



VISUALSONICS

Vevo 2100 System Cardio Measurements



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Instructions

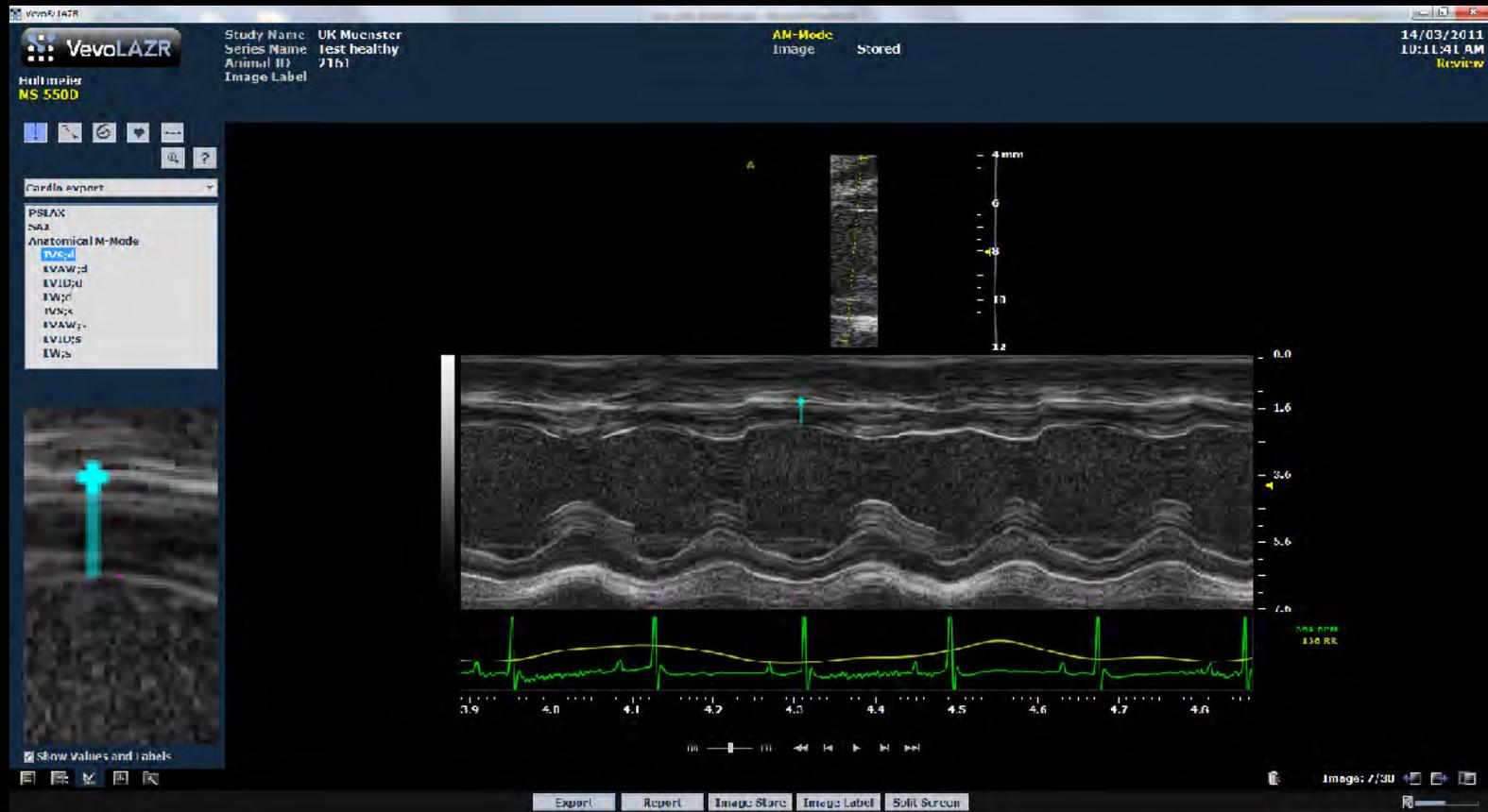


- This document is a guideline on how to assess cardiac function in rodents imaged with a Vevo[®] 1100 or Vevo 2100 system
- All data analysis was done using the Vevo[®] LAB desktop software*
- Please note that it is up to the user to decide which of the available measurements are most applicable

*Please contact your VisualSonics representative for more information on the Vevo LAB software

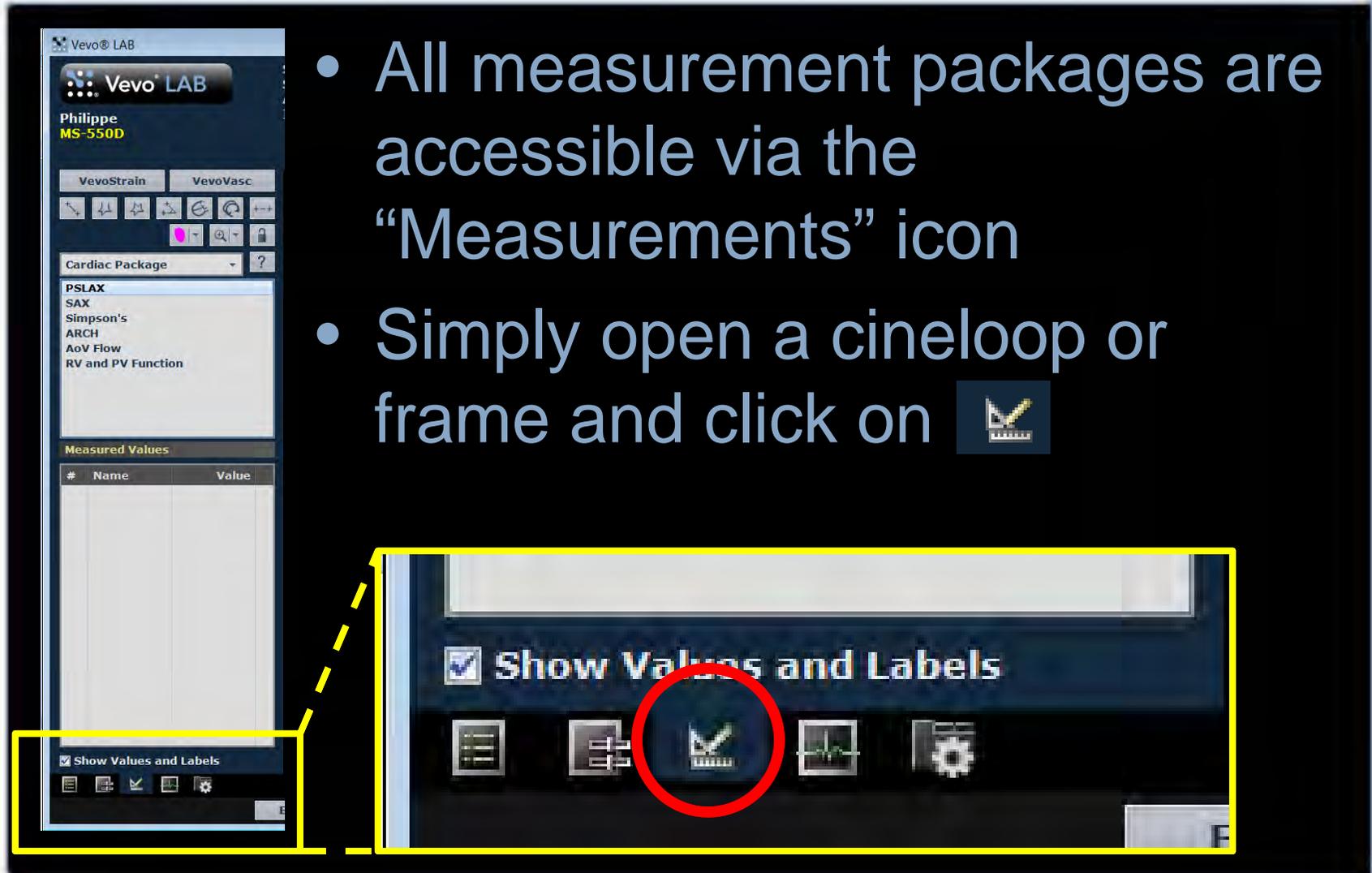
Automated Zoom

The automated zoom function during any measurement allows precise quantification



Measurements

- All measurement packages are accessible via the “Measurements” icon
- Simply open a cine loop or frame and click on 



The screenshot displays the Vevo LAB software interface. On the left, a sidebar shows the 'Cardiac Package' menu with options: PSLAX, SAX, Simpson's, ARCH, AoV Flow, and RV and PV Function. Below this is a 'Measured Values' table with columns for '#', 'Name', and 'Value'. At the bottom of the sidebar, there is a 'Show Values and Labels' checkbox and a toolbar with various icons. A yellow dashed line connects this toolbar to a larger, detailed view of the software's main interface on the right. In this detailed view, the 'Show Values and Labels' checkbox is checked, and the 'Measurements' icon (a blue square with a white checkmark and a bar chart) is circled in red.

