

# 3D TEE Vocabulary

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Toronto General Hospital



University of Toronto



Toronto General Hospital

University Health Network

# Outline

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- 3D Technology
- Image acquisition modes
- Display



# Disclosure

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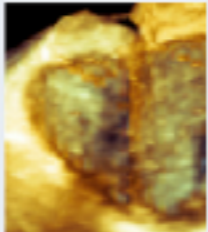
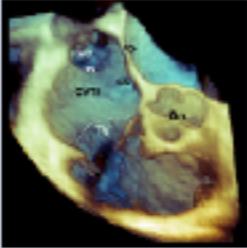
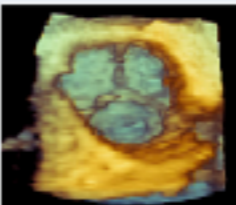
- UoT Merit Award
- APIL lab
- Research agreement  
Siemens

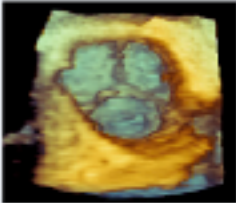
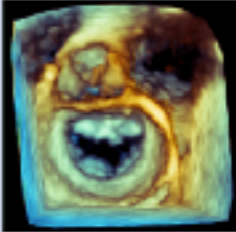
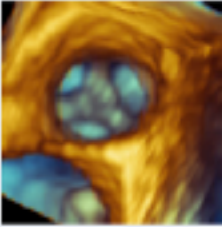
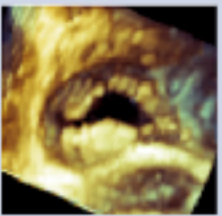


# ASE GUIDELINES AND STANDARDS

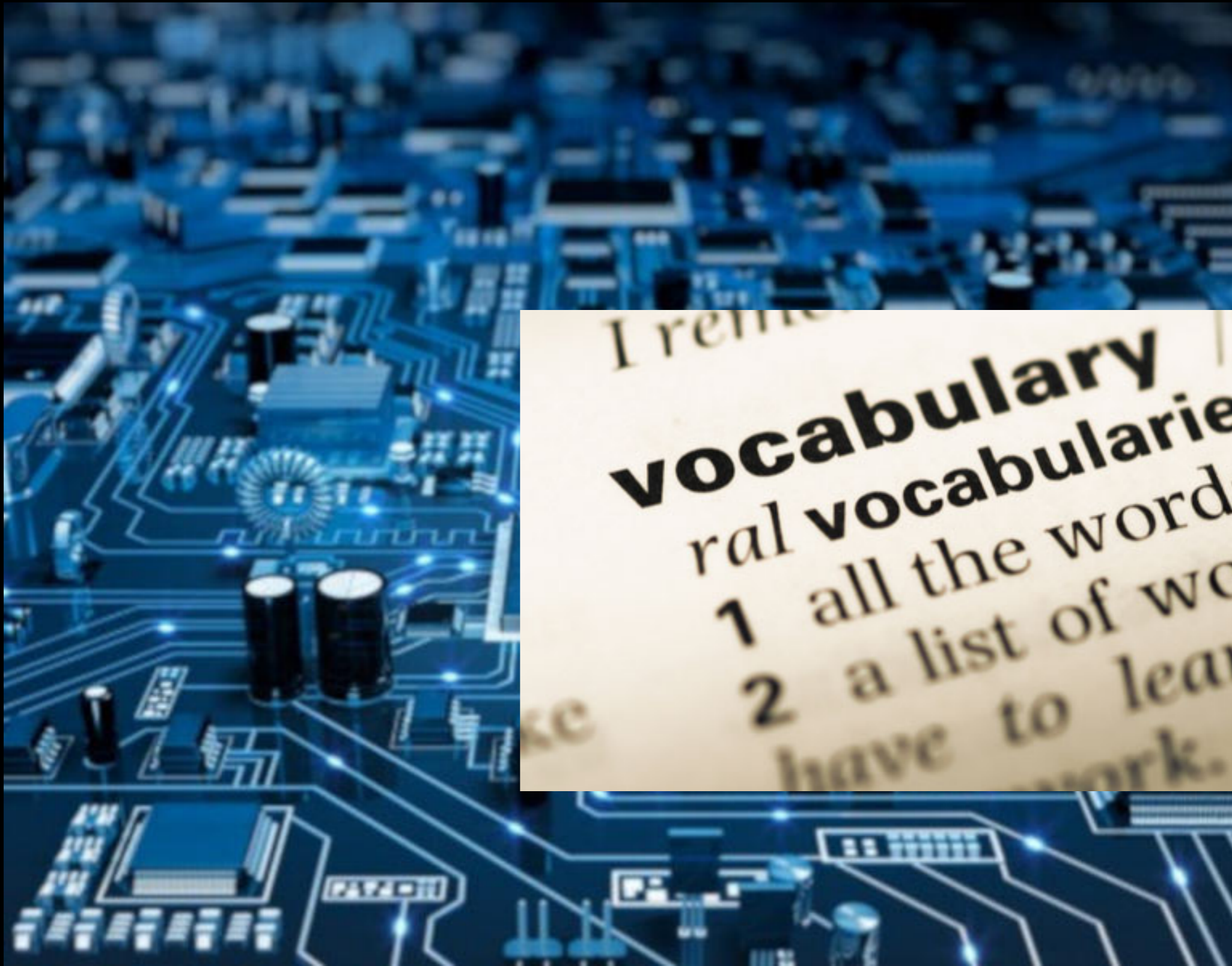
## Guidelines for Performing a Comprehensive Transesophageal Echocardiographic Examination: Recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists

Rebecca T. Hahn, MD, FASE, Chair, Theodore Abraham, MD, FASE, Mark S. Adams, RDCS, FASE,

<b>Left Ventricle</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the left ventricle from the 0°, 60°, or 120° mid-esophageal positions</li> <li>2. Use the biplane mode to check that the left ventricle is centered in a second view 90° to the original.</li> <li>3. Acquire using wide-angle, multi-beat mode</li> </ol>	
<b>Right Ventricle</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the right ventricle from the 0° mid-esophageal position with the right ventricle tilted so that it is in the center of the image</li> <li>2. Acquire using wide-angle, multi-beat mode</li> </ol>	
<b>Interatrial Septum</b>	<ol style="list-style-type: none"> <li>1. 0° with the probe rotated to the interatrial septum</li> <li>2. Acquire using narrow-angle, single-beat or wide-angle, multi-beat modes</li> </ol>	
<b>Aortic Valve</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the aortic valve from either the 60° mid-esophageal, short-axis view or the 120° mid-esophageal, long-axis view</li> <li>2. Acquire using either the narrow-angle, single-beat or the wide-angle, multi-beat modes</li> </ol>	

<b>Aortic Valve</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the aortic valve from either the 60° mid-esophageal, short-axis view or the 120° mid-esophageal, long-axis view</li> <li>2. Acquire using either the narrow-angle, single-beat or the wide-angle, multi-beat modes</li> </ol>	
<b>Mitral Valve</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the mitral valve from the 0°, 60°, 90° or 120° mid-esophageal views</li> <li>2. Use the biplane mode to check that the mitral valve annulus is centered with the acquisition plane in a second view 90° to the original.</li> <li>3. Acquire using narrow-angle, single-beat mode</li> </ol>	
<b>Pulmonic Valve</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the pulmonic valve from either the 90° high-esophageal view or the 120° mid-esophageal, 3-chamber view rotated to center the pulmonic valve</li> <li>2. Acquire using narrow-angle, single-beat mode</li> </ol>	
<b>Tricuspid Valve</b>	<ol style="list-style-type: none"> <li>1. Obtain a view of the tricuspid valve from either the 0° to 30° mid-esophageal, 4-chamber view tilted so that the valve is centered in the imaging plane or the 40° transgastric view with antelexion</li> <li>2. Acquire using a narrow-angle, single-beat mode</li> </ol>	

# Technology+terminology



Irene

**vocabulary**

ral **vocabularies**)

- 1 all the words in a la
- 2 a list of words in

have to learn this

work.

# Proprietary strings



Α α Β β Γ γ Δ δ  
 Ε ε Ζ ζ Η η Θ θ  
 Ι ι Κ κ Λ λ Μ μ  
 Ν ν Ξ ξ Ο ο Π π  
 Ρ ρ Σ σς Τ τ Υ υ  
 Φ φ Χ χ Ψ ψ Ω ω



Consonants

خ	ح	ج	پ	ٹ	ت	ب	ا
x	h/h	j	p	tʰ	t	b	ā/a/e/i/u/
[x~xʰ]	[h]	[dʒ~ʒ]	[p]	[θ~t]	[t]	[b~bʰ~p]	[a:/a:/e/i/u/ʔ]
ض	ص	ش	س	ز	ر	ذ	د
ʒ	s	ʃ	s	z	r	d/ʒ	d
[ʒʰ~dʒʰ]	[sʰ]	[ʃ]	[s]	[z~zʰ]	[r~rʰ~rʰʰ]	[ð~d]	[d]
ق	ق	ك	ف	غ	ع	ظ	ط
q	q	v	f	ɣ	eʰ	ʒ	t
[q]	[q~q]	[v]	[f~v]	[ɣ~ɣ]	[ʕ]	[ʒʰ~dʒʰ]	[rʰ]
ي	و	ه	ن	م	ل	ك	ك
y	w	h	n	m	l	g	k
[y/i:/e:]	[w/u:/o:]	[h]	[n~nʰ]	[m~mʰ]	[l~lʰ]	[g]	[k]

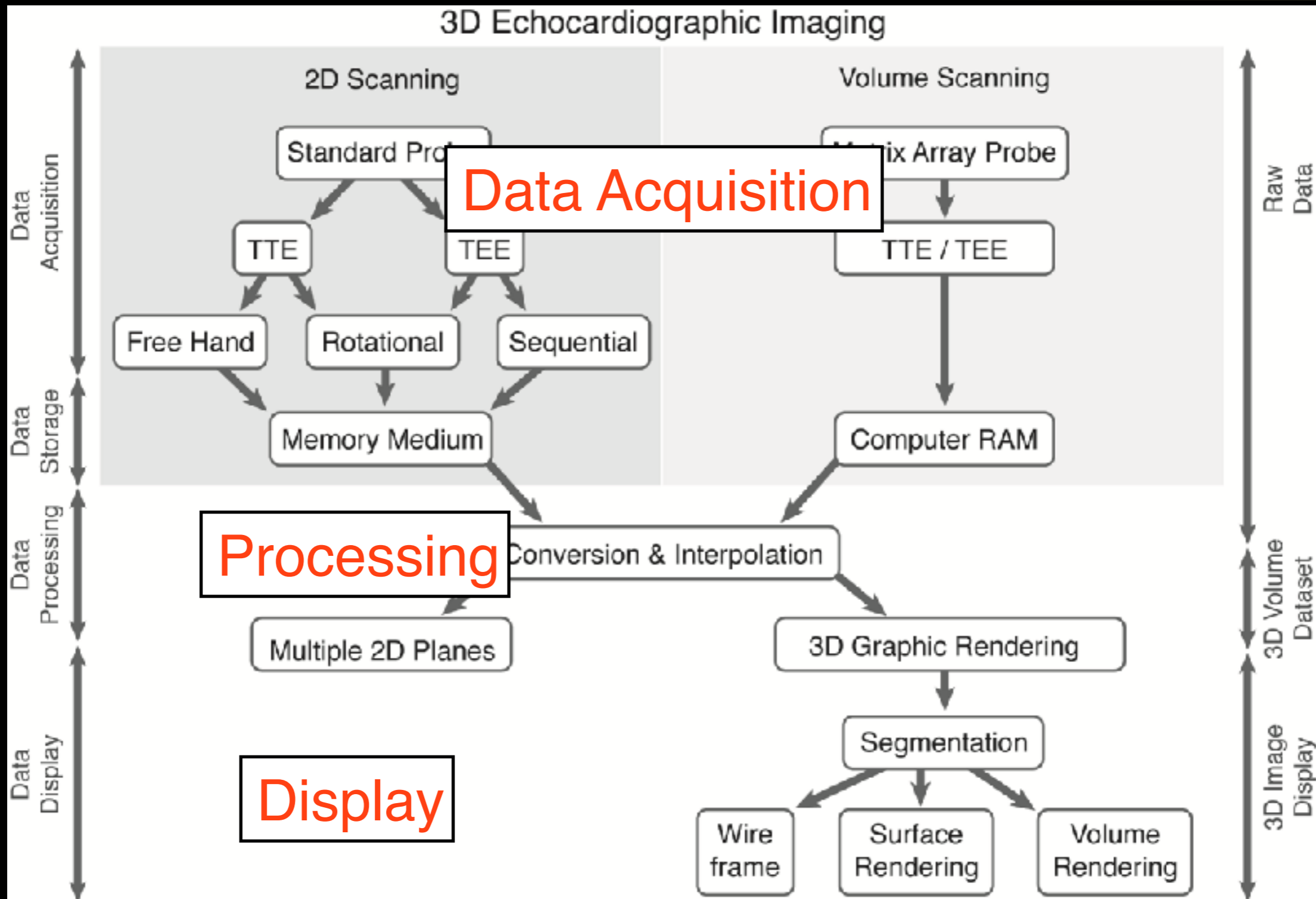
Vowels



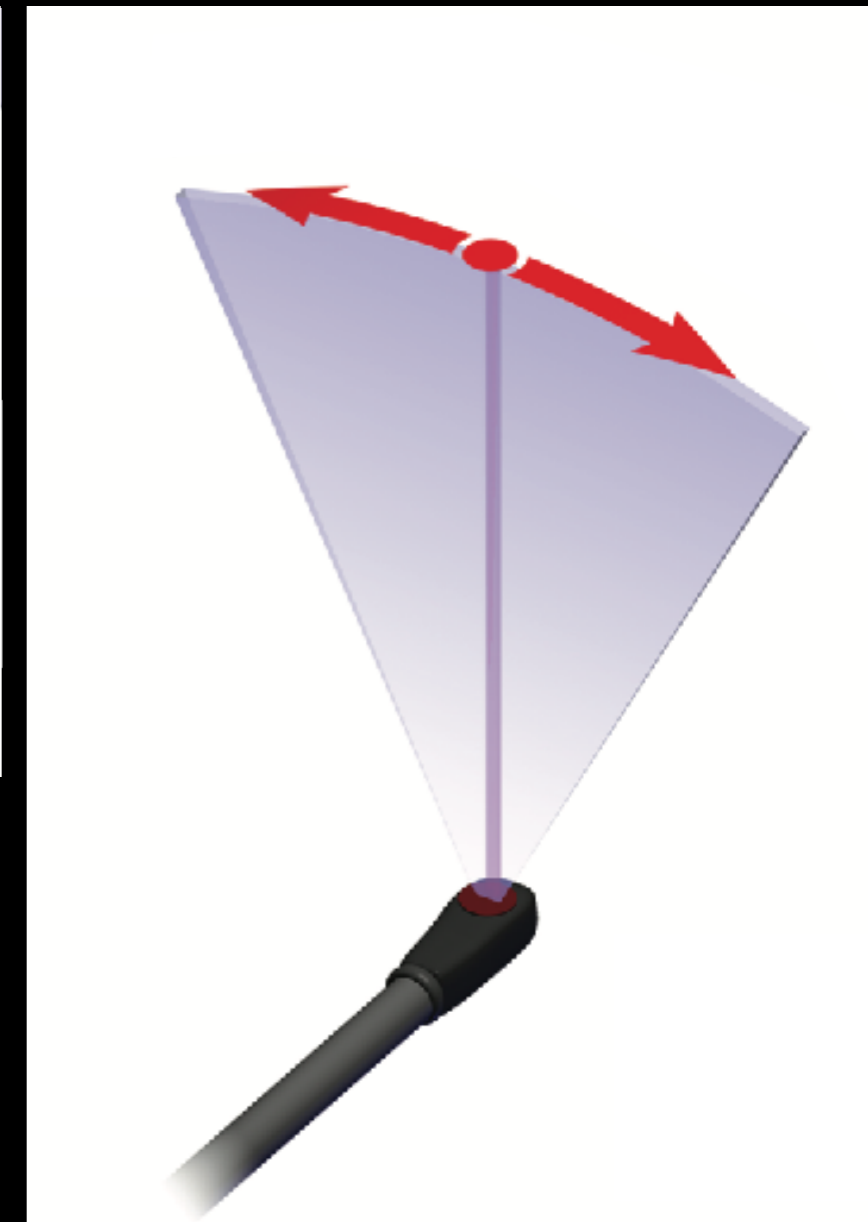
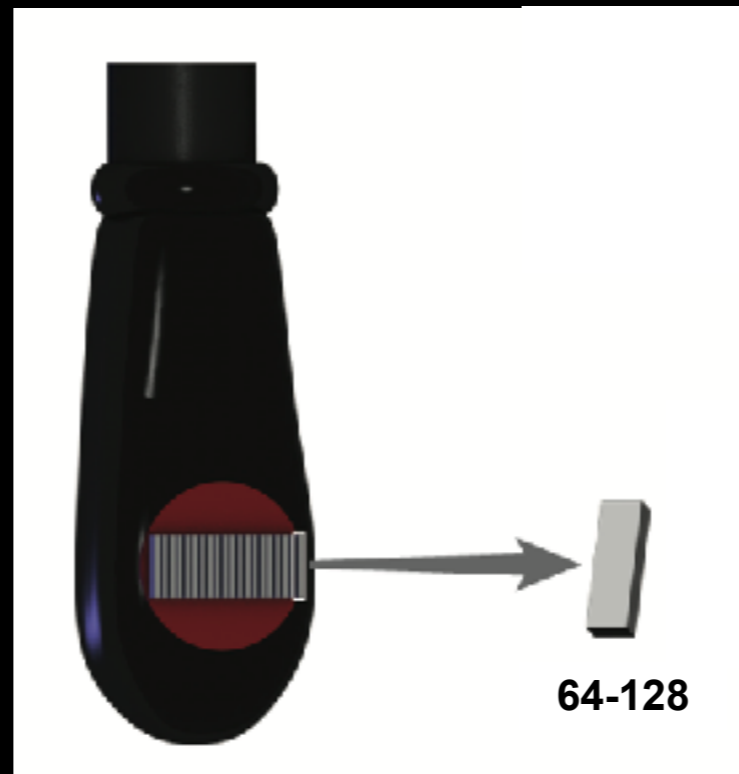
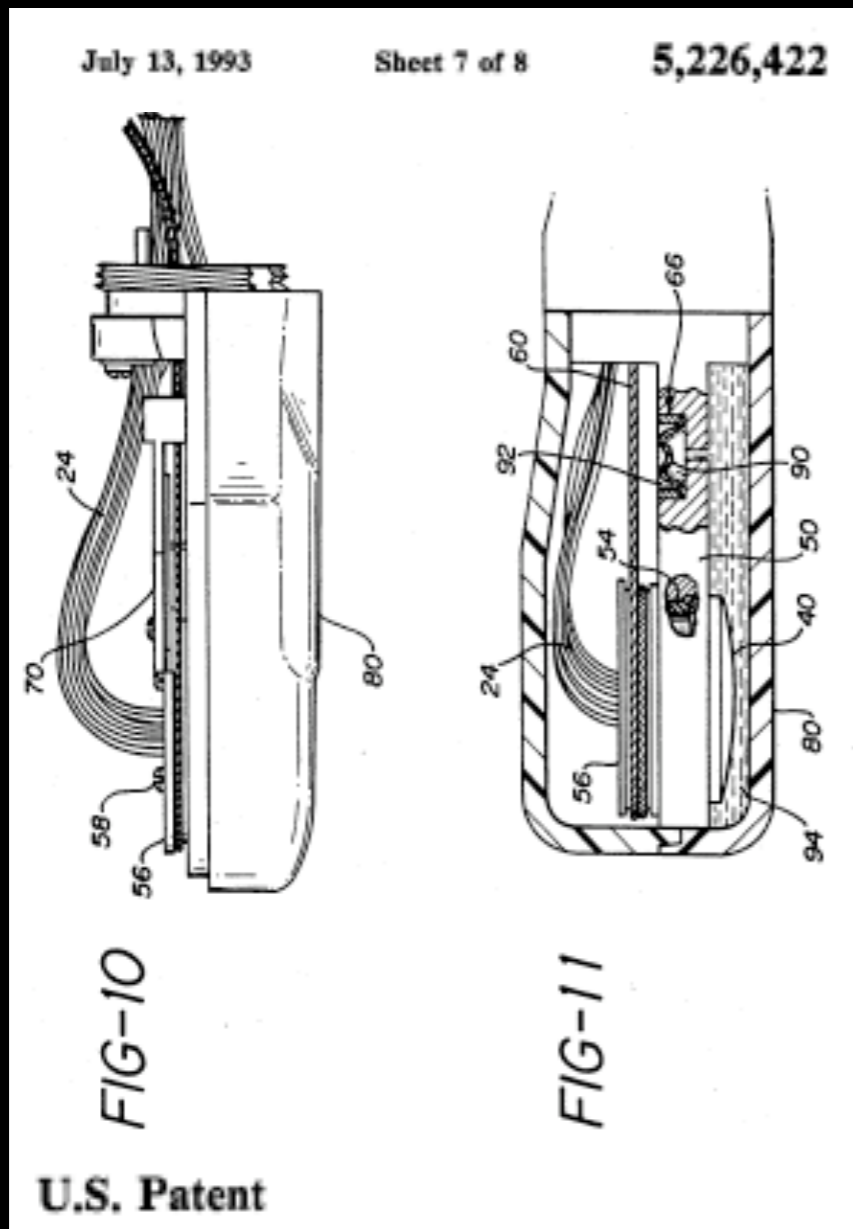
akana

