RAYSTATION 11B SPC1

RayCommand 2B SPC1 Instructions for Use

RayCommand

2B

Declaration of conformity

CE 2862

Complies with Medical Device Regulation (MDR) 2017/745. A copy of the corresponding Declaration of Conformity is available on request.

Safety notices

This user documentation contains WARNINGS concerning the safe use of the product. These must be followed.

> ⚠️ **WARNING!**
>
> The general warning sign informs you of a risk for bodily harm. In most cases the risk is related to mistreatment of the patient.

Note: *The note gives additional information concerning a specific topic, for example, things to consider when performing a certain step in an instruction.*

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Printed material

Hard copies of Instructions for Use and Release Notes related documents are available upon request.

Trademarks

RaySearch Laboratories

TABLE OF CONTENTS

1   INTRODUCTION

About RayCommand

The RayCommand application integrates with RayCare to allow the clinic to deliver plans created in RayStation as treatment sessions on treatment systems with a patient positioning system.

This manual describes the parts of the workflow that are directly related to the delivery of treatment plans and controlling the patient positioning system:

- Handling treatment appointments created in RayCare

- Preparation of the patient positioning system for imaging and delivery in RayCommand

- Performing treatment delivery in RayCommand

- Monitoring the treatment machine and patient positioning system using the RayCommand Machine monitor

About this manual

This document is an addition to *RSL-D-RS-11B-USM, RayStation 11B User Manual* and summarizes some of the most important features of the RayCommand application.

The document includes appendices that are also parts of *RSL-D-RS-11B-USM, RayStation 11B User Manual* and *RSL-D-RS-11B-RPHY, RayStation 11B RayPhysics Manual*, relevant for RayCommand users.

Study this manual and the *RSL-D-RS-11B-IFU, RayStation 11B SPC1 Instructions for Use* carefully before using the RayCommand application. Proper functioning of the device can only be guaranteed if the instructions in these documents are adhered to.

Study the Release Notes in this manual as well as the *RSL-D-RS-11B-RN, RayStation 11B SP1 Release Notes* carefully. These notes provide final instructions on how to use the RayCommand application.

The RayStation 11B system is further described in the RayStation 11B product documentation.

Refer to the RayCare 5B product documentation for information about the RayCare 5B system.

2   PRODUCT INFORMATION

This chapter describes the RayCommand product label. For product information regarding the RayStation 11B system, refer to the *RSL-D-RS-11B-IFU, RayStation 11B SPC1 Instructions for Use*.

The version number of an installed RayStation 11B system can be found by choosing **Help: About RayStation** in the RayCommand menu.

The following information can be identified:

- Product name = RayStation

- 产品型号: RayStation   (for the Chinese market only)

- Release version = **12.1**

- Marketing name = RayStation RayCommand 2B SPC1

- Software build number = **12.1.1.41**

- Clinical build = Indicates that the software is designed for clinical use.

    Note: A clinical installation requires both a clinical build and a clinical license. Otherwise, 'Not for clinical use' will be displayed in the title bar.

- Product lifetime = The lifetime per market is one year after the next major release, but no less than three years

- Radiation Treatment Planning System Software = The generic name of the product

- 产品名称: 放射治疗计划系统软件 (for the Chinese market only)

- MD = Indicates that the product is a medical device

- UDI = Unique Device Identification number

- CE 2862 = The CE mark and the notified body number

- = Production date

- = Consult instructions for use

- = The name and address of the manufacturer

- @ = The support e-mail address

About RayCommand   ✕

RaySearch Laboratories

RayStation

Product name: RayStation   CE 2862
产品型号: RayStation
Release version: 12.1   ⋀ 30 Mar 2022
Marketing name: RayStation RayCommand 2B SPC1
Software build no: 12.1.1.41   📖 Consult instructions for use

Clinical build   🏭 RaySearch Laboratories AB (publ)
                                                     Eugeniavägen 18
Product lifetime: The lifetime per   SE-113 68 Stockholm
market is one year after the next   Sweden
major release, but no less than three
years   @ support@raysearchlabs.com

Radiation treatment planning system software
产品名称: 放射治疗计划系统软件
MD Medical device
UDI 0735000201058720220330

                                                            [Close]

Figure 1.   The **About RayCommand** dialog.

3 INFORMATION NEEDED FOR SAFE OPERATION

Adhere to the following warnings as well as the warnings described in *RSL-D-RS-11B-IFU, RayStation 11B SPC1 Instructions for Use* for safe operation of the RayCommand application.

3.1 SAFETY PRECAUTIONS

3.1.1 General warnings

⚠️ **WARNING!**

Ensure sufficient training. The user organization shall ensure that individuals authorized to perform treatment functions are appropriately trained for the functions they perform. Only individuals authorized to enter and accept machine setup or other patient treatment data should use this software. Carefully read all instructions prior to use. The user is responsible for proper clinical use and the prescribed radiation dose.

(334374)

⚠️ **WARNING!**

Installation and reconfiguration testing. The correct functioning of RayCommand depends on configuration and external systems. Configuration changes in RayCommand, RayCare or RayStation require testing according to *RSL-D-RS-11B-RCMDITS, RayStation 11B RayCommand 2B Installation Test Specification*.

(334371)

3

> ⚠️ **WARNING!**
>
> **Ensure unobstructed view of patient.** Always ensure unobstructed view of the patient before and during irradiation or any other activity related to risk of patient safety.
>
> (334373)

> ⚠️ **WARNING!**
>
> **Only results from completed treatment sessions are displayed in RayCare.** The results of the treatment sessions will not be displayed in RayCare until the session is completed. If it is not possible to complete the session, the result will not be displayed in RayCare.
>
> (334370)

> ⚠️ **WARNING!**
>
> **Safety when moving gantry and snout.** When the patient is finally positioned for treatment, the gantry and snout positions must be verified before the last medical personnel leaves the treatment room.
>
> (334391)

> ⚠️ **WARNING!**
>
> **Safety when moving table top.** When using the motion service in RayCommand to move the patient positioning device, the user operating the Operator Deadman's Switch (ODS) must be attentive during the complete range of movement. The ODS must be released immediately when there is a risk of collision or patient injury.
>
> (334372)

> ⚠️ **WARNING!**
>
> **Patient movement between imaging and completed treatment.** Patient movement between imaging and completed treatment is not automatically detected. Patient movement after imaging may cause incorrect patient setup.
>
> (334434)

> ⚠️ **WARNING!**
>
> **Some state may not be persisted in services or drivers.** If the RayCommand room driver is restarted, the driver's cache of the state of external systems is lost. After a restart, the state will be unknown until the external system is reset.
>
> (334439)

> ⚠️ **WARNING!**
>
> **Configuration of treatment room machine models.** Only compatible machine models must be listed in the machine models list when configuring the treatment room. Incorrect configuration can cause failure of service or incorrect treatment delivery.
>
> (342666)

> ⚠️ **WARNING!**
>
> **Review automatic registration.** Always ensure that the automatic registration between the setup images and the planning CT is properly done by manually reviewing the result.
>
> (344618)

3

> ⚠️ **WARNING!**
>
> **Imaging ring position.** RayCommand does not detect if the imaging ring is blocking the beam. Before delivering the beam, always ensure that the imager source, detector and ring are in a safe position that does not block the beam path.
>
> (344503)

> ⚠️ **WARNING!**
>
> **Possible to approve/export plan with outdated setup instructions.** In RayStation, the fixation devices in the setup instructions are cached when a patient is loaded in RayStation and remain unchanged as long as the patient is opened. Hence, warnings related to fixation devices at plan approval/export will operate on old data if the setup instructions have been changed elsewhere while the patient was opened in RayStation. A consequence is that any actions performed in RayStation that depend on setup instructions (e.g., creation of fixation device ROIs, performing a collision check, etc.) may be invalid.
>
> (408999)

> ⚠️ **WARNING!**
>
> **Possible to approve/export plan with collision based on outdated imaging device transformation.** The RayStation collision check result is not invalidated if the imaging device transformation (IDT) vector for the treatment room is changed in Clinic Settings. It is the user's responsibility to ensure that the collision check is re-run for unapproved beam sets if the IDT is updated.
>
> (409517)

> ⚠️ **WARNING!**
>
> **Changing IDT requires re-assignment of beam sets to ongoing treatment courses.** A changed IDT affects the calculated table top positions in the plan, thus the beam set to be used in subsequent sessions must be re-added to the Treatment Course via the Use plan in treatment course dialog to apply the updated IDT.
>
> (410055)

> ⚠️ **WARNING!**
>
> **Room view is an approximate representation of the treatment room and must not be used for determining patient setup or collisions.** Room view is not sufficiently accurate for determining patient setup or collisions.
>
> (410298)

⚠️ **WARNING!**

Ensure that the correct setup beam is used for imaging. In RayCommand there is no connection between the setup beams and the treatment beams. For plans with multiple isocenters, the user must be aware of the risk of using the wrong setup beam. If setup images are acquired based on the wrong imaging position, the patient displacement for the resulting registration may be unsuitable for the treatment beam. Always give the setup beam a unique and understandable name so that the correct setup beam is selected for image acquisition and registration before beam delivery. The body site for the setup beams can be used as a redundant indication of where the setup beam isocenter is positioned.

(410108, 410398)

⚠️ **WARNING!**

Machine models. The user who configures which machine models are supported in which rooms shall have a very clear understanding of the clinic and it's rooms and machine models. It is strongly discouraged to remove or rename any machine model in the configuration of a room. Instead it is recommended to deprecate the machine in RayPhysics if a machine model is not to be used anymore. It is still possible to add new machine models to a room.

(341177)

3

⚠️ **WARNING!**

Make sure that the intended plan is used. All plans can be included in the treatment course, regardless of the prescription or the planned number of fractions. Exercise caution when assigning different plans to different fractions.

(7190)

> ⚠️ **WARNING!**
>
> **Prescription in Approve treatment course dialog.** The planned prescribed nominal dose shown in the *Approve treatment course* dialog is the sum of the nominal dose contributions for all fractions in the treatment course. The prescription is not automatically synchronized between RayStation and RayCare. The user is responsible for making sure that the prescription in the *Approve treatment course* dialog corresponds to the prescription in RayCare.
>
> (341634)

4   RELEASE NOTES

This chapter contains important notes about the use of the RayCommand application. It contains information related to patient safety and lists new features, known issues and possible workarounds.

Every user of the RayCommand application must be familiar with these known issues as well as the known issues described in *RSL-D-RS-11B-RN, RayStation 11B SP1 Release Notes***.** Contact the manufacturer for any questions about the content.

Use compatible versions of RayCommand, RayCare and RayStation

When using RayCommand and RayCare with RayStation, the versions of the products must be compatible. For the release of RayCommand 2B SPC1 (version 12.1.1), validation was performed with RayStation 11B SP1 (version 12.1.0) and RayCare 5B SP1 (version 5.1.1). For other versions, check compatibility with RaySearch Service before use.

Note: *Beware that additional safety-related release notes may be distributed separately within a month of software installation.*

In this chapter

This chapter contains the following sections:

4

4.1   KNOWN ISSUES RELATED TO PATIENT SAFETY

RayCommand application

Machine parameter verification Range Shifter or Range modulator difference is not detected

If the planned nozzle filters are positioned OUT but the actual nozzle filters are positioned IN, the difference will not be displayed in the machine parameter verification result. The only indication of mismatching nozzle filters is that the *NozzleInPosition* interlock is in an unexpected state (locked).

(576176)

4.2   OTHER KNOWN ISSUES

RayCommand application

Site prescriptions cannot be delivered

Only ROI prescriptions can be used in RayCommand. Avoid creating plans with any other prescription type.

(344850)

Plan specific tolerance table updates will not affect delivery

If a tolerance table for a beam set is updated using scripting, it will not be used for treatment. Only the template tolerance table will be used.

(406811)

PPS dialog: Memory leak may result in slow response from the system

The *Room navigator* allocates 150-200MB each time it is opened. When it is closed, the memory is not reclaimed. Restarting the main monitor will release the memory. If the system is responding slowly, try restarting the main monitor.

(398406)

The patient card for QA sessions does not show Case/Care plan

Verify that the correct plan is loaded when starting QA session.

(407612)

Level/window range slider gets stuck if both handles are moved to the far right

Sliders for min/max level and window, in image registration, can get stuck if both are moved to the far right. The stuck position can be resolved by selecting a preset.

(576173)

RayCare task for Confirm preparation is not reset when the preparation is reset in RayCommand

If the session preparation is reset in RayCommand, the corresponding task in RayCare will not be reset, but remain in state Complete. Always verify patient setup based on the situation in the treatment room, and not on the status of tasks and checked fixation devices in RayCommand.

(576174)

Approved registration not visible when restarting the Main monitor

The Registration panel in the Imaging module is locked after approving the registration. If the selected image set is not the image set used for the approved registration, the approved registration will not be displayed. This happens from any secondary Main monitor (not used to approve the registration), or if restarting the primary Main monitor. The registration must be unapproved to avoid the issue.

(576177)

Registration description is not displayed when registration is approved

Registration description is blank after approving the registration. The registration must be unapproved to display the description text.

(576178)

Possible to execute a path planned for previous session

Initiated PPS movement is not cleared when starting or stopping sessions. Never execute movements of the table top by using a planned path from a previous session.

(576179)

Canceling a session must be done from RayCommand only

RayStation must not be used for canceling sessions. Manual recording of a signed session in RayCommand will not update the treatment history in RayCare. RayCommand will display delivered meterset equal to 0 (zero) when there are manual records in RayStation, as RayCommand calculates the delivered meterset from the latest energy layer and spot.

(576194)

Confirming an enabled beam that was previously disabled may cause an error

Confirming a beam after enabling a disabled beam may cause the error "Unsupported BeamLineType 'UNKNOWN'". It is not possible to recover from this state during the ongoing session. To continue, complete the session and create a continuation session.

(576904)

Continuing a session from the next beam is not possible during a continuation session

During a continuation session, it is not possible to continue from the next beam by selecting *Beam* in the *Create continuation* dialog. Instead, disable the first beam and then continue the delivery on the next beam.

(576923)

Session for another day not visible if scheduled while a session is in progress for the patient

If sessions are scheduled in RayCare for another day while a session is in progress, these sessions will not be visible until the ongoing session is closed.

(576976)

4

RayStation application

Rotation point for patient displacement when geometry is missing in prescription ROI

The rotation point used for patient displacement in RayCommand is set to the geometrical center of the primary prescription ROI. If the primary prescription ROI does not have a geometry, the rotation point is set to 0,0,0 (Right-Left, Inf-Sup, Post-Ant).

(410343)

Room IR3 must define same nozzle elements as room IR2

The IR2 and IR3 rooms must be identically configured in Clinic Settings. The *Room navigator* in MedAustron room IR3 allows ad-hoc movements of vertical nozzle elements even though the room does not have a vertical nozzle. Using the command for moving the vertical nozzle elements in IR3 will result in an error message.

(407995)

Old beam set note may remain in the treatment course when clearing and reassigning an updated plan

If a beam set is assigned to the treatment course and the note for the beam set is changed, the note will remain even if the user unassigns the beam set from the treatment course, changes the beam set comment in Plan design in RayStation, and reassigns the beam set to the treatment course.

(576175)

Collision check: Imaging ring is sometimes visible in Room view

The imaging ring is sometimes visible in the collision check Room view in RayStation even though the imaging ring is never considered in the collision check calculation in RayStation. However, the imaging ring is always visible and considered in the path planning in RayCommand.

(410803)

Not possible to use a plan with sag-corrected POI and multiple isocenters in treatment course

Plans with sag-corrected POI and multiple isocenters will crash if they are used in treatment course. Contact RaySearch support.

(576182)

RayCare application

No beam set and plan when scheduling fraction 1.1 in RayCare

In rare cases, scheduled continuation sessions are not assigned room or beam set in RayCare. This can be corrected by the following steps: unapproving the treatment course, clearing the beam set, assigning the beam set and approving the treatment course.

(576180)

RayCommand, RayStation and RayCare applications

Faulted session is shown as Partially delivered in RayCommand, RayCare and RayStation

Faulted sessions are shown as Partially delivered. It is not possible to distinguish between faulted sessions and partially delivered sessions in RayCommand, RayCare and RayStation. Use RayCare to cross-check sessions that must be signed off.

(576181)

4.3   UPDATES IN RAYCOMMAND 2B SPC1

This chapter describes the updates in RayCommand 2B SPC1 as compared to RayCommand 2B.

4.3.1   News and improvements in RayCommand 2B SPC1

RayCommand application

Movement of in-room components

- It is now possible to move the table top without first having to run the path planner with collision detection. To be able to do this the user must select and approve this.

- It is now possible to select a new goal position for the table top and do a preview of the path before executing the movement.

- Possibility to move to treatment position directly in *Delivery* module has been added. In the previous version, the user had to open the *Room navigator* and the *PPS* tab.

- Possibility to move the imaging ring to parking positions directly in *Imaging* module has been added. In the previous version, the user had to open the *Room navigator* and the *Imager* tab.

Manual editing of treatment records

- It is now possible to edit/delete manual records. In the previous version, manual treatment records could only be added (not edited or deleted).

Schedule

- Possibility to see other dates than today has been added. In the previous version, the user could only view the scheduled sessions of today.

- *Start in limited mode* has been added. It is used for opening sessions to be able to sign unsigned or faulted session.

Imaging module

- Improvements have been done to the registration view, to registrations, and to the view of DRRs and RT images.

- When sending an image request to medPhoton, weight and length from RayCare are used.

4

Physical collision check

- It is now possible to enter an isocenter and move to this position without having the patient checked in. It is also possible to add different setup margins and examine if it is possible to reach them.

Collision check

- An imager has been added to collision detection:

    - When moving the imager, a control will be made to verify that it will not collide with anything in the room.

    - When acquiring images, a control will be made to verify that it will not collide with anything in the room.

- Gantry and snout have been added to the collision detection. When moving the gantry or the snout, a control will be made to verify that it will not collide with anything in the room.

Delivery module

- Beam list has been updated with new columns, and some columns have also been removed.

RayStation application

Extended support for QA planning

- Possibility to create QA plans also for treatment plans using medPhoton imaging has been added. Note that the created QA plan will not have motion synchronization defined.

Improvements in the Treatment course tab

- The tooltip displayed for an approved treatment course now includes information about the user who approved the treatment course, and also the approval time.

- The option to refresh the treatment course has been added, displayed when right-clicking in the treatment course panel. Refreshing the treatment course synchronizes data with RayCare.

4.3.2   Found issues

RayCommand application

- The following new safety related issue has been found, described in detail in *section 4.1 Known issues related to patient safety on page 18*:

    576176

- The following new issues (not safety related) have been found, described in detail in *section 4.2 Other known issues on page 18*:

576173, 576174, 576177, 576178, 576179, 576194, 576904, 576923, 576976

RayStation application

The following new issues (not safety related) have been found, described in detail in *section 4.2 Other known issues on page 18*:

410803, 576175, 576182

RayCare application

The following new issue (not safety related) has been found, described in detail in *section 4.2 Other known issues on page 18*:

576180

RayCommand, RayStation and RayCareapplications

The following new issue (not safety related) has been found, described in detail in *section 4.2 Other known issues on page 18*:

576181

4.3.3 Resolved issues

RayCommand application

Resolved: Possible to start session when setup instruction versions differ

When starting a session in RayCommand, the setup instructions are now validated to correspond to the latest version of the setup instructions in RayCare.

(332782)

Resolved: *Confirm preparation* state is not cleared when stopping a session

There was an issue where the *Confirm preparation* state was saved and persisted in a session, and not cleared when the session was stopped. This has now been resolved.

(409600)

Resolved: Patient weight and size are not retrieved from RayCare for image acquisition requests

The imaging acquisition request sent to MedPhoton Console was not using *Patient Weight* and *Patient Size* from RayCare. The imaging energy had to be adjusted as needed from the MedPhoton Console before initiating the imaging protocol. This has now been resolved.

(410401)

Resolved: The continuation operation *Next beam* is not working

There was an issue with the continuation operation *Next beam*, where an error was displayed during *Initiate beam line*. A make-up plan had to be created in RayStation if the remainder of the beam was less than the possible minimum with regards to energy layer and spot. This has now been resolved.

(410868)

Resolved: Avatar and fixation devices not included in the path planning collision model
Path planning did not account for patient and fixation device structures in collision detection. This has now been resolved.

(411019)

Resolved: Check the status of previous offline image reviews in RayCare before starting a treatment session
There was no warning when starting a treatment session when there were rejected offline image reviews for the treatment course. The user had to check in RayCare to see the status of previous offline image reviews. This has now been resolved.

(333534)

Resolved: Verify that all tasks have been completed before completing session
There was an issue with session completion, making it possible to complete a session in RayCommand without having completed all the configured tasks from the RayCare workflow. It is still possible to complete the session, but the user will be informed that there are unresolved RayCare tasks when completing a session.

(345098)

Resolved: Beamline name is not shown
The name of the beamline was not shown in the *Beam preparation* panel. This has now been resolved.

(335201)

Resolved: Ensure correct room configuration
The user was required to use the *Room view* to verify the currently configured room of the motion service. This has now been resolved.

(410386)

Resolved: Inconsistent treatment record data sent to PACS
There was an issue with inconsistent treatment record data, where the post processing of the files must use Scan spot Meterset Weights (300A,0396) to determine the delivered meterset for a given session. This has now been resolved.

(410594)

Resolved: Confirm beam is not stored in audit log
The action *Confirm beam* was not stored as a separate action in the audit log. This has now been resolved.

(410696)

Resolved: Incorrect spot map for first beam in continuation session
When opening or starting a continuation session, the first beam to be delivered showed an incorrect spot map until the continuation had been created. This has now been resolved.

(410786)

Resolved: Beamline for continuation session cannot be initiated
There was an issue with the *Next layer* option for an in-session continuation, where the beam sometimes did not reach its planned meterset (within tolerance). This has now been resolved.

(410865)

Resolved: Collapse gantry angle button is shown inconsistently

The *Collapse gantry angle* button was hidden in Physics/QA mode but shown as enabled in Clinical mode. This has now been resolved.

(410951)

RayStation application

Resolved: The clear beam sets action crashes if the treatment course is not saved

There was an issue where unsaved changes in the treatment course could make the clear beam sets action crash. This has now been resolved.

(463763)

4

5   RAYCOMMAND

In this chapter

This chapter contains the following sections:

5

5.1 SYSTEM OVERVIEW

The RayCommand 2B system consists of two different applications: *RayCommand Main monitor* and *RayCommand Machine monitor*. The applications are intended to be run on one monitor each. Together they constitute a dual screen control system for the treatment control room.

Information displayed on the two monitors is meant to supplement each other. To get the best experience, the Machine monitor should be placed adjacent of the Main monitor in the control room.

An additional RayCommand Main monitor application can also be run separately, for example inside the treatment room.

5.1.1 Main monitor

The Main monitor provides workflow support and provides the user with tools and information for managing and delivering a selected session.

The list of tasks guides the user through the predefined activities to perform during the session. However, the user is always free to navigate to other parts of the interface.

