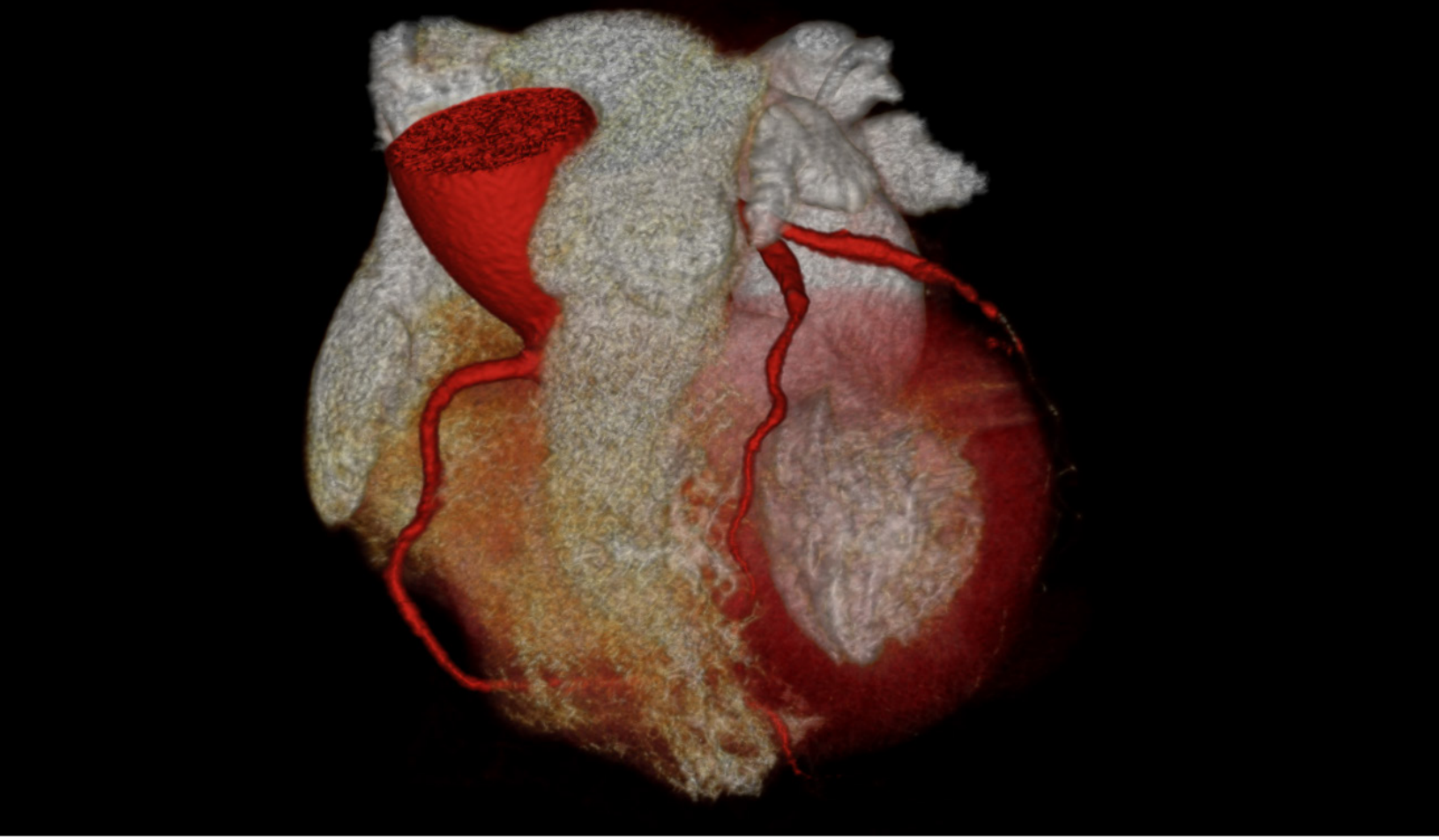

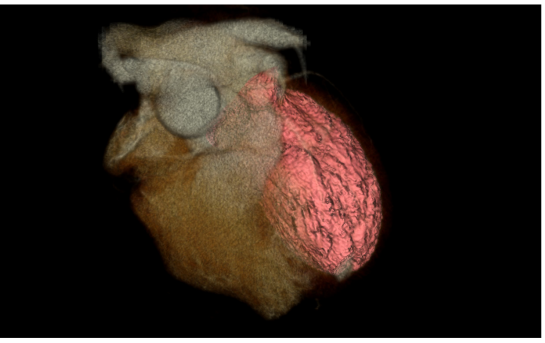

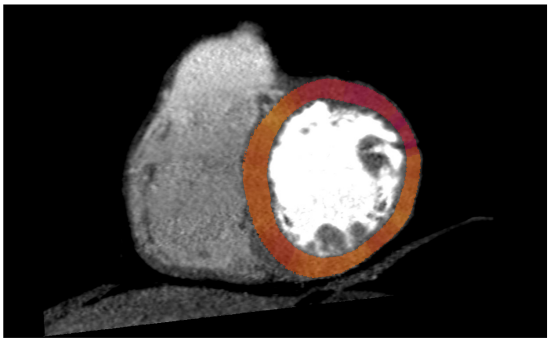

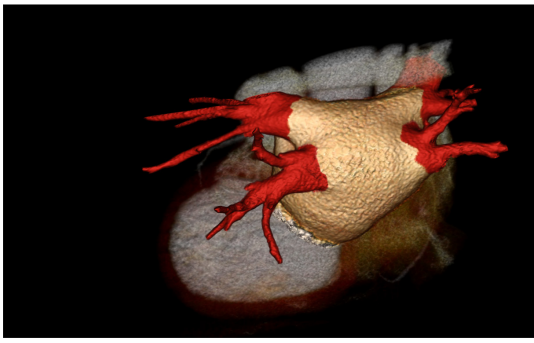

Vitrea Advanced®
Vitrea Workstation™

Education and Reference Guide
Cardiac

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Safety and Regulatory Considerations

PLEASE REFER TO THE **ABOUT VITAL IMAGES MEDICAL IMAGING SOFTWARE** DOCUMENT BEFORE USING THIS PRODUCT. This document includes important information regarding general Vitrea Safety and Regulatory considerations.

CAUTION: Federal law restricts this device to sale by or on the order of a physician, as directed by 21 CFR 801.109(b)(1).

Contact Us

- For general, non-technical support questions, contact us through our Web site: www.vitalimages.com.
- For customer technical support, contact us:
  - In the U.S., call the Customer Support line at 1.800.208.3005.
  - Outside the U.S., contact your Vital distributor.
  - Send an email to support@vitalimages.com.
- For a printed version of the Release Notes, Education and Reference Guide, or Installation Guides, contact Customer Support at 1.800.208.3005.

Release Notes

Vitrea® Release Notes contain late-breaking information not available at the time the Education and Reference Guide was released. This document is available from your System Administrator or from Vital Images.

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CT VScore™ (CT Cardiac Calcium Scoring)

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VScore Overview

A calcium score is computed for each of the coronary arteries based upon the volume and density of the calcium deposits. This can be referred to as calcified plaque burden. It does not correspond directly to the percentage of narrowing in the artery but does correlate with the severity of the underlying coronary atherosclerosis.

Typical settings include 3 pixel threshold, 130 HU Density threshold.

Pixel Threshold

The pixel threshold determines the minimum number of adjacent pixels that can constitute a lesion. The reason for using a pixel threshold is that, if a very small region contains data with values above the density threshold, it is possible that this data is “noise” and does not indicate calcification. Taken together, the density threshold and the pixel threshold determine which parts of the volume are considered to be calcified regions. The pixels in the region must have values that are at least as high as the density threshold, and the number of pixels in the region must at least equal the pixel threshold.

Density (Hounsfield Unit) Threshold

The HU threshold field determines a density threshold in Hounsfield units. Data values at or above this value are considered potentially calcified. Some data with values above the threshold will not indicate calcification. For example, bone will be above the density threshold. Taken together, the density threshold and the pixel threshold determine which parts of the volume are considered to be calcified regions. The pixels in the region must have values that are at least as high as the density threshold, and the number of pixels in the region must at least equal the pixel threshold.

Calcium Score and Calcium Percentile

The calcium score is used to determine the patient's **calcium percentile**. This percentile is displayed on a graph that compares the patient's calcified plaque burden to that of other asymptomatic men or women of the same age range and/or ethnic group. Use one of three select reference databases to report calcium percentile: Hoff. 2001, MESA 2006, or Nasu 2002. It is your responsibility to select the appropriate database for reporting calcium percentile.

VScore Lesson

I. Select Study

Load a Calcium Scoring study.

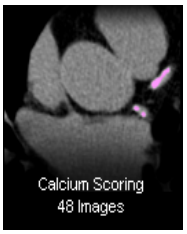
See the instructions for your Vitrea type (VitreaAdvanced Through the Data Manager or VitreaWorkstation) in the **Select Study** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide**.

II. Choose Protocol and Preset

Use one of these procedures:

Data Manager

- Double-click the **Calcium Scoring** application thumbnail.



Gallery Window

1. On the Gallery window, select the **Cardiac: CA Scoring CT** protocol.

   The Gallery choices update automatically.

2. Click Pick next to the **2D VScore with Color** preset.

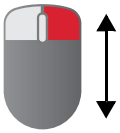
III. Perform Analysis

Identify Plaque

1. Locate the calcified plaque in the coronary arteries.

   TIP: Roll the middle mouse wheel, or

   TIP: Right-click to scroll through the images.



   Calcium is highlighted in pink.

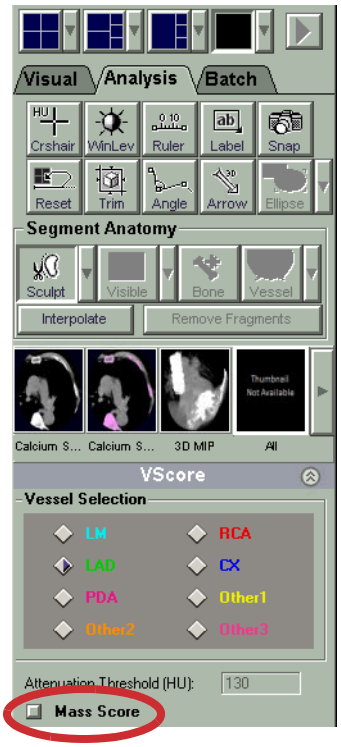
2. Magnify and pan the images.

   TIP: Press the left and center wheel together to magnify.

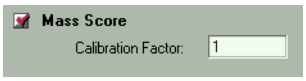
   TIP: Press the center mouse wheel to pan.

3. On the Analysis tab, select the Mass Score option to enable Mass Scoring.

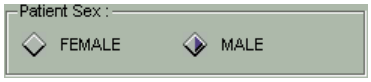
   NOTE: The Mass Score is the cumulative region mass based on the measured calibration factor. Mass Score must be selected on the Analysis tab in order for the Mass column to display in the report.



   TIP: When Mass Score is enabled, the calibration factor can be modified.

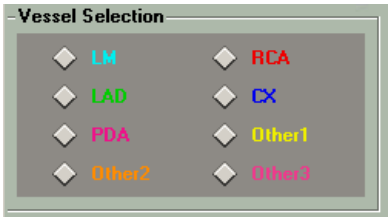


4. If the DICOM tag for patient sex is missing or “O,” select the gender.



NOTE: If the DICOM tag for patient sex is present, Vitrea will make the gender selection and the selection boxes will be unavailable.

5. Select **LAD** in the Vessel Selection area.

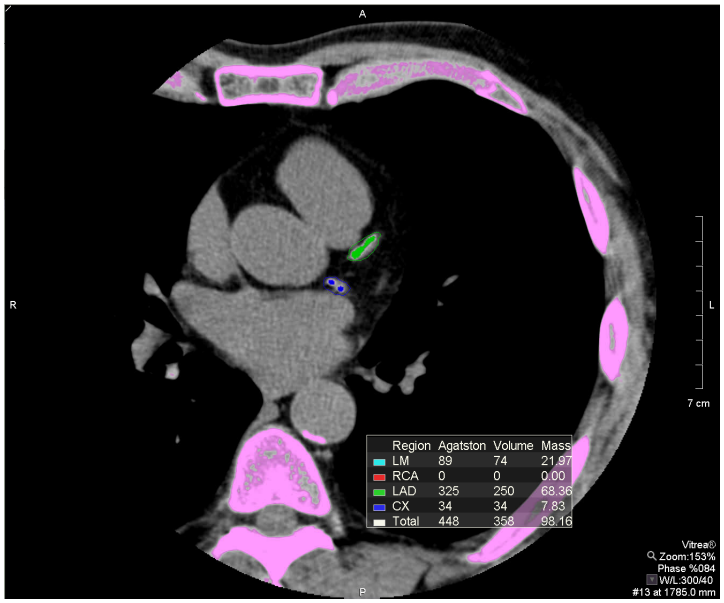


In the Vessel Selection area, select the coronary artery you want to examine for calcium:

- LM — Left Main coronary artery
- RCA — Right Coronary Artery
- LAD — Left Anterior Descending coronary artery
- CX — Circumflex coronary artery
- PDA — Posterior Descending Artery
- Other 1, Other 2, and Other 3 — use to score areas of calcium found after a bifurcation in an artery or if you need to create contour lines on more than one area of the same artery

6. On the first image that demonstrates calcium in the LAD, draw a contour around the plaque.

When you move into the image field, the cursor looks like a feather or pen.



As you draw contours, Vitrea color-codes the calcified regions in the vessel to the color corresponding to the vessel label in the VScore area.

7. On every third image that demonstrates calcium, draw a contour around the plaque.

8. Continue this process until you reach the final image.

   The Results table updates as you draw contours.

   NOTE: This process may vary depending on how tortuous the vessel is.

9. Click **Interpolate** to interpolate between the drawn contours.

   The Results table updates to include the interpolated contours.

CAUTION: Click Interpolate again if you draw additional contours to extend the interpolation to the new contours. You will not be able to take snapshots until all contours are interpolated.

10. Repeat the steps above until you have drawn contour lines around calcium in all necessary vessels.

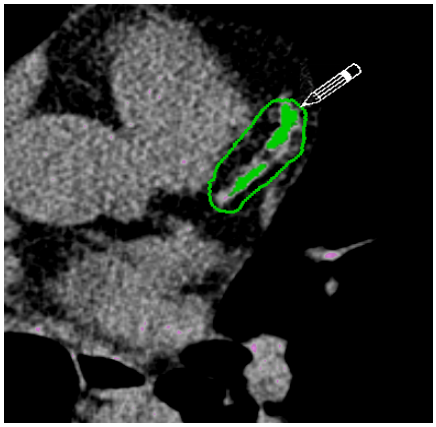
    TIP: To move the Results table, click the top edge and drag.

Edit Contours

CAUTION: Review and edit the contour lines, if necessary. The accuracy of the calcium scores is affected by the accuracy of the contour lines.

11. Float the mouse over the contour line.

    The cursor changes to a pencil icon.



12. Click and drag the mouse and re-draw.

    OR

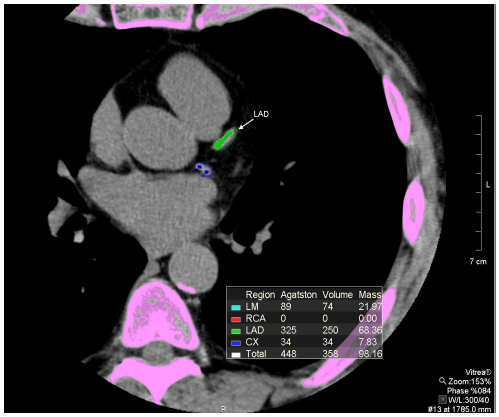
    Press Delete on the keyboard to delete the contour.

Add Labels and Arrows

13. Right-click on the image to activate the toolbar menu.

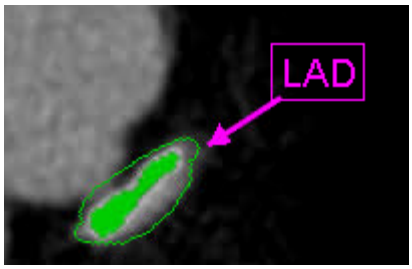
14. Choose .

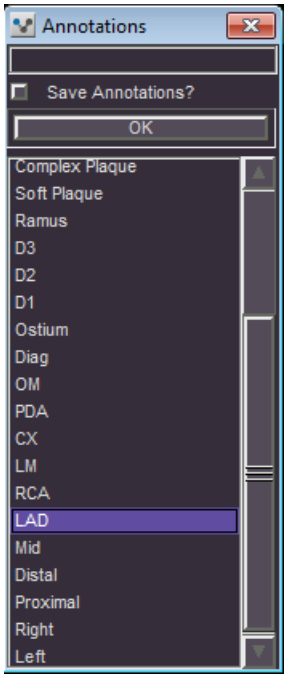
Click on the image to open the pre-defined labels to choose from.



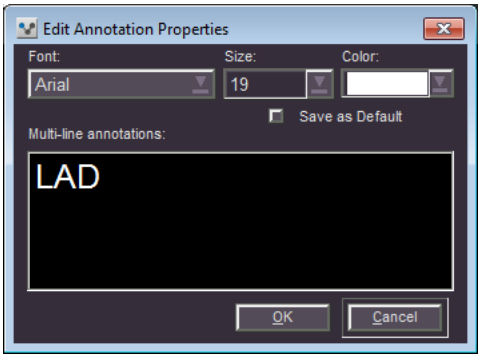
15. Select a label from the pre-defined list, or type a new label and click **OK**.

16. Click the text and drag to move the label.





17. Right-click and select **Edit**. Change size, font, and color. Use the Text box to edit the label.



18. Float the mouse to the corners of the label to activate an arrow.

19. Right-click and select to add arrows in 3D and MPR views.

Take Snapshots

20. Right-click and select (or press S) to activate the camera.

21. Move the cursor to the image and click.

Snapshots, measurements, rulers, W/L, or segmentation option can be restored from the Report page or the Study Directory.

IV. Distribute Findings

The snapshots you take in the Viewer tab demonstrate calcium findings for the patient's report.

1. Click

at the bottom of the window.

The default report page is specific to CT Calcium Scoring. The report includes the results table of the scored vessels.

Results

Region	Calcium Score (Agatston)	Volume (mm^3)	Mass (g)
LM	8	12	2.20
RCA	39	70	11.28
LAD	331	260	70.07
CX	117	99	28.09
PDA	---	---	---
Other1	---	---	---
Other2	---	---	---
Other3	---	---	---
Total	495	441	111.64

Copy to Clipboard (CSV)

Copy to Clipboard (Tabbed)

Total Calcium Score 495

NOTE: The Mass score displays in the report only when the **Mass Score** check box on the Viewer window is selected.

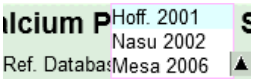
2. To copy the results to your computer clipboard to paste into another application, select the Ca Score Full Report, then click **Copy to Clipboard (CSV)** or **Copy to Clipboard (Tabbed)**.

3. Review the Calcium Percentile Score and graph.

NOTE: If the patient age is missing from the DICOM information, Vitrea will calculate the patient age using the patient's birth date and study date. If in that case either of those are missing from the DICOM information, no graph will display.

TIP: If you are using the Full Cardiac or CA Score full report, click ► to advance the report to the page with the Calcium Percentile Score.

4. To change the reference database, click the **Ref. Database** dropdown and select a database.



NOTE: When you change reference databases, be sure the automatically-populated portions of the report update appropriately.

5. If you are using the MESA 2006 database, click the **Ethnicity** dropdown and select an ethnicity.

See the Appendix for more information regarding the graphs.

See the **Distribute Findings** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide** for instructions on exporting findings, restoring workflow, and creating reports.

Additional Procedures

Edit Text in the Report

To customize text area in a report template:

1. Click a heading or text area enclosed by a box.

2. Enter the text.

3. Click outside the box.

NOTE: Only text areas enclosed by a box are editable.

To add to a list of pre-defined text:

1. Right-click a heading or text area enclosed by a box.

2. Click Add New Item.

3. Type the text.

Optional To make the text the default, select the Make this the default box.

4. Click Save & Close.

To hide or show a text section:

1. Click the **-** button next to the section to hide.

2. Click the + button next to the section to show.

Build a Multi-phase Volume

Build a multi-phase volume to compensate for motion in studies completed at higher heart rates and reconstructed into multiple images per slice/location.

1. Load multiple series into the Calcium Scoring application.

   The Viewer window opens to the 2D All Exams layout displaying all the phases/time points.

2. Scroll through various phases to determine the best overall phase.

   The phases are locked so they all scroll together.

3. In the phase you determined to be the best overall, select the **Pick Phase** Pick Phase check box.

   This selects all the slices in that phase.

4. Scroll through the phases again to determine if there are slices you want to replace with slices from other phases.

5. Select the **Pick Slice**

check box in the new phase slice. This clears the selection in the original phase slice.

6. Continue scrolling and selecting slices until you are satisfied that you have the best slices from the available phases.

7. Click the Play button

to start scoring.

NOTE: The Play button is available only when every slice is represented with a **Pick Slice** check mark.

TIP: To find slices that do not have a **Pick Slice** check mark, press the SPACEBAR.

A virtual volume is created from the selected slices, and the axial view displays in the Viewer window.

NOTE: The virtual volume cannot be saved, but Vitrea saves the slice selections so that the virtual volume can be re-created.

Appendix

Calcium Scores

Region	Agatston	Volume	Mass
LM	89	74	21.97
RCA	0	0	0.00
LAD	325	250	68.36
CX	34	34	7.83
Total	448	358	98.16

Vitrea calculates the calcium scores for each artery. The color block before each score corresponds to the color-coding of the calcified regions in the vessels.

Only scored vessels display in the Results table. Scored vessels with no calcium detected have a result of “O.”

The following information displays on the images in the 2D 1-up or 3D 4-up Viewer window formats (Axial MPR view only):

- Agatston or Continuous score (depending on how Vitrea is configured) — The two methods for calculating calcium scoring, Agatston or Continuous. The Calcium Score area displays calcium scores based on one or the other of these methods, depending on how Vitrea is configured.
- Volume — the total volume of calcium, in cubic millimeters of the calcified areas
- Mass — the cumulative region mass based on the measured calibration factor.

NOTE: The Mass column only displays if the Mass Score check box is selected on the Analysis tab.

Calcium Scoring Methods

Vitrea provides two methods for calculating calcium scoring, Agatston or Continuous. The method that is used depends on how Vitrea is configured.

NOTE: For information about your Vitrea configuration, contact your System Administrator or Technical Support.

For both methods, Vitrea first defines the calcified lesions, then determines the calcium scores. Regardless of which calcium scoring method VitreaAdvanced uses, scoring is done for just the slices that were actually acquired. This section discusses the method Vitrea uses to determine the extent of calcified lesions and the two methods of calcium scoring.

Calcified Lesions

Vitrea checks for calcified lesions within the region you defined for each artery. For each data value within the artery, if the density is at or above a particular value (called the density threshold), the data is considered potentially calcified.

NOTE: Some data with values above the threshold will not indicate calcification. For example, bone is above the density threshold.)

An area within an artery is considered to be a calcified lesion if it is larger than a minimum size (set by the System Administrator), and if all data within the area has a density greater than the density threshold. After Vitrea identifies the calcified lesions in each artery, it uses one of the two methods for calcium scoring.

Agatston Scoring

The Agatston method of calculating calcium scores assigns each lesion a rating of 1, 2, 3, or 4, depending on the data value with the highest density within the lesion.

Density threshold <= data value < 200 rating 1

200 <= data value < 300 rating 2

The score for the lesion is calculated based on the rating, the area of the lesion, and the slice thickness and spacing. Scores for all lesions in a particular artery are added up to get the score for that artery. Scores for all arteries are added up to get the total score.

Continuous Scoring

The Continuous method of calculating calcium scores assigns each lesion a rating by computing the following: (maximum data value within the lesion/100) — 0.5.

EXAMPLE If the maximum data value within a lesion is 375, the rating for the lesion would be 375/100 — 0.5, or 3.75 — 0.5, which is 3.25.

The score for the lesion is calculated based on the rating, the area of the lesion, and the slice thickness and spacing. The scores for all the lesions in a particular artery are added up to get the score for that artery. The scores for all arteries are added up to get the total score.

300 ≤ data value < 400 rating 3

400 ≤ data value rating

Calcium Percentile Score Graphs

The Calcium Percentile Score portion of the Full Cardiac and Ca Score reports offers graphs based on three reference databases: Hoff. 2001, MESA 2006, and Nasu 2002. Snapshots of all the graphs and corresponding charts are also included in the Findings tray so you can export or add to a generic report template.

NOTE: If patient gender is missing or invalid, a graph will not display. In this case, return to the Viewer window and select the patient's gender.

NOTE: If the patient age is missing from the DICOM information, Vitrea will calculate the patient age using the patient's birth date and study date. If in that case either of those are missing from the DICOM information, no graph will display.

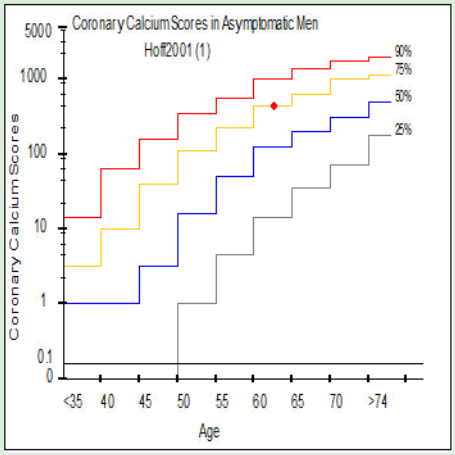
A red dot displays on the graph that indicates the calcium score for the patient's age. Follow the colored lines to determine the percentile listed on the right. The score and percentile are included in the paragraph below.

A chart defining the implications and risks of the calcium score is also included, depending on reference database used.

Hoff 2001

Calcium Percentile Score

Ref. Database: Hoff. 2001



Calcium Score (2, 3)	Implication	Risk of Coronary Artery Disease
0	No identifiable plaque	Very low, generally less than 5 percent
1 - 10	Minimal identifiable plaque	Very unlikely, less than 10 percent
11 - 100	Definite, at least mild atherosclerotic plaque	Mild or minimal coronary narrowings likely
101 - 400	Definite, at least moderate atherosclerotic plaque	Mild coronary artery disease highly likely, significant narrowings possible
401 or Higher	Extensive atherosclerotic plaque	High likelihood of at least one significant coronary narrowing

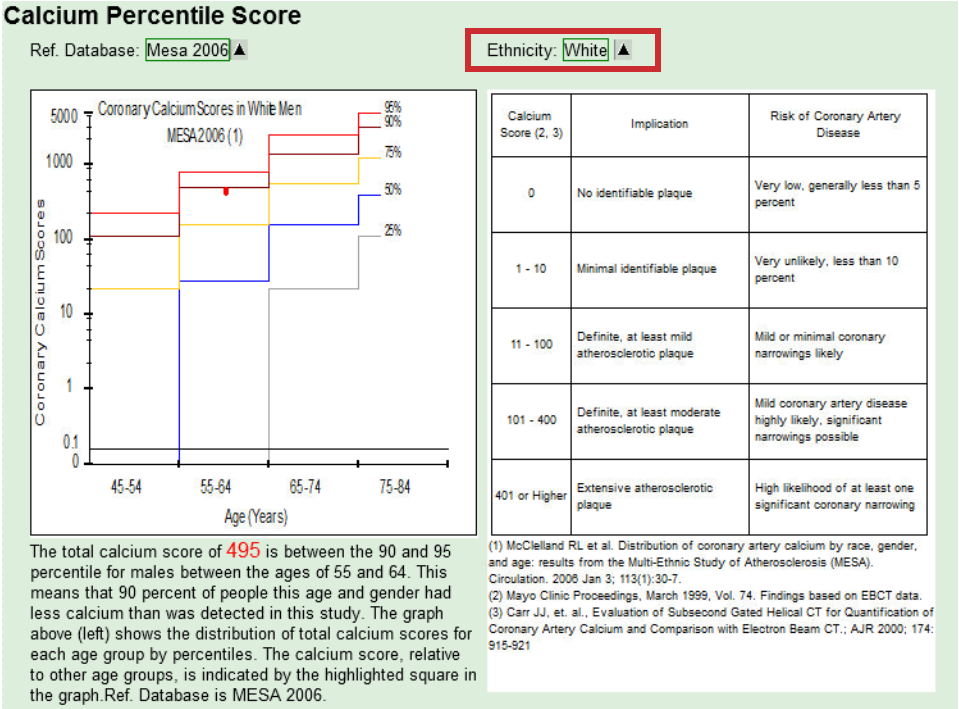
The total calcium score of 495 is between the 75 and 90 percentile for males between the ages of 60 and 64. This means that 75 percent of people this age and gender had less calcium than was detected in this study. The graph above (left) shows the distribution of total calcium scores for each age group by percentiles. The calcium score, relative to other age groups, is indicated by the highlighted square in the graph. Ref. Database is Hoff 2001.

(1) Hoff JA et al. Age and gender distributions of coronary artery calcium detected by electron beam tomography in 35,246 adults. Am J Cardiol. 2001 Jun 15;87 (12):1335-9.
(2) Mayo Clinic Proceedings, March 1999, Vol. 74. Findings based on EBCT data.
(3) Carr JJ, et. al., Evaluation of Subsecond Gated Helical CT for Quantification of Coronary Artery Calcium and Comparison with Electron Beam CT.; AJR 2000; 174: 915-921

Example of Hoff 2001[1] graph and Calcium Score[2, 3] chart

1. Hoff JA et al. Age and gender distributions of coronary artery calcium detected by electron beam tomography in 35,246 adults. Am J Cardiol. 2001 Jun 15;87 (12):1335-9.
2. Mayo Clinic Proceedings, March 1999, vol. 74. Findings based on EBCT data.
3. Carr JJ, et. al., Evaluation of Subsecond Gated Helical CT for Quantification of Coronary Artery Calcium and Comparison with Electron Beam CT.; AJR 2000; 174:915-921.

MESA 2006



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Example of MESA 2006[1] graph and Calcium Score[2, 3] chart

1. McClelland RL et. al. Distribution of coronary artery calcium by race, gender, and age: results from the Multi-Ethnic Study of Atherosclerosis (MESA). Circulation. 2006 Jan 3; 113(1): 30-7.
2. Mayo Clinic Proceedings, March 1999, vol. 74. Findings based on EBCT data.
3. Carr JJ, et. al., Evaluation of Subsecond Gated Helical CT for Quantification of Coronary Artery Calcium and Comparison with Electron Beam CT.; AJR 2000; 174:915-921.

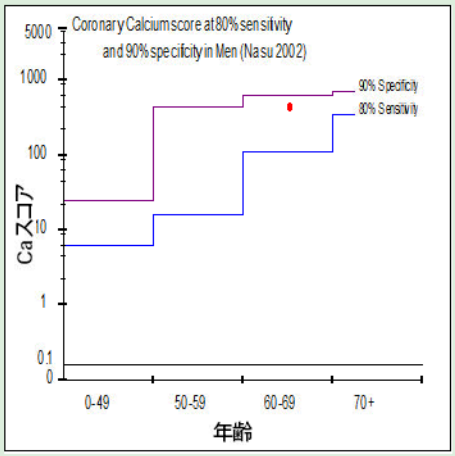
- If you are using the MESA 2006 database, click the **Ethnicity** dropdown and select an ethnicity.

NOTE: The valid age range for the MESA 2006 database is between 45 and 84 years. If the patient age is less than 45 years, the age 45 line on the graph will be used. If the patient age is more than 84 years, the age 84 line on the graph will be used.

Nasu 2002

Calcium Percentile Score

Ref. Database: Nasu 2002



The total calcium score is 495 . This is above the 80% sensitivity curve. This is below the 90% specificity curve. This is based on the data for males between the ages of 60 and 69. Ref. Database is NASU 2002.

	Sensitivity 80%	Specificity 90%
Men		
Age Group (Year)		
<=49	6	24
50-59	15	430
60-69	104	602
70<=	318	658
Women		
Age Group (Year)		
<=49	0.1	13
50-59	6	2
60-69	118	118
70<=	196	416

(1) K.Nasu, et .al; Coronary Artery Calcification Score Measured by Electron Beam Computed Tomography for Evaluation of Ischemic Heart Disease in Japanese. NIPPON ACTA RADIOLOGICA 2002;62:701-706

Example of Nasu 2002 graph and Sensitivity/Specificity chart[1]

NOTE: A 0.1 line is included to help distinguish between a score of 0 and >0.

1. K.Nasu, et. al.; Coronary Artery Calcification Score Measured by Electron Beam Computed Tomography for Evaluation of Ischemic Heart Disease in Japanese. NIPPON ACTA RADIOLOGICA 2002; 62: 701-706.

CT Cardiac Analysis (Cardiac CTA)

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  - Gallery Window
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- Create Centerline Angles
- View the Diameter and Area in Graph Format
- Create Custom Window/Level Settings
- View Subtracted Series

Appendix

- Automated Cross-sectional Measurements
- Transluminal Attenuation Gradients (TAG)

CT Cardiac Analysis (Cardiac CTA) Overview

The CT Cardiac option provides a variety of tools and views for working with clinical CT images of the coronary arteries, heart, and surrounding tissue.

The software supports CTA studies acquired by 4-slice and above MS-CT scanners. The software does not support MRA studies.

The automatic segmentation will perform best when the HU intensity of the vessel lumen is below 1500 HU. If there are artifacts, such as clips or wires, present in the image, the automatic segmentation will perform best when the HU intensity of the artifacts is below 2000 HU.

NOTE: Because of the high HU value of contrast media in 80-100kV scans, the reliability of calcium detection within the vessel is expected to be lower than that of regular kV scans.

CT Cardiac includes:

- Automatic segmentation of the heart from the rest of the anatomy
- Zero-click coronary vessel tree segmentation and automatic labeling of main coronary arteries
- Selection of any coronary artery for viewing with the Vessel Probe tool with easy centerline review and editing
- Full Vessel Probe capabilities for coronary arteries including the Lesion Tool, Vessel Walk, and Cath View
- A fly-through preset configured for flying through the coronary vessels
- Unique Heart Mode to automatically orient oblique MPR views to show one short-axis view and two long-axis views
- Key findings classification during reading of the study for semi-automated structured report generation
- Measure plaque burden between the lumen and the outer wall with the SUREPlaque tool
- Display a Transluminal Attenuation Gradient for probed vessels.

CT Cardiac Analysis (Cardiac CTA) Lesson

I. Select Study

Load a Coronary Arteries study.

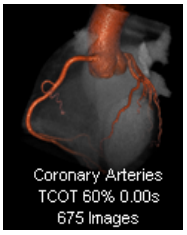
See the instructions for your Vitrea type (VitreaAdvanced Through the Data Manager or VitreaWorkstation) in the **Select Study** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide**.

II. Choose Protocol and Preset

Use one of these procedures:

Data Manager

- Double-click the **Coronary Arteries** application thumbnail.



Gallery Window

1. On the Gallery window, select the **Cardiac: Arteries CT** protocol.

   The Gallery choices update automatically.

   For detailed information on modifying presets, see the Additional Procedures section.

2. Click Pick next to the **3D Analysis-Auto Vessels** preset.

Vitrea probes the vessels.

NOTE: To manually probe vessels, click Pick next to the **3D Analysis** option.