u	ウ	宇	e	エ	江	o	オ	於
ku	ク	久	ke	ケ	介	ko	コ	己
su	ス	須	se	セ	世	so	ソ	曾
tsu	ツ	川	te	テ	天	to	ト	止
nu	ヌ	奴	ne	ネ	祢	no	ノ	乃
fu	フ	不	he	ヘ	部	ho	ホ	保
mu	ム	牟	me	メ	女	mo	モ	毛
yu	ユ	由				yo	ヨ	也
ru	ル	流					呂	呂

# 3D Echocardiography

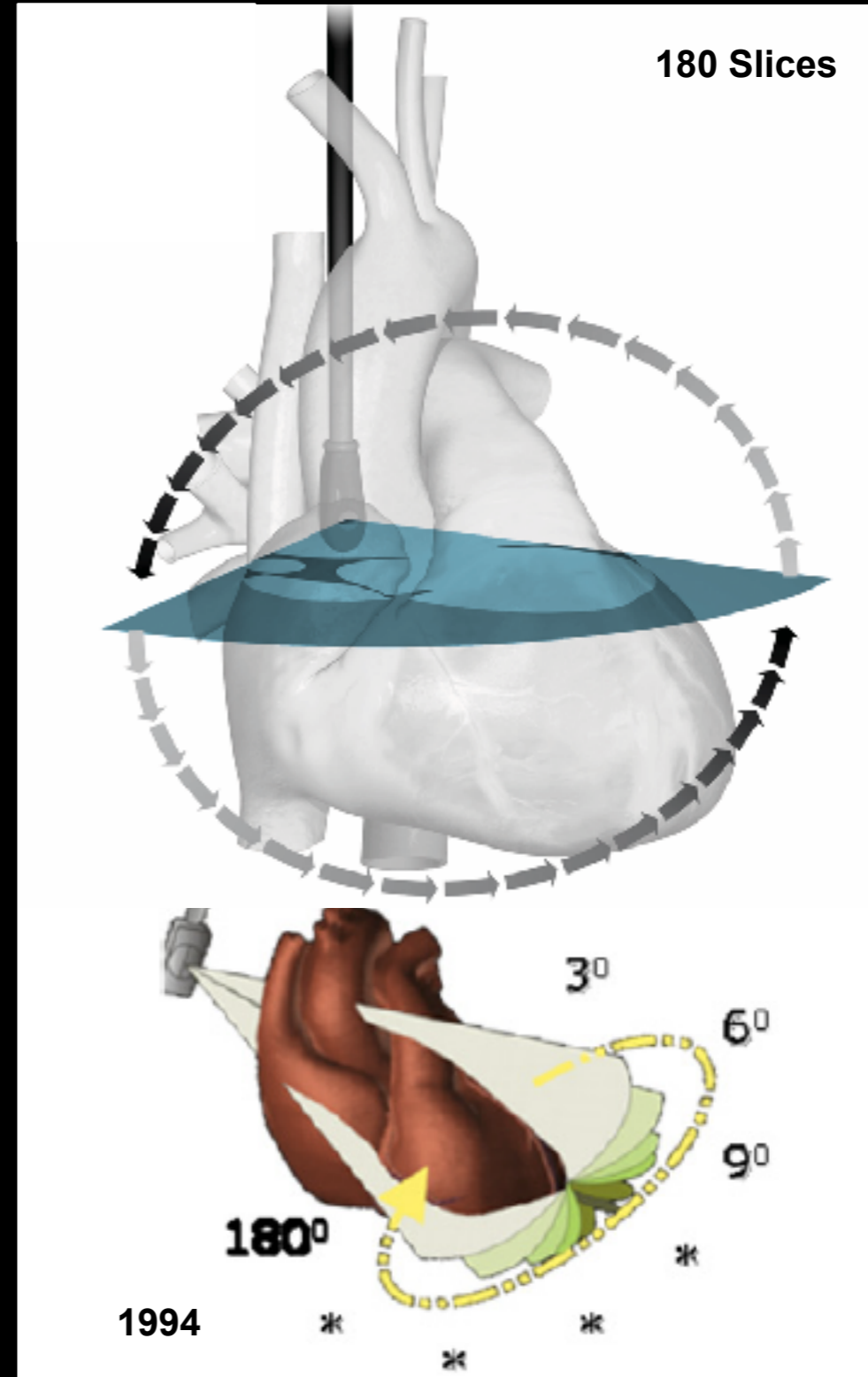
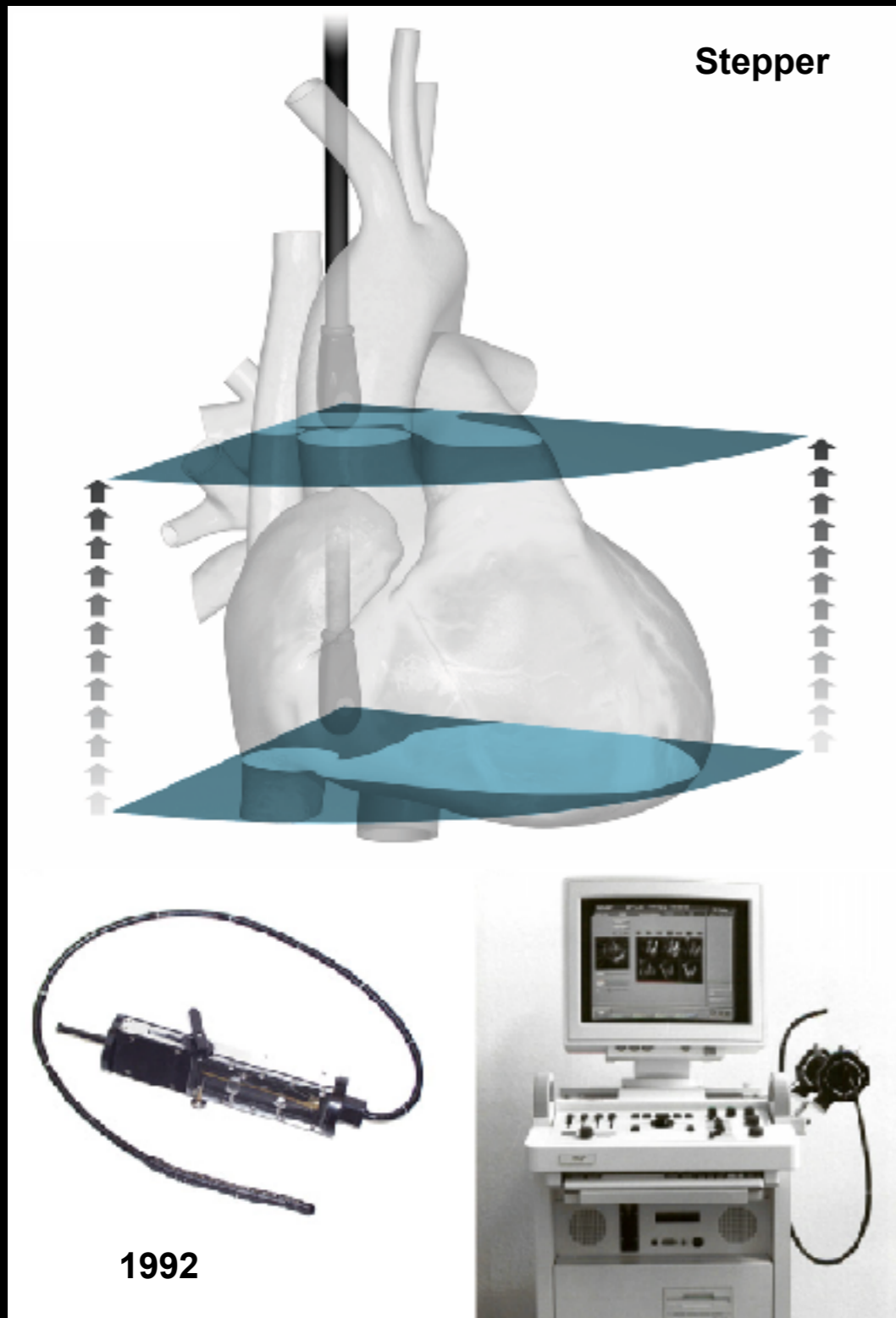


# Echocardiographic transducers

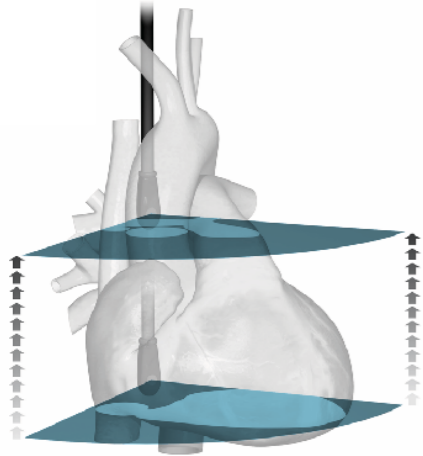




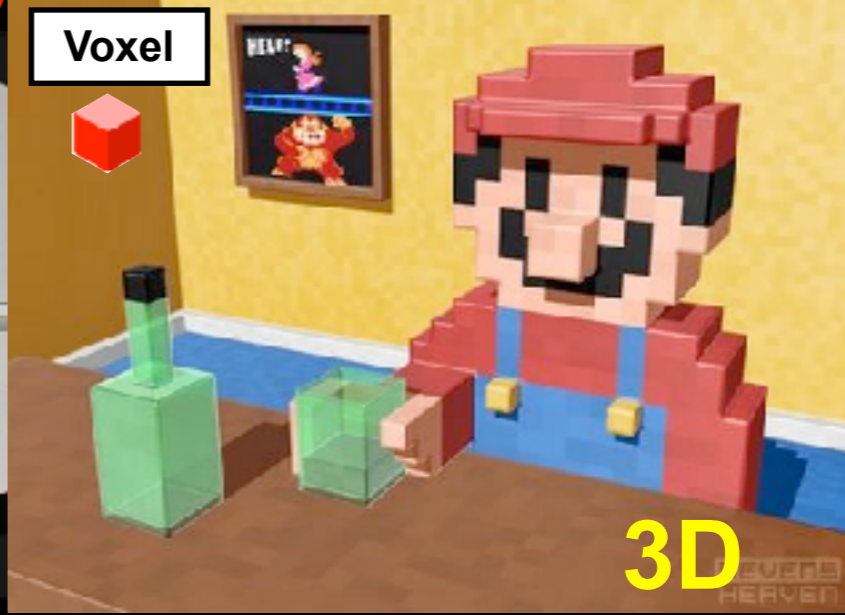
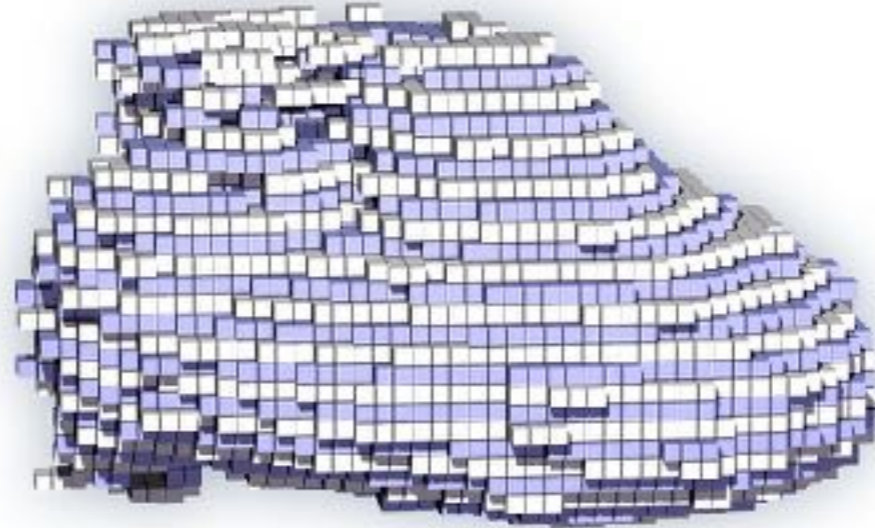
# 3D Scanning



