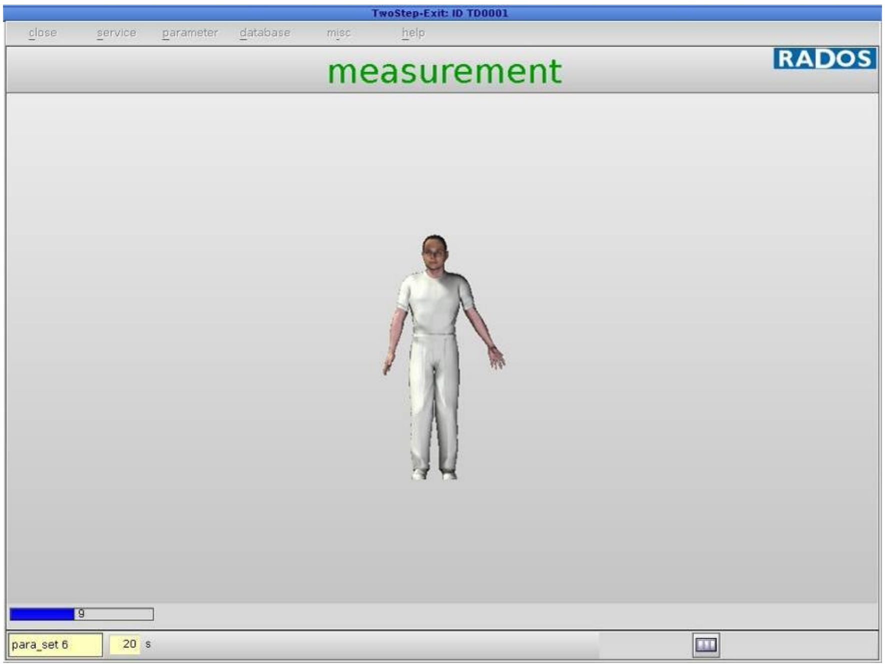



*Figure 3-28: Graphical display "measurement" I*

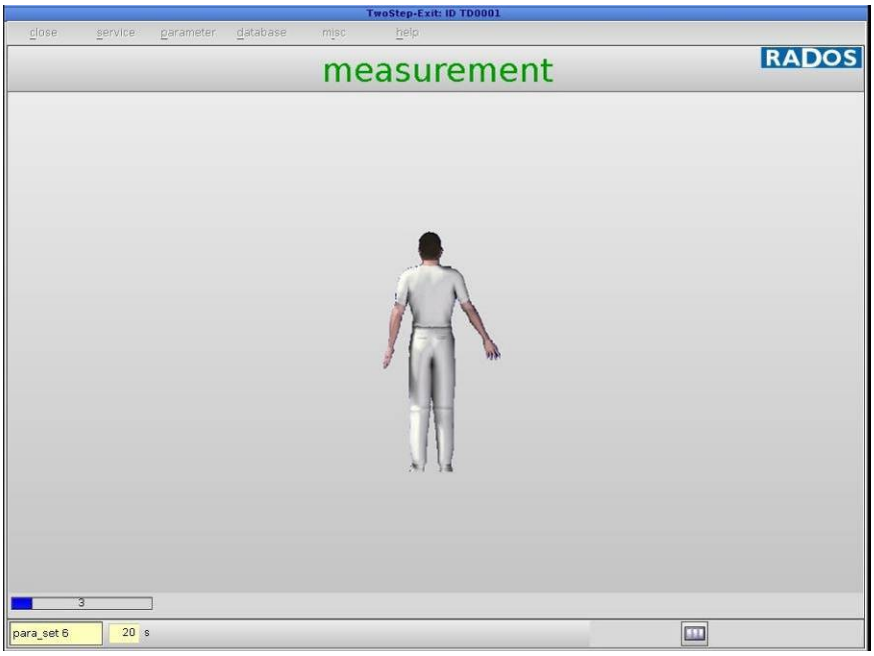



*Figure 3-29: Graphical display "measurement" II*

If any of the measuring channels exceed the alarm threshold, a contamination is detected that causes an alarm signal.

The message "NOTIFY RADIATION PROTECTION; CONTAMINATION; GO BACK OUT; SEE DISPLAY" will be announced.

In this case, the body monitor shall be left to the entrance side. If there is an entrance door, it opens again and the exit door will still remain closed. In case of a contamination, a graphical display is shown on the screen locating the contamination (see next figures).

For the tabular indication of the net count rates the „display" button has to be activated (see next figures).

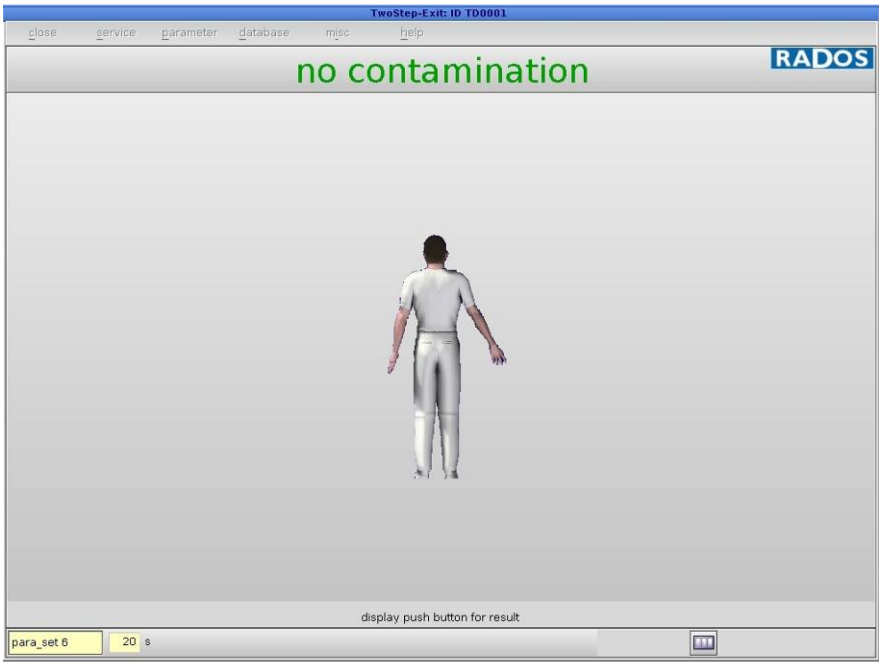



*Figure 3-30: Graphical display "no contamination"*

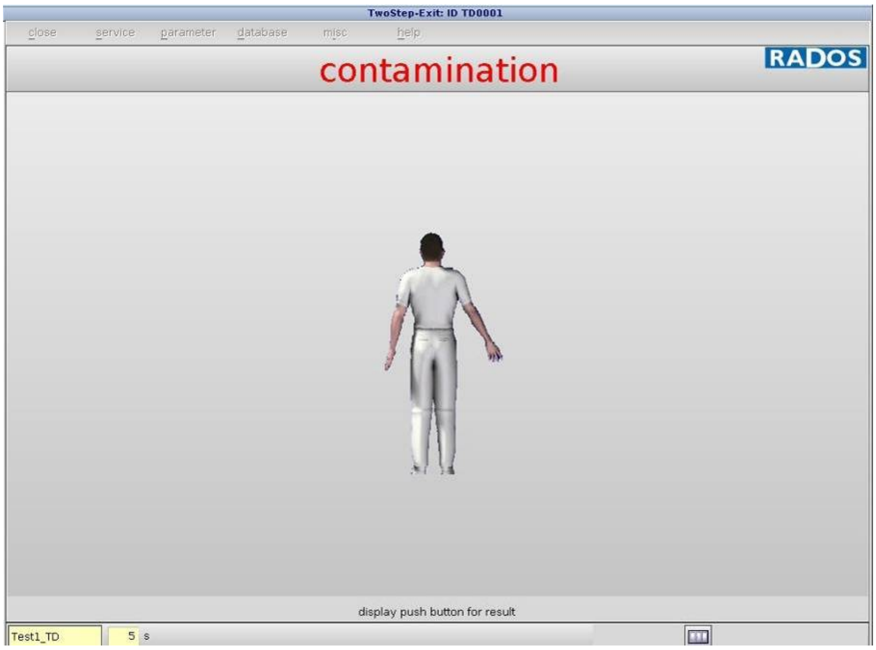



*Figure 3-31: Graphical display "contamination"*

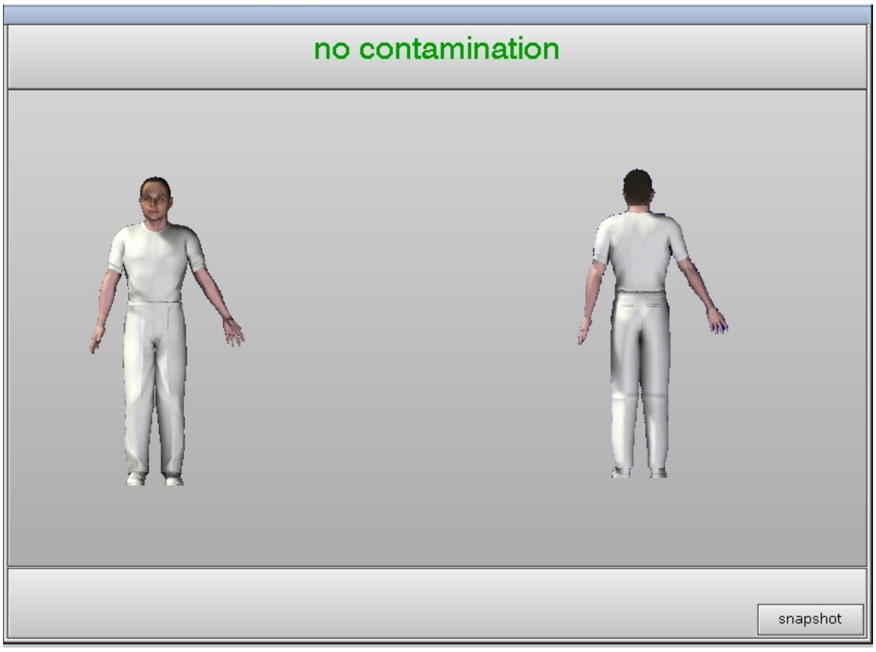



*Figure 3-32: Graphical result display "no contamination"*

measurement result

no contamination

cps

| front | beta | gamma | | beta | back | beta | gamma | | beta |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.18 | 0.15 | 21 | 0.04 | 1 | 0.00 | 0.05 | 21 | 0.00 |
| 2 | 0.08 | | 22 | 0.17 | 2 | 0.00 | | 22 | 0.07 |
| 3 | 0.00 | | 23 | 0.00 | 3 | 0.00 | | 23 | 0.15 |
| 4 | 0.08 | | 24 | 0.11 | 4 | 0.00 | | 24 | 0.00 |
| 5 | 0.02 | | 25 | 0.00 | 5 | 0.07 | | 25 | 0.18 |
| 6 | 0.00 | | 26 | 0.01 | 6 | 0.00 | | 26 | 0.01 |
| 7 | 0.00 | | 27 | 0.00 | 7 | 0.00 | | 27 | 0.00 |
| 8 | 0.18 | | 28 | 0.02 | 8 | 0.03 | | 28 | 0.00 |
| 9 | 0.00 | | 29 | 0.00 | 9 | 0.00 | | 29 | 0.00 |
| 10 | 0.12 | | 30 | 0.00 | 10 | 0.07 | | 30 | 0.04 |
| 11 | 0.07 | | 31 | 0.15 | 11 | 0.07 | | 31 | 0.15 |
| 12 | 0.00 | | 32 | 0.22 | 12 | 0.03 | | 32 | 0.00 |
| 13 | 0.00 | | 33 | 0.00 | 13 | 0.04 | | 33 | 0.00 |
| 14 | 0.03 | | 34 | 0.20 | 14 | 0.00 | | 34 | 0.10 |
| 15 | 0.00 | | 35 | 0.11 | 15 | 0.00 | | 35 | 0.00 |
| 16 | 0.05 | | 36 | 0.08 | 16 | 0.10 | | 36 | 0.03 |
| 17 | 0.00 | | 37 | 0.27 | 17 | 0.00 | | 37 | 0.00 |
| 18 | 0.00 | | 38 | 0.00 | 18 | 0.09 | | 38 | 0.00 |
| 19 | 0.07 | | 39 | | 19 | 0.00 | | 39 | |
| 20 | 0.10 | | 40 | | 20 | 0.00 | | 40 | |

snapshot

*Figure 3-33: Graphical result display "no contamination"*

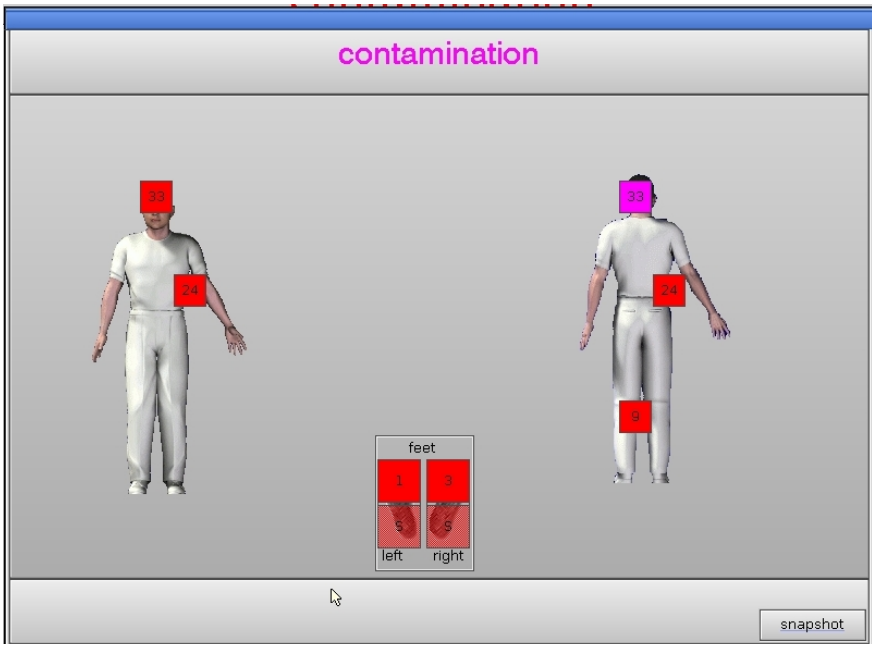
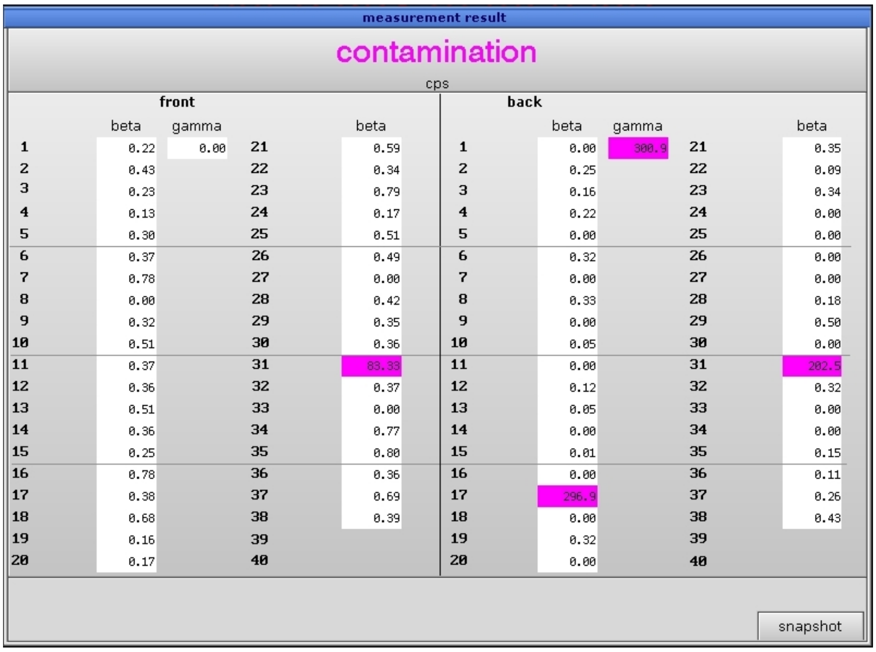



*Figure 3-34: Graphical result display "contamination" (all channel position)*



measurement result

contamination

cps

| front | beta | gamma | | beta | back | beta | gamma | | beta |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.22 | 0.00 | 21 | 0.59 | 1 | 0.00 | 300.9 | 21 | 0.35 |
| 2 | 0.43 | | 22 | 0.34 | 2 | 0.25 | | 22 | 0.09 |
| 3 | 0.23 | | 23 | 0.79 | 3 | 0.16 | | 23 | 0.34 |
| 4 | 0.13 | | 24 | 0.17 | 4 | 0.22 | | 24 | 0.00 |
| 5 | 0.30 | | 25 | 0.51 | 5 | 0.00 | | 25 | 0.00 |
| 6 | 0.37 | | 26 | 0.49 | 6 | 0.32 | | 26 | 0.00 |
| 7 | 0.78 | | 27 | 0.00 | 7 | 0.00 | | 27 | 0.00 |
| 8 | 0.00 | | 28 | 0.42 | 8 | 0.33 | | 28 | 0.18 |
| 9 | 0.32 | | 29 | 0.35 | 9 | 0.00 | | 29 | 0.50 |
| 10 | 0.51 | | 30 | 0.36 | 10 | 0.05 | | 30 | 0.00 |
| 11 | 0.37 | | 31 | 83.33 | 11 | 0.00 | | 31 | 202.5 |
| 12 | 0.36 | | 32 | 0.37 | 12 | 0.12 | | 32 | 0.32 |
| 13 | 0.51 | | 33 | 0.00 | 13 | 0.05 | | 33 | 0.00 |
| 14 | 0.36 | | 34 | 0.77 | 14 | 0.00 | | 34 | 0.00 |
| 15 | 0.25 | | 35 | 0.80 | 15 | 0.01 | | 35 | 0.15 |
| 16 | 0.78 | | 36 | 0.36 | 16 | 0.00 | | 36 | 0.11 |
| 17 | 0.38 | | 37 | 0.69 | 17 | 296.9 | | 37 | 0.26 |
| 18 | 0.68 | | 38 | 0.39 | 18 | 0.00 | | 38 | 0.43 |
| 19 | 0.16 | | 39 | | 19 | 0.32 | | 39 | |
| 20 | 0.17 | | 40 | | 20 | 0.00 | | 40 | |

snapshot

*Figure 3-35: Graphical result values display "contamination"*

If the service operation to print out a protocol is set, the printout will start at this process state.

If the foot or hand contacts are interrupted during the body measurement, the voice recorder will give a respective message announcing the reason of the interruption (e.g., "MEASUREMENT ABORTED, GO BACK OUT PLEASE!"). After the user has left the monitor, it is ready for new measurements. The background will be automatically adjusted during this time.

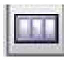
If during the measurement the initiator contacts (like the PIM sensor) loose contact to measured person, the measurement will be aborted.


*Figure 3-36: Graphical result "measurement aborted"*

If the foot measurement is extended with a second foot detector the message "PLEASE WAIT FOR MEASUREMENT OF FEET" might be announced when the body measurement is completed but the OneStep™ foot measurement has to continue.

After the user has left the monitor, it is ready for new measurements. The background will be automatically adjusted during this time.

## 3.8.2 Channel configuration

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

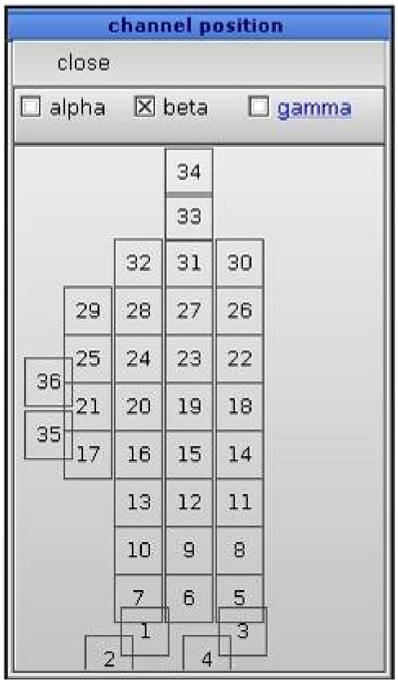



Figure 3-37: Example of beta channel configuration

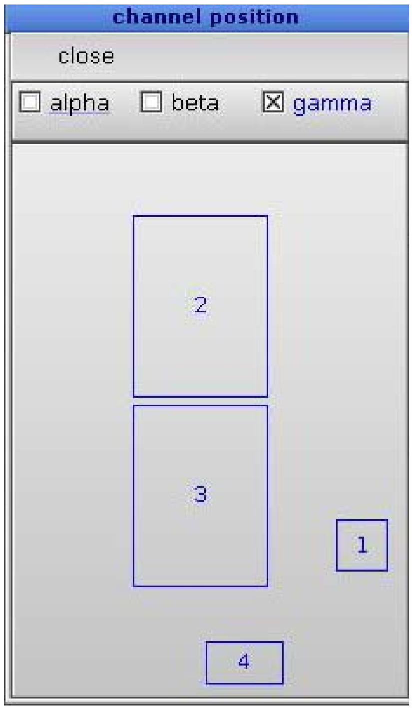



Figure 3-38: Example of gamma channel configuration

## 3.8.3 Foot measurement channel configuration

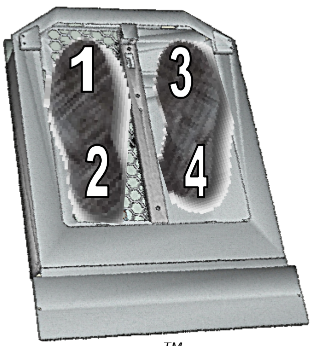



*Figure 3-39: TwoStep™-Exit foot measurement I*

The foot measurement with two beta detectors is designed as cross-channel analysis due to two step measurements (front and back measurement).
The cross channel analysis uses two different channels to use the most modern methods of analysis and offers an improved efficiency.
The normal data collection complied with the cross-channel analysis is an excellent basis for identifying contaminations.

**Cross-channel for left foot**

**Foot toe** **cross channel 1-4**
**Foot heel** **cross channel 2-3**
**Sum-channel** **channel 1, 2 –channel 4, 3**

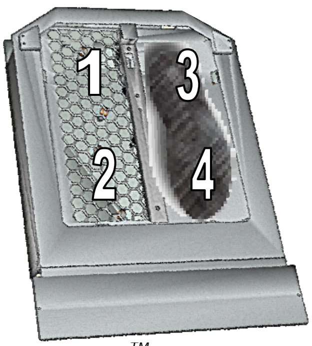



*Figure 3-40: TwoStep™-Exit foot measurement II*

**Cross-channel for right foot**
**Foot toe** **cross channel 4-1**
**Foot heel** **cross channel 3-2**
**Sum-channel** **channel 3, 4 – channel 2, 1**

## 3.9 Head detector control

The head detector control unit is built as a module on a support circuit board.

All the control inputs are electrically isolated using opto couplers. A DC voltage of 24V is used for the drive. The supply for the control unit (+24V) is supplied via terminals.

The movement is controlled via input (6) and input (7). The head detector moves down for "1" on input (6) and it moves up for "0" on input (7).
Input 7 (upwards) has priority.

When the detector is driven downwards, the input of the motor driver IC1 (PHASE), which determines the direction of rotation, is set to "1". The detector moves down until input (9) receives a "1" from the "working position" light barrier. If the detector moves to the mechanical end-stop, then the movement is stopped by the end position initiator on input (10) (head detector down).

When the detector is driven upwards, the input of the motor driver IC1 (PHASE), which determines the direction of rotation, is set to "0". The head detector moves upwards until input (8) receives a "1" from the upper end position initiator.

The EMERGENCY OPEN input (5) is driven with "1" in normal operation. If the input (5) goes to „0", the head detector is moved upwards. The control input 6 (head detector down) has no function in the EMERGENCY OPEN state.

**Setting the speed of movement**

The speed of movement is adjusted on potentiometer R23.

The speed should be adjusted so that the detector moves to the end position within 2 to 3 seconds.

# 3.10 Door and barrier control (option)

The CheckPoint:Body™, TwoStep™-Exit may be equipped with door or barrier options.

Available door options are:

- sliding exit door with light barrier
- sliding entrance door with light barrier
- sliding entrance and exit door with light barrier

Available barrier options are:

- exit barrier with sensors
- entrance barrier with sensors
- entrance and exit barrier with sensors

> **NOTE**
>
> Any Combination of glass door and barrier could be selected meeting the customer's premises. At least the combination of a entrance barrier with a hand box is not possible.

## 3.10.1 Functional description

Below the function of the monitor with sliding doors is described.

### 3.10.1.1 Initial state

Immediately after the monitor is switched on, the doors move to the initial state:

| | |
|---|---|
| entrance door | -> open |
| exit door | -> closed |

> **NOTE**
>
> The monitor learns the current background. It is ready to measure after the first background measurement; the doors remain in the initial state.

### 3.10.1.2 Entering the monitor

If the monitor is ready to measure and a person enters it, the entrance door does not close immediately. This will only be done, in accordance to the hardware setup, when the front – or back measurement stage starts.

### 3.10.1.3 Interruption of the measurement

If the measurement period is interrupted for more than 10 seconds, for example if an initiator was not actuated, the person is requested to leave the monitor. Then, the monitor returns to the initial state.

### 3.10.1.4 End of measurement in case of non-contamination

If no contamination is detected, the exit door opens after the measurement is finished. This door will remain open until the person has left the monitor.

It is not possible to enter through the monitor from the exit side, since the door does not close as long as there is a person in the monitor (is only valid for the version with two sliding doors).

Only if the exit door has been closed, the entrance door opens.

### 3.10.1.5 End of measurement in case of contamination

If any contamination is detected, the exit door remains closed, and the entrance door opens. The monitor has to be left through the entrance side.

### 3.10.1.6 Emergency open

The body monitor has two emergency open switches, one at the entrance side and one at the exit side (optionally also inside the monitor). This emergency open switch can be secured by a leaden seal. When the emergency open switch is actuated, the doors open.

### 3.10.1.7 Door lock

In the closed state, the door is held by an electromagnet. A retaining plate is placed close to the retaining magnet in the closed state.

In the active locking state the pull-off strength is > 600 N.

### 3.10.1.8 Power failure

If a power failure occurs, the doors remain in the state they were before the failure. In this case they can be pushed aside by hand.

## 3.10.2 Drive and control

### 3.10.2.1 Sliding door drive

On the top, the door is suspended on linear sliding balls. At the bottom it is guided by sliding bars.

It is driven by a 24 V-DC geared motor, which is connected with an adjustable slip friction clutch. The motion is transferred via cogwheel and cog chain to the door. The slip friction clutch is used to protect the persons and to avoid crushing dangers.

### 3.10.2.2 Barrier drive

The exit barrier is attached to the housing of the personal monitor. It is driven by a 24 V-DC geared motor that is positioned inside the monitor. The drive is equipped with a slip friction clutch to protect the persons.

### 3.10.2.3 Door or barrier control

There is a control unit for each door or barrier inside the monitor. This control unit is used to adjust the speed of the door or barrier. The control unit monitors the door positions using terminal switches.

The locking is activated, if the control signal is set on "door closed".

This unit is triggered by the computer through binary exits. The emergency open function overrides above-mentioned controls.

### 3.10.3 Door control (sliding door option)

The door control unit is assembled as a module on a support circuit board.

All control inputs of the door control are potentially separated by opto couplers (IC1, IC2).

24 V direct current is used for control (Kl1 19/20).

The supply of the door control (+ 24 V) is fed by the terminals 25/26.

Door movement is controlled through entrance 8. The J1 bridge (at the door control board) has to be set to 1/2. The door opens, if there is a "1" and closes at a "0" at entrance 8.

If the door is opened, the entrance of the IC10 motor driver (PHASE) that determines the rotational direction is set to "0". The door moves quickly until the entrance 4 (creep speed-OPEN) gets a "1" through the primary limit switch. In the creep speed the movement speed is reduced by the IC5 analogue switch by changing to the R17+R25 series resistors. If "Limit (terminal) position-OPEN" is reached, entrance 6 gets a "1". The entrance 5 of the IC10 motor controller (BRAKE) is set to "0" and the motor stops. The locking is not activated.

If the door control is switched to close, the entrance of the IC10 motor controller (PHASE) that controls the rotational direction is set to "1". The locking exit is actuated. The door closes quickly until entrance 3 (creep speed-CLOSE) gets a "1" via the primary limit switch.

The door now moves with reduced speed. If "Limit (terminal) position-CLOSE" is reached, entrance 5 gets a "1". The entrance 5 of the IC10 (BRAKE) is set to "0", and the motor stops. The locking remains to be activated until "Close door" is triggered.

The EMERGENCY OPEN exit (10) is normally triggered with "1". If triggering comes to "0", the locking exit is inactive, and the door moves to the 'open' status. In the EMERGENCY OPEN status, the door control entrance 8 does not have any function.

## 3.10.4 Setting the movement speed

At first, the normal speed shall be set at the R24 potentiometer.

The speed for the "creep speed" has to be set at the R25 potentiometer in such a way that the door travels smoothly to the stop position.

The normal speed has to be always adjusted at first, since it influences the adjustment of the creep speed.

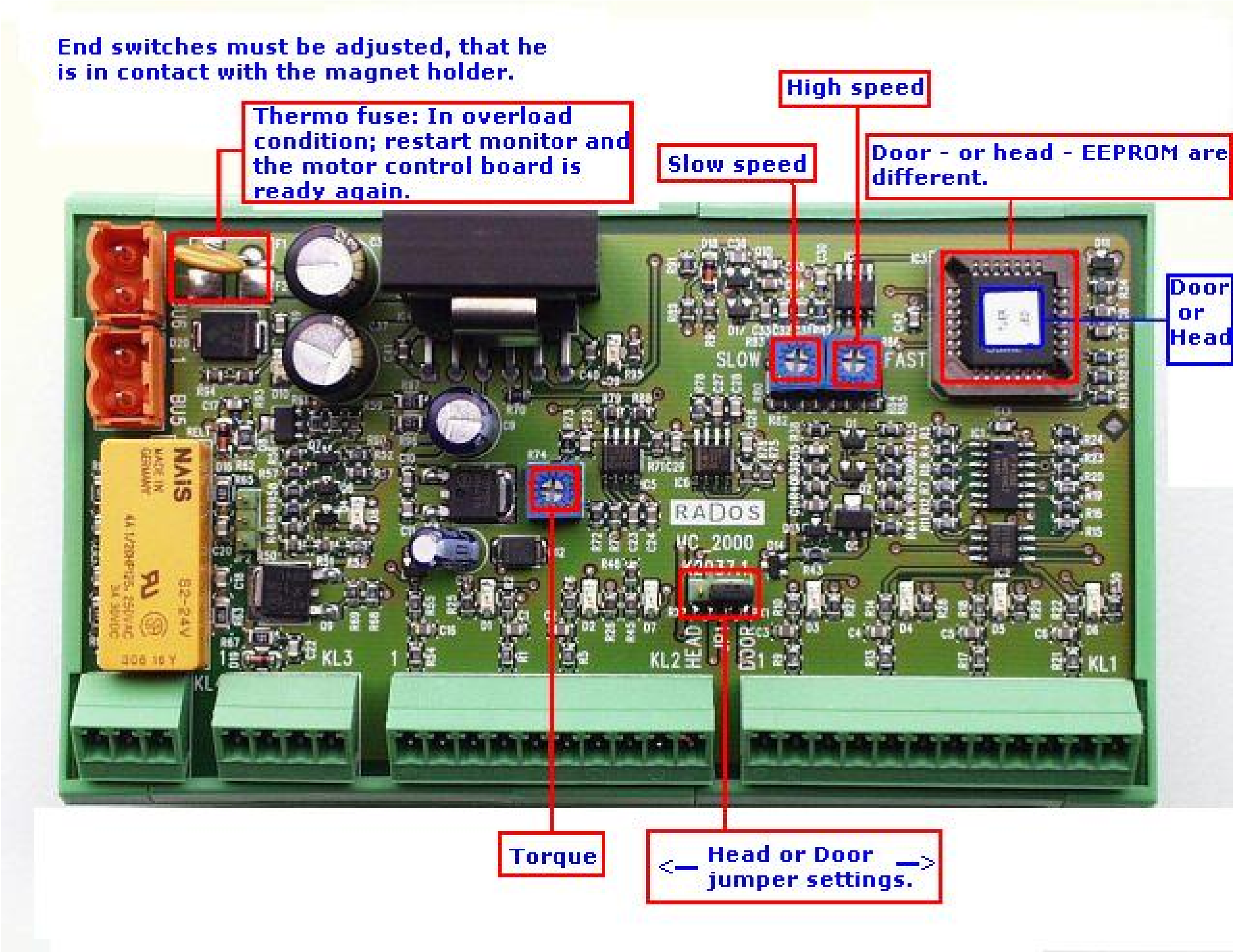



*Figure 3-41: Control- board for movement options*

# Register 4

# 4 Service

# Table of contents (continued)

# Figures

# 4.1 Service

## 4.1.1 Prefix

The CheckPoint:Body™ contamination monitor family with the monitor TwoStep™- Exit has different graphical and entry elements for the user communication with the. 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 **TwoStep™-Exit** it is absolutely necessary to follow the shutdown process given in This handbook to prevent the **TwoStep™-Exit** from any damages.

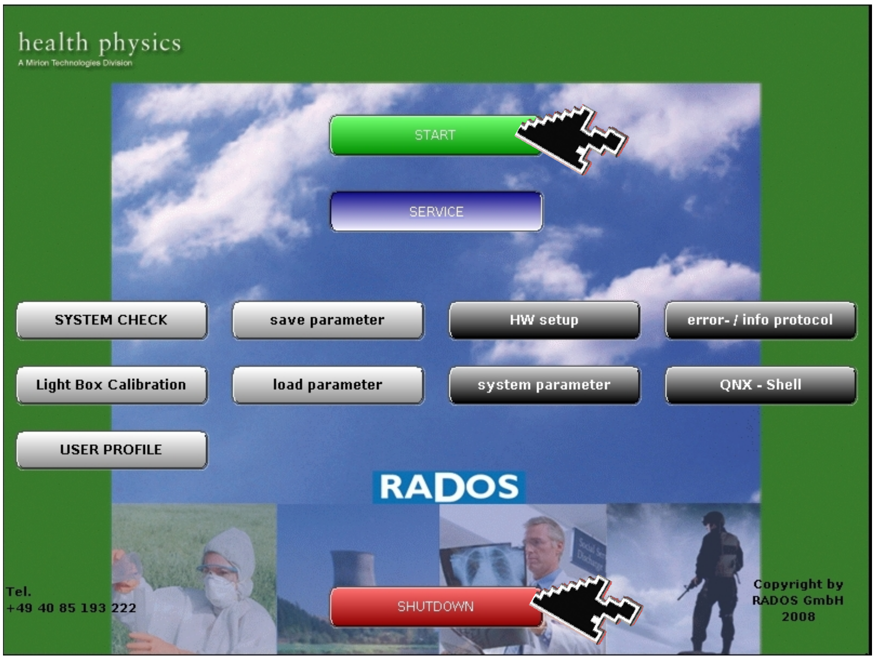



*Figure 4-1: Start-up menu*

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.

shutdown TwoStep™-Exit

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

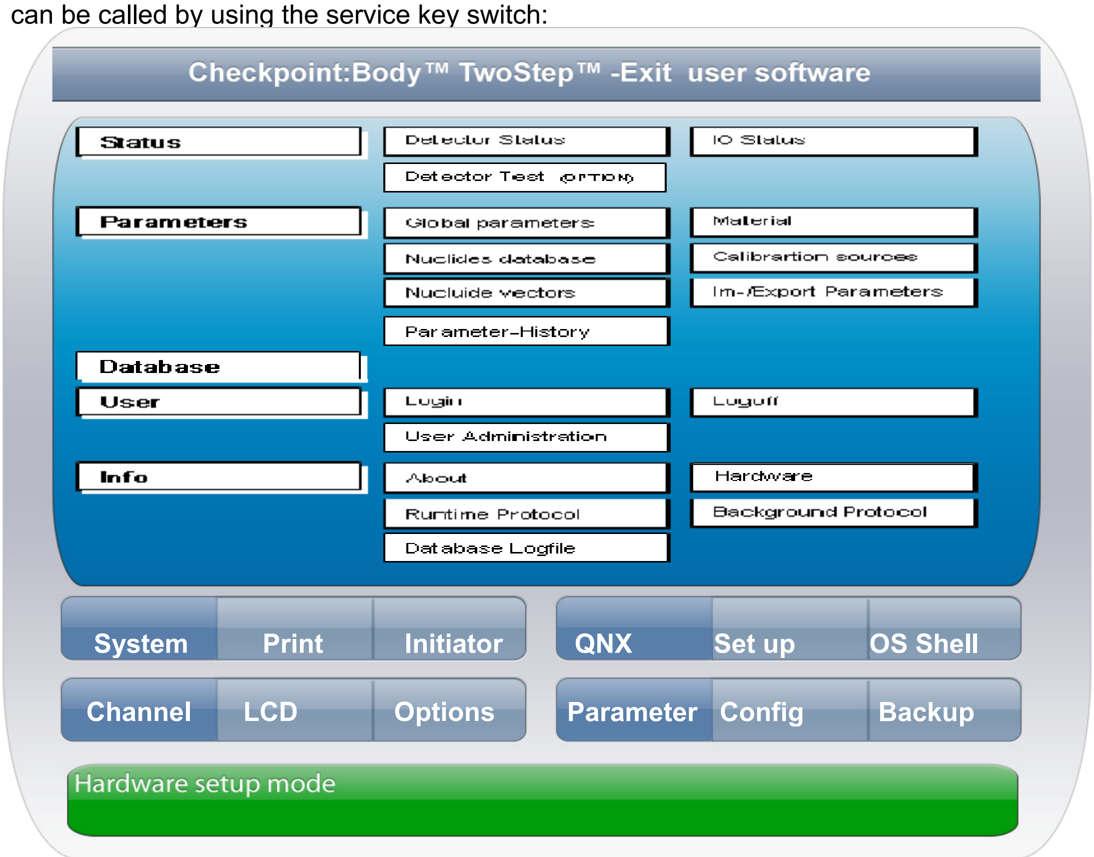



*Figure 4-2: Service menu overview*

### 4.1.2 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.**

## 4.2 Service main menu

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

Optional

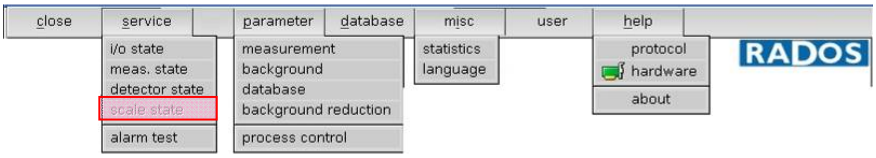



*Figure 4-3: Service main menu*

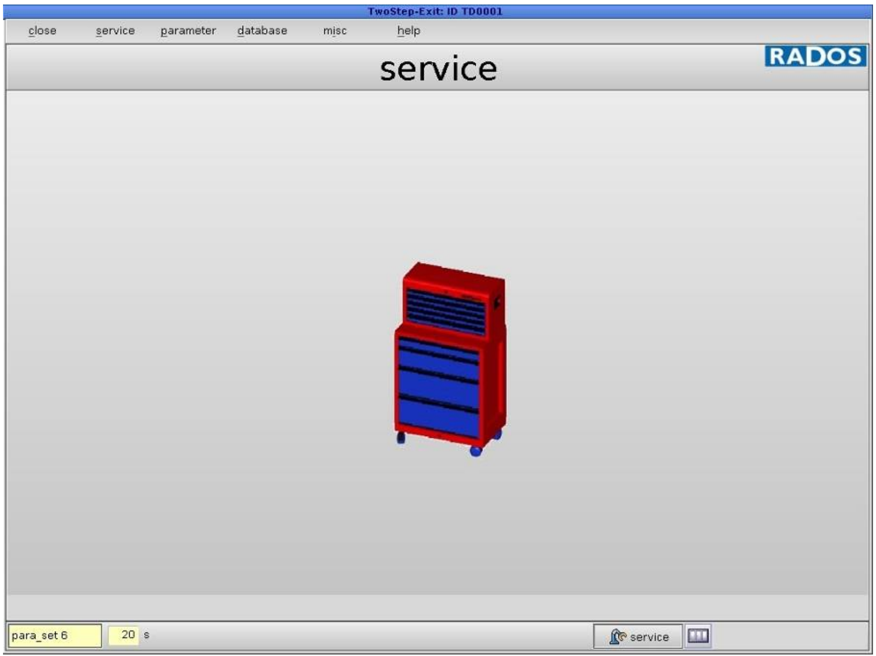



*Figure 4-4: Service main screen*

*Figure 4-5: Icons change operating language and print screen*

The main menu also displays two icons which enable the user to change between installed operation languages and to print a screenshot.

**NOTE**

If measurement parameters have been altered the user will be asked to save or discard the change with following query.

# 4.3 Out of operation conditions

The ***out of service*** mode allows the administrator of a contamination monitor to put the instrument out of service if outstanding maintenance or repair cannot be performed immediately.

The ***out of service*** mode can be activated by entering the service mode (use of service key) and pressing the out of service button. After turning the service key again, the monitor stays in the mode ***out of service***. It is displayed on the screen ***out of service- do not use***.


