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Eclipse Photon and Electron Instructions for Use

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Document Title	*Eclipse Photon and Electron Instructions for Use*
Abstract	This document provides basic information and procedures for using the Eclipse treatment planning application, version 13.6, in the daily workflow. This publication is the English-language original.
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Chapter 1 Getting Started

About this Guide

This guide contains instructions and supporting information for using the Eclipse treatment planning system in daily treatment planning tasks. The information covers the most common treatment planning workflows.

Reference information and instructions for tasks performed outside the daily workflow: Eclipse Photon and Electron Reference Guide,

Who Should Read This Guide

The Eclipse Treatment Planning System (Eclipse TPS) is used to plan radiotherapy treatments for patients with malignant or benign diseases. Eclipse TPS is used to plan external beam irradiation with photon, electron and proton beams, as well as for internal irradiation (brachytherapy) treatments. In addition, the Eclipse Proton Eye algorithm is specifically indicated for planning proton treatment of neoplasms of the eye.

Eclipse should only be used by qualified medical professionals.

This guide is written mainly for medical physicists, radiation oncologists, and radiation therapists, who perform daily treatment planning tasks. These tasks include, for example, working with patient images, creating treatment plans, calculating dose distribution, and evaluating treatment plans.

Related Publications

- *Eclipse Photon and Electron Reference Guide*: Provides reference information for using the Eclipse treatment planning system and instructions for tasks performed outside the daily treatment planning workflow.
- *Beam Configuration Reference Guide*: Provides reference information and instructions for beam data configuration required for performing dose calculation for external treatment plans in the Eclipse treatment planning system.
- *Eclipse Photon and Electron Algorithms Reference Guide*: Describes algorithms supported in the Eclipse treatment planning system.
- *RT and Imaging Online Help*: Describes the functions available in Radiation Oncology applications and provides instructions for using them.

Visual Cues

This publication uses the following visual cues to help you find information:

WARNING: A warning describes actions or conditions that can result in serious injury or death.

CAUTION: A caution describes hazardous actions or conditions that can result in minor or moderate injury.

NOTICE: A notice describes actions or conditions that can result in damage to equipment or loss of data.

Note: *A note describes information that may pertain to only some conditions, readers, or sites.*

Tip: *A tip describes useful but optional information such as a shortcut, reminder, or suggestion, to help get optimal performance from the equipment or software.*

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4. Enter your user name and password.
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Getting Familiar with Eclipse

Eclipse is designed for 3D image viewing, definition of the tumor and other anatomical structures, field setup, virtual simulation, dose calculation and plan evaluation.

Eclipse is divided into different applications, each used for specific purposes at different phases of treatment planning: the Selection application is meant for importing and creating patient images, whereas External Beam Planning and Plan Evaluation applications provide tools for treatment planning and evaluation of the completed treatment plans.

Note: *Ensure that individuals authorized to perform treatment planning functions are appropriately trained for the functions they perform.*

Note: *All treatment plan reports shall be approved by a qualified person before the information in them is used for radiotherapy treatment purposes.*

NOTICE: Do not install any third party software, or updates to the operating system without instructions from Varian Medical Systems.

WARNING: It is the responsibility of the user to ensure the validity and integrity of the input data, and to understand that the quality of the output depends critically on the quality of the input. Any irregularities or uncertainties about input data, units, identification, or quality of any other nature shall be thoroughly investigated before the data are used.

WARNING: Always check the patient information displayed on screen, especially if multiple instances of the application are open, to make sure that you are working on the correct patient. The patient information is displayed in the title bar of the application main window, and in the Assistant menu bar.

NOTICE: Regional Settings in the Windows operating system using commas as the decimal separator are not recognized by Eclipse. For example, the entry “1,23” will not be recognized as “1.23”. The decimal point “.” should always be used regardless of the Regional Settings.

What is New in Eclipse

Eclipse contains the following new and enhanced features:

- IMRT, VMAT and Siemens mARC plans can be optimized in the new Optimization dialog box. To use the new Optimization dialog box you need to select the new Photon Optimization (PO) algorithm to optimize the plans. If you use the PRO algorithm to optimize a VMAT plan, or the DVO algorithm to optimize an IMRT plan, plans are optimized in the IMRT and VMAT Optimization dialog boxes as in previous versions of Eclipse.
- RapidPlan: DVH estimates and optimization objectives can be generated from DVH estimation models. A DVH estimation model uses knowledge from existing treatment plans to generate DVH estimates and estimate-based optimization objectives in optimization. The data from the existing treatment plans is extracted and then used to train the DVH estimation models. DVH estimation models are configured, trained and managed in the DVH Estimation Model Configuration workspace. When you use a DVH estimation model to generate DVH estimates and objectives in a plan, you can use all the features in the Optimization dialog box in the same way as in optimization without a DVH estimation model.
- Changes and enhancements in optimization objectives that can be used with the PO algorithm include, for example, the following:
  - Generalized Equivalent Uniform Dose (gEUD) optimization objectives can be used in IMRT and VMAT plans
  - Mean dose objective can be used in IMRT plans.
  - The priority of new objectives is 0, and it must be modified for the objectives to have the intended effect on the optimization.
- Siemens mARC plans can now be optimized in Eclipse. Also conformal arc planning with Siemens MLC 160 is now possible in Eclipse.
- Structure codes have been added to identify the anatomical role of a structure, the treatment role of a structure (such as PTV or organ at risk), or both, with a single code. Structure codes are easier to use for reliably identifying structures than freely modifiable codes. Structure codes are used for automatic structure matching in DVH estimation models. The set of structure codes available in treatment planning is defined in RT Administration.
- It is now possible to save default CT values for different couch types. Saving CT values as defaults is a clinic-wide setting; it affects all workstations that are connected to the same database.
- The AAA dose calculation algorithm can now be used to calculate the dose distribution for Cobalt plans.
- Optimal fluences can now be converted into compensators in photon fields.
- Elekta MLC 160 is now supported in Eclipse.

- The Plan Conversion feature can be used to make changes in a photon source plan to best replicate the dose-volume histograms of the original plan when using another treatment unit. The changes are applied based on correspondence criteria for the new treatment unit by finding the best matches. After the plan conversion, you need to assign the intended new fraction number, and evaluate and approve the converted plan normally.
- Eclipse now uses the same user-defined Window/level presets as the SmartAdapt application.
- When using the multiple plane views in Plan Evaluation Application, you can now select between transversal, frontal and sagittal views.
- You can now create the DRR images for all fields simultaneously in a multi-field plan.
- When using the cross-hair tool to inspect the DVH, you can use the left and right arrow keys to move the cross-hair along the selected DVH curve.
- When exporting plans or dose planes, you can now set the selected export parameters as default for the export operations.

Chapter 2 Photon Planning Workflows for External Beam

Contouring with 3D Images Workflow

Step	See
Create the patient. ■ You can also create the patient while importing the images. Application: All	Importing Images on page 34
Import the 2D images. ■ Select the import filter and the images to import. ■ Connect the images to the created patient, or create a new patient and connect the images to the new patient. Application: All	Importing Images on page 34
Create the 3D image. ■ If not done automatically, select the 2D images to use and create a 3D image. ■ Check the image orientation. Application: Selection/Contouring	Creating 3D Images on page 39 More information about changing the image orientation: *Eclipse Photon and Electron Reference Guide* More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*
(Optional) Import the second image set. ■ Import, for example, an MR image set. ■ Register the CT and MR image sets. ■ Verify and approve the registration. Application: Registration and SmartAdapt	

Step	See
Create a structure set for the patient, and add the required structures. ■ Add structures from a structure template. ■ Add structures from a clinical protocol. ■ Add each structure one by one. ■ Create couch structures, if appropriate. Application: Contouring	Adding Structures on page 58 Add New Structures from a Structure Template on page 79 Using Clinical Protocols to Create New Structures, Objectives and Plans on page 82
Segment the structures. ■ Use automated segmentation tools: Verify visually each slice, use post-processing tools, and if necessary, correct manually. ■ Use manual segmentation tools: Draw a contour for each structure on each image slice, or paint the structure segment on each image slice. Application: Contouring	

Forward Planning Workflow in External Beam Planning

Step	See
Open the patient and check that the patient and possible couch structures are correctly contoured.	
Create a plan for the patient. ■ If necessary, create a course for the plan. ■ Create a plan for the patient. ■ Prescribe the dose for the plan. ■ If desired, define the fractionations for the plan. Application: External Beam Planning	Creating New Plans on page 73 Prescribe the Dose for a Plan on page 75 More information about creating courses and fractionations: *Eclipse Photon and Electron Reference Guide*
Insert fields into the plan. ■ Insert static fields or arc fields to the plan. ■ Move the fields as necessary. ■ Rotate the fields as necessary. ■ Resize the fields to conform to the target volume. Application: External Beam Planning	Adding Static Fields to Plans on page 87 Adding Arc Fields to Plans on page 95 Moving Fields on page 105 Rotate Fields Graphically on page 108 Resizing Fields on page 111

Step	See
Insert field accessories into the plan. ■ MLC: Insert an MLC object, adjust the leaves to the target volume. ■ Blocks: Insert a block object, delineate the block. ■ Wedges: Define the wedge type, direction and width. ■ Compensator: Insert a compensator object, verify the compensator matrix and edit if necessary. ■ Bolus: Insert the bolus structure, link the structure to the field(s).	Add an MLC to a Static Field on page 119 Add the Block Object on page 125 Add a Wedge on page 131 Add a Plane Compensator to a Photon Field on page 133 Create the Bolus Structure on page 141
Create reference points to the plan. ■ Create the necessary reference points and define the reference point locations. ■ Link the points to plan and define one of them as primary reference point. Application: External Beam Planning	About Reference Points and Reference Lines on page 221 Defining the Use of Reference Points on page 225
Calculate the dose distribution. ■ Set the calculation options. ■ Define the calculation volume. ■ Calculate the dose distribution. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216 More information about calculation options: *Eclipse Photon and Electron Reference Guide*
Evaluate the plan. ■ Calculate and evaluate the DVH for the PTV and each critical organ. ■ Evaluate the dose distribution with the evaluation tools. Application: External Beam Planning, Plan Evaluation	Dose-Volume Histogram on page 242 Display the Dose at the Selected Point for an External Beam Plan on page 241
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. If there are multiple plans: ■ Compare the plans visually. ■ Compare by summing up the plans. ■ Compare by subtracting the plans. Application: External Beam Planning, Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256 Sum or Subtract Plans on page 260

Step	See
Send the plan to virtual simulation. Application: External Beam Planning	Exporting Plans to Virtual Simulation on page 263
Approve the plan for treatment. Application: External Beam Planning, Plan Evaluation	Approving Plans for Treatment on page 275

IMRT Planning Workflow with Fluence Optimization (PO Algorithm)

Step	See
Open the patient. Import the patient's images, create a 3D image, patient structures and possible couch structures. Contour the structures. Pay particular attention to accurate contouring. Application: Selection/Contouring	Importing Images on page 34 Creating 3D Images on page 39 Adding Structures on page 58 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*
Create a plan for the patient. ■ Prescribe the dose for the plan. ■ Insert fields into the plan. ■ Rotate the fields to the desired angle manually. ■ Select the PO algorithm as IMRT Optimization algorithm. Application: External Beam Planning	Creating New Plans on page 73 Prescribe the Dose for a Plan on page 75 Adding Static Fields to Plans on page 87 Rotate Fields Graphically on page 108 Select Default Calculation Models for an External Beam Plan on page 218
Optimize the fluences. ■ Define the dose objectives for the target and all critical organs. ■ Use a base dose plan, if appropriate. ■ Adjust the dose priorities and fluence smoothing objectives interactively during the optimization to attain the desired dose distribution. Application: External Beam Planning	Create an IMRT Plan on page 164 More information about using the base dose: *Eclipse Photon and Electron Reference Guide*.
Create reference points to the plan. Application: External Beam Planning	About Reference Points and Reference Lines on page 221

Step	See
Calculate the dose distribution. ■ This can also be automated. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. Application: Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256
Verify the plan. ■ Use an appropriate phantom or portal dose verification. Application: External Beam Planning	Verification of Treatment Planning on page 272
Approve the plan for treatment. Application: External Beam Planning	Approving Plans for Treatment on page 275

IMRT Planning Workflow with Fluence Optimization (DVO Algorithm)

Step	See
Open the patient. Import the patient's images, create a 3D image, patient structures and possible couch structures. Contour the structures. Pay particular attention to accurate contouring. Application: Selection/Contouring	Importing Images on page 34 Creating 3D Images on page 39 Adding Structures on page 58 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*

Step	See
Create a plan for the patient. ■ Prescribe the dose for the plan. ■ Insert fields into the plan. ■ Rotate the fields to the desired angle manually. ■ Select the DVO algorithm as IMRT Optimization algorithm. Application: External Beam Planning	Creating New Plans on page 73 Prescribe the Dose for a Plan on page 75 Adding Static Fields to Plans on page 87 Rotate Fields Graphically on page 108 Select Default Calculation Models for an External Beam Plan on page 218
Optimize the fluences. ■ Define the dose objectives for the target and all critical organs. ■ Adjust the dose priorities and fluence smoothing objectives interactively during the optimization to attain the desired dose distribution. Application: External Beam Planning	More information about optimizing IMRT plans with the DVO algorithm: *Eclipse Photon and Electron Reference Guide*.
Create reference points to the plan. Application: External Beam Planning	About Reference Points and Reference Lines on page 221
Calculate the dose distribution. ■ This can also be automated. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. Application: Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256
Verify the plan. ■ Use an appropriate phantom or portal dose verification. Application: External Beam Planning	Verification of Treatment Planning on page 272
Approve the plan for treatment. Application: External Beam Planning	Approving Plans for Treatment on page 275

IMRT Planning Workflow with Beam Angle Optimization and Fluence Optimization

Step	See
Open the patient. Import the patient's images, create a 3D image, patient structures and possible couch structures. Contour the structures. Pay particular attention to accurate contouring. Application: Selection/Contouring	Importing Images on page 34 Creating 3D Images on page 39 Adding Structures on page 58 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*
Create a plan for the patient. ■ Prescribe the dose for the plan. Application: External Beam Planning	Creating New Plans on page 73 Prescribe the Dose for a Plan on page 75
Insert one initial field for the Beam Angle Optimization. Application: External Beam Planning	Adding Static Fields to Plans on page 87
Optimize the field geometry with Beam Angle Optimization. ■ Define the dose objectives for the target and all critical organs. Application: External Beam Planning	More information about Beam Angle Optimization: *Eclipse Photon and Electron Reference Guide*
Optimize the fluences. ■ You can modify the DVH optimization objectives, but bear in mind that the best results are achieved by using the same objectives for beam angle optimization and fluence optimization. ■ You can use either the PO or the DVO algorithm for fluence optimization. Application: External Beam Planning	Create an IMRT Plan on page 164 More information about optimizing IMRT plans with the DVO algorithm: *Eclipse Photon and Electron Reference Guide*.
Create reference points in the plan. Application: External Beam Planning	About Reference Points and Reference Lines on page 221
Calculate the dose distribution. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216

Step	See
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. Application: Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256
Verify the plan. ■ Use an appropriate phantom or portal dose verification. Application: External Beam Planning	Verification of Treatment Planning on page 272
Approve the plan for treatment. Application: External Beam Planning	Approving Plans for Treatment on page 275

VMAT and Siemens mARC Planning Workflow in External Beam Planning (PO Algorithm)

Step	See
Open the patient. Import the patient's images, create a 3D image, patient structures and possible couch structures. Contour the structures. Pay particular attention to accurate contouring. Application: External Beam Planning, Contouring	Importing Images on page 34 Creating 3D Images on page 39 Adding Structures on page 58 Inserting Couch Structures in an Image on page 70 More information about Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*.
Create a plan for the patient. ■ Insert one static field, one arc field, or multiple arc fields for the arc optimization. ■ Define the dose prescription for the plan. ■ Select the PO algorithm as VMAT Optimization algorithm. Application: External Beam Planning	Creating New Plans on page 73 Adding Static Fields to Plans on page 87 Adding Arc Fields to Plans on page 95 Prescribe the Dose for a Plan on page 75 Select Default Calculation Models for an External Beam Plan on page 218

Step	See
Select the initial arc field geometry in the Arc Geometry Tool Application: External Beam Planning	Select the Initial Arc Field Geometry Using the Arc Geometry Tool on page 169
Optimize the plan. ■ Define the dose objectives for the target and all critical organs. ■ Adjust the field geometry and use a base dose plan, if appropriate. Application: External Beam Planning	Create a VMAT or a Siemens mARC Plan on page 173 More information about using the base dose: *Eclipse Photon and Electron Reference Guide*.
Create reference points in the plan. Application: External Beam Planning	About Reference Points and Reference Lines on page 221
Calculate the dose distribution. ■ This can also be automated. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. Application: Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256
Verify the plan. ■ Use an appropriate phantom or portal dose verification. Application: External Beam Planning	Verification of Treatment Planning on page 272
Approve the plan for treatment. Application: External Beam Planning	Approving Plans for Treatment on page 275

VMAT Planning Workflow in External Beam Planning (PRO Algorithm)

Step	See
Open the patient. Import the patient's images, create a 3D image, patient structures and possible couch structures. Contour the structures. Pay particular attention to accurate contouring. Application: External Beam Planning, Contouring	Importing Images on page 34 Creating 3D Images on page 39 Adding Structures on page 58 Inserting Couch Structures in an Image on page 70 More information about Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*.
Create a plan for the patient. ■ Insert one static field, one arc field, or multiple arc fields for the arc optimization. ■ Define the dose prescription for the plan. ■ Select the PRO algorithm as VMAT Optimization algorithm. Application: External Beam Planning	Creating New Plans on page 73 Adding Static Fields to Plans on page 87 Adding Arc Fields to Plans on page 95 Prescribe the Dose for a Plan on page 75 Select Default Calculation Models for an External Beam Plan on page 218
Select the initial arc field geometry in the Arc Geometry Tool Application: External Beam Planning	Select the Initial Arc Field Geometry Using the Arc Geometry Tool on page 169
Optimize the plan with VMAT optimization. ■ Define the dose objectives for the target and all critical organs. ■ Adjust the field geometry and use a base dose plan, if appropriate. Application: External Beam Planning	More information about optimizing VMAT plans with the PRO algorithm and using the base dose: *Eclipse Photon and Electron Reference Guide*.
Create reference points in the plan. Application: External Beam Planning	About Reference Points and Reference Lines on page 221
Calculate the dose distribution. ■ This can also be automated. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216

Step	See
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. Application: Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256
Verify the plan. ■ Use an appropriate phantom or portal dose verification. Application: External Beam Planning	Verification of Treatment Planning on page 272
Approve the plan for treatment. Application: External Beam Planning	Approving Plans for Treatment on page 275

RapidPlan: Optimization Workflow Using DVH Estimates and Objectives from a Model

Step	See
Open the patient. Import the patient's images, create a 3D image, patient structures and possible couch structures. Contour the structures. Pay particular attention to accurate contouring. Application: Selection/Contouring	Importing Images on page 34 Creating 3D Images on page 39 Adding Structures on page 58 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*

Step	See
Create a plan for the patient. ■ Prescribe the dose for the plan. ■ Insert fields into the plan. ■ Select the PO algorithm as the VMAT and IMRT Optimization algorithm, and the DVH Estimation Algorithm for the DVH Estimation calculation. ■ IMRT plans: rotate the fields to the desired angle manually. ■ VMAT plans: Select the initial arc field geometry in the Arc Geometry Tool Application: External Beam Planning	Creating New Plans on page 73 Prescribe the Dose for a Plan on page 75 Adding Static Fields to Plans on page 87 Adding Arc Fields to Plans on page 95 Select Default Calculation Models for an External Beam Plan on page 218 Rotate Fields Graphically on page 108 Select the Initial Arc Field Geometry Using the Arc Geometry Tool on page 169
Create DVH estimates. ■ Select an appropriate DVH estimation model for the plan. ■ Match the structures in your plan to the structures in the DVH estimation model. ■ Generate DVH estimates and objectives by using a DVH estimation model. ■ If desired, modify the objectives or add more objectives in the Optimization dialog. Application: External Beam Planning	Optimize a Plan by Using DVH Estimates and Objectives from a Model on page 206
Create reference points to the plan. Application: External Beam Planning	About Reference Points and Reference Lines on page 221
Calculate the dose distribution. ■ This can also be automated. Application: External Beam Planning	Calculate the Dose Distribution for an External Beam Plan on page 216
Evaluate the plan. ■ You can view the DVH Estimates also in External Beam Planning. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231 Display a DVH for One Plan on page 243
Create setup fields to the plan. Application: External Beam Planning	Generate a Setup Field from a Photon Field on page 116
Compare the plan with alternative plans. Application: Plan Evaluation	Compare Plans Visually on page 256 Creating Plan Sums in External Beam Planning on page 256

Step	See
Verify the plan. ■ Use an appropriate phantom or portal dose verification. Application: External Beam Planning	Verification of Treatment Planning on page 272
Approve the plan for treatment. Application: External Beam Planning	Approving Plans for Treatment on page 275

Clinical Protocol Workflow in External Beam Planning

Step	See
Open the patient, and insert a clinical protocol reference to the patient. Application: External Beam Planning	Inserting a Clinical Protocol Reference to a Patient on page 82
Create structures according to a clinical protocol. ■ Select the reference point locations that need to be created. ■ Segment the structures. Application: Contouring	Creating Structures According to a Clinical Protocol on page 82 About Reference Points and Reference Lines on page 221 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*.
Create plans according to a clinical protocol. ■ Create a single clinical protocol plan, or create all clinical protocol plans. ■ Modify the plan as necessary. ■ Set the calculation options. ■ Define the calculation volume. ■ Calculate the dose distribution. Application: External Beam Planning	Creating Plans According to a Clinical Protocol in External Beam Planning on page 83 Forward Planning Workflow in External Beam Planning on page 20 Calculate the Dose Distribution for an External Beam Plan on page 216
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Send the plan to virtual simulation. Application: External Beam Planning	Exporting Plans to Virtual Simulation on page 263

Step	See
Approve the plan. Application: External Beam Planning, Plan Evaluation	Approving Plans for Treatment on page 275

4D Planning Workflow in External Beam Planning

Step	See
Open the patient and import 4D image data. ■ Import a 4D imaging study into Eclipse from a 4D imaging device. ■ (Optional) Create a 3D image for each respiratory phase (in automatic import, 3D images are created automatically from all binned images). Application: Selection/Contouring	Importing 4D Image Data on page 35 Creating 3D Images on page 39 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*
Create structures. ■ Define structures to one of the 3D images. ■ Copy structure sets or individual structures from the primary 3D image to one registered 3D image, or to all of them. ■ Visually verify the structures and select one 3D image for creating a treatment plan. Application: Contouring	Adding Structures on page 58 Copying Structures to Registered Images on page 68 Selecting the Viewing Plane Displayed in the 2D Views on page 47 More information about copying structure sets: *Eclipse Photon and Electron Reference Guide*
Create a plan. ■ Create a treatment plan using the selected 3D image. ■ Copy and paste the plan to another 3D image or all other 3D images representing the patient's respiratory cycle. The isocenter position and reference points are also copied. ■ Calculate the dose distribution. Application: External Beam Planning	Creating New Plans on page 73 Copying and Pasting Plans on page 76 Calculate the Dose Distribution for an External Beam Plan on page 216
Evaluate the plan. Application: External Beam Planning, Plan Evaluation	Evaluating Plans on page 231
Send the plan to virtual simulation. Application: External Beam Planning	Exporting Plans to Virtual Simulation on page 263

Step	See
Approve the plan for treatment. Application: External Beam Planning, Plan Evaluation	Approving Plans for Treatment on page 275

Chapter 3 Working with Images

Importing Images

One of the main purposes of the Selection application is importing images. The Import wizard is used for transferring image data from various imaging devices, using different image formats and media.

CAUTION: Always verify the imaging interface (CT, MR, etc.) for each imaging device for correctness. Check the images for correct image pixel size scaling, mirroring, and image rotation. Check and calibrate the imaging devices before using them. Periodically check the calibration by imaging and plotting test phantoms. Use correct scaling for the secondary imaging devices (Vidar scanner and Film digitizer).

Import filters must be configured for importing images.

To import images using the Vidar or Matrox filters, choose **Quicklinks** > **DICOM** > **Import Export**.

More information about configuring these filters and about DICOM Import Export: *DICOM Import and Export Reference Guide*.

To import images using DICOM import filters, start the Import/export wizard, then select the import filter, the data to be imported and the target of the import. The Import/Export wizard guides you through the image import process.

In the dialog boxes of the Import wizard, use the following buttons:

- Click **Next** to continue to the following step
- Click **Back** to return to the previous step
- Click **Cancel** to close the wizard discarding the changes
- Click **Finish** to accept the changes and close the wizard

Related Topics

Approving Images on page 46

Requirements for Image Import

Before starting the image import, make sure that the imaging devices are properly configured and calibrated, and that the CT calibration curve has been approved for the CT scanner in Beam Configuration. Check the calibration by imaging and plotting test phantoms regularly.

Verify the image aspect ratio, especially if you are using a camera-based imaging system.

Be careful to manually select the correct patient when importing images that do not include patient demographic information.

NOTICE: Always make sure that the correct images are used for treatment planning. When using scanned images with a radiograph, make sure that each scanned image contains information that identifies the patient unambiguously as a means to avoid associating the scanned images with the wrong patient.

NOTICE: Prior to digitizing radiographs, place reference marks on them as a means to verify the correct image orientation in the system.

When importing images from scanned films that consist of multiple images, you need to extract the images from the films to be able to create 3D images of these scanned images. The X and Y coordinates needed for the 3D image are defined as extraction parameters.

Save the imported images before using them, for instance, to create a 3D image.

Use image approval to prevent accidental changes.

Importing 4D Image Data

NOTICE: Visually verify the display of 4D images in the application to confirm proper organization of the 3D images into a series of images that represent the breathing cycle.

Note: *The 4D data to be imported must contain image series comments from an external binning software. If the comments are missing, the application is unable to automatically create 4D images.*

Note: *Importing large amounts of 4D image data at once can fail if the memory resources of the computer and its operating system are insufficient. If this occurs, import the 4D image study in two or more smaller parts.*

When importing a 4D imaging study (a set of binned 3D images that have the same coordinate system and modality), the application recognizes the images as being registered with each other and creates a 4D image object. The system also automatically creates the 3D images for each phase and the Body structure, if so defined in import. If the imported 4D imaging study is already organized into separate but related image series (for example, phase-binned, MIP or Ave), the system creates 3D images for each of the separate series. By default, a 4D image object contains all the 3D images that have the same coordinate system (DICOM Frame of Reference) and modality. These images cannot be unregistered.

Patient images acquired during one session share the same coordinate system. When the patient has been scanned during the same session for two different image modalities (for example, CT and PET), the application considers the 3D images in the two 4D imaging studies as being registered with each other in the import. These images cannot be unregistered.

If the patient images of different modalities have been acquired during different imaging sessions, you need to manually register the 3D images.

After the import is complete, a 4D image object containing the information of a 4D imaging study appears in the Scope window. The 3D images automatically created in the study are grouped together and sorted to form a 4D image set. Each imported image contains an image series comment containing information on the phases of the respiratory cycle.

Import Images with the Wizard

This information does not apply to Vidar and Matrox filters or Pixel Image filter. To transfer data using these filters, choose **Quicklinks** > **DICOM** > **Import Export**.

More information about DICOM Import Export: *DICOM Import and Export Reference Guide*.

1. If you are importing 4D image data, make sure that you have selected the Study View option in the import filter settings.
2. Choose **File** > **Import** > **Wizard**.
3. Select the appropriate import filter and click **Next**.

Action	Selected option
View the 4D data series information, including respiratory phase information.	Select the **Series** option from the view options.
View image series located in separate subdirectories.	Select **Scan Subdirectories**.

Action	Selected option
Navigate to another directory.	Click **Change Directory**.
Import more data.	Click **Add**.
Remove data from the list.	Select the data and click **Remove Selected**.

4. To import a patient's predefined structure set, make sure that the RT Structure Set is selected among the image data you are going to import.
5. Click **Next**.
6. Select the target patient. The detailed information about the selected patient will be displayed in the **Selected Target Patient** group box.

Action	Selected option
Select a patient suggested by the wizard.	Select the patient in the **Closest Matches in Database** box.
Import the data to the patient currently open.	Click **Current Patient**.
Open the Patient Explorer and import the data to another patient in the database.	Click **Open**.
Create a new patient and import the data to the new patient.	Click **New**.
Let the wizard automatically import the data to the selected patient.	Select **Try automatic import**. This will create the 3D image(s), the structure set, Body structure and the possible 4D image object automatically. The Body structure will be automatically assigned a default structure code.

7. Click **Next**.

   Automatic import: The wizard closes after the automatic import is completed.

   Manual import: The wizard proceeds to the next step.
8. Do one of the following:

Action	Selected option
Allow the system to create the 3D images and define the Body structure automatically.	Select the **Create Volume Image Automatically** check box.
If the data has gray indicators in the tree structures in the Import Data and ARIA Data panes, connect the data to the object hierarchy under the selected patient.	Drag the data from the Import Data pane to an appropriate place under the patient in the ARIA Data pane. Click **Finish** to close the wizard.
Data has green indicators in the tree structure.	Click **Finish**. When importing images without calibration data or with inadequate calibration data, the application prompts you to scale the images.

9. Save the imported images.

View 2D or 3D Images

Tip: *To remove images from the Image Gallery, select the image and choose **File** > **Close**.*

1. Click and drag an image from the Scope window or the Image Gallery to an image view.
2. To view another image, drag it to an image view.

View a 4D Image

1. Drag a 4D image object from the Scope window to an image view.

   The first 3D image in the selected 4D imaging study opens in the three different orthogonal image views and the detailed information about the 3D image is displayed in the Focus window.
2. To view another 4D image, drag it to an image view.

Creating 3D Images

3D images are three-dimensional images created from multiple 2D images. To create a 3D image, you import the desired images, or if this is already done, open the 2D images of the desired patient in the Selection workspace and continue by choosing the New 3D Image command and defining the necessary parameters for the 3D image.

3D images can be created either automatically (using all the patient's 2D images) or manually (using a range of manually selected 2D images).

NOTICE: When manually selecting images to be used in the creation of a 3D image, make sure that you select a sufficient number of images. This ensures that the 3D image covers all the structures necessary for treatment planning.

Selecting a sufficient number of images is particularly important when using non-coplanar fields in External Beam Planning.

If you are manually selecting the 2D images to be used in the creation of a 3D image, pay attention to the following:

- Make sure that the 3D image covers the structures necessary in planning.
- If you need to create a 3D image by manually selecting slices from multiple image series which share the same geometry (frame of reference, FOR), the slices will be copied into a new image series in the database.

The application creates 3D images in accordance with the primary axes of the 2D images. The method of creating the 3D image is one of the following:

- If the Image Gallery contains images with different primary axes (different image orientations), and none of the images are selected, the application attempts to create the 3D image from the images with the orientation and series that form the majority in the Image Gallery.
- If one image is selected in the Image Gallery, the application attempts to create the 3D image using the images that have the same orientation and the series as the selected image.
- If the automatic selection of the 2D images fails, manually select the 2D images from which to create the 3D image. This may be necessary if, for instance, the Image Gallery contains images with the same orientation but produced in different imaging sessions. However, usually the automatically selected slices for creating the 3D image are sufficient.

Safety Considerations When Using SRS Localization

WARNING: Always visually verify the result of the head frame detection carefully, and manually correct any visually incorrect results. Do not approve the detection if the results are incorrect to avoid forwarding incorrect results to treatment planning. It may not be possible to notice incorrect detection results after the head frame has been removed from the image, which may lead to incorrect treatment planning and mistreatment.

WARNING: Incorrect mounting of the localizer box to the head ring leads to incorrect results, false planning and mistreatment. Eclipse SRS Localization cannot detect this error. After one person has attached the localizer box to the head ring, a qualified member of the personnel must verify the correct attachment of the frame to the head ring. If there is any doubt about the rotation and pitch angles of the transformation applied by Eclipse SRS Localization, check if the head ring is visible and parallel to the X-Y plane in the stereotactic volume. If the head ring is not visible, review the acquisition and process used to acquire the images. Always make sure that the localizer box is correctly mounted on the head ring. If possible, always include the head ring in your CT scanning range.

Create a 3D Image

1. Do one of the following:
   - Automatically: Choose **Insert** > **New 3D Image**.
   - Manually: Select the images from the Image Gallery by holding down Ctrl and clicking the images. Then choose **Insert** > **New 3D Image**.

   Note: *Select a sufficient number of images.*

2. Give an ID and name for the 3D image.
3. Define the width and height for the 3D image.

Note: *Normally the construction parameters that the application suggests are the most appropriate ones for the selected slice set.*

4. To define the slice that must be represented as a plane (bind slice) in the 3D image, such as the plane where the isocenter is to be located, double-click the desired slice in the **Usable slices** group box.

   An X mark appears next to the slice you clicked.

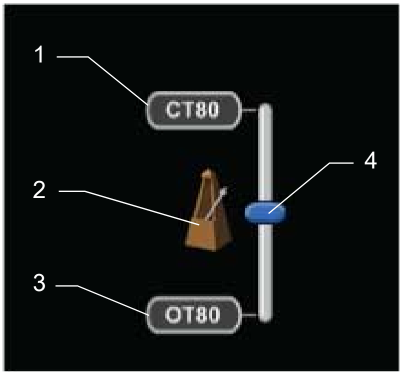
5. To define the separation between the planes in the 3D image, type the separation in cm in the **Plane separation** list box.

   In the **Current plane setup** group box, the list box shows the use of original slices and interpolated planes in the 3D image. The text boxes show the number of planes in the 3D image.
6. To create the 3D image, click **OK**.

   The 3D image creation starts. The 3D image opens in the Image Gallery, its thumbnail appears in the Image Gallery and its icon in the Focus window.

Blending Registered Images with the Blend Control Tool

The Blend Control tool is visible in the image view only when two 3D images are selected as visible. You can use the Blend Control slider to control the visibility level of each image. Clicking the Blend Control metronome switches to the blinking mode where the displayed images alternate. You can adjust the blinking speed.



1. The ID of the first image selected for blending.
2. Metronome icon for switching to the blinking mode.
3. The ID of the second image selected for blending.
4. Slider for controlling the visibility level of the blended images.

Figure 1 Blend Control Tool

The Registration and SmartAdapt applications also provide a blend function.

More information: *Registration, SmartAdapt and Contouring Instructions for Use*.

Blend Registered Images

1. Do one of the following:
   - In the Focus window, right-click the registered image and choose **Blend with**.
   - In the Focus window, select the visibility check box of the first image to blend, press **Ctrl** and select the visibility check box of the second image to blend.

   The selected images are blended and the Blend Control tool is displayed in the image view. The IDs of the blended images are displayed both in the title bar of the blended view, and in the Blend Control tool.
2. To increase the visibility level of an image, move the Blend Control slider towards the ID of the image.
3. To view the blended images in a blinking mode, click the Blend Control metronome.
   - You can adjust the blinking speed by right-clicking the metronome icon and choosing **Slow**, **Medium** or **Fast**.
   - To return to the non-blinking mode, click the metronome icon again.
4. To exit the blend image mode, select the visibility check box of the image you want to display in the image views.

Setting the User Origin

The imaging device used for patient imaging saves the DICOM origin to the image data. When the images are imported into Eclipse, the user origin is created and positioned at the DICOM origin location. The user origin is shown in the 3D images in the image views and as an object in the Focus window (). When the viewing planes are positioned exactly on the user origin, it is highlighted () in the 2D views.

All information in Eclipse related to positions (indicated with X, Y, and Z coordinates), for example, the isocenter, and reference points, is presented in relation to the DICOM origin or the user origin. You can change the position of the user origin in a 3D image only before calculating the dose.

Set the User Origin

Tip: *In external beam plans, you can use the user origin for automatically calculating the couch shifts required for the patient treatment.*

More information: Eclipse Photon and Electron Reference Guide

1. In the Focus window, right-click the 3D image or User Origin and choose **Set User Origin**.
2. To define the location of the origin, do one of the following:
   - Define the location of the new origin in relation to the DICOM coordinates in the appropriate text boxes.
   - In the Set to Predefined Target drop-down list, select a new location for the origin, and then choose the appropriate check boxes to keep the DICOM X, Y or Z coordinate, if desired.

     Note: *This may be useful if you have several image sets, or films, for the patient and you wish to make sure that the origin is on a specific plane, often the DICOM Z plane, in all of the image sets.*
   - Move the origin with the mouse. To do this, move the mouse pointer on top of the origin in an image view (the pointer changes to a cross), right-click and choose **Move with Mouse**. When you move the origin on a single plane in one of the 2D image views, one of the axes is locked.
3. Add an annotation in the Comment text box if desired.
4. Click **OK**.

The origin is shown in its new location in the image views.

Note: *To show or hide the user origin in the image views, select or clear the visibility box of the user origin object in the Focus window.*

Move the Viewing Planes to the User Origin

1. In the Focus window, select the user origin.
2. Choose **View** > **Move Viewing Planes to** > **User Origin**.

   Image planes are moved to intersect at the user origin. The user origin is highlighted in the 2D views ( ).

Scaling Images

When importing images that do not have any calibration information or whose calibration information is inadequate, you will need to scale the images in the Selection workspace. This means that you calibrate the pixel size of the digitized images. For example, to use the measurement tools, advance scaling of the images is essential.

Scale an Image

Tip: *To make the scaling as accurate as possible, display the grid or scale, or use the scale provided on the film.*

1. Display the image to scale.
2. To make the calibration as accurate as possible, maximize the image.
3. Choose **Edit** > **Scale Image**.
4. Define the distance between the two points with the mouse. Move the line so that it covers a line of a known length in the patient.
5. Enter the line length in the **Length of scaling line** text box. Make sure that the **Current Image** check is selected.

Note: *For axial images, this line length is the actual length in the patient. For film images, the length depends on the image source. For standard film images that contain a magnification factor, this should be the length on the film, that is, multiplied by the magnification factor.*

6. To update the scaling line label, click **Set**.
7. Calibrate either the current image, or the selected images and the current image. Click the appropriate option button.
8. Click **OK** to complete the calibration.

Note: *You can scale all images by the same amount. Place the line in the correct position, enter the line length on one image and select the* ***Selected images in the gallery and current image*** *check box. Then select all images to be scaled in the gallery and click* ***Set****. Do not select the images until you have set up the scaling line, because setting up the line deselects them.*

9. Visually verify the result of horizontal and vertical scaling.

Segmenting High Density Artifacts

The Segment High Density Artifacts tool is available in External Beam Planning and Brachytherapy Planning.

CT images can contain artifacts, for example from prosthesis or dental fillings, that may reduce the accuracy of dose calculation. With the Segment High Density Artifacts tool, you can find these high density areas in the image. You can create a new structure or modify an existing structure, and use the tool to find the high density areas in the structure. Then you can assign a desired HU value for the structure. You must have the Body structure defined before using the Segment High Density Artifacts tool.

The tool converts the selected structure to a high resolution segment that covers all image pixels where mass density is higher than 3.000 g/cm^3. It adds a 1 mm margin around the structure to ensure even the smallest artifacts are covered. The result is stored to the selected structure overwriting its previous contents.

Tip: *If you use the Acuros XB dose calculation algorithm, you can first assign a material, and then the desired HU value for the structure. The Segment High Density Artifacts tool reads the value (maximum density set for bone) from the selected physical material table.*

Segment a High Density Artifact

1. Define the Body structure, if not already defined.
2. Select a structure in the Focus window.
3. In the Focus window, right-click the structure and choose **Segment High Density Artifacts**.
4. Click **Yes**.

   High density areas appear in the image views and the CT Value and Material tab of the Structure Properties dialog box opens.
5. Define the CT value and material.

Approving Images

Images can have the following statuses: New, Reviewed, Action Required, and Approved. The Reviewed status and the Action Required status are indicated with a blue frame around the image icon in the Scope window. A reviewed image has a blue mark, and an action required image has a red mark in the 2D image views and in the Image Gallery. An approved image has a green frame around the image icon in the Scope window and a green check mark in the 2D image views and the Image Gallery. Approved images cannot be modified.

Note: *Image approval does not change the approval status of structures. Structures are approved separately from images.*

Related Topics

Approving Structures on page 71

Approve an Image

1. In the Scope window, select the image.
2. Choose **Edit** > **Properties**.
3. In the **Status** drop-down list, select Approved.
4. Click **OK**.
5. Type the correct user name and password and click **OK**.

   The dialog box closes. The image status is changed to Approved, and the status is marked in the Scope window and the image views.

Chapter 4 Visualization of Images

Selecting the Viewing Plane Displayed in the 2D Views

When viewing the planes constructed from the 3D image in 2D image views, you can move from one plane to another to view particular areas of interest. This can be done in the following ways:

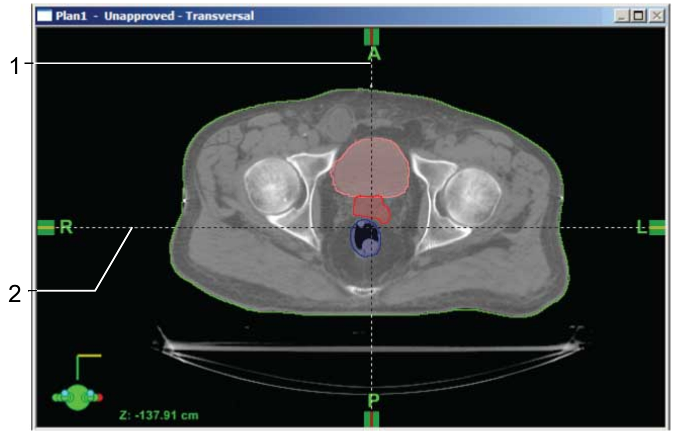
- Use the plane sliders contained in each 2D view.
- Browse through the 3D image with the mouse scroll wheel.
- Browse through the 3D image with the Page Up and Page Down keys on the keyboard.
- Browse through the 3D image with the **Next Plane** and **Previous Plane** toolbar buttons.

In each 2D view, the plane sliders mark the position of the viewing planes shown in the other 2D views. You can move the plane sliders to show different planes in the other 2D views, and when you browse through the 3D image, the plane sliders show the location of each current viewing plane.

Each 2D view also indicates the currently displayed plane by showing the X-, Y- or Z-coordinate at which the plane is located if the plane is parallel to the normal axes.

Using the Plane Sliders to Select the Viewing Plane

In each 2D view, the plane sliders mark the position of the viewing planes shown in the other 2D views. You can move the plane sliders to show different planes in the other 2D views. The figure shows a 2D view containing a transversal viewing plane. In this case, the plane sliders mark the position of the frontal and sagittal planes displayed in the other 2D views.



1. Position of the sagittal plane shown in another 2D view. Move this slider to show another sagittal plane.
2. Position of the frontal plane shown in another 2D view. Move this slider to show another frontal plane.

Figure 2 Plane Sliders in 2D Views

Select the Viewing Plane with the Plane Sliders

1. In a 2D view, point at the handle of a plane slider with the mouse.

   The mouse pointer changes to a resize pointer.
2. To show another plane in 2D views, drag the plane slider handle.

Browsing the 3D Image

To get a better overview of, for instance, the dose distribution, you can easily browse through the entire 3D image in the 2D views, topogram views, and the Model View. This means that you can move through the 3D image plane by plane using the mouse scroll wheel, the PgUp and PgDown keys or the Next Plane and Previous Plane toolbar buttons. You can browse through the 3D image in every 2D view in the direction normal to the axis view. In other words, in the case of a rotated plane, the image planes are not browsed along the main axis (X, Y or Z axis).

The step of planes shown when browsing is controlled with the plane distance value in all directions. When browsing the 3D image in a direction normal to the image slices, the plane displayed at each step is the nearest slice after the step. The plane distance value defines the browse step as follows:

- Z-direction: Plane distance directly defines the browse step.

- X- and Y-direction: Plane distance value equals the native image resolution along the axis. Usually the image resolution is higher in the X- and Y-directions than in the Z-direction.
- Rotated images: Plane distance value is modified to fall between the image resolution and the slice spacing.

When browsing the 3D image in the Model view, it is helpful to first display the viewing planes in the Model view and rotate the patient model to view it from the desired angle. Browsing in the Model view moves the intersection point of the viewing planes along the axis perpendicular to the Model view. Depending on the orientation of the 3D model, all three planes, two planes or only one plane moves. For instance, if the patient coordinates Z-axis is perpendicular to the Model View, only the frontal and sagittal planes move when browsing.

To be able to browse the 3D image in an image view, you need to activate an image view and place the mouse pointer inside the view.

Browsing is available in the following applications:

- Selection
- External Beam Planning
- Plan Evaluation

Browse the 3D Image in 2D Views

1. Activate the 2D view in which you wish to browse through the image planes.
   - You can also maximize the activated 2D view.
2. To define the interval at which the planes are shown, go to the Display toolbar and define the plane distance value in the green box (1). The value must be an integer in the range of 1–99.
3. To browse through the image planes, do one of the following:
   - Use the mouse scroll wheel.
   - Press the PgUp and PgDown keys.
   - Click the **Next Plane** and **Previous Plane** toolbar buttons.

     The image planes are browsed in the direction normal to the active view.

Browse the 3D Image in the Model View

1. Show the viewing planes in the Model View.
2. Activate the Model View.

3. To define the interval at which the planes are shown, go to the Display toolbar and define the plane distance value in the green box ( ).
   The value must be an integer in the range of 1–99.
4. To browse through the image planes, do one of the following:
   - Use the mouse scroll wheel.
   - Press the PgUp and PgDown keys.
   - Click the **Next Plane** and **Previous Plane** toolbar buttons.

Related Topics

Display the Viewing Planes in the Model View on page 57

Selecting the Default Viewing Planes

You can define the default viewing planes that are displayed each time you view the plan. Before setting the default viewing planes, zoom, pan and rotate the orthogonal image views as desired.

If you use the Multiple Plans window layout in Plan Evaluation, all plans are displayed according to the default viewing planes of the plan that is most recently dragged into an image view. If you want to display the default viewing planes of another plan, activate the view of the plan and reset plan geometry.

Default viewing planes cannot be set for approved plans.

Related Topics

Selecting the Viewing Plane Displayed in the 2D Views on page 47
Zooming and Panning in the Image Views on page 54

Select the Default Viewing Planes

1. Select the desired viewing planes and zoom/rotate the orthogonal views as necessary.
2. Choose **View** > **Set Default Viewing Planes** .
3. Do one of the following:
   - To set the current placement, rotation and zooming of the viewing planes as default, select **Set to Current**.
   - To return to the system default viewing planes, select **Set to System Default**.
4. Click **OK**.

Next time you open the plan or reset the plan geometry, the selected default viewing planes are displayed.

Related Topics

Selecting the Viewing Plane Displayed in the 2D Views on page 47
Zooming and Panning in the Image Views on page 54

Using the Movie Control Tool

The Movie Control tool is visible in the main image view when you are working on a 3D image that is part of a 4D image. The Movie Control tool becomes visible also in other image views when the image views are maximized. Pressing the Play button of the Movie Control tool activates a movie loop that shows the phases of the 4D image, for example, the respiratory phases of the patient.

Different phases are indicated with tabs around the Play button. Clicking these tabs changes the image visible in the image views. You can also use the right arrow key to view the next 3D image contained in the 4D image, and the left arrow key to view the previous 3D image contained in the 4D image. When the movie loop is running, the tab of the currently active phase is displayed. The primary image is indicated with a blue tab. You can change the primary image by pressing Shift and clicking the tab of the desired phase.

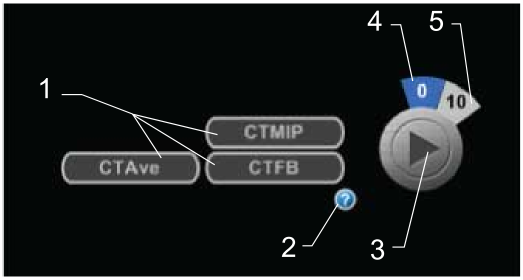
When you have defined a structure in all 3D images, you can view the motion of the defined structure in the Model view.

In External Beam Planning, you can view the motion also in the BEV.

If you have added DRR images, you can view them in the movie loop in the Model view.

In External Beam Planning, a temporary DRR is calculated for each phase of the movie loop for a live DRR. You can view the DRR image in a movie loop also in the BEV.

Non-phase images (MIP, Min, Ave and FB images) can be part of 4D images, but cannot be included in the movie loop. These images are displayed as image buttons on the left side of the Movie Control Tool. You can view them by clicking the image buttons.



1. Image buttons for images that are part of the 4D image but cannot be included in the movie loop. Click the buttons to display the images.
2. Button opening the online help topic for the Movie Control tool.
3. Play button activating a movie loop that displays motion on the orthogonal image planes.
4. The primary image in the respiratory cycle.
5. Tab indicating a phase in the respiratory cycle. Click the tab to jump to the phase.

Figure 3 Movie Control Tool

You can, for example, move viewing planes, zoom in or out, display the line profile, and contour while the movie loop is running. The contours of the selected structure in the primary image are highlighted when the movie loop is running. All contours drawn while the movie loop is running are saved in the primary image.

You can add or remove images to the movie loop in the 4D Image Properties dialog box while the movie loop is running. This is useful, for example, when deciding the respiratory phase used in a gated treatment.

You can use the Movie Control tool together with the Blend Control tool. If two 4D images are blended, the movie loop loops them in the same phase, provided that the images have the same amount of phases and the corresponding phases are blended when the movie loop is started. If a 4D image is blended with a 3D image, the movie loop loops only the 4D image and blends it with the 3D image. You can blend the phase images by pressing Ctrl and clicking the dials of the phases to blend. Blending is maintained when changing from one 3D image to another if you use the right and left arrow keys in the Movie Control tool to view the next and previous 3D image in the 4D image.

When the movie loop is running, the dose displayed in the image view is that of the planning image.

Use the Movie Control Tool

1. Drag a 3D image that is part of a 4D image into the image view.

   The Movie Control tool appears in the lower right corner of the image view.

2. To view motion, click the **Play** button .

Note: *You can also start and stop the movie loop pressing the Space bar.*

   The movie loop is started and the dials of currently active 3D images are displayed around the Play button. If this is the first time you are viewing the images in a movie loop, allow a moment for the images to load.

3. You can adjust the speed of the movie loop by right-clicking the **Play** button and choosing **Slow**, **Medium** or **Fast**.
4. To stop the movie loop, click the **Play** button again.
5. To jump into a desired 3D image of the 4D image, move the mouse on the edge of the Play button and when the tabs appear, click the tab of the desired 3D image.

   You can also jump into a desired 3D image when the movie loop is running. Use the right and left arrow keys to jump to the next or previous 3D image.

Note: *You can blend the phase images by pressing Ctrl and clicking the tabs of the 3D images to blend.*

6. To view a MIP, Min, FB or Ave type of image that is part of the 4D image but cannot be included in the movie loop, click the image buttons on the left side of the Movie Control tool.

Define Brightness and Contrast

1. Choose **View** > **View Parameters**.
2. Type new values in the **Window** and **Level** text boxes.
3. Click **OK** to change the view.

Adjust Window/Level Settings Manually

1. Choose **View** > **Window/Level** .
2. To change the window value, move the upper or lower window level slider with the mouse to the desired value.

   As you slide the handle, the brightness and contrast of all 2D images are changed.
3. To change the level value only, move the mouse pointer between the window/level sliders, and keeping the mouse button down, move the level to the desired position.

   As you move the mouse, the level values of all 2D images are changed.

   When you adjust the window/level settings of an image that is part of a 4D image, the change affects all the images in the 4D imaging study.
4. To hide the window level slider bar, select the **Window/Level** command again.

Tip: *By default, the slider is displayed only in one 2D view. You can show the hidden slider in the other image views by maximizing the view.*

Use the Window/Level Presets

1. Choose **View** > **Window/Level** .
2. Press the Ctrl key and right-click the window/level slider bar.
3. Choose one of the window/level presets in the menu that opens.

The window level is set to value of the selected preset.

Zooming and Panning in the Image Views

You can zoom in and out the image views by using the Zoom In and Zoom Out toolbar buttons or with the mouse wheel.

After zooming in on the image, the image may grow so big as not to fit in the window. To examine all parts of the image, you can shift, or pan, the image in the image window.

Zoom In

1. Choose **View** > **Zoom** > **Zoom In** .

   The mouse pointer changes to an arrow with a small circle.
2. Place the mouse pointer on the desired position in the active image and click and hold down the mouse button.
3. Move the mouse pointer to form a rectangular area.

   A red rectangle is drawn on the active image.
4. Release the mouse button when the rectangle covers the part of the image you wish to zoom.

   You can repeat zooming as many times as needed. When you zoom in an image that is part of a 4D image, all image views for the images in the 4D imaging study are zoomed in accordingly.

Note: *While zooming in note that:*

- *If you accidentally start to drag the zooming rectangle and wish to cancel the operation, press the right mouse button while still holding down the left mouse button. Once you release the left mouse button the zoom operation cannot be canceled.*
- *The amount of magnification or demagnification of the image is related to the size of the rectangle you draw.*
- *To zoom in with the mouse scroll wheel, press Ctrl key and rotate the wheel.*

Zoom Out

- Choose **View** > **Zoom** > **Zoom Out** .

  The image is zoomed out.

  When you zoom out an image that is part of a 4D image, all image views for the images in the 4D imaging study are zoomed out accordingly.

Note: *To zoom out with the mouse scroll wheel, press Ctrl key and rotate the wheel.*

Move Visible Plane

1. Choose **View** > **Pan** .

   The mouse pointer turns into a hand.
2. Place the mouse pointer on the image and press the mouse button.
3. Keeping the mouse button down, move the image until you see the part you wish to examine and release the mouse button.

   The active image moves with the mouse. The inactive images change to indicate the corresponding position.

   When you pan an image that is part of a 4D image, all the images in the 4D imaging study are panned accordingly.

Tip: *On the scroll mouse you can also use the scroll wheel to pan the image. Press the scroll wheel and drag the image as desired while holding the scroll wheel down.*

Measuring Information in Images

The point measurement tool shows the image pixel value or CT number at the selected point. With the distance measurement tool, you can measure distances between two points, for example, to check quantitative locations for reference or for selecting optimization points.

Note: *Since the Model view is a perspective view and the proportions in the image are not realistic, you cannot do measurements in it. The Beam's Eye View shows realistic proportions only at the active field's Source-to-Axis Distance (SAD) level. Do not do any measurements anywhere else in the BEV.*

Measure Pixel Values or CT Numbers

1. Choose **View** > **Measure** > **Pixel/CT Value** .
2. Click on the desired point in the image.

   The crosshair is fixed to the image, and a flag indicating the HU or pixel value at that point appears next to the crosshair.
3. Click the flag to delete the crosshair and the measurement flag.

Measure Distances

Note: *Before measuring distances on the image, ensure that the image is scaled. Otherwise no distances can be measured.*

1. Choose **View** > **Measure** > **Distance** .
2. Move the mouse pointer to the start point of the measured line and click.
3. Move the mouse pointer to the end point of the measured line and click.

   As you move the mouse, a red line appears on the image, and a flag indicates the drawn distance next to it.
4. Click the flag to delete the red line and the measurement flag.

Note: *You can convert the distance measurement of an RT image, secondary capture (SC), or computed radiography (CR) image into a measurement layer by right-clicking on the measurement flag.*

Display the Viewing Planes in the Model View

The orthogonal viewing planes can be displayed in the Model view in the following applications:

- External Beam Planning
- Plan Evaluation

Tip: *You can also browse through the image planes in the Model view.*

1. Choose **View** > **Options**.
2. Go to the Plan Viewing tab and select the **Orthogonal Planes in Model View** check box.
3. Click **OK**.

The orthogonal viewing planes are displayed in the Model view.

Related Topics

Browse the 3D Image in the Model View on page 49

Chapter 5 Structures

Adding Structures

You can add structures to a patient image using the following methods. The patient must have a volumetric image.

- Use a clinical protocol—Insert a predefined set of structures (structure template group) through a clinical protocol reference. The clinical protocol reference is also used for creating plans.
- Use a structure template—Insert a predefined set of structures through a structure template group, which is a collection of structures frequently used in a particular type of image set. For instance, a structure template group named Pelvic can contain the Body, PTV and Bone structures, and it can be used for an image set constructed of the pelvic area.
- Add structures individually one by one.

