RAYSTATION 2024A SP2

Release Notes

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Declaration of conformity

CE 2862

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

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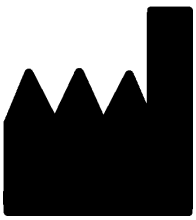
1 INTRODUCTION

1.1 ABOUT THIS DOCUMENT

This document contains important notes about the RayStation 2024A system. It contains information related to patient safety and lists new features, known issues and possible workarounds.

Every user of RayStation 2024A must be familiar with these known issues. Contact the manufacturer for any questions about the content.

1.2 MANUFACTURER CONTACT INFORMATION



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1.3 REPORTING OF INCIDENTS AND ERRORS IN SYSTEM OPERATION

Report incidents and errors to the RaySearch support email: support@raysearchlabs.com or to your local support organization via telephone.

Any serious incident that has occurred in relation to the device must be reported to the manufacturer.

Depending on applicable regulations, incidents may also need to be reported to national authorities. For the European Union, serious incidents must be reported to the competent authority of the European Union Member State in which the user and/or patient is established.

2 NEWS AND IMPROVEMENTS IN RAYSTATION 2024A

This chapter describes the news and improvements in RayStation 2024A as compared to RayStation 2023B.

2.1 RESOLVED FIELD SAFETY NOTICES (FSNS)

There are no resolved field safety notices (FSNs) in RayStation 2024A.

2.2 NEW AND SIGNIFICANTLY UPDATED WARNINGS

For the complete list of warnings, see *RSL-D-RS-2024A-IFU, RayStation 2024A SP2 Instructions for Use*.

2.2.1 New warnings

WARNING!

Treatment data stored in secondary databases. Do not upgrade secondary databases that hold treatment related data outside of the system connected to RayCare. These secondary databases shall remain in their current schema version.

(824240)

WARNING!

Ensure that all clinically relevant fixation and support ROIs are included in the beam set. By default, all Fixation and Support ROIs will be included in all beam sets. All Fixation and Support ROIs that are included in a beam set will be used for dose computation for the beam set. If a Fixation or Support ROI has been excluded from a beam set, it will be disregarded in the dose computation for that beam set.

Support and Fixation ROIs included in the beam set will be:

- marked with a blue beam set icon in the ROI list
- marked with a checked checkbox in the Fixation and support tab
- shown with solid line style in the 2D patient views
- included in the Material patient view when the beam set is selected.

(713679)

WARNING!

Register scanned avatar. The Register Scanned Avatar method is a scriptable method that will register an avatar that can be used for collision detection.

The user must make sure that the avatar is a suitable representation of the patient and that it is correctly registered to the given patient ROI before using it for collision detection. The avatar can provide an early indication of a potential collision when used in collision detection but must not be used as a final protection against collisions.

(824789)

WARNING!

High-dose Technique Type settings. Thresholds should only be set for treatment techniques intended for use with high dose technique types. The thresholds allow a safety control of the treatment machine to be overridden. This could potentially lead to a harmful treatment if the values are set incorrectly. An appropriate Maximum beam MU limit should also be set.

(825142)

WARNING!

Dose accuracy for the proton MC dose engine used for small shallow fields. The Monte Carlo PBS dose engine validation of RayStation shows some deviations from the dose accuracy requirements when compared with measurements for small shallow fields. The validation includes fields with depth ranging from 5 to 30 mm, using aperture openings with diameters of 8 and 15 mm. The treatment nozzle used in the test setup has a range shifter that is placed 72 cm upstream of the aperture. For these setups, the accuracy requirements are a gamma (3%,0.3mm) pass rate above 90% and a gamma (5%,0.5mm) pass rate above 95%. For the test cases using an 8 mm aperture diameter, the RayStation Monte Carlo PBS dose engine tends to overestimate the dose relative to measurements, and in one case the validation fails the gamma (3%,0.3mm) accuracy requirement, with a fail rate of about 14%. Test cases for an equivalent setup but with a 15 mm aperture diameter pass all accuracy requirements, and all test cases for small shallow fields pass the gamma (5%,0.5mm) requirement.

The user is advised to be extra careful when creating plans with aperture openings smaller than 15 mm.

(824407)

2.2.2 Significantly updated warnings

WARNING!

Material visualization. The material view displays the combined voxel densities from image set values and material override. Any material override ROIs inside the External ROI, ROIs of type Fixation and Support included in the selected beam set, and ROIs of type Bolus assigned to the selected beam are included in this density computation. The displayed density values are the voxel densities used for dose computation.

When Stopping Power Ratio (SPR) is used as input for proton and light ion dose computation, the material view displays the combined voxel SPR values used in dose computation instead.

The user is advised to carefully review the material values (density or SPR) to ensure that the input to the dose computation is correct.

Note that for BNCT and Brachy TG43, material visualization is not available. For the BNCT technique, the dose computation is performed by an external dose engine and the material handling is different, while for Brachy TG43 dose computation the entire patient is considered as water.

2638

WARNING!

Assignment of CBCT density table. For direct usage of the raw CBCT information in dose computation, RayStation uses an image-specific CBCT density table. Since there is a limited set of density levels specified for a CBCT compared to what is normally specified for a CT, dose computation on CBCT images may be less accurate than using CT images or converted CBCT images. The accuracy of the dose computation using CBCT with an assigned density table relates to the tuning of this table, and how well the real density in the patient maps to the selected densities in the table.

Always review the density table before it is used in dose computation. The review can be performed through spot check of selected slices in the Create Density Table for CBCT dialog where the effect of the density table is visualized.

Dose calculation on raw CBCT image data sets is only supported for photons.

(9355)

WARNING!

Beam models must be validated before clinical use. It is the responsibility of the user to validate and commission all beam models before they are used to create clinical external beam radiotherapy treatment plans.

RayStation is developed to be used by trained Radiation Oncology professionals. We strongly suggest that users adhere to recommendations published in AAPM TG40, TG142, TG53, TG135, IAEA TRS 430, IAEA TRS 483 and other standards to ensure accurate treatment plans.

Computed dose accuracy depends directly on the beam model quality. Beam model insufficiency may lead to deviations between approved and delivered dose. All parameter values and plan QA and QC shall be reviewed and approved by qualified physicists. The dose calculation must be validated for all commissioned CT machines.

- The computed dose shall be validated for all relevant clinical situations including, but not limited to, variation in SAD, SSD, field-size, field-shape, off-axis position (x, y and diagonal), collimation type, degree of modulation, leakage dose (variation in MU/Gy or NP/Gy), couch/gantry/collimator angles, CyberKnife node sets, patient/phantom material composition and patient/phantom material geometry.
- The computed dose shall be validated for all clinically relevant dose grid resolutions.
- Known limitations are described in the *RSL-D-RS-2024A-REF, RayStation 2024A Reference Manual*. Additional limits of operation for each beam model must be identified during validation and adhered to during planning.

For photons:

Special care should be taken before using RayStation with MLC leaves smaller than 5 mm, materials that differ from common patient materials, blocks, small circular cones, wedges (in particular off-axis wedges), complex VMAT plans, rotational plans with small field sizes, Siemens mARC plans and wave arc plans, especially with larger ring rotation than 15 degrees.

Note that:

- a beam model validated for 3D-CRT is not necessarily suitable for IMRT plans.
- a beam model validated for SMLC is not necessarily suitable for DMLC plans.
- a beam model validated for SMLC or DMLC is not necessarily suitable for VMAT plans.
- a beam model validated for VMAT is not necessarily suitable for plans created using sliding window VMAT sequencing.

- a beam model commissioned for one photon dose engine (Collapsed Cone or Monte Carlo) is not suitable for the other dose engine without adaptation of the beam model parameters.

Validation must be performed for each selected treatment technique using Beam 3D modeling or RayStation. For C-arm and CyberKnife LINACs, see warning 3438. For TomoTherapy treatment machines, see also warning 10172.

