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# Technical Challenges: 3D Color

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University of Utah Dept of Anesthesiology

# Disclosures

USTAR
UTAH'S TECHNOLOGY CATALYST

- USTAR grant ~ state of Utah for developing technology in AKI
- KScube ~ partial owner in a company with no product, no revenue, doesn't even have a logo…

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# 1960s - The Color Revolution

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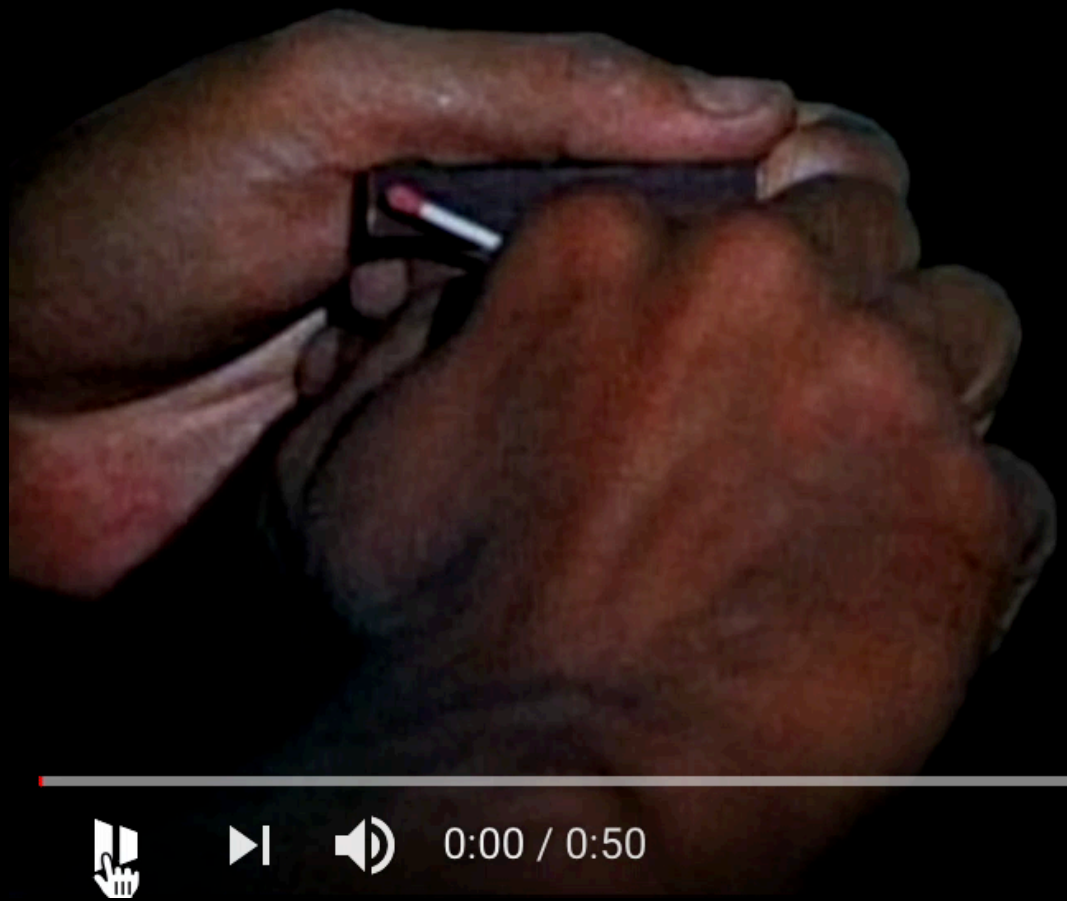

0:00 / 0:50

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# A Study of Mitral Valve Action Recorded by Reflected Ultrasound and Its Application in the Diagnosis of Mitral Stenosis

*By* Adib Zaky, M.D., William K. Nasser, M.D., and Harvey Feigenbaum, M.D.

Circulation May 1968

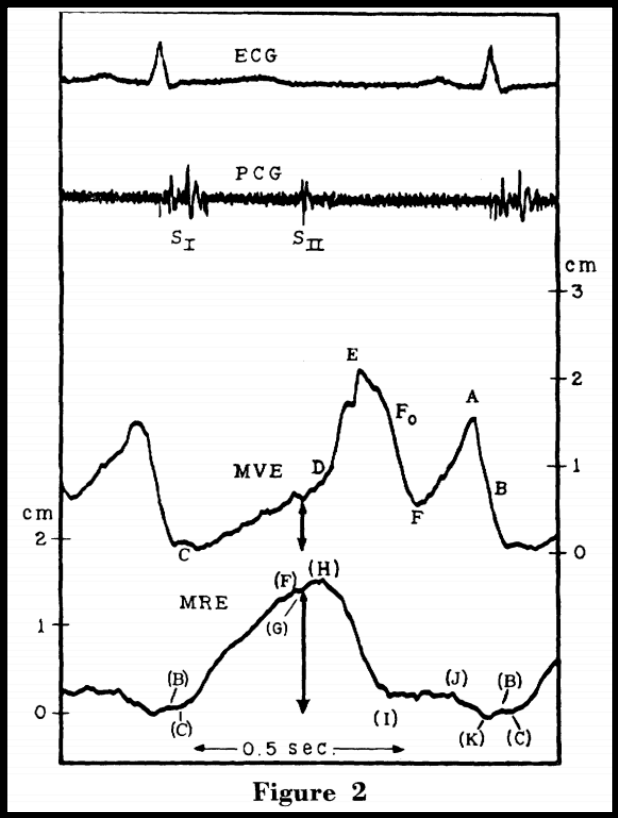


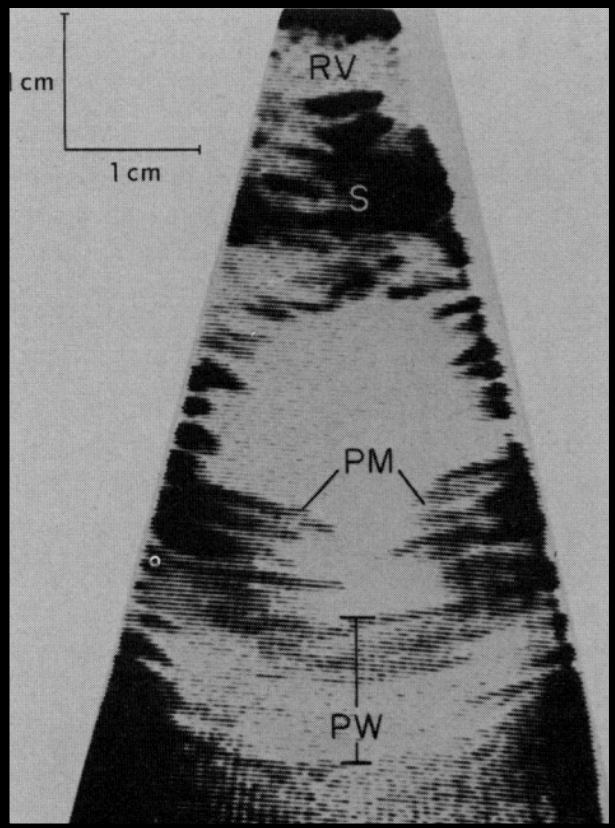

Figure 2

M Mode

# A Sector Scanner for Real Time Two-Dimensional Echocardiography

*By* JAMES M. GRIFFITH, M.S.E.E. AND WALTER L. HENRY, M.D.

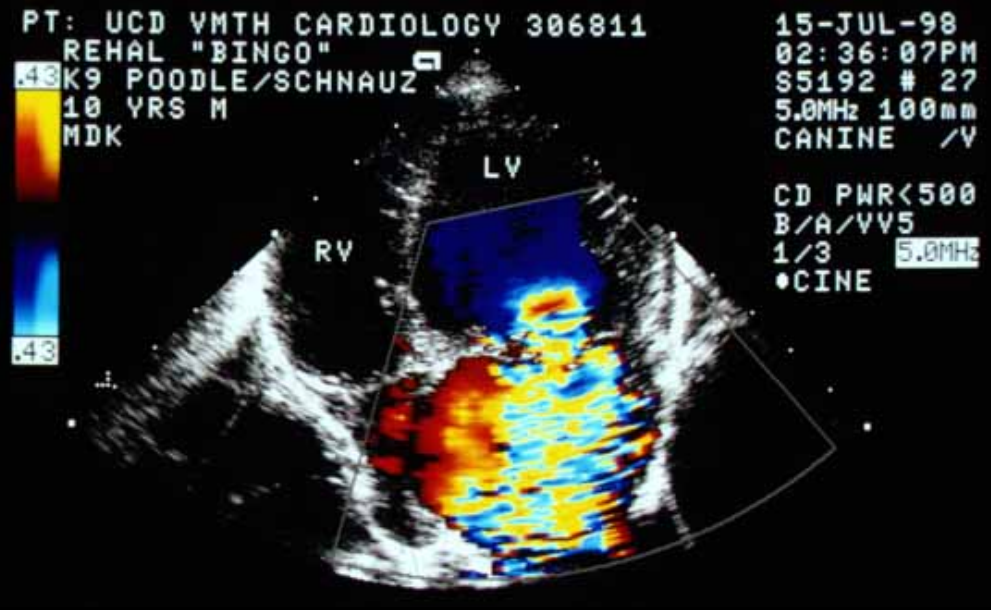
## Circulation February 1974



# Two-Dimensional Color Flow Doppler Echocardiography for the Intraoperative Monitoring of Cardiac Shunt Flows in Patients With Congenital Heart Disease

Zaharia Hillel, MD, PhD, Daniel Thys, MD, Samuel Ritter, MD, Martin Goldman, MD, Randall Griepp, MD, and Joel Kaplan, MD

Journal of Cardiothoracic and Vascular Anesthesia 1987

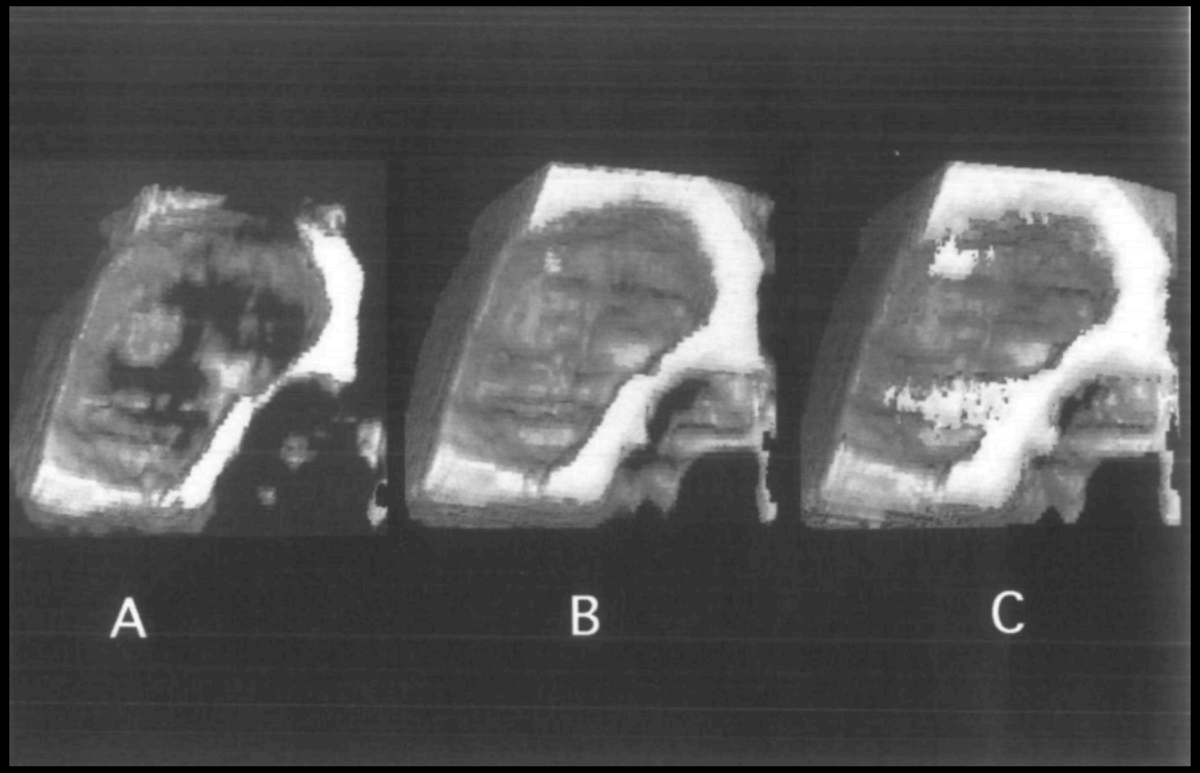


Comput Biomed Res. 1974 Dec;7(6):544-53.

**A system for ultrasonically imaging the human heart in three dimensions.**

Dekker DL, Piziali RL, Dong E Jr.

# Dekker et al. 1974




Binder et al. 1996 European Heart Journal

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# Early 3D


Reconstructed Offline ~ Limited Application

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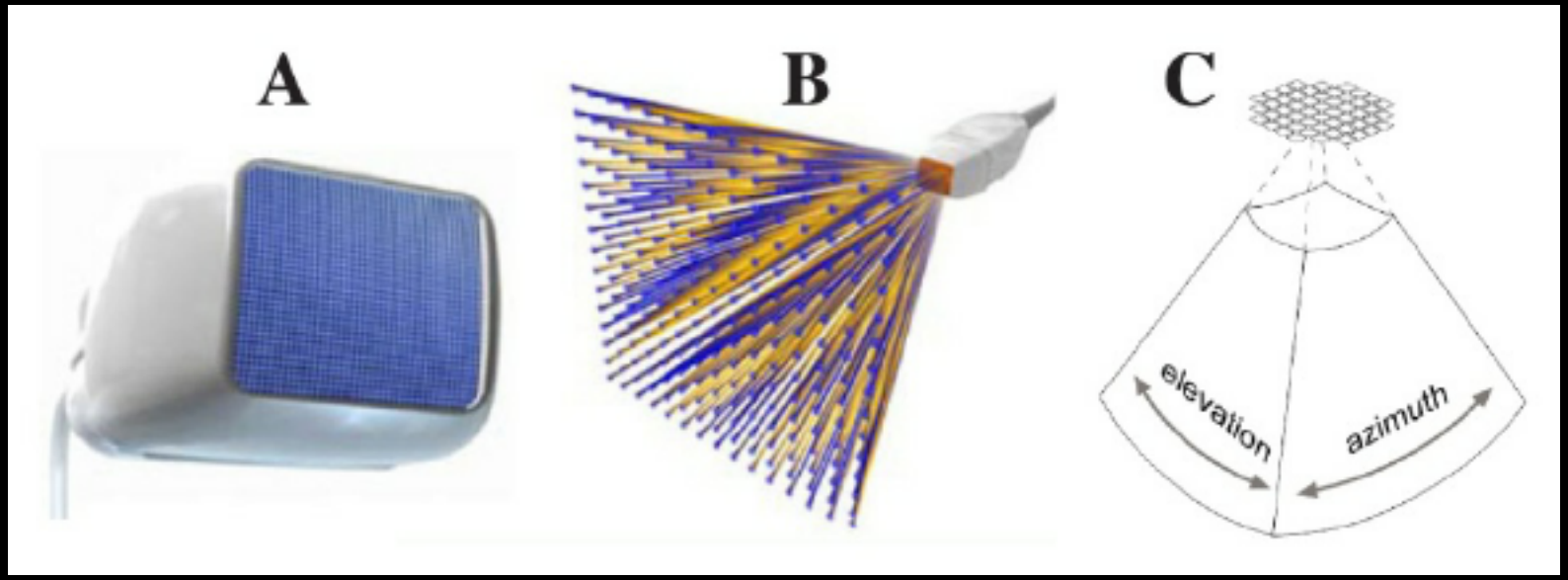
# Turn of the Century…




Matrix Array Transducers

+

Faster More Computing Power

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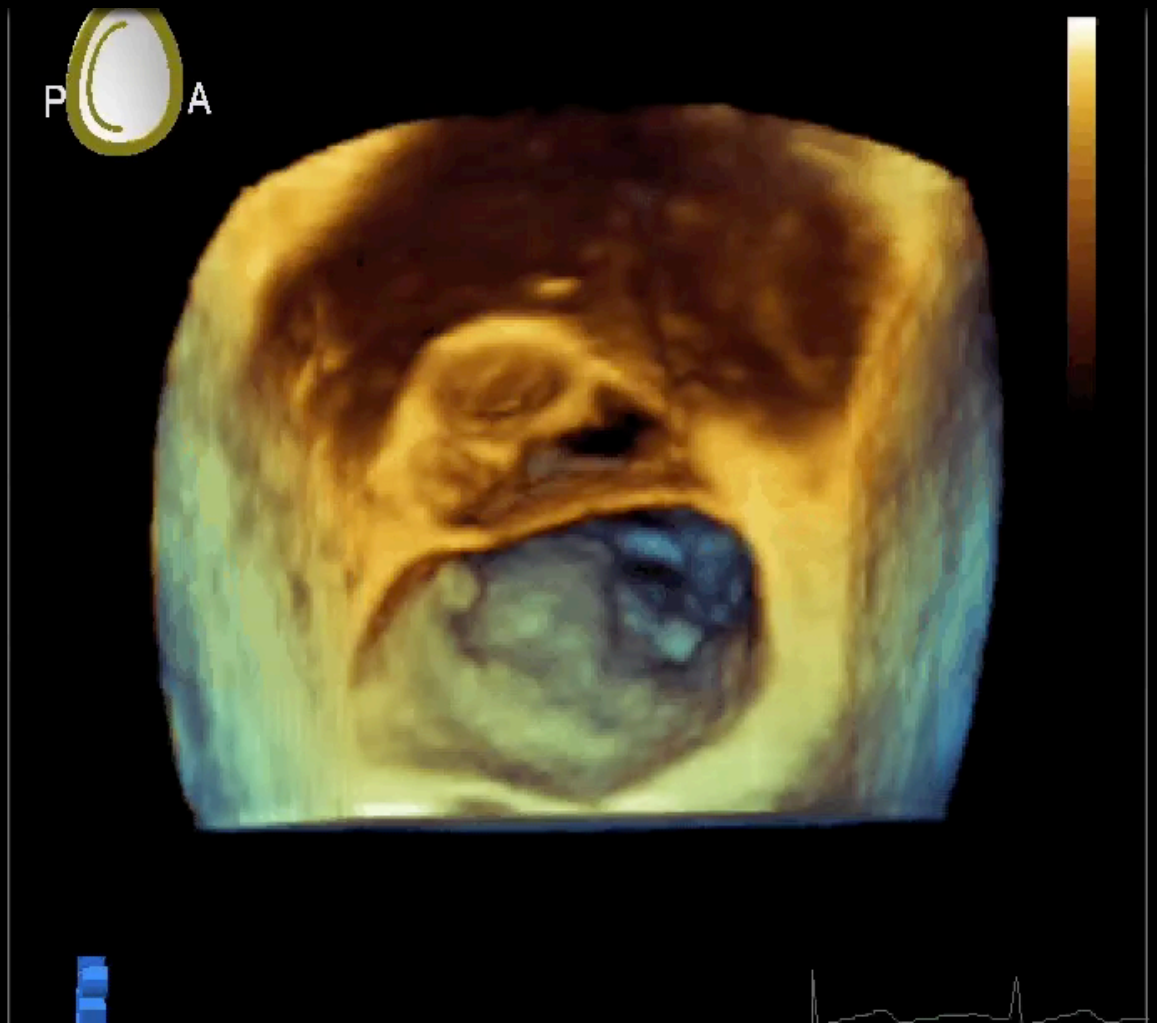
# Allowing Real-Time Imaging