Structures are attached to a structure set. You can create a structure set separately or simultaneously with the first structure you create.

If other images already exist in the patient record and they already contain structures, you are asked to select a patient volume from the list of available volumes during structure creation. The volumes available depend on which structures have been added in other structure sets for the patient.

You can also assign a structure code to the structure. A structure code identifies the anatomical or the treatment role of a structure. Availability of a structure code in treatment planning depends on the active structure code set defined in RT Administration.

More information: *RT Administration Reference Guide* and *Eclipse Photon and Electron Reference Guide*.

In photon planning, structure identifiers are used for the automatic structure matching in DVH estimation models. On the basis of the defined structure identifiers (and structure codes), the plan structures can be automatically matched to corresponding model structures when you are adding a plan to a model, or when applying the model to a plan. To take full advantage of automatic structure matching, check that the structure identifiers correspond to the ones used in existing models, and keep the identifiers consistent in your treatment plans.

Related Topics

Add New Structures from a Structure Template on page 79

Add a New Structure

This topic applies to External Beam Planning and Brachytherapy Planning.

Note: *If a structure set does not yet exist yet for the patient, it is created simultaneously with the first structure you create.*

1. Choose **Insert** > **New Structure**.
2. If you are prompted to do so, select a patient volume for the structure from the available volumes, or select **New** and click **Next**.
3. Type the identification information for the structure.
4. To define the structure code for the new structure, go to the **Structure Code** group box and click **Search**.
5. In the **Select Code** dialog box, do the following:
   a. Scroll the code list to find the desired structure code, or type your search criteria in the **Search** box.
   b. In the list box, select the desired structure code.
   c. To complete the selection, click **OK**.
6. To define the patient volume for the structure, select the volume type in the **Type** drop-down list.

   If you selected one of the available volumes, it is shown in the Type drop-down list automatically.
7. To define the volume code, go to the **Volume** group box, click **Search** and then do the following in the **Select Code** dialog box:
   a. In the **Table** drop-down list, select the code system to use.
   b. Scroll the code list to find the desired structure code, or type your search criteria in the **Search** box.
   c. In the list box, select the desired volume code.
   d. To complete the selection, click **OK**.

8. Select the **General (continued)** tab, and do the following:
   - A default color is displayed in the **Color and Style** list box. Change it, if necessary.
   - In the **DVH Visualization** group box, select the line color, style or width for the DVH line.
   - Continue by defining the generation algorithm options or finish by clicking **OK**.

Note: *Inserted structures remain active for other actions, but are not visible in the images until you have defined contours or segments.*

Assign a CT Value to a Structure

Assign a CT value to a structure to make it a specified uniform density (no heterogeneity correction) in dose calculation. If there are calculated plans associated to a strucure, it is not possible to assign a CT value to the structure.

NOTICE: In a case of determining the CT value where several structures with different CT values overlap, the highest CT value is used which is assigned to a non-body structure. A possible CT value assignment of a body structure is always overridden by other structures with assigned CT values.

1. In the Focus window, select the structure to assign the CT value to.
2. Choose **Edit** > **Properties**.
3. Select the CT Value and Material tab and do one of the following:
   - To assign a CT value for the structure in the defined image, select the check box and give the desired CT value.
   - To use the CT value from the CT image, clear the check box.

   If it is not possible to edit the CT value, the reason for that is displayed on the tab.
4. Click **OK**.

Assign a Material for a Structure

If a material is assigned for a structure, its CT value is automatically displayed in the CT value box. You can change the default CT value if necessary.

NOTICE: In a case where two non-body structures with material assignment overlap, the material of the structure with the higher CT value is used. A possible material assignment of a body structure is always overridden by other structures with assigned materials.

1. In the Focus window, select the structure to assign a material to.
2. Choose **Edit** > **Properties**.
3. In the CT Value and Material tab, first select the **Assign CT Value** check box.
4. Select the **Assign Material** check box and select the desired material.

   The default CT value of the selected material is displayed.
5. If necessary, type a new CT value for the structure. Information on the CT value ranges for different materials: *Eclipse Photon and Electron Algorithms Reference Guide* or *Acuros BV Algorithm Reference Guide*.

   If you try to assign a material for which the corresponding HU cannot be calculated from the Mass Density CT calibration curve, a warning is displayed instructing you to extend the calibration curve to cover the density of the assigned material.
6. Click **OK**.

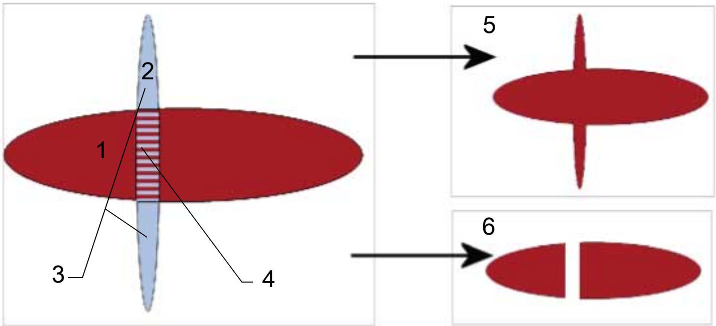
Using the Freehand Tool

You can use the Freehand tool in External Beam Planning and Brachytherapy Planning to define contours and segments on the active image plane with the mouse either by clicking them point by point, or by drawing a continuous line. Contours and segments on one plane can also be modified and optimized with the tool.

If you copy-paste contours by using the Freehand Tool, note that the copy-paste is independent between images. Different image size, orientation, registration, rotation, etc. is not taken into account, and only the shape of the contour is preserved. When you paste the contour on an image, the contour may be pasted to the viewed plane of the same or different 3D image. Only the position from the top left corner of the source image and the size of the contour is maintained. In addition to segments drawn with the Freehand tool, you can define rectangular and elliptical contours and segments.

The Freehand tool has the following drawing modes:

- Smart mode —In this mode the application decides, based on the areas inside and outside of the segment, which operation should be performed.
- Add mode —In this mode, you can add a segment to a structure.
- Remove mode —In this mode, you can remove a segment from a structure.
- Correct mode —In this mode, you can replace a contour of a segment.



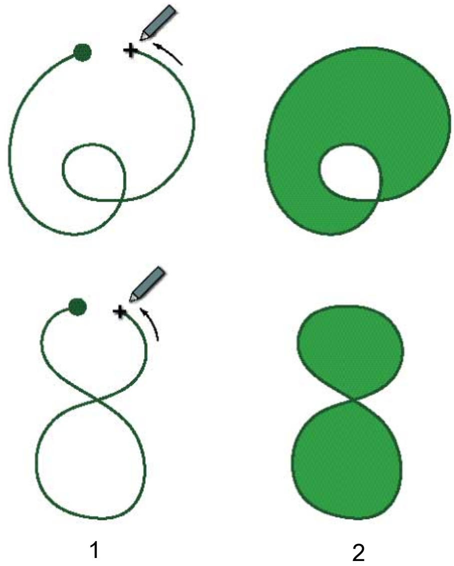
1. Larger segment.
2. Smaller segment overlapping the larger segment.
3. If these areas together are larger than area 4, segment 2 is added to segment 1.
4. If this area is larger than areas 3 together, segment 2 is removed from segment 1 causing segment 1 to be divided in two.
5. Segment 2 is added to segment 1.
6. Segment 2 is removed from segment 1.

Figure 4 Smart Mode of the Freehand Tool

In all drawing modes of the Freehand tool:

- It is possible to move or stretch a part of a segment or a contour. Stretching is zoom-dependent: the more you zoom in before stretching, the smaller the change that you can make. You can move or stretch a segment or a contour in all modes when the contour line is highlighted.
- Pressing **Ctrl** and drawing adds a segment to a structure or a contour to a segment. A small plus sign appears next to the mouse pointer.
- Pressing Shift and drawing removes a segment from a structure or a contour from a segment. A small minus sign appears next to the mouse pointer.
- The segment on the current image plane in the active structure can be moved by pressing **Shift** and dragging the segment.

Note: *When drawing contours manually, avoid intersecting lines to make sure that all contours are correctly interpreted by the application. The figure illustrates how the application interprets manually drawn contours that contain intersecting lines.*



1. Manually drawn contours that contain intersecting lines.
2. The same contours interpreted by the application.

Figure 5 Intersecting Lines Interpreted by the Application

Draw a Segment Using the Freehand Tool

This tool is available in External Beam Planning and Brachytherapy Planning.

1. In the Focus window, select the desired structure.
2. Select the desired plane.
3. Right-click the structure and choose **Freehand**.
4. Do one of the following:
   - To use the smart mode, click the Smart mode button.
   - To add a segment to a structure, click the Add mode button.
   - To remove a segment from a structure, click the Remove mode button.
   - To replace a contour of a segment, click the Correct mode button.

5. Position the mouse pointer where you want to start drawing, and do one of the following:
   - To draw curved lines, press the left mouse button and move the mouse pointer.
   - To draw straight lines, click the line point by point.
6. To close the line:
   - Move the mouse pointer back to the same spot where you started drawing the line and release the mouse button when the connection point is highlighted.
   - Right-click when you are close to the starting point. The application connects the line.

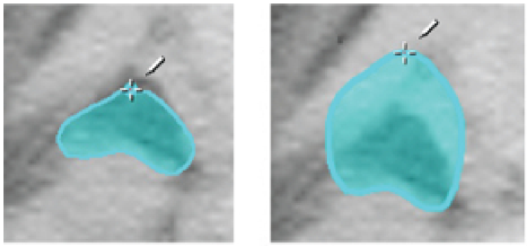
Note: *Moving to another plane closes the freehand segment drawn on the previous plane.*

Modify a Contour or a Segment Using the Freehand Tool

1. In the Focus window, select the desired structure.
2. Select the desired plane.
3. Right-click the structure and choose **Freehand** .
4. Do one of the following:

Desired Action	Steps to be Taken
Move a contour	Move the mouse pointer on the contour line, press **Shift** and drag the contour as desired. You can join two contours by dragging one on top of the other.

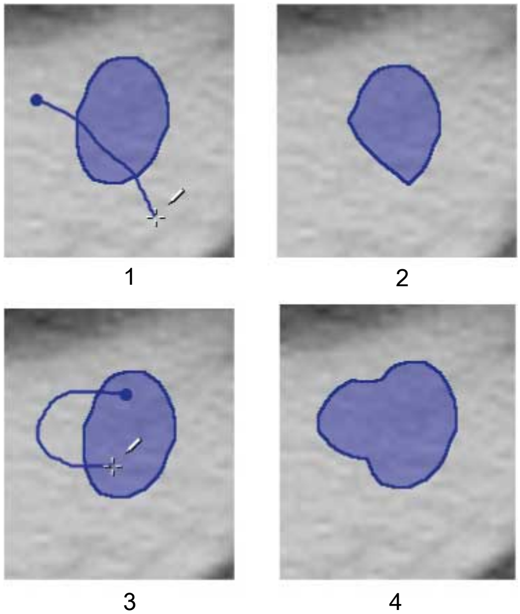
Desired Action	Steps to be Taken
Reshape a contour	Move the mouse pointer on the contour line, press the left mouse button down and drag the contour line. To reach greater accuracy in the reshaping of the contour, zoom in on the particular region of the contour.



1 2

1. Position the mouse pointer over the contour line.
2. Drag the contour line.

Desired Action	Steps to be Taken
Remove or add a part to the contour	Remove: Start and end drawing outside the existing contour. Right-click to finish removing a part. Add: Start and end drawing inside the existing contour. Right-click to finish adding a part.



1. To remove a part, start and end drawing outside the existing segment or contour.
2. Right-click to end drawing and remove the part.
3. To add a part, start and end drawing inside the existing segment or contour.
4. Right-click to end drawing and add the part.

Note: *When modifying contours and segments:*

- *To remove the segmentation, right-click the structure in the Focus window, choose* ***Clear*** *and depending on what you want to do select* ***from Current Plane of Primary Image****,* ***from All Planes of Primary Image****, or* ***from all 3D Images in 4D Image****.*
- *When you modify the structure properties of a structure, the change is applied to all images under the patient. The only exception is assigning a new CT value, as the changed value is applied only to the selected image.*

Copy a Segment or a Contour with the Freehand Tool

This tool is available in External Beam Planning and Brachytherapy Planning.

1. In the Focus window, select the desired structure.
2. Right-click the structure and choose **Freehand** .
3. On the desired image plane, right-click the segment or contour and choose **Copy**.
4. Move to another plane.
5. To paste the segment or contour in the active plane, right-click and choose **Paste**.

Copy a Contour to a Structure in Another Image

This tool is available in External Beam Planning and Brachytherapy Planning.

1. In the Focus window, select the desired structure.
2. Right-click the structure and choose **Freehand** .
3. On the desired image plane, right-click the contour and choose **Copy**.
4. Display the image where to paste the contour and select the target structure.
5. Choose **Edit** > **Paste Contour**.

Continue by modifying the copied contour as needed.

Modify a Structure

1. In the Focus window, select the desired structure.

   Only one structure can be active at a time, and the active structure is displayed in the image views.
2. If the structure contains DVH estimates, you must clear them to be able to modify the structure. Do one of the following:

   a. In the Focus window, right-click the structure, select **Clear DVH Estimates**, and then click **OK**.

   b. In the Focus window, right-click the structure set, select **Clear DVH Estimates**, and then click **OK**.

Note: *Selecting the command will clear the DVH estimates from the seleted structure or from all structures in the selected structure set immediately.*

3. Choose **Edit** > **Properties**.

4. Do the necessary modifications.

   When you modify the structure properties of a structure, the change is applied to all images under the patient. The only exception is assigning a new CT value, as the changed value is applied only to the selected image.
5. Click **OK** to update the structure properties.

Note: *Approved structures cannot be modified.*

Related Topics

Add a New Structure on page 59

Delete a Structure

1. In the Focus window, select the structure to delete.
2. Choose **Edit** > **Delete**.
3. To delete the structure and the reference points associated with the structure, do one of the following:
   - Choose **Current Structure Set only** to delete the structure from the current image
   - Choose **All Structure Sets** to delete the structure from the current image and from all images.
4. Click **OK**.

Note: *Approved structures cannot be deleted.*

Copying Structures to Registered Images

Structures can be transferred from one 3D image to another, or to all 3D images in a 4D image, either by copying and pasting one structure at a time or by copying and pasting the entire structure set.

NOTICE: It is important that both 3D images have the same image resolution. When a structure is copied and pasted from a registered image to another, the resolution of the structure changes to match the resolution of the target image. This may result in changes in the shape and volume of the structure.

Copying Individual Structures

Copying structures to a registered image can be useful, for example, when you want to define the PTV in the MR image. If the target image already contains a structure with the same name as the one that you are copying, the program creates a new structure with a new name to the target image.

Registration can be performed in the Registration and the SmartAdapt applications. These applications also contain a function for copying structures.

Instructions on using the Registration and SmartAdapt applications: *Registration, SmartAdapt and Contouring Instructions for Use*.

Copy a Structure from the Original Image to the Registered Image

This procedure applies to the External Beam Planning and Brachytherapy Planning applications.

1. In External Beam Planning or Brachytherapy Planning, define structures in one of the two 3D images using the Freehand tool.
2. In the Registration and SmartAdapt application, register the images.

   If the 3D images belong to the same 4D image, the application already considers the 3D images as being registered with each other.
3. In External Beam Planning or Brachytherapy Planning, go to the Focus window and select the structure to be copied.
4. To copy the structure for the other 3D image (for instance, define a target structure on an MR 3D image and copy it to a CT 3D image), choose **Edit** > **Copy Structure**.
5. Do one of the following:
   - In the Focus window, select the registered image.
   - To paste the structure to all 3D images in a 4D image, select a 4D image object in the Scope or Focus window.

6. Do one of the following:
   - Choose **Edit** > **Paste Structure** to paste the copied structure to the selected image.
   - Choose **Edit** > **Paste Structures to Images in 4D** to paste the copied structure to all 3D images in the 4D image.

Note: *When copying structures, pay attention to the following:*

- *Always visually verify the result. Minor inaccuracies may occur in the copy due to different resolutions and orientations of the images.*
- *If there are multiple registrations between the images, copying and pasting structures is possible in the Registration and SmartAdapt application, which enable structure propagation between registered images with more than one registration.*

Inserting Couch Structures in an Image

You can insert couch structures in an image in External Beam Planning. When the plan is active, the treatment orientation of the plan is used to position the couch structures in the image. When the image is active, the imaging orientation is used for that. If the 3D image is too small, Eclipse can enlarge the image to fit couch structures.

Note: *When inserting couch structures in an image:*

- *Make sure that you have selected the correct couch profile, and that the couch structures are positioned correctly. Visually verify the correctness of couch structures in each image plane.*
- *If the 3D image is too small to fit the couch structures and you choose not to enlarge the image, some couch structures might not be created completely. This can cause inaccuracies in dose calculation.*
- *Before using a couch structure for actual treatment, verify the HU values and resulting dose distribution by using a phantom.*

Insert Couch Structures in an Image

1. To insert a couch structure in an image, choose **Insert** > **New Couch Structures**.
2. Select the couch profile to create from the drop-down list.
3. In the Movable structural rails group box, select the location for the left and right rail. This setting applies to the Varian Exact couch (flat panel or unipanel) and Qfix Calypso kVue couch top.
4. In the CT values group box, ensure that applicable HU values are defined for the panel surface, panel interior, and movable structural rails.

5. Define whether to save the CT values as defaults for the selected couch.

   Saving CT values as defaults is a clinic-wide setting; it affects all workstations that are connected to the same database.
6. To insert the couch structures in the image, click **OK**.
7. If the planning image is too small to fit the couch structures, Eclipse suggests enlarging the image.

Note: *Image enlargement cannot be undone.*

   Do one of the following:
   - To enlarge the image, click **Yes**.
   - To keep the image size, but still insert the couch structures in the image, click **No**. Some couch structures might not be created completely.
   - To return back to the Create Couch Structures dialog box, click **Cancel**.

Move All Couch Structures

Couch structures can be moved in the transversal image view.

1. In the Focus window, select a couch structure.
2. On the Planning toolbar, click **Move Support Structures** .
3. Move the cursor on the selected couch structure and when the structure is highlighted, do one of the following:
   - To move all couch structures freely, press the left mouse button down and drag the couch structure.
   - To move all couch structures in vertical and horizontal directions, press Shift, press the left mouse button down and drag the couch structure.

Tip: *You can move a single couch structure with the Move Structure tool.*

Approving Structures

Individual structures or all structures in a structure set can be approved to prevent further modifications or accidental changes of a structure after it has been created, contoured, and verified. It is recommended that automatically segmented structures in particular be reviewed and approved before being used to plan a treatment.

WARNING: Always approve the structures and images after the completion of segmentation to avoid accidentally changing the definition of the patient anatomy or using of non-finished structures.

Structures can have the following approval statuses:

- Approved—This status can be used to indicate that someone has looked at and analyzed the structure, and then approved it for use in treatment planning. You need to enter your user name and password to approve structures. An approved structure is read-only, and it cannot be modified.
- Reviewed—This status can be used to indicate that someone has looked at and analyzed the structure.
- Unapproved—This is the default status of a structure after it has been created.
- Rejected—This status can be used to indicate that someone has looked at the structure and rejected it, for example, because the structure needs further modifications.

The status of an approved structure is shown as a frame around the image icon ( ) in the Scope window and in the Object Explorer. Approved structures cannot be modified. You can approve structures one by one, or approve several or all structures in a structure set simultaneously. The approval status and approval history of a structure are shown in Approval tab in the Structure properties dialog box.

When you approve a plan, the structures belonging to the structure set that the plan references can be approved simultaneously, depending on the system configuration. This option is configured in RT Administration.

Approve a Structure or Structure Set

Before approving structures, review the images and segmentation and ensure that they belong to the intended patient.

1. In the Focus window, right-click the structure or the structure set you want to approve.
2. Select **Change Structure(s) Status to** > **Approved**.
3. For a structure set, all structures are selected by default. Click **OK** to continue.
4. Type the correct user name and password and click **OK**.

   The dialog box closes. The status of a structure or all structures is changed to Approved and the status is marked in the Focus window and in Object Explorer.

   You can use the same procedure to change the structure to any of the four possible statuses.

Chapter 6 Courses and Plans

Creating New Plans

Plan or plans of a patient are always created to a course, sometimes multiple courses, depending on the clinical practices. Before starting to create the plan, check whether there are any courses created for a selected patient, and if there are, whether they can be used for the new plan. (For instance, if the same patient has been given a different diagnosis than before, you may want to create a new course.) For each plan, select the desired plan target and record the dose and fractionations that best correspond to the treatment prescribed for the patient.

The plan target can be selected later on, but it is recommended at the creation of the plan, because the fields are, by default, positioned to the center of the plan target and fitted to the plan target. In External Beam Planning, a reference point (without a location) is also automatically created to a new plan. The reference point is used to transfer planning information to ARIA RTM applications and other record-and-verify systems.

In addition to creating plans from scratch, you can create plans using templates, or according to a clinical protocol.

Related Topics

Create an External Beam Plan Using a Plan Template on page 79
Primary Reference Point on page 222
Using Clinical Protocols to Create New Structures, Objectives and Plans on page 82

Image and Structure Checks Before Creating a New Plan

CAUTION: Make sure that a qualified physician reviews the accuracy and placement of all patient structures (target structure and critical structures) used for treatment planning and for evaluating the plans prior to patient treatment.

See that the 3D image you are using is constructed of a sufficient number of planes. This ensures that the 3D image covers all the structures necessary for treatment planning.

Make sure that the necessary clinical contours are defined in the images. For dose calculation in external beam plans, the Body outline must be defined. First create at least the Body and PTV structures for the selected patient before creating a plan.

Sometimes the image and structure import through DICOM may result in multiple structures marked with Body volume type. Check the properties of these structures and either delete the extraneous ones or change their volume type.

In External Beam Planning, the image orientation must be defined in the images.

Always make sure that the correct images are used for treatment planning. When using scanned images with a radiograph, make sure that each scanned image contains information that identifies the patient unambiguously as a means to avoid associating the scanned images with the wrong patient.

In photon planning, structure identifiers are used for the automatic structure matching in DVH estimation models. On the basis of the defined structure identifiers (and structure codes), the plan structures can be automatically matched to corresponding model structures when you are adding a plan to a model, or when applying the model to a plan. To take full advantage of automatic structure matching, check that the structure identifiers correspond to the ones used in existing models, and keep the identifiers consistent in your treatment plans.

Create a New Plan Using a 3D Image

If the patient file is not already open, use the Patient Explorer and the Object Explorer to open the desired patient and structure set. When you open a structure set, the 3D image the structure set refers to is opened in the image views. The 3D image can belong to a 4D image.

Tip: *If there are multiple structure sets or 3D images, right-click the structure set icon in the left window of Object Explorer and select Properties to check which 3D image the structure set refers to.*

1. Choose **Insert** > **New Plan**.
2. If prompted to do so, select a course for the plan or create a new course.
3. If prompted to do so, select an RT prescription for the plan. To review the RT prescription, click **Preview**.

   If RT prescriptions have been defined for multiple prescription targets, select the appropriate prescription target.
4. In the Plan Properties dialog box, define the settings for the plan.

Note: *To use gating when delivering the plan, select the **Use Gated** option. When this option is selected, gating information is transferred with the plan to the verification and treatment control systems. Note that for this setting to have an effect, the verification and treatment control system must support transferring gating information via DICOM. You can also use the setting to indicate that a gating protocol should be added to the plan during treatment preparation.*

5. When prompted to do so, select the treatment unit for the plan.
6. In the Field Properties dialog box, define the appropriate settings for the first field.

The primary reference point is also created for the new plan. If the plan has a defined target volume, the point is connected to it. If the patient already has reference points with geometrical locations, they are automatically taken into use in the new plan.

Related Topics

Adding Static Fields to Plans on page 87

Prescribe the Dose for a Plan

Tip: *You can also prescribe the dose for a plan in the Plan Organizer.*

1. In the Context window, select the plan to prescribe the dose for.
2. Choose **Edit** > **Properties**.
3. In the General tab, type the dose prescription information.

Prescribe the Dose in the Info Window in External Beam Planning

1. In the Info Window, select the Dose Prescription tab.
2. Edit the dose-related values in the cells.

Open an Existing Plan

1. If the patient file is not already open, use the Patient Explorer to open the desired patient.
2. In the Object Explorer, select the desired plan.
3. If there are several plans, drag the desired plan from the Scope window to an image view.

Import Plan Information

This information does not apply to Vidar, Matrox or Bitmap filters. To transfer data using Vidar, Matrox or Bitmap filters, choose **Quicklinks** > **DICOM** > **ImportExport**.

More information on using the DICOM Import Export: *DICOM Import and Export Reference Guide*.

1. Choose **File** > **Import** > **Wizard**.
2. Select the appropriate import filter and click **Next**.
3. If the data is located in separate subdirectories, select the **Scan subdirectories** check box.
4. Select the data to be imported from the appropriate directory.
5. Click **Next**.
6. Select the target patient to whom to import the data or create a new patient.
7. You can connect the images to the object hierarchy under the selected patient either automatically or by hand. To let the wizard automatically import the data to the selected patient, select the **Try automatic import** check box.
8. Click **Next**.

   Automatic import: The wizard closes after the automatic import is completed.

   Import by hand: The wizard proceeds to the next step.
9. Do one of the following:
   - If the data has gray indicators in the tree structures in the Import Data and ARIA Data panes, you need to connect the data to the object hierarchy under the selected patient. To do this, drag the data from the Import Data pane to an appropriate place under the patient in the ARIA Data pane. Click **Finish** to close the wizard.
   - If the data has green indicators in the tree structure, click **Finish**.

Copying and Pasting Plans

You can copy and paste plans from one course to another. Depending on the treatment modality, the copied plan includes the following data:

- Field setup
- Field accessories, such as MLC, block and compensator
- Fractionation data
- Reference images
- Dose data, if calculated for the plan
- Link to an RT prescription when pasting the plan to the same course with the original plan.

Copy a Plan

1. In the Scope window, select the plan.
2. Choose **Edit** > **Copy Plan**.
3. Select the course to which to paste the plan.
4. Choose **Edit** > **Paste Plan**.

Using the Info Window

The Info window displays parameter values set for the plans, plan sums and fields. You can also define and modify some of the values in the Info window.

By default, the Info window is shown below the image views and the Focus window. You can also move the window and have it float over the image views or the Focus window.

Note: *Do not use screen print-outs containing the Info window for conveying any planning information to the treatment. Some of the information contained in it can only be viewed on screen by changing the column widths in or by scrolling the Info window.*

Show the Info Window for External Beam Plans

- To show the Info window, choose **Window** > **Info Window**.

Treatment Planning Concepts

Plan	An external beam plan comprises the geometrical positioning of the fields, including all field accessories and parameters, and the dose prescription defined for the plan.
Fraction	One fraction is the dose given to a patient during one treatment session in a series of treatment sessions.
Fractionation	Fractionation is a technique of administering external radiation therapy in multiple doses over a number of days or weeks to achieve a maximum therapeutic ratio. During a single fractionation, the fraction dose and weekly dose do not change. But, if multiple fractionations are used, the dose received by the patient on different days of the week may differ. Multiple fractionations are shown in the Plan Organizer and the Info window.

Dose Prescription Dose prescription refers to the procedure of determining the total dose to be administered to the patient. The dose is determined differently in the treatment planning and in functions related to treatment delivery or treatment scheduling. In External Beam Planning and Brachytherapy Planning, the dose is prescribed to a specific isodose percentage or to a reference point. In ARIA RTM applications, the determination of the dose is based only on reference points.

Dose The dose distribution is indicated either as an absolute (Gy or cGy) or relative (%) dose, and conveyed by means of isodoses or color wash visualization. The check box next to the Dose icon in the Focus window can be cleared to hide the dose distribution in the 2D and 3D views.

Note: *The dose displayed is physical dose, not biological dose.*

Chapter 7 Templates and Clinical Protocols

Add New Structures from a Structure Template

Note: *Always visually verify the result produced by templates.*

1. Open a patient and an image.
2. Choose **Insert** > **New Structures from Template**.
3. To search for a structure template group in the **Structure Template Groups** group box, define the search criteria and click **Search**.
4. Select the desired structure template group from the table.
5. Select the check boxes of the structure templates you want to use and click **Select**.

   If a selected structure already exists in the plan, it is omitted and a message is displayed stating that not all structures could be created.

Continue by segmenting the created structures.

Related Topics

Searching Templates and Clinical Protocols on page 85

Create an External Beam Plan Using a Plan Template

You can create a plan using a template in External Beam Planning.

Note: *Always visually verify the result produced by templates. For instance, make sure that you are using the correct reference image in the created plan.*

1. Choose **Insert** > **New Plan from Template**.
2. If prompted to do so, select the patient to which to connect the new plan, and select a structure set for the new plan.
3. Select a course for the plan or create a new course.
4. If prompted to do so, select an RT prescription for the plan. To view the properties of the selected RT prescription, click **Preview**.

   If RT prescriptions have been defined for multiple prescription targets, select the appropriate prescription target.
5. Select the template to use.

6. Select a treatment unit to use. The default treatment unit is the one used when the plan template was created.

   If the energy or dose rate included in a photon plan template have not been configured for the selected treatment unit, they are changed to the closest corresponding energy and dose rate.

   Only one treatment unit is saved in a plan template.
7. Define the prescription for the plan.
8. To change the placement of an item, click the appropriate cell in the **Placement** column of the table and select a new placement from the list.

   Changing the plan target volume changes the target for all fields, but does not affect the settings defined in the template for fitting the field accessories.
9. To place all isocenters at the same location, select the desired location from the drop-down list.
10. To define how the add-ons are fitted to structures:
    - To fit all add-ons, click **Fit All Add-Ons**.
    - To remove fitting from all add-ons, click **Unfit All Add-Ons**.

Tip: *To remove all modifications and return to the default values, click **Reset to Defaults**.*

11. Verify the matched parameters.

Note: *If the match between the selected treatment unit and the field accessories required in the template is partial, the rows of the accessories are highlighted in the parameter table. Some parameters are required to match exactly, and if the match cannot be made, the **Next** button is grayed out and an error message is shown.*

12. Select the reference point or create a new reference point for the new plan. By default, the reference point is connected to the target volume of the plan, if there is one defined.
13. Select the treatment orientation for the patient.
14. Click **Finish** to create the new plan.

    Fields included in the template but not allowed in the selected treatment unit are not verified during the creation of the plan. Make sure you verify the field geometry settings when the plan is completed.
15. Save the new plan.

Note: *If fields or add-ons are incorrectly positioned in relation to the structures, use the field grouping tools to reposition the fields and refit the add-ons.*

Related Topics

Searching Templates and Clinical Protocols on page 85

Add New Objectives from an Objective Template

Note: *Always visually verify the result produced by templates.*

1. Open a plan to which you wish to add the objectives and choose **Insert** > **New Objectives from Template**.

   Tip: *In External Beam Planning, you can also click **Load Objectives from a Template** in the optimization dialog box while optimizing a plan.*

   You can also create new objectives in the optimization dialog box.
2. To search for an objective template in the **Objective Templates** group box,define the search criteria and click **Search**.
3. Select the template that contains the desired objectives.

   In External Beam Planning, you cannot select an objective template that is meant for Brachytherapy Planning and vice versa.
4. In the **Objectives** group box, change the structure to which the objective is matched in the plan, if necessary, by clicking the cell in the appropriate column and selecting a new structure in the drop-down list that opens.

   Note: *When you change a structure to which the objective is matched in the plan, all objectives assigned to the same matched structure in the template change accordingly. If you leave the matched structure cell empty, the objective is not taken into account.*
5. Click **Select**.

Related Topics

Searching Templates and Clinical Protocols on page 85
Optimization Dialog Box on page 149

Using Clinical Protocols to Create New Structures, Objectives and Plans

You can use clinical protocols to create new structures and plans:

- Creating structures using a clinical protocol automatically adds the structures and reference points based on those structures from the protocol.
- Creating a plan using a clinical protocol plan automatically adds the plan objectives and the optimization objectives of the plan from the protocol.

Inserting a Clinical Protocol Reference to a Patient

To create structures and plans using a clinical protocol for a patient, you need to insert a clinical protocol reference to the patient.

For external beam plans, you can insert a clinical protocol reference to a patient in External Beam Planning.

Clinical protocol references are displayed in the Scope window under a course. One course can contain several clinical protocol references. Before creating the protocol plans, you can modify the attached clinical protocol by showing its properties. Modifications apply only to attached protocol plans for the current patient.

Creating Structures According to a Clinical Protocol

You can create structures according to a clinical protocol in Contouring. In order to do that, you need to have a patient with an image and a clinical protocol inserted to the patient.

If the patient image already contains a previously created structure with the same structure ID as the structure in the clinical protocol, the existing structure is not overwritten.

In External Beam Planning, if the clinical protocol contains plan objective items that use reference points, the reference points are automatically created without locations. The reference points are named according to the structure names. Existing reference points with the same ID as those coming in from the protocol are not overwritten.

Note: *To be able to later use the reference points created using a clinical protocol for plan normalization or for evaluating the plan against the plan objectives in the protocol, the points must have locations defined. Omitting the use of a clinical protocol for creating structures and only using the clinical protocol for creating the plan(s) will not create any reference points or reference point locations, except for the primary reference point (that will not have a location in this case).*

Create Structures Using a Clinical Protocol

1. Choose **Insert** > **Attach Clinical Protocol to Patient**.
2. Select a course or create a new course for attaching the clinical protocol reference.
3. Select the primary reference point for the plan.
4. Find the desired clinical protocol and click **Select**.
5. Right-click the clinical protocol item in the Scope window and choose **Create clinical protocol structures**.

   If no structure set exists in the 3D image, you are prompted to create one.
6. In the **Reference point locations** list box, select the reference point locations that need to be created.

   Note: *The reference point locations are created at the bottom of the image view. When you finish creating the structures according to the clinical protocol, you must drag the reference point locations to the desired places.*
7. Click **OK**.

   If there was a conflict in the structure creation process, the Structure Creation Log opens. Green background indicates that the structure was successfully created. Red background indicates a conflict in the structure creation process.
8. To close the log, click **Close**.

   The new structures appear in the Focus window.

Continue by segmenting the structures.

Creating Plans According to a Clinical Protocol in External Beam Planning

You can create external beam plans according to clinical protocol plans in External Beam Planning. In order to do that, you need to have a patient with course and a clinical protocol reference inserted for the patient.

Note: *Although it is possible to omit the use of a clinical protocol for creating structures and only use the protocol for creating the plan(s), this procedure will not automatically create any reference points, except for the primary reference point. This means that all the reference points and reference point locations used in the clinical protocol definitions for plan normalization or plan objectives must be manually created if clinical protocol structures are not used.*

When you create a plan according to a clinical protocol, the application creates objectives for the new plan using the protocol objectives. If there is no matching structure for the optimization objective in the planning image, the objective is not created. The application also creates DVH settings for the new plan according to the review settings in the clinical protocol inserted. If the review structures do not exist, they are dropped.

The plan objectives of the protocol plan in the clinical protocol reference are examined for plan objectives to reference points. If there are any, the reference points named by the relevant structures are moved to the plan. Based on the primary plan objective content, a primary reference point is assigned in the plan.

The application also creates a dose prescription for the plan according to the protocol plan used. The primary plan objective in the plan objectives of the protocol plan is used for this purpose. For conventional plans, the plan normalization mode is selected according to the primary plan objective. For IMRT plans this is not done.

When you create all plans according to the clinical protocol at once, a plan sum containing the protocol plans is also created.

Note: *You cannot create a brachytherapy plan from a clinical protocol in External Beam Planning, or an external beam plan from a clinical protocol in Brachytherapy Planning.*

Create External Beam Plans Using a Clinical Protocol

1. Choose **Insert** > **New Clinical Protocol Reference**.
2. Select a course or create a new course for attaching the clinical protocol reference.
3. Select the primary reference point for the plan.
4. Find the desired clinical protocol and click **Select**.
5. In the Scope window, right-click the clinical protocol item and do one of the following:
   - To create a single clinical protocol plan: choose **Create plan** and select the desired plan.
   - To create all clinical protocol plans: choose **Create all plans**.
6. In the **Map prescription** column, select the protocol phases that will be normalized when the plans are created. This option is not available for IMRT plans.
7. If necessary, type a new ID and select the treatment unit and energy.
8. Click **OK**.

   The selected protocol plans appear in the Focus window. In External Beam Planning, the plan sum used to create the protocol plans is also displayed.

Change the Clinical Protocol Reference of a Protocol Plan

You can change the clinical protocol reference of a protocol plan in External Beam Planning.

1. In the Scope window, select the protocol plan whose clinical protocol reference you want to change.
2. Choose **Edit** > **Properties**.
3. Select the **General** tab.
4. In **Protocol Plan** drop-down list, select the desired clinical protocol reference.

   You can also select an empty list item. In that case, the protocol plan is moved directly under the course.
5. Click **OK**.

Delete a Clinical Protocol Reference from a Course

For external beam plans, you can delete a clinical protocol reference from a course in External Beam Planning.

1. From the Scope window, select the clinical protocol reference to delete.
2. Choose **Edit** > **Delete**.
3. Click **Yes** in the confirmation dialog that opens.

   When you delete a clinical protocol reference, the protocol plans under the reference in the Scope window are moved under the relevant course.

Searching Templates and Clinical Protocols

You can search templates and clinical protocols by their approval status, or by using search words. The search is performed on the items visible in the relevant manager. By default, the Template Managers and the Clinical Protocol Manager display approved templates and clinical protocols when the manager is opened for the first time. The approval statuses that can be used for searching templates and clinical protocols are Approved, Unapproved, Reviewed, Retired, and All.

You can use one or more search words to find templates and clinical protocols. The searches are not case sensitive. When using several search words, there is no need to type and between the words. For example, the search “thorax breast” gives the results where either of the words is present. You can use an empty space, comma (,) and semicolon (;) as a word separator.

You can search phrases by inserting quotation marks around the search words (for example “John Doe” or “ left breast”). You can also exclude words form the search results by typing a minus sign (−) immediately in front of the word to exclude (for example, −thorax).

Search a Template and a Clinical Protocol

This information applies to External Beam Planning.

1. Choose **Planning** > **Templates and Clinical Protocols** > **Clinical Protocol Manager**, **Objective Template Manager**, **Plan Template Manager** or **Structure Template Manager**.
2. To search for a clinical protocol or a template:
   a. Select the approval status of the clinical protocol or template you want to find from the first drop-down list. You can also type a search word in the second drop-down list.
   b. Click **Search**.

   The clinical protocols or templates matching the search criteria are displayed in the table. You can sort any table column by clicking the column header. You can also preview templates and clinical protocols.

Chapter 8 Fields

Adding Static Fields to Plans

If you use a clinical protocol or plan template for creating plans, fields and field modifiers included in the protocol or template are automatically created. Using a clinical protocol or a plan template for setting up fields is recommended.

The insertion of the first field is started automatically when you create a new plan. The structures defined in the images in the Contouring application aid you in positioning the fields.

NOTICE: To ensure the integrity of the calculated treatment plans, do not use more than 25 fields in any single treatment plan in External Beam Planning.

Note: *Before starting to add fields, make sure that the 3D image you are using contains all relevant structures to enable a correct field setup.*

Add a Static Photon Field

1. Choose **Insert** > **New Field**.
2. Type the identification and name for the field.
3. Select the treatment unit.

Note: *When inserting a new VMAT field, the dose rate defined in the Field Properties dialog box will be the maximum dose rate used in the arc optimization. It is recommended to use the highest dose rate available on the treatment unit.*

4. Select the energy mode and dose rate.
5. On the **Geometry** tab, set the technique to STATIC.
6. Fixed SSD field: From the **Setup** drop-down list, select Fixed SSD and then define the appropriate source-to-field entry point distance in the **SFED** text box.
7. Click **OK** to accept the settings.

Tip: *You can also edit the field properties in the Info window.*

Add an Electron Field

1. Choose **Insert** > **New Field**.
2. Type the identification and name for the field.
3. Select the treatment unit.

Note: *Although the creation of isocentric electron fields is allowed, do not use them because of potential inconsistencies in the dose normalization.*

4. Select the energy mode and dose rate.
5. On the **Geometry** tab, set the technique to STATIC.
6. Selecting the electron energy automatically creates a fixed SSD electron field. Define the appropriate source-to-field entry point distance in the **SFED** text box.

Note: *You can change the SSD only for fields to be calculated with the eMC calculation model.*

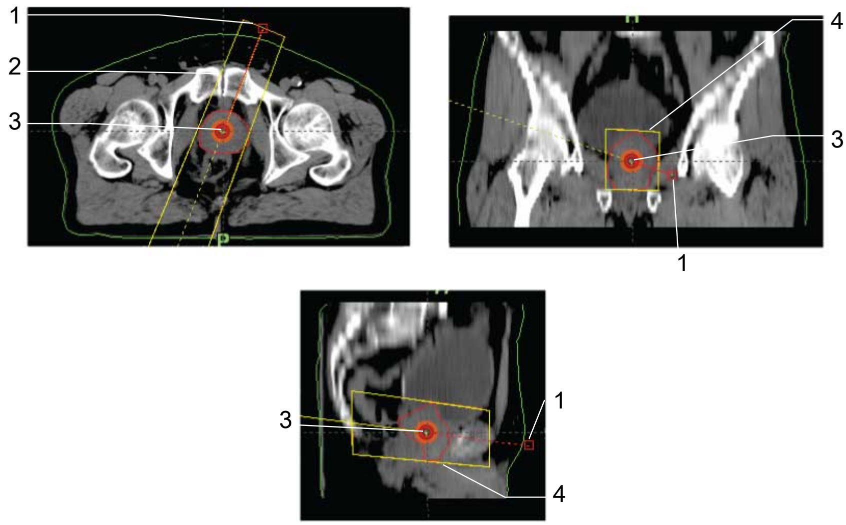
7. On the **Accessories** tab, select the correct accessory mount for the electron applicator. This is a mandatory setting.
8. Click **OK** to accept the settings.

Tip: *You can also edit the field properties in the Info window.*

Static Field Visualization in 2D Views

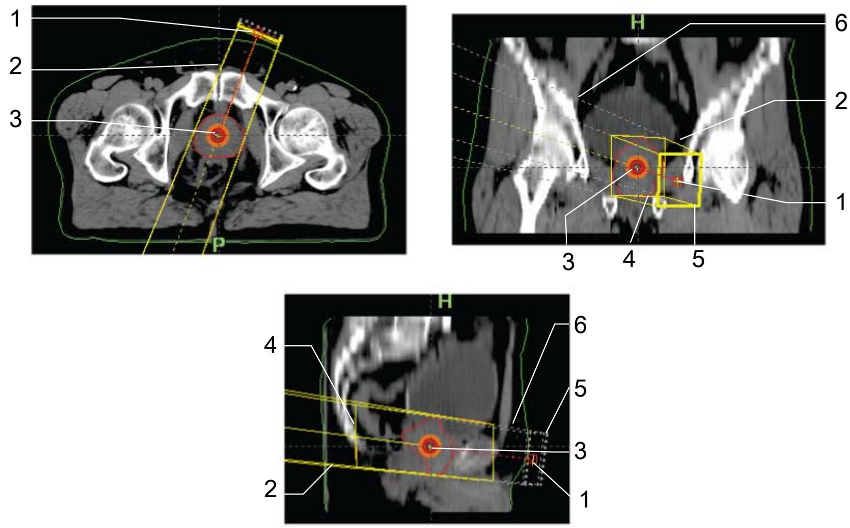
Note: *Eclipse does not accurately represent the collimator jaw structure of Siemens treatment units in dose calculation or the field visualization in External Beam Planning. Eclipse assumes that the field edges in both X and Y directions are limited by a collimator jaw block, whereas in Siemens treatment units the MLC device replaces the collimator X jaws.*

The field visualization modes in 2D views are cut mode and projection mode. The figures compare these two field visualization modes.



1. Field direction point
2. Beam edge
3. Isocenter and field central axis intersection with the viewing plane
4. Field edge on the viewing plane

Figure 6 Isocentric, Non-Coplanar Field in Cut Mode



1. Field direction point
2. Beam edge projection in front of the viewing plane
3. Isocenter and field central axis intersection with the viewing plane
4. Field edge on the viewing plane
5. Collimator jaws at the field direction point
6. Beam edge projection behind the viewing plane

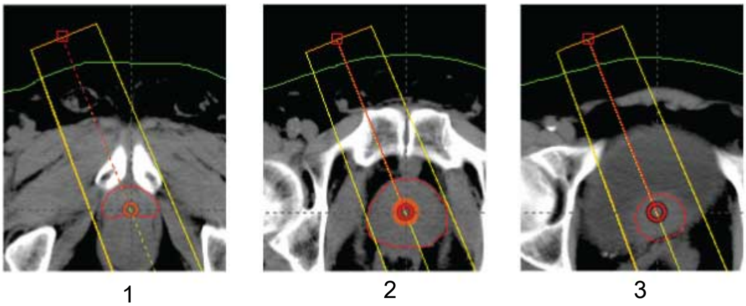
Figure 7 Isocentric, Non-Coplanar Field in Projection Mode

By default, field paths are displayed in 2D views as lines along their central axes, and the four collimator jaws are displayed as lines. The field path lines start outside the active plane and can be defined to extend through it or be cut at the isocenter. The isocenter also serves as a moving handle, and fields can be moved by dragging their isocenters. In addition, each field has a rotation handle used for changing rotation angles of fields.

The isocenter is marked with a circle using different colors, depending on its position:

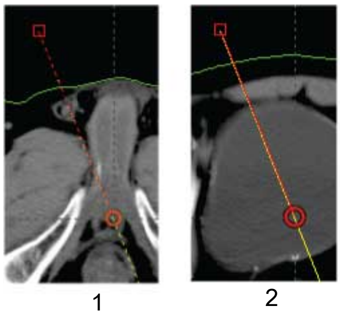
- —On the active viewing plane
- —Behind the active viewing plane
- —In front of the active viewing plane

The field lines are also displayed in relation to the active viewing plane, using different line types.



1. Field central axis and isocenter above the viewing plane
2. Field central axis and isocenter on the viewing plane
3. Field central axis and isocenter below the viewing plane

Figure 8 Field Lines in Relation to Active Viewing Plane (inside Active Field)



1. Field central axis and isocenter above the viewing plane
2. Field central axis and isocenter below the viewing plane

Figure 9 Field Lines in Relation to Active Viewing Plane (outside Active Field)

The visualization of the field on the active viewing plane is also different depending on whether the field is active or inactive:

- Active field: Field shape on the viewing plane is shown in bright yellow
- Inactive field: Field shape on the viewing plane is shown in pale yellow

Note: *A field is made active either by selecting it in the Focus window or by clicking the field label in a 2D image view.*

You can also display only the central axis (CAX) of fields and hide the field edges and field accessories in the 2D views and the Model view.

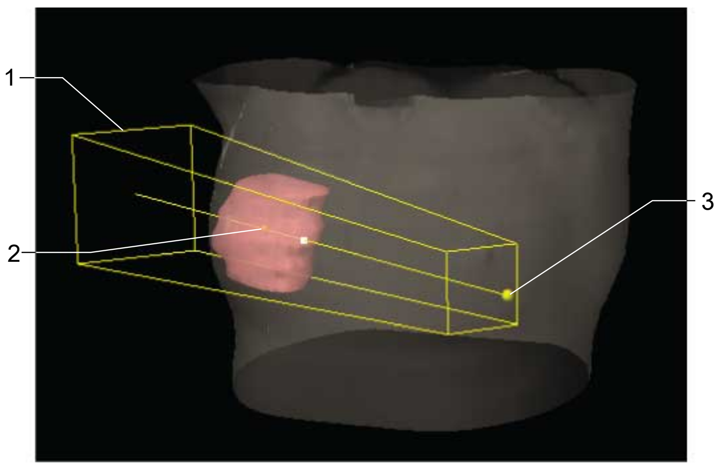
Related Topics

Rotate Fields Graphically on page 108
Moving Fields on page 105

Photon Field Visualization in the Model View

Note: *Eclipse does not accurately represent the collimator jaw structure of Siemens or Elekta (Agility and Beam Modulator) treatment units in dose calculation or the field visualization in External Beam Planning. Eclipse assumes that the field edges in both X and Y directions are limited by a collimator jaw block, whereas in Siemens and Elekta treatment units the MLC device replaces the collimator X jaws.*

By default, photon field paths are displayed in the Model view as lines along their central axes, and the four collimator jaws as lines. If the field contains fixed jaws, the field paths are displayed with dotted lines. The field path lines start outside the patient's body surface and extend through it. The field isocenter is marked with a solid yellow square. The SSD point is marked with a solid white square. Each field also has a rotation handle. In addition, if a field displayed in the Model view is active (selected in the Focus window), the view contains the patient orientation indicator, and it shows the gantry and couch positions.



1. Field path
2. Isocenter
3. Rotation handle

Figure 10 Active Isocentric Field in Model View

Arc fields are displayed in the Model view similarly to static fields. In addition, the rotation span of an arc field is visualized with a curved line and an arrow to indicate the rotation direction, and the arc is drawn with bars that indicate the delivered dose. The end of the curved line marks the end of the rotation (if not full arc).

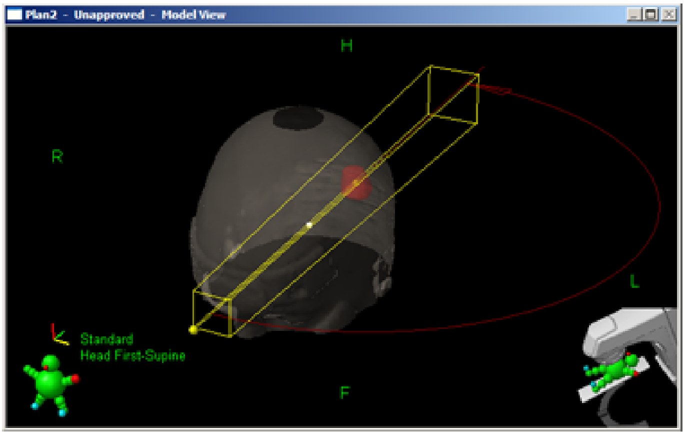


Figure 11 Arc Field in Model View

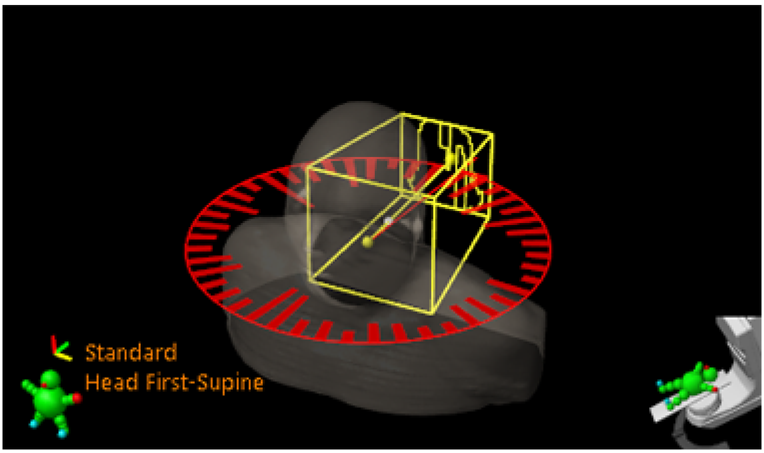


Figure 12 Conformal Arc Field in Model View

In addition to the default 3D visualization, fields can also be displayed as translucent cones in the Model view, and the field shape can be displayed on the surface of the Body structure.

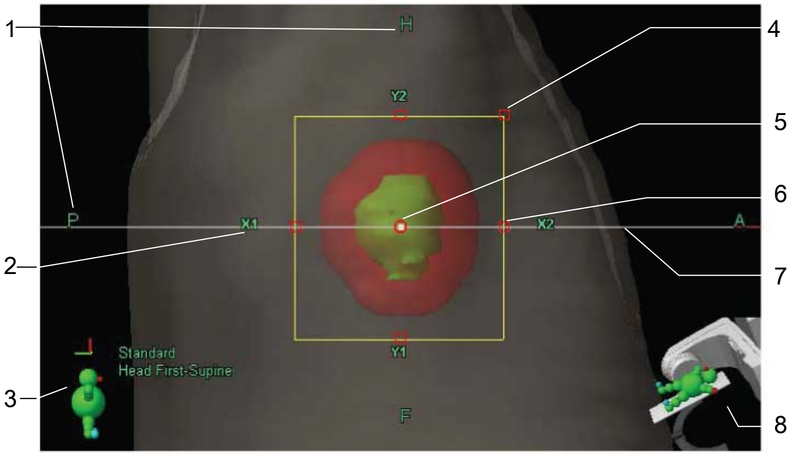
Photon Field Visualization in the Beam's Eye View (BEV)

Note: *Eclipse does not accurately represent the collimator jaw structure of Siemens or Elekta (Agility and Beam Modulator) treatment units in dose calculation or the field visualization in External Beam Planning. Eclipse assumes that the field edges in both X and Y directions are limited by a collimator jaw block, whereas in Siemens and Elekta treatment units the MLC device replaces the collimator X jaws.*

In the Beam's Eye View, photon fields are displayed as rectangles with sizing handles and field dimension labels on each side of the rectangle. If the field has fixed jaws, the corner lines of the field cone and the IEC X jaws of the field rectangle are drawn with a dotted line. Sizing handles are not available for fixed jaws. The size of the field rectangle for fields with fixed IEC X jaws is defined as follows:

- Y direction: The position of the IEC Y jaw.
- X direction: The width of the MLC aperture, or the width of the non-zero values in the optimal fluence.

The field also has a collimator rotation handle, and the isocenter is marked with a red square, which is also used as a handle to move the field. In addition, the BEV contains the patient orientation indicator and shows the gantry and couch positions. You can also choose to show the intersection of the active transversal plane and the SAD plane of the active field in the BEV.



1. Patient orientation labels
2. Field dimension label
3. Patient orientation indicator
4. Collimator rotation handle
5. Isocenter and field moving handle
6. Sizing handle
7. Intersection of the active transversal plane and the SAD plane of the active field.
8. Gantry and couch position

Figure 13 Photon Field in the BEV

The title bar of the BEV window shows the plan ID, plan approval status, the name of the view, viewing distance, field information and structure set information.

You can also animate the movement of an arc field in the BEV.

Related Topics

Animate an Arc Field in the BEV on page 97

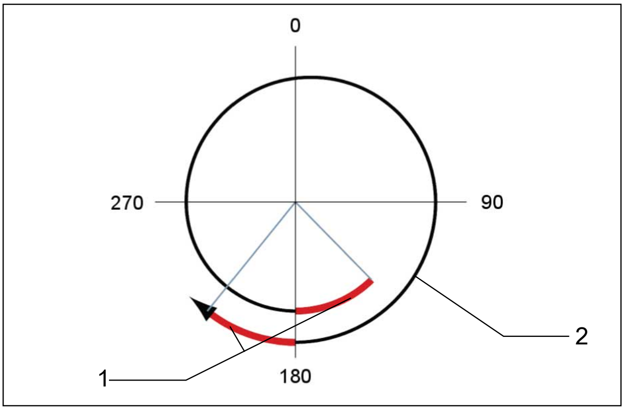
Adding Arc Fields to Plans

An arc field is inserted to a plan in the same way as static fields: you insert the field and define the general field properties. After this, you define properties specific to arc fields.

If you use a clinical protocol or plan template for creating plans, fields and field modifiers included in the protocol or template are automatically created. Using a clinical protocol or a plan template for setting up fields is recommended.

Conformal arc fields are created by adding Dynamic MLCs into arc fields, and by fitting the MLCs to target structures.

The allowed rotation direction of an arc field is determined on the basis of the start and stop angles of the rotation span. In the configuration of the system, you define for each treatment unit the amount of extended arc rotation, allowing arc fields with angles in the extended area. The extended area is shown in the 2D views, in the Arc Plane View, and in the Field Properties dialog box.



1. Extended area
2. Gantry rotation span

Figure 14 Extended Area, Clockwise Direction

For instance, to achieve a full 360° rotation in the clockwise direction, start the rotation from 180° and stop it at 180° in the extended area.