#	Name	Value
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Systolic Parameters

Systolic Parameters

- Various options to calculate systolic parameters
- Which measurement should be used depends on the model imaged

- **LV-Trace**
 - Long axis
- **M-Mode**
 - Short- or long axis
- **Simpson's**
 - Short- and long axis
- **EndoArea & -Major**
 - Short- and long axis
- **PW Doppler Mode**
 - + outflow tract



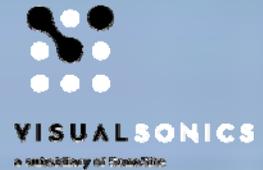
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LV Trace in B-Mode

Long Axis View

LV Trace is part of the "LV Analysis" Package

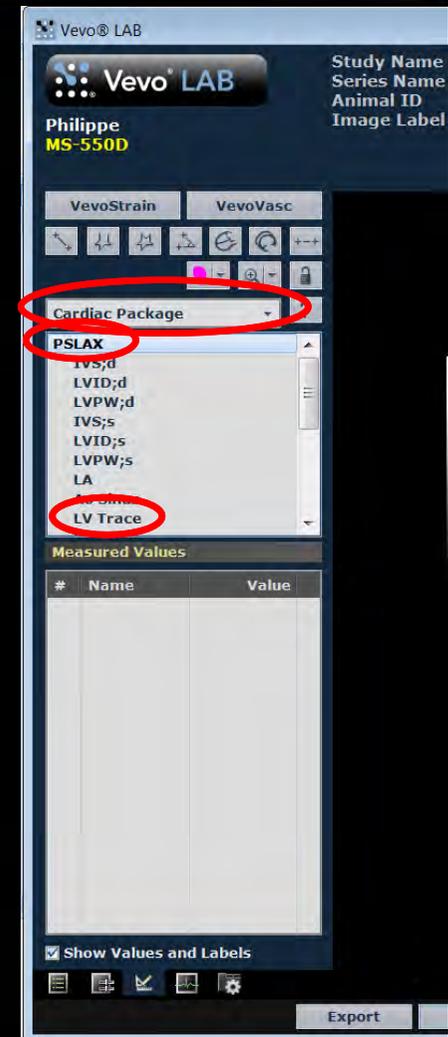
LV Trace Tool in B-Mode



Workflow

- 1) Select Cardiac Package
- 2) Select PLAX
- 3) Select LV Trace

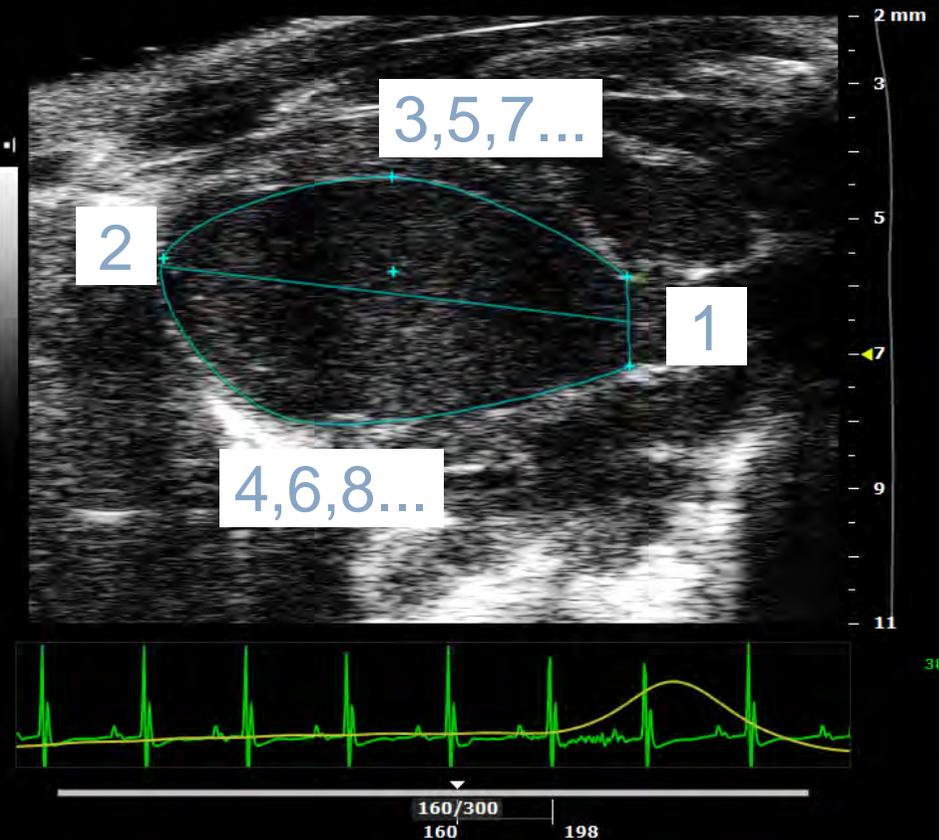
LV-Trace for outlining the endocardium in end systole and end diastole



LV Trace Tool in B-Mode

Place measurements in the following order:

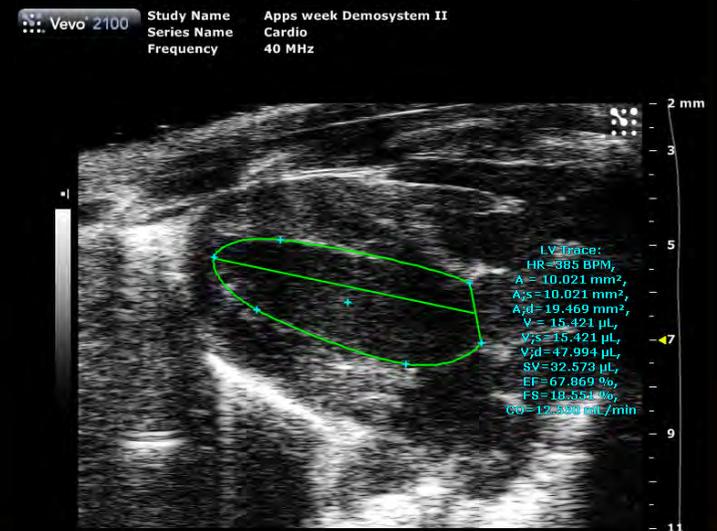
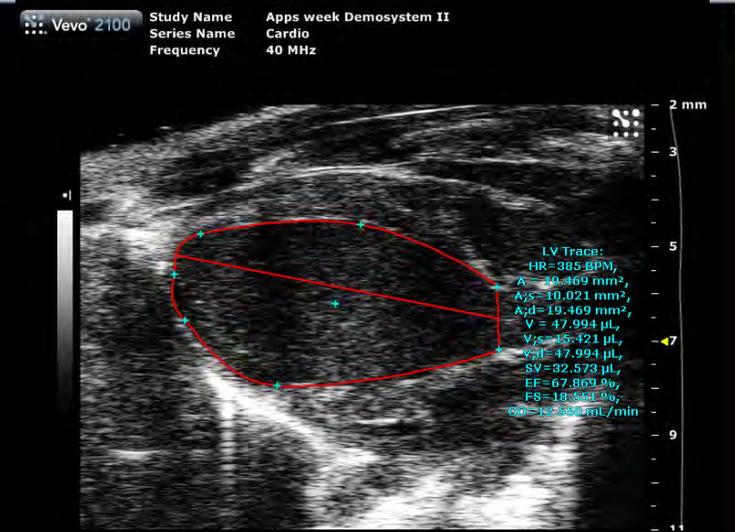
- 1) Aortic root
 - 2 clicks
- 2) Apex
- 3) Anterior wall
- 4) Posterior wall
- 5) Repeat 3+4 until the wall is outlined



