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Materialise Mimics Enlight Training

LAAO Workshop

Materialise Mimics Enlight 2.0

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Notices

This training handout is designed to help you get started with 3D planning for LAAO using the Materialise Mimics Enlight software. As such, this handout is not designed to be a substitute for training provided by Materialise.

Note: This familiarization-training does assume the user is familiar with Windows usage and terminology.

I hear and I forget

I see and I remember

I do and I understand

Confucius

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Regulatory Information:

Materialise Mimics Enlight is intended for use as a software interface and image segmentation system for the transfer of DICOM imaging information from a medical scanner to an output file.

It is also intended as a software to aid in reading and interpreting DICOM compliant images for structural heart and vascular treatment options. For this purpose, Mimics Enlight provides additional visualization and measurement tools to enable the user to screen and plan the procedure.

The Mimics Enlight output file can be used for the fabrication of physical replicas of the output file using traditional or additive manufacturing methods. The physical replica can be used for diagnostic purposes in the field of cardiovascular applications.

Mimics Enlight should be used in conjunction with other diagnostic tools and expert clinical judgement.

Mimics Enlight is not intended to predict the performance of a medical device. Materialise Mimics Enlight is not intended for mammography imaging or diagnosis.

Materialise Mimics Enlight is a CE-marked product.
Materialise Mimics Enlight Research is not a medical device.



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Introduction to Materialise Mimics Enlight

Materialise Mimics Enlight is a desktop software used for cardiac pre-procedural screening and planning.

The software enables true 3D Planning in a step-by-step, guided workflow. 3D planning uses accurate 3D models to enable automated analysis and enhanced spatial insights. When using accurate 3D models, measurements snap to the model, which allows evaluation in all three dimensions. True 3D models also allow for automation of measurements which enables a higher level of consistency and a more efficient process.

For more information, please see: <https://www.materialise.com/en/medical/software/mimics-enlight>.

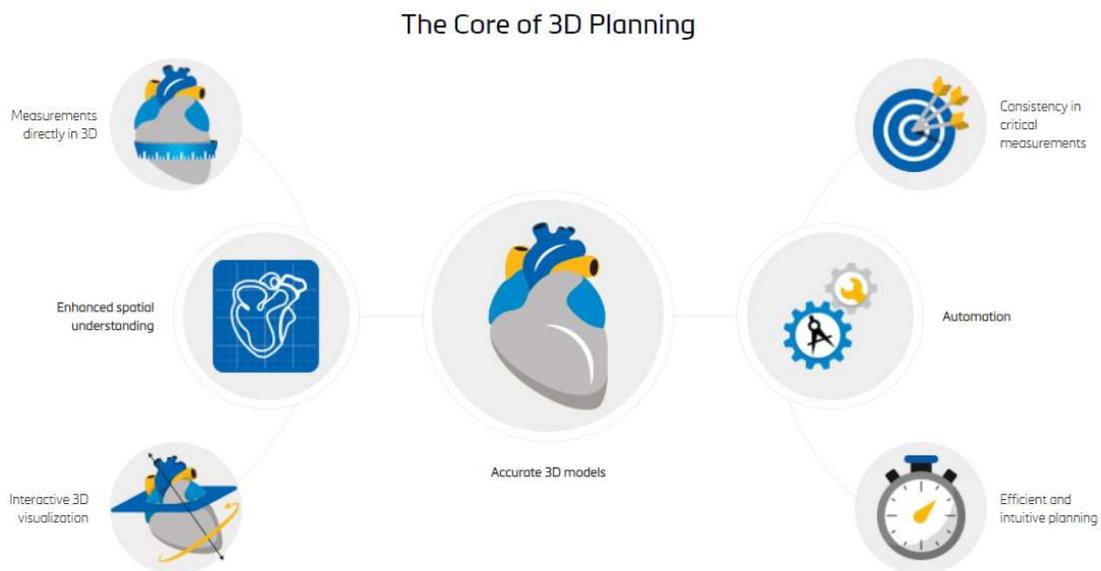
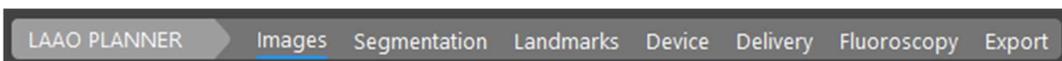


Figure 1: The Value of 3D Planning

The LAAO workflow consists of the following steps:



Images: View multiple images series and select a cardiac phase to analyze.

Segmentation: Generate 3D models of the cardiac anatomy.

Landing Zone: Identify and measure the ostium of the atrial appendage.

Device: Import a virtual device and measure the ostium for device implant.

Delivery: Analyze the delivery path to the atrial appendage.