*Figure 4-6: Out of service button*

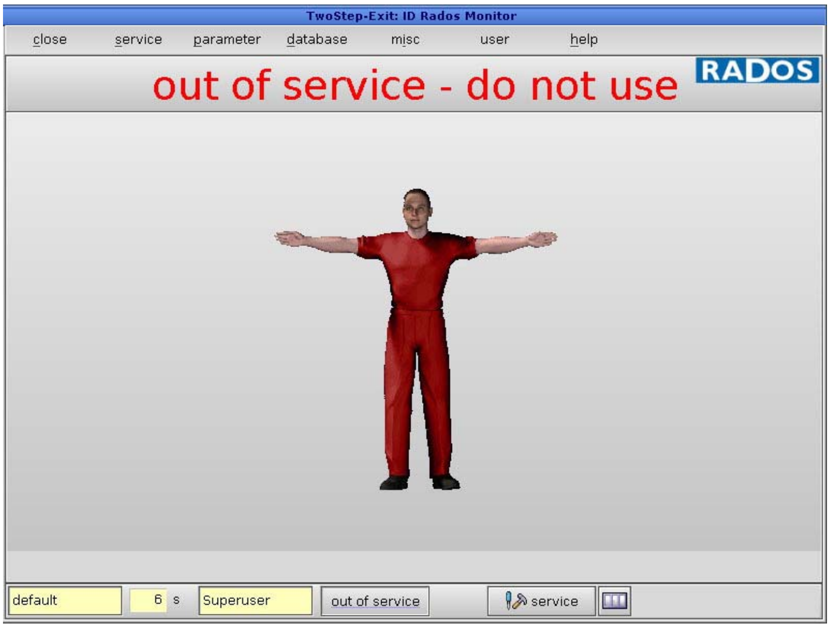



*Figure 4-7: Out of service button and service view*

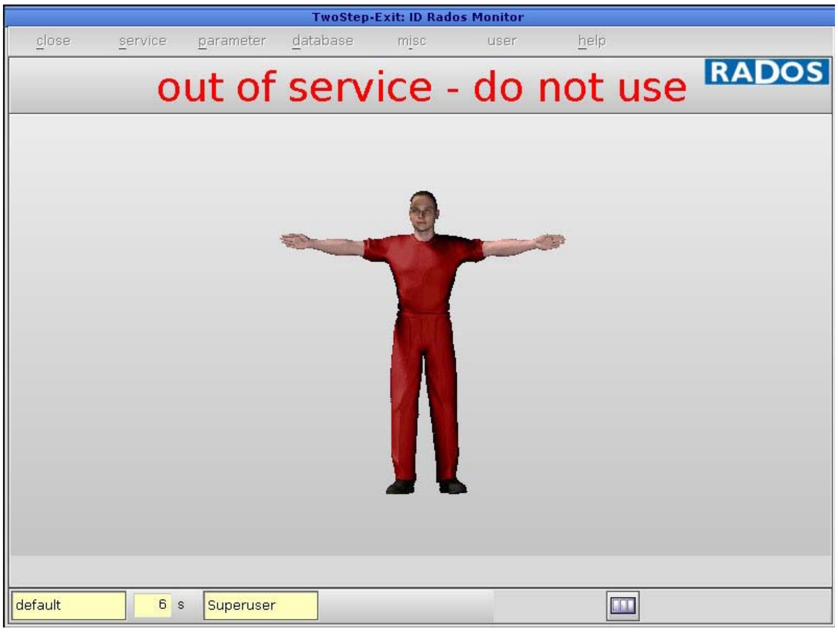



*Figure 4-8: Out of service mode*

## 4.4 Service (enter and exit)

When the key switch has been brought into the “Service“ position, a grey button, called ***“service”***, appears at the bottom of the display and the “service cart” is visible. The monitor is **not** 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.

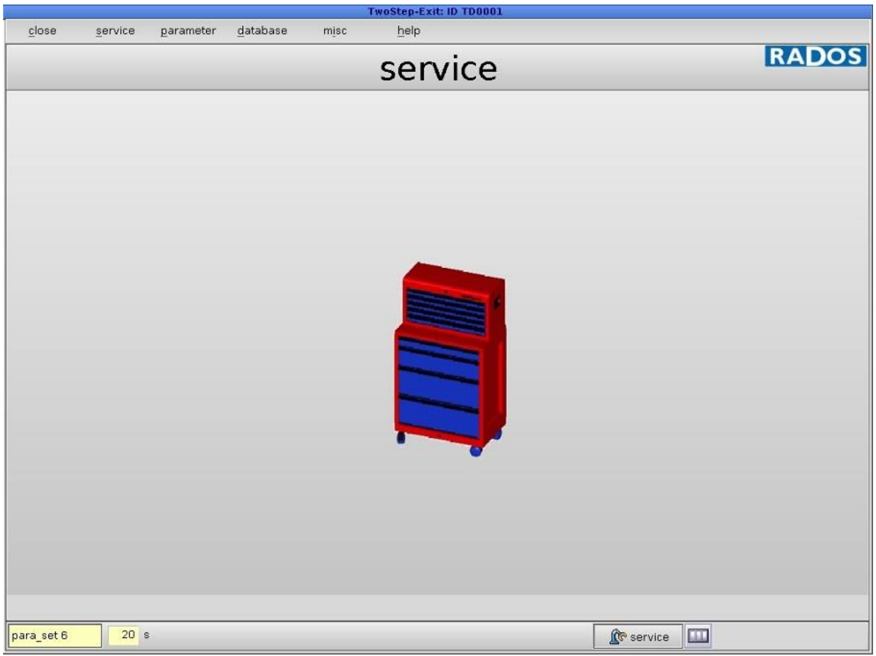



*Figure 4-9: Service mode – service*

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


*Figure 4-10: 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.

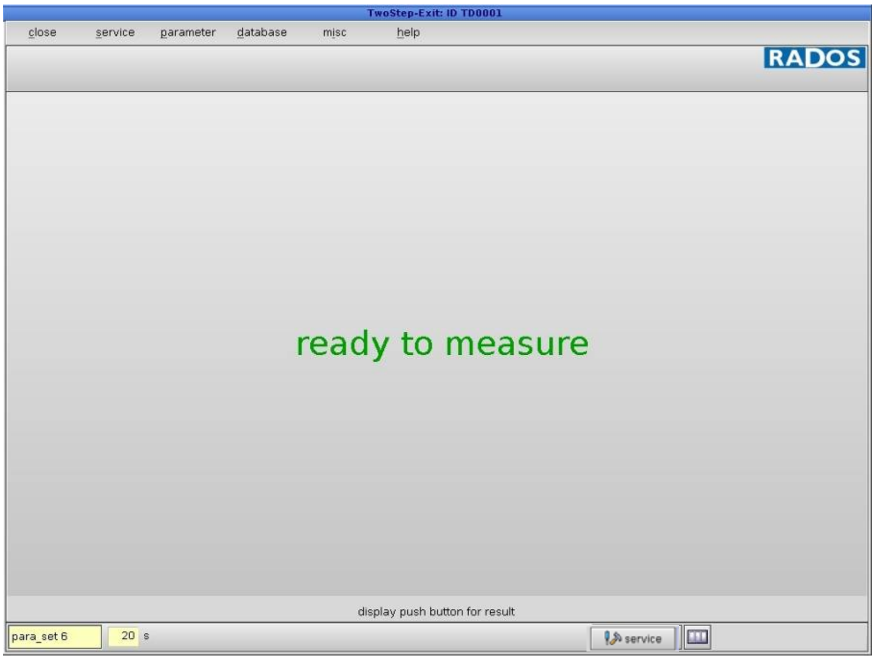



*Figure 4-11: Service operation - ready to measure*

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

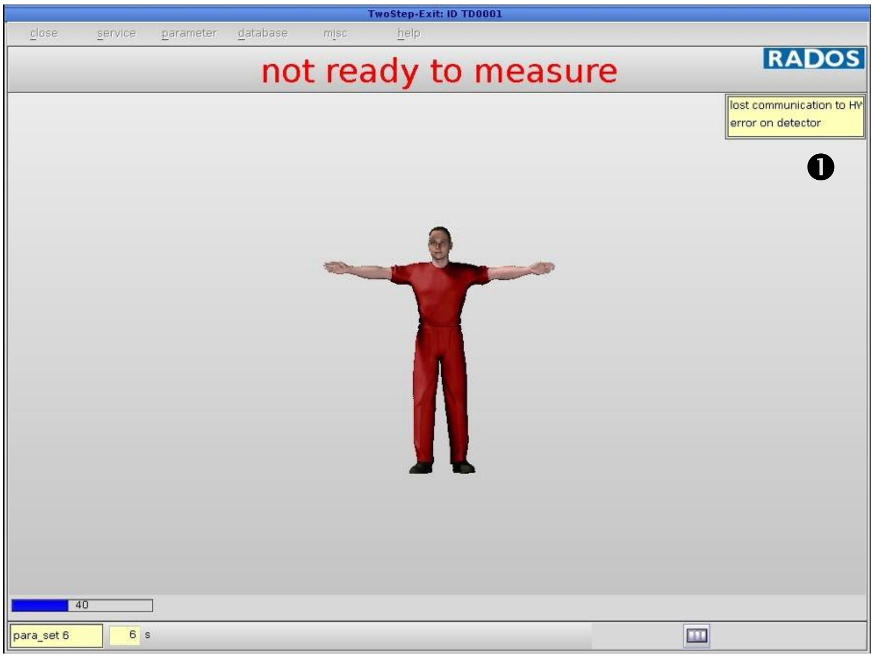



*Figure 4-12: Not ready to measure*

Should an error occur during the start, an error message appears on the main window➊. 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"***.

# 4.5 Service task bar

## 4.5.1 Input and Output test

The input and output test is available via the service mode menu ***service / I/O-test***.

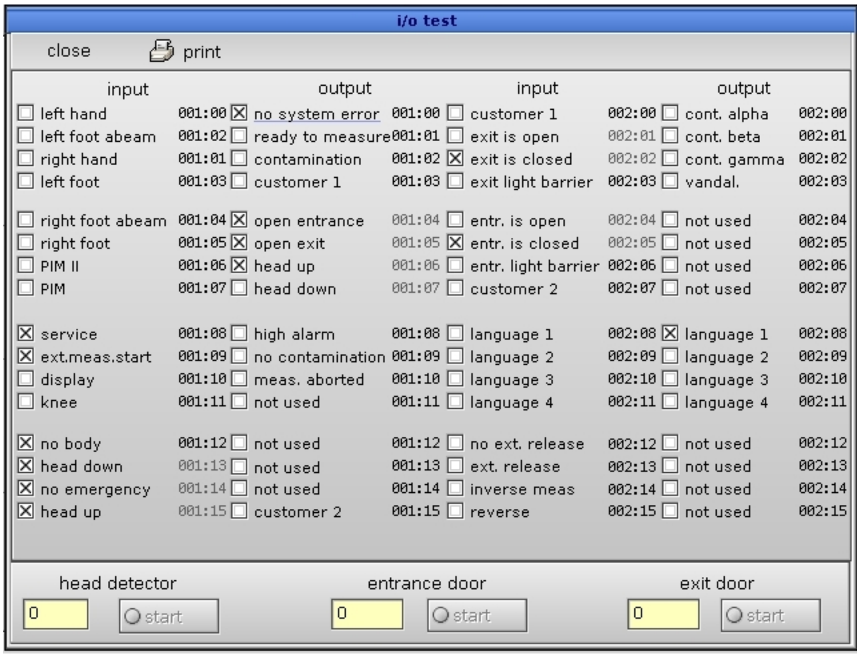



*Figure 4-13: I/O test*

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

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

The button **close**, exits the I/O menu.

# 4.6 Scale state

The scale status is called up via the menu ***service/scale state***

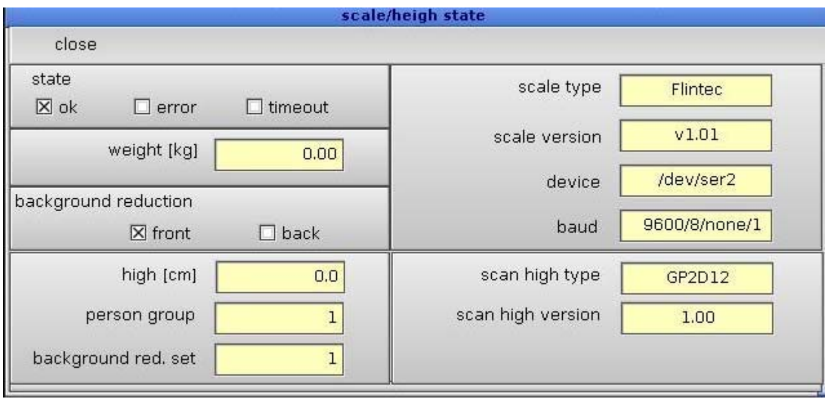



*Figure 4-14: I/O test*

**Scale state**

All digital inputs are continuously controlled and the states are displayed on the video display. The user cannot change the states.

The button **close**, exits the scale/height state menu.

## 4.6.1 Measurement status

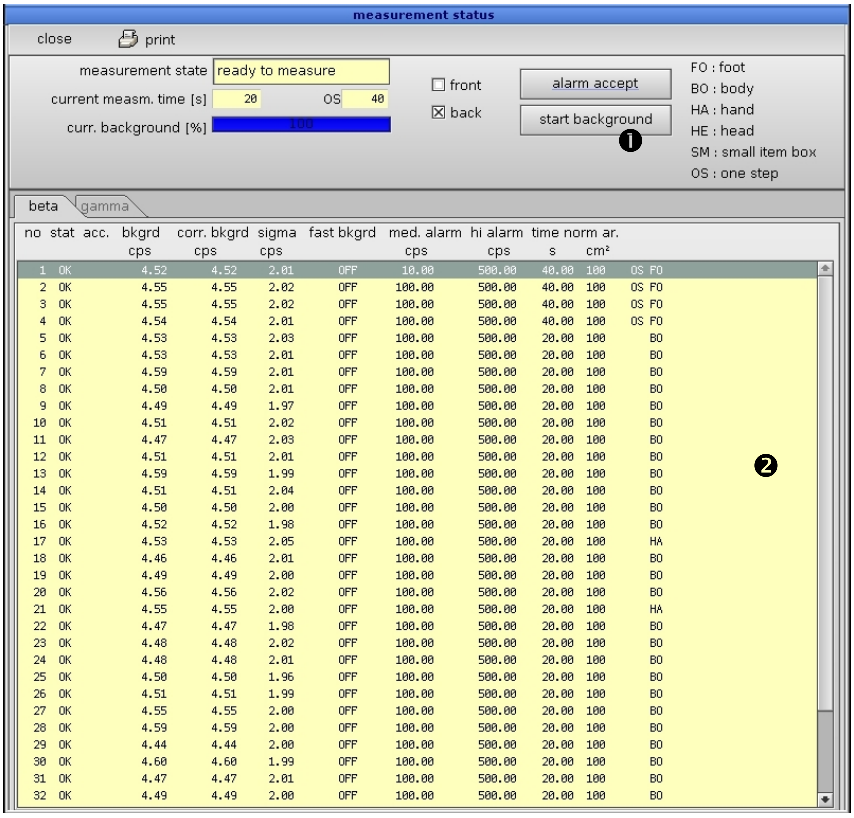
The measurement status is called up via the menu ***service/meas. status***. This **Service menu** is separated in two areas:

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

### 4.6.1.1 Measurement status of the monitors

The monitor may have following states of measurement:

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




| no | stat | acc. | bkgrd cps | corr. bkgrd cps | sigma cps | fast bkgrd | med. alarm cps | hi alarm cps | time s | norm ar. cm² | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | OK | | 4.52 | 4.52 | 2.01 | OFF | 10.00 | 500.00 | 40.00 | 100 | OS FO |
| 2 | OK | | 4.55 | 4.55 | 2.02 | OFF | 100.00 | 500.00 | 40.00 | 100 | OS FO |
| 3 | OK | | 4.55 | 4.55 | 2.02 | OFF | 100.00 | 500.00 | 40.00 | 100 | OS FO |
| 4 | OK | | 4.54 | 4.54 | 2.01 | OFF | 100.00 | 500.00 | 40.00 | 100 | OS FO |
| 5 | OK | | 4.53 | 4.53 | 2.03 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 6 | OK | | 4.53 | 4.53 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 7 | OK | | 4.59 | 4.59 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 8 | OK | | 4.50 | 4.50 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 9 | OK | | 4.49 | 4.49 | 1.97 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 10 | OK | | 4.51 | 4.51 | 2.02 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 11 | OK | | 4.47 | 4.47 | 2.03 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 12 | OK | | 4.51 | 4.51 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 13 | OK | | 4.59 | 4.59 | 1.99 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 14 | OK | | 4.51 | 4.51 | 2.04 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 15 | OK | | 4.50 | 4.50 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 16 | OK | | 4.52 | 4.52 | 1.98 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 17 | OK | | 4.53 | 4.53 | 2.05 | OFF | 100.00 | 500.00 | 20.00 | 100 | HA |
| 18 | OK | | 4.46 | 4.46 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 19 | OK | | 4.49 | 4.49 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 20 | OK | | 4.56 | 4.56 | 2.02 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 21 | OK | | 4.55 | 4.55 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | HA |
| 22 | OK | | 4.47 | 4.47 | 1.98 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 23 | OK | | 4.48 | 4.48 | 2.02 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 24 | OK | | 4.48 | 4.48 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 25 | OK | | 4.50 | 4.50 | 1.96 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 26 | OK | | 4.51 | 4.51 | 1.99 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 27 | OK | | 4.55 | 4.55 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 28 | OK | | 4.59 | 4.59 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 29 | OK | | 4.44 | 4.44 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 30 | OK | | 4.60 | 4.60 | 1.99 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 31 | OK | | 4.47 | 4.47 | 2.01 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |
| 32 | OK | | 4.49 | 4.49 | 2.00 | OFF | 100.00 | 500.00 | 20.00 | 100 | BO |

*Figure 4-15: Measurement status (example beta)*

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 meas. 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"***. ❶

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.

#### 4.6.1.2 Measurement status of each measurement channel

A list with following information, separated into respective windows for β- and γ-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** | - calculated alarm threshold for medium contamination [cps] |
| **high** | - calculated alarm threshold for high contamination [cps] |

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 |

For informational purposes the detector location can be found with a caption ❷ in this menu.

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

## 4.6.2 Detector state

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

This service menu is separated in four areas:

- ❶ Calculation of mean values
- ❷ Channel adjus™ent information
  HT (V)= High voltage photomultiplier
  TH. A = **A**lpha discriminator threshold
  TH. B = **B**eta discriminator threshold
- ❸ Display detector type and channel information
- ❹ Check light leakage in detector
- ❺ Deactivate coop board

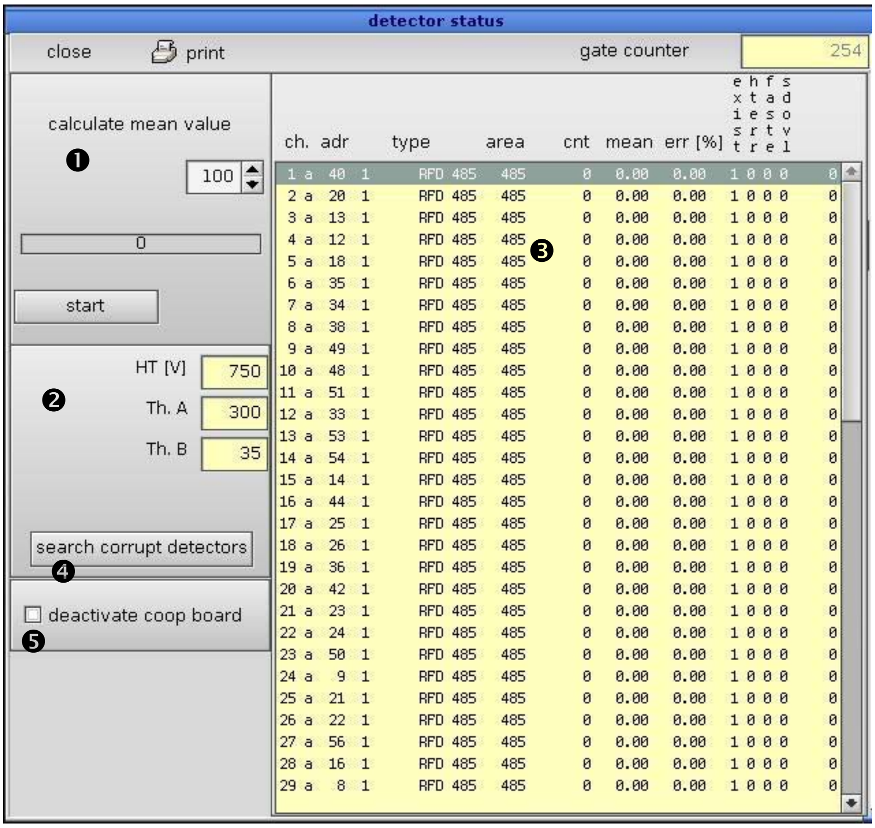



*Figure 4-16: Detector status*

### 4.6.2.1 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.

### 4.6.2.2 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 can not be changed by user.

**Display of detector type and channel information**

The detector and channel information measured by the electronics is displayed as followed:

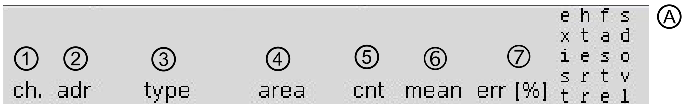



*Figure 4-17: Detector information*

| | | |
|---|---|---|
| **ch.** | ① | the number of channel within the monitor |
| **adr** | ② | address of the detector (firmly set on light guide box) |
| **type** | ③ | type of detector |
| **area** | ④ | area of detector |
| **cnt** | ⑤ | current net count rates per gate time |
| **mean.** | ⑥ | calculated mean value of the last 100 values count rates |
| **err. (%)** | ⑦ | default deviation in % referred to the current mean value |
| **Status of channel** | Ⓐ | |
| exist | | module is located by ATEWIS2000 and attached |
| hterr | | Status bit shows HT-Error. target/actual high tension for detector too high |
| faste | | Status bit shows HT-fast-disable-error. HT- fast-disable |
| sdovl | | Status bit shows counter-overflow-error. |

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.

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

*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 saved. On confirmation, the detectors will operate with the new settings.

### 4.6.2.3 Check light leakage in detector


*Figure 4-18: Leakage test*

The detector state menu also enables the user to perform an automatic selftest for light leakages in the detectors by actuating the button with the anouncement "**search corrupt detectors**".

The following selftest of the TwoStep™- Exit electronics will display a detector overview window in which every estimated failure or leakage will be displayed ❷. This information will be useful to find out which detector has to be checked or maintained.

The search corrupt detector test will be started with a mouse click on the button **start** ➊. The performed test and the result will be displayed ❸.

Please refer to register 8 to get knowledge about detector exchange or feel free to call the RADOS service team for assistance.

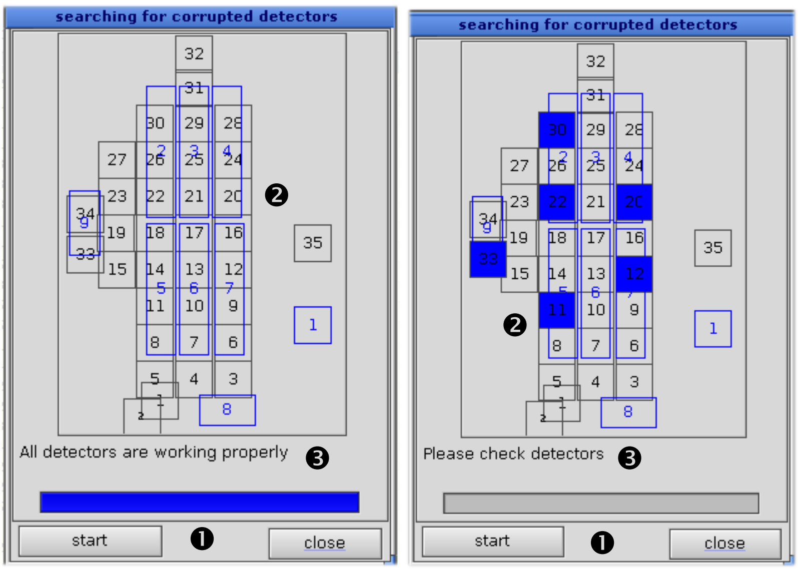



*Figure 4-19: Corrupted detector test gamma and beta (example OK and detector failure)*

### 4.6.2.4 Deactivate coop board

The detector state menu also enables to enable the coop board. This functions offers a possibility to test the function of the coop board as well as a equitation of measured and aggregated values.

# 4.7 Detector alarm test (option)

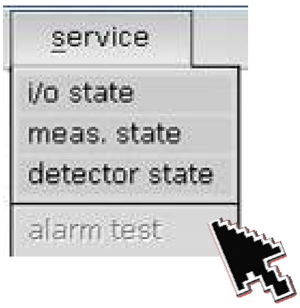



*Figure 4-20: Service menu*

The detector alarm test programm is 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.

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

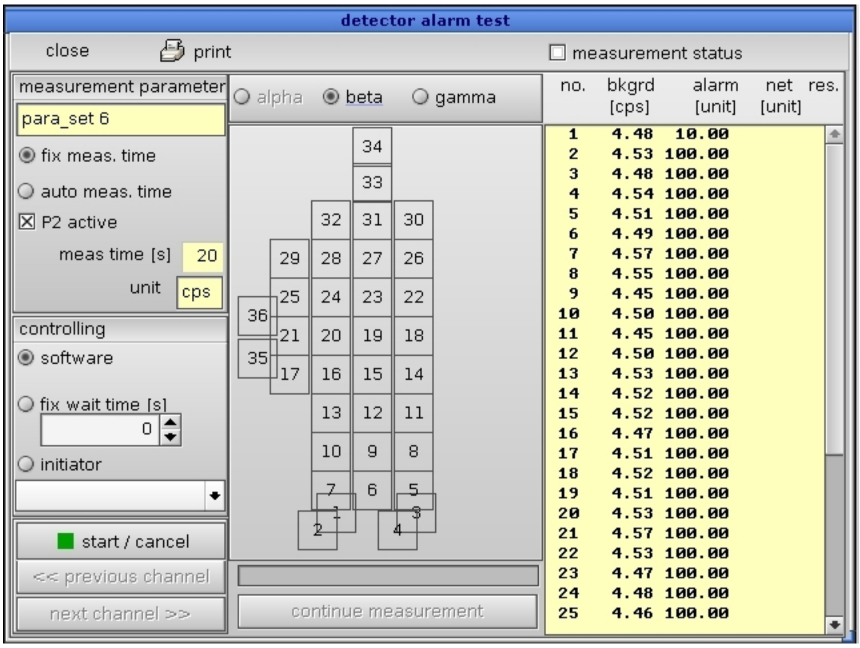



*Figure 4-21: Detector alarm test (example beta)*

**NOTE**

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

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.

Up to 15 different parameter sets can be created. For identification purposes each parameter set is provided with a name in the field *"parameter 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]
- p² active or inactive

Additionally the user (respectively test processor) can decide how the test process should be controlled.

## 4.7.1 Use of the detector alarm test

The detector alarm test is designed with the principle of measurement process in measurement mode, which means the TwoStep™- Exit 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 TwoStep™- Exit 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.

## 4.7.2 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 installed on the TwoStep™-Exit and the detector alarm test can not be performed. Please feel free to contact the RADOS service team for assistance on this matter.** |

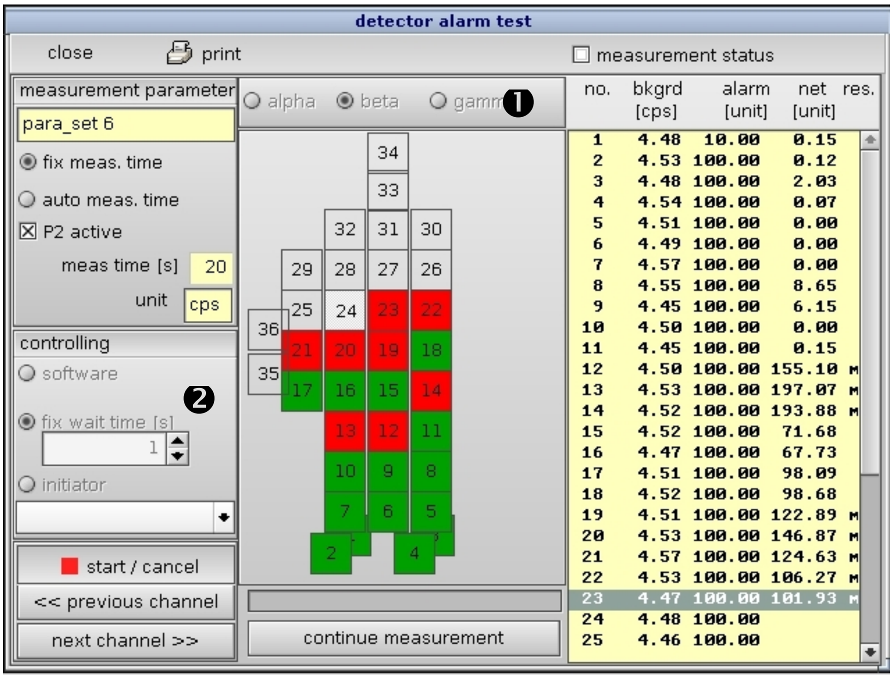



*Figure 4-22: Detector alarm test settings (screenshot for illustration only)*

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 3.5.2 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**).

## 4.7.3 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.

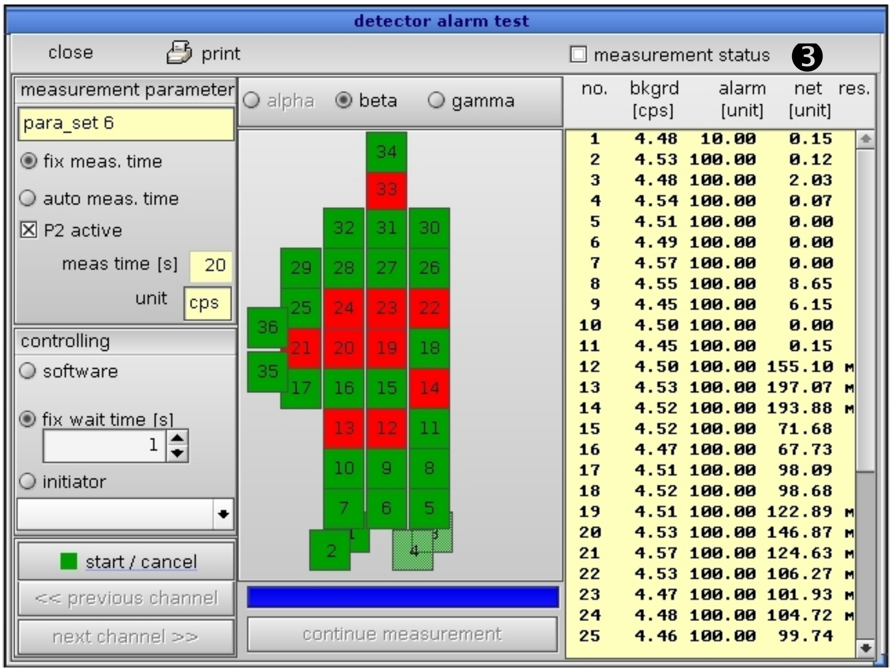



*Figure 4-23: Test results measurement values (screenshot for illustration only)*

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 white background (see channel 24 in figure 4-20).

If the counts of a measurement were below the set threshold, than the fields are in purple color 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 8 for example).

If the background color of a channel changes into pink, the high threshold was exceeded (see therefore channel 12 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.

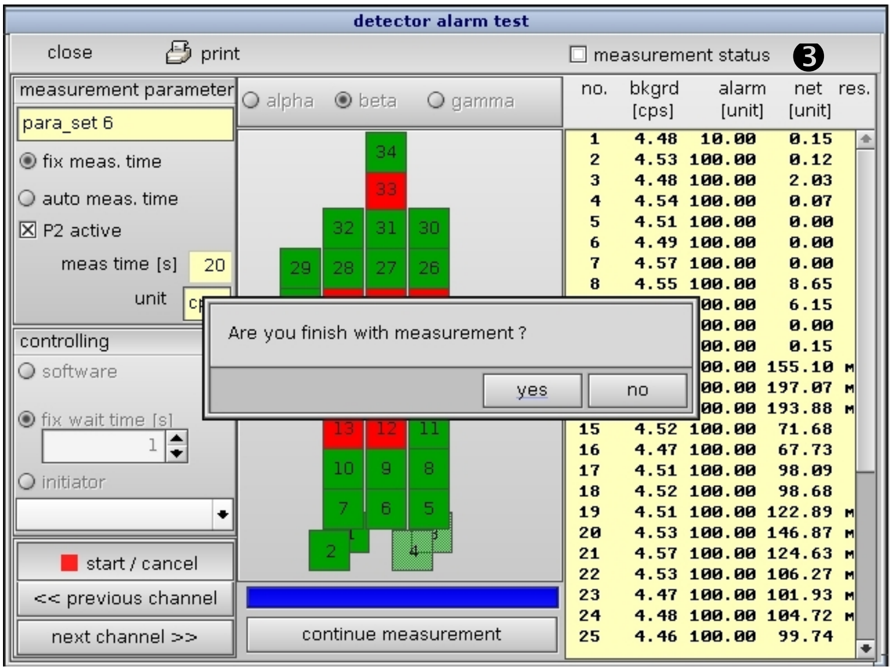
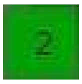


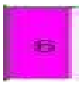

*Figure 4-24: Test results measurement values (screenshot for illustration only)*

<u>Caption of used colors</u>

next channel to be tested



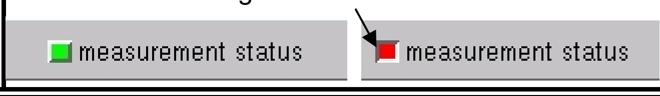
Measured values are below alarm threshold announcement: „no contamination"


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.



# 4.8 Parameter setting

## 4.8.1 Calculation of measurement time

The calculation of the measurement time is carried out automatically on users choice either in accordance with the regulations from the DIN 25482 part 1or to the MDA (minimal detection activity). The DIN paper and the MDA give calculation guidelines for the detection and the recognition limits for different measurement methods. From the given safeties, the background and the measurement time to be expected can be derived. This is not an exact function but rather a progression, which is however very close to the true value or leads to an overestimation of the measuring time.

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

## 4.8.2 Measurement parameters

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

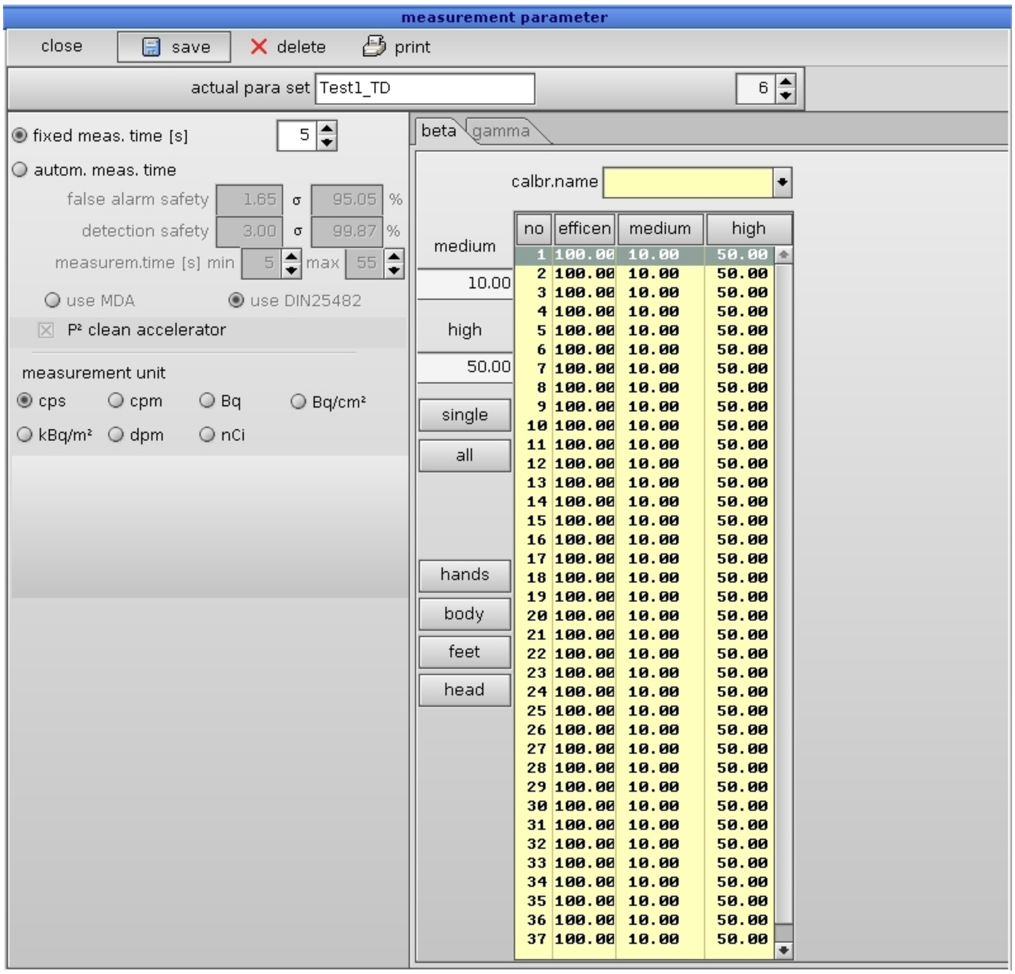



*Figure 4-25: Setting of parameters*

This menu is to be used for the display as well as the input of parameters which are relevant for the procedure of the person measurement.

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 entries, shown in the window on the left side, as:

- fixed or automatic measurement time (body measurement)
  - duration of the fixed measurement time [s]
  - safety against false alarm
  - safety of detection (only for automatic measurement time)
  - min. and max. measurement time (only for automatic measurement time)
- selection of the mathematical calculation base (MDA or DIN)
- selection of $P^2$ accelerator
- 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 (decays per minutes)
- Alarms

  The alarm values for the respective set of parameters can be defined. The values can be individually set for each channel.
  - medium contamination of the channel
  - high contamination of the channel

The activation (pressing) of one of the buttons ***"single"***, ***"all"***, ***"box"***, ***"hands"***, ***"body"*** and ***"feet"*** will alter the set alarm values for the individual channel or the chosen detector group.

The chosen parameter can be saved as a "**parameter set**". The name of the parameter set is shown in the right upper corner of the display.

## 4.8.3 Expiration of calibration

To meet the customer preferences for body contamination measurement the detector data of a calibration❷ performed with the system check detector calibration tool (Refer to Register 6) can be selected in the measurement parameter menu. This selection is based on measurement unit selection ❶ and will not be selectable for count rate display units like cps or cpm.
The expiration time of a calibration is defined during calibration measurement in the system check module and is only displayed for user information ❸ in this menu. This parameter is not changeable after completion of calibration.

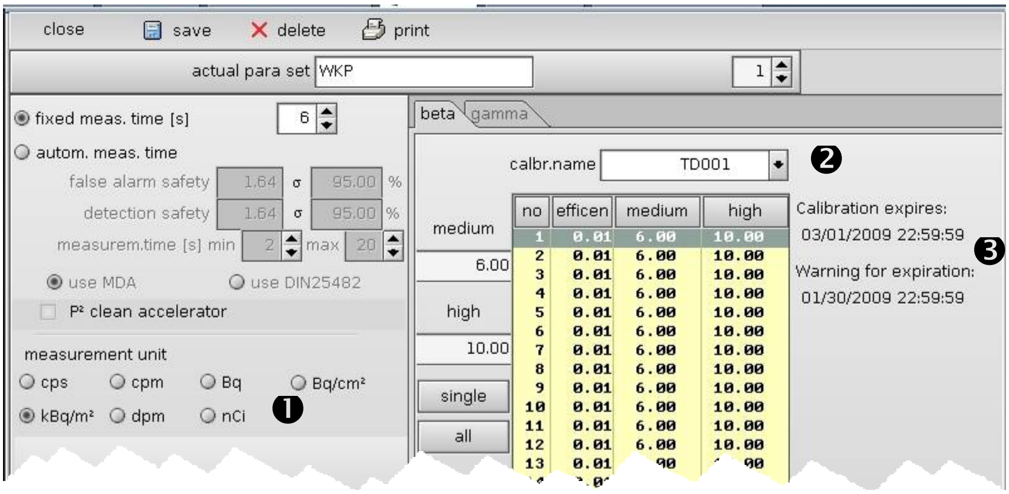



*Figure 4-26: Parameter setting detailed*

After the warning time for expiration has been reached the user is informed on the ready to measure screen about the expiration time.

