

Call Agenda (2014-01-17)

Moderator: Palmeri

- Review / approve [minutes](#) from last meeting
- Simulation study
 - Material models to simulate (Dr. McAleavey)
 - FEBio implementation update (Dr. Jiang)
 - Ultrasonic configurations to simulate (Dr. Palmeri)
 - Software packages to compare / contrast
 - Point-people for each package
- Sharing "raw" data formats (Dr. Palmeri)
 - A. Samir has clinical data that does *not* currently include raw data
 - What would the research / industry community want in raw data?
 - Test data formats in simulation data output (already available for elastic simulation)
 - Matlab?
 - Generic binary data w/ readers for different formats?
 - DICOM?
 - What raw data is available from Phase I (and will be from Phase II) studies
- Feedback from subcommittee members on the call frequency and the days for the "combined" call (Mondays, 1pm CT vs. Fridays, 11 am CT)

Copyright (C) 2014 Radiological Society of
North America

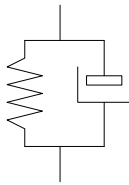
Simulation Study Updates

- Material model / finite-difference code (Steve)
- FEBio development (JJ)
- Simulation code-base (Mark)

Copyright (C) 2014 Radiological Society of
North America

FDTD model

Voigt-Model



$$\sigma = \left[\mu + \eta \frac{\partial}{\partial t} \right] \varepsilon$$



Program GPUs with OpenCL

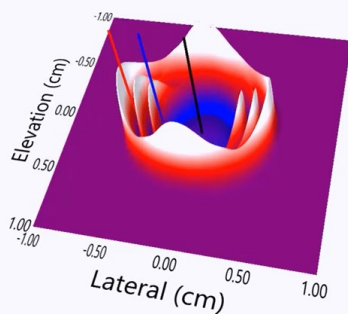
Input API
 → Material Properties
 → Beam Shape
 → PRF
 → Tracking Setting

OpenCL based Kelvin-Voigt FDTD Model

Postview, reconstruction software
 → same algorithms used for imaging

Copyright (C) 2014 Radiological Society of North America

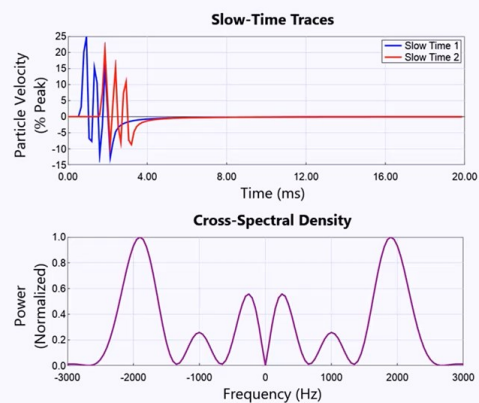
FDTD simulation of SMURF in elastic material