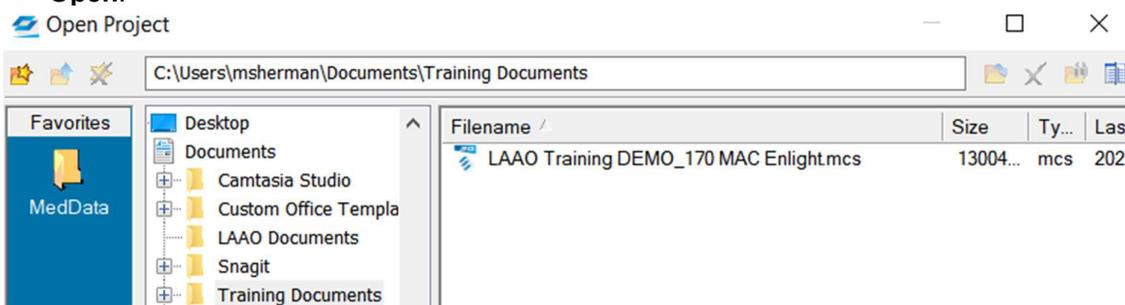
Fluoroscopy: Identify an optimal C-arm angle for the procedure and simulate the resulting fluoroscopic view.

Export: Export a PPT report and other files for online case sharing and/or 3D printing.

Exercise 1: 3D Planning for LAAO

Starting Materialise Mimics Enlight Medical and opening a project.

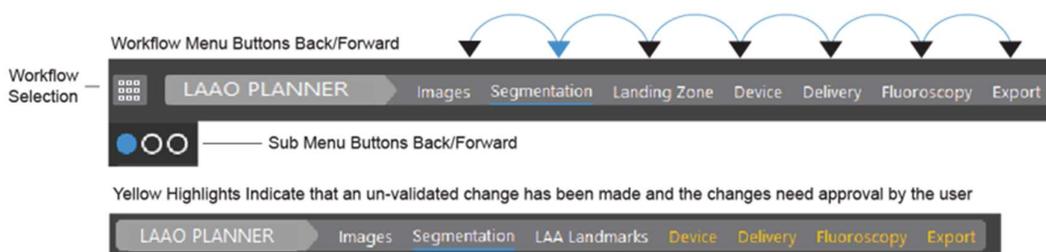
1.  Open Materialise Mimics Enlight Medical from the start menu or desktop icon.
2. Go to File and select **Open**.
3. Navigate to and select the “*LAAO Training DEMO_170 MAC Enlight*” demo file. Click **Open**.



*NOTE: If you want to create a new project from DICOM images, go to File and select **New from Disk**.*

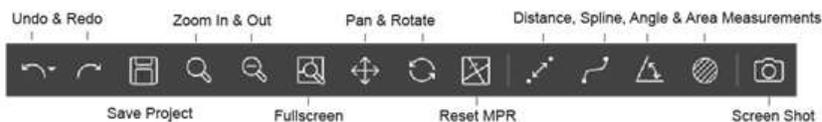
NOTE: Although this is labeled an LAAO case but is also the same case file demonstrated for TMVR DEMO_170 Final Enlight

General LAAO Workflow Overview and Navigation



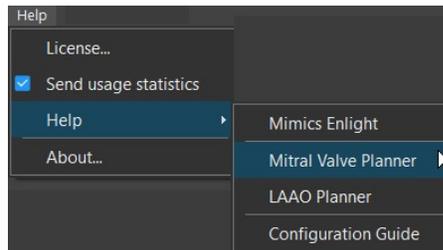
Move back and forth through the workflow by clicking the steps in the Workflow Selection and Sub-Menu buttons.

Note the shortcuts available on the top-right of the interface.



Here, you can undo/redo an action, save, navigate the images, and perform your own distance, angle, spline, and area measurements at any time. The last icon allows you to capture a screenshot for later use in the report.

4. Navigate to *Help > Help > LAAO Planner* for more workflow instruction.



Shortcuts

There are several mouse and keyboard shortcuts to help you navigate the software, the 2D image views and the 3D view.

General Shortcuts

General

| Action | Shortcut | Description |
|--------|----------|-------------------------------------|
| Undo | Ctrl + Z | Undo the last action |
| Redo | Ctrl + Y | Redo the last undone action |
| Delete | Delete | Delete the selected point or object |

2D Image View Shortcuts

2D Views*

| Action | Shortcut** | Description |
|----------|-------------------------------------|--|
| Zoom In | Ctrl + RMB + move mouse cursor up | Zoom 2D view |
| Zoom Out | Ctrl + RMB + move mouse cursor down | Zoom 2D view |
| Zoom | Space bar | Toggles between zoomed in and zoomed out of one viewport |
| Pan | Shift + Arrow keys | Pan 2D view |
| | Shift + RMB | |
| | Hold the MMB | |
| Scroll | Scroll wheel | Scroll through the image slices |

* The above mentioned shortcuts are working on the view over which the mouse cursor is hovering.

