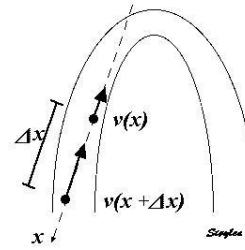


Pitfalls in deformation imaging

Asbjørn Støylen,
Dr. Med.
NTNU

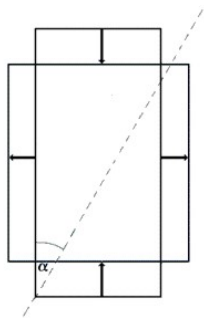
<http://folk.ntnu.no/stoylen/strainrate/>
<http://folk.ntnu.no/stoylen/strainrate/Howto/Pitfalls.html>

Strain rate:

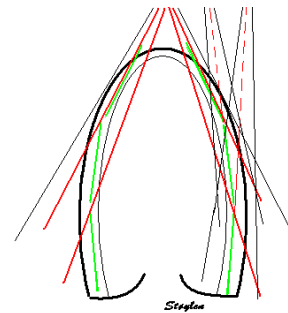


$$SR = \frac{v(x) - v(x + \Delta x)}{\Delta x}$$

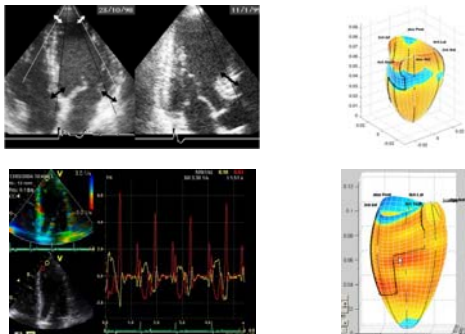
The angle problem:



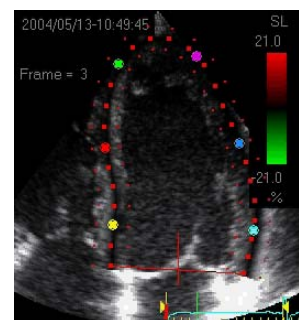
Alignment with the wall:



The angle problem:



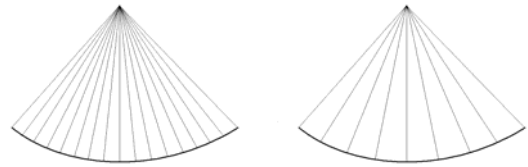
Angle dependency of speckle tracking



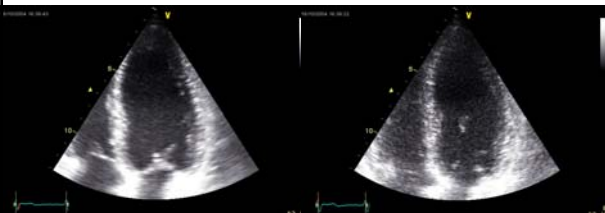
Limitations of speckle tracking

- **Frame rate sensitive**
 - Too big change from frame to frame – poor tracking
- **Heart rate sensitive**
 - More motion from frame to frame – equivalent to lower frame rate relative to HR – needs higher frame rate
- **Less noisy, due to lower frame rate and smoothing**
- **Sensitive for reverberations and drop outs**
- **Lateral tracking dependent on line density**

Increase frame rate: reduces line density

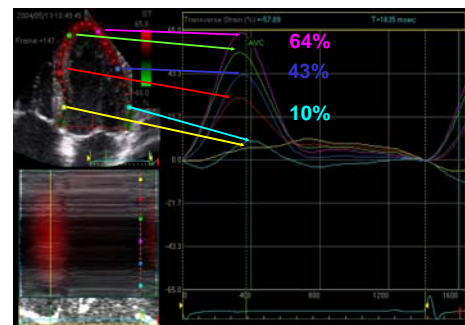


Line density:



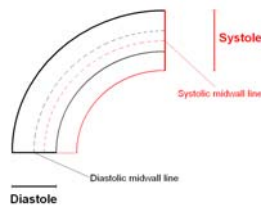
- Frame rate 112
- Frame rate 34
- Transverse tracking poor with low lateral resolution
- ⇒ Tracking mostly along the ultrasound beam
- ⇒ Angle dependent tracking

Lateral resolution – transmural strain:

