Technical Handbook

CheckPoint:Body™

Hand, foot and clothing monitor

HandFoot-Fibre™

&

HandFoot-Fibre™ XL

August 2013

D310061

MIRION TECHNOLOGIES Health Physics Division

Mirion Technologies (RADOS) GmbH

D-22761 Hamburg (Germany)

Ruhrstraße 49

fon: +49 (0)40 851 93 0
fax: +49 (0)40 851 93 256

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

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

E-mail address: hamburg-info@mirion.com

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MANUFACTURER

Mirion Technologies (RADOS) GmbH	
Address:	Ruhrstraße 49 22761 Hamburg Germany fon: +49 (0)40 851 93 0 fax: +49 (0)40 851 93 256 e-mail: hamburg-info@mirion.com

EDITORIAL STAFF

PREPARION	**Mirion Technologies (RADOS) GmbH–TD**
TRANSLATION	**Mirion Technologies (RADOS) GmbH–TD**
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Register 3	Structure and measuring operation		13.08.2013	Reg3_e.docx
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1 General

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1.1 Health Physics product families

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

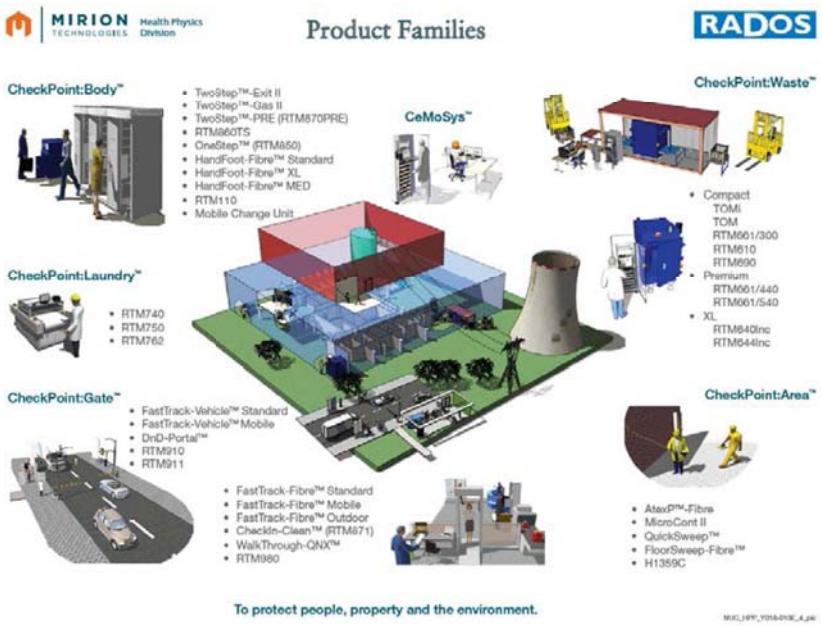


Figure 1-1: product families' overview

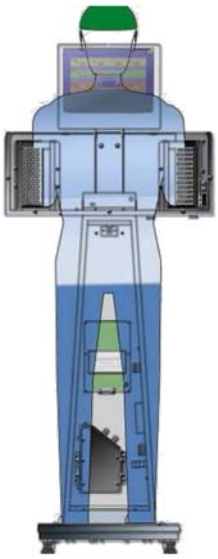


*Figure 1-2: **HandFoot-Fibre™** design view*

CheckPoint:Body™ family:

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

Applicable to family members: **HandFoot-Fibre™ and HandFoot-Fibre™ XL**

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

To avoid confusion, this documentation will consistently refer to the product name HandFoot-Fibre™ or the abbreviation HFF.

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, in this documentation not referring to the actual build type series.

Type series members:

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

❶	**HandFoot-Fibre™** **HandFoot-Fibre™ XL**	**Hand, foot and clothing monitor**
➲	Equipped with RADOS Fibre Detectors (type RFD485) for detection of beta contamination.	

Table 1-3: Type series

Detector type list:

Name	Abbr.	Type	Location	L x W [mm]
RADOS Fibre Detector	RFD	RFD485	Hand, foot and clothing probe	228 x 228

Table 1-4: Detector type list

Function and operation of both monitor types are the same. The only difference between the two monitor types arises in the equipment of the each monitor and the number of detector channels in the foot area. The **HFF XL** is equipped with a mini-photomultiplier box, containing 8 channels and enabling the connection of 4 measurement channels in the foot area. Each detector channel can therefore be evaluated separately and better detection limits and a shorter measurement time can be reached. The **HFF** monitor is equipped with a mini-photomultiplier box, containing 4-6 detector channels. The monitor has 2 preprogrammed detector channels in the foot area.

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 **HandFoot-Fibre™** types' series are individually marked in this Technical Handbook.

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

NOTE

The update of a **HandFoot-Fibre™** 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 built with options.

Type series detector options:

Detector options		Type	Family / Series
❶	Fibre detector	RFD	**HandFoot-Fibre™**

Type series expansion options:

Options		Number	Location
❶	CeMoSys™	1	LAN
❷	Protocol printer	1 (local/LAN)	beside monitor/LAN

1.3.2 Software options

As the technology used for contamination measurements has to meet not only different requirements depending on the country but is also subject to substantial changes over 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.

Figure 1-5: additional software license needed

Type series software options:

Name	Specification
❶ PDF print	Create protocol printout as a PDF document. (Optional, per license)
❷ Network print	Use a network printer for protocol hardcopies. (Optional, per license)
❸ Nuclide vectors	A nuclide vector enables of activity contributions of defined nuclides in the total activity. (For use with RFD4.8/3.8 detectors only)
❹ Detector test	A reference measurement with a test source in combination with actual parameter settings can be done for future checks of the detectors efficiencies.

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 **HandFoot-Fibre™** 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 **HandFoot-Fibre™** 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

1.3.4 Technical Handbook systems and data carrier

Text and CAD system

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

The drawing documents used in this Technical Handbook have been created with a CAD system and can be supplied in a common exchange format. These are:

- *.dwg

For creating the design drawings a CAD system is used:

- Auto-CAD©
- Auto-CAD©, Mechanical Desktop

1.3.5 Data carrier for text systems

Data carrier

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

The Technical Handbook is saved and supplied in Adobe Acrobat in *.pdf format.

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

1.4 Applied symbols and writing style conventions

NOTE

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

CAUTION

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

WARNING

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

DANGER

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

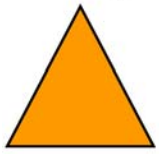
Note the operation instruction or the documentation.

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

Prohibited action

Mandatory action

Warning



Example:

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

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

These symbols indicate important instructions accompanying the **HandFoot-Fibre™** or special procedures with the **HandFoot-Fibre™**.

These symbols should indicate the kind of danger precisely.

Writing style conventions

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

1.5 Product information

Product name:	Machine type:	CheckPoint:Body™ Hand, foot and clothing monitor
	Model:	**HandFoot-Fibre™**
	Serial number	
	Order number:	
	Year of make:	2014
Entries by customer:	Inventory-no.:	
	location:	
Address of manufacturer:	Company name:	Mirion Technologies (RADOS) GmbH
	Street:	Ruhrstrasse 49
	City:	22761 Hamburg
	Telephone: Fax: E-mail:	+49 (0)40 - 85 193-0 +49 (0)40 - 85 193-256 hamburg-info@mirion.com
Orders for spares and service:	Company name / address	Same as above
	Telephone: Fax:	+49 (0)40 - 85 193-222 +49 (0)40 - 85 193-208
Document data:	No. of document and operating manual:	D3.10.06.1
	Date:	08/13

1.6 Maintenance and safety

This chapter describes procedures necessary for keeping your **HandFoot-Fibre™** operating reliably.

For troubleshooting problems, refer to the troubleshooting section (Register 9) of the technical handbook. Problems that cannot be solved need to be referred to your RADOS customer service.

1.6.1 Safety notices

This **HandFoot-Fibre™** 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.

1.6.2 Calling for service

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

Follow the instructions below before calling for service.

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

1.6.3 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 **HandFoot-Fibre™**.
- Do not use extension cords.

CAUTION

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

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

1.6.4 Maintenance safety

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

1.6.5 Operational safety

The **HandFoot-Fibre™** 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 **HandFoot-Fibre™**:

- ⇨ Use the materials and supplies specifically designed for your **HandFoot-Fibre™** 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.

1.7 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 the 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 Mirion Technologies (RADOS) GmbH service personnel.

The operation of the monitor requires trained personnel.

1.7.1 Electronics

Marking

WARNING

Life Danger

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

Marking of dangers and danger areas

High voltage

Danger!
High Voltage

Electric shock

Label:

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

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

Transport

1.7.2 Transport

The **HandFoot-Fibre™** is equipped with a handle and transport-wheels to ease the transport on final destination.

Refer to Register 10 for closer information.

1.7.3 Name plate

The nameplate attached to the monitor is clearly visible.

Typ	- type of monitor, e. g. **HandFoot-Fibre™**
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

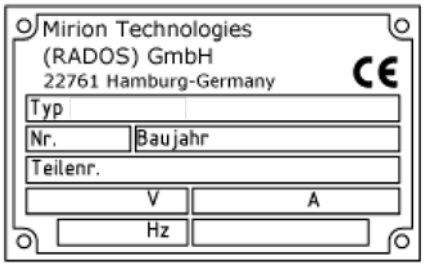


*Figure 1-6: Name plate **HandFoot-Fibre™***

1.8 Disposal and recycling

1.8.1 Disposal and long time storage

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

Preparation tasks:

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

1.8.2 Recycling

The sign labeled on the product indicates that it is not allowed to use customer waste sides or bins for disposal.

The operator of the device is committed to use other waste material streams. Generally this becomes necessary to examine the issues of prevention, product recycling and materials recycling when evaluating individual electro scrap recycling options prior to final disposal.

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

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

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

Software

1.9 Operating and User Software

1.9.1 QNX 6.3x – operating system

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

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

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

The modular design of the operating system makes it possible to employ computers of different capacity and size, depending on the task range to be accomplished. The computer capacity of the processors is made fully available to the user with the 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 24/7 (24 hours a day, 7 days a week).

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

But it is also important that all components communicate via a single, well-defined form of communication: synchronous message passing. This message passing 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 provides 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.

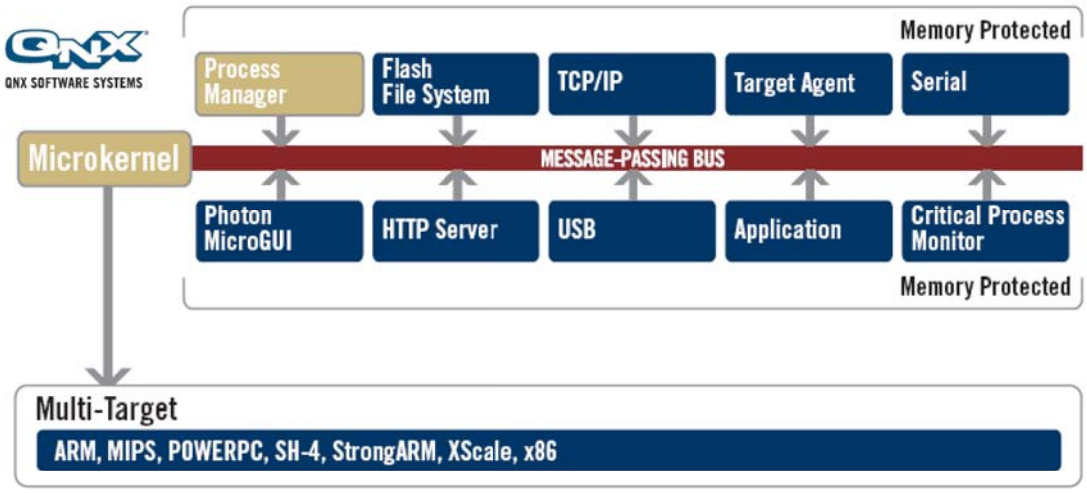


Figure 1-7: QNX RTOS system overview (picture source: QNX Software systems)

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.
  The switched-on mode is either displayed by a blue-collared rectangle or by a pressed switch.
- Button: to start a specific program action
- Menu button: request to display a pull-down menu

1.9.4 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 the <Enter> key is to be activated.
Menu/Input in Menu:	An input in the menu has to be activated; for instance the meaning of service/ measurement status: there is a service menu, where the input "measurement status" has to be selected. (For operation of menus refer to next chapter" select menu").
(Button:	A 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 via touch screen.

Button

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

Figure 1-8: CeMoSys™

1.9.6 CeMoSys™ Server (OPTION)

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

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

CheckPoint:Body™	TwoStep-Gas II, TwoStep™–Exit II, OneStep™, RTM860TS, TwoStep™-PRE, RTM110, **HandFoot-Fibre™**, **HandFoot-Fibre™ XL**, HandFoot-Fibre™ MED.
CheckPoint:Laundry™	RTM750, RTM740, RTM762.
CheckPoint:Gate™	CheckIn-Clean™, GammaPortal-CMS™, RTM910, RTM910N, RTM911i, FastTrack-Fibre™, FastTrack-Vehicle™, D&D-Portal™.
CheckPoint:Waste™	RTM610*, RTM661/300*, RTM661/440*, RTM661/540*; RTM644*, Tool&Object-Monitor (TOM*). *only Measurement status is embedded

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

1.10 Start-up menu

The start-up menu is the central navigation tool for all **HandFoot-Fibre™** software modules. Every software module can be reached by pressing the corresponding touch button.

Figure 1-9: start-up menu

Software modules provided via the RADOS monitor start-up menu:

Start — The simple touch on the button “Start” leads to the user software – the main program to perform radioactive contamination measurement.

Service — The touch of the button “Service” leads to the utility programs, to perform system and hardware administration.

System check — The maintenance and calibration program for body contamination monitor (see Register 6).

User administration — User administration program (see Register 5).

Load parameters — The program “Load parameters” enables the user to load monitor parameters that are stored on a hard drive or an USB stick.

Save parameters — The program “Save parameters” enables the user to store monitor parameters on a hard drive or an USB stick.

HW Setup — The program “Hardware set-up” is used, to configure the monitor hardware.

System parameters — The program “System parameters” makes possible, to configure the system: setting the parameters of the system (time zone, language, setting language for the keyboard, adjustment of the time & date, screen resolution), choose external devices and configure network services.

Error/info protocol — List of the last system internal messages, e.g., useful for troubleshooting.

QNX Shell — The program “QNX shell” permits access to the command line interface of QNX.

SHUTDOWN — The button “Shutdown” switches the monitor off.

1.10.1 Software functional sequence

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

These modes are divided like following:

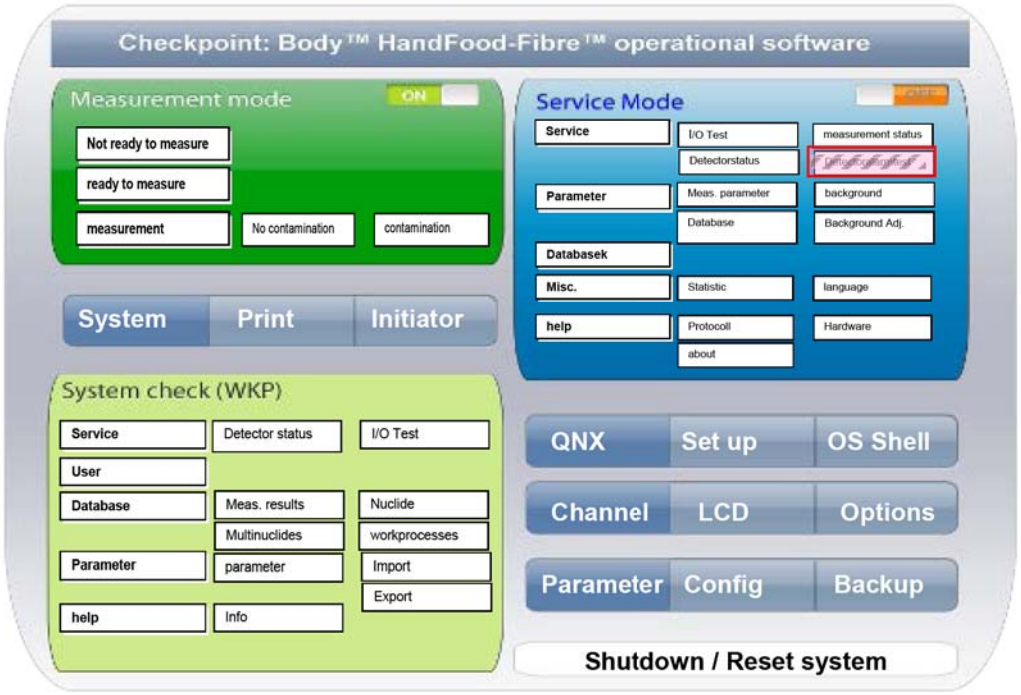


Figure 1-10: Software functional sequence

1.10.2 Operating conditions

The user software differentiates two operation conditions:

Measurement mode

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

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/key. In the service mode there are different sub-menus available to control the function of the monitor and to adjust all parameters influencing the measured value.

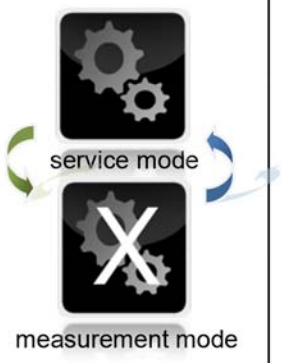


Figure 1-11: Service button

1.10.3 Operational submenu

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

System check see register 6

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

User administration see register 5

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

Load /Save configuration see register 10

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

HW setup and system parameter see register 10

The **HW setup** program is designed to alter sensible monitor parameter after hardware changes are done to the **HandFoot-Fibre™**.

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

QNX-Shell

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

Figure 1-12: Pictogram "printer"

Print screenshot/protocol

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

1.10.4 Exit user software

ATTENTION

The shutdown of the **HandFoot-Fibre™** (e.g. for maintenance) MUST follow this guideline, to prevent any damages at the measurement computer or the electronic.

A damage of the **HandFoot-Fibre™**, caused by ignorance of this guideline, will lead to a loss of guarantee and warrantee by Mirion Technologies (RADOS) GmbH.

*Figure 1-13: **HandFoot-Fibre™** Accept button*

(1) Quit the running user software with the touch of the button “Exit application”.

(2) Confirm the query by touching the “Accept”-button.

(3) In the RADOS monitor start-up menu press the touch button “Shutdown” and confirm the query with the touch on the “Accept”-button, to quit operational software.

*Figure 1-14: **HandFoot-Fibre™** shutdown*

(4) A message appears, informing you that the shut down process has been completed.

*Figure 1-15: **HandFoot-Fibre™** shutdown complete*

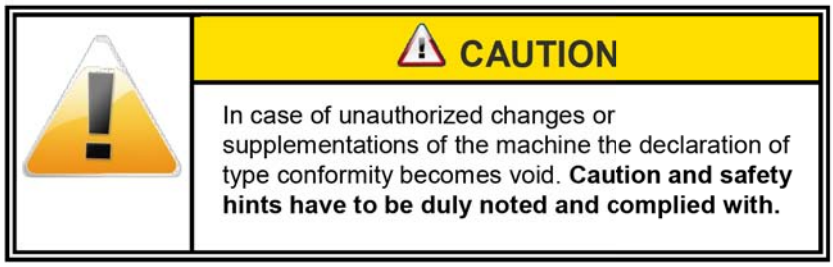
(5) Use the mains switch to shut down the monitor.

1.11 Authoritative regulations and guide lines

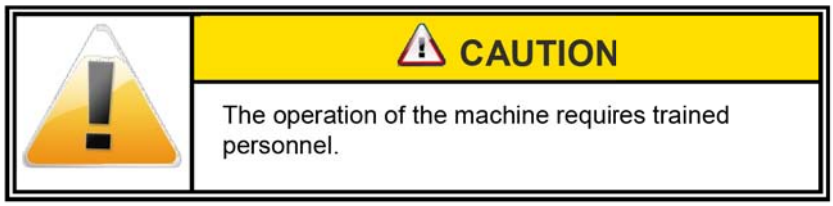
1.11.1 Guide line for machines

Before commissioning the **HandFoot-Fibre™** monitor, this documentation must be read, in order to carry out a safe operation.

Changes



Operation



1.11.2 Supporting documentation

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

1.12 Copyright

Technical handbook

The copyright protection claim includes all forms and matters of copyrighted material and information. These are now allowed by statutory or judicial law and are hereinafter granted without limitation including 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 Mirion Technologies (RADOS) GmbH. Other company brands and product names may be trademarks or registered trademarks of the respective companies and are also acknowledged.

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

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

Copying or multiplying for internal use is permitted.

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

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2 Technical data / Circuit drawings

2.1 Technical data

HandFoot-Fibre™ type series

Type	No. of measurement channels	Power; rated current
☐ **HandFoot-Fibre™**	☐ 6	☐ 230V-50Hz; 0.5A
☐ **HandFoot-Fibre™ XL**	☐ 8	☐ 110V-60Hz; 1.0A

General Data		**L x W x H**	
Dimensions			
Electronics housing with transport roller		480 (655) x 750 x 1660 mm	
☑ coated steel		RAL 7016	
	structure	IGP-622MA	matt glaze
Weight			
Electronics housing		approx. 55 kg	

Options

☐ CeMoSys™

☐ Protocol printer ☐ PDF print
☐ Network print

PC

computer PC board	Celeron , Onboard VIA Eden V4 1.0 GHz CPU
RAM	512 MB SODIMM DDR2 SDRAM
interface	3 x USB 2.0, 2 x LAN,1 x COM
graphic display	VGA on board
keyboard	Optional by customer specification (order)
HDD	≥ 80 GB
monitor	15” TFT touch screen display
sound card	on board 16 Bit

Software

Operating system: QNX 6.3x
User Software: V: 03.xx

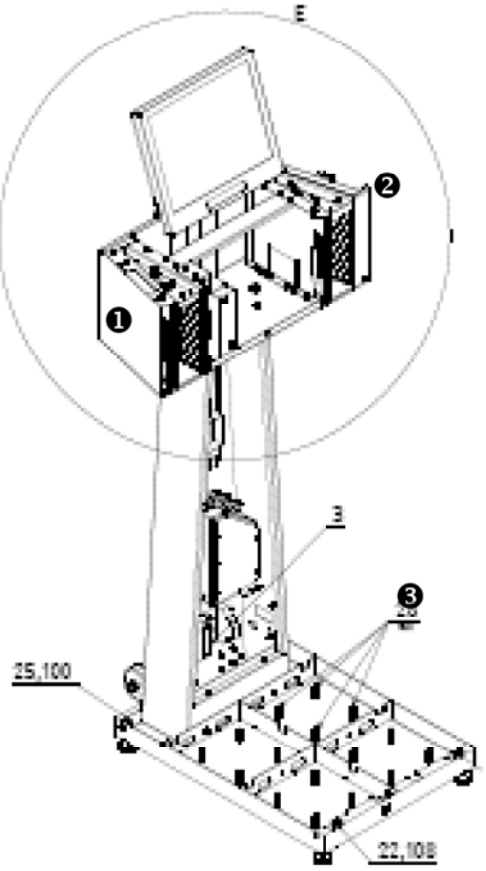
☐ CeMoSys™ ☐ User profile
☐ PDF print ☐ Network print
☐ Nuclide selection ☐ Detector alarm test

Detector net

Module: ☐ FiLiCo board

Technical data (continued)

Detectors	**RADOS BetaFibre™ plastic scintillation detectors (RFD)**
Type	**Mounting location**
☑ **RFD485**	❶❷❸



Ambient conditions	
Detector housing	
temperature	-20°C up to +55°C
humidity	outdoor conditions
Electronic rack	
temperature	5 °C up to +45 °C
humidity	relative humidity 85 % on annual average, 95% for 5 h, no condensation

CE conformity

This contamination monitor fulfils 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.

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.

Definition:

S(β)min	=	minimum attainable response capability
S(β)	=	response capability attained
S(α)min	=	minimum attainable response capability
S(α)	=	response capability attained
k1min	=	smallest detectable contamination
N0	=	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 Minimal detectable activity (MDA)

The following table shows the detection limits.

HandFoot-Fibre™			
Parameter / settings	Sigma 1.65 + 1.65	BG 0.1 µSv/h	Meas. Time 10 s
Detector	RADOS Fibre Detector, type RFD485		
Source in contact to standard grid	Hand	Foot	
Sr-90 / Y90	10 Bq	20 Bq	
Cl-36	20 Bq	35 Bq	
Co-60	45 Bq	75 Bq	
Tc-99	48 Bq	85 Bq	
C-14	210 Bq	340 Bq	
Am-241	25 Bq	60 Bq	

HandFoot-Fibre™ XL			
Parameter / settings	Sigma 1.65 + 1.65	BG 0.1 µSv/h	Meas. Time 10 s
Detector	RADOS Fibre Detector, type RFD485		
Source in contact to standard grid	Hand	Foot	
Sr-90 / Y90	8 Bq	11 Bq	
Cl-36	15 Bq	25 Bq	
Co-60	30 Bq	45 Bq	
Tc-99	35 Bq	48 Bq	
C-14	115 Bq	190 Bq	
Am-241	23 Bq	45 Bq	

2.4 Circuit drawings

Description	Drawing number
Mechanic	
Connection diagram	4M2333.3
Electric	
Basic **HandFoot-Fibre™**	3E0540A4
MicroBox PC with Hard Disk	3215MICPCGE0
USB connection, shielded and angulated	4E0287A1
LAN network connection	4E0252-2

3 Structure and measuring operation

Table of figures

3.1 Total view HandFoot-Fibre™

*Figure 3-1: **HandFoot-Fibre™** view*

Description	Drawing number
Total view	3M3297…

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 functions of the monitor and shall get him acquainted with its specific features. In this relation, a number of basic physical connections are described and explained in detail where it is necessary.

NOTE

This documentation will explain the "maximum version" of the body contamination monitor **HandFoot-Fibre™**.
All possible options and extensions like drive control, WKP or MPP 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 **HandFoot-Fibre™**, please, jump to the next paragraph.

The absence of optional functions will not impair the correct work of the **HandFoot-Fibre™**.

If you are interested in upgrading your **HandFoot-Fibre™** with options please feel free to contact the RADOS customer service with the address given in register 1.

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

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

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

It is the function of the RADOS hand-, foot-, clothing monitor (called **HandFoot-Fibre™**) 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 Fibre™- detector
- the intensity of the background radiation
- the statistical detection safety
- the statistical safety against false alarms caused by the background
- the measurement-time per person

The **HandFoot-Fibre™** measures contamination by use of Beta Fibre™-detectors. The efficiency of these detectors in contact is 35% for 90Sr (related to the 90Sr 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 cm2), 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.

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

Therefore, the warning thresholds of all connected detectors of the Mirion Technologies (RADOS) GmbH monitor are automatically adapted to a changing background.

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

3.3.1 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 background measurement is also called 'the learning stage'.

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

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

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

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

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

Radioactive rays are constantly emitted from the earth into the environment, as well as from the space. This radiation is called "background radiation" or "background".

The detectors also measured these radioactive rays. The following requirements are set to achieve a reliable measurement of the background:

> High preciseness at short measuring time
> i.e the error of a result shall be so small that it can be neglected.

An ideal case would be to take a "snapshot" of the actual background before the body measurement begins. This would guarantee that the following measurement and evaluation of the current background at the time of the personal measurement could be used.

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

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

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

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

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

Statement of the background measurement time

normal background measurement:	calculation of median with	100	values
fast background measurement:	calculation of median with	30	values
measurement result every 1 s ➔ background measurement =		100s	normal
		30s	fast

3.3.2 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 which makes it possible to substitute the long-time background by a short-time background.

For that purpose, the standard deviation of the current median value is calculated. This standard deviation is put around the median value as a multiple, 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 on 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.

First of all the same procedure for α-background and β-background is used. But there are different time constants of the mean values as well as a different determination of the sigma tube. The reason is that the normal background cannot be calculated as 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 which 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 Quitting of channels

It is not possible to perform a safe detection of contamination by using 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 notification 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 contamination measurement. The system stores the measured data until the end of this contamination measurement to continue with the background measurements.

When the **HandFoot-Fibre™** 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.

3.3.4 Calculation of measurement time

3.3.4.1 DIN 25482 measurement time calculation

The calculation of the measurement time is carried out automatically in accordance with the regulations from DIN 25482 part 1. In this DIN standard the calculation for the detection and the recognition limits for different measurement methods are given. 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} = expected value of the background
R_{Eb} = expected value of the gross measurement effect
R_{En} = expected value of the net measurement effect
$k_{1-\alpha}$ = Quantile error type I = false alarm safety
$k_{1-\beta}$ = Quantile error type II = detection safety = $k_{1-\gamma/2}$

NOTE

The expected net measurement value is calculated from the minimal measurable activity value 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 can revoke this coupling, if desired.

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

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

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

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

3.3.4.2 MDA measurement time calculation

In aberration to the above described method to calculate the measurement time, alternatively the calculation can be done using the MDA method. The 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,
- the measurement geometry,
- the gate time,
- the photon energy E and the probability of absorption,
- the transition probability P for the gamma line used for the proof.

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

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

with

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

3.3.5 Personal measurement with P^2

Mirion Technologies (RADOS) GmbH has developed a program tool to reduce measurement times in the field of personnel contamination: **P**robability **P**ropagation, **P^2**, a measurement procedure based on conditional probability according to DIN 25482/1.

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

First of all a measurement time calculation according to DIN 25482/1 is carried out. During the measurement a remaining probability for the occurrence of the exceeded limit value is determined after each measurement cycle. Depending on the settings of the monitor and the radiation relevant ambient conditions, measurement time reductions of up to 30 per cent for non-contaminated people can be attained. In case of low contamination, which is below the limit value, the measurement time automatically gets near to the DIN measurement time; in case the limit values are exceeded, the DIN measurement time is applied in full length. All calculations run in real time. Therefore there are no changes in the measurement procedure if the P^2 procedure is activated.

Example measurements with P^2 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.

P^2 is a feature of the Checkpoint: Body™ software. It can be activated or de-activated in the mode **automatic measurement time calculation**.

3.3.5.1 The optimizing procedure

In the CheckPoint:Body™ families series 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 the 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 form e. g. one of the 8 channels supplies the standing time of a person on the monitor.

In between the body measurement times, the background count rate is constantly checked and if it changes, an automatic adaptation of the measurement time to the current situation is carried out.

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

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

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

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

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

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

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

Due to the double query of the release message per channel as well as the “waiting” for the channel with the longest measurement time there are

already two safeties integrated into the procedure. For further safety, the software automatically excludes a measurement time reduction of more than 50 per cent of the measurement time calculated according to DIN.

3.3.5.2 Results by experiments

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

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

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

3.3.6 Alarm triggering

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

For 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]

3.4 The monitor

The housing is made of painted steel. For dimension see dimension sketch in register 2.

The operating elements of the monitor:

- TFT-LC touch screen colour display
  Graphical resolution of 1024x768 pixels
- Mains input
- Foot switch
- Hand sensor

With respect to measurement technique the **HandFoot-Fibre™** consists of six parts:

① hand box (with two detectors)

② foot plinth

③ clothing probe

④ LC touch screen display

⑤ measurement electronics

⑥ USB and LAN port

Refer to Register 1 and Register 2 for detailed information on detectors used in your version of the **HandFoot-Fibre™**.

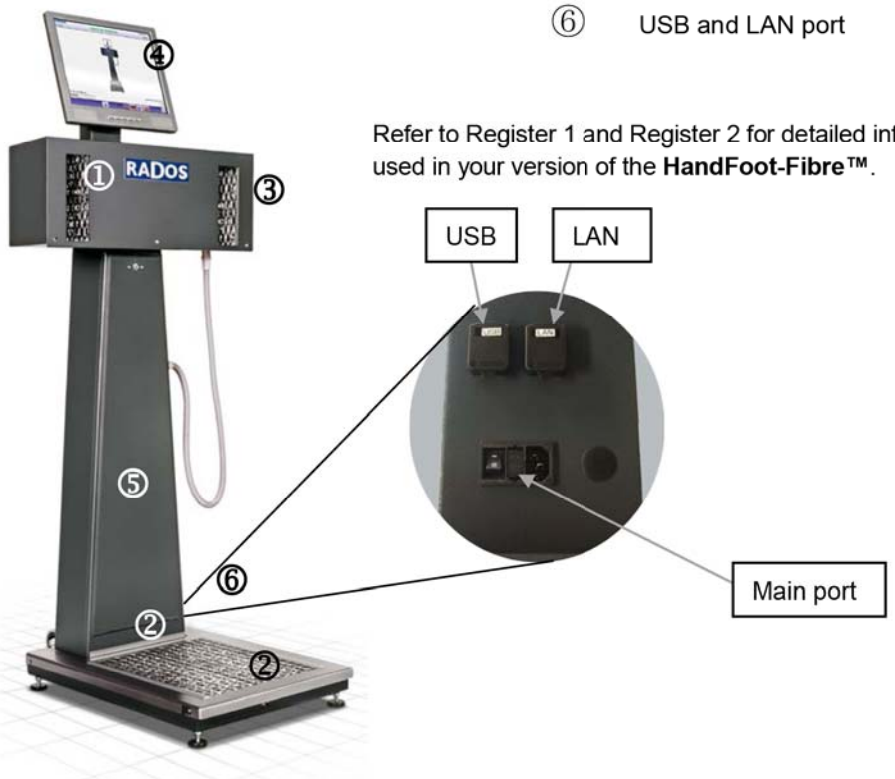


*Figure 3-2: **HandFoot-Fibre™** monitor*

3.4.1 HandFoot-Fibre™

If a measurement is to be carried out, the user steps on the foot plinth facing the display. By triggering the foot weight switch the monitor recognizes that the user wants to carry out a measurement and thus the background measurement is interrupted. Then the last measured background value applies for the following measurement.

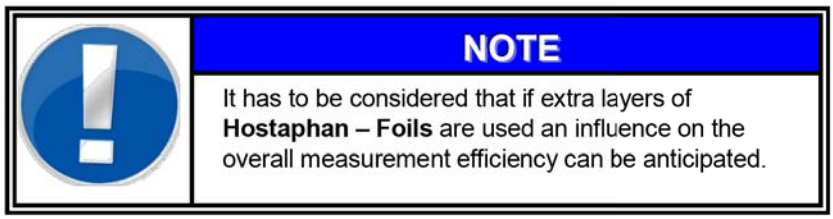
To measure the hands there is a hand box with two detectors at each side of the monitor. In a one-phased measurement the top and the palm of the hand are measured simultaneously.

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

The clothing probe for measuring contamination on the garment is positioned at the right side of the monitor. If the clothing probe is taken out of its compartment, automatically an acoustical amplifier is switched on, similar to a "Geiger - Müller" probe. In this way contamination can easily be "heard" by the higher count rate. Of course, the exact count rates can also be seen on the display. If the clothing probe is hanging in its compartment, the probe is ready to measure without acoustical signal.

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

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



3.4.2 HandFoot-Fibre™ detector allocation

standard	*BetaFibre™ detectors*
1	**RFD485** Hands
2	**RFD485** clothing probe
3	**RFD485** foot

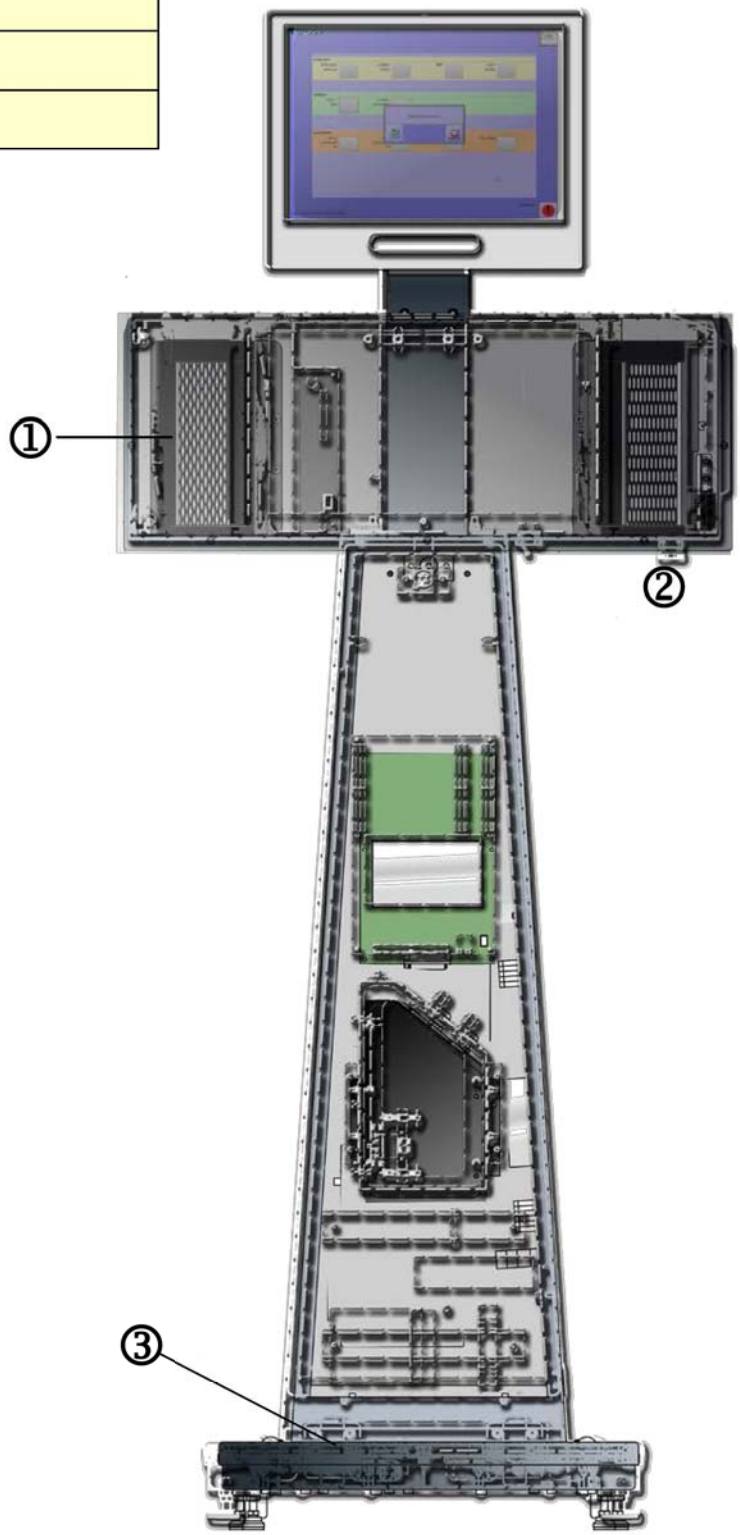


*Figure 3-3: **HandFoot-Fibre™** detector allocation*

3.4.3 Measurement computer

The complete electronics ❶ are located in the central part of the housing and can be reached by opening the front door. The measurement PC ❷ is located in the upper box.

