SIEMENS Healthineers

ACUSON Sequoia Ultrasound System

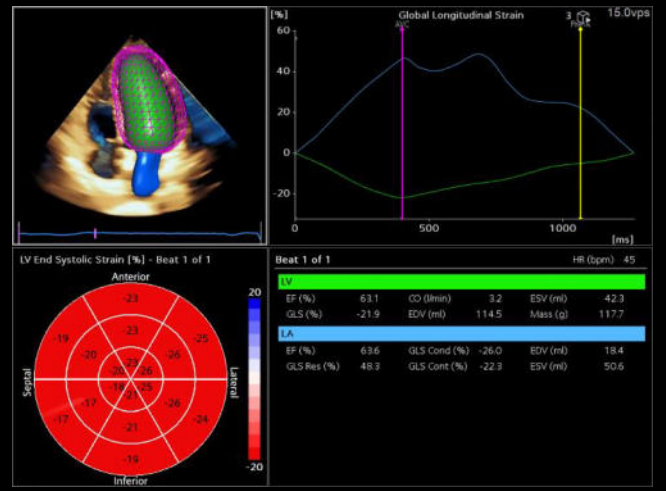
4D Heart^{AI}
3.5 (VB30)

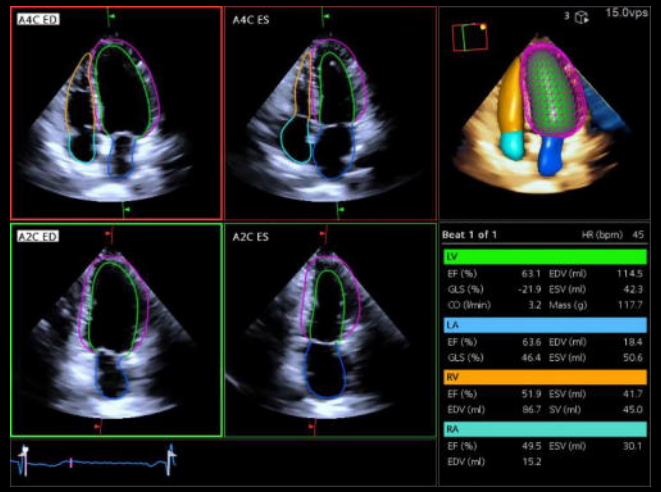
Objectives

- **Overview of 4D Heart^{AI} application**
- Review 4D Heart^{AI} configuration and touch screen layout
- Illustrate imaging for 4D Heart^{AI}
- Review 4D Heart^{AI} workflow
- Evaluate 4D Heart^{AI} analysis and report

4D Heart^{AI} – clinical relevance and benefit

- Clinical guidelines recommend 3D evaluation for cardiac size and function[1]
- 3D strain analysis is faster with good reproducibility compared to 2D[2]
- 3D strain is more accurate with less variability due to entire LV cavity detection[3]
- AI-enabled analysis:
  - Chamber contouring for size and function
  - 4D strain analysis of left heart
- Assessment:
  - All visible chambers in TTE
  - Visible ventricles in TEE
- Available without ECG





Sources | 1. Mitchell, Carol, et al., Journal of the American Society of Echocardiography (2019) 32;1
2. Hasanfatta, Naeem et al., *ACTA Scientific Clinical Case Reports* (2022) 3;6: 45-56
3. Kosarju, Ateet, et al., *Left Ventricular Ejection Fraction*. StatPearls Publishing (2023) Jan

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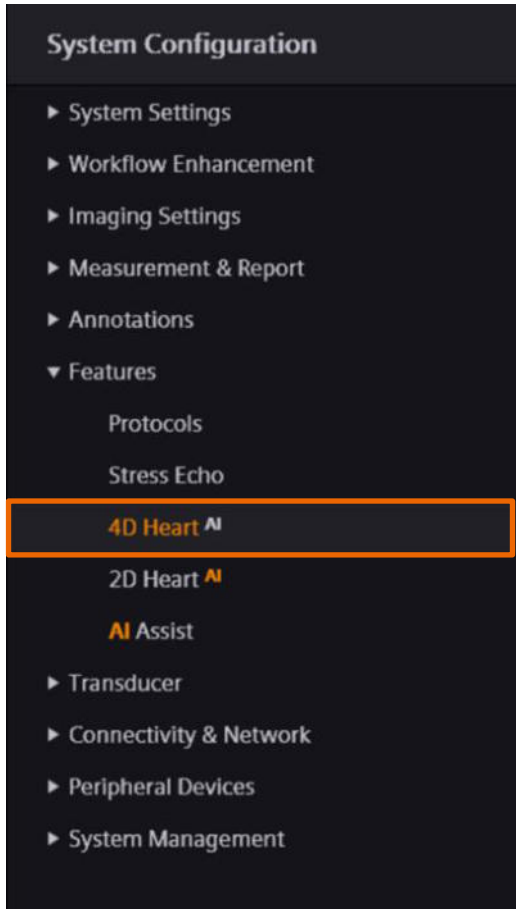
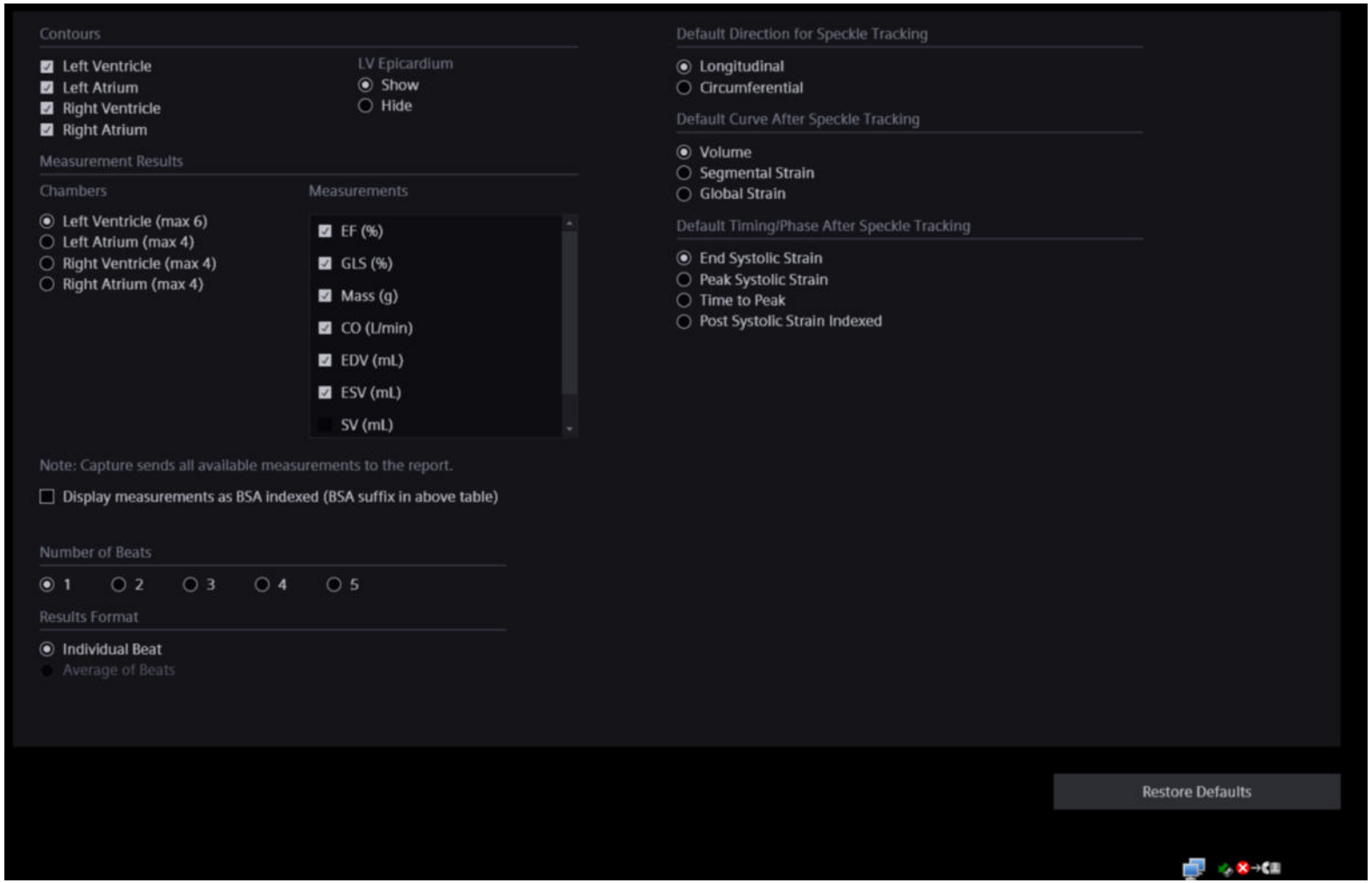
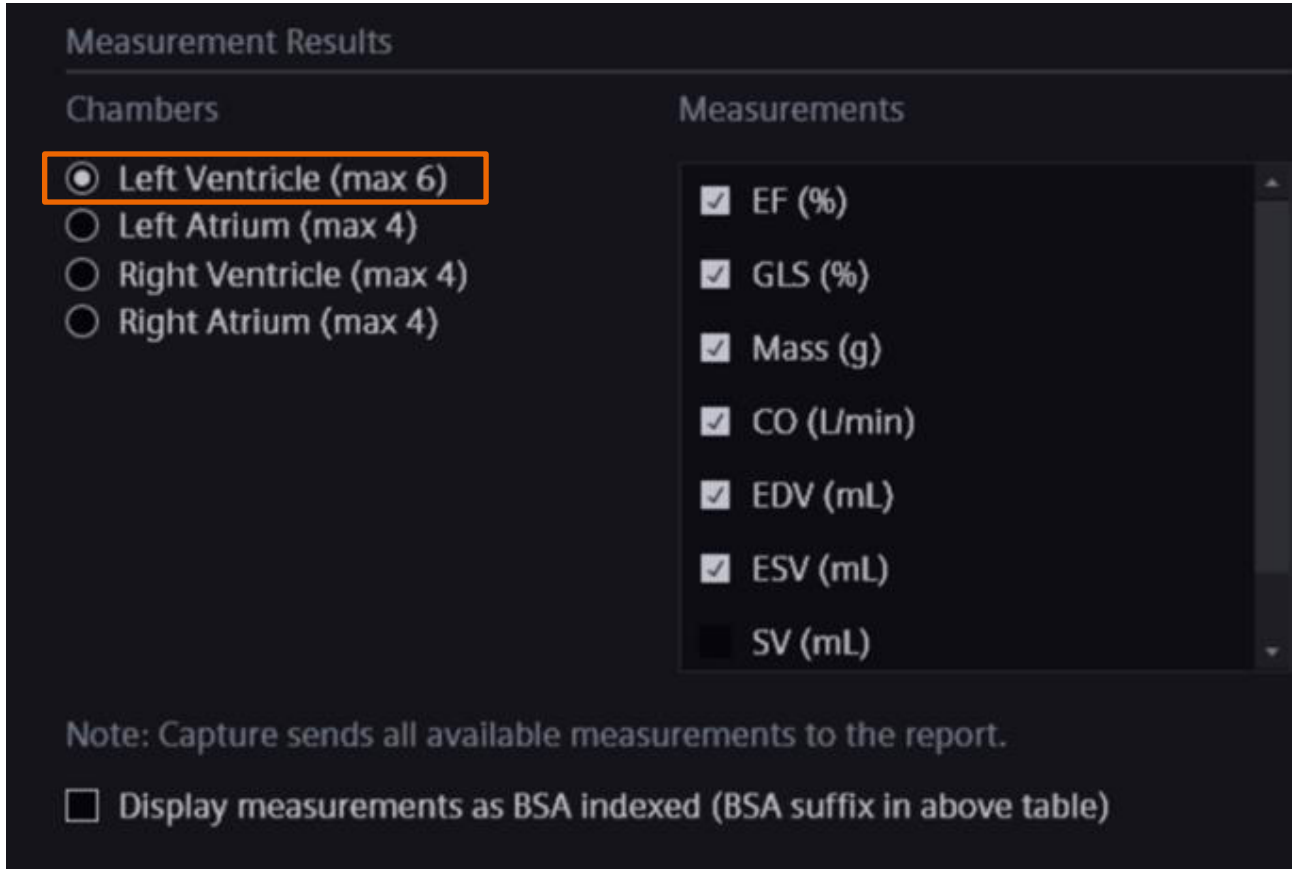
4D Heart[AI] configuration





System configuration – left ventricle (LV) chamber options



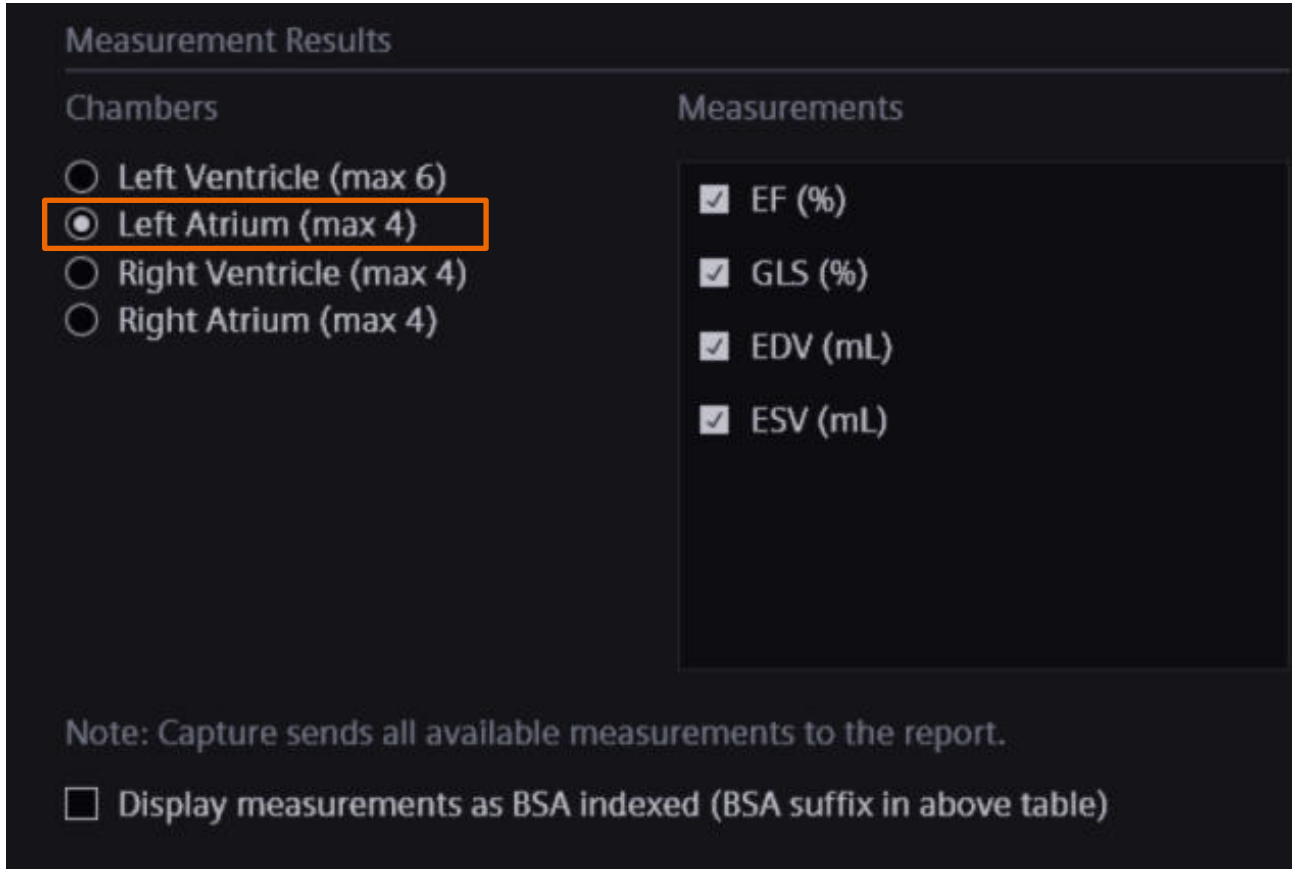
Measurements available for the left ventricle include:

- Ejection Fraction (EF)
- Global Longitudinal Strain (GLS)
- Mass
- Cardiac Output (CO)
- End Diastolic Volume (EDV)
- End Systolic Volume (ESV)
- Stroke Volume (SV)

- Maximum display of 6 measurements for LV

Note: *All measurements are populated to the report regardless of the options selected for on-screen display in system configuration.*

System configuration – left atrium (LA) chamber options

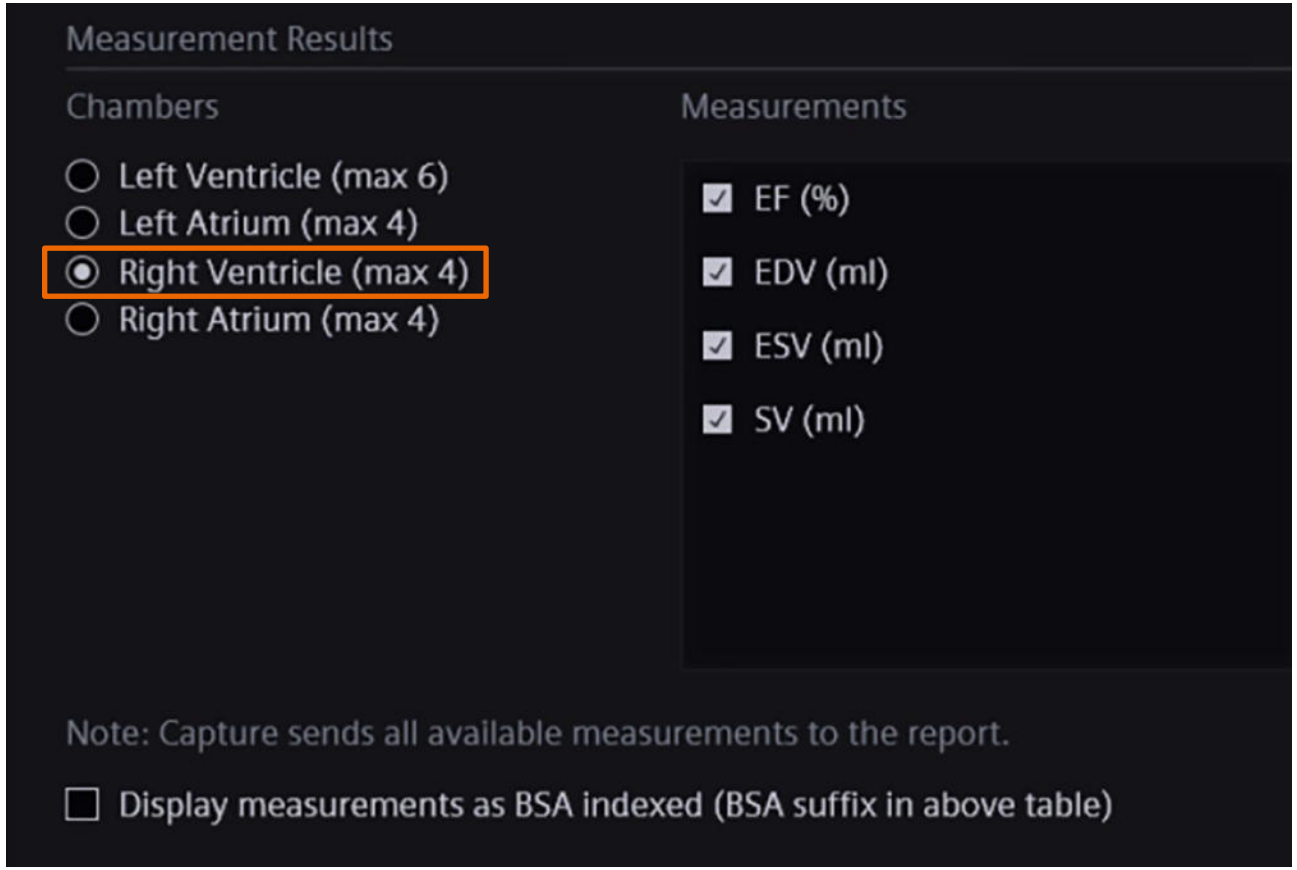


Measurements available for the left atrium include:

- Ejection Fraction (EF)
- Global Longitudinal Strain (GLS)
- End Diastolic Volume (EDV)
- End Systolic Volume (ESV)

- Maximum display of 4 measurements for LA

System configuration – right ventricle (RV) chamber options

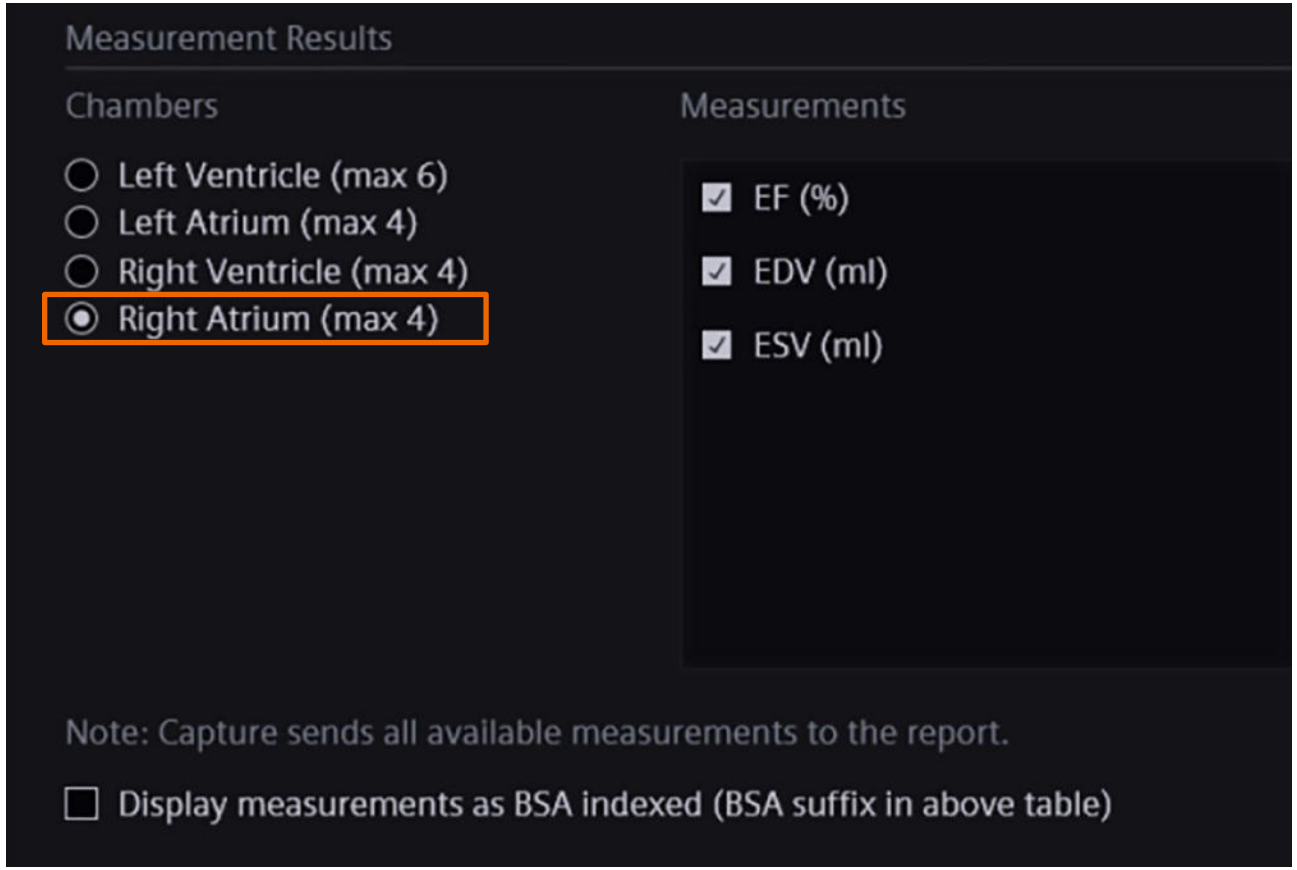


Measurements available for the right ventricle include:

- Ejection Fraction (EF)
- End Diastolic Volume (EDV)
- End Systolic Volume (ESV)
- Stroke Volume (SV)

- Maximum display of 4 measurements for RV

System configuration – right atrium (RA) chamber options

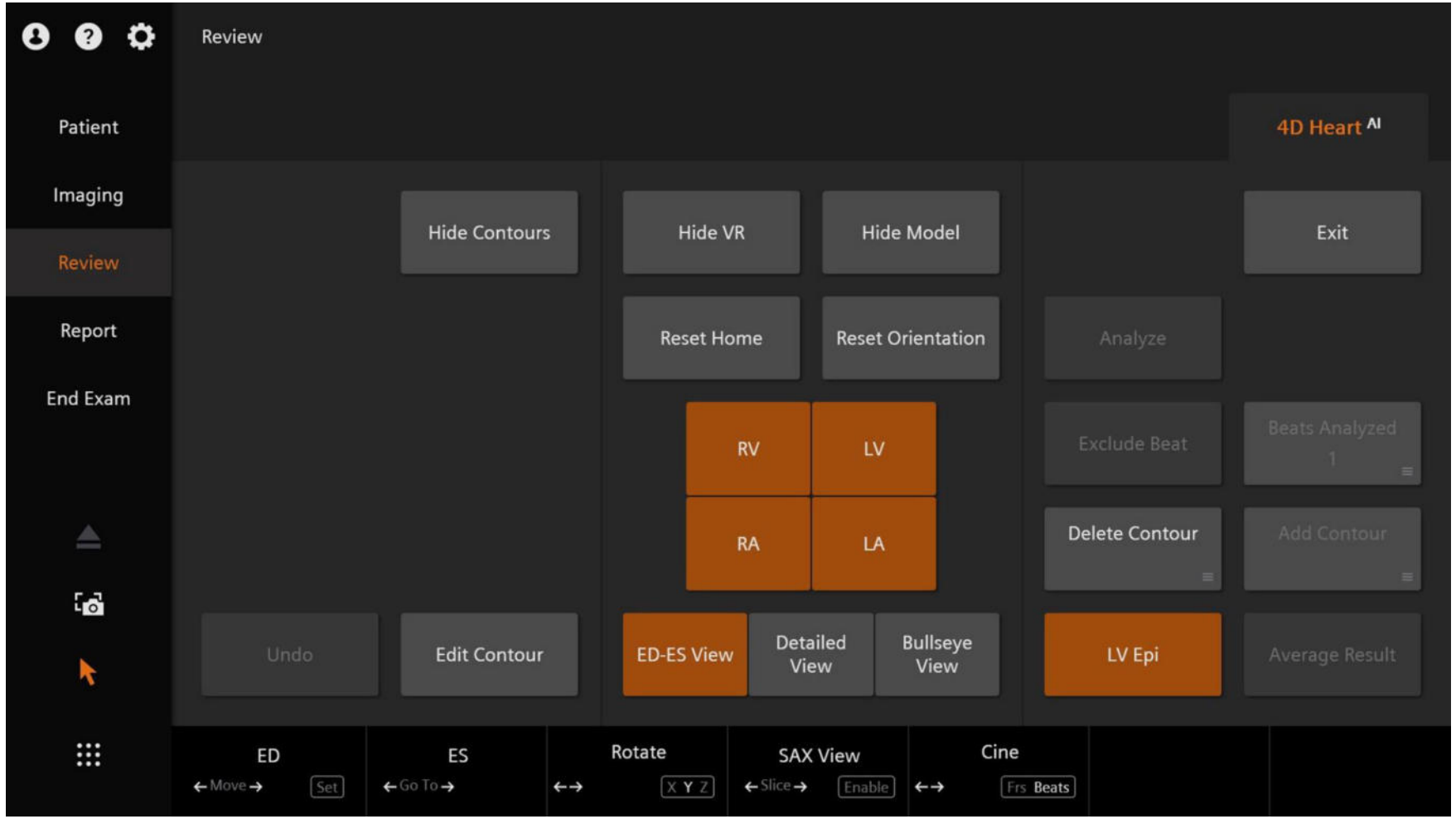


Measurements available for the right atrium include:

- Ejection Fraction (EF)
- End Diastolic Volume (EDV)
- End Systolic Volume (ESV)

- Maximum display of 4 measurements for RA

4D Heart[AI] touch screen layout



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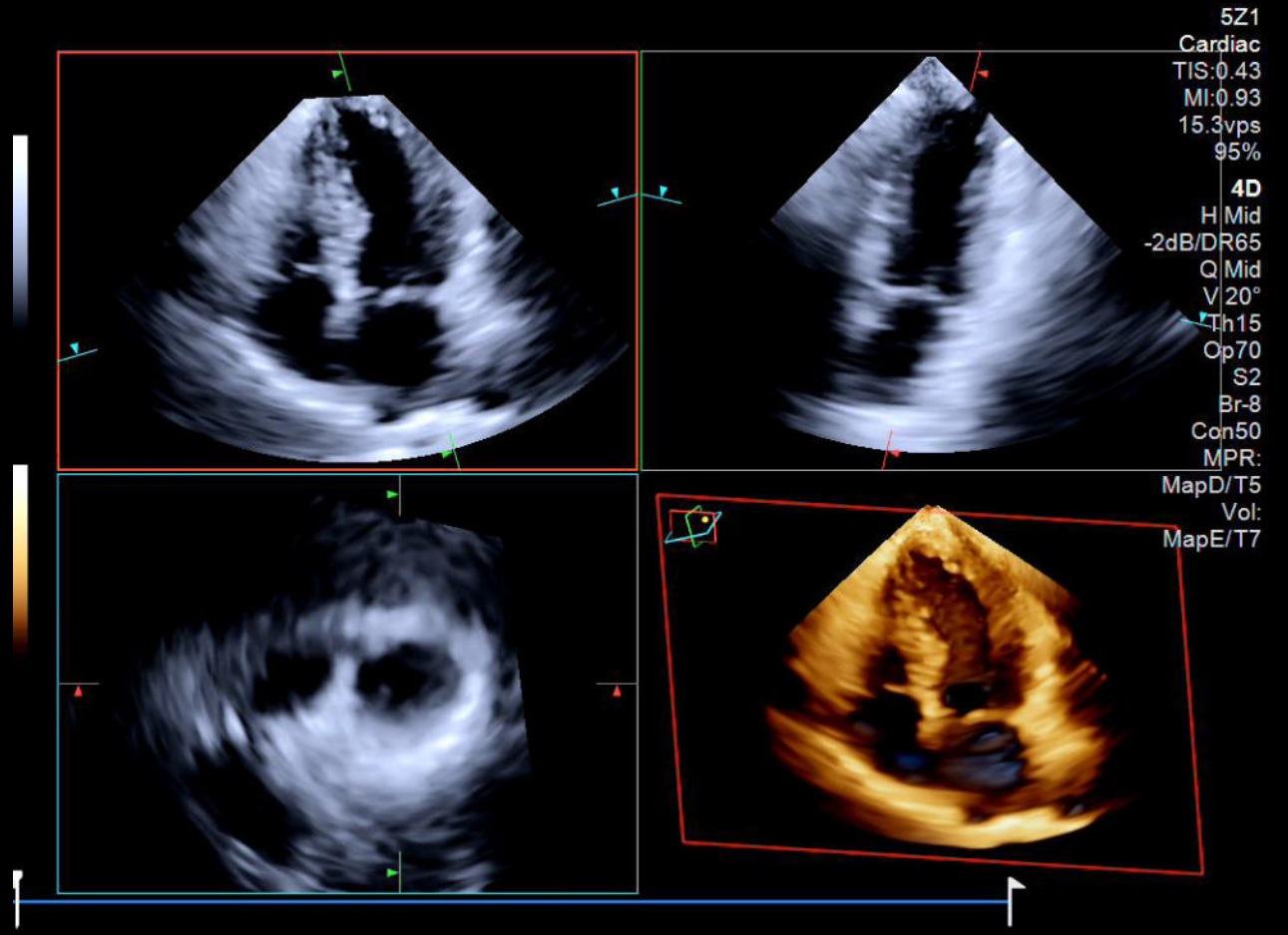
Volume acquisition

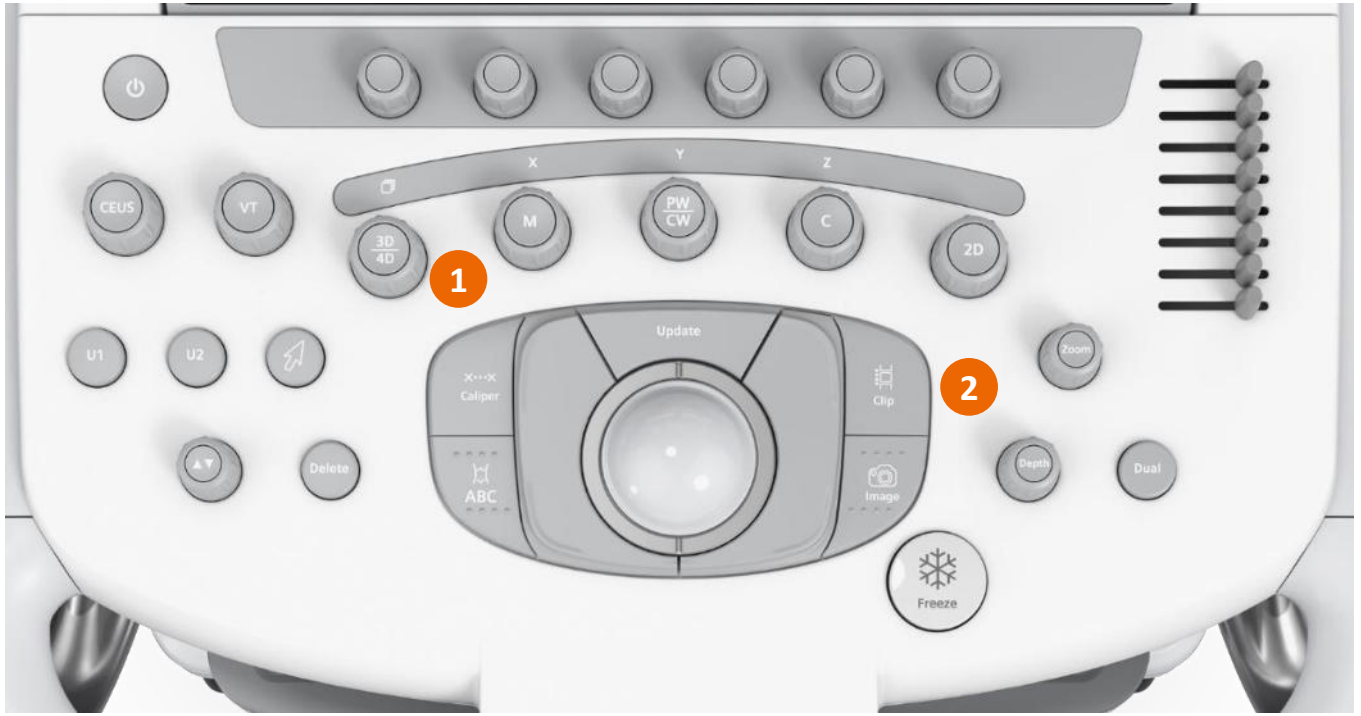
- Optimal 2D imaging is essential to a quality volume acquisition
- Prior to acquisition it’s important to evaluate all reference planes for structural boundaries
- Alignment is important for assessment of specific anatomy



Volume acquisition

Optimize the 2D image

1. Press **4D**
   - Further optimize 4D image as needed
2. To acquire a volume, select **Clip** key



Tip: *Ensure entire chambers are in field of view and have patient perform a breath hold to reduce motion of the heart.*

4D volume acquisition: physio vs. non-physio

Acquisition with ECG (physio)

- Use a beat capture – must have at least one full R-R capture
- Ensure ECG tracing is optimal and clean
- Multiple heart cycles can be analyzed and averaged (up to **five**)

Acquisition without ECG (non-physio)

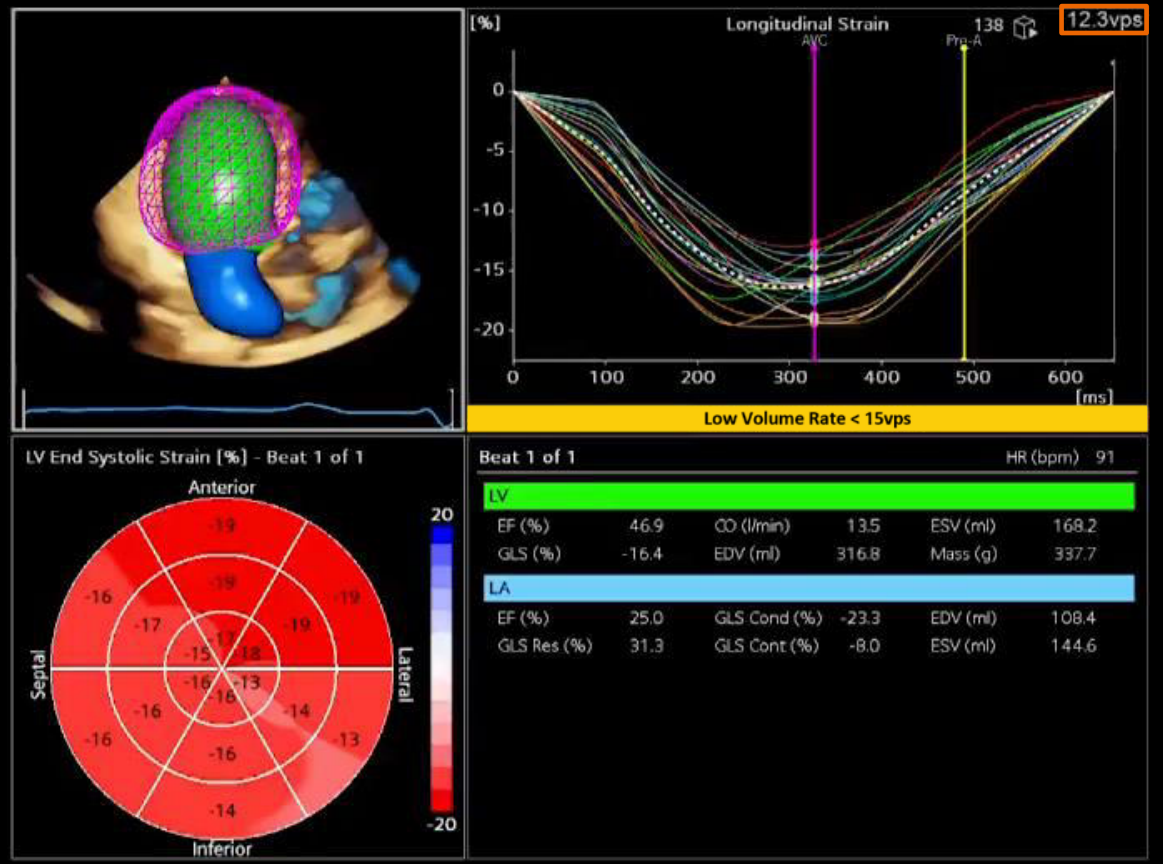
- Use a time capture
- ED/ES key frames are set by user and proceeds to analysis
- Only **one** cardiac cycle can be analyzed
  - Exclude Beat, Beats Analyzed and Average Result are therefore not available
- Tracking is available for all visible chambers in TTE, and visible ventricles in TEE