** LMB = Left Mouse Button, RMB = Right Mouse Button, MMB = Middle Mouse Button / Scroll wheel.

Contrast Shortcuts

To adjust the grayscale of how the images are visualized, use the right mouse button:

| | |
|------------------|----------------------------------|
| RMB + move up | Increases the width of grayscale |
| RMB + move down | Decreases the width of grayscale |
| RMB + move right | Increases the level of grayscale |
| RMB + move left | Decreases the level of grayscale |

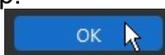
3D View Shortcuts

3D view*

| Action | Shortcut** | Description |
|----------|-------------------------------------|--|
| Zoom In | Ctrl + RMB + move mouse cursor up | Zoom 3D view |
| | Scroll up | |
| Zoom Out | Ctrl + RMB + move mouse cursor down | Zoom 3D view |
| | Scroll down | |
| Rotate | Hold the RMB | Rotate the 3D view |
| | Arrow keys | Rotate the 3D view left/right and up/down |
| Pan | Hold the MMB | Pan the 3D view |
| | Shift + Arrow keys | |
| | Shift + RMB | |
| Locate | Shift + LMB | Locate the point indicated in 3D on the 2D views when the cursor is in another tool mode |

** LMB = Left Mouse Button, RMB = Right Mouse Button, MMB = Middle Mouse Button / Scroll wheel.

- Practice locating and zooming in on the left atrial anatomy in the images and 3D view.
- Click **OK** to move on to the next step.



Landing Zone

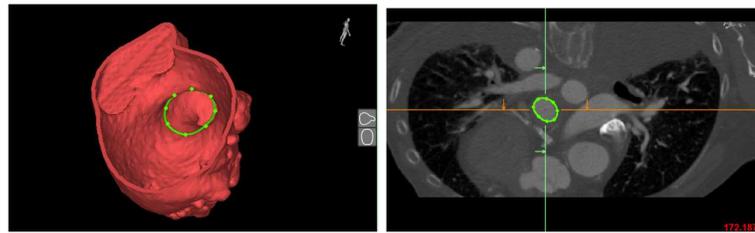
In the *Landing Zone* step, you will define a curve around the ostium, or landing zone for the device, of the atrial appendage.

- Since this is a LAAO case, click the **Manual** button, then click points on the **inner surface** of the ostium of the LAAO in either the 3D window or the 2D CT scans.



To aid with this, click on the ostium of the 3D model with your Left Mouse Button to visualize that point in 2D or click on the ostium of the 2D image with your Left Mouse Button to visualize that point in 3D. This should give you some sense of the 2D to 3D relationship for the landmark.

Make sure landmarks correspond between 2D and 3D images by scrolling through your CT images. You can scroll through these images using your middle mouse wheel.



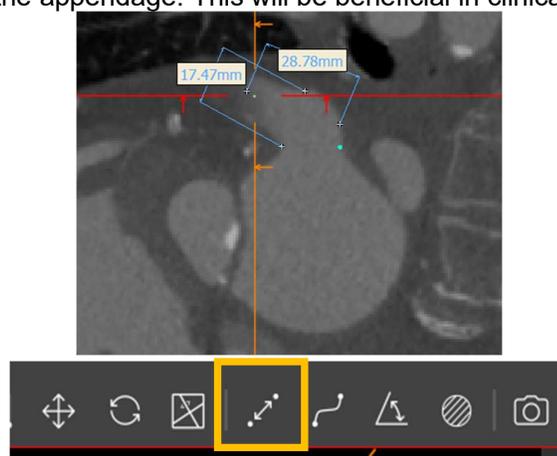
8. Next, click **Calculate** to automatically fit a plane to the ostium curve and calculate measurements of the ostium. This will also update your image views to an optimal atrial appendage view based on the best-fit atrial appendage ostium plane.

Calculate

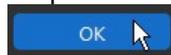
| Measurements | |
|--|------------------------|
| Perimeter (projected) | 60.13 mm |
| Area (projected) | 279.96 mm ² |
| Perimeter derived Diameter | 19.14 mm |
| Area derived Diameter | 18.88 mm |
| Largest Diameter (projected) | 21.41 mm |
| Smallest Diameter (projected) | 16.44 mm |
| Available Depth | 17.08 mm |
| Change the direction of the depth measurement by dragging the red dot. | |

*NOTE: you can edit the ostium again if needed. When you finish editing the ostium, just make sure to click the **Recalculate** button to update the annulus measurements.*

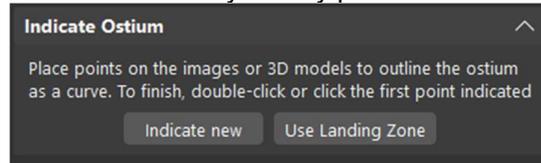
9. Use the measuring tool in the top right of the screen to create points in order to measure the correct size of the appendage. This will be beneficial in clinical aspects.



10. Click **OK** to move on to the next step.

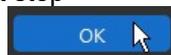


11. Here, you will be presented with a choice to indicate the ostium. However, since we previously did this with our landmarks you may press **“Use Landing Zone.”**



Measurements will be automatically calculated again and your landing zone will also become your ostium indicator.

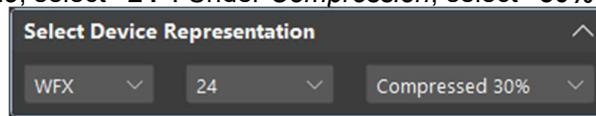
12. Click **OK** to move on to the next step



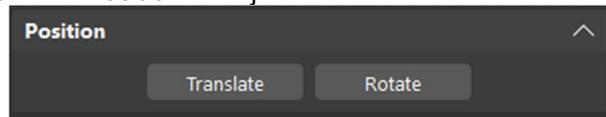
Device

In the *Device* step, you will import a virtual device and quantify the potential effects on the left ventricle outflow tract.