For protons:

Validation shall include relevant compensator and range shifter geometries, block and/or MLC aperture contours, air gaps/snout positions, isocenter to surface distance, spot tune and patterns, spread out Bragg peak depth and modulation width, field sizes (see also warning 1714).

For Mevion Hyperscan, see also warning 369009.

For light ions:

Validation shall include relevant air gaps/snout positions, isocenter to surface distances, spot size and patterns, field sizes, heterogeneous/anthropomorphic phantoms, CT machines, range shifter settings, spill dose and delivery settings (see also warning 1714).

For electrons:

Validation must include relevant applicator geometries, field sizes without cutout, field sizes and field shapes with cutout, field shape orientations for rectangular applicators, cutout materials and thicknesses, air gaps to isocenter and D50 water ranges per nominal beam energy. Only Cerrobend cutouts with straight edges, i.e., parallel to the beam axis line, are supported.

(4001)

WARNING!

Dose grid effects for proton and light ion PBS plans. The Pencil Beam dose engines in RayStation calculate the average dose to a voxel along the integrated depth dose (IDD) and the dose to the center point of each voxel laterally and lets this dose value represent the dose in the entire voxel, while the RayStation Monte Carlo dose engine calculates the average dose deposited to a voxel. This means that any variation in dose that occurs on a resolution that is finer than that of the current dose grid may be lost in the dose calculation. The user has the responsibility to choose a dose grid resolution that is suitable for each plan. However, for low energy proton fields, and light ion fields without a ripple filter, the Bragg peak may be so sharp that even the highest dose grid resolution in RayStation (0.5 mm) is insufficient to resolve the Bragg peak, leading to a systematic underestimation of computed dose in relation to delivered dose. This may generate treatment plans that give a higher delivered dose than expected.

Be aware of this limitation in the dose calculation. To determine if this discrepancy is on a significant level, be extra careful in the patient-specific QA process.

(439)

WARNING!

Field size limitations for Proton PBS MC dose engine. The Monte Carlo PBS dose engine validation of RayStation only covers the following setups related to field size:

- Scanned field sizes down to 4 x 4 cm^2
- MLC aperture openings down to 2 x 2 cm^2
- Block aperture openings down to 4 x 4 cm^2
- Block aperture openings with diameters between 8 and 15 mm for shallow fields with ranges between 5 and 30 mm

Be extra careful when creating PBS and Line Scanning plans with scanned field sizes or aperture openings smaller than the setups covered in the dose engine validation.

(369532)

WARNING!

Absolute dose accuracy for helium ion PBS with range shifters. There are limitations to the modeling of the beam spread in the region between a range shifter and the patient, also called the air gap, in the analytical dose engine used for helium ion dose calculation in RayStation. The dose engine has been successfully validated for air gaps up to 40 cm, while for larger air gaps discrepancies have been observed, especially for small fields and/or thick range shifters. The user is therefore encouraged to be extra careful when using air gaps larger than 40 cm.

(219202)

WARNING!

Approximate lateral dependence of the mixed radiation field for RBE weighted dose and dose-averaged LET. The lateral fluence distribution of primary particles and fragments is computed using a trichrome approximation. The trichrome approximation makes use of the MCS and nuclear halo gaussians and associates them with different particle species to achieve realistic lateral distributions of the fluence of primaries and fragments. The approximation can cause significant errors in areas of the field where the distribution of primary particles and fragments is different to where there is a lateral equilibrium in the mixed radiation field, for example, outside of the field, within a small field, or at the edge of a larger field. Note that the effect is directly visible in the dose-averaged LET, but contributes only as a secondary effect for the RBE.

(408315)

2.3 CLINICAL GOALS PER BEAM SET OR PLAN

- It is now possible to associate clinical goals to either the plan or a beam set within the plan.
- In the regular planning modules (e.g., Plan optimization), the result of the clinical goal is calculated using the dose given by their association.
- In modules where doses can be compared (e.g., Plan evaluation, MCO and Dose tracking), clinical goals can still be evaluated against multiple doses at the same time.
- The associations are stored in clinical goal templates. The association can be manually configured when applying the template, similar to how ROIs can be configured.
- The tables in plan and beam set reports have been updated. The clinical goals tables available in reports are 'clinical goals associated to plan', 'clinical goals associated to beam set' and 'clinical goals (evaluation dose)'.

2.4 SELECTION OF FIXATION AND SUPPORT ROI PER BEAM SET

- It is now possible to select Fixation and Support ROIs per beam set. This makes it possible to contour for example multiple couches to be used for different modalities.
- Only selected Fixation and Support ROIs will be included in dose computation, SSD calculation, air gap calculation, beam entry validation, physical depth calculation, water equivalent depth calculation, dose computations on other image sets, perturbed dose calculations, and fraction dose computations in the Dose tracking module.
- By default, all Fixation and Support ROIs will be included in a beam set.
- When approving a beam set or a plan, only the Fixation and Support ROIs included in the beam set will be included in the approval. Any excluded Fixation and Support ROIs will remain unapproved. All other ROIs and POIs will be approved as usual.
- In the plan report, there is a new table for each beam set displaying the used Fixation and Support ROIs and their material properties.
- A new protocol step has been added; *Include fixation & support ROIs*. In the step it is possible to specify which fixation and support ROIs to include in a beam set that will be created by the protocol.

2.5 DEEP LEARNING SEGMENTATION

- ROIs are now grouped by body site in the *Deep learning segmentation* dialog.
- It is now possible to set color codes for ROI colors in RayMachine. Color codes must be in HEX or ARGB format (the A component must be FF, i.e. completely opaque). Examples of color codes: "#?b?bc0", "#FF?b?bc0", "blue".

2.6 MACHINE LEARNING PLANNING

- The structure of the settings file is rearranged. The *PredictSettings* field is now removed, and DVH modifications are instead specified under *MimicSettings.PreprocessingSettings*. Syntax for the modifications remains the same.
- RayStation 2024A models have new naming conventions. The name mappings between RayStation 2023B and RayStation 2024A Deep learning planning models are listed below.

2023B model names	2024A model names
RSL-Breast-L-4005, RSL-Breast-L-4240, RSL-Breast-L-2600-SBRT	RSL Breast Left
RSL-Breast-L-4800-SIB	RSL Breast Left 2LVS
RSL-IMPT-Oropharynx-7000-SIB	RSL Oropharynx Proton 2LVS
RSL-Oropharynx-7000-SIB	RSL Oropharynx 2LVS

2023B model names	2024A model names
RSL-Lung-4800-SBRT, RSL-Lung-5000-SBRT, RSL-Lung-6000-SBRT	RSL Lung
RSL-Prostate-6000, RSL-Prostate-3625-SBRT, RSL-Prostate-3500-SBRT	RSL Prostate
RSL-Prostate-6000-SIB	RSL Prostate 3LVS
RSL-ProstateBed-SVs-Nodes-7000-SIB	RSL ProstateBed SVs Nodes 2LVS
RSL-Prostate-SVs-Nodes-7700-SIB	RSL Prostate SVs Nodes 2LVS
RSL-Rectum-5000	RSL Rectum

2.7 PERFORMANCE IMPROVEMENTS

- It is now faster to save a case, especially for patients with a very large number of plans.
- It is now faster to open a planning module, especially when having triangulated ROIs.
- The computation of voxel volumes is now faster. This is detected as faster initial phase of optimization and dose computation when the dose grid has been set or changed.
- *Copy to all* of *Visualization settings* in the ROI/POI details is now faster.

2.8 GENERAL SYSTEM IMPROVEMENTS

- ROI and POI lists are now initially sorted alphabetically.
- Sorting on sub columns is now enabled for some tables. For example, ROI details can be sorted on visualization sub columns.
- Static tables in reports can be configured to be output in landscape orientation.
- The entire toolbar in 3DCRT and VSIM module is now fully visible (there is no need to scroll to see prescription) due to compacted *Aperture shapes* toolbar (labels are removed and icons are moved).
- In the Material patient view, which shows material values on the dose grid resolution, bolus is included when beam dose for a beam with a bolus ROI assigned is selected.
- When loading clinical goal templates or optimization function templates it is now possible to select if existing functions should be replaced. This is similar to the current behavior for loading beam list templates.