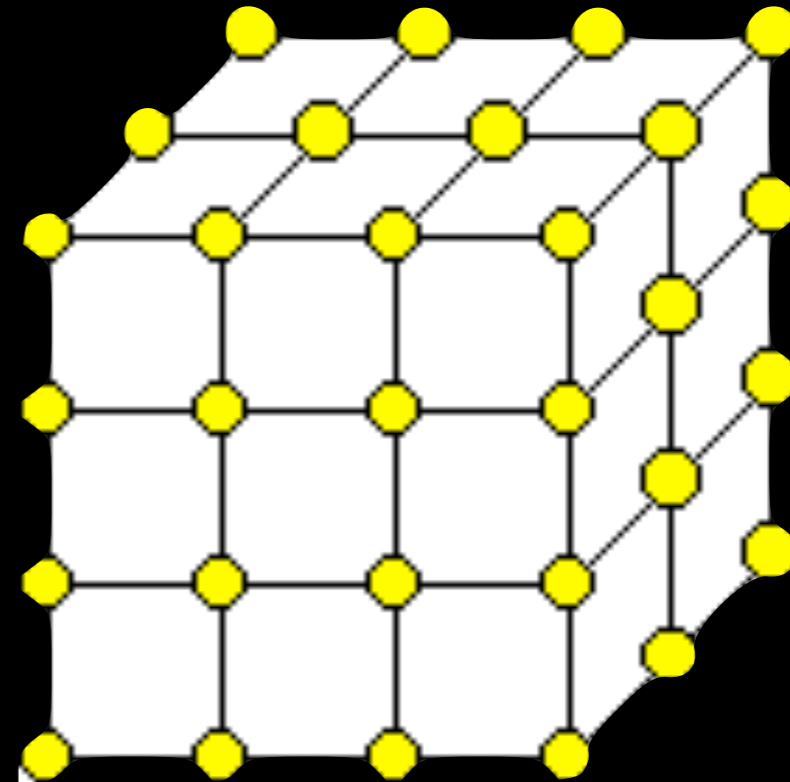
# 3D Reconstruction



Interpolation



# Dataset



Dataset

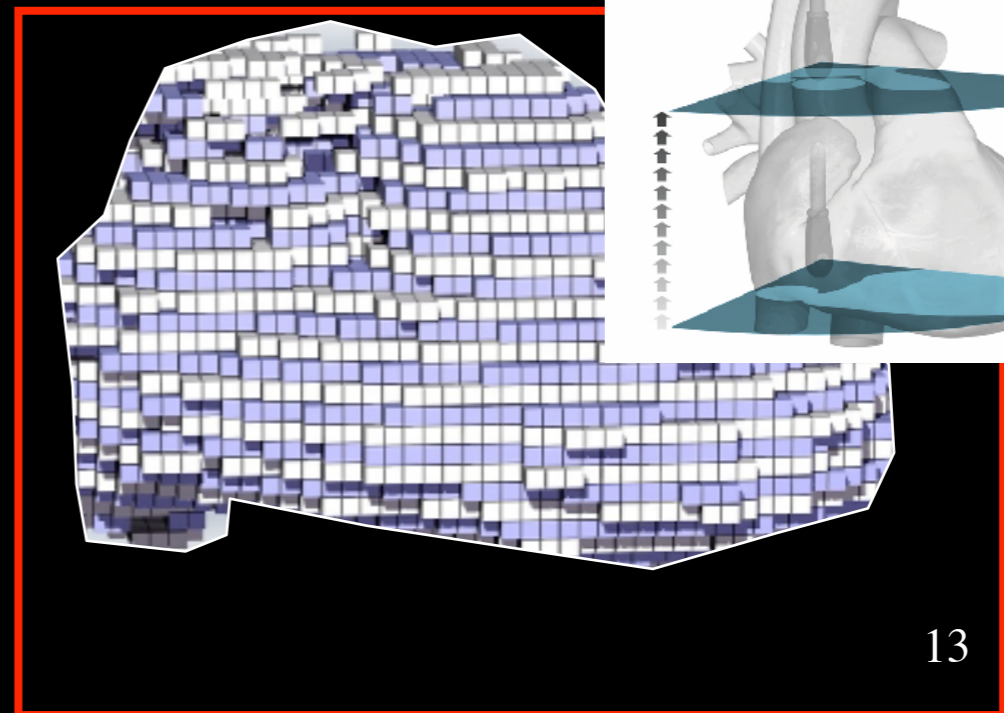
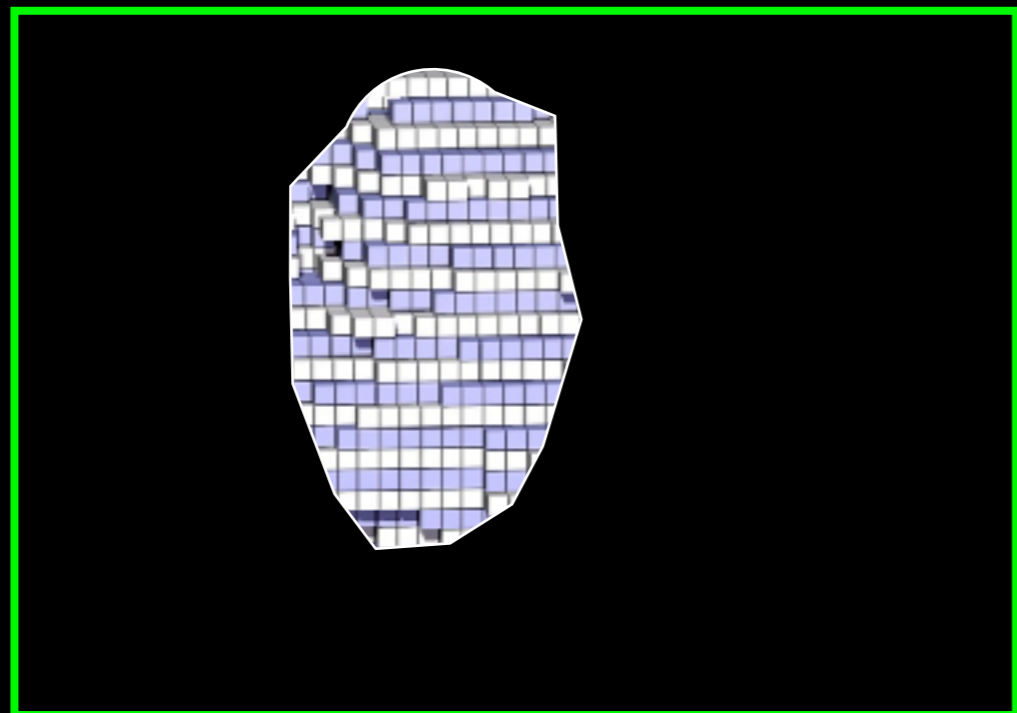
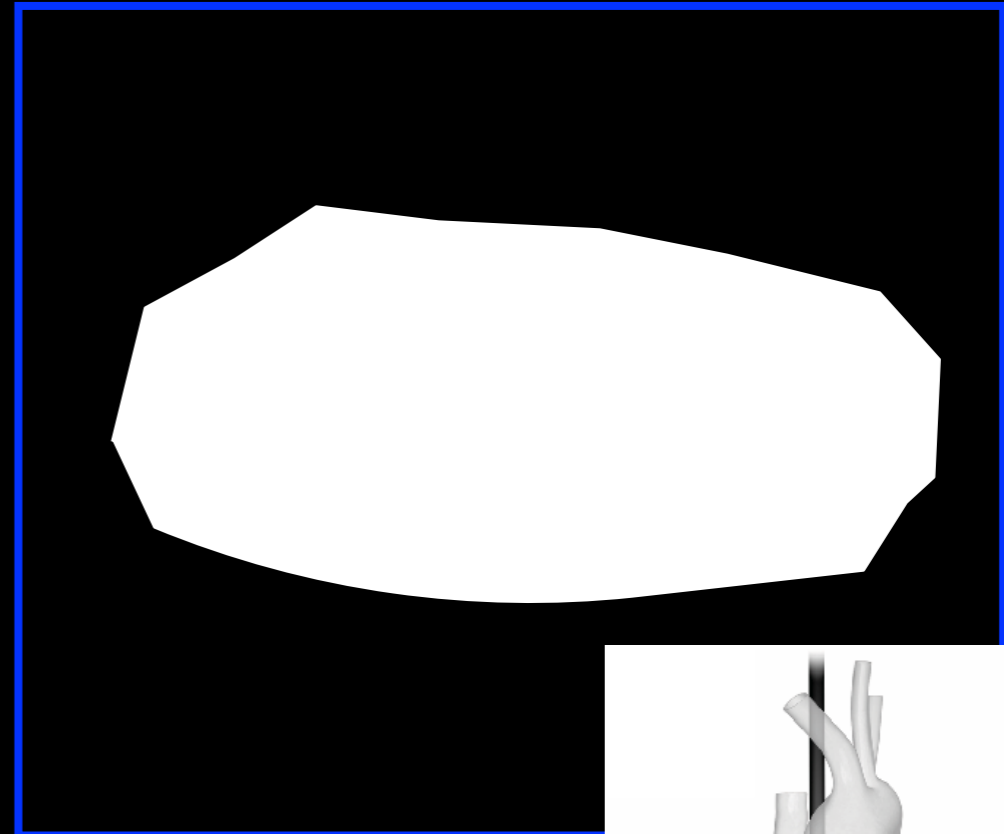
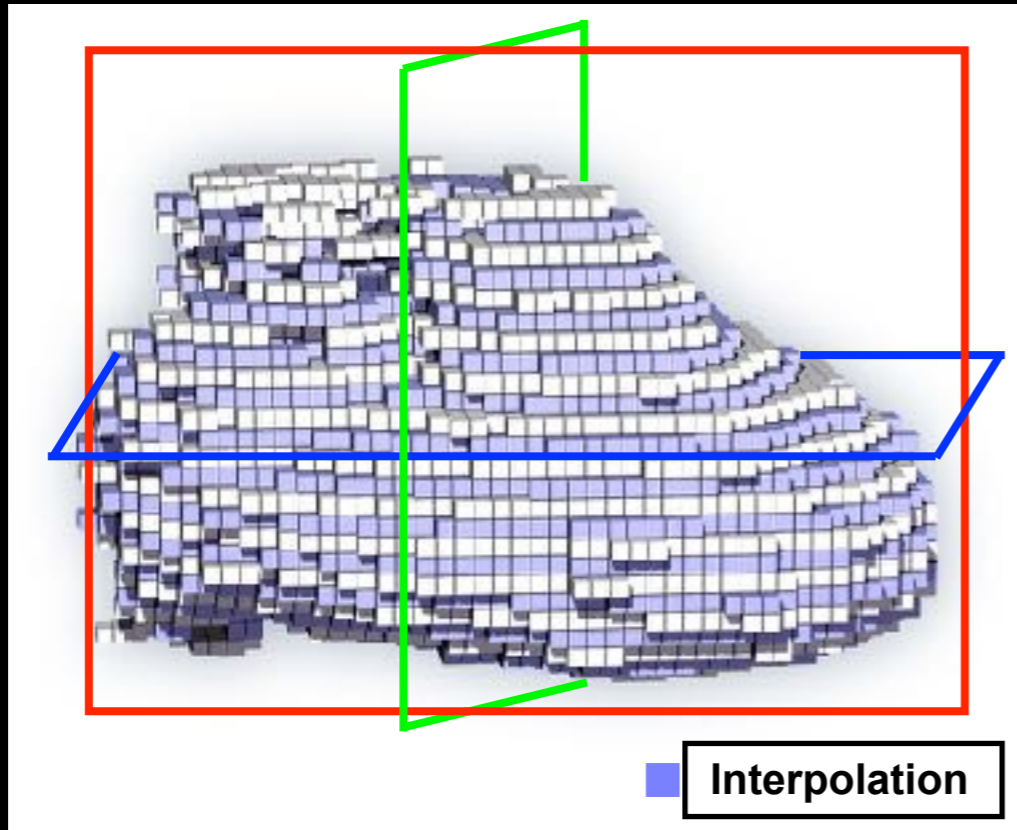


# 3D Display

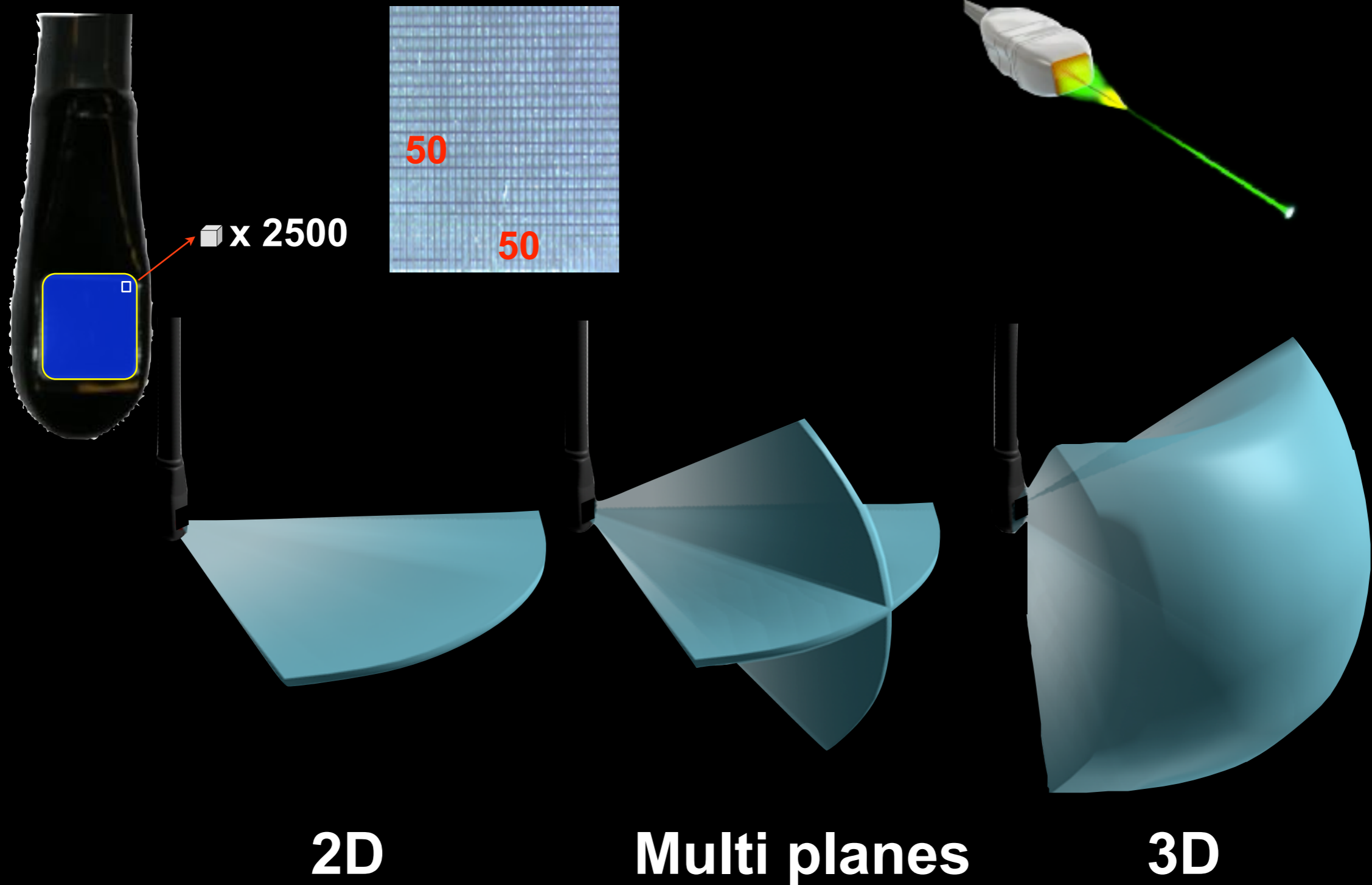
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# 3D Display Multi Planar Reformating



# Matrix Array Probe



2D

Multi planes

3D

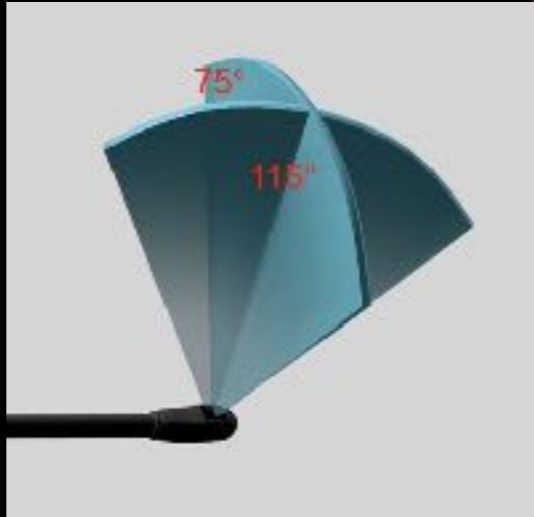
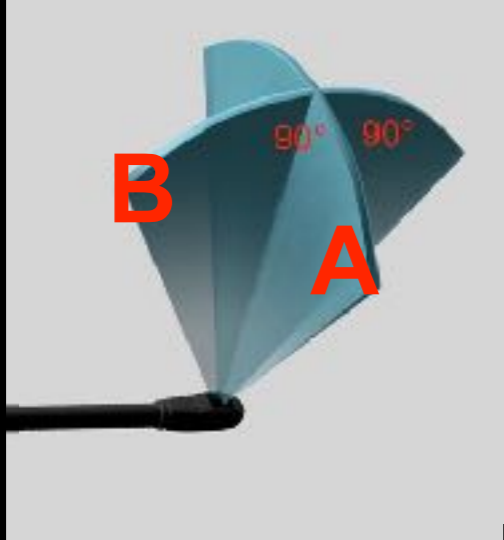


