

# RaySafe i3

– with on-screen display

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# ABOUT THE RAYSAFE i3 SYSTEM

RaySafe i3 is designed for personal use on hospital staff. It measures scattered radiation in examination rooms using a dosimeter, and shows a graphical visualization of dose rate in real time on a display.

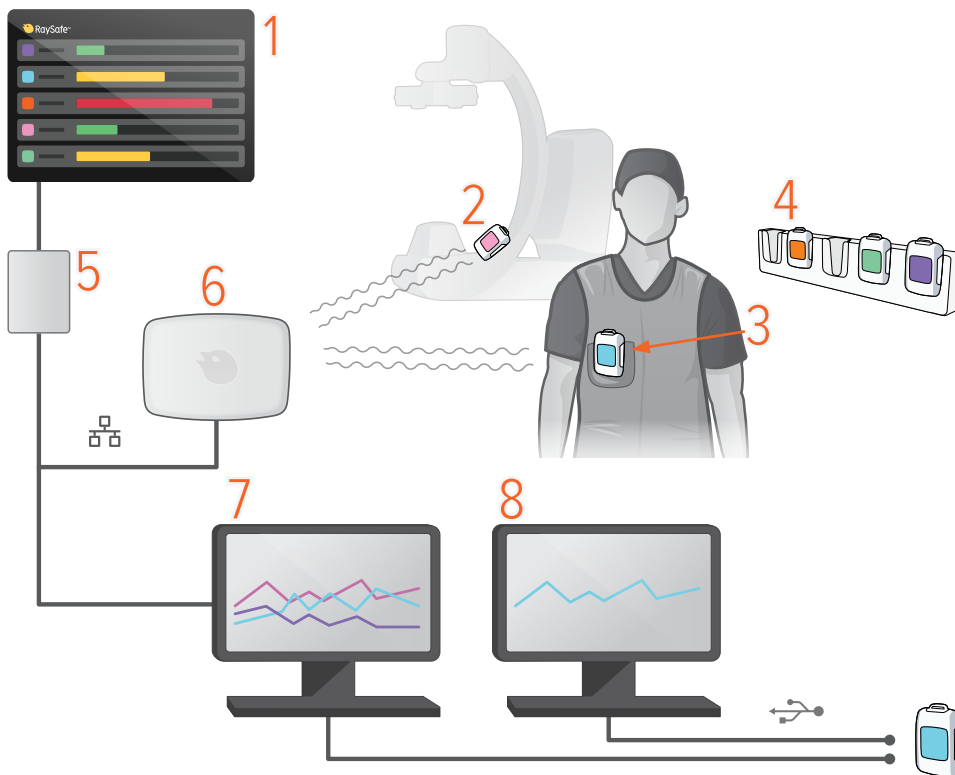


Figure 1. 1: Real-time View, 2: Reference Dosimeter, 3: Real-time Dosimeter, 4: Dosimeter Rack, 5: Video Unit, 6: Real-time Hub, 7: Dose Manager software, 8: Dose Viewer software.

The dosimeters measure radiation and store measurements. When a dosimeter is in range of a Real-time Hub, it automatically connects to the hub via radio. When a dosimeter is connected via radio to a Real-time Hub, measurements are transferred once per second and are displayed as dose rate bars, low to high dose rate: green, yellow or red.

All measurements recorded while connected to a Real-time Hub are saved in the hub and can be exported later in different formats.

To view the measurements stored in a dosimeter, connect the dosimeter to a computer running Dose Viewer. Dose Viewer can also be used for changing dosimeter settings, such as displayed name and annual dose limit.

Dose Manager is an optional analysis software.

## RAYSAFE i3 IN A SIEMENS OR CANON LAB

For installations in a Siemens or Canon lab:

- The reference dosimeter and the reference dosimeter holder shall not be used.
- When configuring the Real-time Hub, leave the field for reference dosimeter serial number blank.

**NOTE:** *When no reference dosimeter is present in the system, there will be no history dose rate bars at the right side of the screen.*

# PREPARATIONS

The installation process may take a few hours.

## PRE-INSTALLATION CHECKLIST

During the installation, you will need the following information.

Reference dosimeter serial number:	<input type="text"/>	<i>Printed on the back side of the reference dosimeter.</i>
Real-time Hub IP address <sup>1</sup> :	<input type="text"/>	<i>From the hospital's IT department.</i>
Video Unit IP address <sup>1</sup> :	<input type="text"/>	<i>From the hospital's IT department.</i>
Subnet mask:	<input type="text"/>	<i>From the hospital's IT department.</i>
Default gateway:	<input type="text"/>	<i>From the hospital's IT department.</i>
DNS server <sup>2</sup> (recommended):	<input type="text"/>	<i>From the hospital's IT department.</i>
NTP1 <sup>2</sup> (recommended):	<input type="text"/>	<i>From the hospital's IT department.</i>
NTP2 <sup>2</sup> (recommended):	<input type="text"/>	<i>From the hospital's IT department.</i>

<sup>1</sup> You might need to provide MAC addresses for the Video Unit and the Real-time Hub to the hospital's IT department. MAC addresses are printed on the back side of the products.

<sup>2</sup> If you want to use NTP servers defined by hostnames, you also need the IP address of a DNS server and the names of the NTP servers.

## SYSTEM PASSWORDS

During the installation, you will also be prompted to enter new passwords for signing in. You can document the new passwords for your system here.

Video Unit password:	<input type="text"/>
Real-time Hub, Data export password:	<input type="text"/>
Real-time Hub, System configuration password:	<input type="text"/>

## PACKAGE CONTENTS

**NOTE:** *The content depends on purchased configuration.*



Figure 2. Instructions for Use, Installation & service manual, Quick Guide.



Figure 3. Real-time Hub, Video Unit, Reference Dosimeter, Reference holder, Dose Viewer software, screws and plugs, Power over Ethernet, power adapters.



Figure 4. Cables: USB, ethernet, HDMI, power.

## SYSTEM REQUIREMENTS FOR DOSE VIEWER

Dose Viewer is required during the installation to initiate dosimeters.

- Operating system: 32 bit or 64 bit version of Windows 7, 8.1 or 10
- .NET 4.6.2 or higher (.NET 4.6.2 included in installation, needs 6 GB extra disk space)
- At least one USB port available
- At least 2 GB RAM available
- At least 2 GB free disk space
- Recommended screen resolution at least 1024 × 768

## SYSTEM REQUIREMENTS FOR DOSE MANAGER

Dose Manager is optional.

- Operating system: 64 bit version of Windows 7, 8.1 or 10
- .NET 4.6.2 or higher (.NET 4.6.2 included in installation, needs 6 GB extra disk space)
- At least one USB port available
- At least 2 GB RAM available
- At least 15 GB free disk space
- Recommended screen resolution at least 1280 × 1024

## LEARN MORE

- *Real-time Dosimeter quick guide* under the lid of the dosimeter packaging
- *Dose Viewer manual* via the Help button in Dose Viewer
- *Dose Manager manual* via the Help button in Dose Manager

# INSTALLATION

## DOSE VIEWER

1. Check that the system requirements (on page 7) is met.
2. Log on as local administrator on the computer.
3. Insert the Dose Viewer USB memory.
4. Double click on *InstallDoseViewer.exe*.
5. Follow the instructions on the screen to finish the installation.

## TROUBLESHOOTING

If the installation procedure fails, verify that:

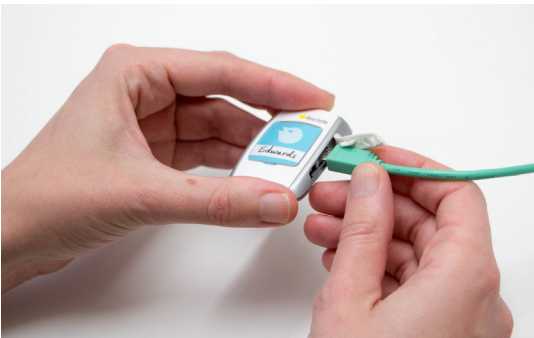
- the system requirements are met (on page 7).
- you are logged on as local administrator.

