Biomedical Imaging & Analysis

Lecture 4, Part 2. Fall 2014

Image Formation & Visualization (III):

Ultrasound.

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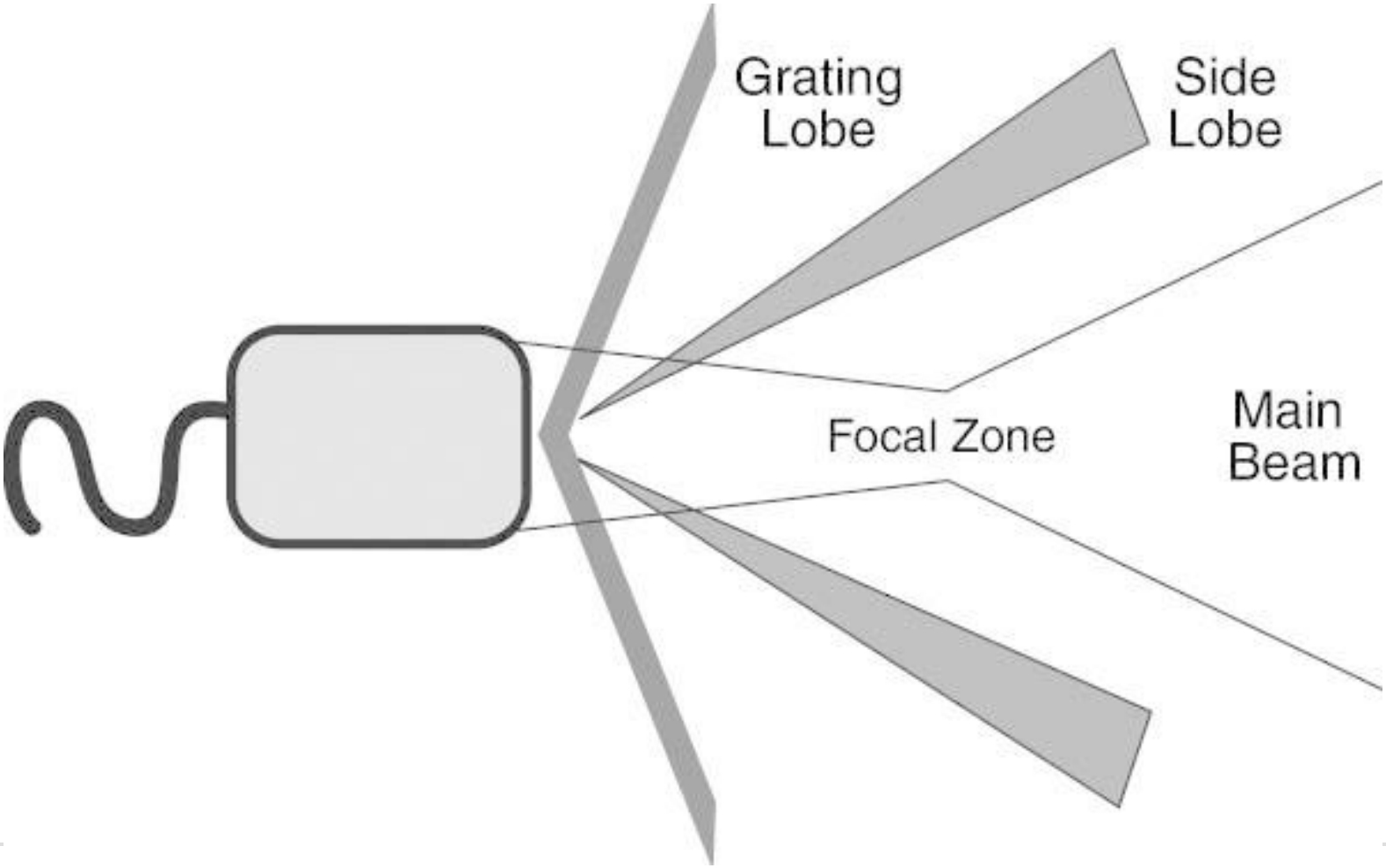
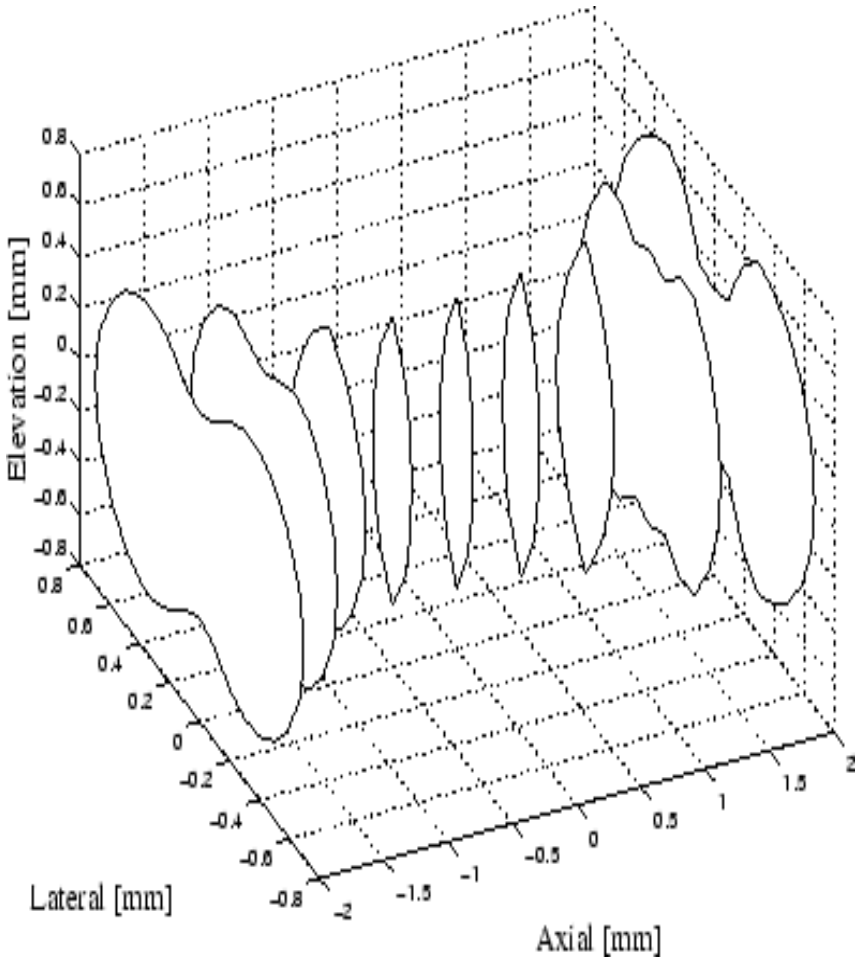
Joint Institute of Engineering