III. Perform Analysis

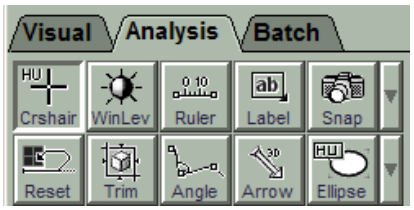
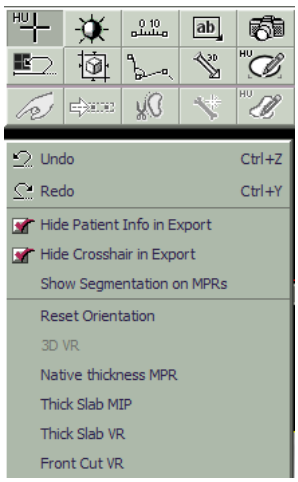
Perform 3D Overview

1. Evaluate the overall quality of the study.

   a. Click to maximize the 3D image. Rotate the volume to look for gross abnormalities, origins of coronary vessels, bypass grafts, aorta, pulmonary arteries, and pulmonary veins.

   b. Verify the Show Vessel check box is cleared.

   c. Access the window/level, ruler, and crosshair tools from the Analysis tab or right-click menu.

Analysis Tab Tools	Right-click Menu Tools
	

   d. Adjust the orientation of the heart for viewing using the function keys.

2. Assess study quality by scrolling through the orthogonal planes.

   a. Click to return to the 4-up view.

   b. Select Orthogonal from the MPR dropdown list.

c. In the axial plane, right-click and drag or roll the center wheel to assess overall quality of the study to look for gross abnormalities.

d. Assess contrast bolus enhancement using the crosshair or ROI tools.

- Use the Crosshair tool

and click and hold on the image for a single HU reading.
- Use the ROI tool

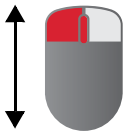
(available from the Ellipse dropdown) or the Ellipse tool

to draw a region of interest.
- The HU should be approximately 250-450 HU.

e. Scroll through the coronal and sagittal views to check for artifacts such as misregistration, metal artifact, or beam hardening.

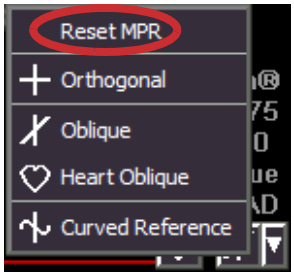
f. Click and hold the left and center mouse and drag up to increase or down to decrease the magnification of the MPR and 3D images.

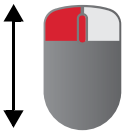
- Click and hold the left and center mouse wheel while moving the mouse away from you to magnify.
- Click and hold the left and center mouse wheel while moving the mouse closer to you to minify.



g. Press and hold the center mouse wheel and move to the center to re-center or pan the image to keep the point of interest centered in the Viewer window.

Review the Study

Function	Procedure
Review anatomy, study quality of study in the axial, coronal, and sagittal views	Use the MPR views to review.
Display the MPR view menu	In the lower right corner of the MPR views, click the dropdown arrow to display the menu.
Reset MPR	Resets the volumes to the orthogonal view and is useful after walking the vessel for resetting the data. 
Display the different planes	• Orthogonal – This view displays in sagittal, coronal, and axial planes. • Oblique – This view displays in an oblique plane. • Curved Reference – This view sets crosshairs for you to define a curve.
Display image in 1-up view	Click Maximize to switch to 1-up Viewer window format
Rotate MPR views	Click **Rotate MPRs** to change the arrangement of sagittal, coronal, and axial images.

Function	Procedure
Maximize and Minimize the views	Press and hold the left and center mouse wheel and move the mouse towards or away from you. 
Review the Heart Mode images.	In the bottom right corner of the oblique MPR view, select . When the Heart Mode is active, the Heart changes to a filled heart . **TIP:** The Heart Mode button toggles between orthogonal views, cardiac short axis, and 2 and 4 chamber views.

Evaluate Coronary Arteries

3. Adjust visualization of vessels to better visualize vessels and check for artifacts.

- Adjust the MPR views to MIP, Average, Volume Render, or Colored Lit from the dropdown menu.

- Adjust the slider bar in MPR views to increase or decrease the MPR thickness for a MIP image.

TIP: The size of the MIP should not be larger than the vessel diameter.

- Click

to adjust window/level values. Click and drag the mouse up and down and left and right to differentiate the types of lesions (calcific vs non-calcific).

NOTE: When you adjust the window/level for either the Heart or Vessels regions, both regions will adjust to avoid a difference in appearance between probed and unprobed vessels.

TIP: Window level is also available when you left + right-click and drag.

4. Right-click and scroll to visualize arteries in the oblique MPR view to best identify atheromas, lesions, and areas of stenosis.

5. Use the MPR Mode tool on the lower right hand corner of the views to select Orthogonal, Oblique, Curved, and Heart Oblique to change MPR views to visualize vessels in multiple planes of view.

Probe Vessels

Vessel probe allows you to click on an artery to view the highlighted vessel in 3D, curved reformat, and cross-sectional reformat views simultaneously. Use the Vessel Probe option on contrast-enhanced CTA and MRA studies.

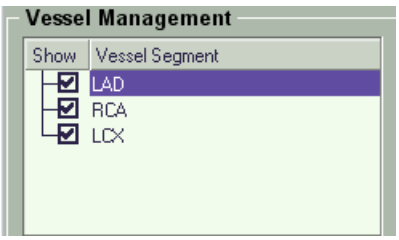
With the 3D Analysis - Auto Vessels preset, Vitrea automatically segments and labels the three main coronary vessels (LAD, RCA, and LCX) in all loaded phases.

TIP: Use the space bar to toggle through the probed vessels.

6. View the Phase Navigation Bar (located at the bottom of the viewer window):

   - Navigate between phases instead of using previous or next.
   - Vessel Probe (auto) carries you through all phases quickly for CPR and MPR viewing.

To select or probe an additional vessel:



7. Verify the Show Vessel check box is selected.

8. Select and highlight the vessel you want to view in the Vessel management box, or

   If the vessel you want to view is not already probed for you, locate the vessel you want to probe in the 3D or MPR viewer.

   a. From the Analysis tab, click

.

   b. Click the vessel.

   c. Select the vessel name and right-click to rename the vessel.

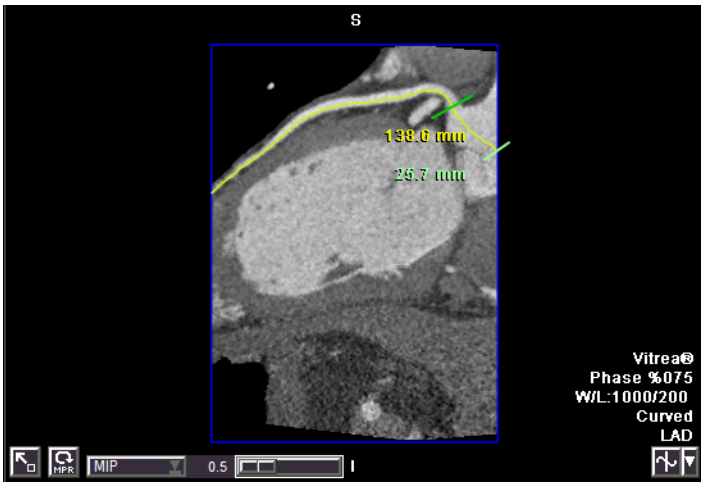
   See the Additional Procedures section for detailed information on how to extend a probed vessel.

Automatic Curved MPR Mode Vessel Probe

Use the steps below for stent placement to achieve exact vessel length measurements.

9. Select the probed vessel from the Vessel Management list.

10. Select the axial view and choose Curved Reference from the dropdown list.



TIP: The color of the curved reference line changes depending on if you choose axial, coronal, or sagittal view from the curved reference choice.

11. Distance measurements along the centerline between the big line and the measuring bar (short line).

a. Click on the big line and a hand displays.

b. Move the hand and place the line along the vessel.

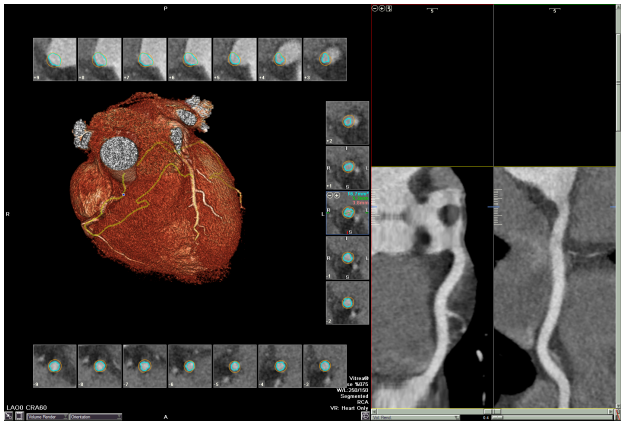
c. Repeat on the short line for distance measurement.

View 3D, Cath, and Curved Planar Reformatted Views

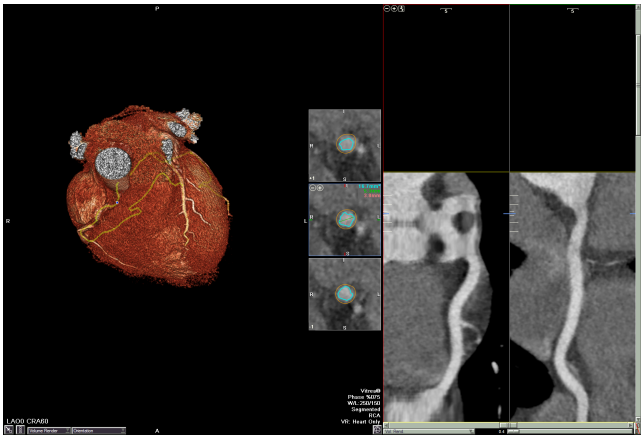
12. Click the 1-up arrow located in the bottom left corner of 3D volume image.

A mode button is displayed next to the 1-up arrow .

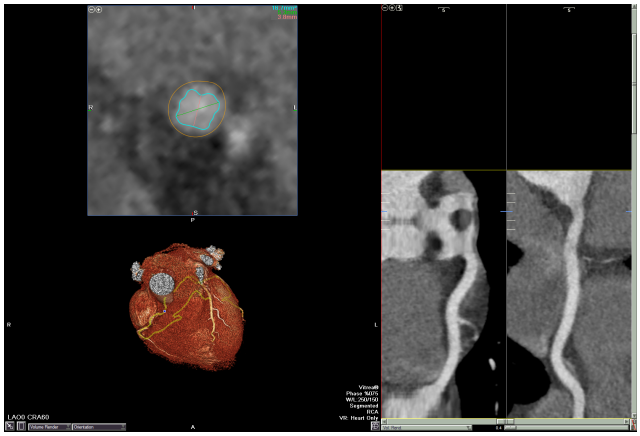
Montage Layout – This is the default in the 1-up format. This view displays several 1 mm cross-sectional views of the vessel.



Large Cross-sectional Layout – Three large viewing insets. The default view is the middle of the curved MPR.

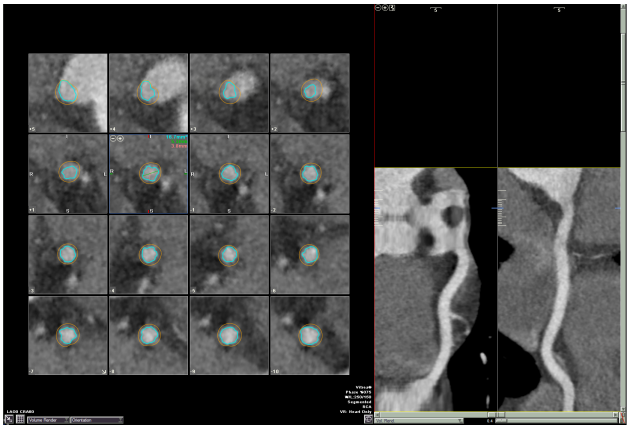


Large Transaxial Layout – One large viewing inset. The default view is the middle of the curved MPR.



Contour Editing Layout – This view displays several transverse views spaced at 1mm increments. Use this view for contour editing. When you are in this mode, you will not be able to view the 3D volume or MPR.

The number of transverse viewers that displays depends on the resolution of the viewer.



Cath View Layout – Interactive display that updates when rotating either cath or 3D views.

See the Cath view steps below for more information.

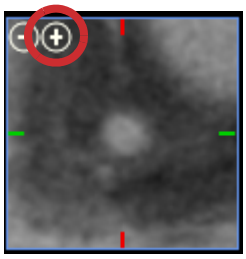
13. Click the mode button to open the Cath view.

TIP: The mode button changes to a square when you are in Cath view.

- When the crosshair tool is active, a blue crosshair displays at the location of the current centerline point to allow cross-referencing across images. The display location of the current centerline point updates interactively when you scroll along the centerline (by scrolling in the curved inset, adjusting the transverse line in the curved MPR, cine in the transverse MPR).
- When the Crosshair tool is active, change the view angle of the CathView image. Click and hold on the image and drag in the desired direction.
- Click and drag to rotate the 3D volume image.
- In the CPR view, move bottom arrows L-R on horizontal slide bar to rotate CPR views.
- Vertical slide bar moves the CPR image proximal and distal to view the entire vessel length.

Explore the Lumen

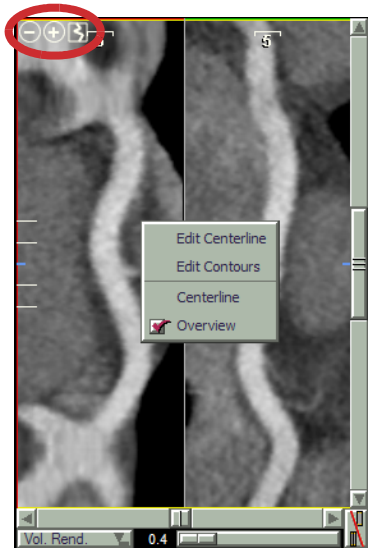
14. Click on the plus sign in the upper left corner of the blue box to magnify the cross-sectional vessel view.



15. Click the plus/minus sign above the CPR views to magnify/minify the image, and click the optimal zoom sign to maximize the image.

16. Click

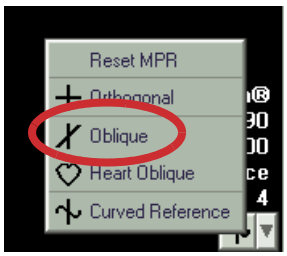
and hold in lumen to evaluate plaque HU characteristics.



Oblique Reformations or Vessel Walk

17. Select the axial view from the 4 on 1 image display.

18. Select Oblique from the dropdown list located on the bottom right corner of each MPR view.



19. Scroll the axial cardiac images and locate the left main and proximal left anterior descending artery.

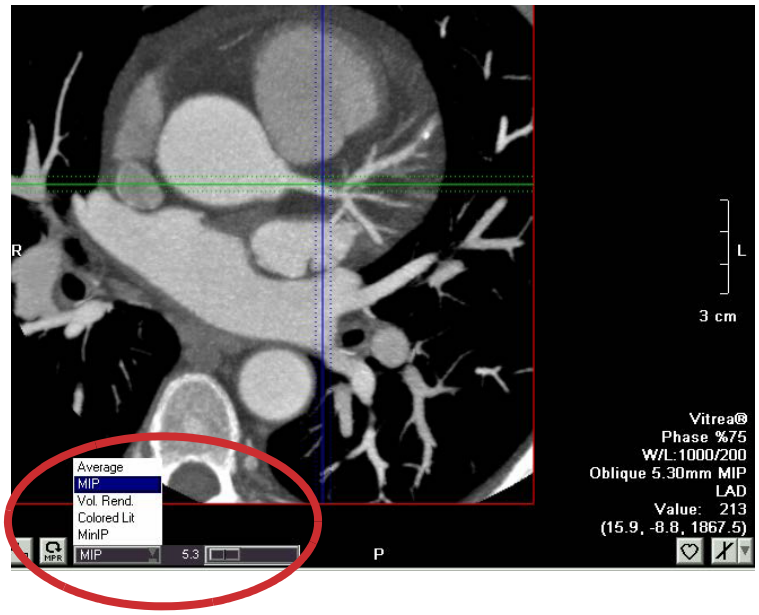
20. Place the crosshair on the vessel.

The cursor changes to the oblique angle orientation tool.

21. Click and drag to rotate the image.

Optional Apply a slab thickness. The MPR Slice Thickness slider reconstructs the brightest pixels from a stack of images. Click and drag the Thickness slider to view as much of the vessel as possible. In the MPR Options menu, **MIP** is automatically selected.

TIP: For best results, set the thickness slider to the vessel diameter.



22. Activate the crosshair and double-click the vessel to reset the crosshair further along the vessel. Repeat the steps above.

23. Double-click to center the image.

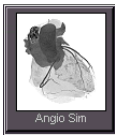
TIP: Reset MPR returns the image to oblique MPR. This is helpful when the vessel you are tracking becomes disoriented.

Apply an Angio or MIP Preset

24. Click to 1-up the 3D image.

25. Clear the Show Vessel box to hide curved planar reformatted views.

26. From the Visualization Preset options, select one of these presets:

Preset	Description
Angio MIP	A simulated angiographic MIP image (dark background with light contrast) where Vitrea segments and hides the heart chambers. **NOTE:** If you have already segmented the chambers, no further segmentation will occur.
 Angio Sim	A simulated angiographic image (light background with dark contrast) where Vitrea segments and hides the heart chambers. **NOTE:** If you have already segmented the chambers, no further segmentation will occur.
MIP	A MIP image (dark background with light contrast) where the heart chambers are not segmented.
Inverted MIP	An inverted MIP image (light background with dark contrast) where the heart chambers are not segmented.

27. Press and hold Shift and choose F3, F4, F5, F6, F7, and F8 for additional cath views.

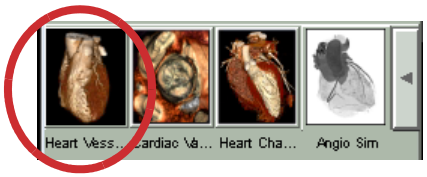
NOTE: It is recommended that you apply angio presets only to the original data. If you apply an angio presets when using a modified preset with denoising, the results may be unexpected.

Display Transluminal Attenuation Gradient (TAG)

Transluminal Attenuation Gradient (TAG) shows the CT value gradient of probed coronary arteries along the centerlines.

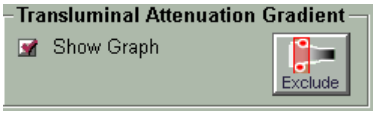
When the TAG graph is displayed, the results for all probed vessels display in the findings tray, and the results for the LAD, RCA, and LCX automatically populate in the Coronaries report.

28. Select **Heart Vessels**.



29. Click to change the 3D view to a 1-up image.

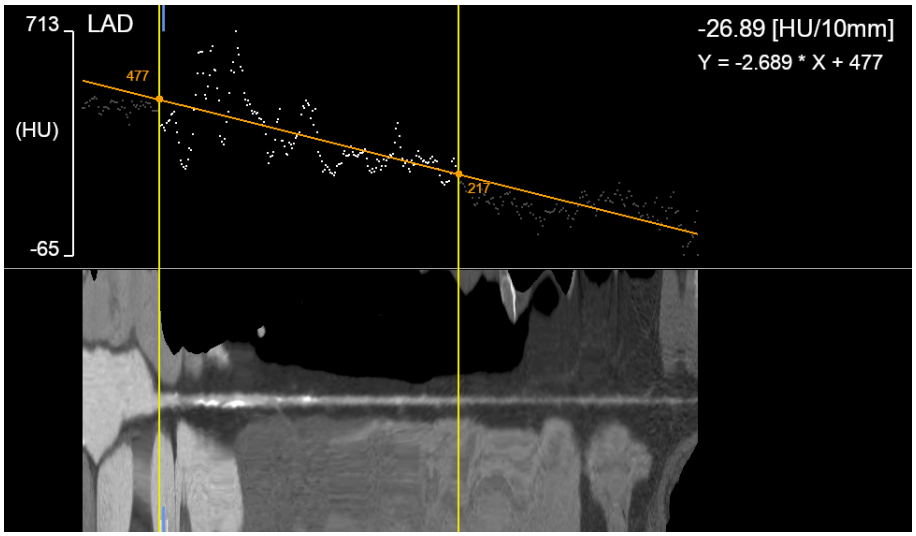
30. Select **Show Graph**.



A TAG graph and a straightened planar reformat (SPR) view display.

The graph shows plotted points representing HU values along the length of the lumen.

The graph and SPR view shows a range with yellow lines for calculating the gradient. The yellow lines are set at the ostium and at the first 2mm minimum diameter of the lumen from the distal end.



The short blue lines on the graph and SPR view correspond to the blue dot on the 3D view and the center cross-sectional view.

31. To adjust the yellow lines in the graph, click the line until the cursor changes to a double arrow, and drag to the new location.

NOTE: If the peripheral vessel seems to have a partial volume effect, it should be excluded.

32. To rotate the SPR view, click and drag up and down within the view.

33. To exclude a portion of the vessel from the calculations:

EXAMPLE Exclude the area where another vessel takes off or areas of heavy calcification.

a. Click

.

b. Click and drag in either the TAG or SPR views.

c. Adjust the orange exclude definition lines by clicking and dragging.

d. To delete the excluded area, right click the contour in the SPR view, and select **Delete**.

34. Select vessels in the Vessel Management area to review the TAG for other vessels.

35. Use the Volume Navigation buttons to review vessels of other loaded volumes.

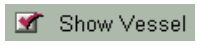
NOTE: When switching vessels or volumes, review the labels on the TAG to verify it is displaying the correct vessel.

See the Appendix of this chapter for further information on TAG.

Lesion Analysis

36. Click to change the 3D view to a 1-up image and display a vessel probe view.

37. Verify the Show Vessel check box is selected to display the curved planar reformatted views.



38. Select **Single**

. The cursor changes to the selected Lesion Measurement shape.

The Lesion dropdown contains three lesion tools for you to choose from:

	Single – When you draw a lesion using the Single method, Vitrea automatically identifies a point as the reference point. Vitrea displays the minimum diameter at the narrowest point and at the reference point.
	Average – When you draw a lesion using the Averaged method, Vitrea does not need a reference point, so it does not display a point marked in green. Vitrea displays the minimum diameter at the narrowest point and both end points.
	Dual – Dual Reference allows average reference measurements and separate length measurements. The top and bottom green cross sections as reference. The red cross section is the minimum diameter. The blue line represents the length measurement.
	Volume – When you draw a region using the Volume method, Vitrea displays the volume of the lumen and outer wall. It also identifies the maximum outer wall diameter. Use this option for thrombosed regions.
	Landing Zone – Use the Landing Zones option to define specific regions for in-depth analysis.

39. Move the mouse into the CPR view over the region of interest such as a lesion.

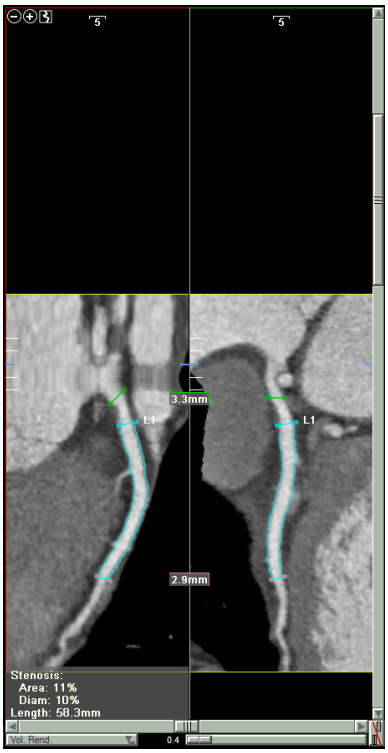
40. Click near the start of the lesion and drag to the end.

TIP: Vitrea identifies key positions by analyzing the cross-sections along the centerline:

- Point of maximum narrowing (marked in red) – the point on the lesion between the start and the end points where the cross-section area is the smallest.
- Reference lumen (marked in green) – point outside the lesion, 10 mm from the end of the lesion, for lesions that use the Single Lumen Reference method.

- Once a user-defined lesion exists, the lesion volume measurements (lower black box) display.

41. Verify the green reference line is at a normal part of the vessel. The red line in the vessel displays a decreased area and diameter compared to the green line.



42. To delete a lesion, be sure the lesion you want to delete is the active lesion, then press DELETE.

CAUTION: Be aware that the Stenosis point within an identified lesion is initialized to the minimum luminal area and not to the minimum luminal diameter of the overall identified lesion.

SUREPlaque

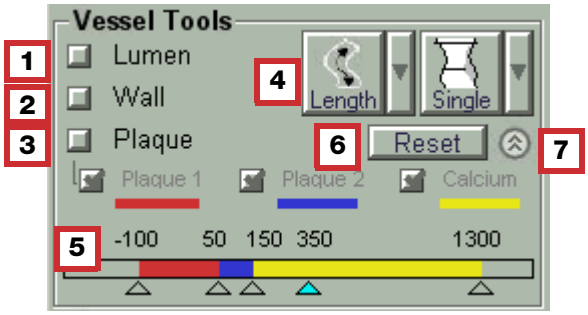
The SUREPlaque™ workflow for Vitrea software is a post-processing software application that facilitates faster and easier visualization of vascular lumens, vessel walls, and plaque in the vessels. This software lays vessels out in curved planar reformats, cross-sectional views, and

maximum intensity views. Colors based on a density range can then be applied to various parts of the vessel for easier reading. In addition, the software can quantify the color-coded parts of the vessel and display the derived quantitative values on the screen.

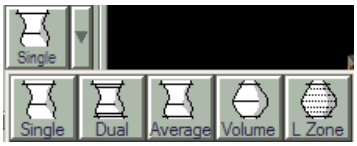
Use SUREPlaque for coronary, carotid, renal, and peripheral vessels.

CAUTION: To prevent incorrect diagnosis, verify the centerline, the accuracy of the location of the lumen and outer wall boundary contours, the HU ranges set for the plaque description correspond to the true pathology, and that the location of the lesion and reference points correspond to the correct anatomical locations. Correct it if the physician judges it to be inappropriate. Clinical decisions should not be completely based on these results. You must correlate the interpretation with the original 2D images.

43. After performing the lesion tool analysis, select Lumen, Plaque, and Wall from the Vessel Tools box on the Analysis tab.



Callout	Description
1	**Lumen** check box — Select to display lumen boundary contours. Clear to hide. Lumen contours display in cyan.
2	**Wall** check box — Select to display the outer wall contour. Clear to hide. Wall contours display in orange.

Callout	Description
3	**Plaque** check box — Select to display the color overlay for all plaque components and plaque measurements. Clear to hide. The HU value settings for each plaque component is initialized from the preset. When you clear the Plaque box, the color overlay disappears. When the values are not specified in the preset, the following settings are used: • **Plaque 1** Check box: -100 to 49 (HU) is the default range Select to display red for the Plaque 1 (non-calcified plaque) component • **Plaque 2** Check box: 50 to 149 (HU) is the default range Select to display blue for the Plaque 2 (non-calcified plaque) component • **Calcium** check box: 150 to 1300 (HU) is the default range Select to display yellow for the Calcium (hard plaque) component If you make changes to the settings, press CTRL-P (modified preset) to save the new settings for future sessions. **TIP:** For additional information about modified presets, see the Using Modified Presets section in the Common Tasks chapter.
4	**Lesion** button — Click to highlight and measure stenosis and plaque within user-defined vessel segments. Click the dropdown arrow to select Single, Average, Dual, or Volume. Use the L Zone (Landing Zone) option for Endovascular Stent Planning. 

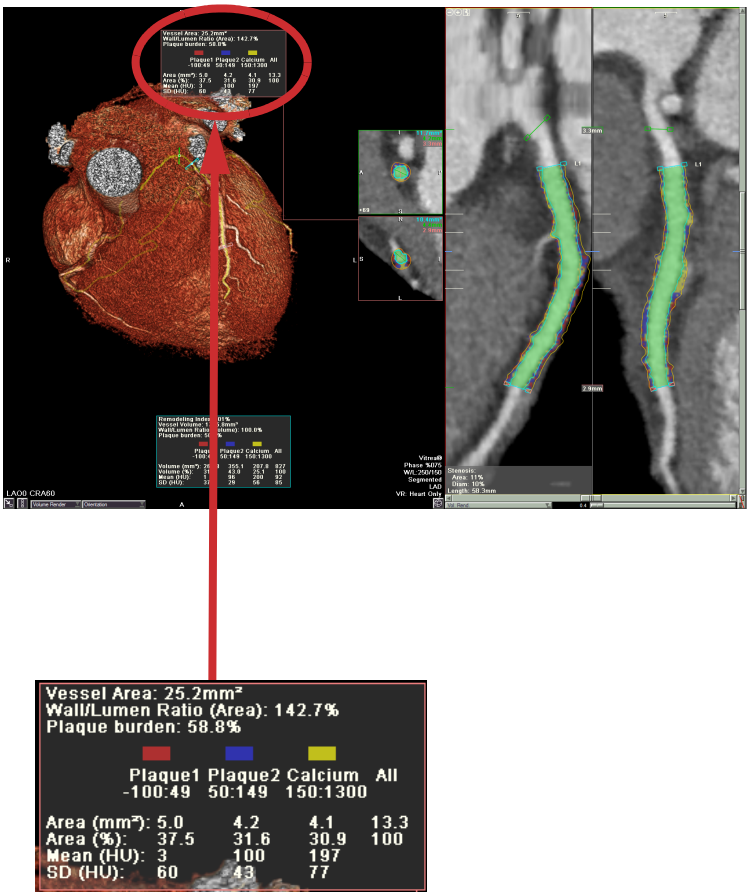
Callout	Description
5	**Plaque Settings** bar — Adjust the HU value settings defining plaque components. Click the HU value text to activate a text box. The box turns white. Adjust the HU value. The following HU settings are updated: • color-coded overlay on curved and cross-sectional images. • cross-sectional measurements. • lesion volume measurements. Click and drag a triangle or separation bar to increase or decrease HU value range. Click and drag the **Lumen Threshold** (cyan triangle) to adjust the lumen boundary whenever the lumen boundary results are not satisfactory in the presence of calcium, stent, or high intensity artifacts.
6	**Reset** button — Click to change the plaque settings bar to default values.
7	**Expand/Collapse** button — Click to show or hide the Plaque Settings bar.

44. The inset view displays total area and minimum and maximum diameters of the displayed vessel.

Cross-sectional Measurements

The cross-sectional measurements display in a black box at the top of the screen. They also display in the upper right corner of the cross-sectional view corresponding to the current point of interest.

The cross-section measurements calculate from the boundary contours of each cross-section.



The following cross-sectional measurements are extracted at 0.5 mm intervals along the centerline:

NOTE: You must use the mouse wheel to view each .5mm slice.

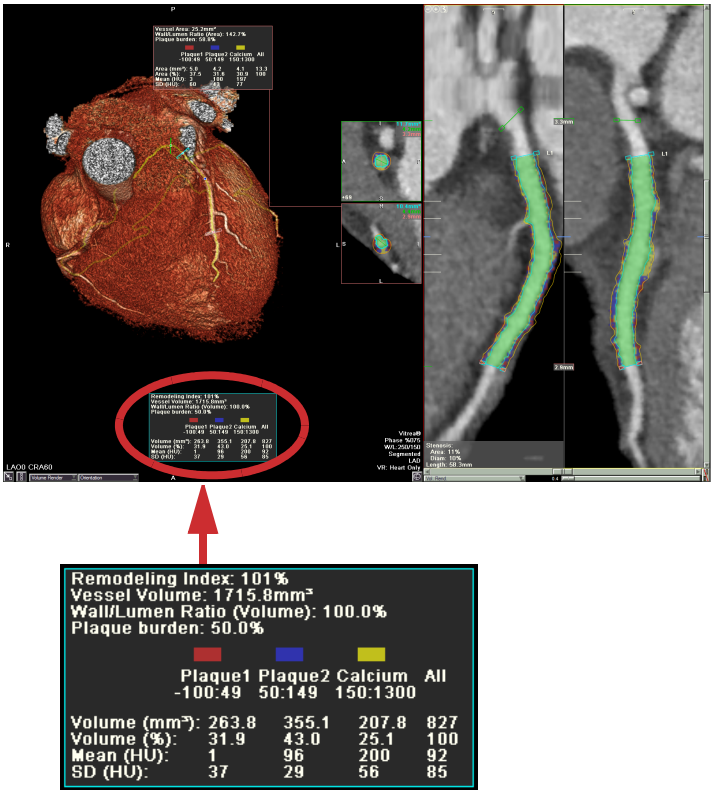
Item	Purpose
Vessel Area	**Area (mm2) —** The area within the outer wall contour.
Wall to Lumen Area ratio (%)	The wall is the space between the inner and outer contours. The wall area is the vessel area minus the lumen area. Wall area/Lumen area x 100 A low wall to lumen ratio means there is not much plaque.

Item	Purpose
Plaque burden (%)	Plaque burden is another way of comparing the wall area and the lumen area. The wall area is the vessel area minus the lumen area. The plaque burden is a measure of cross-sectional area stenosis. Wall area/Vessel area x 100 A low plaque burden means there is not much plaque.
Plaque components (Plaque 1, Plaque 2, Calcium)	**Area (mm2)** — The area of all pixels on the cross-section corresponding to the plaque component. **Area (%)** — Individual percentages of plaque within that cross-section. **Mean (HU)** — The mean value of the intensity of pixels on the cross-section corresponding to the plaque component. **SD (HU)** — The standard deviation of the intensity of pixels on the cross-section corresponding to the plaque component.

NOTE: To view the SUREPlaque measurements in a spreadsheet format, contact Vital Support.

45. Text boxes show remodeling index, wall/lumen ratios, plaque burden.

The lesion volume measurements calculate for each user-defined lesion or vessel segment. If there is not a user-defined lesion, these measurements will not display.



Measurement	Description
Remodeling index	The remodeling index is the ratio of the vessel area (the area within the outer contour) at the point in the lesion that has the red mark, divided by the vessel area at the reference point.
Plaque components (Plaque 1, Plaque 2, Calcium	**Volume (mm3)** – The total plaque volume within the outer wall boundary in the highlighted extent of the lesion corresponding to the plaque component. **Mean (HU)** – average **Standard Deviation (HU)**

Take Snapshots

46. Right-click and select (or press S) to activate the camera.

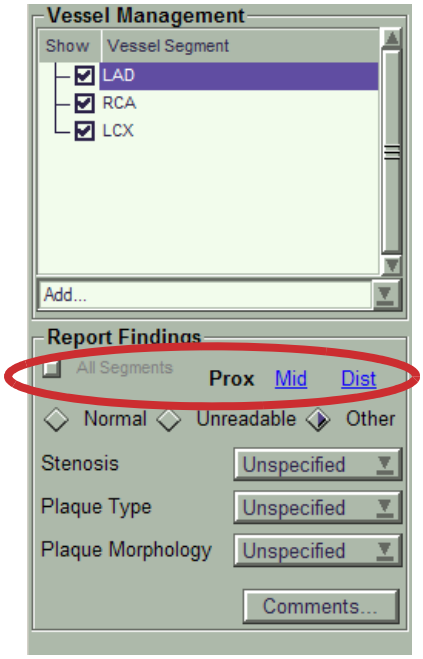
47. Move cursor to image and click.

Snapshots, measurements, rulers, W/L, or segmentation option can be restored from the Report page or the Study Directory.

TIP: To capture the entire screen, press CTRL and click in the view.

Cardiac Report Findings

1. From the Viewer window Analysis tab, use Report Findings to report on vessels, grafts, and stents.



NOTE: Select the Add dropdown box to add additional vessels, grafts, or stents to the Vessel Management list. Enter a name in the Add box.

2. Select Prox, Mid, or Dist to report findings for the different segments of the vessel.
   - Black – segments you are reporting on.
   - Blue – segments not reported or not available.
   - Purple – segments that are reported.
   - Select All – segments to report on the entire vessel.

TIP: All segments only display if a vessel with segments is active.

3. The options below are only available for vessels and grafts.

Normal — The dropdown and comments section are disabled. Normal displays in the report.