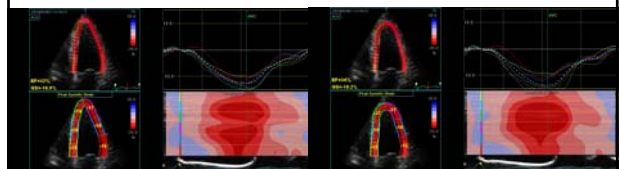


Strain is curvature dependent

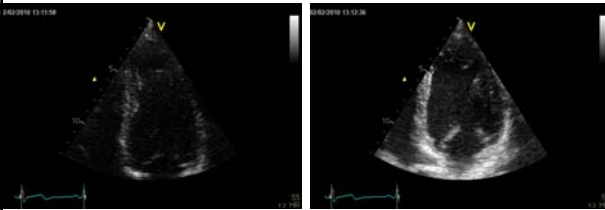
- Longitudinal shortening is curvature dependent
- Part of midwall shortening is due to wall thickening if wall is curved
 - Depends on wall thickness
 - Wall thickening
 - Wall curvature



Strain is curvature dependent



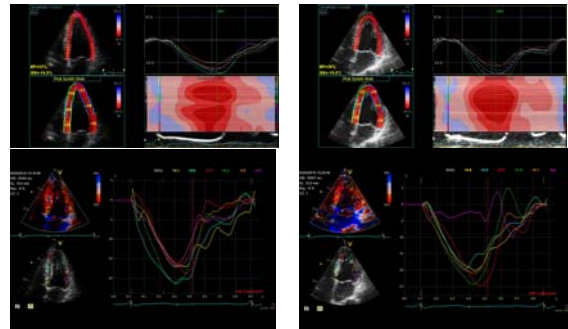
Foreshortening:



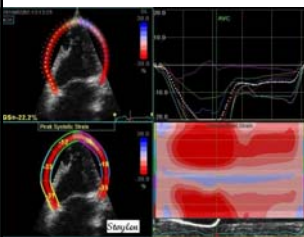
• 5th intercostal space

4th intercostal space

Foreshortening

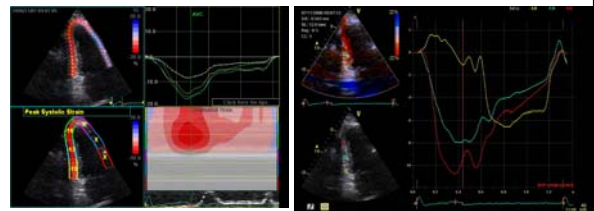


Smoothing



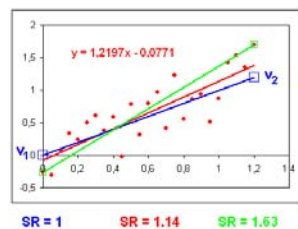
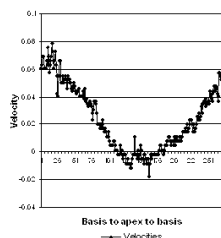
- Much of the information is from AV-plane motion
- Information is global, not regional
- Sensitivity may be an issue

Inferior infarct:



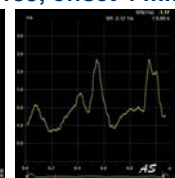
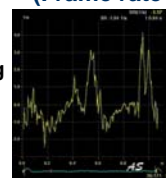
Random noise:

Spatial velocity distribution : v-plot



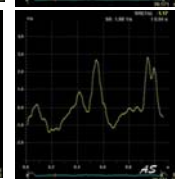
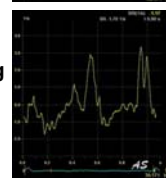
Temporal smoothing (Frame rate 185, offset 4 mm)

No smoothing



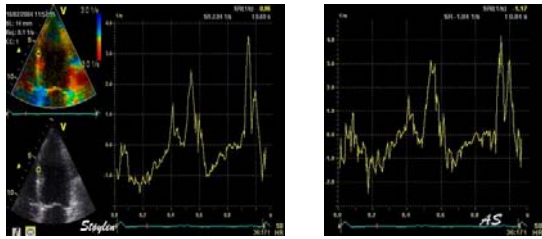
Flat smoothing
7 samples
= 35 ms

Gaussian smoothing
40 ms



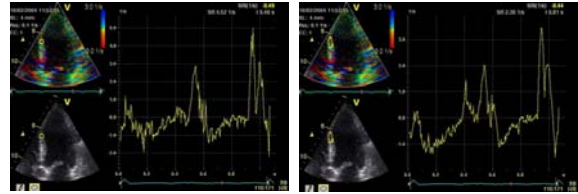
Gaussian smoothing
80 ms

Strain length- improved signal / noise ratio



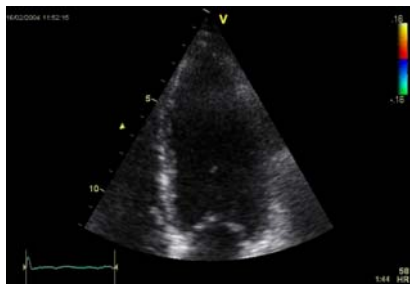
Offset 14 mm 4 mm
 Increased offset: Larger difference between $v(x)$ and $v(\Delta x)$
 – reduced axial resolution