Acquisition for 4D strain analysis – volume rates

- 4D bullseye analysis on a dataset > 15vps (volumes per second) results in a cautionary display within the viewport

Low Volume Rate < 15vps

- To optimize vps
  - Decrease line density
  - Reduce depth
  - Reduce lateral and/or elevational field of view when needed
- Acquire steady beats, without any changes to field of view – have patient hold breath if needed



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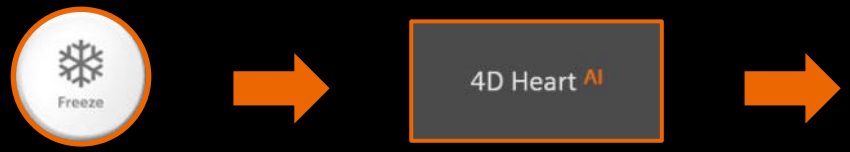
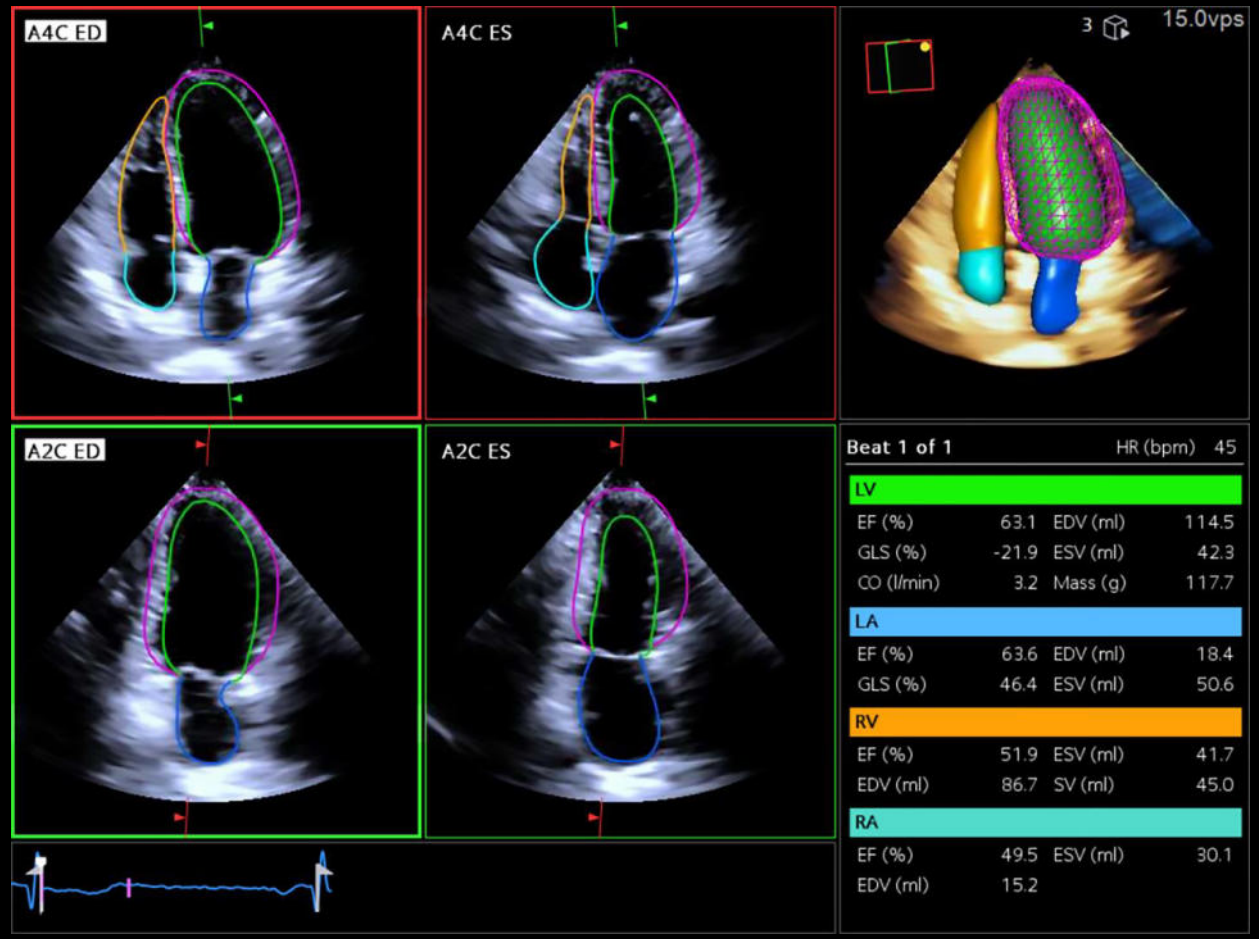
Launching 4D Heart^{AI} from cine

- Ability to launch 4D Heart^{AI} while imaging
  - During live 4D imaging, select **Freeze**
    - At least one R-R cycle must be in cine
  - Select **4D Heart^{AI}** on touch screen

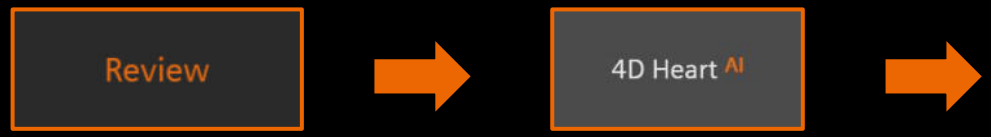


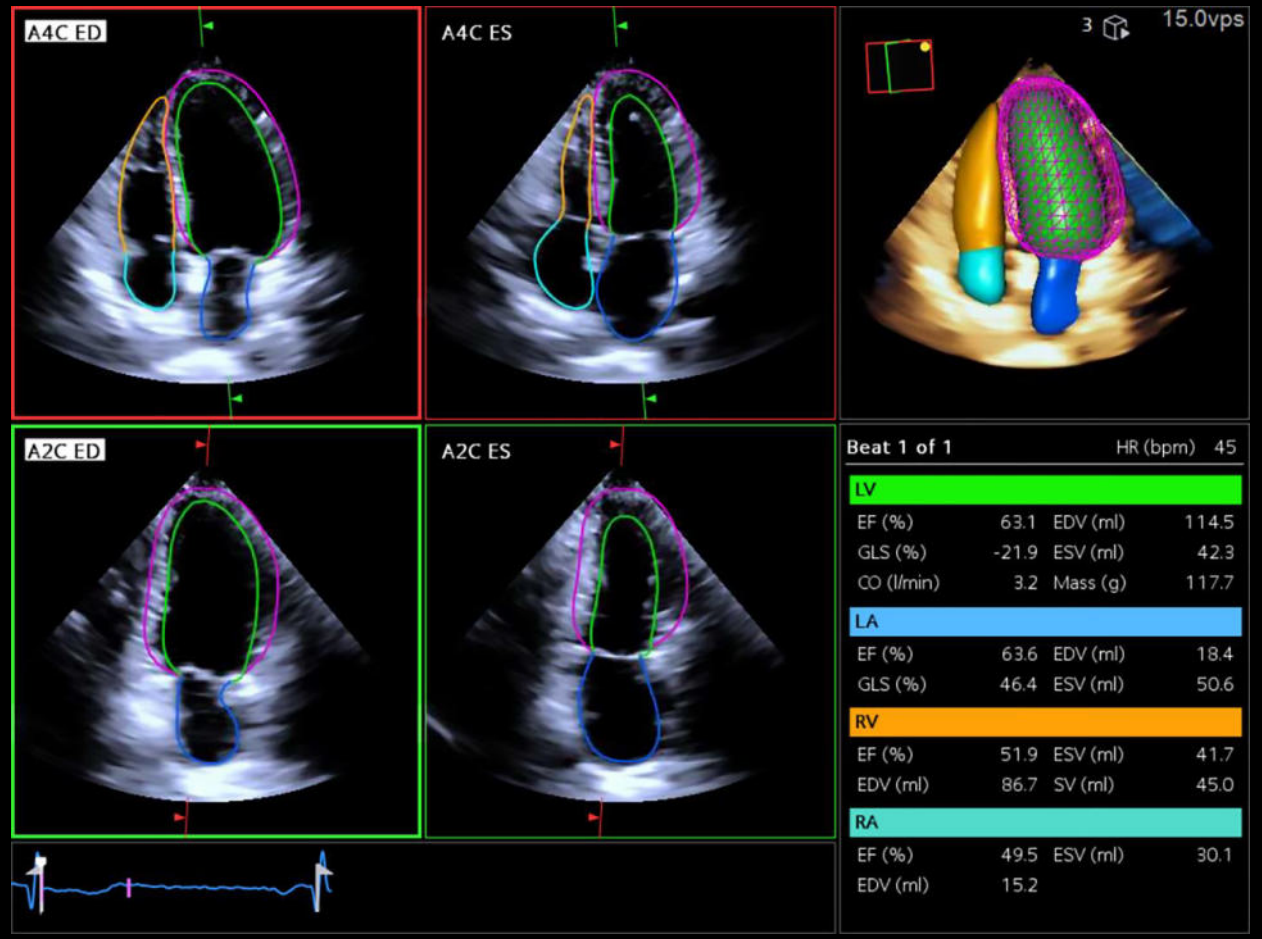


Note: *Bullseye analysis is ONLY available in Review workflow.*

Launching 4D Heart^{AI} from review

- From Review, select one 4D dataset
- Select **4D Heart^{AI}** on touch screen
- Visible cardiac chambers are analyzed
  - All four chambers in transthoracic 4D imaging
  - Left and right ventricles in transesophageal 4D imaging

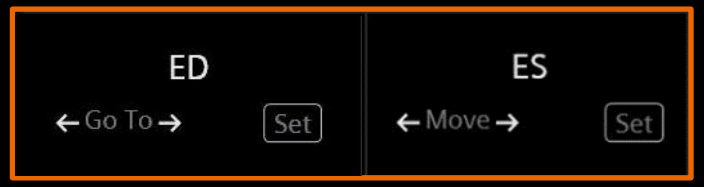




Non-physio workflow example

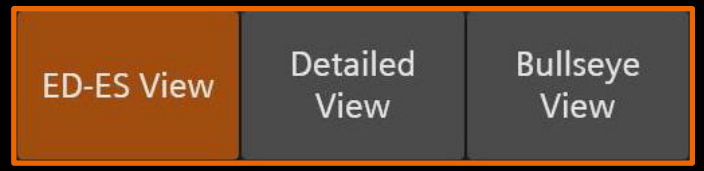
Ability to launch application without physio

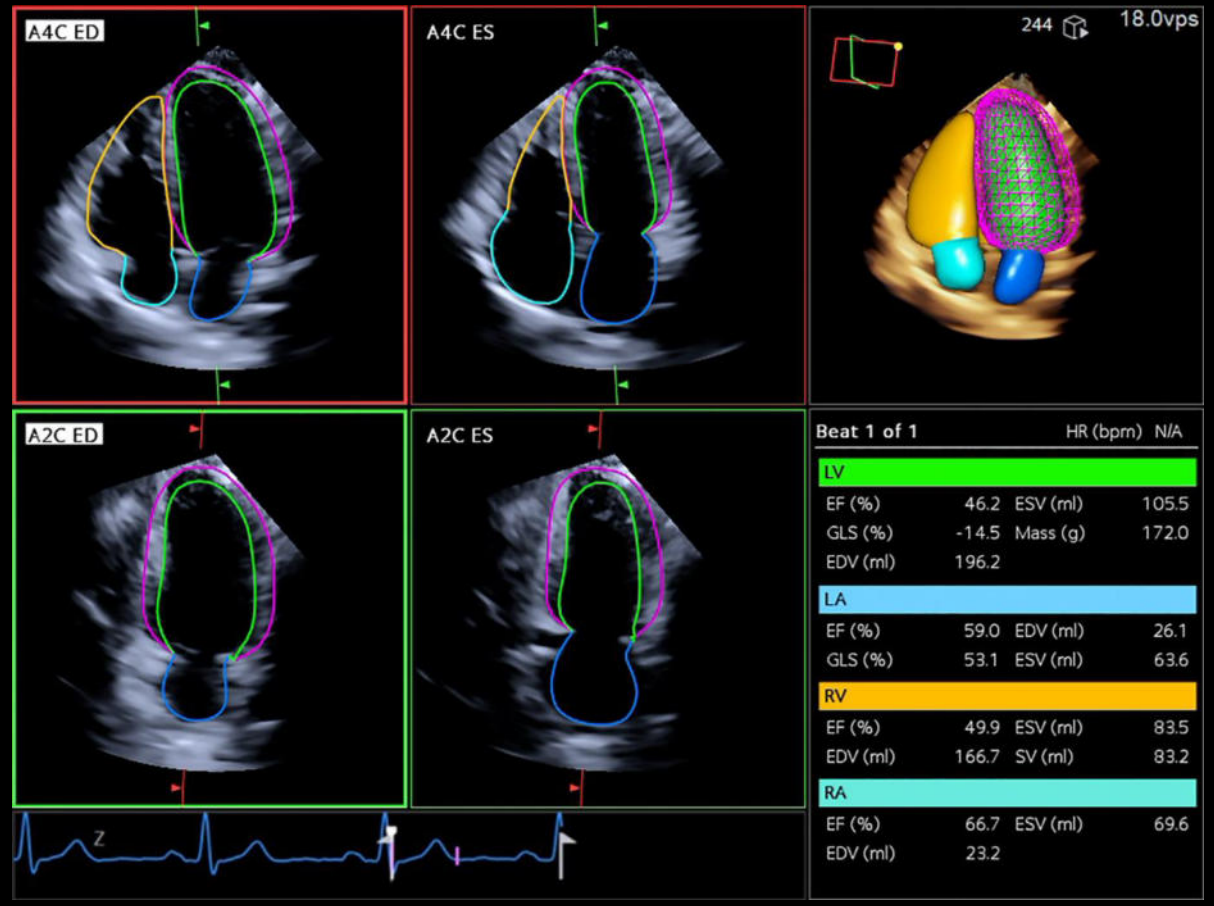
- Use soft key to define key frames (ED & ES) and tap **Analyze** to proceed with analysis
- Only 1 cardiac cycle is analyzed with non-physio workflow
- Controls for Beat Analyzed, Exclude Beat and Average Result will not be available



Analysis display (ED-ES View)

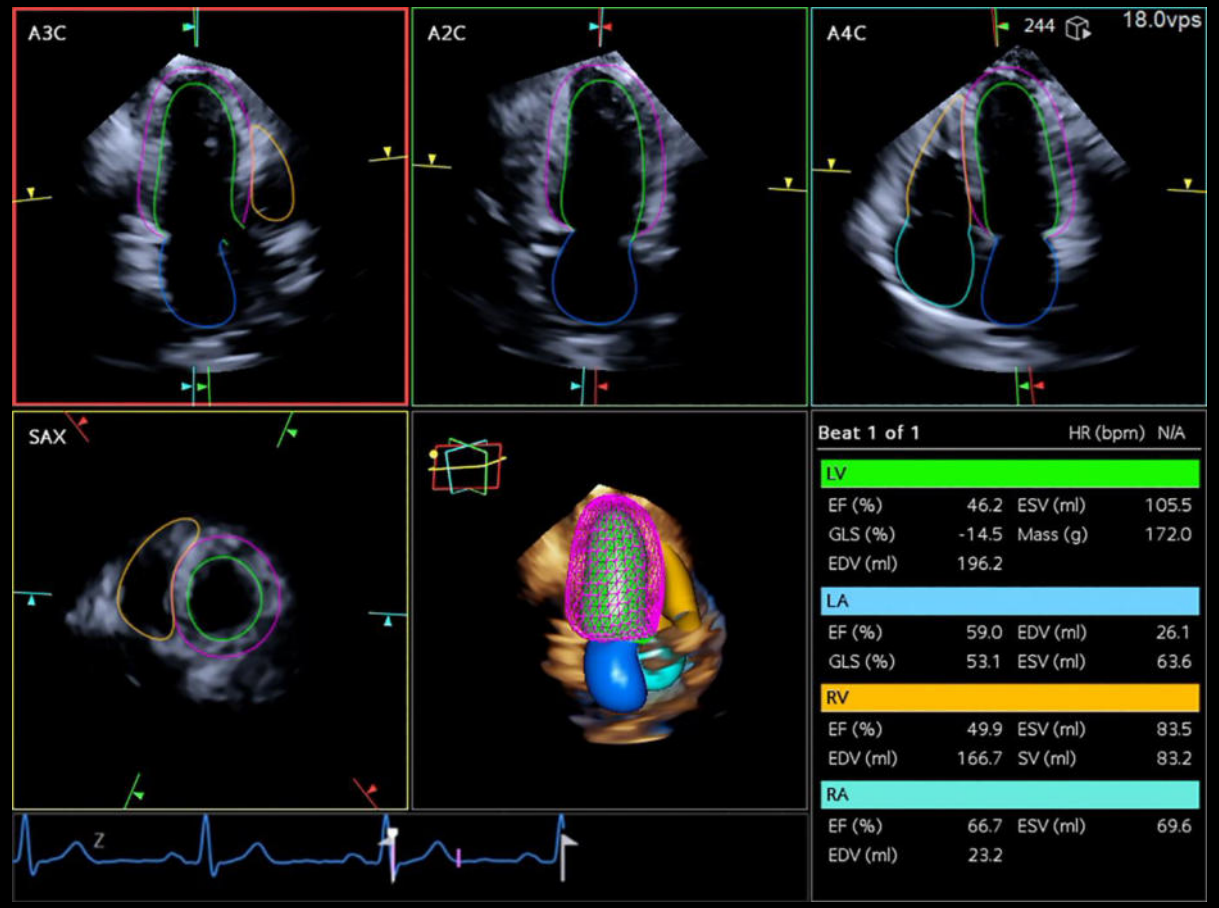
- Contours display on key frames ED & ES:
  - Apical 4
  - Apical 2 or PSAX or Coronal
- Viewports include
  - ED Viewport
  - ES Viewport
  - Volume render with contours
  - Results Table
- Freeze button is disabled; use Cine soft key to scroll between frames or beats





Analysis display (Detailed View)

- Provides multiple views for one frame, to give better representation of the contours
- Layout can differ depending on chamber(s) selected for display
  - LV: Apical 3, Apical 2, Apical 4 and SAX
  - LA: Apical 3, Apical 2, Apical 4 and SAX
  - RV: Apical 4, Coronal, SAX
  - RA: Apical 4, RH A2, SAX
- Freeze button is available and users can play image or use Cine soft key to scroll between frames or beats