2.9 PATIENT DATA MANAGEMENT

- The *Treatment delivery* section has been renamed to *Dose tracking* and it will now additionally display the image set used for dose accumulation.

2.10 PATIENT MODELING

- Creating structures from a template now has the option to automatically update derived ROIs for all initialization options. Existing protocols will get the default behavior, i.e., to update the derived ROIs when running a protocol with a structure template.
- There is a new option under *Basic shapes* for creation of ellipsoid ROIs.
- There is a tool for segmentation of vessels in lungs.
- Default names for MBS ROIs now follow the TG263 standard.
- Non-uniform expansion and contraction of ROIs have been improved.
    - A new algorithm uses grayscale values at the edges of ROIs to get smoother expansions and contractions. The algorithm is run on GPU.
    - For large ROIs and for large margins the old algorithm is still used, which creates a binary border to the ROI before expansion or contraction. This is to avoid long computation times.
- To delete multiple contours (keeping every n:th) now works in all view directions; transversal, sagittal, coronal and slice aligned (for oblique image sets).
- The floating view in *Image registration* has been updated, and it now works like it did in RayStation 11A and earlier RayStation versions.
- It is now possible to use limited field-of-view as deformation strategy for hybrid deformable registrations. The strategy is introduced to better handle cases with a planning CT as reference image and a CBCT with limited field-of-view as target image. It can be used through scripting and requires a Focus ROI with type 'Field-of-view'.
- In the Deformable registration module, the *Deformation grid* view now shows the image set in the same direction as the reference image set, i.e., it will look the same as the fusion view when the reference image has another patient position than HFS.

2.11 IMAGE CONVERSION

- Converted CBCT creation (both corrected CBCT and virtual CT) now by default includes creation of Field-of-view ROI and deformable registration. The deformable registration is created using the new deformation strategy limited field-of-view. It is still possible to select another field-of-view ROI and another deformable registration.

2.12 BRACHYTHERAPY PLANNING

- Channel numbers are now displayed in the 3D views.

2.13 PLAN OPTIMIZATION

- A *Copy* button has been added to the *Objectives/constraints* tab.

- Function values are no longer automatically computed after final dose.
- It is now possible to use background ion dose computed on converted CBCT image sets in optimization.
- The sliding window VMAT sequencing algorithm has been modified to create control points with a gantry spacing of exactly 2 degrees, as opposed to a gantry spacing of maximum 2 degrees.

2.14 MULTI CRITERIA OPTIMIZATION (MCO)

- A *Copy* button has been added to the *Tradeoffs/constraints* tab.
- The sliding window VMAT sequencing, used for the segment-based Pareto plan mode, has been modified to create control points with a gantry spacing of exactly 2 degrees, as opposed to a gantry spacing of maximum 2 degrees.

2.15 GENERAL PHOTON PLANNING

- Support for High-Dose Technique Type.
  - In RayPhysics, it is possible to define thresholds for different treatment techniques.
  - During DICOM export, the tag (300A, 00C7) in RTPlan is set to *SRS* for beams where MU exceeds the threshold.

2.16 PROTON PENCIL BEAM SCANNING PLANNING

- It is now possible to optimize and compute dose using 0.5 mm dose grid resolution for proton PBS using the Monte Carlo and Pencil beam dose engines.
- Treat and protect settings are now scriptable.

2.17 PROTON BROAD BEAM PLANNING

- Treat and protect settings are now scriptable.

2.18 LIGHT ION PENCIL BEAM SCANNING PLANNING

- Trichrome approximation in the computation of RBE for light ions:
  - Trichrome approximation is replacing the previous monochrome approximation, where a lateral equilibrium in the particle fluence was assumed, regardless of the distance to the central axis of the beam.
  - Particles are now associated with the lateral fluence components of the beam, leading to primary ions and heavy fragments close to the central axis, and lighter fragments further away.

- Trichrome approximation will in general lead to higher RBE inside small fields and at lateral field edges, and lower RBE in the low dose region outside of the fields.

- Improved redistribution of particle constituents in the computation of dose-averaged LET (LETd) for lower energies (i.e. improved trichrome approximation).
  - LETd was overestimated in the low dose region lateral to the SOBP for short to mid ranges in RayStation 2023B. This has now been fixed.

2.19 ELECTRON PLANNING

- Treat and protect settings are now scriptable.
- It is now possible to compute dose for Varian TrueBeam with HDMLC for applicators larger in the y-direction than the extension of the MLC. (There was an issue stopping this in RayStation 2023B.)

2.20 PLAN EVALUATION

- The results of the clinical goals are now displayed in separate columns, one for each evaluated dose distribution. Previously, the clinical goals were duplicated on multiple rows.
  - The clinical goals are evaluated against the dose(s) displayed in the 2D patient views, but also against the plan and beam set doses they are associated with. (See *section 2.3 Clinical goals per beam set or plan on page 16* for details on clinical goal association.)
  - The evaluation of the comparison dose(s) is displayed in a separate section within the clinical goals list, named *Comparison*.

2.21 QA PREPARATION

- The EPID QA functionality has been validated for Varian Halcyon.[1]

2.22 ADAPTIVE REPLANNING

- It is now possible to use background ion dose computed on converted CBCT image sets in adapted plans.

1 The mark HALCYON is a trademark of Varian Medical Systems, Inc. Varian does not sponsor or endorse the use of RayStation with its HALCYON product.

2.23 DICOM

- The way RayStation handles DICOM data when a filter is applied has been updated. Previously, the datasets were passed on to the filter using the same Transfer Syntax as it was received with. This has now been updated so that the Transfer Syntax Implicit VR Little Endian will always be used.
- The population of the DICOM attributes Prescription Description (300A,000E) and Dose Reference Description (300A,0016) has been updated. Previously, default values were used to populate these attributes. For the Dose Reference Description, it is now possible to select between four different default modes for populating the values. This setting can be configured per machine.

  It is also possible to set user defined overrides for both attributes, either in the RayStation user interface or via scripting.

  This functionality will replace parts of the DICOM filter 'RSL-D-61-393 Modify RTPLAN for Mosaiq'.
- It is now possible to set a dose rate for RayStation setup beams when using a Linac treatment machine. A new setting for this is available in RayPhysics.
- An option has been added to Linac machines to export the Referenced Reference Image Sequence (300A,0016). This sequence contains references to RT Images (DRRs). This option is a temporary solution that will most likely be removed in future versions.
- An issue causing incorrectly exported nominal jaw positions for electron plans where all Applicator IDs are equal in the machine model has been fixed. Correct nominal jaw positions are now exported for this setup. It will also no longer be possible to commission machines with non-unique Applicator IDs. For use cases where this is desired, the setting Export applicator IDs as in the DICOM tab shall be used instead.

2.24 VISUALIZATION

- Relative dose value has been added to Dose cloud visualization.
  - The dose cloud setting (relative/absolute) is linked to the color table. If the color table is relative, '100% equals' text will correspond to 'primary prescription' and if the color table is absolute, it will correspond to 'max dose'.
- The *Show beam parts*, *Volume rendering settings* and *DRR settings* dialogs are now non-modal and no longer block interaction with other parts of RayStation.
- Performance improvements have been made for Bragg Peak rendering.
- Beam gantry angle is now displayed in BEV.