If there is an older version of Dose Viewer already installed, try uninstalling that before installing the new one.

## INITIATE A REAL-TIME DOSIMETER

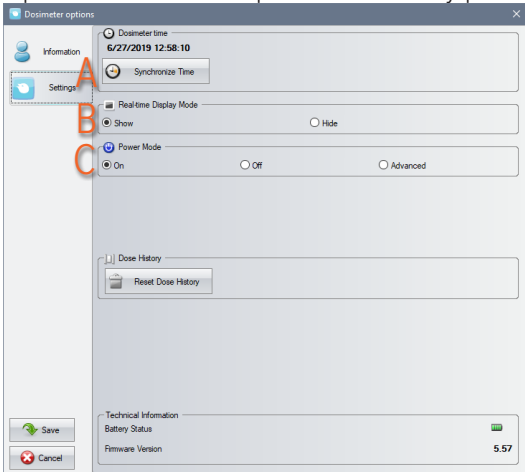
Each dosimeter needs to be initiated using Dose Viewer before use.

1. Start Dose Viewer.
2. Connect the dosimeter via USB cable to the computer running Dose Viewer.



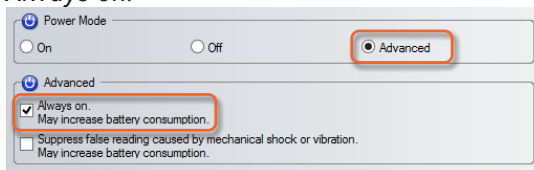


3. Open the dosimeter options window by pressing *Dosimeter options*  and then the *Settings* tab:

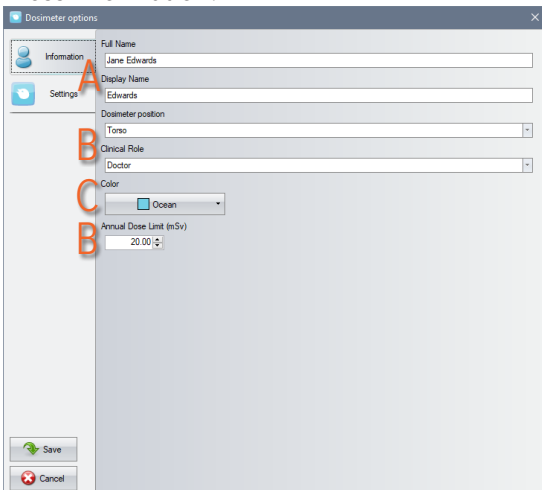


- A. Verify that the computer time is correct and then synchronize the dosimeter time. Be sure to do this with all dosimeters in a lab.
- B. Set the *Real-time Display Mode* to *Show*, to make the dosimeter appear on a display.
- C. Set *Power Mode* to *On* to start radio communication and dose logging.

**NOTE:** *Power Mode On includes an automatic power saving function controlled by accelerometers. When the dosimeter is stationary for 9 minutes, it switches to power save mode (no dose logging, no radio communication). The dosimeter wakes up again when moved. If the dosimeter is stationary positioned, not worn by a person, turn off the automatic power saving by selecting **Advanced: Always on**.*



4. Press *Information*:



- A. Set *Full Name* and *Display Name*. The Display Name appears on the display. The Full Name is visible in the data export files from the Real-time Hub and in Dose Viewer.
- B. Change *Dosimeter Position*, *Clinical Role* and *Annual Dose Limit* if desired. These settings do not affect the dose registration.

- C. Select **Color** and insert a corresponding inlay under the plastic shield on the front of the dosimeter. The color setting defines the identification color to the left on the display.

Tip: Write a name or other identification of the dosimeter wearer on the label.



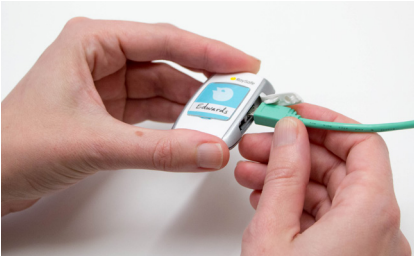
5. Press **Save** and then disconnect the dosimeter.

**NOTE:** *Always power **OFF** the dosimeter before air transport, to make sure that the radio communication is completely turned off.*

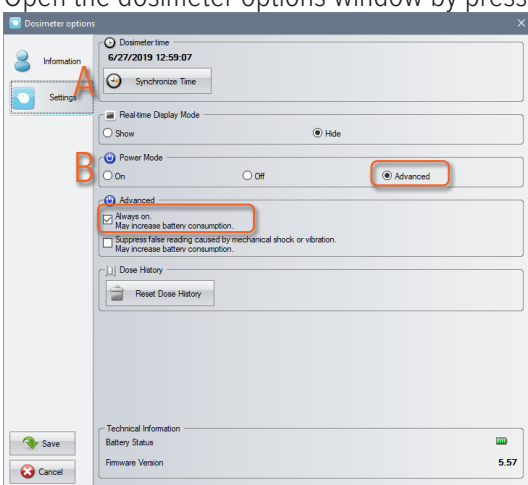
## INITIATE THE REFERENCE DOSIMETER

The reference dosimeter is not a personal dosimeter, but a reference for the lab. Since it will be stationary positioned, it needs specific settings.

1. Start Dose Viewer.
2. Connect the dosimeter via USB cable to the computer running Dose Viewer.



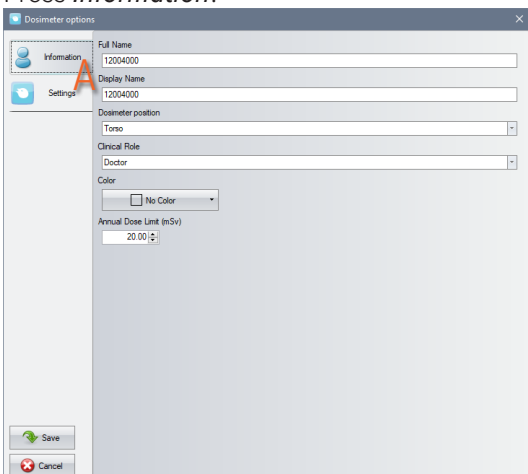
3. Open the dosimeter options window by pressing *Dosimeter options*  and then the *Settings* tab.



A. Verify that the computer time is correct and then synchronize the dosimeter time.

B. Set *Power Mode* to *Advanced: Always on* to make sure that the reference dosimeter never will fall asleep.

4. Press *Information*:



A. Set *Full Name* and *Display Name*, for example “REF” followed by the name of the lab. The names are visible in the data export files from the Real-time Hub and in Dose Viewer.

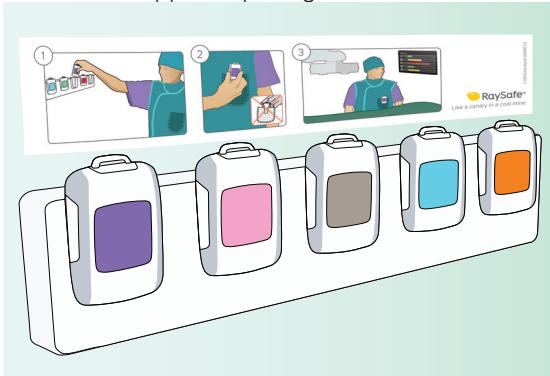
The other settings do not affect the measurement and can be ignored for a reference dosimeter.

5. Press *Save* and then disconnect the dosimeter.

## MOUNT THE REAL-TIME DOSIMETER RACK

A Real-time Dosimeter rack provides room for 5 dosimeters. Mount it on a wall with easy access, for example near a storage of radiation protection garment.

