Fast Ultrasound Simulation in K-space

Torbjørn Hergum, NTNU

NTNU
Norwegian University of
Science and Technology

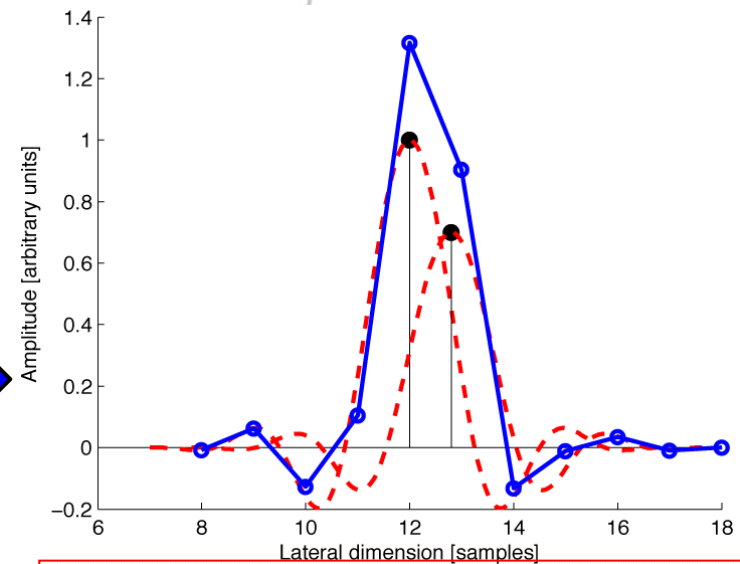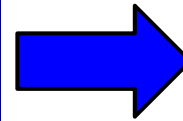# Fast Ultrasound Simulation in K-space

- Want tool for validation of 3D quantitative methods

- *Fusk* = Fast Ultrasound simulation in K-space

- *Fusk* simulates one frame of a 3D ventricle in ~20 seconds

- Point scatterers as input object, for instance from FEM-simulations
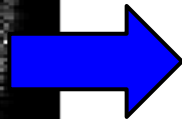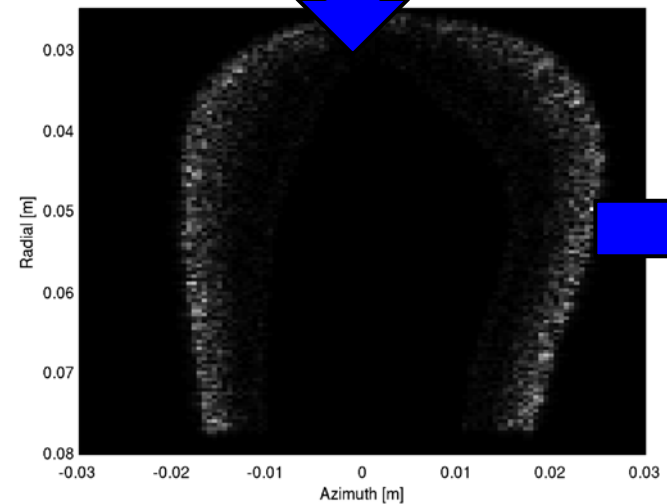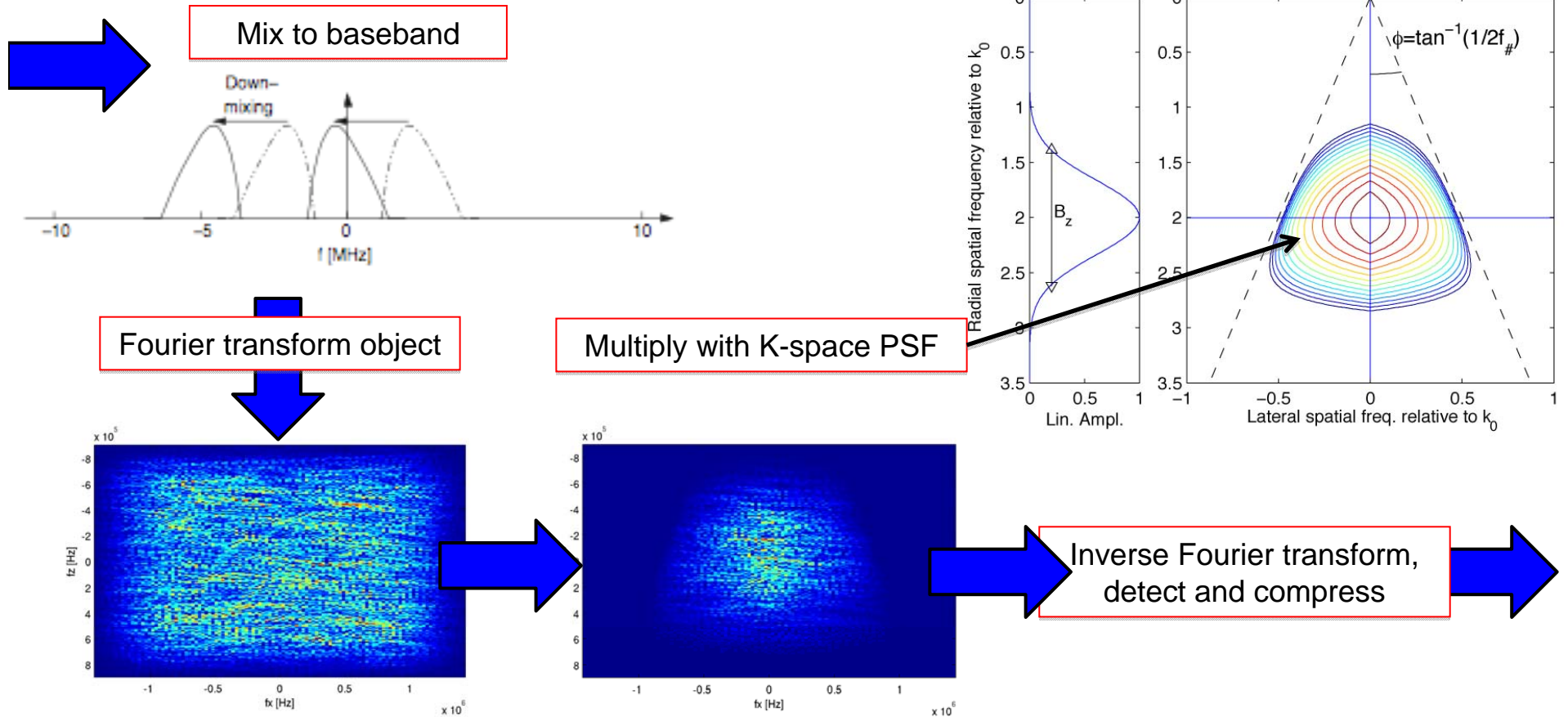