LV Trace Tool in B-Mode

Vevo LAB will highlight end-diastole (red) and end-systole (green) automatically

They are used for assessing systolic parameters



LV Trace Tool in B-Mode Calculated Parameters



- Stroke Volume (SV)
- Ejection fraction (EF)
- Cardiac output (CO)
- Fractional shortening (FS)
 - Please note that the longitudinal shortening is calculated

Measured Values		
#	Name	Value
1	LV Trace	
	Heart Rate	385 BPM
	Area	10.021 mm ²
	Area;s	10.021 mm ²
	Area;d	19.469 mm ²
	Volume	15.421 μL
	Volume;s	15.421 μL
	Volume;d	47.994 μL
	Stroke Vo...	32.573 μL
	Ejection F...	67.869 %
	Fractional...	18.551 %
	Cardiac O...	12.550 mL/min



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LV Trace in M-Mode

Long or Short Axis View

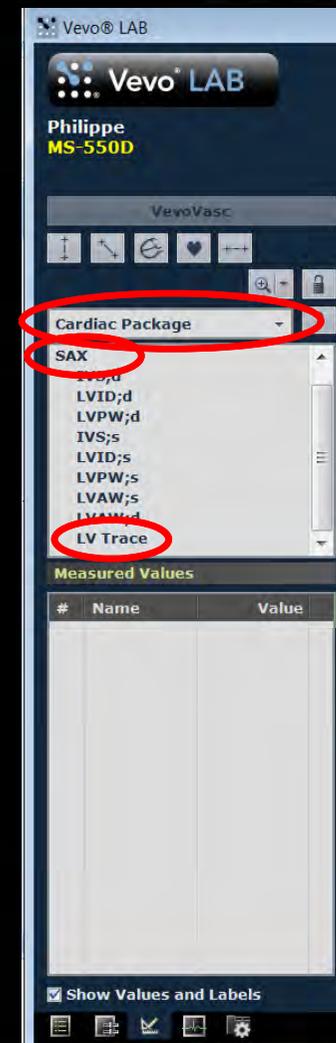
- LV Trace is part of the "LV Analysis" Package

LV Trace Tool in M-Mode

Workflow

- 1) Select Cardiac Package
- 2) Select PLAX or SAX
- 3) Select LV Trace

LV-Trace for outlining the end- and epicardium through multiple cardiac cycles



LV Trace Tool in M-Mode

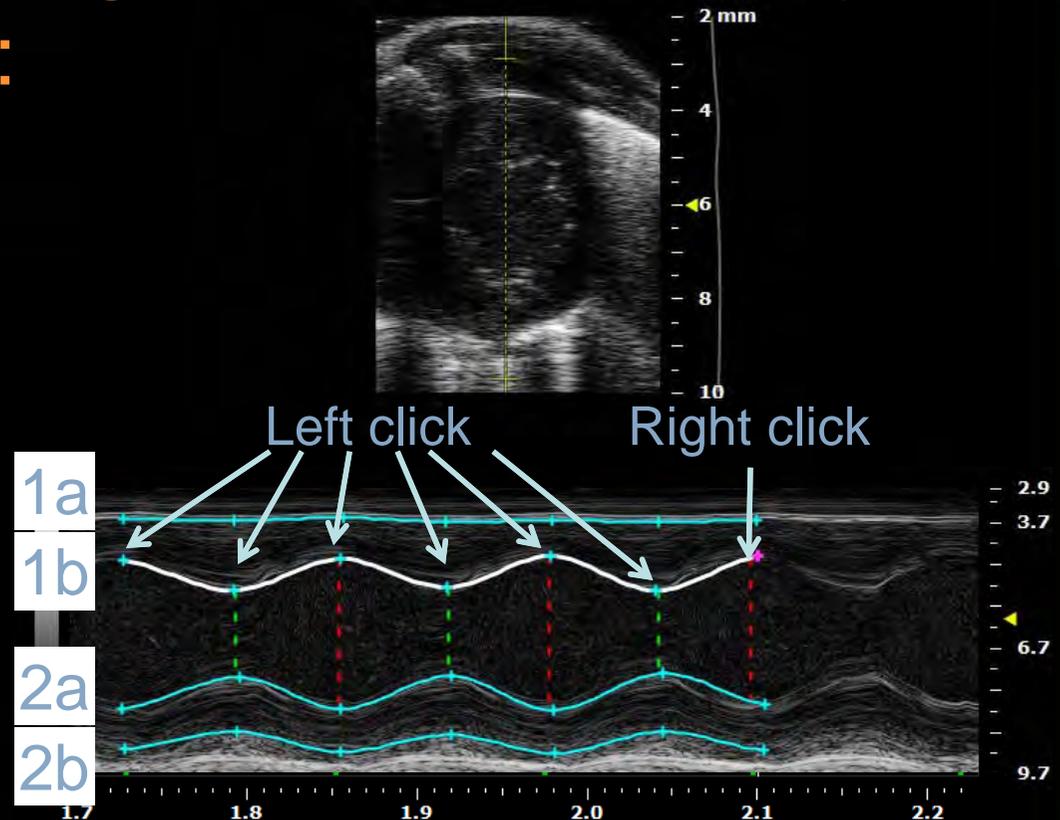
Place the following measurements in your preferred order:

1) Anterior

- a. Epicard
- b. Endocard

2) Posterior

- a. Endocard
- b. Epicard



Each trace has to be completed by clicking the right mouse button

LV Trace Tool in M-Mode



Vevo LAB will highlight end-diastole (red) and end-systole (green) automatically

They are used for assessing systolic parameters



LV Trace Tool in M-Mode Calculated Parameters



- Stroke Volume (SV)
- Ejection fraction (EF)
- Cardiac output (CO)
- Fractional shortening (FS)
- LV Mass
 - Only if epicard is traced

Measured Values		
#	Name	Value
1	SAX:LV Tr...	
	Heart Rate	482 BPM
	Diameter;s	2.056 mm
	Diameter;d	3.534 mm
	Volume;s	13.665 μ L
	Volume;d	52.166 μ L
	Stroke Vo...	38.501 μ L
	Ejection F...	73.804 %
	Fractional...	41.829 %
	Cardiac O...	18.540 m...
	LV Mass	130.168 mg
	LV Mass Cor	104.134 mg



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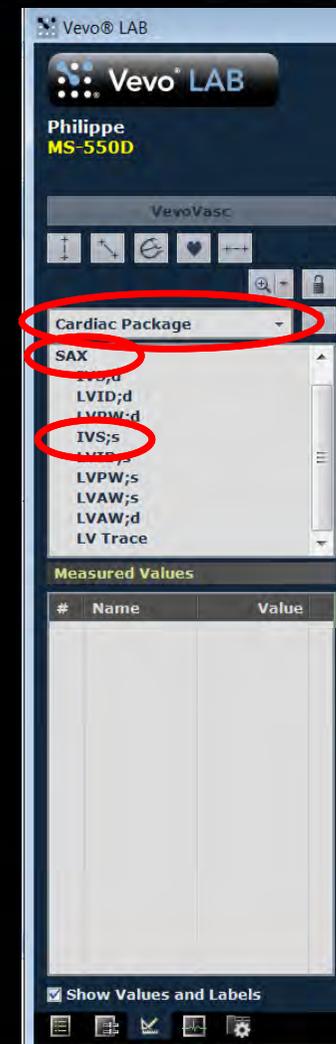
M-Mode