US Beam Components



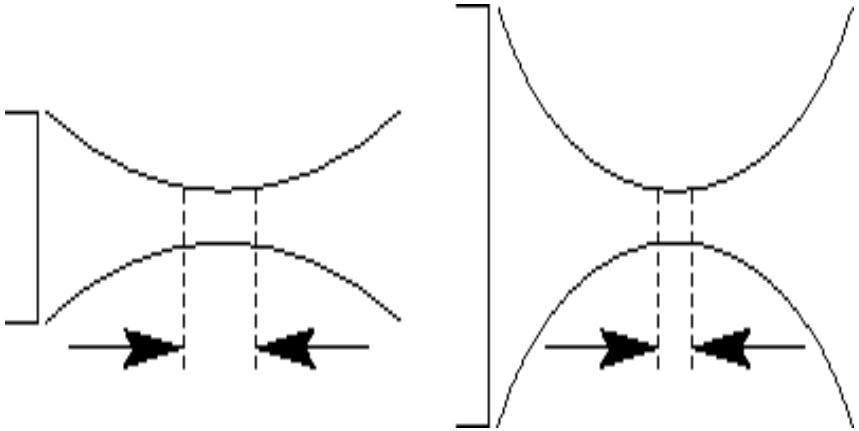
Axial Resolution

- Along the beam (axial direction), the resolution gets worse with distance from the focal point



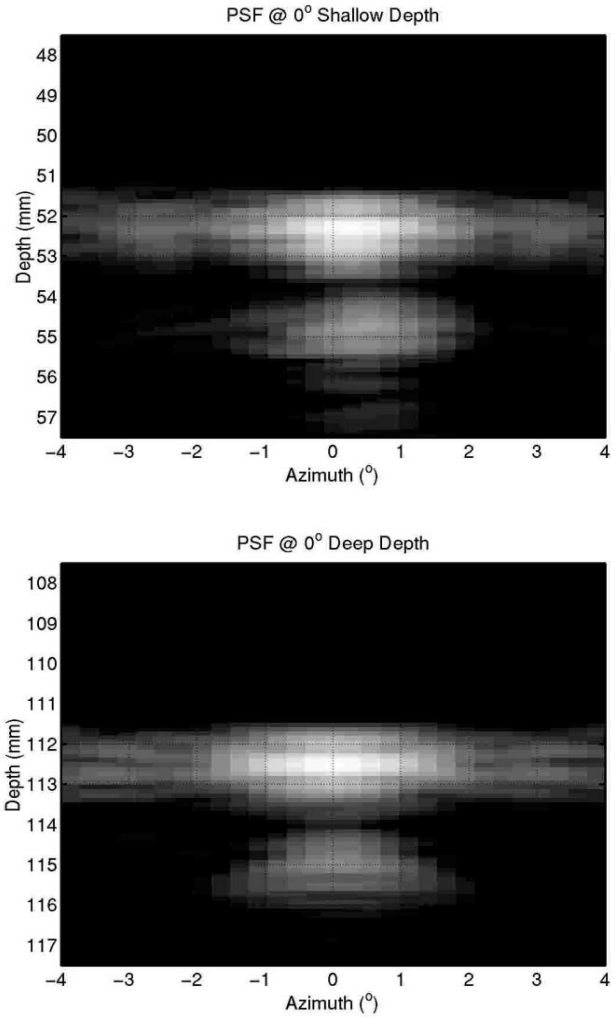
Depth of Field and Beam Form

- The depth of field describes how the US beam widens on either side of the focal point (sweet spot).
- The elevation spatial resolution can vary by a factor of 10 within a typical range of interest.



Lateral Point Spread Function

- The lateral spread of signal in an US beam can be up to 10 times the spread along the axial dimension and therefore results an in inherent Point Spread Function (PSF) that convolutes the US image.



2D velocity from ultrasound Transverse Oscillations..?