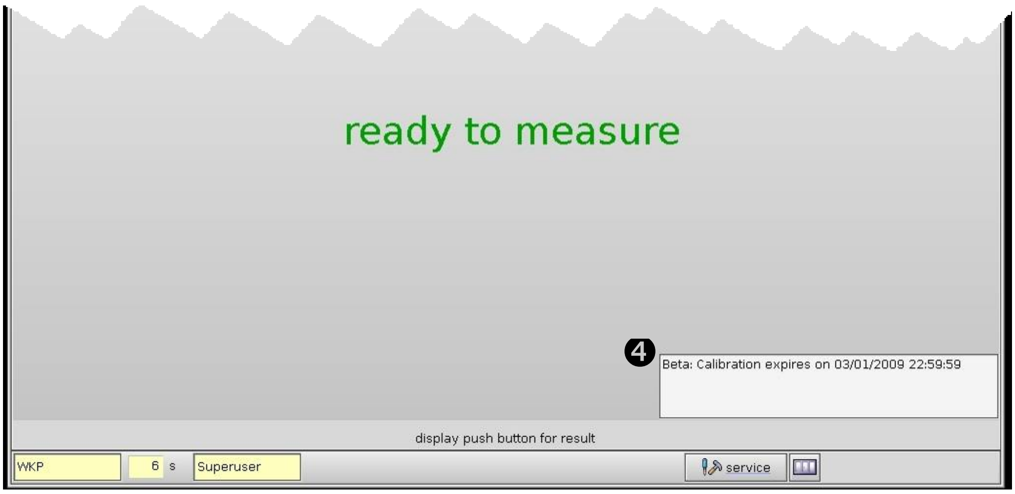



*Figure 4-27: Expiration time user information*

After the expiration time has exceeded the contamination monitor will start in “not ready to measure” mode and the monitor has to be recalibrated to be back in service.

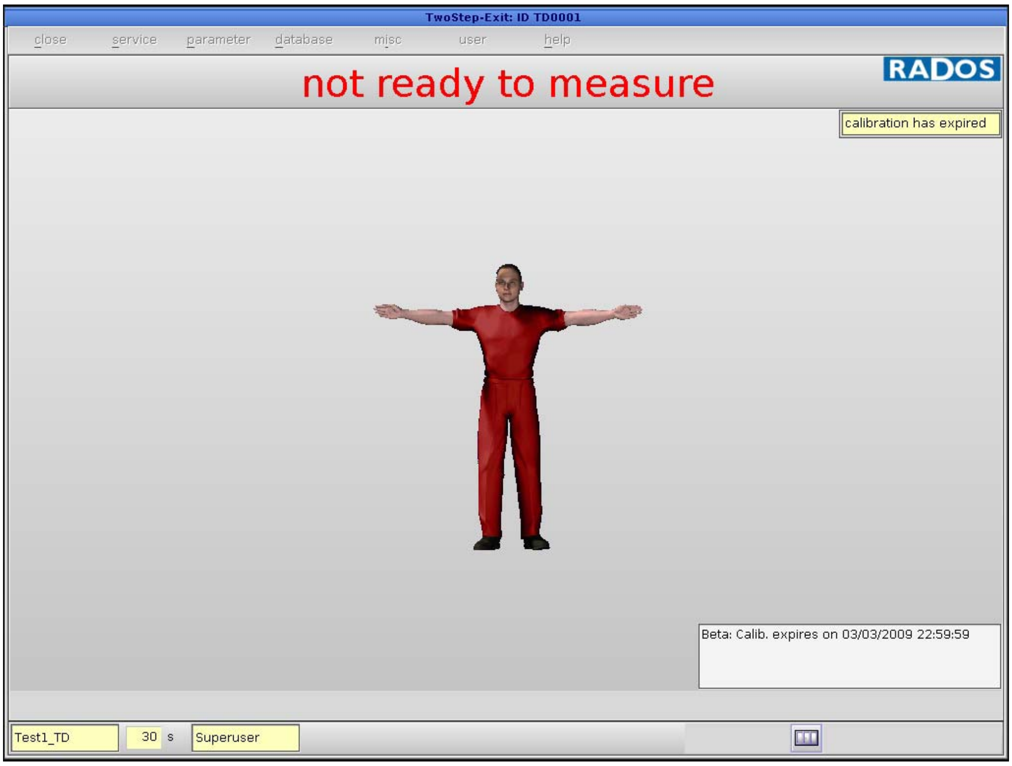



*Figure 4-28: Expiration time “not ready to measure”*

## 4.8.4 Background (min. / max. – alarm)

The parameters in this menu set the monitor readiness for operation. Under certain circumstances unfavorable values can lead to the fact that the unit is not longer ready to operate.The background parameters can be modified in the running service mode via the menu **parameter / background**.

If the measured background is outside of the range, either a faulty or contaminated detector can be assumed or the presence of a source in the range of the detectors lead to a higher background. The entered alarm limits are always based on **750 cm²** (see note). Subsequently, 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** or respective the message **increased background** is displayed.

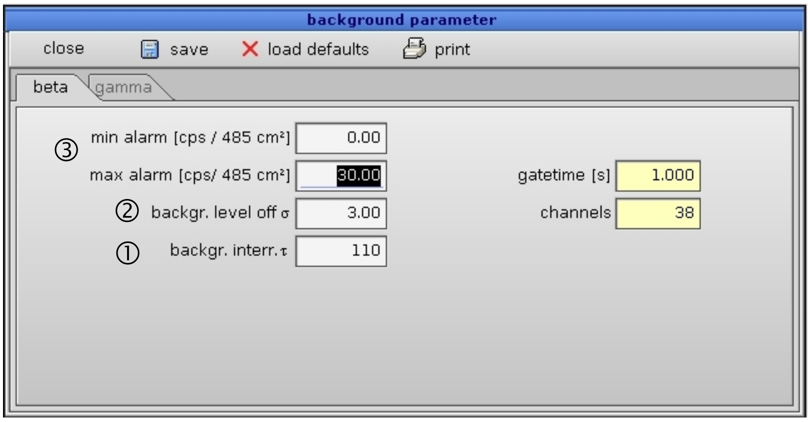



*Figure 4-29: Beta  background parameters*

**Beta**
- ☐ β - min alarm [cps / 485 cm$^2$]
- ☐ β - max alarm [cps / 485 cm$^2$]
- ☐ β - Background level-off [σ]
- ☐ β - Background interr [τ => sec]

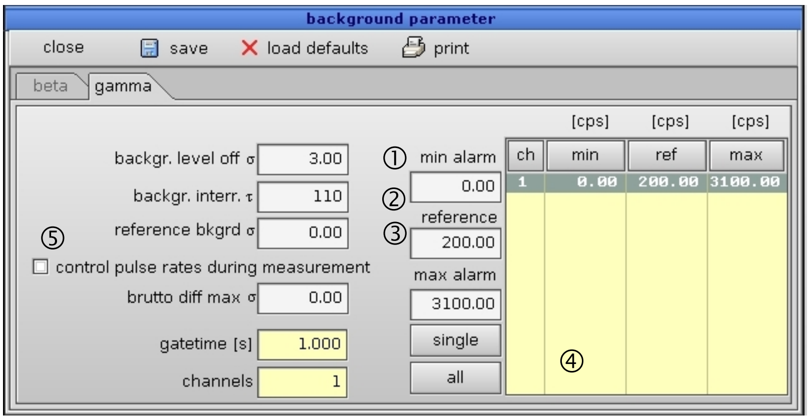



*Figure 4-30: Gamma background parameters*

**Gamma**
- ☐ γ - min alarm [cps]
- ☐ γ - max alarm [cps]
- ☐ γ - Background level-off [σ]
- ☐ γ - Background interr [τ => sec]

The parameters in detail:

① **background level off σ** Width of the permitted standard deviations for the background measurement before the background measurement is stopped. The value is set as sigma factor.

② **background interr. τ** Determines the tolerated number of cycles in which the background measurement values are outside the sigma tube. After these cycles have been performed the monitor automatically re-initializes itself to learn the new significantly changed background. This is indicated by a correspondent message on the display.

③ **MIN-reference-MAX-Alarm** If a counting rate, which has been adjusted at a low (MIN), high (MAX) value, is reached, it can be assumed that there are problems at the detector channel and that it is impossible to carry out further measurements. In this cases the unit is not longer ready to measure and has to be switched in "**conditionally ready to measure**" mode (see section measurement status). If a counting rate, which has been adjusted to a reference value in counts per gate time, is reached, a radiation due to source presence can be assumed and the monitor is switched in "**increased background**" mode.

**NOTE**

**The "increased background" mode will be displayed with a yellow status line in the main measurement menu. This message is for user informational purposes, the monitor is still "ready to measure" with the increased background.**

<u>**RADOS recommended basic parameter adjustment:**</u>

**Basic** If the during the background update the measured values are out of the sigma tube without recognition of an object to be measured by the light barriers, the time is counted. If this value exceeds the set limit of 11seconds, it is assumed that the user accepts this situation. For a period of time which is necessary to learn the current background, the device is not ready to operate. In this case it is not distinguished whether there is a decrease (caused by a shielding) or an increase (caused by additional radiation) of the background.

**MIN** 50 % below the expected background.

**reference** 20 % above the expected background.

**MAX** 200 % above the expected background
(Always considering that an actual radiation can lead to the same value).

## 4.8.5 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.

Therefore, it is possible to state an individual shielding value $H_i$ in percentage for each detector 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 $R^k_0$ as follows:

$$R^k_0 := R_0 * ( 1 – G * H_i)$$

Normally the global factor is set to 100 per cent, i. e. the stated shielding per channel is applied in full. A setting of 80 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.

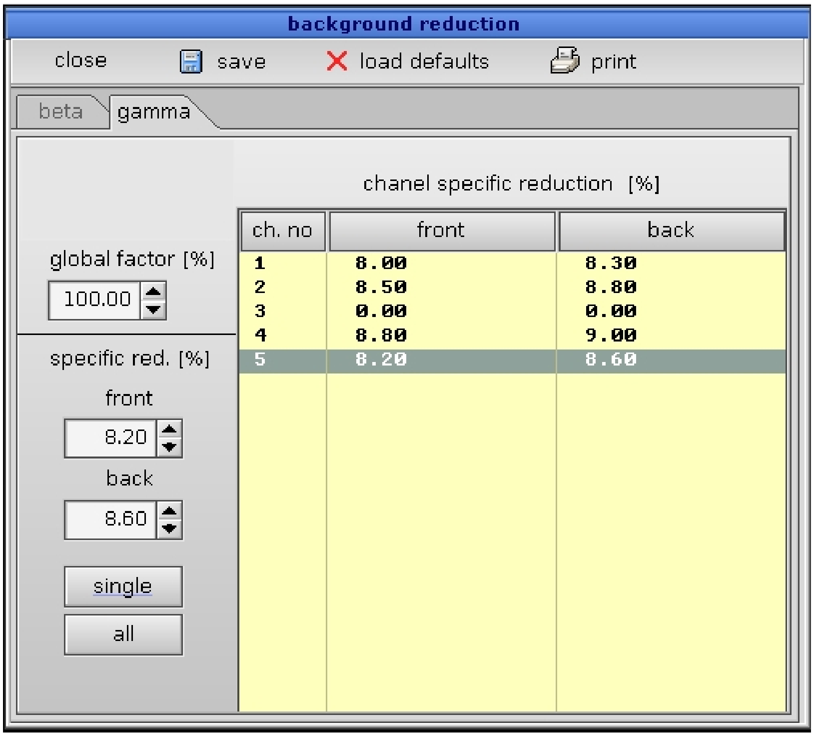



*Figure 4-31: Background reduction*

## 4.8.6 Database

### 4.8.6.1 Database parameters (general)

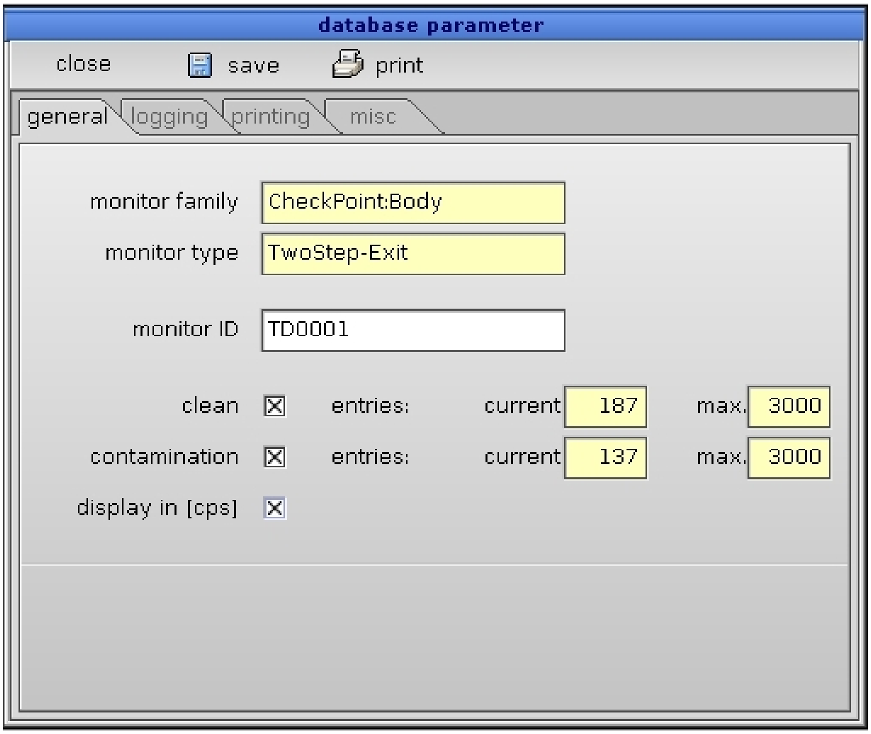



*Figure 4-32: Database entries (general)*

- Monitor ID:
  In this field an unequivocal name for the monitor can be entered (i.e. serial no.).
  The entry is user defined 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.
- Clean/Contamination:
  By activating the fields "**clean**" or "**contamination**" the respective measurement results will be saved into the database.
- 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.

## 4.8.6.2 Database entries (logging)

All measurements can be saved as a log file and later be copied onto a USB-stick. 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 further be processed (see 4.8.7.5).

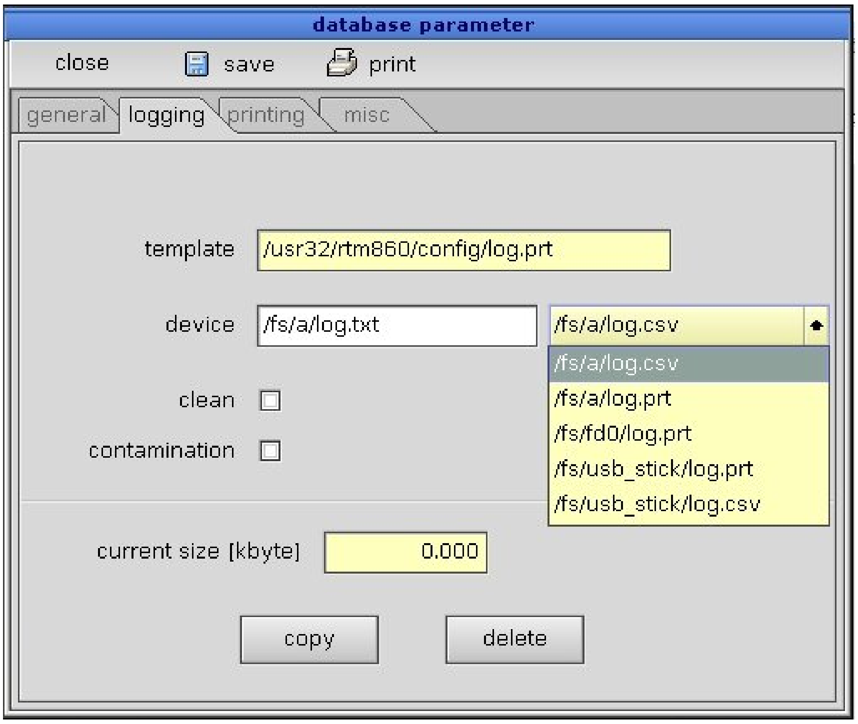



*Figure 4-33: Database entries (logging)*

The field "**current size [Kbytes]** "shows the current size of this log file. It is possible to decide which measurements are entered in the log file by selecting the fields "**clean**"(no contamination) or "**contamination**".

If ***"copy"*** is selected, the current log file could be copied to a USB stick. If the log file is larger than the memory capacity of the save media, then the file can be split up into a sufficient number of files.

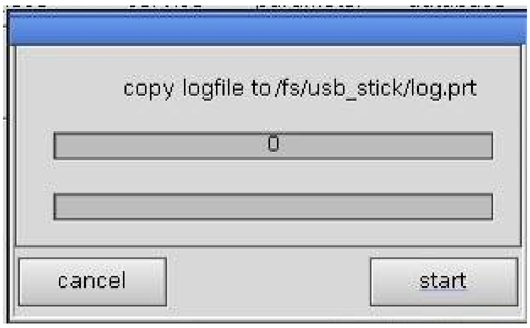



*Figure 4-34: Progress window for data copy*

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

#### 4.8.6.3 Record printout (printing)

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

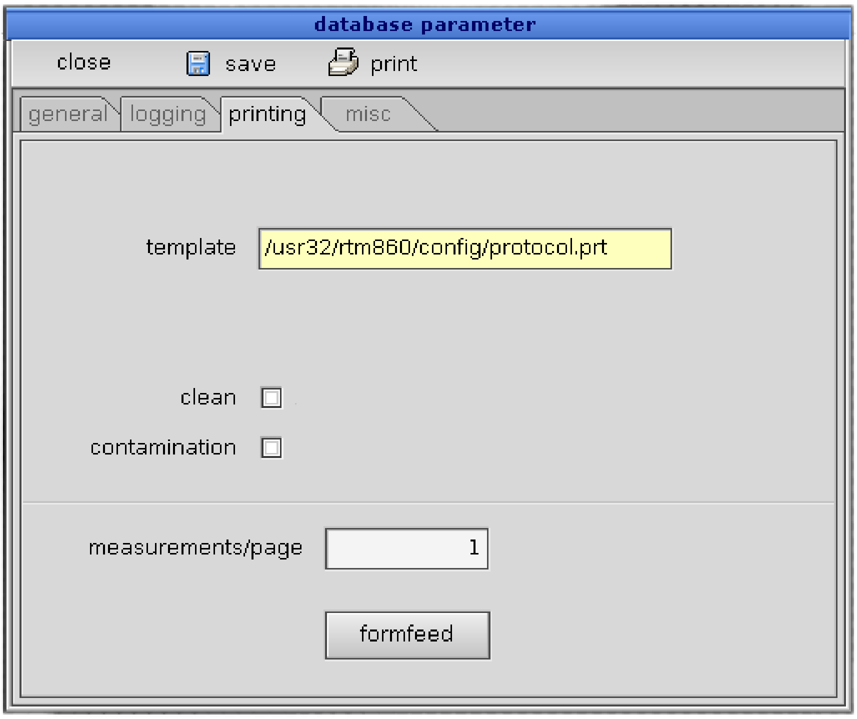



*Figure 4-35: Database entries (printing)*

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.

### 4.8.6.4 Misc

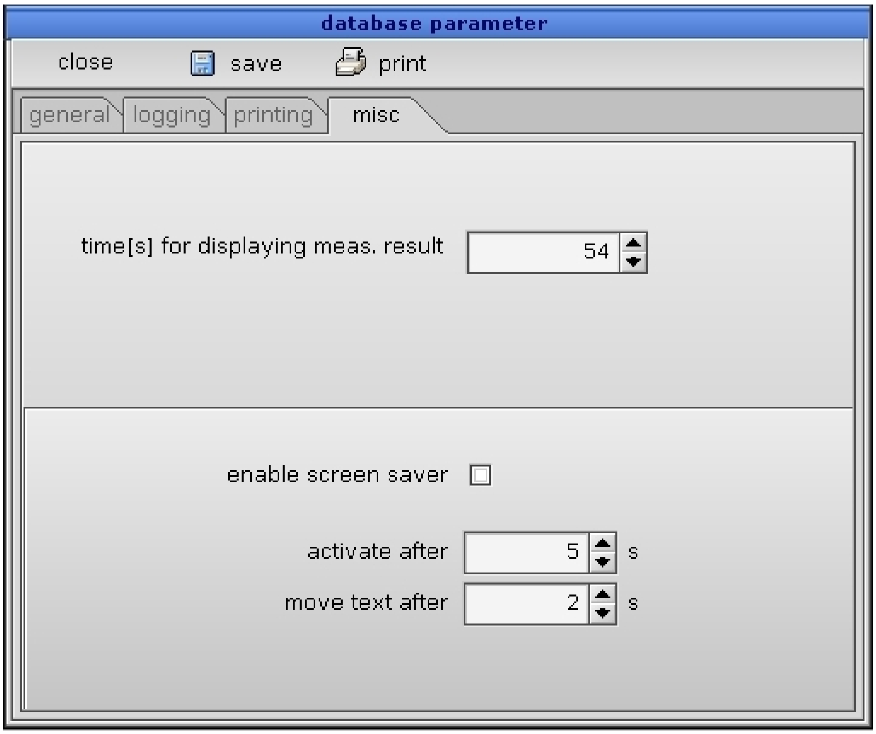



*Figure 4-36: Database entries (misc)*

- 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.

- Enable screensaver:

  The parameter defines the time to activate the screensaver, while no action is taken on the contamination monitor

## 4.8.7 Process control parameter

### 4.8.7.1 Custom specific output

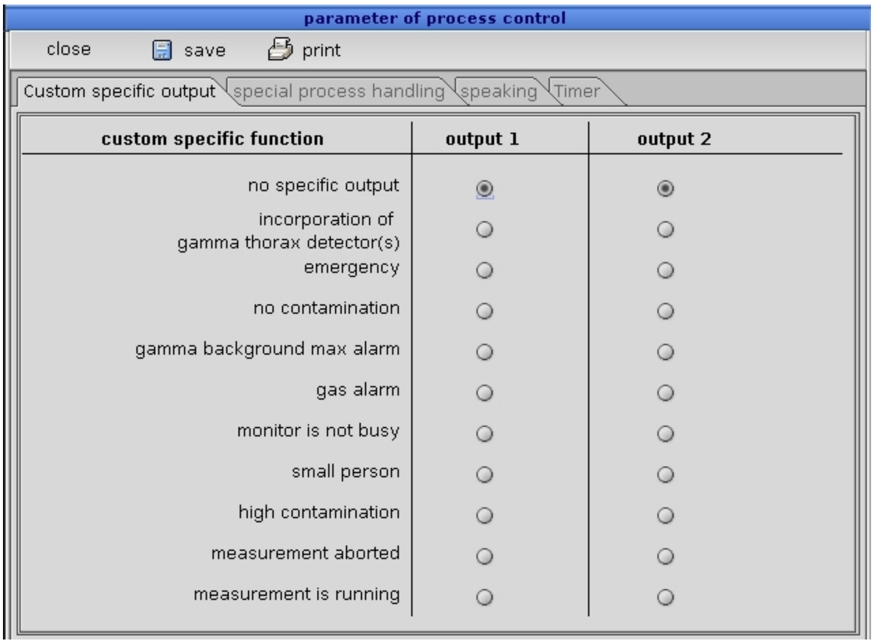



*Figure 4-37: Process control parameter – Custom specific output*

The Health Physics product family with the CheckPoint:Body™ contamination monitors offers 2 allocatable relays which individually be reserved for special procedures notices to meet the customers preferences. The customer specific relay allocation can be chosen in this menu.

### 4.8.7.2 Handling of special procedures

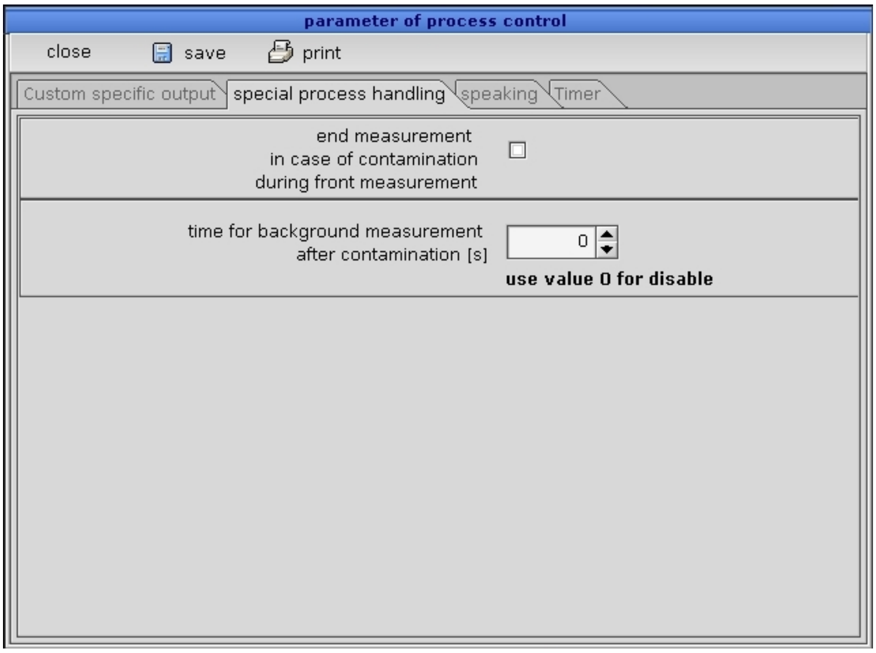



*Figure 4-38: Process control parameter – Handling of special procedures*

The personnel measurement mode the Two Step™ contamination measurement methodology is used. In this aspect special procedures for the second measurement step can be allocated if the measurement results of the first step lead to contamination:

- END measurement → measurement of persons back is not necessary as contamination is already detected.
- REDUCE second step → measurement of persons back is shortened as contamination is already detected.

| NOTE |
|---|
| **For foot measurement the One Step™ measurement methodology is.**<br>**The foot measurement time therefore takes place during front <u>and</u> back measurement.**<br>**If the measurement should ended or be REDUCEd the ongoing foot measurement leads extends the measurement end (no instant stop).** |

### 4.8.7.3 Speak sequences

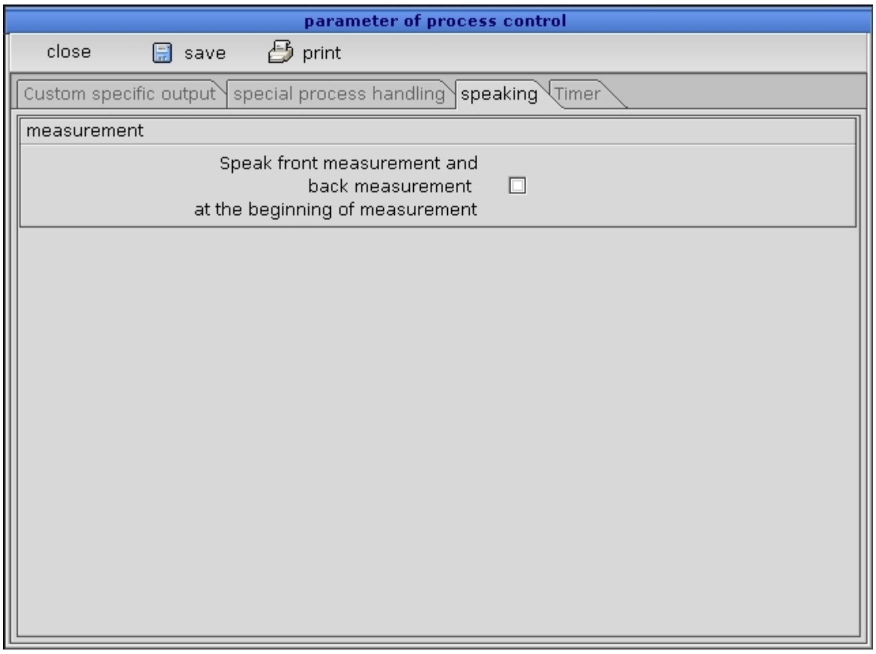



*Figure 4-39: Process control parameter – Speaking*

The personnel measurement mode the Two Step™ contamination measurement methodology is used. In this aspect the announcement of measurement phase to the user can be customer specific allocated.

### 4.8.7.4 Timer

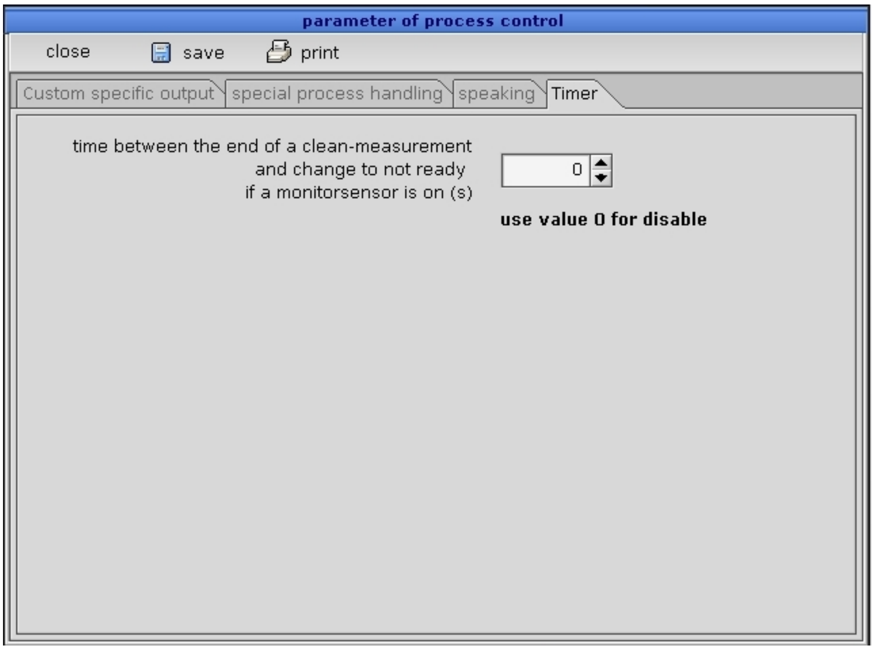



*Figure 4-40: Process control parameter – timer*

The time to leave the CheckPoint:Body™ monitor can be adjusted to meet the customer preferences.

### 4.8.7.5 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 figure below)

1. activate: **delimited**, start from row **1**, file origin: **Windows (ANSI)**❹
2. Delimiters: **Comma** 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

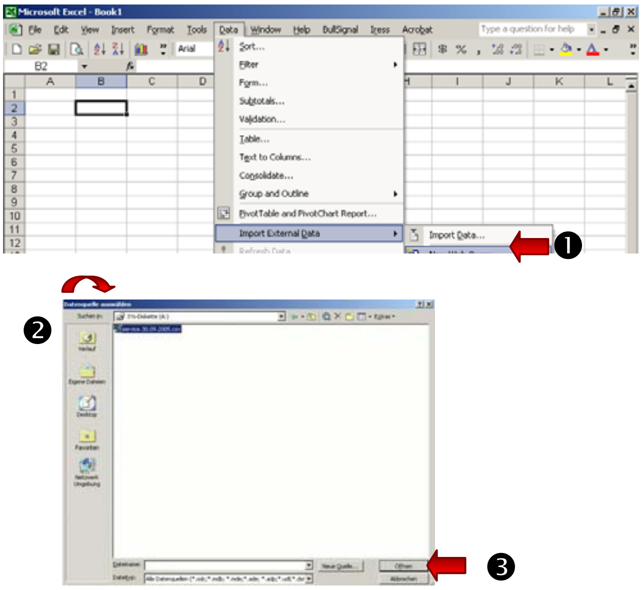


*Figure 4-41: Data import to MSExcel©*

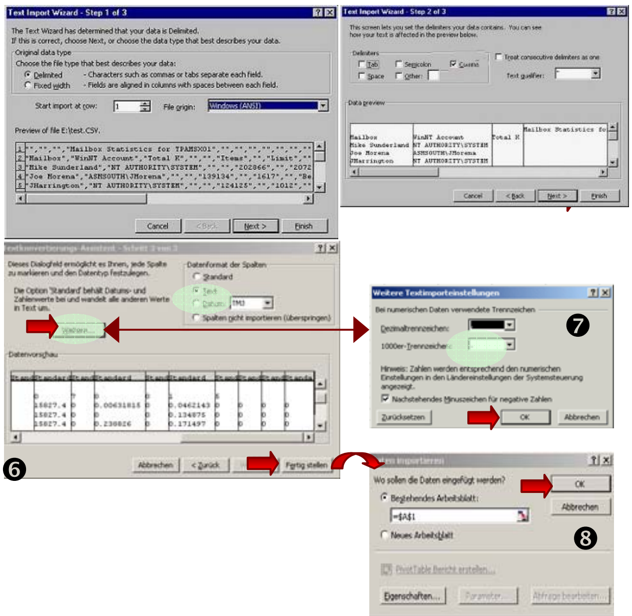


*Figure 4-42: Data import assistant in MSExcel©*

## 4.9 Database

The window shows the measurement results saved in the database.

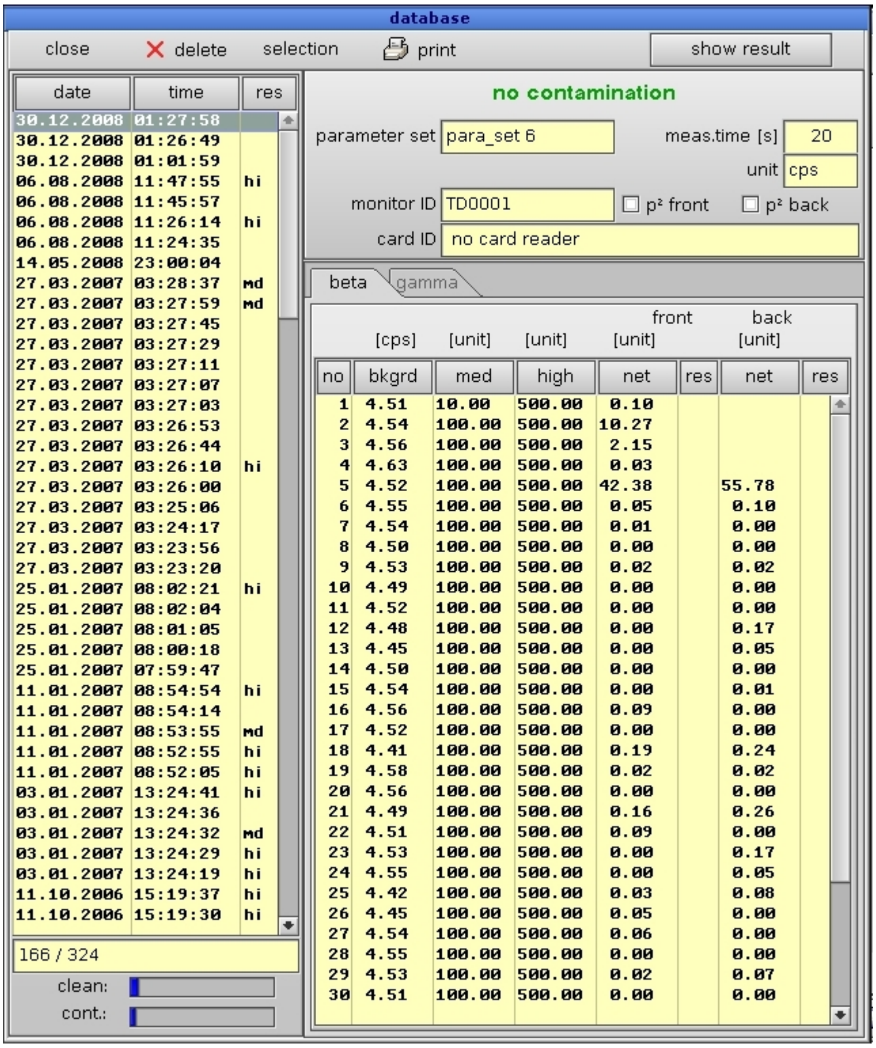



*Figure 4-43: Database*

In the left window all measurements are displayed with a timestamp and a mark (little star) in case of contamination.
If the cursor is moved within this window, the measurement values of the individual channels are displayed at the right hand side.
It is possible to delete selected database entries by clicking the button ***"delete"***.

The button "**show result**" enables the measurement result display of the chosen measurement.

## 4.9.1 Selection criteria

A selection of the displayed datasets may be done due to time, identification features or measurement results.

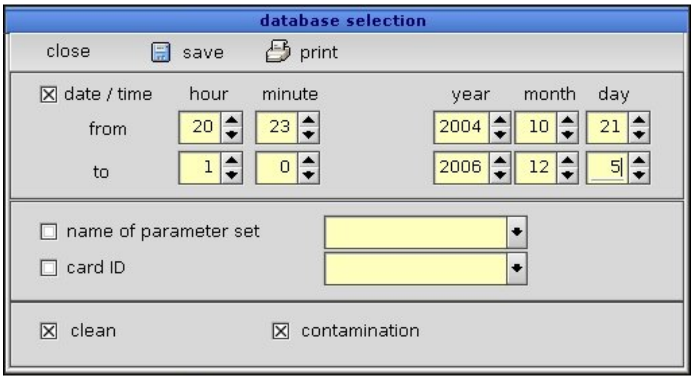



*Figure 4-44: Database selection*

## 4.9.2 Results display

The button display shows a graphical display of the measurement results saved in the database.

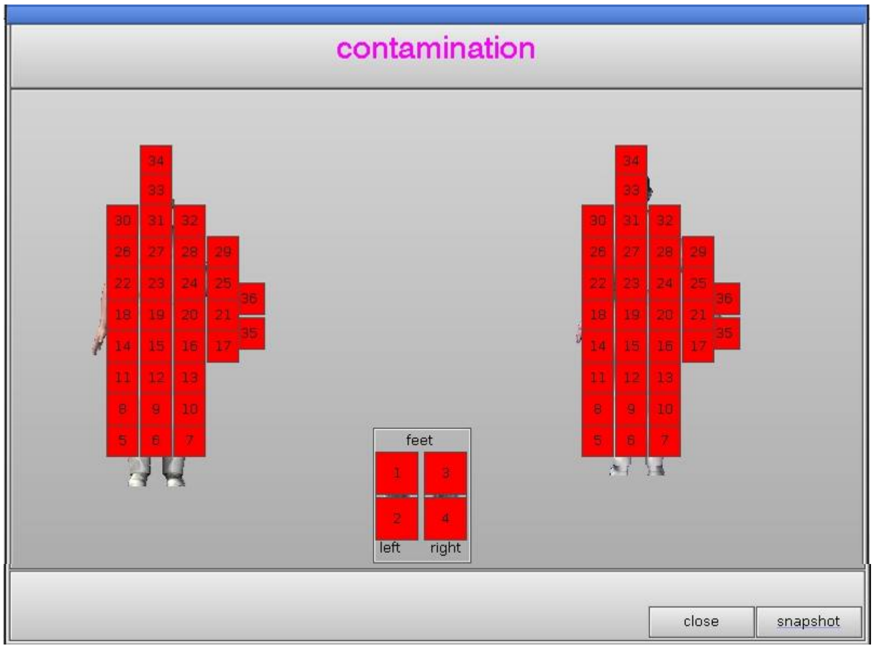



*Figure 4-45: Results display*

# 4.10 Misc

## 4.10.1 Statistics

The statistic is entered via the service 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 while the bottom window reflects the total operating time since set up of the monitor.

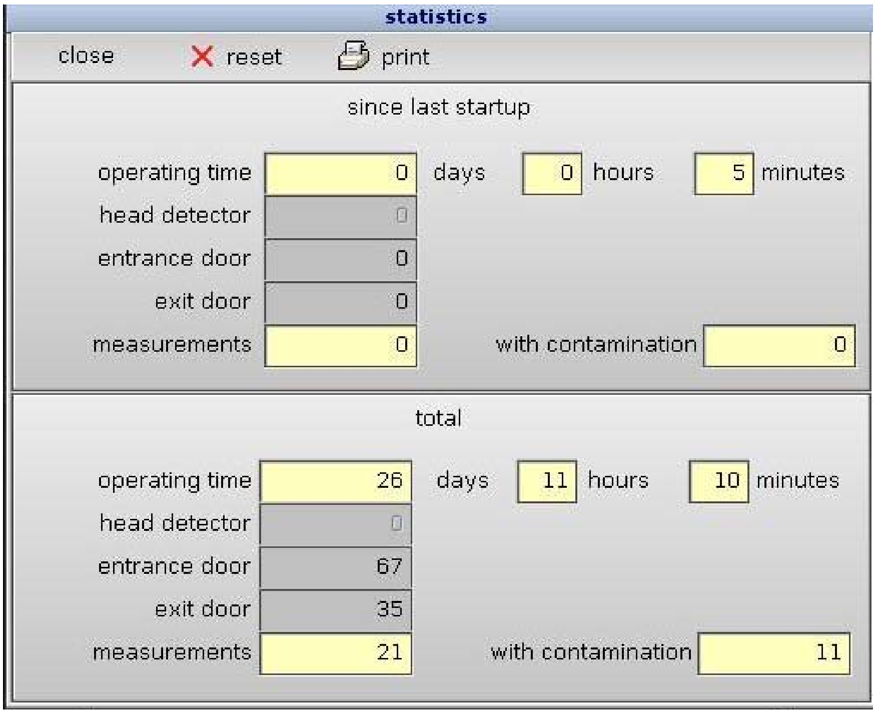



*Figure 4-46: Setting statistics*

Duration of the operation:

- ☐ days, hours, minutes

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

- ☐ head detector (option)
- ☐ entrance door (option)
- ☐ exit door (option)
- ☐ 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 not be set back to "0".

