



SNS COLLEGE OF ALLIED HEALTH SCIENCES
SNS Kalvi Nagar, Coimbatore - 35
Affiliated to Dr MGR Medical University, Chennai



DEPARTMENT OF CARDIAC TECHNOLOGY

COURSE NAME:

I YEAR

UNIT II:

TOPIC 1 : ECHO IN DYSSYNCHRONY



ECHO In dyssynchrony



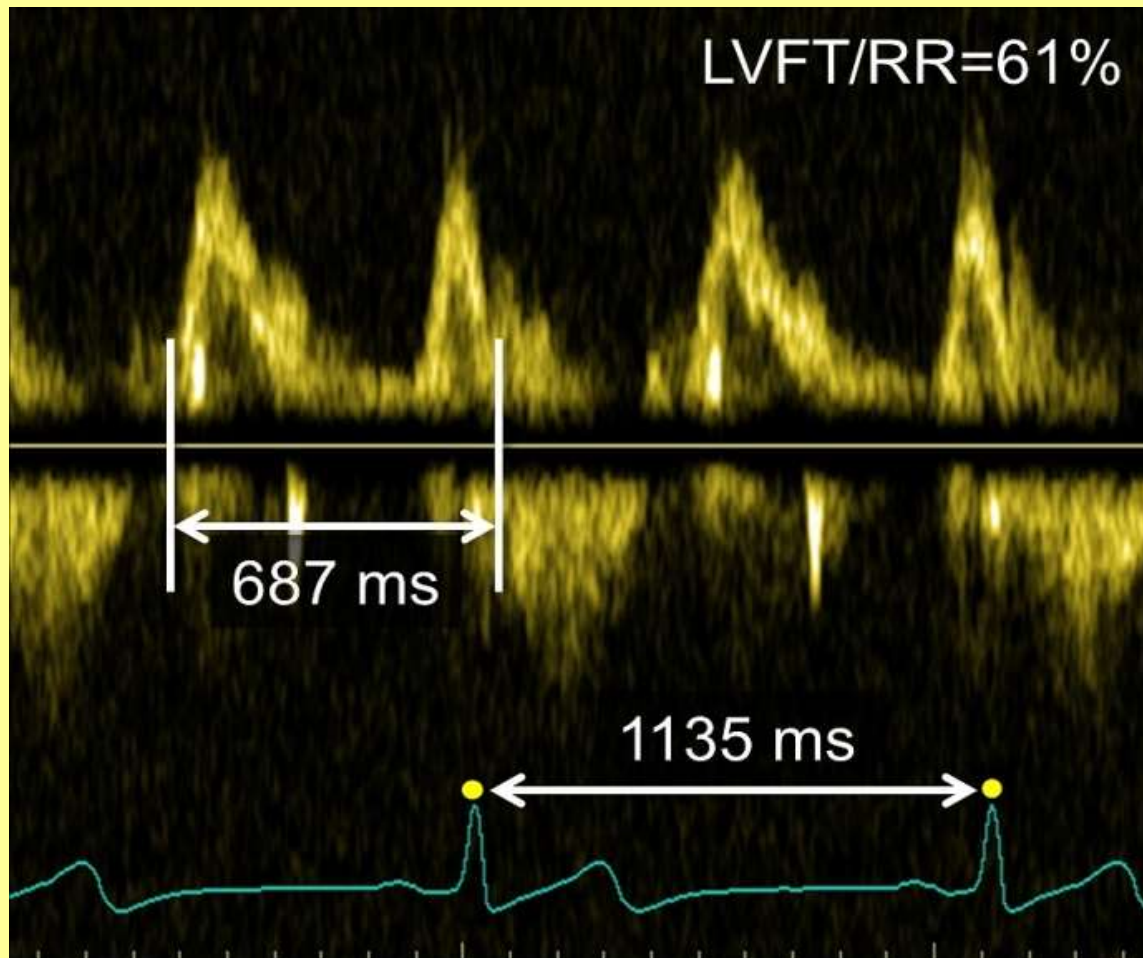
- Patients with chronic heart failure who remain symptomatic (NYHA class II-IV) despite optimal medical treatment
- Severe systolic dysfunction (left ventricular ejection fraction (LVEF) $\leq 35\%$)
- Widened LBBB QRS complex.



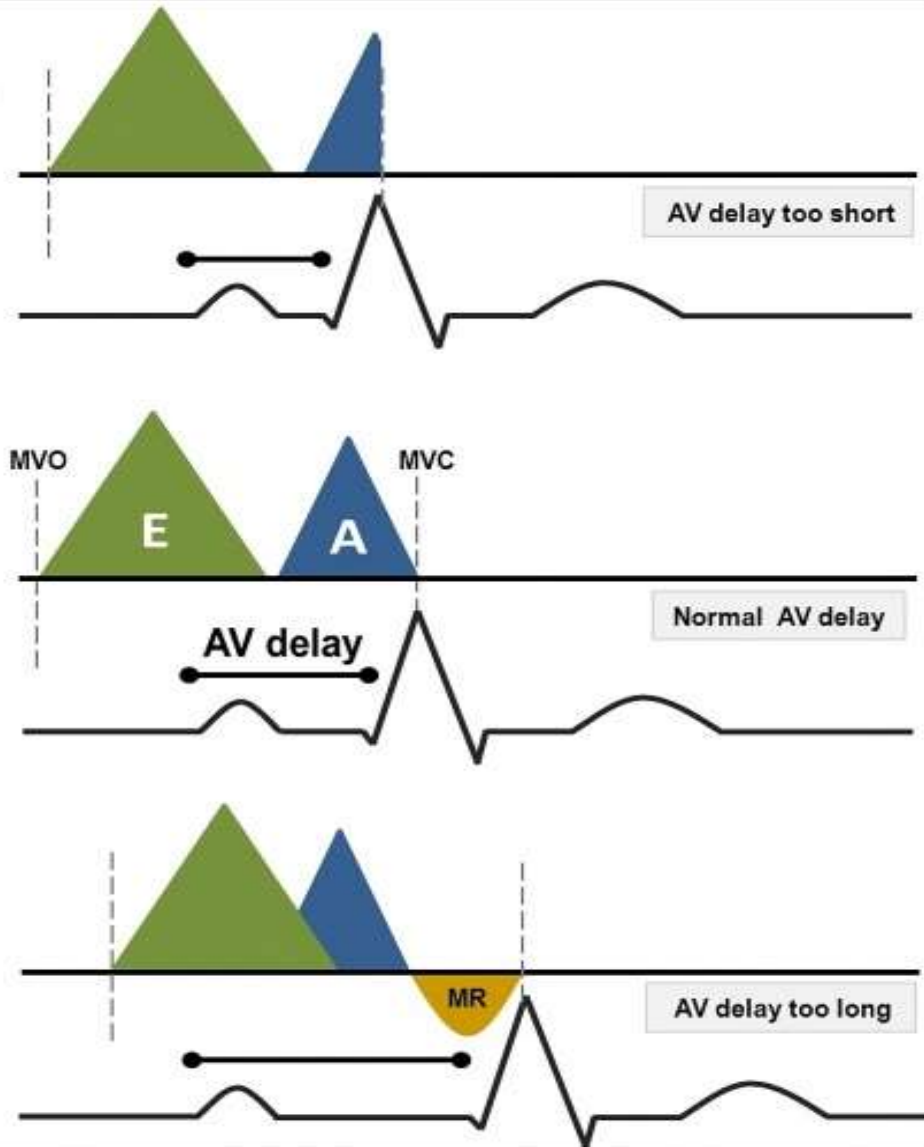
ECHO to improve CRT success rate

- A plethora of echocardiographic parameters to identify true mechanical dyssynchrony, i.e. uncoordinated contraction in different myocardial regions, has been proposed, with no consensus on the incremental value of any of these parameters