The user interface in the Main monitor is divided into several areas:
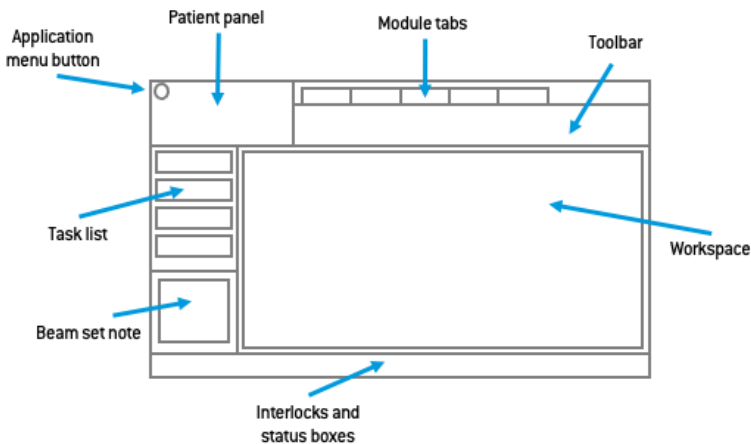
Application menu

The application menu button opens a menu with general application functionality. The application menu is opened by clicking the RayCommand icon in the upper left corner.
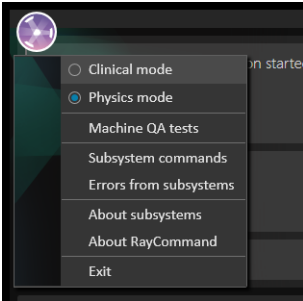
- **Clinical mode** – Normal treatment of patients.

- **Physics mode** – Non-clinical task, see *section 5.6 Physics mode on page 66*.

- **Machine QA tests** – Used to perform machine QA tests. Only available in Physics mode. See *section 5.6.1 Machine QA tests on page 68*.

- **Subsystem commands** – Commands that the user can trigger without having to be in a specific state.

- **Errors from subsystems** – Shows errors received from external subsystems, for example MAPTA and Exacure.

- **About subsystems** – Shows information collected from external subsystems (for example configuration version), and in some cases include the possibility to update the configuration version.

To update the subsystem configuration, the user must be part of the active directory group 'RayCommand-Administration'.

Patient panel
The **Patient** panel shows information about the patient for the current session.

Module tabs
The RayCommand application is divided into different parts called *modules*, which represent well-defined treatment activities. A module is accessed by clicking its module tab. The module tabs are placed sequentially from left to right, according to a typical treatment delivery workflow.

The treatment activities are:

- **Schedule**

- **Preparation**

- **Imaging**

- **Delivery**

- **Results**

Toolbar

The toolbar contains tools and information related to the session and the selected module. Some content in the toolbar is available in several modules.

Delivery information

During irradiation the progress of the beam delivery (current layer of total layers) is displayed.

Session information

The session information shows information about the current session, the plan and beam set to be delivered, and the modality of the treatment.

Task list

The task list guides the user through the tasks that have been assigned to the patient for the current session. Tasks are defined in RayCare as a part of the patient's care plan.

The task list panel is available in all modules apart from the Schedule module as soon as a session has been started.

Click on a task in the task list to open the **Task properties** dialog. Here the task can be set to completed.

Beam set note

This note comes from the beam set note in **Treatment course**. If the note is edited and saved, the edited note will be visible in sessions using this beam set. All saved changes to the note are transferred to RayCare.

Workflow button

Click on the **Workflow** button to complete the main activity in the current module.

• Click on the button to complete the activity without moving to the next module.

• Click on the arrow to complete the activity and navigate to the next module.

Complete delivery	▶

Open session	▶
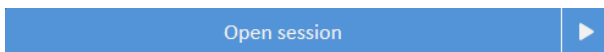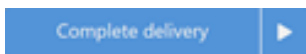
Workspace area

The workspace area displays information and functionality that is specific for the selected module.

Interlock and system status

Along the bottom of the main monitor, interlock and system status is displayed. This information is helpful to get a quick overview of the current state. Tooltips about subsystems show detailed status. Clicking on **System status** opens up a detailed view of individual service health status, and detailed error information if system health is degraded.

5.1.2   Machine monitor

The Machine monitor application complements the Main monitor with real time information from inside the treatment room and from the different devices included.

The main purpose of the Machine monitor application is to monitor the treatment devices. The interface is fixed, and all content is in the same place all the time. This provides users with current information and situational awareness.

5.2   MAIN MONITOR MODULES AND WORKFLOW

5.2.1   Schedule module
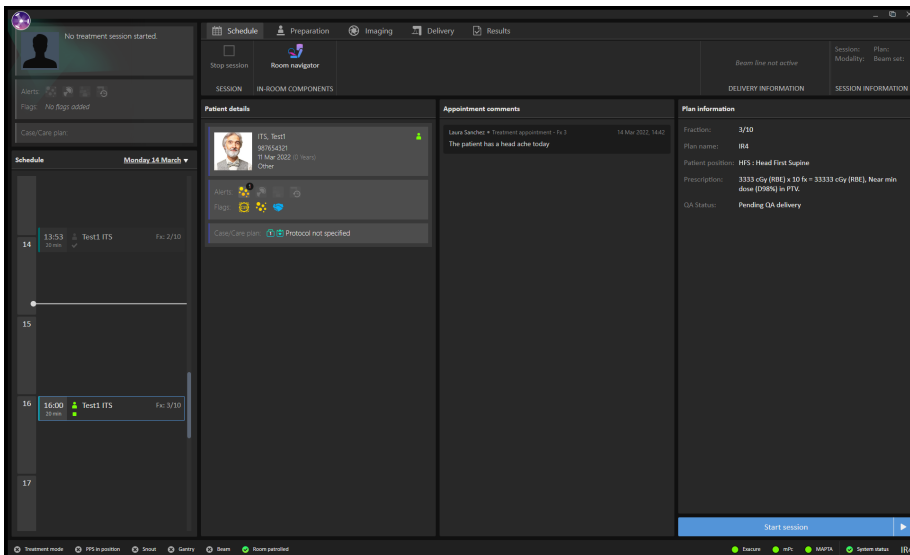
Schedule panel

The **Schedule** panel lists the appointments made for a treatment room on the selected date. Appointments are scheduled in RayCare.

An appointment is associated with a patient and a treatment session. By default, the panel shows today's appointments; however, it is possible to change the date to see sessions scheduled in the past or in the future.

Select an appointment in the **Schedule** panel to get an overview of the patient and the associated treatment session in the **Patient details** panel.
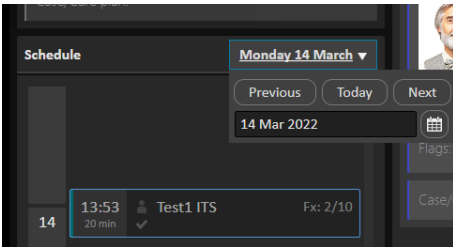
Note: *The patient information shown in the Patient details panel is not necessarily the patient information for the patient in the currently active treatment session. The current patient is always displayed in the Patient panel (to the upper left in the user interface).*

Appointments

Treatment appointments are listed to the left in the **Schedule** workspace. Each appointment is summarized in a treatment appointment tile.

The treatment appointment tile contains the following information:

• Scheduled start time for the treatment appointment

• Estimated duration of the appointment

• Patient check-in status

• Session validation status

• Patient name

• Fraction number out of the total number of fractions. Fraction one is explicitly indicated by a grey background.

The patient check-in status can have the following states:

Patient status	Description
	Patient has not been checked in from RayCare
	Patient has been checked in from RayCare

The following session validation statuses exist:

Session status	Description
	Session has not been validated

Session status	Description
◪	Session is being validated
■	Session successfully validated and is ready for delivery
⊘	Session has been canceled
✓	Session has been delivered and closed
⚠	Session is partially delivered
✕	Session validated with an error and cannot be started

The selected appointment is indicated with a blue frame in the schedule. Information about the patient in the selected appointment is displayed in the **Patient details** panel.

An appointment where a session has been started is indicated by a blue arrow in the left part of the treatment appointment tile:

| 11:40 / 20 min | Carlos Hernandez | rx 6/32 |

The patient in the started session is displayed in the **Patient** panel.

Note: *It is possible to deliver a plan in all rooms in which the appointed machine model is possible to use for delivering a plan.*

Patient details panel
The **Patient details** panel displays information about the patient in the selected appointment.

The **Open session** button
It is possible to open a session in Read Only mode if the session is scheduled for a different date than today, if the patient has not been checked in, or if the treatment has been delivered.

Click the **Open session** button to view the treatment session selected in the appointment schedule, without navigating to the next module.
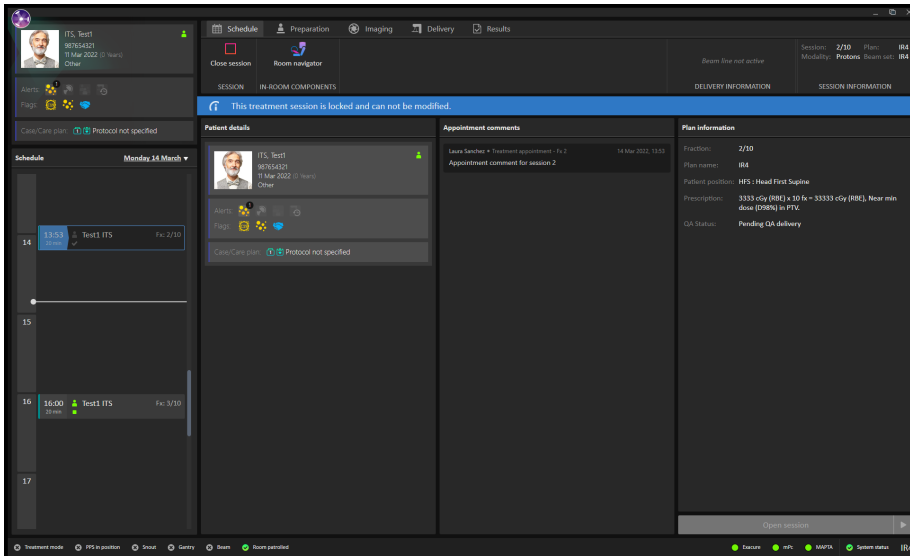
The *Start session* button

Click the **Start session** button to start the treatment session selected in the appointment schedule, without navigating to the next module.

Click on the arrow to start the selected treatment session and navigate to the next module (**Preparation**).

The *Start session (Limited)* button

A session that has been faulted or canceled can be started in Limited mode in order to add a manual recording, to access the **Complete Delivery** button, and sign it.

Click the **Start session (Limited)** button to start the treatment session selected in the appointment schedule, without navigating to the next module.

Click on the arrow to start the selected treatment session and navigate to the next module (**Preparation**).

Workflow – MedAustron

For a treatment session to start, the patient must be checked in from RayCare and the treatment session must be successfully validated. If the session is not successfully validated it is possible to right-click on the session to see why the validation did not pass, and also to restart the validation after the error has been fixed.

To start a session, select the appointment tile in the schedule and click the **Start session** button.

5.2.2   Preparation module

Setup note panel
The **Setup note** panel displays the setup notes created during setup in RayCare.

Fixation devices panel
The **Fixation devices** panel displays a checklist of all devices to be used for patient positioning, defined during setup in RayCare. When a fixation device has been applied, the corresponding checkbox must be selected. If all checkboxes are not selected the user must save a statement of why all fixation devices are not used.

Photos panel
The **Photos** panel displays the photos taken in RayCare during setup of the patient. If several photos are available, they are listed as thumbnails horizontally at the bottom. Select a thumbnail to display the photo in the panel.

Confirm preparation button
Click the **Confirm preparation** button to confirm that the patient setup has been performed as instructed. If all listed fixation devices have not been checked, a reason for this must be provided and signed before preparation can be confirmed.

Clicking the button will confirm the setup without navigating to the next module. Clicking on the arrow will confirm the patient setup and navigate to the next module (**Imaging**).

Confirm patient ID

Click the **Confirm patient ID** button after verifying that the identity of the patient in the room matches the patient for which the session is started. The patient ID must have been confirmed before setup images can be acquired.

Workflow – MedAustron

1. Verify the identity of the patient and then click the **Confirm patient ID** button.

2. Click the **Room navigator** button to open the **Room navigator** dialog.

3. Select the pre-defined target position for patient setup.

4. Click the buttons on the control console to execute the move of the patient positioner to the selected target position.

5. Apply the listed fixation devices. Verify the application of each device by selecting the corresponding checkbox.

6. Position the patient according to the photos and the setup instructions in the setup note.

7. Click the **Confirm preparation** button to confirm that the patient setup is correct.

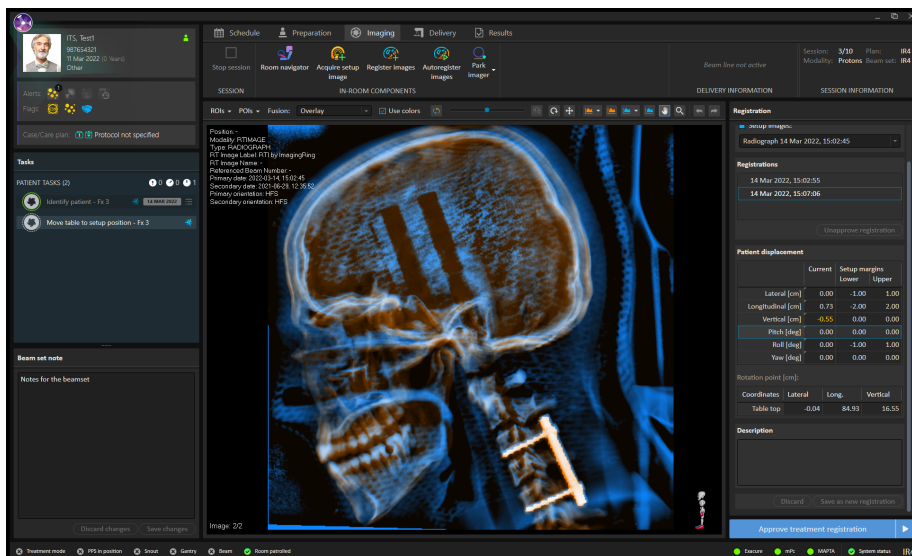## 5.2.3   Imaging module

Image area

By default, the image area displays the planning CT image from the plan. When setup images have been acquired, and a registration between the planning images and the setup images has been performed, the fusion between the planning images and the setup images using the selected registration is displayed in the views.

When clicking the **Acquire image** button, a dialog is opened. Under **Setup beam**, the settings for the setup image are shown, including information about the field-of-view and the body site selected in RayStation for the setup image.

Under **Patient vitals** the patient height and weight to be sent to the imaging system are shown. These values are retrieved from the latest height and weight measurements available in RayCare. If the values do not exist, or if a connection to RayCare could not be established, the dialog will prompt the user for manual input.

Note: *Height and weight are retrieved from RayCare when the Acquire image button is clicked. If modifications to height and/or weight are done in RayCare while the Acquire image dialog is still open, these changes will not be reflected. Hence, if any vitals need to be updated before acquiring the image, new measurements must be entered in RayCare and the Acquire image dialog closed and re-opened.*

Adjusting image quality

The images used for registering the DRRs from the planning CT and the daily images need to be adjusted to be able to compare. This is done from the drop-down filtering lists. As a help, it is possible to create templates for the images made at the clinic. It is recommended to create different templates for different body sites.

To improve the visibility of bone structures, a bone enhancement attenuation factor can be adjusted in the DRR settings to further highlight the higher density. It is also possible to improve the visibility of markers, by highlighting densities above a specific HU threshold. This is done by loading a template where *UseMarker* is set to *true* and *MarkerThreshold* is set to a specific HU threshold value.

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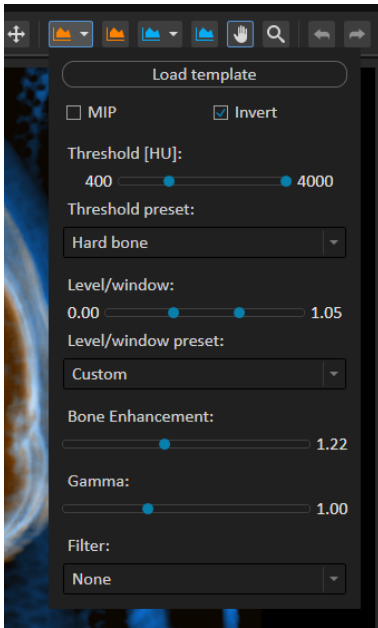
Flip fusion pattern

To flip the fusion pattern, do one of the following:

•   Click the **Flip pattern** button in the tool panel.

•   Press the Space key when the image view is in focus.

For the fusion type **Overlay**, flipping the pattern will invert the fusion slider.
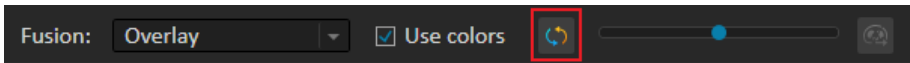

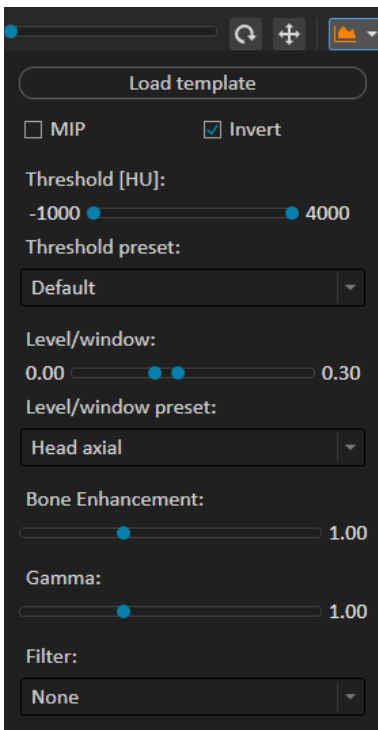**Figure 2.**   The **Flip pattern** button is found on the left side of the fusion slider.

Image settings

List of available DRR settings

The following options are available in the DRR settings.

•   MIP

•   Invert

•   Threshold [HU]

•   Threshold preset

•   Level/window

- Level/window preset

- Bone enhancement

- Gamma

- Filter

    - Sharpening

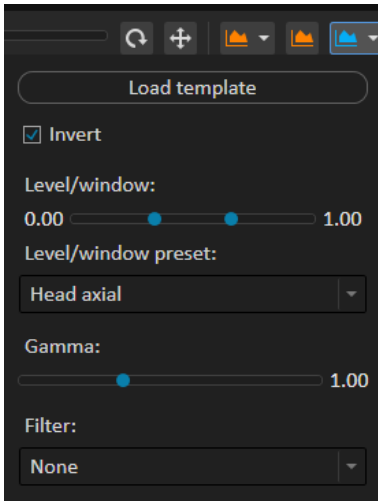   - Edge detection

List of available RT image settings

The following options are available in the RT image settings:

- Invert

- Level/window

- Level/window preset

- Gamma

- Filter

    - Sharpening

- Edge detection

Invert

This setting inverts the DRR or RT image so that it displays bright bones on a dark background, instead of the raw attenuation image where bones are dark and the background is bright.

This invert setting is enabled by default.

Figure 3.   Inverted DRR image: Bright bones on dark background.

Figure 4.   Non-inverted DRR image: Dark bones on bright background.

MIP

The MIP option can be enabled to display a maximum intensity projection of the CT image.

Threshold

Thresholding can be applied on the DRR, to only display CT voxels within a specified Hounsfield unit (HU) range.

Preset threshold values are available in the drop-down menu for soft tissue, soft bone, and hard bone, and the upper and lower thresholds can also be adjusted with a slider. When using thresholding it is recommended to first set the level/window function to the **Default** preset; that is, the identity level/window 0.5/1.0.

Thresholding is available for DRR only.

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Figure 5.   Thresholding for soft tissue, soft bone and hard bone.

Level/Window

The level/window functionality is used to adjust the contrast and brightness of the DRR or RT image, and operates on pixel values in the 0-1 range.

Preset level/window values are available in the drop-down menu, and the level/window can also be adjusted with a slider or with the level/window tool. Moving the level/window tool horizontally while pressing the left mouse button adjusts the contrast, whereas moving the tool vertically adjusts the brightness. Note that the slider specifies the range (upper and lower limits) of the level/window function and not the actual level and window values. For example, setting the lower slider to 0.0 and the upper slider to 0.2 corresponds to using a level/window with level 0.1 and window 0.2.

Level/window is applied after thresholding and bone enhancement.

Bone enhancement

It is possible to adjust the bone enhancement factor to increase or decrease the contrast between bone and other tissue types in a DRR image.

The bone enhancement factor has the range 0-3 and is used to scale the linear attenuation values that are derived from voxel HU values during DRR generation. This affects how much of the (simulated) incoming X-ray beam intensity that is absorbed by a particular tissue type. The default value of the bone enhancement factor is 1, which corresponds to applying no bone enhancement on the DRR.

The figures below show the effect of applying bone enhancement to a lateral DRR image of the pelvic where the contrast between bone and surrounding tissue is low due to occlusion from fat and soft tissue. By reducing the bone enhancement factor from 1 to 0.7, the bone structures become more visible.

Bone enhancement is applied before level/window and is available for DRR only.

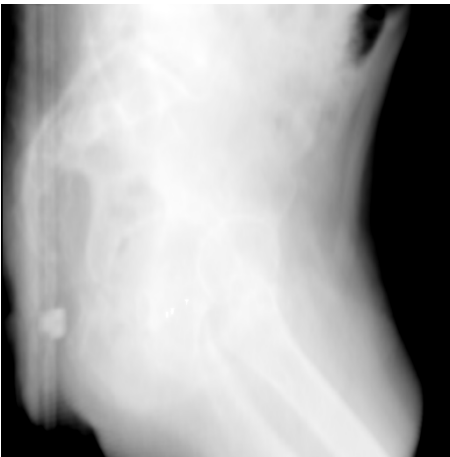**Figure 6.**   Lateral DRR image, with bone enhancement.

Figure 7.   Lateral DRR image, without bone enhancement.

Gamma

The gamma filter is a non-linear contrast enhancement filter that applies a power-law (gamma) transformation $I'(x,y) = I(x,y)^{\gamma}$ on the pixel intensity values $I(x,y)$. The gamma parameter γ can be adjusted with a slider and has the range 0-3, where 1 is the default value and corresponds to applying no contrast enhancement. Typically, γ should be set to a value between 0.5 and 1 to increase the contrast of bone.

The gamma filter is applied after Level/Window.

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Figure 8.   A pelvic DRR image, without gamma correction $(\gamma = 1)$.

Figure 9.   The same DRR image as above, with γ set to 0.7.

Edge detection

The edge detection filter calculates the pixel intensity gradients with central differences and displays the gradient magnitude as an image, where brighter regions correspond to stronger gradients (i.e., edges).

The brightness of the resulting image can be scaled with the amount slider to make edges more visible, where 0 is minimal brightness and 1 maximal brightness.

Edge detection is applied after the gamma filter.