NTNU
Norwegian University of Science and Technology
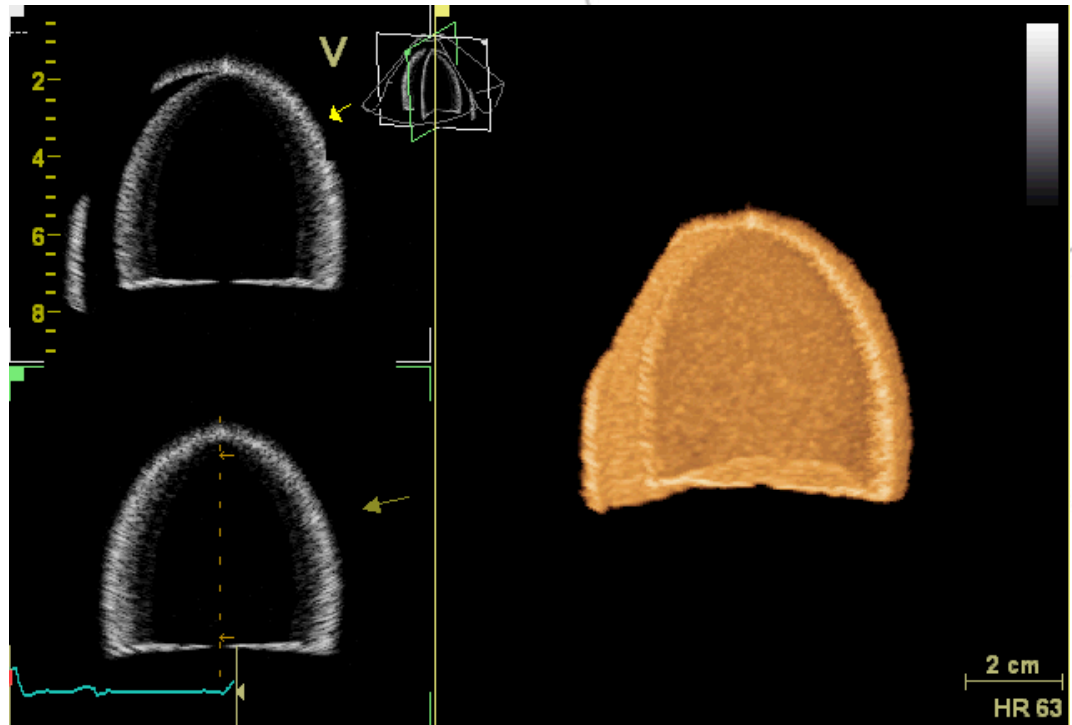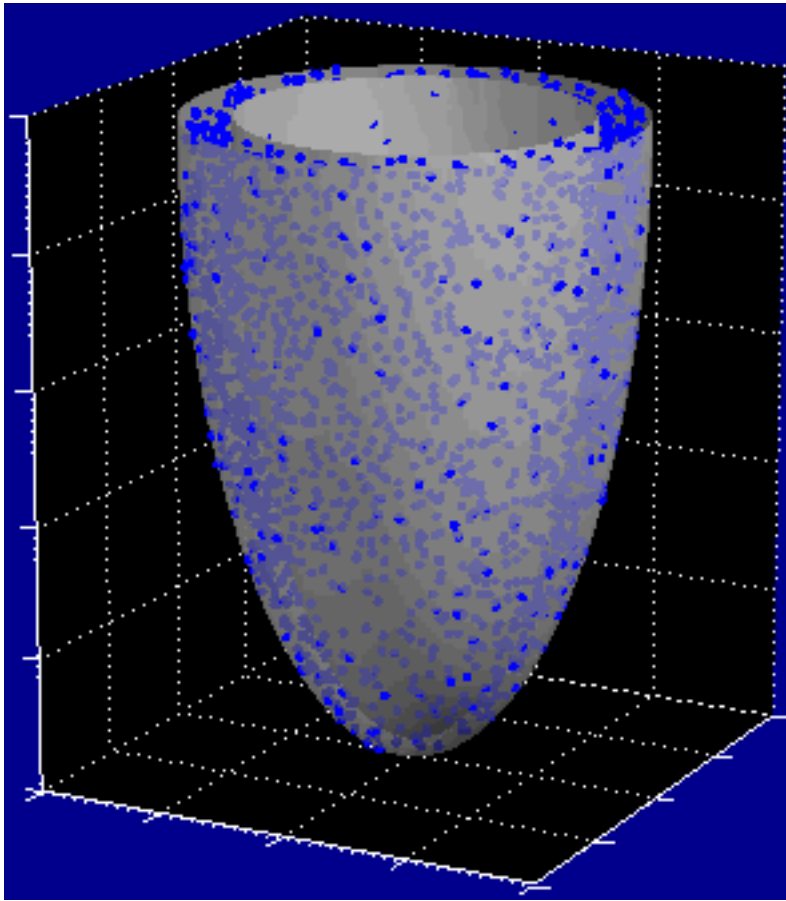
Fusk - the works

Dynamic object w. point scatterers (infinite resolution)

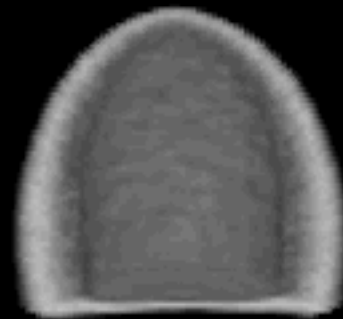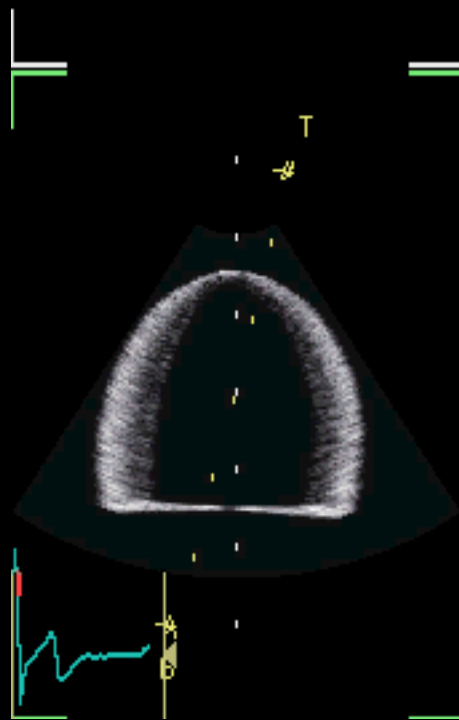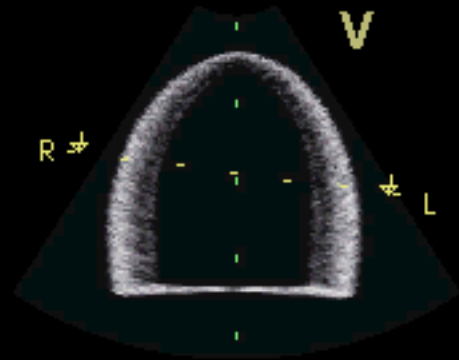Limit to beamspace resolution (anti-aliasing)

