



Quantifying LV Function: *Can We Do Strain with Stress?*

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Relations with Industry

GE: honoraria, consulting

Edwards: honoraria

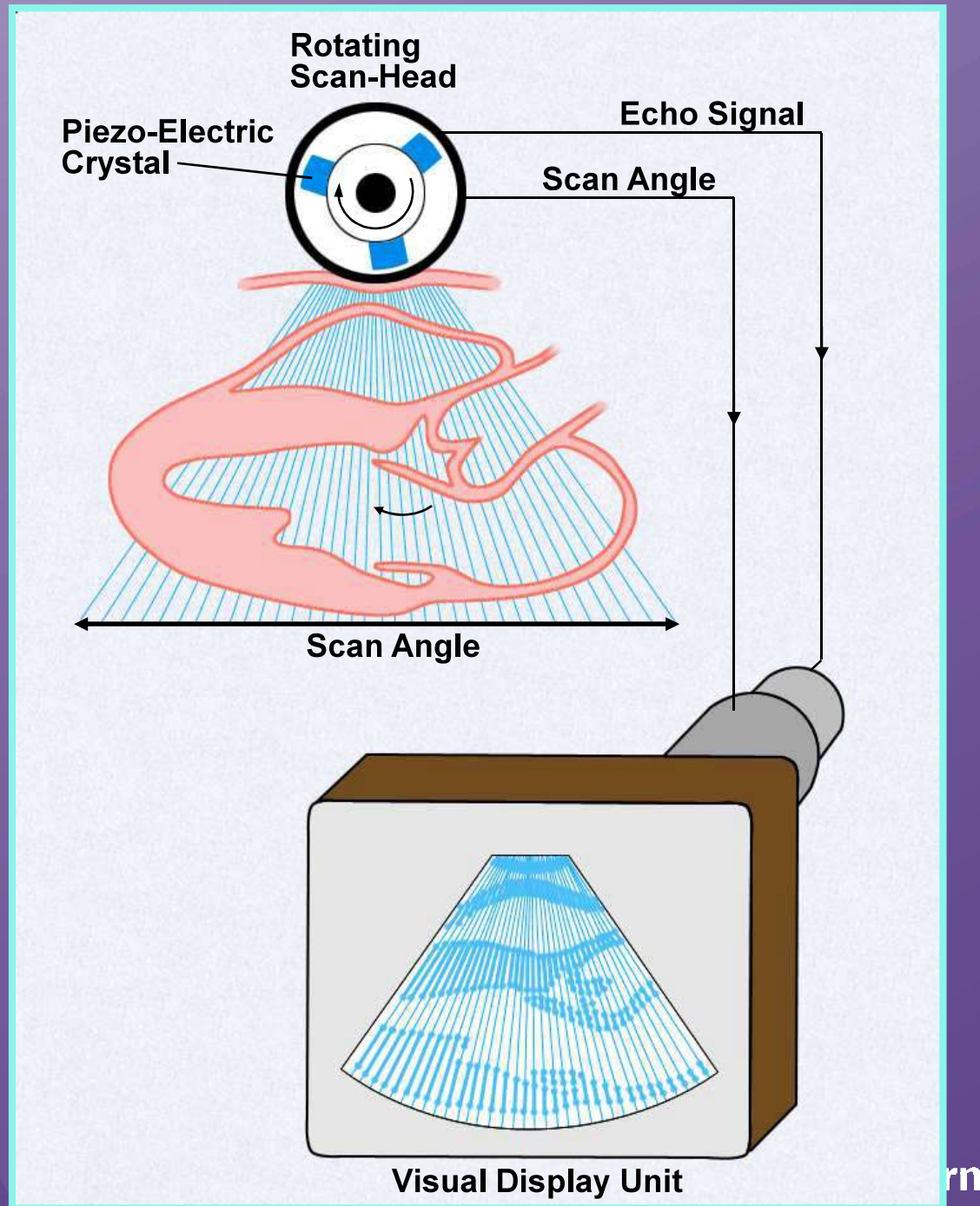
Abbott: honoraria, consulting

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Old School Echo

One Pulse, One Scan Line

- *Frame rate strictly limited by PRF and number of scanlines per frame*
- *Even greater limitation in color Doppler (several pulses, one scan line)*

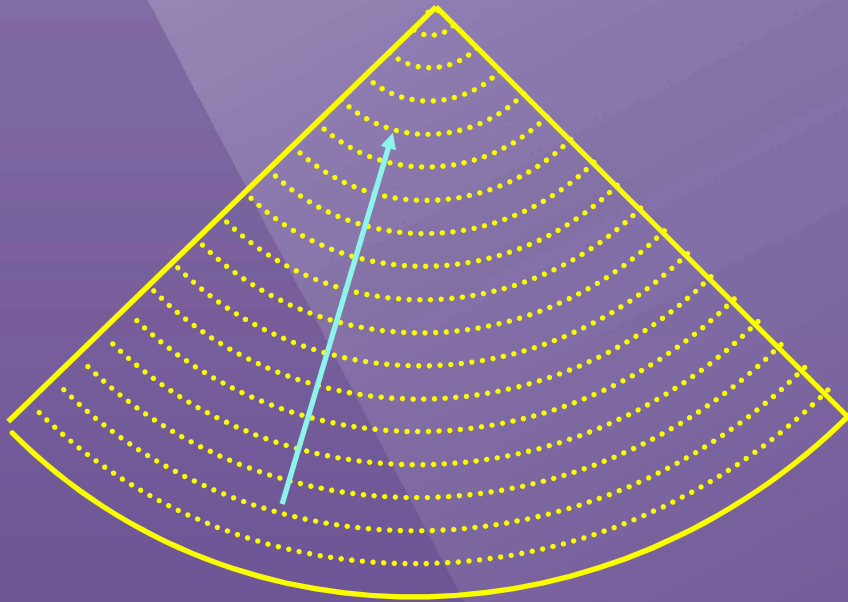


Parallel Processing

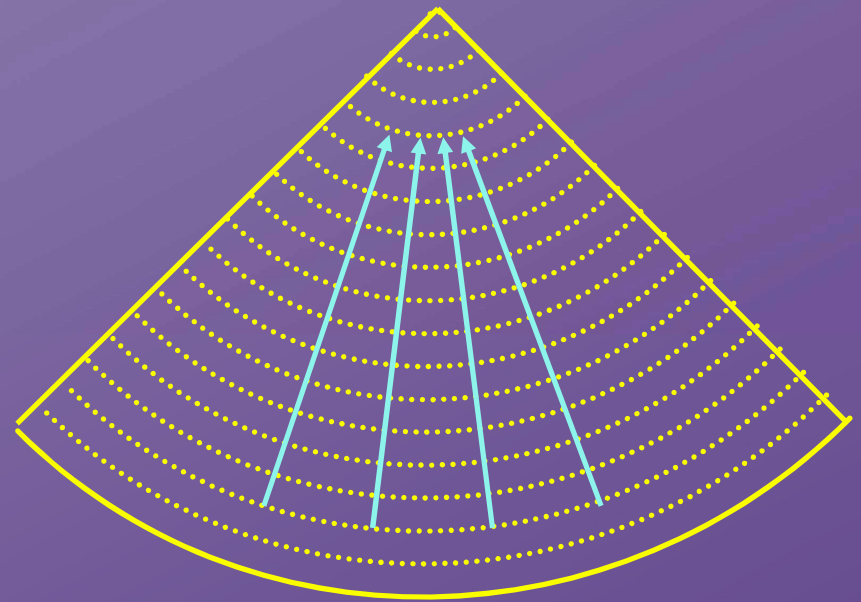
Dramatic Breakthrough in Mid-90's

Serial Processing

Parallel Processing



One scan line is received for each ultrasound pulse.



Several scan lines are received for each ultrasound pulse.

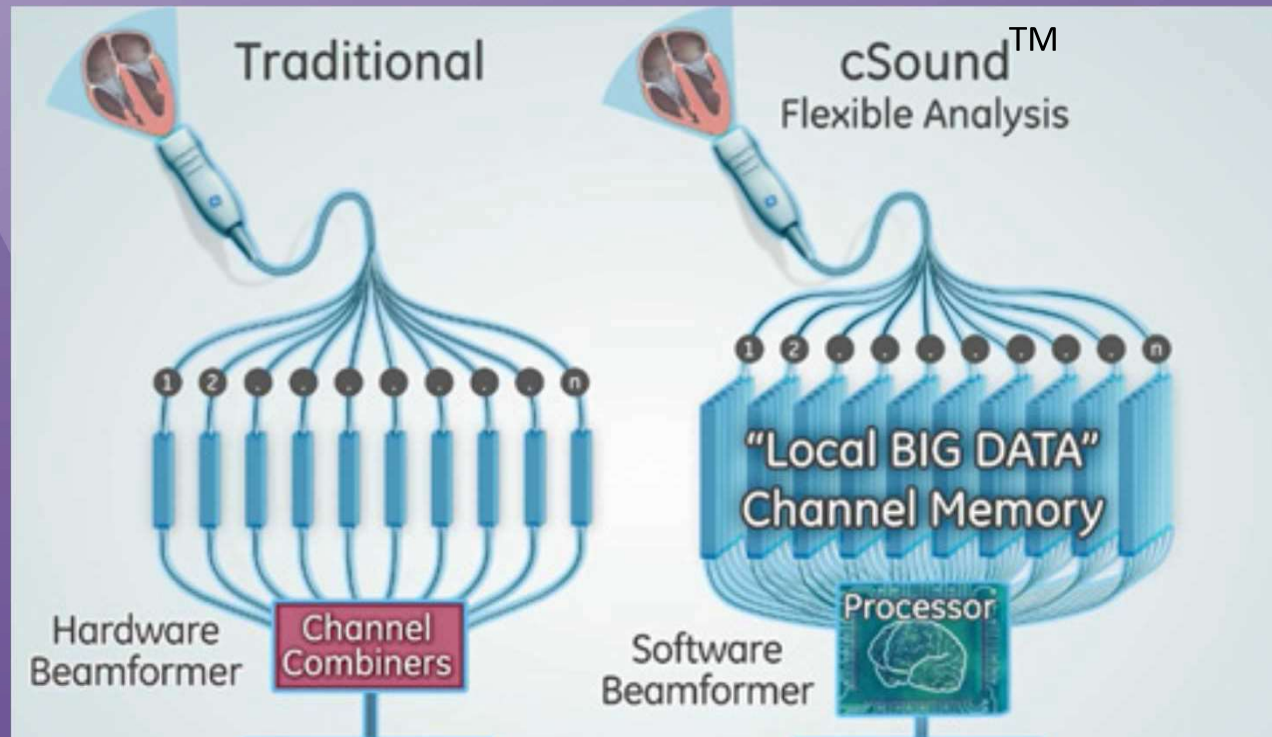
Synthetic Aperture Imaging

Allows Extremely High Frame Rates

- *Theoretically, 2D (and even 3D) images can be generated from a SINGLE unfocused ultrasound pulse*
 - Complex reconstruction algorithms
 - Potentially frame rates in the 1000's
- *This sounds too good to be true...what's the downside?*
 - Unfocused waves are weak, giving poor signal to noise ratio
 - Imperfect processing reduces spatial and contrast resolution

Software Beam Formation

A BIG Breakthrough in Echocardiography



- *Store ALL the RF US data in local memory*
- *Do all the processing with software*
 - High flexibility, easy to trade-off temporal, spatial, and contrast resolution
 - Ride the wave of Moore's Law

Moore's Law in Perspective



In 1965, it took ~\$900 and 7 hours to fly from New York to Paris.