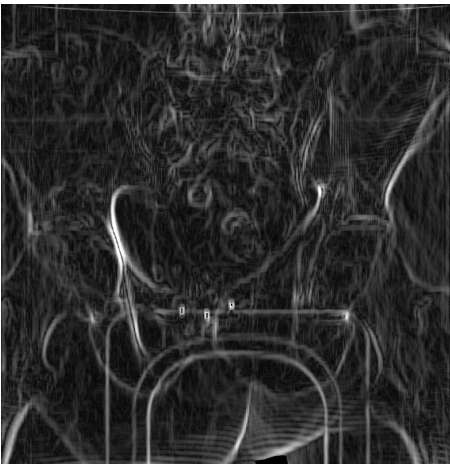**Figure 10.**   A pelvic DRR image without edge detection.

Figure 11.   The same pelvic DRR as above, with edge detection enabled (amount set to 0.4).

Sharpening

The sharpening filter uses the unsharp masking algorithm to sharpen edges in the image.

The strength of the filter can be adjusted with the amount slider, where 0 means that no sharpening is applied and 1 is maximal sharpening. Figure drr_sharpening_disabled.png shows a pelvic DRR without sharpening, whereas Figure drr_sharpening_enabled.png shows the same DRR image with sharpening enabled and sharpening amount set to 0.4.

Sharpening is applied after the gamma filter.

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Figure 12.   A pelvic DRR image without sharpening.

Figure 13.   The same DRR image as above, with sharpening enabled (amount set to 0.4).

Marker highlighting

It is possible to improve the visibility of markers by highlighting voxels above a specific HU value. This can be configured by loading a template where *UseMarker* is set to *true* and *MarkerThreshold* is set to a specific HU threshold, typically >2000 HU. The voxels with a HU value above *MarkerThreshold* will be highlighted. See *Appendix F RT image and DRR templates* for instructions on creating and loading templates.

By default, marker highlighting is enabled and highlights voxels with HU values above 2750 HU.

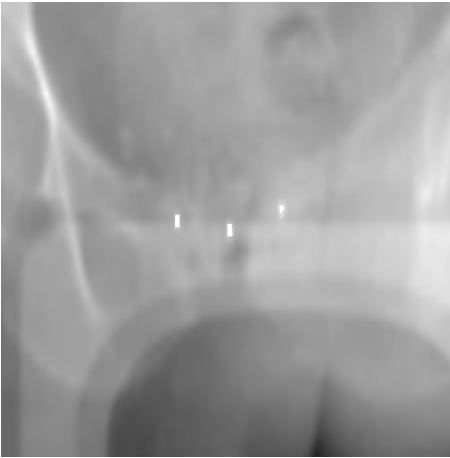Marker highlighting is available for DRR only.

Figure 14.   A DRR image with marker highlighting enabled.

Figure 15.   The same DRR image as above, with marker highlighting disabled.

Registration panel

The **Registration** panel manages images and registrations for the current session.

It is possible to select to show the ROIs and POIs for the plan, to make it easier to register the DRR against the daily setup image.

The correction vector will be shown in the section **Patient displacement**, together with the setup margins from RayStation.

The registration can be modified by first clicking the rotation or translation tool icon in the top right corner, and then clicking and dragging using the left mouse button in the registration view.

5

It is also possible to move and rotate the registration with a fixed step size, one direction at a time, using the arrow keys with the corresponding tool. The same operation can be done using a smaller step size, by holding down the Shift key while using the arrow keys (see also the table below).

It is possible to lock the translation and rotation to a fixed axis: Lateral, longitudinal and vertical axis. These axes are defined both relative to the treatment room and to the patient (see Figure 16 and Figure 17). The keyboard shortcuts for each axis are shown in the table below.
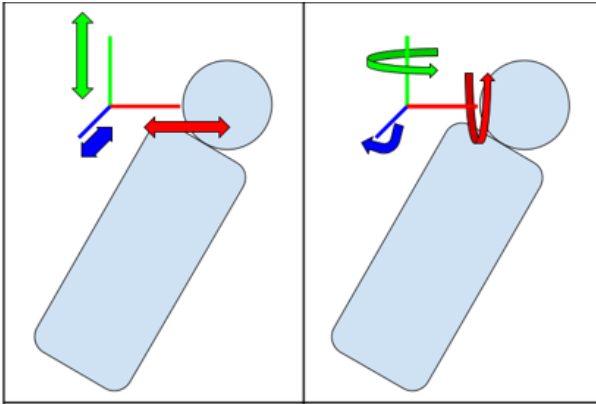

Figure 16.   Translation and rotation axes as defined by the treatment room. Axes are longitudinal (green), lateral (red) and vertical (blue).
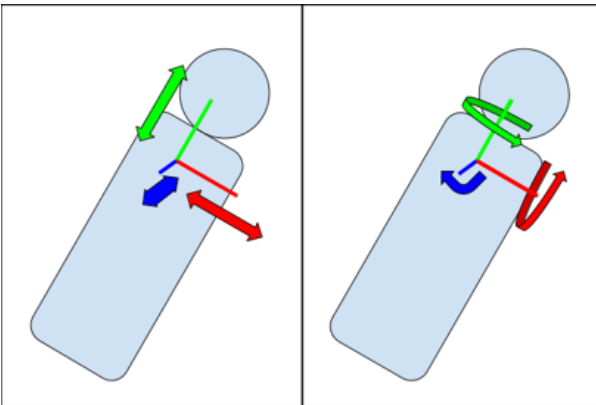

Figure 17.   Translation and rotation axes as defined by the patient. Axes are longitudinal (green), lateral (red) and vertical (blue).

Registration keyboard shortcuts:

Description	Keyboard shortcut key
Lock translation/rotation to lateral axis (relative to treatment room)	Q

Description	Keyboard shortcut key
Lock translation/rotation to longitudinal axis (relative to treatment room)	W
Lock translation/rotation to vertical axis (relative to treatment room)	E
Lock translation/rotation to lateral axis (relative to patient)	A
Lock translation/rotation to longitudinal axis (relative to patient)	S
Lock translation/rotation to vertical axis (relative to patient)	D
Transform image with fixed step size	Arrow keys
Transform image with smaller fixed step size	Shift + Arrow keys
Undo last transformation	Ctrl+Z
Redo last transformation	Ctrl+Y
Zoom tool	Ctrl
Pan tool	Shift
Move fusion pattern tool	Alt
Flip fusion pattern	Space
Next image	N
Previous image	P

Undo and redo registration transformations

To undo transformations to the registration, do one of the following:

• Click the **Undo** button in the tool panel.

• Press Ctrl+Z.

To redo registration transformations that were undone, do one of the following:

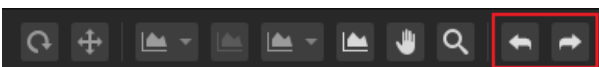• Click the **Redo** button in the tool panel.

• Press Ctrl+Y.

Figure 18.   The **Undo** and **Redo** buttons are found at the far right of the tool panel.

5

Approve treatment registration button

Click the **Approve treatment registration** button to approve the selected registration without navigating to the next module. Click on the arrow to approve the registration and navigate to the next module (**Delivery**).


⚠️ **WARNING!**

Review automatic registration. Always ensure that the automatic registration between the setup images and the planning CT is properly done by manually reviewing the result.

(344618)

Workflow - MedAustron

1. Click the **Room navigator** button to open the **Room navigator** dialog.

2. Select a pre-defined target position for imaging.

3. Use the control console to execute the move of the patient positioner to the selected target position.

4. Click the **Acquire setup image** button to request an image acquisition from the MedPhoton Controls system. If setup beams are available with an imaging device selected and an imaged volume defined, a protocol for the image acquisition can be selected from the list of setup beams. The angle offsets defined in the protocol are applied to the gantry angle of the setup beam to calculate the imaging angles, and the imaging volume corresponds to the volume of interest in the MedPhoton Controls system.

5. Perform imaging acquisition in the MedPhoton application.

6. Click the **Register Images** button.

7. (Optional) Select ROIs or POIs to be shown, to facilitate the registration.

8. If needed, manually adjust the registration by using the registration tools available in the image area.

9. Add a description for the registration and confirm saving.

10. Save the modified registration by clicking the **Save as new registration** button.

11. (Optional) Click the **Auto register images** button to get an automatic 2D-3D registration with the current registration as input. The tracking ROI selected for the setup beam when planning in RayStation is used as the focus region for the automatic registration.

12. Move imager to a parking position that is not colliding with the treatment position ('Park Imager').

13. Click the **Approve treatment registration** button to approve the registration for treatment.

5.2.4   Delivery module
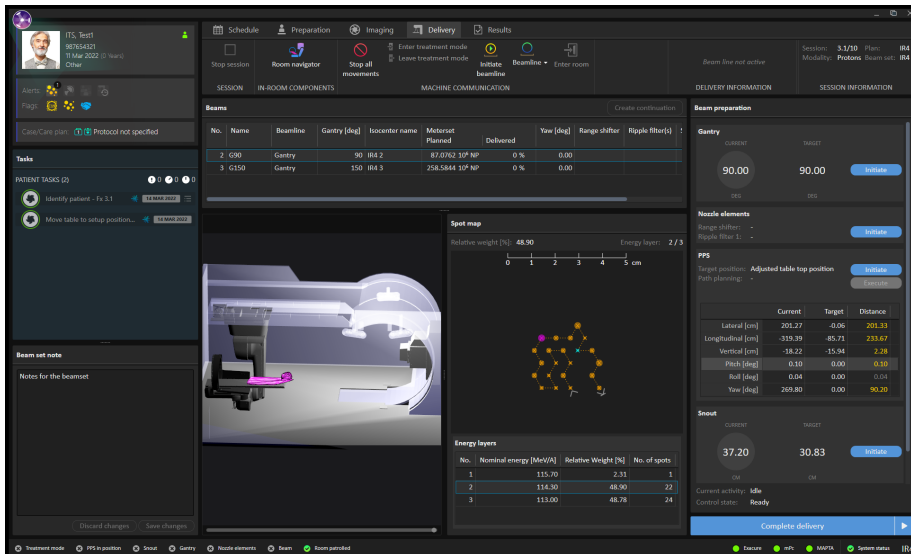
Beams panel

The **Beams** panel displays a list of beams for the plan.

The fields represent the planned values of the beam, with the exception of **Delivered Meterset (%)** and **Status**. When a beam has been successfully delivered, it is marked with a green checkmark in the beam list.

The spot map shows the positions of the specified spots in the energy layer selected in the **Energy layers** table.

Beam preparation panel

The **Beam preparation** panel displays the beam and the devices that have been prepared for delivery of the beam.
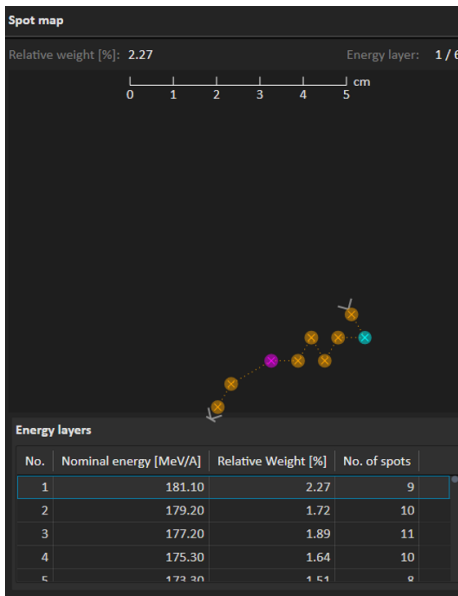
The **Gantry** and **Snout** boxes are only shown in a room that has a gantry and a movable snout.

Room view panel

The **Room view** panel displays the in-room components and their positions in the room.

Spot map panel

The **Spot map** panel displays spot positions for the selected energy layer. The current layer is marked with a blue box. The heaviest and lightest spots per layer are coloured with purple and blue. The direction of the spot delivery order is indicated with entrance and exit spot.
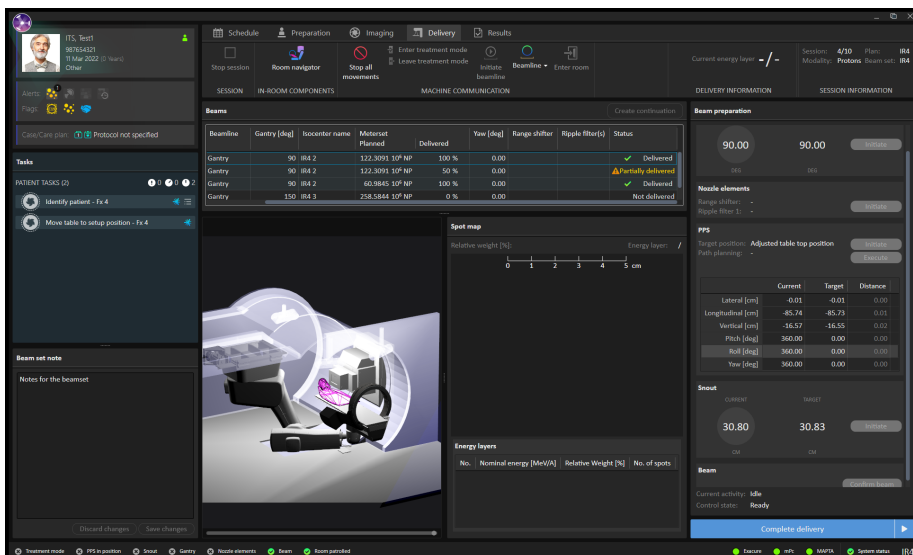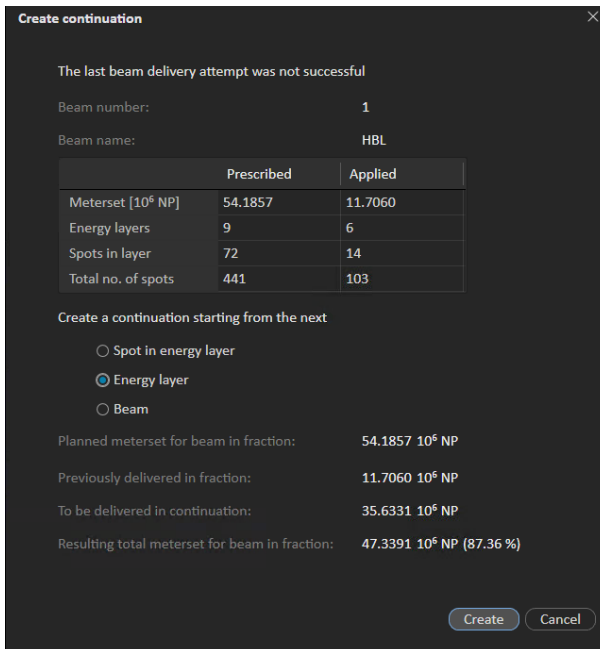
Spot map

Relative weight [%]: 2.27		Energy layer: 1 / 6

Energy layers

No.	Nominal energy [MeV/A]	Relative Weight [%]	No. of spots
1	181.10	2.27	9
2	179.20	1.72	10
3	177.20	1.89	11
4	175.30	1.64	10
5	173.30	1.51	9

Complete delivery button

Click the **Complete delivery** button to complete the delivery and set the status for the treatment session to *delivered* without navigating to the next module. Click on the arrow to complete delivery and navigate to the next module (**Results**).

Continuation sessions

If a beam has been interrupted it is possible to continue the delivery, either in the current session or as a new session.

The continuation session can be planned to continue either from the next spot, from the next energy layer or from the next beam in the plan.

If the delivery can be continued within the current session, a continuation session is created by clicking on the **Create continuation** button above the beam list. The beamline then needs to be re-initiated, and the continuation can be started.

Create continuation

The last beam delivery attempt was not successful

Beam number: 1
Beam name: HBL

	Prescribed	Applied
Meterset [10^6 NP]	54.1857	11.7060
Energy layers	9	6
Spots in layer	72	14
Total no. of spots	441	103

Create a continuation starting from the next

○ Spot in energy layer
◉ Energy layer
○ Beam

Planned meterset for beam in fraction: 54.1857 10^6 NP

Previously delivered in fraction: 11.7060 10^6 NP

To be delivered in continuation: 35.6331 10^6 NP

Resulting total meterset for beam in fraction: 47.3391 10^6 NP (87.36 %)

Create   Cancel

If the continuation of the delivery will be done in a new session, the user must first leave treatment mode and complete the delivery, then sign the session in the **Results** module. The checkmark indicates that the rest of the beam must be planned in a new session.

When the session has been scheduled in RayCare and later starts in RayCommand again, the user must select how to create the continuation session by clicking on the **Create continuation** button

above the beam list. The **Create continuation** dialog contains information about how much dose that should be delivered, has been delivered and is left to deliver.

The spotmap for the partially delivered beam is not shown until the continuation has been created.

Manual recording

In case the treatment record is not delivered from MAPTA, it is possible to manually record the delivered dose in RayCommand.

1. Right-click on the beam that has been delivered.

No.	Name	Beamline	Gantry [deg]	Isocenter name	Meterset Planned	Delivered	Yaw [deg]	Ran
2	G90						0.00	
3	G15						0.00	

Add manual recording
Edit manual recording
Remove manual recording
(Migration only!) Create manual recordings for all beams in a completely delivered session
Disable beam
Enable beam

Relative weight [%]: 7.29
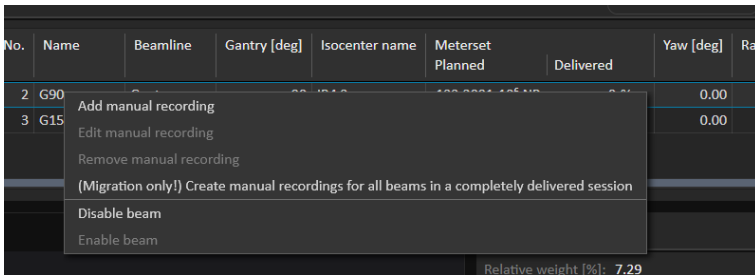
2. Enter the last delivered energy layer and spot, and how much of the beam that will be delivered. RayCommand will record the dose as 'delivered' according to the plan, up till the layer and spot.

Add manual recording   ×

Beam number:	1
Beam name:	Beam1
Last energy layer (read from MTCP):	12
Last spot (read from MTCP):	3
Planned meterset for beam in fraction:	$15123.9983 \cdot 10^6$ NP
This manual recording:	$13830.0661 \cdot 10^6$ NP
Resulting total meterset for beam in fraction:	$13830.0661 \cdot 10^6$ NP (91.44 %)

Add   Cancel

If no treatment record is received after a delivery, RayCommand will be in 'degraded' mode until the treatment has been manually recorded.

A manual recording can be edited or removed. If a continuation has been created, a warning text informs the user that only the recorded dose is affected.

Disabling or enabling a beam

A beam with status **Not delivered** can be disabled from delivery. Disabled beams will not be included when initiating the beamline. Disabled beams have status **Disabled**. A disabled beam can be enabled.

Disabling and enabling of beams can only be done when beam delivery system is in an idle state.

To disable or enable a beam, right-click on the beam and select **Disable beam** or **Enable beam**.

Workflow (MedAustron)

1.   Click the **Room navigator** button to open the **Room navigator** dialog.

2.   Select the target position for the beam.

     The motion planning bar shows the progress status.

3.   Use the control console to move of the patient positioner to the selected target position.

4.   Click the **Initiate** button in the **Gantry/Nozzle/Snout** section to rotate the gantry to the target position (if applicable).

5.   Click the **Set nozzle elements** button to set the position of the nozzle elements to the planned position.

6.   Move the PPS:

     a.   Click **Initiate** to perform the path planning.

     b.   (Optional) Review the planned path.

     c.   Click **Execute** to move the PPS to treatment position.

7.   Click the **Move snout** button to prepare the snout and move it to the target position (if applicable).

8.   Click the **Enter treatment mode** button in the toolbar to lock all devices and set them in treatment mode.

9.   Click the **Confirm beam** button to prepare the beam for delivery. Use the treatment control console to deliver the beam. If machine parameter verification fails, a dialog will be shown with the status of all invalid parameters or required overrides.

10.   When all beams are delivered, click the **Complete delivery** button to set the status for the treatment session to delivered.

5

5.2.5   Results module

Beams panel

The **Beams** panel displays the list of beams that are to be delivered. Beams that have already been delivered are indicated by a green checkmark.

Spot map panel

The **Spot map** panel displays delivered spots per energy layers.

Sign session button

Click the **Sign session** button to complete the treatment session without navigating to the next module. Click on the arrow to complete the treatment session and navigate back to the first module (**Schedule**).

It is possible to enter a final note for the session. This note will also be shown in RayCare.

It is also possible to select if a continuation session should be created if the session was not fully delivered. The session needs to be scheduled in RayCare.
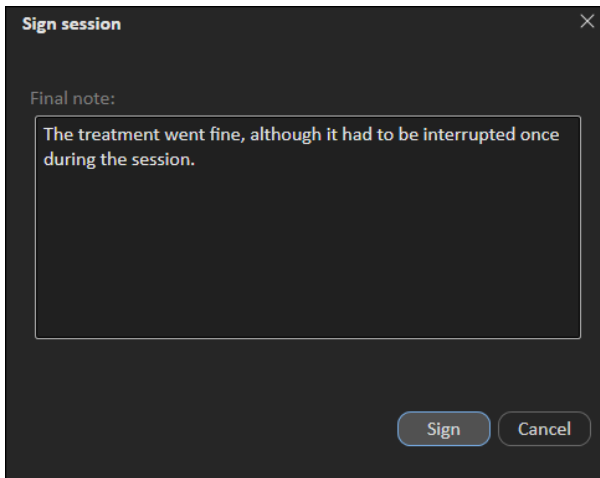
5.3   MACHINE MONITOR

The content on the Machine monitor complements the information on the Main monitor, with real time information from inside the treatment room.

The Machine monitor requires no interaction from the user but is used for viewing information only.
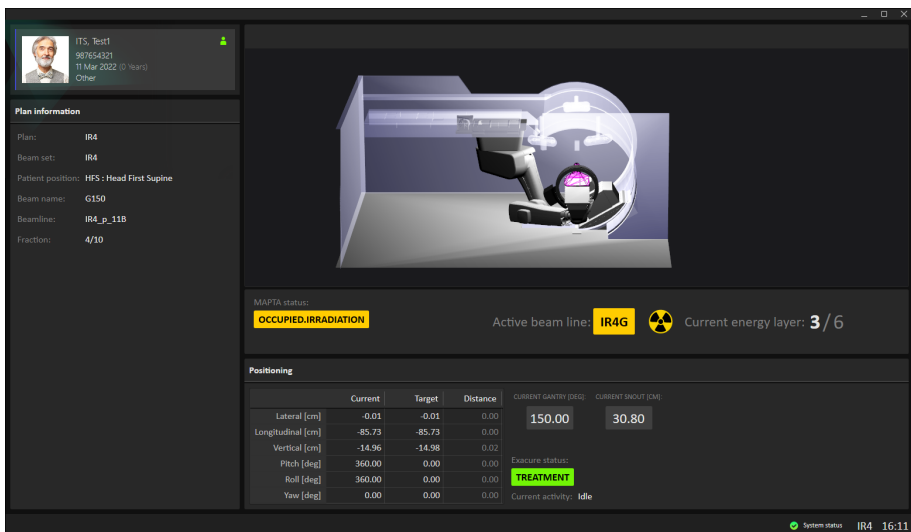
5.3.1   Patient information panel

The **Patient information** panel displays information about the patient associated with the current session.