The computer system used in the **HandFoot-Fibre™** is composed of a single board industrial computer. The computer is placed in the computer housing❷. Please refer to Register 10 for detailed information on the measurement computer setup and maintenance. Operational inputs to the operating software system can be performed via the touch screen❸ and an optional software touch keyboard on LC-display.

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

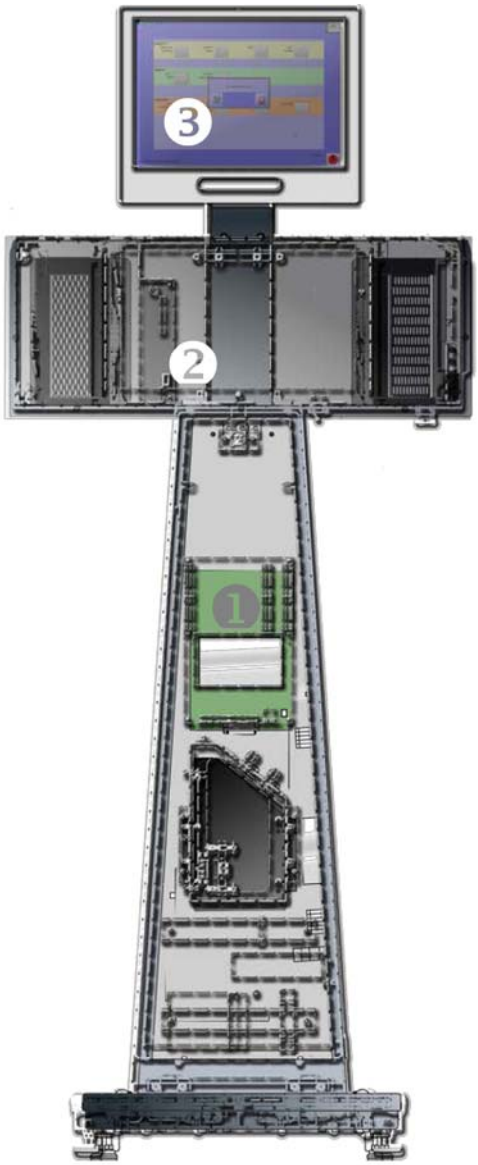


*Figure 3-4: **HandFoot-Fibre™** with open service door*

3.5 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.

3.5.1 Function and design of the system computer

The measurement and communication PC is a tiny box computer (178 mm x 112 mm x 50 mm) with powerful functions and rich I/Os like network card, dual SATA and three USB ports. The Filico board is connected via network directly to the measurement and communication PC.

The USB device slots are available for data exchange. The optional protocol printer may be connected by an USB interface.

The memory must have at least 512 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 80 GBytes available for the operating system and the necessary program. Since hard disks with much larger capacities are used, the capacity should not be any problem.

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

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

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.

3.5.2 Software functional sequence

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

These modes are divided as follows:

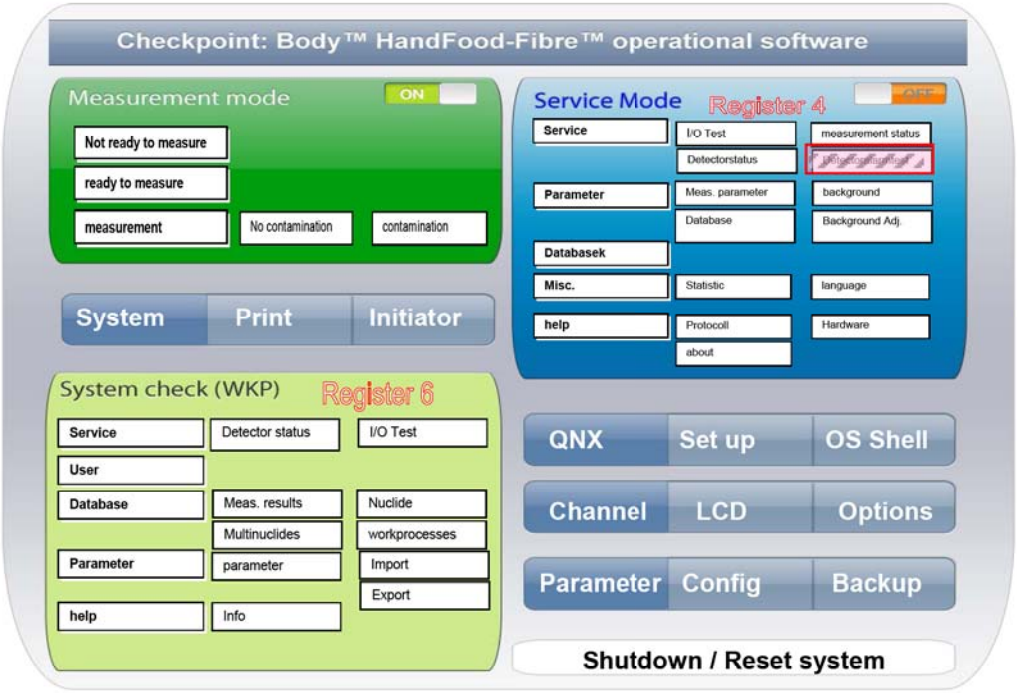


Figure 3-5: Software functional sequence

Optional

3.5.3 Operating conditions

The user software differentiates two operation conditions:

Measurement mode

The **measurement mode** is the normal operation mode.
In this mode the measurement of persons 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 function and to measure the background.

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/key. In the service mode there are different sub-menus available to control the function of the monitor and to adjust all parameters influencing the measured value.

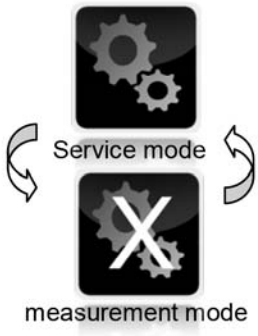


Figure 3-6: Service button

3.6 Start-up menu

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

Figure 3-7: start-up menu

Software modules provided via the RADOS monitor start-up menu:

The simple touch on the button “Start” leads to the user software – the main program for measuring radioactive contamination of persons and their clothes

The touch of the button “Service” leads to the utility programs, to perform system and hardware administration.

The button “Shutdown” switches the monitor off.

3.7 User software start

The user software starts with an internal check on all associated module and sensors before the first background measurement takes place. Detected dysfunctions and failures will be prompted.

Figure 3-8: User software start (first background)

3.8 Measurement mode

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

The **HandFoot-Fibre™** distinguishes between a person measurement and a clothing measurement. The exact differences regarding the mode of operation and evaluation are described in the following chapters.

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

The initiation of operation in the measuring state is done by light barriers and a switch (foot). The user is guided by the graphical display and voice sequences. The measurement result is shown on the screen.

Figure 3-9: Example of the RTM user software - ready to measure

3.8.1 Person measurement

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

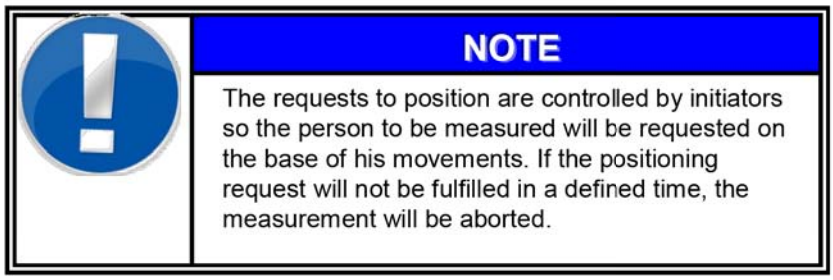
The measurement itself is started as soon as the user has correctly positioned his hands and feet. All parts have to be placed such way that they trigger the light barrier respectively the foot switch.

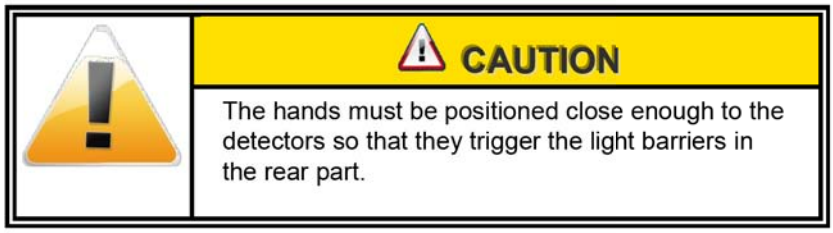
If this is not done immediately, you will hear following request:

- **"POSITION FEET"**

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

- **"INSERT HANDS"**





Request for position screen displays:

Figure 3-10: Display "insert left hand"

Figure 3-11: Display "position right hand"

Figure 3-12: Display "position feet"

Figure 3-13: Display "insert hands"

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

Figure 3-14: Display "measurement"

*Figure 3-15: Measuring **HandFoot-Fibre™** measurement (at 5 seconds)*

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

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

A complete leaving of the monitor leads to an abortion of the measurement.

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

At the end of the measurement the result is shown on the display. The information displayed remains, until the user has completely left the monitor.

If no contamination was measured, a respective message appears on the display and the user will be kept informed by a voice message:

"THANK YOU - NO CONTAMINATION"

Figure 3-16: Display "no contamination"

If any of the measuring channels exceed the alarm threshold, a contamination is detected that causes an alarm signal and a message will be announced:

"CONTAMINATION, SEE DISPLAY! PLEASE, NOTIFY RADIATION PROTECTION"

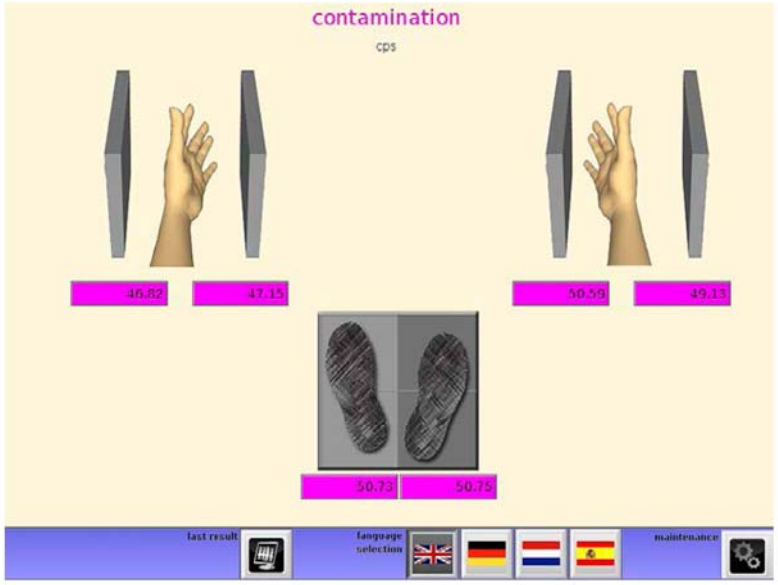


Figure 3-17: Display "Contamination"

If in the service mode an automatically printout is selected, a protocol is now created.After the user has left the monitor, it is now ready for further measurements. At this time the adaptation of the background is automatically continued.

3.8.2 Clothing measurement

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

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

The pulse rates are displayed graphically up to the alarm level. Beside the graphics there are the exact numerical values. Additionally, the last determined backgrounds are numerically displayed.

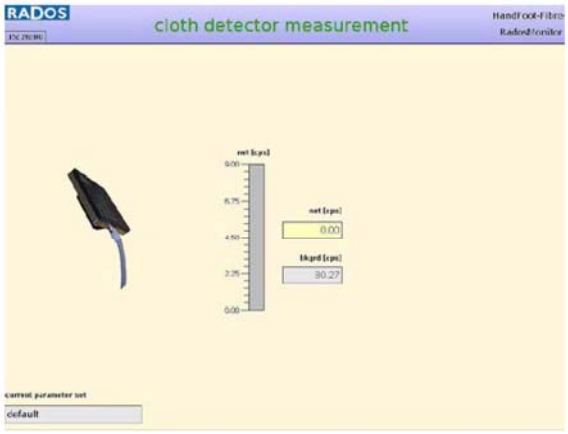


Figure 3-18: Pulse rate graphics

Figure 3-19: Pulse rate graphics with contamination

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

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

3.8.3 Not ready to measure

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

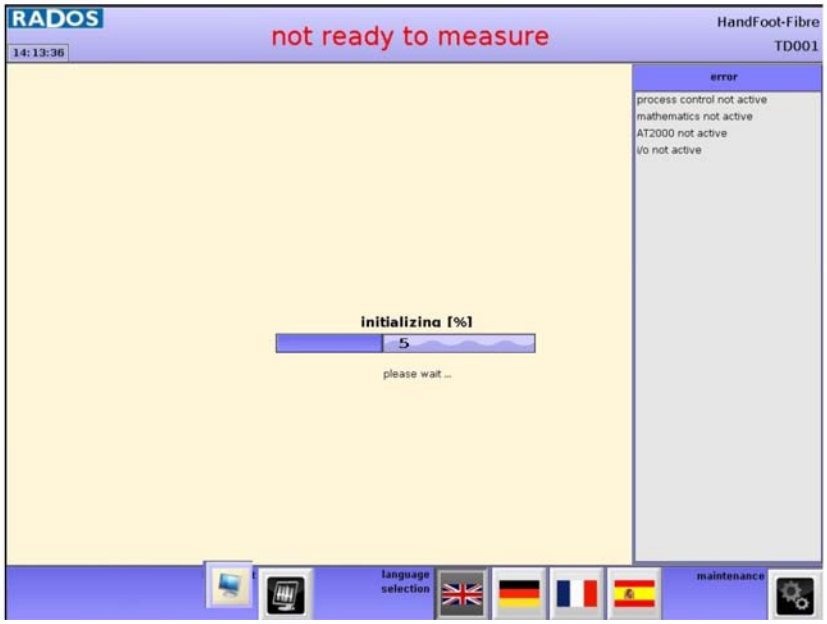


Figure 3-20: Not ready to measure

NOTE

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

3.8.4 Not ready to measure message overview

Following messages as well as the causes of the disturbance are stated.

Background

Progress of the background determination is displayed. The value states to what extend (in percentage) the currently running measurement have been completed. If no further errors are displayed, it is a complete new determination of the background. This measurement is carried out when the monitor is started or upon request in the service mode.

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.

Maximum level

At least one detector has exceeded the maximum threshold set in the service mode. The display of the measuring status (see Register- **Service**) shows the detectors that exceeded it.

Detector fault

If more than one detector is affected, there may be a light leakages fault or a very high background. Otherwise, there may be a defect or contamination of detectors.
At least one detector may not deliver any data or delivers wrong data. The reason could be a defective wiring or damage to detector electronics. More precise information can be found in the menu - **detector status** (see Register- **Service**).

I/O fault

At least one sensor does not communicate. Sensors are affected can be identified from the display of the menu - **I/O test** (see Register- Service).

4 Service

Table of figures

4.1 HandFoot-Fibre™ service general

The system interface has different graphical and entry elements for the communication with the user. A detailed description of the operation is given in the chapter “Real-time operation system QNX”.

The service mode is opened and carried out, by using the “Service” button. The service mode is password protected on a user authorization level (refer to register 5 for detailed information on user administration and user authorizations).

CAUTION

To shut down the **HandFoot-Fibre™** monitor it is absolutely necessary to follow the shut down process given in Register 3 to prevent the monitor from any damages.

All maintenance functions will be described in the following chapter.
A partial repetition of the description from other chapters has been done intentionally.

The following picture shows the maintenance main menu, from which service functions, the monitor parameter settings and the database are accessible.

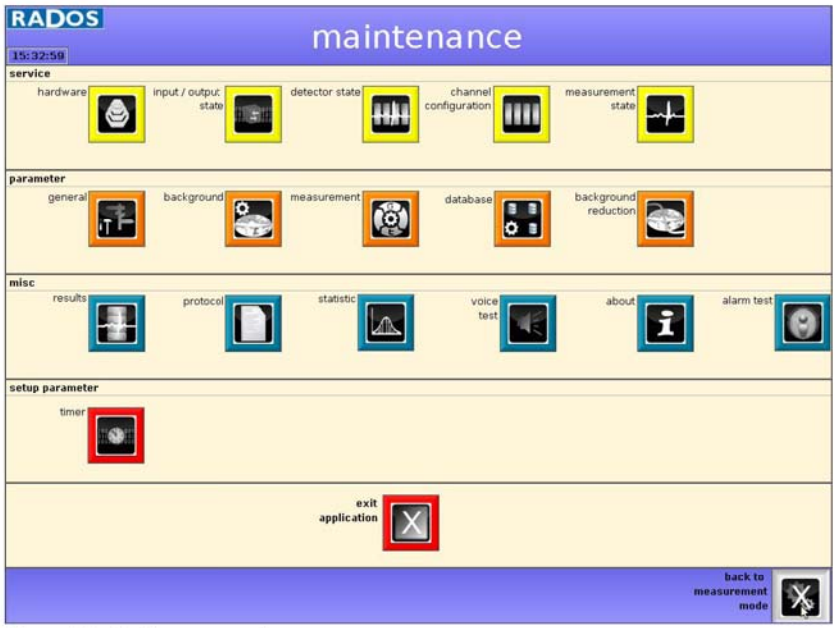


Figure 4-1: Maintenance main menu

Service mode

Measurement mode

Figure 4-2: “Maintenance” button

The maintenance menu is splited in the sections:

- service
- parameter
- misc
- set-up parameter

4.2 Maintenance general

CAUTION

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

NOTE

The entries shown in the 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.

NOTE

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

The button “KBD” is used to display a visual keyboard on the touch screen display, if alpha numeric user inputs are necessary

Figure 4-3: Virtual keyboard

NOTE

The maintenance menu can be password protected. Refer to register 5 for information on user administration.

4.3 Maintenance (enter and exit)

When the button “Maintenance” at the bottom of the display is actuated, the maintenance menu is visible and the menu items are accessible.

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.

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

If the button “Maintenance” is clicked, the “Maintenance” button icon changes from gears to crossed gears. The maintenance menu is now active. The maintenance mode is left, actuating the button “Back to measurement mode”.

Figure 4-5: “Maintenance” button

Figure 4-4: Monitor status “Ready to measure”

Figure 4-6: Monitor status "Not ready to measure"

Should an error occur during the start, an error message appears on the main window❶.

After all errors have been cleared, the error messages will be suppressed.

4.3.1 Recurrent menu controls

Symbol	Name	Function
	**back**	Leave the actual menu and return to maintenance main menu (on context-sensitive menu links the previous menu will be called).
	**Back to meas. mode**	Direct switch between maintenance and measurement mode.
	**save**	The "Save" button (with pulsing red bulb) will be displayed directly after parameter have been altered.
	**save**	The "Save" button (without pulsing red bulb) enables the user to save the data on a USB stick.
	**load**	Load factory parameter in the user software.
	**print**	Print actual screen display for filing.
	**display**	The result of the last contamination measurement will be displayed.
	**delete**	Delete a data set.

Figure 4-7: Service operation – recurrent menu controls

4.3.2 Structure of submenu

bmenu
tate")

xt-

ontext-

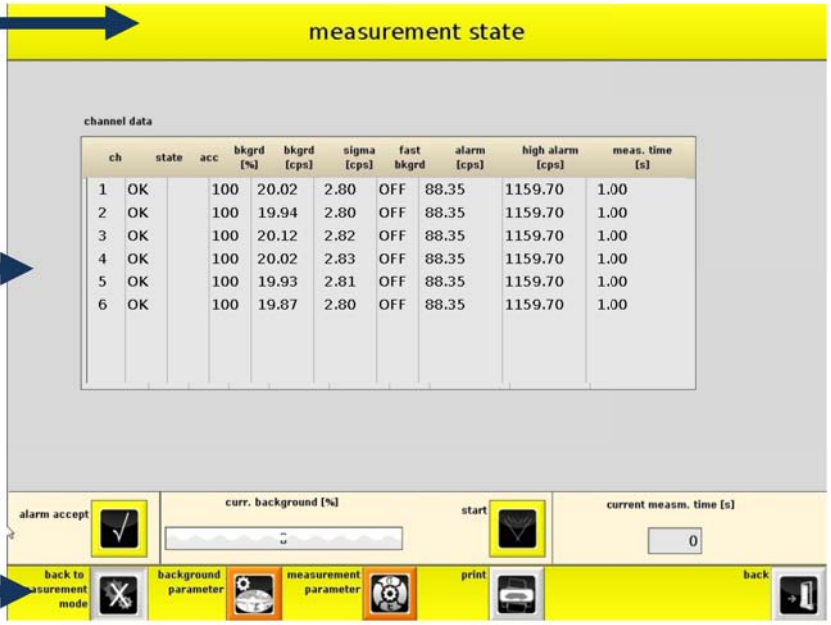


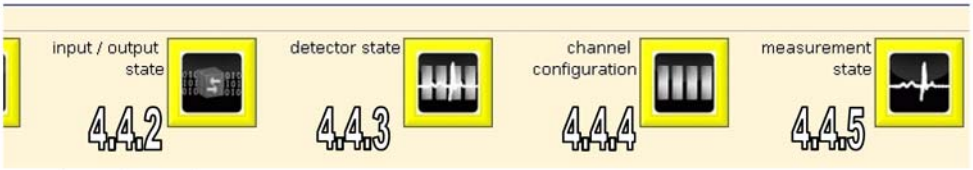
Figure 4-8: Submenu structure

Info bar	Shows company name, date and time, monitor name and monitor ID.
Display area	Display of monitor current state and graphical and numerical display of measurement values.

NOTE

Due to a different monitor type and to a different monitor configuration, the screen shots shown in this manual may slightly differ from the screens on your monitor.

4.4 Service menu area



e mode, service section

4.4.1 Hardware

The hardware menu presents a list of the built-in hardware of your **HandFoot-Fibre™** monitor.

are"

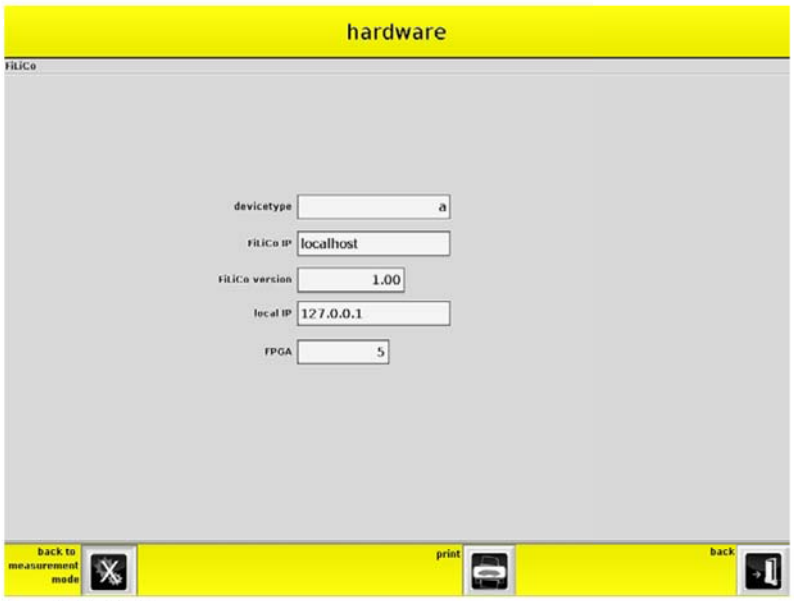


Figure 4-11: Hardware

Menu controls in the hardware menu:	
back Close the menu and return to maintenance menu	
back to measurement mode This button enables a shortcut to the measurement mode	
Print Print actual menu selection.	

4.4.2 Checking of binary inputs and outputs

The call-up of input and output test can only be effected during the running service mode via the “Input/output state” button.

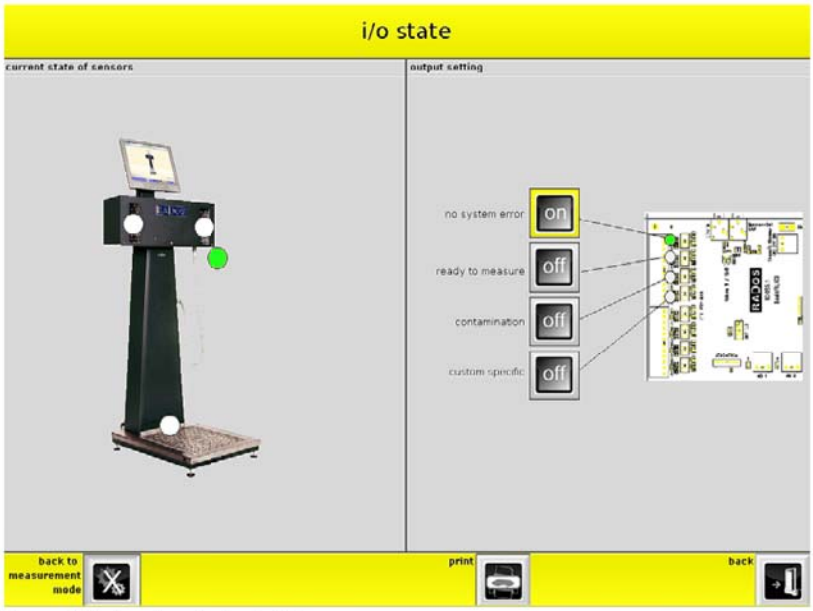


Figure 4-13: Input and output state

Figure output

All digital inputs are continuously controlled and the states are displayed on the video monitor. Active inputs are indicated with a green dot (●).

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

Menu controls in the IO state menu:	
back Close the menu and return to maintenance menu	
back to measurement mode This button enables a shortcut to the measurement mode	
Print Print actual menu selection.	

4.4.3 Detector state

The detector status is called up by touching the button “Detector state”.
This service menu is separated in four areas:

or state”

❶ Detector type and details
❷ FILCO board – information and communication
❸ Calculation of mean value and channel adjustment information
❹ Channel data display
❺ Light leakage check

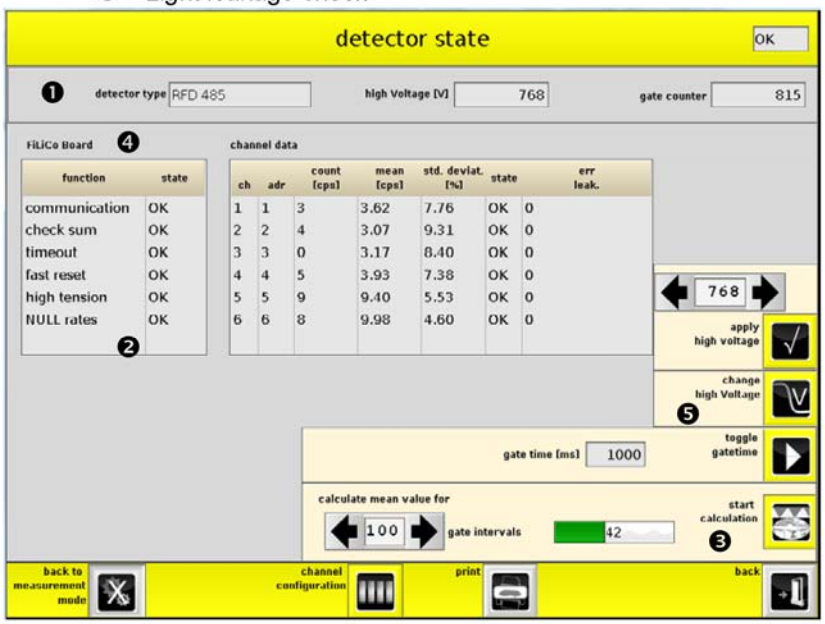


Figure 4-15: Detector status

❶ Detector type and details

The displayed information is structurally stored in the measurement electronic and is displayed for user informational purposes only.

❷ Light box communication

The displayed information is structurally stored in the light box and is displayed for user informational purposes only.

❸ Calculation of mean value

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

Formula 4-1 standard deviation

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

NOTE

The HFF detector channels are coupled sum channels. In normal operation mode each channel represents 2 detectors (see chapter 4.4.6).

❹ Channel data

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

ch ①	adr ②	count low [cps] ③	mean low [cps] ④	std. deviat. low [%] ⑤	count high [cps] ⑥	mean high [cps] ⑦	std.d hi [⑧

ch.	①	the number of channel within the monitor
adr	②	address of channel (firmly preset)
count	③⑥	current net count rates per gate time for high and low channel [cps]
mean.	④⑦	calculated mean value of the last 100 count rates for high and low channel [cps]
Std. dev.	⑤⑧	calculated deviation of the last 100 count rates for high and low channel [%]
State	⑨	actual channel state from following possible states:
		OK the channel is ready to measure
		CHG the status has just been changed
		MIN the value is beyond the minimum background limit
		MAX the maximum background limit has been exceeded
Err leak	⑩	flag for the result of the measurement electronics selftest

❺ Check light leakage in detector

The detector state menu also enables the user to perform an automatic selftest for light leakages in the detectors
The selftest of the measurement electronics will display a detector overview window in which every estimated failure or leakage will be displayed. This information will be useful to find out which detector has to be checked or maintained.

Menu controls in the detector state menu:	
back Close the menu and return to maintenance menu	
back to measurement mode This button enables a shortcut to the measurement mode	
Print Print actual menu selection.	
Menu Quick links :	
Channel configuration Measurement channel display	

4.4.3.1 Calculation of measurement time

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

	More information to measuring time calculation can be read in register 3 of this technical handbook.

4.4.4 Channel configuration

The “Channel configuration” button is used to display the firmly set channel configuration for information purposes.

ıannel

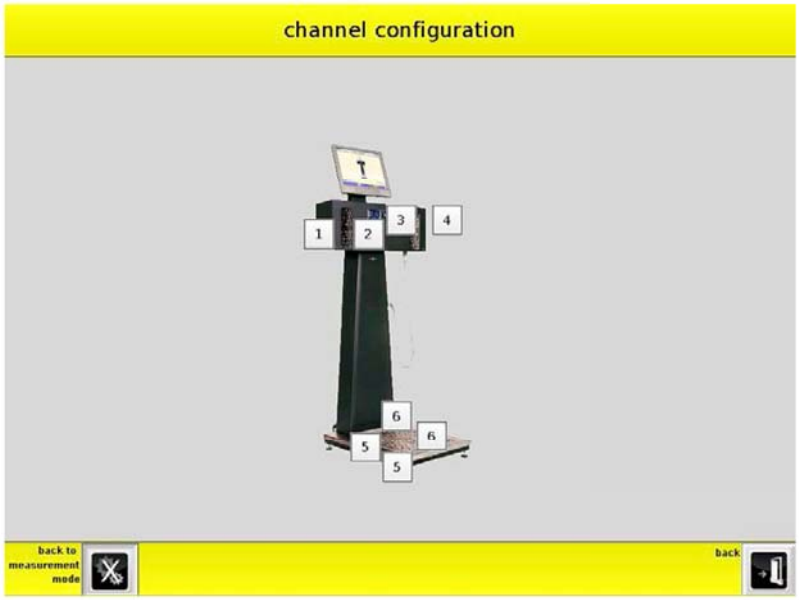


Figure 4-17: Channel configuration view

	More information to detector channel configuration can be read in register 8 of this technical handbook.

4.4.5 Measurement state

The measurement status is called up via the “Measurement state” button. This service point is separated in two areas:

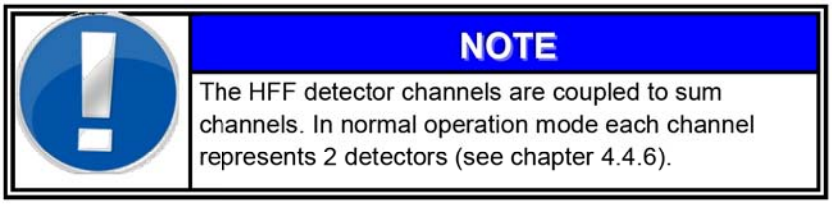
❶ Measurement status of each measurement channel

❷ Measurement status of the monitors

4.4.5.1 Measurement status of measurement channel

A list with following information is displayed for each channel:

ch	- number of the channel
state	- status of the channel
	A measurement channel can be in following **state** :
	OK the channel is ready to measure
	CHG the status has just been changed
	MIN the value is beyond the minimum background limit
	MAX exceeded maximum background limit
acc	- quitting (Q: channel was quitted or no entry)
bkgrd	- background value [%]
bkgrd	- background value [cps]
sigma	- width of the sigma tube [cps]
fast bkgrd	- OFF or ON
alarm	- alarm threshold for medium contamination [cps]
high	- alarm threshold for high contamination [cps]
meas. time	- actual duration of a measurement for channel [s]



4.4.5.2 Measurement status of the monitors

The monitor may have following states of measurement ❶:

ready to measure

The state **ready to measure** demonstrates the availability of all channels for the measurement process

conditionally ready to measure

The state **conditionally ready to measure** announces that at least half of the detector channels have attained the status **OK** and some channel are accepted for not being included in the measurement process

not ready to measure

The state **not ready to measure** indicates that a measurement operation is not possible anymore.

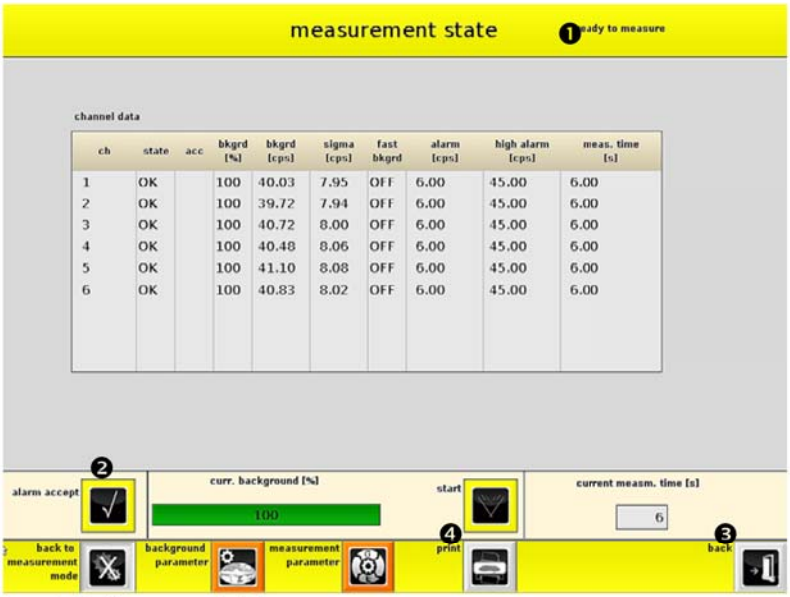


Figure 4-19: Measurement status

Curr. background [%] The used time of the first background measurement in per cent is shown at this place.

Menu Quick links :	
Background menu Adjust background parameter	
Measurement parameter Adjust measurement parameter	

Menu controls in the measurement state menu:	
alarm accept ❷ If some channels should not attain the status **OK**, the alarm accept leaves this channels to remain without consideration for the measurement	
start ❹ A new background measurement is initiated with the button start. During background measurement the **current measm. time [s]** ❸ is re-calculated with the selected parameter set.	
back Close the menu and return to maintenance menu	
back to measurement mode This button enables a shortcut to the measurement mode	
Print Print actual menu selection.	

4.5 Parameter menu area

Figure 4-20: Maintenance mode, parameter section

4.5.1 General parameters

Figure 4-21: Icon "General parameter"

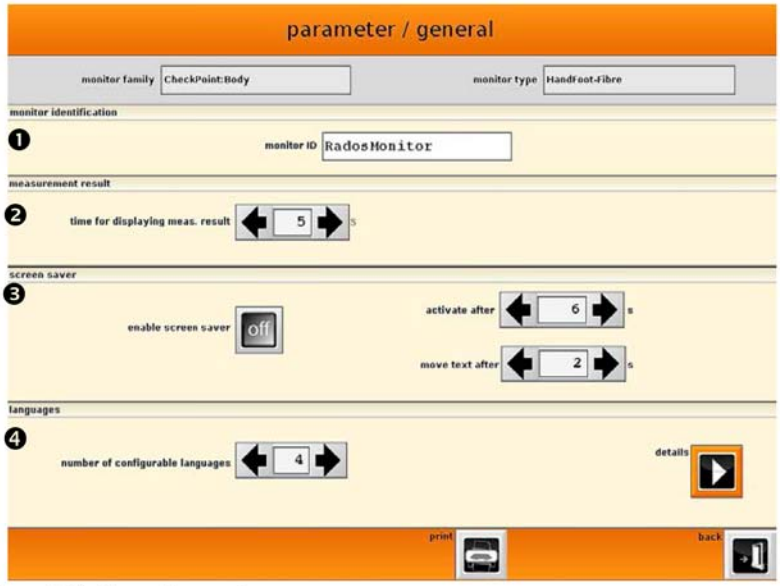


Figure 4-22: General parameters

❶ monitor identification

- In this field an unequivocal name for the monitor can be entered (i.e. serial number).The entry is user defined and is used for the identification of the monitor.

