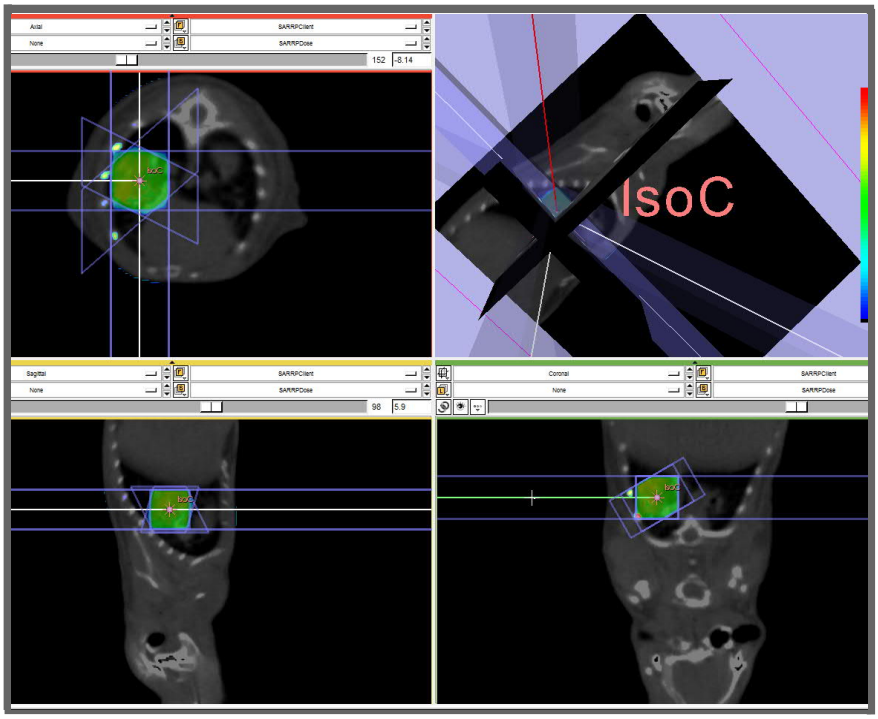

Operator Manual

Xstrahl
Language: English

About Us

Gulmay Medical Inc. (an Xstrahl company) is a leading designer and manufacturer of X-Ray research solutions used by life science researchers and radiation physicists to further biological and cancer research.

Xstrahl's powerful and customizable SARRP (small animal radiation research platform) is the most advanced, commercially available micro-imaging X-Ray research system, while Xstrahl's standalone X-Ray Research Cabinets are often employed by research scientists to safely irradiate both *in vivo* and *in vitro* biological samples.

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To improve reliability, function or design, Xstrahl reserves the right to change the product and/or this manual without notice.

Compliance

The design of Xstrahl Systems is in compliance with internationally recognized standards for safety.

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This document and all accompanying documents have all been drafted in the English language.

Acknowledgments

All manufacturer tradenames and trademarks appearing in this document are hereby acknowledged.

Referenced Documents

Not all documents referred to in this document are part of the scope of delivery for the equipment. Xstrahl Limited reserves the right to determine the documents delivered with the product.

Compatibility/ Contraindications

SARRP Systems must be used only in combination with components expressly recognized by Xstrahl as compatible with SARRP Systems. Before using any equipment or component not supplied by Xstrahl, consult Xstrahl for advice on compatibility.

The use of components other than those specified by Gulmay Medical Inc. may affect electromagnetic compatibility (EMC) performance and result in increased emissions or decreased immunity of the equipment.

Changes and/or additions to *SARRP Systems* must be performed only by persons expressly authorized by Gulmay Medical Inc. Such changes must comply with best engineering practice and all applicable laws and regulations within the jurisdiction.

Safety

All users/operators must read and understand all information in this document.

Intended Function (of document)

The intended function of this document is to enable the SARRP user/ operator to create a dose plan for a specific subject. The user is the authority who has the control of the equipment and the person(s) who operates and works on the equipment.

Xstrahl recommends that this document be kept with the equipment at all times.

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Preface

This is the Operator Manual for the *Xstrahl MuriPlan© Software*. This manual provides the information required to create and execute a conformable dose plan using the Xstrahl SARRP research platform.

MuriPlan© Overview

This section provides an overview of the MuriPlan©; the GPU algorithm and the dose accuracy validation results.

MuriPlan© Workflow

This section provides a complete workflow of the MuriPlan© treatment planning system for Small Animal Radiation Research Platform.

Notes

About Xstrahl

Refer to the About Xstrahl section at the front of this manual for more information about Xstrahl.

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Section 1:

MuriPlan© Overview

in this section

1.1 GPU Algorithm 1
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1 MuriPlan© Overview

MuriPlan® is the treatment planning software for Xstrahl's Small Animal Research Radiation Platform (SARRP).

The treatment planning software is used by the SARRP operator to manipulate the experiment slices in 3-dimensional views, while still allowing for the execution and management of the treatment plan, which includes loading and creating a CBCT, fusion with other images or previous plans, creating contours, planning a new experiment, evaluating a plan and executing the plan utilizing the X-ray control portion of the SARRP Software.

The application is hosted on the local drive (C:\) of the system PC.

1.1 GPU Algorithm

This system uses a superposition-convolution algorithm running on a GPU.

It uses 21 different kernels (simulated at *Monte Carlo* simulations) at 10 keV energy bins to model the spectrum of the beam. The model accommodates for different filters and beam modifiers.

The dose is dominated by primary deposition

1.2 Dose Accuracy Validation

The most recent validation results provide the measurement vs calculation within 5% or better. The calculated penumbra are in good agreement with small field sizes up to 5 mm. Calculations over-estimate the beam by 1 mm for the 10 mm field edge. Source modeling will be required for the future.

Additional measurements are being analyzed to improve statistics and cross-beam profiles for in homogeneity of a finite dimension.

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Section 2:

MuriPlan© Workflow

in this section

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2 MuriPlan©

This section provides the instructions for the workflow for the MuriPlan© Treatment Planning Software.

The software is hosted on the local drive (C:\) of the system PC.

2.1 MuriPlan Overview

MuriPlan is a Pre-Clinical Treatment Planning System. It allows the user to load an existing reconstruction. Registration algorithms are available to fuse DICOM images to allow for functional imaging or better soft tissue imaging. Next the user has tools to create contours for organs at risk and tumor volumes. Using this data a research can create a plan with beams or arcs that mimic clinical geometry. Using a Tesla GPU for reconstruction and calculation dramatically decreases the amount of time spent with the subject under anesthesia. To determine plan quality and accuracy, MuriPlan offers a view with Isodose lines over the contours. The user can evaluate the volumes in a Dose Volume Histogram. Previous plans can be overlayed to evaluate changes in tumor for Adaptive Planning. Plans can be easily exported to the SARRP software for delivery. Each plan parameters can be saved for other mice, consequent treatments or as a text file to report the irradiation from a specific subject.

Using Clinical forethought, MuriPlan well represents a clinical treatment in a pre-clinical setting.

The SARRP Control Interface Software must be running prior to launching MuriPlan.

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2.2 Launching the MuriPlan© Software

To launch the MuriPlan© software:

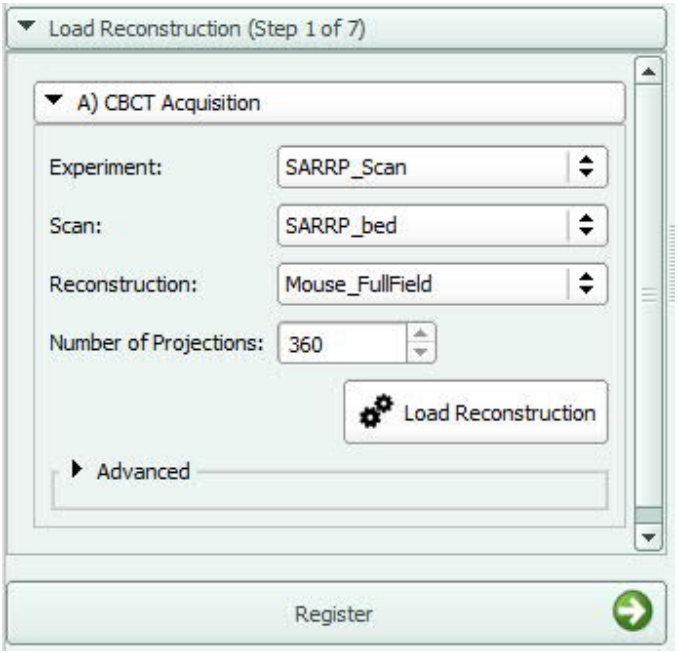
1. Select the *SARRP* icon on the desktop to launch the SARRP control interface.
2. Select the *MuriPlan*© icon on the Desktop launch the treatment planning software.