2.25 SCRIPTING

- *AddOarRangeMarginRoi* and *RemoveOarRangeMarginRoi* have been replaced with *SetOarRangeMarginRois* that sets the whole list at once. Call with empty list to clear ROIs.
- The list *Study.Registrations* has been renamed to *Study.FrameOfReferenceRegistrations*.
- New methods are now available for treat-and-protect functionality on beam level for all modalities supporting treat-or-protect: *SetTreatOrProtectRoi*, *ClearTreatOrProtectRoi*, *SetFluenceProtectRoi*, *SetCompensatorProtectRoi*, *SetCompensatorProtectMargin*, *GetCompensatorProtectMargin*, *SetTreatDistalMargin*, *GetDistalTreatMargin*, *SetTreatProximalMargin*, *GetProximalTreatMargin*
- *RemoveTreatOrProtectRoi* has been removed (use new *ClearTreatOrProtectRoi*).
- *SetTreatAndProtectMarginsForBeam* has been removed (use new *SetTreatOrProtectRoi* with margins in arguments).
- *GetSSD* has been removed, replaced by *GetSourceToSurfaceDistance* and *GetSourceToSkinDistance*.

2.26 RAYPHYSICS

2.26.1 Electron beam commissioning

- It is now possible to compute dose for Varian TrueBeam with HDMLC for applicators larger in the y-direction than the extension of the MLC. (There was an issue stopping this in RayStation 2023B.) The solution causes minor changes in dose for larger applicators, compared to previous version. Machine models for Varian TrueBeam with HDMLC should be reviewed.

2.26.2 Ion beam commissioning

- It is now possible to set different dose grid resolutions in the depth and lateral directions for computation of dose curves and absolute dosimetry.
- For the proton Pencil Beam and Monte Carlo dose engines, the smallest allowed dose grid resolution for computation of dose curves and absolute dosimetry have been decreased from 1.0 to 0.5 mm.
- The recommended values for resolution and number of histories have been updated to the following (for protons only – light ion recommendation are unchanged):
    - Spot profiles
        + Lateral resolution: 0.05 cm
        + Depth resolution: 0.3 cm
        + Number of histories: 100,000,000
    - Pristine Bragg peaks

    + Lateral resolution: 0.3 cm
    + Depth resolution: 0.05 cm
    + Number of histories: 10,000,000

- Absolute dosimetry (no changes to previous recommendations)
    + Lateral resolution: 0.2 cm
    + Depth resolution: 0.2 cm
    + Number of histories: 50,000

2.27 RAYSTATION 2024A DOSE ENGINE UPDATES

The changes to the dose engines for RayStation 2024A are listed below.

Dose engine	2023B	2024A	Requires recommissioning	Dose effect[i]	Comment
All	-	-	-	Negligible	New algorithm for converting ROI triangle meshes into voxel volumes which has negligible effect on computed 3D dose. ROI volumes might be slightly different when comparing with an identical ROI in previous versions of RayStation.
Photon Collapsed Cone	5.8	5.9	No	Negligible	No changes to the dose engine.
Photon Monte Carlo	3.0	3.1	No	Negligible	No changes to the dose engine.

Dose engine	2023B	2024A	Requires recommissioning	Dose effect[i]	Comment
Electron Monte Carlo	5.0	5.1	No	Negligible, except for Varian TrueBeam with HDMLC where minor changes can be seen, especially for larger applicators.	The platform used for GPU computations in RayStation (CUDA) has been upgraded to a new version. This has a minor effect on the computed Electron Monte Carlo dose, which due to the statistical nature can be very sensitive to even small disturbances. For dose calculation with low statistical uncertainty, the difference in dose compared to previous version is negligible. An issue has been resolved; it was not possible to compute dose in RayStation 2023B for Varian TrueBeam with HDMLC for applicators larger in the y-direction than the extension of the MLC. The changes made to fix this issue causes minor changes in dose for larger applicators, compared to previous version.
Proton PBS Monte Carlo	5.5	5.6	No	Reduced the number of large dose spikes in low density voxels.	Improved handling of heavier nuclear fragments in low density regions.
Proton PBS Pencil Beam	6.5	6.6	No	Negligible	No changes to the dose engine.
Proton US/DS/ Wobbling Pencil Beam	4.10	4.11	No	Negligible	No changes to the dose engine.

Dose engine	2023B	2024A	Requires recommissioning	Dose effect[i]	Comment
Carbon PBS Pencil Beam	6.0	7.0	Yes	Major differences expected to dose-averaged LET and RBE. Largest differences expected at the field lateral edges, outside of fields as well as inside small fields. Physical dose has negligible changes.	Improved handling of the lateral distribution of the particle constituents in the computation of RBE by the trichrome approximation. Improved redistribution of particle constituents in the computation of dose-averaged LET (LETd) for lower energies (i.e. improved trichrome approximation). LETd was overestimated in the low dose region lateral to the SOBP for short to mid ranges in 2023B. This has now been fixed.
Brachy TG43	1.4	1.5	No	Negligible	No changes to the dose engine.

i The dose effect (Negligible/Minor/Major) refers to the effect when recommissioning of the machine model is not performed. After successful recommissioning the dose changes should be minor.

2.28 CBCT CONVERSION ALGORITHM UPDATES

The changes to the CBCT conversion algorithms for RayStation 2024A are listed below.

Conversion algorithm	2023B	2024A	Dose effect	Comment
Corrected CBCT	1.2	1.3	Negligible	Minor changes in created image sets due to that voxel volumes of ROIs used in the algorithm might differ slightly compared to previous versions of RayStation.
Virtual CT	1.2	1.3	Negligible	Minor changes in created image sets due to that voxel volumes of ROIs used in the algorithm might differ slightly compared to previous versions of RayStation.

2.29 CHANGED BEHAVIOR OF PREVIOUSLY RELEASED FUNCTIONALITY

- Note that RayStation 11A introduced some changes regarding prescriptions. This information is important if upgrading from a RayStation version earlier than 11A:

  - Prescriptions will always prescribe dose for each beam set separately. Prescriptions defined in RayStation versions prior to 11A relating to beam set + background dose are obsolete. Beam sets with such prescriptions cannot be approved and the prescription will not be included when the beam set is DICOM exported.
  - Prescriptions that are set using a plan generation protocol will now always relate to the beam set dose only. Make sure to review existing plan generation protocols when upgrading.
  - Prescription percentage is no longer included in exported prescription dose levels. In RayStation versions prior to 11A, the Prescription percentage defined in RayStation was included in the exported Target Prescription Dose. This has been changed so that only the Prescribed dose defined in RayStation is exported as Target Prescription Dose. This change also affects exported nominal dose contributions.
  - In RayStation versions prior to 11A, the Dose Reference UID exported in RayStation plans was based on the SOP Instance UID of the RT Plan/RT Ion Plan. This has been changed so that different prescriptions can have the same Dose Reference UID. Because of this change, the Dose Reference UID of plans exported prior to 11A has been updated so that if the plan is re-exported a different value will be used.

- Note that RayStation 11A introduced some changes regarding Setup imaging systems. This information is important if upgrading from a RayStation version earlier than 11A:
  - A Setup imaging system (in earlier versions called Setup imaging device) can now have one or several Setup imagers. This enables multiple setup DRRs for treatment beams as well as a separate identifier name per setup imager.
    + Setup imagers can be gantry-mounted or fixed.
    + Each setup imager has a unique name which is shown in its corresponding DRR view and is exported as a DICOM-RT Image.
    + A beam using a setup imaging system with multiple imagers will get multiple DRRs, one for each imager. This is available for both setup beams and treatment beams.

- Note that RayStation 8B introduced handling of effective dose (RBE dose) for protons. This information is important for proton users if upgrading from a RayStation version earlier than 8B:
  - Existing proton machines in the system will be converted to RBE type, that is, it is assumed that a constant factor of 1.1 has been used. Contact RaySearch if this is not valid for any machine in the database.
  - Import of RayStation RT Ion Plan and RT Dose of modality proton and with dose type PHYSICAL that was exported from RayStation versions earlier than 8B will be treated as RBE level if the machine name in the RT Ion Plan refers to an existing RBE machine.