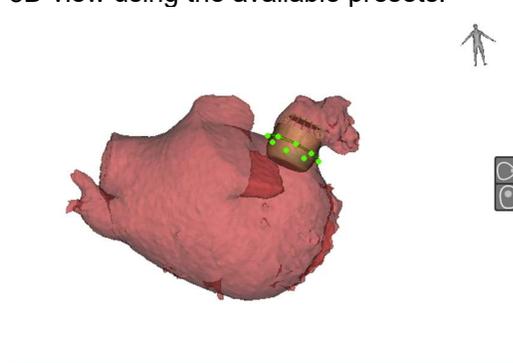
13. From the drop-down device *Library*, choose the **“WFX”** (Watchman Flex) example device. Under *Size*, select **“24”**. Under *Compression*, select **“30%”**.



14. Translate or rotate the device as you see fit, to properly fill the ostium. The Watchman Flex device should correspond to the ostium size and angle. Work between *Device Representation* and *Position* to adjust and move the device accordingly.



15. View the result in the 3D view using the available presets:

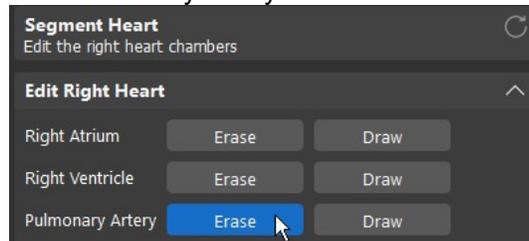


16. Click **OK** to move on to the next step.

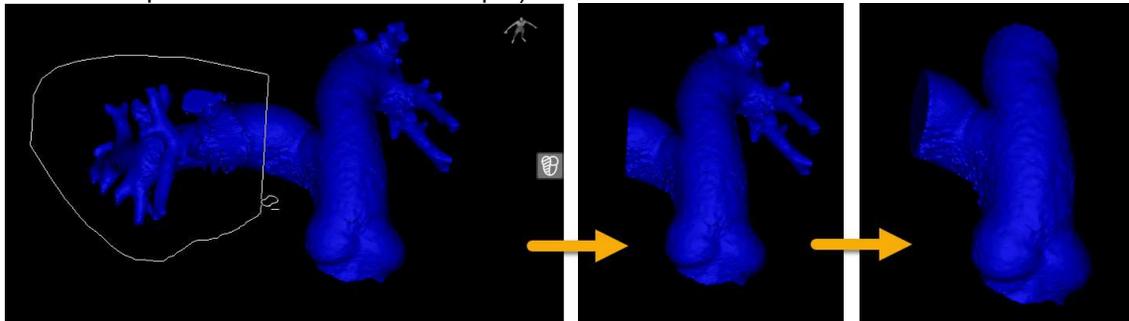
Delivery

In the *Delivery* step, you will be able to view and quantify the predicted delivery path.

- View the segmentation in the 3D View. Edit the Pulmonary Artery model by clicking the **Erase** button next to “Pulmonary Artery”.



Lasso over the 3D view to trim off the pulmonary arteries. (This will help save computation time in the next steps.)



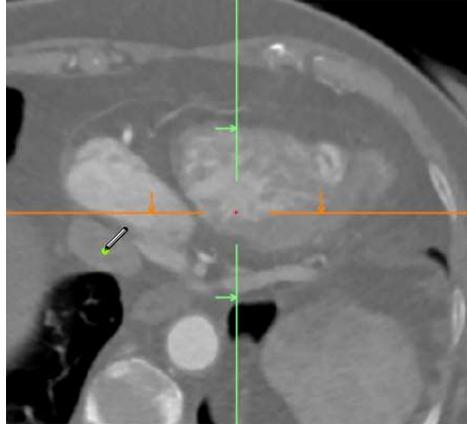
- Click **OK**.

- Identify the *Fossa Ovalis*.

Find the point where the left and right atria get very close in the 3D view. Hold SHIFT, then click on the point to locate it on the image views. Once there, place the point by clicking on the image.



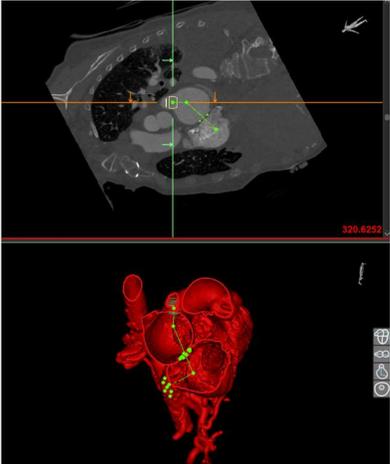
20.  Reset the MPR using the shortcut on the top-right, then scroll down in the axial view to identify and select the IVC point.