Related Topics

Add an MLC to an Arc Field on page 119

Add an Arc Field

Tip: *A conformal arc field is created by adding a Dynamic MLC into an arc field.*

1. Insert the field and define the general field properties.
2. On the Geometry tab, set the technique to ARC.

3. Define the start and stop angles for the gantry rotation.

   If used in the rotation, the **Extended Area** check box becomes selected after entering angles and direction. The **CW** (clockwise) and **CCW** (counterclockwise) option buttons are available depending on the defined rotation start and stop angles.
4. Define the rotation direction of the arc field by selecting the **CW** or the **CCW** option.
5. Click **OK** to accept the settings.

Animate an Arc Field in the BEV

You can animate the movements of conformal arc fields (arc fields that contain a Dynamic MLC).

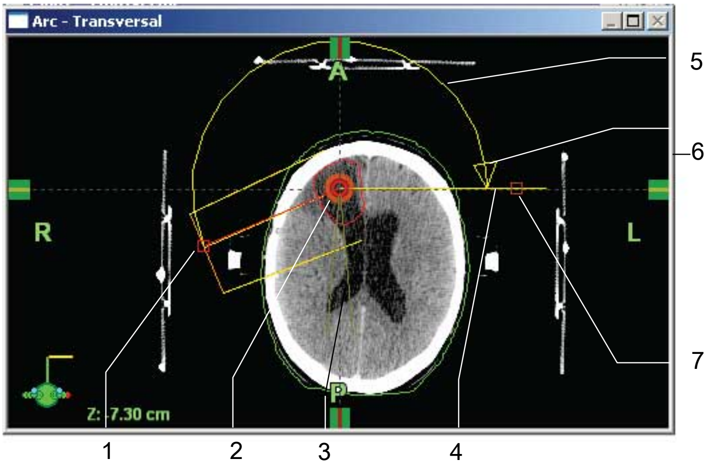
1. To show the arc field in the BEV, right-click in the BEV or Model View, choose **Set Beam's Eye View to** and then select the arc field.
2. To animate the arc field:
   - To show the entire sequence of arc field segments, click .
   - To show the previous or the next segment, click or respectively.
   - To show the first or the last segment, click or respectively.

   For VMAT fields, control points with MLC apertures are shown. For Siemens mARC fields, optimization points with MLC apertures are shown.
3. To stop the animation, click .
4. To view the arc field from a specific angle, type the angle in the text box in the toolbar. The changing arc angle during the animation is shown on the title bar of the BEV window.

Arc Field Visualization in 2D Views

Note: *Eclipse does not accurately represent the collimator jaw structure of Siemens treatment units in dose calculation or the field visualization in External Beam Planning. Eclipse assumes that the field edges in both X and Y directions are limited by a collimator jaw block, whereas in Siemens treatment units the MLC device replaces the collimator X jaws.*

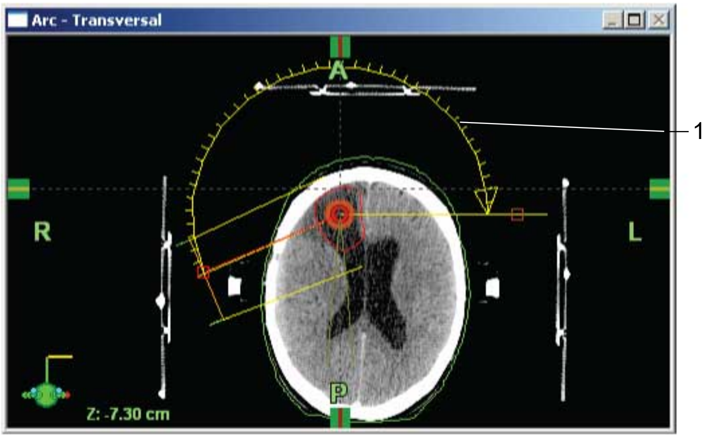
Arc fields are displayed similarly to static fields, but as an additional feature, the rotation span of the field is visualized with a curved line and an arrow to indicate the rotation direction. The end of the curved line marks the end of the rotation.



1. Field rotation handle
2. Isocenter
3. Extended area.
4. Arc rotation stop angle
5. Arc rotation span
6. Arc rotation direction
7. Arc rotation handle

Figure 15 Arc Field in Transversal Image

For conformal arc fields, the field segments are shown along the rotation span line.



1. Arc rotation span with conformal arc segments visualized.

Figure 16 Conformal Arc Field in Transversal Image

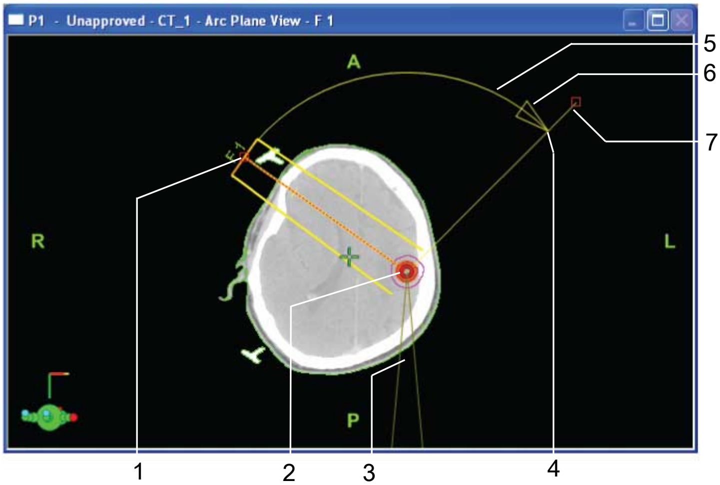
Related Topics

Change the Arc Field Rotation Span on page 110
Adding Arc Fields to Plans on page 95

Field Visualization in the Arc Plane View

Note: *Eclipse does not accurately represent the collimator jaw structure of Siemens treatment units in dose calculation or the field visualization in External Beam Planning. Eclipse assumes that the field edges in both X and Y directions are limited by a collimator jaw block, whereas in Siemens treatment units the MLC device replaces the collimator X jaws.*

The Arc Plane View displays a reconstructed 2D image in a plane parallel to the arc's rotation and viewed from a direction perpendicular to the arc's plane of rotation. Only the active field is shown in the view. The start and stop positions of the arc, rotation direction and the extended area are shown. You can edit the start and stop positions of the rotation in the Arc Plane View.



1. Field rotation handle
2. Isocenter
3. Extended area
4. Arc rotation stop angle
5. Arc rotation span
6. Arc rotation direction
7. Arc rotation handle

Figure 17 Arc Plane View

You can zoom in and out in the Arc Plane View, and scroll in it with the mouse. The fields can be shown in projection mode or cut mode, and the Show CAX only option can be used.

Show the Arc Plane View

- Right-click the Model View or BEV and choose **Set Arc Plane View to Field**.

Conformal Arc Planning with Siemens MLC 160

Setting the MLC type as Arc Dynamic for a Siemens MLC 160 and fitting the MLC to a target structure in an arc field generates an mARC-like conformal arc field. The field contains arclets and zero-dose segments similar to an mARC field. However, the dose delivered in each arclet is constant. The MLC shape in each arclet conforms to the back-projection of target structure shape at the central gantry angle of the arclet.

The schematic overview of the Siemens MLC 160 conformal arc field is similar to the mARC field generated by the Photon Optimization algorithm (PO). An illustration of a Siemens mARC field and more information on Siemens mARC optimization: Optimization of Siemens mARC Plans on page 179.

A Siemens MLC 160 conformal arc does not have dynamic collimator jaws (jaw tracking). The jaws have static positions which are conformal to the union of all MLC apertures within the field. A Siemens MLC 160 conformal arc does not have dose rate variation, except changing to zero in the zero-dose segments between the arclets.

You can define the optimization point interval and the length of an arclet. The arclet length must be 1° to 5°. The optimization point interval must be defined so that there is at least 1° between each arclet. The length of the first arclet in the field is always 0°, and the system will adjust the interval between the first and second arclets so that the last arclet ends where the arc field ends. For example, if the arc field starts at 0° and ends at 40°, and the selected arclet length is 5° and the optimization point interval 15°, the system will create a conformal arc field with 4 arclets and 8 control points as follows:

Arclet	Control Point	Gantry Angle	Meterset Weight
1	1	0°	0.000
	2	0°	0.250
2	3	5°	0.250
	4	10°	0.500
3	5	20°	0.500
	6	25°	0.750
4	7	35°	0.750
	8	40°	1.000

The *Fit and Shield* function is not supported for Siemens mARC fields.

The Siemens MLC 160 conformal arc is similar to Siemens mARC with the exceptions listed in the following table.

Table 1 Comparison of Siemens mARC and Siemens MLC 160 conformal arc techniques

	Siemens mARC	Siemens MLC 160 Conformal Arc
MLC technique name	mARC	Arc Dynamic
Dynamic collimator jaws	Possible to select	No
Dynamic dose rate (in dose segments)	Yes	No

	Siemens mARC	Siemens MLC 160 Conformal Arc
Control point spacing (gantry angle interval between control points, excluding zero-length first arclet)	Equidistant (PhotonOptimizer) or variable (3rd party plans)	User defined arclet and optimization point intervals
Zero-length arclet at arc start angle	Yes	Yes
MLC aperture definition	Optimized at optimization point (center of arclet)	Conformal to target shape
Leaf motion when beam is on	No	No
Can have static (hybrid mode) segments	Yes (3rd party plans)	No
Can have collimator rotation	Yes (3rd party plans)	No

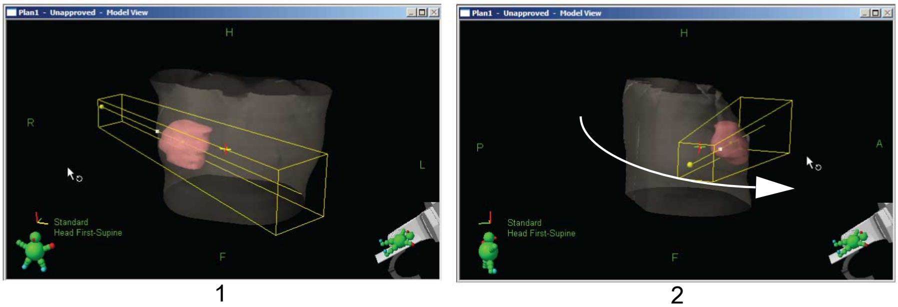
Add an Opposing Field

1. In the Focus window, select the field to add the opposing field to.
2. Choose **Insert** > **New Opposing Field**.

Rotate the Model View with the Mouse

1. Click in the Model view. The Rotate tool is automatically selected in the Model view.

   Be careful not to click on field handles or the treatment unit model, because this will modify the field.
2. Drag to rotate the image.



1. Click in the Model view anywhere but the field rotation handle or the treatment unit symbol.
2. Drag to rotate the image.

Tip: *To pan the image in the Model view, click* ***Pan*** *and drag the image to the desired position. To zoom in the image in the Model view, press Ctrl and move the mouse wheel.*

Show the BEV

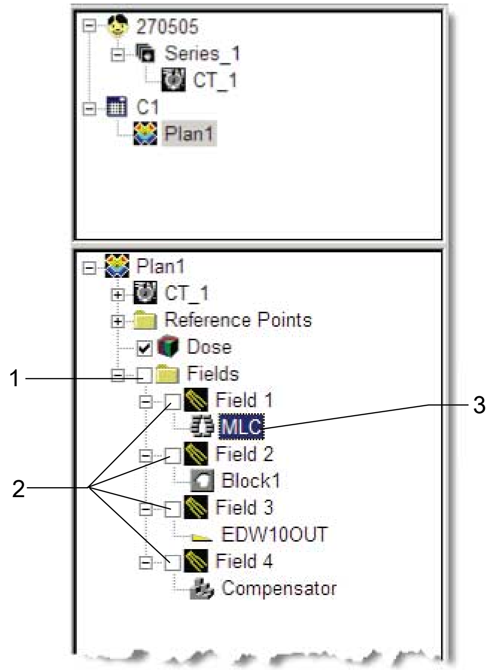
Only the active field can be shown from the Beam's Eye View.

- In the Context window, right-click the field and choose **Show Beam's Eye View**.
- To switch to another field, right-click the BEV window and choose **Set Beam's Eye View to Field**.

Showing and Hiding Fields

You can control the visibility of fields by selecting or clearing the visibility check boxes in the Focus window. You can show or hide all fields, or apply the command on a field-by-field basis. You can also show or hide fields that are part of a plan sum.

The active (selected) field is always displayed in all image views regardless of the visibility setting. Similarly, if the field accessory of a hidden field is selected in the Focus window, the accessory is displayed in the image views.



1. Select this check box to show all fields in the image views.
2. Select an individual check box to show a field in the image views.
3. The accessory of a hidden field selected in the Focus window is displayed in the image views.

Figure 18 Hidden Fields in the Focus Window

If you print a view that contains hidden fields, a warning message is included in the print-out.

Show or Hide Fields

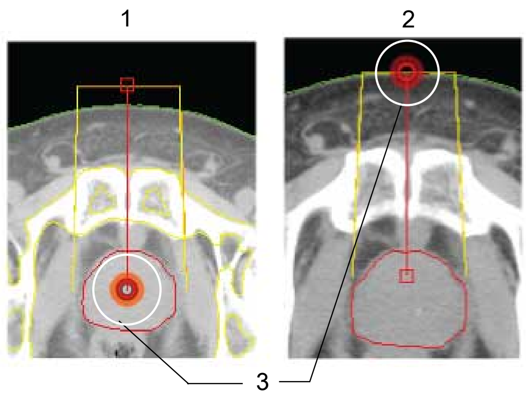
- To show or hide all fields, select or clear the **Fields** visibility check box.

- To show or hide an individual field, select or clear the visibility check box of the field.

Moving Fields

Moving a field from one position to another involves changing the location of the field's isocenter. You can move fields graphically with the mouse or by modifying their isocenter coordinates.

In the 2D views and the Model view, you reposition fields by dragging their moving handles. When a field is active its moving handle is displayed in the 2D image views and the Model view.



1. Isocentric field
2. Fixed SSD field
3. Moving handle

Figure 19 Field Moving Handle

You can also move non-coplanar fields in 2D image views. In non-coplanar fields, the isocenter is on the plane displayed in the current 2D window but the handle can be outside this plane. However, managing non-coplanar fields in the Model view or the BEV is recommended, as the field positions are shown more realistically. In the case of non-coplanar fields, the 2D image views mainly function as reference images.

Tip: *When moving fields, display the field outlines on the surface of the Body structure when positioning adjacent fields seamlessly next to each other.*

Note: *When the isocenter of a photon or electron field is outside the patient, use fixed SSD fields to make sure that the normalization used is fixed SSD normalization. Using isocentric fields with the isocenter outside the patient can result in inconsistent normalization of the dose distribution. However, even in this case, the absolute dose distribution and MU values are correct.*

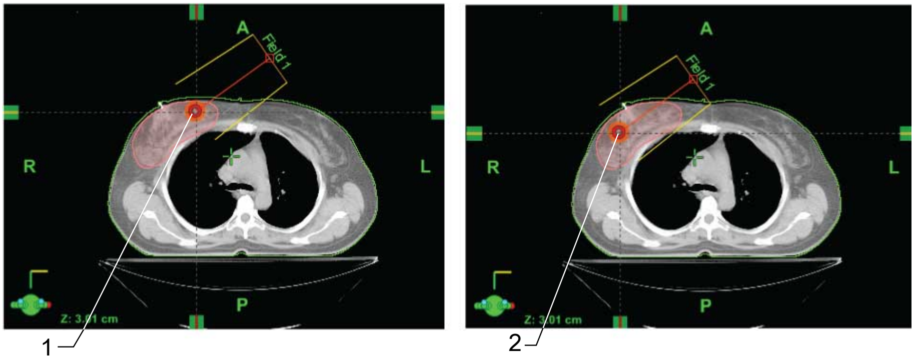
Move the Field Isocenter or Entry Point

- To move the field isocenter to the structure mass center point, go to the Focus window, right-click the field, and choose **Align Field** or **Grouped Fields to** > **Structure** to select the structure to which the field should be moved.
- To move the field entry point to the projection of the selected structure, go to the Focus window, right-click the field, and choose **Align Field** or **Grouped Fields to** > **Structure Projection** and select the structure projection to which the field should be centered.
- To move the field isocenter or entry point to the reference point, go to the Focus window, right-click the field, and choose **Align Field** or**Grouped Fields to** > **Reference Point**.
- To move the field isocenter or entry point to the intersection point of the orthogonal planes, go to the Focus window, right-click the field, and choose **Align Field** or **Grouped Fields to** > **Viewing Plane Intersection**.
- To move the entry point of a fixed SSD field to the patien’s skin, go to the Focus window, right-click the field, and choose **Align Field** or **Grouped Fields to** > **Symmetric jaws**.

Move a Field Graphically

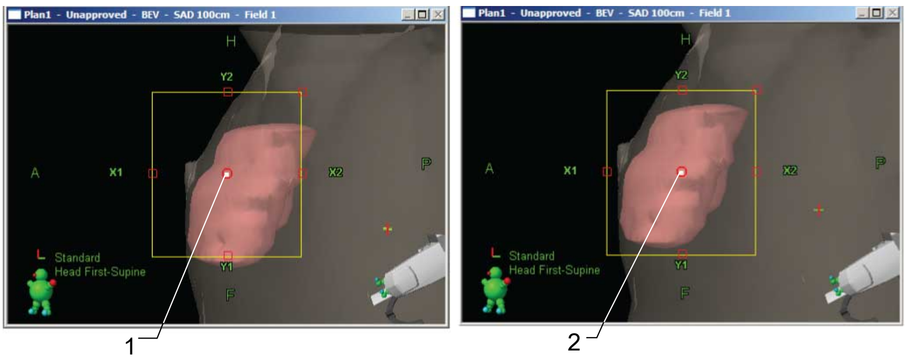
1. In the Focus window, select the field.
2. Choose **Edit** > **Select** .
3. Do one of the following:

   In a 2D view, place the mouse pointer over the field’s isocenter and drag it to a new position.



1. Place the mouse pointer over the moving handle.
2. Drag the field.

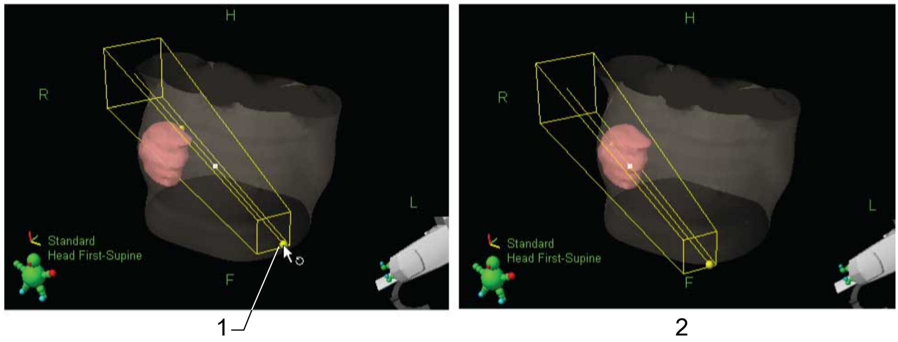
In the BEV, place the mouse pointer over the field isocenter and drag it to a new position.



1. Place the mouse pointer over the field isocenter.
2. Drag the field to the new position.

When moving fields in a 2D view or in the BEV, the viewing plane intersection follows the isocenter or field entry point. The entry point is snapped onto the Body surface if you move it close to the surface.

In the Model view, press Shift and drag the moving handle of the field.



1. Press Shift and drag the moving handle.
2. Release the mouse button to attach the field to the new position.

4. To attach the field to a new position, release the mouse button.

Move a Field by Modifying Isocenter Coordinates

1. In the Focus window, select the field.
2. Choose **Edit** > **Properties**.
3. In the **Isocenter** group box, type the X, Y and Z coordinates.

   If the field is a fixed SSD field, its entry point coordinates are displayed instead of isocenter coordinates.

   If the field is a grouped field, the field coordinate values are changed for all fields in the group.
4. Click **OK** to move the field(s) according to the new coordinate values.

Tip: *You can also edit the field isocenter coordinates in the Info window.*

Rotate Fields Graphically

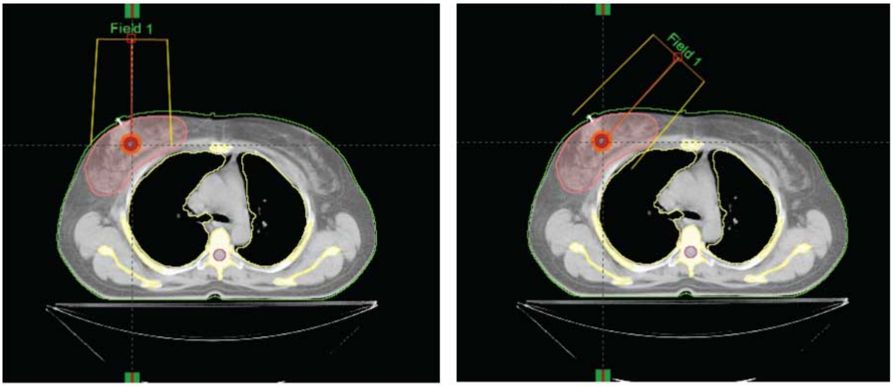
Note: *Verify all fields prior to transferring the plan to the treatment to avoid patient and treatment unit collisions.*

1. In the Focus window, select the field to rotate.
2. 2D views and Model view: Choose **Edit** > **Select** .

3. BEV: Choose **View** > **Geometry** > **Rotate** .

Tip: *It is recommended to manage non-coplanar fields in the Model view or the BEV, as the field positions are shown more realistically.*

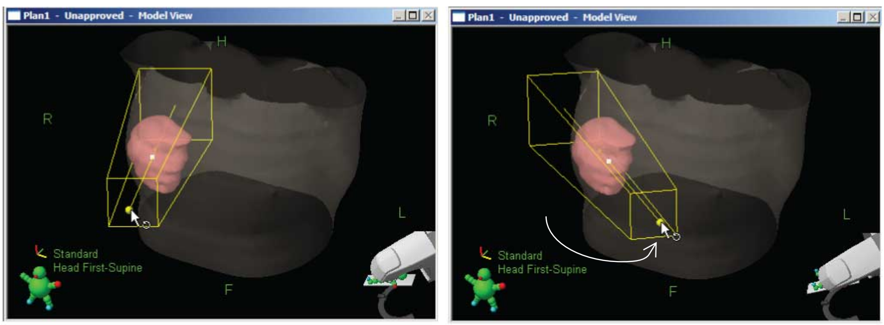
4. In a 2D image view, drag the field rotation handle to rotate the field around its isocenter. Rotating a field in an image view rotates it in all of the image views.



1 2

1. Place the mouse pointer over the field rotation handle.
2. Drag the field rotation handle.

5. In the Model view, move the field rotation handle to rotate the field around its isocenter.



1 2

1. Point at the field rotation handle.
2. Rotate the handle.

6. In the BEV, press the mouse button and move the mouse pointer to rotate the beam around its isocenter.
7. When the field is at the desired angle, release the mouse button to attach the field to the selected position.
8. BEV: To inactivate the rotation tool, select **Rotate** again.

Tip: *You can change the field rotation parameters also on the Geometry tab of the Field Properties dialog box, and change the gantry, collimator and couch rotation values on the Fields tab of the Info window.*

Change the Arc Field Rotation Span

1. In the Focus window, select the arc field.
2. Choose **Edit** > **Select** .
3. In an image view, move the arc rotation handle with the mouse to the desired stop angle to increase or decrease the rotation span.

1 2

1. Point at the arc rotation handle.
2. Increase or decrease the rotation span.

Tip: *To change the rotation direction, point at the rotation handle and right-click.*

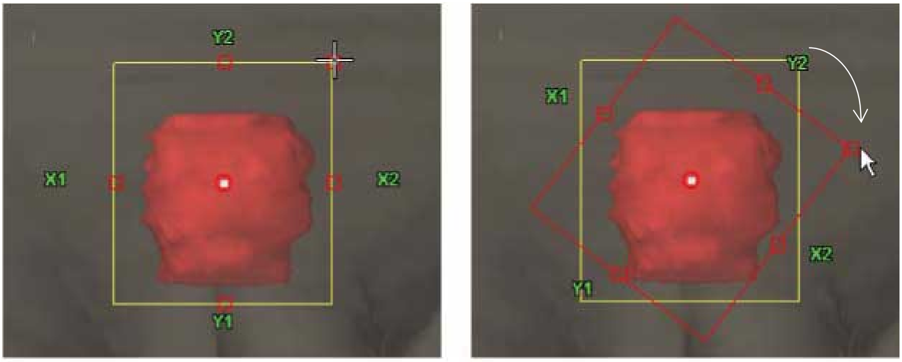
4. When the arc rotation is the desired, release the mouse button to fix the rotation span.

5. In case of a conformal arc field, the MLC leaves are closed in all segments.

Note: *You can adjust the arc rotation span also in the Arc Plane View, which shows the rotation span of non-coplanar fields more realistically.*

Change the Collimator Rotation in the BEV

1. In the Focus window, right-click the field and choose **Show Beam's Eye View**.
2. Choose **Edit** > **Select** .
3. In the BEV, move the collimator rotation handle with the mouse to rotate the collimator.



1 2

1. Place the mouse pointer over the collimator rotation handle.
2. Drag the collimator rotation handle.

4. When the collimator rotation is as desired, release the mouse button to fix the collimator rotation.

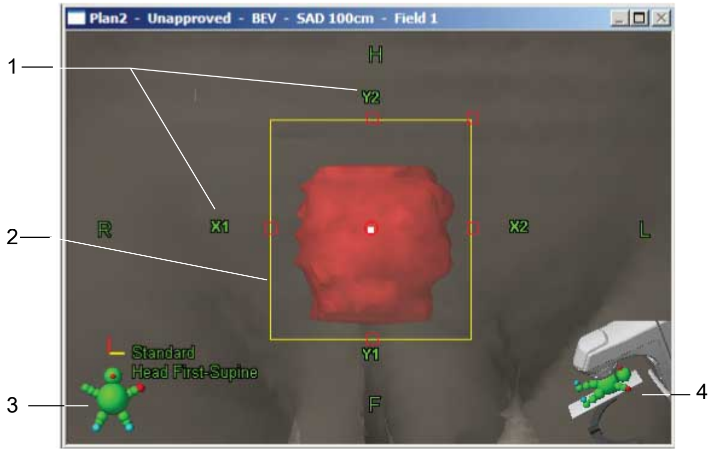
Resizing Fields

To make fields conform better to the target size and shape, you can resize them. Resizing is slightly different depending on whether the field is symmetrical or asymmetrical.

Note: *Some treatment units do not allow asymmetrical fields.*

The naming of the dimensions of a field depends on the configuration of the selected treatment unit. In the IEC system, the field dimensions are named as: X1, X2, Y1 and Y2. The figure shows a field in the BEV when:

- Dimension labeling system is that of the IEC
- Gantry, collimator and couch rotation is 0°(IEC)
- Patient orientation indicator is frontal (the indicator is facing you).



1. Field dimensions in IEC system
2. Collimator rotation 0°
3. Patient Orientation Indicator
4. Gantry and couch rotation 0°

Figure 20 Field Dimensions

Asymmetrical fields can be defined to correspond to the target volume size more accurately, and if necessary, two asymmetrical fields can also be positioned seamlessly next to each other.

Increase or decrease the field size by dragging the sizing handles on the X and Y-axes in the BEV. Depending on the field symmetry or asymmetry, the field edges are moved differently.

Related Topics

Resize a Field Graphically on page 113

Define Field Symmetry or Asymmetry

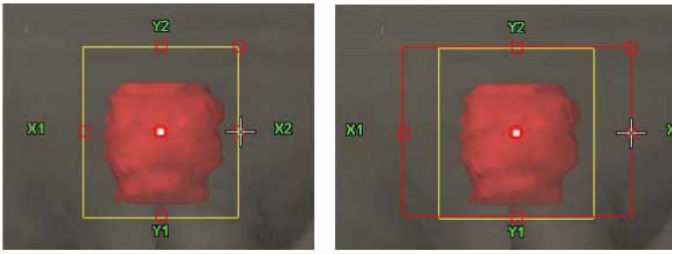
1. In the Focus window, select the field.
2. Choose **Edit** > **Properties**.

3. On the **Geometry** tab, define the field symmetry or asymmetry in the X or Y direction by clearing the **Asym. X** / **Asym Y** check box (symmetrical) or selecting it (asymmetrical).

   You can also define field symmetry or asymmetry in the Info window.

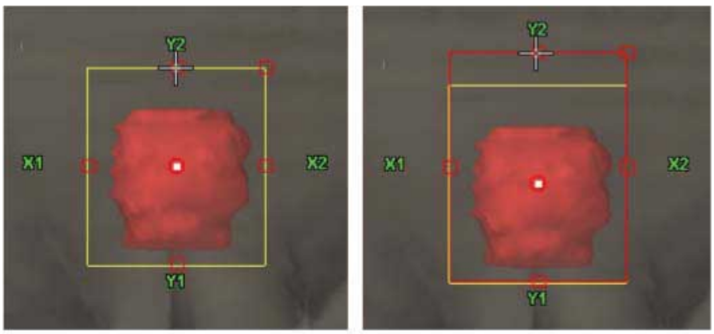
Resize a Field Graphically

1. In the Focus window, right-click the field and choose **Show Beam's Eye View**.
2. Choose **Edit** > **Select** .
3. To resize the field with the mouse, drag the sizing handles on the X- and Y-axes to change the dimension of the field.



1 2

1. Symmetrical field:Place the mouse pointer over a sizing handle.
2. Drag the handle to resize the field.



1 2

1. Asymmetrical field:Place the mouse pointer over a sizing handle.
2. Drag the handle to resize the field.

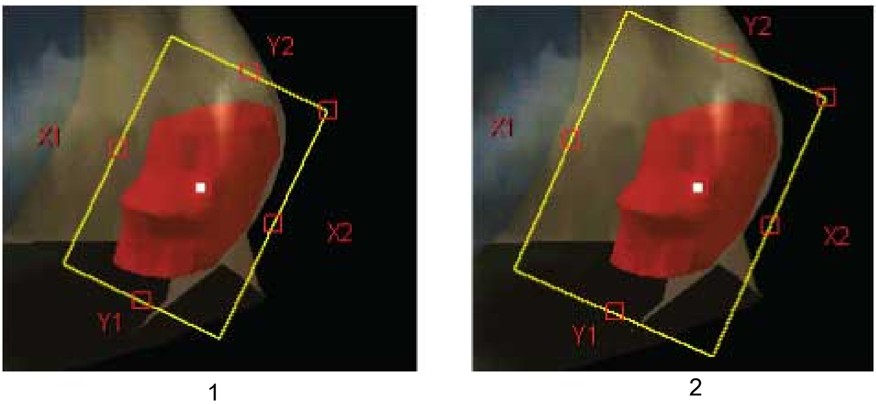
Resize a Field by Modifying the Field Properties

1. In the Focus window, select the field.
2. Choose **Edit** > **Properties**.
3. On the **Geometry** tab, define the field dimensions.
   Fixed jaws cannot be modified.
4. Click **OK**.

Note: *You also can change the field size for non-fixed jaws in the Fields tab of the Info window.*

Resize a Field by Fitting the Collimator Jaws to a Structure

1. In the Focus window, right-click the field and choose **Fit Collimator to Structure**.
2. Select the structure to which to fit the collimator jaws.
3. Define a width for either a circular or elliptical margin.



1. Circular margin using collimator coordinate system and all optimization options. The margin width is 1cm.
2. Elliptical margin using collimator coordinate system and all optimization options. Margin widths: X1 is 3 cm, X2 is 1cm, Y1 is 2 cm and Y2 is 1.5 cm.

4. Select the coordinate system.
5. Select whether to fit X and/or Y jaws asymmetrically. Select also whether to optimize collimator rotation.

6. Do one of the following:
    - To view the effect of each setting in BEV, click **Apply**.
    - To keep the changes and close the dialog box, click **OK**.

Add a Live DRR Image to a Field

A live DRR is created in Eclipse and is updated dynamically when the field geometry changes.

1. In the Focus window, select the field to which a live DRR image will be added.
2. Choose **Insert** > **New DRR**.
3. Select a suitable parameter set. For example, to examine bones in the DRR, select Bones.dps.

Tip: *In addition to the predefined parameter sets, you can create customized sets.*

4. To add live DRRs to all fields in a multi-field plan, select **Apply to all fields**.
5. To define more details for the calculation, adjust the settings manually.
6. To calculate the image, click **Apply**.

Note: *If some of the fields already have live DRRs, you are prompted to select whether you want to replace them with the new live DRR.*

7. If desired, set the live DRR as the field reference image.
8. If the plan image is part of a 4D image, you can view temporary DRR images for all 3D images in that 4D image by clicking the Play button of the Movie Control tool on the lower right corner of the image view, or by selecting the visibility check boxes of the 3D images one by one.

    The temporary DRR images created this way use the parameter settings defined in the above steps. These DRR images are calculated for temporary use and are not saved to the database.

Note: *In the case of arc fields, the live DRR image is calculated for the start angle only.*

Displaying DRR Images in the Transversal 2D Image View

This information applies to External Beam Planning and Plan Evaluation.

You can display DRR (Digitally Reconstructed Radiograph) images in the transversal 2D image view. For approved plans, the DRR will also show the selected structure outlines as layers. Structure outlines are shown as on the SAD plane. You can control the structure visibility in the Focus window by selecting or clearing the visibility check boxes. If you change the field geometry, the structure outlines are updated accordingly.

The field graticule is shown with a resolution of 1 cm.

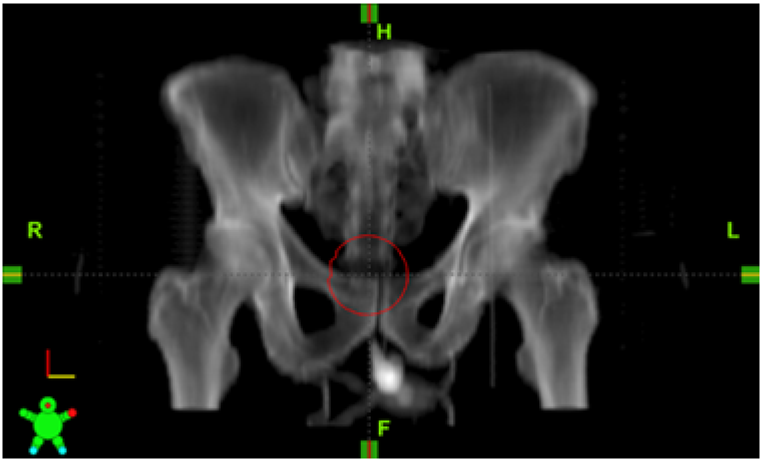


Figure 21 DRR of an Approved Photon Field in 2D Image View

Display a DRR Image in the Transversal 2D View

This information applies to External Beam Planning and Plan Evaluation.

1. In the Focus window, display the subbranches of the field whose DRR you wish to view.
2. Right-click the DRR image you wish to view and then select **Drop to view**. In Plan Evaluation, you may also be able to choose the 2D image view, depending on the view layout.

   If you are viewing an approved plan, and structure outlines have been included in the DRR, the selected structure outlines are shown on the DRR image.

Generate a Setup Field from a Photon Field

- In the Focus window, right-click the field and choose **New Setup Field from Selected Treatment Field**.

Create a New Setup Field in a Photon Plan

- In the Focus window, select the plan to which you wish to create a new setup field and choose **Insert** > **New Setup Field**.

Copy the Field Aperture to a Photon Setup Field

1. If the setup field does not contain a live DRR image, add one.
2. In the Focus window, right-click the live DRR of the setup field and then select **Copy Field Aperture from** and select the desired field.

Related Topics

Add a Live DRR Image to a Field on page 115

Copy a Field

Note: *Registration is not used when copying fields. Confirm the correct positioning of the fields when copying them between registered image sets.*

1. In the Focus window, select the field.
2. Choose **Edit** > **Copy Field** to copy the field to the Clipboard.
3. In the Focus window, select the plan to paste the field into. There is no need to select the plan, if you are copying and pasting fields within the same plan.
4. Choose one of the following:
   - **Edit** > **Paste Field** to paste the field from the Clipboard to the selected plan.
   - **Edit** > **Paste** > **Field with Reference Image** to paste the field and the reference image from the Clipboard to the selected plan. Any accessories added to the fields are copy/pasted together with the fields.
5. Define the field properties and continue by modifying the field as necessary.

Changing the Field Order in a Plan

To make treatment delivery more efficient, you can change the order of fields in a plan. Use the Field Ordering tool to sort static fields and setup fields so that they can be delivered during one clockwise (CW) or counterclockwise (CCW) gantry rotation. All the fields must have the same treatment machine and a gantry rotation defined.

If you use the clockwise or counterclockwise ordering for a plan that contains both setup and treatment fields, the setup fields are ordered first on the list. The treatment fields are ordered in their own sequence after the setup fields.

If you are working with a plan that contains arc fields, you can use the Field Ordering tool to change the order in which the fields are displayed in the Focus window.

Change the Field Order in a Plan

1. Select the plan in the Focus window.
2. Choose **Planning** > **Field Order**.
3. To change the field order, do one of the following:
   - Sort the fields by gantry rotation by clicking **Clockwise** or **Counter CW**. You cannot sort the fields by gantry rotation if one or more of the fields is an arc field.
   - Select a field in the fields list and click **Up** or **Down**.
   - Select a field in the **Fields** list, and drag it with your mouse to the desired location on the list.

   After you have finished modifying the field order, the new order is shown in the Focus and Info windows.

Chapter 9 Field Accessories

Add an MLC to a Static Field

1. In the Focus window, select the field to add an MLC to.
2. Choose **Insert** > **New MLC**.
3. If necessary, select the MLC type to use and click **OK**.

Continue by arranging the MLC leaves.

Note: *Always carefully verify the MLC parameters before fitting the MLC, especially for opposing fields.*

Add an MLC to an Arc Field

1. In the Focus window, select the arc field to which you wish to add the MLC.
2. Choose **Insert** > **New MLC**.
3. If necessary, select the MLC type and click **OK**.
4. Select the desired MLC type in the **Technique** drop-down list:
   - **Static**
   - **Arc Dynamic**: Define the number of DMLC segments for the conformal arc field. To do this, type the desired number of control points (segments), or the angle between the segments.
5. Click **OK**.

Continue by arranging the MLC leaves.

Note: *If manual blocks are used in conformal arc fields, verify the shield or aperture shapes in all segments of the arc field.*

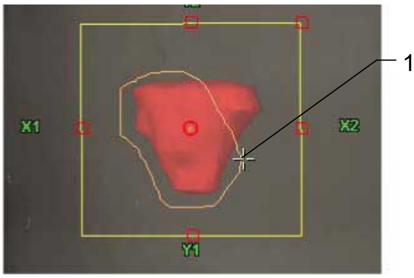
Adjust MLC Leaves with the Shaping Tool

1. If the MLC tools are not visible in the toolbar, in the Focus window, right-click the MLC and choose **Edit**.

   The 3D view changes to the BEV and the MLC tools are activated.
2. In the Focus window, right-click the MLC and choose **Shaper** .

3. Select the following:
   - Leaf edge—contour meet point
   - Closed leaf meeting position
4. In the BEV, draw the MLC outline around the target with the mouse or click the outline point by point.

Tip: *Use the Circle Cursor tool as an aid to manually draw a margin of a determined width.*



1. The MLC outline appears around the target as you move the mouse. (The Circle Cursor tool is not used in the example.)

5. To complete the MLC aperture outline, click at the starting point.
6. Optional: If you want to further adjust some of the MLC leaves, click **Select MLC Leaves** and select the leaves:
   - To select individual MLC leaves, press **Ctrl** and click each leaf.
   - To select an MLC leaf range, press **Shift** and click the first and last leaf in the range.

Adjust MLC Leaves with the Fit to Structure Tool

Note: *The Fit to Structure tool may not recognize very small structures. This may affect the result of the leaf fit in cases where the target structure consists of two parts of which one is very small.*

Note: *Always carefully verify the MLC parameters before fitting the MLC, especially for opposed fields.*

1. If the MLC tools are not visible in the toolbar, in the Focus window, right-click the MLC and choose **Edit**.

   The 3D view changes to the BEV and the MLC tools are activated.
2. In the Focus window, right-click the MLC and choose **Fit to Structure**.
3. If necessary, in the **Target Structure** drop-down list, select the structure to which the MLC leaves should conform.

Tip: *You can also fit the MLC to a selected isodose level that has been converted to a structure.*

4. Define the margin type and width.
5. To define the coordinate system, select the **BEV** or the **Collimator** option.
6. Select the following as necessary:
   - Leaf edge—contour meet point
   - Closed leaf meeting position
   - Optimize collimator jaws (in a photon plan) — The application adjusts the collimator jaws to best fit the MLC leaves to the structure.
   - Use recommended jaw positions (in a photon plan) — The application adjusts the collimator jaw positions along the MLC aperture with an additional margin. The margin is defined by the **Recommended Parallel Jaw Setback** and **Recommended Perpendicular Jaw Setback** values in RT Administration.
   - Optimize collimator rotation—The application adjusts the collimator angle to best fit the MLC leaves to the structure.

   Note: *The collimator rotation optimization is not available for conformal arc fields.*
7. Click **Fit** to arrange the MLC leaves.
8. Click **Close**.
9. Optional: If you want to further adjust some of the MLC leaves, click **Select MLC Leaves** and select the leaves:
   - To select individual MLC leaves, press **Ctrl** and click each leaf.
   - To select an MLC leaf range, press **Shift** and click the first and last leaf in the range.

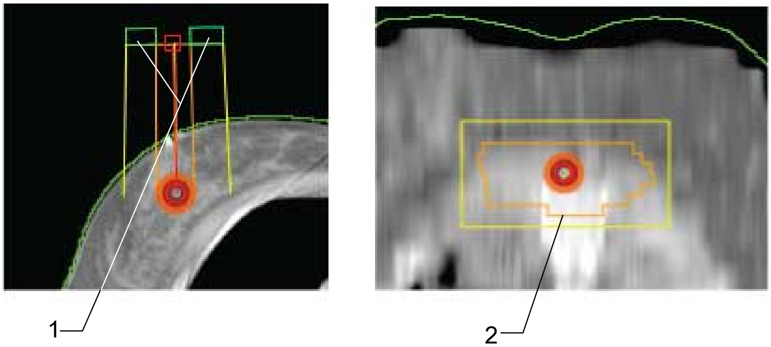
Fit the MLC Outline to Shield Critical Structures

1. In the Focus window, right-click the MLC and choose **Fit and Shield**.
2. In the list boxes, select the target structure(s) to be exposed and the critical structures to be shielded.
3. Click **Next**.
4. To define the directions of the protection margins, select the **Margins in BEV directions** or the **Margins in collimator directions** option.
5. To create the same margin width for all the structures to be radiated or shielded, select the **Use the same margins for all radiated structures** or the **Use the same margins for all shielded structures** check box.
6. Define whether the protection margins will be symmetrical or asymmetrical.
   - To define a symmetrical margin around the structures, select the **Symmetric margin** check box.
   - To use different margin widths in different directions around the structures, clear the **Symmetric margin** check box.
7. Define the width(s) of the margins in the appropriate cells.
8. Click **Next**.
9. Define the number of fields to be created.
   - To define the number of fields to be created by yourself, select the **Define the required number of fields** option and type the number in the text box.
   - To let the application determine the number of fields, select the **Automatically determine the number of fields** option.
10. Click **Finish**.

- Static MLC: The MLC leaves are arranged to expose the target and shield the selected critical organs.
- Arc dynamic MLC: New conformal arc fields are created and the MLC leaves arranged accordingly. All fields are grouped together. All other field parameters, except the MLC shape and arc direction, are the same as for the original fields.

MLC in the Image Views

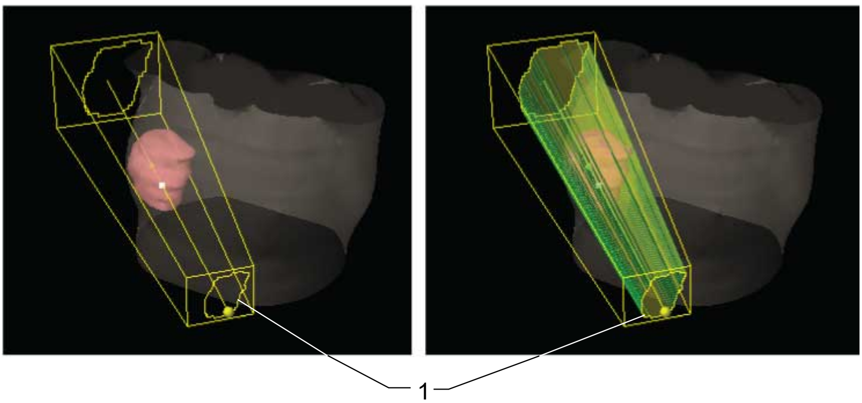
In the 2D views, MLCs are displayed at the field end closer to the treatment unit. The intersection of the field and the image plane show the MLC shape as an outline.



1. MLC shape at the treatment machine end of the field.
2. MLC outline at the intersection of the plane and the field.

Figure 22 MLC in 2D Views

The 3D views display the shape of the MLC aperture on the selected structures and inside the field rectangle at the treatment machine end of the field. If the field is visualized as a cone, the surface of the cone is formed in accordance with the MLC shape.



1. MLC outline

Figure 23 MLC in Model View

To view an MLC in the BEV, you need to select the MLC item in the Focus window.

If you have several fields with DMLC that have the same isocenter, gantry angle, couch rotation and SAD, as in Fit-and-Shield treatments, you can show the MLC shapes from all control points of all fields in the BEV.

The figure shows an active MLC in the BEV.

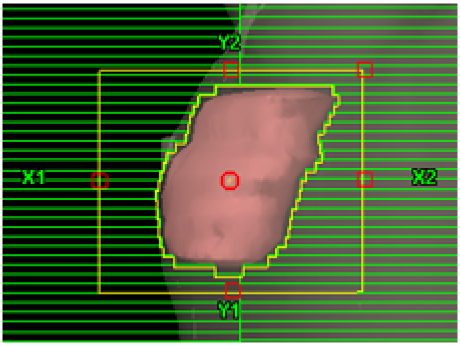


Figure 24 Active MLC in the Beam's Eye View

If a field containing an MLC is hidden, the MLC is also hidden in the image views. However, when the MLC of a hidden field is selected in the Focus window, the MLC is displayed in all image views.

MLC Icons in Photon Fields in the Context Window

MLC Icon	MLC Type
	Static MLC
	DMLC
	DMLC; dose and actual fluence calculated

Related Topics

Showing and Hiding Fields on page 103

Verify and Correct MLC Leaf Positions

Note: *Automatic correction of leaf positions is not available for all MLC types. If it is not available, correct the leaf positions manually.*

1. In the Focus window, select the MLC or DMLC.
2. Choose **Planning** > **Verify MLC Leaf Positions**.

   The Verify and Correct MLC dialog box shows all MLCs in the plan that violate the treatment unit limitations.
3. To view more information about the violating leaves, select one or more MLCs, and click **Details**.
4. To automatically correct the leaf positions, click **OK**.
5. Check the automatically corrected leaf positions.

Delete an MLC

1. In the Focus window, select the MLC.
2. Choose **Edit** > **Delete**.

Note: *You cannot delete an MLC if it is required in a field (for example in Siemens MLC 160, Elekta Beam Modulator, or Elekta Agility MLC 160 fields). In that case, right-click the MLC and choose* ***Reset MLC****. Then define all the MLC properties again.*

Add the Block Object

Note: *You can add a block only if a block add-on material has been configured for the selected treatment energy.*

1. In the Focus window, select the field to which to add a block.
2. Choose **Insert** > **New Block**.
3. Type an identification for the block.
4. Select the material for the block.

   For photon and electron fields, the **Block transmission** box displays the factor configured in Beam Configuration.
5. Click the **Aperture** or **Shielding** option button depending on the desired block type.
6. To have the block cut along the fanline of the beam, select the **Diverging cut** check box.

7. In the **Tray** group box, select the block tray in the **ID** list box.
   - The **Custom code** box displays the code used by the treatment unit to identify the add-on (if custom coding is configured for the treatment unit).
   - For photon and electron fields, the **Tray transmission** box displays the factor configured in Beam Configuration.
8. In the **Slot** group box, select the slot configured for the selected tray in the **ID** list box.
9. Click **OK** to add the block.

Continue by defining the block outlines automatically or manually.

Delineate the Block Outlines Automatically

1. In the Focus window, right-click the block and choose **Fit to Structure** .
2. In the **Target Structure** group box, select the structure around which to create the block.

   You can fit the block also to a selected isodose level that has been converted to a structure.
3. Define the margin type and width.
   - Circular Margin: Define the width of the margin.
   - Elliptical Margin: Define the width of the margin for each edge in the **X1**, **X2**, **Y1** and **Y2** text boxes.
4. Click the **BEV** or the **Collimator** option button to define the margin coordinate system.
5. Select the **Optimize Collimator Jaws** or the **Optimize Collimator Rotation** check box, if desired.

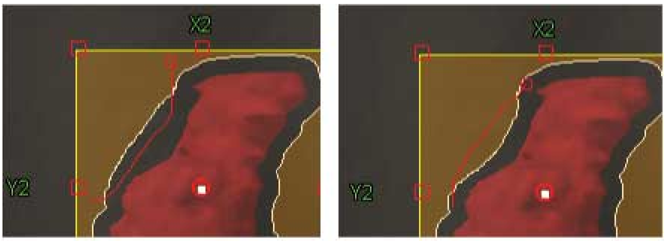
   The optimization of the collimator rotation turns the collimator jaws around the selected structure to be able to decrease the field size. The optimization of the collimator jaws moves the collimator jaws as close to the selected structure as possible to decrease the field size.

   These options are available for aperture blocks only.
6. To fit the block, click **Fit**.
7. To keep the settings and close the dialog box, click **Close**.

Reshape the Block Outline

1. Do one of the following:
   - In the Focus window, right-click the block and choose **Edit** to open the BEV.
   - Click **Freehand**  and select the drawing mode for the Freehand tool from the dialog box that opens.
2. Do one of the following:
   - To add a section to a block, draw the new outline section by beginning and ending inside the existing block outline. Right-click to finish the new outline.
   - To remove a section from a block, draw the new outline section by beginning and ending outside of the existing block outline. Right-click to finish the new outline.

   Start drawing the correction relatively close to the outline.



1 2

1. To add to the block, start drawing from inside the existing block.
2. To remove a part from the block, start drawing from outside the existing block.

3. Right-click and choose one of the following:
   - To cut or add a new part, choose **Correct**.
   - To delete the larger area enclosed by a contour, choose **Correct, Remove Larger**.

Tip: *You can display the previously calculated dose distribution and use the isodose lines as guides in making modifications*

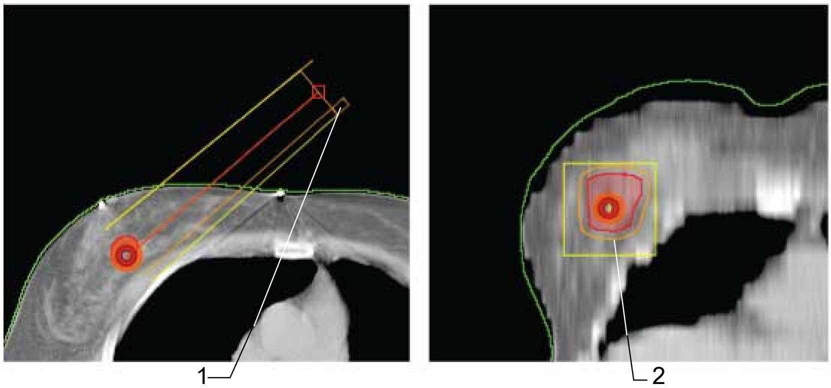
Related Topics

Using the Freehand Tool on page 61

Block Visualization

When you create a new photon block, the block icon of the aperture block or shielding block appears in the Focus window under the field.

The 2D views display blocks at the field end closer to the treatment unit. The field and plane intersection shows the actual block shape as outlines.



1. Block shape at treatment machine end.
2. Block shape at field and plane intersection.

Figure 25 Blocks in 2D View

The 3D views show the shape of the field containing a block at the treatment machine end of the field and at the end of the field visualization. The field shape can also be shown on the Body surface. If the field lines are visualized as surfaces, the surface is formed in accordance with the block shape.

Tip: *Field entry and exit shapes can be shown and hidden by right-clicking in the Model view and selecting the corresponding option.*

More information: Eclipse Proton Reference Guide.

If the 3D view is in the BEV mode, individual blocks are visualized, and the block contours can be reshaped with the Freehand tool. Areas containing block material are shaded to distinguish them from the open areas.

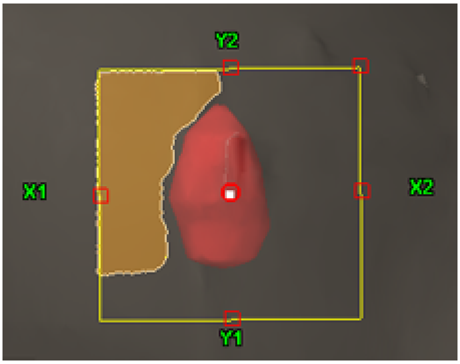


Figure 26 Shielding Block in BEV

If you select a block in the Focus window, all the contours that define it are shown in the BEV. If several overlapping block outlines have been drawn into one block object, all the outlines are displayed. However, if you select the field containing the block in the Focus window, only the net outline formed by the overlapping outlines is shown. In dose calculation, overlapping block outlines are taken into account if they belong to separate blocks. If the overlapping outlines belong to one block, the net outline is used in dose calculation.

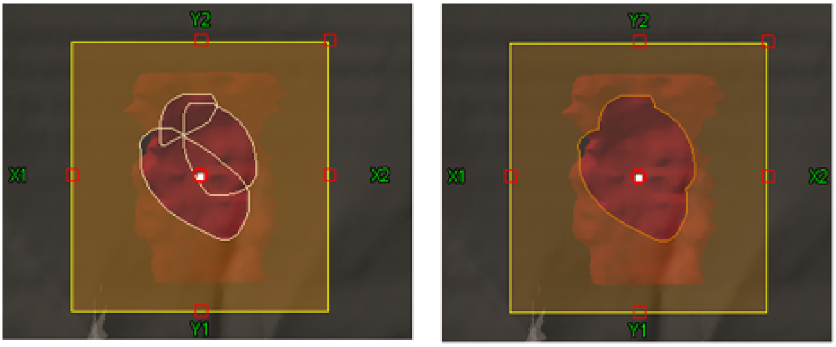


Figure 27 Individual Overlapping Block Outlines and the Net Outline

For aperture blocks, the individual block outlines are exported.

For shielding blocks, the net outline is exported.

If a field containing a block is hidden, the block is also hidden in the image views. However, when you select the block of a hidden field in the Focus window, the block is displayed in all image views.

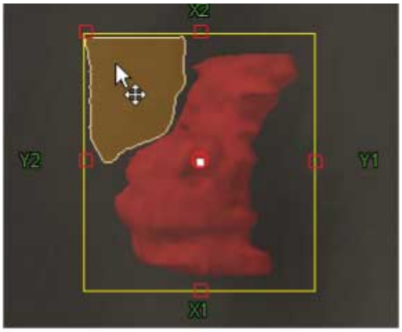
Note: *If a field contains both a block and an MLC, what is visualized in the BEV depends on what is selected in the Focus window. If the block or the MLC is selected, its' individual outline is shown. If a field is selected, the combined outline of the block and MLC is shown. In this case, for example, if some of the MLC leaves are inside the block aperture, the outline is partly formed by the MLC leaves and partly by the block aperture. However, in order to be able to calculate the dose, all MLC leaves must be outside the block aperture.*

Related Topics

Showing and Hiding Fields on page 103

Move a Block

1. Do one of the following:
   - In the Focus window, right-click the block and choose **Edit** to open the BEV.
   - In the Focus window, right-click the block and choose **Select** .
2. In the BEV, place the mouse pointer on the block.
   A white cross appears next to the mouse pointer.
3. Press the mouse button and drag to move the block.



1

1. Moving a block with the Select tool.

Copy a Block

1. In the Focus window, select the block to copy.
2. Choose **Edit** > **Copy Block**.
3. In the Focus window, select the field to paste the block to.
4. Choose **Edit** > **Paste Block**.