Fusk - the works

Mix to baseband

Fourier transform object

Multiply with K-space PSF

Inverse Fourier transform, detect and compress

$\phi = \tan^{-1}(1/2f_{\#})$

NTNU
Norwegian University of
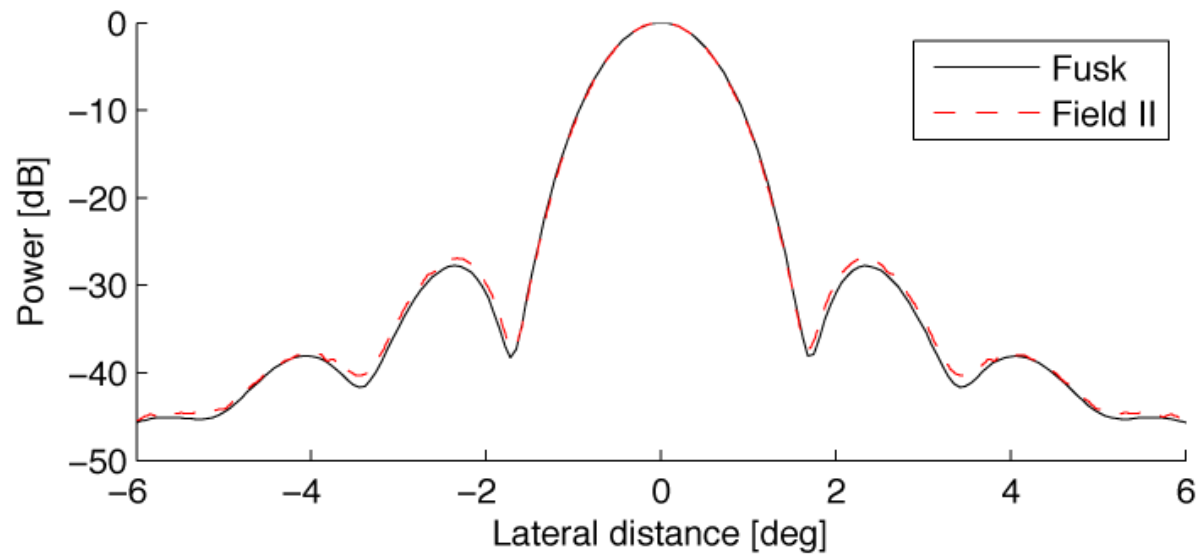Science and Technology
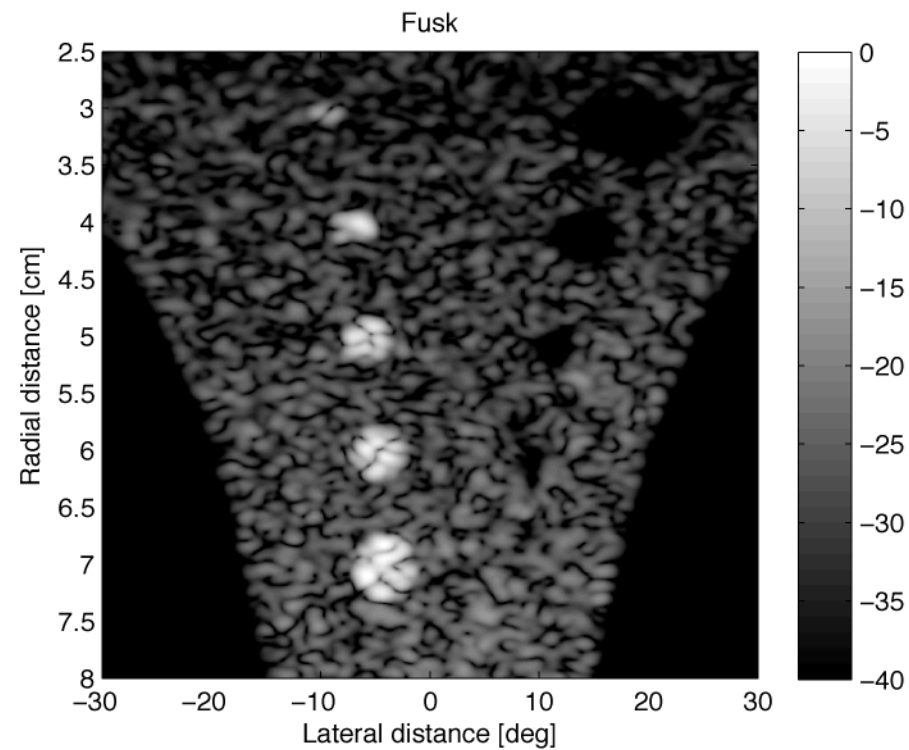
Fusk - the works
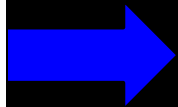
Simulated ultrasound image