21. Click **OK**.

22. On the next page, you can visualize the delivery path and associated measurements. Use the eye and locate buttons to view the individual measurements.

| Measurements | | | |
|------------------------------|--------|-----|---|
| Angle IVC-FO | 85.53 | deg |   |
| Distance IVC-FO to FO-Device | 57.71 | mm |   |
| Angle FO-Device | 137.64 | deg |   |
| Height FO-Device | 20.20 | mm |   |



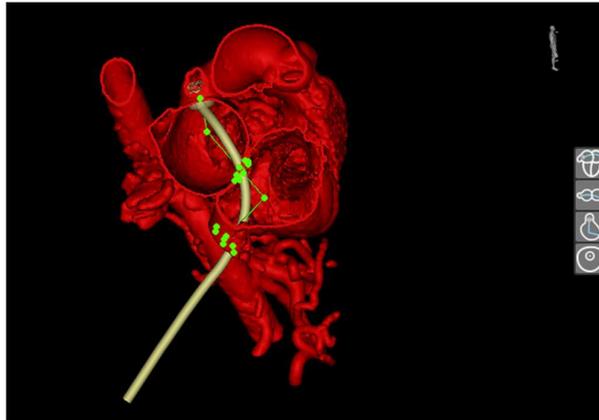
NOTE: you can adjust the delivery pathway by clicking and dragging the points in the 3D view and in the CT images.

23. After getting measurements and location, under *Catheter Representation*, select the proper catheter type and name.

Select Catheter Representation

Name Type

NOTE: Once you have selected name and type you can translate and rotate the catheter into position just as you did with the device in step 20.



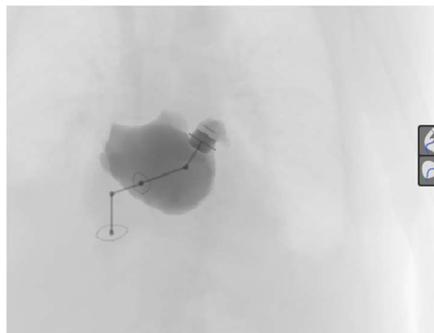
NOTE: You can manually draw the catheter representation for optimal fit and use this manual representation to choose the proper type of catheter to apply.

24. Select **Proceed to Fluoroscopy** to move on.

Fluoroscopy

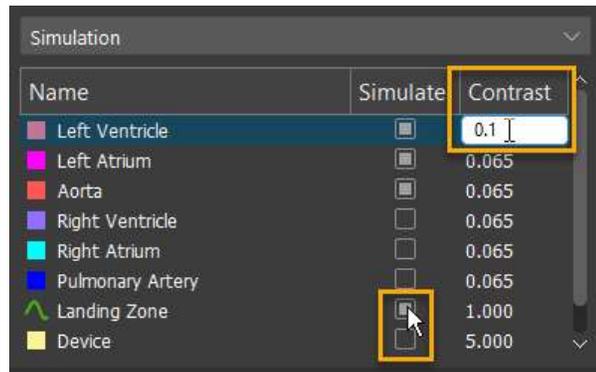
In the *Fluoroscopy* step, you will be able to generate an optimal C-arm angle and simulate a fluoroscopy view.

25. Click on the “**Perpendicular to device**” icon to generate an automatic view and C-arm angle.



Hide the device or other objects by selecting/unselecting the objects in the Simulation menu on the left.

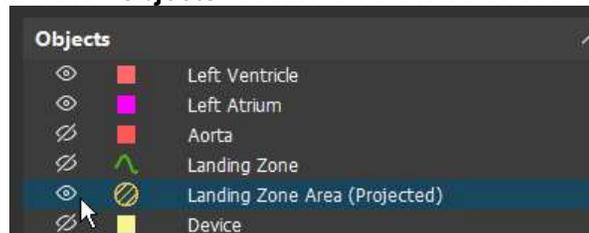
Make an object darker in the fluoro view by increasing the ‘Contrast’ value.



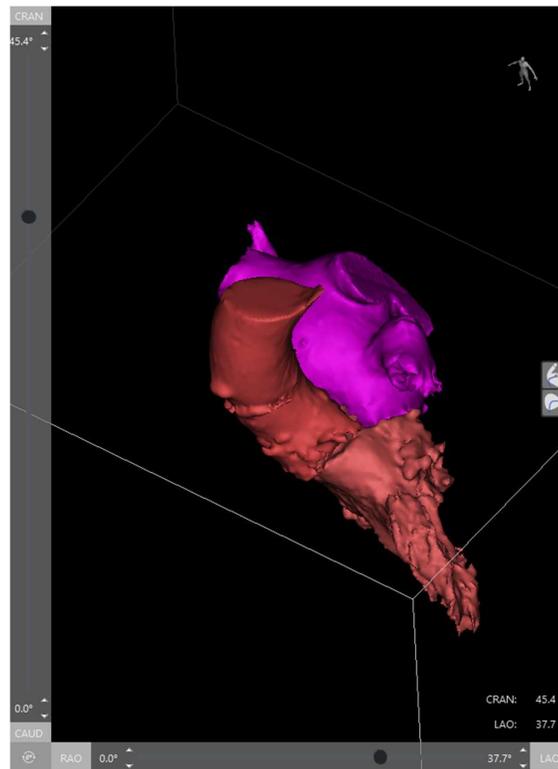
26. Next, change the mode to **“3D View”**, and click the **“Set by the user”** view option.