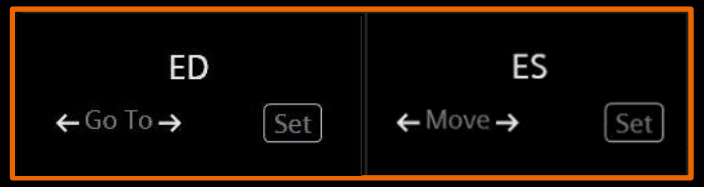


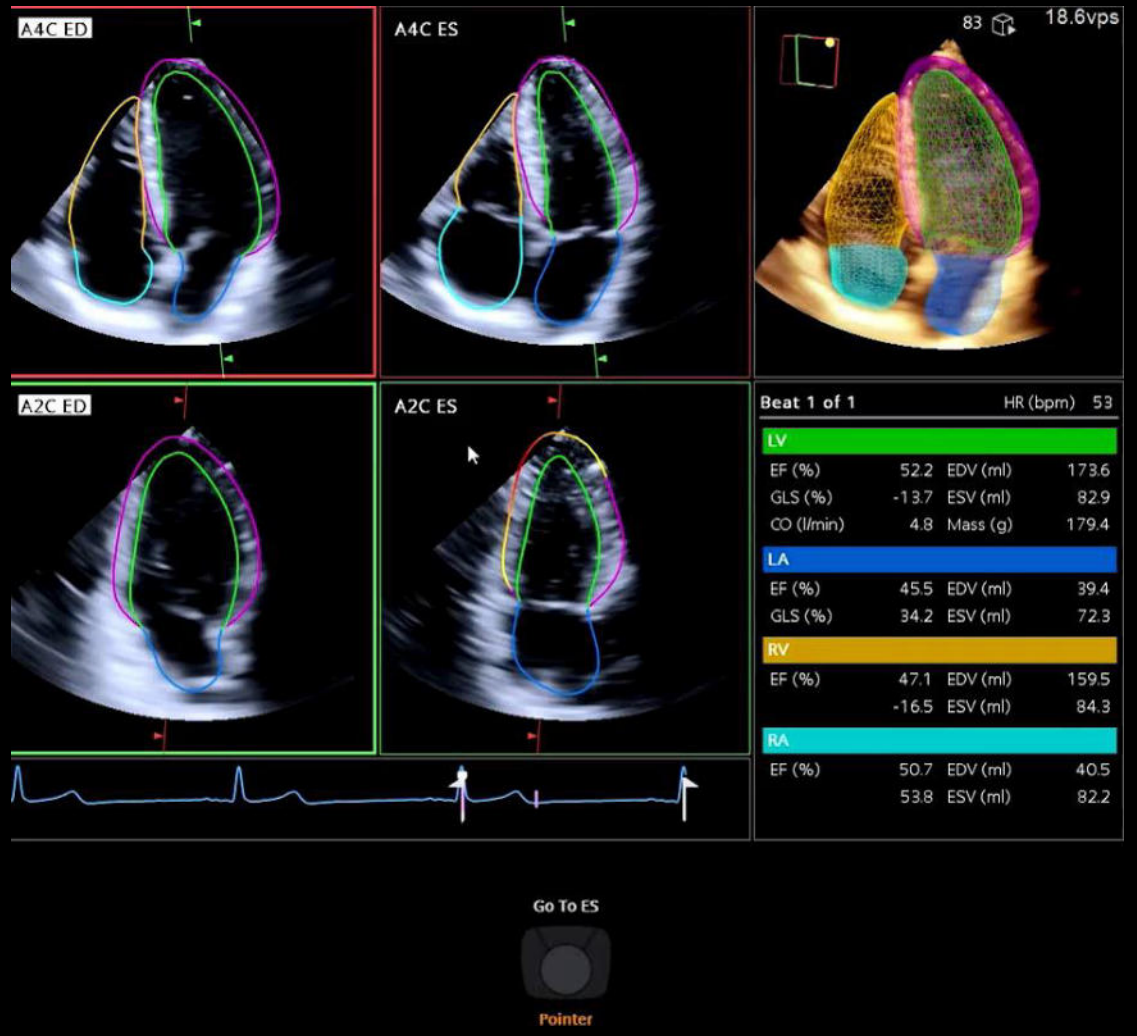
Changing end diastole (ED) and end systole (ES) frames

ED and ES frames are depicted as purple markers on physio line as well as label on viewports

Move ED or ES frames with soft keys (per heart beat analyzed)

- Rotate ED soft key – press to set
- Rotate ES soft key – press to set

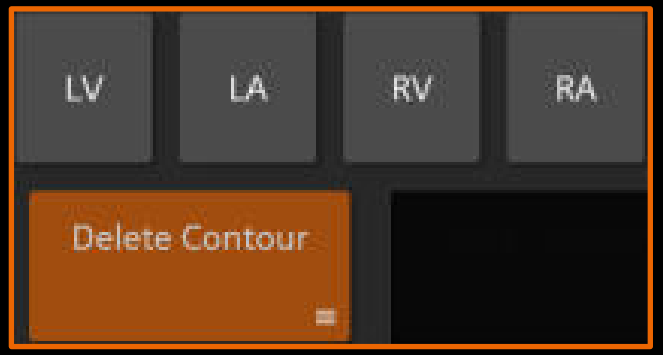




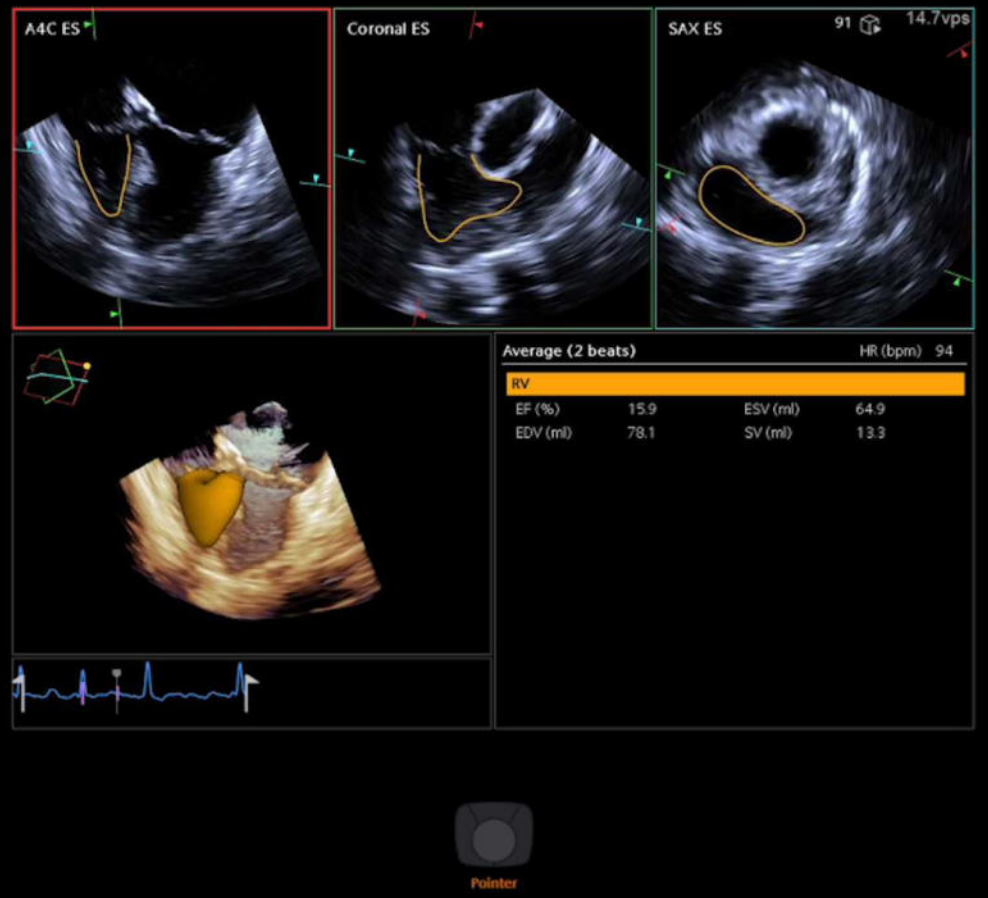
Deleting contour

Ability to delete any chamber on ED or ES key frames

- If performed during ED-ES View, users are automatically taken to Detailed View and prompted to place manual points
- Deletion occurs for the active key frame
- Deleting a contour removes analysis from results table



RV example



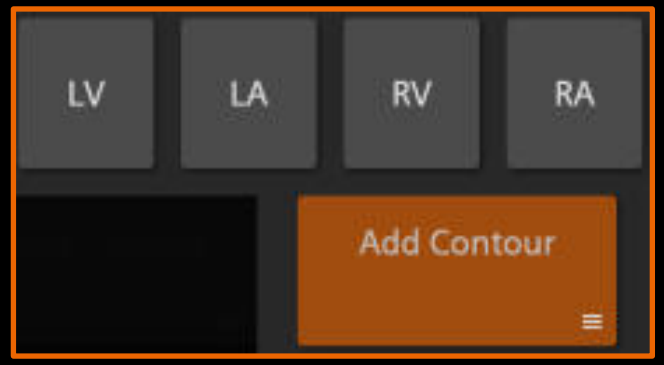
Adding contour

- Available when a chamber contour is missing on ED and/or ES key frame (due to deletion or detection failure)
- Once launched, viewport will change to Detailed View
- On-screen guide at bottom left of monitor prompts user for point placement
- Workflow consist of semi manual contouring with 3 points for LV, LA, RA, and 6 points for RV
  - LV: Anterior Septal, Posterior, Apex
  - LA: Anterior Septal, Posterior, Roof
  - RA: Anterior Septal, Freewall, Roof
  - RV: Septal, Freewall, Apex in *Apical view* and Posterior, Infundibulum, Lateral in *SAX view*

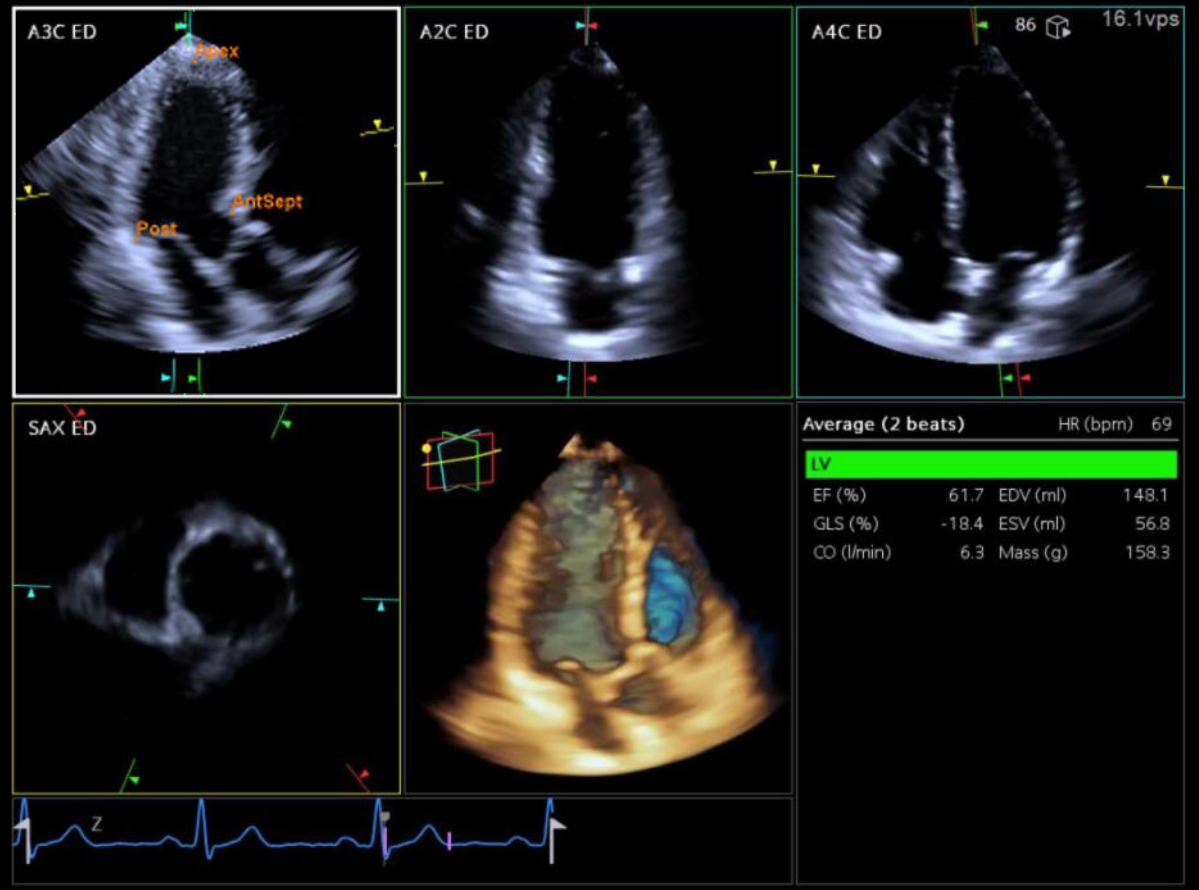
Adding contour – left ventricle (LV)

Views displayed in Detailed View:

- Apical 3
- Apical 2
- Apical 4
- SAX



Place AntSept, Post, Apex points in A3C view



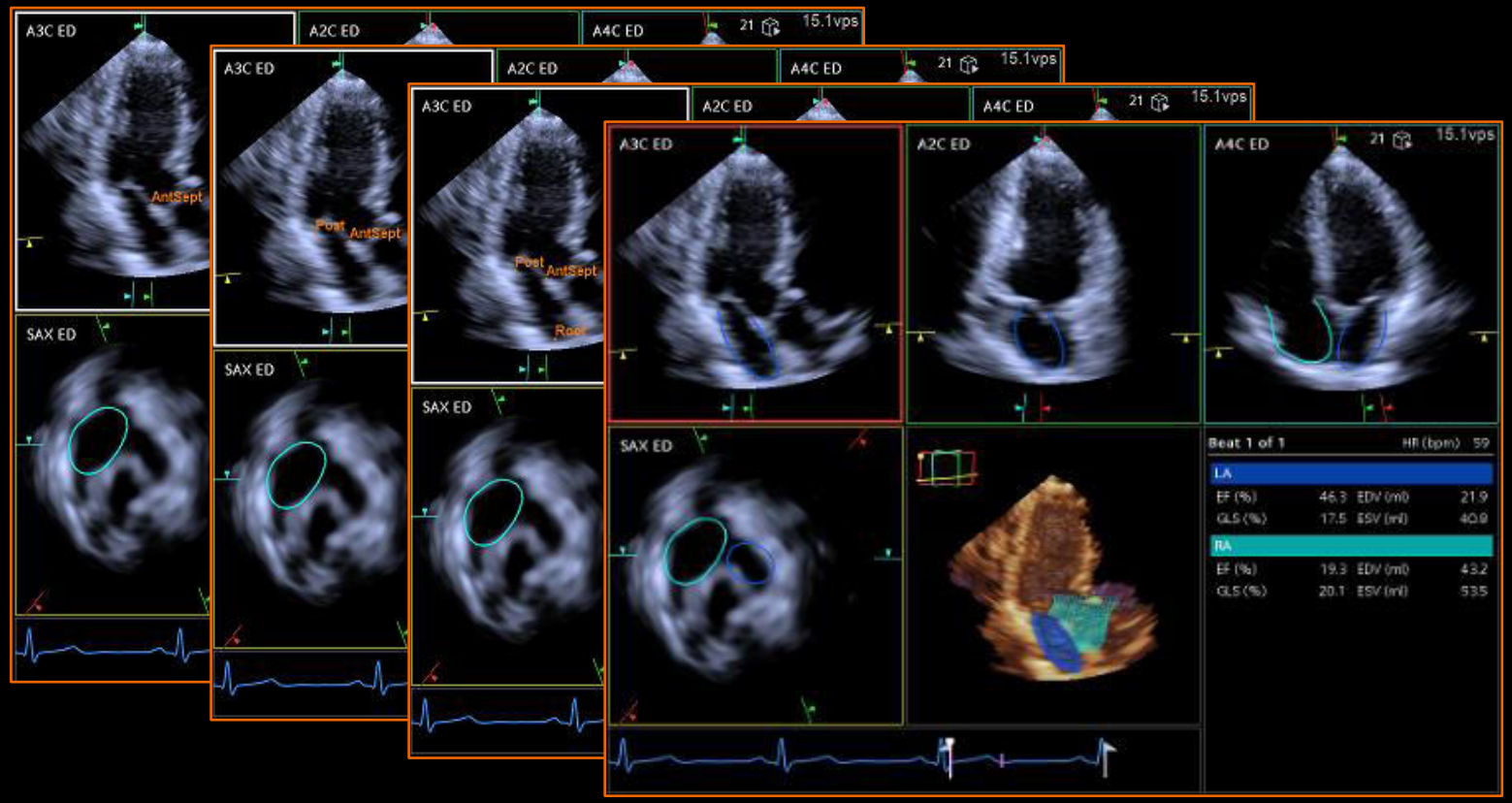
Adding contour – left atrium (LA)

Views displayed in Detailed View:

- Apical 3
- Apical 2
- Apical 4
- SAX

Manual contour points:

- Anterior Septal
- Posterior
- Roof



Place AntSept, Post, Roof points in A3C view

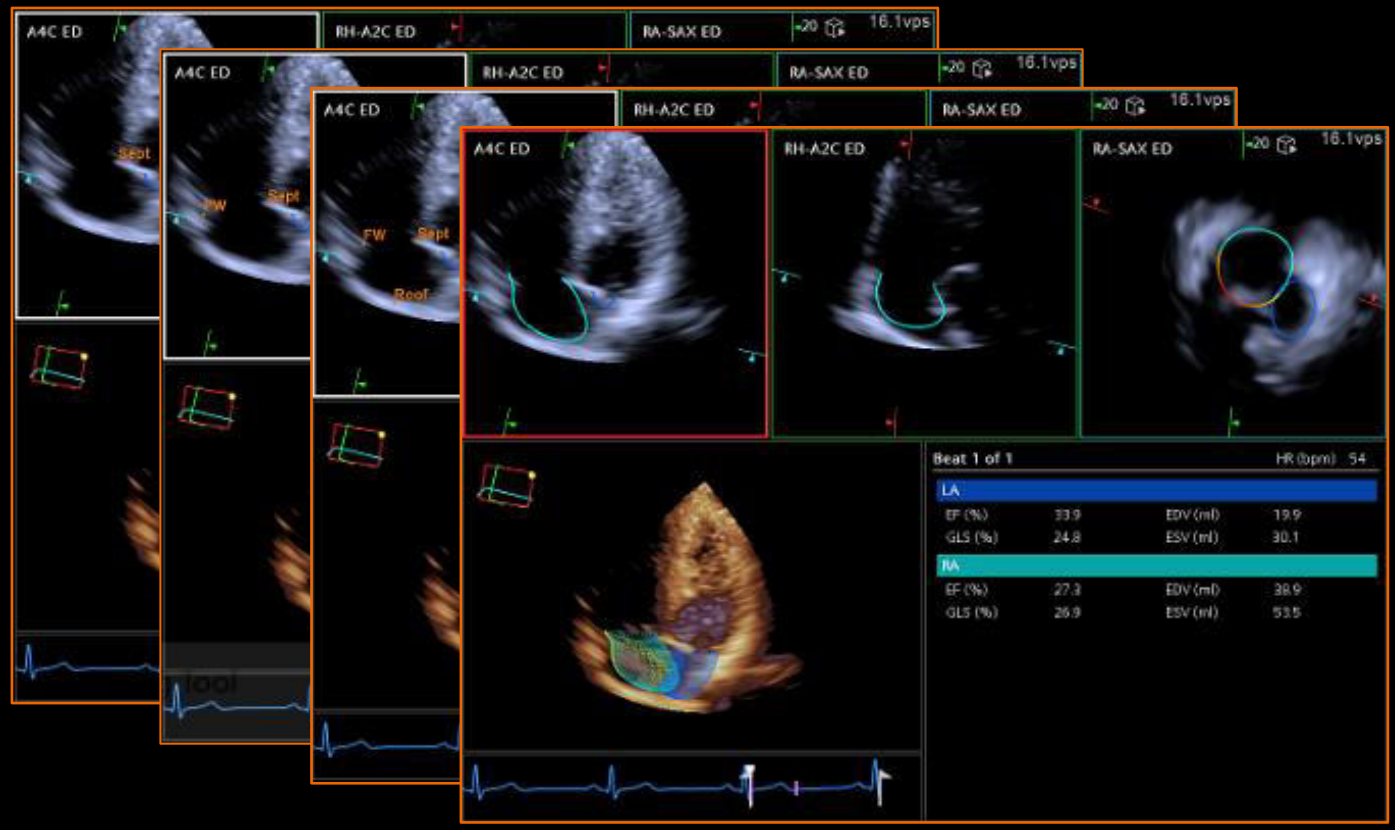
Adding contour – right atrium (RA)

