- **Remote positioning controls**: in Physics mode, the Manual mode of the remote positioning controls is available by default. That is not the case in Clinical mode, where the Manual mode of the remote positioning controls is only available upon explicit request.

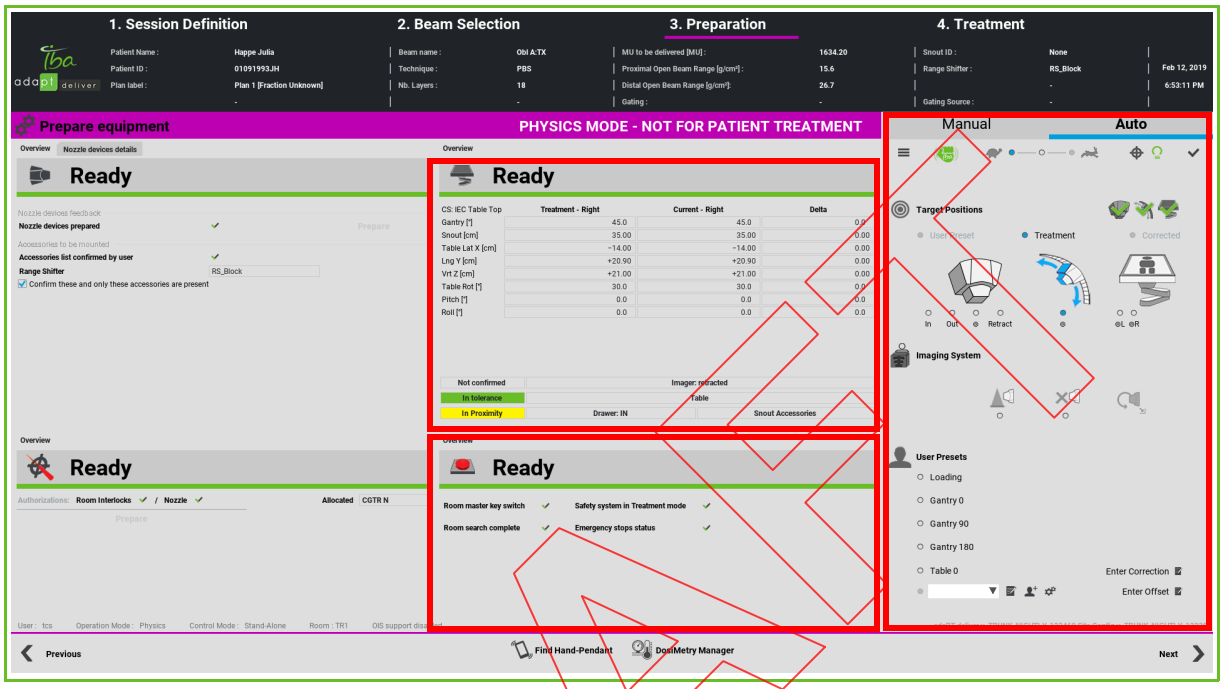

Figure 43-10. Equipment Preparation Screen Physics Mode

Verifying the Position of Devices

Note: *If you want to use another gantry angle than the one from the prescription, you should edit the related field from the* BEAM SELECTION SCREEN *(see Figure 43-9) before entering the Preparation Screen.*
The Set Range is done with the gantry angle defined in the BEAM SELECTION SCREEN, ***not*** *the current gantry angle.*

WARNING

Be aware that in Physics Mode, you are not blocked if you choose to irradiate with a gantry angle different from the prescription; no warning message will appear.

Most of the differences in terms of PMS between Clinical mode and Physics mode are visible on the PMS INTERFACE PANEL.

Be aware that the imaging system must be out of the beam path, like in Clinical mode.

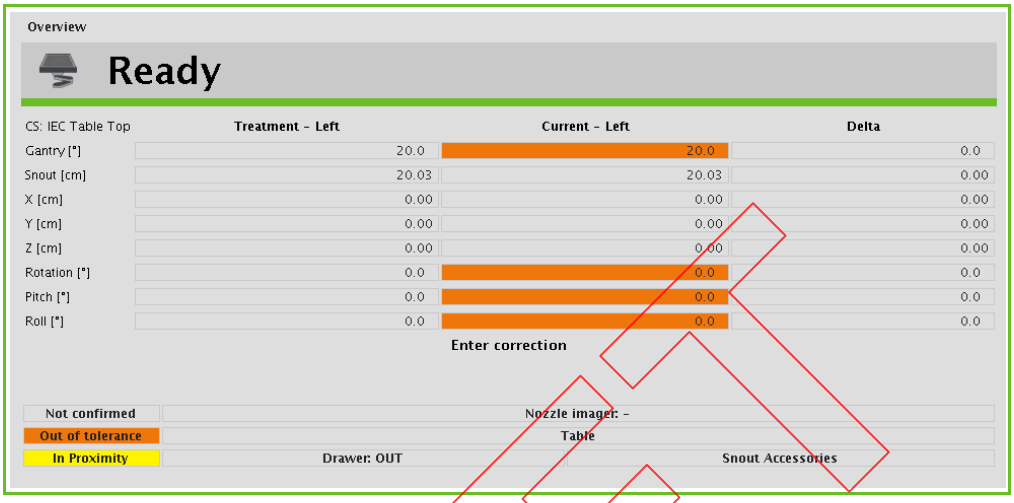

Figure 43-11: PMS Interface Panel

The differences are as follows:

- **Tolerances**: if the values are out of tolerance, you do not need to acknowledge any message to confirm that you are aware that the positioning devices are out of tolerance.
- **Drawer**: the drawer can be IN or OUT, disregarding the prescription. In Clinical mode, the drawer must be in position to proceed to the IRRADIATION SCREEN. In Physics mode, this condition is irrelevant.

  Note: *The drawer must not be in between IN and OUT; it must be fully IN or fully OUT).*

- **Color legend**:
  - *Orange*: screen elements in orange indicate that these settings are acceptable in Physics mode but will block or issue an error message in Clinical mode.
  - *Orange*, **with a red frame**: these settings are blocking, even in Physics mode (see Figure 43-12, where the drawer is still in the beam path).

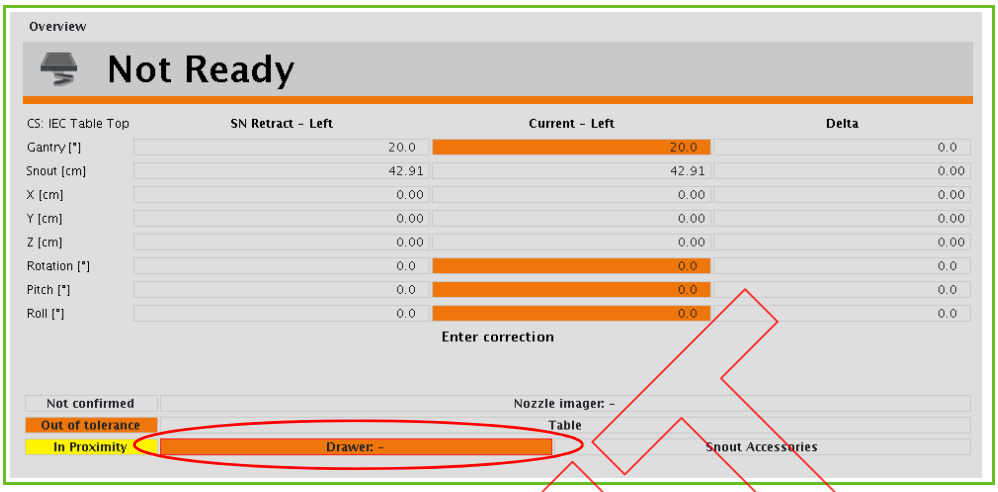

Figure 43-12. PMS Interface Panel, with Blocking Selection

Verifying the Room Interlocks

In Physics mode you have the option to insert the TCR Service Mode key in the key switch on the TCR Safety Interface, which is part of the Safety and Triggering Rack.

When you then rotate the key switch to proceed to irradiation, the nozzle cyclic checks are disabled.

An inserted TCR Service Mode key is indicated by the red cross mark (✘) next to **Session mode control switch**.

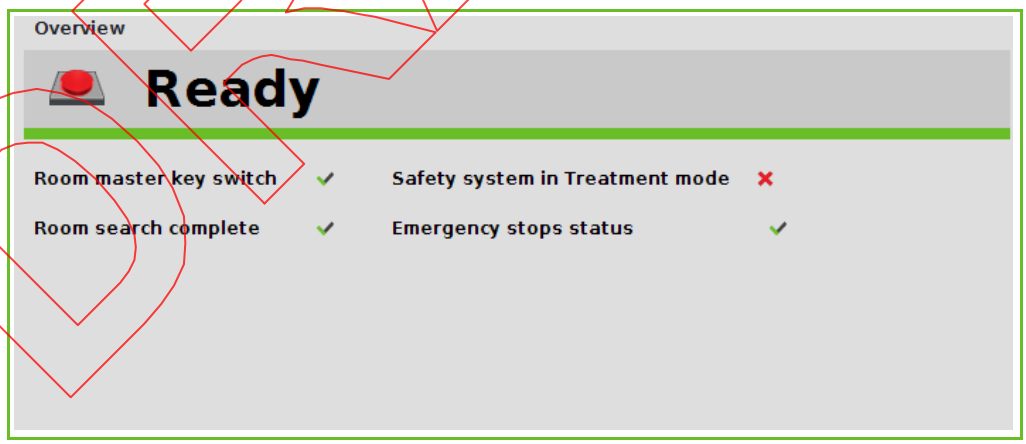

Figure 43-13. Room Interlocks Panel (typical)

Treatment

The TREATMENT SCREEN in Physics mode differs somewhat from the same screen in Clinical mode, as follows:

- **Physics optional actions**: this is an additional tab on the Monitor panel of the TREATMENT SCREEN. This tab enables you to select any given layer and to keep track of the monitor units during your operations.

  From the Irradiation Options pane you can select one of the following actions:

  - Pause after layer
  - Pause after tuning
  - Enable field restart
  - Tuning required
  - Display pop-ups: you can opt to display scanning controller error pop-up messages.

  The Layer Selection pane enables you to select the desired layer, as follows:

  - reselect the first layer
  - select the previous layer
  - select the next layer
  - specify any specific layer that you want to select; click the adjacent arrows button to proceed.

- **Time progress bar**: using this bar on the right of the screen you can keep track of how the irradiation is evolving.

Important	The time progress bar is a cumulative display. Which means that if you irradiate the same layer a few times (e.g., when skipping, restarting, pausing, resuming irradiation within a layer or field), the Monitor Units (UM) do not restart from 0. This means that in Physics mode the time progress bar is not representative of the irradiation activities.

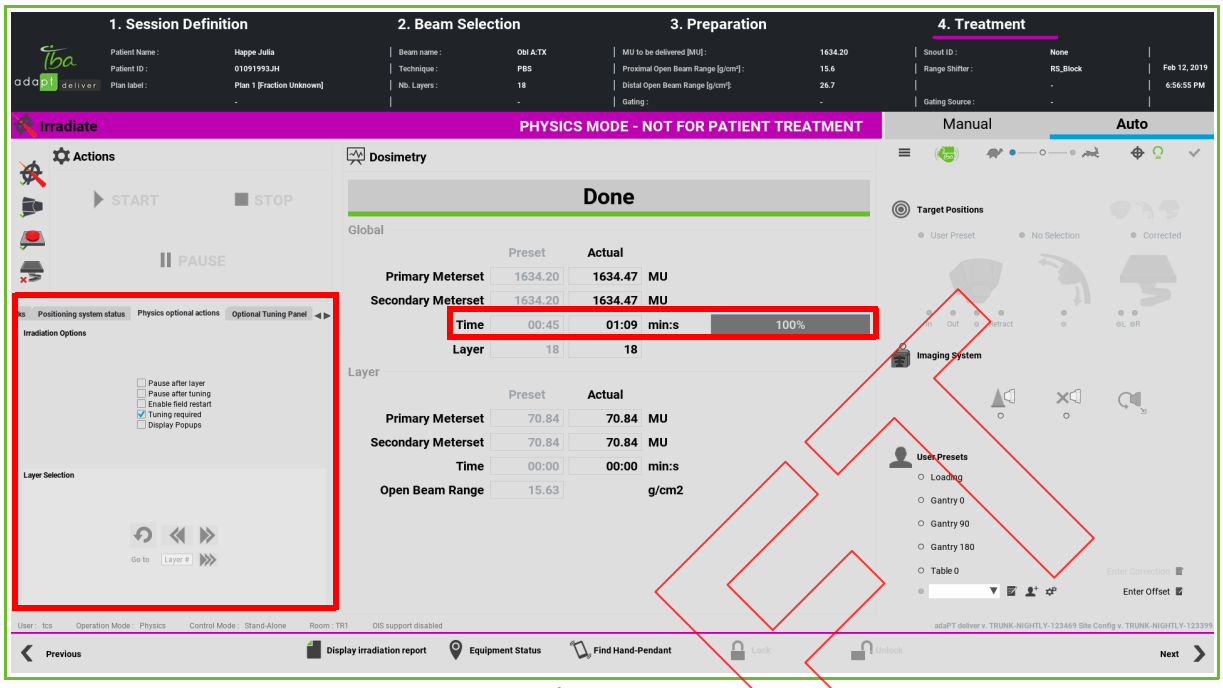

Figure 43-14. Treatment Screen

During a pause you may want to move any Patient Positioning Device (PPD). To do so, click **Unlock** at the bottom of the screen. When your preparation is finished, do not forget to click **Lock** to lock the PPDs again.

WARNING

In Physics mode, ~~when~~ the gantry is rotated during an irradiation pause, the measurements become invalid because the Set Range is done with the prescribed angle instead of the current angle.

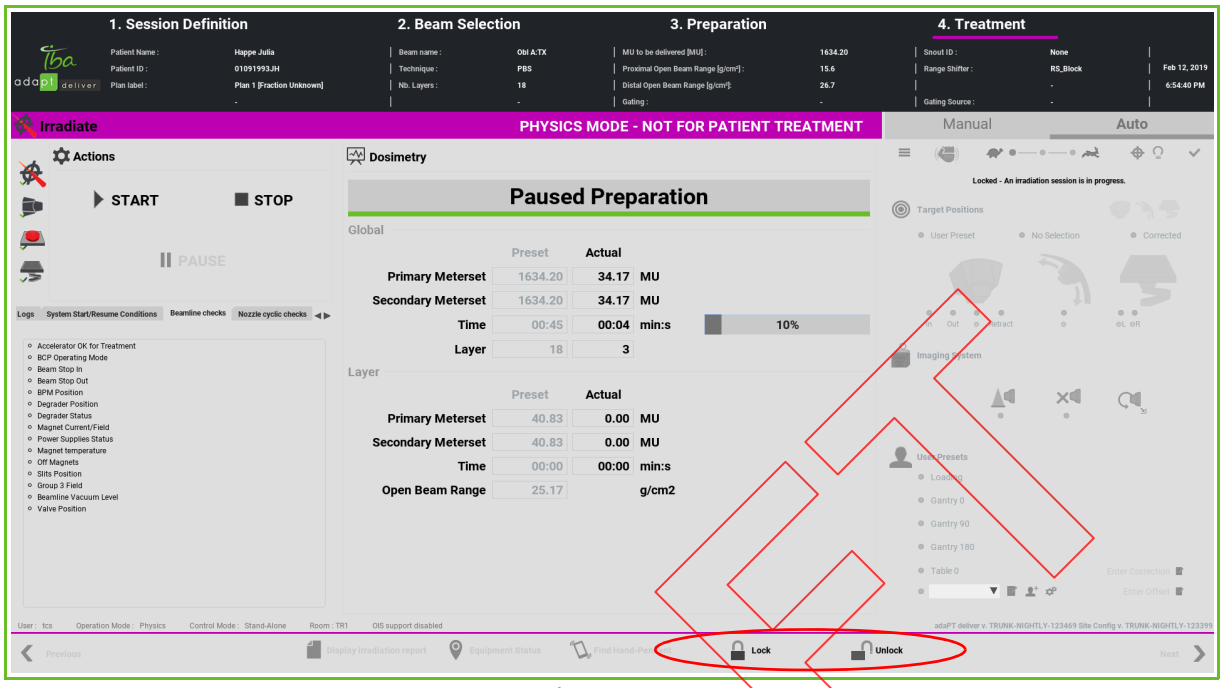

Figure 43-15. Treatment Screen

From the TREATMENT SCREEN you have the option to pause or stop the beam.

When the beam is paused and you do not intend to resume the treatment, click **Stop** Irradiation from the TREATMENT SCREEN.

The PTS terminates the field irradiation. Contrary from Clinical mode, in Physics mode no records are stored in the database.

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Part X

Preparing for Treatment

Chapter 44
Beam Scheduling Principles

Beam generated by the cyclotron can be allocated to any TR, one TR at a time. Therefore, beam requests coming from different TRs must be scheduled. Once beam usage is no longer needed in a given TR, the beam must be released before it can be allocated to another TR.

Beam scheduling can be performed manually by the Accelerator Operator or automatically by the Beam Scheduler. The principle itself is known as **Automatic Beam Scheduling** (ABS) .

ABS Automatic Mode

When ABS is working in **Automatic** mode, the beam request is generated when the RTT in the TR clicks the Normal priority request or High priority request button from the BEAM PANEL of the EQUIPMENT PREPARATION SCREEN. All beam requests end up in the beam request queue, without Accelerator Operator intervention.

Each beam request has a given priority corresponding to the Beam Request button (**High** or **Normal**) that the RTT has clicked. Any request made in Service mode from a TR also appears in the queue.

Beam is automatically allocated based on the priority and the time stamp of the request. The Accelerator Operator in the MCR can overrule this automatic allocation.

ABS Manual Mode

When ABS is working in **Manual** mode, the RTT in the TR sends a beam request from the BEAM PANEL of the EQUIPMENT PREPARATION SCREEN to the Accelerator Operator in the MCR. The Accelerator Operator subsequently allocates the beam, based on the priority.

When the Accelerator Operator allocates the beam, the RTT in the relevant TR is informed that beam is allocated to the corresponding TR. The subsequent beam tuning can then be performed automatically or manually.

Switching ABS Modes

Switching between the Manual or Automatic ABS mode is performed by the Accelerator Operator in the MCR. This can be done unless beam is allocated.

Both in Manual and Automatic ABS mode the beam request queue is visible in each TCR, TR, and in the MCR.

Chapter 45
Preparing a Treatment Room

This procedure does not depend on the availability of patient data and may be performed before or simultaneously with the procedure described in **Part V**, "*Using adaPTdeliver*".

Verifying Removable Patient Supports

At your center you may have different removable patient support types available such as a short couch or a Base of Skull (BoS) frame.

Important	If the patient support types are different, you will not be able to proceed with treatment.

When you are using any of these removable patient supports, verify before irradiation that you are using the patient support type that is specified in the treatment plan.

Preparing a Gantry Treatment Room

Preliminary: GRF Precautions

When you are performing functions in or in the vicinity of the patient enclosure, bear in mind the GRF precautions as specified in section "*Gantry Rolling Floor Precautions*" on page 4-3.

GTR Preparation

Important	Always check the Treatment Room's temperature and pressure in the morning Quality Assurance (QA) and enter the data in the Dosimetry Manager. Monitor the temperature and pressure during the day. Whenever the values deviate from the last values known to the system, these new values must be updated in the system via the Dosimetry Manager. Do instruct the Accelerator Operator to enter and save the ICEUs average pressure and IC2/IC3 temperature on the NOZZLE MORNING CHECKS SCREEN.

WARNING	Whenever the temperature and pressure deviate beyond the treatment center quality management plan threshold, the temperature and pressure have to be updated manually using the Dosimetry Manager.

Procedure

1. Move the gantry to a position suitable for loading the patient onto the coach.
2. Secure the patient onto the couch.

WARNING	If a patient is not safely secured to the PPS, the patient may fall off. Each patient shall be safely secured before moving the PPS.

WARNING	Patients shall be properly secured and their limbs (that is, arms, hands, feet, and legs) shall not hang over the edges of the couch or be able to reach the accessory drawer. In addition, it should be impossible for the patient to access a hazardous moving part under the couch.

Part XI

Patient Positioning and Alignment

Chapter 46
Introducing Patient Positioning and Alignment

This part assumes that the Radiation Therapy Technologist (RTT) is familiar with the equipment (refer to Chapter 5, "Introducing Treatment Room Equipment").

At the time of treatment, positioning the patient takes place in the TR using the hand pendant. The Digital Radiographs (DRs) are acquired at the time of preparation.

Depending on the TR hardware configuration, 2D stereoscopic images are acquired at the time of treatment using one or multiple imaging devices. Equally, and optionally, 3D images can be acquired using a single 2D imaging device which rotates around the volume to be imaged.

AdaPT*insight* computes the correction vector using image registration techniques and automatically transfers them into the Therapy Control System (TCS). Alternatively, the RTT can introduce these corrections manually from the TCS screen in the TR. The therapist finally implements these corrections using the hand pendant or the remote positioning controls.