Irradiation status

The **Irradiation status** panel shows the current status of the irradiation system and which beamline that occupied the synchrotron.

During the irradiation the 'Radiation on' icon is active, and the progress of the beam (delivery of the energy layer information) is shown.

5.3.2   Patient positioning system

The coordinates for the patient positioner show the current position of the patient positioner, the goal of the movement (also known as the target position) and the estimated distance between them.

Note: *The actual distance may differ from the estimated distance if the calculated trajectory is not straight due to collision detection.*

Note: *The patient positioning system will show the same information as shown in the Main monitor, i.e., if the Main monitor is currently showing the preview of the planned path this will also be shown in the Machine Monitor.*

5.4   SYSTEM HEALTH

If some part of RayCommand has experienced a severe error, RayCommand will enter Error mode. A banner will be displayed at the top of the monitors:
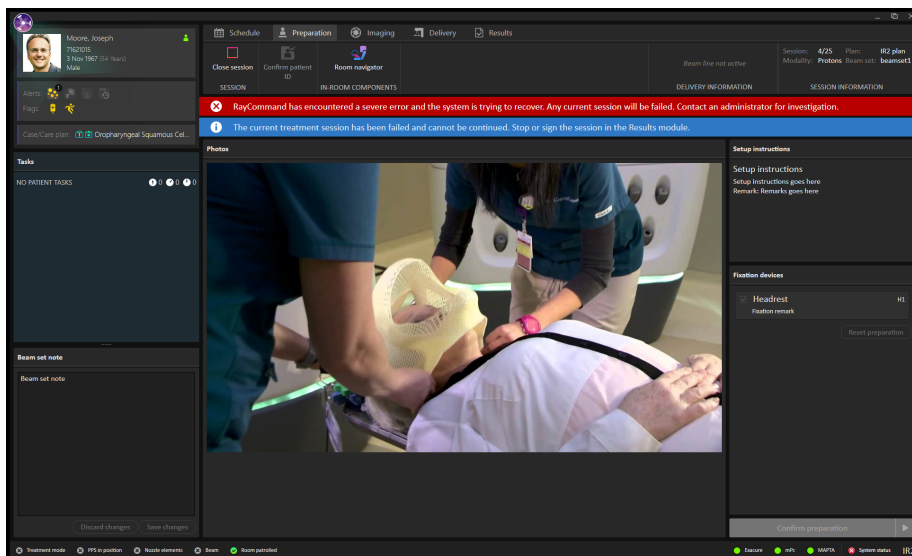
Interaction with a currently open session in the Main monitor will be limited, and the session state will be set to failed. An additional banner will be shown until the session has been stopped or completed.

Once the error has been resolved, the Main monitor will again allow full interaction and the banner with the error message can be closed:
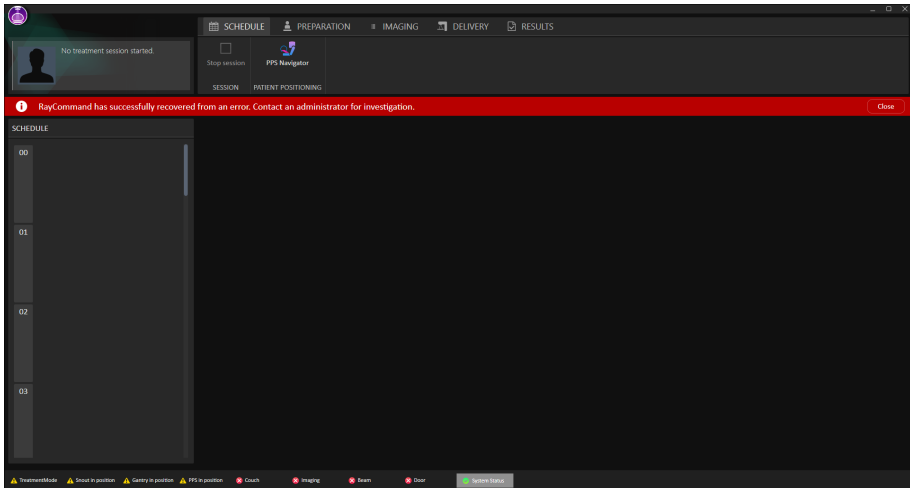
When the system has recovered from error mode, the system should be restarted and the interrupted session should be started in limited mode. Do as follows:

1. Open the **Delivery** module and check if any dose was delivered to the patient. If dose was delivered, this can be added manually (see *Manual recording on page 54*).

2. Click **Complete delivery** and go to the **Result** module.

3. Sign the session with the **Create continuation** checkbox selected.

When an external system is faulty, RayCommand will enter Degraded mode. A banner with a different message is displayed:
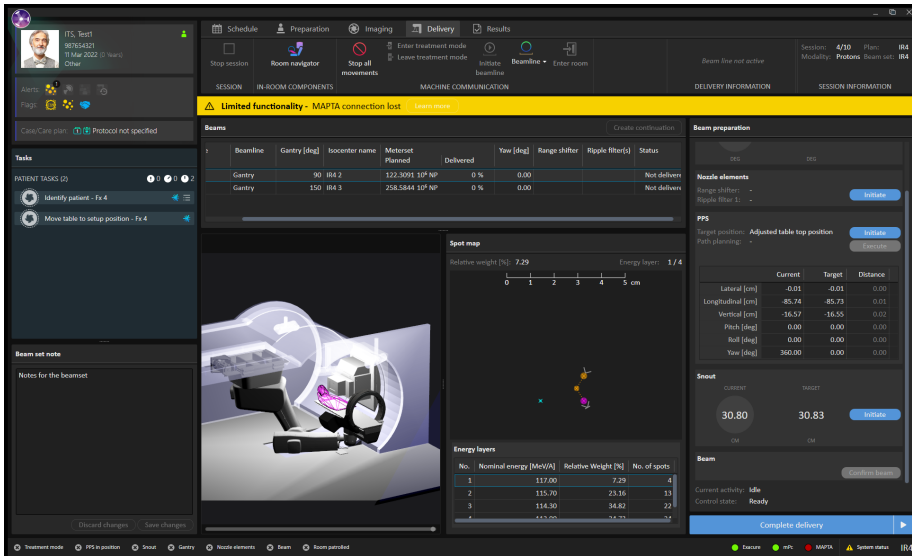
Interaction in Degraded mode is as normal, but confirming beams and interaction with external systems in faulty state will not be possible.

Along the bottom of the main monitor, interlock and system status is displayed. This information is helpful to get a quick overview of the current state. Tooltips about subsystems show detailed status.

To see the status of each subsystem, the user can access the **Subsystems** dialog from the status bar. A list of any current errors per subsystem can also be viewed here.
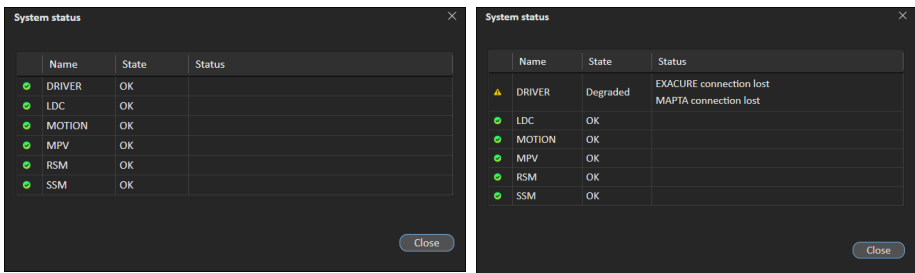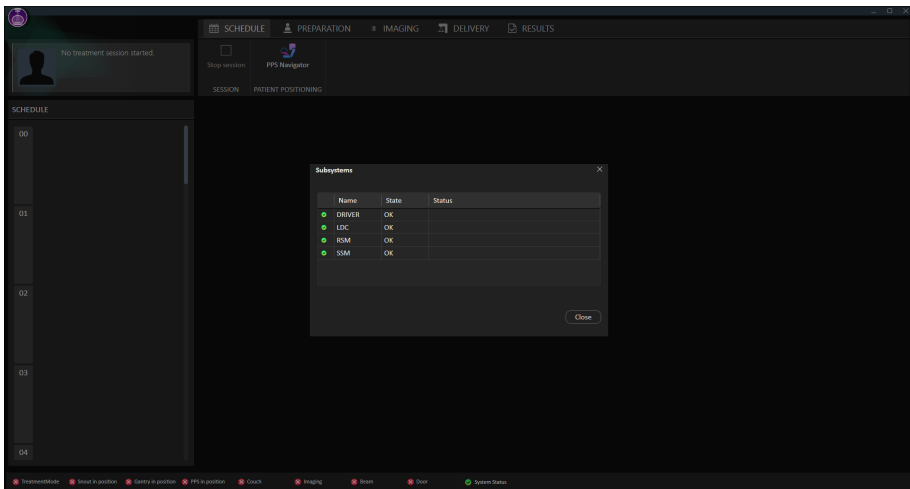
5.5   PATIENT POSITIONING

The patient positioning tools are located to the right of the toolbar and are available from all modules. Use these tools to control the position of the patient positioner.

5.5.1   Couch setup (MedAustron)

Click the **Room navigator** button in the toolbar to open the **Room navigator** dialog.
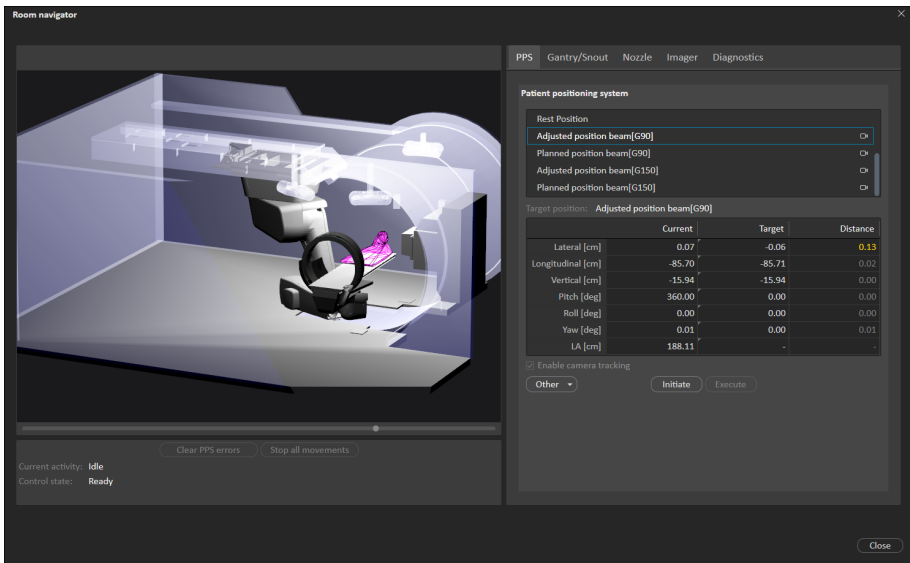
PPS tab

Available positions for the Patient Position System are either predefined at system setup or created based on the beams in the current plan. It is also possible to enter an ad hoc position in the target column for moving the PPS.

To move the Patient Positioning System (PPS) to a new position:

1.   Select a position in the list of target positions, or enter an ad hoc position in the target column.

2.   Press **Initiate**. The motion planning bar shows the progress of the path planning.

3.   When a path has been calculated, it is possible to preview the calculated trajectory by dragging the slider displayed below the room view.

4.   Press **Execute** and use the control console to execute the move.

To move the PPS without performing a collision check:

1.   Select a position in the list of target positions, or enter an ad hoc position in the target column.

2.   Click **Other** and select **Execute movement without collision check** from the menu.

3.   Use the console to execute the move.

Note: *Extra caution must be taken since the trajectory has not been verified to be possible to execute without a collision.*

Coordinates for the patient positioner are shown in a table: current position, target position and the estimated distance between them. The same table is also displayed on the Machine monitor.

Note: *The displayed distance from the start to target may increase and decrease several times before finally converging to the target. This is because the calculated trajectory may not be a straight line in the room.*

Gantry/Snout

Positions for the gantry and snout are available for irradiation rooms with a gantry and movable snout. There are predefined parking positions and a possibility to enter ad hoc positions for the gantry angle and snout extension.

The gantry/snout will move to the initiated position when the control console is used for executing the move.
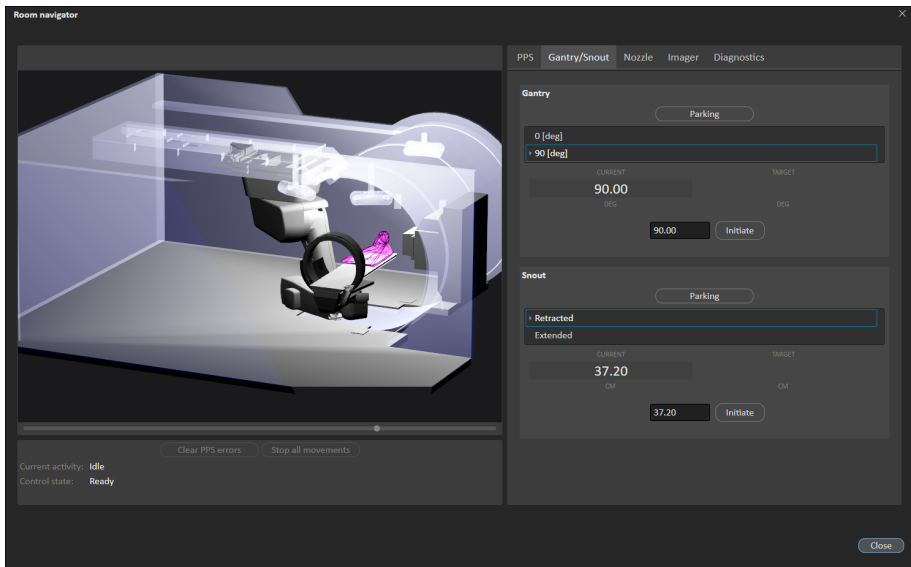
Nozzle

Available positions for the nozzle filters (In or Out) can be set, and the positions initiated ad hoc.

Initially in the grid, all positions are blank. Ad-hoc movements requires all positions to be set.
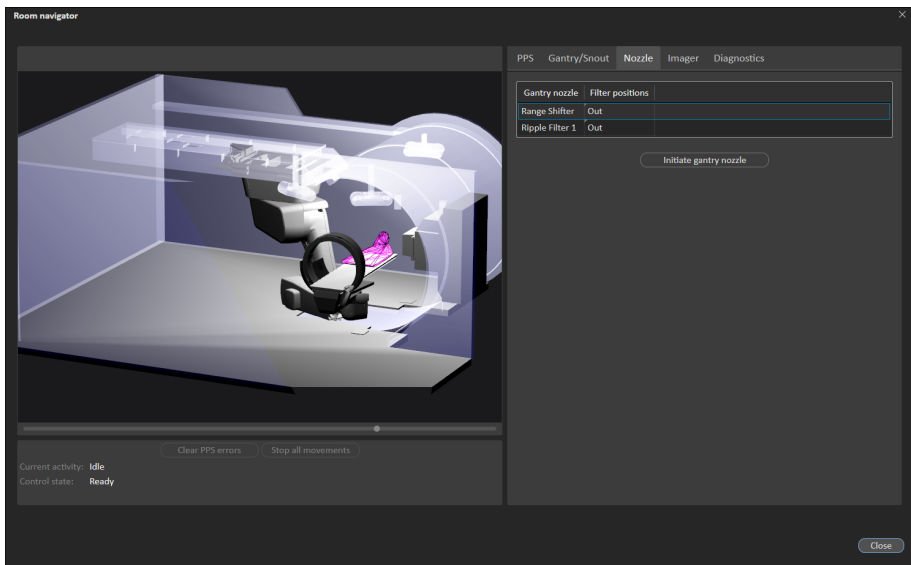
Imager

Available positions for the imager are predefined at system setup. The position is sent directly to the imager system when a parking position is selected.

5

The imager will move to the selected position when the control console is used for executing the move.
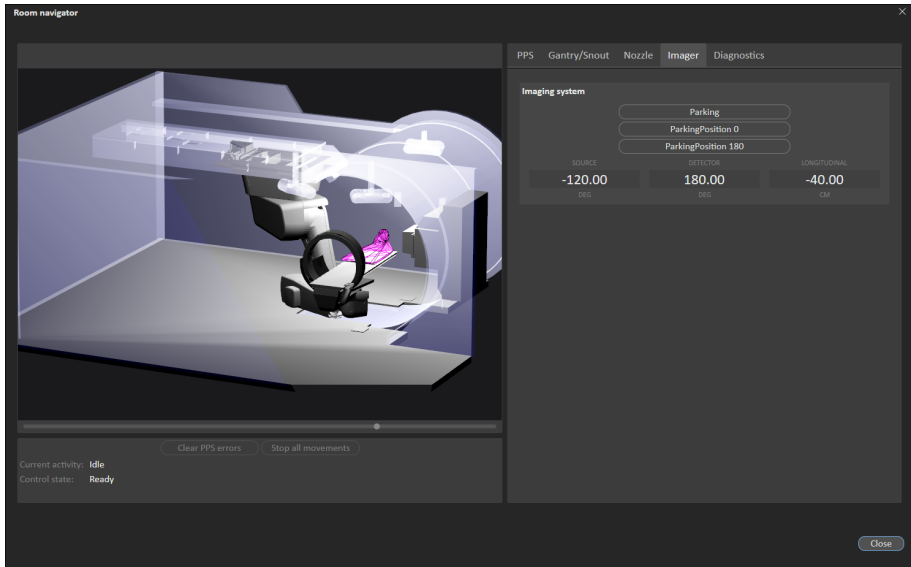
Diagnostics

The **Diagnostics** tab contains information nodes from external systems, to provide values for troubleshooting in RayCommand without the need of other tools.

Collision check (only available in Physics mode)

The **Collision check** tab contains functionality for verifying the setup margins for a planned table top position.

1.   Enter the rotation point position (in the table top coordinate system).

2.   Enter the table top position corresponding to the nominal isocenter position to be verified (in the table top coordinate system).

3.   Click **Initiate** to plan a path from the current position to the nominal table top position.

4.   When a path has been successfully calculated, click **Execute** and use the console to execute the move.

5.   When the table top has been moved to the nominal table top position, enter the shift to verify in the **Shift from isocenter** table.

6.   Try to move the table top to the shifted target position, either by planning a path and executing this plan when successfully calculated, or by selecting to move the table top without performing a collision check. Take extra caution and stop before a collision occurs.

7.   Read the current value of the shift from the **Current** column in the **Shift from isocenter** table.

5.5.2 Automatic motion planning

MedAustron installations of RayCommand provide support for *automatic motion planning*.

Without automatic motion planning, the PPS would take a direct path from start to target positions. When executed without supervision, the direct movement can result in physical contact between components such as in the following examples:

• Patient and nozzle

• Table Top with the nozzle

• Imager with the nozzle

• Imager C-arm with the robot arm

With the automatic motion planning feature enabled, when a target position is selected in the **Room navigator**, RayCommand automatically computes a collision-free PPS movement from the start position to the target position.

In both cases, the user must maintain visual contact of the PPS and anticipate collisions while executing the movement with the control console. See *chapter 3 Information needed for safe operation* for relevant safety precautions.

Considerations for automatic motion planning

There are some important considerations for automatic motion planning.

Determinism

The motion planner does not produce a deterministic solution. This means that if RayCommand plans a motion from position A to position B and later plans another motion from A to B, the second motion can be different than the first.

Since it is important for rehearsed movements to be repeatable after the patient mounts the table, RayCommand caches the motion within a treatment session so that all executions of the motion from A to B are the same. However, in a different treatment session, the motion from A to B from the previous session is not recalled and is instead recalculated.

Timeouts

The planner is not guaranteed to produce a solution. RayCommand imposes a configurable timeout on the planning time, typically 10 seconds. The more constrained the physical space, the more likely this timeout will be reached. If this occurs, it is recommended to try again. If multiple timeouts occur, try changing the start or target position or opening up the physical space, such as by retracting the nozzle or parking the imager.

Contact margins

Motion planning performance is sensitive to the preconfigured contact margins, which specify how close objects can get and in what context. For example, when the PPS is moving, in a suggested configuration, the table top may only approach to 10 cm from the nozzle, but when the nozzle is moving, the nozzle could approach to 0.5 cm from the table top. The contact margins may differ by

5

mode (Service, Physics, Clinical). For Clinical mode, they are locked after customer acceptance. Contact RaySearch if you wish to customize the contact margins for Clinical mode.

Handedness

In some positions, the PPS robot arm can take a 'left' or 'right' handed configuration. Due to technical limitations, RayCommand cannot control which handedness the robot takes. As a rule of thumb, the system attempts to preserve the current handedness unless it is not physically feasible.

5.6   PHYSICS MODE

In Physics mode the user can perform the same activities as in Clinical mode, but the rules in Clinical mode do not apply in Physics mode (e.g., the user can perform activities in any order).

To perform quality assurance on scheduled plans:

1.   Select **Physics mode** from the application menu.
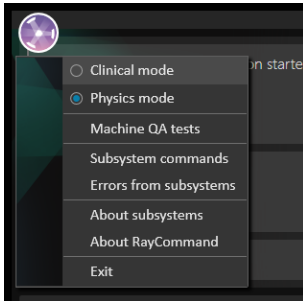
RayCommand will now enter Physics mode. A colored frame is displayed as an indication of the Physics mode.

The schedule will be replaced with a list of scheduled plans for which quality assurance has not yet been performed.
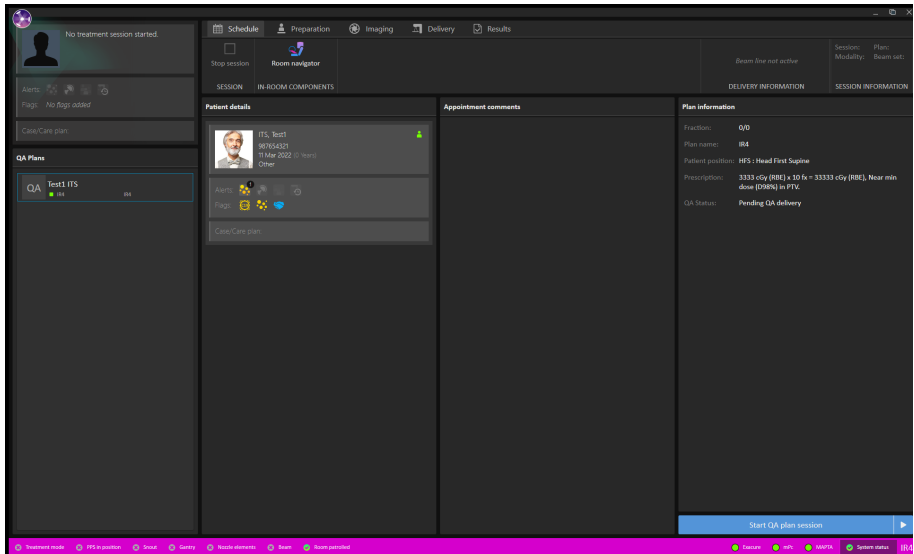
2.   Select a plan and click **Start session**. A QA session is created and started.