Model

$\mu = 4$ kPa
 $\eta = 0.00$ Pa·s
 $f_s = 7.50$ kHz
 FWHM = 0.50 mm

Total Time = 20.0 ms
 Display Time = 2.0 ms

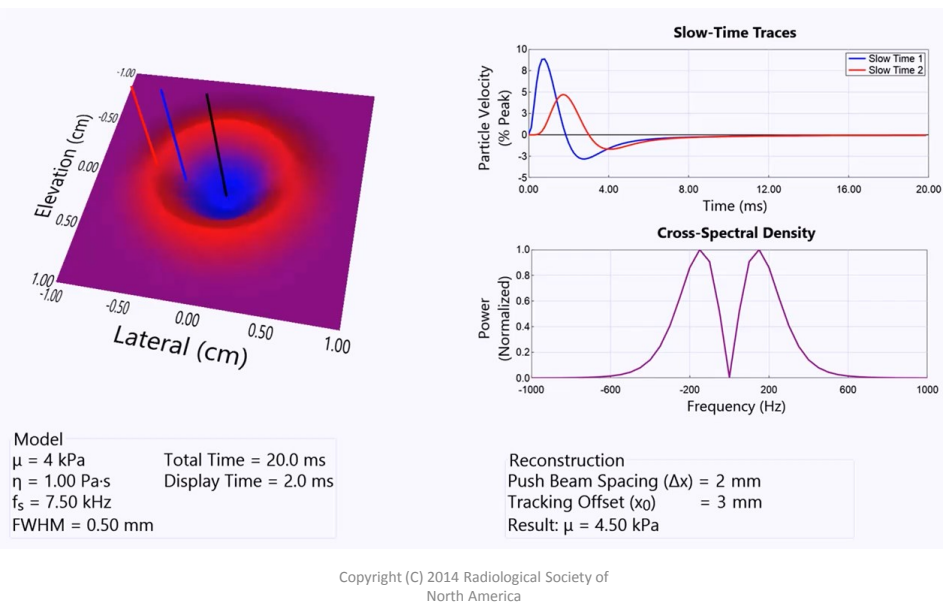


Reconstruction

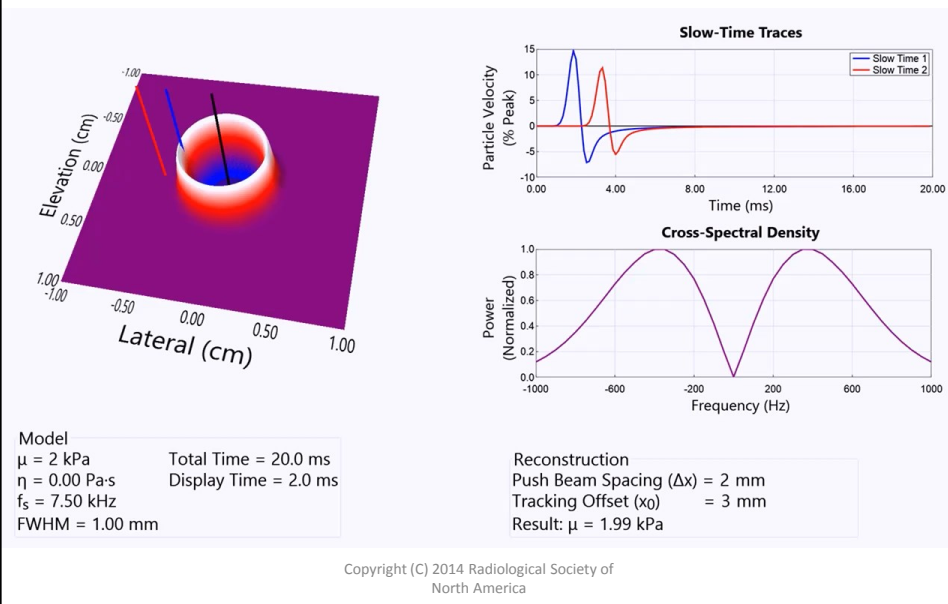
Push Beam Spacing (Δx) = 2 mm
 Tracking Offset (x_0) = 3 mm
 Result: $\mu = 4.04$ kPa

Copyright (C) 2014 Radiological Society of North America

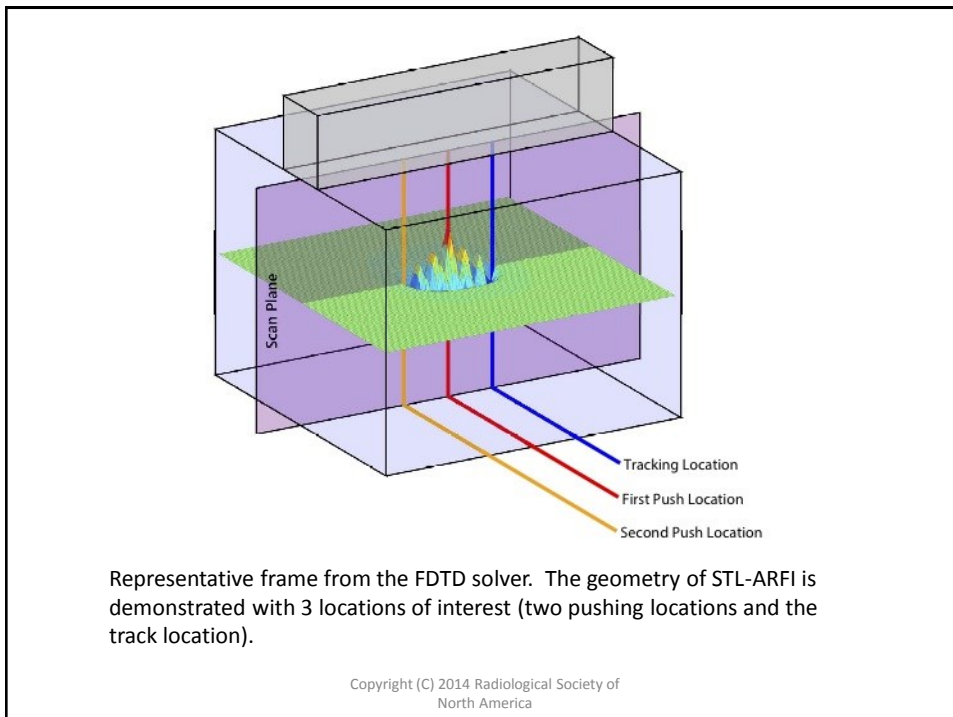
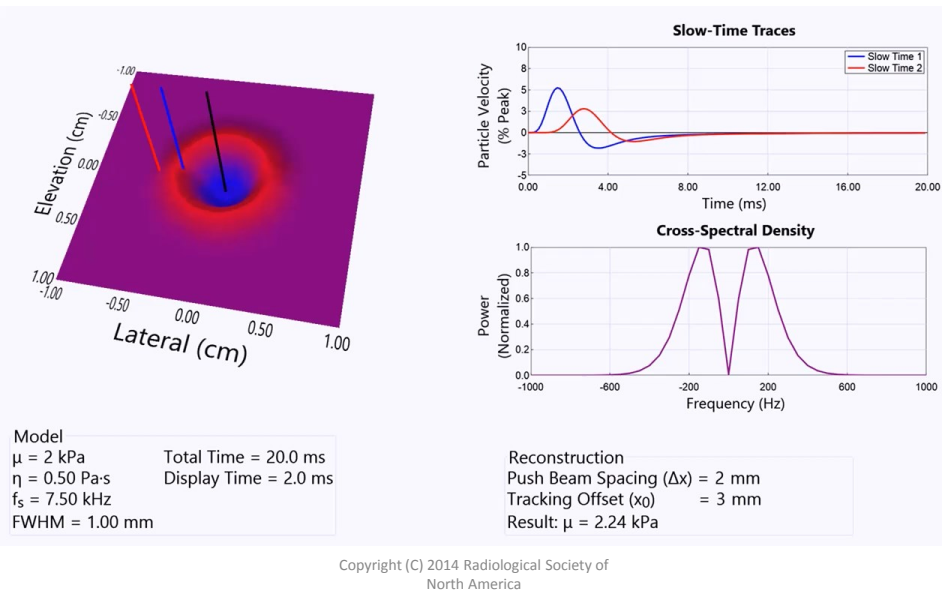
FDTD simulation of SMURF in viscoelastic material