❷ measurement results

- The parameter defines the duration (time in seconds) a measurement result is shown on the display after the measured person has left the monitor.

❸ screen saver

- The parameter defines whether or not a screen saver will be used and the specific time period in which he will be activated.

❹ languages

- This parameter defines the number of languages available on the measurement screen.

Menu controls in the general parameter menu:	
back Close the menu and return to maintenance menu	
Print Print actual menu selection.	
Language details Select and test displayed languages	

4.5.2 Background

Figure 4-23: Icon "Background parameter"

The background parameters can only be modified in the running service mode via the menu ***parameter > background***.
The entered alarm limits are always based on **485 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**.

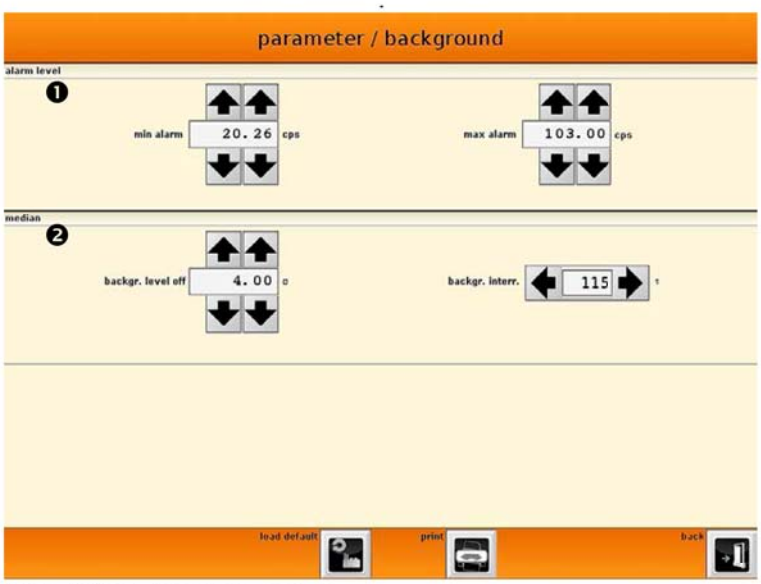


Figure 4-24: Background parameters

❶ Alarm level min-Alarm max-Alarm

If the adjusted low (MIN) or high (MAX) values are not reached by the counting rate, 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).

❷ Median

① background level off σ ② background interr. τ

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

② 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.

Menu controls in the background menu:	
back Close the menu and return to maintenance menu	
Print Print actual menu selection.	
Load default Reload factory settings.	

Figure 4-25: Icon "Measurement parameters"

4.5.3 Measurement parameters

The parameters can only be displayed and modified if the operator is in the maintenance mode via the button **measurement**.
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 input will be done via the touch screen using the appropriate toggle and radio buttons.

Up to 15 different parameter sets (❶) can be created. For identification purposes each parameter set is provided with a user definable name in the field **actual para set**. With the arrow keys <arrow left> and <arrow right> the previous or the following parameter set can be selected.

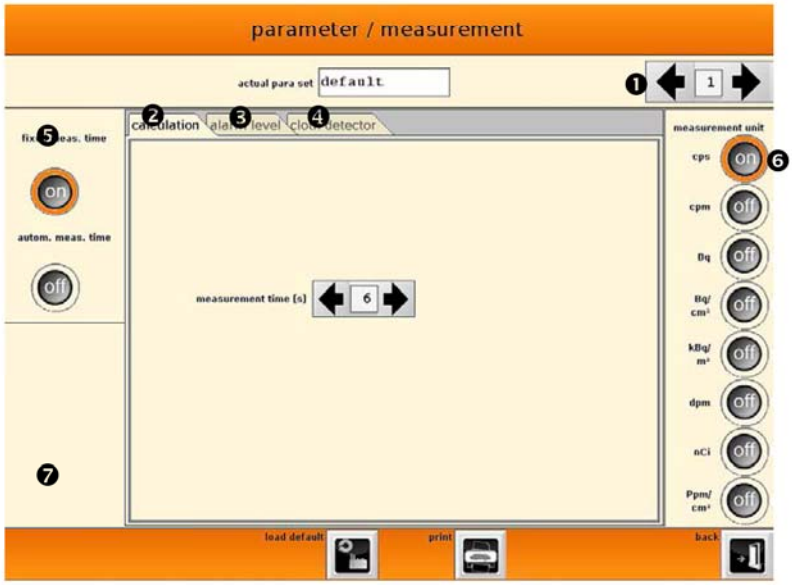


Figure 4-26: Setting of parameters (calculation)

Every parameter set contains following parameters:

Tab calculation ❷

- fixed or automatic measurement time (❺)
- measurement time duration (for fixed measurement time)
- false alarm and detection safety
  (percent display is calculated)
- selection of the measurement unit (❻)
  - cps (counts per second)
  - cpm (counts per minute)
  - Bq (Becquerel)
  - Bq/cm² (Becquerel per cm²)
  - kBq/m² (kilo Becquerel per m²)
  - dpm (decay per minutes)
  - nCi (nano Curie)
- nuclide selection (optional) ❼
  This is activated/deactivated only in case of a built-in nuclide selection switch.

Tab alarm level ❸

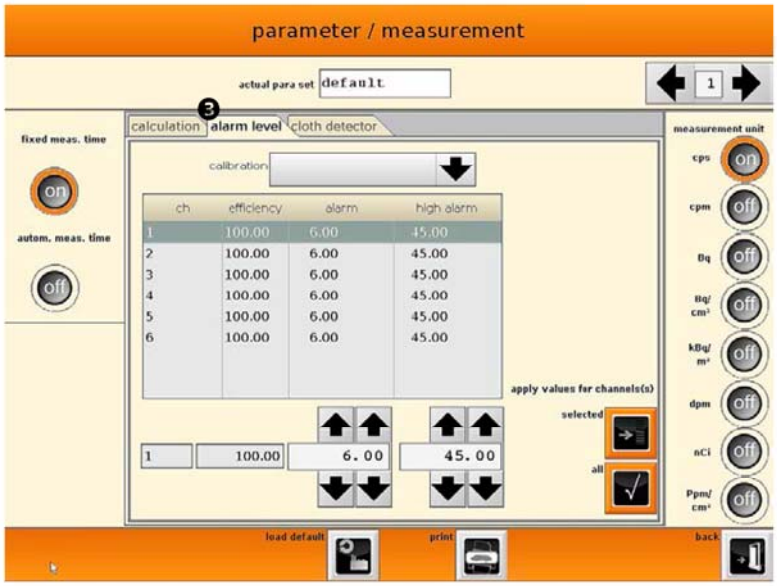


Figure 4-27: Setting of parameters (alarm level)

- Calibration (only for nuclide-referred measurement)
  From a fold-up list the desired calibration with a special nuclide can be chosen. The nuclide and its efficiencies are automatically taken over from SYSTEM CHECK (WKP) for each channel.
- Alarms
  Here the alarm values for the respective set of parameters are defined. The values can be individually set for each channel.
  - alarm of the channel
  - high alarm of the channel

If the button **selected** or **all** is pressed, the altered alarm values for the individual channel or for all channels are taken over for the respective channel.

Tab cloth detector ❹

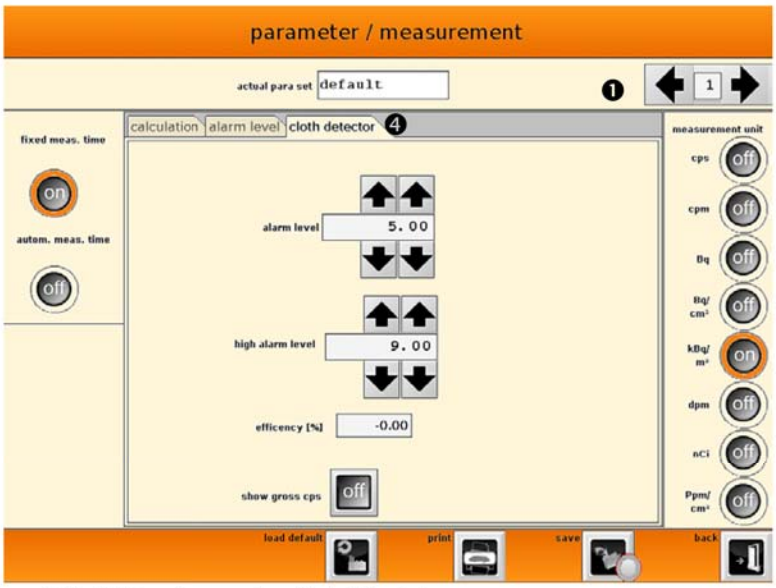


Figure 4-28: Setting of parameters (cloth detector)

Following parameters can be set for the low and high energy measurement channel

- Alarms
  Here the alarm values for the cloth detector measurement can be set
  - alarm level of the channel
  - high alarm level of the channel
- Efficiency
- show gross cps for cloth detector
  If this button is selected, the measurement result of the cloth detector is shown as a gross value

Menu controls in the measurement parameter menu:	
back Close the menu and return to maintenance menu	
Print Print actual menu selection.	
Load default Reload factory settings.	

4.5.4 Database parameters

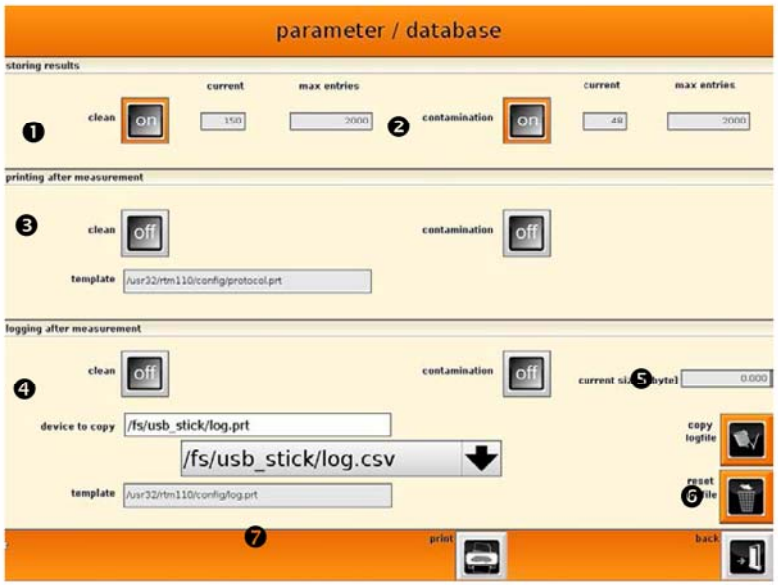


Figure 4-29: Database entries (general)

A storing results

- ❶ clean ❷ contamination

  By activating the fields clean or contamination the respective measurement results will be saved into the database.
  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.

B print after measurement

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

C logging after measurement

- ❹ clean and/or contamination
- This parameter enables the user to log all or selected measurement for database storage.
- ❺ The field current size [Kbytes] shows the current size of this log file. It is possible to decide if contamination measurements should be entered in the log file or not (contamination button).
- ❼ All contamination measurements can be saved in a log file and can later be copied to storage medium. Due to the special format of this file (each measurement is stored in exactly one line: the individual measurement results are separated by a semi-colon) the results of the measurements are easy to read in other programs (such as MS EXCEL) and can be processed.

NOTE

If a copy is selected, the current log file is copied to a storage medium. The kind of storage medium (i.e. USB Stick or compact disc) has to be chosen in reference to the log file size. In the field device the interface to which the log template should be saved is stated. The device can be changed using the listings window next to the device field. After saving (**copy**) the measurements, the log file should be erased from the monitor with delete in order to avoid an unlimited growth of this log file.

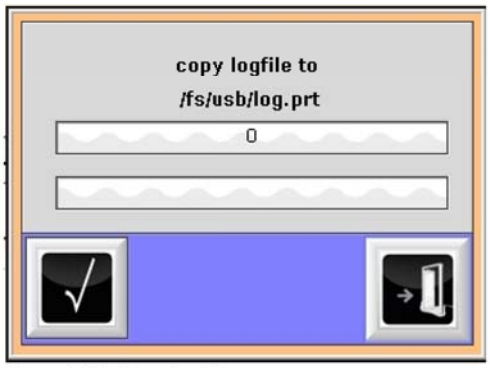


Figure 4-31: Copy log file

Menu controls in the database parameter menu:	
Copy log file ❻ This database administration button enables the user to back-up the internal database,	
delete log file ❻ Delete a existing log file is helpful to save storage space on the measurement computer hard disc	
back Close the menu and return to maintenance menu	
back to measurement mode This button enables a shortcut to the measurement mode	
Print Print actual menu selection.	

4.5.4.1 Further processing of CSV-files

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

(a) Open MS EXCEL©

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

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

(d) Confirm selection with **OK** ❸

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

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

(f) Confirm data import with touch on **OK**❽

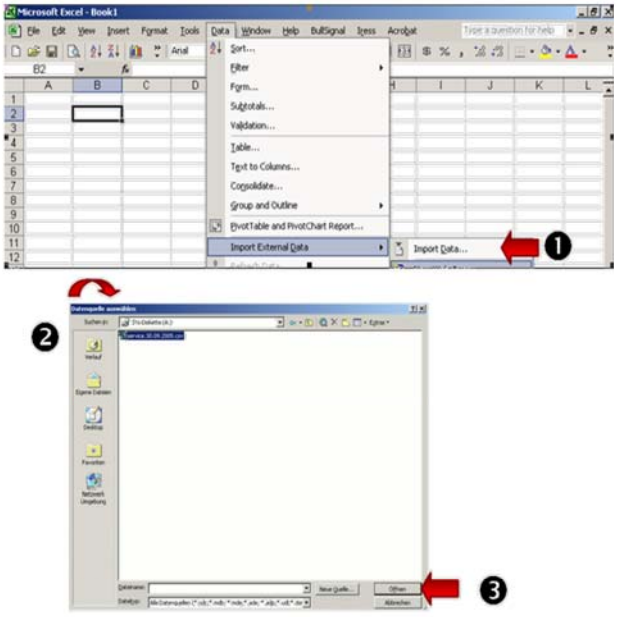


Figure 4-32: Data import to MS-Excel©

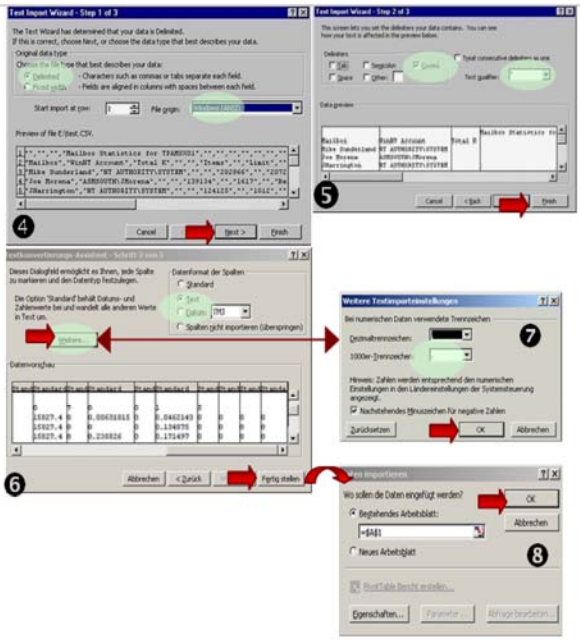


Figure 4-33: Data import assistant in MS-Excel©

4.5.5 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 **HandFoot-Fibre™** 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 tests with persons, to determine the local background shielding factor with the best compromise. To test and optimize 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.

The background reduction of the person measurement can be adjusted globally for all channels in advance. Additionally each channel can be adjusted as one can see in the lower part of the dialog as well as the values of all channels. For this the sensitive arrow fields are to be applied.

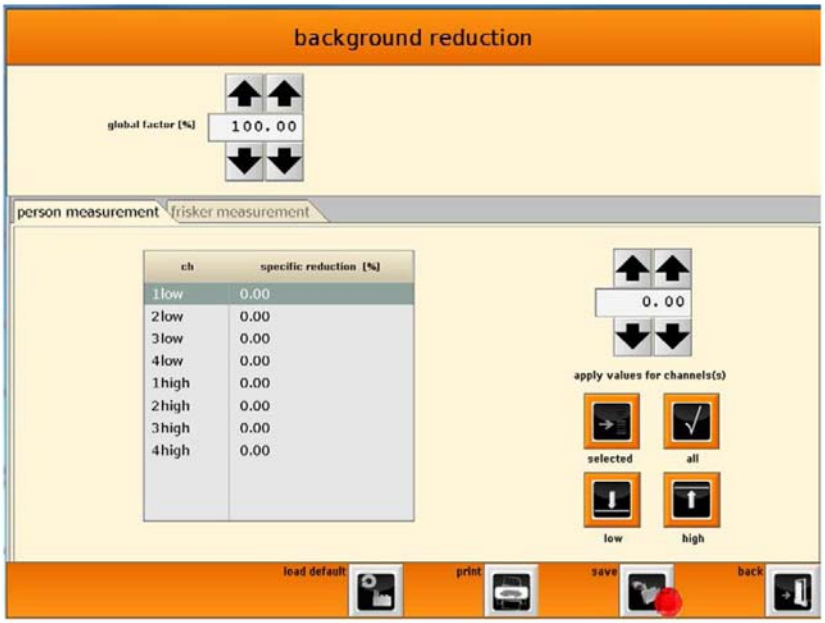


Figure 4-34: Background reduction_person measurement

Parameter menu area

The frisker measurement can be adjusted in specific reduction values for low energy and high energy.

In addition the global percentage factor can be adjusted for all detectors

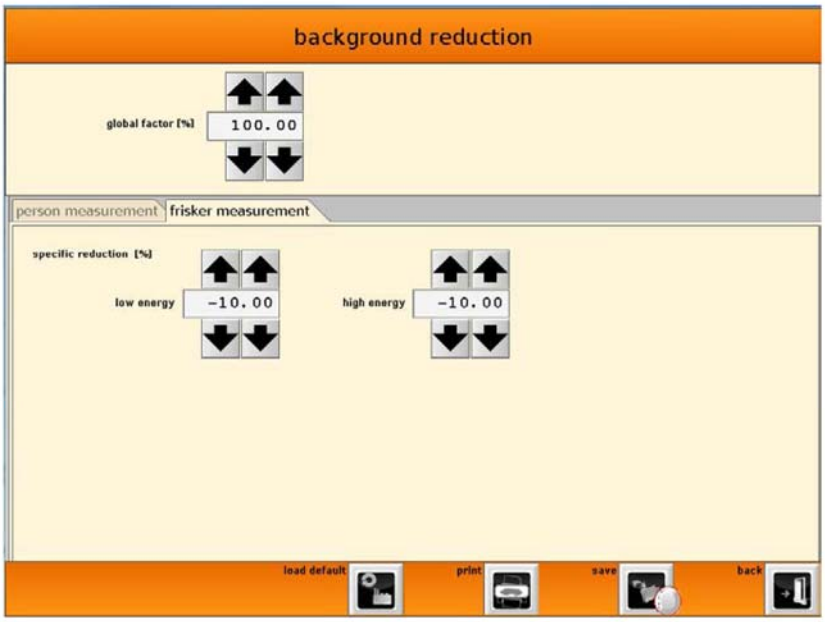


Figure 4-35: Background reduction, frisker measurement

Optional

4.6 Misc menu area

Figure 4-36: Maintenance mode, database section

4.6.1 Measurement results

Figure 4-37: Icon "Measurement results"

The database window shows the measurement results, saved in the database.

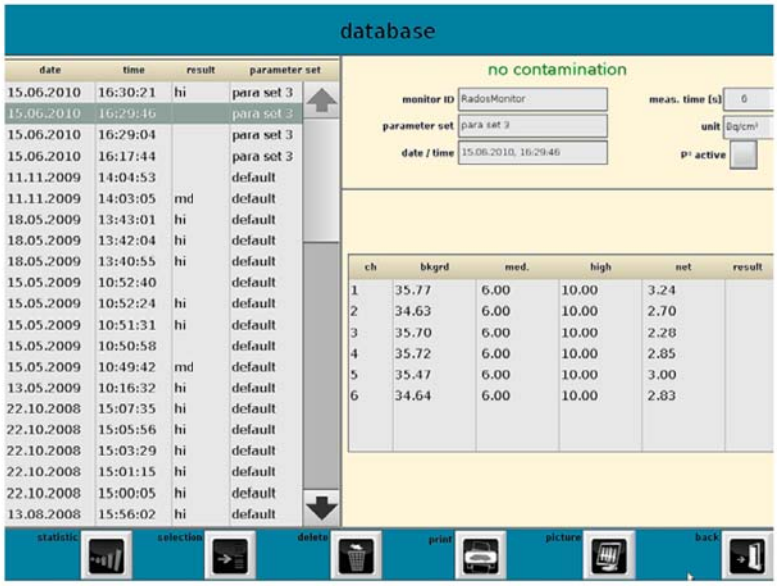


Figure 4-38: Database count rate view

In the left window all measurements are displayed with their date, time and the measurement result. Selected measurements from the log list are shown with measurement details at the right hand side.

Menu controls in the database menu:	
Statistic see chapter 4.6.1.1. Displays the actual database usage.	
Selection see chapter 4.6.1.2 Select measurements shown in log list.	
Delete This enables deletion of measurements from storage.	
picture Switch from count rate view to detector view	
back Close the menu and return to maintenance menu	

Print

Print actual menu selection.

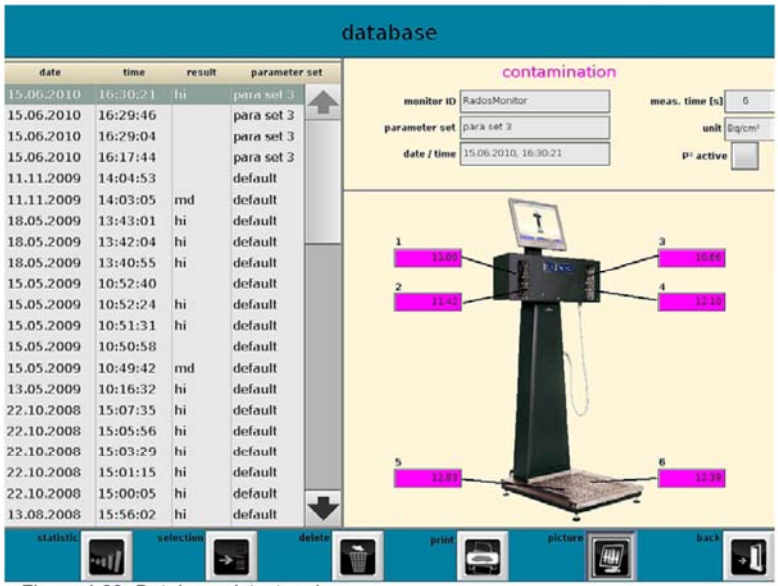


Figure 4-39: Database detector view

4.6.1.1 Database statistic

Figure 4-40: Database statistic

4.6.1.2 Database selection

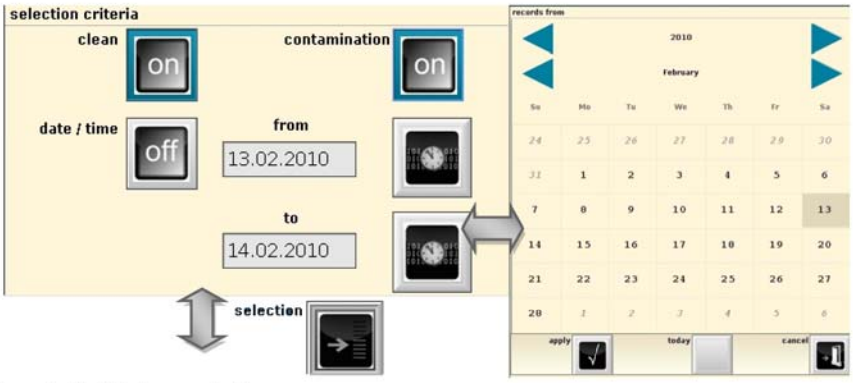


Figure 4-41: Database selection

4.6.2 Protocol

Figure 4-42: Icon "Protocol"

Figure 4-43: Protocol

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

In the protocol:

- Info messages
- Warning messages
- Error messages

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

The left-hand window shows a listing of all available protocol files. There is an automatic delete function so that only the protocols of the last 12 days are displayed in the list.

Menu controls in the protocol view:	
History Switch to specific protocol from the variety of 14 logged protocols	
Close Close the menu and return to maintenance menu	
Print Print actual menu selection.	

4.6.3 Statistics

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

Figure 4-44: Icon "Statistic"

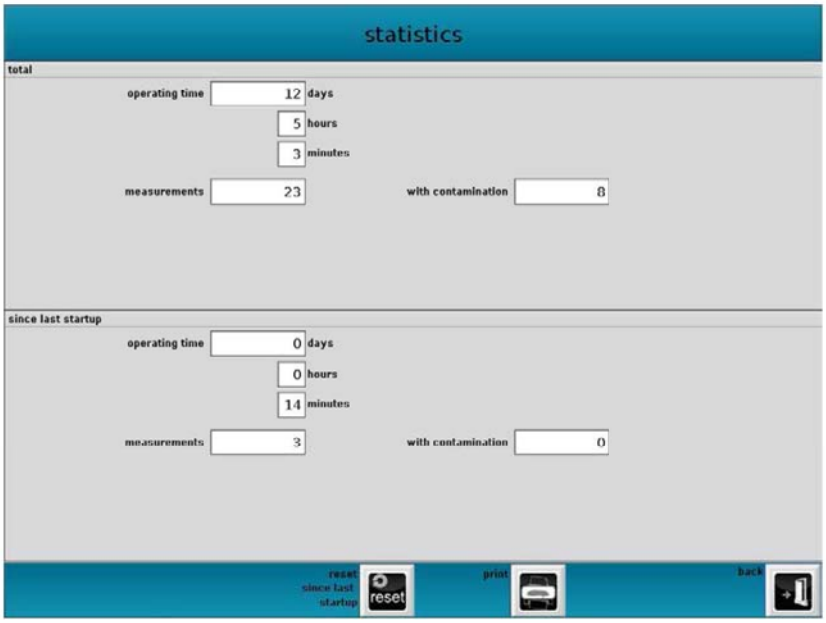


Figure 4-45: Statistics

Duration of the operation:

- ☐ days, hours, minutes

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

- ☐ measurements
- ☐ measurements with contamination

With the button **reset** the data *since last start up* are set back to "0".
The "total" data (since the set up) cannot be set back to "0".

Figure 4-46: Icon "Voice test"

4.6.4 Voice test

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

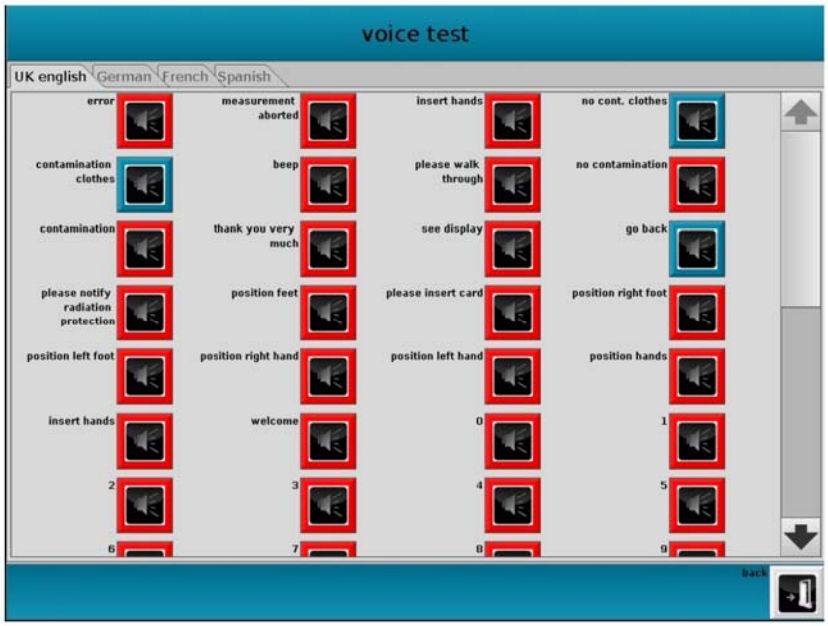


Figure 4-47: Setting language

The available (blue frame) audio files can be tested for each language.

NOTE

The number of languages to be selected and shown in the main menu are set via the maintenance→parameter →general menu

Menu controls in the test audio view:	
back Close the menu and return to maintenance menu	

4.6.5 About (Info)

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

Figure 4-49: Icon "Info"

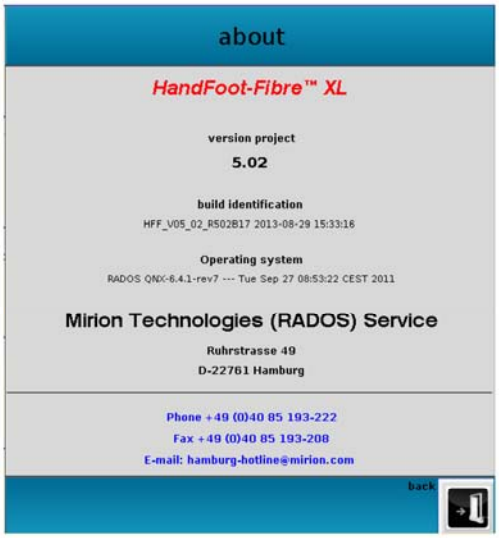


Figure 4-48: Quit program

4.6.6 Detector alarm test (option)

Figure 4-50: Icon "Detector alarm test"

The detector alarm test program 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.

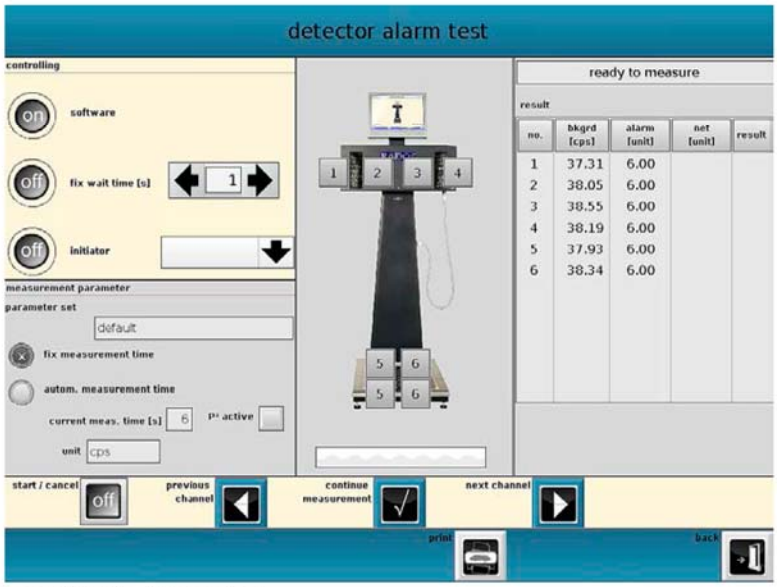


Figure 4-51: detector alarm test

NOTE

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

This point of the service program is to be used for the display as well as the input of parameters which are relevant for the procedure of the measurement.

Use of the detector alarm test

The detector alarm test is designed with the principle of the measurement process, which means the **HandFoot-Fibre™** has to be in **ready to measure** mode before entering the detector alarm test and to start the detector alarm test. This ensures that the measurement parameters are active and the background is measured and saved.

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 **HandFoot-Fibre™** 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.

Detector alarm test process

To start the detector alarm test, change from the **measurement mode** into the **service mode**.
The detector alarm test can be chosen 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 **HandFoot-Fibre™** and the detector alarm test cannot be performed. Please feel free to contact the RADOS Customer Service for assistance on this matter.

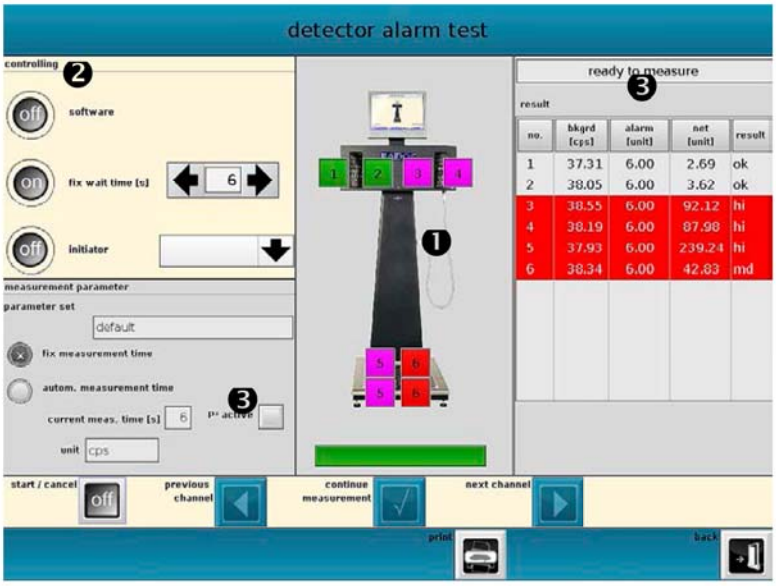


Figure 4-52: Detector alarm test settings (example)

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

Depending on the monitor design different detectors types and positions can be displayed on the main screen ❶.

There are different possibilities under **controlling** ❷ to acknowledge the detector positions.

software acknowledge by mouse, to acknowledge every step, click on the button **next channel**

fix wait time select the button **fix wait time [s]** with finger touch and give a waiting time in seconds with aid of the arrows. The

next step will automatically perform after the set time.
To start the detector test press the button **start / cancel**

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.

NOTE

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

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

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

The whole process of the detector test can be controlled with the buttons **start / cancel, continue measurement, previous channel** and **next channel**.

Test results

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

Depending on the state of a channel, the detector channel will show a different background color. The next actual channel that is to be measured has a white background.

If the counts of a measurement are below the set threshold, than the fields are in green color and the voice output **no contamination**

If the counts are above the medium threshold, the background changes in red and the voice output **contamination** is announced.

If the background color of a channel changes in pink, the high threshold was exceeded. Also in this case the voice output **contamination** is announced.

Caption of used colors

6	grey	next channel to be tested
5	green	Measured values are below alarm threshold announcement: „no contamination“
1	purple	Measured values are above alarm threshold announcement: „contamination“
2	red	Measured values are above high alarm threshold announcement: „contamination“

At the end of the measurement (all channel have been tested) the user will be noticed. A printout of the test results is enabled at this stage.

4.7 Set-up parameters

Figure 4-53: Maintenance mode, set-up parameter section

4.7.1 Timer for the delay clean measurement

Timer for the delay clean measurement allows the user to preset an exact amount of time, before the monitor is ready to measure again between clean measurements.

NOTE

Normally, the entered value should be zero. But if the signal for the clean measurement is linked directly with a barrier, the entered value should be higher than zero.

4.7.2 Timer for the switching the language

The timer for the switching the language allows the user to preset an exact amount of time, before the monitor switches back to the language that is selected as the first language in the user software.

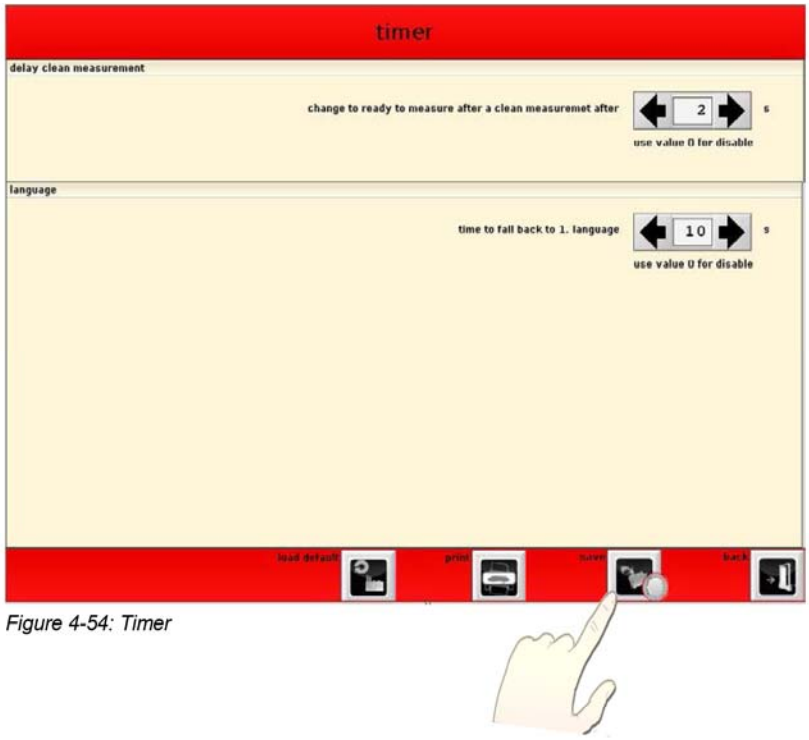


Figure 4-54: Timer

4.8 Exit application

With touch on the button “Exit application” quit the program and return to the start menu.