Figure 2–1: MuriPlan Icon

2.3 Load Reconstruction (Step 1)

This step allows the user to load an existing CBCT Acquisition.

Figure 2–2: Load Reconstruction: Step 1



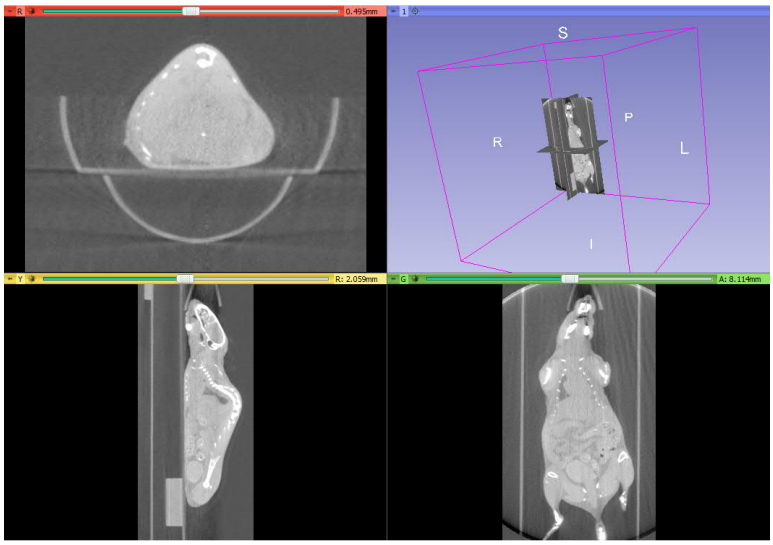
Similar to the SARRP Control Interface, the operator would select the *Experiment* and *Scan* names. If there are multiple *Reconstructions*, choose the one wanted like to use for planning.

- Choose *Load Reconstruction* and a pop up box will show the Loading process.

Shown at the bottom is the next step in the list *Register*. When you have loaded and evaluated your CBCT, you can click on *Register* to move to the next step.

Viewing Window:

Figure 2–3: Viewing Window: Multiple Panes



The viewing window has four panes; a *3D view* and *three planar views*.

To change the window and level of planar views:

- Left + click the mouse and drag the cursor from left/right ⇄ or up/down ⇵

To zoom within a pane:

- Right click and drag the mouse either up or down

To pan within a pane:

- Shift + left click(or click on the middle roller ball on the mouse) and drag the mouse to the desired position

To turn on the 3D view:

- Select *the pushpin icon* in the top Toolbar of any Planar view
- The *linked ring button* enables the user to link the menu for all of the planar windows. This will enable quick adjustments to each planar window at the same time.
- The *eye button* enables the user to turn the visibility of the 3D window both Off and On.

To manipulate the 3D view:

- Use the mouse wheel to zoom in and out of the 3D view
- Left click and drag the mouse to rotate the image.
- To pan the view, click on the middle roller ball on the mouse and drag to the desired position.

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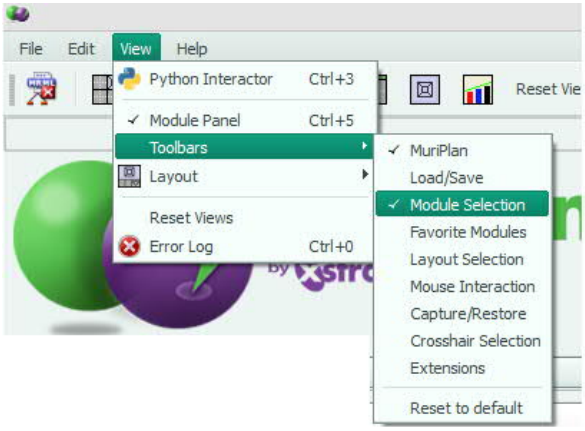
If the user would like to further define the Window/Level of the contrast:

- Select View -> Toolbars -> Module Selection. Click on the drop down Module Selection bar and choose Volumes.

Figure 2–4: Define Module Selection



- Choose the *Active Volume* as the CurrentRecon. This is your SARRP CBCT.
- In this window the user can also manually change the *Window and Level.* When the user grabs the end of the slider, it will open the window or number of CT values being viewed. When the user grabs the slider and moves it to the left or right they are changing the Level of CT values being viewed.

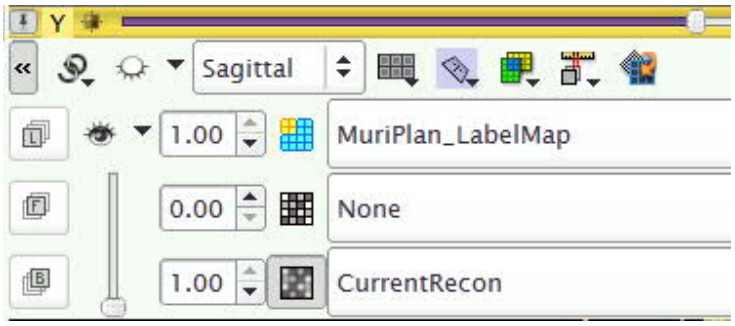
Figure 2–5: Manipulate Manual W/L slider

Planar View Options:

To change the viewing window:

- Select *the pushpin icon* in the top Toolbar on each viewing window for a list of several different ways to view the planar and 3D windows.

Figure 2–6: Planar View Options



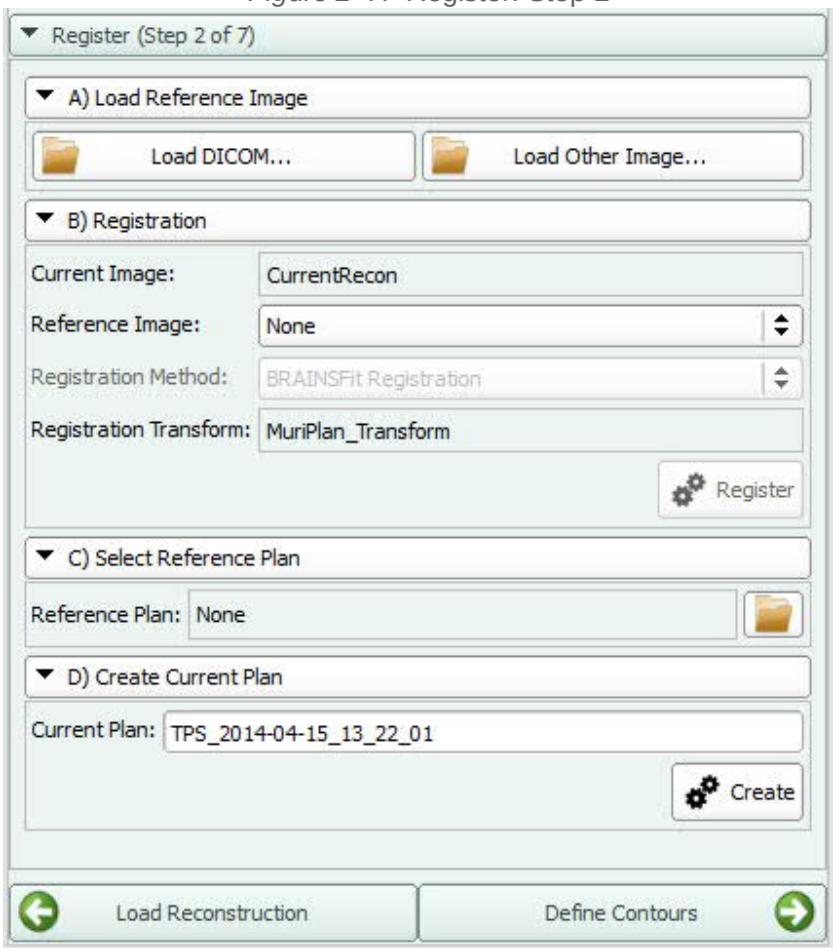
Each planar view has multiple viewing options:

- The “Sagittal” drop down allows the user to define the planar view.
- The two *F(Foreground)* and *B(Background)* drop-down menus to the left enables the user to define what’s visible in the foreground and the background.
- The vertical slider allows the user to move between the Foreground and Background images.
- The top slider enables the user to scroll through the dataset.
- The *linked ring button* enables the user to link the menu for all of the planar windows. This will enable quick adjustments to each planar window at the same time.
- The *eye button* enables the user to turn the visibility of the 3D window both Off and On.

