3D echocardiography

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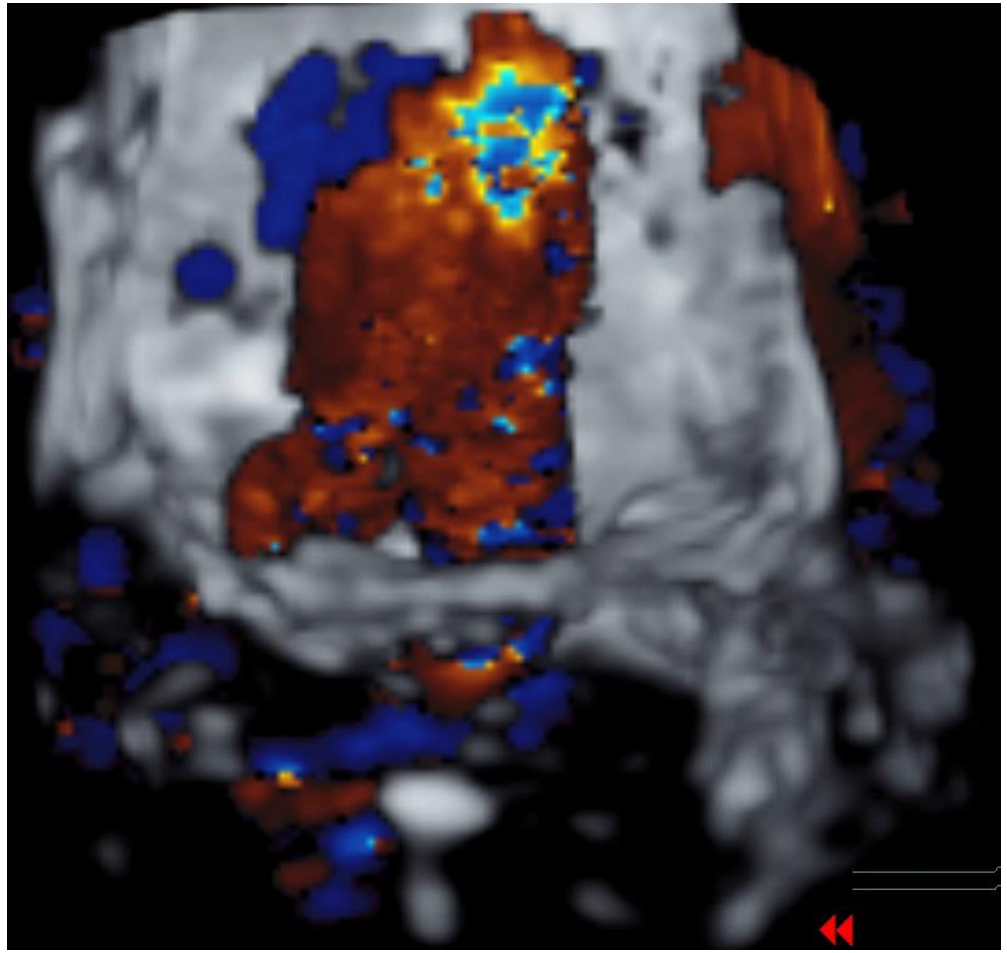


MEDICAL COLLEGE OF WISCONSIN

Disclosures

- None

MEDICAL COLLEGE OF WISCONSIN

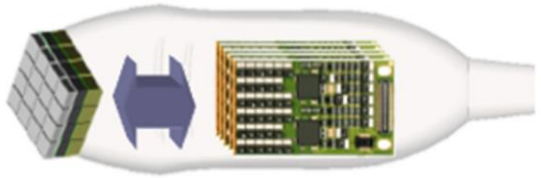
Objective

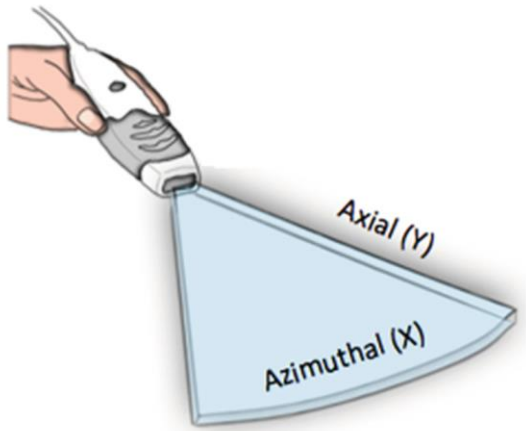
- 3D orientation
- Learn how to obtain high quality 3D images
- Application of 3D echo in MV, TV and LAA pathology

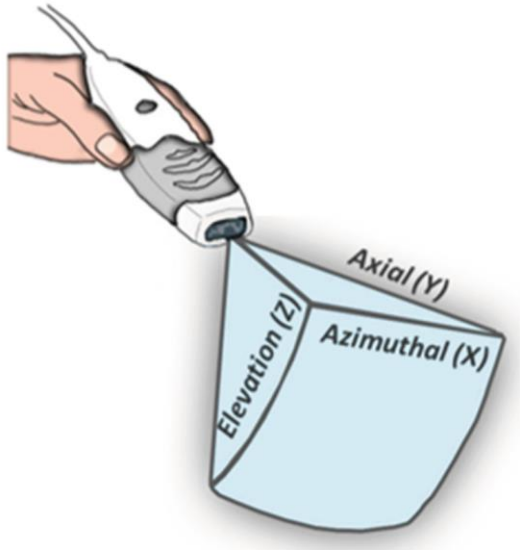
3D versus 2D

2D has a single plane of scanning

3D has two planes of simultaneous scanning

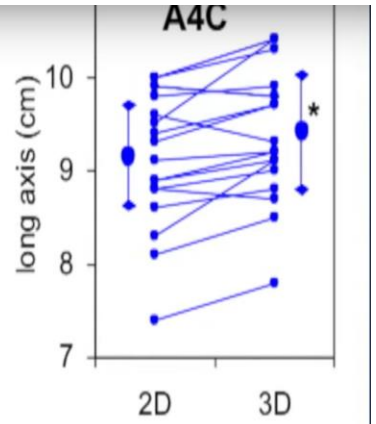


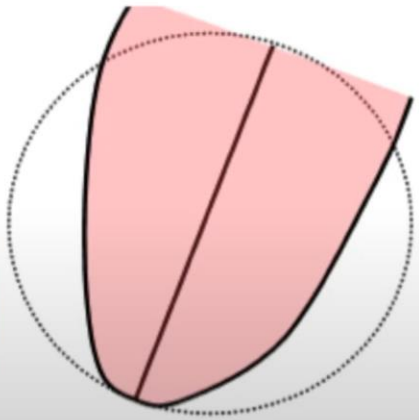




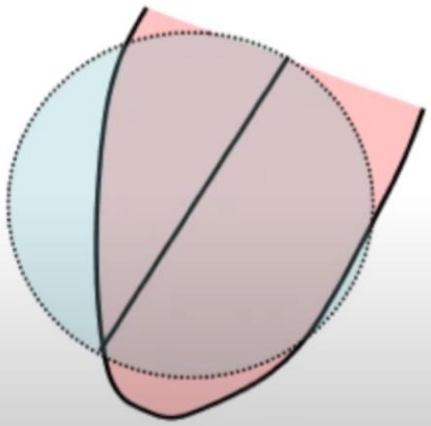
MEDICAL COLLEGE OF WISCONSIN

Why is 3D More Accurate?

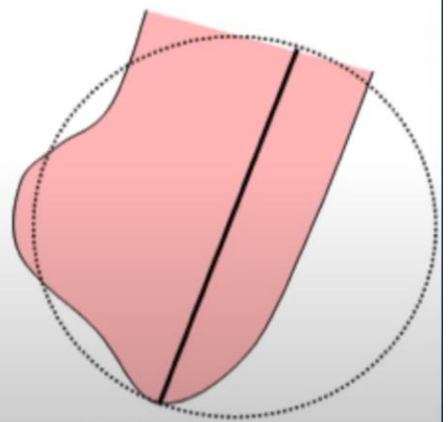




TRUE APEX



FORESHORTENING ERROR



SEGMENTAL DILATATION

Mor-Avi V, Lang RM et al., *Circulation* 2004. 110: 1814-1818.

Scroll for details

MEDICAL COLLEGE OF WISCONSIN

LV Volumes: 3DE

✓ Advantages

- Avoid image foreshortening
- No geometric assumptions
- More accurate and reproducible

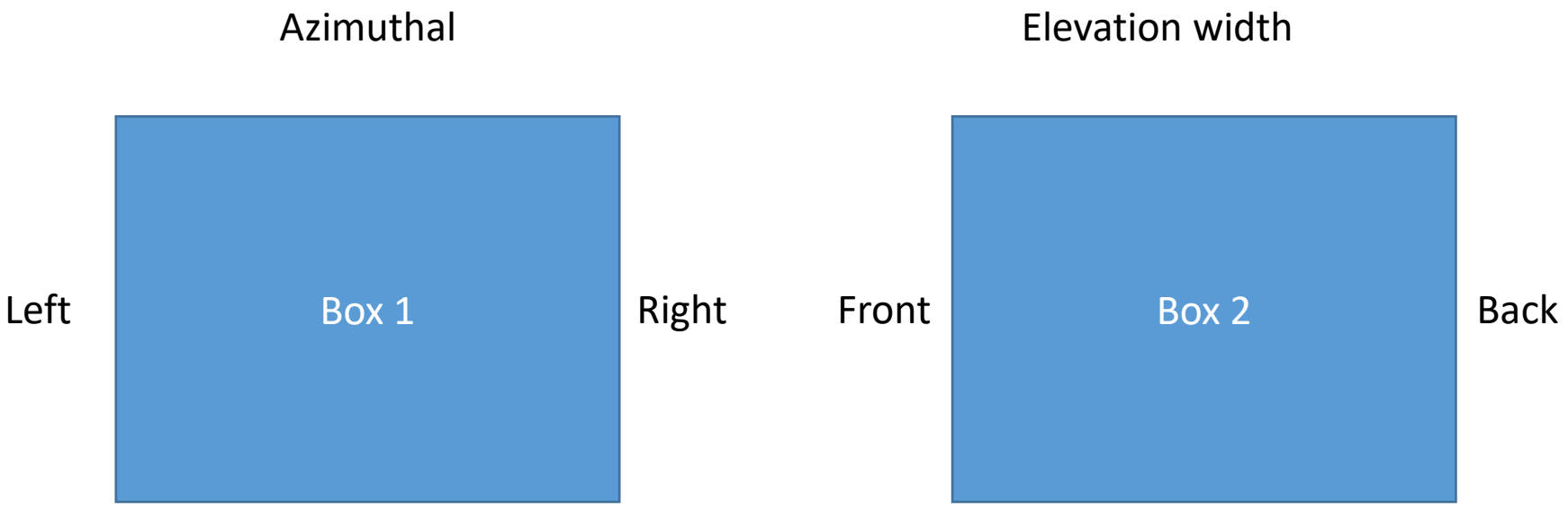
✗ Disadvantages

- Low temporal resolution
- Less data on normals

MEDICAL COLLEGE OF WISCONSIN

3D Acquisition Modes

3D zoom (or 2 click crop)



MEDICAL COLLEGE OF WISCONSIN

3D Full Volume

MEDICAL COLLEGE OF WISCONSIN

3D Full Volume

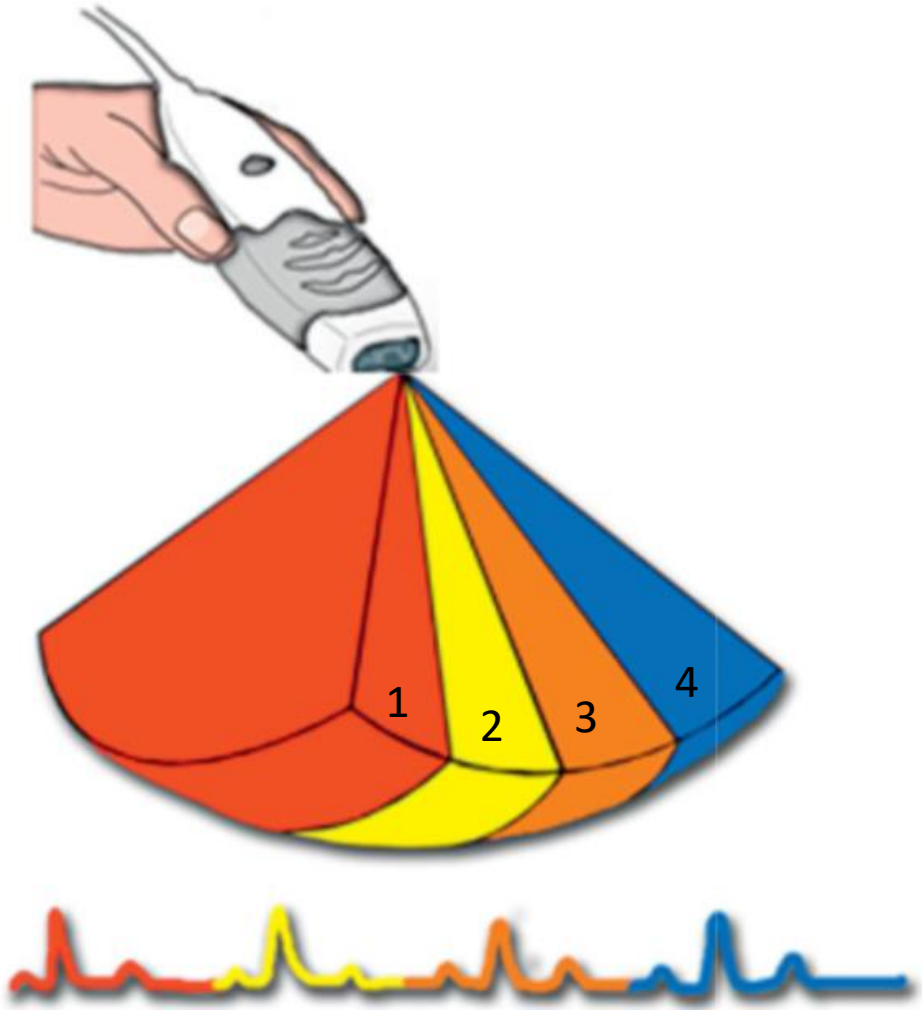
MEDICAL COLLEGE OF WISCONSIN

Multibeat Acquisition

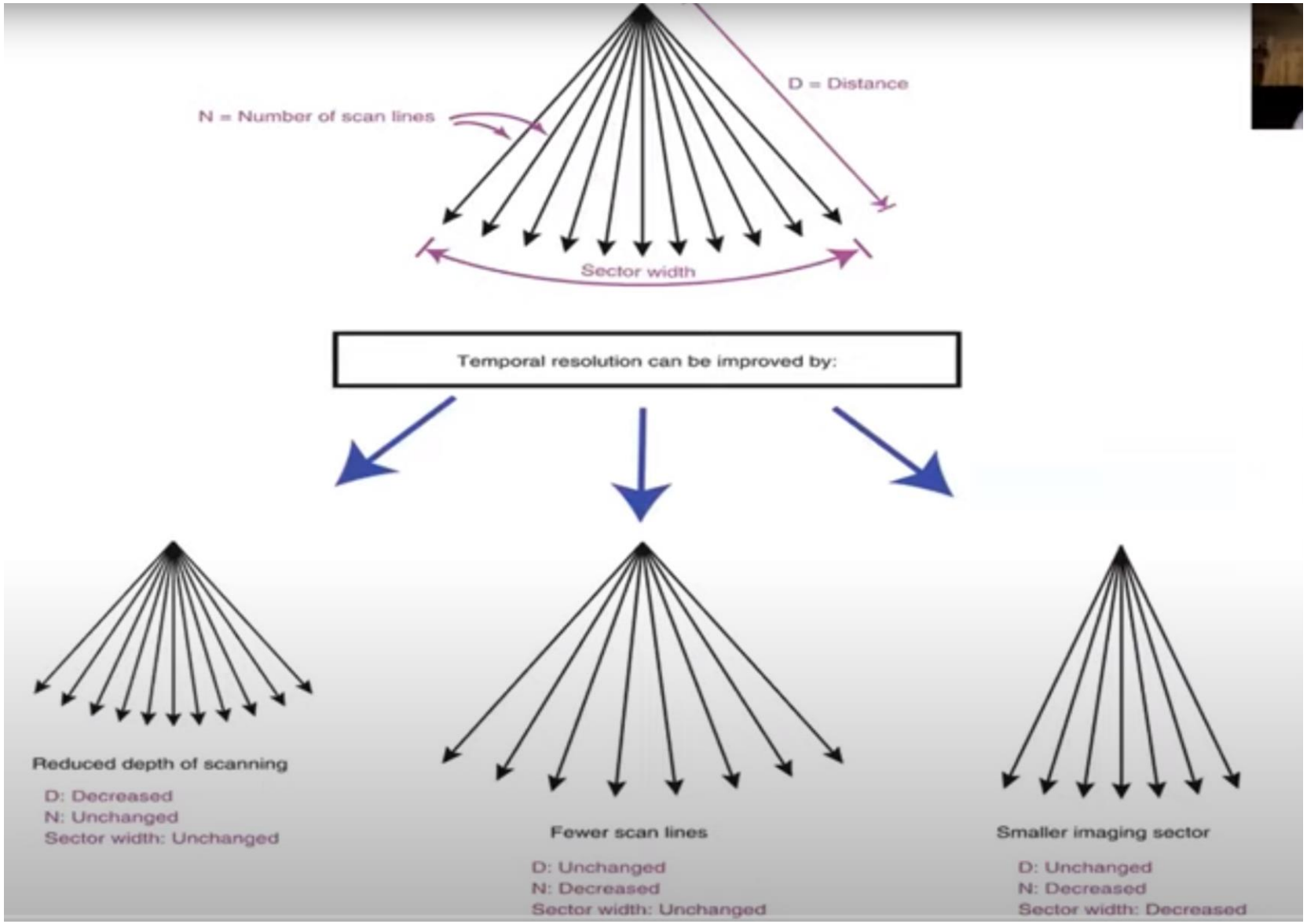
A small piece of the scan sector is imaged in each cardiac cycle

With each cardiac cycle an adjacent portion of the scan sector is imaged.

Finally all the small pieces over multiple cardiac cycle (upto 4) are stitched to form the full image

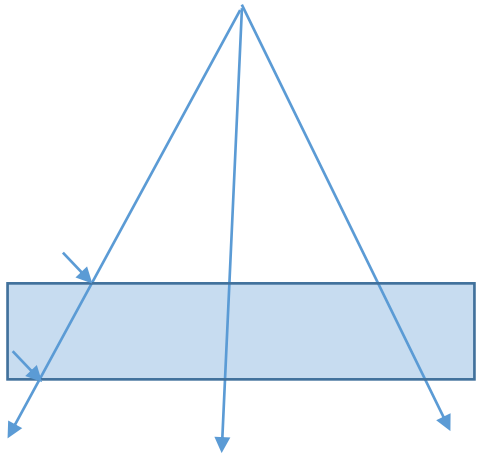


MEDICAL COLLEGE OF WISCONSIN



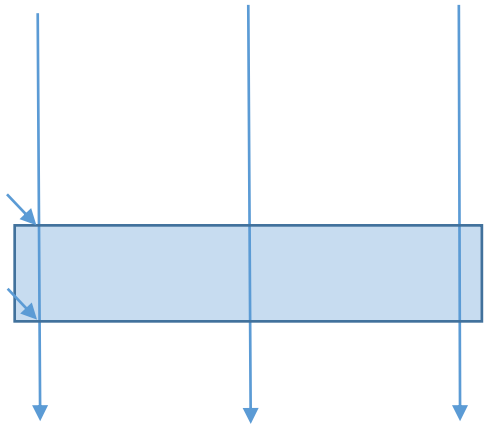
Biplane (X-plane) versus 3D

Biplane



Oblique cut

3D



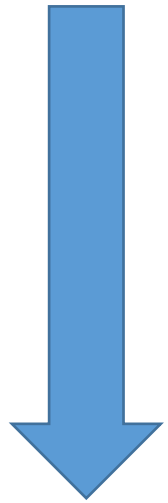
Straight cut

MEDICAL COLLEGE OF WISCONSIN

3D orientation

MEDICAL COLLEGE OF WISCONSIN

3D orientation

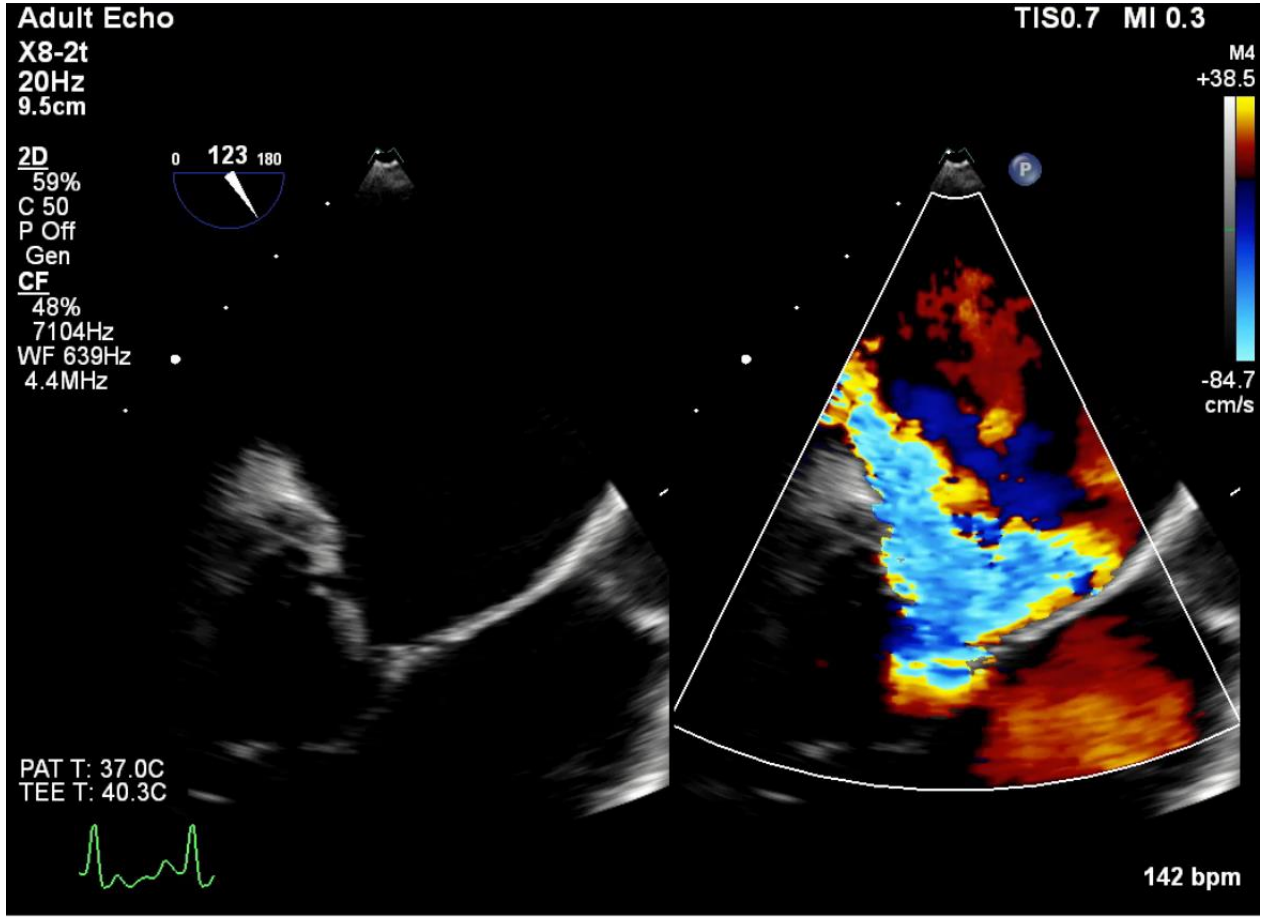


MEDICAL COLLEGE OF WISCONSIN

Frame rate and window width/Heart rate

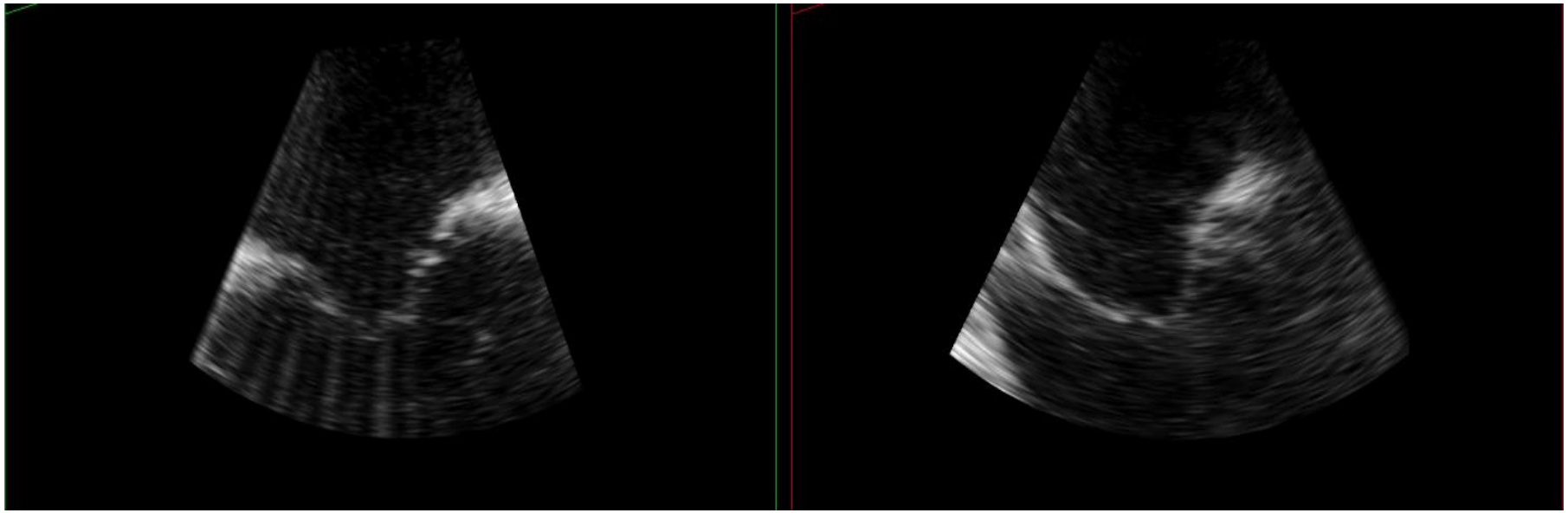
MEDICAL COLLEGE OF WISCONSIN

48 year old woman with functional MR

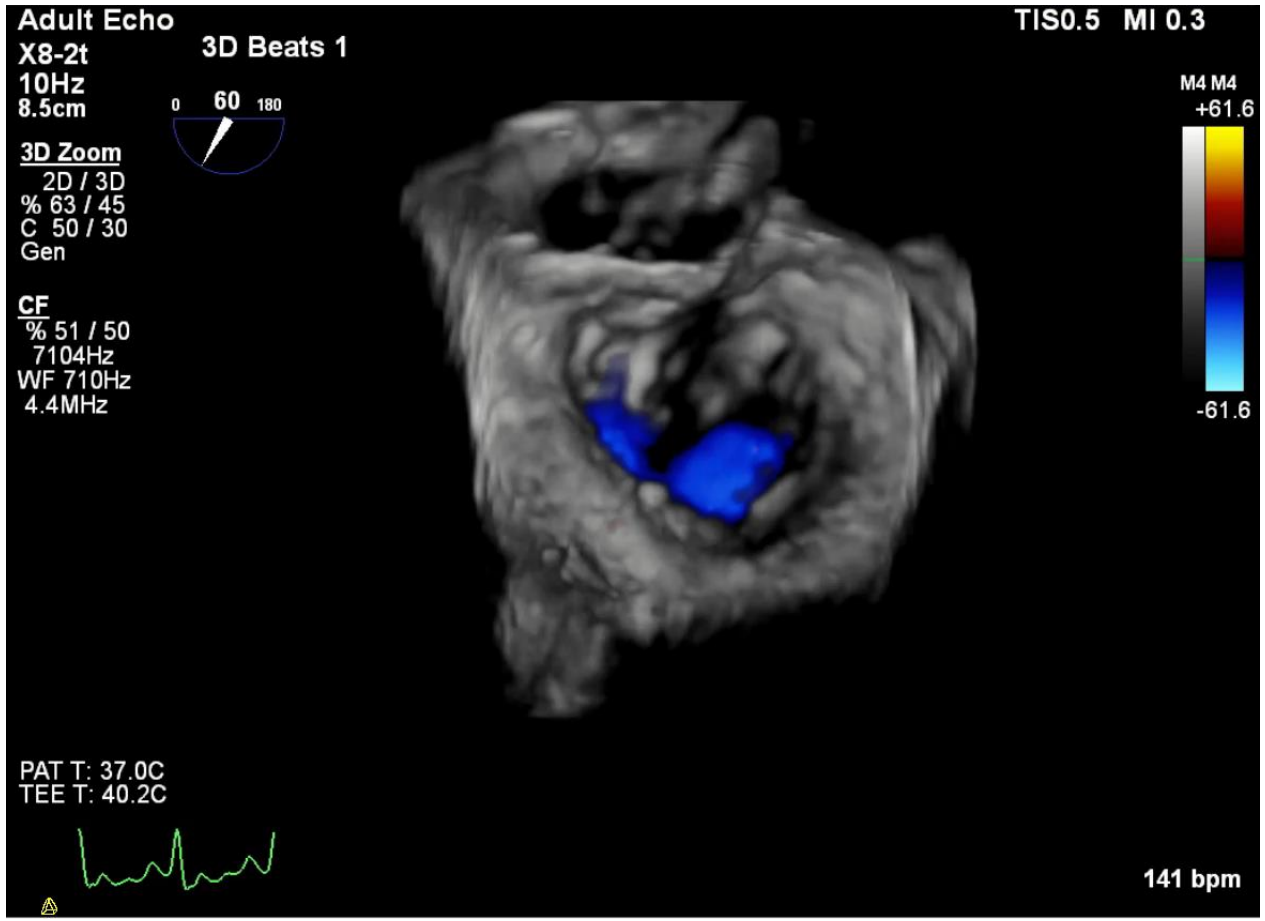


MEDICAL COLLEGE OF WISCONSIN

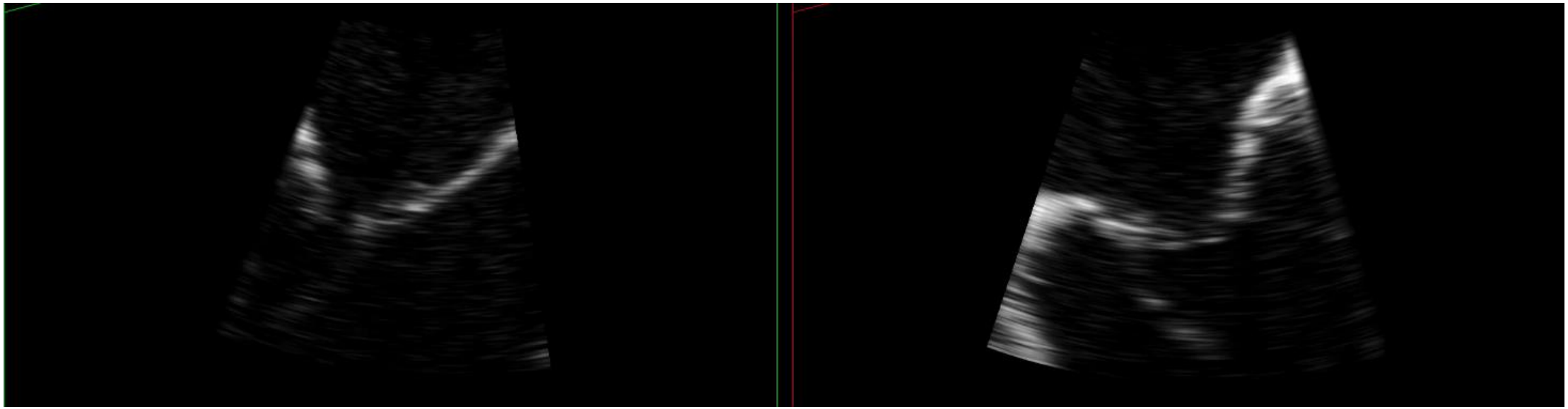
Frame rate and window width/Heart rate E1173256