The same in 2015.

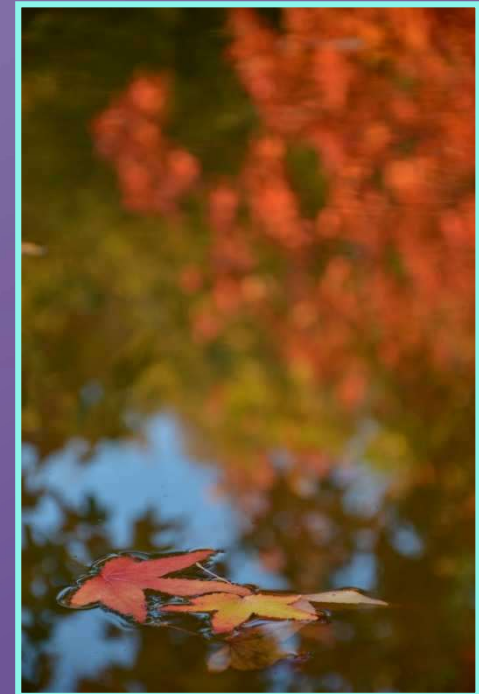
If Moore's law had applied, however, today it would cost less than $\frac{1}{2}\text{¢}$ and take less than a quarter second (10^9 -fold improvement in efficiency!).

Focusing: The Old Way

Transmit focus



Receive focus

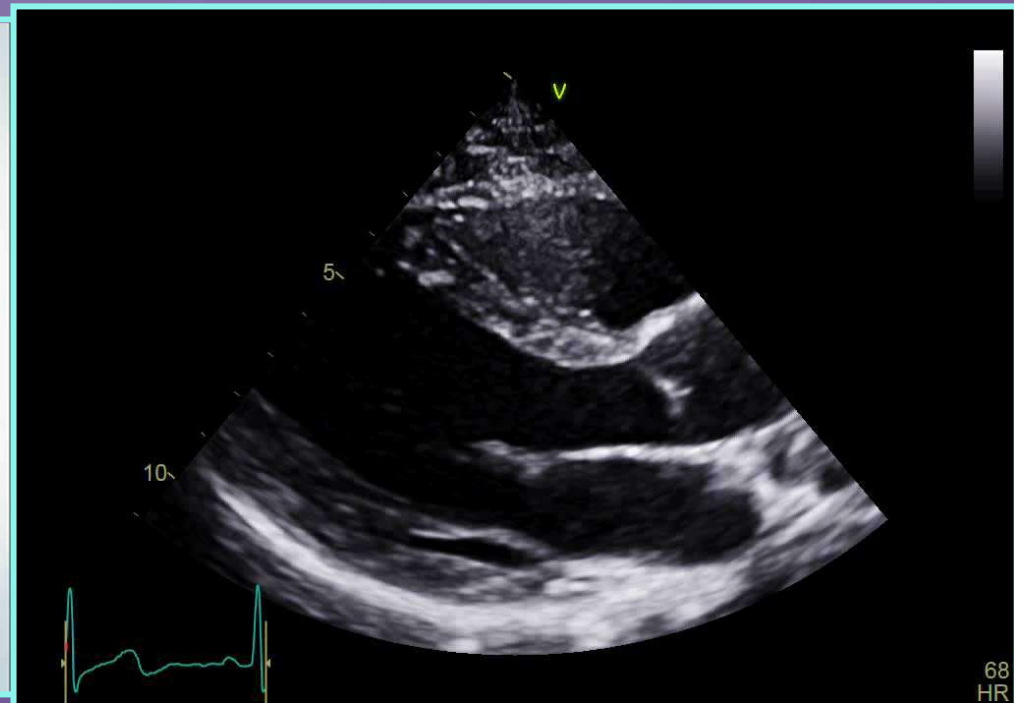
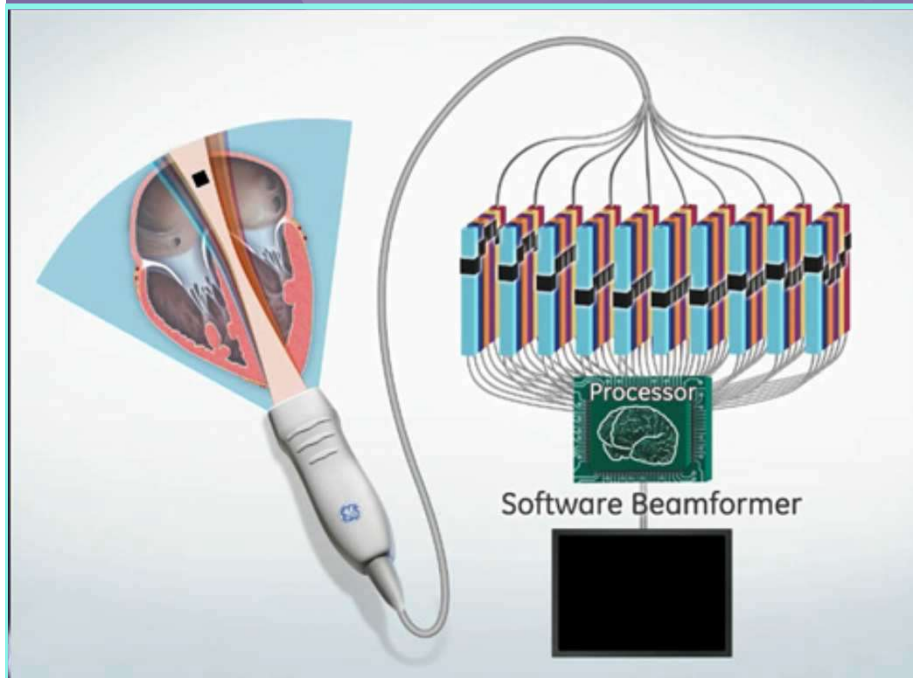


Optimal imaging at only one depth

*Imagine if you could get the whole
picture in focus at once...*

True Confocal Imaging

Equal Focus at All Depths

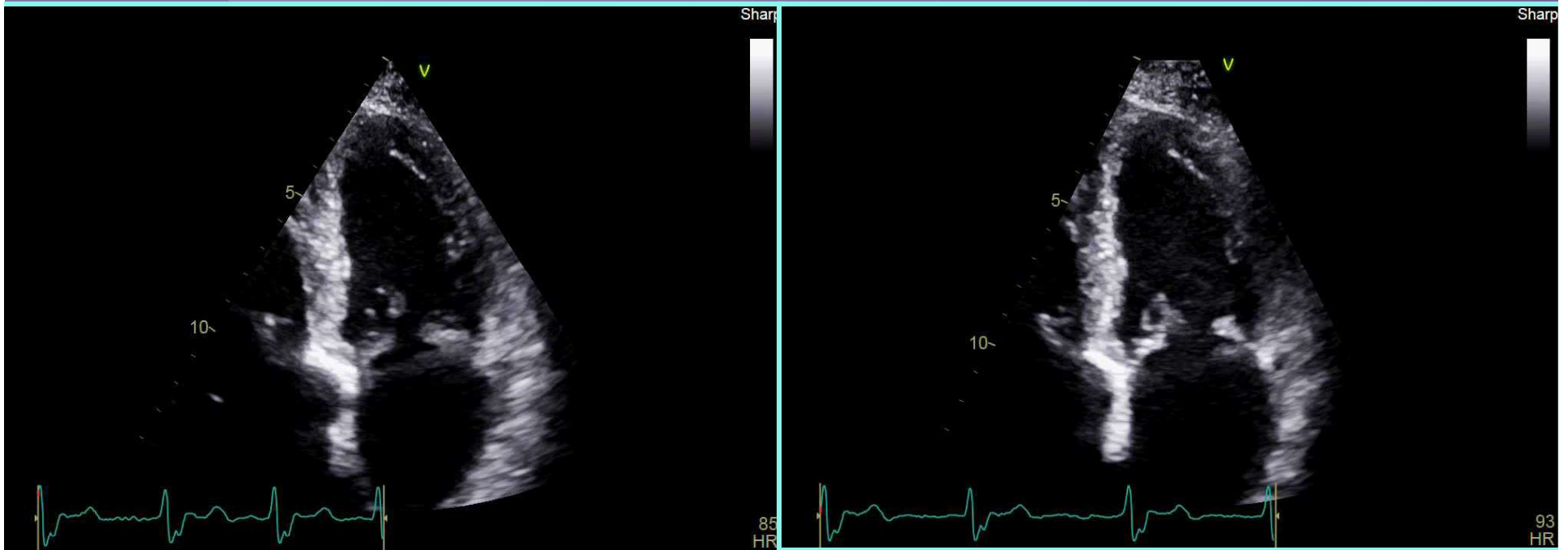


The same RF data is processed repeatedly to optimize all depths

Look, Ma, no focus!

True Confocal Imaging

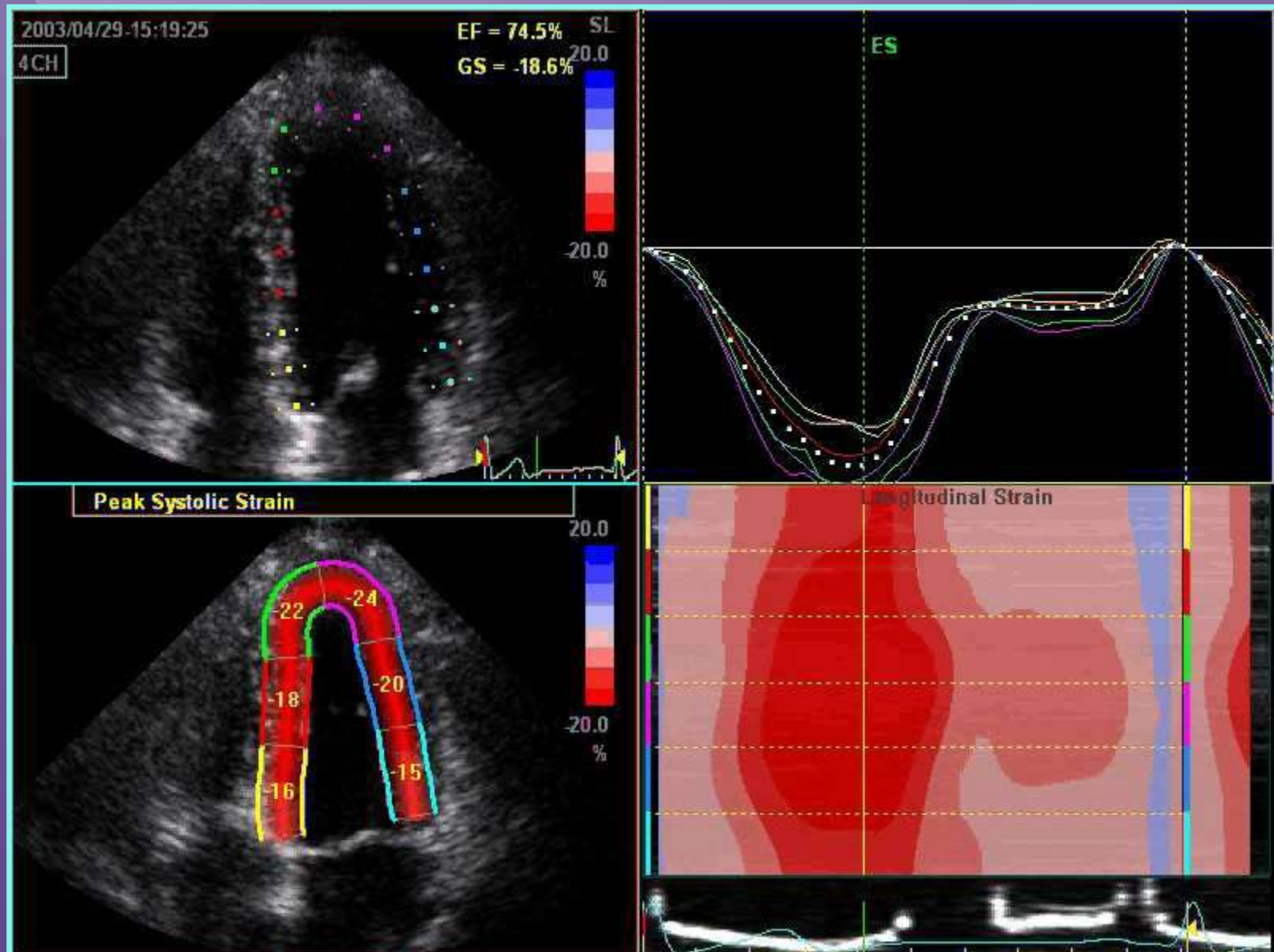
Bonus Feature



Fatten out the apex at the push of a button!