2.4 Register (Step 2)

This step offers many options for fusion of a DICOM image (3D or 2D), Plan comparison registration and simply creating a new plan. At the bottom of the screen are options to go to the Previous Step (*Load Reconstruction*) and Move to the Next Step (*Define Contours*).

Figure 2–7: Register: Step 2

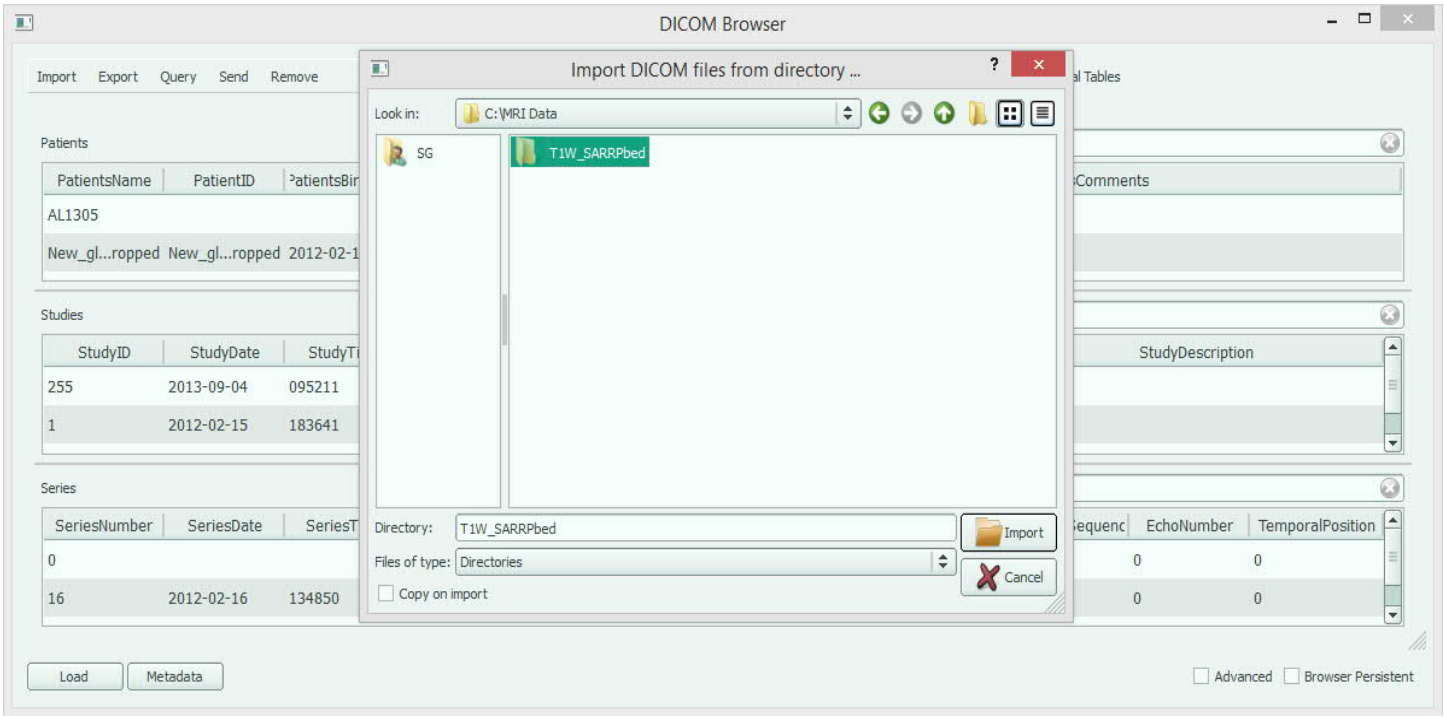


2.4.1 Option A: Load Registration Image

This option is available if the operator would like to register a DICOM image such as BLI, Ultrasound, MRI, PET and more.

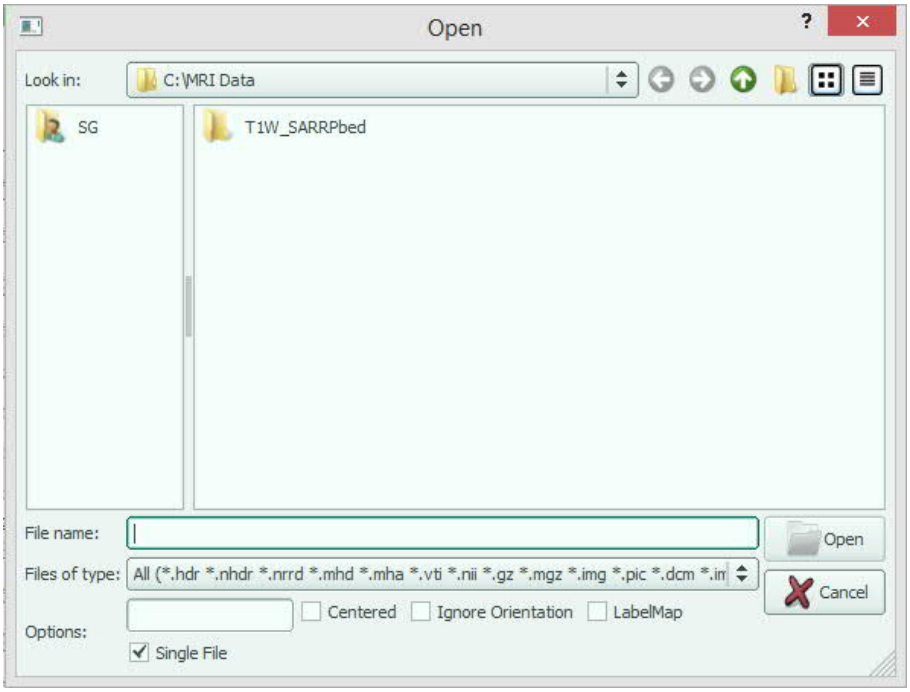
- Choose *Load DICOM* to add a 3D dataset. A pop up box will appear. Choose Import to browse for your dataset. Select the folder housing the raw images and choose Import. This will add the entire entry. After choosing the Patient just added, Select the desire Series and Choose Load.

Figure 2–8: Load DICOM dataset



- Choose *Load Other Image* for .dcm, .nrrd, .nhdr, .mhd, .mha, .vtk, .hdr, .img, .gz, .nia, .nii, .lsm, .png, .rec, .bmp, .pic, .mask, .gipl, .gipl.gz, .jpg, .jpeg, .spr, .tif, .tiff, .mgz, .mrc. Browse for the image you require and be sure to Select Centered. Open the Image.

Figure 2–9: Load Other Image



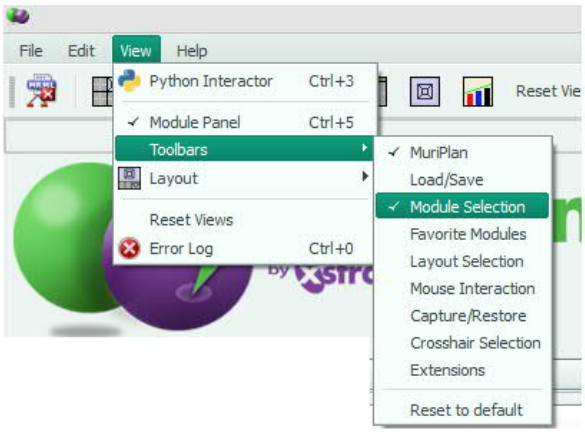
2.4.2 Option B: Registration

Once images or datasets are loaded, the operator can fuse them to the SARRP CBCT. Currently, the options are BRAINSFit rigid algorithm and Manual Transformation.