This correction calculation can be iterated a number of times till a satisfactory alignment is reached.

WARNING

As a Radiation Therapy Technologist (RTT), it is your responsibility to verify that the current machine geometrical configuration is matching the prescribed configuration of the treatment plan (gantry angle, snout position, Patient Positioning System [PPS] position).

WARNING 	As a Radiation Therapy Technologist (RTT) you should perform motion with the patient on the support (i.e., couch or chair) only after the patient has been securely immobilized on the support.

WARNING 	As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

WARNING 	After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

Important 	The same clinical devices must be put on the Patient Positioning System (PPS) for every treatment day in order to maintain a constant weight on the couch.

Various Positions Involved

Patient positioning and alignment involves primarily the following positions:

- *Setup Position*
- *Treatment Position*

Setup Position

The Setup position is the position where the center of the treatment site coincides with the isocenter of the system. The setup position is specific to the setup beam.

Note: *If this is the first beam of the patient's* plan *to be delivered, you must move the patient to the baseline Setup position. For all successive beams, the Setup position will be the last saved Setup position.*

The Setup position is a labeled position; you must perform an Auto motion to bring the patient positioning devices to this Setup position.

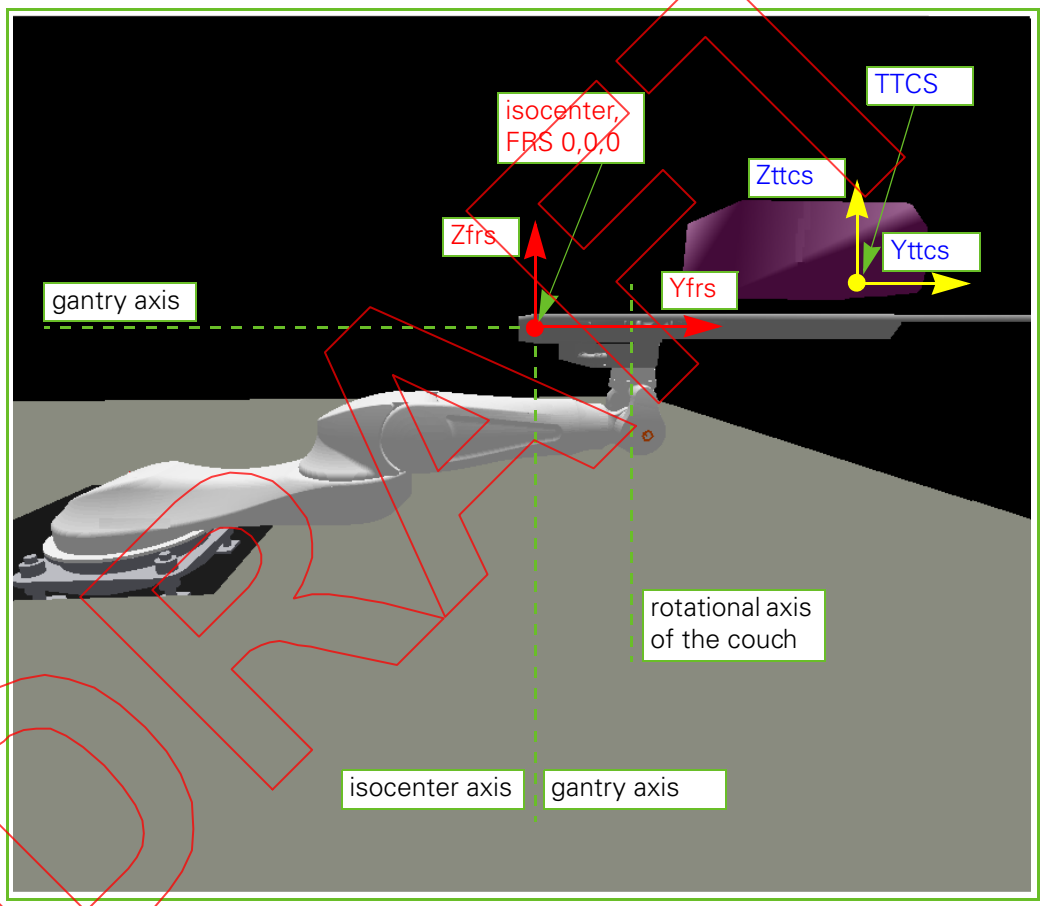

Figure 46-1. Setup Position (GTR, lateral view)

TTCS refers to the Table Top Coordinate System. FRS refers to the Fixed Reference System.

For a further explanation regarding TTCS and FRS, refer to section "About Coordinate Systems" in *PTS System Description*.

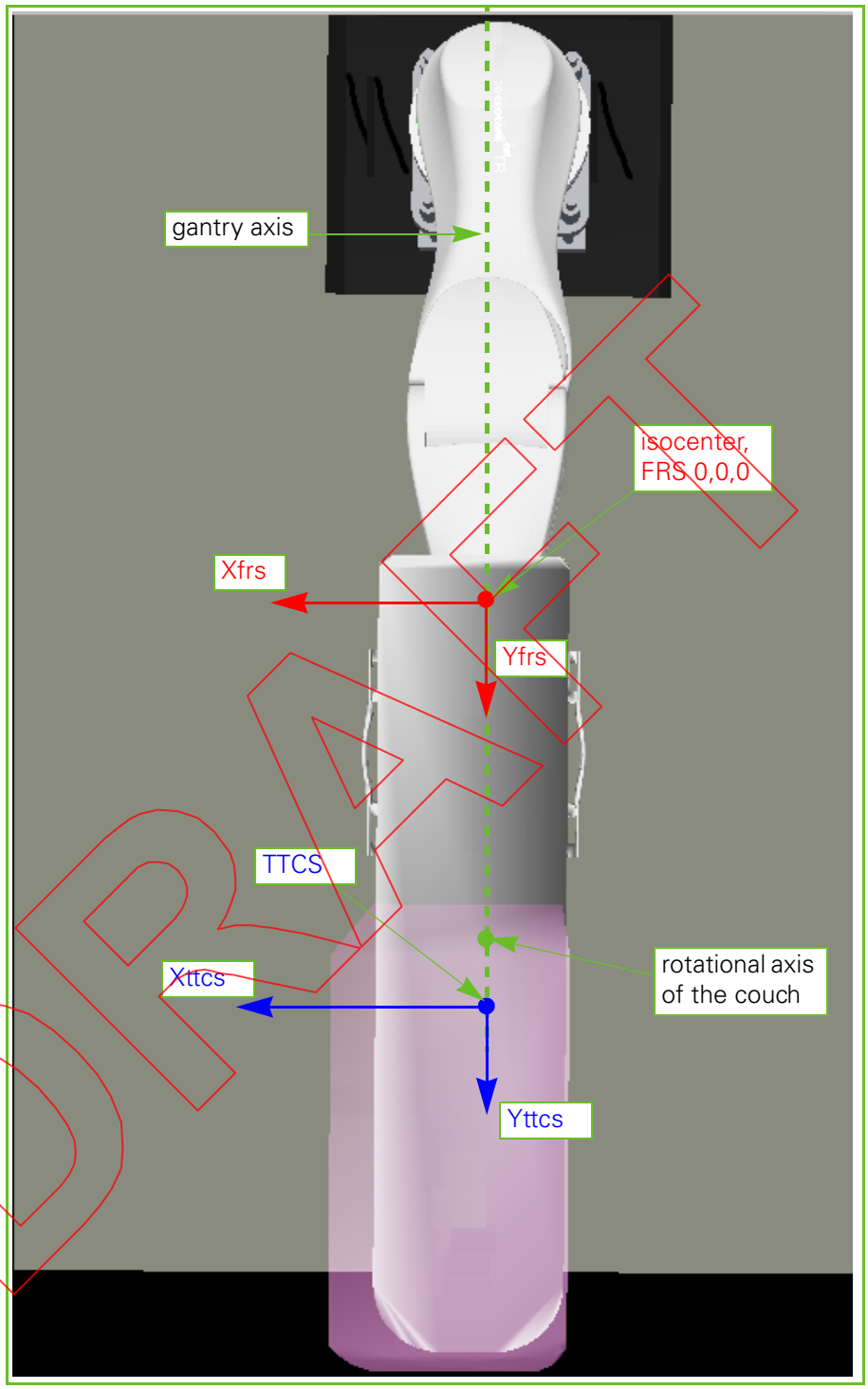

Figure 46-2. Setup Position (GTR, top view)

Prescribed and Corrected Setup Position

The relationship between the **prescribed** Setup position and the **required** Setup position evolves as follows:

- With the patient on the couch or chair, the RTT will verify and finely adjust (correct) the Setup position and then save it. Until the first beam tuning request is made, the RTT may perform as many positioning and adjusting iterations as necessary and then save the results. The difference between the Prescribed and the Corrected Setup positions will be propagated to the treatment beams.

Treatment Position

While the Setup position is specific to the setup beam, a Treatment position is specific to a treatment beam. The configuration of the Treatment position orients the treatment site (tumor) to receive the beam.

The Treatment position is a labeled position; you must perform an Auto or Manual motion to bring the Patient Positioning Devices (PPDs) to this Treatment position.

To ensure an acceptable patient setup timeline, small adjustments in the beam direction/position relative to the patient must be accomplished without large changes in patient positioning setup. Small adjustments in beam angle normal to the plane of rotation of the nozzle cannot be accomplished by small changes in the available translation and rotation variables. Maintaining the accuracy of the original setup point in this case will be achieved by including pitch and roll degrees of freedom with small dynamic range.

Important

The change of couch position involving pitch and/or roll rotation may involve a translation along the Z-axis. This is normal behavior of the Patient Positioning System (PPS).

Couch movements are expressed in the IEC Table Top coordinate system; these movements are performed following the International Standard IEC 61217, Ed2.0, 2011-12, Radiotherapy Equipment - Coordinates, Movement, and Scales.

Couch pitch and roll articulations permit the fine adjustment of patient position with respect to the horizontal plane.

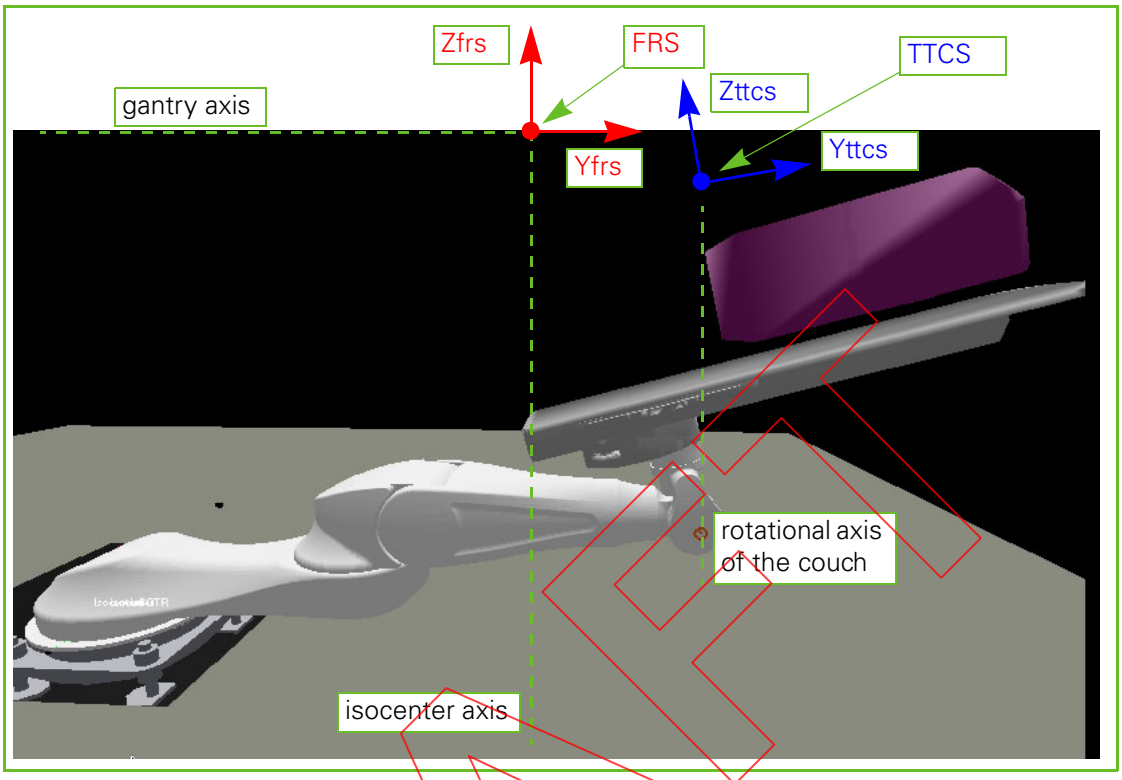

Figure 46-3. Treatment Position (GTR, lateral view)

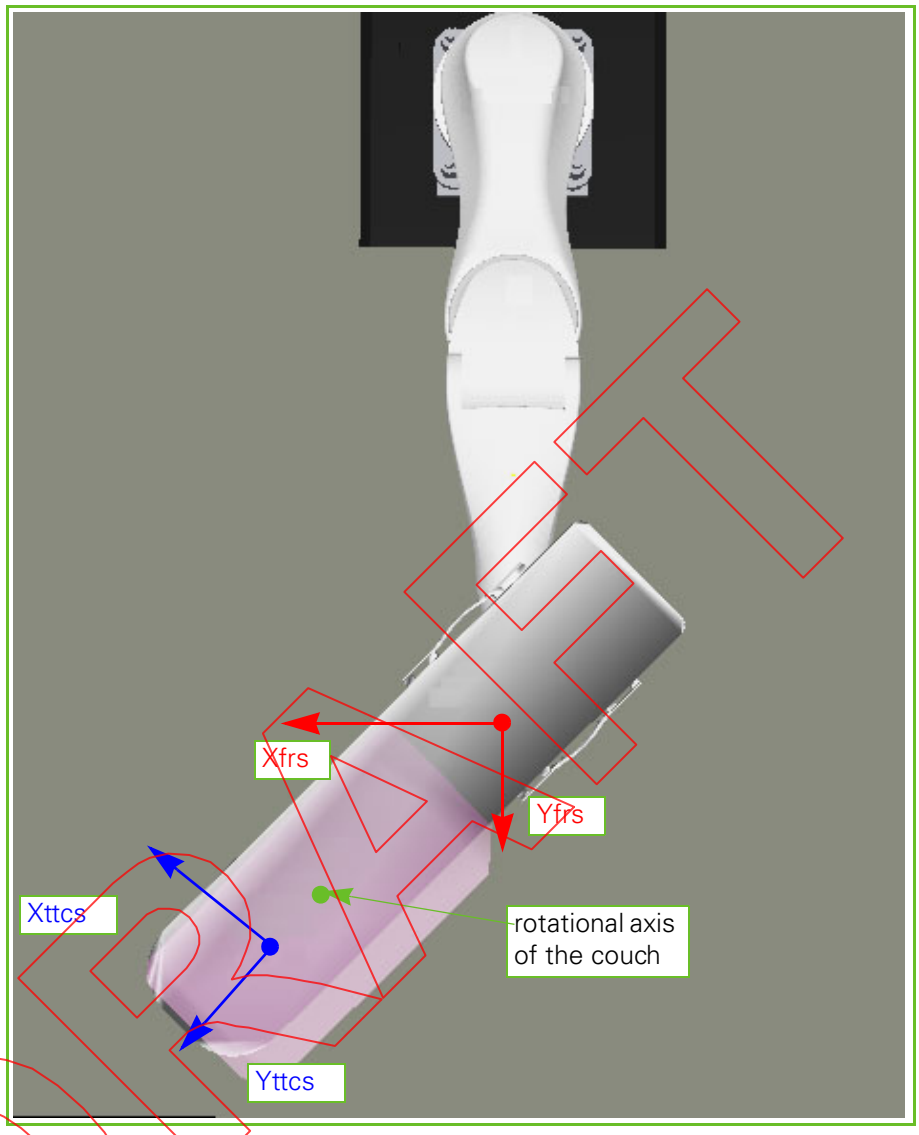

Figure 46-4. Treatment Position (GTR, top view)
Drawing not to scale

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Taring the PPS

What is the tare, and why should it be done?

The PPS Leoni is equipped with a force torque sensor, which allows measuring the mass of the payload (couch, patient) carried by the robot. This measure of payload feeds the algorithms ensuring the high accuracy of the PPS.

As for any weighing machine, a PPS taring procedure (as explained in section *Procedure to perform the tare* below) must be done, in order to define a correct zero reference of the mass measured by the PPS. This procedure is quick and easy to perform, but has to be done carefully after the validation of some prerequisites.

WARNING	Remove all loads from the couch before taring.

When the tare must be done?

- After each new startup of the PPSCU.
- When the PMS software or hand-pendant request it (every 20 hours).

Prerequisites for performing a tare

- The couch is installed on the PPS.
- The couch insert (i.e. couch extension) is attached to the couch base.
- The couch is horizontal (pitch = roll = zero).
- No mass is installed on the couch.
- The couch is recognized by the system.
- No external force is applied on the couch during the tare.
- The PPS is at a standstill during the tare.

Important	Take care to check that all the prerequisites are met before performing a tare. Otherwise the tare is not valid, and the accuracy of the PPS will be deteriorated, possibly resulting into incorrect treatment of the patient.

If tare is performed with an incorrect prerequisite...

- Correct the incorrect prerequisite (For example: remove the mass from the couch).
- Perform a new tare as given in section *Procedure to perform the tare*.

Procedure to perform the tare

Using the wireless hand-pendant.

1. Long press the **PPS** icon from the bottom bar of the hand-pendant menu.

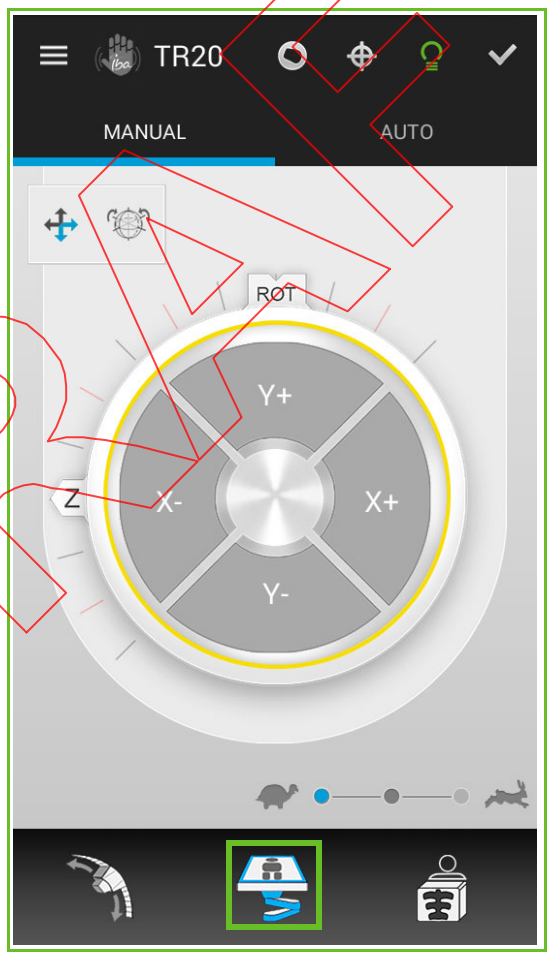

Figure 46-5. PPS icon of the wireless hand-pendant GUI screen

2. Long press on the **Taring Status** section

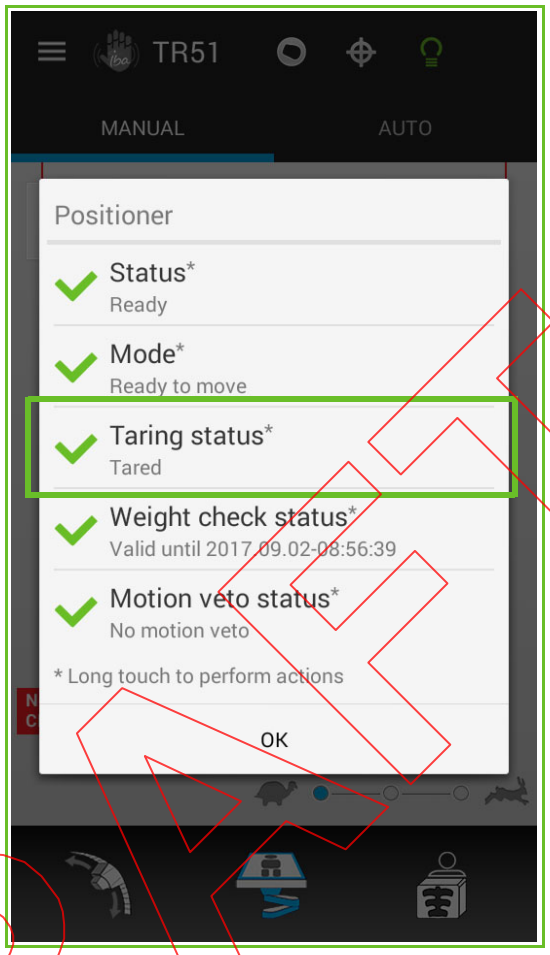

Figure 46-6. Tare section of the wireless hand-pendant GUI screen

3. A message informs the user that the tare is performed
4. If the tare was not performed correctly, an error message will appear inside a pop-up.