Views displayed in Detailed View:

- Apical 4
- RH Apical 2
- SAX

Manual contour points:

- Septal
- Freewall
- Roof



Place Sept, FW, Roof points in A4C view

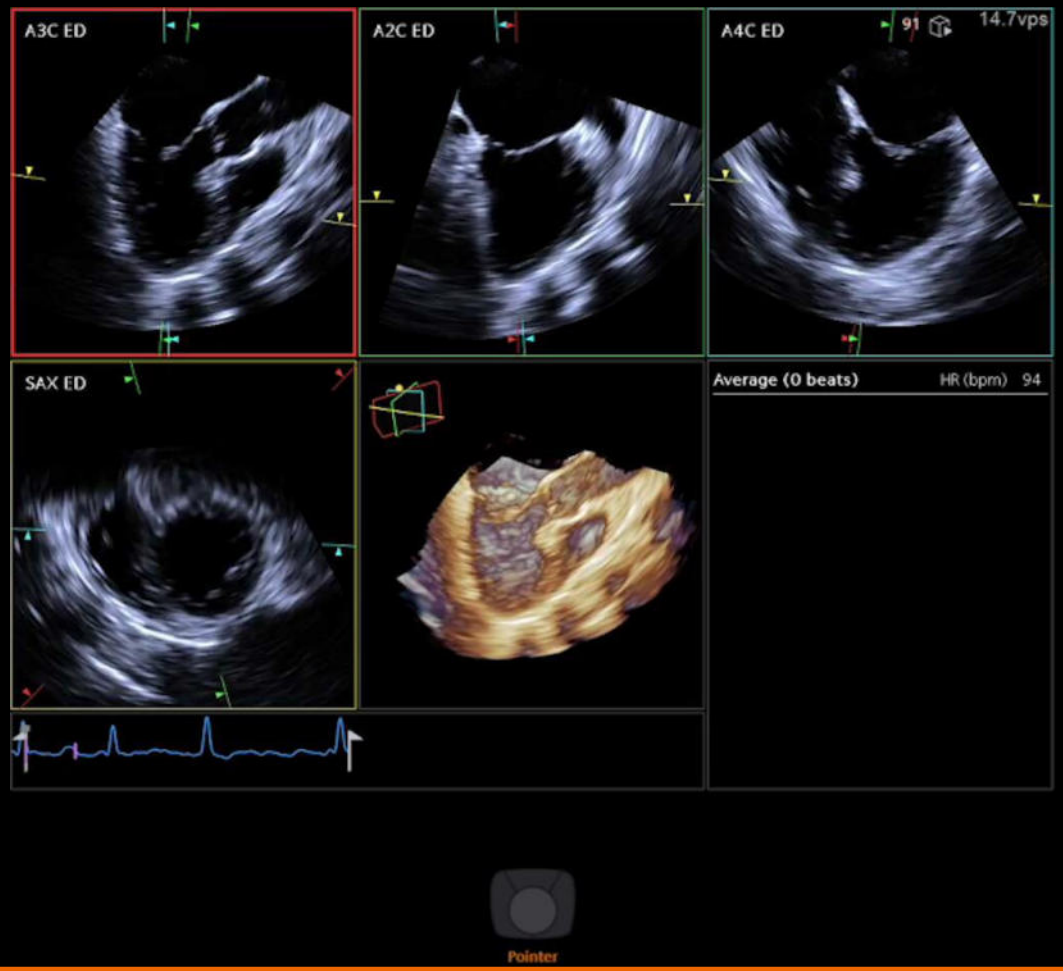
Adding contour – right ventricle (RV)

Views displayed in Detailed View:

- Apical 4
- Coronal
- SAX

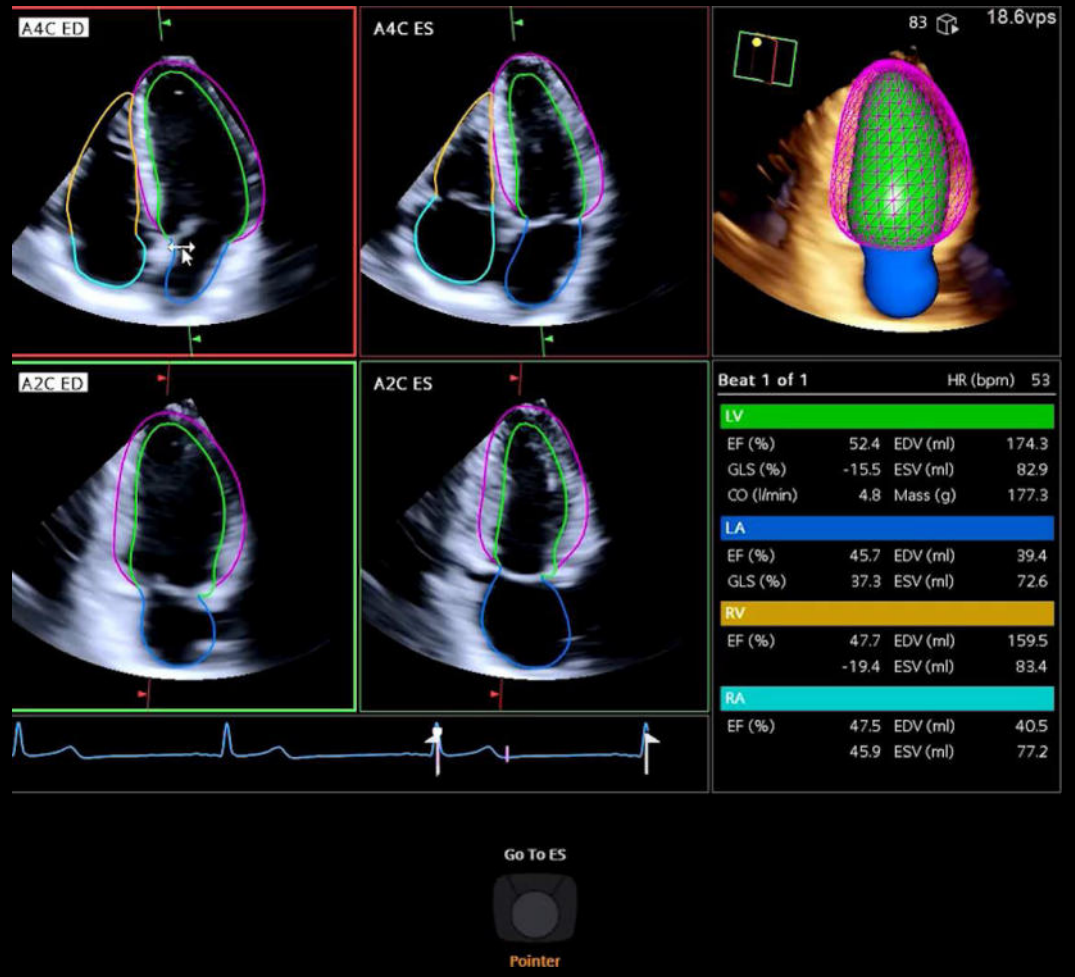
Manual contour points:

- Septal (A4)
- Freewall (A4)
- Apex (A4)
- Posterior (SAX)
- Infundibulum (SAX)
- Lateral (SAX)



Moving MPR axis marker

- Available at 4D Heart^{AI} launch
- Not available in Edit Contour mode
- In ED-ES View, one axis marker is seen for each view
- In Detailed View, axis markers are displayed for each
- Hover, click and move axis marker
  - Pan tool moves axis marker left/right, up/down
  - Z rotation tool allows Z rotation of axis marker

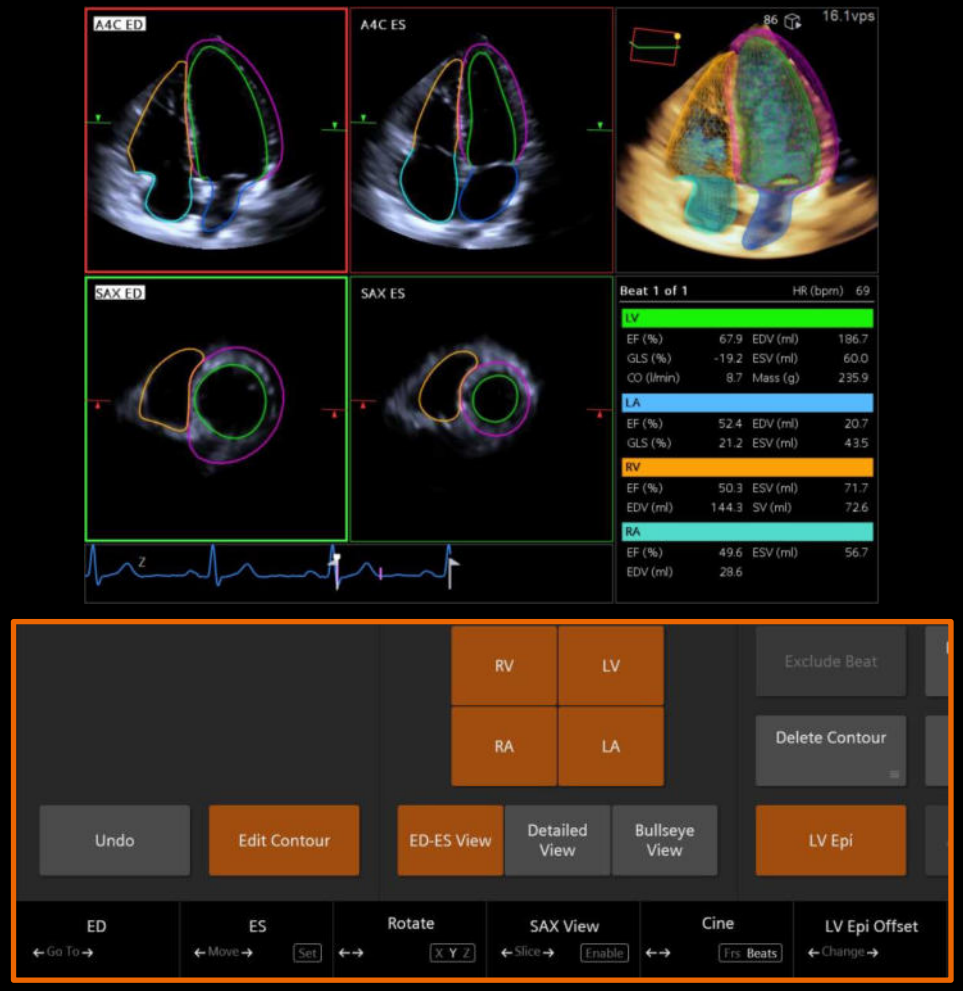


Editing contours

Select **Edit Contour** on touch screen

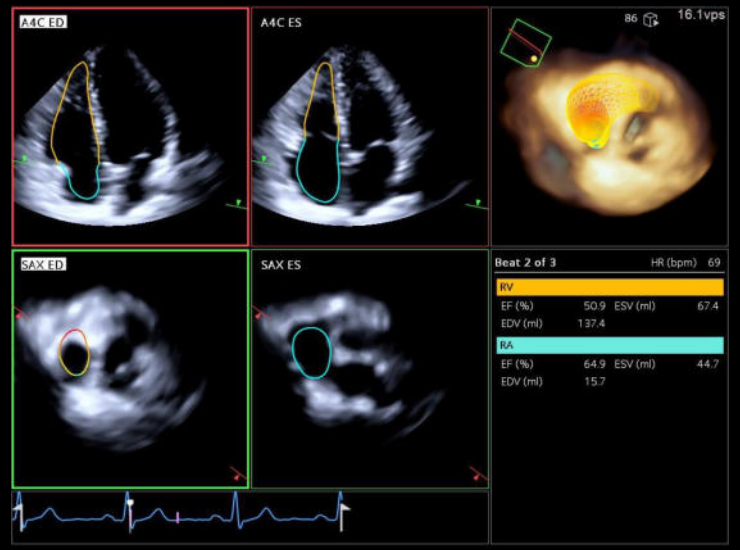
- Model appears as mesh in edit mode
- Perform edits on ED & ES frames only
- Works in both ED-ES View and Detail View
- Move between ED and ES frames for editing
  - Click in ED or ES viewport
  - Select the update key on control panel

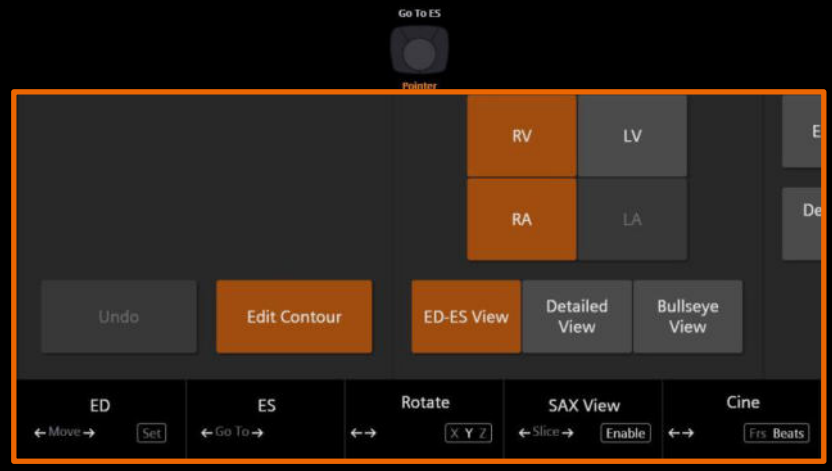
- Selected contour region is highlighted
  - When pointer is closer to contour, a smaller region becomes active
  - When pointer is further from contour, a larger region becomes active



Editing contours – tips and tricks

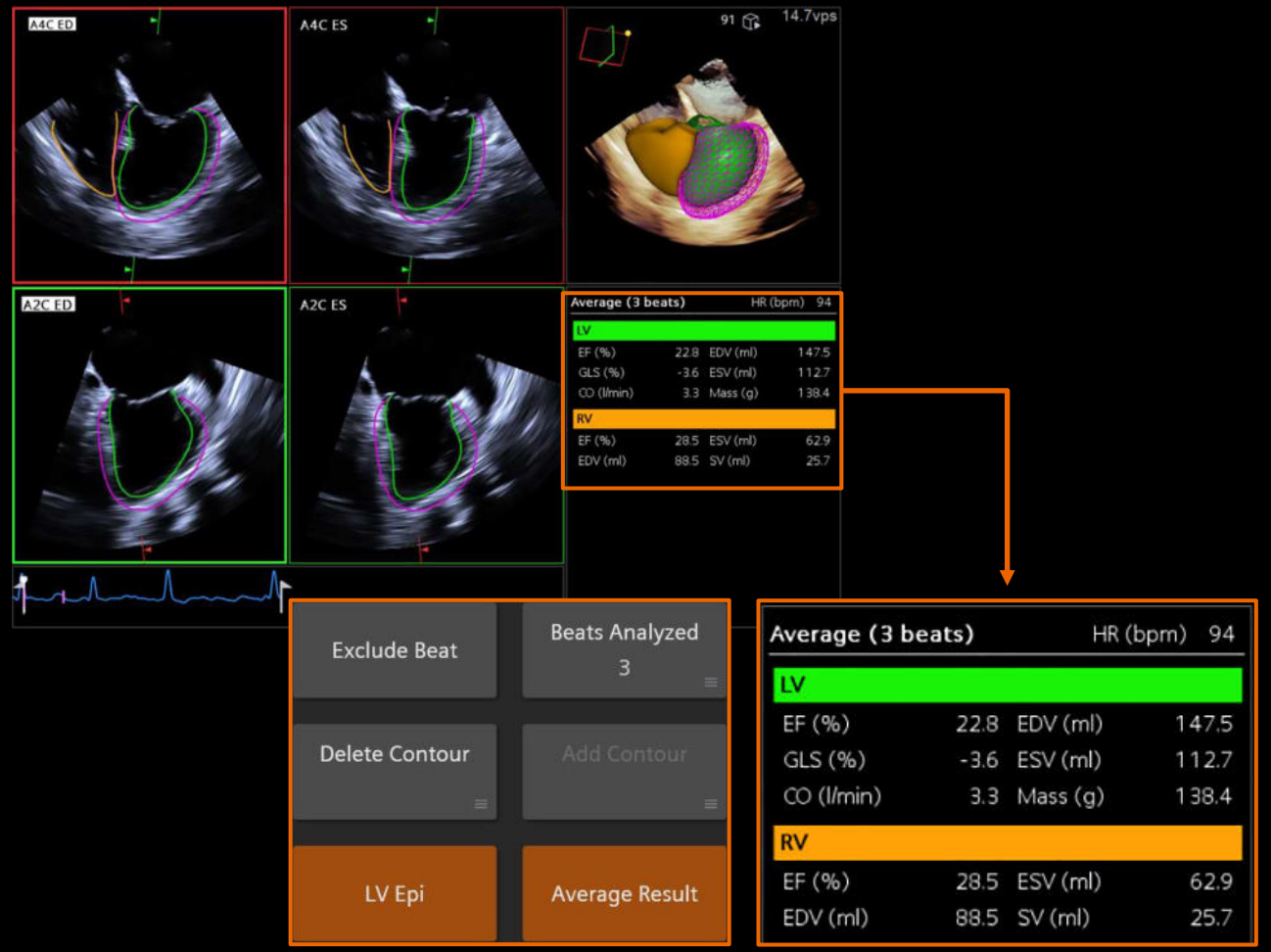
- Select **Edit Contour** on control panel
- To perform edits, enable display for right heart and left heart chambers separately
  - Axis markers auto align to chambers
- If making LV contour edits, disable LV Epi
  - Easier to delineate LV contour
- Enable **SAX View** by pressing soft key
  - Enables slicing up/down through chamber(s) when rotating soft key
- Perform edits in Detail View to see better representation of contours