1. Mount the rack with 2 screws to the wall.
2. Attach the dosimeters.
3. Mount the supplied quick guide sticker above the rack.



## CONNECTION OVERVIEW

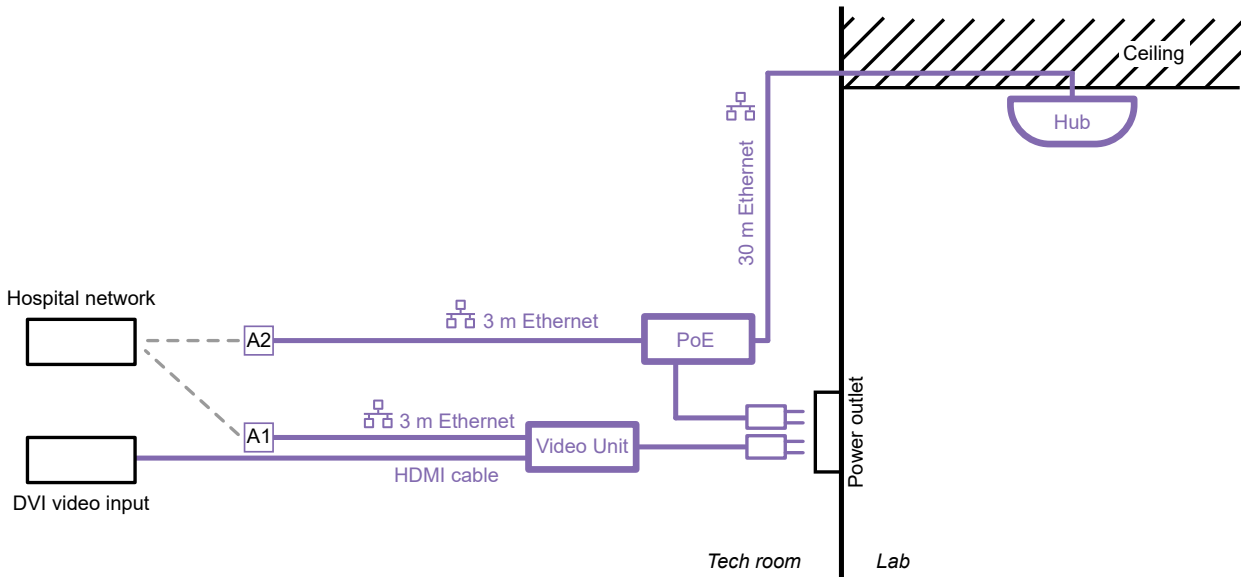


Figure 5. Cable connections. Purple parts provided by RaySafe. A1 and A2 are unconnected cable ends to connect your computer to during the installation, for access to the configuration interface of the Video Unit and the Real-time Hub.

**NOTE:** Do not connect the Ethernet cables to the hospital network (cable end marked A1 and A2 in Figure 5 on page 13) before you have configured the Video Unit (connection A1) and Real-time Hub (connection A2).

## MOUNT THE VIDEO UNIT

Place the Video Unit where suitable for your installation.

**NOTE:** The Video Unit is a fanless computer. To avoid overheating, ensure good ventilation.

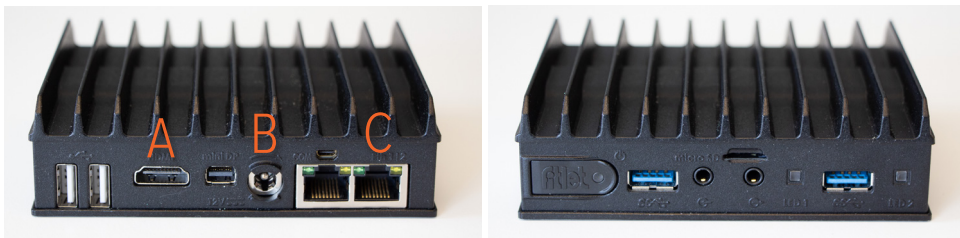


Figure 6. The Video Unit uses three connections: **A:** HDMI (video output), **B:** power supply, **C:** Ethernet.

The Video Unit has a power button. When the unit is on, the LED is green. When the unit is manually turned off, by a press on the power button, the LED is orange. Press the button to turn the unit on.

1. Connect all three cables to the Video Unit. Use one of the 3 m Ethernet cables provided with the system.



2. Connect the HDMI cable to the DVI video input in the lab.
3. Connect the power supply to a power outlet.
4. Leave the other end of the Ethernet cable (A1 in Figure 5 on page 13) unconnected until the Video Unit is configured correctly.

## MOUNT THE REAL-TIME HUB

The Real-time Hub should be mounted such that dosimeters in use are in line of sight and as close as possible to the hub. Ceiling position is recommended, but a wall can also be suitable.

**NOTE:** Do not position the hub above the patient area.

**NOTE:** If several systems are installed in the same building, make sure to keep distance between the hubs, for good performance.

1. Open the Real-time Hub by snapping off the curved cover.
2. Take one end of the 30 m Ethernet cable through an opening in the hub back panel and connect it to the Ethernet port. Check that the USB radio dongle is firmly connected.



3. The hub back panel has two holes (∅ 4.5 mm) for mounting. Position the hub and mount using screws and plugs suitable for the ceiling or wall material.
4. Snap the white cover on.

## CONNECT THE POWER OVER ETHERNET UNIT



Figure 7. Power over Ethernet unit.

1. Connect the 30 m Ethernet cable from the hub to the **Data Power** socket in the Power over Ethernet unit.
2. Connect the Power over Ethernet power cord and connect it to a power outlet.

3. Connect a 3 m Ethernet cable to the **Data** socket on the Power over Ethernet unit. Leave the other end of the Ethernet cable (**A2** in Figure 5 on page 13) unconnected.

## CONFIGURE THE VIDEO UNIT

Before you start, configure the Ethernet settings on your computer to communicate on the same subnet as the Video Unit. The video unit is initially using address 192.168.0.101 with subnet 255.255.255.0.

To avoid security errors when connecting with browser, the certificate provided on Dose viewer USB installer can be installed, but this is not mandatory. For most browsers it is possible to configure the Video Unit without having this certificate installed, but you will have to pass some security steps.

1. Connect a computer to Video Unit by connecting the Ethernet cable marked **A1** in Figure 5 on page 13 to the Ethernet port on the computer.
2. Open a web browser and connect to `https://192.168.0.101`. Be sure to start with `https://`
3. Sign in for the first time with the default password: `raysafe`
4. Enter the **Static IP settings** received from the hospital's IT department: **IP address** for the Video Unit, **subnet mask** and **default gateway**.
5. Set the **Hub IP address**, received from the hospital's IT department.
6. Change the **password**.
7. In most cases, you do not need to change the **video settings**. If problems arise with the video quality, see "Troubleshooting" on page 32.
8. Press **Save and reboot** and then disconnect the Ethernet cable from the computer.
9. Connect the Ethernet cable to the hospital network.

The configuration of the Video Unit is now finished, and you might get a message on the screen, saying that there is no connection to Real-time Hub.

**NOTE:** *A description of the Video Unit configuration options can be found on page 26.*

## CONFIGURE THE REAL-TIME HUB

Before you start, configure the Ethernet settings on your computer to communicate on the same subnet as the Real-time Hub. The Real-time Hub is initially using address 192.168.0.100 with subnet 255.255.255.0.

To avoid security errors when connecting with browser, the certificate provided on Dose viewer USB installer should be installed, but it this not mandatory. For most browsers it is possible to configure the Real-time Hub without having this certificate installed, but you will have to pass some security steps.