Unreadable — The dropdown and comments section is disabled. Unreadable displays in the report.

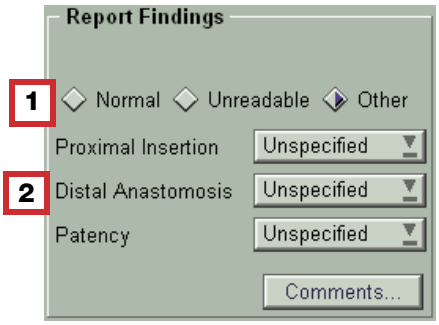
Other (default) — Identify findings by selecting the dropdown boxes and reporting on Stenosis, Plaque Type, and Plaque Morphology.

Stenosis — Click the drop-down and select the type of stenosis (No Stenosis, Mild, Mild/Moderate, Moderate, Severe, Occluded).

Plaque Type — Click the dropdown and select the plaque type (Non-calcified, Mixed, Calcified).

Plaque Morphology — Click the dropdown and select the plaque morphology (Focal, Diffuse).

Report Findings for Grafts:



Callout	Description
1	The options below are only available for vessels and grafts. **Normal** — the dropdown and comments section is disabled. Normal displays in the report. **Unreadable** — the dropdown and comments section is disabled. Unreadable displays in the report. **Other** — the default. You identify your findings by selecting the dropdown boxes and reporting on Stenosis, Plaque Type, and Plaque Morphology.
2	**Proximal Insertion** — Click the dropdown and select the appropriate proximal insertion. **Distal Anastomosis** — Click the dropdown and select the appropriate distal anastomosis. **Patency** — Click the dropdown and select the appropriate patency. **Comments...** — Click **Comments** to enter comments.

Report Findings for Stents:

Callout	Description
1	Select the Prox, Mid, or Dist box to report on stent findings.
2	**Patency** — Click the dropdown and select the type of patency (Patent, Mild, Mild/Moderate, Moderate, Severe, Occluded). **Plaque Type** — Click the dropdown and select the plaque type (Non-calcified, Mixed, Calcified). **Comments...** — Click **Comments** to enter any comments.

4. Select Comments... to add additional information. Your selections and comments display in the report.

V. Distribute Findings

The snapshots, batches, and movies you save in the Viewer window are saved to the Report window.

1. Click Report at the bottom of the window.

2. Export your findings or create a report.

   See the **Distribute Findings** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide** for instructions on exporting findings, restoring workflow, and creating reports.

Additional Procedures

Modify Presets

1. Load a study or volume.
2. Select one of the default presets.
3. Change any of these settings on the Viewer window: Viewer window format, imaging controls, display options, view options, image appearance (rotating the 3D view, panning images, zooming in or out).
4. When finished, press CTRL-P.

   The Save current settings as a modified preset? message displays.
5. Click **OK**.

   This saves new settings as a customized preset. The standard presets are not affected.
6. The next time you load the same type of study, the Gallery displays the **Use Modified Presets** check box. The **Use Modified presets** check box must be selected.

   All customized preset names contain the word (modified).
7. Select the modified preset.

   The Viewer window displays with your customized settings, as defined by the modified preset.

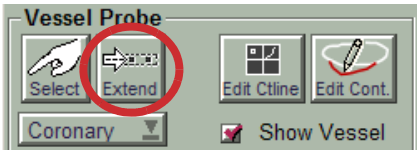
Extend a Probed Vessel

1. Click to 1-up the volume view image.
2. If the vessel you want to extend is not the currently selected vessel in the Vessel Management list, click the vessel name to select it.

   TIP: Probed vessels can be extended on the MPR views.

3. Rotate the image to display the desired area of the vessel.

4. Click **Extend**. The cursor changes to a pointed finger.



TIP: Extend is also available from the right-click menu.

5. Click a point farther along the already selected vessel.

TIP: If the vessel probe can extend the vessel, it adds to the current vessel indicator line. If the vessel probe cannot extend the vessel, the status line displays the message Failed to find vessel.

6. To refine the vessel indicator line, drag the cursor along the vessel indicator line to a desired end point and click.

TIP: As you drag the cursor, the vessel indicator line disappears. It will not be removed until you click.

Trim the Vessel

The CPR views can be edited with the trim function. Yellow trim lines are located on the top and bottom of a probed vessel. Move the trim lines to trim a probed vessel that may have gone out of the vessel.

1. Click and drag the trim line up or down.

   Portions of the vessel outside the trim line will turn gray and be removed.

2. Right-click and select **Undo** to restore the portions removed.

Edit from the Curved MPR

1. Select Curved Reference from the dropdown list located on the bottom right corner of the MPR view.

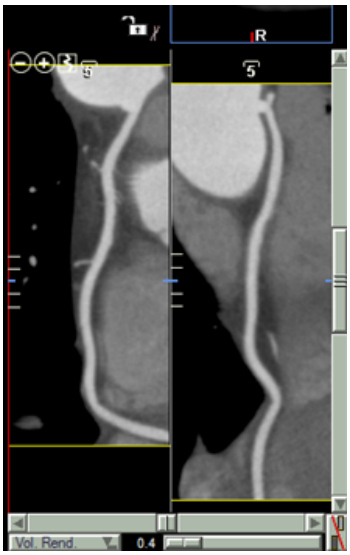
2. Locate the area of interest in the curved MPR view or the cross-sectional image.

3. Draw along the yellow line or move the blue dot to edit.

4. Zoom in on the image to view and edit the image.

Vessel Probe Curved Inset View

The curved inset view is similar to the view you create by changing the MPR to curved reference. The length is preserved when you rotate the CPR.



Fit the image in view

Fit the image on the side that currently has the larger longitudinal length. After the image is fit in the view, zoom the image in and out to cover most of the viewer area.

NOTE: When you fit the image to the viewer in curved mode and switch to the straightened mode, re-fit the image to view it in the viewer.

Measurement in the Left and Right CPR on Y direction

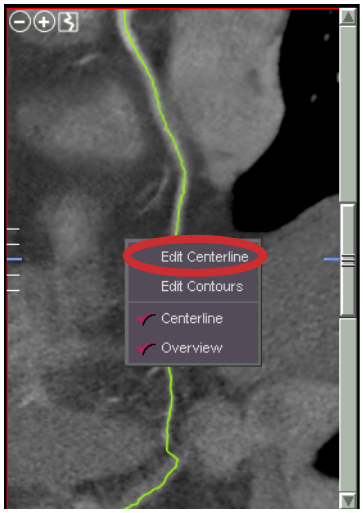
The ruler references that refer to the same ruler have different Y coordinates in the left and right CPR.

- For **ruler** references, the annotation is drawn in different Y coordinates in the left and right CPR view.
- For **lesion** references, the annotation is drawn in the middle of the left and right viewer and uses the Y coordinate from the ruler drawn on the right CPR.

Edit Vessel Centerline

CAUTION: Review the automated vessel segmentation, centerline, and contour results and edit as necessary.

1. Right-click on any inset view and select **Edit Centerline**.



OR

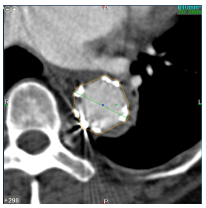
Select **Edit Ctline** in the Vessel Analysis area.

2. Assess the centerline to verify accuracy.

3. Move the cursor (pen) to a specific point along the centerline and click to plot a point to modify the path of the vessel centerline.

   As you plot points, a new red line displays to show you how the edits will finish. This line also displays in the 3D view.

NOTE: A blue dot displays in the transverse view. The blue dot is the location where the centerline intersects the plane. The blue dot is moveable. In montage views, you can move the blue dot in multiple transverse views.



4. If necessary, move the cursor (pen) to a different point along the centerline and click to plot a point.

5. Continue to plot all additional points.

As you plot additional points, the line updates to go through all the user control points.

6. Click and drag the line and it dynamically shows the resulting line as you drag. The point displays after you release the mouse.

7. Rotate, zoom, and scroll the curved view while the line is being created.

8. To move a plotted point, hover until the pencil changes to a hand, then click and drag.

9. To clear the red centerline and start over, click Reset.

10. Click Apply to apply the modified (red) centerline to be the final centerline.

11. Verify that the centerline updates appropriately.

Edit Lumen or Wall Boundary Contour Lines

CAUTION: Review the automated vessel segmentation, centerline, and contour results and edit as necessary.

1. Right-click on any inset view and select **Edit Contours**.

OR

Click

in the Vessel Analysis area.

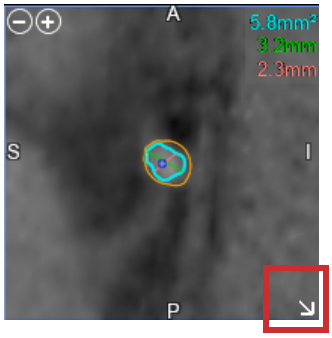
Vitrea switches to the Contour Editing layout.

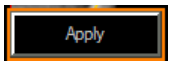
2. Verify the Lumen or Wall check box is selected.

   TIP: For easier editing, clear the check box for the contour you are not editing.

3. Redraw to edit contour lines.

4. To expand one of the cross-section panels, click the arrow in the lower-right corner.



5. Click 

to apply the new contours.

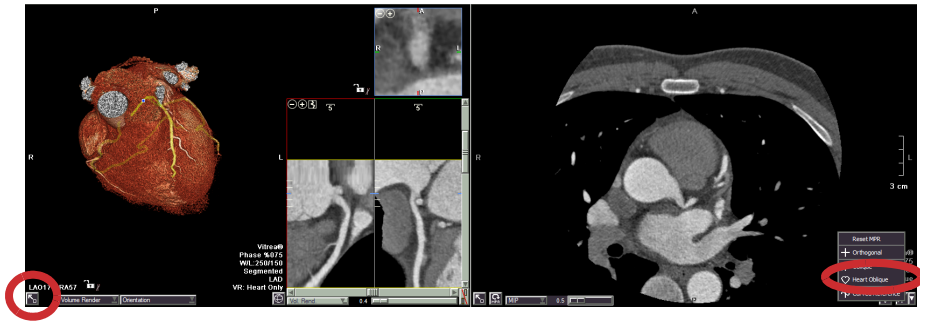
6. Verify that the contours updated appropriately.

Auto-oblique Lock or Unlock

Scroll the CPR views independent of the oblique MPR. You have the option to lock them together (auto-oblique and rotation tracks in all planes.)

1. Use the MPR mode dropdown menu and select Oblique. A lock displays to the right of the orientation degree.

   The mode is defaulted to unlocked when **Oblique** is selected. Changes only apply to the current Vitrea session. Changes will not be saved in snapshots or consecutive Vitrea re-starts.



See the Review section for additional information about the Lock icon.

2. Click the lock to unlock the lock. It changes to the unlock mode.

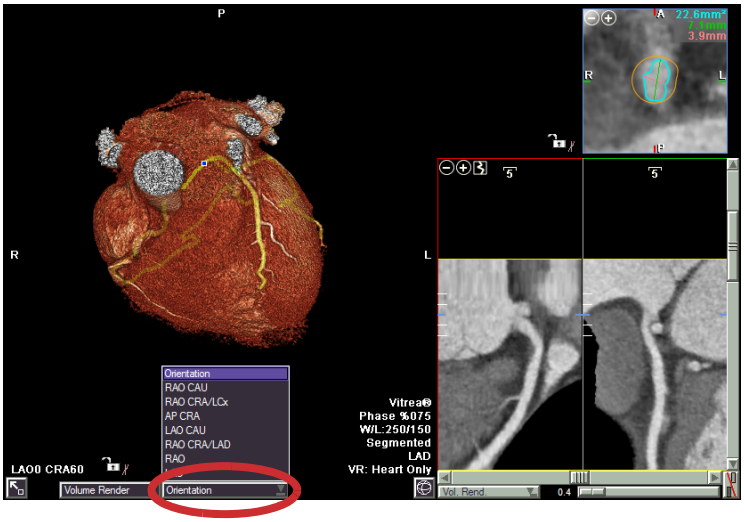
   The MPR oblique plane snaps to align to the 3D view when switching from unlocked to locked mode.

3. Scroll the CPR views. The lock located by CPR images tracks CPR views with MPR images.

4. Rotate the volume view. The lock located by volume view tracks the volume view with the MPR images.

Standard Cardiac Views

An Orientation dropdown list is located at the bottom of the 3D viewer. The dropdown contains the standard cardiac views.



Manual Stenosis Measurements

Perform measurements with the vessel probe:

- Diameter of normal and stenosed portions of a vessel, which the system uses to calculate the percentage of stenosis
- Length of stenosis or distance to bifurcation, which is particularly useful in stent and surgery planning

1. Probe the vessel.

2. Scroll in the CPR views to display a point before the stenosis.

3. Click and drag across the width of the lumen, then release the mouse button to end the ruler.

   The ruler and the measurement (in millimeters) display in the cross-sectional and CPR views.

   NOTE: Draw rulers and measure in any cross-sectional view. Place only one ruler per cross section, but redraw the ruler as many times as needed.

4. Adjust the crosshair position to display a point inside the stenosis.

5. Repeat step 3.

   TIP: Vitrea displays the current maximum and minimum diameter measurements in green and red, respectively, in the curved reformat views. Any other measurements display in cyan (light blue).

6. Repeat this procedure to draw as many rulers as you want.

   The maximum diameter, minimum diameter, and percentage stenosis update with each ruler you draw.

Edit Lesions

Edit lesions by modifying the location of key points in one of the curved reformatted views.

1. Click

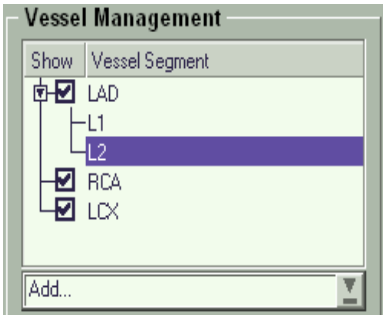
.

2. Click one of the key points of a lesion, and drag it to the desired location along the centerline.

   As you drag the key point, lesion measurements (% area stenosis, % diameter stenosis, and length) are updated.

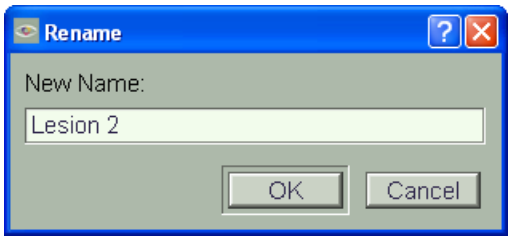
Name Lesions

The first lesion is named L1 by default. If you define another lesion, it is named L2.

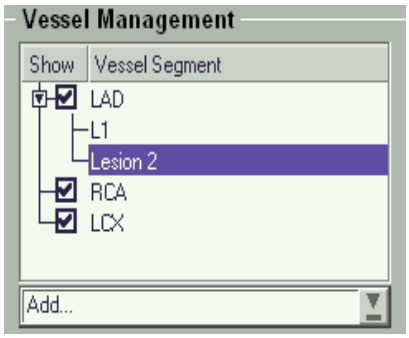


1. Select the lesion in the Vessel management box, right-click and select **Rename**.

2. Rename the lesion and click **OK**.



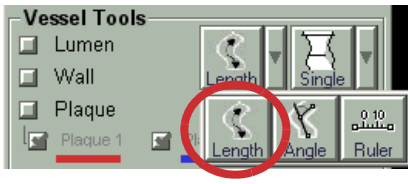
The new lesion displays in the Vessel Management box.



Measure the Centerline Length

The Length tool measures length along the centerline or between two points on the vessel centerline.

1. Click to change the volume view to a 1-up image and display a vessel probe view.

2. Select 

located under Lesion Analysis.

3. Click and drag either end to edit the length.

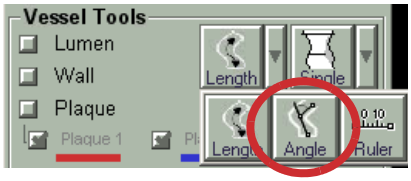
The value of the length displays at the proximal end of the length measurement. It represents the length along the centerline between the two specified points.

Create Centerline Angles

The Angle tool creates an angle along the centerline.

1. Click to change the volume view to a 1-up image and display a vessel probe view.

2. Select located under Lesion Analysis.

3. Select 

NOTE: Once you select Angle, the Length dropdown changes to Angle. Toggle the Length and Angle buttons.

4. In Curved CPR view, click and release at the start of the angle.

5. Move the cursor to the vertex location on the centerline and click and release.

6. Move the cursor to the end point of the angle and click and release to complete the angle.

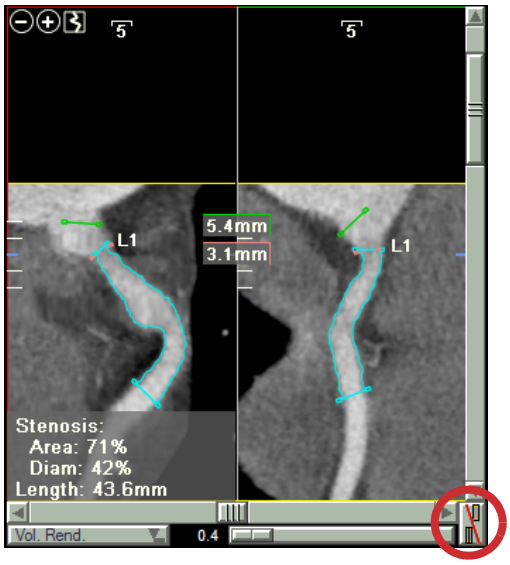
View the Diameter and Area in Graph Format

1. Click in the lower right corner of the CPR view.

   The area graph displays the area measurements along the probed vessel.

   NOTE: When viewing the graph, the vessel displays in a straightened vessel view.

2. Click again to display the minimum diameter along the probed vessel.



Create Custom Window/Level Settings

1. On the Visual tab, in the Window/Level area, click the dropdown arrow.

   The window/level menu displays.

2. Select **New**.

   The New Window/Level Setting dialog box displays.

3. In the **Name** field, enter new setting name.

4. In the **Window** field, enter new Window setting.

5. In the **Level** field, enter new Level setting.

6. To set window/level settings as “key,” select the **Key** check box.

7. Click **OK** to save the setting.

   Select the new setting from the list. A custom setting name displays with an asterisk at the end.

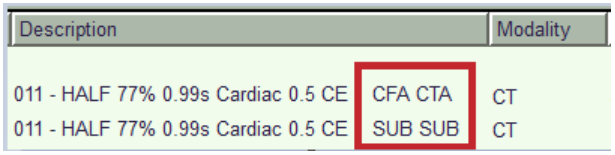
View Subtracted Series

View a subtracted series to visualize the vessel lumens without calcium.

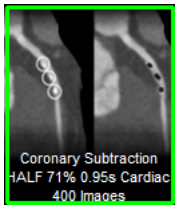
1. Load a CTA and SUB series with matching phase percentages.

   TIP: When you select the SUB series, Vitrea automatically selects the matching CTA series.

NOTE: The DICOM tag Series Description must end with “CTA” and “SUB,” and the cardiac phase percents must match. Vitrea does not support loading the SUB series without the CTA series.



NOTE: If you load studies through the Data Manager, double click the Coronary Subtraction application thumbnail.



In the Gallery, Vitrea selects the **Cardiac: Arteries CT** protocol.

NOTE: Vitrea does not support loading a SUB series into protocols other than Cardiac: Arteries CT.

2. Select either the **3D Analysis** or **3D Analysis - Auto Vessels** preset.

   Vitrea displays the study in a Dual Volume Comparison format. The CTA series is displayed on the left, and the SUB series is displayed on the right.

   NOTE: Vitrea may display the SUB volume with different HU ranges than the CTA volume.

3. Use the Volume Navigation buttons at the bottom of the view to switch active views.

4. Perform reviews, evaluations, measurements, Vessel Probe, Lesion Analysis, vessel walk, and other tasks in either volume to complete your workflow.

   NOTE: Vitrea calculates the Vessel Probe centerlines in the CTA volume and copies them to the SUB volume. If you perform manual Vessel Probe in the SUB volume, Vitrea will set the seed points in the CTA volume. Examine the centerlines of both volumes to verify that Vitrea has correctly copied the Vessel Probe centerlines to the SUB volume.

   NOTE: Wall contours and SUREPlaque measurements are not supported in the SUB volume.

5. Take snapshots.

NOTE: If you restore snapshots into VitreaCore, take note that a restored SUB volume will not display calcium.

Appendix

Automated Cross-sectional Measurements

When you probe a vessel, the lumen boundary (inner wall) is automatically traced along its centerline points. Cross-sectional measurements display in the upper right corner of the cross-sectional view corresponding to the current point of interest.

The following cross-sectional measurements are extracted at 0.5 mm intervals along the centerline:

- Lumen area (mm^2)
- Minimum lumen diameter (mm)
- Maximum lumen diameter (mm)

FIGURE 1. **Cross-sectional View**

Callout	Description
1	6.9mm2 = Area in mm2 3.3mm = Maximum diameter 2.6 mm = Minimum diameter
2	Manual ruler
3	Left and right CPR view indicators

Cross-sectional views contain:

- Lumen boundary contours
- Automated measurements text at the top-right corner
- Manual measurements text at the bottom-right corner

Transluminal Attenuation Gradients (TAG)

TAG is the HU value gradient of coronary arteries along the centerlines. The TAG could be different between normal coronary arteries and coronary arteries with Coronary Artery Disease (CAD).[1]

It is important that the coronary arteries are scanned in a very short time, around the time of peak HU, to show the difference of coronary flow. The time range of Helical scans is much longer than that of a volume scan. Therefore, displaying TAG on Helical scans is not recommended. Thin slice thickness (0.5mm) and zoomed reconstruction are recommended.

Be aware that kV values will effect the TAG values.

Refer to the scanner manufacturer's instructions for scanning guidelines.

1. Rybicki, F. J., & Rybicki, F. J. (2012). Coronary Flow Dynamics Measured by Computed Tomography Angiography*. JAC, 57(11), 1289-1290. Elsevier Inc. doi: 10.1016/j.jacc.2010.10.036.

CT LV Functional Analysis

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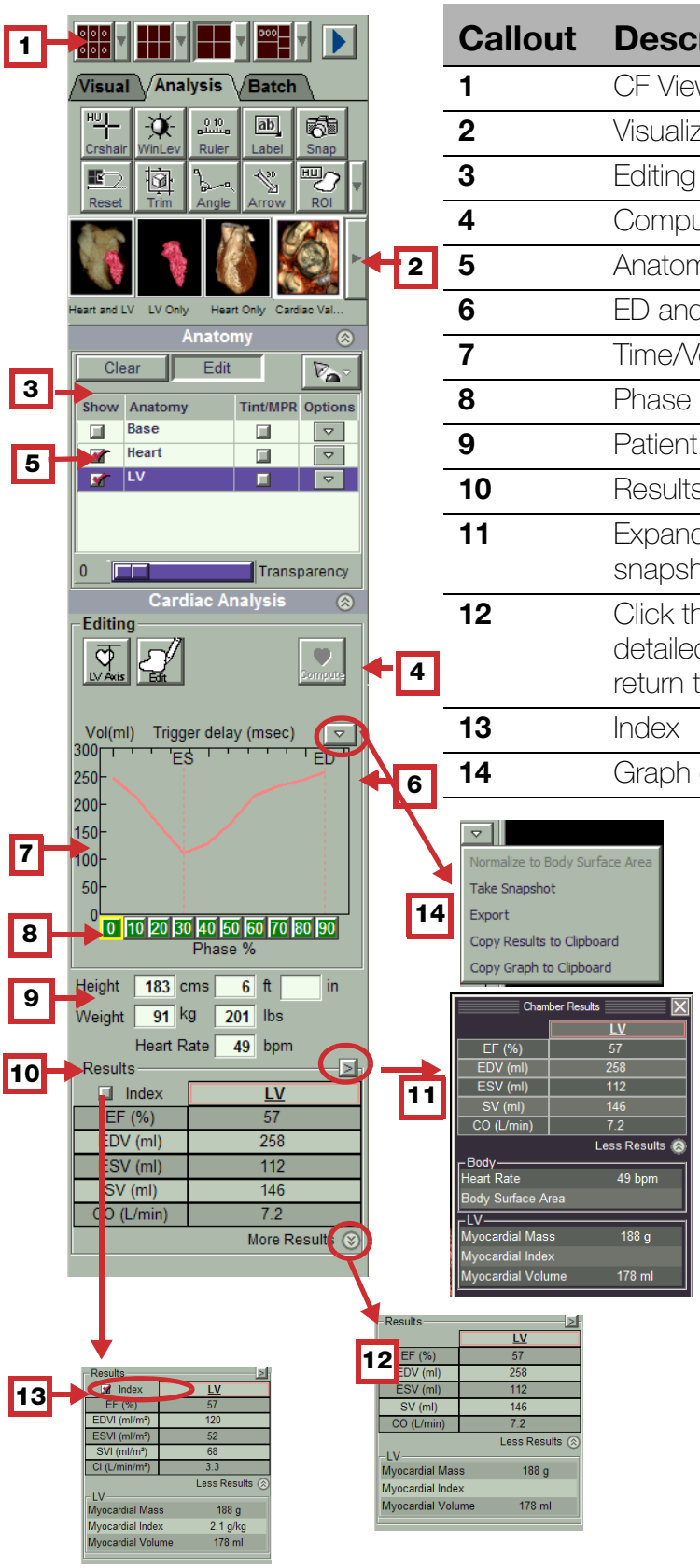
CT LV Functional Analysis Overview

LV Functional Analysis provides a variety of tools for working with clinical CT images of the coronary arteries, heart, and surrounding tissue.

The software supports CTA studies acquired by 4-slice and above MS-CT scanners. The software does not support MRA studies.

The LV Functional Analysis workflow is for single chamber only.

The automatic segmentation will perform best when the HU intensity range of the left ventricle is between 128 and 600 HU and the bulk of the myocardium has a density less than 250 HU.



Callout	Description
1	CF Viewer window formats
2	Visualization Preset buttons
3	Editing buttons
4	Compute button
5	Anatomy Management area
6	ED and ES
7	Time/Volume Graph
8	Phase Navigation Button Bar
9	Patient height and weight entry fields
10	Results
11	Expand the results into the view to take a snapshot
12	Click the More Results arrow to display detailed results. Click Less Results to return to the default view.
13	Index
14	Graph dropdown options

CT LV Functional Analysis Lesson

I. Select Study

Load a Cardiac Function study.

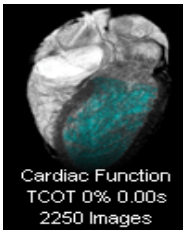
See the instructions for your Vitrea type (VitreaAdvanced Through the Data Manager or VitreaWorkstation) in the **Select Study** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide**.

II. Choose Protocol and Preset

Use one of these procedures:

Data Manager

- Double-click the **Cardiac Function** application thumbnail.



Gallery Window

1. On the Gallery window, select the **Cardiac: Functional CT** protocol.

   The Gallery choices update automatically.

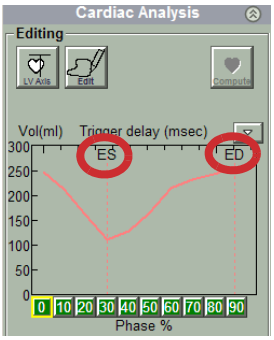
2. Click Pick next to the **LV Functional Analysis** preset.

III. Perform Analysis

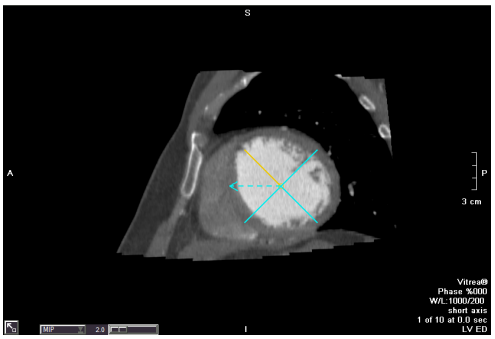
Review the Study

1. Verify the ED and ES phases.

   NOTE: If necessary, adjust the ES and ED lines in the graph.



2. Click to review the LV Axis.



3. On the phase navigation bar, click the phase % button and review all phases.

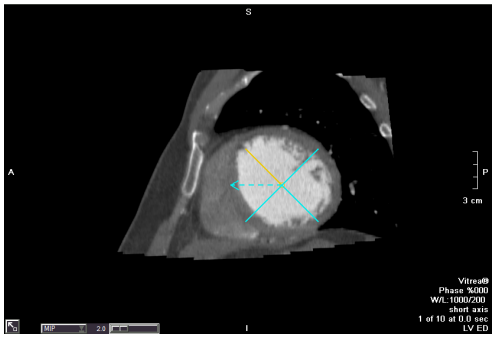
   To edit the LV Axis, see the Additional Procedures section.

Edit the Short Axis Sector Indicator

Vitrea displays the sector indicator lines in the short axis view. The yellow line segment represents the border between Sector 1 and Sector 2. The arrow indicates the septum.

1. Click .

2. Float the cursor over the intersection of the lines and move it to the center of the LV.



3. In the short axis view, float the cursor over a line segment and rotate the sector indicator lines until the arrow points to the septum.

4. Click

.

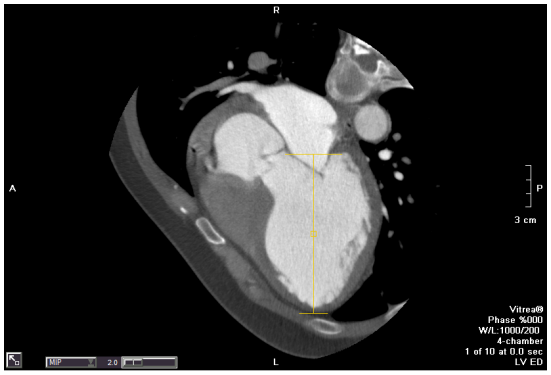
Edit the Mitral Valve Plane

In the long axis views, the mitral valve plane is represented by a line segment perpendicular to and intersecting one end of the LV axis.

NOTE: When you edit the mitral valve plane, the segmentation is invalidated for the current phase only. When you click Compute, the system resegments the current phase only.

1. In a long axis view, float the cursor over the end of the line representing the mitral valve plane.

   NOTE: An up and down arrow displays.



2. Click and drag to move the mitral valve plane along the LV axis.

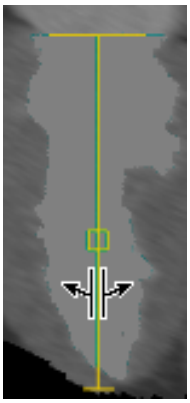
   TIP: The mitral valve plane always remains perpendicular to the LV axis. The Compute button turns orange to indicate the system must recalculate the functional data.

3. Click

.

4. Review the new functional measurements.

To rotate the LV axis:

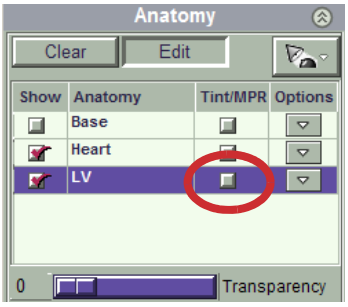


5. In the long axis view, float the cursor over the LV axis. When you rotate the LV axis, rotate about its origin.

6. Click and drag.

Edit LV Contours

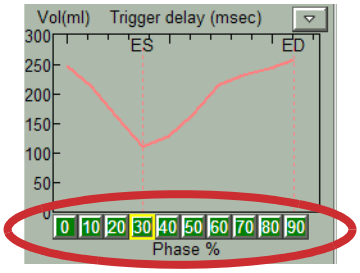
NOTE: The contours for the LV are intended to constrain the algorithm which segments the LV blood pool. The inner contour will be used as a constraint and the software will attempt to subtract the papillary muscles from this region to be used as the volume of the left ventricle. Be sure to verify this final region by selecting the **Tint/MPR** check box for the LV region. In the event of segmentation failure, a default cylindrical region is provided to allow you to create the segmentation manually.



7. Select and highlight **LV** from the Anatomy area.

8. Verify that the **Tint/MPR** check box for the LV region is selected.

9. Click the Phase % button representing the End Systolic (ES) phase.



10. Click

.

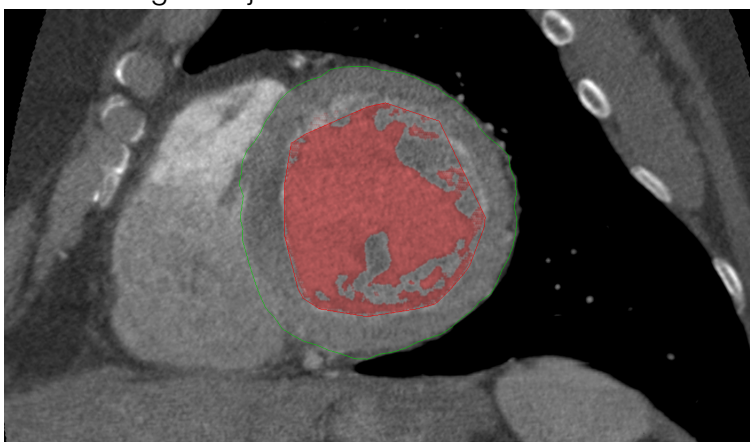
NOTE: The cursor changes to a pen.

11. Scroll in the short axis views and review the positioning of the contour lines to verify they trace the boundaries of the epicardium and endocardium. The software will remove the papillary muscles with the left ventricle.

To make adjustments:

a. Float the cursor over the contour line until its shape changes to a pencil.

b. Click and drag to adjust the border of the contour line.



12. Scroll through the short axis view and edit additional contours as necessary.

CAUTION: You should always scroll through the slices to verify the system accurately placed these anatomical reference points.

TIP: Turn the computer lines off to take snapshots by clearing the Measurements box on the Visual tab. The Measurements box is checked (and the contour lines displayed) by default.

NOTE: After you adjust or edit any of the anatomical reference points or contour lines, the Compute button changes color to indicate that the system needs to recalculate the functional measurements.

13. Click **Compute**

.

CAUTION: You should always review the segmented LV region by selecting the Tint/MPR check box and scrolling through the short-axis views.

CAUTION: When you set the calculation area manually by adjusting the mitral valve plane, LV axis or by adjusting or drawing ROIs, you must align the LV axis so it follows the centerline of the left ventricle. For subsequent calculations, the centerline of the left ventricle is used as the cardiac axis. Because the placement of the centerline greatly affects the Wall Motion map, the % Wall Thickening map, and the Regional EF map where the distance from the cardiac axis to the cardiac wall is calculated, the data may not be correct if the centerline is not correctly aligned with the cardiac axis.

NOTE: The edited contour turns bold and remains bold; any future interpolation will not impact this contour. The bold contours also act as a barrier for the interpolation. The most recent interpolated contours display in orange.

NOTE: In the ED and ES phases, the contour lines are solid and the label ED or ES displays in the lower right corner of the view. These phases affect the functional measurements. If you are not looking at one of these phases, the contour lines are dotted. Edit the contour lines in non-ED/ES phases, to make a cleaner image for a movie, for example. However, doing so will NOT affect the functional measurements.

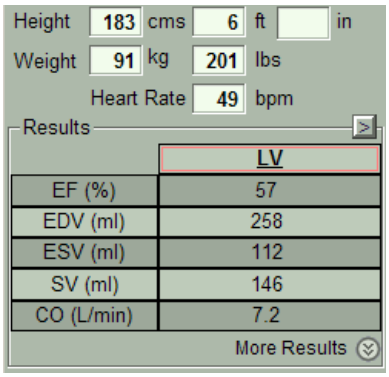
14. Repeat this process for the End Diastolic (ED) phase.

15. Review the new functional measurements.

Enter Patient Information

NOTE: Enter the Height and Weight to display the stroke index (SI), cardiac index (CI), body surface area (BSA), or myocardial mass index (MMI) in the Results.