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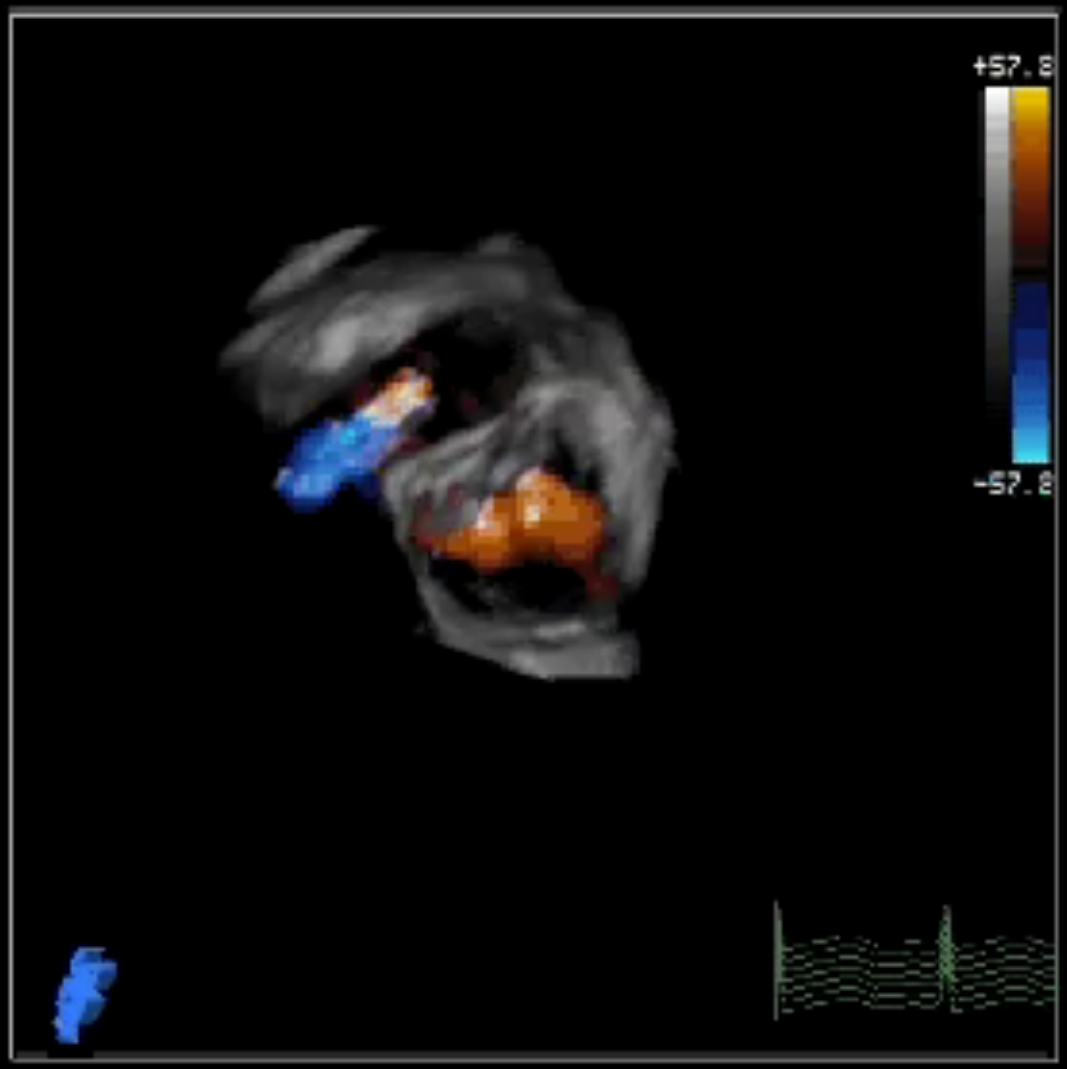
# Color in 3D Echocardiography



# The Plan

1. What can you do with 3D color
2. Getting around major limitations
3. Show you, that you can do it too

# Later this morning….

Dr. Moreno ~ Multiplanar Reconstruction

Dr. Shernan ~ Quantification of valvular lesions using 3D

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# Everyday in the OR

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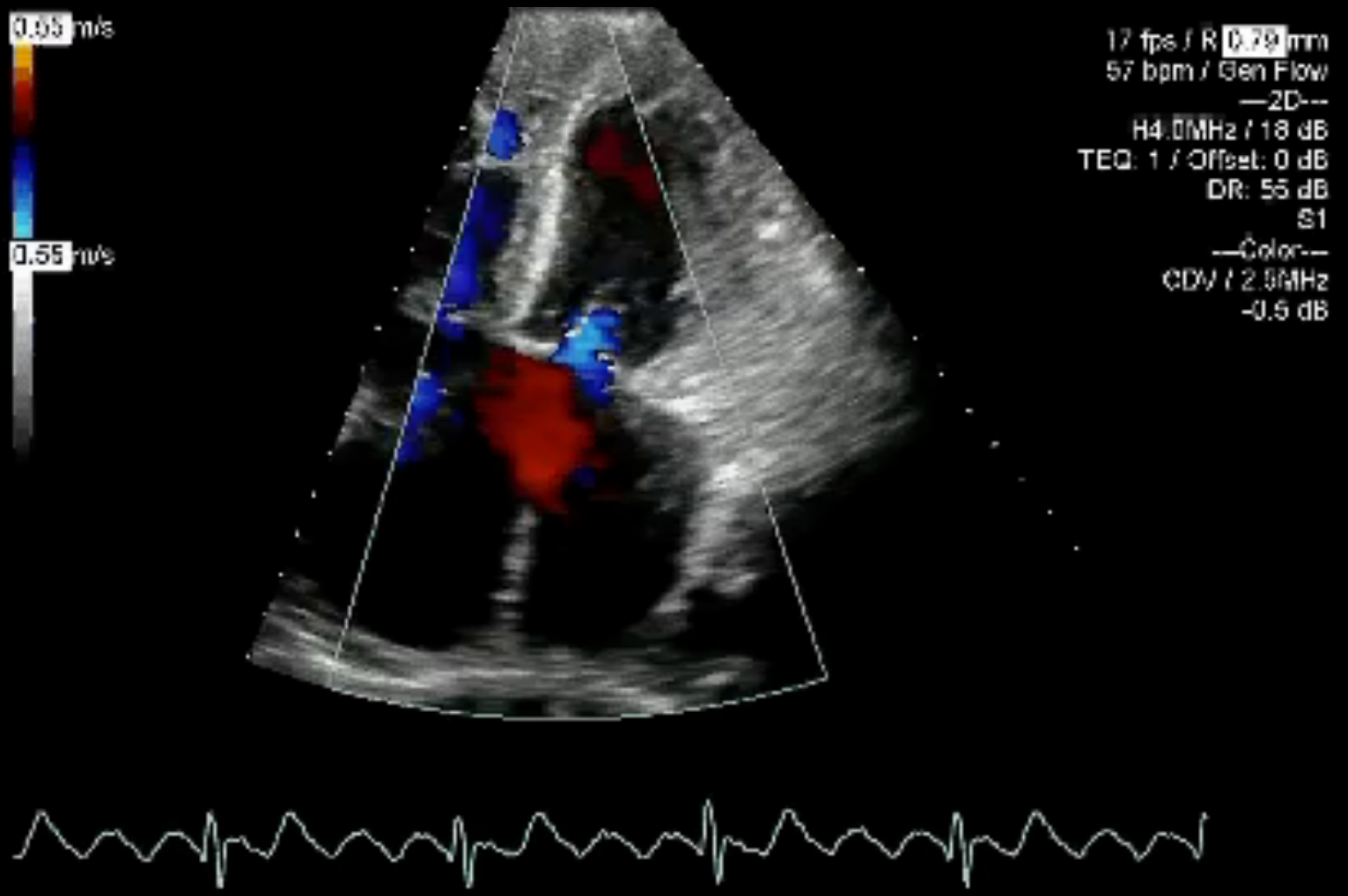
# Color Flow Doppler



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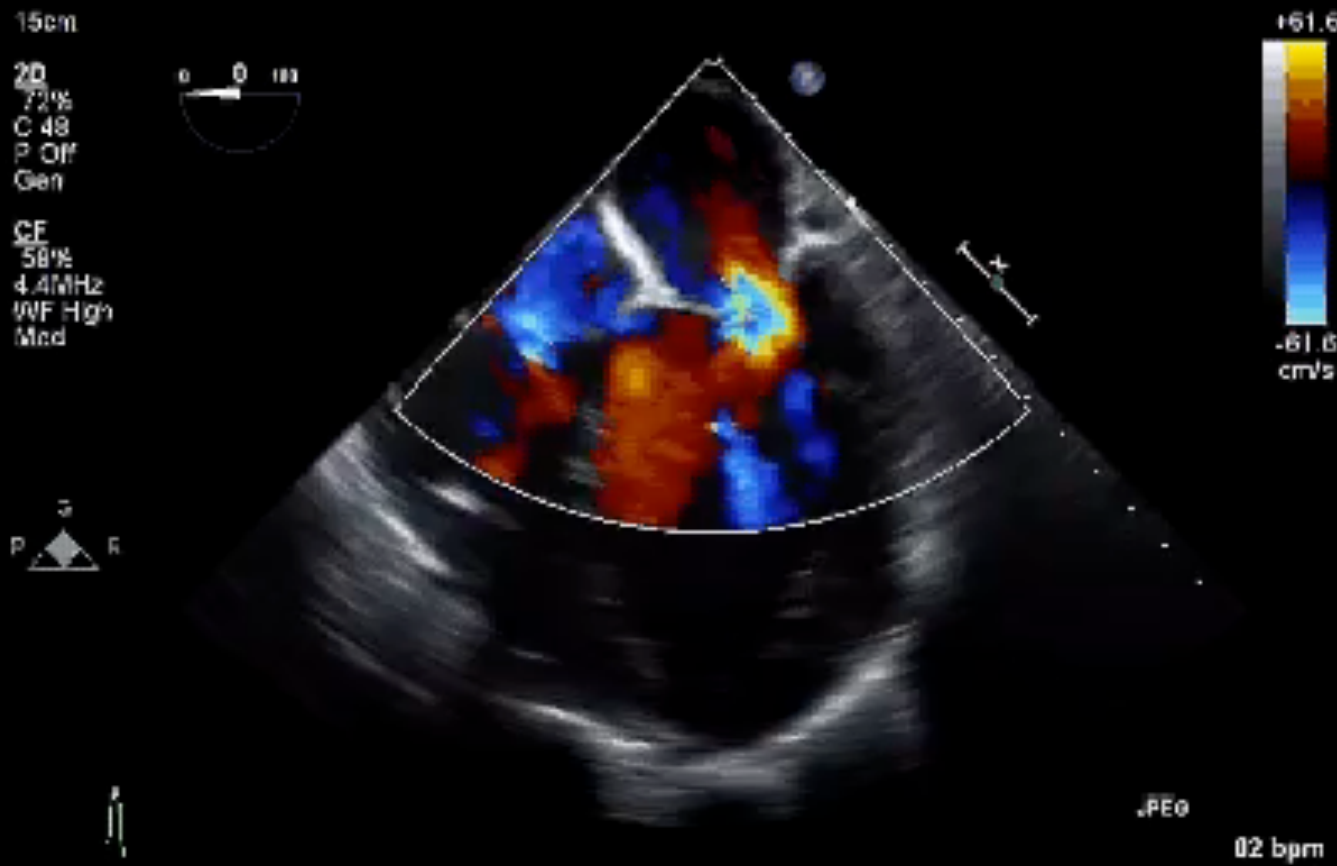
# Evaluation of Valvular Lesions



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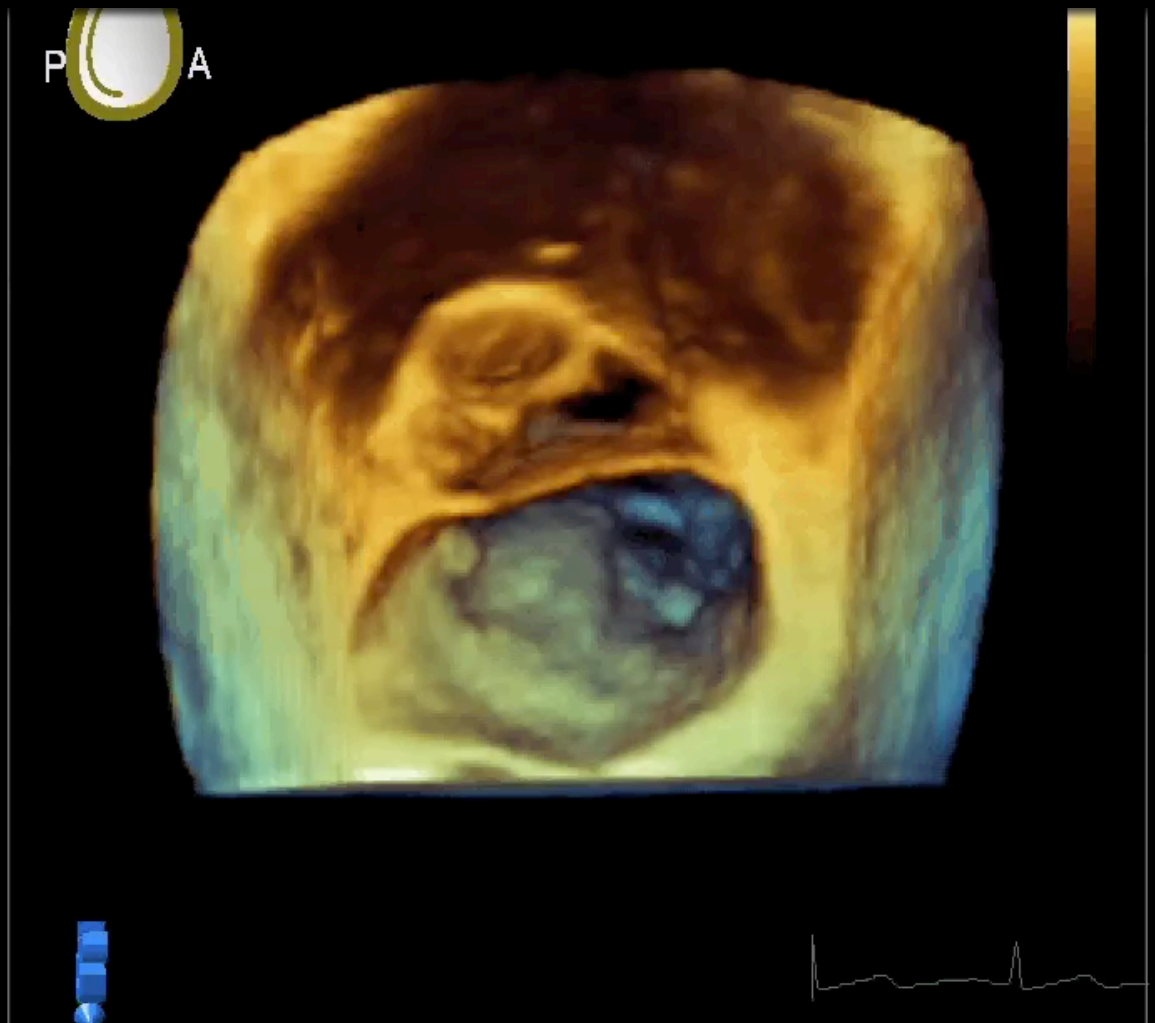
# Evaluation of Valvular Lesions



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# Welcome to the 21st Century

