Computed Tomography

Instructions for Use

Brilliance CT

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English

Volume 3

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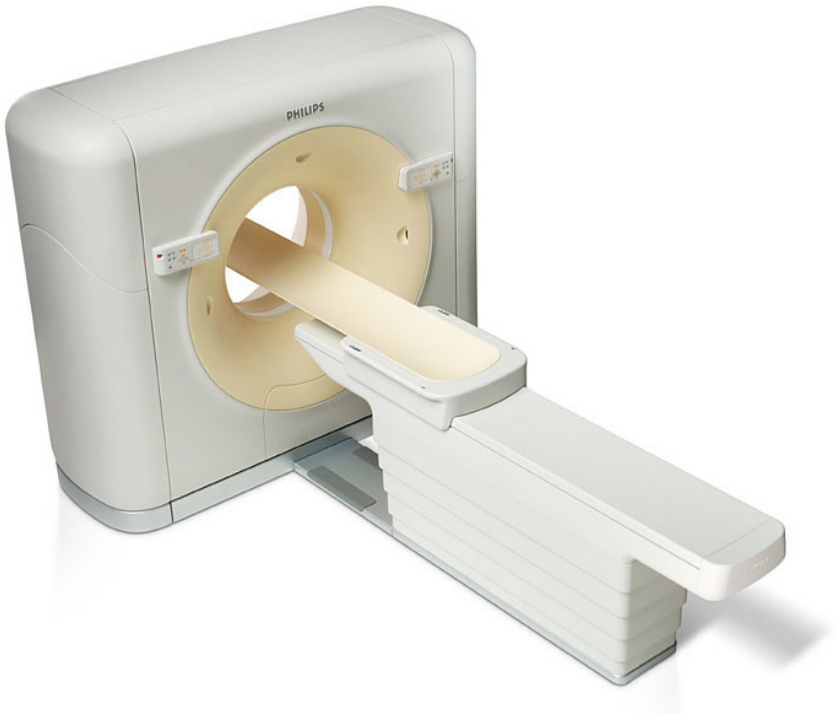
1 Introduction

1.1 About the Brilliance™ CT system

The Philips Brilliance CT system is an advanced continuous-rotation computed tomography system suitable for a wide range of computed tomographic (CT) applications.



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1.2 About this guide

This manual is intended to assist users and operators in the safe and effective operation of the equipment described. It covers the information needed for the Brilliance CT 40 System.

- The “user” is considered to be the body with authority over the equipment.
- The “operators” are those persons who actually handle the equipment.

Before attempting to operate the equipment, you must read, note, and strictly observe all **DANGER** notices and safety markings on the Brilliance CT System.

Before attempting to operate the equipment, you must read this manual thoroughly, paying particular attention to all **WARNINGS**, **Cautions** and **Notes** incorporated in it. You must pay special attention to all the information given and procedures described in the **SAFETY** section.

Warnings ⚠ ***Directions, which if not followed, could cause fatal or serious injury to an operator, patient or any other person, or could lead to a misdiagnosis or mistreatment.***

Cautions ⚠ ***Directions, which if not followed, could cause damage to the equipment described in this Instructions for Use and/or any other equipment or goods, and/or cause environmental pollution.***

Notes ***Highlight unusual points as an aid to an operator.***

Within this for Use, the most extensive configuration of the system is described, with the maximum number of options and accessories. Not every function described may be available on your system.

The documentation for the Brilliance CT System is supplied in four volumes.

Volume 1 - Instructions for Use 4535 671 48811

This volume explains how to use the Brilliance CT scanning system. It also contains information about safety, data security, system start-up, software navigation, scanning protocols, networking, and calibration.

Volume 2 - Review Modes 4535 671 48821

This volume explains how to use the various image viewers supplied with the system, including the CT Viewer and the Cardiac Viewer. Also included in this volume are instructions on how to use graphic tools for annotating studies and making basic measurements.

Volume 3 - Basic Analysis 4535 671 48831

This volume explains how to use the basic analysis and imaging applications supplied with the Brilliance scanner. These include multi planar reformatting (MPR), shaded surface 3D, and maximum (and minimum) projection (MIP).

Volume 4 - Advanced Analysis 4535 671 48841

This volume explains how to use the advanced analysis applications available on the Brilliance scanner. These include liver and brain perfusion, angiography, and dental, lung, colon, and cardiac imaging and analysis applications.

This *Instructions for Use*was originally drafted, approved, and supplied by Philips Medical Systems (Cleveland), Inc. in the English language under the product part code 12NC.

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1.3 Intended use

The Philips Brilliance CT system is intended to be used and operated only in accordance with the safety procedures and operating instructions given in this *for Use* for the purpose for which it was designed. The purpose for which the equipment is intended are given below. However, nothing stated in this *for Use* reduces user's and operator's responsibilities for sound clinical judgement and best clinical procedure.

The Philips Brilliance CT system is intended for use as a diagnostic patient imaging device that produces images that correspond to tissue density. The quality of the images depends on the level and amount of X-ray energy delivered to the tissue. CT imaging displays both high-density tissue, such as bone, and soft tissue. When interpreted by a trained physician, CT images yield useful diagnostic information. It is intended for use in the head and whole body.

Use and operation of this equipment is subject to the law in the jurisdiction(s) in which the equipment is being used. Both users and operators must only use and operate the equipment in such ways as do not conflict with applicable laws, or regulations which have the force of law.

Caution ***In the United States, Federal law restricts this device to sale, distribution, and use by or on the order of a physician.***

Note ***Equipment described in this manual is designed to be compatible with PMS products. It is designed to operate according to recognized and accepted compatibility standards.***
The equipment produces images which may be transferred by the user to other non PMS workstations by a network or other means. When doing so, the user or manufacturer of that workstation has the responsibility to validate that images are correctly transferred and displayed under all conditions of use. Use of incompatible equipment may result in the incorrect transfer, display, or other processing of the data.

1.4 Contraindications

The Philips Brilliance CT system should not be used if any of the following contraindications exist or are thought to exist.

- The image performance quality assurance checks listed under the heading, *Maintenance*, have not been satisfactorily completed.
- The preventative maintenance program is not up to date.
- If any part of the equipment or system is known (or suspected to be) operating improperly.

1.5 Compatibility

Equipment described in this manual should not be used in combination with other equipment or components unless such other equipment or components are recognized as compatible.

Changes and/or additions to the equipment should only be carried out by Philips Medical Systems or by third parties expressly authorized by Philips Medical Systems to do so. Such changes and/or additions must comply with all applicable laws and regulations that have the force of law within the jurisdiction(s) concerned, and with best engineering practice.

Changes and/or additions to the equipment that are carried out by persons without the appropriate training and/or using unapproved spare parts may lead to the PMS warranty being voided. As with all complex technical equipment, maintenance by persons not appropriately qualified and/or using unapproved spare parts carries serious risks of damage to the equipment and of personal injury.

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1.6 Compliance

The Philips Brilliance CT system complies with relevant international and national standards and laws. Information on compliance will be supplied on request by your local PMS representative, or by:

Philips Medical Systems
PO Box 10 000
5680 DA BEST
The Netherlands

Facsimile: +31 40 276 2205

The Philips Brilliance CT system complies with relevant international and national laws and standards on EMC (electromagnetic compatibility) for this type of equipment when used as intended. Such laws and standards define both the permissible electromagnetic emission levels from equipment and its required immunity to electromagnetic interference from external sources.

The *Maintenance* schedule identifies the procedures and frequency of their performance, which is necessary to ensure (continued) compliance with the *Federal Performance Standards for Diagnostics X-Ray Equipment*, 21 CFR Subchapter J, Radiological Health Section 1020.30 and 1020.33.

1.6.1 IEC-60601 classification

Type of protection against electric shock	Class I equipment
Degree of protection against electric shock	Type B equipment
Degree of protection against harmful ingress of water	Ordinary equipment
Possible interference with other equipment	IEC 60601-1-2 Group 1 Class A Device for Radiated Emission
Mode of operation	Continuous mode with short time loading

1.6.2 Electrical ratings

Voltage (VAC)	Phase	Frequency (Hz)	Power consumption (KVA)	
			Continuous	Short time
380	3	50/60	8	90
400	3	50/60	8	90
420	3	50/60	8	90
440	3	50/60	8	90
460	3	50/60	8	90
480	3	50/60	8	90

1.7 Training

Operators of the Philips Brilliance CT system must have received adequate training on its safe and effective use before attempting to operate the equipment described in this *for Use*. Users must also ensure that operators receive adequate training in accordance with local laws or regulations which have the force of law.

If you require further information about training in the use of this equipment, please contact your local Philips Medical Systems representative. Alternatively, contact:

Philips Medical Systems
PO Box 10 000
5680 DA BEST
The Netherlands

Facsimile: +31 40 276 2205

2 Safety

Warning ***Before attempting to operate the system, it is imperative for the user to read Volume 1, chapter 2 of the Brilliance CT Instructions for use in its entirety and to comply with all safety and emergency measures contained therein. Furthermore, the user must strictly observe all Cautions and Warnings that appear in each volume of the Brilliance CT Operation Manual.***

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3 Security of system and data

Philips Medical Systems is dedicated to helping you maintain the confidentiality, integrity, and availability of electronic protected health information and the hardware and software products that create and manage these data.

Many governments require maintaining the confidentiality of the patient's health related information, and also require verifying and validating the correct operation of, and modifications to, medical devices.

Please refer to the chapter “Security of System and Data” in volume 1 for more information about security issues and effective security safeguards.

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4 Multi-planar reformatting

4.1 Overview

The MPR function - Multi-Planar Reformatting (Oblique) - is used to reformat the tomographic data in view planes orthogonal or inclined to the original slices, or in curved planes for better visualization of organs and tissues, and the relation between them.

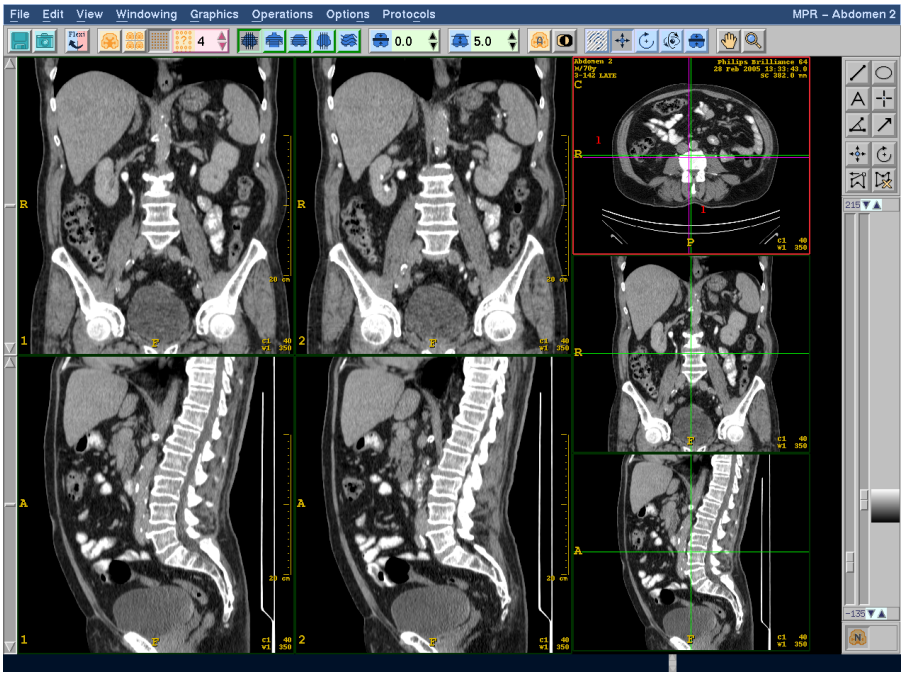
The available planes are:

- Orthogonal planes together
- Coronal and Sagittal planes
- Curved planes

Note ***The slices that are reformatted have to comply with the following conditions:***

- ***They must belong to the same series***
- ***The spacing between the images should be the same; some missing images are tolerated.***
- ***The reconstruction matrix, zoom and pan of all images should be the same.***
- ***Their orientation (tilt and swivel angles) should be the same.***

4.2 MPR window



The **Main Image Area** or workspace displays the reference images and resulting cuts.

The **Menu Bar** consists of several menu options which when selected display a list of operations that can be performed. The menu options are described below.

- **File** includes all the file management and filming functions; the whole window or a user-defined series of cuts may be saved and filmed.
- **Edit** enables resetting of image zoom and windowing, changing overlay colors or hiding them, and copying images to other applications.
- **View** includes setting of the display format, display of the image parameters and resizing of the window to fit around the image.

- **Windowing** consists of the windowing functions and preset windows. **<Alt>** + **<1–8>** (the Alt key pressed together with a number between 1 and 8) also activates the preset windows.

  Fine tuning of the windowing Center and Width is performed by dragging the mouse on the image while the middle button is pressed; up/down for Center adjustment and left/right for Width.

- **Graphics** includes activation of the graphical elements and their operations.

- **Operations** enables changing of the MPR mode, MPR slice parameters (number of cuts and their spacing and thickness), moving and rotating the cut planes, zoom and pan.

- **Options** selects to display either originally acquired images or images interpolated between the original ones, selects between concentric series or parallel series of curved cuts, and which ROI data to display. Also offered are three MPR modes: of Average (default), Maximum and Minimum;. Selecting Maximum or Minimum provides Slab MIP manipulation features.

- **Protocols** lists available MPR Preset Protocols, and has a utility for saving new protocols or deleting old ones.

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The **Tool Bar** contains the following buttons for activating the frequently used functions.

The buttons (from left to right) are:

- **Save** for saving the window contents.
- **Film Display** for sending the window contents to Filming prior to printing.
- **Real-time MPR** for activating the Real-time MPR application. See the next chapter in this volume for more information.
- **Formats**
  - One-image - to display a single large image and a small reference image.
  - Four-images - to display three orthogonal planes and a resulting cut.
  - Multi-image - to display the number of cuts defined in the Number of cuts text box.
  - Number of cuts - to set the desired number of cuts; the maximum is 200 cuts; the minimum in the coronal, sagittal, axial, or curved mode is 1; the minimum in the orthogonal mode is 2.
- **MPR** modes:
  - Orthogonal planes for displaying cuts orthogonal to the original plane.
  - Axial planes for displaying cuts at any arbitrary angle, where the initial display is of axial planes.
  - Coronal planes for displaying cuts at any arbitrary angle, where the initial display is of coronal planes.
  - Sagittal planes for displaying cuts at any arbitrary angle, where the initial display is of sagittal planes.

- Curved planes for displaying cuts along any user-defined curve.

- **Thickness** for setting the thickness of the cuts.

Note ***A second Thickness button is placed before the Pan button, which allows you to set thickness by dragging the mouse within an image.***

- **Spacing** between cuts for setting the spacing between the cuts.
- **Alternate** window to switch from the normal window to the alternate one and vice versa.
- **Inverse** window to invert the gray levels for a negative image.
- **Operations**
  - Define curve (active in Curved planes only) for drawing the curved cut.
  - Move for moving the cuts.
  - Rotate for rotating the cuts.
  - Pan for moving the images within the window.
  - Zoom for magnifying and reducing the images.

The **Message Line**, located at the bottom of the screen, displays on-line help and system messages.

The **Scroll Bar**, on the left or right side of the window, is for scrolling through the images.

The **Tool Box**, located at the upper-right side of the Viewer window, contains the graphical aids for annotating and measuring features on the images. It includes:

- Line (straight, curved and freehand lines) for length measurement
- ROI (elliptical, rectangular, curved and freehand Regions Of Interest) for measuring area, mean and standard deviation of the pixel values.

Note ***To access curved and freehand lines -- and rectangular, curved, and freehand ROIs -- right-click on the Line and ROI buttons.***

- Text for annotation on the images
- Cursor for measuring pinpoint pixel values
- Angle for measuring angles between features on the image
- Arrow for pointing to features of interest

Operations on graphic elements are: Move, Rotate, Change Shape and Delete.

For detailed operation instructions of the graphic elements, refer to Viewer and Graphics chapters in volume 1.

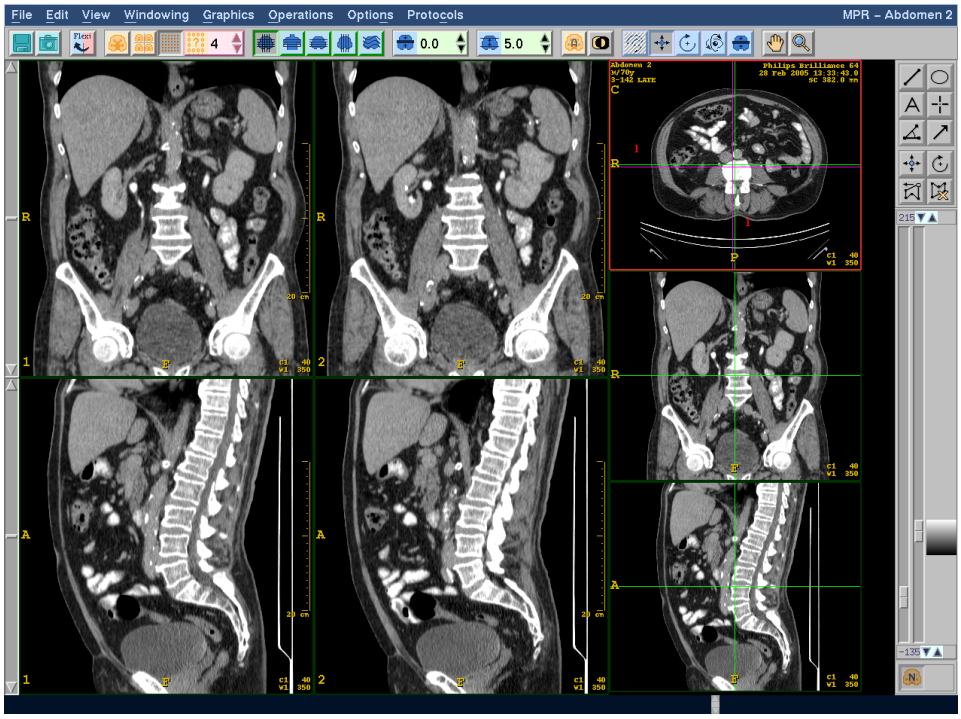
Right click on an image to view the shortcut menu; this menu contains commonly used functions and tools. To invoke the pop-up menu, place the pointer on any one of the images and click the right mouse button.

4.3 MPR display formats

There are three display formats:

- Multi-images format
- Four-images format
- One-image format

4.3.1 Multi-image format



The window is divided into two sections:

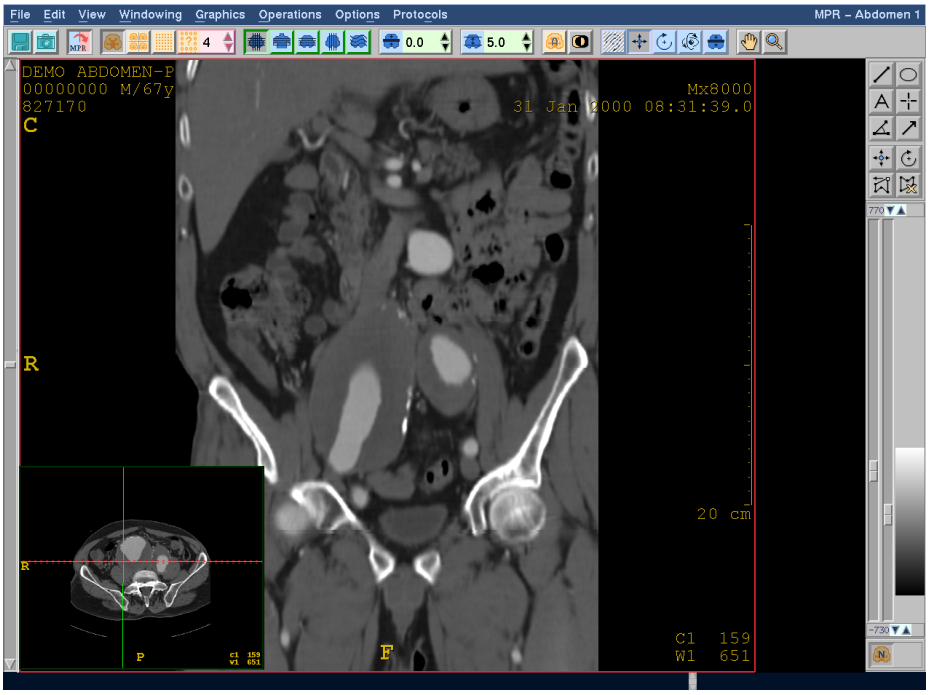
- Reference strip on the right includes the original image, and images orthogonal to it (usually axial, coronal, sagittal), and an orientation image (view is set by MPR mode buttons). The lines on these images can be manipulated and the images changed in real-time.
- Result area on the left shows the series of cuts. The images are updated when the mouse is idle.

4.3.2 Four-images format

The window is divided into four quadrants.

- the original image
- two orthogonal image quadrants
- a reformatted general oblique or curved plane image

4.3.3 One-image format



In the one-image format, there is an option to view a localizer image. Select **Localizer** in the View menu and a small image is displayed in the corner of the view window. A crosshair overlay appears in both the large image and the localizer image. Drag the crosshair in either viewer window to view the related image that corresponds to the crosshair position.

- If a surview was loaded with the series, the localizer will be the surview image.
- If a surview was not loaded with the series, the localizer will be the same view (plane) as the selected image in the previous window format. (For example, if the previous window format was axial images, the localizer will be axial.)

Notes

Refer to the later section for instructions about how to Save and/or Film the images with Surview.

Select File>film/Save Series>Label. The label will appear on the film images. Make sure to select “Cuts with Mini-Surview.”