Treatment **Imaging** and **Delivery** can now proceed as normal, with the exception that the user needs to confirm that no patient is present on the table before delivering a beam.

In Physics mode, the beams delivered will not contribute to nominal dose, and unapproved treatment courses can be delivered.

To be able to exit Physics mode, the session must first be stopped or completed.

Collapse gantry angle

When making a delivery in Physics mode and the room has a gantry, the user can choose to collapse the gantry angles to 0 and 90 degrees for QA deliveries. All beams can then be delivered from the same gantry angle for the QA delivery.

The reason to why the gantry can be collapsed is that the phantom used only supports 0 or 90 degree angles. If the planned gantry angle of a beam is not 0 or 90 degrees, and the gantry is not collapsed, a warning is shown when confirming the beam.

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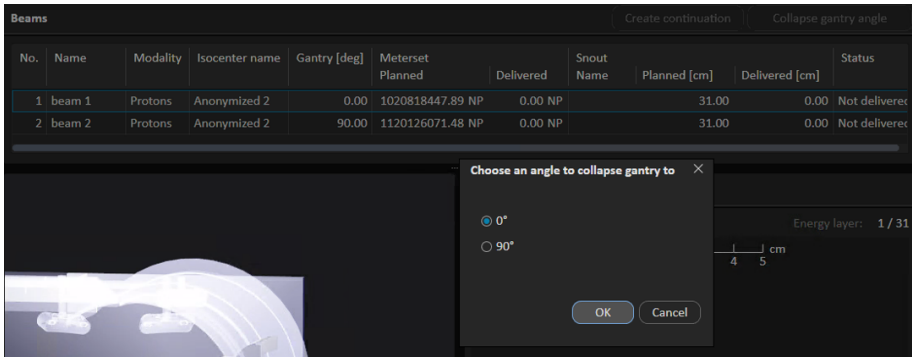
To collapse gantry angle:

1. Click the **Collapse gantry angle** button.

2. Select which angle to collapse the gantry to.

3. Click **OK**.

5.6.1   Machine QA tests

The following options are available for machine QA tests:

*   **Start QA test** – Starts a QA test of the Exacure system.

*   **Start camera measurement** – Starts camera tracking.

*   **Stop all movements** – Stops any ongoing Exacure request.

*   **Clear PPS errors** – Clears any PPS errors.

One of these texts will be shown, depending on current Exacure status:

*   **QA test is required**

*   **QA test is NOT required**
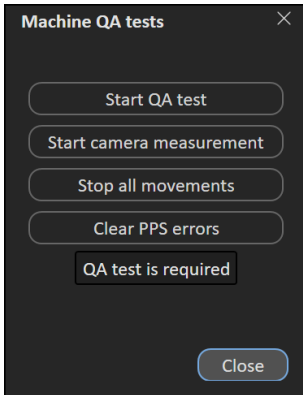
5.7 MACHINE PARAMETER VERIFICATION

The machine parameter verification compares planned and current values, and checks interlock status.

Interlocks are considered only unlocked or unlocked, and cannot be overridden. Values such as positions and angles have a hard tolerance that cannot be overridden. Hard tolerances always have precedence over user-defined tolerances.

The table below shows a complete list of verified machine parameters.

Machine parameter	Hard tolerance	Soft tolerance	Description
Interlocks	—	—	All relevant interlocks.
Machine name	—	—	Verifies the machine model name.
Range shifters	—	—	Verifies inserted accessories.
Range modulators	—	—	
Total Meterset	—	—	Verifies the total delivered meterset of the fraction accounting the specified meterset.
Planned Meterset	—	User-defined	Verifies the planned meterset using absolute and relative tolerances.
Gantry angle	0.5 degrees	User-defined	Verifies current gantry angle.
Snout position	1 mm	User-defined	Verifies current snout position.

Machine parameter	Hard tolerance	Soft tolerance	Description
Table top vertical position	1 mm	User-defined	Verifies current table top position.
Table top longitudinal position	1 mm	User-defined	
Table top lateral position	1 mm	User-defined	
Table top pitch angle	0.5 degrees	User-defined	
Table top roll angle	0.5 degrees	User-defined	
Table top yaw angle	0.5 degrees	User-defined	

5.8   INTERLOCKS

The interlocks used by RayCommand are software interlocks. There are two main types of interlocks:

- Relay interlocks are based on external signals.

- In-position interlocks are based on combinations of external signals and internal information. In-position interlocks use the tolerance table to evaluate if a target position has been reached.

Note: *Using large tolerance values will enable the confirm beam command also in cases when hard tolerances prevent beam delivery.*

Interlock	Type	Description
Treatment mode	Relay	Patient positioning system is in treatment mode. In-room components cannot be moved.
Beam	Relay	Beam is occupied by current room.
Room patrolled	Relay	Room is patrolled. This includes technical area and storage area interlocks, if applicable.
PPS	In-position	Table top is at the target position of the current beam.
Nozzle elements	In-position	Nozzle elements are at the target position of the current beam.
Gantry	In-position	Gantry is at the target position of the current beam.

Interlock	Type	Description
Snout	In-position	Snout is at the target position of the current beam.

Note: *The PPS interlock evaluates the table top position with regard to the planned position of the current beam. This is also referred to as the nominal position. Approving a registration of the daily image provides the adjusted position. The adjusted position has precedence for evaluating the table top position.*

5

A CLINIC SETTINGS CONFIGURATION FOR RAYCOMMAND

In order to use RayCommand, configuration of the treatment settings in the Clinic settings application is needed. Most of the settings are configured at installation and are therefore described in the RayCommand installation documents. This section describes some important things to keep in mind for the user.
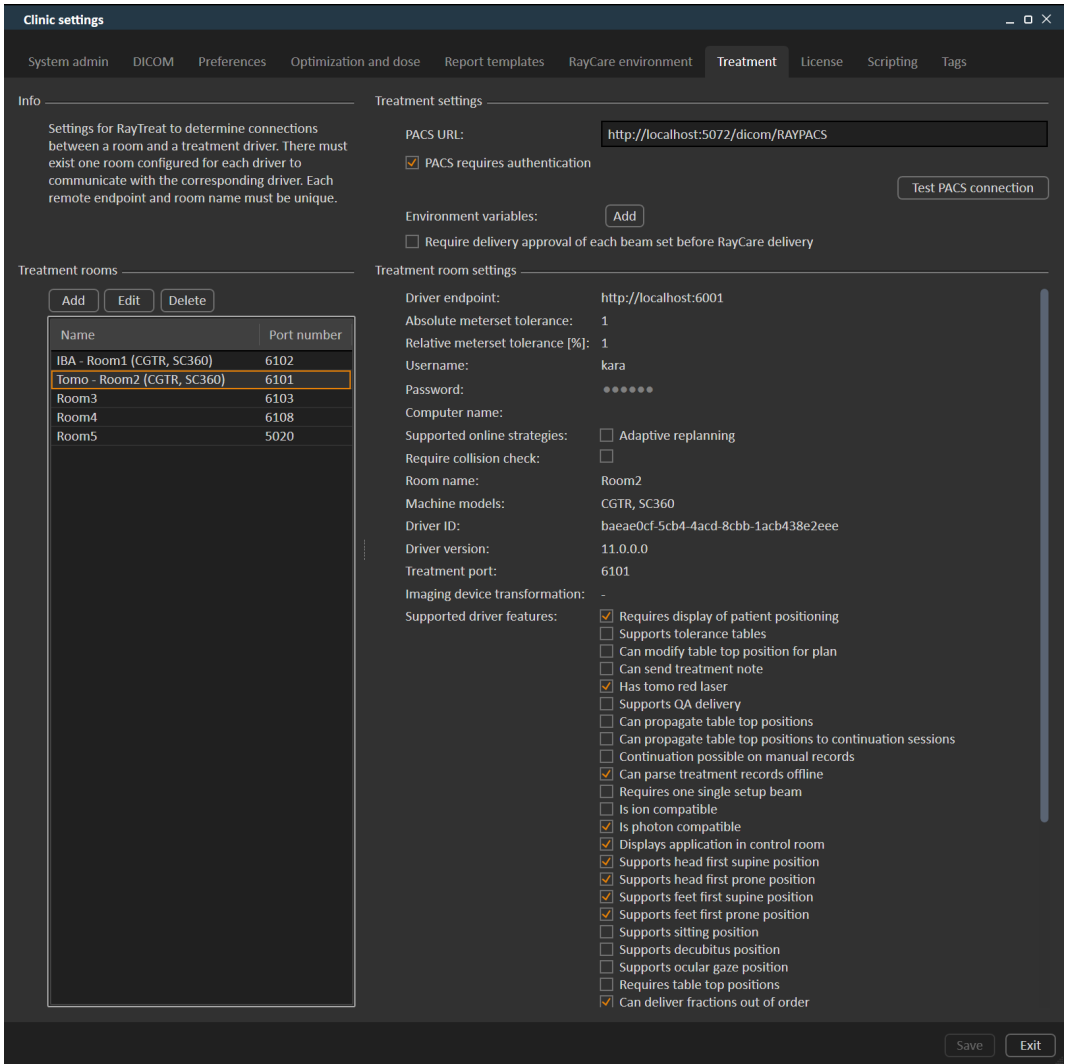
Figure 19. The **Treatment** tab in **Clinic settings**.

The configuration has a list of rooms. These reflect the rooms that the user can schedule an appointment for in RayCare. Each room also has a list of machine models. These reflect the models of the machine setup in RayPhysics and are used when creating a beam set in RayStation. The same machine model can be referenced in multiple rooms. It is also possible to let a single room support multiple machine models.

> ⚠️ **WARNING!**
>
> **Machine models.** The user who configures which machine models are supported in which rooms shall have a very clear understanding of the clinic and it's rooms and machine models. It is strongly discouraged to remove or rename any machine model in the configuration of a room. Instead it is recommended to deprecate the machine in RayPhysics if a machine model is not to be used anymore. It is still possible to add new machine models to a room.
>
> (341177)

To edit treatment room settings, click the **Edit** button. This opens the **Edit treatment room settings** dialog.
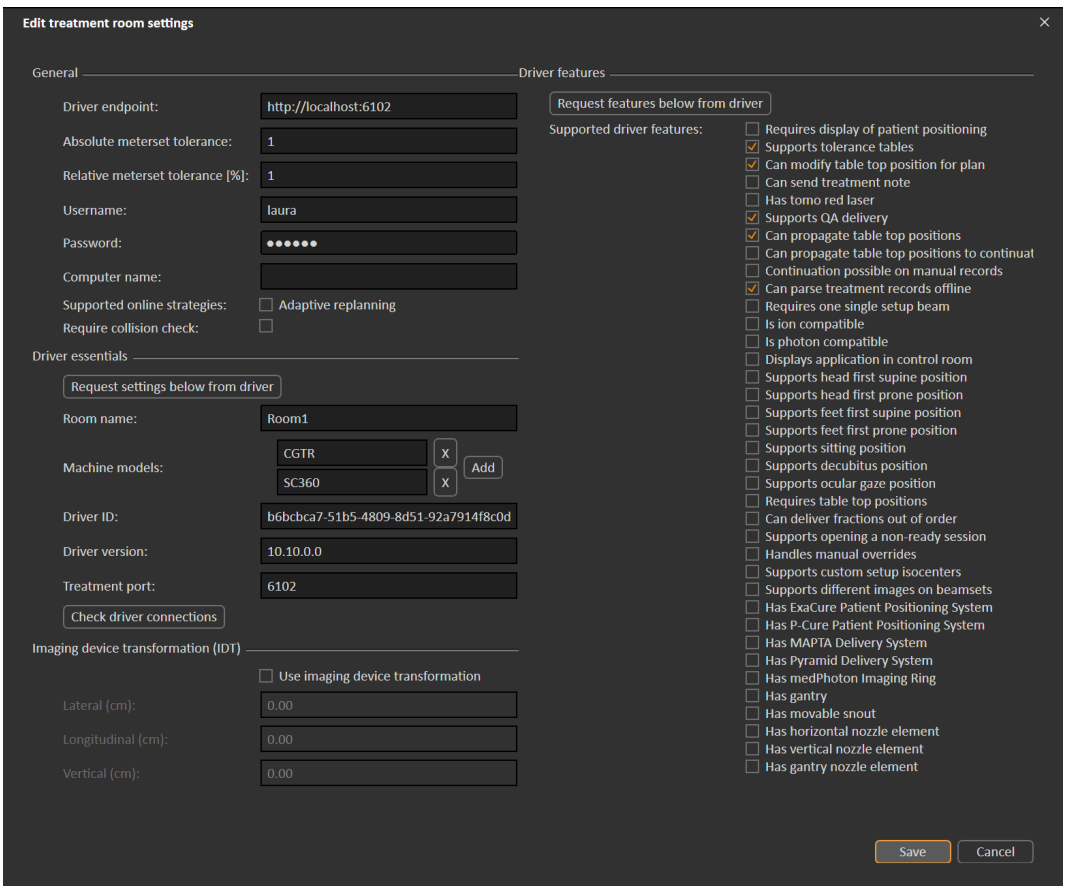
Figure 20. The **Edit treatment room settings** dialog.

Absolute meterset tolerance and **Relative meterset tolerance** can be configured to indicate how much of the delivered meterset can be missing while the system still considers the delivery completed. When the system considers the delivery completed, a checkmark is shown on the session/fraction/beam, and no more continuation can be delivered.

Absolute meterset tolerance takes the unit into account. For example, a machine of a vendor using MU, NP (number of particles) and Minutes as the meterset unit shall all have very different absolute meterset tolerances defined.

It is possible to specify only one of the tolerances. When having both absolute and relative tolerances set, the delivery is considered complete if any of the tolerances is a pass.

In **Imaging device system** it is possible to enter an imaging device transformation in case the patient coordinate system and the imaging device do not match. If IDT is set to 0,0,0 the coordinate system for the patient and the imaging system is coinciding.

A.1 CONFIGURE BEAM SET DELIVERY APPROVAL IN CLINIC SETTINGS

It is possible to configure Clinic settings to require an additional approval step before a specific beam set can be delivered.
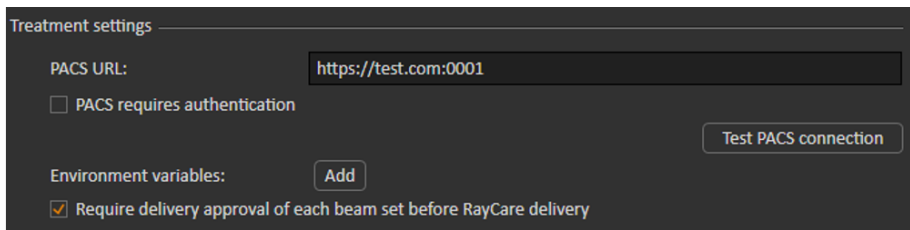

Figure 21. The **Treatment settings** in **Clinic settings**.

When **Require delivery approval of each beam set before RayCare delivery** is selected, all beam sets added to a treatment course will require delivery approval and it will not be possible to check in a patient for a session or to validate the session for delivery in RayCommand. It will not apply for beam sets already part of a treatment course when the setting is enabled. For further information see *section D.9 Beam set delivery approval in treatment course on page 109*.

Note: *This feature is only applicable for RayCare treatments.*

B DEFINING SETUP IMAGING PARAMETERS IN RAYSTATION

This section describes the workflow in RayStation for configuring setup beams and imaging parameters for the medPhoton specific patient setup and imaging procedures performed by RayCommand.

In this chapter

This chapter contains the following sections:

B.1 COMMISSION AN ION TREATMENT MACHINE TO SUPPORT WORKFLOWS FOR MEDPHOTON IMAGING PROCEDURES

To support the patient setup and imaging procedures required for medPhoton delivery, the Ion treatment machine needs to be configured with the appropriate type of motion synchronization support.

How to configure motion synchronization.

1. Open the Add synchronization technique dialog in the **Motion synchronization** tab, see *Motion synchronization* in the *RSL-D-RS-11B-RPHY, RayStation 11B RayPhysics Manual.*
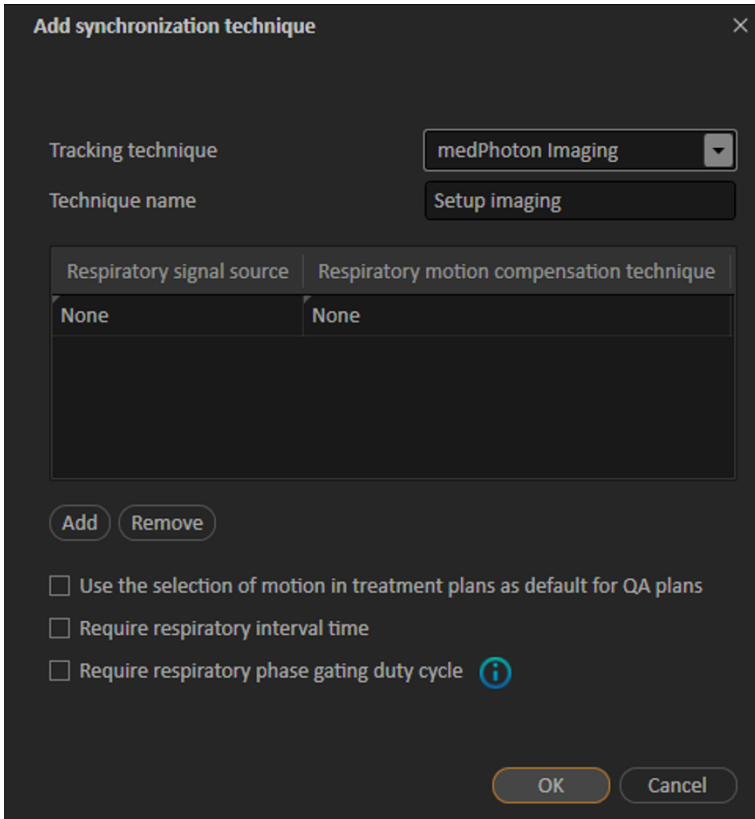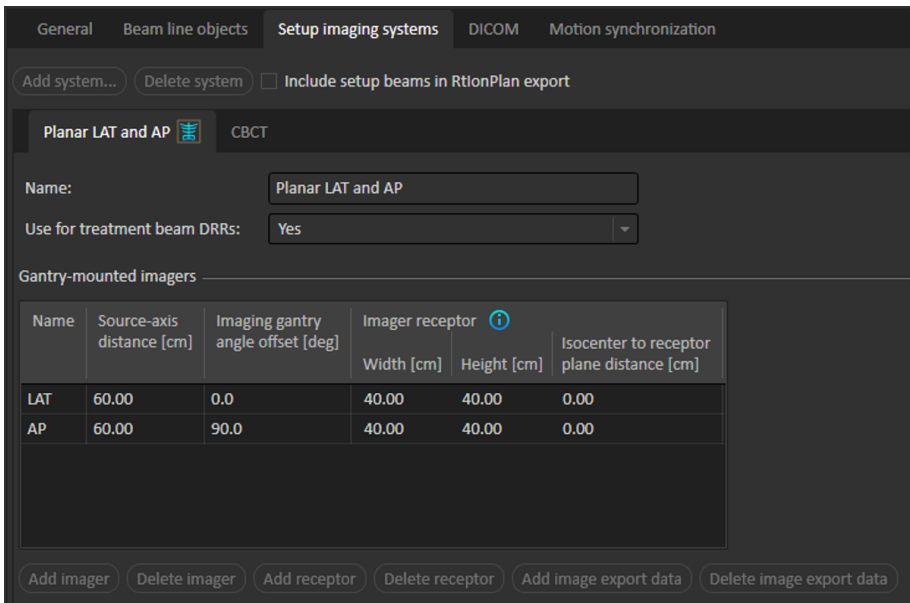
Figure 22.   Add synchronization technique with support for medPhoton imaging procedures.
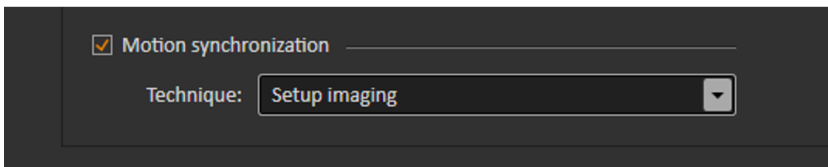
2.   Add a motion synchronization technique with the Tracking technique selected as 'medPhoton Imaging'.

3.   Add a name for the Tracking technique.

The other available properties in the **Motion synchronization** tab will not affect the standardized medPhoton patient setup and imaging flow.

Name	Source-axis distance [cm]	Imaging gantry angle offset [deg]	Imager receptor ⓘ		Isocenter to receptor plane distance [cm]
			Width [cm]	Height [cm]	
LAT	60.00	0.0	40.00	40.00	0.00
AP	60.00	90.0	40.00	40.00	0.00

B.2   CREATE A BEAM SET INCLUDING IMAGING PARAMETERS

In the Add/Edit beam set dialog, select a motion synchronization technique with Tracking technique 'medPhoton' to enable the medPhoton flow for imaging and patient setup. For more information on how to define the technique, see *Commission an Ion Treatment Machine to support workflows for medPhoton imaging procedures on how such a technique is defined*.

When a motion synchronization technique of type 'medPhoton imaging' is selected, it will have the following consequences for that beam set.

- Setup beams with custom imaging isocenter will automatically be used.

    - Note that as a consequence the section for setup beam creation and setup beam isocenter selection will be hidden.

    - Setup beams will be created according to standard RayStation rules for gantry mounted and fixed imagers.

- Additional custom imaging isocenters for the setup beams are allowed to be created.

- A selected Tracked ROI is required per imaging isocenter.

- A selected Body site is required per imaging isocenter.

- An Imaged volume representation will be created, which can be edited.

B.3   EDIT SETUP BEAM PROPERTIES IN THE SETUP BEAM LIST

The setup beams and imaging parameters are configured from the **Setup beams** tab. For further information, see *Setup beams* in the *RSL-D-RS-11B-USM, RayStation 11B User Manual*.

No.	Name	Description	Isocenter [cm] Name	R-L	I-S	P-A	Gantry [deg]	Couch [deg] Rotation	Imaging system	Tracked ROI	Imaged volume Width [cm]	Imaged volume Height [cm]	Imaged volume Aspect ratio	Body site
1	CD1_1	SetupBeam_CD(1)_1	●	-0.06	-37.35	-7.84	0.0	0.0	Planar LAT and AP	PTV	4.00	7.00	1.75	Abdomen
2	CD1_2	SetupBeam_CD(1)_2	●	-0.06	-37.35	-7.84	90.0	0.0	CBCT	PTV	4.00	7.00	1.75	Abdomen

Figure 23.   The setup beam list when using medPhoton imaging.