1. Connect a computer to the Ethernet cable marked **A2** in Figure 5 on page 13.
2. Open a web browser and connect to `https://192.168.0.100`. Be sure to start with `https://`
3. Sign in for the first time to **System configuration** with the default password: `raysafe`
4. Stay on the **Configuration** tab.
5. Enter the **serial number** for the reference dosimeter. The serial number can be found on the back of the reference dosimeter.

6. Go to the *Set-up* tab.
7. Enter a *Lab name*. The lab name will be used in the data export files and when connecting from Dose Manager.
8. Enter the *Static IP settings* received from the hospital's IT department. It is recommended to use NTP servers to synchronize the time of the system.
9. Change the passwords for data export and system configuration. We recommend you to have two different passwords.
10. Press *Save and reboot* and then disconnect the Ethernet cable from the computer.
11. Connect the Ethernet cable to the hospital network.

The configuration of the Real-time Hub is now finished, and within a few minutes the Real-time View will appear on the screen.

**NOTE:** *A description of the Real-time Hub configuration options can be found on page 27.*



## MOUNT THE REFERENCE DOSIMETER

The reference dosimeter is used to determine when the X-ray tube is emitting X-rays and when it is not. This information is required to show the history bars on the right-hand side of the Real-time view. It is also needed for the data export to correctly report when a dosimeter does not receive any dose, even when there is radiation reported by the reference dosimeter.

If no NTP server is configured, the reference dosimeter is used as time source for the saved data. The dose detected by the reference dosimeter is also saved and can be used for normalization when comparing procedures, labs and operators.

The reference dosimeter shall be placed on the C-arm, in the vicinity of the X-ray tube. The exact positioning is not crucial, see Figure 8 on page 17. The reference dosimeter may be covered with a sterile sheet or plastic bag. The function and performance will be unaffected.

The reference dosimeter holder comes with adhesive Velcro strips.

1. Put the reference dosimeter in the holder.



2. Remove the protection tabs from the Velcro and press the reference dosimeter holder in place, with the dots towards the radiation source.

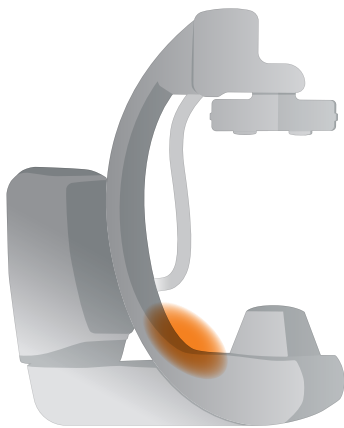


Figure 8. Reference dosimeter positioning.

**TIP!**

*If the holder does not stay in place, for example on uneven surfaces, try adding another layer of Velcro where suitable, to fill gaps and add stability.*

# SYSTEM FUNCTION TESTS

We recommend these tests in order to verify the correct installation and configuration of the system.

## REAL-TIME VIEW TEST

Follow the instructions below to verify that the dosimeter appears on the display and reports dose:

1. Check that the dosimeter appears in the Real-time View. The Real-time Dosimeter has a power saving function. You can try moving the dosimeter to wake it up.
2. Check that there is no error message at the bottom of the screen. It may take up to five minutes for error messages to appear after the hub is rebooted.
3. Expose the dosimeter to scattered radiation by placing the dosimeter outside the primary beam, close to a phantom which is placed in the X-ray field. Verify that the display shows a dose rate bar instantaneously, updating once per second (Figure 9).



Figure 9. The Real-time View.

4. Verify that the history bars to the right are visible. If not, there might be a communication problem with the reference dosimeter. If you have a reference dosimeter mounted, check that you have entered the serial number for the reference dosimeter (see “Configure the Real-time Hub” on page 15).

For troubleshooting purposes, you can activate **Service mode** for 20 minutes from the **Configuration** tab in the Real-time Hub configuration settings (see instruction under “Configuration tab” on page 28). Radio signal strength will be displayed for all connected dosimeters, including reference dosimeter and other dosimeters configured to be hidden. Also check that the reference dosimeter reports radiation. Service mode will automatically turn off after 20 minutes.

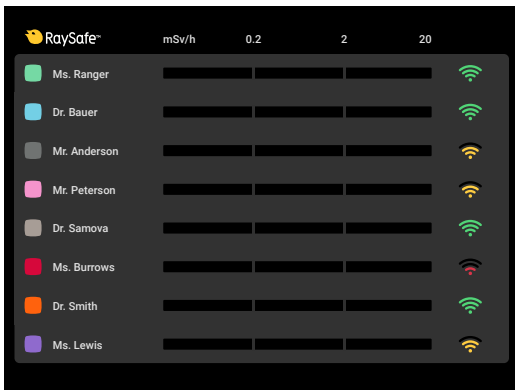


Figure 10. The Real-time View in *Service mode*. The signal strength for each connected dosimeter is indicated to the right.

## DOSE VIEWER TEST

Follow the instructions below to verify that Dose Viewer detects the dosimeter:

1. Connect the dosimeter to a computer running Dose Viewer.
2. Dose Viewer will detect the dosimeter within a few seconds. Verify that *Dosimeter information* and *Dose graph* are presented (Figure 11).

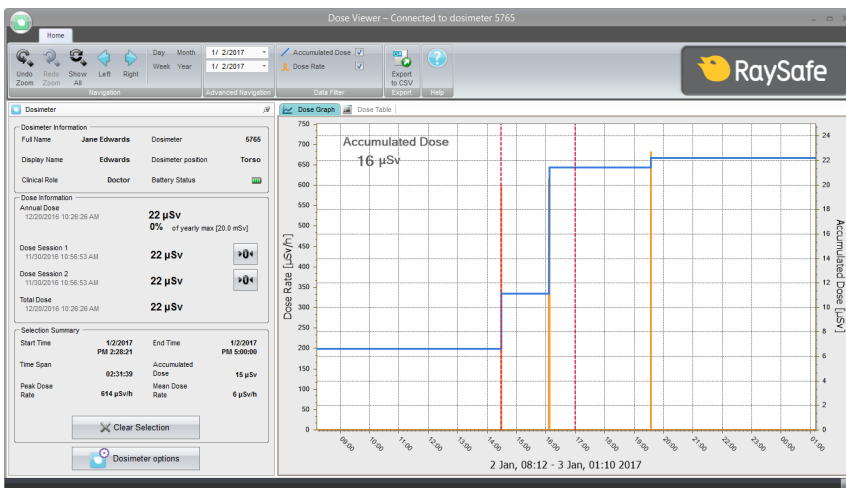


Figure 11. Dose Viewer with a dosimeter connected.

## COMMUNICATION RANGE TEST

Follow the instructions below to verify the function of an environment with several Real-time Hubs installed.

**NOTE:** *If several systems are installed in the same building, make sure to keep distance between the hubs, for good performance.*

Check that the dosimeter communication range configuration is correctly tuned, that is, dosimeters currently not in use does not appear on the display, but will appear when they approach the hub.

1. Position a dosimeter near Real-time Hub **A**.
2. Visually check that the dosimeter is shown on the screen connected to Real-time Hub **A**.
3. Move the dosimeter within range of Real-time Hub **B**.
4. Visually check that the dosimeter appears on the screen connected to Real-time Hub **B** within 30 seconds within range.
5. Put the dosimeter in a rack and verify that it disappears from all displays within 9 minutes.

If anything fails in this test, see “Troubleshooting” on page 32.