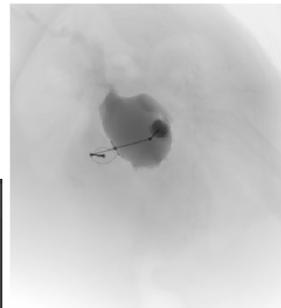
Rotate the model in 3D to find an appropriate view for the intervention, showing/hiding objects as needed from the **“Objects”** section on the left side of the interface.



Note the resulting C-arm angles on the sides of the window.



Switch back to the “Simulation” mode to see the result.

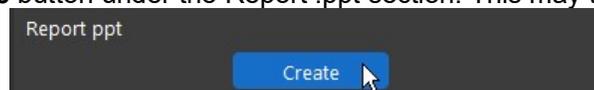


27. Click **OK** to go to the *Export* page.

Export

In the *Export* step, you will be able to export a PowerPoint (PPT) report containing the measurements you took, as well as a file to share on the online Mimics Viewer and a file for further processing for 3D printing.

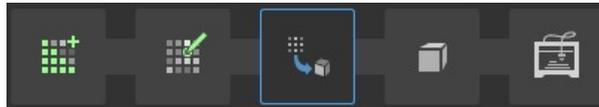
28. Click the **Create** button under the Report .ppt section. This may take a minute or so.



29. Open the PPT report once exported. Create a new slide and import the screenshot saved from earlier in the workflow into the report.
30. Next, export a file to Mimics InPrint by clicking **Create** in the Mimics Viewer file section of the workflow.

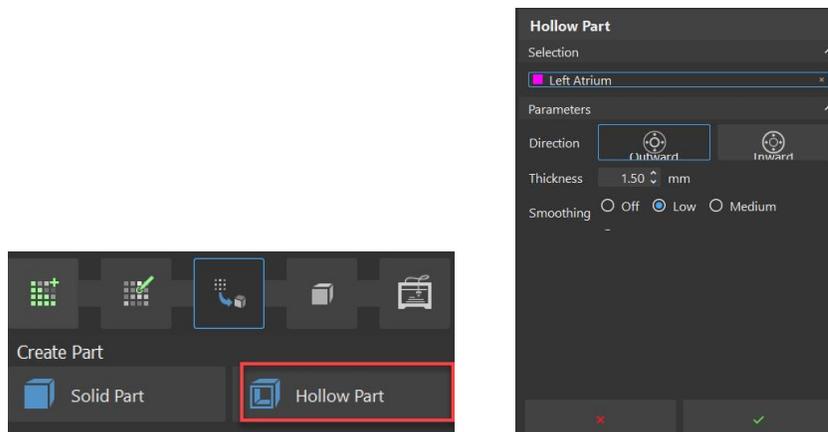
Mimics InPrint

31. In Mimics InPrint, you can preview a 3D model and edit it before finally sending it to the print lab to be printed. One of the best aspects of InPrint is the labelling guide that allows for users to quickly label a part before sending it to the printer.
32. The first two steps **Create ROI & Edit ROI**, we have already done within Mimics Enlight. Therefore, we can go to the third step of InPrint, **Add Part**. This step converts our ROI into an STL file for printing.

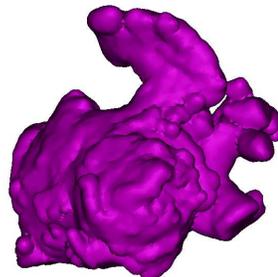


Note: For this step we will be converting the Left Atrium ROI into a part for 3D printing

33. In order to create a part with a defined thickness, choose Hollow part. Make sure the “Left Atrium” is selected. Choose “Outward” as direction, set Thickness to 1.5 mm and set a low smoothing.



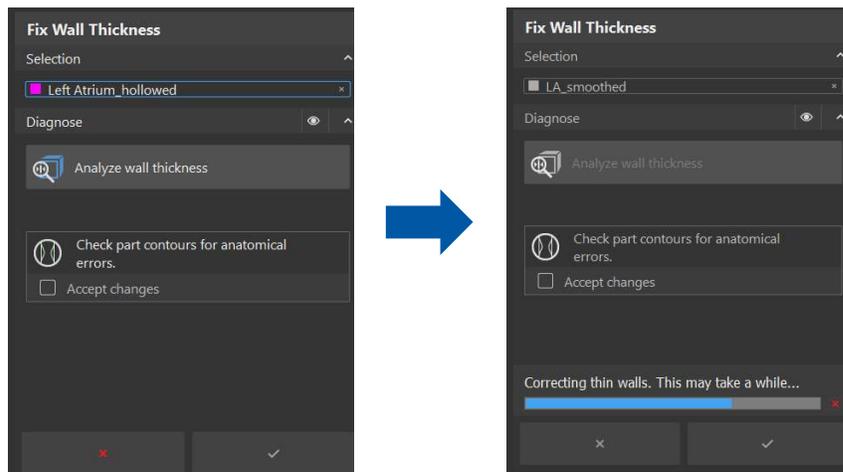
34. Click validate  to generate the new part.