16. In the Height field, enter the patient height, in either centimeters (metric units) or feet and inches (English units).

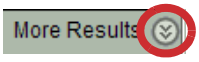


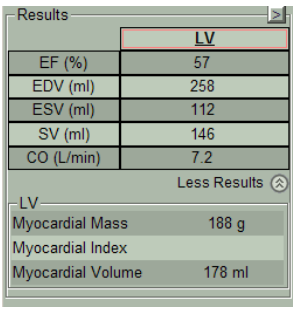
TIP: You cannot specify a patient height in inches alone.

17. In the Weight field, enter the patient weight, in either kilograms (metric units) or pounds (English units).

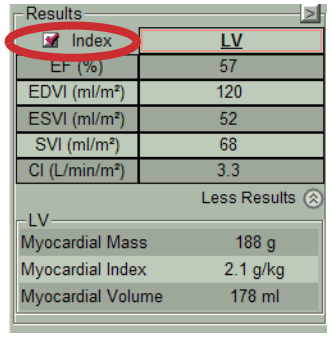
NOTE: The Results automatically display for you.

18. Select the More Results arrow to display additional results.

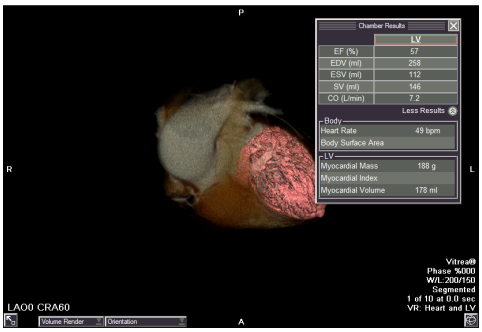




TIP: Select **Index** to normalize values to body surface area.



TIP: Select the arrow next to Results to display the in-viewer results.



Take Snapshots

19. Right-click and select (or press S) to activate the camera.

20. Move cursor to image and click.

Snapshots, measurements, rulers, W/L, or segmentation option can be restored from the Report page or the Study Directory.

21. Select ED phase, right-click and select from the menu. Press and hold CTRL and take a snapshot.

22. Select ES phase, right-click and select from the menu. Press and hold CTRL and take a snapshot.

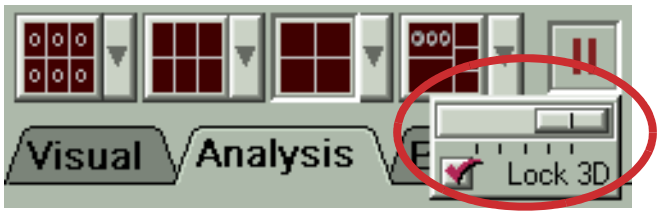
TIP: Hold down the Ctrl key to take a snapshot of the entire screen.

Examine the Heart in Motion

Use the Playback Control tools to adjust the speed of the beating heart.

23. With multiple volumes loaded, select the blue arrow located at the top of the window.

The Playback Control Tool displays.



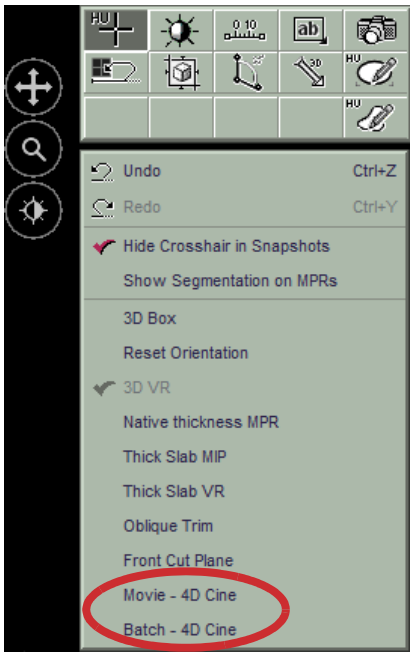
24. Use the Playback Control tools to adjust the speed of the cine.

TIP: The **Lock 3D** check box is selected by default to lock the 3D image. The MPR view plays while the 3D image is locked.

To Save a Cine as a Movie or Batch for the Selected Phase, save the cine in 4D or 3D MPR.

25. Right-click in the viewer window format to open the dropdown menu.

26. Select **Movie - 4D Cine** to save it as a movie, or select **Batch - 4D Cine** to save it as a batch.



IV. Distribute Findings

The snapshots you save in the Viewer window are saved to the Report window.

1. Click Report at the bottom of the window.

2. Export your findings or create a report.

See the **Distribute Findings** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide** for instructions on exporting findings, restoring workflow, and creating reports.

Additional Procedures

Measure the Heart Muscle Wall

1. Press R on the keyboard to activate the ruler.

2. Click to maximize the end diastolic short axis view.

3. Click and drag the ruler across the endocardiac border.

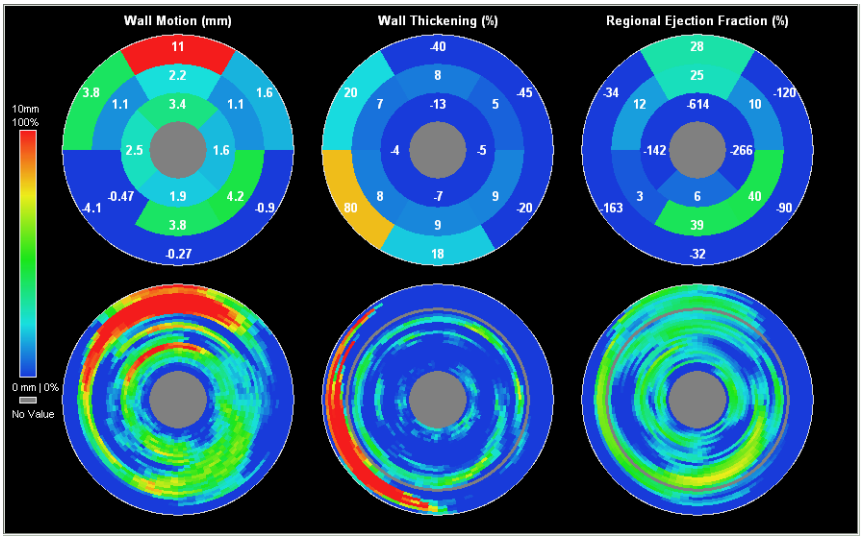
   TIP: To Delete, click on the line to change color or press CTRL + A to select all rulers. Press Delete or Backspace on the keyboard.

4. Take snapshots.

Polar Maps

In the Regional Measurements Viewer window format, the upper left view contains three polar plots representing regional functional measurements. Each polar plot is a false-color representation of regional LV function. The polar plot view contains a legend, which is a color strip indicating the numerical values of the false color map.

The regional measurements calculate from the end diastolic and end systolic cardiac wall contour lines. From left to right, the three polar plots represent Wall Motion, Wall Thickening, and Regional Ejection Fraction.



The polar plots follow the standards described in AHA Standardized Myocardial Segmentation and Nomenclature for Tomographic Imaging of the Heart.

Measurement	Units	Formula
Wall Motion	mm	Wall Motion = ED outer (epicardial) wall diameter - ES outer wall diameter **NOTE:** Wall motion is calculated from the epicardial contour lines.
Wall Thickening	%	% Wall Thickening = (ES wall thickness - ED wall thickness)/ED wall thickness x 100%
Regional Ejection Fraction (EF)	%	Regional EF = (ED inner diameter^2 - ES inner diameter^2)/ED inner diameter^2 x 100%

To display the MPR slice(s) that correspond with a location in a polar plot:

1. Click

.

2. Click **Regional Measurements** from the top left corner of the Viewer window.

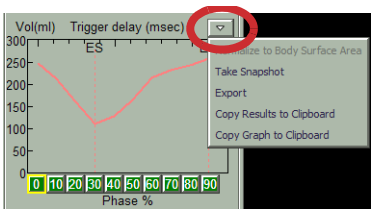
3. Click the location in the polar plot representing the area you want to see in the MPR views.

The MPR views update to display the corresponding images.

Export Results to CSV (VitreaWorkstation Only)

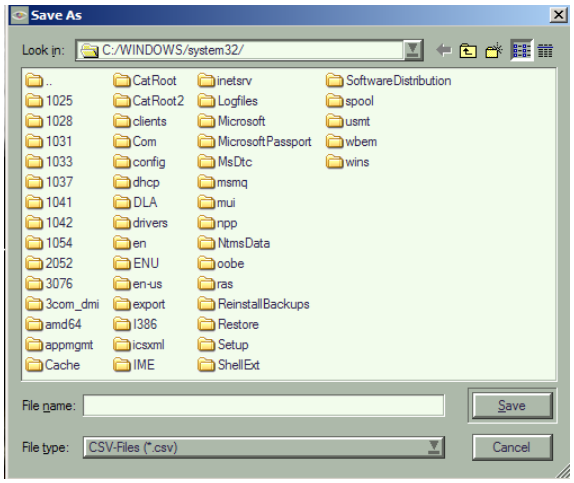
Use the Export option to export results to a CSV file. The results are exported and put into a spreadsheet format.

1. Select the arrow above the graph.



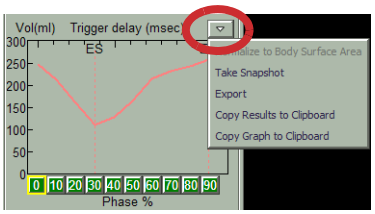
2. Select **Export**.

3. Enter a file name and click **Save** to Export the results as a CSV.



Copy Results or Graph to Clipboard (VitreaWorkstation Only)

1. Select the arrow above the graph.



2. Select **Copy Results to Clipboard** to copy the results to the clipboard,

   OR

select **Copy Graph to Clipboard** to copy the graph to the clipboard.

3. The items copied to the clipboard can be used in another program.

Create Batches and Movies

Use the Batch tab of the Viewer window to create image batches and movies of multiphase cardiac datasets which capture the motion of the heart.

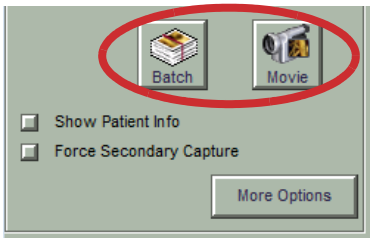
1. With multiple volumes loaded, select the Batch tab.

   The Start button is automatically active.

2. Click on the image and a green arrow displays on the MPR view.

   The End button is automatically active.

3. Click on the image again and a green arrow appears on the MPR view where you want to end the batch/movie.
   - To include patient information in the batch, select the **Show Patient Info** check box.



4. Click **Batch** or **Movie**.

   NOTE: Batch images display best on a PACS. Movies are created as .avi files.

CAUTION: When previewing or playing back the movie, do not assume that the speed of the movie represents the actual heart rate. Movie playback speeds are a function of a number of factors, including the timing of the scan and rendering speeds in Vitrea.

Appendix

Global Measurements

For Cardiac Function studies, the Viewer window displays measurements related to overall left ventricle (LV), right ventricle (RV), and left atrium (LA). Each measurement displays only if the data required to calculate is available.

EXAMPLE Index values display only if you enter patient height and weight.

TABLE 1. **LV, RV, and LA Global Measurements and Formulas**

Measurement	Units	Description/Formula
Common Measurements for LV		
Ejection Fraction (EF)	%	Fraction of blood contained in the chamber at the end of diastole, which is expelled during the chamber contraction. EF= SV/EDV x 100%
End Diastolic Volume (EDV)	ml	The maximum volume during mid-diastolic expansion.
End Systolic Volume (ESV)	ml	Smallest chamber volume across all loaded phases.
Stroke Volume (SV)	ml/beat	The volume of blood expelled during a single heartbeat. V = EDV — ESV
Cardiac Output (CO)	L/min	The volume of blood ejected per minute by the heart, calculated as CO=HR x SV/1000
Heart Rate (HR)	beats/min	If it is not supplied by the DICOM data, you must manually enter this value once the series are loaded.

Body Surface Area (BSA)	m^2	BSA = 0.007246 x $height^{0.725}$ (cm) x $weight^{0.425}$ (kg) **NOTE:** If you do not enter the patient height and weight, the system cannot calculate SI, CI, BSA, or MMI.

LV Measurements		
Myocardial Mass	g	MV x 1.05 1.05 is the specific gravity of myocardium.
Myocardial Mass Index	g/kg	MMI = Myocardial Mass (g) / Patient Weight (kg)
Myocardial Volume (MV)	ml	Calculated using the myocardial segmentation results for the ED phase. Myocardial volume does not include the cyan-tinted volume (the cyan-tinted region represents the volume of blood within the LV). Myocardial Volume = The volume of tissue encompassed by green lines which has a density greater than 0 (zero) HU. **NOTE:** The Myocardial Volume includes papillary muscles.

CT Multi-Chamber Functional Analysis (CFA)

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- CT Multi-chamber Cardiac Functional Analysis Tools

CT Multi-Chamber Cardiac Functional Analysis (CFA) Lesson

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- Data Manager
- Gallery Window

III Perform Analysis

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- Enter Patient Information
- Take Snapshots
- Examine the Heart in Motion

IV Distribute Findings

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- Edit the Mitral Valve Plane

- Measure the Heart Muscle Wall
- Polar Maps
- Export Results to CSV (VitreaWorkstation Only)
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- Create Batches and Movies

Appendix

- Global Measurements

CT Multi-Chamber Cardiac Functional Analysis (CFA) Overview

The CT Multi-Chamber Cardiac Functional Analysis (CFA) option for the Vitrea® software provides a variety of tools for working with clinical CT images of the coronary arteries, heart, and surrounding tissue. This option includes three chambers (LV, RV, and LA).

The software supports CTA studies acquired by 4-slice and above MS-CT scanners. The study must cover the entire heart and have sufficient contrast enhancement in the LV, RV, and LA. The software does not support MRA studies.

Caution Statements

Observe these precautions to ensure the safe and effective use of the software.

CAUTIONS:

- **This product is intended for use only as a supplement to standard methods of interpreting radiological images. It should not be**

exclusively relied upon for arriving at a diagnosis, treatment plan, or other decision that may affect patient care.

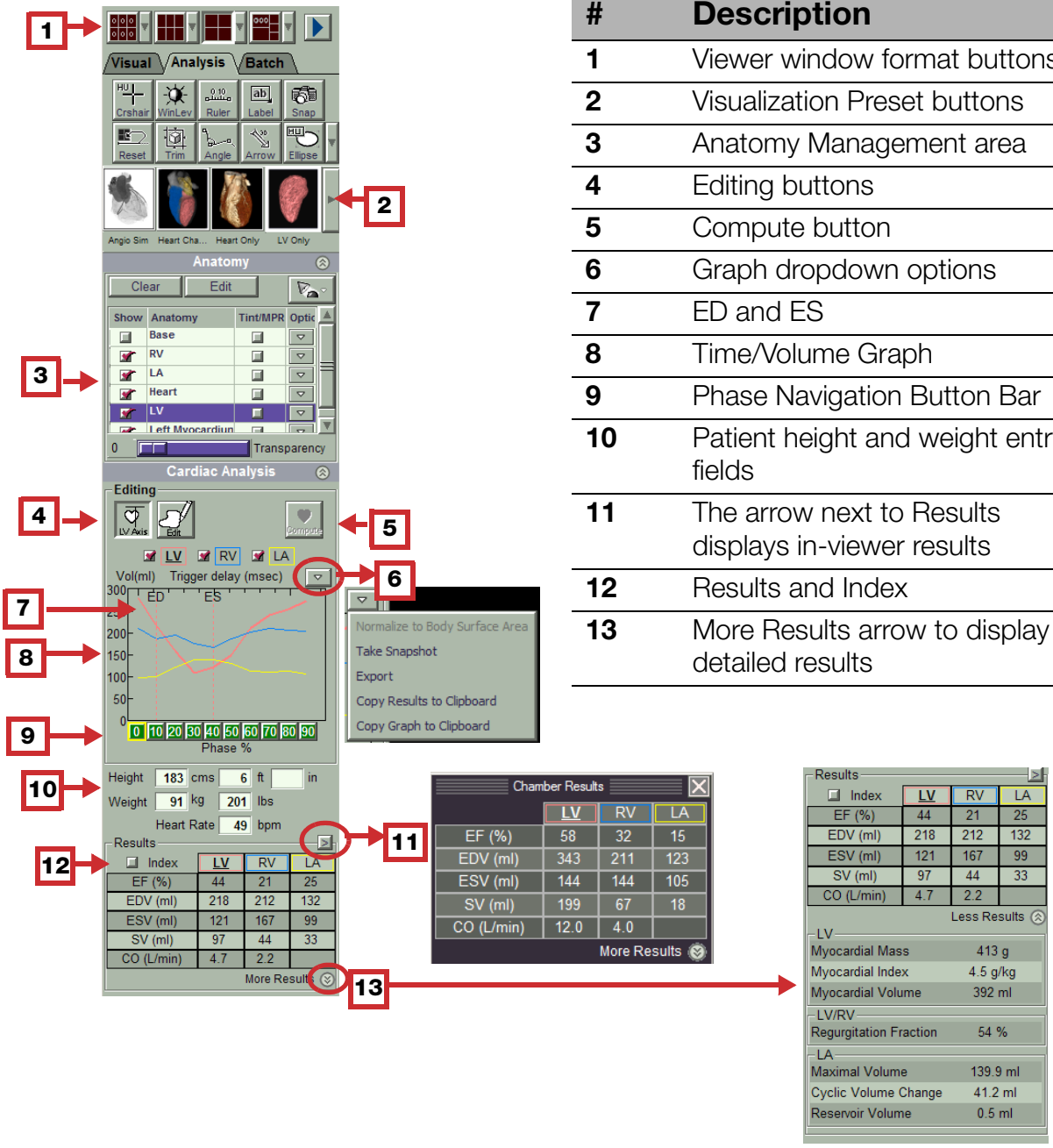
- **The system automatically generates the endocardial contour lines that determine the chambers (LV, RV, and LA) segmentation results. These segmentation results are only initial values. To prevent incorrect diagnosis, you must check the contour lines and segmentation results and correct them if the physician judges them to be inappropriate.**
- **A physician must evaluate the system-generated endocardial and epicardial contour lines at end diastole and end systole and the LV (left ventricle) axis placement and verify them as accurate or adjust them so they are accurate. The myocardial contour lines and the position of the LV axis are used to determine the left ventricle volume, which is used to determine the ejection fraction, wall motion, etc. For regional evaluations, in particular (wall motion, wall thickness, EF), a single pixel constitutes a large proportion of the value. Therefore, an error in the contour lines could create a significant adverse effect in the calculations, which could lead to incorrect diagnosis.**
- **Each segmented chamber (LV, RV, LA) has specific time points or volumes which are the basis for the computations for the chamber. The right and left ventricle have ED and ES settings and the LA has ED, ES, Max, and Mid. These are unique and independent for each chamber and are only initial values. To prevent incorrect diagnosis, you must check where these are defined and correct them if the physician judges them to be inappropriate.**
- **The endocardial and epicardial contour line extraction method for cardiac analysis based on the Volume method involves a number of errors at the apex. You must therefore evaluate the contour line at the apex for appropriateness. If the contour line is not appropriate, erroneous diagnosis may result.**
- **When restoring a snapshot, the software will, the majority of the time, restore the study to the workflow state at the time it was taken. However, there are some conditions in which the workflow cannot be restored exactly. Therefore, it is important to always review the images after a restored snapshot to verify the workflow has restored properly. It is also important to confirm clinically-relevant information that was restored with the snapshot.**
- **It is possible to restore a snapshot associated with multiple volumes with too many, too few, or incorrect volumes loaded. Doing so may yield different results than the original calculations.**
- **After performing any type of editing, such as rotating the LV axis, editing region contours, or moving the ED/ES lines on the graph, be sure to verify that the images, graph, and results have updated as expected.**

CT Multi-chamber Cardiac Functional Analysis Tools

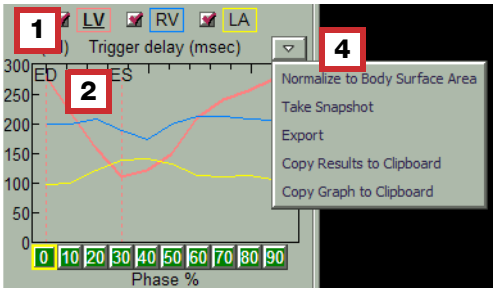
When you load the protocol and preset, the system semi-automatically segments the LV, RV, LA, Heart and Left Myocardium for each phase/volume.

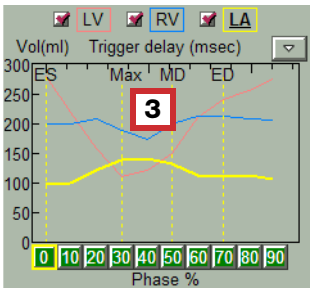
When you select the **Cardiac: Functional CT** protocol and **3-Chamber Functional Analysis** preset, the Cardiac Analysis tools display on the Analysis tab of the Viewer window. Some of the Cardiac Analysis tools are available when using any of the Viewer window formats, and some are only available when using one or two of the formats.

NOTE: Undo/Redo functionality is not supported in the CT Multi-chamber Cardiac Functionality protocol.



#	Description
1	Viewer window format buttons
2	Visualization Preset buttons
3	Anatomy Management area
4	Editing buttons
5	Compute button
6	Graph dropdown options
7	ED and ES
8	Time/Volume Graph
9	Phase Navigation Button Bar
10	Patient height and weight entry fields
11	The arrow next to Results displays in-viewer results
12	Results and Index
13	More Results arrow to display detailed results





#	Description
1	LV, RV, and LA check boxes — The LV, RV, and/or LA check boxes must be selected in order for them to display in the graph and on the Report page. LV displays in red, RV displays in blue, and LA displays in yellow. The selected chambers will display results in the Results area.
2	ED and ES — Click and drag ED or ES in the graph to adjust the ED or ES.
3	Max and Mid (LA Only) — Click and Drag Max or MD in the graph to adjust the Max or Min.
4	Graph dropdown • Normalize to Body Surface Area — Selects the Index box in the Results section and displays the index values. • Take Snapshot — Takes a snapshot of the graph and is available on the Report tab. • Export — Exports results to a CSV file. • Copy Results to Clipboard — The results copied to the clipboard can be used in another program. • Copy Graph to Clipboard — The graph copied to the clipboard can be used in another program.

Tool	Description
LV Axis	Click to display the LV axis for reviewing and editing.
Edit	Click to edit LV, RV, or LA contours.
Compute	Click to compute the results after you have performed editing.
Viewer window format buttons	Click to change the layout of the views on the Viewer window.
Playback button	Click to scroll through all phases to view the heart in motion.
Lock 3D Playback controls	Use the slider bar to control the speed of the playback.
Snapshot button	Click to save snapshot of workflow.

CT Multi-Chamber Cardiac Functional Analysis (CFA) Lesson

I. Select Study

Load a CT Multi-Chamber Cardiac Functional Analysis study.

See the instructions for your Vitrea type (VitreaAdvanced Through the Data Manager or VitreaWorkstation) in the **Select Study** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide**.

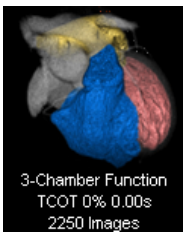
You can load up to 21 coincident volumes into CT Multi-Chamber CFA.

II. Choose Protocol and Preset

Use one of these procedures:

Data Manager

- Double-click the **3-Chamber Function** application thumbnail.



Gallery Window

Multi-Chamber Functional Analysis

1. On the Gallery window, select **Cardiac: Functional CT**.

   The Gallery choices update automatically.

2. Click Pick next to the **3-Chamber Functional Analysis** preset.

III. Perform Analysis

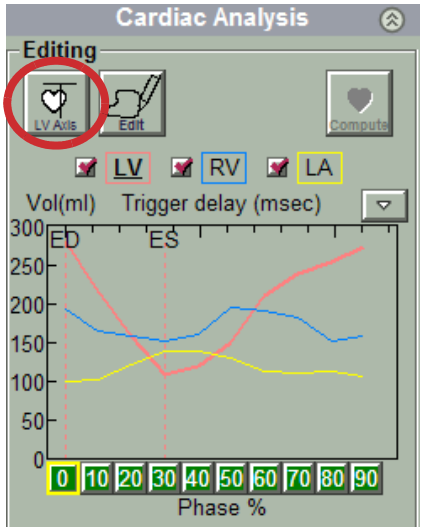
Review the Study

1. Review all phases of the study.

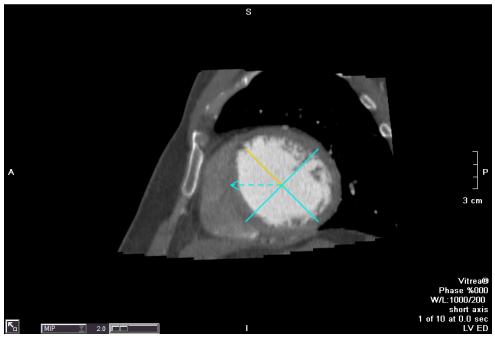
2. Identify the ED and ES phases for the LV, RV, and LA chambers.

3. Identify the Mid and Max phases for the LA chamber.

   NOTE: If necessary, move the ES, ED, Mid, or Max lines in the graph.



4. Click to review the LV axis.

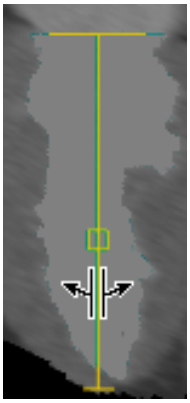


Edit the LV axis:

5. In the long axis view, float the cursor over the LV axis. When you rotate the LV axis, rotate about its origin.

6. Click and drag the line to position it in the center of the LV.

   NOTE: If you edit the LV axis, any previous contour editing you performed may be lost. For that reason, perform axis editing before contour editing.

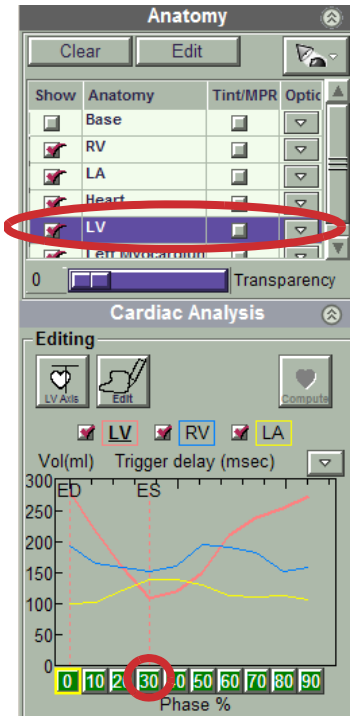


Edit LV and RV Contours

7. Select and highlight **LV** from the Anatomy area.

8. Click the Phase % button representing the End Systolic (ES) phase.

   TIP: In the Cardiac Analysis area, LV and RV must be selected in order for them to display in the graph and on the Report page. LV displays in red and RV displays in blue.



9. Click .

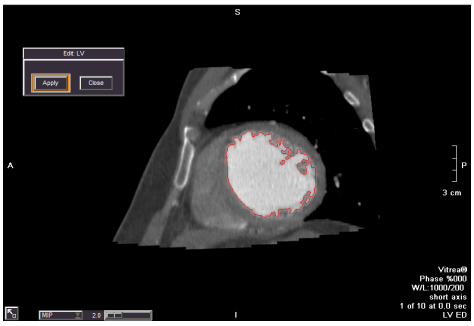
   TIP: Edit is available from the Anatomy area, the Options dropdown, and the Cardiac Analysis area.

   NOTE: The cursor changes to a pen.

CAUTION: Each segmentation chamber (LV, RV, LA) has specific time points or volumes which are the basis for the computations for the chamber. The right and left ventricle have ED and ES settings and the LA has ED, ES, Max, and Mid. These are unique and independent for each chamber and are only initial values. To prevent incorrect diagnosis, you must check where these are defined and correct them if the physician judges them to be inappropriate.

   a. Review the positioning and shape of the contour lines.

   b. To edit, click and drag to adjust the border of the contour line.



10. Click **Apply**.

TIP: To display the LV red overlay in the MPR views, select **Tint/MPR** next to the LV listing in the Anatomy list.

11. Scroll through the short axis view and edit additional contours as necessary.

CAUTION: You should always scroll through the slices to verify the system accurately placed these anatomical reference points and that it segmented the left ventricle appropriately.

CAUTION: You must align the LV axis so it follows the centerline of the left ventricle when you set the calculation area manually by adjusting the mitral valve plane, LV axis or by adjusting or drawing ROIs. For subsequent calculations, the centerline of the left ventricle is used as the cardiac axis. Because the placement of the centerline greatly affects the Wall Motion map, the % Wall Thickening map, and the Regional EF map where the distance from the cardiac axis to the cardiac wall is calculated, the data may not be correct if the centerline is not correctly aligned with the cardiac axis.

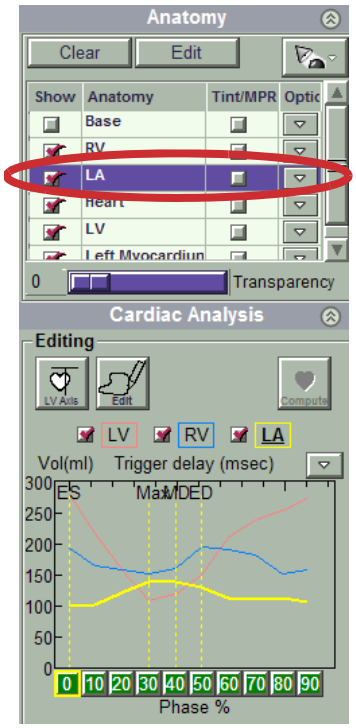
12. Repeat this process for the End Diastolic (ED) phase.

13. Review the new functional measurements.

14. Repeat the steps above for the **RV**.

Edit LA Contours

15. Select and highlight **LA** from the Anatomy area.



16. Click the Phase % button representing the End Systolic (ES) phase.

TIP: In the Cardiac Analysis area, LA must be selected in order for it to display in the graph and on the Report page. LA displays in yellow.

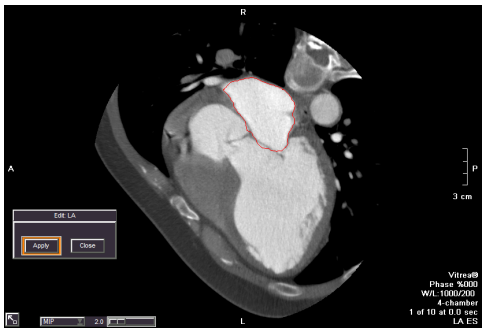
17. Click .

TIP: Edit is available from the Anatomy area, the Options dropdown, and the Cardiac Analysis area.

NOTE: The cursor changes to a pen.

a. Review the positioning and shape of the contour lines.

b. To edit, click and drag to adjust the border of the contour line.



18. Click **Apply**.

19. Repeat this process for the End Diastolic (ED), Mid, and Max phases.

20. Review the new functional measurements.

Enter Patient Information

NOTE: Enter the Height and Weight to display the stroke index (SI), cardiac index (CI), body surface area (BSA), or myocardial mass index (MMI) in the Results.

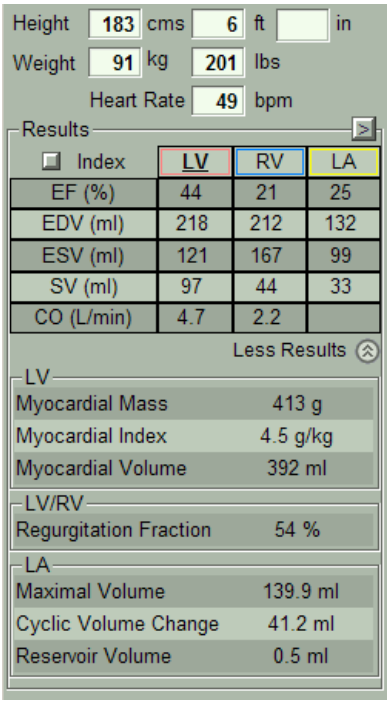
21. In the Height field, enter the patient height, in either centimeters (metric units) or feet and inches (English units).

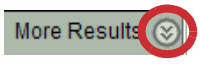
TIP: You cannot specify a patient height in inches alone.

22. In the Weight field, enter the patient weight, in either kilograms (metric units) or pounds (English units).

23. If the Heart Rate is not supplied by the DICOM data, manually enter the value.

NOTE: If the Heart Rate is missing from the DICOM data, Vitrea enters a default value of 60 bpm.

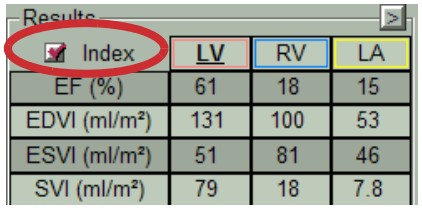


24. Select the More Results arrow 

to display additional results.

NOTE: Review the LV/RV Regurgitation Fraction results to get the difference of volume of the LV and RV.

TIP: Click **Index** to normalize values to body surface area.



TIP: Select the arrow next to Results to display the in-viewer results.

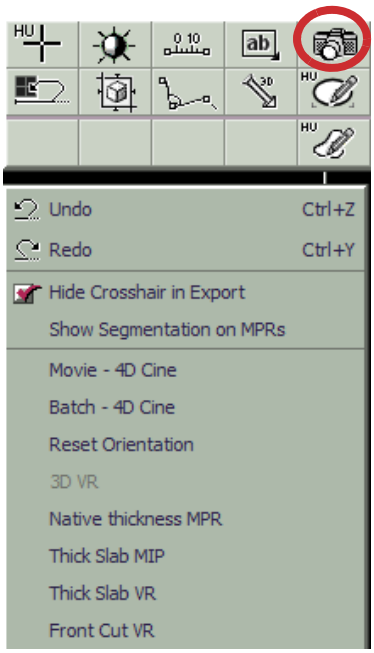
Take Snapshots

25. Right-click and select (or press S) to activate the camera.

26. Move cursor to image and click.

Snapshots, measurements, rulers, W/L, or segmentation option can be restored from the Report page or the Study Directory.

27. To show or hide patient information or crosshairs in the snapshot, right-click and select or clear the desired check box.



28. Select ED phase, right-click and select from the menu. Press and hold CTRL and take a snapshot.

29. Select ES phase, right-click and select from the menu. Press and hold CTRL and take a snapshot.

TIP: Hold down the Ctrl key to take a snapshot of the entire screen.

Examine the Heart in Motion

Use the Playback Control tools to adjust the speed of the beating heart.

30. With multiple volumes loaded, select the blue arrow located at the top of the window.

The Playback Control Tool displays.

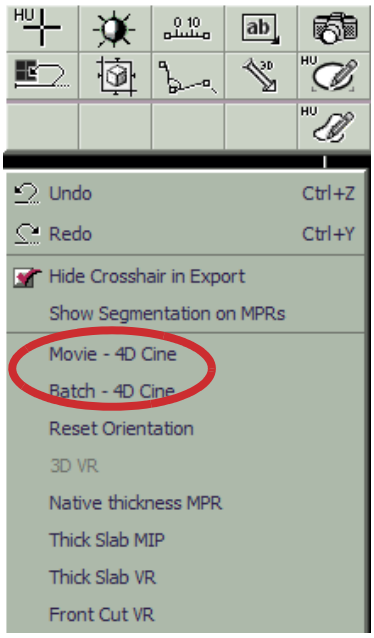
31. Use the Playback Control tools to adjust the speed of the cine.

TIP: The **Lock 3D** check box is selected by default to lock the 3D image. The MPR view plays while the 3D image is locked.

To Save a Cine as a Movie or Batch for the Selected Phase, save the cine in 4D or 3D MPR.