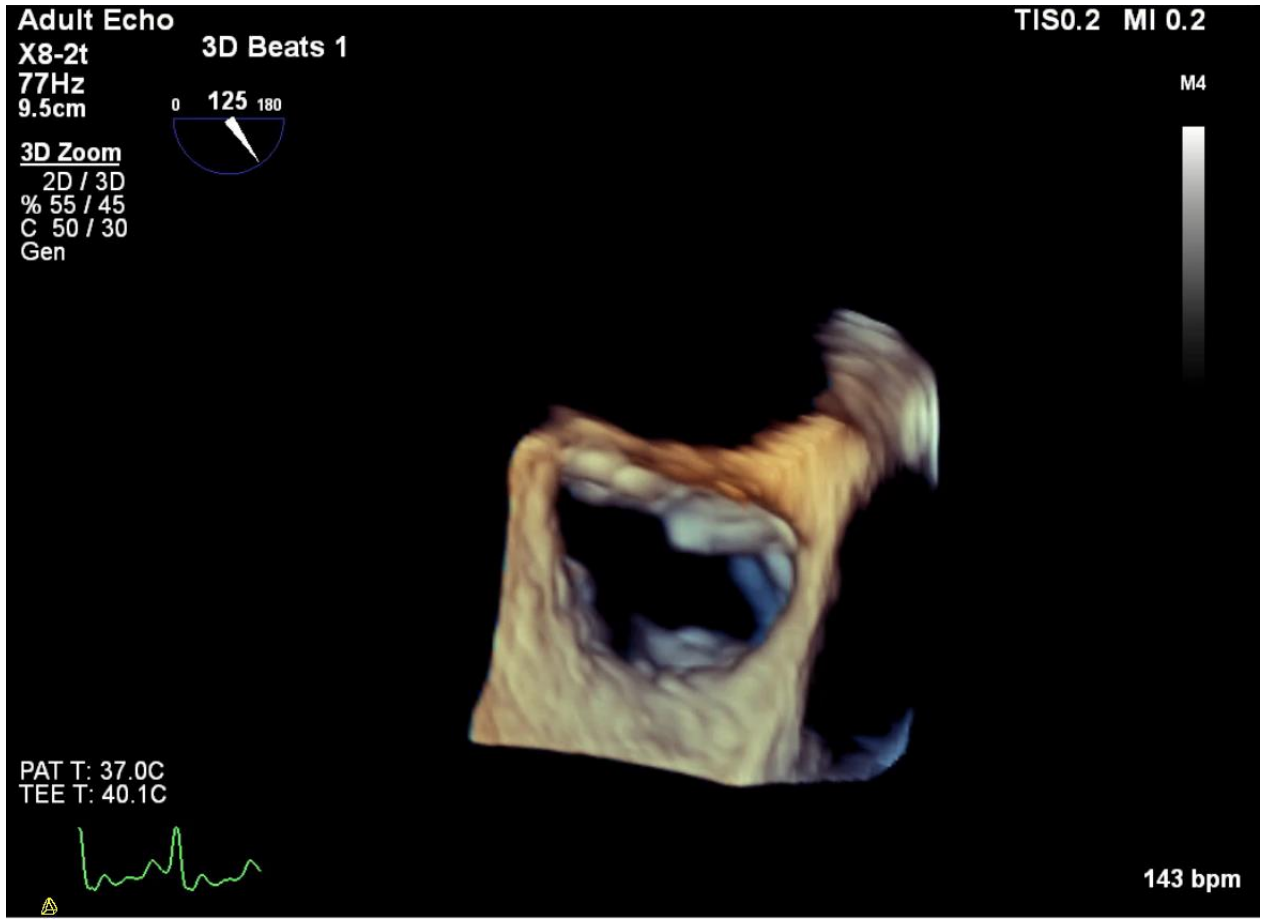
MEDICAL COLLEGE OF WISCONSIN



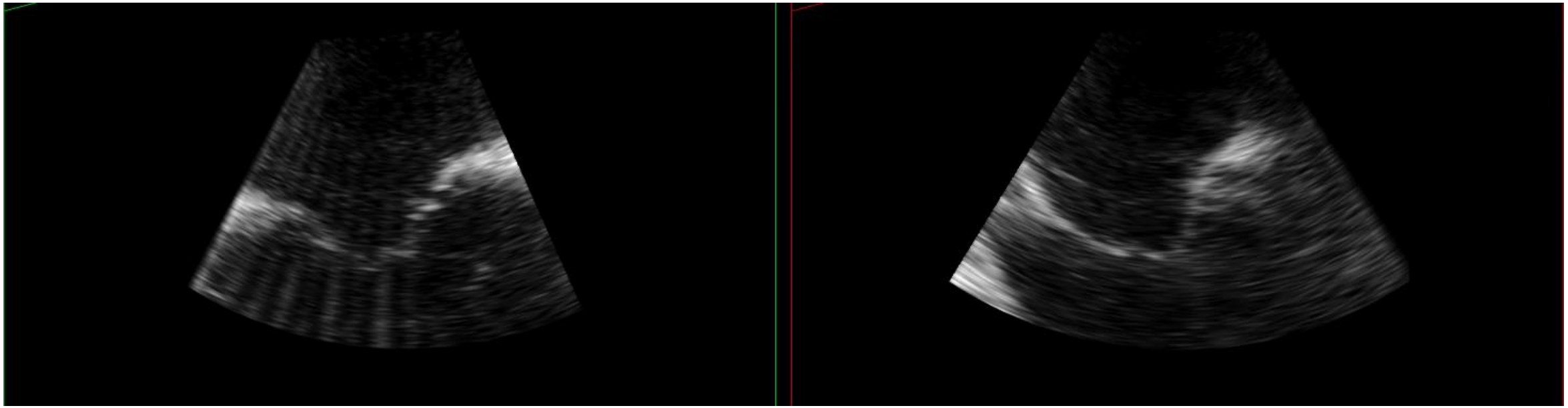
MEDICAL COLLEGE OF WISCONSIN

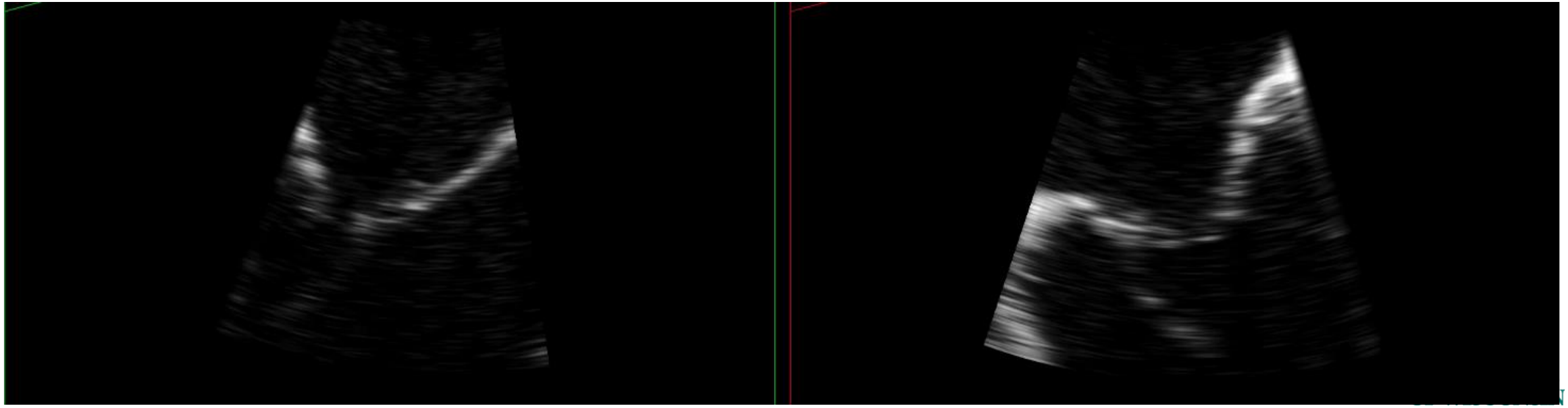


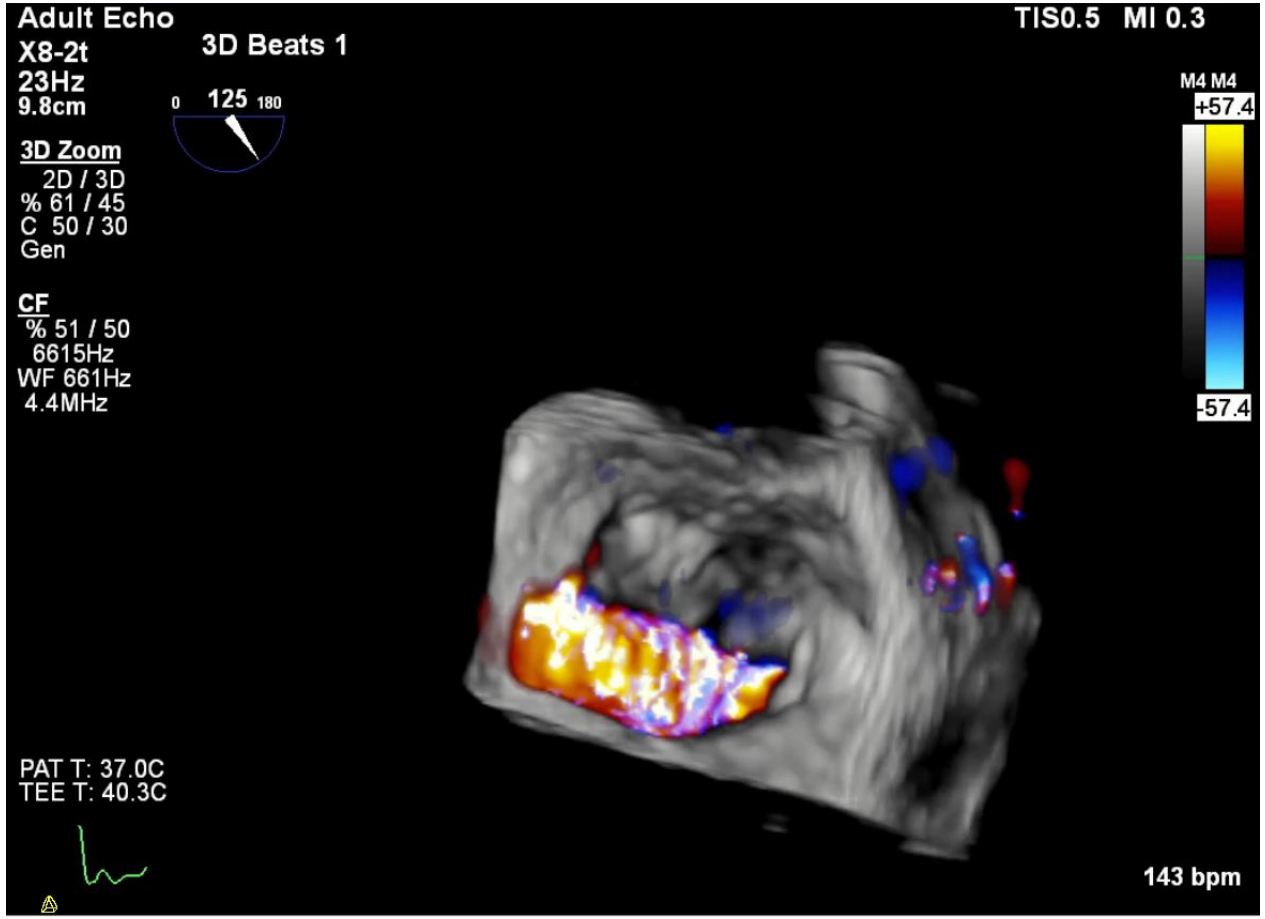
MEDICAL COLLEGE OF WISCONSIN



MEDICAL COLLEGE OF WISCONSIN

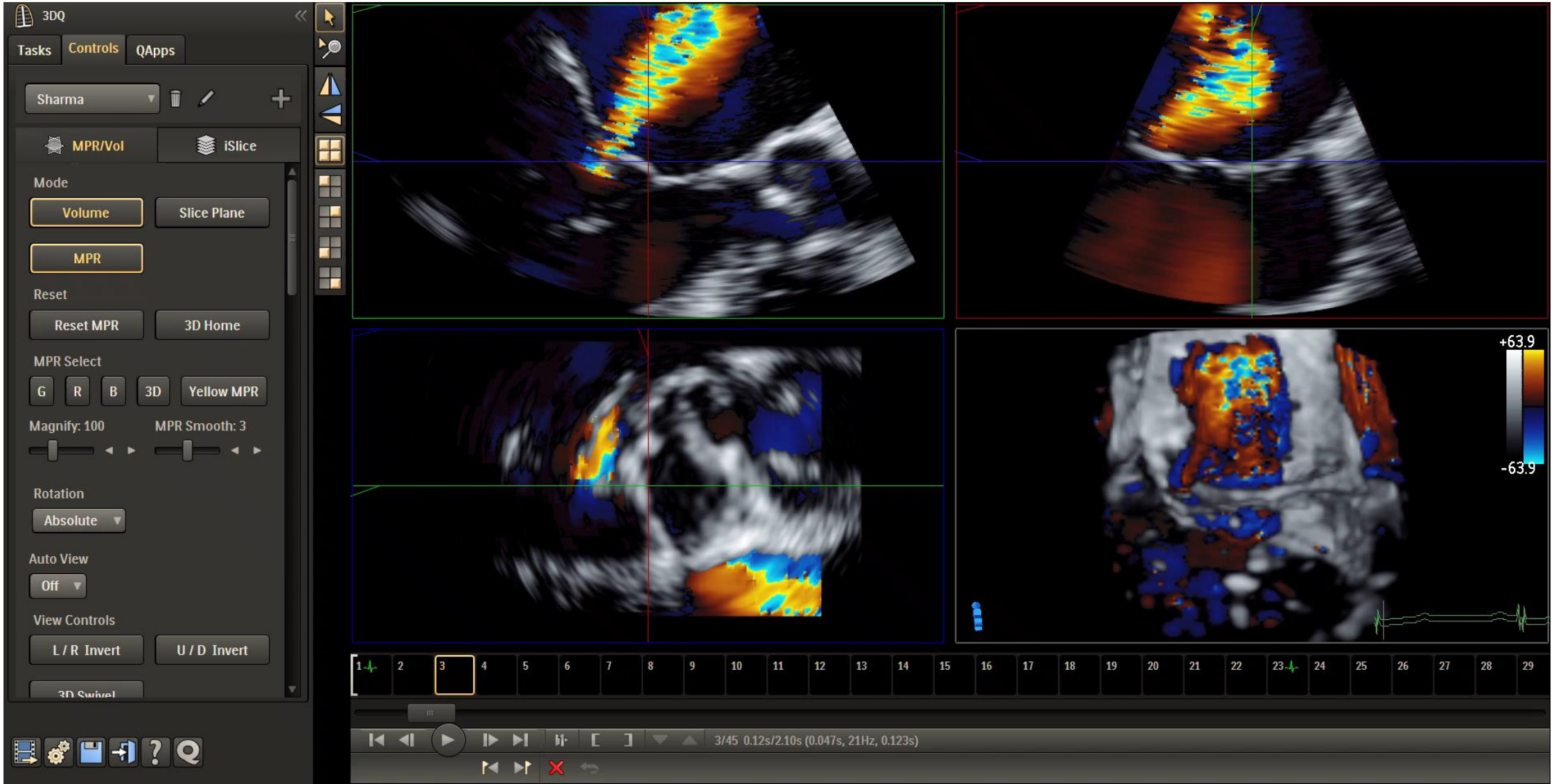






MEDICAL COLLEGE OF WISCONSIN

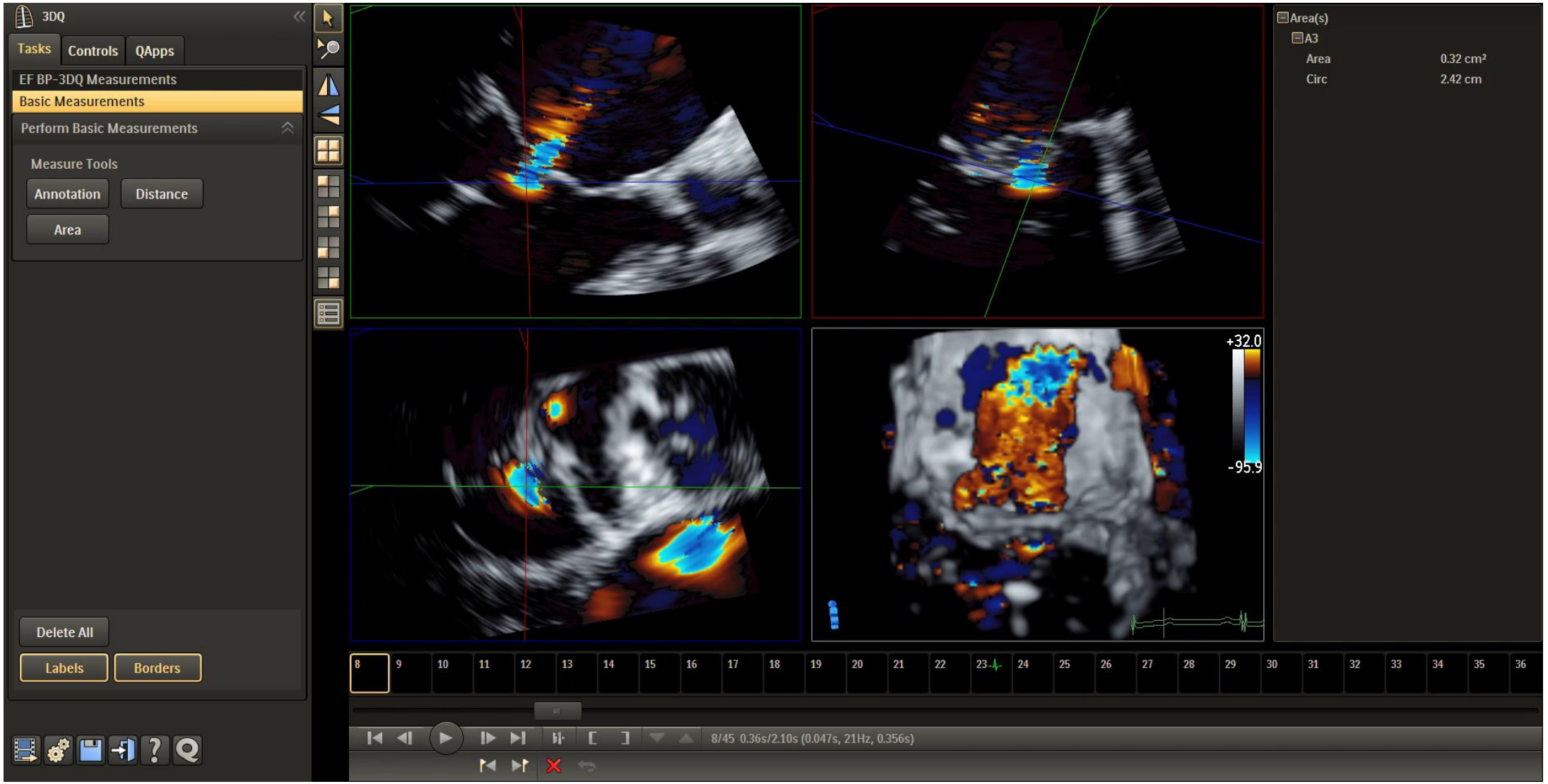
Using color 3D for direct EROA measurement



3D EROA (>0.40 cm^2 is severe)

