Numerical Modeling of Ultrasonic Data for Elastography

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Overview

1. **Introduction**
   - Elastography: definition
   - Ultrasonic signals analysis
   - Block-diagram of the elastography method
2. Transducer Simulation
3. Simulation of Ultrasonic Data
4. Deformation Modeling
5. Conclusion

1.1 Elastography: Definition

- *Elastography* is a non-invasive imaging technique for measurement and visualization of the mechanical properties of biological tissues

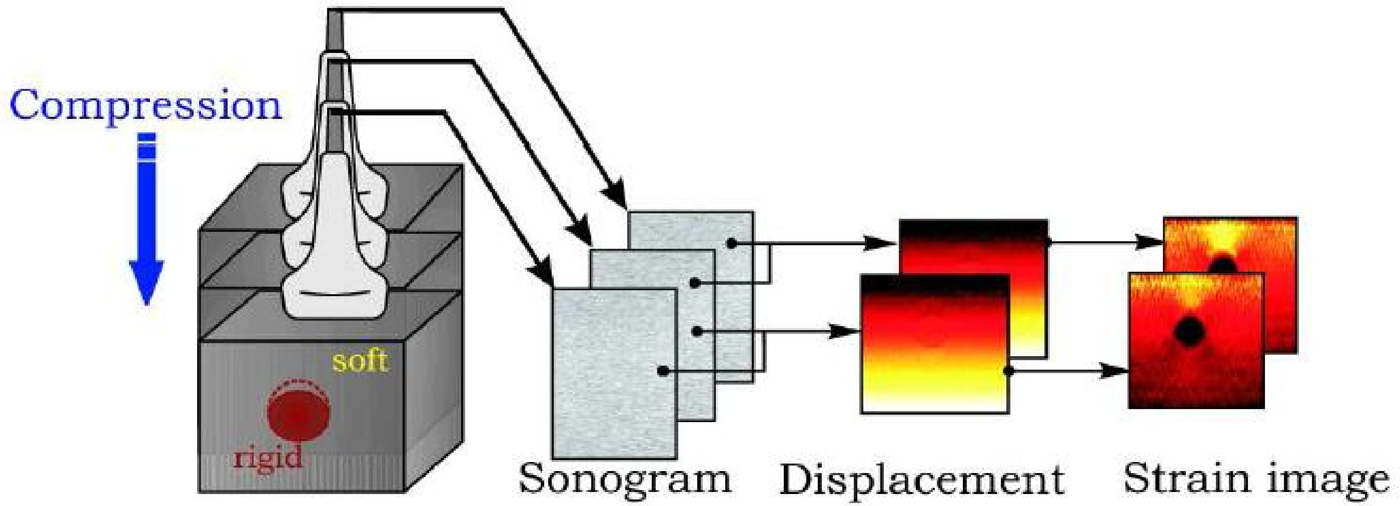


Fig. 1. Stages of producing elastogram

1.2 Ultrasonic Signals Analysis

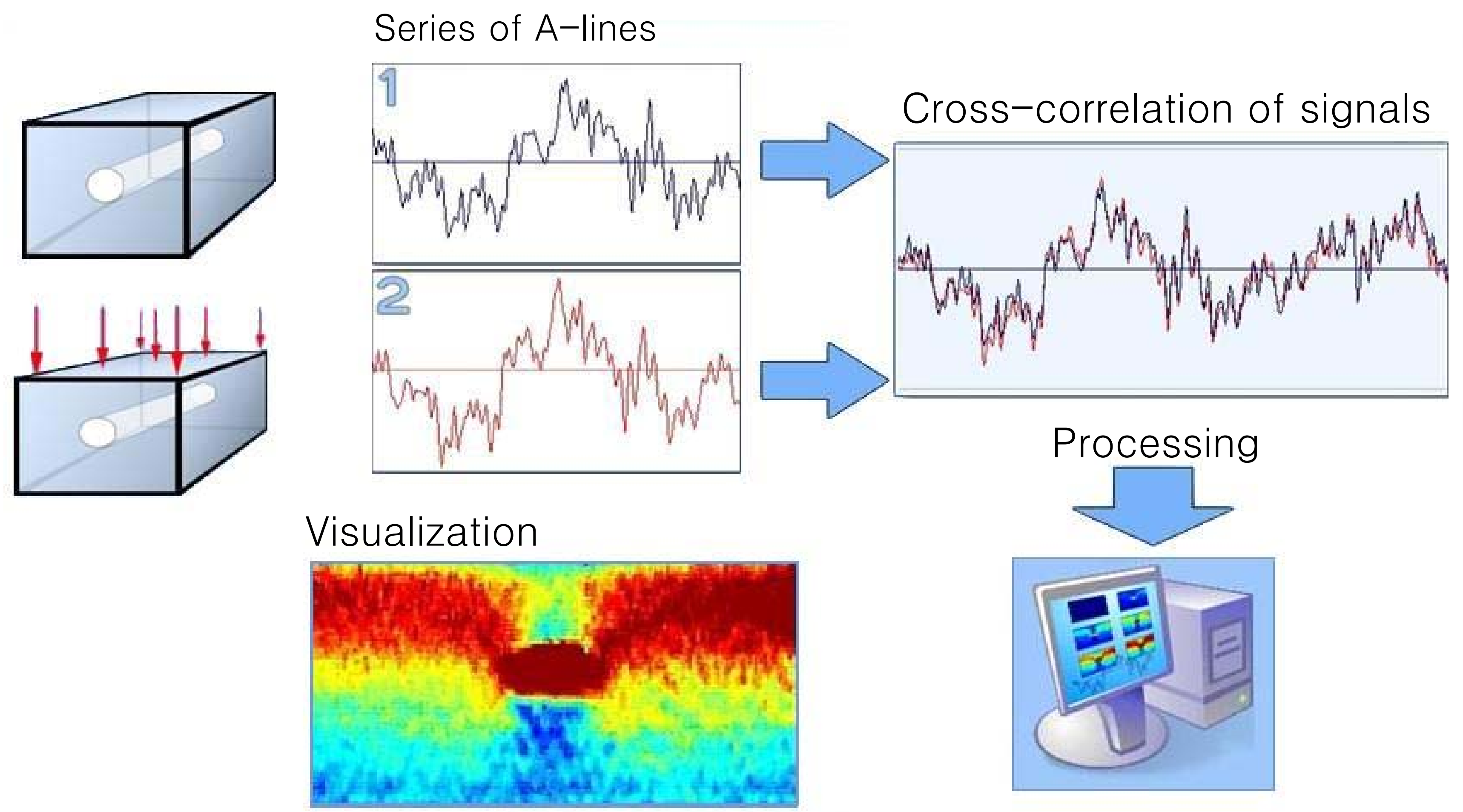
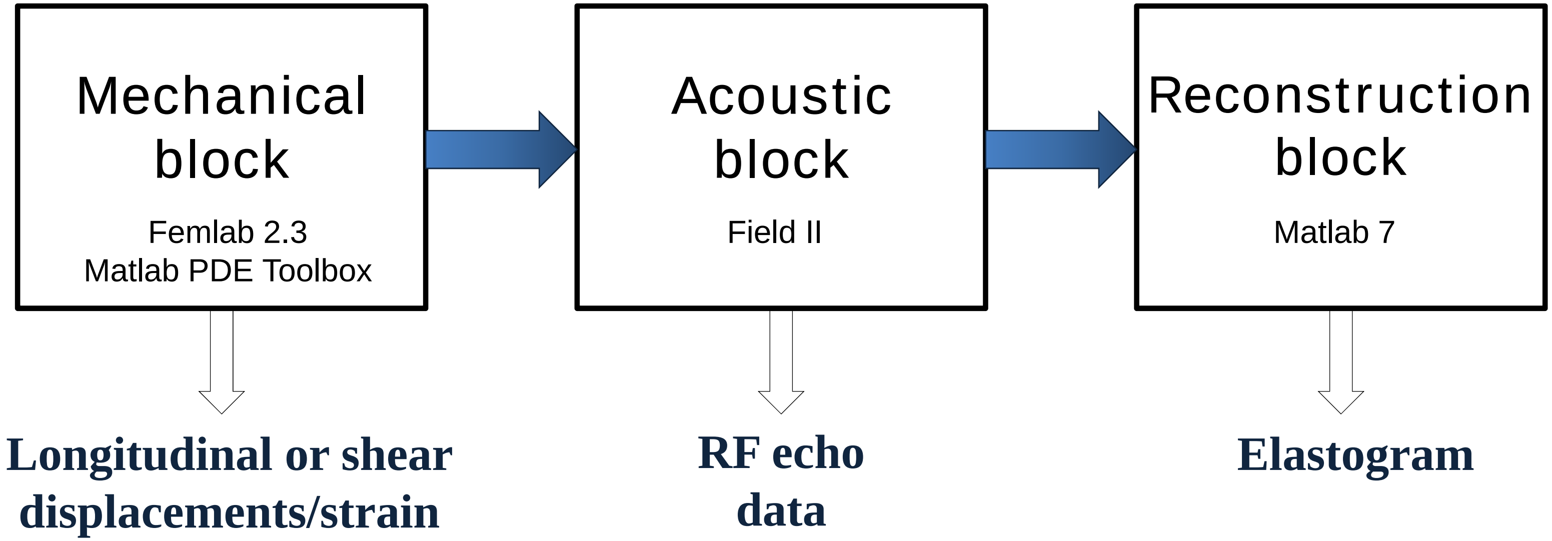