Assign a separate isocenter for a setup beam

Define a new separate isocenter for the beam by right-clicking on an existing isocenter in the setup beam list and select **Duplicate isocenter**.
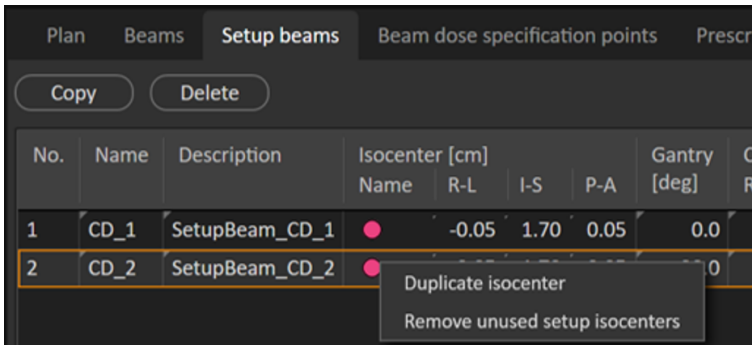
Select another isocenter for a setup beam

Select another existing isocenter for a setup beam by right-clicking on the isocenter in the setup beam list and select another isocenter from the drop-down list.
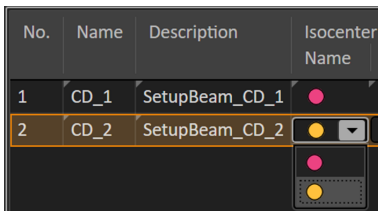
Remove unused isocenters

If undesired and unused isocenters exist in the beam sets, select **Clear unused isocenters**. All isocenters in the beam set that are not used by a beam will be deleted.

Note that the imaging isocenters do not have a name. Setup beam isocenters are marked in the patient views as 'Setup iso'.
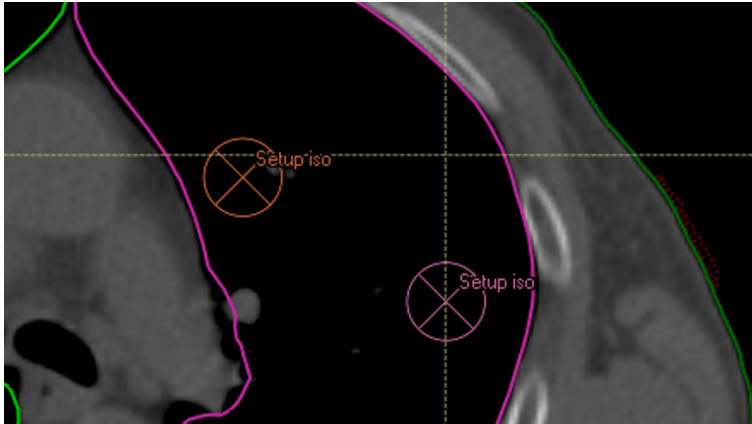

Figure 24.   Setup isocenters in the patient view.

B.4   SELECT PARAMETERS FOR IMAGING

For standard editing of setup beam parameters, see *Setup beams for proton plans and light ion plans* in the *RSL-D-RS-11B-USM, RayStation 11B User Manual*.

No.	Name	Description	Isocenter [cm] Name	R-L	I-S	P-A	Gantry [deg]	Couch [deg] Rotation	Imaging system	Tracked ROI	Imaged volume Width [cm]	Imaged volume Height [cm]	Imaged volume Aspect ratio	Body site
1	CD_1	SetupBeam_CD_1	●	-0.06	-37.35	-7.84	0.0	0.0	Planar LAT and CT	■ PTV	4.00	7.00	1.75	Abdomen
2	CD_2	SetupBeam_CD_2	●	-2.51	-37.35	-5.67	90.0	0.0	CBCT	■ PTV	4.00	7.00	1.75	Abdomen
3	CD_3	SetupBeam_CD_3	●	-2.51	-37.35	-5.67	90.0	0.0	CBCT	■ PTV	4.00	7.00	1.75	Abdomen

Figure 25.   The setup beam list for medPhoton imaging

The setup beam list will, in addition to present information for each setup beam, also display information that is defined per imaging isocenter. When editing properties related to the imaging isocenter, the information will be updated in all rows containing setup beams sharing that same imaging isocenter.

Imaging system

The user can select which imaging protocol to use per setup beam. The protocol includes the definition of the angles to use for setup imaging performed by that setup beam. If selecting an imaging system with multiple imagers with different offsets, setup imaging with RayCommand will be performed from all angles defined as the setup beam angle + the imager offset.
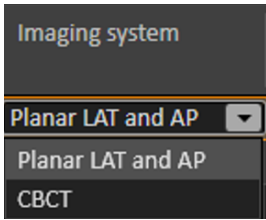
Tracked ROI

A **Tracked ROI** is required to select per imaging isocenter. Select the appropriate ROI from the drop-down list that is populated with all ROIs which are not of **Organ at risk** type.

The selected ROI will be used in RayCommand as the default focus ROI for registrations of images acquired at that setup beam isocenter.
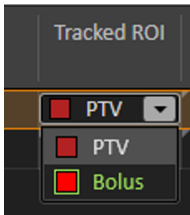

Width, height and aspect ratio of Imaged volume

The width, height and aspect ratio of the volume to be imaged can be edited in the setup beam list as well as interactively changed from the DRR views. The relation ship (height = aspect ration * width) is always preserved when editing.

Body site

A **Body site** is required to select per imaging isocenter. The **Body site** will be forwarded from RayCommand to the imaging system to define imaging parameters, to give optimal image quality of the body site imaged at this imaging isocenter.

The available body sites to select from is defined in Clinic Settings, see *Preferences* in the *RSL-D-RS-11B-USM, RayStation 11B User Manual*.
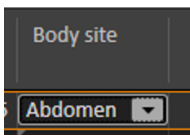
DRR view

For more information regarding what is displayed in the DRR views, see *DRR views and Settings* and *Setup beams* in the *RSL-D-RS-11B-USM, RayStation 11B User Manual*.

When looking at the setup DRR for a setup beam, DRRs for the different imaging angles will be possible to select in the different sections in the pie diagram in the upper right corner of the workspace. Change the selected imaging angle by clicking in the pie diagram or use arrow right/arrow left keys.
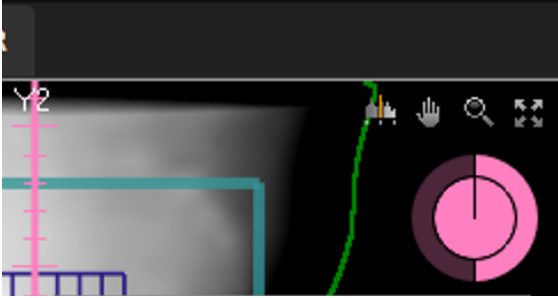

In the DRR, the imaged area is visualized as a grid, centered at the setup beam isocenter.

By right-clicking in the **Setup DRR** view and selecting the **Edit imaged volume** tool, it is possible to move and resize the imaged volume.

By using the **Edit imaged volume** tool, the isocenter of the setup beam can be moved in the DRR view by clicking and dragging in the central part of the grid. The isocenter is moved with the grid following.

To change the size of the imaged volume, for the isocenter of the selected setup beam, click and drag on the border of the grid. Interactive resizing is possible only with a fixed aspect ratio.
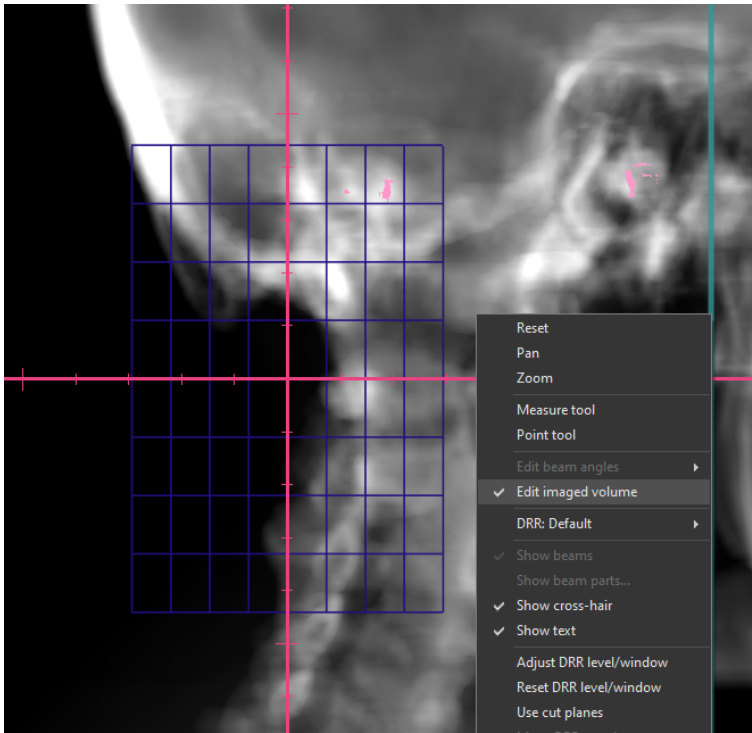
C COLLISION CHECK IN RAYSTATION

C.1 INTRODUCTION

The Collision check functionality in RayStation consists of tools designed for predicting collisions in the treatment room already in the planning phase, to avoid the discovery that a plan is non-deliverable when the patient is positioned on the treatment table and is ready for treatment.

In addition to the geometries of the treatment room, delivery system and robotic couch, the Collision check also enables the insert of a patient avatar whose shape is specified by the user in RayStation, and that is automatically positioned in the patient image stack. The Collision check also includes the modeling of fixation devices whose ID and position on the table top are defined in RayCare prior to planning.

The Collision check can be performed with the table top in its nominal position, as well as for a multitude of table top correction scenarios which are sampled by user-defined setup margins in all 6 degrees of freedom of the robotic couch. At plan approval, the user is not allowed to proceed if the Collision check has not been executed and a warning is shown if a collision has been detected.

The setup margins are exported to RayCommand along with the plan and structures representing the fixation devices and patient avatar. The setup margins and collision status are also included in the plan report.

C.2 ADD FIXATION DEVICES

The fixation devices are created in RayStation as regular ROIs. These ROIs will also be used in the collision check of the robotic motion tracking algorithm in RayCommand.

The fixation device IDs and table top positions (indices) used for the planning image data set are defined in RayCare and are automatically pushed to RayStation prior to planning. The geometry of each available fixation device is stored in a structure template in RayStation. The devices used for the current plan are positioned in the image stack according to the table top position (index). The position and shapes of the fixation devices may be adjusted manually after being placed in the patient, for example to compensate for potential couch sag. The creation of the fixation ROIs in the patient is triggered from a script in RayStation.
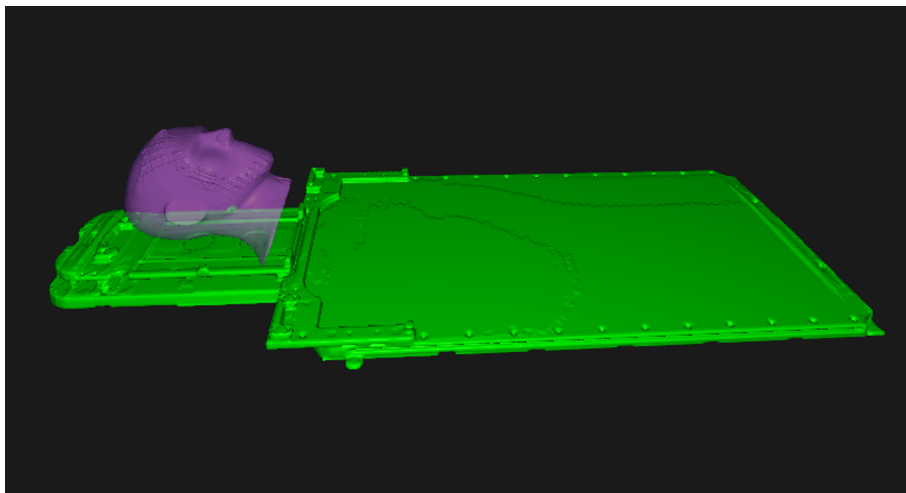
Figure 26.   Example where the fixation device 'HeadStep' has been added to the patient.

C.3   ADD A PATIENT AVATAR

The patient avatar is composed of regular RayStation ROIs of type 'Avatar'. The avatar is constructed by a series of ROIs (torso, two arms, two legs and head & neck) so that individual body components may be manually adjusted if needed. The external ROI is also considered by the Collision check.
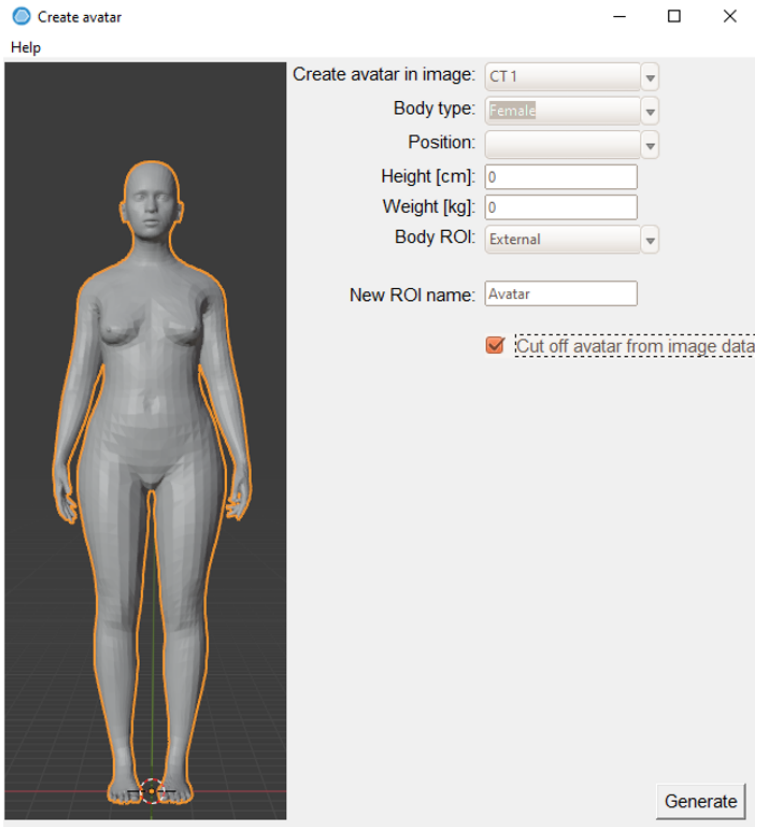
The creation of the avatar is handled by a RayStation script (script UI is shown above). If more than one CT is available, the CT image to be used is selected first in the script. The shape of the avatar is then defined by the following:

- Length

- Weight

- Body type (woman/man/child)

- Body position (arms down, arms up etc.).

The length and weight are populated automatically by data from RayCare. The body type is determined from the patient's sex and age according to the following:

- Man >= 13 years -> Man body type

- Man < 13 year -> Child body type

- Woman >= 11 year -> Woman body type
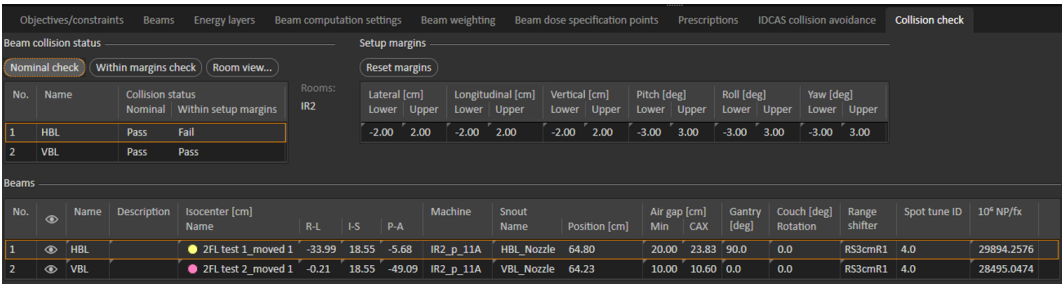
- Woman < 11 year -> Child body type

This data may be overridden in the avatar user interface. The avatar ROIs are automatically positioned in the patient coordinate system by a rigid registration to the external ROI, but the positions may be subsequently manually adjusted. Since the External ROI is included in the Collision check and often is the best representation of the true patient outline, the volume covered by the image data stack can optionally be subtracted from the avatar ROI (via the **Cut off Avatar by image data** checkbox). The effect of this function is exemplified below, where the **Cut off Avatar by image data** checkbox was selected for the avatar to the right.
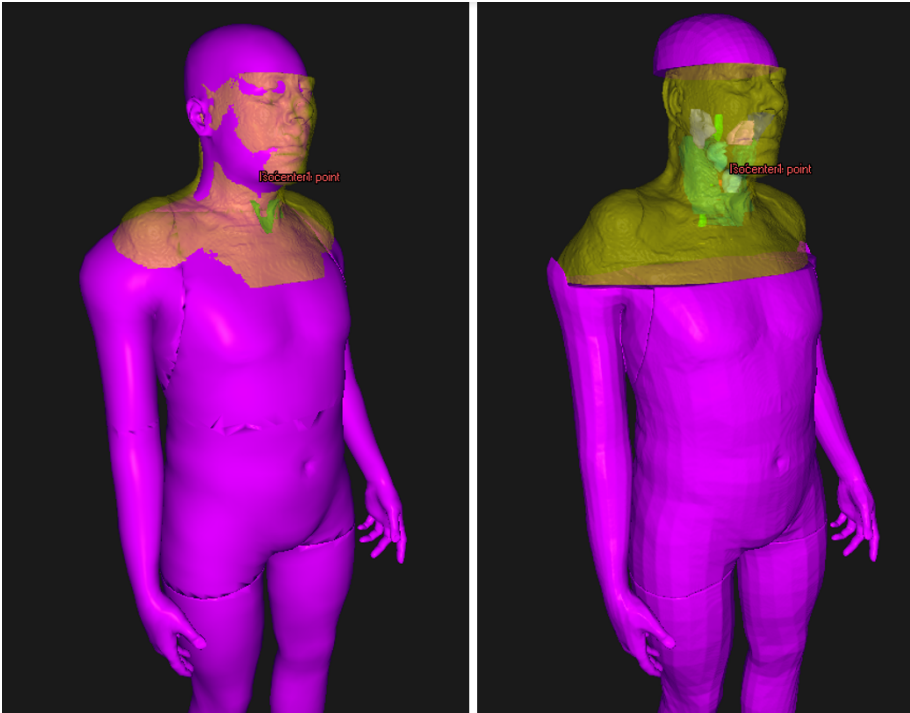
C.4   COLLISION CHECK TAB

The **Collision check** tab is the main workspace for the Collision check in RayStation, and is included in the **Plan design** and **Plan optimization** modules. The **Collision check** tab includes:

- Collision check execution buttons

- Collision status table

- Setup margins table

- List of rooms that the Collision check is performed for

- Room view execution button

- Planning parameters beams list

No.	Name	Collision status		Rooms:
		Nominal	Within setup margins	IR2
1	HBL	Pass	Fail	
2	VBL	Pass	Pass	

Setup margins

Reset margins

	Lateral [cm]		Longitudinal [cm]		Vertical [cm]		Pitch [deg]		Roll [deg]		Yaw [deg]	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
	-2.00	2.00	-2.00	2.00	-2.00	2.00	-3.00	3.00	-3.00	3.00	-3.00	3.00

Beams

No.	👁	Name	Description	Isocenter [cm]				Machine	Snout		Air gap [cm]		Gantry [deg]	Couch [deg] Rotation	Range shifter	Spot tune ID	10⁶ NP/fx
				Name	R-L	I-S	P-A		Name	Position [cm]	Min	CAX					
1	👁	HBL		🟡 2FL test 1_moved 1	-33.99	18.55	-5.68	IR2_p_11A	HBL_Nozzle	64.80	20.00	23.83	90.0	0.0	RS3cmR1	4.0	29894.2576
2	👁	VBL		🔴 2FL test 2_moved 1	-0.21	18.55	-49.09	IR2_p_11A	VBL_Nozzle	64.23	10.00	10.60	0.0	0.0	RS3cmR1	4.0	28495.0474

C.5 COLLISION CHECK FUNCTIONS

The Collision check can be performed with the patient in its nominal position (**Nominal check**), and for collisions considering the 6D movement of the table within the given setup margins (**Within margins check**). The result of these two tests is presented in the **Beam collision status** table. The status is one of the following:

- **Unknown** (if no check has been executed for the given setup)

- **Pass**

- **Fail**

Within margins check is performed for all possible scenarios combining the setup margin limits plus the nominal scenario (=65 scenarios). The setup margins are shown in the **Setup margins** table, with separate values for positive and negative margins. The setup margins are editable in the table, with default values of 2 cm for spatial margins and 3 degrees for angular margins. The default values are brought back by clicking the **Reset margins** button. The rotational center of the table top correction is by default taken as the center-of-mass of the primary prescription ROI.

The values of the setup margins do not refer to margins relative to the table top, but rather to the displacement of the body that leads to a counter movement of the table. For example, the scenario including a Lateral margin of +2 cm will investigate the scenario where the table is positioned at a Lateral position of −2 cm (see *section C.7 Room view on page 90*).

The treatment room which is used for the Collision check is identified by the beam model of the beam set and the treatment room settings as given in Clinic Settings. If the beam model of the current beam set serves more than one room, the Collision check is performed for all the rooms. This means that the so-called imaging device transformation (IDT) vector, which is needed for positioning the fixation devices and avatar correctly on the treatment table top and is stored per treatment room in Clinic settings, is required to be equal for the rooms that are included in a Collision check. This is verified by the Collision check algorithm. The names of the treatment rooms used in the Collision check are displayed in the **Collison check** tab.

A collision is noted if the convex hulls of the geometries of the model are within a specified contact margin. In RayStation 11B, these margins are by default set to 3 cm for collisions with snout or nozzle and is otherwise 1 cm. To change these values, contact RaySearch support.

C.6 COLLISION STATUS INVALIDATION

The collision status is invalidated upon any change to:

- Patient plan

- Patient avatar ROIs

- Fixation ROIs

- External ROI

- Setup margin values (only Margin Collision check status)

- Plan prescription (only Margin Collision check status)

Note that the collision status is not invalidated in the following scenarios:

- The setup instructions (fixation devices and positions) have been updated in RayCare since the patient was last opened in RayStation.

- The IDT vector for a room is changed after a Collision check has been executed.

C.7 ROOM VIEW

Room view is a dialog that is opened from the **Collision check** tab.

The dialog shows a 3D rendition of the treatment room, displaying all the geometries included in the Collision check for the selected beam (**Beam** drop-down list) of the current beam set. For beam sets with a beam model that is supported by more than one room, the room to be visualized is selected by the **Room** drop-down list.

Besides investigating the nominal patient position, the **Room view** dialog also supports the possibility to study the effect of a 6D couch correction. It should be noted that the setup correction values entered in the user interface refer to the displacement of the patient and only implicitly the correction of the table since the patient displacement will generate a counter motion of the table top. However, in RayStation 11B the patient avatar will remain in its nominal position on the table top. The relation of the table top motion to the input patient displacement parameters is further explained in the table below.