Phillips

Siemens

GE E9

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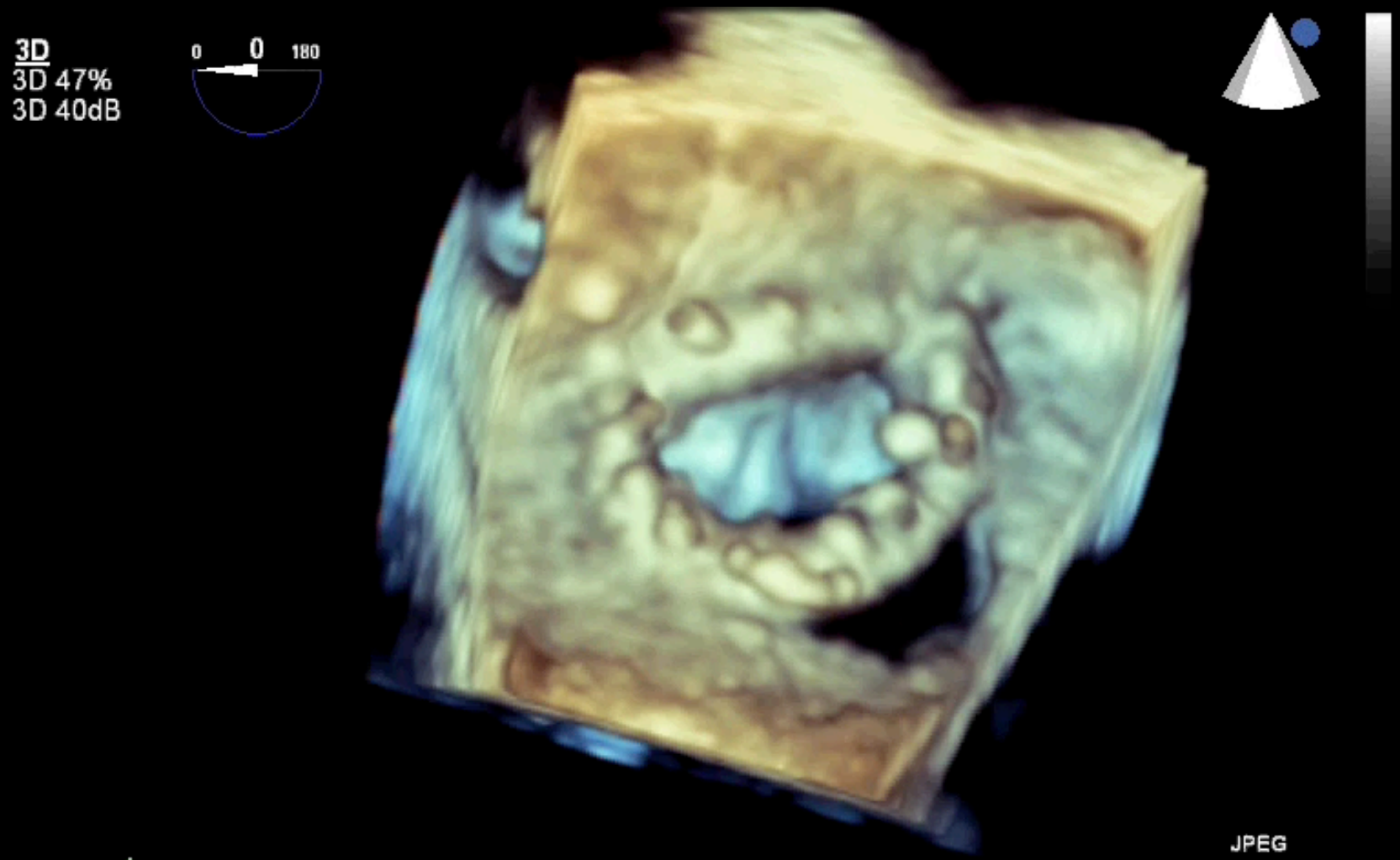
# 3D Images in the OR



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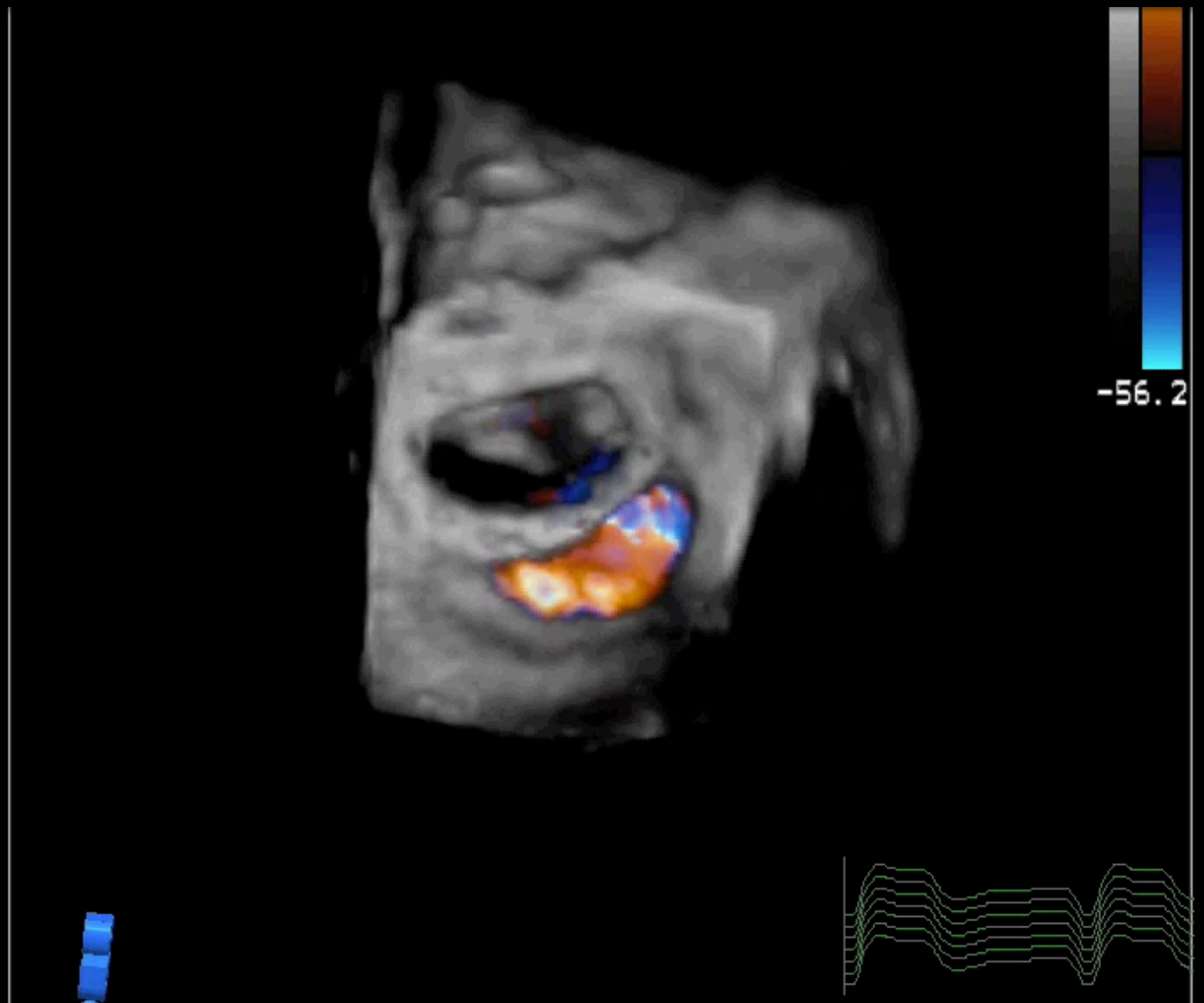
# Adding Color



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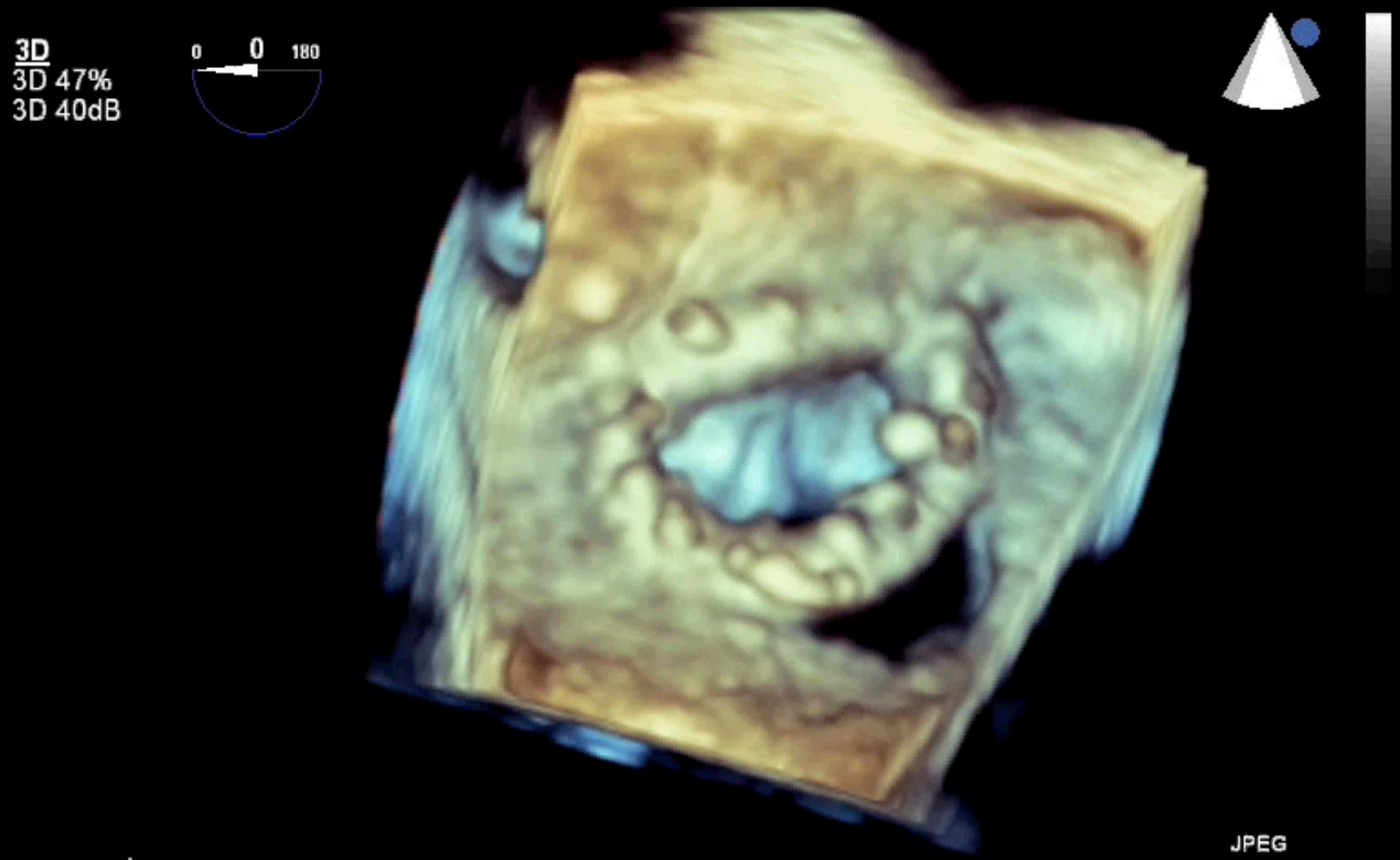
# Don’t Always Need Color



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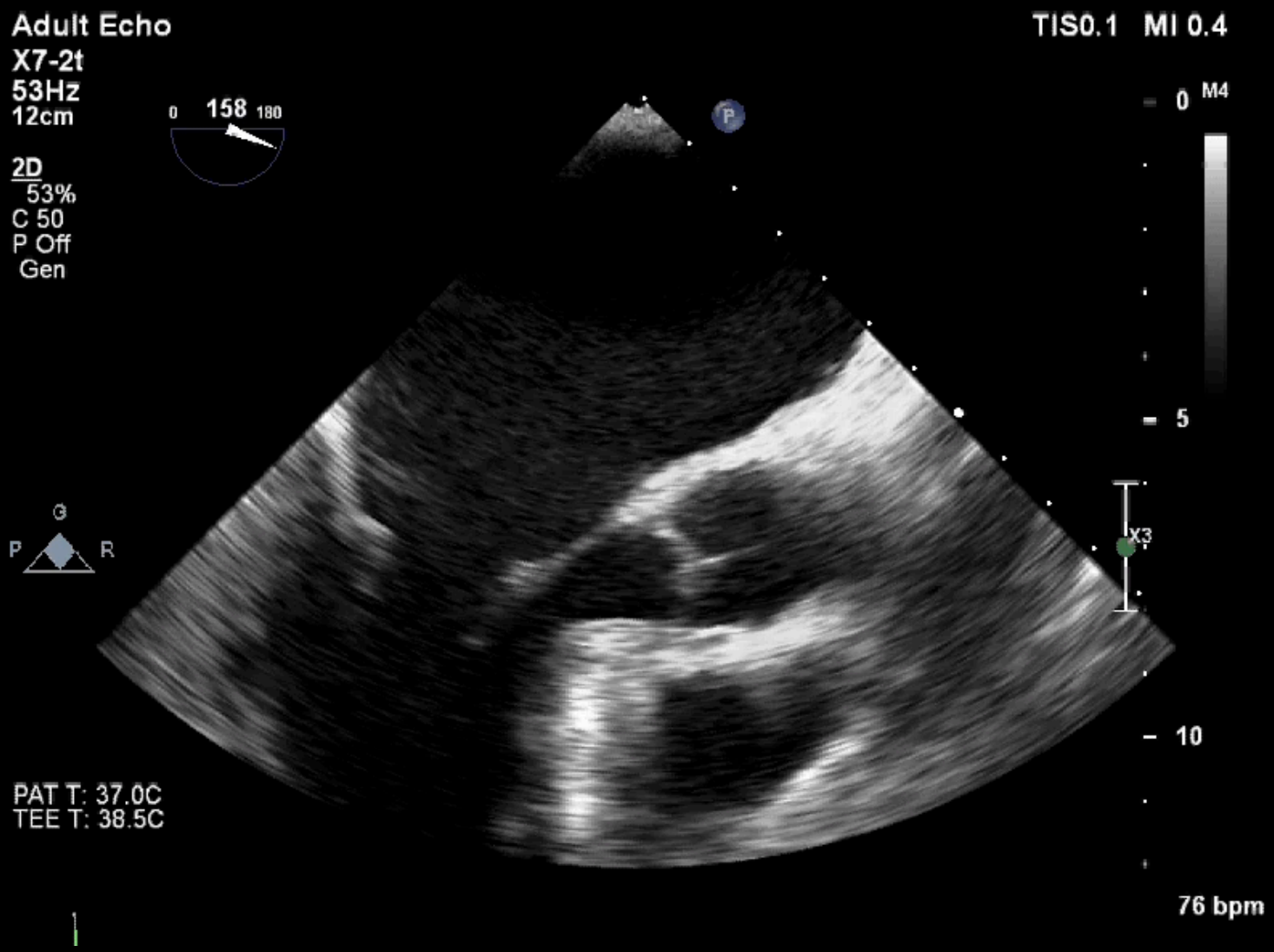
# Don’t Always Need 3D



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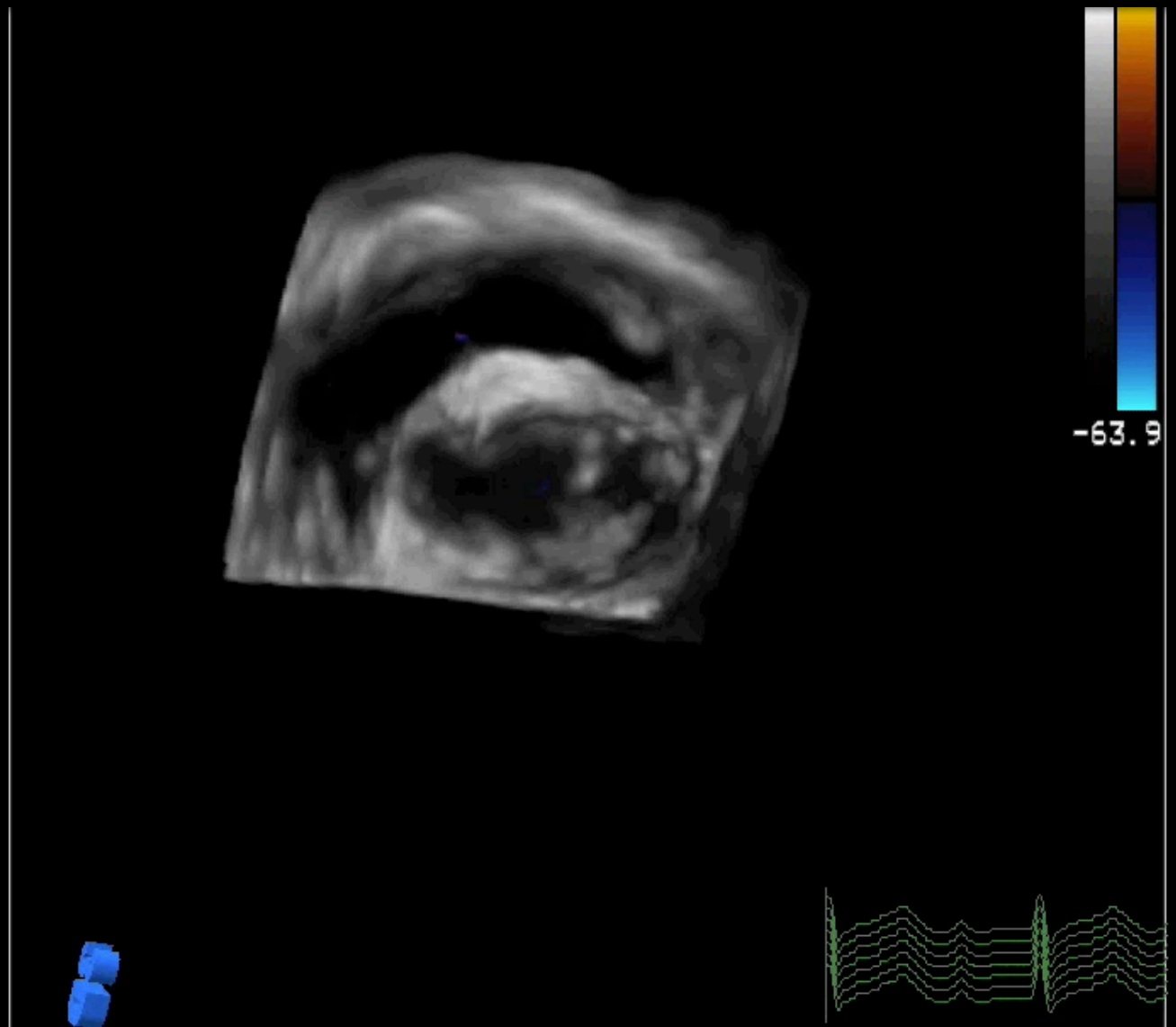
# Repair of Atrial Septal Defect