- RT Dose of dose type PHYSICAL from other systems or from RayStation versions earlier than 8B with a machine that does not have the RBE included in the beam model will be imported as in earlier versions and will not be displayed as RBE dose in RayStation. The same applies if the referenced machine does not exist in the database. It is the responsibility of the user to know if the dose should be treated as physical or as RBE/photon equivalent. However, if such a dose is used as background dose in subsequent planning, it will be treated as an effective dose.

For more details, refer to *Appendix A Effective dose for protons*.

- Note that RayStation 11B introduced changes in the dose statistics calculations. This means that small differences in evaluated dose statistics are expected when comparing to a prior version.

  This affects:

  - DVHs
  - Dose statistics
  - Clinical goals
  - Prescription evaluation
  - Optimization objective values
  - Fetching dose statistics measures via scripting

  This change also applies to approved beam sets and plans, meaning that, for example, prescription and clinical goals fulfillment may change when opening a previously approved beam set or plan from a RayStation version prior to 11B.

  The dose statistics accuracy improvement is more noticeable with increasing dose range (difference between minimum and maximum dose within an ROI), and only minor differences are expected for ROIs with dose ranges smaller than 100 Gy. The updated dose statistics no longer interpolates values for Dose at volume, $D(v)$, and Volume at dose, $V(d)$. For $D(v)$, the minimum dose received by the accumulated volume v is instead returned. For $V(d)$, the accumulated volume that receives at least the dose d is returned. When the number of voxels within an ROI is small, the discretization of the volume will become apparent in the resulting dose statistics. Multiple dose statistics measures (e.g., D5 and D2) may get the same value when there are steep dose gradients within the ROI, and similarly, the dose ranges lacking volume will appear as horizontal steps in the DVH.

- Note that RayStation 2024A introduces the possibility to associate a clinical goal to either the beam set dose or the plan dose. This information regarding existing plans and templates with clinical goals is important if upgrading from a RayStation version earlier than 2024A:

  - Physical clinical goals in single beam set plans will now be automatically associated with that beam set.

  - For plans with multiple beam sets, physical clinical goals will be duplicated to ensure all possible associations within the plan. For example, a plan with two beam sets will yield three corresponding copies of each clinical goal: one for the plan and one for each of the two beam sets.
  - Clinical goals defined in templates will be assigned to beam set with name 'BeamSet1'. Users who plan with multiple beam sets are advised to update their templates with the correct association and beam set name. Pay special attention to templates used in protocols. Beam set names stored in templates should match a beam set created in the protocol.

- It is now possible to exclude Fixation and Support ROIs from a beam set. If an ROI is excluded it will be disregarded when computing dose for the beam set.
- Boli that are not used in any beam will not be displayed in 3D/Room view/DRR/Setup DRR/BEV views.
- Protons: In RayStation 2024A, the smallest dose grid voxel size allowed in treatment planning and beam commissioning is decreased from 1 to 0.5 mm for the proton PBS Monte Carlo and Pencil Beam dose engines. When commissioning a proton treatment machine model, the user is recommended to use 0.5 mm resolution in the lateral directions for spot profiles and in the depth direction for pristine Bragg peaks. There are no additional restrictions on the resolution used in treatment planning. Hence, it is possible to compute dose with 0.5 mm resolution using machine models commissioned in previous versions of RayStation, where it was not possible to compute dose curves using such a fine resolution. It is the responsibility of the user to ensure that beam models intended for clinical use are validated for all relevant dose grid resolutions.
- The Material patient view which shows material values on the dose grid resolution is more limited in RayStation 2024A compared to previous versions. The material distribution can now only be seen for beam doses and beam set doses when there is computed dose.
- Between RayStation 2023B and RayStation 2024A, an error in the algorithm for centering of imported dose curves in RayPhysics has been corrected. In RayStation 2023B and previous versions, the calculated dose curve center point could sometimes be wrong for noisy profile curves. The measured curves visualized in RayStation 2024A will use the centering after correction of the error, even when the dose curves were imported in a previous RayStation version. This applies to both commissioned and uncommissioned machine models. When reviewing a machine model created in a previous version, there may be differences in alignment between measured and computed curves in RayStation 2024A compared to the alignment in previous RayStation versions. Only the measured curves might be changed, computed curves will not change. Gamma and dose difference curves will not change either and will show the difference between measured and computed curves as it was in the RayStation version where the curves were computed.
- Changes to handling of converted images

  - The imaging system assigned to converted images (generated via the Corrected CBCT or the Virtual CT methods) now corresponds to the imaging system of the reference image set (planning CT). All existing images have been patched. Consequently, the modality of such images is now CT instead of CBCT. Hence use-cases that require image modality to be CT are now open for converted images (except for ion planning).
  - The user can manually change the imaging system of a converted image (generated via the Corrected CBCT or the Virtual CT methods) after its creation. The user's choice persists upon re-computation of invalidated images.
  - Upon DICOM export of converted images created in 2024A (generated via the Corrected CBCT or the Virtual CT methods), the Station Name (0008,1010) and Protocol Name (0018,1030) are set to the be identical to that of the imported DICOM data of the reference image (planning CT). This ensures consistent behavior of DICOM export of regular and converted images. DICOM export of images created prior to 2024A is unchanged and still get the Station Name and Protocol Name from the imaging system of the original CBCT image (not from the imported DICOM data).

- The way UIDs are generated for RT Images (DRRs) has been updated. If the same DRR is exported from 2024A or any previous version, different DICOM instances will be created.
- The Dose Reference UID generation was updated in RayStation 2023B. If a beam set with a prescription is exported in a prior version and a second beam set with a prescription for the same treatment site and dose volume is exported in 2023B or later, the Dose Reference UIDs will not match. RayCare connected patients are not affected by this.
- A limitation on the MLC leaf motion during VMAT optimization has been removed for machines with discrete dose rates.

3 KNOWN ISSUES RELATED TO PATIENT SAFETY

Note: *Additional release notes may potentially be distributed shortly after installation.*

Inconsistency in the use of density uncertainty for protons and light ions when using HU-to-mass density CT calibration (FSN 148655)

There is an inconsistency in the use of *Density uncertainty* in the RayStation functions *Robust optimization*, *Robust evaluation* and *Compute perturbed dose* for proton and light ion treatment plans when a HU-to-mass density CT calibration curve is used.

In *Robust evaluation* and *Compute perturbed dose*, in cases when a HU-to-mass density CT calibration curve is used, the density uncertainty is added to the nominal mass densities of the patient *prior* to the elemental composition assignment of the voxels. This handling is in line with the description in the UI, which states that *"The density uncertainty is modelled by scaling the mass density of the patient"*. However, since the stopping power is not a linear function of the mass densities found in a patient, a scaling of the mass densities prior to the elemental composition assignment of the voxels will not lead to a corresponding scaling of stopping power and water equivalent (WE) range. The result is that the relative change in stopping power and WE range will be less than the given change in mass density. For example, for a prostate case with a distal depth of 240 mm, a density change of -3.5% will lead to an increased range of about 6 mm. However, an increase of 6 mm in range corresponds to only -2.5% change in stopping power, and +2.5% in range. If the change of -3.5% is applied to the stopping power instead of the mass density, the resulting change in range would be 8.4 mm, which is 2.4 mm more than the 6 mm resulting from the same change in mass density. While the handling of scaling the patient's mass densities is not incorrect, a user may assume that a change of the mass density in the RayStation UI would lead to a corresponding change in stopping power and WE range.

In *Robust optimization*, on the other hand, the stopping power and WE range of the scenario doses do scale according to the *Density uncertainty* given in the *Robustness settings* dialog. This is explained by the fact that the mass densities used in the dose calculation of the robust optimization are scaled after the elemental composition assignment of the voxels. This behavior is inconsistent with the behavior in *Robust evaluation* and *Compute perturbed dose* as described above, but may be more in line with what the user expects (i,e, that the given uncertainty is related to stopping power and WE range, rather than mass density).