Right-Left	HFS reference: Positive (negative) values indicate couch movement in patient's right (left) direction.
Inf-Sup	HFS reference: Positive (negative) values indicate couch movement in patient's inferior (superior) direction.
Post-Ant	HFS reference: Positive (negative) values indicate couch movement in patient's posterior (anterior) direction.
Pitch	HFS reference: Positive (negative) values indicate counterclockwise (clockwise) rotation as seen from patient's right side. Patient's head lowers (elevates).

Roll	HFS reference: Positive (negative) values indicate clockwise (counterclockwise) couch rotation as seen from patient's head. Patient's right hand lowers (elevates).
Yaw	HFS reference: Positive (negative) values indicate clockwise (counterclockwise) couch rotation as seen from above. Head moves to patient's left (right).

The **Room view** dialog further indicates the collision status for the current room/beam/patient displacement. The possible states are:

• **Pass** (green)

• **Fail** (red)

• **Unreachable position** (red). Indicates that the couch robot cannot bring the table to the desired position.
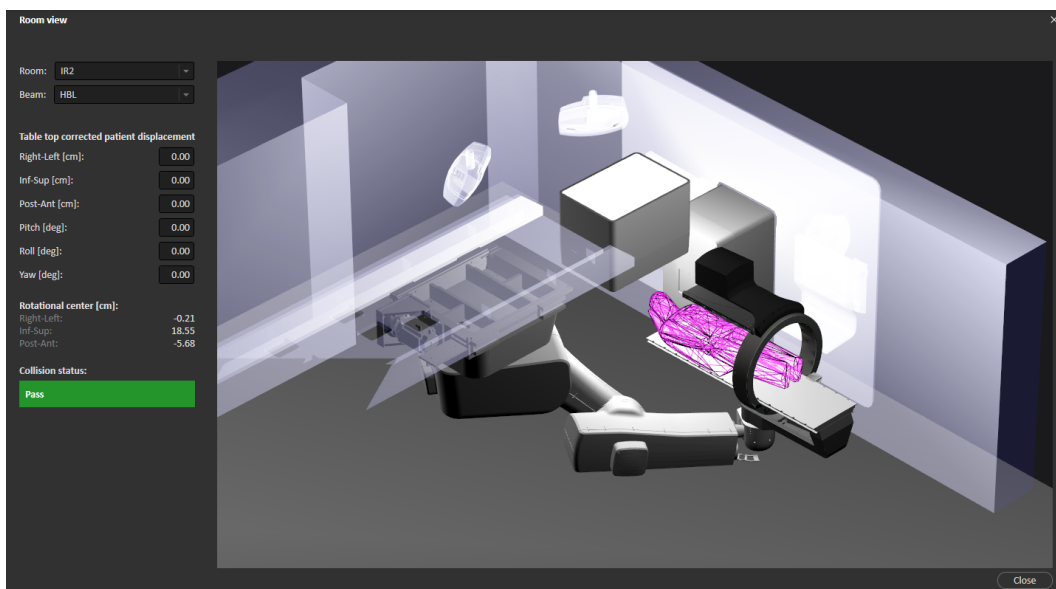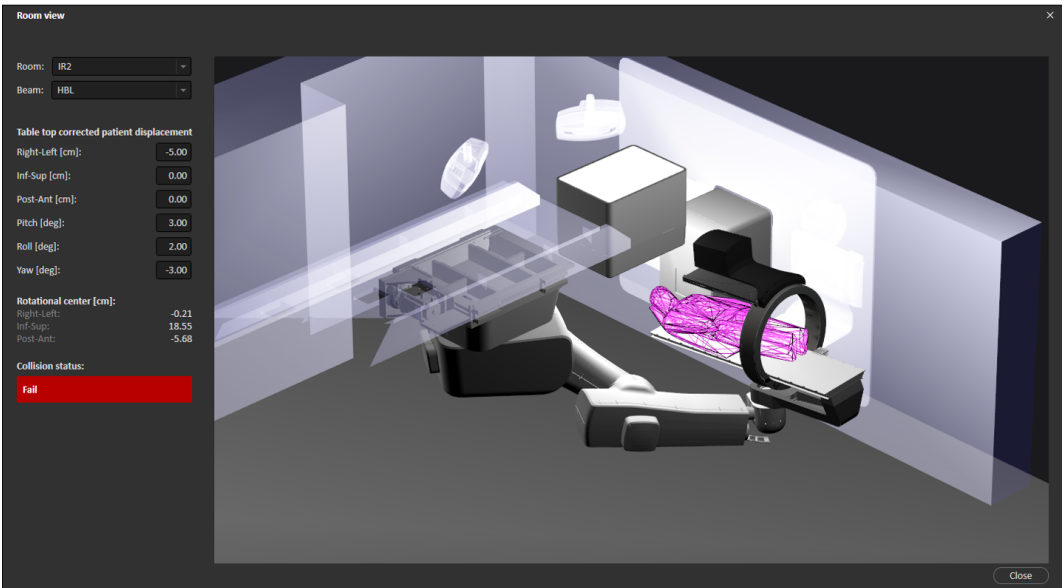
The information in the **Room view** is controlled via the mouse and keyboard as summarized in the table below.

Key	Function	Description
Left mouse button	Rotate camera	Rotates the camera to view the room from different angles.
Mouse wheel	Zoom in/out	Zooms in/out to get a closer or a more distant view of the room.
Space	Camera reset	Sets the camera to its default position.
C	Show lines	Closest points of collision between objects.
F	Show frames	Frame-of-reference of various components and their origin and rotational direction relative the reference coordinate system.
G	Show grid	Grid of isocentric planes.
1	Show collision models	Shows the convex hull geometries that are used in the Collision check.

Key	Function	Description
2	Show spheres	Linear Axis Heuristic (LAH) spheres depicting the permissible minimum and maximum positions of the linear sliding overhead rail.

C.8 PLAN APPROVAL

The user may select whether a Collision check (**Nominal** and **Within margins check**) must have been executed to allow plan approval. This is defined per treatment room and is controlled by the **Require collision check** checkbox in Clinic Settings.
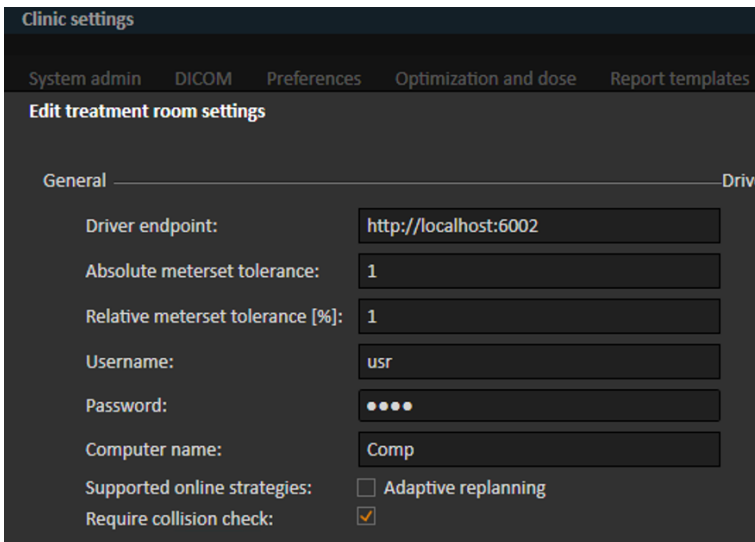
At plan approval, the user will get a warning if any collision has been detected, but plan approval is not prohibited.

C.9 PLAN REPORT

The setup margins and collision status tables are included in the plan report (see example below). If the **Require collision check** checkbox is selected in Clinic Settings (see *section C.8 Plan approval on page 93*), a Collison check must have been executed to allow plan report generation.

Lateral [cm]		Longitudinal [cm]		Vertical [cm]		Yaw [deg]		Pitch [deg]		Roll [deg]	
Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
-2.0	1.0	-2.0	2.0	-1.00	2.0	-3.0	3.0	-3.0	3.0	-1.00	3.0

Beam collision status

Beam #	Beam name	Collision status	
		Nominal	Within setup margins
1	HBL	Pass	Pass
2	B2	Pass	Fail

C.10 SCRIPTABLE FUNCTIONS

The following are the Collision check related actions available via scripting:

NominalCollisionCheck()	Same as the **Nominal** check in the **Collison check** tab.
WithinMarginsCollisionCheck()	Same as the **Within margins check** in the **Collison check** tab.
ReadOnlyNominalCollisionCheckForBeam(..)	Performs the **Nominal** check for a given beam without affecting the collision status.
ReadOnlyWithinMarginsCollisionCheckFor-Beam(..)	Performs the **Within margins check** for a given beam without affecting the collision status.

C.11 SCRIPTABLE PROPERTIES

The following are the Collision check related properties available via scripting:
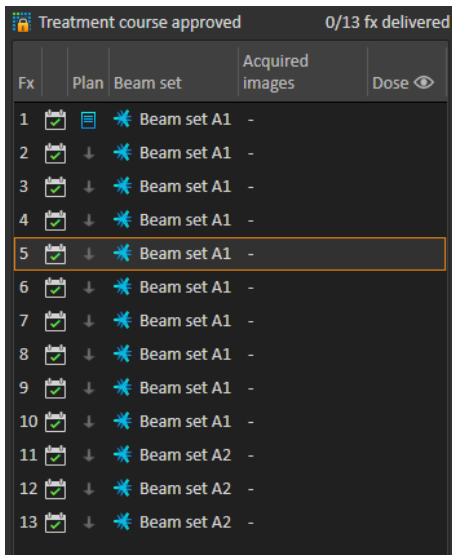
```
PatientSetup.CollisionProperties
    BeamCollisionStatus -> ScriptCollection
    SetupMargins -> ScriptObject
BeamCollisionStatus
    Nominal (get)
    WithinSetupMargins (get)
SetupMargins
    LateralLowerMargin (get/set)
    LateralUpperMargin (get/set)
    LongitudinalLowerMargin (get/set)
    LongitudinalUpperMargin (get/set)
    PitchLowerMargin (get/set)
    PitchUpperMargin (get/set)
    RollLowerMargin (get/set)
    RollUpperMargin (get/set)
    VerticalLowerMargin (get/set)
    VerticalUpperMargin (get/set)
    YawLowerMargin (get/set)
```

```
YawUpperMargin (get/set)
```

D TREATMENT MANAGEMENT IN RAYSTATION

D.1 OVERVIEW

Before an approved treatment plan from RayStation can be used for delivery in RayCommand, it is necessary to specify which plans and beam sets to use for a specific fraction in the treatment course. An overview of the treatment course can be found in the **Treatment course** tool panel to the left.

Figure 27. **Treatment course** tool panel.

Management of the treatment course prior to delivery can either be done by right-clicking on selected fractions in the panel, or in the **Approval** tab in the **Plan evaluation** module.

Additional information regarding fractions included in the treatment course is available in the tooltip.
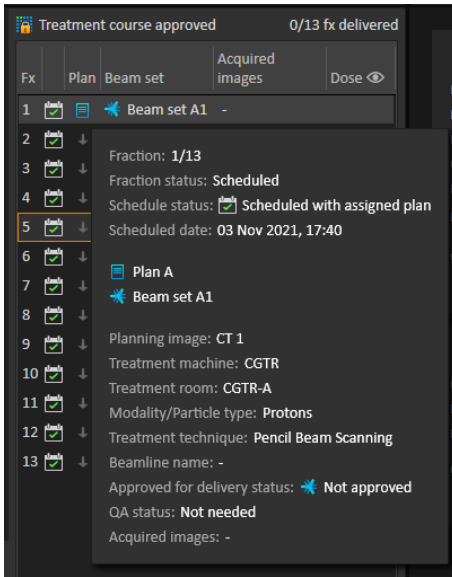
Figure 28.   Tooltip with information about a fraction.
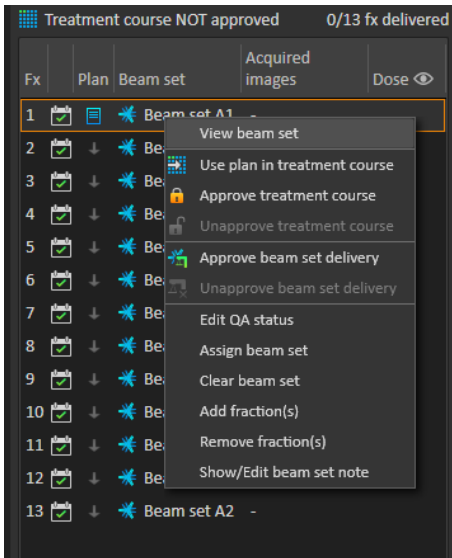
Figure 29.   **Treatment course** tool panel menu.
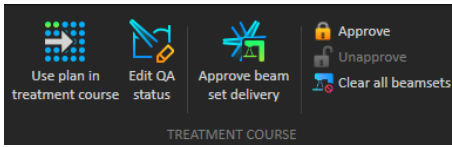
Figure 30.   Treatment course management in the **Approval** tab.

In the **Patient data** management module in RayStation, the treatment delivery overview displays the available plans to deliver, as well as the number of delivered fractions.

The treatment delivery overview shows all beam sets that can be used for upcoming delivery. The name, machine and assigned fractions are displayed.
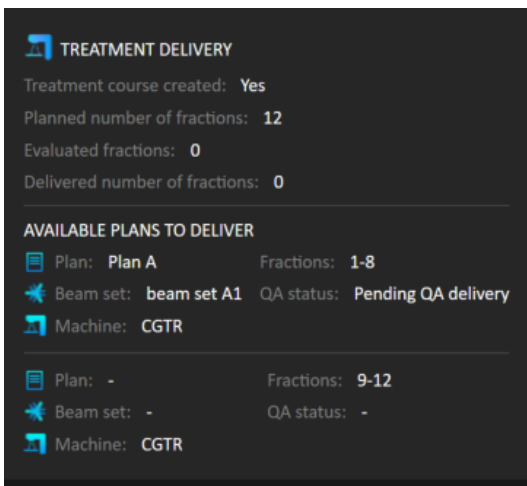
Figure 31.   Treatment delivery overview in **Patient data** management.

If any fractions are scheduled in RayCare, for a room with no plan assigned for a machine model corresponding to one that the room supports for delivery, the plan and beam set will be displayed as - .

When having alternative plans, the same fraction may occur for multiple beam sets. This indicates that these fractions can be delivered by either of the machines specified.

Different actions to manage the treatment course are described below.

D.2   USE PLAN IN TREATMENT COURSE

Assigning plans for treatment is done in the **Use plan in treatment course** dialog in RayStation. The dialog is accessed by clicking the **Use plan in treatment course** button.
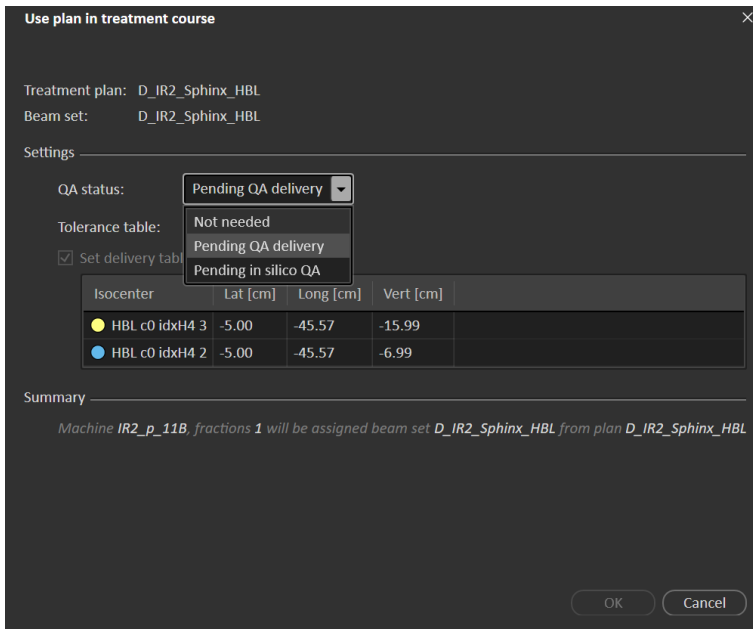
Figure 32. The **Use plan in treatment course** dialog in RayStation. The dialog may look different depending on the machine model.

The **Use plan in treatment course** dialog shows the currently open plan, all approved beam sets and to which fractions each beam set will be assigned. The assignment depends on the current plan's fractionation schedule and the fractions that have already been delivered.

To be able to assign a beam set for treatment, the following is required:

- The machine used in the plan must have a corresponding machine model configured in a treatment room in the **Treatment** section of the Clinic Settings application (for more information, see *Appendix A Clinic Settings configuration for RayCommand*).

- The approved plan must have a dose computed with the current dose engine version and the latest, not deprecated, treatment machine model version.

- Each beam set in the plan needs to have a primary prescription.

Note: *For IBA, there must be exactly one single setup beam in the list.*

Note: *In RayTreat, the beam sets will be displayed with both their plan and beam set name. Make sure to use unique beam set names.*

> ⚠️ **WARNING!**
>
> **Make sure that the intended plan is used.** All plans can be included in the treatment course, regardless of the prescription or the planned number of fractions. Exercise caution when assigning different plans to different fractions.
>
> (7190)

Typically, when treatment planning has been completed for a patient, the approved plan is assigned to be delivered for all fractions in the treatment course. This can be accomplished by opening the **Use plan in treatment course** dialog, and verifying that the selected beam set will be used for all expected fractions. If the treatment machine for the plan requires a tolerance table to be selected for a plan, that must also be selected in the **Tolerance table** drop-down menu.

If fractions do not have an approved beam set, they will be left unassigned. They can later be assigned by opening the same dialog again, or by manually editing the treatment course. For more information, see *section D.7 Modify treatment course on page 107*.

If the plan needs to be replaced during the treatment course (e.g., if a replanned treatment plan, adapted treatment plan or fallback plan needs to be used instead of the original plan), the new plan will be used according to its fractionation schedule. The user is responsible for verifying that the new plan is assigned to the correct fractions in the **Use plan in treatment course** dialog.

Note: *When the patient has been checked in to a treatment session, the plan for the corresponding fraction cannot be changed.*

Set delivery table top position

If the machine is set to support modifying table top positions, it is possible to set the default absolute table top position for the plan in the **Use plan in treatment course** dialog.

Once the table top positions are set and the plan has been assigned for treatment, it is possible to open the **Use plan in Treatment Course** dialog again to edit the table top position values but it is not possible to clear the values.

Alternative plans

When using a plan for treatment it is possible to include alternative plans for different rooms, if needed. Having alternative plans does not increase the number of fractions. However, it will be useful when having several treatment rooms, and to easily be able to reschedule a fraction for another room which does not share a common machine model. It adds a backup if any of the machines needs maintenance, for example.

There are a number of requirements that need to be fulfilled in order for a plan to be considered as an alternative plan:

- It must have been planned on the same image set as the original plan.

- It must use the same approved structure set as the original plan.

- It must have exactly the same prescriptions as the original plan.

- There must be a localization point and it must be the same localization point as the original plan.

- It must have the same fractionation schedule as the original plan.

- It must be for a different machine model than the original plan.

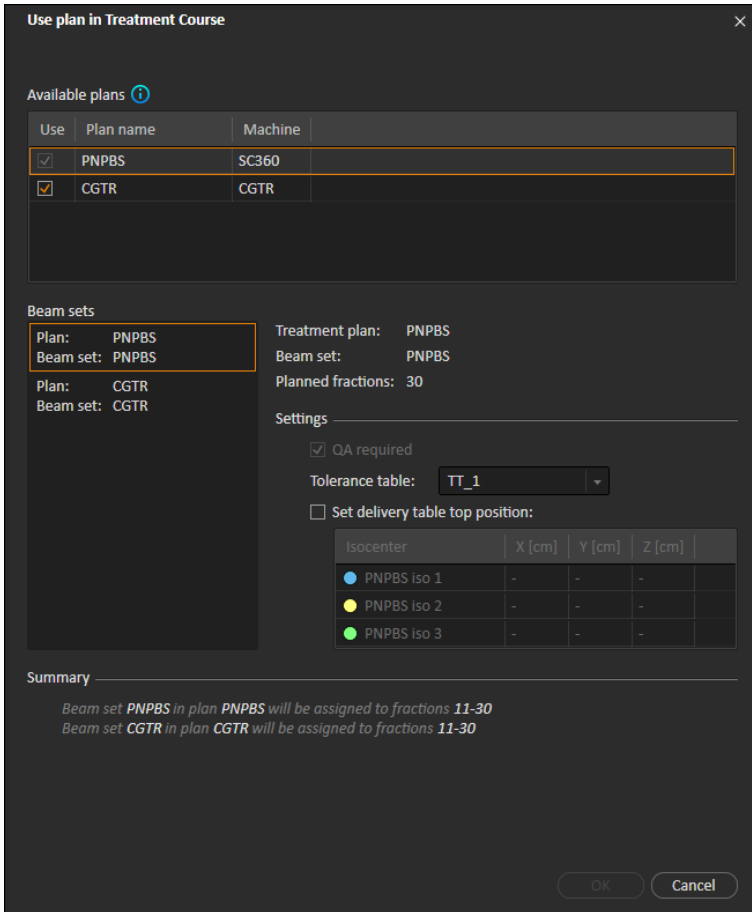- The plan must not be deliverable in the same room as the original plan.

Figure 33.   The **Use plan in treatment course** dialog, with alternative plans.

Any alternative plans are displayed in the **Available plans** list in the **Use plan in treatment course** dialog. When using alternative plans, each beam set needs to be prepared by configuring its **Settings** in the **Use plan in treatment course** dialog.

Note: When selecting an alternative plan, other plans for the same machine may be disabled. This happens if selecting them would cause any fraction to get alternative beam sets for the same machine.

Note: It is not possible to reschedule a continuation session for a machine other than the one for which the fraction was originally scheduled.

Plans with multiple isocenters

For plans with multiple isocenters, table top positions for all treatment isocenters are shown. Note that there are some specific requirements for plans with multiple isocenters:

• There must be a POI of type "Localization point".

• Isocenters must only be used for a consecutive set of beams and not be used in multiple beams with non-consecutive beam numbers. This means that a previously used isocenter cannot be repeated after another isocenter has been used.

This is OK
Beam 1 - Iso 1
Beam 2 - Iso 1
Beam 3 - Iso 2

This is NOT OK
Beam 1 - Iso 1
Beam 2 - Iso 2
Beam 3 - Iso 1

• Delivery table top positions must be specified in the **Use plan in treatment course** dialog.

• Validated plans with treatment patient position **HFS** (Head First Supine) is supported.