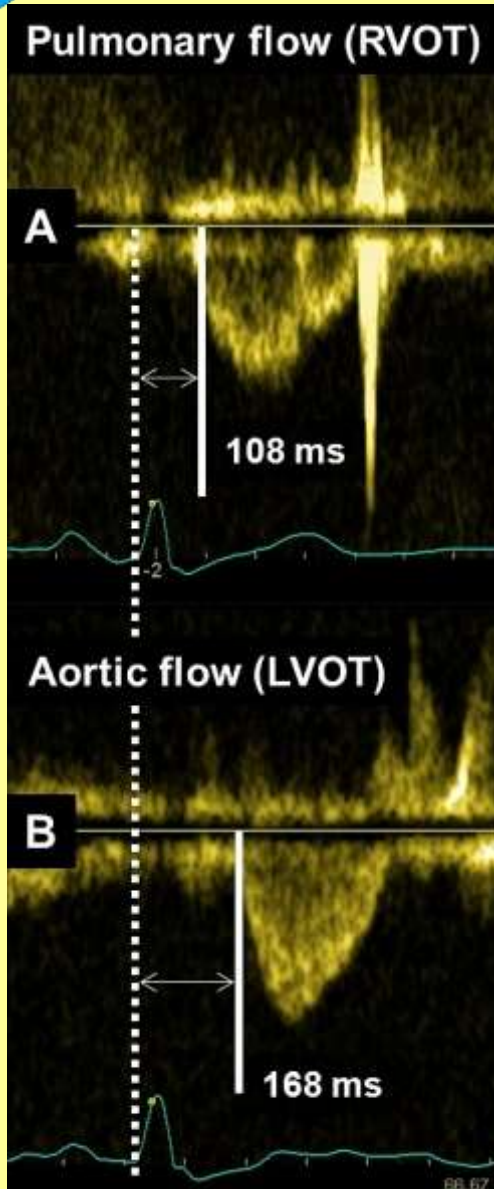
Atrioventricular dyssynchrony



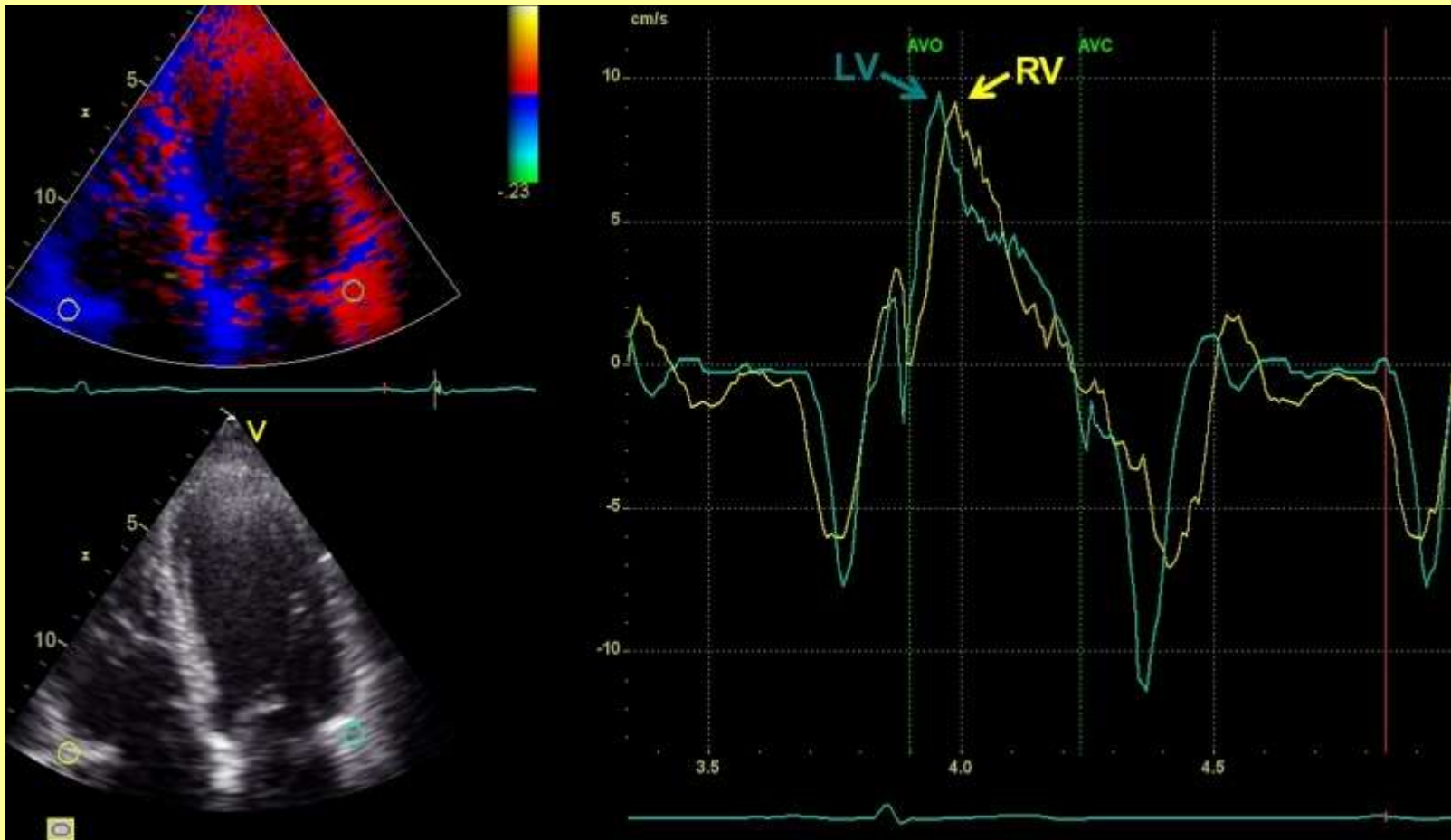
Significant atrioventricular dyssynchrony is assumed if LVFT/RR is <40%.



Interventricular dyssynchrony

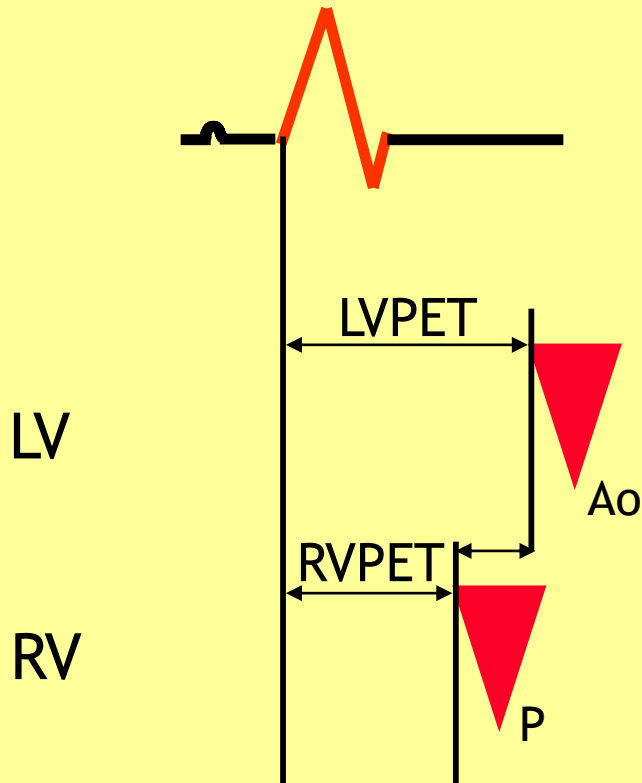


- Inter-ventricular dyssynchrony is indicated by the difference of >40 ms between left ventricular and right ventricular pre-ejection time



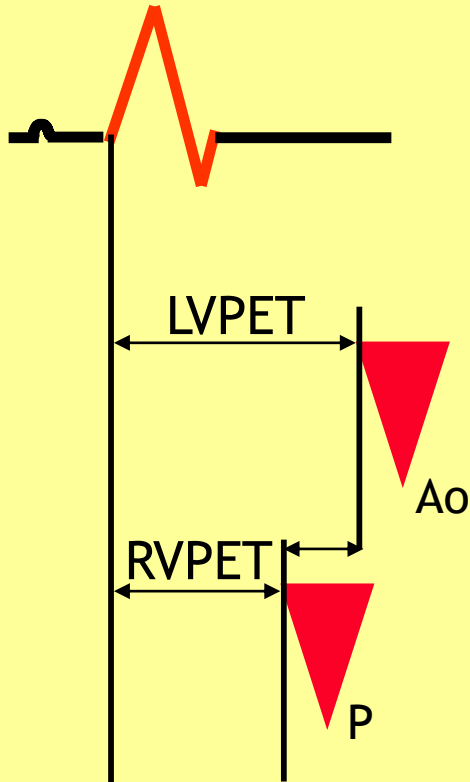
- Delay of >56 ms between the onset of systolic motion in the basal right ventricular free wall versus the most delayed basal LV segment measured by tissue Doppler

Inter-ventricular Dyssynchrony



- LVPET : Left Ventricular Pre-Ejection time
- RVPET : Right Ventricular Pre-Ejection time
- $IVD = LVPET - RVPET$

Inter-ventricular Dyssynchrony



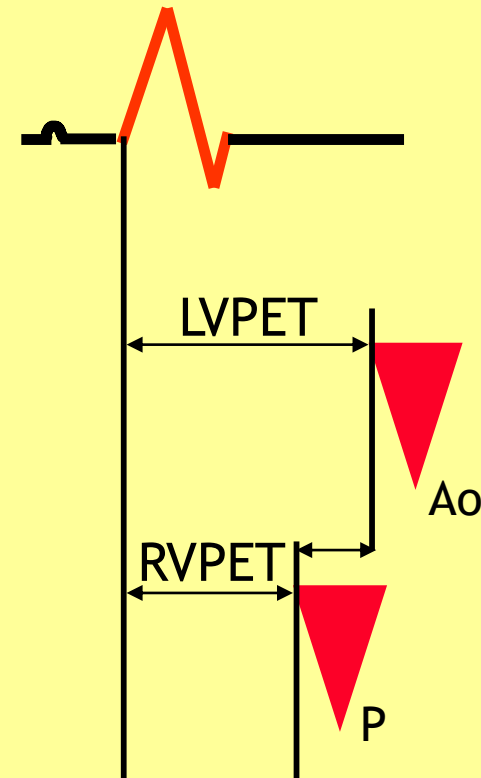
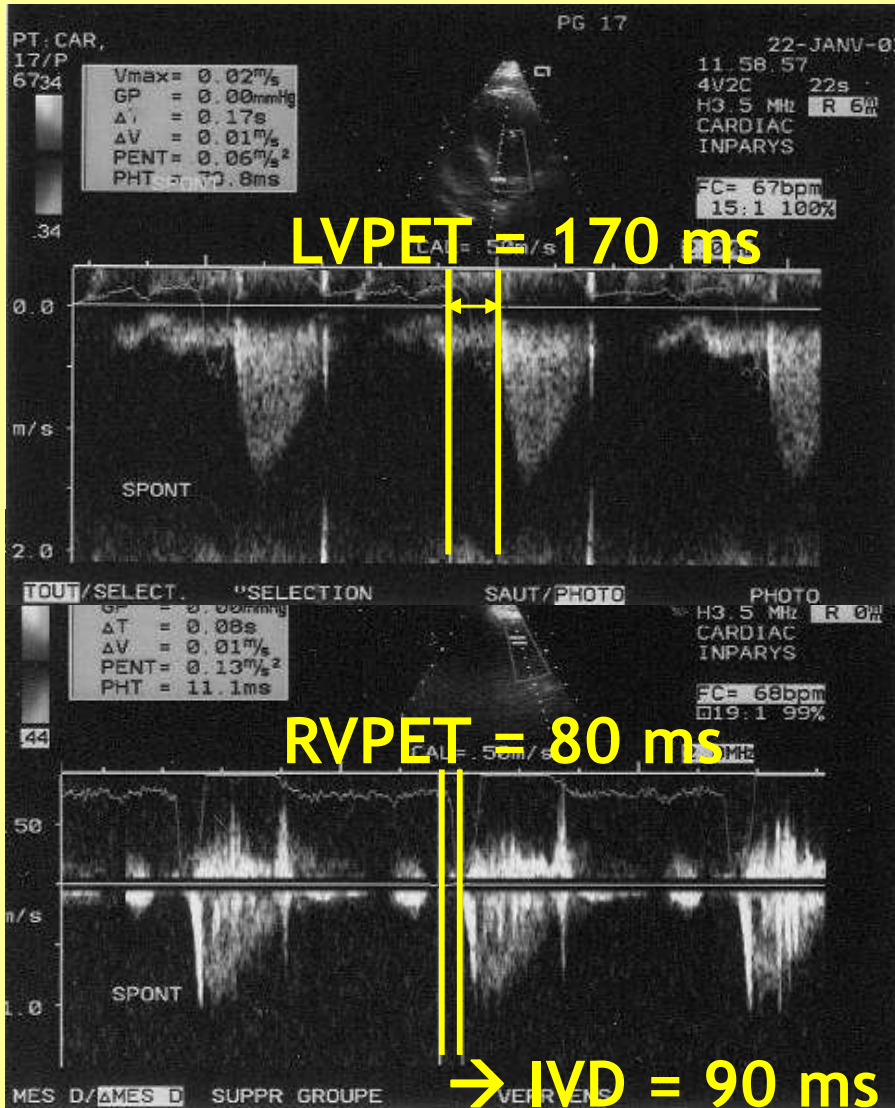
Inter-ventricular delay if :