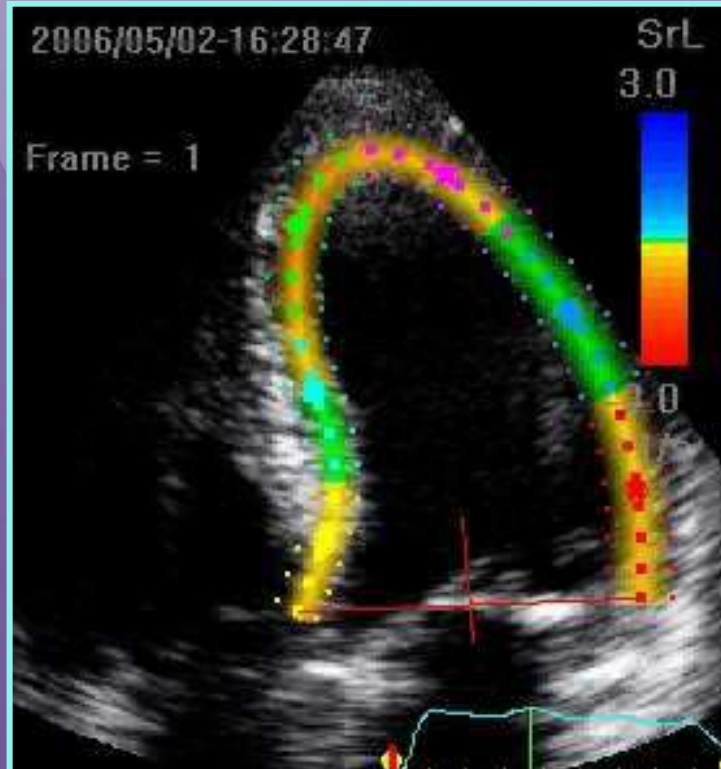
12 Years of Speckle Tracking!

What Can We Do with cSound?

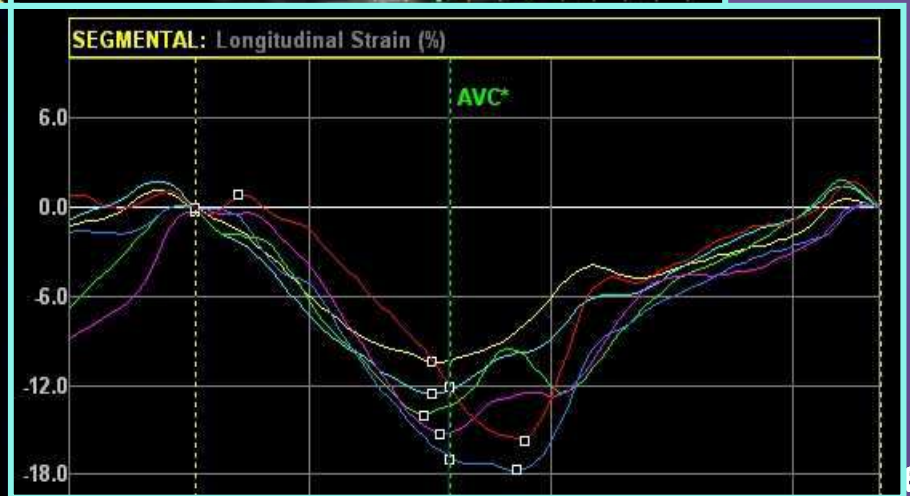
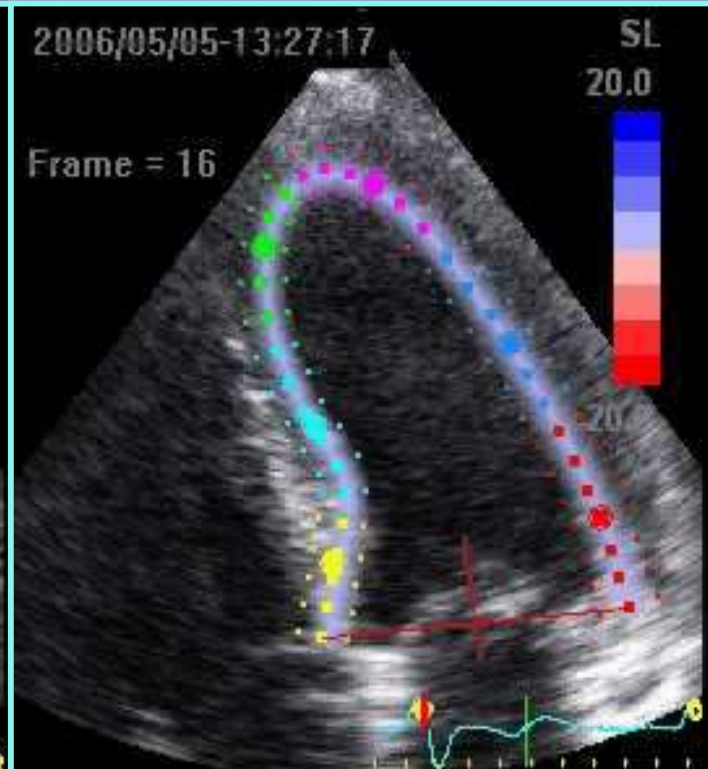


Increased Strain After Percutaneous AVR

Pre



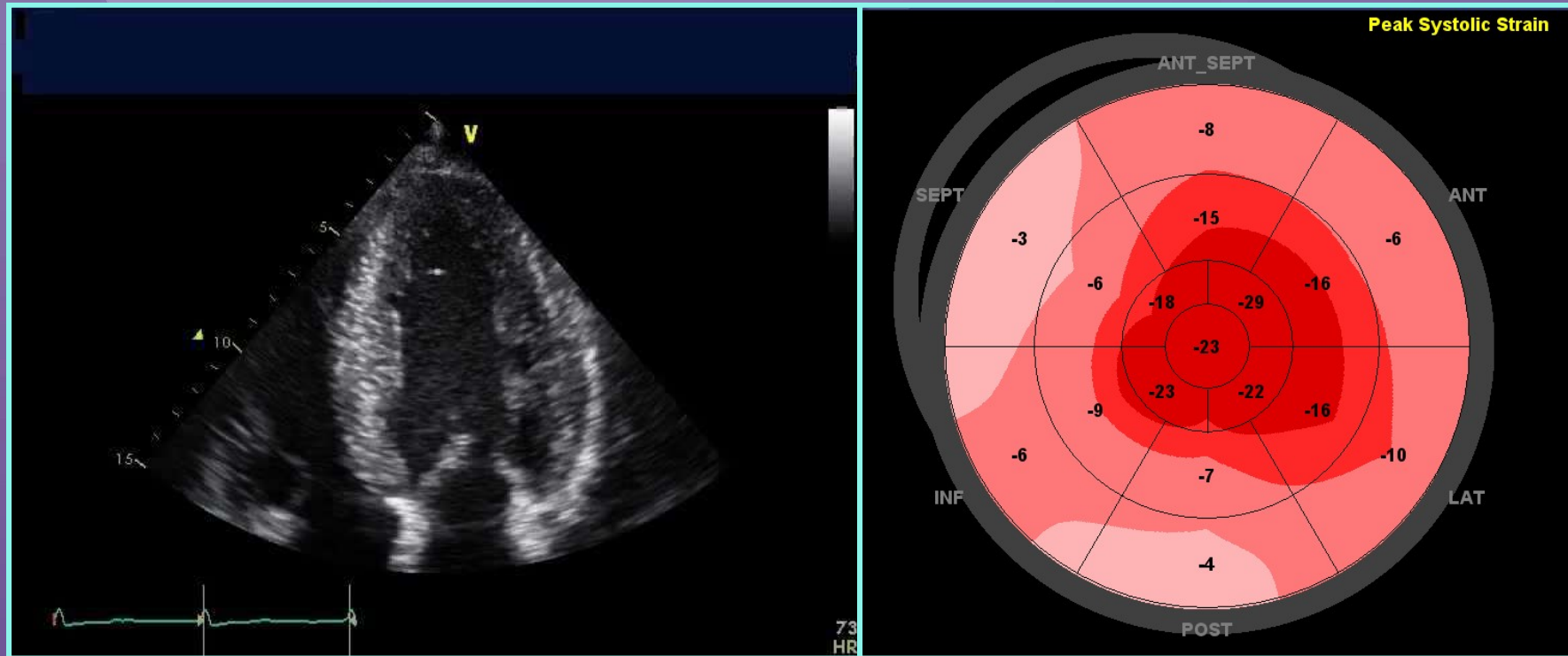
Post



Expert Consensus for Multimodality Imaging Evaluation of Adult Patients During and After Cancer Therapy

- Strain can be measured with DTI or (preferred) STE
- GLS is optimal parameter for early detection of LV dysfunction
- Compare patient to his/her baseline with change of 15% likely significant

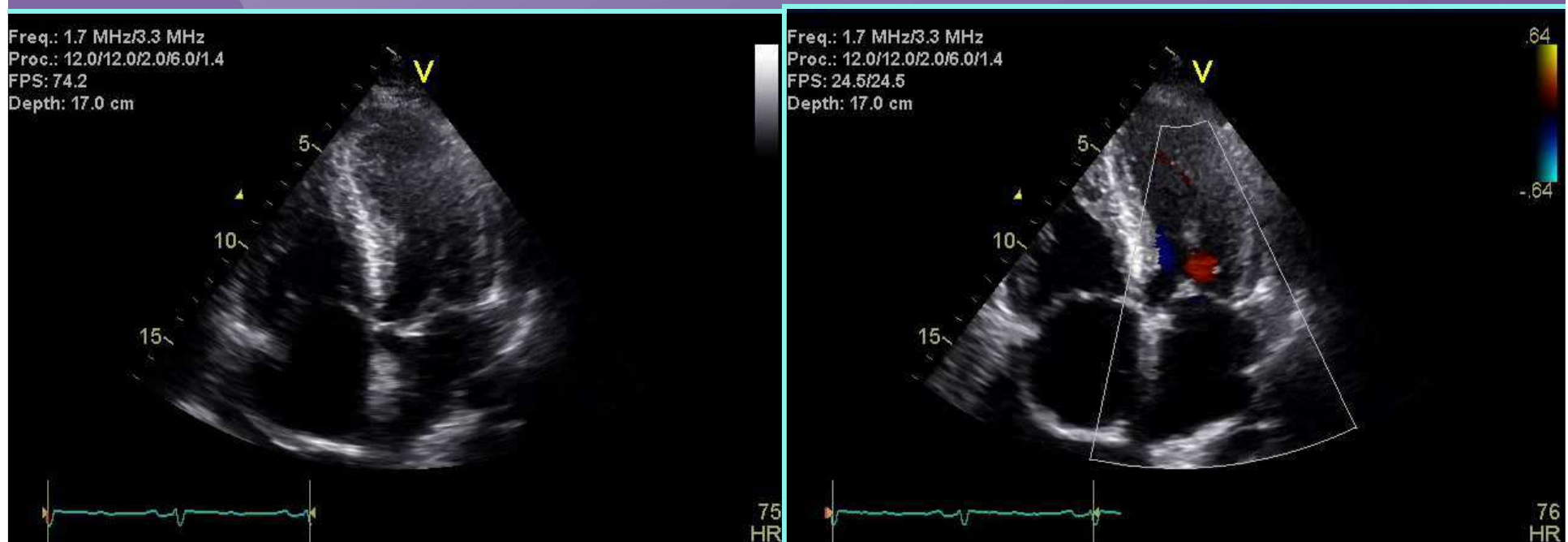
Cardiac Amyloidosis



Amyloidosis patients often show apical sparing

50ish yo Woman with Bx Proven Lung Sarcoidosis

Is There Cardiac Involvement?