## 4.10.2 Language

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

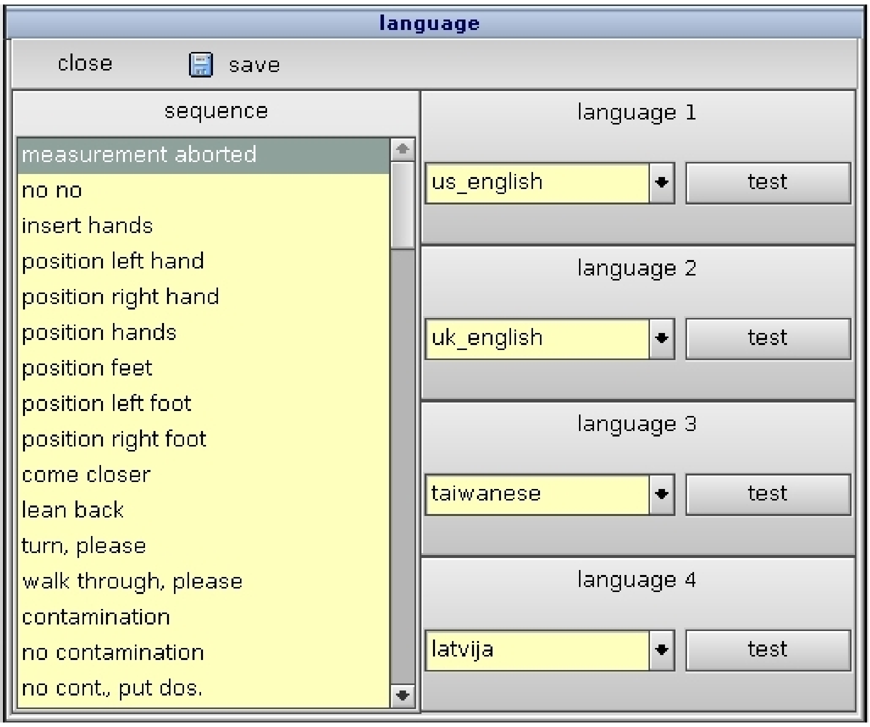



*Figure 4-47: Setting language*

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 installed language.

# 4.11 Help

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

- Protocol
- Hardware
- About (Info)

## 4.11.1 Protocol

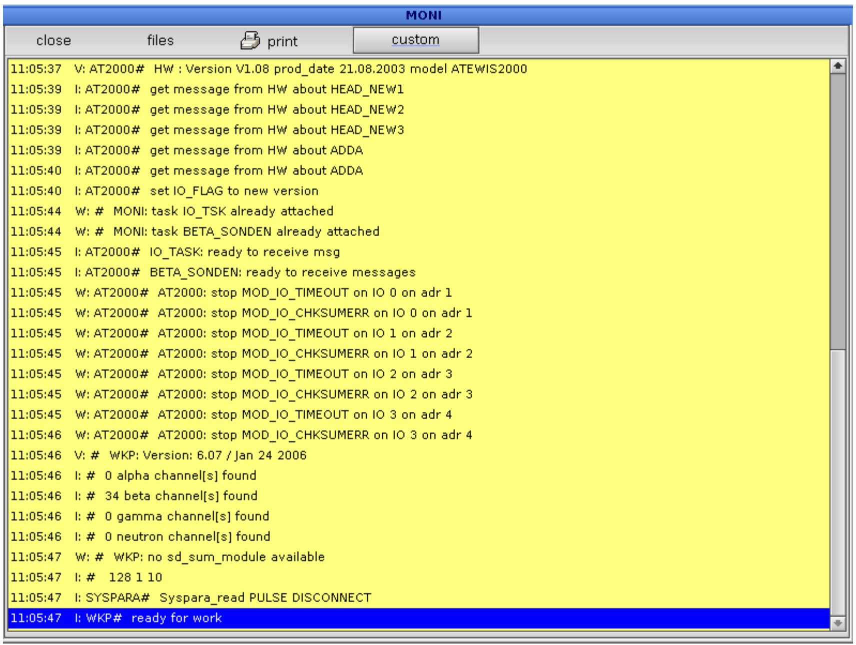



*Figure 4-48: Protocol*

Before entering the TwoStep™- Exit User Software a protocol manager is started. In the protocol:

- Info messages
- Warning messages
- Error messages

are recorded, which occurred during the start and the program sequences.

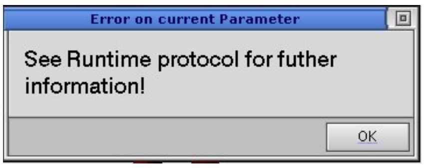



*Figure 4-49: Possible error message on start*

In the field "**directory**" the local path for daily protocols 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 stored.

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"*** one can return to the start menu.

## 4.11.2 Hardware

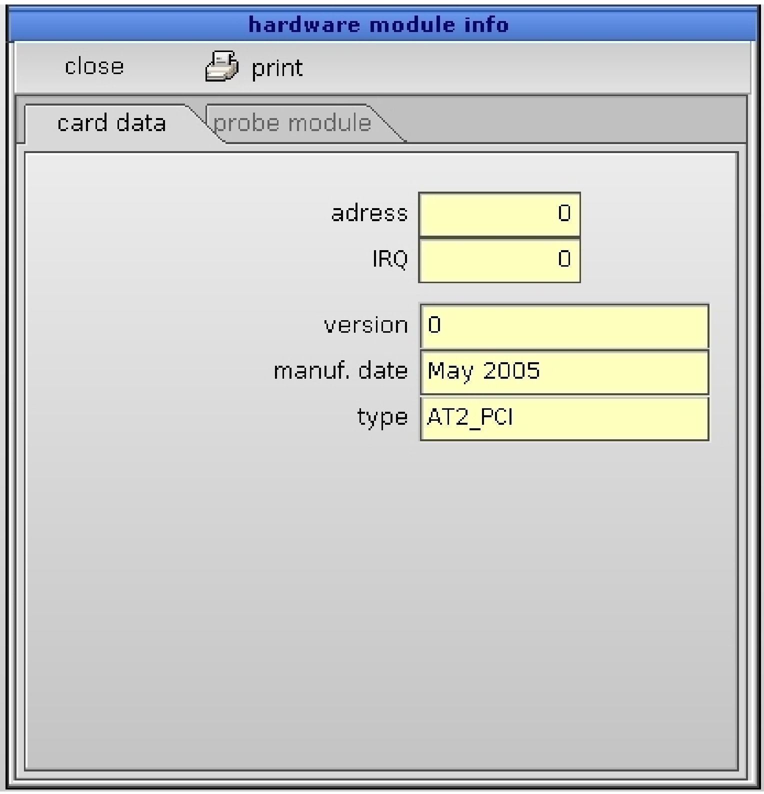



*Figure 4-50: Hardware info card data*

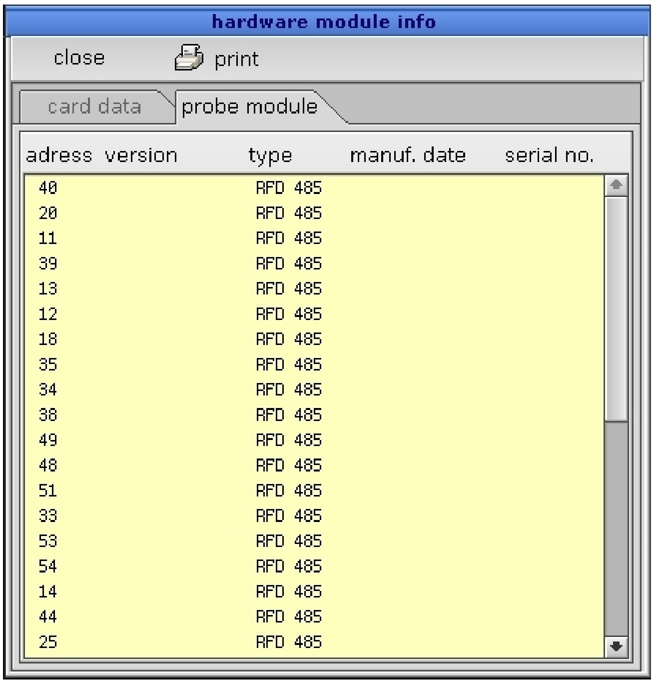



*Figure 4-51: Hardware info counter modules*

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

### 4.11.3 About (Info)


*Figure 4-52: About (Info)*

In the info window the current monitor name (TwoStep™-Exit) and its current User Software version, with which the monitor is operated, are displayed.

## 4.12 Quit (leave program)

With the ***"close"*** button one quits the program and returns to the startup menu.

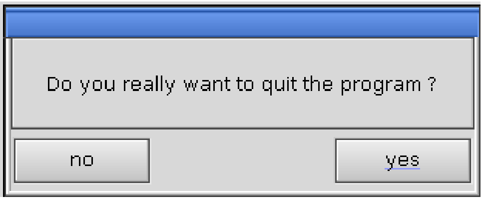



*Figure 4-53: Quit program*

# Register 5

# 5 User administration

# Figure

# 5.1 User profile program

In the **user profile program** group authorizations for each user in different subprograms and module can be defined. With the aid of **user administration** global authorizations can be connected to:

- RTM User Software
- System check
- User profile
- HW set-up

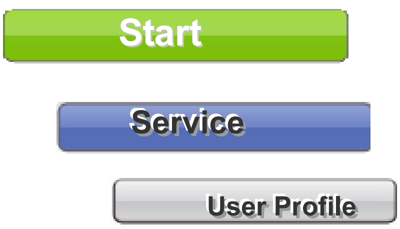
## 5.1.1 Prefix

The body contamination monitor family with the monitor TwoStep™- Exit has different graphical and entry elements for the user communication with the. A detailed description of the operation is given in chapter "Computer system QNX".

In order to start the **user profile program** 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 **user profile program** is opened and carried out using the **service -** and afterwards the **user profile** - button in the startup-menu.


*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 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** |
| **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 profile program**. The user group “default” is only used as a login_user in order to prevent that every user supplied with a service key can exit the measurement mode.

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

### 5.1.2.1 Authorizations in 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.

**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.

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

| No. | Function | Authorization |
|---|---|---|
| 1 | **End application**<br>➲Menu | **User** |
| 2 | **Change IO**<br>➲ Service/ IO-Test<br>➲ Misc/language | **Service** |
| 3 | **Measure background**<br>➲ (Service/Meas. -status) | **Service** |
| 4 | **Quit Channel**<br>➲Service/Meas. -status | **Master** |
| 5 | **High- / Discriminator changes** (temporarly)<br>➲ Service/Detector status | **Service** |
| 6 | **Parameter changes**<br>➲Parameter/Meas. parameter<br>➲Parameter/database<br>➲Parameter/BKG<br>➲ Misc/Statistic<br>➲ Misc/language | **Master** |
| 7 | **Hoch-/Discriminator changes**<br>➲Service/Detector status | **Master** |
| 8 | **Parameter view**<br>➲ Service | **User_Low** |
| 9 | **System function**<br>➲Change Date/Time<br>➲Hardware-Setup<br>➲QNX-Shell<br>➲Parameter load/save | **Master** |
| 10 | **Contamination measurement** | **Nobody** |

*Table 5-1: Authorisation User software*

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

## System check

| No. | Function | Authorisation |
|---|---|---|
| 1 | **Perform Working Processes**<br>➲ View Parameter, Nuclides and Results.<br>➲Printing | **User** |
| 2 | **View Results**<br>➲ Add Working processes<br>➲ Parameter changes. | **Service** |
| 3 | **All Authorisations** | **Master** |

*Table 5-2: Authorisation System Check*

## 5.1.3 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 5-2: Log in user profile program*

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

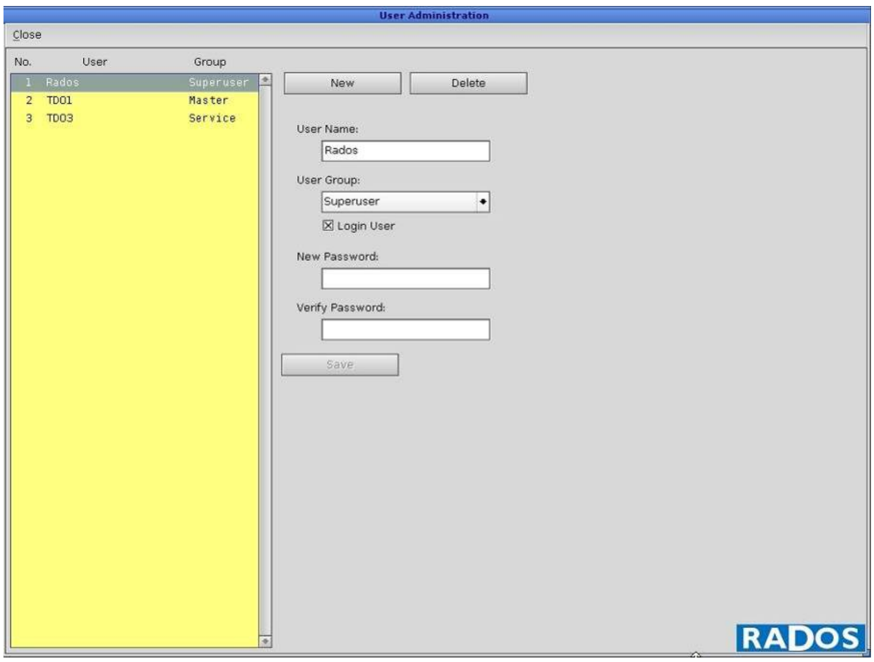



*Figure 5-3: Main menu user profile*

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

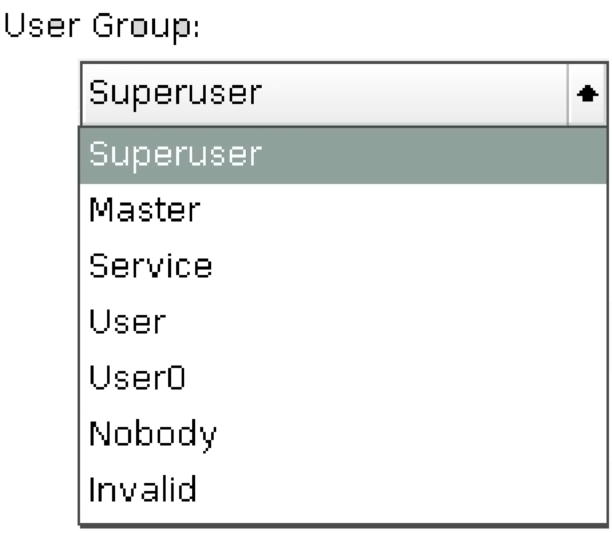



*Figure 5-4: User group selection*

**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.**

### 5.1.3.1 Installation of a new user profile

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

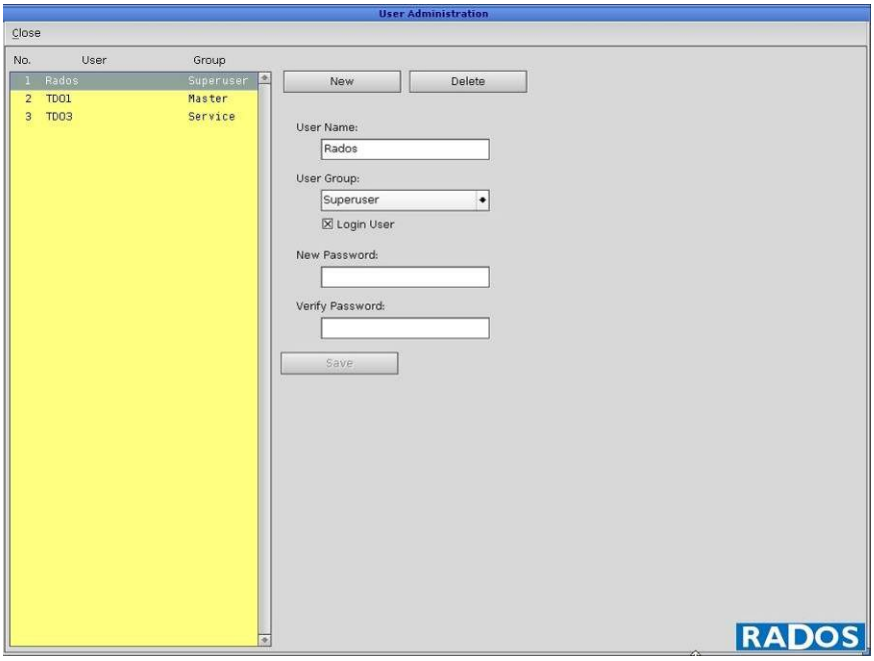



*Figure 5-5: Set up of a new user profile*

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* at the menu panel. The new **user profile** is displayed in the left window include a consecutively number.

### 5.1.3.2 Modify a user profile

To modify a **user profile** one need to click on *modify* at the menu panel. The white window is used to modify the **user profile**. The change is confirmed with *save*.

### 5.1.3.3 Saving a user profile

To store a new/modified **user profile** you need to click on *save* at the menu panel.

### 5.1.3.4 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 5-6: 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 TwoStep™-Exit measurement software and the sub menu **user** will not be shown in the User Software.

### 5.1.3.5 Delete a user profile

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


*Figure 5-7: Delete a user profile*

## 5.1.4 Close the user profile program

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

# Register 6

# 6 System check

# Figure

# 6.1 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 these 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.

## 6.1.1 Prefix

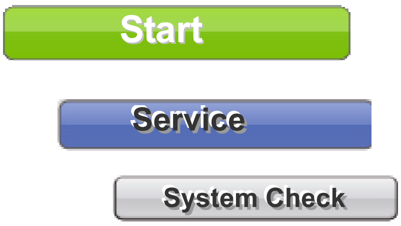
The body contamination monitor family with the monitor TwoStep™-Exit has different graphical and entry elements for the user communication with the. A detailed description of the operation is given in chapter "Computer system QNX".

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**.

**System check**

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*




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

the maintenance and calibration program for body contamination monitors.

Following service functions are provided in the **system check** menu:

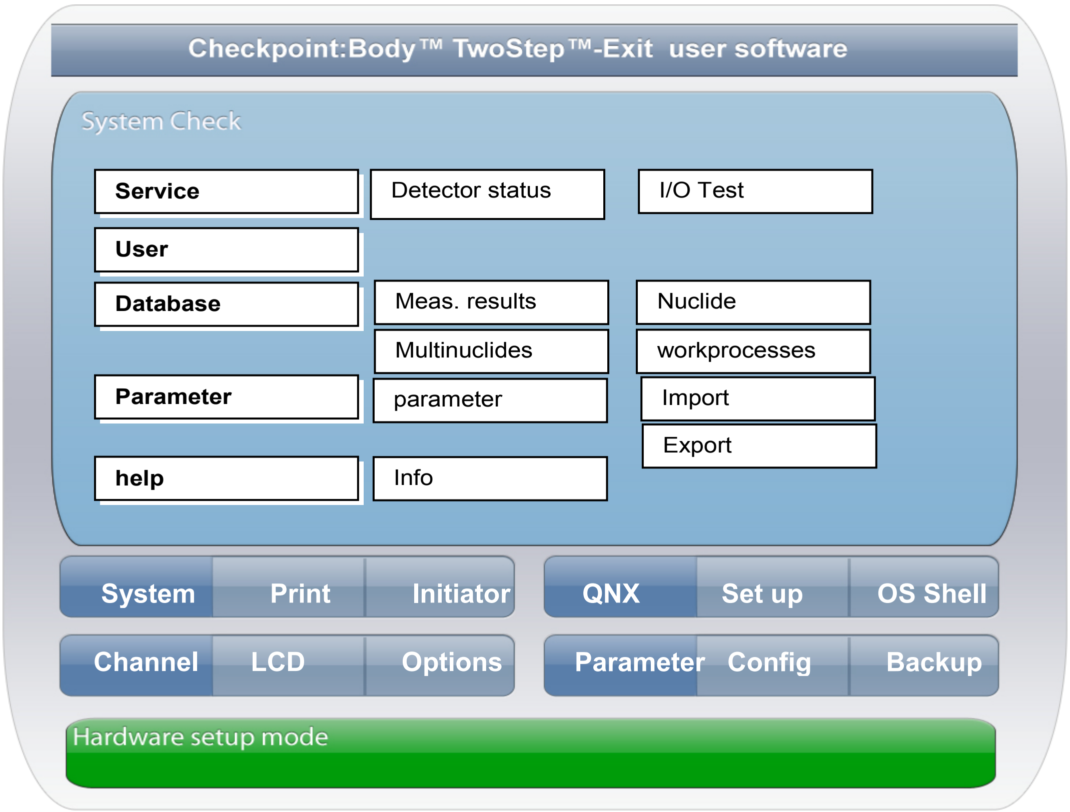



*Figure 6-2: system check menu overview*

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).

- 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 canbe as well selected as multi sources
- Setting of parameters
- Selection of source or protocol
- Background measurement
- Measurement of channels; successively measuring is possible for different types of radiation
- Test of the binary in/outputs in the main menu

**System check**

## 6.1.2 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 informational purposes only.** |

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

## 6.2 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.

### 6.2.1 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]

$\Delta t$ = time elapsed [days]

### 6.2.2 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*

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

$\eta$ = 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.

## 6.2.3 Default deviation

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

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

*formula 6-3: default deviation*

| | | |
|---|---|---|
| $\sigma_n$ | = | 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.

## 6.2.4 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*

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

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

## 6.2.5 Error propagation of efficiency

The error expansion for efficiency is described as:

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

*formula 6-5: error propagation of efficiency*

| | | |
|---|---|---|
| $\sigma(\eta)$ | = | 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] |
| $\sigma_A$ | = | error of current activity |
| $\sigma_N$ | = | default deviation of mean gross count rate [cps] or [cpg] |
| $\sigma_{No}$ | = | default deviation of mean background count rate [cps] or [cpg] |

## 6.3 Start

On start a protocol manager records and displays the start routines of system check module. The main menu of the system check program will automatically displayed at the end of the start routine.

**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)

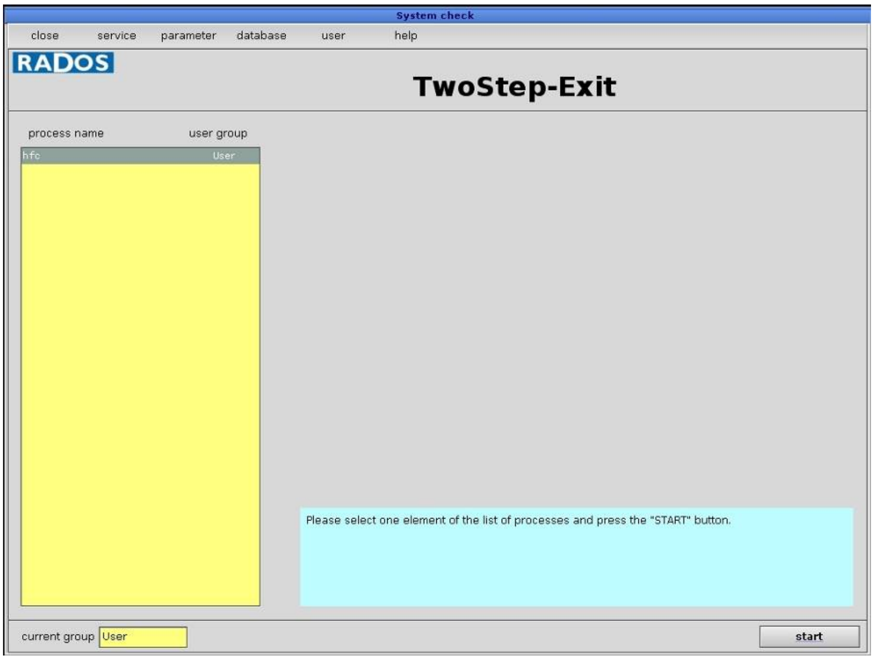
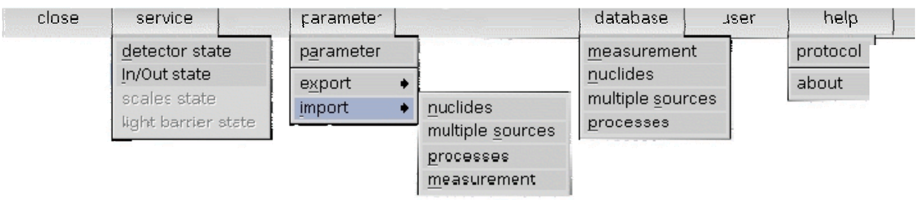



*Figure 6-3: Start menu System check*

This menu is the gate to the submenus:




**NOTE**

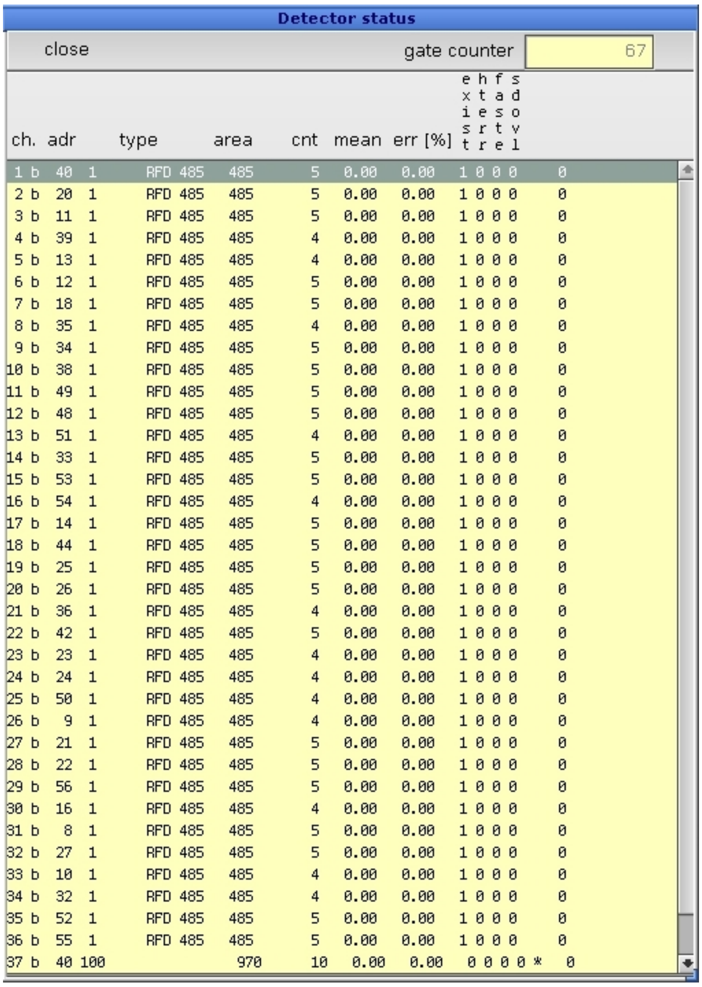
Menu items displayed in light grey could not to be chosen in this TwoStep™-Exit

# 6.4 Service

## 6.4.1 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 gate counter 67

| ch. | | adr | | type | area | cnt | mean | err [%] | exist | hterr | faste | sdovl | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | b | 40 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 2 | b | 20 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 3 | b | 11 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 4 | b | 39 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 5 | b | 13 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 6 | b | 12 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 7 | b | 18 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 8 | b | 35 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 9 | b | 34 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 10 | b | 38 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 11 | b | 49 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 12 | b | 48 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 13 | b | 51 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 14 | b | 33 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 15 | b | 53 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 16 | b | 54 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 17 | b | 14 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 18 | b | 44 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 19 | b | 25 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 20 | b | 26 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 21 | b | 36 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 22 | b | 42 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 23 | b | 23 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 24 | b | 24 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 25 | b | 50 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 26 | b | 9 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 27 | b | 21 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 28 | b | 22 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 29 | b | 56 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 30 | b | 16 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 31 | b | 8 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 32 | b | 27 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 33 | b | 10 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 34 | b | 32 | 1 | RFD 485 | 485 | 4 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 35 | b | 52 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 36 | b | 55 | 1 | RFD 485 | 485 | 5 | 0.00 | 0.00 | 1 | 0 | 0 | 0 | 0 |
| 37 | b | 40 | 100 | | 970 | 10 | 0.00 | 0.00 | 0 | 0 | 0 | 0 * | 0 |

*Figure 6-4: Detector status*

This sub-menu is splitted in3 parts:

- ❍ channel - Information
- ❍ measurement value display
- ❍ measurement time display

## 6.4.2 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.

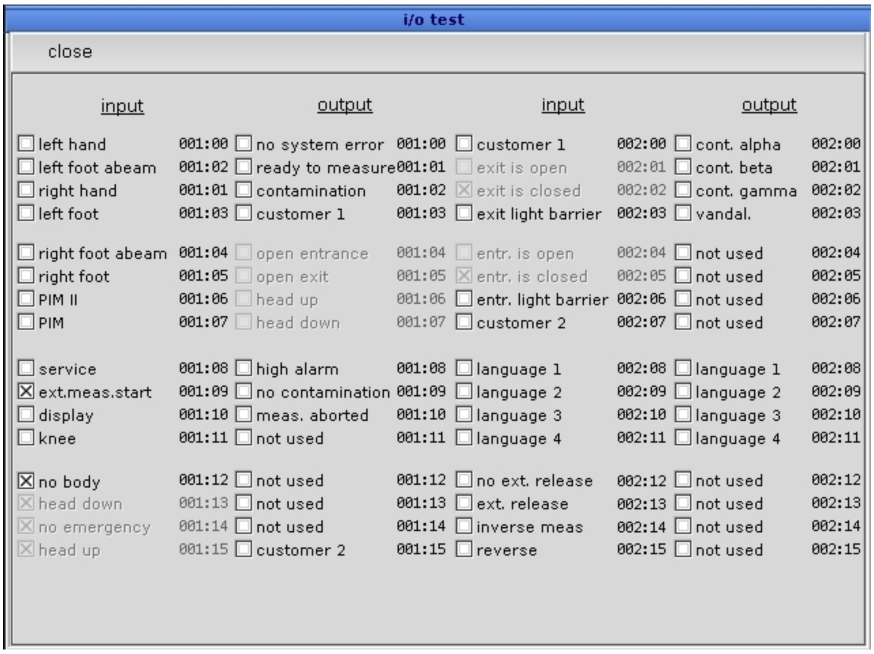



*Figure 6-5: I/O state*

## 6.5 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 6-6: 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 |

# 6.6 Parameter

## 6.6.1 Global Parameters

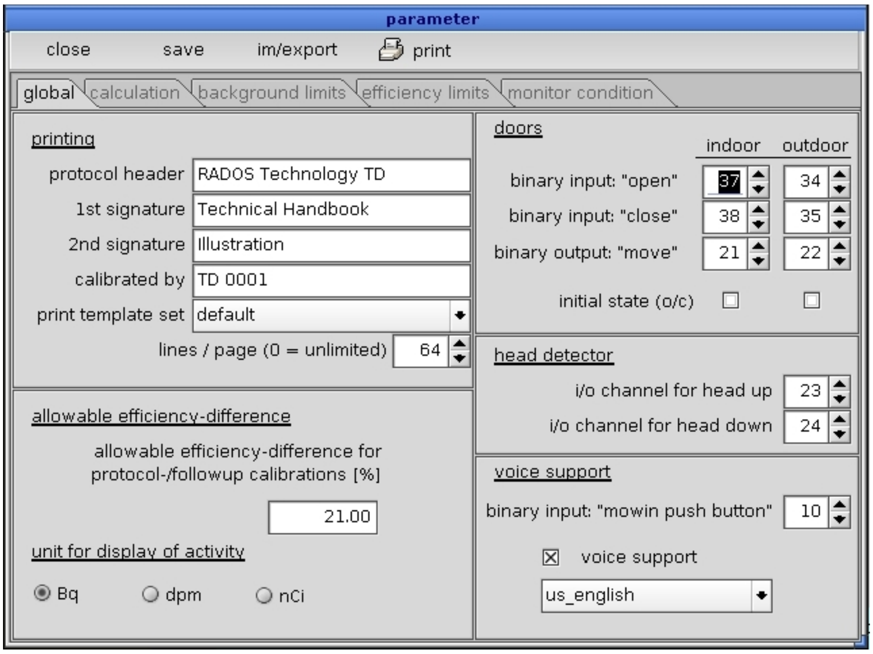



*Figure 6-7: Parameter global*

### 6.6.1.1 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)

### 6.6.1.2 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.

## 6.6.2 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.

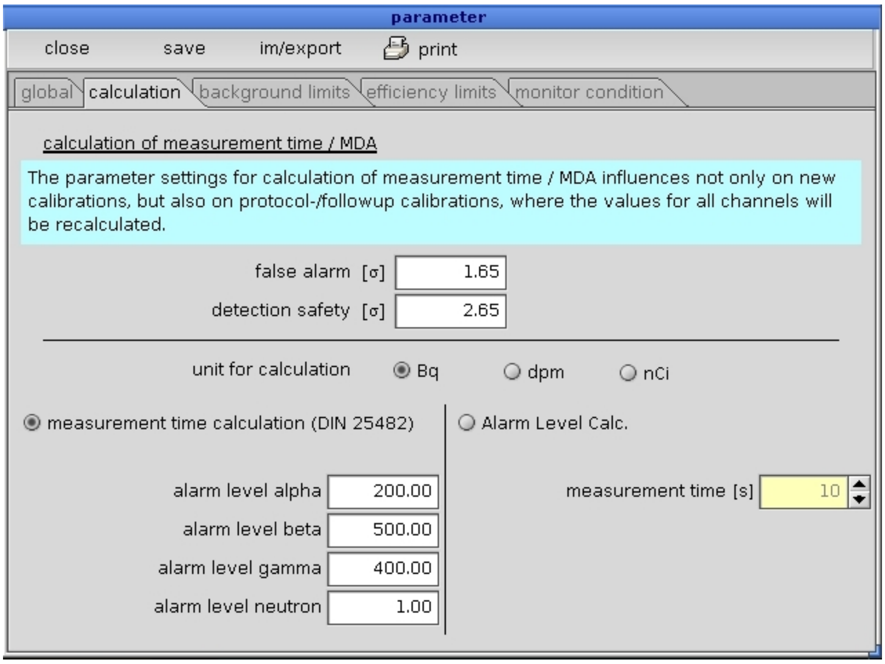



*Figure 6-8: Parameter calculation*

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 (Bequerel)
- 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.**

## 6.6.3 Background limits

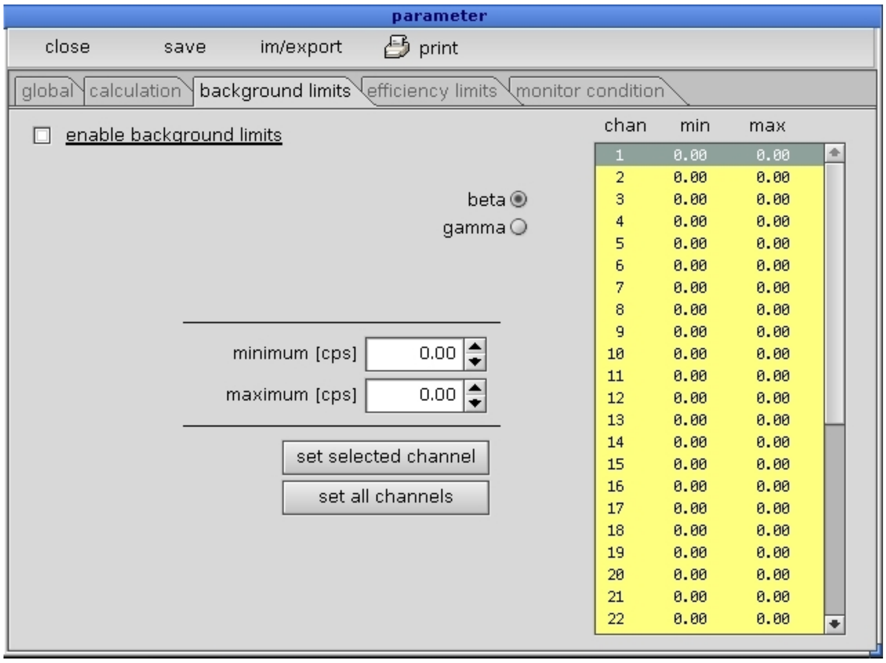



*Figure 6-9: Parameter background limits*

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.

## 6.6.4 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.

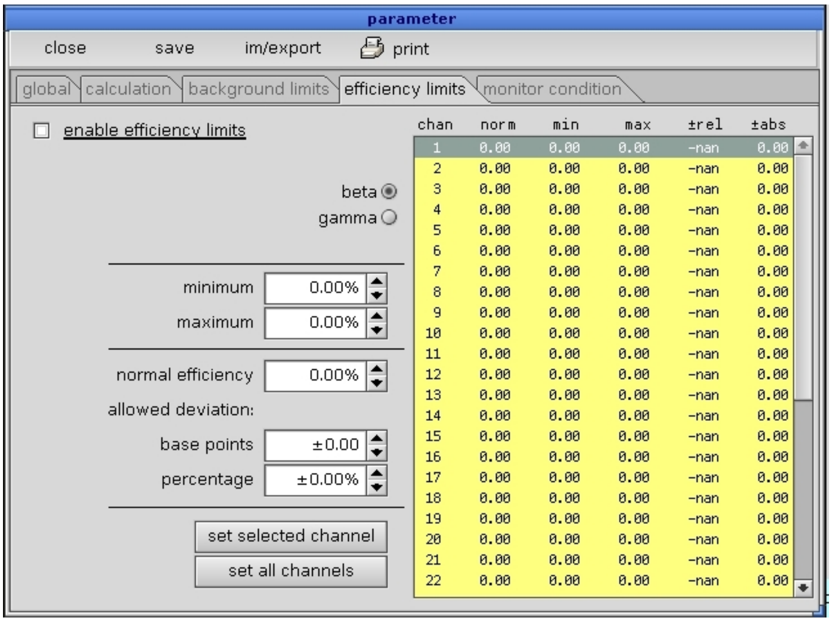



*Figure 6-10: Parameter efficiency limits*

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

Efficiency limits can be set for all or just one channel and kind of radiation. This setting will be taken in account while calculating and producing the protocol.

The efficiency limits can either be set with the min or max efficiency or by setting must efficiency in percent for each channel.

## 6.6.5 Monitor status

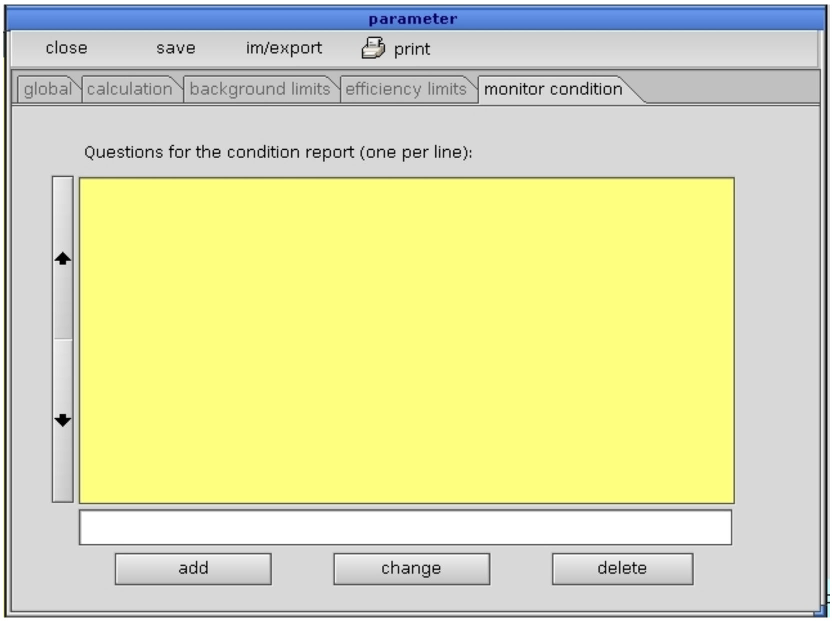



*Figure 6-11: Parameter monitor condition*

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 than transferred into the protocol.

**Administration of parameter sets**

All parameter adjusted for the individual TwoStep™-Exit can be saved (export) on a destination (e.g. USB-stick or local hard disk) to be filed or to be stored in the TwoStep™-Exit again (import). For a detailed description the import – or export process refer to chapter 6.6.6 and 6.6.7.

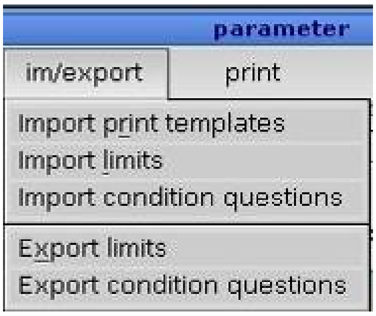
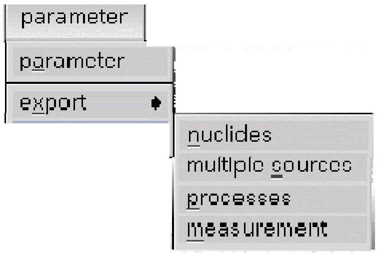



*Figure 6-12: Parameter import and export*

## 6.6.6 Export

To export, select in the main menu:



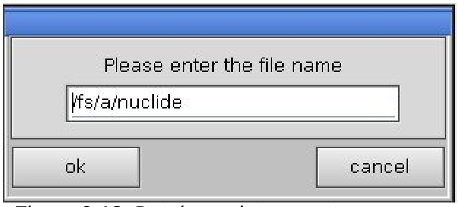




*Figure 6-13: Database data export*

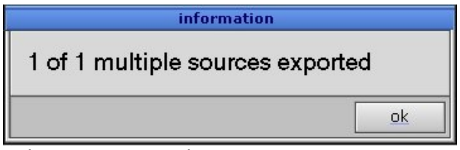


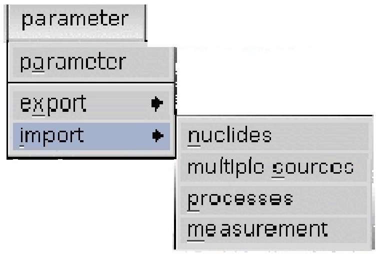

*Figure 6-14: Data base export message*

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

All data will be stored at a 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.