To Change Image Colors:

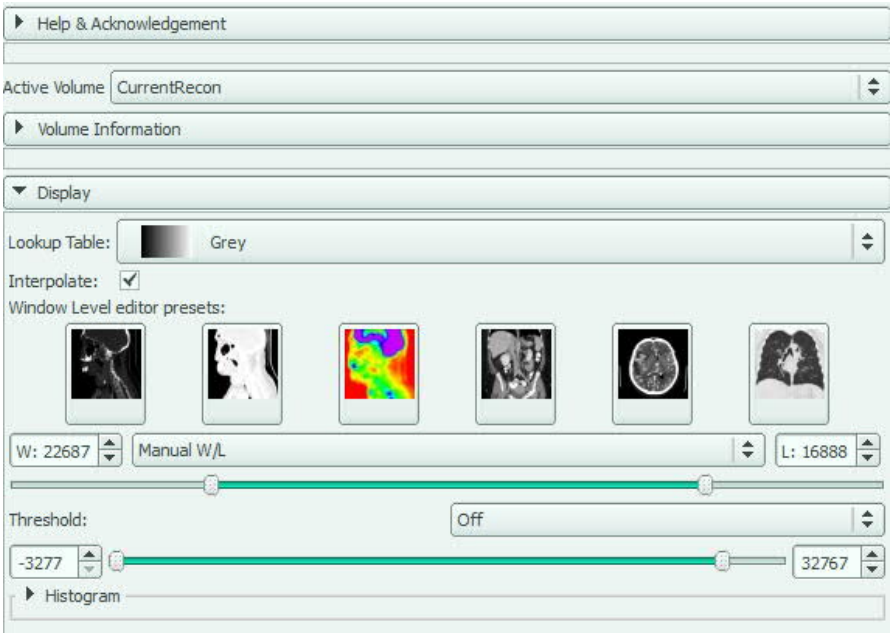
- In the Top Horizontal Bar, Select View -> Toolbars -> Module Selection. Click on the drop down Module Selection bar and choose Volumes.

Figure 2–10: Define Module Selection



- Choose the *Active Volume* as one of your images and Select the wanted color in the drop down menu for the *Lookup Table*.
- In this window the user can also manually change the *Window and Level*.

Figure 2–11: Load DICOM dataset



The *BRAINSFit algorithm* offers a rigid, fast transformation for CT to CT only.

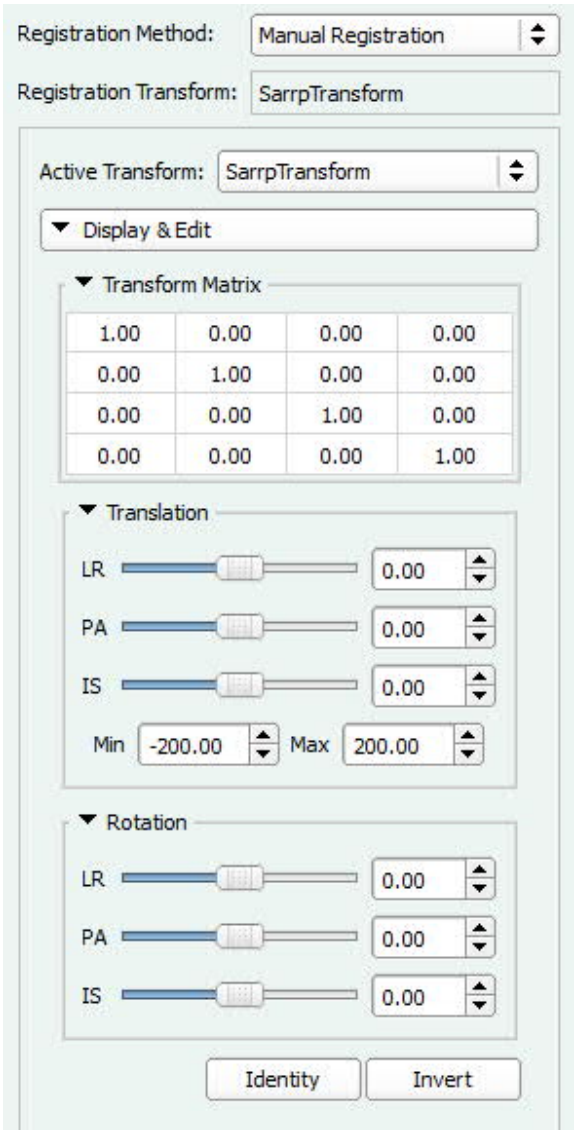
- To get the best fusion results make sure to grab the corners of the box to cover the subject (not the bed). Verify in all 3 planes.

- Choose *Register*. Evaluate the Transform through the CBCT before moving on.

Figure 2–12: BRAINSfit Algorithm Fusion Area Selection

Manual Registration allows the user to create their own transform by altering the translation and rotation for all 3 planes.

Figure 2–13: Manual Transformation for Fusion



Identity allows the user to reset the parameters. The Transformation matrix will automatically save once completed.

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2.4.3 Option C: Select Reference Plan

This option is available for an operator to add a plan that had already been created. For instance, a user may have multiple subjects in the same protocol. This option allows you to quickly adjust the isocenter and recomputed as the contours and beam parameters have already been uploaded.

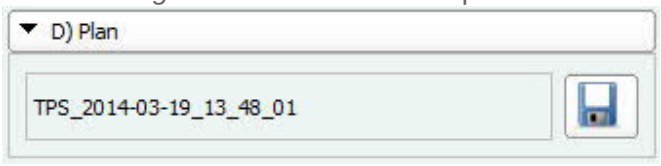
Another option would be for a Multiple Fraction treatment. A user may define a plan for a subject and then want to load the same plan on consecutive days. This also allows the user the ability to view each DVH overlaid to compare plan changes throughout the course of treatment.

Note:If you choose to Load a Reference Plan, you must create a New Plan in Step D.

2.4.4 Option D: Create Current Plan

This option allows the user to Create a New Plan. The name of the new plan will be defined automatically based on the date and time of creation. During each step in the following processes, the user has the ability to save parameters changed in that section such as contours and beam properties.

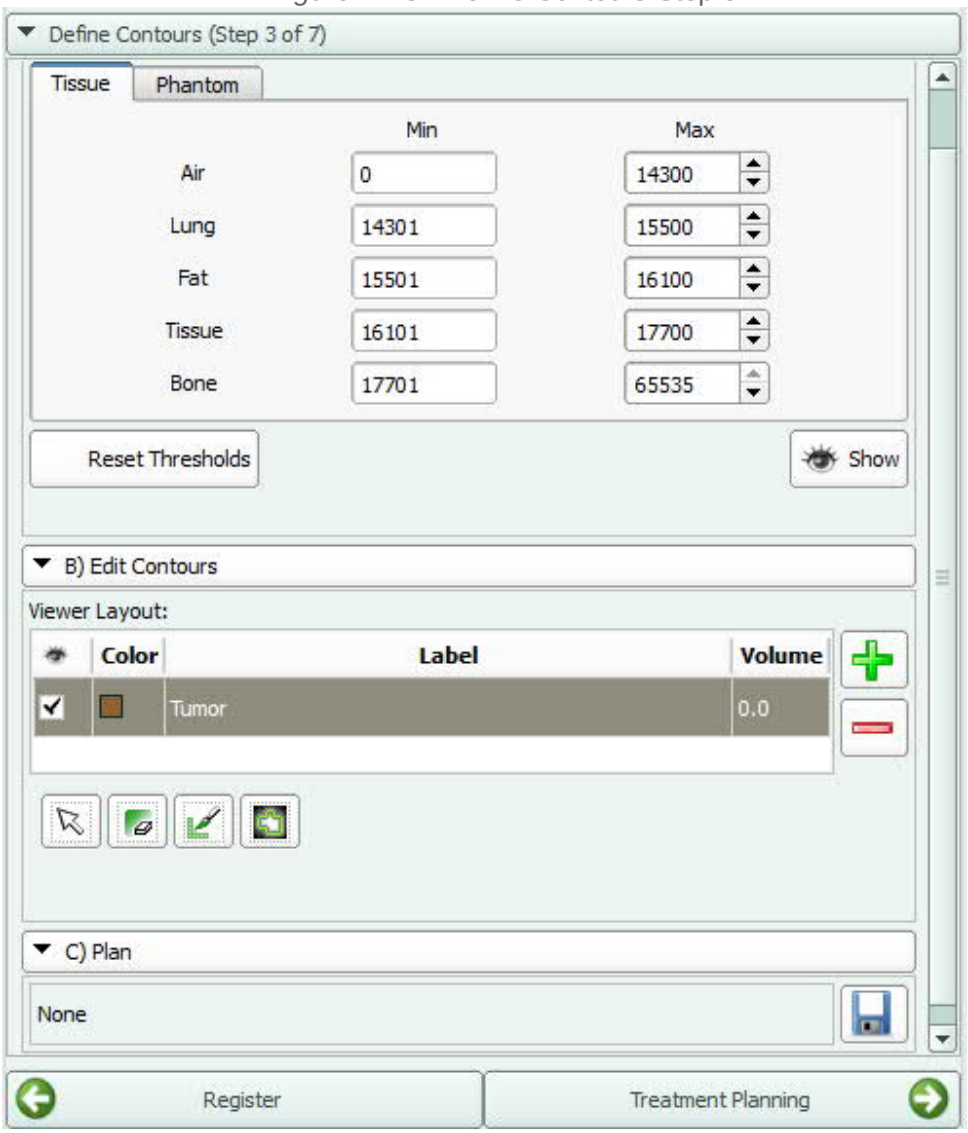
Figure 2–14: Save Plan Option



2.5 Define Contours (Step 3)

This step allows the user to first define *Segmentation* and then create *Contours* for the Organs at Risk and Target Region.