# Multi-planes

FR 36Hz  
9.0cm  
xPlane  
66%  
66%  
48dB  
P Off  
Gen



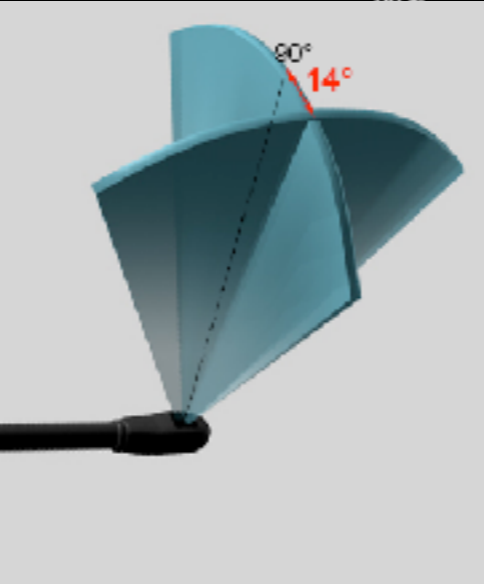
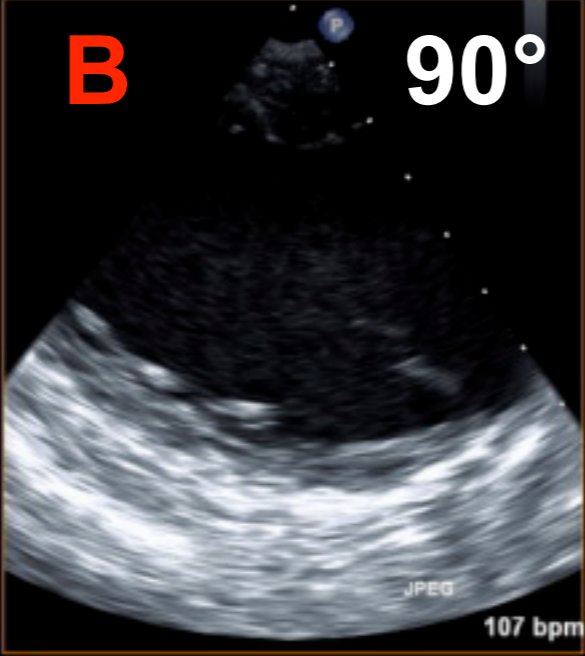
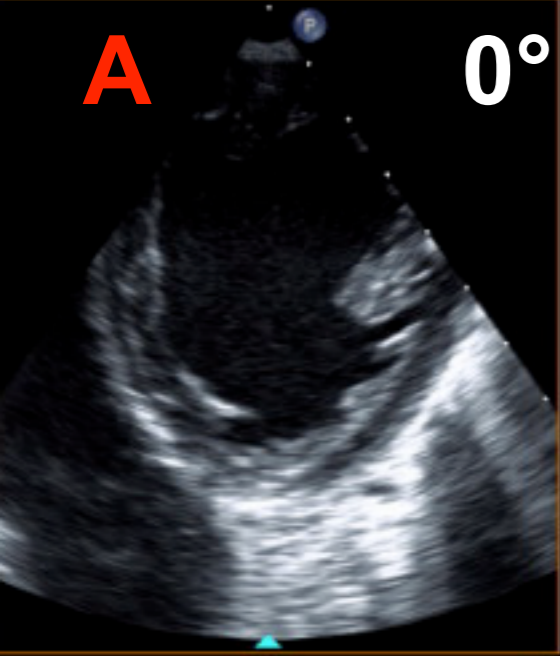
M4



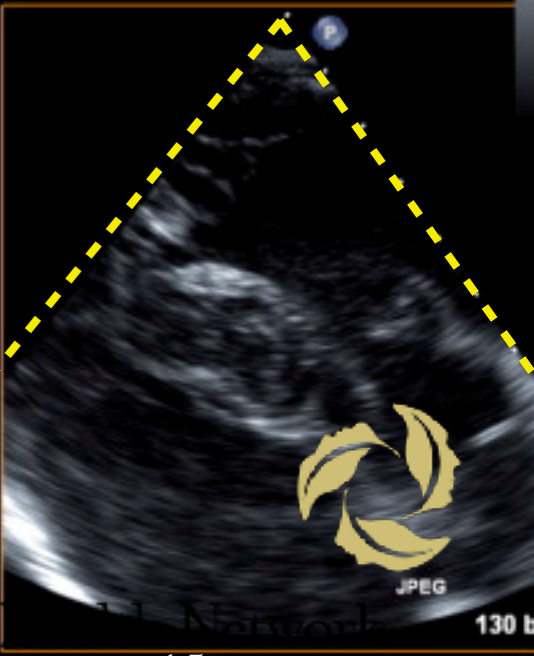
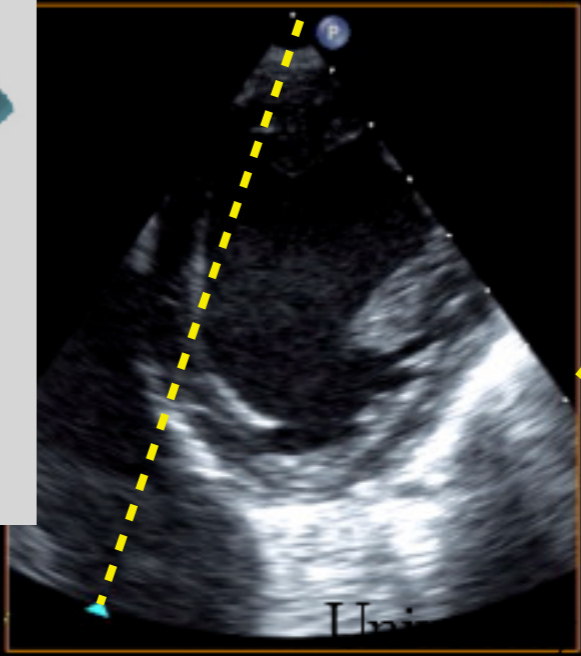
FR 36Hz  
9.0cm  
xPlane  
66%  
66%



M4



Color



# Multi-planes

**Acquisition Modes - xPlanes**  
 The xPlane mode of acquisition allows the simultaneous acquiring and display of two perpendicular planes.  
 To enter the xPlane mode, press the xPlane button (Show Fig).

**Acquisition Modes - Multi Dimension**  
 To enter into In-Plane mode the In-Plane button is pressed (Show me)

**Bi-Plane +**  
 Cardiac / TEE YALE\* / 2DMs  
 Lens Temp: 38.3° C  
 64 fps / 80 mm  
 64 bpm / AV\*  
 3.0MHz / 6 dB  
 DR: 82 dB  
 81

X Planes

Multi D

Bi-Plane +





# 3D vs. 4D



**4D = 3D X time**

# RT=Real Time

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- Real time  $\neq$  Live
- Real time = Acquisition to display
- TTE Withdraw probe from skin: image disappears
- TEE Move the probe: image changes



# Real Time

FR 8Hz  
7.2cm

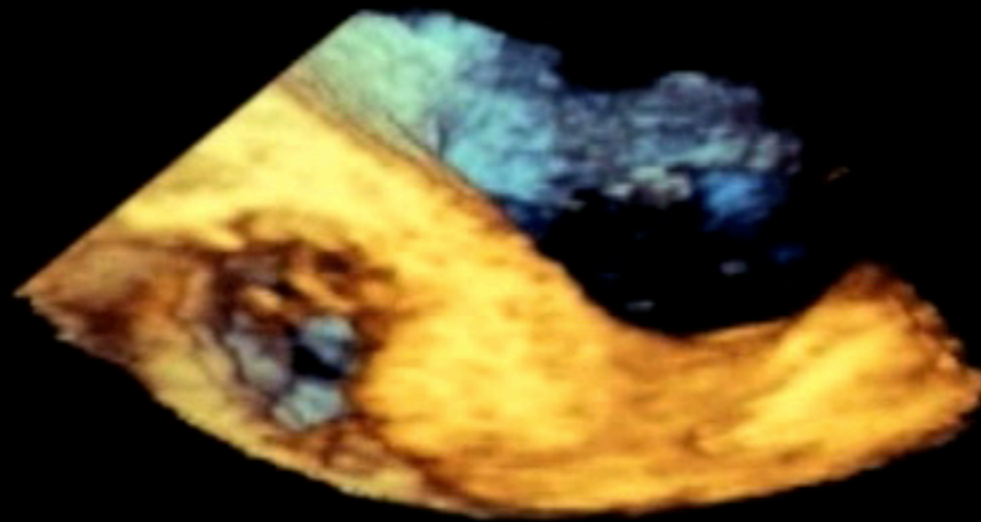
Live 3D  
3D 0%  
3D 40dB  
Pen



**live**



M4



91bpm

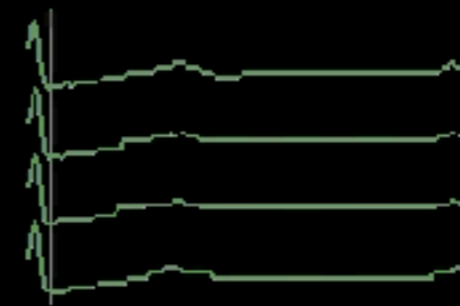
**Moving**



# Real Time

Displayed in real time

~~live~~



50 bpm

Moving

3D↑

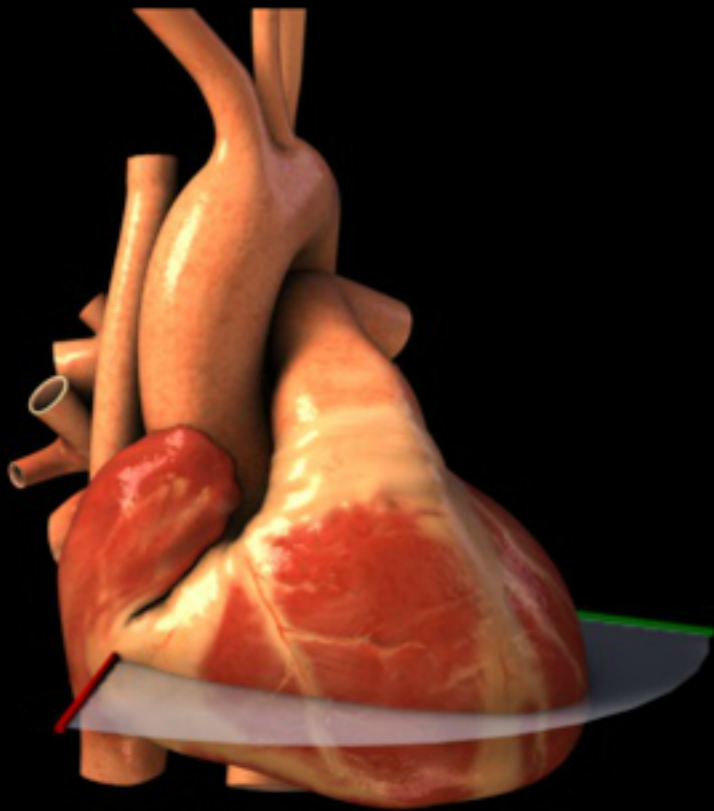


PHILIPS

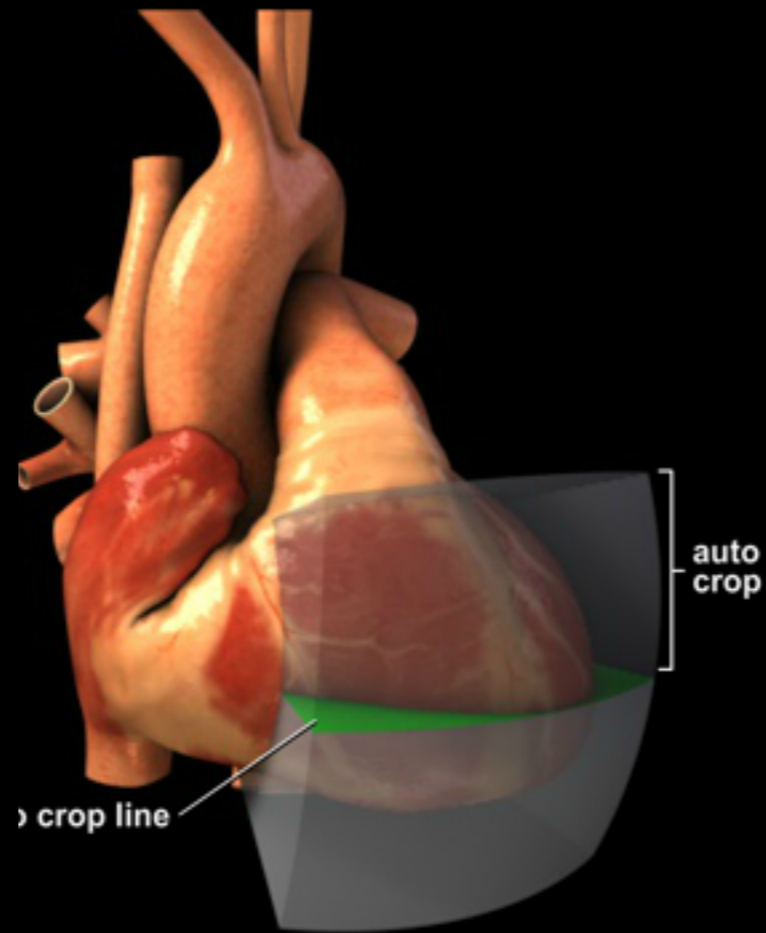


# Wide volume

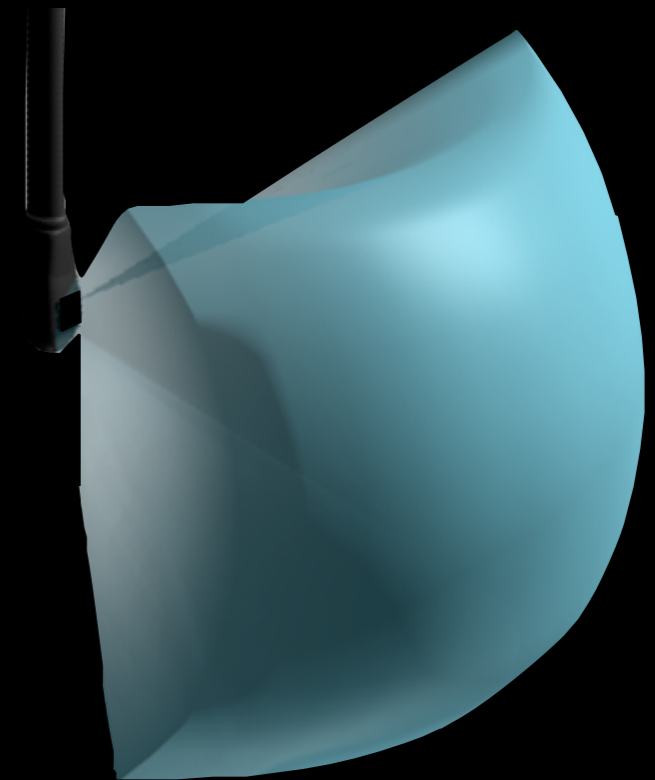
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90

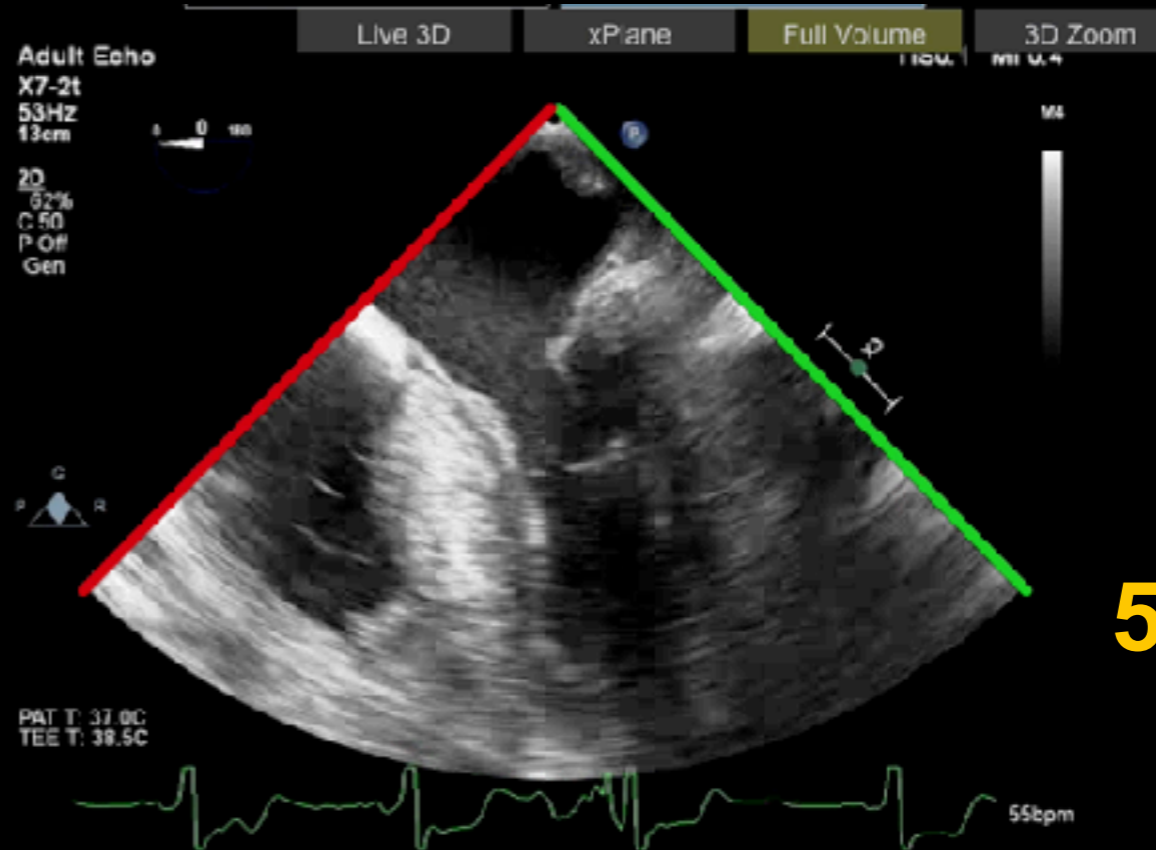
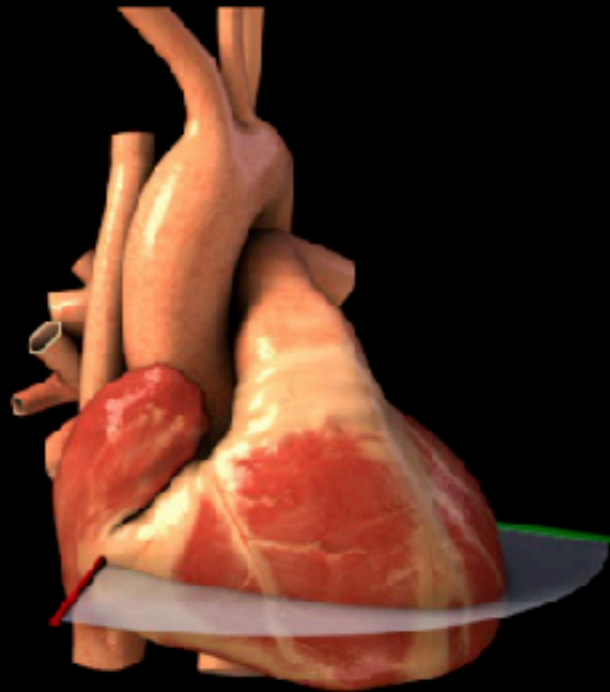


90X90



110X110

# Wide volume



53 to 9 Hz

## Acquisition Modes - Full Volume

The 'Full Volume' mode is commonly used in the assessment of large structures such as the ventricles.