## 6.6.7 Import

To import, select in the main menu:



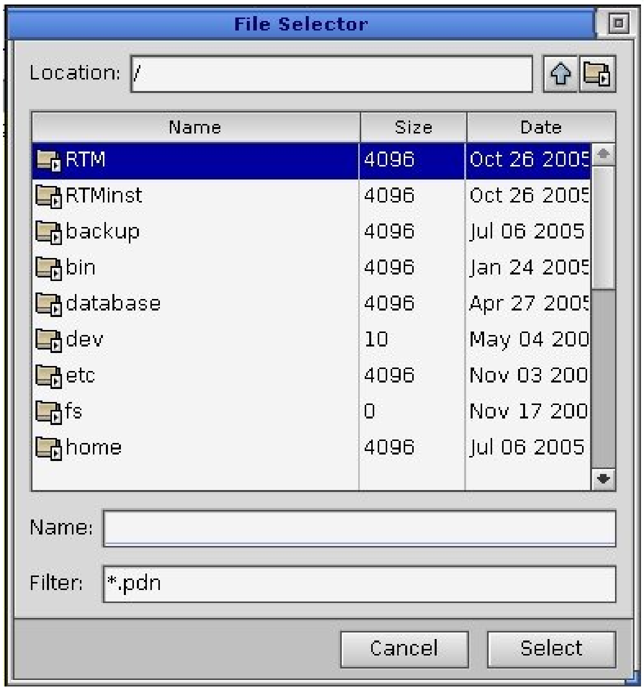




*Figure 6-15: Import-file selector*


*Figure 6-16: 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.

# 6.7 Measurement database

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

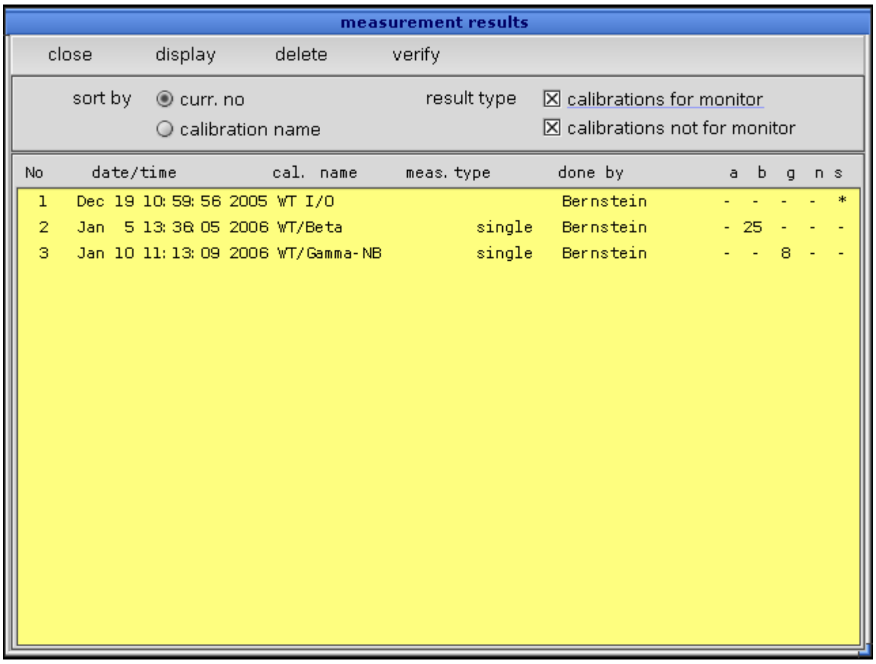



*Figure 6-17: Measurement results*

Each calibration can be selected with the mouse pointer from the provided menu and displayed and/or printed in detail and saved to a 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.

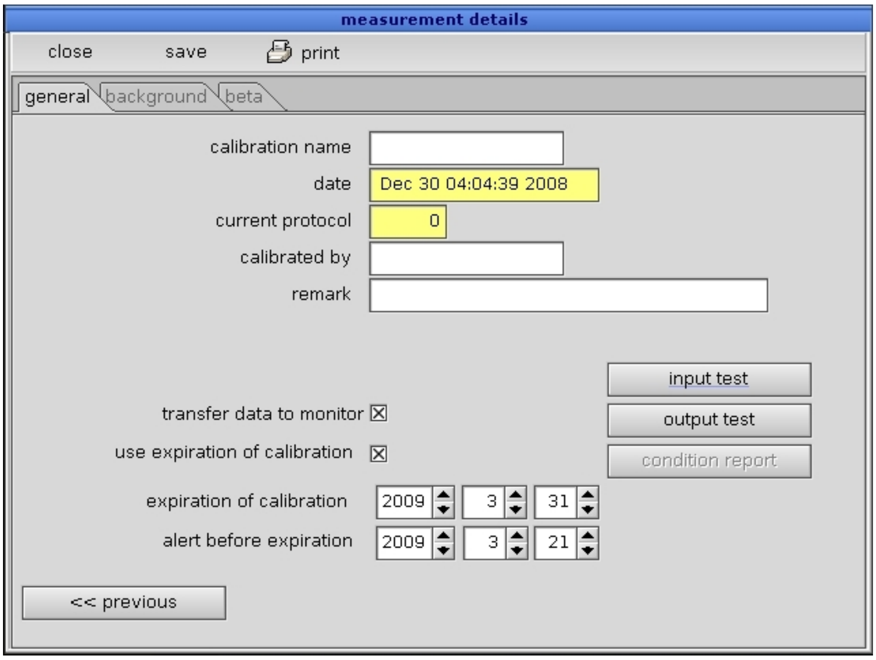



*Figure 6-18: Measurement details I*

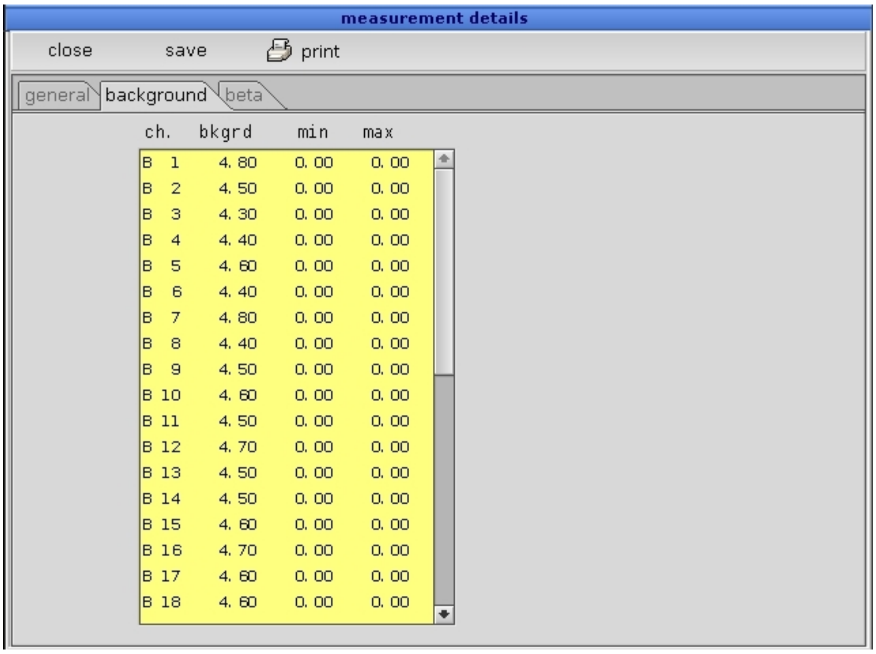
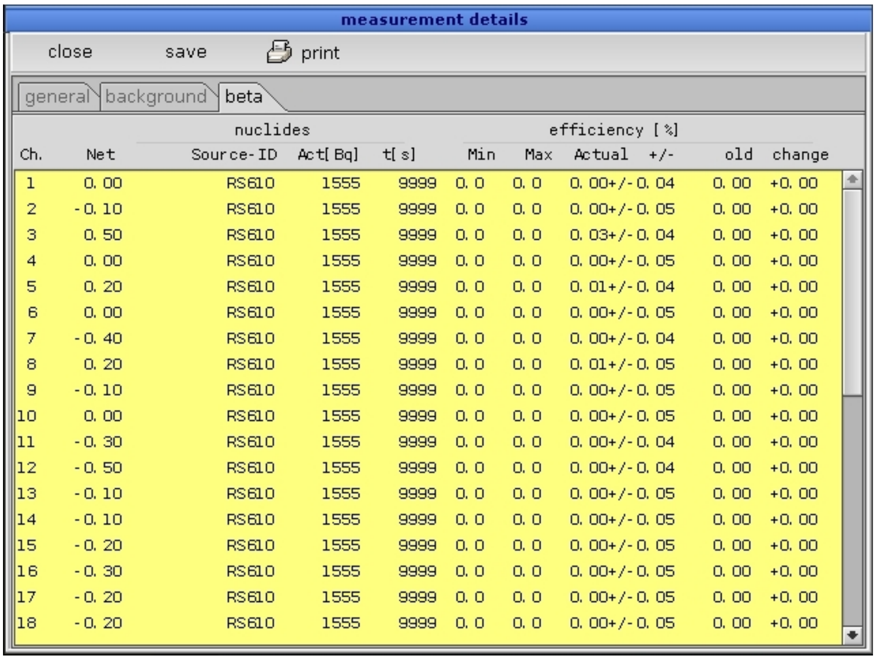



*Figure 6-19: Measurement details II*




| | | nuclides | | | | efficiency [%] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ch. | Net | Source-ID | Act[Bq] | t[s] | Min | Max | Actual +/- | old | change |
| 1 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 2 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 3 | 0.50 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.03+/-0.04 | 0.00 | +0.00 |
| 4 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 5 | 0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.01+/-0.04 | 0.00 | +0.00 |
| 6 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 7 | -0.40 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 8 | 0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.01+/-0.05 | 0.00 | +0.00 |
| 9 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 10 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 11 | -0.30 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 12 | -0.50 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 13 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 14 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 15 | -0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 16 | -0.30 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 17 | -0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 18 | -0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |

*Figure 6-20: Measurement details III*


*Figure 6-21: 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 show up and added with information for trouble shooting (see Figure 6-11).**

# 6.8 Nuclide database

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

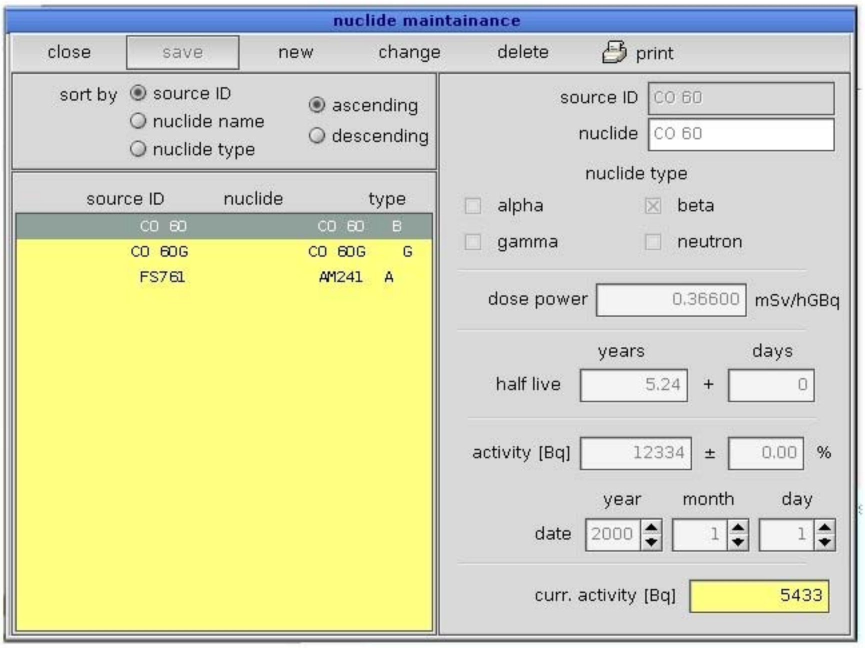



*Figure 6-22: Nuclide maintenance*

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.

## 6.8.1 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 / dos 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. $^{60}CO$ = 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.

### 6.8.2 Test source 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.

# 6.9 Multiple sources

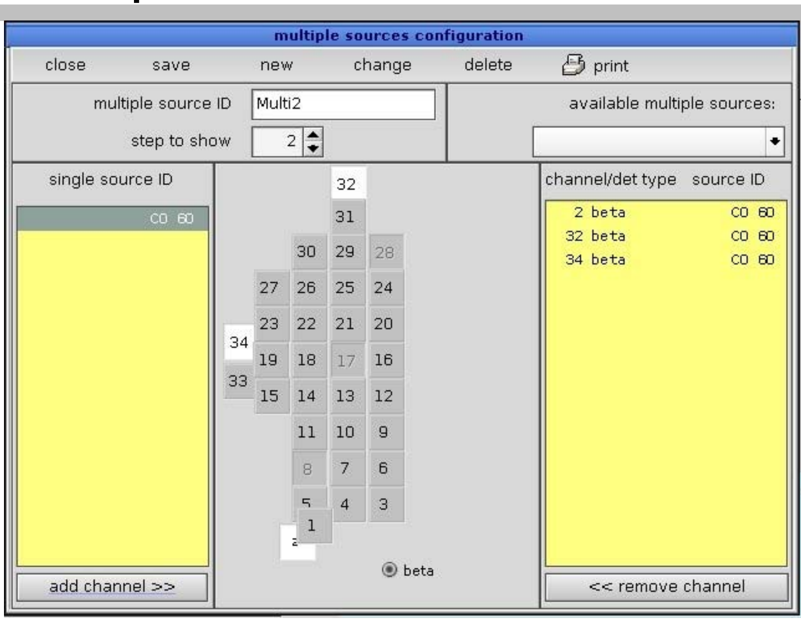



*Figure 6-23: Multiple sources configuration beta*

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.

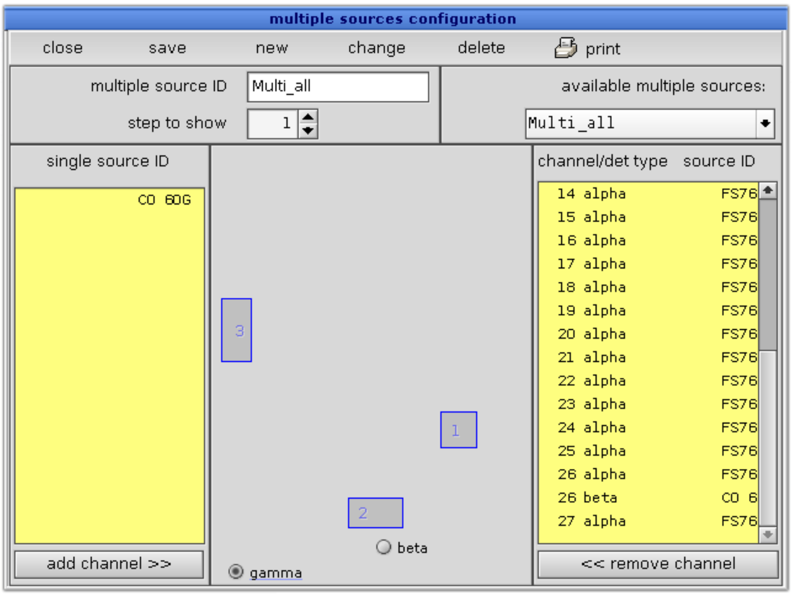



*Figure 6-24: Multiple sources configuration gamma*

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 source (same name). The calibration takes place with the activation of the start button in the main **System check** menu.

# 6.10 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.***

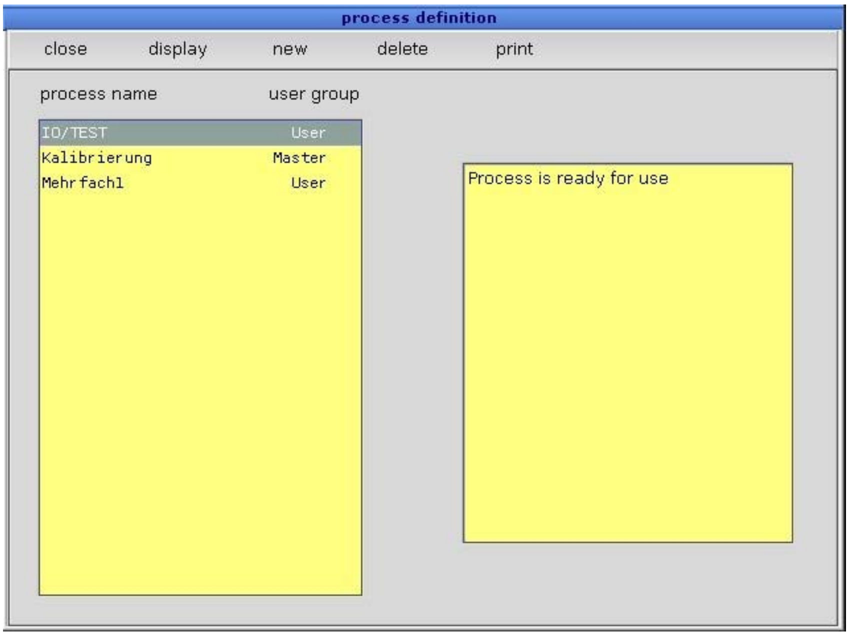



*Figure 6-25: Overview processes*

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.

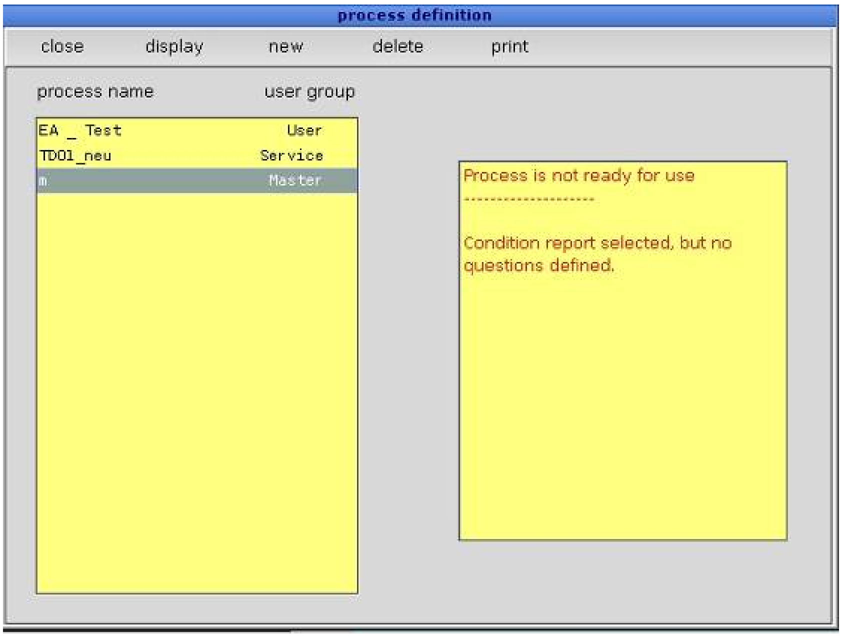



*Figure 6-26: Overview processes*

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


*Figure 6-27: 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.

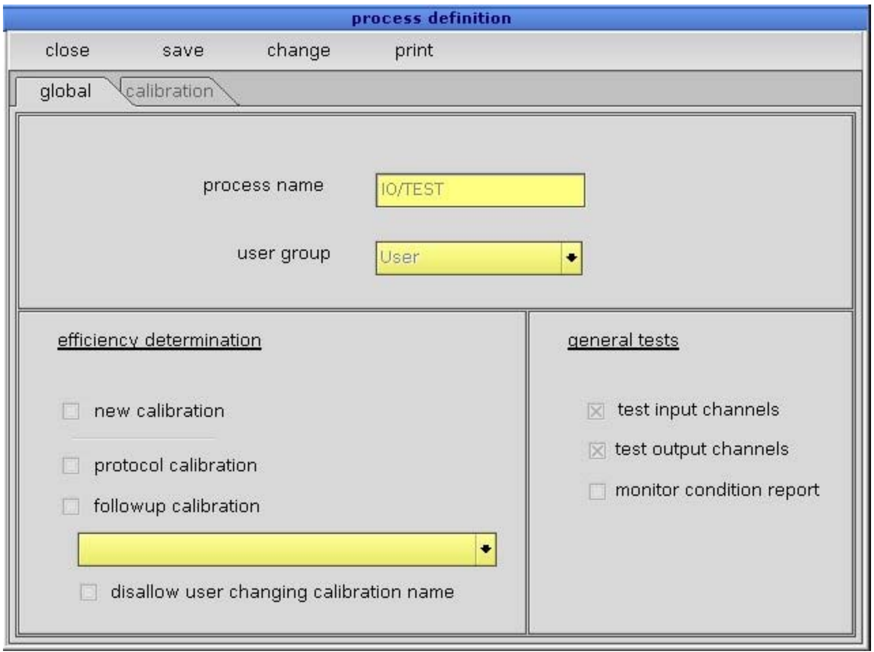



*Figure 6-28: Modify a process*

## 6.10.1 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.

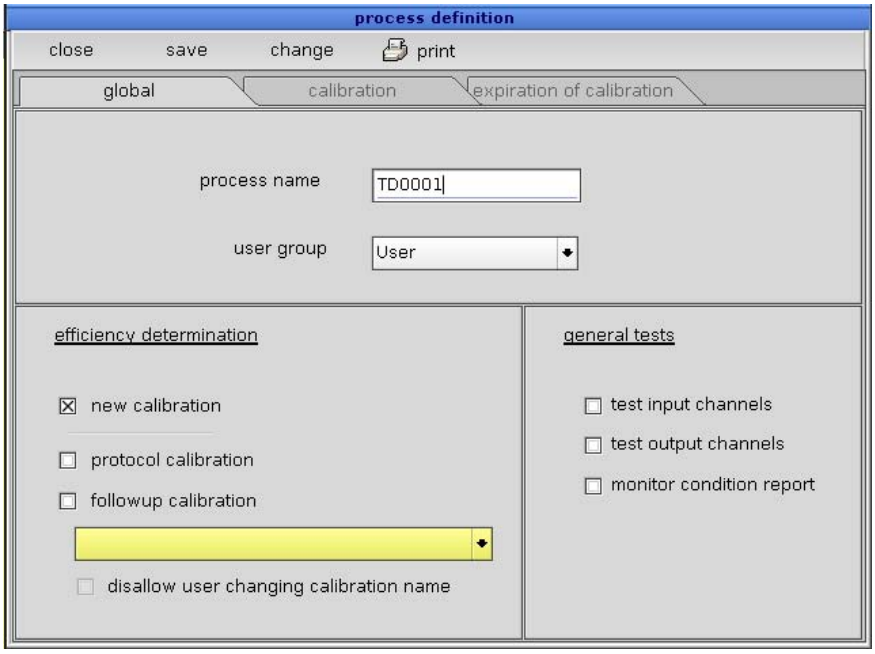



*Figure 6-29: Installation of new processes*

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.

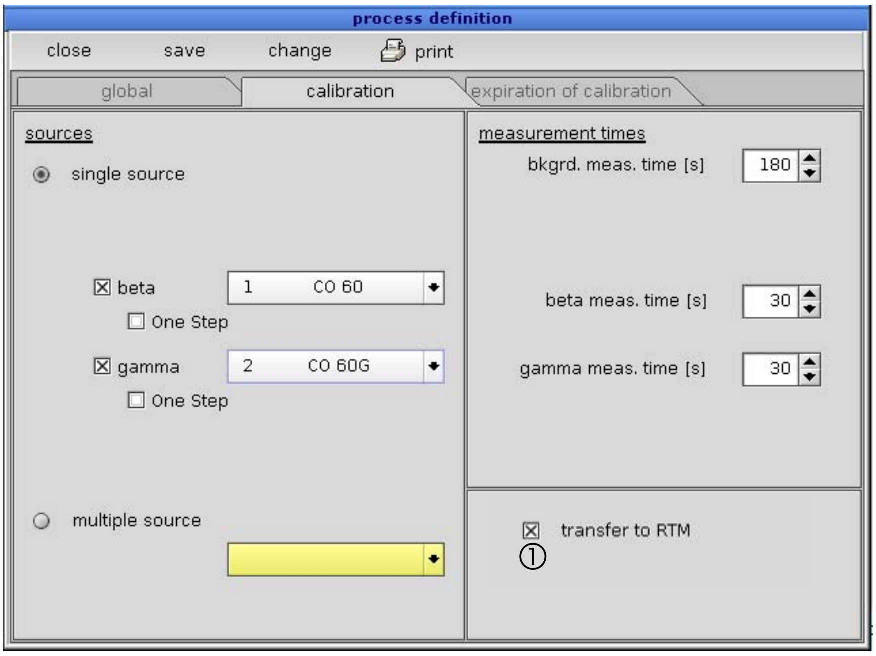



*Figure 6-30: Installation of new processes, registry card calibration*

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

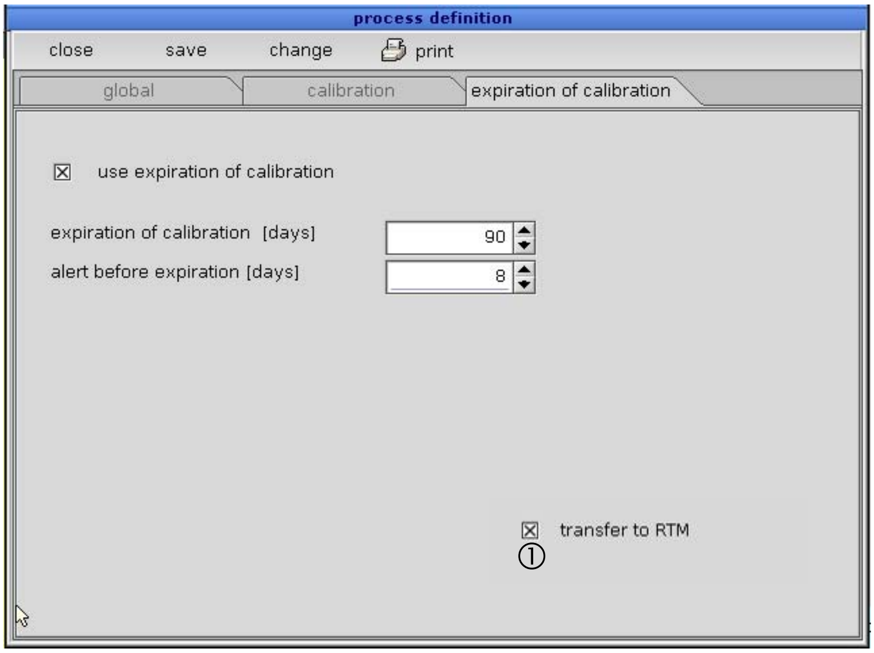



*Figure 6-31: Installation of new processes, registry card calibration*

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

## 6.10.2 Start of a process

Dependant on login authorization all or 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. 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.

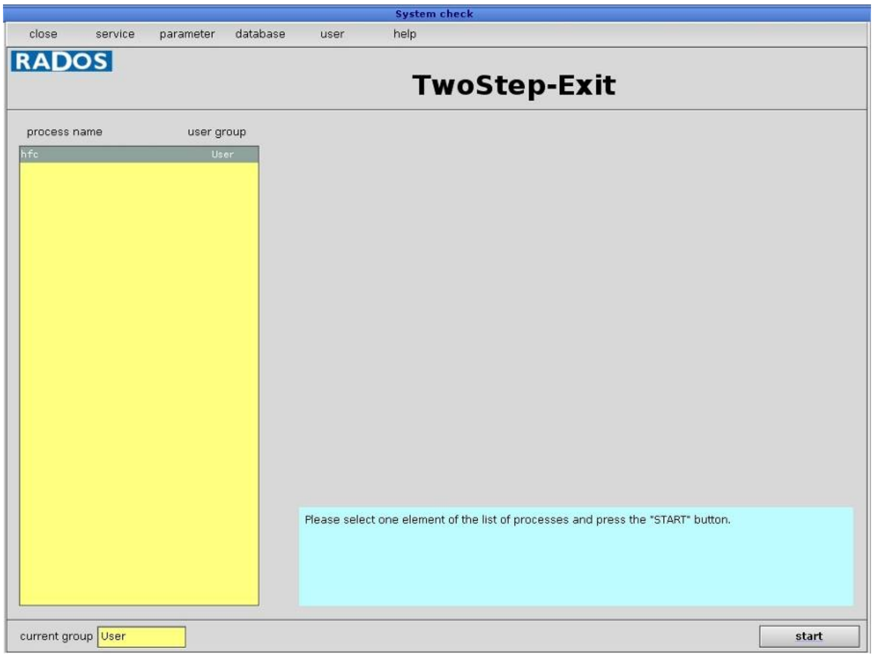



*Figure 6-32: Start System check*

## 6.10.3 Background measurement

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

**CAUTION**

No source should be in or close to the monitor while the background is measured. Please remove all sources in close proximity of the monitors.

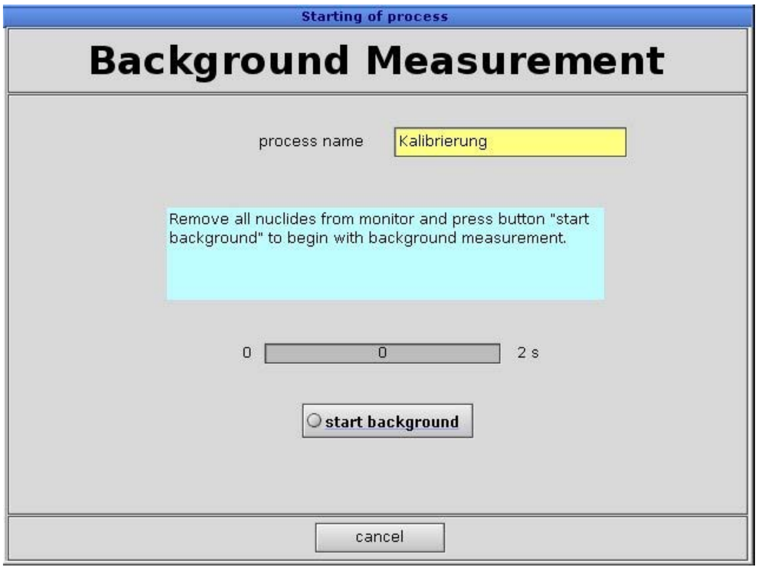



*Figure 6-33: Background measurement*

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

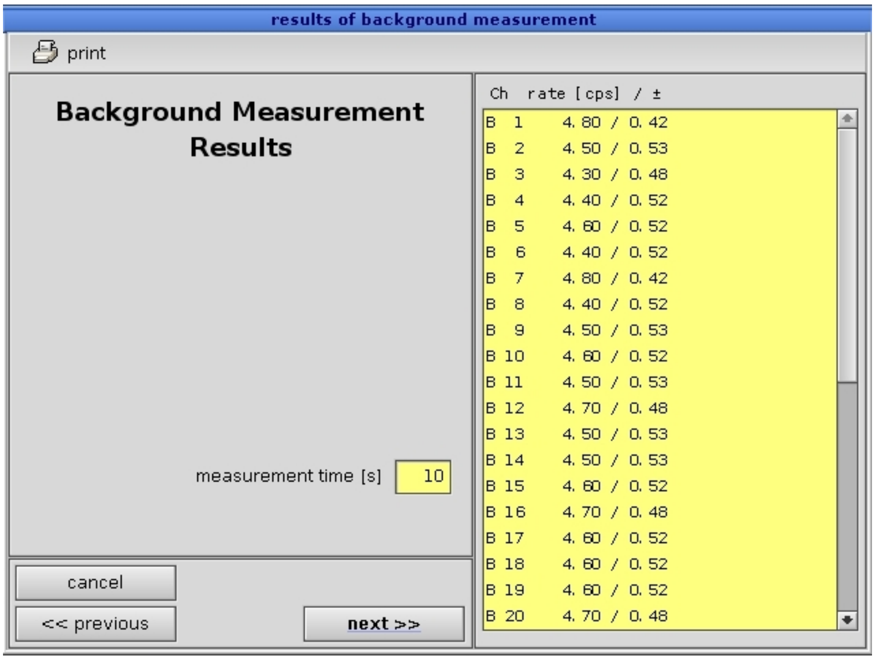



*Figure 6-34: Result of background measurement*

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

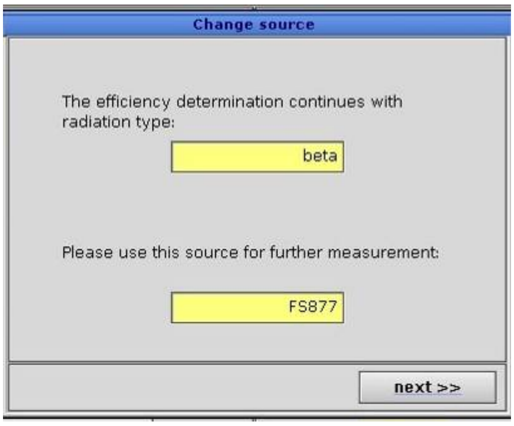



*Figure 6-35: Change source*

Select and place the correct source for the calibration.

## 6.11 Determination of channel efficiency (calibration)

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

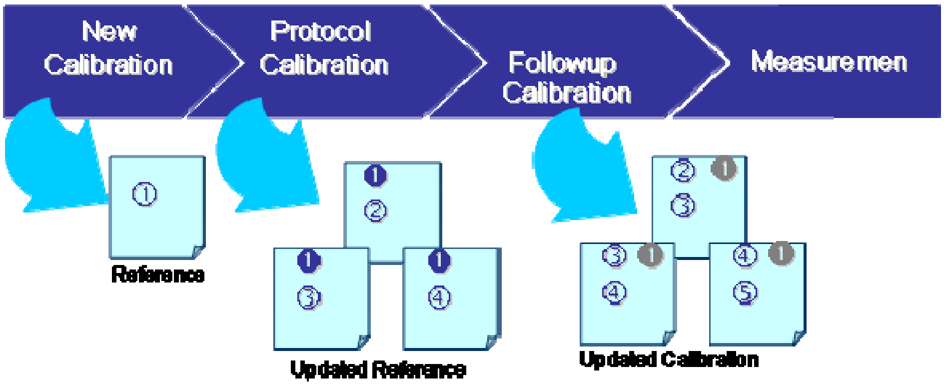



*Figure 6-36: Calibration modes*

**New Calibration – Chapter 6.11.1**
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 6.11.2**
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 TwoStep™-Exit after factory acceptance.

**Follow-up Calibration – Chapter 6.11.3**
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.

## 6.11.1 New calibration

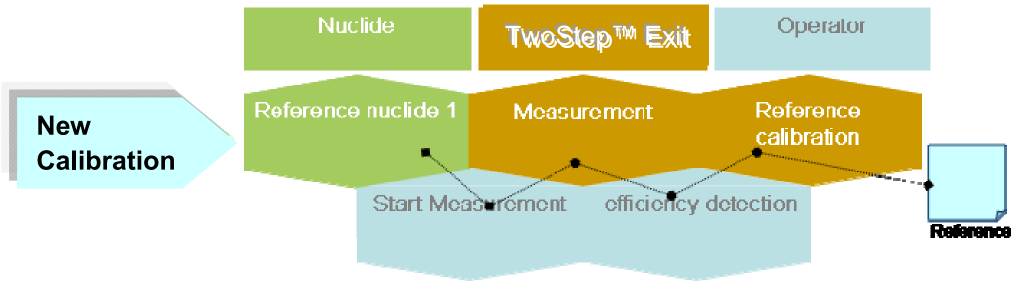



*Figure 6-37: New calibration process*

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

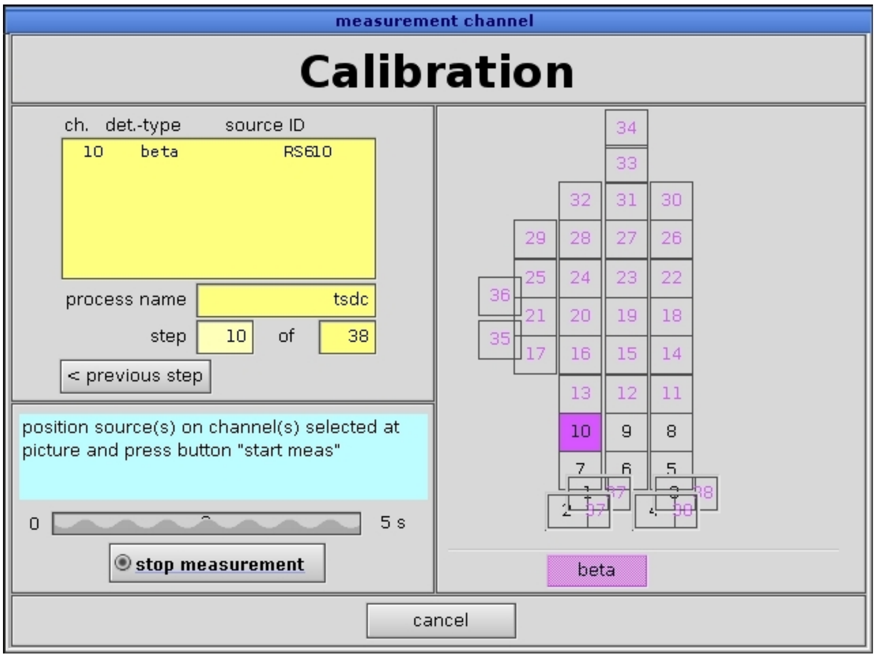



*Figure 6-38: Calibration of all channels*

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)

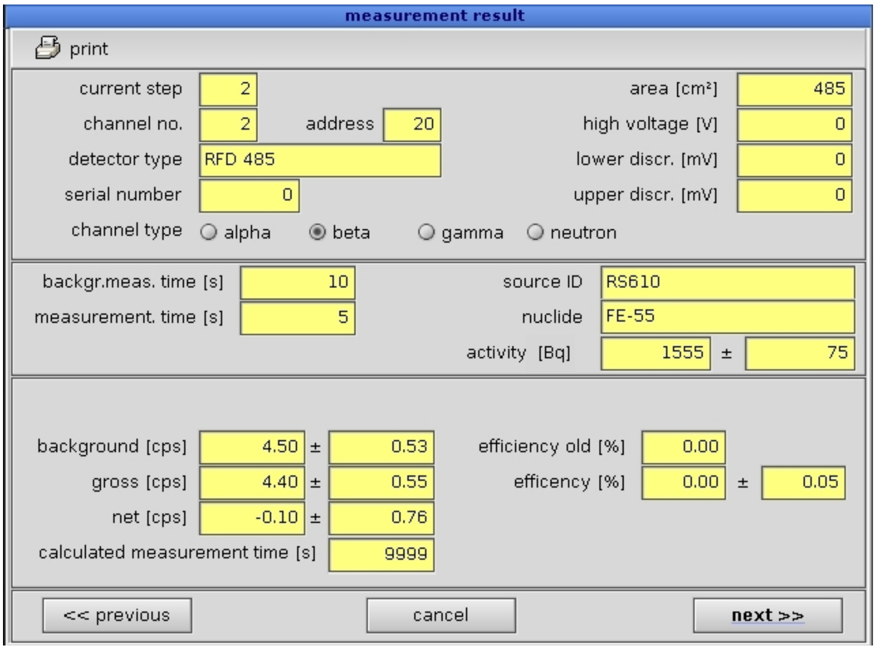



*Figure 6-39: Measurement result*

If necessary the measurement of a channel can be repeated. That will be needed, 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.

## 6.11.2 Protocol calibration

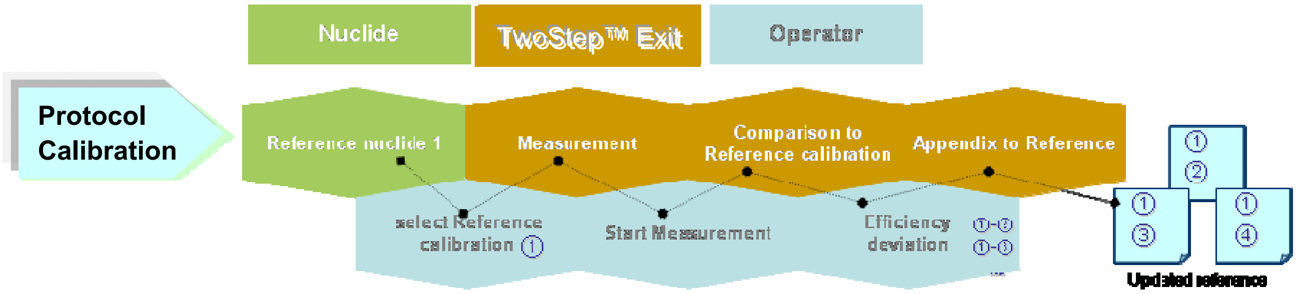



*Figure 6-40: Calibration protocol process*

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.