$$IVD > 40 \text{ ms}$$

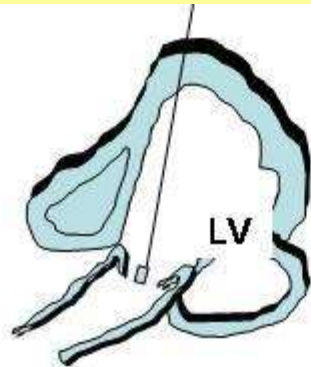
One can also say that there is
Ventricular asynchronism if

$$LVPET > 140 \text{ ms}$$

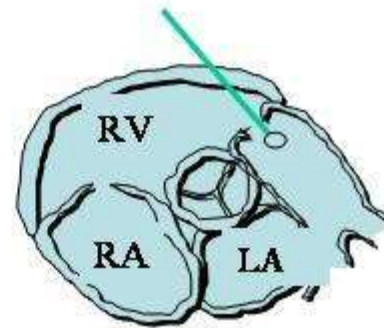
Inter-ventricular Dyssynchrony



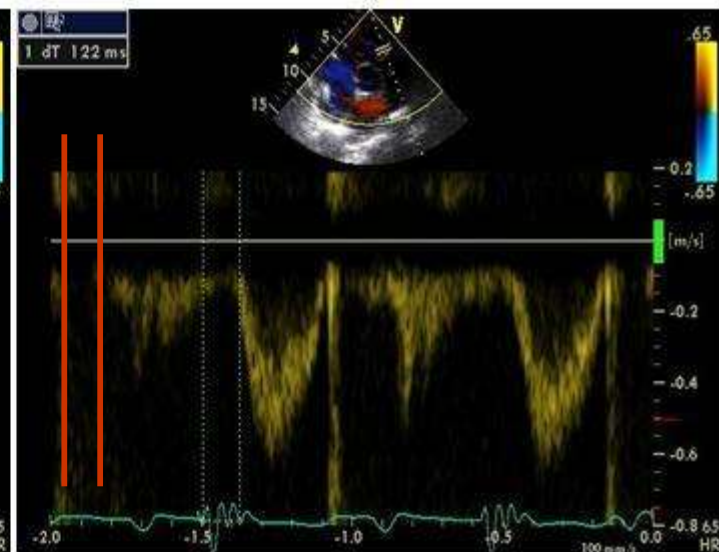
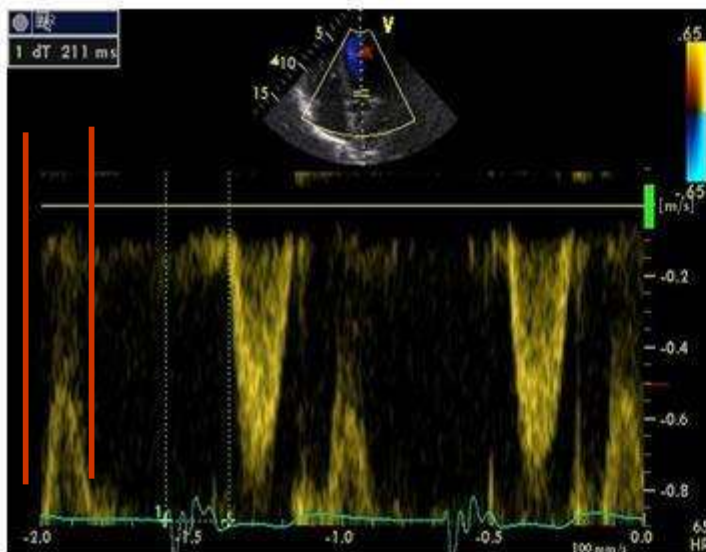
From Cazeau, Lazarus, Ritter et al; Heart Dec 2000



Aortic time to onset



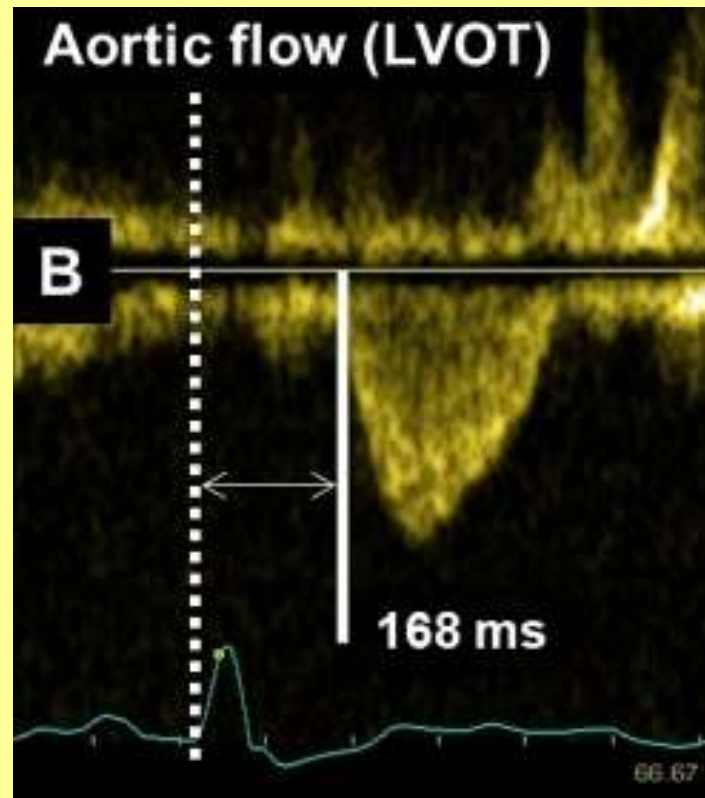
Pulmonary time to onset



$$\text{IVMD} = 211 \text{ ms} - 122 = 89 \text{ ms}$$



Left ventricular electromechanical delay >140 ms



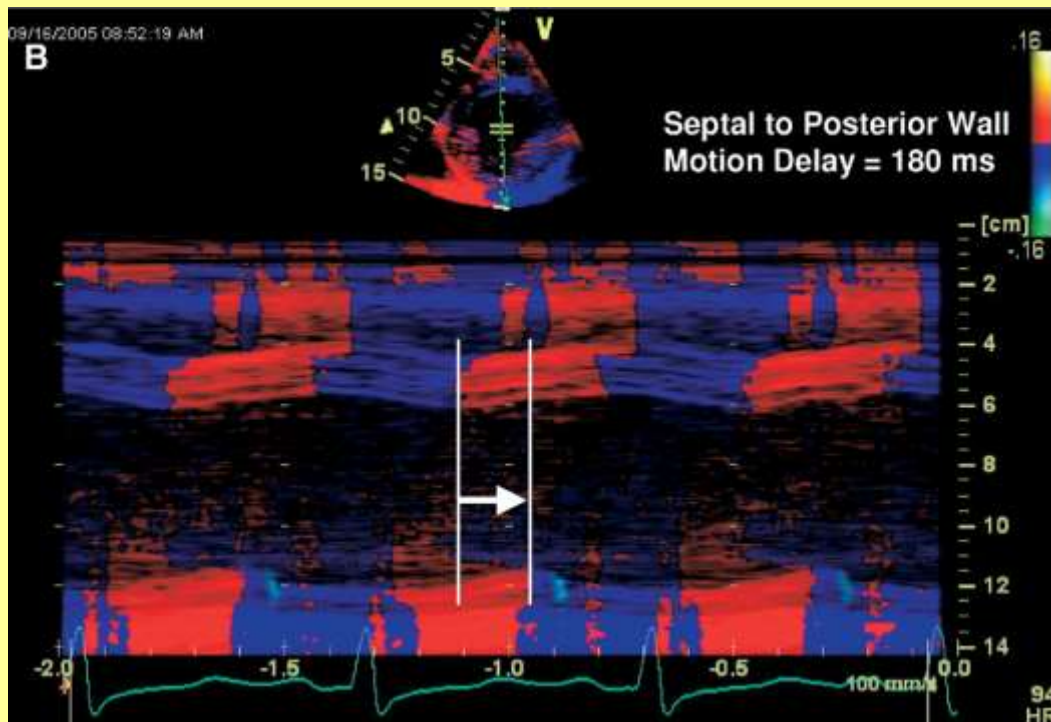
Conventional echocardiography

- Septal to posterior wall motion delay (cut-off >130 ms)