MEDICAL COLLEGE OF WISCONSIN

Second jet



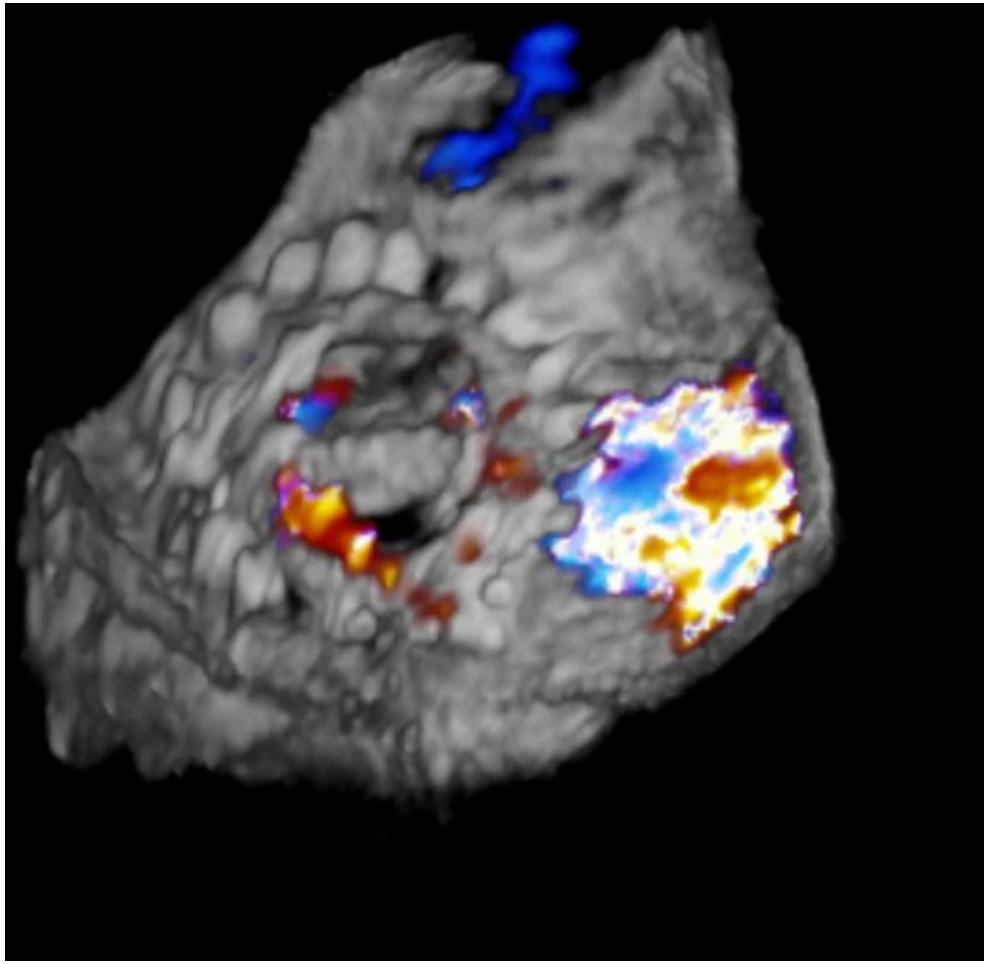
Total 3D EROA
0.03 + 0.32 cm^2

MEDICAL COLLEGE OF WISCONSIN

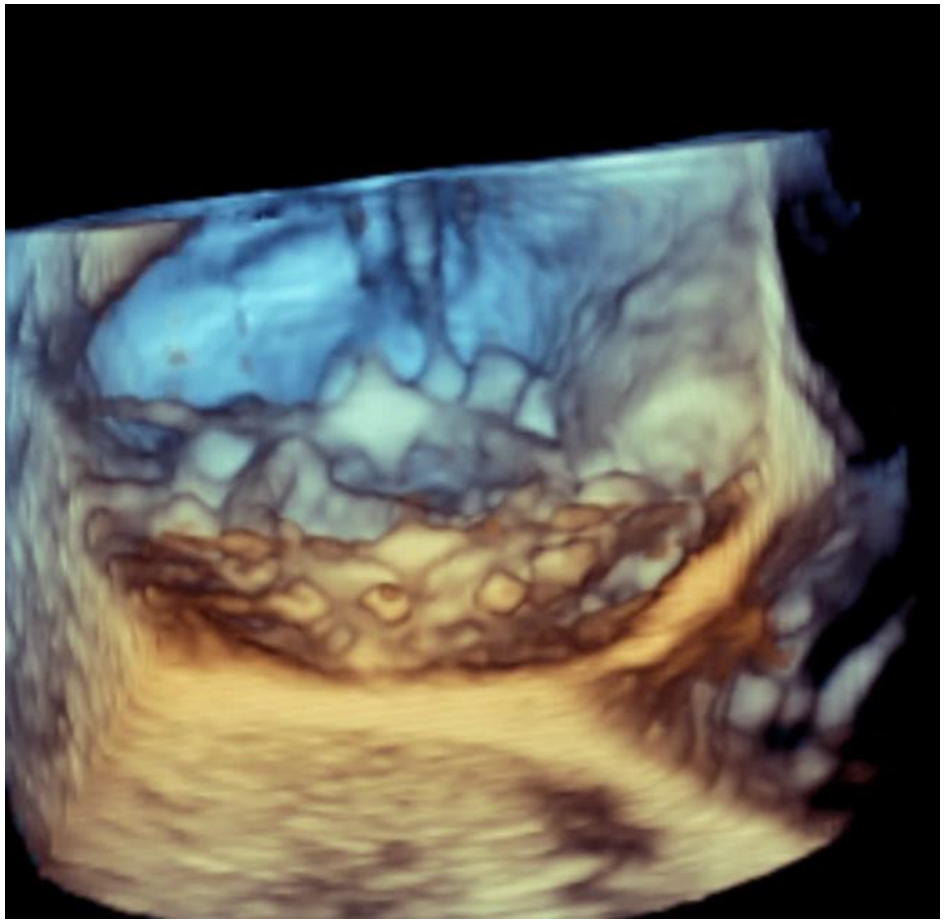
61 year old with recent mechanical MVR

MEDICAL COLLEGE OF WISCONSIN

Perivalvular medial MR

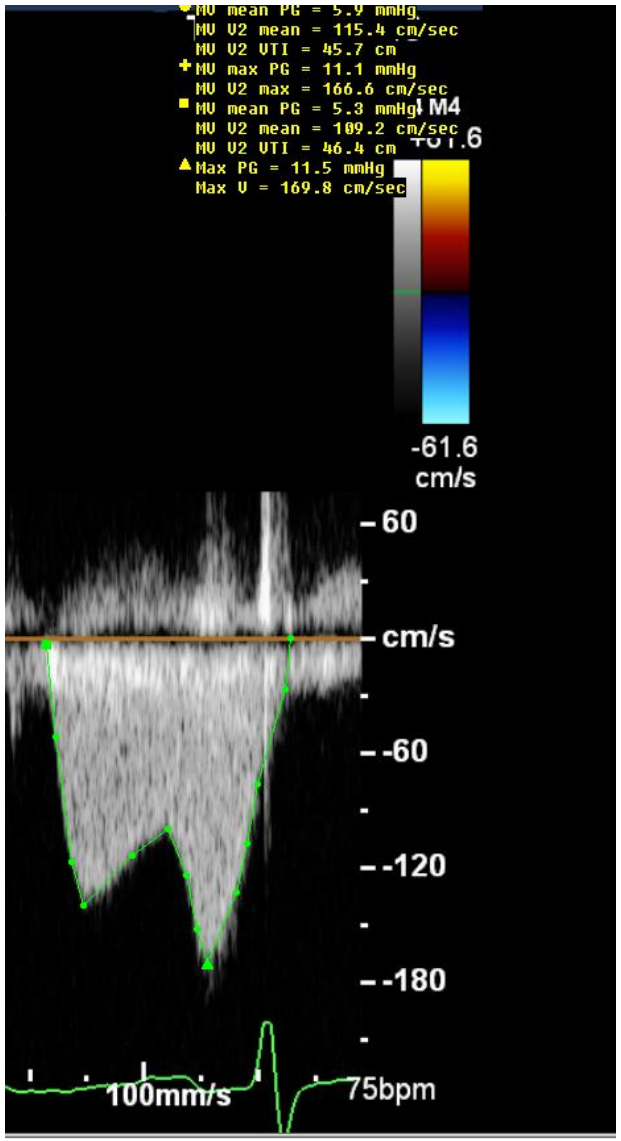


MEDICAL COLLEGE OF WISCONSIN



MEDICAL COLLEGE OF WISCONSIN

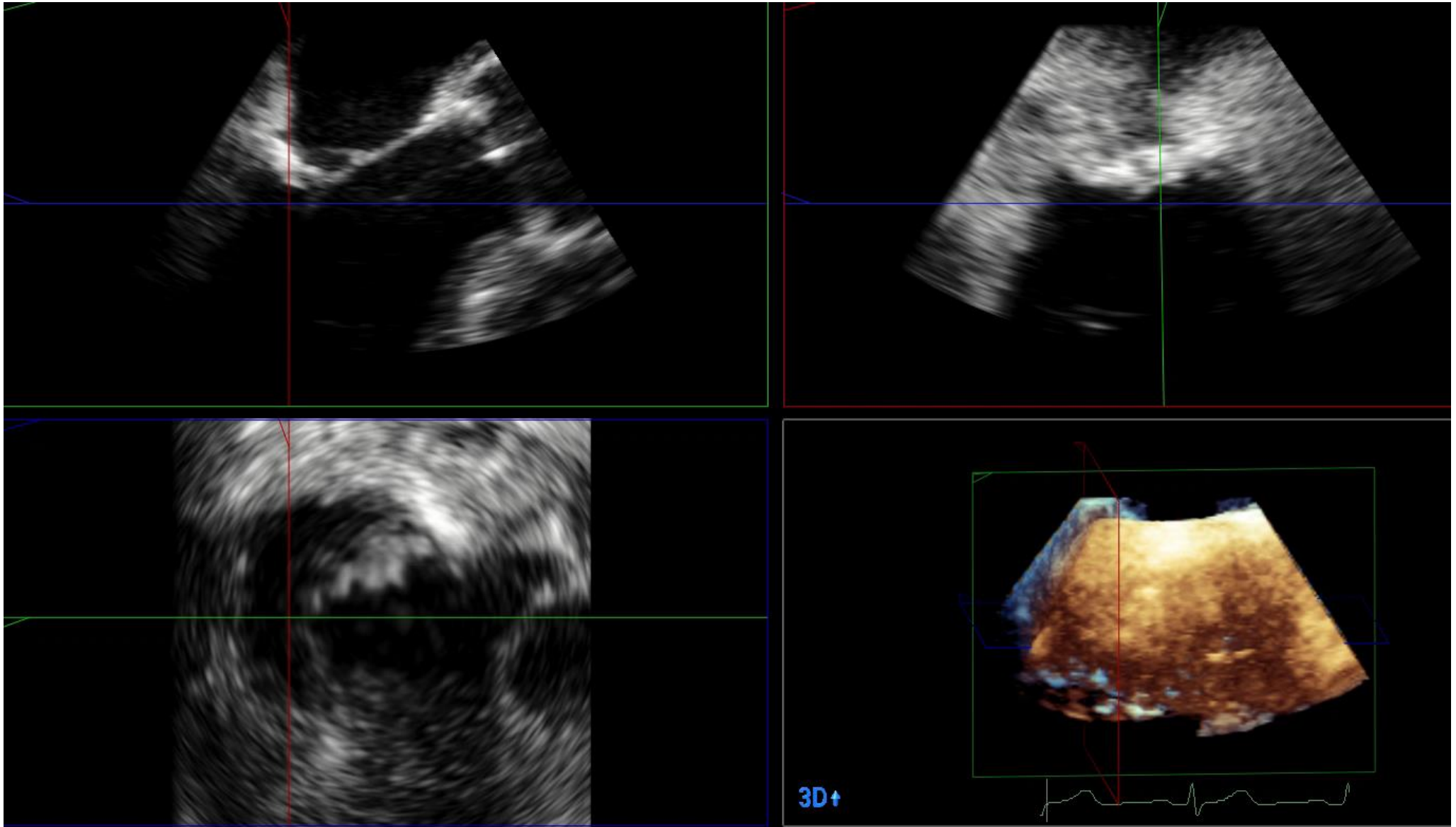
Mitral stenosis



MVA by pressure half time 1.9 cm^2

MEDICAL COLLEGE OF WISCONSIN

Mitral stenosis



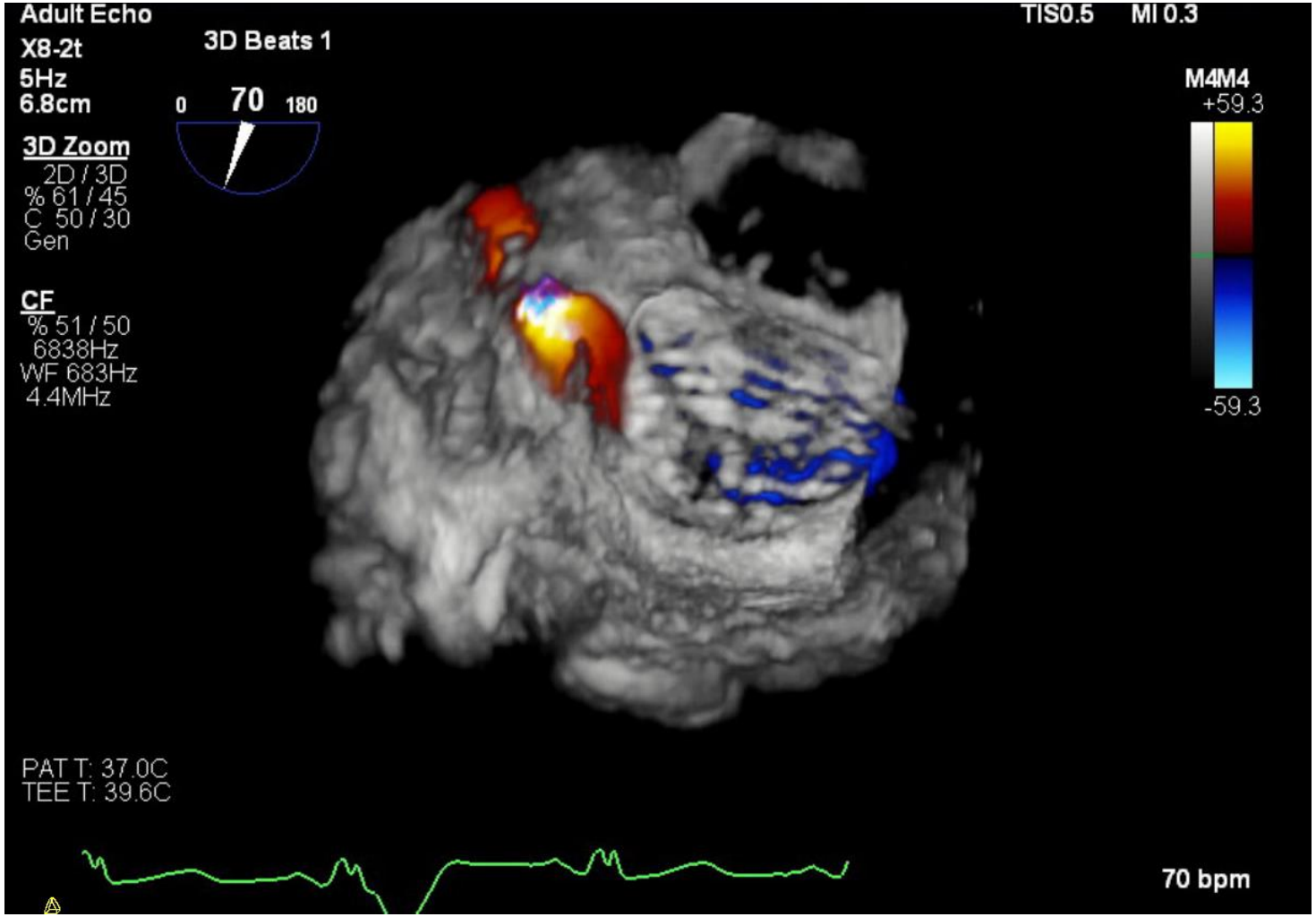
MEDICAL COLLEGE OF WISCONSIN

Prosthetic valve 3D

79 year old woman with a pericardial valve mitral bioprosthesis, heart failure, fever and leukocytosis