Fig. 2. Algorithm of strain estimation
from RF signals

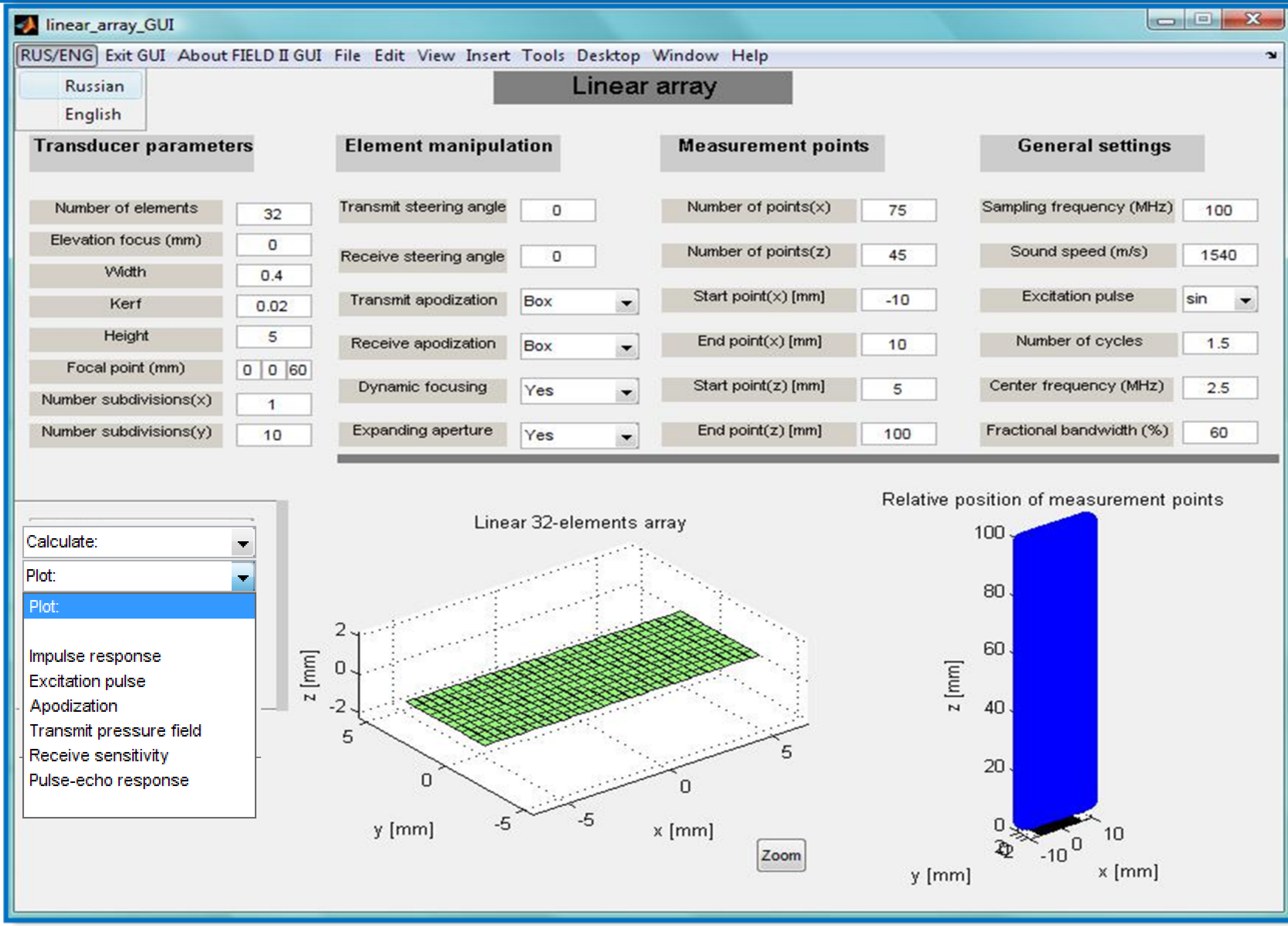
1.3 Block Diagram of the Elastography Method