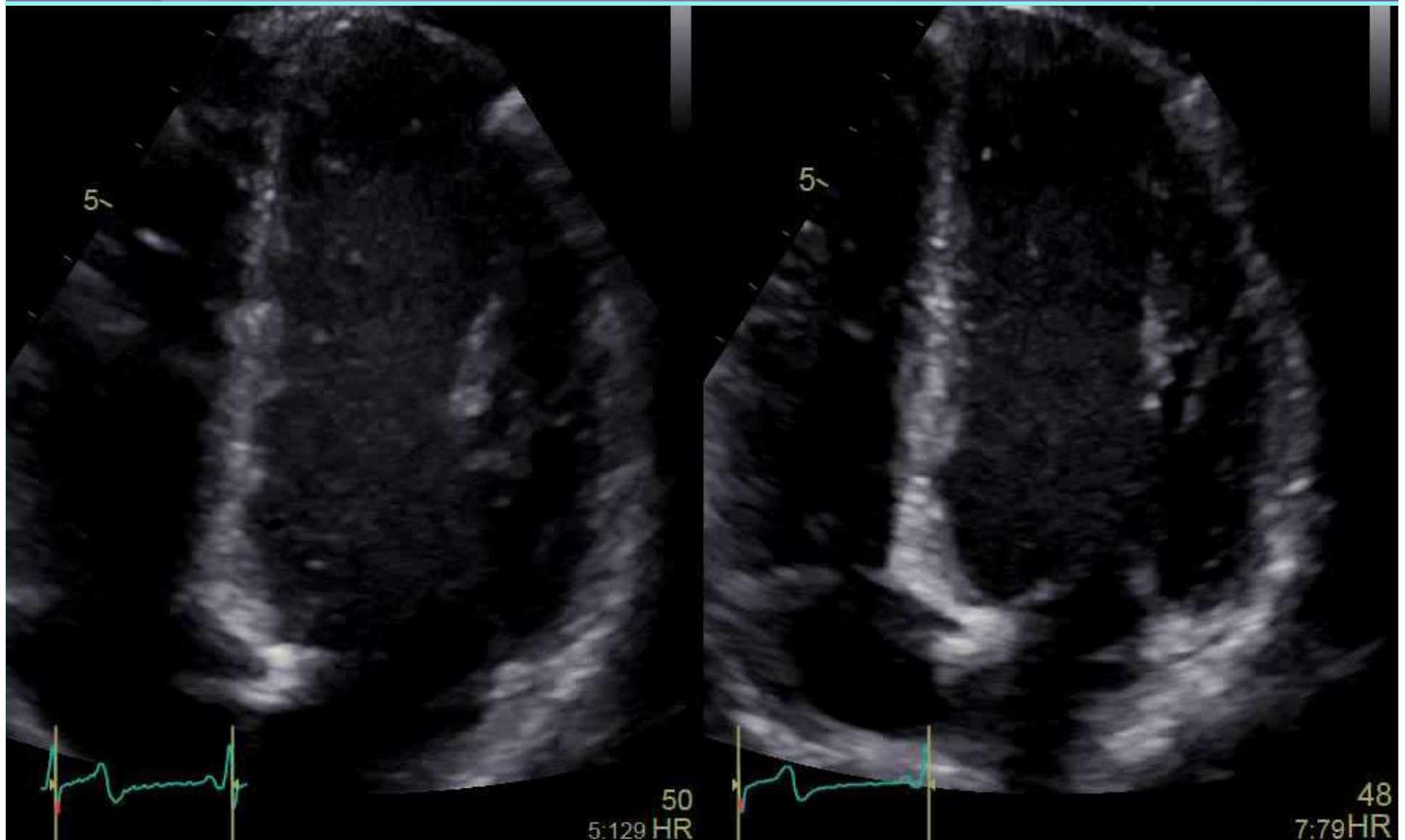


Thick walls, mild MR, preserved EF

Frame Rate Limits Use of Strain Imaging in Stress and Dobutamine

- For excellent tracking, we'd like ~60 frames/beat
- So FR in Hz should roughly equal HR in BPM
- Till now, there has been too much degradation in image quality to use above HR of 100.

One of These is at 52 Hz, the Other at 122 Hz
Can You Tell the Difference???