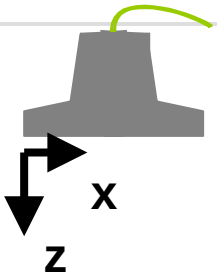
- *Reading Assignment*:

  Ultrasonic colour Doppler imaging

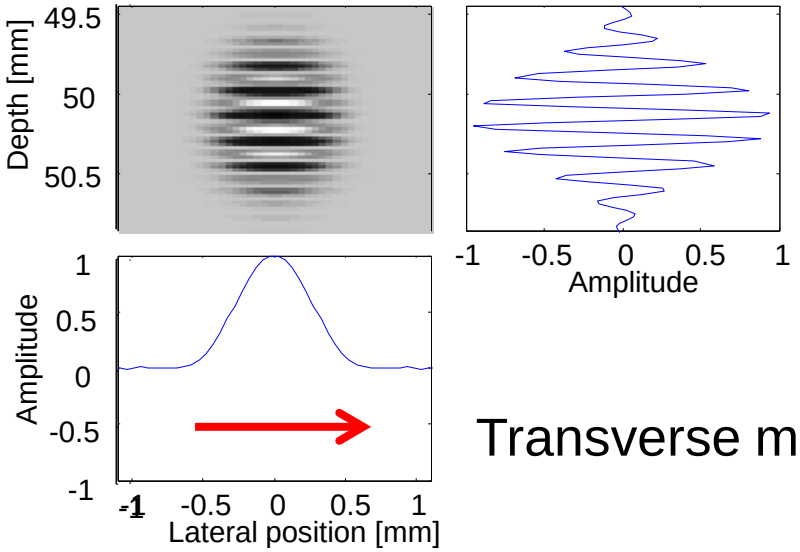
  David H. Evans, Jørgen Arendt Jensen and Michael Bachmann Nielsen

Motion estimation with "Tagged" imaging

US Tagging or Transverse oscillations (TO)



Conventional *PSF

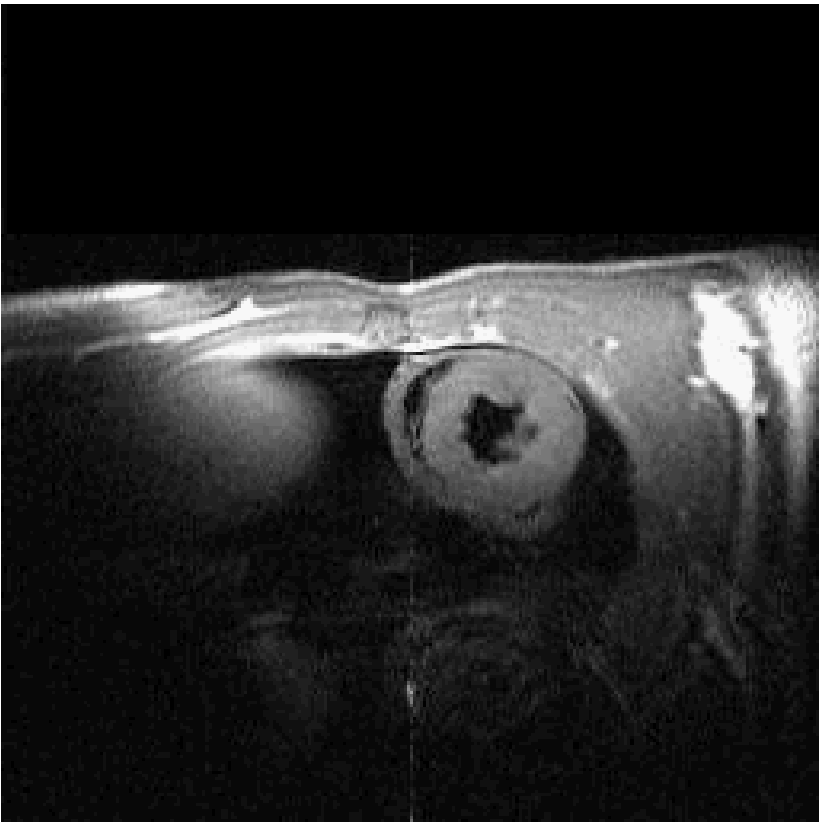


Axial motion estimation OK

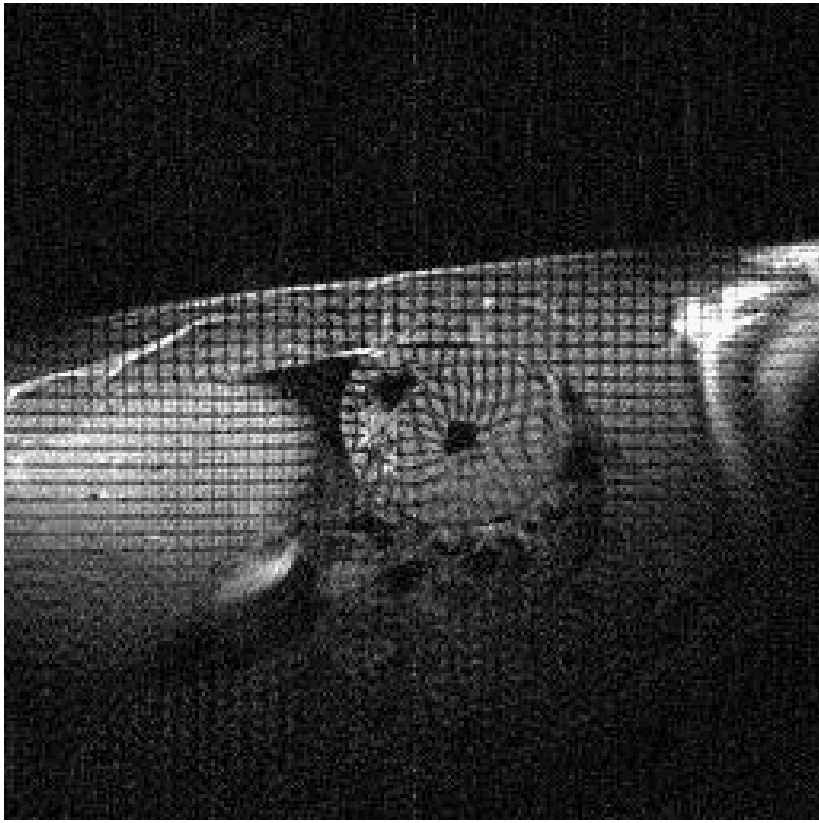
Transverse motion estimation more difficult