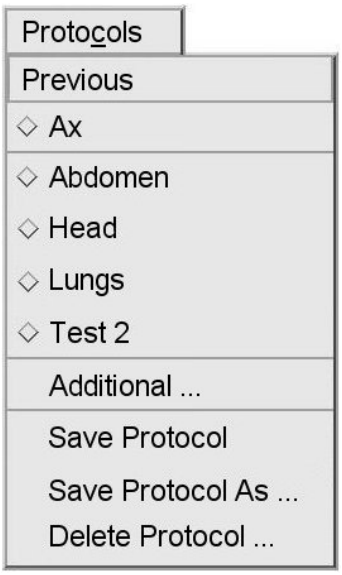
Notes

- ***Make sure the images are displayed correctly before filming or saving. Once you film/save the series, they become one image, and cannot be separately zoomed or panned.***
- ***Series can be adjusted normally; surviews can be adjusted with their Window and Center only.***
- ***To select the image plane for the localizer when there is no Surview, set the view to Multiview, then select the reference image with the desired plane, and then select One image display.***
- ***Only a Surview can be filmed with cuts.***

4.4 Selecting images

1. Click **Directory** if the Directory is not already open.
2. Select a study from the Patient list.
3. Select the series to open from the Series List.
4. Select **MPR** from the Application menu. The MPR viewer appears with the selected series.

4.4.1 Display protocols



When a new image set is loaded, an initial protocol is selected according to the scan protocol name and body part DICOM tags of the loaded images. Use the Protocols menu to select another display mode from a list of MPR display protocols:

- **Previous**
- Select from a **List** of existing protocols
- **Additional…** (This selection is displayed if there are more protocols than can be shown in the opening list.) Opens a dialog box with the protocols list, OK, and Cancel buttons.
- **Save** will save the current settings under the same protocol name, after user confirmation.
- **Save as...** saves current settings under a new protocol name.
- **Delete...** will open a dialog box showing the protocols list (with the last protocol selected), and will offer Delete and Cancel buttons. Upon activating Delete, the selected protocol is deleted, after user confirmation.

Selection of a new protocol changes MPR parameters as if the user performs manual changes (that is, one by one).

- number of slices
- slice thickness
- slice spacing
- working mode (orthogonal, axial, etc.)
- view mode (one, four, or multi-image view)

4.5 Orthogonal planes

In the Multi-image format, the central slice of the study is displayed in the upper-right quadrant (in the Four-image format it appears on the upper left quadrant). A reference crisscross of perpendicular lines marks the planes of the perpendicular cuts. Series of perpendicular cuts are displayed in the result area.

To **display** orthogonal cuts through the desired tissue:

1. Click Move on the Tool Bar.
2. Move the pointer to the original image. The pointer shape changes when placed on a reference image.
3. Click on the point of interest on one of the reference images. The origin of the lines jumps to the pointer position.
4. Fine-tune the position of the cuts by dragging the lines while checking the corresponding orthogonal images.

To **move** the two orthogonal planes together:

1. Click near the intersection of the lines.
2. Drag to the desired position.

To **move only one** of the planes:

1. Click near the appropriate line far from the intersection.
2. Drag the line. The other line and plane will not move.

To **rotate** the planes for displaying angled features:

1. Click on the Rotate button on the Tool Bar, or from the Operations menu, select **Rotate**.
2. The pointer shape changes to indicate the mode (on the original image only). Rotate the lines by dragging the mouse horizontally on the original image. Note that you can rotate in all planes.

To **change** the displayed acquired image:

1. Click on Move on the Tool Bar.
2. Move the pointer to one of the reference orthogonal images. The shape of the pointer changes to indicate the mode.
3. Drag the reference line to the desired position. The original image, corresponding to the line, is displayed.

To **enlarge** images:

1. Click on the Zoom button on the Tool Bar, or from the Operations menu, select Zoom. The cursor changes to indicate the mode.
2. To magnify the images, drag the mouse upwards on one of the reference images.
3. To reduce the size of the images, drag the mouse downwards. All the images are simultaneously zoomed.

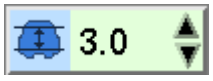
To **pan** images:

1. Click on the Pan button on the Tool Bar, or from the Operations menu, select Pan. The cursor changes to indicate pan mode.
2. Drag one of the reference images in the desired direction.

To increase or decrease the **number** of displayed cuts:

1. Click on the Number of Cuts textbox on the Tool Bar, or from the Operations menu select Slice Parameters.
2. Type in the number of the cuts to be displayed or use the arrows to decrease or increase the value.

To increase or decrease the **spacing** between the cuts:



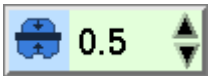
1. Click on the Spacing textbox on the Tool Bar, or from the Operations menu select Slice Parameters.
2. Type in the desired spacing between the cuts in millimeters or use the arrows to decrease or increase the value.

To display the cuts in **reverse** order:

1. Click to the left of the number in the Slice Spacing box on the toolbar.
2. Insert a minus (-) sign.

Note ***When saving in reverse order, the last image becomes the first when the Number of Slices is an odd number. Because an even number cannot be exactly mirrored, when the Number of Slices is even, the last image is not saved.***

To change the **thickness** of the cuts:



1. Click on the Thickness textbox on the Tool Bar, or from the Operations menu select Slice Parameters.
2. Type in the desired thickness or use the arrows to decrease or increase the value.

Note ***Calculation of cuts with thickness takes longer than with zero thickness. It is therefore recommended to perform all other manipulations first and define thickness on the final cuts last.***

To **revert to the original** position, Zoom and windowing values, from the Edit menu select **Reset all**.

To **remove** an unwanted slice from the MPR planes:

1. Move the line on the coronal or sagittal image until the original image to be removed is displayed.
2. From the Edit menu select **Remove**.
3. Confirm that you really want to remove the slice. The images are reformatted so that the missing data are replaced by interpolation between the adjacent slices. The images are deleted from the MPR set and not from the Directory.

   The original images may be displayed as acquired or interpolated.

   • Interpolate gives smoother leafing.

   • Original keeps the original images intact.
4. To change from one to the other, click on **Interpolated** or **Original** in the Options menu.

Graphic aids may be used to measure and annotate the MPR images. Refer to the Viewer and Graphics chapters in volumes 1 and 2 for operation instructions.

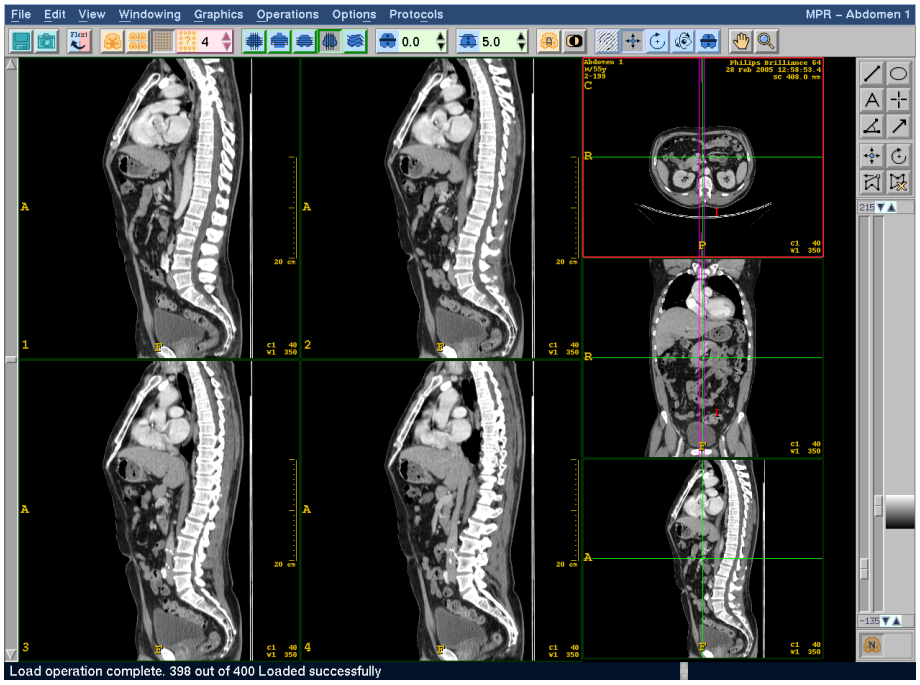
4.6 Axial, coronal & sagittal planes

Axial, coronal and sagittal images are displayed as reference planes. On each reference plane, a line denotes the intersection of the oblique plane with the reference plane.

Notes

- ***The difference between axial, coronal and sagittal is the initial direction of the displayed image.***
- ***The discussion below refers to sagittal images; however, the actions are the same for axial and coronal images.***

In the Four-images format, the original image is displayed together with the orthogonal images and a result image initially set in the axial plane.



In the Multi-image format, the central axial image is displayed in the reference area, with the sagittal and coronal cuts. It is updated in real-time during mouse manipulation, while the axial cuts in the result area are completed when the mouse is idle.

To **move** the planes to the region of interest:

1. Click **Move** on the Tool Bar.
2. Move the pointer to the original image. When placed on a reference image, the pointer shape changes to indicate the mode.
3. Click on the point of interest on one of the reference images. The origin of the lines jumps to the pointer position.
4. Fine-tune the position of the cuts by dragging the lines while checking the corresponding orthogonal images and central resulting cut.

To **move** the **two** planes together:

1. Click near the intersection of the lines.
2. Drag to the desired position.

To **move** only **one** of the planes:

1. Click near the appropriate line far from the intersection.
2. Drag the line. The other line and the other plane will not move.

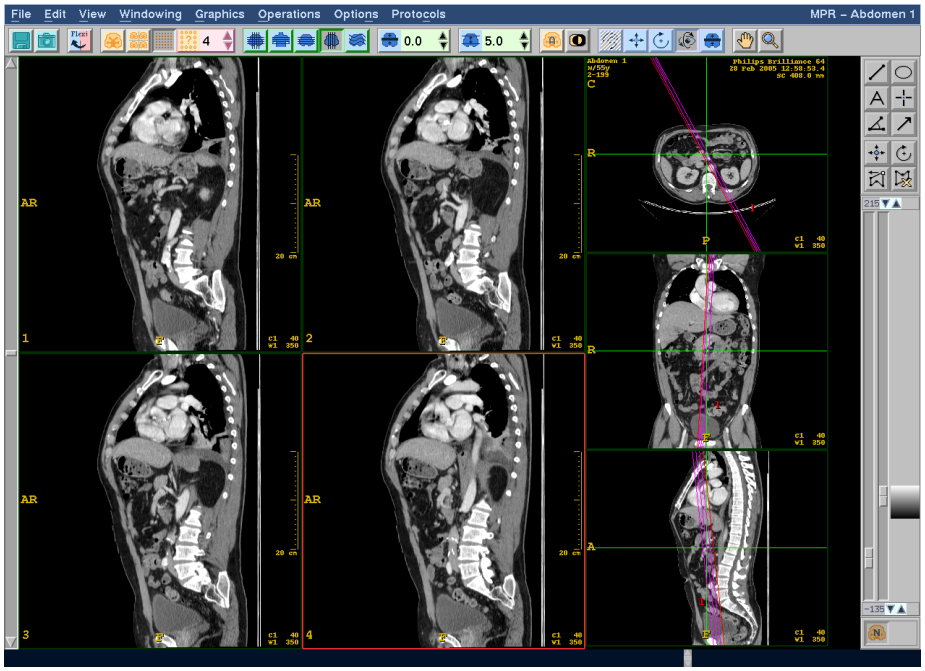
To **change** the plane **angles**:

1. Click the rotate button on the Tool Bar, or from the Operations menu select **Rotate**.

   The pointer shape changes when placed on one of the reference images.

2. Rotate the lines by dragging the mouse horizontally on any reference image, so that they overlay the interesting feature on the images.

3. Repeat the rotation on the other reference images until the desired oblique plane is achieved.



4.7 Curved surfaces

From the **Operations** menu, select **Curve**. or click the **Curved Planes** button on the Toolbar.

Axial, coronal and sagittal images are displayed as reference planes. The Define curve button on the Tool Bar appears depressed.

If the displayed images do not depict the desired feature clearly enough for drawing the curved plane, use Move and Rotate to change the orientation.

Draw a straight or curved line on any reference image:

1. Click **Define Curve** on the Tool Bar (if not already active). The pointer is transformed into a pencil.
2. Move the pointer to the beginning of the feature to be cut.
3. Click the left mouse button and move along the feature.
   - The line should overlay the feature; if the line begins to deviate, release and press again the mouse button to create a fixed point and continue dragging. Repeat until the line covers the whole feature to be cut.
   - To view and check where the line appears on the other images while drawing, leaf through the images using the gray + and - keys on the numeric pad.
   - To delete the last segment while drawing, press <BackSpace> on the keyboard.
   - Press <BackSpace> repeatedly to delete the segments in reverse creation order.

4. Double-click or press <Esc> on the keyboard to finish drawing. A number of concentric lines (as set in the **Number of Cuts** button) are drawn on the appropriate reference image and the curved cuts are drawn in the result area.
   - To correct the line, click on the Change Shape button in the Tool Box or select it from the Graphics menu. The

pivot points on the curve become visible; drag the deviant ones to their correct places.

- If you click between two pivot points, a new pivot point is added and can be manipulated for better accuracy.

5 To move the curved lines, click the **Move** button in the Tool Box or, from the Graphics menu, select **Move**.

- Move the pointer to one of the line's handles and drag it to another location. This moves all of the lines without changing their shape.

6 To continue drawing the curve beyond the last point, click the **Define Curve** button and drag the end-point with the <Shift> button pressed; continue drawing the curve as explained above.

For other operations that can be performed on curved cuts, refer to the previous sections.

The curved planes may be drawn concentric or parallel to each other.

- To change the mode, from the **Options** menu select **Concentric Curve** or **Parallel Curve**. If the item was marked (and the curves were concentric), they change to parallel and vice versa.

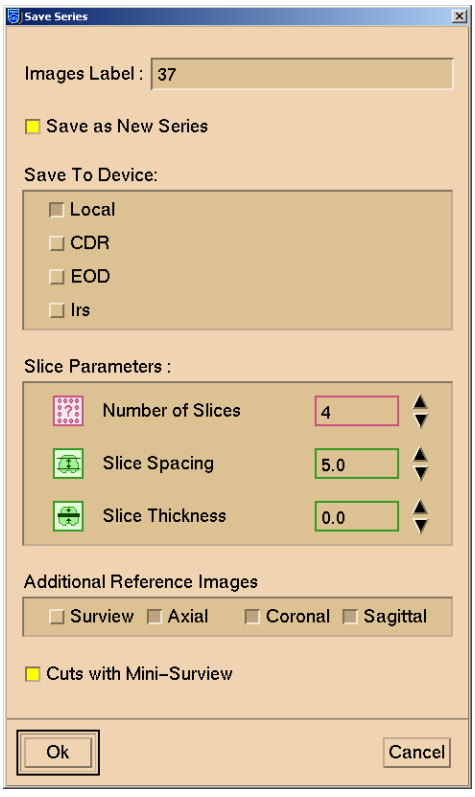
4.8 Save screen and series

To save the window contents:

1. Click the **Save** button on the Tool Bar or, from the File menu select **Save Display**. Note that you can "Save as a New Series."
2. In the Dialog Box that appears, type an identifying label.
3. Click on the devices on which the screen will be saved. The resulting cuts and the reference image(s) as seen on screen are saved to the selected location.

To save a series of cuts:

1. From the File menu, select **Save Series**. The following Dialog Box is displayed:



2 Type an identifying label. (Note that the label field will contain the previous label, if you entered one in “Save Display.”)

3 Click on the devices on which you want to save the series.

4 The values of the Number of Slices, Slice Spacing and Slice Thickness are the same as the values of the currently displayed MPR window. To change any value, type the desired value in the appropriate box or use the arrows at the right of the text boxes to increase or decrease the values.

5 To store the cuts in reverse order, click in the Slice Spacing box to the left of the number and insert a minus (-) sign.

Note ***When saving in reverse order, the last image becomes the first when the Number of Slices is an odd number. When the Number of Slices is even, the last image is not saved because an even number cannot be exactly mirrored.***

6 To **Save Additional Reference Images**, click the desired selection boxes. The reference images will be saved individually.

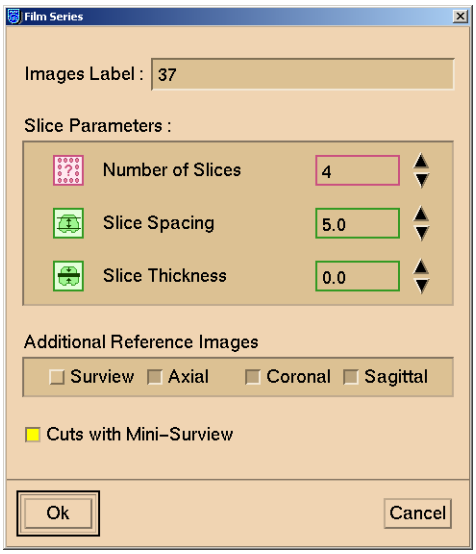
7 To have a **Mini-Surview** saved in the lower-left corner of all cuts, click the appropriate selection button. The mini-surview represents the location of the cut in the volume of interest.

8 Click **Ok** to store the series on the selected location.

4.9 Film screen and series

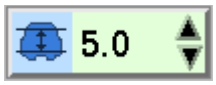
To film the window contents, click on the **Film Display** button in the Tool Bar or from the File menu select **Film Display** or **Film Series**. The resulting cuts and the reference image(s) are sent to the Filming as one frame.

1 To film a series of cuts, from the File menu select Film Series. The following Dialog Box is displayed:



2 Type an identifying label. (Note that the label field will contain the previous label, if you entered one in “Save Display,” or “Save Series.”)

3 The values of the Number of Slices, Slice Spacing and Slice Thickness are the same as the values of the currently displayed MPR window. To change any value, type the desired value in the appropriate box or use the arrows at the right of the text boxes to increase or decrease the values.



4 To film the cuts in reverse order, click in the Slice Spacing box to the left of the number and insert a minus (-) sign.

5 Click **Ok** to send the series to filming.

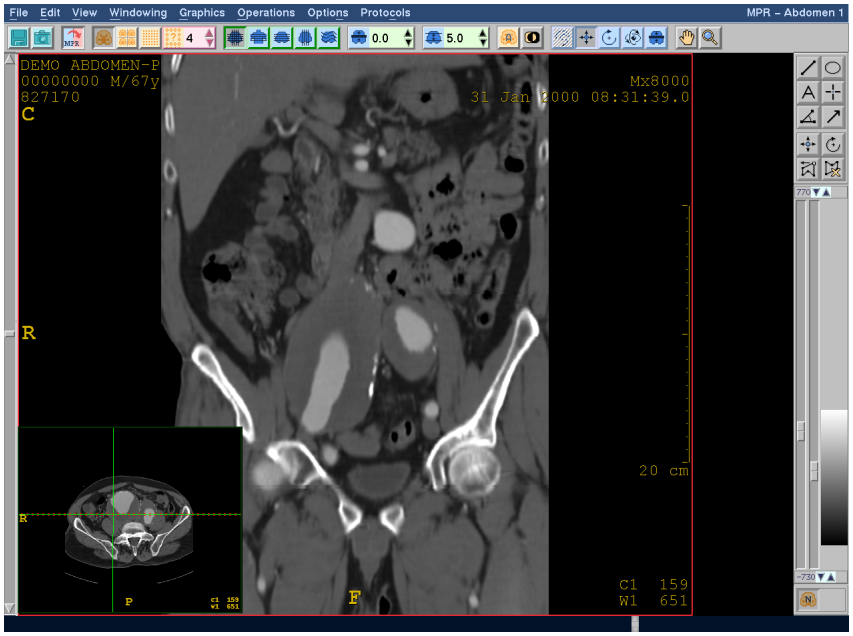
Note ***When filming in reverse order, the last image becomes the first when the Number of Slices is an odd number. When the Number of Slices is even, the last image is not filmed because an even number cannot be exactly mirrored.***

6 To film **Additional Reference Images**, click the desired selection boxes. The reference images will be filmed individually.

7 To have a **Mini-Surview** filmed in the lower-left corner of all cuts, click the appropriate selection button. The mini-surview represents the location of the cut in the volume of interest.

4.10 Mini-surview on MPR images

The surview image can be used as a localizer for MPR planar cuts. When you load a Surview image to MPR along with its original images and select **Localizer** in the View menu, the image displays as a localizer in the One image viewing format. A green crosshair appears at the location of the main image viewed. Drag with the mouse the localizer crosshair and the main image will update to the image at the new location.



Both the Save series and Film series dialog boxes have a check box that allows you to set this option on (the default setting is on). When the checkbox is checked it enables you to save and film planar cuts with the surview image as a localizer in the lower left corner of the image.

- If the surview image has a different study UID or Frame of reference UID than the axial images, the image is rejected.
- The surview image gray-level window parameters can be manipulated separately from the MPR cuts.
- Generated images are DICOM secondary capture images.

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- If a surview was not loaded with the series, the localizer will be the same view (plane) as the selected image in the previous window format. (For example, if the previous window format was axial images, the localizer will be axial.)

Notes

- ***To select the image plane for the localizer when there is no Surview, set the view to Multiview, then select the reference image with the desired plane, and then select One image display.***
- ***Only a Surview can be filmed with cuts.***

5 Real-time MPR (option)

5.1 Overview

Real-time MPR is an enhancement of the MPR application. Use Real-time MPR to view MPR reformatted patient images as they arrive -- in "streaming" fashion - at the LOCAL drive from a networked scanner or Extended Brilliance Workspace.

Display is automatic: Once Real-time MPR is activated and the remote source is identified, images sent by the scanner or Extended Brilliance Workspace display in an MPR window upon arrival. There is a maximum latency of 8 seconds after arriving at the LOCAL directory. Since images displayed in Real-time MPR are already in memory, any other application on the Brilliance CT scanner has immediate access to the images.

Real-time MPR speeds up the availability of the data to Radiologists, so images can be viewed almost concurrently with scanning.

The active display of arriving images can be suspended, allowing interactive MPR manipulations and graphics.

The transfer rate of reconstructed images to the Brilliance CT scanner is limited by the rate of images being pushed to the scanner and by your local network's performance.