122 Hz

52 Hz

20/08/2014 15:23:35

Baseline : 4-ch

T1: 0:32

FPS: 122

20/08/2014 15:14:09

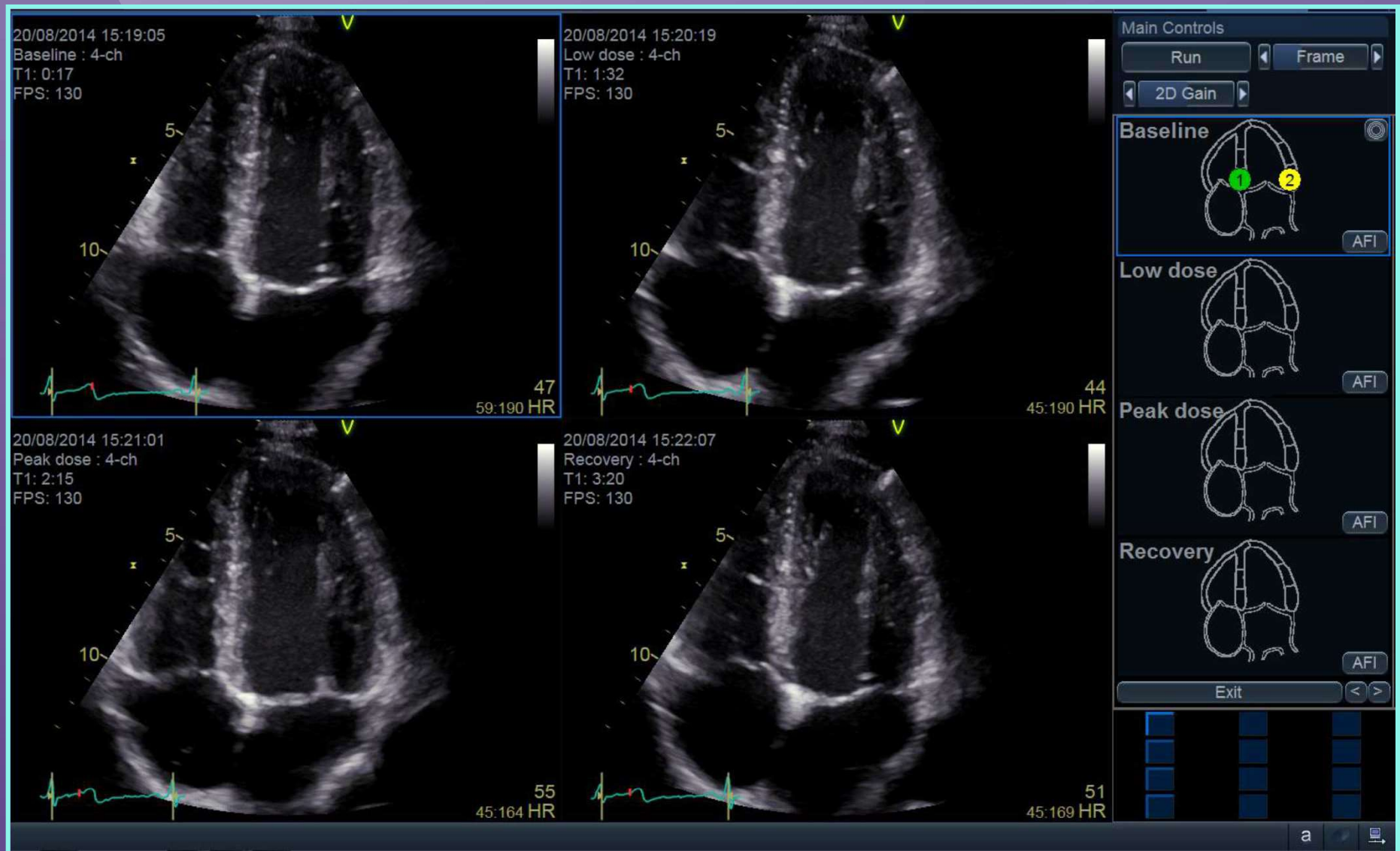
Baseline : 4-ch

T1: 1:17

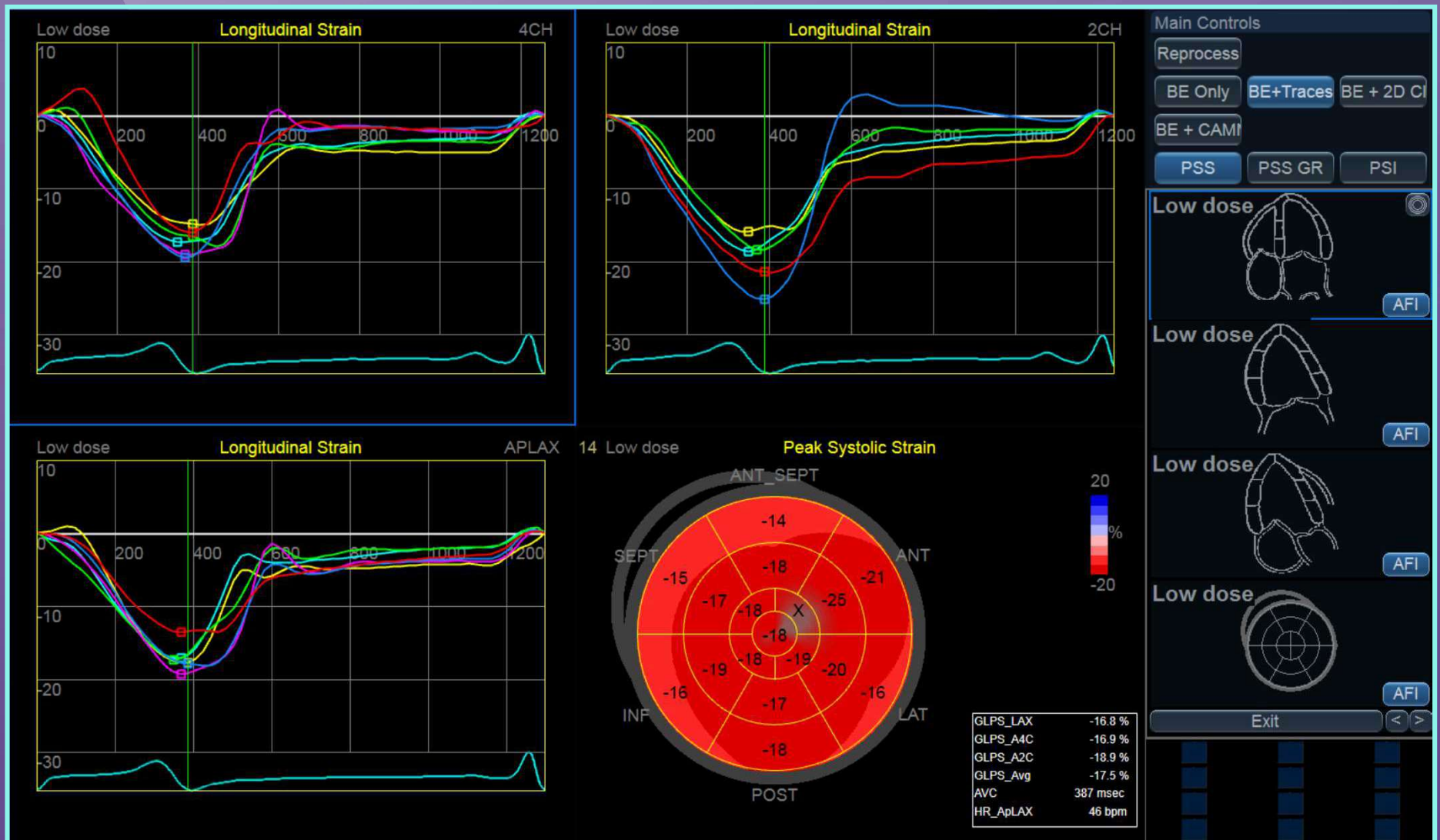
FPS: 52



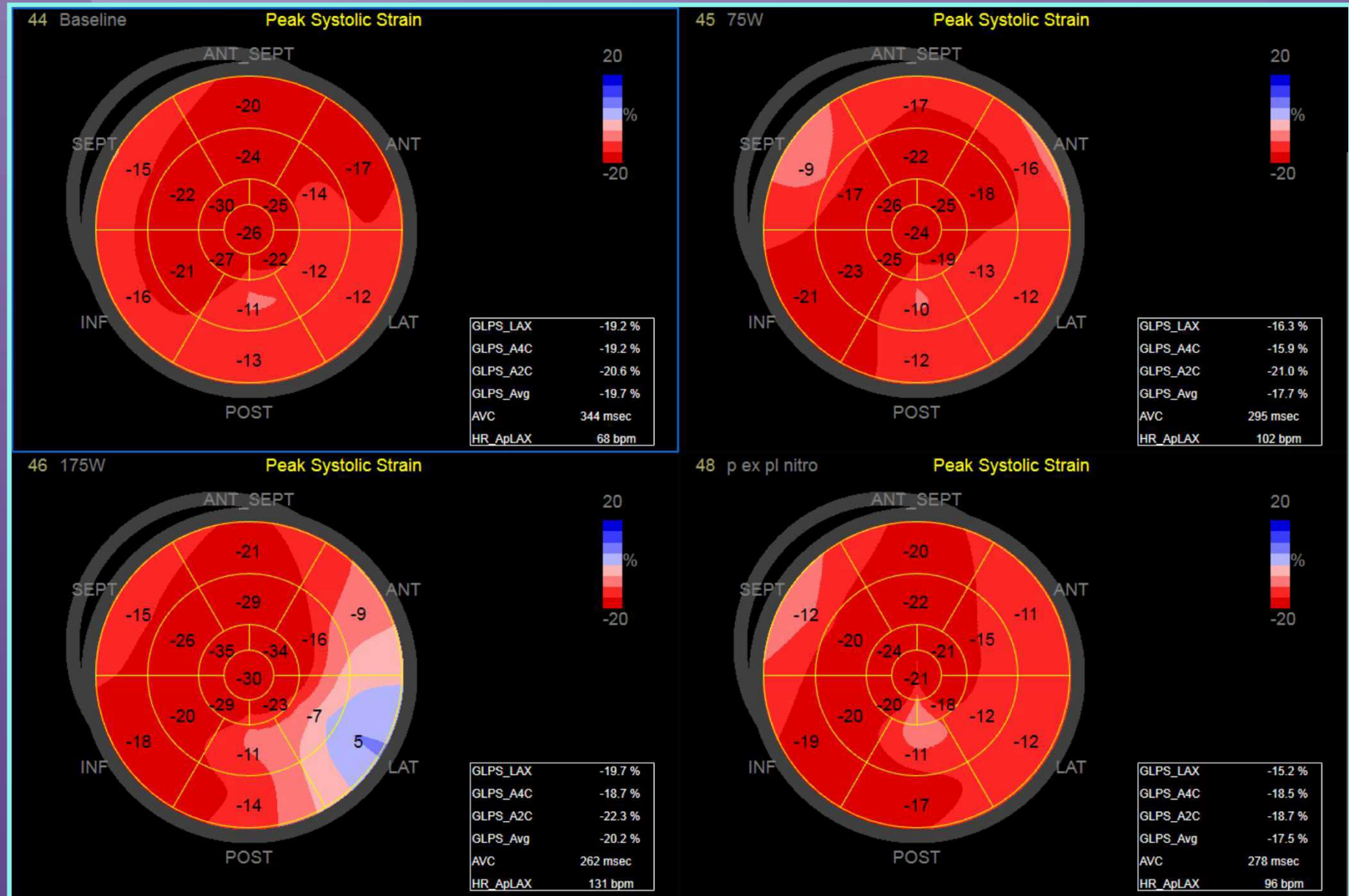