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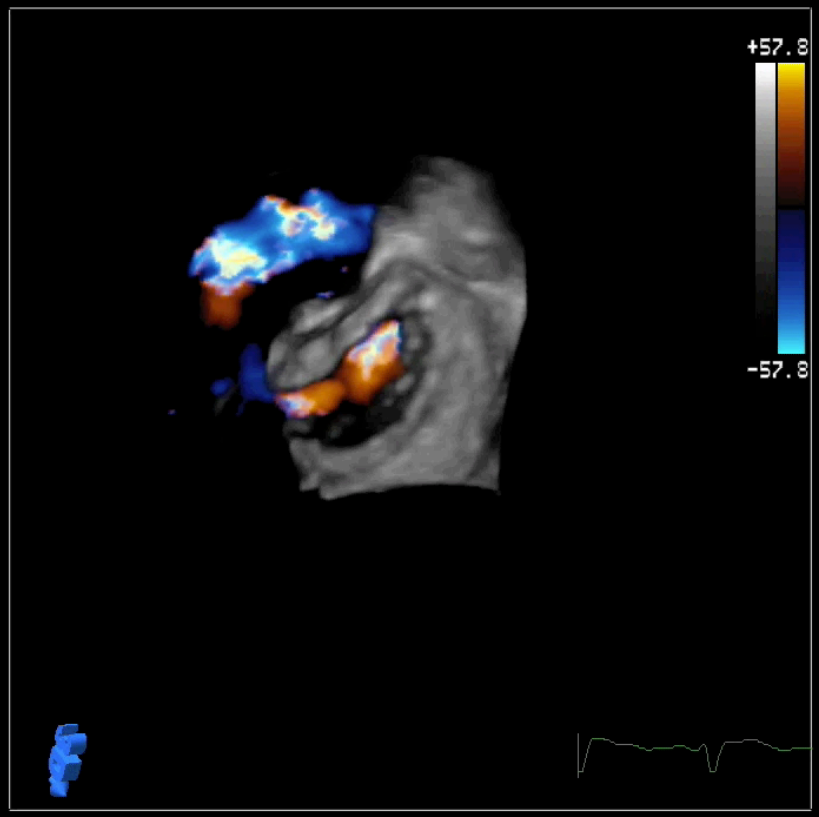
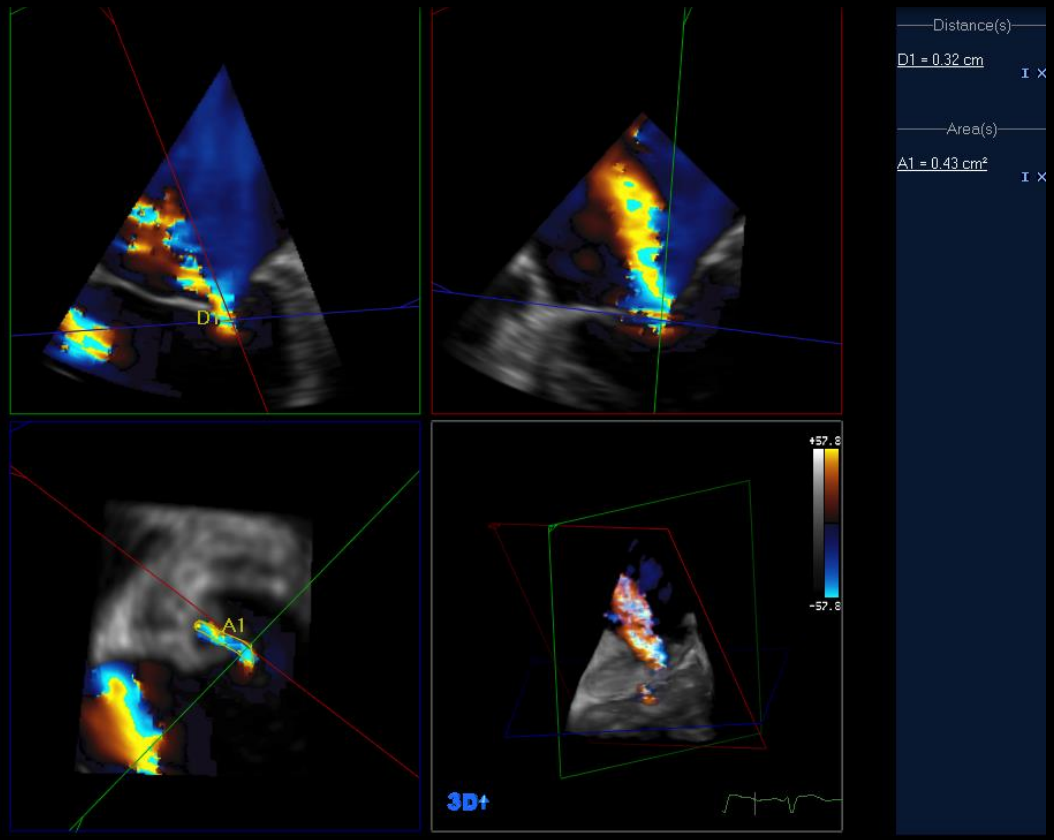
# Quantifying Mitral Regurgitation



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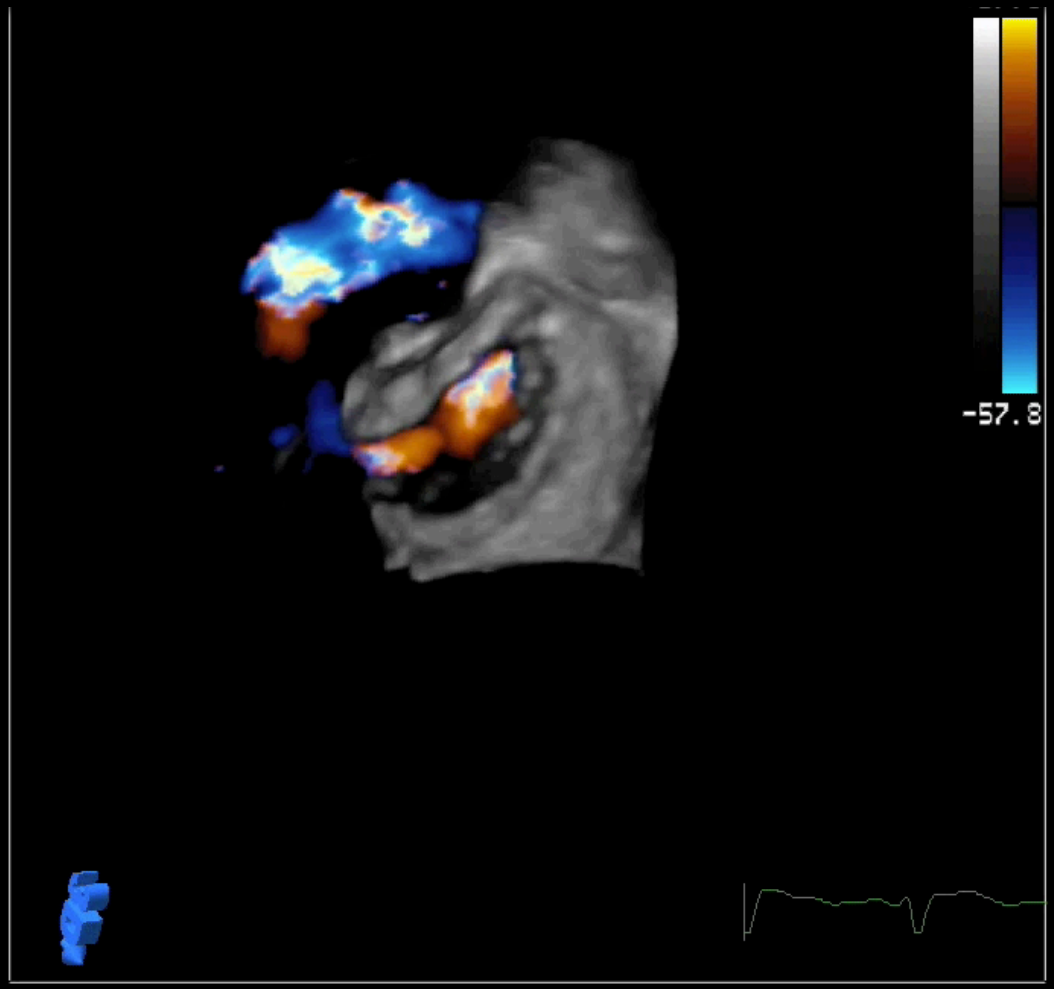
# What is the Regurgitant Oriface Area?



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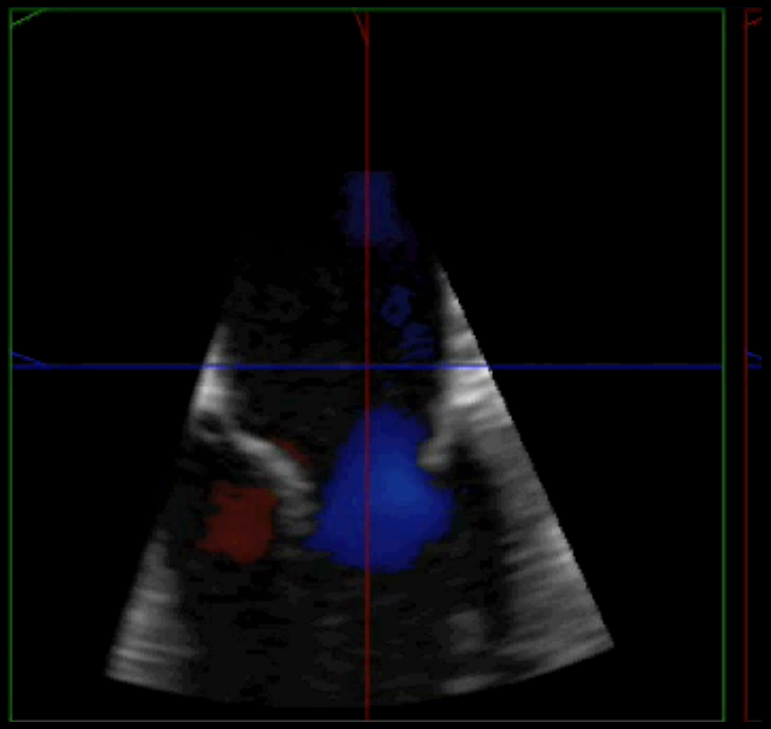
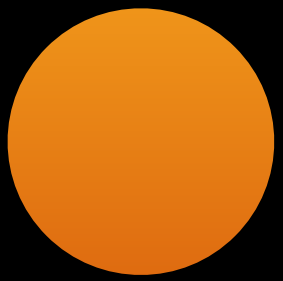
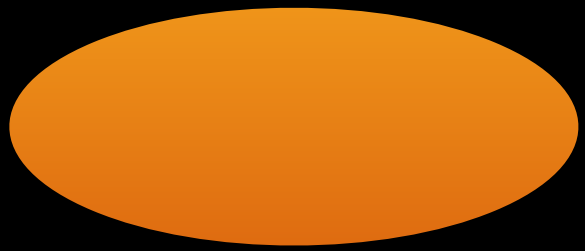
# Accuracy of 2D





2D EROA (PISA)



True EROA

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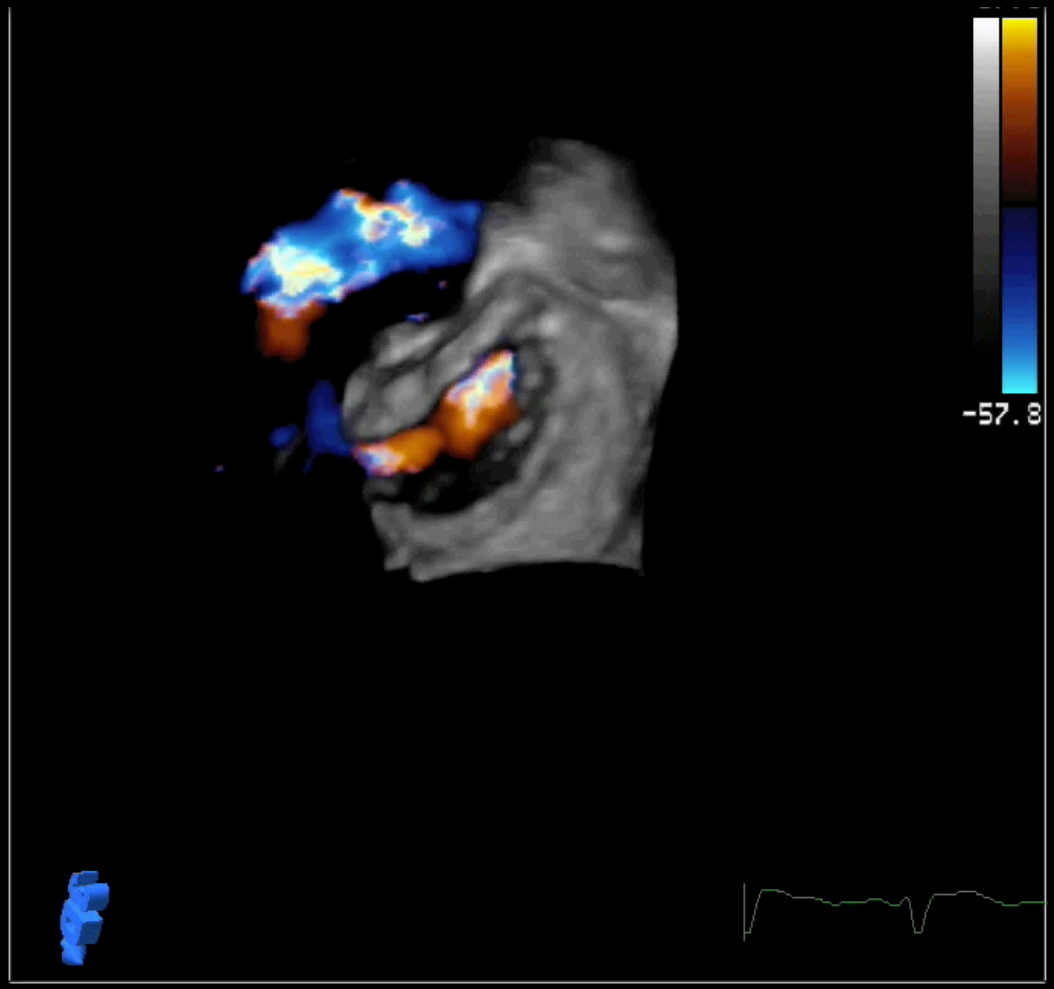
# Take This Image



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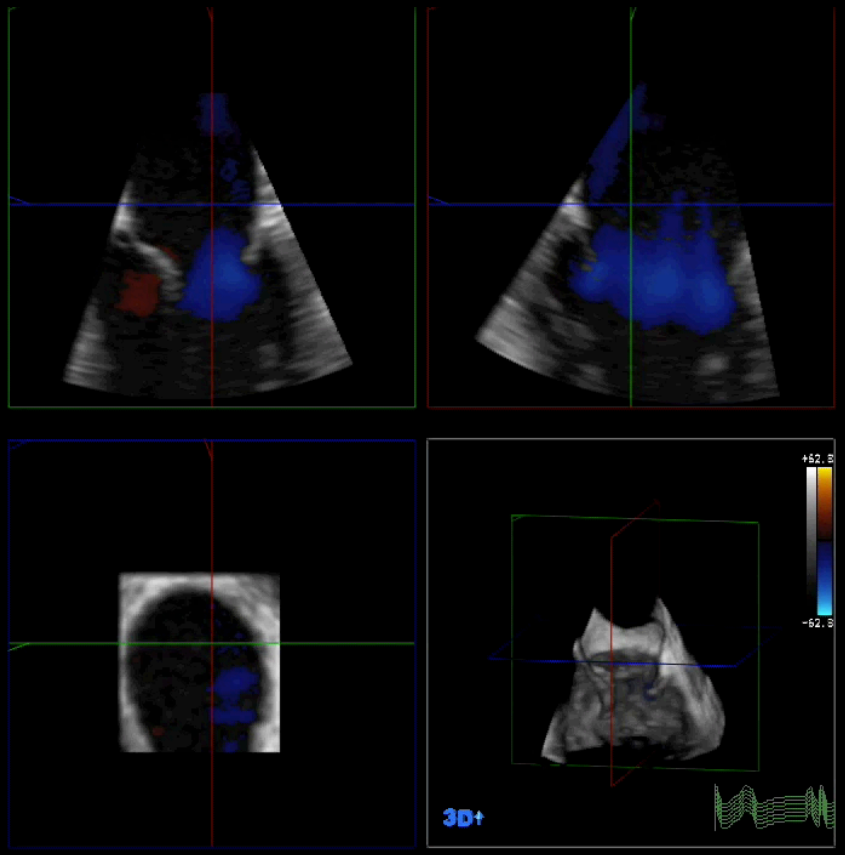
# Multiplanar Reconstruction