Long or Short Axis View

Workflow

- 1) Select Cardiac Package
- 2) Select PLAX or SAX
- 3) Select IVS

**Measuring distances
between anterior and
posterior endocard**



Place the following measurements in the following order:

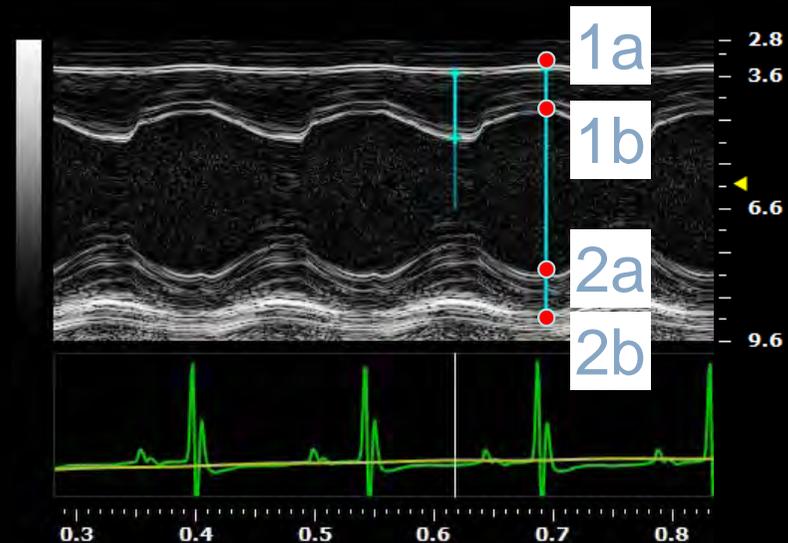
1) Anterior wall

- a. Epicard
- b. Endocard

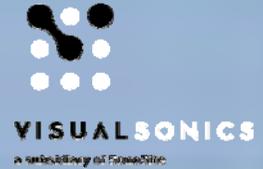
2) Posterior wall

- a. Endocard
- b. Epicard

Do this for IVS,s
and IVS,d



M-Mode Calculated Parameters



- Ejection fraction (EF)
- Fractional shortening (FS)
- LV Mass

Note that duplicated measurements will automatically be used for calculating average and standard deviation



The screenshot shows the Vevo LAB software interface. The 'Analysis Browser' section displays a 'Cardiac Package' with a table of 'Measurements' and a table of 'Calculations'. The 'Measurements' table has columns for Description, Mode, Units, Avg, STD, Instance 1, and Instance 2. The 'Calculations' table has columns for Description, Units, and Value. The 'Avg' and 'STD' columns in the 'Measurements' table are circled in red.

Description	Mode	Units	Avg	STD	Instance 1	Instance 2
IVS;d - D	M-Mode	mm	0.952	0.000	0.952	0.952
IVS;s - D	M-Mode	mm	1.462		1.462	
LVID;d - D	M-Mode	mm	3.689	0.072	3.638	3.740
LVID;s - D	M-Mode	mm	2.380		2.380	
LVPW;d - D	M-Mode	mm	0.901	0.024	0.884	0.918
LVPW;s - D	M-Mode	mm	1.156		1.156	

Description	Units	Value
EF	%	65.792
FS	%	35.484
LV Mass	mg	126.374
LV Mass (Corrected)	mg	101.099
LV Vol;d	µL	57.714
LV Vol;s	µL	19.742



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Simpson's

1 Long and 3 Short Axis Views

Systolic Function

Measurement According to Simpson

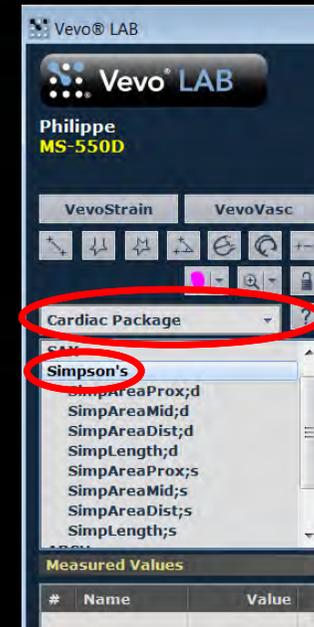


Workflow

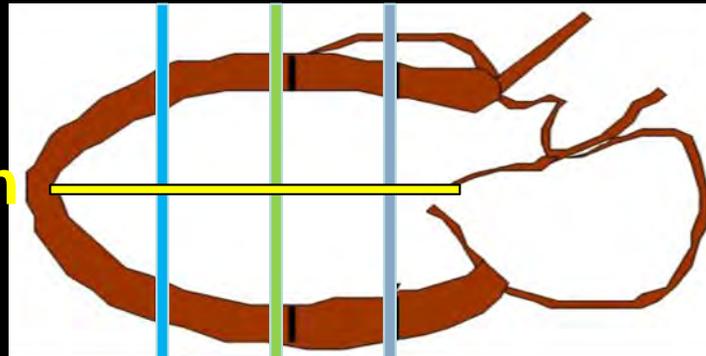
1) Select Cardiac Package

2) Select Simpson's

SimpAreaDist
SimpAreaMid
SimpAreaProx



SimpLength



Measurements from one long axis and three short axis views are required

Systolic Function Measurement According to Simpson

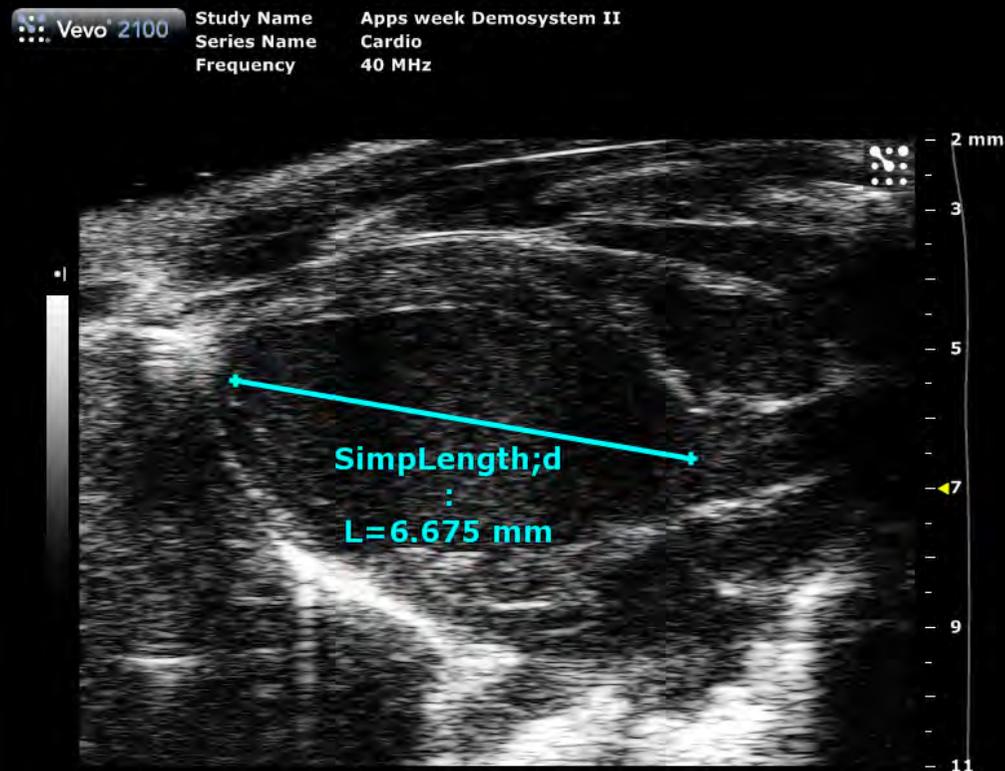


Place the following measurements in your preferred order:

1) Long axis

- a. `SimpLength,s`
- b. `SimpLength,d`

Length: Distance aortic root to apical endocard in systole and diastole (two measurements)



Systolic Function

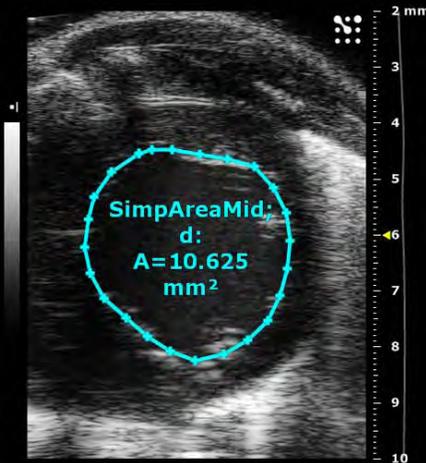
Measurement According to Simpson



Place the following measurements in your preferred order:

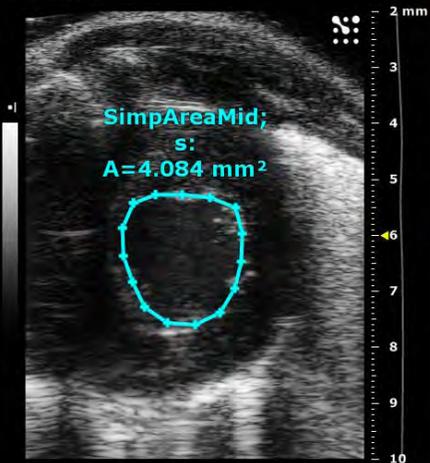
1) Short axis proximal

- SimpAreaProx,s
- SimpAreaProx,d



2) Short axis mid

- SimpAreaMid,s
- SimpAreaMid,d



3) Short axis distal

- SimpAreaDist,s
- SimpAreaDist,d

Systolic Function According to Simpson – Calculated Parameters



- Stroke Volume (Simp SV)
- Fractional Area Change (Simp FAC)
- Ejection fraction (Simp EF)
- Fractional shortening (Simp FS)
- Cardiac output (Simp CO)

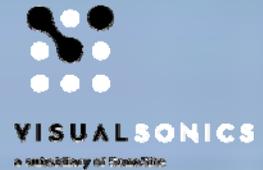


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ENDO/EPI major

1 Long and 1 Short Axis View

Systolic Function Measurement with ENDOmajr/area

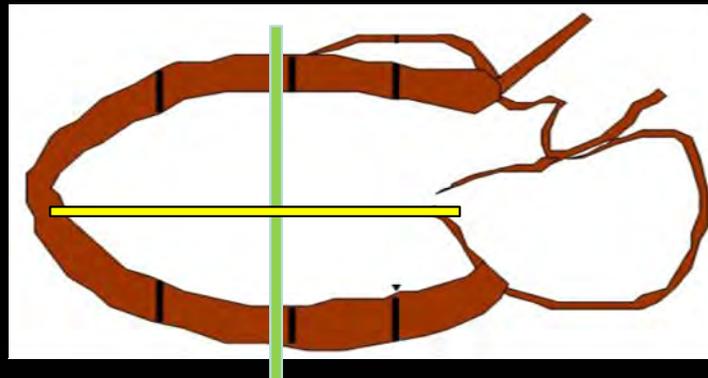


Workflow

- 1) Select Cardiac Package
- 2) Select PLAX or SAX

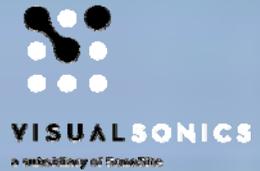
ENDOarea

ENDOmajr



Measurements from one long axis and one short axis views are required

Systolic Function Measurement with ENDOmajr/area



Place the following measurements in your preferred order:

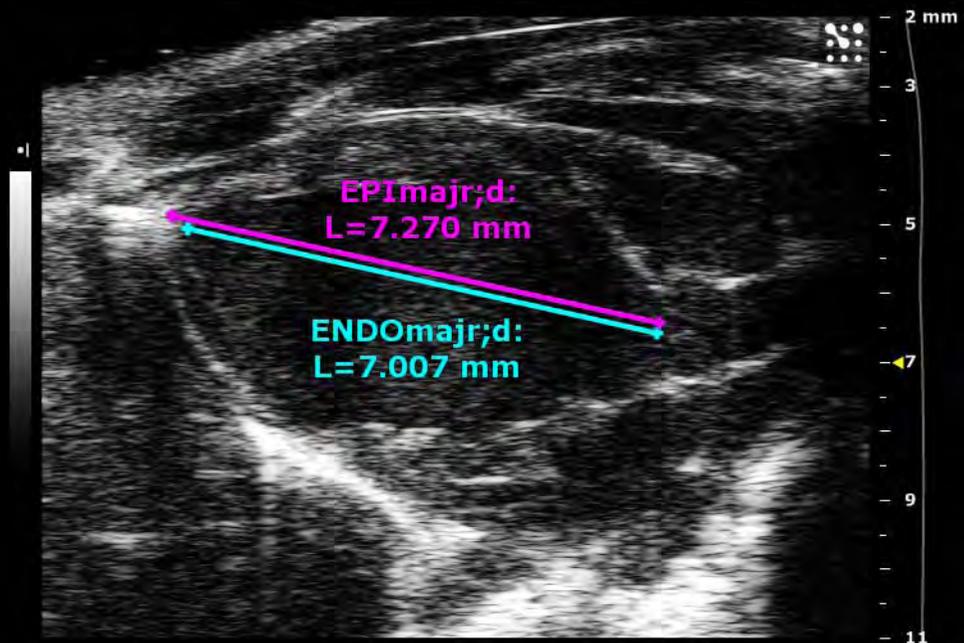
1) Long axis

- a. ENDOmajr,s
- b. ENDOmajr,d

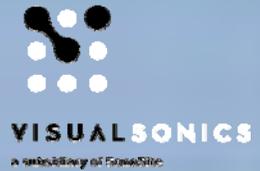
2) Long axis

- a. EPImajr,s
- b. EPImajr,d

Point 2) is optional, as measuring EPImajr,d and EPImajr,s are for calculating LV Mass



Systolic Function Measurement with ENDOmajr/area



Place the following measurements in your preferred order:

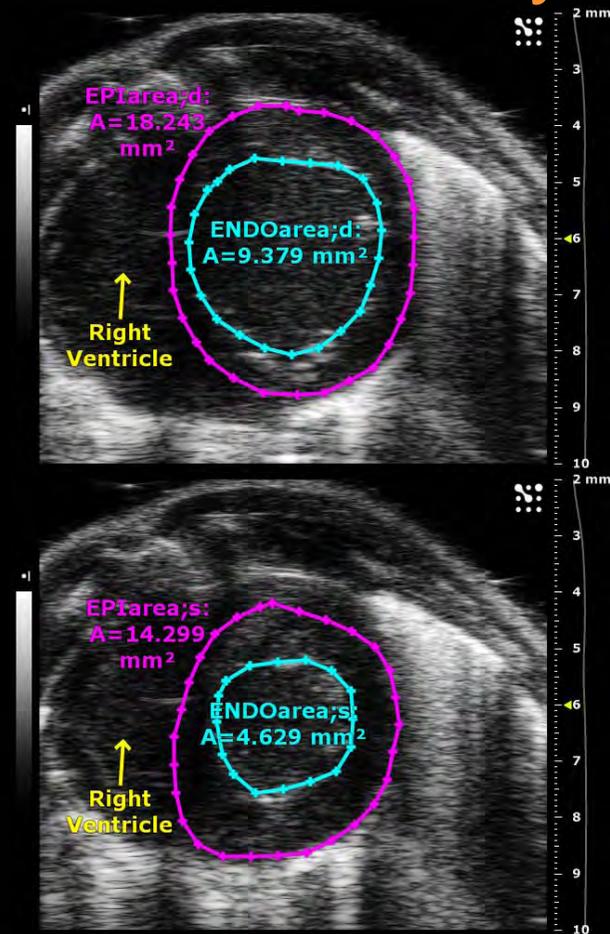
1) Short axis

- ENDOarea,s
- ENDOare,d

2) Short axis

- EPIarea,s
- EPIarea,d

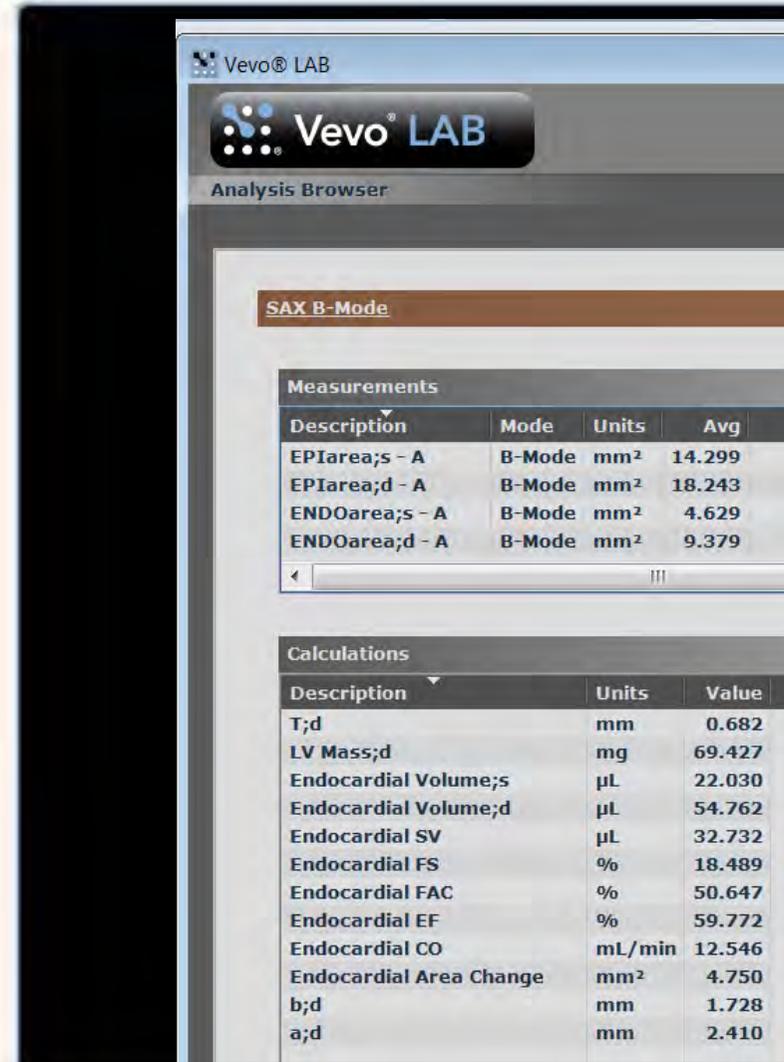
Point 2) is optional, as measuring EPIarea,d and EPIarea,s are for calculating LV Mass



Systolic Function Measurement with ENDOmajr/area



- LV Mass
- Stroke Volume (SV)
- Fractional shortening (FS)
- Fractional Area Change (FAC)
- Ejection Fraction (EF)
- Cardiac Output (CO)



Vevo® LAB

Analysis Browser

SAX B-Mode

Measurements			
Description	Mode	Units	Avg
EPIarea;s - A	B-Mode	mm ²	14.299
EPIarea;d - A	B-Mode	mm ²	18.243
ENDOarea;s - A	B-Mode	mm ²	4.629
ENDOarea;d - A	B-Mode	mm ²	9.379

Calculations		
Description	Units	Value
T;d	mm	0.682
LV Mass;d	mg	69.427
Endocardial Volume;s	μL	22.030
Endocardial Volume;d	μL	54.762
Endocardial SV	μL	32.732
Endocardial FS	%	18.489
Endocardial FAC	%	50.647
Endocardial EF	%	59.772
Endocardial CO	mL/min	12.546
Endocardial Area Change	mm ²	4.750
b;d	mm	1.728
a;d	mm	2.410



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Cardiac Output

Pulsed-Wave (PW) Doppler Mode

Systolic Function Assessed with PW Doppler Mode



- Determining
 - vessel diameter
 - Vessel blood flow
- Calculating
 - Blood volume per heart beat
 - Stroke volume (SV)
 - Blood volume per time
 - Cardiac output (CO)

Systolic Function Assessed with PW Doppler Mode



Workflow

1) Select Cardiac Package

2) Select AoV Flow

3) Measure

AoV Diam in B-Mode

AoV VTI in PW Doppler Mode

Measurements from
the suprasternal view
in B Mode and PW
Doppler Mode



Systolic Function Assessed with PW Doppler Mode

Place the following measurements in your preferred order:

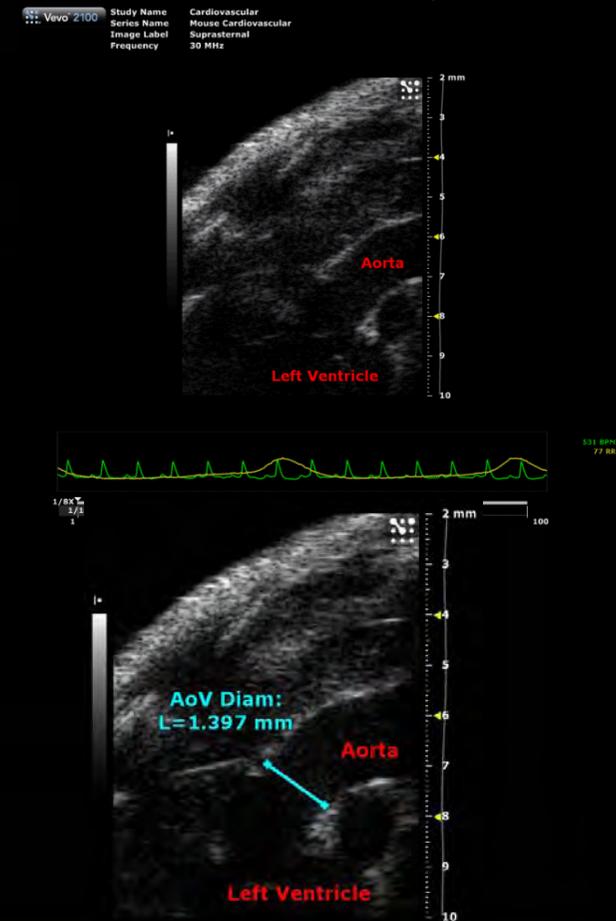
1) B-Mode

a. AoV Diam

2) PW Doppler Mode

a. AoV VTI

AoV: measured outside the left ventricle (LVOT measured before the aortic valves)