Spatial averaging

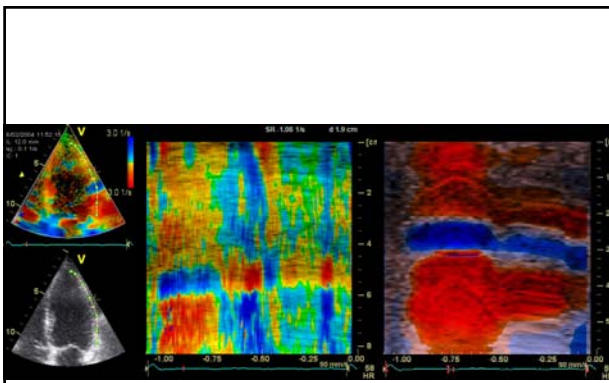
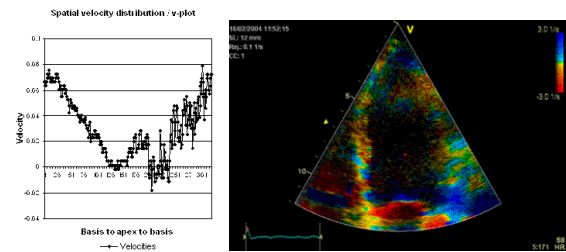


Offset 4 mm, no temporal smoothing
 ROI 6x6 mm ROI 12x6 mm

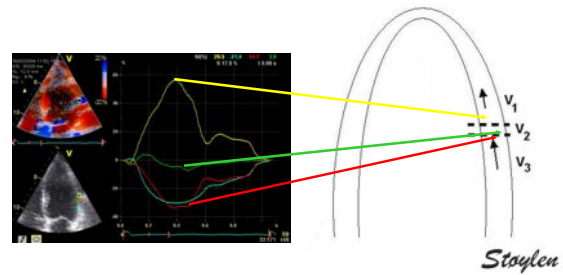
Reverberations:



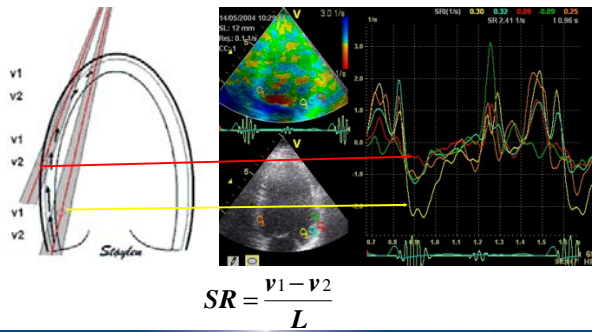
Reverberations:



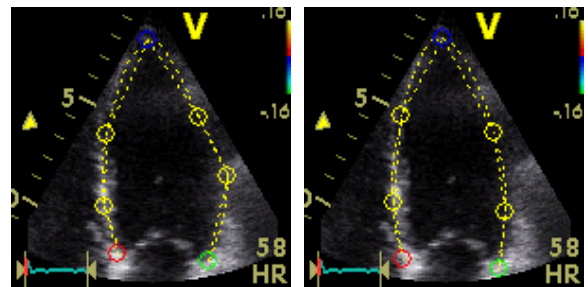
Reverberation artefact:



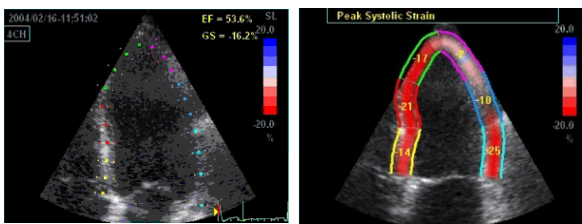
Lateral resolution:



Reverberation artefact:

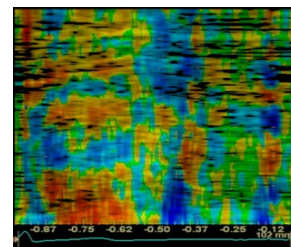


Smoothing:



The smoothing gives an interdependence of measurements

Shadowy reverberations



May be less pronounced in B-mode because B-mode analyses second harmonic, while tissue Doppler analyses native frequencies