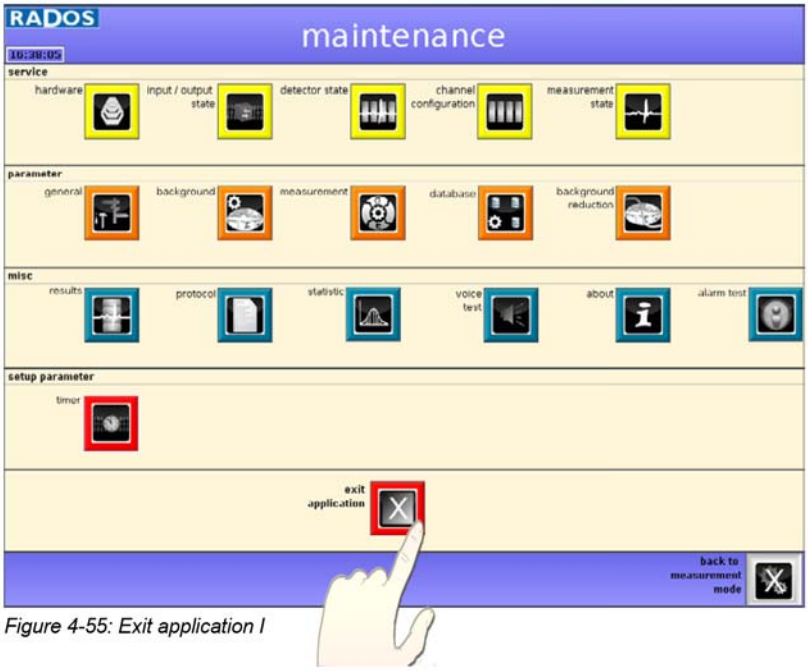


Figure 4-55: Exit application I

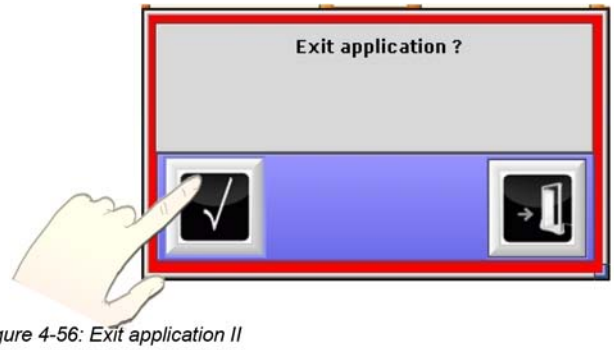


Figure 4-56: Exit application II

5 User administration

Table of figures

5.1 User administration

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

5.1.1 Prefix

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

In order to start the **user administration** it is necessary to close the user software. To close the measurement mode, enter the maintenance mode in the user software and select menu-item “Exit application”.

Regarding the case you are logged in as a **default** user, please, change your login authorization to the user group **user** at minimum to get access to the menu item **close**.

The **user administration** is opened and carried out using the **service** and afterwards the **user profile** button in the RADOS monitor start-up menu.

Figure 5-1: Start-up menu

calls the RTM user software – the main program to perform radioactive contamination measurement
(see Register 3 and Register 4)

calls the utility programs to perform for computer and detector administration.

user administration program (see Register 5)

5.1.2 User administration general

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

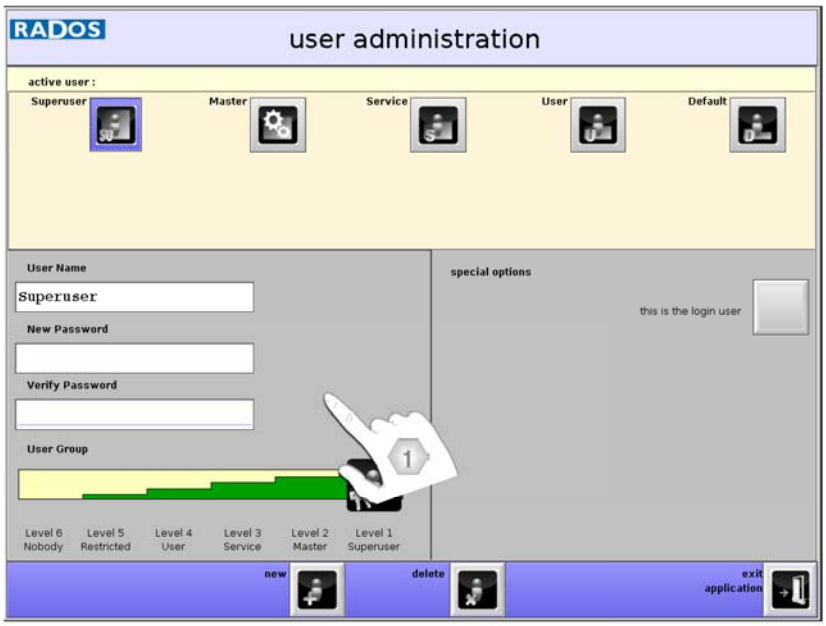


Figure 5-2: user administration –Start menu

Note

If the **login-user** is defined with the group- right **Master**, the user profile will be deactivated in the measurement software.

5.1.3 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**

Restricted **Level 5**

Nobody **Level 6**

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

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

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

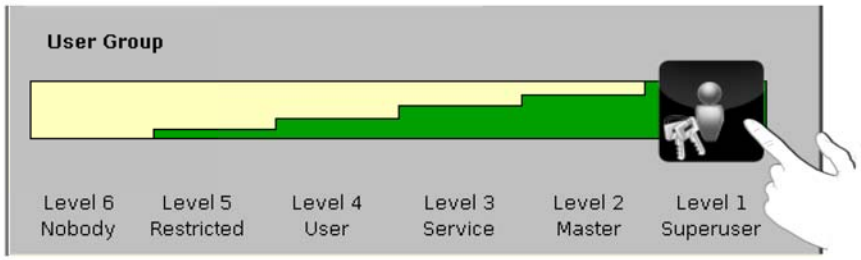


Figure 5-3: User administration – user authorization selection

5.1.4 Authorizations in user software

The **user profile** defined in a user group 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.
Authorization needed to operate functions in the User Software:
(higher authorization by password query):

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

Table 5-1: Authorization User software

The user authorization and the **login-user** must be defined according their tasks and respective authorizations in the user administration.

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.

System check

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

Table 5-2: Authorization System Check

5.2 Accessing the user administration

Start the **user administration** by selection in the RADOS monitor start-up menu.

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

The **user administration** 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 is enabled to create new user accounts, change or even delete existing user accounts. If a superuser account exists, the work with the **user administration** program is allowed to these users only.

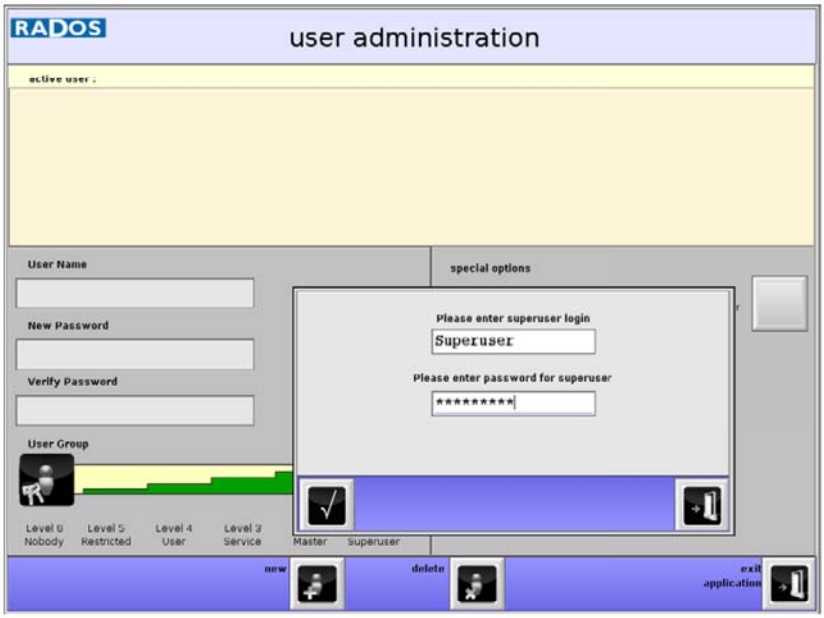


Figure 5-4: Log in user administration

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

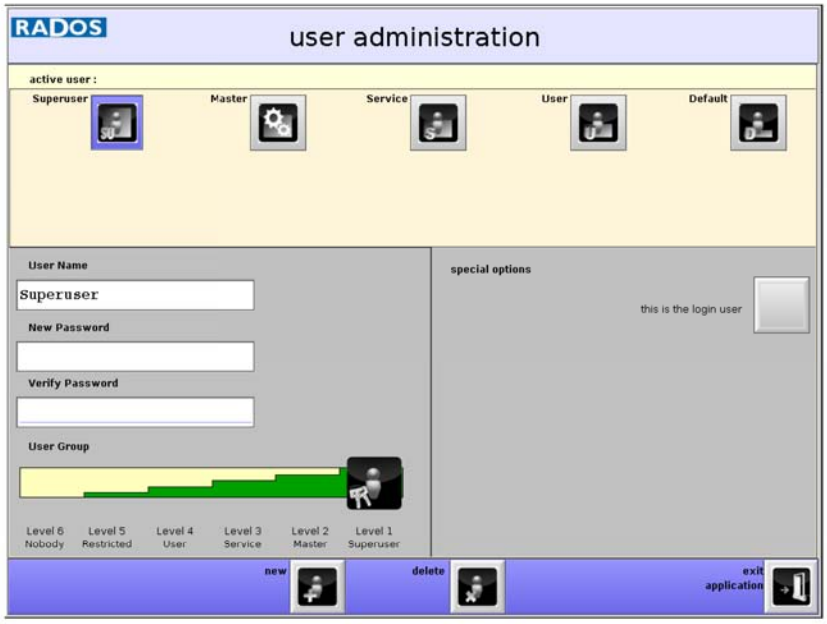


Figure 5-5: Main menu user profile

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

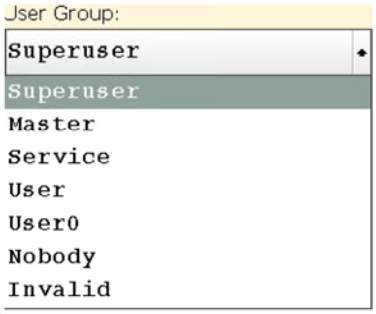


Figure 5-6: User group selection

NOTE

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

NOTE

While entering user name and password attention has to be paid for capital and small letters.

The items in the white fields (in the running program) can be modified. However the items in the yellow fields are fixed.

5.2.1 Menu controls

Symbol	Name	Function
	**Close**	Close user administration and return to start-up menu.
	**Save**	The button is displayed to save changes after altering data.
	**Delete**	Delete user from list.
	**New**	Add new user to list.

Figure 5-7: User group menu controls

5.2.2 Installation of a new user profile

Figure 5-8: NEW user

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

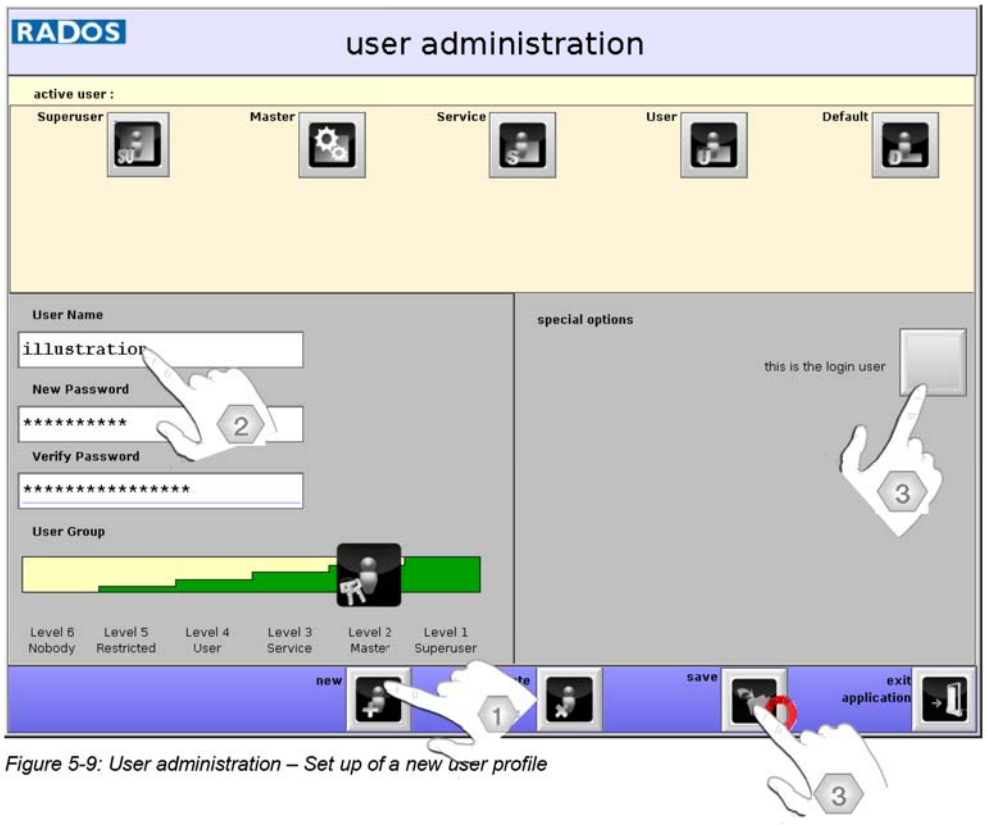


Figure 5-9: User administration – Set up of a new user profile

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 touch on the button "S*ave"* at the menu panel.

The new **user profile** is displayed in the left window including a consecutively number.

5.2.3 Change a user profile

With a mouse-click on the button **new** (1) in the context menu a new user will be stored. Define or change user name, password or user authorization (2).
Activate button ***save*** (3) to store changes.

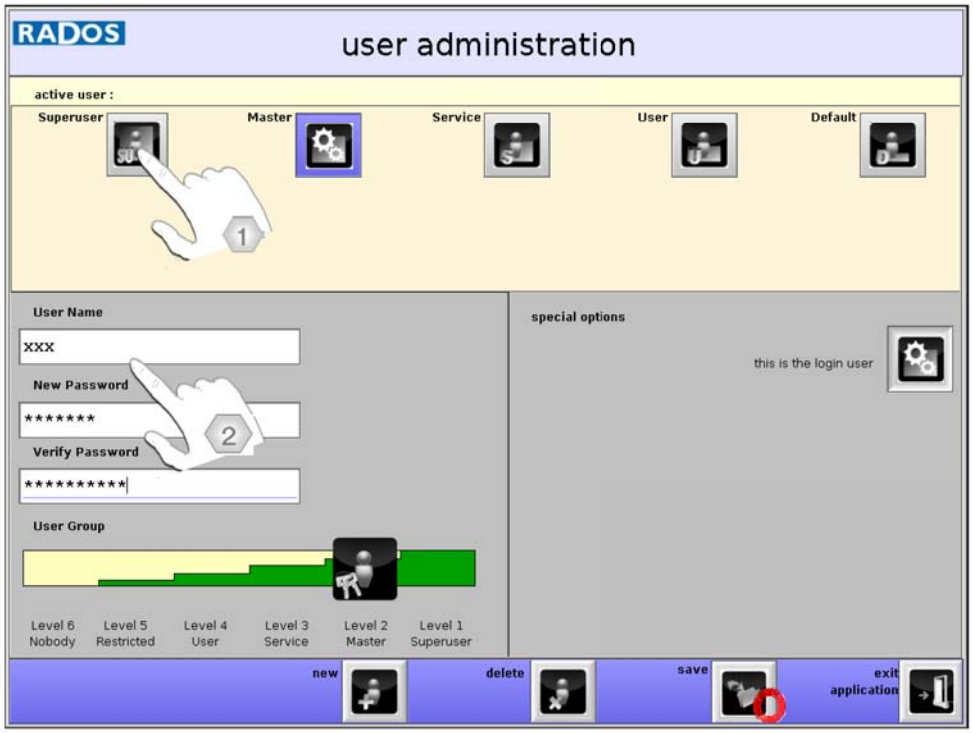


Figure 5-10: User administration – Change user profile

5.2.4 Delete a user

Figure 5-11: Delete user

To delete a user, the user, to be deleted, must be selected in the active user area (1). Initiating the delete user button (2) starts the deletion.

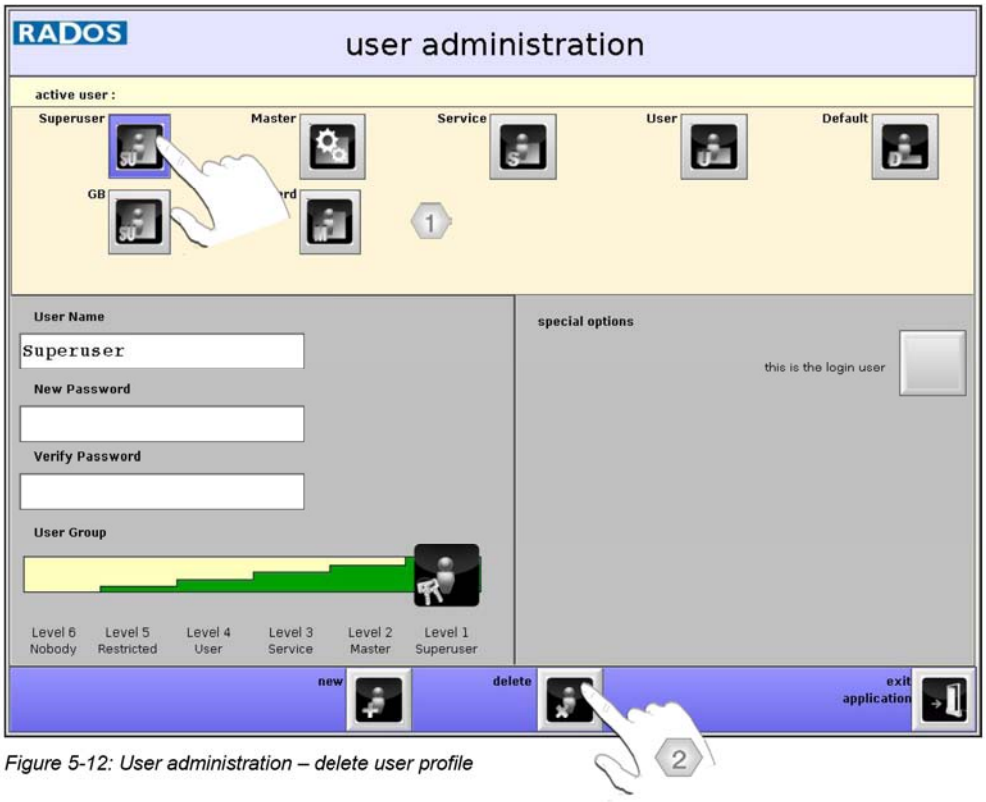


Figure 5-12: User administration – delete user profile

A second window will appear with the inquiry *"Are you sure, to delete the user"?* The user is requested to confirm this step to avoid the accidental erasure of datasets.

Figure 5-13: Query by deleting an user profile

5.2.5 Close the user profile program

To close the **user administration** program click on **exit application** at the menu panel.

6 System Check

Table of figures

6.1 Start system check

The start-up menu is the central navigation tool for all **HandFoot-Fibre™** software modules. Every software module can be reached by pressing a corresponding touch button. The **HandFoot-Fibre™** user software should be quit, before activating any other menu item, because the internal parameter alteration, which can be done from here is only available after restart of the software. **System check** is selected in the RADOS monitor start-up menu.

Figure 6-1: Start-up menu

Start system check via the start-up menu:

Start	calls the user software – the main program to perform radioactive contamination measurement (see Register 3 and Register 4)
Service	calls the utility programs to perform system and hardware administration.
System check	the maintenance and calibration program for body contamination monitor (see Register 6)

6.2 System check general

The **system check** software includes features as:

- Access to nuclide database
- Input / output tests
- Define working processes
- Carry out a working process
- Print out of working processes
- Import and export of 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.

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 nuclide 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 for database use in the main menu can be selected
- 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

Figure 6-2: System check Log-in

NOTE

It is assumed from now on that the login for the system check was done under the "Master" authorization (refer to register 5 “User profiles program” to get knowledge about administration of user login).

6.2.1 Prefix

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.

NOTE

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

Figure 6-3: Virtual keyboard

The button KBD is used to display a visual keyboard on the touch screen display.

NOTE

The maintenance menu can be password protected.
Refer to register 5 for information on user administration.

6.2.2 Recurrent menu controls

Symbol	Name	Function
	**back**	Leave the actual menu and return to maintenance main menu. (On context-sensitive menu links the previous menu will be called.)
	**Back to meas. mode**	Direct switch between maintenance and measurement mode.
	**save**	The button save (with pulsing red bulb) will be displayed directly after parameter have been altered.
	**save**	The button save (without pulsing red bulb) enables the user to save the data on a USB-Stick
	**load**	Load priory saved parameter in the user software.
	**print**	Print actual screen display for filing.
	**display**	The result of the last contamination measurement will be displayed.
	**user**	Change actual LogIn user
	**new**	Add new dataset to menu
	**delete**	Delete a dataset.

Figure 6-4: System check operation – recurrent menu controls

6.3 General mathematical calculations

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

6.3.1 Current activity

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

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

Formula 6-1: current activity

A = current activity [Bq]

A_0 = initial activity [Bq]

$T\frac{1}{2}$ = half life [days]

Δt = time elapsed [days]

6.3.2 Efficiency

The ratio of measured counts per gate time [cpg] and the radioactivity of the measurement source is called efficiency and is used as dimension for the quality of the measurement channel.

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

Formula 6-2: efficiency

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

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

6.3.3 Default deviation

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

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

Formula 6-3: default deviation

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

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

6.3.4 Error propagation net count rate

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

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

Formula 6-4: net count rate

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

6.3.5 Error propagation of efficiency

The error expansion for efficiency is described as:

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

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]
σ_A = error of current activity
σ_N = default deviation of mean gross count rate [cps] or [cpg]
σ_{No} = default deviation of mean background count rate [cps] or [cpg]

6.4 Start

At first a protocol manager is started which records the start routine of the program. The start-up menu of the system check program will appear automatically.

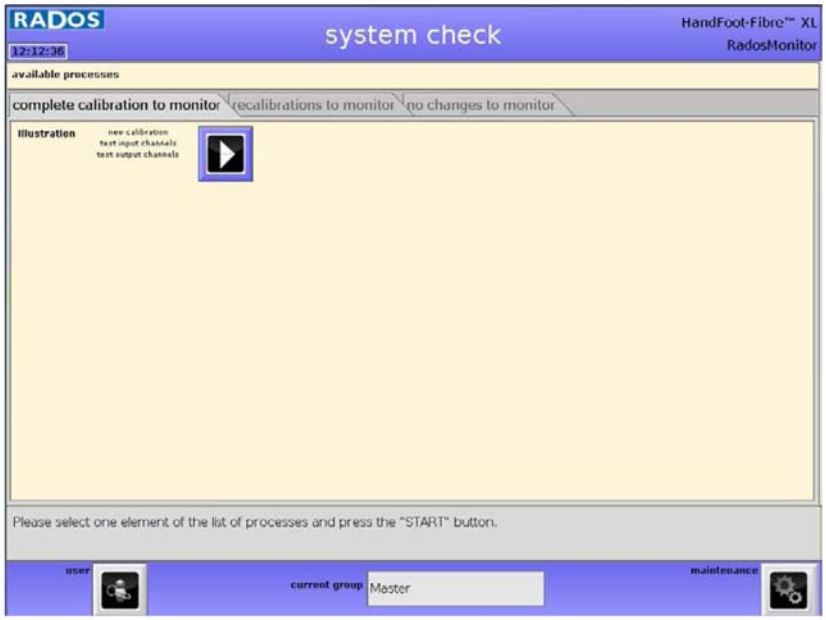


Figure 6-5: Start menu system check

This menu is the detector efficiency measurements.

maintenance mode

efficiency mode

Figure 6-6: Mode - button

When the **maintenance** button at the bottom of the display is actuated the maintenance menu is visible and the menu items are accessible.
The monitor is in a **wait state**. From this menu the desired service functions may be chosen.

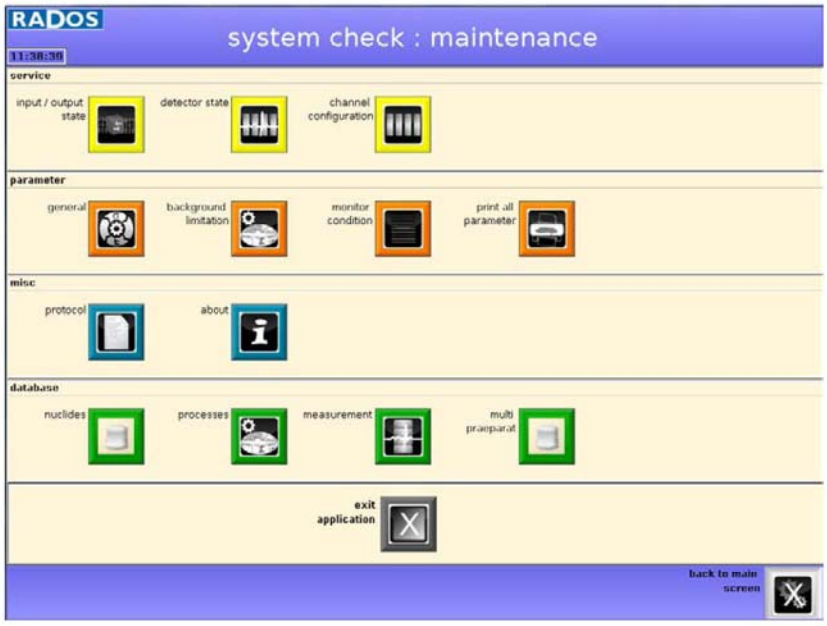


Figure 6-7: Start menu system check

6.4.1 Submenu structure

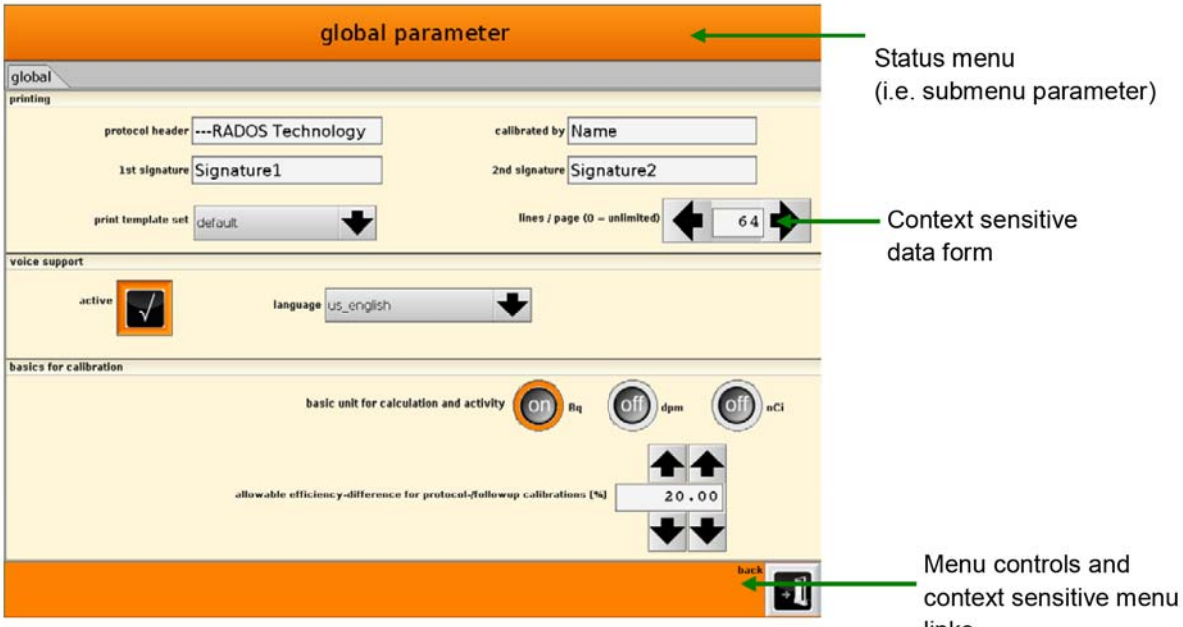


Figure 6-8: System check – submenu structure

NOTE

Due to a different monitor type and to a different monitor configuration, the screen shots shown in this manual may slightly differ from the screens on your monitor.

6.4.2 Change login user

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

Figure 6-9: User

Every user belongs to a user group with specific authorization for the program **system check**.

	Refer to register 5 User administration for detailed information.

6.5 Start of a process

The selected working process is activated from the selection of *available processes*.
Every process will be started in this way, either new, protocol or follow-up calibration.

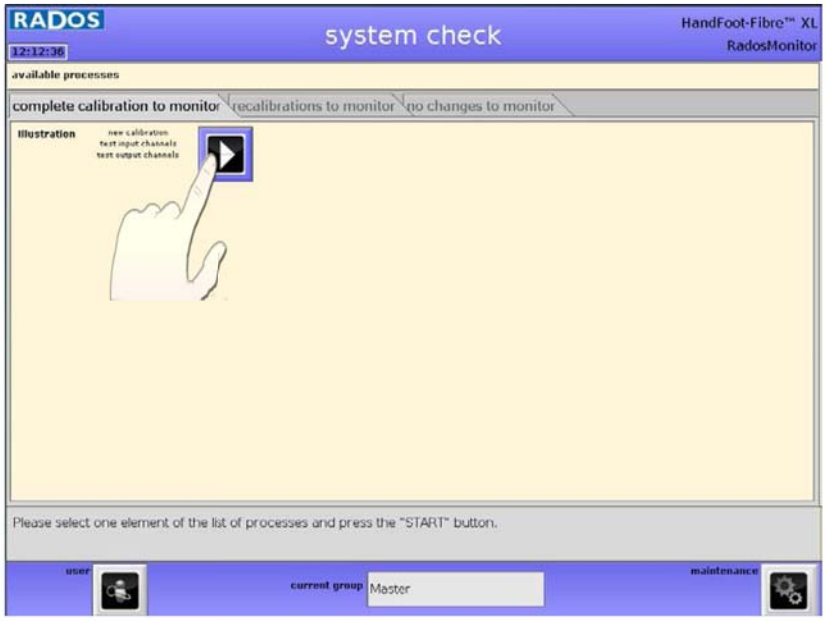
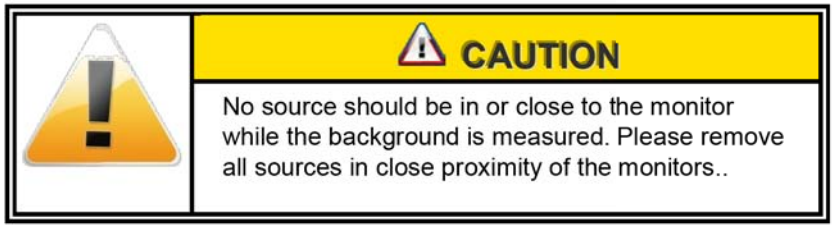


Figure 6-10: Start system check

6.5.1 Background measurement

Each process begins with a background measurement.



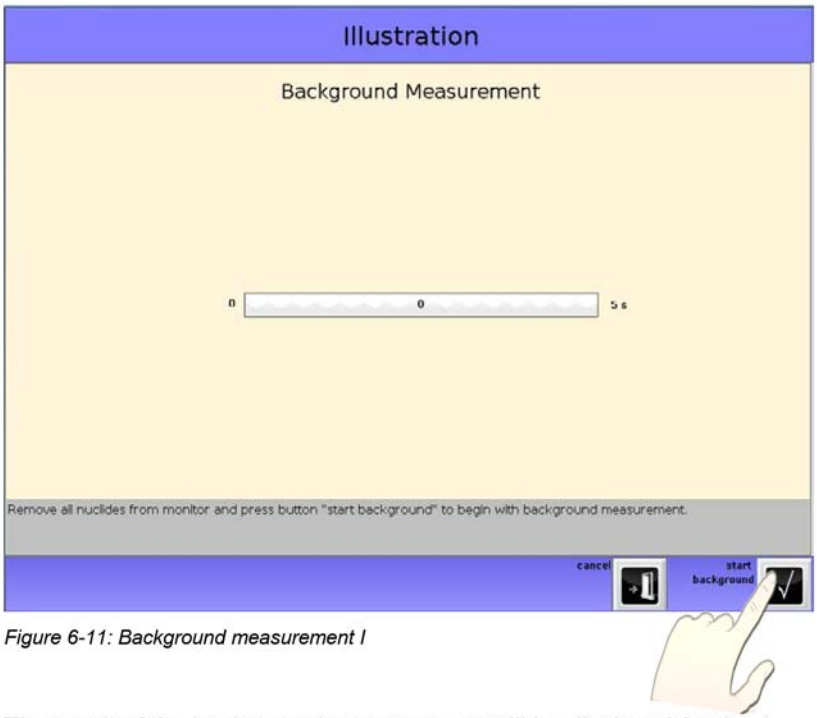


Figure 6-11: Background measurement I

The result of the background measurement will be displayed for the activated channels.

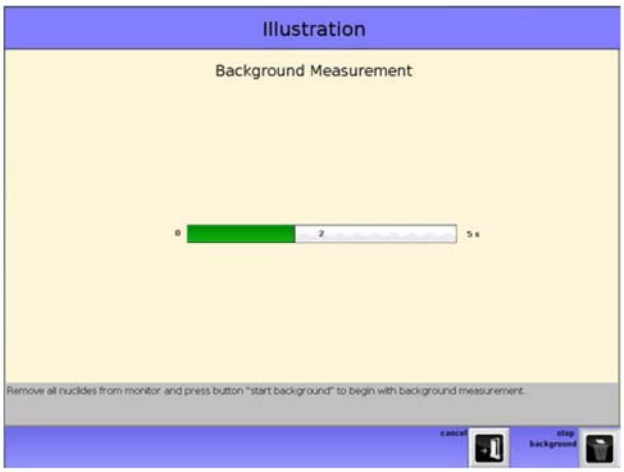


Figure 6-12: Background measurement II

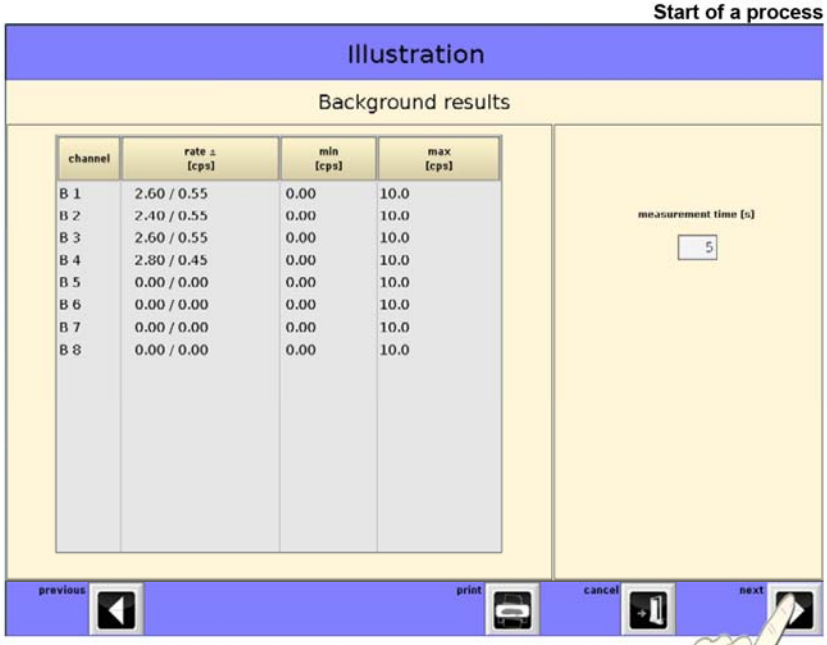


Figure 6-13: Result of background measurement

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

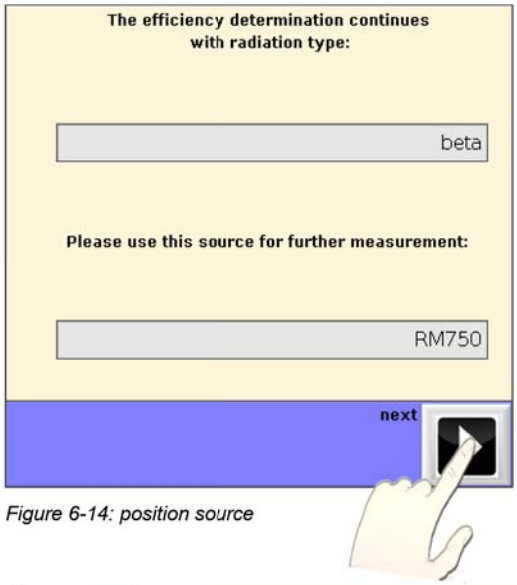


Figure 6-14: position source

NOTE

As all kind of calibration tasks are identical until this measurement step the differentiation will be described in the following only.

6.5.2 Determination of channel efficiency (calibration)

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

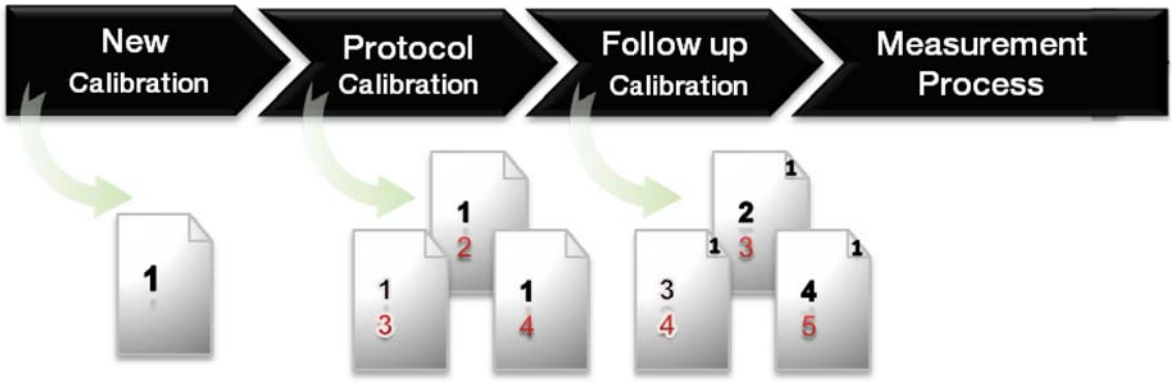


Figure 6-15: Calibration modes

New Calibration

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

Protocol Calibration

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 **HandFoot-Fibre™** after factory acceptance.