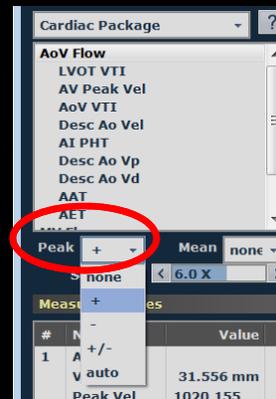


Systolic Function Assessed with PW Doppler Mode

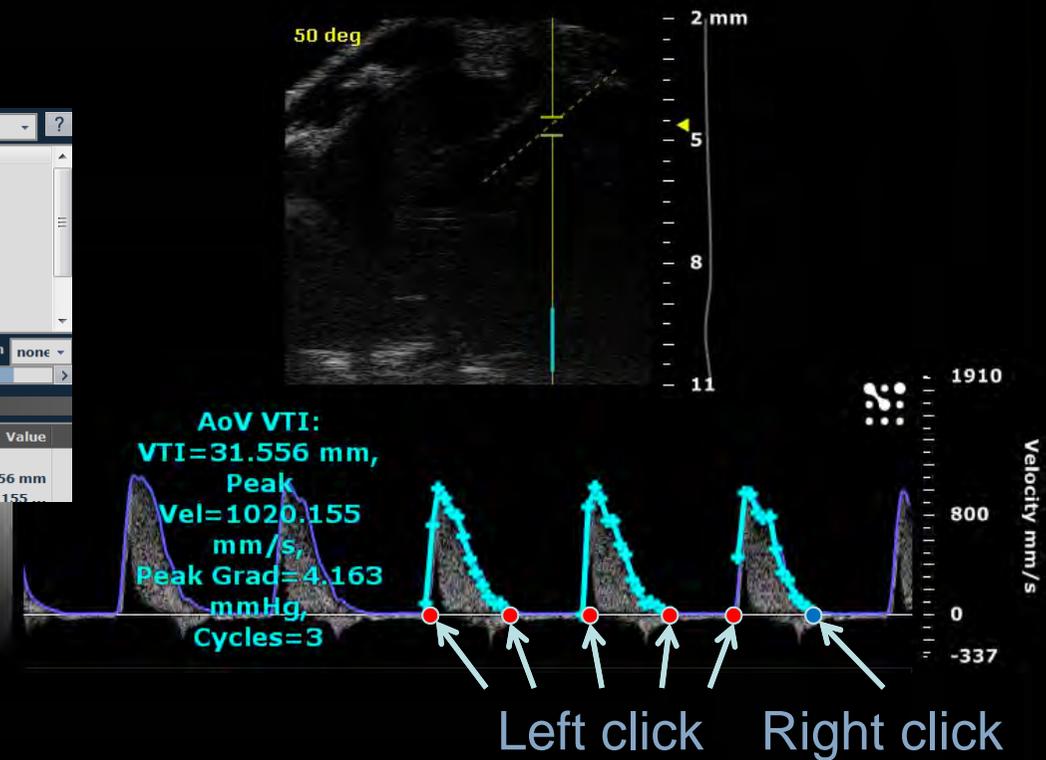


Blood flow through the ascending aorta:

1) Select automated tracing



2) Assess flow using
AoV VTI

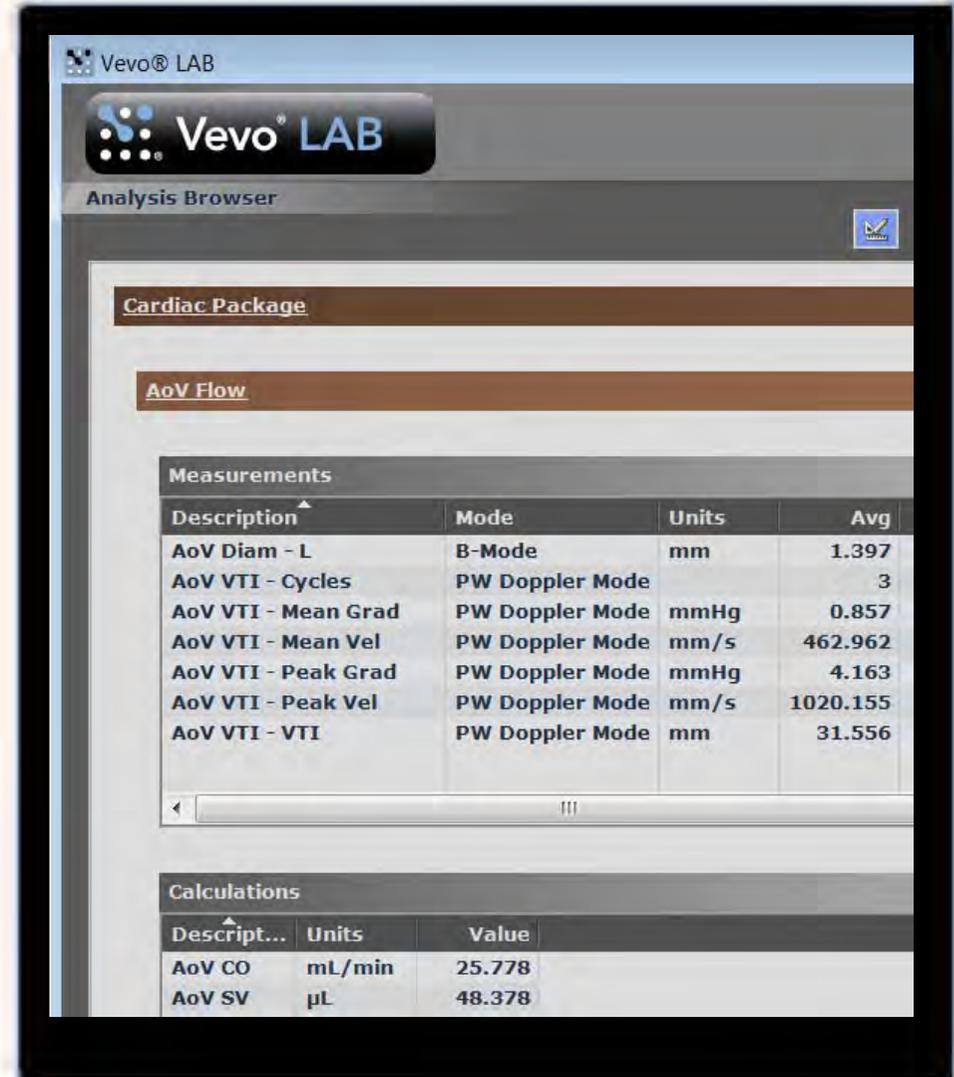


Automated averaging when selecting multiple cardiac cycles

Systolic Function Assessed with PW Doppler Mode



- Stroke Volume
 - AoV SV
- Cardiac output
 - AoV CO
- SV and CO can be assessed by similar measurements on the Pulmonary artery



Vevo® LAB

Analysis Browser

Cardiac Package

AoV Flow

Measurements			
Description	Mode	Units	Avg
AoV Diam - L	B-Mode	mm	1.397
AoV VTI - Cycles	PW Doppler Mode		3
AoV VTI - Mean Grad	PW Doppler Mode	mmHg	0.857
AoV VTI - Mean Vel	PW Doppler Mode	mm/s	462.962
AoV VTI - Peak Grad	PW Doppler Mode	mmHg	4.163
AoV VTI - Peak Vel	PW Doppler Mode	mm/s	1020.155
AoV VTI - VTI	PW Doppler Mode	mm	31.556