HR 53

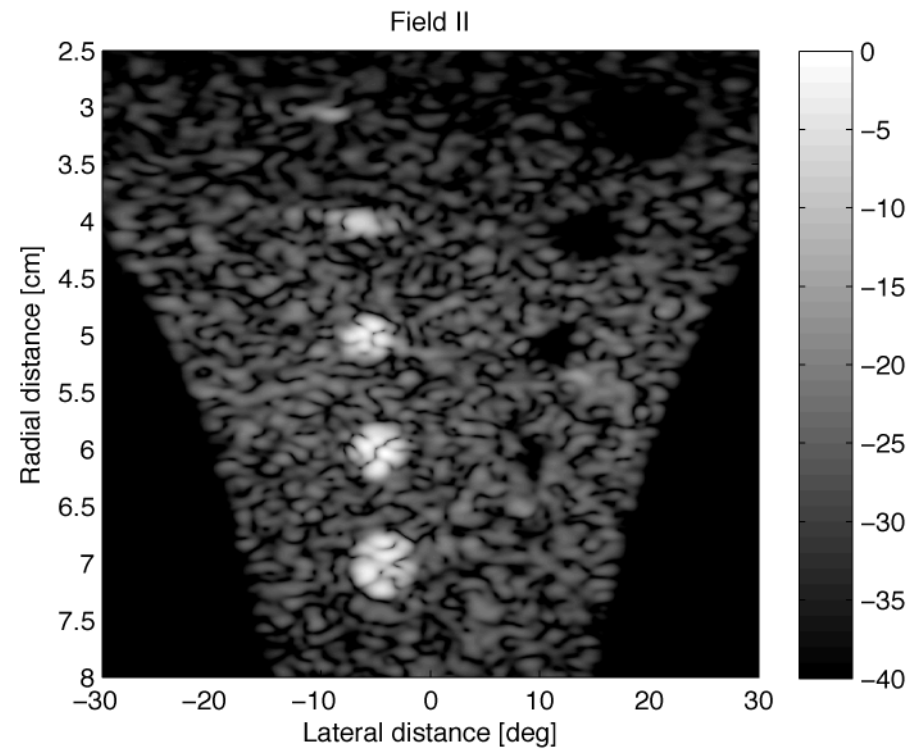# Results

Comparing beam
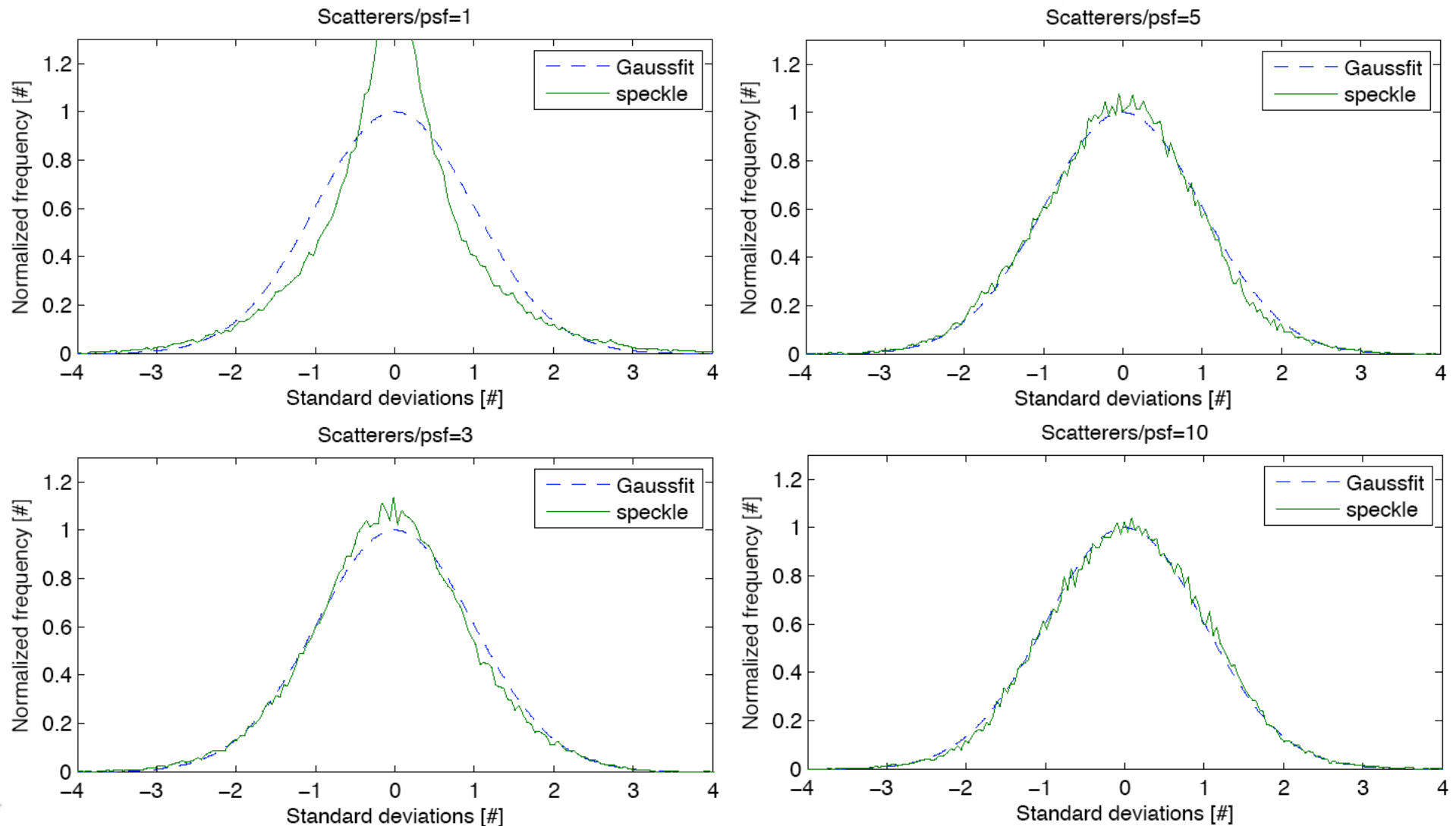profiles with Field 2

Results

Comparing cyst phantoms

Results

Comparing cyst phantoms

- Similar speckle pattern
- Varying gain
- 7200 times slower!

NTNU
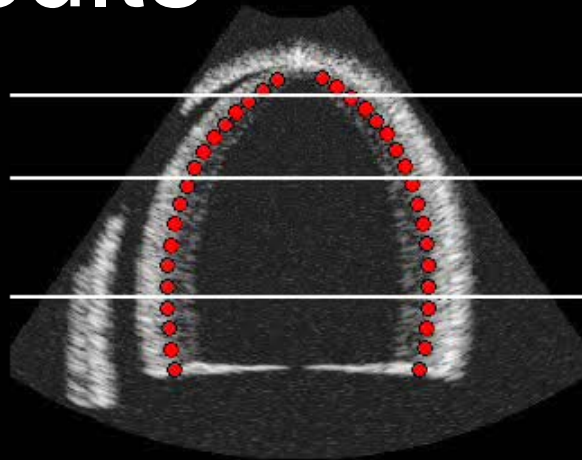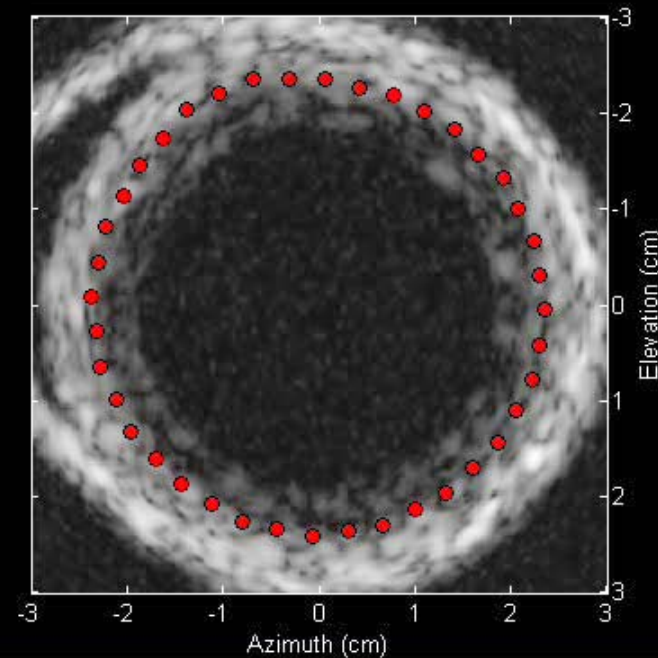Norwegian University of
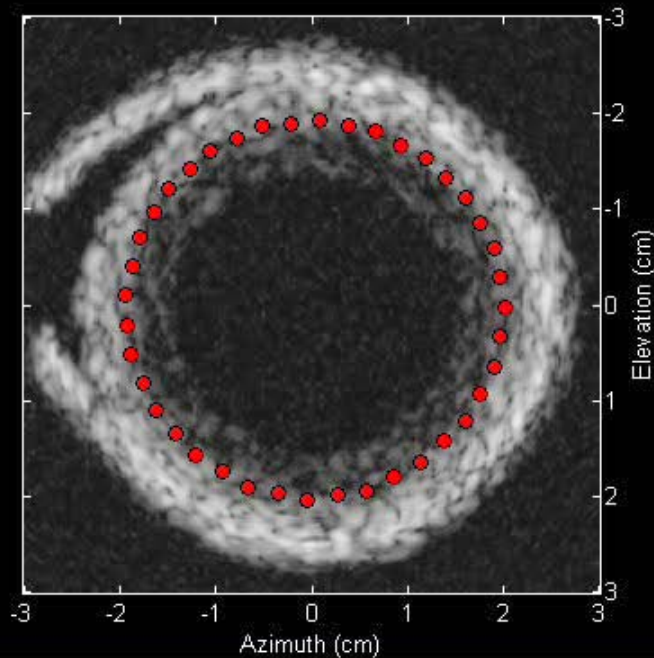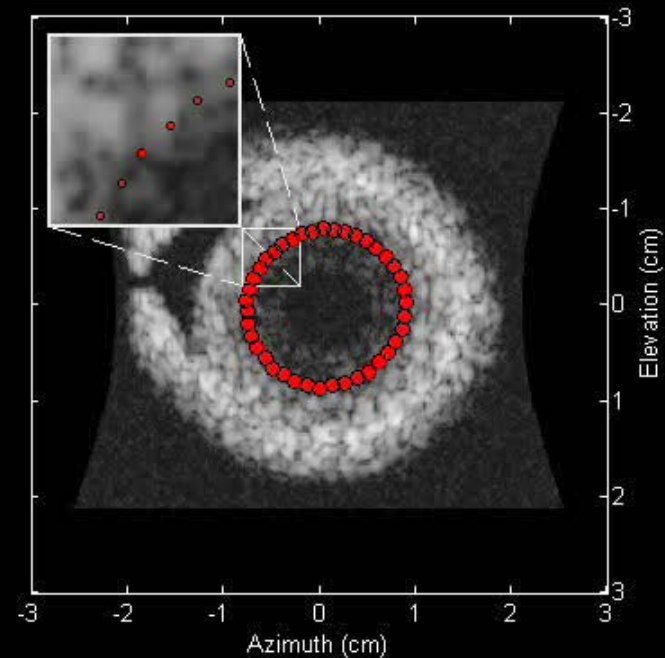Science and Technology

Scatterer density, random pos.

