9 ElectroPhysiology Planning

Before treating heart rate arrhythmia with an interventional RF ablation procedure, it is useful to have an anatomic view of the left atrium (LA) and the pulmonary veins (PV). You can obtain these views using the ElectroPhysiology Planning (EP Planning) application.

NOTICE

Before continuing, refer to the “Instructions for Use” that came with your scanner.

NOTICE

This application was verified using only cases from Philips scanners. If you load cases from another manufacturer, there may be differences in application behavior.

These anatomic images can be exported to other modalities to provide three-dimensional visualization of the anatomy during the ablation. The application has 2 stages, with specific goals and clinical uses:

- **Segmentation.** Verify auto-segmentation of the heart; edit tissues; and identify landmarks.
- **EP Planning.** Analyze the left atrium and pulmonary veins using various viewing modes.

The EP Planning application is also useful during patient follow-up to help assure that pulmonary vein stenosis did not develop following the ablation.

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WARNING

Cross sectional images might rotate around the centerline. Please note orientation annotations on images. One or more of the following image types may appear in this application: curved MPR, straightened MPR, volume images, and thick slab images. Measurements you make on such processed images can sometimes be misleading. When saving such images, make sure they are labeled properly. Objects in thick curved MPR images may appear distorted. Use caution when making measurements on MPR images.

WARNING

When loading images into the application, all images which contain 16 bit data are converted into 12 bit images. (Therefore, when the rescale intercept equals -1000, Hounsfield Unit values above 3095 are displayed as 3095, and when the rescale intercept equals -1024, Hounsfield Unit values above 3071 are displayed as 3071.)

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NOTICE

Depending on your Portal configuration, this application may not be available.

Indications for Use

With the CT Electro Physiology Planning (EP Planning) application, the user can generate anatomical views of the left atrium (LA), Pulmonary Veins (PV) and appendage as an orientation input before treating heart arrhythmia with an interventional RF ablation procedure.

EP Planning Options and Tools

Use the EP Planning options and tools to modify the view and perform analysis. Note that some tools and options are stage dependent.

Key Images

Save groups of images that can be reviewed in any system supporting the defined standard. See **Instructions for Use** > **Directory** > **Key Image Notes** for more information.

See **Report**, **Film**, **CT Common Processes** and **CT Common Tools** for information on using common options, tools, functions, and processes.

Brush

Add to unsegmented areas of active tissue by “painting” with 3 sizes of brushes: 3 cm; 1 cm; and 0.5 cm).

1. Activate the appropriate tissue segmentation.
2. Select the brush size from the drop down.
3. Drag the mouse across the unsegmented tissue while holding down the mouse button. The brush will “paint” new segmentation in the same color as the selected tissue.

Create New Vessel

The application detects the maximum LA diameter automatically. If necessary, use the Draw LA Diameter tool to redraw the LA Diameter.

1. Select the **Draw LA** diameter button.
2. Redraw the line on the axial image.
3. Click the **Draw LA** diameter button again to finish.

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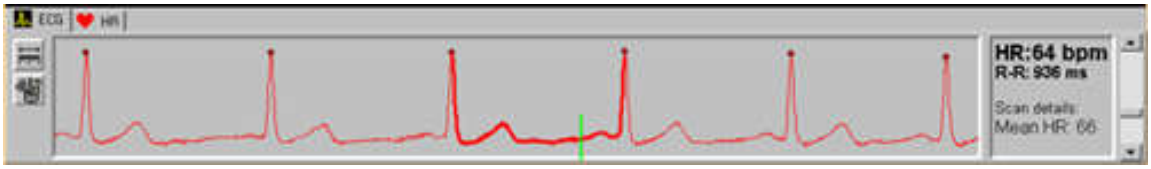
ECG Display

Click the **Show/Hide ECG** button to display the ECG strip if one was loaded as part of the study.



The display appears at the bottom of the window and shows the ECG signal in graphic form.