*PSF = Point spread function, image of a single scatterrer

MRI Tagging: facilitating motion estimation

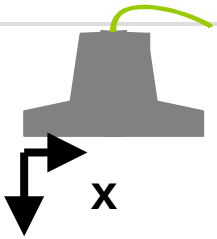


Conventional
MRI sequence

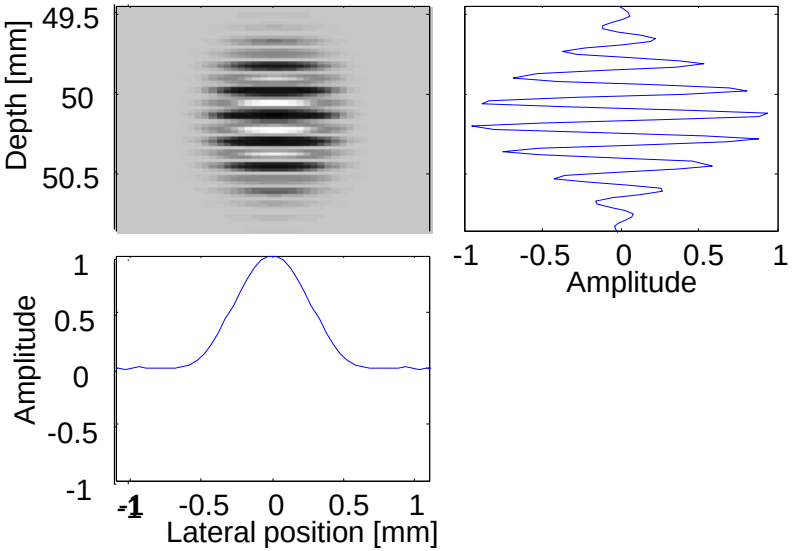


Tagged MRI sequence

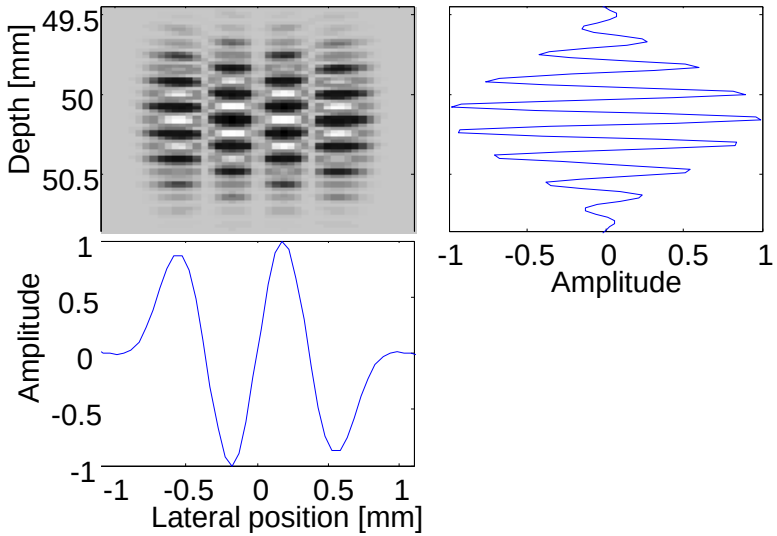
US Tagging or Transverse oscillations (TO)



Conventional *PSF



???Tagged PSF ???