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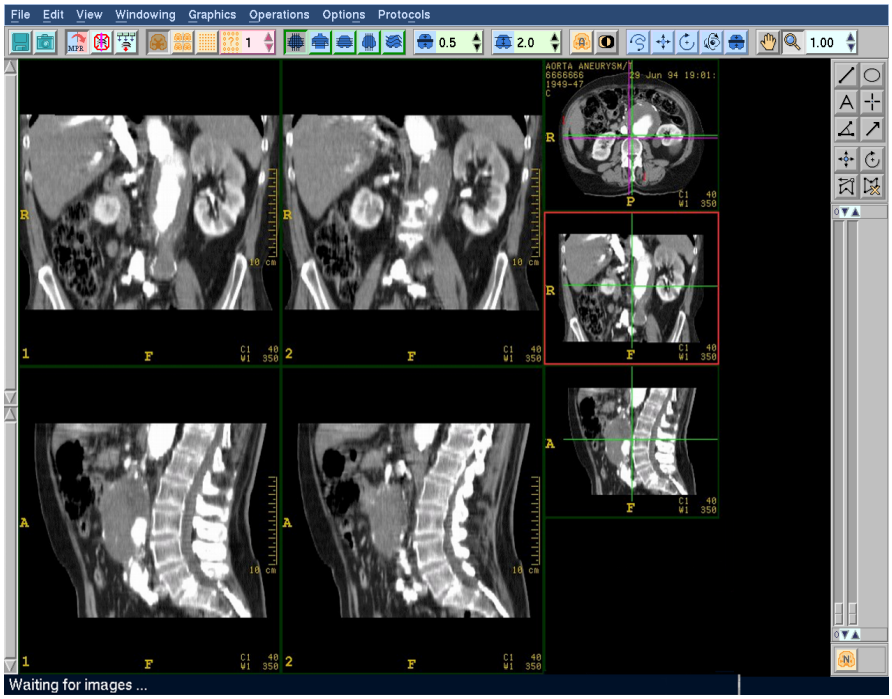
5.2 Real-time MPR window



Modes and operations

The operation of Real-time MPR is identical to that of the Multi-Planar Reformatting application. For details, refer to the Multi-Planar Reformatting chapter in volume 3.

The **Menu Bar** of Real-time MPR is similar to that of the MPR application. Several menus have new selections, specific to Real-time MPR, as described below.

- **File** includes all the file management and filming functions. For Real-time MPR, there is also a Select Source menu pick, and the Open item is removed.
- **Edit** functions are the same as in MPR.
- **View** functions are the same as in MPR.
- **Windowing** functions are the same as in MPR.
- **Graphics** include the usual graphical elements and operations.
- **Operations** functions are the same as MPR, with added selections allowing the user to toggle between the MPR and Real-time MPR applications.
- **Options** functions are the same as in MPR.
- **Protocols** allows you to select from either factory-default or user-developed MPR protocols, and allows new or edited protocols to be Saved, Saved As . . ., or Deleted.

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The **Tool Bar** is similar to the one in MPR, with the addition of three Real-time MPR icons.

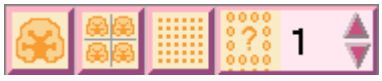
Save for saving the window contents.

Film display for sending the window contents to Filming prior to printing.

MPR/Real-time MPR for toggling between the Real-time MPR and MPR applications.

Suspend/Resume for suspending continuous updating, so that MPR and graphic functions can be performed on the present images without interruptions.

Select Source brings up the Select Source dialog box, from which a station is selected as the source for Real-time MPR images.

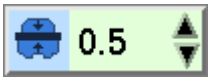


Formats

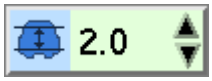
- One-image to display a single large image and a small reference image.
- Four-images to display 3 orthogonal planes and a resulting cut.
- Multi-image to display the number of cuts defined in the Number of cuts text box.
- Number of cuts allows the user to set any desired number of cuts between 2 and 200.

MPR modes:

- Orthogonal planes for displaying cuts orthogonal to the original plane.
- Axial planes for displaying cuts at any arbitrary angle, where the initial display is of axial planes.
- Coronal planes for displaying cuts at any arbitrary angle, where the initial display is of coronal planes.
- Sagittal planes for displaying cuts at any arbitrary angle, where the initial display is of sagittal planes.
- Curved planes for displaying cuts along any user-defined curve.



Thickness for setting the thickness of the cuts.



Spacing between Cuts for setting the spacing between the cuts.

Windowing - Alternate window to switch from the normal window to the alternate one and vice versa. **Inverse** window to invert the gray levels for a negative image.

Define curve (active in Curved planes only) for drawing the curved cut.

- Move for moving the cuts.
- Rotate for rotating the cuts.
- A second Thickness button is placed before the Pan button, which allows you to set thickness by dragging the mouse within an image.
- Pan for moving the images within the window.
- Zoom for magnifying and reducing the images.

The **Message Line**, located at the bottom of the screen, displays on-line help and system messages.

The **Scroll Bar**, on the left or right side of the window, is for scrolling through the images.

The **Tool Box**, at the upper-right side of the Viewer window, contains the graphical aids for annotating and measuring features on the images. It includes:

- Line (straight, curved and freehand lines) for length measurement
- ROI (elliptical, rectangular, curved and freehand Regions Of Interest) for measuring area, mean and standard deviation of the pixel values
- Text for annotation on the images
- Cursor for measuring pinpoint pixel values
- Angle for measuring angles between features on the image
- Arrow for pointing to features of interest

Operations on graphic elements are: Move, Rotate, Change Shape and Delete.

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For detailed operation instructions of the graphic elements, refer to the Viewer and Graphics chapters in volume 2.

A **pop-up menu**, which when invoked, appears on the image and can be used to activate the most commonly used functions and tools. To invoke the pop-up menu, place the pointer on any one of the images and click the right mouse button.

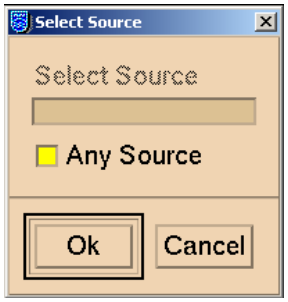
The **Main Image Area** or workspace displays the reference images and resulting cuts.

5.3 Opening Real-time MPR

Click the **Real-time MPR** button to open the Real-time MPR application.

Note ***When opening Real-time MPR from MPR, you will be prompted "Change to Real-time MPR? Yes/No," because opening Real-time MPR from MPR causes the currently displayed study to be cleared.***

5.3.1 Selecting the source



After clicking Real-time MPR, the Select device dialog box appears, as shown at left.

The source of images can be any DICOM Remote Storage location or any compatible scanner -- for example another Extended Brilliance Workspace or SeleCT or PQ.

Select the device that is sending the images and click OK. As the images arrive, they are displayed in the MPR viewer.

After the source selection is made, Real-time MPR becomes active and needs no further user intervention -- the transfer and display of images are automatic.

The message line at the screen bottom shows "**Waiting for images. . .**" while waiting for images from the selected source.

Real-time MPR displays only one study

A Real-time MPR window will display images belonging to a single study only. As soon as the Real-time MPR mode is activated and source selected, the study displayed is the one whose images arrive as follows:

- are either already arriving from the selected source, or
- will be the next to arrive from the selected source

Images from subsequent studies arriving from the same source will be ignored by Real-time MPR.

5.4 Sending images from the source

The sending station must be configured to send images to the Brilliance CT LOCAL disk, and the send or copy function must be initiated at that station.

Real-time MPR reads the LOCAL folder's DICOM directory files periodically, identifies new images from the selected source and loads them automatically to the Real-time MPR window. The display will be updated with the new images and cuts every 4 seconds; (this is a default value and can be configured.)

5.5 Suspend/resume function

The display of arriving images can be suspended and then resumed at any time. Suspension allows "freezing" the updating of images so interactive manipulations can be performed uninterrupted on the display.

The Suspend/Resume button on the tool bar can show one of three states:

- A grayed-out button indicates that no source has been selected for the Real-time MPR window.
- 
  A button with an exclamation point endicates the Resumed mode, during which arriving images will be automatically displayed. The message “Waiting for Images” is displayed.
- 
  Click the Resumed button to suspend image updates and the exclamation point disappears. In this Suspended state the display is not updated with any arriving images. (Click the button to re-activate the Resumed state.)

After Resuming from the Suspend state, the MPR display is updated to the latest arrived image.

Note ***If you leaf through axial images that have already arrived, the streaming display will not automatically resume.***

5.6 Additional information

Display protocol

When a new image set is loaded when activating Real-time MPR mode, an initial protocol is selected according to the scan protocol name and body part DICOM tags of the loaded images.

The Protocols menu allows you to select another display mode from a list of MPR display protocols, as well as create and save user-defined protocols.

How images are displayed

When displaying MPR images, Real-time MPR begins their growth from the center of the window to its edges. After exceeding display edges, there is an automatic zoom adjustment unless the user performs a manual zoom operation. After such user intervention, the image size will no longer be updated automatically, and parts of the image may remain invisible, beyond the frame.

Closing the Real-time MPR window

You can close the application window when finished with it. Alternately, to switch back to MPR, click MPR on the toolbar.

If there is an unfinished operation in process (for example, Save or Film) a warning pops up.

6 Combine images

6.1 Overview

The **Combine Images** application is used to produce new images by summation or subtraction of a given set of images. For each pixel in each image in the set, a weighted calculation is applied, or the minimum or maximum values are used to produce the combined image.

The application is useful in the following cases:

- For reducing statistical noise by averaging the pixel values of several images scanned at the same location.
- For scaling the pixel values of an image.
- For adding two or more images scanned as thin slices into one thick slice.
- For better visualization of contrast agent uptake where pre-contrast images are subtracted from the corresponding slices taken after the contrast agent is injected.
- For comparing images by subtracting.

This section describes the following features of the Combine Images function:

- Combine Images Window and its menu and tool bars
- Selecting Images
- Combine Images Parameters
- Image Selection Modes
- Setting the number of displayed images
- Scrolling through the images
- Images Parameters
- Saving Images
- Film Display and Film Images
- Resetting to original appearance

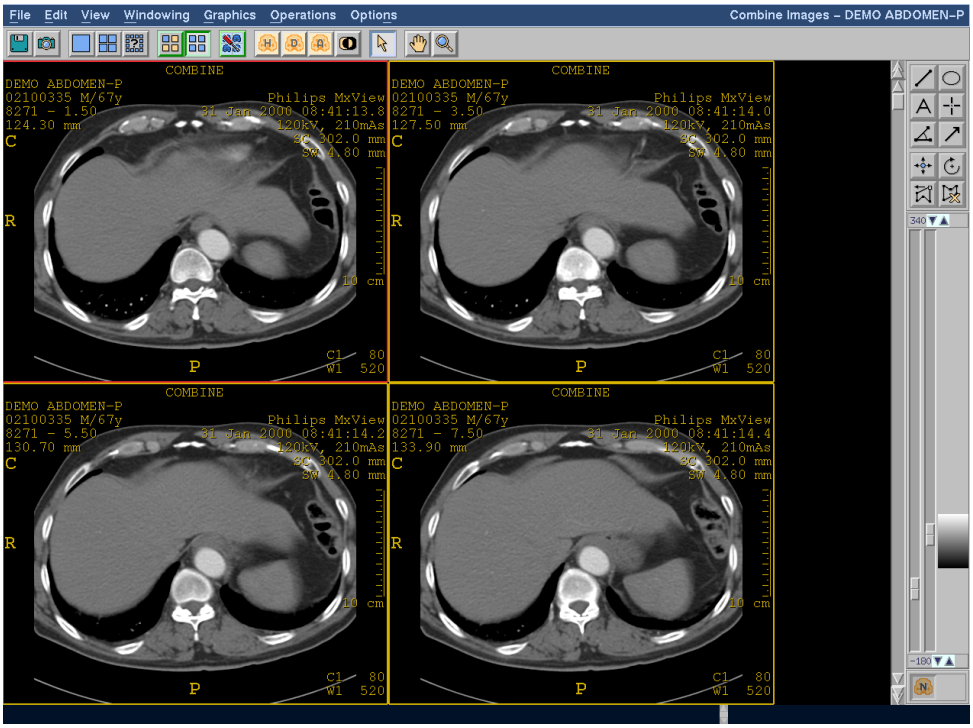
Note

- ***Derived images, odd size images, and localizer cannot be combined.***
- ***The slices that are being combined must belong to the same patient.***

In some cases, although all the images may have been successfully loaded into the application, the result of the **combine** operation may produce unexpected images and a warning will be displayed. This may happen when the images selected in the Directory for input have different values for one of the following parameters:

- X and Y center position
- Tilt and/or swivel angle
- Pixel size
- Slice Thickness
- Some images are inverted (horizontally or vertically)

6.2 Combine images window



The **Menu Bar** consists of several menu options which when selected display a list of operations that can be performed. The menu options are described below:

- **File** includes all the file management and filming functions.
- **Edit** allows resetting of 'image zoom', 'windowing' and 'combine parameters' (weight, bias...), changing overlay colors or hiding them, and copying images to other applications via the Clipboard.
- **View** includes setting of the display format, display of the image parameters and resizing of the window to fit around the image.
- **Windowing** consists of the windowing functions and pre-set windows. **<Alt> + <1–8>** (the **Alt** key pressed together with a number between **1** and **8**) also activates the preset windows.

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Fine tuning of the **windowing** Center and Width is performed by dragging the mouse on the image while the middle button is pressed; up/down for Center adjustment and left/right for Width.

- **Graphics** includes activation of the graphical elements and their operations.
- **Operations** enables changing zoom and pan.
- **Options** enables selective display of ROI measurement data and titles.

The **Tool Bar** contains the following icons for activating the frequently used functions.

The icons (from left to right) are:

- **Save** for saving the selected images.
- **Film** for sending the selected images to **Filming** prior to printing.
- **Formats**
  - One-image to display a single large image.
  - Four-images to display four images.
  - Desired number of images allows the user to set any desired number of images (Max 8 x 8).
- **Selection modes**:
  - **Select Image** to select the active image.
  - **All images** to select all the combined images.
- **Combine Parameters** to select the function parameters: weight, bias, number of images to combine and whether to sum or subtract the images or to create a minimum or maximum image of the pixel data of the images.

- **Windowing** modes:
  - **Highlight** window for highlighting a range of pixel values.
  - **Dual** window for activating the second windowing range in addition to the normal one.
  - **Alternate** window for switching from one window to an alternate one and back again.
  - **Invert** window is used to reverse the gray levels of the image, thereby displaying a negative of the image.
- **Pan** for moving the selected images within the window.
- **Zoom** for magnifying and minifying the selected images.

The **Message Line**, located at the bottom of the screen, displays on-line help and system messages.

The **Tool Box** located on the right side of the Display window contains the graphical aids for annotating and measuring features on the images. It includes the following:

- **Line** (straight, curved and freehand lines) for length measurement
- **ROI** (elliptical, rectangular, curved and freehand Regions Of Interest) for measuring area, mean and standard deviation of the pixel values
- **Text** for annotations on the images
- **Cursor** for measuring pinpoint pixel values
- **Angle** for measuring angles between features on the image
- **Arrow** for pointing to features of interest
- Operations on graphic elements: **Move, Rotate, Change shape** and **Delete.**

For detailed operation instructions of the graphic elements, refer to the Viewer and Graphics chapters in volume 2.

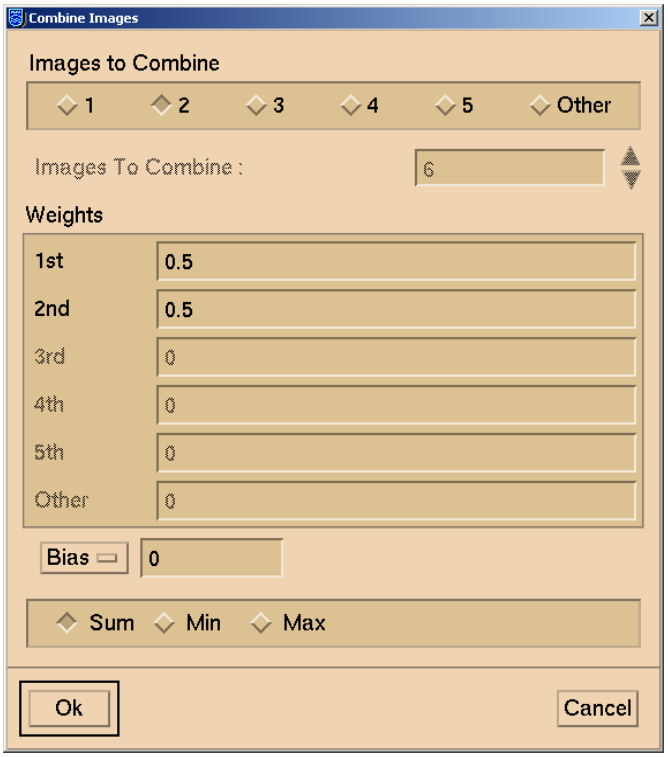
6.3 Selecting images

Click Directory if the Directory is not already open.

1. Select a study from the Patient list.
2. Select the series to open from the Series List.
3. Select **Combine Images** from the Application menu. The Combine Images dialog box appears.
4. Change the parameters in the dialog box for the required combination of images (refer to the next section for detailed description).
5. Click **Ok.** The combined images are reconstructed and displayed in the viewer window.

6.4 Combine parameters

After the images selected in the Directory have been loaded into memory, the **Combine Images** parameters dialog box will open.



The dialog box provides a set of parameters which can be modified according to requirements. They are used to calculate the combined images.

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The **Combine Images** parameters that can be changed are:

- **Images to combine** - number of images to combine into one image, from 1 to the number of images that were loaded (maximum of 20).

Note ***If, for example, 11 images were loaded, and the "Images to combine" was set to 3, then only three images will be produced from the first 9 original ones, and the last two will be discarded.***

- **Sum/ Min/ Max** - the type of image created. Sum will add or subtract the images together while minimum or maximum will produce an image based on the minimum or maximum of each pixel value in the set of images loaded. The default is set to **Sum**.
- **Weights** - (active for Sum only). Select the proportion of each image to be used in the calculation of each combined result. The default weights are set to **1**/(Number of images to combine), which means that all the images have the same weight.
- **Bias** - (active for Sum only). Select a constant value that will be added to the combined pixels. The default value is set to **0** (zero). For CT images the bias value range is between (-1000) and (+3095), for MR images the bias value range is between (-4095) and (+4095).

  For MR images, **automatic bias** may be selected. The application will then automatically calculate the bias. This will help prevent "bright spot" artifacts in the combined images.

Note ***This dialog box can also be opened at any time by clicking on the Combine Parameters button in the Tool Bar, or from the Edit menu by selecting the "Parameters...." option. You can redefine the Combine Parameters, and after selecting the OK button, the combined images will be recalculated based on the new values.***

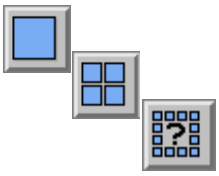
6.5 Image selection mode

There are two selection modes:

- **All Images** are selected by clicking on the icon or from the **Edit** menu by clicking on Select and then choosing the Select All option. If this mode is selected, all the image operations (such as, zoom, pan, windowing, film and save) are performed on all the images (even those that are not visible in the window).

- **Select Image** is made active by clicking on the button, or from the **Edit** menu by clicking on Select and then choosing the Select Image option. All the image operations (such as, zoom, pan, windowing, film and save) will be executed only on the active image.

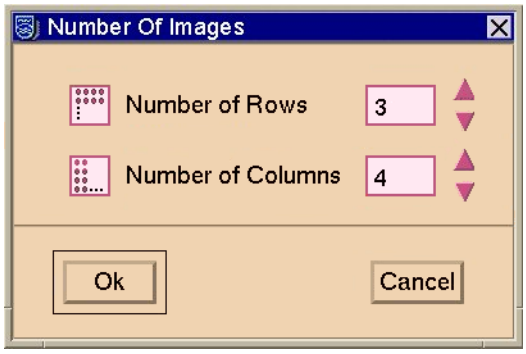
6.6 Set number of images in the display window



1 To set the number of images that appear in the **Combine** window, click on one of the following icons on the Tool Bar or, from the **View** menu, select one of the options:

- **One-image** to display a single large image.
- **Four-images** to display four images in a 2x2 format.
- **Number of Images** (**?**) to display a user-set number of images.

The following Dialog Box is displayed:



2 Enter the number of rows and columns or click on the up/down arrows to set the number of images in each dimension.

3 Click OK. The images will now appear in the defined format. (min value = **1**, max value = **8**).

6.7 Operations on images

The following operations can be performed on the combined images:

- Scrolling
- Zoom and Pan
- Windowing
- Display of image parameters
- Saving images
- Filming images or display
- Reset all image parameters to initial values

For detailed instructions refer to the Viewer chapters in volume 2.

All **graphic elements** are available for measuring and annotating features on the images. For details, refer to the Viewer and Graphic chapters in volume 2.

6.8 Image parameters (mAs and slice thickness)

When the original images are contiguous, the mAs and slice thickness of the combined images are calculated and displayed according to their overlap and total coverage.

The mAs are calculated as a function of the spacing/overlap between the original images. For example, if Helix images with a pitch of 0.7 are added, there is an overlap of 1/0.7 between them. The calculated mAs will then be 1.4 x original mAs.

The combined slice thickness is calculated as the totality coverage of the original images. For example, an addition of two slices with an original thickness and spacing of 5 mm will result in a 10 mm thickness for the combined image. If the spacing is only 3 mm, the total thickness will be 8 mm.

7 Test Injection Bolus Timing

The Test Injection Bolus Timing application analyzes time dependent processes, in particular the uptake and dispersion of contrast material with relation to time. Information measured via the application is then used to help identify the delay time and amount of contrast to inject for a clinical scan.

When using a test injection the vessel or organ of interest is scanned with the use of contrast. An axial scan over the area of interest is performed with a cycle time based on the expected rate of enhancement change.