To enter 'Full Volume' mode, the 'Full Volume' button (Show me) is pressed.



# US Rules

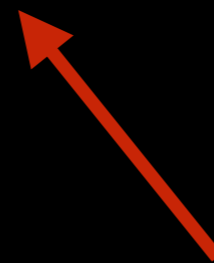
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**Size**

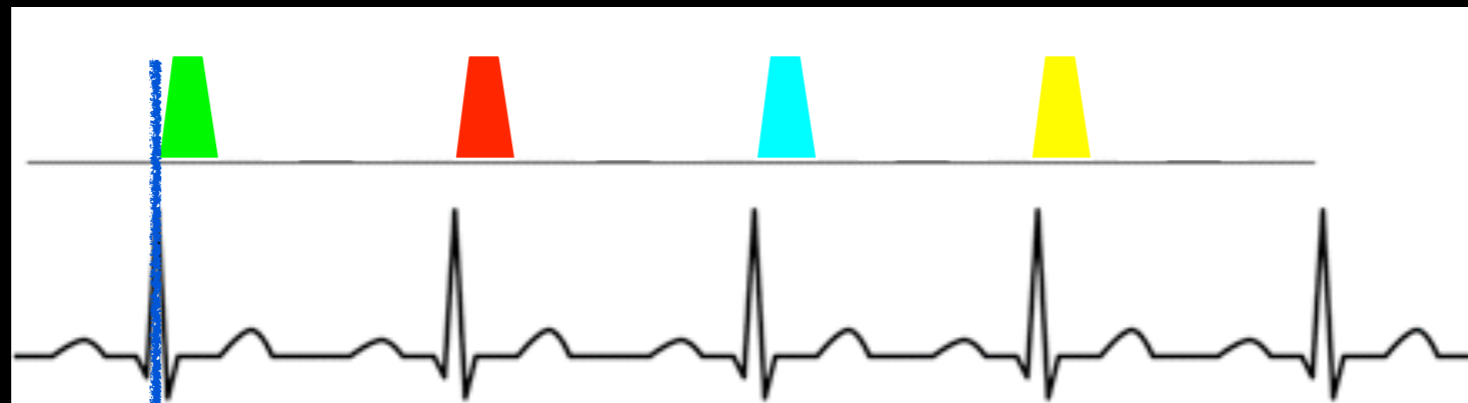
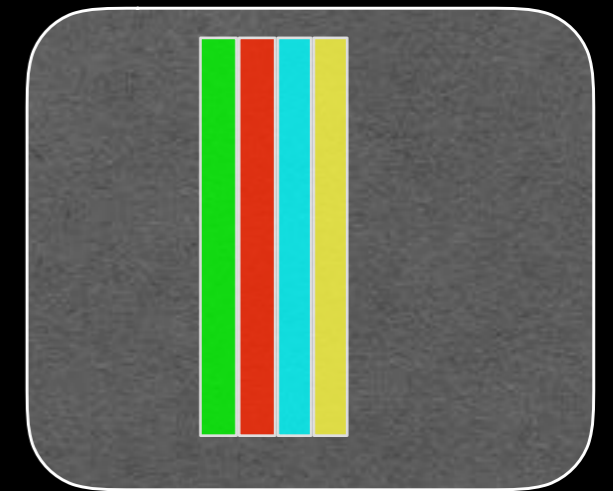
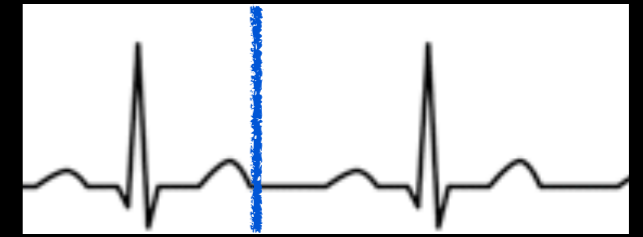
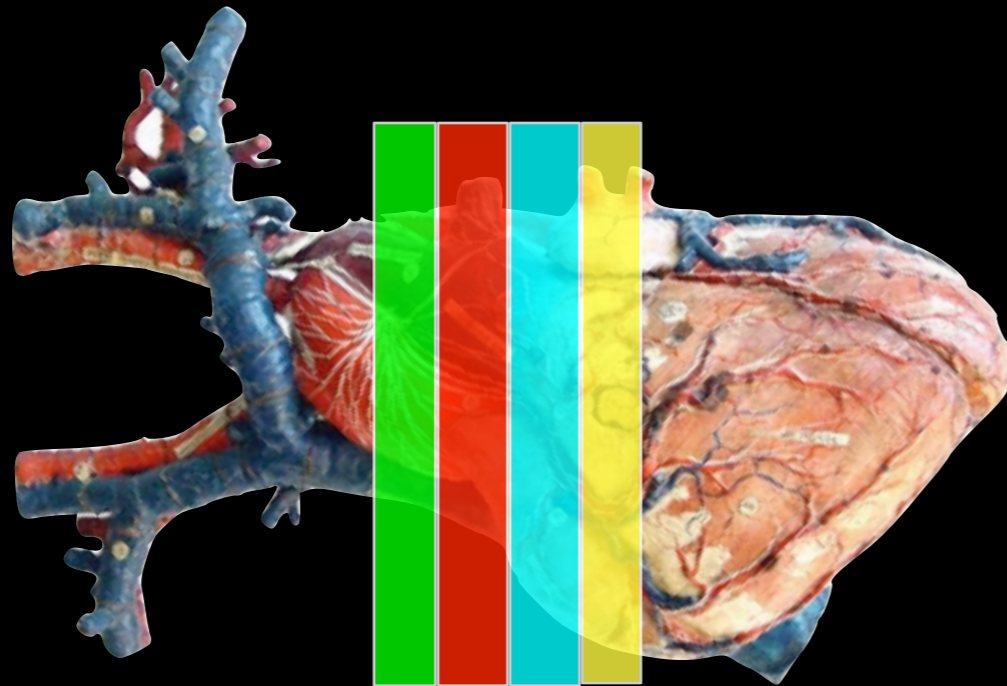


**Spatial**

**Temporal**

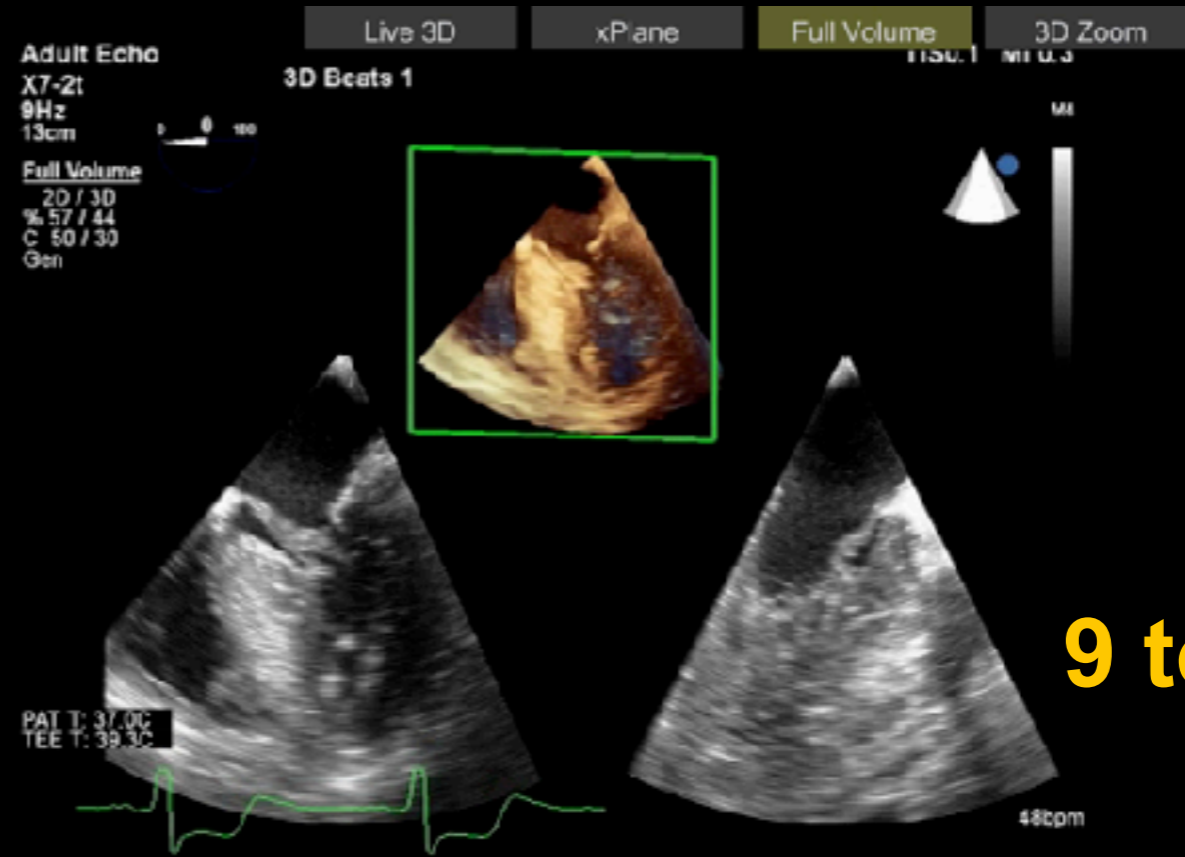
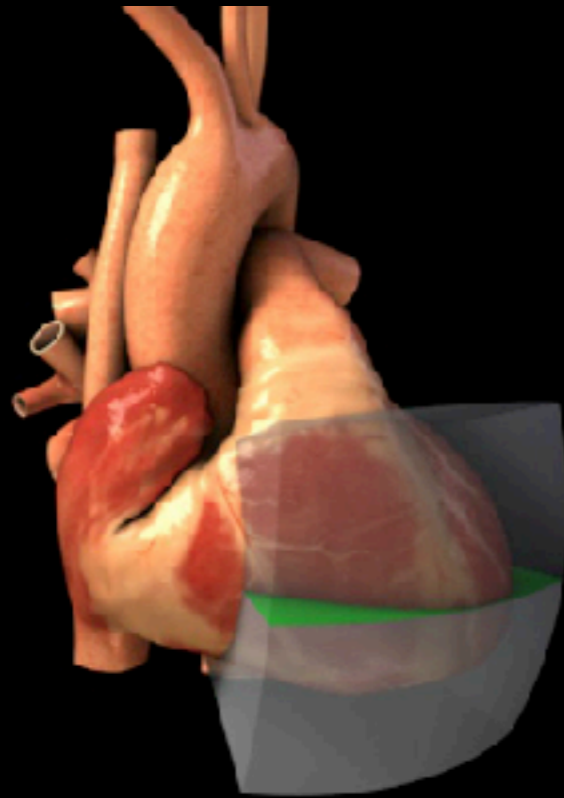


# ECG Gating





# Gated Acquisition



9 to 48 Hz

## Acquisition Modes - Full Volume

The 3D dataset can be obtained over 1 beat (real time) or multiple consecutive heart beats (2, 4, or 6 beats) (ECG gated). ECG gating will increase temporal and spatial resolution but it is subject to stitch artifacts. Given the large size of Full Volume datasets, ECG gating is almost invariably required.

To change the number of beats over which the volume is acquired the '3D Opt' knob (Show me) is used.

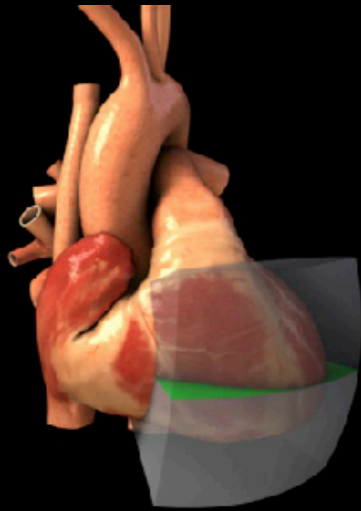


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Next



# ROI

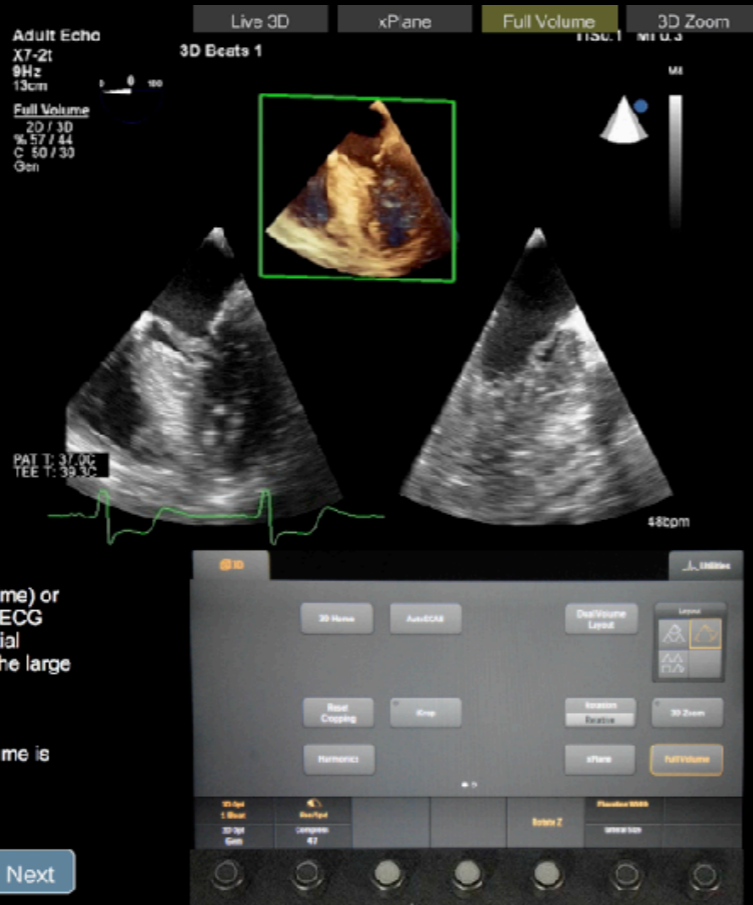


## Acquisition Modes - Full Volume

The 3D dataset can be obtained over 1 beat (real time) or multiple consecutive heart beats (2, 4, or 6 beats) (ECG gated). ECG gating will increase temporal and spatial resolution but it is subject to stitch artifacts. Given the large size of Full Volume datasets, ECG gating is almost invariably required.

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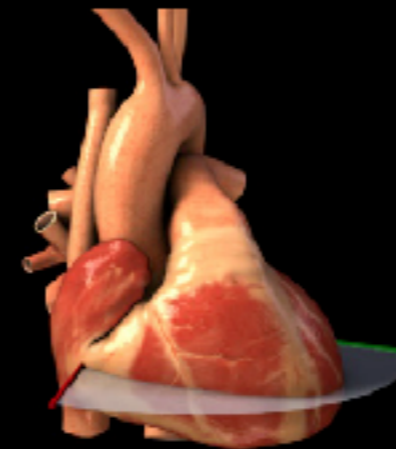
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## Acquisition Modes - Live 3D

The 'Live 3D' acquisition mode produces small size, 3D volumes allowing for high spatial and temporal resolution, although it may be insufficient to contain the entire structure of interest. This modality is often used as a 3D image test and to guide the placement of wires or devices.

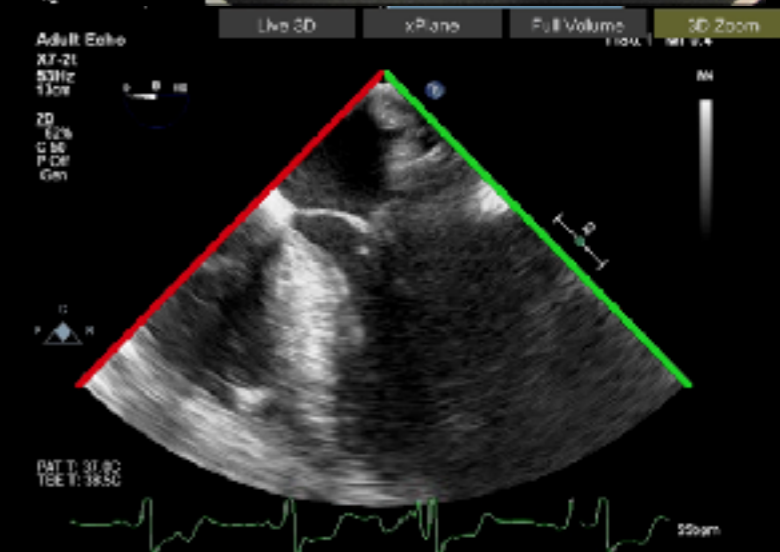
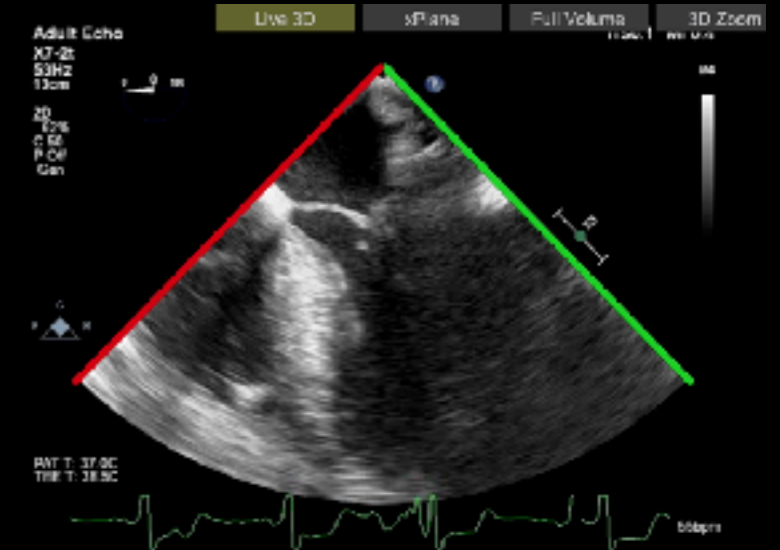
To acquire a 3D volume using 'Live 3D' the Live 3D button (Show me) on the right control touch screen is pressed when in the 2D mode.