Follow-up Calibration

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.

NOTE

Rados advises to perform protocol measurements as a reference to the new measurements to monitor long term deviations.

6.5.2.1 New calibration

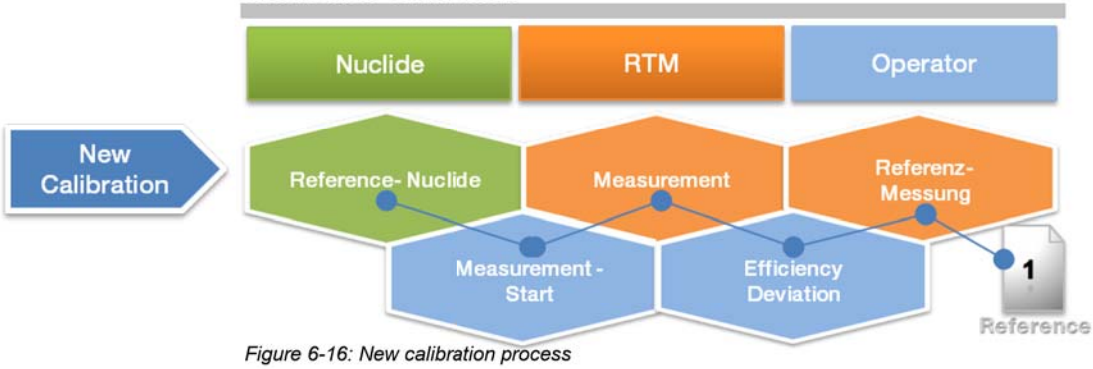


Figure 6-16: New calibration process

After the background determination, all channels have to be measured. Actuate the button ***start meas*** to start the measurement or respectively ***stop measurement*** for a break /restart. For a better understanding, the location and name of the channels are displayed.

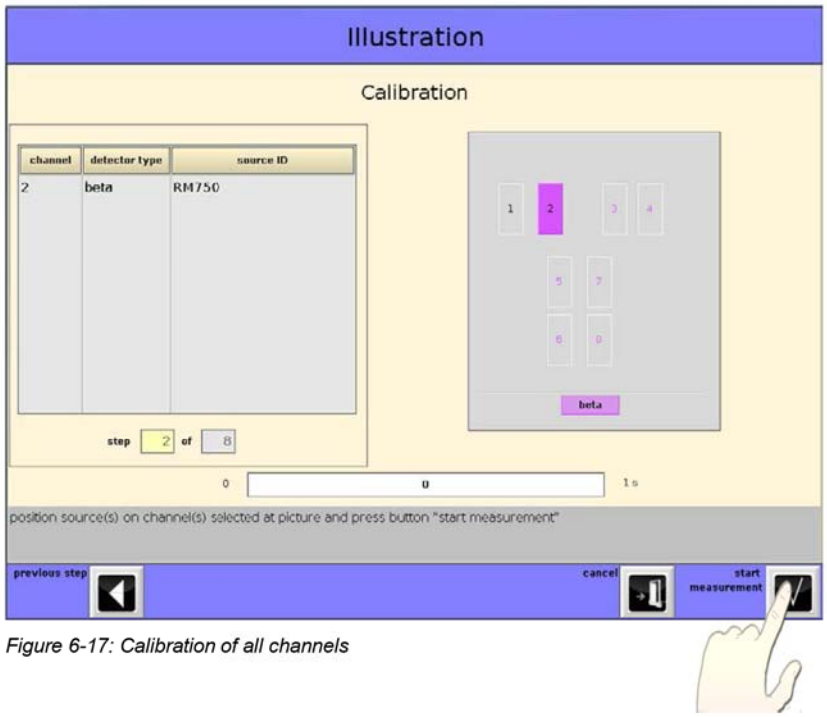


Figure 6-17: Calibration of all channels

After the measurement process the results are displayed as:

- Channel number
- Background count rate [cps] (standard deviation)
  - gross count rate [cps]
  - net count rate [cps]
    (see also chapter error propagation net count rate)
- Nuclide, Source ID
- Efficiency [%] (old and actual)
- Limits

Start of a process

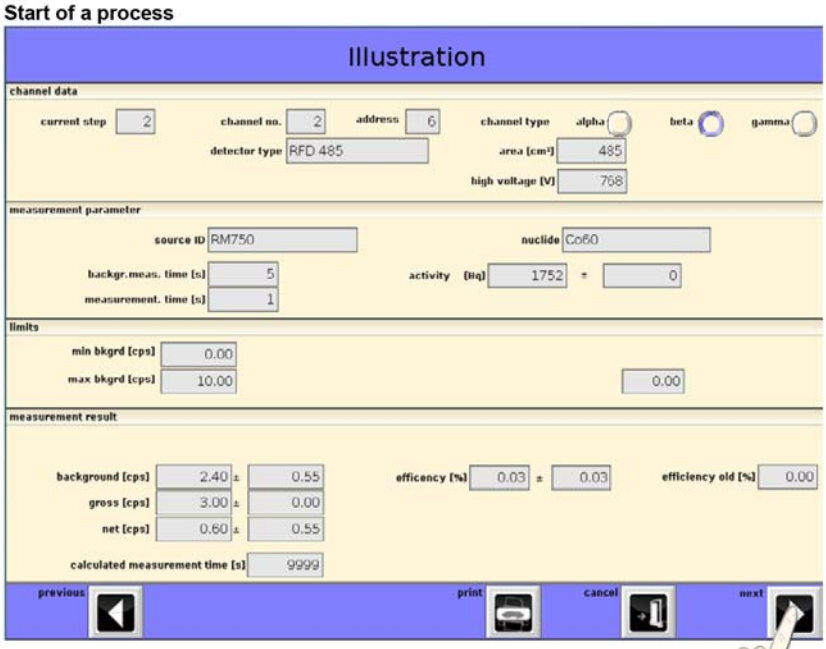


Figure 6-18: Measurement result

If necessary the measurement of a channel can be repeated. That will be needed, if the source was displaced. Use the ***previous*** button for a restart.

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

6.5.2.2 Protocol calibration

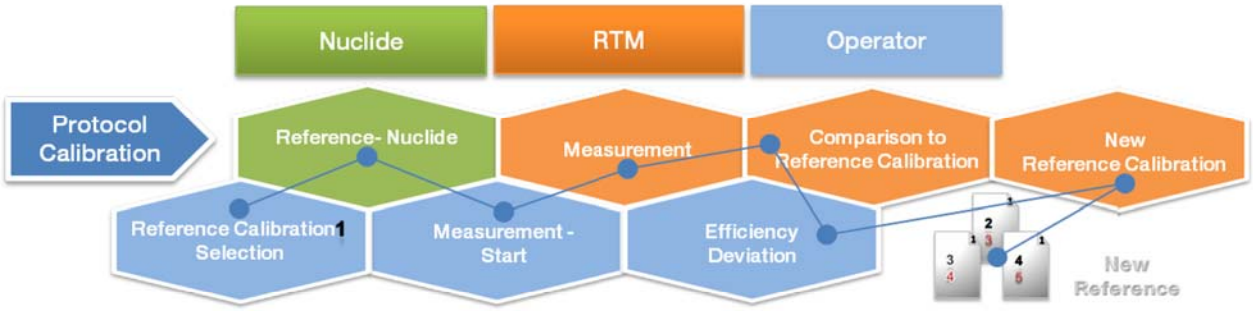


Figure 6-19: Calibration protocol process

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 ***databases/measurements*** as well as the resulting deviation in percent.

It is not necessary to measure all channels. Therefore a selection can be made using 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.

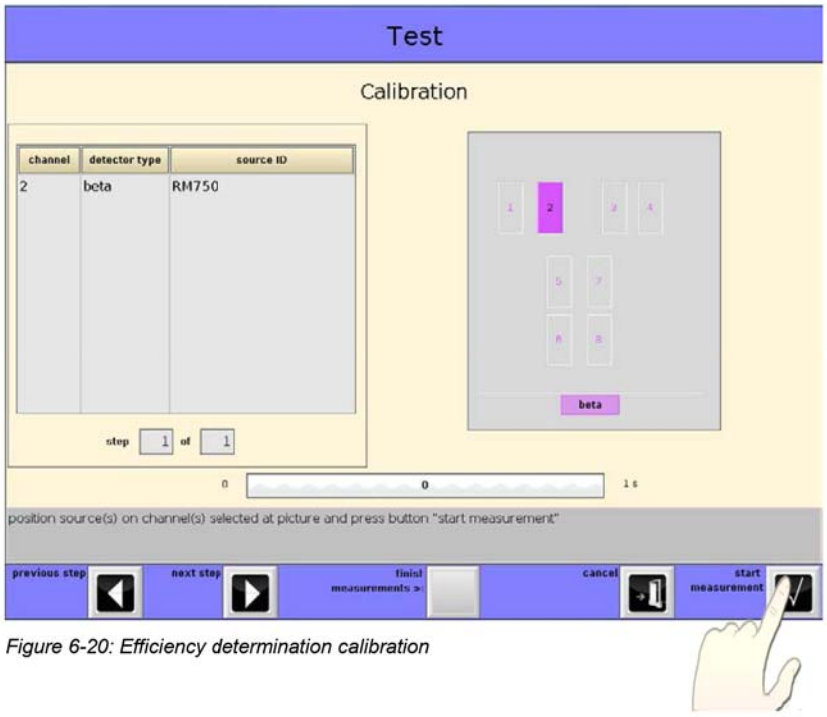


Figure 6-20: Efficiency determination calibration

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

6.5.2.3 Follow-up calibration

Figure 6-21: Follow-up calibration process

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

The efficiency determination for the ***follow-up calibration*** will be calculated using a reference calibration.

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

This task applies if the monitor shall use the efficiencies of the new calibration during measurement. The current test is used as control to check whether the variation is in the demanded tolerance limit.

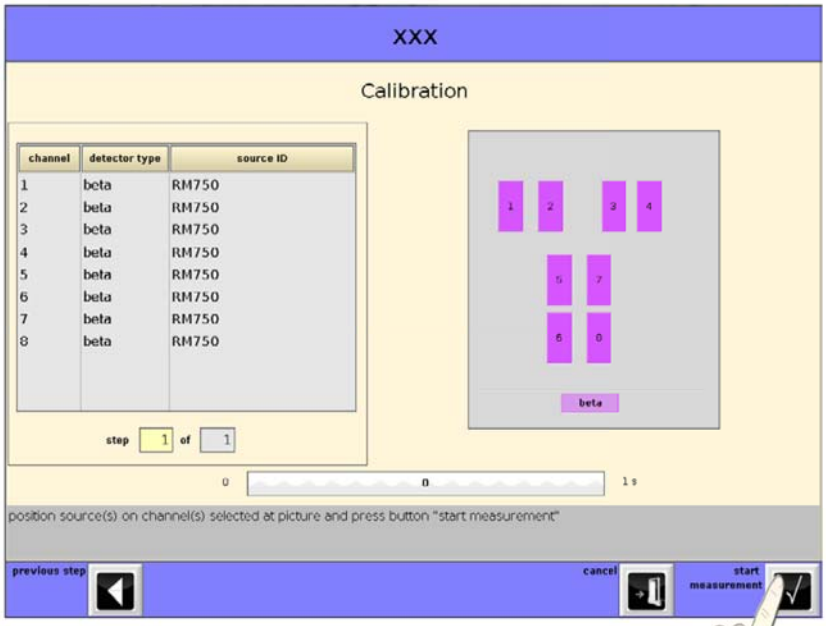


Figure 6-22: Efficiency determination follow up calibration

After the last channel measurement the binary inputs and outputs can be checked or the measurement results will be displayed immediately according to the working process.

6.5.2.4 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.

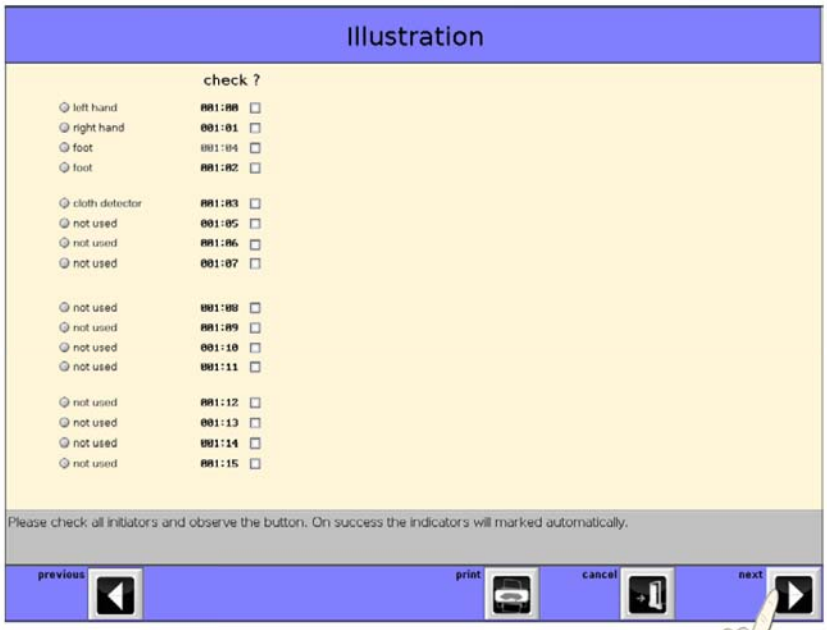


Figure 6-23: System check input test

Use the button ***next*** to enter the binary output check.

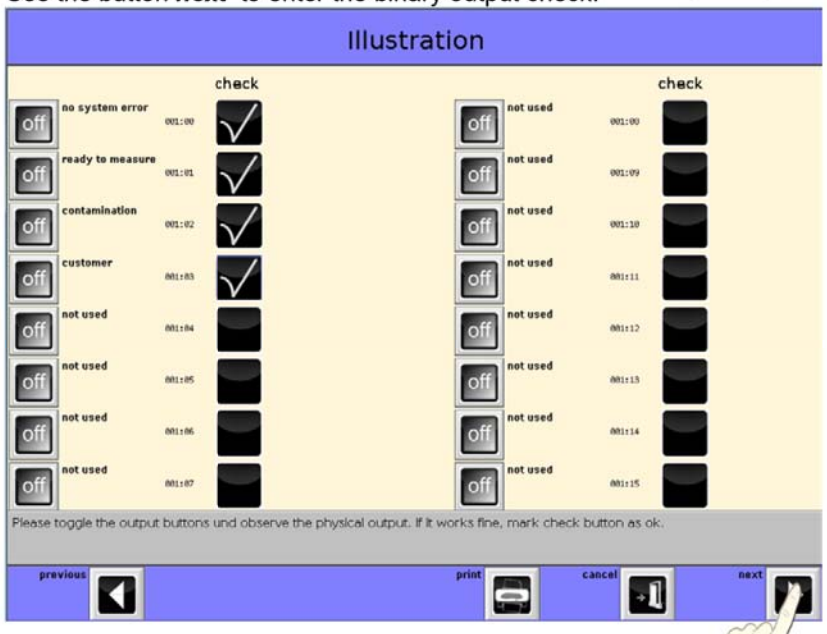


Figure 6-24: System check output test

The binary outputs need to be checked manually on the related relay outputs. The output is activated by clicking the respective output. If the binary output is working properly the tick is added manually in the related fields. Use the button ***next*** to continue.

6.5.2.5 Total result of the efficiency determination

After all detectors have gone through the measurement process, the total results for each channel are displayed separated by the respective tabs.

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

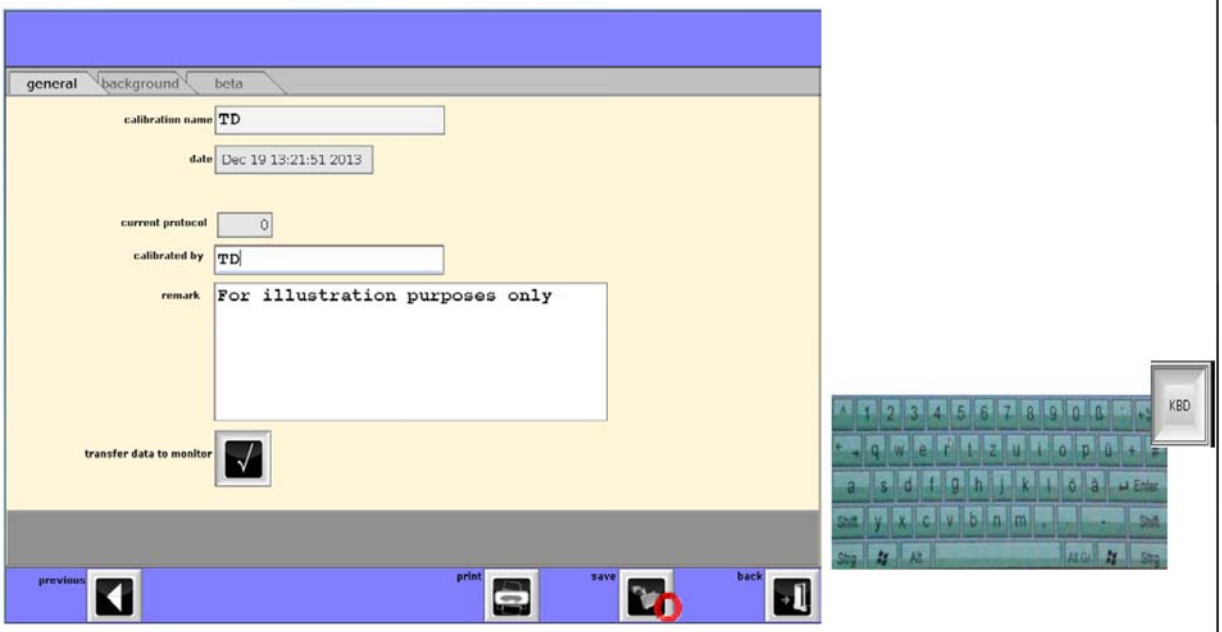


Figure 6-25: Measuring calibration result

The result of the background measurement is displayed for each channel in tab background.

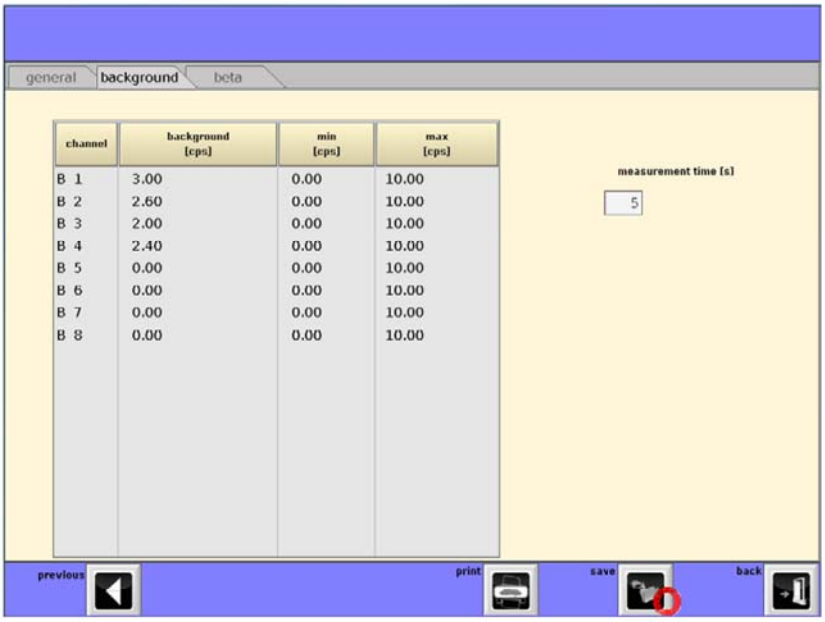


Figure 6-26: Background details

The result of the efficiency measurement is displayed for each channel in the tab beta (or gamma based on the kind of radiation measured).

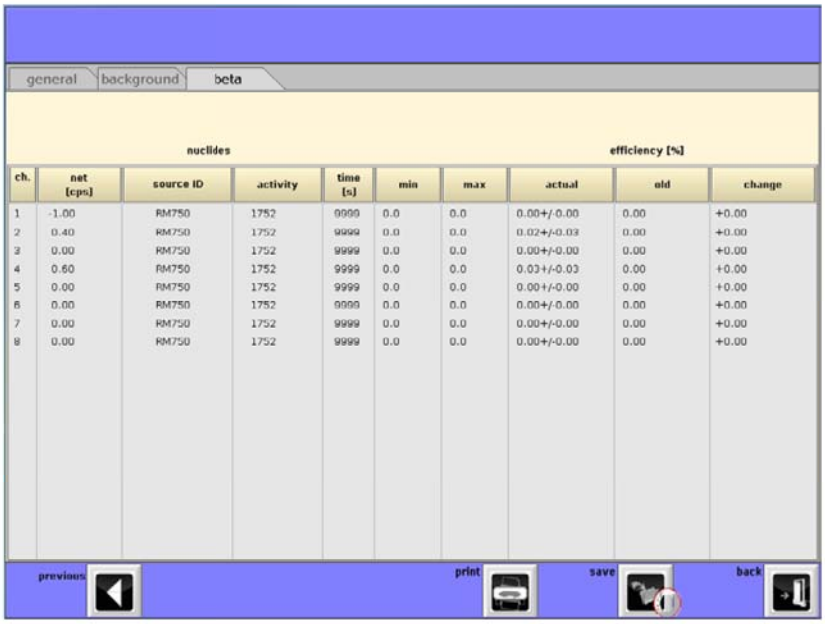


Figure 6-27: Channel details

Abstract of measurement result display:

- data regarding the protocol (data transfer e. g. to the monitor)
  - current no.
  - protocol no.
  - name of calibration
  - date and time of measurement
  - name of tester (only if required)
  - remarks
- data regarding the test source
  - source no.
  - name of nuclide
  - current activity [Bq]
- data regarding the measurement (per detector)
  - channel no.
  - background count rate [cps], default deviation
  - gross count rate [cps], standard deviation (gross)
  - net count rate [cps], error
  - efficiency [percentage rate], error
  - deviation of efficiency if compared to reference protocol[%]
  - high voltage [volt]
  - theoretical measurement time for the channels

If the binary in- and outputs were checked during the process, the ***Input*** button shows the binary inputs. 1

Start of a process

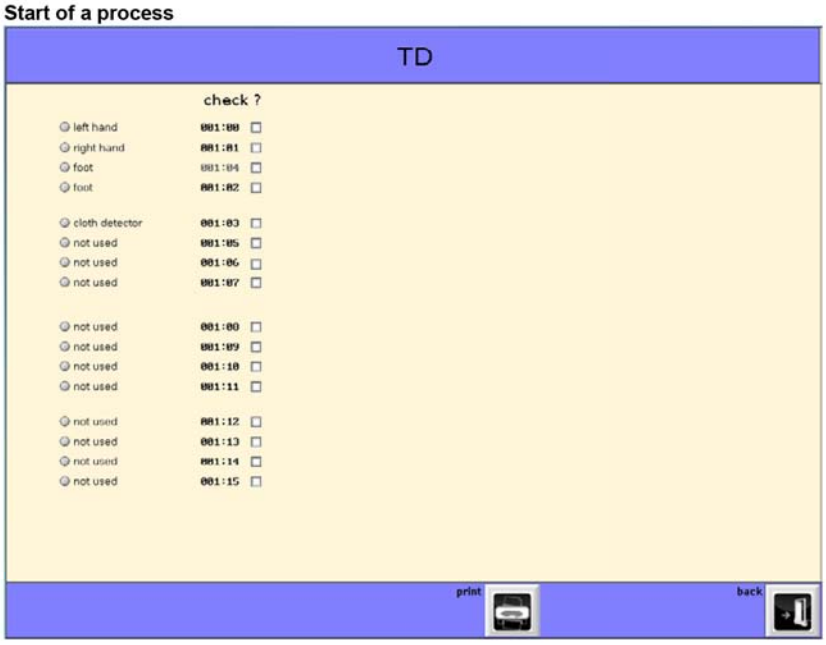


Figure 6-28: Input test

The ***Output*** button shows the binary outputs. 2

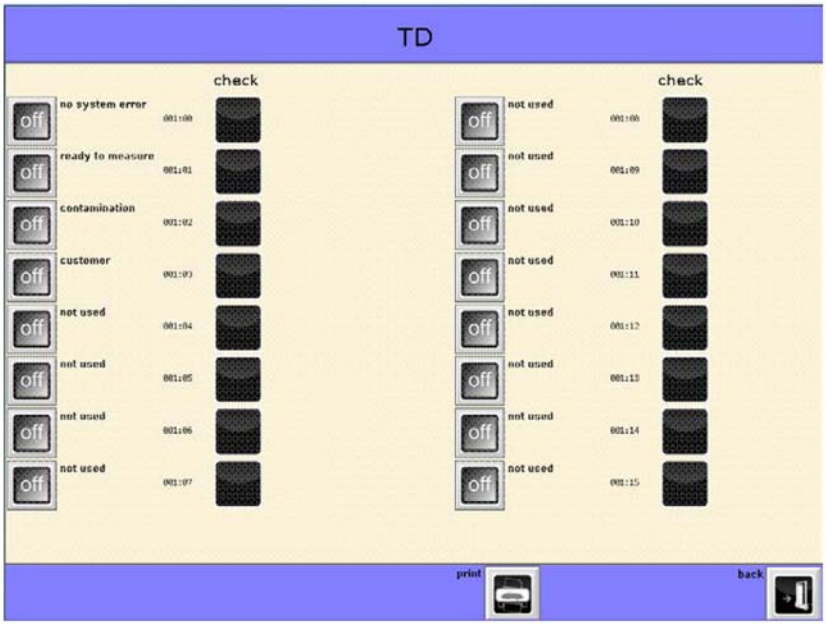


Figure 6-29: Output test

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 ***databases/measurement***.

System check results can be printed as a protocol directly via a printer interface (if available).

The button ***back*** leads back to the main menu.

6.5.3 Total result of the efficiency determination

After all detectors have gone through the measurement process the total result for each channel is displayed separated by the respective kind of radiation and a protocol can be generated (refer also to chapter printing parameter):

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

Protocol Date/time Page 1/x

Protocol-data

Current protocol No: 9 Reference No: 0

date: Mon 10.07.06 15:30:22

calibration name: Beta ALL
calibrated by TD0001
Remark :

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

BETA

EXAMPLE
(excerpt of data)

No Bkgrd gross net nuclide source-ID activity time efficiency

.....data.....

INPUT OUTPUT TEST
No/Type status function

EXAMPLE
(excerpt of data)

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

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

Figure 6-30: Protocol example

6.6 Maintenance

The system interface has different graphical and entry elements for the communication with the user. A detailed description of the operation is given in chapter Computer system QNX.
The service mode is opened and carried out by using the **service** button (see also the following chapter).

CAUTION

To shutdown the **HandFoot-Fibre™** it is absolutely necessary to follow the shutdown process given in Register 3 to prevent the **HandFoot-Fibre™** from any damages.

maintenance mode

efficiency mode

Figure 6-31: Service button

All maintenance functions will be described in the following chapter.
A partial repetition of the description from other chapters has been done intentionally.
The following picture shows the maintenance main menu from which service functions, the monitor's parameter settings and the database are accessible.

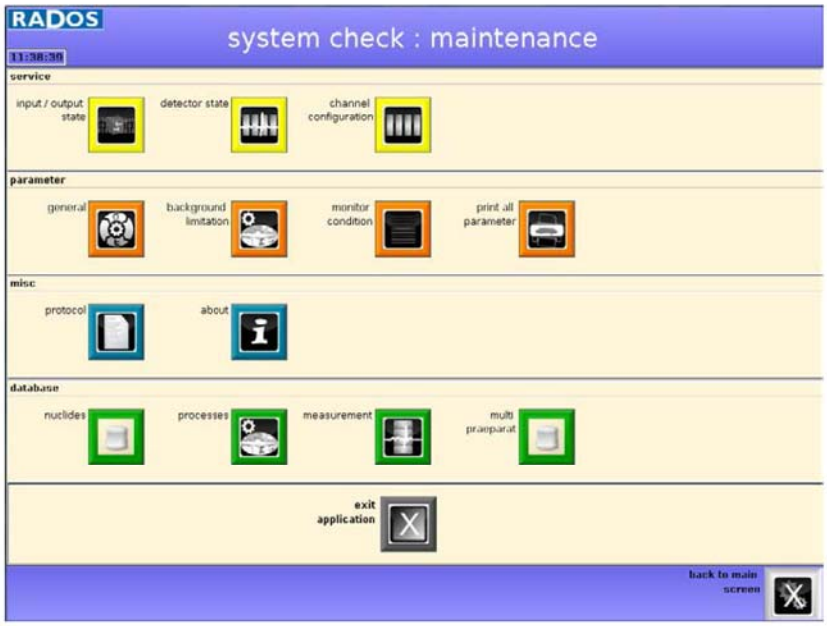


Figure 6-32: System check–maintenance

The maintenance menu is splitted in the sections

- service
- parameter
- database
- misc

The button **exit application** is used to leave the **system check** program. To return to the measurement mode press button **back to measurement mode**

6.6.1 Service menu area

Figure 6-33: System check–maintenance-service

6.6.1.1 Binary inputs and outputs

The sub menu ***input/output 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.

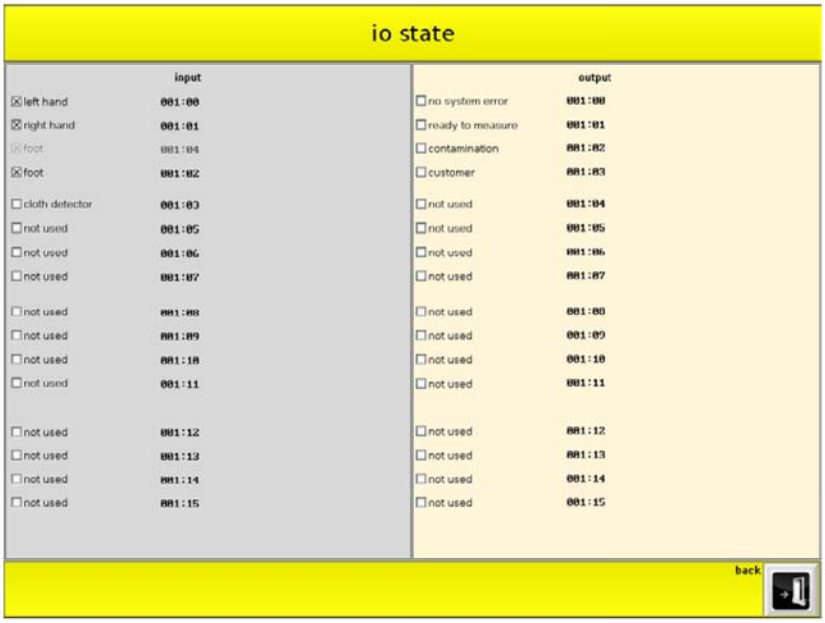


Figure 6-34: System check–maintenance-I/O state

6.6.1.2 Detector state

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

The menu point is divided in 4 areas:

❶ Detector type and -details

❷ FILCO Board – Information

❸ Channel data

❹ Mean value calculation

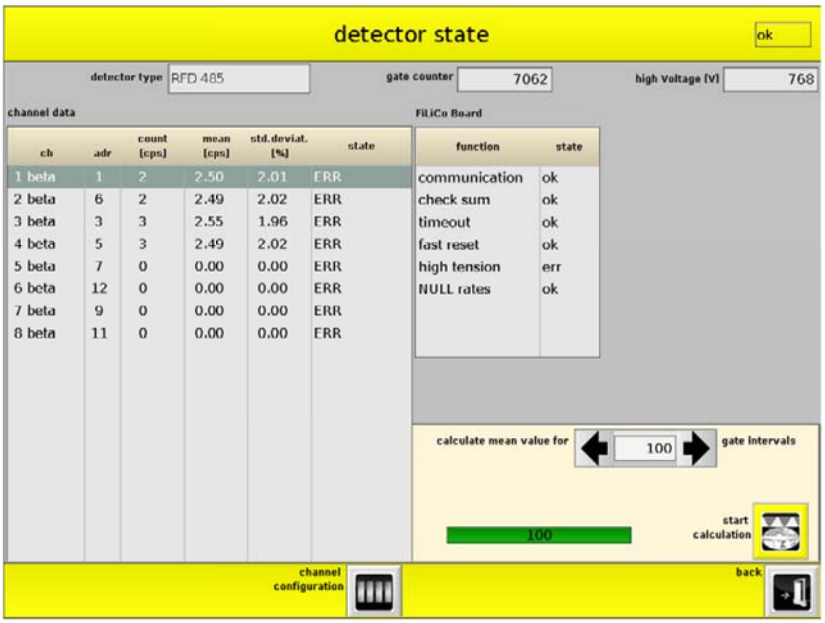


Figure 6-35: Detector status

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

❶ Detector type and details

The displayed information is structurally stored in the measurement electronic and is displayed for user informational purposes only.

❷ Light box communication

The displayed information is structurally stored in the light box and is displayed for user informational purposes only.

❸ Channel data (in measurement electronic)

ch. ❶ the number of channel within the monitor
adr ❷ address of channel (firmly preset)
count ❸ current net count rates per gate time [cps]
mean. ❹ calculated mean value of the last 100 values count rates [cps]
Stdabw. ❺ calculated deviation of the last 100 values count rates [%]
State ❻ actual channel state from following possible states:

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

❹ Calculation of mean value

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

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

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

Formula 6-6: Standard deviation

6.6.1.3 Channel configuration

The **channel configuration** button is used to display the firmly set channel configuration for informational purposes.

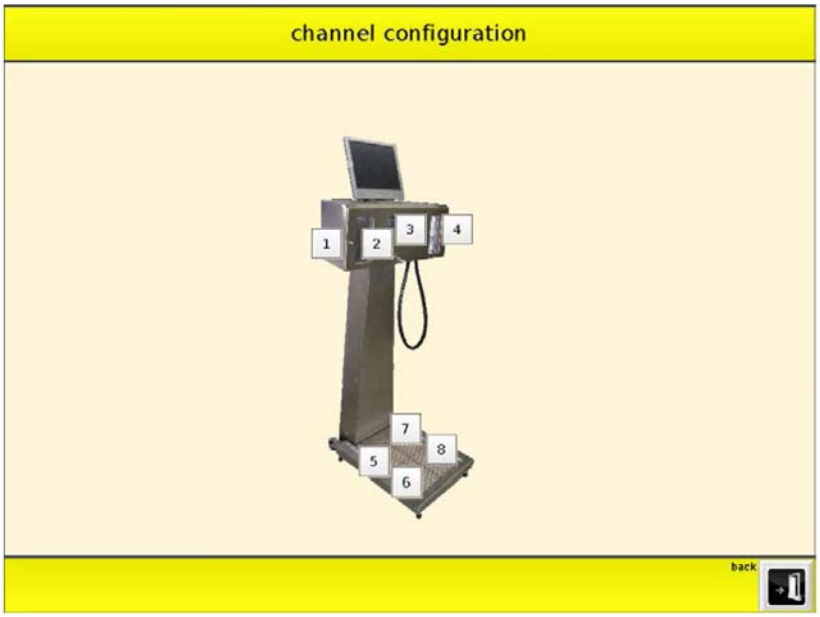


Figure 6-36: Channel configuration view (figure similar)

6.6.2 Parameter menu area

Figure 6-37: System check–maintenance-parameter

6.6.2.1 Global

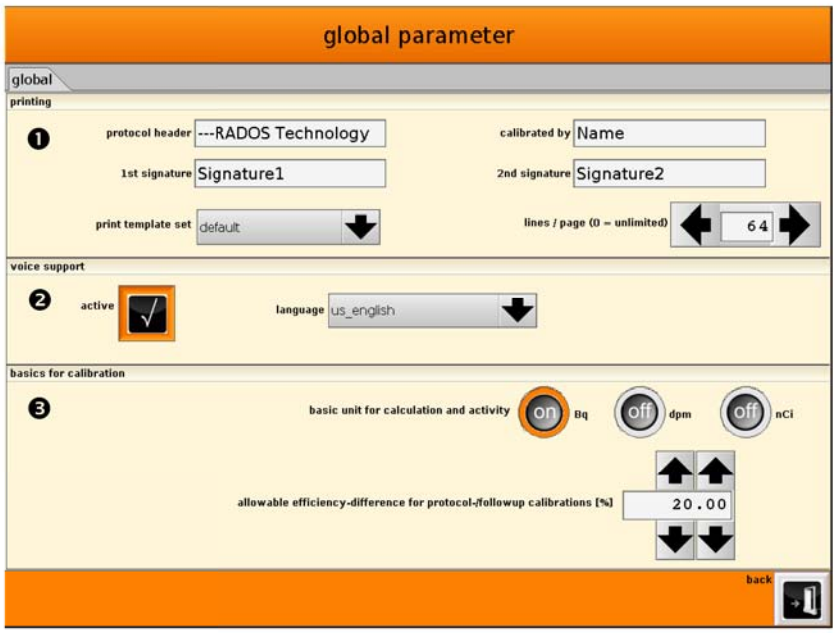


Figure 6-38: Parameter global

❶ Printing parameter

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

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

❷ Voice support

The parameter defines either if the voice support for efficiency measurement is in use and which language should be used.