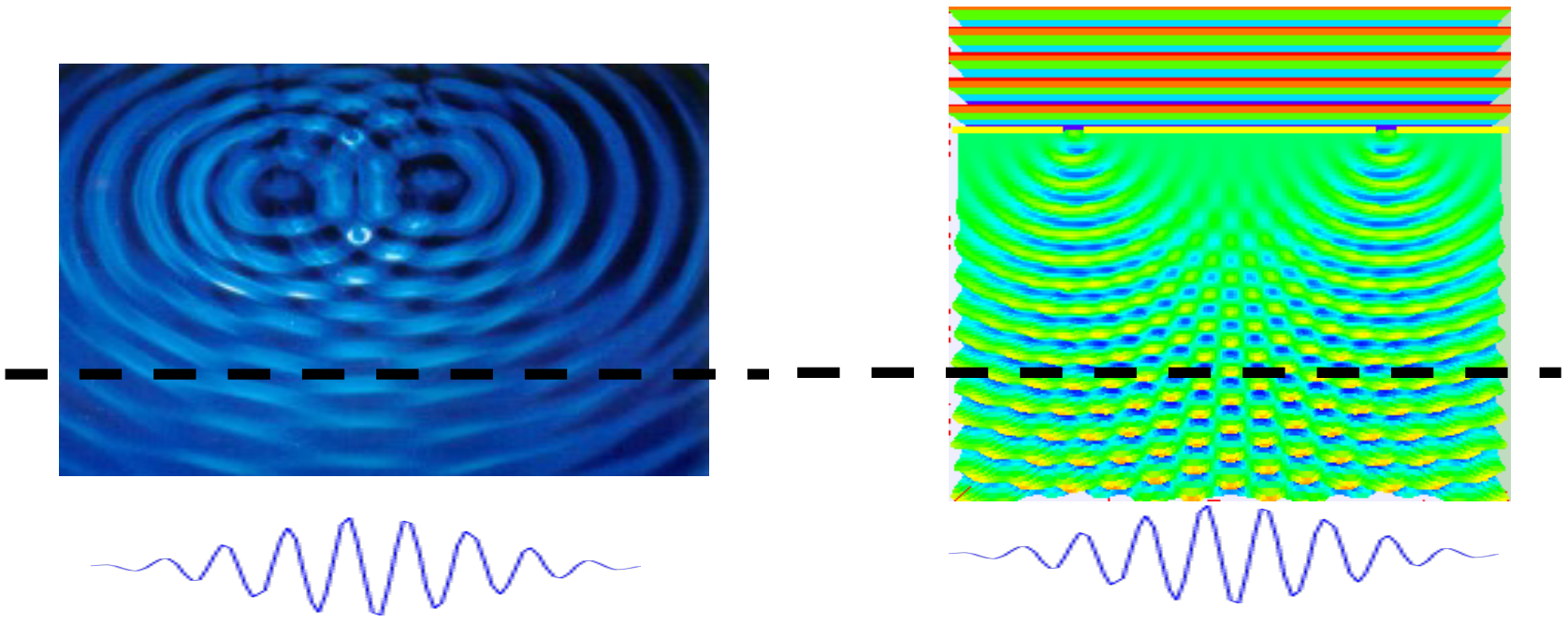


*PSF = Point spread function, image of a single scatterrer

TO image formation principle

US Tagging is created using specific **beamforming*** strategies

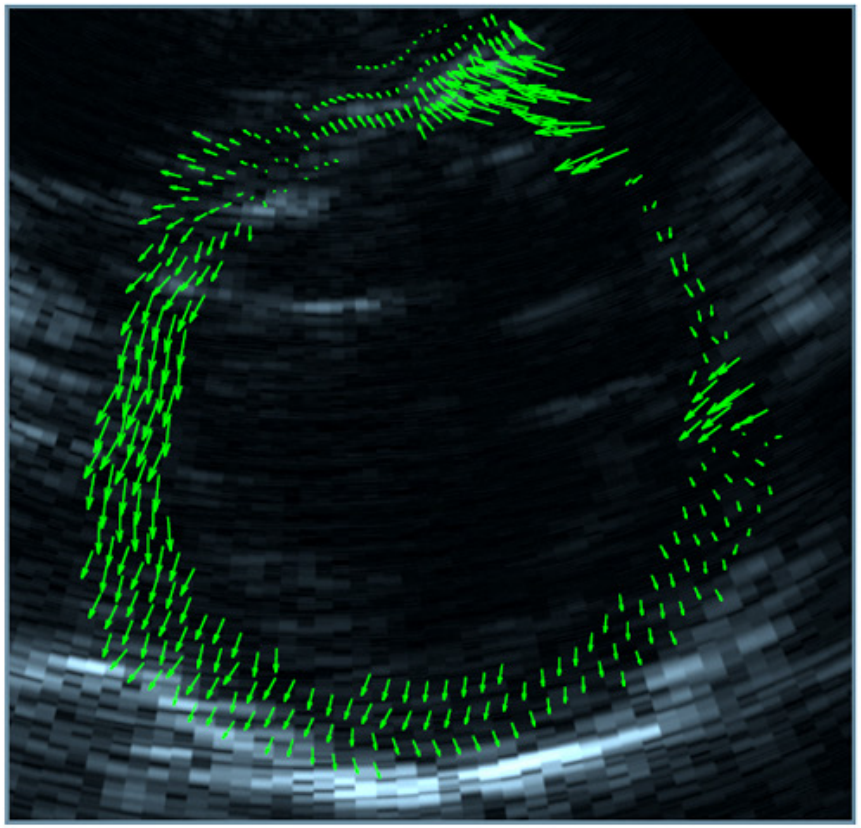
It can be seen as the interferences between two sources



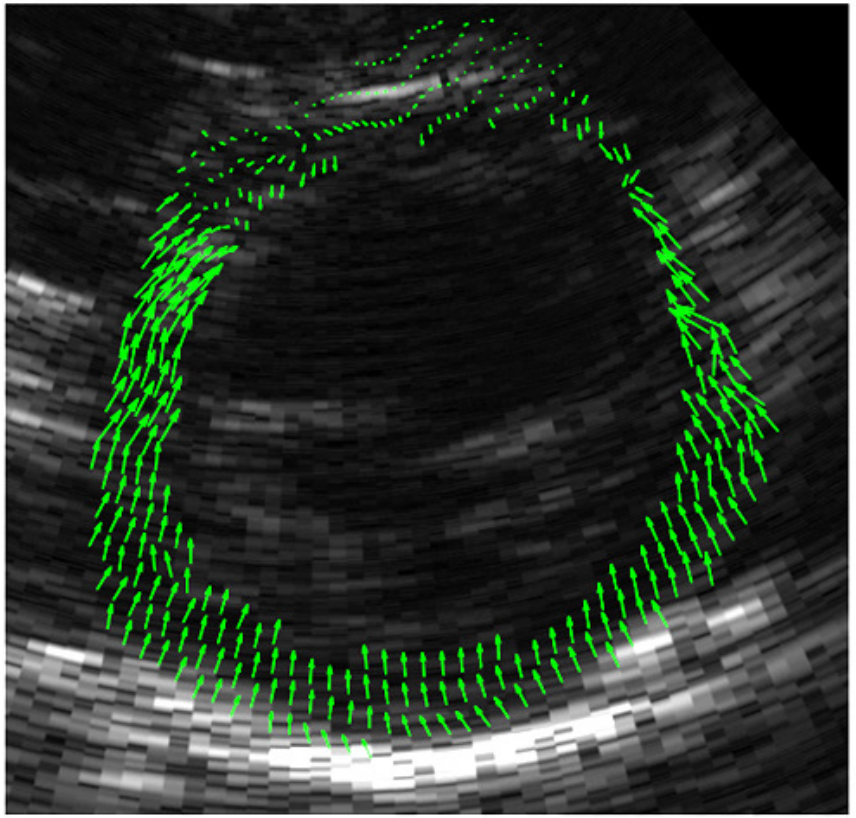
*__Beamforming__ = combination of the signals received by the probe's elements