Overview

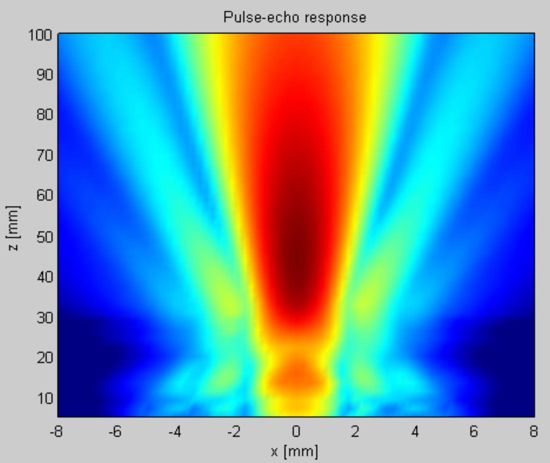
1. Introduction
2. **Transducer Simulation**
    - Modeling of linear array
    - Optimization of parameters
    - Comparison with experiment
3. Simulation of Ultrasonic Data
4. Deformation Modeling
5. Conclusion

2.1 Modeling of Linear Array

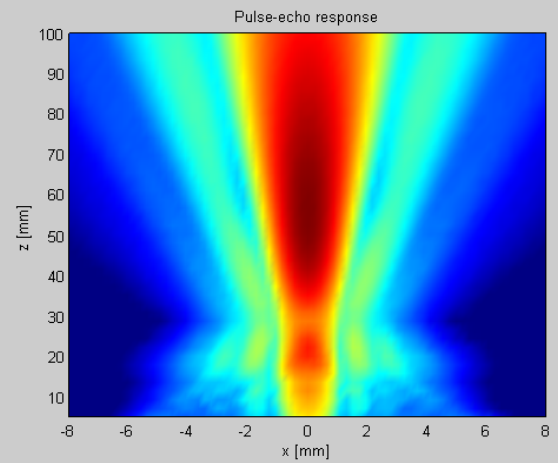


2.2 Optimization of Parameters