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Automatic Weight Check

WARNING	Be careful to avoid collisions of the Patient Positioning System. Collisions may damage the PPS. It may also deteriorate the robot accuracy and performance. In case of a collision, the robot must be calibrated.

Important	Make sure that the area near the PPS robot is clear before starting the automatic weight check.

Perform the automatic weight check as follows:

1. Long touch on PPS icon in hand-pendant for the POSITIONER screen. The **Weight check status** is orange (Figure 46-7).

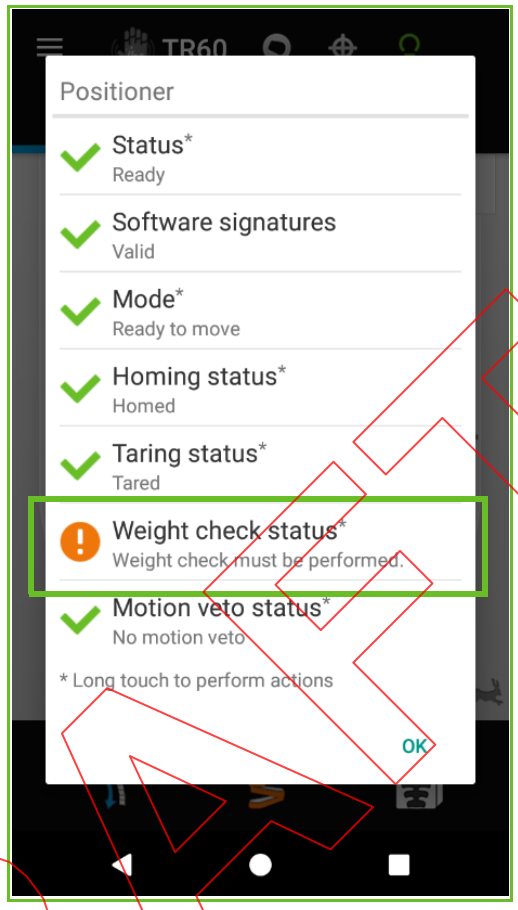

Figure 46-7. Automatic weight check - Positioner screen

2. Long touch on the **Weight check Status**.
3. Depending on which device is ready for weight check, you might have to perform the following actions:
   a. Retract the imager by pressing the **Retract Imager** ( ) icon (Figure 46-8).

Figure 46-8. Automatic weight check - Retract imager

b. Move the gantry in [-20,20] range (already ready in Figure 46-9) and retract the nozzle by pressing the **Retract Nozzle** ( ) icon (see Figure 46-9).

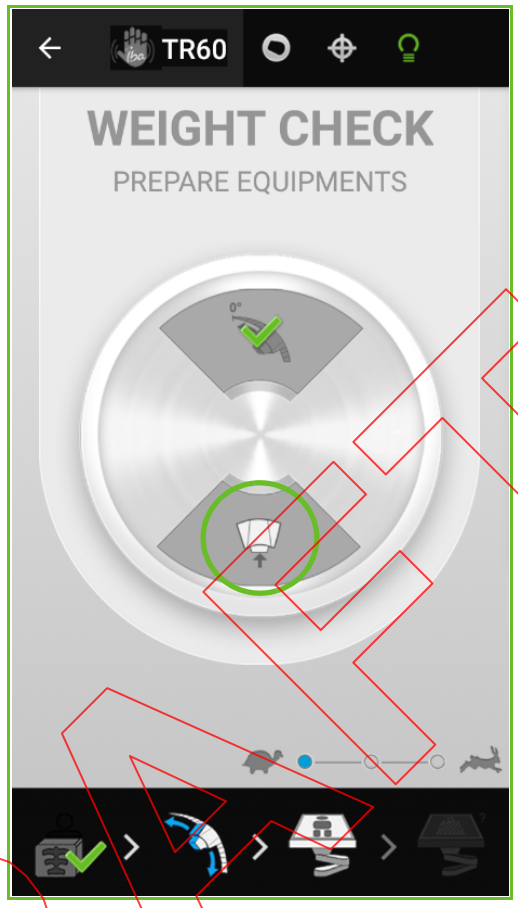

Figure 46-9. Automatic weight check - Move Gantry

c. Move the PPS to [0,0,0,0,0,0] position by pressing the **Move PPS** ( ) icon (Figure 46-10).

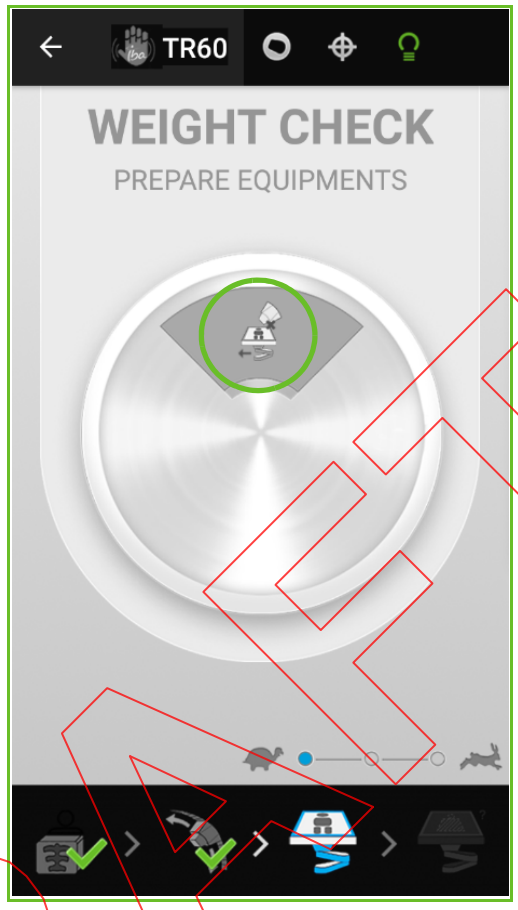

Figure 46-10. Automatic weight check - Move PPS

4. Verify that there is no patient and no object on the couch. Then, check the box with the message `Nothing/Nobody is present on the couch` (green box in Figure 46-11).

Important	Make sure that the area near the Patient Positioning System robot is clear before starting the automatic weight check.

5. Execute the automatic weight check by pressing the icon (green circle in Figure 46-11).

CAUTION	Ensure that the area near the PPS is clear as the automatic load cell check function of the PPS performs large pitch and roll motions.

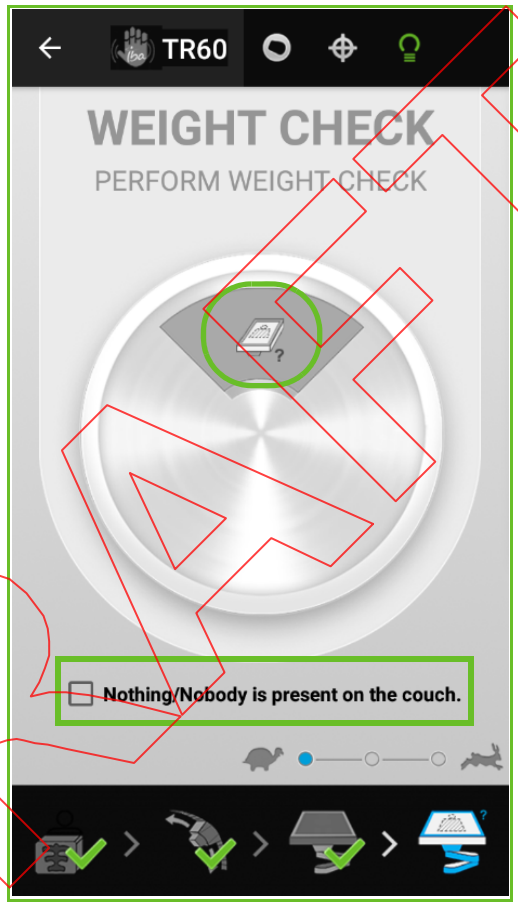

Figure 46-11. Automatic weight check - Perform weight check

The Typical Alignment Correction Process

A typical alignment correction procedure is as follows:

1. Position the patient on the couch.

WARNING	In a gantry treatment room equipped with a gantry rolling floor, patient loading should only be performed with the nozzle positioned in the upper part of the gantry, between 90° and 270°.

2. Move the PPS into the prescribed Setup position.

WARNING	Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

3. Verify patient alignment at Setup position:
   a. Take one Digital Radiograph (DR) for every relevant radiographic axis.

      If you are using a gating system, follow the procedure described in Section "*Triggering Procedure*" on page 48-16. Check the X-ray triggering display (see Figure 48-2) to see that the correct gating system has been selected.

WARNING	As a Radiation Therapy Technologist (RTT), do evaluate the longest acceptable exposure time considering that taking the X-ray image may finish after the end of the triggering cycle.

WARNING	As a Radiation Therapy Technologist (RTT), check the gating signal with respect to the presence of the X-ray beam. In case a mismatch occurs, do NOT use the resulting X-ray images for patient alignment.

b. Use the PPVS software (e.g., adaPT*insight*) to compute a correction vector that orients the patient as planned. The correction vector consists of corrections to one or several PPS axes.

WARNING

As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

c. If the PPVS is connected to the PTS and configured to do it, the correction vector is transmitted automatically. Else, manually enter the correction vector into the TCS.

d. Apply the corrections.

WARNING

When all alignment corrections have been applied and recorded by the user, make sure that, according to treatment center procedures, a second Radiation Therapy Technologist (RTT) verifies the entered corrections.

e. Use the hand-pendant (e.g., Auto motion) to implement the entered correction with the PPS.

WARNING

Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

WARNING

After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

f. Verify the corrections.

4. Confirm the optimized Setup position.

5. Move the equipment to the Treatment position.

WARNING	Be careful to apply the movement sequence of the gantry and the Patient Positioning System (PPS) in the correct order to ensure accurate patient positioning for treatment. Rotating the gantry BEFORE moving the PPS is the only correct order that ensures accurate patient positioning. Moving the PPS before the gantry will introduce an error in patient positioning.

6. Verify patient alignment at Treatment position:

   a. Take a Digital Radiograph (DR).

      If you are using a gating system, follow the procedure described in Section "*Triggering Procedure*" on page 48-16. Check the X-ray triggering display (see Figure 48-2) to see that the correct gating system has been selected.

WARNING	As a Radiation Therapy Technologist (RTT), do evaluate the longest acceptable exposure time considering that taking the X-ray image may finish after the end of the triggering cycle.

WARNING	As a Radiation Therapy Technologist (RTT), check the gating signal with respect to the presence of the X-ray beam. In case a mismatch occurs, do NOT use the resulting X-ray images for patient alignment.

   b. Use the PPVS software (e.g., adaPT*insight*) to compute a correction vector.

WARNING	As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

   c. If the PPVS is connected to the PTS and configured to do it, the correction vector is transmitted automatically. Else, manually enter the correction vector into the TCS.

d. Apply the corrections.

WARNING	When all alignment corrections have been applied and recorded by the user, make sure that, according to treatment center procedures, a second Radiation Therapy Technologist (RTT) verifies the entered corrections.

e. Use the hand-pendant to implement the correction with the PPS.

WARNING	Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

WARNING	After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

7. Confirm the optimized Treatment position.

WARNING	The Radiation Therapy Technologist (RTT) can only press the Motion Enable Button when the patient is safely secured on the couch or outside the moving equipment's operating range. Releasing the motion enable button on the hand pendant stops the Patient Positioning System (PPS) motion abruptly and can cause the patient to move if not properly secured.

Important	The Patient Positioning System (PPS) and the gantry rotation are connected to emergency power in order to allow patient unloading in case the main power supply fails.

CAUTION	There is risk of misalignment induced by the application of the position correction proposed by the OIS. Application of the correction may induce a misalignment of maximum 0.7mm.

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Recovering From an Equipment Error

In the unlikely event an equipment failure occurs while performing the patient positioning and alignment procedure, a number of actions must be taken after normal equipment operation has been restored and prior to continue positioning and aligning the patient.

In case an equipment error occurs, request for assistance from an operator. As a therapist, thereby take the following into consideration:

WARNING	Whenever homing is accomplished, re-imaging and realignment of the patient is required because all previous reference points are lost during the homing process.

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Chapter 47
Calculating Corrections Using adaPTinsight

The adaPT*insight* application enables to perform Image Guided Proton Therapy (IGPT). The required patient setup verifications are performed prior to treatment using either stereoscopic 2D and/or 3D images (depending on the TR hardware configuration).

In order to do this, adaPT*insight* features the following main functions:

- It acts as a control interface for X-ray imaging hardware such as X-ray generators and flat panels.
- It acts as an interface between the TPS, the OIS, and the PTS for patient position verification.
- It enables to automatically or manually compute alignment corrections between the treatment plan's images and the radiographs acquired in the treatment room.

The correction generated by adaPT*insight* is expressed in the IEC-TTCS coordinates. It represents the shift that needs to be applied to the PPS in order to properly align the patient to the prescribed position. The order in which the rotations and translations are expressed is the one defined by the IEC 61217 standard.

The adaPT*insight* application calculates corrections for:

- the Gantry Treatment Room (GTR)

This chapter contains general guidelines on how to use the adaPT*insight* application. For detailed information, refer to the adaPT*insight* documentation listed in chapter About this Manual.

*Preliminary adaPT*insight *Activities*

In the Treatment Planning Room (TPR) the DICOM CT series, the DICOM RT Plan data, and the DICOM RT Structure Set data of the patient are compiled. All this data serves as the input for the Digitally Reconstructed Radiographs (DRRs) that are generated by adaPT*insight* prior to computing the correction.

The adaPT*insight* monitor, keyboard, and mouse are in the shielded area of the TR. These devices are connected to the adaPT*insight* workstation, which is located in the TCR, and serve to acquire the Digital Radiographs (DRs) at the time of treatment.

Note: *Both before and during treatment, a number of DRs and DRRs are taken of the patient. Most of these images are stored on disk in electronic format. Disk storage capacity, understandably, has size limitations. Therefore, specific archiving procedures may have been put in place at your PT center.*

Starting up adaPT*insight*

In order to use adaPT*insight* you must start up the computer workstation in the TCR on which it is installed. Proceed as follows:

1. If the station is not started yet, press the **Start** button.
2. Select «therapist» in the list of users on Windows login screen and press enter (without password). Windows will then start and adaPT*insight* will be automatically launched.
3. The ADAPTINSIGHT LOGIN SCREEN appears.

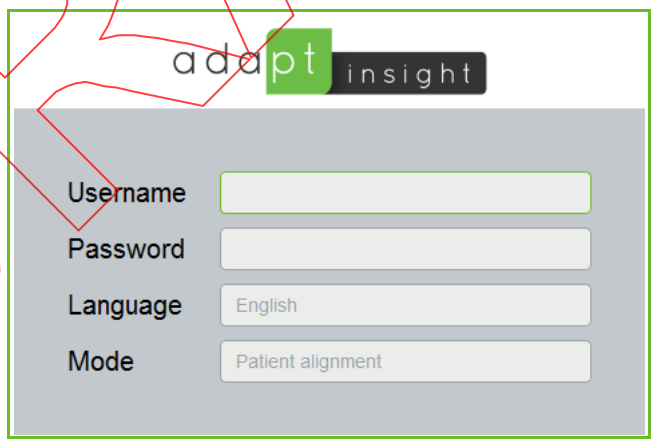

*Figure 47-1. AdaPT*insight *Login*

Logging Into adaPT*insight*

Upon startup of adaPT*insight* the ADAPTINSIGHT LOGIN SCREEN appears.

Enter your user name and password; both are case sensitive.

In addition select the following:

- your language (currently only one option: English).
- session mode (currently only one option: Patient Alignment).

Press Enter. The adaPT*insight* application is then started and the WORKFLOW SELECTION SCREEN appears.

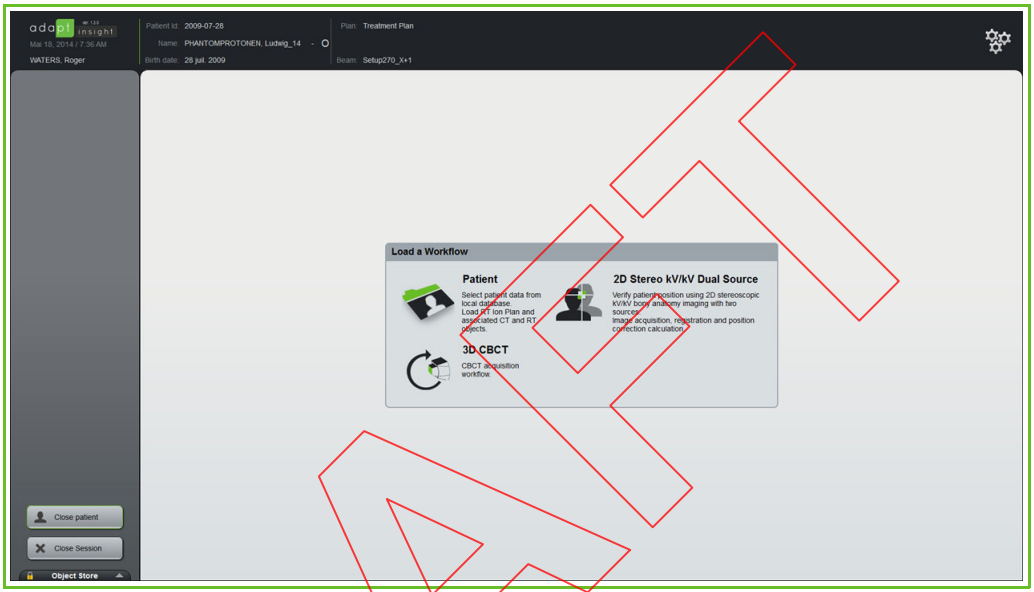

*Figure 47-2. AdaPT*insight WORKFLOW SELECTION SCREEN

Logging Out From adaPT*insight*

To logout from adaPT*insight,* click **Close Session** at the bottom left of all adaPT*insight* screens.

Starting the X-ray Generators

To start up the X-ray generators, switch the power switch at the back of the X-ray console to the ON position. All generators become switched on.

Figure 47-3. Power Switch for X-ray Generators

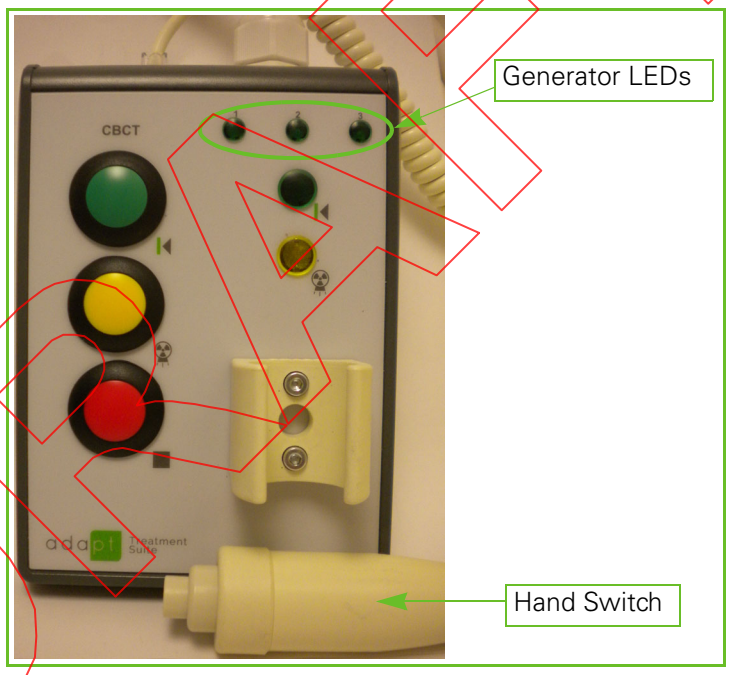

Figure 47-4. X-ray Console

Note: *Once a workflow is started on adaPT*insight*, communication between the adaPTinsight workstation and the X-ray generator(s) is automatically established.*

Calculating Corrections

As a therapist you calculate the necessary corrections in the treatment room, when the patient comes for treatment.

The complete correction calculation process comprises the following sequential steps:

1. Start adaPT*insight*, if not already started (refer to section "*Starting up adaPTinsight*" on page 47-2).
2. Log into the adaPT*insight* workstation, if not already logged in (refer to section "*Logging Into adaPTinsight*" on page 47-2).
3. Start up X-ray generators, if not already started (refer to section "*Starting the X-ray Generators*" on page 47-3).
4. *Selecting the Patient, Plan and Beam*.

   Note: *When operating in OIS mode, this selection is done automatically from the OIS.*
5. *Pre-aligning the Patient*.
6. *Acquiring Images*.
7. *Registering Images*.

Selecting the Patient, Plan and Beam

Start by selecting the required patient. For detailed information, refer to the adaPT*insight* documentation listed in chapter "About this Manual".

Select the plan and beam that you want delivered, based on all clinical information related to the patient stored electronically or on paper, following the internal rules of your treatment center.