Cardiac Examples, *in vivo*

DIASTOLE



SYSTOLE



2D+Time Trans-Thoracic (TTE) Echo

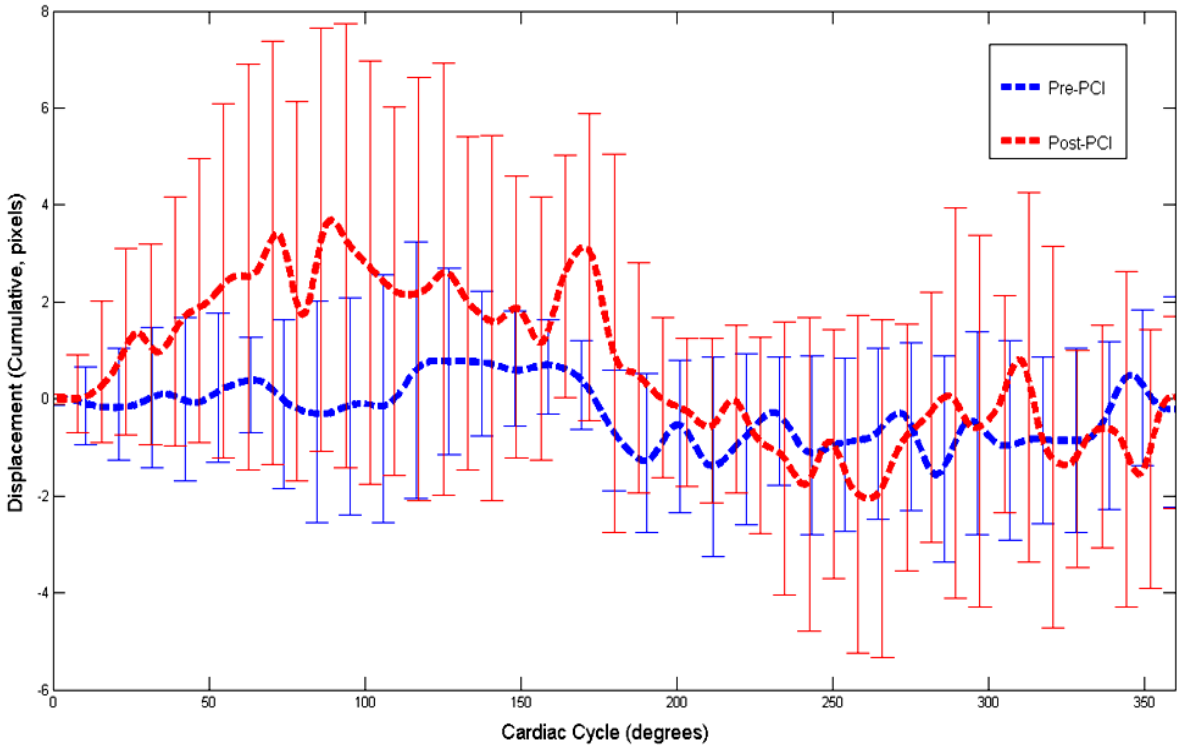
Carnegie Mellon University

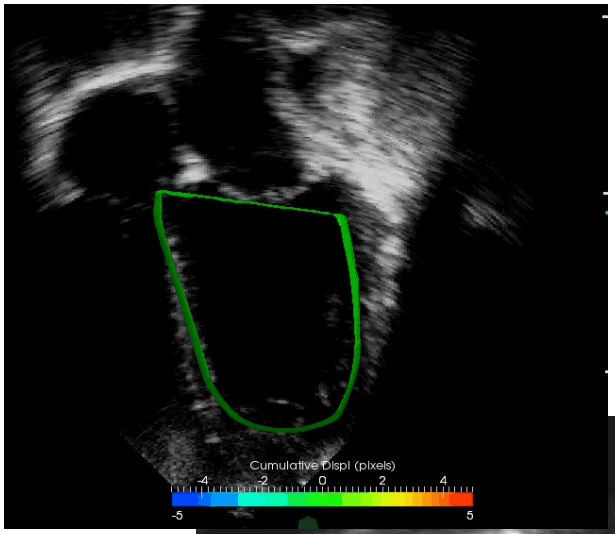
Analysis from 4 Chamber Cardiac Videos

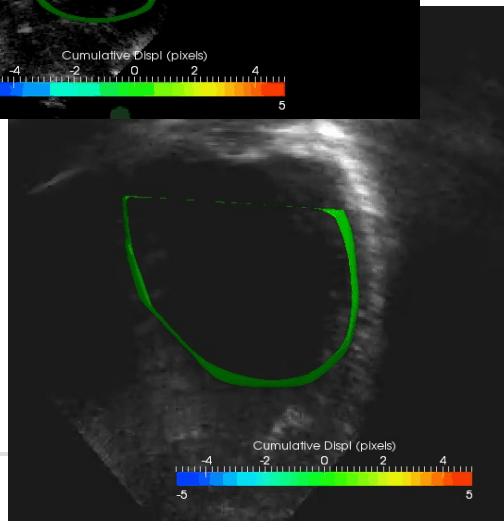
Pre- vs Post- Percutaneous Coronary Intervention (PCI) patients...