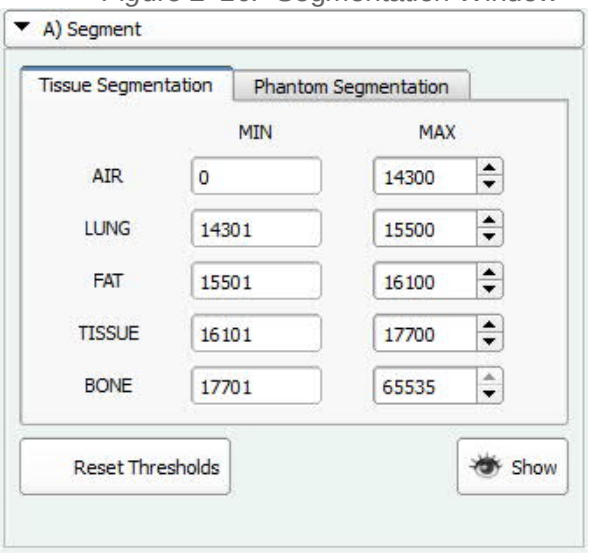
Figure 2–15: Define Contours Step 3



2.5.1 Option A: Segmentation

This menu enables the user to define the grey values for each tissue type: air, lung, tissue, fat and bone. By changing these values to match each CBCT, computation will be more accurate in accounting for the specific tissue types (heterogeneities).

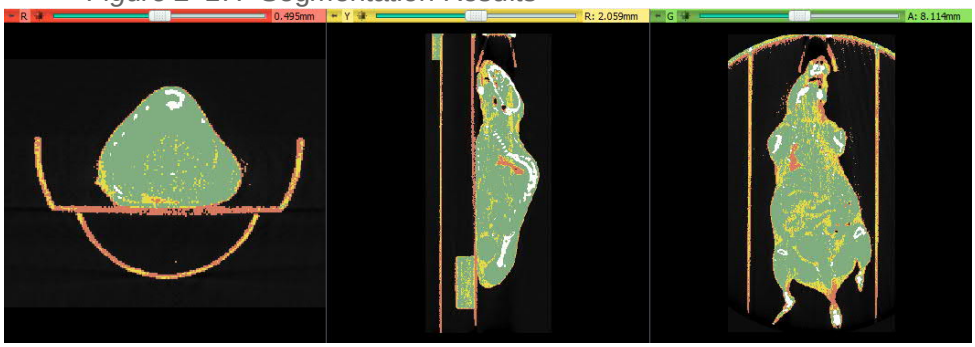
Figure 2–16: Segmentation Window



The default values can be set by the user based on a CBCT with a subject of similar size and with the same kV and mA for future applications.

The default values can by changed by typing in the *Max* Value box for each tissue or Clicking in the *Max* Value box for each tissue and scrolling with the mouse wheel or simply using the up and down arrows at the end of the value box.

Figure 2–17: Segmentation Results



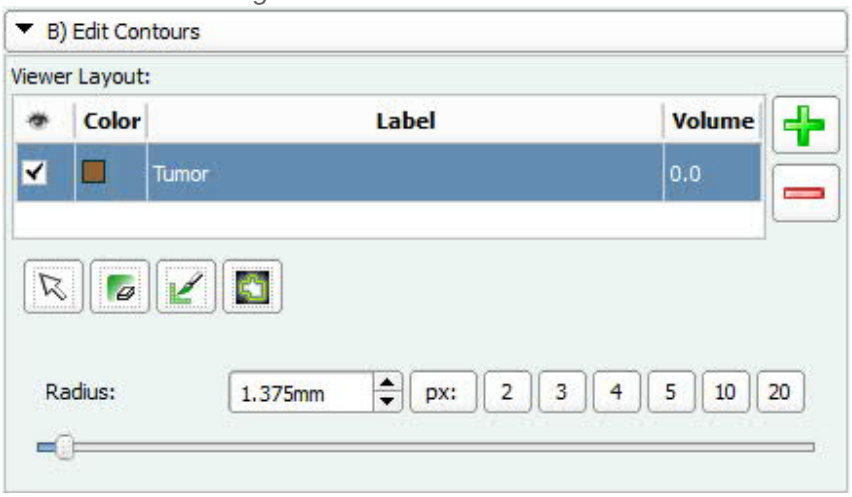
If the values are altered from the default a user can always Select *Reset Thresholds* to return to the default values.

Once the Contours section is selected, the Segmentation will remove from the window. To make it return Click *Show* under the Threshold values.

2.5.2 Option B: Creating Contours

This menu enables the user to delineate the Organs at Risk and Targeted Regions.

Figure 2–18: Define Contours Window

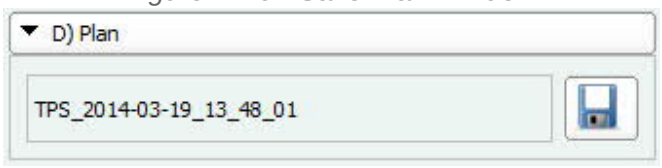


- Create a Contour by clicking on the Green + sign. This creates the line that shows the color and name.
- To change the color, click on the color and choose an option.
- To change the name, simply double click on the current name and type the desired name. Hit Enter.
- The Pen tool allows the user to define a volume with a range of pen size options.
- The Eraser will erase any contour and the size can be modified with the slider.
- The auto threshold tool utilizes the CT numbers to create a contour of an area. Simply drag the mouse towards the edge of the desired organ/target and the tool will grab similar CT numbers in the area. Click to create the contour.
- When neither are desired click on the Arrow button to exit the Contour Tools.

2.5.3 Option C: Save Plan

This option enables the user to save the Segmentation values and created Contours in the current Plan.

Figure 2–19: Save Plan Window

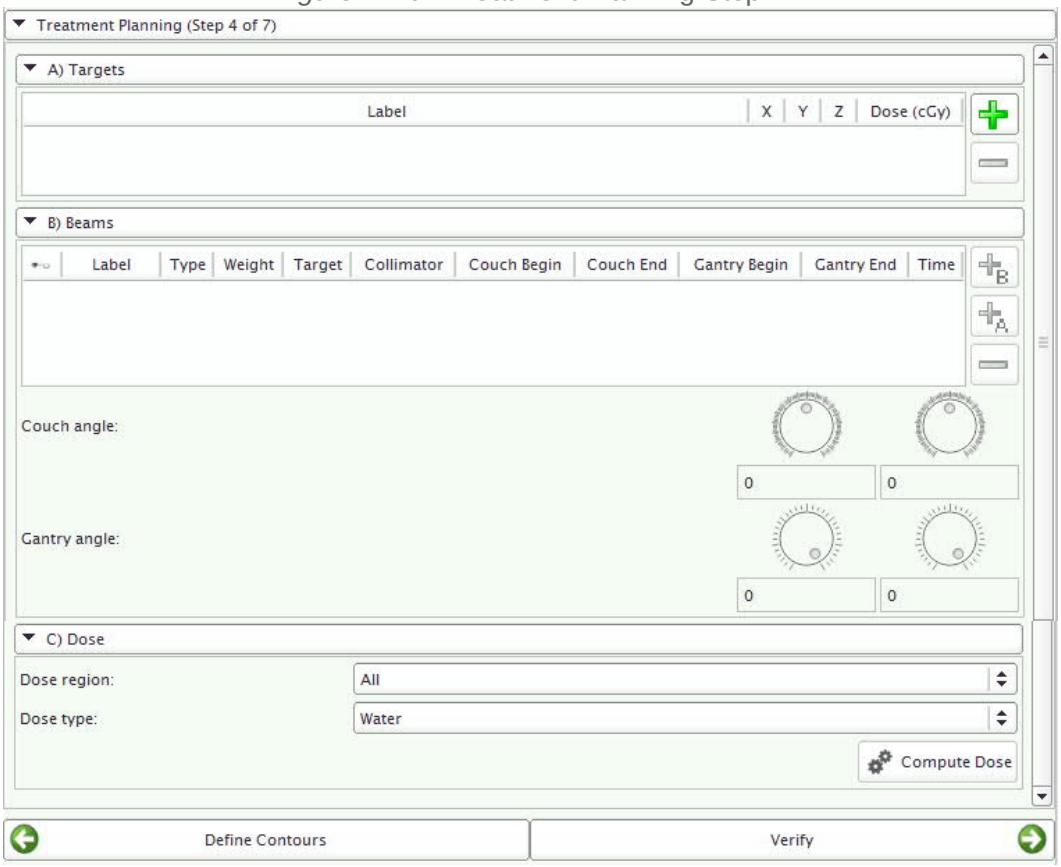


Click on Treatment Planning to Proceed to the Next Step.