The scan images are then loaded into the Test Injection Bolus Timing application.

ROIs are drawn over the regions whose changes are to be measured. The average pixel values of the ROIs are plotted over time for a graphical description of the time variations.

The Test Injection Bolus Timing application procedure consists of the following steps:

- Inject contrast
- Scan the region of interest in an axial scan with contrast. Set the cycle time of the scan according to the expected contrast movement.
- Open the scan series in the Test Injection Bolus Timing application.
- Draw ROI's and check the results. Manipulate the ROI's until the scan delay and amount of contrast material can be determined.
- These results are then used to set the injection delay and amount of contrast to use in the clinical scan.

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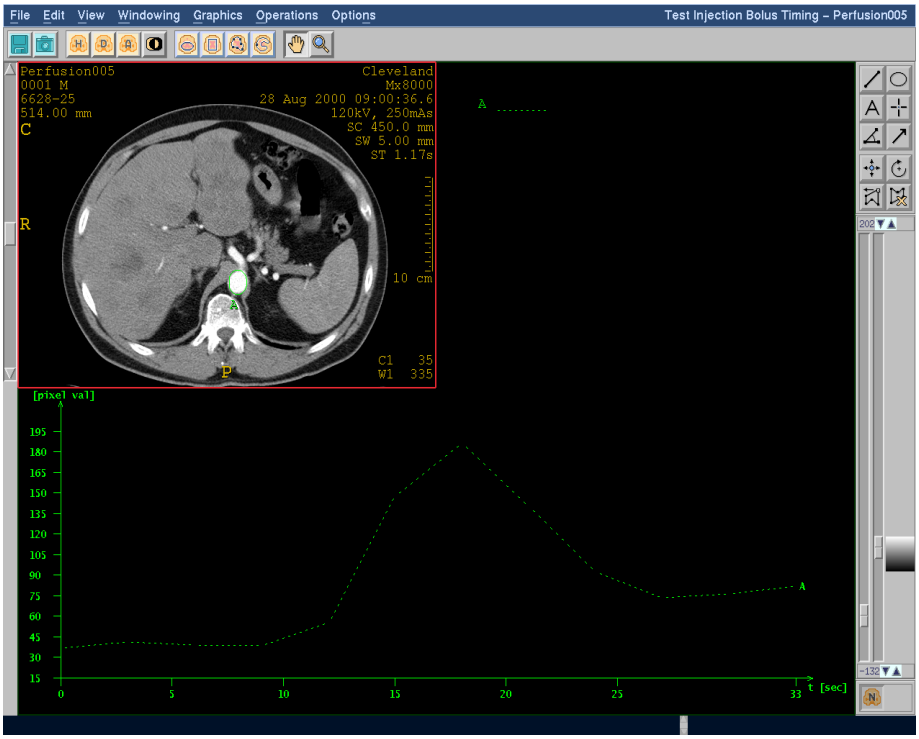
7.1 Test Injection Bolus Timing window



The **Menu Bar** consists of several menu options which when selected display a list of operations that can be performed. These menu options are described below:

- **File** includes all the file management and filming functions.
- **Edit** consists of Reset All, Reset all ROIs, Removing or Restoring graph points, Examining values and Hiding or showing the overlay colors.
- **View** enables you to view the selected graphs in Absolute values or relatively to a Reference image.
- **Windowing** is used to change the brightness and contrast of the images presented. Automatic, Inverse and Normal/ Highlight windowing are available. The preset windowing option is also available, as well as eight different preset values.

- **Graphics** includes activation of the graphical elements and their operations. These are the available graphic elements:
  - **Line** (straight, curve or freehand), **ROI** (oval, rectangular, curve, freehand and sum/subtract options), **Cursor**, **Arrow**, **Text**, **Angle**, **Grid**, **Profile** and **Histogram**.
  - There are also options to change, rotate, delete, copy and paste graphic elements.
- **Operations** consists of Pan and Zoom as well as the option to add ROIs of different shapes.
- **Options** consists of a number of utility options such as hiding or showing Ticks, Text Background or Titles and changing of ROI values. The option of drawing the ROI on each image separately or on all images collectively is also available.

The **Tool Bar** contains the following buttons for activating frequently used functions.

The buttons (from left to right) are:

- **Save** for saving the displayed image.
- **Film** to send the selected images to **Filming** before printing.
- **Highlight** window for marking, in color, the image regions that have pixel values within a user-defined range.
- **Dual Window** for activating the second windowing range in addition to the normal one.
- **Alternate Window** to switch from the normal window to the alternate one and vice versa.
- **Inverse Window** for reversing the gray scale and displaying a negative image.
- **Add Oval ROI** for adding an oval ROI to the image along with graph.
- **Add Rectangular ROI** for adding a rectangular ROI to the image along with graph.

- **Add Freehand ROI** for adding a freehand ROI to the image along with graph.
- **Add Spline ROI** for adding a Spline ROI to the image along with graph.
- **Pan** for moving the image within the window.
- **Zoom** for magnifying and reducing the image.

The **Message Line**, located at the bottom of the screen, displays on-line help and system messages.

The **Tool Box**, located on the right side of the program window contains all the graphical aids for annotating and measuring features on the images. It includes:

- **Line** (straight, curve or freehand) for measurement of features on the images.
- **ROI** oval, rectangular, curve or freehand.
- **Text** for annotating on the images.
- **Cursor** for measurement of the value of image pixels.
- **Angle** for measurement of angles between two image features.
- **Arrow** for pointing to features of interest.
- **Operations** on graphic elements are **Move**, **Rotate**, **Change Shape** and **Delete**.

Note ***Graphic elements are not saved or filmed.***

For detailed operation instructions on the graphic elements, refer to the Viewer and Graphics chapters in volume 2.

Right click on an image to view the shortcut menu; this menu contains commonly used functions and tools. To invoke the pop-up menu, place the pointer on any one of the images and click the right mouse button.

7.2 Manipulating images

7.2.1 Zoom and pan

Zoom is used to magnify or reduce the size of the image.

Pan is used to move the image for centering the feature of interest in the image frame.

Zoom and Pan may be activated by clicking on the **Zoom** or **Pan** buttons on the Tool Bar or by selecting them from the Operations Menu.

To display the feature of interest with the optimal size and centered within the image frame:

1. Select the image or group of images to zoom or pan.
2. Click the Zoom button located on the Tool Bar or from the **Operations** menu choose **Zoom**.
3. The pointer changes to indicate the mode. A text box appears to the right of the Zoom button.
   - To magnify the image, drag the mouse up (a factor up to 10 is available).
   - To reduce the image, drag the mouse down (a factor down to 0.8 is available).
   - To achieve a precise zoom factor, type the desired value in the text box to the right of the Zoom button.
   - To make small changes, click on the up or down arrows to the right of the text box.

Note ***If images with different zoom factors are selected, the zoom value in the text box is colored blue and represents the zoom of the active (red) frame and not of the whole selection.***

4. To reposition the image within its frame, click Pan on the Tool Bar or from the Operations menu, select Pan. The pointer changes. Drag the image in the desired direction.

7.3 Test Injection Bolus Timing measurement procedure

7.3.1 Adding an ROI

1. On the Tool Bar, choose one of the **ROI** buttons, or from the Operations menu select one of the **Add ROI** options.
2. Move the cursor to the location of interest on the image and draw the ROI. The following appears:
   - The ROI is drawn in color and is marked with a letter at the side of its shape.
   - A graph showing the average pixel value as a function of the time appears on the bottom of the screen.
   - The letter and line shape of the ROI appear at the right of the image. (This is the legend of the ROI within the graph).
3. Repeat the procedure for all Regions of Interest on the image.

This application allows up to fifteen different ROIs to be displayed simultaneously.

Note ***Each ROI is assigned a different color and letter.***

7.3.2 Deleting an ROI

1. Click the Delete button in the Graphical Tool Box

   The handles of the ROI elements are revealed.
2. Click on the handle of the ROI to be deleted. The ROI is erased.

7.3.3 Moving an ROI

1 Click the **Move** button in the Graphics Graphical Tool Box or from the Graphics menu select **Operations**; a sub-menu will open.

2 Choose Move. The handles of the ROI elements are revealed.

3 Move the pointer to one of the ROI's handles and drag it to another location.

7.3.4 Changing the shape of an ROI

1 Click on the **Change Shape** button in the Graphics Graphical Tool Box or from the Graphics menu select **Operations**; a sub-menu will open.

2 Choose **Change Shape**. The handles of the ROI elements are revealed.

3 Move the pointer to the handle nearest the side to be changed and drag to achieve the desired shape.

7.3.5 Fitting an ROI on each image individually

Normally, an ROI is common to all images and changing it on one image will change it on each image. However, if corrections are required on part of the images, use the **One Slice** mode in Options.

To correct an ROI on an image, without affecting the other images:

1. From the Options menu, select **ROI Manipulation - One slice**.
2. To change the shape of an ROI which is not properly included inside the region to be measured, use the **Change Shape** and **Move** buttons in the Graphics toolbox. Refer to the Viewer and Graphics chapters in volume 2 for further details.
3. Repeat this procedure for all images with incorrectly placed ROIs.
4. To return to collective manipulation of the ROIs, select **ROI Manipulation - All Slices** from the **Options** menu.

Note ***If any ROI was individually changed and then the All mode was selected, changing the ROI in this mode will change the ROIs on each image relative to its current shape and position.***

7.3.6 Manipulating graphs

Absolute and reference modes

Graphs can be viewed in two modes:

- **Absolute Value** mode—where the points on the graph are absolute pixel values.
- **Reference** mode—where the points on the graph are relative to the current image displayed.

To change the graph display mode, from the **View** menu select the desired mode.

Removing and restoring graph points

To remove graph points:

1. From the Edit menu, select the **Remove Graph Points** option. Handles at each point of each graph are revealed.
2. Click the left mouse button on a handle to be removed. The point is removed from the graph and an updated graph is drawn.

To restore graph points:

1. From the Edit menu, select the **Restore Graph Points** option. The graph is redrawn with all points.

Examining graph values

To view the ROI's average values:

1. From the **Edit** menu, select **Examine Values**.
2. Click the left mouse button at the required point on the graph. A vertical line is drawn and the average pixel value for each ROI, at that point of time, is displayed to the right of the image.

Note ***For graphics and other functions such as Save, Film, and Copy, refer to the Viewer and Graphics chapters in volume 2.***

7.4 Save and film

1 To save the contents of the window, click **Save** on the Tool Bar or select **Save** from the **File** menu.

2 In the dialog box, type a label, if desired.

3 Select the location where you wish to save the images. The whole window is saved as one file.

The contents of the window can be sent to Filming for filming.

Click on the **Film** button on the Tool Bar or select **Film Images** from the **File** menu. The whole window is sent as one frame to Filming.

8 CT Endoscopy

8.1 Overview

CT Endoscopy enables the non-invasive simulation of endoscopic procedures, using reconstructed 2D/3-D CT or MRI data. It is designed for enhanced visualization of internal cavities within the human body.

The application provides the following:

- Volume and surface rendered perspective viewing of internal cavities within the body.
- Pre-endoscopic simulation/planning which can help to reduce complications and shorten procedure times.
- Interactive manual navigation through cavities within the body. This path is constantly recorded and can be used later on for automatic navigation.
- Automatic navigation through a pre-defined path.
- 3-D and 2D measurements and annotations through a wide variety of tools.
- Displays MPR and oblique cuts of your location in multiple planes for enhanced diagnosis. Six planes are available; three are related to the view direction, three are related to the original study orientation.
- Displays your location in a 3-D or MIP Image of the participating tissues.
- Relating between the perspective and the MIP image.
- Ability to pass through the walls of the lumen and view the adjacent tissues.

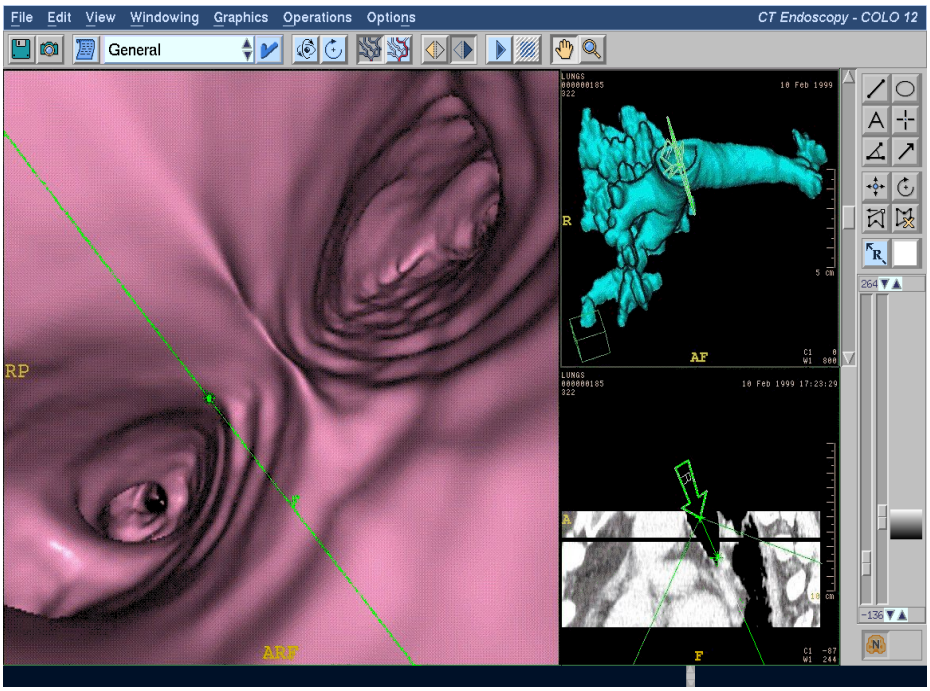
- The CT Endoscopy application can demonstrate the anatomy in two perspective modes, Surface (Shaded Surface Display) or Volume (Volume Rendering):
  - When a 3-D tissue (typical or hollow) is also loaded together with the 2D slices, CT Endoscopy will start in Surface perspective and enable automatic path planning and designate the 3-D as its reference image.
  - Switching to Volume Rendering is possible (View [in the Menu Bar]>Perspective>Volume) keeping both the 3-D reference image and the path in the new perspective.

⚠

Caution

- ***The CT Endoscopy application is not equivalent to conventional invasive endoscopy.***
- ***The CT Endoscopy application is under evaluation. It should not be used as the SOLE incontrovertible basis for clinical diagnosis.***

8.2 CT Endoscopy window



After you have loaded a study for viewing in CT Endoscopy, the application opens to the above window.

- The left side of the screen shows the CT Endoscopy image, as seen from the relate point specified on the 3-D image.
- The top right of the screen shows the selected 3-D tissue.
- The bottom right section of the screen is an MPR window, and shows MPR slices in relevant places of the 3-D image.
- To open a previously defined tissue together with the original series, first select the tissue, hold down the <Ctrl> key, and then select the study. Now open CT Endoscopy from the Application menu.

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The **Menu Bar** consists of several menu options which, when selected, display a list of operations that can be performed.

The menu options are described below:

- **File** includes all the file management and filming functions.
- **Edit** consists of Reset All, Reset of the light source position, the wedge aperture cut and Path. Options to hide, show or change the overlays colors are also available.
- **View** includes the various viewing modes:
  - The MPR slices can be viewed in regular or eye views.
  - The Perspective Mode option lets you choose between a surface rendered image, created from one or more pre-defined tissues, and a volume rendered image, created directly from the volumetric data.

Note ***The surface rendering mode is only available when at least one tissue is loaded, whereas the volume rendering mode is only available when data slices are loaded.***

  - The 3-D display option opens a dialog box where the display parameters can be set. These parameters include enabling tissue display, defining a tissue as hollow, tissue cutting (slicing), switching MPR on or off for each tissue, tissue color and setting transparency on for viewing underlying tissues.
  - Axial, Coronal and Sagittal viewing modes can also be selected. Furthermore, a number of functions can be invoked which include viewing the beginning and end of a path, switching to Cine mode and a Flip Eye option.
  - When switching from Surface to Volume mode, the relevant user interface become active, such as class list viewing and editing and the whole protocol list arranged in a tool box
- **Windowing** is used to change the brightness and contrast of the 3-D tissues, and to change the windowing values on the surfaces of the tissues whose MPR value is switched on.

Inverse, Automatic, Dual and Highlighted windowing are available. There is also an option to set the preset values.

- **Graphics** includes activation of the graphical elements and their operations. The available graphic elements are:
  - **Hide** or show the path and MPR plane on the 3-D image
  - **Line** (straight, curve or freehand)
  - **ROI** (oval, rectangular, curve, freehand, sum, subtract and automatic options)
  - **Cursor, Arrow, Text, Angle, Grid, Profile** and **Histogram**

  There are also options to Move, Change shape, Rotate and Delete graphic elements.
- **Operations** consists of the following options:
  - Pan, Zoom, Swivel and Roll.
  - Go, Stop, Move Forward and Move Backward.
  - In the Cut mode there are additional operations that allow for manipulation of the area to be cut as well as freezing the cut during rotation and swivel of the 3-D image.
  - When a Surface Perspective mode is selected, an automatic path can be drawn using the 3-D tissue. Automatic Path Markers (a, b, etc.) can be marked on the surface which will generate an automatic path in the center of the volume using a certain granularity algorithm (coarse, fine, super fine).
- **Options** consists of the following features:
  - To determine whether the reference image should be MIP or 3-D.
  - To change the image in the main display.
  - To determine Step Size, Illumination Decay, Interactive or Predefined Navigation, Wall Crossing and several utilities

which allow hiding or showing of titles, ticks and text background and changing the ROI values.

The **Tool Bar** contains the following buttons for activating the frequently used functions.

The buttons (from left to right) are:

- **Open Directory** for selecting the tissues and slices as input.
- **Save** for saving the displayed image.
- **Film** for sending the image to the Film Preview prior to printing.
- **Classes List** for manipulating the classes in the current protocol.
- **Protocol Name** displays the name of the current protocol and allows browsing through the available protocols.
- **Protocol Name "Check"** for loading the current protocol displayed in the protocol name field.
- **Rotate** for rotating the SSD 3-D or CT Endoscopy image in any direction.
- **Roll** for rotating the image in the screen plane.
- **Interactive Navigation** for mouse-controlled movement.
- **Predefined Navigation** for automatic movement along a previously traversed path.
- **Backward** for viewing a path in reverse.
- **Forward** for viewing a path in forward motion.
- **Go** for starting to move along a path.
- **Stop** for stopping a movement along a path.
- **AutoPath Marker** activates marker points on the surface for the AutoPath calculation. (Available only when the data set includes at least one tissue).

- **AutoPath "Check"** for calculating the AutoPath on the surface. (Available only when the data set includes at least one tissue).
- **Pan** for moving the image within the window.
- **Zoom** for magnifying and reducing the image.

The **Message Line**, located at the bottom of the screen, displays on-line help and system messages.

The **Tool Box** on the right side of the program window contains the graphical aids for annotating and measuring features on the images. It includes:

- **Line** (straight, curve or freehand) for length measurement between two points on an MPR image, a tissue or a perspective image. Curve and Freehand type lines can only be applied on an MPR image.

  When measuring a distance on the volume rendered perspective image, the distance will only be displayed when the line end-points lie on data points which are sufficiently opaque so that no ambiguity exists regarding the depth of these points.

- **Angle** for measuring an angle on the 3-D, MPR or perspective image.

  As with the distance measurement, when measuring an angle on the volume rendered perspective image, the angle value will only be displayed if all three points defining the angle lie on data points which are sufficiently opaque so that no ambiguity exists regarding the depth of these points.

- **Text** for annotating on the images.
- **Arrow** for pointing to features of interest.

- **Relate Point** enables the user to change the point of view of the perspective image by clicking on the 3-D, MIP or MPR reference images.

  This is particularly useful for defining a starting point from which navigation on the perspective image is to begin.

- **Operations** on graphic elements are: **Move**, **Rotate**, **Change Shape** and **Delete**.

Notes

- ***The length of the Line is measured between points on the 3-D surface, along the straight line connecting them (and not "crawling" on the 3-D surface).***
- ***The Angle is measured on the 3-D surface at the point on which the vertex lies on it.***
- ***When measuring on the 3-D image, if the end points of the line or the vertex of the angle are not on a tissue surface, the length or angle will not be displayed.***
- ***Transparent tissues are disregarded when pointed on; instead, the measurements are performed on the non-transparent tissues behind them.***
- ***All graphic elements are erased when the image is rotated or rolled.***
- ***Graphic elements are not saved or filmed.***

Important Note

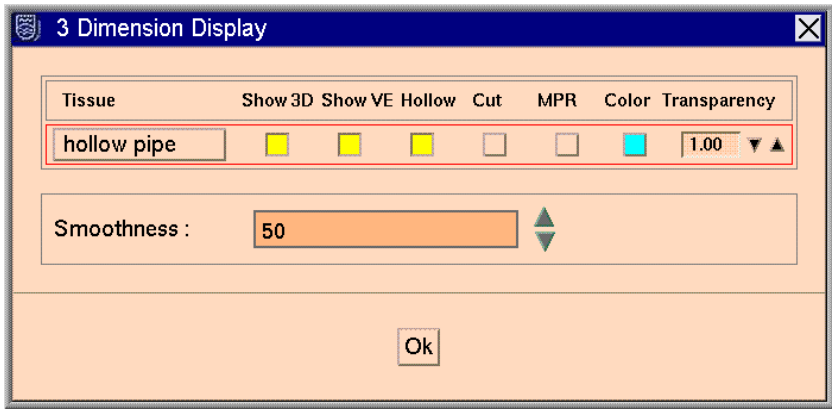
When performing distance or angle measurements on the CT Endoscopy image in Volume Rendering mode, it is important to understand which point along the ray defined by the mouse pointer is taken for the distance measurement. Precautions were taken to avoid measurement when the depth of this point is not clearly defined. The measurement is considered well defined if the position pointed to has an opacity of at least 0.95, and there are no classes more opaque than it between it and the viewing eye. When the measurement is not well defined, no distance or angle values will appear.