The first beam to select is the setup beam, followed by the defined treatment beams. When you select a beam, adaPT*insight* displays the associated DRRs.

Pre-aligning the Patient

In the TR, pre-align the patient: load the patient on the couch and perform pre-alignment using the lasers. Try to do this as precisely as possible, this will enhance efficiency and reduce the total alignment time and effort.

Important	As a Radiation Therapy Technologist (RTT), pre-position the patient using lasers. During this process, pay attention to the potential large difference between the position of isocenter indicated by the lasers and the position of isocenter indicated by the x-ray image guidance system. Such a large difference would indicate that one of these systems needs to be re-aligned.

Acquiring Images

Note: *For more detailed information on how to perform X-ray Image Acquisition, refer to the* adaPT*insight documentation listed in the chapter "About this Manual".*

Depending on the TR hardware configuration, 2D stereoscopic images are acquired at the time of treatment using either one (rad-A) or multiple imaging devices (rad-A, rad-B). Equally, 3D images can be obtained using a single 2D imaging device that rotates around the volume to be imaged (CBCT Rad-B X-ray tube). 3D images are then reconstructed using the acquired 2D images and the associated spatial information (angle of acquisition).

The adaPT*insight* application supports different acquisition modes in a TR depending on the treatment room's hardware configuration. The configuration of treatment rooms at your center support:

- **kV CBCT** (3D): in this mode, a sequence of 2D images is acquired using the Rad-B X-ray tube. This sequence of images is then reconstructed by adaPT*insight* into a 3D image.

Perform the procedure that is applicable to your treatment room:

- **GTR**: refer to section "*Working with X-ray Images in a GTR, for Use With adaPTinsight*" on page 10-11.

After successfully completing the procedure that is applicable to your treatment room, proceed as follows:

1. Start up X-ray generator(s), if not already started (refer to section "*Starting the X-ray Generators*" on page 47-3).
2. From the ADAPTINSIGHT WORKFLOW SELECTION SCREEN (see Figure 47-2), select the appropriate workflow for the desired image acquisition mode, if not sent automatically

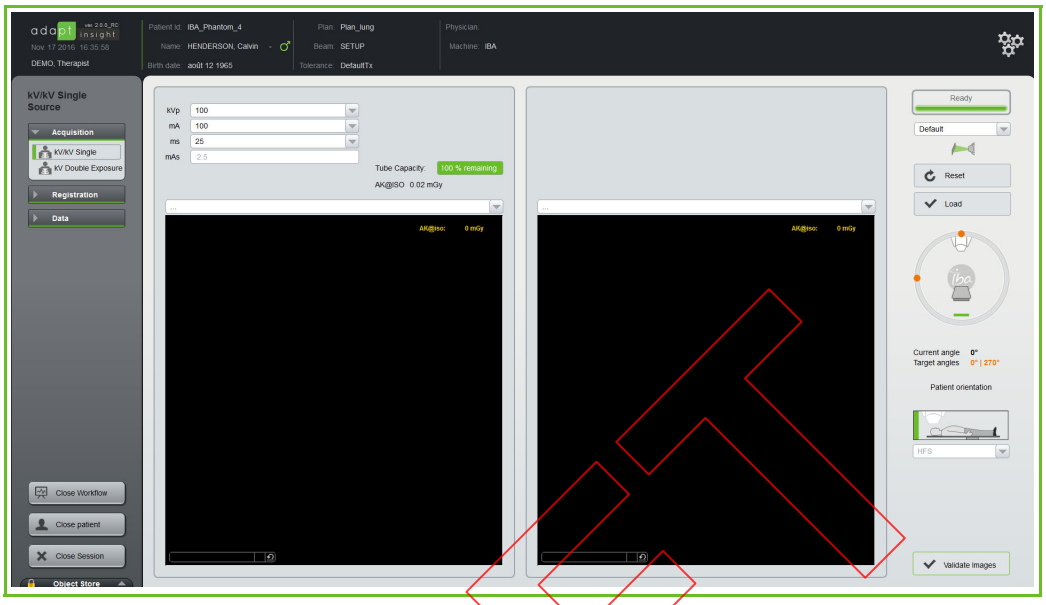

Figure 47-5. kV/kV Single Source Workflow

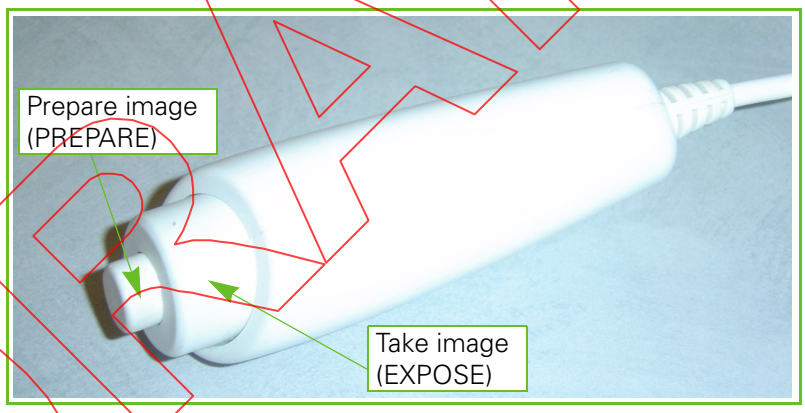

Figure 47-6. X-ray Console Hand-switch

WARNING

As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

3D Acquisition: kV CBCT

Note: *For more detailed information on how to perform X-ray Image Acquisition, refer to the* adaPT*insight documentation listed in chapter "About this Manual".*

In the kV CBCT mode, the acquisition of projection radiographs requires the following sequence of operations:

1. **Select the tube settings** (kVp, mA, ms) by using one of the **Presets**.
2. Press the **Load** button to send the settings to the generator.
3. In the drop down list under the gantry view, select the type of acquisition: full scan, half scan, etc. The PRE-START and DRY RUN positions are automatically synchronized on the hand pendant.
4. On the hardware console, press **Green** button (see Figure 47-4).
5. On the adaPT*insight* screen, press **Start**. The gantry starts rotating to its initial position. The status button in the adaPT*insight* screen turns green, indicating that the generator is in the PREPARE state.
6. When the gantry has reached its initial position, press the **Yellow** button (see Figure 47-4) on the hardware console.
7. The gantry starts rotating. The status button on the adaPT*insight* screen turns yellow, indicating that the generator is exposing X-ray. During the full duration of the X-ray exposure, there is a beeping signal. The radiograph projections are displayed in the image area of the screen The images are refreshed at a frequency of 1Hz, which is slower than the actual acquisition rate from the detector.
8. The volume reconstruction takes place simultaneously with the radiographs acquisition (inline reconstruction). A progress bar is displayed in the left column to show the progress of the reconstruction
9. When the acquisition is complete, a message appears on the adaPT*insight* screen prompting to press the **Red** button. On the hardware console, press the **Red** button (see Figure 47-4).
10. The reconstructed volume is automatically displayed in the 3D registration software (see section "*3D-3D Image Registration*" on page 47-10). If the reconstructed volume is not satisfactory, it is possible to restart a new reconstruction with already acquired data (offline reconstruction).

WARNING	
	As a Radiation Therapy Technologist (RTT), it is your responsibility to verify the absence of collision with the patient or any equipment before initiating a CBCT image acquisition by performing a dry-run. If the patient position or the position of immobilization devices changes between two different fractions, a new verification shall be performed.

WARNING	As a Radiation Therapy Technologist (RTT), always monitor the patient during motion in the CBCT X-ray image acquisition. In case the patient moves, the RTT shall interrupt the acquisition.

Registering Images

Note: *For more detailed information on how to perform Image Registration, refer to the* adaPT*insight documentation listed in chapter "About this Manual".*

The adaPT*insight*'s Image Registration feature fulfills the following functions:

1. Based on the DRRs and DRs, it verifies that the position of the patient in regard to the equipment matches the treatment plan geometry.
2. It computes a correction that can be applied to ensure correct patient positioning.

The best match between reference (DRRs) and acquired (DRs) images can be assessed visually on the interface and is provided by adaPT*insight* as a correction with 6 degrees of freedom that can be sent to third party systems. This correction is a sequence of translations and rotations that are applied in the order defined in the IEC-61217 standard[1].

The image registration process is available in two modalities, each one of them named after the dimensionality of the images involved (radiographs being 2D images and planning CT and CBCT being 3D images):

1. 2D-3D registration is the position verification and computation of a correction between planning CT images and acquired radiographs.
2. 3D-3D registration is the position verification and computation of a correction between planning CT images and CBCT.

Note: *The registration step starts after the image acquisition. Its objective is to obtain the correction that brings the given images to a best spatial alignment. The quality of the registration should be visually assessed, manually refined, if necessary, and validated to proceed with the treatment workflow.*

1. The IEC 61217 standard defines the transformation from the IEC-Fix to the IEC-TTCS coordinate system.

2D-3D Image Registration

This step is launched after the 2D stereographic dual source mode acquisition is performed. The two orthogonal radiographs acquired by rad-A and rad-B are compared with numerically generated projections of the planning CT in order to correctly set up the patient for treatment.

This step can be performed in one of the following ways:

- **Point-based image registration** uses a set of given markers or anatomical landmarks as a list of control points for patient setup. After point-based 2D-3D registration, alignment can be manually refined, if needed.
- **Intensity-based image registration** finds the best match between images based on pixel values or intensity information of each image. After Intensity-based registration, alignment can be manually refined, if needed.
- **Manual image registration** can be performed by the user between DRRs and acquired DR images by a simple drag and drop of the DR with the mouse and/or by changing the correction values. Alternatively, the arrows of the keyboard can be used; to rotate an image, a combination of the arrows and the CTRL key can be used.

Note: *For more detailed information on how to perform 2D-3D Image Registration, refer to the* adaPT*insight documentation listed in chapter "About this Manual".*

3D-3D Image Registration

Registration between 3D images plays the role of aligning Cone-Beam CT image and Planning CT image. The application has three views, from left to right and top to bottom: axial, sagittal and coronal. The corresponding slices of the volumes being registered are shown superimposed on each view.

There are two available applications for this task:

- **Intensity-based image registration** finds the best match between images based on pixel values or intensity information of each image. After Intensity-based registration, alignment can be manually refined if needed.
- **Manual image registration** can be performed by the user between DRRs and acquired DR images by a simple drag and drop of the DR with the mouse and/or by changing the correction values.

Note: *For more detailed information on how to perform 3D-3D Image Registration, refer to the* adaPT*insight documentation listed in chapter "About this Manual".*

Generating the Correction

At the end of the Image Registration process, the correction appears on the toolbox. There, you can either manually refine it or validate it to end the registration step. To validate the Correction, click **Validate**.

After completing the registration, images are "locked" to enable you to cross check the result but not modify it.

Correction Feedback

After Image Registration and calculation of the correction, it is necessary to apply these corrections to the Patient Positioning Devices.

How to Interpret adaPT*insight* Corrections

The correction is expressed as a transformation from the IEC-Fix to the IEC-TTCS coordinate system according to the IEC 61217 standard, which defines the order of the translation and rotation calculations. It represents the shift to apply to the PPS in order to properly align the patient to the prescribed position.

Six different corrections are supplied:

- The **X, Y, and Z corrections** are expressed in cm.
- The **Rot, Pitch, and Roll corrections** are expressed in degrees.

If a value N/A (not applicable) appears, this means that the value cannot be computed due to insufficient input data, e.g., if only one DR has been taken.

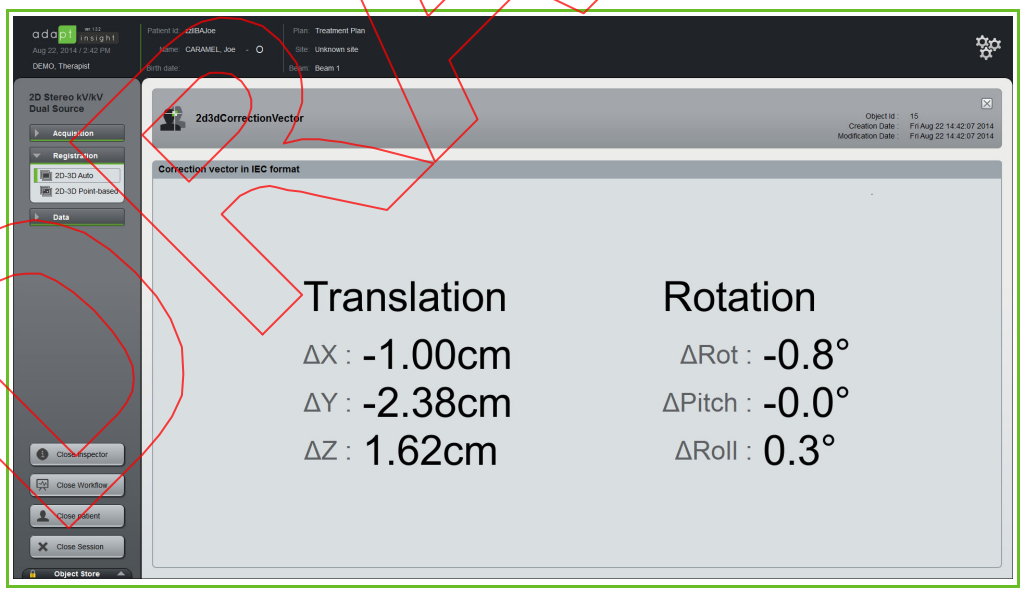

Figure 47-7. Correction

How to Apply and Implement the Calculated Corrections

Click **Validate** on the adaPT*insight* screen*:* the corrections supplied by adaPT*insight* are transferred to the PMS INTERFACE PANEL of the EQUIPMENT PREPARATION SCREEN that is displayed on the TCS monitor in the treatment room.

If the corrections are filled out correctly and you deem them appropriate, click **Apply Correction**.

Which corrections must be transferred depends on the selected position, as follows:

- **Setup position**: enter all six corrections.
- **Treatment position**: enter 6 corrections (if 2 X-ray images were acquired) or only 3 translation corrections (if only 1 X-ray image was acquired).

Note: *Applying the position corrections downloads the values to the Positioning Control Unit (PCU) but does not move the PPS.*

Next you have to **implement** that correction from the hand pendant.

If the entered correction is too big, an error message appears. In such case, check correction computation or change the initial position.

Therefore it is important to position the patient fairly precisely during the pre-alignment phase. The thresholds for this pre-alignment can be configured on the TCS.

For detailed information, refer to the chapter that is relevant for the treatment room in which you are working:

- **GTR**: refer to Chapter 52, "Aligning a Patient in the GTR".

WARNING	
	As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

WARNING	
	When all alignment corrections have been applied and recorded by the user, make sure that, according to treatment center procedures, a second Radiation Therapy Technologist (RTT) verifies the entered corrections.

WARNING

After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

If, after taking the final DR pair, the alignment is deemed unsatisfactory, you can reiterate the entire alignment process.

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Chapter 48
Using the Universal Beam Triggering Interface

Introducing Triggering

Why Use Triggering With the Proton Beam?

When treating patients using particle therapy, it is important to deliver a high dose to a target volume while minimizing the dose to surrounding healthy tissues.

Physiological movements of the patient, such as the patient's respiratory movements, among others, may cause the target volume to move during irradiation, which can result in insufficient dose delivery to the target volume and unwanted dose delivery to surrounding healthy tissues.

A gating system helps to overcome the problem of intrafraction motion in proton therapy. Beam triggering is the capability to switch the beam On and Off.

Why Use Triggering With the Patient Positioning Verification System (PPVS)?

The same physiological movements can affect the effectiveness of X-ray images that are taken during patient alignment for the setup or treatment position.

Prior to beam irradiation, the position of the target volume is verified using a PPVS. With the X-ray system, X-ray images are taken and compared with a set of reference radiographs and corrections can be made to the patient's position.

The PPVS can also be sensitive to physiological motions of the patient. To solve this problem, the PPVS can be enabled/disabled following a triggering signal from a physiological cycle measuring device.

The Triggering Solution

To overcome this problem, the radiation beam, be it the proton beam or X-rays emitted by the X-ray tube, can be subjected to a triggering technique, whereby the beam may be interrupted at given points in time (i.e., beam not authorized), and triggered again when the position of the patient returns to a given state (i.e., beam authorized).

Detection of the patient's movements may be done by various techniques, and each technique may have its own patient monitoring equipment. The information supplied by the gating equipment can then be used for commanding a beam triggering scheme.

Important	Only use gating sources that are compliant with the Universal Beam Triggering Interface (UBTI) specification, and certified for intent of use for X-rays and with proton and/or particle therapy.

CAUTION	As a Radiation Therapy Technologist, when planning a treatment with automatic beam gating, choose the treatment delivery settings (such as beam delivery technique, dose rate, number of repaintings) and patient monitoring settings (such as duty cycle, acquisition frequency) in function of the clinical goals to be achieved and safety criteria to be met, taking into account the global latency of the system (latency of the patient monitoring system combined with the latency of the treatment machine and the latency to detect and process a system failure).

The PTS caters to a variety of gating devices, using the UBTI.

Triggering is only applicable between the start and the end of the irradiation. No triggering is needed during beam tuning and preparation.

Triggering Requirements

The PTS operates within the following beam triggering timing constraints:

- The PTS shall accept a beam triggering frequency going from 1 cycle per minute to 30 cycles per minute. A cycle assumes one start and one stop of the beam.
- The minimal time between two requests of beam triggering (Request "Beam Off" to request "Beam On") will never be smaller than 1 sec.

For PBS, the maximal time between two requests of beam triggering (Beam Hold request to Beam Resume request) will be greater than 3 sec and shorter than 30 sec.

- The PTS shall guarantee the following latency requirements for the PBS beam delivery technique:
  - The system latency from reception of beam hold request to actual beam off state (beam hold latency) is equal or less than 100 ms.
  - The system latency from reception of beam resume request to actual beam on state (beam resume latency) is equal or less than 200 ms.
- The PTS shall guarantee the following latency requirements for the DS beam delivery technique:
  - The system latency from reception of beam hold request to actual beam off state (beam hold latency) is equal or less than 120 ms.
  - The system latency from reception of beam resume request to actual beam on state (beam resume latency) is equal or less than 120 ms.

UBTI Details

Specific types of treatment and tumors may require specific types of gating equipment to monitor physiological motions. The UBTI therefore caters to four distinctive gating devices that can remain connected to the Universal Triggering Electronic Unit (UTEU) rack at any given time. In this way gating equipment can remain installed in the TR, without a need to reinstall and reconnect other gating equipment.

The UTEU enables the RTT to switch between various types of physiological cycle measuring devices and the use of the resulting triggering signal for patient positioning verification and for irradiation with the proton beam.

Explaining the Universal Beam Triggering Interface

Location

The UBTI is accessible through the UTEU, which is the rightmost module of the Safety and Triggering rack in the TCR.

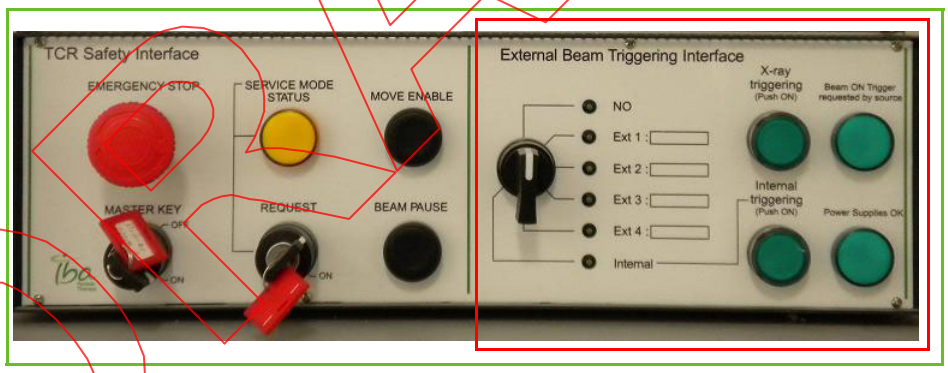


Figure 48-1. UTEU Rack
(as part of the Safety and Triggering Rack)

Up to four distinctive gating systems can simultaneously remain connected to the UTEU rack. The X-ray generator is also connected to the rack in order to trigger the X-ray beam.

In addition, the UTEU rack is connected to the BGEU, which interfaces with the following:

- Scanning Controller: for Pencil Beam Scanning
- UTEU rack: to receive triggering information

Once installed and connected, you do not have to interfere with the BGEU.

Operating the UTEU

Two Modes of Operation: Manual or Automatic

Note: *Whether you are using the Universal Triggering Electronic Unit (UTEU) in manual mode or in automatic mode, you are always capable of pausing the irradiation following the procedure described in Chapter "Pausing, Resuming and Stopping an Irradiation".*

Automatic Triggering

When operating in **automatic triggering mode**, the selected gating system dictates when beam is authorized.

The gating system generates a beam triggering signal as long as the gating signal is within boundaries, predefined to be acceptable for taking X-ray images or treatment with beam.

During irradiation, the beam is interrupted and restarted upon instruction by the beam triggering signal.