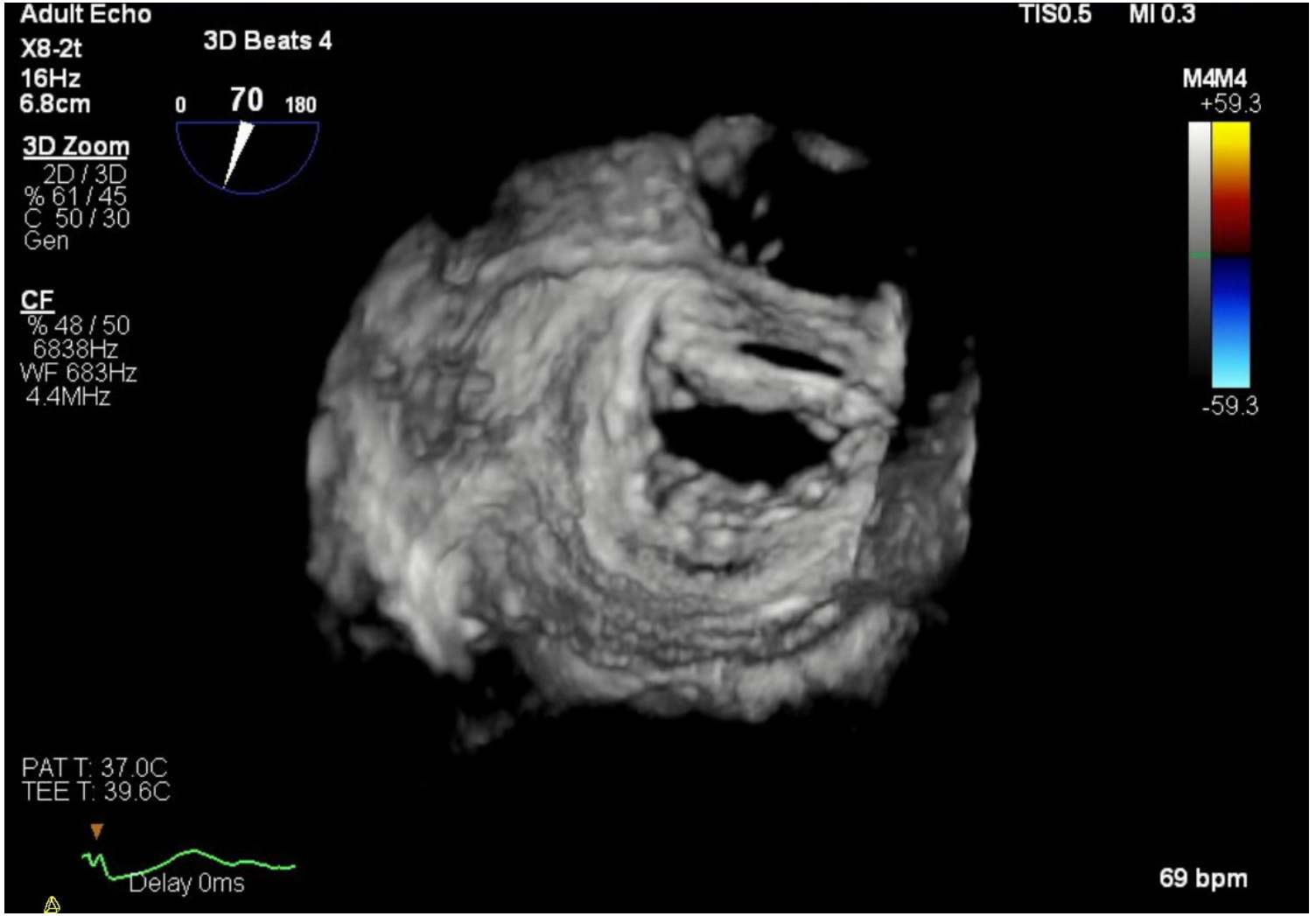
MEDICAL COLLEGE OF WISCONSIN

E1522815



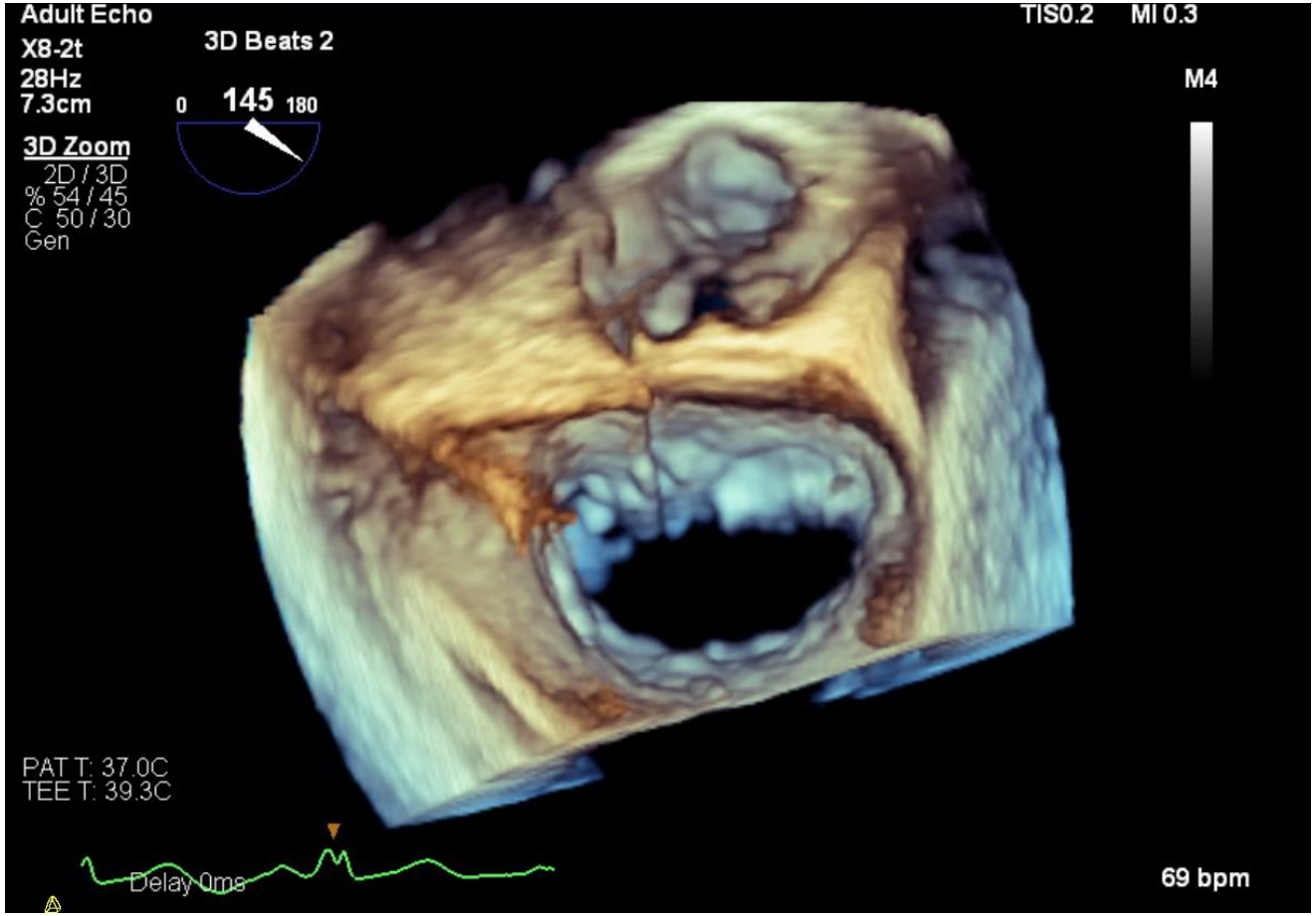
MEDICAL COLLEGE OF WISCONSIN

Stitch artifact



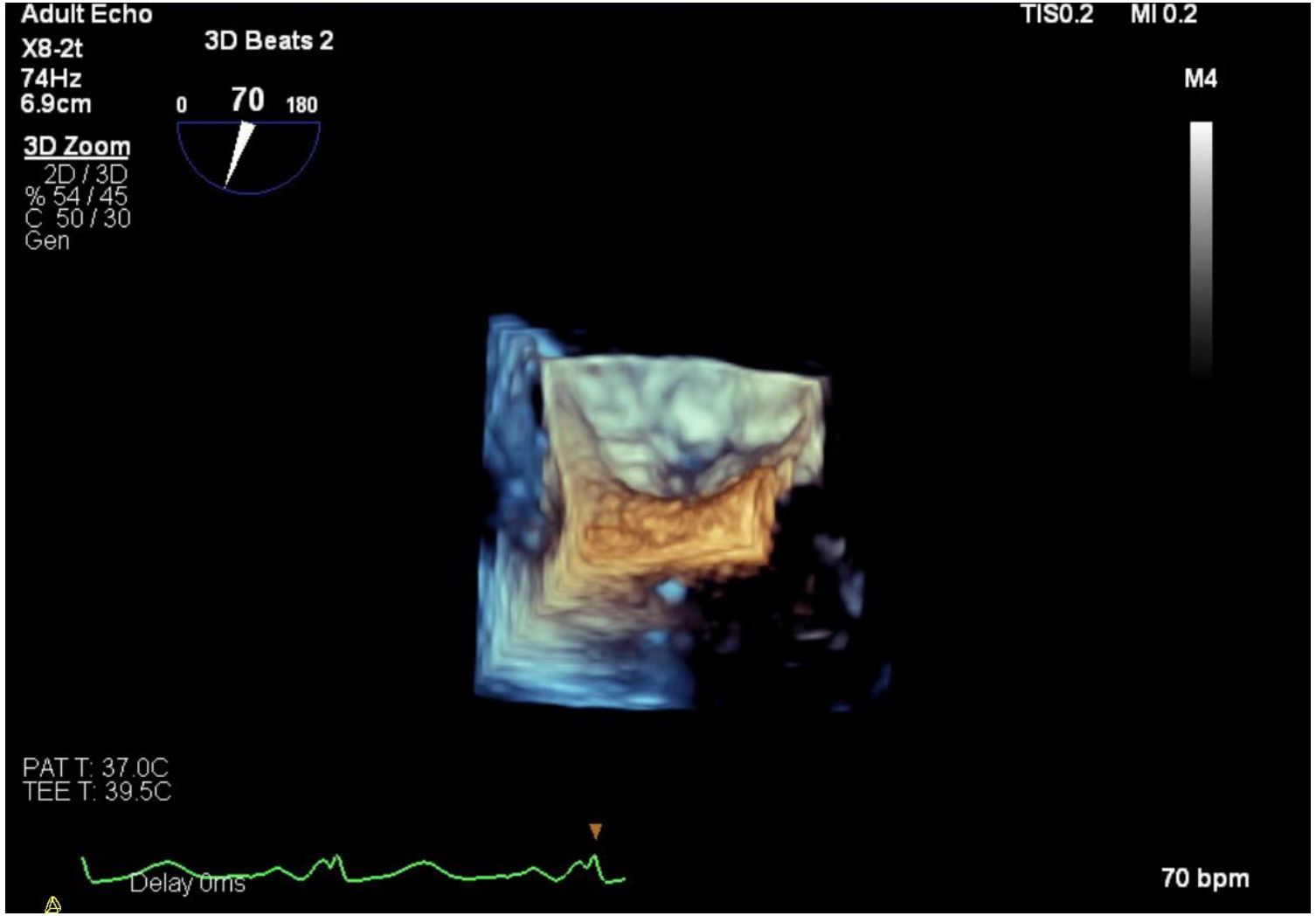
MEDICAL COLLEGE OF WISCONSIN

Stitch artifact



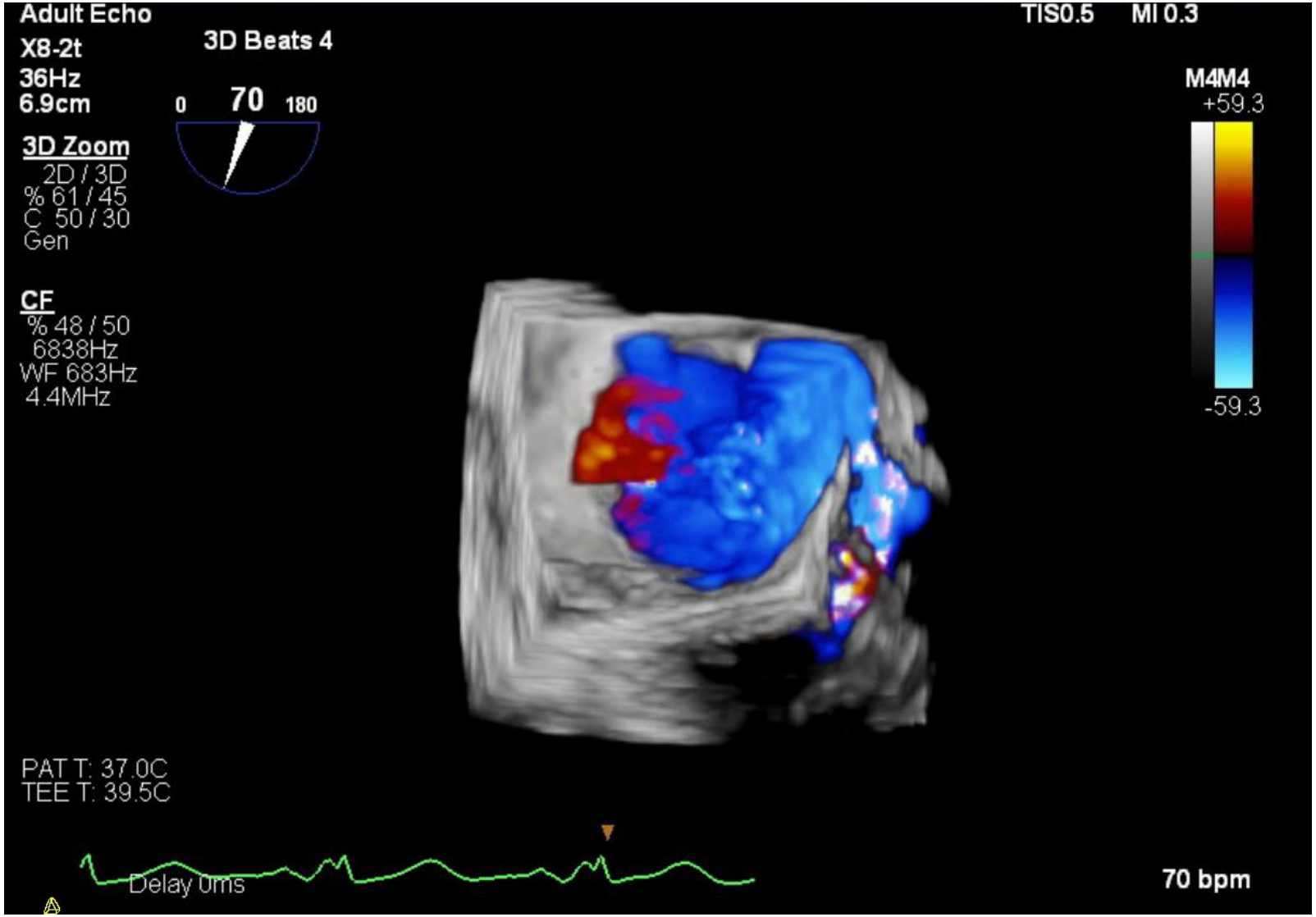
MEDICAL COLLEGE OF WISCONSIN

Multibeat acquisition and narrow window



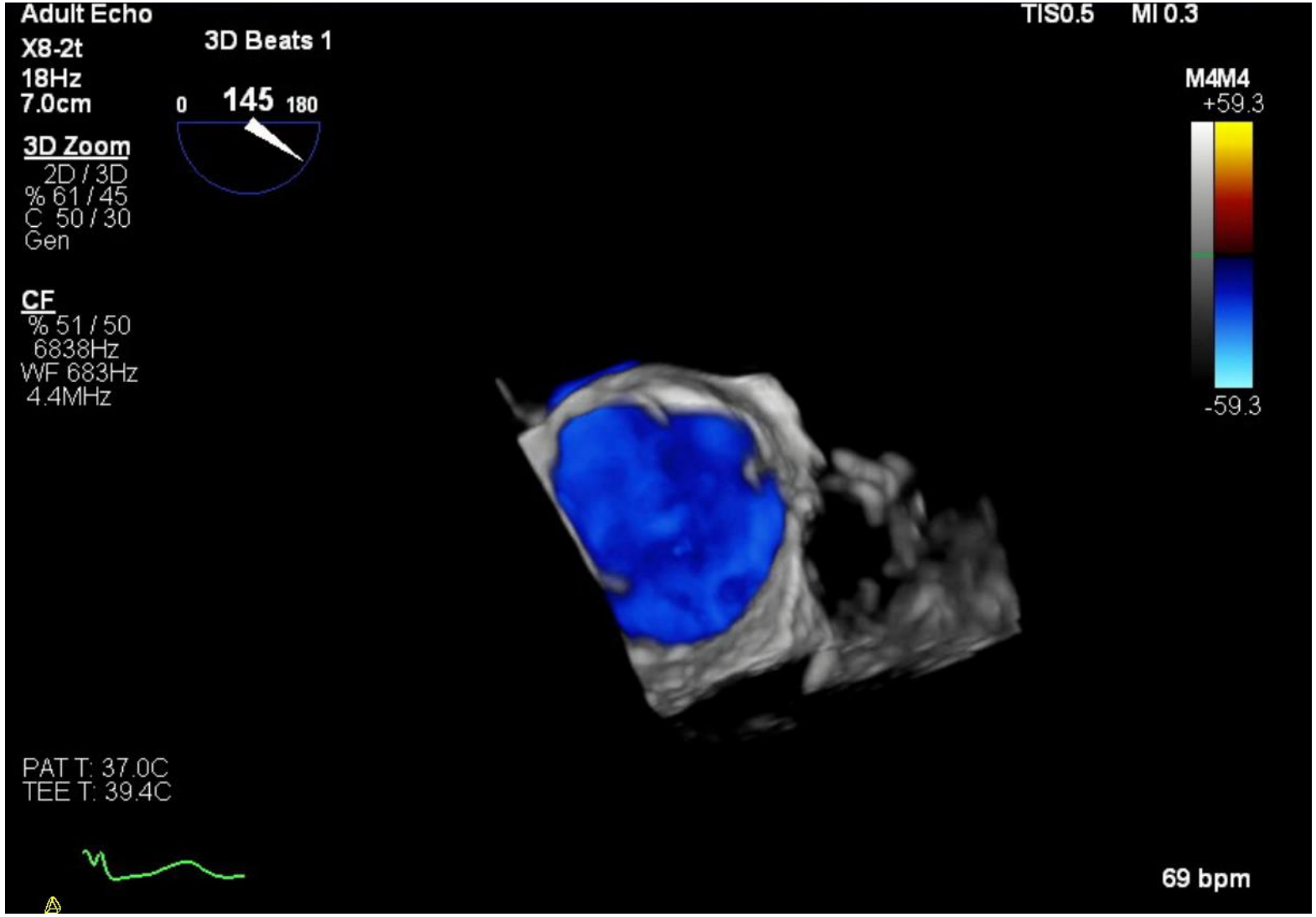
MEDICAL COLLEGE OF WISCONSIN

Color multibeat acquisition and narrow window



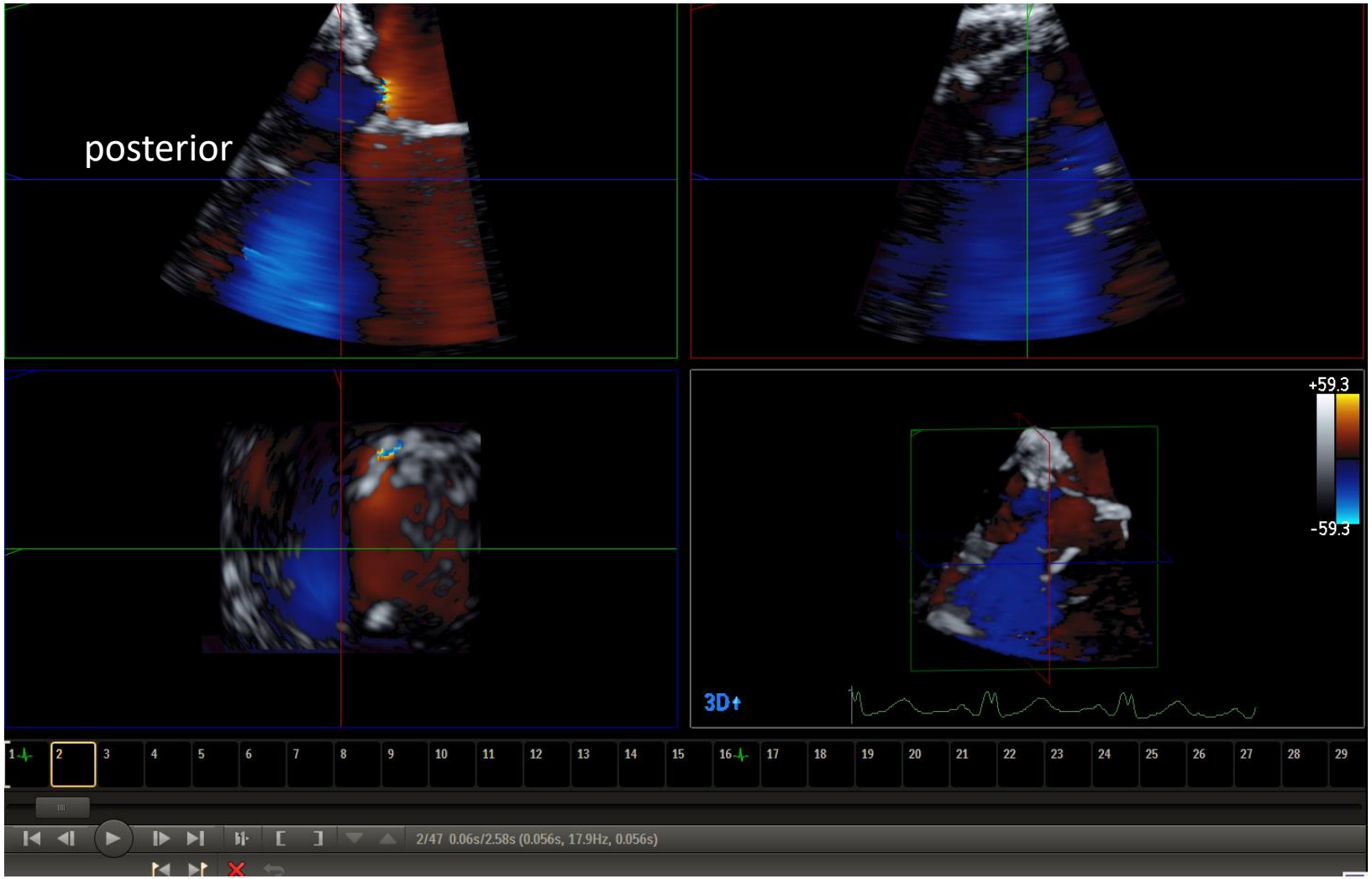
MEDICAL COLLEGE OF WISCONSIN

Single beat color with narrow window



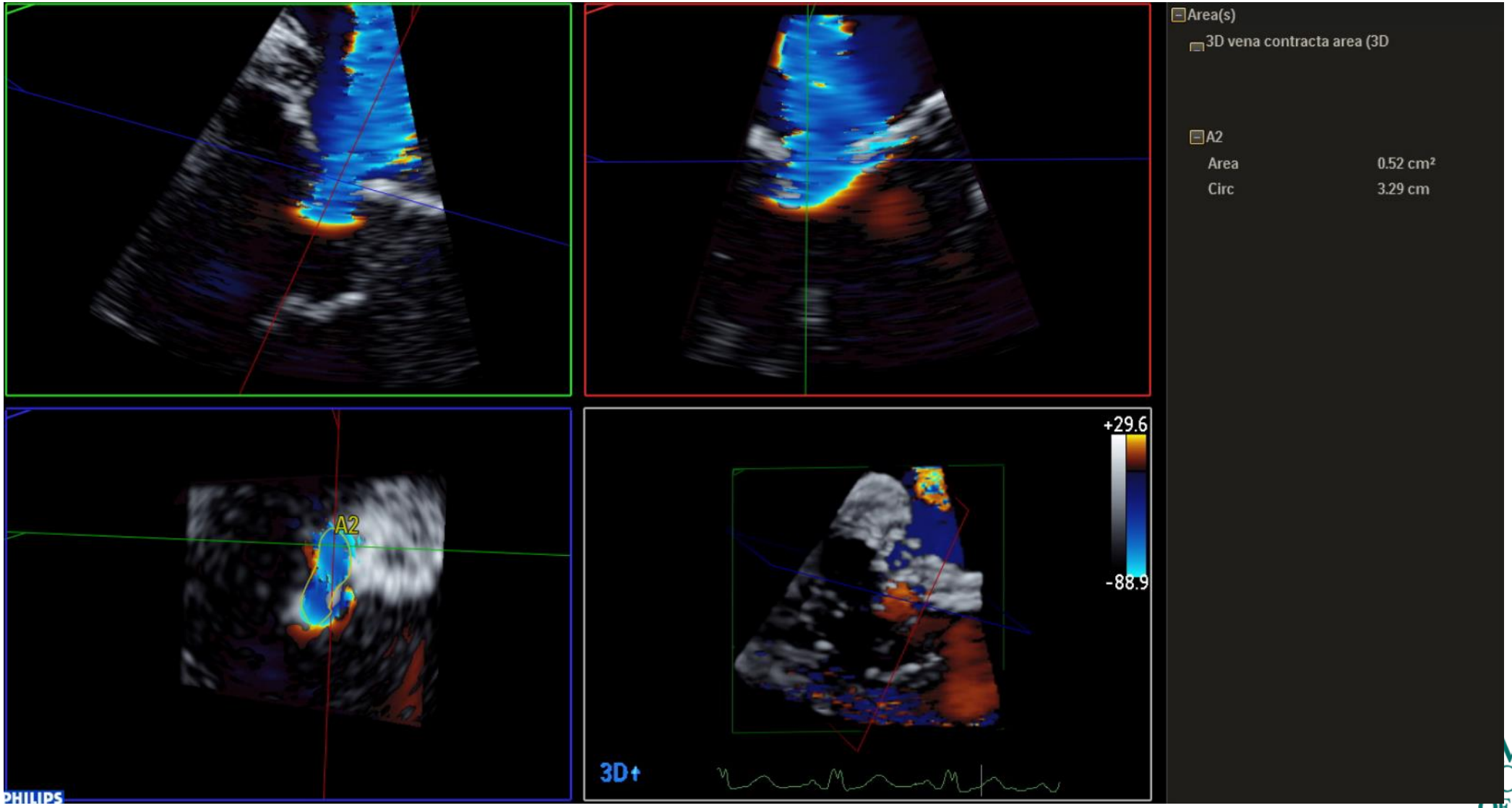
MEDICAL COLLEGE OF WISCONSIN

Post processing



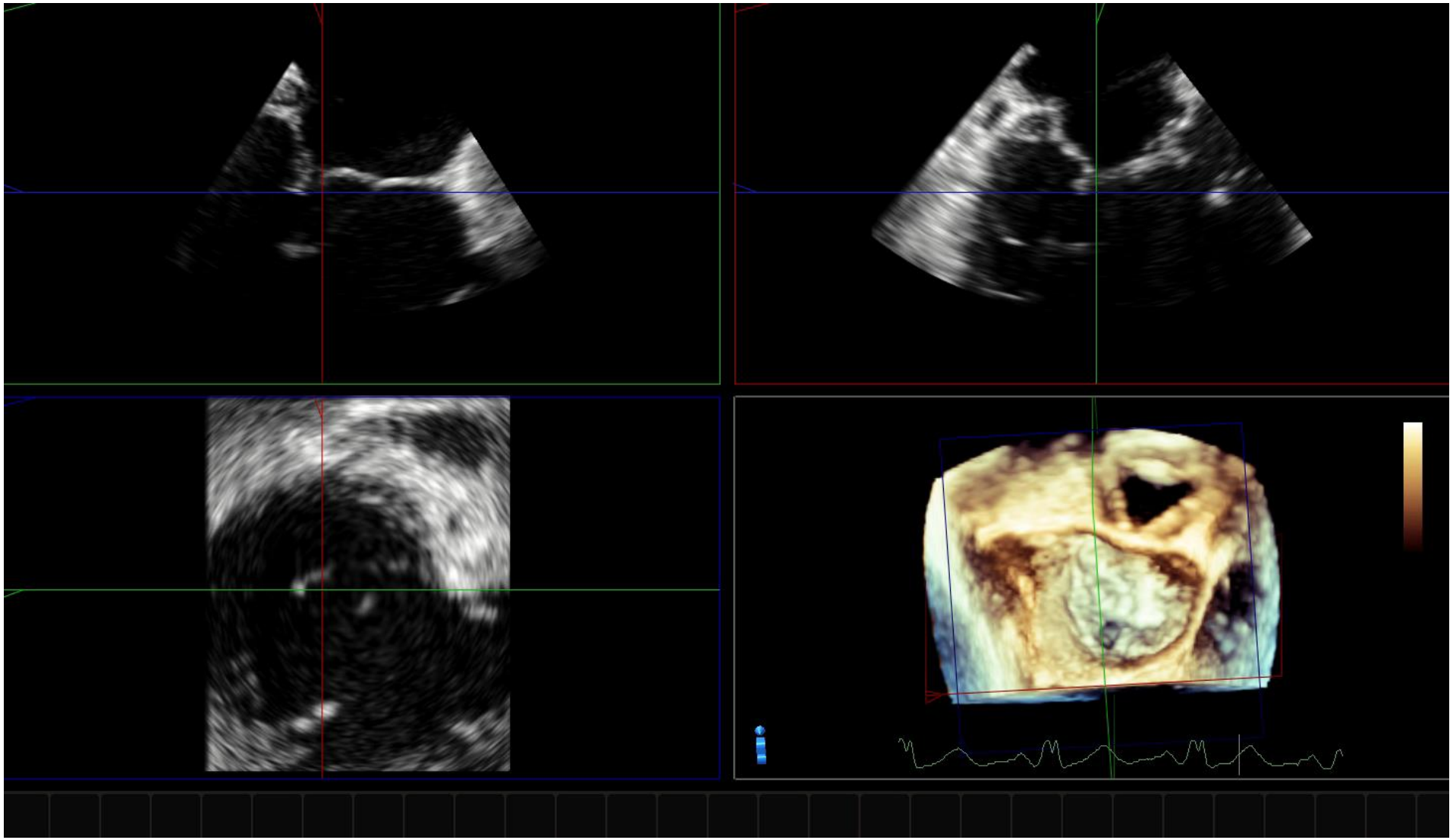
MEDICAL COLLEGE OF WISCONSIN

PISA and 3D EROA post processing



Post processing orientation

145°

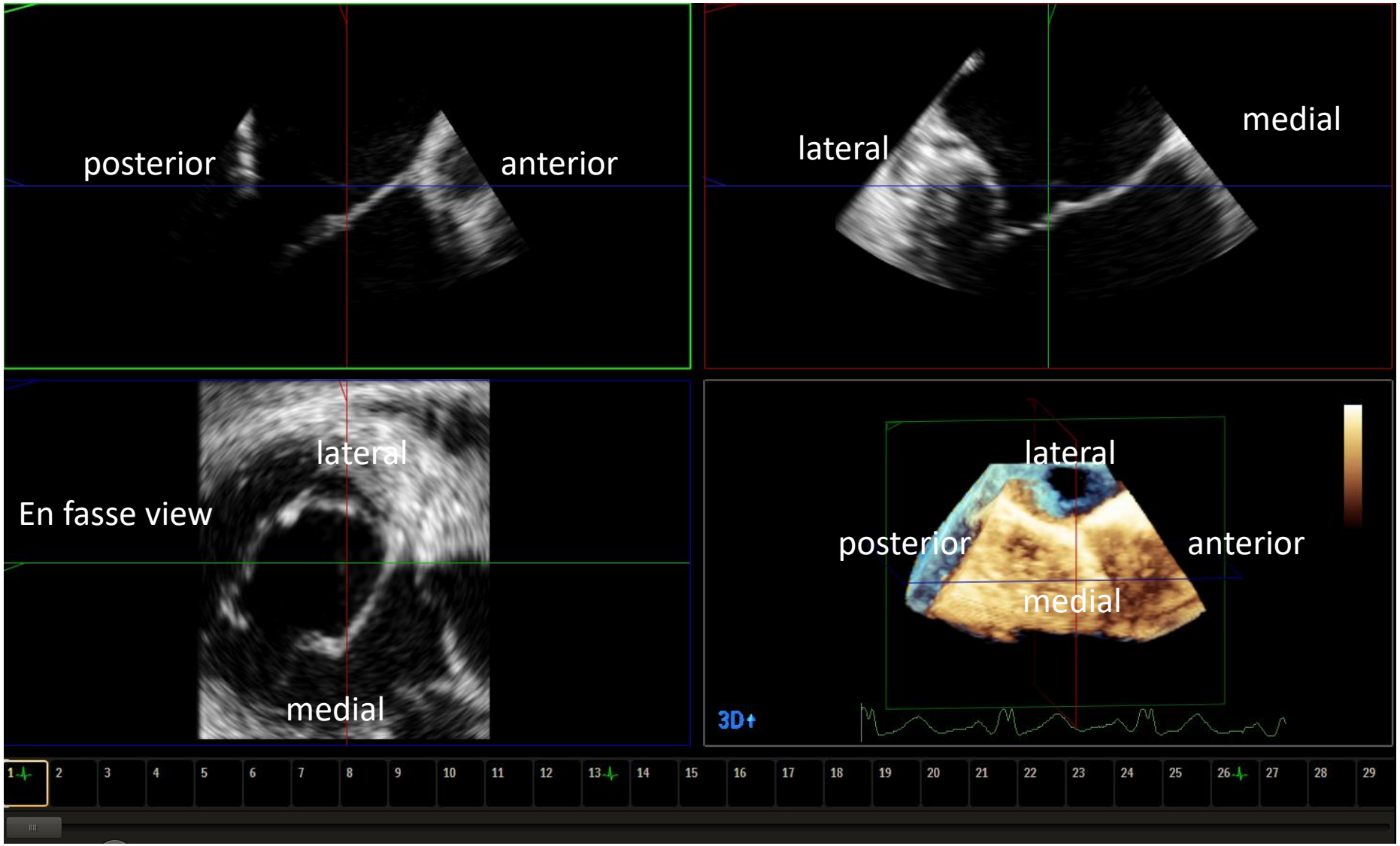


145°+ 90° = 235°
Reverse of 145-90
(reverse of 55°)

MEDICAL COLLEGE OF WISCONSIN

Post processing orientation

145°



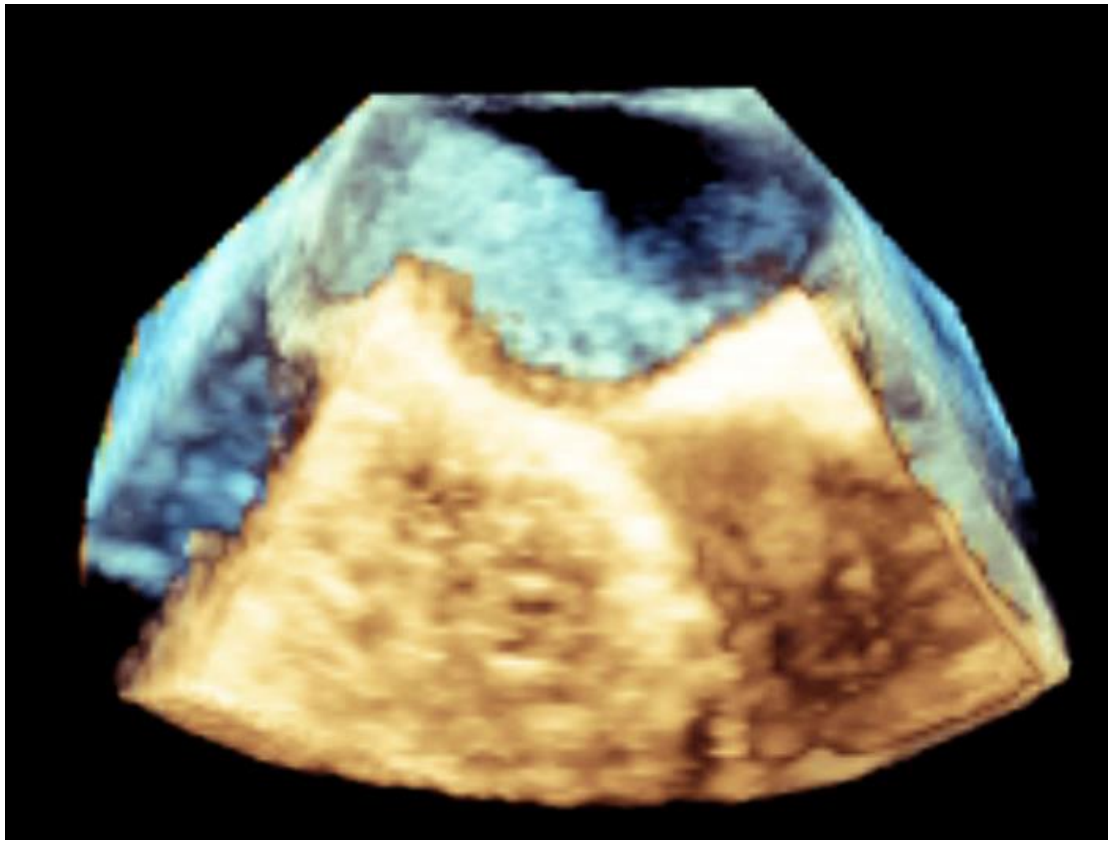
145°+ 90° = 235°
Reverse of 145-90
(reverse of 55°)

MEDICAL COLLEGE OF WISCONSIN

Initial Image

Lateral

Posterior



Anterior

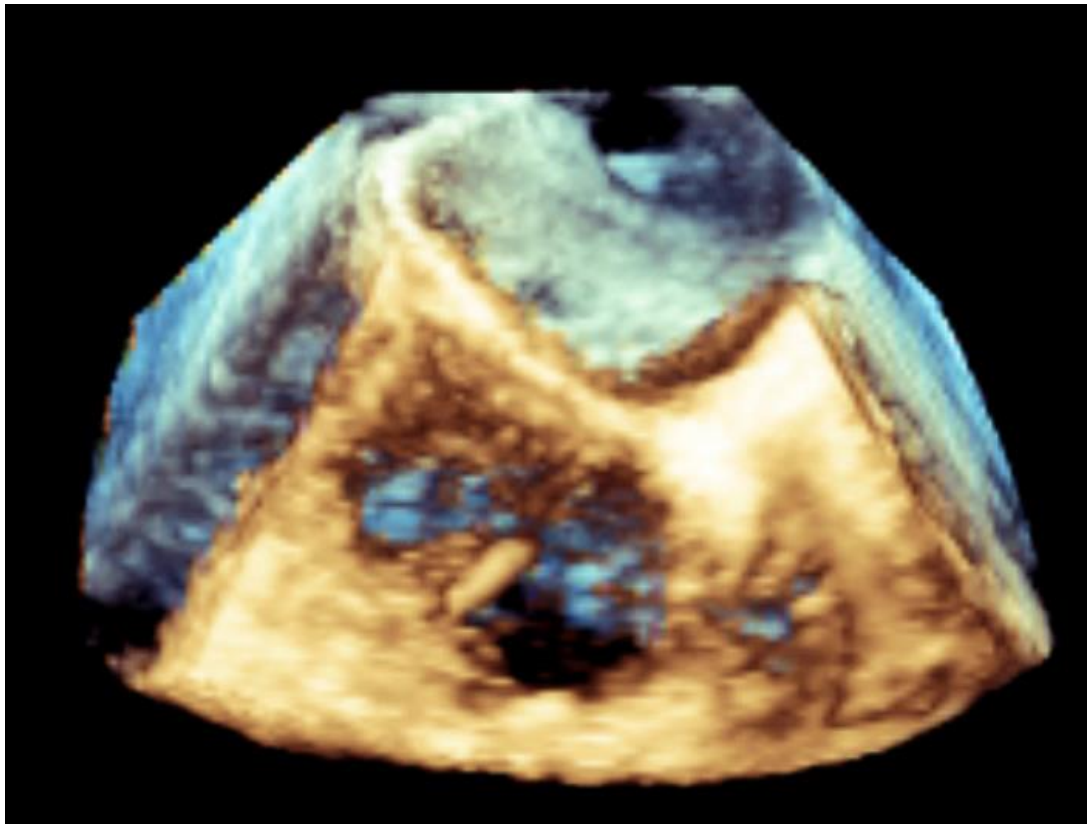
Medial

MEDICAL COLLEGE OF WISCONSIN

Rotate down for en fasse (looking down from the LA into the valve)

Lateral

Posterior



Anterior

Medial

MEDICAL COLLEGE OF WISCONSIN

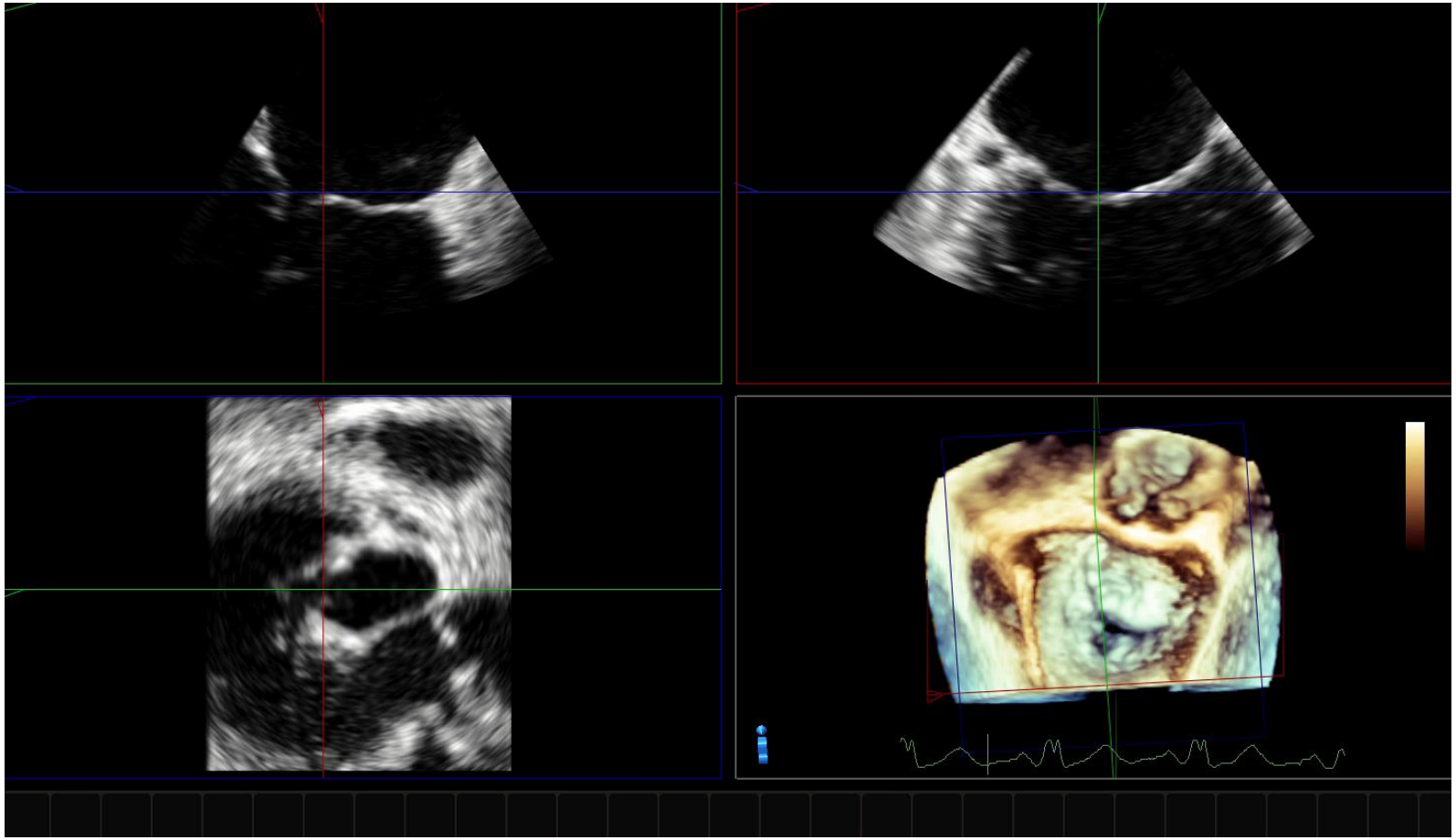
Z rotate to put aortic valve on top

Lateral

Medial

MEDICAL COLLEGE OF WISCONSIN

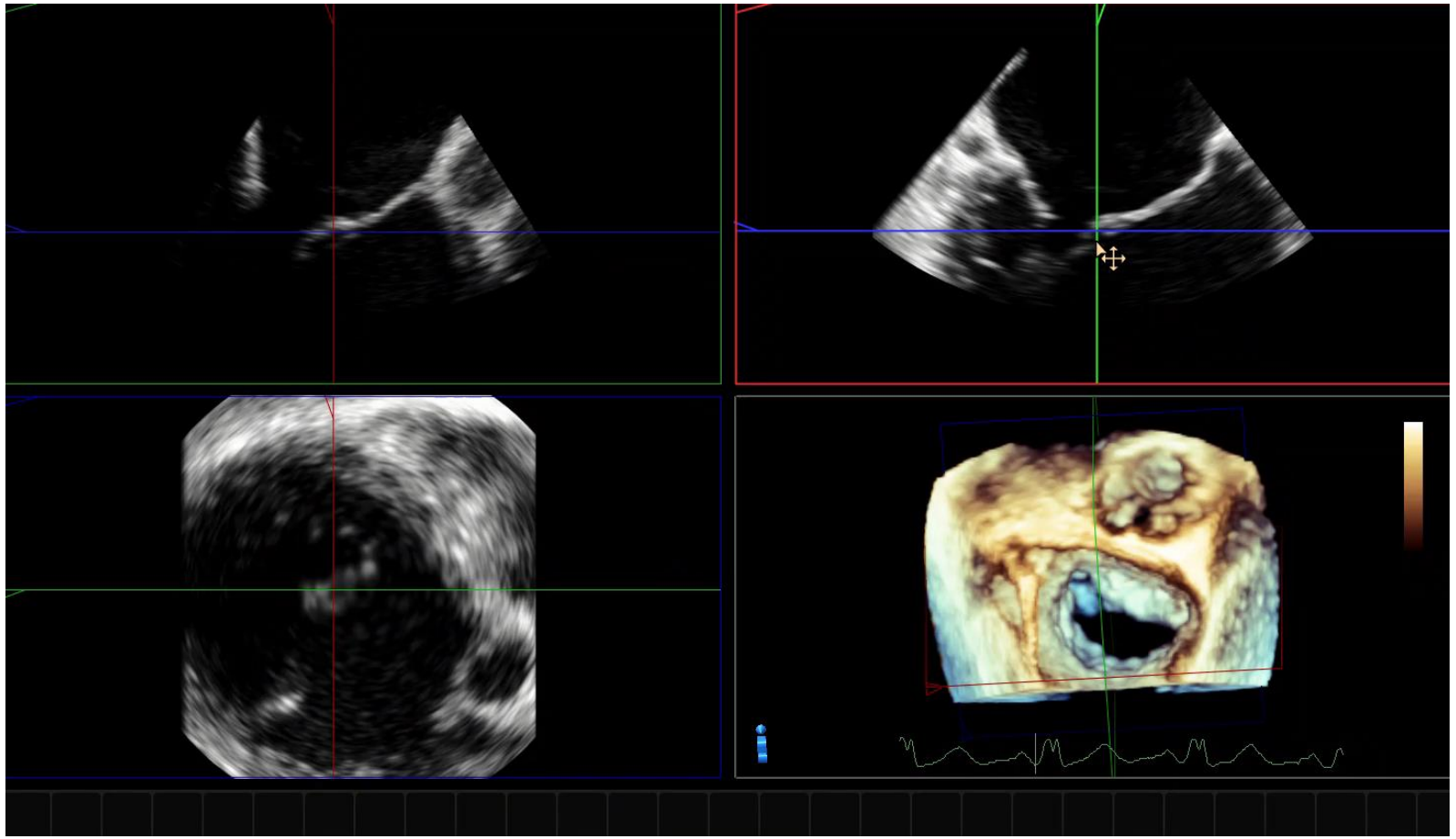
3D MPR movement



Track to confirm 3D orientation along Ant-posterior direction

MEDICAL COLLEGE OF WISCONSIN

3D MPR movement



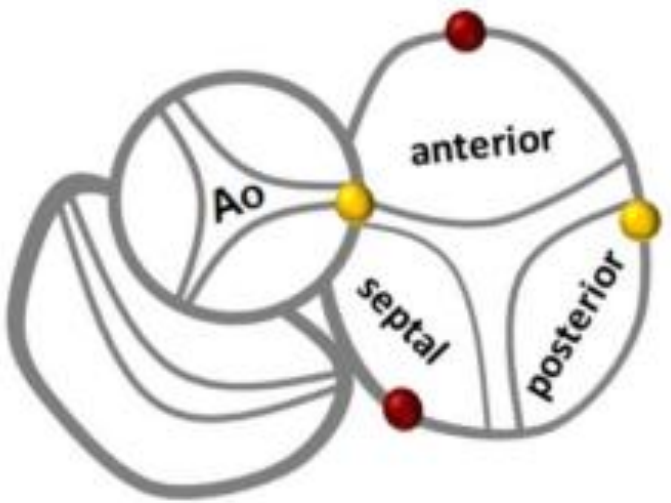
Track to confirm 3D orientation along medial-lateral direction

MEDICAL COLLEGE OF WISCONSIN

Tricuspid Valve

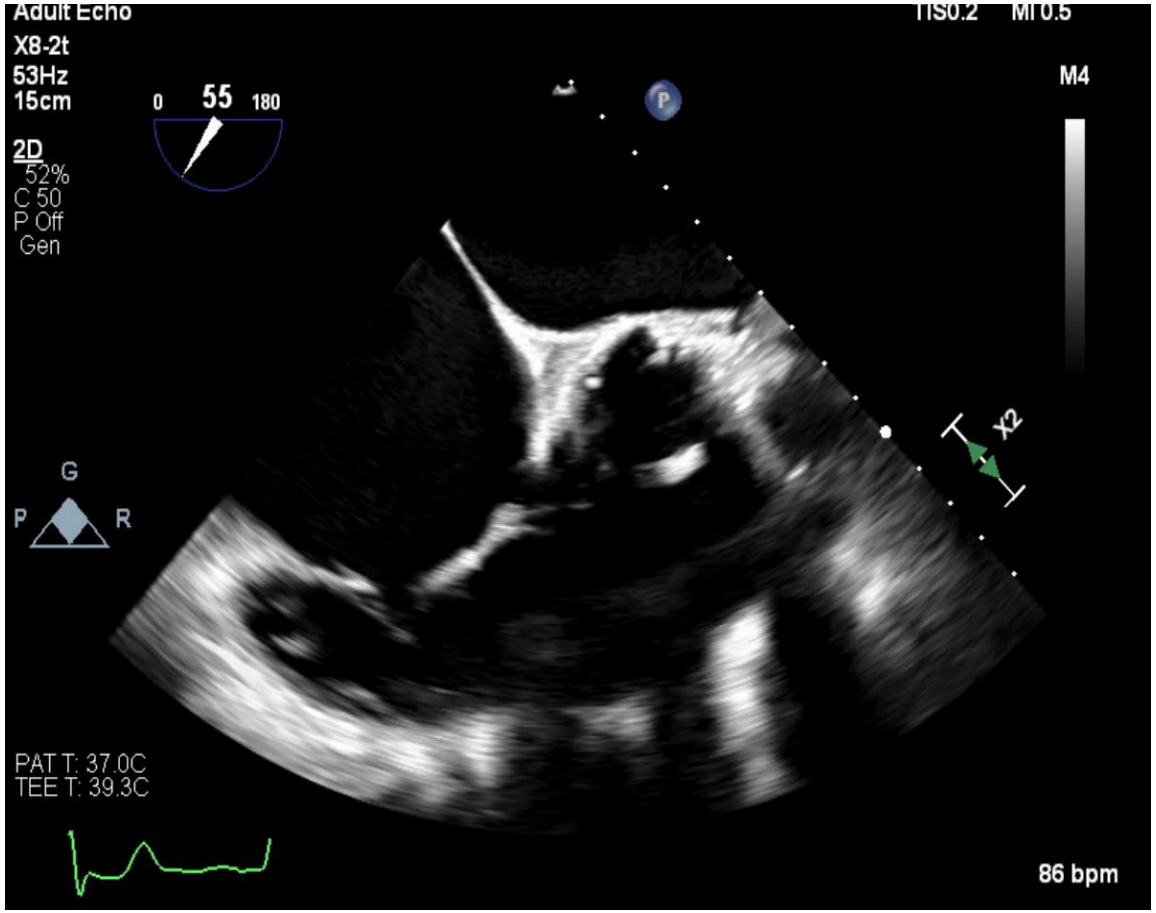
Target TV orientation

- Aortic valve at 11’o clock
- Septum on left
- TV on right of screen
- Looking down on the TV from RA