Only the table top position for the first isocenter can be edited — the other table top positions are automatically calculated based on the relative positions of the isocenters.
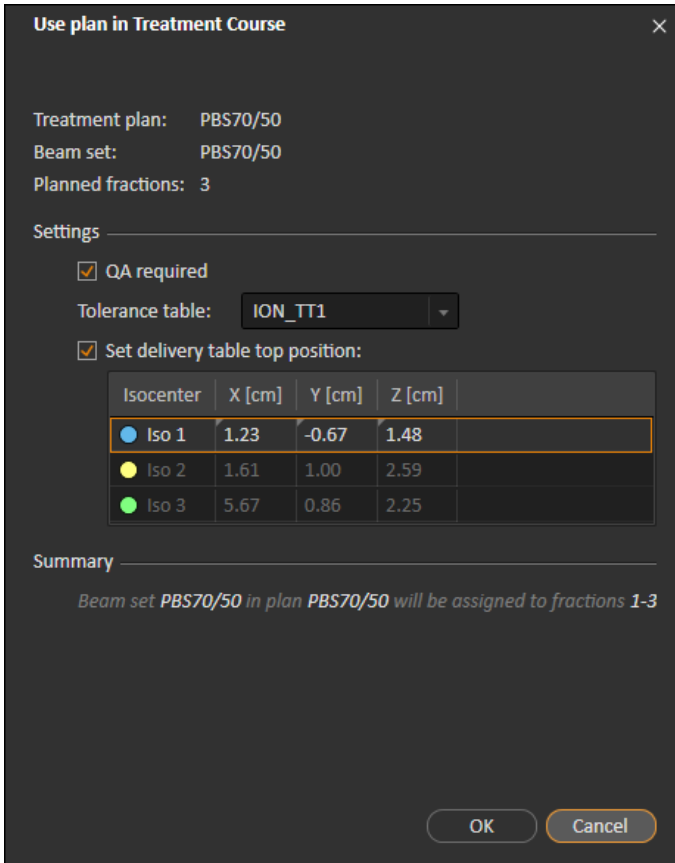
Figure 34. The **Use plan in treatment course** dialog for multiple beams at separate isocenters. The dialog may look different depending on the machine model.

D.3 CLEAR ALL BEAM SETS

This button will clear all existing fractions which have not been delivered of their existing assigned beam sets. Similar functionality for individual fractions is found in the **Treatment course** tool panel. The treatment course must be unapproved to allow any removal of beam sets from fractions. A warning is displayed where the user can choose to verify the action to remove all plans from undelivered fractions.
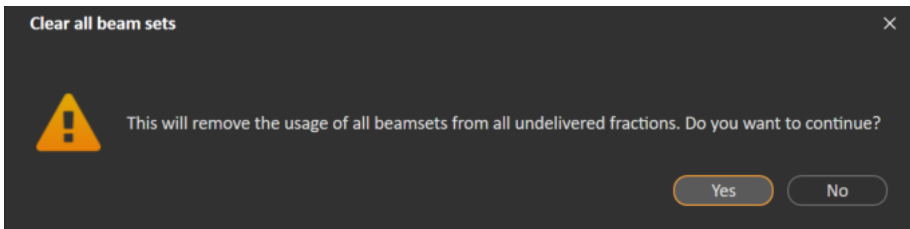
Figure 35.　　　Warning dialog displayed when clearing all beam sets.

D.4　EDIT QA STATUS

In the **Use plan in Treatment Course** dialog, it is possible to define whether or not the beam set will require QA delivery. Note that only treatment plans, as opposed to QA plans, will be used for delivery in this RayTreat version, both for treatment and QA delivery. When QA delivery is performed, or if the requirement of QA delivery changes, it is possible to edit the QA status by clicking the **Edit QA status** button.
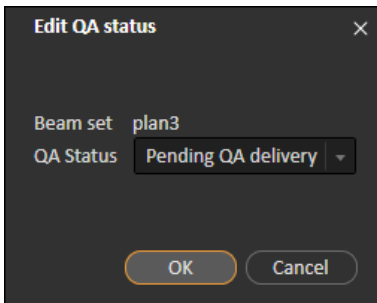

Figure 36.　　　The **Edit QA status** dialog.

The available QA statuses are listed in the following table.

Table D.1: List of the available QA statuses.

QA status	Meaning
Pending In-silico QA	The plan is expected to get an In-silico QA performed prior to use for patient treatment delivery.
Pending QA delivery	The plan is expected to be delivered and measured for plan-specific QA and analyzed prior to use for patient treatment delivery.
Pending QA analysis	The plan has been delivered for plan-specific QA, but the results have not been analyzed yet.
Not needed	The plan is of a type that either does not require plan-specific QA before patient treatment delivery, or the QA status of treatment plans is managed in another system.

QA status	Meaning
Pass	The plan has been delivered and measured for plan-specific QA, and the results have been analyzed and are acceptable for patient treatment delivery.
Failed measurements	The plan has been delivered and measured for plan-specific QA, and the results have been analyzed but are unacceptable for patient treatment delivery. The reason is likely that the plan is correct but the measurement procedure has failed. Repeated QA delivery and measurement is recommended.
Failed plan	The plan has been delivered and measured for plan-specific QA, and the results have been analyzed but are unacceptable for patient treatment delivery. The reason is likely to be a problem with the plan. Therefore, it shall not be used and replanning is required.
-	QA status is unknown.

D.5   APPROVE TREATMENT COURSE

Before a treatment course can be used for delivery, approval is needed. This is done by clicking the **Approve** button, available both in the right-click menu in the **Treatment course** tool panel and in the **Approval** tab (see *section D.1 Overview on page 97*). A table shows all the prescriptions of the treatment course and the total prescribed contribution of all fractions to each prescription.
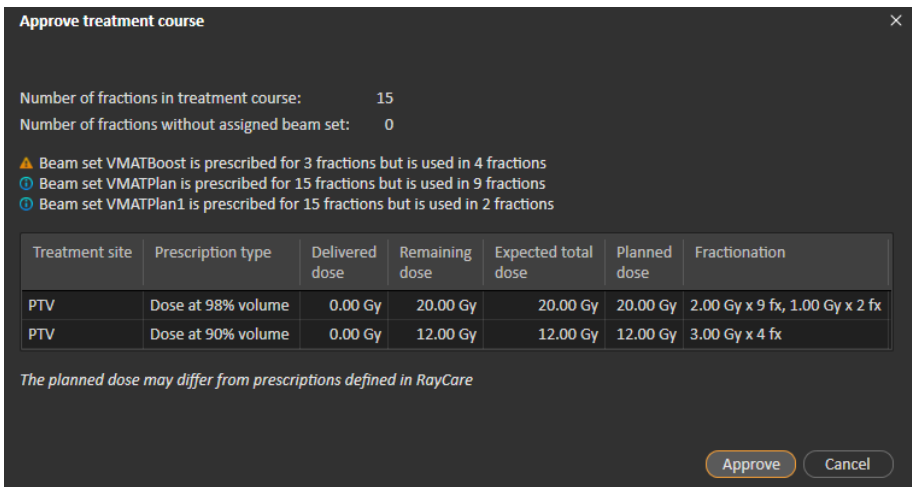

Figure 37.   The **Approve treatment course** dialog.

By clicking the **Approve** button the user confirms that the prescribed dose of the total treatment course is as expected. Only patients with a treatment course approved for delivery will be possible to treat in RayTreat. QA delivery is still possible without approval.

> ⚠️ **WARNING!**
>
> **Prescription in Approve treatment course dialog.** The planned prescribed nominal dose shown in the *Approve treatment course* dialog is the sum of the nominal dose contributions for all fractions in the treatment course. The prescription is not automatically synchronized between RayStation and RayCare. The user is responsible for making sure that the prescription in the *Approve treatment course* dialog corresponds to the prescription in RayCare.
>
> (341634)

D.6 UNAPPROVE TREATMENT COURSE

By clicking the **Unapprove treatment course** button, the treatment course becomes unapproved for delivery. When a treatment course is unapproved the user can make modifications, such as assigning or clearing the beam set on fractions. A patient with an unapproved treatment course can be scheduled for treatment. However, RayTreat will not allow any delivery to be made, and the patient cannot be checked in from RayCare.

Unapproving the treatment course can only be done when no session is checked in. Only a fraction with no recorded delivery can be modified.

D.7 MODIFY TREATMENT COURSE

The following actions can be found in the **Treatment course** tool panel menu. Some actions are only available for an unapproved treatment course.
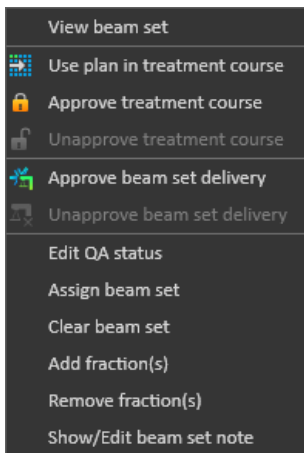

Figure 38. Menu displayed when right-clicking in the **Treatment course** tool panel.

- **View beam set**: Changes the current viewed beam set in RayStation.

- **Use plan in treatment course**: Assigns the current selected plan in RayStation for the entire treatment course. For more information, see *section D.2 Use plan in treatment course on page 99*.

- **Approve treatment course**: Approves treatment course for delivery. For more information, see *section D.5 Approve treatment course on page 106*.

- **Unapprove treatment course**: Unapproves treatment course for delivery. For more information, see *section D.6 Unapprove treatment course on page 107*.

- **Edit QA status**: Edits the beam set QA status. For more information, see *section D.4 Edit QA status on page 105*.

- **Assign beam set**: Updates the beam set to be delivered on a fraction. Any approved beam set from any plan can be assigned to any undelivered fraction. Assigning a beam set to fractions opens a dialog similar to the **Use plan in treatment course** dialog, where tolerance table, QA status and table top positions can be reassigned.

  Note: *The tolerance table, QA status and table top positions will be modified for all upcoming fractions using the same beam set.*

- **Clear beam set**: Clears the selected fractions of their assigned beam sets. If the beam set for a fraction needs to be reassigned but the intended new beam set is not approved or decided yet, the fraction can be cleared of its current beam set.

- **Add fraction(s)**: Extends the treatment course with a number of desired fractions. The fractions are always added at the end of the treatment course.

- **Remove fraction(s)**: Removes selected fractions to shorten the treatment course. Fractions are removed from the end of the treatment course, and only fractions without any delivery can be removed.

Note: *Some of the above actions will alter the treatment course nominal contributions to the defined prescriptions. These will, thus, require the user to first unapprove and then re-approve the treatment course.*

D.8   SHOW/EDIT BEAM SET NOTE

It is possible to edit the beam set note for a plan. The edited note will be saved for the plan in the treatment course. The note can also be edited from the started session.

If the beam set has a beam set note there is a speech bubble in all rows for this beam set in the treatment course list.

To show/edit a note, right-click on the fraction in the treatment course and select **Show/Edit beam set note**.

D.9   BEAM SET DELIVERY APPROVAL IN TREATMENT COURSE

When Clinic settings is configured to require beam set delivery approval, an additional approval step is required before the scheduled beam set can be delivered. For further information, see *section A.1 Configure beam set delivery approval in Clinic settings on page 76*.

The **Approve beam set delivery** option is accessible by right-clicking on a fraction in the treatment course list. The delivery approval will apply to the beam set that is shown for the fraction.
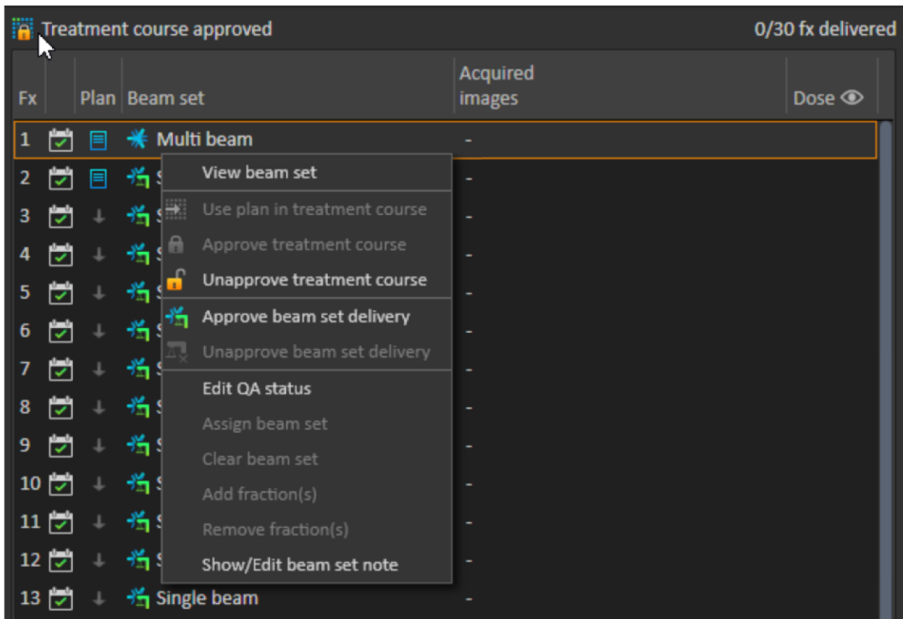
Figure 39.   The **Approve beam set delivery** option in Treatment course.

Delivery approval can also be set for the currently selected beam set by clicking the **Approve beam set delivery** button in the top tool bar. This also allows approving beam sets not currently shown in the treatment course list (alternative beam sets).
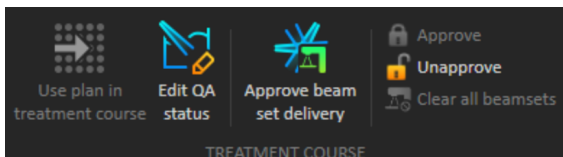
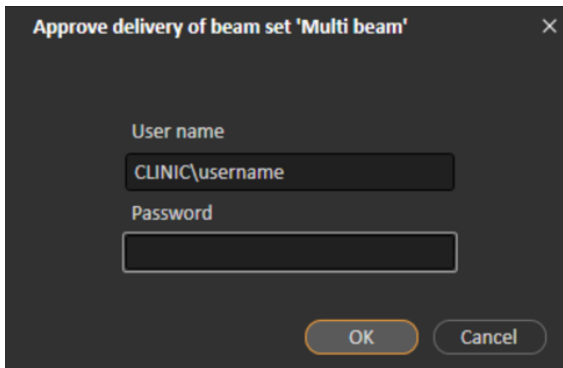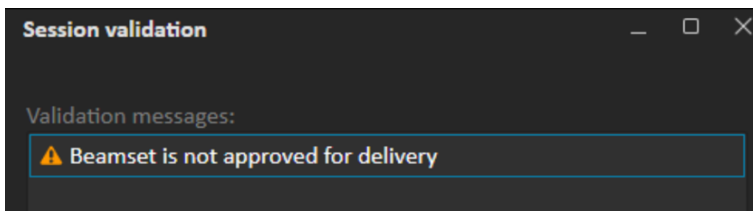Beam set delivery approval requires authentication by a user with treatment administration rights.

Figure 40.   The Beam set delivery approval authentication dialog.

If the scheduled beam set is missing delivery approval, it will not be possible to check in the patient for the session.

RayCommand will also validate beam set delivery approval before the beam set can be delivered.

Once a beam set delivery is approved it is possible to undo the approval by unapproving it. This also requires treatment administration rights. Removing a beam set completely from the treatment course will unapprove the delivery and if a previously approved beam set is re-added to the treatment course, its delivery will have to be approved again.

It is possible to see the delivery approval status in the treatment course list as well as in the session tooltip. An approved beam set delivery is indicated by a beam set icon with a green treatment unit. The delivery approval status is also shared with RayCare and its state shows up as a treatment alert for a specific session.
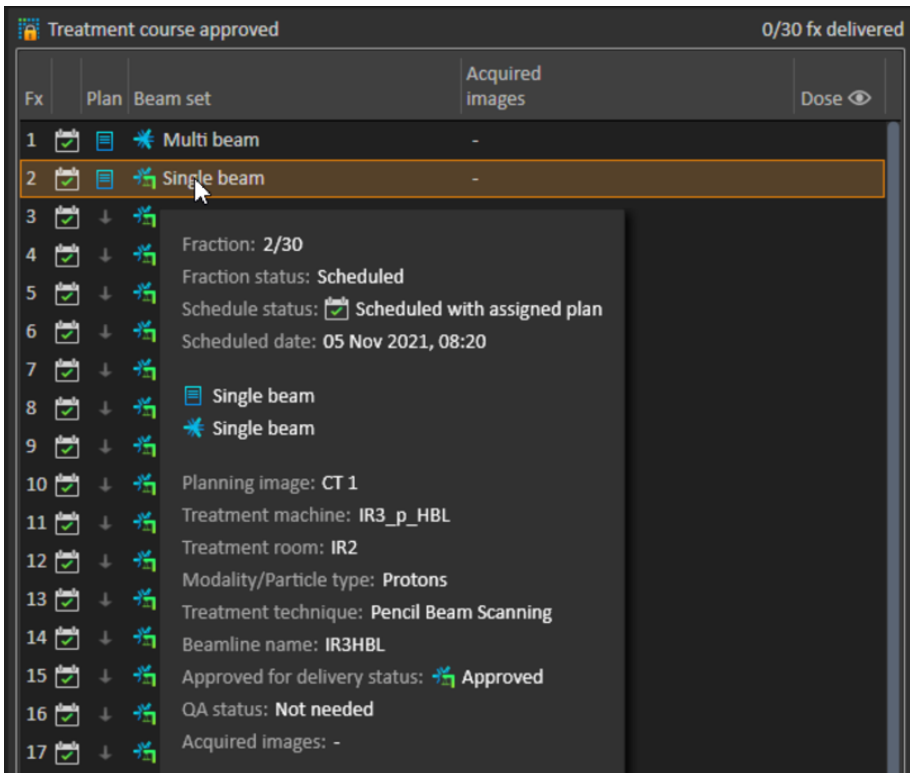
Figure 41.   The delivery approval status in Treatment course.

When Clinic settings is set to require beam set delivery approval, but the scheduled beam set does not require delivery approval (i.e., if the beam set was added to the treatment course before selecting the delivery approval option in Clinic settings), the delivery approval buttons will be visible but disabled. To require delivery approval for such beam sets they need to be removed and re-added to the treatment course.

Note: *This feature is only applicable for RayCare treatments.*

E TREATMENT RESULTS IN RAYSTATION

After the treatment delivery has been performed, it is possible to examine the results of the delivery in RayStation. The delivery results are presented in the **Result** workspace layout in the Dose Tracking module in RayStation. Delivery results such as beam delivery result status, couch positions, couch angles and online couch correction can be examined for each delivered treatment session.

Figure 42. The **Result** workspace layout in the Dose Tracking module in RayStation.

Note: *Modifications done in this workspace cannot be undone. Any changes here require that no previous unsaved modifications exist. All changes also require user authentication to be performed before completion.*

Note: *The treatment course needs to be approved in order to modify delivery or cancel a session.*

E.1   ADD SESSION TO FRACTION

Add an additional treatment session to the selected fraction by clicking the **Add session to fraction** button. That is, if the last session is completed, and there is still more to be delivered on that fraction.

Note: *Treatment course needs to be unapproved before session can be added to fraction.*
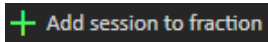
The new session that is added will then have to be scheduled manually through RayCare.

E.2   COMPLETE TREATMENT COURSE

When all fractions have been delivered and completed, it is possible to complete the entire treatment course by clicking the **Complete Treatment Course** button. A completed treatment course will be locked from further delivery.
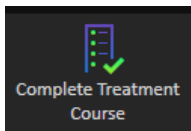
F   RT IMAGE AND DRR TEMPLATES

Adding templates

It is possible to add RT image and DRR templates, by modifying the values belonging to the following keys:

- *MainMonitor.VtkView.RtImageSettingsTemplates*

- *MainMonitor.VtkView.DrrSettingsTemplates*

Both keys are found in the file *RayCommand.MainMonitor.exe.config*.

Each key value expects a list of templates that are specified in JSON format.

Example

To add two DRR templates, modify the value of the key *MainMonitor.VtkView.DrrSettingsTemplates* to:

```
"[
  {'Name':'FirstTemplate','Mip':false,'Invert':true,'ThresholdMin':-1000.0,
    'ThresholdMax':4000.0,'LevelWindowMin':0.0,'LevelWindowMax':0.2,
    'UseMarker':false,'MarkerThreshold':2750.0,'BoneEnhancement':1.0,
    'Gamma':1.0,'FilterType':0},

  {'Name':'SecondTemplate','Mip':true,'Invert':false,'ThresholdMin':-800.0,
    'ThresholdMax':3700.0,'LevelWindowMin':0.1,'LevelWindowMax':0.3,
    'UseMarker':true,'MarkerThreshold':2800.0,'BoneEnhancement':0.7,
    'Gamma':1.2,'FilterType':1,'SharpeningAmount':0.1}
]"
```

Available properties for RT image templates

Name	Required
Name	Yes
Invert	Yes
LevelWindowMin	Yes
LevelWindowMax	Yes
Gamma	Yes
FilterType	Yes

Name	Required
SharpeningAmount	No
EdgeDetectionAmount	No

Available properties for DRR templates

Name	Required
Name	Yes
Mip	Yes
Invert	Yes
ThresholdMin	Yes
ThresholdMax	Yes
LevelWindowMin	Yes
LevelWindowMax	Yes
UseMarker	Yes
MarkerThreshold	Yes
BoneEnhancement	Yes
Gamma	Yes
FilterType	Yes
SharpeningAmount	No
EdgeDetectionAmount	No

Filter type

The filter type is specified using a number.

Available filter types and their corresponding numbers:
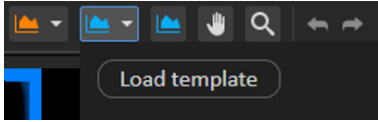
Filter type	Number
None	0
Sharpening	1
Edge detection	2

Loading templates

To load templates:

1.   Click the **DRR** or **RT Image** drop-down list in the tool view.

2.   Click the **Load template** button.

APPENDIX G - DEFINITIONS

G   DEFINITIONS

Term	Meaning
GPU	Graphics Processing Unit
BEV	Beam's Eye View
Control point	Position of the PPS in the treatment room according to IEC 61217: Yaw (IEC theta, Rz), X (table top lateral), Y (table top longitude), Z (vertical), Pitch (IEC psi, Rx), Roll (IEC phi, Ry)
DVH	Dose Volume Histogram
deg	When the term deg is seen in RayStation this refers to degrees.
DRR	Digitally Reconstructed Radiograph
External ROI	The ROI used to define the outline of the patient in the dose computation. The ROI used to define the outline of the patient in the dose computation.
GUI	Graphical User Interface
MU	Monitor Units
ROI	Region of Interest
Path	A sequence of control points.
Patient positioner	Collective name for the device used to place the patient on. This can typically be a treatment couch, or a chair mounted on a positioning device.

RSL-D-RS-11B-RCMDIFU-EN-2.1-2022-04-11 RAYSTATION 11B SPC1 RAYCOMMAND 2B SPC1 INSTRUCTIONS FOR USE   119

Term	Meaning
Trajectory	PPS speeds and accelerations through a path, calculated for the comfort of the patient, stability of the ROI, and protection of the PPS, with respect to mechanical limits and IEC standards.
Control console	The physical control panel provided by the manufacturer of the patient positioning system or the treatment machine.
PPS	Patient Positioning System

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