NOTICE

The ECG display is available only in the Heart Review mode. Close it with the Show/Hide button before you leave the Heart Review mode.

The display's starting point is 5 seconds before the scan started. The ending point is 5 seconds after the scan ended.

The ECG signal is colored red for the duration of the scan (that is, the period that radiation is applied). It is synchronized with the other viewports, and as you scroll through the images, a green line correlates the displayed viewport images to the ECG signal. A green line marks the position of the currently viewed slab image.

On the right of the ECG viewport, the instantaneous heart rate and R-R interval are shown, as well as the mean heart rate over the scan and the number of heart beats.

Various other measurement and viewing functions are available. Refer to the CCA chapter in this volume for more details about the ECG display.

Edit Centerline

Edit a centerline on the cMPR view.

1. Select a vessel from the Vessel List. To select a vessel from the Result Table, click on the appropriate small, cross-sectional image.
2. Click the **Edit centerline** button. The system will automatically create centerline points in one of the viewports.
3. Grab the centerline and drag it to the desired location. You may also drag the centerline markers as well.
4. To add an addition centerline marker, click on the line.
5. Click the **Edit centerline** button again to update the centerline.

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Edit Contour

Select to create new lumen contours in the cross-section and sMPR viewports. Change the contour using any of the active cross-sectional images. Modifying the contour works similar to what is described in the Edit Centerline section.

Place Landmark

Use the Place Landmark tool to name, delete or define a landmark. Once created, a landmark's name can be changed by right clicking over the landmark.

1. Determine the location of the landmark on one of the MPR images.
2. Activate the **Place Landmark** button.
3. When the center of the crosshairs pointer is over the desired area, click the mouse to place the landmark. To place multiple landmarks, click another region: your landmarks will be saved.
4. Change the name of the landmark by double clicking it in the Select Landmark to Display list and typing the new name.
5. To delete a landmark, select it from the list and use the Delete button.

WARNING

It is possible to delete auto-generated landmarks as well as landmarks you create.

Rendering Tools

Use the rendering tools options for viewing the 3D image.

Left Atrium	2D Rendering Map
In this window the Left Atrium (LA) is displayed, together with the Pulmonary Veins (PV), which may be individually viewed and measured.	he 2D map is a slab MIP through the LA, showing a quick view of the PV's anatomy.

On the volume image, selecting the “Left Atrium” annotation gives you the option to view the entire heart.

Result Table with Cross-sectional Cuts

Once a PV is named, its cross-section at the level of its ostium appears, outlined in red. The vein’s maximum and minimum diameters are indicated by crosshairs. Various measurements and data are listed below the image.

Area	The Area of the cross section.
Max Diam	The maximum diameter of the cross section.

Min Diam	The minimum diameter of the cross section.
Effective Diam	The mean diameter of the cross section.
Eccentricity	Is defined as: sqrt (1- (min diameter2 / max diameter2)) Eccentricity index varies from 0 (minimum, perfectly circular) to 1 (maximum, highly elliptical).
LA volume	When you first enter the scene, the volume includes the pulmonary veins. When a vessel is named, its volume is excluded from the volume calculation. Note that when you move the ostia location, the volume is updated.
LA diameter	The max AP diameter of the LA. You can draw LA diameter in a different location using 'Line' tool from the common graphic toolbox and the table will be updated accordingly.

Show Contours

Check the box to show the contours of the selected vessel on the viewports during the EP Planning stage.

Show Diameters

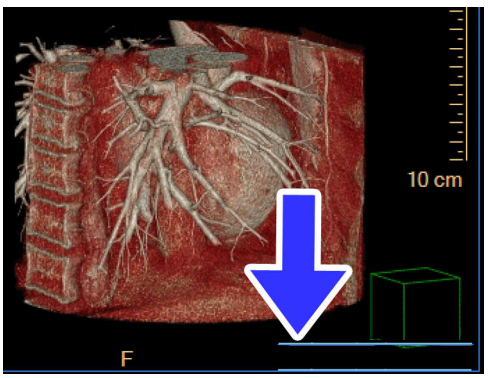
Check the box to show the diameter of the selected vessel on the viewports during the EP Planning stage.