2.6 Treatment Planning (Step 4)

This step allows the user to create one or multiple targets each with their own *Dose*, Define *Beams* or *Arcs* and their associate *Collimator*, *Gantry* and *Couch* angles, Set *Dose Computation Options* and *Compute Dose*. Once dose computation is complete, the software will automatically move to the Verify Step.

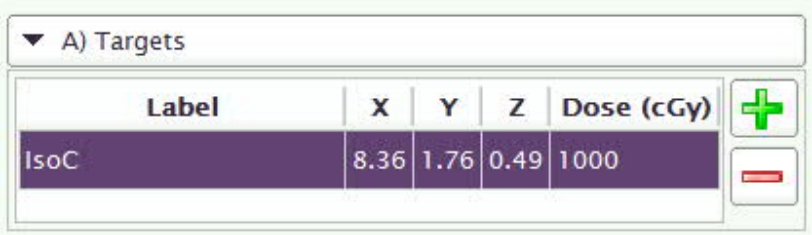
Figure 2–20: Treatment Planning Step 4



2.6.1 Option A: Targets - Create an Isocenter

This option enables the user to create one or many *Isocenters* each with an associated Dose.

Figure 2–21: Create Isocenter and Define Dose



- Select the Green + button to activate the Isocenter Placement tool.
- Locate the area on a planar window and click to place the Isocenter.
- Verify in all 3 planar views the Isocenter position. If it needs to be moved, it can simply be grabbed with the left mouse click and dragged to the new position. Verify in all 3 planes after each movement.

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2.6.2 Option B: Create Beams or Arcs

This option enables the user to define the number of beams/arcs, the Gantry/Couch Start and Stop angles and Beam Weight.

There are two types of treatment ARCs:

- Conventional ARCs enable dose delivery to stationary subjects while the gantry rotates from the start to end point around the subject.
- Conical ARCs enable dose delivery to a subject which rotates around the stage (theta) from user-defined start to end points.

Figure 2–22: Treatment Planning Options: Add Beams or Arcs

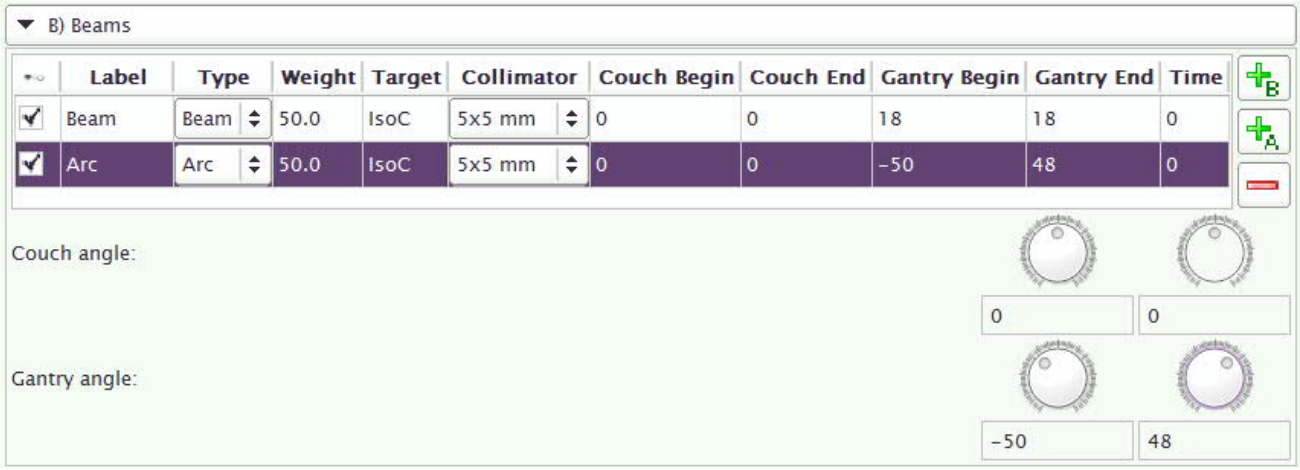

Figure 2–23: Treatment Planning Parameters

Beam Parameters	
1	Select an *Isocenter* for the beam
2	Choose a *Collimator* from the drop-down list
3	*Beam Name*: this can be changed by double-clicking on the name, entering the desired name and choosing Enter.
4	*Beam Weight*: when there are multiple beams, you can adjust the weighting by double + clicking on the Beam Weight option for each individual beam and alter it. If there are multiple beams for a single Isocenter, they must add up to 100%—this means each contribution of beam has been allocated.
5	Beams can be delivered in *Beam Mode* and/or *ARC Mode* (Arc)
6	To adjust the *Gantry* and *Couch* angle, adjust the *Dials* while the beam is highlighted or simply Type the desired Angle in the corresponding boxes on the Beam/Arc.
7	To Add a beam, use the Green + sign.
8	To Delete a beam, use the Red – sign.

2.6.3 Option C: Dose Parameters

In this section, the user is choosing the area to compute and the type of computation.

The user can choose to define a region of interest or computing on the total scan.

The two types of computation are *Dose to Water* and *Dose to Medium.* Both options will consider density corrections. Dose-to-water considers primary interactions only and dose-to-medium considers all possible interactions of the beam in the tissue.

Figure 2–24: Define Dose Parameters

When *Compute Dose* is Selected, a pop up window will show the dose computation progress.

After dose has been computed, MuriPlan will automatically proceed to the Verify Step.

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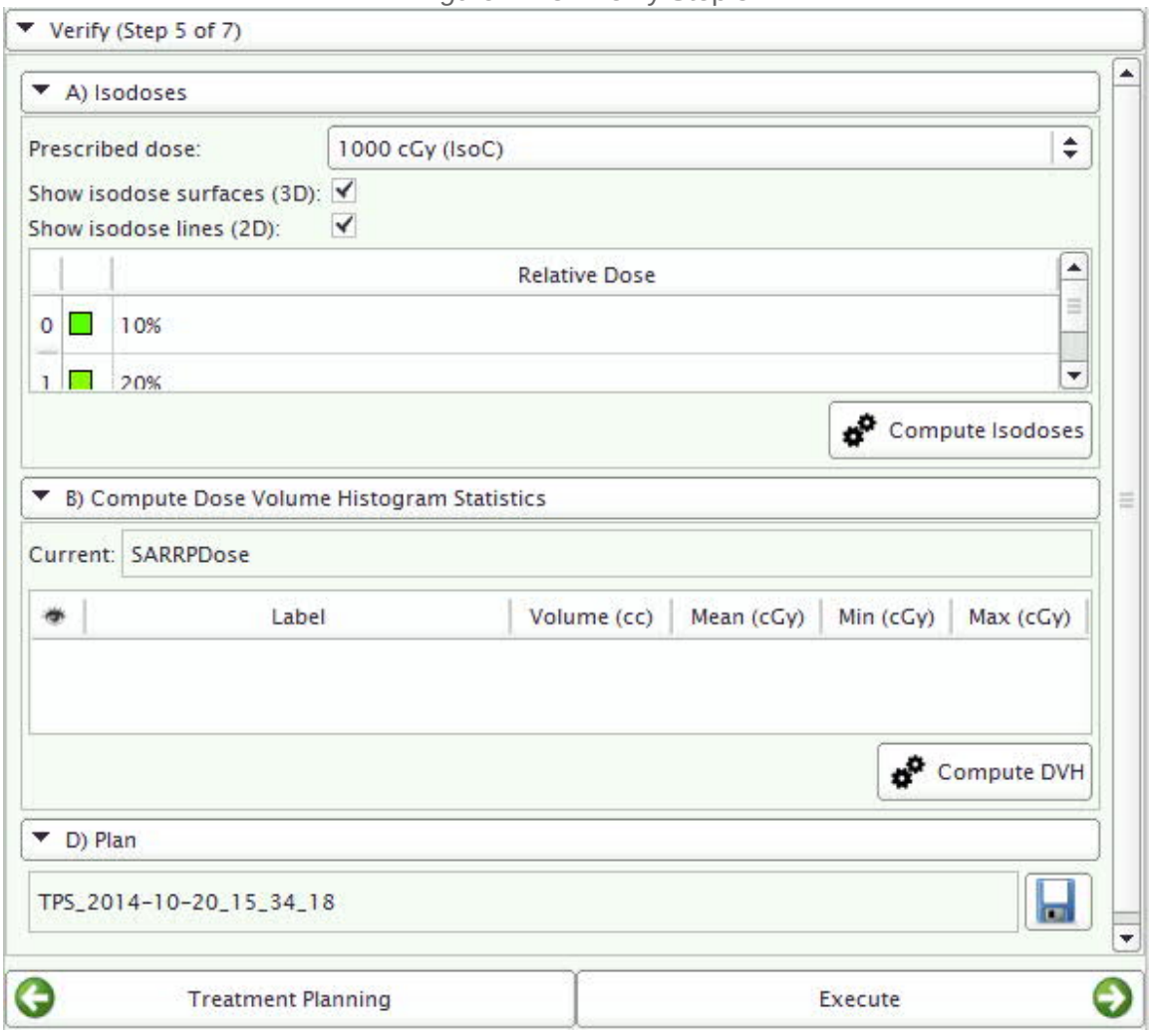
2.7 Verify (Step 5)