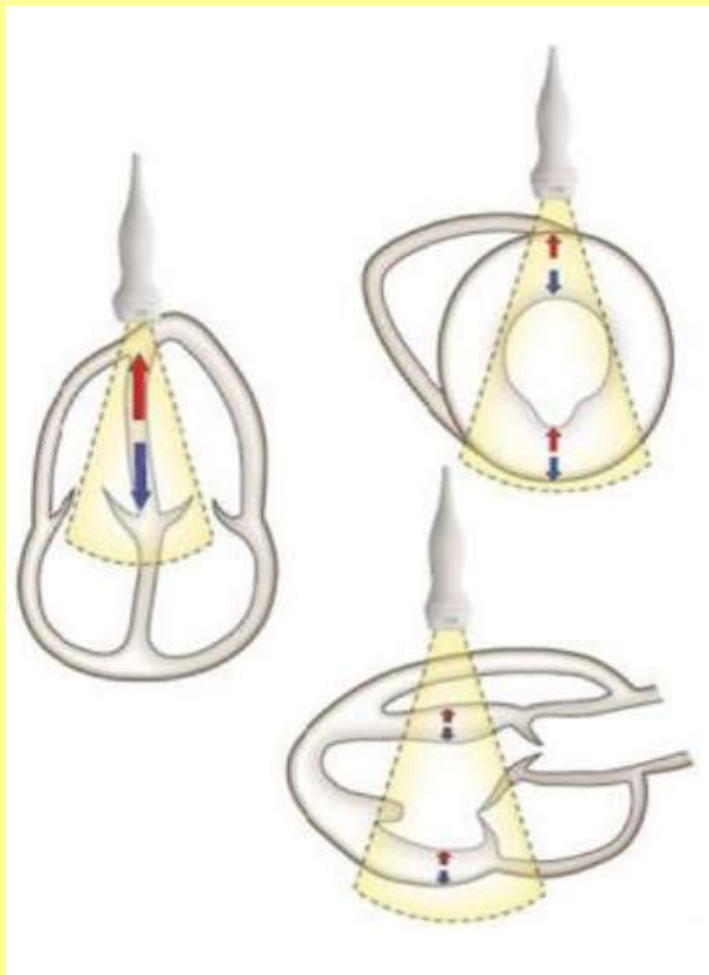
Quantifying Mechanical Dyssynchrony

Color TD M-Mode



- Changes in direction are color coded.
- Septal-to-posterior wall motion delay > 130ms is significant

Tissue Doppler Imaging



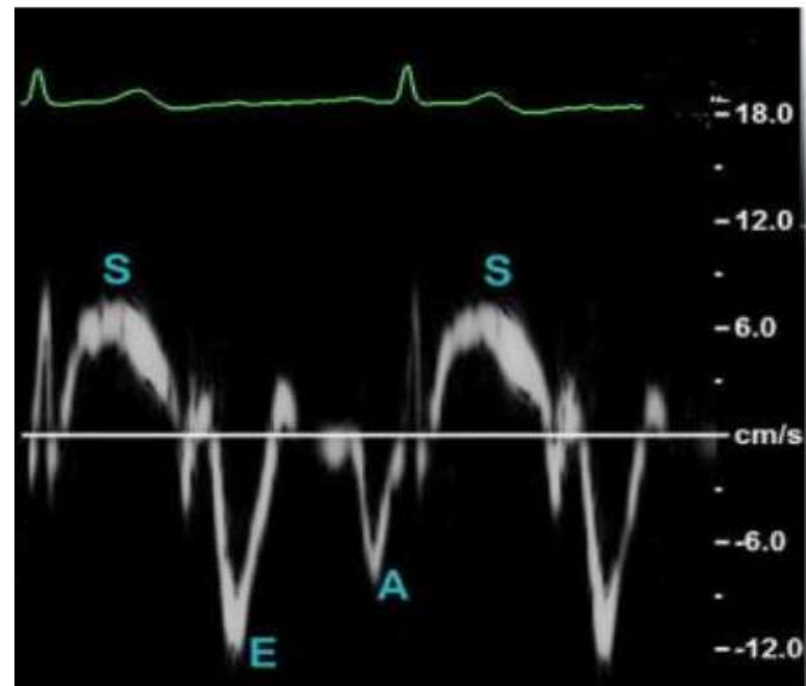
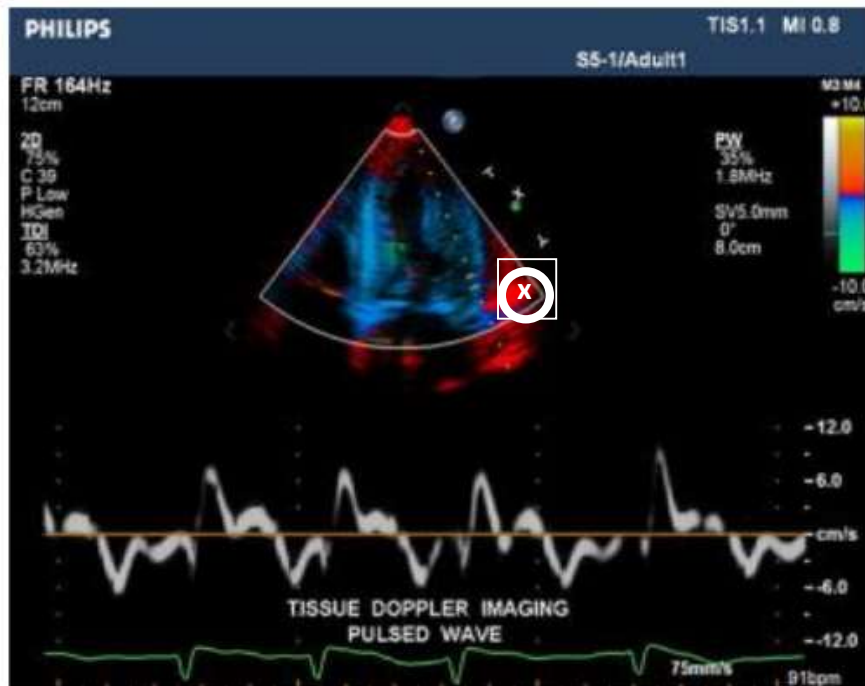
Movement of myocardium

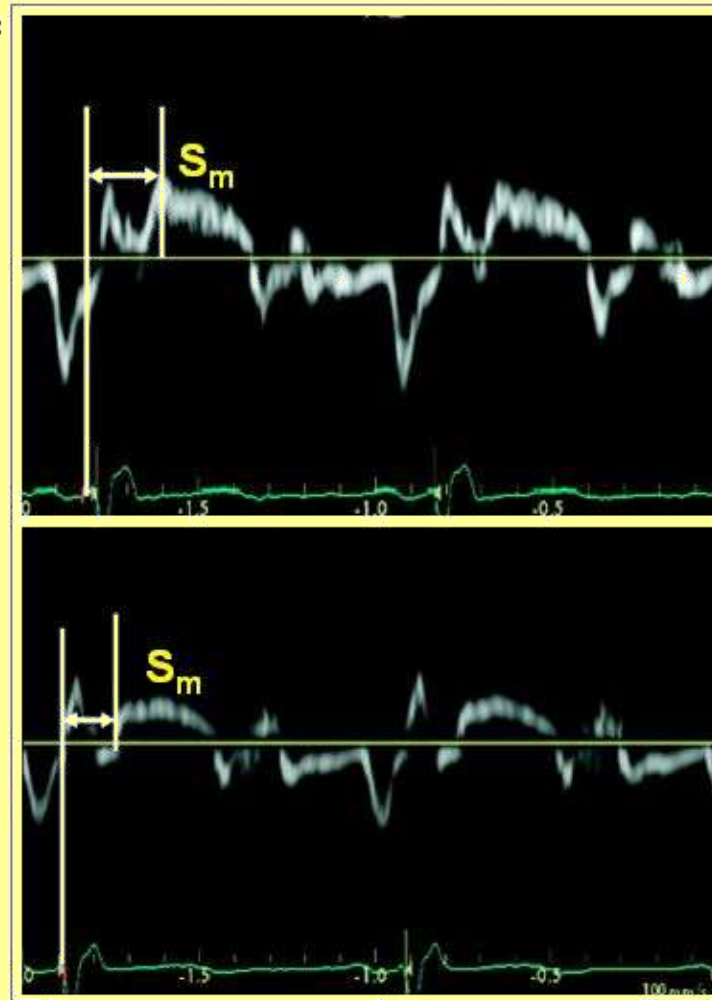
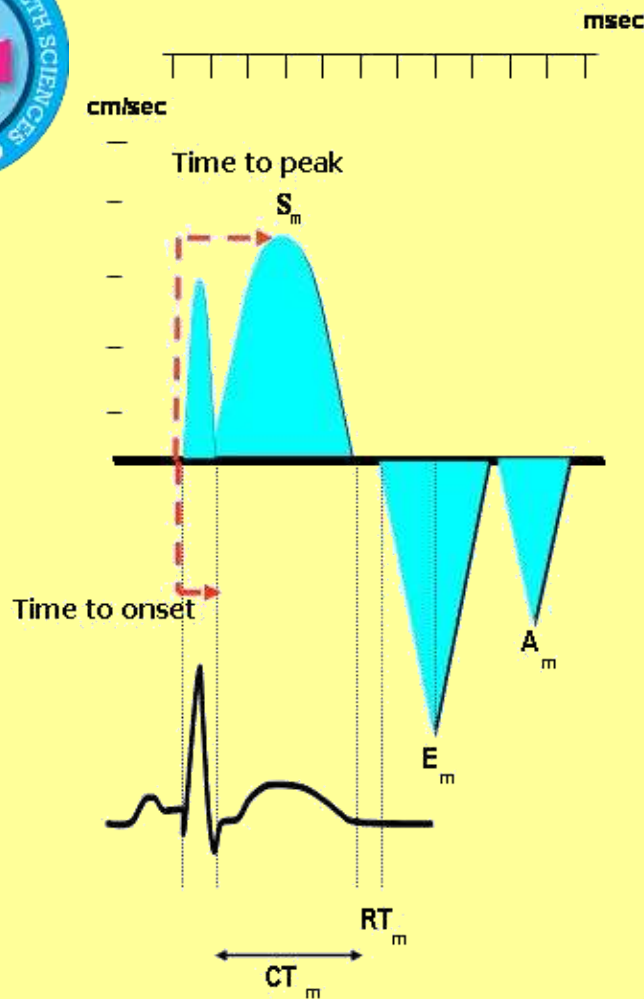
- towards (red) or
- backwards (blue)

Mitral Annular Displacement

Tissue Doppler Imaging – Pulsed Wave

- Annular excursion velocity and timing measurement
- Indicator of global systolic and diastolic function





Methodology for measuring pulsed Tissue Doppler derived time to peak S_m and time to onset S_m (left panel).

In the right panel measurements of time to peak S_m (upper panel) and of time to onset S_m (lower panel) are depicted. A_m = Myocardial atrial velocity, CT_m = Contraction time, E_m = Myocardial early diastolic velocity, RT_m = Myocardial relaxation time, S_m = Myocardial systolic velocity. Mod from Agler DA et al, *J Am Soc Echocardiogr* 2007;20:76–90.