Show Centerline

Check the box to show the centerline of the selected vessel on the viewports during the EP Planning stage.

Modify Standard Cardiac Angles

Change the standard cardiac angles on the volume image to modify the orientation of the volume image. Select either from a preset option or enter exact angles manually. The angles are located in the lower right-hand corner of the volume image.



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NOTICE

The standard cardiac angles may be modified on Volume images within the Cardiac Viewer, the Comprehensive Cardiac Analysis application, and the EP Planning application.

Use Preset Options

Use the preset options to adjust the common viewing angles. In the bottom right-hand corner of the image, click on the drop-down menu to select the viewing angle:

- RAO 30
- AP
- LAO 60
- LAO 60 Cranial 20
- Left Lateral
- LAO 45 Caudal 15
- RAO 45
- RAO 120 Cranial 10

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NOTICE

In addition to setting the angles, use the Roll/Rotate tool to grab and rotate the image. The cardiac angles are updated in real time.

Manually Enter Angles

For a precise view, use the drop-downs and insert fields to enter the angles.

1. Select either **RAO** or **LAO** from the second drop-down menu.
2. Click in the filed next to the RAO/LAO selection and enter the appropriate angle.
3. Select either **Caudal** or **Cranial** from the drop-down menu.
4. Click in the filed next to the Caudal/Cranial selection and enter the appropriate angle.

Segmentation Stage

The Segmentation stage opens with 4 image viewports showing axial, coronal, sagittal and volume images. In addition, the application launches the Cardiac Viewer.

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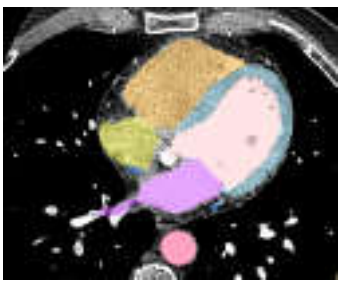
NOTICE

Change the standard cardiac angles on the volume image to modify the view. Select either from a preset option or enter exact angles manually. See the Cardiac Viewer section of the Operator Notes for more information on changing the standard cardiac angles.

The automatically segmented heart tissues (shown in the Heart Tissue List) include the following:

Left Atrium + Pulmonary Veins	Aorta
Left Ventricle	LV Myocardium
Right Atrium	Coronary Sinus+SVC +IVC
Right Ventricle	–



WARNING

Verify segmentation correctness. If necessary, correct the segmentation using the correction tools provided in this work stage.

The automatic segmentation that is initially performed by the EP Planning application requires your review and possible modification. The various tissue definitions may be incomplete, or may exceed or fall short of the actual tissue boundaries.

Segmentation Workflow

1. Load a Study into the EP Planning application. Select the Heart Segmentation tab if the viewer did not open it by default.

   Auto-segmentation may take several minutes. During this time, the Heart Review stage is functional and you may examine the heart images using the review tools. Until the opening process is finished you cannot move to any subsequent work stages.
2. Review the segmentation using the Heart Tissue List and use the Edit Active Tissue tools to correct the segmentation if required. See section “EP Planning Options and Tools” on page 277.
3. Identify landmarks using the presets using the Landmarks tab. Optionally, create additional landmarks to use. See section “EP Planning Options and Tools” on page 277.

Heart Segmentation

Use the Heart Tissue List to display or hide segmented tissue when verifying and modifying the automatic segmentation. Click the **Left Atrium** button for a quick view.

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CAUTION

The cubic volume displayed in the viewport is only as reliable as the correctness of the segmentation.

Before you save any EP Planning images and data or move to the next stage, verify the accuracy of the segmentation. If necessary, use the Edit Active Tissue tools to add or remove tissue from the segmentation.