For detailed operation instructions of the graphic elements, refer to the Viewer and Graphics chapters in volume 2.

8.3 Display settings

8.3.1 3-D image

The 3-D window displays a MIP or 3-D image created from the tissues loaded into the application. These tissues may be manipulated through the 3-D Display dialog box (shown below).



See the Shaded Surface Display 3-D chapter in volume 3 for details about the 3-D Display dialog box.

The following graphic elements overlay the 3-D image:

- An arrow indicating the orientation and direction of the path being defined. On the sides of the arrow are **R** and **L** characters, indicating the **R**ight and **L**eft orientations.
- The path that has been traversed in this session.
- A rectangular plane (MPR plane) which correlates to the MPR image currently being displayed in the MPR window

8.3.2 The Position Indicator

The Position Indicator is a graphic element which appears on the CT Endoscopy and MPR images, and provides a means for identifying a single position on both images. Since the Indicator is one, but appears on both images, manually changing its position on one image automatically and interactively causes its position on the other image to change to correspond to the new position.

On the CT Endoscopy image, the Indicator can only be moved along the line depicting the intersection of the MPR plane and the CT Endoscopy image.

On the MPR image, the Indicator can be moved freely, although moving it outside the Field-of-View (marked on the MPR image by two rays emanating from the viewing position) causes its counterpart to disappear altogether from the CT Endoscopy image.

8.3.3 Relate point

The Relate Point function provides a means of setting a new point of view for the perspective image. This is particularly useful for defining a starting point from which navigation on the perspective image is to begin.

To select a new viewing point:

1. If the reference image used for the Relate Point operation is the 3-D or MIP image, rotate the image so that the entry point is at the front and approximately in the desired penetration direction.

   If the reference image used for the Relate Point operation is the MPR image, use the MPR image scrollbar to locate a desired new position.

2. Zoom in on a small portion of the image, if necessary, to help discern small details.
3. In the Graphics Tool box, click the **Relate Point** button.
4. Click on the desired point on the reference image. The MPR

plane and the arrow showing the exact starting point move to this point. The CT Endoscopy window displays the new perspective image at this point.

Note ***When using Relate Point from a 3-D or MIP reference image, the new viewing direction is perpendicular to the plane of the screen relative to that image.***
When using Relate Point from an MPR reference image, the viewing direction remains unaltered, and only the viewing position is changed

8.3.4 Hiding the MPR relate plane

The Relate Plane describes the MPR image currently being displayed in the MPR window.

You may hide or show the relate plane on the 3-D image by clicking on the Graphics menu and selecting the **MPR plane** option. This is a toggle button and will toggle the state of the plane on the 3-D image.

8.3.5 Hiding a path

During manual navigation, a curve is drawn on the 3-D image indicating the path which has already been traversed. In the Predefined mode, the entire curve is displayed in the 3-D image.

You may hide or show the path on the 3-D image, by clicking in the Graphics menu on **CT Endoscopy Display options** and selecting the **Path** option. This is a toggle button which toggles the state of the path on the 3-D image.

8.3.6 Selecting a reference image

The **3-D** window can display a MIP image created from the tissues loaded into the application.

To change the reference image:

1. From the Options menu, select the **Reference Image** option.
2. From the sub-menu, select **MIP** or **3-D** depending on the type of image you would like to display in the 3-D window.

Note ***Operations on the MIP image are identical to those on the 3-D image (except for Cut).***

8.3.7 Changing the main display

You can display the CT Endoscopy image, the 3-D image or the MPR image in the Main Display window. The other images are displayed in the reference windows to the right of the main window display.

To change the image that is displayed in the Main Display window:

1. From the Options menu, select the **Main Display** option. A sub-menu opens up displaying the three options available (3-D, MPR or CT Endoscopy).
2. Choose the desired option. This image is displayed in the Main window and the others are displayed in the reference windows.

8.4 Operations on the CT Endoscopy image

The CT Endoscopy image is a perspective view of the volume of data loaded into the application. The image is calculated from any arbitrary point inside or outside the body and from any viewing direction desired.

8.4.1 Interactive navigation

When invoking the application, the following default modes are activated:

- Interactive navigation
- Forward direction
- Stop (no advance)

To navigate, proceed as follows:

1 Select **Wall Crossing** from the **Options** menu. This permits the navigation to move into the colon.

Note ***After navigating into the colon, de-select Wall Crossing from the Options menu.***

2 Rotate the 3-D image so that the entry point is at the front and approximately in the desired penetration direction.

3 Zoom the 3-D image to clearly view the beginning point.

4 In the Graphics Tool box, click the **Relate Point** button.

5 Click on the desired location on the 3-D image. The MPR plane and the arrow showing the exact starting point move to this location. The CT Endoscopy window displays the CT Endoscopy image at this point.

6 From the Tool Bar, click Play, or select the **Go** option from the **Operations** menu. The pointer changes to an up arrow.

7 To move and advance in the CT Endoscopy image, place the arrow on the desired point, click and hold the left mouse button. Keep the button pressed as long as movement is

required.

8 On the 3-D image, the arrow and relate plane move accordingly, and the path of the movement is being drawn.

9 To retrace the path, click the **Backward** direction button on the Tool Bar and then click **Go**. The pointer changes to a down arrow.

10 To retrace, click and hold the left mouse button. Keep the mouse button pressed as long as movement is required.

8.4.2 Rotate (swivel)

The CT Endoscopy image can be swiveled at any point during the navigation.

1 Click the **Rotate** button, or from the Operations menu, select **Swivel**. The pointer shape changes to indicate Rotate mode.

2 Drag the mouse in the desired direction of rotation.

8.4.3 Roll

The CT Endoscopy image can be rolled at any point during the navigation.

1 Click on the **Roll** button, or from the Operations menu, select **Roll**. The pointer changes to indicate Roll mode.

- To roll the image clockwise, drag the mouse to the right.
- To roll the image counter clockwise, drag the mouse to the left.

Note ***To resume the fly-through click Play.***

8.5 Operations on 3-D image

All operations on 3-D image (such as, pan, swivel, roll, zoom, graphic features, cutting, changing tissue colors and transparency) are identical to those operations in the Shaded Surface Display 3-D application (see the SSD 3D chapter in volume 3 for detailed instructions).

The 3-D graphic options may also be activated from a popup menu by clicking on the right mouse button.

8.6 Operations on the MPR image

The MPR window displays a real-time calculated MPR image passing through the current viewing position. The orientation of this plane in space is visible as the MPR plane graphic element on the 3-D image.

A scrollbar next to the image allows showing the planes which are parallel to the current location of the eye. The scrollbar is scaled in such a way that moving it from one end to the other covers the entire volume of the data.

After scrolling the MPR image, use Edit->Reset->MPR Slider to return the scrollbar to its original position.

8.6.1 Viewing

The orientation of the MPR plane in space is determined in two ways, **Automatic or Manual**.

Automatic Viewing:

Whenever the viewing point or direction is changed (causing a change in the CT Endoscopy image), the MPR plane is determined anew according to one of six options: Axial, Coronal or Sagittal, with each of those three being either relative to the patient (in which case they have their regular meaning), or relative to the viewing direction (virtual eye).

To change the MPR plane:

1. From the View menu, select the MPR option.
2. Choose the desired plane from the six options that appear in the sub-menu (Axial, Coronal, Sagittal, Eye Axial, Eye Coronal, Eye Sagittal).

   The Relate Plane rectangle on the 3-D image changes to show the new viewing plane and the new calculated MPR image is displayed in the MPR window.

Manual Viewing

If the plane resulting from the automatically determined plane is visible (at least in part) within the field of view, it is visible on the CT Endoscopy image as a line crossing the image. This line represents the projection of the MPR plane on the CT Endoscopy image.

When choosing the "MOVE" or "MOVE VERTEX" graphic modes, two vertices appear along the line, enabling it in a manner similar to a regular line. This enables a manual manipulation of the MPR plane orientation.

Changing the MPR line causes the MPR image to update interactively as the line is manipulated, thus providing an invaluable tool for enhancing the understanding of the CT Endoscopy image.

Note ***The MPR image is calculated from the images loaded into the application, therefore full resolution and coverage are achieved only if all original images were loaded.***

8.6.2 Other operations

All other operations on the MPR image (Pan, Zoom, Graphics, Windowing) are identical to those operations available in the MPR application (see the Multi-planar reformatting chapter in volume 3 for detailed instructions).

8.7 Predefined navigation

This option enables you to play a predefined path. You may load a prepared path from the Directory, or you can prepare a path in the Interactive Navigation mode, and then play it in the Predefined mode.

1. Load a series with its defined colon tissue and with the Path file if it exists.
2. Select the **Predefined** option in the **Navigation** sub-menu from the **Options** menu, or click the button on the Toolbar.
3. Click **AutoPath Marker** button.
4. On the 3-D tissue image mark the seed points to define the path to observe; two points are enough.
5. Click the **AutoPath Check** button to calculate and display the colon from the first seed point.
6. Click **Forward** to view the images along the path defined.

8.7.1 Operations on a path

Movement

Go, Stop, Forward and Backward options are available to change the movement along a path. Any one of these options can be selected by pressing its button in the Tool Bar, or by selecting the desired option from the Operations menu.

Wall crossing

In the default mode crossing tissue walls during movement is enabled.

To avoid penetrating tissue walls, select the **Wall Crossing** option from the Options menu.

Illumination decay

After you have saved the 3-D tissue and loaded it into the application, this option controls the shading elements that are farther away on the CT Endoscopy image. The preset value is 1.00.

To change the illumination select the **Illumination Decay** option from the Options menu. The illumination ranges from 0.00 to 10.00; the smaller the number, the farther the apparent illumination extends.

Step size

This option determines the step sizes while moving along a path. The preset value is 2 mm.

To change the preset value select the **Step Size** option from the Options menu. The size ranges from 0.00 to 20.00 mm.

8.7.2 Viewing

The CT Endoscopy image can be viewed in the Axial, Coronal or Sagittal modes. Before selecting a viewing mode from the View menu, ensure that the CT Endoscopy image frame is highlighted.

- **3-D Display** enables you to hide or show tissues on the CT Endoscopy image and to change their color. For detailed instructions on 3-D display operation see the Shaded Surface Display 3-D chapter in volume 3.
- **Flip Eye** enables the user to turn the viewing point by 180 degrees. To select this option, choose the **Flip Eye** option from the View menu.
- **Path** - If a path has been defined and the **Predefined Navigation** option has been selected, it is possible to view the beginning or end points of the path by choosing the desired option from the View menu.

8.7.3 Cine Display

To display the CT Endoscopy path as an animated fly-through, proceed as follows:

1 Select Cine from the View menu. The toolbar will change, showing new Cine buttons and a speed control box. The display will cycle slowly, preparing one image at a time, and will then stop.

2 To start the cine display, click on the Play button in the Tool Bar. The CT Endoscopy fly-through will begin displaying.

3 To change the rate at which the images are displayed, change the rate on the speed control box.

4 To return to the normal Operation mode, click on the Exit button.

For detailed Cine operation, refer to the Viewer chapters in volume 2.

8.7.4 Save to AVI Movie

Note ***The Save Movie and Play Movie functions are described in more detail in the Viewer chapters in volume 2.***

The Cine sequence you set up according to the previous procedure can be saved as an AVI movie. The movie will be saved at the current speed, windowing, and size.

1. Click the Save to Movie button on the toolbar.
2. The Save Movie dialog box appears and you are prompted to type a movie name.
3. Type in the name and click Ok. The movie name cannot include blank spaces.

   The movie will be saved by the following path:
   D:\Movies\[application name]\movie_title.avi
   where the application name is this current application.

   Before the movie can be saved you must play the movie; after it is played the movie will be saved.
4. Click **Play**. The fly-through begins. At the end of the path, the movie is saved.

8.7.5 Play Last AVI Movie

You can play the last movie you saved. (Refer to the Viewer chapters in volume 2 for more details.)

1. Click the Play Movie button on toolbar.
2. The MicroSoft Windows Media Player application will be opened.
3. By default, the last movie you saved will be opened and will begin to play automatically.

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8.8 Save and film images

To save one of the three images in the window:

1 Click on the image to be saved. It is enclosed in a red frame.

Note ***Clicking on the CT Endoscopy image with the Advance button on the Toolbar pressed will move the viewpoint. To avoid this, click on the Rotate (Swivel) button first.***

2 Click the **Save** button on the Tool bar, or from the File menu select **Save image**.

3 In the dialog box, type a label, if desired.

4 Select the location where you wish to save the images. The image is saved as a separate file.

To send to Filming one of the three images in the window:

1 Click on the image to be filmed. It is now enclosed in a red frame.

Note ***Clicking on the CT Endoscopy image with the Advance button on the Toolbar pressed will move the viewpoint. To avoid this, click on the Rotate (Swivel) button first.***

2 Click the **Film** button on the Toolbar or from the File menu select **Film image**. The image enclosed in the red frame is sent to Filming.

8.9 Save path

For reviewing the CT Endoscopy case in Predefined Navigation mode at a later date, the defined path may be saved.

1. In the **File** menu, select **Save Path**.
2. In the dialog box, type a label, if desired.
3. Select the location where you wish to save the path. The path is saved as a separate file.

Note ***When the CT Endoscopy case is selected at a later date for reviewing, make sure to add the Path file to the selection in the Directory.***

8.9 Save path

9 Shaded surface display 3-D

9.1 Overview

The **Shaded Surface Display 3-D** (**SSD 3-D**) application uses a series of pre-defined three-dimensional tissues and two-dimensional slices to reconstruct 3-D images of user-selected organs or tissues. The SSD 3-D allows you to:

- Define new tissues and redefine old tissues.
- Activate real-time rotation and magnification of a 3-D image for viewing the internal anatomy of patients in its most natural appearance.
- Perform real-time cutting of a user-adjustable aperture on the 3-D image.
- Superimpose MPR/oblique images on the cutting aperture.
- Correlate features of the 3-D image with those of the originally acquired images.

9.2 Starting the SSD 3-D application

Use the following procedure to begin work with SSD 3-D.

You may open a study and create new tissue definitions, or you may open a study in conjunction with previously defined tissues.

1. Click Directory (if the Directory is not already open). (Refer to the Directory chapter in volume 1 for details about accessing patient studies.)
2. Select a study from the Patient list.
3. Select the series to open from the Series List.

   -- or --

4. To open a previously defined tissue together with the original series:
   - Select the tissue
   - Holding down the <Ctrl> key, select the study.
5. Select the SSD 3D application from the Application menu

Note

- ***When a series is opened without a saved tissue, the SSD 3D Tissue definition window opens.***
- ***If a saved tissue was selected with its original image series, the SSD 3D window appears with the selected series.***

9.2.1 Loading tissues from different series

Tissues can be loaded from different series of the same patient.

- When a patient is scanned in both CT and MRI modalities, you can use the CT/MR Image Fusion application to reformat both scans to have the same orientation, position, slice thickness, etc. The reformatted series (either CT or MRI) can then be loaded into this SSD 3-D application, where tissues can be defined using the reformatted slices.
- You can simultaneously load original slices from one series within the study, and tissues from a different series.

When loading tissues from different series, note the following:

- If tissues from several series within the same study are selected, make sure that these tissues are accurately aligned. This is done by either scanning in the same position or through registration.
- Redefining a saved tissue must be done by loading the original set of images used to create the tissue.
- Images constructed from more than one series are marked as **Multi Series** within the image frame and on film.
- The spacing between the images should be the same. Some missing images are tolerated.
- The reconstruction matrix, zoom and pan parameters of all images should be the same.
- The orientation (tilt and swivel angles) should be the same for all images

Pop-up menu - Right click on an image to view the pop-up shortcut menu. This menu contains commonly used image functions and tools.

9.3 Tissue definition work stage

When a series is opened without a saved tissue, the SSD 3D Tissue definition window opens. Tissue Definition is used to define tissues for displaying 3D images. There are two methods of tissue definition:

- The **Threshold** method.
- The **Small Volume Assessment** method.

Note ***To access Small Volume Assessment, from the Options menu select Segmentation Tools, then select Small Volume Assessment.***

The tools available for these two methods vary slightly, depending on which method you are using.

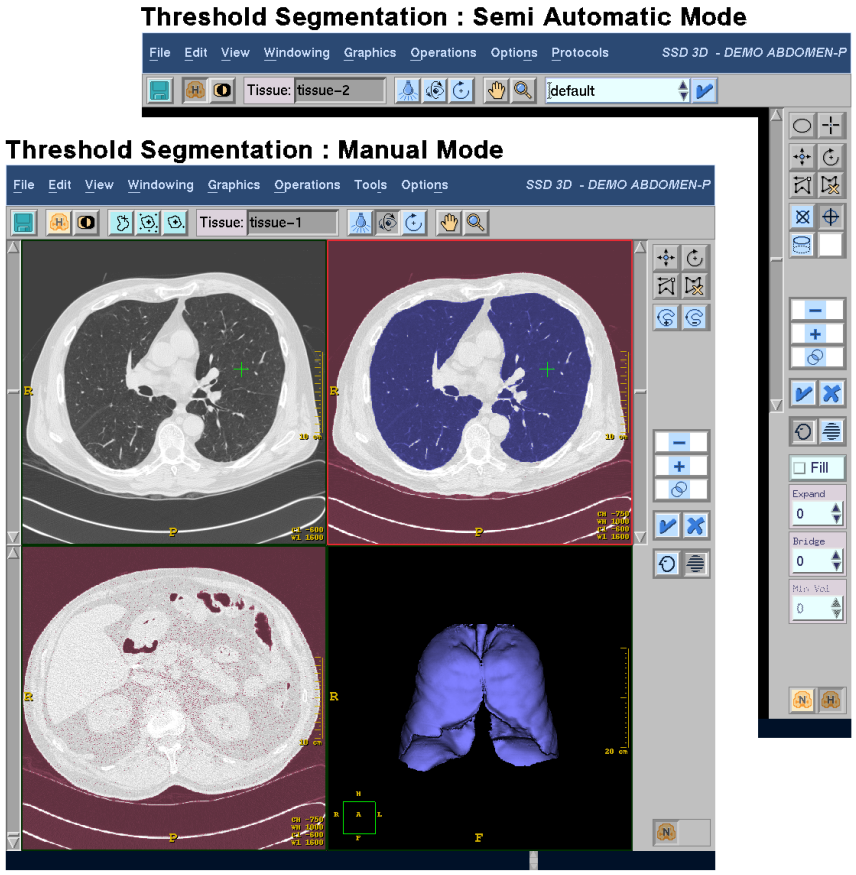
Also, within each of the above tissue definition methods, there are two modes of operation:

- **Semi-Automatic Volume Definition** - This mode is used when the desired tissue has CT values significantly different from the surrounding tissues (such as blood vessels with contrast, bones and skin). The tissue is defined by setting the highlight window. If the automatic tools are not successful, or the results are not satisfactory, you can define tissues manually, slice by slice.

- **Manual Contour Drawing** - The desired tissue contour may be defined by drawing freehand ROIs on a slice-by-slice basis. The manual mode may also be used to correct tissues defined in the semi-automatic mode.
  - All slices are defined together.
  - The covered volume may be limited by ROI.
  - Part of the highlighted tissue may be separated by "seed" planting and other tools, if it is connected throughout the volume and does not touch the other parts.

Note ***Manual changes are incremental. That is, the current change is performed on the results of the previous change. This is unlike the Semi-Automatic mode, where the tissue is calculated from scratch each time a change is made.***

9.4 Tissue definition by threshold.



Semi Automatic and Manual Modes

Two modes of Threshold segmentation are available, semi automatic and manual.

In the **semi automatic mode**, the protocol selection is available in the tool bar as well as the Check button to display the 3D view. The tool box has tools for seeding and fine tuning tissues.

In the **manual mode**, protocols are not available. Three Q-CTA tools are available (either from the tool bar or the Tools menu).

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Also in the manual mode, fine tuning tools for tissue are not available, while two ROI drawing tools are provided.

The window is divided into 4 quarters: The 2 upper frames contain the mid-slice of the study. The lower-left frame shows the bottom slice. The upper frames are scrolled simultaneously but show the same slice with and without highlight window.

Note ***Accumulation is blue before clicking Accept Tissue Selection (check mark) button.***

Any protocol can be selected from the protocols list and modified according to the following parameters in the Tissue Definition stage:

- Highlight Center & Width
- Tissue Quality (fast, high, extra-fine)
- Fill
- Bridge
- Expand/Erode value and type
- Min Volume

Tissue name - The name of the tissue is in the text box in the center of the Tool Bar. You can change this name by clicking on it and typing in a new name.

9.4.1 Menu bars in threshold mode

Semi automatic 

Manual 

File includes save tissue or exit.

Edit consists of Reset all, which reverts the image to its former position, zoom and window before manipulation. It also includes reset of Seed, Outside Points, VOI (Volume Of Interest), Current Tissue, Orientation and Light. Overlay color may be changed to monochrome or temporarily hidden.

View includes setting of the 3D image orientation to Axial, Coronal or Sagittal, and Define Tissue and Tissue Volume

functions. setting the tissue quality (Fast, High, and Extra-Fine), and also its volume.

Windowing consists of the windowing functions, preset windows and the Set Preset window utility. In the Semi-Automatic mode, the Highlight window is active; while in the Manual mode, the Highlight window is inactive.

Graphics consists of some of the common graphical tools (ROI and cursor measurements) plus the tissue definition aids: oval, curved and rectangle VOI for limiting the volume to be included in the tissue, Seed and Outside Points for further delimiting the connected region.

Operations consists of the Zoom, Pan, Light position, Swivel (rotate) and Roll manipulations.