# REAL-TIME VIEW EXPLAINED

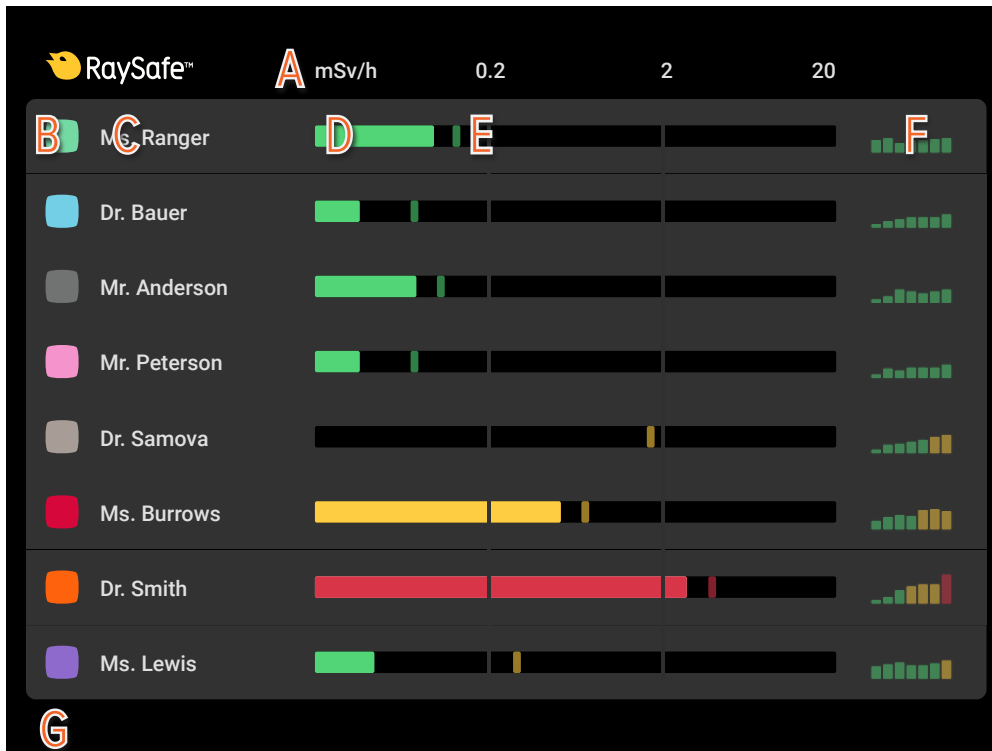


Figure 12. Real-time view, graphical components.

**A:** Dose rate scale (see “Configuration tab” on page 28 for settings)

**B:** Dosimeter color (can be set using Dose Viewer, see “Initiate a Real-time Dosimeter” on page 8)

**C:** Dosimeter display name (can be set using Dose Viewer, see “Initiate a Real-time Dosimeter” on page 8)

**D:** Real-time dose rate bar in green, yellow or red, depending on the current dose rate. Updated once per second.

**E:** Dose rate peak, the highest dose rate value recorded during the last 15 seconds.

**F:** History dose rate bars for the last seven dose events. The history bars are updated for all dosimeters whenever at least one dosimeter has a detected dose event, with the most recent event to the right.

**G:** Area reserved for error messages.

**NOTE:** *The history bars are omitted when service mode is on. When the dosimeter battery needs to be replaced, a battery symbol is shown instead of the history bars for the specific dosimeter.*

# MAINTENANCE AND SOFTWARE UPDATE

## DOSIMETER BATTERY REPLACEMENT



Figure 13. Low battery indicated on display.

When a red LED flashes on the side of the dosimeter, or when a battery symbol is present on the display, the battery needs to be replaced. You need a Phillips screwdriver (PH1) and a battery (CR2450) for this.

**NOTE:** *Make sure that the dosimeter is not connected to a computer with a USB cable while replacing the battery.*

1. Remove the screws on both sides of the dosimeter clip.
2. Remove the battery cover.
3. Take out the battery by carefully bending with for example the plastic clip under the battery at the top side of the dosimeter.



4. Wait at least 5 seconds before inserting the new battery, to make sure that the dosimeter registers that a new battery is inserted.
5. Put on the cover and the clip (optional) and insert the screws carefully (max 0.15 Nm torque), to avoid damage on the screw threads.
6. Connect the dosimeter to a computer with Dose View and synchronize the time. The internal clock is the only thing that is affected by a battery change. Other information in the dosimeter such as name, dose history and calibration are unaffected.

Check that the dosimeter appears on a display again.

## DOSE VIEWER SOFTWARE UPDATE

Follow the installation instructions in section “Dose Viewer” on page 8 to upgrade Dose Viewer.

**NOTE:** *Configuration from a previous version of the Dose Viewer software will remain unaffected by the software update.*

## REAL-TIME HUB SOFTWARE UPDATE

Follow the instructions on the **Set-up** tab in the Real-time Hub configuration interface to upgrade the software in the Real-time Hub.

## CLEANING

For cleaning of dosimeter and hub, use a damp cloth and mild detergent.

# DATA EXPORT

The Real-time Hub has a data export interface. You find it by signing in to the *System configuration*, under the *Data export* tab, or by signing in to the *Data export* directly from the sign in page of the Real-time Hub.

The time stamps used in the export depends on the time source and are described in the user interface. When using NTP as source there is a possibility to export in local time or UTC.

The downloadable files are in CSV (comma-separated values) format, and can be analyzed for example using a spreadsheet program.

Select if you want to use a specific start date or if you want to download all data. You can also change the decimal separator.

**NOTE:** *If you select **Point** as decimal separator, comma will be list separator. If you select **Comma** as decimal separator, semicolon will be list separator.*

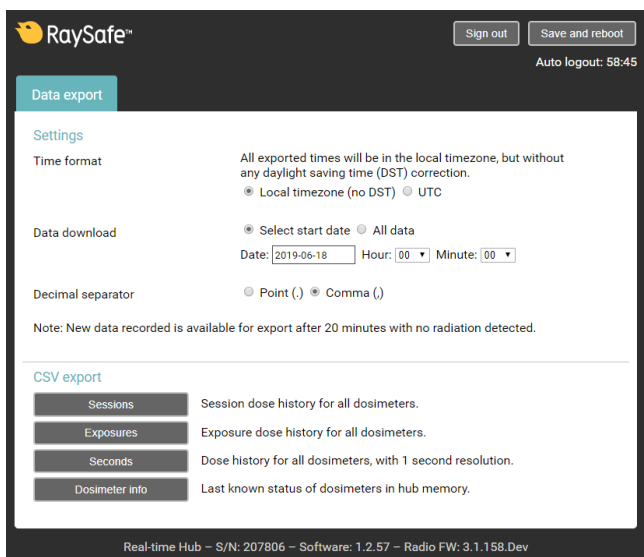


Figure 14. Real-time Hub Data export.

## EXPOSURES

Exposure dose history for all dosimeters.

An exposure, or a dose event, is defined from the instance in time when the first dosimeter reports dose until the last dosimeter reports dose. Each pedal press on an interventional machine generates an exposure in the memory of the Real-time Hub. The data set contains the time stamp for each exposure, dosimeter ID for all connected dosimeters during the exposure and the detected dose for each dosimeter. An RSO or physicists can use this data to monitor, visualize and investigate the delivered dose, average dose rates and the length distribution of the exposures. The data can be used for forensic purposes to understand when and where the staff is exposed.

## SESSIONS

Session dose history for all dosimeters.

A session is a series of exposures. A new session is commenced when no radiation has been detected for 15 minutes. The dose reported in each session can be used to monitor dose trends among the staff in performed procedures. Comparison can also be made between interventional suits or specific procedures.



## SECONDS

Dose history for all dosimeters, with 1 second resolution.

The seconds log contains all dose registered by all connected dosimeters, with one second resolution. The data can be used to do more thorough forensic investigations of radiation exposures. The data set contains the time stamp for each reported dose sample, dosimeter ID and the measured dose.

## DOSIMETER INFO

Last known status of dosimeters in hub memory.

Dosimeter info log contains id, name, full name, role, position, battery status and the time for latest connection for all dosimeters in the hub memory.

# SETTINGS EXPLAINED

## VIDEO UNIT

### SIGN IN



Figure 15. Video Unit Sign in screen.