3D

Any 2D Plane You Want

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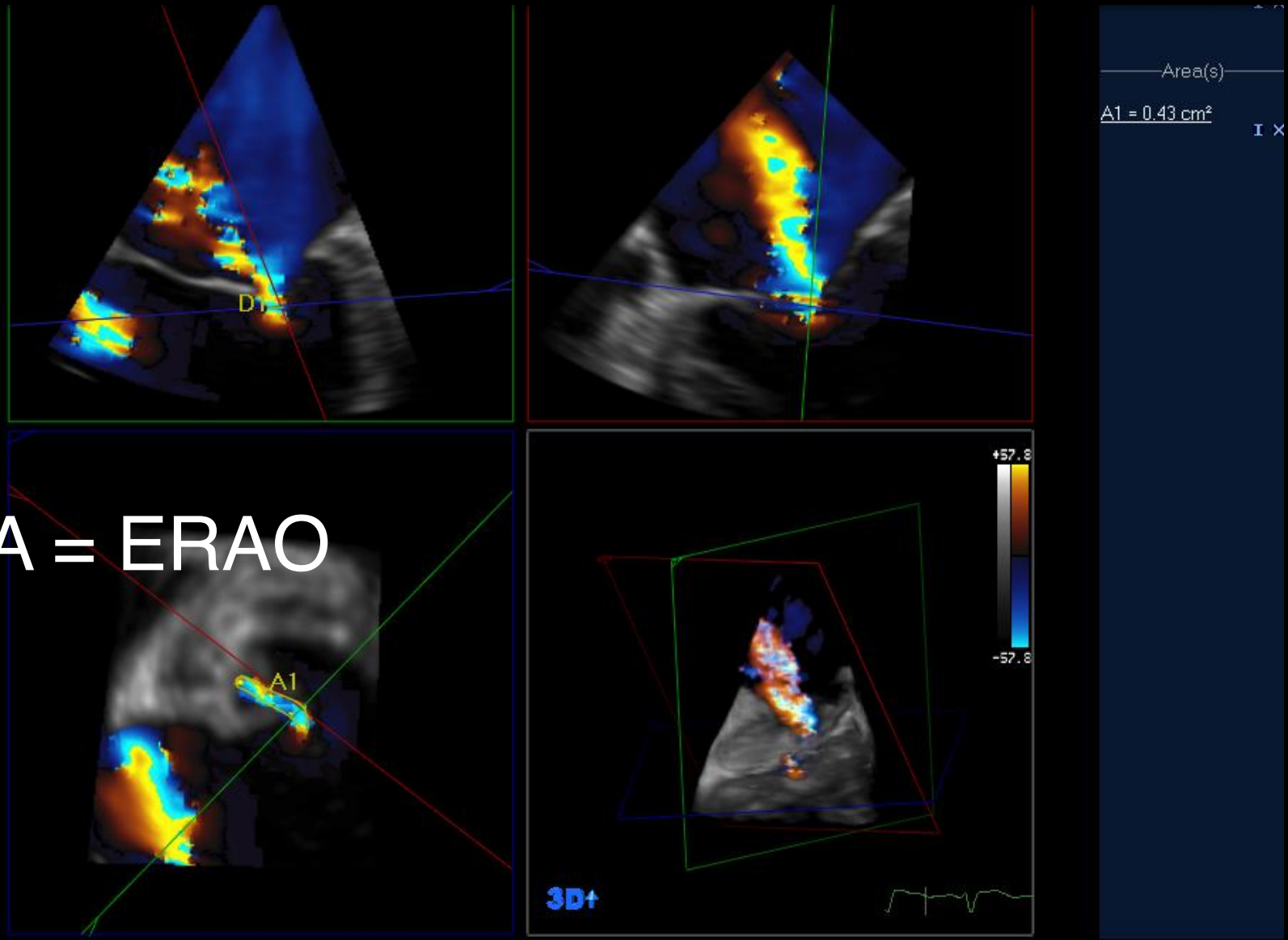
# Quantifying Mitral Regurgitation

VCA = ERAO



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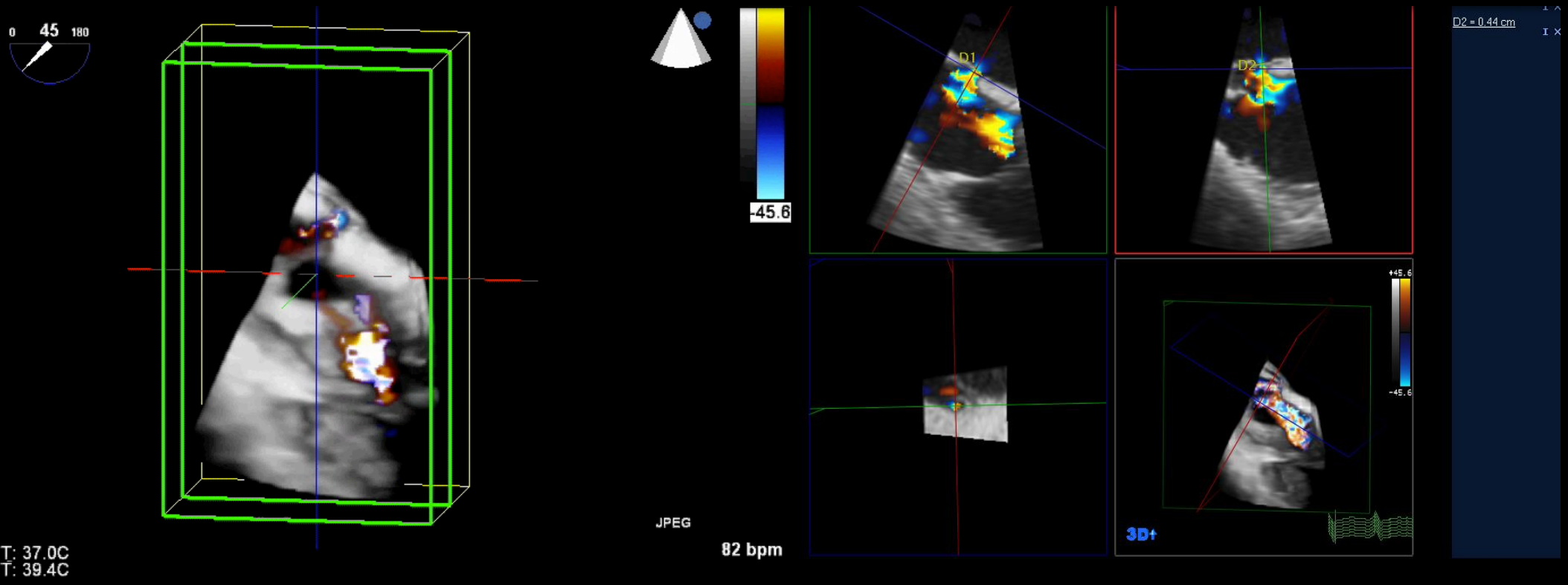
# Sizing ASDs



# The Plan

1. What can you do with 3D color
2. Getting around major limitations
3. Show you, that you can do it too

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# How To Make Pictures Like This?

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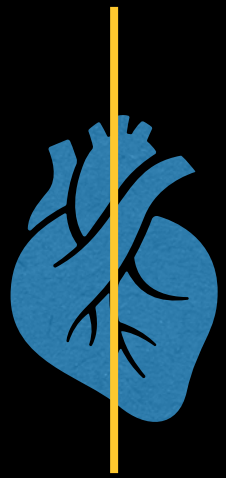
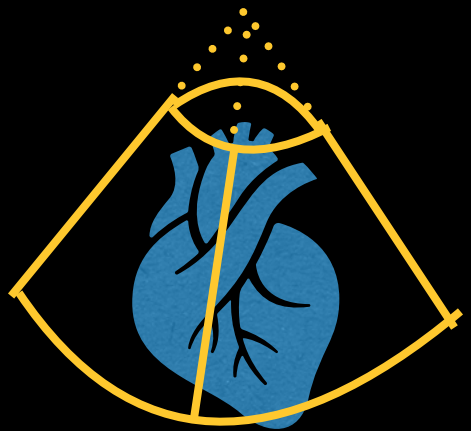
# Limitations: #1 Frame Rate

High Temporal Resolution Low

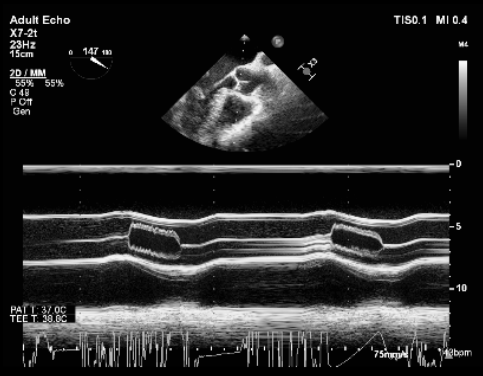


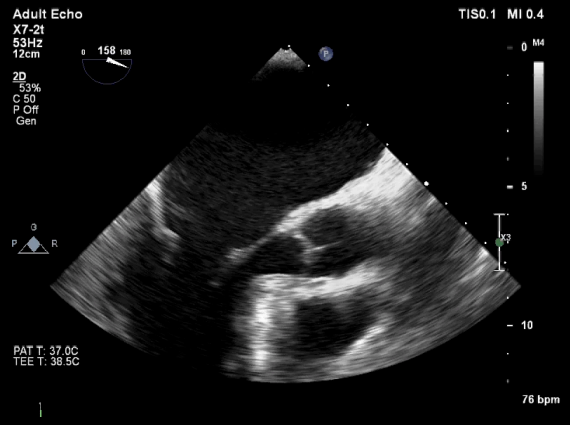
M Mode

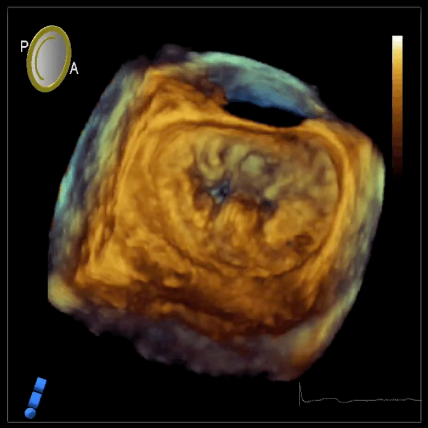
2D



3D



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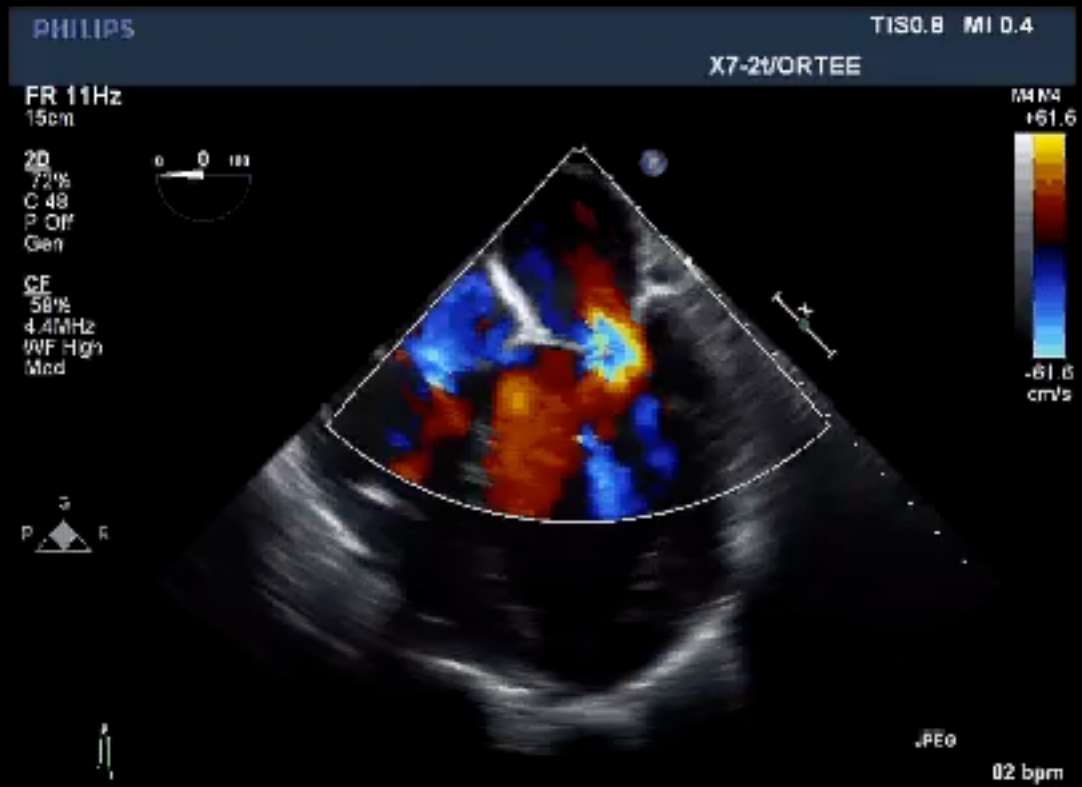
# Now Add Color


50 Hz

11 Hz

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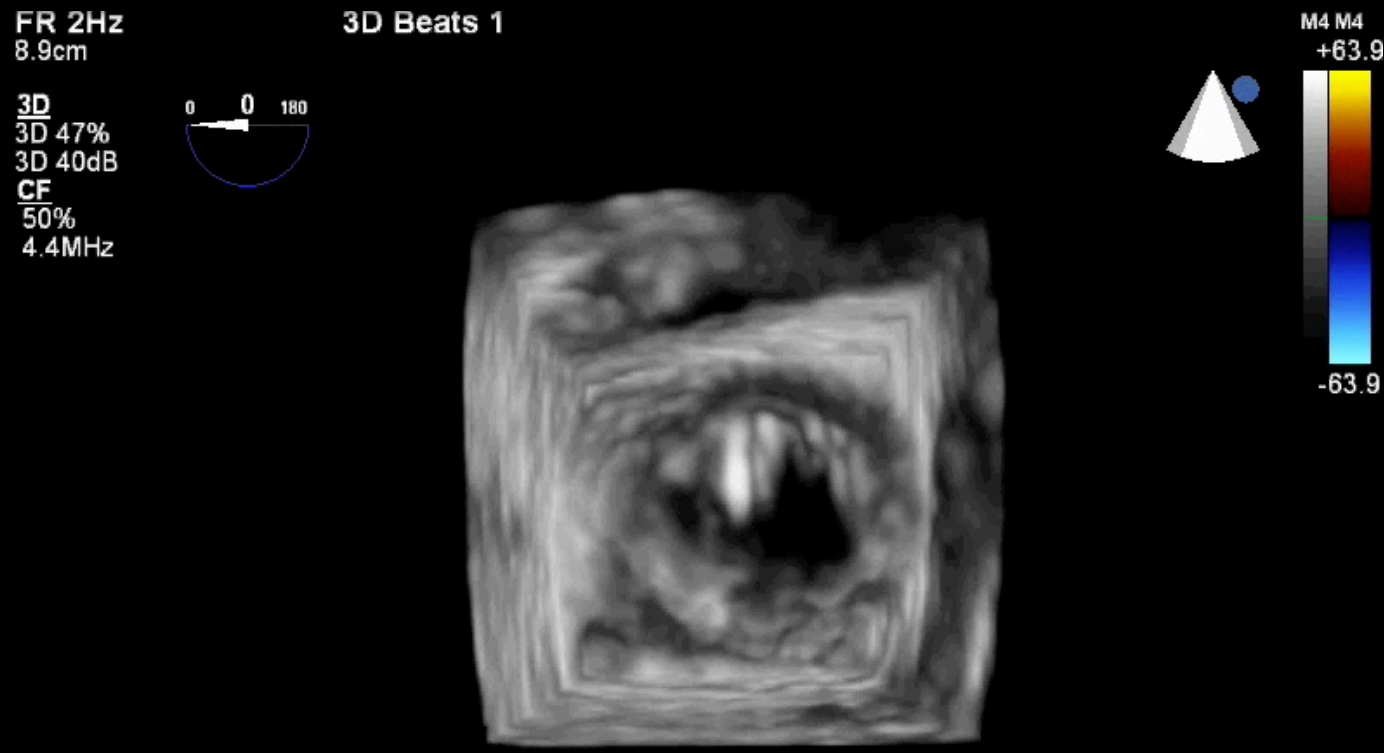
# 3D + Color = Low Frame Rate




2 Hz

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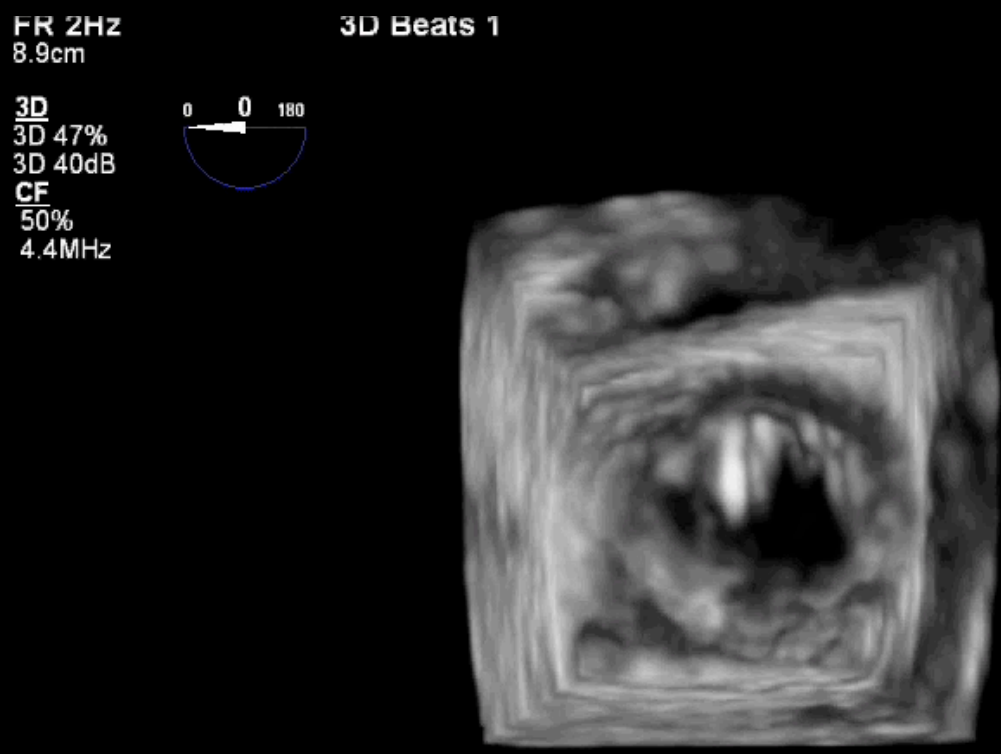
# What's the Problem?