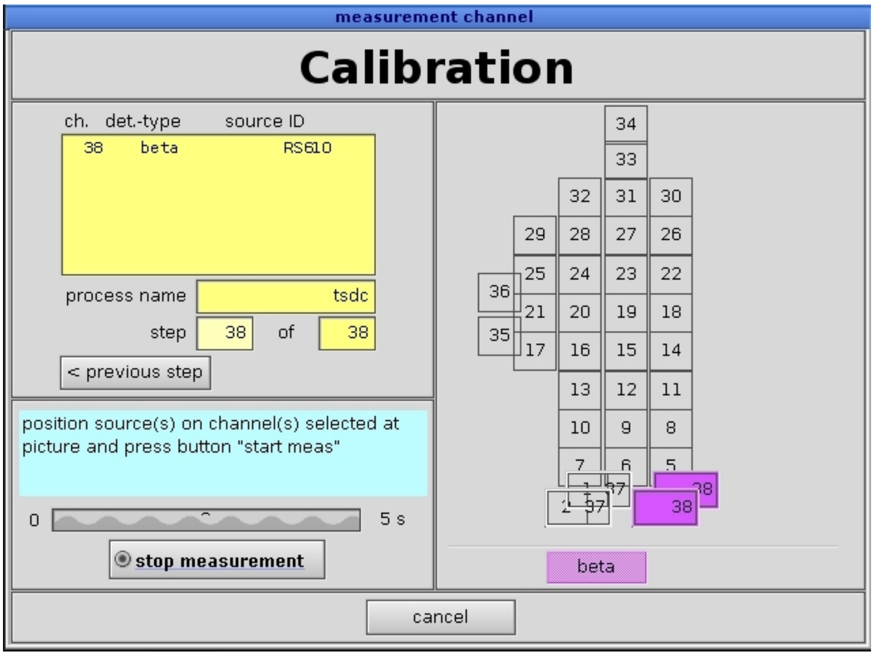



*Figure 6-41: Efficiency determination calibration (gamma)*

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.

### 6.11.3 Follow-up calibration

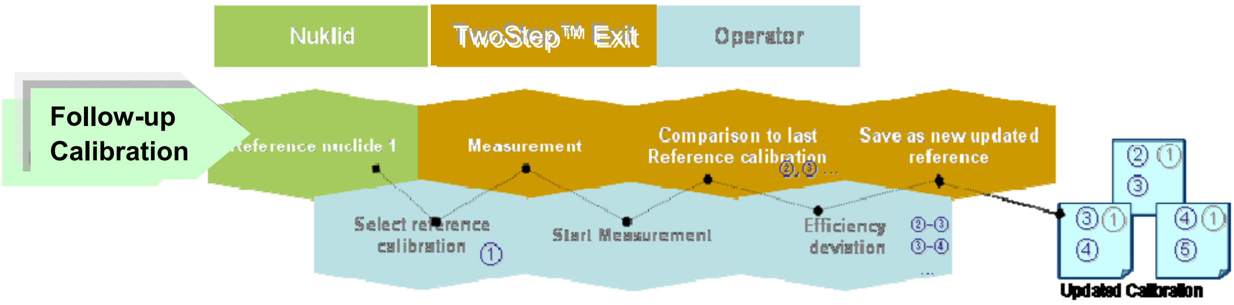



*Figure 6-42: Follow-up calibration process*

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.

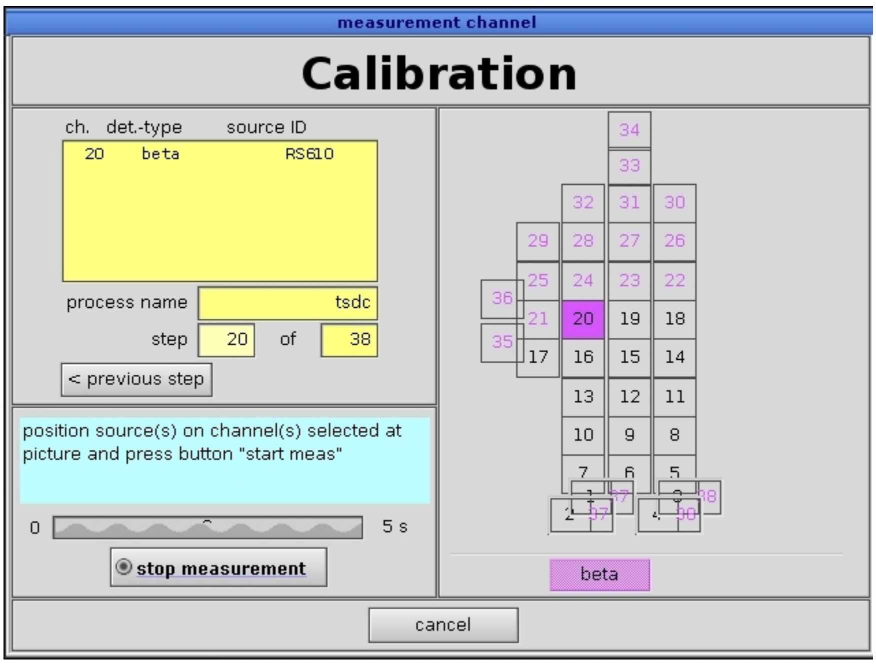



*Figure 6-43: Efficiency determination follow up calibration*

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.

## 6.11.4 Check of binary in- and outputs

This test can be done either in the service menu or in line with a working process if requested. 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.

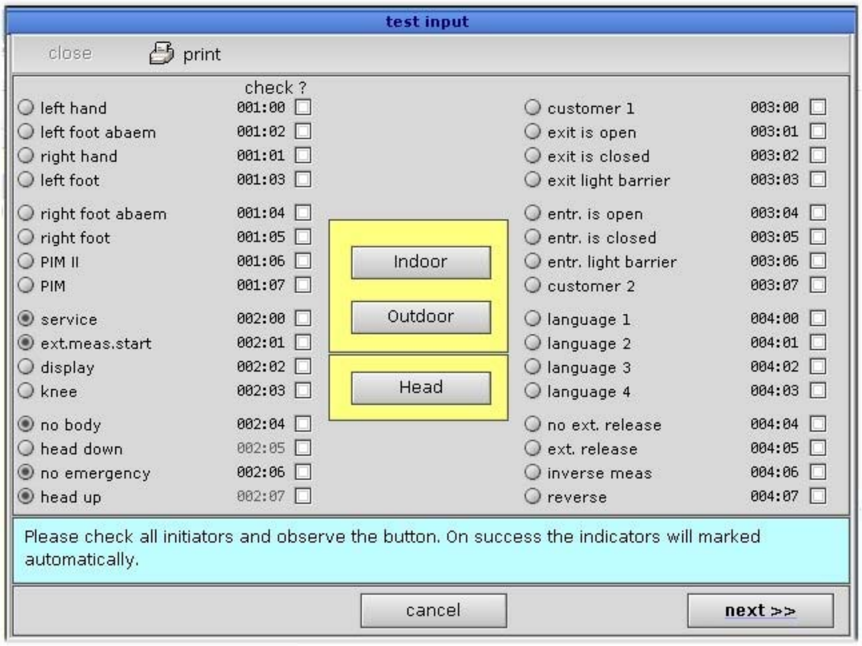



*Figure 6-44: System check input test*

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

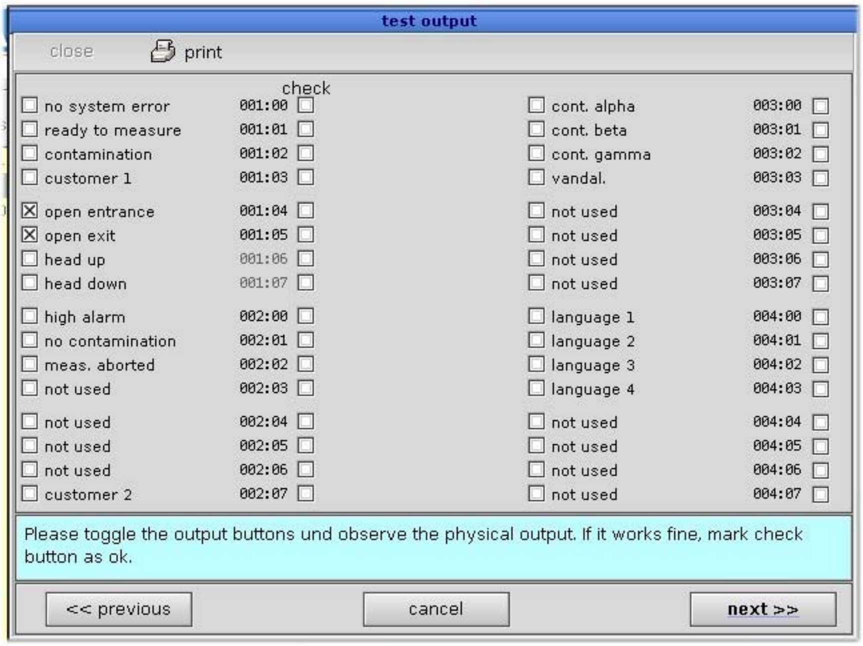



*Figure 6-45: System check Output test*

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.

## 6.11.5 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 ):

--- RADOS Technology 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 6-46: 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.

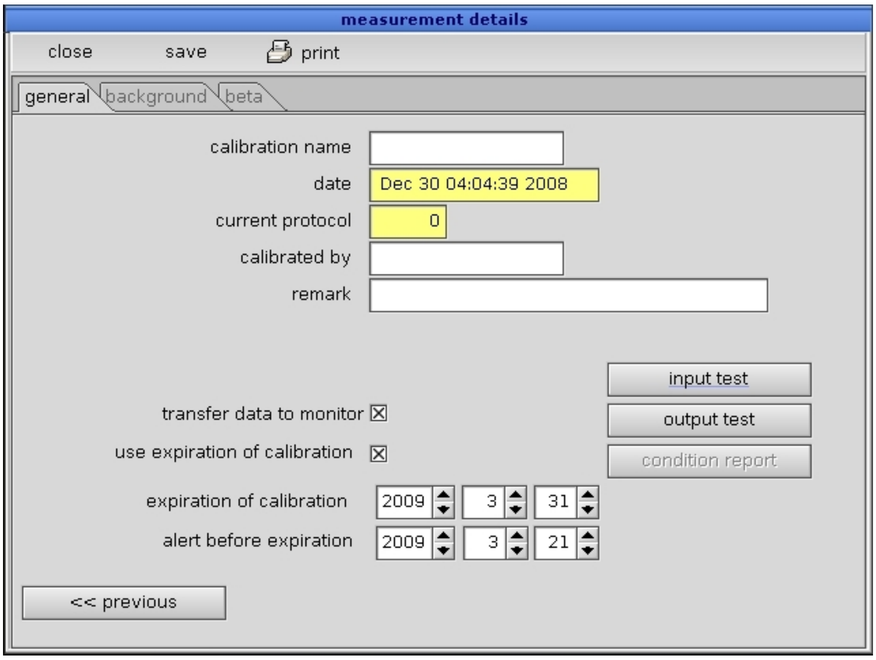



*Figure 6-47: Measuring calibration result*

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.

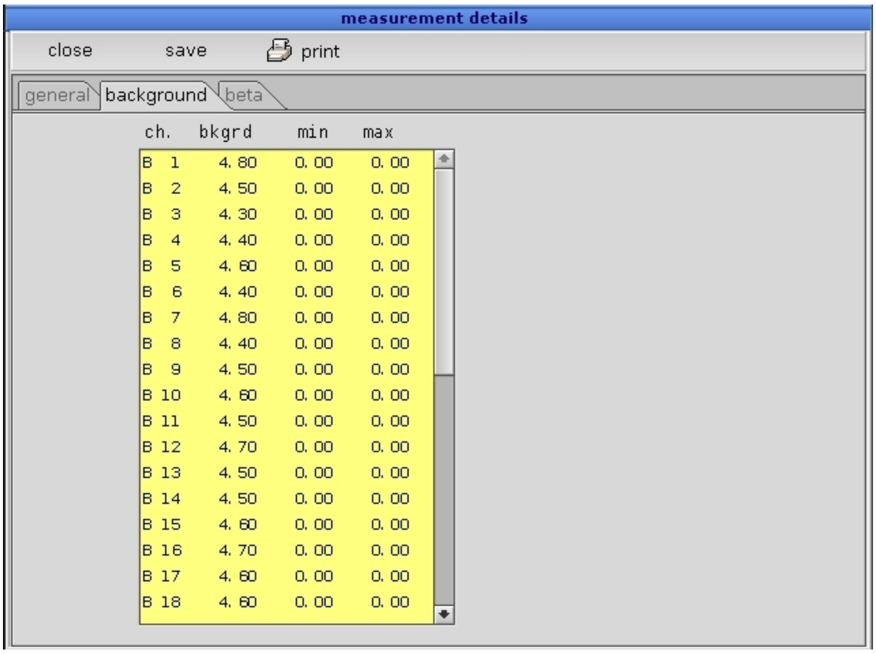
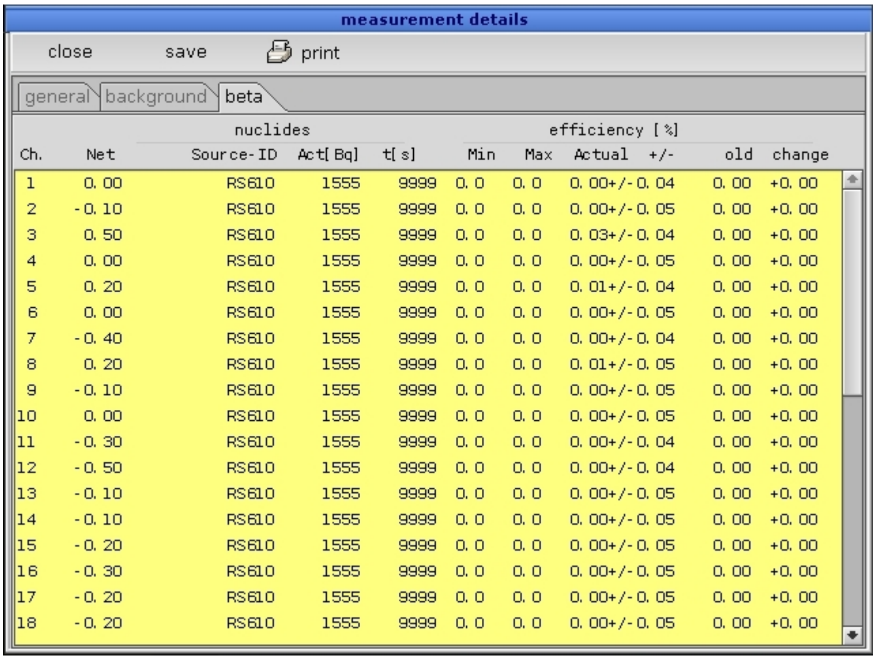



*Figure 6-48: Background details*

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




| Ch. | Net | Source-ID (nuclides) | Act[Bq] (nuclides) | t[s] (nuclides) | Min (efficiency [%]) | Max (efficiency [%]) | Actual +/- (efficiency [%]) | old (efficiency [%]) | change (efficiency [%]) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 2 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 3 | 0.50 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.03+/-0.04 | 0.00 | +0.00 |
| 4 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 5 | 0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.01+/-0.04 | 0.00 | +0.00 |
| 6 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 7 | -0.40 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 8 | 0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.01+/-0.05 | 0.00 | +0.00 |
| 9 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 10 | 0.00 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 11 | -0.30 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 12 | -0.50 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.04 | 0.00 | +0.00 |
| 13 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 14 | -0.10 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 15 | -0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 16 | -0.30 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 17 | -0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |
| 18 | -0.20 | RS610 | 1555 | 9999 | 0.0 | 0.0 | 0.00+/-0.05 | 0.00 | +0.00 |

*Figure 6-49: Channel details*

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

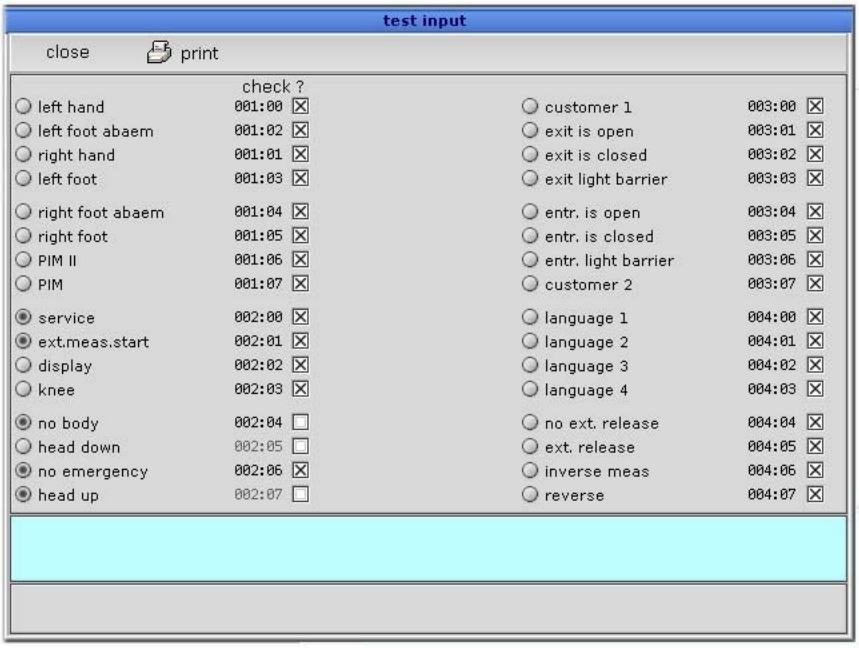



*Figure 6-50: Input test*

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

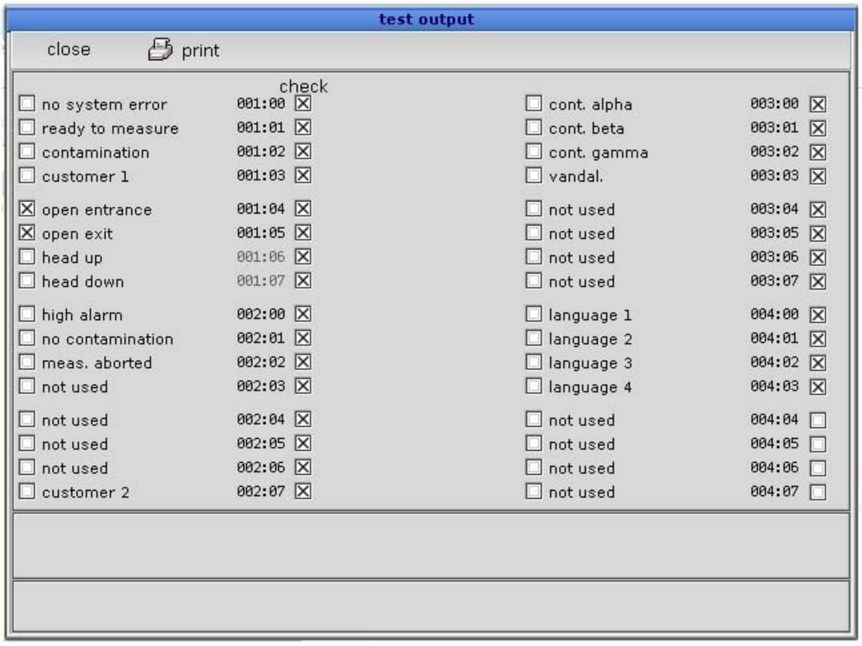



*Figure 6-51: Output test*

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.

## 6.12 Help

The button **help** leads to the submenu "About".


*Figure 6-52: 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 start-up menu comes up.


*Figure 6-53: Close the program*

# Register 7

# 7 Light Box Calibration

# Figure

## 7.1 Light Box Calibration

In the **Light Box Calibration** program the parameter for the light box, a core component of the body contamination measurement assembly, can stored in the TwoStep™-Exit electric. This is necessary as the Light Box provides no internal memory to store parameter data.

The function of the Light Box is a similar to a camera. The setting of the working point is an adjustment process according the light conditions as it is done while taking photos, where normally the aperture is adjusted to the light conditions and the fine tuning is carried out regarding the exposure time and film quality.

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 Light Box 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 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 Light Box parameter evaluation can not be performed elsewhere and is part of the distinctive Light Box information. The Light Box parameter will be provided with light box itself.
The aid of Light Box Calibration program is especially needed to calibrate an exchanged Light Box.

**WARNING**

**The Light Box parameter is unique for each Light Box.**
**DO NOT alter the Light Box parameter, if the factory set parameter for the Light Box is not at hand.**

**The TwoStep™-Exit body contamination measurement results will not be reasonable or reliable if the parameter is changed.**

## 7.1.1 Prefix

The body contamination monitor family with the monitor TwoStep™-Exit has different graphical and entry elements for the user communication with the. A detailed description of the operation is given in chapter "Computer system QNX".

In order to start the **Light Box Calibration program** 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 **master** at minimum to get access to the menu-item **close**.

The **Light Box Calibration program** is opened and carried out using the **service -** and afterwards the **Light Box Calibration** - button in the startup-menu.

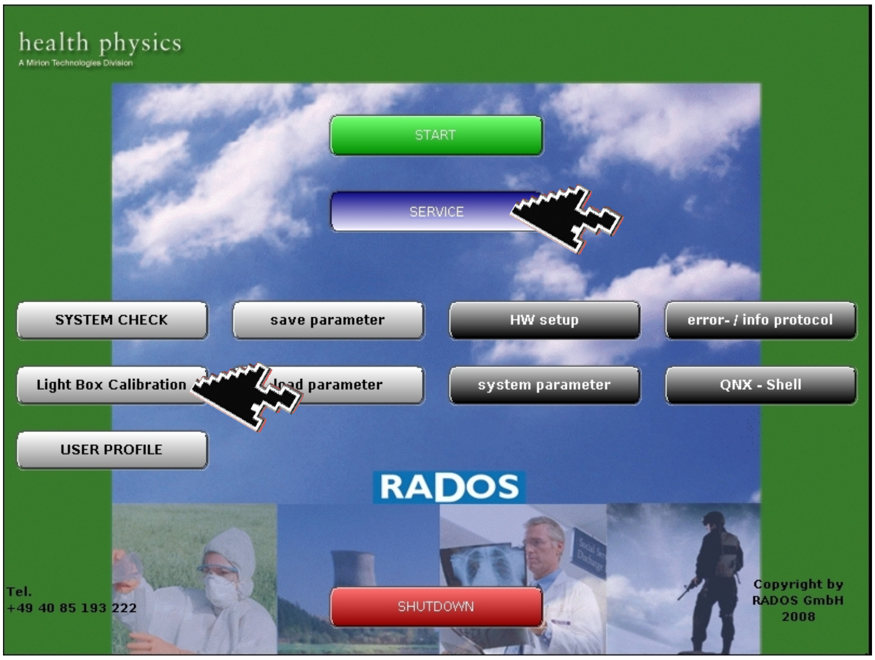



*Figure 7-1: Start-up menu*


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

the Light Box Calibration tool for body contamination monitors.

### 7.1.2 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.** |

### 7.1.3 Authorizations in RTM Software

The **user profile**, defined in the special user groups, will also organize the authorizations in the **Light Box Calibration s**oftware. With the aid of the **user profile program**, 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.

**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.**

**Refer to register 5 for detailed information on user profiles.**

## 7.2 Start of the Light Box Calibration

The Light Box Calibration (CALT-Calibration Tool) is required to store the discriminator thresholds and high tension needed for internal communication between the analog digital converter and the Light Box.

The **Light Box Calibration** is **s**tarted by selection in the start-up menu.

**NOTE**

**The presence of Light Box parameters is checked by the start protocol MONI.**

**If the Light Box parameter is not stored in the electric, the light Box calibration is automatically called.**

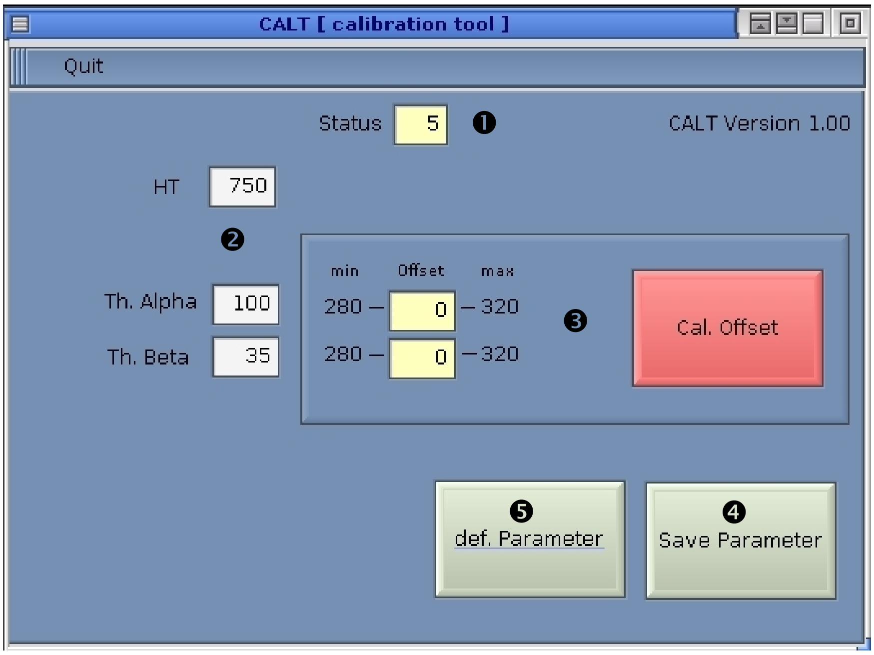



*Figure 7-2: Light Box Calibration program (CALT)*

This service menu is separated in four areas:

❶ Actual status of the Light Box
This status is necessary for maintenance by the RADOS Service team only.

❷ Channel adjustment information

HT (V) = High voltage photomultiplier
TH. A = **A**lpha discriminator threshold
TH. B = **B**eta discriminator threshold

❸ Read actual offset from Light Box (see following figure)

❹ Save new parameter to electric

❺ Read default parameter settings

## 7.3 The CALT - Calibration tool

1 Insert **HT** and **Th** data ❶ from factory calibration protocol.

2 Use **def. Parameter** button to use settings for calibration.

3 Use **Cal. Offset** button to read the actual parameter offset.

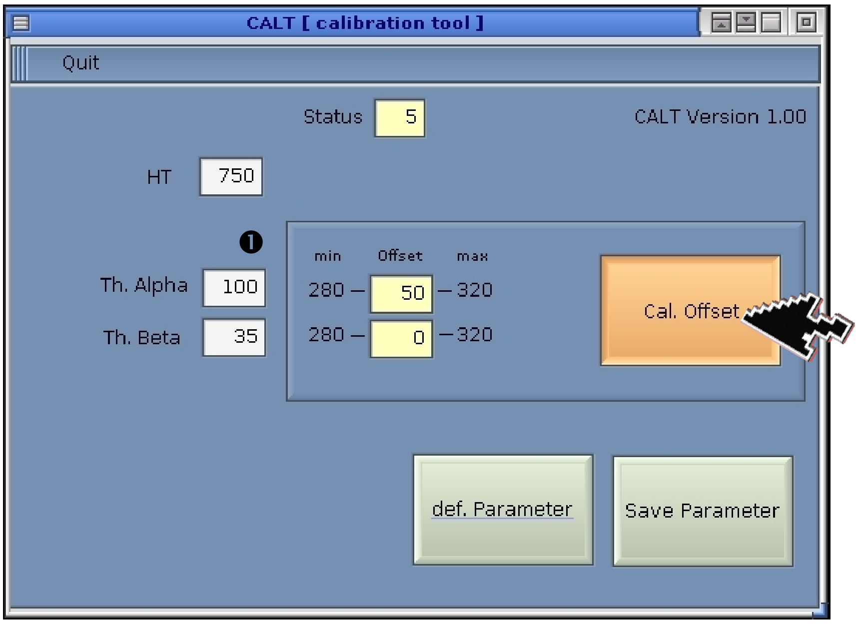



*Figure 7-3: Light Box Calibration program (CALT) – read Light Box offset I*

4 During parameter analysis and calibration in the analog digital converter the **Cal. Offset** button is colored in amber and the off set value calculated is displayed.

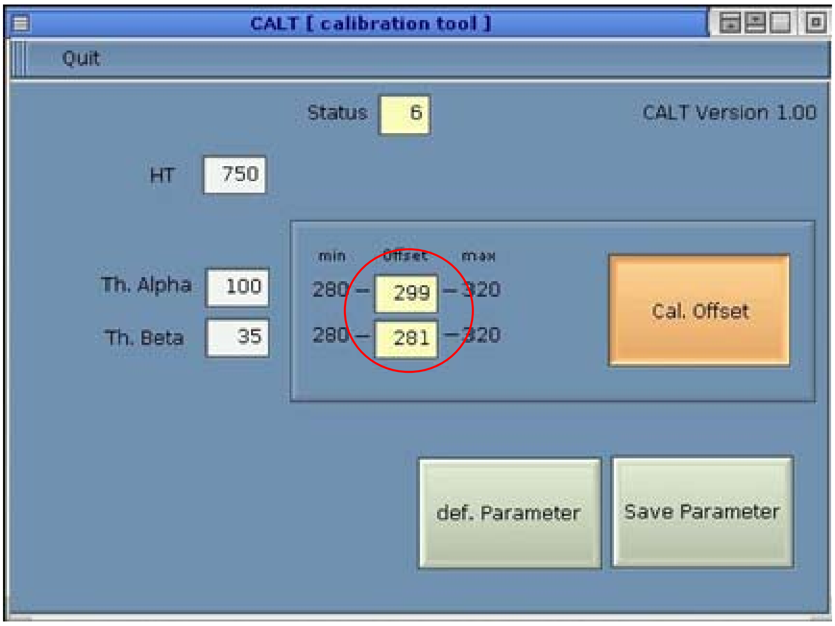



*Figure 7-4: Light Box Calibration program (CALT) – read Light Box offset II*

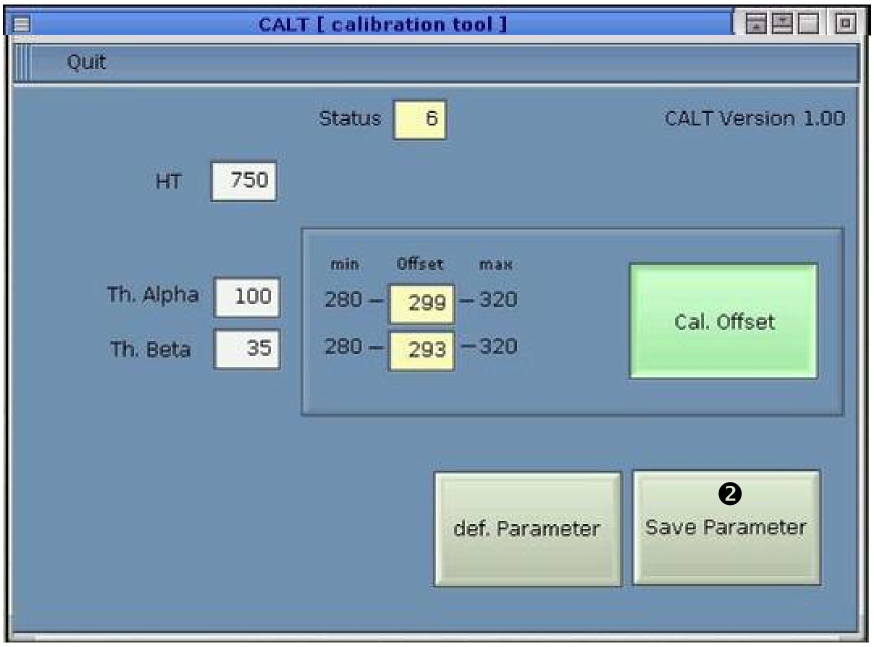



*Figure 7-5: Light Box Calibration program (CALT) – read Light Box offset III*

5 After parameter analysis the **Cal. Offset** button is colored in green, if the offset values are between the **min/max** values.

6 With the button **Save Parameter** ❷ the calibrated values will be stored to the measurement electronics.

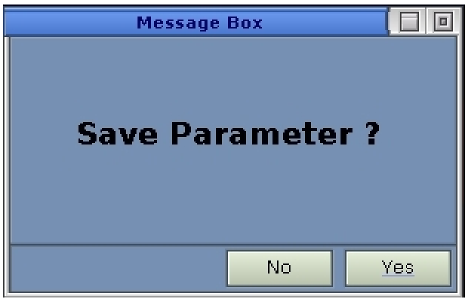



*Figure 7-6: Light Box Calibration program (CALT) – save query*

## 7.4 Close the calibration tool

To close the **Light Box Calibration** program one clicks at *quit* at the menu panel.

# Register 8

# 8 Detector

# Figure

## 8.1 General

The TwoStep™-Exit monitor has been developed and designed to work with the RFD Fibre™- detectors (one detector type for the whole monitor).

The detector placement on the TwoStep™-Exit guarantees optimal detection geometry for body measurement and supplies the user via initiators and light barriers to achieve the optimal detection position.

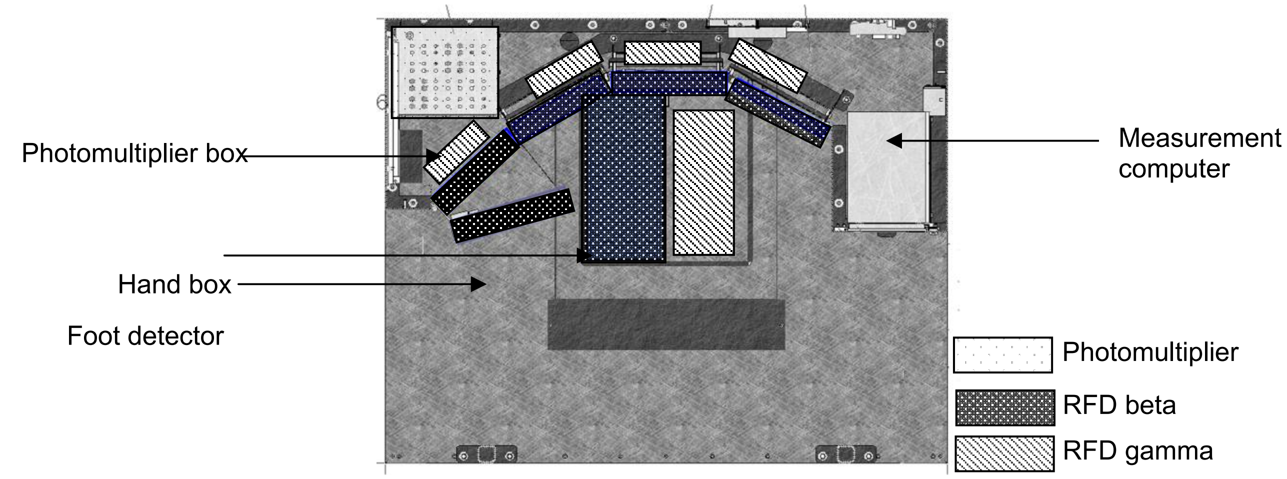



*Figure 8-1: TwoStep™-Exit top inside view RFD detector location*

## 8.2 Detectors

For the detection of covered activities and "Hot Spots" the new RFD-Fibre™ scintillation detectors are integrated into the TwoStep™-Exit. The following attributes are characteristic for the RFD-Fibre™ Scintillation detector:

- Almost no dead zones
- Less sensitivity on background radiation
- Increased detector geometry
- plug & play properties for the detectors
- maintenance-free

The detectors are merged into the two-phase body measurement instrumentation, whereby during a measurement a localization of the emitter is made possible. The thickness of the scintillators is optimized for getting the best possible response for particles in the relevant energy region.

## 8.3 Detector unit

In the following a detector unit will be used to describe the RADOS Fibre™ scintillation detector with the light-tight cover, RFD - detector for short.

A detector unit consists of the lower mounting plate, with a mounted beta or gamma Fibre™ scintillator, the protective detector cover and multiple layers of special aluminum vaporized foil.

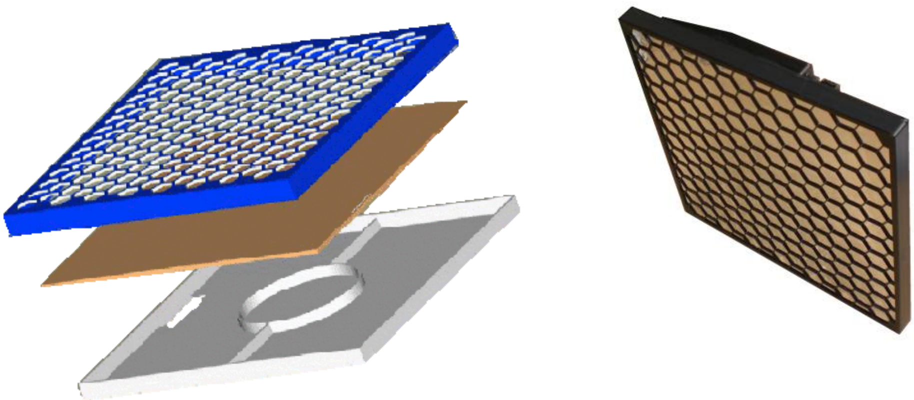


*Figure 8-2: Isometric view of a detector unit*

The detector housing was especially designed to enhance the stability and measurement properties on the highest level reflecting the state of the art. The measurement qualities are additional raised by moving the sensible detection area close to the detector edges.

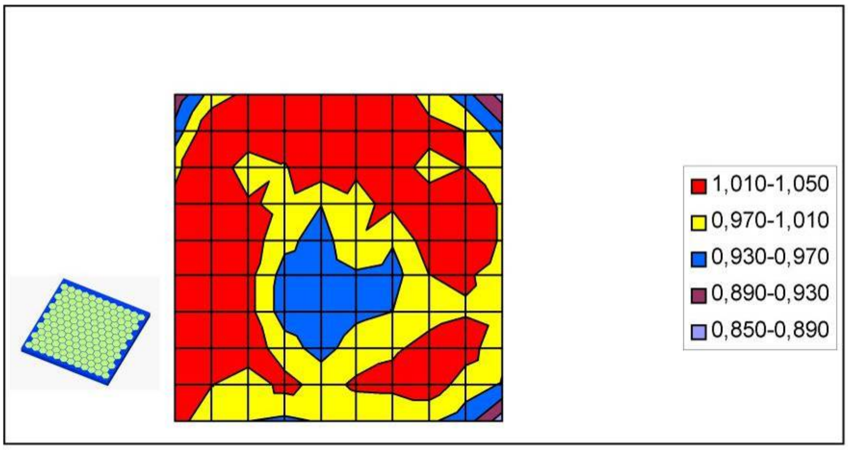



*Figure 8-3: Detection distribution example for a RFD485 detector*

The detectors are connected to a central photomultiplier board ① (PM-board) using coated fibre glass cable. The PM-board, which is designed for light detection, is especially aligned to the light spectrum of the scintillator. The detector addresses ② are directly set via the plug position of the coated fibre glass cable on the PM-board.

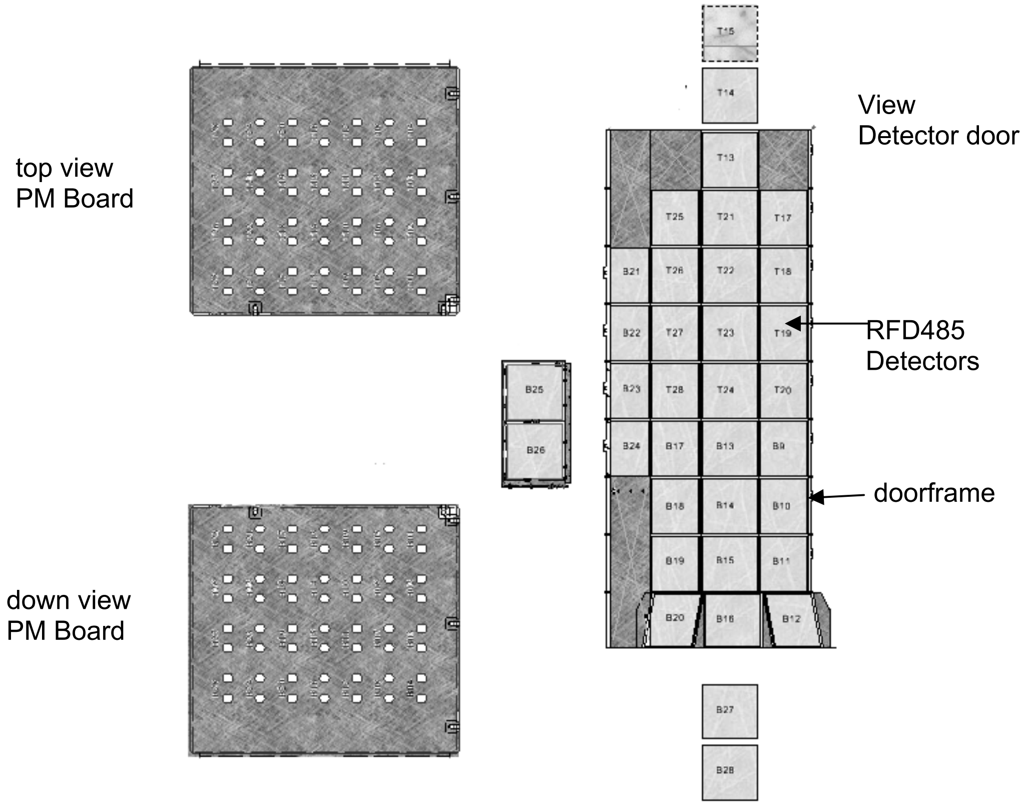



*Figure 8-4: Beta Fibre™-detector position in the detector door and view of PM Board*

The PM Board is connected with a counter board, which transmits (via network) the signal to the measurement computer, which also takes control of the I/O relays. The measurement computer calculates all necessary arithmetic operations needed for a contamination measurement.

## 8.4 Light Box

The function of the Light Box is a similar to a camera. The setting of the working point is an adjustment process according the light conditions as it is done while taking photos, where normally the aperture is adjusted to the light conditions and the fine tuning is carried out regarding the exposure time and film quality.

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 Light Box 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 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.

**CAUTION**

Please feel free to call RADOS Service in any case regarding the exchange of detectors with different efficiency's.

In general all calibration work should only be carried out by special trained persons or the RADOS Customer Service.