CAUTION	As a Radiation Therapy Technologist, when planning a treatment with automatic beam gating, choose the treatment delivery settings (such as beam delivery technique, dose rate, number of repaintings) and patient monitoring settings (such as duty cycle, acquisition frequency) in function of the clinical goals to be achieved and safety criteria to be met, taking into account the global latency of the system (latency of the patient monitoring system combined with the latency of the treatment machine and the latency to detect and process a system failure).

Manual Triggering

In **manual triggering mode**, you have to press the **Internal triggering** button and keep it pressed for as long as you want beam to be authorized. When doing so, you have to carefully monitor the gating system in use and press the **Internal triggering** button whenever beam is authorized.

Operating in manual mode means that you opt not to use the beam triggering signal issued by the gating system but to supply the signal yourself by the push of a button.

UTEU Controls

The UTEU rack features the following controls:

- **A source selector switch**: you can set the switch to any of the following positions:
  - No: no gating equipment is currently in use.
  - Ext 1 - Ext 4 (external gating system 1- 4): the system that you intend to use to perform **automatic** triggering (refer to Section "*Automatic Triggering*" on page 48-6.
  - Internal: to perform triggering in **manual** mode (refer to Section "*Manual Triggering*" on page 48-6.
- **X-ray triggering toggle button**: this toggle button is lit when depressed; this indicates that you intend to use triggering when taking X-ray images. Press this toggle button again if you want to deselect it.
- **Internal triggering button**: this button enables you to perform manual triggering. This button can only take effect when the selector switch is set to **Internal**. Keep this button pressed as long as you want beam to be authorized by the beam triggering signal; release this button whenever you want beam **not** to be authorized by the beam triggering signal.
- **Beam On trigger LED**: when blinking, the selected gating system is issuing the beam triggering signal. When this LED is Off, no beam triggering is being requested.

  Note: *When the source selector switch is set to the NO position, this LED is continuously lit, meaning: beam is continually authorized.*
- **Power supplies OK LED**: when lit, the UBTI is powered.

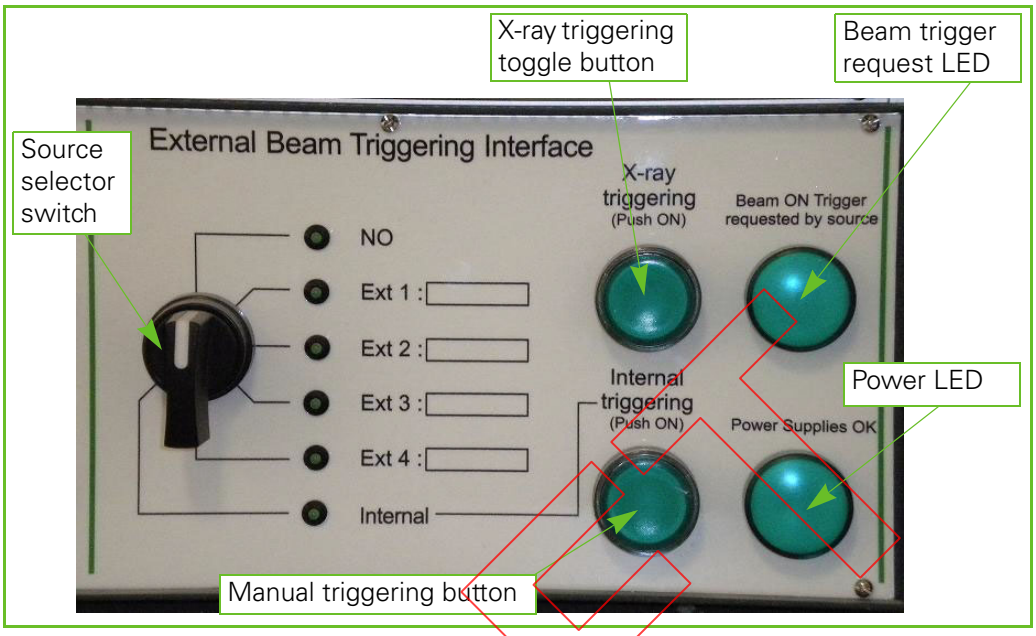


Figure 48-2. Universal Triggering Electronic Unit (UTEU) Module

Gating Prescription

Specify the prescription at TPS/OIS level

Your Treatment Planning System (TPS) and/or Oncology Information System (OIS) allows you to specify in the prescription if gating is to be used for this treatment plan or this treatment beam. This information is transferred to the PTS via DICOM. The PTS will use this information to determine if gating is required or not.

Note on the OIS:

- **OIS EMRC integration:** Gating is specified at Beam level (could vary for different treatment beams)
- **OIS DEVC integration:** Gating is specified at Plan level (same for all treatment beams). In this case, the PTS extends the Gating information to each of the individual treatment beam.
- **Batch/Standalone mode:** It is not possible to specify gating in the prescription when using adaPT*prescribe*.

Relationship between prescription and source selected on the triggering rack

When gating is required, the PTS will assume that one of the following source must be selected on the UTEU rack (Figure 48-2):

- Internal
- Ext 1
- Ext 2
- Ext 3
- Ext 4

You will still need to verify which one of this source is appropriate for your patient because this information is not provided by your TPS/OIS.

When gating is not required, only "NO" may be selected on the UTEU rack.

Prescription display

The gating information is displayed in the header part of the screen.

When a plan or setup beam is selected, the prescription at plan level is displayed and can be:

- GATING: Yes, or
- GATING: No, or
- GATING: Mixed (in case individual treatment beams have different prescriptions).

When a treatment beam is selected, the prescription at beam level is displayed and can be:

- GATING: Yes, or
- GATING: No

Prescription mismatch

As soon as the setup beam is selected, if gating is prescribed at plan level, the PTS will warn you if no gating input is selected (selector in position NO), and prevent the preparation of the beam. This ensures that the gating system is set up when the patient is aligned on the table (Figure 48-3).

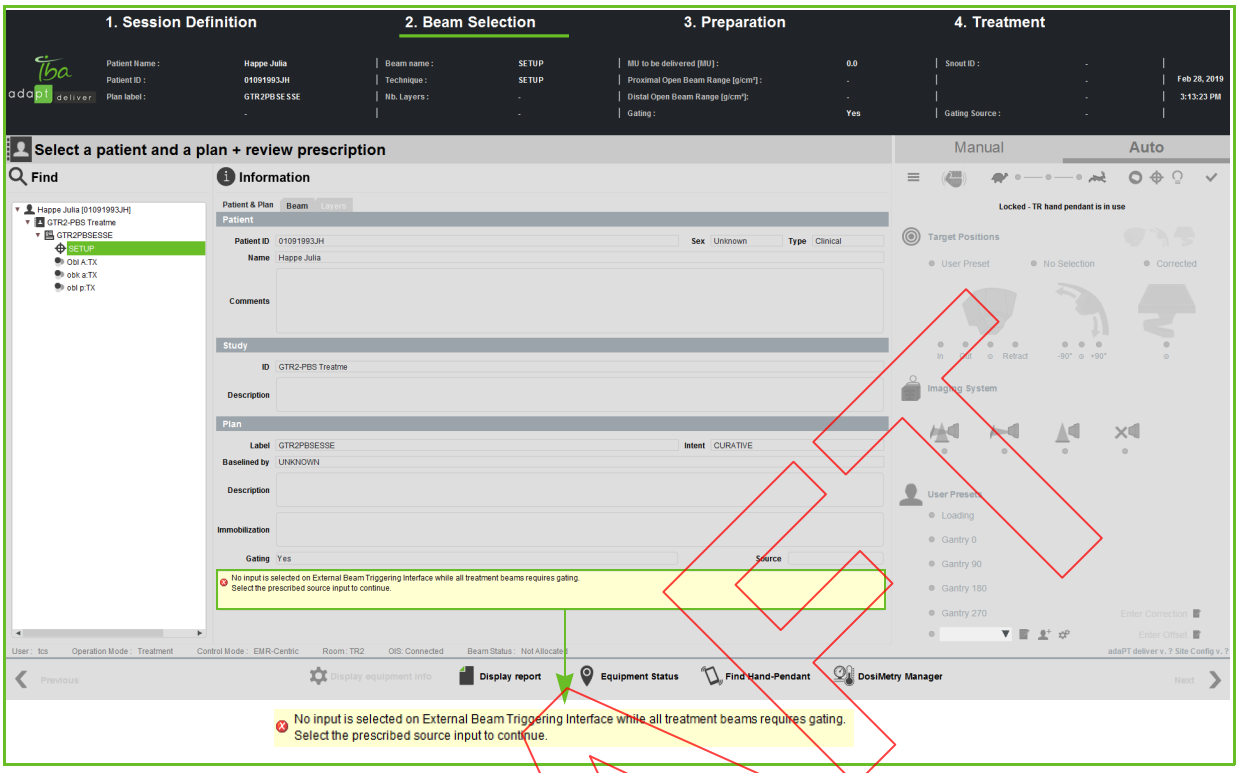


Figure 48-3. Gating Prescription - No gating input selected

If gating is not prescribed, the PTS will also warn you if a gating input is selected (selector in a position other than NO) when the setup beam is selected (Figure 48-4). However in this case, setup beam preparation will not be prevented as an override to a gated prescription is possible at treatment beam level (Figure 48-5). For the override to be taken into account, you will need to enter your credentials.

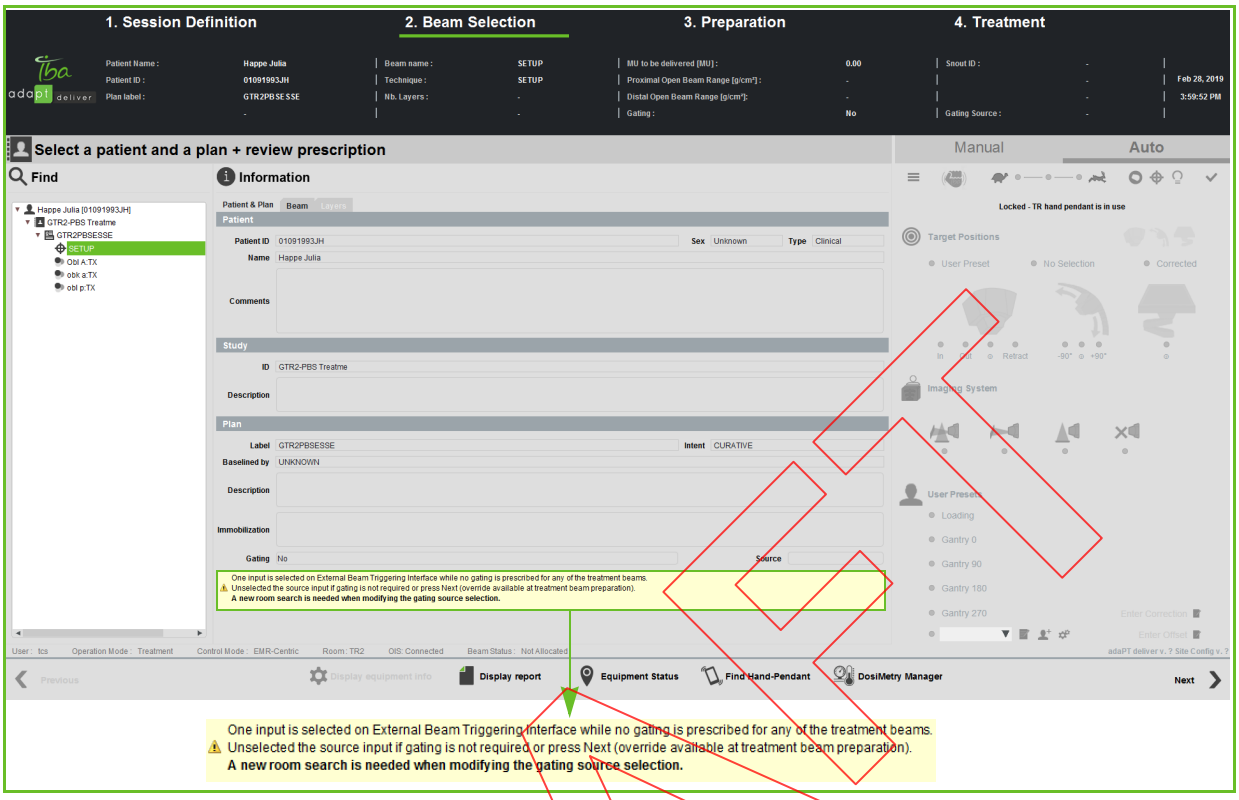


Figure 48-4. Gating Prescription - Gating input selected for setup beam

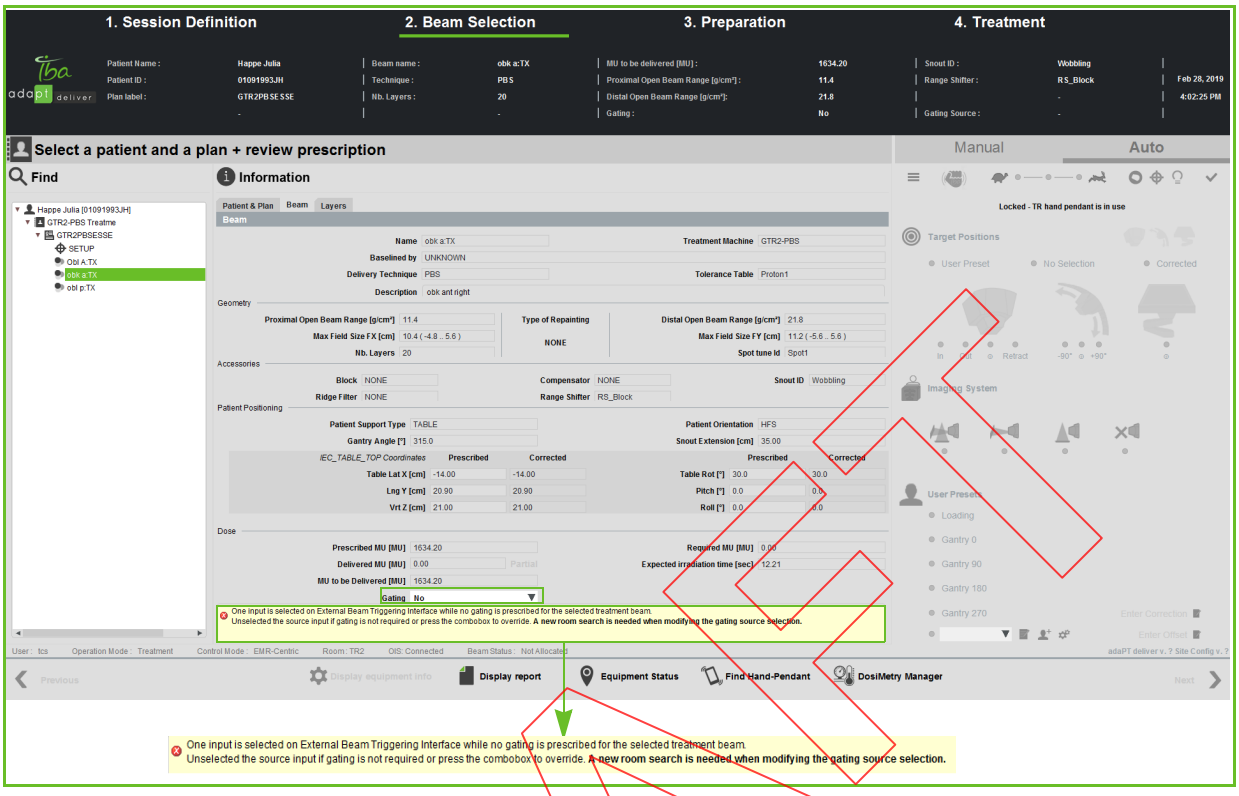


Figure 48-5. Gating Prescription - Gating input selected for treatment beam

In any case, the gating input selector needs to match the prescription (after override, if any) in order to prepare a treatment beam. (Figure 48-6 and Figure 48-7)

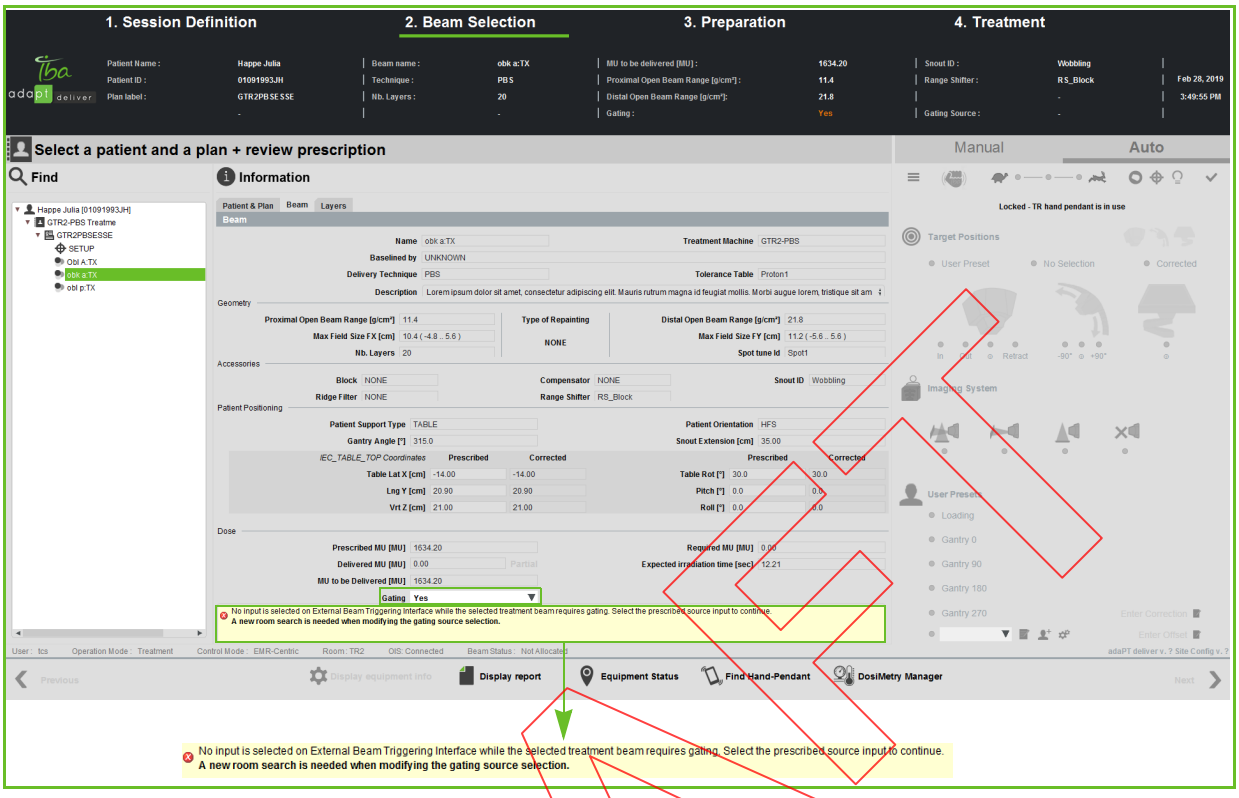


Figure 48-6. Gating Prescription - User override for Gating YES and no input selected for treatment beam

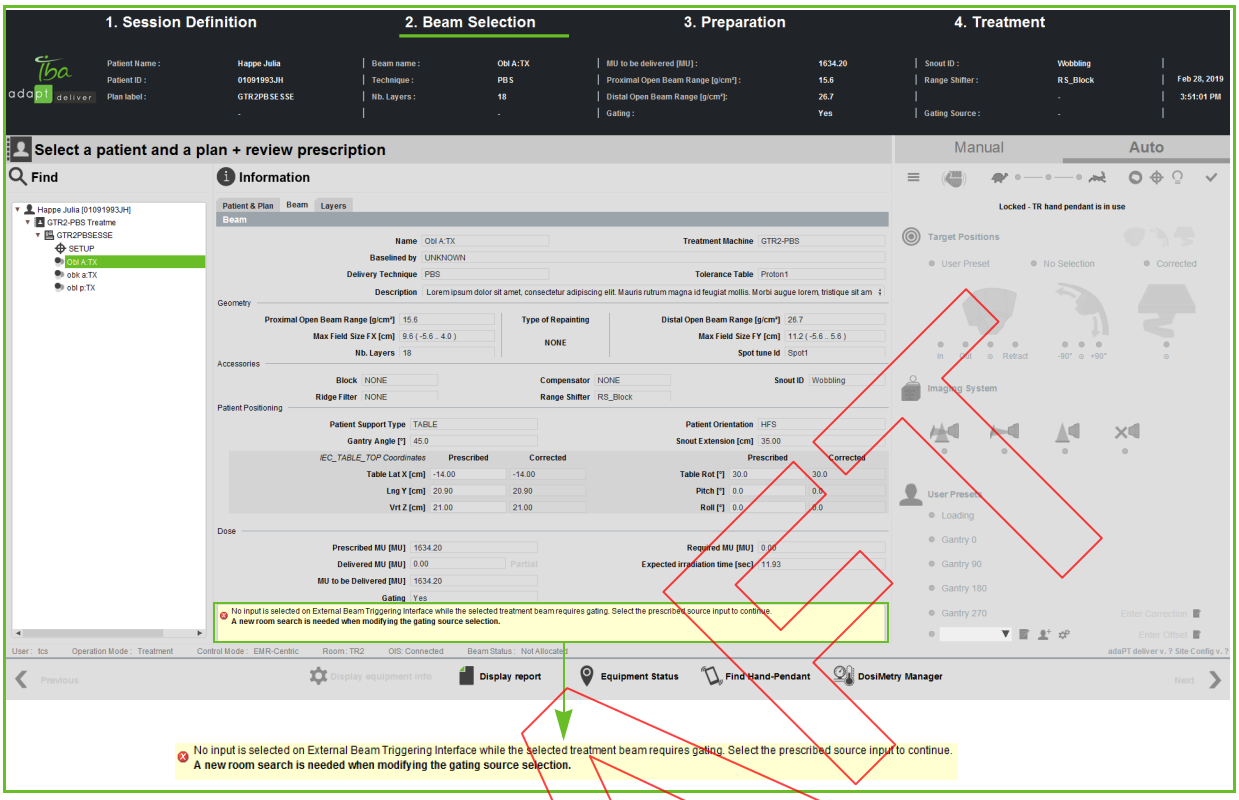


Figure 48-7. Gating Prescription - Gating YES and no input selected for treatment beam

The PTS will also perform a last minute check just before allowing the irradiation to start.