Beats analyzed

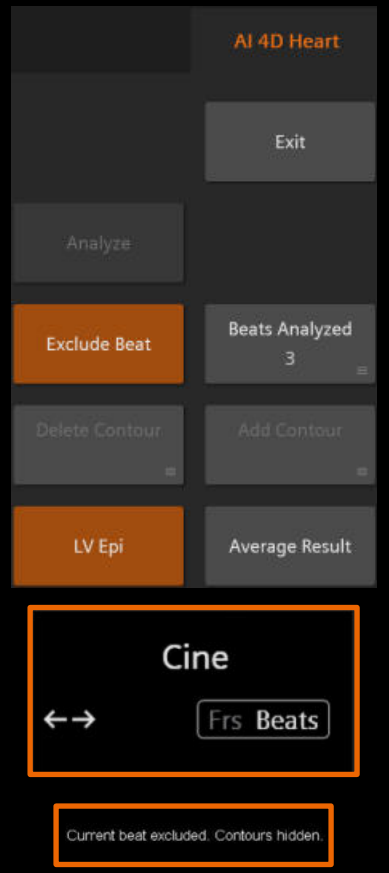
- Ability to change number of beats analyzed
- Supports between 1 to 5 beats
- If more than 1 beat is analyzed, results can be averaged
- Default number of beats analyzed at software launch is dependent on feature configuration
- Increasing number of beats analyzed after software launch results in algorithm re-running

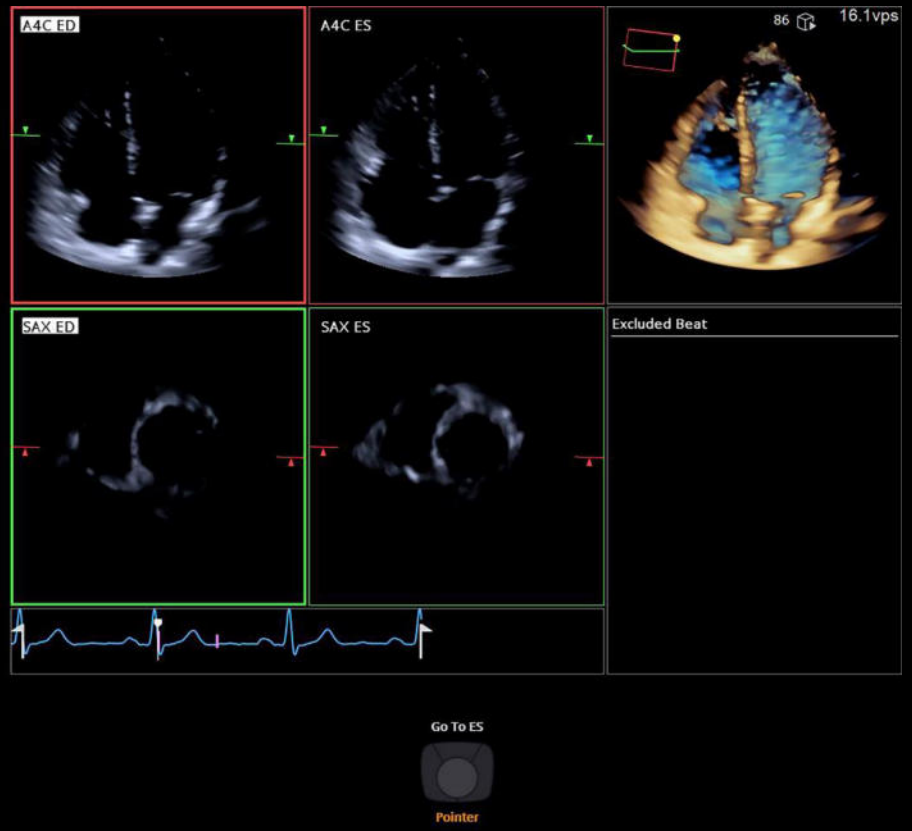


Excluding beat

- Available when number of beats analyzed is more than 1
- Used to remove specific beat(s) results when multiple beats are analyzed
- Hides contours in model for selected beat for exclusion
- Excludes selected beat(s) from results
- On-screen message displays in bottom left hand of monitor

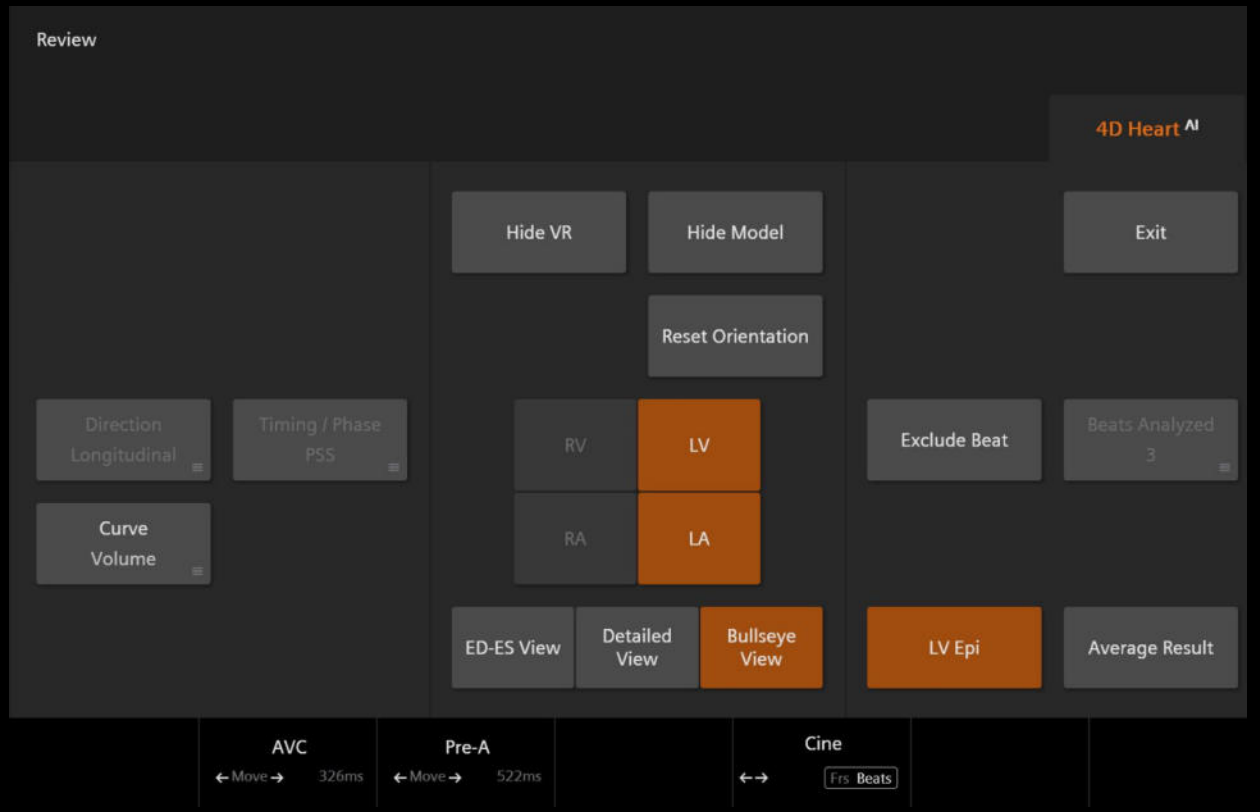
Current beat excluded. Contours hidden.





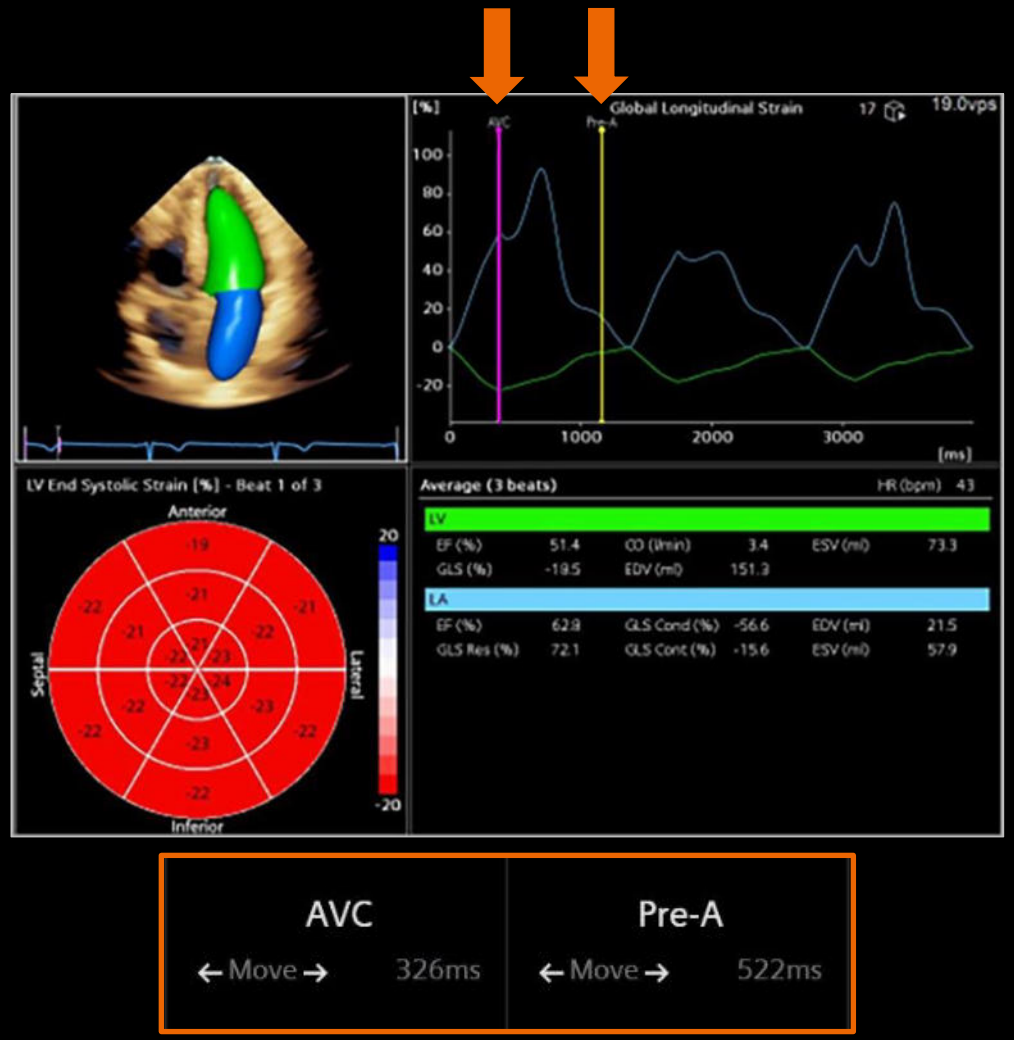
Bullseye View workflow

- Bullseye View option is only available when 4D Heart^{AI} is launched from Review
- Left heart chambers LV & LA have to be selected for display in order to select Bullseye View
- 4D strain tracking is available for LV and LA chambers
- While in 4D Heart^{AI} analysis, select **Bullseye View** on the touch screen



4D strain cardiac timing

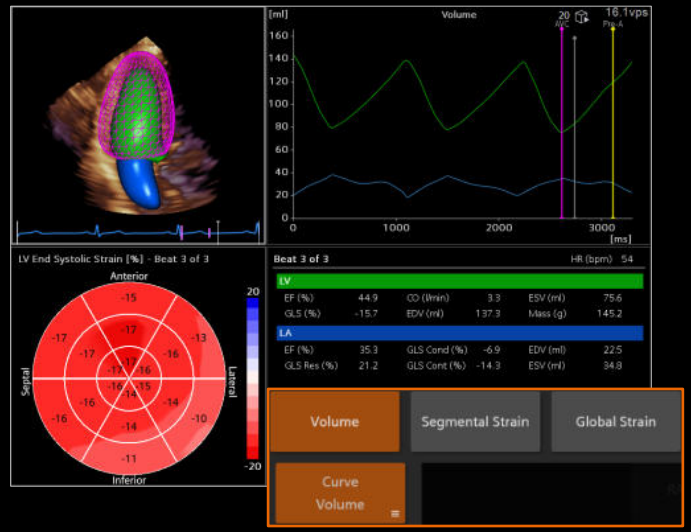
- Flexibility to adjust cardiac timing
- Rotate soft keys to adjust
  - **AVC** (aortic valve closure)
  - **Pre-A** (just before mitral valve opening as a result of atrial contraction)

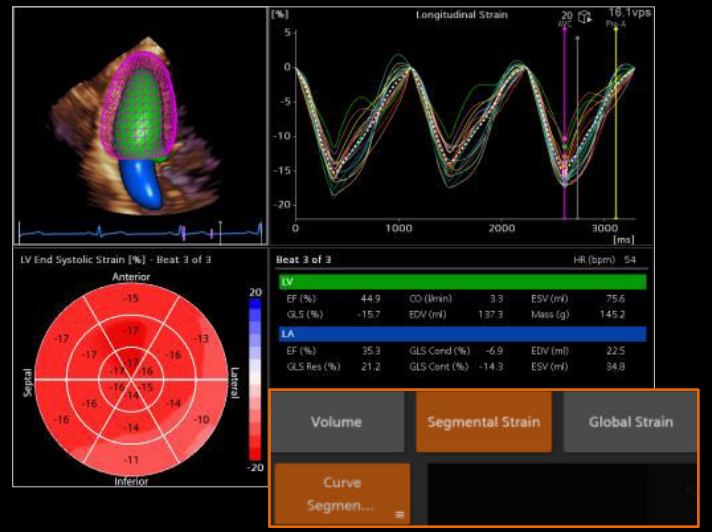


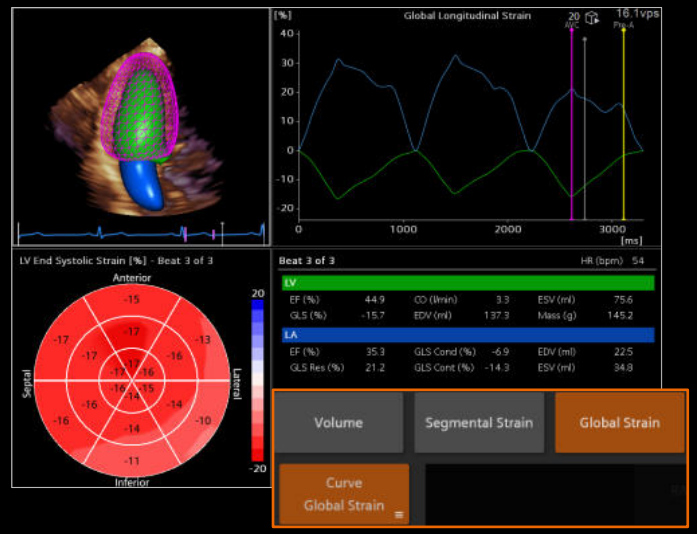
Note: *AVC and Pre-A soft keys are available for timing adjustment when the display is frozen.*

4D strain curve display options

- Left ventricle (LV)
  - Volume
  - Segmental Strain
  - Global Strain
- Left atrium (LA)
  - Volume
  - Global Strain



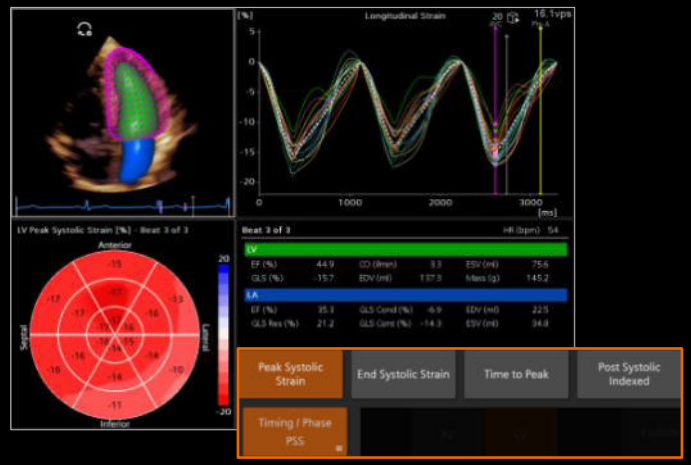


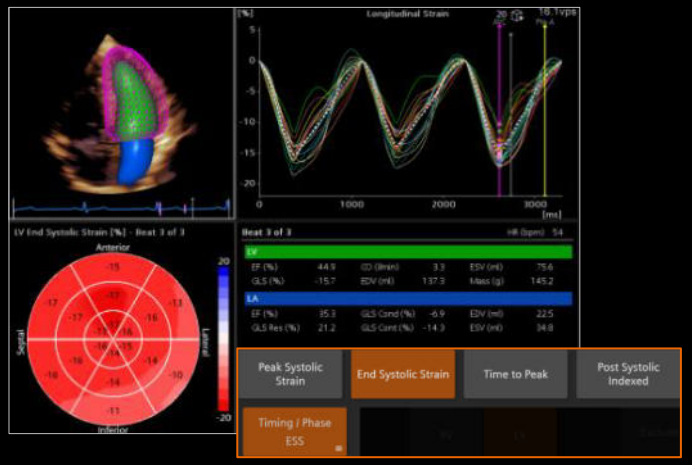


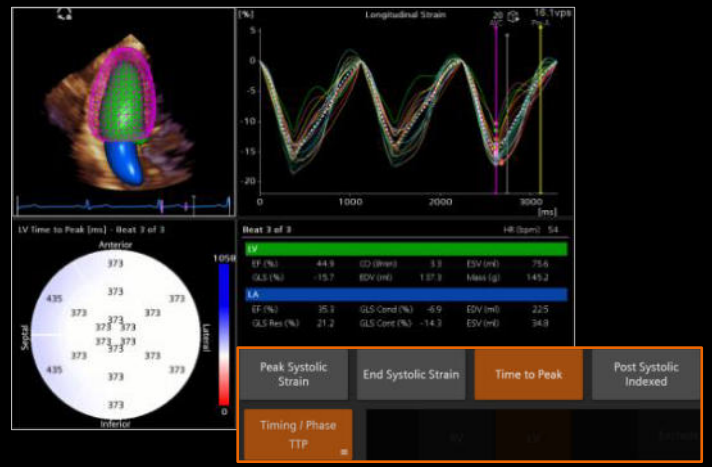
4D strain timing display options

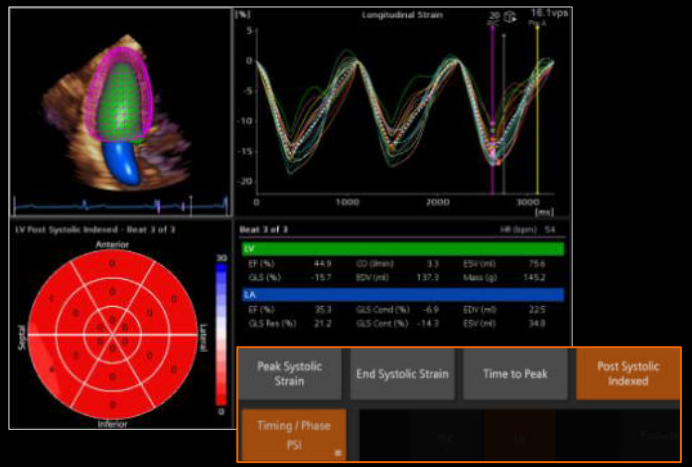
4D strain timing options for the left ventricle (LV) are only available with Segmental Strain curve display

- Peak Systolic Strain
- End Systolic Strain
- Time to Peak
- Post Systolic Indexed