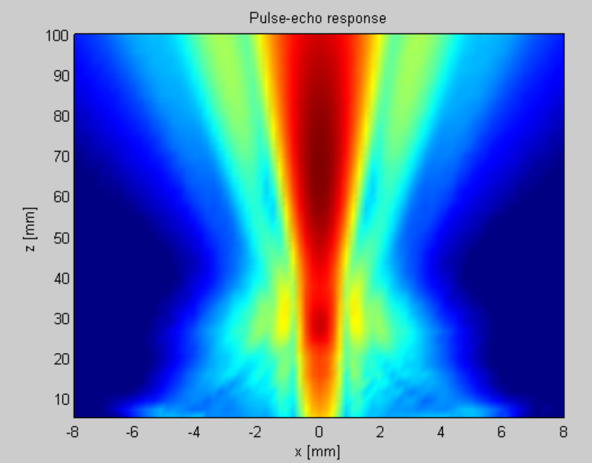
Transducer frequency



2.5 MHz

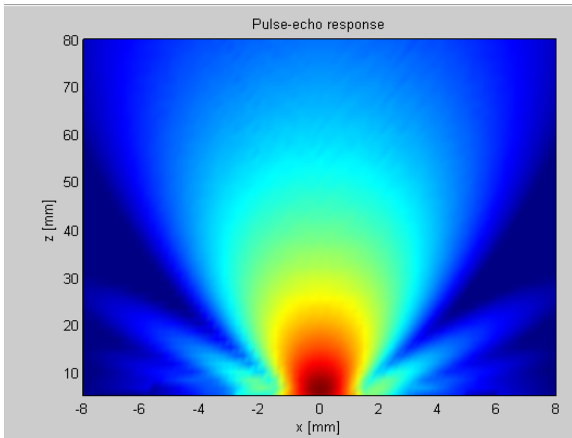


3.5 MHz

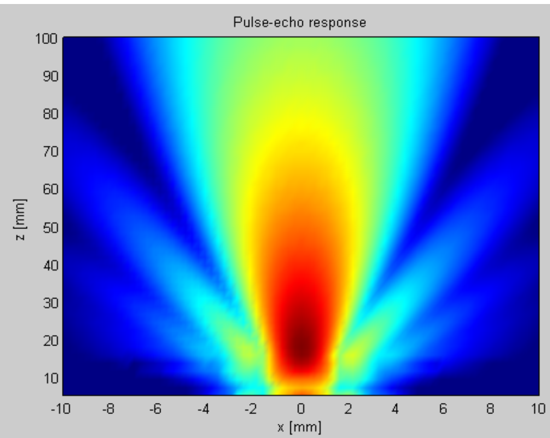


5 MHz

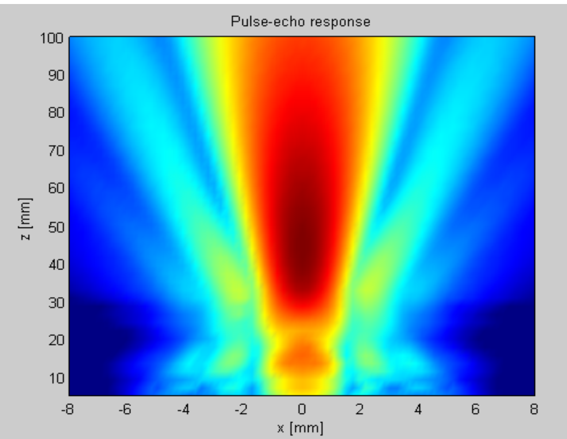
Aperture size



8 el.



16 el.

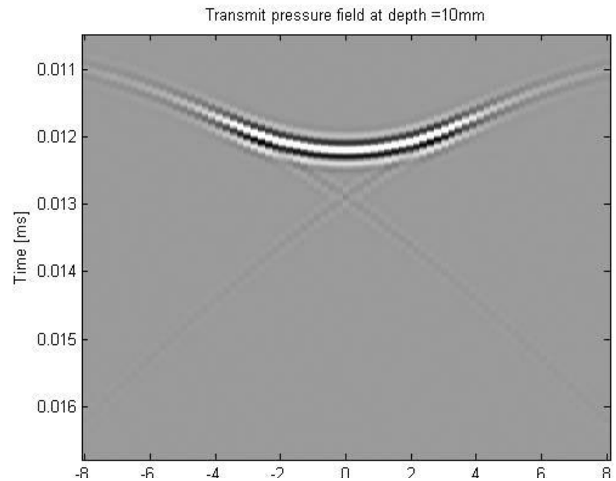


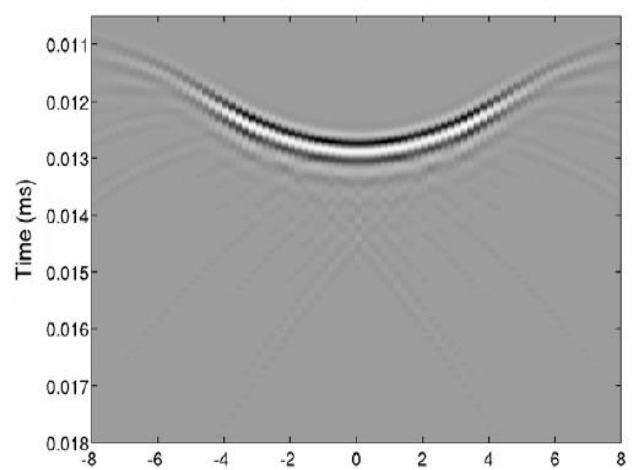
32 el.