35. The **Edit Part** stage allows you to modify the parts generated in the previous step.



36.  In order to ensure that the thickness of the hollowed model is over 1mm, choose the **Fix Wall Thickness** tool. A minimum thickness of 1mm is required in hollow parts to ensure that the printed parts are robust and insusceptible to tear or damage. Make sure that the “LA_smoothed” is selected and click on **Analyze wall thickness**.

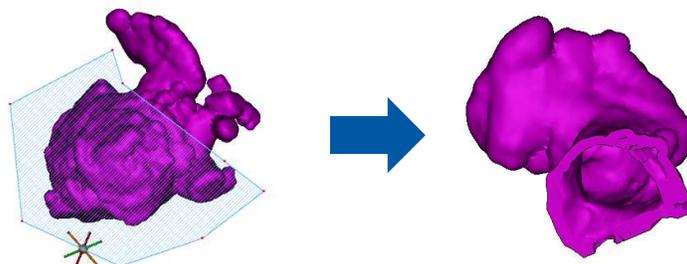


37. The contours of the original part and the corrected part are displayed in the 2D images. Check the wall thickness of the corrected part to ensure anatomical correctness the contours displayed in green are the corrected contours.

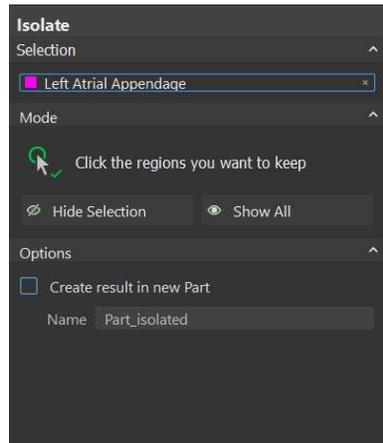
38. After checking the wall thickness (If there is no significant anatomical error generated), select the option **Accept changes** and click on validate  to accept the changes. A new part will be created: “Left Atrium_hollowed_fixed”.

39.  **Duplicate** this part “Left Atrium_hollowed_fixed” by right clicking on the part name. Rename it to “Left Atrial Appendage”. This part will be sectioned to only display the Left Atrial Appendage.

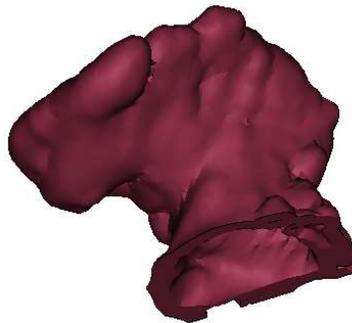
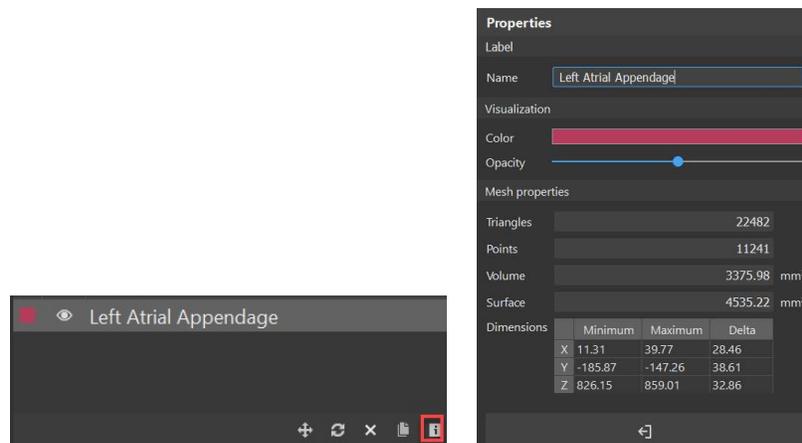
40.  Choose the **Cut** tool to section the model in order to visualize the atrial appendage. Select the “Left Atrial Appendage”, choose **Remove Inner** and start trimming the model by clicking multiple times around the area to be deleted in the 3D view.



41.  A part can consist out of multiple shells (separated parts within a 3D model). To create a part with one single shell, it is necessary to remove the undesired shells in the part. Choose the **Isolate** tool for this process. Make sure that the “Left Atrial Appendage” is selected. Click on the part you want to keep in the 3D viewport and then on the **Apply** icon .