For plans that are based on a HU-to-SPR CT-calibration curve, the density uncertainty given in *Robust evaluation*, *Compute perturbed dose* and *Robust optimization* is used directly to scale stopping

power and therefore WE range. This is in contrast to the description of the functions in the UI, which states that it is the mass density that is scaled (see above).

For patient volumes associated with a material override, only the mass density of those volumes is affected by the density uncertainty while the elemental composition remains unchanged. This means that the stopping power in volumes with a material override will scale according to the user-defined mass density uncertainty for all functions in RayStation and irrespective of type of CT calibration curve.

For users of HU-to-mass density CT calibration curves

If a user wants to evaluate a plan with respect to relative stopping power/WE range error rather than mass density errors, there are two options, with option 1 being the preferred option:

Option 1. Use a HU-to-SPR CT calibration curve instead of a HU-to-mass density curve.

- For evaluation of an existing case, the evaluation can be done on an anonymized and exported copy of the patient and plan.
- Contact RaySearch Service if you need help with the creation of a HU-to-SPR curve from an existing HU-to-mass density curve.

Option 2. Evaluate the plan using a higher (effective) mass density uncertainty that gives similar relative stopping power and WE range change as the nominal value.

- The following values of Effective mass density errors that give similar result as an intended Stopping power error have been deduced from a limited set of patients:

Stopping power error (%)	Effective mass density error (%)
-3.5	-4.7
3.5	4.2
-2.0	-3.0
2.0	2.2

- For other values of intended Stopping power error, interpolate the approximate Effective mass density value from the table above.
- The values are estimates based on a few patients and are expected to vary slightly depending on the mass densities along the beam path.
- Note that the values are not symmetrical around 0.

For users of HU-to-SPR CT calibration curves

Be aware that the density uncertainty given in *Robust evaluation*, *Compute perturbed dose* and *Robust optimization* is used directly to scale stopping power and therefore WE range.

(1151977)

4 OTHER KNOWN ISSUES

4.1 GENERAL

Material distribution can only be seen when dose is computed

When the 2D patient views are set to show mass density or SPR in dose grid resolution (material visualization view), the material information is only displayed after a dose has been computed. The user is advised to always examine the material visualization view after dose computation to understand which mass density or SPR values the dose has been computed on. This is especially important for Ocular Gaze proton planning where the user should avoid using the image set view since it does not correspond to the patient geometry used for dose computation, due to the mandatory material override on the External ROI and the presence of a skin-plane. It is also of special importance in MR-only planning for photons, where the dose computation relies on accurate material override assignment to the External ROI and other relevant structures.

(826963)

The auto recovery feature does not handle all types of crashes

The auto recovery feature does not handle all types of crashes and sometimes when trying to recover from a crash RayStation will show an error message with the text "Unfortunately auto recovery does not work for this case yet". If RayStation crashes during auto recovery, the auto recovery screen will pop up next time RayStation is started. If this is the case, discard the changes or try to apply a limited number of actions to prevent RayStation from crashing.

(144699)

Limitations when using RayStation with large image set

RayStation now supports import of large image sets (>2GB), but some functionality will be slow or cause crashes when using such large image sets:

- Smart brush/Smart contour/2D region growing are slow when a new slice is loaded
- Hybrid deformable registration might run out of memory for large image sets
- Biomechanical deformable registration might crash for large image sets
- Automated Breast Planning does not work with large image sets
- Creating large ROIs with gray-level thresholding might cause a crash

(144212)

Limitations when using multiple image sets in a treatment plan

Plan total dose is not available for plans with multiple beam sets that have different planning image sets. Without plan dose it is not possible to:

- Approve the plan
- Generate plan report
- Enable the plan for dose tracking
- Use the plan in adaptive replanning

(341059)

Slight inconsistency in dose display

The following applies to all patient views where dose can be viewed on a patient image slice. If a slice is positioned exactly on the border between two voxels, and dose interpolation is disabled, the dose value presented in the view by the "Dose: XX Gy" annotation can differ from the actual presented color, with regards to the dose color table.

This is caused by the text value and the rendered dose color being fetched from different voxels. Both values are essentially correct, but they are not consistent.

The same can occur in the dose difference view, where the difference might seem larger than it actually is, because of neighboring voxels being compared.

(284619)

Cut plane indicators are not displayed in 2D patient views

The cut planes, used to limit the CT data used for computing a DRR, are not visualized in regular 2D patient views. To be able to view and use cut planes, use the DRR settings window.

(146375)

No warning is given when deleting a case containing approved plans

When a patient containing an approved plan is selected for deletion, the user will be notified and given the opportunity to cancel the deletion. However, if a case containing an approved plan is selected for deletion for a patient with multiple cases, no warning will be given to the user that an approved plan is about to be deleted.

(??0318)

4.2 IMPORT, EXPORT AND PLAN REPORTS

Import of approved plan causes all existing ROIs to be approved

When importing an approved plan to a patient with existing unapproved ROIs, the existing ROIs can become automatically approved. If this occurs, a UI message is given at import stating that the plan approval status will be transferred to the RTStruct. If importing via scripting, this information is given in the import log.

336266

Laser export not possible for decubitus patients

Using the laser export functionality in the Virtual simulation module with a decubitus patient causes RayStation to crash.

(331880)

RayStation sometimes reports a successful TomoTherapy plan export as failed

When sending a RayStation TomoTherapy plan to iDMS via RayGateway, there is a timeout in the connection between RayStation and RayGateway after 10 minutes. If the transfer is still ongoing when the timeout starts, RayStation will report a failed plan export even though the transfer is still in progress.

If this happens, review the RayGateway log to determine if the transfer was successful or not.

338918

Report Templates must be upgraded after upgrade to RayStation 2024A

The upgrade to RayStation 2024A requires upgrade of all Report Templates. Also note that if a Report Template from an older version is added using Clinic Settings, this template must be upgraded to be used for report generation.

Report Templates are upgraded using the Report Designer. Export the Report Template from Clinic Settings and open it in the Report Designer. Save the upgraded Report Template and add it in Clinic Settings. Do not forget to delete the old version of the Report Template.

(138338)

4.3 PATIENT MODELING

Memory crashes can occur when running large hybrid deformable registration computations on GPU

GPU computation of deformable registration on large cases can result in memory related crashes when using the highest grid resolution. The occurrence depends on the GPU specification and the grid size.

(69150)

4.4 BRACHYTHERAPY PLANNING

Mismatch of planned number of fractions and prescription between RayStation and SagiNova

There is a mismatch in the interpretation of the DICOM RT Plan attributes *Planned number of fractions* (300A, 0078) and *Target prescription dose* (300A,0026) in RayStation compared to the brachytherapy afterloading system SagiNova. This applies specifically to SagiNova versions 2.1.4.0 or earlier. If the clinic is using a version later that 2.1.4.0, contact customer support to verify whether the issue persists.

When exporting plans from RayStation:

- The target prescription dose is exported as the prescription dose per fraction multiplied by the number of fractions of the beam set.
- The planned number of fractions is exported as the number of fractions for the beam set.

When importing plans into SagiNova for treatment delivery:

- The prescription is interpreted as the prescription dose per fraction.
- The number of fractions is interpreted as the total number of fractions, including fractions for any previously delivered plans.

Possible consequences are:

- At treatment delivery, what is displayed as prescription per fraction on the SagiNova console is actually the total prescription dose for all fractions.
- It might not be possible to deliver more than one plan for each patient.

Consult with SagiNova application specialists for appropriate solutions.

(285641)

4.5 PLAN DESIGN AND 3D-CRT BEAM DESIGN

Center beam in field and collimator rotation may not keep the desired beam openings for certain MLCs

Center beam in field and collimator rotation in combination with "Keep edited opening" might expand the opening. Review apertures after use and if possible use a collimator rotation state with "Auto conform".

(144701)

4.6 PLAN OPTIMIZATION

No feasibility check of max leaf speed performed for DMLC beams after dose scaling

DMLC plans that result from an optimization are feasible with respect to all machine constraints. However, manual rescaling of dose (MU) after optimization may result in violation of the maximum leaf speed depending on the dose rate used during treatment delivery.