In the *Verify* step the user will be able to Create *Isodose Lines* and a *Dose Volume Histogram (DVH).*

Figure 2–25: Verify Step 5



2.7.1 Option A: Isodose Lines

This menu allows the user to visualize the Isodose lines and their percent volume of the total dose for an Isocenter. These will be visualized on the planar views and a 3D volume will be seen on the 3D window.

Isodose lines can be viewed separately for each Isocenter and its respective dose.

Figure 2–26: Isodose Lines

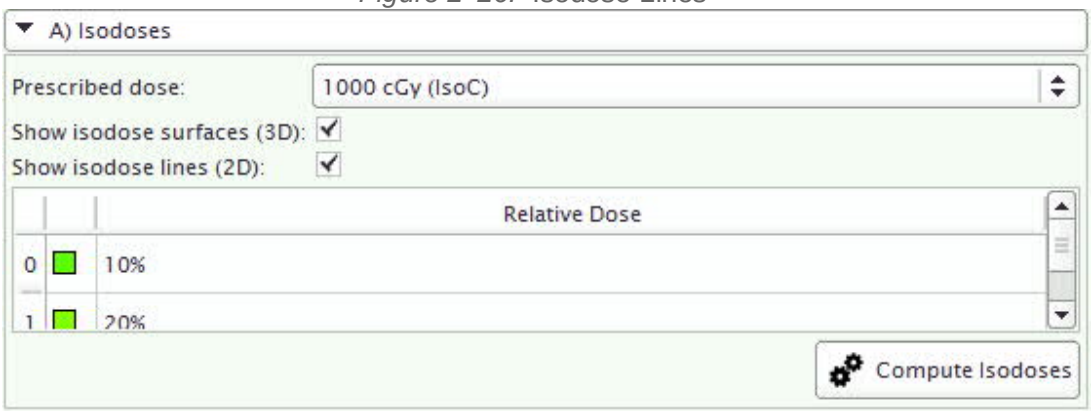


Figure 2–27: Isodose Lines on Planar Views

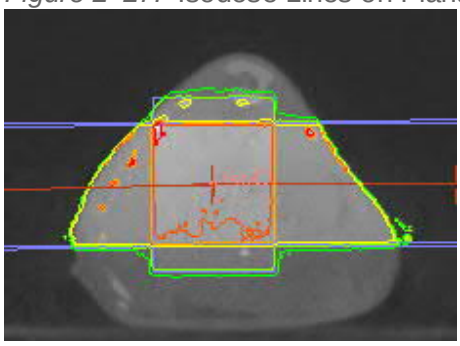
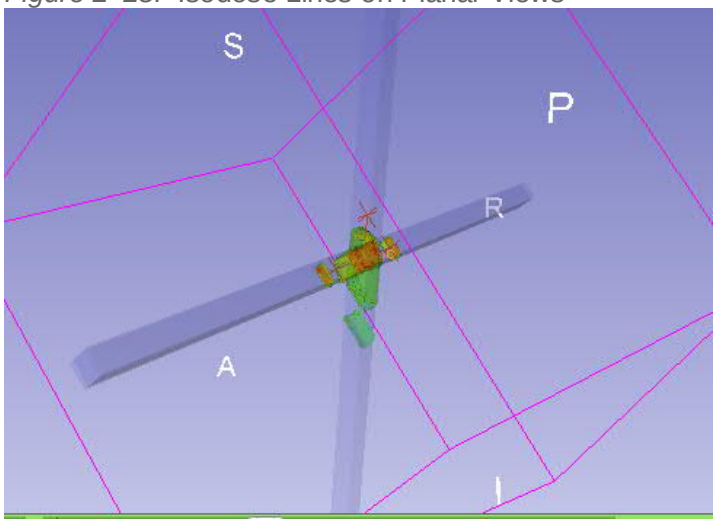


Figure 2–28: Isodose Lines on Planar Views



2.7.2 Option B: Create Dose Volume Histogram

This option enables the user to create a *Dose Volume Histogram* based on the *Contours* selected. If there was a previous plan registered the DVH from that can be overlaid.

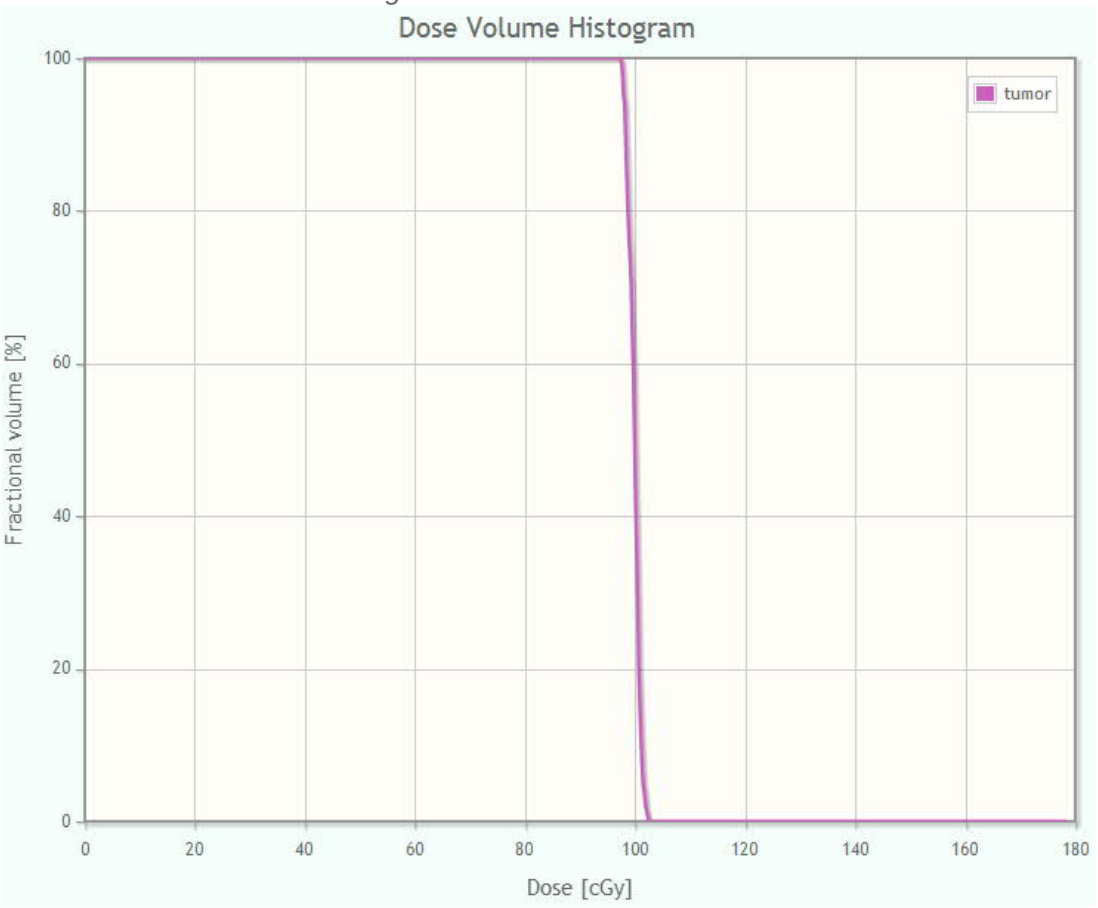
The contours can be turned on or off by checking the eye for each individual volume (contour).