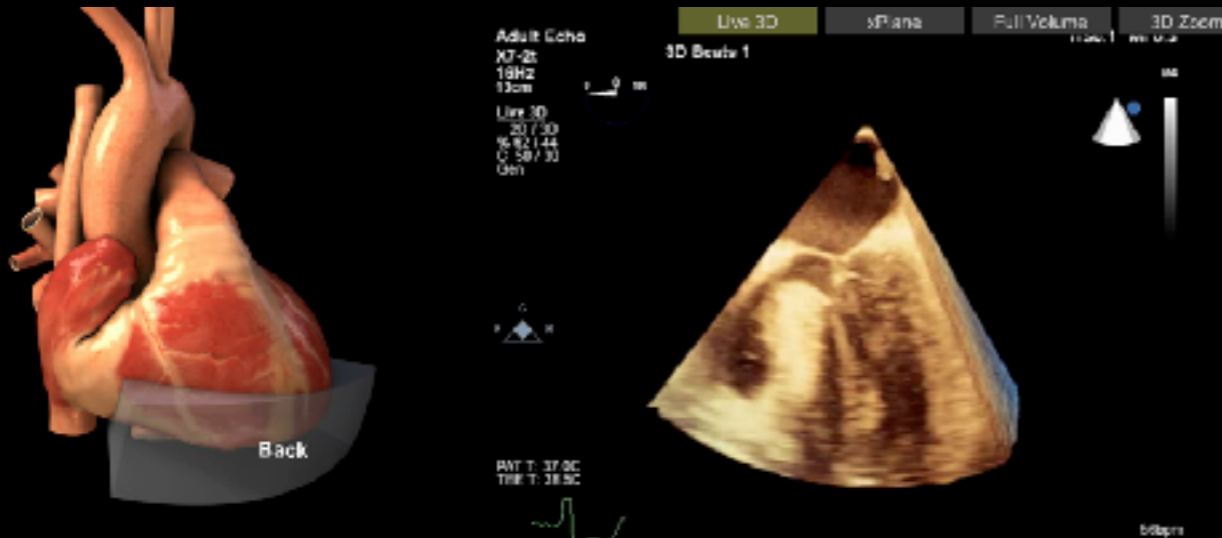
## Acquisition Modes - 3D Zoom

The '3D Zoom' mode is commonly used for the assessment of individual valves and small structures.

To begin '3D Zoom' acquisition the '3D Zoom' button (Show me) is pressed.



Next



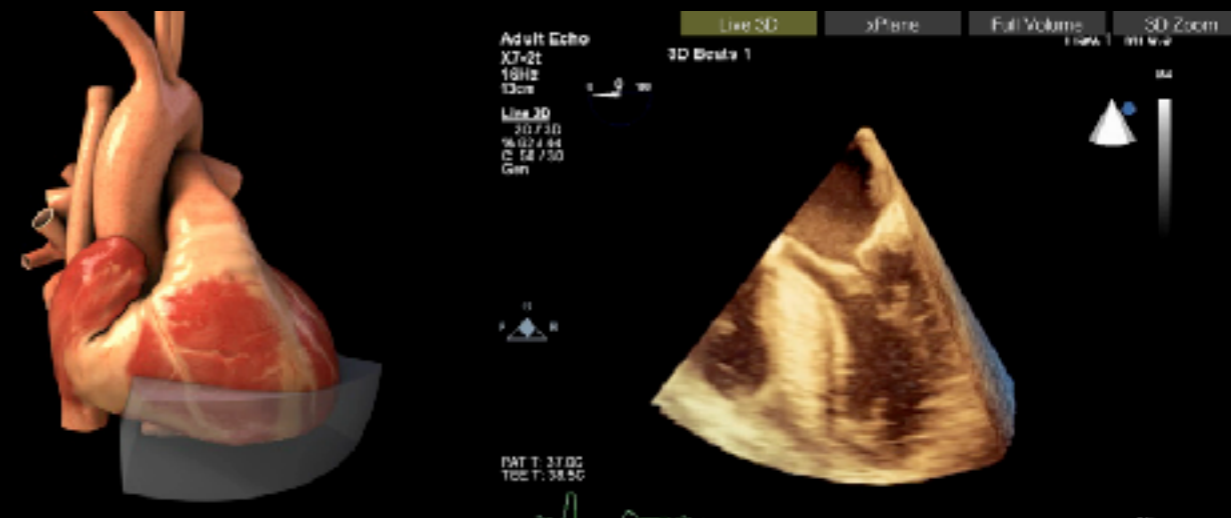
### Acquisition Modes - Live 3D

The 'Live 3D' mode of acquisition generates a narrow volume 3D dataset of a fixed size: 60 degrees in width, 30 degrees in elevation and a height of 90% the 2D plane depth.

By default, the 3D volume originates from the 'back' of the 2D scanning plane but can be moved against the marker side by clicking the 'Elevation' button. (Show me)



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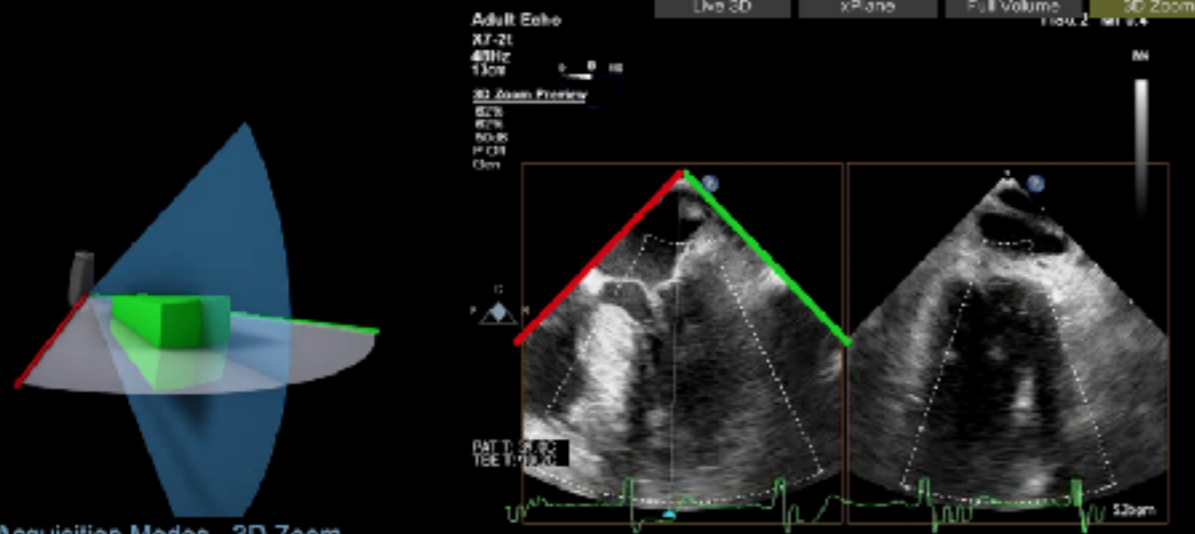
### Acquisition Modes - Live 3D

The 3D dataset can be obtained over one beat (real time) or multiple consecutive heart beats (two, four, or six beats) (ECG gated). Multi-beat acquisition will increase temporal and spatial resolution but it is subject to stitch artifacts.

The default setting is one beat. The '3D Opt' knob (Show me) is used to change the number of beats over which the volume is acquired.



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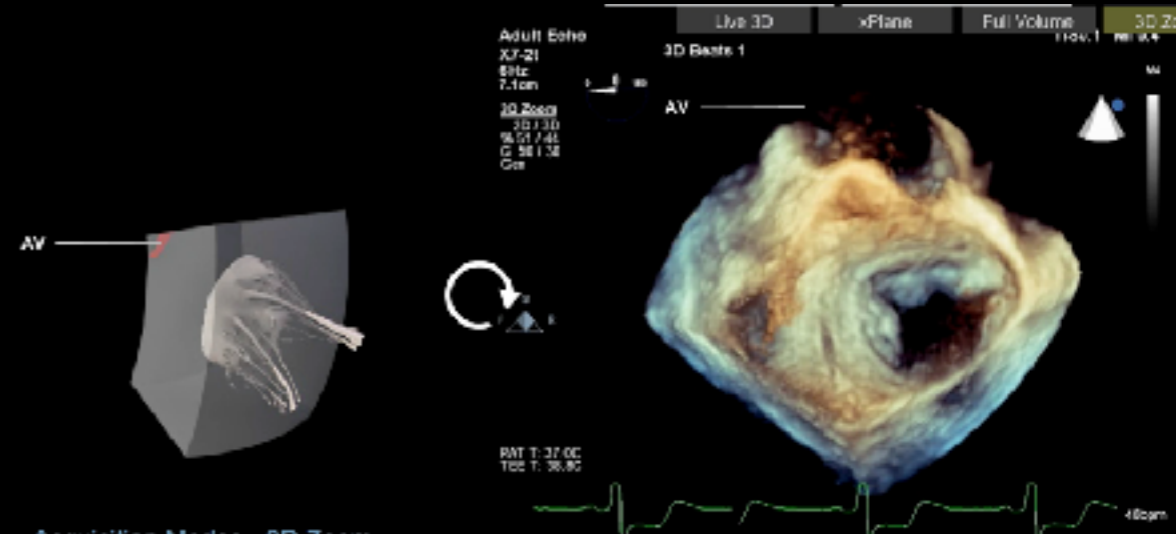


### Acquisition Modes - 3D Zoom

The trackball is also used to change the height and width of the ROI. To access this function, either of the kidney shaped buttons (Show me) beside the trackball are clicked and then the trackball can be used to adjust the size of the ROI.



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### Acquisition Modes - 3D Zoom

Next, the volume is rotated right, using the 'Rotate Z' knob. (Show me)

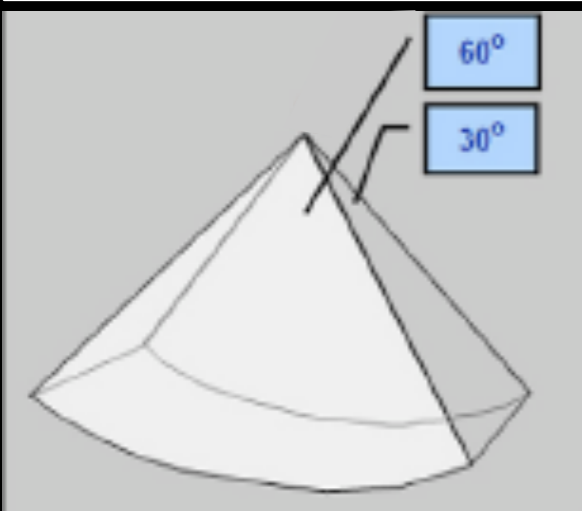
As with the other 3D volume acquisition modes, the 3D dataset can be obtained over 1 beat (real time) or multiple consecutive heart beats (2, 4, or 6 beats) (ECG gated). ECG gating will increase temporal and spatial resolution but it is subject to stitch artifacts. ECG gating is often required for large 3D volumes.



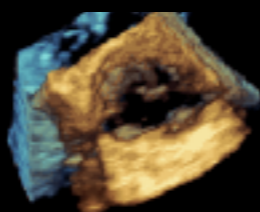
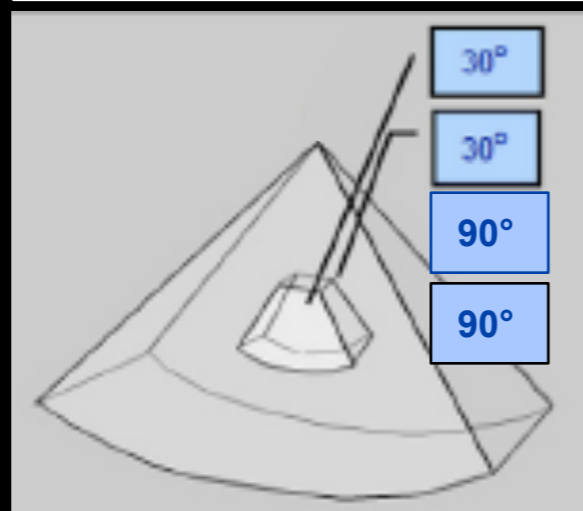
Back Next



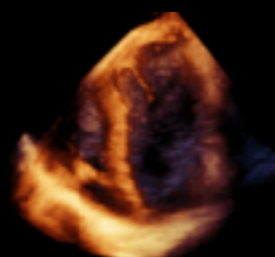
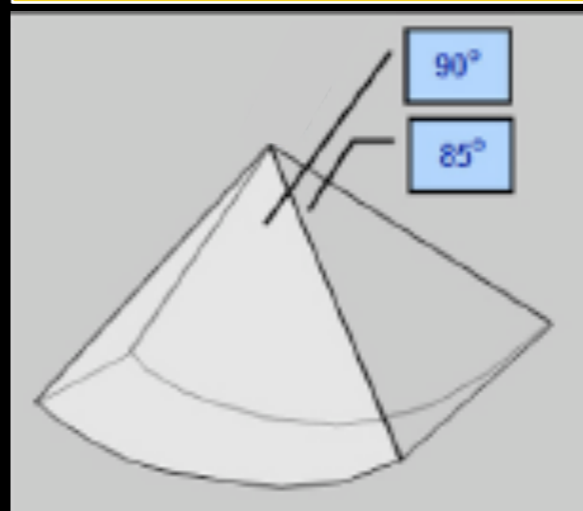
Narrow angle



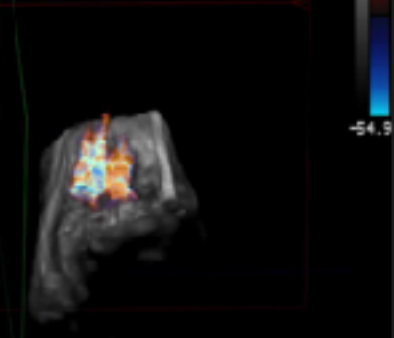
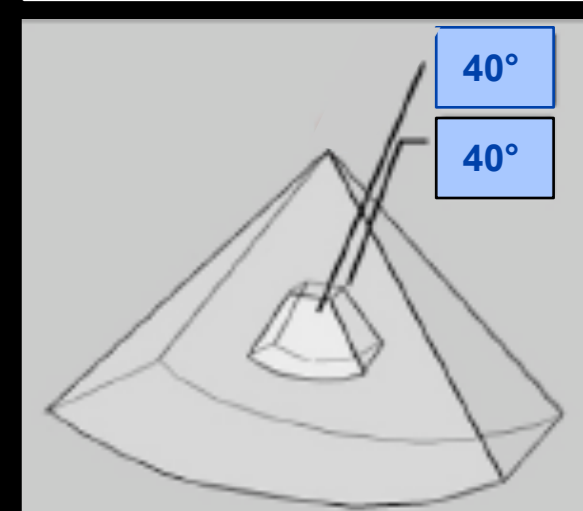
Zoom



Wide angle



Colour

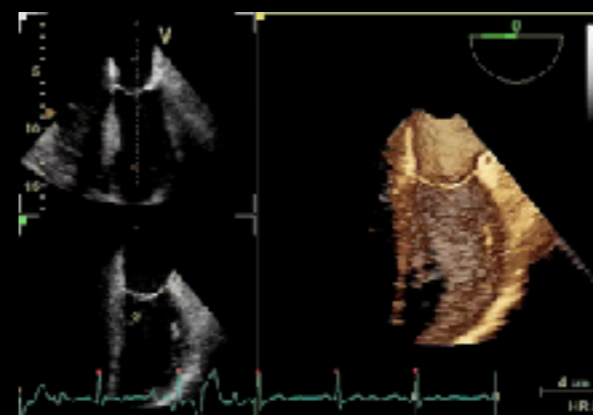
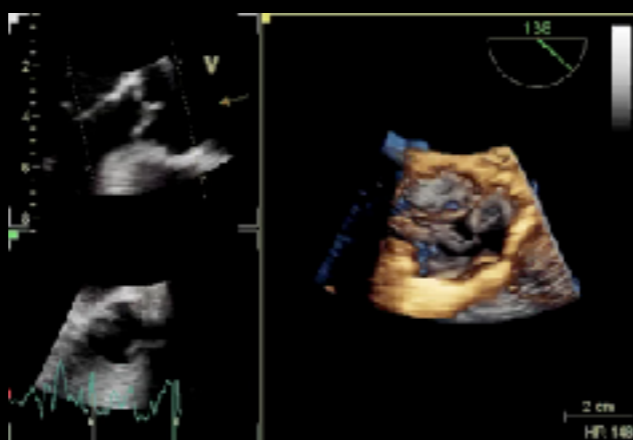