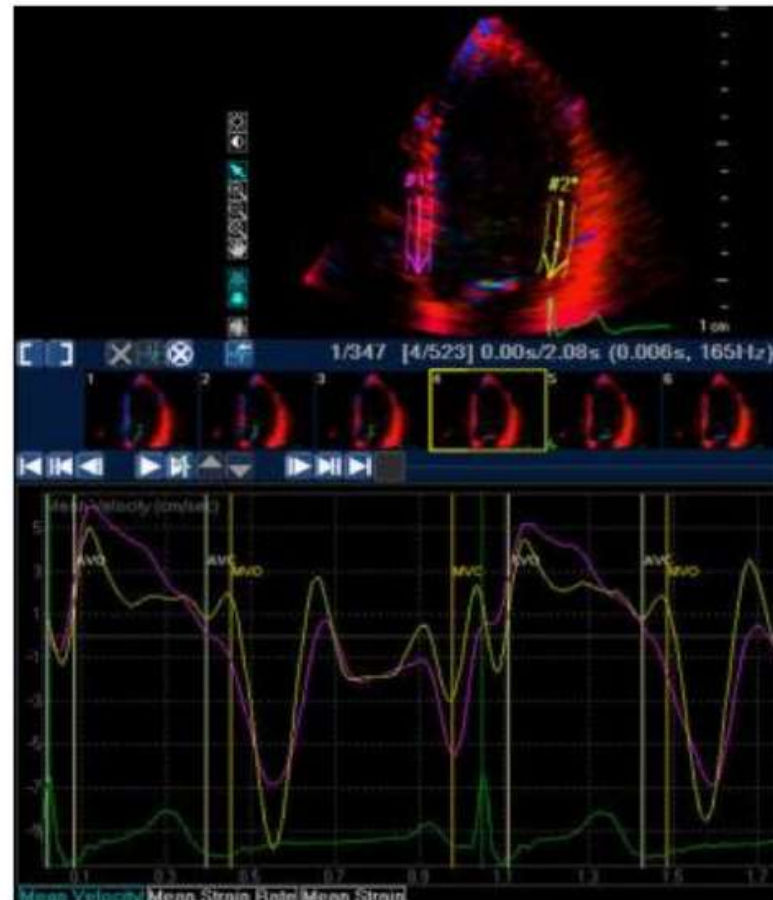
Tissue velocity imaging

- With tissue velocity imaging, longitudinal velocities of basal and mid myocardial segments are measured from standard apical views.
- Two Categories
 - Time delays between opposing walls and
 - Standard deviations of time-to-peak systolic velocities.

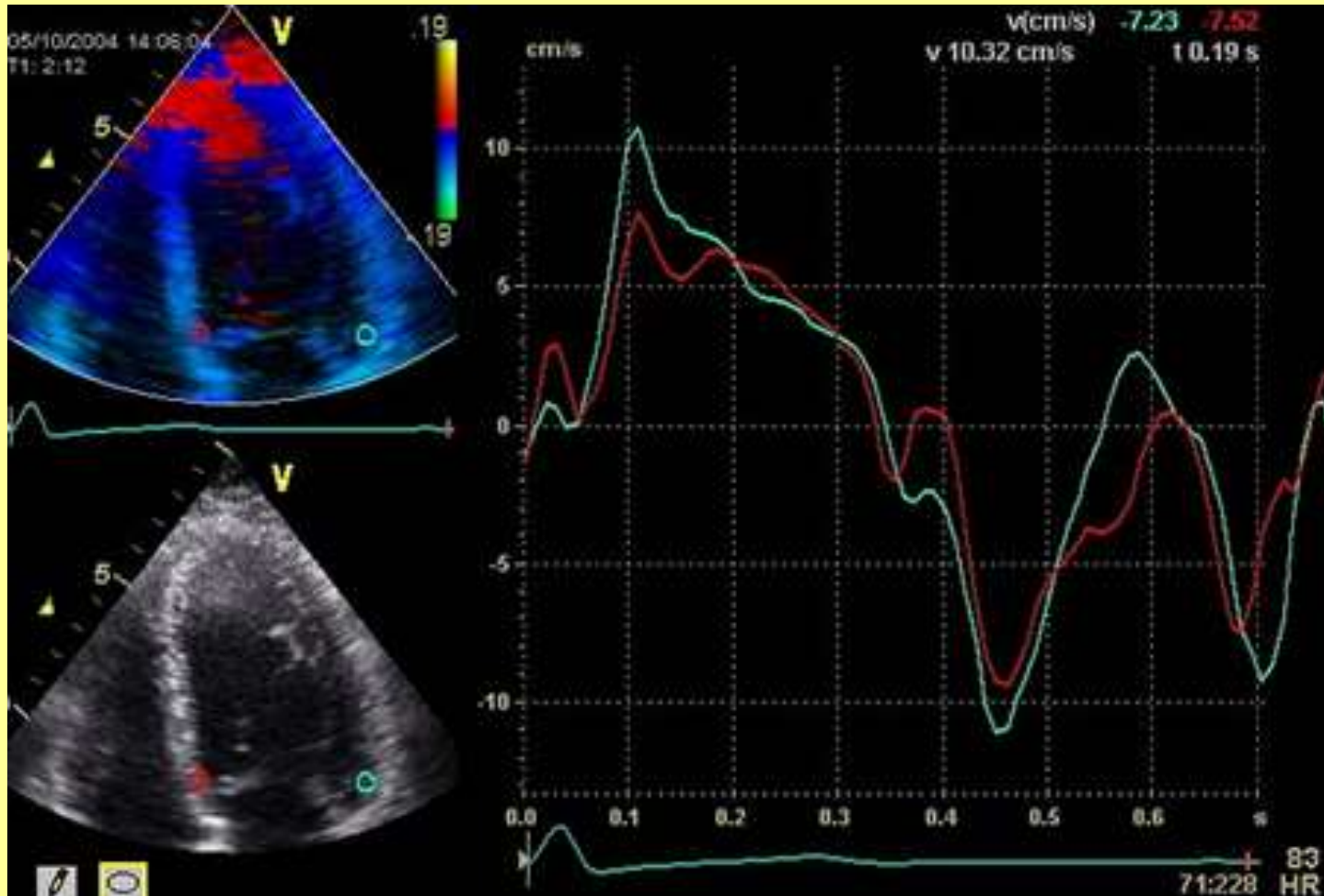
Intraventricular Dysynchrony

Tissue Doppler Imaging - Velocity

- Velocity traces acquired from a TDI Loop
- M-lines manually drawn on wall segment(s) of interest
- Displays opposing wall segments in same loop for comparison measurements
- Measure time to peak and peak to peak of mean velocity