Important

Any attempt to change your selection of gating source after securing the treatment room will be inhibited by the Therapy Safety System (TSS). Therefore, you will need to unsearch the treatment room, change the source selection so it matches the prescription, then re-secure the room to start irradiation.

In Physics mode, the PTS will display the same warnings, without preventing anything. In order to be able to perform QA irradiation in physics mode in the same conditions as in clinical mode, the override to gated prescription will also be allowed, without need to enter credentials. (Figure 48-8)

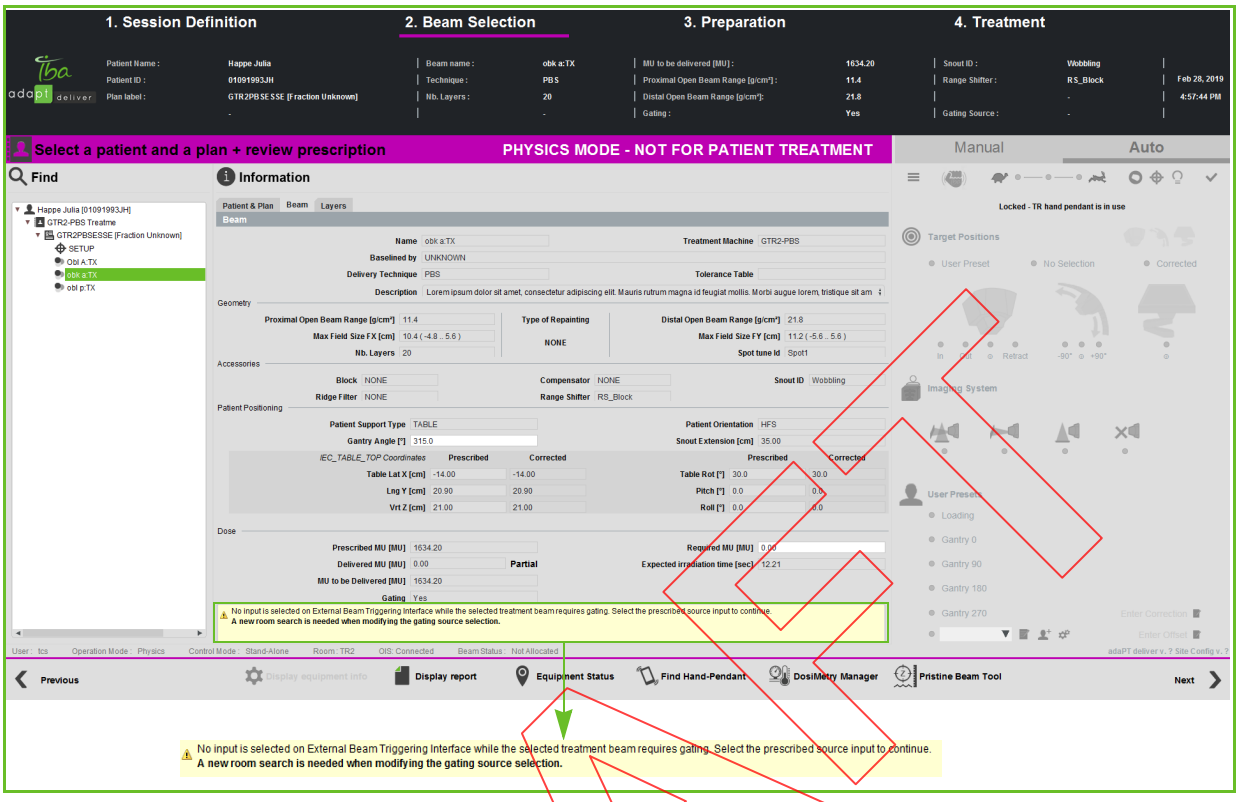


Figure 48-8. Gating Prescription in Physics mode - Gating YES and no input selected for treatment beam

CAUTION

As a Radiation Therapy Technologist, in case:

- you perform a treatment with gating,
- this treatment has no gating parameters,
- you perform an override to allow the treatment,

you shall ensure you have performed the Quality Assurance (QA) of the plan with the same gating parameters which will be used during treatment.

If not, you might induce inconsistencies between the delivered treatment and the QA results.

Note: *Optimization of the irradiation time is more complex when using gating. As a consequence, irradiation time will be longer when gating is prescribed than when gating is not prescribed.*

Triggering Procedure

Important	Any attempt to change your selection of gating source after securing the treatment room will be inhibited by the Therapy Safety System (TSS). Therefore, you will need to unsearch the treatment room, change the source selection so it matches the prescription, then re-secure the room to start irradiation.

When selecting the setup beam:

1. Verify which gating system is required for the patient irradiation (i.e. which source to select) in the patient file/OIS.
2. Make sure that the desired gating system is in the proper operational state.
3. On the UTEU:
   a. Verify that the UTEU **Power** LED is On.
   b. Rotate the source selector switch to the required gating system source.

WARNING	As a Radiation Therapy Technologist (RTT), check before allowing the irradiation that the position of the selector switch of the external beam triggering interface is consistent with the prescription data in the patient file. There is a risk of mistreatment as the system does not automatically detect the gating prescription thereby always generating a continuous irradiation.

CAUTION	As a Radiation Therapy Technologist (RTT), check prior to the actual irradiation that the gating signal displayed on the Universal Triggering Electronic Unit (UTEU) is in line with the triggering device gating signal, and is within appropriate timing specifications. If the above conditions are not met, do NOT start the irradiation and verify the set-up (i.e., proper connection to the UTEU, source selection, etc.).

c. Optionally, if you want to use the gating equipment for patient alignment, press the **X-ray triggering** toggle button.

d. When working in **manual** mode: press the **Internal triggering** button and keep it pressed. Release this button when beam is no longer authorized.

Before starting irradiation:

1. When working in **automatic** mode, verify the consistency of the **Beam On trigger** LED with the beam authorization information generated by the gating system (Figure 48-9)"

WARNING	As a Radiation Therapy Technologist, you shall make sure that the position of the selector switch of the external beam triggering interface is consistent with the display on the irradiation screen.

During irradiation:

1. When working in **manual** mode: release the **Internal triggering** button when beam is no longer authorized.
2. When working in **automatic** mode, verify that the **Beam On trigger** LED remains flashing, which indicates that beam triggering signals are being received.

When irradiation has finished:

1. When finished using the UBTI, make sure that the **X-ray triggering** toggle button is deselected.

1. Gating system screen (e.g. gateRT screen)
2. adaPT *deliver* screen
3. Status lamp on gating system hardware (e.g. gateRT gating controller)
4. Status lamp on UBTI console (Beam On Trigger lamp)
5. Status lamp on imaging booth UBTI box

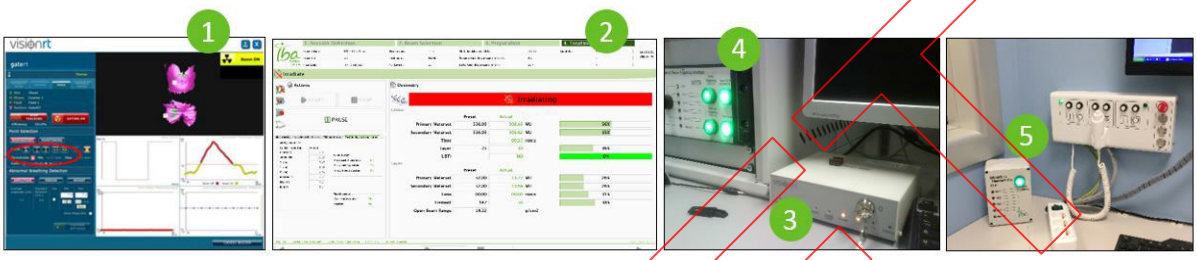


Figure 48-9. Gating Interface Visual Checks

How the UBTI Affects the Irradiation Process

The UBTI operates differently with each of the treatment modes, as follows:

- **Pencil Beam Scanning**: refer to Section "*Using UBTI in the Pencil Beam Scanning Treatment Mode*" on page 48-18.

Using UBTI in the Pencil Beam Scanning Treatment Mode

CAUTION	As a Radiation Therapy Technologist, when planning a treatment with automatic beam gating, choose the treatment delivery settings (such as beam delivery technique, dose rate, number of repaintings) and patient monitoring settings (such as duty cycle, acquisition frequency) in function of the clinical goals to be achieved and safety criteria to be met, taking into account the global latency of the system (latency of the patient monitoring system combined with the latency of the treatment machine and the latency to detect and process a system failure).

In Pencil Beam Scanning mode, the beam is switched On (i.e. beam is authorized) when all the following conditions are met:

- The beam has been **allocated** to the TR and it has **not been paused** by the RTT.
- The **Beam Triggering signal** is On (i.e. beam is authorized).
- The **Scanning Controller** has finished calculating the scanning map and the map has been downloaded.

Beam Enabling/Disabling

Beam is **enabled** as long as all three aforementioned conditions are met. Beam remains On as long as the Beam Triggering signal remains On (i.e. beam is authorized), or until the entire map has been irradiated.

Beam is **disabled** on the falling edge of the Beam Triggering signal. If the previously calculated map was not entirely irradiated, the scanning controller will calculate and download a new map.

See Figure 48-10. Beam enabling is indicated by the upward arrow (▲); beam disabling is indicated by the downward arrow (▼).

Table 48-1: Triggering in Pencil Beam Scanning

Beam Triggering signal	Off	On	Off	On
Scanning Controller	Computing/ Downloading	Computing/ Downloading	Ready	Ready
Beam	✘	✘	✘	✓

Figure 48-10 illustrates the triggering principle in the Pencil Beam Scanning treatment mode.

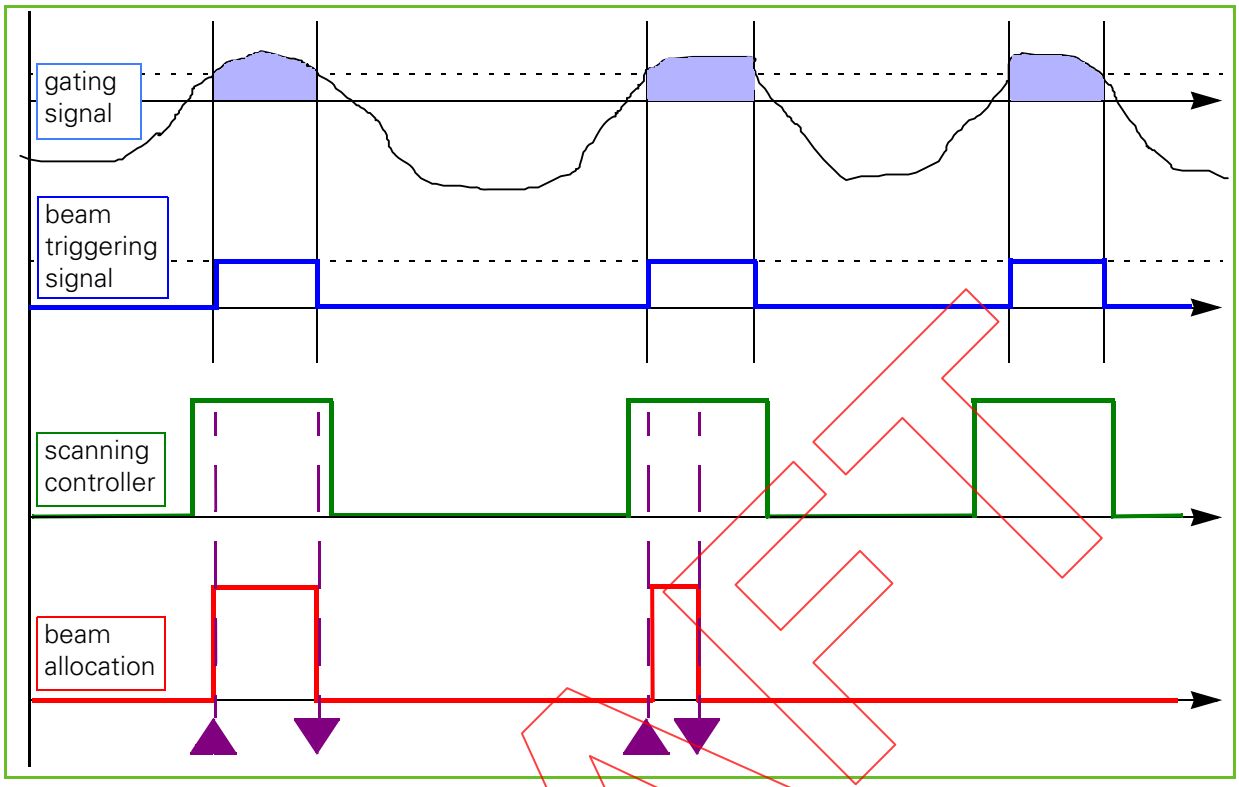


Figure 48-10. UBTI, in Pencil Beam Scanning Treatment Mode

Chapter 49
Aligning a Patient in the GTR

Positioning and aligning a patient in the GTR involves the operations that follow.

WARNING 	In a gantry treatment room equipped with a gantry rolling floor, patient loading should only be performed with the nozzle positioned in the upper part of the gantry, between 90° and 270°.

WARNING 	As a Radiation Therapy Technologist (RTT) you should perform motion with the patient on the support (i.e., couch or chair) only after the patient has been securely immobilized on the support.

CAUTION 	When installing the patient onto the couch, do respect the maximum weight allowed by the Patient Positioning system (PPS). Exceeding the allowed values will jeopardize result precision. For details on the allowed weights, refer to section *Allowed Maximum Weight on the Couch* in Chapter 7.

CAUTION	The patient may only be loaded onto the couch when the surface of the couch is flat, i.e., when pitch and roll angles are equal to zero.

Important	Verify the weight of the patient on a day to day basis. If the patient weight changes by more than 10 kg, the correction vector shall be recomputed for the table plate associated to the patient.

CAUTION	Using the long couch extension with the Patient Positioning System (PPS) for vertex fields in a Gantry Treatment Room (GTR) is not possible because of a mechanical interference between the couch and the nozzle. In order to avoid the risk of collisions, a short table-top must be used.

Moving Equipment to the Setup Position

Use the wireless hand-pendant or remote positioning controls in Auto mode to move the patient positioning devices to the *Setup* target position, as described in Chapter 9 and Chapter 11respectively.

WARNING	Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

When a device reaches the *Setup* position the hand-pendant or the remote positioning controls beep one time.

If the remaining device(s) is (are) at the *Setup* position when the last device reaches the *Setup* position the hand-pendant beeps two times.

Verifying Patient Alignment in Setup Position

When the equipment is at the *Setup* position, the RTT may use the lasers, X-ray tubes, or other patient alignment aids to verify the position of the target site with respect to the isocenter.

CAUTION	The nozzle lasers have been calibrated at 270° only. Lasers therefore should be used for rough alignment only.

As set forth in the treatment center's procedures, the RTT may choose to:

- Use the lasers (refer to section "*Working With Laser Devices*" on page 12-9)
- Take orthogonal X-ray images (using adaPT*insight*), following the procedure applicable in the TR type. For detailed information, refer to section "*Setting up for Orthogonal X-ray Images in a GTR*" on page 12-13.

Note: *The lasers and/or light field are less accurate than the X-ray tubes and are therefore used for initial positioning of the patient only; use the X-ray tubes for accurate patient alignment.*
Lasers and/or light field have a precision of ~3 mm; the precision of the X-ray based method: is <1 mm.

If you are using a gating system, follow the procedure described in Section "*Triggering Procedure*" on page 48-16. Check the X-ray triggering display (see Figure 48-2) to see that the correct gating system has been selected.

WARNING	As a Radiation Therapy Technologist (RTT), do evaluate the longest acceptable exposure time considering that taking the X-ray image may finish after the end of the triggering cycle.

WARNING	As a Radiation Therapy Technologist (RTT), check the gating signal with respect to the presence of the X-ray beam. In case a mismatch occurs, do NOT use the resulting X-ray images for patient alignment.

- Make subsequent corrections to the *Setup* position (refer to Section "*Correcting the Setup Position*" on page 49-5.

Note: *Refer to the treatment center procedure to establish how many X-ray images shall be taken.*

Correcting the Setup Position

Corrections to the *Setup* position are computed using adaPT*insight*. For detailed information on how to use adaPT*insight*, refer to the adaPT*insight* documentation listed in the Delivery Note.

WARNING

As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

WARNING

After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

As the *Setup* position is used to confirm patient alignment on the couch, the only settings that can be corrected (adjusted) for this position are the six axes of the PPS.

The allowed setup corrections include the following PPS axes:

- PPS Delta x (cm)
- PPS Delta y (cm)
- PPS Delta z (cm)
- PPS Delta Rotation (degree)
- PPS Delta Pitch (degree)
- PPS Delta Roll (degree)

To correct the *Setup* position:

1. Input the correction values using the terminal in the TR (refer to Section "*Inputting the Setup Corrections*" on page 49-6).
2. Implement the corrections (refer to Section "*Implementing the Corrections*" on page 49-6) using the hand-pendant or the remote positioning controls.

Inputting the Setup Corrections

If small corrections to the *Setup* position are necessary, determined by a review of the X-ray images, prepare the equipment for this Setup beam. For detailed information, refer to Section "*Equipment Preparation for a Setup Beam*" on page 33-2.

WARNING

As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

WARNING

When all alignment corrections have been applied and recorded by the user, make sure that, according to treatment center procedures, a second Radiation Therapy Technologist (RTT) verifies the entered corrections.

Note: *Applying the corrections downloads the values to the Positioning Control Unit (PCU) but does not move the PPS.*

Implementing the Corrections

WARNING

Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

Use the wireless hand-pendant or remote positioning controls in Auto mode to implement the corrections by moving the patient positioning devices to the *Corrected* target position, as described in Chapter 9 and Chapter 11 respectively.

WARNING

After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

WARNING	Whenever a pre-programmed motion (e.g., a GoTo motion,) has been used, as a the Radiation Therapy Technologist (RTT), perform a final verification of the position of all moving parts (e.g., Patient Positioning system [PPS], snout, gantry,) in the treatment room before irradiation begins.

When a device reaches the *Corrected* position the hand-pendant or the remote positioning controls beep one time.

If the remaining device(s) is (are) at the *Corrected* position when the last device reaches the *Corrected* position the hand-pendant beeps two times.

Confirming the Setup Position

When all devices are in the *Corrected* position, confirm the *Setup* position as follows:

1. Touch the green ✔ (**Tick**) icon at the top right of the wireless hand-pendant screen.

   Note: *If the current position is outside the treatment volume, the* `Position outside treatment volume. Position verifications are mandatory` *message appears on the hand-pendant.*

Working With the Treatment Session Manager

The system compares the values of the required position against limits defined in the tolerance tables. For detailed information on tolerance tables, refer to section "*Managing Tolerance Tables*" on page C-2.

The remainder of the procedure depends on the result of the check:

- **Successful check**: the Setup position is saved and a message on the hand pendant ackowledges the successful completion.
- **Unsuccessful check**: the hand pendant generates an error beep and an error message appears on the hand pendant.

Moving Equipment to Treatment Position

Use the wireless hand-pendant or remote positioning controls in Auto mode to move the patient positioning devices to the *Treatment* target position, as described in Chapter 9 and Chapter 11respectively.

WARNING	Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

When a device reaches the *Treatment* position the hand-pendant or the remote positioning controls beep one time.

If the remaining device(s) is (are) at the *Treatment* position when the last device reaches the *Treatment* position the hand-pendant beeps two times.

Verifying Patient Alignment in Treatment Position

When the equipment is in the Treatment position, the RTT may choose to perform further verifications according to treatment center procedure by:

- **Taking Portal View X-ray images** (using adaPT*insight*), following the procedure applicable in the TR type. For detailed information, refer to section "*Setting up for Portal View X-ray Images in a GTR*" on page 12-16.
- **Acquiring CBCT images**, following the procedure applicable in the TR type. For detailed information, refer to section "*Setting up for Acquiring CBCT Images*" on page 12-21.