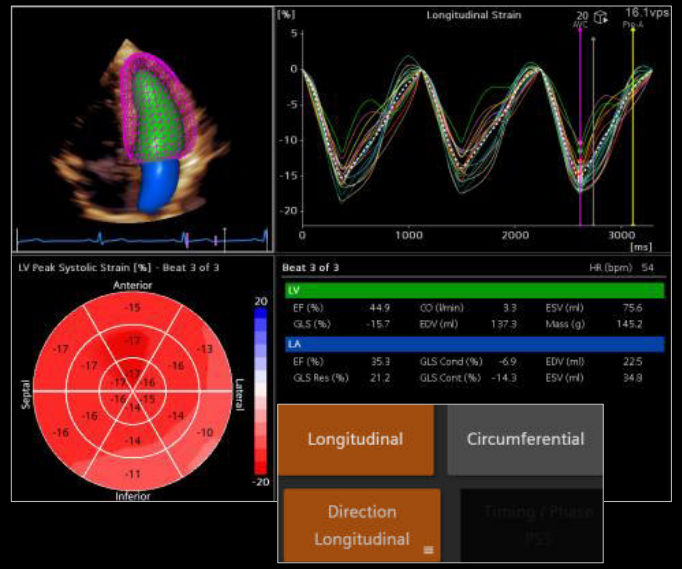


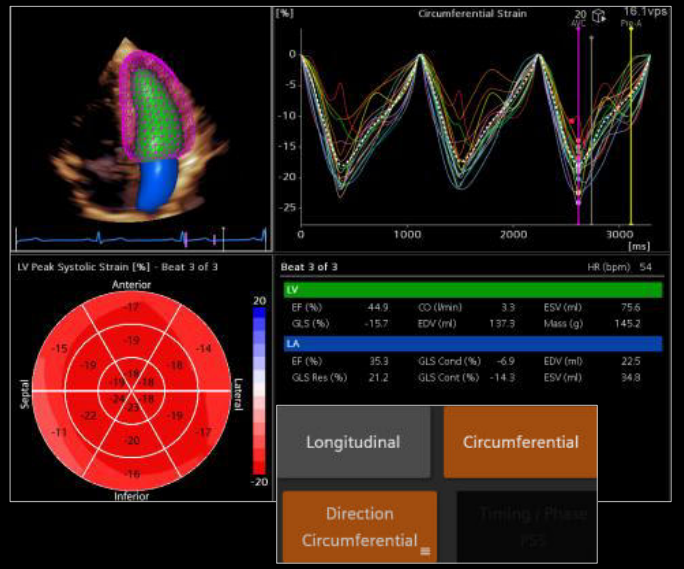


4D strain direction display options

4D strain direction options for the left ventricle (LV) are only available with Segmental Strain curve display

- Longitudinal
- Circumferential

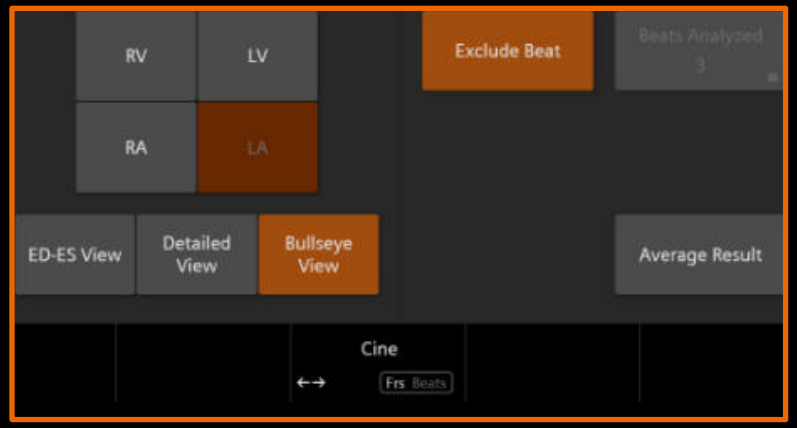


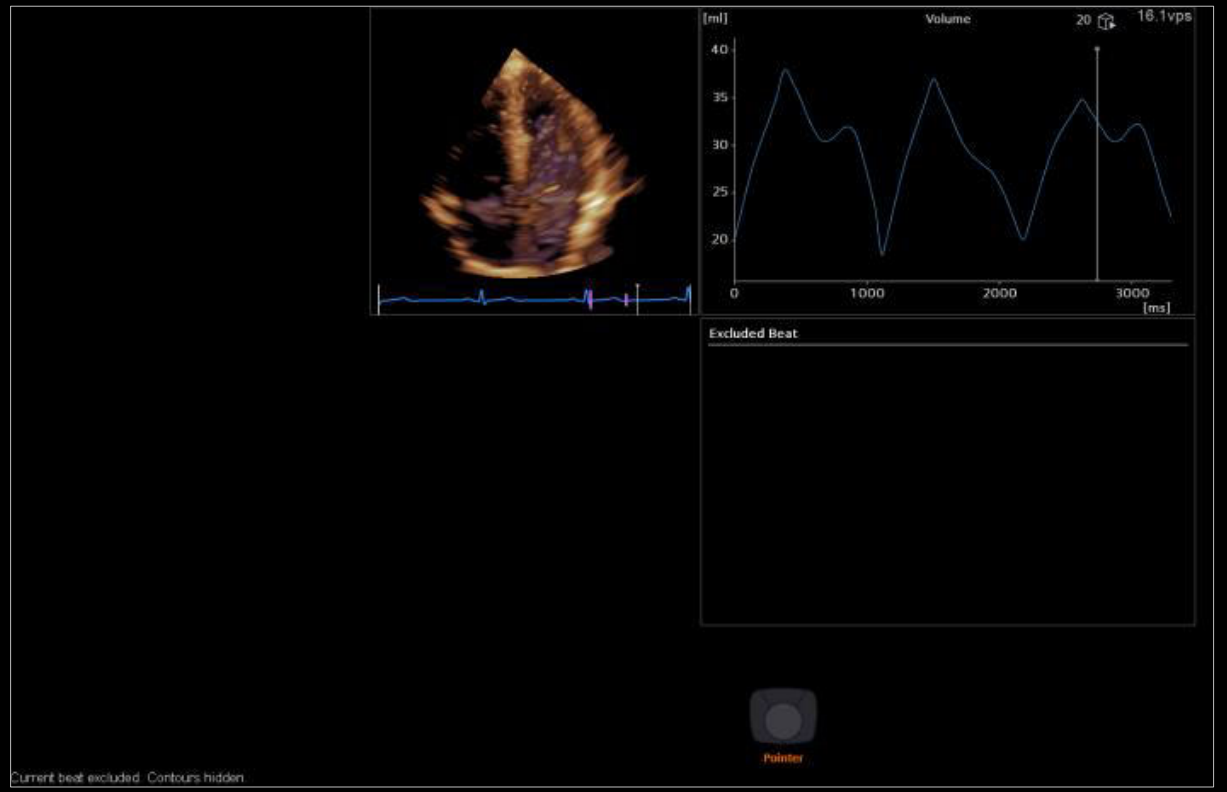


4D strain: Bullseye View Exclude Beat

- Used to remove specific beat(s) 4D strain results when multiple beats are analyzed
- Available when number of beats analyzed is more than 1
- Hides contours in model for the excluded beat
- Excludes selected beat(s) from results
- On-screen message displays in bottom left hand of monitor

  Current beat excluded. Contours hidden.

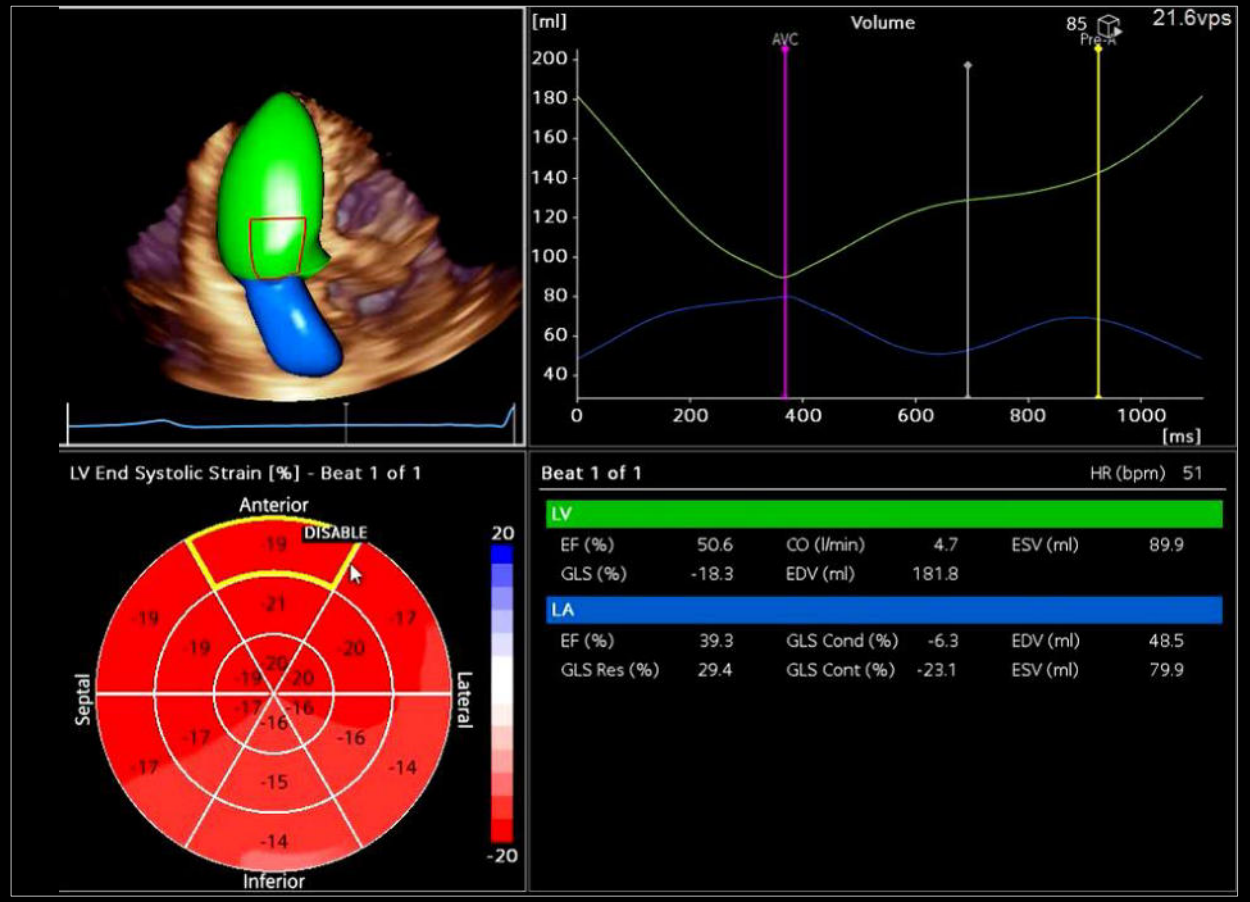




Bullseye View interactions

Users can use the pointer to interact with bullseye segments and curves

- Highlighting a segment on bullseye will highlight corresponding segment on model
  - Segment(s) can be enabled or disabled by clicking in bullseye
  - If segmental strain is active, disabling a segment removes corresponding curve
- Hovering over a point on the curve displays the value at that location



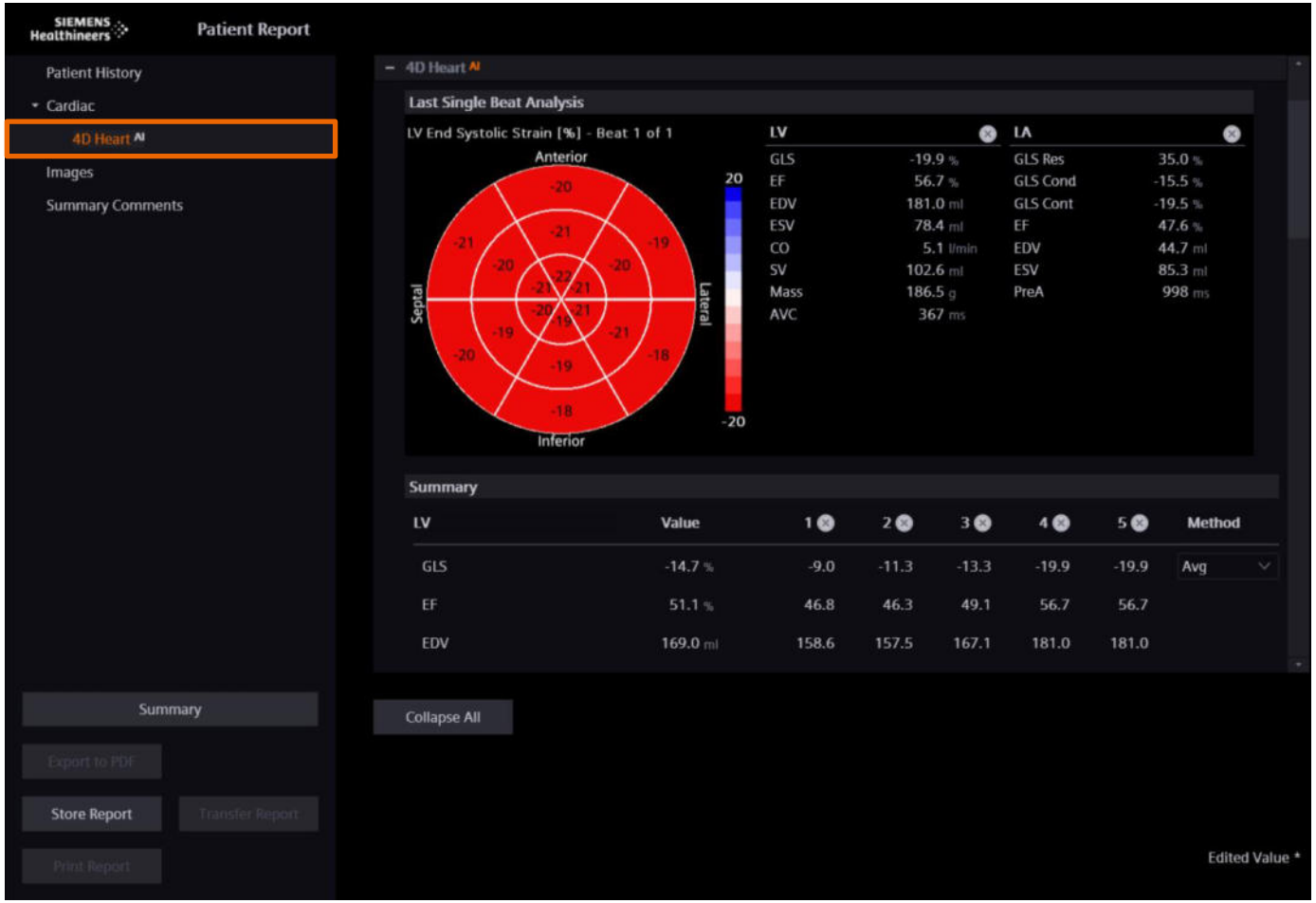
Objectives

- Overview of 4D Heart^{AI} application
- Review 4D Heart^{AI} configuration and touch screen layout
- Illustrate imaging for 4D Heart^{AI}
- Review 4D Heart^{AI} workflow
- **Evaluate 4D Heart^{AI} analysis and report**

Accessing 4D Heart^{AI} report worksheet

To access the 4D Heart^{AI} report worksheet:

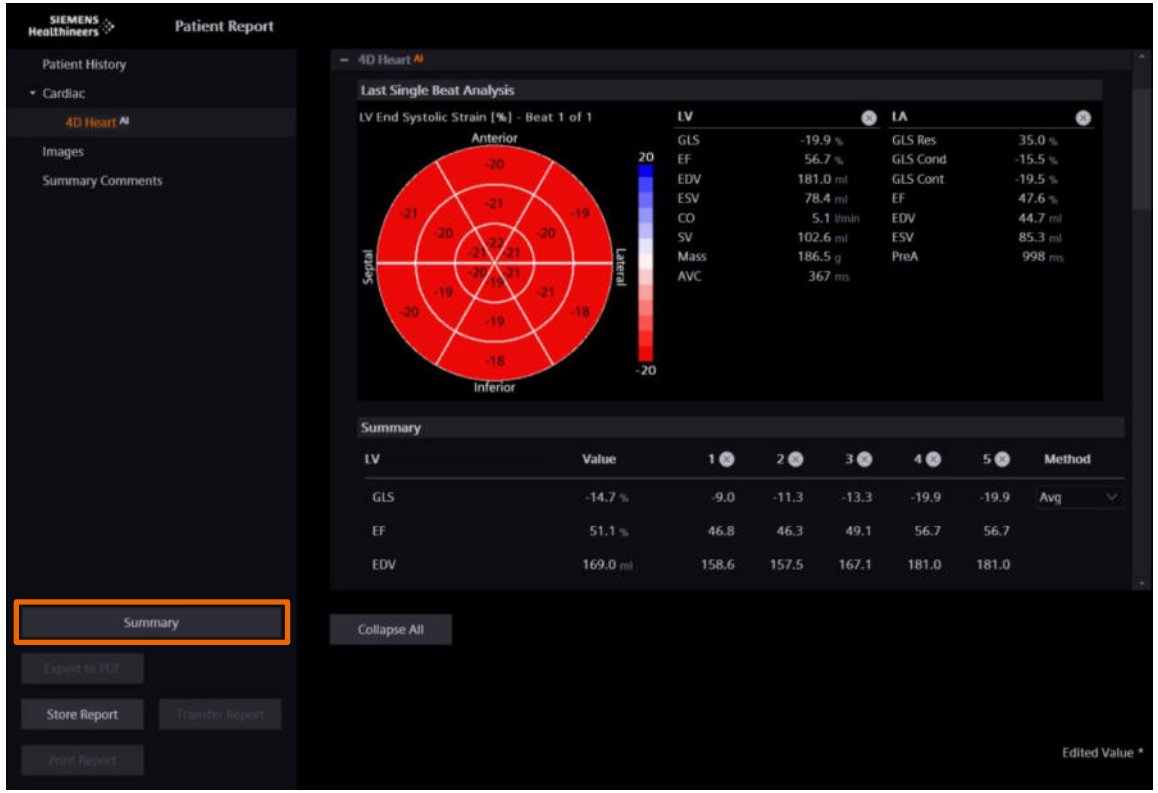
- Select **Report** on the touch screen
- Select **4D Heart^{AI}** on left-hand side of report