Calculations		
Descript...	Units	Value
AoV CO	mL/min	25.778
AoV SV	µL	48.378



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Diastolic Parameters

Color Doppler Mode

PW Doppler Mode

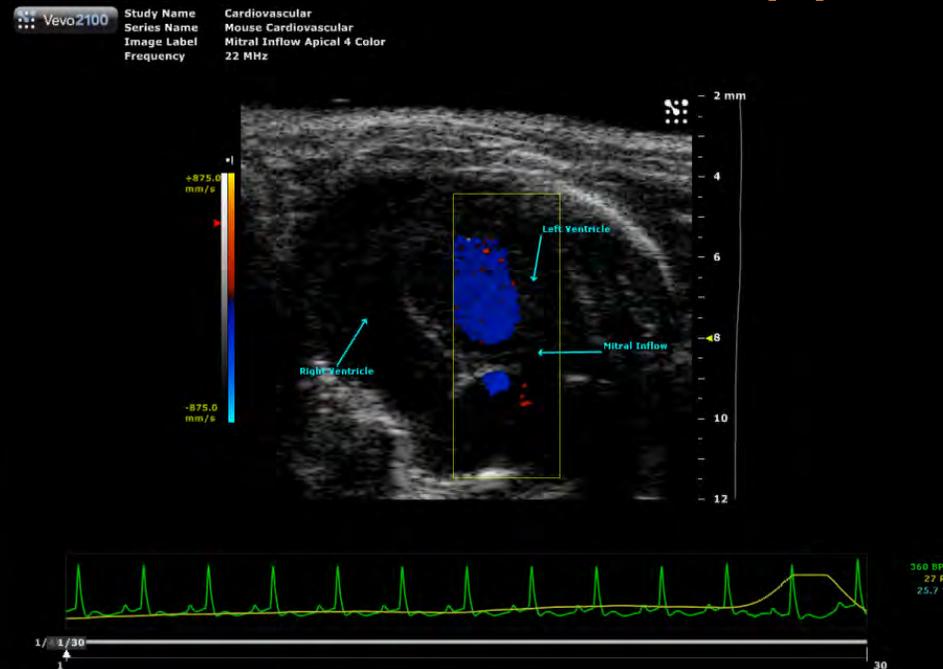
Tissue Doppler Mode*

* Tissue Doppler Mode only available on Vevo 2100 and Vevo LAZR systems

Distolic Function Workflow

Workflow

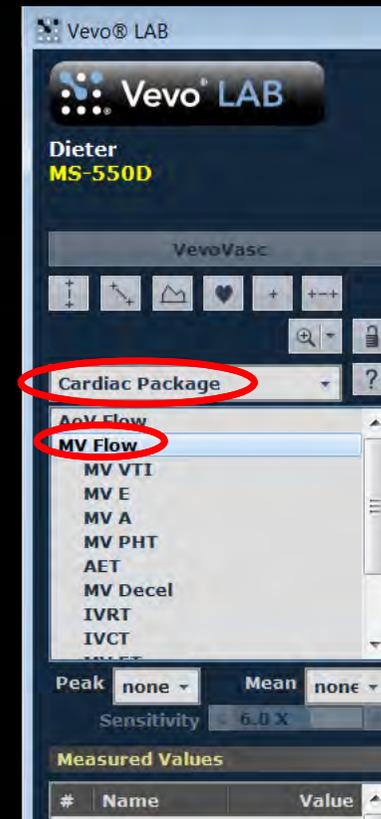
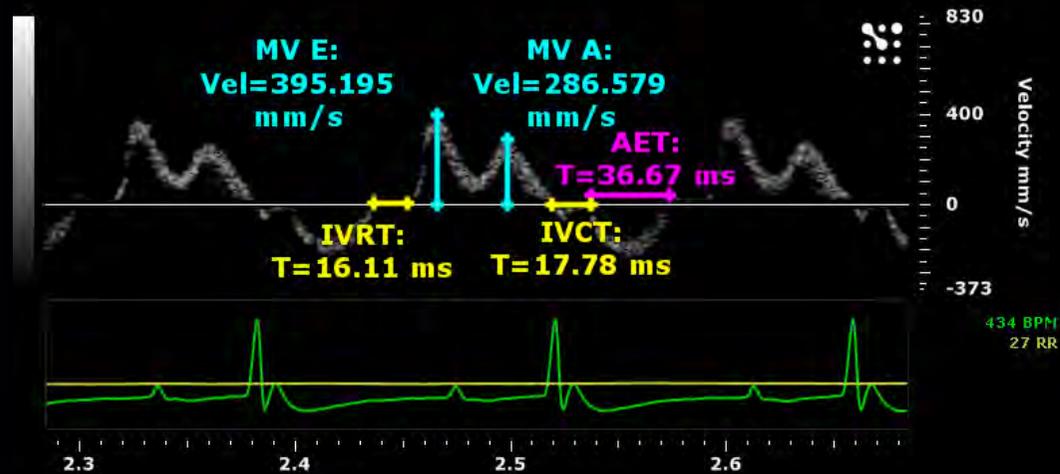
- 1) Apical view in B-Mode
- 2) Optimize view in Color Doppler Mode



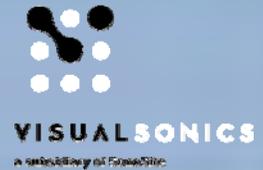
Distolic Function Workflow

Workflow

- 1) Apical view in B-Mode
- 2) Optimize view in Color Doppler Mode
- 3) Assess Mitral flow in PW Doppler Mode

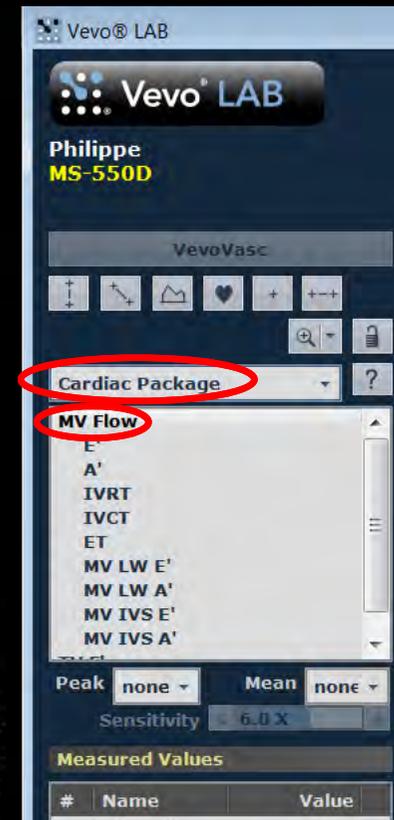
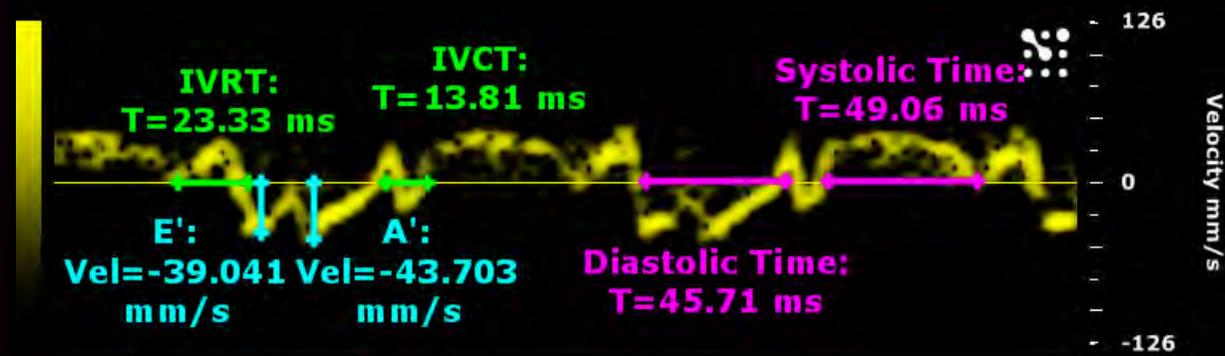


Distolic Function Workflow



Workflow

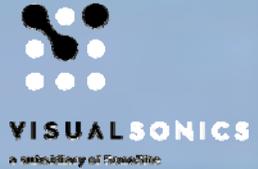
- 1) Apical view in B-Mode
- 2) Optimize view in Color Doppler Mode
- 3) Assess Mitral flow in PW Doppler Mode
- 4) Assess valve movement in Tissue Doppler Mode*



* Tissue Doppler Mode only available on Vevo 2100 and Vevo LAZR systems

Image

Distolic Function Calculations*



- E/A ratio
- Myocardial Performance Index – MPI
- E/E' ratio
- E'/A' ratio

E/E' ratio can detect left ventricular diastolic dysfunction more sensitively than the ratio of E to mitral peak velocity of late filling (A) (E/A ratio).

* Not all calculations listed



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Questions?

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Insight through *in vivo* imaging

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