MEDICAL COLLEGE OF WISCONSIN

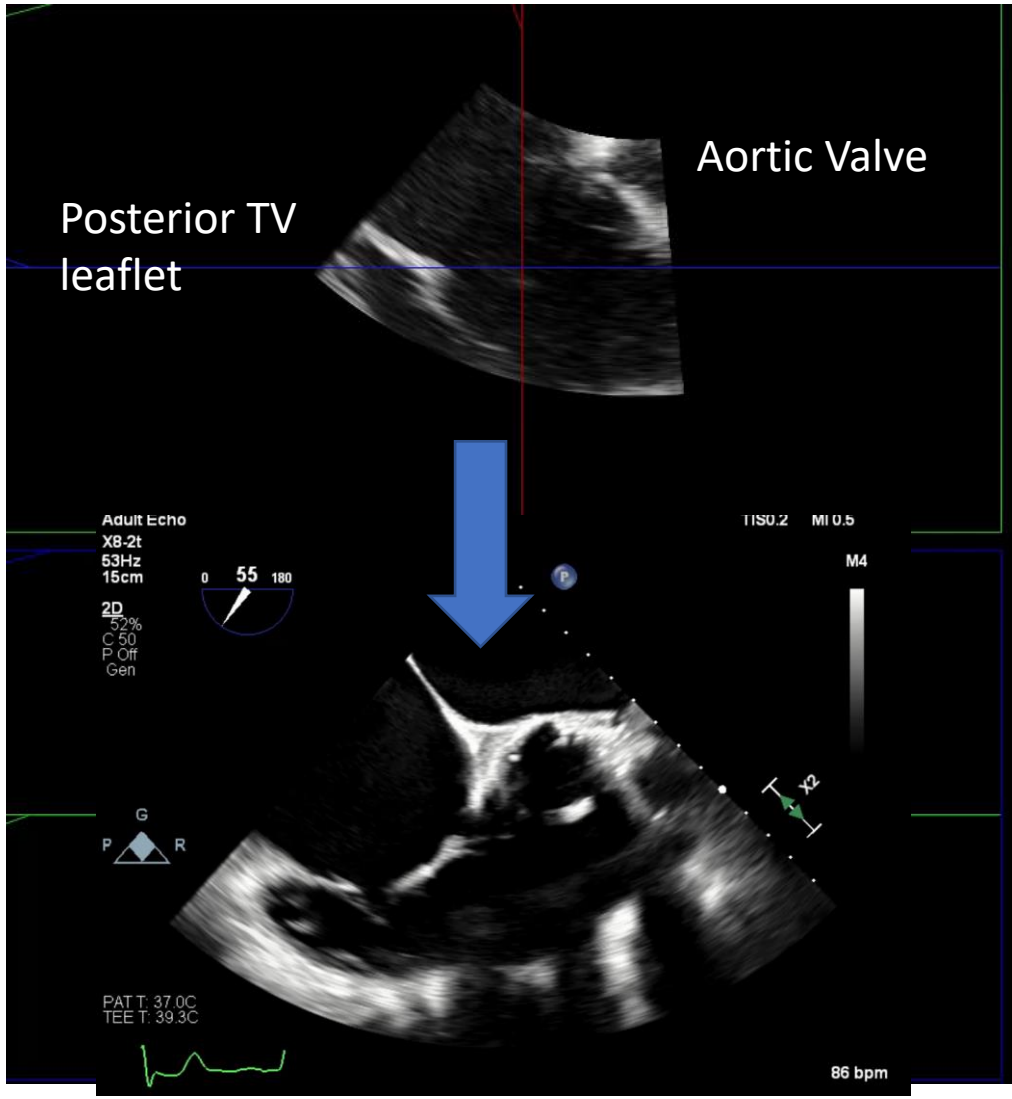
TV from 60 degrees

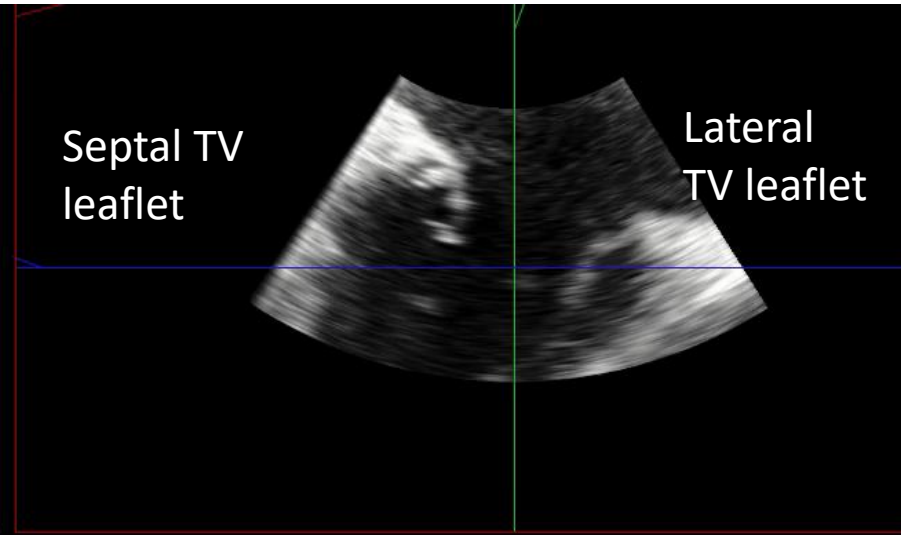


MEDICAL COLLEGE OF WISCONSIN

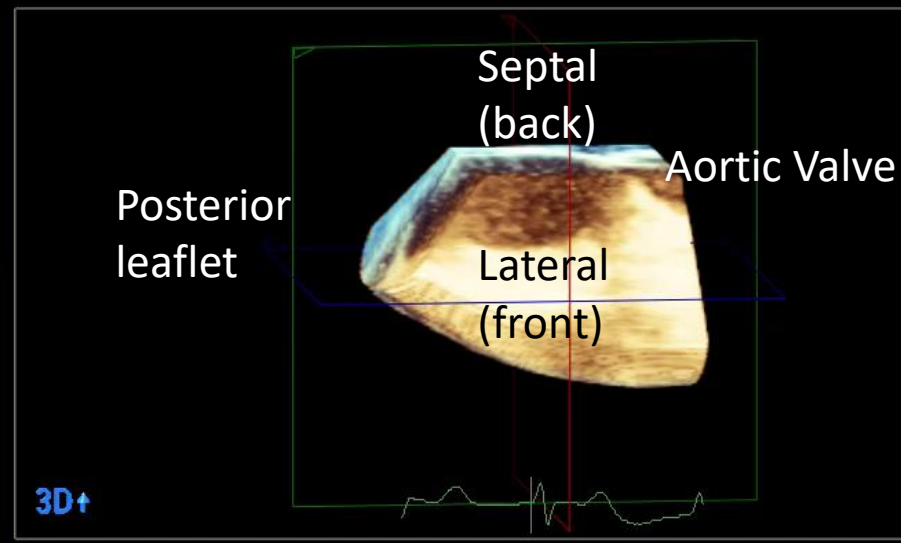
TV from 60 degrees

60º
(Azimuthal)



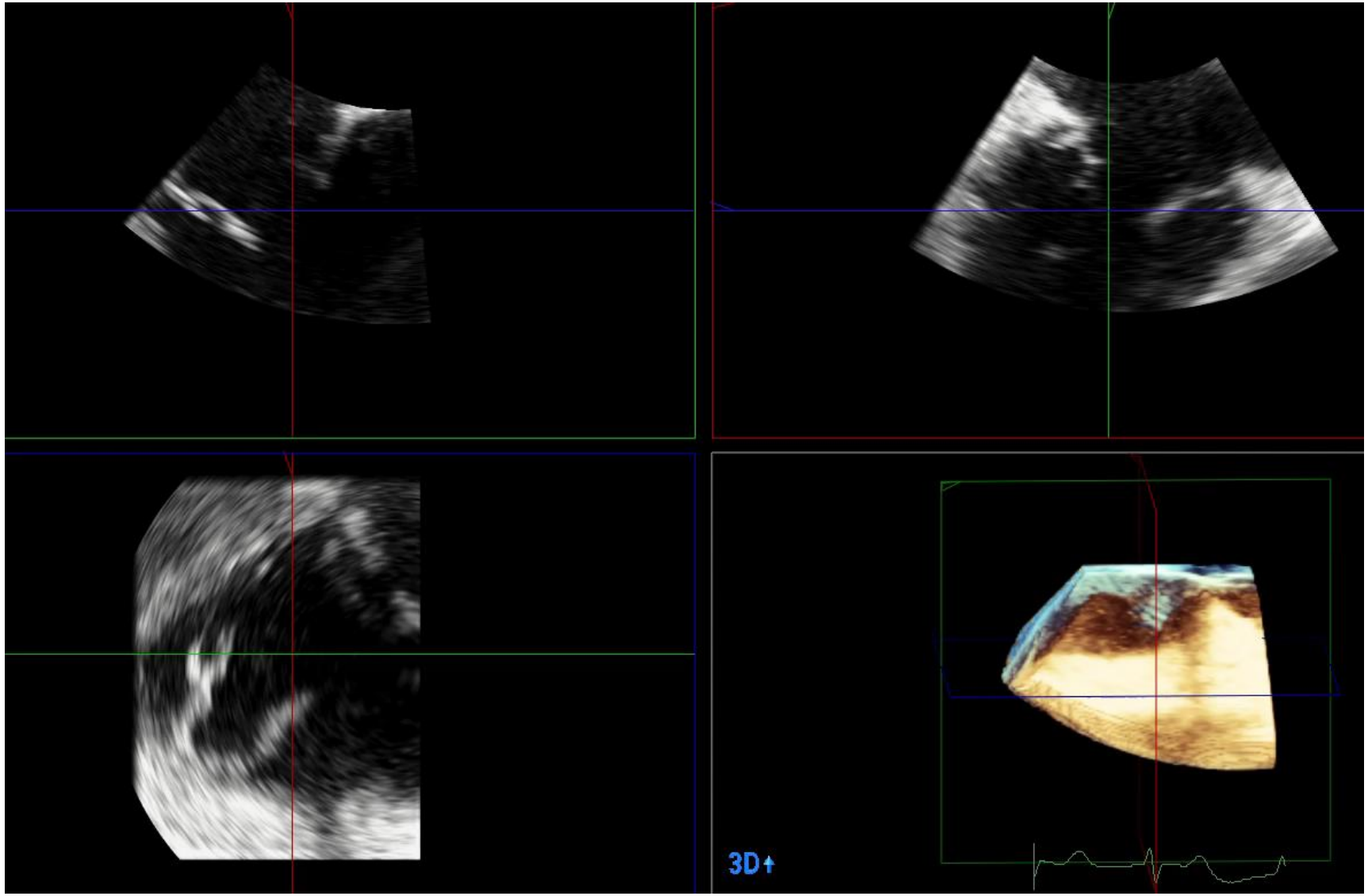


150º
(Elevation)



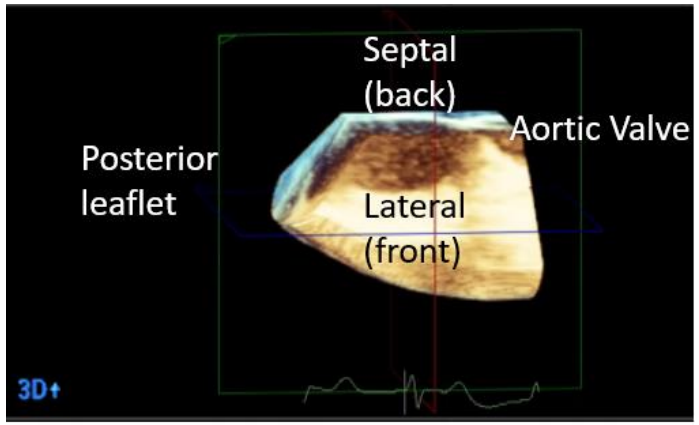
MEDICAL COLLEGE OF WISCONSIN

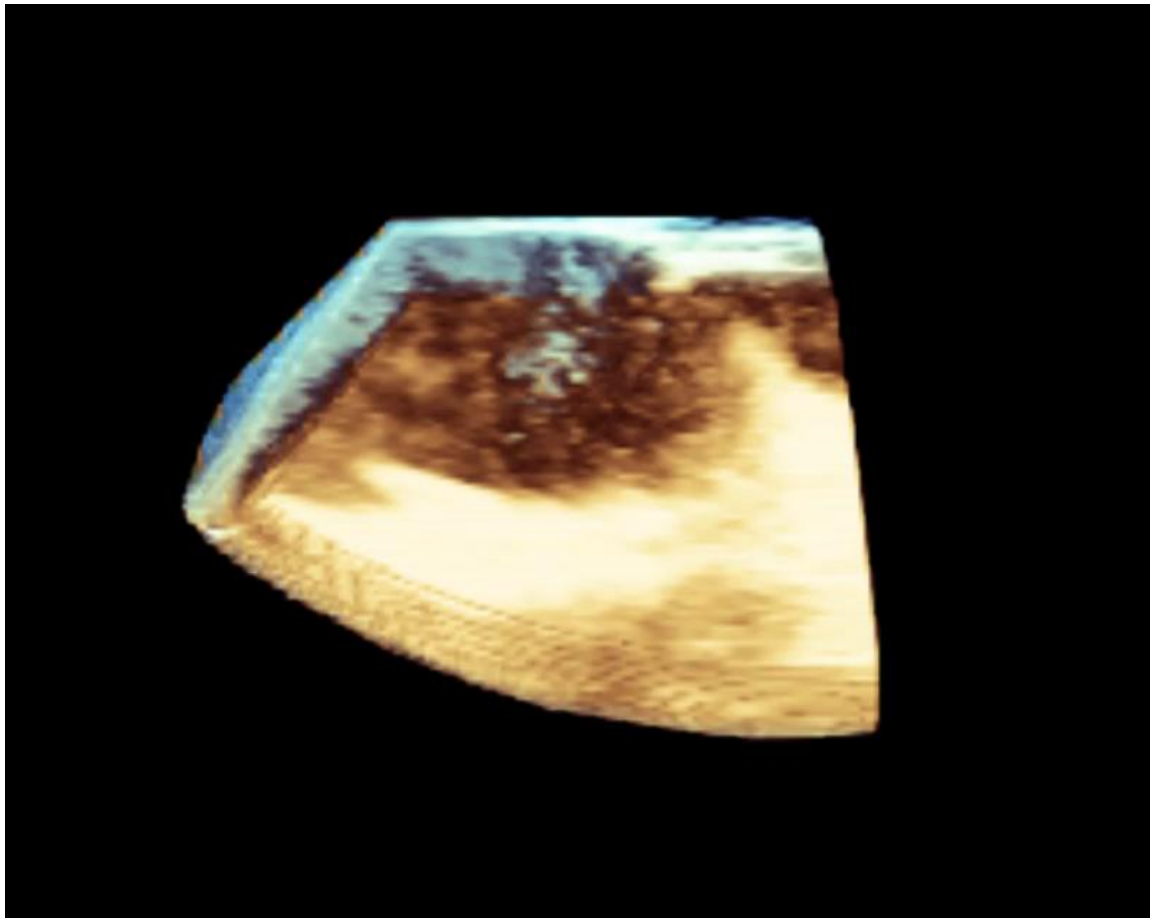
Confirmation of orientation



MEDICAL COLLEGE OF WISCONSIN

Starting

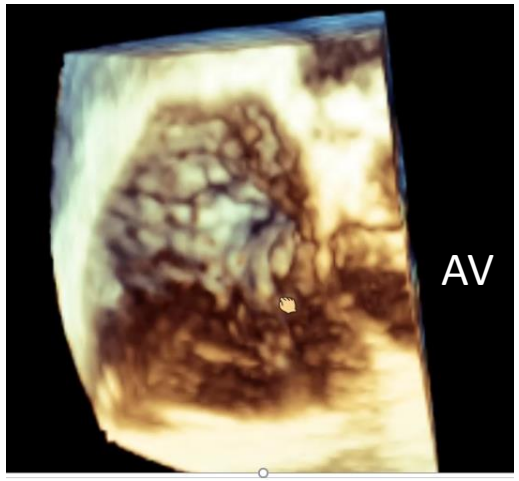




End

Septal (up)

Post



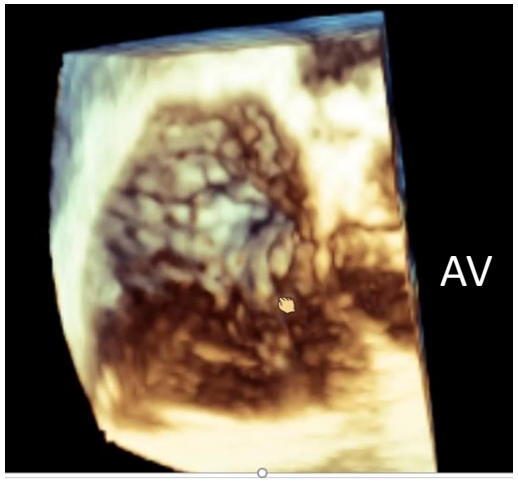
Lateral
(down)

MEDICAL COLLEGE OF WISCONSIN

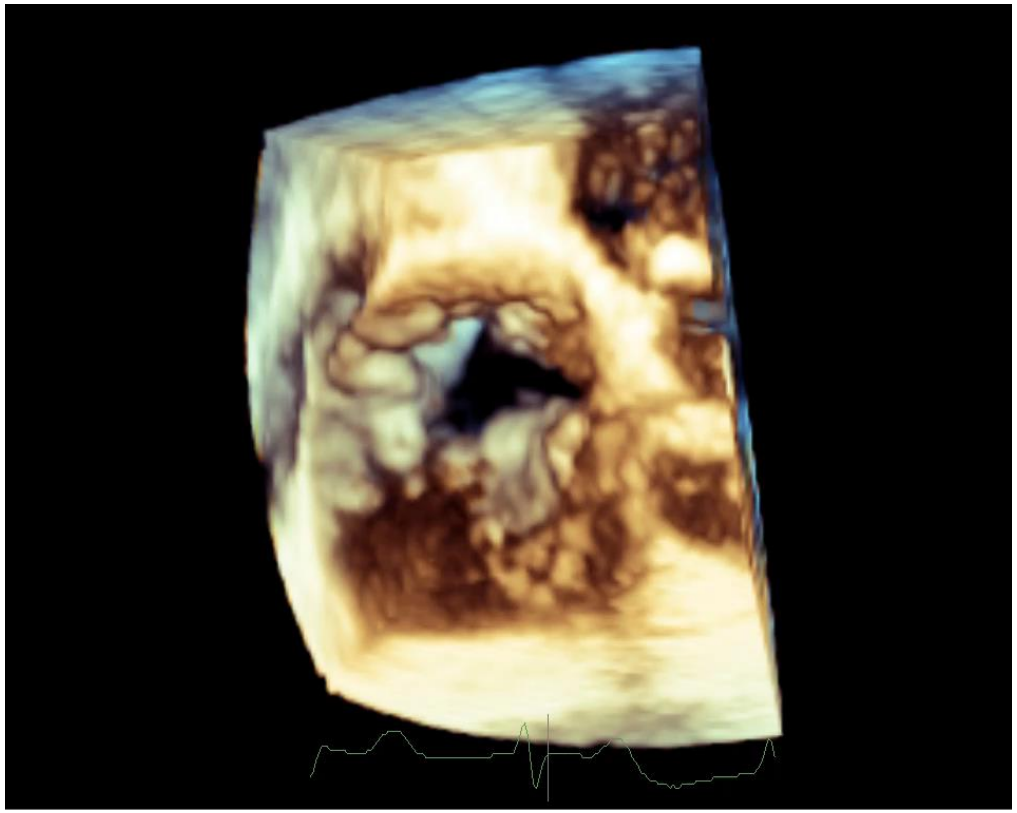
Desired TV orientation

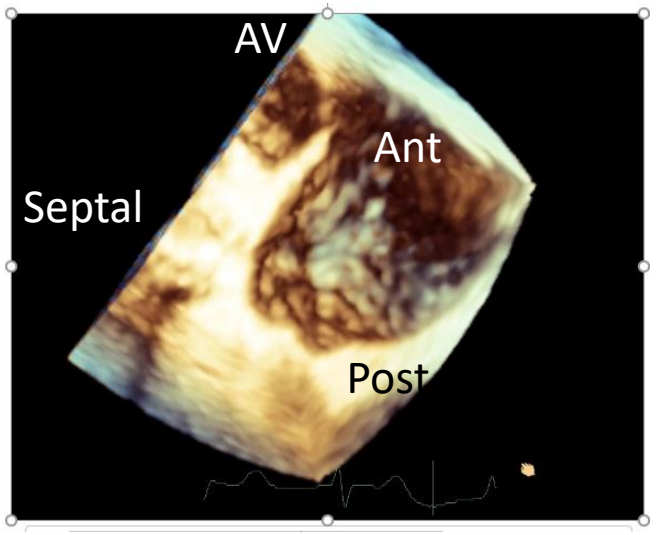
Start

Septal (up)



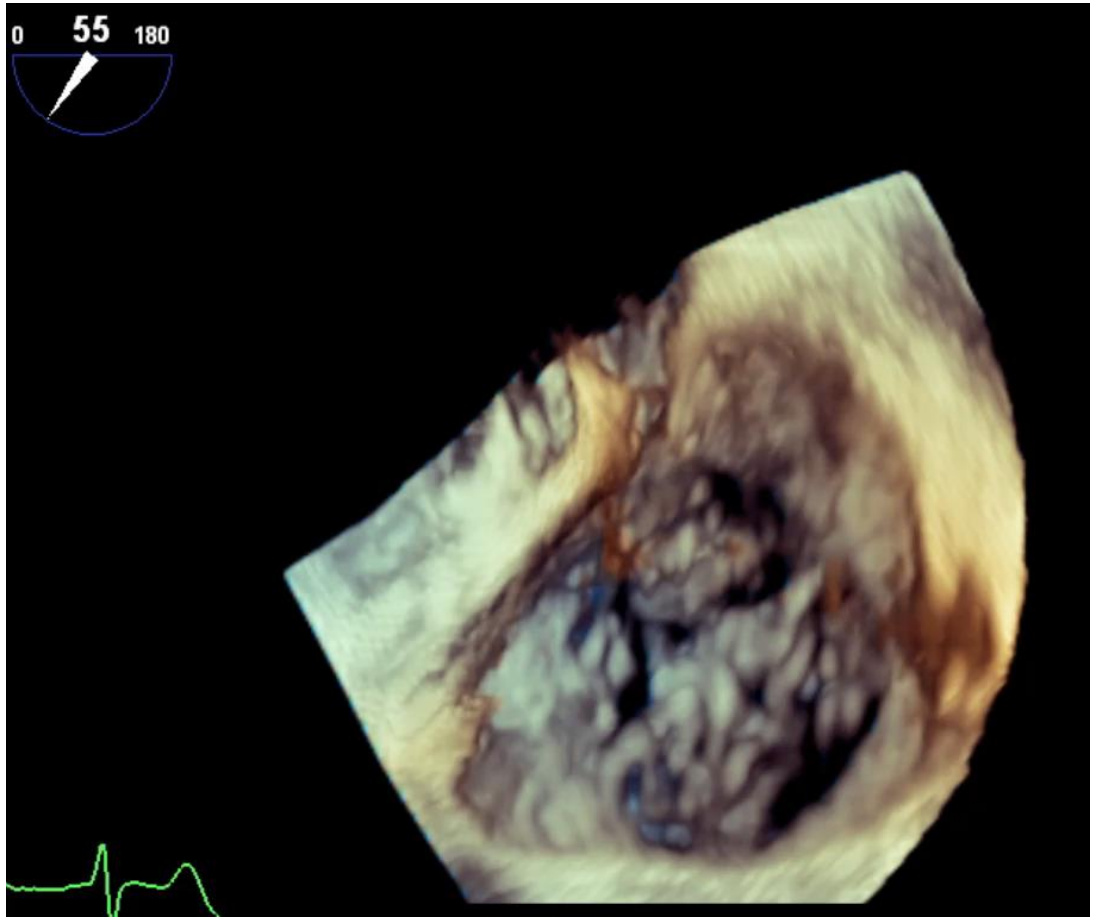
Lateral
(down)





MEDICAL COLLEGE OF WISCONSIN

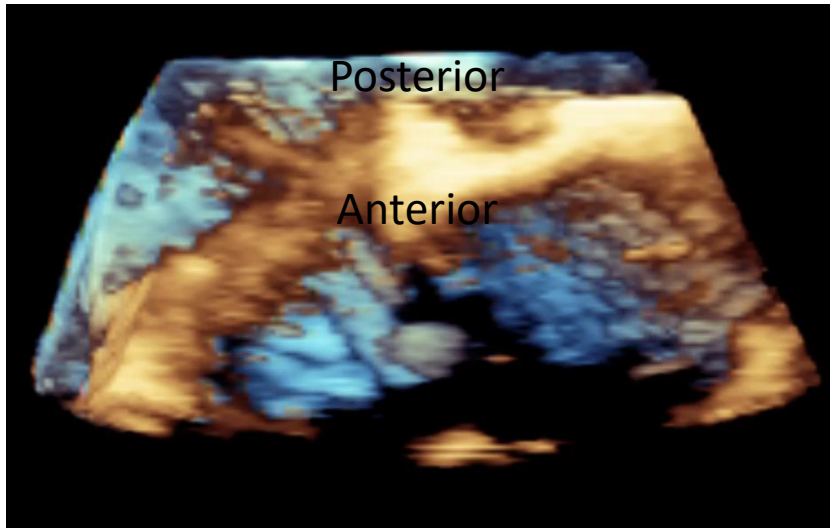
Fine tune gain and rotation



MEDICAL COLLEGE OF WISCONSIN

3D orientation

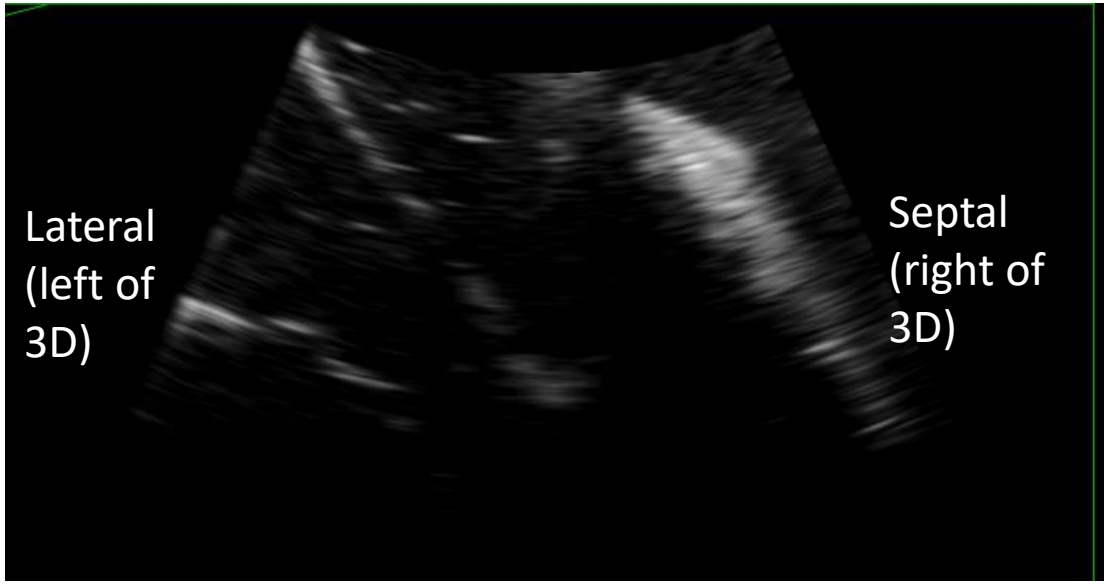
Starting at 0 degrees



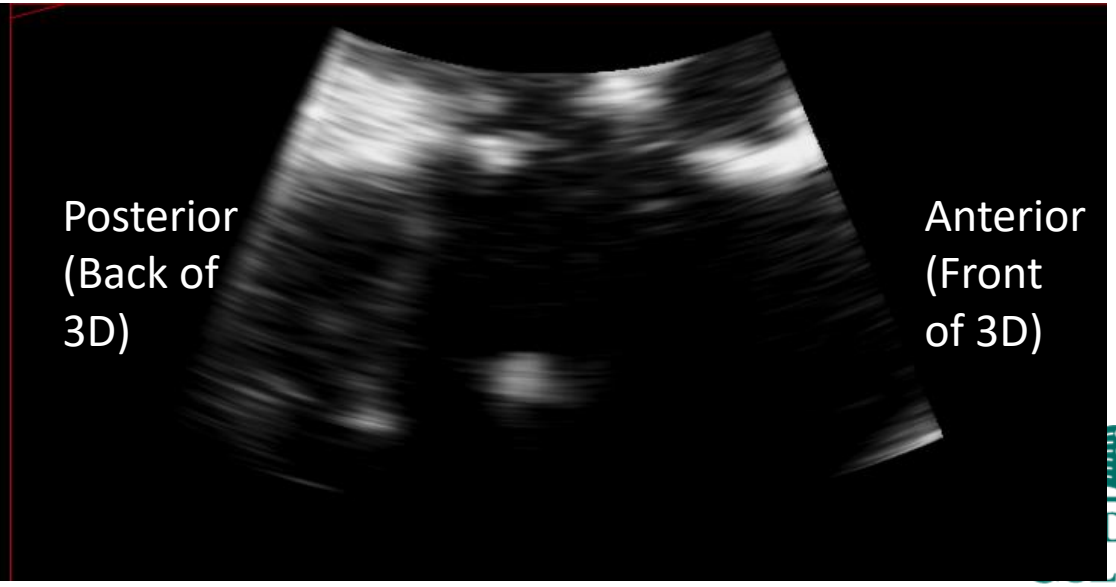
Lateral

Septal

0º



Azimuthal



90º

Elevation

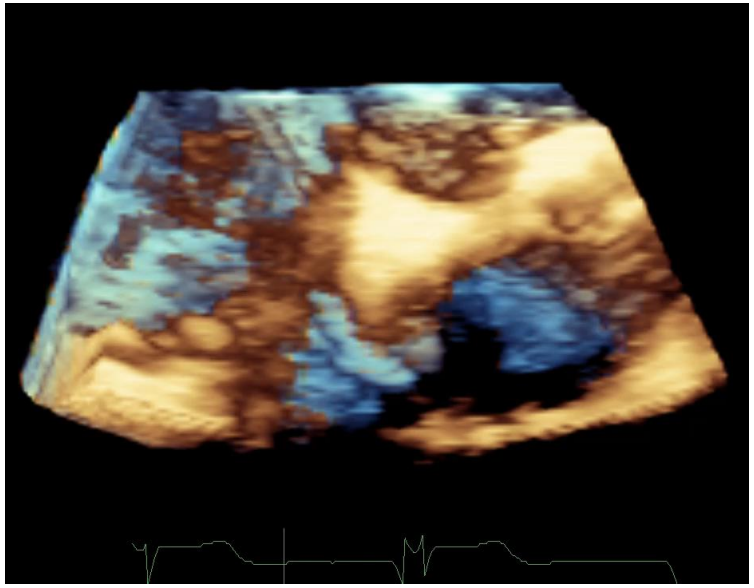
DICAL
LLEGE.
OF WISCONSIN

3D orientation

Turn down for 'en fasse' view (looking down from RA on to the TV)