60 beats per minute = 1 beat per second

2Hz = 2 Frames per second




= 2 Frames per beat (Missing Most of the MR)

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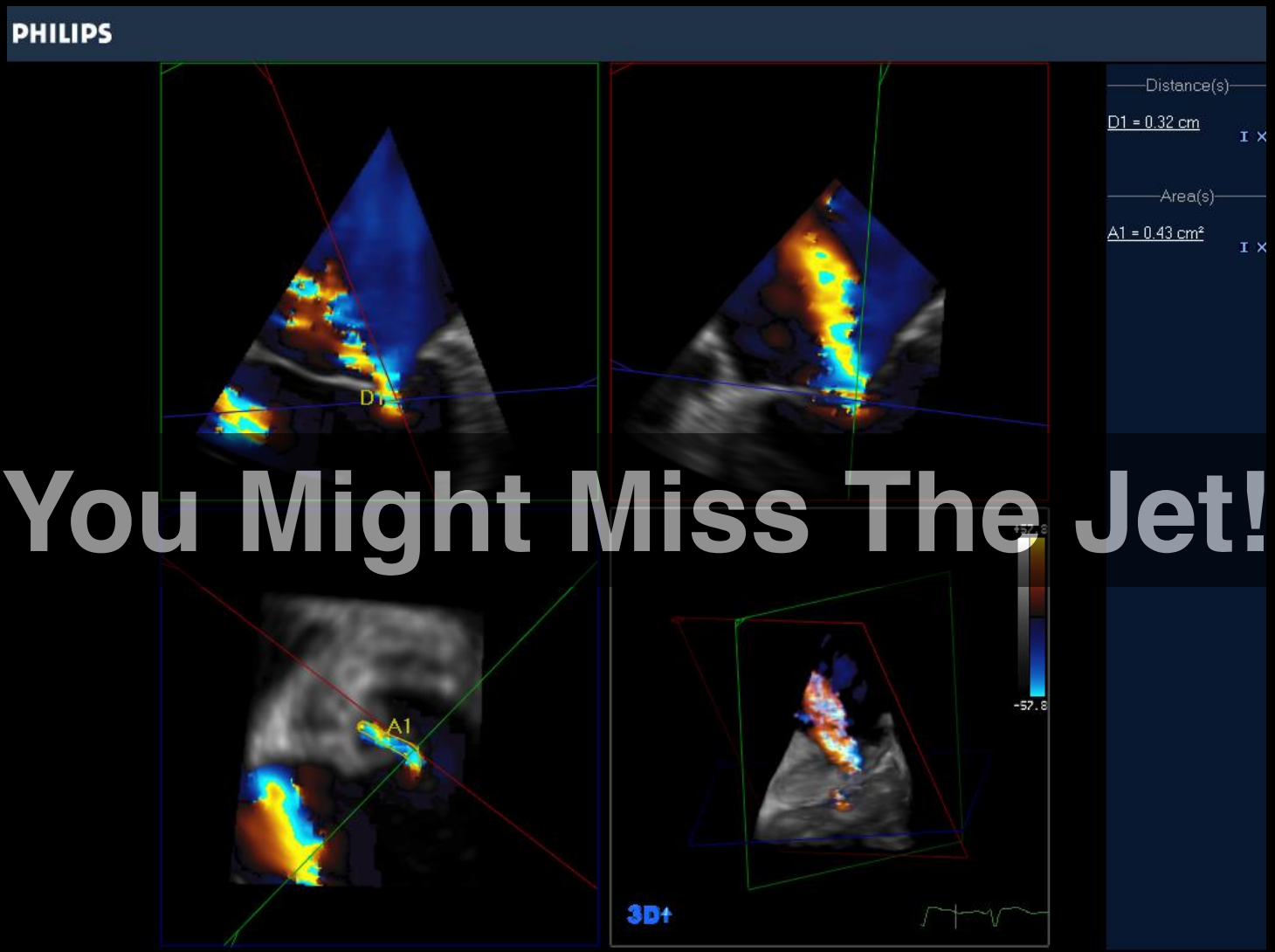
# Especially Important For Quantification




## You Might Miss The Jet!

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# Basic Principles of 3D Echo….

Volume Size
(Sector Depth & Width)

Spacial Resolution
(Line Density)

Temporal Resolution
(Volume Rate)

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# Improving Frame Rate in 3D

1. Only image what you need
2. Cheat…

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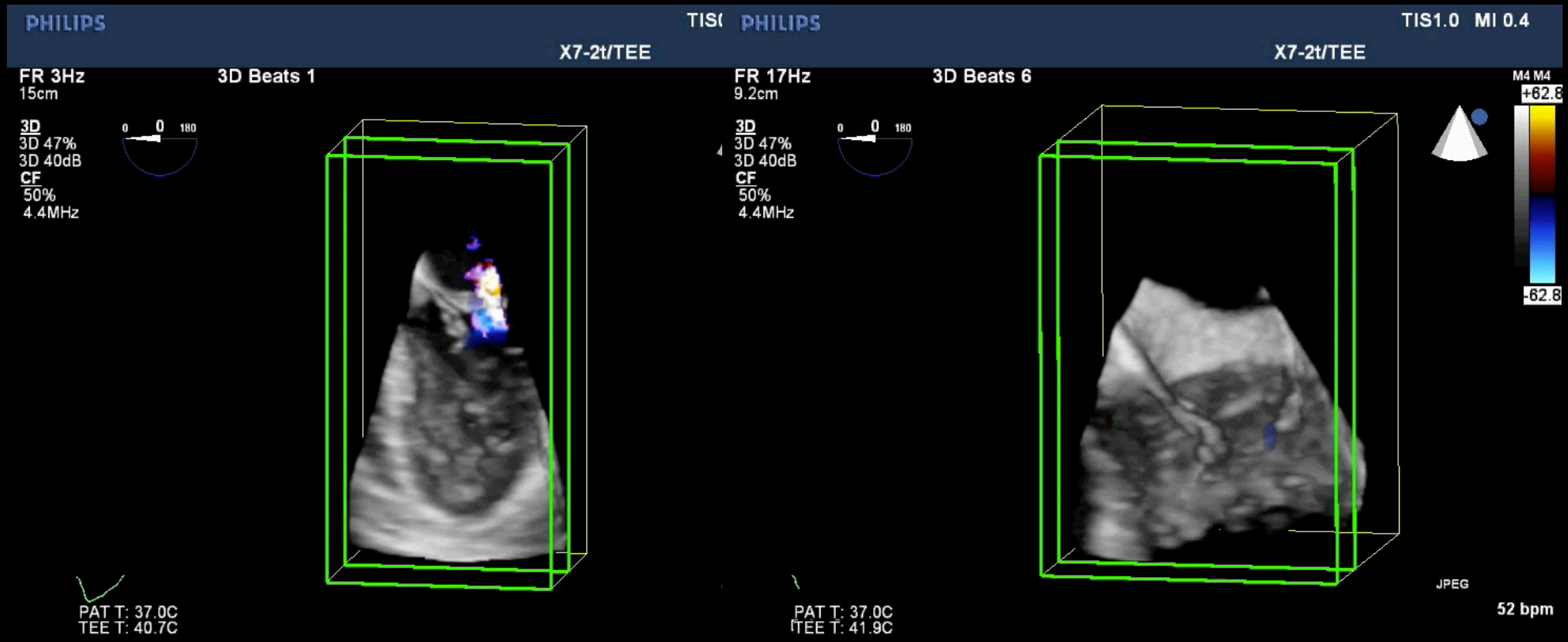
# Only Image What You Need




3 Hz

17 Hz

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# Only Imaging What You Need

1. 3D Zoom
2. Full Volume with Fine Tuning

Goal: Get what you want to see
Smallest Sector Size you can!

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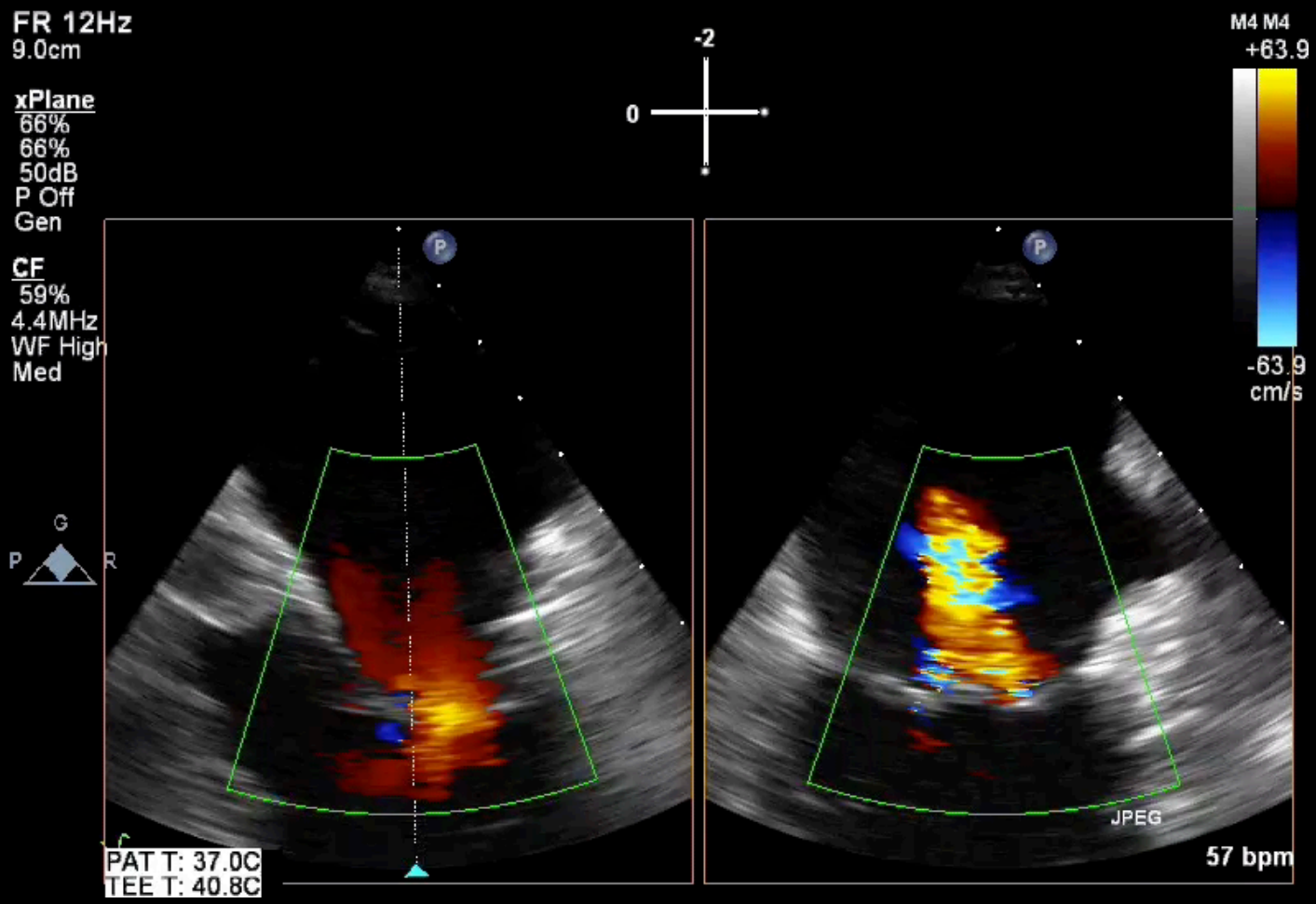
# 3D Zoom and Color



# Fine Tuning Full Volume

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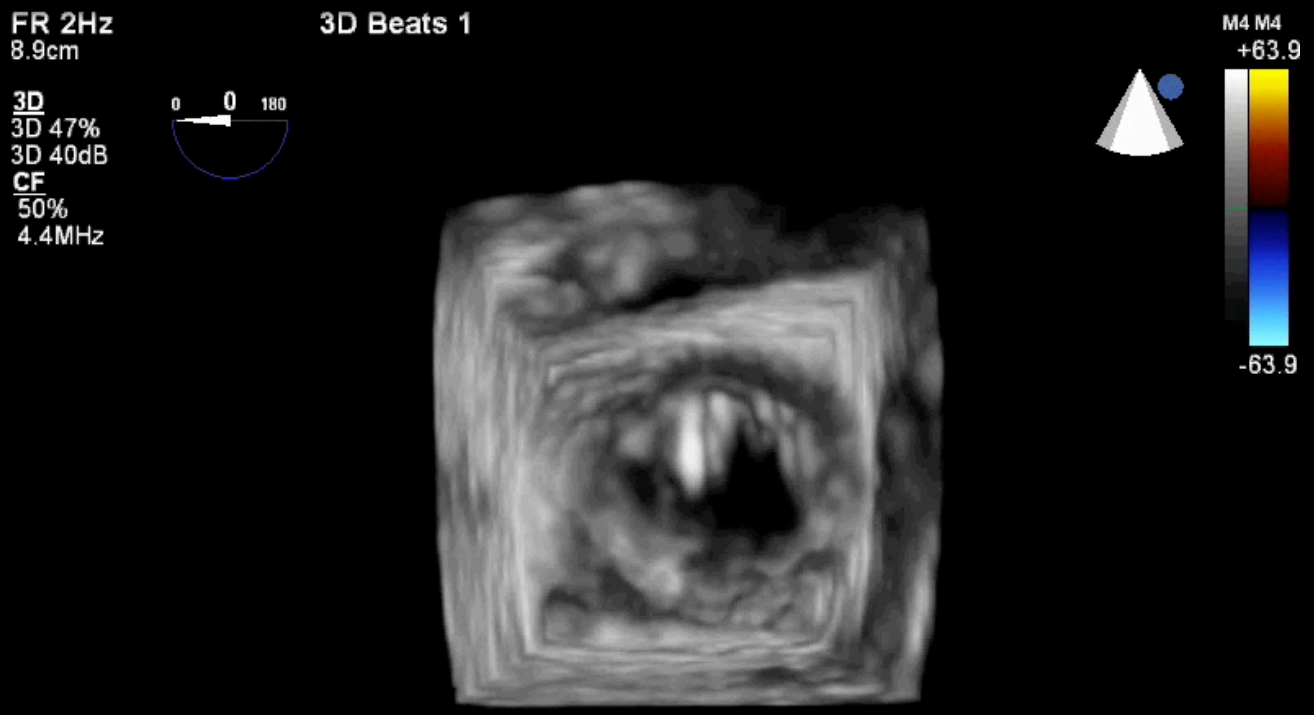
# Fine Tuned




Still Terrible Temporal Resolution

…. Now it's time to cheat….

# Cheating….

1. Multibeat Acquisition (6 beats if possible)
2. High Volume Rate Imaging

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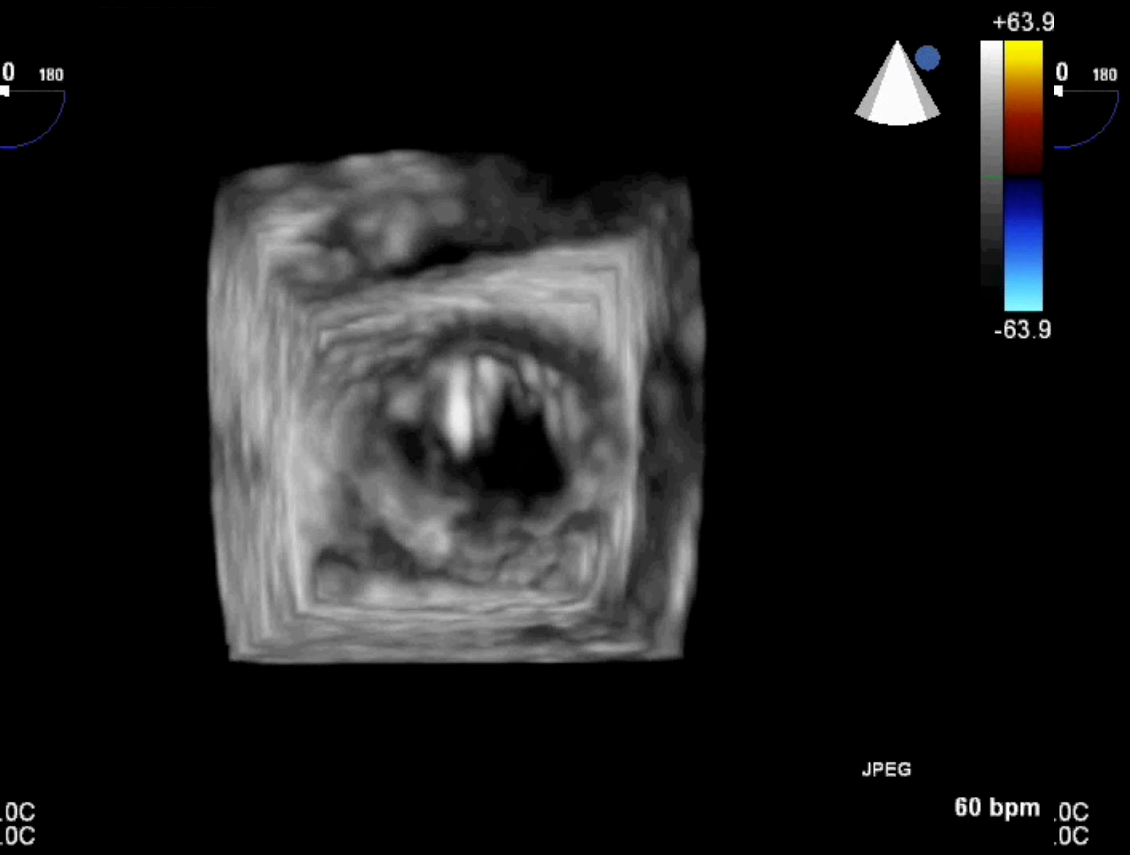
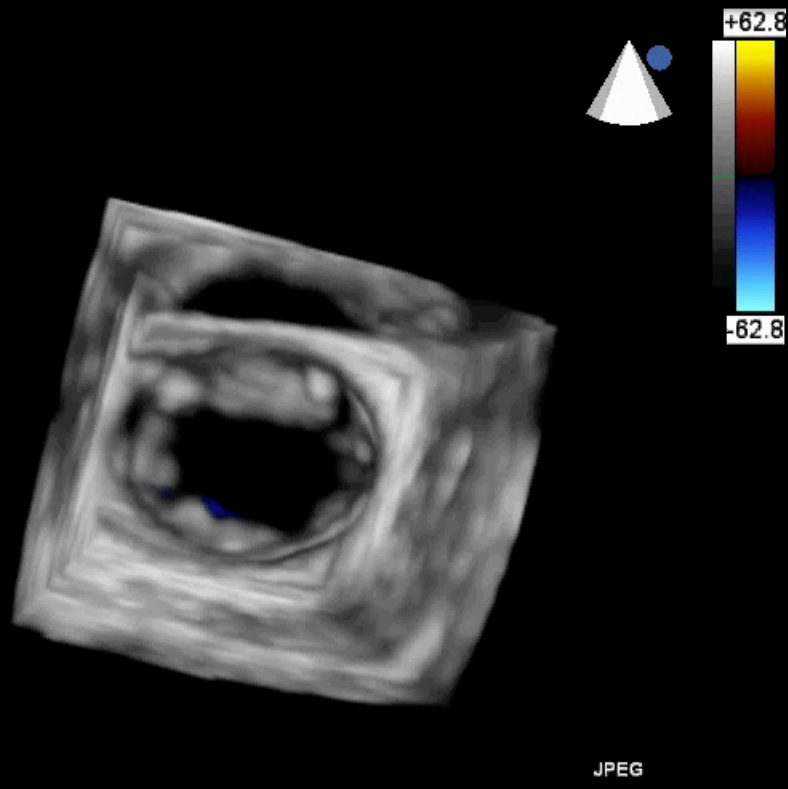
# Multibeat Acquisition