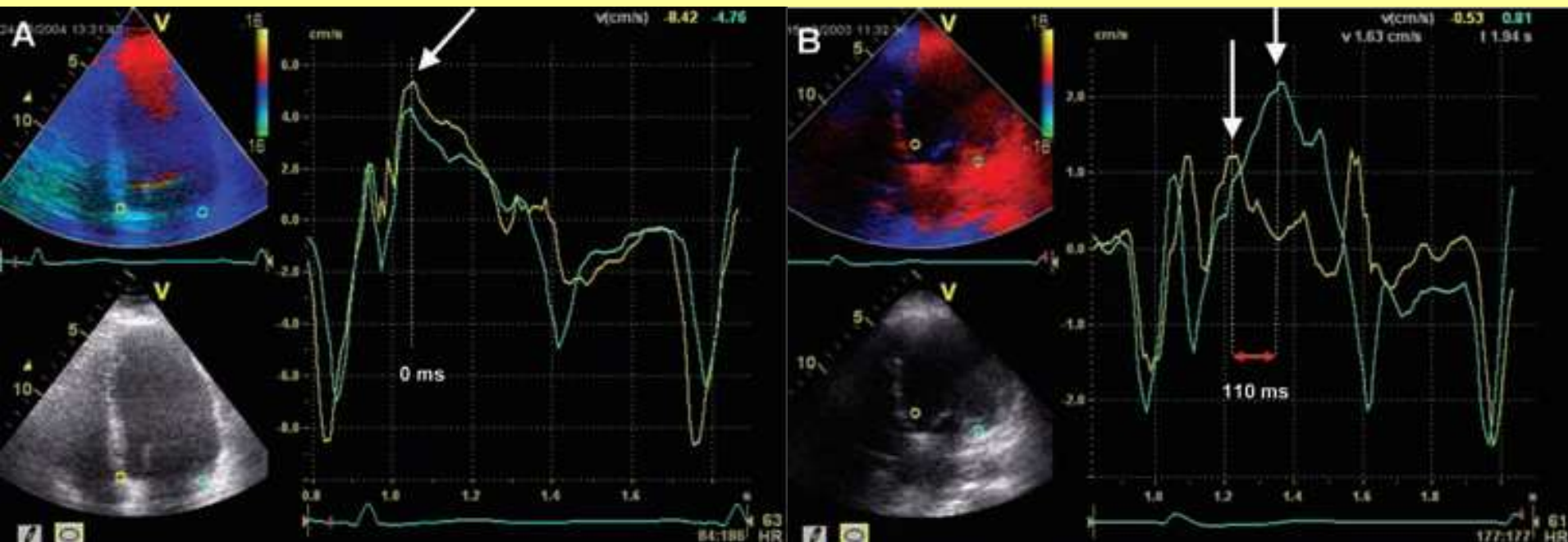


Tissue doppler velocity curves



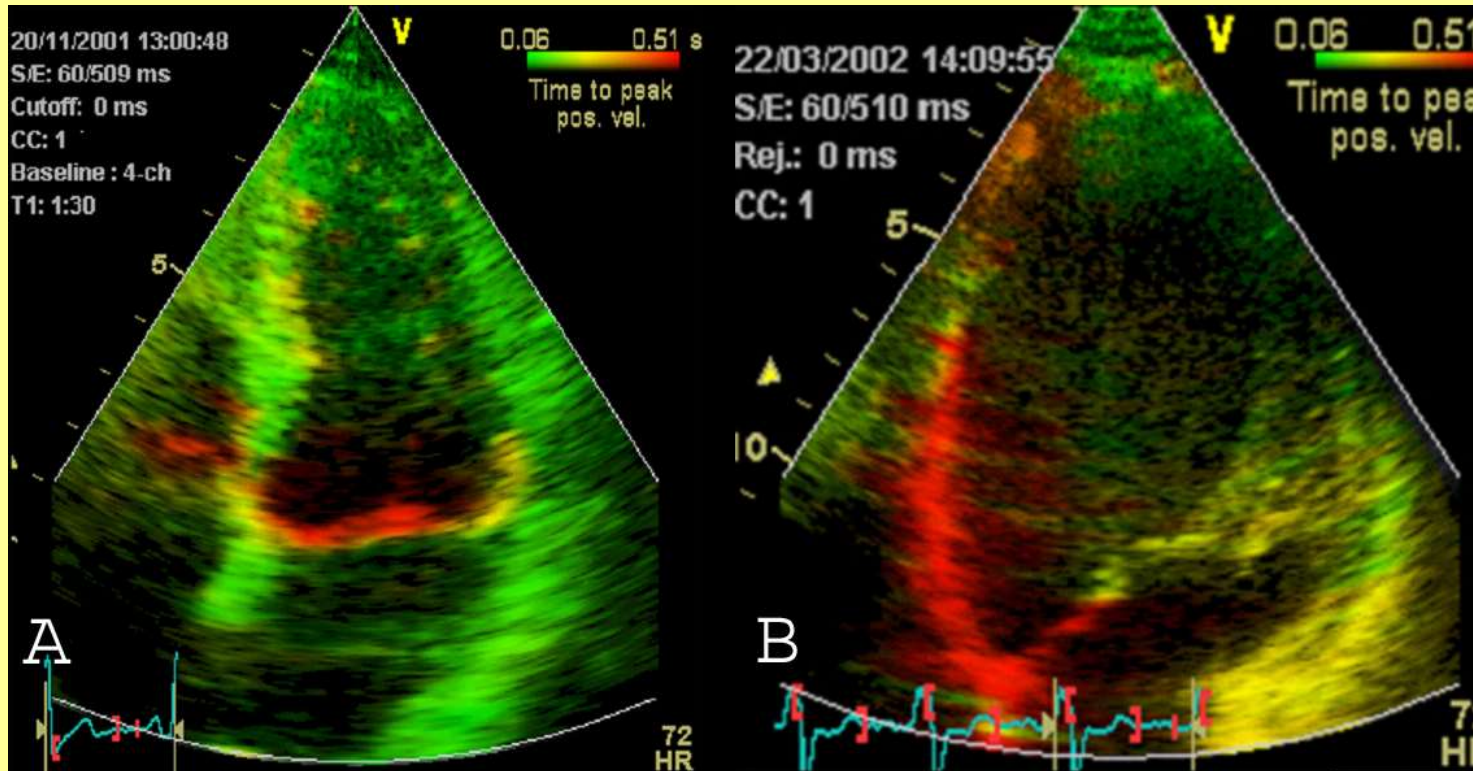
TDI – Velocity curves

Peak systolic velocity = movement of muscle



Normal

LV Dyssynchrony



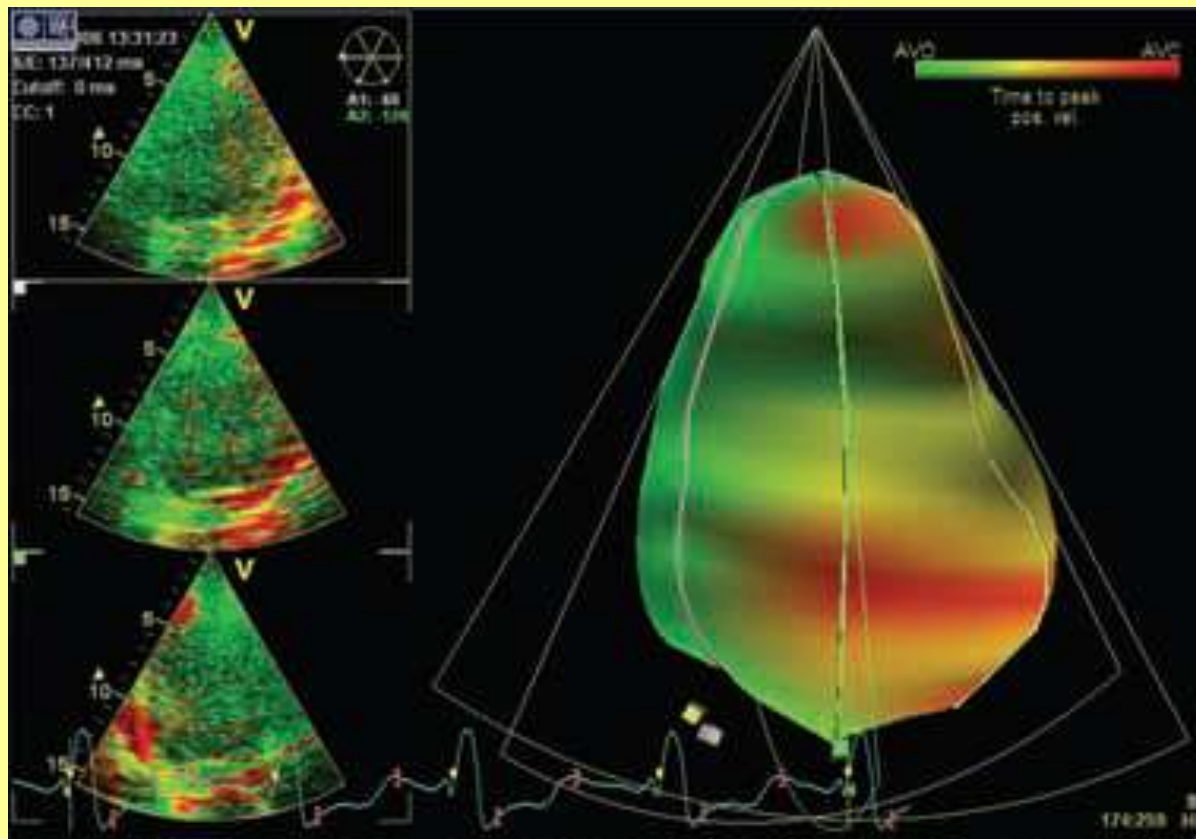
Tissue Synchronization Imaging displays colour-coded time-to-peak tissue Doppler velocities. The colour-coding is green (normal time-to-peak velocity: 20–150 ms), yellow (150–300 ms) and red (300–500 ms) Apical four chamber view. A) TSI in a control patient (only green colour coding indicating synchronous contraction) B) TSI in a patient with LBBB:

The basal and mid-septal segments show a delayed time-to-peak velocity (red colour).

Knebel *et al. Cardiovascular Ultrasound* 2004 **2**:17 doi:10.1186/1476-7120-2-17

3D TSI

- 3D = simultaneous apical four, two and 3 chamber view
- 3D image regenerated by post processing



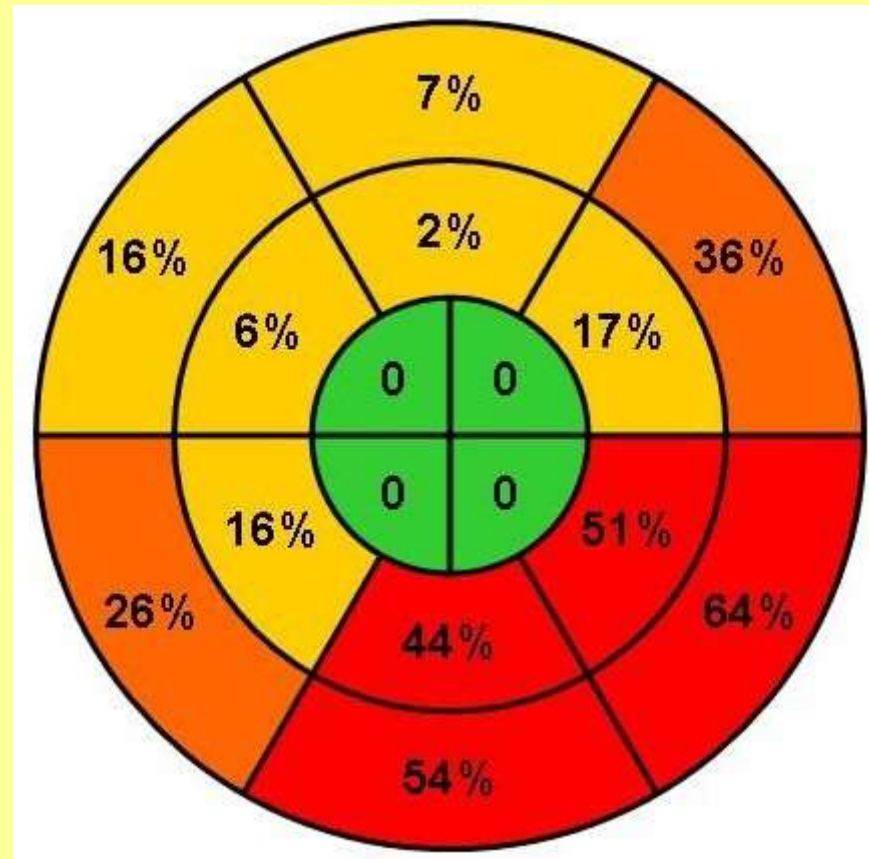
Bulls-eye representation





Distribution of intra-ventricular dyssynchrony in affected segments in the heart failure population (by TSI)