Posterior

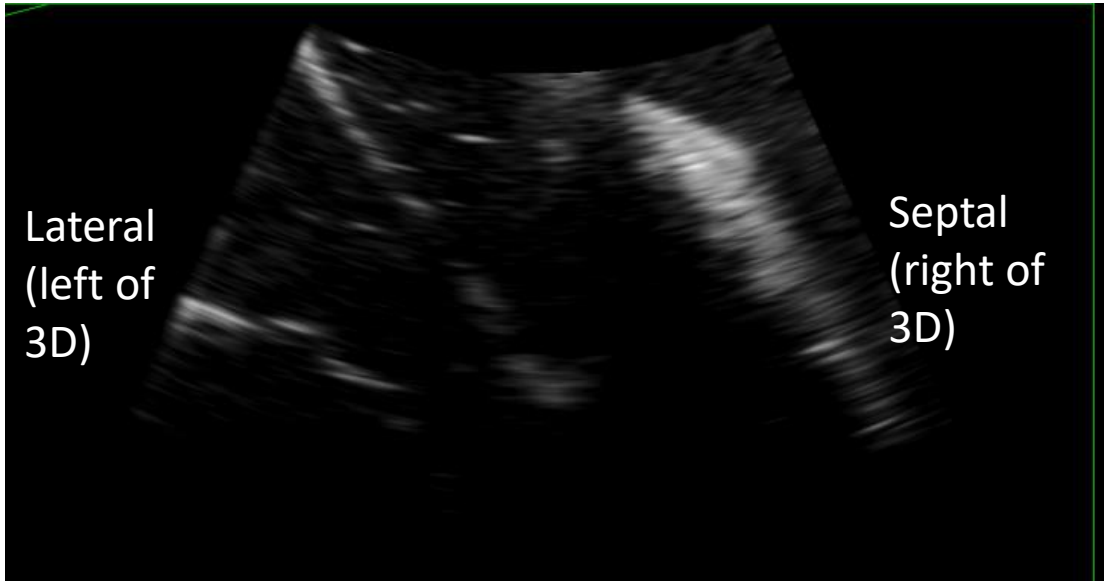
Lateral



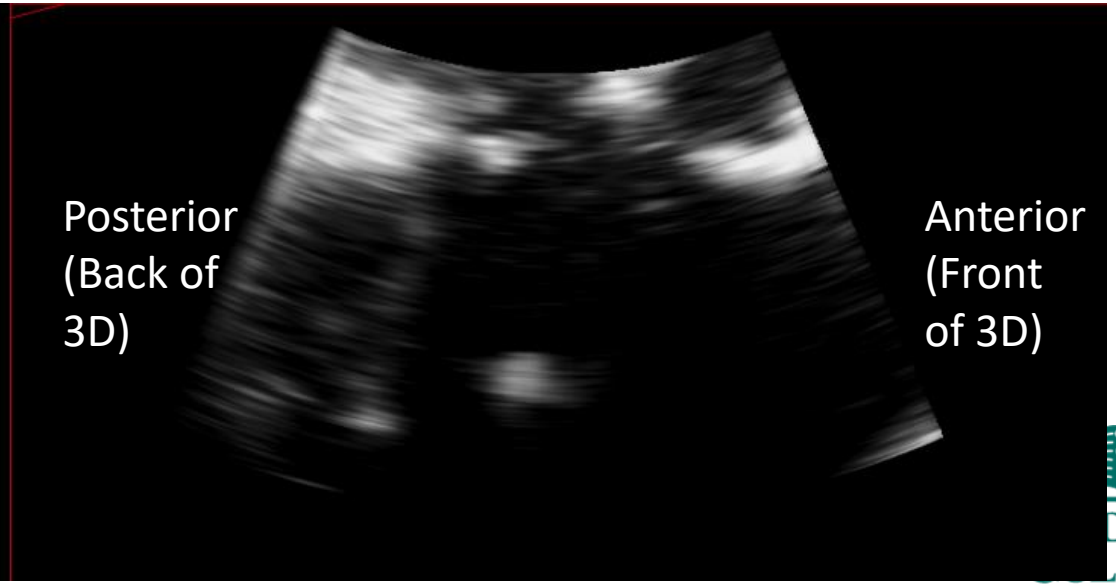
Septal

Anterior

0º



Azimuthal



90º

Elevation

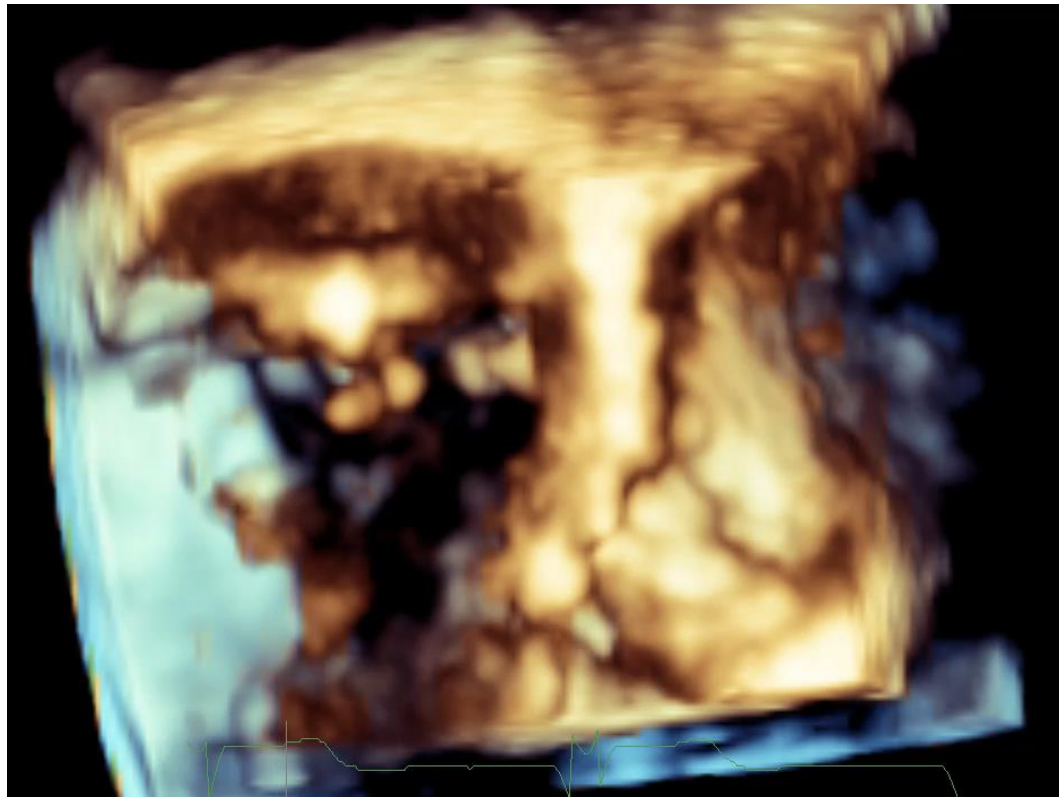
DICAL
LLEGE.
OF WISCONSIN

3D orientation

- Rotate to bring the AV at 11'0 clock

Anterior

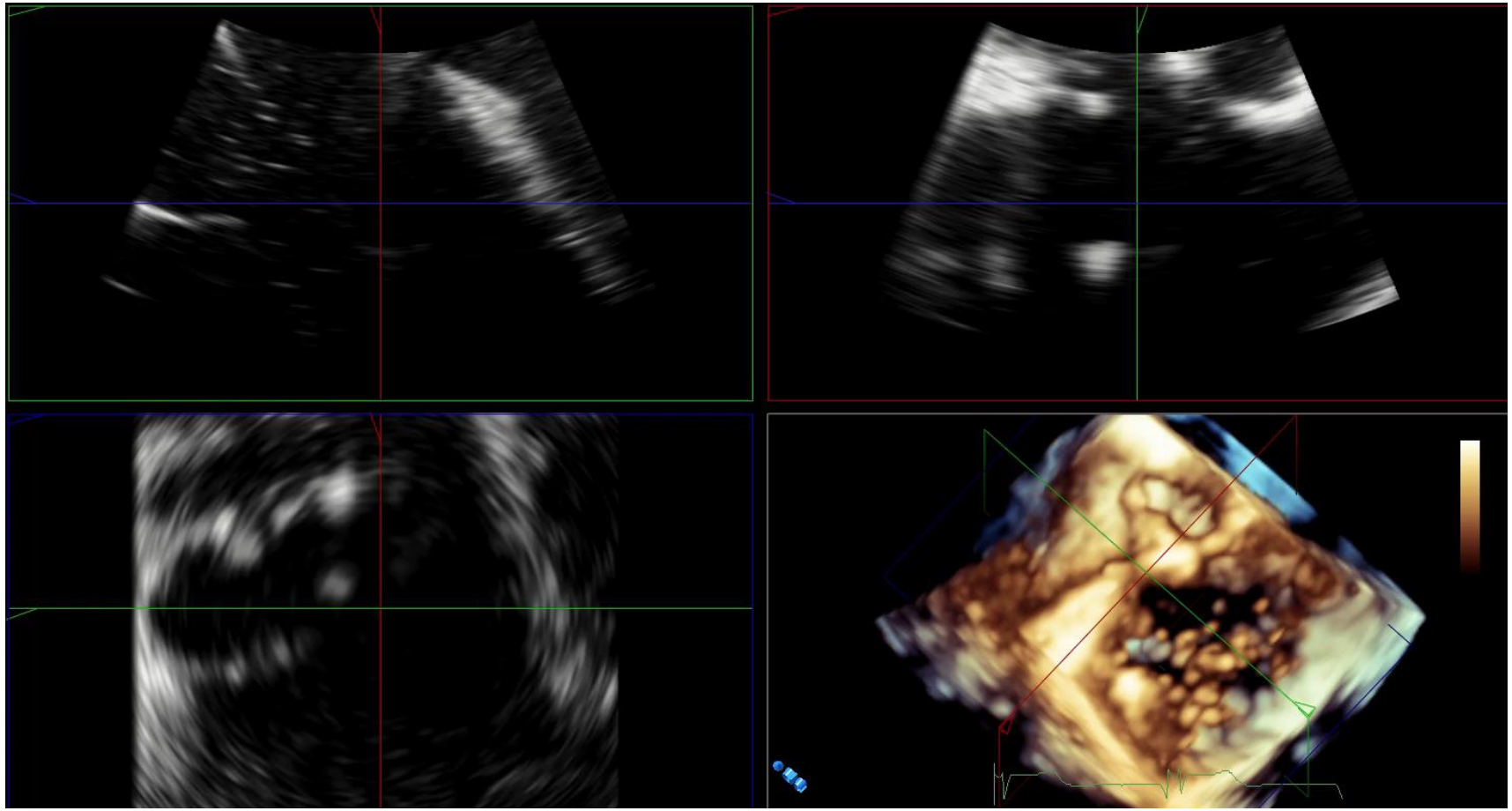
Septal



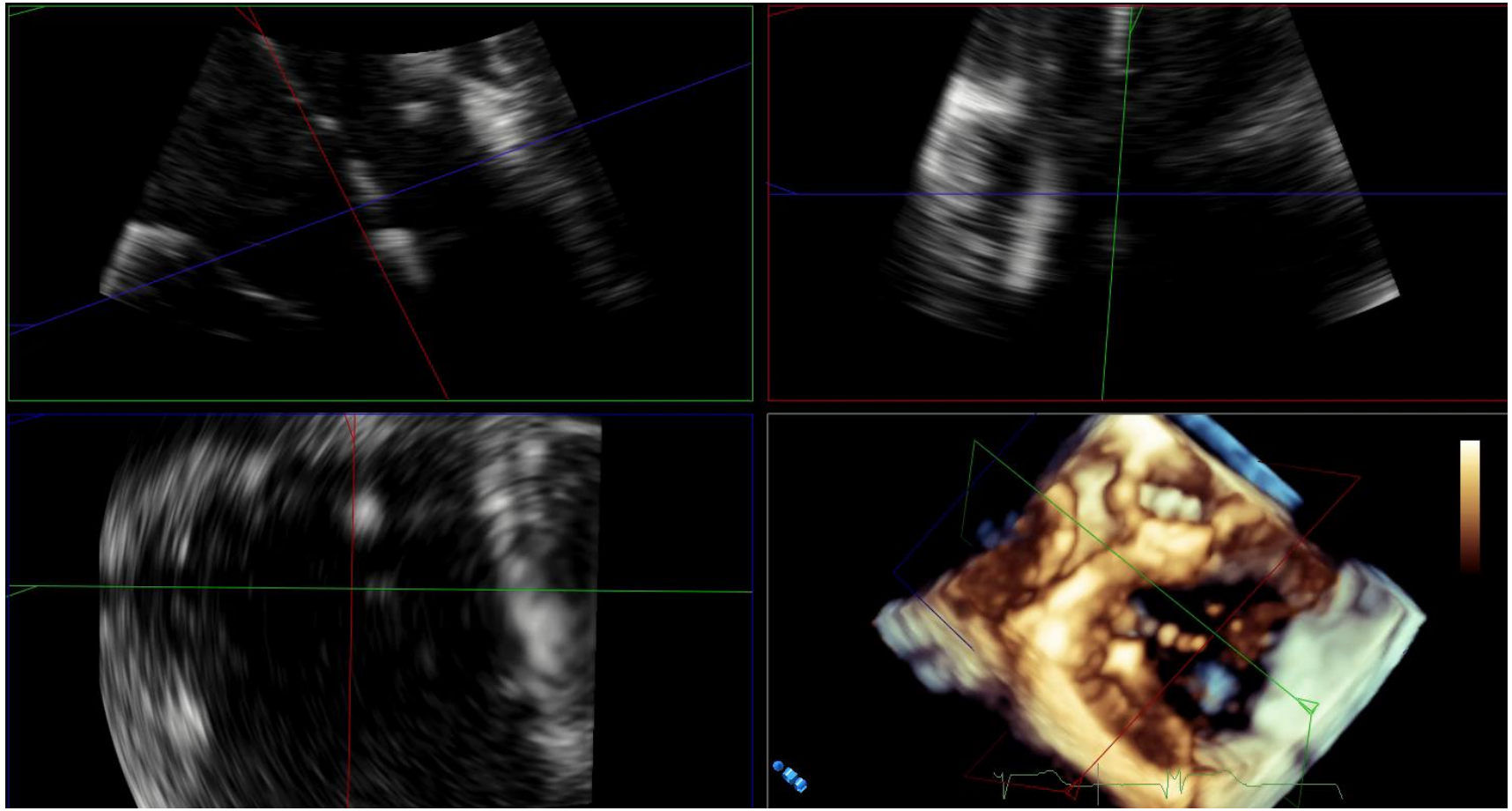
Lateral

Posterior

MEDICAL COLLEGE OF WISCONSIN

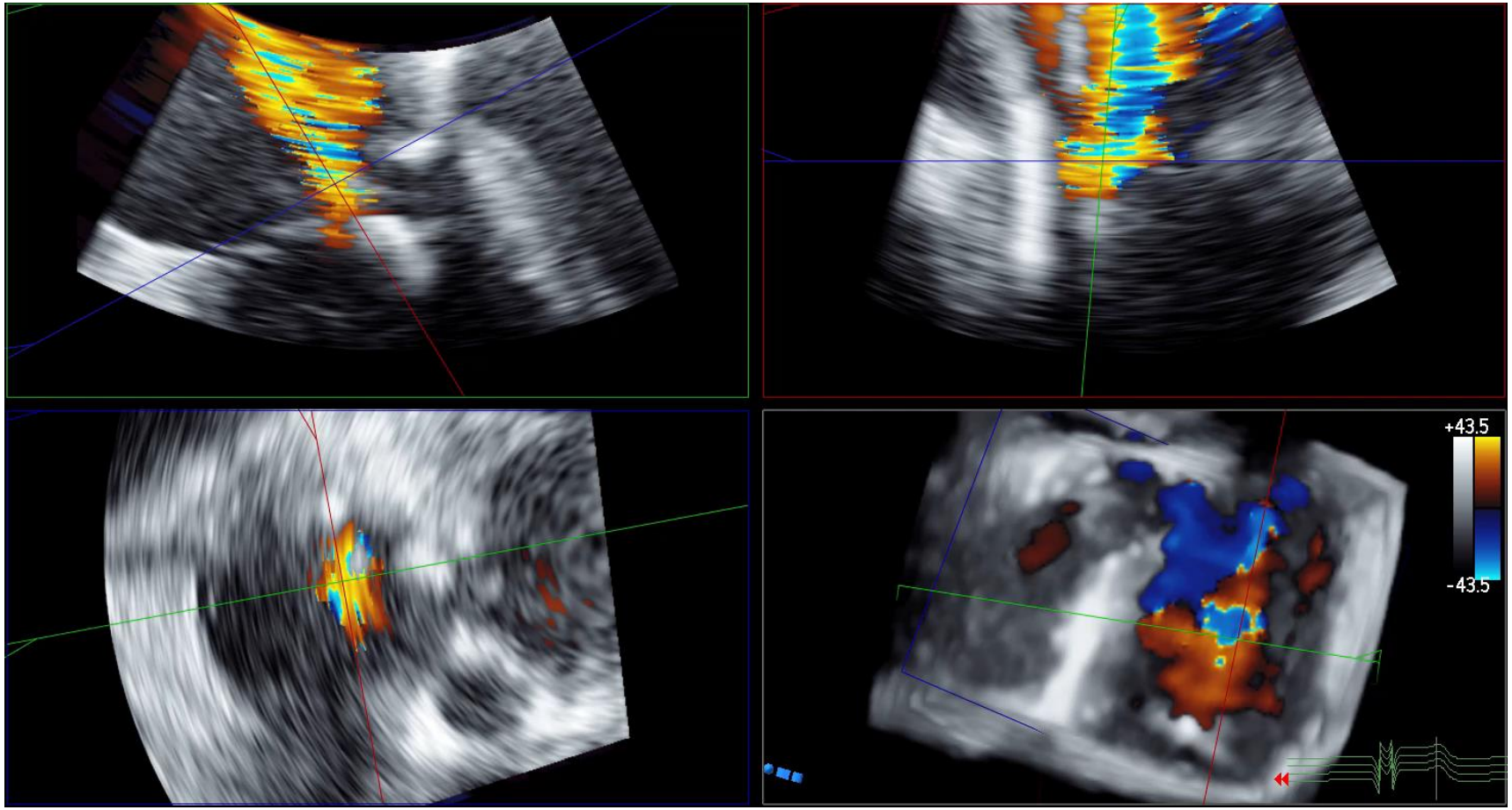


MEDICAL COLLEGE OF WISCONSIN



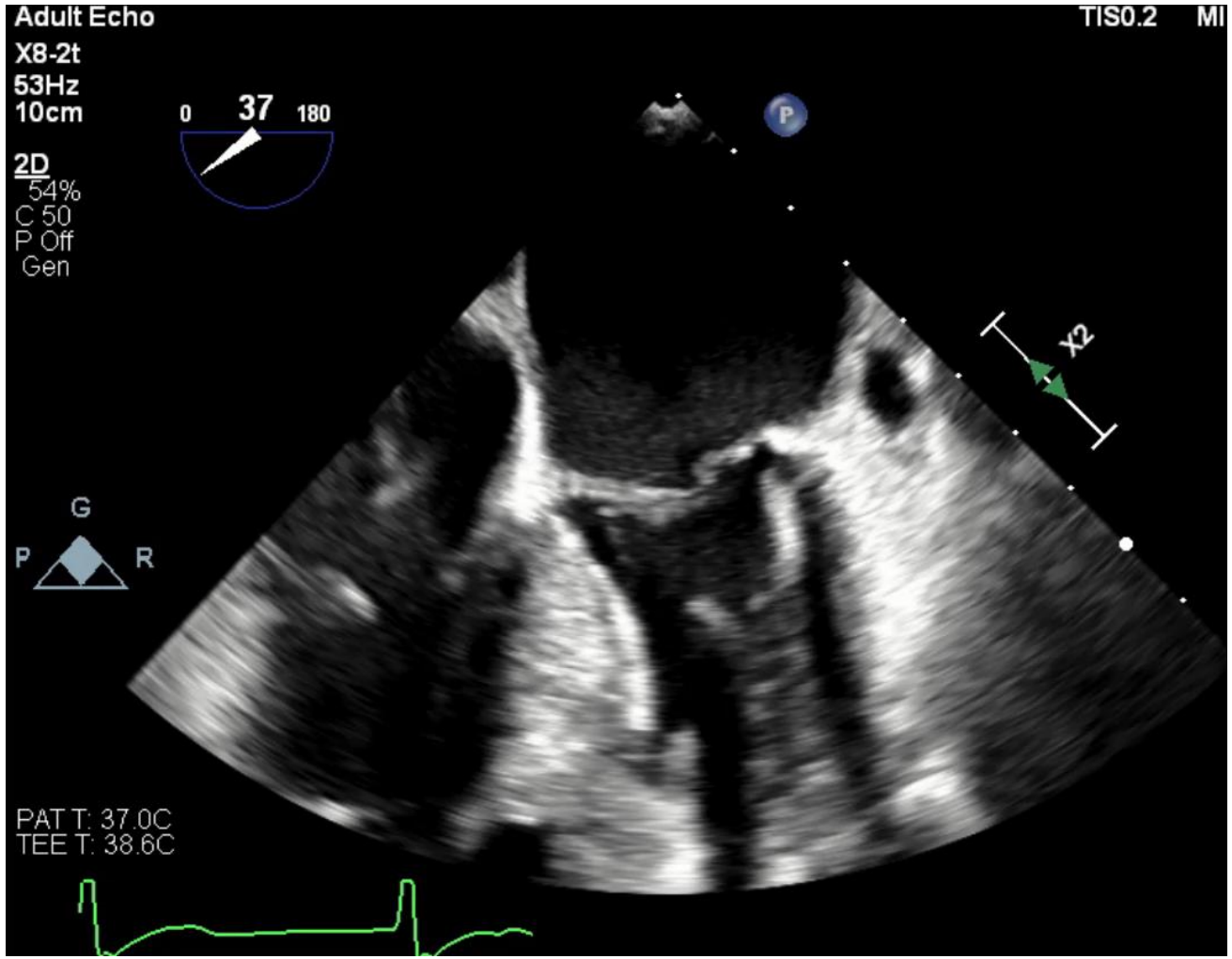
MEDICAL COLLEGE OF WISCONSIN

Jet localization using 3D guided 2D color



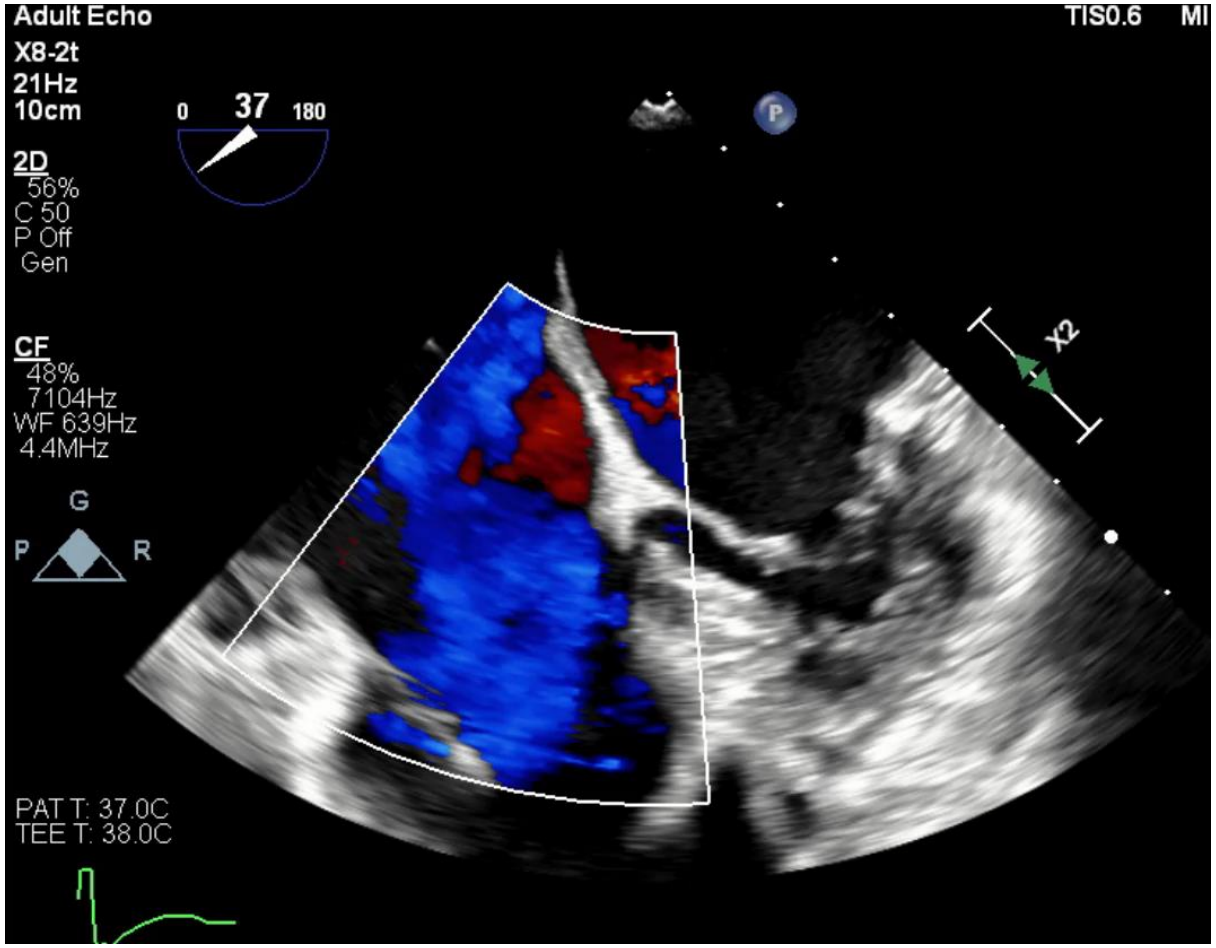
MEDICAL COLLEGE OF WISCONSIN

Decision for clip suitability



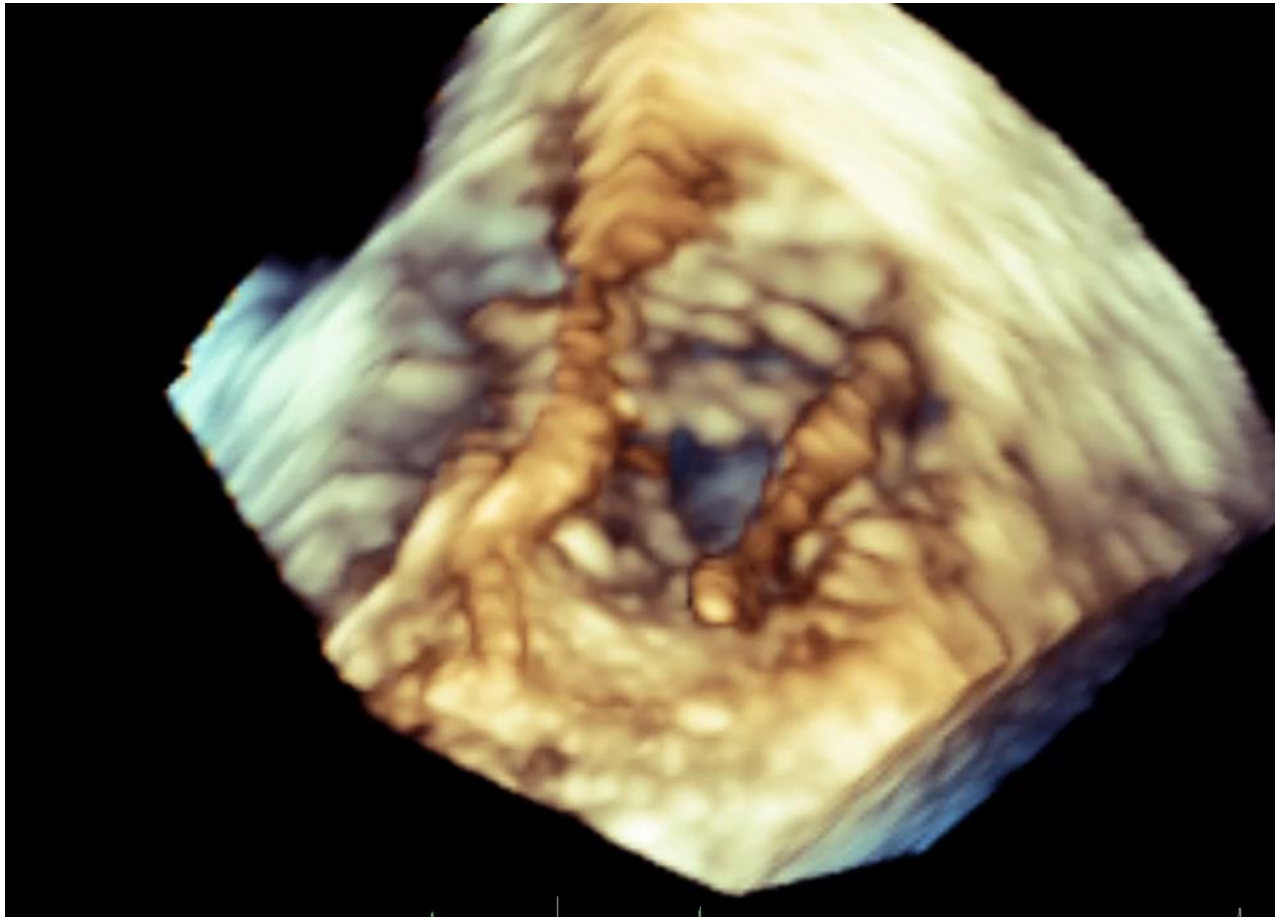
MEDICAL COLLEGE OF WISCONSIN

Decision for clip suitability

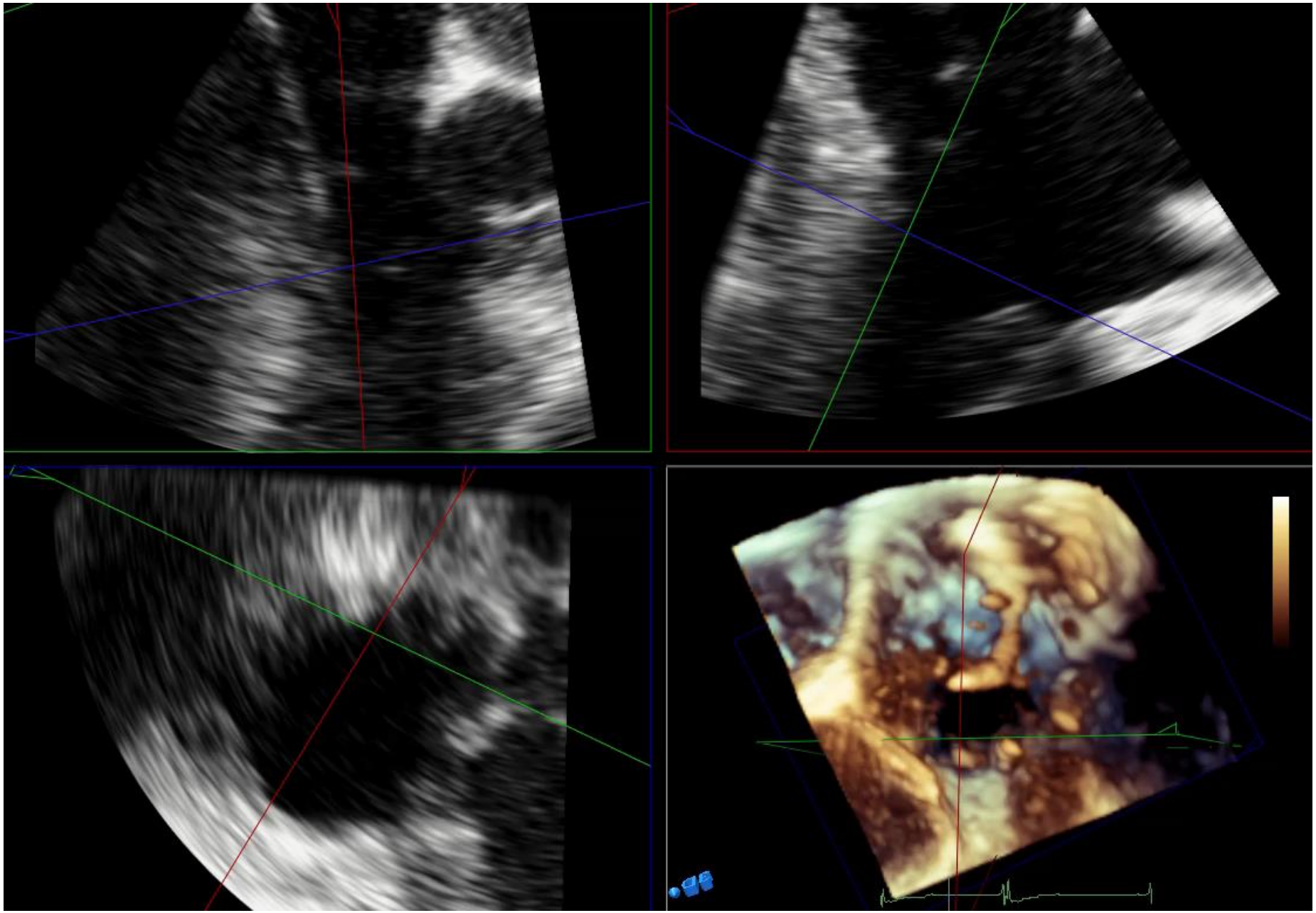


MEDICAL COLLEGE OF WISCONSIN

Decision for clip suitability

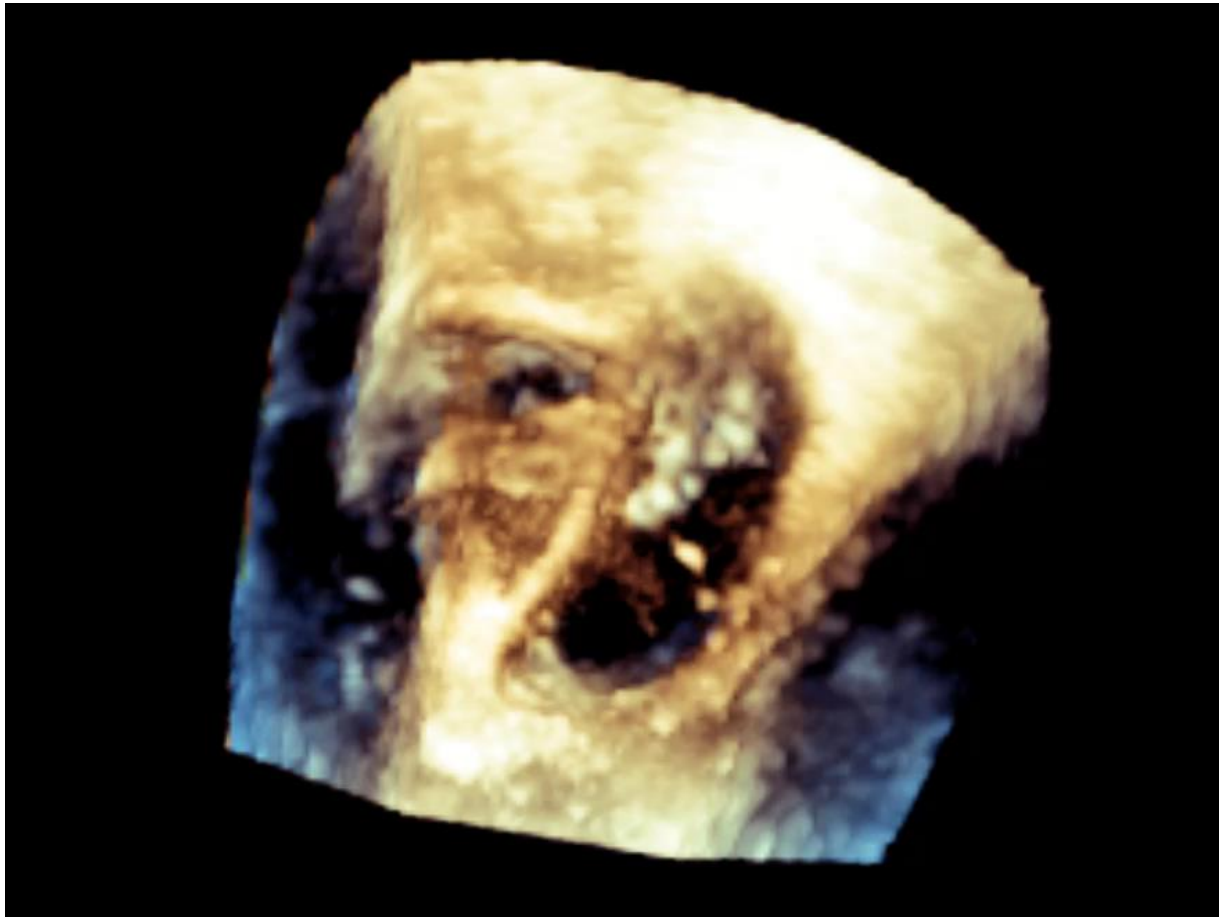


MEDICAL COLLEGE OF WISCONSIN



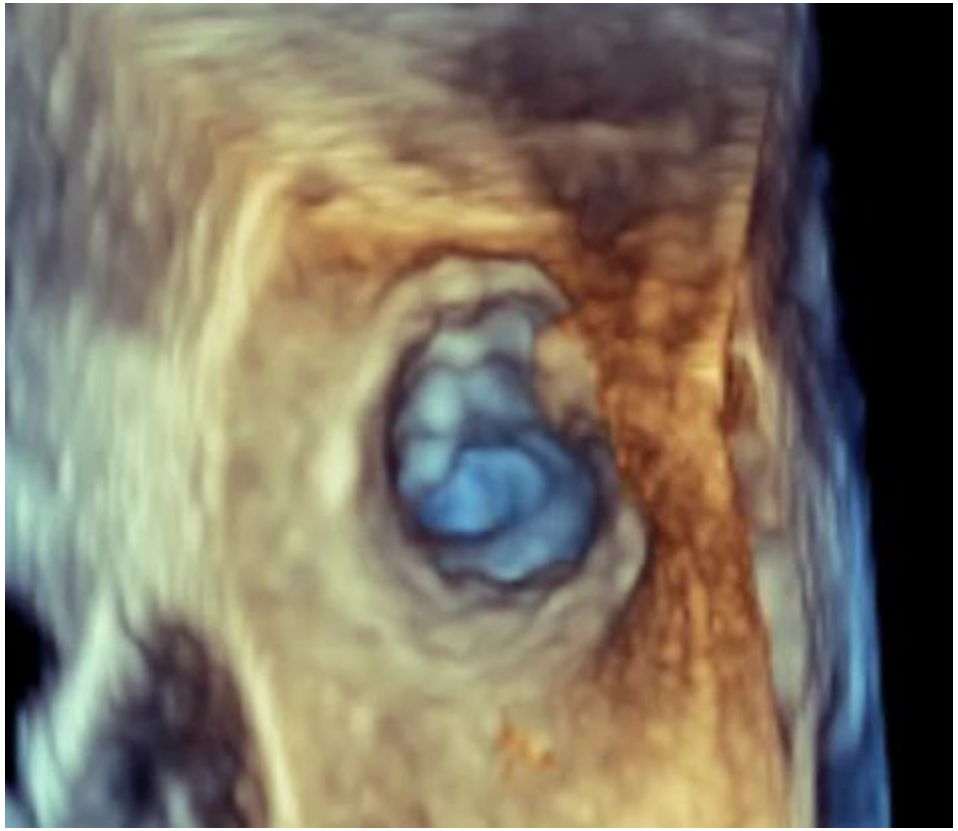
MEDICAL COLLEGE OF WISCONSIN

Atypical TV anatomy



MEDICAL COLLEGE OF WISCONSIN

LAA



Orientation

- Start from 45 degrees or 135 degrees (useful for deployment)