Narrow angle

3D Zoom

Full volume

Colour



Bird's View

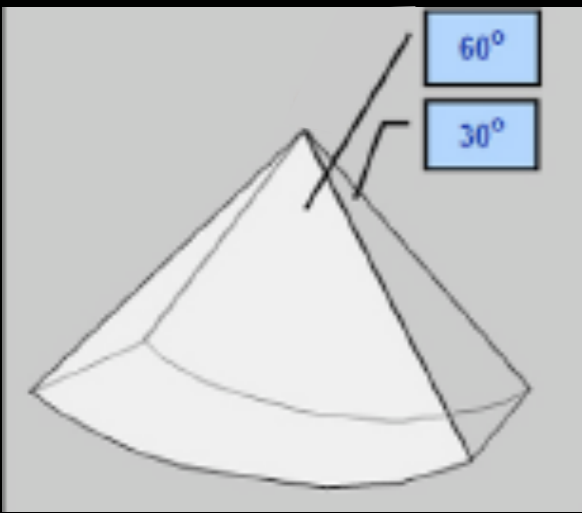
4D Prepare

Med/Large Volume

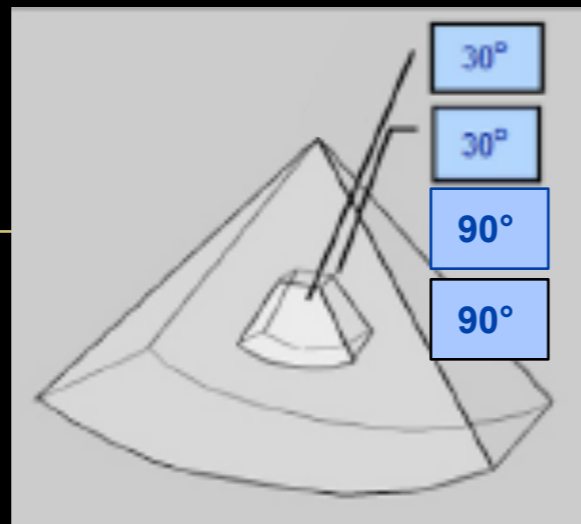
Colour



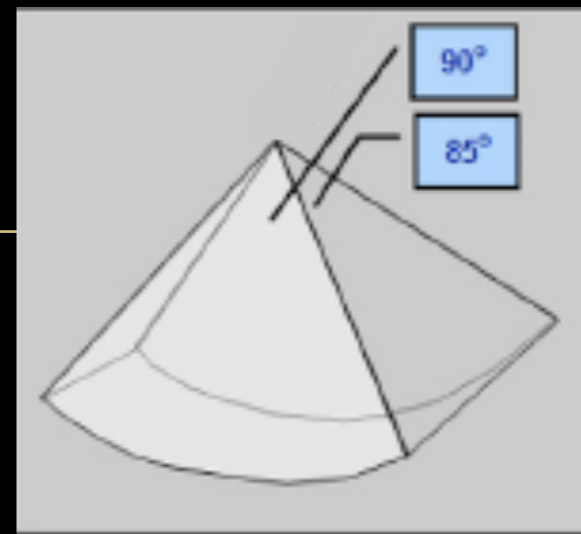
Narrow angle



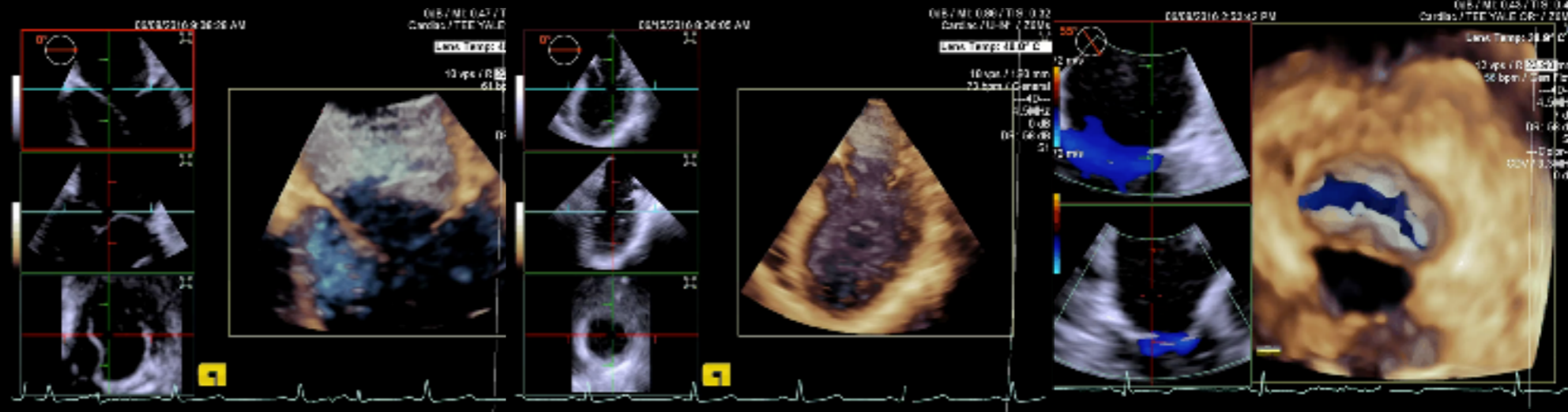
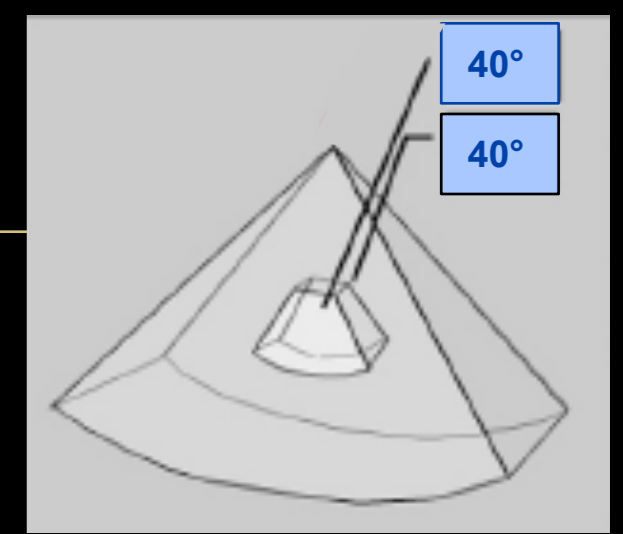
Zoom