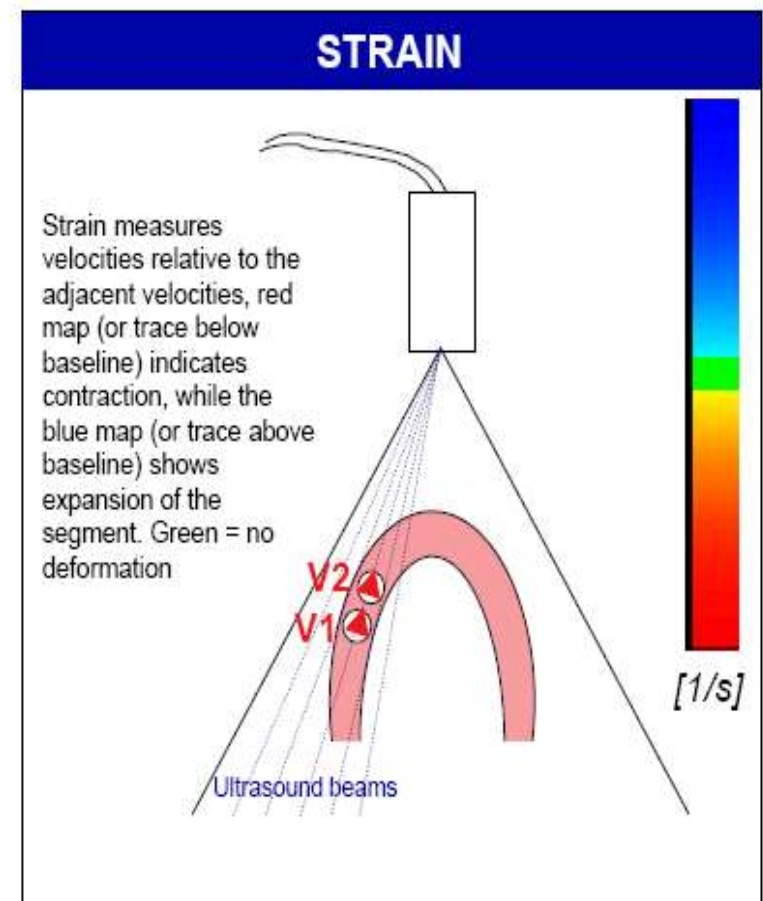
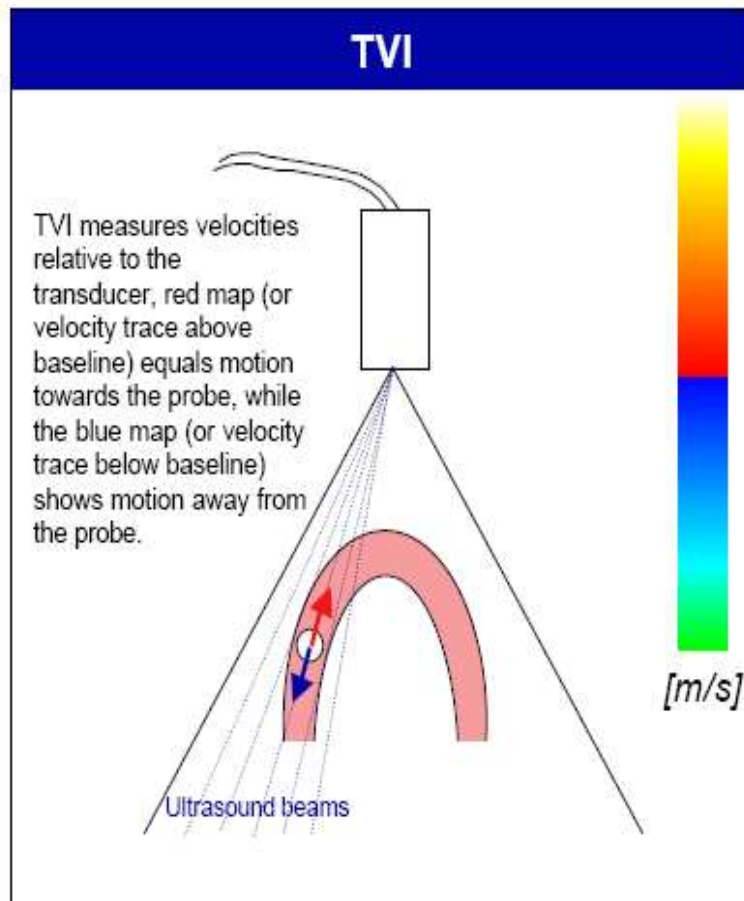
Edner *et al. Cardiovascular Ultrasound* 2009 7:1 doi:10.1186/1476-7120-7-1





Deformation imaging

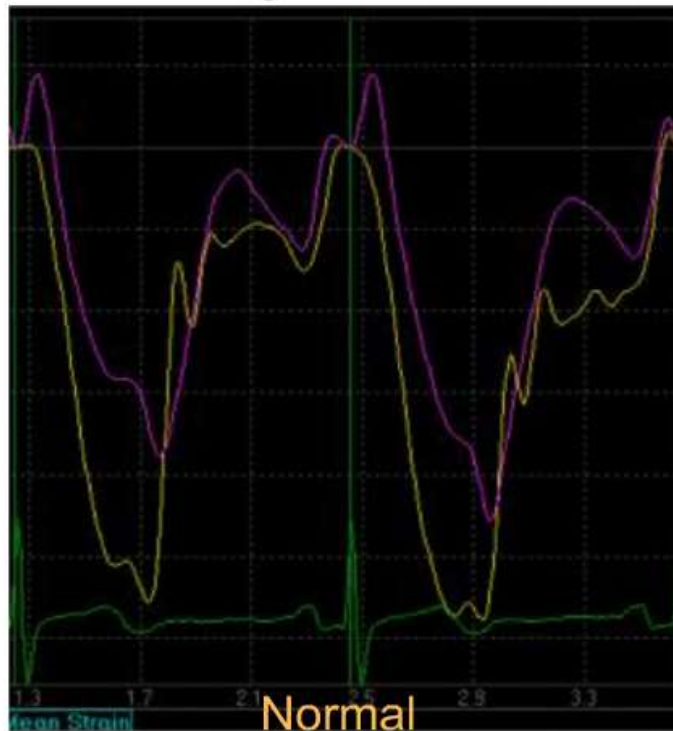
Strain versus velocity



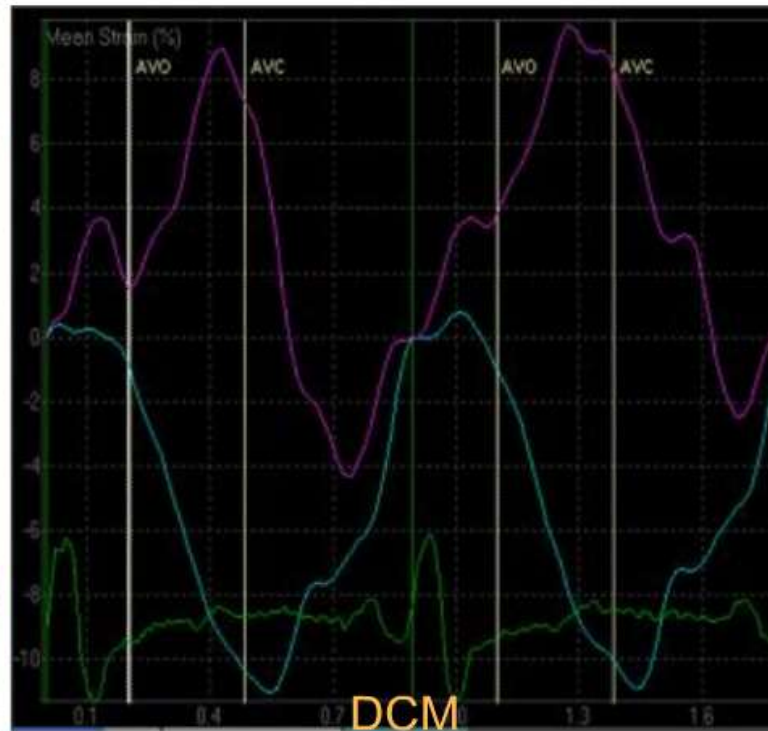
Intraventricular Dysynchrony

Tissue Doppler Imaging - Strain

Strain Timings



Pink = sep, Yellow = lat



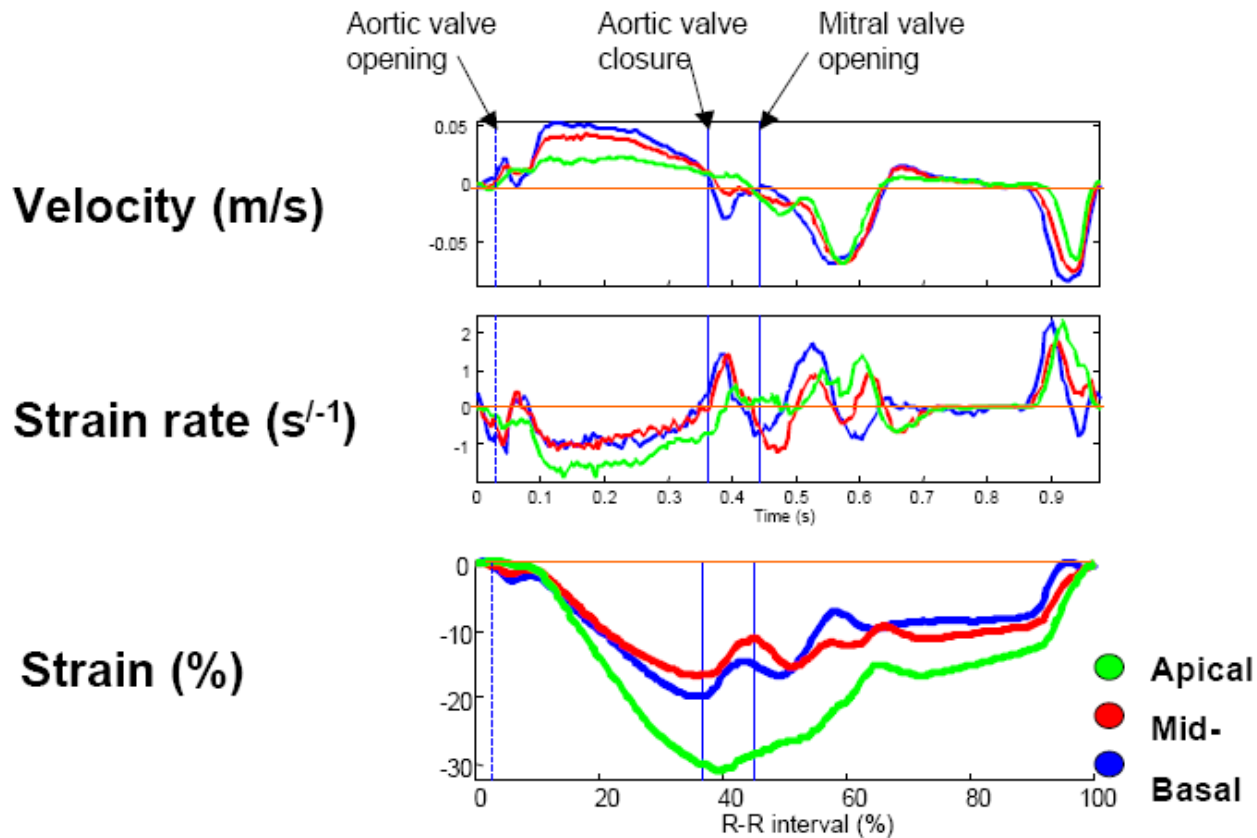
Pink = sep, Blue = lat

Time from ECG onset to peak negative strain > 60 ms has been proposed as a strain dyssynchrony index.