Delete the Block Outline

1. If the block tools are not activated, in the Focus window, right-click the block and choose **Edit** to open the BEV.
2. Select **Remove all contours** .

Cut-Outs in Electron Fields

Cut-outs are used in electron fields to specify the treatment area more precisely and to protect sensitive tissue. The shape of an electron cut-out can be rectangular or circular. The created cut-out shape and size are shown in the BEV and can be edited after adding the cut-out to the field.

Cut-outs are added to electron fields in the same way as blocks. To add a cut-out to an electron field, you first define the cut-out (block) object and then define the cut-out aperture. In the context of electron cut-outs, the block Tray ID parameter (in the Block Properties dialog box) defines the electron applicator, and the Slot ID parameter defines the applicator slot into which the cut-out should be inserted.

Add a Wedge

1. In the Focus window, select the field to add the wedge to.
2. Choose **Edit** > **Properties**.
3. Select the Accessories tab.
4. Do one of the following:
   - Standard wedge: Select the ID of the desired wedge in the **Slot** list box.
   - Dynamic wedge or motorized wedge: In the **Wedge ID** list box, select the desired wedge.
5. Motorized wedge: In the **Weight Factor**, define the weight of the wedged part of the field.

   After the dose calculation, the **Wedge Dose** box shows the coefficient used to indicate the MU of the wedged and open part of the field.
6. If the selected treatment unit has multiple slots, select the accessory in the **Slot** list boxes.
7. Click **OK**.

Wedge Visualization

Wedges are displayed in all image views. The wedge outlines are indicated in orange, and the wedges point in the selected direction. As the wedge direction is always indicated in relation to a collimator angle of 0°, the actual direction of the wedge depends on the collimator angle.

When you insert a wedge to a field, the wedge icon appears in the Focus window under the field.

In the 2D views, the wedge is displayed realistically, meaning that the wedge outline symbol is shown as seen from different angles, depending on the gantry, collimator, and couch rotation. The figure presents wedges in a transversal image.

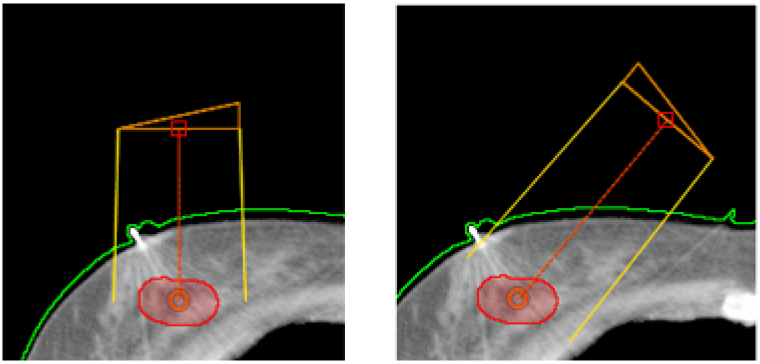


Figure 28 Wedge in a Coplanar and Non-coplanar Field, Transversal Image

In the BEV, the wedge is always indicated as a triangle fixed to the collimator jaws.

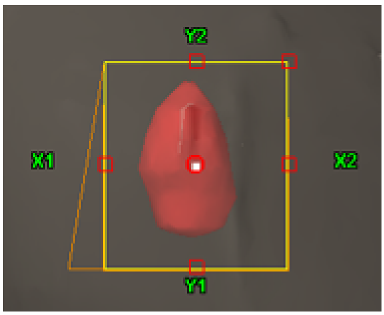


Figure 29 Wedge in a Field, BEV

In the Model view, the wedge is displayed realistically, meaning that the wedge outline symbol is shown as seen from different angles, depending on the gantry, collimator, and couch rotation.

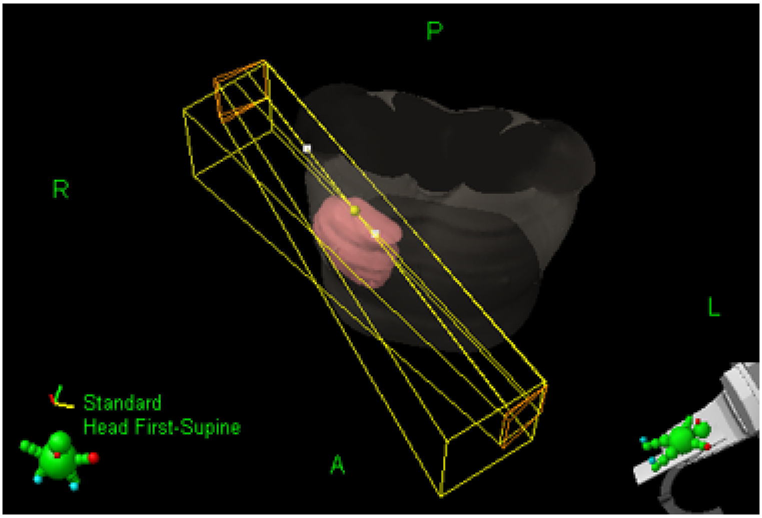


Figure 30 Wedges in Model View

If a field containing a wedge is hidden, the wedge is also hidden in the image views. However, when you select the wedge of a hidden field in the Focus window, the wedge is displayed in all image views.

Related Topics

Showing and Hiding Fields on page 103

Modify a Wedge in a Field

1. In the Focus window, select the field containing the wedge to modify.
2. Choose **Edit** > **Properties**.
3. In the Accessories tab, change the settings as necessary.
4. Click **OK**.

Add a Plane Compensator to a Photon Field

Note: *Compensators cannot be added to arc fields or electron fields.*

1. Check that you have the PBC selected as the calculation model for the compensator.
2. In the Focus window, select the photon field into which to add a standard plane compensator.

3. Choose **Insert** > **New Compensator**.
4. Define an ID for the new compensator.
5. Select the compensator material.

   The available compensator materials, and the linear attenuation factor of each compensator material are configured in RT Administration.

   More information on RT Administration: *RT Administration Reference Guide*.
6. Define the width of the penumbra margin to exclude from the compensation calculation.
7. Specify the distance between the isocenter and the compensation plane.
8. Select the compensator tray.

   The Custom Code box displays a code by which the treatment unit identifies the compensator, if configured.
9. If necessary, select the tray slot to use for the compensator.
10. Click **OK** to start the calculation.

Note: *If you change a field after adding a compensator to it, the original compensator matrix is invalidated. This is indicated by a red X attached to the compensator icon . To recalculate the compensator, go to the Focus window, right-click the compensator icon and choose* ***Recalculate****.*

Convert a Fluence into a Compensator

Make sure that the photon field has an optimal fluence, and that the maximum compensator thickness is defined in the Slot Properties in RT Administration.

1. In the Focus window, right-click the field and choose **Convert fluence into compensator**.
2. Define an ID for the new compensator.
3. Select the compensator material.

   The available compensator materials, and the linear attenuation factor of each compensator material are configured in RT Administration.

   More information on RT Administration: *RT Administration Reference Guide*.
4. Select the compensator tray.
5. Click **OK**.

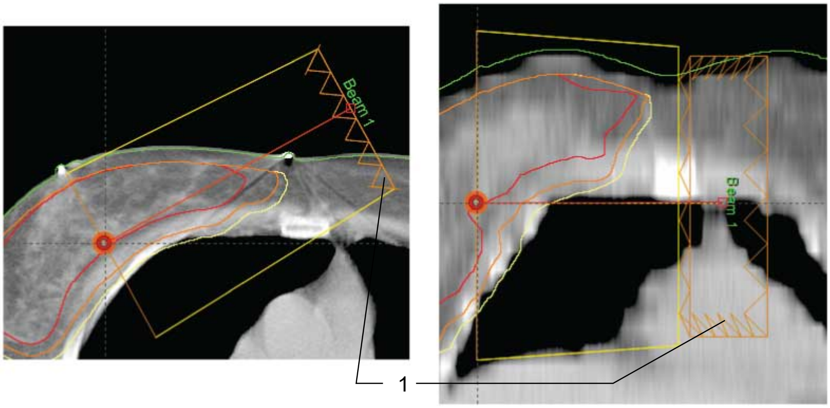
Note: *If you modify the field after converting a fluence into a compensator, the compensator matrix is not invalidated.*

Note: *The MU of the field will change when fluence is converted into a compensator. That is, the MU of the field with a compensator converted from fluence are different from the MU of a field with an MLC.*

Photon Compensator Visualization

When you create a new compensator, a calculated compensator icon appears below the field in the Focus window. If you change the field geometry, the compensator is no longer valid, and the icon turns into an invalid compensator icon .

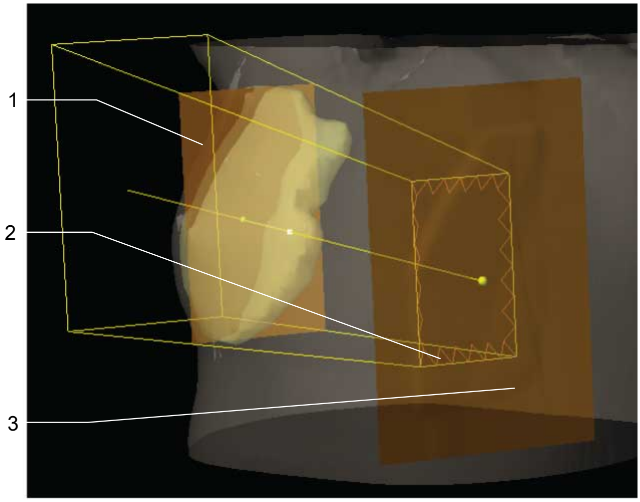
In all 2D views, compensators in photon fields are visualized as a symbol drawn next to the field entry point. The compensation plane is also visualized for plane compensators. Compensators converted from fluence have no compensation plane.



1. Compensator symbol

Figure 31 Compensator in 2D Views

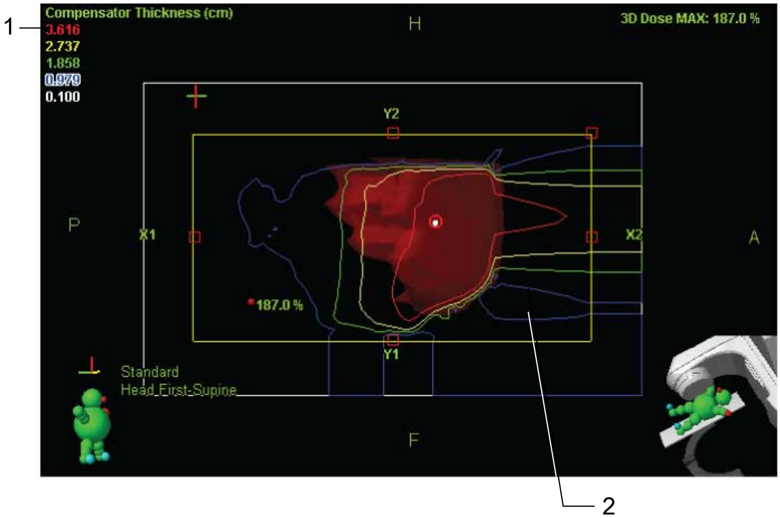
In addition to the symbol and compensation plane (for plane compensators), the Model view also shows the compensator as a 3D model. The compensation plane and compensator model are shown only when the compensator is selected in the Focus window; the compensator symbol is always shown.



1. Compensation plane
2. Compensator symbol
3. Compensator surface model

Figure 32 Compensator in Model View

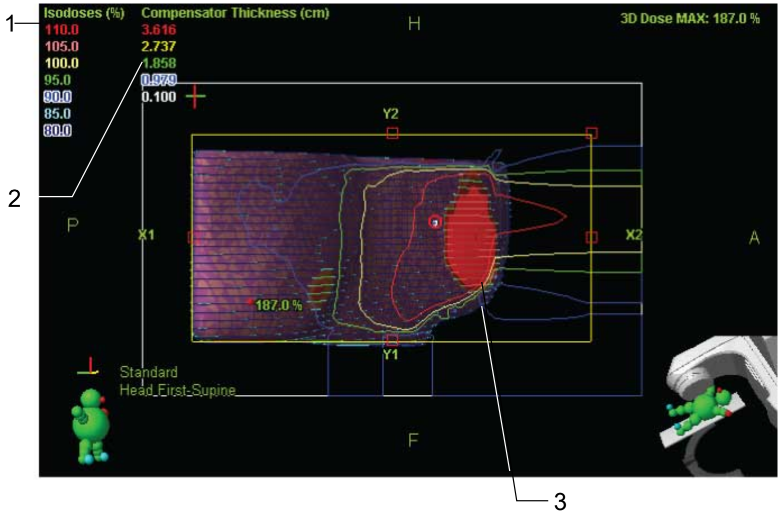
In the BEV, compensators for photon fields are visualized as isolines indicating the compensator thicknesses. The Compensator Thickness legend indicates the significance of each isoline color.



1. Compensator thickness legend
2. Compensator isolines

Figure 33 Compensator Visualization in Beam's Eye View

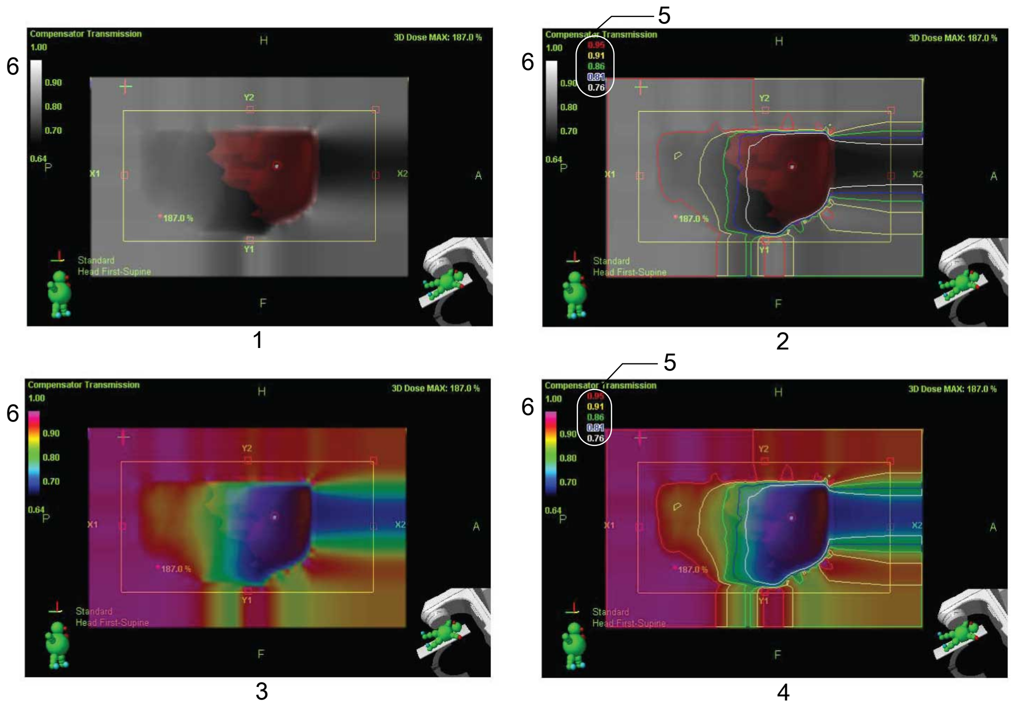
If the dose is also shown in the image views, the BEV shows the compensator for photon fields on top of the dose visualization. The Isodoses legend indicates the significance of each color in the dose visualization.



1. Isodoses legend
2. Compensator thickness legend
3. Compensator isolines

Figure 34 Compensator and Dose Visualization in Beam's Eye View

When the Compensator Editor is active, the isolevels (transmission) of a compensator can be visualized in greyscale or color wash with or without isolevel lines.



1. Compensator fluence in greyscale
2. Grayscale compensator fluence with isolevel lines
3. Compensator fluence in color wash
4. Color wash compensator fluence with isolevel lines
5. Compensator transmission legend
6. Isolevel line legend

Figure 35 Compensator Isolevel Visualization (Greyscale, Color wash and Lines)

If a field containing a compensator is hidden, the compensator is also hidden in the image views. However, when you select the compensator of a hidden field in the Focus window, the compensator is displayed in all image views. This can be useful for hiding distracting field graphics when viewing compensator fluence.

Related Topics

Showing and Hiding Fields on page 103

Using Electronic Compensators

Electronic compensation is available for open coplanar photon fields. You cannot add an electronic compensator to an electron field, and electronic compensators cannot be used for arc fields. Moreover, one field may not contain both a physical plane compensator and an electronic compensator.

Note: *When using an electronic compensator, note that:*

- *Adding an electronic compensator to a plan zeroes the total dose distribution.*
- *Eclipse is not able to convert a standard compensator into an electronic compensator if the isocenter of the field is not inside the field aperture (one of the field edges, or collimator jaws, extends over the field central axis).*
- *Evaluate the distribution of isodoses visually.*
- *Visually verify the shape of the initial DMLC before actual treatment.*
- *Verify the plan with DVH analysis before transferring it to the treatment unit.*

WARNING: Always perform QA tests on a physics phantom to make sure that the plan is correctly transferred to the treatment machine. The delivered dose must correspond to the calculated dose.

CAUTION: Verify the maximum dose and its location inside the irradiated volume after the volumetric dose calculation.

Add an Electronic Compensator

Note: *Make sure that you do not need to make any other changes in the plan. If you modify the plan after adding an electronic compensator, the compensator may not work as expected.*

1. In the Focus window, select the field into which to add an electronic compensator.
2. Choose **Insert** > **New Compensator**.
3. Define the compensator properties as for a regular photon compensator.
4. In the Focus window, right-click the compensator and choose **Convert to Electronic Compensator**.

   The plane compensator is converted into an optimal fluence.

Add an Irregular Surface Compensator to a Field

1. In the active plan, insert the necessary fields and field accessories.
2. If desired, calculate the dose distribution.
3. In the Focus window, right-click a field and choose **New Irregular Surface Compensator**.

   You are prompted to select the MLC device, if there are several of them configured to your system.
4. To specify the desired position of the irregular surface for the compensation along each fanline, type the penetration depth and click **OK**.

   The range of possible values is 0–100% penetration (0% = entry point, 100% = exit point). The default value is 50%.

   The irregular surface calculation is started. The fluence appears in the Focus window under the selected field.
5. Re-calculate the dose distribution.
6. Define the LMC settings.

   The leaf motions are calculated and MLCs appear under the fluence in the Focus window.

Note: *An irregular surface compensator does not apply any skin flash to the generated fluence. If necessary, you can apply additional skin flash to the fluence by using the Skin Flash tool.*

Create the Bolus Structure

1. Choose **Insert** > **New Bolus**.
2. Type a name, ID, and CT value for the new bolus structure. The default CT value is 0 (water in Hounsfield units).

   CT values are calibrated to correspond to electron densities in Beam Configuration.

   More information: *Beam Configuration Reference Guide*.
3. Click **OK**.

4. Use the VOI tool to define the area of the bolus on the Body surface.

Note: *The VOI tool restricts the bolus size three-dimensionally. To enable correct dose calculation taking the bolus into account, make sure you place the edges of the VOI tool appropriately. For instance, if the thickness of a bolus is 4 cm, place the edges of the VOI at least 4 cm from the surface of the skin.*

5. In the Edit Bolus dialog box, type a thickness for the new bolus structure.
6. Click **OK**.

Note: *If you modify the Body structure after creating a bolus, re-create the bolus to have Eclipse recalculate it. The bolus is not automatically recalculated after changes to the Body structure.*

Bolus Visualization

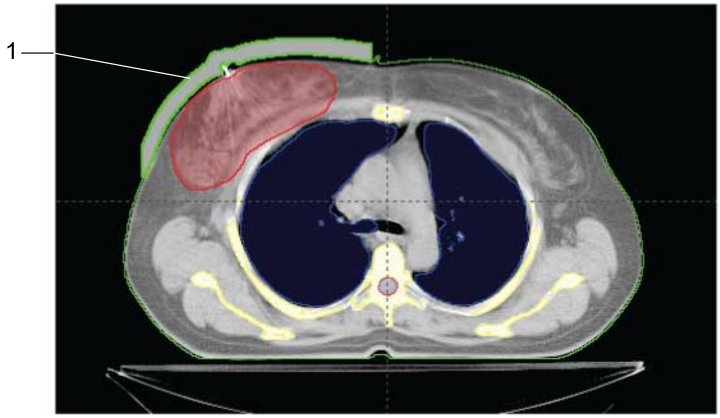
Bolus structures are displayed in the 2D image views, the Model view and the BEV. They are also shown in the Focus window similarly to other structures and reference points.

When you create a new bolus, the bolus structure icon appears in the Focus window under the structure set icon.

When you link a bolus to a photon field, the linked bolus icon appears under the field.

You can select the color and style for each bolus.

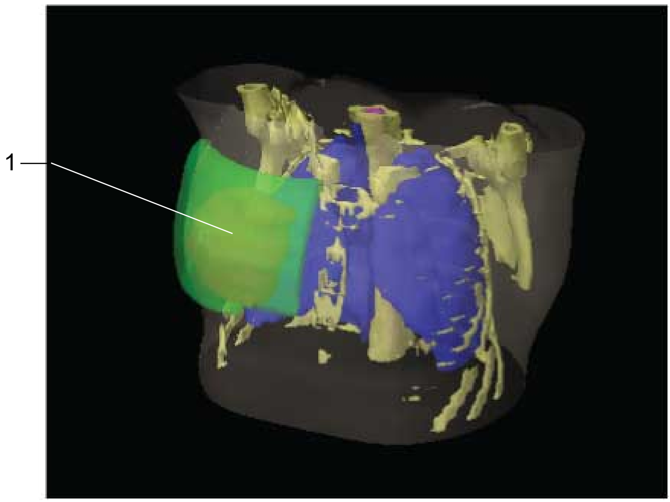
The 2D image views display bolus structures as outlines.



1. Bolus

Figure 36 Bolus in 2D Image View

The Model view displays bolus structures in the same way as other structures, for example, as solid surfaces.



1. Bolus

Figure 37 Bolus in Model View

The BEV displays the bolus structure(s) linked to the active photon field on top of other structures contained in the image and below the field outlines. You cannot edit a bolus in the BEV.

Link a Bolus to a Field

This information applies to photon and electron fields.

To include the effect of the bolus in the dose calculation, you must link the bolus to a field in the plan. The dose calculation only takes into account bolus structures linked to the fields in a photon or electron plan. If you are using the Acuros XB dose calculation algorithm with the plan dose calculation option on, you must link the bolus to all fields in the plan.

You can link multiple boluses to a single field, or one bolus to several fields.

1. To link a bolus to a field,
   - In the Focus window, right-click the field and choose **Link to Bolus**.

     A linked bolus icon appears under the field.
2. To remove the link,
   - In the Focus window, right-click the field and choose **Remove link to Bolus**.

     The linked bolus icon disappears.

Edit the Bolus Shape and Thickness with the VOI Tool

Note: *You cannot edit a bolus used in an approved plan.*

1. In the Focus window, right-click the bolus and choose **Edit Bolus**.
2. In the image views, define a new bolus shape by dragging the handles with the mouse.
3. Type a thickness in the Edit Bolus dialog box.
4. Click **OK**.

Edit the Bolus Outlines with the Freehand Tool

You can use the Freehand tool to edit bolus outlines in External Beam Planning.

Note: *You cannot edit a bolus used in an approved plan.*

1. Select the desired plane.
2. In the Focus window, right-click the bolus to be edited and choose **Freehand**.
3. Select the drawing mode for the Freehand tool.
4. Do one of the following:
   - To add a part to the bolus, start and end drawing inside the existing bolus contour.
   - To remove a part of the bolus, start and end drawing outside the existing bolus contour.
   - To move part of the bolus contour, move the mouse pointer on the bolus contour line and when the contour is highlighted, press the left mouse button down and drag the contour line.
   - To move the whole bolus, move the mouse pointer on the bolus contour line and when the contour is highlighted, press Shift and drag the contour as desired.

Related Topics

Using the Freehand Tool on page 61

Delete a Bolus

When you delete a photon field containing a linked bolus, only the link is actually removed with the field. The bolus structure remains in the image.

Note: *You cannot delete a bolus if it is linked to a photon field.*

1. In the Focus window, break all the links to the bolus you wish to delete if you are working with a photon plan.
2. In the Focus window, select the bolus.
3. Choose **Edit** > **Delete**.

Note: *You cannot delete a bolus if it is part of an approved plan.*

Related Topics

Link a Bolus to a Field on page 144

Chapter 10 Inverse Treatment Planning

Overview of Inverse Planning Features in Eclipse

The new Optimization dialog box enables you to optimize IMRT, VMAT (RapidArc and Elekta VMAT) and Siemens mARC plans. To use the new Optimization dialog box, you need to use the new Photon Optimization (PO) algorithm to optimize the plans. If you use the PRO algorithm to optimize a VMAT plan, or the DVO algorithm to optimize an IMRT plan, you optimize the plans in the IMRT and VMAT Optimization dialog boxes as in previous versions of Eclipse.

More information about optimizing IMRT plans with the DVO algorithm and VMAT plans with the PRO algorithm: *Eclipse Photon and Electron Reference Guide*.

In addition, you can generate DVH estimates and optimization objectives from DVH estimation models. When you use a DVH estimation model to generate DVH estimates and objectives in a plan, you can use all the features in the Optimization dialog box in the same way as in optimization without a DVH estimation model.

The new Optimization dialog box and the Photon Optimization algorithm support the following new features and introduce the following changes:

- The default priority of new objectives is 0, and it must be modified for the objectives to have the intended effect on the optimization.
- You can use mean dose objective in IMRT plans.
- You can add Generalized Equivalent Uniform Dose (gEUD) optimization objectives in IMRT and VMAT plans.
- You can select the optimization resolution in the Optimization dialog box (under the **Settings** expander).
- The 2D view in the Optimization dialog box shows an approximation of the dose distribution during optimization.
- The Photon Optimization (PO) algorithm uses a new voxel-based structure model where structures, DVH calculation and dose sampling are defined spatially by using one single matrix over the image.
- Before starting VMAT optimization, you need to open the Arc Geometry tool manually. It is not opened automatically by the system.
- You can optimize Siemens mARC plans in the new Optimization dialog box.
- Adding line objectives by drawing is not supported in this version. However, line objectives can be included in a DVH estimation model, and they can be loaded from optimization objective templates that have been created in the IMRT or VMAT Optimization dialog boxes. Line objectives cannot be edited in the new Optimization dialog box, but they can be deleted.

- Deleting objectives by selecting them with the mouse in the DVH view is not supported in this version. To delete an objective you need to Click the **X** on the row of the objective in the Structure list.

In the new Optimization dialog box, the settings and parameters are grouped under expanders, which are located below the structure and optimization objectives list. Some of the optimization parameters, for example *Smoothing x* and *Smoothing y* for IMRT plans and *Avoidance Sectors* and *Jaw Tracking* for VMAT plans, are located in the **Plan Information** drawer.

More information on the optimization and DVH estimation algorithms: *Eclipse Photon and Electron Algorithms Reference Guide*.

Related Topics

Optimization Dialog Box on page 149

Safety Considerations Related to Inverse Planning

WARNING: The DVH and volumetric dose shown in the Optimization dialog box in External Beam Planning are representations only. They may slightly deviate from the dose and DVH calculated for plan evaluation. Always verify the result of the optimization by separately calculating the dose and a DVH (using the Dose Volume Histogram command). Always verify the final plan using DVH analysis inside Eclipse when approving plans or plan sums for treatment.

WARNING: Always perform QA tests on a physics phantom to make sure that the plan is correctly transferred to the treatment machine. The delivered dose must correspond to the calculated dose.

WARNING: Prior to delivering an IMRT or a VMAT plan to a patient, patient-specific quality assurance should be performed and evaluated by a medical physicist or other qualified professional.

CAUTION: Verify the maximum dose and its location inside the irradiated volume after the volumetric dose calculation.

IMRT Planning Quality Assurance Related Literature

- Ezzell GA, Galvin JM, Low D, et al.: Guidance document on delivery, treatment planning, and clinical implementation of IMRT: report of the IMRT Subcommittee of the AAPM Radiation Therapy Committee. *Medical Physics* 2003; 30: 2089-2115.

- Galvin JM, Ezzell G, Eisbrauch A, et al.: Implementing IMRT in clinical practice: a joint document of the American Society for Therapeutic Radiology and Oncology and the American Association of Physicists in Medicine. *International Journal of Radiation Oncology Biology Physics* 2004; 58: 1616-1634.
- ESTRO (2008). Guidelines for the Verification of IMRT. Mijnheer B and Georg D, *ESTRO Booklet 9*.
- ACR (2007). Practice Guideline for Intensity-Modulated Radiation Therapy (IMRT). Res. 7. Radiology, ACo. Res. 17.

VMAT Planning Quality Assurance Related Literature

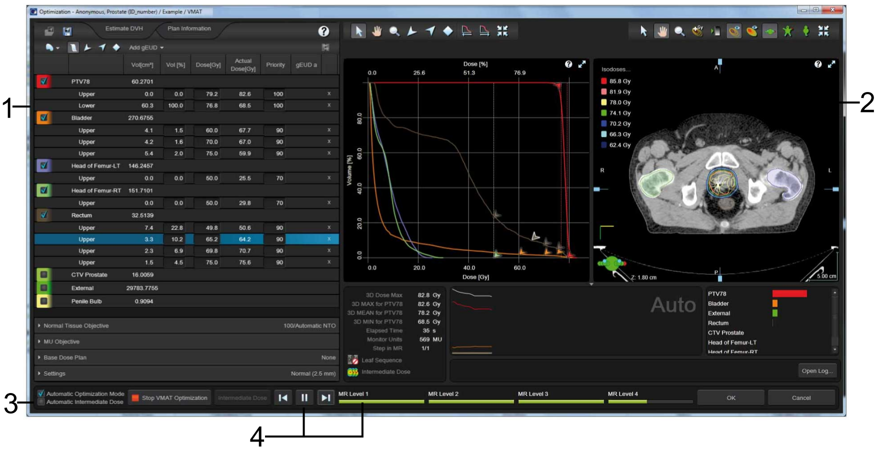
- Ezzell GA, Galvin JM, Low D, et al.: Guidance document on delivery, treatment planning, and clinical implementation of IMRT: report of the IMRT Subcommittee of the AAPM Radiation Therapy Committee. *Medical Physics* 2003; 30: 2089-2115.
- Galvin JM, Ezzell G, Eisbrauch A, et al.: Implementing IMRT in clinical practice: a joint document of the American Society for Therapeutic Radiology and Oncology and the American Association of Physicists in Medicine. *International Journal of Radiation Oncology Biology Physics* 2004; 58: 1616-1634.
- ESTRO (2008). Guidelines for the Verification of IMRT. Mijnheer B and Georg D, *ESTRO Booklet 9*.
- ACR (2007). Practice Guideline for Intensity-Modulated Radiation Therapy (IMRT). Res. 7. Radiology, ACo. Res. 17.
- Ann Van Esch, Dominique P. Huyskens, Claus F. Behrens et al. Implementing RapidArc into clinical routine: A comprehensive program from machine QA to TPS validation and patient QA. *Medical Physics* 2011; 38, 5146–5166.
- Schreibmann E, Dhabaan A, Elder E, et al. Patient-specific quality assurance for VMAT treatment delivery. *Medical Physics* 2009; 36: 4530–4535.
- Korreman S, Medin J, Kjaer-Kristoffersen F. Dosimetric verification of RapidArc treatment delivery. *Acta Oncologica* 2009; 48: 185–191.
- Nicolini G, Vanetti E, Clivio A. et al., The GLAaS algorithm for portal dosimetry and quality assurance of RapidArc, an intensity modulated rotational therapy, *Radiation Oncology* 3(24), 1–10 (2008).

Optimization Dialog Box

Note: *This information applies to optimizing IMRT, VMAT (RapidArc and Elekta VMAT) and Siemens mARC plans with the PO algorithm, and to generating DVH estimates.*

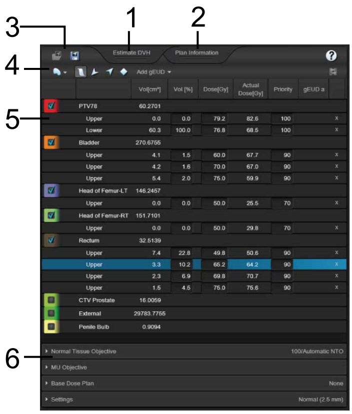
Plan optimization is controlled with the optimization objectives, which you define in the Optimization dialog box. You can either define the optimization objectives manually, use DVH estimation models or use an objective template, which restores objectives defined earlier for other plans. Some of the settings and command names are different for IMRT and VMAT optimizations.

Some of the optimization objectives and settings are grouped on expanders, which you can open by clicking on the expander title (preceded by a triangle icon pointing to the right). When an expander is closed, the currently selected values of the settings grouped under the expander are shown aligned to the right side of the expander. In addition, some settings are grouped on the Estimate DVH and Plan Information drawers that can be opened and closed by clicking on the drawer name.



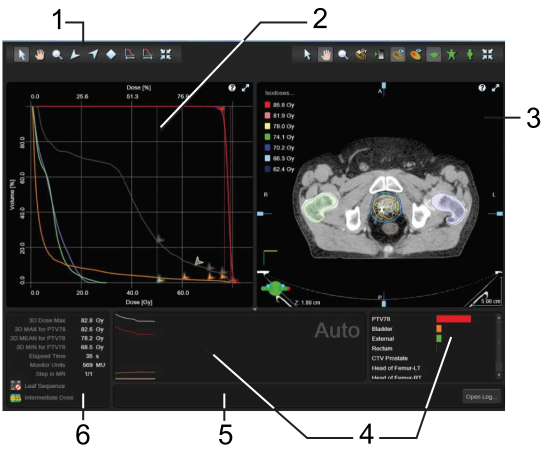
1. Shows the structures contained in the plan (excluding support structures), the volumes of the structures, the values of the defined objectives and actual doses when the plan is being optimized.
2. The 2D view shows the dose in the optimized plan.
3. Selection for using automatic optimization and automatic intermediate dose, and buttons for starting the optimization and calculating intermediate dose.
4. VMAT plans only: Click multi-resolution level buttons during optimization to move between optimization levels. You can also view an indicator of the overall progress of the VMAT optimization process.

Figure 38 Overview of Optimization Dialog Box



1. Click the Estimate DVH drawer to select a DVH estimation model to use.
2. Click the Plan Information drawer to view details of the plan, modify field specific settings, select the MLC to use if multiple MLCs are configured, view fluence maps in IMRT plans and define avoidance sectors jaw tracking use for VMAT plans.
3. Click to load objectives from an objective template and save objectives to a template.
4. Click to show or hide structures and DVH estimates, add objectives for structures and exclude structures from optimization.
5. Shows the structures contained in the plan (excluding support structures), the volumes of the structures, the values of the defined objectives and actual doses when the plan is being optimized. The volume (in cm^3) covered by an upper or lower objective is calculated using the formula: (objective volume in percentage/100) x total volume of the structure.
6. Click the expanders to define Normal Tissue Objective, MU Objective (for VMAT plans only), Base Dose Plan usage and other plan specific settings.

Figure 39 Drawers in Optimization Dialog Box



1. Click to add or modify optimization objectives graphically, or to zoom, pan and scale the DVH.
2. Shows the optimization results in the form of a DVH (and DVH estimates when DVH Estimation is used). You can also view the cost of each objective by hovering your mouse cursor over the objective.
3. The 2D view shows the dose in the optimized plan.
4. Shows the objective function as a line chart, and the optimization cost of structures.
5. This area shows information and error messages. Click the button on the right to open the log.
6. Shows information on the dose, optimization progress, statuses of leaf sequences (VMAT only), fluence (IMRT only) and intermediate dose in the plan.

Figure 40 Graphical Information in Optimization Dialog Box

You can monitor the progress of the optimization process in the Optimization dialog box, which shows a DVH calculated for each structure after each iteration, the number of iterations, and a fluence map for each field (shown on Plan Information drawer). You can evaluate the effectiveness of the dose objectives and, if necessary, modify the objectives without stopping the optimization.

On the lower right corner of the Optimization dialog box, you can view the objective function as a line chart. It shows you the overall progress of the optimization, and how close the plan is to the target dose objectives. The bars next to the line chart shows the optimization cost of structures. The area below the objective function shows error and informational messages, and you can open the log to get more information on the optimization.

Note: *For IMRT plans, when the optimization result does not improve any longer, the text Converged is displayed at the lower right part of the Optimization dialog box. If the automatic optimization is not turned on, the optimization continues until either the maximum time or maximum number of iterations limit is reached. If the automatic optimization is on, the Optimization dialog is closed and dose calculation is started automatically.*

The DVH is calculated and displayed in the DVH view for each structure, and it shows how well the pre-calculated dose will conform to the set objectives. You can also modify the objectives in the DVH view. The DVH represents the dose for contoured volumes only. Always evaluate the final dose distribution on each slice in External Beam Planning, noting hot and cold areas within the plan, especially in areas outside contoured structures. The dose shown in the 2D view in the Optimization dialog box is an approximation only.

Use Optimization Objective Tools in the Optimization Dialog Box

The tools for defining objectives for structures and for showing and hiding structures and DVH estimates are available above the Structure list in the **Optimization** dialog box.

Note: *The default priority of a new objective is 0. For the objective to be taken into account in optimization, you need to type a non-zero value in the Priority.*

1. Select the row of the structure for which you want to add an objective.

   If you use the template tools or are excluding a structure from optimization, you do not need to select a particular structure.
2. Choose from the following options:

Desired Action	Steps to be Taken
Load an objective template	Click **Load Objective Template** .
Save objective template	Click **Save Objective Template** . More information on creating objective templates: *Eclipse Photon and Electron Reference Guide*

Desired Action	Steps to be Taken
Show or hide structures	Click **Show or Hide Structures** and do one of the following: ■ To show all structures in the Dose-Volume Histogram and 2D View, select **Show All Structures**. ■ To show the structures that have objectives defined in the Dose-Volume Histogram and 2D View, select **Show All Structures with Objectives**. ■ To hide all structures in the Dose-Volume Histogram and 2D View, select **Hide All Structures**. To show or hide individual structures, select or clear the visibility check box in front of the structure in the structure list.
Show or hide DVH estimates	Do one of the following: ■ To show or hide all DVH estimates at once, click **Show or Hide DVH Estimates** above the structure list. ■ To show or hide DVH estimates for individual structures, click **Show or Hide DVH Estimates** next to the structure name in the structure list. If the structure has no DVH estimates, there is no icon next to the structure name.
Add an upper objective	Select a structure and choose **Add Upper Objective with Default Values** to define the upper dose-volume objective. Modify the default Volume and Dose values in the appropriate cells, if necessary, and type an appropriate value in the **Priority** cell.
Add a lower objective	Select a structure and choose **Add Lower Objective with Default Values** to define the lower dose-volume objective. Modify the default Volume and Dose values in the appropriate cells, if necessary, and type an appropriate value in the **Priority** cell.

Desired Action	Steps to be Taken
Add a mean objective	Select a structure and choose **Add Mean Objective with Default Values** to define the lower dose-volume objective. Modify the default Dose value in the appropriate cell, if necessary, and type an appropriate value in the **Priority** cell.
Add a gEUD objective	Select a structure and do one of the following: ▪ Click **Add gEUD** > **Upper gEUD** to define the maximum Equivalent Uniform Dose value that the structure may receive. ▪ Click **Add gEUD** > **Lower gEUD** to define the minimum Equivalent Uniform Dose value that the structure must receive. ▪ Click **Add gEUD** > **Target gEUD** to define the exact Equivalent Uniform Dose value that the structure must receive. Modify the default Dose value in the appropriate cell, if necessary, add a value for the **gEUD a** parameter and type an appropriate value in the **Priority** cell.
Exclude structures from optimization	Click **Exclude Structures from Optimization** . In the dialog box that opens, click the row of the structure that you want to exclude, and click the right arrow to move the structure to the Structures Excluded from Optimization list.
Delete an objective	Click the **X** on the row of the objective you want to delete.

Note: *If you have no structure selected when you start adding an objective, you are prompted to select a structure in the* ***Select Structure*** *dialog box that opens.*

Related Topics

Add New Objectives from an Objective Template on page 81

DVH View in the Optimization Dialog Box

The DVH is calculated and displayed in the DVH view for each structure, and it shows how well the pre-calculated dose will conform to the set objectives. You can also modify and add new objectives in the DVH view. The DVH represents the dose for contoured volumes only. Always evaluate the dose distribution on each slice, noting hot and cold areas within the plan, especially in areas outside contoured structures.

Note: *The DVH shows the absolute dose values on the x-axis at the bottom of the graph and relative dose values at the top of the graph. The conversion used during optimization is done so that 100% relative dose equals total prescribed dose.*

You can control the DVH visualization with the tools located above the DVH view. When the optimization is running, you can view the relative cost of the objectives by moving the mouse cursor on top of an objective in the DVH view. The relative cost is shown as a highlighted circle around the objective, or at the beginning of the line for line objectives. The bigger the circle, the more cost the objective has in the optimization.

If you add objectives from a DVH estimation model, the DVH view shows the estimated DVH range for structures as transparent DVH bands. The model does not create a DVH range for the plan target.

View the DVH in the Optimization Dialog Box

The DVH view in the Optimization dialog box shows DVH curves for the structures that are currently selected to be visible in the structures list, and that are not excluded from optimization.

Tip: *You can expand the DVH view by clicking the arrow icon ( ) at the upper right corner of the DVH view. You can also hide the objective function area below (click the down-pointing arrow between the DVH view and the 2D image view) to show the DVH even bigger.*

1. To show or hide a structure and its objectives in the DVH view, select or clear the visibility check box of the structure in the structure list, or select one of the options in the **Show or hide structures** tool.
2. To view a pop-up with more information on the DVH of an individual structure, hover your mouse cursor on the DVH graph of the structure.
3. To view a pop-up with more information on an optimization objective and its cost in the optimization, hover your mouse cursor on the objective in the DVH view.

4. To modify the DVH dose axis range or to zoom and pan the DVH, use the DVH tools located above the DVH view.

Use the DVH Tools in Optimization

The DVH tools are available above the Dose-Volume Histogram view in the **Optimization** dialog box.

1. Select the visibility check boxes of the structures for which you want to display the DVH curves.
2. When the DVH graph is shown in the Dose-Volume Histogram View, choose from the following options:

Desired Action	Steps to be Taken
Zoom into a defined area in the DVH graph	To zoom in, choose the **Zoom**  tool and click in the Dose-Volume Histogram view. To zoom out, choose the **Zoom**  tool and right-click in the Dose-Volume Histogram view.
Pan the zoomed area	Choose the **Pan**  tool and drag the zoomed area as desired, or use the scroll mouse: press the scroll wheel and drag the zoomed area.
Add an upper objective for a structure	Select a structure and choose **Add Upper Objective**  to define the upper dose-volume objective. Type the priority for the objective in the **Priority** text box and click with the left mouse button in the Dose-Volume Histogram view to place the upper objective. You can drag the arrow or modify the values in the appropriate cells in the structure list.
Add a lower objective for a structure	Select a structure and choose **Add Lower Objective**  to define the lower dose-volume objective. Type the priority for the objective in the **Priority** text box and click in the Dose-Volume Histogram view to place the lower objective. You can drag the arrow or modify the values in the appropriate cells in the structure list.

Desired Action	Steps to be Taken
Add a mean objective for a structure	Select a structure and choose **Add Mean Objective** to define the mean dose-volume objective. Type the priority for the objective in the **Priority** text box and in the Dose-Volume Histogram view to place the mean objective. You can drag the diamond that appears on the x-axis or modify the values in the appropriate cells in the structure list.
Scale the DVH towards the maximum or minimum dose	To scale the DVH towards the maximum dose, click **Decrease DVH Dose Axis Range** . To scale the DVH towards the minimum dose, click **Increase DVH Dose Axis Range** .
Reset the DVH geometry	To reset the DVH geometry, click the **Reset DVH Zoom or Pan** .

Tip: *When you have one of the optimization objective tools selected above the DVH view, you can define the priority for the objective in the* ***Priority*** *text box that is displayed between the DVH tools and the DVH view.*

Note: *If you have no structure selected when you start adding an objective, you are prompted to select a structure in the* ***Select Structure*** *dialog box that opens.*

2D Image View in Optimization Dialog Box

You can use the 2D view in the Optimization dialog box to view the dose distribution provided by the optimization algorithm on the 2D images during and after optimization. You can scroll through the image planes with your mouse or use the plane sliders to select a viewing plane. You can change the image viewing direction and modify the image and isodose visualization by using the image visualization tools that are available above the 2D image view.

Note: *The dose distribution shown in the 2D view in the Optimization dialog box is an approximation only. Perform the final evaluation after the real dose calculation.*

When you use Dose Color Wash to visualize the dose in the Optimization dialog box, the colors defined for the isodose lines are used to fill the area between isodose lines. This means that the colors change in steps.

Use the Image Visualization Tools in the Optimization Dialog Box

The image visualization tools are available above the 2D image view in the **Optimization** dialog box.

1. Select the visibility check boxes of the structures for which you want to display the contours in the 2D image view.
2. Choose the following options:

<table>
<tr><th>Desired Action</th><th>Steps to be Taken</th></tr>
<tr><td>Change the image viewing direction</td><td>You can display the 2D image of the patient from three different directions in the Optimization dialog box.
■ To display a frontal image, click Show Image in Frontal Direction .
■ To display a sagittal image, click Show Image in Sagittal Direction .
■ To display a transversal image, click Show Image in Transversal Direction .</td></tr>
<tr><td>Add or edit an isodose level</td><td>1. In the 2D image view, click the Isodoses button above the isodose legend.
2. In the Edit Isodose Lines dialog box, click the isodose level you want to edit in the Isodose Lines list, or click Add Isodose, and do one or more of the following:
■ Edit the isodose level in the Level text box.
■ Set the visibility for the isodose line in 2D and 3D views by selecting the appropriate check boxes.
■ Select a new color for the isodose level by clicking one of the available colors.
■ Remove an isodose from the list by clicking the x button next to the level.
3. Click OK.

The modifications of the isodose levels in done in Optimization affect the isodose set visualization in External Beam Planning and Plan Evaluation.</td></tr>
</table>

Desired Action	Steps to be Taken
Show dose in color wash or using isodose lines	■ To show dose in color wash in the 2D views, click **Show Dose Colorwash** . ■ To show isodose lines in the 2D views, click **Show Isodose Lines** .
Use the point dose tool	**1.** In the toolbar above the 2D image view, click the **Show Point Dose** . **2.** Click a point in the image where you want to display the dose. **3.** To adjust the location of the point, click and drag the point. **4.** You can also do one of the following: ■ To show or hide the dose curve for the dose at the selected point, right-click the point dose flag and select or deselect **Show Dose Curve**. ■ When a dose curve is displayed, you can change its color by right-clicking the point dose flag and selecting **Select Color**. Then select a new color from the color palette. ■ To show more information on the point in a pop-up, for example CT value and mass density, hover your mouse on the point in the image view. The information shown in the pop-up can be viewed in External Beam Planning and Plan Evaluation using the Physical Property tool. More information: *Eclipse Photon and Electron Reference Guide*. ■ To delete the point dose from the image views, right-click the point dose flag and select **Delete**.
Define the window level	**1.** In the toolbar above the 2D image view, click **Window Level** . **2.** Adjust the window/level settings of the image by doing one of the following: ■ Drag the window/level slider with your mouse. ■ Type new window/level values in the **Window** and **Level** text boxes. ■ Select one of the window/level presets from the **Presets** drop-down menu.

Desired Action	Steps to be Taken
Select the viewing plane with plane sliders	**1.** In the 2D view, point at the handle of a plane slider with the mouse. The mouse pointer visualization changes and the plane sliders become active. **2.** To show another plane in 2D views, drag the plane slider handle.
Pan the 2D image view	After zooming in on the image, the image may grow so big as not to fit in the window. To examine all parts of the image, you can shift, or pan, the image in the 2D view. **1.** Click **Pan** in the toolbar above the 2D view. **2.** Place the mouse pointer on the image and press the left mouse button. **3.** Keeping the mouse button down, move the image until you see the part you wish to examine and release the mouse button. You can also pan the image with a scroll mouse by pressing the scroll wheel and dragging the image while holding the scroll wheel down.
Zoom the 2D image views	You can zoom in and out the image views by using the **Zoom** tool or by pressing and holding down the CTRL key and scrolling with the mouse wheel. **1.** Click **Zoom** in the toolbar above the 2D view. **2.** Do one of the following: ■ To zoom in, click with your left mouse button. You can also press and hold down your left mouse button, and draw a rectangle over the area you want to zoom into. ■ To zoom out, click with your right mouse button. You can also zoom in and out by pressing down the CTRL key and scrolling with your mouse wheel.

View the Dose in the 2D View in Optimization

Note: *The dose color wash in the Optimization dialog box uses the colors defined for the isodose lines to fill the area between isodose lines, which means that the colors change in steps.*

1. To show or hide a structure in the 2D view, select or clear the visibility check box of the structure in the structure list, or select one of the options in the **Show or hide structures** tool.
2. Scroll the image or use the plane sliders to change the viewing plane and use the image visualization tools above the 2D image view to modify the image and dose visualization.
3. Use the Point Dose tool to view the dose value at a point you click. To display a dose curve for the dose value, right-click the point dose flag and select **Show Dose Curve**.

Viewing Plan Information in Optimization

The Plan Information drawer shows the following information and parameters of the plan:

- The **General** expander shows patient, course, image and Plan IDs. This information is read-only.
- The **Dose Prescription** expander shows the values for prescribed percentage, number of fractions, dose per fraction and total dose. This information is read-only.
- The **Treatment Unit** expander shows the ID, energy and dose rate of the treatment unit used in the plan. This information is read-only.
- The **MLC** expander shows the MLC that is currently used in the plan. If the treatment unit has several MLCs configured, you can change the MLC by selecting another one from the **ID** drop-down menu.
- The **Fields** expander shows details of the field setup in the plan and optimization parameters you can define separately for each field.
  - For IMRT plans you can also select which fields are optimized, and define X smooth, Y smooth and fixed jaw settings for each field.
  - For VMAT plans you can define whether jaw tracking is used.
- In the **Avoidance Sectors** expander (shown for Varian VMAT and Siemens mARC plans only) you can define avoidance sectors in which dose is not delivered. If you are using only one avoidance sector, always enter the gantry angle ranges in the **Avoidance Sector 1** column.

In addition, for IMRT plans the Plan Information tab shows the fluence for the currently selected field below the Fields list. You can modify the fluence visualization by selecting or clearing the **View with Interpolation** and **Use Color** options.

More information on VMAT and IMRT specific optimization parameters, jaw tracking, fixed jaws and avoidance sectors: *Eclipse Photon and Electron Reference Guide*.

IMRT Optimization

Intensity-modulated radiotherapy (IMRT) planning in Eclipse creates highly conformal dose distributions by iteratively optimizing the beam intensity modulation to satisfy a set of user-defined dose volume objectives. IMRT plans enable you to deliver a relatively uniform dose distribution to a target volume while sparing surrounding healthy tissue. Eclipse IMRT planning combines intensity modulation and inverse planning to accomplish this goal.

IMRT plans are created following a particular workflow, which differs slightly from the workflow followed in conventional planning:

1. Contour patient structures, including targets and avoidance volumes. Since IMRT plans produce dose distributions that are highly conformed to the shapes of the targets, greater precision is typically required in defining structures for IMRT plans than in conventional planning.
2. Add fields to the IMRT plan. Use clinical protocols and plan templates, or add the fields manually.

Note: *Eclipse IMRT does not automatically select field angles for plans. You can use Beam Angle Optimization before IMRT Optimization to optimize the field angles.*

3. Optimize the IMRT plan. Define a set of dose-volume objectives for each target and critical structure of concern, and start the optimization. You can also define fluence smoothing parameters to achieve more deliverable DMLC sequences and fewer MU to treat the fields.
4. Calculate the dose and continue planning and plan evaluation as usual.

The following types of optimization objectives are used in IMRT optimization:

- Lower objectives, which ensure that a volume receives a minimum dose. Any structure with a lower dose-volume objective is considered to be a target.
- Upper objectives, which limit the dose to any structure and can be used to enhance dose uniformity in target volumes.
- Mean objectives, which are used to decrease the dose that a structure receives.
- gEUD objectives; Generalized Equivalent Uniform Dose (gEUD) is a uniform dose that, if delivered over the same number of fractions, yields the same radiobiological effect as the non-uniform dose distribution of interest. Structures with Lower gEUD and Target gEUD objectives are considered to be targets.

Note: *If you use the DVO algorithm to optimize the plan, mean objectives and gEUD objectives are not available.*

The optimization process is interactive: you can interrupt the iteration at any time during the optimization process and change the dose objectives according to the results of the optimization. The interactive optimization of the objectives achieves better dosimetric results in less time. You can also leave the optimization process to terminate on its own. The optimization stops when one of the following conditions are met:

- The objective function curve does not change anymore (in automatic optimization).
- The maximum time limit has been reached.
- The maximum number of iterations has been reached.

More information about the algorithms used in dose optimization: *Eclipse Photon and Electron Algorithms Reference Guide*.

Create an IMRT Plan

This information applies when you are using the PO algorithm to optimize the plan.

Note: *Eclipse IMRT does not automatically select field angles for plans. You can use Beam Angle Optimization before IMRT Optimization to optimize the field angles.*

Tip: *If you use the Acuros XB dose calculation algorithm, contour all structures that have a mass density value above 3.000 g/cm^3 and assign materials for them. Otherwise, the intermediate dose calculation is disabled.*

1. Insert new plan.
2. Insert the fields in the plan one by one or use a template.

   IMRT optimization is available for static photon fields. Blocks, wedges, compensators or static MLCs cannot be used (MLCs can be present in those treatment units that require an MLC defined in the field). The treatment unit used in the plan must be configured with a dose-enabled MLC and all fields must use the same treatment unit. If the fields in the plan do not meet these requirements, the plan cannot be opened in the Optimization dialog box.
3. Define the dose prescription for the plan.
4. Select the PO algorithm as IMRT Optimization algorithm in the **Calculation Models** tab.
5. Choose **Planning** > **Optimization** > **Optimize**.

6. To exclude structures from optimization, click **Exclude Structures from Optimization** and select the structures to exclude.
7. Select structures for which to display the DVH and define the optimization objectives or load the objectives from an objective template.

Note: *Indicate all desired doses as unfractionated total doses.*

You need to add at least one lower objective, or gEUD lower or gEUD target objective for one of the target structures to be able to start the optimization process. More information on the optimization objectives and parameters: Eclipse Photon and Electron Reference Guide.

8. To add a gEUD objective with default values for a structure, select the structure and then select one of the options in the **Add gEUD** menu.
9. Define priorities for the optimization objectives.

Note: *The default priority of a new objective is 0. If the priority of an objective is 0, the objective will not have the intended effect on the optimization. The priority determines the relative importance of the optimization object in relation to other optimization objects.*

10. To minimize the dose received by organs outside the target structures for which objectives have been defined, open the **Normal Tissue Objective** expander, select **In Use** and define the Normal Tissue Objective parameters.
11. To modify the default calculation parameters, open the **Settings** expander and define the following values:
    - **Maximum iterations:** Number of iterations after which Eclipse IMRT stops the optimization process.
    - **Maximum optimization time:** Time (in seconds) after which Eclipse IMRT stops the iteration.
    - **Resolution:** The voxel resolution of the spatial matrix that is used for modeling structures.
12. To modify the default MLC and smoothing parameters, open the **Plan Information** drawer and do the following:
    - Click the **MLC** expander, and select the MLC to use.
    - Click the **Fields** expander, and select which fields are to be optimized.
    - To avoid drastic changes in adjacent fluence transmission values, define the X Smooth or Y Smooth parameters.
    - To prevent the automatic resizing of the X and Y jaws to frame the completed irradiated area outline (CIAO), select the **Fixed jaws** option.

13. Define how the field fluence is displayed by selecting or deselecting the **View with interpolation** and **Use color** options.

Tip: *To view the field fluence when the optimization is running, select a field in the Fields list.*

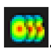
14. Automate the optimization process, if so desired.
    - To start leaf motion calculation and final dose calculation automatically after optimization, select the **Automatic Optimization Mode** check box.