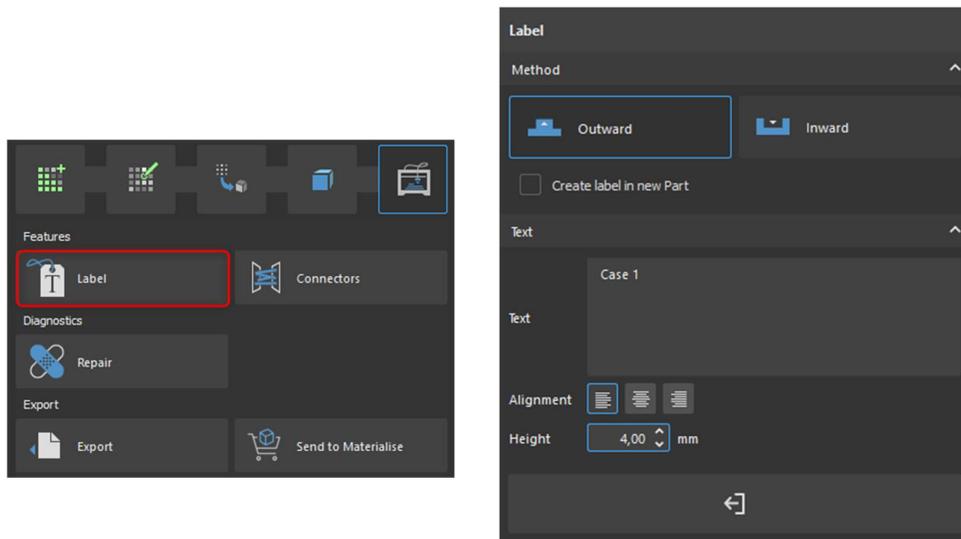
42.  Select the **Properties** icon to modify properties of the part such as color and opacity, as shown below.



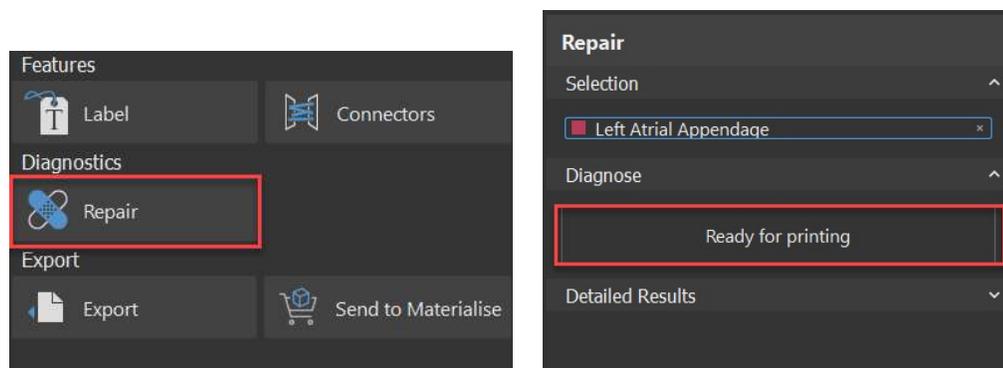
43. The **Prepare Print step** is the final stage of the workflow. It ensures that the part prepared previously is ready for 3D printing.



44.  Choose the **Label** tool and type “**Case 1**” into the Text field. Make sure that the method is set to **Outward** and the Height is **4.00 mm**. In the 3D viewport, click on the place in the part where you want to label.

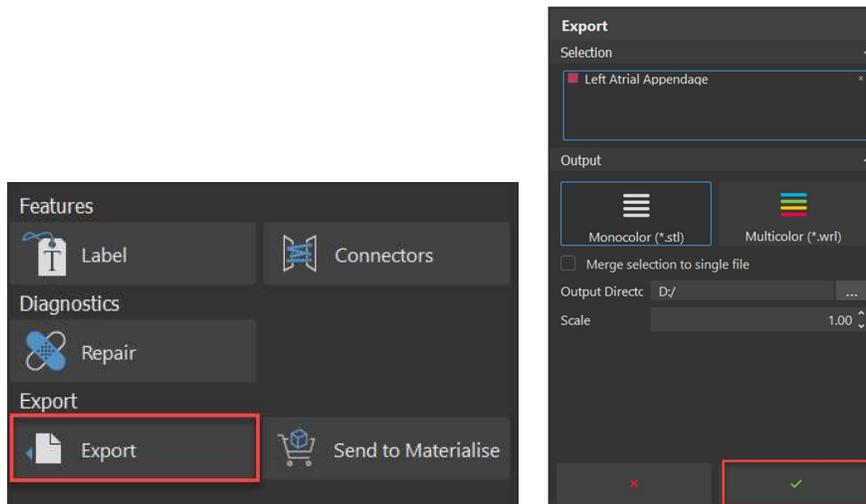


45.  To ensure that the part can be printed, several parameters, such as noise shells and bad triangles, need to be fixed. Use the **Repair** tool to fix the part. The diagnostics is done immediately once the part is selected. In case the status is “Not ready to print”, click on the Diagnose & Fix icon to initiate the automatic fixing process. If needed, repeat until the status is “Ready for printing”. Then, exit the tool .



46.  Once the part is ready for printing, you can export it as an STL using the **Export** tool. Make sure you select the Left Atrial Appendage part and that you select your

desired output directory. Use **Monocolor (*.stl)** as the output and validate to export the part . A message in the logger indicates you the part was exported successfully.



Congratulations!

Congratulations, you have finished the workflow! Thank you for joining us!