1 beat ~ 2 Hz

6 beat ~ 17 Hz

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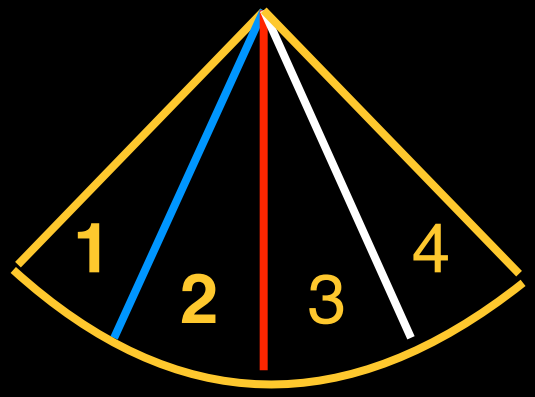
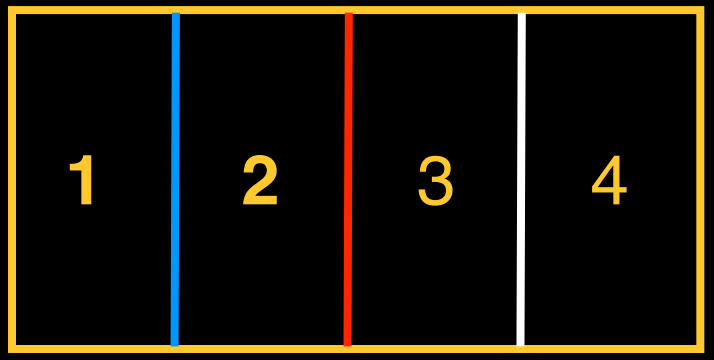
# Multi-beat Acquisition: Averaging of 2-6 beats



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# Multibeat Acquisition

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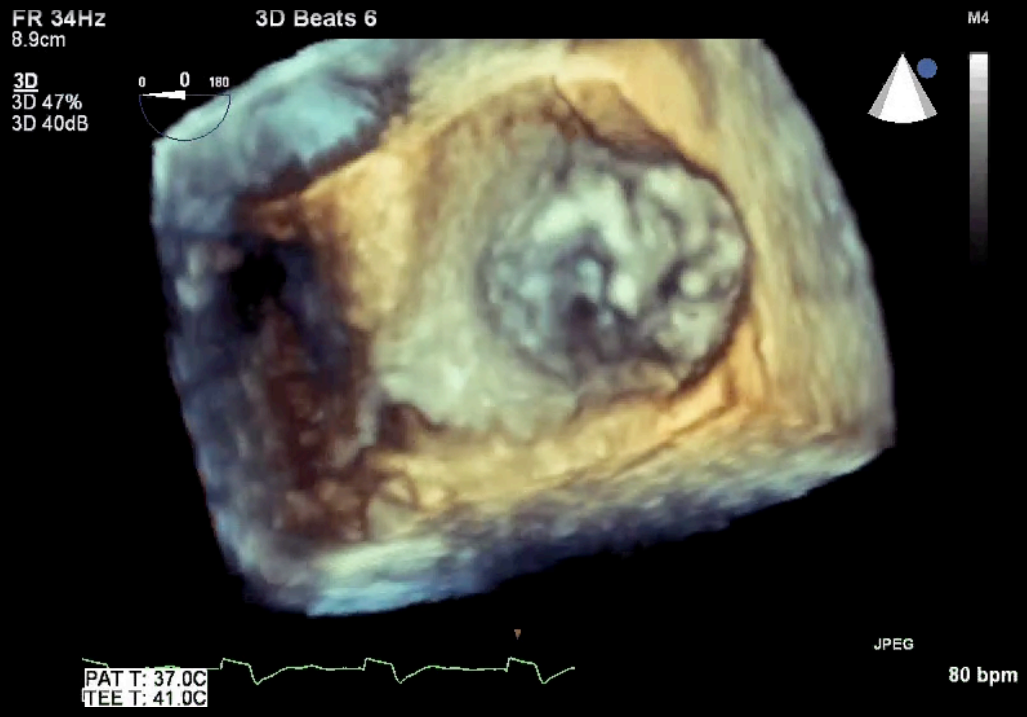
# The Problem With Multi-beat Acquisition




1. Afib
2. PVCs
3. Bovie
4. Moving the pt
5. etc…

Stitching Artifact

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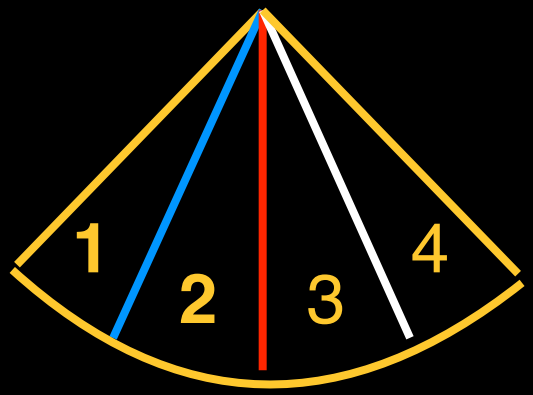
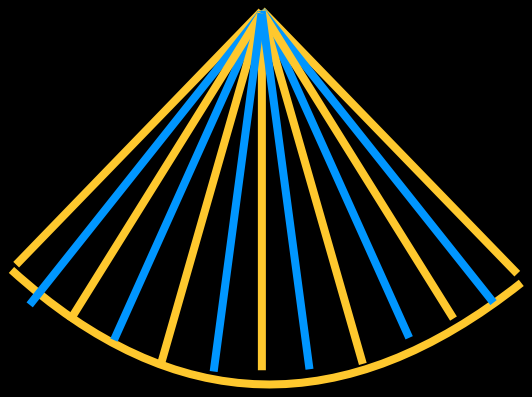
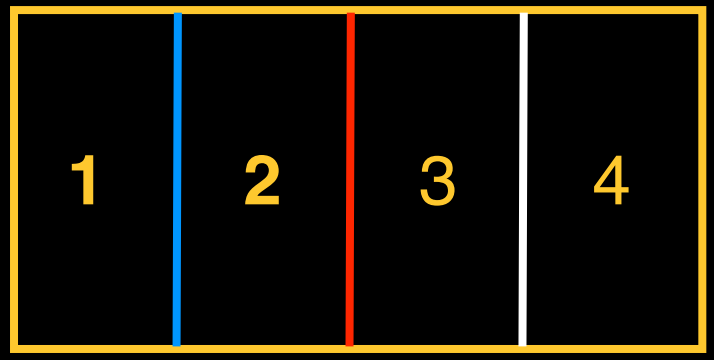
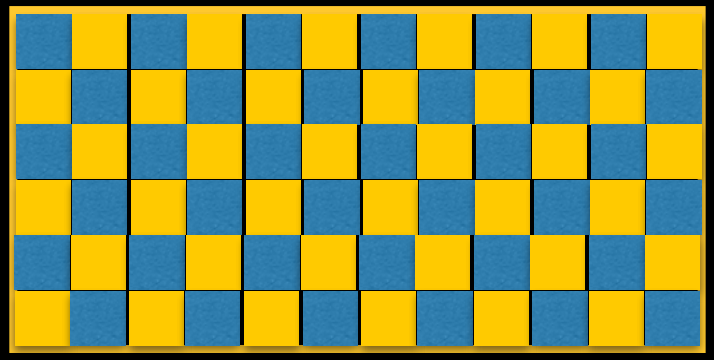
# High Volume Rate Imaging





Multi-beat Acquisition

HVR

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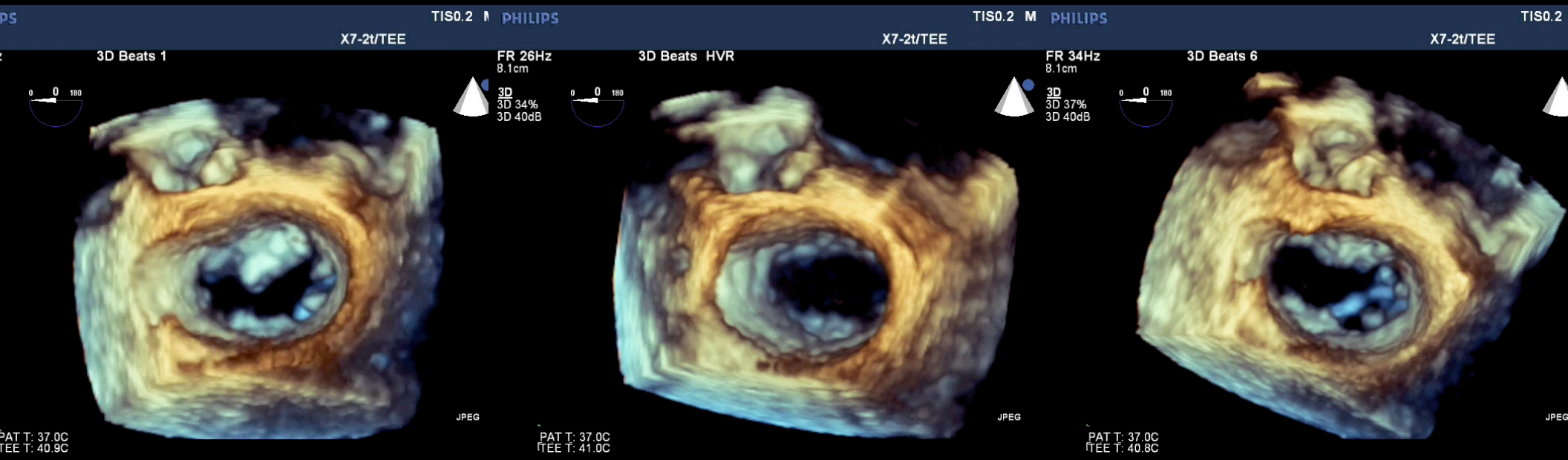
# Multi-Beat vs HVR




1 Beat
~ 7 Hz

HVR
~ 26 Hz
Spacial Res

6 Beat
~ 34 Hz
Great Spacial Res; Stitching

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# 6 Steps To Getting Great Images

1. Good 3D comes from good 2D
2. Only image what you need
3. Set yourself up in a real-time mode (HVR)
4. Hold ventilations
5. You like it?
6. Dial it up to 6 Beats!!

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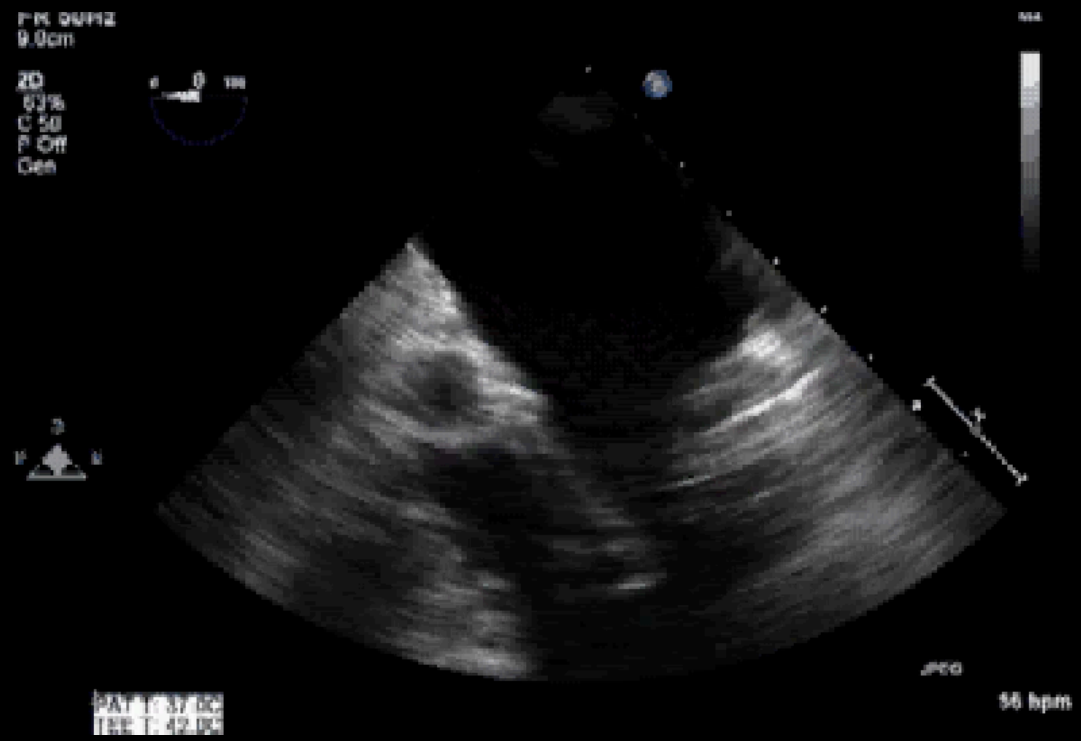
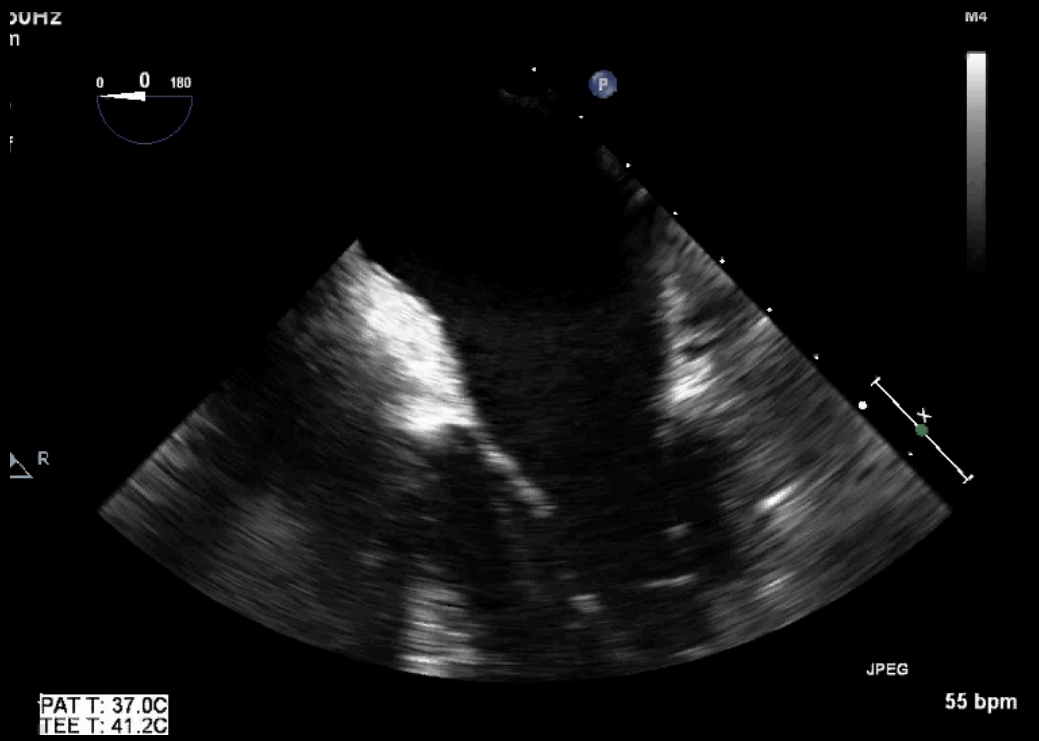
# 1. Good 3D Comes From Good 2D