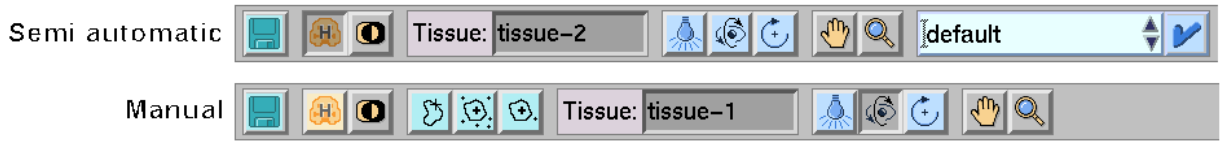
Tools (a menu option in the small volume assessment mode) contains the contour tools.

Options consists of Expand/Erode of the highlighted region in either 2D or 3D, and setting the selective display of ROI values.

Note ***In the semi automatic mode, the Options menu also allows you to select either the Threshold or the Small Volume Assessment segmentation method.***

Protocols contains a list the preset protocols for defining the current tissue, and allows deleting or modifying any protocol on the list.

9.4.2 Tool bars in threshold mode



Save for saving the displayed image.

Highlight window for marking, in color, image regions which have pixel values within a user-defined range.

Inverse window for reversing the gray scale and displaying a negative image.

Q-CTA tools for semi-automatic assessment (Auto Contour, Flexi Contour, and Edge Finder. Refer to the Q-CTA chapter in volume 4 for details for use.)

Tissue for displaying the current tissue selection name. To change the name click in the box and type the new name.

Move Light Source to change the light shadow direction.

Rotate for rotating the 3-D image in any direction.

Roll for rotating the image in the screen plane.

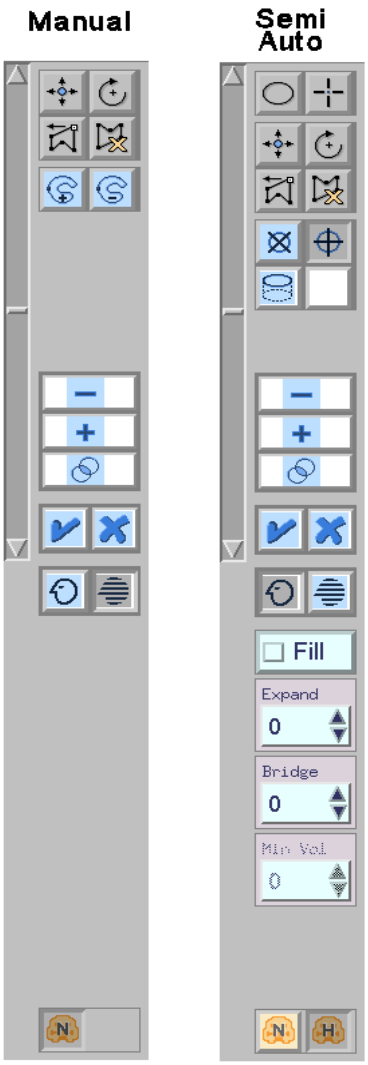
Pan for moving the image within the window.

Zoom for magnifying and reducing the image.

Protocol selection to change the displayed tissue selection protocol.

Check to accept tissue accumulation and open the 3-D viewer.

9.4.3 Threshold tool boxes



The Tool Box, located to the right of the window, consists of some graphical tools (ROI and cursor measurements) and tissue definition aids.

Click **Define Seed** and click an area to add the tissue area to the current tissue accumulation.

Click **Define Outside Points** and click an area to remove the tissue area from the accumulation.

Draw a **VOI** around a tissue to add or remove from the accumulation.Right-mouse click to access all VOI tools.

Add Freehand ROI to add tissue parts.

Remove Freehand ROI to remove tissue parts.

Move the VOI over the tissue

Rotate the VOI

Adjust the VOI.

Delete part or all of the drawn VOI

Add a tissue that has been successfully defined to the accumulation.

Subtract the defined tissue from the accumulation.

To remove a selection from a seeded tissue, draw an ROI over the area, click **Mask Accumulation**. The overlapping area remains in the accumulation

Accept the tissue and insert into the tissue list.

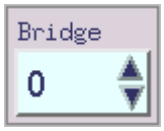
Reject the tissue and reset the segmentation screen.

This button activates the **Semi Automatic** mode.

This button activates the **Manual** mode.

To prevent holes inside the tissue, click **Fill**.

If a seeded tissue has bridged areas, the bridge can be removed by increasing the value of the **bridge**.



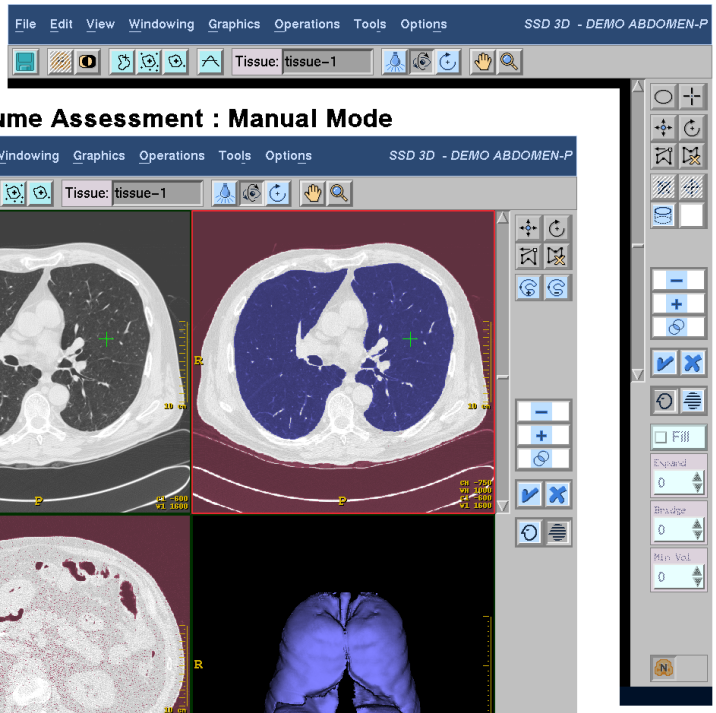
To cover the borders of the tissue that have pixel values different than the Highlight window due to partial volume effects, increase the size of the blue region by increasing the **Expand** value. A negative value will have an opposite effect. Note that the tissue volume is then not well-covered and not true to size.

To decrease small unnecessary inclusions increase the **Min Vol**.

9.5 Tissue definition by small volume assessment

Small Volume Assessment provides better assessment of small volume objects. This gives a more precise and repeatable definition of small tissues that have a higher Hounsfield Unit than their background (for example, nodules).

Small Volume Assessment : Semi Automatic Mode



Small Volume Assessment : Manual Mode

Note ***To access Small Volume Assessment: from the Options menu select Segmentation Tools, then select Small Volume Assessment.***

Semi Automatic and Manual Modes

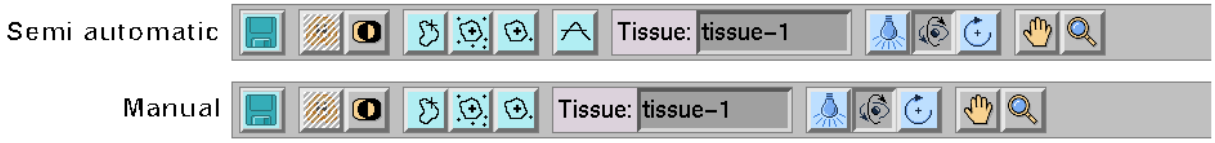
As with the Threshold mode, there are two modes of Small Volume Assessment segmentation, semi automatic and manual.

Refer to description of these modes in the Threshold section, earlier

9.5.1 Menu bar in small volume assessment mode

The menu bar is the same as in the Threshold manual mode, described earlier.

9.5.2 Tool bars in small volume assessment mode.

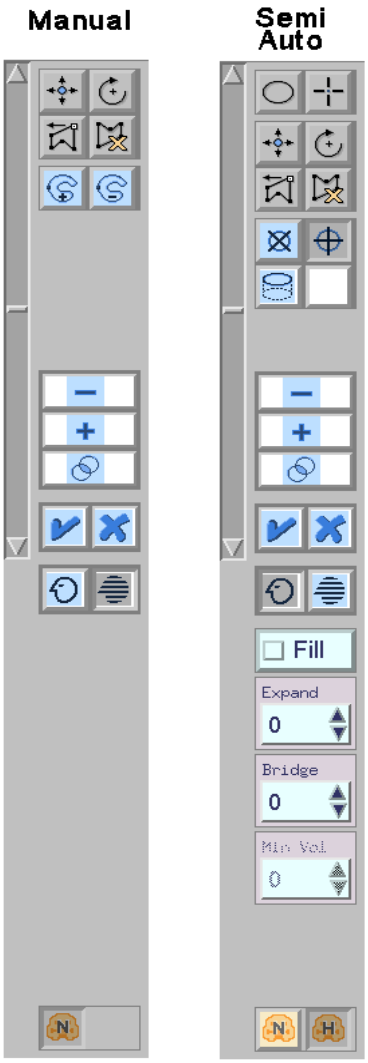


The tool bars in small volume assessment are very similar to the ones in threshold mode described earlier; refer to that section for tool descriptions.

In the semi automatic mode, a fourth Q-CTA tool is added, FWHM. Refer to the Q-CTA chapter in volume 4 for details about using this tool.

9.5.3 Small volume assessment tool boxes

The tool boxes are the same as in the Threshold mode described earlier; refer to that section for tool descriptions.



9.6 Semi automatic tissue definition

When the desired tissue has CT values significantly different than the surrounding tissues (such as bones, skin and blood vessels with contrast), the tissue is defined by setting the highlight window.

- All slices are defined together.
- The covered volume may be changed through the use of VOI (rectangular, circular or curved).
- Defining a seed tissue may separate parts of the highlighted tissue.

In this mode you adjust the highlight window until the desired tissue in the 2D images is overlaid by the highlight color.

9.6.1 Using mouse manipulations for windowing

1. Drag the mouse up and down with the middle button pressed to change the center of the range of pixel values that are included in the tissue.
2. Drag the mouse left and right to change the range width.

   After a delay, a tissue accumulation will be displayed at the bottom right. The highlight on the slice images will be blue.
3. To adjust the accumulation, drag the mouse to change the Highlight - the tissue accumulation will automatically be updated.

Notes

- ***Use the top right and bottom left images to adjust the tissue highlighting.***
- ***Use the top left image to adjust the brightness and contrast.***

9.6.2 To view the tissue

1 Click the middle mouse button

2 Drag the mouse. When you let go of the mouse button the 3D image appears

-- or --

3 Select a protocol and click the check button next to the protocol name on the tool bar (not in the toolbox). The 3D image appears.

Note ***As long as the defined tissue is blue it may be edited. After clicking the Check button in the toolbox to accept the tissue, any changes to the tissue must be done by redefining the tissue (accessed through the edit menu).***

9.6.3 Using the preset values in the Protocol menu

1 From the Protocol menu select a protocol.

The highlight on the slice images will change color to blue. The 3D image (blue in color) of the tissue accumulation appears in the bottom right image area.

9.6.4 Defining tissue by seed

To define one tissue separately from other tissues with the same pixel values, use the seed method.

In this method, a seed point is marked by a cursor on the desired tissue and all the pixels within the highlight range connected to it on all slices are included in the tissue definition.

If two different tissues are not touching

1 To mark the tissue, select Define seed from the Graphics menu or click the Seed icon from the tool box.

2 Click inside the desired tissue on any slice in the upper right image. The connected pixels within the highlight range on

all slices are colored blue and the resulting 3-D image (blue in color) of the tissue accumulation is displayed.

- To add the tissue to the current tissue click Add to Accumulation (+). The 3D image turns Red in color.
- To subtract the tissue from the accumulation click (-). The tissue is deleted from the accumulation.

3 To select another seed point, click on an area in one of the two highlighted images. The new tissue selection appears in blue in the 3D tissue accumulation area.

4 Click the Add (+) or Subtract (-) to make the accumulation correction.

If two different tissues touch

If two different tissues touch, the accumulation will include both. To separate the tissues:

1 Click Define outside point.

2 Adjust the highlight level and click on the unwanted area. An X appears on the designated point.

3 Click the + to accept the tissue accumulation change.

4 To add another outside point, click on another area. The number of outside points is unlimited (as opposed to the seed point which is only one).

Moving or deleting an existing outside point is done using the standard tools in the Tool Box.

Note ***It is good practice to place the seed and outside point as far as possible from the edges of the tissue. To visualize the overall tissue structure, you should leaf through the slices before picking a point.***

5 To erase one of the outside points, click the Delete graphic button and then click on the X to be deleted.

6 To erase the seed and all the outside points, select the Delete Graphics tool and click on each seed mark (+) to delete it, or from the Edit menu select Reset and then from the sub-

menu click Seed, Outside Points.

7 If the desired tissue is connected to many other tissues, increase the value in the Bridge text box until achieving the wanted result. This operation will disconnect the tissues that are connected by a narrow bridge (i.e. when only a few pixels of the two tissues are touching).

8 If a seed point is not defined, you can remove small connected areas floating around the tissue by increasing the value in the Min-Vol box located in the Tool Box.

9 To prevent "holes" inside the tissue, check the Fill button in the Tool Box.

10 To cover the borders of the tissue that have different pixel values than the Highlight window due to partial volume effects, increase the Tissue Definition size of the blue region by increasing the value in the Expand box from the Tool Box. A negative value will have an opposite effect. Please note that the tissue volume is then not well-covered and not true to size.

9.6.5 Limiting the tissue volume using a VOI

To better separate a tissue from its surroundings you can choose to limit the tissue accumulation within a Volume of Interest (VOI). A VOI is a 3 dimensional volume (between more than one slice). The system interpolates a ROI drawn on one slice to create a VOI. If another ROI is drawn on a different slice, the system interpolates and smoothens the transition from one ROI to the next ROI.

Note ***Only one ROI may exist per slice.***

Create a VOI

1 Delimit the VOI by one of three ROI types: Oval, Rectangle, or Freehand.

2 Draw the ROI on a highlighted image so that it forms a boundary around the tissue area to exclude.

3 Leaf through the images containing the tissue. Note that the ROI you have defined is copied onto each slice, but its color is violet (indicating an Interpolated VOI).

4 If the outcome is not satisfactory, that is, if the VOI is not providing sufficient separation of the tissue from its surroundings, you may modify the VOI.

When delimiting a VOI with the freehand ROI, corrections may be made to the ROI:

1 Leaf to the slice where a correction must be made.

2 Press shift and drag the mouse between two points on the freehand ROI.

3 The ROI on the outside of the new contour is deleted and the new contour line is used as the ROI boundary. The system interpolates the new VOI.

To redefine the VOI to extent only through certain slices

1 Leaf to the slice above/below the last slice to contain the VOI

2 Select the Delete Graphic tool.

3 Click the VOI handle. The VOI above/below the current slice is deleted and the 3D image is updated.

To redefine the VOI

1 Leaf to the slice where the VOI must be modified.
- If a freehand ROI was used and must be modified press shift and redraw the new contour line.
- If a circle or rectangle was used draw a new ROI.

2 The new ROI line is interpolated through the slices, to the last image of the series.

3 Continue to leaf through the slices making corrections until

the VOI is correctly defined.

Note ***After any reshaping, the ROI changes to a user defined ROI, indicated by its color changing to green. To delete a user defined ROI, its color changes from green to purple.***

Note ***Changes to the VOI may be performed only while the tissue appears in blue (before the tissue definition has been added/subtracted or accepted).***

4 After completing the VOI click - or + to add or subtract from the tissue accumulation.

9.6.6 Accumulating a tissue

If the tissue is made from several disconnected parts, or from parts that have different pixel values, or that may be better defined by several tissues, then each part may be defined separately, as follows:

1 After you define the first part of the tissue (see earlier procedure), click Add to accumulation in order to apply it on the volume and to be able to save it.

2 You can add more parts to that tissue by defining those parts using the same tools, and again clicking Add to accumulation.

3 To remove the tissue from the volume, click Subtract from accumulation.

9.6.7 Accept or Cancel

After defining the tissue, if you want it to be available on the volume outside the segmentation tab, click **Accept** (the "check" button).The tissue then is accepted and inserted into the tissue list that is available in Volume tools.

To reject the tissue and reset the segmentation screen click **Cancel** (the "X" button).

9.6.8 Using the Edge Finder tool

1 From the **Options** menu select **Segmentation Tools**, then select **Small Volume Assessment**.

2 Click the **Edge Finder** button.

3 Move the cursor to the center of the organ to be assessed and click.

Note ***The first point selected should be at the center of the tissue in the image with the best-contrasted display.***

4 Move the cursor to a point outside the assessed organ and click.

Note ***The second point (and the others) selected should be at a typical background tissue, whose H.U. is lower then the first one.***

5 Adding additional points outside the tissue will recalculate and redraw the line of equal density.

6 Press <Esc> to conclude point selection and to define the volumetric tissue, (this redraws the line of equal density in that and all the adjacent slices).

Note ***If the tissue of interest is positioned next to other tissues (especially near a high density tissue, such as a suspected nodule next to a rib) use the VOI tool for separation from its surroundings. To do so, before using the Edge Finder tool (step 2 above), you can limit the tissue within a Volume of Interest (VOI) by drawing an ROI on the 2D slice.***

7 Press the <Ctrl> and <V> keys to view the result of the Small Volume Assessment for the last defined tissue.

Save the tissue

Save the tissue by clicking Save in the Toolbar or select Save from the File menu.

When you are finished defining tissues, to accept the tissue accumulation and open the 3-D viewer, click the Check button in the **tool bar**.

9.7 Manual tissue definition

1 Begin by clicking the Manual button in the Tool Box.

2 Click on Add Freehand ROI to add tissue parts. Using this tool allows only the part enclosed by the ROI to remain.

3 Click on Remove Freehand ROI to remove tissue parts. Using this tool removes the part enclosed by the ROI.

4 When using the above functions on a 2D image, only the slice of the current image is affected. On a 2D image, leaf through the slices and correct the blue overlay using Add ROI or Remove ROI tools. (Refer to the Graphics chapter in volume 1 for using Freehand ROIs).

5 To use the ROI functions on a 3D image, swivel the tissue until the desired part is visible and can be isolated, and then draw the Freehand ROI. The ROI advances into the tissue following the line of sight and affects all slices on the way.

You may use the Q-CTA tools in Manual definition for more precise definition of small tissue. (FWHM is not available in the Manual mode). For detailed explanations of Q-CTA tools refer to the Q-CTA chapter in volume 4.

6 Save the tissue by clicking Save in the Toolbar or select Save from the File menu.

7 If you want to exit the Manual definition mode and repeat the semi automatic process, click the Semi Automatic button.

8 When you are finished defining tissues, to accept the tissue accumulation and open the 3-D viewer, click the Check button in the **tool bar**.

9.8 Redefine an existing tissue

1. Select Redefine Tissue from the View menu. A Dialog Box opens listing all of the defined tissues.
2. Click on the tissue you want to redefine.
3. Click the Ok button, the Tissue Definition function is activated.

Note ***Trying to exit the 3-D program without saving all tissues will generate a warning message that tissues have not been saved.***

To save tissue(s)

1. From the View menu select Redefine Tissue. Unsaved tissues will appear in the Dialog Box marked with an asterisk (*).
2. Select the unsaved tissue(s).
3. Click Ok.

9.9 SSD 3-D window

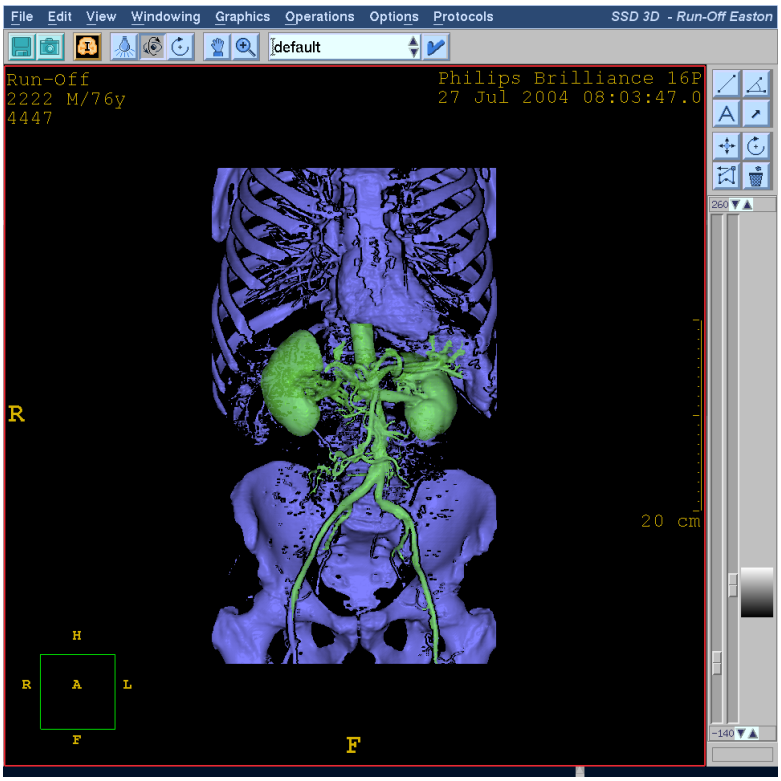
When you are finished defining tissues, click the Check button to accept the tissue accumulation and open the 3-D viewer.

The SSD 3D window (example shown below) will display:

- When opening a saved tissue together with the original series.

  -- and--

- After accepting the defined tissue accumulation.



Menu Bar for SSD 3D viewer

File includes all the file management and filming functions.

Edit consists of Reset All, Reset of image orientation, Reset of the light source position and wedge aperture cut, hiding of overlays and changing of overlay colors.

View includes these various view modes:

- 3-D, which enables removing, cutting and changing colors of tissues
- Transparency for viewing underlying tissues
- Axial, Coronal and Sagittal viewing angles
- activation of the Cine mode
- Tissue Volume and Tissue Measurements display
- defining New Tissues and Redefining existing tissue.

Windowing is used to change the brightness and contrast of the 3-D tissues. In the Cut mode windowing changes the values of the MPR values on cut surfaces. Also in the Cut mode, preset windows are available.