      Note: *If multiple LMC algorithms are available, make sure that the default LMC algorithm has been defined for each MLC model in **Tools** > **Task Configuration**.*

    - To calculate an intermediate dose automatically during the optimization, select the **Automatic Intermediate Dose** check box. The program calculates an intermediate dose during the optimization, and uses it to improve the optimization results. If you want to return to manual intermediate dose calculation, clear the check box.

Note: *If the Automatic Intermediate Dose calculation is on intermediate dose calculation starts when there is no further change in the objective function. Automatic Optimization can be enabled for IMRT plans at any time during the optimization.*

15. Click **Start IMRT Optimization**.

    If the plan has been optimized earlier, you can choose to continue the previous optimization or start from the beginning. You can also select to use the calculated dose from the previous optimization as an intermediate dose.
    - You can change the dose objectives during the optimization.
    - To manually calculate an intermediate dose, click **Intermediate dose**. You can do this several times during the optimization.
    - To interrupt the optimization, click **Stop IMRT Optimization**.
    - When the objective function curves for all structures are going down after the last modification of the optimization objectives or other changes to settings that can be made when the optimization is running, the Optimization dialog shows that the optimization has converged. This means that the PO algorithm has determined that the improvement of the objective function has slowed down to such an extent that the optimization has converged to a solution.
    - Once there is a valid optimal fluence, the fluence icon changes from  to . Once intermediate dose has been calculated, the intermediate dose icon changes from  to .

16. When the optimization is finished:
    - If you use automatic optimization, the program proceeds automatically to leaf motion calculation and final dose calculation.
    - If you use manual optimization, click **OK**. You need to start the dose calculation manually. When prompted to do so, select the leaf motion calculator.

Note: *If, after the Optimization dialog box is closed, a message is shown that the plan normalization mode has been changed to No Plan Normalization or prescribed percentage value has been changed to 100%, you can change the values back after optimization and dose calculation.*

After optimization, evaluate the dose distribution visually. Verify the maximum dose and its location inside the irradiated target after dose calculation. Visually verify the shape of the initial DMLC before treating.

Related Topics

Add New Objectives from an Objective Template on page 81

Optimal and Actual Fluences

Eclipse IMRT generates optimal fluences as output from the fluence optimization. The optimal fluences are created by adjusting the ray weights using a gradient optimization method. Each beam is divided into small elementary pencil beams, and the dose contributions of each pencil beam to the target and critical organ grid points are computed.

The optimal fluences represent the ideal field modulation in which the physical and mechanical characteristics of the DMLC device have not yet been taken into account. Often, the optimal fluence cannot be delivered in practice; therefore, it is later converted into an actual fluence. The optimal fluences are converted into leaf motion patterns by the Leaf Motion Calculator (LMC) program.

On the basis of the leaf motion patterns, the dose calculation algorithm calculates one actual fluence per field. The resulting actual fluence matrices produce a three-dimensional dose distribution for final evaluation. If you make changes in the plan, for example, change the calculation model or calculation options, and the dose becomes invalid, the whole DMLC is removed. You have to calculate the leaf motions and dose again. Similarly, you have to re-calculate the leaf motions and the dose if you make changes to the dosimetric parameters of the MLC in Beam Configuration and then return to a previously calculated plan, because the dose calculation is based on the original actual fluence.

Note: *The actual fluences are produced during dose calculation only if you use version 11.0 or later dose calculation algorithms and LMCs. If you use an older dose calculation algorithm and LMC, the actual fluences are calculated by the LMC. You cannot use version 11.0 or later dose calculation algorithms together with older LMCs, or vice versa.*

More information: *Eclipse Photon and Electron Algorithms Reference Guide*.

Tips for Using IMRT Optimization

If you accidentally define a target structure outside the body or bolus outline, the DVO or PO algorithms may produce high fluence values for some field directions. To overcome the problem, remove the parts outside the body with contouring tools.

Indicate all desired dose objectives and doses as unfractionated total doses.

Remember that the optimization uses inhomogeneity correction by default. If a plan contains support structures and you want them to be taken into account in optimization, inhomogeneity correction must be used.

You can prevent unwanted hot spots outside the target by defining suitable values for the Normal Tissue Objective. Hot spots resulting from the dose distribution may be reduced by adding new volumes to the hot spot area, defining objectives as you would for critical organs, and then re-optimizing the plan.

You have to re-calculate the leaf motions and the dose if you make changes to the dosimetric parameters of the MLC in Beam Configuration and then return to a previously calculated plan, because the final dose calculation is based on the actual fluence.

If you are re-optimizing a plan, remove all lower objectives from structures that are no longer needed in the optimization. If you only set the priority of lower optimization objectives as zero, the objectives still affect the optimization results.

VMAT Optimization for RapidArc

RapidArc is Varian's volumetric modulated arc therapy that delivers a highly conformal volumetric dose distribution. (Other manufacturers' VMAT techniques are also supported.) The gantry rotation speed, the shape of the treatment aperture and the delivery dose rate automatically change during the gantry rotation. The input for the calculation of the modulations is determined by using VMAT optimization in External Beam Planning. The modulations are calculated by the Photon Optimization (PO) or PRO algorithms.

Note: *More information on the PO and PRO algorithms: Eclipse Photon and Electron Algorithms Reference Guide.*

VMAT plans are created following a particular workflow:

1. Contour patient structures, including targets and avoidance volumes. Since VMAT plans produce dose distributions that are highly conformal to the shapes of the targets, greater precision is typically required in defining structures for the plans than in conventional planning.
2. Add one or more fields to the VMAT plan. Use the Arc Geometry tool, add fields one by one, or use a template.
3. Optimize the VMAT plan. Define a set of dose-volume objectives for each target and critical structure of concern, and start the VMAT optimization. You can also use a template to add the optimization objectives in the plan.
4. Calculate the final dose to produce the volumetric dose distribution for final evaluation. Use plan normalization to adjust the total dose level of the plan.

The following types of optimization objectives are used in VMAT optimization:

- Lower objectives, which ensure that a volume receives a minimum dose. Any structure with a lower dose-volume objective is considered to be a target.
- Upper objectives, which limit the dose to any structure and can be used to enhance dose uniformity in target volumes.
- Mean objectives, which are used to decrease the dose that a structure receives.
- gEUD objectives; Generalized Equivalent Uniform Dose (gEUD) is a uniform dose that, if delivered over the same number of fractions, yields the same radiobiological effect as the non-uniform dose distribution of interest. Structures with Lower gEUD and Target gEUD objectives are considered to be targets.

Note: *If you use the PRO algorithm to optimize the plan, gEUD objectives are not supported.*

Select the Initial Arc Field Geometry Using the Arc Geometry Tool

Before starting the optimization, you need to open the Arc Geometry Tool to select the initial arc geometry.

1. To open the Arc Geometry Tool prior to starting optimization, select **Planning** > **Arc Geometry Tool**.

   The tool opens, showing the suggested arc setup for the currently defined target in the plan.
2. Select new or multiple targets in the **Targets** list, if necessary.

   To select multiple targets, press the **Ctrl** key and click the targets in the list.

Tip: *You can click **Apply** after any modification you make in this tool to see the effect of each individual modification.*

3. Verify the coverage on the target surface displayed in BEV or Model View while the Arc geometry tool is open.

Tip: *You can modify the field size and collimator rotation graphically in the BEV or modify the values in the Fields tab of the Info Window. To get an unobstructed view of the target in BEV and Model view, deselect the structure set in the Focus window, and then select the visibility check box of the target structure.*

4. To modify the suggested arc setup, do one or more of the following:
   - Specify a new target margin in centimeters.
   - Specify a new collimator rotation. If you have multiple arc fields at one isocenter, select **Use Complement Angle** to get a more uniform dose distribution.
   - Select the first arc rotation direction (for plans with multiple arc fields only) in the **First Arc** group box.
   - In plans with multiple isocenters, select the treatment order in the **Treatment Order** group box.
5. Click **Apply**.

   The tool modifies the field geometry. The target coverage visualization is updated in the image views.

Tip: *To see what kind of results using another predefined setup would give, select another setup in the Setup list and click **Apply**.*

6. Verify the coverage displayed in the image views.

Note: *The tool shows a warning text at the bottom of the dialog box if parts of the target are not irradiated at all, if parts of the target are irradiated with an open field (collimator X opening is larger than 30 cm), if the collimator X opening in a single field plan is larger than 20 cm, or if there is a risk of collision (when couch rotation is less than 15 degrees).*

7. Do one of the following:
   - Click **To Optimization** to open the Optimization dialog.
   - Click **Close** to close the tool.

You can now continue to VMAT optimization.

Defining the Initial Arc Field Geometry

The Arc Geometry Tool can be used to get a good initial arc field geometry before starting VMAT Optimization, and to estimate whether the target would be better covered and whether better modulation results would be reached when using more than one isocenter or another arc setup. If the treatment target is very long (such as spine), or if the target is laterally wide or far from body center, the MLC hardware limitations, such as leaf span limitations, may prohibit achieving proper modulation. The tool uses heuristic rules based on the geometry of the target to determine how many isocenters are needed and where they should be placed. However, if the tool suggests an arc setup with one isocenter, the isocenter location is not changed.

You need to open the Arc Geometry Tool to select the initial arc geometry before starting the optimization. The Arc Geometry Tool takes the current target in the plan and suggests an arc setup based on the target size and location. It sets field order for the fields it creates, and tries to minimize unnecessary gantry and couch movements. If you already have multiple fields in the plan, the tool suggests an arc setup, but does not create it until you click Apply. You can use the suggested setup for the plan, or select another setup from the list and see how that affects the target coverage.

Note: *In arc setups with multiple isocenters, the isocenters are set at the center of the VOI. If a setup with one isocenter is selected, the original isocenter location is preserved.*

The tool shows all contoured structures in the target list. If necessary, you can select a new treatment target or multiple targets in the tool, and the suggested setup changes accordingly. If there are multiple MLCs configured for the treatment machine, you can select which of them to use. You can also specify a target margin, collimator rotation, and rotation direction for the first arc field. In case of long targets or multiple isocenters, you can also specify treatment order (Head to Feet or Feet to Head).

The tool uses a complement rule for collimator rotation if there are two arcs at one isocenter in the suggested setup. In these cases, the Use Complement Angle option in the tool is selected. This is done to improve target coverage. Using two fields at the same isocenter together with the complement angle allows you to use smaller fields than when using one field; however, you need to adjust the field sizes manually.

Note: *The Arc Geometry Tool does not perform any form of field size optimization. It only adjusts the field by fitting it to the target with the specified margin. Try to keep the fields as small as possible, and prefer using fields smaller than 14.5 cm in the X direction. When using setups with two arcs at the same isocenter, it is often beneficial to reduce the X field size. Reduce the X1 size of one arc and X2 size of the other arc so that the size of each field is smaller than 15 cm. For Elekta treatment units, reduce the Y field size (Y1, Y2) correspondingly. This will improve the MLC modulation potential.*

Predefined Arc Field Setups

The Arc Geometry Tool includes a number of predefined arc setups. The tool selects an arc setup for the target as follows:

Table 2 Arc Setup Selection Criteria

Setup Selection Criteria:		Suggested Setup:		
Target size / placement:	**MLC:**	**Setup**	**Collimator Rotation**	
If target size along machine y-axis is more than 75 cm	If MLC Y-span is 40 cm	3 isocenters – 3 full rotations	10° and 350°	Target is longitudinally divided into three parts by VOIs.
If target size along machine y-axis is more than 42 cm	If MLC Y-span is 22 cm	3 isocenters – 3 full rotations	10° and 350°	Target is longitudinally divided into three parts by VOIs.
If target size along machine y-axis is more than 35 cm	If MLC Y-span is 40 cm	2 isocenters – 2 full rotations	10° and 350°	Target is longitudinally divided into two parts by VOIs.
If target size along machine y-axis is more than 20 cm	If MLC Y-span is 22 cm	2 isocenters – 2 full rotations	10° and 350°	Target is longitudinally divided into two parts by VOIs.
If target size along machine x-axis is more than 30 cm	–	2 isocenters – 4 half rotations	30° and 330°	Target is laterally divided into two parts by VOIs.
If target center line along machine x-axis is more than 5 cm from body center line	–	1 isocenter – 2 half rotations	30° and 330°	Target is bound by VOI.
If target size along machine x-axis is more than MLC x-span	–	1 isocenter – 2 full rotations	30° and 330	Target is bound by VOI.

In other cases, a plan with single isocenter and one full rotation is created, and collimator rotation is set to 30 degrees.

In addition, the tool contains the following setups that can be selected manually:

- 1 isocenter – 1 half rotation. Collimator rotation is set to 30 degrees.
- 2 isocenters – 2 half rotations. Target is divided into two parts laterally. Collimator rotation is set to 30 degrees.

When applying a setup with multiple fields, the treatment unit and energy are taken from the first field. When the tool creates a full rotation arc, the start and stop angles are at 181 degrees and 179 degrees. In all the setups the target is bound by a VOI, and in setups with multiple isocenters there is one VOI per isocenter. The isocenter is always set at the center of the VOI.

Create a VMAT or a Siemens mARC Plan

This information applies when you are using the PO algorithm to optimize the plan.

VMAT and Siemens mARC plans are created using one static or arc field, or up to 10 arc fields as the input fields.

- If you start with a static field, you need to change it to an arc field with the **Arc Geometry Tool** before opening the **Optimization** dialog box. Otherwise the plan is considered an IMRT plan.
- If you start with an arc field, you can use the **Arc Geometry Tool** to get a good initial arc field geometry. The Photon Optimization algorithm does not modify the isocenter position, collimator rotation, or field size (unless jaw tracking is used). To modify them, you need to use the Arc Geometry Tool or adjust them manually.

Any setup fields are ignored in optimization. The target structures must be defined before you start optimization. New targets cannot be added after the optimization has been started. You must define at least one Lower, Lower gEUD or Target gEUD objective for one of the target structures in order to be able to start optimization.

You can also continue the previous optimization of a plan containing fields that have either arc dynamic MLC, VMAT MLC, or mARC MLC. Previous optimizations are continued from the last multi-resolution level. Field geometry, jaw tracking and avoidance sectors are read from the previous optimization and cannot be changed. However, if you need to adjust these, start the optimization from the beginning.

1. Insert new plan.
2. Insert the fields one by one or use a template.

   If you use a template to add fields, the fields must not contain any field accessories.

   The dose rate defined in the Field Properties dialog box will be the maximum dose rate used in the optimization. It is recommended to use the highest dose rate available on the treatment unit.

3. Define dose prescription.
4. Select the PO algorithm as VMAT Optimization algorithm in the **Calculation Models** tab.
5. Use the Arc Geometry Tool to adjust field geometry before starting the optimization.
6. Choose **Planning** > **Optimization** > **Optimize**.
7. To exclude structures from optimization, click **Exclude Structures from Optimization** and select the structures to exclude.

   Structures excluded from optimization are not shown in the Structures list in the Optimization dialog box.
8. Define the optimization objectives or load the objectives from an objective template, and select structures for which to display the DVH by selecting their check boxes in the structure list or by selecting one of the options under **Show or hide structures** .

Note: *Indicate all desired doses as unfractionated total doses.*

You need to add at least one lower objective, or gEUD lower or gEUD target objective for one of the structures to be able to start the optimization process. More information on the optimization objectives and parameters: *Eclipse Photon and Electron Reference Guide*.

9. To add a gEUD objective with default values for a structure, select the structure and then select one of the options in the **Add gEUD** menu.
10. Define priorities for the optimization objectives.

Note: *If the priority of an objective is 0, the objective will not have the intended effect on the optimization. The priority determines the relative importance of the optimization object in relation to other optimization objects.*

11. To minimize the dose received by organs outside the target structures for which objectives have been defined, open the **Normal Tissue Objective** expander, select **In use** and define the Normal Tissue Objective parameters.
12. To set an MU objective, open the **MU Objective** expander, select the **In use** check box and define the values for minimum MU, maximum MU and strength.

13. Open the **Settings** expander do one of the following:
    - Select the resolution to use during optimization.

    Tip: *A finer resolution may be necessary if the structure set has several small structures and the first optimization results were not satisfactory. The small structures will be taken into account with the finer resolution.*

    - Select the arclet size to be used for Siemens mARC plan optimization.
14. Open the **Plan Information** drawer and the **Fields** expander.
15. For a VMAT or Siemens mARC plan: Define whether jaw tracking is used by selecting or deselecting the **Jaw Tracking** option.

    For Elekta plans, the jaw tracking option is set on or off automatically.

    Even though a treatment unit supports VMAT, it may not support jaw tracking. You can turn on jaw tracking in a VMAT plan only if the selected treatment unit supports it, and jaw tracking has been enabled in RT Administration.
16. To define avoidance sectors in which dose is not delivered, open the **Avoidance Sector** expander and set the gantry angle ranges for the desired fields.

    Avoidance sectors are not available for Elekta VMAT plans.

    If you are using only one avoidance sector, always enter the gantry angle range in the **Avoidance Sector 1** column.

Note: *You cannot add or modify avoidance sectors once the optimization process is started.*

17. Close the **Plan Information** drawer.
18. Automate the optimization process, if so desired.
    - To continue automatically to dose calculation after optimization, select the **Automatic Optimization Mode** check box.
    - To calculate an intermediate dose during optimization, select the **Automatic Intermediate Dose** check box.

19. Click **Start VMAT Optimization**.

    If the plan has been optimized earlier:

    - You can choose to continue the previous optimization or to start from the beginning. However, if you have modified the jaw tracking, avoidance sectors or base dose plan settings in the plan, the optimization starts from the beginning.
    - You can choose to use the calculated dose or dose from the previous optimization as an intermediate dose.

    During the optimization process, you can view the progress of the optimization, pause the optimization and modify the objectives, or move between or skip multi-resolution levels. Once the plan contains a valid leaf sequence, the leaf sequence icon changes from  to .

20. After the first optimization round, the automatic intermediate dose calculation starts (if selected).

    Once the intermediate dose calculation has completed, the intermediate dose icon changes from  to .

21. When the optimization process is finished, do one of the following:

    - If you selected the option to proceed to final dose calculation automatically, you do not have to do anything. The dose calculation starts automatically.
    - Otherwise, click **OK** to accept the result of the optimization. You cannot do this if optimization has not finished.
    - If you do not want to save the optimization result or other modifications, click **Cancel**.

Note: *If, after the Optimization dialog box is closed, a message is shown that the plan normalization mode has been changed to No Plan Normalization or prescribed percentage value has been changed to 100%, you can change the values back after optimization and dose calculation.*

To check the changes done after the optimization:

- In the Info window, click the **Fields** tab. For VMAT plans, the MLC type is VMAT. For Siemens mARC plans, the MLC type is mARC.
- Right-click the MLC, and select **Properties**.

  The General tab shows that the plan type is either VMAT or mARC.

  If the dose is calculated, the Control Points tab lists the meterset weight, jaw positions, gantry rotation, estimated dose rate, gantry speed, and estimated MU/degree. The control point information is also shown in the Field Properties dialog box.

When the optimized plan is saved, the following optimization parameters are also saved with the plan: MU objective, dose volume objectives, normal tissue objectives, avoidance sectors, base dose plan, excluded structures, and jaw tracking.

After optimization, evaluate the dose distribution visually, and visually verify the shape of the initial DMLC before treating. To verify the accuracy of VMAT plans, you can create verification plans using a phantom or using Portal Dose Prediction (Varian treatment units only).

Related Topics

Select the Initial Arc Field Geometry Using the Arc Geometry Tool on page 169
Add New Objectives from an Objective Template on page 81
View the Progress of VMAT Optimization on page 177

View the Progress of VMAT Optimization

During VMAT optimization, you can do the following in the Optimization dialog box:

- To show or hide structures in the DVH, click **Show or Hide Structures**  and select **Show All Structures**, **Hide All Structures** or **Show All Structures with Objectives**.
- To view the relative cost of the objectives, go to the DVH view and move the mouse cursor on top of an objective. The relative cost is shown as a highlighted circle around the objective. The bigger the circle, the more cost the objective has in the optimization. The relative costs of the objectives are also shown as a objective function chart and bar chart below the 2D image view.
- To modify the objectives, type new values for each objective or change the values graphically.
- To move between the multiresolution levels, do the following:
  - To stay on the current level, click the  button. To continue the optimization, click the button again. The **Hold** text is displayed in the optimization progress pane when the button is down.
  - To return to the previous level, click the  button. The **Previous Level** text is displayed in the optimization progress pane until the resolution level changes.
  - To jump to the next level, click the  button. The **Next Level** text is displayed in the optimization progress pane until the resolution level changes.
  - To get the current optimization results and end the optimization process, click the  button until you reach the last level, and then click **OK**.

Dose Calculation in VMAT Plans

Dose calculation is performed based on the MLC control points. For each control point, the fluence used in the dose calculation accounts for leaf motion based on the neighboring control points.

The dose calculation can also be started automatically at the end of the VMAT optimization, if desired. Field weights produced by VMAT optimization are used to achieve the wanted dose level in plan, and also to set the relative weight of each field of a multi-field plan. The calculation results can be saved automatically after the dose calculation has finished.

Tips for Using VMAT Optimization

Indicate all desired dose objectives and doses as unfractionated total doses.

Remember that the optimization uses inhomogeneity correction by default. If a plan contains support structures and you want them to be taken into account in optimization, inhomogeneity correction must be used.

You can prevent unwanted hot spots outside the target by defining suitable values for the Normal Tissue Objective. Hot spots resulting from the dose distribution may be reduced by adding new volumes to the hot spot area, defining objectives as you would for critical organs, and then re-optimizing the plan.

If you use the Acuros XB dose calculation algorithm, contour all structures that have a mass density value above 3.000 g/cm^3 and assign materials for them. Otherwise, the intermediate dose calculation and the possibility to continue automatically to dose calculation are disabled.

Successive optimizations of the same plan can produce slightly different results.

Stopping the optimization by canceling it will lose the optimization results. To finish the optimization quicker and keep the current optimization results, skip through the remaining multi-resolution levels to the last level and then accept the optimization results.

When selecting the treatment unit for the field, make sure that you use one that is able to produce VMAT beams. Check that the treatment unit has been configured as follows:

- The Motion Mode for the Dose Rate has been set to Dynamic (**Administration** > **RT Administration** > **Radiation and Imaging Devices** > **Operating Limits**).
- The treatment unit has an MLC that supports VMAT. For Varian treatments units it is either the Millennium MLC 120 or HD120 MLC, for Siemens treatment units it is Siemens 160 MLC, and for Elekta treatment units it is Elekta Beam Modulator

MLC, MLCi, MLCi2, or Elekta MLC 160 (**Administration** > **RT Administration** > **Radiation and Imaging Devices** > **MLC**).

If you are re-optimizing a plan, remove all lower objectives from structures that are no longer needed in the optimization. If you only set the priority of lower optimization objectives as zero, the objectives still affect the optimization results.

Modifying VMAT Plans

It is not possible to modify the gantry start and stop angles in VMAT plans, but it is possible to modify collimator rotation, couch rotation and field size. Making such modifications to an optimized arc field may produce results which cause the plan to deviate significantly from the defined optimization objectives and the achieved optimization result.

The optimization objectives for a VMAT plan are for the total dose, but the leaf sequences produced by the VMAT optimization are for the fraction dose delivery. If you change either the plan normalization or the prescription of a VMAT plan, validate the plan with the **Verify MLC Leaf positions** command. Re-calculation of the plan dose is not needed, because the dose calculation of a VMAT plan does not affect the MLC leaf sequencing. If the modified VMAT plan fails the MLC validation, do the following:

- If the total dose was kept intact and only the number of fractions was changed, re-optimize the plan as it is.
- If the total dose was changed, modify the optimization objectives to reflect this change and re-optimize the plan with the modified objectives.

After any re-calculation of the dose, make sure that the resulting absolute dose distribution is reviewed prior to approving the plan.

Optimization of Siemens mARC Plans

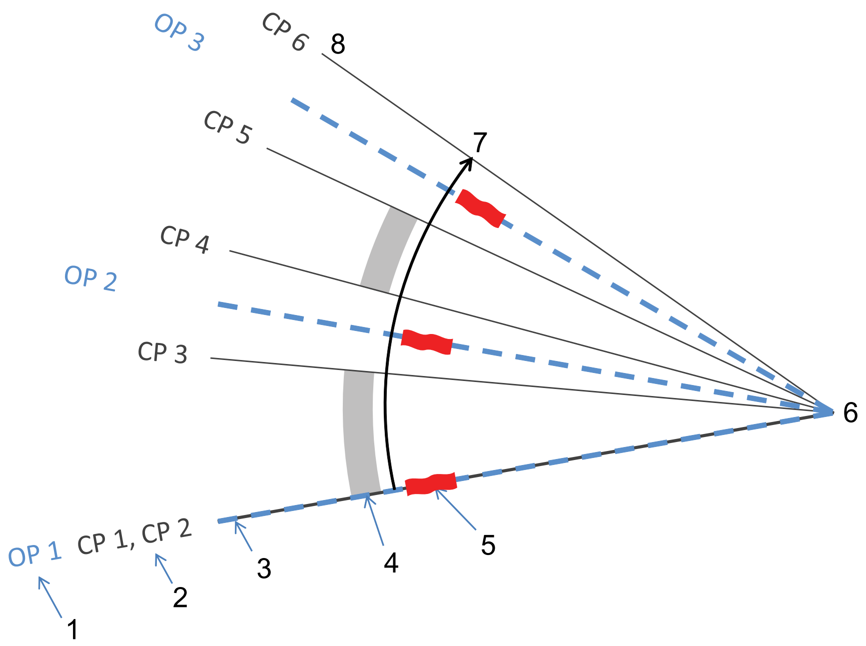
mARC is the Siemens approach to volume modulated arc therapy (VMAT) or rotational IMRT. mARC is available on Siemens Artiste and Oncor machines equipped with Siemens MLC 160. mARC differs from other volume modulated arc therapy techniques in that radiation is not delivered continuously across the arc, but in small radiation bursts (arclets) while the gantry is rotating. Eclipse models an mARC field as a VMAT field and the optimization of an mARC field is done using the VMAT optimization and the PO algorithm. You need to have at least one arc field in the plan for optimizing an mARC plan. You can use the **Arc Geometry Tool** to define or fine-tune the arc field.

In mARC, the arclet size defines the length of the angle interval in which the treatment unit is allowed to deliver the dose. The arclet size is defined by the user before starting the optimization.

During arclets, the MLC shape, jaw positions, collimator angle, gantry speed and dose rate remain unchanged, but they all may vary from one arclet to another. The centers of arclets correspond to so-called optimization points. The optimization points are used in the optimization and dose calculation to correspond the arclet.

In optimization, a static 0 degree arclet is always created in the beginning of an mARC field. This ensures that the dose delivery starts from the start angle of the arc field.

Extended gantry angles cannot be used in mARC optimization.



1. Optimization points (OP)
2. Control points (CP)
3. Image geometry and field gantry rotation
4. Leaf and jaw motion
5. Dose delivery
6. Isocenter
7. Gantry rotation
8. Field stop angle

Figure 41 Siemens mARC Field Generated by Varian mARC Optimization

During mARC optimization, you can interactively edit optimization objectives and evaluate the spatial dose distribution while the optimization is running. The optimization supports dose-volume objectives for each structure, MU objective and Normal Tissue objective. Optimization for an optimization point is performed using iterative optimization dose calculations (MRDC) for the corresponding full arclets.

The mARC optimization defines the MU values and meterset weights for each optimization point. During beam-off intervals, the so-called silent periods, arclet shapes, jaw positions and collimator angles are adapted to the values of the next arclet determined by the treatment plan. During these intervals, the gantry speed is adapted by the Control Console to allow for the necessary adaptations and minimize the treatment time of the mARC. You cannot manually adjust beam-off intervals during mARC optimization. You can modify the arclet size and avoidance sectors in the Optimization dialog box before you start or re-start the optimization.

The mARC treatment modality also offers a way to perform conformal arc treatments (more information: Conformal Arc Planning with Siemens MLC 160 on page 100). However, conformal mARC fields cannot be optimized using the mARC optimization.

You can change the couch position and angle between arc fields, but not during the delivery of an arc field.

Information on the PO algorithm and calculating the dose for mARC plans: *Eclipse Photon and Electron Algorithms Reference Guide*.

Siemens mARC plans created in a 3rd party system can be imported into Eclipse. Those mARC plans have different characteristics than the ones created in Eclipse. The following table lists the differences.

Table 3 Comparison of Varian and 3rd Party mARC Plans

	Varian	3rd Party
First arclet – planned	Static zero-length arclet	Arclet
First arclet – delivery	Gantry starts at the first static zero-length arclet	Gantry starts at middle angle (optimization point) of the first arclet
Collimator rotation in arc fields	Static	Dynamic possible
Static (hybrid mode) segments	No	Possible
Gantry angle interval	Equidistant (excluding the first static zero-length arclet)	Variation possible
Gantry angle in first control point always describes actual gantry motion at delivery	Yes	No

	Varian	3rd Party
Field image geometry at gantry start angle always conforms to field geometry	Yes	No

View the Leaf Motions of a Dynamic MLC

1. In the Focus window, select the field containing the DMLC.
2. Show the field in BEV.

   If the DMLC has several segments, the animation toolbar is activated.
3. Click .

   In a conformal arc or VMAT field, the BEV moves from the start angle to the stop angle, consecutively showing the field for each segment. The current gantry angle and segment number are shown in the title bar.

   In an IMRT field, the motions of the leaves are animated in accordance with the calculated field intensities. The BEV moves from the first to the last segment, consecutively showing the DMLC aperture for each segment. The current segment and carriage group are shown in the BEV title bar.
4. Do one of the following:
   - To stop the animation, click .
   - To show the previous segment, click .
   - To show the next segment, click .
   - To show the first segment, click .
   - To show the last segment, click .
   - If an IMRT field was a large field that was split into several parts, navigate backwards or forwards through the parts by clicking  or  respectively.

Note: *To modify the segment currently displayed in the BEV, use the MLC editing tools. They can be used for conformal arc and VMAT fields.*

Chapter 11 DVH Estimation Models for RapidPlan

DVH Estimation Models for RapidPlan

A DVH estimation model can be used to evaluate what kind of Dose-Volume Histograms (DVH) are achievable in a treatment plan based on previous experience from similar treatment plans. DVH estimation models can be used in treatment planning with RapidPlan. The model creates an estimated DVH range for an Organ at Risk (OAR), which shows where the actual DVH curve of the OAR will most likely fall. Typically, the model also creates a set of optimization objectives, which aim at achieving the estimated DVH range. Some models may also contain fixed optimization objectives, not based on DVH estimates. These objectives can be used to limit the absolute maximum dose for critical organs, such as spinal cord. Additionally, models may contain NTO and smoothing parameters to be used in optimization.

When you apply a model to a plan, the model takes into account the field geometry, structure set, and dose prescription of the current patient. You can use the generated objectives and settings as such, but if you are not satisfied with the results, you can modify them. After the dose calculation, you can compare the shapes and doses of the final DVH curves with the estimated DVH ranges.

DVH estimation models are specific to an anatomical region, for example, the pelvic area, and they can be used in VMAT and IMRT plans. Multiple target dose levels are supported. The system contains a set of Varian-provided models, but you can also create your own models, and share them with other clinics.

A DVH estimation model is created on the basis of the information extracted from a selected set of treatment plans. These plans are called training plans, and the extracted information contains the structure sets, field geometry, dose matrices, and dose prescription of the plans. The training plans are selected according to the purpose of the model, which defines whether the model will be used for a wide variety of patient cases with different organ sizes, field geometry and dose prescriptions, or for more specific cases. Since the results that the model produces are dependent on the training plans, the plans should be clinically acceptable and meet the treatment goal. After the plan information has been extracted, it is used for training the DVH estimation model. The DVH estimation model can be used independently, without the original treatment plans that were used for training the model. All models should be validated with a set of plans before using them clinically.

More information on the model configuration component of the DVH estimation algorithm: *Eclipse Photon and Electron Algorithms Reference Guide*

DVH Estimation Concepts

DVH Estimation Model

A DVH estimation model is a mathematical model that uses knowledge from existing treatment plans to generate DVH estimates and estimate-based optimization objectives in optimization. A model may also contain only fixed optimization objectives, which are not based on mathematical learning, but are added manually to the model. Models have a training status (trained: yes/no) and a publishing status (yes/no). A published model displays the user who published the model and the publication date. Published models can be used for optimizing plans for clinical use. Unpublished models cannot be used clinically. However, users with specific rights can apply them in optimization when they are verifying and validating the quality of the model. A DVH estimation model consists of model structures, model objectives, model plan data, and the results of the training. Only the data extracted for model training is stored in the model; the actual plan data in the database stays untouched.

DVH Estimate

A DVH estimate is an estimated range where the DVH line of an organ at risk will most likely land based on the information from a DVH estimation model. Target structures receive no DVH estimates.

Estimate-based Optimization Objectives

Estimate-based optimization objectives are generated by the DVH estimation algorithm, either partly or completely. For example, a line objective or an upper objective with fixed dose and generated volume.

Fixed Optimization Objectives

A model may contain fixed optimization objectives, which are not based on mathematical learning or DVH estimates, but are added manually to the model in the DVH Estimation Model Configuration. For example, an upper objective with manually defined dose, volume and priority, or a mean objective with manually defined dose and priority.

Model Plan

A model plan is a treatment plan, from which data is extracted. After the plan has been added to a model and its data has been extracted, the model plan becomes a “model plan with extracted data”. This is indicated by the text Yes in the **Extracted** column in DVH Estimation Model Configuration. A model plan contains no extracted data if it is in a Varian-provided model, or its duplicate, or if the model has been imported without extracted data. In addition, changes you make in the model may also remove the extracted data. In this case, the **Extracted** column is empty.

The model plan may or may not preserve a link to the original treatment plan. If the link is preserved, you see plan identification information in the **Patient ID/Course ID/Plan ID** column. No link exists if the plan is in a Varian-provided model, or its duplicate, or if the model has been imported. In this case, the column shows N/A.

If the plan has been used for training the model (is a training plan), the model version is shown in the **In Model** column. If the plan has not been used for training the model (is not a training plan), the **In Model** column is empty.

Model Plan Set

A model plan set is a set of treatment plans, from which data is extracted. The model plan set is visible in the **Plans of the DVH Estimation Model** list in the DVH Estimation Model Configuration.

Training Plan

A training plan is a model plan which has been used for training the model. For training plans, the model version is shown in the **In Model** column. You cannot train a model with plans that contain no extracted data.

Training Plan Set

A training plan set is a set of model plans that have been used for training a DVH estimation model.

Data Extraction

In data extraction, the system extracts data from the model plans. Extracted data contains information about the structures, field geometry, dose matrices, and dose prescription. Data is extracted when you add a plan to a DVH estimation model in External Beam Planning, or click **Extract** in the DVH Estimation Model Configuration.

Structure Matching

In structure matching, you associate treatment plan structures to corresponding model structures. Some structures are automatically matched if their structure codes or identifiers are the same. Structures are matched when you use a DVH estimation model in a plan. Structure matching makes sure that the correct DVH estimates and objectives are generated for a specific structure. Structures are matched also when you add plans to a model. This ensures that the extracted information of a plan structure is associated to the correct model structure.

Model Training

In model training, the system processes plan data that has been extracted from the training plans. The model uses machine learning to map the structure and geometry information in the plans (OAR distances relative to the target, OAR volumes, etc.) to corresponding dosimetric information (DVHs).

Model Verification

In model verification, you check the results of model training by using statistical plots and tables in DVH Estimation Model Configuration.

Model Validation

In model validation, you ensure that the use of a DVH estimation model produces plans that are clinically acceptable. A model is validated by applying the model to similar plans, where you intend to use the model, and then by reviewing the produced optimization results and DVH estimate ranges. All models should be validated before clinical use.

Validation Plan

A validation plan is a plan that you use for model validation. The plan should be similar to the plans where you intend to use the model. The validation plan should not be a plan that has been used for training the model.

Validation Set

A validation set is a set of plans that you are going to use for model validation. These plans should be similar to the type of plans where you intend to use the model.

Outlier

An outlier is a training plan or a structure in a trained DVH estimation model with statistical parameters that differ considerably from the average in the training set. The features that can differ, are, for example, volume of the OAR and the out-of-field volume of the OAR.

Varian-Provided Models

Varian-provided DVH estimation models are ready-made models that can be used for generating DVH estimates and optimization objectives. You need to validate Varian-provided models, and then publish them for clinical use if the validation results are acceptable. You cannot modify or train Varian-provided models. You can only duplicate them, which provides you the optimization objectives and structures of the original model. For more details about Varian-provided models, see the document attached to the models.

Configuring a DVH Estimation Model

When you start creating a DVH estimation model, you need to consider for which anatomical region (for example, the pelvic area) you want to use the model. In addition, you need to decide whether to create a general model that suits a wide variety of patient cases, or a specific model that works best for specific patient cases. For example, you might want to create a prostate model that works for patient cases with different anatomical features, field setups, and dose prescriptions. Or you might want to create a prostate model for treating patient cases with specific anatomical features, field setup, and dose prescription.

After these initial considerations, you define the properties of the model in DVH Estimation Model Configuration and add those structures to the model, for which you want to generate DVH estimates. If you also want the model to generate optimization objectives, you need to add the desired optimization objectives to the model structures. When adding the optimization objectives, you can either define values for some of the parameters, or let the DVH estimation algorithm define them for you. It is also possible to add fixed optimization objectives, not based on DVH estimates, to be used for limiting the absolute maximum dose for critical organs. If you do not want to use DVH estimates or estimate-based optimization objectives, you can also create a model that contains only fixed optimization objectives. After adding the objectives, you may want to define the smoothing parameters (only for IMRT plans) and the Normal Tissue Objective (NTO) for the model. To help users in selecting an appropriate model in optimization, you can attach a model description document (.pdf) to each model.

Next, you can start adding plans to the model one by one in External Beam Planning. The plans must be clinically acceptable, and fulfill the intended treatment goal. In addition, they must be suitable for the type of model you are creating (general vs. specific). Keep in mind that the model can only produce results as good in the new plans as the results in the model plans. Therefore, you must review and if needed, fine-tune the plans carefully before adding them to the model. Existing models can be used as an aid in fine-tuning.

If you know for what kind of plans you are planning to use the model, add similar plans to the model plan set. If you are not quite sure yet, consider adding several types of plans to the model plan set, and only later, validate the model with a set of plans to see how it works for different types of plans. When you find out the plan types, in which the model works poorly, add more similar plans to the model plan set. When you add plans to a model, an initial automatic structure matching is performed between the model structures and plan structures. The matching is based on structure codes and identifiers used in the plans and in the model. You need to verify the results of the automatic matching and make the necessary corrections.

When a plan is added to the model, the system extracts the plan data needed for training the model. If the plan or model changes after this, you can re-extract the plan data later in DVH Estimation Model Configuration. After adding all the plans to the model, you have to train the model. During the training, the system analyzes the patient anatomy and DVHs in the plans, and creates the final mathematical DVH estimation model. You can verify the results of the model training in statistical presentations of the training set. They help you estimate the quality of the model and find potential outlier values that differ from the average in the training set. You have to process the outlier findings, and after that, re-extract the plan data if needed and retrain the model iteratively until the results are acceptable. You should carefully validate the model with a set of plans before taking the model into clinical use.

When the model is applied to a plan in the Optimization dialog box in External Beam Planning, the following happens:

- DVH estimates and estimate-based objectives are generated for those OAR structures in the plan that have been matched to trained OARs in the model.
- Target structures receive no DVH estimates or estimate-based objectives.
- Fixed objectives are generated for all matched structures, regardless of whether they have been trained.

The default NTO and smoothing parameters will also be applied. The optimization objectives, NTO, and smoothing parameters can be adjusted before or during optimization. After applying the model, it is important to verify the optimization results, since the model might not work optimally for all patient cases.

Note: *If multiple simultaneous users work with the same DVH estimation model, this may lead to situations where another user has modified and saved the model that you are currently working with. Therefore, avoid situations with multiple users concurrently working with the same model. If you try to save your changes, the system will issue a warning message about another user already editing the same model. Always carefully verify the synchronized model, because it may contain changes made by both you and the other user.*

Creating a Model Plan Set

You need to consider for which kind of plans you are planning to use the DVH estimation model, and try to include similar plans in the model plan set. If you are creating a general model for a wide variety of patient cases, include a wide variety of plans into your plan set. If you are creating a more specific model for more specific patient cases, you can include a smaller variety of plans into your plan set.

You need to consider the general vs. specific aspect for each of the following plan features related to the anatomy of the patient:

- The size of the OARs (small, large, medium, or all; full, half full, empty, or all).
- The position of the OARs with respect to each other (overlapping, non-overlapping, or both).
- The size of the target (small, medium, large, or all).
- The relative position of the target with respect to OARs (far, close, or both; overlapping, non-overlapping, or both).

For example, if you want to use the model for patients with all types of bladder (full, half full, empty), include all bladder types in your model plan set. If you are planning to use the model only for specific patient cases, for example, for patients with full bladders, you can include a smaller variety of bladder types, in this case, full bladders, in your model.

In addition, you have to consider the general vs. specific aspect also for the following features related to field setup and dose prescription:

- Treatment technique (VMAT, IMRT, or both).
- The position of the fields (how much of the OARs are inside or outside the field).
- Non-coplanar vs. coplanar fields.
- The direction of the fields (entry angle).
- Different treatment orientations.
- Dose prescription (specific dose prescription, dose prescription range).
- Dose fractionation.
- Used dose calculation algorithm and version.

You need to consider the amount of variety you want to include into your model. Keep in mind that the more variation you want, the more treatment plans you need. If you add a wide variety of features into your model, but do not increase the number of treatment plans at the same time, the model will not work properly. The more variation your model will include, the more generic it will be and you are able to use it for a wider range of patient cases.

However, if you are creating a more specific model with a smaller variety of features, keep in mind that you do not narrow the features too much. For example, if most of the plan features are very similar in your training set, the model will not work properly despite the number of training plans you use for training the model. In this case, the model will work only for plans that are very similar to the training plans.

In addition, keep in mind the following aspects when selecting plans for your model:

- Use reviewed and clinically acceptable plans with optimal target coverage and organ-at-risk (OAR) sparing. The model can only produce results as good in new plans as the results in the training plans.
- Use plans that fulfill the treatment goal of the model.
- Use plans which have consistently high quality. The model is based on the mean values in the majority of the training set plans - not on the best plan in the training set. Therefore, only one or few good plans in the training set are not enough.

Tip: *You can first improve the quality of a plan by optimizing it with an existing model. After that, you can add the plan to a model - either to the same model that you used for optimizing the plan, or to another one. In this way, the quality improvement becomes a continuous process - the model improves the quality of the training plans, which, in turn, improve the quality of the model.*

Modifying a DVH Estimation Model

By duplicating an existing model, you can create several model versions of the same model plan set. You can make modifications to the model duplicate, re-extract data (if needed), train the model, and save it. During the model verification and validation you can compare the new model to the original one and see which one of them produces better results. After comparison, you can consider whether you want to keep both of the models, or remove the one that produces worse results. When you duplicate a model, you lose the revision history of the original model (information about how many times it has been published).

You can modify the model, for example, to add new structures, or to modify the structure codes, identifiers, or optimization objectives of existing structures.

You can also modify the plan set of a model by adding new plans to it or by removing existing ones. You can study how the removal or addition of a single training plan affects the results of the model by including the plan in the model training, or by excluding it. You can also study, how the removal or addition of a single structure affects the results of the model by changing the structure matching of that structure.

If you have access to the original treatment plans, it is possible to modify them, for example, to re-contour or re-optimize, and re-extract their data to be used in the model. In this case, you have two options for re-extraction: you can extract the data of this specific plan by adding it to the model again, or you can re-extract the data of all plans by clicking **Extract** in DVH Estimation Model Configuration.

If the model has been published, most of the modifications are prevented, which means that you need to unpublish the model before you are able to modify it. In an imported model, you may not be able to make modifications that require re-extracting the data or re-training the model.

Some of the modifications remove the extracted plan data from the model. In this case, the text Yes in the **Extracted** column is cleared. If the model has been trained, the **In Model** column shows the version number of the model. Some of the changes you make in the model remove the trained model. In this case, the statistical presentations disappear from the lower part of the screen.

If your modifications remove the extracted data, you have to re-extract the plan data to make it available for model training. Re-extraction replaces the existing plan data with the new data for the whole model plan set, including the possible modifications made to the plan in External Beam Planning. To make sure that no unwanted modifications end up in your model, verify the changes that have been made to the original treatment plans in External Beam Planning before re-extracting the data. To apply the changes to the model, you need to retrain the model.

You cannot modify Varian-provided models. You can only duplicate them, which provides you the optimization objectives and structures of the original model. No other information about the original model or the model plan set is included.

When you export, import, or duplicate a model, the model description documents attached to the model are retained. If you duplicate a Varian-provided model, the documents are removed from the duplicate.

Tip: *If you have made changes to the model that you do not wish to keep, close the model without saving and open it again.*

Note: *When you are modifying a model, remember to save your changes frequently. If another user opens the same model, modifies it in the DVH Estimation Model Configuration application, and saves the changes, you may not be able to save your changes anymore. This may happen also if you are modifying a model, and another user adds plans to the same model at the same time in External Beam Planning.*

Verifying the Results of Model Training

After the DVH estimation model has been trained, you need to verify the results. During the verification, you check the following:

- Model fit, in other words, how well the model is able to estimate plans that were included in the training set.
- The preliminary results of the estimation ability of the model, in other words, how well the model is able to estimate new patient cases. The final estimation ability of the model is checked in the model validation phase.

If the model fit is poor, it indicates that the model does not represent the training data, and has not been able to capture the relationship between anatomical features and DVHs. If the model fit proves to be good, it indicates that the model has been able to capture this relationship.

If the estimation ability of the model is good, it indicates that the model is likely to estimate new patient cases adequately. However, you should still make sure that this is the case by validating the model with a sufficient number of plans.

During the model verification, you need to pay attention to the following aspects:

- Make sure that the number of training plans and structures is sufficient for the model.
- Check the general quality of the model (initial model fit).
- Check that no overfitting of data occurs (good model fit, bad estimation ability). If this happens, consider adding more plans to the model.
- Check the consistency of the data in the training set - make sure that the data does not form multiple data groups. If this happens, consider adding more plans to the model, or dividing the model into separate models.
- Check that no gaps between data point groups exist. If this happens, consider adding more plans to the model that fulfill the gap.
- Identify influential data points that have a great effect on the model fit and the estimation ability of the model.
- Identify single training plans or structures that differ from the average in the training set (outliers).
- Verify the final model fit and estimation ability of the model.

You can use the statistical presentations (plots and tables) as an aid in model verification. If you want to make any changes to the model during verification, you can duplicate the model, make the changes, re-extract the plan data (if necessary), retrain the model, and compare the results to those of the original model. Because retraining may cause different outliers to appear, you have to start the verification process again from the beginning.

Validating a DVH Estimation Model

Note: *You should validate every DVH estimation model before using it clinically. This applies to all model types - the Varian-provided models, imported models shared by other clinics, and the models you create yourself.*

The purpose of validation is to verify that the model can be used to estimate new patient cases with the required quality. During model validation, you should validate the following:

- DVH estimates produced by a model.
- The optimization results produced by using a model.
- The final dose distribution produced by using a model.

In validation, you compare existing clinical plans to plans that have been created by using a model. You can copy an existing clinical plan, and apply the model to the plan copy, and see how the results differ from the results in the original plan. You can apply unpublished models to plans in External Beam Planning for validation purposes if you have the appropriate user rights.

During the plan comparison, do the following for each plan:

1. Generate DVH estimates and optimization objectives for the plan copy. Check the DVH estimate range for each structure. A narrow range indicates a more accurate DVH estimate, and a wider range indicates a less accurate one. Check for each structure, whether the original DVH falls within the generated DVH estimate range. If you are validating a model that contains the plan data, you can also perform the initial validation of the DVH estimates by using the DVH plots in DVH Estimation Model Configuration. However, keep in mind that the DVH curves visible in the DVH plots are only approximations of the actual DVHs available in the DVH view in External Beam Planning.
2. Optimize the plan copy by using the model. Check whether the final DVH of each structure falls within the DVH estimate range.
3. Compare the DVHs in the plan copy to the DVHs in the original plan.

After comparing the plans, verify the final clinical quality of the validation plan.

If you are validating a Varian-provided model, see the model description document for further information about the preliminary validation of the model.

Avoid modifying the model during the model validation process. If you modify the model, start the validation process from the beginning.

Creating a Validation Plan Set

Select validation plans that represent the type of plans where you intend to use the DVH estimation model. Include a representative sample of similar plans to the validation set. Even though the original training set would have been defined for a wide variety of patient cases, by validation you define the final purpose of the model. If you intend to use the model for a wide variety of patient cases, include a wide variety of plans into your validation set. If you intend to use the model for more specific patient cases, you can include a smaller variety of validation plans into your validation set. Validation plans do not necessarily have to be similar to plans in the training set of the model. This is true especially if the model has been created elsewhere (Varian-provided model or imported model). If the intended use of the model is not in line with the training set of the model, the risk of validation to fail increases.

Validate the model by using (IMRT or VMAT) plans that have been calculated, and optionally, also treated. Use clinically acceptable plans with optimal target coverage and Organ-at-Risk (OAR) sparing. Do not use the same plans that were used to train the model.

When selecting the validation plans, you need to consider the general vs. specific aspect for each of the following features related to plan structures:

- The size of the OARs (small, large, medium, or all; full, half full, empty, or all).
- The position of the OARs with respect to each other (overlapping, non-overlapping, or both).
- The size of the target (small, medium, large, or all).
- The relative position of the target with respect to OARs (far, close, or both; overlapping, non-overlapping, or both).

For example, if you are going to use the model for patients with an empty bladder, validate the model with plans that have been created for patients with an empty bladder. If you are going to use the model for different bladder volumes, empty, half full, or full, validate the model with plans created for patients with different bladder volumes.

In addition, you have to consider the general vs. specific aspect also for the following features related to field setup and dose prescription:

- Treatment technique (VMAT, IMRT, or both).
- The position of the fields (how much of the OARs are inside or outside the field).
- Non-coplanar vs. coplanar fields.
- The direction of the fields (entry angle).
- Different treatment orientations.
- Dose prescription (specific dose prescription, dose prescription range).

- Dose fractionation.
- Used dose calculation algorithm and version.

Number of Patients and Validation Plans

Select a representative sample of the type of plans for which the model is intended. Use enough plans from different patients. When estimating the appropriate number of plans you need, consider the purpose of the model - is it meant for specific patient cases (similar structures, field setup, and dose prescriptions) or for all kinds of patient cases. For example, if the model is intended for very specific types of patient cases, about 20 patients (one or more plans per patient) might be enough. For a very generic model you might need over 30-40 patients (one or more plans per patient). Keep in mind that these figures are only examples.

Structures in Validation Plans

Consider the following aspects regarding structures when selecting validation plans:

- The anatomical treatment region (for example, prostate) should be the same as for the model.
- Select plans where the form, size, and position of the structures are similar to the ones in the plans where you intend to use the model.
- Check that the validation plans contain all those structures, to which you want to apply the model. The validation plans can contain structures that are not included in the model.
- If you are planning to use the model for multi-target plans, validate the model with multi-target plans.

Field Setup in Validation Plans

Consider the following aspects regarding field setup and treatment technique when selecting validation plans:

- If you are using the model for VMAT plans, validate the model with VMAT plans. If you are using the model for IMRT plans, validate the model with IMRT plans. If you are using the model for both treatment techniques, validate it with both.
- Use the field setup and couch angles, for which you intend to use the model for (field entry angles, orientation, position).

Dose Prescription in Validation Plans

Select validation plans that have similar fractionation and dose prescription to the plans for which you are planning to use the model. For example, if you will use the model for all kinds of fractionations, validate the model with all kinds of fractionations. If you will use the model only for plans with hypofractionation, validate the model with plans that use hypofractionation.

If you are validating a lung model, pay specific attention to the dose calculation algorithms and versions in your validation plans. Make sure to use validation plans that cover all dose calculation algorithms and versions that you intend to use for your lung cases. This is essential because of the heterogeneity of lung tissue. If the model has been created by using a different dose calculation algorithm or version than the one used in the apply phase, the generated DVH estimates may appear reasonable, but the final dose distribution can be sub-optimal.

Validate the Estimated DVHs in the Optimization Dialog Box

1. In External Beam Planning, select the clinical plan that you are using for model validation.
2. Copy the plan.
3. Keep the treatment technique (IMRT or VMAT) and field arrangement the same as in the original plan.
4. On the **Calculation Models** tab, verify the calculation model selections.

Note: *If you change any of the calculation models, the dose is cleared. In this case, you must calculate the dose again by using the same MU as in the original plan (fixed MU).*

- For the **DVH Estimation** calculation type, choose **DVH Estimation Algorithm** as the calculation model.
- For the **IMRT Optimization** and **VMAT Optimization** calculation types, choose **Photon Optimizer** as the calculation model.
- For the volume dose calculation, it is recommended to use the same calculation model as in the original plan.

5. Choose **Planning** > **Optimization** > **Optimize**.
6. Select the **Estimate DVH** drawer.
7. In the **DVH Estimation Model** drop-down list, select the model you are validating.

   To view unpublished models, select the **Show Unpublished Models** check box.
8. Verify that all those plan structures that you want to compare to the corresponding structures in the original plan are matched to model structures.

9. Click **Generate Estimates and Objectives**.

   The Estimate DVH drawer closes automatically if the generated objectives are within the limits determined by the DVH estimation algorithm. If the Estimation Statistics dialog box opens, it indicates that the estimation statistics for one or more matched structures are outside of the limits (are potential outliers). In this case, the DVHs of the structures may not fall into the estimated DVH ranges, because the model may not be able to estimate the DVHs for this specific plan type. To generate the DVH estimates and objectives, click **Yes**.
10. Check for each structure, whether the original DVH falls within the generated DVH estimate range.

If the estimated DVHs in the copied plan are better or similar to the DVHs in the original plan, you can continue with the model validation. If the results are worse than in the original plan, analyze the potential reasons thoroughly before continuing the validation.

Related Topics

Evaluating Validation Results on page 199
Estimation Statistics in Optimization on page 212

Validate the Estimated DVHs in the DVH Plot

1. In DVH Estimation Model Configuration, duplicate the model that you want to validate.
2. Add the validation plans to the model duplicate in External Beam Planning.
3. In DVH Estimation Model Configuration, clear the check boxes in the **Include** column for the validation plans.

   The validation plans will be excluded from model training.
4. Train the model.
5. Select the DVH plot for an OAR in the list located in the lower part of the screen.
6. Select a validation plan in the **Plans of the DVH Estimation Model** list.

   The DVH curve for the selected validation plan is highlighted in the DVH plot.
7. Check whether the original DVH of the validation plan falls within the generated DVH estimate range.
8. Repeat this process for each OAR and each validation plan.

Validate a Plan Optimized by Using a Model

1. In External Beam Planning, open the same plan copy that you used for validating the DVH estimates.
2. Optimize the plan by using the objectives from the model that you are validating.

   If old fluences exist, start the optimization from the beginning. Do not add any additional objectives or modify objectives before or during the optimization.
3. Check whether the DVHs fall within the DVH estimate range.

   If they do not fall in the range, check the optimization objectives.
4. In External Beam Planning, calculate the dose.
5. To view the DVH, choose **Planning** > **Show Dose Volume Histogram View**.
6. Go to the Dose Statistics tab of the Info window, and do the following:
   - In the Show DVH column, select the structures, for which you want to see the final DVH curves.
   - In the Show DVHE column, select the structures for which you want to see the DVH estimates.
7. Check that the final DVHs are within the estimated DVH ranges (between the upper and lower bound, or near the upper or lower bound).
8. Check that the optimization objectives generated by the model produced similar or better results than the optimization objectives in the original plan.

   You can do this by comparing the DVHs in the original plan with the final DVHs in the copied plan. You can use the standard DVH tools for this purpose. If the plan contains structures that are not included in the selected model, check that those structures do not receive too much dose.

Note: *Plan comparison DVH does not show DVH estimates.*

9. Check that the final DVH and 3D dose distribution are clinically acceptable.

   You can use the standard plan evaluation tools for this purpose.
10. If the final dose distribution is not clinically satisfactory, check the following:
    - NTO objectives.
    - Balance between the target and OARs.