Sign in for the system configuration. The default password is `raysafe`.

### SET-UP TAB

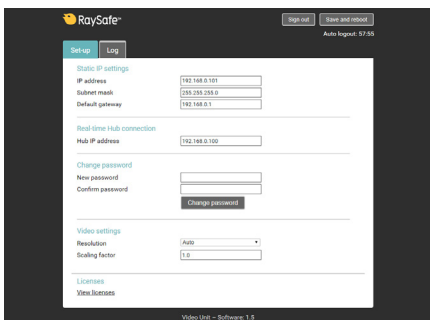


Figure 16. Video Unit Set-up tab.

PARAMETER	EXPLANATION
IP address	Enter the IP address for the Video Unit.
Subnet mask	Enter the address for the Subnet mask.
Default gateway	Enter the address for the Default gateway.
Hub IP address	Enter the IP address for the Real-time Hub connected to the system.
Password	Change the password for the Video Unit.
Video settings, Resolution Video settings, Refresh rate (Hz)	Auto will use the resolution preferred by the monitor and is suitable in most cases.  If there are problems with the automatic resolution, you can manually select a resolution from the list. The options for <i>Resolution</i> and <i>Refresh rate</i> are defined by the connected monitor.
Video settings, Scaling factor	In some cases, you need to scale the picture for proper fit.

## LOG TAB

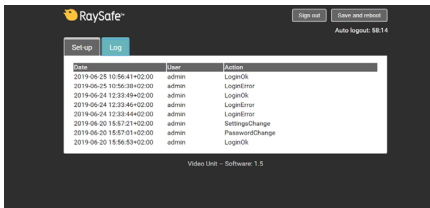


Figure 17. Video Unit Log tab.

The log contains events in the Video Unit, such as setting changes, login attempts and password changes.

## REAL-TIME HUB

## SIGN IN

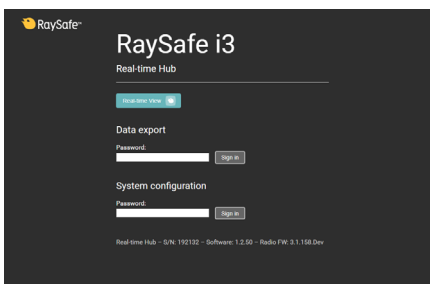


Figure 18. Real-time Hub Unit Sign in screen.

Press the button *Real-time View* to see a duplicate of the Real-time View in a web browser.

**NOTE:** *More than 3 simultaneous connections to the Real-time View may impact the refresh rate.*

Sign in to *Data export* for access to only the export files. The default password is `raysafe`. You will only have access to the *Data export* tab.

Sign in for the system configuration. The default password is `raysafe`.

## CONFIGURATION TAB

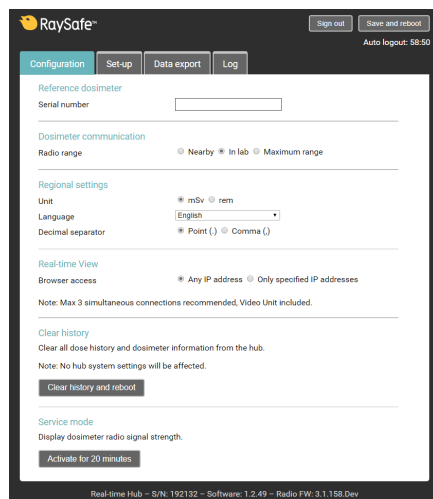


Figure 19. Real-time Hub Configuration tab.

PARAMETER	EXPLANATION
Reference dosimeter, Serial number	Enter the serial number of the reference dosimeter for use with the system.
Radio range	<i>Nearby</i> , <i>In lab</i> or <i>Maximum range</i> . The default setting <i>In lab</i> is suitable in most environments. Use <i>Maximum range</i> with care, since it can pick up dosimeters from other labs.
Unit	Displayed dose and dose rate unit. 1 mSv = 0.1 rem.
Language	The language displayed on the Real-time View, for example in error messages. The configuration interface is not affected by this setting.
Decimal separator	Use point or comma as decimal separator in the system. For the data export, <i>Point</i> as decimal separator will result in comma as list separator, and <i>Comma</i> as decimal separator will result in semicolon as list separator.
Browser access	The Real-time View can be accessed from the button Real-time View on the sign in page, or by pointing a web browser to <code>https://hubIP/display</code>  Note: More than 3 simultaneous connections to the Real-time View may impact the refresh rate.  It is possible to restrict access to up to two IP addresses, where the Video Unit normally should be one of them. Input fields for the IP addresses are shown when selecting <i>Only specified IP addresses</i> .
Clear history and reboot	Clear all the dose history data collected in the hub. The configurations are not affected, but the information under the <i>Log</i> tab is erased.
Service mode	For troubleshooting purposes, you can activate <i>Service mode</i> for 20 minutes. Radio signal strength will be displayed for all connected dosimeters, including the reference dosimeter and other dosimeters configured to be hidden. Service mode will turn off automatically after 20 minutes. If you want to turn it off manually, you can do this by rebooting the hub.

## SET-UP TAB

The screenshot displays the 'Set-up' tab of the RaySafe Real-time Hub configuration interface. It is organized into several sections: 'Real-time Hub' with a 'Lab name' field; 'Static IP settings' with fields for IP address, Subnet mask, Default gateway, DNS server, and two Time (NTP) server fields, each with a 'test NTP server' button; 'Hub time' showing the current time and source; 'Change data export password' and 'Change system configuration password' sections, each with 'New password' and 'Confirm password' fields and a 'Change password' button; 'Dose Manager access' with a radio button for 'Enabled' (selected) and 'Disabled'; 'Connection test' with a 'Remote host' field and a 'Ping' button; 'Install a https certificate' with a file selection field, a password field, and an 'Upload, install and reboot' button; 'Currently installed certificate' showing 'O=RaySafe, CN=RaySafe Root CA'; 'Software update' with a file selection field and an 'Upload and reboot' button; and a 'Licenses' section with a 'View licenses' link. The top navigation bar includes 'Configuration', 'Set-up', 'Data export', and 'Log' tabs, along with 'Sign out' and 'Save and reboot' buttons. The bottom status bar indicates 'Real-time Hub - S/N: 192132 - Software: 1.2.50 - Radio FW: 3.1.158 Dev'.

Figure 20. Real-time Hub Set-up tab.

PARAMETER	EXPLANATION
IP address	Enter the IP address for the Real-time Hub.
Subnet mask	Enter the address for the Subnet mask.
Default gateway	Enter the address for the Default gateway
DNS server	If you want to use NTP servers defined by hostnames, you need to specify a DNS server.
Time (NTP) server 1	IP number or hostname for a time server to set the hub time.
Time (NTP) server 2	IP number or hostname for a time server to set the hub time.
Hub time	The current hub time. Updated every fifth second.
Current time source	The hub time can be set by NTP servers, reference dosimeter or from a regular dosimeter. NTP server is recommended.
Data export password	Change the password for the data export account in the Real-time Hub.
System configuration password	Change the password for the system configuration account in the Real-time Hub.
Dose manager access	If you don't want to use Dose Manager with your system, you can disable the Dose Manager access. This action will close port 8060 and 8070 in the hub.

PARAMETER	EXPLANATION
Connection test	Check the connectivity for the hub by pinging for example the Video Unit.
Install a https certificate	If you want to use a custom https certificate, you can install it on the hub. The hub needs to reboot to start using the new certificate. Only https certificates in pfx formats are supported.
Software update	If the hub needs a software update, you select a file for upload and follow the instructions.