- Take pictures with high 2D gain to start with

MEDICAL COLLEGE OF WISCONSIN

Orientation

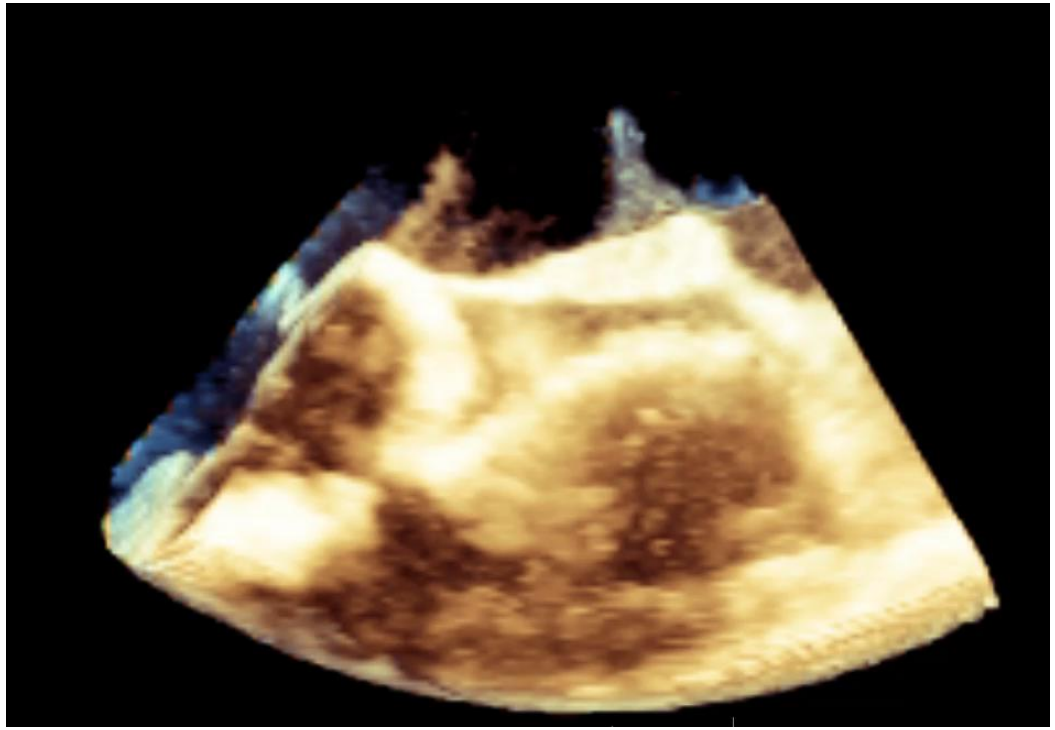
- Gain can be decreased post acquisition but not increased so best to take high gain and lower it.

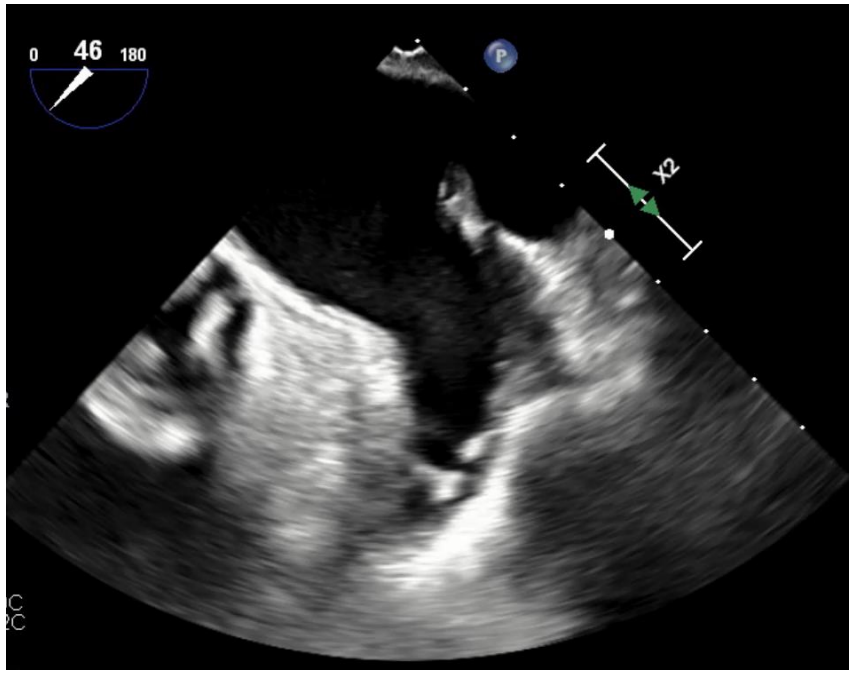
- Or take a high gain first and then take lower gain pictures so that post processing does not have missing data.

MEDICAL COLLEGE OF WISCONSIN

Orientation

- Starting image is 50 degrees
  - Where is the aortic valve
  - Where is the pulmonary vein

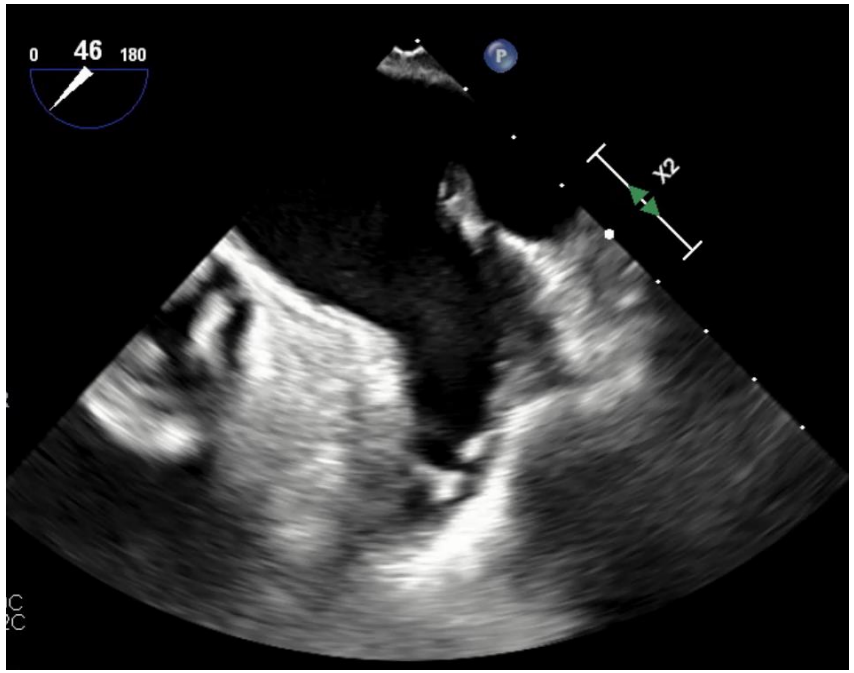


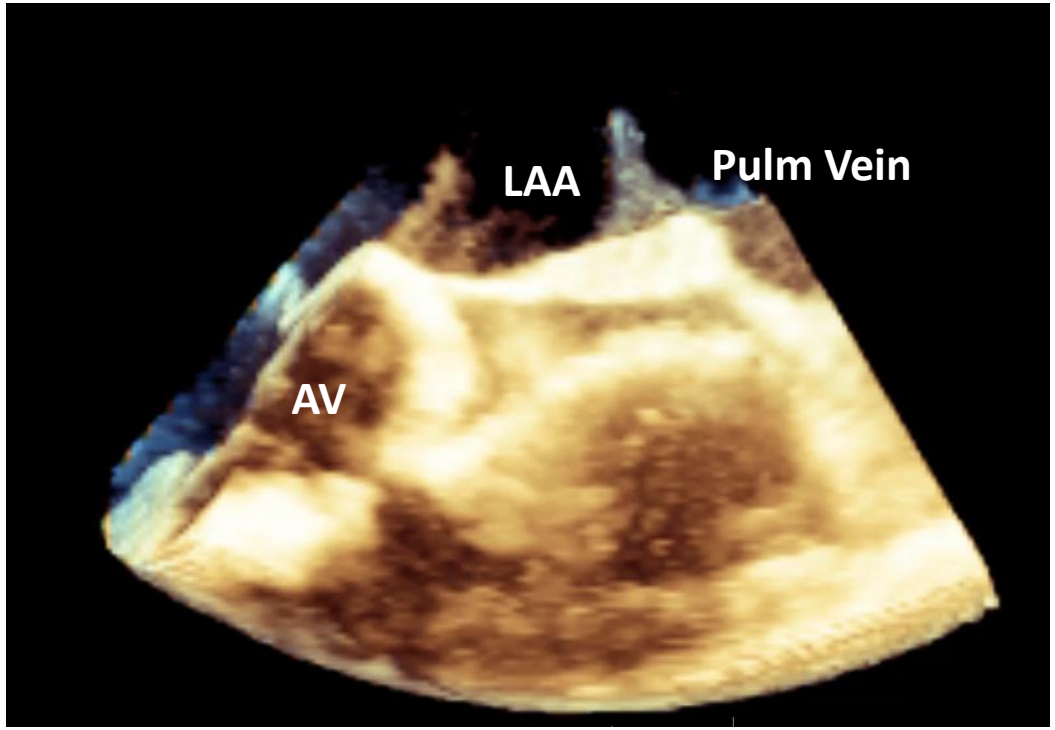


MEDICAL COLLEGE OF WISCONSIN

Orientation

- Starting image is 50 degrees
  - What is on the left
  - What is on the right

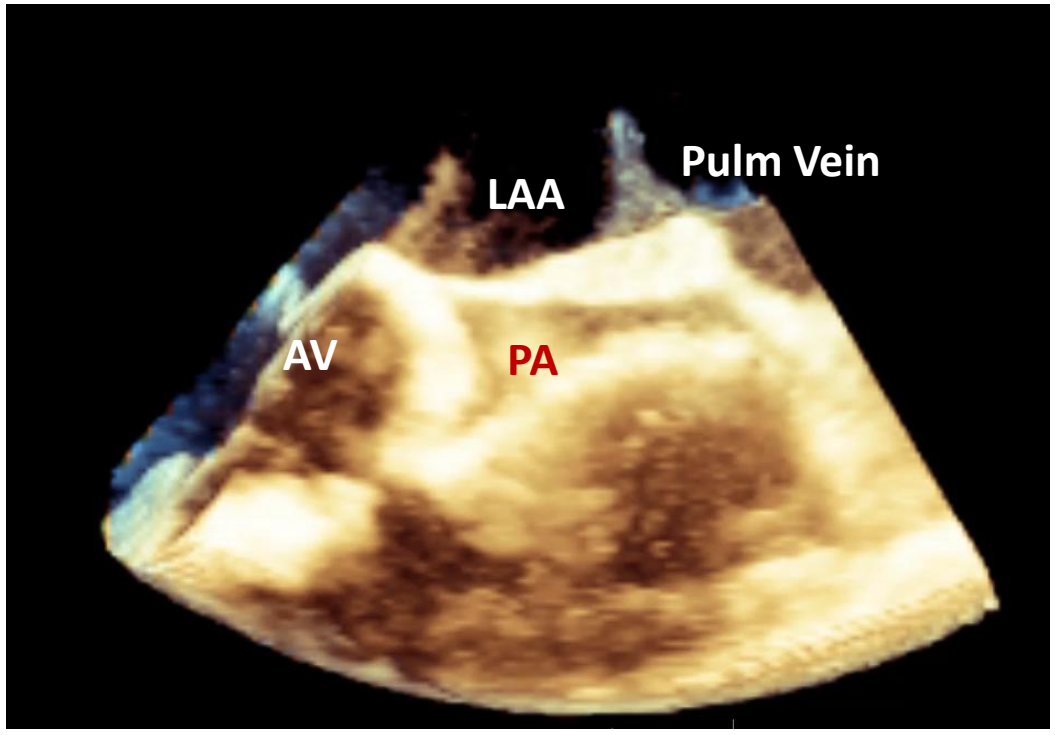


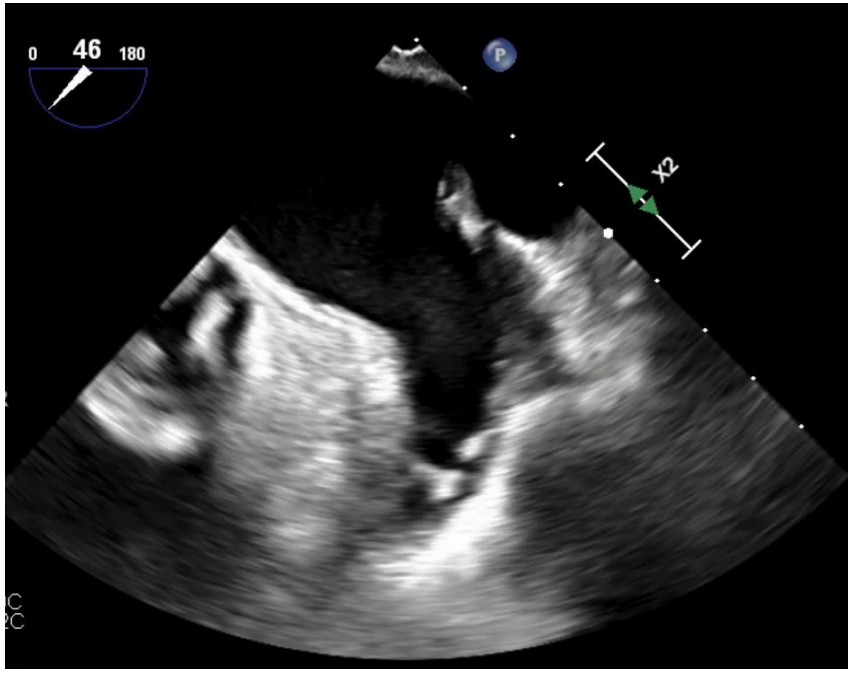


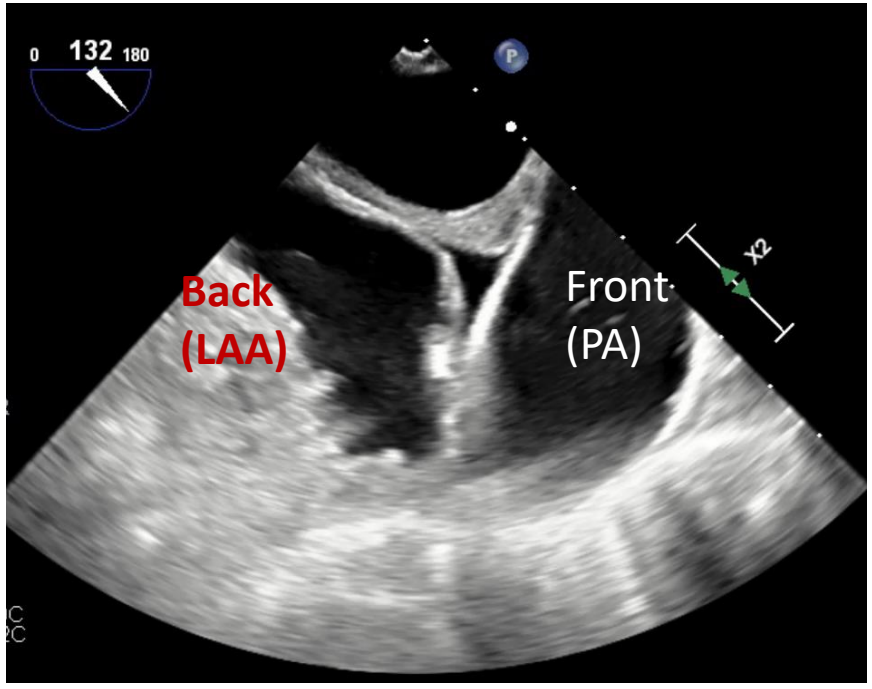
MEDICAL COLLEGE OF WISCONSIN

Orientation

- What is in front
- What is at the back



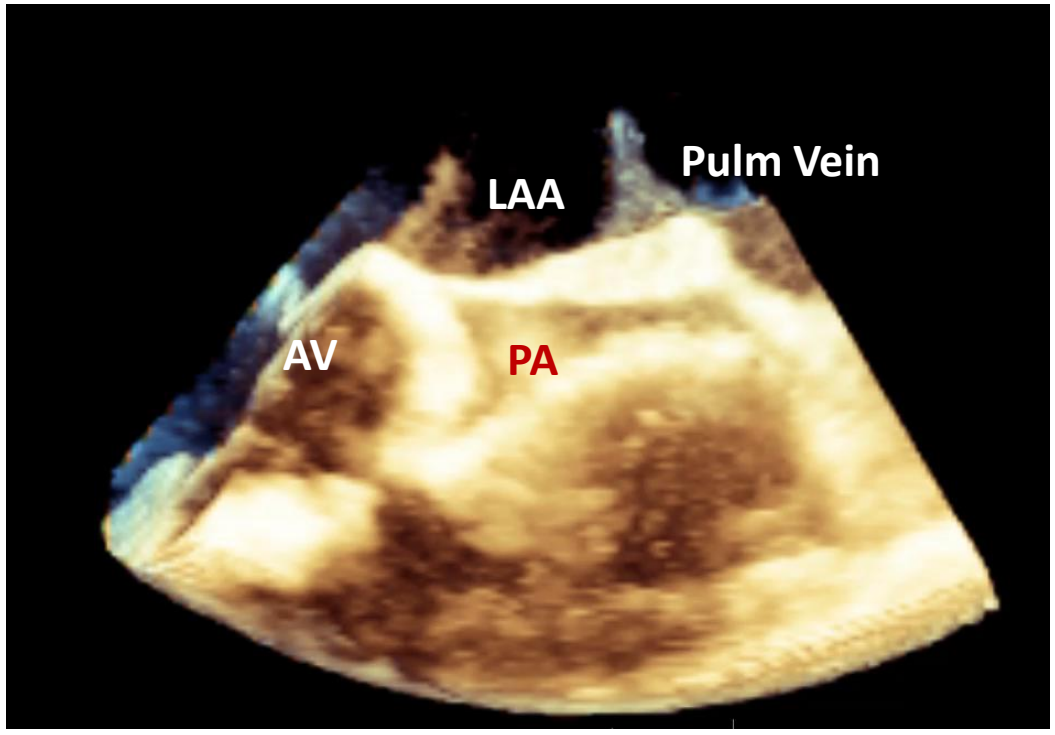


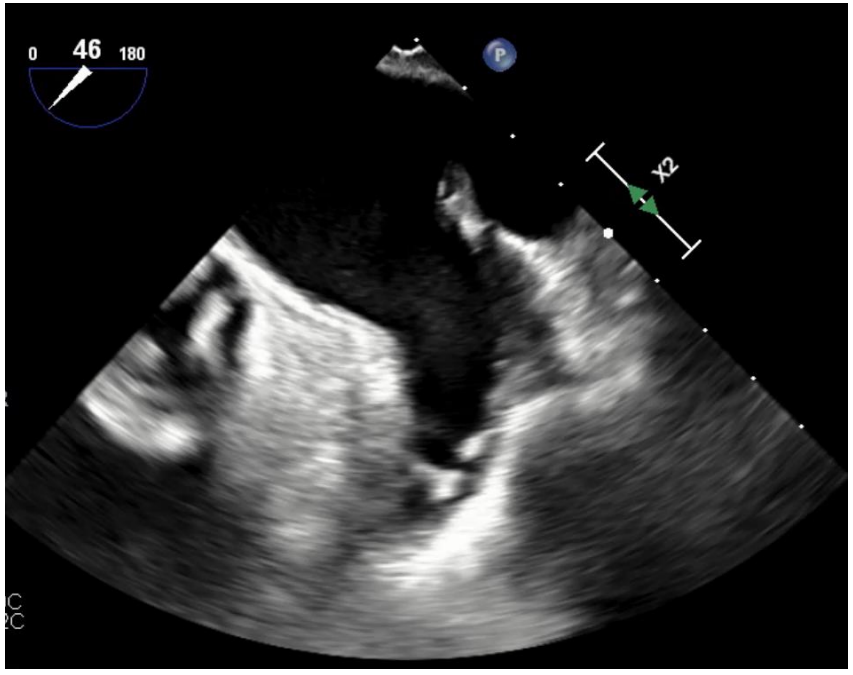


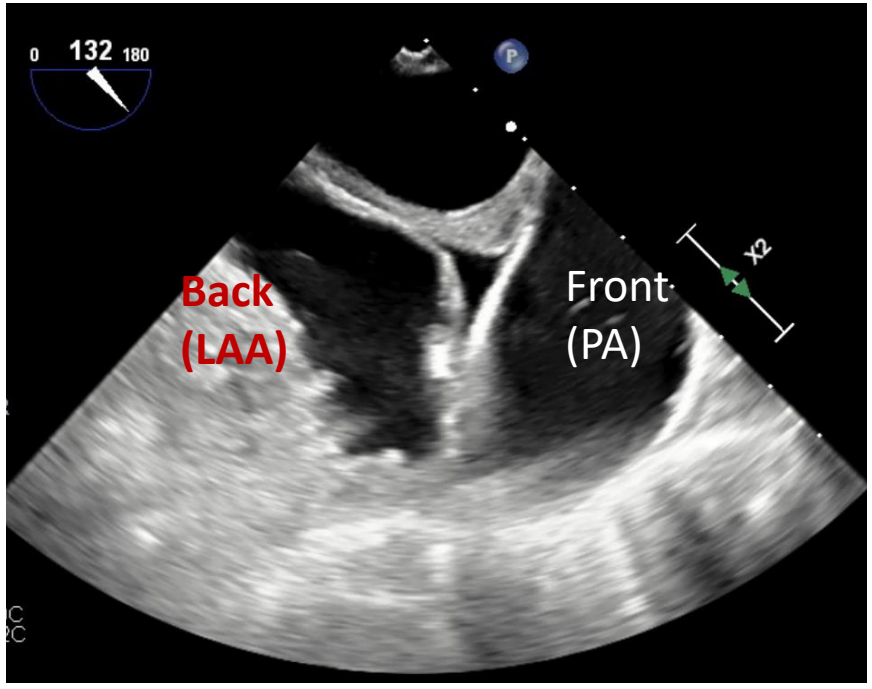
MEDICAL COLLEGE OF WISCONSIN

Orientation

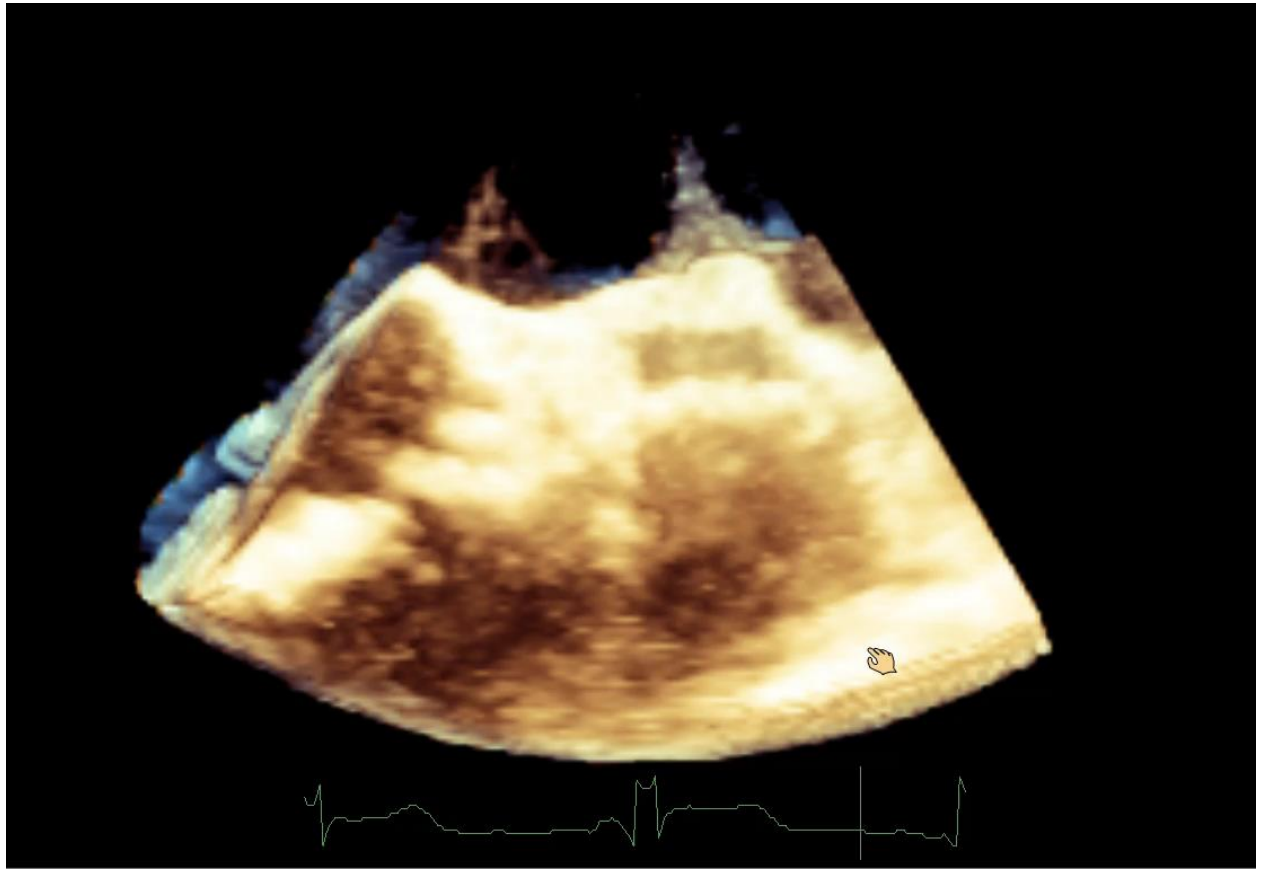
- What is in front
- What is at the back