## 8.5 Sensors and positioning

The changed monitor geometry of the body contamination monitor the positioning of a person has to be adopted and differs to the positioning taking place in TwoStep™-Exit monitors. The sensors were specially designed to meet the new geometry used in the monitor.

**Sensor location:**

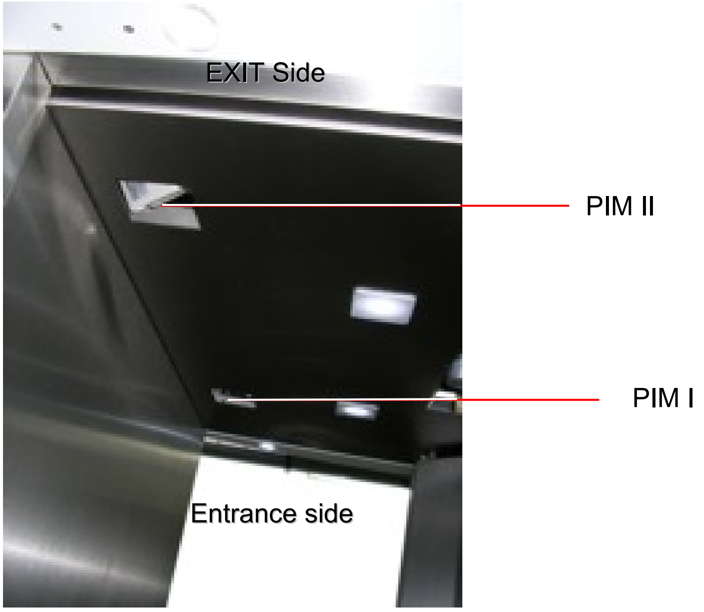



*Figure 8-5: TwoStep$^{TM}$- PIM- Sensors*

The PIM sensors (PIMI and PIMII) are used to recognise a person entering the monitor and to control the person's position in front of the monitor.

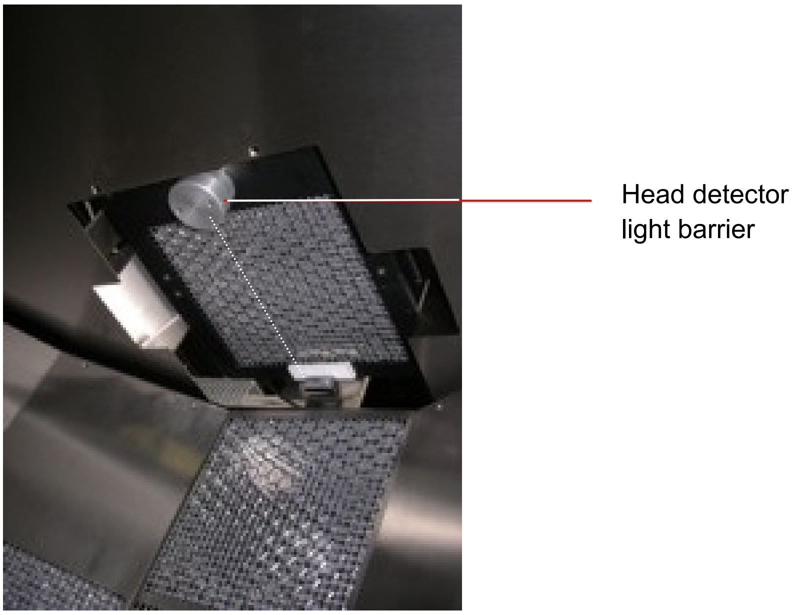



*Figure 8-6: TwoStep$^{TM}$-head detector sensors*

The type series with automatic moveable head detector are designed with a head detector light barrier. This light barrier gives a signal to the electronic every time the head of a person is in the reach of the light barrier (head detector).

During the body measurement process the light barrier contact it will be

controlled whether the head is in reach of the light barrier or not. If the light barrier is not contacted while the head detector movement reached the lower end, the small person process from HS setup is taken into account.
Following adjustments are possible in the HW setup of the TwoStep™-Exit software:

① Normal measurement with head position control for person larger than 1.60 m and without head position control for persons smaller than 1.60m.

② Normal measurement with release of person larger than 1.60m by TwoStep™-Exit software and no release for person smaller than 1.60m.

③ Normal measurement for person larger than 1.60m.
No measurement of person smaller than 1.60 m.

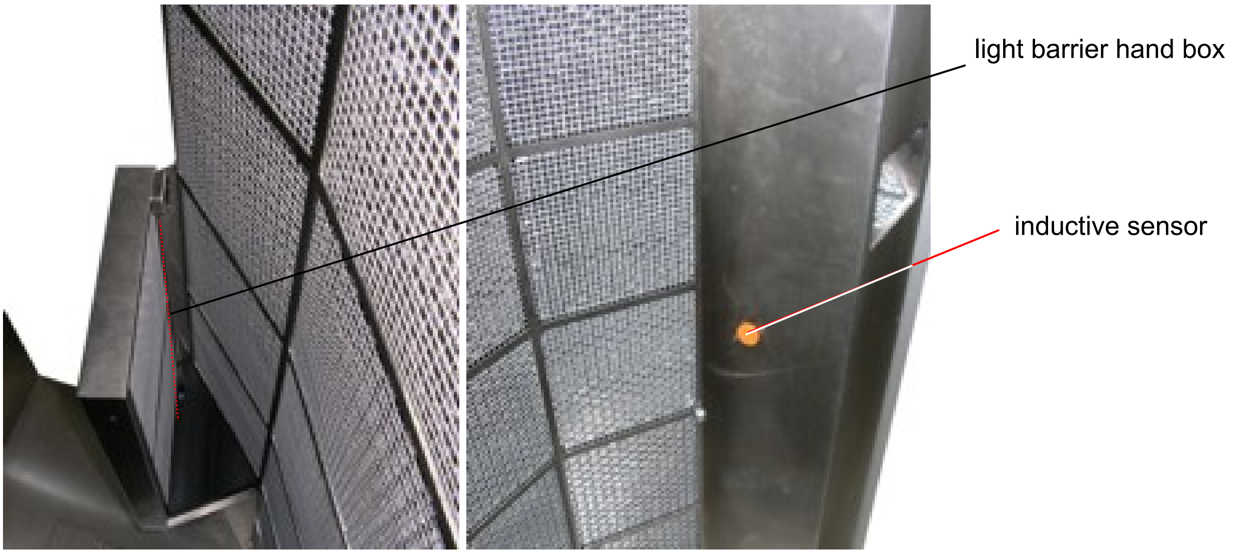



*Figure 8-7: TwoStep™-Exit hand sensor*

To position the hands the respective hand has to be placed in the hand box as deeply as needed to reach the hand box light barrier. The remaining hand has to be placed near the inductive sensor to safeguard the position.

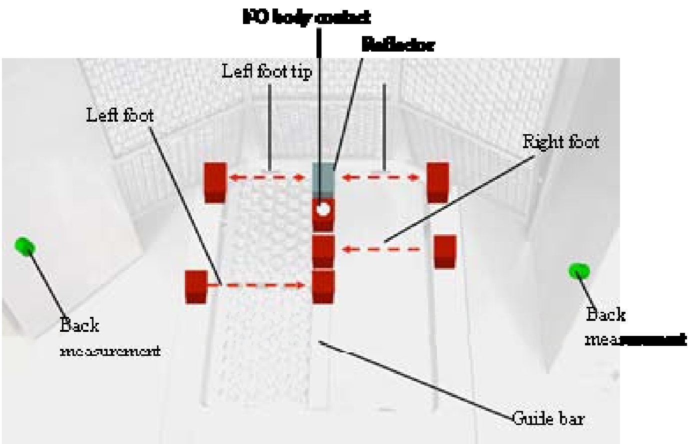



*Figure 8-8: TwoStep™ Exit s foot frame and light barriers*

Refer to Register 3 of this technical hand book for further information.

## 8.6 Small item measurement

The TwoStep™-Exit can optionally be equipped with a small item box.

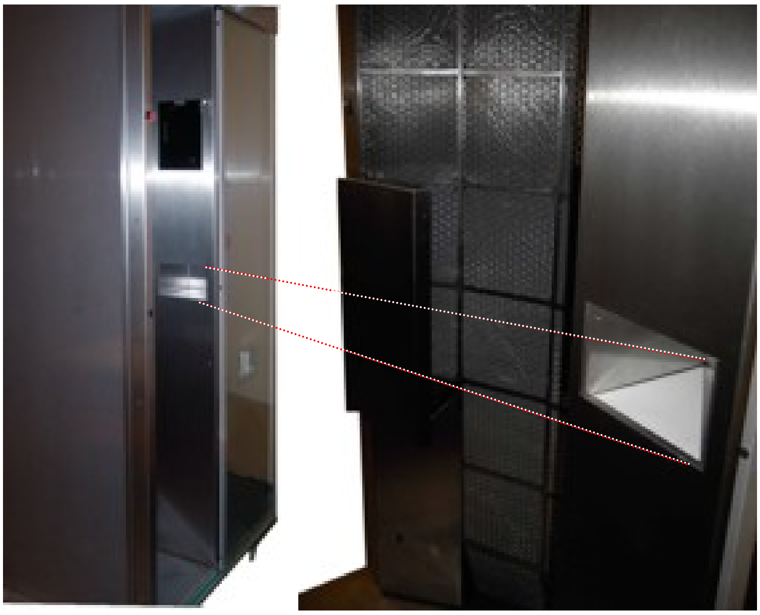


*Figure 8-9: Small Item box with a RFD detector on bottom (OPTION 2)*

The type series with small items box will measure the small items in one step measurement mode.
After entering the monitor a voice guided request "INSERT SMALL ITEMS, PLEASE". The small items are not controlled by sensors.

## 8.6.1 Small items box middle Frame (option)

Inside dimension: **100 * 150 * 200 mm**

Detectors: **RFD485** Beta Fibre™ scintillation detector
**RFD 4.8/4.8** Gamma Fibre™ scintillation detector

Design and allocation:

*Option 1:* RFD485 on top and RFD4.8/4.8 on bottom
*Option 2:* RFD485 on bottom
*Option 3:* RFD4.8/4.8 on top and bottom

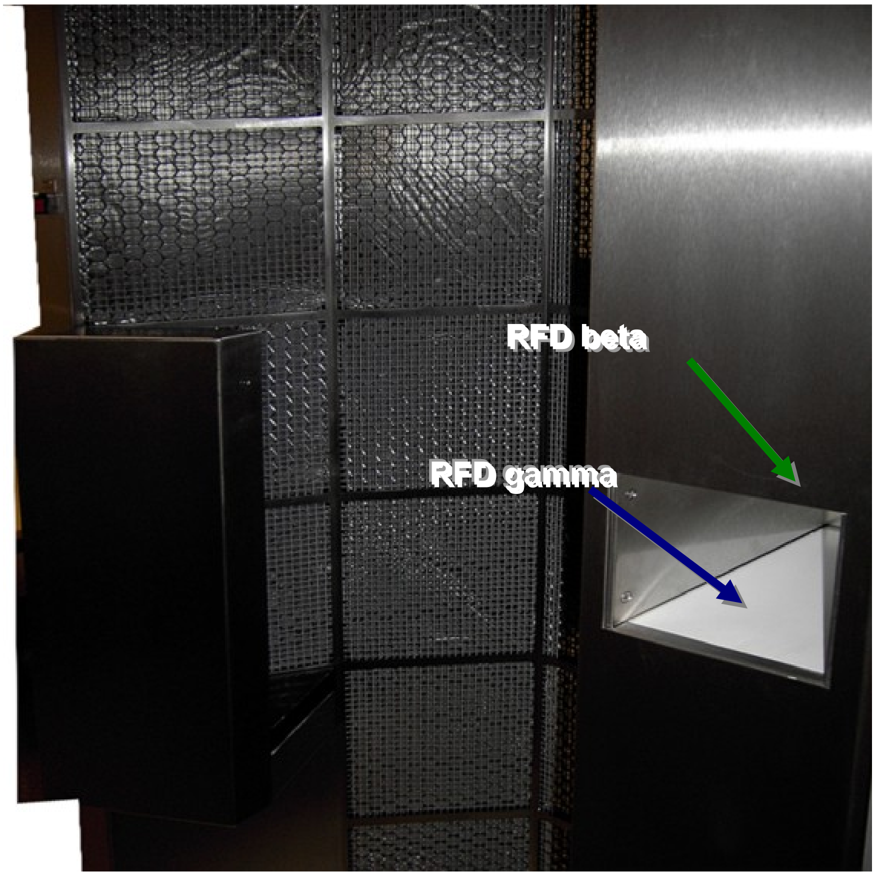



*Figure 8-10: Small Item box (example Option 1)*

## 8.6.2 DIN A4 Small itelms (Option)

**Equipment**

Detectors: 2 EA **RFD4.8/4.8** Gamma Fibre™ Szintillation detector (middle of box).

Lead shielding for whole box (5 sides) with 20mmlead bricks.

1 Sum channel with alarm parameters

detector 1

heigth

detektor 2

length

width

*Figure 8-11: Small Item box (example Option  A4)*

## 8.6.3 Dosimeterreader inside (Option)

Dimension: **100 * 150 * 800 mm**

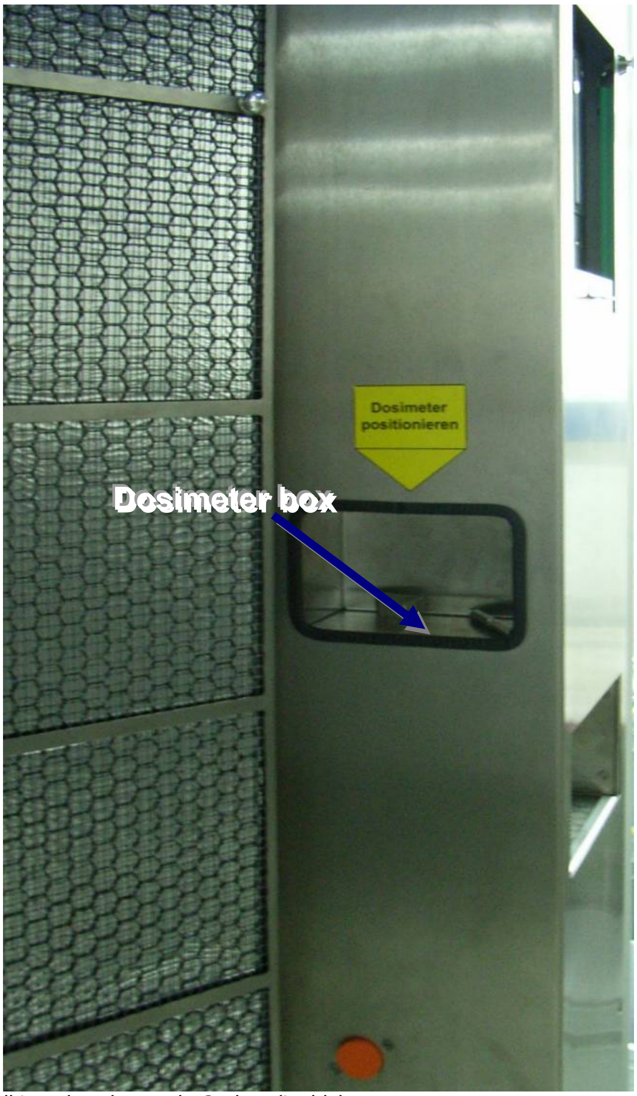



*Figure 8-12: Small Item box (example Option (Inside)*

## 8.6.4 Detector- and measurement data

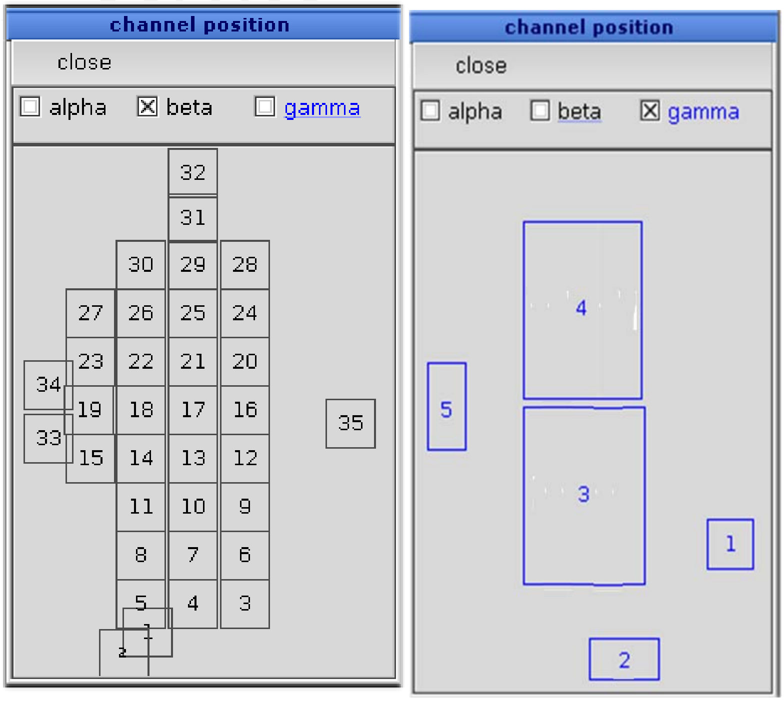



*Figure 8-13: Channel numbering and channel position (this view can differ due to type series)*

The standard TwoStep™- Exit is equipped with 34 beta- RFD485-detectors.

**RFD485**:

| | |
|---|---|
| Dimensions (l x w): | 22 x 22 cm |
| Housing (l x w): | ~22.8 x 22.8 cm |
| active surface: | 485cm² |

**Beta detection channel:**

| Detector number | Position | Remark |
|---|---|---|
| **1-2** | Foot palm | Front measurement - left foot<br>Back measurement - right foot |
| **3-5** | Top of foot | |
| **15, 19, 33, 34** | Arm (front and back) | Front measurement - left arm<br>Back measurement - right arm |
| **6-14, 16-16, 20-30** | Body | |
| **31** | Head | Front measurement - forehead<br>Back measurement - back of the head |
| **32** | Head | Top of head |
| **(35)** | Small item box | |

## 8.7 Repair information

**NOTE**

There is no need addressing the detector in the TwoStep™-Exit environment, because only one detector type is used on the TwoStep™-Exit body contamination monitor and the detector themselves are indicated using the "plug and play" properties.

**CAUTION**

The addressing of the detectors will depend on the plug-in position on the PM Board.

### 8.7.1 Detector foil

Multiple layers of a special coated aluminum vaporized foil are used as detector foil.

**NOTE**

For detection of light leakages in detector caused by damaged **detector foils**, please refer to register 4 service chapter detector state.

## 8.7.2 Detector – mounting / unmounting

**CAUTION**

The power must be switched off before any detector is removed from the TwoStep™-Exit in first.
**Refer to Register 3 concerning the shut down process of the TwoStep™-Exit.**
The monitor is only to be switched on again after the work has been completed!

**CAUTION**

The coated fibre glass cable should not be bended, folded or cracked during these installation tasks. Damages to the coated fibre glass cable will initiate a loss of measurement data or lead to false measurement findings.
**Handle coated fibre glass cable with care.**

In the following the unmounting and mounting of detectors in various locations is described.

## 8.7.3 Body detector

**Unmounting detectors:**

1. Shut down TwoStep™-Exit and close mains.
2. Open detector door


*Figure 8-14: Beta Fibre™-detector attachment in detector door*

3. Beta RFD Detector:
4. Remove dedicated coated fibre glass cable from plug on RFD detector and keep cable for reinstallation.
5. Remove and keep attachment screw and hold attachment bracket.
6. Swing back attachment bracket.
7. Remove (exchange) detector.


*Figure 8-15: Gamma Fibre™-detector attachment inside monitor*

8. <u>Gamma RFD Detector:</u>
9. Remove dedicated coated fibre glass cable from plug on RFD detector and keep cable for reinstallation.
10. Hold dedicated upper detector briefly to prevent it from falling down.
11. Move detector bracket upwards and remove detector bracket
12. Remove (exchange) detector.

## Mounting detectors:

Follow unmounting tasks in reverse direction to mount detectors

## 8.7.4 Foot detector

*Figure 8-16: Top view of foot detector*

**Mounting / Unmounting**

1. Switch of monitor and shutdown mains
2. Remove the safety screw and take off the cover metal sheet
3. Push the foot grid about 5 cm away from the detector door and lift it up.
4. Remove the protective foil

**Working steps for unmounting**

1. Take the detector out of the monitor
2. exchange detector and place in new detector

**Working steps for mounting**

1. The protective foil is pulled over the detector, but before the dirty section of the foil being cut off with a shears.
2. The protective foil is pulled over the detector, the dirty section of the foil being cut off with scissors.
3. Carefully lay the foot grid down and push in direction of detector door.
4. Insert cover metal sheet and tighten the safety screws

## 8.7.5 Hand detector

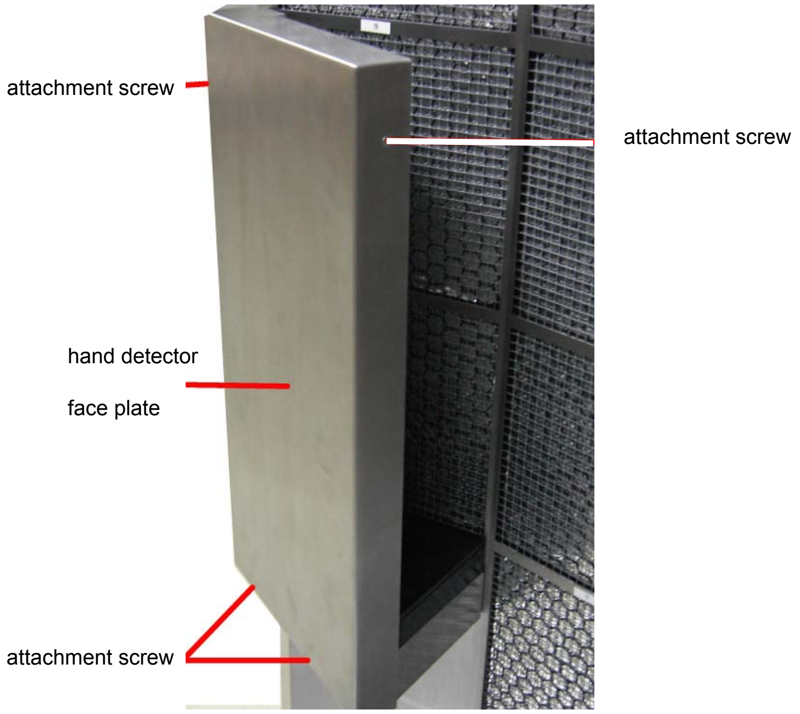



*Figure 8-17: View of hand detector (hand box)*

### Unmounting detectors:

1. Remove attachment screws of hand detector face plate (side and bottom)
2. Remove hand detector face plate.
3. Remove dedicated coated fibre glass cable from plug on RFD detector and keep cable for reinstallation.
4. Remove and keep attachment screw and hold attachment bracket.
5. Swing back attachment bracket.
6. Remove (exchange) detector.

### Mounting detectors:

Follow unmounting tasks in reverse direction to mount detectors

### 8.7.6 Head detector

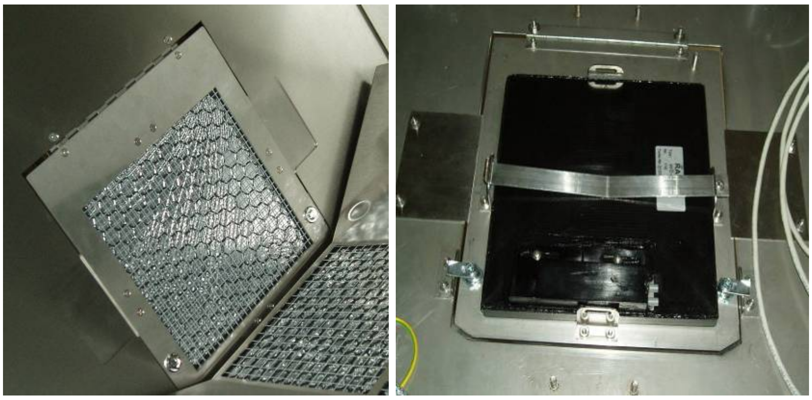


*Figure 8-18: View of head detector*

**Mounting / Unmounting**

1. Hold head detector unit high and loose the two screw locks with a square wrench.
2. Carefully lay down the head detector unit.
3. Pull of detector retaining clamps
4. Take of detector
5. Position new or repaired detector in the retaining lug and take care that the protective grid butts up against the detector.
6. Slide in the retaining clamps
7. Fold up head detector again and tighten the two screw locks with a square wrench.

## 8.8 Calibration

All Beta-Fibre™ detectors of the Checkpoint: Body™ TwoStep™- Exit monitor will be calibrated with the user software module **system check**.

This software module is identical to the system check module, which is described in register 6 of this TwoStep™- Exit Technical Handbook.

The System check software module will be activated from the start up menu.

# Register 9

# 9 Trouble shooting and repair

# 9.1 General Guideline and performance criteria

1 Work must be carried out in accordance with organisational requirements, licensing requirements, legislative requirements, and industrial agreements.

2 Preventative maintenance covering repairs or replacement of equipment components will be conducted within workplace agreements.

3 Faults may be in individual units, sub-systems or systems.

4 Tools and equipment used for repairs/replacements may include small hand tools, hand held power tools.

5 Environmental aspects may include dust, noise, heat, waste handling.

6 Reporting systems may include electronic and manual data recording and storage systems.

## 9.1.1 Locate equipment faults

- Unit or subsystem or system performance is monitored to identify presence of actual and/or potential faults.
- Built in test functions, fault indicators or alarms and error codes are monitored.
- Equipment faults are detected using agreed fault diagnosis techniques and procedures.
- Faults are recorded and/or reported according to Register 1.

## 9.1.2 Repair and/or replace faulty equipment

- Equipment is isolated in preparation for component repair and/or replacement.
- Faulty components are repaired and/or replaced in accordance with manufacturer’s specifications and organizational requirements.
- Unit and/or sub-system and/or system is checked and tested according to manufacturer’s specifications.
- Tools are used according to manufacturers’ specifications.
- Waste arising from maintenance is disposed of according to waste management requirements.

## 9.1.3 Demonstrate knowledge of the diagnosis and rectification

- The purpose of routine preventative maintenance and fault diagnosis techniques and procedures is identified.
- The purpose and use of hand and power tools is identified in terms of their use for component repair and/or replacement.
- Preventative maintenance requirements are identified in terms of organisational implications.
- Safety issues are identified in terms of performing preventative maintenance.

# 9.2 Guideline for trouble shooting

## 9.2.1 Troubles hooting general

Please keep in mind that excessive troubleshooting is bad for your (mental) health, therefore

- Know when to take a break
- Talk problems out
- Know when to consult specific help.

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 Trouble shooting process

- Gather information
  - define the problem
  - Ask questions
- Identify the kind of problem
  - Hardware failures
  - Percussive Maintenance
  - Thermals
- Try quick fixes
  - Look a recent changes
  - Check connections
  - Reboot the computer
- Isolate the problem
- Perform the repair

## 9.2.3 Distinction criteria

Types of faults are:

- Detector faults:
  - minimum level
  - maximum level
- Sensor specific faults:
  - sensor does not trip
  - sensor is constantly tripped
  - sensor is insensitive
  - sensor is unstable
- Electronic faults:
  - system faults
  - various fault messages

The main goal is to conclude the correct fault origin from the observed fault symptoms.

Trouble shooting on the Mirion Technologies (RADOS) GmbH personnel monitor is supported by comprehensive help functions in the service menu. Fault messages, their possible cause and their correction are described in the next section.

# 9.3 Fault messages and rectification

A lists common error messages, their causes and possible solutions.

The RTM can produce various error messages depending on the conditions encountered. This list shows the messages in error categories with explanations of what the messages mean and how to rectify them.

The occurring faults and malfunctions can be split in hard- and software fault as described in the following paragraphs.

## 9.3.1 Hardware

| FAULT | ORIGIN | RECTIFFICATION |
|---|---|---|
| **Monitor does not operate** | a) power supply failure<br>- no mains supply | a) service department<br>- check wire and fuses<br>- check mains connection<br>- measure low voltages |
| **Video display is blank** | a) power supply failure<br>- no mains supply | a) service department<br>b) check wire and fuses<br>- check mains connection<br>- measure low voltages<br>c) restart the monitor again<br>- replace the video- monitor or LC-display<br>- adjust contrast in BIOS of CPU |
| **Light barrier failure**<br><br>**Continual request to leave the monitor** | a) the light barrier is continually active due to a tripped sensor<br>b) the monitor cannot carry out first background measurement<br>c) sensor is set too sensitively<br>d) sensor defect | a) check all inputs in service menu "I/O- test"<br>b) without person in the monitor only the following input signals should be active:<br>- body contact<br>- service<br>- emergency passage<br>- head detector is up<br>- exit is closed<br>c) sensor should be cleaned<br>- Adjusted if necessary<br>d) replace |
| **Minimum limit** | a) background – pulse rate <u>below</u> minimum limit<br>b) high voltage set too low | a) turn to service menu - measurement status, look at MIN level of channels<br>b) check high voltage (*detector status)*<br>c) check sensors (menu I/O-test) |
| **Maximum limit** | a) background- pulse rate <u>above</u> maximum limit<br>b) high voltage set too high<br>c) contamination of monitor<br>d) housing damaged | a) more exact evaluation in service menu “detector-status“<br>- check MAX-level of detectors<br>c) check high voltage (*detector status)*<br>d) decontaminate<br>e) check housing for damages,<br>- check for light tightness<br>- remove detector and exchange |

| FAULT | BE RESPONSIBLE FOR | RECTIFFICATION |
|---|---|---|
| | **RFD detectors** | |
| **Minimum level** | a) no background count rate below minimum level<br>b) disturbed gas supply of the detector big hole in the detector foil<br>c) counting wire is broken<br>d) high voltage set too low | a) turn to service menu, measurement status look at MIN level of channels<br>b) exchange the complete detector<br>c) check high voltage (*detector status)* |
| **Maximum level** | a) no background count rate above maximum limit<br>b) hole in detector foil<br>c) high voltage set too high<br>d) contamination of detector or contamination of monitor | a) more exact evaluation in service menu “detector-status“<br>b) check MAX-level of detectors<br>c) exchange detector<br>d) check high voltage (menu detector status)<br>e) take out detector with protective grid decontaminate |
| | **RPD detectors** | |
| **Minimum level** | a) background count rate below minimum level<br>b) high voltage set too low | a) turn to service menu, measurement status look at MIN level of channels<br>b) exchange detector<br>c) check high voltage (*detector status)* |
| **Maximum level** | a) background count rate above maximum level<br>b) counting wire broken<br>c) high voltage set too high<br>d) detector housing broken | a) more exact evaluation in service menu “detector-status“<br>- check MAX-level of detectors<br>b) exchange detector<br>c) check high voltage (menu detector status)<br>d) examine detector on not luminescent state<br>e) exchange detector |

### 9.3.1.1 Software

If a reliable operation is not guaranteed, further measurements will be averted. Troubles and faults that lead to the interruption of the measurements are displayed on the screen ❶.

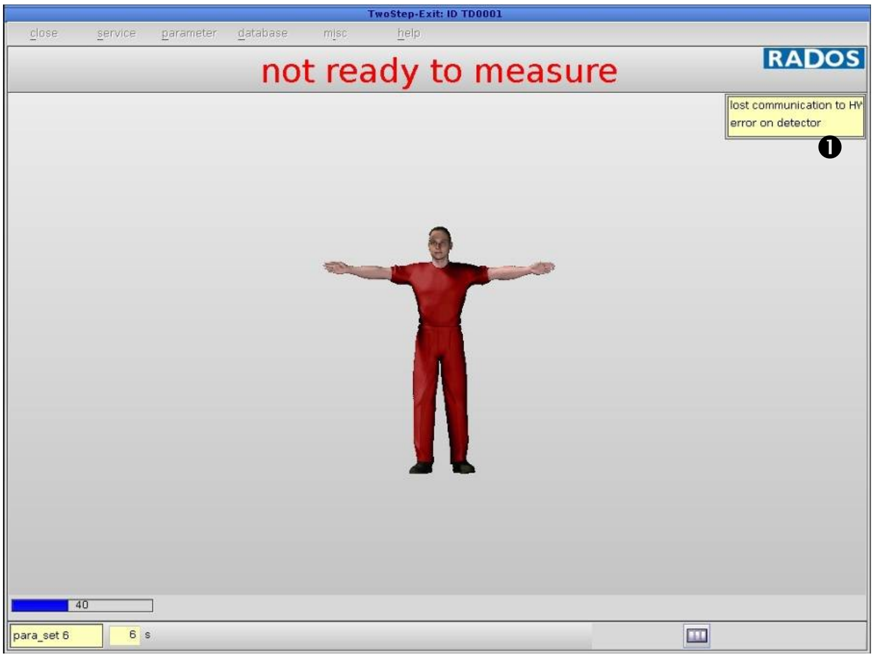



*Figure 9-1: Exception - not ready to measure*

**<u>Possible messages for troubles or faults:</u>**

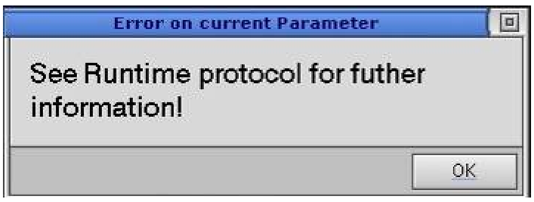



*Figure 9-2: Error-message*

Any possible messages and the causes for troubles and faults are described below:

**<u>Background</u>**

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.

### 9.3.1.2 Failure 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.

| ABLA MESSAGE | ORIGIN | RECTIFFICATION |
|---|---|---|
| **"error on I/O module"** | a) at start: ABLA could not locate AT2000 and /or the LS task<br>b) in operational mode: AT2000 could not communicate or locate with in –or output channel | a) restart the monitor<br>b) call RADOS service<br>c) restart the monitor<br>d) check camera and light barrier for proper function<br>e) call RADOS service |
| **"error on process control"** | a) ABLA application was not initiated correctly | a) restart the monitor<br>b) call RADOS service |
| **"error on Service key"** | a) ABLA could not define input on io "service key" | a) restart the monitor<br>b) call RADOS service |
| **"gamma min alarm"** | a) minimum rates on gamma channel are to low | a) turn to service menu - measurement status<br>- look at MIN level of channels<br>- change detector settings<br>b) detector defective<br>- change detector<br>- call RADOS service |
| **"gamma max alarm"** | a) background- pulse rate <u>above</u> maximum limit<br>b) contamination of monitor | a) more exact evaluation in service menu "detector-status"<br>- check MAX-level of detectors<br>- change detector settings<br>b) source in direct detector contact during background measurement<br>- remove source<br>- decontaminate detector<br>c) detector defective<br>- change detector<br>- call RADOS service |
| **"process control not active"** | a) internal fault of ABLA application, data could not be retrieved | a) restart the monitor<br>- call RADOS service |
| **"mathematics not active"** | a) measurement data could not be retrieved during start of monitor | a) restart the monitor<br>- call RADOS service |
| **"i/o not active"** | a) no AT2000 data received from ABLA at start | a) restart the monitor<br>- call RADOS service |

**Fault messages and rectification**

| ABLA MESSAGE | ORIGIN | RECTIFFICATION |
|---|---|---|
| **"error on detector"** | a) detector data (rates) are out of range<br>b) detector defective | a) more exact evaluation in service menu “detector-status“<br>b) change detector settings<br>c) detector defective<br>d) change detector<br>call RADOS service |
| **"error on parameter setting"** | a) measurement data could not calculated | a) more exact evaluation in service menu “parameter“<br>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)<br>b) switch to “service” mode and return to “measurement” mode to reinitialize io -module |

**NOTE**

**“call RADOS service”**

**Please refer to register 1 chapter “call for service”, if the rectification “call RADOS service” is mentioned in above list.**

## 9.3.2 Protocol

Before entering the different programs of the TwoStep™-Exit a protocol manager is started that record the start routine.

In this protocol:

- Info messages
- Warning messages
- Error messages

are recorded ❶, which occurred during the start and the program sequences.

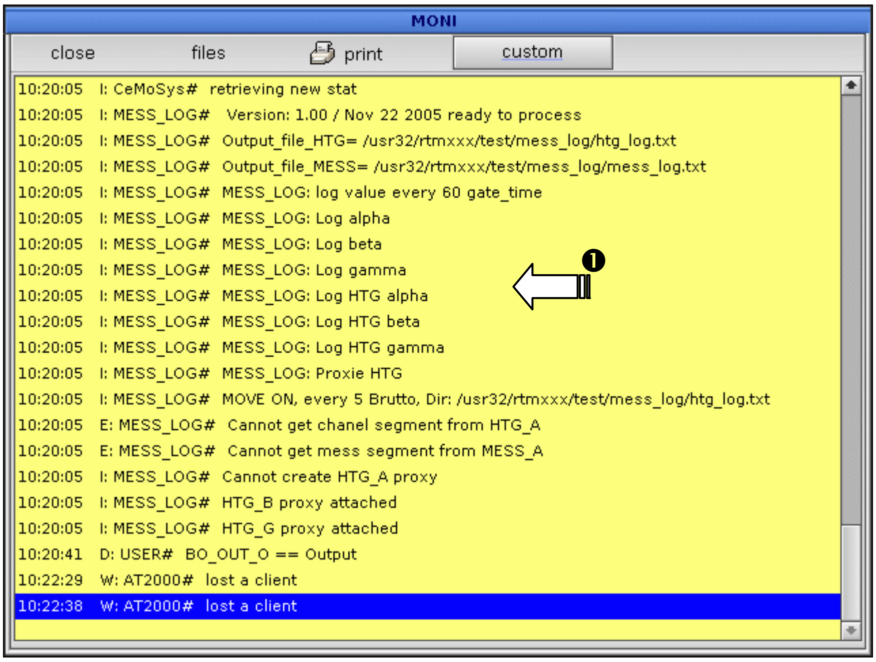



*Figure 9-3: Protocol*

The "***files***" button opens 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 ***"custom"*** it is possible to search for messages in the protocol files.

With the button ***"close"*** one can return to the start menu.

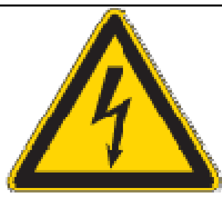
Furthermore, there are messages that are only provided for the commissioning, such as service, error in sequence control, service not possible, and not active.

Should one of these errors ❶ appear during running operation, please start the monitor again or contact the RADOS customer service.

# 9.4 Repair

## 9.4.1 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 |

Sticked to the high tension module the detectors and also sticked at the electrical terminal.

**WARNING**

**The main switch should be at OFF position before opening the detector covers.**

## 9.4.2 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.

## 9.4.3 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 earthing 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.

### 9.4.3.1 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.

### 9.4.3.2 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.

### 9.4.3.3 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.

### 9.4.3.4 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).

## 9.4.4 Stock keeping of spare parts / service department

| | |
|---|---|
| Address: | Mirion Technologies (RADOS) GmbH<br>Ruhrstraße 49<br>22761 Hamburg |
| Phone: | x49 - 40 85 193-0 |
| Fax: | x49 - 40 85 193-165 |
| e-mail | |

# Register 10

# 10 Maintenance

# Figure

# 10.1 Maintenance

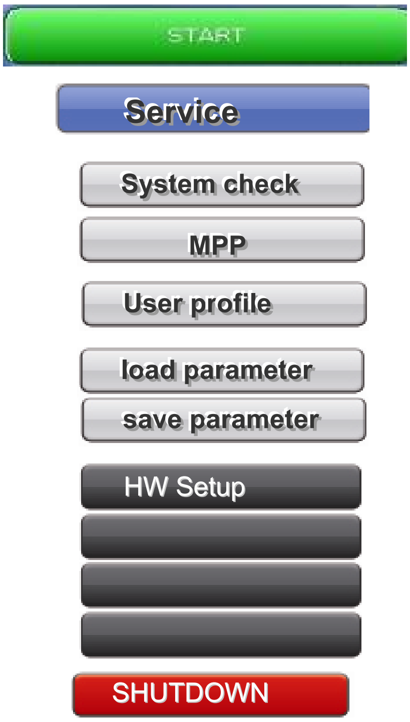
Under normal conditions, the CheckPoint:Body™ TwoStep™-Exit monitor does not need any maintenance. Nevertheless, it is advisable to perform some small repeat tests (system checks) from time to time.

## 10.1.1 Start-up menu

The start-up menu is the central navigation tool for all TwoStep™-Exit 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**:




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.

the maintenance and calibration program for body contamination monitor (see Register 6).

a detector working point module (see Register 7)

user administration program (see Register 5)

enables the user to im- and export all TwoStep™-Exit parameter on a USB-stick

program to configured the hardware settings of the present TwoStep™-Exit

program to set i.e. the timestamp and screen resolution

list of the last system internal messages i.e. useful for troubleshooting

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

shutdown TwoStep™-Exit

## 10.1.2 Save/load configuration

To enable the user with the feature of a central parameter backup, the import and export of all TwoStep™-Exit settings and parameter on data storage media (usually hard disk or USB-stick) was designed to be a part to the user software.