Easy Navigation During the DbE Test



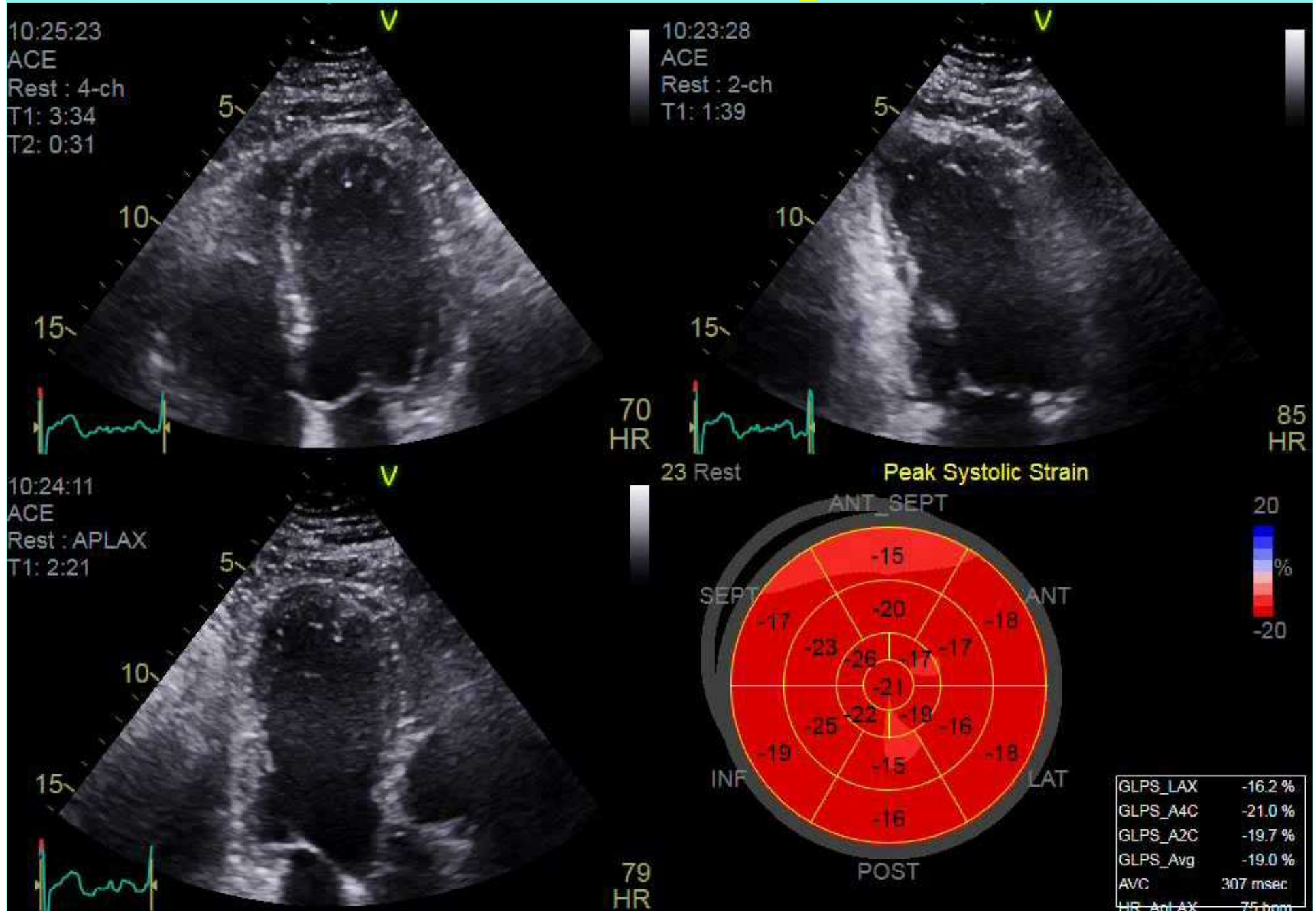
Automated AFI at Each Stage



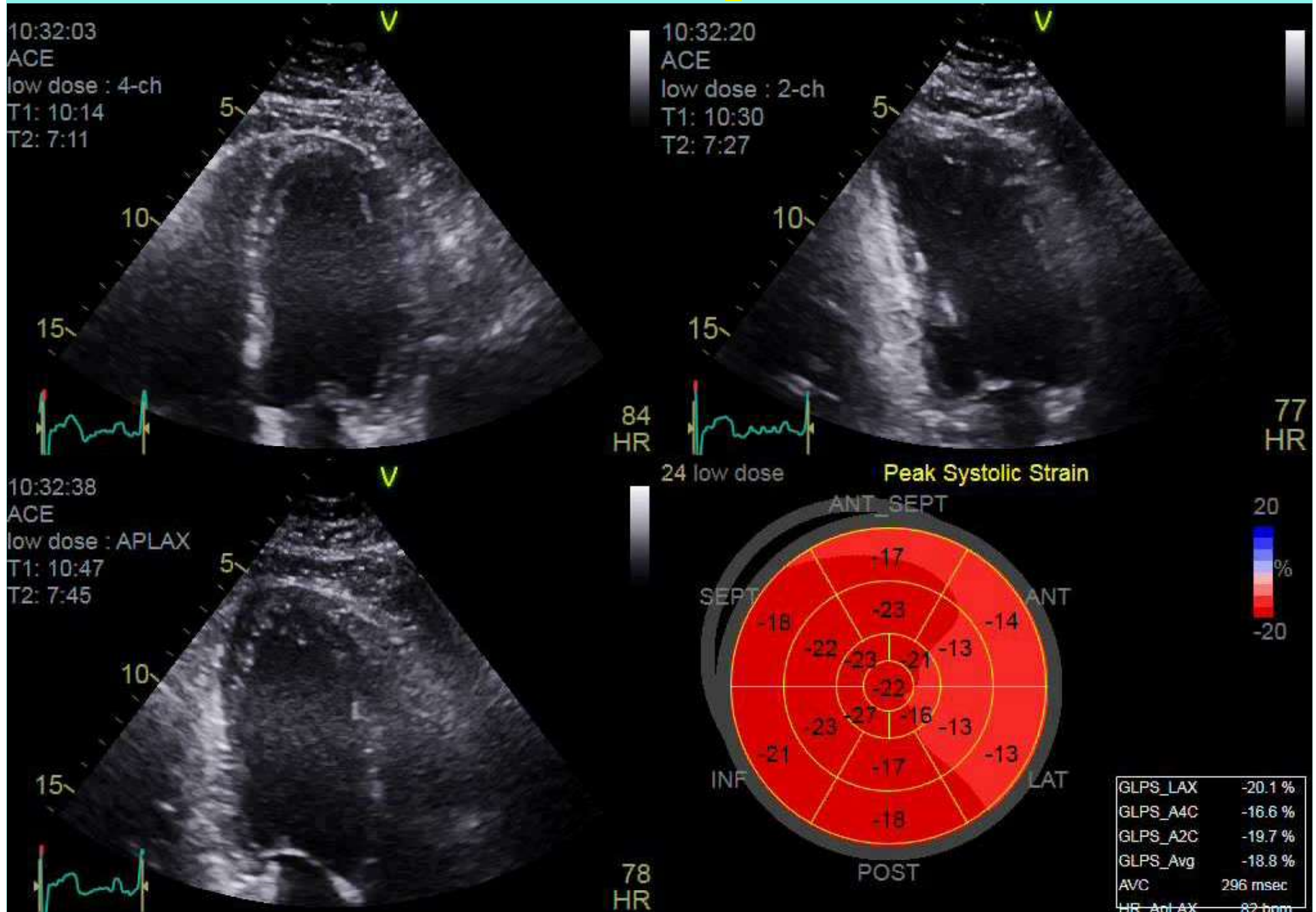
Applicable to Supine Bicycle Stress



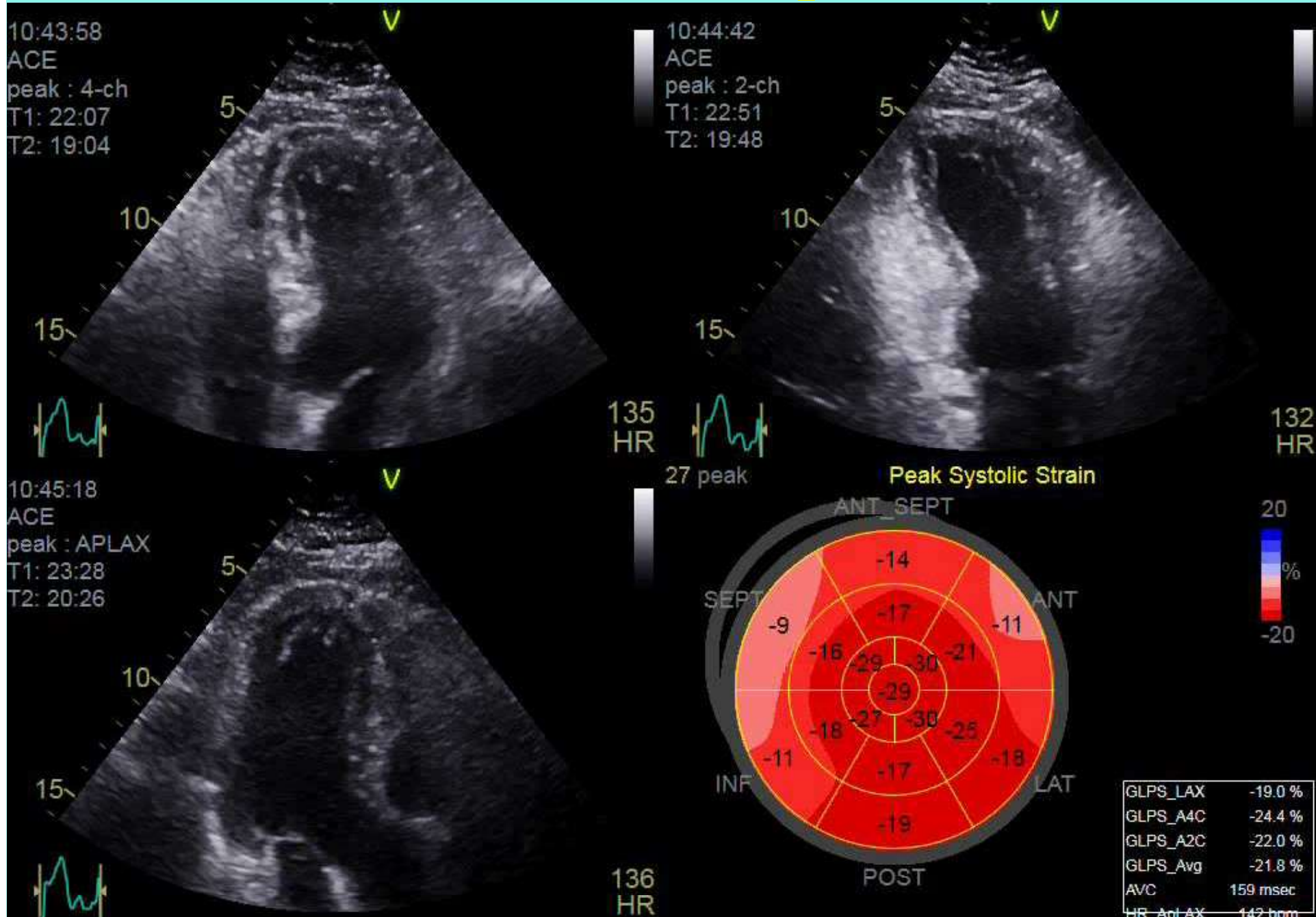