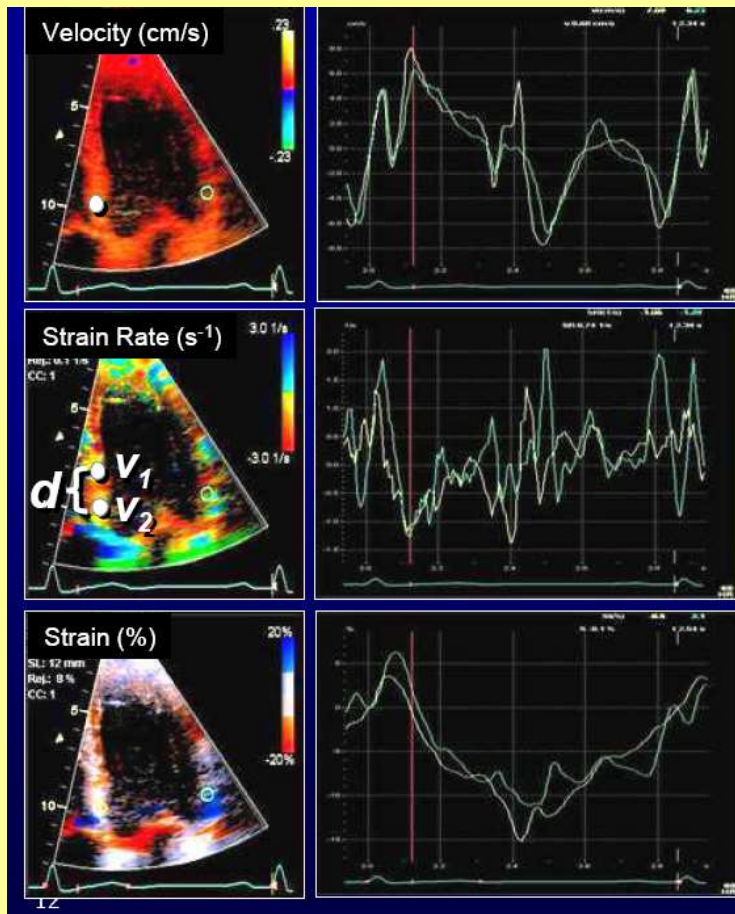
ECG

Velocity / Strain rate / Strain %

Normal longitudinal deformation - septum

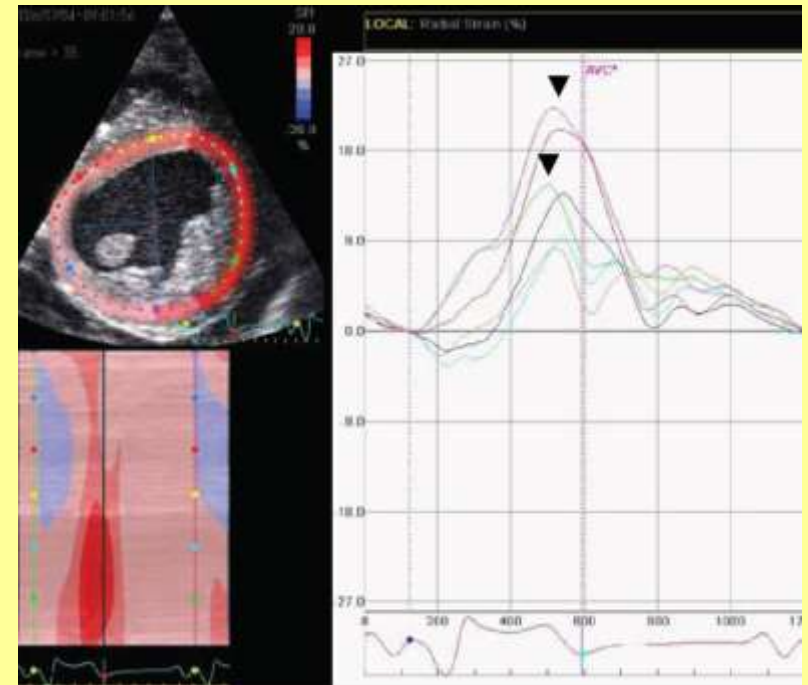


Velocity – Strain – Strain Rate

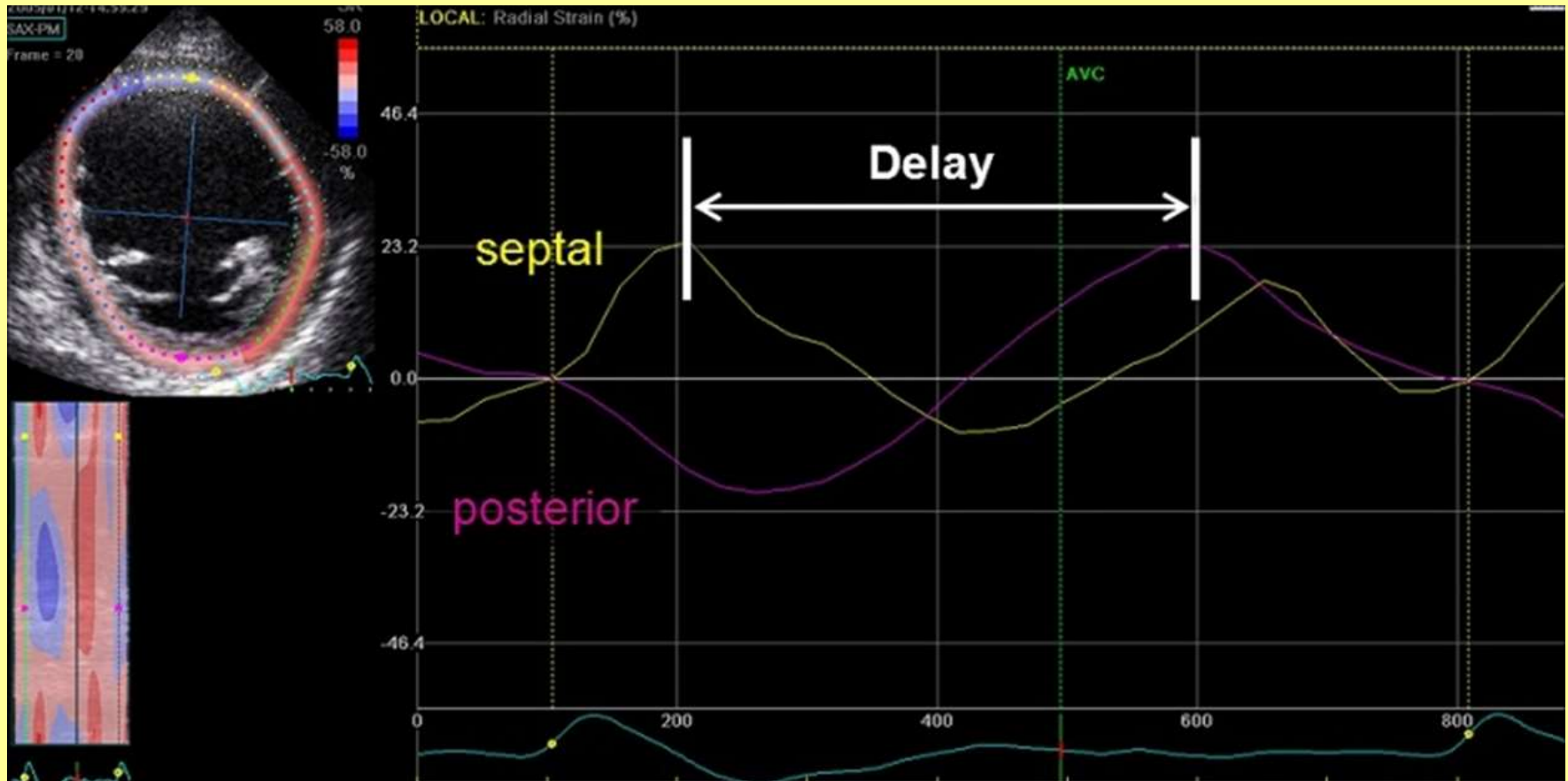


- **Velocity:** “speed” of movement
- **Strain Rate:** The rate at which the myocardium deforms: negative active contraction, positive lengthening or relaxation
- **Strain(%):** The % of local deformation

Radial Strain Curves



Radial strain curves from short-axis view of speckle tracking echocardiography. Significant timing difference was found among time to peak radial strain before CRT (a), and it was reduced after CRT (b).



Difference ≥ 130 ms in peak radial strain between the basal anteroseptal and basal posterior wall segments is one of most commonly used speckle tracking-based dyssynchrony parameter



Parameter	Echo modality	Cutoff
Septal to posterior wall motion delay ^[7]	M-mode	≥ 130 ms
Septal to lateral Ts delay ^[8]	Tissue velocity imaging	≥ 60 ms
Max delay in Ts in 4 basal LV segments ^[9]	Tissue velocity imaging	> 65 ms
SD of Ts of 6 basal LV segments ^[10]	Tissue velocity imaging	≥ 36.5 ms
Max delay in Ts in 12 basal and mid LV segments ^[11]	Tissue velocity imaging	≥ 100 ms
SD of Ts in 12 basal and mid LV segments (Dyssynchrony Index) ^[12]	Tissue velocity imaging	≥ 32.6 ms
Anteroseptal to posterior time to peak strain difference (radial strain) ^[13]	2D speckle tracking	≥ 130 ms
SD of time-to peak longitudinal strain in 12 basal and mid LV segments ^[14]	Colour –Tissue Doppler imaging	> 60 ms
SD of time to minimum systolic volume of 16 LV segments (systolic dyssynchrony index) ^[15]	3D echocardiography	> 5.6 %



THANK YOU