❸ Basic calibration parameter

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

6.6.2.2 Background limits

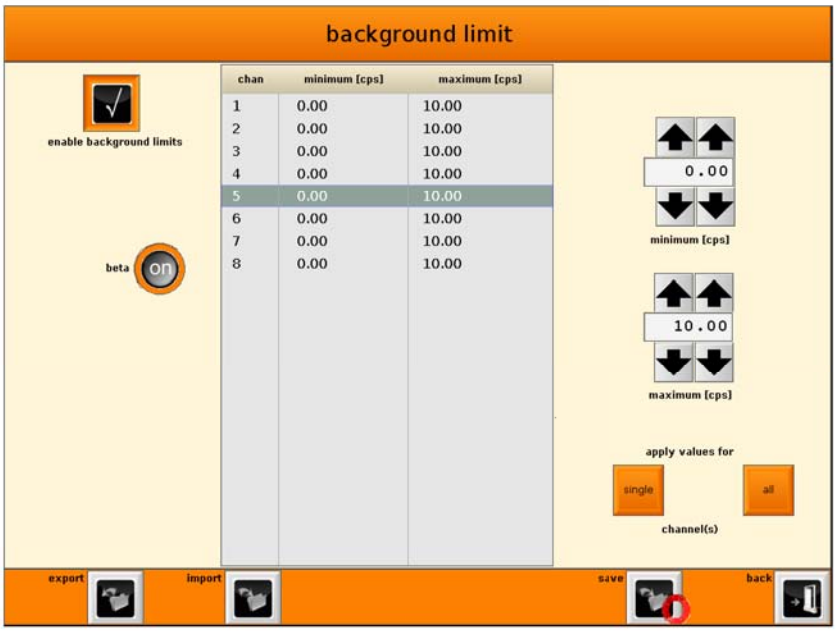


Figure 6-39: Parameter background

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.

6.6.2.3 Tab monitor condition

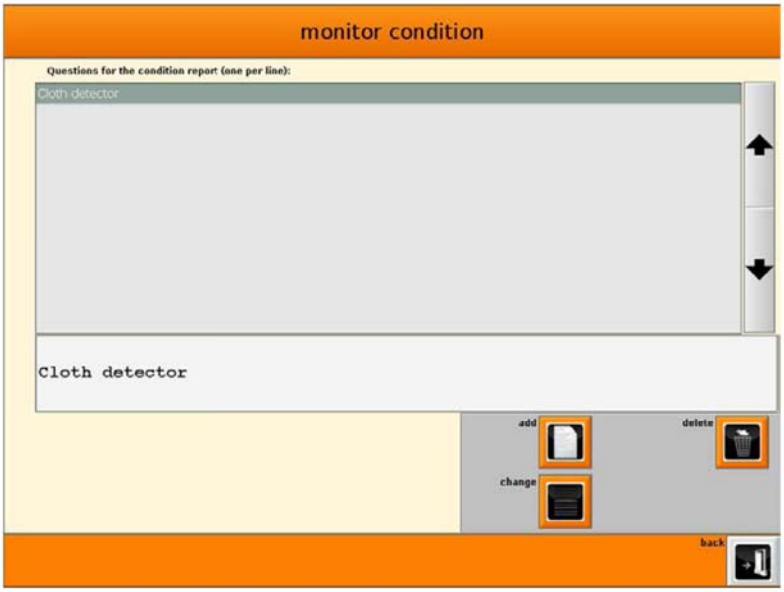


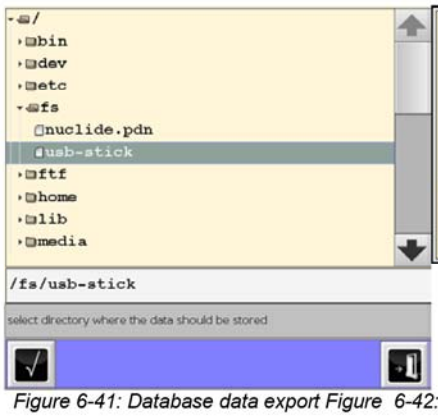
Figure 6-40: Parameter monitor condition

Specific questions about the monitor can be provided for use in work processes in this menu. The monitor condition report must therefore be activated in the working process definition.
The questions are completely user defined and will come up at the end of the system check- process where they are to be answered. Questions and answers are then transferred to the protocol.

6.6.2.4 Parameter set administration

All parameters adjusted for the individual RTM can be saved (export) to an USB-stick or the local hard disk to be filed or to be stored in the RTM again (import) using the maintenance menu items ***parameter/import*** or ***export***.

To **export**, select  in the main menu:



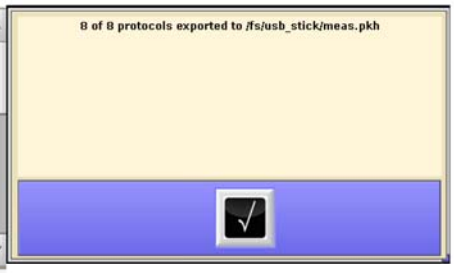


Figure 6-41: Database data export *Figure 6-42: Database export message*

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

All data will be stored on a USB-stick or the local hard disk. Measurements are called *.pdh, sources are *.pdn and for the processes the extension is *.wkp.

To **import**, select  in the main menu:

Figure 6-43: Import-file selector *Figure 6-44: 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 if the data to be saved should be renamed.

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

6.6.3 Database menu area

Figure 6-45: System check–maintenance-databases

6.6.3.1 Nuclide database

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

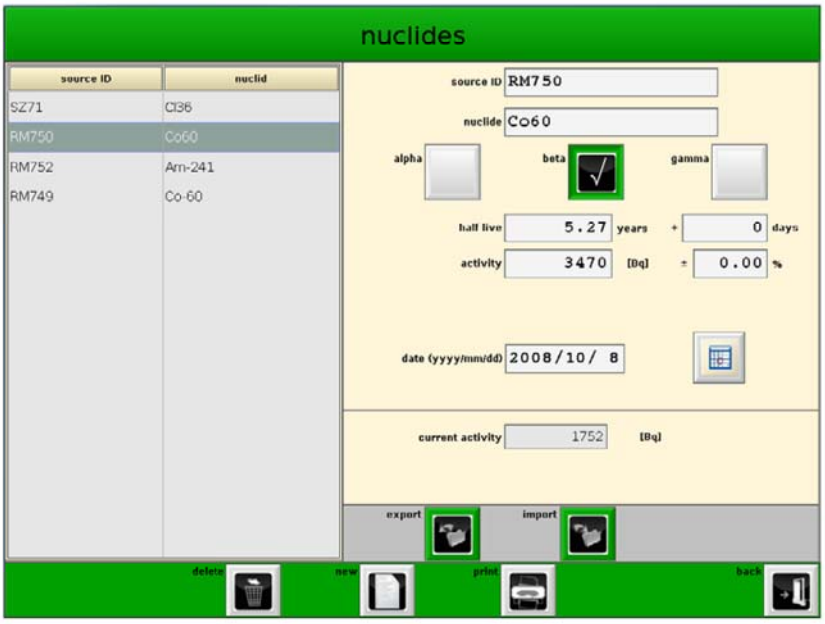


Figure 6-46: Nuclide maintenance

On the left-hand side of the display window all available nuclides are listed, while the data of the selected nuclide is seen on the right hand side.

6.6.3.2 Nuclide data

Parameters connected to a test source are administrated as:

- source ID:
  User defined name administration purposes
- nuclide:
  nuclide name
- nuclide type:
  alpha, beta, gamma or neutron radiation
- Dose power:
  The input of the exposure rate constant for one calibrated nuclide is only needed, if the exposure rate shall be calculated. Please consult the physical literature for the value of the constant (e.g. ^{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 in decimal units, i.e. 0.5 refers to half a year.
- activity:
  The activity of a nuclide on the date of the calibration certificate in Becquerel [Bq], as well as its deviance in percentage rate.
- date:
  The 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.

6.6.3.3 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.

6.6.3.4 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 via sub menu ***database/ processes.***

This menu is for process definition. The global registry card includes the name of the process and user group. For efficiency determination various parameters are involved. Also, the binary in- and outputs and the monitor condition can be checked within the system check.

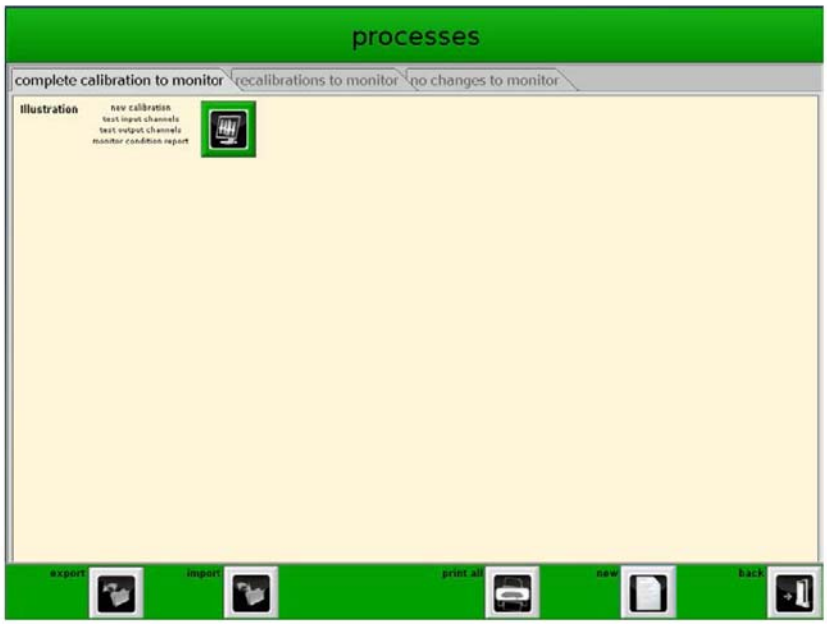


Figure 6-47: Overview processes

At the main menu an overview of all processes will be displayed. 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.

Dependant on the login authorization all or a selection of installed processes appears 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. After selecting a working process the measurement will be done for all selected detectors 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.

From the overview of all processes the detailed description of one process can be displayed selecting the process. The process can be modified after being opened *or* printed with the button ***print*** at the menu panel.

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

Performing 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 the first (oldest) selected protocol, while the follow-up is connected to the latest reference protocol with same name.

Adding a new process:

To add a new process at first an explicit name and the desired user group to perform the test has to be chosen.

The kind of process and the test coverage can be defined on user's request.

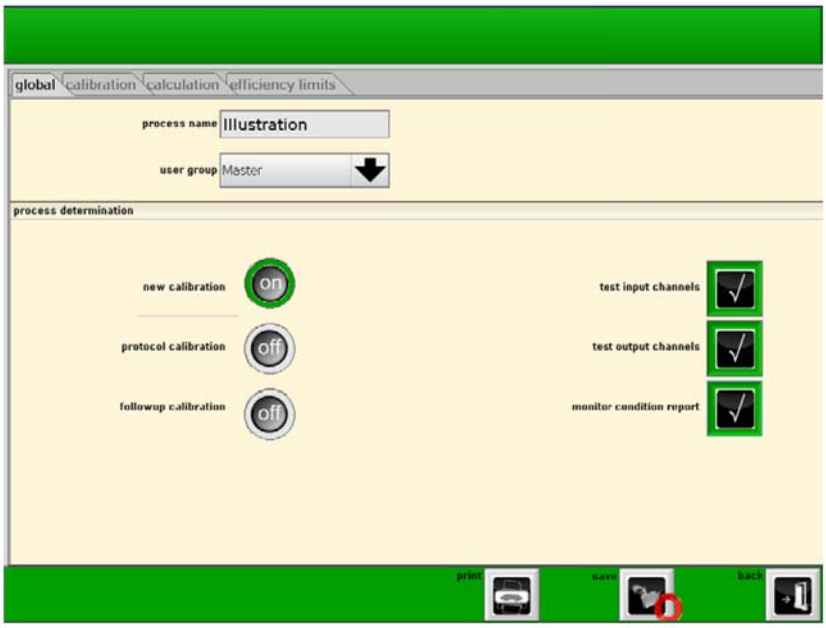


Figure 6-48: Overview processes

On the tab calibration the test source to be used in the working process and the measurement time has to be defined.

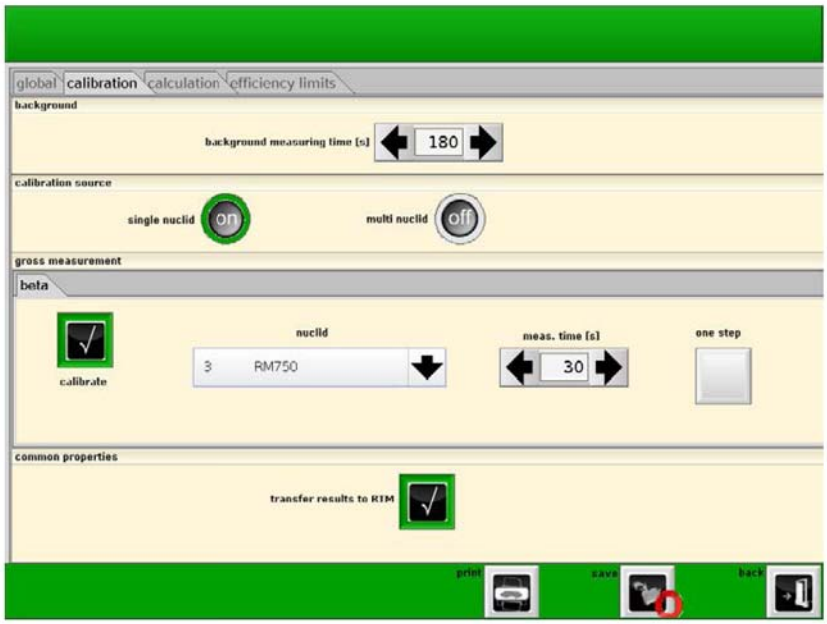


Figure 6-49: Modify a process

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

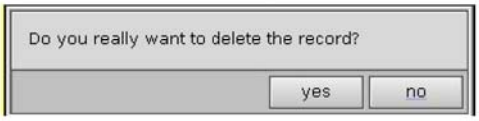


Figure 6-50: Delete a process

On the tab calculation the following parameters can be set:

Unit for calculation

The unit used in the calculation is defined here

Sigma setting for MDA calculation

Measurement time base

The mathematical routines available for use in the calculation routines are set here.

Alarm level definition for alarm level 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.
The measurement times mentioned here are not necessarily the same as they are used for the actual personnel contamination measurement, since the values for the calculation may vary.
The mathematical routines available for use in the calculation routines are set here.

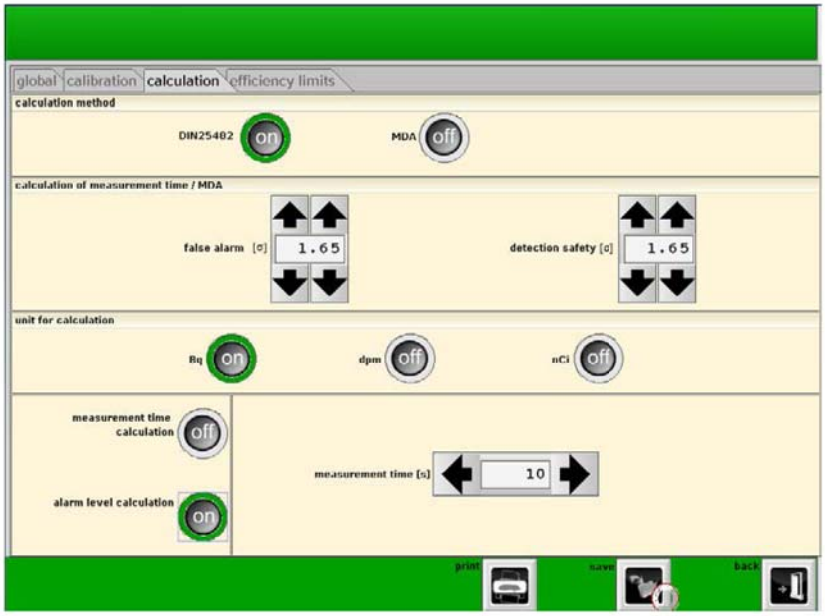


Figure 6-51: Modify a process

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

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

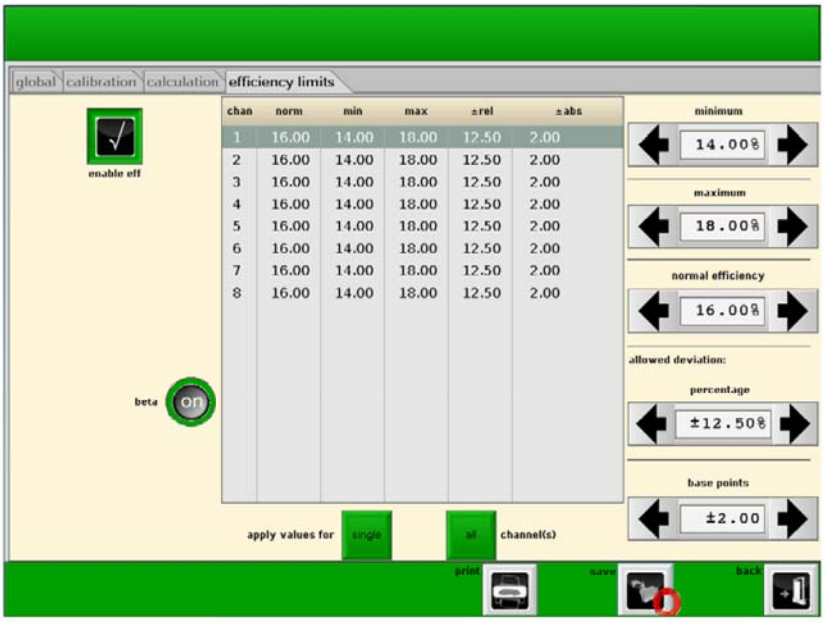


Figure 6-52: Modify a process

6.6.3.5 Measurement results

The measurement database with all calibrations will appear in the sub menu ***databases/measurement.***

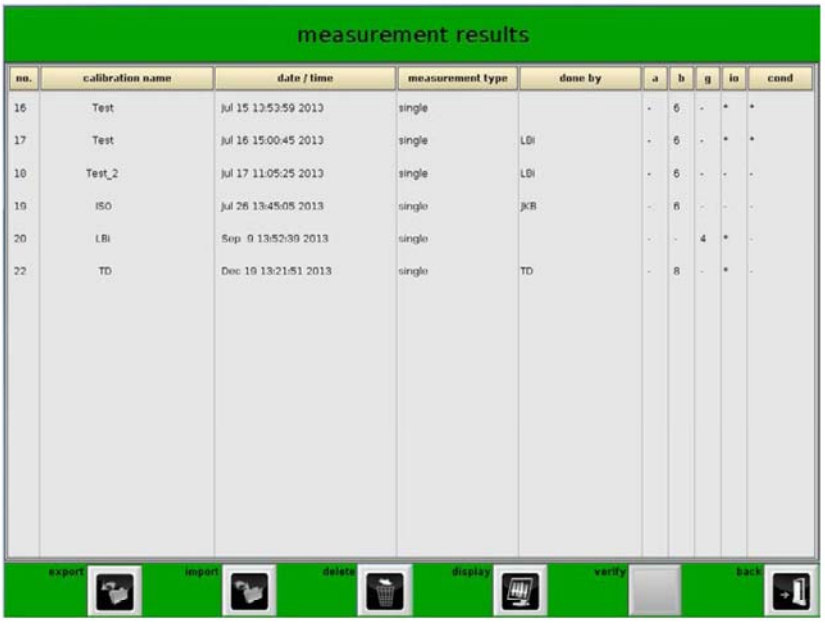


Figure 6-53: Measurement results

Each calibration can be selected from the provided menu and displayed and/or printed in detail.
It is not possible to modify a calibration.

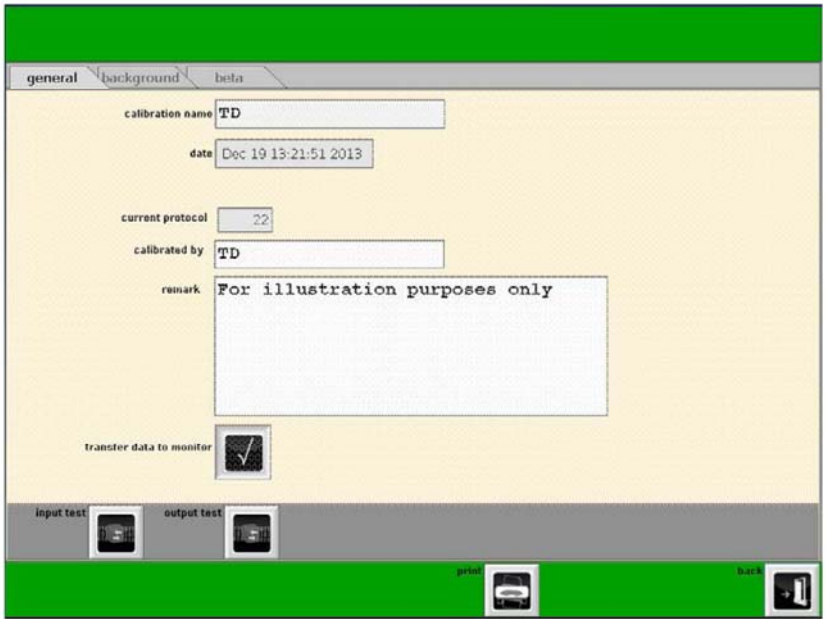


Figure 6-54: Measurement details I

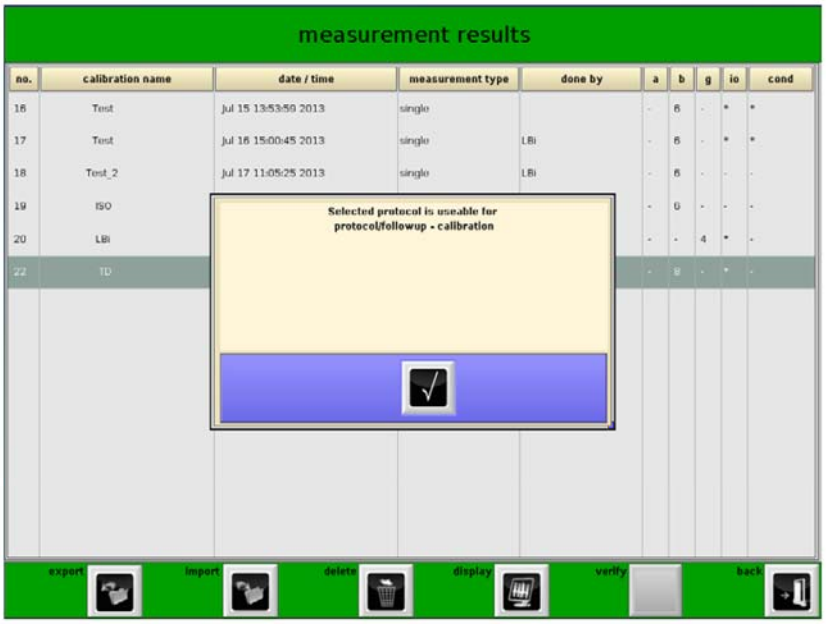


Figure 6-55: Measurement details protocol message

NOTE

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

Inconsistency or error in data will show up and will be added with information for trouble shooting.

6.6.4 Miscellaneous (misc)

Figure 6-56: System check–maintenance-misc

6.6.4.1 Protocol

Refer to register 4 for protocol information

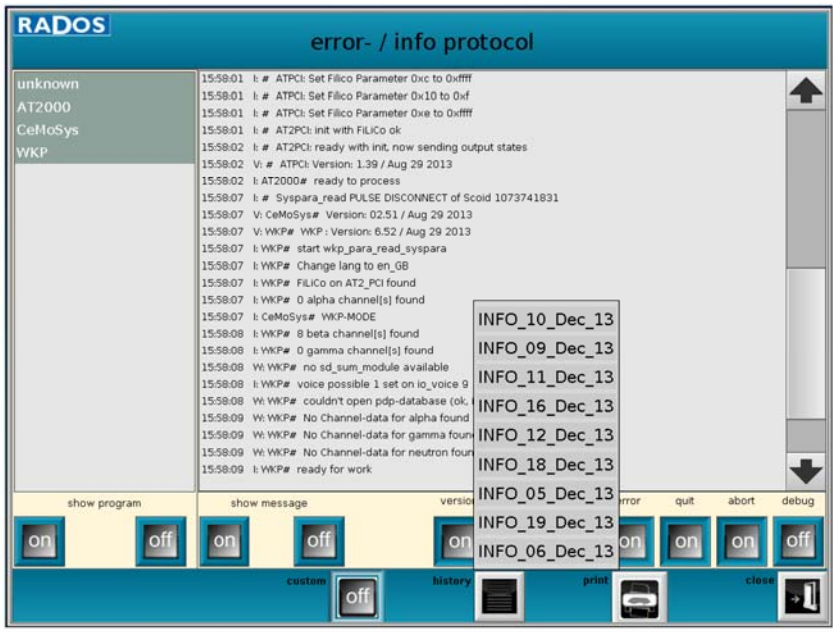


Figure 6-57: Misc; protocol

6.6.4.2 About

The button **"about"** displays the version of the system check-software.

Figure 6-58: About; system check-version

6.7 Exit application

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

Figure 6-59: Close the program

7 Not used

8 Detector

Table of figures

8.1 General

The hand, foot and clothing monitor **HandFoot-Fibre™** was specially designed to work with the RADOS Fibre Detectors (RFD), with only one kind of detector for the whole monitor.

The mounting location of detectors and initiators in the **HandFoot-Fibre™** guarantees that the surface of the person to be measured is optimal covered.

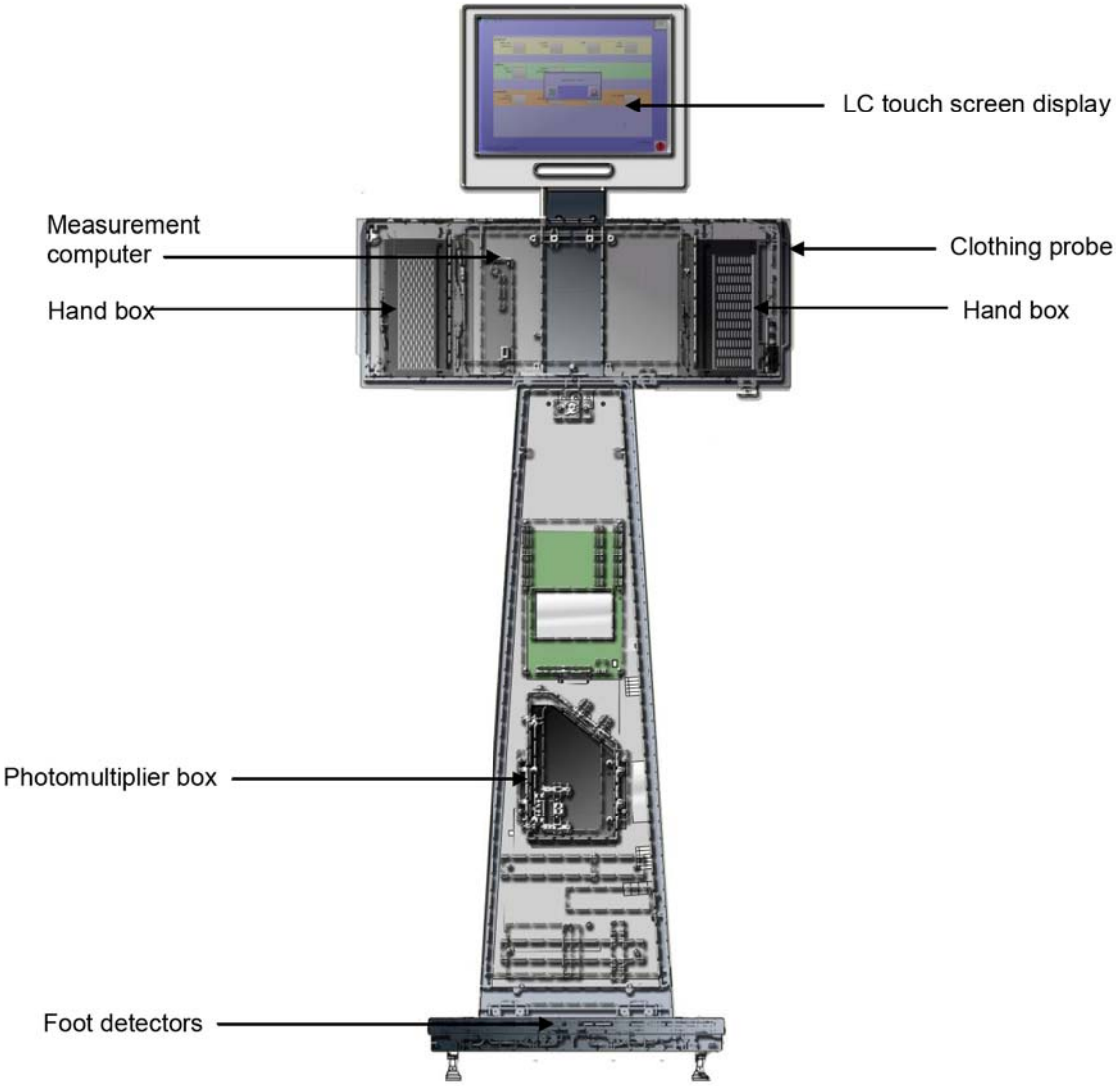


Figure 8-1: HandFoot-Fibre™ component view

8.2 Detector and measurement electronics

For the detection of covered activities and "Hot Spots" the new RADOS Fibre Detectors (RFD) are integrated into the **HandFoot-Fibre™**.

The following attributes are characteristic for the RADOS Fibre Detectors (RFD):

- Almost no dead zones
- Less sensitivity on background radiation
- plug & play properties for the detectors
- nearly maintenance-free and easy to repair

8.2.1 Detector unit

In the following a detector unit will be used to describe the RADOS Fibre detector with the light-tight cover. A detector unit consists of the lower mounting plate, with a mounted beta fibre scintillator, the protective detector cover and multiple layers of special aluminium vaporized foil, called Mylar.

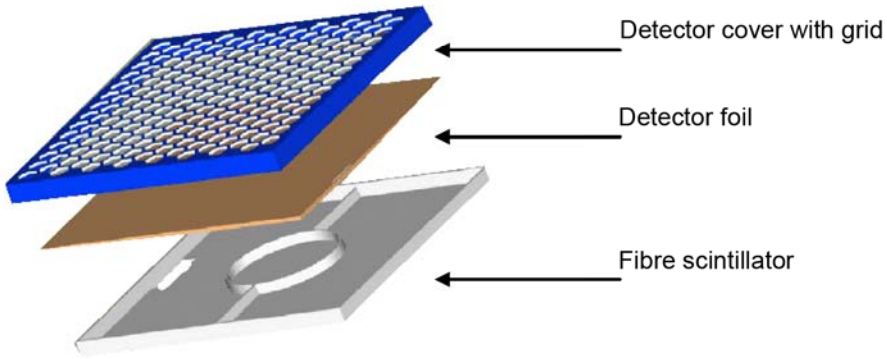


Figure 8-2: Isometric view of a detector unit

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.
The thickness of the scintillator is optimized for getting the best possible response for particles in the relevant energy region.

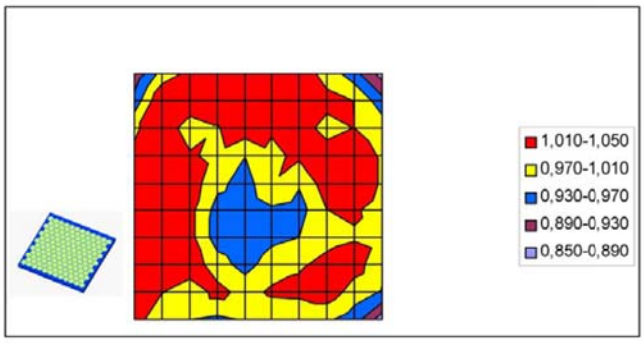


Figure 8-3: Detection distribution example for a RFD485 detector

8.2.2 Measurement electronics

The detectors are connected to a multi channel photomultiplier using coated fibre glass cables. These cables are firmly fixed to the photomultiplier and then connected to the detectors.

The photomultiplier is set into a box, the so-called mini-light box, which is connected to the FiLiCo board. This board combines different functions like analyzing the input and output signals and filtering the measurement signals. The FiLiCo board transmits measurement and sensory signals to the measurement computer which calculates all necessary arithmetic operations needed for a contamination measurement.

Finally the result is shown on the display using the user software.

8.2.3 Fibre line communicator board (FiLiCo)

FiLiCo is the short for the **Fi**bre **Li**ne **Co**mmunicator which is a digital switch board that is based on an embedded micro processor with FPGA technology and is used to control gate times and monitor counting pulses like alpha, beta and gamma. It was especially designed to work with the new RADOS fibre detector technology and sensory.

8.2.4 Mini-light box

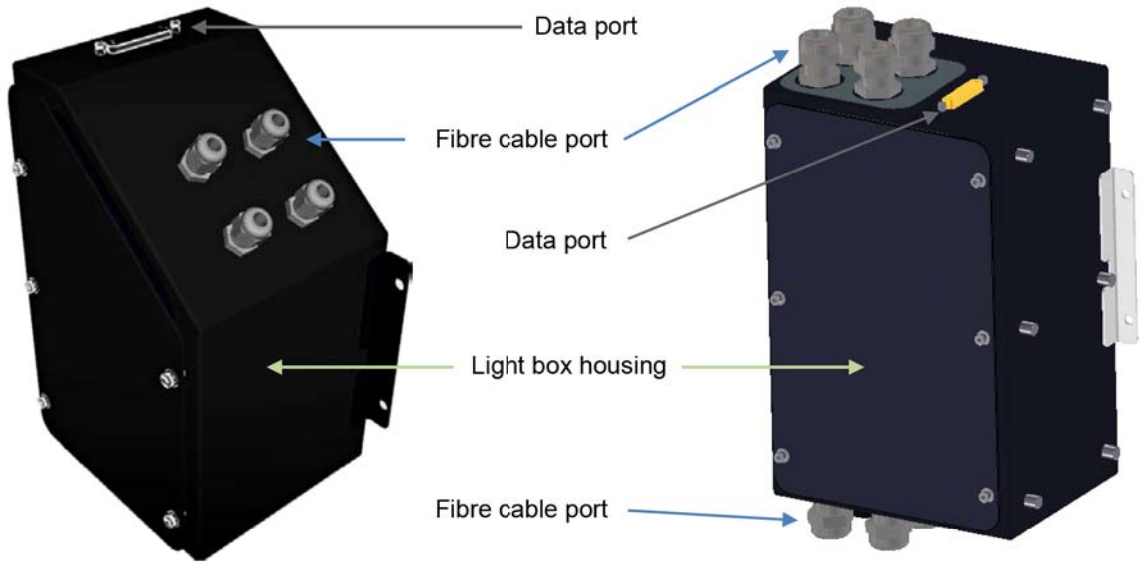


*Figure 8-4: isometric view of the mini-light box with 4-6 channels built in the **HFF***

*Figure 8-5: isometric view of the mini-light box with 8 channels built in the **HFF XL***

The function of the mini-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 mini-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 photomultiplier, which keep the adjustments very stable, to choose the high voltage (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 customer service in any case regarding the exchange of detectors with different efficiencies.

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

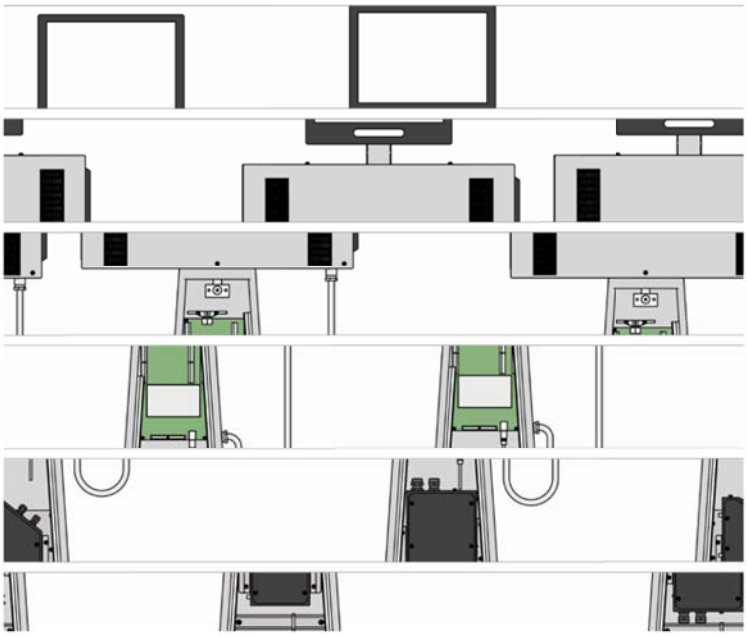


*Figure 8-6: mounting location of the mini-light box (on the left the mini-light box with 4-6 channels mounted in the **HFF** and on the right the mini-light box with 8 channels mounted in the **HFF XL***

8.2.5 Measuring position and sensory

The geometric and mechanical layout of the **HandFoot-Fibre™** represents the optimal user position while the sensory is placed to control the person measuring position.

Sensory location on the HandFoot-Fibre™:

*Figure 8-7: sensory location on the **HandFoot-Fibre™***

The compression sensitive foot contact is used to recognize a person on the HFF monitor (prepared for measurement).

The light barriers located in the hand boxes are used to guarantee that the person to measured places his hands deep enough to be fully covered by the detectors. The correct positioning of the person takes places throughout the measurement process. Leaving this position will lead to a aborted measurement.
The reed contact for the clothing probe monitors the placement in the hand box and initiates the clothing probe measurement if not.