1. Go to the Heart Segmentation tab (if not already open) and select a tissue from the Heart Tissue List.
2. Use the **Inject dye (3D)** tool to add unsegmented areas to the active tissue. The rate and type (viscosity) of the injection can be controlled by the relevant boxes.

WARNING

When using the dye-injection tool verify the correctness of volume segmentation. If necessary, correct the dye tracing using correction tools supplied by this application.

3. To remove either manually or automatically segmented tissue, use one of the erasers.

NOTICE

Since the eraser is cylindrical, it erases from the volume, not just the slice you use it on. Be sure to verify the results of the eraser by scrolling the reference images.

4. Use the **Fill**, **Expand**, **Erode**, and **Brush** tools to fill all the “holes” in the color overlay of the active tissue; increase or decrease the edges of the active contrasted tissue; and add to the active tissue. See section “EP Planning Options and Tools” on page 277.
5. To remove volume from the tissue segment, use the **Sculpting Tools**. See section “EP Planning Options and Tools” on page 277.

CAUTION

Remove All replaces the active tissue permanently. Therefore, if you want to restore the original segmentation before you proceed to another overlay in the overlays list, you should choose 'Undo'.

6. Repeat the previous steps for all automatically segmented tissues. When done, switch to the **Landmarks** tab.

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Landmarks

Landmarks are segmented automatically, and their locations can be seen by selecting each landmark from the list. (The exception is the Fossa Ovalis, which must be manually located and segmented.) The automatically segmented landmarks (shown in the Select Landmark to Display list) include the following:

Aortic Valve	RV Center	IVC Os
Mitral Valve	LIPV Os	SVC Os
Tricuspid Valve	LSPV Os	Apex
LA Center	RIPV Os	LCA Os
LV Center	RSPV Os	RCA Os
RA Center	Coronary Sinus Os	Pulmonary Valve

Select landmarks for viewing from the Landmark list and you may define new landmarks if desired.

NOTICE

The Landmarks tab displays only the tissue segments you selected on the previous tab.

Clicking on a landmark will cause the axial, sagittal and coronal views to jump to the location of the landmark.

WARNING

Segmentation and landmarks must be verified.

To manually define a landmark use the Define tool. A landmark's name can also be changed by right clicking over the landmark. See section “EP Planning Options and Tools” on page 277.

NOTICE

It is possible to delete auto-generated landmarks as well as landmarks you create.

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Planning Stage

When finished with the Heart Segmentation stage, access the EP Planning stage from the navigation tool bar. Use the EP Planning stage to perform qualitative and quantitative analysis of the left atrium and pulmonary veins (using various viewing modes).

NOTICE

Change the standard cardiac angles on the volume image to modify the view. Select either from a preset option or enter exact angles manually. See "Cardiac Viewer" in the CT Review section for more information on changing the standard cardiac angles.

When a new study is loaded into the EP Planning window for the first time, two of the viewports will be blank: the curved MPR view, and the measurements table. As you move through the EP Planning stage, the viewports are populated with relevant images.

EP Planning Workflow

- On the Extract & Define PV tab, use the automatic extraction to choose vessel. You may need to also extract a new vessel or edit the vessel centerline, contour, and LA diameter of the selected vessels.
- Use the Clip tab to remove unwanted anatomy from the volume images using common tools and processes.

Extract and Define PV

WARNING

Verify the correctness of the extracted centerlines and contours and correct if required.

1. Click on the location of the vessel you wish to define.
2. Choose a vessel name from the list. To mark a vessel not on the list, type the name of the new vessel in the text box on the Choose Vessel Name dialogue box.
3. If necessary, extract a new vessel using the multi-seed tool. Repeat the steps until all vessels of interest are defined.
4. Verify the vessel extraction and definition. If necessary, use the Edit centerline, Edit contour, and Draw LA diameter tools to modify the vessels. See section “EP Planning Options and Tools” on page 277.
5. When vessel extraction is verified, switch to the Clip tab.

Clip

The Clip tools are used to remove unwanted anatomy from the volume images using common tools and processes.

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