Results

Testing 3D speckle tracking

Testing automated volume measurements
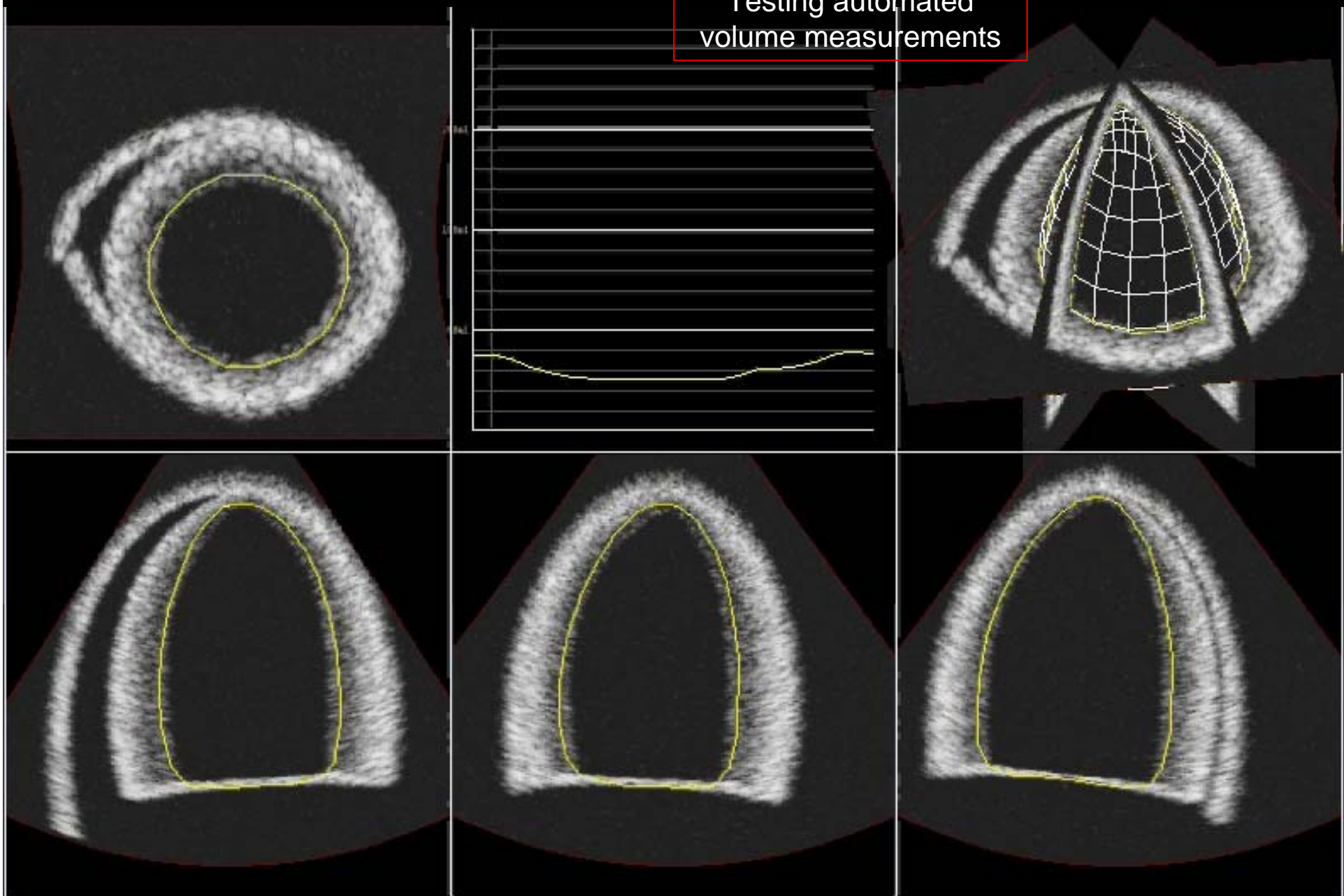
Figure by Fredrik Orderud
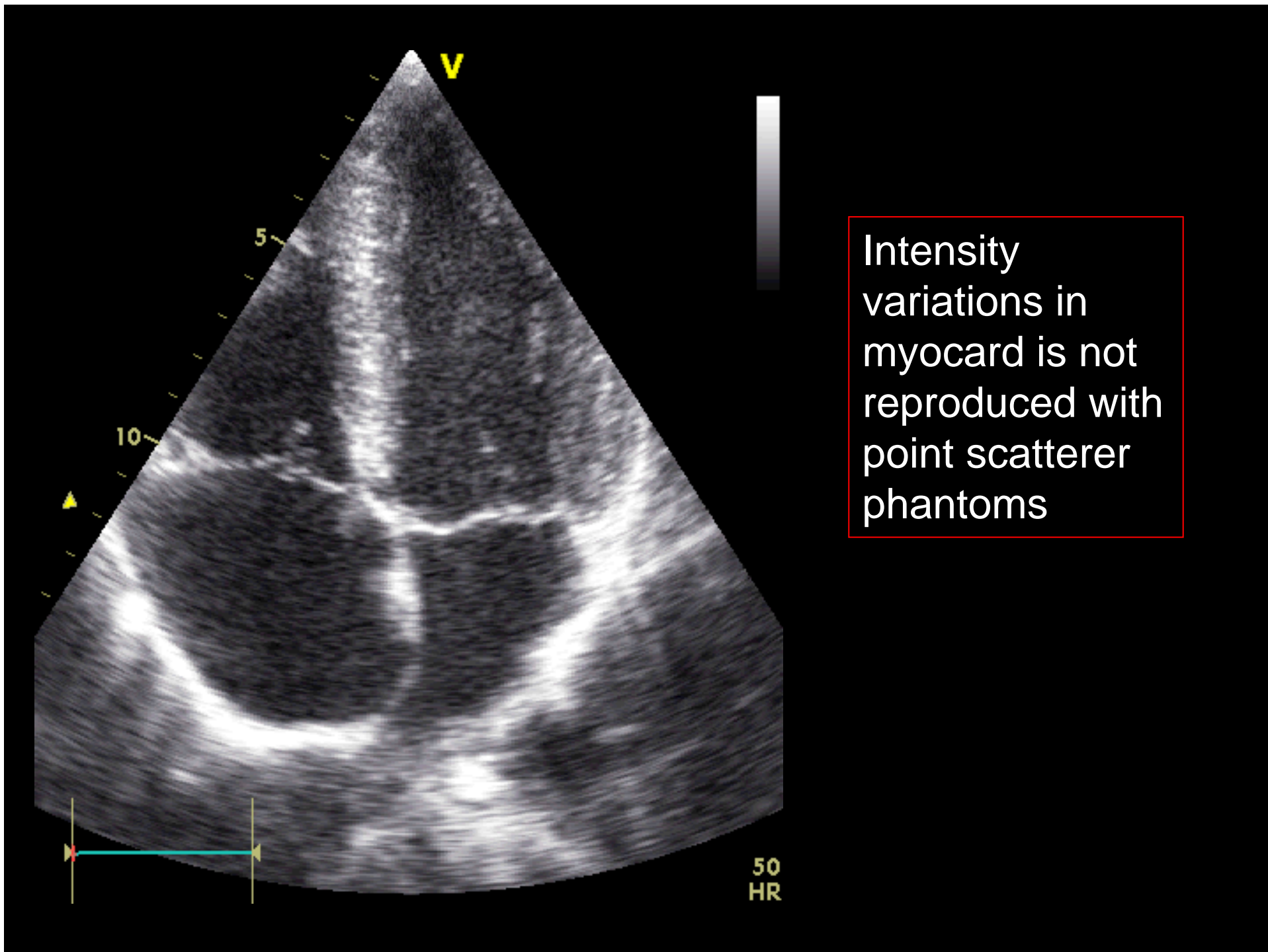
Intensity variations in myocard is not reproduced with point scatterer phantoms