32. Right-click in the viewer window format to open the dropdown menu.

33. Select **Movie - 4D Cine** to save it as a movie, or select **Batch - 4D Cine** to save it as a batch.



IV. Distribute Findings

The snapshots you save in the Viewer window are saved to the Report window.

1. Click Report at the bottom of the window.

2. Follow the instructions in the Distribute Findings chapter to distribute your findings.

Additional Procedures

Viewer Window Formats for CFA

The CT Multi-Chamber CFA option includes these Viewer window formats. In these formats, the images of the heart are arranged according to space, not time. The epicardial and endocardial contours display in the short axis view.

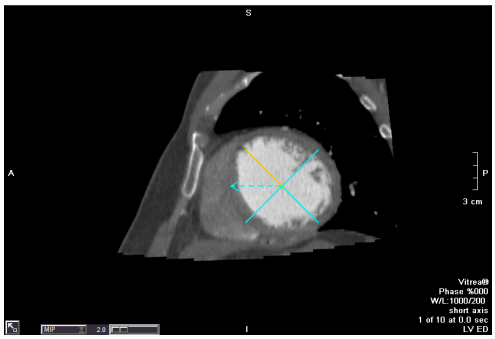
You change the Viewer window formats the same way you would in standard Vitrea, using the Viewer Window Formats toolbar on the Analysis tab.

Format	Description
	Cardiac Six-up Short Axis: Six short axis views (SA) views from base to apex. The SA views will uniformly intersect the LV or RV axis midline from base to apex.
	Cardiac Six-up Chamber: The top row displays a 2-chamber view, 3-chamber view, and 4-chamber view. The bottom row displays basal, mid, and apical short axis views. If you use the crosshair tool, the crosshair line on the two chamber view and four chamber view shows the location of the bottom three short axis views.
	Cardiac Four-up 3D: The top row displays the 2-chamber and 4-chamber views, and the bottom row displays the 3D view and the short axis view.
	Cardiac Five-up Polar Map: The top left displays the polar maps, and the bottom left displays the 3D view. The right side displays the 2-chamber view, the 4-chamber view, and the short axis view.
	Cardiac Nine-up Short Axis: Nine short axis views from base to apex.

Edit the Short Axis Sector Indicator

Vitrea displays the sector indicator lines in the short axis view. The yellow line segment represents the border between Sector 1 and Sector 2. The arrow indicates the septum.

1. Click .



2. Float the cursor over the intersection of the lines and move it to the center of the LV.

3. In the short axis view, float the cursor over a line segment and rotate the sector indicator lines until the arrow points to the septum.

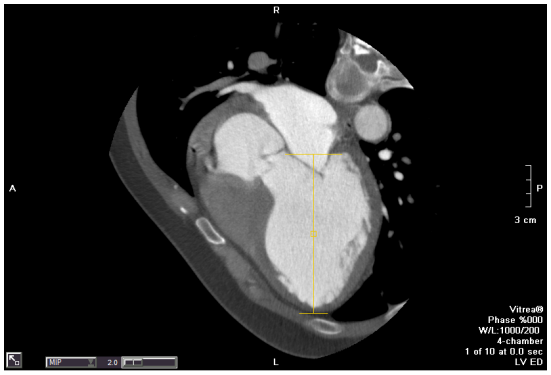
4. Click .

Edit the Mitral Valve Plane

In the long axis views, the mitral valve plane is represented by a line segment perpendicular to and intersecting one end of the LV axis.

NOTE: When you edit the mitral valve plane, the segmentation is invalidated for the current phase only. When you click Compute, the system resegments the current phase only.

1. In a long axis view, float the cursor over the end of the line representing the mitral valve plane.



NOTE: An up and down arrow displays.

2. Click and drag to move the mitral valve plane along the LV axis.

TIP: The mitral valve plane always remains perpendicular to the LV axis. The Compute button turns orange to indicate the system must recalculate the functional data.

3. Click .

4. Review the new functional measurements.

Measure the Heart Muscle Wall

1. Press R on the keyboard to activate the ruler.

2. Click to maximize the end diastolic short axis view.

3. Click and drag the ruler across the endocardiac border.

   TIP: To Delete, click on the line to change color or press CTRL + A to select all rulers. Press Delete or Backspace on the keyboard.

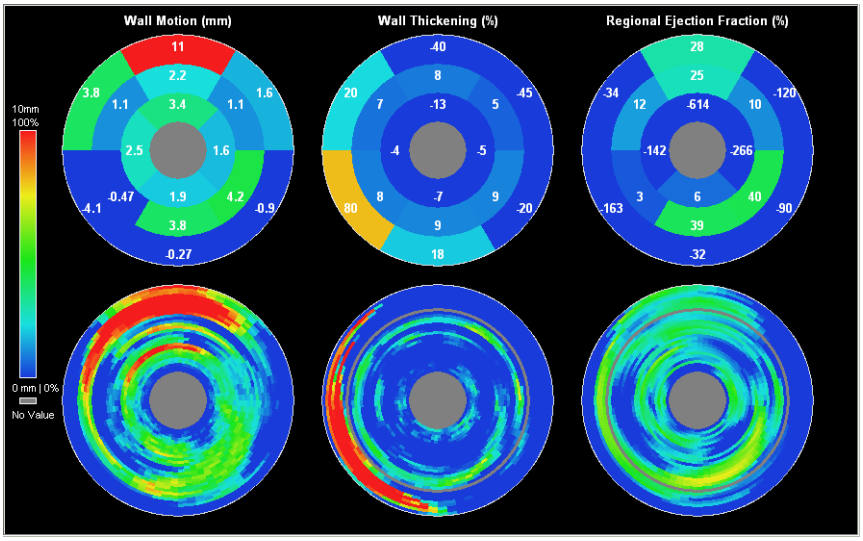
4. Take snapshots.

Polar Maps

NOTE: The Polar Maps are for LV only.

In the Regional Measurements Viewer window format, the upper left view contains three polar plots representing regional functional measurements. Each polar plot is a false-color representation of regional LV function. The polar plot view contains a legend, which is a color strip indicating the numerical values of the false color map.

The regional measurements calculate from the end diastolic and end systolic cardiac wall contour lines. From left to right, the three polar plots represent Wall Motion, Wall Thickening, and Regional Ejection Fraction.



The polar plots follow the standards described in AHA Standardized Myocardial Segmentation and Nomenclature for Tomographic Imaging of the Heart.

Measurement	Units	Formula
Wall Motion	mm	Wall Motion = ED outer (epicardial) wall diameter - ES outer wall diameter **NOTE:** Wall motion is calculated from the epicardial contour lines.
Wall Thickening	%	% Wall Thickening = (ES wall thickness - ED wall thickness)/ED wall thickness x 100%
Regional Ejection Fraction (EF)	%	Regional EF = (ED inner diameter^2 - ES inner diameter^2)/ED inner diameter^2 x 100%

To display the MPR slice(s) that correspond with a location in a polar plot:

1. Click

.

2. Click **Regional Measurements** from the top left corner of the Viewer window.

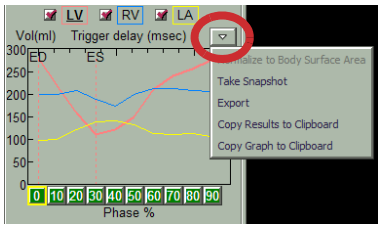
3. Click the location in the polar plot representing the area you want to see in the MPR views.

The MPR views update to display the corresponding images.

Export Results to CSV (VitreaWorkstation Only)

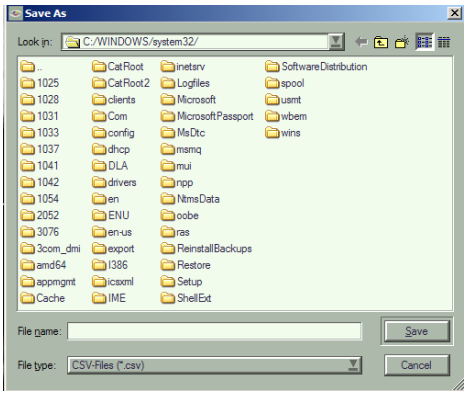
Use the Export option to export results to a CSV file. The results are exported and put into a spreadsheet format.

1. Select the arrow above the graph.



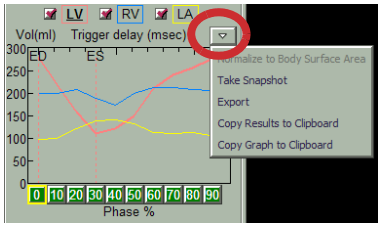
2. Select **Export**.

3. Enter a file name and click **Save** to Export the results as a CSV.



Copy Results or Graph to Clipboard (VitreaWorkstation Only)

1. Select the arrow above the graph.



2. Select **Copy Results to Clipboard** to copy the results to the clipboard,

   OR

   select **Copy Graph to Clipboard** to copy the graph to the clipboard.

3. The items copied to the clipboard can be used in another program.

Create Batches and Movies

Use the Batch tab of the Viewer window to create image batches and movies of multiphase cardiac datasets which capture the motion of the heart.

1. With multiple volumes loaded, select the Batch tab.

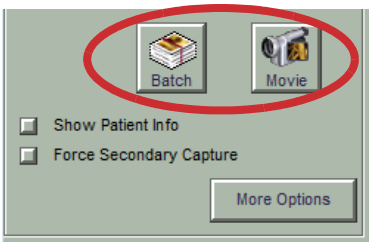
   The Start button is automatically active.

2. Click on the image and a green arrow displays on the MPR view.

   The End button is automatically active.

3. Click on the image again and a green arrow appears on the MPR view where you want to end the batch/movie.

   - To include patient information in the batch, select the **Show Patient Info** check box.



4. Click **Batch** or **Movie**.

   NOTE: Batch images display best on a PACS. Movies are created as .avi files.

CAUTION: Do not assume that the speed of the movie represents the actual heart rate when previewing or playing back the movie. Movie playback speeds are a function of a number of factors, including the timing of the scan and rendering speeds in Vitrea.

Appendix

Global Measurements

For Cardiac Function studies, the Viewer window displays measurements related to overall left ventricle (LV), right ventricle (RV), and left atrium (LA). Each measurement displays only if the data required to calculate is available.

EXAMPLE Index values display only if you enter patient height and weight.

Measurement	Units	Description/Formula
Common Measurements for LV, RV, and LA		
Ejection Fraction (EF)	%	Fraction of blood contained in the chamber at the end of diastole, which is expelled during the chamber contraction. EF= SV/EDV x 100%
End Diastolic Volume (EDV)	ml	The maximum volume during mid-diastolic expansion.
End Systolic Volume (ESV)	ml	Smallest chamber volume across all loaded phases.
Stroke Volume (SV)	ml/beat	The volume of blood expelled during a single heartbeat. SV = EDV — ESV
Heart Rate (HR)	beats/min	If it is not supplied by the DICOM data, you must manually enter this value once the series are loaded.
Body Surface Area (BSA)	m^2	BSA = 0.007246 x $height^{0.725}$ (cm) x $weight^{0.425}$ (kg) **NOTE:** If you do not enter the patient height and weight, the system cannot calculate SI, CI, BSA, or MMI.

LV Measurements		
Myocardial Mass	g	Myocardial Mass = MV x 1.055 1.055 g/ml is the specific gravity of myocardium.
Myocardial Mass Index	g/kg	MMI = Myocardial Mass (g) / Patient Weight (kg)
Myocardial Volume (MV)	mL	Calculated using the myocardial segmentation results for the ED phase. Myocardial volume does not include the volume of blood within the LV. Myocardial Volume = The volume of tissue included in the Left Myocardium segmentation. **NOTE:** The Myocardial Volume includes papillary muscles.
LV\RV Measurements		
Regurgitation Fraction		The difference of volume of the LV and RV. $ABS(SV_{LV} - SV_{RV}) / MAX(SV_{LV}, SV_{RV})$
Cardiac Output (CO)	L/min	The volume of blood ejected per minute by the heart, calculated as CO=HR x SV/1000
LA Measurements		
Maximum Volume	mL	The maximum LA volume.
Cyclic Volume Change	mL	The maximal difference in LA volumes. LA maximum volume — LA minimum volume
Reservoir Volume	mL	The difference between the maximum LA volume and the mid-diastolic local minimum atrial volume.

CT Cardiac EP Planning

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CT Cardiac EP Planning Overview

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- **I** Select Study
- **II** Choose Protocol and Preset
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  - Gallery Window
- **III** Perform Analysis
  - Perform an Overall Review
  - Perform Quantitative Measurements of the Left Atrium and Pulmonary Vein Anatomy
  - Show Esophagus
  - Take Snapshots
- **IV** Distribute Findings

Additional Procedures

- Create 3D Model (VitreaWorkstation Only)
- Accessing the 3D model from the EnSite NavX System.
- Edit if necessary
- Cath View
- Perform Fly Through (endoluminal views) Using the EP Planning FlyThrough PV Preset

CT Cardiac EP Planning Overview

CT Cardiac EP Planning is an advanced post processing software to assess anatomy of the left atrium and pulmonary veins for EP Procedure Planning. After you complete the assessment and measurements, export the 3D model to an EP navigation and mapping system (EnSite). The 3D anatomical model can be used in planning the electrophysiology procedure or correlation with the model generated during the procedure.

The pulmonary anatomy varies from person to person. The number and placement of the pulmonary veins is part of the information needed for EP Planning.

CT Cardiac EP Planning Lesson

I. Select Study

Load an EP Planning study.

See the instructions for your Vitrea type (VitreaAdvanced Through the Data Manager or VitreaWorkstation) in the **Select Study** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide**.

II. Choose Protocol and Preset

Use one of these procedures:

Data Manager

- Double-click the **EP Planning** application thumbnail.

Gallery Window

1. On the Gallery window, select the **Cardiac: EP Planning CT** protocol.

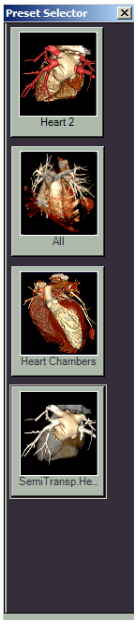
   The Gallery choices update automatically.

2. Click Pick next to the **EP 3D Analysis** preset.

III. Perform Analysis

Perform an Overall Review

1. Click the Visualization Preset dropdown button and select an appropriate format.



2. Review the 3D volume image.

3. On the Analysis tab, verify the Show Vessel check box is selected and the automatically probed vessels are correct.

4. Rename a vessel by selecting the vessel name. Right-click and select **Rename,** or double-click the vessel name to rename.

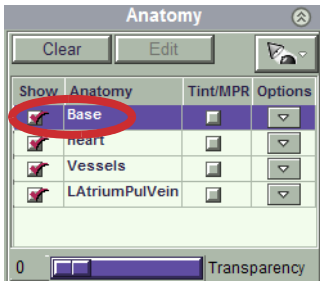
TIP: Vessel Management allows you to remove the probed vessel by selecting the vessel name, right-click and select **Delete**.

5. To probe additional vessels, locate the vessel you want to probe in 2D or 3D view.

   a. Right-click and select .

   b. Probe a vessel in the volume view, or probe a vessel in the MPR planes.

TIP: When probing in the volume view, verify the **Base** listing in the Anatomy Management area is selected.



See the Additional Procedures section of this Module for information about editing the vessels if they are not probed correctly.

Perform Quantitative Measurements of the Left Atrium and Pulmonary Vein Anatomy

6. Verify LAtriumPulVein region is selected in the Anatomy list.

7. Use a method below to perform measurements:

- Use Curved insets to perform measurements:

  a. Rotate the curved insets to desired orientation.

  b. Align the cross-section of the pulmonary vein you need to measure in the blue box located above the CPR images.

  c. Right-click and select .

  d. Click and drag across the vessel in the blue box and the measurement automatically computes.

8. Delete a measurement by clicking on the line (the color changes to magenta), then press DELETE.

9. Select the Oblique crosshair mode in any MPR view to perform manual measurements.

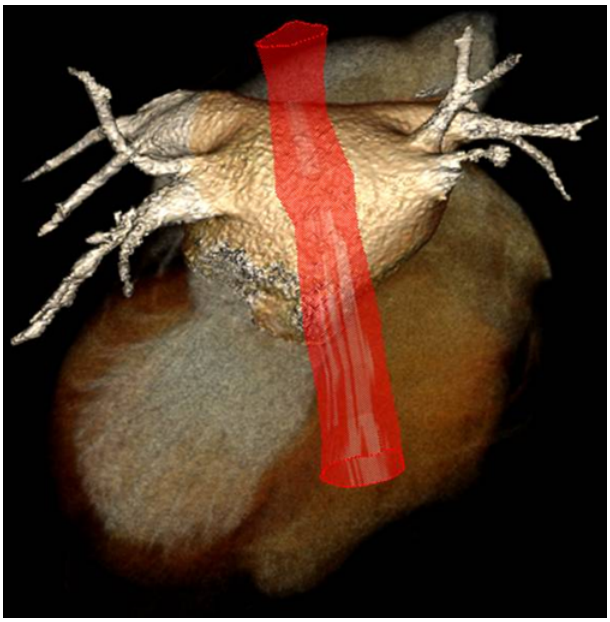
Show Esophagus

Perform the steps below to view the esophagus.

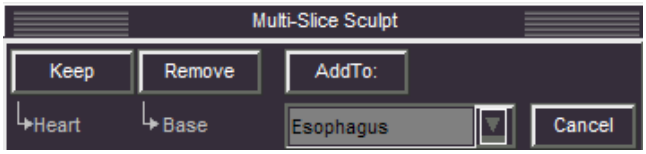
10. Right-click and select .

11. In the Axial view, draw free contours from top to bottom in the esophagus.

12. View the contour in 3D.



13. In the dropdown box, type Esophagus.



14. Click **Add To**.

15. Right-click and select Window Level and drag in the view to window level the esophagus in.

TIP: Window level is also available when you left + right-click and drag.

Take Snapshots

Snapshots may be restored from the Study directory and from the Report page. Snapshots may be restored on the same Vitrea or a different licensed Vitrea.

16. Right-click and select (or press S) to activate the camera.

17. Move cursor to image and click.

V. Distribute Findings

The snapshots you save in the Viewer window are saved to the Report window.

1. Click

at the bottom of the window.

2. Export your findings or create a report.

See the **Distribute Findings** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide** for instructions on exporting findings, restoring workflow, and creating reports.

Additional Procedures

Create 3D Model (VitreaWorkstation Only)

1. Verify the model is complete.

If the model is not complete, perform vessel probe.

2. Select the Save 3D button

. When the save is complete, a **Save done** message displays at the bottom of the window.

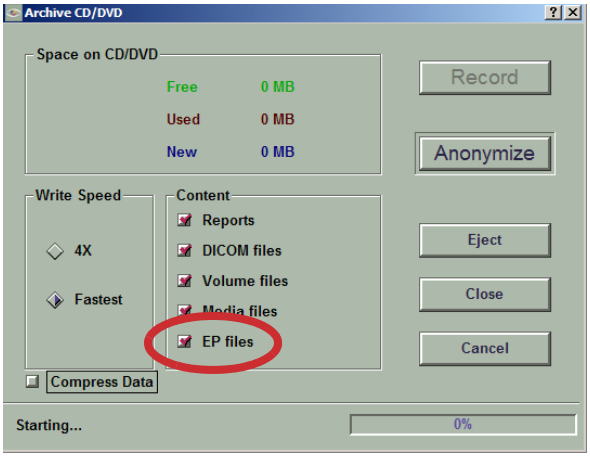
NOTE: This saves a model of the left atrium region in a proprietary format (.dif) for the St. Jude Ensite system. The model is saved on disk in the location of the dataset. If you make adjustments and click Save 3D, it overwrites the existing one.

a. Select the Study Directory tab.

b. Highlight the series you are working in.

c. Click Archive to CD/DVD .

d. Verify the EP files check box is selected.



e. Insert a blank CD.

f. Deliver the CD to the EP lab (physician or technologist using the EnSite system).

Accessing the 3D model from the EnSite NavX System.

Refer to the EnSite® System Instructions for Use for information on Accessing the 3D model.

Edit if necessary

1. Verify Crosshair is selected.
2. Select a 4-up layout.
3. Click Edit Ctline .
4. Edit the CPR views by moving the two yellow lines up or down to remove anatomy.

5. Scroll through the Reference view and advance the end points.

6. If a portion of the atrium is not visible:

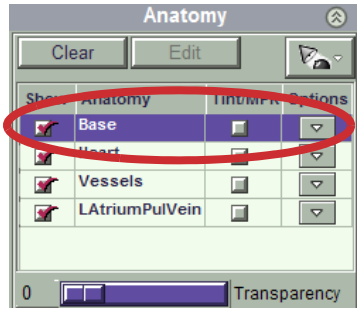
   a. Select **Show** next to Base in the Anatomy Management area.

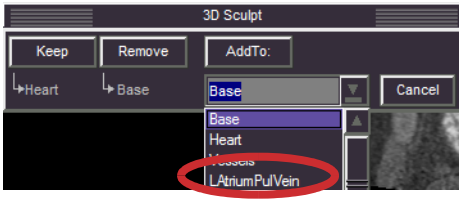
   b. Select **Tint/MPR** next to the LAtriumPulVein (the region is tinted in the MPRs).

   c. Right-click and select .

   d. From the reference view, draw contours around structures you want to add back in.

   e. In the in-viewer 3D Sculpt box, select **LAtriumPulVein**.

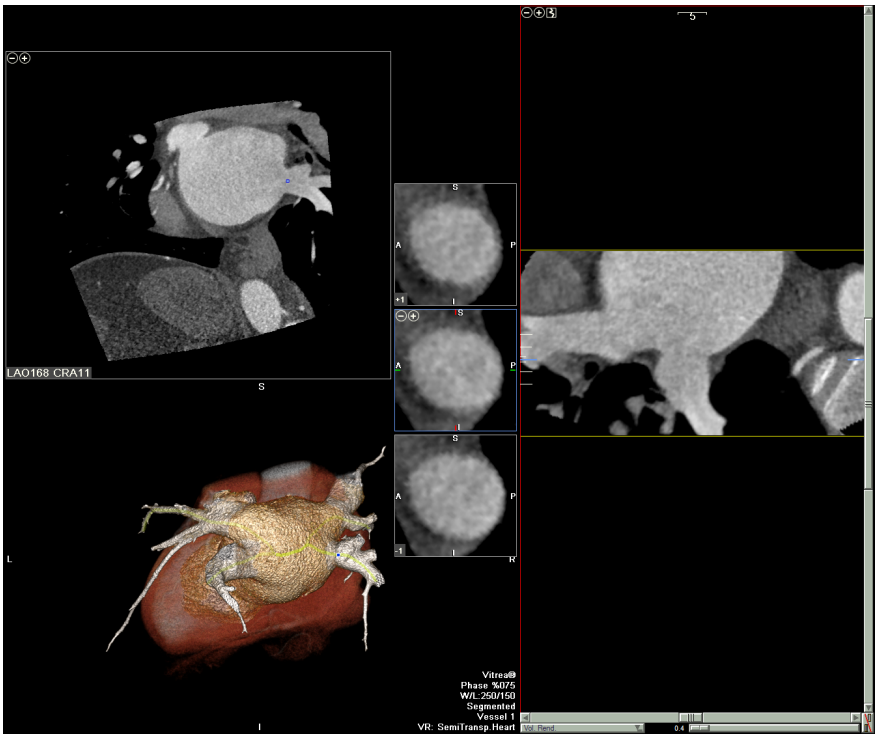




Cath View

1. Click the 1-up format in the 3D image.

2. Select **Show Vessel** Show Vessel .



Perform Fly Through (endoluminal views) Using the EP Planning FlyThrough PV Preset

1. From the Gallery tab, select Pick next to the EP Flythrough preset.

   NOTE: All segmentation must be complete before performing the steps below.

2. Locate the center of the atrium and click HU Crshair.

3. Hold the Alt Point & Go key and click to the right side of the pulmonary vein side.

4. Select the 180° key to look at the other side. Click on the image to rotate.

5. Use the mouse roller or Nav Fwd key to perform a flythrough.

Myocardial Perfusion

Contents

I Select Study

II Choose Protocol and Preset

- Data Manager
- Gallery Window

III Perform Analysis

- Inspect the Orthogonal Views
- Edit the LV Axis, Mitral Valve Plane, Inner Apex Plane, and Outer Apex Plane
- Edit the Short Axis Sector Indicator
- Edit the Epicardial/Endocardial Contour Lines in the Short Axis View
- Review the Polar Maps
- Define Hypo-attenuated Areas Using the Defect Scoring Tool
- Review Results
- Take Snapshots

IV Distribute Findings

Additional Procedures

- Change the Viewer Window Format
- Swap Series
- Measure the Heart Muscle Wall
- Display the CT/Perfusion Map Fusion View
- Edit Findings

- Edit the Epicardial/Endocardial Contour Lines in the 2-chamber or 4-chamber View
- Create Batches and Movies
- Use Alternative Means to Find and Apply the LV HU Value

Appendix

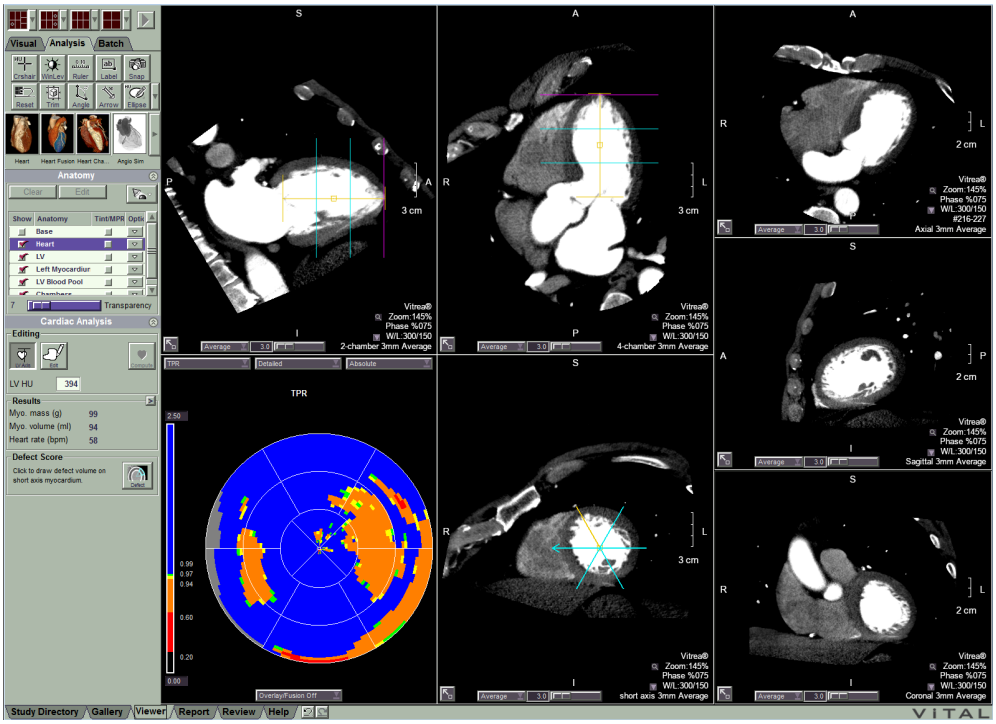
- Regional Measurements
- Polar Map Models
- Polar Map Overlays
- Results

Myocardial Perfusion Overview

Vitrea® CT Myocardial Perfusion is intended to assist a trained user for the visualization of hypo/hyper dense areas in patients with angina or with a previous myocardial infarction to assess the disease state and treatment. This software provides semi-automated heart and left ventricle segmentation and color polar maps of the myocardial tissue.

The information provided is intended to be qualitative in nature and, when used by a qualified physician, may aid in the identification of myocardial enhancement defects and the follow up of such findings.

The CT Myocardial Perfusion application supports cardiac CTA studies. The CT Myocardial Perfusion application does not support MRA studies.



The CT Myocardial Perfusion application allows you to load one or two volumes. In dual-volume cases, the volumes are displayed based on time. Vitrea labels the volumes as Series1 (earlier acquisition time) and Series2 (later acquisition time).

If you wish to switch the order of the volumes, see the Swap Series portion of Additional Procedures.

Caution Statements and Notes

Observe these precautions and guidelines to ensure the safe and effective use of the software.

CAUTION: The Vitrea CT Myocardial Perfusion software is intended to operate with any CT scanner model capable of performing a coronary CT angiography. Currently the software is validated on Toshiba Aquilion One scanner. If you are using data from other CT scanners, please contact Vital customer support for more information.

CAUTION:

- **This product is intended for use only as a supplement to standard methods of interpreting radiological images. It should not be exclusively relied upon for arriving at a diagnosis, treatment plan, or other decision that may affect patient care.**
- **Verify that the software-generated LV axis line is accurate, or adjust it so that it is accurate. The position of the LV axis line is used to calculate classification of the 17-segment polar map model.**
- **Evaluate the software-generated endocardial and epicardial contour lines to verify that they are accurate, or adjust them so they are accurate. The myocardial contour lines are used to calculate the measurements. Be certain that the contour lines do not include data outside the true myocardium (for example, be sure the contour lines avoid the coronary vessels). An error in the contour lines could create a significant adverse effect in the calculations, which could lead to incorrect diagnosis.**
- **This software is not intended for the visualization of reversible low perfusion defects.**

CAUTION: Prior to restoring a multiple-series snapshot, make sure you load all associated studies. It is possible to restore a snapshot associated with multiple volumes with too many, too few, or incorrect volumes loaded. Doing so may yield different results than the original calculations.

NOTE: The accuracy of the Perfusion Index values is highly dependent upon the accuracy of the myocardium segmentation, as well as the LV HU value. You should check the validity of the LV blood pool region, from which the LV HU value is derived. If the LV blood pool region is deemed to be incorrect, then you may ascertain a suitable LV HU value and enter it into the LV HU text box. One way to do this is to use the software to manually define an ROI within the left ventricle and extract the mean attenuation.

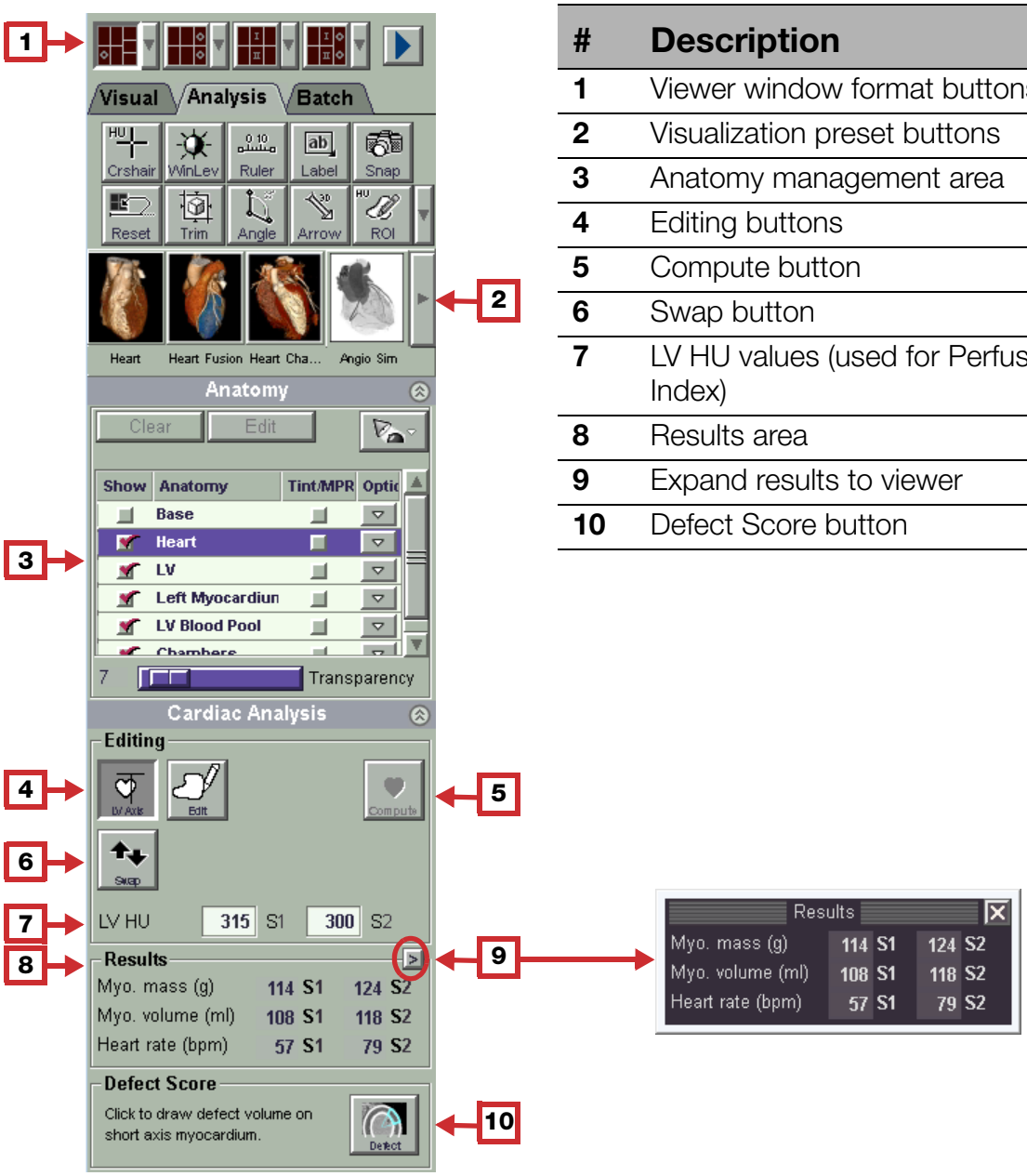
See the Use Alternative Means to Find and Apply the LV HU Value section for instructions.

CT Myocardial Perfusion Tools

When you load the protocol and preset, the system semi-automatically segments the Heart, LV, Left Myocardium, LV Blood Pool, and Chambers.

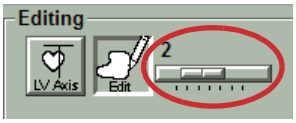
When you select the **Cardiac: Myocardial CT** protocol and **Myocardial Perfusion** preset, the Cardiac Analysis tools display on the Analysis tab

of the Viewer window. Some of the Cardiac Analysis tools are available when using any of the Viewer window formats, and some are only available when using one or two of the formats.



#	Description
1	Viewer window format buttons
2	Visualization preset buttons
3	Anatomy management area
4	Editing buttons
5	Compute button
6	Swap button
7	LV HU values (used for Perfusion Index)
8	Results area
9	Expand results to viewer
10	Defect Score button

Tool	Description
LV Axis button	Display the LV axis, mitral valve plane, inner apex plane, and outer apex plane for reviewing and editing. Activated upon loading.
Edit button	Click to edit the epicardial/endocardial contour lines.

Tool	Description
 Interpolation slider	Set the interpolation slider to specify the number of unique contours the edit mode should interpolate or propagate to on either side.
Compute button	Click to compute the perfusion results after editing.
Polar Map dropdown	Use to switch between maps (TPR, Contrast, or Perfusion Index).
Model dropdown	Use to switch between models (Detailed or 17-Segment).
Scale dropdown	Use to switch between scales (Absolute or Relative).
Overlay/Fusion dropdown	Use to display or hide an overlay of the map on the short-axis view.
Defect Score button	Click then draw along an area of defect in the myocardium to define hypo-attenuated areas.
Snapshot button	Click to save snapshot of workflow.
Viewer window format buttons	Click to change the layout of the views on the Viewer window.
Swap button	Click to switch the order of the series.
CT/ Perfusion Map Fusion dropdown	Use to display a 3D CT view fused with a perfusion map.