Bad 2D




Good 2D

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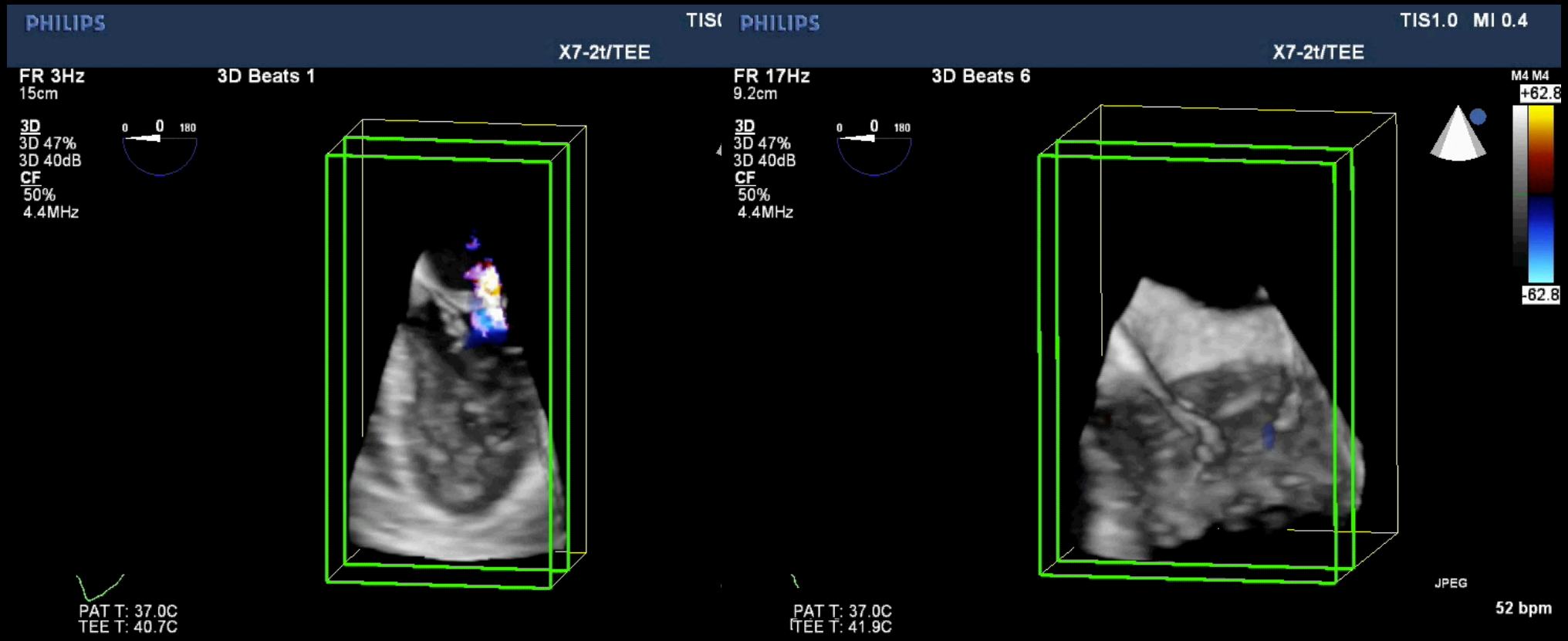
# 2. Only Image What You Need




3 Hz

17 Hz

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# 2. Only Image What You Need

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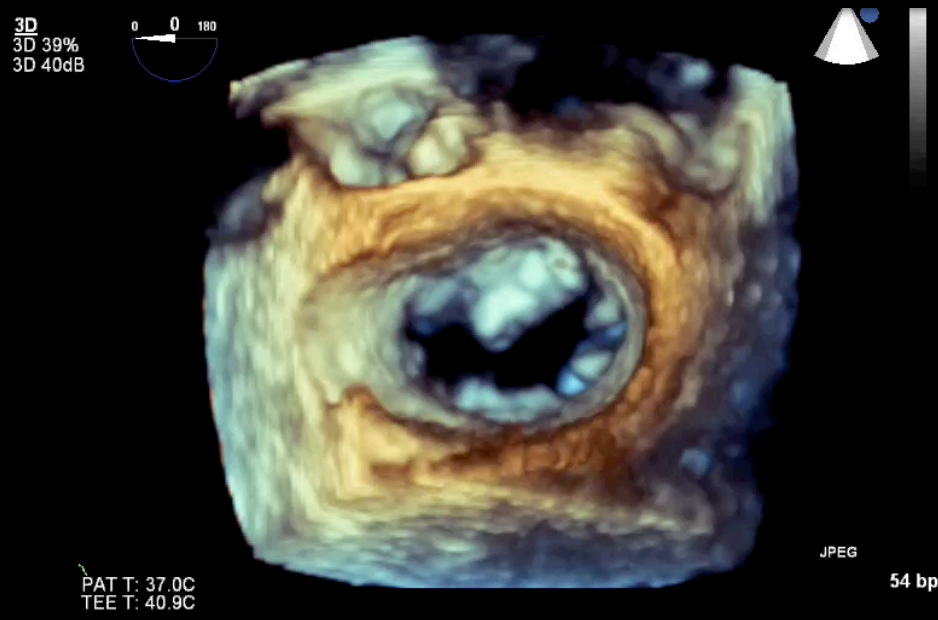
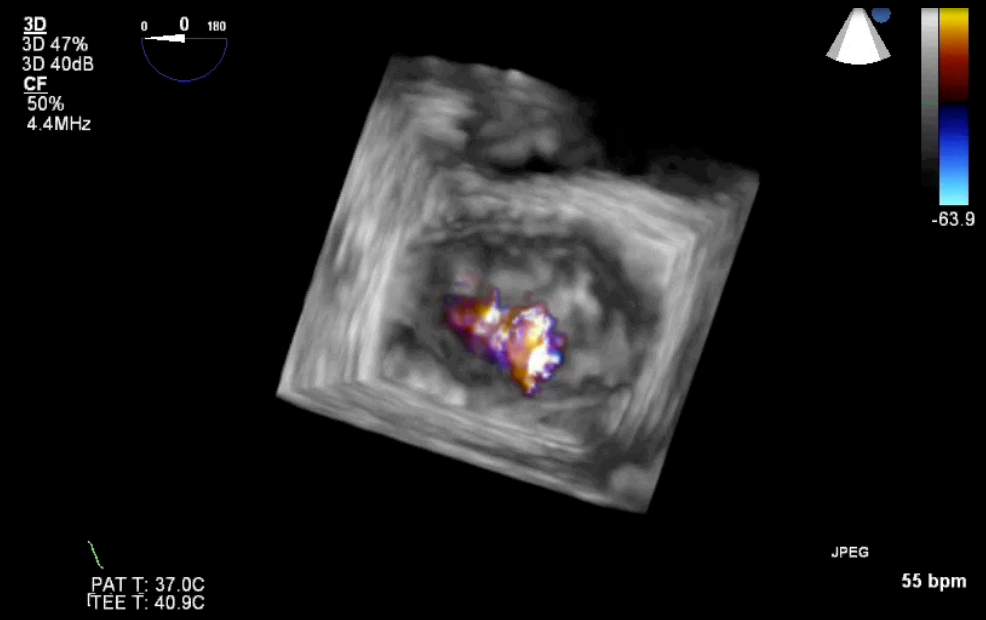
# 3. Set Yourself Up In A Real-Time Mode




For regular 3D ~ 1 Beat
For 3D Color ~ HVR

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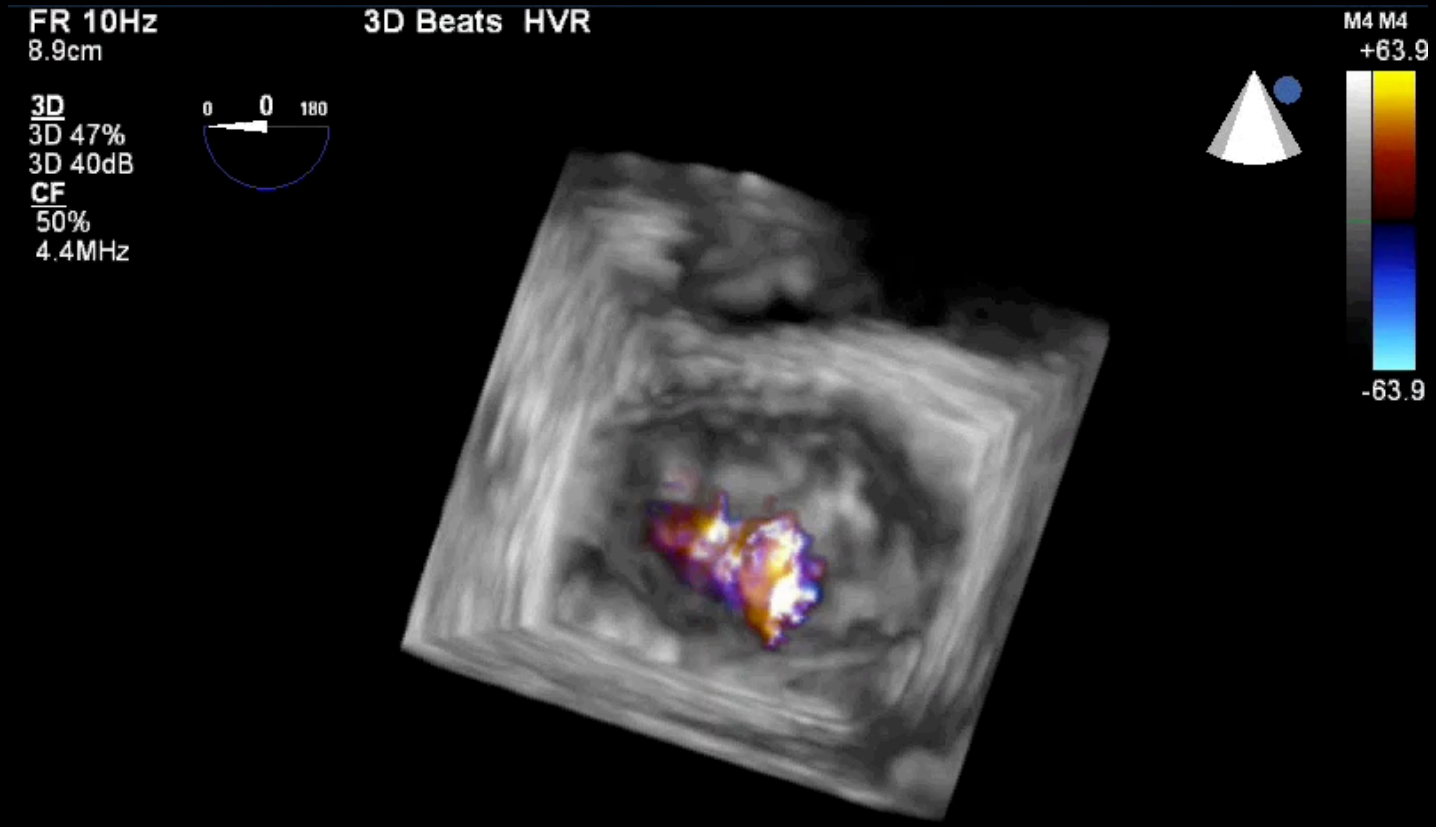
# 4. Hold Ventilations

# 5. You Like It?




## Readjust in Real-Time Mode

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# 6. Dial It Up To 6 Beats!

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# Know Your Buttons

1. Gain
2. Cropping
3. Rotational Display

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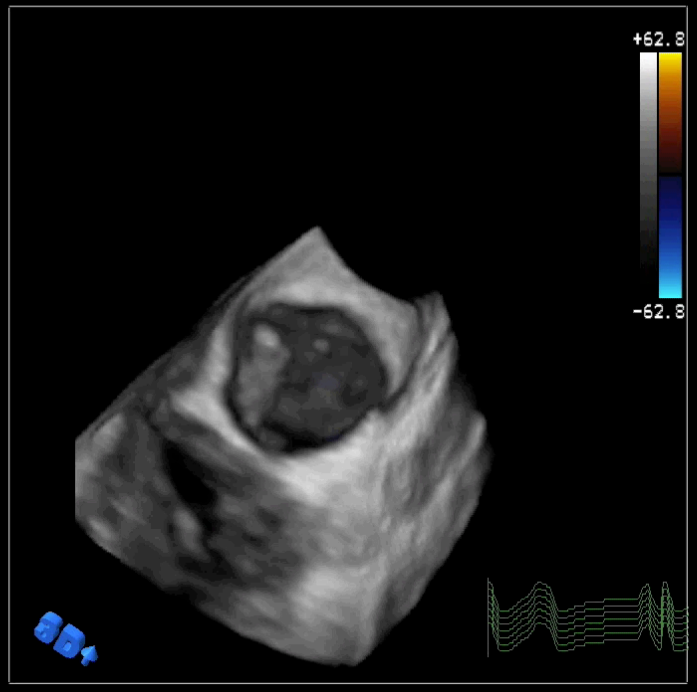
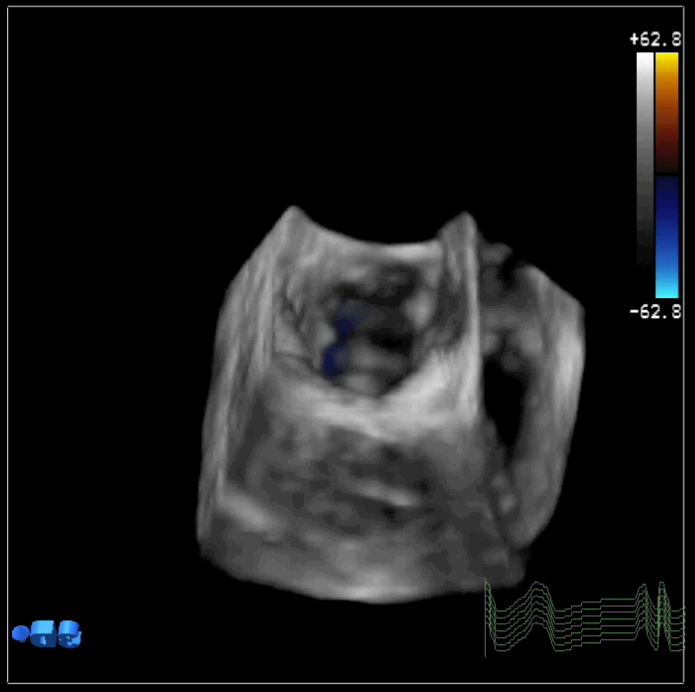
# Know Your Knobs




# How To Manipulate Your Images

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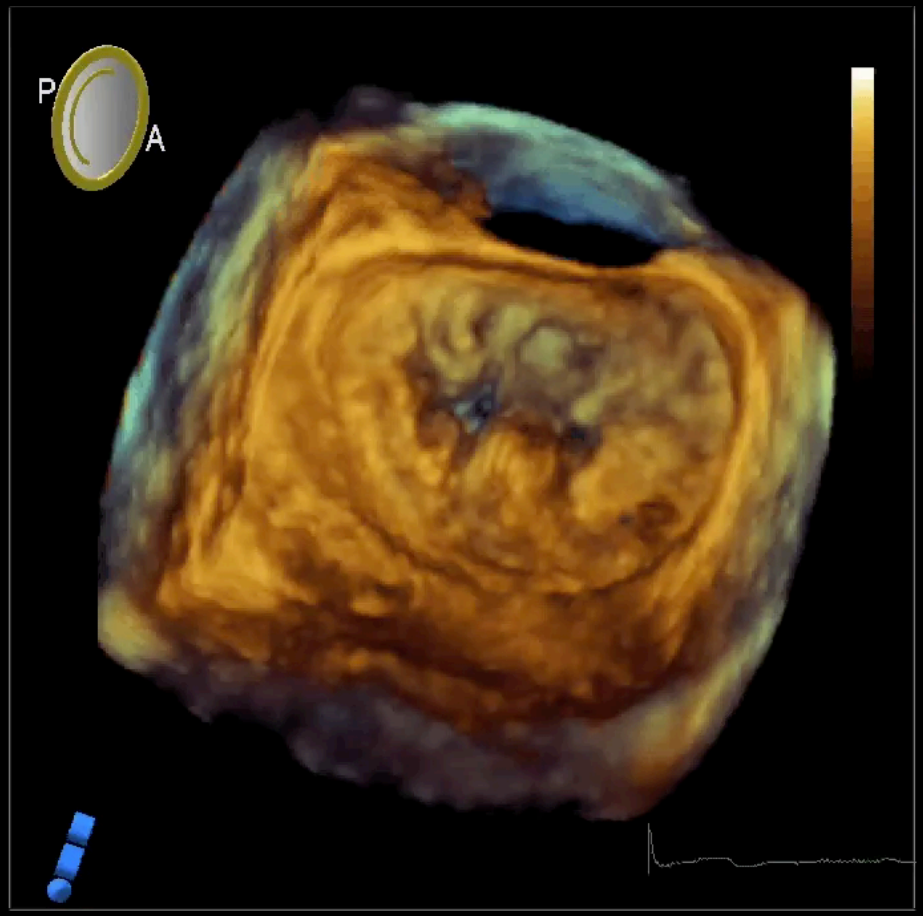
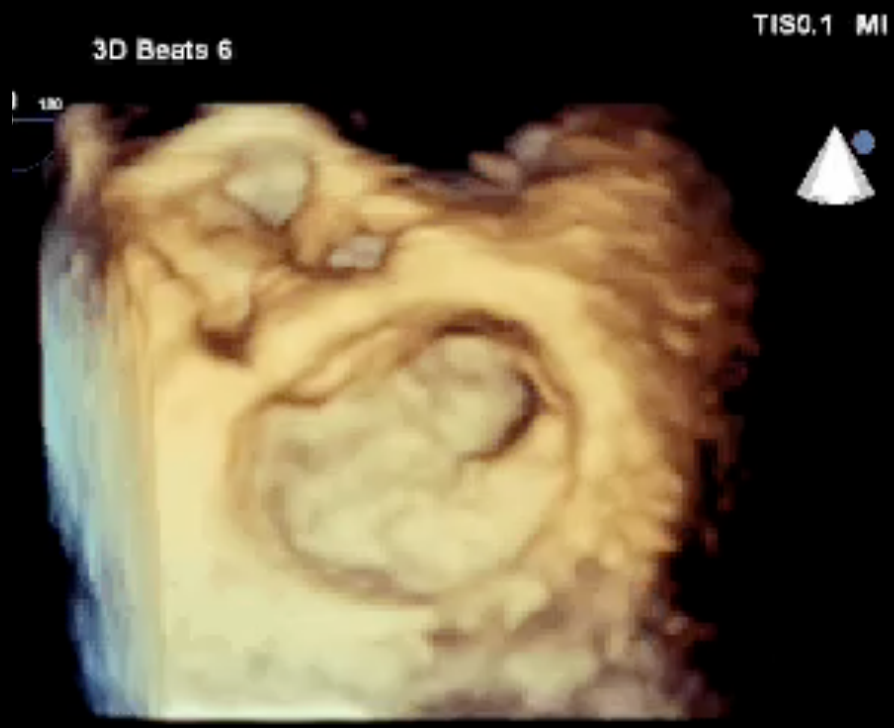
# Know Your Software




# IE33 (in Qlab) vs Epiq

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