Dobutamine Example: Rest



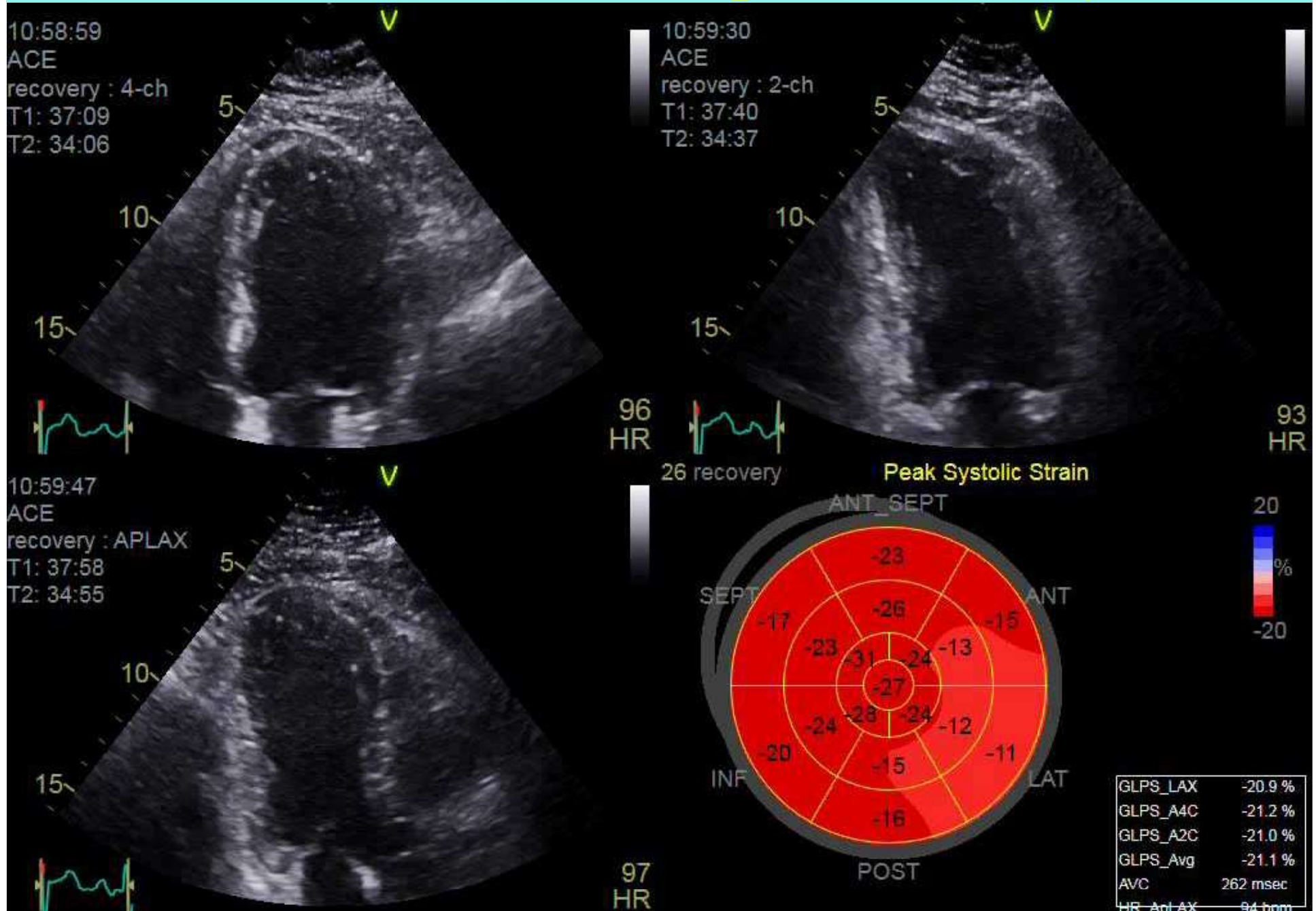
Dobutamine Example: Low Dose



Dobutamine Example: Peak

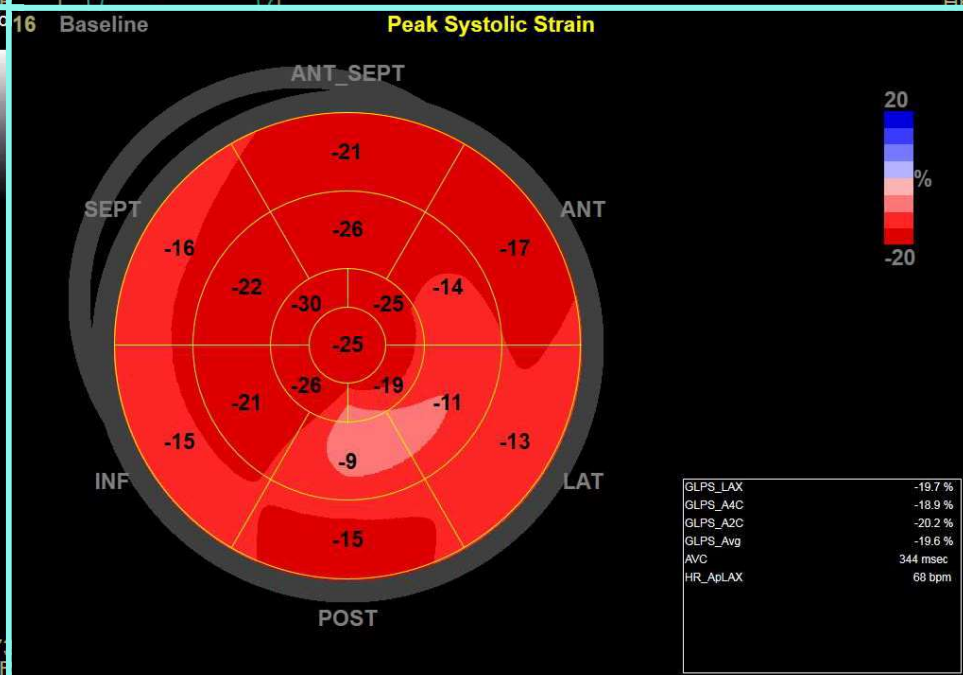
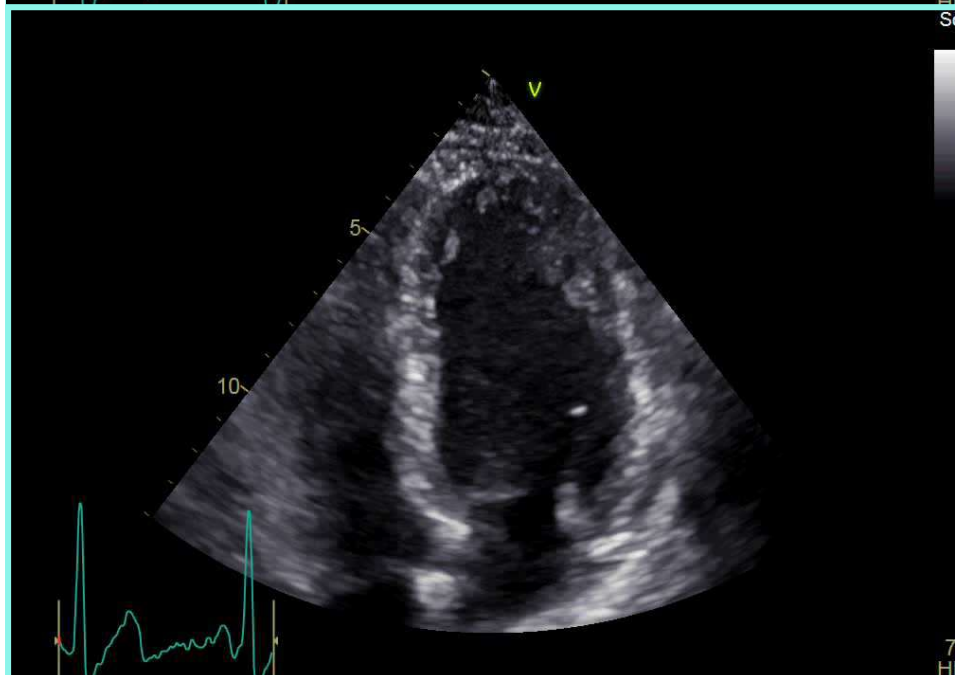
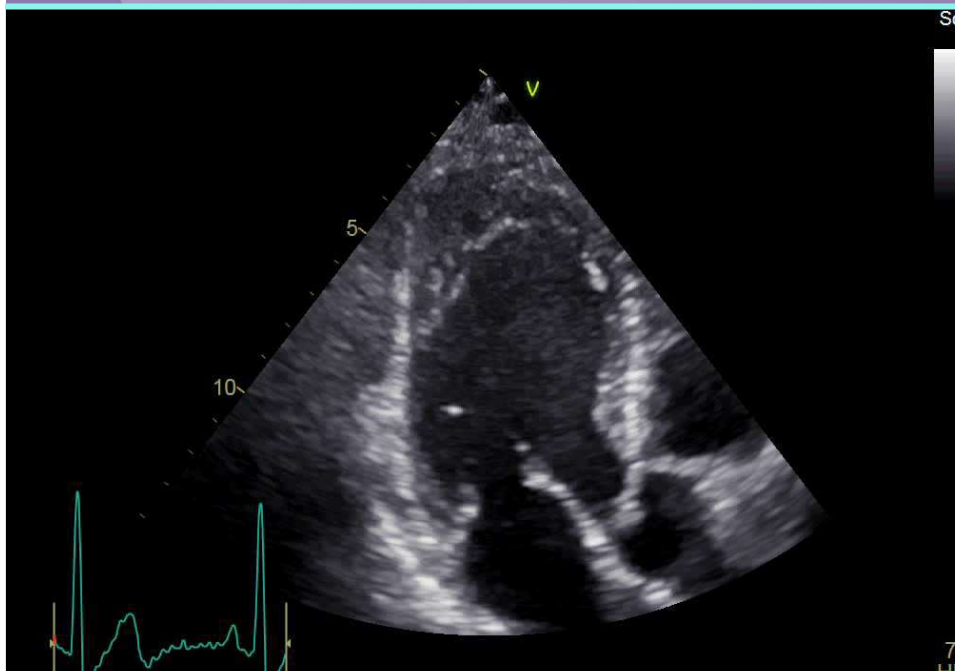