The MeDCaVE™

Cumulative wall displacement of the left ventricle (LV) is studied based on a fully-automated workflow:







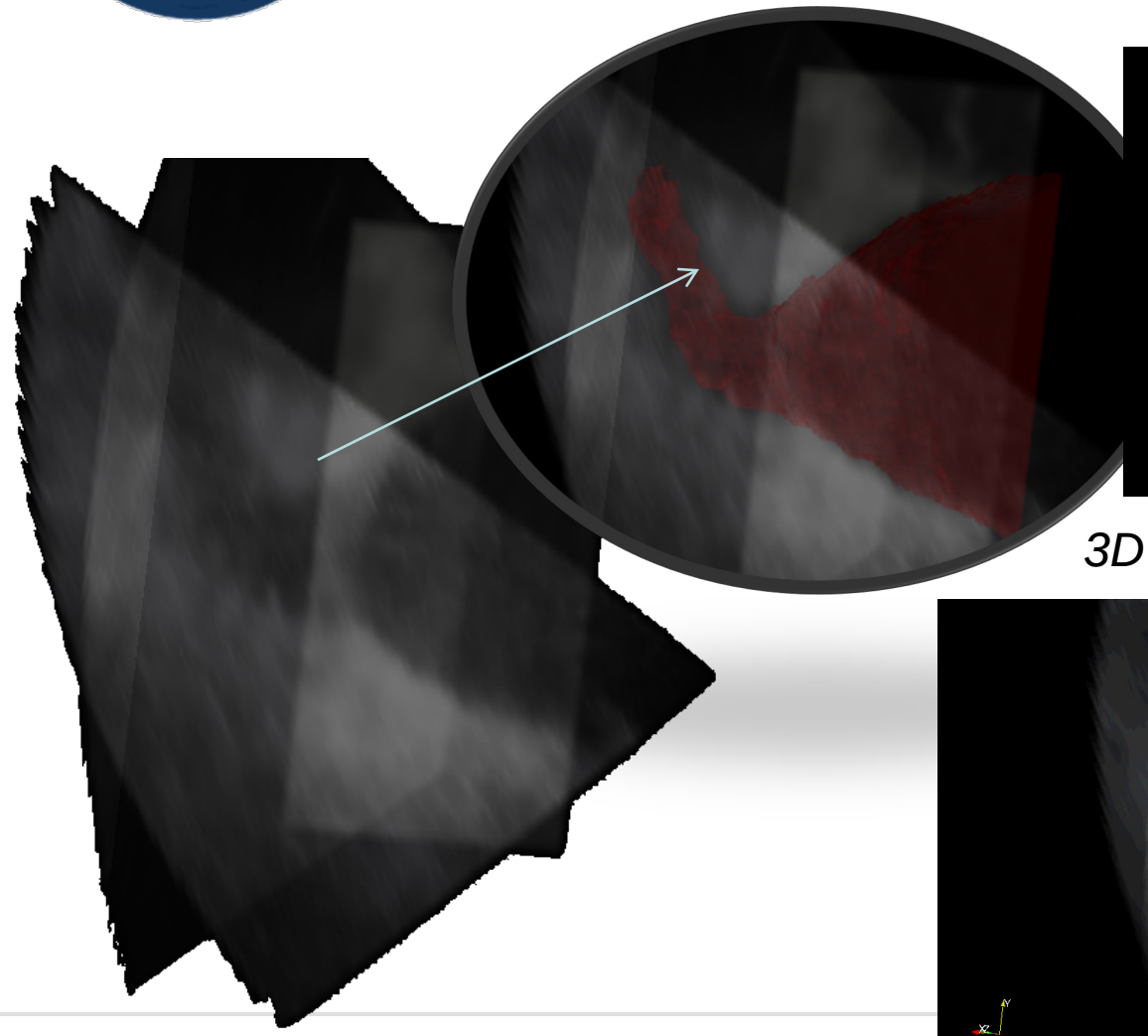
3D+Time TEE example –

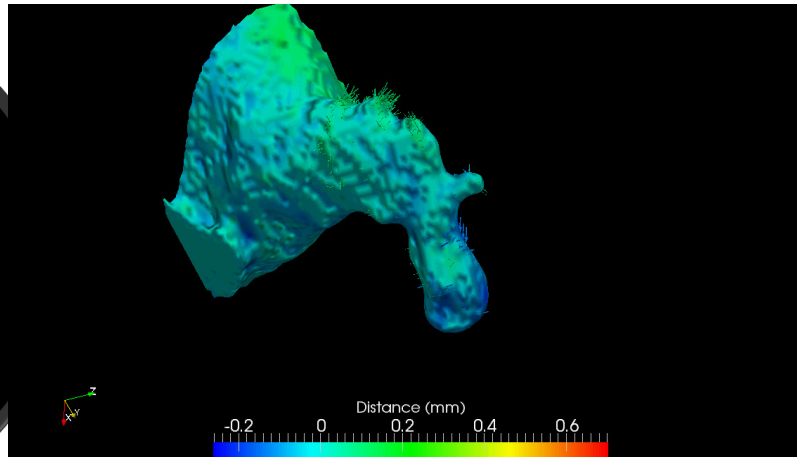
Using Echocardiography Images

Carnegie Mellon University

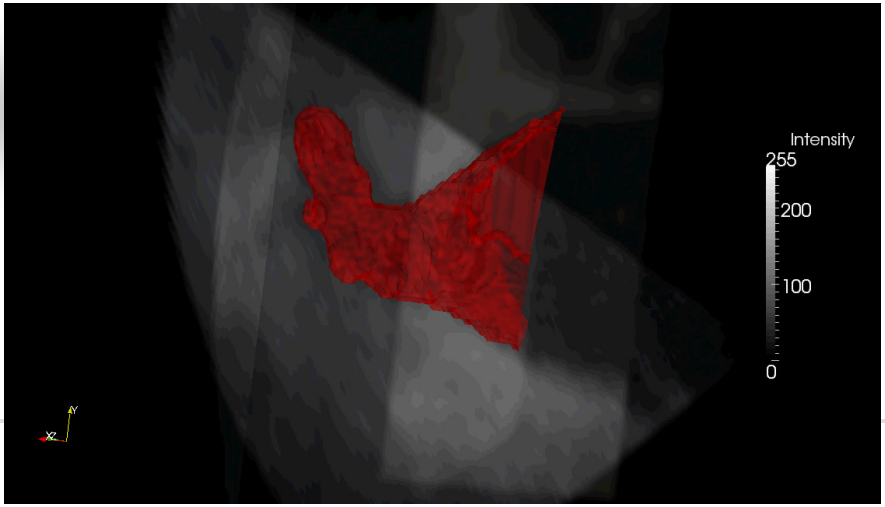
Left Atrial Appendage

The MeDCaVE™