MEDICAL COLLEGE OF WISCONSIN

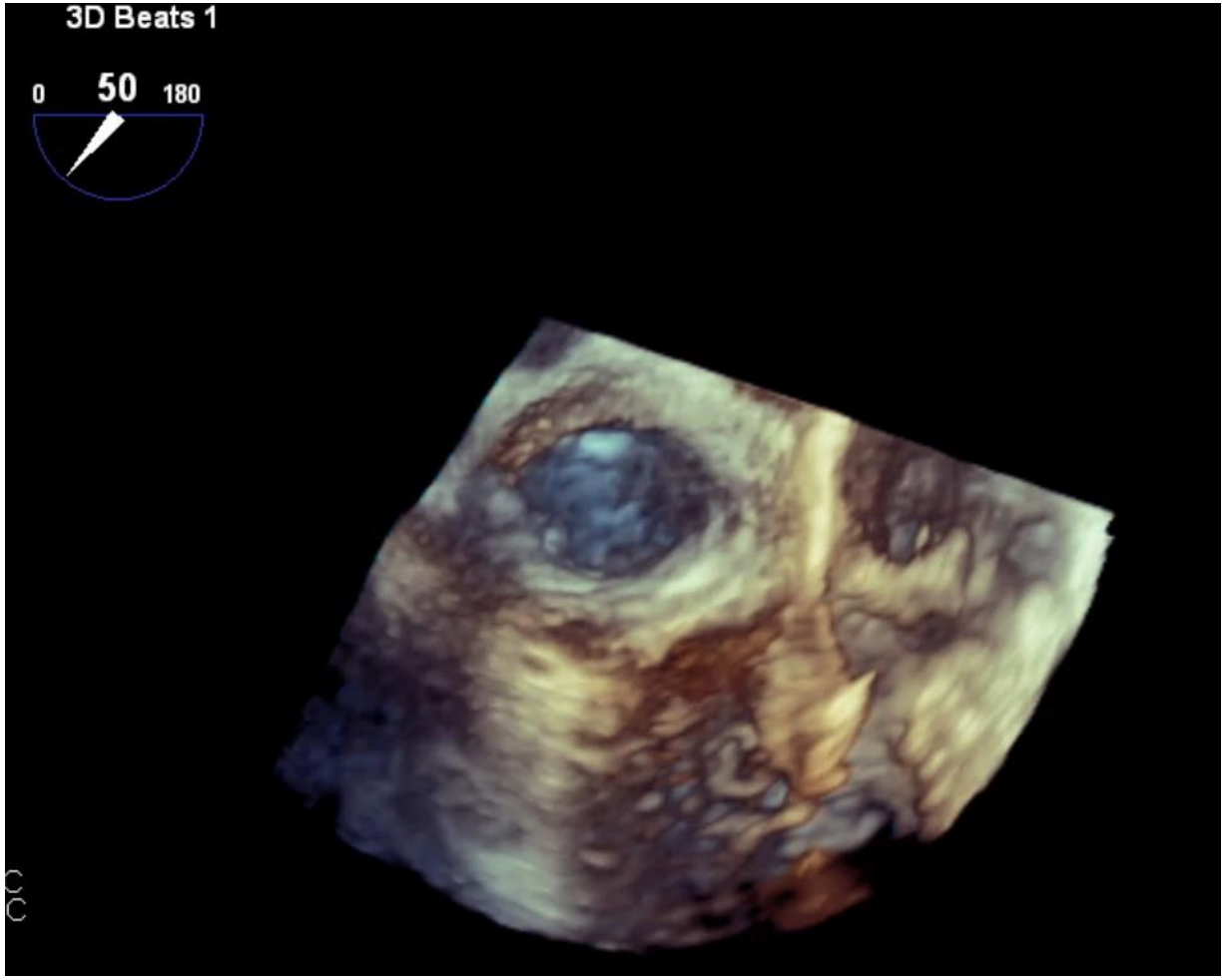


To bring into orientation (like it is seen from the LA, looking down).

Turn down and bring AV to 1’o clock

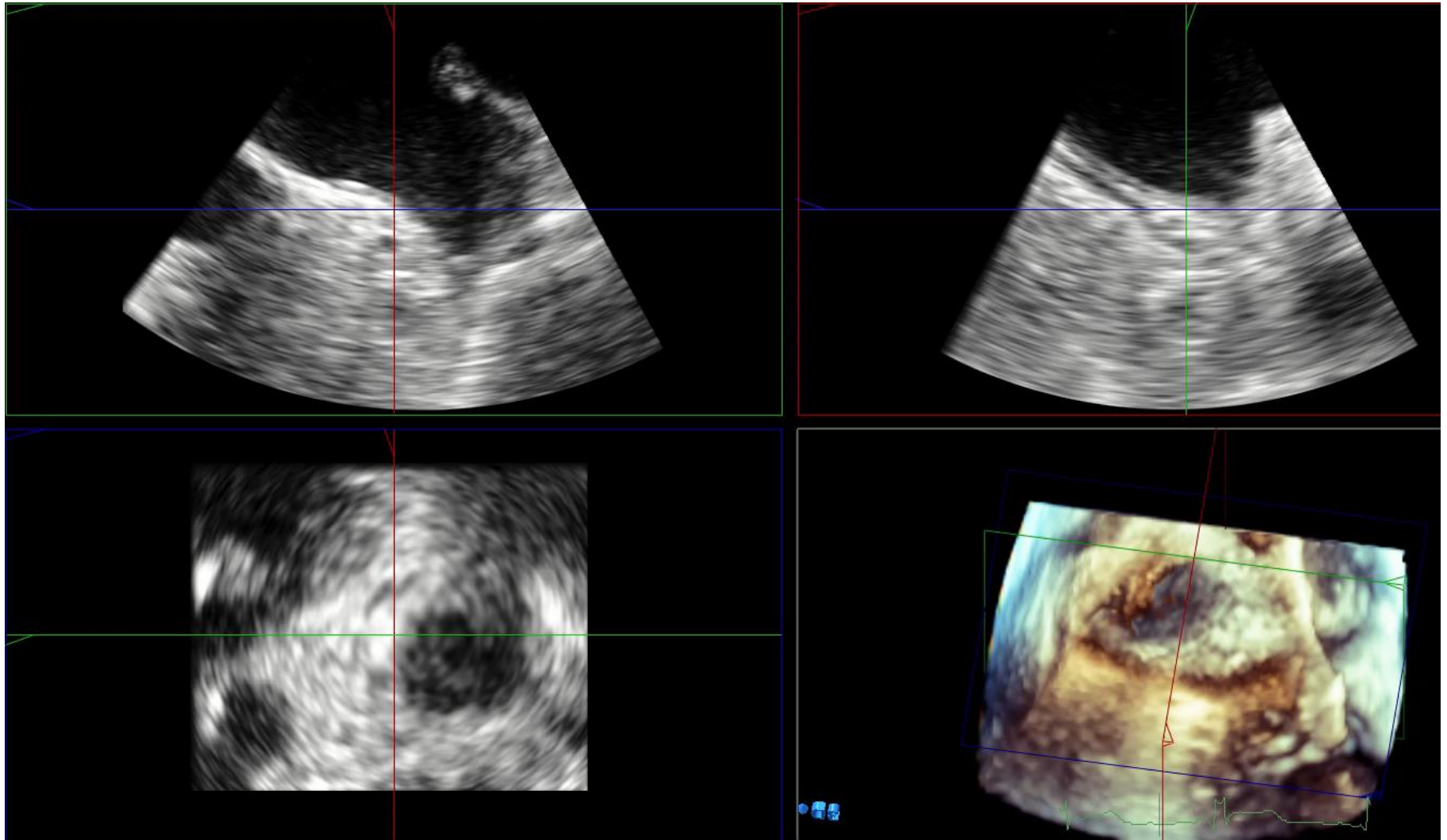
MEDICAL COLLEGE OF WISCONSIN

High 2D gain on 3D echo acquisition



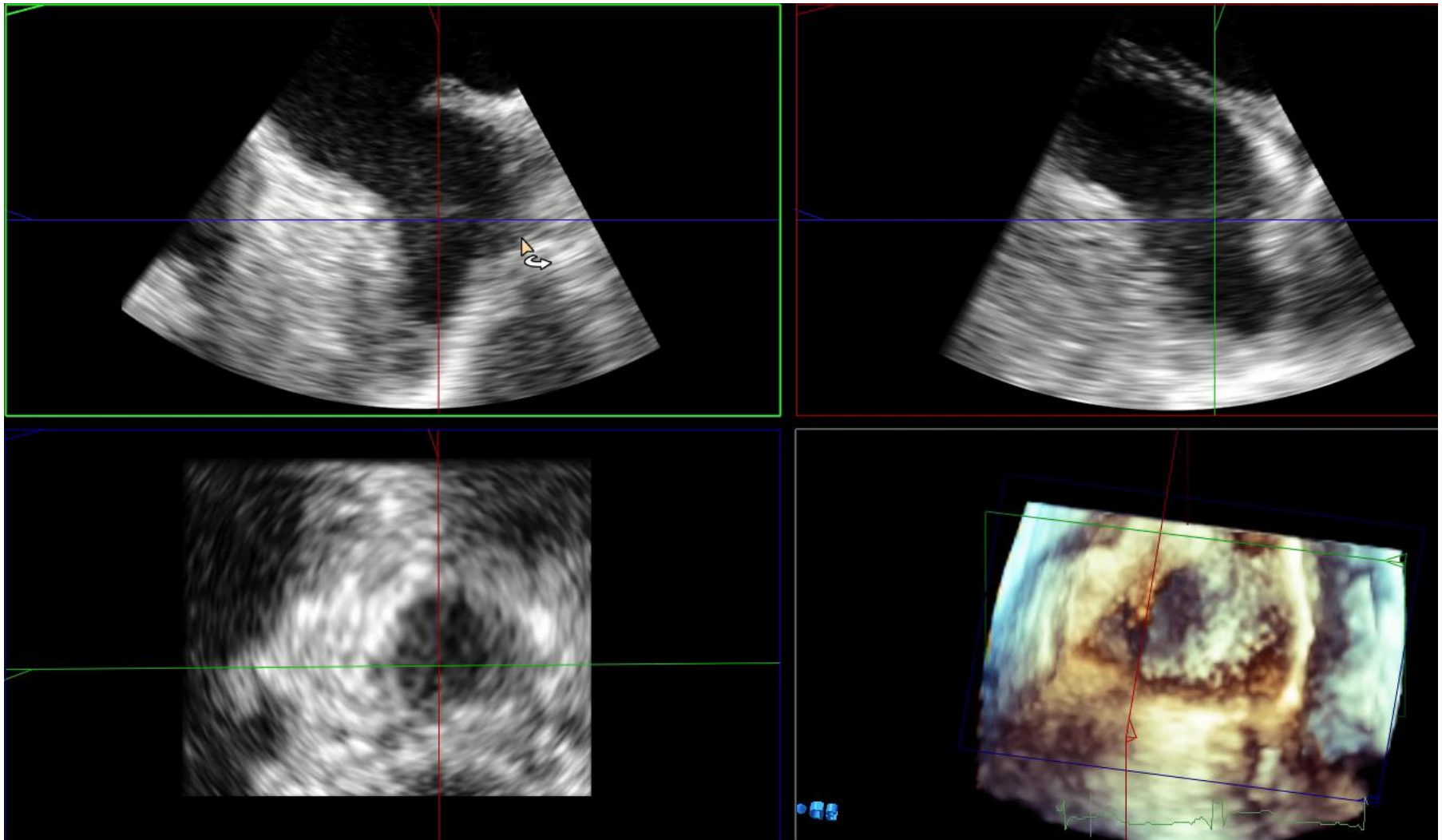
MEDICAL COLLEGE OF WISCONSIN

Adjust image including 2D gain to ensure the orifice is well defined before acquiring (“Multiview” button)



MEDICAL COLLEGE OF WISCONSIN

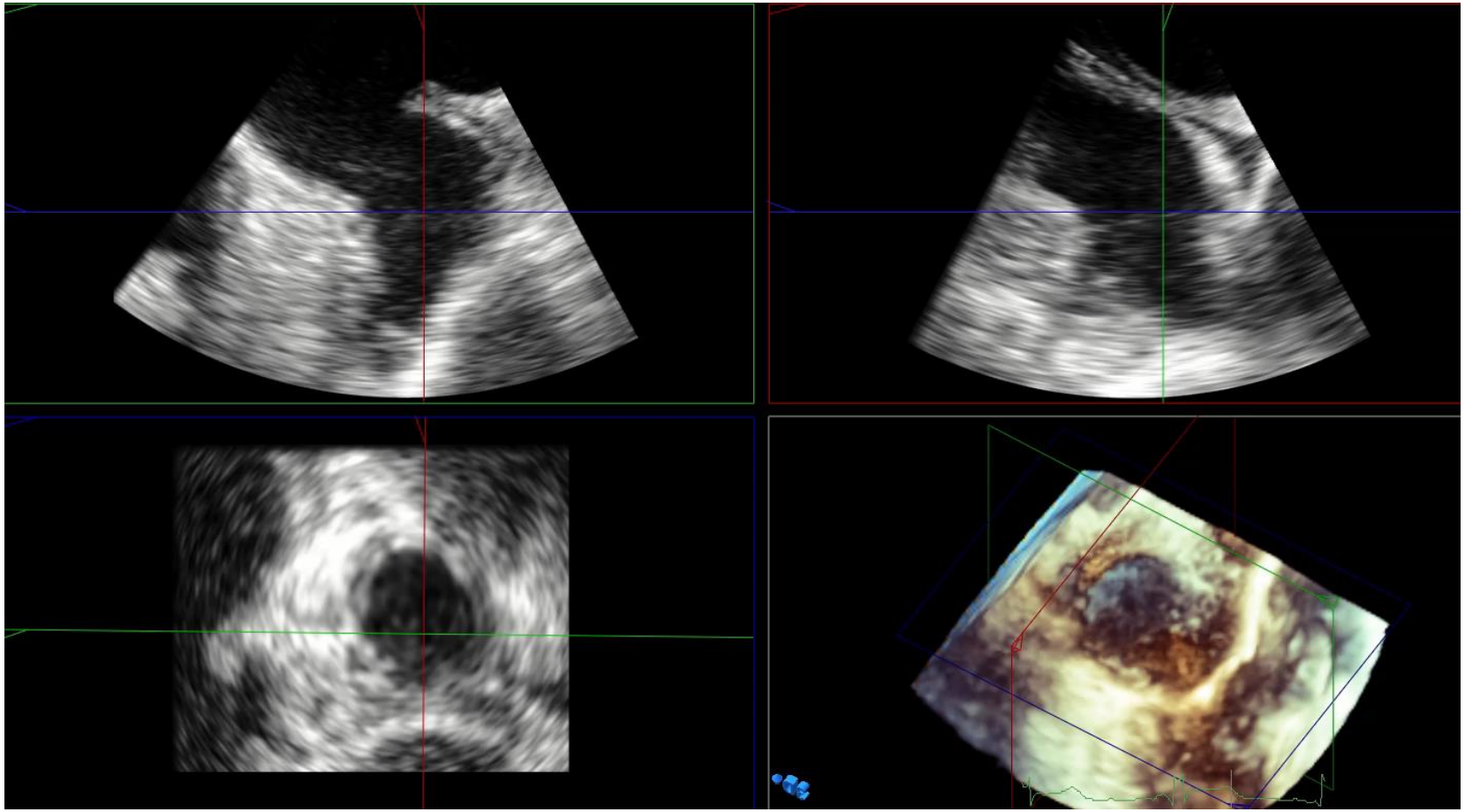
Measure max orifice diameter without coming out of the appendage on any side (particularly the mitral valve side)



Most of the time the orifice is measured near the LCX

MEDICAL COLLEGE OF WISCONSIN

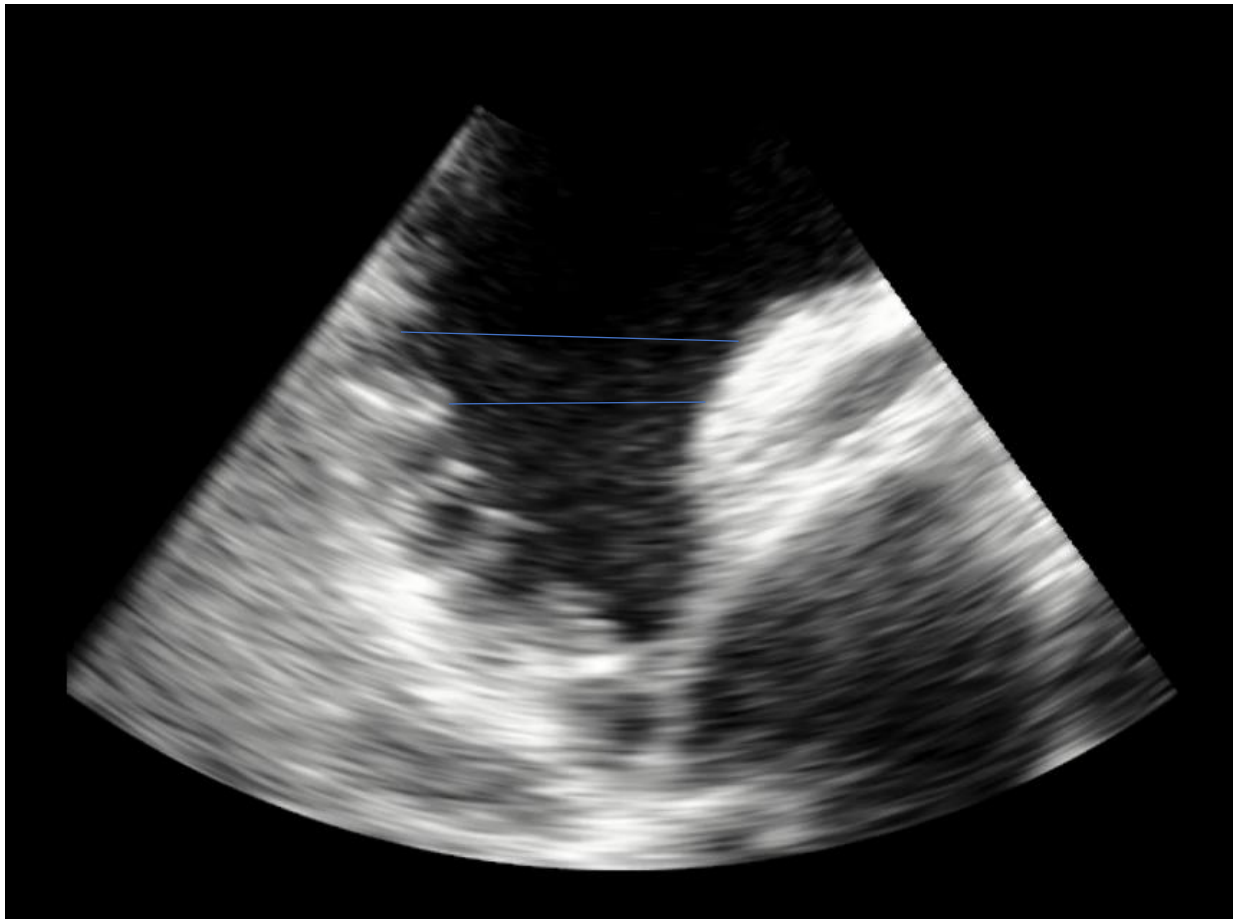
Blue plane can be lowered or brought up to rest at the true orifice



Measure when the orifice is largest (in sinus rhythm this is mostly near the end of T wave)

MEDICAL COLLEGE OF WISCONSIN

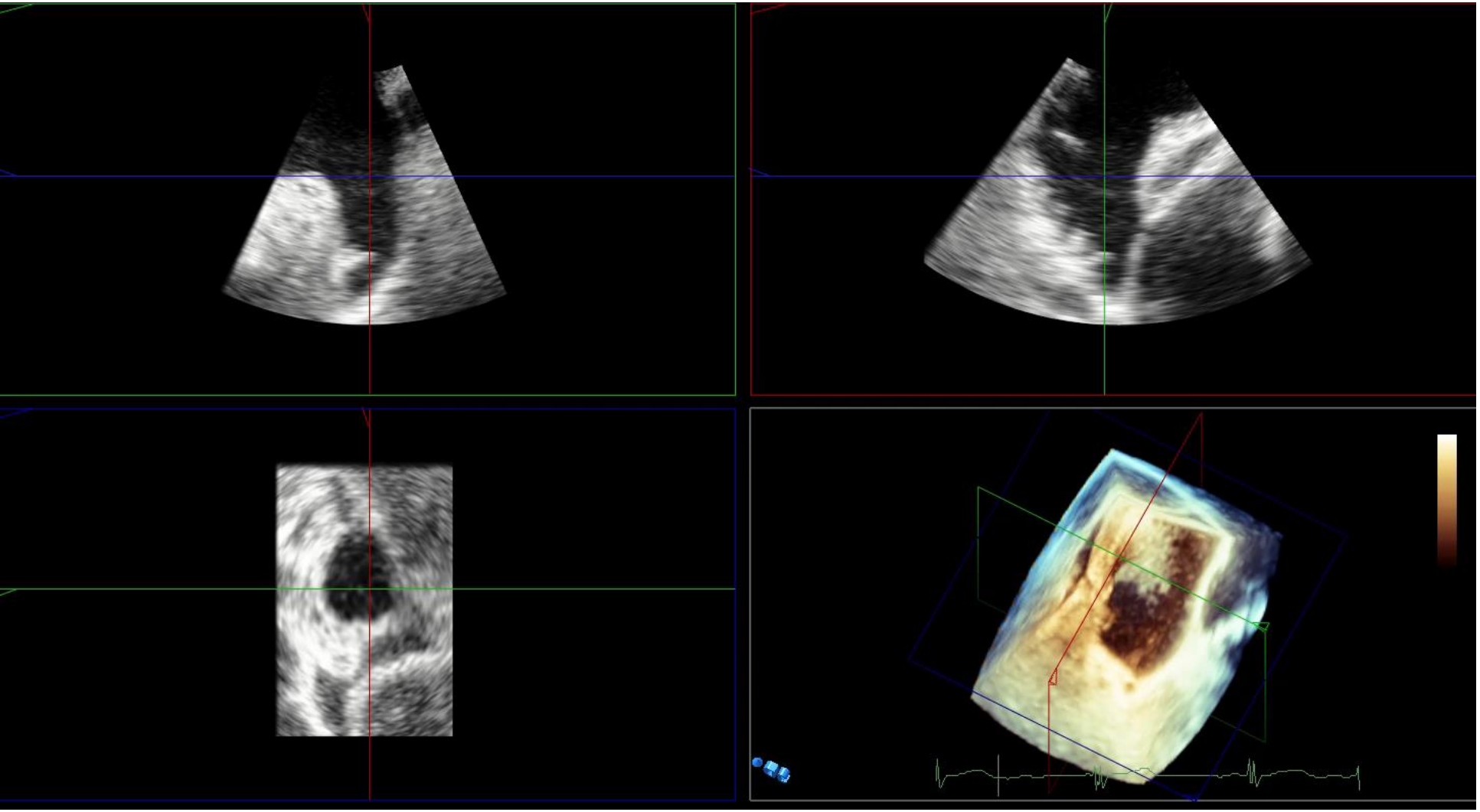
Example 2



Where is the landing zone

MEDICAL COLLEGE OF WISCONSIN

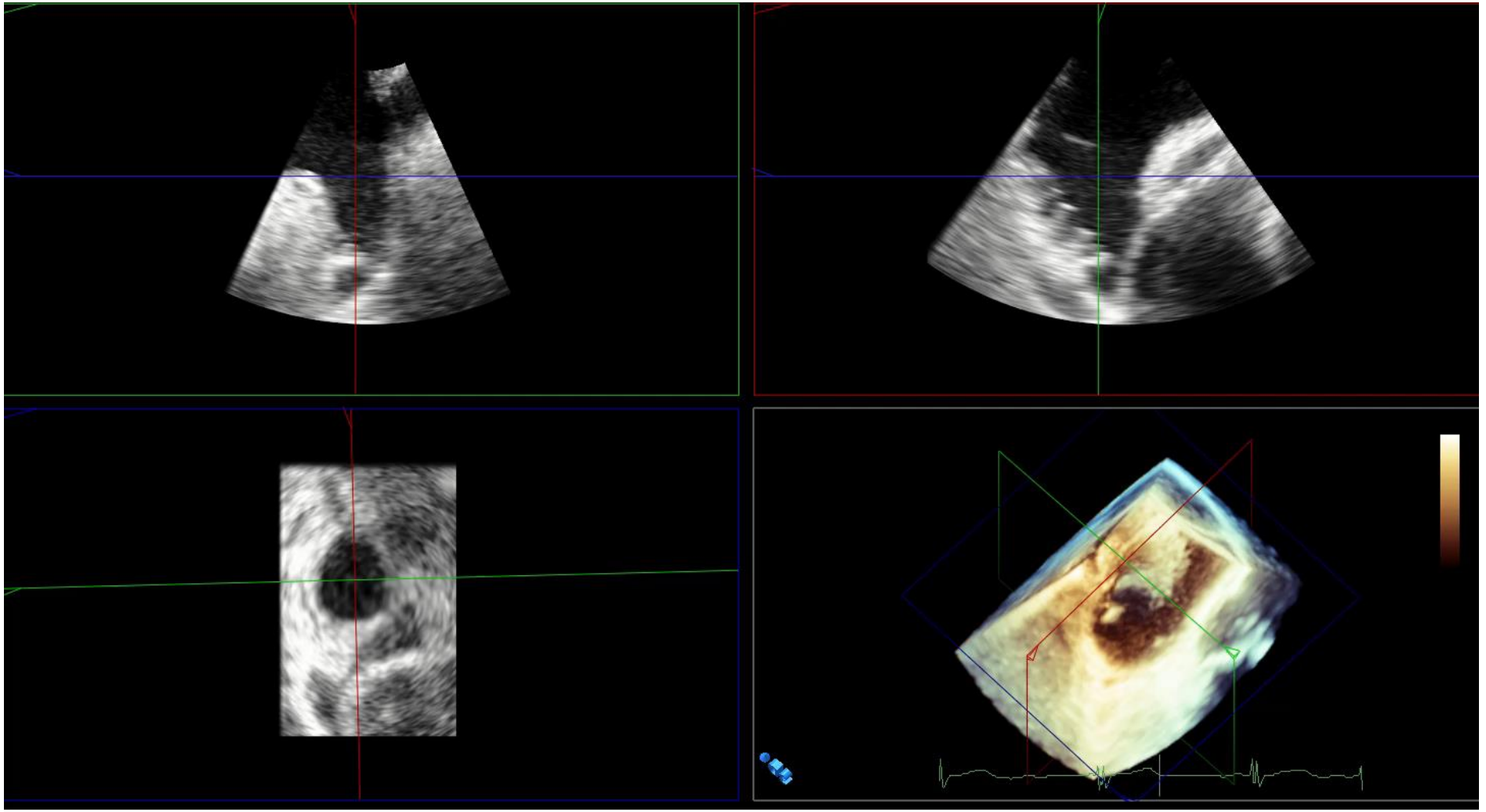
Example 2



Using 3D aided 2D, easier to know where the orifice is

MEDICAL COLLEGE OF WISCONSIN

Finding 0 and 90 from 3D at 45 degrees



Turn the green plane (or 45^{o} plane anticlockwise by 45^{o} to come to 0

Turn the red plane (or the 135^{o}plane anticlockwise by 45^{o} to come to 90^{o})

MEDICAL COLLEGE OF WISCONSIN

Conclusion

- 3D echocardiography should be done routinely to increase acquisition as well as post processing skills.

- 3D echocardiography provides accurate assessment of valvular heart disease, anatomy and localization of structures of interest within the heart (eg. PPM leads in relation to the tricuspid valve).

- Image orientation and high frame rate acquisition are key to optimal 3D echocardiography.

MEDICAL COLLEGE OF WISCONSIN