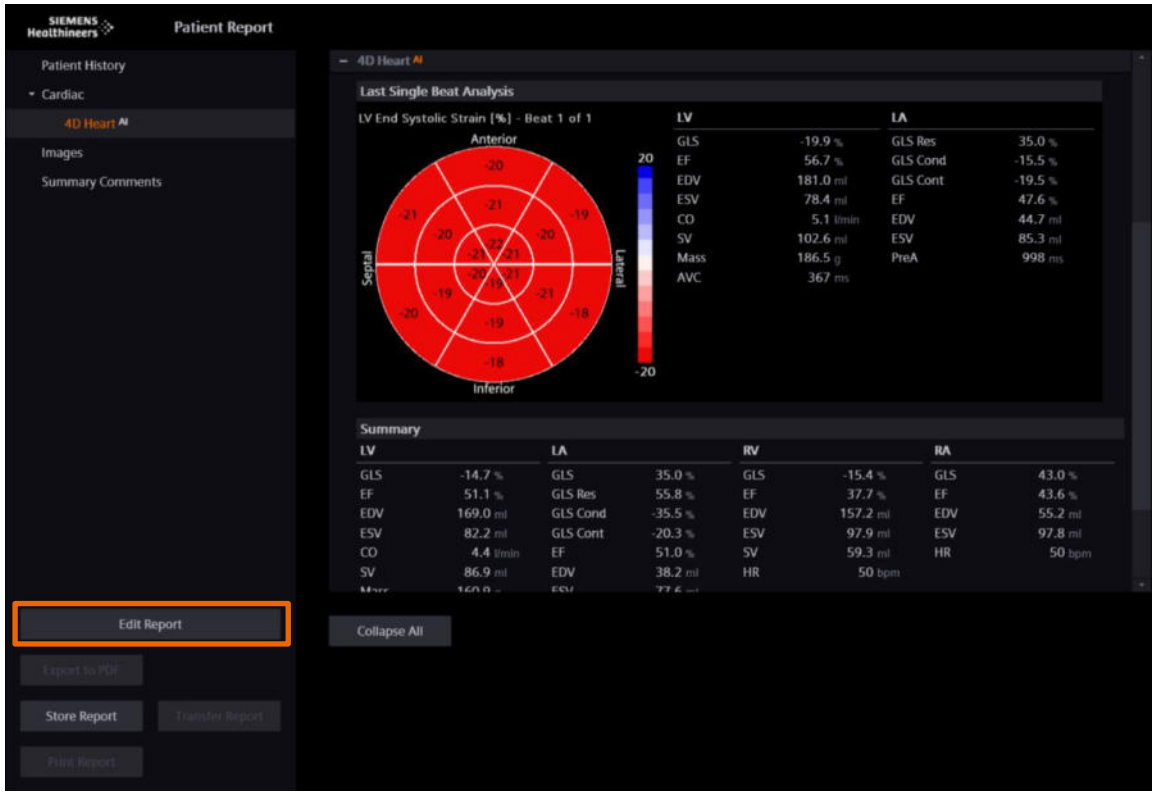


Note: *Entering the report prompts user to exit the 4D Heart^{AI} application.*

Edit Report | Summary

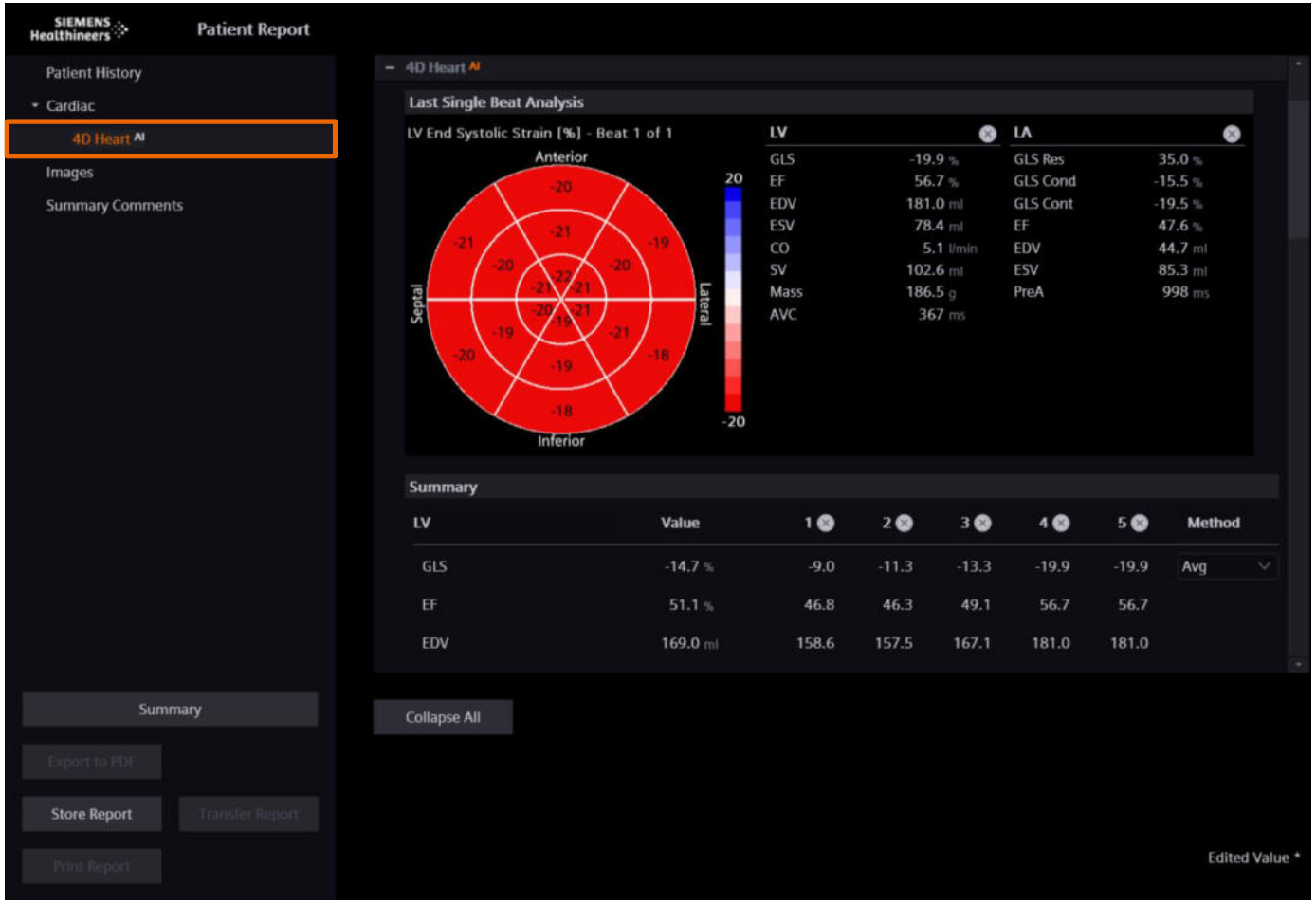
- Worksheet opens at default for edits
- Selecting **Summary** toggles from edit report to report summary





4D Heart^{AI} edit report layout - bullseye

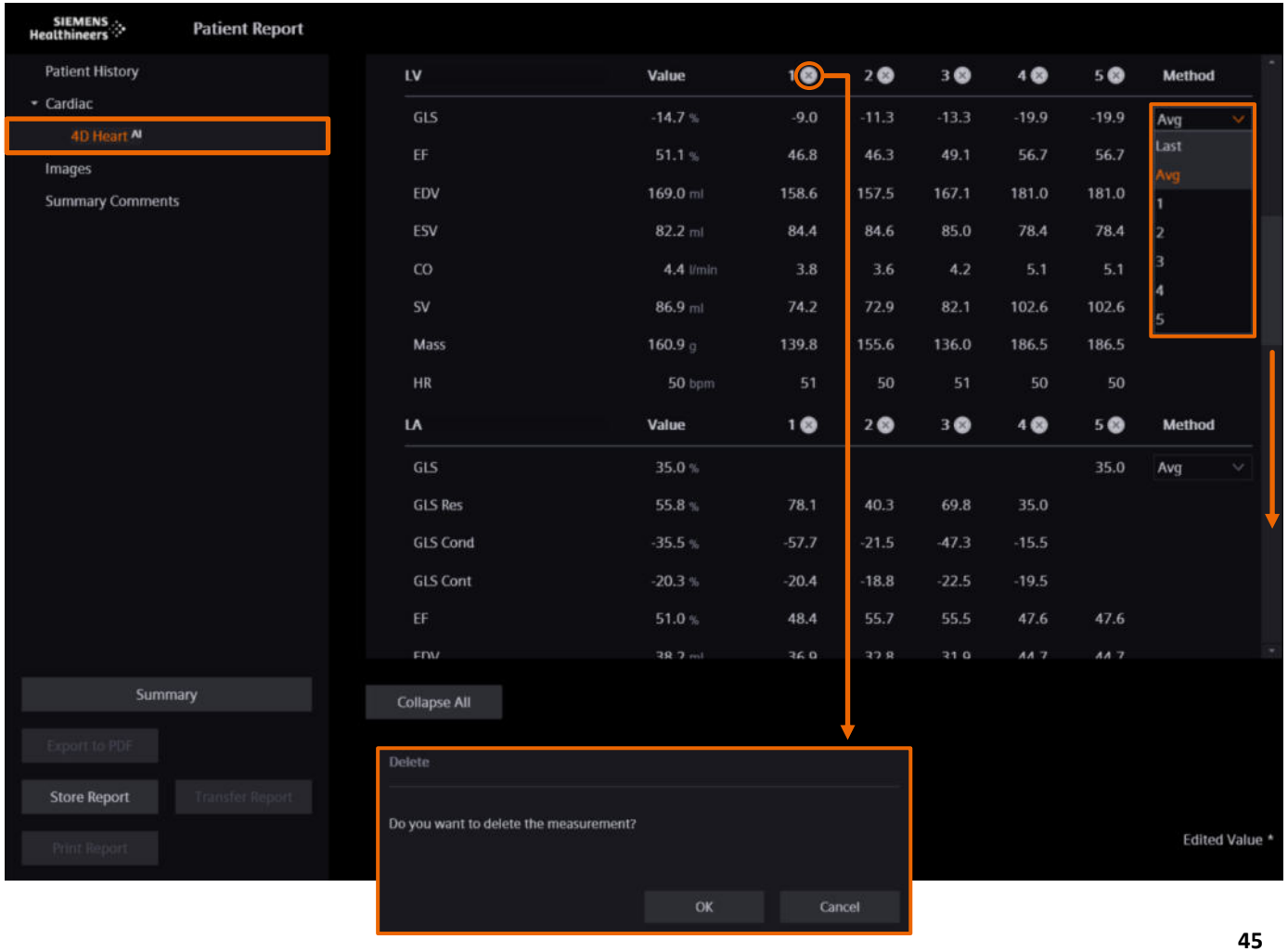
- The last bullseye captured is displayed in the report
- Bullseye displays the Timing / Phase value selected in system configuration or during the exam from the touch screen
- Segments cannot be removed from the bullseye in the report
- 4D strain and quantification of left heart chambers are listed
- Bullseye results cannot be edited; can only delete per chamber by selecting **X**



4D Heart^{AI} edit report layout - worksheet

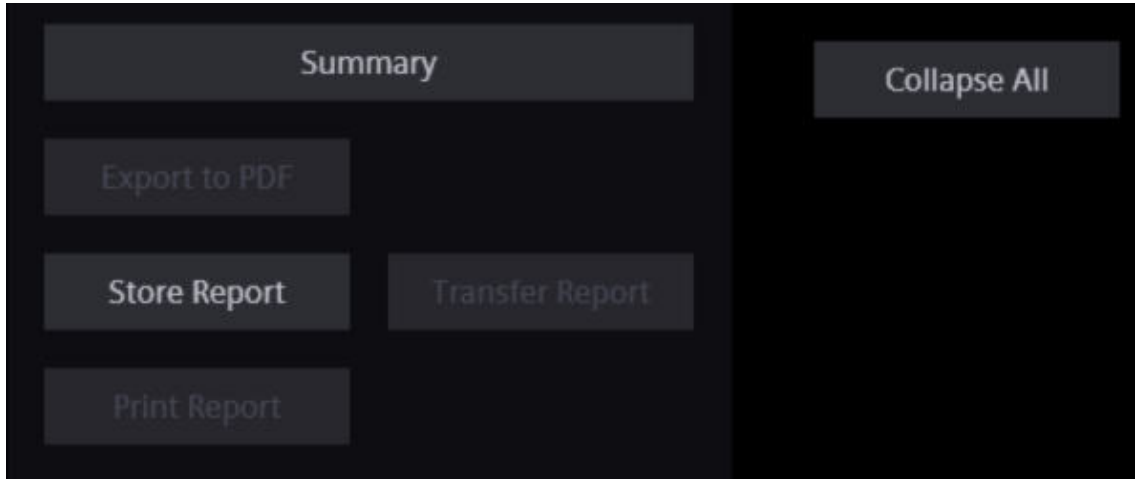
Worksheet includes last five instances captured

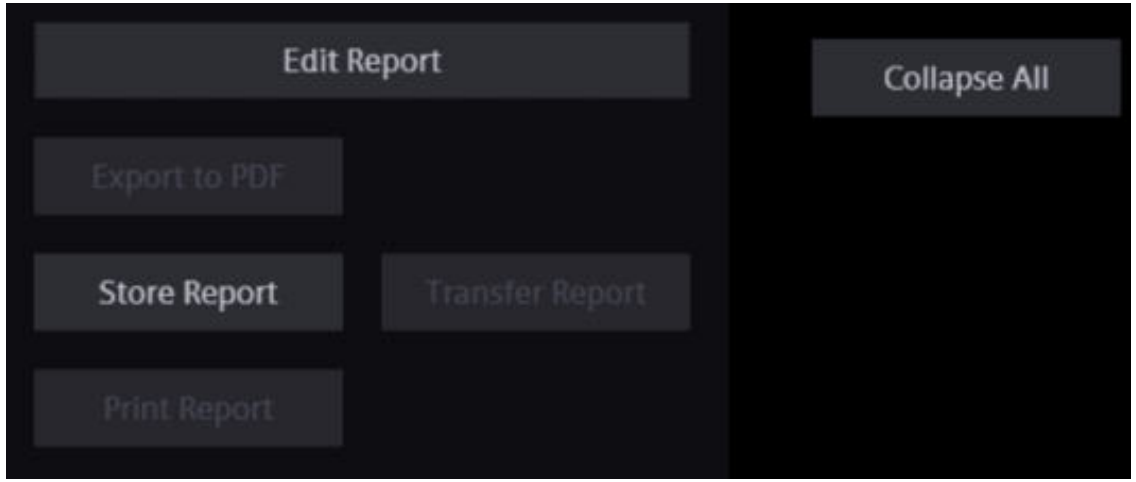
- Average Result enabled - individual beat results sent to report as a separate instance
- Average Result disabled - only current beat result sent to report
- Results cannot be edited, only deleted
- Method can be set to Last, Average, or select the instance 1 thru 5
- Results are listed by chamber (LV, LA, RV, RA)



Report control options

- **Summary & Edit Report** – toggle between edit report function and report summary
- **Export to PDF** – exports a pdf version of the report to a USB
- **Store Report** – saves an image of the entire report
- **Print Report** – prints the report to the configured printer
- **Collapse All** – collapses all sections contained within the report

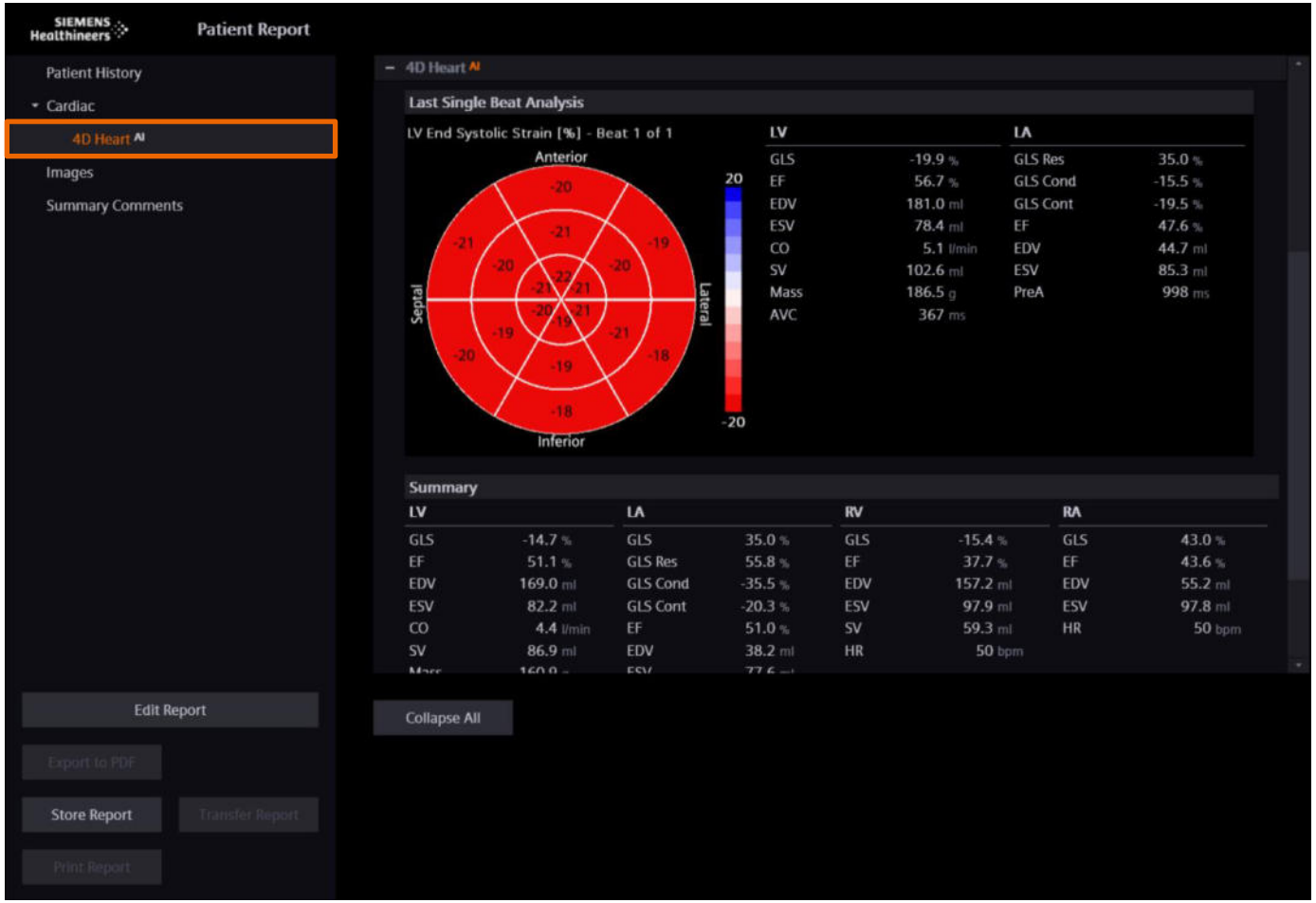




4D Heart^{AI} report summary

The report summary is displayed when selecting **Summary** from the Patient Report

- 4D strain results
- Cardiac chamber results from 4D dataset
  - GLS, EF, and volumes
  - LV cardiac output (CO), and LV mass



Summary

- Overview of 4D Heart^{AI} application
- Review 4D Heart^{AI} configuration and touch screen layout
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- Review 4D Heart^{AI} workflow
- Evaluate 4D Heart^{AI} analysis and report

4D Heart^{AI} Key Takeaways

SIEMENS Healthineers

AI-driven analysis

- Semi-automated contour placement for heart chambers
- AI-enabled size and function analysis
- Ability to edit when needed

4D chamber quantification plus left heart strain

- Analysis for irregular heart beats can be performed
- Ability to edit ED/ES frames, AVC, and Pre-A
- Average up to 5 beats

Physio and non-physio workflow

- Analysis for irregular heart beats can be performed
- Ability to set ED/ES frames
- Average up to 5 beats
- ***Only vendor to have non-physio feature!***

Resources

1. Mitchell, Carol, et al., Journal of the American Society of Echocardiography (2019) 32;1

2. Hasanfatta, Naeem et al., *ACTA Scientific Clinical Case Reports* (2022) 3;6: 45-56

3. Kosarju, Ateet, et al., *Left Ventricular Ejection Fraction*. StatPearls Publishing (2023) Jan

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Thank you for your enthusiasm!

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Questions?