If the quality of the copied plan, including the final DVHs, is better or similar to the quality of the original plan, you can continue with the model validation. If the results are worse than in the original plan, analyze the potential reasons thoroughly before continuing the validation.

Related Topics

Dose-Volume Histogram on page 242
Evaluating Plans on page 231
Optimize a Plan by Using DVH Estimates and Objectives from a Model on page 206

Evaluating Validation Results

After you have applied a DVH estimation model to a set of validation plans, evaluate the results. If an estimated DVH is different than the clinical DVH, the reason is likely to be in the model. If the estimated DVH is better, this may not require any actions from you. If the estimated DVH is better compared to the clinical DVH, but the DVH in the optimized plan is worse than the estimated DVH, the reason is also likely to be in the model. If the estimated DVH and optimization results are acceptable, but the final dose distribution is not clinically satisfactory, the reason may be in the NTO objectives, or in the balance between the target and OARs.

Consider the following aspects when evaluating the validation results:

- Check whether the poor results have been caused by incorrect structure matching. For example, the validation plan may have two targets - target 1 and target 2. The dose prescription has been defined for target 2, but target 1 is matched to the target structure in the model. Therefore, the model uses the incorrect dose prescription.
- Check the contouring in the validation plan. If the validation plan contains, for example, only a half of a bladder contour, and in the training set the whole bladder is contoured, it may have an effect on the out-of-field volume. In addition, part of a contour may be outside the Body structure in the validation plan, which means that this part has not been processed by the model.
- Check if the model does not fit the plan type, and either the structure size or position, field geometry, or dose prescription differ considerably from the average in the training set (you can find out potential outliers in the estimation statistics by clicking **Estimation Statistics** in the **Estimate DVH** drawer). For example, the size of an organ in the validation plan may be medium, but the training set contains only small or large organs. Even though the results might seem good for single patient cases, keep in mind that if the model is meant for medium organ sizes, it should be validated (and preferably also trained) with medium organ sized patient cases.
- If you notice that a model with only IMRT plans does not work optimally for VMAT plans, or vice versa, consider adding both types of plans to the training set, or creating different models for VMAT and IMRT.
- Check whether the validation plan has a certain trade-off between two organs which does not exist in any of the training plans. For example, a DVH for one organ might be poorer, but the DVH for another organ might be correspondingly better.

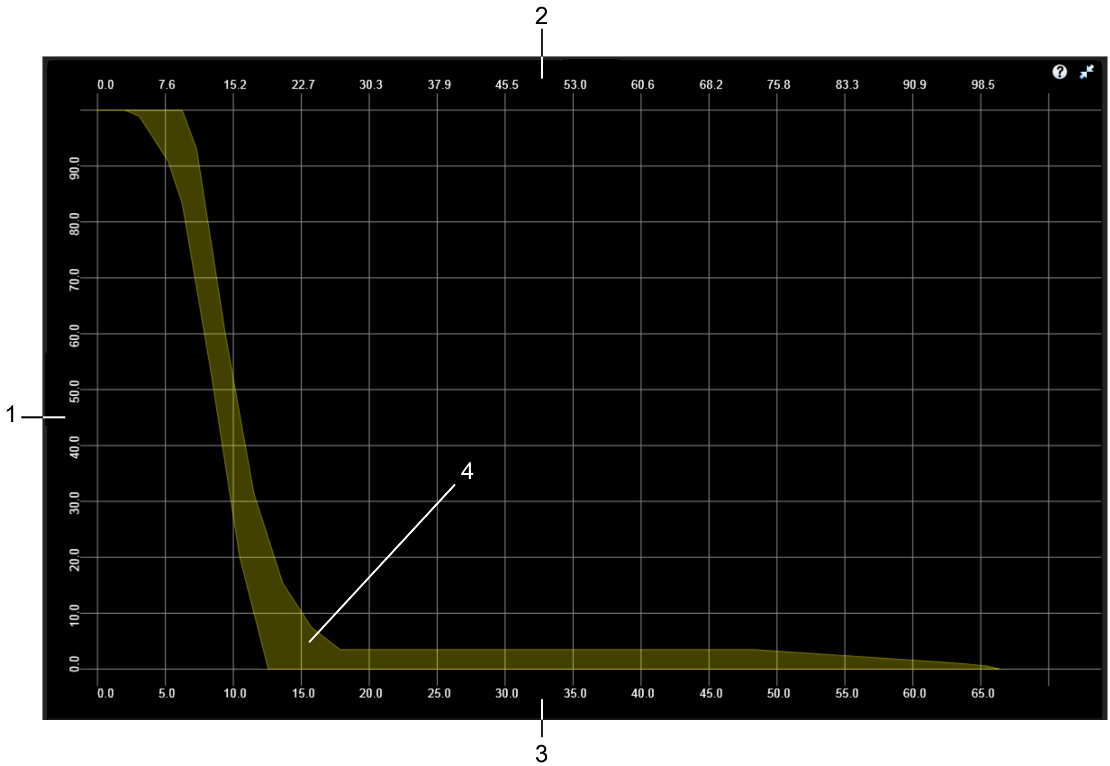
- Check whether the validation plan is such that the model cannot estimate it properly. Apply the model to similar patient cases and check whether the results are consistently worse. If this is the case, you may consider adding more plans to the training set, deleting certain plans from the training set, or modifying the optimization objectives. You may also consider not using the model for similar cases. This is the only option if you have not created the model yourself or you have no access to the training set (imported models that contain no plan data).
- If you receive poor results only for some of the model structures, consider removing them from the model.
- Note that the generated DVH estimates for small structures may not be optimal.
- If you are validating a Varian-provided model, the generated DVH estimates may be slightly different than what you would expect on the basis of your current planning experience. This may be caused by differences in the used training plans and your own validation plans (see the model description documents for details). If you are validating your own model, the model is more likely to produce results that are more consistent with your own previous planning experience.
- If the model contains absolute dose values for the optimization objectives of target structures, pay special attention to the used dose prescriptions in the training set and in the validation plan. If the dose prescription in the validation plan differs considerably from the ones in the trainings set, the generated estimate-based optimization objectives may not be optimal. For example, if you apply a model meant for prescriptions of 5040 cGy to a plan with 4500 cGy, the DVH estimate ranges may be scaled according to the used lower dose prescription, but the generated objectives may not be scaled. In this case, consider using the model only for 5040 cGy prescriptions.
- If the model has been trained with OARs that are not usually optimized in low prescription-plans, for example, spinal cord, and you use this model for a high-prescription plan, the estimates and generated objectives for the spinal cord may be too high. If you use a high-prescription model for a low-prescription plan, the generated estimates and objectives for the spinal cord may be too low. In either case, you need to validate the results carefully.

DVH Estimate Examples

L-shaped DVH Estimate Range

When you are validating generated DVH estimates, keep in mind that if your training set contains a structure that has very variable DVH shapes, the estimated DVH range may look L-shaped in the DVH view in External Beam Planning. This may happen, for example, if the structure is located in the low-dose region in some of the training plans, and in the high-dose region in others.

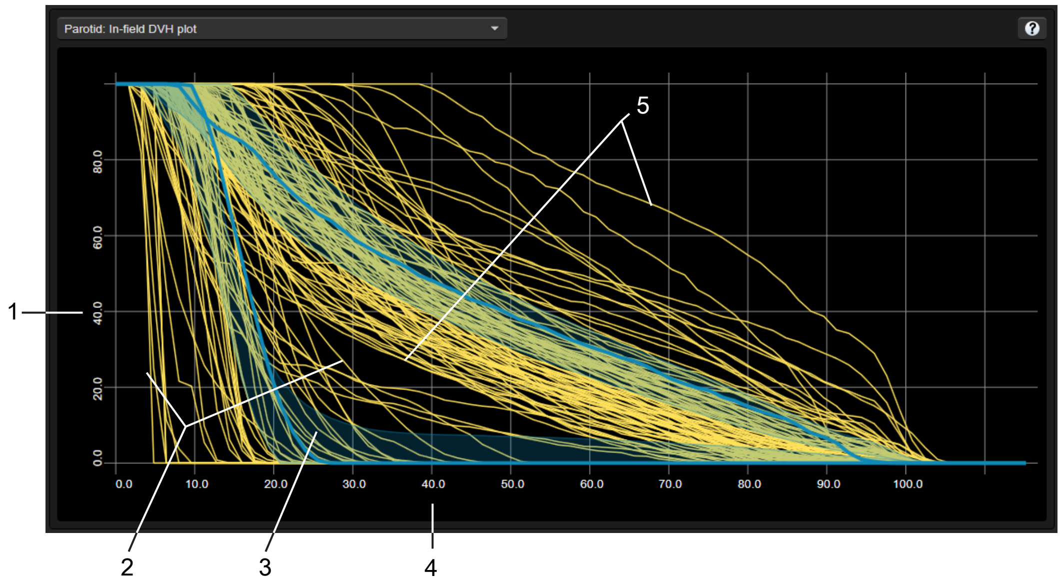
The following figure illustrates an L-shaped DVH estimate range:



1. Volume percentage
2. Dose percentage
3. Dose (Gy)
4. L-shaped DVH estimate range

Figure 42 L-shaped DVH Estimate Range

The L-shaped DVH estimate can be further illustrated in the in-field DVH plot, which shows that separate data groups exist for the DVH curves in the low-dose region, and for the DVH curves in the high-dose region:



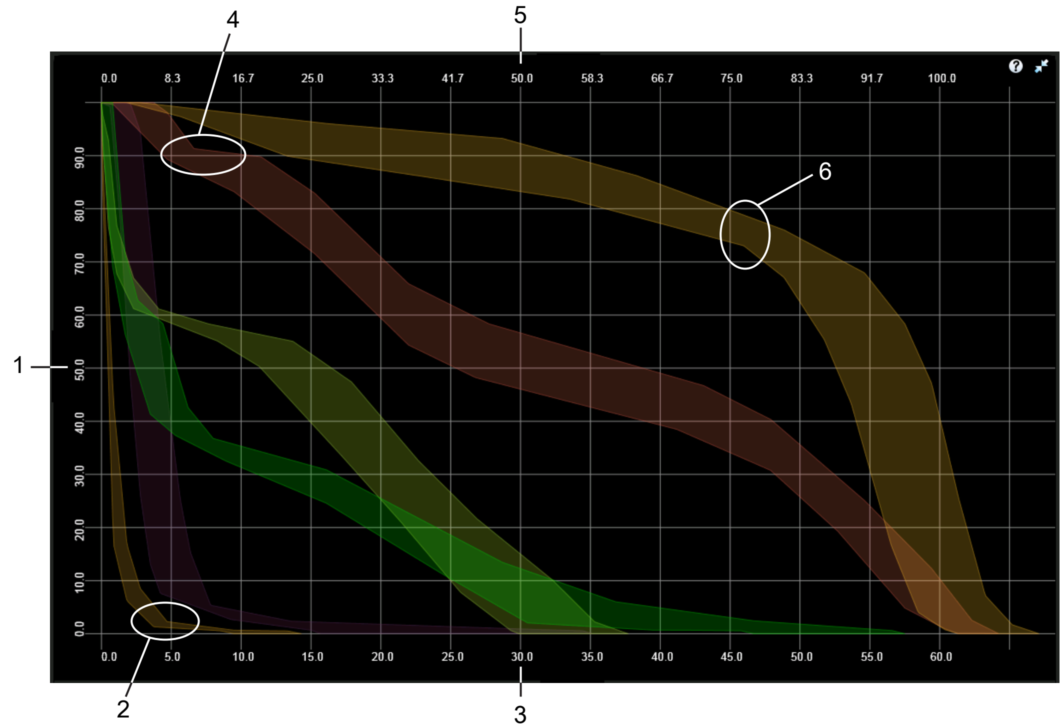
1. Relative volume
2. The first potential data group (low-dose)
3. L-shaped DVH estimate range
4. Relative dose
5. The second potential data group (high-dose)

Figure 43 L-shaped DVH Estimate Range in the In-field DVH Plot

Steps in the DVH Estimate Range

When you are validating generated DVH estimate ranges, you may notice that the range is not even, but contains small steps. The steps are caused by the way the DVH estimation algorithm constructs the DVH ranges. They are constructed separately for different regions of the structure – for the out-of-field region, leaf-transmission region, in-field region, and the overlap region. The steps are located in the transition areas between these regions. More information on the structure regions: *Eclipse Photon and Electron Algorithms Reference Guide*. The steps may also appear if the structure volume is very small.

The following figure illustrates what the steps in the transition areas may look like:



1. Volume percentage
2. Transition area between the out-of-field region and leaf-transmission region
3. Dose (Gy)
4. Transition area between the leaf-transmission region and in-field region
5. Dose percentage
6. Transition area between the in-field region and overlap region

Figure 44 Steps in the DVH Estimate Range

Calculation Log

The calculation log in the Optimization dialog box provides information about the plan, to which a model was applied, and shows how well the plan data fits the model data. In addition, it lists the used structure matchings. The log contains information about how much a structure feature in the plan differs from the corresponding structure feature in the training set.

Publish a DVH Estimation Model

Make sure that the DVH estimation model has been trained and validated. If you are publishing a Varian-provided model, make sure that the model has been validated.

1. In DVH Estimation Model Configuration, click **Open**.
2. Click **Publish**.
3. Enter your user name and password.
4. Click **OK**.

   The status of the model changes to **Published**, and the model is available for clinical use. By default, only published models are available in the Optimization dialog box.

Unpublish a DVH Estimation Model

1. In DVH Estimation Model Configuration, click **Open**.
2. Click **Unpublish**.
3. Enter your user name and password.
4. Click **OK**.

   The status of the model changes to **Unpublished**, and the model is unavailable for clinical use.

Chapter 12 Treatment Planning with RapidPlan

RapidPlan and DVH Estimates

RapidPlan is a treatment planning tool that allows clinics to use the dose and patient anatomy information from existing plans, in the form of DVH estimation models, to estimate the dose distribution in new plans. The DVH estimation models are representative of their clinical practice or, in the case of the Varian provided models, the clinical practice of the clinical site that Varian collaborated with to create the model.

A DVH estimation model generates an estimated DVH range that shows where the DVH curve of a structure will most likely land. You can generate DVH estimates for IMRT or a VMAT plans. The DVH estimation models are available in the new Optimization dialog box. To be able to use DVH estimates, you need to optimize the IMRT or VMAT plans with the PO algorithm.

A DVH estimation model uses knowledge from existing treatment plans to generate DVH estimates and estimate-based optimization objectives in optimization. The data from the existing treatment plans is extracted and then used to train the DVH estimation models. DVH estimation models are configured, trained and managed in DVH Estimation Model Configuration workspace.

Note: *RapidPlan knowledge-based planning and its models are not intended to replace clinical decisions, provide medical advice or endorse any particular radiation plan or treatment procedure. The patient's medical professionals are solely responsible for and must rely on their professional clinical judgment when deciding how to plan and provide radiation therapy.*

Optimize a Plan by Using DVH Estimates and Objectives from a Model

Note: *Notice the following about using optimization objectives from a DVH estimation model:*

- *If you want to use dose objectives from a DVH estimation model together with dose objectives you enter yourself, add the objectives from the model first, as adding them will override all manually entered dose objectives.*
- *Dose objectives from a template cannot be used in the same plan as dose objectives from a DVH estimation model.*
- *If you use a base dose plan together with dose objectives from a DVH estimation model, you need to carefully verify the optimization result and the final dose distribution.*

1. In External Beam Planning, create a new plan, add the fields, and define the dose prescription.
2. On the **Calculation Models** tab, make sure that **DVH Estimation Algorithm** is selected as the calculation model for the DVH Estimation calculation type, and that the PO algorithm is selected as IMRT and VMAT optimization algorithm.
3. Choose **Planning** > **Optimization** > **Optimize**.
4. Select the **Estimate DVH** drawer, and do the following:

    a. In the **DVH Estimation Models** drop-down list, select the estimation model you want to use.

    b. Verify the target dose values of all targets in the plan carefully, and modify them if required.

    The target dose values define the dose levels which are used when generating DVH estimates and optimization objectives for OARs, and optimization objectives for each of the targets. You need to verify that the target dose values for all the targets in the plan are correct. Note that the target dose values do not come from the DVH estimation model.

    - If there is only one target in the plan, the default value is the prescribed dose, which can be modified if required.
    - If there are more than one target in the plan, each target dose level is used for generating optimization objectives for the corresponding target. The highest target dose level is used for generating the objectives for the OARs.

    c. Verify which of the structures in the plan have been automatically matched to the structures in the model, and modify the matches if necessary. You can also match additional structures.

    A list of unmatched model structures is shown below the structures list. You do not need to match all structures.

Tip: *If there are bilateral structures, such as femoral heads, in the structure set, and the field setup used in the plan is symmetrical for the bilateral structure, you can match both structures in a plan to the same model structure. For example, Left Femoral Head and Right Femoral Head structures in the plan can be matched to Femoral Head structure in the model.*

d. Click **Generate Estimates and Objectives**.

The model generates the optimization objectives and DVH estimates for the matched structures. The objectives generated depend on how the model is configured. The DVH estimate range is shown as a translucent band, which cannot be modified. The **Estimate DVH** drawer closes automatically if the generated objectives are within the limits determined by the DVH estimation algorithm.

5. If the **Estimation Statistics** dialog box opens automatically, or you want to view the estimation statistics, click **Open Estimation Statistics** to view estimation statistics for the structures for which DVH estimates were created.

   The **Estimation Statistics** dialog box shows the estimation statistics status for each structure. If the estimation statistics are outside of the threshold values, it is likely that the estimates do not really represent a DVH that can be obtained with the current plan. To correct the situation, you can, for example, check and modify the field geometry, check whether you have matched all the structures correctly and to check the structures to see if something in the structure set causes the issue. Possible errors are described in the Calculation Log, which you can open by clicking **Open Log**.

   More information on the data variables in DVH Estimation regression model: *Eclipse Photon and Electron Reference Guide*.

6. Click the **Estimate DVH** drawer again to close it, if it remained open after the estimates and objectives were generated.
7. You can modify the objectives and add more objectives in the Structures list and the DVH view.

   You can use all the features in the Optimization dialog box in the same way as in optimization without a model.
8. Optimize the plan, and calculate the dose.
9. To view the DVH estimates in External Beam Planning, choose **Planning** > **Show Dose Volume Histogram View**.

10. To display the DVH graphs and estimates, go to the **Dose Statistics** tab of the Info window, and do the following:
    - In the **Show DVH** column, select the check boxes of the structures to be included in the DVH or right-click in the **Dose Statistics** tab and select **Show DVH for All Structures**.
    - In the **Show DVHE** column, select the check boxes of the DVH estimates to be included in the DVH or right-click in the **Dose Statistics** tab and select **Show DVH Estimates for All Structures**.
11. Optional: If you want to see the optimization objectives in the DVH, select the check box next to the **Optimization Objectives** tab title in the Info window.
12. Compare the estimated DVH ranges with the actual DVH lines in the plan.
13. Use all the other necessary plan evaluation tools to make sure that your plan is clinically acceptable.

Using Optimization Objectives from a Model

When you use DVH estimation models, the types of objectives that are generated depend on how the model is configured. The objectives that are generated may be upper, lower, mean, gEUD and line objectives. Estimates are generated automatically for all matched structures, except the plan target, which only gets objectives, if configured so in the model. When optimizing the plan, you can use the automatically generated optimization objectives from the model as a basis, and adjust them if needed before or during optimization.

When applying the model, some of the structures in the plan may be matched automatically to the structures in the model. The matching is based on structure codes and structure identifiers defined for the model structures and plan structures. Structure codes can be modified in Structure Properties.

To take full advantage of the automatic matching, structure codes and identifiers used in plans should correspond to the ones used in the model. A plan structure is automatically matched to a model structure if the plan structure code matches one of the structure codes defined for the model structure. If a plan structure has no code, or several model structures contain a matching code, matching is based on the structure ID. If neither a matching code nor a matching ID exists, the structure is not matched automatically.

Target structures are matched automatically if both the model and the plan have only one target structure. If the model or the plan contain several target structures, or the plan has no target defined, the targets are not matched automatically.

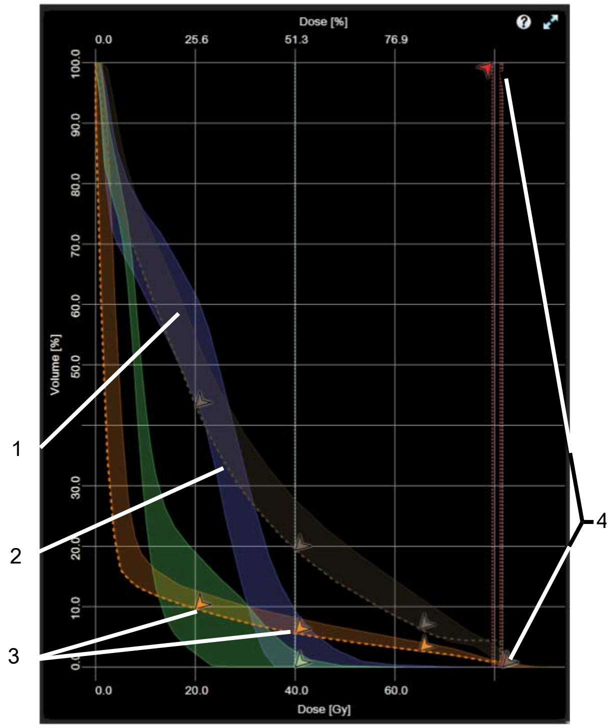
You need to verify the results of the automatic matching, modify them if necessary, and match additional structures. Make sure that you match the structures in the plan to the corresponding structure in the model.

The target dose values define the dose levels which are used when generating DVH estimates and optimization objectives for OARs, and optimization objectives for each of the targets. You need to verify that the target dose values for all the targets in the plan are correct. Note that the target dose values do not come from the DVH estimation model.

- If there is only one target in the plan, the default value is the prescribed dose, which can be modified by defining a different target dose value.
- If there are more than one target in the plan, each target dose level is used for generating optimization objectives for the corresponding target. The highest target dose level is used for generating the objectives for the OARs.

Check all target dose values carefully and modify them if required.

After you have matched the structures and defined the target dose values, you can generate the optimization objectives and DVH estimates for the matched structures based on the DVH estimation model. The DVH estimate range is presented as a translucent band, which cannot be modified. You can use the estimated DVH range as an aid in plan evaluation and compare it to the actual DVH of the plan.



1. DVH estimate range for a structure
2. Line objective for a structure (defined in the DVH estimation model)
3. Point objectives
4. Upper and lower objectives for the target

Figure 45 DVH estimates in the Optimization Dialog Box

Note: *Always use a validated, published DVH estimation model, and only use a model for similar patient cases that were used in the model validation.*

Structures in the plan cannot be edited after the DVH estimates and objectives have been generated. If you need to clear DVH estimates from a structure or from a structure set, you can do that in External Beam Planning by right-clicking the structure or structure set in the Focus window and selecting **Clear DVH Estimates**.

When you copy a plan, the DVH estimates and objectives are also copied. DVH estimates cannot be exported. DVH estimates are included in the DVH print-outs if they are visualized in External Beam Planning or Plan Evaluation.

Note: *The estimated DVH range and objectives only illustrate the situation at the time of estimation. If you change the structures, prescription, or plan after the DVH estimates have been generated, these changes have no effect on the DVH estimates. To update the estimates according to the changes in the plan, re-apply the DVH estimation model.*

NOTICE: Do not base treatment decisions only on the DVH estimations. DVH estimations can be used in plan evaluation, but they alone do not indicate that the plan is clinically acceptable. Evaluate the plan, including the dose distribution in 2D views and calculated DVH, thoroughly before clinical use. In addition to DVH estimations, use all the other necessary plan evaluation tools available.

A model may not always produce optimal results for all patient cases. You can check a few things in the plan to find out why this happens. For example, you can check and modify the field geometry, check whether you have mapped all the structures correctly and check the structures to see if something in the structure set causes the issue. However, if you cannot find the reason, you can try to achieve better results by adjusting the objectives manually or by adding additional objectives. You can also try to improve the result by modifying the field geometry in External Beam Planning.

Related Topics

Estimation Statistics in Optimization on page 212

Selecting a DVH Estimation Model for a Plan

When you are selecting DVH estimation model for a plan, consider the following:

- The treatment site must be the same that the DVH estimation model has been configured, trained and validated for.
- Number of targets (single target, multiple targets). The number of targets does not have to be the same.
- Field geometry (including number of fields). The generated DVH estimates depend on the field geometry that you define for a plan. If the defined field geometry is not optimal, the generated DVH estimates may also be suboptimal.
- Patient's geometry, size, anatomical features, diagnosis.
- Contouring. The structures must be contoured according to the same guidelines as the structures in the plans that were used to train and validate the DVH estimation model.
- Fractionation (for example, standard vs. hypofractionated).
- Total dose.
- Optimization objectives.

If the model contains absolute dose values for the optimization objectives of target structures, pay special attention to the dose prescription. The model produces more accurate DVH estimates and estimate-based optimization objectives if the dose prescription used in the plan is similar to the dose prescriptions used in the training plans.

If the model has been trained with plans, in which an OAR, such as spinal cord has been excluded from optimization in low-prescription plans, and you use this model for a high-prescription plan, check the results carefully. The generated DVH estimates and estimate-based objectives may not be optimal.

- Delivery technique.

You can view information about the configured DVH estimation models and the types of treatment plans they are intended for by opening the model description from the **Estimate DVH** drawer.

Use only validated, published DVH estimation models in planning. Unpublished models should only be used for validation purposes.

Once you have generated the estimates and objectives from a model, the **Estimation Statistics** dialog box shows the estimation statistics status for all structures that have been matched to the model structures, except the target, for which no DVH estimate is generated. The Estimation Statistics dialog opens automatically if any OAR (organ-at-risk) had a value outside of the limit, or you can open it by clicking **Open Estimation Statistics**. The box-and-whiskers plots shown for each structure represent the statistical properties of the data that was used to train the DVH estimation model.

More information on the data variables in the DVH Estimation regression model: *Eclipse Photon and Electron Reference Guide*.

Estimation Statistics in Optimization

The **Estimation Statistics** dialog box shows the estimation statistics status for each structure with DVH estimates:

- Green icon—Indicates that the statistics are within the threshold values determined by the DVH Estimation algorithm.
- Yellow icon—Indicates that the statistics are outside of the threshold values determined by the DVH Estimation algorithm.

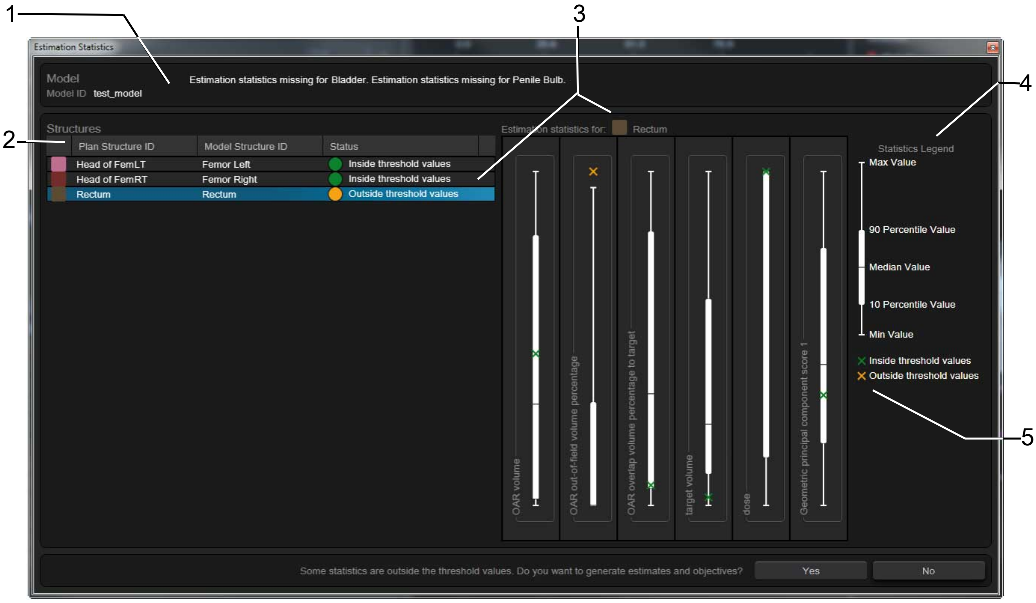
The box-and-whiskers plots in the dialog box represent the statistical properties of the data that was used to train the DVH estimation model. The green or yellow X displayed in each box-and-whiskers plot show how well the plan conforms to the statistical data from the training set:

- The middle of the box (indicated by a line) represents the median of the data set.
- The upper end of the box represents the area where the top 90 percentile of the dataset falls.

- The bottom of the box represents the area where the bottom 10 percentile of the dataset falls.
- The line at the end of the upper whisker represents the highest value in the training set
- The line at the end of the lower whisker represents the smallest value in the training set.
- The X (in green or yellow, depending on the case), represents the current plan.

If X is green, the data value falls within the box, or is less than 2 standard deviations away from the median in the training set (also considering potential skewness of the distribution). If all data values of the plan are green, the Estimation Statistics dialog box does not open automatically after estimate generation.

If X is yellow, the data value falls outside the whiskers, or is more than 2 standard deviations away from the median in the training set (considering potential skewness of the distribution). If at least one data value of the plan is yellow, the Estimation Statistics dialog box opens automatically after estimate generation.



1. ID of the DVH estimation model. If no estimates were created for certain structures, those structures are listed here.
2. List of matched structures in the plan and their estimation statistic statuses.
3. Currently selected structure for which the box-and-whiskers plots are shown in the dialog box. Click a structure in the list to view the box-and-whiskers plot for that structure.
4. Statistics Legend showing how the Maximum, Minimum, Median, 90 Percentile and 10 Percentile values are visualized in the box-and-whiskers plots.
5. The color of the X in the box-and-whiskers plot indicates whether the structure in the current plan is inside or outside the threshold values determined by the algorithm.

Figure 46 An Example on Estimation Statistics Shown for Matched Structures

The estimation statistics being outside of the threshold values is an indication that the estimation might be less reliable than usual. It might also indicate that there is a mistake in structure matching, the field geometry is different from that used in the training plans, or you are trying to use a model that is not suitable for the current patient and field geometry. To correct the situation, you can, for example, check and modify the field geometry, check whether you have matched all the structures correctly, and check the structures to see if something in the structure set is causing the issue.

For individual structures, the box-and-whiskers plots are shown for some of the following, depending on the structure:

- OAR volume

- OAR overlap volume percentage with targets
- Target volume
- OAR out-of-field volume percentage
- Geometric principal component score 1

More information on the data variables in DVH Estimation regression model: *Eclipse Photon and Electron Reference Guide*.

If the model has been trained with different kinds of data than what exists in a plan where you are applying the model, an information message is shown in the **Estimation Statistics** dialog box. The message is shown if a data variable value in the plan is outside the value range used in the training set. This might happen, for example, if you apply a model that has been trained with full-bladder plans to a patient with an empty bladder. However, if your model has been trained with both full-bladder plans and empty-bladder plans, and you apply it to a half-full bladder plan, you receive no information message. This is not a problem if the model has also been successfully validated with half-full-bladder plans, but if this is not the case, the model may yield incorrect results.

Tips for Using DVH Estimates in Optimization

If you want to use dose objectives from a model together with dose objectives you enter yourself, add the objectives from the model first, as adding them will override all manually entered dose objectives.

Dose objectives from a template cannot be used in the same plan as dose objectives from a DVH estimation model.

If you are re-optimizing a plan, remove all lower objectives from structures that are no longer needed in the optimization. If you only set the priority of lower optimization objectives as zero, the objectives still affect the optimization results.

Using Objectives from a DVH Estimation Model for Comparing Plans

You can use objectives from a DVH estimation model to evaluate a previously optimized and calculated plan. You can create a copy of the original plan, generate objectives in the copied plan from a DVH Estimation model, optimize the plan and calculate the dose, and then compare the DVH curves of the two plans, for example, in a plan comparison DVH.

Note: *DVH estimates cannot be used to evaluate previously optimized plans, as DVH estimates are not shown in multiple plan DVHs.*

Chapter 13 Dose Calculation

Calculate the Dose Distribution for an External Beam Plan

CAUTION: Make sure that the calculation volume covers the entire volume of interest.

CAUTION: Verify the maximum dose and its location inside the irradiated volume after the volumetric dose calculation.

CAUTION: Verify the dose calculation and dose display against independent verification methods, for example, manual calculations or measurements. This is to ensure that the following is correct:

- **MU data is correctly interpolated and calibrated.**
- **MU calculation is correct.**
- **Configuration of the dosimetric data is correct.**

WARNING: Verify the dose calculation and dose display against manual calculations for Cobalt machines to ensure that the source decay used in the calculation corresponds to the actual source decay.

1. From the Scope window, drag the plan to an image view, or right-click and choose **Drop to view**.
2. If necessary, define the calculation volume.
3. To calculate the volume dose, choose **Planning** > **Dose Calculation** > **Calculate Volume** .

   You are prompted to select an imaging device for the image series if it has not been defined earlier.
4. To calculate the 2D dose for photon and electron plans in the direction of the primary imaging plane, go to the image plane for which to calculate the dose and choose **Planning** > **Dose Calculation** > **Calculate Plane** . This option is not available for plan sums.

If you are calculating the dose distribution for a plan sum, the calculation progress indicator is displayed for each plan in the plan sum separately. Error and warning messages, if any, are displayed automatically after the dose calculation is done. Read these messages carefully. If there was an error during calculation, only fields that were calculated correctly have dose and no plan dose is shown.

If you are using Acuros XB with plan dose calculation option set on, no dose is shown if there was an error during calculation. With the Acuros XB calculation algorithm, information on the used radiation transport method (transport in medium) and whether the dose is reported to medium or water is displayed in the image views.

Image Requirements for Correct Dose Calculation

To ensure that the images used for treatment planning are properly prepared to achieve acceptable results in dose calculation, make sure that the images fulfill the following requirements.

All External Beam Plans

- All necessary clinical contours have been defined. In Eclipse, at least the Body structure must be defined for dose calculation.
- Make sure that the CT scanner is correctly configured. The images must be CT images with a valid mapping from pixel values to HU values. Normally, this mapping is correct in DICOM images.
- In a case of determining the CT value where several structures with different CT values overlap, the highest CT value assigned to a non-body structure is used. A possible CT value assignment of a body structure is always overridden by other structures with assigned CT values.
- The calculation algorithms require that the image set is constructed from transversal slices with no gantry tilt. All other image orientations result in an error message and abortion of the calculation.

All External Beam Photon Plans

- If you use images of some other modality than CT for photon plans, define the Body structure and assign a CT value for it to indicate the HU values for the dose calculation.
- If you are using images produced with contrast agent, bear in mind that this affects the result of dose calculation and inhomogeneity correction.
- Each image used for a plan must have an imaging device attached to it and an electron density or a mass density calibration curve of the imager must be approved in Beam Configuration. Eclipse notifies if either the imaging device is missing or the CT calibration curve is not approved. The imaging device is attached for an image series in the Series Properties dialog box.

- If you wish to use MR images for dose calculation in photon plans, link the CT scanner to the images by hand in the Series Properties dialog box, and assign a bulk CT value for the structures.
- If there are artifacts in the CT image, cut off the high mass density values by creating a new structure, and use the Segment High Density Artifacts tool to find the high density areas in the created structure. Then, for plans using the Acuros XB dose calculation algorithm, assign a material and a new HU value to the structure. For other plans, just assign a new HU value to the structure.

Select Default Calculation Models for an External Beam Plan

1. In the Scope window, select the plan for which to set the default calculation models.
2. In the Info Window, select the **Calculation Models** tab.
3. To set the default calculation models, click **Use Default Models**.

   A confirmation message opens stating that if you proceed, all calculated dose distributions will be invalidated.
4. Click **Yes**.

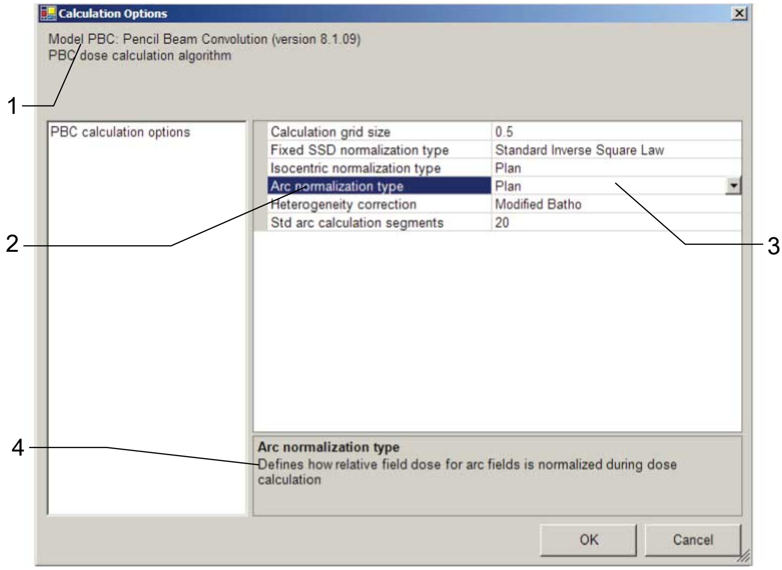
   The default calculation models defined in Beam Configuration are selected for the plan.

Change the Plan-Specific Calculation Options for External Beam Plans

1. In the Scope window, select the plan for which to change the calculation options.
2. In the Info Window, select the **Calculation Models** tab.

3. Click the **Edit** button on the row of the calculation model whose calculation options you wish to change.

Note: *You can also edit the calculation options in the Calculation Models tab of the Plan Properties dialog box.*



1. The selected calculation model.
2. Calculation options of the selected calculation model.
3. Calculation option values. Click the down-pointing arrow head to choose a new value, or type a new value in the text box
4. Information on the selected calculation option.

4. If necessary, select the desired calculation option group on the left side of the Calculation Options dialog box.
5. Click the desired calculation option and do one of the following:
   - Click the down-pointing arrow head and choose a new value for the calculation option.
   - Type a new value for the calculation option in the text box.
6. To finish, click **OK**.
7. To save the new calculation options in the database, save the plan.

Plan Normalization in External Beam Planning

In plan normalization, total dose distributions are normalized to 100% at a selected value or point, or to a selected dose percentage of a selected percentage of a patient structure.

Eclipse supports two types of plan normalization:

- Default plan normalization, which is a clinic-wide normalization used for all new plans
- Plan-specific plan normalization, which can be selected to override the default normalization method if you do not want to use the default plan normalization

The normalization options supported in these two types are the same.

The selected normalization method, its parameters and the coordinates of the normalization point are shown in the Plan Properties dialog box. In addition, the resulting plan normalization value is shown in the Info window and in print-outs.

When changes are made to the active plan, it is automatically re-normalized using the selected method. There is no need to manually re-normalize the plan. Automatic re-normalization is done when you:

- Re-calculate the dose
- Change the field weighting
- Modify or move the reference point, primary or other, selected for normalization to another location
- Change the target structure, if a target-related normalization method is selected
- Remove a field from the plan
- Change the normalization mode
- Modify a motorized wedge contained in the plan

Note: *The plan does not necessarily contain any single point that would exactly correspond to the defined normalization percentage.*

Note: *If you change the normalization of an IMRT plan, it is advisable to run the Leaf Motion Calculator (LMC) again. This is because the original leaf motions with renormalized MU may violate the operating limits of the treatment unit (maximum MLC leaf speed, and minimum MU limitation). Small changes in normalization (about 1-5 %) may not lead to the violation of the operating limits. However, if there are larger changes, always rerun the LMC and recalculate the dose. Before treatment, also verify the leaf sequences.*

Related Topics

Using the Info Window on page 77

Normalize an External Beam Plan

1. Choose **Planning** > **Plan Normalization**.
2. To select the normalization method, select the appropriate option button:
   - **100% at Body Maximum**
   - **100% at Target Maximum**
   - **100% at Target Mean**
   - **100% at Target Minimum**
   - **<n>% Covers <n>% of Target Volume** and then define the percentage of the dose and the target volume in the text boxes
   - **100% at Primary Reference Point**
   - **100% at Reference Point** and then select the reference point in the drop-down list box.

     When normalizing the dose to a reference point, check that the point is not placed in a low dose area.
   - **100% at Field Isocenter** and then select the field in the drop-down list box
   - **Plan Normalization Value** and then define the value in the text box
   - **No Plan Normalization**

Tip: *If the normalization mode has a normalization point with a location, you can move viewing planes to that location by selecting* ***View*** *>* ***Move Viewing Planes to*** *>* ***Normalization Point****.*

Move Viewing Planes to Normalization Point in External Beam Planning

1. Go to External Beam Planning or Plan Evaluation.
2. Choose **View** > **Move Viewing Planes to** > **Normalization Point**.

   This command can be used with normalization modes that have a normalization point with a location.

About Reference Points and Reference Lines

Reference points are used for displaying, defining and prescribing the therapeutic absorbed dose at specific locations. Reference points are available both in External Beam Planning and Brachytherapy Planning. Reference lines are available in Brachytherapy Planning.

In External Beam Planning, you can use reference points to:

- Transfer the MU for the treatment applications through the primary reference point, which is automatically created for new plans. The MU are calculated for the primary reference point.

  Calculated MU are not available in ARIA RTM applications unless a primary reference point is defined.
- Limit the dose for specific organs by creating breakpoints in the treatment
- Collect the dose from different fields
- Normalize the dose to the selected reference point
- Reference lines can be used to mark specific sites in the patient

Reference points, like structures, are always linked to internal patient volumes. When using a structure template to create structures, the application checks whether patient volumes already exist for the patient, and, if found, matches the existing patient volumes with those used in the template. A particular situation affected by this use of patient volumes is changing a reference point ID in a setup where two different image sets and one structure template are used for a particular patient. In this situation, the reference point ID changes for both image sets because of the linking to the internal patient volume IDs.

Primary Reference Point

For new plans, a reference point is automatically created and linked to the target volume of the plan and marked as the primary reference point. This reference point does not have a geometrical location. If you do not wish to use this point as the primary reference point, you can define another one.

In External Beam Planning, the primary reference point is used to:

- Transfer the MU for ARIA RTM applications (not available for proton plans)

  In ARIA RTM, it is beneficial to have a primary reference point without location to track the prescription dose regardless of which volume the plan is prescribed to. This way the dose adds up with a round number in the Reference Points workspace, for instance, 180 cGy instead of 181.2 cGy, as treatments are accumulated.
- Evaluate the dose at this point in the Plan Organizer
- Normalize the plan to this point

In External Beam Planning, the dose prescribed for the plan is calculated for the primary reference point by dividing the total dose into dose contributions of each field according to the field weights. The total dose and the dose per fraction at the primary reference point are shown in the Plan Properties dialog box.

Related Topics

Defining the Use of Reference Points on page 225

Reference Points and Geometrical Locations

A reference point comprises an abstract, conceptual point with defined dose limits, and can have a separately defined geometrical location in 3D space.

Reference points without a geometrical location include:

- Reference points created automatically with new plans. By default, these reference points are linked to the target volume of the plan and are defined primary reference points.
- Reference points defined in an existing 3D image when creating a new 3D image for a patient. In this case, the reference point still exists for the patient, but the reference point locations are not included in the new 3D image.

Reference points without a geometrical location are shown in the Focus window but not in the image views.

Reference points with a geometrical location normally represent an anatomical structure or some other geometrical structure of interest. One reference point can also be linked to different images, in which case it can have a different geometrical location in each image. You can view how the dose distribution of a plan affects the reference points, and when using multiple plans, you can accumulate dose from different plans to the primary reference point.

Add a Reference Point without a Geometrical Location

1. Add a reference point as usual.
2. Press Del on the keyboard.
3. To delete the geometrical reference point location from the currently active image, select **Current Image**.
4. Click **OK**.

Tip: *You can edit the reference point by choosing **Edit** > **Properties**.*

Add a Reference Point with a Geometrical Location

1. Choose **Insert** > **New Reference Point and Location**.
2. Type an identification and name for the reference point.

3. Select a patient volume that the point will represent. If there are no suitable volumes, select the volume type “None”.

Tip: *The dose delivered to date will display at the treatment unit only for volumes that end with “TV”, such as CTV, PTV or GTV.*

4. Define the dose limits.
5. If necessary, select the Location tab and define the location with the X, Y, and Z coordinates.

Tip: *You can also drag the point to the correct position after adding it, or right-click the point and choose Move Reference Point to Viewing Planes Intersection.*

6. Click **OK**.

   The reference point is automatically included in the open plan. If the patient has more than one plan, include the reference points to the desired plans.

Tip: *You ca edit the reference point by choosing* ***Edit*** *>* ***Properties****.*

Related Topics

Include Reference Points in Plans on page 225
Define the Primary Reference Point on page 226

Add a Location for an Existing Reference Point

1. Choose **Insert** > **New Location for Existing Reference Point**.

   The Select Reference Point dialog box lists the reference points that do not have a location in the currently active image.
2. Select the point for which to add the location.
3. Select the Location tab to define the location of the reference point with the X-, Y- and Z-coordinates.

Tip: *You can also drag the point to the desired position, or right-click the point and choose Move Reference Point to Viewing Planes Intersection.*

4. Click **OK**.

Defining the Use of Reference Points

To be able to use reference points created for a patient, the points must be linked to each relevant plan. The reference point automatically created for a new plan is also automatically linked to the plan and marked as the primary reference point. If you define reference points for a patient with one of the patient's plans open, the points are automatically linked to the plan that is open. Also when you create multiple plans for the patient using the same image, the reference points are automatically linked to the plans. You can evaluate the planned dose per fraction at each reference point for selected plans in the Plan Organizer.

Only one of the reference points can be marked as the primary reference point.

In External Beam Planning, the primary reference point specifies the dose specific to each field. You can determine which of the reference points contained in a plan is used as the primary reference point. The primary reference point is marked with a yellow frame in the Plan Organizer. The MU are calculated for the primary reference point. It is also used in plan normalization, and in the system to indicate the amount of dose received and to trigger breakpoints in the treatment.

Note: *Notice the following when working with reference points:*

- *MU calculated for an external plan are not available in ARIA RTM applications unless a primary reference point is defined.*

Related Topics

Primary Reference Point on page 222

Include Reference Points in Plans

1. In the Scope window, select the plan.
2. Choose **Planning** > **Reference Point Organizer**.

Tip: *You can also open the Reference Point Organizer by clicking **Edit Reference Points** in the Plan Organizer.*

   Reference points defined for the selected patient are displayed on the left. Reference points selected for the active plan are displayed on the right.

3. Include or exclude reference points as necessary.

Define the Primary Reference Point

1. Do one of the following:
   - Choose **Planning** > **Reference Point Organizer**, select the point in the Reference points in plan list box and click **Primary**.

     Note: *In ARIA RTM, it is beneficial to have a primary reference point without location to track the prescription dose regardless of which volume the plan is prescribed to. This way the dose adds up with a round number in the Reference Points workspace, for instance, 180 cGy instead of 181.2 cGy, as treatments are accumulated.*

   - Choose **Planning** > **Plan Organizer**, click the Point cell at the row of the desired plan and select the primary reference point from the list.

   Each reference point is linked to a patient volume. This link is kept and the defined patient volume is automatically selected.

Tip: *In External Beam Planning you can also go to the Dose Prescription tab of the Info window and define the primary reference point there.*

Evaluate the Planned Dose for the Reference Points

1. Choose **Planning** > **Plan Organizer**.
2. Select the Ref. Points tab.
3. In the **In Total** column, select the check box for each plan to include in the planned total dose.
4. Click **Close** to close the dialog box.

Move a Reference Point

1. In the Focus window, select the reference point to move.
2. On the toolbar, click **Edit Reference Points** .
3. Move the mouse pointer to the reference point and drag it to a new position.

Move the Viewing Planes to a Reference Point

- In the Focus window, right-click the reference point and choose **Move Viewing Planes to Reference Point**.

Move a Reference Point to Viewing Planes Intersection

- In the Focus window, right-click the reference point and choose **Move Reference Point to Viewing Planes Intersection**.

Move a Reference Point to the Isocenter or Entry Point

- In the Focus window, right-click the reference point to move and click **Move Reference Point to Isocenter**.

Delete a Reference Point

1. Select the point to delete.
2. Choose **Edit** > **Delete**.
3. Do one of the following:

Action	Steps to be taken
Delete the geometrical reference point location from the currently active image	Select **Current Image**. If the reference point is not part of the currently active image, this option is not available.
Delete the geometrical reference point location from the currently active plan	Select **Current Plan**. If the reference point is not part of the currently active plan, this option is not available.
Delete the geometrical reference point location from the currently active image and plan	Select **Current Image and Plan**. If the reference point is not part of the currently active image or the currently active plan, this option is not available.
Delete both the reference point and its geometrical location	Select **Current Patient**. If there are other reference point locations defined than the one currently in use, this option is not available.

4. Click **OK**.

Reference Point and Reference Line Visualization

Reference points linked to the active plan are shown in the Focus window with a special icon (primary reference point , other reference points) in the Reference points folder. If a plan has been dragged to the image views, the Reference Points folder is shown under the Plan object, or if an image has been dragged to the image views, the folder is shown under the Image object. For a plan sum, reference points with a location are shown under the image in the Focus window. You can show or hide reference points by selecting or clearing their visibility check boxes in the Focus window.

The following figure shows reference points in a transversal image in a 2D view in External Beam Planning.

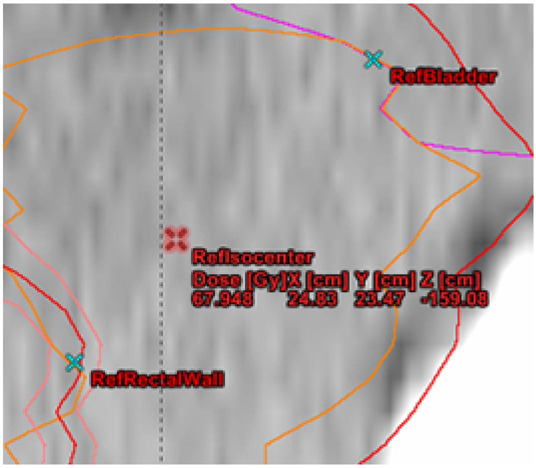


Figure 47 Reference Points in 2D View (not Selected)

The following figure shows a reference line in a transversal image in a 2D view in External Beam Planning.

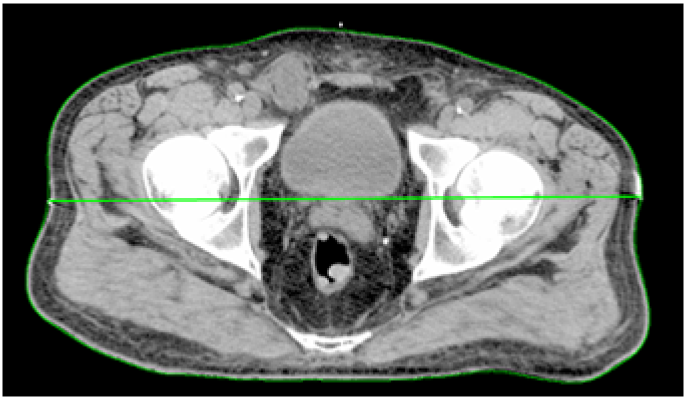


Figure 48 Reference Line in 2D View

Reference points, along with their IDs, are also shown in the BEV and the Model view if they belong to the active plan.

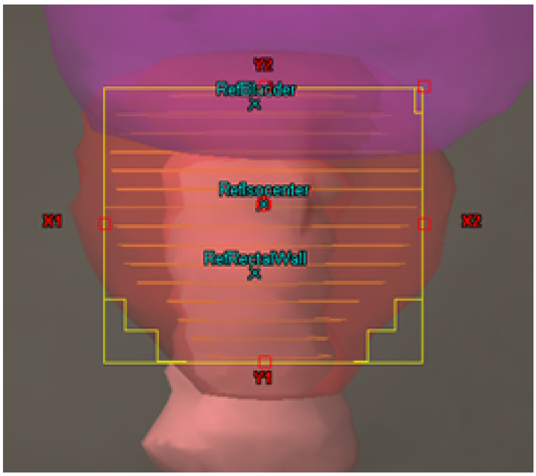


Figure 49 Reference Points in Beam's Eye View

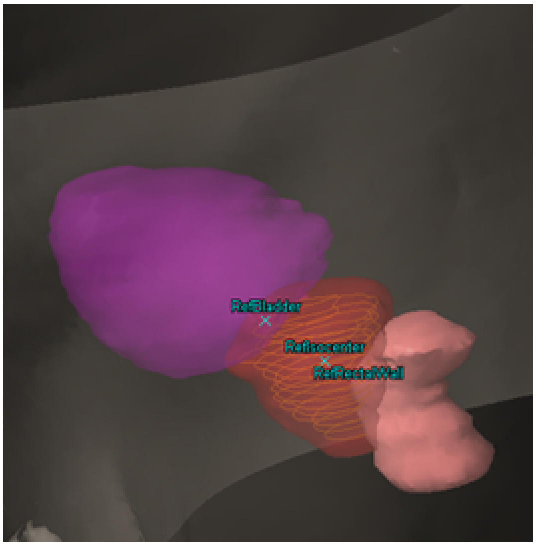


Figure 50   Reference Points in Model View

Reference points may be seemingly invisible in the Model view. This is because they are positioned realistically in 3D space and, depending on the viewing angle, may be obstructed by a structure.

In the BEV, reference points are always shown on top of all structures.

You can show or hide reference points by selecting or clearing their visibility boxes in the Focus window.

Related Topics

Defining the Use of Reference Points on page 225

Chapter 14 Plan Evaluation

Evaluating Plans

You can evaluate your treatment plans:

- Visually by reviewing and comparing 3D dose distributions to decide which of the alternative plans will be used for treatment. In Plan Evaluation, you cannot change any parameters that would invalidate the dose calculation.
- Quantitatively by using the dose measurement tools—point dose value and dose profile.
- Reductively by using dose-volume histograms that summarize the overall dose received by structures. The dose-volume histogram information can also be viewed in statistical format, together with dose conformality values.
- Summing plans to make sure that the delivered dose is acceptable if the treatment consists of multiple plans.

CAUTION: Make sure that a qualified physician reviews the accuracy and placement of all patient structures (target structure and critical structures) used for treatment planning and for evaluating the plans prior to patient treatment.

Managing the Dose Visualization

After creating a plan and calculating the dose distribution in External Beam Planning, you can display the dose distribution in the 2D image views and the Model view.

In photon plans that contain arc fields, you can display the dose distribution also in the Arc Plane View.

The dose distribution information is indicated either as an absolute (Gy) or a relative (%) dose, and visualized respectively.

In External Beam Planning, the absolute dose distributions are shown only when the dose prescription has been defined, and the absolute dose shown is always the total dose, if there are multiple fractionations.

Note: *The dose displayed is physical dose, not biological dose.*

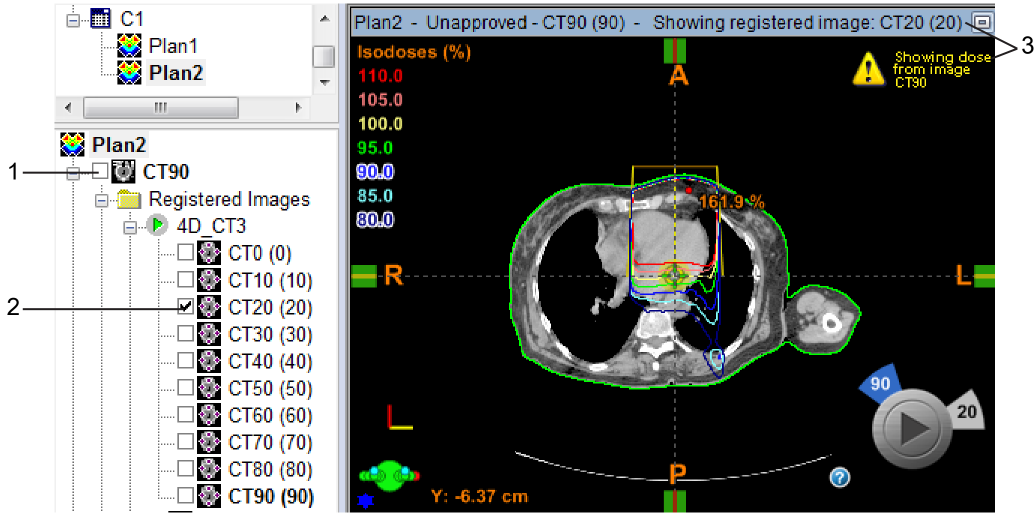
You can change the visualization mode as necessary and define how the dose values are displayed:

- Show the dose in the isodose or color wash mode in 2D image views; or in the dose cloud mode or surface dose mode in Model view.
- Select the isodose levels shown, and display only the most significant dose levels, depending on what is appropriate in each situation.
- Show the persistent dose in the image views, when the plan has been changed after the dose is calculated.
- Modify the isodose color and style used in Model view (contour, translucent, segment).
- Show or hide the isodose labels and the dose maximum point.
- Show or hide the dose statistics in the 2D image views and the Model view.
- Show a field-specific dose in the image views.