FDTD simulation of STL-ARFI in elastic material



FDTD simulation of STL-ARFI in viscoelastic material



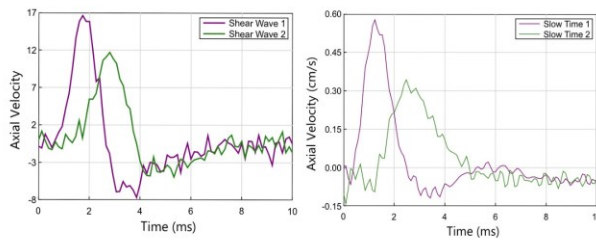


Figure 2: Representative traces from the FDTD simulation software (left) and traces generated in our real-time viscosity processing software (right) discussed in Aim 3. The FDTD simulation reproduces the attenuation, dispersion, noise, and tracking positions of the experimental STL-ARFI data.

Copyright (C) 2014 Radiological Society of North America

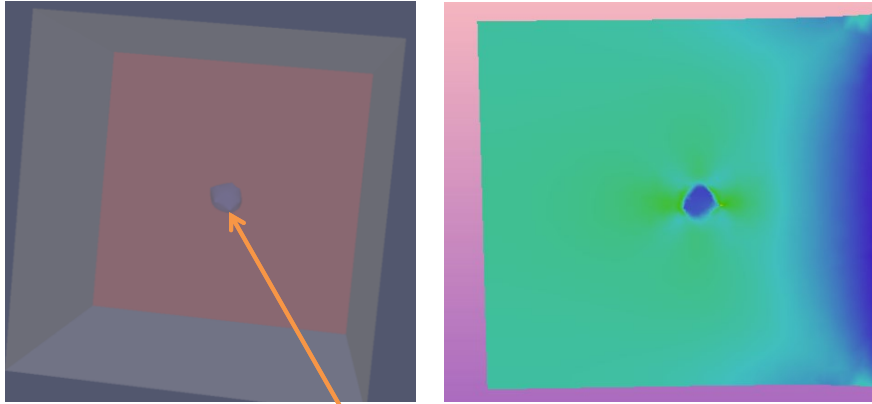
Progress of FEBio Simulations

- Overall approach:
 - Simple message/file passing using command line between two open source packages
 - Tetgen: Mesh generation for tetrahedrons
 - FEBio: Open source FEM solver for biomechanics
- Progress:
 - Automated numerical phantom creation -- Embed arbitrary shaped targets into background
 - Perform static simulations
 - **Work in progress toward implementation of acoustic pulses as dynamic mechanical stimuli**

Copyright (C) 2014 Radiological Society of North America

One Example

Strain animation of a cutting plane



Arrow points to the an arbitrary target

Surfaces can be labelled (e.g. red, blue and gray) for applying boundary conditions

Copyright (C) 2014 Radiological Society of North America

Available Code

- Meshing tools
- Field II implementation
- Tracking implementation
- Post-processing tools



- <https://github.com/Duke-Ultrasound/fem>
- <https://github.com/Duke-Ultrasound/ultrack>

Copyright (C) 2014 Radiological Society of North America

Raw Data Sharing

- Currently available elastic FE data:
 - Matlab-format
 - Focal configurations used in Duke Phase I phantom characterization
 - Dataset: Displacement data in imaging plane as a function of lateral position, depth and time
- Utilization? None?

Copyright (C) 2014 Radiological Society of
North America

What would be useful?

- Why hasn't existing data been utilized?
 - Format?
 - Matlab
 - "Rawer"
 - DICOM?
 - No need? What would researchers / industry use these data for?
- Phase I / II phantom data?
- More simulation data?
- Commercial data?

Copyright (C) 2014 Radiological Society of
North America

Collective Feedback

- Feedback from subcommittee members on the call frequency
 - How much time b/w complete committee calls and subcommittee calls?
- and the days for the “combined” call
 - Mondays, 1pm CT
 - Fridays, 11 am CT

Copyright (C) 2014 Radiological Society of
North America