  If you are using a gating system, follow the procedure described in section "*Triggering Procedure*" on page 48-16. Check the X-ray triggering display (see Figure 48-2) to see that the correct gating system has been selected.

WARNING	As a Radiation Therapy Technologist (RTT), do evaluate the longest acceptable exposure time considering that taking the X-ray image may finish after the end of the triggering cycle.

WARNING	As a Radiation Therapy Technologist (RTT), check the gating signal with respect to the presence of the X-ray beam. In case a mismatch occurs, do NOT use the resulting X-ray images for patient alignment.

Correct the *Treatment* position, as needed (refer to the next section "*Correcting the Treatment Position*").

Correcting the Treatment Position

AdaPT*insight* sends correction values to the PTS as a 4x4 matrix that is displayed as a TTCS vector.

The settings that may be corrected for the *Treatment* position are the:

- **Translation of the couch**
- **Rotation of the couch** (1 angle if only 1 X-ray image was acquired; 3 angles if 2 X-ray images were acquired).

Corrections to the Treatment position are computed using adaPT*insight*. For detailed information on how to use adaPT*insight*, refer to the adaPT*insight* documentation listed in the Delivery Note.

WARNING	As a Radiation Therapy Technologist (RTT) it is your responsibility to verify the appropriateness of the corrections generated by the Patient Position Verification System (PPVS).

There are two steps necessary to correct the *Treatment* position:

1. Input the correction values using the terminal in the TR (refer to Section "*Inputting the Treatment Position Corrections*" on page 49-10).
2. Implement the corrections (refer to Section "*Implementing the Position Corrections*" on page 49-11).

WARNING	After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

Inputting the Treatment Position Corrections

If small corrections to the Treatment position are necessary, prepare the equipment for this Treatment beam. For detailed information, refer to Section "*Equipment Preparation for a Treatment Beam*" on page 33-8.

WARNING	When all alignment corrections have been applied and recorded by the user, make sure that, according to treatment center procedures, a second Radiation Therapy Technologist (RTT) verifies the entered corrections.

Implementing the Position Corrections

WARNING

Make sure that the DID flat panel arms are fully retracted before attempting to move Patient Positioning Devices (PPDs) that can collide with the flat panels.

Use the wireless hand-pendant or remote positioning controls in Auto mode to implement the corrections by moving the PPS to the *Corrected* target position, as described in Chapter 9, "Using the Wireless Hand-Pendant", and Chapter 11, "Using the Remote Positioning Controls", respectively.

WARNING

After applying and implementing the corrections calculated by the Patient Position Verification System (PPVS) software (e.g., adaPT*insight*), it is recommended to take a new set of X-ray images to verify proper positioning of the patient.

When the PPS reaches the *Corrected* position, the hand-pendant or the remote positioning controls beep one time.

If the remaining device(s) is (are) at the required position when the PPS reaches the *Corrected* position the hand-pendant beeps two times.

Confirming the Treatment Position

When you are satisfied that the Treatment position is correct, confirm it as follows:

1. Touch the green ✔ (**Tick**) icon at the top right of the wireless hand-pendant screen.

   Note: *If the current position is outside the treatment volume, the* `Position outside treatment volume. Position verifications are mandatory` *message appears on the hand-pendant.*

   In case the current position is out of tolerance or outside the treatment volume, this **OK** acknowledges that you accept the situation. If you do not want to accept the situation, press **Cancel**.

The system compares the values of the required setup position against limits defined in the tolerance tables. If the check is successful, the corrected position shall be saved, the patient position status *Treatment Saved* check box is selected on the TR monitor.

Part XII

Monitoring an Irradiation

Chapter 50
Monitoring an Irradiation

If the beam is slightly out of specifications, a warning is displayed to the RTT in the TCR but the warning does not interrupt the beam. If the beam is severely out of specifications, the irradiation is interrupted.

Monitor the irradiation by:

- Listening carefully to the regular signals. The beep frequency is determined by the dose delivery. If an irregular beep is heard, there may be a problem.
- Watching the timer and the two Monitor Unit (MU) counters.

WARNING

Press the hardware emergency stop button if the irradiation fails to halt when the software PAUSE or STOP button is clicked or when the hardware PAUSE button is pressed.

WARNING

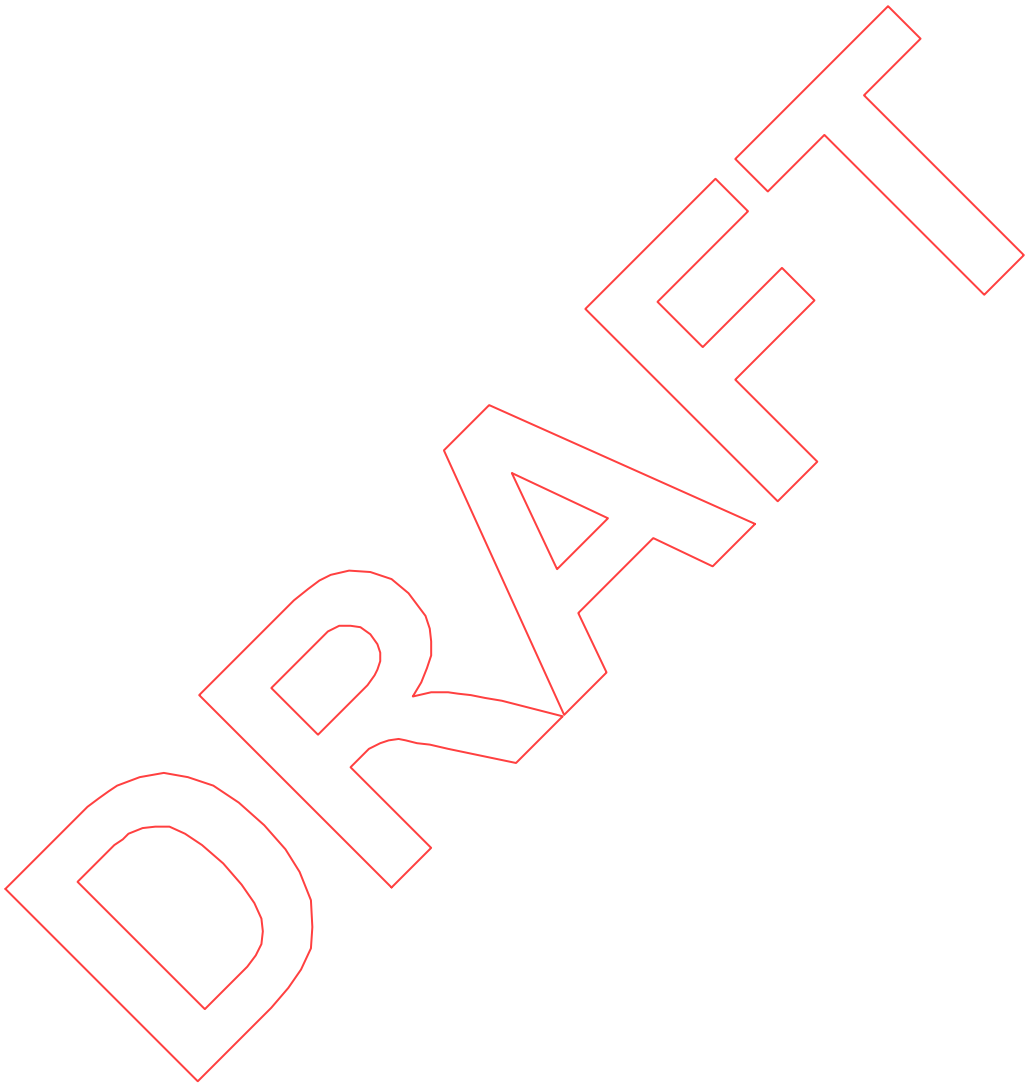
Emergency stop buttons shut off energy to most components in the Proton Therapy System (PTS). However, the electrical power to some components will not be interrupted, so be aware that electrical hazards and faults (faulty parts made live or induced fire) may still be present.

Note: *System behavior is also monitored by the Accelerator Operator who may also pause or resume the beam, for instance by inserting or removing beam stops.*

If you are using a gating system, follow the procedure described in Section "*Triggering Procedure*" on page 48-16.

WARNING	As a Radiation Therapy Technologist (RTT), during irradiation, you are recommended to check the gating signal (on the gating equipment) against the presence of the triggering request (i.e., the 'Beam On Trigger requested by source' LED on the UBTI). In case a mismatch occurs, pause the beam immediately.

Appendices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Appendix A
Nozzle Types and Components

Nozzle Position

The nozzle has a different position depending on the type of TR, as follows:

- **GTR**: the nozzle is located at the 270° (9:00 o'clock) position on the gantry frame. The weight of the nozzle is significant and is offset on the gantry by the use of a counterweight located at the 90° (3:00 o'clock) position on the gantry frame.

Nozzle Types

The Pencil Beam Scanning (PBS) Dedicated Nozzle is installed in each TR offering the PBS treatment mode.

	Treatment Modes			
Nozzle Types	**Single Scattering**	**Double Scattering**	**Uniform Scanning**	**Pencil Beam Scanning**
PBS Dedicated Nozzle	✘	✘	✘	✓

Pencil Beam Scanning (PBS) Dedicated Nozzle

The PBS Dedicated Nozzle is described in section "*Nozzle Types and Components PBS Dedicated Nozzle Structure*" on page A-3.

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Nozzle Types and Components PBS Dedicated Nozzle Structure

The PBS Dedicated Nozzle is specifically designed for delivering beam in the Pencil Beam Scanning (PBS) treatment mode.

To identify the major components, refer to Figure A-1.

- **Ionization Chamber 1 (IC1)** (or **Low Pressure Ionization Chamber 1 - LPIC1)**: to check the alignment of beam at the nozzle entrance.
- **PBS Dedicated Quadrupole Magnets**: a set of two quadrupole magnets that focus the beam at isocenter.
- **Scanning Magnets**: to bend the beam in order to send it at the prescribed position according to the location requested by the Treatment Planning System (TPS). One magnet bends the beam horizontally, the other vertically.
- **Retractable X-ray Tube**: the X-ray tube is inserted in the beam line to take Beam Eye View (BEV) X-ray pictures; the X-ray tube is retracted from the beam line during proton beam irradiation. This X-ray tube is located in the PBS dedicated nozzle pre-assembly, which is under vacuum.
- **Ionization Chambers 2&3 (IC2/3)**: to monitor beam characteristics (such as flatness, beam position, beam size, etc.) and the dose just before the beam leaves the nozzle.
- **Snout Holder**: to be able to move the accessory drawer towards or away from the isocenter.
- **Accessory Drawer**: at the end of the PBS dedicated nozzle an **accessory drawer** caters to an optional range shifter ridge filter, or snout. This accessory drawer can be put in or out of the beam path depending on whether or not an accessory or snout is used in the prescription. Possible accessories:
  - *Range Shifter*: consists of different sets of blocks of different thickness; it is used to treat very shallow targets and have full modulation to the skin.
  - *Ridge Filter*: an accessory that reduces the number of layers required for the small range by enlarging the width of the Bragg peak. The value of the enlargement is a functions of the ridge filter design.
  - *PBS Dedicated Snout*: optionally, the snout can be inserted into the accessory drawer. The snout can hold a maximum of two accessories.

The Scanning Controller

Particle therapy uses positively charged particles of varying energies (i.e., varying speeds) to irradiate tumors inside a patient's body. In the PBS beam delivery technique, a narrow particle beam is deflected in two perpendicular directions, both orthogonal to the beam axis, in order to scan the beam. These deflections are

obtained using both scanning magnets; each of these magnets is driven by a dedicated power amplifier, the so-called Scanning Magnet Power Supply (SMPS). The SMPS is controlled by the Scanning Controller.

The Scanning Controller handles most of the functionality required for the pencil beam scanning treatment delivery. The Scanning Controller (SC) is largely responsible for the controls and feedbacks of some elements that affect the beam trajectory and intensity as well as some other aspects of the beam.

The Scanning Controller is a distributed system and includes shared parts in the Power Supply Room, and TR specific parts, located near the nozzle.

PBS Dedicated Nozzle Layout

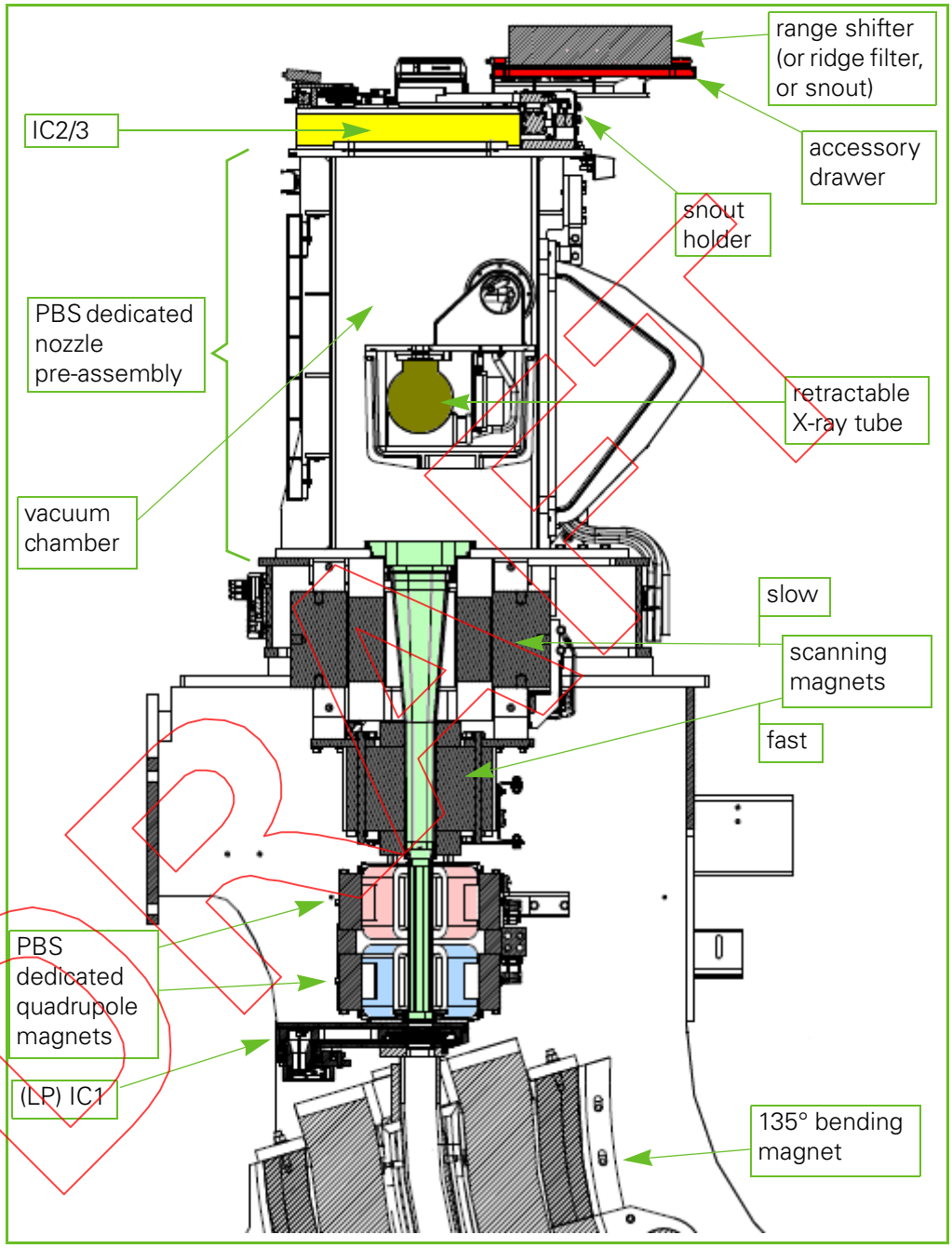

Figure A-1. PBS Dedicated Nozzle

PBS Dedicated Nozzle Components

Nozzle Frame

The nozzle frame is the housing used to support and contain all of the nozzle subsystems accessible from a TR. The nozzle frame has a hollow configuration and is almost entirely under vacuum.

(Low Pressure) Ionization Chamber No. 1 - (LP)IC1

Ionization Chamber No. 1 (IC1) is the nozzle component where the beam enters the nozzle. (The Low Pressure Ionization Chamber No. 1 is a model of the IC1).

IC1 consists of a single ionization chamber with the following components:

- **First single-surface collecting electrode:** this electrode is installed along the path of the beam and is divided into four quadrants surrounding a circular (20 mm diameter) electrode at its center. The whole single-surface collecting electrode serves as a beam-centering monitor.
- **Double-surface collecting electrode**: this electrode is comprised of the following:
  - *Upstream face of the double-surface collecting electrode*: it is divided into 12 parallel strips used to measure the profile and position of the beam in the "Y" direction.
  - *Downstream face of the double-surface collecting electrode*: it is an integral collecting electrode that is used to check beam interruption with each Range Modulator (RM) cycle in Double-scattering mode.
- **Second single-surface collecting electrode**: this electrode is divided into 12 parallel strips used to measure the profile and position of the beam in the "X" direction.

CAUTION	Be aware that the lifetime of Ionization Chambers may be reduced if exposed to over 10E6 Gray, which corresponds to approximately 450 hours of beam exposure at 5 nA. Ionization Chamber 1 (IC1) can sustain 450 hours of beam exposure at 5 nA. Ionization Chamber 2/3 (IC 2/3) can sustain 450 hours of unscanned beam exposure at 5 nA.

PBS Dedicated Quadrupole Magnets

Purpose of the PBS dedicated quadrupole magnets is to focus the beam at isocenter so that the size of the beam remains limited. These quadrupole magnets are made of laminated steel to enable a fast current change without overheating the structure of the quadrupole magnets.

Scanning Magnets

The two scanning magnets located in the nozzle deflect the beam and continuously paint the treatment field with a relatively wide beam area. The upstream magnet scans the beam in the Y direction at 30 Hz; the downstream scanning magnet scans in the X direction at 3 Hz, all expressed in the nozzle coordinate system.

PBS Dedicated Nozzle Pre-assembly

The PBS Dedicated Nozzle Pre-assembly is primarily a vacuum chamber that houses the retractable X-ray tube and onto which the range shifter and ridge filter are mounted.

Retractable X-ray Tube

Aligning the patient for treatment is accomplished with the use of two X-ray (XR) tubes. One of the X-ray tubes is located inside the nozzle. It can be pneumatically rotated into or out of the beam path without interrupting the vacuum.

Range Verifier

The Range Verifier (RV) is located downstream of the PBS nozzle dedicated pre-assembly. The range verifier is only used to detect discrepancies in beam range to protect the patient from large errors in range setting.

The range verifier includes 9 tugsten/copper plates insulated from each other by a thin kapton film. The plates and insulators are stacked together and located perpendicular to the beam axis. When the range verifier is placed in the beam path, the beam stops in the stack of plates, at a specific depth determined by the energy of the protons. The current collected in each plate is measured, thereby making it possible to determine the range of the beam.

Beam Stop Assembly

The beam stop is a copper block that can pneumatically be moved into the beam path to block the beam.

Ionization Chambers No. 2 & No. 3 (IC2 & IC3)

Ionization Chambers No. 2 & No. 3 (IC2 & IC3) consist of two ionization chambers:.

The first single-surface collecting electrode along the path of the beam in Ionization Chamber no. 2 (IC2) is divided into 32 parallel strips used to measure the profile and position of the beam in the "X" direction. The second single-surface collecting electrode in IC2 contains a circular (2-cm diameter) electrode at its center that serves as a dosimetry monitor for the dosimetry channel. The surface around the circular electrode is used to check if the beam is turned off after a beam stop request.

The first single-surface collecting electrode along the beam path in Ionization Chamber no. 3 (IC3) contains a circular (2-cm diameter) electrode at its center that serves as a dosimetry monitor for the dosimetry channel. The second single-surface collecting electrode in IC3 is divided into 32 parallel strips used to measure the profile and position of the beam in the "Y" direction. The surface around the circular electrode is used to check if the beam is turned off after a beam stop request.

Snout Holder

The snout holder enables the accessory drawer to be moved towards or away from the isocenter.