Backscatter depends on fiber angle

Examining septum from different angles makes the bright line shift sideways

Backscatter depends on fiber angle

Examining septum from different angles makes the bright line shift sideways
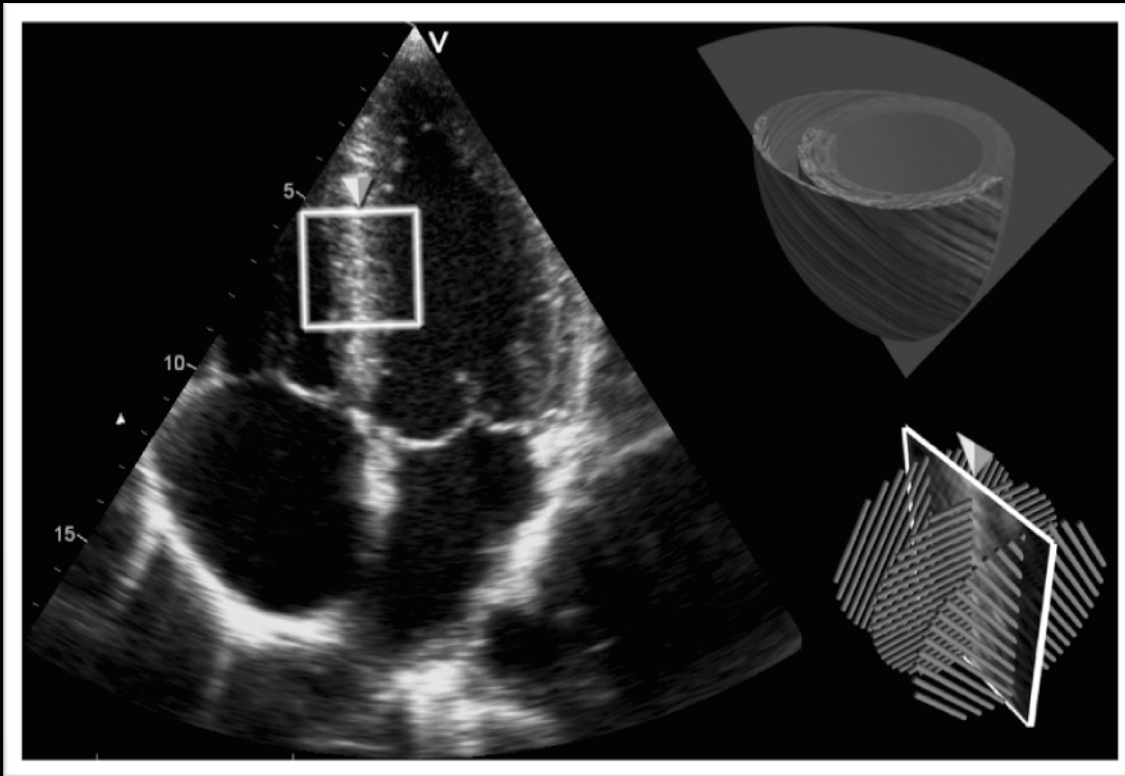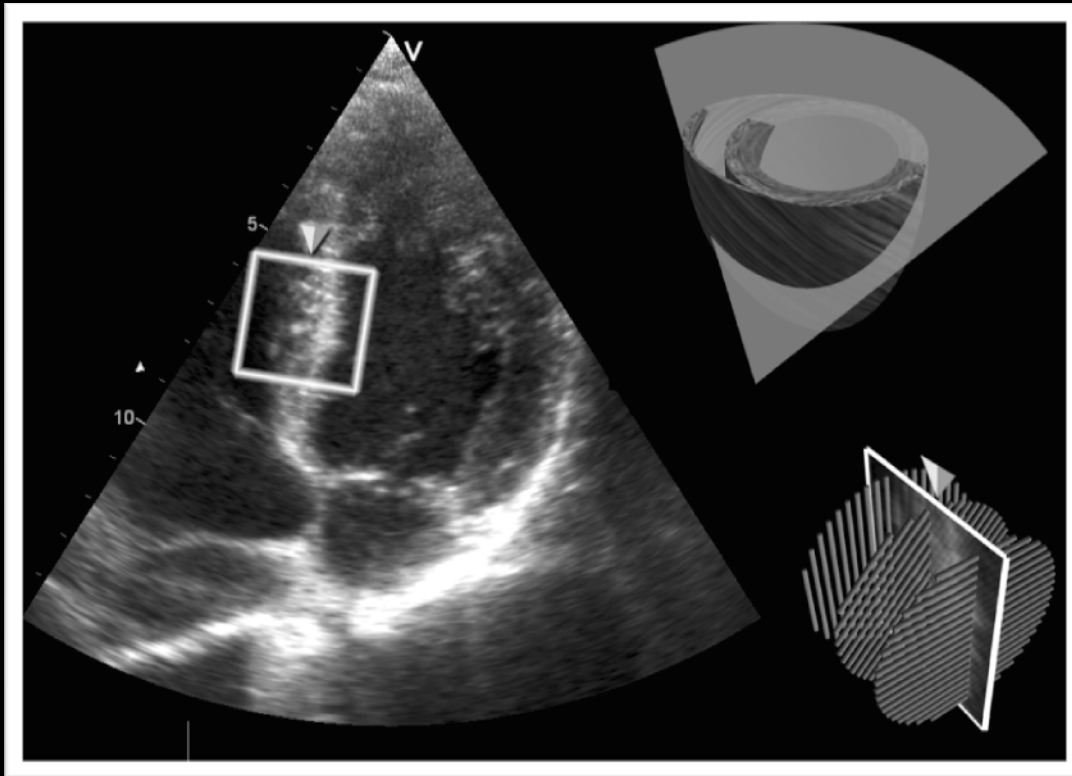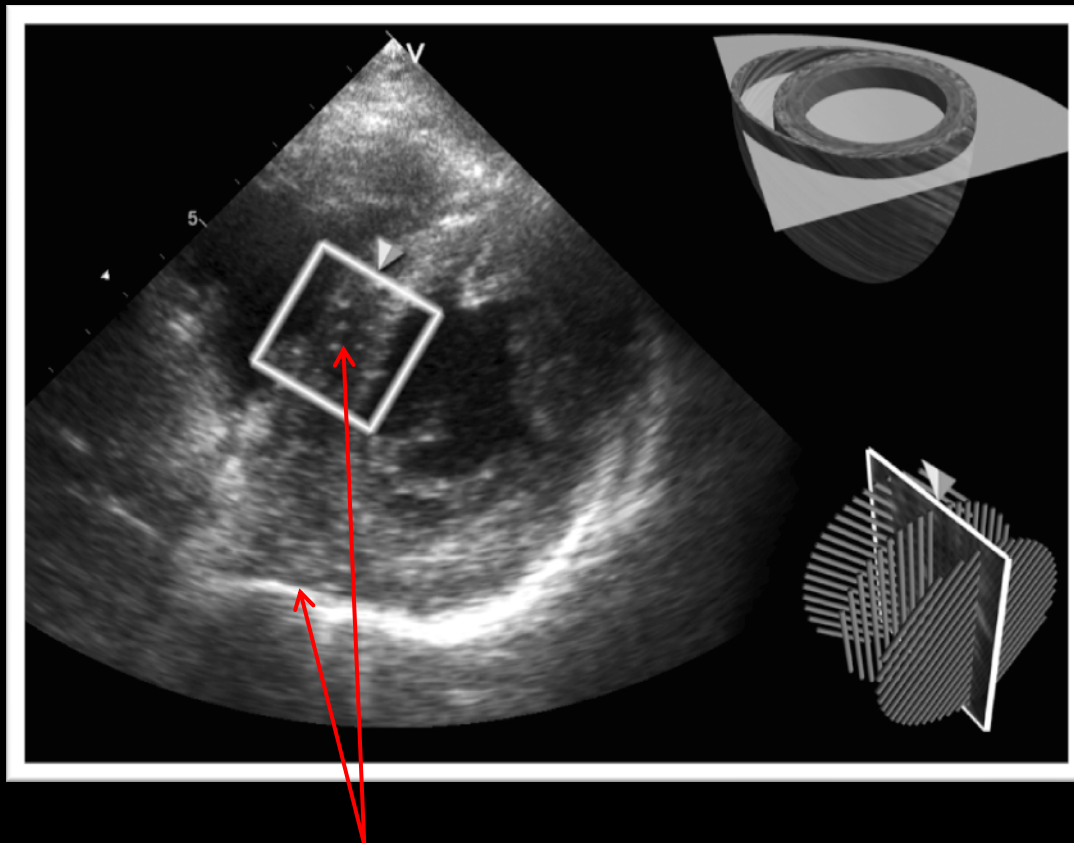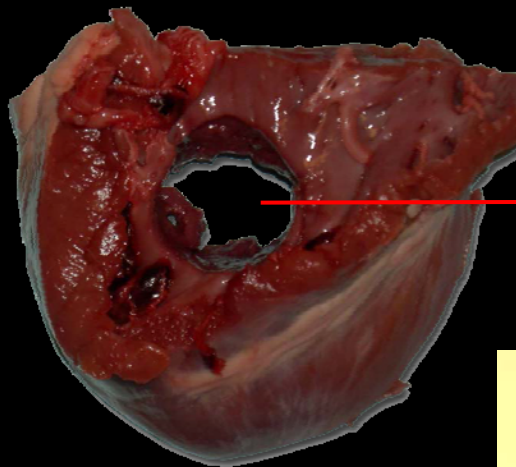
Backscatter depends on fiber angle