Only one visualization mode can be used at a time. You cannot display the dose as isodose lines in one 2D image view and in the color wash mode in another.

CAUTION: Modifications to the treatment strategy should not be based on outdated or not fully visualized dose for any plans or plan sums, or dose for plan sums containing weighted plans.

CAUTION: When planning with 4D images, you can choose to view another 3D image instead of the planning image. In this case, the visualized dose is still that of the planning image, because the dose is calculated to the planning image only. This is indicated with a warning message and by showing the IDs of the planning image and the currently viewed image in the graphical user interface. Be careful not to make any treatment decisions based on the dose shown over a different image than the one to which the dose was calculated. To evaluate the dose distribution in another phase image, copy the plan and calculate it, or assign the plan to another phase image.



1. Planning image.
2. Registered 3D image selected to be shown in the image views.
3. Title bar indicating the shown image, and warning stating that the dose is shown from the planning image.

Figure 51 Showing the Dose from the Planning Image in a Registered Image

NOTICE: Visually verify the display of 4D images in the application to confirm proper organization of the 3D images into a series of images that represent the breathing cycle.

Note: *In External Beam Planning, due to interpolation in the dose visualization, the dose distribution may extend outside the Body structure, especially when you use large calculation grid sizes, for instance, 10 mm.*

Note: *For photon and electron plans, the dose is calculated on a grid which is aligned along the transversal planes. Between the dose matrix points the dose is always trilinearly interpolated. The interpolation is dependent on the calculation grid points of the dose calculation algorithm:*

- *For example, AAA and Acuros XB may calculate the dose also on dose planes added between the transversal image slices (more information: Eclipse Photon and Electron Algorithms Reference Guide). The dose displayed on sagittal and frontal reconstructions, and in the Arc Plane View, is interpolated from the dose grid.*
- *In the case of other algorithms, the dose displayed on sagittal and frontal reconstructions, and in the Arc Plane View, is an interpolation of the dose calculated on the transversal planes, and dependent on the plane distance. To increase the accuracy in viewing the interpolated dose, use a plane distance smaller than 5 mm. The plane distance is defined in the Create 3D Image dialog box which opens when you create a new 3D image with the* ***Insert*** *>* ***New 3D Image*** *command.*

Show the Dose as Isodoses or in the Color Wash Mode

1. In the Focus window, right-click the dose.
2. Do one of the following:
   - To display the dose in the color wash mode, choose **Dose Color Wash** > **Show Dose in Color Wash** (a check mark appears next to the command).
   - To display the dose as isodose lines, clear the **Show Dose in Color Wash** menu command (the check mark disappears).

   By default the slider is displayed only in one 2D view in External Beam Planning. You can show the hidden slider in the other image views by maximizing the view.

Isodoses in External Beam Planning

By default, the image views display the resulting dose as isodoses. The figure shows an example of the dose displayed as isodoses.

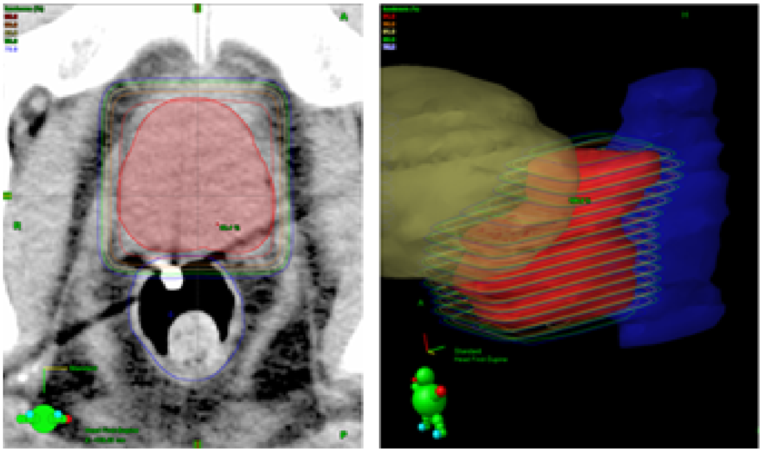


Figure 52 Isodoses in 2D View and Model View

The selected isodoses are displayed as colored contours in the 2D image views, the Arc Plane View (if the plan contains arc fields) and the Model view. A legend in the upper left corner of the image views shows the color used for each isodose and the dose values either in relative (%) or absolute (Gy) mode, depending on the selection. The absolute dose distributions are shown only when the dose prescription is completed. Absolute dose is displayed as the total dose for the fractions and/or fractionations defined for the dose prescription.

Note: *You can view only significant isodose levels in the 2D image views in particular treatment cases by using predefined isodose sets, or by hiding isodose levels in the isodose set. The isodose levels included in each set are defined in RT Administration.*

Select the Isodose Levels Displayed

1. Choose **Planning** > **Isodose Levels**.

   Depending on the selected dose display mode, either the Relative Dose Isolevel Editor or the Absolute Dose Isolevel Editor opens. If the dose displayed is absolute, the unit in the Dose column is Gy. If the dose displayed is relative, the unit in the Dose column is percentage.
2. In the 2D and 3D columns, select the check boxes of the isodose levels you wish to show, or clear the check boxes to hide the isodose levels. To show or hide all isodose levels, select or clear the check box on the All row.

Select a Predefined Isodose Set

1. Choose **Planning** > **Isodose Levels**.
2. In **Copy Levels from** drop-down list, select the isodose set.

   The isodose level set is saved with the plan.

Color Wash in External Beam Planning

The dose is displayed with a continuous color map in the 2D image views and in the Arc Plane View, and as a dose cloud or surface dose in the Model view.

The following figure shows an example of a dose distribution displayed in the color wash mode in a 2D view. For clarity, the fields are hidden in the figure.

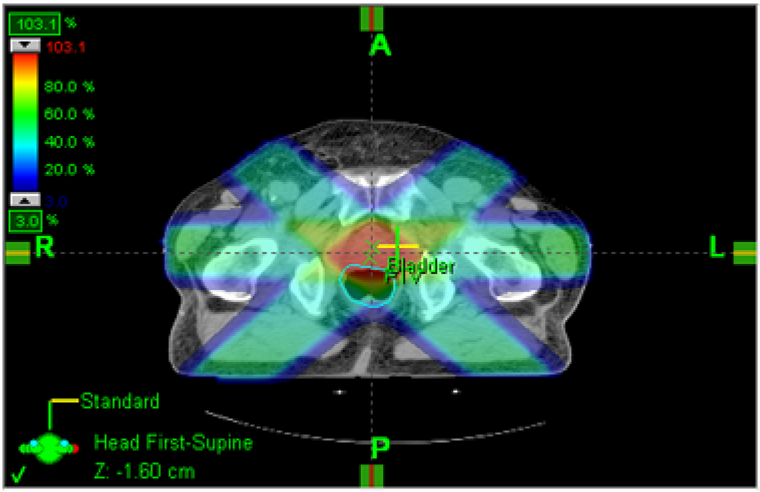


Figure 53 Dose Color Wash in 2D View

The following figure shows an example of a dose distribution displayed in the color wash mode in the Arc Plane View.

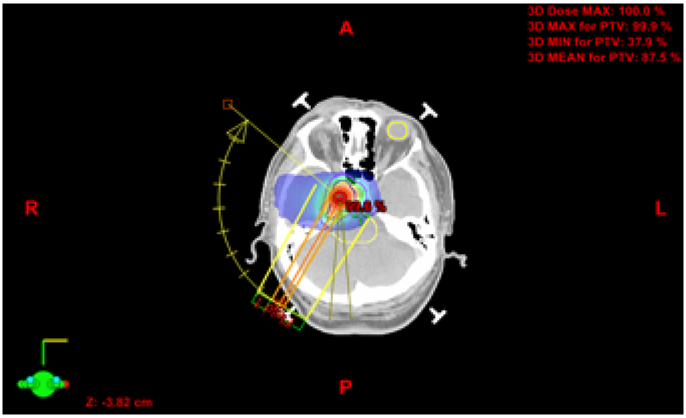


Figure 54 Dose Color Wash in Arc Plane View

The following figure shows an example of the dose visualized as a dose cloud and a surface dose on the surface of the selected, visible structure. In the surface dose, only the dose for the selected structure is shown.

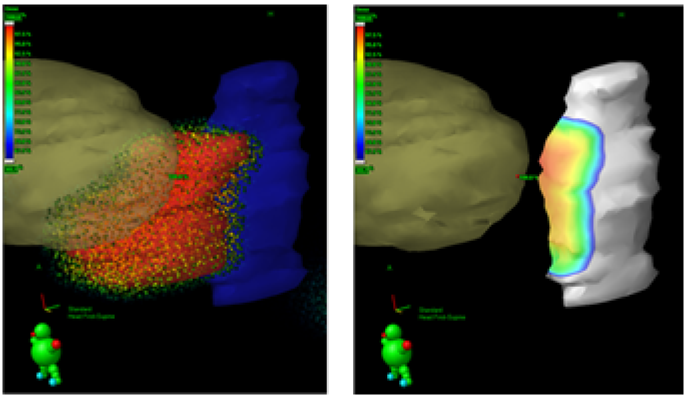


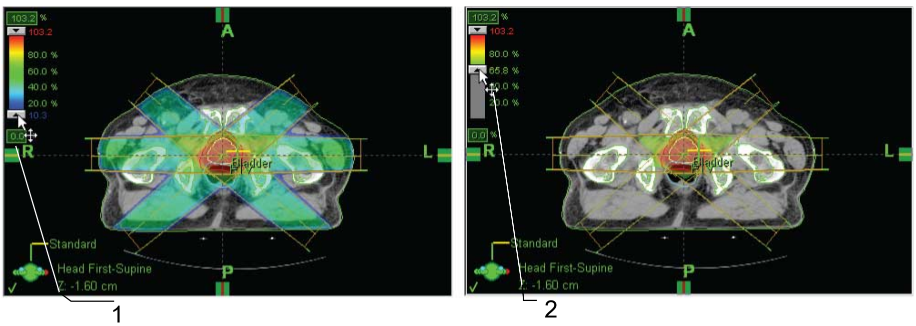
Figure 55 Dose Cloud and Surface Dose in Model View

In both 2D views and the Model view, the left corner of the view contains the dose color wash slider, that is used to show and define the range of dose levels displayed. The slider also shows the use of relative (%) or absolute (Gy) dose values. The absolute dose distributions are shown only when the dose prescription is done, and the absolute dose is always the total dose, if there are multiple fractionations.

Select the Dose Color Wash Levels in the 2D Image Views

- To define the upper and lower dose level shown with the color wash slider, drag the slider handles.

  In this option, the color wash map is not compressed between the upper and lower dose level.
- To show the dose distribution in full color scale between the isodose levels defined by the positions of the color wash slider handles, drag the slider handles to the desired levels. Then go to the Focus window, right-click the dose, choose **Dose Color Wash** > **Range between Slider Handles**.
- To define the upper and lower dose level numerically, in the text boxes below and above the slider, type the level values and press Enter.
- To show the dose distribution between the target minimum dose and the target maximum dose, go to the Focus window and right-click the dose. Choose **Dose Color Wash** > **Range from Target Dose Minimum to Maximum**.
- To use the lowest and highest isodose level in the selected isodose level set, go to the Focus window and right-click the dose. Choose **Dose Color Wash** > **Range between Isodose Set Levels**.
- To return the color wash to the default state, in the Focus window, right-click the dose, choose **Dose Color Wash** > **Reset Color Wash**.



1. Point at a handle in the color wash slider.
2. Move the slider.

Figure 56 Dose Color Wash Slider in a Photon Plan

Showing the Field Dose in External Beam Planning

You can view the dose for one field at a time in the 2D image views. In photon plans, you can view the field dose also in the Arc Plane View. The field dose is available both as isodose lines and in color wash mode. You can view the field dose for all plan statuses, but not for plan sums.

When the field dose is displayed in an image view, a warning message is shown to indicate that the visible dose is not the plan dose. In this case, you cannot print any reports, export the plan data, or change the status of the plan.

Show the Field Dose

1. In the Focus window, right-click the field, and:
   - To define that the field dose is visualized in the image views, select **Show Field Dose**.
   - To define that the field dose is not visualized in the image views, clear the selection from **Show Field Dose**. You can also clear the selection in the Focus window by clicking any item that is above Field in hierarchy.
2. If the isodose lines do not show clearly enough for the field dose in the image view, you can change the isodose levels by selecting **Planning** > **Isodose Levels**. Enter a low enough value for the lowest isodose level.

Show Absolute or Relative Dose

In External Beam Planning, to be able to show the absolute dose on screen, you must first define the dose prescription. If the dose prescription is not defined, the relative dose is always displayed, even if the absolute dose is selected. The absolute dose is always the total dose, if there are multiple fractionations.

1. In the Focus window, right-click the dose.
2. Do one of the following:
   - To display the absolute dose, make sure that the **Absolute Dose** menu command is selected (has a check mark).
   - To display the relative dose, make sure that the **Absolute Dose** menu command is not selected (there is no check mark).

Show or Hide the Dose Statistics

1. Choose **View** > **Options**.
2. Select the tab specific to the application currently in use.

3. In the **Dose** group box, do one of the following:
   - To show the statistical dose information in the Model view, select the 3D Statistics check box.
   - To show the statistical dose information in the top left 2D image view, select the 2D Statistics (DAH) check box and the **In primary view** option.
   - To show the statistical dose information in all 2D image views, select the 2D Statistics (DAH) check box and the **In all views** option.
   - To hide the statistical dose information, clear the appropriate check box.

Show or Hide the Dose Maximum Point

The Dmax can be shown in the External Beam Planning and Plan Evaluation.

1. Choose **View** > **Options**.
2. Select the tab specific to the application currently in use.
3. To show the dose maximum point, select the **Show DMAX** check box.
   - To hide the point, clear the check box.
4. To see the coordinates of the Dmax point, move the viewing planes to the Global Dose Maximum and check the coordinates at the bottom of each image view.

Move Viewing Planes to the Dose

External beam plans: Go to External Beam Planning or Plan Evaluation.
Brachytherapy plans: Go to Plan Evaluation.

1. Choose **View** > **Move Viewing Planes to** and select:
   - **Dose** > **Global Dose Maximum**, to move the intersection point of the viewing planes to the point that receives the maximum dose in the plan
   - **Dose** > **Target Dose Maximum**, and then select the target dose if appropriate, to move the intersection point of the viewing planes to the point that receives the maximum dose in the target structure
   - **Dose** > **Target Dose Minimum**, and then select the target dose if appropriate, to move the intersection point of the viewing planes to the point that receives the minimum dose in the target structure.
   - **Normalization Point** to move the intersection point of the viewing planes to the reference point used for the plan normalization.

Display the Dose at the Selected Point for an External Beam Plan

1. Choose **View** > **Measure** > **Point Dose** .
2. In an image view, click a point of interest to show the point dose information at the point, contributed by each field separately.

Display the Dose Profile Along a Line

1. Open the plan. If you want to compare the dose profiles of two alternative plans, open both plans.
2. Choose **View** > **Measure** > **Dose Profile** .
3. In an orthogonal view, click the starting point of the dose profile.
4. Move the mouse to where you wish to end the line.
5. Click the end point of the line.

Tip: *You can move the line in the image view by using the pan tool or by dragging the handles at either end of the line. To constrain the movement to vertical and horizontal directions, press Shift when dragging. You can maximize, minimize or resize the dose line profile dialog box as necessary and print the dose profile.*

6. To display the dose value and distance at any point along the line profile, place the mouse pointer in the graph.

7. By default, you can view also the dose profiles for each field. To hide the field-specific profiles in the graph, select the **Hide field profiles** check box.

Tip: *To print the dose profile, click **Print** in the Dose Line Profile dialog box. Select the desired printer and number of copies to be printed. Click **OK**.*

Dose-Volume Histogram

This information applies to External Beam Planning and Plan Evaluation.

A dose-volume histogram (DVH) displays a 3D dose distribution in a two-dimensional graph. The DVH reveals the dose uniformity throughout structures, and helps you evaluate dose distributions from various plans. You can calculate DVHs for structure combinations, and view the dose for the selected structures in one plan or multiple plans. You can display the structure, course, plan, dose, and the equivalent sphere depth relevant to points along a histogram curve.

You can also include the DVH estimate curve for structures in photon plans that contain DVH estimates.

The function of the DVH algorithm is based on calculated dose distributions and a shape-based interpolation model for volumes, which rounds structure edges to better reproduce the shapes of biological structures. The rounding effect is strongest in the Z-direction. The same shape-based model is also used in volume calculation and 3D visualization.

You can view the dose-volume information, together with the dose conformity values, in statistical format in the Dose Statistics tab of the Info Window. The dose statistics shown for structures in the DVH view may differ from dose statistics shown elsewhere. This is due to different modeling of the structure.

More information on volume modeling in DVH: *Eclipse Photon and Electron Algorithms Reference Guide*.

In cases where a defined structure is very small, the spatial resolution is different for the dose matrix and the defined structure. This leads to a situation where the sampling coverage of the DVH is not 100%, and the DVH curve and statistics may not be fully accurate.

You can print the DVH and export it in the ASCII format. You can also export the DVH in DICOM format with the dose data.

Display a DVH for One Plan

Use a single-plan DVH to compare the dose received by several structures in one plan or one plan sum. A single-plan DVH contains the X- and Y-axis information. The curve for a structure in the DVH graph is drawn in the color selected in the Structure Properties dialog box.

In External Beam Planning, before creating the DVH, prescribe the dose for the plan.

1. To switch to the Dose-Volume Histogram View, do one of the following:
   - Choose **Planning** > **Show Dose Volume Histogram View**.
   - Right-click in the Model view and choose **Show Dose Volume Histogram View**.
2. In the Dose Statistics tab of the Info Window, select the check box in the Show DVH column of each structure to be included in the DVH, or right-click in the Dose Statistics tab and select **Show DVH for All Structures**. To remove the selection, clear the check boxes or right-click and select **Hide DVH for All Structures**.

   The DVH line of the structure that is last selected in the Dose Statistics tab or with the Cross-hair tool is highlighted.

   A notification text is displayed at the bottom of the Dose-Volume Histogram view and the relevant cell is highlighted in red in the Info window, if the dose coverage is less than 100% and the sampling coverage less than 90% for a structure.
3. To include the DVH estimates if available in a photon plan, in the Dose Statistics tab of the Info Window, select the check box of the structures containing DVH estimate in the Show DVHE column, or right-click in the Dose Statistics tab and select **Show DVH Estimates for All Structures**. To remove the selection, clear the check boxes or right-click and select **Hide DVH Estimates for All Structures**.

   The Show DVHE column is only shown when the photon plan contains structures that have DVH estimates. DVH estimates cannot be shown in the DVH view for a differential DVH.

Tip: *You can sort the Show DVHE column to bring the structures that have DVH estimates on top of the structure list.*

4. To close the DVH graph, right-click in the Dose-Volume Histogram view and deselect **Show Dose Volume Histogram View**.

Note: *When using DVH calculation, notice the following:*

- *If the target structure exceeds the selected calculation volume, the DVH is partially calculated and a message is displayed. This may often be the case for the Body structure because the dose calculation and the volume calculation interpret the volume differently. If the Partial calculation percentage stated is close to 100% for the Body structure, the message is not critical.*
- *Dose statistics shown for structures in DVH dialog box may differ from dose statistics shown elsewhere. This is due to different modeling of the structure.*

Related Topics

Use the DVH Tools on page 247

DVH for Multiple Plans

This information applies to External Beam Planning and Plan Evaluation.

A multi-plan DVH shows the DVH curves for multiple structures from several different plans on the same graph. Use a multi-plan DVH to compare the absolute dose received by one or several structures included in a number of plans or summed plans. The plans can belong to different courses. You can also create Boolean structures for a multi-plan DVH.

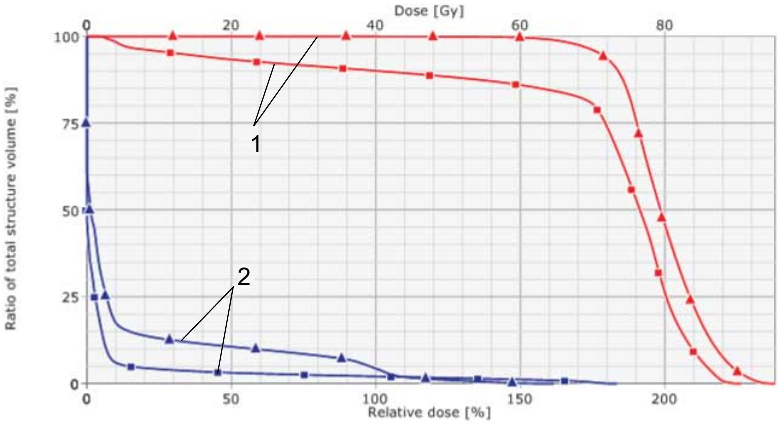
The curves in a multi-plan DVH are differentiated from each other using different symbols for each curve. The DVH curves for the same structure have the same color in all plans, if the plans use the same image. Different plans are indicated with different symbols.

Tip: *You can display the structure, course, plan and dose relevant to points along a histogram curve by activating the Cross-hair tool, moving the mouse pointer on the curve and clicking.*

Note: *When using a DVH, note the following:*

- *Dose statistics shown for structures in the Dose-Volume Histogram view may differ from dose statistics shown elsewhere. This is due to different modeling of the structure. More information on volume modeling in DVH: Eclipse Photon and Electron Algorithms Reference Guide.*
- *If the plans for the multi-plan DVH contains a plan sum and a plan without prescription, the DVH cannot be displayed.*
- *If the plans contain different prescriptions, you can choose to display the DVH either in absolute or in relative dose. Note that the DVH graphs might look similar when viewed in relative dose, but very different when viewed in absolute dose.*

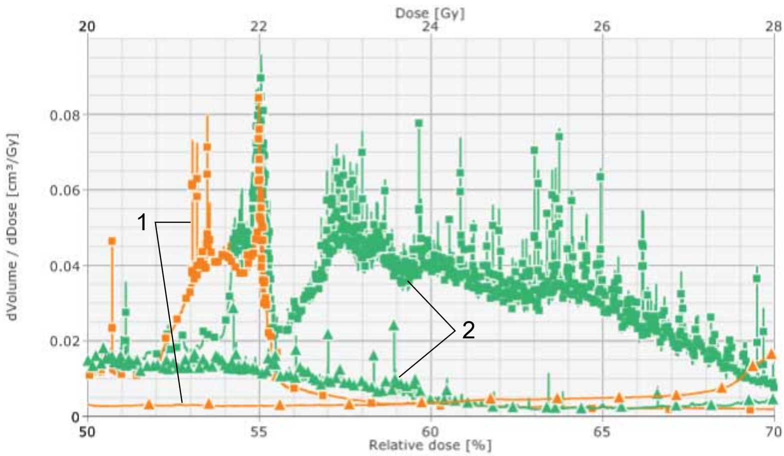
The figure shows an example of a cumulative multi-plan DVH:



1. Cumulative DVH curves for structure A in two plans.
2. Cumulative DVH curves for structure B in two plans.

Figure 57 Cumulative Multi-Plan DVH

The figure shows an example of a differential multi-plan DVH:



1. Differential DVH curves for structure A in two plans.
2. Differential DVH curves for structure B in two plans.

Figure 58 Differential Multi-Plan DVH in External Beam Planning

Display a DVH for Multiple Plans

Before creating the DVH, prescribe the dose for the plans. The plans must use the same dose units (percentages, Gy or cGy) or have the same prescription or plan normalization, otherwise the DVH cannot be displayed.

1. Choose **Planning** > **Create Plan Comparison DVH**.
2. Select the plans to include in the multi-plan DVH.
3. Click **OK** to display the multi-plan DVH.

   The Plan Comparison icon appears in the Scope window. The DVH line of the structure that is last selected in the Dose Statistics tab or with the Cross-hair tool is highlighted.

   If the Dose-Volume Histogram view is not activated, right-click in the Model view and choose **Show Dose Volume Histogram view**. If not already selected in the individual plans, select the desired structures to compare in the DVH in the Dose Statistics tab of the Info Window, or right-click in the Dose Statistics tab and select **Select All Structures**.

   A notification text is displayed at the bottom of the Dose-Volume Histogram view and the relevant cell is highlighted in red in the Info window, if the dose coverage is less than 100% and the sampling coverage less than 90% for a structure.

Tip: *You can display a multi-plan DVH also by showing a single-plan DVH in the Dose-Volume Histogram view and dragging another plan on top of it.*

Note: *Dose statistics shown for structures in Dose-Volume Histogram view may differ from dose statistics shown elsewhere. This is due to different modeling of the structure. More information on volume modeling in DVH: Eclipse Photon and Electron Algorithms Reference Guide.*

Note: *DVH estimates cannot be shown in the DVH view for multiple photon plans.*

Related Topics

Use the DVH Tools on page 247

Display a DVH for Multiple Plans in Plan Evaluation

1. To select the appropriate view layout, choose **Window** > **View Layouts**, select the desired layout and click **OK**.
2. From the Scope window, drag the plans to include in the multi-plan DVH into the plan evaluation view sets.
3. Choose **Evaluation** > **Show Dose Volume Histogram view**.
4. Define the structures that are included in the DVH graph by selecting them in the Dose Statistics tab of the Info window, or right-click in the Dose Statistics tab and select **Select All Structures**.

Use the DVH Tools

Most of the DVH tools are available in the right-click menu of the Dose-Volume Histogram view and in the **DVH Options** dialog box.

1. Choose **Planning** > **Show Dose Volume Histogram View** or Choose **Planning** > **Create Plan Comparison DVH**.
2. When the DVH graph is shown in the Dose-Volume Histogram View, choose the following options:

Desired Action	Steps to be Taken
Define the DVH type	Right-click in the Dose-Volume Histogram view and choose **Cumulative Graph** or **Differential Graph** or **Natural Graph**. Natural Graph is available only in Brachytherapy Planning.
View the absolute dose information for each structure	Right-click in the Dose-Volume Histogram view and choose **Absolute Dose**.
View the dose distribution in the total structure volume	Right-click in the Dose-Volume Histogram view and choose **Absolute volume**. By default, the volume scale is set to relative volume.

Desired Action	Steps to be Taken
Zoom into a defined area in the DVH graph	1. Right-click in the Dose-Volume Histogram view and choose **Zoom Region**. 2. Place the mouse pointer on the DVH graph and do one of the following: ■ To zoom a rectangular region: a. Click and hold down the left mouse button. b. Move the mouse pointer to form a rectangular area. c. Release the mouse button when the rectangle covers the desired area of the DVH graph. You can repeat the zooming as many times as needed. ■ To scroll and zoom, press Ctrl and move the mouse scroll wheel. 3. To reset the zoom to the original display, right-click in the Dose-Volume Histogram view and choose **Zoom Reset**.
Pan the zoomed area	1. Zoom in to the desired area. 2. Choose **View** > **Pan**  and drag the zoomed area as desired, or use the scroll mouse: press the scroll wheel and drag the zoomed area. You can pan within the limits of the unzoomed Dose-Volume Histogram view.

Desired Action	Steps to be Taken
View the dose in a certain point of the DVH line	1. Right-click in the Dose-Volume Histogram view and choose **Show Cross-hair** . 2. Click the desired point in the DVH line. The DVH graph displays the structure, course ID, plan ID, the dose at the selected point and the equivalent sphere diameter of the part of the structure volume covered by the selected dose level. The structure and the isodose level at the point that you clicked are highlighted in the image views, and the structure is activated both in the Focus window and Info window. **Tip:** *You can move the cross-hair along the selected DVH curve using the left and right arrow keys. The cursor moves to the next grid line in X-direction, and the size of the step depends on the scale of the DVH graph. To move the cursor in smaller steps, press **Shift**. To move the cursor in larger steps, press **Ctrl**. If you change another structure on the Dose Statistics tab, the cross-hair moves to the corresponding DVH curve.*
Show a grid in the DVH graph	Right-click in the Dose-Volume Histogram view and choose **Show Grid** . The grid is shown by default.
Display dose levels in the DVH graph	Right-click in the Dose-Volume Histogram view and choose **Show Dose Levels** . Depending on the dose visualization mode, either the isodose lines or dose color wash colors are shown in the DVH graph.
Change the displayed dose levels	Switch to dose color wash visualization and specify the desired dose levels with the dose color wash slider. Note: If the DVH graph contains plans that have different dose levels, the dose levels cannot be displayed in the DVH graph.
Change the black background of the DVH graph to white	Right-click in the Dose-Volume Histogram view and choose **Show Graph on White Background** .

Desired Action	Steps to be Taken
Set the scale for the DVH graph	1. Right-click in the Dose-Volume Histogram view and choose **DVH Options**. 2. In the **Scale** group box, define the desired minimum and maximum values for the dose and volume information. 3. To test the settings without closing the dialog box, click **Apply**, and to accept the settings, click **OK**.
Change the DVH columns that are visible in the Dose Statistics tab of the Info window	1. Right-click in the Dose-Volume Histogram view and choose **Select Statistics Columns**. 2. Select the check boxes of the columns you want to view. The Volume, Dose Coverage, and Sampling Coverage columns are always displayed. 3. Click **OK**.

Calculate a DVH for Summed Plans

1. Create a plan sum.
2. Show the Dose Volume Histogram View.
3. From the Dose Statistics tab of the Info Window, select the check boxes of the structures to be included in the DVH, or right-click in the Dose Statistics tab and select **Select All Structures**.

Related Topics

Creating Plan Sums in External Beam Planning on page 256

Create Boolean Structures for DVH Calculation

1. In the Dose Statistics tab of the Info window, click the down pointing arrowhead in the end of the structure row and select **Add Expression**.
2. In the **Structures** list box, select the first structure to include in the new combined structure.

Note: *For correct results, check the structure IDs for double quotation marks. If they are found, either remove the quotation marks, or do not include those structures in Boolean expressions.*

3. In the **Operators** group box, click the appropriate operator button.

Tip: *To explicitly indicate the grouping and order of compound expressions, use parentheses in the Boolean expressions. For example, to create the expression "A" AND "B" AND "C", use parentheses, as in ("A" and "B") and "C", or define the expression "A" OR "B" OR "C" as ("A" or "B") or "C".*

4. Repeat the steps above as many times as needed to build the desired expression.
5. In the **DVH** group box, select the line color, style or width.
6. When the expression is ready, click **OK** to close the dialog box.

   The combined structures are temporary, and they are not saved into the database. You can only use them to evaluate plans with DVHs.
7. Do one of the following:
   - To edit a combined structure, click **Properties** in the end of the combined structure row in the Dose Statistics tab of the Info Window, and modify the structure as needed.
   - To remove a combined structure, click the down pointing arrowhead in the end of the combined structure row in the Dose Statistics tab of the Info Window, and select **Remove**.

Accuracy of the DVH

Some compromises are inevitable regarding the accuracy of a DVH, because the DVH algorithm performs interpolation and sampling to combine the dose and structure set data. Interpolation and sampling are needed because of the differences in the spatial resolution and position of the dose matrix and the 3D image (the dose matrix usually has coarser resolution than the structures in the 3D image). The structure shapes are sampled and interpolated from the images to the dose matrices, and volume modeling uses the interpolated structure shapes. The cumulative DVH is generated as an integral of the sampled dose over the interpolated structures.

This process interpolation and sampling leads to inaccuracy of the volume in the dose space. The inaccuracies are most pronounced in very small structures, where a minor error in the volume estimation can be a large fraction of the structure volume. The effect is also amplified if the dose calculation planes are far apart from the image planes.

The statistical parameters are extracted from the calculated DVH curve. The volumes of structures are calculated more accurately from the original structure data in the image to allow verifying the parameters and the accuracy of the volume modeling.

The volume inaccuracy is shown in the Dose Statistics tab of the Info Window, which displays the percentage of each structure's volume covered by the dose matrix (Dose Coverage) and the percentage of the structure's volume used for the DVH calculation (Sampling Coverage).

Related Topics

Display a DVH for One Plan on page 243
Display a DVH for Multiple Plans on page 246

Plan Uncertainty Evaluation

Photon planning contains uncertainty factors caused by, for example, organ motion and patient setup errors. There may also be variation in CT numbers obtained from the CT scanner and in their conversion into electron density or mass density.

Using the plan uncertainty tools, you can calculate plan uncertainty doses that can be used to evaluate the robustness of the plan in External Beam Planning. Plan uncertainty doses are based on a nominal (original) plan that is varied by a percentage of error in the CT calibration curve and by shifts of the treatment isocenters in the X, Y and Z directions. The isocenter shift coordinates are shown in the planning coordinate system selected in RT Administration. You can create the parameters for varying the dose in the Plan Uncertainty Parameters dialog box. When creating the parameters, consider the number of dose variations you want to achieve in regard to the capacity of the system. The more properties and uncertainty parameters the plan has, the more time and memory the calculation consumes.

In photon planning, you have two options for evaluating plan uncertainties - Patient Setup Error and Target Shift. The selected option is applied to all variations of the plan.

By selecting the Patient Setup Error option, you can estimate the dosimetric effect of a patient setup error on structures. You can estimate how differences between the planned patient setup and treated patient setup affect the dose distribution. The presumption in this option is that all structures move similarly. You can enter several isocenter shift values and see their effect on the DVH curves. The DVH curve variations are shown for all structures, including target structures.

By selecting the Target Shift option, you can estimate the dosimetric effect on non-target structures in case the tumour moves in respect to the rest of the anatomy. This option is meant for image-guided treatments, during which you can compensate for the target shift and ensure that the target is aligned with the beam as intended in the plan. That is why the DVH curve variations are shown only for non-target structures.

Plan uncertainty doses are always associated with the nominal plan. Calculation of plan uncertainty doses is possible only if the dose of the nominal plan is valid. If the dose of the nominal plan is invalidated, or if the plan uncertainty parameters of a calculated plan uncertainty dose are modified, the plan uncertainty dose is invalidated.

Plan uncertainty doses can be calculated at the same time as the nominal dose, or they can be calculated separately after the dose for the nominal plan has been calculated. In the Focus window, a calculated plan uncertainty dose is shown with  icon. Invalid or not calculated plan uncertainty dose is shown with  icon. The parameters that were used to create the plan uncertainty dose are shown after the plan uncertainty dose ID in the Focus window. You can evaluate the plan uncertainty doses with the dose visualization tools, and compare the DVH of the nominal plan with the plan uncertainty doses.

Plan uncertainty doses are saved in the database, and you can open and view them later in External Beam Planning when you open the nominal plan they are associated with. Plan uncertainty doses are for evaluation purposes only, and you can only export the DVH in tabular format.

You cannot create plan uncertainty doses for reviewed plans, approved plans, or verification plans.

You can calculate plan uncertainty doses before treatment. If you want to calculate plan uncertainty doses during the treatment, you can copy the approved plan, and calculate the uncertainty doses in the copied plan.

Calculate Plan Uncertainty Doses

1. Create a plan.
2. Calculate the dose.
3. Select **Planning** > **Plan Uncertainty Parameters** to create a set of plan uncertainty parameters.
4. For a photon plan, first select the plan uncertainty type:
   - Select the **Target Shift** option to evaluate the dosimetric consequences caused by the tumour moving in respect to OARs. The calculated DVH shows variations for anatomical structures.
   - Select the **Patient Setup** option to evaluate the dosimetric consequences of a patient setup error on the target and OARs. The calculated DVH shows variations for both target structures and anatomical structures.

Tip: *You can change the plan uncertainty type also after the uncertainty doses have been calculated. This allows you to toggle between showing and hiding the target structures in the DVH. No recalculation is needed after the change.*

5. Type a value for **Isocenter shift [cm]** or **Calibration curve error [%]**, or both, and click **Generate**.

6. To modify individual plan uncertainty parameters in the parameter list, do one of the following:
   - To modify the isocenter shift or curve error, click in the corresponding cell and type a new value.
   - To delete an individual parameter set from the list, click **Remove** on the row of the parameter set.
   - To add a new parameter set, click **Add New** and type values for the isocenter shift and curve error.
   - To delete all plan uncertainty parameters, click **Remove All**.
7. When the parameter set is ready, do one of the following:
   - If the dose of the nominal plan is valid, select **Calculate after clicking OK**, and click **OK**.
   - If the dose of the nominal plan is not valid or has not yet been calculated, select **Calculate automatically after nominal dose calculation**, and click **OK**.

Tip: *You can also calculate the uncertainty doses in the Focus window. Right-click the Plan Uncertainty Doses item and choose **Calculate Plan Uncertainty Doses**.*

8. Once the calculation is completed, you can compare the plan uncertainty doses with the dose of the nominal plan:
   - Select **Window** > **Plan Uncertainty View**.
   - Right-click one of the plan uncertainty doses in the Focus window, and choose **Drop to View**.

   Tip: *You can also double-click a plan uncertainty dose to display it in the Plan Uncertainty View.*

   In the Plan Uncertainty View, plan uncertainty doses are always displayed in the image views on the right, and the nominal plan in the image views on the left.
9. If the plan is not robust enough, you can adjust the nominal plan taking the plan uncertainty effects into account. You can then re-calculate the dose of the nominal plan and the plan uncertainty doses, and evaluate robustness of the modified plan.

Evaluating Plan Uncertainty Doses

You can evaluate plan robustness by displaying plan uncertainty doses in the Plan Uncertainty View, and comparing them with the dose in the nominal plan. You can also calculate a Max-Min dose based on nominal dose and all the calculated plan uncertainty doses. By using the Max-Min dose it is possible to evaluate where the biggest differences in dose may occur in case of:

- setup errors
- variations in CT calibration curve
- target shifts in photon plans

The dose volume histogram can be used to compare the DVH curves in the nominal plan with the curves in the plan uncertainty doses.

If the plan normalization method of the nominal plan is changed, the plan normalization value (shown in Plan Properties) ensures that plan uncertainty doses can be compared with the nominal plan. The change of normalization method is always made in the nominal plan, and after the change the dose matrices in both plans are scaled by the same plan normalization value.

Evaluate Plan Uncertainty Doses

1. Choose **Window** > **Plan Uncertainty View**.
2. Do one of the following:
   - To display an individual plan uncertainty dose, right-click it in the Focus window and choose **Drop to View**.
   - To display the Max-Min dose, right-click the **Plan Uncertainty Doses** folder in the Focus window, and choose **Show the Max-Min Dose Distribution**.
   - To print the image view with uncertainty doses, select **Print** > **View**.
3. To display the DVH of the plan uncertainty doses, do the following:
   - Choose **Planning** > **Show Dose Volume Histogram View**, or right-click in the biggest image view on the right.
   - Right-click in the DVH, and choose **Show Plan Uncertainty Doses in the DVH**.
   - To print the DVH, right-click the DVH and select **Print DVH Report**.
4. To close the layout, select **Window** > **Orthogonal Views and BEV**.

Compare Plans Visually

Calculate the dose distribution for external beam plans before comparing the plans.

1. In Plan Evaluation, open the plans to compare.
2. Depending on the selected window layout, drag two or more plans to the image views for comparison.
3. To see the same location in both plans, select the **Link View Geometries** tool .

   When the tool is selected, changes to the view geometry of the left view set are also applied to right view set and vice versa.
4. Do one of the following:
   - View the dose distribution with the viewing tools (Zoom, Pan, Reset, Next plane, Previous plane, Rotate).
   - Evaluate the dose with the dose measurement tools (Point dose, Dose profile).
5. To view the dose on different planes, use the plane slider, the mouse scroll wheel, the PgUp and PgDown keys, or the **Next Plane** and **Previous Plane** toolbar buttons.

Related Topics

Selecting the Viewing Plane Displayed in the 2D Views on page 47

Creating Plan Sums in External Beam Planning

This information applies to External Beam Planning and Plan Evaluation.

You can combine the dose distribution from separate plans to form a plan sum. For example, plan sums can be formed by a treatment and its boost (photon or proton), or a combination of photon and electron treatments in a mammary case. You can sum plans if the plans are based on the same 3D image and structure set. If the plans use different 3D images, you must first register the images. Plan sums containing plans that use different 3D images can be viewed only in Plan Evaluation. You can print out the plan sum images like any other plan images.

More information and instructions on image registration: *Registration, SmartAdapt and Contouring Instructions for Use* and *Registration, SmartAdapt and Contouring Reference Guide*.

Note: *You cannot add or change the patient image of a plan that is included in a plan sum.*

You can create a plan sum by:

- Including existing plans in a new plan sum.
- Creating a new plan sum and new plans simultaneously.
- Creating an empty plan sum and adding new plans to it later on.

Each plan in the sum can have its own prescription point. The dose mode for summed plans is always absolute. You can sum plans even if they do not have dose prescriptions or calculated dose. The dose can also be calculated for the completed plan sum. In this case, the dose is calculated to all fields and plans in a plan sum that do not have calculated dose. When calculating the dose distribution for a plan sum, the calculation progress indicator is displayed for each plan in the plan sum separately. If a plan sum contains plans without dose prescription, the dose for the plan sum is not visualized in the image views.

You can modify the field geometry and field accessory of the external beam plans included in a plan sum. You can modify either the individual plans or the plan sum. If you modify the individual plans, the modifications are reflected in the plan sum, and vice versa. You must recalculate the dose for modified fields.

CAUTION: If a plan included in an existing plan sum is edited, the changes to the edited plan may affect the combined dose of the plan sum. The dose of all plan sums must be reviewed if any of the component plans forming the plan sum will be used for treatment.

You can also modify the normalization, dose prescription, fractionation, and plan and field weight of each plan while the plan sum is active. You can make these changes without dragging the individual plans into the image views.

You can copy, paste, modify and delete external beam plan sums in External Beam Planning. You can, for example, make two or more similar "trials" of a proposed treatment plan.Y ou can also compare two or more plan sums side-by-side in Plan Evaluation, and evaluate plan sums using DVH calculations.

For external beam plans, when you approve a plan sum for treatment, all the individual plans in the plan sum are approved at once.

In External Beam Planning, treatment reports contain information on the plan sum. Summed plans can also be exported. To be able to export a plan sum, you need to set all plan weights to 1.00 and display all dose distributions in the image views.

In addition to summing plans, you can also subtract plans. Unlike summed plans, subtracted plans cannot be approved for treatment or exported. Subtracted plans can be viewed only in Plan Evaluation.

View a Plan Sum in Image Views

You can view external beam plan sums in all image views of External Beam Planning and in Plan Evaluation.

You can sum external beam plans without calculated dose distributions, and then calculate the dose for the plan sum. If a plan sum contains a plan without a dose prescription, the dose of the plan sum is not visualized in the image views.

The 3D dose statistics in the Model view show statistical dose information for the target volume of the first plan in the list of plans included in the plan sum.

- To view a plan sum in the image views, drag it to an image view from the Scope window.

  The 3D image used for the plan sum, and the geometry and the dose distribution of the plan sum is shown in all image views.

Visualization of Photon Fields in Plan Sums

You can control the visibility of fields in the plan sum by selecting or clearing the field visibility check boxes in the Focus window. The active (selected) field is always displayed in all image views regardless of the setting in the field visibility check box. Similarly, if the field accessory of a hidden field is selected in the Focus window, the accessory is displayed in the image views. You can also quickly show or hide all the fields and DRRs of a plan sum in the image views. In addition, you can use the Plan Sum tab of the Info window to control how plan sums are visualized in the image views.

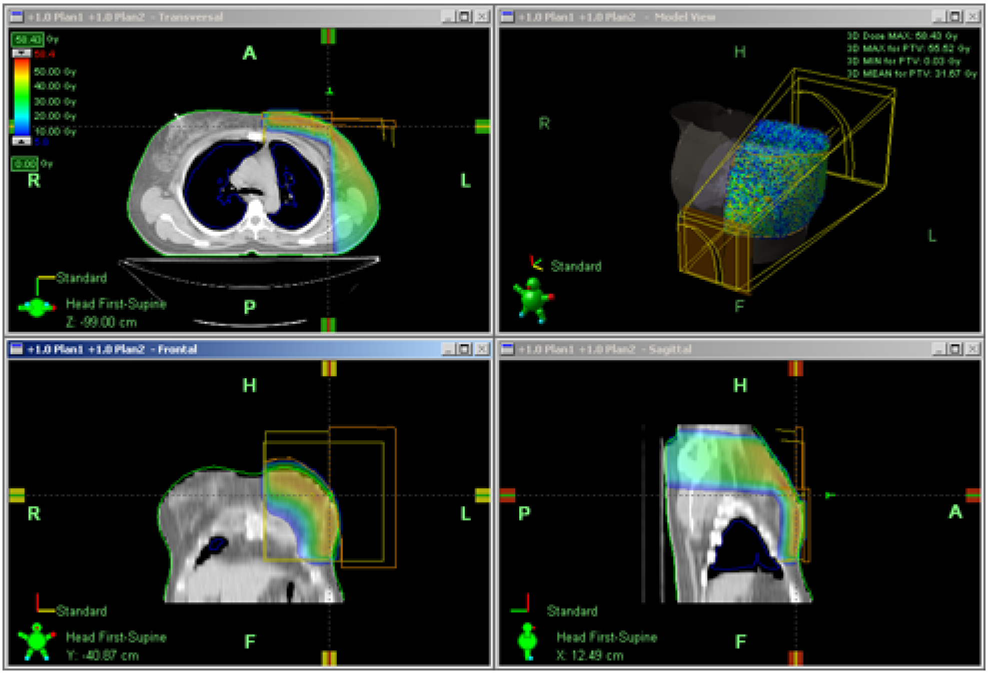
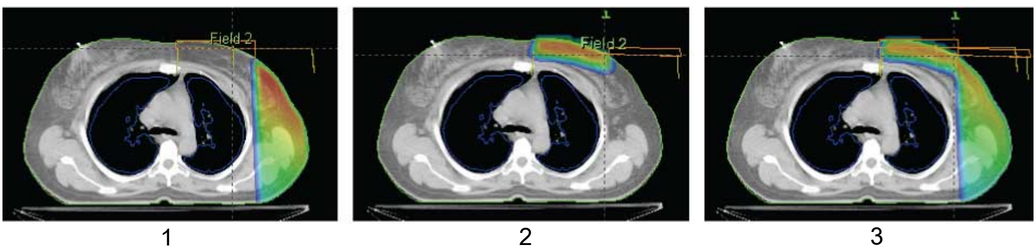


Figure 59 Plan Sum in External Beam Planning

You can animate the motion of static and dynamic arc fields included in the plans of the plan sum in the BEV.

The figure compares the dose distributions of individual external beam plans included in a plan sum and the combined dose distribution of the plan sum.



1. Dose distribution of plan 1
2. Dose distribution of plan 2
3. Combined dose distribution of the plan sum

Figure 60 Individual Plans and Plan Sum on Transversal Plane

You can show projections of all the fields on the Body surface of a plan sum in the Model view.

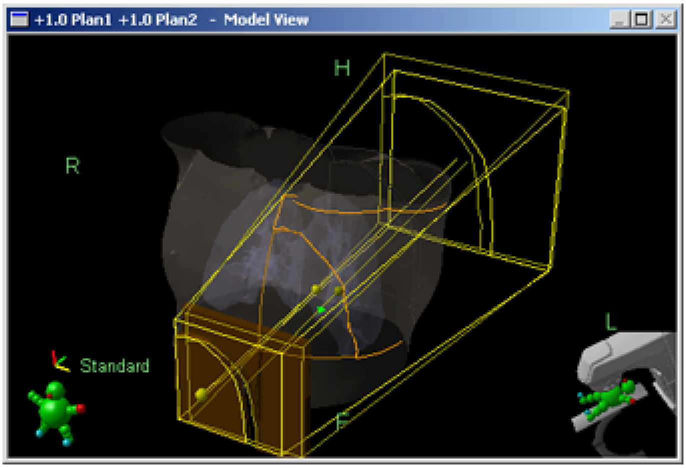


Figure 61 Plan Sum and Field Shapes Shown on Body Surface in Model View

Sum or Subtract Plans

This information applies to External Beam Planning and Plan Evaluation.

1. Open the patient and all the courses that include plans to be summed.
2. Select the course, or create a new course for the plan sum.

   In External Beam Planning, if only one course is open, the plan sum is automatically created in that course.
3. Choose **Insert** > **New Plan Sum**.
4. Give an identification for the new plan sum.
5. Select the image to be used in the plan sum.

   If you are summing plans that are based on registered images, select the image on which you wish to display the sum.
6. Define the plans to include in the plan sum by selecting or clearing the check box in front of the plan.
7. Do one of the following:
   - To sum a plan, click in the Operation column and select "+"
   - To subtract a plan, click in the Operation column and select "-"

     If you create a negative plan sum, DVHs are not displayed.
8. Modify the plan details, if necessary.
9. Click **OK**.

10. To save the plan sum, choose **File** > **Save All**.

Related Topics

Dose-Volume Histogram on page 242

Create a New Plan Sum and New Plans Simultaneously

1. Choose **Insert** > **New Plan Sum**.
2. Type an identification for the new plan sum.
3. Select the image to be used in the plan sum.

   If you are summing plans that are based on registered images, select the image on which you wish to display the sum.
4. To add a new plan in the plan sum, click **Add New Plan** and fill in the necessary information.
5. Select the course or create a new course.
6. If prompted to do so, select an RT prescription for the plan.

   If RT prescriptions have been defined for multiple prescription targets, select the appropriate prescription target.
7. Select the primary reference point or create a new one.
8. Click **OK**.

   The image selected for the plan sum and the plan sum are shown in the image views. A plan sum icon  appears in the Scope window.
9. To save the plan sum, choose **File** > **Save All**.

   Continue by modifying the plans in the plan sum, if necessary. You can also create an empty plan sum and add plans to it later on.

Evaluate the Plan Sum

1. Evaluate the summed dose distribution with viewing tools and dose measurement tools as usual.
2. To edit the plan sum, go to the Plan Sum tab of the Info Window.
3. To compare two or more plan sums visually, drag the plan sum icons from the Scope window into the image views in Plan Evaluation.

Related Topics

Dose-Volume Histogram on page 242

Show or Hide Fields and DRRs in the Image Views

1. To show the fields and DRR images of all plans in the plan sum simultaneously in the image views, right-click a plan sum in the Context window and select **Show fields and DRRs**.
2. To hide fields and DRR images from the image views, right-click the plan sum and deselect **Show fields and DRRs**.

Add a Plan to a Plan Sum (External Beam Planning)

1. Select the plan sum to which you wish to add a new plan and drag it to the image views.
2. Choose **Insert** > **New Plan to Plan Sum**.
3. Select a course or create a course for the new plan and click **Next**.
4. If prompted to do so, select an RT prescription for the new plan, and click **Next**.

   If RT prescriptions have been defined for multiple prescription targets, select the appropriate prescription target.
5. Fill in the plan properties and click **OK**.
6. Select the treatment unit and click **OK**.
7. Fill in the field properties and click **OK**.

Remove a Plan from a Plan Sum

1. In the Context window, select the plan to remove from the plan sum.
2. Choose **Edit** > **Delete Plan from Plan Sum**.

   The plan is deleted from the plan sum, but exists still as an individual plan in the Context window.

Chapter 15 Exporting and Printing Plans

Export Plan Information

This information does not apply to Vidar, Matrox and Bitmap filters. To transfer data using Vidar, Matrox or Bitmap filters, choose **Quicklinks** > **DICOM** > **Import Export**.

More information on using the DICOM Import Export: *DICOM Import and Export Reference Guide*.

Note: *Selecting the Compatible to* ***Varian Treatment Consoles 6.5 - 8.6*** *check box in the wizard removes the definition of stereotactic applicators from the plan.*

1. Select the plan to export in the Scope window.
2. Choose **File** > **Export** > **Wizard**.
3. Define what you wish to export and click **Next**.
4. Define other export parameters in the wizard and click **Next**.

Tip: *To set the selected export parameters as default for exported plans, click* ***Set as Default****.*

The number of steps depends on the selected objects to be exported.

5. Select the appropriate export filter and click **Next**.
   - If the plan has not been approved in the system, but you have authorization to export it, confirm that you have been authorized to do so.
6. Check the items to be exported.
7. To remove data from the list, select them and click **Remove Selected Object(s)**.
8. To save the selected data to the defined export directory, click **Finish**.

Exporting Plans to Virtual Simulation

Virtual simulation using laser alignment systems provides accurate patient positioning and markup. You can mark field coordinates on the patient's skin with the help of the laser alignment system, and use the CT scanner for simulation instead of a conventional simulator. Eclipse supports exporting field coordinates to LAP, Gammex and A2J laser positioning systems.

You can define the reference plane for virtual simulation in two ways for laser systems with three moving lasers: You can use the CT zero plane as the reference plane, or define the reference plane in the Virtual Simulation wizard.

The data communication between Eclipse, the laser alignment system and the CT scanner is based on the definition of a fixed reference plane in the patient. The reference plane usually marks an anatomically meaningful area in the patient, or it can also mark the first slice to be scanned. The position of the reference plane is known when scanning the patient, when exporting the plan to virtual simulation, and when doing the patient markup.

The reference plane is usually defined to be the zero plane. Depending on the equipment used for scanning and CT simulation, this is done either in relation to the CT couch or fixed to the gantry of the CT scanner.

The reference plane is often, but not always, marked on the patient skin with fiducial markers, usually with at least two markers for the transversal and frontal position. The fiducials are placed to the laser intersections of the laser alignment system.

Virtual Simulation Process in Eclipse

1. Define the reference plane for the laser alignment system and the CT scanner:
    a. Position the patient on the CT scanner couch.
    b. Move the couch so that the lasers of the laser alignment system point to the desired location in the patient. Zero the lasers. If desired, locate the plane on the patient with fiducial markers.
    c. To give the reference plane zero coordinates along the Y-axis of the CT scanner, either zero the CT couch in/out position (Siemens-type scanners), or move the CT couch so that the CT zero plane (GE-type scanners) points at the reference plane.
2. Scan the patient, with the reference plane included. Depending on the clinical practices, the patient goes home or waits on the couch.
3. Create a plan with the required fields and field accessories in Eclipse.
4. Perform virtual simulation in Eclipse:
    a. Position the patient on the CT couch.
    b. To start the plan export to virtual simulation in Eclipse, choose **File** > **Export** > **Virtual Simulation**.
    c. Move the CT couch so that the reference plane is aligned with the lasers of the laser alignment system. Then, depending on the CT scanner, either zero the CT couch positions, or type the CT scanner couch positions in Eclipse.
    d. Review the field markings to be exported in Eclipse, then export them.
5. Mark the exported points on the patient’s skin. If required by the laser alignment system, move the couch manually between each point.

Export a Plan for Virtual Simulation with Three Moving Laser Axes

1. Open the plan that you wish to export for virtual simulation.
2. If required by your system, convert asymmetrical fields into symmetrical ones.
3. To be able to better review the lasers projected on the Body surface, maximize the Model view.
4. Choose **File** > **Export** > **Virtual Simulation**.
5. To specify the position of the reference plane, move the CT couch to the initial position as follows:

    a. Position the patient reference plane to the origin of the laser alignment system.

    b. Zero the CT table in/out position.

    c. Define the reference plane position if the reference plane is not the zero plane of the CT device.

6. Do one or both of the following:
    - To select the fields whose coordinates you wish to export, click each field in the Fields list.
    - To select the segments of a conformal arc field, click each segment in the Fields list.

Tip: *To select multiple fields or conformal arc field segments, press Shift or Ctrl and click the desired items.*

7. To define the static arc field angles from which to pick up the points to be exported, select the arc field in the list and click **Arc Field**. Do one of the following in the dialog box that opens:
    - To change the angle shown in the Fields list, type the desired value in the Angle box and click **OK**.
    - To define new angles, type the desired value in the Angle box and click **New**. Repeat for each new angle.
8. To export the corners of the field aperture for markup on the patient's skin, select the **Include aperture corners** check box.
    - To export the collimator corners of the MLC aperture, select the **Use collimator corners for MLC** check box.
9. To export the central axis of the field for markup on the patient's skin, select the **Include central axis on surface** check box.
10. In the **Comment** text box, type your comment if necessary.