(138830)

4.7 PROTON PLANNING

Incorrect statistical uncertainty for plan dose when using proton MC dose

The RayStation proton Monte Carlo dose engine does not compute the statistical uncertainty for the total plan dose, but only for the individual beam doses. The beam dose statistical uncertainty is displayed in the 2D patient views for each individual beam dose. In RayStation 2024A, a value for the statistical uncertainty is erroneously shown also for the plan dose. The displayed value corresponds to the statistical uncertainty of one of the beams in the beam list. This value will most

often be higher than the actual plan dose statistical uncertainty but could for some scenarios be lower than the true value if *Ions/spot* has been used in the final dose calculation settings. However, the clinical status of the plan dose is still correct since it only depends on the statistical uncertainty of the individual beam doses.

(826775)

4.8 CYBERKNIFE PLANNING

Verifying deliverability of CyberKnife plans

CyberKnife plans created in RayStation may, for about 1% of the cases, fail the deliverability validation. Such plans will not be deliverable. The affected beam angles will be identified by the deliverability checks that are run at plan approval and plan export.

To check if a plan is affected by this issue before approval, the script method `beam_set.CheckCyberKnifeDeliverability()` can be run. The affected segments can be manually removed before running a continued optimization for the last adjustments.

(344672)

4.9 TREATMENT DELIVERY

Mixed beam sets in plan fraction schedule

For plans with multiple beam sets where the plan fraction schedule has been manually edited for a subsequent beam set, a change to the number of fractions for a preceding beam set will result in a faulty fraction schedule where beam sets are no longer planned in sequence. This can lead to issues in dose tracking and adaptive replanning. To prevent this, always reset the plan fraction schedule to default before changing number of fractions for beam sets in a multi beam set plan after the fractionation pattern has been manually edited.

(331775)

4.10 AUTOMATED PLANNING

Incorrect Beam on interval might be set back without notification

In the Plan Explorer Edit Exploration Plan dialog, when editing the Beam on interval value in the Beam Optimization Settings tab, the value will change back to the previous value without notice if the entered value is out of range. This could easily be missed, for example if the dialog is closed directly after entering an incorrect value. The Beam on interval value is only applicable for VMAT treatment machines commissioned for burst mode (mArc).

(144086)

4.11 BIOLOGICAL EVALUATION AND OPTIMIZATION

Biological evaluation of fractionation schedule can lead to crash when creating new adapted plan

If the fractionation schedule is edited from the Biological Evaluation module, the system will crash when creating an adapted plan. To perform biological evaluation, copy the plan and do the fractionation schedule changes on the copy.

(138535)

Undo/redo invalidates response curves in the Biological Evaluation module

In the Biological Evaluation module, the response curves are removed on undo/redo. Recompute the function values to restore the response curves.

(138536)

Biological function values not invalidated when modifying the fractionation scheme for plans with more than one beam set

Modifying the fractionation schedule for a beam set other than the first one does not invalidate the *Biological Progress* graph or the evaluation function values in the Biological Evaluation module. Always recompute function values manually after moving fractions in plans with more than one beam set.

(48314)

Limitation when evaluating biological clinical goals with time dependent effects in the Dose tracking module

The Dose tracking module supports evaluation of biological clinical goals with time dependent effects (repair and repopulation). Input to this evaluation is the time of treatment of the fractions in the dose tracking treatment course. However, the time of treatment for the fractions is not displayed in the Dose tracking module which makes it difficult for the user to know exactly what the basis for the evaluation is. When initializing dose tracking from a treatment plan, the time of treatment is copied from the plan to the dose tracking treatment course. However, when manually adding or removing fractions the time of treatment might be different from the intended fractionation. Time of treatment for the dose tracking fraction is currently only accessible via scripting. The user must be aware of this limitation when evaluating biological clinical goals with time dependent effects in the Dose tracking module.

(722865)

4.12 RAYPHYSICS

Updated recommendations for detector height usage

Between RayStation 11A and RayStation 11B, recommendations on the usage of detector height and depth offset for depth dose curves have been updated. If the previous recommendations were followed, the modeling of the build-up region for photon beam models could lead to surface dose overestimation in computed 3D dose. When upgrading to a RayStation version newer than 11A, it is recommended to review and, if needed, update photon beam models with respect to the new

recommendations. Refer to section *Detector height and depth offset* in *RSL-D-RS-2024A-REF, RayStation 2024A Reference Manual*, section *Depth offset and detector height* in *RSL-D-RS-2024A-RPHY, RayStation 2024A RayPhysics Manual* and *RSL-D-RS-2024A-BCDS, RayStation 2024A Beam Commissioning Data Specification* for information about the new recommendations.

(410561)

4.13 SCRIPTING

Limitations regarding scripted reference functions

It is not possible to approve a beam set that includes a scripted reference dose function referencing an unlocked dose. This will lead to a crash. Also, approving a beam set that includes a scripted reference dose function referencing a locked dose, and consecutively unlocking the referenced dose will lead to a crash.

If a scripted reference dose function refers to an unlocked dose, there will be no notifications if the referenced dose is changed or removed. Finally, there is no guarantee when upgrading to new versions of RayStation that upgrades of optimization problems including scripted reference dose functions will retain the dose references.

(285544)

5 UPDATES IN RAYSTATION 2024A SP1

This chapter describes the updates in RayStation 2024A SP1 as compared to RayStation 2024A.

5.1 NEWS AND IMPROVEMENTS

5.1.1 Resolved safety notices (FSNs)

The issue described in Field Safety Notice (FSN) 130646 has been resolved.

5.1.2 New and significantly updated warnings

There are no new or significantly updated warnings in RayStation 2024A SP1.

5.2 RESOLVED ISSUES

Resolved: Possible to export Elekta Motorized wedge in/out fractions that do not correspond to the computed dose

There was an issue where a change of the dose algorithm updated the wedge in/out fractions for a beam with an Elekta Motorized wedge, without invalidating the dose. The plan could be exported containing other wedge in/out fractions than the ones used when computing the dose. This has now been resolved.

(931461)

Resolved: DVH occasionally not redrawn correctly

There was an issue with redrawing of the DVH view. Occasionally, the redrawing resulted in a view with no values displayed. This has now been resolved.

(931786)

Resolved: Decreased system performance after using deep-learning segmentation

There was an issue making the overall performance of RayStation decrease when working with patients delineated with deep-learning segmentation. This has now been resolved.

(936129)

Resolved: Not possible to use the same block or compensator for proton beams having different snout positions

Due to an issue related to validation of accessory codes for proton planning, it was not possible to use the same physical block or compensator for multiple beams having different snout positions. This has now been resolved.

(931326)

Resolved: Too high resource consumption during database upgrade

Due to an issue related to high usage of database connections, it was not possible to upgrade an older database to the latest version. This has now been resolved.

(928370)

Resolved: Performance problems in database upgrade

There were issues with slow data patches that made the database upgrade very slow. These patches are now optimized to speed up the database upgrade.

(928470)

Resolved: Typo in the included script update_library

There was an issue with a tool used for making scripts compatible with the new RayStation version. This has now been resolved.

(928078)

Resolved: Not possible to move a patient from older database using RayStorage

There was an issue making RayStorage copy a patient instead of moving it between databases, when the source database is of RayStation version 6 or 7. This has now been resolved.

(876757)

Resolved: Target database changes after transferring patients using RayStorage

RayStorage can be used for moving patient data between databases. There was an issue making another database selected as target database, after a data transfer was finished. This has now been resolved.