Examining septum from different angles makes the bright line shift sideways

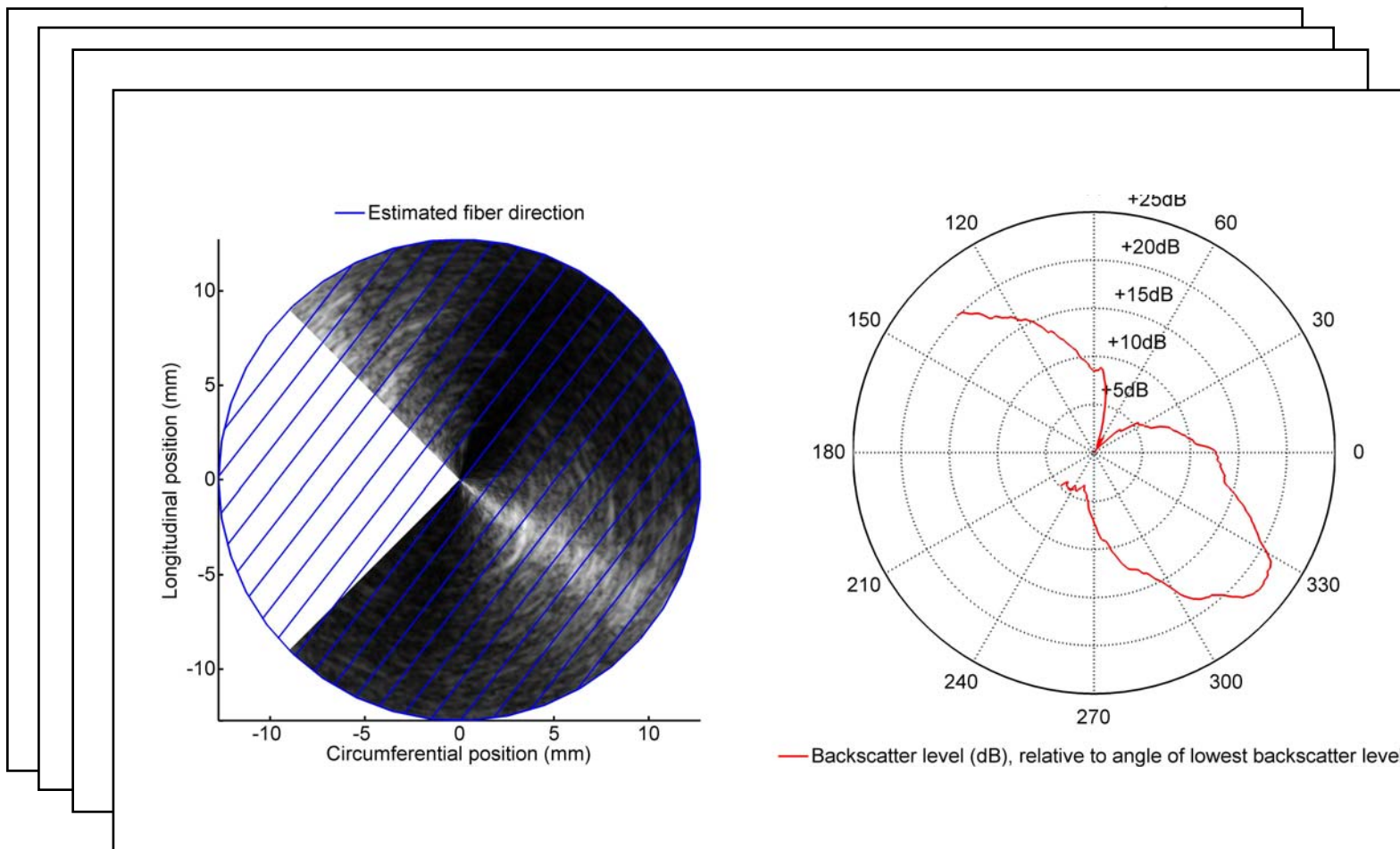Backscatter void not just attenuation: no shadow beneath
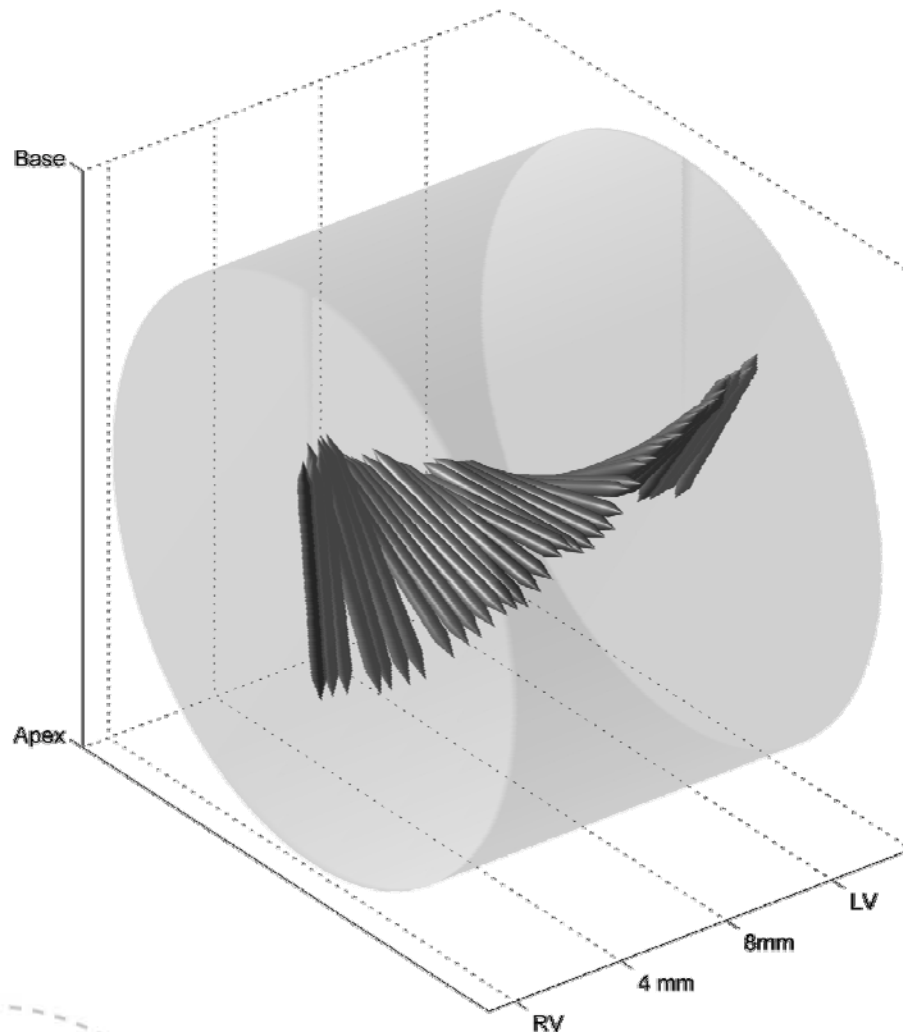
Estimation of