11. To correct for deviations caused by, for example, CT couch bending, go to the **Table Deviation** group box and define the patient-specific deviation from X and Z-directions in mm. This is not possible in all laser alignment system interfaces.

    In LAP CT4, transversal lasers can only move 60 cm, and it cannot show points located further than 60 cm from the first image. Using fields exceeding this distance may result in a warning message.
12. To view the laser beams in the Model view, select the **Display laser beams in Model view** check box.
13. To view the cross lasers marking each point on the Body surface in the Model view, select the row of each point in the table.

Tip: *If the wizard obstructs your view to the Model view, move it by dragging it by its title bar.*

    The lasers of the point that you double-click are shown color-coded in the Model view.
14. After you have reviewed all the necessary points, click **Export** to continue.

    The coordinates of the fields are computed and saved to the export file or sent to the laser alignment system, depending on the configuration of your system. All points are exported relative to the origin of the laser alignment system. There is no CT coordinate system correction for the Y and Z (IEC 61217) axes.

Export a Plan for Virtual Simulation with One or Two Moving Laser Axes

1. Open the plan that you wish to export for virtual simulation.
2. If required by your system, convert asymmetrical fields into symmetrical ones.
3. To be able to better review the lasers projected on the Body surface, maximize the Model view.
4. Choose **File** > **Export** > **Virtual Simulation**.
5. Set up the CT couch to specify the position of the reference plane as follows:

    a. Position the reference plane to the origin of the laser alignment system.
    b. Zero the CT couch in/out and up/down position or enter the current CT in/out reading (depending on the configuration of the system).
    c. Define the reference plane position if the reference plane is not the zero plane of the CT device.

6. Do one or both of the following:
   - To select the fields whose coordinates you wish to export, click each field in the Fields list.
   - To select the segments of a conformal arc field, click each segment in the Fields list.

Tip: *To select multiple fields or conformal arc field segments, press Shift or Ctrl and click the desired items.*

7. To define the static arc field angles from which to pick up the points to be exported, select the arc field in the list and click **Arc Field**. Do one of the following in the dialog box that opens:
   - To change the angle shown in the Fields list, type the desired value in the Angle box and click **OK**.
   - To define new angles, type the desired value in the Angle box and click **New**. Repeat for each new angle.
8. In the **Comment** text box, type your comment if necessary.
9. To view the laser beams in the Model view, select the **Display laser beams in Model view** check box.
10. To view the cross lasers marking each point on the Body surface in the Model view, select the row of each point in the table.

Tip: *If the wizard obstructs your view to the Model view, move it by dragging it by its title bar.*

    When double-clicked, the point lasers are color-coded in the Model view.
11. After you have reviewed all the necessary points, click **Export** to continue.
12. If prompted to do so, define the filename and the directory to save the file to and click **OK**.

    The coordinates of the fields are computed and saved to the export file or sent to the laser alignment system, depending on the configuration of your system.

    Two moving laser axes: The Y coordinates (IEC 61217) of the isocenter positions are exported in the coordinate system of the CT device. The X and Z coordinates (IEC 61217) of the exported points are relative to virtual simulation system origin.

    One moving laser axis: The Y and Z coordinates (IEC 61217) of the isocenter positions are exported in the coordinate system of the CT device. The X coordinates (IEC 61217) of the exported points are relative to virtual simulation system origin.

Print a Screen or a Window

Note: *When printing screens, note that:*

- *Do not use screen print-outs for conveying any planning information to treatment, because some of the information may be viewed only by changing the column width or by scrolling it on screen. For example, this is the case with Info window (visible in External Beam Planning and Plan Evaluation).*
- *Before printing the screen, display the viewing scale on screen to have it included in the print-out.*

1. Choose **File** > **Print** > **Print Screen**.
2. In the **Name** drop-down list, select the desired printer.
3. Click **OK**.

Note: *The resulting print-out is not to scale.*

Print an Image View

1. To activate the view, click its title bar.
2. Choose **File** > **Print** > **View**.
3. Select the printer to use and define the printer properties.
4. Define the number of copies to print out.
5. Type a print comment that show on the print-out.
6. To print the field information lines above the image, select **Field summary**.
7. To print the image in the active 2D view, select 3D image.
8. To print the textual information and the image on separate pages, select **Separate page for header**.
9. To print the image on a white background, select **Use white background**.
10. To print lines black, select **Draw lines as black**.
11. Define the page layout for the print-out:
    - To define the number of pages used horizontally and vertically, click **Use** and type the numbers of pages in the text boxes.
    - To let the program determine the number of pages used, click **Automatically arrange on multiple pages**.

12. Define the zoom factor:
    - To define the zoom ratio, click **Scale** and type the zoom ratio in the text box.
    - To let the program zoom the image on the selected number of pages, click **Fit to page**.
13. Do one of the following:
    - Click **Preview**. Click **Print** in the preview window that opens.
    - Click **OK** to print the active window to the selected printer.

Tip: *If you select* ***Automatically arrange on multiple pages****, the first preview page illustrates the order in which the image parts will be printed.*

Print the Beam's Eye View

1. To activate the BEV, click its title bar.
2. Choose **File** > **Print** > **View**.
3. Select the printer to use and define the printer properties.
4. Define the number of copies to print out.
5. Type a print comment that show on the print-out.
6. To print the textual information and the image on separate pages, select **Separate page for header**.
7. To print lines black, select **Draw lines as black**.
8. Define the page layout for the print-out:
    - To define the number of pages used horizontally and vertically, click **Use** and define the pages in the text boxes.
    - To let the program decide the number of pages used, click **Automatically arrange on multiple pages**.
9. Define the scale of the BEV image on the print-out:
    - To print the image in 1:1 scale at the SSD, click **SSD**.
    - To print the image in 1:1 scale at the SAD, click **SAD**.
    - To print the image in 1:1 scale at a user-defined distance, click **Other** and define the distance in the text box.
10. Do one of the following:
    - Click **Preview**. Click **Print** in the preview window that opens.
    - Click **OK** to print the active window to the selected printer.

Print an Image Using a Template

1. Choose **File** > **Print** > **Using Templates**.

   If this is the first time the print templates are used, the Print templates list is empty.
2. From the **Print Templates** list, select the template that best suits your needs.

   When you select a template in the list, the **Print items** list displays items that are included in the template (for example DVH, treatment report and 2D view). When you select a print item in the list, its settings are displayed in the lower part of the dialog box.

Tip: *If the application shows Unknown Printer in the* ***Printer*** *column of a print item, you cannot print the item since the printer is not accessible at the moment. To be able to print the item, define new printer settings through the Print Setup dialog box.*

3. To view printer-specific information of the selected print item, click **Print Setup**.
4. To produce a print-out with the defined information, click **Print**.

Treatment Reports

A treatment report is a description of a plan in textual format.

In External Beam Planning, a treatment report contains all the relevant information of the patient, the plan or plans included in the plan sum, and all fields in the plan or plan sum in textual form.

In External Beam Planning, the information is printed in a scale specific to the treatment unit, using treatment unit specific labels if they have been defined.

The application contains a few ready-made treatment report templates, determining the layout of and the information included in a treatment report. When printing out a treatment report, you can select the layout to use and include only the information relevant in your environment.

Note: *When working with plan sums, note that:*

- *Treatment report templates are not available for plan sums.*
- *To be able to print a treatment report for a plan sum, all dose distributions must be displayed and all plan weights must be set to 1.*

Print a Treatment Report

This information applies to External Beam Planning.

Note: *You can also use print templates for printing treatment reports.*

1. Choose **File** > **Print** > **Report**.
2. In the **Layout** drop-down list, select a layout template for the report.

   The **Description** box displays a comment, if defined in the template file.
3. In the **Print comment** text box, type your comment to add on the report.
4. Do one of the following:
   - Click **Preview**. To print the view, click **Print**, or to close the preview window and cancel the print-out action, click **Close**.
   - Click **OK**.

Chapter 16 Preparing Plans for Treatment

Verification of Treatment Planning

To verify the accuracy of treatment planning before going to actual treatment of a patient, you can create verification plans from treatment plans in Eclipse.

Photon verification plans are created using either of the following methods:

- Verification using a phantom
- Verification using portal dose prediction

The photon fields contained in a verification plan have the same geometry and accessories as their counterparts in the original plan, with the exception of arc fields and large IMRT fields that can be split in verification plans. The field angles in verification plans are always defined in IEC scale. The MU, actual fluences (for IMRT plans) and DMLC (dynamic MLC) motions in the fields in a verification plan are identical to their counterparts in the original fields. If the photon verification plan uses the same structure set as the original plan, planned SSD is copied to the verification plan.

NOTICE: To ensure the integrity of the calculated treatment plans, the number of split fields in a any single arc verification plan should not exceed 99 fields in External Beam Planning.

If the plan has been linked to an RT prescription, the link is copied to the verification plan. Reference points are not copied from the original plan to the verification plan.

For each verification plan created using a phantom, you define whether all the fields are stored to the same verification plan or each field to a separate verification plan. For all verification plans, you also define whether you wish to override tolerance tables and the gantry, collimator and couch rotation.

When creating verification plans using portal dose prediction, all fields are stored in the same verification plan.

The verification plan and the original plan are separate from each other, that is, changes made to the original plan are not reflected in the verification plan. Moreover, the treatment unit, energy and dose rate cannot be modified in a verification plan.

Changes made to the photon field geometry in the verification plan do not affect the actual fluences or the DMLC motions.

Note: *If you change the treatment unit or energy in the original photon plan, the actual fluence, DMLC motions and MU in the verification plan are no longer valid.*

Verification plans are shown in the Focus window with a special icon ( ).

WARNING: When exporting a verification plan that contains VMAT fields where the gantry rotation has been reset to a fixed gantry angle, the fields will be fixed gantry IMRT fields in the resulting DICOM RT Plan. When delivering these fields, the treatment unit will consider them as fixed gantry IMRT fields and will not operate in VMAT mode. More specifically, the features necessary to deliver variable gantry rotation speed and variable dose rate will not be used. If you intend to use the DICOM RT Plan resulting from this export for pre-treatment QA of your VMAT plan, it is important that you understand the following:

- **When delivering the plan, the treatment unit will operate in fixed gantry IMRT mode.**
- **The features required to deliver variable gantry rotation speed and variable dose rate will not be used by the treatment unit.**
- **It is recommended that you include VMAT-specific tests in your regular machine QA program similar or equivalent to those described in C. Ling et al, "Commissioning and quality assurance of RapidArc radiotherapy delivery system"** ***International Journal of Radiation Oncology Biology Physics*** **2008, Vol. 72, No. 2, pp. 575-581. VMAT-specific quality assurance testing should be performed and evaluated by a qualified medical physicist on a regular basis and any time a software or hardware configuration change or upgrade is performed to the treatment unit.**

Create a Verification Plan Using a Phantom

Before you begin, check that you have an image of the phantom you are going to use for verifying the plan.

1. Choose **Planning** > **Create Verification Plan**.
2. Select the course or create a new course.
3. Select the **Phantom or Structure Set** option.
4. Select the verification structure set.
   - To select the structure set from the Object Explorer, click **Select**.
   - To use the current structure set as verification structure set, click **Use Current**.
   - To set the selected structure set as default verification structure set for verification plans, click **Set as Default**.
   - To remove the default verification structure set, click **Clear Default**.
5. Define the field geometry and tolerance table.

6. Select **Automatically calculate dose after plan creation** to speed up the dose calculation, especially in those cases when the fields are placed into separate verification plans.
7. Define how fields are to be split in the verification plan.
8. Define the plan generation method.
9. Review the verification plan parameters.
10. Click **Finish**.

    Calculate the dose distribution for the verification plan. Then move the verification plan to treatment, schedule and treat it using the phantom. Measure the dose in the phantom and compare the dose with the calculated dose distribution.

Note: *If you are creating a verification plan for a proton plan that uses a block and an MLC in the same field, a change in the snout position may lead to a situation where some of the MLC leaves are inside the block aperture. To be able to calculate the dose for the verification plan, you need to move the MLC leaves outside of the block aperture, for example, by right-clicking the MLC icon in the Context window and selecting **Open MLC Leaves**.*

Create a Verification Plan Using Portal Dose Prediction

Portal dose prediction is possible only for fields with a DMLC. The FFF energy mode is allowed only if the 43 × 43 cm imager is configured for the machine.

1. Choose **Planning** > **Create Verification Plan**.
2. Select the course or create a new course.
3. Select **Portal Dose Prediction**.
4. Define the Source-Imager Distance in the text box. The default value is read from the operating limits of the selected treatment unit (configured in RT Administration).
5. Define the field geometry and the tolerance table (for example, use a tolerance table that allows verification with the portal imaging device without the couch).

Note: *You cannot reset the gantry angles of arc fields during verification plan creation.*

6. Define how fields are to be split in the verification plan.

    All fields are stored in the same verification plan.
7. Review the verification plan parameters.

8. Click **Finish**.

   Move the verification plan to treatment. Export the plan to the treatment unit and deliver the plan without the couch, patient and phantom data while exposing the portal imager to radiation. Compare the predicted and measured dose in Portal Imaging. If there is good agreement between the predicted and measured dose, the original plan can be approved for treatment.

Use Delta Couch Shift Editor

1. Choose **Planning** > **Delta Couch Shift Editor**.
   - The Delta Couch Shift Editor also opens after choosing **Edit** > **Plan Approval** > **Planning Approved** . Make sure that you have the Show Delta Couch Shift upon Plan Approval setting selected in RT Administration.
2. To define the couch shifts manually, type the desired values for each isocenter in the cells in the table.

   Notice that the isocenter shared by multiple grouped fields is indicated as one isocenter. Notice also that editing is not possible if you are in the Plan Approval wizard.
3. To use the couch shifts calculated from the user origin, click **Use Calculated Values**. Using the calculated values overrides the values defined manually.
4. To clear the calculated delta couch shift values, click **Clear**.
5. Click **OK**.

Approving Plans for Treatment

WARNING: Before transfering a plan to treatment, make sure that all necessary approvals have been obtained for the plan and that a qualified medical professional has reviewed the intended treatment plan and plan parameters in their entirety.

The stage which a plan has reached in the planning process can be communicated with the different approval statuses, which are saved with the plan to the database. Changing the approval status also locks the plan for certain changes in the database, which helps in preventing unauthorized modifications to completed plans. Any changes require first unapproving the plan, or making a copy of the plan and editing the copy, or creating a revision of the original plan and editing the revision.

Completed external beam plans are approved for treatment in stages. First, the plan needs to be planning approved in External Beam Planning. Then, you need to schedule the plan in Treatment Preparation before you can treatment approve it in Eclipse, Reference Points workspace, or Treatment Preparation.

WARNING: Always check the plan or plan sum for completeness, patient identification and plan identification prior to delivering a treatment.

WARNING: The DVH and volumetric dose shown in the Optimization dialog box in External Beam Planning are representations only. They may slightly deviate from the dose and DVH calculated for plan evaluation. Always verify the result of the optimization by separately calculating the dose and a DVH (using the Dose Volume Histogram command). Always verify the final plan using DVH analysis inside Eclipse when approving plans or plan sums for treatment.

WARNING: Always perform QA tests on a physics phantom to make sure that the plan is correctly transferred to the treatment machine. The delivered dose must correspond to the calculated dose.

WARNING: Prior to delivering an IMRT or a VMAT plan to a patient, patient-specific quality assurance should be performed and evaluated by a medical physicist or other qualified professional.

CAUTION: Make sure that a qualified physician reviews the accuracy and placement of all patient structures (target structure and critical structures) used for treatment planning and for evaluating the plans prior to patient treatment.

NOTICE: Quality assurance of the plan should be performed by a qualified medical professional prior to approval for treatment delivery. For additional guidance on the Quality assurance process, refer to the guidelines published by ASTRO, ESTRO, and other relevant organizations.

Note: *When approving external beam and proton plans or plan sums for treatment, notice the following:*

- *Make sure that the Eclipse treatment planning system is correctly configured and that the treatment unit configuration in RT Administration reflects the properties of the treatment unit. Check that no required operating limits are missing from the treatment unit configuration. If the approval wizard shows an error message about an operating limit (for example, MU/degree), check that the operating limit is defined correctly for the treatment unit in RT Administration, as missing operating limits might prevent planning approval.*
- *You can define technique and primary fluence mode specific operating limit overrides in the Technique tab in RT Administration.*

  More information on these overrides: RT Administration Reference Guide.

Note: *When approving DMLC plans for treatment, always make sure that:*

- *A qualified person will verify the plan on the MLC viewing station before the treatment is started, or phantom testing is performed before starting the treatment.*
- *You use the same treatment unit for treating a patient as you used for creating the plan. Notice that when your system has a group or groups of equivalent machines configured you can perform treatment planning using one machine from the group, and perform the patient treatment using another.*

Planning Approve a Plan in External Beam Planning

Note: *If you have linked an RT prescription to a plan, you might want to check that the RT prescription has not changed before approving the plan. Right-click the plan in the Focus window, and select* ***Properties*** *>* ***RT Prescription****. If the prescription has changed, you can see a warning icon and a notification text on the tab. If you want to update the new dose values to the current plan, click Update Plan.*

Before approving a plan, review the plan, images and segmentation and ensure that they belong to the intended patient.

1. In the Scope window, select the plan or plan sum to be approved.
2. Choose **Edit** > **Plan Approval** > **Planning Approved**.

   If configured in RT Administration, structures referenced by the plan are approved during the plan approval.
3. Review the messages shown, and, if appropriate, click **Next** to proceed.
4. Review the prescription and 3D dose statistics for the plan target volume and, if appropriate, click **Next** to proceed.

Note: *If you are approving a plan created from an RT prescription, the wizard page also shows whether there are other plans created from the same RT prescription.*

5. In the wizard pages that follow, review the information shown and choose from the following options:

Choice	Description
Use values calculated from user origin	Uses the calculated delta couch shift values. To clear the couch shift values, click **Clear**.
Structure outlines in reference images	Select each structure whose outlines you wish to add to live DRRs if you are going to create them. To select all of the structures, click **Select All**.

Choice	Description
Generate DRRs to Fields	Creates a live DRR image for each field. If you have already created a live DRR for a field, the existing DRR is retained.
Planned SSD	Defines the planned SSD for the fields. Click **OK** to accept the SSD value suggested. To use some other value, type the desired value to the **Planned** box and then select **OK**.
Calculate treatment times	Calculates the treatment time for the fields. Define the treatment time factor in the **Multiply with Factor** box. The range of the factor is 1.00 to 5.00.
Retain as one field	Retains a large IMRT field as one field. This option is available only if the selected treatment unit supports large IMRT fields.
Split large IMRT fields	Splits a large IMRT field into individual fields, and saves them to a new copy of the original plan. The status of the original plan changes to Rejected.

6. To grant the plan Planning Approval, review the information in the wizard, type your user authentication information and click **Finish**.

Related Topics

Approving Structures on page 71

Treatment Approve a Plan

1. In the Scope window, select the plan or plan sum scheduled in Treatment Preparation to be treatment approved.
2. Choose **Edit** > **Plan Approval** > **Treatment Approved**.
3. To grant the plan Treatment Approval, type your user authentication information and click **OK**.

Chapter 17 Cone Planning

Cone Planning

Stereotactic radiosurgery is a form of radiation therapy mainly used for treating intracranial targets. During the treatment, multiple narrow x-ray beams deliver a concentrated dose to cover the tumor area.

The cone planning process involves the selection, positioning and relative weighting of different groups of arc beams, referred to as arc sets, at different locations in the patient's head in order to achieve optimal dose coverage of a volume of tissue to be treated to a very high dose.

Cone Planning Workflow with CT Image

Step	See
Import and open the CT image. Application: External Beam Planning	Importing Images on page 34
Create the 3D image: ■ If the CT image contains a localization device, localize the device and create a 3D image. Application: SRS Localization ■ If no localization device has been used in the CT image, create a 3D image. Application: External Beam Planning	More information about SRS localization: *Eclipse Photon and Electron Reference Guide* Creating 3D Images on page 39
Define the body structure and segment other relevant structures. Application: Contouring	More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*.
Create a new plan. Application: Cone Planning	Creating and Editing Cone Plans on page 288
Insert the first arc set and select the cone size. Application: Cone Planning	Inserting Arc Fields and Arc Sets on page 290
Insert additional arcs or arc sets. Application: Cone Planning	Inserting Arc Fields and Arc Sets on page 290

Step	See
Edit arc sets as necessary. Application: Cone Planning	Editing Arc Fields and Arc Sets on page 292
Define the dose prescription. Application: Cone Planning	Define the Dose Prescription for a Plan on page 297
Calculate the 3D dose. Application: Cone Planning	Calculate the 3D Dose Distribution on page 298
(Optional) Evaluate the plan. Application: Cone Planning	Evaluating the Dose in Cone Planning on page 298
Compare the plan with alternative plans. Application: External Beam Planning	Compare Plans Visually on page 256
Approve the plan. Application: Cone Planning	Approve a Cone Plan on page 300
Print forms. Application: Cone Planning	Printing Reports and Forms on page 301
Export the plan. Application: External Beam Planning	Export Plan Information on page 263

Cone Planning Workflow with MR and CT Images

Step	See
Import and open the MR image. Application: External Beam Planning	Importing Images on page 34
Create a 3D image. Application: External Beam Planning	Creating 3D Images on page 39
Define the body structure and segment other relevant structures. Application: Contouring	More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*.
Create a new plan. Application: Cone Planning	Creating and Editing Cone Plans on page 288
Insert the first arc set and select the cone size. Application: Cone Planning	Inserting Arc Fields and Arc Sets on page 290

Step	See
Insert additional arcs or arc sets. Application: Cone Planning	Inserting Arc Fields and Arc Sets on page 290
Edit arc sets as necessary. Application: Cone Planning	Editing Arc Fields and Arc Sets on page 292
(Optional) Evaluate the plan. Application: Cone Planning	Evaluating the Dose in Cone Planning on page 298
Import and open the CT image. Application: External Beam Planning	Importing Images on page 34
Create the 3D image: ■ If the CT image contains a localization device, localize the device and create a 3D image. Application: SRS Localization ■ If no localization device has been used in the CT image, create a 3D image. Application: External Beam Planning	More information about SRS localization: *Eclipse Photon and Electron Reference Guide* Creating 3D Images on page 39
Register CT and MR images. Application: Registration and SmartAdapt	*Registration, SmartAdapt and Contouring Instructions for Use*
Copy structures from the MR image to the CT image. Application: External Beam Planning, Registration and SmartAdapt	Copying Structures to Registered Images on page 68 *Registration, SmartAdapt and Contouring Instructions for Use*
Copy the plan from the MR image to the CT image. Application: Cone Planning	Creating and Editing Cone Plans on page 288
Edit the plan as necessary. Application: Cone Planning	Editing Arc Fields and Arc Sets on page 292
Define the dose prescription. Application: Cone Planning	Define the Dose Prescription for a Plan on page 297
Calculate the 3D dose. Application: Cone Planning	Calculate the 3D Dose Distribution on page 298
(Optional) Evaluate the plan. Application: Cone Planning	Evaluating the Dose in Cone Planning on page 298

Step	See
Compare the plan with alternative plans. Application: External Beam Planning	Compare Plans Visually on page 256
Approve the plan. Application: Cone Planning	Approve a Cone Plan on page 300
Print forms. Application: Cone Planning	Printing Reports and Forms on page 301
Export the plan. Application: External Beam Planning	Export Plan Information on page 263

Open a Patient Record in Patient Explorer

1. In the menu bar, click **Patient Explorer** .
2. Do one of the following:
   - Type in your search criteria and click **Search**.
   - Click **Show Advanced Filters** or **Show Status Filters**, and use the filters to narrow down search results.
   - Click **Show Recent Patients** to display a list of recent patient records.
3. Select a patient record by clicking a patient record in the right pane.
4. Click **OK** to open the patient record.

Open an Image or a Plan in Object Finder

1. In the Menu bar, click **Object Finder** .
2. Do one of the following:
   - To open an image, click the icon of an image under Available images.
   - To open a plan, click the icon of a plan under Available plans.

Note: *When opening images or plans in Object Finder, note the following:*
- *Only 3D images with imaging orientation Head first—supine can be opened in Cone Planning. No gantry tilt is allowed.*
- *Only valid cone plans or plans with no fields can be opened in Cone Planning.*

Display Registered Images

1. Go to the **Images** tab.
2. Click the image you want to display in the **Select Registration to Display** text box.
3. Adjust the visibility level of the blended images by dragging the slider of the Blend Control tool.

Note: *When you create or copy a plan, the view settings, including blending, are reset.*

Browse Through the 3D Image in the 2D Image Views

1. Activate the 2D view in which you wish to browse through the image planes.

Tip: *You can also maximize the activated 2D view.*

2. To browse through the image planes, do one of the following:
   - Use the mouse scroll wheel.
   - Press the PgUp and PgDown keys.

The image planes are browsed in the direction perpendicular to the active view.

Select the Viewing Plane with the Plane Sliders

1. In a 2D view, point at the handle of a plane slider with the mouse.
   The mouse pointer visualization changes and the plane sliders become active.
2. To show another plane in 2D views, drag the plane slider handle.

Pan the Image

After zooming in on the image, the image may grow so big as not to fit in the window. To examine all parts of the image, you can shift, or pan, the image in the image window. You can use the Pan tool in the orthogonal views and in the Arc Plane View.

1. In the vertical toolbar, click **Pan** .
2. Place the mouse pointer on the image and press the left mouse button.
3. Keeping the mouse button down, move the image until you see the part you wish to examine and release the mouse button.

Tip: *You can also pan the image with a scroll mouse by pressing the scroll wheel and dragging the image while holding the scroll wheel down.*

Zoom the Image Views

You can zoom in and out the image views by using the **Zoom** tool or by pressing and holding down the Ctrl key and scrolling with the mouse wheel. You can use the Zoom tool in the orthogonal views and in the Arc Plane View. In the Model View, you can zoom in and out using the Ctrl key and mouse wheel.

1. In the vertical toolbar, click **Zoom** .
2. Do one of the following:
   - To zoom in, click with your left mouse button.
   - To zoom out, click with your right mouse button.

Tip: *You can also zoom in and out by pressing down the CTRL key and scrolling with your mouse wheel.*

Define the Window Level

1. In the vertical toolbar, click **Window/Level** .
2. Select the image the window/level settings of which you want to modify from the **Select image for window/level** drop-down menu.

3. Adjust the window/level settings of the image by doing one of the following:
   - Move the trackball with your mouse in the Window Level Dialog, or press the left mouse button and drag with your mouse in one of the 2D views.
   - Drag the window/level slider with your mouse.
   - Type new window/level values in the **Window** and **Level** text boxes.
   - Select one of the window/level presets from the **Presets** drop-down menu.
   - Select a colormap from the **Colormap** drop-down menu.

Measure Distance in an Image

You can measure distances between two points, for example, to check quantitative locations for reference. The Measure Distance tool can be used in all 2D views, including the Arc Plane View. The distance measured is shown in the image view next to the measurement line. The down-pointing triangle next to the measured distance indicates there is a right-click menu with further options.

1. In the vertical toolbar, click **Measure Distance** .
2. Move the mouse pointer to the start point of the measured line and click and hold down the mouse button.
3. Drag the mouse pointer to the end point of the measured line and release the mouse button.
4. To delete the measured line, right click the distance flag and select **Delete**.

Show and Hide the Tab Panel

- To hide the tab panel and maximize the area for the image views, click **Hide Tabs** .
- To show the tab panel again, click **Show Tabs** .

View Structure Data

1. Go to the **Structures** tab.
2. Select a structure from the list of structures.

   The Structures tab displays data of the selected structure. This data is read-only.

Move Viewing Planes to Structure Center

1. In the **Structures** tab, select a structure from the list of structures.
2. Click **Move Viewing Plane to Structure Center Point** .

Show and Hide Contoured Structures

You can show or hide a structure by selecting or clearing the visibility check box in front of the structure name in the Structures tab. When you hide a structure, it is hidden in all the 2D views and in the Model view. If the structure is currently active (selected), it is visible in the image views, regardless of the setting in the visibility check box.

1. In the **Structures** tab, do one of the following:
   - To show a contoured structure in the image views, select the visibility check box in front of the structure.
   - To hide a contoured structure in the image views, clear the visibility check box in front of the structure.

Note: *If the structure is currently active (selected), it is visible in the image views, regardless of the setting in the visibility check box.*

Annotate Structures

1. In the Structures tab, select a structure from the list of structures.
2. In the vertical toolbar, click **Annotate Structure** .

   A placeholder for the annotation with a blinking cursor appears in the 2D views.
3. Type the annotation text in the image view.
4. Click **Annotate Structure** again to deselect the tool.

Show and Hide Annotations

You can show and hide annotations in all 2D views by using the Show/Hide Annotations tool. If a structure that has been annotated is hidden, the annotations are also hidden.

Note: *You can edit the annotation texts in the Structures tab also when annotations are hidden in the 2D views.*

- To show all annotations in the 2D views, click **Show/Hide Annotations** in the vertical toolbar.
- To hide all annotations in the 2D views, click **Show/Hide Annotations** again.

Edit an Annotation

1. In the Structures tab, select the structure that has been annotated from the list of structures.
2. Select the annotation text you want to edit from the **Annotations** list.
3. Modify the annotation text in the **Edit selected annotation** text box.

Tip: *You can also right-click the annotation flag in one of the 2D views, and select* ***Edit*** *from the menu that opens.*

Move Viewing Planes to an Annotation

1. In the **Structures** tab, select the structure that has been annotated from the list of structures.
2. Select an annotation from the Annotations list.
3. Click **Move Viewing Plane to Annotation** .

Move an Annotation in the Image Views

1. In the Structures tab, select the structure that has been annotated from the list of structures.
2. Select the annotation you want to move from the Annotations list.
3. Click **Move Viewing Plane to Annotation** .
4. Click the pointing end of the annotation callout line, and drag the annotation into a new position with your mouse.
5. To attach the annotation to the new position, release the mouse button.

6. To move the annotation text, place your mouse cursor on top of the text end of the callout line and drag the text into a new position with your mouse.

Note: *The annotation text position changes are not saved in the database.*

Delete an Annotation

1. In the **Structures** tab, select the structure that has been annotated from the list of structures.
2. Select an annotation from the **Annotations** list.
3. Click **Remove**.

Tip: *You can also right-click the annotation flag in an image view, and select* ***Delete*** *from the menu that opens.*

Creating and Editing Cone Plans

You create a cone plan using a CT or MR image, but MUs can be calculated only when a CT image is used. A CT image is obtained when the patient is wearing a stereotactic localization device; an MR image can be obtained prior to the CT image.

To speed the treatment planning process, you can do pre-planning using the MR image, and make necessary adjustments to the plan after the CT image with the localization device becomes available. When you open the CT image, the system automatically makes the registered MR images available for selection as a secondary image. Additionally, the system automatically makes the plans created on registered MR images available for copying to the CT image. The advantage of pre-planning is that it shortens the time that the patient needs to wear the localization device.

In Cone Planning, plans can be created using the Plan Wizard or in the Prescription tab. Furthermore, if you open Cone Planning with an image that has no plans, you can create a plan to the image by clicking the Create New Plan button displayed in the Fields tab.

When copying plans with the Plan Wizard, you can copy a plan from a registered image or from an image sharing the same DICOM Frame of Reference (FOR). This option can be used for copying a pre-plan from an MR image to the primary image. You can also create a copy of the currently open plan to the primary image.

Note: *If there are multiple registrations between the same two images, copying plans is not possible.*

All arc fields in a cone plan must use the same treatment unit and have the same energy, dose rate, technique, and primary fluence mode. Furthermore, a cone plan must have one reference point that has no location, which is the primary reference point of the plan.

In External Beam Planning, you can attach clinical protocol references to patients. In Cone Planning, you can select one of these clinical protocol references to use. When a clinical protocol is selected to a plan, protocol objectives are displayed in the Prescription and Structures tabs.

When a plan is ready, approve it before printing reports and check lists.

For measurement purposes, you can create a cone plan containing static fields.

Create a Cone Plan

1. In the menu bar, click **Plan Wizard** .
2. Select **Create a new plan to the current image** and click **Next**.

Tip: *You can start plan creation also in the Prescription tab.*

3. In the Plan information dialog, do the following:
   a. Type an ID for the plan in the **Plan ID** text box.
   b. Select a course for the plan from the **Course ID** drop-down list.

      To create a new course for the plan, type an ID for the course in the **Course ID** drop-down list.
   c. Optional: Select a clinical protocol for the plan in the **Protocol/Phase** drop-down list.

      This option is available only if a clinical protocol reference has been attached to the patient in External Beam Planning.
   d. Click **Next**.
4. In the Treatment Unit dialog, do the following:
   a. Select the treatment unit and technique/energy to use.

      Click the down-pointing arrow in front of the treatment unit to display detailed technique or energy information.
   b. Select the dose rate and tolerance table to use.

c. Click **Finish** to close the Plan Wizard.

5. If multiple reference points have been defined for the target structure of the plan in External Beam Planning, the Select Primary Reference Point dialog box is shown. Select a primary reference point from the drop-down list and click **Select**.

Note: *If a reference point without location has been defined for the target structure of the plan in External Beam Planning, that reference point is assigned as primary reference point automatically. If no reference points have been defined for the target structure in External Beam Planning, reference point None is assigned automatically.*

Copy a Cone Plan

1. On the Menu Bar, click **Plan Wizard** .
2. In the Select Operation dialog, do one of the following:
   - To copy a plan from a registered image, select **Copy a plan from a registered image to the current image** and click **Next**.
   - To create a copy of the current plan, select **Create a copy of the current plan to the current image** and click **Next**.

   The wizard proceeds to the Plan Information dialog.
3. Select the image that was used for creating the plan you want to copy and click **Next**.
4. Select the plan from the list of plans and click **Next**.
5. In the Plan Information dialog, do the following:

   a. Type an ID for the plan in the **Plan ID** text box.

   b. Select a course for the plan from the **Course ID** drop-down list. To create a new course for the plan, type an ID for the course in the **Course ID** drop-down list.

   c. Optional: Select a clinical protocol for the plan in the **Protocol/Phase** drop-down list.

   This option is available only if a clinical protocol reference has been attached to the patient in External Beam Planning.

   d. Click **Next**.
6. Click **Finish** to close the Plan Wizard.

Inserting Arc Fields and Arc Sets

Individual arc fields and arc sets are added in the Fields tab. A plan is needed for adding arcs and arc sets.

Arc sets are inserted in a plan from an arc set template. An arc set contains multiple arc fields, typically between three and nine, all sharing the same isocenter position but each having a different couch angle. Typically, all the arc fields in a given set use the same cone size, but this is not mandatory. It is also typical that the same values for the couch angle are used by the different arc sets.

The new arc field or arc set is inserted in the location specified by the viewing planes in the image views. If the plan already contains an arc field and its isocenter is selected in the Fields tab, the isocenter of a new arc field or arc set is inserted in the same location.

By default, 80/40% isodose levels are shown for a plan that contains one isocenter. When you insert multiple arc sets, the system asks whether to switch showing 70/35% isodose levels.

When you insert an arc field, the new field and its isocenter appear in the upper part of the tab. You can control the visibility of arc fields and isocenters by selecting/clearing the visibility check box in the tab. If a field has invalid values, a red exclamation mark is displayed in front of the field in the Fields tab.

When you select the arc field, its properties are displayed in the lower part of the tab and the field is displayed in the image views. If you select an isocenter, its properties are displayed in the lower part of the tab and the viewing planes in the image views are moved to the selected isocenter.

NOTICE: To ensure the integrity of the calculated treatment plans, do not use more than 99 fields in any single treatment plan in Cone Planning.

Insert Individual Arc Fields

Tip: *If you open Cone Planning with an image that has no plans, you can create a plan to the image by clicking the Create New Plan button displayed in the Fields tab.*

1. Do one of the following:
   - Move the viewing planes to the location where you want to place a new isocenter, and in the Fields tab click **Insert Arc**.
   - Select an existing isocenter in the Fields tab and click **Insert Arc**. The arc field appears in the tab and in the Model view, if displayed.
2. In the Fields tab, select the new field.

   The field properties are displayed in the lower part of the tab.

3. Define the field properties as necessary:
   - In the **ID** text box, type an ID for the field.
   - In the **Cone size** list box, select the cone size to use.
   - In the **Field Weight** text box, type the field weight.
   - Define the start and stop angles, and the rotation direction for the field.
   - Define the couch rotation for the field.
   - The monitor units for the field are displayed once the 3D dose distribution is calculated.
   - If needed, type a comment and setup note for the field.
   - To view non-editable field information, click **More Info**.

Editing Arc Fields and Arc Sets

You can edit an individual arc field by changing its cone size, field weight, gantry start or stop angles, rotation direction, couch rotation, field comment and setup note. You can edit an arc set by moving its isocenter and changing the cone size. Couch rotation can also be edited graphically in the frontal view, and gantry start and stop angles can be edited graphically in the Arc Plane view.

You can also edit the distance between two isocenters in the plan by using the isocenter spacing tool, and specify the order in which the arc fields are treated.

If an arc field exceeds the maximum MU/degree limit of the treatment unit, a yellow indicator is displayed in front of the field in the Fields tab. To be able to approve the plan, the field must be split into multiple arc fields that have the same geometry but allowed MU values.

Note: *The maximum MU/degree limit of the treatment unit can be viewed in Administration (**Radiation & Imaging Devices** > **Technique** tab). The limit is defined for the combination of technique and primary fluence mode.*

Edit an Arc Field

1. In the Fields tab, select the arc field to edit.

   The properties of the selected field are displayed on the lower part of the tab.
2. Edit the ID, cone size, field weight, gantry start or stop angles, rotation direction, couch rotation, field comment and setup note as needed.

   If you are using a CT image for planning, monitor units for the field are displayed once the 3D dose distribution is calculated. The MU value cannot be edited.

Tip: *You can also adjust the arc rotation span graphically in the Arc Plane view, and couch rotation in the frontal view.*

Edit an Arc Set

1. In the Fields tab, select the isocenter of the arc set to edit.

   The properties of the selected arc set are displayed on the lower part of the tab.
2. Edit the cone size and isocenter coordinates as needed.

Split an Arc Field

1. In the Fields tab, select the field to split. A yellow icon in front of a field indicates that the field needs to be split.
2. To split the arc field into several arc fields, click **Split Arc**.

   New arc fields with MU values that conform to the limits of the treatment unit appear in the Fields tab.
3. Repeat the above steps to all fields that need to be split.

Note: *The maximum MU/degree limit of the treatment unit can be viewed in Administration (**Radiation & Imaging Devices** > **Technique** tab). The limit is defined for the combination of technique and primary fluence mode.*

Move an Isocenter

1. In the Fields tab, select the isocenter to move.
2. Do one of the following:
   - Type new X, Y and Z coordinates for the isocenter in the isocenter properties.
   - In the vertical toolbar, click **Move Isocenter** and drag the isocenter to a new location in any of the 2D image views. The isocenter is moved to the new location.

Move All Isocenters

1. In the Fields tab , select the isocenter that is located on the plane where you want to move all isocenters.
2. In the vertical toolbar, click **Move All Isocenters** .
3. Position the mouse pointer on the selected isocenter in any of the 2D views and when the isocenter is highlighted, drag the isocenters to a new location.

Edit Isocenter Spacing

1. In the Fields tab , click **Isocenter Spacing** .
2. Select the isocenter to move and the isocenter relative to which the first isocenter is moved.
3. Do one of the following:
   - To define the desired distance in cm between isocenters, drag the slider.
   - To automatically find the minimum distance between isocenters without a hotspot, click **Auto**. The hotspot threshold for the isocenters is displayed under the slider. As you move the selected isocenter, new isocenter coordinates are displayed. More information on optimal distances bewteen isocenters: *Eclipse Photon and Electron Algorithms Reference Guide*.
4. To disable hotspot warnings, select the appropriate check box.
5. Do one of the following:
   - To move the isocenter to the new location, click **Apply**. The selected isocenter is moved in 3D space along the line defined by the two isocenters.
   - To close the dialog box, click **OK**.
   - To discard the changes (before clicking Apply), click **Cancel**.

Change the Treatment Order of Fields

1. In the Fields tab , click **Edit Treatment Order** .
2. In the Treatment Order Editor, do one of the following:
   - To change the treatment order of a field, select the field and click **Move Up** / **Move Down**.
   - To change the treatment order of an isocenter, select the isocenter and click **Move Up** / **Move Down**.

3. To change the treatment order, click **Apply** and answer **Yes** to the confirmation message that opens.

   Isocenters are renumbered automatically in the descending order from top to bottom. Field names are not changed.

4. To rename fields according to the new treatment order, click **Rename Fields** and answer **Yes** to the confirmation message that opens.

   The fields are renamed according to the new treatment order and a field comment is added in the field properties. The comment contains the number of the field, number of the isocenter, and the cone size. For example, `BM:4ISO:1CL:18mm`, where:

   - `BM:4` indicates the 4th field.
   - `ISO:1` indicates the first isocenter.
   - `CL:18mm` indicates the cone size of the field.

Tip: *You can rename fields to create the field comment without changing the treatment order of fields.*

5. To close the dialog box, click **Close**.

Delete an Arc Field or an Isocenter

1. In the Fields tab, select the arc field or isocenter to delete.
2. In the lower part of the tab, do one of the following:
   - To delete an arc field, click **Delete Arc**.
   - To delete an isocenter and all its arc fields, click **Delete Isocenter**.

Note: *When you delete the last field from an isocenter, or an individual field, also the isocenter is deleted.*

3. Answer **Yes** to the confirmation message that opens.

   The selected arc field or isocenter is deleted.

Insert an Arc Set from Template

1. Do one of the following:
   - Move the viewing planes to the location where you want to place a new isocenter and arc set, and do one of the following:
     - In the Fields tab, click **Insert Arcs from Template**.
     - In the vertical toolbar, click **Drop Isocenter**. The Select Arc Set Template dialog box opens and the location of the new isocenter is visualized in the image views. You can adjust the isocenter position by dragging the isocenter in a new location, if needed.
   - Select an existing isocenter in the Fields tab and click **Insert Arcs from Template**.
2. In the Select Arc Set template dialog box, select the template to use.

Tip: *Click the ID header to sort the templates in alphabetic order.*

3. Select the cone size to use and define the desired weight for the arc set.
4. Click **Insert**.

   The arcs of the selected arc set appear in the tab and in the Model view, if displayed.
5. Select an arc field or the isocenter of the arc set to view and define its properties.

Display the Model View

1. To display the Model View, select **Model View** from the drop-down menu above the image views.
2. To rotate the image in the Model View, press and hold down the left mouse button, and drag with the mouse.

Modify Field Visualization in the Model View

1. Right-click in the Model View.
2. Select one of the visualization options in the menu.

Display the Arc Plane View

1. Select **Arc Plane View** from the drop-down menu above the image views.
2. To set the arc plane view to show a different field, select the **Fields** tab and select one of the fields in the list.
3. To browse through the image planes, do one of the following:
   - Use the mouse scroll wheel.
   - Press the PgUp and PgDown keys.

Select a Clinical Protocol for a Plan

1. Go to the Prescription tab .
2. Select the desired clinical protocol from the **Protocol/Phase** drop-down list.

   The list displays the clinical protocols that are attached to the selected course in the External Beam Planning. If you want to attach a new clinical protocol to the course, go to the External Beam Planning.
3. If the clinical protocol contains structures that are not present in the current plan, you are asked whether to add the missing structures.

   The clinical protocol objectives are displayed in the Prescription and Structures tabs.

Define the Dose Prescription for a Plan

1. Go to the Prescription tab .
2. Select the target volume for the plan.
3. Define the following:
   - treatment percentage
   - number of fractions
   - dose/fraction in Gy
4. Click **Save**.

Set Automatic 2D Dose Calculation On or Off

- In the Calculation tab , do one of the following:
  - To turn automatic calculation on, click .
  - To turn automatic calculation off, click .

Calculate the 3D Dose Distribution

CAUTION: Verify the dose calculation and dose display against independent verification methods, for example, manual calculations or measurements. This is to ensure that the following is correct:

- **MU data is correctly interpolated and calibrated.**
- **MU calculation is correct.**
- **Configuration of the dosimetric data is correct.**

- To calculate the volume dose, in the Calculation tab click **Calculate 3D Dose** .

Tip: *To cancel the 3D dose calculation, click* ***Abort*** *in the Calculation tab.*

Evaluating the Dose in Cone Planning

You can use the dose evaluation tools in Cone Planning to evaluate the dose distribution.

The dose measurement tools — Point Dose Tool and Dose Line Profile — can be used together with the isodoses to evaluate the dose quantitatively. The dose-volume histogram (DVH) reveals the dose uniformity throughout structures. The dose-volume information for contoured structures, together with the dose conformity values, can also be viewed in statistical format in the Structures tab.

Move Viewing Planes to 3D Dose Maximum

- In the Fields tab , click **Move Viewing Planes to 3D Dose Maximum** .

  To be able to move the viewing planes to the 3D dose maximum, the 3D dose must be calculated.

Use the Point Dose Tool

1. In the vertical toolbar, click **Point Dose** .
2. Click a point in the image where you want to display the dose.
3. To adjust the location of the point, click and drag the point.
4. You can also do one of the following:
   - To delete the point dose from the image views, right-click the point dose flag and select **Delete**.
   - To show or hide the dose curve for the dose at the selected point, right-click the point dose flag and select or deselect **Show dose curve**.
   - To change the color of the dose curve, right-click the point dose flag and select **Select Color**. Then select a new color from the color palette.
   - To show or hide the point coordinates in the image views, right-click the point dose flag and select **Show Coordinates**.
   - To edit the coordinates of the point, right-click the point dose flag and select **Move to**. Then type new coordinates for the point and click **OK**.

Show Absolute or Relative Dose

1. To change the dose display mode from relative to absolute, click **Show Absolute/ Relative Dose** in the vertical toolbar.
2. To change the dose display mode back, click **Show Absolute/Relative Dose** again.

Show Dose Line Profile

1. In the vertical toolbar, click **Measure Distance** .
2. Move the mouse pointer to the start point of the measured line and click and hold down the mouse button.
3. Drag the mouse pointer to the end point of the measured line and release the mouse button.

4. Right-click the distance flag next to the end of the measured line, and select **Show Dose Line Profile**.
5. To display the dose value and distance at any point along the dose line profile, place the mouse pointer on the dose line profile graph.

Tip: *While the dose line profile dialog is open, you can move the line in the image view by clicking and dragging the line.*

Show the Cumulative DVH Chart

1. Select **Cumulative DVH Chart** in the drop-down menu above the image views.

   The DVH Chart opens, showing a DVH curve for the target structure.
2. To show DVH curves for other structures, click **Select structures to show** and select the desired structures from the list.
3. To modify the dose visualization or to view more detailed dose data for a structure, do one of the following:
   - Place your mouse pointer on the DVH curve of a structure to view dose details on a point along the curve.
   - Select the **Absolute volume** check box to display the structure volume in cm^3.

Tip: *To zoom in or out in the cumulative DVH, press CTRL and scroll with your mouse wheel.*

View Dose Statistics per Structure

1. Go to the **Structures** tab.
2. Select a structure from the list of structures.

   The Dose Statistics section of the Structures tab displays dose statistics for the currently selected structure.

Approve a Cone Plan

1. Open a plan that is based on a CT image.
2. Split fields, if needed, and calculate the 3D dose.

   A yellow icon in front of a field indicates that the field needs to be split.
3. Go to the Prescription tab .

4. To change the approval status of the plan, click **Change Status**.

   The Plan Approval Status dialog box opens. If the plan is incomplete, you are prompted to add and verify missing items.
5. Review the prescription and 3D dose statistics for the plan target volume.
6. Select the appropriate approval status for the plan.
7. To calculate the treatment time for the fields, select the **Calculate treatment times** check box and define the treatment time factor in the **Multiply with factor** box.

   The range of the factor is 1.00 to 5.00.
8. Type your password and click **Finish**.

Note: *During plan approval, the plan is checked against the operating limits of the treatment unit. These limits are defined for the combination of technique and primary fluence mode, and they can be viewed in RT Administration (**Radiation & Imaging Devices** > **Technique** tab).*

Printing Reports and Forms

There are five different reports or forms that you can print out from Cone Planning. You can preview and print different reports and forms individually, or print multiple reports and forms at once. It is recommended to print the reports and forms only after the plan has been approved.

The header in all printed reports and forms contains the patient name, patient ID, plan ID and plan approval status. The footer in all printed reports and forms contains the user name and the date and time the report or form was printed.

NOTICE: Always compare the information shown on the 4D Treatment Console and the OGP monitor with the instruction forms printed from Cone Planning. Do not make any modifications to the plan after printing the instruction forms and exporting the plan to the OGP system.

Print a Report or a Form

1. In the menu bar, click **Print** .
2. Select a report or a form to print in the menu.
3. Click **Print** in the upper left corner of the preview.
4. In the **Select Printer** group box, select the desired printer.
5. To print multiple copies, define the desired number in the **Number of copies** spin box.
6. Click **Print**.

Print Multiple Reports or Forms Simultaneously

1. In the menu bar, click **Print** .
2. Select **Print Multiple Reports and Forms**.
3. Select the check boxes of the reports and forms you want to print.
4. Click **Print**.
5. Click **Print** in the upper left corner of the preview.
6. In the **Select Printer** group box, select the desired printer.
7. To print multiple copies, define the desired number in the **Number of copies** spin box. By default, one copy is printed.
8. Click **Print**.
9. Repeat the four previous steps to print the remaining reports.
10. Click **Close** to close the Print Multiple Forms dialog box.

Chapter 18 IRREG Planning

IRREG Planning without Simulation Workflow

Step	See
Import or digitize the images. Application: Contouring	Importing Images on page 34 More information on Contouring: *Registration, SmartAdapt and Contouring Instructions for Use* or *Registration, SmartAdapt and Contouring Reference Guide*
Create a plan for the patient. Application: IRREG Planning	Creating IRREG Plans on page 304
Insert the IRREG fields. ▪ If necessary, use opposing fields. ▪ If necessary, use an MLC, wedge or blocks to shape the field. Application: IRREG Planning	Add an IRREG Field on page 306 Add an Opposing IRREG Field on page 306
(Optional) Attach the patient image to the fields. Application: IRREG Planning	Add a Field Image to an IRREG Field on page 306
Add the primary reference point and additional reference points. Application: IRREG Planning	Insert IRREG Reference Points with the Mouse on page 307
Calculate the MU and the dose to the reference points. Application: IRREG Planning	Calculate the Dose Distribution and MU for an IRREG Plan on page 307
Approve the plan for treatment. Application: IRREG Planning	Approving Plans for Treatment on page 275

IRREG Planning with Simulation Workflow

Step	See
Define the treatment orientation. Application: Ximatron Digital Imaging / Acuity	*Acuity Reference Guide*
Perform field simulation. Application: Ximatron Digital Imaging / Acuity	*Acuity Reference Guide*
Go to IRREG Planning and open the simulated plan. Application: IRREG Planning	Convert a Simulated Plan into an IRREG Plan on page 305
Add the primary reference point and additional reference points. Application: IRREG Planning	Insert IRREG Reference Points with the Mouse on page 307
Calculate the MU and the dose to the reference points. Application: IRREG Planning	Calculate the Dose Distribution and MU for an IRREG Plan on page 307
Approve the plan for treatment. Application: IRREG Planning	Approving Plans for Treatment on page 275

Creating IRREG Plans

Usually, IRREG planning involves creating plans with either X-ray or simulation images, or without image data. If image data is used, you can import the image(s) or use the image through a digitizer for defining the plan information. No patient volume model is used and no volumetric dose distribution is calculated. The field technique of IRREG fields is always Static.

Instructions for importing and viewing images: *Eclipse Photon and Electron Reference Guide*.

IRREG plans can be created either with or without field simulation. When field simulation is used, the workflow starts in Ximatron Digital Imaging or Acuity. In this case, you define the field geometry, SSD value, MLC or block apertures, if applicable, and acquire the couch coordinates and the simulation images in Ximatron Digital Imaging or Acuity. When you open the simulated plan in IRREG Planning, it is automatically converted into an IRREG plan. The following are imported from Ximatron Digital Imaging/Acuity:

- Field geometry: The original fields created in simulation are replaced with IRREG fields using the same geometry as the original fields.
- MLC and block apertures, wedges
- Couch coordinates

If you have RT prescriptions defined in the RT Prescription workspace, you can also use them in IRREG plans. An RT prescription is a way of communicating dose prescription information between ARIA RTM workflow management components and other applications. Using an RT prescription allows the definition of the dose prescription for the target, for instance, by the oncologist in the RT Prescription workspace before starting treatment planning. You can use RT prescriptions in treatment plans by linking them to your plans.

More information on RT prescription: *Eclipse Photon and Electron Reference Guide*.

Create an IRREG Plan

1. Choose **Insert** > **New Plan**.
2. Select the course or create a new course.
3. If prompted to do so, select an RT prescription for the plan.
4. Define the plan properties as necessary.
5. Select the treatment unit.
6. Define the properties for the first field.
7. If appropriate, define the reference point for the first field.

   More instructions for creating and editing fields and using RT prescriptions: *Eclipse Photon and Electron Reference Guide*.

Convert a Simulated Plan into an IRREG Plan

1. Open the patient. In the Object Explorer, select the plan created in Ximatron Digital Imaging or Acuity.
2. Convert the plan into an IRREG plan.
3. Add the primary reference point to the plan and define the reference point properties.

Add an IRREG Field

1. In the Focus window, select the plan to which you wish to add the new field.
2. Choose **Insert** > **New Field**.
3. Define the field properties.
4. You are prompted to add the primary reference point. Click **Yes** to add the point, click **No** to define it later.

Add an Opposing IRREG Field

1. In the Focus window, select the plan to which you want to add the new field.
2. Choose **Insert** > **New Opposing Field**.

   Primary reference point defined in the field central axis: The opposing field appears in the image view. The opposing field has the same SSD, PSSD and the depth of the reference point as the original field.

   Primary reference point not defined or not located on the field central axis: After you add the skin-to-skin distance, the opposing field is created. The opposing field has the same SSD and PSSD as the original field, and the depth of the reference point is calculated according to the patient geometry.

Add a Field Image to an IRREG Field

1. Open the plan.
2. Right-click the IRREG field to which you wish to add a field image and choose **Add Field Image**.
3. Select the image.
4. To align the image, choose **Edit** > **Align Image to Field CAX**.
5. Drag the field graticule to the desired position.
6. When the field image is positioned as desired, click **OK**.

   The image detection unit (IDU) position lateral, IDU position longitudinal, IDU rotation, image resolution, image SAD and collimator rotation are stored with the image.
7. If there are more field images, repeat the steps for each image.

Tip: *To show the field image later, select the visibility check box of the field image in the Focus window.*

Select the Reference Image of a Field in IRREG Planning

1. In the Focus window, right-click the field image (simulation or RT image) that you wish to define as the reference image of the field and choose **Set Image as Reference Image**.

   The Align Image to Field CAX dialog box shows the current location of the field image and the field graticule. The mouse pointer changes to the alignment tool.
2. Do one of the following:
   - To move the field, place the mouse inside the alignment circle and drag, or click inside the circle to move the field.
   - To rotate the field, place the mouse outside the alignment circle and drag.
3. When the field image is positioned as desired, click **OK**.

Insert IRREG Reference Points with the Mouse

1. Choose **Insert** > **New Reference Point** .
2. Click at the location in the BEV to which you wish to add the reference point.
3. Click each reference point as necessary.

Move an IRREG Reference Point with the Mouse

1. Show the BEV.

   You can only move the reference points for which the active field is dominant.
2. On the toolbar, click the **Move Existing Reference Point** tool .
3. Drag the reference point to a new X–Y location with the mouse.

Calculate the Dose Distribution and MU for an IRREG Plan

1. In the Points tab of the Info window, mark one of the reference points as the primary point.
2. In the Doses tab of the Info Window, define the prescribed dose/fraction for the primary reference point in Gy.
3. Choose **Planning** > **Calculate Point Doses**.

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