(876773)

5.3 UPDATED MANUALS

The following manuals have been updated in RayStation 2024A SP1:

- RSL-D-RS-2024A-IFU-2.0 RayStation 2024A SP1 Instructions for Use
- RSL-D-RS-2024A-RN-2.1 RayStation 2024A SP1 Release Notes
- RSL-D-RCMD-2024A-IFU-1.0 RayCommand 2024A SP1 Instructions for Use
- RSL-D-RCMD-2024ASP1-ATP MA-1.0 RayCommand 2024A SP1 Acceptance Test Protocol MedAustron

- RSL-D-RCMD-2024ASP1-ITS MA-1.0 RayCommand 2024A SP1 Installation Test Specification MedAustron
- RSL-D-RCMD-2024ASP1-MADID-1.0 RayCommand 2024A SP1 MedAustron Driver Interface Description
- RSL-D-RS-2024A-RTIFU-1.0 RayTreat 2024A SP1 Instructions for Use
- RSL-D-RS-2024ASP1-RTITS-1.0 RayTreat 2024A SP1 Installation Test Specification
- RSL-D-RS-2024ASP1-RTTDITS-1.0 RayTreat 2024A SP1 Treatment Device Integration Test Specification
- RSL-D-RS-2024ASP1-DCSAD-1.0 RayTreat 2024A SP1 DICOM Conformance Statement Accuray Driver
- RSL-D-RS-2024ASP1-DCSID-1.0 RayTreat 2024A SP1 DICOM Conformance Statement IBA Driver
- RSL-D-RS-2024ASP1-DCSPD-1.0 RayTreat 2024A SP1 DICOM Conformance Statement ProNova Driver

6 UPDATES IN RAYSTATION 2024A SP2

This chapter describes the updates in RayStation 2024A SP2 as compared to RayStation 2024A SP1.

6.1 NEWS AND IMPROVEMENTS

6.1.1 Resolved Field Safety Notices (FSNs)

The issue described in Field Safety Notice (FSN) 133261 has been resolved.

6.1.2 New and significantly updated warnings

There are no new or significantly updated warnings in RayStation 2024A SP2.

For new and significantly updated warnings in major release RayStation 2024A, see *section 2.2 New and significantly updated warnings on page 9*.

For the complete list of warnings, see *RSL-D-RS-2024A-IFU, RayStation 2024A SP2 Instructions for Use*.

6.1.3 New license for vessel segmentation

There is now a separate technical license for lung vessel segmentation.

6.1.4 Toshiba carbon ion machines: Spot weight limits automatically scaled by the number of repaintings

The minimum and maximum (if present) spot metersets that are used during optimization will be automatically scaled by the fixed number of repaintings per beam for a Toshiba carbon ion machine. During DICOM export, plan approval and report generation, a warning will be given if any spot weight is below the minimum spot meterset or above the maximum spot meterset, multiplied by the number of repaintings per energy layer.

6.1.5 Erratum: Equation 219 in the Reference Manual

The right-hand side of equation 219 (Eq. 219) in *RSL-D-RS-2024A-REF, RayStation 2024A Reference Manual* should be multiplied by a factor N_r, corresponding to the fixed number of repaintings for this energy layer. The corrected equation reads:

$$w(E)_i = I(E) \times N_r \times Max\left(Max(\tfrac{x_i}{v_{x(E)}}, \tfrac{y_i}{v_{y(E)}}) + t_c, t_r + t_c\right) / BeamMeterset \qquad \text{[Eq. 219]}$$

6.1.6 Machine learning models

No new machine learning models/ROIs are introduced.

6.2 FOUND ISSUES

One new safety related issue has been found, 1151977 (FSN 148655). It is described in detail in *Chapter 3 Known issues related to patient safety*.

6.3 RESOLVED ISSUES

Resolved: Intensity scaling for Toshiba carbon ion machines

The intensity scaling for plans created with Toshiba machines has been reverted to the behavior of versions before RayStation 12A (values changed by < 0.05%).

(1091188)

6.4 UPDATED MANUALS

The following manuals have been updated in RayStation 2024A SP2:

- RSL-D-RS-2024A-IFU-4.0 RayStation 2024A SP2 Instructions for Use
- RSL-D-RS-2024A-RN-3.0 RayStation 2024A SP2 Release Notes
- RSL-D-RS-2024A-RTIFU-2.0 RayTreat 2024A SP2 Instructions for Use
- RSL-D-RS-2024ASP2-RTITS-1.0 RayTreat 2024A SP2 Installation Test Specification
- RSL-D-RS-2024ASP2-RTTDITS-1.0 RayTreat 2024A SP2 Treatment Device Integration Test Specification
- RSL-D-RS-2024A SP2-DCSTD-1.0 RayTreat 2024A SP2 DICOM Conformance Statement for Toshiba Driver

A EFFECTIVE DOSE FOR PROTONS

A.1 BACKGROUND

Starting with RayStation 8B the effective dose of proton treatments is treated explicitly, either by including a constant factor in the absolute dosimetry in the machine model or by combining a machine model based on physical dose in the absolute dosimetry with a constant factor RBE model. When upgrading from a RayStation version prior to RayStation 8B to RayStation 8B or later, all existing machine models in the database will be assumed to have been modeled with a constant factor of 1.1 in the absolute dosimetry to take the relative biological effects of protons into account. Contact RaySearch support if this is not valid for any machine in the database.

A.2 DESCRIPTION

- The RBE factor can either be included in the machine model (as was the standard workflow in RayStation versions prior to 8B) or be set in an RBE model.
  - If the RBE factor is included in the machine model, it is assumed to be 1.1. These machines are referred to as 'RBE'.
  - A clinical RBE model with factor 1.1 is included in every proton RayStation package. This is to be combined with machine models based on physical dose. These machines are referred to as 'PHY'.
  - For other constant factors than 1.1, the user needs to specify and commission a new RBE model in RayBiology. This option can only be used for PHY machines.
- **All existing proton machines in the system will be converted to dose type RBE, where it is assumed that a constant factor of 1.1 has been used to scale absolute dosimetry measurements. Correspondingly, the dose in all existing plans will be converted to RBE dose.**
- Display of RBE/PHY for PHY machine in the RayStation modules Plan design, Plan optimization and Plan evaluation.
  - Possible to toggle between physical and RBE dose in these modules.
  - Possible to view the RBE factor in the Difference view in Plan evaluation.
- For RBE machines, the only existing dose object is RBE dose. For PHY machines, RBE dose is the primary dose in all modules with the following exceptions:

  - Display of Beam Dose Specification Points (BDSP) will be in physical dose.
  - All doses in the QA preparation module will be in physical dose.

- DICOM import:
  - Import of RayStation RtIonPlan and RtDose of modality proton and with dose type PHYSICAL from earlier versions of RayStation than RayStation 8B will be treated as RBE dose if the machine name in the RtIonPlan refers to an existing machine with RBE included in the model.
  - RtDose of dose type PHYSICAL from other systems or from RayStation versions prior to 8B with a machine that does not have the RBE included in the beam model will be imported as in earlier versions and will not be displayed as RBE dose in RayStation. The same applies if the referenced machine does not exist in the database. It is the responsibility of the user to know if the dose should be treated as physical or RBE/photon equivalent. However, if such a dose is used as background dose in subsequent planning, it will be treated as an effective dose.

  Note: *Plans for machines from Mitsubishi Electric Co follow different rules and the behavior has not been changed from versions prior to RayStation 8B.*

- DICOM export:
  - Treatment plans and QA plans for proton machines with dose type RBE (changed behavior compared to RayStation versions prior to 8B where all proton doses were exported as PHYSICAL):
    + Only EFFECTIVE RT Dose elements will be exported.
    + BDSP in RT Plan elements will be exported as EFFECTIVE.
  - Treatment plans for machines with dose type PHY:
    + Both EFFECTIVE and PHYSICAL RT Dose elements will be exported.
    + BDSP in RT Plan elements will be exported as PHYSICAL.
  - QA plans for machines with dose type PHY:
    + Only PHYSICAL RT Dose elements will be exported.
    + BDSP in RT Plan elements will be exported as PHYSICAL.

  Note: *Plans for machines from Mitsubishi Electric Co follow different rules and the behavior has not been changed from versions prior to RayStation 8B.*

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