Porcine septum

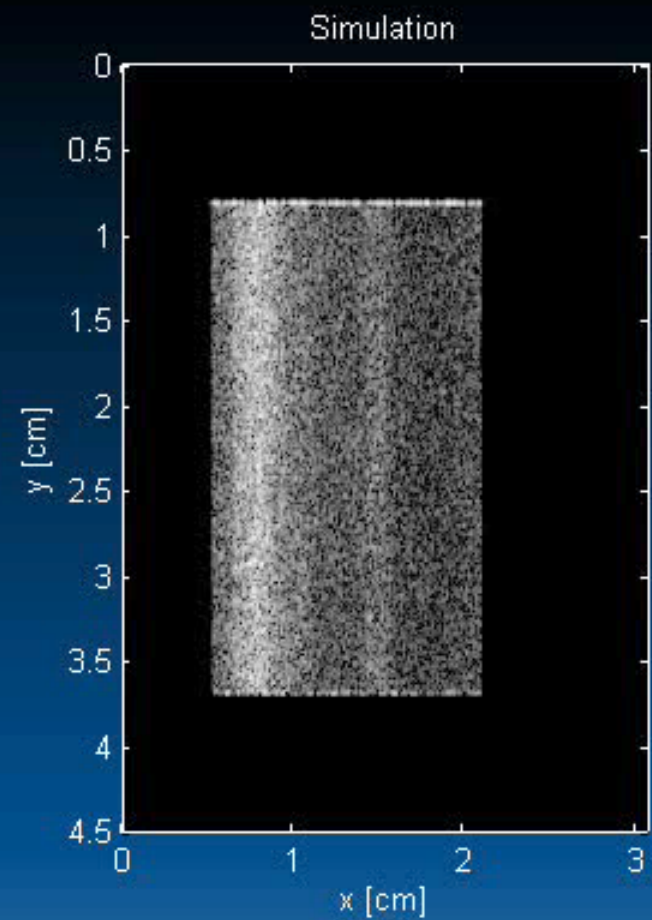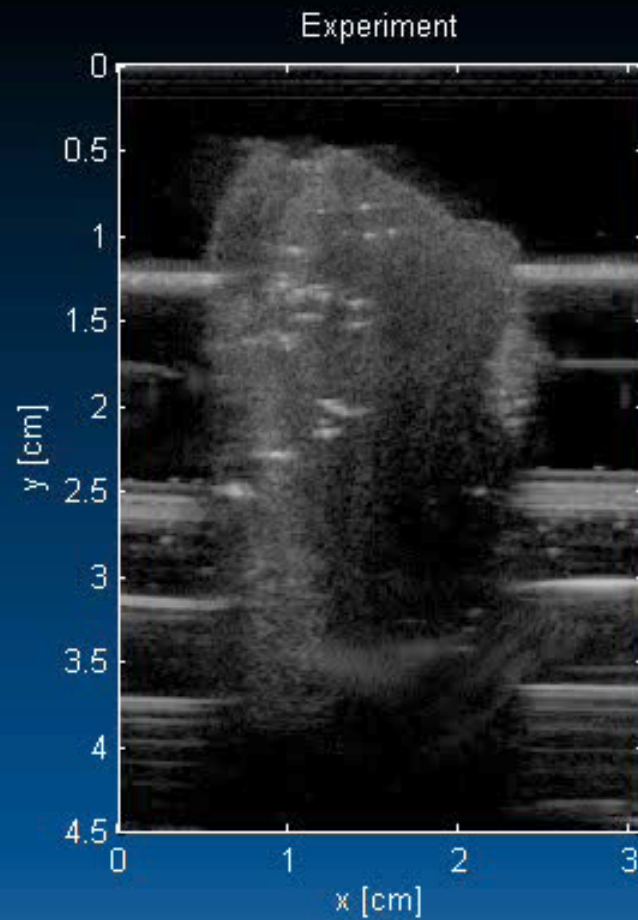# Fiber direction estimated for layers through septum

Estimated fiber angle of the sample

- These fiber angles used for simulation
- Initially point scatterers with gaussian amplitudes
- Filtered with directional smoothing

Result

Experiment

Simulation

Bright line in simulations matches reality