8.2.6 Number and location of built-in detectors and configured measurement channels

*Figure 8-8: channel configuration of the **HFF***

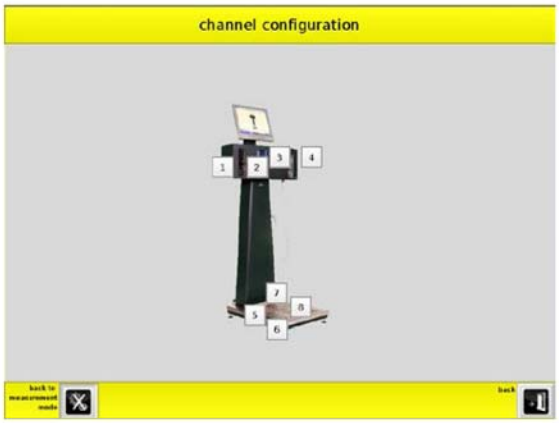


*Figure 8-9: channel configuration of the **HFF XL***

The HandFoot-Fibre™ is equipped with 8 RFD485 in basic configuration.

RFD485	
Dimensions (L x B):	22 x 22 cm
Dimension (cover) (L x B):	~22,8 x 22,8 cm
Measurement surface	485 cm²

Model	No. of detector channels	Position	Remark
HandFoot-Fibre™ HandFoot-Fibre™ XL	1 2	left hand	1 outer left hand 2 inner left hand
HandFoot-Fibre™ HandFoot-Fibre™ XL	3 4	right hand	3 outer right hand 4 inner right hand
HandFoot-Fibre™ HandFoot-Fibre™ XL	4	clothing probe	
HandFoot-Fibre™	5	left foot	
HandFoot-Fibre™	6	right foot	
HandFoot-Fibre™ XL	5 6	left foot	
HandFoot-Fibre™ XL	7 8	right foot	

8.3 Detector repair information

NOTE

There is no need to address the detector in the **HandFoot-Fibre™** environment, because only one detector type is used on the **HandFoot-Fibre™** 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 photomultiplier box.

WARNING

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.

8.3.1 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”.

8.3.2 Detector mounting / dismounting

CAUTION

The power must be switched off, before any detector is removed from the **HandFoot-Fibre™**. Refer to Register 3 concerning the shut down process of the **HandFoot-Fibre™**. 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 dismounting and mounting of detectors in various locations is described.

8.3.3 Hand detectors

Dismounting detectors:

1. Turn off **HandFoot-Fibre™** and unplug mains connection.
2. Remove and retain screws in hand box front cover.
3. Remove and retain hand box front cover.
4. Unplug light fibre cable from detector alignment.
5. Remove detector from detector attachment in front direction (arrow in figure).

Figure 8-10: hand detector located in the device top

Mounting detectors:

1. Follow dismounting tasks in reverse direction to mount detectors.

8.3.4 Clothing probe

Dismounting detector:

1. Turn off **HandFoot-Fibre™** and unplug mains connection.
2. Remove and retain screws (1) in clothing probe handle.
3. Remove and retain clothing probe cover (2).
4. Unplug light fibre cable from detector alignment.
5. Remove and retain studs on clothing probe detector attachment plate.
6. Remove and retain detector attachment plate (3).

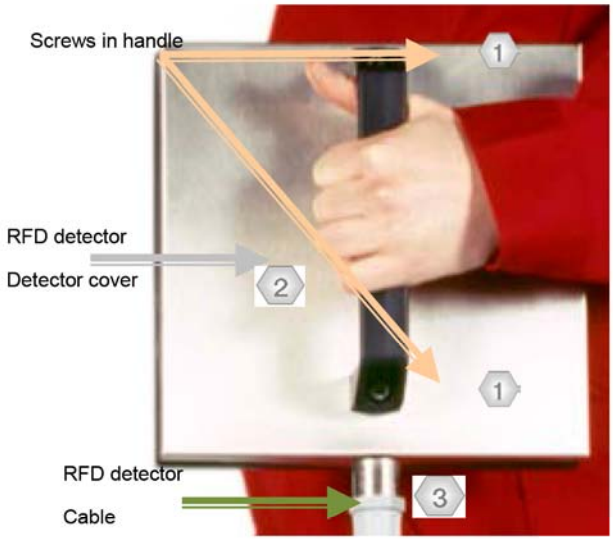


Figure 8-11: clothing probe detector

Mounting detector:

1. Follow dismounting tasks in reverse direction to mount detector.

8.3.5 Foot detectors

Dismounting:

1. Turn off **HandFoot-Fibre™** and unplug mains connection.
2. Push both securing studs (left and right) on electronic pillar of the **HandFoot-Fibre™**.
3. Move foot detector cover in front direction (see arrow in figure).
4. Remove and retain foot detector cover.
5. Lift detector upwards from detector attachment (see arrow 3 in figure).
6. Unplug light fibre cable from detector alignment

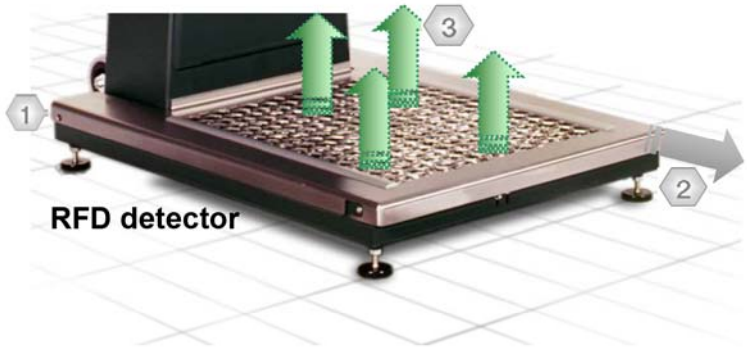


Figure 8-12: foot detector

Mounting detector:

1. Follow dismounting tasks in reverse direction to mount detector.

8.4 Calibration

All detectors of the **HandFoot-Fibre™** monitor will be calibrated with the user software module “System check” (refer to register 6 of this technical handbook).

The “System check” software module will be called up from the start-up menu.

CAUTION

A detector calibration on a yearly basis seems sufficient, if a functional test is performed in a three month interval.
Therefore, it is advised to perform a detector alarm test on a three month basis and a system check on a yearly basis.

9 Trouble shooting and repair

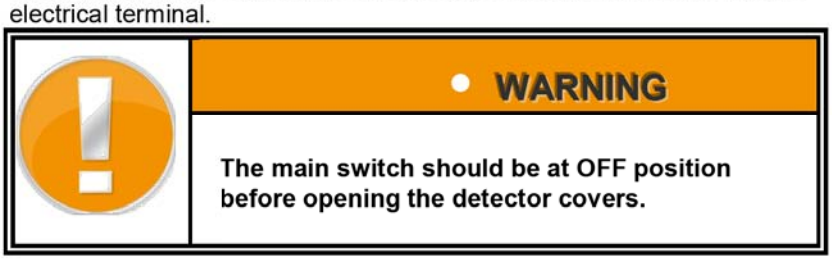
Table of figures

9.1 Repair

9.1.1 Safety precautions

When carrying out service work at the personnel monitor, the mains supply switch must always be switched off or, where applicable, the mains plug should be removed.

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



9.1.2 General safety regulations

In any case, accident prevention regulations have to be obeyed during maintenance and repair work.

In addition, the following is to be taken into account:

- Working on electric systems is only to be done by adequately trained persons.
- Before working on electric systems, those parts, which undergo work, are to be switched off.
- This applies even if the repair seems to be trivial and the de-energization affects significant parts of the electric system.

9.1.3 Safety precautions

- Switch OFF automatic circuit breakers.
- Mark individual parts before disassembling.
- For all work use proper tools, which are in perfect condition.
- Replace gaskets and seals before reassembly.
- Pay special attention to perfect restoration of 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.

9.1.3.1 Cables

- In case of disconnecting cables, these must be protected against breaking. The cable ends have to be prevented by wrapping with insulating tape and PVC-foil.

9.1.3.2 Fuses

- It is forbidden to mend or bridge fuses and to use mended fuses.
- In case of replacing fuses only those of equal or smaller nominal current and characteristic (slow-acting, quick-acting, super-quick-acting) must be used.

9.1.3.3 Plugs and sockets

- Movable electrical equipment must only be connected and operated via the provided plugs and sockets.
- Use of adapters and plugs, which fit into sockets of different voltage, is forbidden.
- Plugs and sockets must not be pulled while energized.
- When replacing plugs and sockets, care needs to be taken of connecting in proper phase.

9.1.3.4 Cable accessories

- Cable clamps must be secured against shaking off by means of retainer washers and spring washers.
- When reconnecting cable connections to devices and systems, care needs to be taken of the cable-shields grounding (by means of grounding cone) and the cable inlet's tightness (according to the protective system of the respective device).

9.2 Guideline for troubleshooting

9.2.1 Troubleshooting general

Following good practices will be recommended by Mirion Technologies (RADOS) GmbH:

- Document solution
- Prepare for failures
  - Keep spares
  - Keep technical handbook
  - Keep software
  - Keep configuration info
  - Back up data!

9.2.2 Troubleshooting process

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

9.2.3 Trouble shooting

9.2.3.1 Distinction criteria

There are following classes of faults:

a) Detector faults:
   - minimum level
   - maximum level

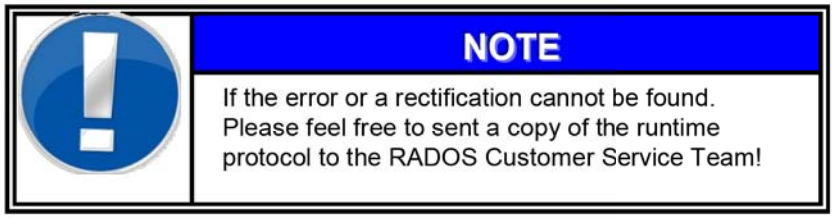
b) Sensor faults:
   - sensor does not trip
   - sensor is constantly tripped
   - sensor is insensitive
   - sensor is unstable

c) Electronic faults:
   - system faults
   - various fault messages

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

Trouble shooting on the **HandFoot-Fibre™** is supported by comprehensive help functions in the service menu.

Fault messages, their possible causes and their correction are described in the following section.



9.2.3.2 Trouble shooting examples

Measurement computer

Possible fault	Possible causes
Does the PC boot and start the user program?	- hard drive broken - bios settings lost - CPU battery down - no connection to main - Fuse broken - Hardware settings were cancelled - parameter settings - system check was not carried out right

Sensory

Possible fault	Possible causes
Is there dirt on the sensor?	- Check the physical adjustment by sensor and I/O- menu. - pay attention for inverse sensors like nobody contact
Does the reflector exist or is there dirt	- check the cabling
LEDs: at the modules are blinking for BIN In, BIN out and A1	- check mains - check status of I/O‘s in the I/O menu or see runtime protocol

9.3 Detector fault messages and rectification

As an evidence for a contaminated or defective detector the increase or decrease of the minimum or maximum threshold of only one detector is to be adopted.

Rectification flowchart:

Message /fault	Chapter
In- or decrease of the minimum or maximum threshold of only one detector. 	**9.4.1 Software fault messages and rectification**
Change to **maintenance mode** and select **measurement status** menu. Press button **Alarm accept** for confirmation. 	**4.4.2 Measurement status**
The contamination monitor switches the **measurement mode** to conditionally ready to measure	**4.4.2 Measurement status**
Replace faulty detector 	**8.4.2.Detector mounting / dismounting**
Change to **maintenance mode** and select **measurement status** menu. Press button **start** to initiate a background measurment update. 	**4.4.2 Measurement status**
The contamination monitor switches the **measurement mode** to ready to measure	**4.4.2 Measurement status**
Re-calibrate the changed detector using the **System check** software.	**6.6.2 Detector efficiency calculation**

Figure 9-1: Detector- Rectification flowchart

9.4 Software fault messages and rectification

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

Figure 9-2: Failure - not ready to measure

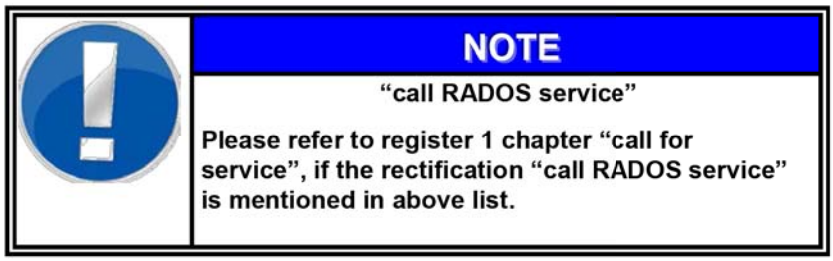
Below any possible messages, causes for troubles and faults, are described.

9.4.1.1 Failure messages

The Software procedures and failure messages are guided by the ABLA routine (ABLA is a short in German [**ABLA**uf-Steuerung] what means sequential control) which will display following messages if a failure occurs.

ABLA MESSAGE	ORIGIN	RECTIFFICATION
lost communication on HW	no communication with FiLiCo board (send receive data)	(1) restart the monitor (2) check detector status (3) check cabling (4) call RADOS service
error on process control	ABLA application was not initiated correctly	(1) restart the monitor (2) call RADOS service
min alarm	minimum rates on gamma channel are to low	(1) turn to service menu - measurement status - look at MIN level of channels - change detector settings (2) detector defective (3) change detector (4) call RADOS service
max alarm	background- pulse rate above maximum limit contamination of monitor	(1) more exact evaluation in service menu "detector-status" (2) check MAX-level of detectors (3) change detector settings (4) source in direct detector contact during background measurement (5) remove source (6) decontaminate detector (7) detector defective (8) change detector (9) call RADOS service
process control not active	internal fault of ABLA application, data could not be retrieved	(1) restart the monitor (2) call RADOS service
mathematics not active	measurement data could not be retrieved during start of monitor	(1) restart the monitor (2) call RADOS service
i/o not active	no data received from ABLA at start	(1) restart the monitor (2) call RADOS service

ABLA MESSAGE	ORIGIN	RECTIFFICATION
error on detector	detector data (rates) are out of range detector defective	(1) more exact evaluation in service menu "detector-status" (2) change detector settings (3) detector defective (4) change detector call RADOS service
error on parameter setting	measurement data could not calculated	(1) more exact evaluation in service menu "parameter" (2) - change monitor parameter to default parameter
error on light barrier	light barrier contacts are blocked or just one barrier is actuated several times	(1) remove blocking and actuate light barrier by hand (simulate measurement) (2) switch to **maintenance** mode and return to **measurement** mode to reinitialize I/O-module



9.5 Adjustment of the monitor sensors

In this chapter you will find the adjustment of the monitor sensors described and explained in detail.

9.5.1 Error messages

The HandFoot™-Fibre has three sensors, to ensure, the person, to be measured, is positioned correctly. Also there is an additional reed contact for the hand frisker, so the monitor knows, if the hand frisker is used or in its holder. The hand box sensors can produce a malfunctioning of the monitor, if they are interrupted by dirt, dispositioned or part of it is missing, for example – a reflector or the magnet of the reed contact. Another reason can be that the sensors aren't adjusted properly and, therefore, the light barriers are interrupted. The compression sensitive feet contact can produce a malfunctioning, if the foot grid is stuck.

Figure 9-3: HandFoot™-Fibre

If the light barriers are in the wrong position or reflectors are missing, the monitor wants to start a measurement. For the monitor the state is that a hand is inserted or the feet are positioned and, therefore, it's waiting for the activation of the other sensors, so it can start a measurement.

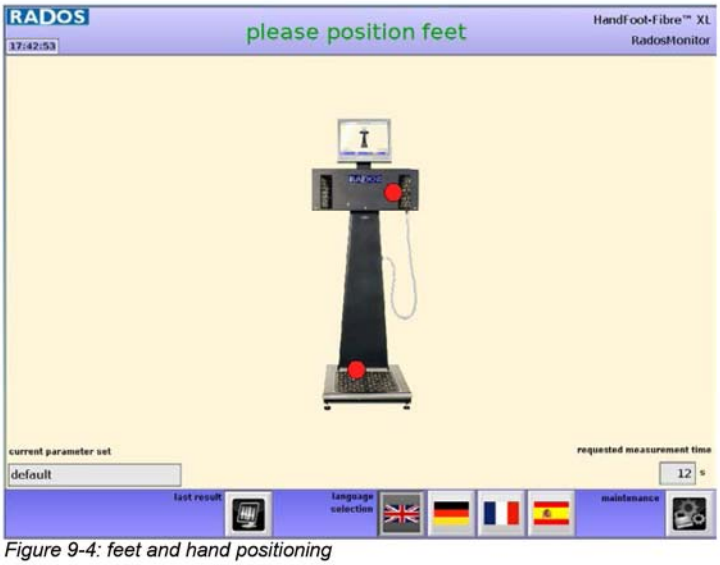


Figure 9-4: feet and hand positioning

The monitor turns into the "not ready to measure" mode, once the background is not valid anymore (valid time). The monitor can't start a new background measurement, because of the activated sensor(s).

Figure 9-5: error message: insert cloth detector

If the magnet or reed contact is missing, a hand-foot measurement can't take place. The monitor stays in the frisking probe measurement state, as long as the monitor has a valid background. If a sensor is activated, the monitor doesn't measure the background continuously and the actual background is exceeded after a certain time.

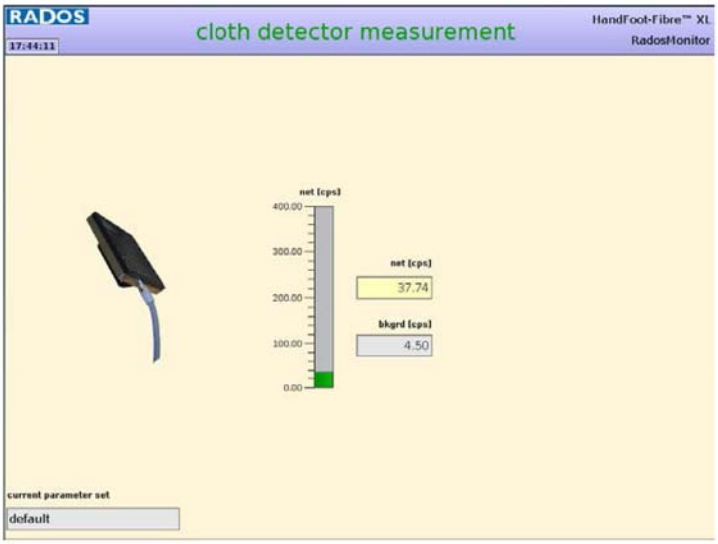


Figure 9-6: cloth detector measurement

Therefore the monitor doesn't have a valid background anymore and is not ready to measure. Also the monitor can't start a new background measurement since a sensor is activated and, therefore, the monitor will stay in the state "not ready to measure".

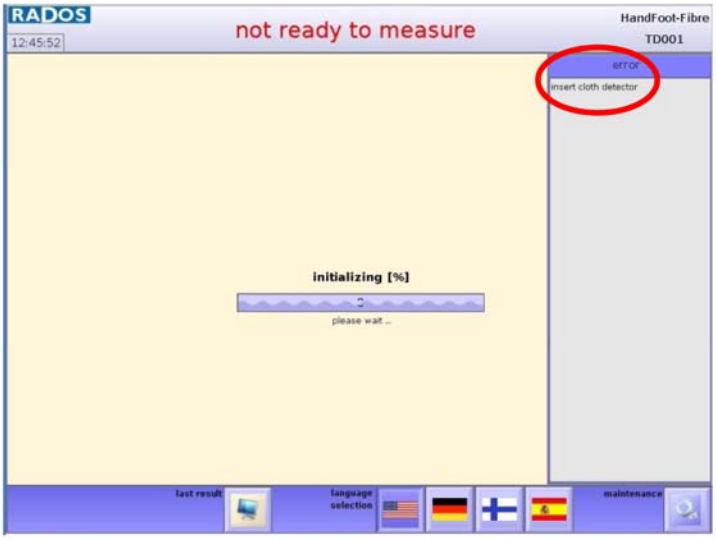


Figure 9-7: error message: insert cloth detector

An error message, for example “insert cloth detector”, will be displayed, if magnet switch is missing, the frisking probe is not in the correct position or another sensor is dispositioned, while the monitor tries to measure the background.

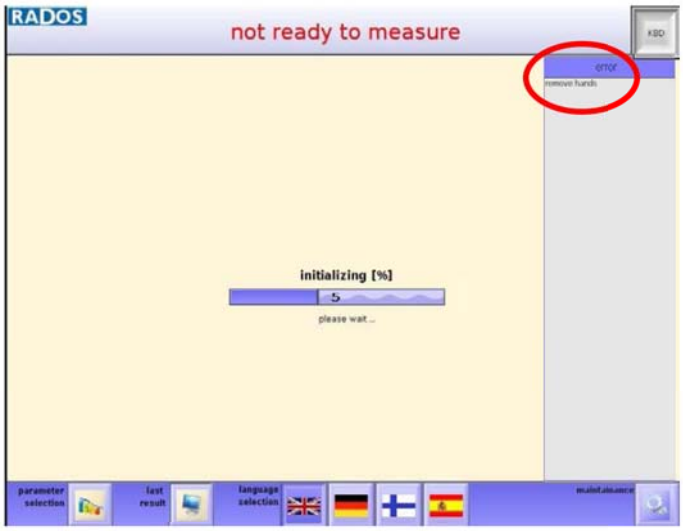


Figure 9-8: error message: remove hands

9.5.2 Troubleshooting

Enter the maintenance menu and then the I/O state.

The green dot on the left side shows, which sensor is initiated (left hand light barrier, right hand light barrier, reed contact or compression sensitive feet contact).

Stay in the I/O state menu for adjusting the sensors. As soon as the green dot turns white, the sensor is adjusted properly. But the frisking probe dot should be green. It indicates that the contact between reed contact and magnet exists.

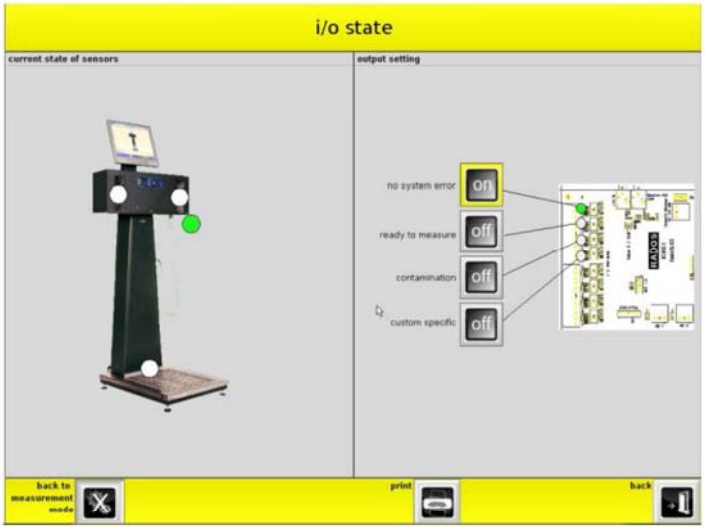


Figure 9-9: menu for input and output state

9.5.2.1 Light barriers

Check in the I/O menu, whether the green dot has disappeared. If the green dot has changed to white, the light barrier works properly and the reflector is in the right position.

After returning to the measurement mode the monitor starts to measure the background or changes to the ready to measure state.

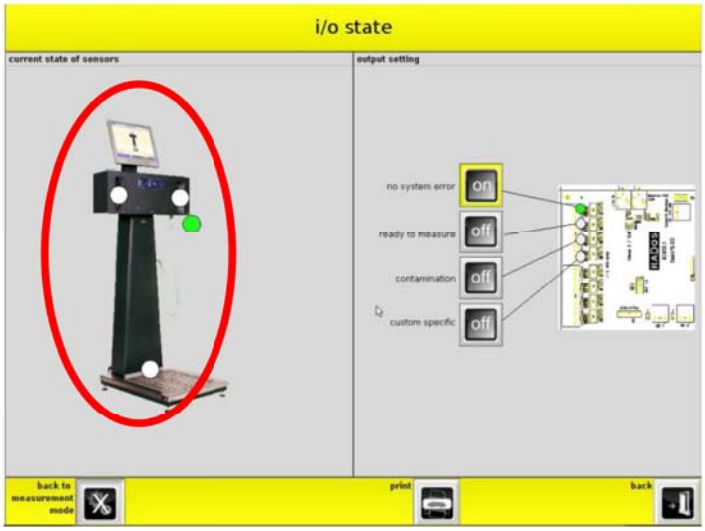


Figure 9-10: menu for input and output state

Is there still a green dot, continue by opening the top of the HFF: loose the 5 screws and put them in a place, where you can find them again. Be careful, by removing the top, because the grounding cable has to be detached first. The top can be removed, by lifting it slightly and, then pulling it into your direction. Please, be careful so the casing doesn't get scratched. Put it in a safe place so nobody can fall over it.

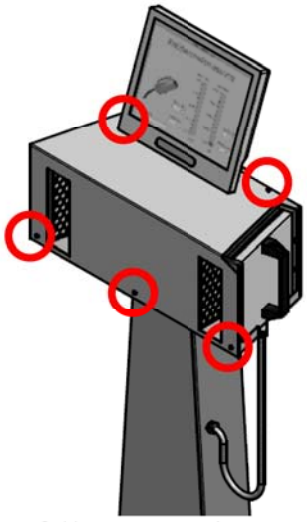


Figure 9-11: screw removal

Adjust the light barrier, shown in the I/O state. Loose the screws a little bit, so the light barrier can be moved in the right position. Once the light barrier is back in the right position, the green dot in the I/O menu turns white. But only, if the reflector is also in the right position and not missing.

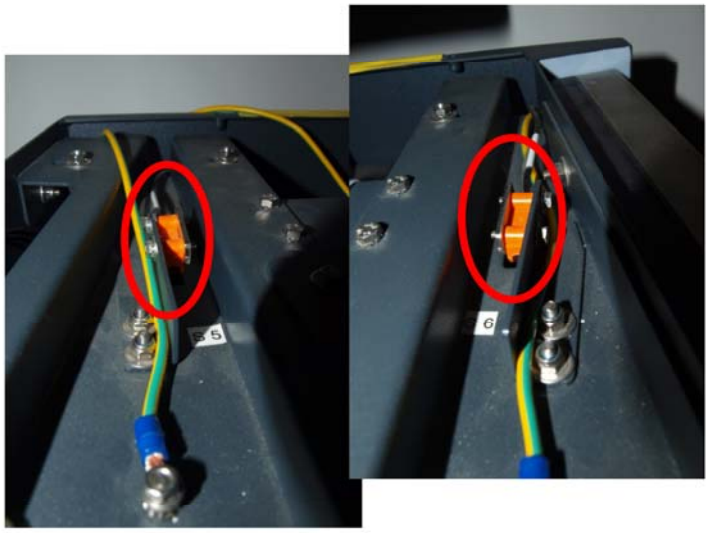


Figure 9-12: Adjusting the light barrier

Check in the I/O menu, whether the green dot has disappeared. If the green dot has changed to white, the light barrier works properly.

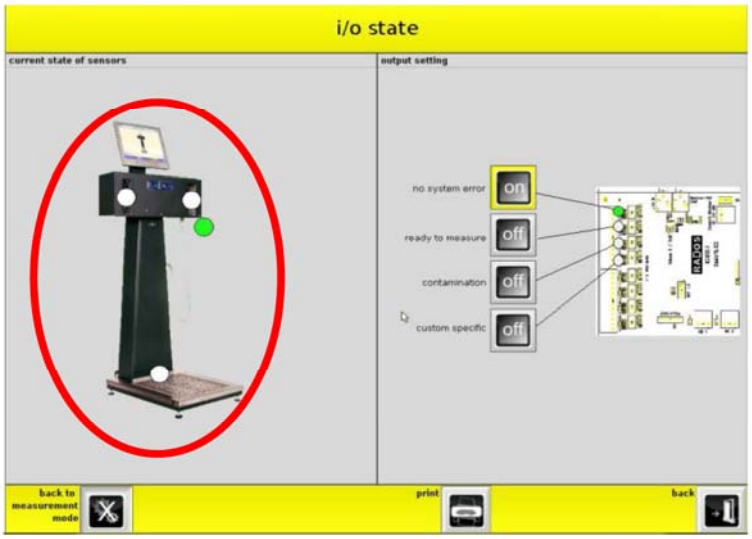


Figure 9-13: menu for input and output state

After returning to the measurement mode the monitor changes to the ready to measure state.

9.5.2.2 Reed contact and magnet

The reed contact is in the housing of the frisking probe and necessary for the software, to know, if the frisking probe is used or in its holder. This contact can only work, if the magnet is properly positioned in the frisking probe holder. In this case a green dot in the I/O state should be displayed. Otherwise, the sensor is malfunctioning.

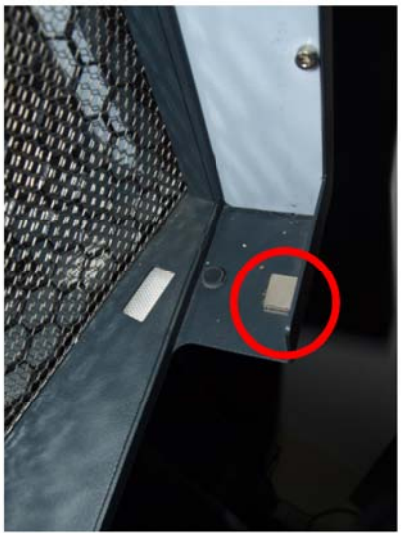


Figure 9-14: menu for input and output state

After placing the frisking probe in the holder, the white dot should be disappeared. Is the dot white, even, if the frisking probe is in the holder, the magnet has to be checked.

Take the frisking probe down and check, if the magnet is properly positioned. Make sure, it is in the right position and, if necessary, fix it so, it can't be displaced. After placing the frisking probe in the holder, the white dot should be disappeared. The monitor changes in "ready to measure" state. If there is still a white dot, the reed contact is not working properly or cable break is existing.

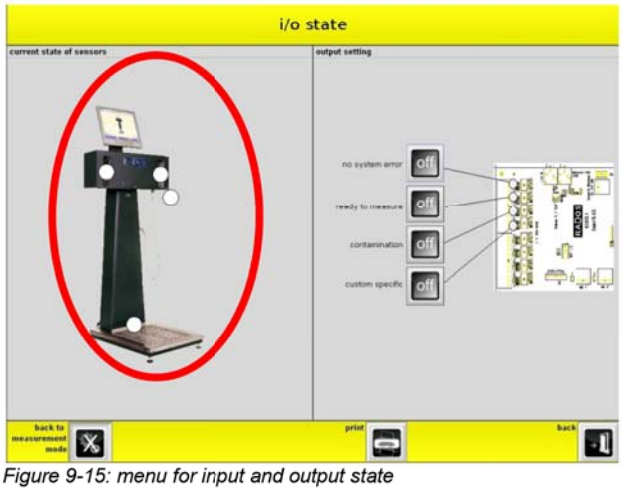


Figure 9-15: menu for input and output state

9.5.2.3 Compression sensitive foot contact

Is in the I/O menu green dot on the foot sensor, even, if nobody is standing on the monitor, the foot contact is not working properly.

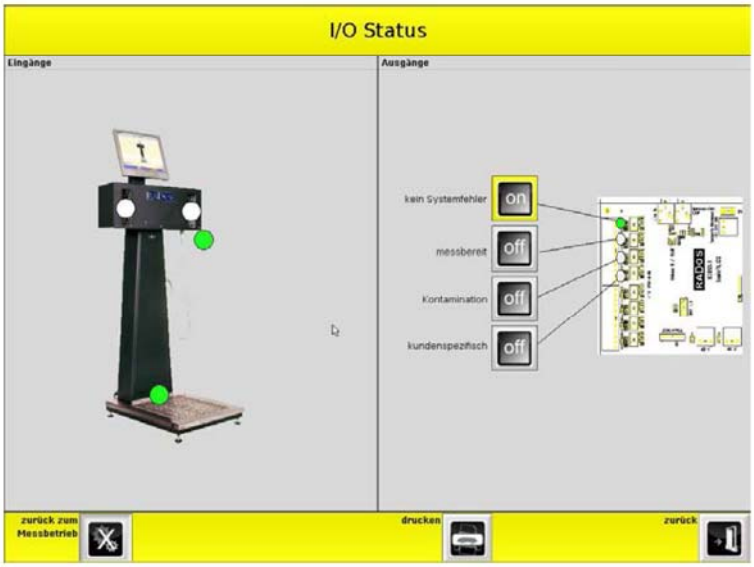


Figure 9-16: menu for input and output state

To check the compression sensitive foot contact continue by opening the bottom of the monitor housing. Therefore, press the metal pins on both sides of the housing and pull the housing few centmeters into your direction and afterwards lift it.

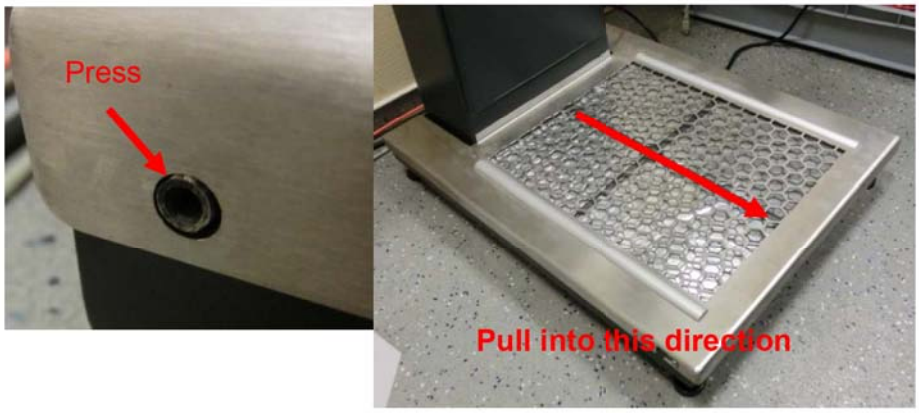


Figure 9-17: the compression sensitive foot contact

Be careful – the housing is connected with ground cable!

If the foot grid is stucked, replaced it correctly and check in I/O state, whether the green dot is gone.

Otherwise, the compression sensitive foot contact is not working and needs to be exchanged.

Figure 9-18: the compression sensitive foot contact

9.5.3 Stock-keeping of spare parts / service department

Address:	**Mirion Technologies (RADOS) GmbH** Ruhrstraße 49 22761 Hamburg
Phone:	+49 - 40 85 193-222
Fax:	+49 - 40 85 193-208
e-mail	hamburg-hotline@mirion.com

9.5.4 Protocol

Figure 9-19: Protocol

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

In the protocol:

- Info messages
- Warning messages
- Error messages

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

The left-hand window shows a listing of all available protocol files. There is an automatic delete function, so that only the protocols of the last 12 days are displayed in the list.

With the button ***print*** it is possible to make a printout of all recorded data in the selected protocol file.
With the button ***history*** it is possible to view the log-file history.
With the button ***close*** you can return to the start menu.

10 Maintenance

Table of figures

10.1 Maintenance

Under normal conditions, the CheckPoint:Body™ **HandFoot-Fibre™** monitor does not need any maintenance as it is a maintenance-free monitor with no moving parts in operation. Nevertheless, it is advisable to perform some small repeat tests (system checks) from time to time.

NOTE

The monitor should be cleaned at regular intervals! Heavy contamination may quite possibly have an influence on the characteristics of the measurement techniques.

Furthermore, it has to be ensured that the monitor is disconnected from the power supply, if any jobs at the electronics or the electrical part of the monitor are to be carried out.

DANGER

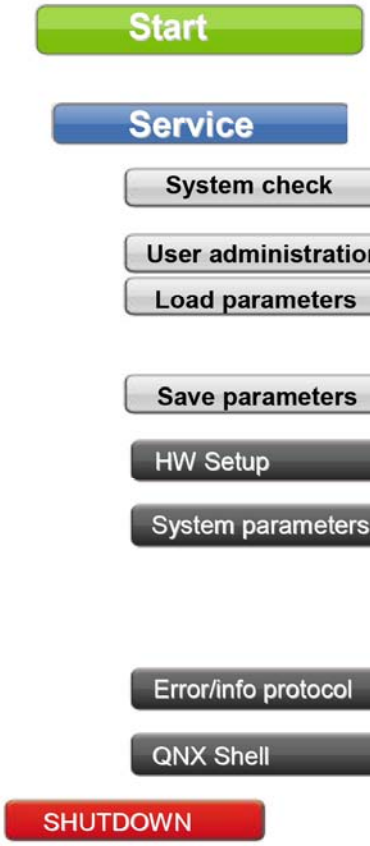
If any work on electric parts is necessary, the mains switch must be in the off state.

10.1.1 Start-up menu

The start-up menu is the central navigation tool for all **HandFoot-Fibre™** software modules. Every software module can be reached by pressing a corresponding touch button.

Figure 10-1: Start-up menu

Software modules provided via the start-up menu:



The simple touch on the button “Start” leads to the user software – the main program to perform radioactive contamination measurement.

The touch of the button “Service” leads to the utility programs, to perform system and hardware administration.

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

User administration program (see Register 5).

The program “Load parameters” enables the user to load monitor parameters that are stored on a hard drive or an USB-stick.

The program “Save parameters” enables the user to store monitor parameters on a hard drive or an USB-stick.

The program “Hardware set-up” is used, to configure the monitor hardware.

The program “System parameters” makes possible, to configure the system: setting the parameters of the system (time zone, language, setting language for the keyboard, adjustment of the time & date, screen resolution), choose external devices and configure network services.

List of the last system internal messages, e.g., useful for troubleshooting.

The program “QNX shell” permits access to the command line interface of QNX.

The button “Shutdown” switches the monitor off.

10.1.2 Save/load configuration

The program for loading/ storing monitor parameters allows the user to load monitor settings and parameters from data storage media such as hard drive or USB stick.