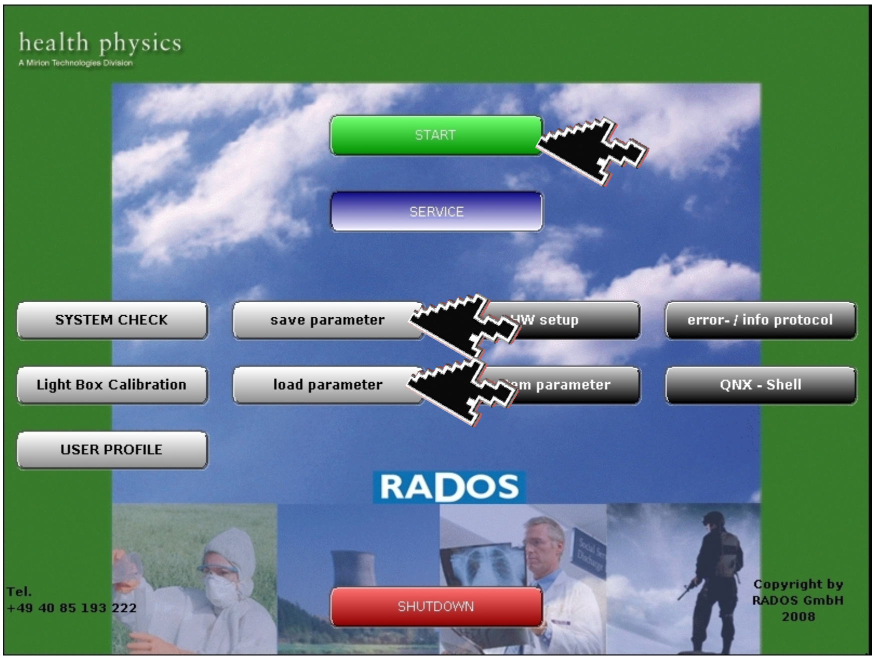
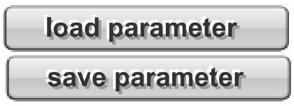



*Figure 10-2: Start-up menu*

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

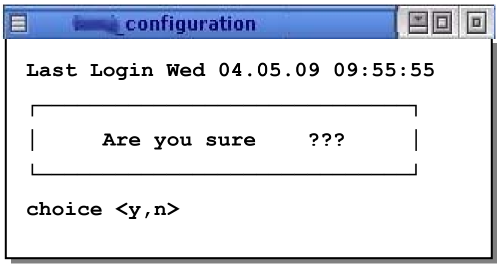

used to call the **RTM user software** the main program to perform contamination measurement (see Register 3 and Register 4)


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.



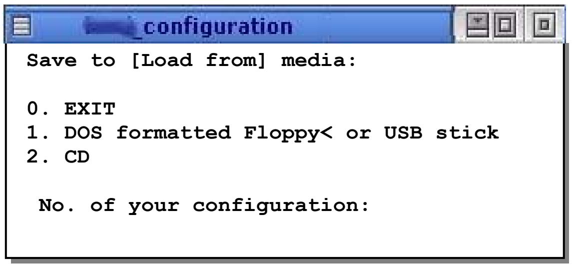




*Figure 10-3: Safety inquiry*

*Figure 10-4: Data storage media*

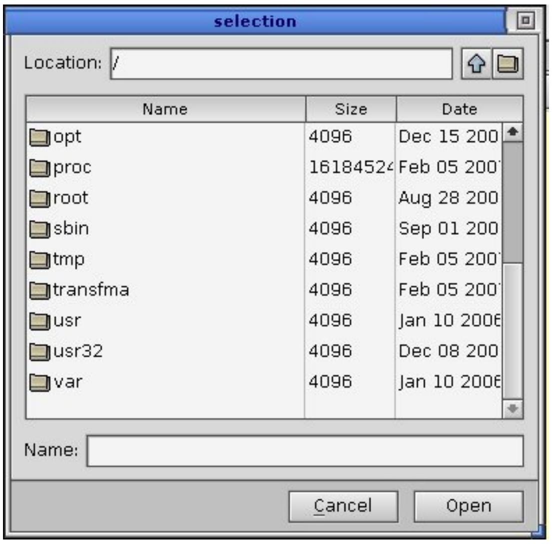



*Figure 10-5: Data storage media path (save/load)*

Regarding the case that backup data already exists on the chosen path, the following statements have to be given by the backup operator.

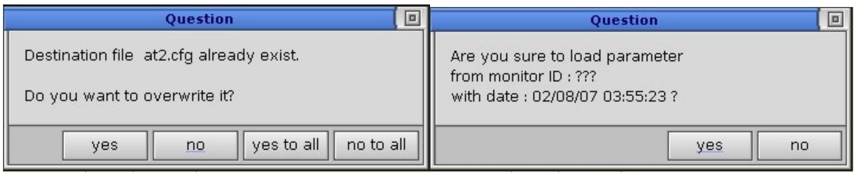



*Figure 10-6: Data safety questions*

## Save configuration

To save the configuration data of the monitor the menu button "**save**" ➊ has to be actuated. The actual saved data ➋, the result of the saving process➌ (serviceable in case of errors) and an overall progress bar ➍ will be displayed throughout the saving process.

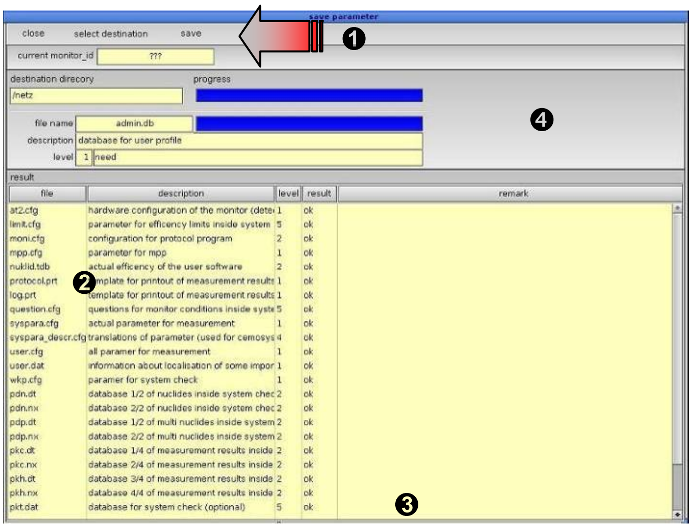



*Figure 10-7: Save configuration menu*

## Load configuration

To restore a configuration in the monitor the menu button "**load**" ➊ has to be actuated. The actual restored data ➋, the result of the loading process➌ (serviceable in case of errors) and an overall progress bar ➍ will be displayed throughout the "load configuration" process.

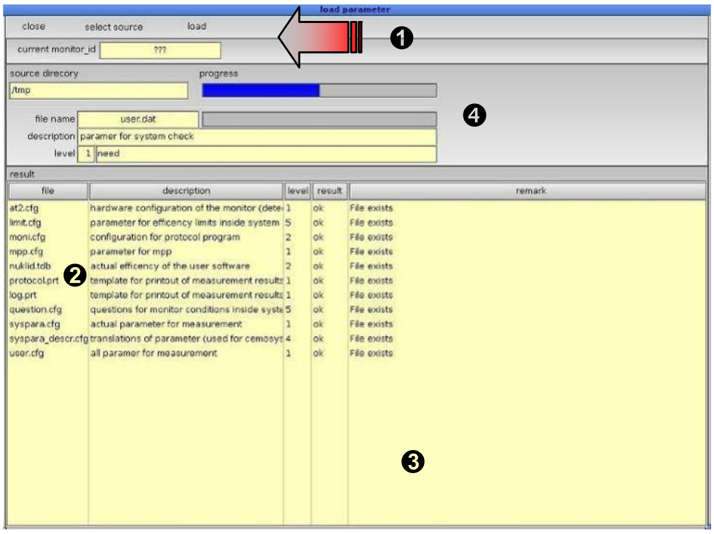



*Figure 10-8: Load configuration menu*

| 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.

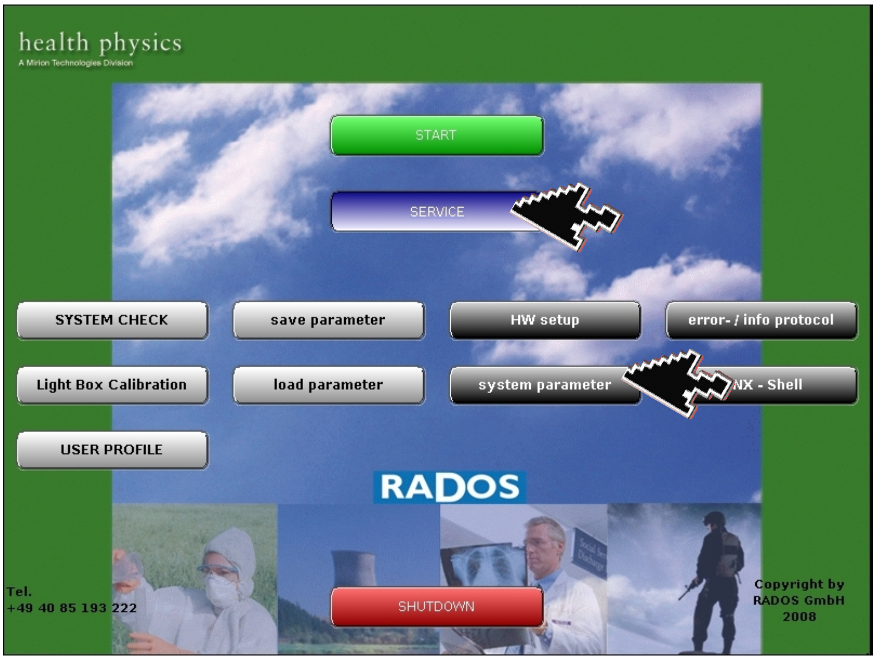



*Figure 10-9: Start-up menu*

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.

**In general:**

- A mouse click on **<Apply>** will apply the setting and the changed data will be stored in the TwoStep™-Exit.
- A mouse click on **<save>** will store the settings to the TwoStep™-Exit.
- The monitor must be restarted 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).

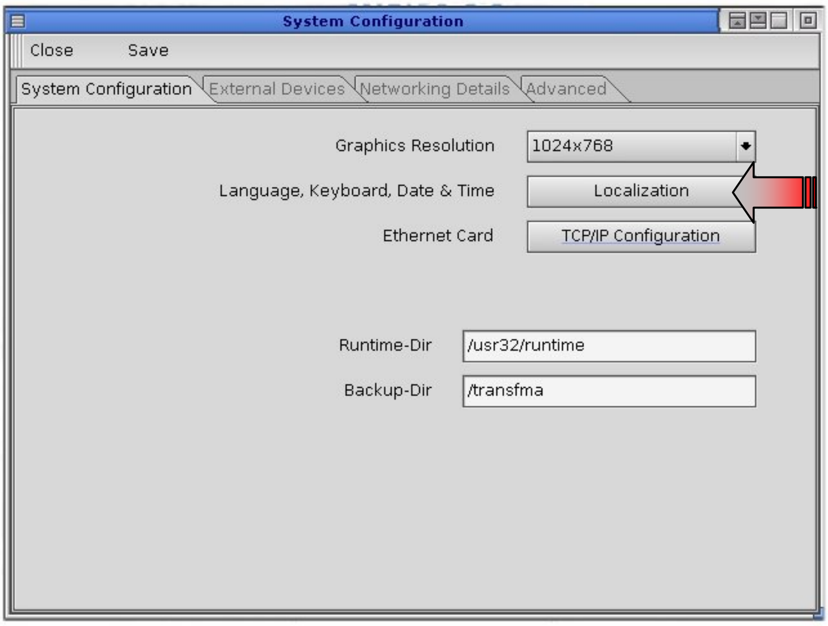



*Figure 10-10: Localization*

Select *localization* on tab *System configuration*.
The display *user configuration* starts with defining the *time zone.*

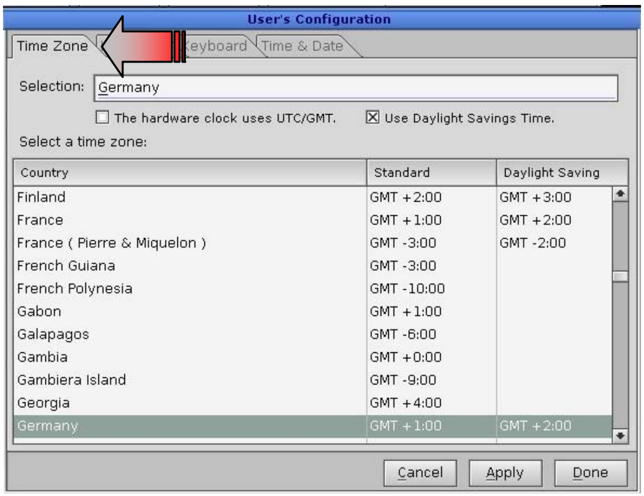



*Figure 10-11: Localization Time Zone*

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)

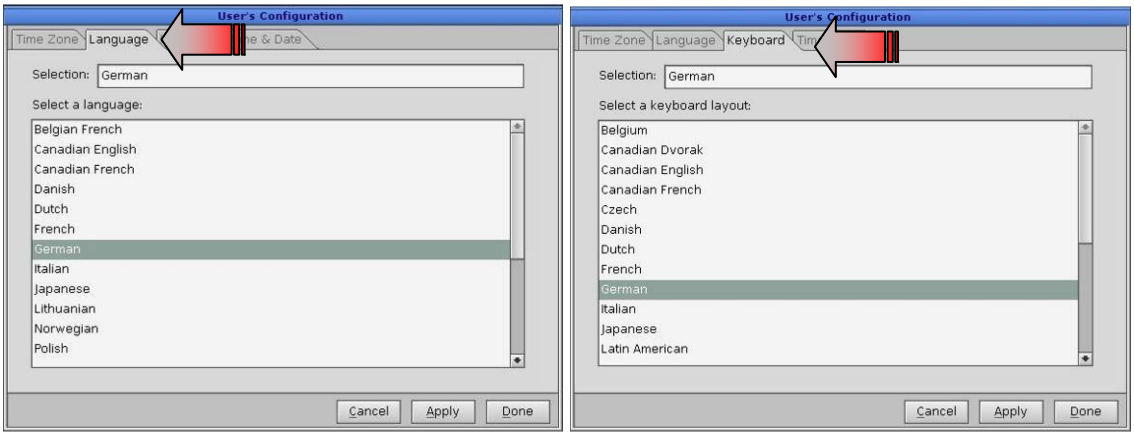



*Figure 10-12: Localization language and keyboard*

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.

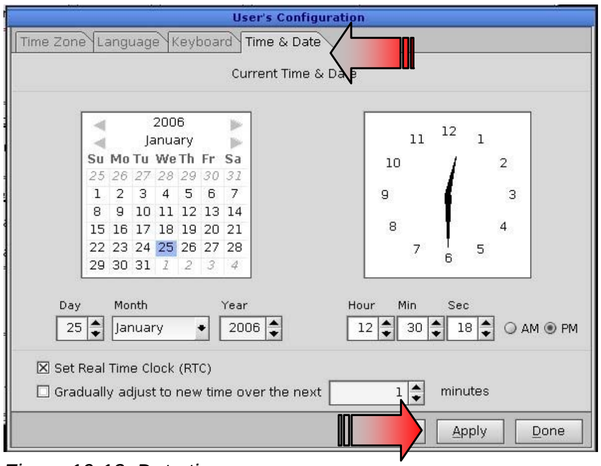



*Figure 10-13: Date time*

## 10.1.3.2 TCP/IP configuration

Select *TCP/IP configuration* on tab *System configuration* in order to alter network settings.

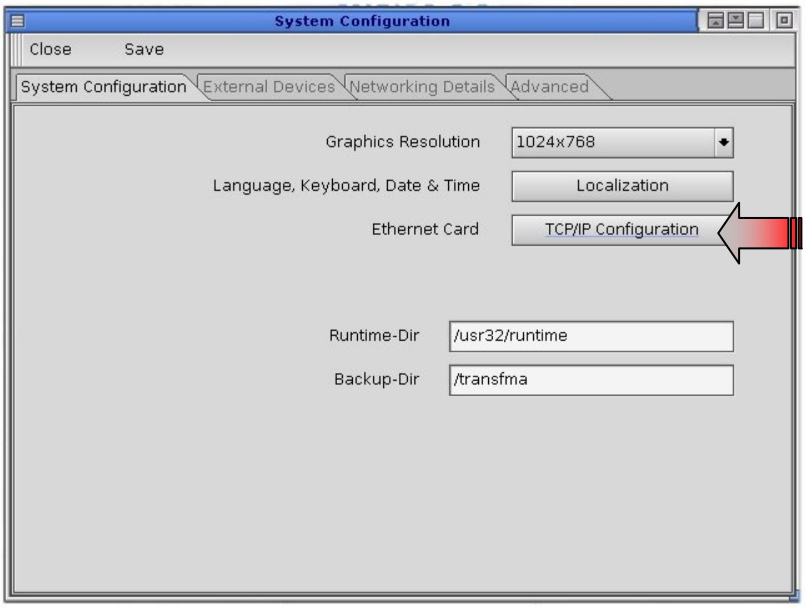



*Figure 10-14: TCP/IP configuration*

The display *TCP/IP configuration* starts with defining the *global network settings* on final destination.

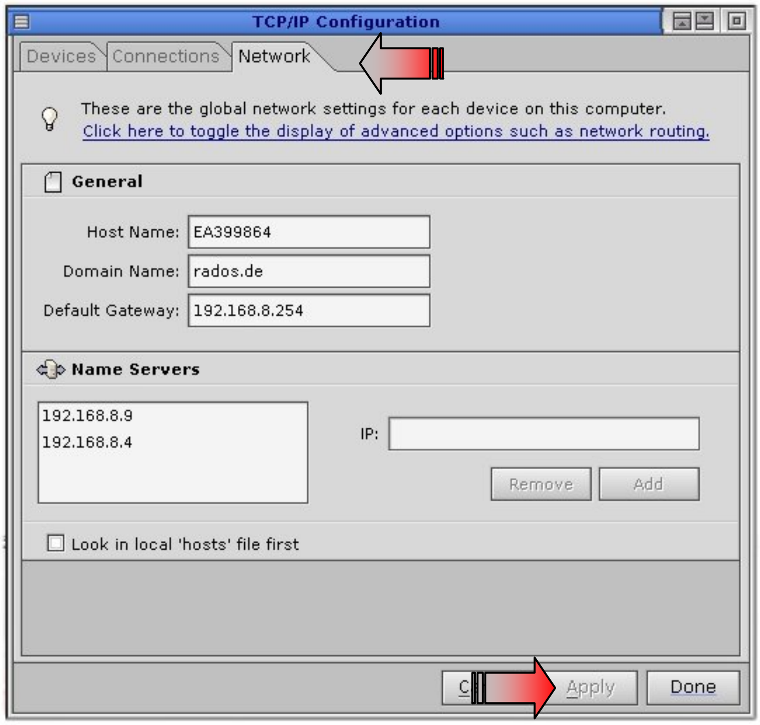



*Figure 10-15: Network*

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 TwoStepTM- Exit i.e. after weigh cell update or printer change.

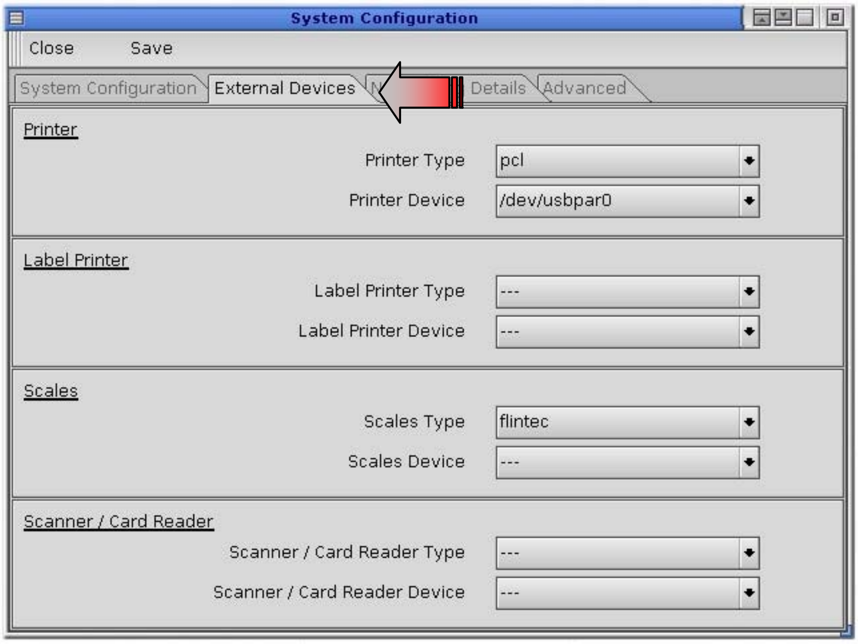



*Figure 10-16: External Devices*

**NOTE**

The devices selectable are shown in the drop down menu only and represent the recommended devices, which have been approved by RADOS.

**Regarding the case other devices should be used, please contact the RADOS Service Team 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.

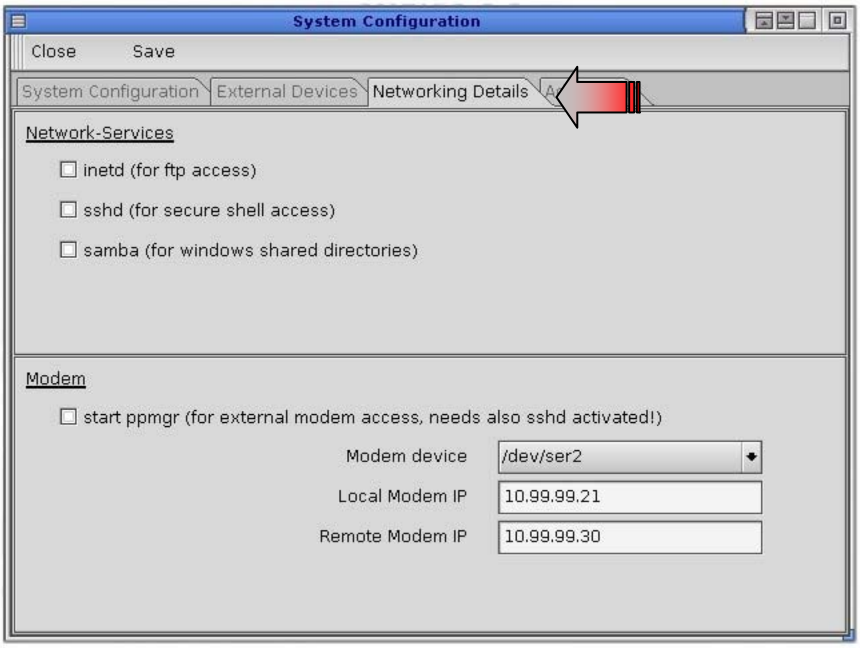



*Figure 10-17: Networking details*

**NOTE**

The modem device selectable is shown in the drop down menu only and represent the recommended devices, which have been approved by RADOS.

**Regarding the case other devices should be used, please contact the RADOS Service Team 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.

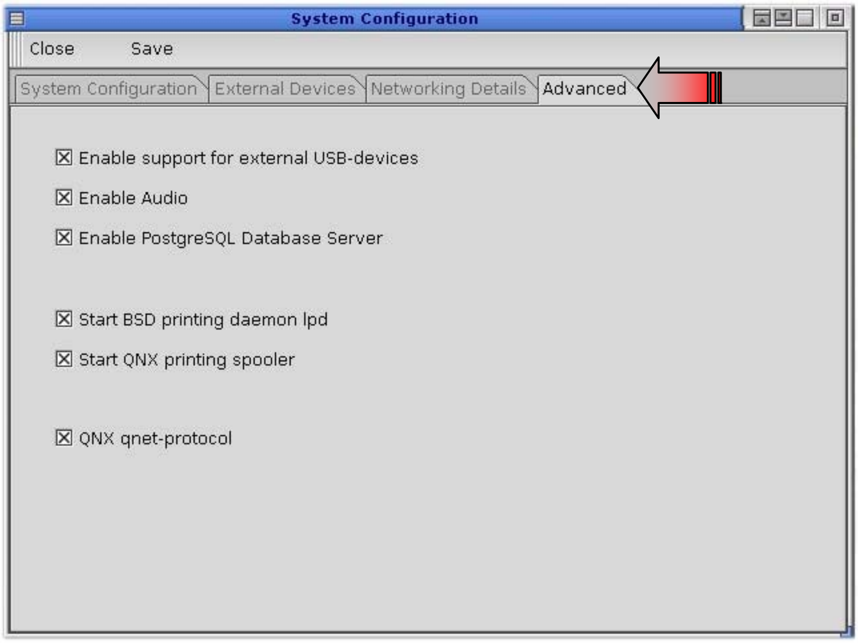



*Figure 10-18: Networking details*

## 10.1.4 HW Setup

The start of the **HW setup** is necessary after the peripheral equipment of the TwoStep™-Exit or the TwoStep™-Exit environment has been changed.
As the **HW setup** will address all possible TwoStep™-Exit 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 TwoStep™-Exit** 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.<br><br><u>If the **HW setup** was stopped or cancelled during the setup process all menu items in the start menu will be inaccessible.</u><br><br>**Please contact the RADOS service team if the above described problem has been achieved.** |

# HW setup in QNX shell

Inputs have to be done by keyboard
<Return> for validation of input

```
HW_Setup
Last Login Wed 04.05.09 19:55:55

   Are you sure    ???

choice <y,n>
```

```
HW_Setup
General monitor type:
   1. with gas detectors
   2. with beta plast detectors
   3. with RFD-detectors FGPA Matrix 1.01
   4. with RFD-detectors FGPA Matrix 1.02
   5. with RFD-detectors FGPA Matrix 1.03
 No. of your configuration: 0
```

```
HW_Setup
List of available beta channel
configurations for small items:

 0. without beta detectors
 1. with 1 beta detectors on top
 2. with 1 beta detectors on bottom
 3. with 2 beta detectors (top/bottom)

No. of your configuration:
```

```
HW_Setup
List of detector type:

   1. with gamma detectors
   2. without gamma detectors

 No. of your configuration:
```

```
HW_Setup
List of available γ channel configurations
on small item box:

0. without gamma detectors
1. with 1 gamma on bottom
2. with 1 gamma on top
3. with 2 gamma on bottom and top
4. with 2 gamma on left and right
5. with 1 gamma on A4
6. with 2 gamma on A4
7. with 3 gamma on A4

No. of your configuration:
```

```
HW_Setup
List of available channel configurations
on front:

 0. without gamma detectors on front
 1. with 2 gamma thorax detectors on front
 2. with 4 gamma detectors on front
 3. with 6 gamma detectors on front

No. of your configuration:
```

```
HW_Setup
List of available channel configurations on
foot:

 0. without gamma detectors on foot
 1. with 1 gamma detectors on right foot
 2. with 1 gamma detectors on left foot

No. of your configuration:
```

```
HW_Setup
List of available channel configurations
for hand:

 0. without gamma detectors for hand
 1. with 1 gamma detectors for hand


No. of your configuration:
```

```
HW_Setup
List of available sum channel
configurations for gamma:

 0. without gamma sum detectors
 1. with 3 gamma sum detectors (validity)
 2. with 2 gamma sum detectors (validity)
 3. with 2 gamma sum detectors (validity)
 4. with 3 gamma sum detectors (validity)

No. of your configuration:
```

*Figure 10-20: Hardware setup process flow illustration*
*I*

HW_Setup

```
List of available card readers:

 0. without card reader
 1. with symbol LS6X20 card reader
 2. with MATRIX card reader
 3. with INTERMEC 9740/1355 card reader
 4. with symbol LS1220 card reader (ser1)
    and terminal SMT (ser2)
 5. with OMRON HSR4 card reader (ser2)
 6. with symbol LS1220 card reader (ser2)
 7. with TVO card reader (ser2)
 8. with DATALOGIC DLL2020 card reader
    (ser2)
 9. with Maxis can 2210 (ser2)
 a. with THERMO ACU-2 (ser2)
 b. with meas start after signal
 c. with meas start after signal and
    check

No. of your card reader:
```

HW_Setup

```
List of available movement configurations:
(only existing electrical movements listed
below other not existing or are manual)

0. no electrical movement
    (1 BINOUT on adr 224)
1. head
    (1 BINOUT on adr 224)
2.          outdoor
3. indoor
4.         outdoor, head
5. indoor, outdoor
6. indoor, outdoor, head
7.                   head, output control
8.                         output control
9. no electrical movement  with language
    selection
a. with language selection, output control
b. no electrical movement
    <headetector on startup>
c. no electrical movement
    <manual headetector>

No. of your configuration:
```

HW_Setup

```
custom specific output relais 1 on 224:03:

 0. no specific output
 1. incorporation of gamma thorax
   detector(s)
 2. emergency
 3. no contamination
 4. gamma background max alarm
 5. gas alarm
 6. monitor is not busy
 7. small person
 8. high contamination
 9. measurement aborted
 a. measurement is running

No. of your configuration:
```

HW_Setup

```
custom specific output relais 2 on 224:15:

0. no specific output
 1. incorporation of gamma thorax
   detector(s)
 2. emergency
 3. no contamination
 4. gamma background max alarm
 5. gas alarm
 6. monitor is not busy
 7. small person
 8. high contamination
 9. measurement aborted
 a. measurement is running

No. of your configuration:
```

HW_Setup

```
end measurement in case of contamination
during front measurement:

   0. deactivate
   1. activate

No. of your configuration:
```

HW_Setup

```
Time for background measurement after
   contamination
   0. no background measurement
   >0 time [ms] for background measurement

No. of your configuration:
```

HW_Setup

```
WKP configuration file:

 1. No  - leave existing wkp.cfg untouched

 2. Yes - replace with distributed wkp.cfg
         (means parameter reset)

No. of your configuration:
```

Inputs have been done
Restart monitor

*Figure 10-21: Hardware setup process flow illustration*

## 10.1.5 Head detector (manual adjusting)

For manual adjusting head detectors the stainless steel rope has to be changed every 100 000 measurements.
The number of measurements performed is displayed ❷ in the service menu under the item **misc/statistics**.

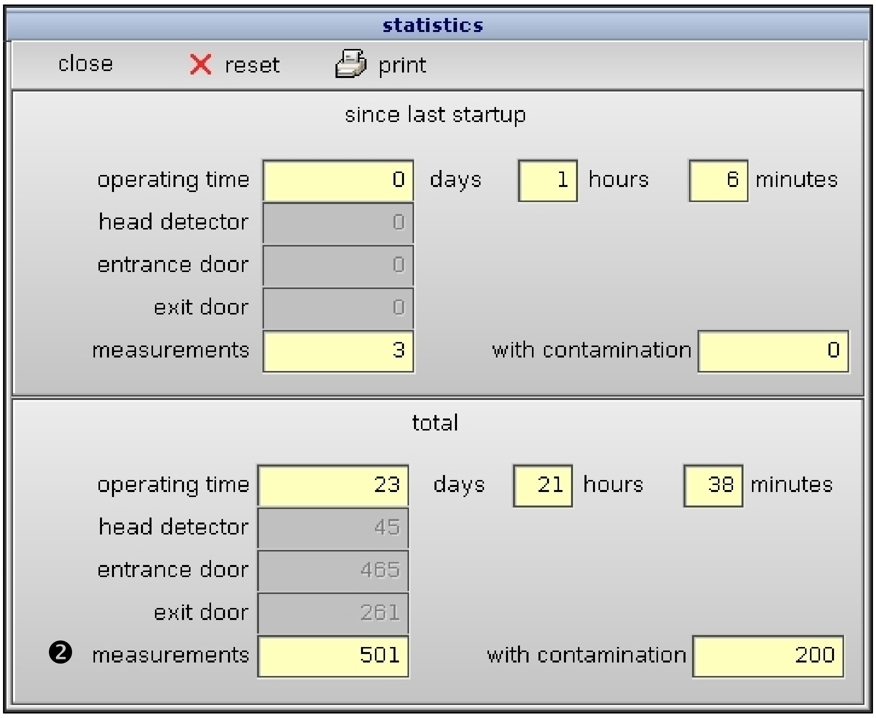



*Figure 10-22*: *Statistics menu*

## 10.1.6 Protective plastic cover of the feet detector

It is advisable to vacuum clean the foot area from time to time so that it will not be damaged by any dirt, little stones, etc.

In case the protective plastic cover is defective, it must be exchanged. It is available from RADOS under the stock number: 6995HR400B00. To exchange it, a suitable piece is cut out for both detectors. When it is placed in its position, be careful not to cover the body contact sensor or feet sensor.

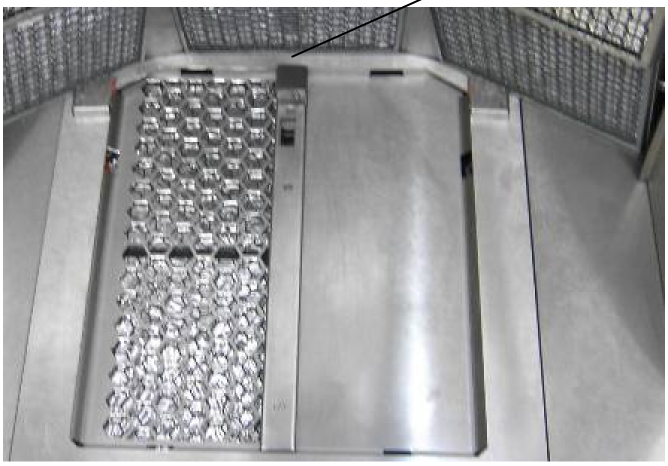


*Figure 10-23: Foot detector*

## 10.1.7 Light switch button and sensor

In order to guarantee an exact recognition of a "**P**erson **I**n **M**onitor", the PIM sensor - a light switch button - should be cleaned from time to time. These are located on the roof of the monitor.

*Figure 10-24: Typical view of light switch*

The same procedure applies to the body contact sensor. It is located in the foot area, near the detectors.

## 10.1.8 Illumination

The light bulbs to illuminate the entrance and exit areas are located inside the top coverage. The top coverage is hinged to the monitor and set easily set loose using the key attachment locks. They are located on the left and right end of the top coverage.

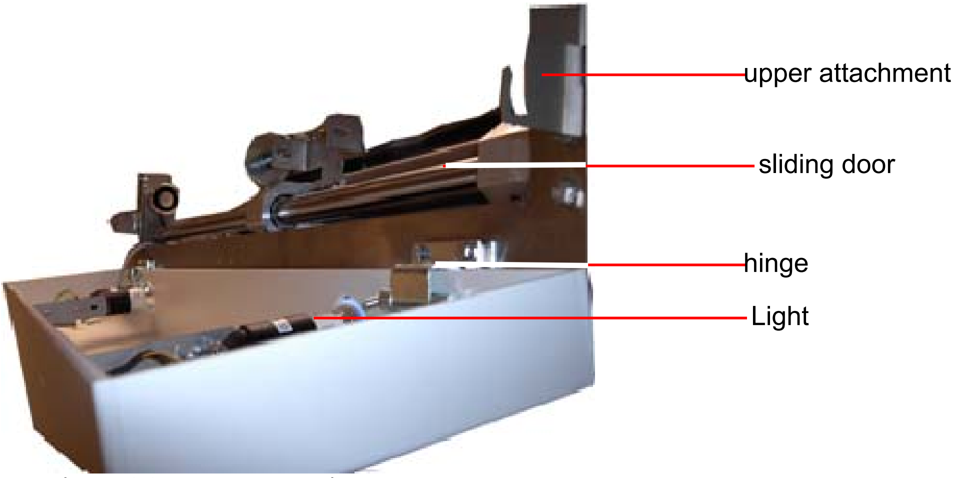



*Figure 10-25: Top coverage view*

# 10.2 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.

## 10.2.1 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.

## 10.2.2 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 when ever 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.

## 10.2.3 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..

## 10.2.4 Case cleaning

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 Transport

Immediately after the shipment has arrived, please check the consignment for possible transportation damages. In that case please inform the Transport Company and RADOS. If necessary the commissioning should be carried out.

### 10.3.1 UPS-unit

Prior any transporting or movement of the monitor the UPS-unit has to be removed from monitor roof.

**CAUTION**

The UPS is heavy load.
The weight of the UPS is

- Transformer 7.80kg
- battery 33.18kg
- USP 29.55kg

**Take care while moving the USP**

### 10.3.2 Convey

The TwoStep™-Exit is provided with four holes at the top of the monitor for the insertion of eyebolts. Herewith it is possible to transport the monitor with a crane.

Transportation with a forklift truck is also possible.

It must be observed that the forklift is placed below the complete monitor and not at the edge only. For transportation the jacking screws of the monitor must be inserted completely in order to avoid damaging them when the monitor is put down.

If the place of assembly has a PVC floor, then 4 pieces of VA sheet metals approx. 100x100x3 mm are suitable to put under the jacking screws.

*of transport support*

### 10.3.3 Headcounter safety

If the monitor has an adjustable headcounter it must be securely fastened before the transportation.

### 10.3.4 Securing of the door

Before transport the detector doors need to be secured. The provided safety angle at the foot part should be sufficient.

Additionally all detectors are covered with a protective cardboard.

If the monitor is supplied with entrance and/or exit door(s) the doors need to be secured by safety straps or tension straps.

Before set-up the transport safety features must be removed.

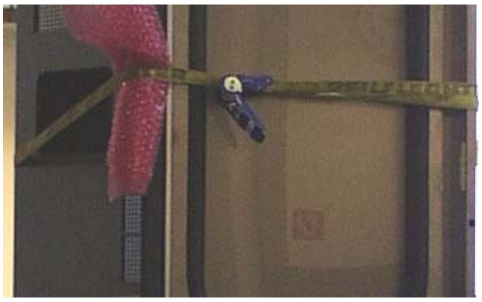


*Figure 10-27: Example of safety straps on transport box*

## 10.4 Storage

Storage conditions:

- 20° C up to +55° C,

Relative humidity 75 % on yearly average, 95 % over 5 hrs, no condensation.

# Register 11

# 11 Nomenclature

# 11.1 Index

## F



## G



## H



## I



## K



## L



## M

## T



## 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.

| | |
|---|---|
| **Activity** | 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. Naturally, 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)<br>■ 1 Bq = 27 * $10^{-12}$ Ci or<br>■ 1 Ci = 37 * $10^{9}$ Bq. |
| **Channels** | Detector unit including the evaluating electronics and software. If channels are mentioned, the signal processing has already been completed. |
| **Contamination** | Pollution ➔ in this case with radioactive material or substance. |
| **Coincidence** | Measurement of several events which happen simultaneously |
| **Compton-effect** | Physical interaction where a photon is scattered at the nucleus. A free electron emerges |
| **Cps** | Counts per second ➔ can be linked directly with activity via the efficiency factor. |
| **Decay constant** | The decay constant λ of a radioactive decay is equal to the reciprocal value of the average life period π. The following relation exists between decay constant λ, average life period π and half-life period T:<br>$\lambda = \pi^{-1} = T^{-1} \cdot \ln 2$ |
| **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. |

| | |
|---|---|
| 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.<br>1 J/kg = 1 Gy (Gray)<br>1 Gy = 100 rad (old measurement unit: Radiation Absorbed Dose).<br><br>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, $\gamma$, $\beta$ radiation Q is = 1 Sv/Gy, for $\alpha$ radiation Q is = 20 Sv/Gy. | **Dose** |
| Special algorithm for continuous determination of the background | **EFISYS** |
| Common abbreviation is EF. Ratio between measured count rate and activity. The efficiency can be stated as fraction or percentage (*100). | **Efficiency** |
| Energy quantum of short-wave electromagnetic radiation | **Gamma quantum** |
| Measurement value of background and applied radiation. | **Gross effect** |
| 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 $10^{-7}$. | **Half life** |
| Small constituent with a very high activity. Hot spots possible have the same capability to jump as fleas. Therefore it is very difficult to locate them. | **Hot spot** |
| Efficiency factor for the whole unit. | **Integral efficiency local dose** |
| A value is measured which is significantly different from the background. | **Measuring effect** |
| 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. | **Median** |
| A device which carries out measurements independently within a period of time. | **Monitor** |
| Measured value after deduction of the background. | **Net effect** |
| 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. | **Nuclide** |
| It's the efficiency of the individual detector. | **Partial efficiency** |
| Fixed setting of the high voltage at which all measurements are carried out. | **Operating point** |
| Multi–Tasking Operating System, capable of Real Time. | **QNX** |
| Numerical value which, as multiple to a normalized standard distribution, corresponds to a determined probability. In the co-ordinate system this means a value on the abscissa. | **Quantile** |

| | |
|---|---|
| **Radiation** | Contrary to gamma radiation, which is a wave radiation, α and β radiation is a kind of particle radiation.<br>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 loose 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 energy on the average is by a factor 10 lower than that of the α-particles. (β energy lies in the range of 100 to 1000 keV, α particles in the range of 5 MeV). |
| **Radioactive substance** | Also called radioactive source. Determined chemically unambiguous material, which emits radiation. |
| **Reference nuclide** | The most frequent nuclide which occurs in the plant. |
| **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. |
| **Shielding equivalent** | The thickness of a selected material which corresponds in, is shielding effect to the actual material in, is density and distribution. |
| **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. |
| **Photo multiplier** | Converts light fluctuations into current or voltage fluctuations. |
| **Option** | Option design of RTM… |
| **Plast** | Scintillation material, which is often called "plast" or "plastic" due to its material. |
| **RNET** | RADOS NETWORK – asynchronous serial network (RADOS development) |
| **RPD** | RADOS - Plastic – Detectors (RADOS development) |
| **RFD** | RADOS Beta Fibre™ Detector (RADOS development) |

# Register 12

# 12 Supporting documents

## 12.1 Test protocol

# 12.2 Software / License

## 12.3 Conformity documents

# 12.4 Third party documents

**x**