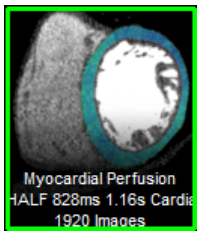
CT Myocardial Perfusion Lesson

I. Select Study

Follow the instructions in the Select Study Chapter to load a CT Myocardial Perfusion study for your Vitrea type (Vitrea Through the Data Manager or VitreaWorkstation).

II. Choose Protocol and Preset

Data Manager

- Double-click the application thumbnail 

.

Upon choosing the Myocardial Perfusion protocol and preset, the software automatically segments the heart into six regions: Base, Heart, LV, Left Myocardium, LV (left ventricle) Blood Pool, and Chambers.

Gallery Window

1. On the Gallery window, select the **Cardiac: Myocardial CT** protocol.

2. Click Pick next to the **Myocardial Perfusion** preset.

III. Perform Analysis

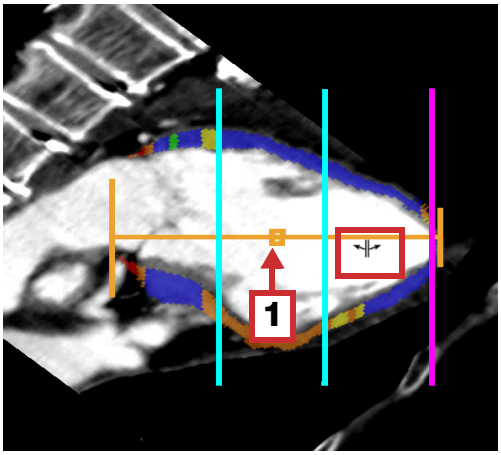
Inspect the Orthogonal Views

1. Scroll through the orthogonal views to verify the absence of cone beam and beam hardening artifacts.

Edit the LV Axis, Mitral Valve Plane, Inner Apex Plane, and Outer Apex Plane

The long yellow line (#1 in the figure below) represents the LV axis. The mitral valve plane (#2), inner apex plane (#3), and outer apex plane (#4) are represented by three line segments. The short line represents the outer apex plane, and the longer pink line represents the inner apex plane. The origin of the axis is marked by a square. Use the 6-up Chambers Viewer window layout for editing.

To rotate the LV Axis Line (#1):



2. In the 2-chamber long axis view, float the cursor over the LV Axis Line (#1).

   NOTE: The cursor changes to indicate rotation.

   When you rotate the LV axis, it rotates about its origin (represented by the small square in the center of the line).

3. Click and drag to tip the line.

   TIP: Tip the LV Axis Line so that the Mitral Valve Plane Line (#2) lines up with the myocardium on both sides.

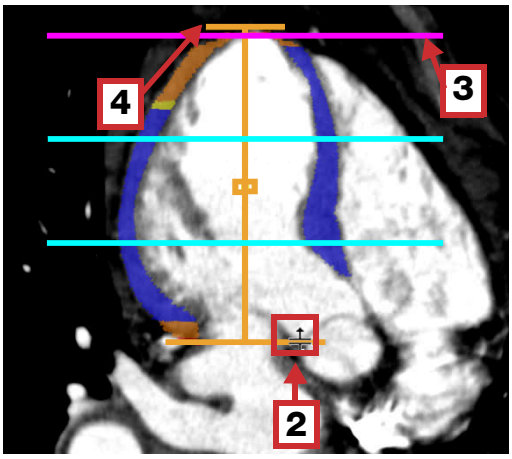
To edit the Mitral Valve Plane Line (#2):

TIP: Be sure that at least 50% of the myocardium is visible at the mitral valve plane in the short axis view.

4. In the 4-chamber long axis view, float the cursor over the Mitral Valve Plane Line (#2).

   NOTE: The cursor changes to an up and down arrow.

5. Click and drag to move the Mitral Valve Plane Line along the LV axis until it rests on the top of the myocardium.



   NOTE: The mitral valve plane always remains perpendicular to the LV axis.

6. Scroll through the long axis views to verify the placement of the mitral valve plane. Adjust the position of the line if necessary.

To edit the Inner Apex Plane Line (#3):

7. In either long axis view, float the cursor over the long pink line representing the inner apex plane (#3).

   NOTE: The cursor changes to an up and down arrow.

8. Click and drag to move the inner apex plane line until it rests on the bottom of the LV blood pool.

   NOTE: The blue-green slab/layer boundary lines remain equally spaced as you edit the mitral valve plane or inner apex plane.

To edit the Outer Apex Plane Line (#4):

9. In the 4-chamber long axis view, float the cursor over the short yellow line segment representing the outer apex plane (#4).

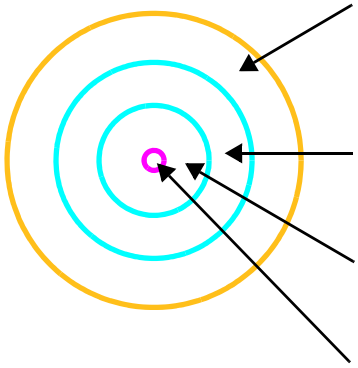
   NOTE: The cursor changes to an up and down arrow.

10. Click and drag to move the outer apex plane line until it rests on the bottom of the myocardial apex.

11. If you have dual volumes loaded, repeat steps 2 - 10 for the other volume.

NOTE: It is important to edit the lines in both volumes so that they match each other.

The software divides the myocardium into four “slabs” or layers. The lines that you edited along the LV axis determine the slab/layers. Looking at the myocardium from the top, the slab/layers appear as follows:



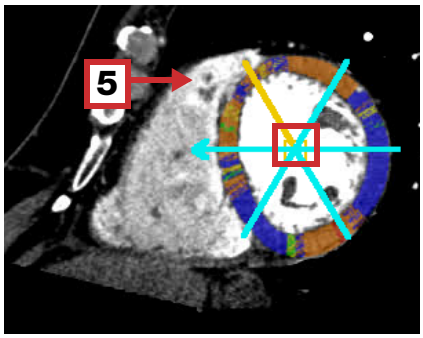
- Basal slab/layer - area between Mitral Valve Plane line (#2) and the first blue-green line.
- Mid-cavity slab/layer - area between the two blue-green lines.
- Apical slab/layer - area between the second blue-green line and the long pink line (#3).
- Apex - area between the long pink line and the short yellow line (#4).

Edit the Short Axis Sector Indicator

The software displays the sector indicator lines in the short axis view. The yellow line segment (#5) represents the border between Sector 1 and Sector 2. The arrow indicates the septum.

12. Click .

13. In the short axis view, float the cursor over the yellow line segment (#5) and rotate the sector indicator lines until the arrow points to the septum.



TIP: Scroll through the image to visualize the entire myocardium and adjust the yellow line (#5) so it

rests just to the right of the right ventricle insertion point in most planes.

NOTE: If you edit the short axis sector indicator, be sure to review the LV axis view.

14. If you have dual volumes loaded, repeat step 13 for the other volume.

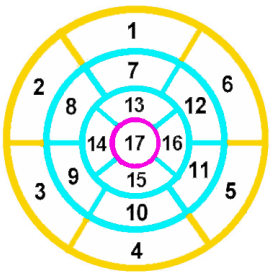
NOTE: It is important to edit the lines in both volumes so that they match each other.

15. Click

.

The software divides each of the slab/layers into sectors. The yellow line (#5) you rotated in the short axis view determines Sector 1 and Sector 2. The Basal and Mid-cavity slab/layers are divided into six sectors each; the Apical slab/layer is divided into four sectors; the Apex is one sector:

Left Ventricular Segmentation



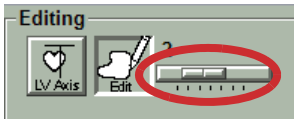
1. basal anterior
2. basal anteroseptal
3. basal inferoseptal
4. basal inferior
5. basal inferolateral
6. basal anterolateral
7. mid anterior
8. mid anteroseptal
9. mid inferoseptal
10. mid inferior
11. mid inferolateral
12. mid anterolatereal
13. apical anterior
14. apical septal
15. apical inferior
16. apical lateral
17. apex

Edit the Epicardial/Endocardial Contour Lines in the Short Axis View

16. Click

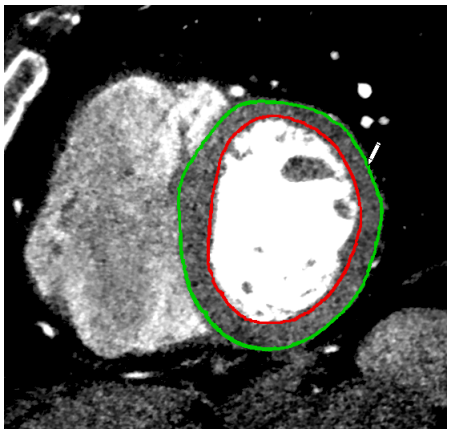
.

17. Set the interpolation slider to specify the number of unique contours the edit mode should interpolate or propagate to on either side.



NOTE: The default setting is two contours.

TIP: Edit any contours after verifying that the slider is set appropriately.



18. Scroll in the short axis views and review the positioning and shape of the contour lines to verify they trace the epicardium or endocardium.

NOTE: The area between the contours should not contain contrast, coronary vessel, or air.

To make adjustments:

19. Float the cursor over the contour line until it changes to a pencil.

20. Click and drag to adjust the border of the contour line, just like you would to edit a freehand ROI in standard Vitrea.

21. Scroll through the short axis view and edit additional contours as necessary.

CAUTION: You should always scroll through the slices to verify the system accurately placed these anatomical reference points and that it segmented the myocardium appropriately.

22. If you have dual volumes loaded, repeat steps 18 - 21 for the other volume.

NOTE: It is important to edit the contours in both volumes so that they match each other.

23. When finished editing, click

.

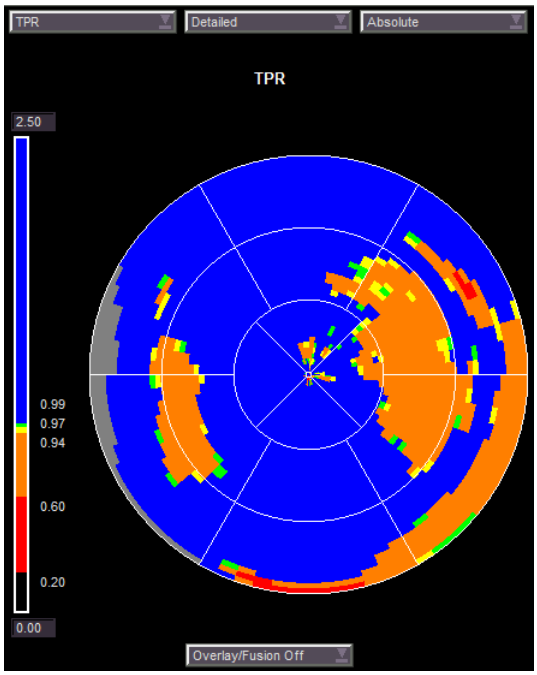
CAUTION: Always scroll through the slices after clicking compute as Vitrea may alter your contours to fit the model used for calculating the polar maps.

Verify that the polar maps are consistent with the contours, LV axis, and Short Axis Indicator. The gray area will alway indicate the aortic valve.

Review the Polar Maps

Once the regions generate, Vitrea sectors the myocardium into polar maps representing Contrast, Transmural Perfusion Ratio (TPR), and Perfusion Index measurements. Each map contains a legend indicating the numerical values of the color map. The TPR map is the default displayed map in the seven-up view.

The TPR map also contains a written legend indicating the map score for the colors in the map.

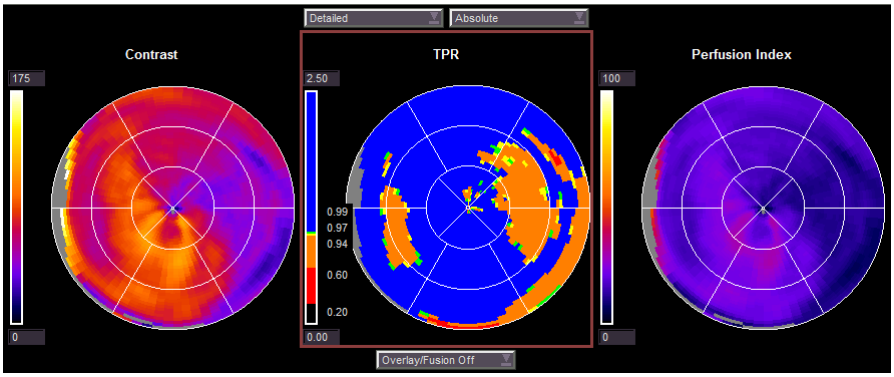


- Blue — 0. (Above 0.99) transmural perfusion ratio
- Green — 1. (0.97 -0.99]
- Yellow — 2. (0.94 - 0.97]
- Orange — 3. (0.60 - 0.94]
- Red — 4. (0.20 - 0.60]
- Black — 5. (Below 0.20)

NOTE: Gray indicates aortic valve.

See the Appendix for definitions and formulas of the regional measurements.

Use the dropdowns in the map view to switch maps and models.



24. Use the **Polar Map** dropdown

to switch between maps (TPR, Contrast, or Perfusion Index).

25. Click the Color Scale bar to open a panel of other color schemes — Hot Metal and Rainbow.

Vitrea provides two models for displaying the regions within the polar maps: 17-Segment and Detailed.

See the Appendix for definitions and illustrations of the segment models.

26. Use the **Model** dropdown

to switch between models.

Vitrea provides two scales: Absolute and Relative.

27. Use the **Scale** dropdown

to switch between the scales.

28. Click the dropdown at the bottom of the map panel to display a colored overlay on the MPR images.

NOTE: Voxel Overlay/Fusion selection is available with the Contrast polar map.

Define Hypo-attenuated Areas Using the Defect Scoring Tool

Optional Click the dropdown at the bottom of the map panel and select **OverlayFusion On** to display a colored overlay on the short axis image.

1. Click to maximize the short axis view.

2. Scroll in the view to find the defect.

3. Click

.

4. Click and drag along the defect in the myocardium.

   TIP: To edit any of the sides of the highlight box, click and drag.

5. Scroll a few slices and click and drag along the defect in the myocardium.

   Vitrea interpolates between selections.

   NOTE: Interpolation results may not be satisfactory if there are too many short-axis slices between the drawn regions.

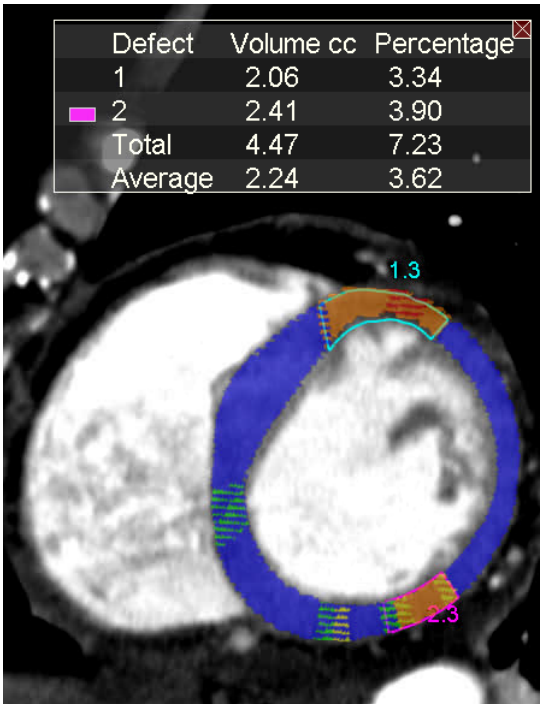
6. Repeat the previous step until the entire defect is identified.

7. If necessary, correct the interpolation by adding more reference arcs where appropriate.

8. Click

.

A dialog box displays with the defect volume and percentage of the myocardium.



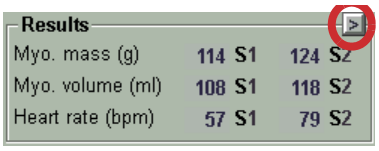
NOTE: The pink color bar indicates the currently selected highlight box.

9. Repeat from step 2 for additional defects.

10. Take snapshots.

Review Results

11. Review the myocardial mass, myocardial volume, and heart rate.



See the Appendix for definitions and formulas of the results.

NOTE: To overlay the results area on the viewer for snapshots, click the small button in the results area.

Take Snapshots

12. Right-click and select (or press S) to activate the camera.

13. Move cursor to image and click.

Snapshots, with associated measurements, rulers, W/L, or segmentation options, can be restored from the Report page or the Study Directory.

TIP: Hold down CTRL to take a snapshot of the entire screen.

NOTE: Snapshots of individual polar maps are automatically populated to the report Findings tray.

IV. Distribute Findings

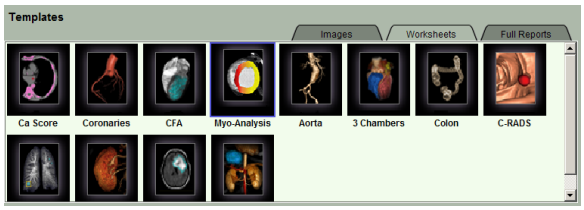
The snapshots you save in the Viewer window are saved to the Report window.

1. Click Report at the bottom of the window.

2. Export your findings or create a report.

   See the **Distribute Findings** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide** for instructions on exporting findings, restoring workflow, and creating reports.

NOTE: The Myocardial template contains a report specific to Myocardial Perfusion.



Additional Procedures

Change the Viewer Window Format

Use the Viewer window format buttons to change the layout of the Viewer window.

- Click a **Viewer Window Format** button.

TIP: Click the dropdown next to any format button to see the whole panel of format buttons.

Format	Description
	Cardiac Seven-up Polar Map (default): The 2-chamber long axis view and the polar map in the left column, the 4-chamber long axis and the short axis views in the center column, and the three MPR (axial, sagittal, and coronal) views in the right column.
	Cardiac Six-up Scoring: Use to compare the detailed and 17-segment polar maps. The 2-chamber long axis and 3D view in the left column, the 4-chamber long axis and short axis views in the center column, and the detailed and 17-segment polar maps in the right column.
	Cardiac Six-up Chamber: The top row displays a 2-chamber long axis view, short axis view, and 4-chamber view. The bottom row displays basal, mid, and apical short axis views. If you select the crosshair tool, the crosshair line on the two chamber view and four chamber view shows the location of the bottom three short axis views.
	Cardiac Four-up 3D: Three MPR views and a 3D view. The top row displays long axis views, and the bottom row displays a 3D view and the short axis view.
	Cardiac Five-up Polar Maps: The polar maps and short axis views on the left side, and the 3D, 4-chamber long axis, and 2-chamber long axis views on the right.
	Cardiac Six-up Short Axis: Six short axis views. The display shows short axis views from the base to the apex of the heart.

Format	Description
	Cardiac Dual Six-up Chambers: A 2-chamber, 4-chamber, and short axis view for Series1 (earlier acquisition) and Series2 (later acquisition) volumes.
	Cardiac Dual Six-up Polar Map 3D: A 3D and short axis views for Series1 and Series2 volumes on the left side, and a polar map for each volume on the right side.
	Cardiac Dual Short Axis: The short axis views for Series1 and Series2 volumes.
	Cardiac Dual Six-up Polar Map Chambers: A short axis and 2-chamber view for Series1 and Series2 volumes on the left side, and a polar map for each volume on the right side.
	Cardiac Dual Sixteen-up: Six short-axis views of the Series1 and Series2 volumes. Contains reference views of 2-chamber and 4-chamber views of each volume. The reference views display cross-sectional lines that correspond to the short axis views. The cross-reference lines are editable; however the spacing between them will remain constant.

Swap Series

With multiple studies loaded, Vitrea labels the series based on acquisition time. You can change this labeling by swapping the series.

1. Click .
2. Select Yes in the confirmation dialog box.

   NOTE: This will cause Vitrea to completely reset the volumes. Be sure to take snapshots of anything you want to save prior to swapping the series.

Measure the Heart Muscle Wall

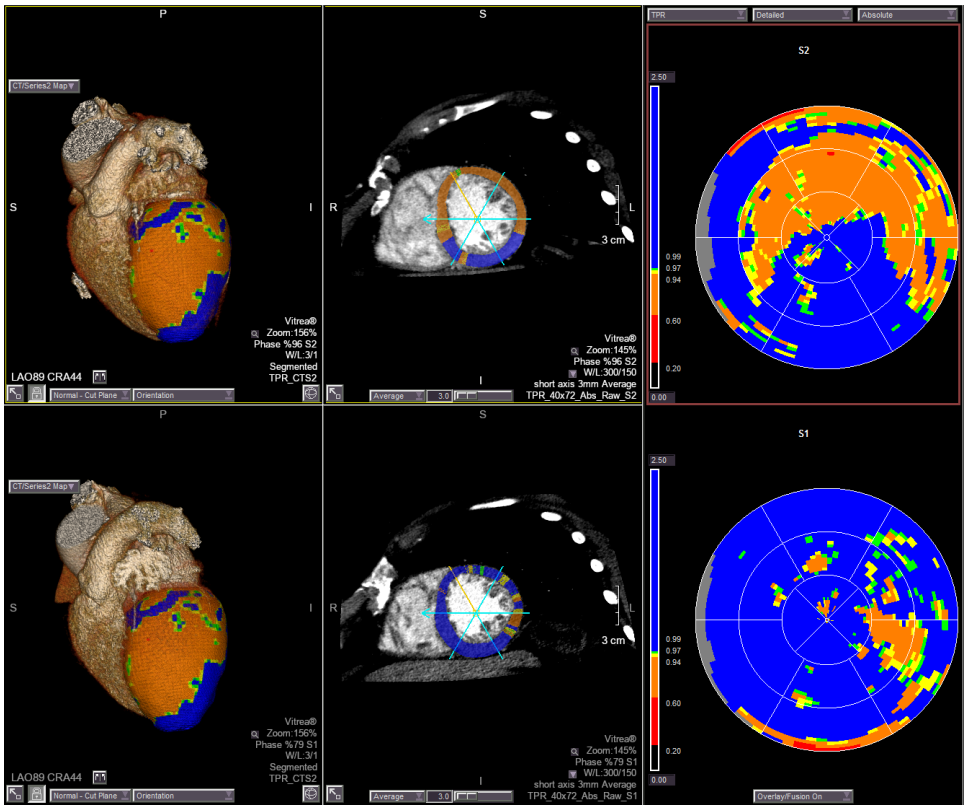
1. Press R on the keyboard to activate the ruler.
2. Click to maximize the short axis view.
3. Click and drag the ruler across the endocardial border.

TIP: To Delete, click the line to change color or press CTRL + A to select all rulers. Press Delete or Backspace on the keyboard.

4. Take snapshots.

Display the CT/Perfusion Map Fusion View

Display a 3D CT view fused with a perfusion map. When you make a selection, the same perfusion map will display in both 3D viewers.

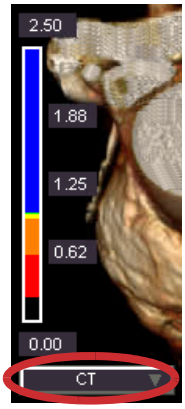


1. Select a Viewer window layout that includes a 3D image (, , , or).

TIP: You may need to click one of the Viewer window layout dropdown buttons to display all the Viewer window layout buttons.

2. Click

.



3. Select one of the following options:

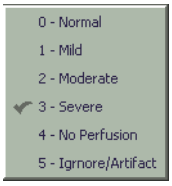
   - **CT/Series1 Map** - fuses the Series1 (earlier acquisition) map on the CT image
   - **CT/Series2 Map** - fuses the Series2 (later acquisition) map on the CT image
   - **Map** - displays the corresponding map in 3D

   NOTE: If a single volume is loaded, the CT/Map option is available.

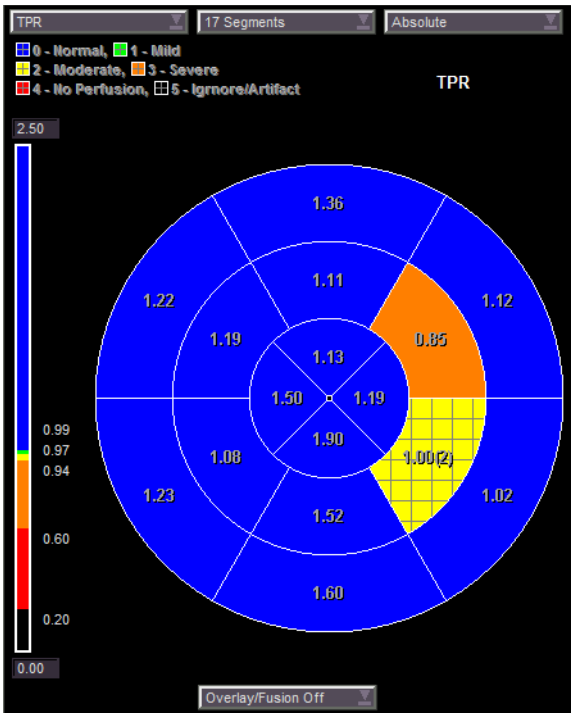
   NOTE: The CT/Series1 and CT/Series2 maps are available only if the two studies are coincident in regard to origin, slice thickness, and number of slices.

Edit Findings

1. Display a 17-Segment TPR polar map.
2. Verify the 6-color bar is selected.
3. Select the **Absolute** scale.
4. Right-click a segment.
5. Make a selection from the menu to edit the finding.

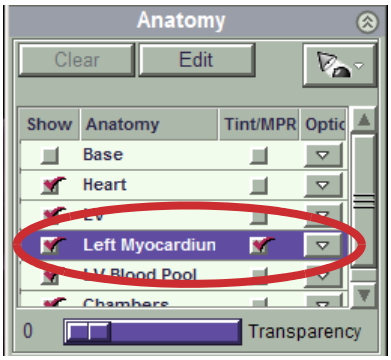


The color of the segment will change to match the TPR legend. Edited findings are marked with a crosshatch pattern on the segment and the classification number will display within parentheses.



When findings are edited, the TPR map thumbnail updates in the Report window Findings Tray.

Edit the Epicardial/Endocardial Contour Lines in the 2-chamber or 4-chamber View



1. Highlight the Left Myocardial region in the Anatomy Management area and select the **Tint/MPR** check box.

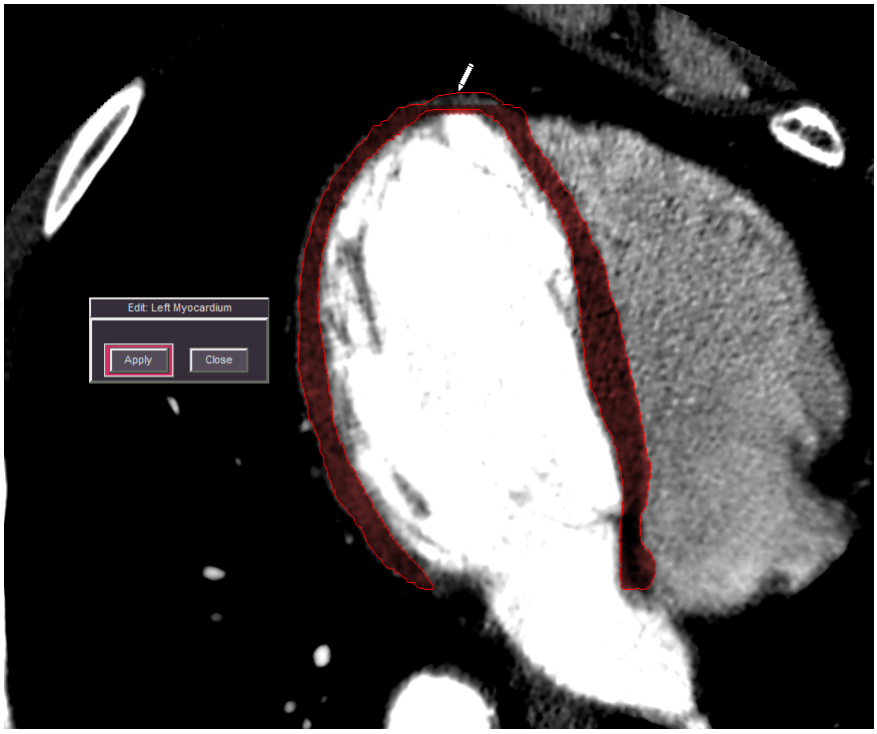
   The Left Myocardium will be tinted red.

2. Click Edit.

3. Scroll in either the 2-chamber or 4-chamber views and review the positioning and shape of the contour lines to verify they trace the epicardium or endocardium.

NOTE: The area between the contours should not contain contrast, coronary vessel, or air.

4. Edit the contour lines as necessary.



5. When you are done editing, click Apply.

6. Click Compute.

CAUTION: Always scroll through the slices after clicking compute as the software may alter your contours to construct the polar maps.

Create Batches and Movies

The Batch tab of the Viewer window creates image batches and movies.

1. Select the Batch tab.

   The Start button is automatically active.

2. Click the image and a green arrow displays on the MPR view.

The End button is automatically active.

3. Scroll to the ending image.

4. Click the image again and a green arrow displays on the MPR view to end the batch/movie.

   - To include patient information in the batch, select the **Show Patient Info** check box.

     OR

     To remove patient information from the images in the batch or movie, clear the **Show Patient Info** check box.

5. Click **Batch** or **Movie**.

   NOTE: Batch images display best on a PACS. Movies are created as .avi files.

Use Alternative Means to Find and Apply the LV HU Value

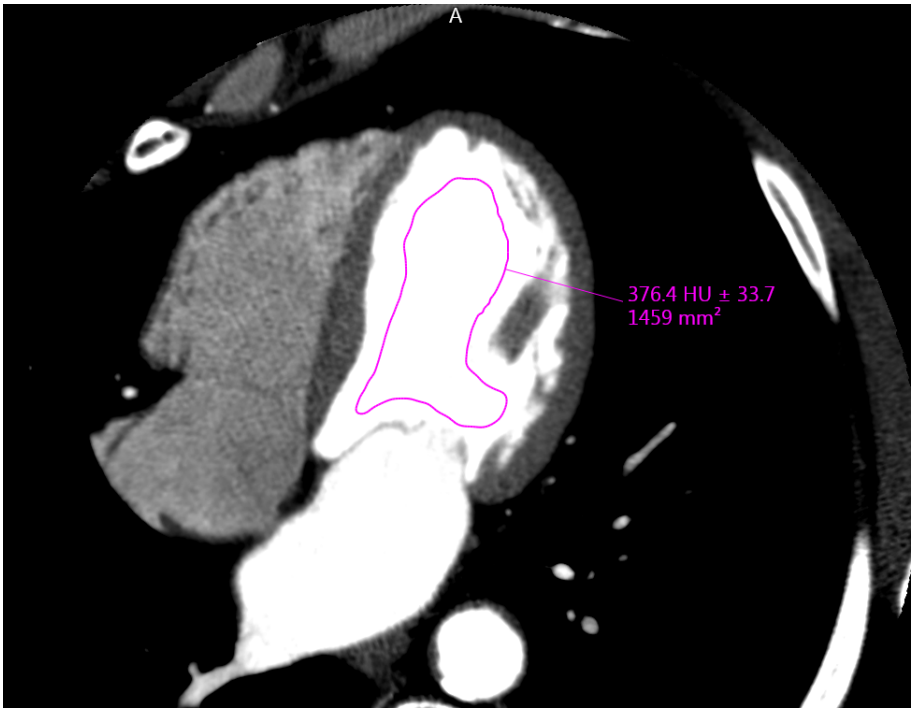
The LV HU value is derived from the segmented LV Blood Pool region. If you wish to manually determine and edit the LV HU value, complete these steps:

1. Scroll in the 4-chamber view to fully view the LV blood pool.

2. Right-click and select .

3. Draw a contour within the LV blood pool.

TIP: Draw the contour large enough to obtain a good sample, but be sure to avoid including myocardium or papillary muscle.



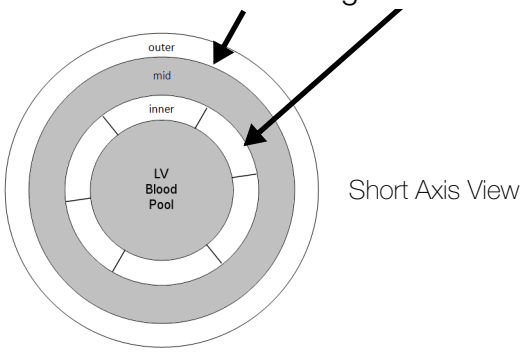
The average HU for the ROI displays.

4. Enter the HU value, rounded to the nearest integer, in the LV HU text box.

5. If two series are loaded, repeat this procedure for the second series.

Appendix

Regional Measurements

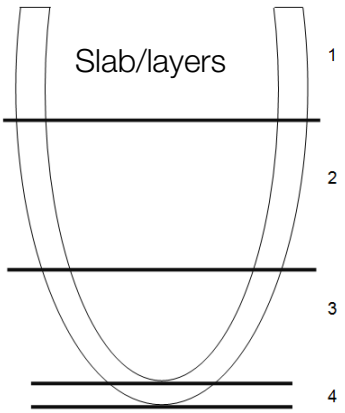
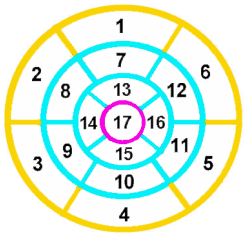
Measurement	Formula
Contrast	Contrast = average HU over all voxels in a region
TPR (Transmural Perfusion Ratio)	TPR = average HU over all voxels in one inner region / average HU over all voxels in the entire outer slab/layer.[1] **NOTE:** The computed TPR values are clamped such that all values are in the range from 0 to 10.  Short Axis View **NOTE:** The denominator is always the average with respect to the 17-segment model, even in the case of the detailed polar map. 1. George RT, et al. Circ Cardiovasc Imaging. 2009;2(3):174-182.

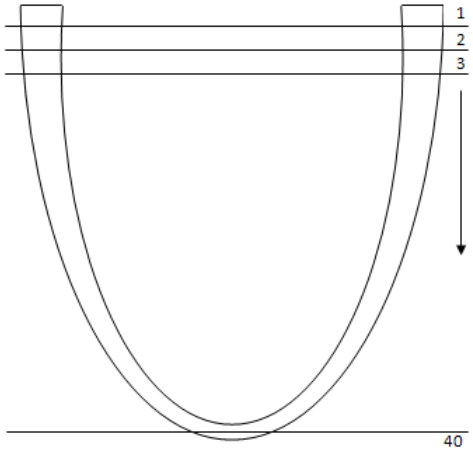
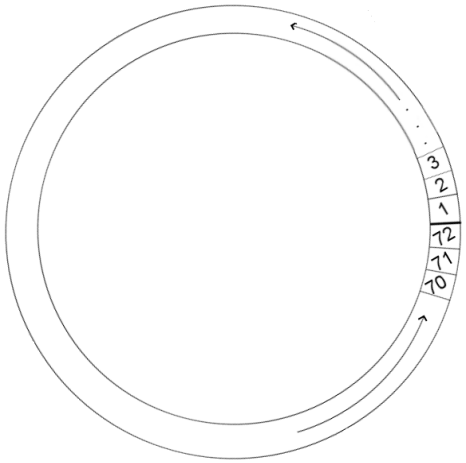
Measurement	Formula
TPR Color Mapping	The color mapping scale displayed on the TPR map is as follows: Blue — 0. (Above 0.99) transmural perfusion ratio Green — 1. (0.97 -0.99] Yellow — 2. (0.94 - 0.97] Orange — 3. (0.60 - 0.94] Red — 4. (0.20 - 0.60] Black — 5. (Below 0.20) **NOTE:** Gray indicates aortic valve.
Perfusion Index	Perfusion Index (PI) = average HU of region / LV HU [1] **NOTE:** The Perfusion Index, aka PI, puts all of the contrast values (excluding outliers) on a scale from 0 to LV HU. This means that it is similar to a relative map in that the scale goes from 0 to 100, except that 0 corresponds to 0 HU and 100 corresponds to LV HU. The usefulness of this map is apparent if you recall that the LV HU is the Contrast reading of pure blood so that is the highest value one would expect for a perfusion measurement. The idea of PI is to remove factors that might be specific to the scanning equipment and/or protocol and just look at the information that is contributed by the amount of blood in a voxel/sector. 1. George, RT, et al. J Am Coll Cardiol. 2006; 48(1):153-160.