Figure 10-2: Start-up menu

Software modules provided via the start-up menu:

Start calls the user software – the main program to perform contamination measurement (see Register 3 and Register 4)

Service

Load parameters

Save parameters

"Load parameters" enables the user to load monitor parameters from data storage media. "Save parameters" enables the user to store monitor parameters on data storage media.

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.

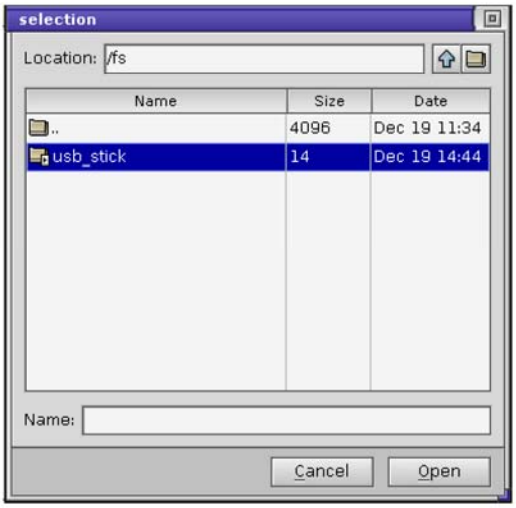


Figure 10-3: Data storage media path (save/load)

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

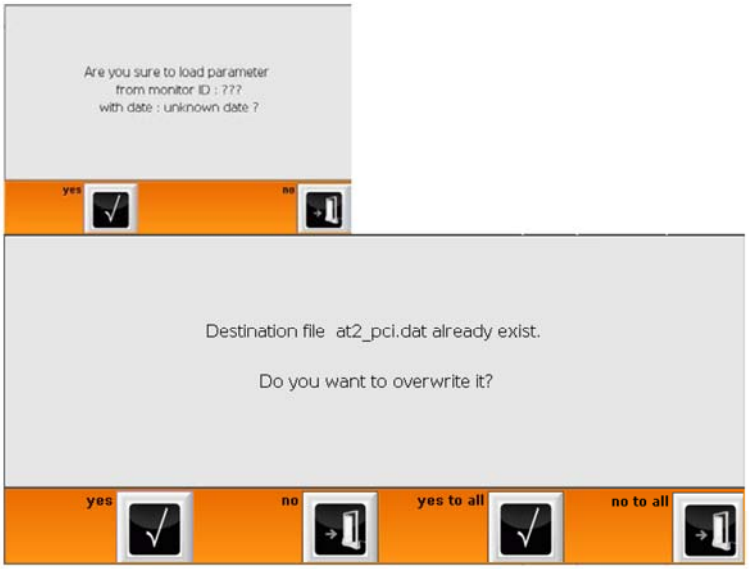


Figure 10-4: Data safety questions

Save configuration

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

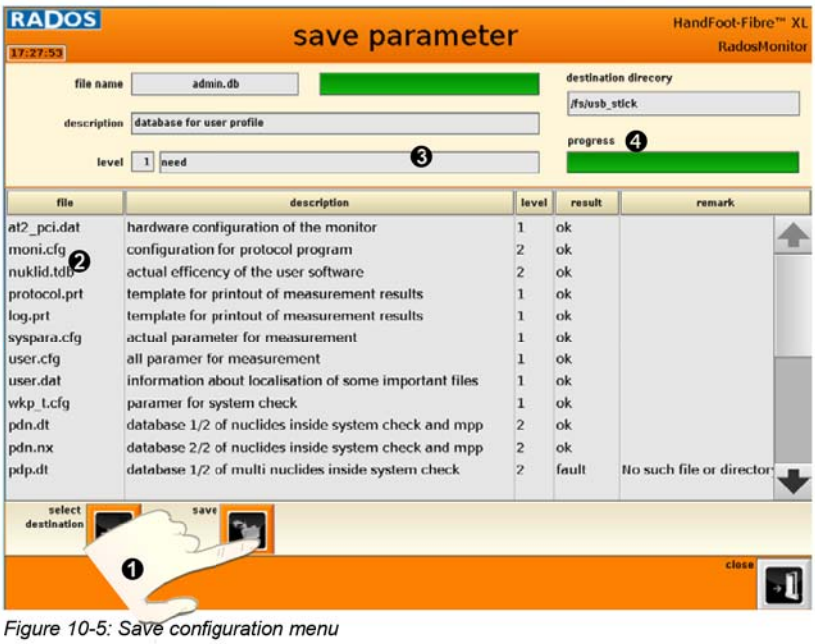


Figure 10-5: Save configuration menu

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.

Load configuration

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

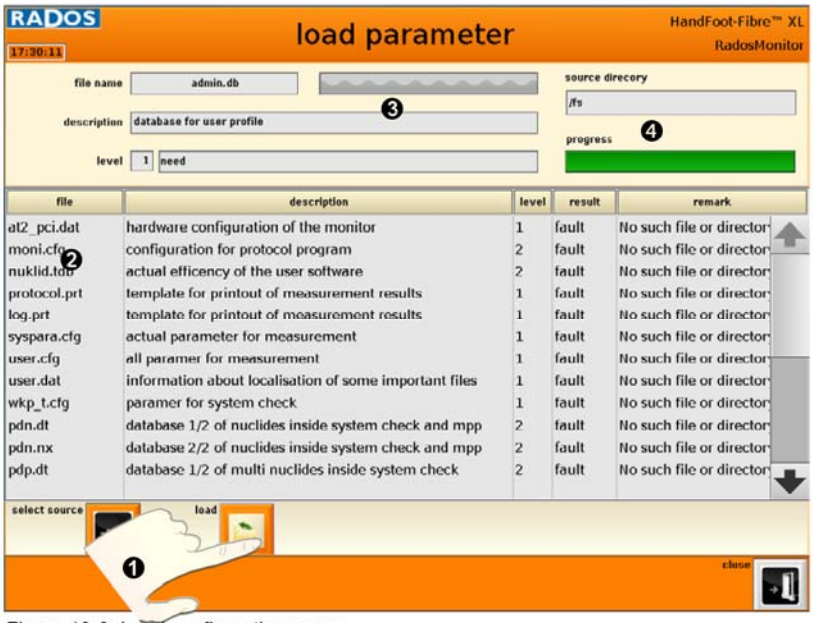


Figure 10-6: Load configuration menu

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 10-7: Start-up menu

Software modules provided via the RADOS monitor start-up menu:

Start calls the RTM user software – the main program to perform contamination measurement
(see Register 3 and Register 4)

Service

System parameters Program to configure the system: setting the parameters of the system (time zone, language, setting language for the keyboard, adjustment of the time & date, screen resolution), choose external devices and configure network services.

In general:

- A simple touch on the button **<Apply>** will apply the setting and the changed data will be stored in the **HandFoot-Fibre™**.
- A simple touch on the button **<save>** will store the settings to the **HandFoot-Fibre™**.
- The monitor must be restarted to enable the settings.

NOTE

Please, make sure, that all RTM parameters are at hand or known prior altering system parameters. It is not advised or needed to change system parameters 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 1024x768 is mandatory) and the system immanent directories (use care changing the directories).

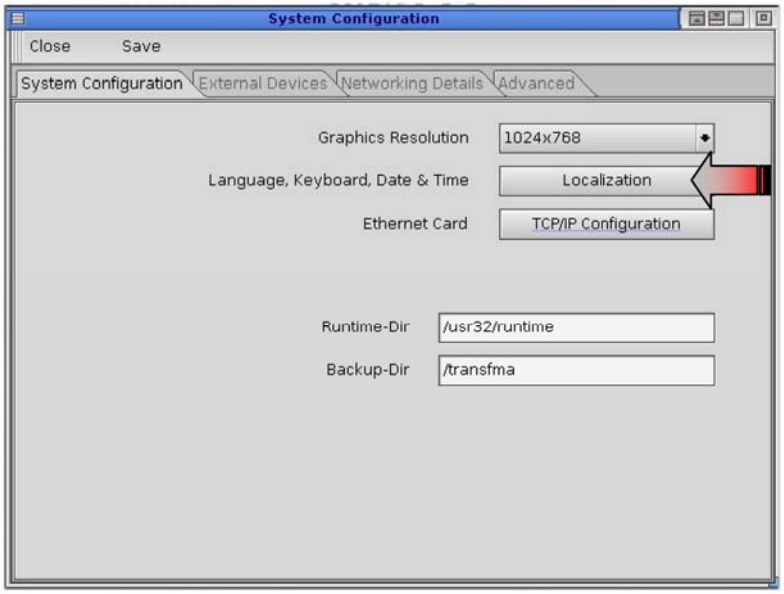


Figure 10-8: Localization

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

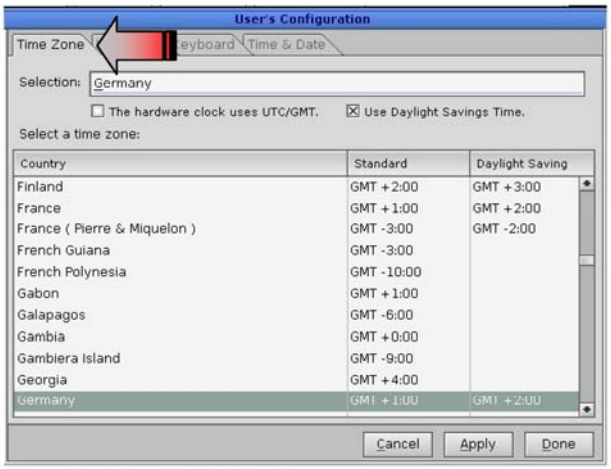


Figure 10-9: Localization Time Zone

The tabs *language* and *keyboard* will define the operation system language and the keyboard layout (especially used to access german "umlaute" or other special national character)

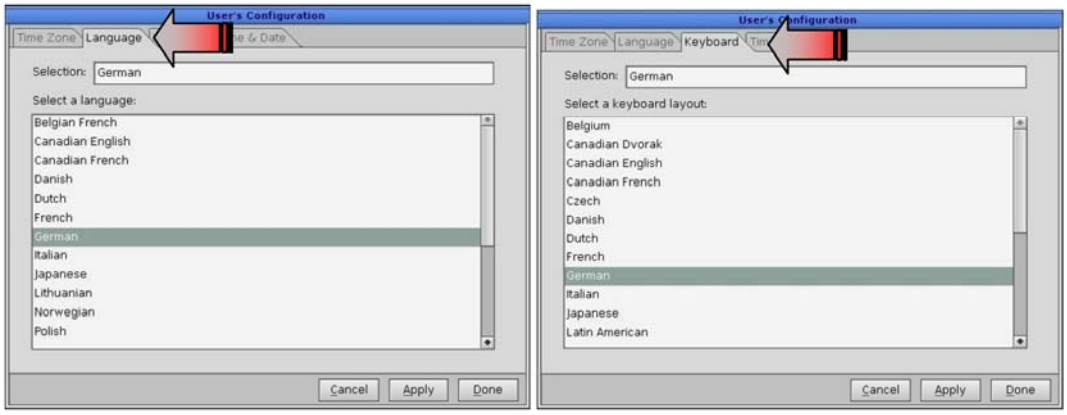


Figure 10-10: Localization language and keyboard

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.

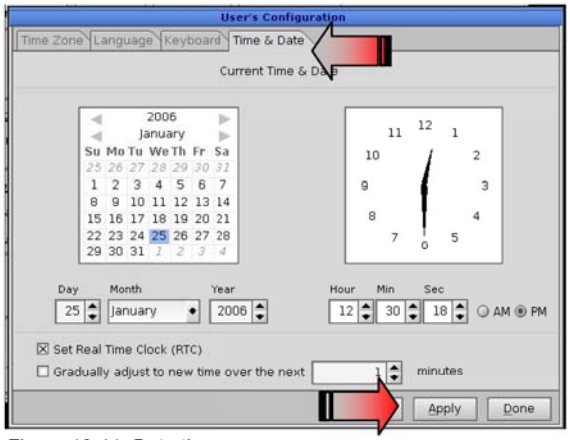


Figure 10-11: Date time

10.1.3.2 TCP/IP configuration

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

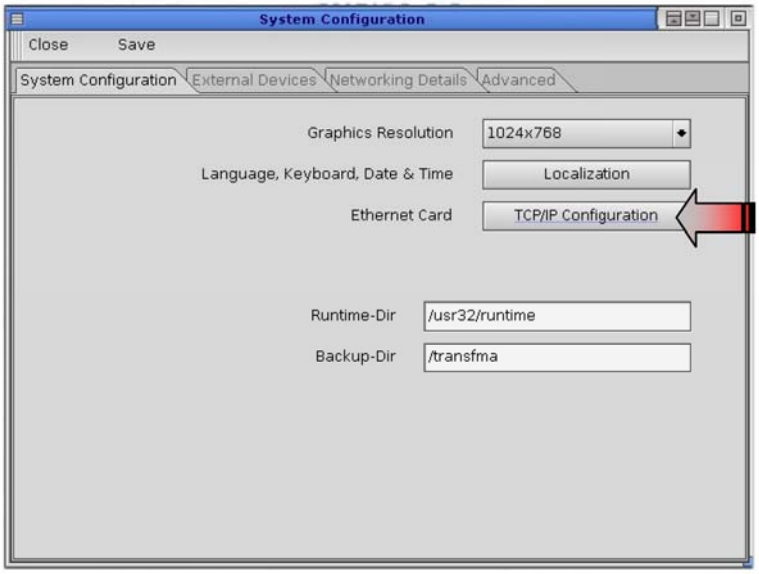


Figure 10-12: TCP/IP configuration

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

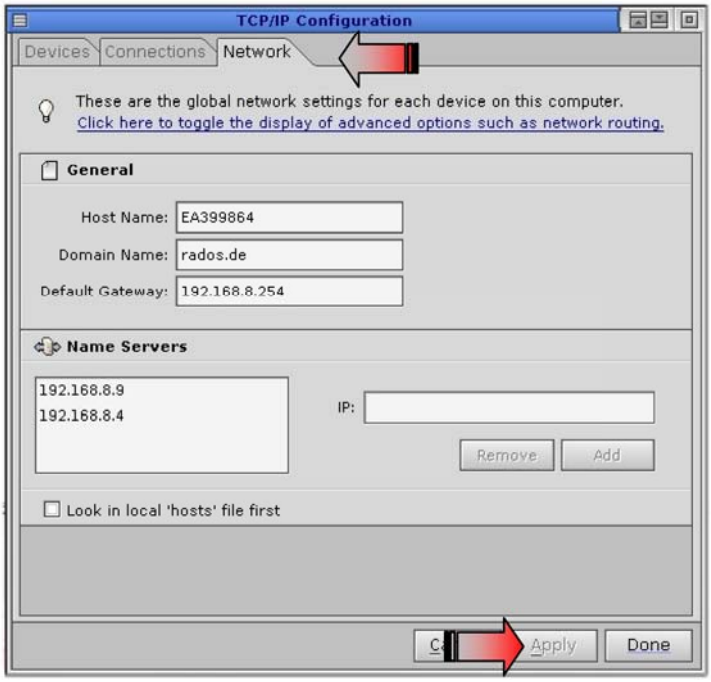


Figure 10-13: Network

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 **HandFoot-Fibre™** i.e. after weigh cell update or printer change.

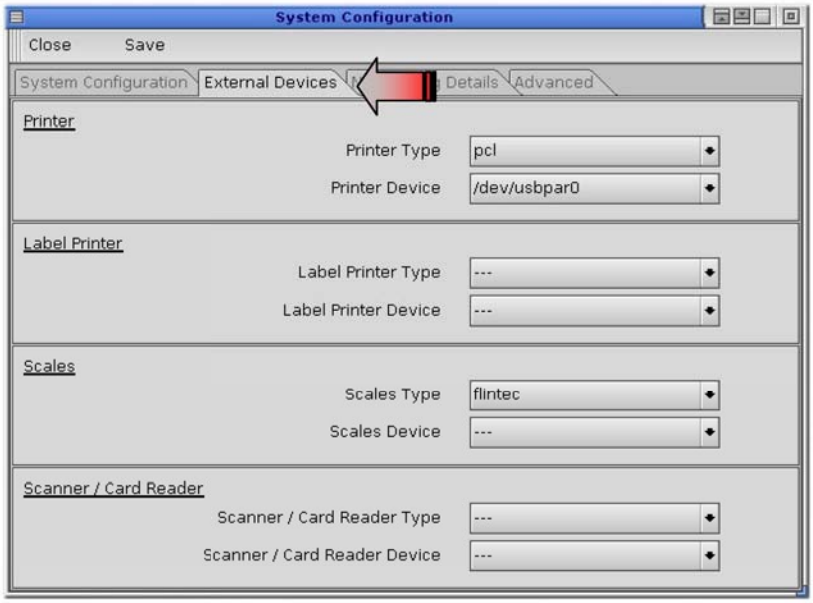


Figure 10-14: External Devices

NOTE

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

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

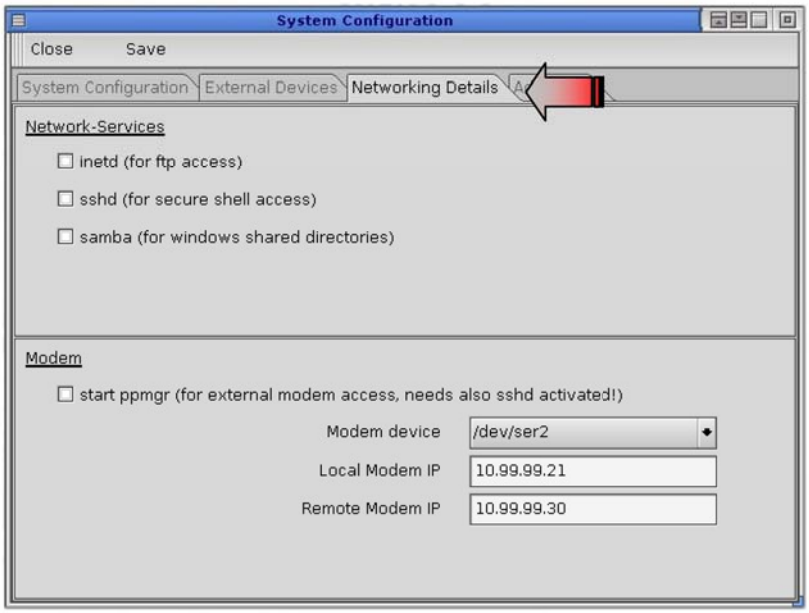


Figure 10-15: Networking details

NOTE

The modem device selectable is shown in the drop down menu only and represents the recommended devices, which have been approved by Mirion Technologies (RADOS) GmbH.

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

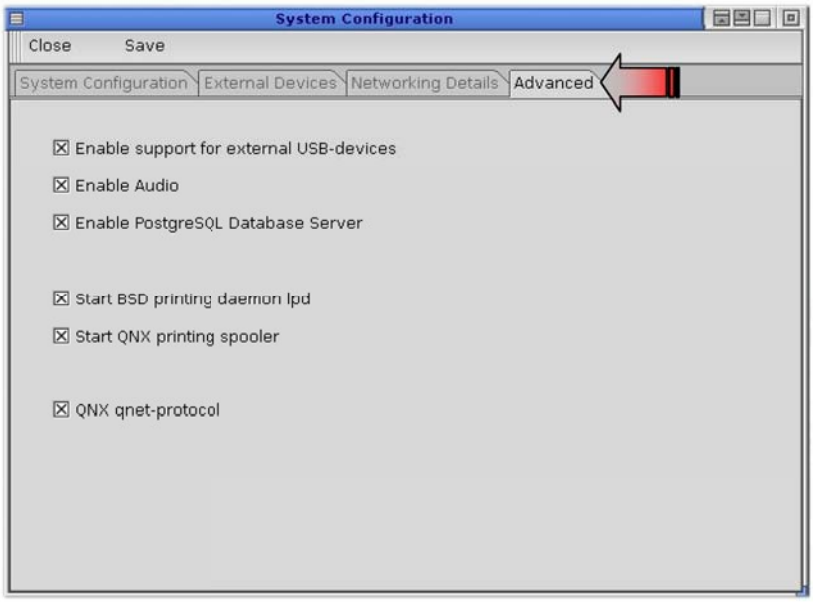


Figure 10-16: Networking details

10.1.4 Hardware set-up

The start of the hardware setup is necessary after the peripheral equipment of the **HandFoot-Fibre™** or the **HandFoot-Fibre™** environment has been changed.

As the **HW setup** will address all possible **HandFoot-Fibre™** configurations, this chapter will be the guide through the **HW setup** screens.

Figure 10-17: start-up menu

Software modules, provided via the start-up menu:

Start — the touch of the button “Start” leads into the user software – the main program to perform radioactive contamination measurement (see Register 3 and Register 4)

Service

HW setup — program to 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 **HandFoot-Fibre™**, before starting the HW setup.

WARNING

The **HW setup** program is designed to alter sensible monitor parameters. Therefore, it is not allowed, to cancel or discontinue the **HW setup** program, after it is once started.

If the **HW setup** was stopped or cancelled during the setup process, all menu items in the start menu will be inaccessible.

Please, contact the **RADOS customer service,** if the above described problem has been achieved.

The following illustrations show the user interface of the hardware setup and the queries that are provided in the hardware setup.

In the start-up menu touch the button „Service“ and select HW setup – the program to alter monitor configuration.

In the HW setup start-up menu touch the button „Next“, to start the monitor configuration. The monitor configuration can be aborted by touching the button „Abort”.

Figure 10-18: HandFoot-Fibre™ setup start menu

The program is enabled and activation of the software options can be done by entering the license number in the license dialog box.

Please, enter the license number, supplied with the monitor, and accept your entry with touch on the “Accept”-button, to show the installed licenses. Touch the button “Next”, to continue.

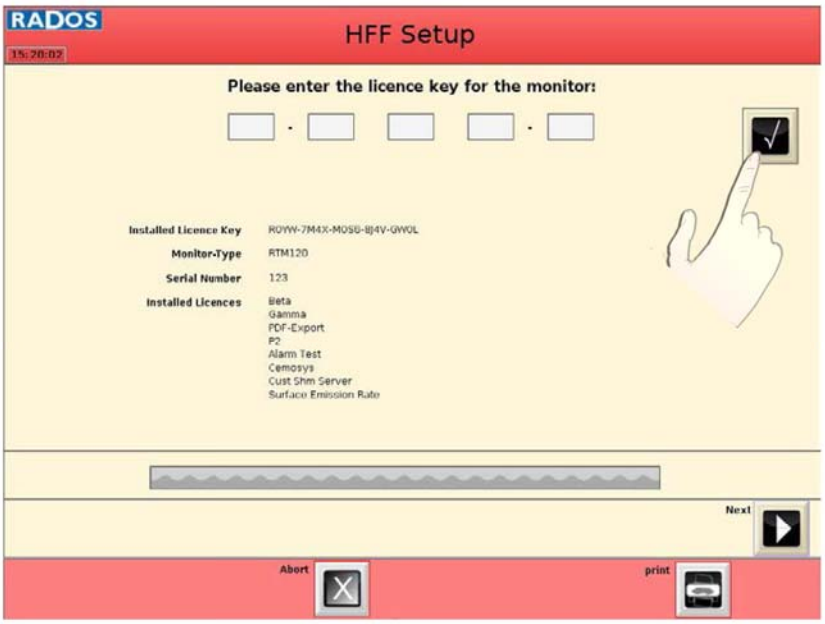


Figure 10-19: entering a license number

After entering a valid license key and touching the button “Next”, you proceed to the following screen where you have to configure your monitor type.

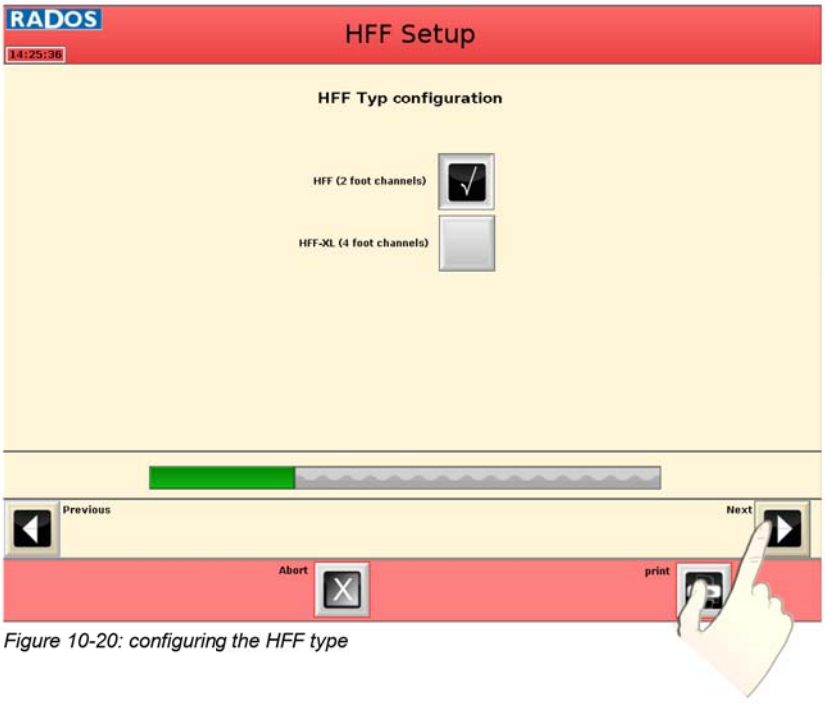


Figure 10-20: configuring the HFF type

In the menu for configuration of the Central Monitoring System (CeMoSys™) select, which data of your monitor should be transferred to the Central Monitoring System.

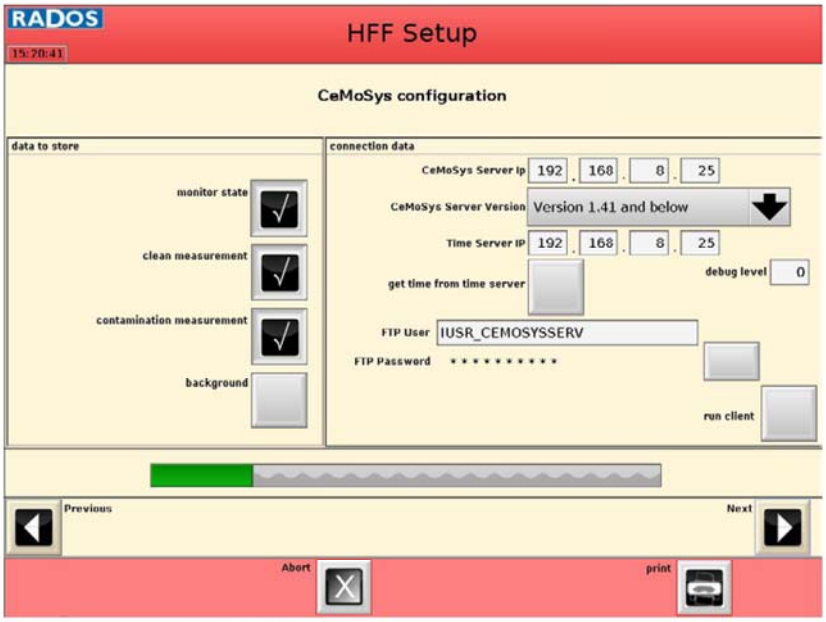


Figure 10-21: configuring CeMoSys™

Select, whether the system check configuration file should be overwritten.

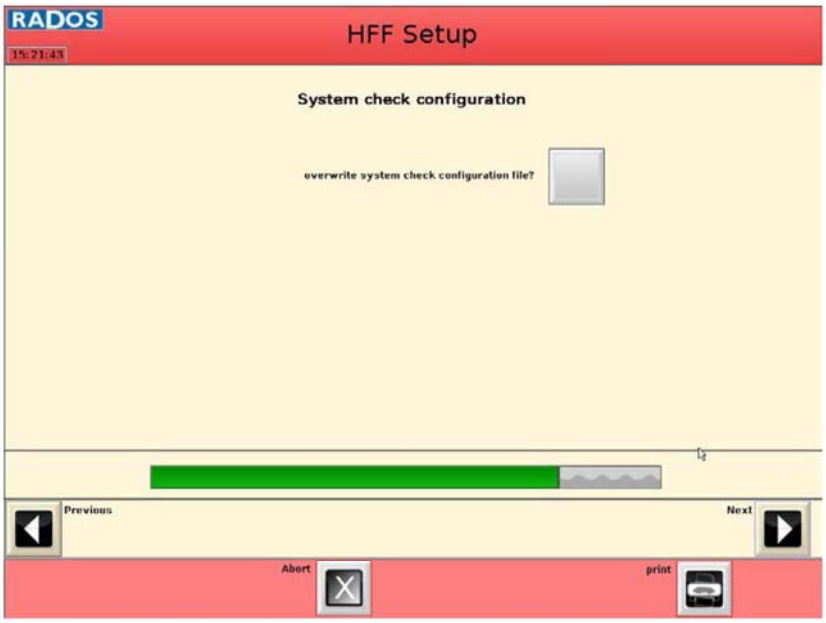


Figure 10-22: configuring system check

If you are ready with the monitor configuration, touch the button “Next”, to save your configuration.

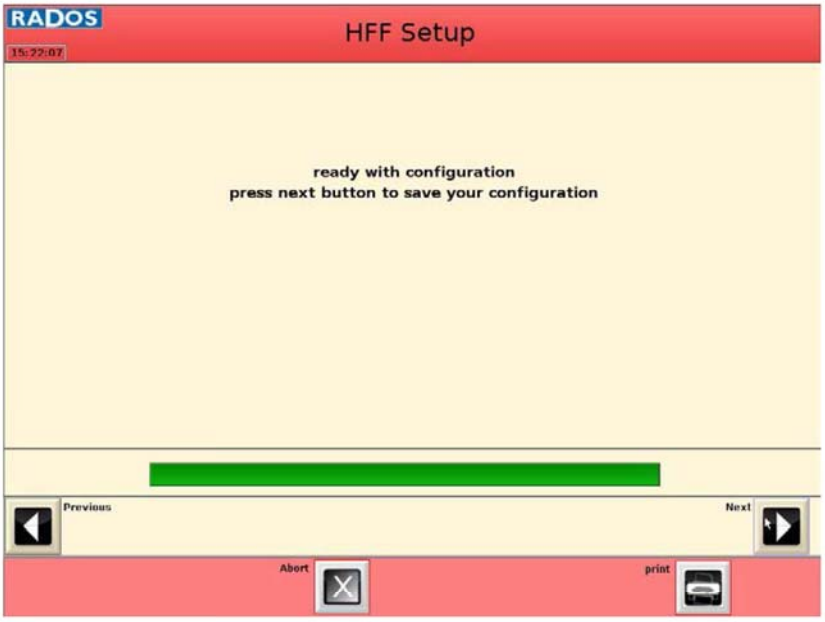


Figure 10-23: saving configuration

Please, wait, while saving your configuration.

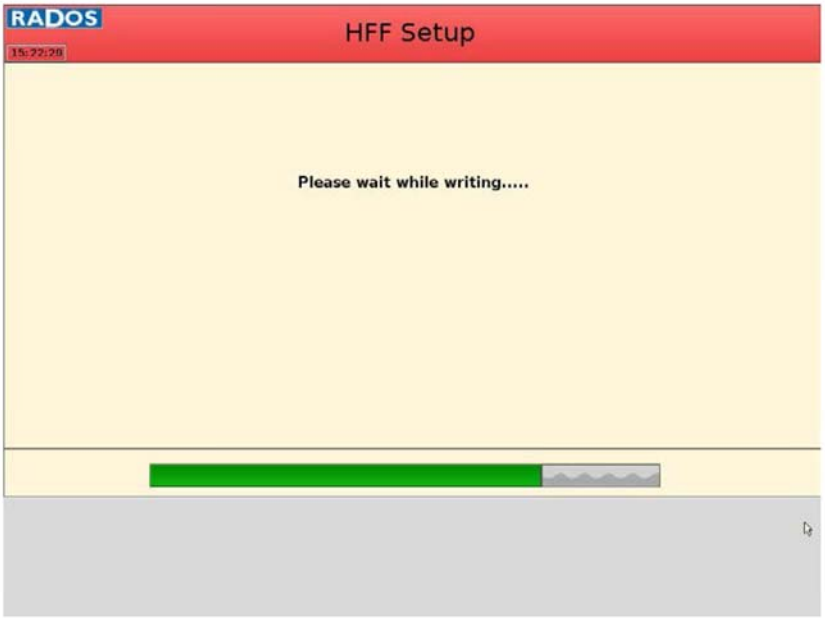


Figure 10-24: saving configuration

10.2 Fuses

The two mains fuses (see drawing basic device) are located on the mounting plate inside the terminal block. The mounting plate is accessible through the front wall (service door) of the main cabinet.

10.3 Protective plastic cover of the foot detector

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

In case this protective plastic cover is defective, it must be exchanged. It is available from Mirion Technologies (RADOS) GmbH under the stock number.

To exchange it, a suitable piece is cut out according to the size of the detector. When the foil is placed, be careful not to cover the light barrier.

10.4 Cleaning

Cleaning your monitor, its components and peripherals helps to keep 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.

10.4.1 General cleaning tips

General tips that should be taken in account when cleaning any of the components as well as tips to 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.

10.4.2 Cleaning tools

Although many products are available to help improve the process of cleaning, please use water or a highly diluted solvent to clean.

- Cloth
  A cloth is the best tool used when rubbing down a component; although paper towels can be used, we recommend using a cloth whenever possible.
- Water or rubbing alcohol
  When moistening a cloth, it is best to use water or rubbing alcohol. Other solvents may be bad for the plastics used at the monitor.
- Portable Vacuum
  Sucking the dust, dirt, hair and other particles out can be one of the best methods of cleaning. Over time, these items can restrict the airflow and cause circuitry to corrode.
  Do not use a standard vacuum as it can generate a lot of static electricity that can damage your computer.
- Cotton swabs
  cotton swaps moistened with rubbing alcohol or water are excellent tools for wiping hard to reach areas in any location.
- Foam swabs
  whenever possible, it is better to use lint-free swabs such as foam swabs.

10.4.3 LCD and touch screen cleaning

Dirt, dust, and finger prints can cause the computer screen to be difficult to read. Unlike a computer monitor, the LC-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.

10.5 Transport

Immediately after the delivery, please check the consignment for possible transportation damages. In that case, please inform both the Transport Company and Mirion Technologies (RADOS) GmbH. If necessary the commissioning should be carried out.

The feet of the monitor have to be aligned so that the monitor is horizontally levelled and does not wobble if there is weight put on it. For this alignment the monitor feet are equipped with screws that can be wound up and down.

If the monitor has to be moved, the clothing probe is not to be used as a handle! For small moves of the monitor there is a transport handle at the back side of the monitor. If the monitor is cautiously leaned backward, it is possible to move the monitor, which is equipped with two transport rollers for short distance.

The monitor can be optionally equipped with the large rear mounted transport wheels, to ease the longer distance transport of the monitor. The large transport wheels can be replaced with small standard wheels on-site.

Please note that the monitor has a weight of about 58 kg. For larger distances a trolley or something similar should be used.

The monitor should not be operated in a humid or dusty environment.

CAUTION

The **HandFoot-Fibre™** must be moved only by trained expert personnel. The relevant safety rules must be observed!

Please pay attention that the HandFoot-Fibre™ is let down gently.

WARNING

Pay attention to the markings on the monitor, to find the sufficiently supporting areas!

Ensure that the monitor is secured against toppling during transport!

In addition, all detectors should be covered with a protective cardboard.

Before setting-up, the transport safety features and the protecting caps should be removed.

10.6 Storage

Storage conditions:

- -20 °C up to +55 °C
- Relative humidity 85 % on yearly average
  95 % over 5 hrs (non-condensing)

The **HandFoot-Fibre™** must be stored in a dust-free environment; otherwise it should be properly covered against dust.

11 Nomenclature

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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) 1 Bq = 27 * 10-12 Ci or 1 Ci = 37 * 109 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 τ. The following relation exists between decay constant λ, average life period τ and half-life period T: $\lambda = \tau^{-1} = T^{-1} \cdot \ln 2$
Detector	Detection medium in the original form without electronic read-out.
Detector unit	Detection medium with appropriate electronics and housing.
Discriminator	Electronic component to discriminate the output counts of the photo multiplier.

Total absorbed energy in a mass unit. Physical unit is joule / kilogram. One J/kg is equal to the amount of energy, which develops when energy of 1 J is transmitted to matter with a mass of 1 kg by means of ionising radiation. 1 J/kg = 1 Gy (Gray) 1 Gy = 100 rad (old measurement unit: Radiation Absorbed Dose). Equivalent dose in Sv = Q * energy dose in Gy, Sv (Sievert) Quality factor Q = 1 Sv / Gy, expresses the characteristic of the radiation (source) the ionization density along the way of a charged particle. For x-ray, γ, β radiation Q is = 1 Sv/Gy, for α radiation Q is = 20 Sv/Gy.	**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. Possible hot spots 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 corresponds as multiple of a normalized standard distribution 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. α-particles are heavy particles. They have a very high binding energy. They are 2times loaded helium ions. In contrast to β-particles they are more difficult to measure, as they lose their starting energy rather quickly, while going through matter. α-particles ionise densely, β-particles however rather loosely. This difference is of great importance with respect to the damaging effect of the different kinds of radiation within the living tissue. β-particles are light-weight particles. They are electrons. Their average energy is by a factor 10 lower than the energy of the α-particles. (β energy lies in the range of 100 to 1000 keV, α particles in the range of 5 MeV).
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.
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	Optional design of RTM…
Plast	Scintillation material, which is often called “plast” or “plastic” due to its material.
RPD	RADOS - Plastic – Detectors (RADOS development)
RFD	RADOS Fibre™ Detector (RADOS development)

12 Supporting documents

12.1 Test protocol

12.2 Software / License

12.3 Conformity documents

12.4 Third party documents