## DATA EXPORT TAB

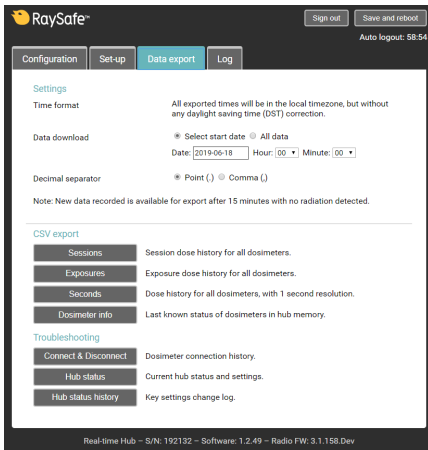


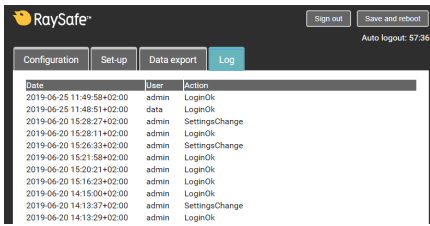
Figure 21. Real-time Hub Data export tab.

For the *CSV export* choices, see “Data export” on page 24.

When you log in with the System configuration account, you will also access the following exports below the header *Troubleshooting*.

BUTTON	EXPLANATION
Connect & Disconnect	A log of <ul style="list-style-type: none"> <li>dosimeter connect and disconnect events</li> <li>hub reboots</li> <li>hub time set events.</li> </ul>
Hub status	An overview of the most important status parameters for the hub.
Hub status history	A change log for the most important configuration change events. <p><b>NOTE:</b> <i>Selecting Local timezone for export will not be reflected in this export, which always uses the time defined by the time source (UTC if NTP is used).</i></p>

## LOG TAB



Date	User	Action
2019-06-25 11:49:58+02:00	admin	LoginOk
2019-06-25 11:48:51+02:00	data	LoginOk
2019-06-20 15:28:27+02:00	admin	SettingsChange
2019-06-20 15:28:11+02:00	admin	LoginOk
2019-06-20 15:26:23+02:00	admin	SettingsChange
2019-06-20 15:21:58+02:00	admin	LoginOk
2019-06-20 15:20:21+02:00	admin	LoginOk
2019-06-20 15:16:23+02:00	admin	LoginOk
2019-06-20 14:15:00+02:00	admin	LoginOk
2019-06-20 14:13:37+02:00	admin	SettingsChange
2019-06-20 14:13:29+02:00	admin	LoginOk

Figure 22. Real-time Hub Log tab.

The log contains events in the Real-time Hub, such as setting changes, login attempts and password changes.

# TROUBLESHOOTING

PROBLEM	POSSIBLE REASON	ACTION
I cannot configure my computer network to connect directly with Ethernet cable to the Real-time Hub.	Local IT department rules.	<p>You can use a USB memory to configure the hub. Save a pure text file named <code>raysafe.cfg</code> on the root of the USB memory (formatted as FAT32) with the following content. Change the digits to your wished addresses.</p> <pre>dm_hub : { ipaddr = "192.168.0.100"; netmask = "255.255.255.0"; defaultgw = "192.168.0.1"; nameserver = "192.168.0.1"; };</pre> <p>Connect the USB memory to a USB port on the hub. Restart the hub while the USB memory is connected. When the hub is restarted, the settings will be changed and you can disconnect the USB memory.</p>
I cannot configure my computer network to connect directly with Ethernet cable to the Video Unit.	Local IT department rules.	<p>You can use a USB memory to configure the Video Unit. Save a pure text file named <code>raysafe.cfg</code> on the root of the USB memory with the following content. Change the digits to your wished addresses.</p> <pre>videoadapter : { ipaddr = "192.168.0.101"; netmask = "255.255.255.0"; defaultgw = "192.168.0.1"; nameserver = "192.168.0.1"; hubip = "192.168.0.100"; };</pre> <p>Start the Video Unit and wait until the application is up and running (the display shows a start screen with IP numbers or a Real-time View).</p> <p>Connect the USB memory to the Video Unit and wait at least 5 seconds. Then disconnect the USB memory.</p> <p>The Video Unit will automatically reboot to start using the new settings.</p>



PROBLEM	POSSIBLE REASON	ACTION
Some dosimeters do not show up on screen.	Dosimeter problems.	<p>Check the dosimeter battery status by connecting the dosimeter to a computer running Dose Viewer.</p> <p>Verify dosimeter functionality with another system, if available.</p> <p>Check dosimeter configuration with Dose Viewer: (<b>Power mode: On, Real-time Display Mode: Show</b>) See “Initiate a Real-time Dosimeter” on page 8.</p>
	Dosimeter has connected to another system nearby.	<p>Ensure that hubs are positioned as far from each other as possible and near where the dosimeters are in use.</p> <p>Try other <i>radio range</i> settings for the hubs. See “Configuration tab” on page 28.</p>
	Real-time Hub poor positioning.	<p>Check that the dosimeter is in line of sight with the hub. Try moving the hub closer to the dosimeters.</p> <p>You can observe the connection strength by activating <b>Service mode</b> for 20 minutes. See “Configuration tab” on page 28. Radio signal strength will be displayed for all connected dosimeters, including reference dosimeter and other dosimeters configured to be hidden.</p>
	Radio configuration problems.	Increase radio range in Real-time Hub settings. The default setting <b>In lab</b> is suitable in most environments. <b>Maximum range</b> is not recommended, since it can pick up dosimeters from other labs.
	Frequencies of dosimeters and Real-time Hub do not match.	Check labels on the back of the dosimeter and the Real-time Hub to verify that they communicate on the same frequency.
Dosimeter does not disappear from screen after 9 minutes of inactivity.	Dosimeter power mode settings not suitable.	Check that the dosimeter power mode is set to <b>On</b> . See “Initiate a Real-time Dosimeter” on page 8. If the dosimeter power mode is set to <b>Advanced: Always on</b> , the dosimeter will not automatically fall asleep.
Dosimeter visible on the display but does not seem to record dose.	Dosimeter has connected to another system nearby.	<p>Ensure that hubs are positioned as far from each other as possible and near where the dosimeters are in use.</p> <p>Try other radio range settings for the hubs. See “Configuration tab” on page 28.</p>
	Defective dosimeter or bad radio connection.	Test the dosimeter with another system (if available).
The history bars to the right of the Real-time View is not visible.	No reference dosimeter configured.	If the system has a reference dosimeter mounted, verify that the serial number of the reference dosimeter is entered. See “Configure the Real-time Hub” on page 15.
	No connection with reference dosimeter.	Activate <b>Service mode</b> (see “Configuration tab” on page 28) to view the communication strength of the dosimeters, including the reference dosimeter.
Dosimeter turns off (disappears from the screen) in unwanted situations.	The auto power save is not suitable for the application.	Change the Power Mode setting to <b>Advanced: Always on</b> . This may decrease the battery life.
	Dosimeter has connected to another system nearby.	<p>Ensure that hubs are positioned as far from each other as possible and near where the dosimeters are in use.</p> <p>Try other radio range settings for the hubs. See “Configuration tab” on page 28.</p>

PROBLEM	POSSIBLE REASON	ACTION
There is a blinking red light on the side of the dosimeter.	The battery needs to be replaced.	Follow the instructions in “Dosimeter battery replacement” on page 22.
I cannot reach the sign in page of the Video Unit or the Real-time Hub.	Forgot IP number.	Disconnect the Video Unit from the network. The screen will show the IP address of the Video Unit and the Real-time Hub.  Other solutions: Check with the local IT department or look for a note in “Pre-installation checklist” on page 5.
	Forgot <code>https://</code> in the address.	Write the address as:  <code>https://IP-number</code>
I cannot sign in to the Video Unit.	Forgot password.	To reset the password to factory default ( <code>raysafe</code> ), save a pure text file named <code>raysafe.cfg</code> directly on a USB memory. The content of the file must be:  <pre>videoadapter : { usrpassw = ""; };</pre> Do not write anything between the quotation marks.  Start the Video Unit and wait until the application is up and running (the display shows a start screen with IP numbers or a real-time view).  Connect the USB memory to the Video Unit and wait at least 5 seconds. Then disconnect the USB memory.  The Video Unit will automatically reboot and reset the password to the default: <code>raysafe</code> .
I cannot sign in to the Real-time Hub.	Forgot password.	To reset the password to factory default ( <code>raysafe</code> ), save a pure text file named <code>raysafe.cfg</code> directly on a USB memory (formatted as FAT32). The content of the file must be:  <pre>dm_hub : { usrpassw = ""; };</pre> Do not write anything between the quotation marks.  Connect the USB memory to a USB port on the hub. Restart the hub while the USB memory is connected. When the hub is restarted, disconnect the USB memory. This will reset the password to the default: <code>raysafe</code> .
I want to reset the Real-time Hub to factory defaults.	Start over the installation.	Remove the cover and press and hold <b>button 1</b> for 10 seconds to reset the configuration to default settings.