Wide angle



Colour



Res

4D

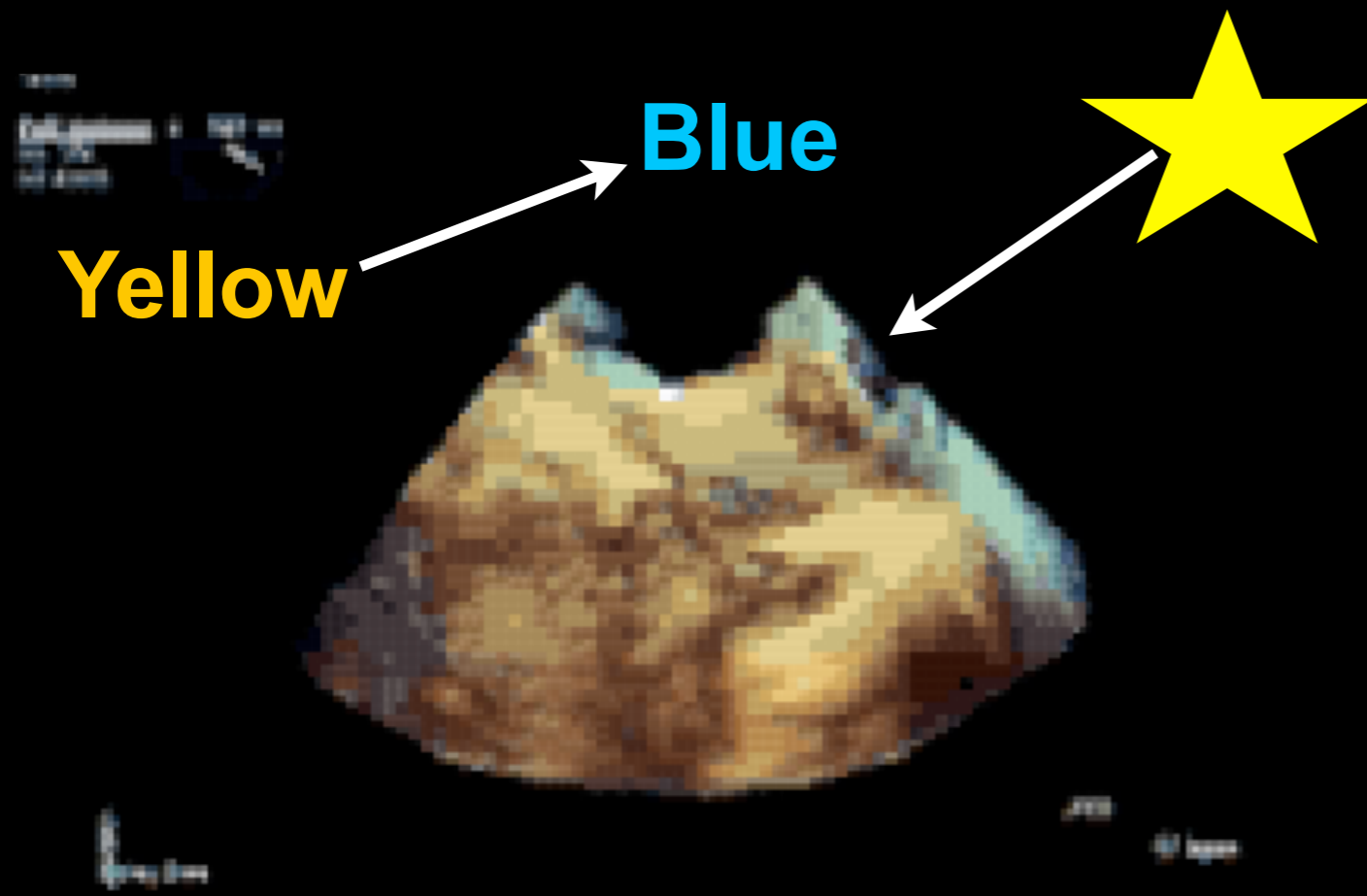
Colour



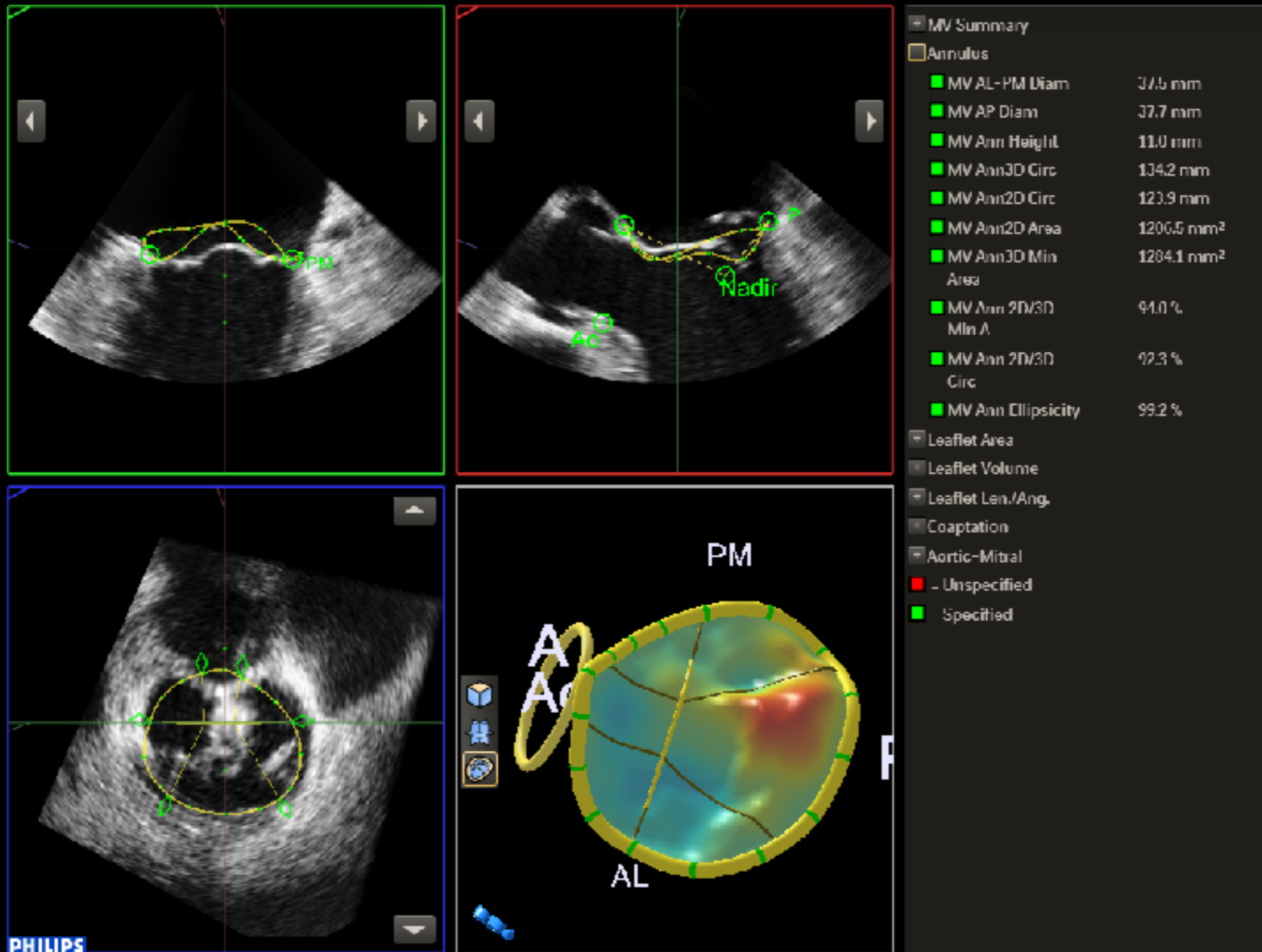
# Image Display



# Volume Rendering



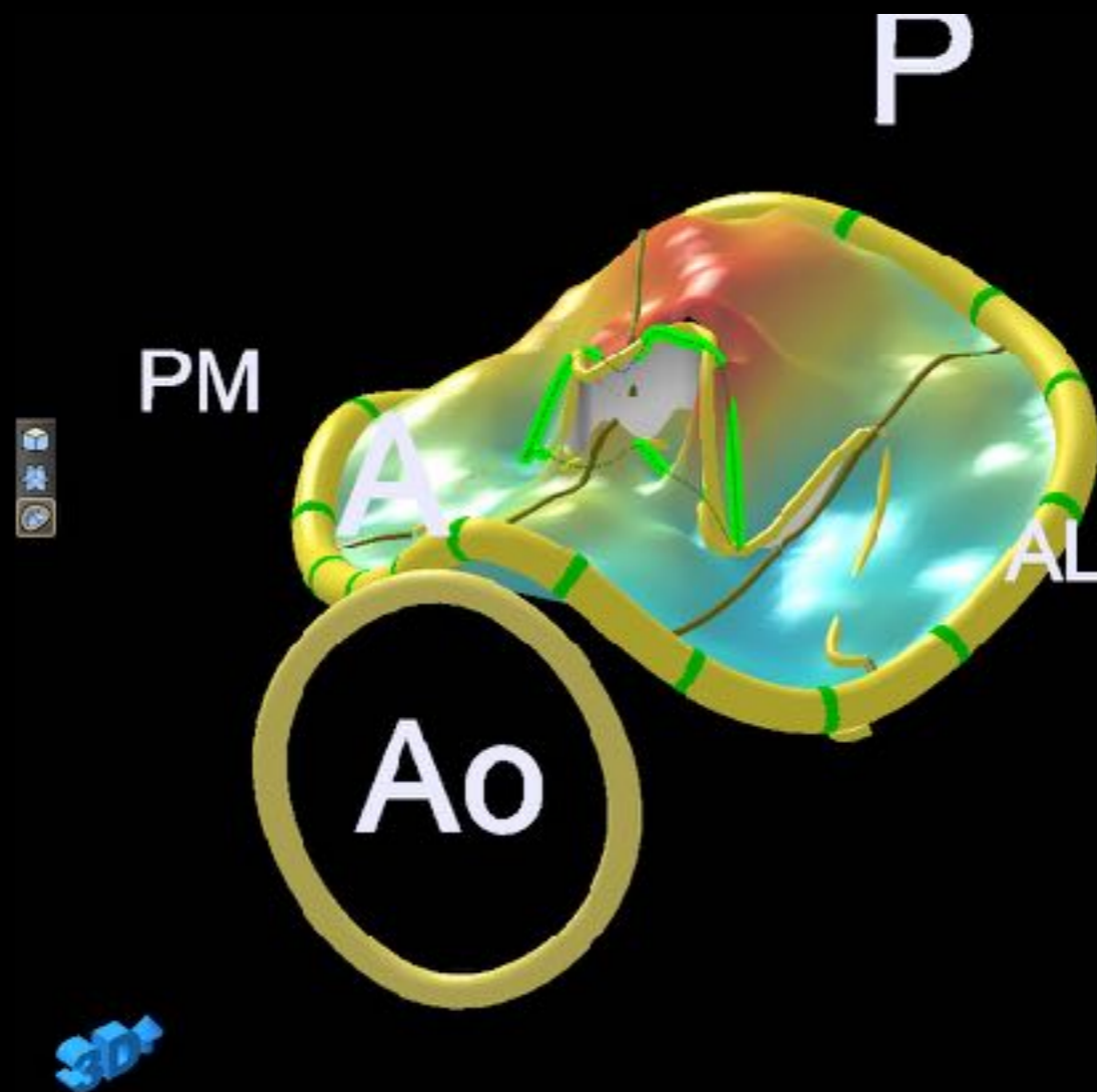
# Segmentation





# Surface Rendering

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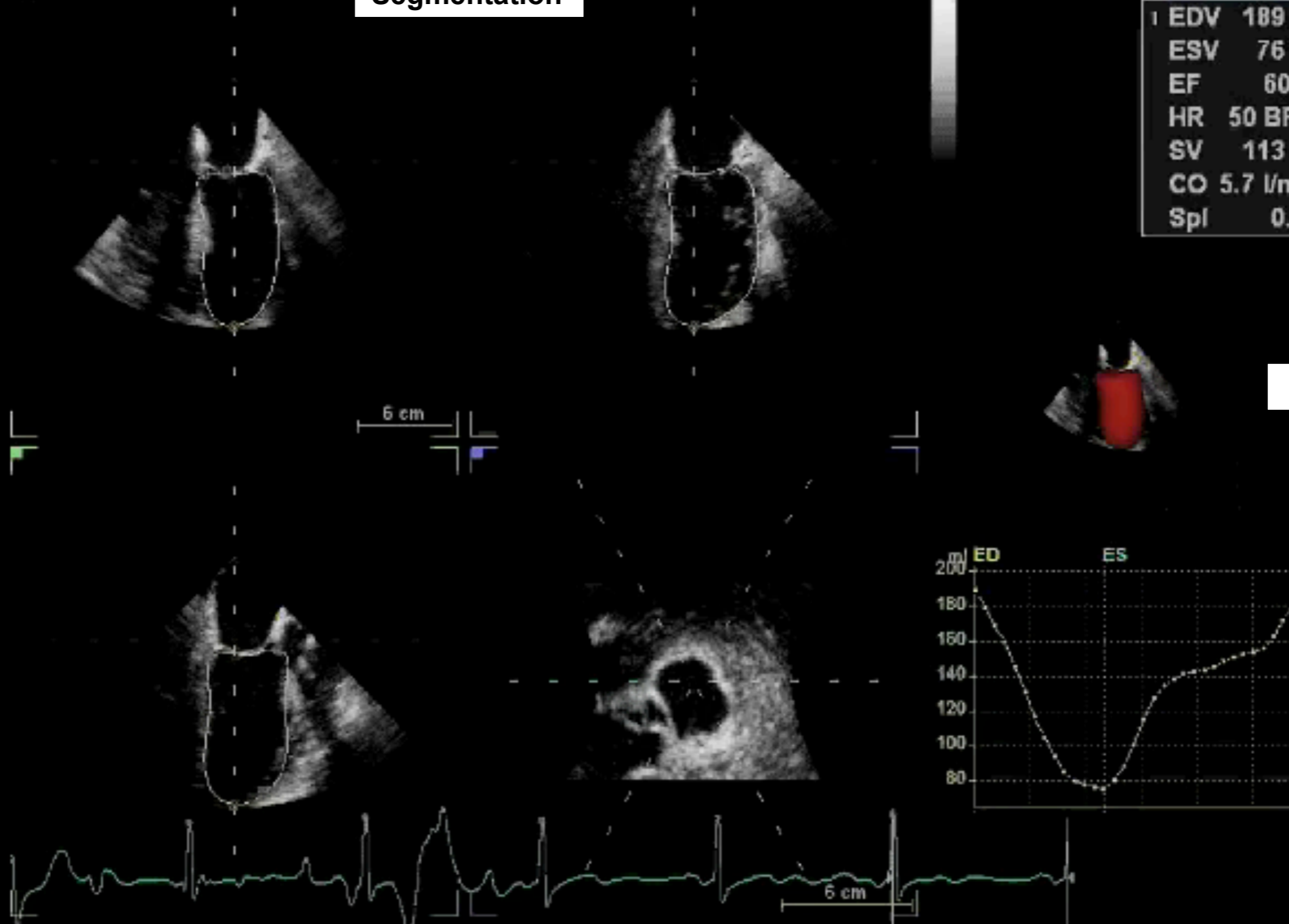
# Surface Rendering

09:39:06

Segmentation

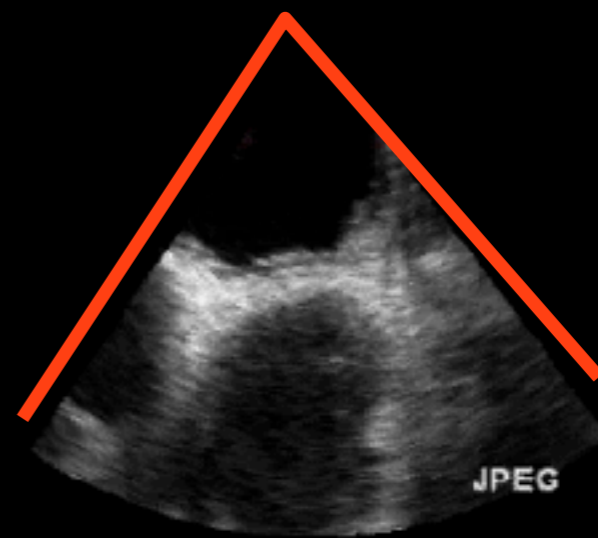
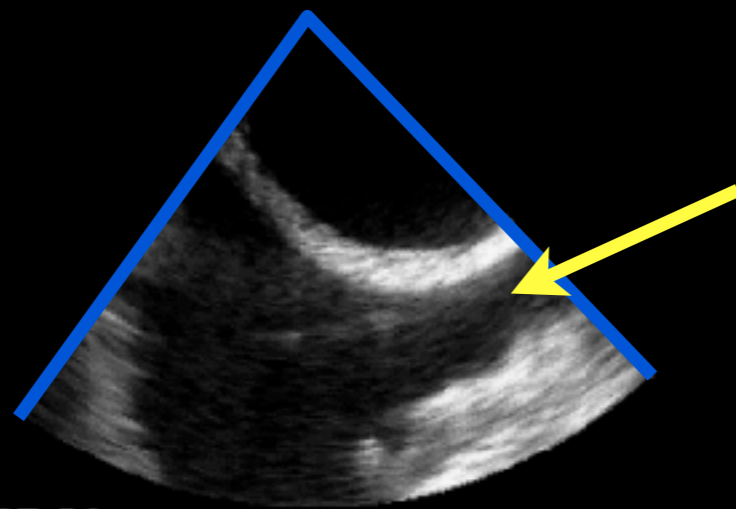
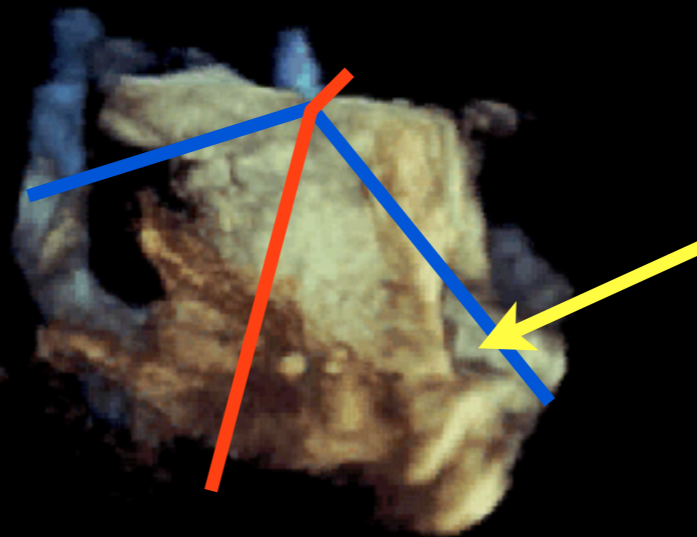
EDV	189 ml
ESV	76 ml
EF	60 %
HR	50 BPM
SV	113 ml
CO	5.7 l/min
Spl	0.27

Rendering



# 2D reference planes

Live 3D  
3D 4%  
3D 40dB  
Gen



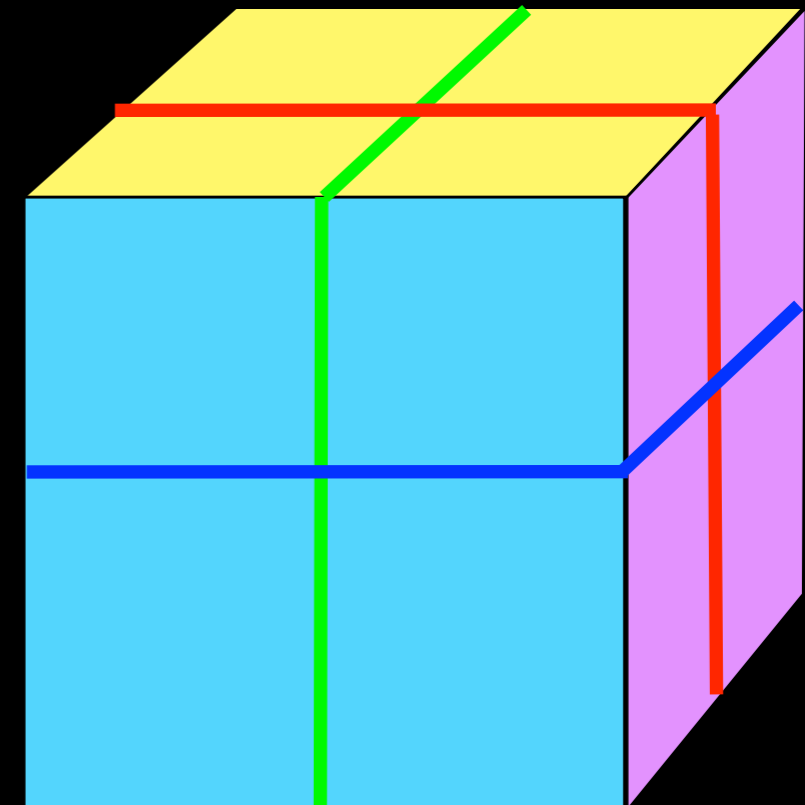
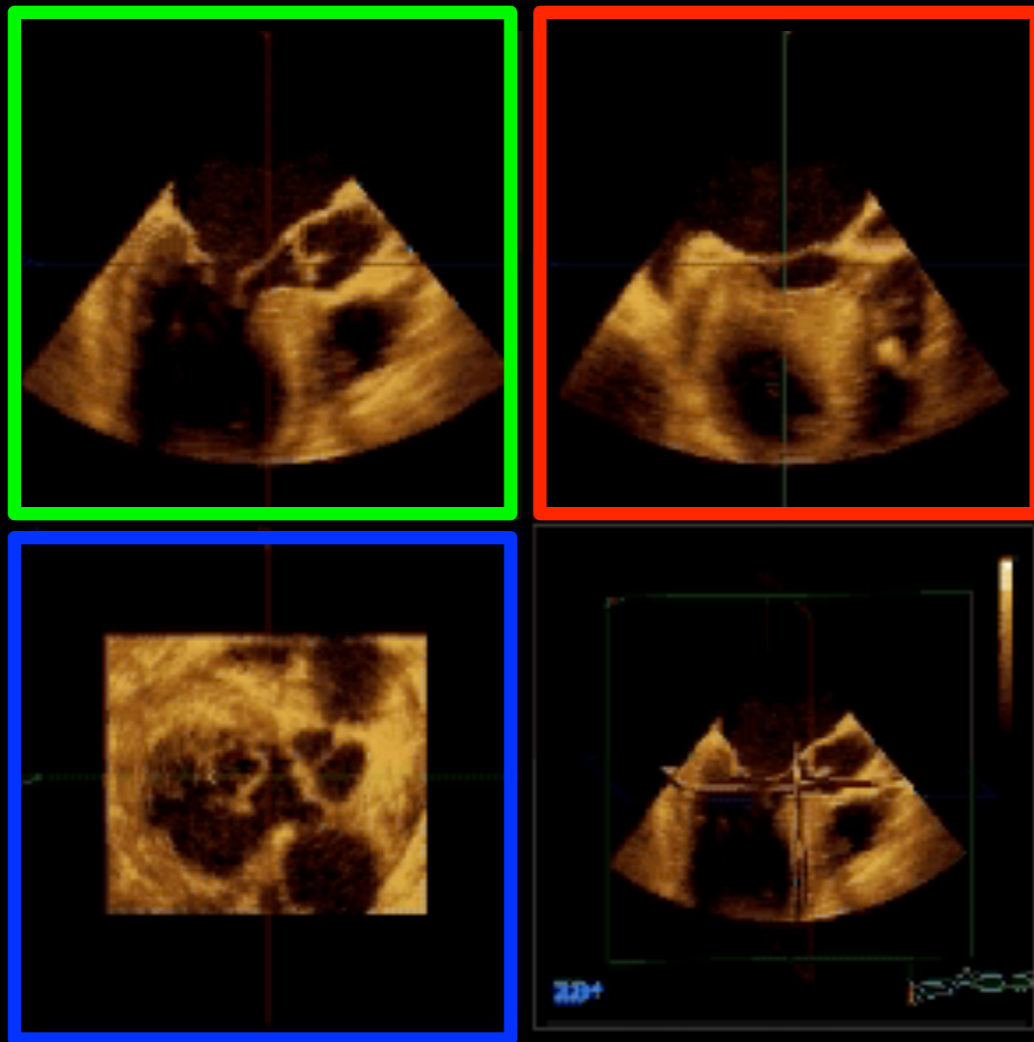
PAT T: 37.0C  
TEE T: 38.0C

86 bpm

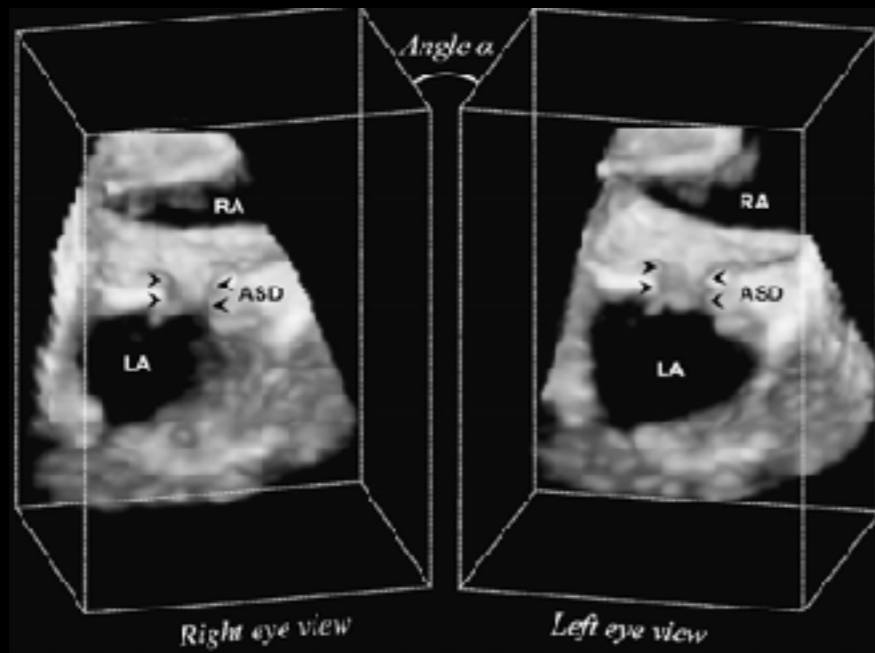
35



# Multiplanar Reformatting



# 3D Display



## Stereoscopy



## Hologram



Vasilyev et al  
J Thorac Cardiovasc Surg 2008;135:1334-41



# Summary

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- Part of guidelines
- Requires training
- US rules
- Navigate through confusing terminology



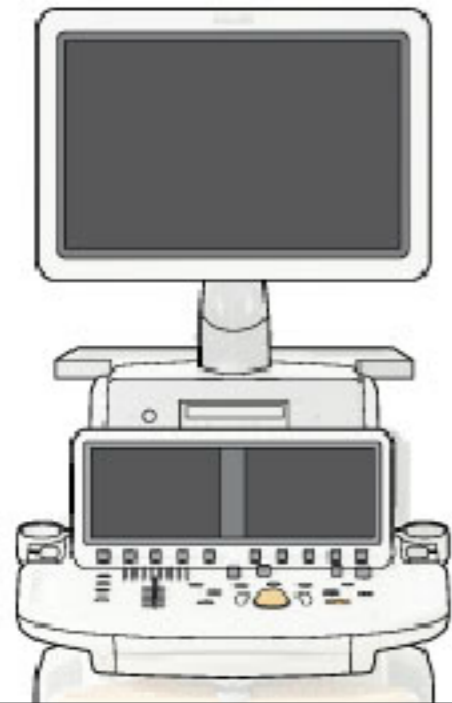
## 3D TEE Acquisition

The acquisition of 3D TEE datasets is not as straightforward as the process of obtaining 2D images and requires the user to acquire additional skills. Such skills include:

- How to optimize the 2D image to acquire the 3D dataset.
- What 3D TEE imaging mode to use for acquiring the 3D TEE dataset (focused, narrow or wide pyramidal)
- How to improve temporal and spatial resolution of 3D TEE images (single beat versus multi-beat)

The aim of this teaching module is to relieve some of the anxiety about using 3D TEE and walk users through these basic acquisition steps of 3D TEE in order to obtain quality 3D TEE datasets.

To get started, choose the machine you interested in below:



**Philips iE33**



**Philips Epiq 7**



**GE Vivid E9**

# Thank you !

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## Virtual Transesophageal Echocardiography

Toronto General Hospital Department of Anesthesia  
Perioperative Interactive Education



<http://pie.med.utoronto.ca/TEE/index.htm>