Graphics includes activation of the graphical elements and their operations. The available graphic elements are: Straight Line (measures length in 3-D space between two points on the tissue surface), Angle (between three points in the 3-D space), Text, and Arrows.

Operations consists of the Zoom, Pan, Light position, Swivel (Rotate) and Roll manipulations. In the Cut mode there are additional operations that allow for manipulation of the area to be cut.

Options determines the way in which graphic and 3-D images are displayed, filmed and saved.

Protocols allows saving new protocols or deleting old protocols from the list.

9.10 Manipulating 3-D images

3-D Rotate (swivel)

1 On the **Tool Bar**, click on the **Rotate** icon, or from the Operations menu select **Swivel**. The pointer shape changes to indicate Rotate Mode.

2 Drag the mouse in the desired direction of rotation.

- To display the projection in one of the principal axes, from the View menu select **Coronal**, **Sagittal** or **Axial**.
- To reset to the original orientation, from the Edit menu select **Reset** and from the sub-menu select **Orientation.**

Roll

- On the Tool Bar, click the **Roll** icon, or from the Operations menu select **Roll**. The pointer changes to indicate roll mode.
  - To roll the image clockwise, drag the mouse to the right.
  - To roll the image counter clockwise, drag the mouse to the left.

Light

1 On the **Tool Bar**, click the **Light** icon or from the Operations menu select **Light**. The pointer changes to indicate Light mode**.**

2 Drag the mouse to the desired position on the image. The shadowing of the image changes.

3 Set the light angle at the position that best emphasizes the desired features of the image.

- To reset to the original light source angle, from the Edit menu select **Reset** and from the sub-menu select **Light.**

Zoom

To magnify or reduce the size of the image:

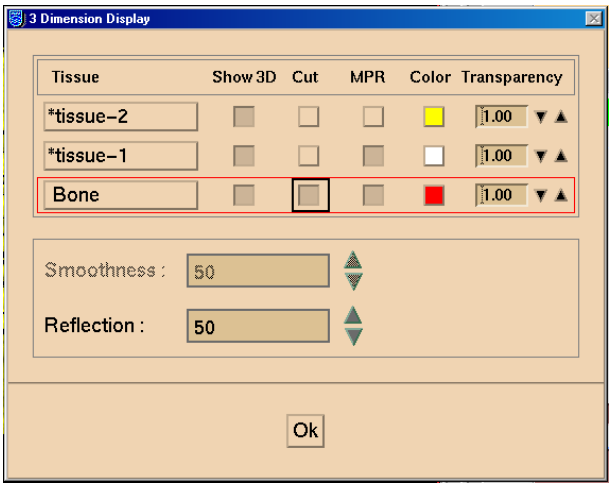
- On the Tool Bar, click the **Zoom** icon or from the Operations menu select **Zoom**. The pointer changes to indicate Zoom mode.
  - To **magnify** the image, drag the mouse up.
  - To **reduce** the size of the image, drag the mouse down.

For an exact zoom value, type the desired value in the text box to the right of the icon or use the arrows to increase/decrease the zoom value.

Pan

1. Click the **Pan** icon, or from the Operations menu select **Pan**. The pointer changes to indicate Pan mode.
2. Drag the image in the desired direction.
3. To reset to the original pan and zoom values, from the Edit menu select **Reset** and from the sub-menu select **Reset all.**

9.11 Removing predefined tissues



If you select **3D Display** from the View menu, the dialog box shown above is displayed, listing tissues. The list can show 3 types of tissues - those that were:

- loaded from the Directory
- defined and saved during the current work session
- defined or modified in the current session, but not yet saved (these tissues are marked with an * asterisk.)

For each tissue, there are various display options. If the button under the option is depressed, the tissue display feature is viewed. If the button is not depressed the display feature is not viewed.

- **Show 3D** - to display/hide the tissue.
- **Cut** - to view the 3-D image with its aperture. When selected the aperture manipulation buttons appear on the toolbar and can be used to manipulate the aperture (see the next section, Manipulating 3-D image with its aperture).
- **Color** - to redefine a tissue color, **right click** on the color button of the tissue. A list of colors appears. Click on the desired color.

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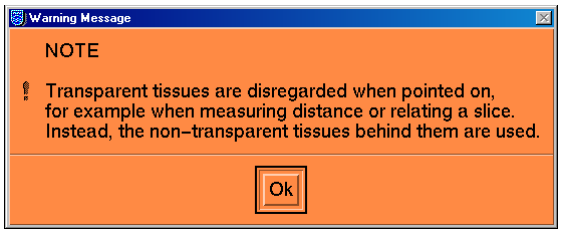
- **MPR** - to highlight and display the MPR of the surface of the cutting aperture. The pixel values of the cut surfaces are displayed on the bottom right corner of the window.

Note ***For the MPR to be displayed.,the original slices have to be selected in the Directory and the tissue should be cut.***

- **Smoothness** - to control the smoothing of the tissue surfaces.
- **Transparency** - to adjust the transparency level of the tissue, click on the up or down arrows in the Transparency option.
  - If the value is 1.00, the tissue will be completely opaque.
  - If the value is 0.00, the tissue will be almost invisible.

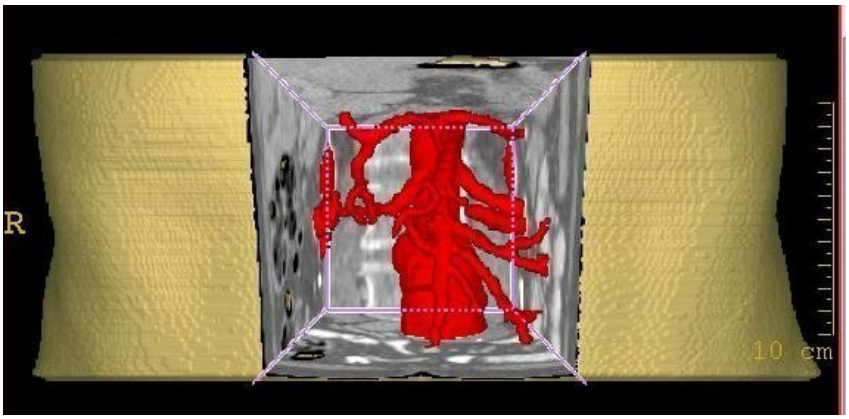
When Transparency is first accessed, this warning is displayed:



After setting the desired details of the cut, click **OK** to exit.

Note ***Tissues from the Directory that were originally saved from MIP application will automatically be removed when the application opens.***

In the Image below, the skin tissue was defined as cut and MPR displayed on the cut surfaces.



9.11.1 Manipulating 3-D image with its aperture

The 3-D image with its aperture can be manipulated with the aperture tools

Notes

- ***To access these tools, the Cut option in the 3 dimension display dialog box must be selected.***
- ***Even if the dialog box is closed these tools remain. Only after clearing the Cut selection in the dialog box will these tools disappear from the toolbar.***

Swivel (**Rotate**) - To rotate the aperture for viewing the interior of the image from a different angle, click on the Swivel (rotate) icon. Drag the mouse in the desired direction. If the aperture rotates out of sight, rotate the whole 3-D image (by the 3-D Rotate operation) until the aperture comes in view.

Roll - To roll the aperture walls, click the Roll icon. Drag the mouse in the desired direction (right for clockwise rotation, left for counter-clockwise rotation).

Drag (**Move**) To move the aperture, click the Drag (Move) icon and drag it to the desired position.

Angle - To widen the aperture angle, click the Angle icon and drag the mouse left to widen or right to narrow the angle.

In-Out - To deepen the aperture or make it shallower, click the In-Out icon and drag the mouse up to deepen or down to bring it closer to the screen.

Size - To enlarge the aperture, click the Size icon and drag the mouse left to enlarge or right to narrow it.

Notes

- ***To rotate or roll the 3-D image, use the Rotate and Roll operations. The image will rotate or roll with the aperture.***
- ***To rotate or roll the 3-D image while the aperture remains fixed relative to the screen, from the Operations menu, select Freeze and then manipulate the image. To exit this mode, select Freeze again.***

9.12 Editing, saving and deleting 3-D protocols

Editing

After defining the tissue and displaying it, the 3-D image can be also edited by using different settings of smoothness and reflection.

·From the View menu, select 3-D Display to change those settings in the "3-Dimension Display" box.

After all adjustments are made, the parameters you have just applied to the current created images can be saved as a new protocol (or can be made to override an existing one).

Saving

From the Protocols menu, select Save as and type in a protocol name. A new protocol will be added to list.

Deleting

To erase a protocol click Delete. The "Delete Protocol " box will be opened. Select and delete the appropriate protocol.

Note ***The saved protocol will keep all the preset parameters that were chosen in Tissue Definition stage such as: highlight window, image quality, fill, expand/erode value and type, and bridge; as well as these display parameters: smoothness, reflection and extra lighting.***

9.13 Tissue measurements

Tissue volume

Select **Tissue Volume** from the View menu to display the calculated volume and error of the tissues in the 3-D image. A dialog box opens with a list of the tissues and their volumes. The error is also displayed as a percentage of the calculated volume. All measurements are in millimeter increments.

Tissue measurements

Select **Tissue Measurements** from the View menu to display the calculated volume and error (in cubic mm) of the tissues and the dimensions of the minimum box that contains each tissue. A table will list the tissues, their volumes, and the dimensions of the smallest box that contains the tissues. All measurements are in millimeter increments.

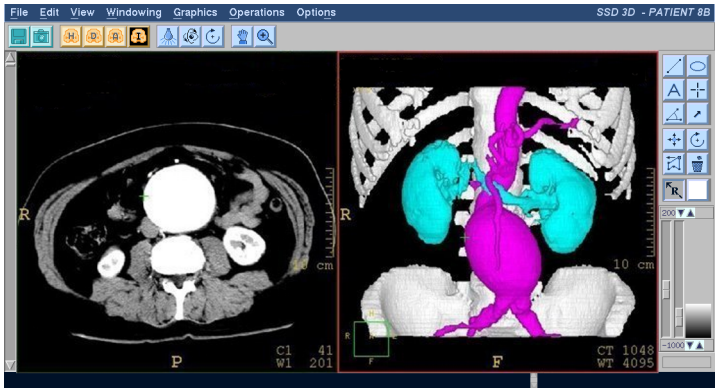
Tissues names	tissue-1	tissue-2
Volume	1009.74±36.5 cm³	866.91±34.5 cm³
EDiameter	*****	*****
Box Length	*****	*****
Box Width	*****	*****
Box Depth	*****	*****

Export the tissue measurements

Click **Export** on the File menu to save the tissues measurements as an HTML file and/or as Text file. The file will be stored in the folder **C:\usr\tmp**, under the tissue's name (for example, \usr\tmp\tissue-1).

9.14 Relate Slices

Select **Relate/Slice** from the View menu to correlate features on the 3-D image to the corresponding slice image. The Relate Slice window is shown.



The Relate Slice window consists of two frames, with the original image on the left and the 3-D image on the right. A cursor is displayed on the 3-D image. A corresponding cursor is shown on the original image in relation to the location of the cursor on the 3-D image.

To change the cursor position, click on a new location and the cursor will move to this location. The original slice is displayed with a cursor at the position corresponding to the position of the cursor on the 3-D image.

Notes

- ***The Relate mode may be activated only if original slices were selected in the Directory and loaded into the program.***
- ***If the cursor is not placed on a tissue in the 3-D image, there will be no related cursor on the original image.***

The 3-D image may be rotated, zoomed and cut and the original image may be windowed and zoomed.

The Tool Box includes all the operations described in the Viewer and Graphics chapters in volume 2; the additional operations, however, may be applied only to the original image.

To return to the Relate operation, click on the Relate button in the Tool Box.

To see contours of the tissues on the 2D slice, from the View menu select **Tissue**, then from the Tissue sub-menu select **Contour**.

To revert to display of the 3-D image without the correlated image, select **One Image** in the View menu.

9.14.1 Windowing the MPR values

To change the MPR windowing Center and Width on the cut:

1 Click the Normal button in the lower-right corner of the window.

-- OR --

2 Alternately, from the Windowing menu select **Current**, then select **Current | Normal.**

Note ***The Windowing menu has preset windowing settings and a set preset option to change the preset values. There are also normal, automatic, inverse, and highlight modes. To return to Normal as opposed to highlight or inverse select Current | Normal.***

3 Use the windowing functions and middle button of the mouse as detailed in the Windowing section of the Viewer chapters in volume 2.

9.15 Cine display

To display a continuously rotating 3-D image, proceed as follows:

1. Rotate the 3-D image to the desired initial orientation.
2. Select **Cine** from the View menu. The image slowly rotates while 40 projections are prepared by rotating around the vertical axis. When the image stops rotating, the preparation period is over.
3. To start the cine display, click the **Play** button in the Tool Bar. The 3-D image will rotate continuously around the vertical axis.

For detailed operation, refer to the Cine section in the Viewer chapters in volume 2.

Note ***Cine direction and speed can be changed while cine loop is being played; there is no need to interrupt play in order to change them.***

9.15.1 Save to AVI Movie

Note ***The Save Movie and Play Movie functions are described in more detail in Viewer chapters in volume 2.***

The Cine sequence you set up according to the previous procedure can be saved as an AVI movie. The movie will be saved at the current speed, windowing, and size.

1. Click the **Save to Movie** button on the toolbar.
2. The Save Movie dialog box appears and you are prompted to type a movie name.
3. Type in the name and click **Ok**. The movie name cannot include blank spaces.
4. The movie will be saved by the following path: D:\Movies\[application name]\movie_title.avi where the application name is this current application.

9.15.2 Play Last AVI Movie

You can play the last movie you saved. (Refer to the Viewer chapters in volume 2 for more details.)

1 Click the **Play Movie** button on toolbar. The MicroSoft Windows Media Player application opens.

By default, the last movie you saved will be opened and will begin to play automatically.

9.16 Filming

If you do not have a color printer, from the Options menu set **Color Save/Film** to OFF.

To film the image, select the **Film** button in the Tool Bar or, alternately, from the File menu select Film Image.

9.17 Speed

You may increase the response for lower image qualities from the Options menu by setting **High Quality** to OFF

9.18 Saving contours

To save the contours of all the displayed tissues, from the File menu select **Save Series**. This will save a new copy of all the original slices that were selected in the Directory and loaded into the 3-D program.

Each new copy will include the 2D contours made from the intersections of the slice with all of the displayed tissues.

10 Maximum (minimum) intensity projection - (MIP)

10.1 Overview

The maximum (minimum) intensity projection (MIP or MinIP) function generates interactive display of ray-traced MIP images from sets of CT slices. The term MIP denotes both maximum and minimum intensity projection. The MIP option is used to respectively display the results of CT Angiography or air ways.

The program calculates and displays two dimensional projections of the highest or lowest intensity pixels in a three dimensional volume of interest. These images can demonstrate either contrast enhanced vascular structures and other high density tissue or respiratory airways. Interactive rotation of the selected volume to any desired orientation enables assessment of the desired structures.

The MIP function enables selecting the area to be processed and removing bone and other high density tissue.

⚠

Caution ***The MIP application is not equivalent to conventional X-ray angiography.***

The slices that can be used in the MIP function have to comply with the following conditions:

- They belong to the same series.
- The spacing between the images should be the same; some missing images are tolerated.
- The reconstruction matrix, zoom and pan of all images should be the same.
- The orientation (tilt and swivel angles) should be the same for all images.

Caution

- ***Length and area measurements are valid in the screen plane only, and they have no three dimensional significance.***
- ***If the original images have been up/down inverted, the H and F indications on the orientation cube are not valid.***

10.2 Summary of MIP workflow

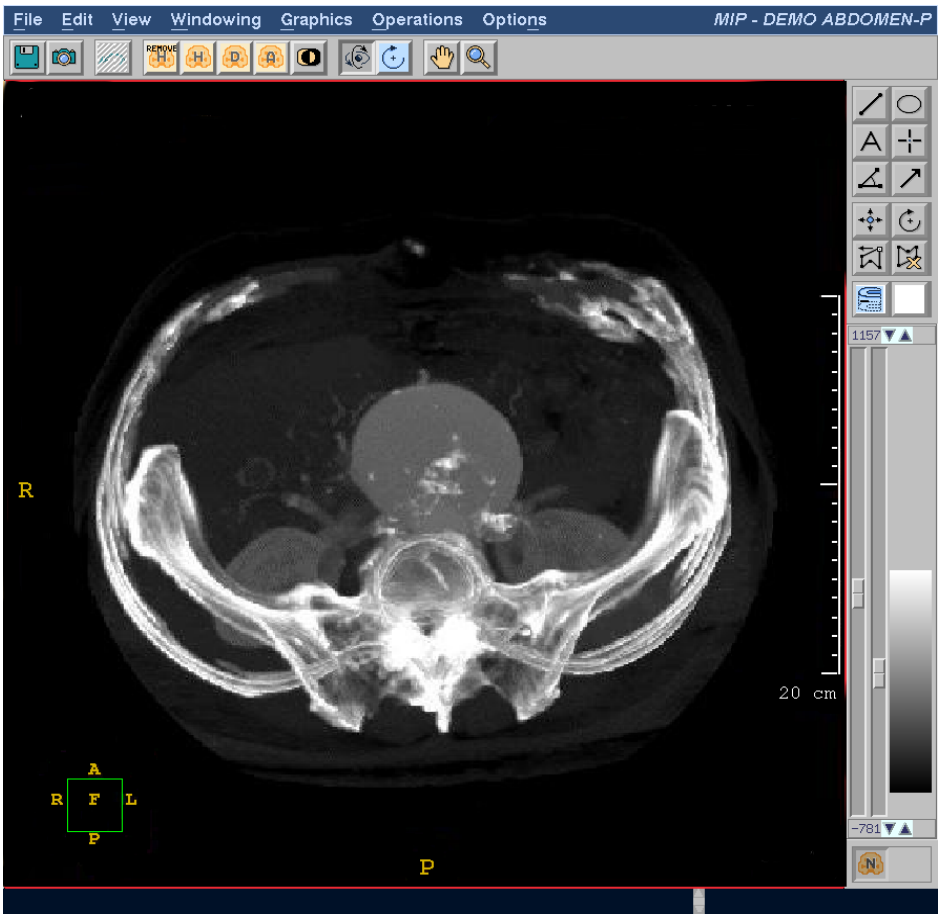
1. Select the series from the **Directory** and click **MIP** in the Application menu.
2. If there are no tissues defined or the tissue to be analyzed is partially hidden, click **View >Define Tissue.**
3. To Remove the bone tissue, highlight or seed:
   - To remove bone by highlighting, click the highlight tool. See “Calcifications Removal” later in this chapter.
   - To define the tissue with the seed method, see “Define Tissue” later in this chapter.
4. After defining the tissue, select **View>MasterCut**.
5. Draw a **Relate curve** through the center of the tissue volume. See “MasterCut” later in this chapter.

Note ***The Relate curve line can be edited either in the 3D or panoramic windows.***

6. When the Relate curve is complete, select **Cut mode>Sectional** from the View menu.

   The Q-CTA tools appear on the toolbar. Define the volume contour through the different sections. See “Generate sectional cut.”
7. Use the **Q-CTA tools**: click the **MultiSectional** tool and click the edge of the vessel. The vessel contour appears and two new editing tools appear: + ROI or - ROI.
8. If the vessel is not well defined you can use the other Q-CTA tools and can edit the contours with the editing tools in the toolbox.
9. Click **Relate slice** to use the Q-CTA tools and define the tissue contours.

10.3 MIP window



10.3.1 Menu bar

The **Menu Bar** consists of several menu options which when selected display a list of operations that can be performed. These menu options are described below:

- **File** includes all the file management and filming functions.
- **Edit** consists of Reset All, Reset VOI for reverting to full image after ROI limiting of the volume, Reset of image orientation, hiding overlays and changing of overlay colors.

- **View** includes Relate to acquired slices and the curved plane, removal from MIP image of pre-defined tissues and defining new tissue, display of the MIP image in axial, coronal and sagittal orientations and controlling the Volume of Interest, switching between maximum and minimum projections and activation of the Cine mode, which includes the Save and Play Movie functions.
- **Windowing** consists of the windowing functions and preset windows. **<Alt> + <1–8>** (the **Alt** key pressed together with a number between **1** and **8**) also activates the preset windows.

  Fine tuning of the **windowing** Center and Width is performed by dragging the mouse on the image while the middle button is pressed: up/down for Center adjustment and left/right for Width.
- **Graphics** includes activation of the graphical elements and their operations.
- **Operations** consists of the Zoom, Pan, Swivel (Rotate) and Roll manipulations.
- **Options** enables selective display of ROI measurement data and controlling the MIP quality.

10.3.2 Toolbar selections

The **Tool Bar** contains the following icons for activating the frequently used function

MIP Opening Window Toolbar Buttons		
	All MIP modes	Save for saving the displayed image in the Archives.
	All MIP modes	Film for sending the image to Filming prior to printing.
	Available in master cut sectional view after a curved sectional line is drawn	Undo Last VOI for canceling the effect of last volume of interest.

	MIP and Relate to Slice	Remove Highlight for removing the highlighted pixels from the volume.
	MIP and Relate to Slice	Highlight window for painting in color a range of pixel values.
	MIP and Relate to Slice	Dual window for activating the second windowing range in addition to the normal one.
	MIP and Relate to Slice	Alternate window for switching from the normal window to the alternate one and vice versa.
	MIP and Relate to Slice	Inverse window for reversing the gray scale and displaying a negative image.
	All MIP modes	Swivel the MIP image in any direction.
	All MIP modes	Roll for rotating the MIP image in the screen plane
	All MIP modes	Pan for moving the MIP image within the window.
	All MIP modes	Zoom for magnifying and reducing the size of the MIP image.

The **Message Line**, located at the bottom of the screen, displays on-line help and system messages.

The **Tool Box** at the right side of the application window contains the graphical aids for annotating and measuring features on the images. It includes:

- **Line** (straight, curved and freehand lines) for length measurement in the screen plane.
- **ROI** (elliptical, rectangular, curved and freehand Regions Of Interest) for measuring area in the screen plane, mean and standard deviation of the pixel values.