PROBLEM	POSSIBLE REASON	ACTION
Error message on screen: No connection with reference dosimeter. Contact service.	Reference dosimeter serial number incorrect in hub configuration.	Check and correct the reference dosimeter serial number in the hub configuration interface.
	Reference dosimeter battery needs to be replaced.	Follow the instructions in “Dosimeter battery replacement” on page 22.
	Real-time Hub gives blind spot for radio at some places in the room.	Check that the dosimeter is in line of sight with the hub.  You can observe the connection strength by activating <i>Service mode</i> for 20 minutes (see “Configuration tab” on page 28). Radio signal strength will be displayed for all connected dosimeters, including reference dosimeter and other dosimeters configured to be hidden.
Error message on screen: Reference dosimeter battery low. Contact service.	Reference dosimeter battery needs to be replaced.	Follow the instructions in “Dosimeter battery replacement” on page 22.
Error message on screen: Internal storage error. Dose history cannot be stored. Contact service.	Problems with data storage in hub.	Try turning off the hub for a few seconds and turn it on again. If the problem remains, or if you cannot turn off the hub, wait to see if it still remains after the next automatic reboot, which normally happens within 24 hours during a long time of inactivity. If the problem still remains, the hub needs to be replaced.
Error message on screen: Hub internal radio out of order. Contact service.	Radio stick not properly mounted.	Open the hub and verify that the radio stick is properly mounted.
	Problems with the radio unit in the hub.	Wait for 10 minutes. The hub will try to restart the internal radio unit. If the problem remains, try turning off the hub for a few seconds and turn it on again. If the problem remains, or if you cannot turn off the hub, wait to see if it still remains after next automatic reboot, which normally happens within 24 hours during a long time of inactivity. If the problem still remains, the hub needs to be replaced
Error message on screen: Time source not available. Dose history cannot be stored. Contact service.	There are problems with the configured time source (NTP server or reference dosimeter).	If time source is NTP server, check the configuration of the NTP servers. Test the connection with the button “Test NTP server”.  If time source is reference dosimeter, see the error message “No connection with reference dosimeter” above.
Problems downloading CSV files (Data export).	Hub time incorrect.	If the hub time is incorrect, you might not get any data in your date selection. Check your time source, see “Set-up tab” on page 29 for more information. Reboot the hub to start using any changed settings.
	Cookies in web browser block the download.	Clear the cookies in your web browser and try again.
I get “403 Forbidden” when trying to access the Real-time View, either by pressing the button from the configuration or by entering <code>https://hubIP/display</code>	The browser access to the Real-time View is restricted to specific IP addresses.	Check the <i>Browser access</i> settings under the <i>Configurations</i> tab in the Real-time Hub configuration interface. See “Configuration tab” on page 28.

PROBLEM	POSSIBLE REASON	ACTION
Hub time is incorrect.	Time source sends wrong time.	Check the time source under the Set-up tab in the Real-time Hub configuration interface, “Configuration tab” on page 28. If a reference dosimeter is the time source, the time setting in the dosimeter might be incorrect. Connect the dosimeter to Dose Viewer and set the time, see “Initiate a Real-time Dosimeter” on page 8.
I have connected two video cables to the Video Unit, but I only get video signal in one of them.	Only one video connection can be used at a time.	If you want to have the Real-time View on several screens, you can use the <i>Browser access</i> option, see “Set-up tab” on page 29.

## MEASUREMENT PERFORMANCE VERIFICATION

All dosimeters are delivered calibrated, with no need for re-calibration during their lifetime. See the radiological specification in the accompanying *Instructions for Use*. If you want to check the measurement accuracy, we recommend the following arrangement.

The purpose of this test is to verify the measurement performance of dosimeters using scattered radiation from diagnostic X-ray units.

**CAUTION:** *Do not expose yourself to X-ray radiation.*

Required equipment:

- Two PMMA phantoms or other scattering material, for example a bucket with water.
- Dosimeters for test
- Real-time Hub, Video Unit and display, for dosimeter readings

### INSTRUCTION

1. Place one of the phantoms (simulating the patient) on the patient support. Use a large phantom or a bucket filled with water.
2. Place the other phantom (simulating the staff) at the same height, but 1.5 m away from the first one.
3. Place the dosimeter at the staff phantom, centered on the side facing the patient phantom. Test one dosimeter at a time.
4. Expose with a field fully covering the patient phantom, at 80 kVp set, 4 mA, for 60 s. Adjust the mA to get a dose rate of above 1 mSv/h. The dose rate can also be increased by placing a larger (or several) phantom(s) to simulate the patient.
5. Note the dose rate from the display. Repeat steps 1 – 4 with the dosimeters you want to compare.



Figure 23. Performance verification arrangement. 1. Patient phantom. 2. Staff phantom. 3. Dosimeter. 4. X-ray field.

**NOTE:** *Radiologic specification in Instructions for Use (separate document).*

# TECHNICAL DATA

## REAL-TIME DOSIMETER

CHARACTERISTIC	MEASURE
Weight	34 g (1.2 oz)
Dimensions (W × H × D)	40 × 58 × 17 mm (1.6 × 2.3 × 0.7 in)
Mounting	Clip and lanyard holder
Communication interface	USB, radio
Battery type	CR2450, Li/MnO <sub>2</sub>
Battery life	Approximately 1 year of normal use
Radio frequency	866.0 MHz, 868.3 MHz, 927.9 MHz or 918.3 MHz (depending on purchased configuration)

## REAL-TIME HUB

CHARACTERISTIC	MEASURE
Weight	180 g (6.3 oz)
Dimensions (W × H × D)	184 × 134 × 35 mm (7.2 × 5.3 × 1.4 in)
Power supply	Power over Ethernet: GT-963003648-T3-PP (included)
Communication interfaces	Ethernet 100 Mbps, radio
Radio frequency	866.0 MHz, 868.3 MHz, 927.9 MHz or 918.3 MHz (depending on purchased configuration)

## VIDEO UNIT

CHARACTERISTIC	MEASURE
Weight	355 g (12.5 oz)
Dimensions (W × H × D)	112 × 84 × 34 mm (4.4 × 3.3 × 1.3 in)
Power supply	External supply: EA1024PR
Video output	HDMI 1.4b, Mini DP (only one can be used at a time)

## REAL-TIME DOSIMETER RACK

CHARACTERISTIC	MEASURE
Dimensions (WxHxD)	300 × 63 × 20 mm (11.8 × 2.5 × 0.8 in)

## CLIMATIC CONDITIONS

PARAMETER	MEASURE
Temperature	+15 °C – +35 °C (for operation) -25 °C – +70 °C (for storage)
Temperature rate of change	< 0.5 °C/minute
Relative humidity	20 – 80 % (for operation) 5 – 95 % (for storage)