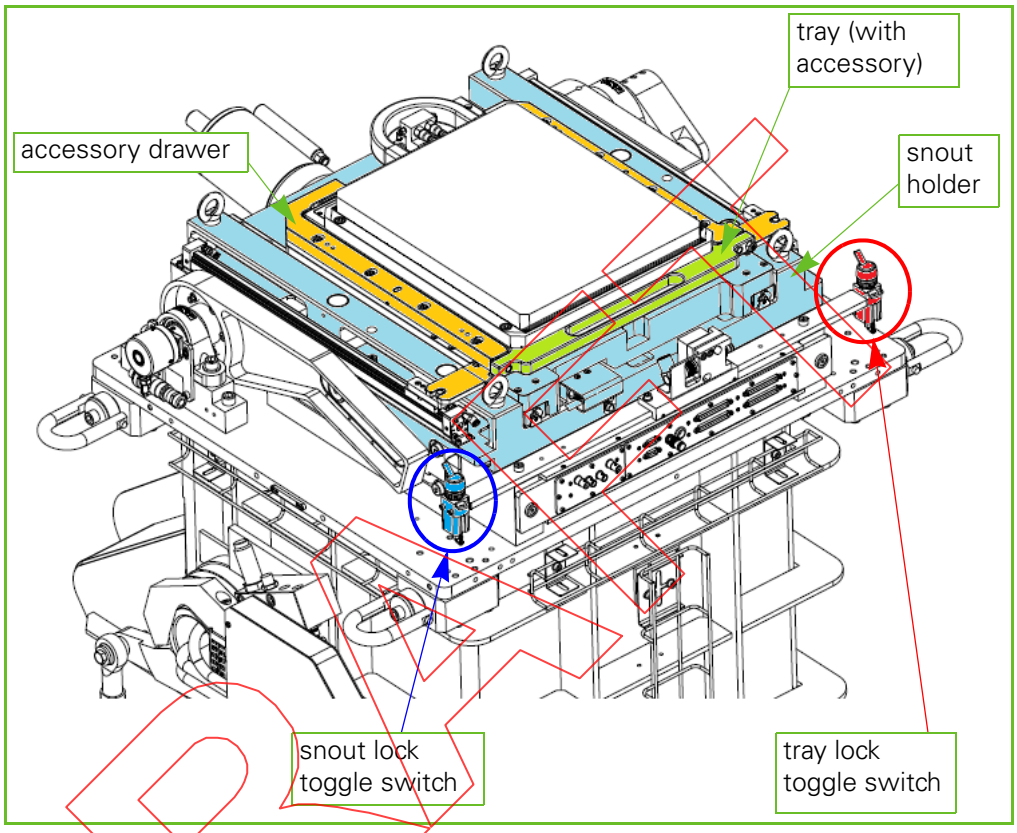

Figure A-2. PBS Dedicated Snout Holder

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Appendix B
Using the Dosimetry Manager

The Dosimetry Manager enables users to:

- manually enter temperature and pressure measurements into the system: This data is used to correct the dose output factor.
- manually enter the k_{IC} (Dose Correction Factor): This data is used to finely adjust system behavior to absolute calibration measurements. The Dose Correction Factor is defined based on the morning QA.
- manually enter the tolerance (in %) on the drift of the k_{TP} (Temperature and Pressure Correction Factor, TPCF) between two subsequent beams.

Starting the Dosimetry Manager

The Dosimetry Manager is accessible via a button at the bottom of the adaPT*deliver* screens. (Once clicked, the button is grayed out; see Figure B-1.)

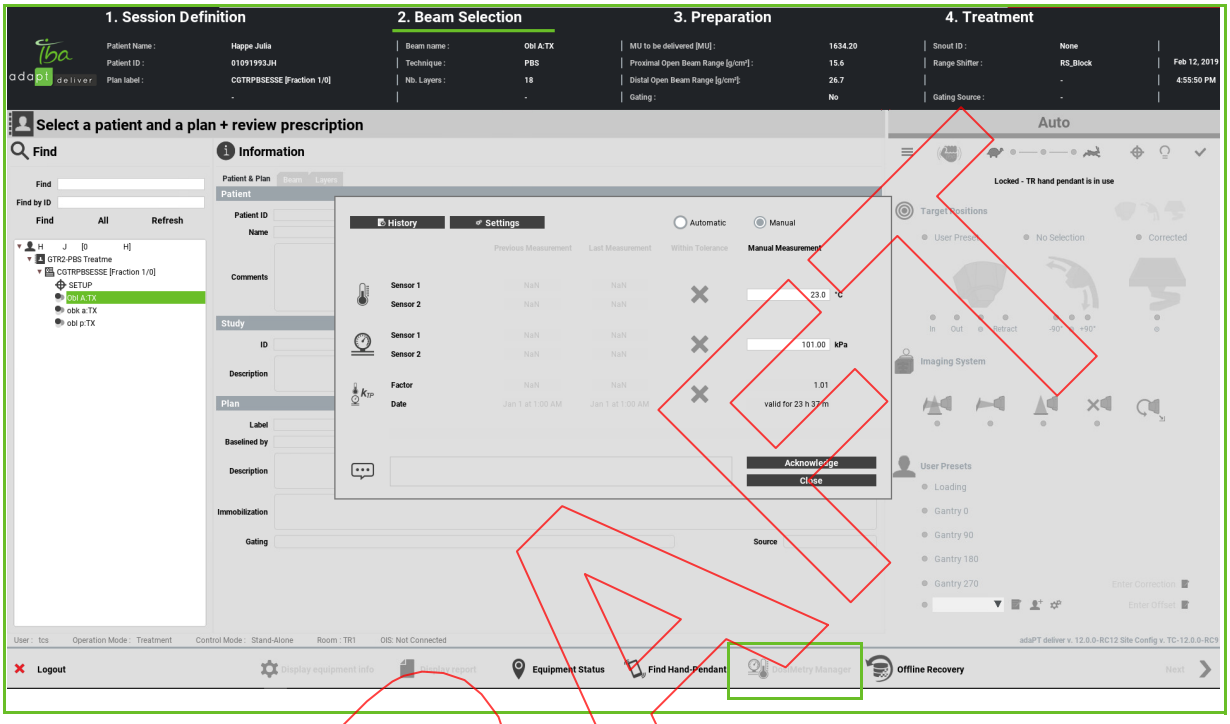

Figure B-1. adaPTdeliver: Dosimetry Manager Button

The main display of the Dosimetry Manager is presented in Figure B-2.

The screen is divided in two parts:

- one for automatic acquisition of temperature and pressure display (Automatic TPCF mode)
- one for manual input of temperature and pressure values (Manual TPCF mode).

When the automatic mode is activated, the part of the screen dedicated to the manual mode is disabled. When the manual mode is activated, the part of the screen dedicated to the automatic mode is disabled.

Note: *For the Proteus PLUS, the Automatic TPCF mode is always disabled because there are no sensors.*

If the **Automatic** TPCF mode is always **disabled** (i.e. if the system does not include temperature and pressure sensors), only the manual mode can be activated.

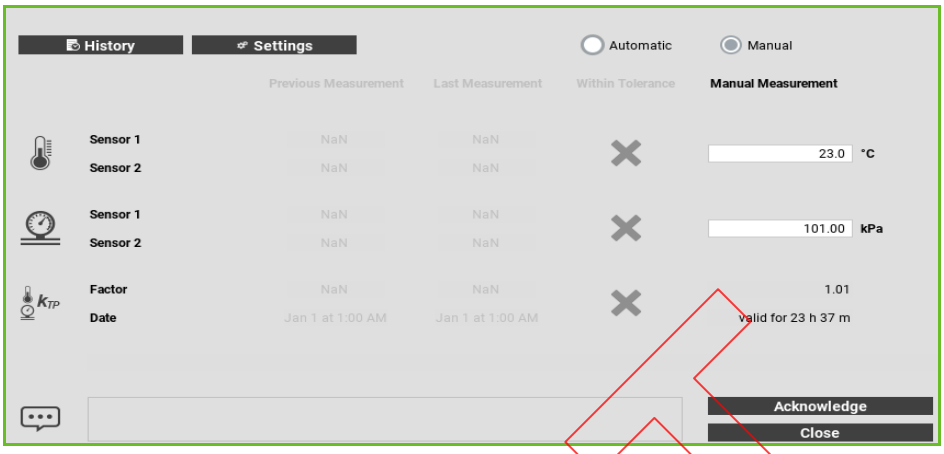

Figure B-2. Dosimetry Manager Main Display

Entering Temperature and Pressure Values

When the **Manual** mode is activated (Figure B-4), you may enter:

- Temperature: expressed in °C (degrees Celsius)
- Pressure: expressed in kPa (kiloPascal)

Optionally, you can add a free text comment.

Immediately after entering new values, the system checks that the entered values are within acceptable ranges according to the Dosimetry Manager settings and display an error otherwise. The acceptable range for the temperature and pressure values are displayed in the Dosimetry Manager **Settings** tab.

To confirm and record the newly entered values in the database, click **Acknowledge**.

Then, the system will prompt authorized users for login credentials (username and password as given in Figure B-3). If you do not have the appropriate user rights, an error message will appear.

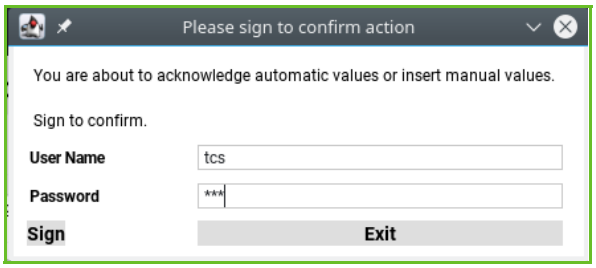

Figure B-3. Dosimetry Manager: Entering credentials for confirmation

Note: *If the system is not able to communicate with the database and store the new values you have entered, an error will be displayed. In this case, you may retry or call an IBA operator*

Finally, close the Dosimetry Manager.

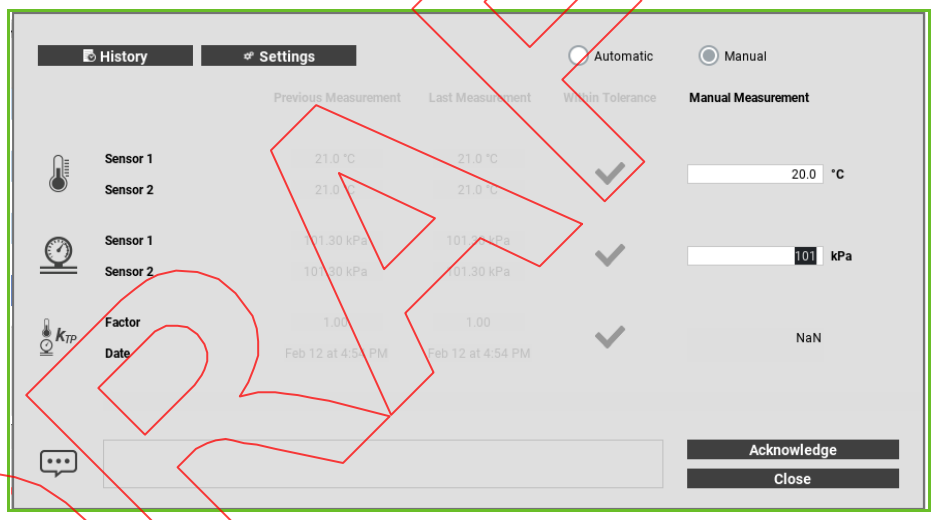

Figure B-4. Dosimetry Manager: Entering Temperature and Pressure Values

Handling Errors

If an error occurs when the system updates the temperature and pressure values, an error or warning message will be displayed explaining the error or warning, and what needs to be done in order to fix it.

In **Manual** mode, two types of errors may appear:

1. **Values outdated**

The temperature and pressure values must be updated at least every 24 hours or less if specified differently by the treatment center quality management plan. If the values entered manually are outdated, you will be prevented to proceed with treatment and will be asked to enter new temperature and pressure values manually (see section "*Entering Temperature and Pressure Values*").

2. **No manual entry found**

   If there is no value to retrieve in the database, the system will inform you through an error message. In this case, you will be prevented to proceed with treatment and will be asked to enter values manually.

Entering Dose Correction Factor

The **Dose Correction Factor** can be updated from the Dosimetry Manager **Settings** tab. To record the newly entered value in the database, click **Save**. You must enter your login credentials (see Figure B-3). If you do not have the appropriate user rights, an error message will appear.

Optionally, you can enter a comment in the main Dosimetry Manager screen.

The Dose Correction Factor is used to compensate for changing IC (Ionization Chamber) behavior. The current Dose Correction Factor remains valid until a new one is entered.

Note: *A Dose Correction Factor must exist to enable adaPTdeliver to become operational.*

Note: *It is good practice to specify a new correction factor regularly. Ask the management of your center for the recommended frequency.*

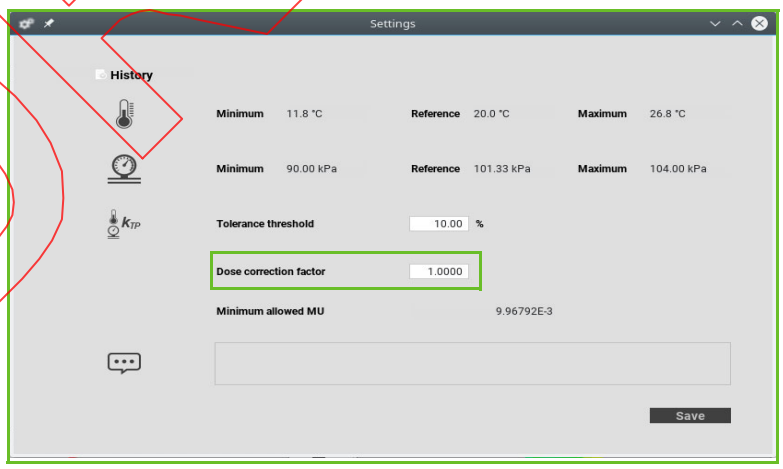

Figure B-5. Dosimetry Manager: Entering Dose Correction Factor

Determining the Minimum Allowed MU

The Treatment Planning System (TPS) provides a dose setpoint in Monitor Units (MU) to the Proton Therapy System (PTS), that the PTS converts into charge to be collected in the ion chamber.

This conversion depends on the temperature, pressure, and the dose correction factor. If the entered temperature or pressure is out of the acceptable range, the TPS may generate treatment plans that will be rejected by the PTS.

To enable the TPS to provide treatment plans that are acceptable to the PTS, the **Minimum allowed MU** for the PTS needs to be established based on the acceptable range for temperature and pressure values.

To achieve this:

1. Enter extreme values for temperature and pressure in the Dosimetry Manager. Suggested extreme values are:
   - Temperature: 26°C
   - Pressure: 90 kPa
2. The computed Meterset parameters (i.e. the **Minimum allowed MUs**) will be updated accordingly in the Dosimetry Manager **Settings** tab (Figure B-6).
3. Enter these values in the TPS.

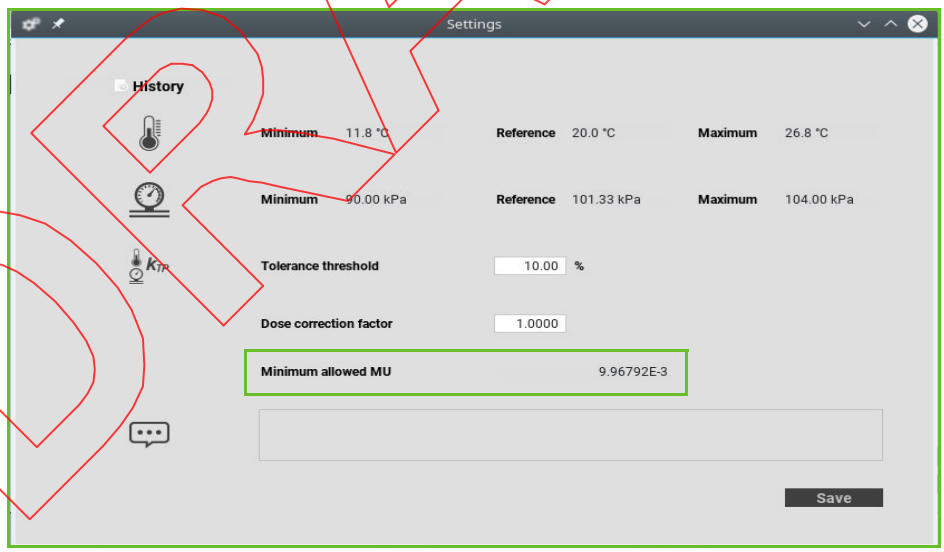

Figure B-6. Dosimetry Manager: Determining the Minimum Allowed MU

Viewing the History Log

The Dosimetry Manager **History** tab enables you to view the history log of the atmospheric conditions of the treatment room (TR). It contains a line for each automatic acquisition or each manual entry, along with the date, logged user and comment. For an automatic acquisition, the temperature and pressure displayed are the average values, used for k_{TP} computation.

The **History** tab in the **Settings** panel enables you to view the history log of the dose correction factor of the treatment room (TR). It contains a line for each entry, along with the date, logged user and comment.

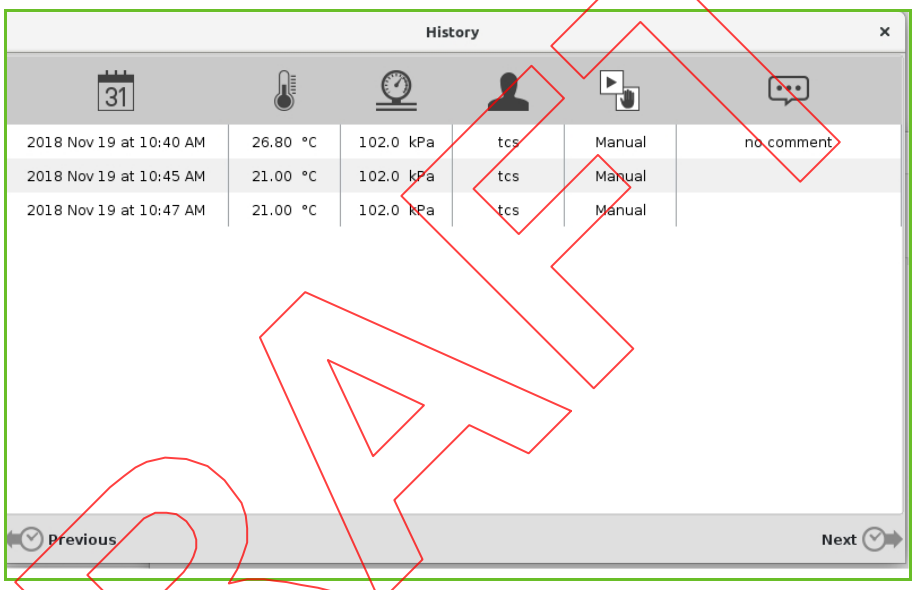

Figure B-7. Dosimetry Manager: Viewing the History Log

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Appendix C
Managing PTS Users

Users of the PTS are managed using the User Manager.

Only a limited number of staff in your organization is authorized to manage users of the PT system. If you have such rights, from the USER MANAGER LOGIN SCREEN, login to the User Manager using your user name and password.

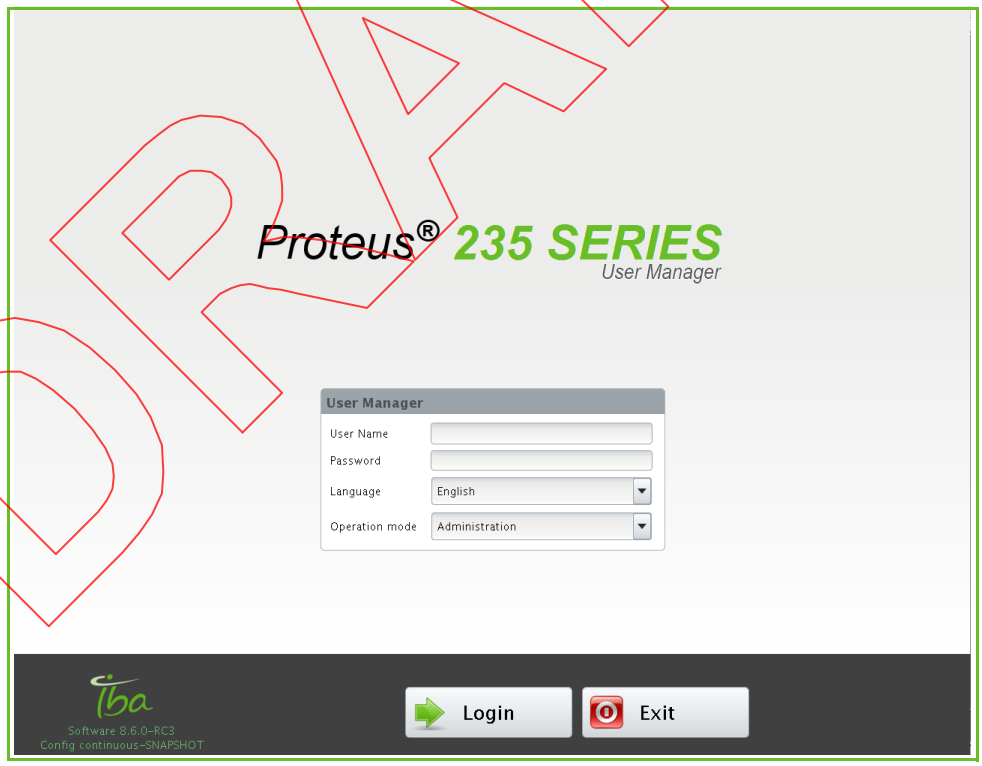

Figure C-1. User Manager Login Screen

The USER MANAGER MAIN SCREEN appears.