- **Text** for annotation on the images.
- **Cursor** for measuring pinpoint pixel values.
- **Angle** for measuring angles between features on the image in the screen plane.
- **Arrow** for pointing to features of interest.
- **VOI** for removing inside or outside pixels of elliptical, rectangular and freehand Volumes of Interest.

Operations on graphic elements are: **Move, Rotate, Change shape** and **Delete.**

For detailed operation instructions of the graphic elements, refer to the Viewer chapters in volume 2.

A **pop-up menu**, when invoked, appears on the image and can be used to activate the most commonly used functions and tools. To invoke the pop-up menu, place the pointer on any one of the images and click the right mouse button.

10.3.3 Selecting images

1. Click **Directory** if the Directory is not already open.
2. Select a study from the Patient list.
3. Select the series to open from the Series List.
4. Select **MIP** from the Application menu. The MIP viewer appears with the selected series.

10.3.4 Loading Tissues

For details on how to **load tissues** from different series of the same patient, see the Shaded Surface Display 3D chapter in volume 3, “Selecting Images” section.

If tissues to be removed were previously defined, make sure to include them among the images selected (up to 15 tissues may be used).

⚠

Caution ***In this case, selected tissues which were saved in MIP will automatically be removed from the volume.***

10.3.5 Removing masking tissues

⚠

Caution ***The process of tissue removal can affect tissue that was not intended to be removed. For example, blood vessels in contact with bone.***
Use the scroll bar on the side of the images to leaf through all slices to make sure only intended tissue has been removed.

If there are loaded tissues that block viewing of the vasculature (for example, bones in CT images, or surrounding air), remove them by using **Define Tissue** in the Operations menu. After defining of the tissue to be removed, the MIP image is displayed again.

10.4 Tissue definition

From the Operations menu, select **Define tissue.** A window is opened, similar to that detailed in the CT Viewer - Volume mode chapter in volume 2. The window is organized as follows:

- The middle slice is viewed in the top images.
- The left top image is used for changing the image contrast and brightness.
- The top right slice is used for windowing.
- The bottom left image is the bottom slice and is used for windowing.
- The bottom right image is the resulting MIP 3D image.

MIP Define Tissue Window Toolbar Buttons in Manual Mode		
	Master cut sectional mode	Relate slice
		Add ROI leaves only the part enclosed by the ROI
		Minus ROI removes the part enclosed by the ROI
	All modes	Create a VOI

Operation is similar as in the CT Viewer - Volume mode chapter. A few highlights are mentioned below:

- Adjust the highlight window to cover the bones to be removed from the MIP projection.
- Select **Seed** from the Tool Box and click on the bone on the MIP image; after a while the bone will appear as a blue overlay on the slices.
- In order to remove the blue tissue from the project, click on "**+**" in the Tool Box. To undo the last "**+**" operation, click on"**-**" in the Tool Box.

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- If the removed tissue is too small, increase the value in the **Expand** box and click "+" again.
- Repeat the above process until all obscuring tissues are removed.

- Once the tissue definition is completed, return to MIP window by clicking **Accept Tissue Selection** (check mark).

- To return without removing the masking tissues, click the **X** button.
- To view or hide the defined tissue select from the View menu **MIP Display**. A dialog box appears. Select Remove or Add the masking tissue.

Note ***Only one tissue may be defined, although the masking tissue may be redefined.***

10.4.1 To redefine the tissue

- From Operations menu select **Define tissue**.
- Repeat the procedure of tissue selection. If the Check is selected after each new selection, the new definition is added to the masking tissue.

10.4.2 To save the masking tissue

- From the File menu select **Save Tissue**. Each Save Tissue will save a new masking Tissue file.
- To add or remove each masking tissue separately the application must be closed and reopened together with the saved masking tissues and original series.
- To open the saved tissues together with the original series hold <Ctrl> and click each tissue and the original series. (When more than one series is opened at the same time the title Multi Series appears on the images).

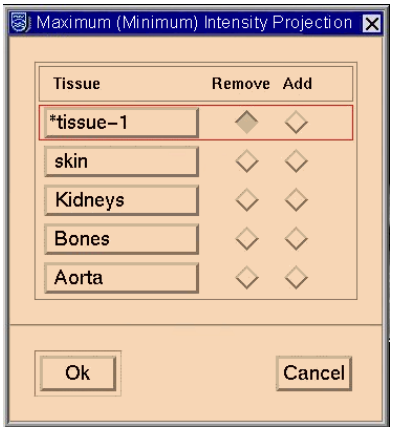
- In the Directory series list the Masking tissue series type will be **Derived**. The image file will display a T in the top left corner. This appears even if the titles are turned off.

10.4.3 To remove masking tissues

Note

- ***In order to separately add or remove from view more than one tissue, the saved tissue file must be opened together with the original series.***
- ***To open the saved tissues together with the original series press <Ctrl> and click each tissue and the original series.***
- ***When more than one series is opened at the same time the title Multi Series appears on the images.***

1 From the View menu select **MIP**. The following Dialog Box is displayed:



- The Dialog Box shows the list of tissues that were selected in the **Directory** and the tissue that was defined in **Operations>Define Tissue**. (In the box above, the first entry, "tissue," is marked with an asterisk to show that it has not been saved since its last modification.)
- To remove a tissue from the MIP image, click the **Remove** button to the right of the tissue's name; the button becomes shaded gray. The tissue is removed after **Ok** is clicked.

- To reinstate a tissue, click **Remove** again. The button reverts to white and the tissue is reinstated after **Ok** is clicked.

2 Click **Ok** to view the resulting MIP image (the changes take effect only after clicking **Ok**).

- To check the exact shape of the tissue(s) that are removed, click on the **Add** buttons of the tissue(s). After the **Ok** button is clicked, only the volume included in the defined tissue(s) is projected, with no extraneous data.

Note ***Tissues which were loaded in the Directory and were originally saved from MIP application will automatically be removed.***

10.4.4 To remove calcifications

⚠

Caution ***The process of tissue removal can affect tissue that was not intended to be removed. For example, blood vessels in contact with bone.***
Use the scroll bar on the side of the images to leaf through all slices to make sure that only intended tissue has been removed.

Use this procedure to remove calcifications:

1 On the Tool Bar, click on the **Highlight** icon, or from the Windowing menu, select **Highlight**.

2 Hold down the middle mouse button and drag the mouse up and down to adjust the highlight window to view the calcifications to be removed.

3 On the **Tool Bar**, click on the **Remove Highlight** icon, or from the *Windowing* menu, select **Remove Highlight**.

4 Adjust the window to interactively remove the calcifications. The highlighted areas are interactively removed.

Note ***Use this function very carefully, since you may unknowingly remove tissues from the image that should not be removed.***

10.4.5 Adjusting the MIP volume by VOI

User-defined Volumes of Interest (VOIs) may be used to display only the volumes of interest or eliminate parts which conceal the anatomy. Six options are available:

- **+**elliptical, **+**rectangular and **+**freehand which allow you to display the enclosed volumes of interest and exclude all regions outside.
- **-**elliptical, **-**rectangular and **-**freehand which remove the enclosed volumes of interest and display only the volume outside the outlined region.

To activate the current shape of VOI, click on the **VOI** button in the tool box with the left mouse button. The cursor changes to a pencil for drawing the VOI.

To change to another VOI shape, click on the **VOI** button in the tool box with the right button and select the desired shape from the list. Alternatively, from the **Graphics** menu, enter the **VOI** sub-menu and choose the desired type of VOI.

To cancel the effect of the defined VOIs and to re-display the entire image, from the **Edit** menu select Reset and from the sub-menu select VOI.

To save a VOI for later use, from the File menu, use the **Save VOI** function.

To reload a saved VOI, include it in the list of loaded images, when entering the MIP function, or when reloading.

10.4.6 Controlling the MIP quality

From the View menu select **Image Quality**. A sub-menu appears, with three possible values to choose from: **Fast Mode**, **High Quality**, and **Print Quality** in ascending order of MIP quality.

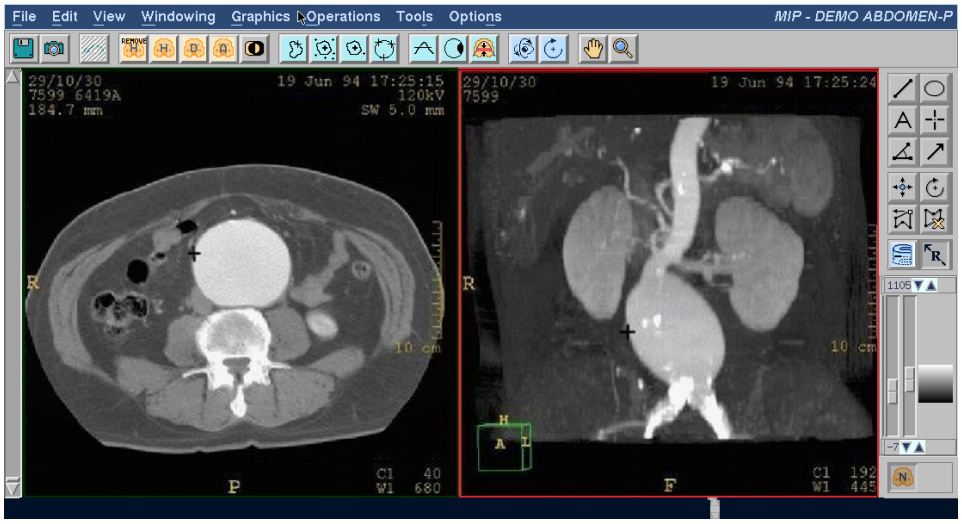
Note:

- ***Print Quality takes longer to calculate and display.***
- ***When filming and saving a MIP image, the MIP Quality of the filmed/saved image is the current MIP Quality in use.***

10.5 Relating tissues to original images

1 From the View menu, select **Relate.Slice**.

The window is split into two frames—one contains the MIP image and the other an original image:



2 Click on the desired point on the MIP image. The point is marked by a cursor. The original image which contains that point is displayed, and a cursor appears at the nearest point corresponding to the cursor on the MIP image.

Warning ***The cursor shows the relationship between dots on the MIP and original image. Occasionally, the dot on the MIP image does not belong to the perceived tissue (that comprises the majority of the neighboring points) and therefore the related cursor on the original image may point to a completely different tissue.***

3 To choose another point on the MIP image, click on that point and the cursor will move to that point. The corresponding original image is displayed and the related point is marked on it. Any manipulation of the images may be performed by selecting the appropriate operation.

4 To return to the Relate operation, click on the **Relate** button in the Tool Box.

5 To revert to display of the MIP image without the correlated image, select **One Image** in the View menu.

10.5.1 Toolbar menu

MIP Relate Slice Window Toolbar Buttons		
	Relate to slice and define tissue manual mode	Auto Contour calculates the contour of a vessel along the line of equal density.
	Relate to slice and define tissue manual mode	Flexi Contour calculates the contour of a vessel where a contour value is interpolated according to its relative location between the rays drawn through outside selected points.
	Relate to slice and define tissue manual mode	Edge Finder calculates average density difference between points outside the vessel and a point in the center of the vessel. A contour is then drawn along the equal density line at half the density difference.
	Relate to slice	Circle Fitter calculates the most accurate circle for vessels that are not entirely visible.
	Relate to Slice	FWHM (Full Width Half Max) Calculator calculates the average profile of a vessel.
	Relate to Slice	Occlusion Calculator calculates the percentage of stenosis in blood vessels.
	Relate to Slice	Threshold Definition highlights tissue with the same threshold values as selected ROI.

10.5.2 Menu bar

The Menu bar functions remain the same as in the other MIP windows except the Tools menu. This tools menu is available in the relate slice window and the define tissue window. Use the **Tools** menu to access the to Q-CTA tool aids for the assessment of blood vessel pathology.

10.5.3 Manipulating MIP images

Swivel (rotate)

1. On the Tool Bar, click on the **Swivel** icon, or from the Operations menu select **Swivel**. The pointer shape changes to indicate rotate mode.
2. Drag the mouse in the desired direction of rotation.
3. To display the projection in one of the principal axes, from the View menu select **Coronal**, **Sagittal** or **Axial.**
4. To reset to the original orientation, from the Edit menu select **Reset.**
5. From the sub-menu select **Orientation.**

Roll

On the **Tool Bar**, click on the **Roll** icon, or from the Operations menu select **Roll**. The pointer changes to indicate roll mode.

- To roll the image **clockwise**, drag the mouse to the right.
- To roll the image **counter clockwise**, drag the mouse to the left.

Zoom

On the **Tool Bar**, click on the **Zoom** icon or from the Operations menu select **Zoom**. The pointer changes shape.

- To **magnify** the image, drag the mouse up.
- To **reduce** the image, drag the mouse down.

- **For an exact zoom value**, type the desired value in the text box to the right of the icon or use the arrows to increase/ decrease the zoom value.

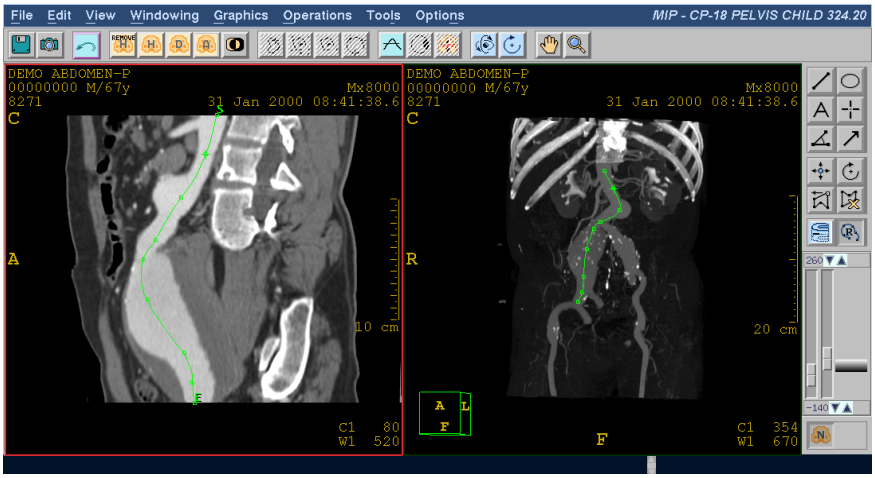
Pan

1. Click on the **Pan** icon, or from the Operations menu select **Pan**. The pointer changes.
2. Drag the image in the desired direction.
3. To reset to the original pan and zoom values, from the Edit menu select **Reset**
4. From the sub-menu select **Reset all.**

10.6 MasterCut

To relate the MIP to a Curved Plane (that is, a plane passing through a blood vessel), from the View menu select **MasterCut**.

The window is split into two frames. The right hand frame contains the MIP image, and the left hand frame (which is initially empty) will contain a panoramic image.



Master Cut Panoramic Mode Toolbar Buttons		
	Master cut in panoramic mode	Draw a curved line.
	Master cut in panoramic mode	FWHM (Full Width Half Max) Calculate the average profile of a vessel.

Menu bar

The menu bar functions remain the same for the other MIP windows except the View menu. This menu contains the cut mode options of viewing the panoramic or the sectional view.

Note ***The sectional view is active only after a sectional line has been drawn on the MIP image***

10.6.1 Draw a curved line over the blood vessel

Note that the **Relate Curve** in the Tool Box appears depressed.

If the displayed MIP image does not depict the desired blood vessel clearly enough, use the **Swivel**, **Roll**, **Zoom** and **Pan** tools to manipulate the image.

1. Click on **Relate Curve**, if it is not already active, or from the Graphic menu select **Relate Curve**. Note that the cursor shape changes to a pencil.
2. Move the cursor to the beginning of the blood vessel to be cut on the MIP image.
3. Click the left mouse button (to initialize the start point).
4. Move the cursor along the blood vessel, note that a line is traced in accordance with the cursor movement.
   - If the line begins to deviate, click the left button (this creates a new fixed point) and continue moving the cursor.
5. Repeat this operation until the line encompasses the entire blood vessel.
6. To delete the last line segment while drawing, press the **<Backspace>** key.
   - Press the **<Backspace>** key repeatedly to delete each line segment in reverse order of their creation.
7. When the entire blood vessel is outlined by the line, double-click the left mouse button (or press the **<Esc>** key) to indicate that the drawing is complete. A panoramic image of the blood vessel will appear in the right hand frame.

To make any corrections in the line on the MIP image:

1. Click on the **Change Shape** button from the Tool Box (or from the Graphics menu select Change **Shape**). The pivot points on the line appear.
2. Drag the pivot points to correct the orientation of the line. If there is no pivot point where the line deviates from the blood vessel, click on the line and drag it to its correct

position (note that a new pivot point is created).

To continue the line on the MIP image beyond the last point:

1. Click on the **Relate Curve** button.
2. Hold down the <**Shift**> key and click on the end point; this frees it so you can continue drawing the line.

You may define a new line at any time by performing the above steps. The previous line will be erased.

The panoramic image is generated by spreading a curved surface. The curved surface is folded in one direction to fit the Relate Curve appearing on the MIP image. The other direction of the surface is taken along the direction in which the MIP image is viewed (perpendicular to the screen).

Note ***Any change you make to the Relate Curve line on the MIP image will generate a new panoramic image.***

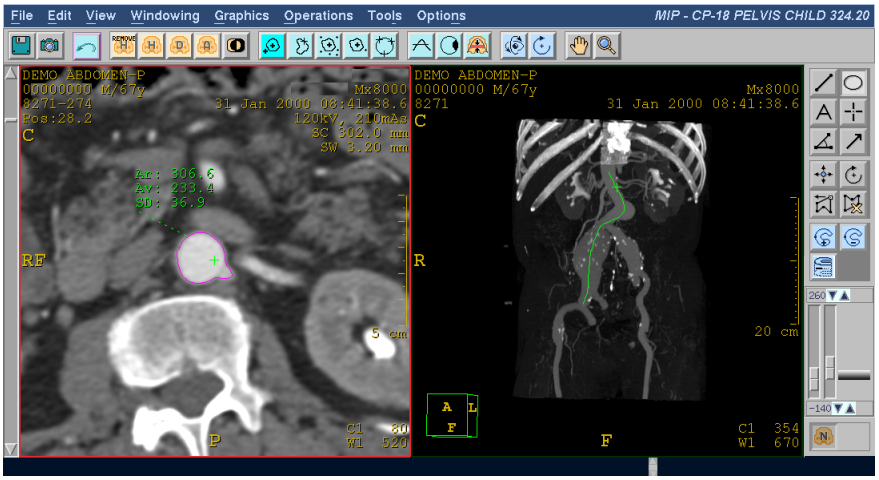
A curved line will also appear on the panoramic image. It should run along the center of the blood vessel. You can correct the curve, if need be, via the **Change Shape** and **Move** buttons.

Note ***The pivot points on the panoramic image are limited to either left/right or up/down movement. This movement corresponds to moving into or out of the MIP image. You cannot move the pivot points in any other direction (for example, diagonally).***

You can generate new panoramic images from different directions by performing a **Swivel** function on the MIP image. After each swivel, the curves will project over the new images of the blood vessel and you can continue to make corrections.

A Relate Curve cursor is placed at the end of both lines. You can move the location of the cursor on the MIP image by clicking the **Move** button and the cursor on the panoramic image will follow along the Relate Curve location in space.

10.6.2 Generate sectional cut



After you are satisfied that the curve passes through the blood vessel, you can then generate a sectional cut of the vessel:

1. From the View menu select **Cut Mode**.
2. From the sub-menu select **Sectional**.
   - The left frame image is replaced with a 2D image with a scrollbar to its left. The image is a 2D planar cut perpendicular to the blood vessel.
   - The intersection of the blood vessel with the plane is marked with a cursor both at the center of the image and along the Relate Curve on the MIP image.
   - You can move to new locations in the image by using the scrollbar, or by moving the cursor in the MIP image by clicking on the button. The position of the intersection along the blood vessel is given in millimeters in the top left corner of the 2D image.
   - You may save all the sectional planar images every 2.5 mm along the curve. From the File menu, select **Save Sectional Series**… Fill in the device and label of the saved images.

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Master Cut Window in Sectional Cut Mode Toolbar Buttons		
	Relate to slice and master cut sectional view after a curved sectional line drawn	Multi sectional center. Available in sectional mode (in master cut mode this is available after a curved sectional line drawn). This contour is projected through all the sections

3 To reduce the number of images, limit the curve to its absolute necessary length.

4 To revert to the panoramic image, from the View menu select **Cut Mode**, then from the sub-menu select **Panoramic**.

5 To revert to a single MIP frame, from the View menu select **One Image**.

10.7 Cine

To display a continuously rotating MIP image, do the following:

1. Rotate the MIP image to direct the desired initial image of the Cine.
2. From the View menu, select **Cine**. The image slowly rotates around the vertical axis while 40 projections are prepared. When the image stops rotating, the preparation period is over.

3. To start the Cine display, click **Play** in the Tool Bar. The MIP image will rotate continuously around the vertical axis.

For detailed operation, refer to the **Cine** section in the Viewer chapters in volume 2.

Note ***Cine direction and speed can be changed while cine loop is being played—there is no need to interrupt play in order to change them.***

10.7.1 Save to AVI movie

Note ***The Save Movie and Play Movie functions are described in more detail in the Viewer chapters of volume 2.***

The Cine sequence you set up according to the previous procedure can be saved as an AVI movie. The movie will be saved at the current speed, windowing, and size.

1. Click the Save to Movie button on the toolbar.
2. The Save Movie dialog box appears and you are prompted to type a movie name.
3. Type in the name and click Ok. The movie name cannot include blank spaces.
4. The movie will be saved by the following path:
   D:\Movies\[application name]\movie_title.avi

   where the application name is this current application.

10.7.2 Play last AVI Movie

You can play the last movie you saved. (Refer to the Viewer chapters of volume 2 for more details.)

1. Click the Play Movie button on toolbar.
2. The MicroSoft Windows Media Player application will be opened.
3. By default, the last movie you saved will be opened and will begin to play automatically.