Polar Map Models

Vitrea provides two models for displaying the polar map: 17-segment and detailed. Click the dropdown arrow at the top of the maps panel.

Model	Description

17 Segment Model	• Three slabs/layers from mitral valve plane (slab/layer 1) to apical extreme of left ventricle (slab/layer 3)
	  • Slab/layers 1 and 2 are divided into six segments, counter-clockwise starting at -120° from the septal direction (sectors 1 - 6 and 7 - 12)
	  • Slab/layer 3 is divided into four segments counter-clockwise starting at -135° from the septal direction (sectors 13-16)
	• One slab/layer from apical extreme of left ventricle to apical extreme of myocardium (slab/layer 4)
	  • Slab/layer 4 consists of one segment (sector 17). If inner and outer apex planes are very close together, this segment may appear in the polar map as a tiny circle.
	 
	
	Left Ventricular Segmentation
	 
	
	1. basal anterior
	2. basal anteroseptal
	3. basal inferoseptal
	4. basal inferior
	5. basal inferolateral
	6. basal anterolateral
	7. mid anterior
	8. mid anteroseptal
	9. mid inferoseptal
	10. mid inferior
	11. mid inferolateral
	12. mid anterolatereal
	13. apical anterior
	14. apical septal
	15. apical inferior
	16. apical lateral
	17. apex

Model	Description
Detailed Segment Model	Forty equally-spaced slices from the mitral valve plane (slice 1) to the apical extreme of the myocardium (slice 40). • Each slice is divided into 72 sectors, counter-clockwise starting from 180° from the septal direction (sectors 1-72, sectors 73-144,..., sectors 2809-2880).  Slices  Sectors within Slices
Relative Scale	The same scheme as Absolute scales, with the outlying values thrown out. The lowest remaining value is set at 0% and the highest remaining value is set at 100%. The outliers are thrown out based on two standard deviations from the mean value (and clamped to either 0% or 100% in the displayed results).

Polar Map Overlays

Vitrea provides three options for displaying the polar map results on the MPR images. Click the dropdown arrow at the top of the maps panel.

Model	Description
Polar Map Overlay drop down	Displays a colored overlay representing the selected polar map, by slab/ layer or slice, on the region between the epicardial and endocardial contour lines. • Voxel Overlay/Fusion (contrast model only) • Overlay/Fusion On • Overlay/Fusion Off

Results

The Results area displays myocardial tissue measurements. Click the arrow button in the Results area to overlay the results on to the view, then take a snapshot for the report.

Measurement	Units	Description/Formula
Heart Rate (HR)	beats/min	The patient's heart rate.
Myocardial Volume	ml	The volume of the region as defined by the segmented anatomy (contour lines), excluding vessels (based on a density threshold).
Myocardial Mass	g	Myo. volume x 1.05 1.05 is the specific gravity of myocardium.[1]

1. Pohost, Gerald M. and Krishna S. Nayak. ed. 2007. Handbook of Cardiovascular Magnetic Resonance Imaging. New York: Informa Healthcare USA.

CT Transcatheter Aortic Valve Replacement (TAVR) Planning

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CT TAVR Planning Overview

CT Transcatheter Aortic Valve Replacement (TAVR) Planning assists with the assessment of the aortic valve and in pre-operational planning and post-operative evaluation of transcatheter aortic valve replacement procedures.

Key Features:

- Comprehensive template of measurements, including diameter, circumference and length
- Automated segmentation and centerlines of aorta and aortic root for assessment and delivery approach
- Display of C-Arm angle for device placement
- Flexibility to enable planning for the transfemoral, subclavian and transapical delivery approaches
- 3D display of TAVR measurements
- Report template auto fills with user-selected measurements
- Optimized viewing for cardiac valves and calcium
- Tortuosity calculations along a centerline
- Volume rendering, MIP, MPR and curved MPR

NOTE: Because of the high HU value of contrast media in 100kV scans, the reliability of calcium detection within the vessel lumen is expected to be lower than that of regular kV scans.

NOTE: For best segmentation results, it is recommended that these scanning parameters are followed:

- 200HU+ and relatively uniform contrast in the vasculature,
- Scan starts below shoulders, and
- Scan FOV is appropriate to include the vascular anatomy and not be overly constrained.

CT TAVR Planning Lesson

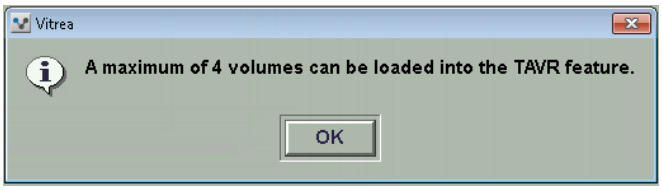
I. Select Study

Load a Transcatheter Aortic Valve Replacement (TAVR) Planning study.

See the instructions for your Vitrea type (VitreaAdvanced Through the Data Manager or VitreaWorkstation) in the **Select Study** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide**.

You may load up to four series in TAVR, (this could be three gated series along with a single run-off series).

NOTE: If more than four volumes are loaded, the following message displays:



TIP: To help you determine the end-systolic and end-diastolic phases from which to define a valve plane, load several volumes into the Generic CT protocol.

II. Choose Protocol and Preset

Use one of these procedures:

Data Manager

- From the Applications tab, double-click the TAVR application thumbnail.

Gallery Window

1. On the Gallery window, select the **Vascular: TAVR CT** protocol. The Gallery choices update automatically.

   NOTE: Automatic segmentation of the aorta and iliacs takes place after you select the Vascular: TAVR CT protocol.

2. Click Pick next to the **TAVR** preset.

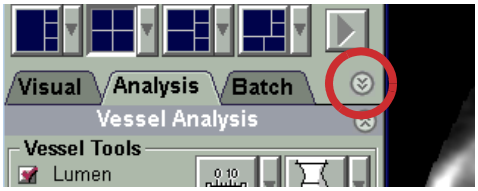
III. Perform Analysis

The Perform Analysis section contains four main sections:

- TAVR Tools
- Review Automatic Segmentation
- Aortic Root Analysis
- Approach Planning

TAVR Tools

TIP: If the full set of TAVR Tools is not visible, click the Expand icon to display the tools.



NOTE: Each loaded series will have its own set of measurements. TAVR will display the measurements of the currently selected series.

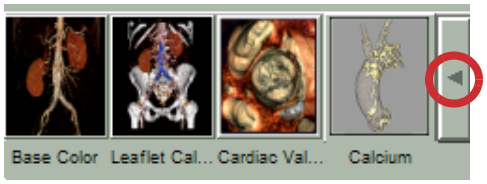
Tool	Description
Ruler	Draw a simple ruler in any view.
Angle	Draw a multi-line ruler and angle measurement in any view.
ROI	Draw contours to define a region of interest.
Vessel Probe tools	Define vessels: • **Select**: probe the vessel. • **Extend**: extend the probed vessel. • **Edit Ctline**: examine and edit the vessel centerline. • **Edit Cont**: open the contour editing view.
Vessel Grow	Segment vessels by dynamically “growing” the selection area.
Centerline Length	Measure length of vessel along centerline.
Centerline Angle	Measure angle of vessel along centerline.

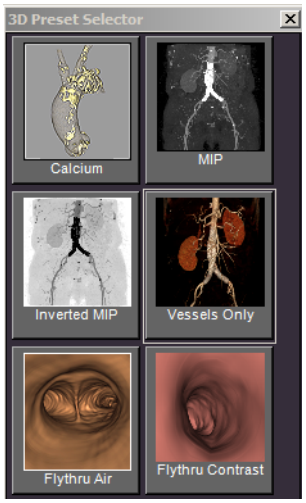
Review Automatic Segmentation

Assess the Vascular Anatomy

1. Review the anatomy.
   - MPR view
   - Orthogonal view
   - 3D view

2. On the Analysis tab, select the dropdown to display the additional visualization options.



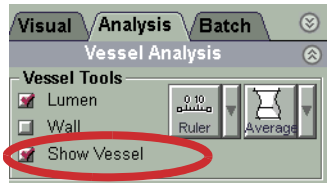


See the Additional Procedures section for additional information on the 3D Preset Selector settings.

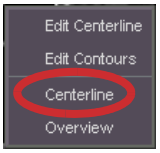
Review the Vessel Centerline

NOTE: Follow the instructions below if you are going to perform the Iliac Access and Subclavian Access procedures.

3. From the Analysis tab, select **Show Vessel.**.



4. Right-click in the CPR view and select **Centerline**.



NOTE: To turn off the centerline, right-click and select **Centerline** again.

5. Press the spacebar to toggle between the aortic, left iliac, and right iliac centerlines.

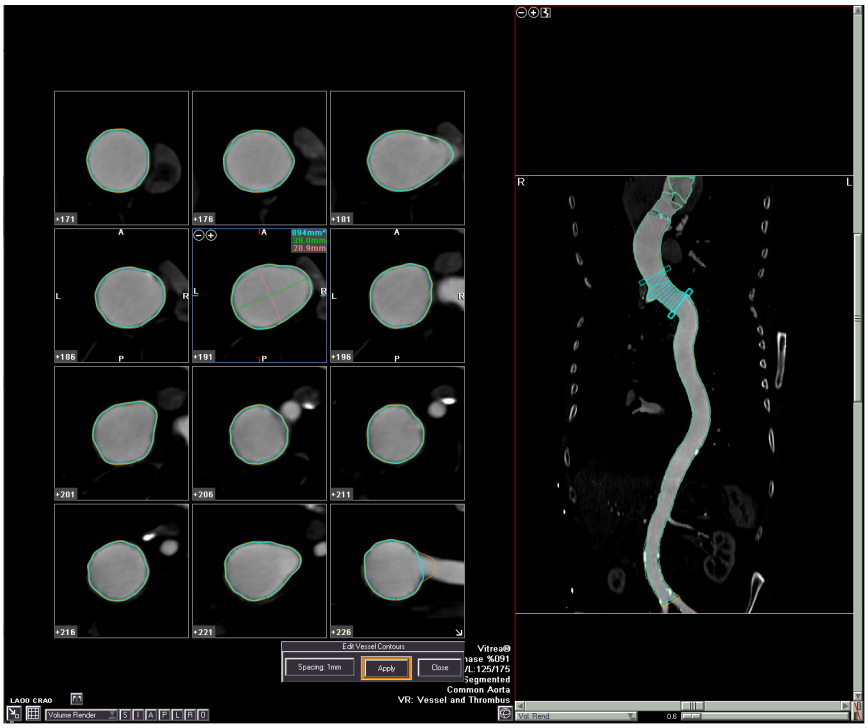
See the Additional Procedures section for additional information on how to edit the vessel centerline.

Review the Contours

NOTE: Follow the instructions below if you are going to perform the Iliac Access and Subclavian Access procedures.

6. Right-click on the inset view and select **Edit Contours** to open the contour editing view with several cross-sectional views .

7. Press **Page Up** or **Page Down** to toggle to the area of interest.



The curved image displays in a straightened view next to the graph of the lumen and wall. A grid on the straightened view represents locations of the corresponding cross-sections along the curved view.

See the Additional Procedures section for additional information on how to edit contours.

Aortic Root Analysis

View the C-arm Angles

When you are in oblique crosshair mode, the C-arm angles display. The view displays the 3D and oblique MPR views relative to the valve plane. The clinical values display in the lower right corner of the view.

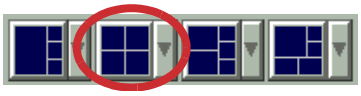
TIP: You also have the option to rotate the 3D view. The C-arm angles display in the lower left corner of the 3D view.

NOTE: The first value indicates Right Anterior Oblique or Left Anterior Oblique. The second value indicates Cranial or Caudal.

Define the Valve Plane

See the Additional Procedures section for information regarding using the crosshair tool to define a valve plane.

This workflow will help you define three points in a plane in any oblique MPR plane.

1. Select a 4-up view  .
2. Select **Valve Plane** in the Measurements list in the Vessel Analysis section.

   NOTE: When **Valve Plane** is selected, the cursor will change to .
3. Scroll in the MPR views to best display the bottom of an aortic cusp.
4. Place a point at the bottom of the cusp.
5. Repeat from step 3 for the other two cusps.

When the third point is placed, the axial view snaps to the new valve plane.

6. To refine the valve plane, click and drag the point to the desired location.

7. To toggle between defined points, press SPACEBAR.

NOTE: Points are editable in the MPRs but not the 3D view.

NOTE: The points will be visible in all MPRs and 3D views when the valve plane is highlighted.

Display a Semi-automated Approximate Valve Plane

8. Select **Valve Plane** in the Measurements list in the Vessel Analysis section.

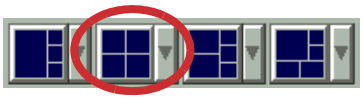
9. Double-click inside an MPR.

NOTE: This plane will overwrite an existing valve plane or create one if one does not exist.

CAUTION: Review the valve plane for accuracy as this procedure only defines an approximation. Failure to do so may result in incorrect diagnosis or planning.

Define Device Measurements

This section includes a device measurements workflow for Transcatheter Aortic Valve Replacement Planning using the orthogonal (MPR) planes without centerlines.

10. Select a 4-up view. 

Right-Click Menu

a. Select

Ruler.

OR

Click **Angle** to draw a polyline measurement.

b. Scroll through the MPR view to locate the measurement.

c. Click and drag to draw ruler(s) or angle(s) to define the measurement.

d. Right-click in the view and name the measurement

TIP: The listing in the Measurements box automatically changes when you name the measurement.

e. To add a custom ruler or angle to the measurement list, select **Add Ruler to Measurement List** or **Add Angle to Measurement List** and enter a name.

f. Scroll to the location of the next measurement and continue this process for all measurements.

Measurements Menu

a. Select a grayed-out measurement in the Measurements box.

NOTE: The appropriate tool is automatically selected when you select a measurement in the Measurements box.

b. Scroll through the MPR view to locate the measurement.

TIP: Click and drag to draw ruler(s) to define the measurement.

NOTE: After you define the measurement, the measurement displays in bold in the Measurements box.

TIP: The schematic worksheet below the measurements provides a visual of the measurements location along the vessel. The measurement is highlighted in blue on the worksheet. Work from the Measurements list or the worksheet.

c. Select the spacebar to move to the next grayed-out measurement. Continue this process to define all measurements.

Display Semi-automated Contour Measurements

CAUTION: Review every measurement for accuracy as this procedure only establishes an approximate measurement. Failure to do so may result in incorrect diagnosis or planning.

NOTE: These measurements are generated on an oblique MPR plane based on the vessel region.

11. Click

.

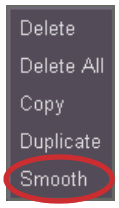
OR

Select a contour-based measurement in the Measurements list in the Vessel Analysis section.

NOTE: The Semi-Automated Region of Interest (ROI) tool is active when an item in the Measurements List that uses the ROI tool is selected.

12. Double-click on an oblique MPR plane near where you want to take your measurement.

13. To smooth the contour, right-click and select **Smooth**.



14. To edit the contour, put the cursor on the contour, then drag the edge to the new location.

OR

Click to add more anchor points.

Display Semi-automated Ruler Measurements

CAUTION: Review every measurement for accuracy as this procedure only establishes an approximate measurement. Failure to do so may result in incorrect diagnosis or planning.

NOTE: These measurements are generated on an oblique MPR plane based on the vessel region.

15. Click

.

OR

Select a diameter measurement in the Measurements list in the Vessel Analysis section.

NOTE: The Semi-Automated Ruler Tool is active when an diameter measurement in the Measurements List is selected.

16. Double-click on an oblique MPR plane near where you want to take your measurement.

Approach Planning

Select the appropriate procedure to complete approach planning:

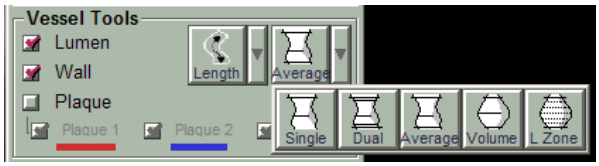
- Display Illiac Access
- Display Subclavian Access
- Trans-apical Planning

Display Iliac Access

You can use the existing lesion tool to perform the procedure below.

1. From the Average dropdown in the Vessel Tools area, select

to analyze long segments of the vessel.

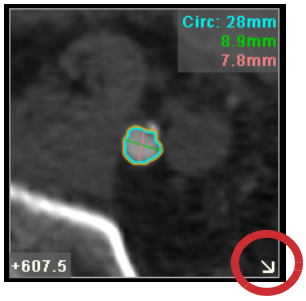


See the Additional Procedures section for information regarding displaying landing zones.

2. Click and drag in the CPR view for the area to survey.

3. Review the diameter measurements in the grid.

4. Click ↘ to magnify the axial image of interest.



TIP: Create diameter measurements if you want to define measurements other than the automated measurements.

See the Additional Procedures section for information on how to rename vessels and measurements.

TIP: If necessary, perform this procedure on the other side.

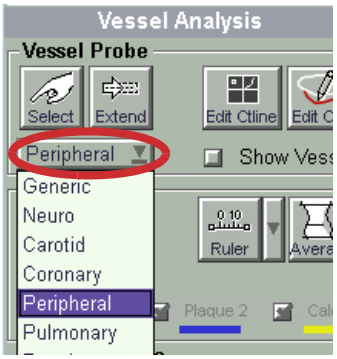
5. Take Snapshots.

See the Review and Verify Measurements section for more detailed information on taking snapshots.

Display Subclavian Access

Use vessel probe to probe any accessory vessels. The segmentation displays in 3D and MPR for visualization of anatomic landmarks.

6. From the Analysis tab, select a vessel type from the dropdown in the Vessel Probe section.



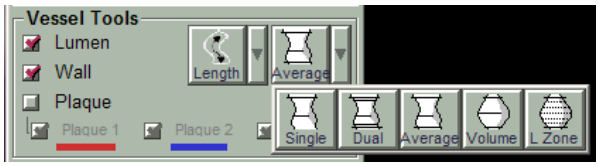
7. Click select and probe the subclavian vessel.

8. View the vessels in 3D.

See the Additional Procedures section for information on how to rename vessels and measurements.

9. From the Average dropdown in the Vessel Tools area, select

to document diameters along the vessel.



See the Additional Procedures section for information regarding displaying landing zones.

10. Verify

is selected.

11. Click and drag across the vessel.

Trans-apical Planning

12. Select an Aorta protocol.

13. Use vessel grow to segment the heart.

a. From the Vessel dropdown, click

.

b. Click and hold on the vessel to grow the vessel branches.

c. Type `heart` in the box.

d. Select **Add to:**.

14. Use vessel grow to segment the aorta.

a. From the Vessel dropdown, click

.

b. Click and hold on the vessel to grow the vessel branches.

a. Type `aorta` in the box.

b. Select **Add to:**.

15. Use the Transparency Slider to adjust the transparency of the Bone region to get a better view of the heart.

NOTE: Verify you can see the ribs.

16. Create a valve plane with an oblique MPR.

17. Click

.

18. Create an angle measurement in 2D for proposed angle of access to the ventricle.

19. Right-click in the 2D view and select **Show in 3D**.

Review and Verify Measurements

Review and verify the measurements along the vessels to plan placement.

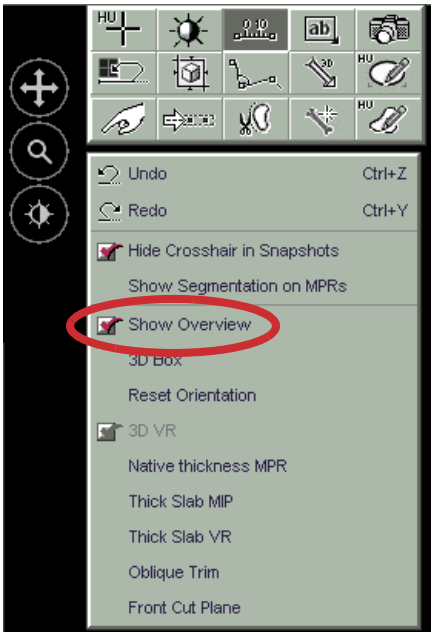
CAUTION: Review every measurement for accuracy as this tool only establishes an approximate measurement. Failure to do so may result in incorrect diagnosis or planning.

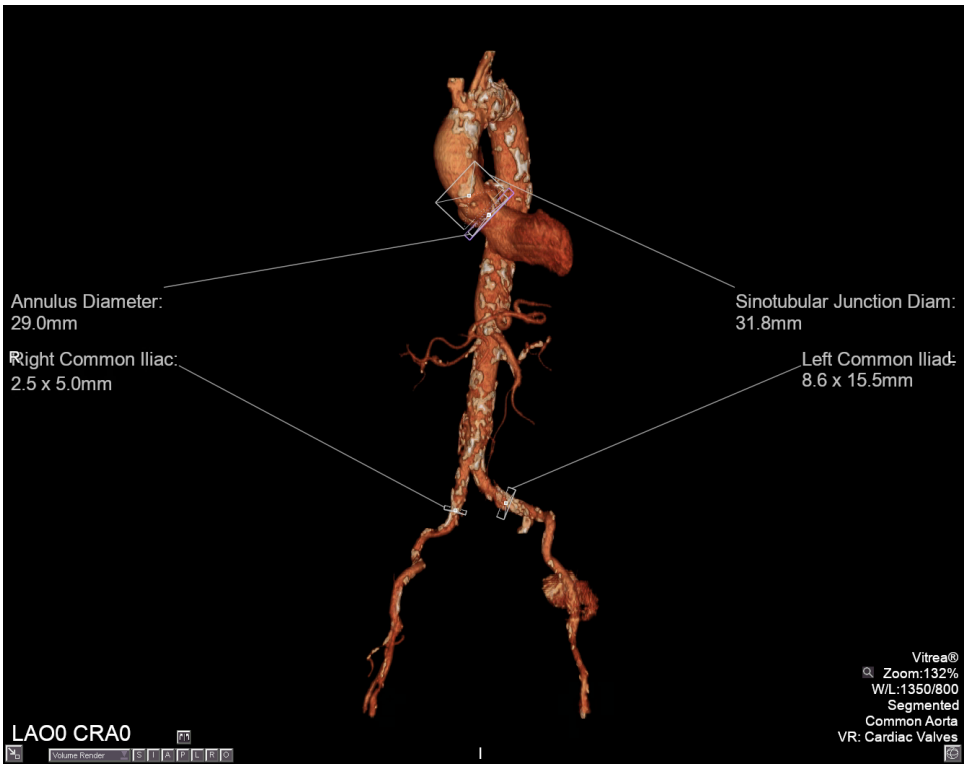
NOTE: Some of the steps in this section may have been completed in the Approach Planning section.

1. In the lower left corner of the 3D image, click to maximize the 3D image.

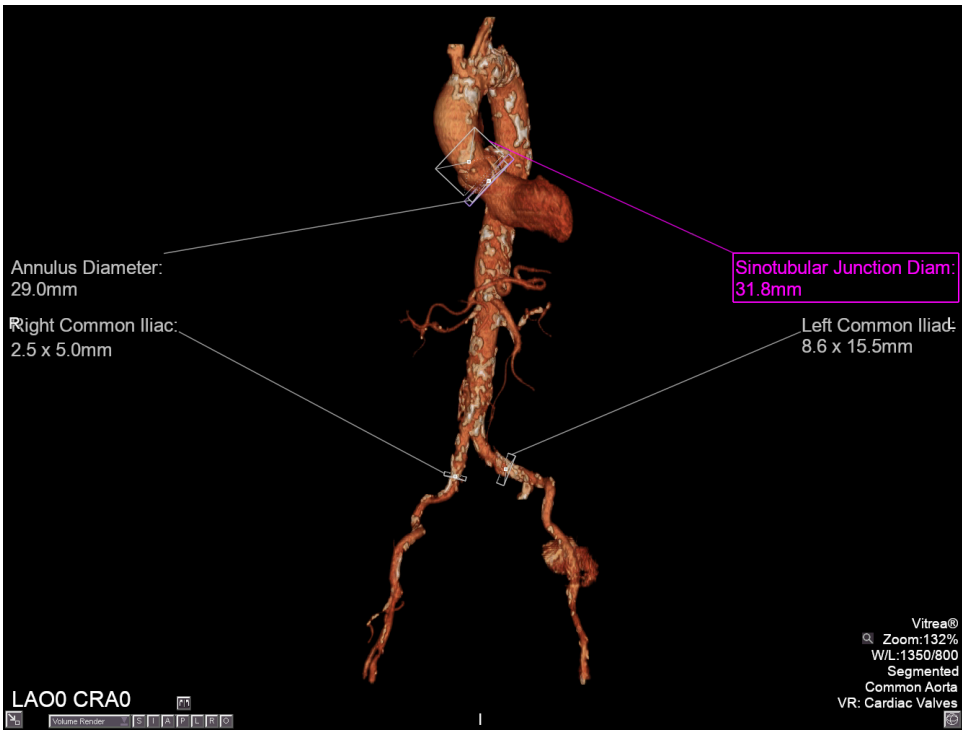
2. Right-click in a 3D view and select **Show Overview** to view all of the diameter measurements from the worklist.

   TIP: Only the measurements selected as **Done** will display when you select **Show Overview**.





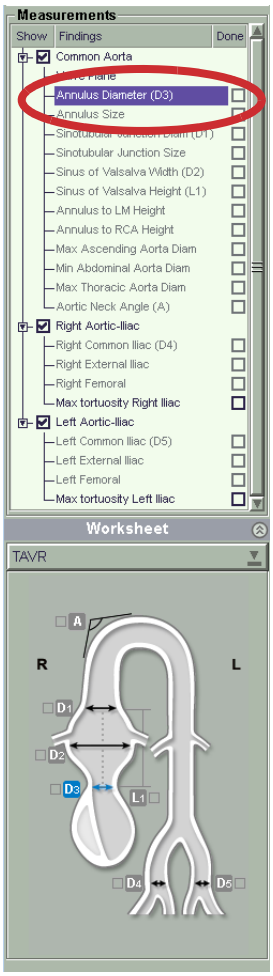
TIP: Click the name of the measurement to highlight and drag the name to a different location. The name changes color when you click on it.



TIP: To remove tortuosity measurements, right-click on a highlighted measurement and select **Delete** or **Delete All** to delete all measurements.

3. Choose a 3D preset from the Preset Selector.

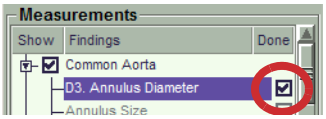
4. Select a measurement listed in the Measurements box and review the diameter. Make any necessary adjustments to the measurements.



TIP: The schematic worksheet below the measurements provides a visual of the measurements location along the vessel. The measurement is highlighted in blue on the worksheet. Work from the Measurements list or the worksheet.

See the Additional Procedures section for information on how to rename vessels and measurements.

5. When you finish reviewing the measurement, select the Done box next to the name of the measurement or click the box in the schematic worksheet.



TIP: When the Done box is selected, the measurement automatically displays in the report.

6. Select the spacebar to move to the next measurement. Continue this process to review all measurements.

TIP: Right-click in the Measurements box and select Mark All Reviewed or Unmark All Reviewed.

TIP: If there are measurements you do not want to display in the report, do not select Done.

Take Snapshots

7. Right-click and select (or press S) to activate the camera.

8. Move the cursor to the image and click.

   Snapshots, measurements, rulers, W/L, or segmentation option can be restored from the Report page or the Study Directory.

IV. Distribute Findings

The snapshots you save in the Viewer window are saved to the Report window.

1. Click

at the bottom of the window.

2. Export your findings or create a report.

   See the **Distribute Findings** chapter of the **VitreaAdvanced-VitreaWorkstation General Education and Reference Guide** for instructions on exporting findings, restoring workflow, and creating reports.

Additional Procedures

Edit the Vessel Centerline

CAUTION: Review and edit the automated vessel segmentation, centerline, and contour results as necessary.

1. Press the spacebar to verify the aortic and iliac centerlines for possible editing.

2. Right-click on any inset view and select **Edit Centerline**.

   The cursor changes to a pen.

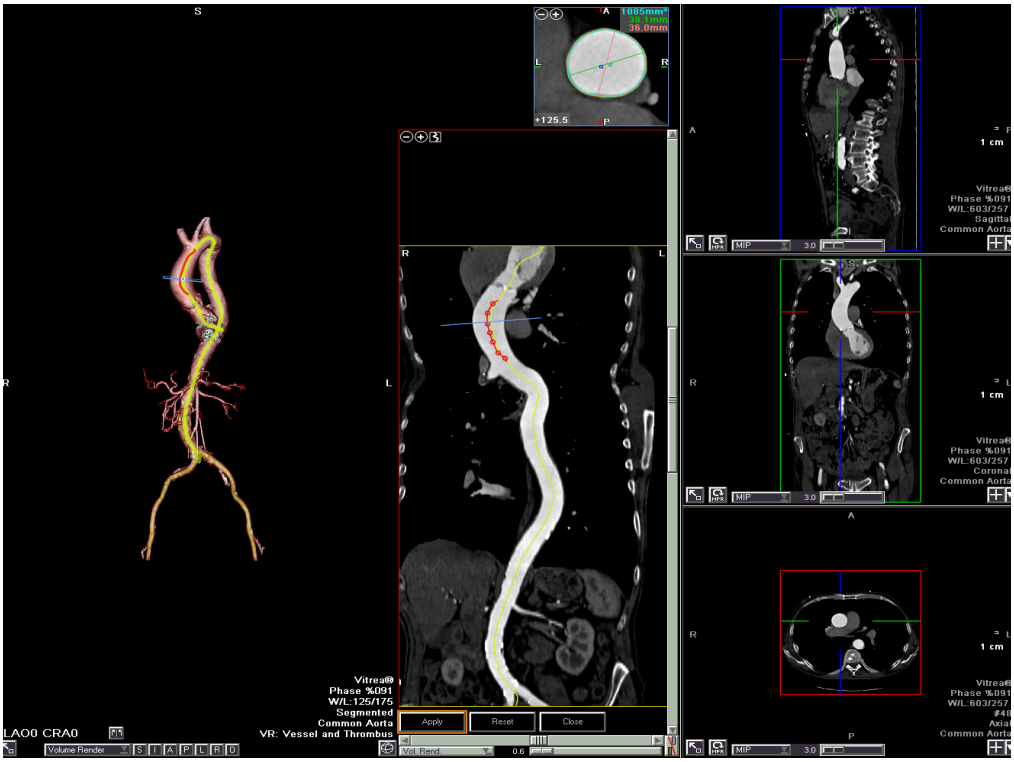
   TIP: Select

   from the Analysis tab to edit the centerline.

3. Assess the centerline to verify accuracy.

4. Move the cursor (pen) to a specific point along the centerline and click to plot a point to modify the path of the vessel centerline.

TIP: As you plot points, a new red line displays to show you how the centerline will display. This line also displays in the 3D view.



5. If necessary, move the cursor (pen) to a different point along the centerline and click to plot a point.

6. Continue to plot all additional points.

   TIP: As you plot additional points, the line updates to go through all the user control points.

   NOTE: The line becomes dynamic if you click and drag. The point displays after you release the mouse.

7. Rotate, zoom, and scroll the curved view while the line is being created.

   TIP: The pencil changes to a hand over a plotted point. Click and drag to move the plotted point.

   NOTE: Click Reset to clear the red centerline and start over.

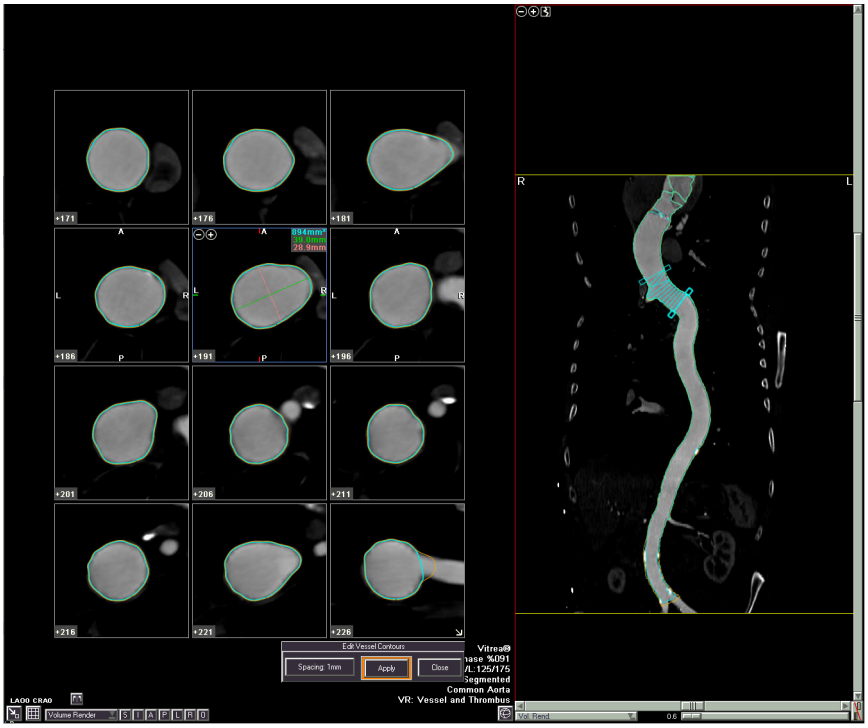
8. Click

to apply the modified (red) centerline to be the final centerline.

Edit Vessel Contours

1. Press the spacebar to toggle to the desired centerline.

2. Right-click on any inset view and select **Edit Contours** to open the contour editing view with several cross-sectional views, or access contour editing from the contour editing button in the lower left corner of the image .



The curved image displays in a straightened view next to the graph of the lumen and wall. A grid on the straightened view represents locations of the corresponding cross-sections along the curved view.

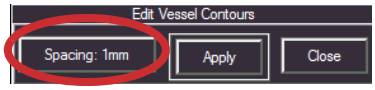
- Click and drag the grid to move it vertically.
- Page Up and Page Down keys to set the last displayed cross-section to the first.

- Use the arrow keys to cine the cross-sectional images by 1 mm each.

3. Click and drag to set the proximal end of the grid at the first inaccurate contour you want to edit.

4. Click and drag to set the distal end of the grid at the last inaccurate contour you want to edit.

5. Edit the first level of contours.

6. Click 

to perform an interpolation between all edited slices to form a smooth region.

TIP: The Apply button will have an orange border after two or more contours have been edited. The orange border identifies that interpolation can be applied.

TIP: Start at the top of the anatomy and use **Page Up** and **Page Down** to review the anatomy.

TIP: You may also edit from the 1mm Review mode.

7. Return to the Original view.

Display Analysis Tab Tools

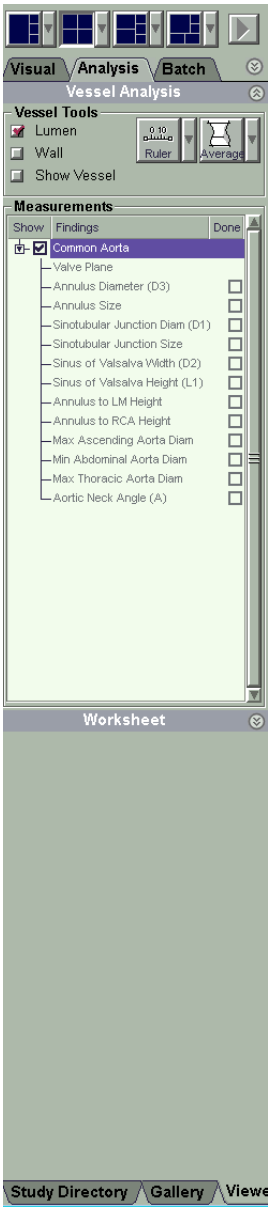
The Analysis Tab defaults to a full view to show tools necessary for Transcatheter Aortic Valve Replacement Planning (Vessel Tools, Measurements, and the Worksheet).