Dobutamine Example: Recovery

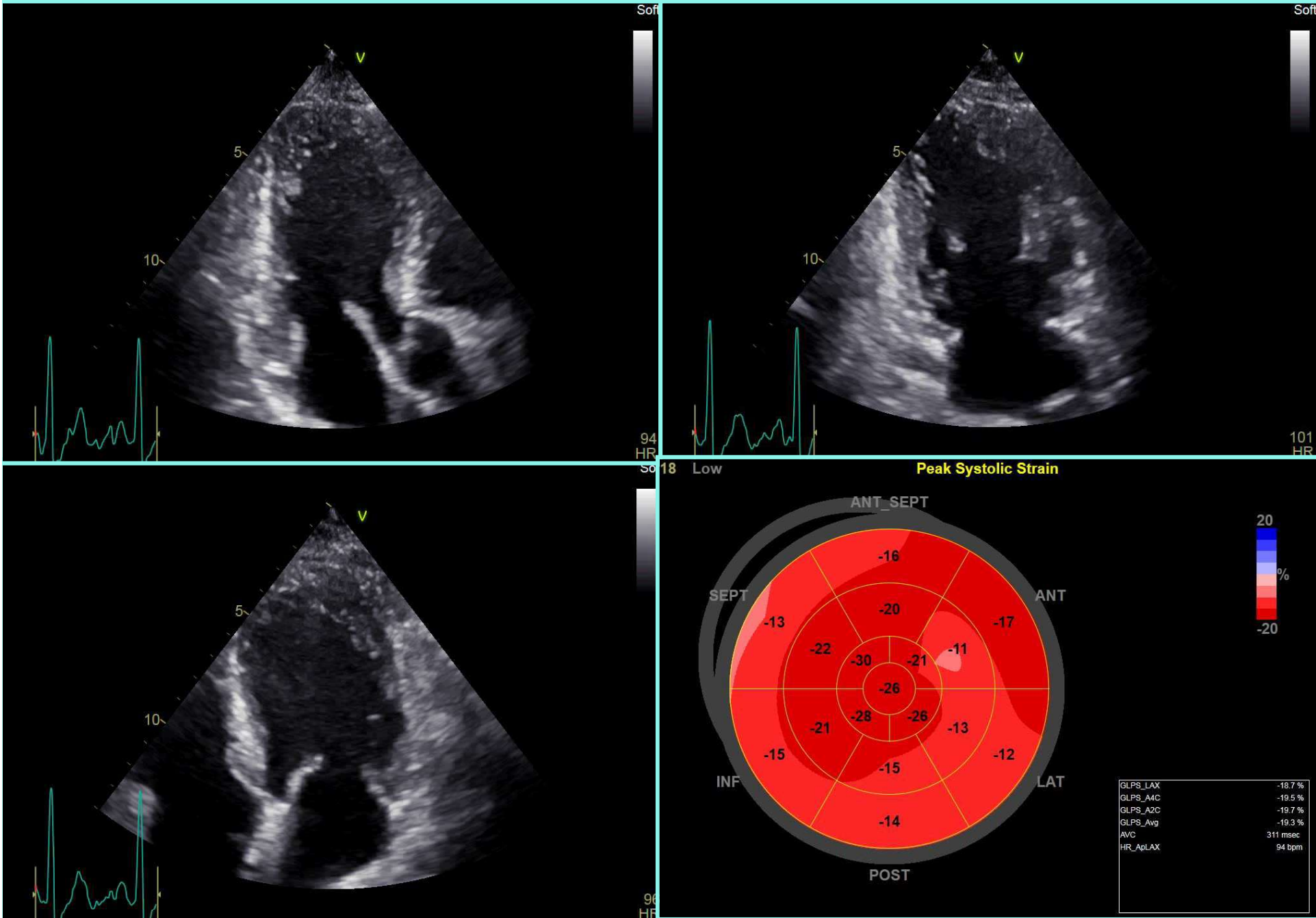


Another case

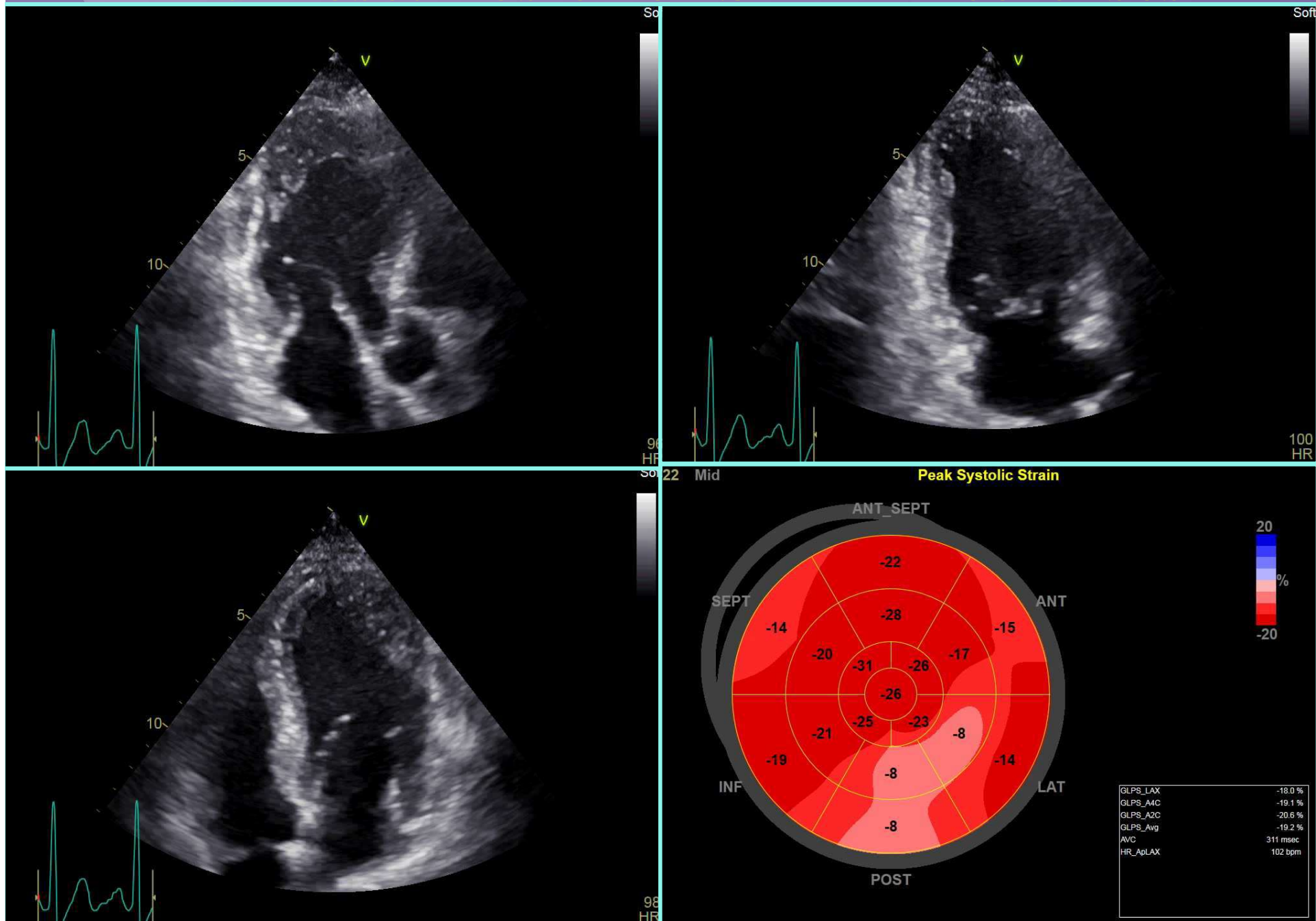
Baseline: Posterior Hypokinesia



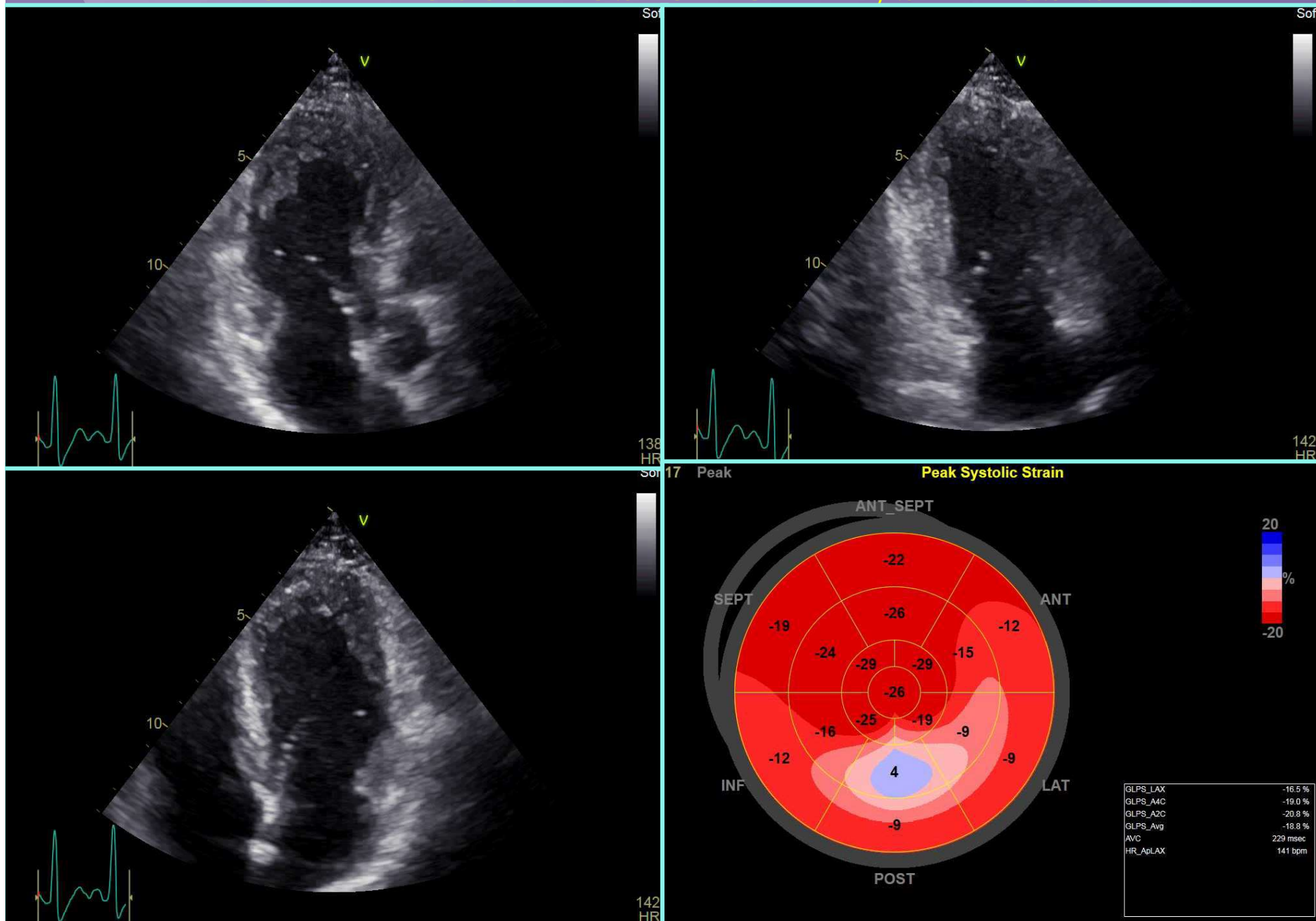
Low Dose: Posterior Strain Increases



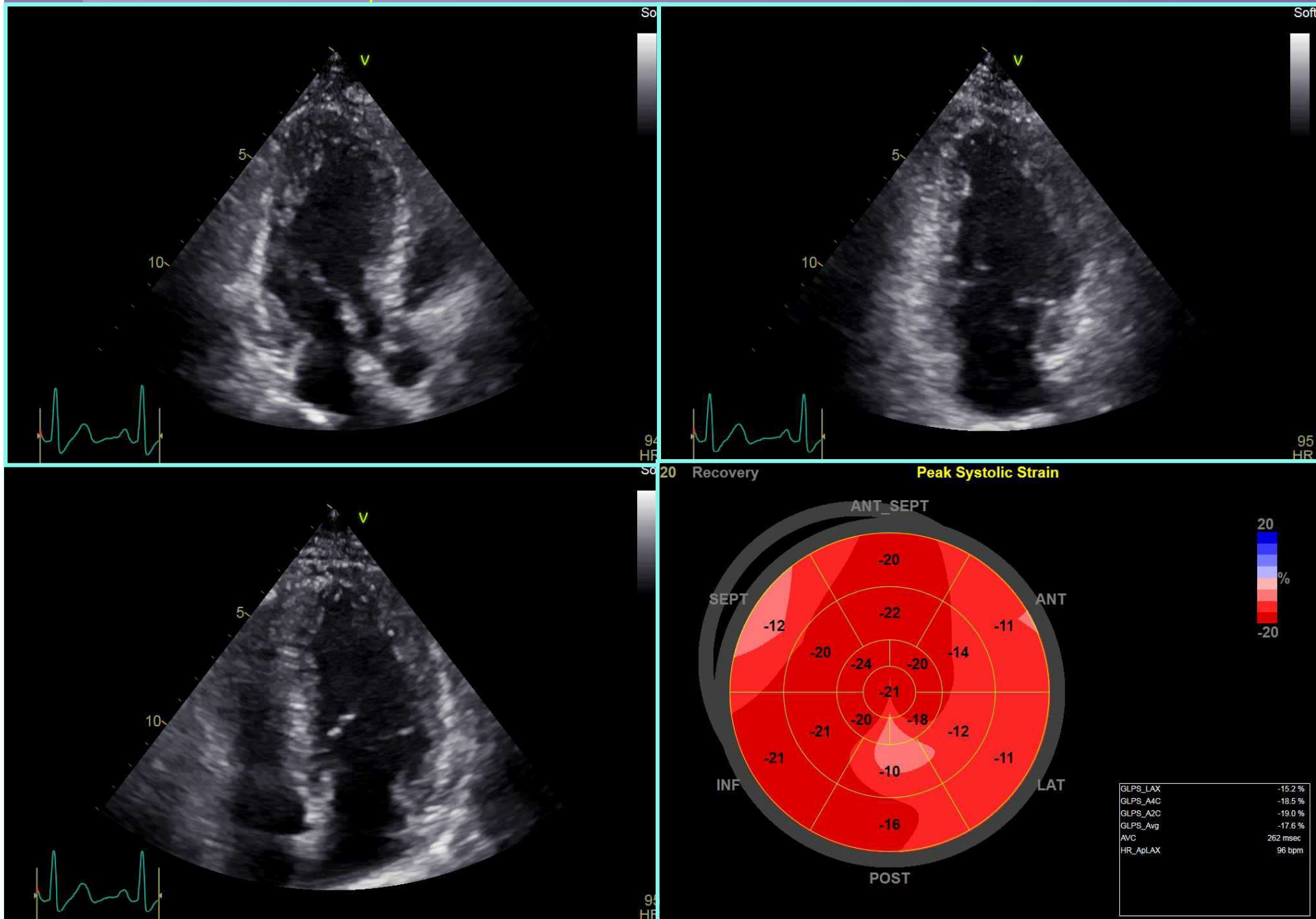
Mid Dose: Posterior Strain Decreases



Peak Dose: Posterior Dyskinesia

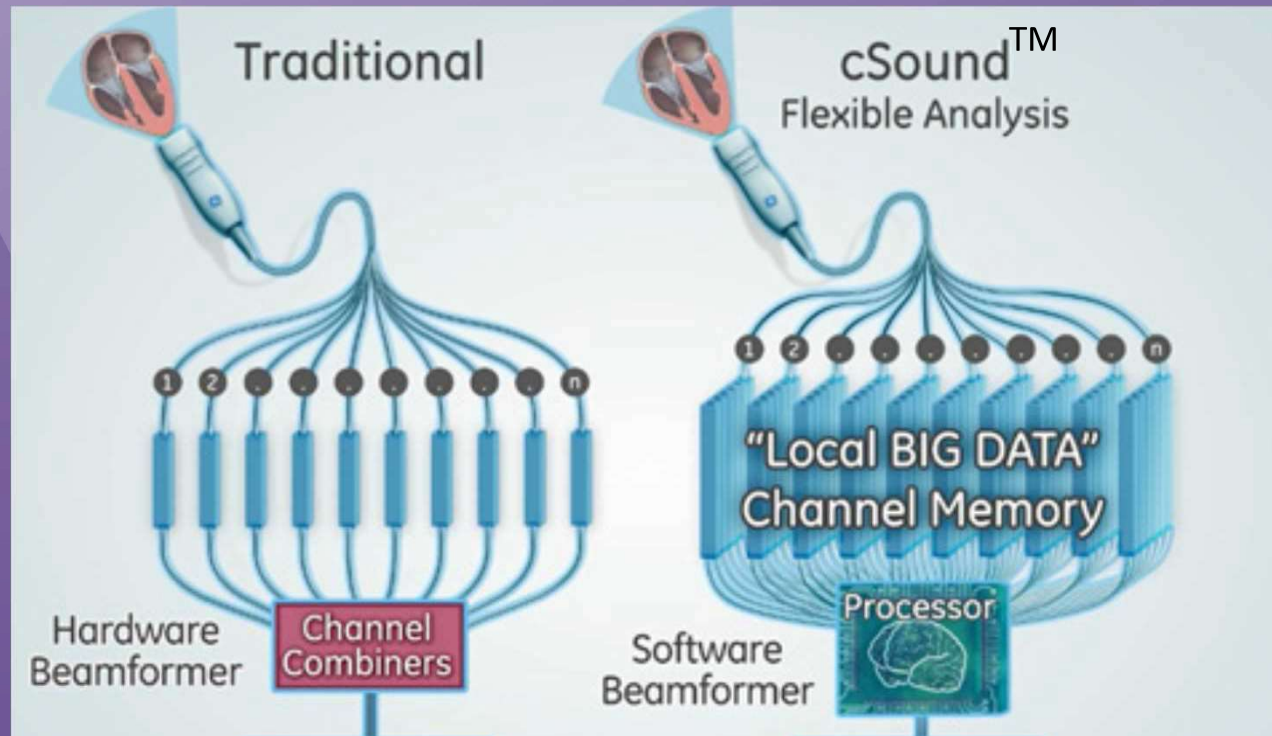


Recovery: Posterior Strain at Baseline



Software Beam Formation

A BIG Breakthrough in Echocardiography



- *Highly flexible processing of RF US data*
- *Opens possibility of new applications*
- *As computers become more powerful, echocardiography should further improve*