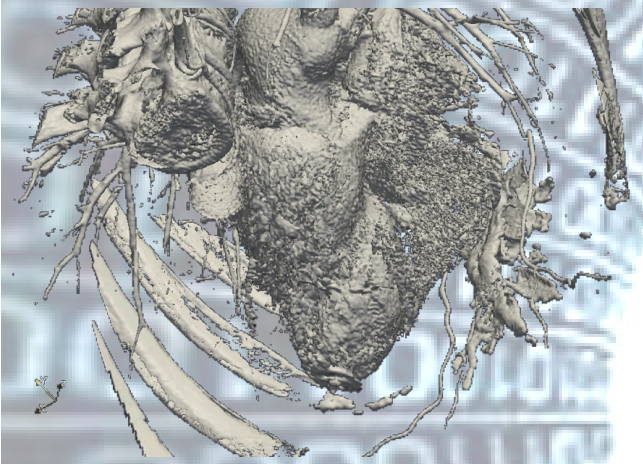


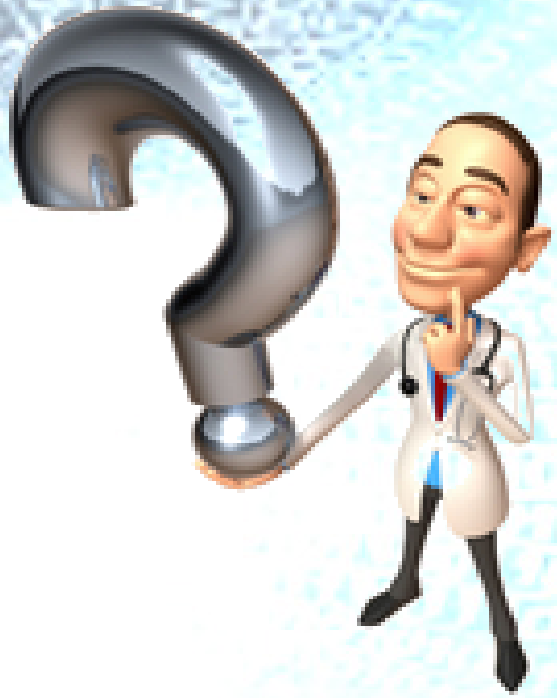


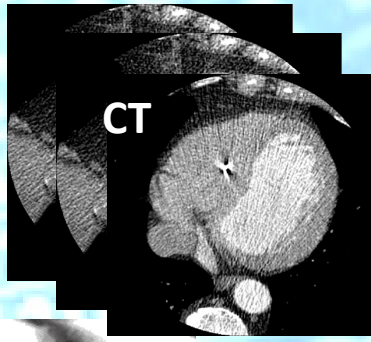
3D reconstruction & motion analysis

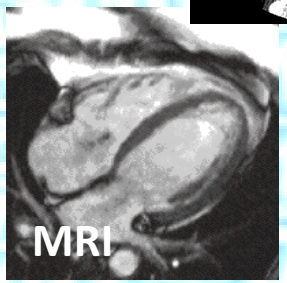


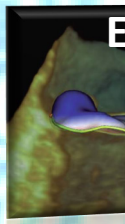
BIA 2014

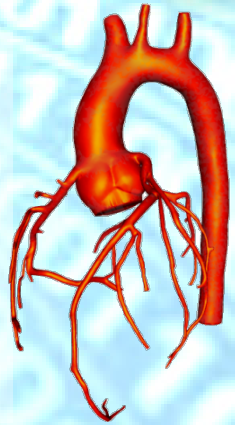












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