Click the Expand icons to display/collapse all tools.

TIP: The state of the toolbar can be saved as a modified preset.

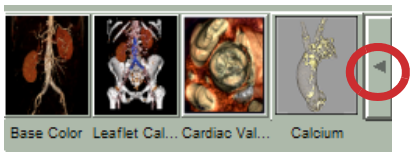
Expanded View

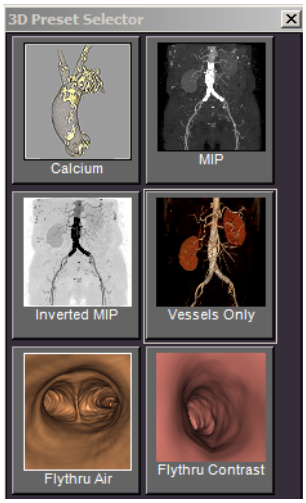
Collapsed View



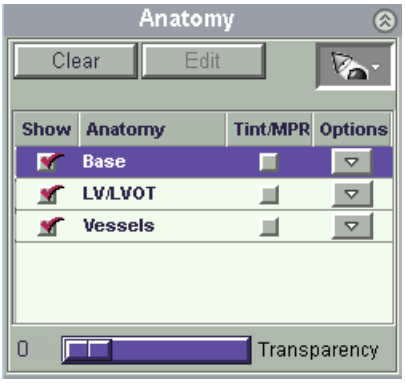
Display Visualization Preset Settings

Select the Visualization Preset buttons dropdown. The options display in the Preset Selector dialog box. On the Vessels tab, choose from Visualization Preset buttons.





Select a region in the Anatomy Management list to apply a preset visibility setting to a single region.

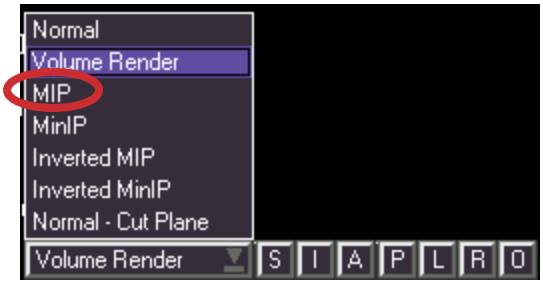


TIP: To change the Transparency of the region, drag the Transparency slider.

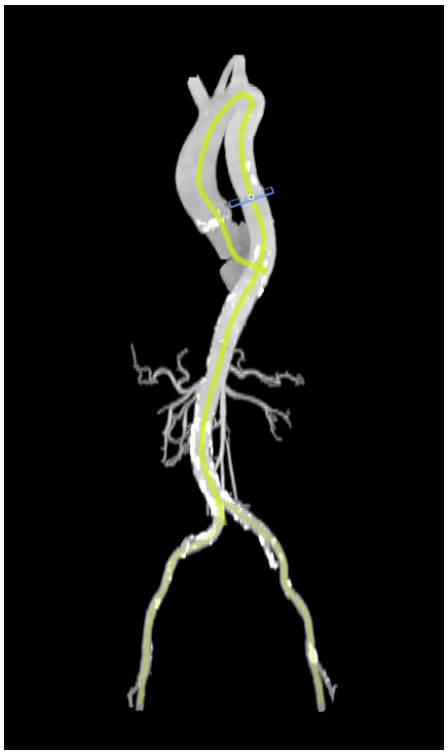
Create a MIP

MIP is a shading setting that displays data using the highest data values for each voxel of the image. MIP is a good setting to use when competing features composed of voxels with similar or higher values might be obscuring the feature of interest.

1. From the Volume Render dropdown list, select **MIP**.



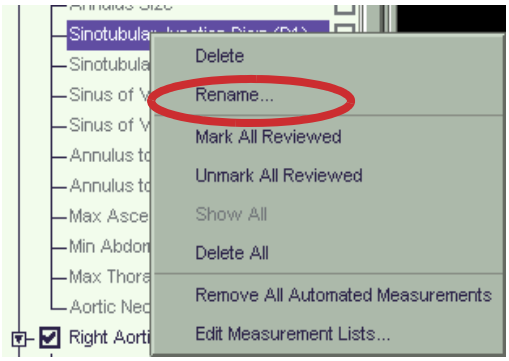
2. View the 3D image as a MIP.



Rename Vessels and Measurements

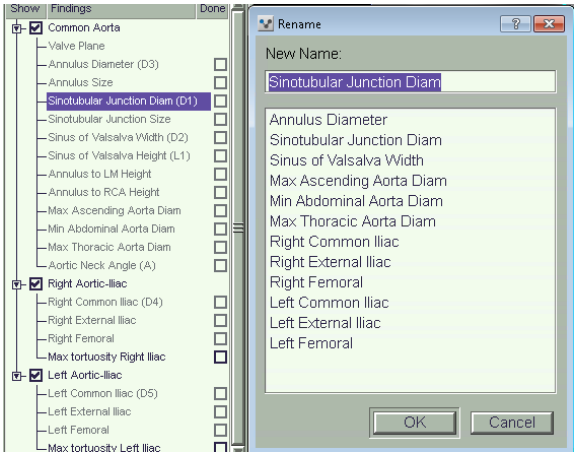
To rename vessels and measurements:

1. Right-click and select **Rename** from the right-click menu.



TIP: Double-click on the measurement to open the Rename dialog box.

2. Rename the vessel or measurement and click **OK**.



Extend Probed Vessels

You have the option to extend or refine a probed vessel. The vessel you want to extend or refine must be selected in the Vessel Management list.

To extend a vessel, right-click and select Extend and click a point farther along the already selected vessel.

To refine the vessel indicator line, drag the cursor along the vessel indicator line to a desired end point and click.

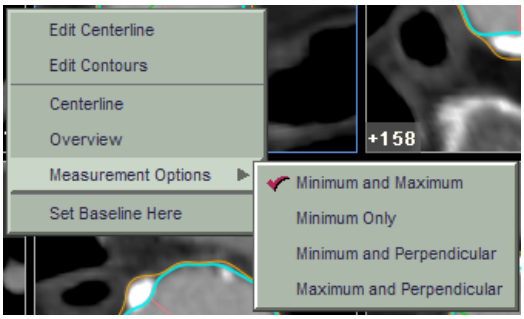
NOTE: As you drag the cursor, the vessel indicator line disappears. It will not be removed until you click.

Select Measurement Options

From the Cross-section view, right-click and select **Measurement Options**.

Select one of the cross-section options:

- Minimum and Maximum
- Minimum Only
- Minimum and Perpendicular
- Maximum and Perpendicular



Draw Contours

1. Click .
2. Click and drag in the view to draw.

   OR

   a. Click around the perimeter of the area of interest placing anchor points.

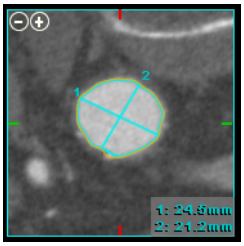
   b. Double-click to place the final anchor point.
3. To edit a contour, put the cursor on the contour, then drag the edge to the new location.

   OR

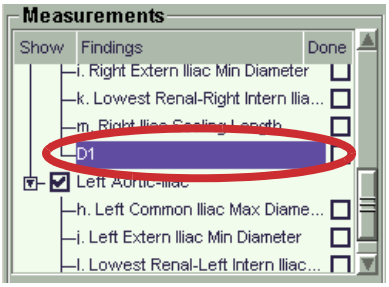
   Click to add more anchor points.

Measure the Diameter

1. Click .

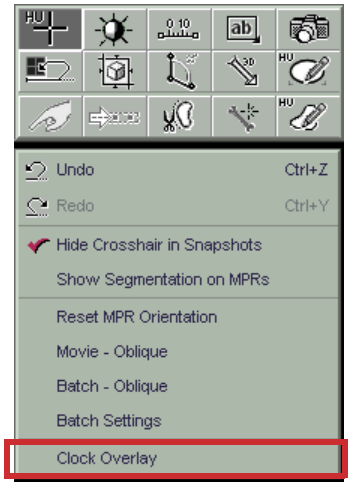
2. Draw the ruler measurements. 

The new diameter measurement displays in the Measurements box on the Analysis tab.

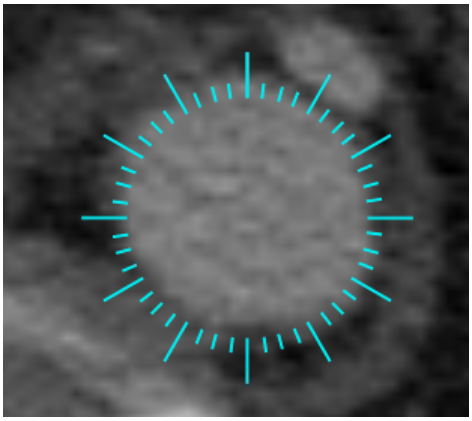


Display Clock Overlay

3. Right-click in an MPR view and select **Clock Overlay**.



4. Zoom and pan the image to fit the overlay.



5. To hide the clock overlay, right-click and select **Clock Overlay** again.

Display Landing Zone

Use the Landing Zones option to define specific regions for in-depth analysis.

1. Click .

2. Select

from the Vessel Tools.

3. Click and drag in the curved view to define the proximal and distal ends of the zone.

   TIP: After you define the landing zone, it displays in the Measurements box. Right-click to rename the landing zone.

4. View the diameters for the landing zone in the cross-sectional views.

Measure Centerline Length

The Length tool measures length along the centerline or between two points on the vessel centerline.

1. Click to change the volume view to a 1-up image and display a vessel probe view.

2. Select

located under Vessel Tools.

3. Click and drag either end to edit the length.

   The value of the length displays at the proximal end of the length measurement. It represents the length along the centerline between the two specified points.

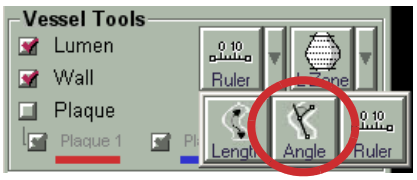
Create Centerline Angles

The Angle tool creates an angle along the centerline.

1. Click to change the volume view to a 1-up image and display a vessel probe view.

2. Select

located under Vessel Tools.

3. Select 

   TIP: Once you select Angle, the Length dropdown changes to Angle. Toggle the Length and Angle buttons.

4. In Curved CPR view, click and release at the start of the angle.

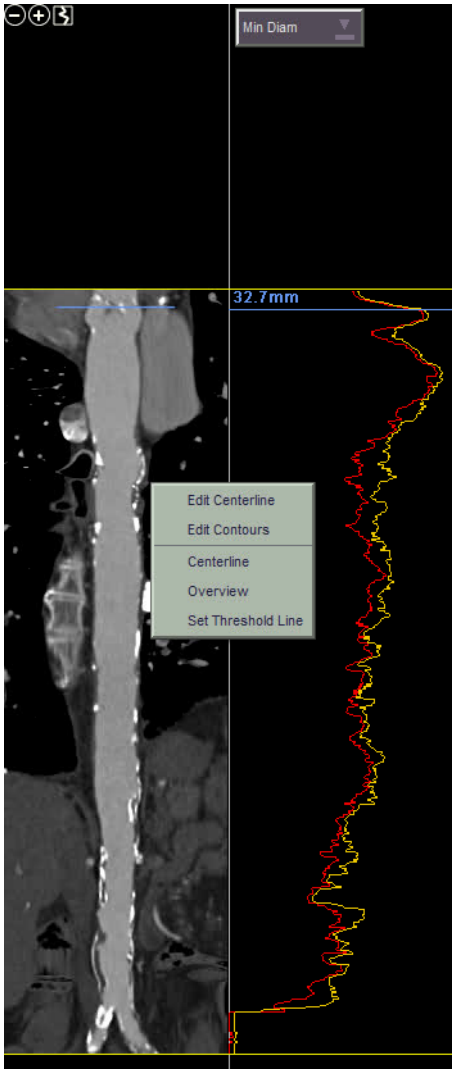
5. Move the cursor to the vertex location on the centerline and click and release.

6. Move the cursor to the end point of the angle and click and release to complete the angle.

Set Threshold Line

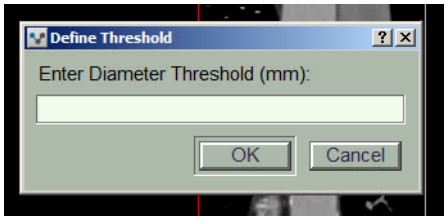
1. Click in the bottom right corner of the CPR view to display the straightened vessel view.

2. Right-click in the view and select **Set Threshold Line**.



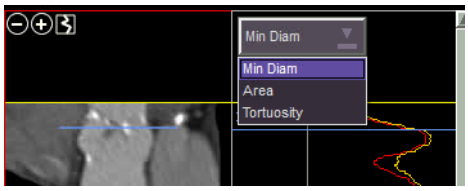
CAUTION: Zoom in to review specific sections of the graph. Graph detail may be lost if the zoom factor is too small.

3. Enter the measurement (area or diameter).



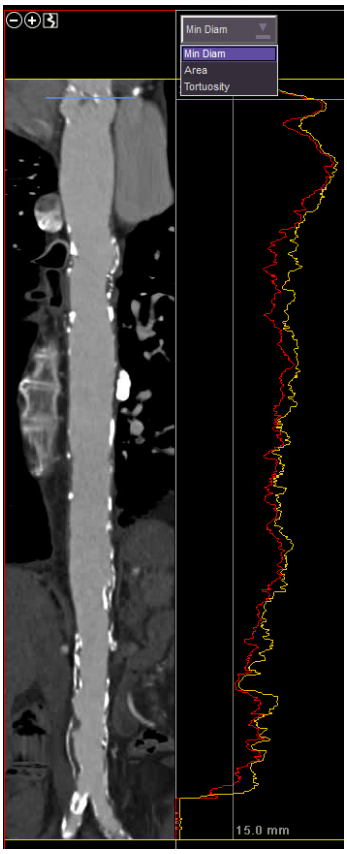
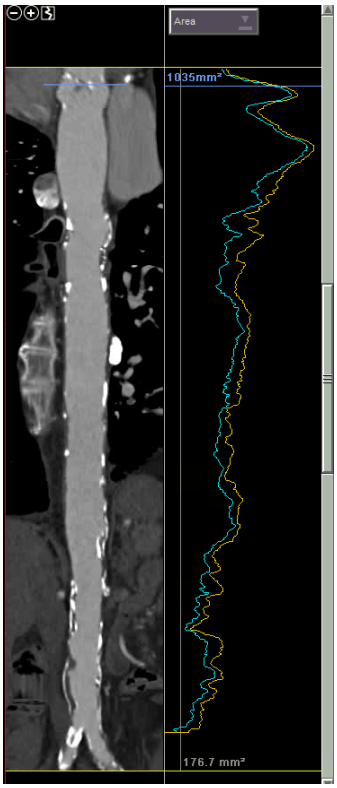
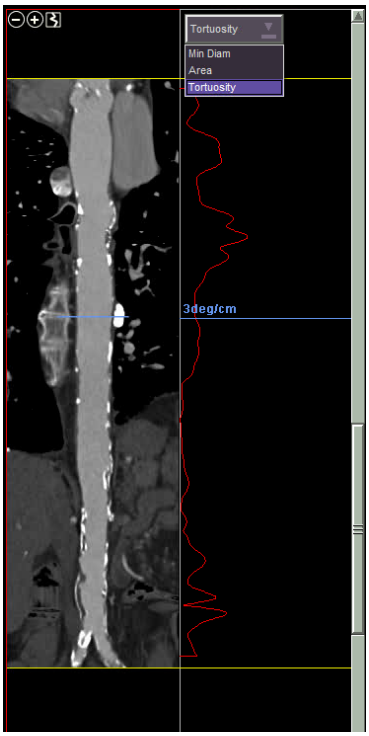
4. Click **OK**.

View Minimum Diameter, Area, and Tortuosity



1. Click in the bottom right corner of the CPR view to display the straightened vessel view.

2. From the CPR straightened vessel view dropdown, select one of the following layouts:

Minimum Diameter	Area	Tortuosity
		

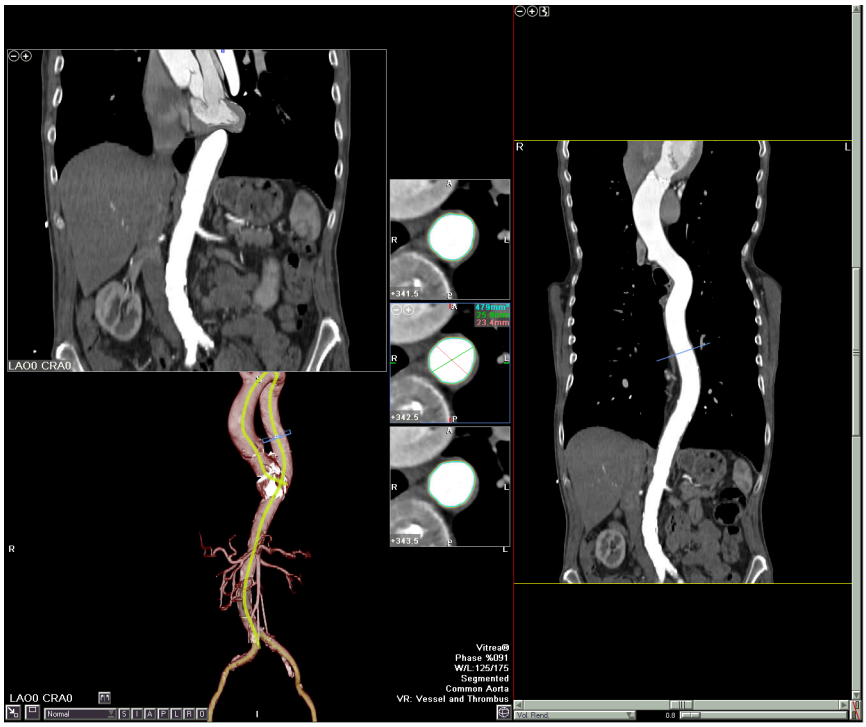
NOTE:
Tortuosity is calculated by taking the length of the curve divided by the shortest distance between the two points.

Review in the CathView Layout

1. Select the mode button in the lower left corner of the image.

2. Select the mode button until you select the CathView layout.

NOTE: The mode button allows you to toggle between different layouts of the reformatted views.



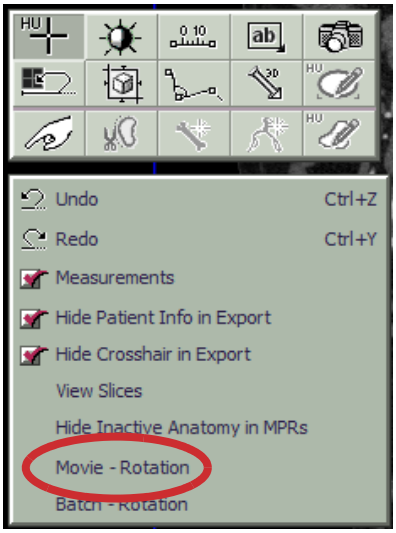
When the crosshair tool is active, a blue crosshair displays at the location of the current centerline point to allow cross-referencing across images.

Create a Batch Rotation in Curved View

1. Select the Curved MPR mode in the sagittal plane and generate the curved batch from the coronal plane.
2. Set the reference line where the fulcrum point of the rotation occurs.
3. From the Curved view, right-click and select **Batch-rotation**.

TIP: Right-click and select **Movie-rotation**.

4. A batch preview window opens for you to review the batch.

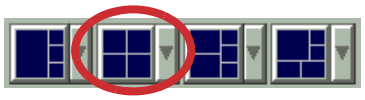


Define the Valve Plane using the Crosshair Tool

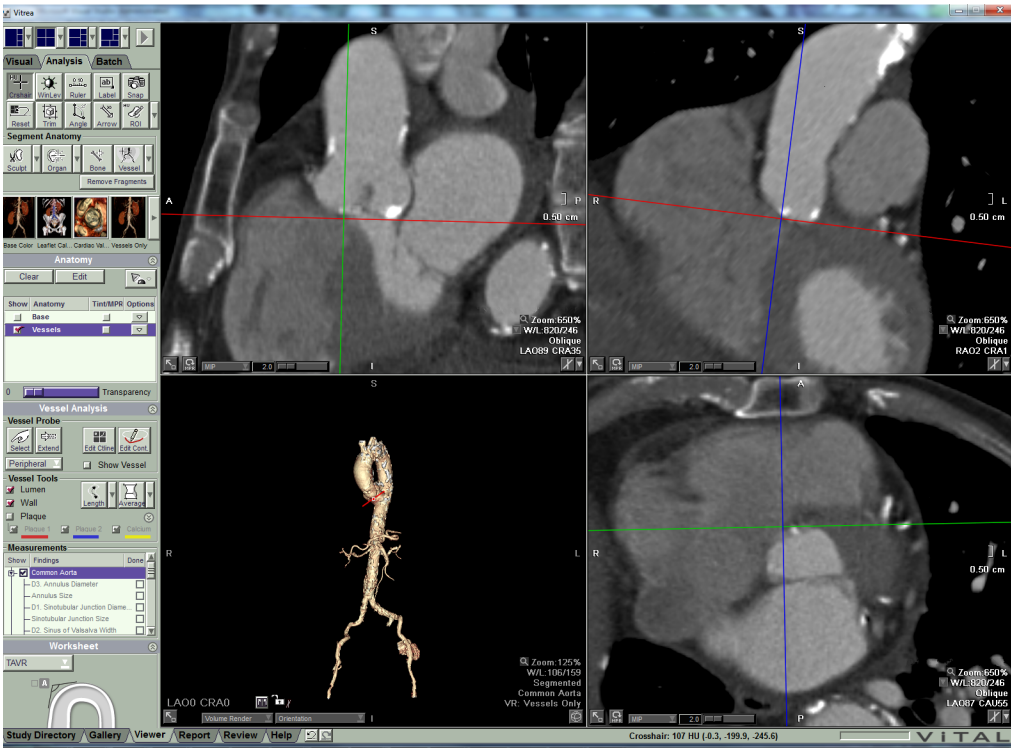
1. From the Analysis tab, verify is selected.

2. Verify you are in oblique crosshair mode.

3. Select a 4-up view.



4. In one of the long axis views, place the crosshair at the bottom of one of the cusps.



5. In the same view, scroll to locate the bottom of the second cusp.

6. Rotate the red line until it meets up with the two cusps.

7. In the other long axis view, rotate the red line to be parallel with the cusps.

   TIP: The red plane should touch the bottom of the cusps.

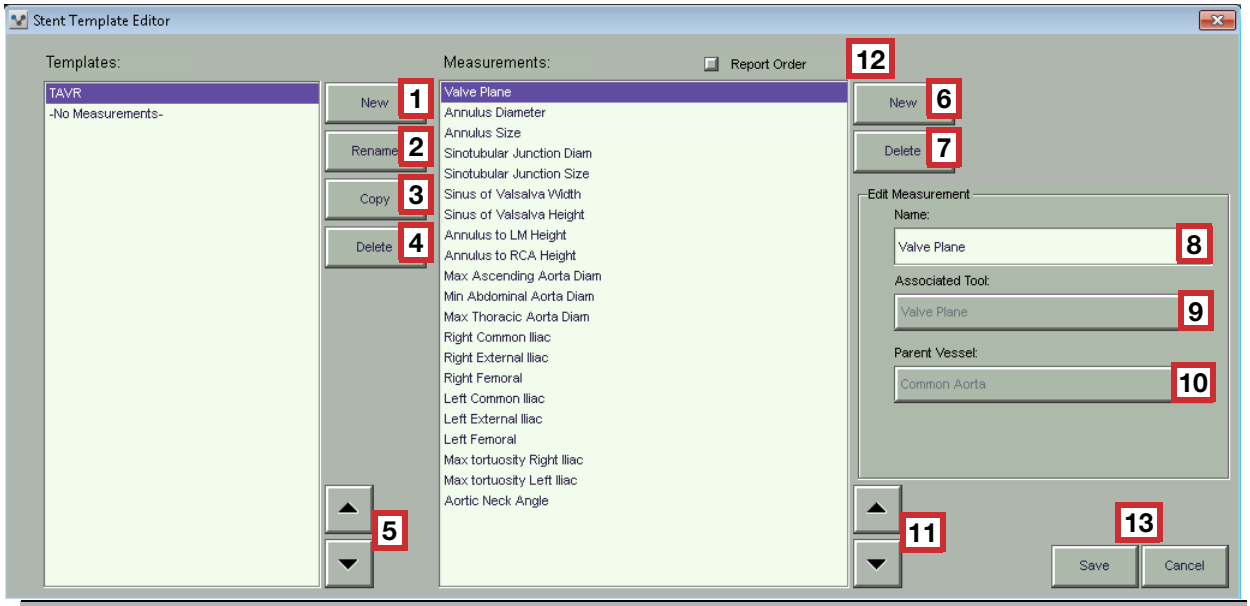
8. To verify you are in the correct plane, scroll through the valve until all three cusps come into view at the same time in the short axis view.

Edit Stent Templates

Use the Stent Template Editor to create, delete, or modify stent templates.

1. Right-click in the Measurements area and select **Edit Measurement Lists**.

   The Stent Template Editor Displays



Task	Workflow
Add a new template	**1.** Click **New** [1]. **2.** Click **Rename** [2], then enter a name for the template. **3.** Add new measurements [6] as described below.
Rename a template	**1.** Select a template. **2.** Click **Rename** [2], then enter a name for the template.
Copy a template (create a new template while preserving the original)	**1.** Select a template. **2.** Click **Copy** [3]. **3.** Click **Rename** [2], then enter a name for the template. **4.** Add, remove, or edit measurements as described below, if desired.
Delete a template	**1.** Select a template **2.** Click **Delete** [4].
Rearrange the order of the templates in the list	**1.** Select a template **2.** Click the Up or Down arrow [5] to move the name in the list.
Add a new measurement	**1.** Click **New** [6]. **2.** Edit measurement [8], [9], and [10] as described below.

Task	Workflow
Delete a measurement	**1.** Select a measurement. **2.** Click **Delete** [7].
Rename a measurement	**1.** Select a measurement. **2.** Type the name [8].
Associate a tool with a new measurement	**1.** Select the new measurement. **2.** Click the Associated Tool dropdown [9], and select the tool that will be the default when the measurement is used. **NOTE:** The associated tool for a default measurement cannot be changed.
Assign the parent vessel to a new measurement	**1.** Select the new measurement. **2.** Click the Parent Vessel dropdown [10] and select the vessel where the measurement is applied. **NOTE:** The parent vessel for a default measurement cannot be changed.
Rearrange the order of the measurements in the list	**1.** Select a measurement. **2.** Click the Up or Down arrow [11] to move the name in the list.
Rearrange the order of the measurements in the report	**1.** Select the **Report Order** check box [12]. **2.** Click the Up or Down arrow [11] to move the name in the list.
Save or cancel your changes	**1.** Press **Save** or **Cancel** [13].

Use the Volume Navigation Panel

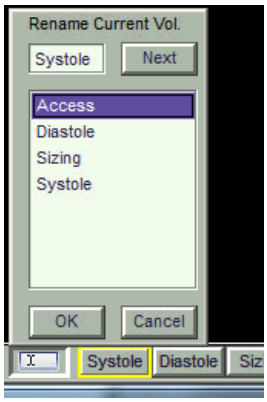
When multiple volumes are loaded, the Volume Navigation Panel will display at the bottom of the viewer window.

The Volume Navigation Panel is pre-populated with the TAVR identifiers Systole, Diastole, Access and Sizing. The user may use their own identifiers.

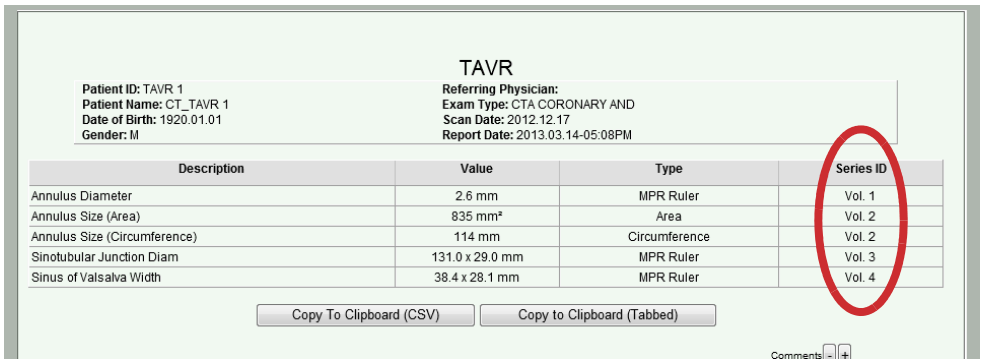
To assign an identifier to a volume:

1. Click on Rename Current Volume

2. Select either a pre-determined identifier, or create your own.



NOTE: The identifiers are tied to the measurements in the report linking them to the appropriate series.



TAVR

Patient ID: TAVR 1
Patient Name: CT_TAVR 1
Date of Birth: 1920.01.01
Gender: M

Referring Physician:
Exam Type: CTA CORONARY AND
Scan Date: 2012.12.17
Report Date: 2013.03.14-05:08PM

Description	Value	Type	Series ID
Annulus Diameter	2.6 mm	MPR Ruler	Vol. 1
Annulus Size (Area)	835 mm²	Area	Vol. 2
Annulus Size (Circumference)	114 mm	Circumference	Vol. 2
Sinotubular Junction Diam	131.0 x 29.0 mm	MPR Ruler	Vol. 3
Sinus of Valsalva Width	38.4 x 28.1 mm	MPR Ruler	Vol. 4

Copy To Clipboard (CSV)
Copy to Clipboard (Tabbed)

Comments

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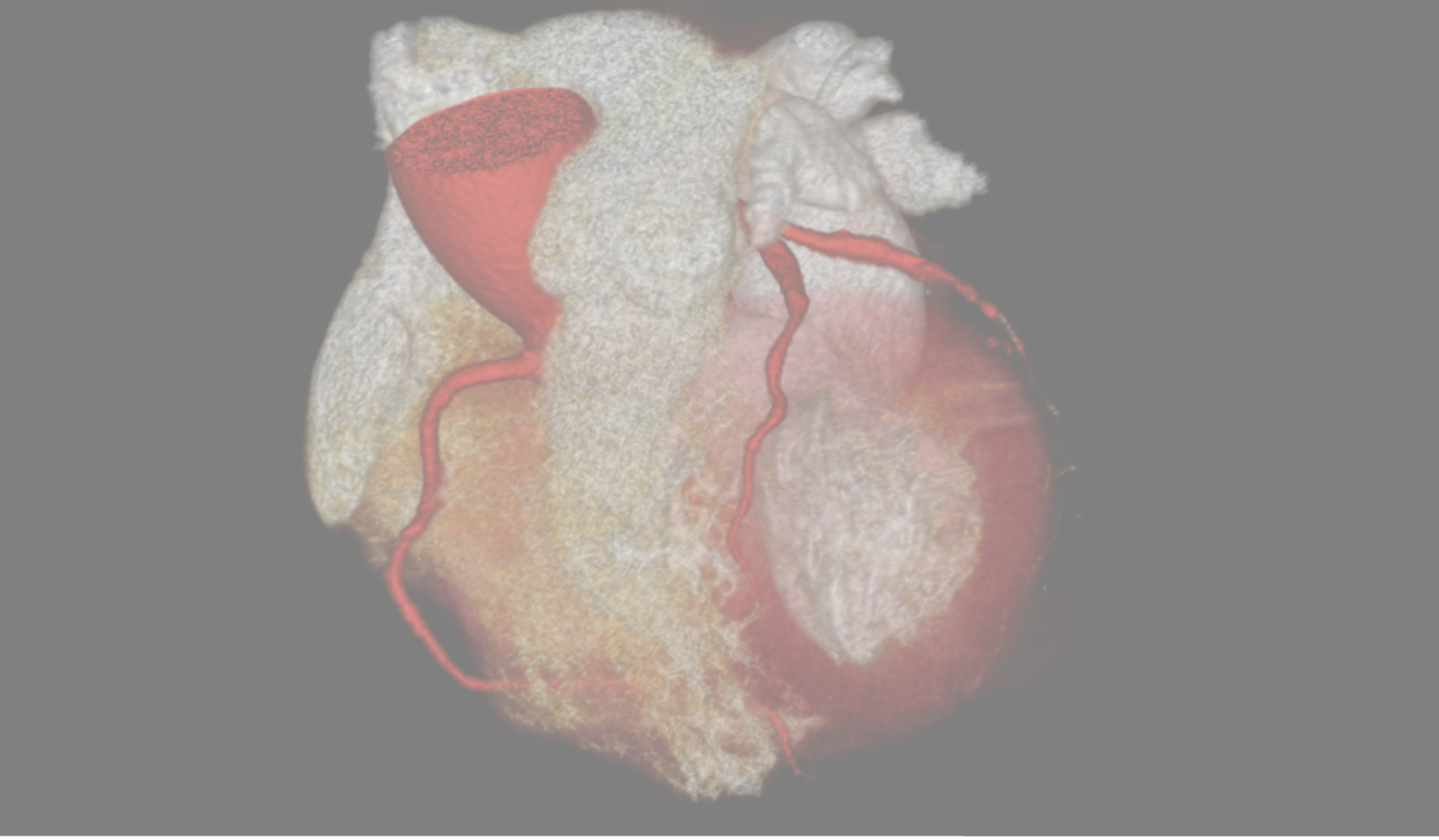

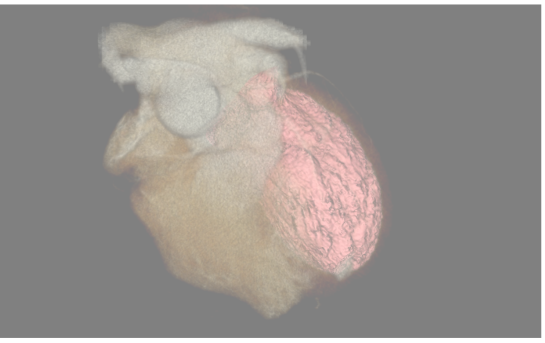

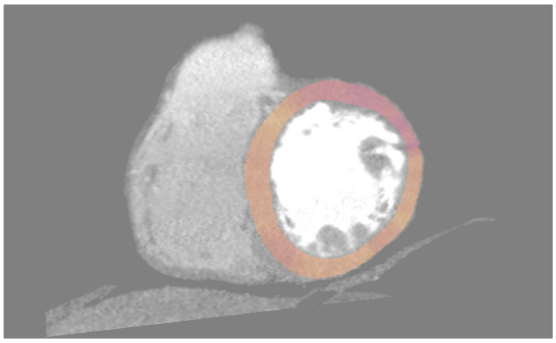

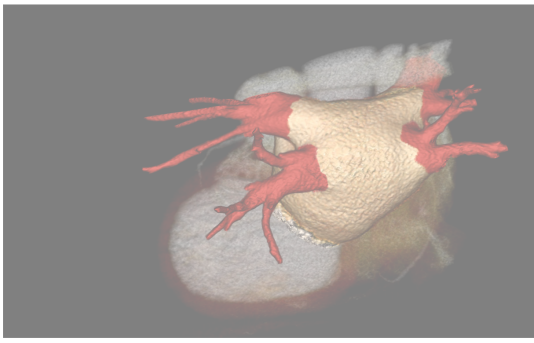

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