This menu will show each *Contour Volume(cc) and Minimum, Mean and Max Doses* in the Volume.

Figure 2–29: DVH Stats

		Label	Volume (cc)	Mean (cGy)	Min (cGy)	Max (cGy)
1	☑	tumor	0.0118126	99.8121	97.4745	102.47

Figure 2–30: DVH Window

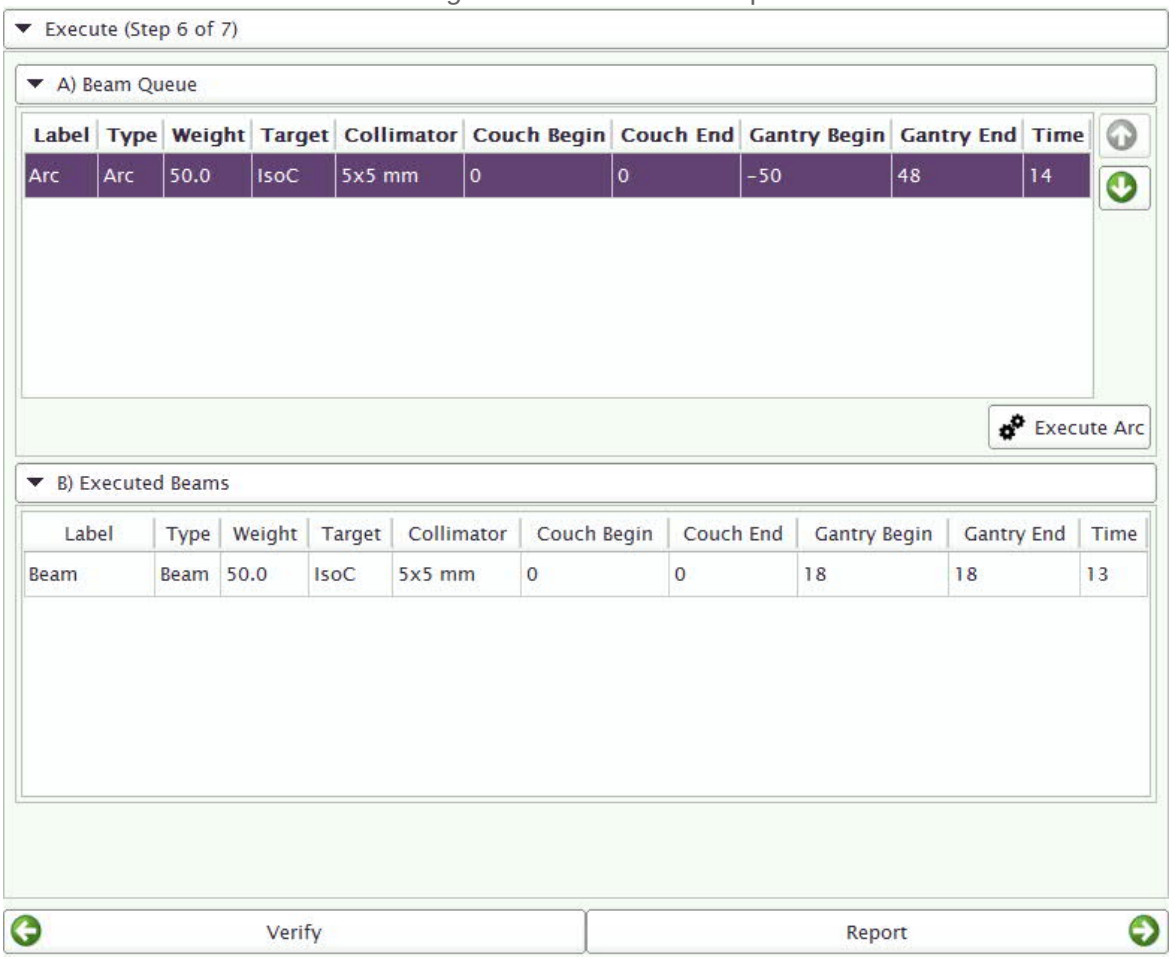


2.8 Execute(Step 6)

In this step the user will Select each *Beam* or *Arc* and send the parameters to the SARRP software for Robotic movements and X-ray Control.

Once a Beam or Arc is Executed it will automatically populate in the *Executed Beams* window and remove from the *Beam Queue*.

Figure 2–31: Execute Step 6

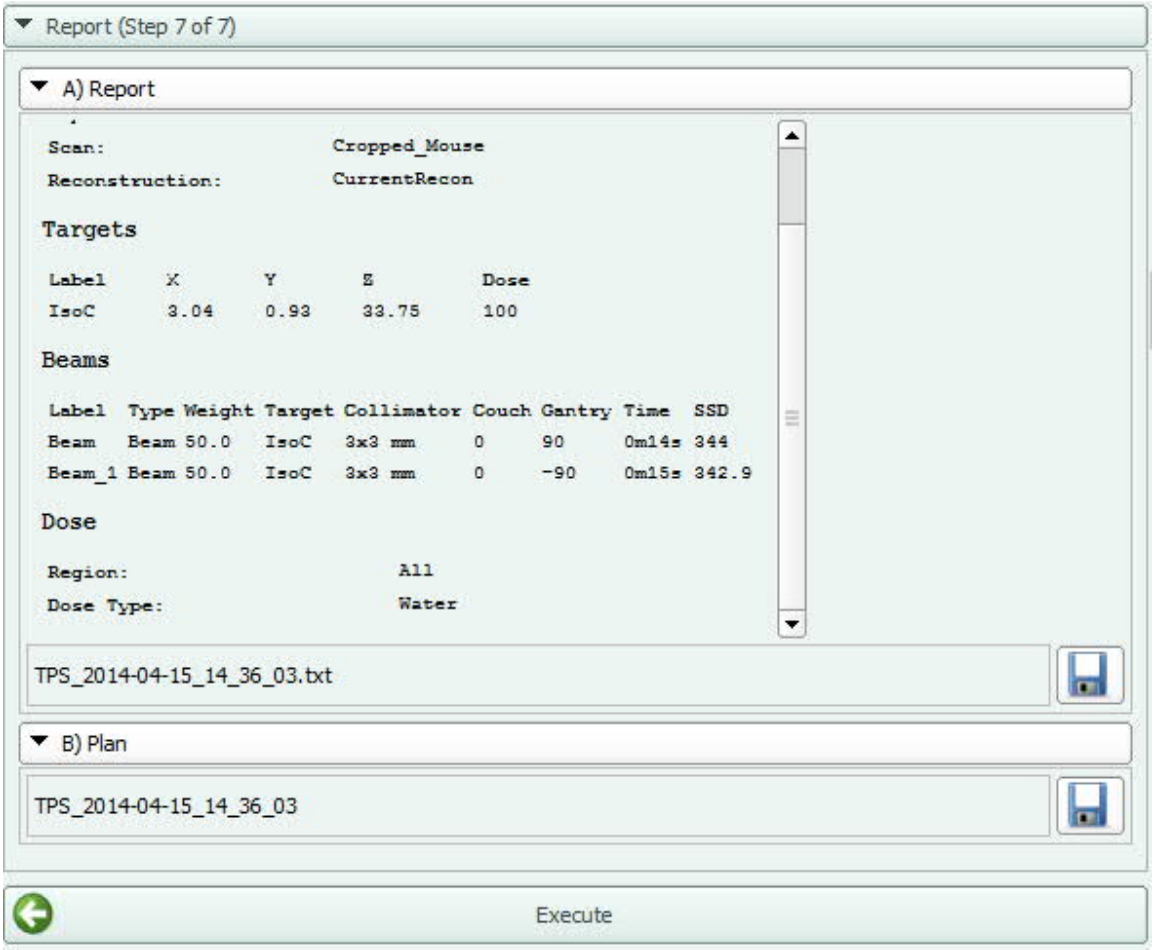


2.9 Report (Step 7)

The user can create a *Treatment Plan Report* of the treatment parameters and images used to define a treatment for a specific subject.

Also the Plan can be saved for use on the same mouse at a later date or on other mice by saving the Plan at the end.

Figure 2–32: Report Step 7



2.10 Exiting the Software

To exit the MuriPlan© software:

- Select *File*, then *Exit*

Appendix: A

Notes

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