2.3 Comparison of Simulated and Experimental Pressure Field

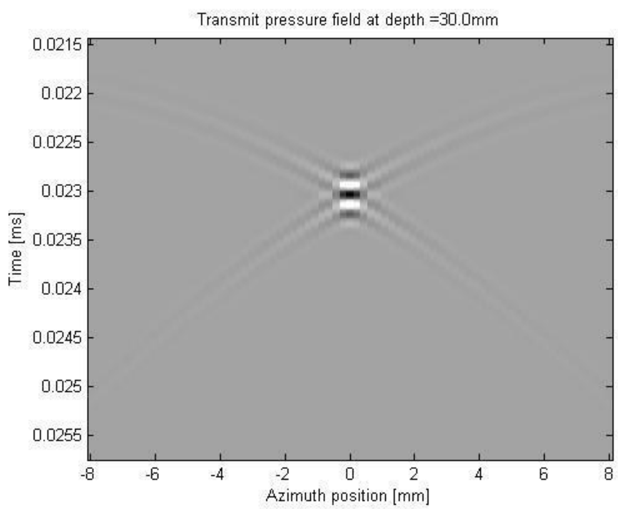
Simulation | **Experiment ***

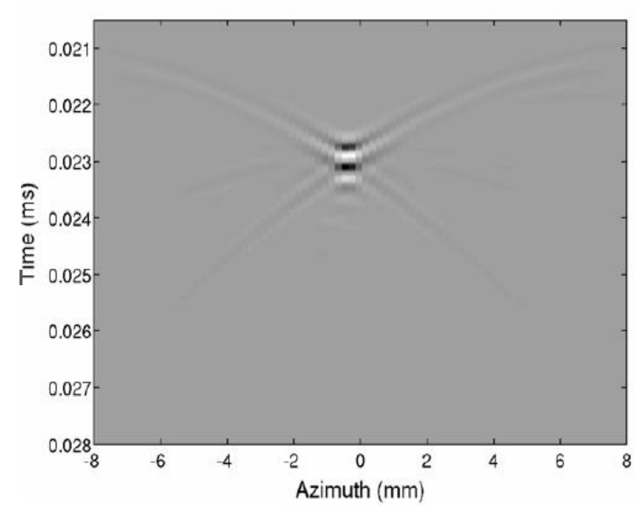
Near-field
(10 mm depth)





Focal plane
(30 mm depth)

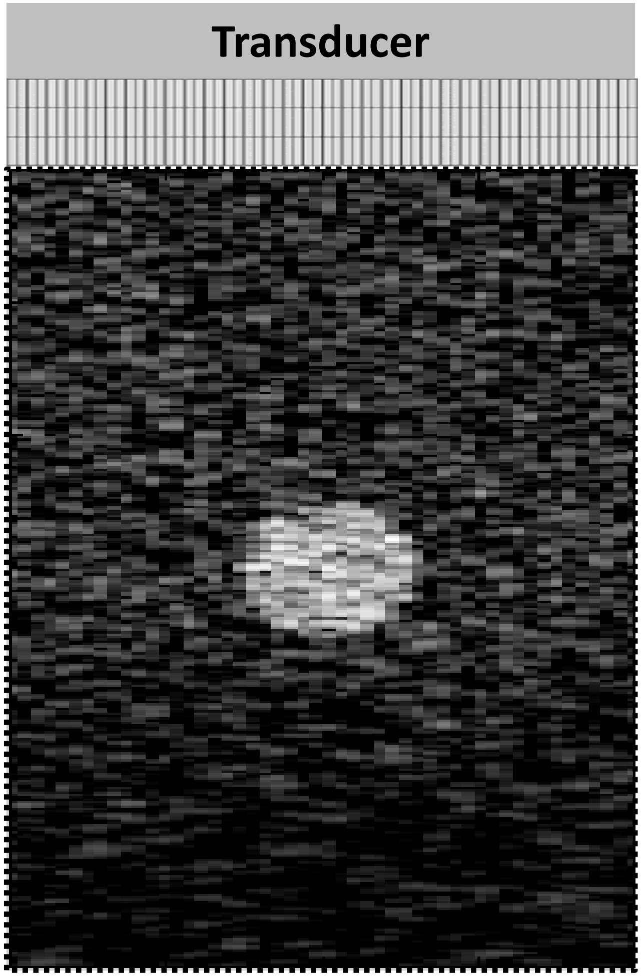




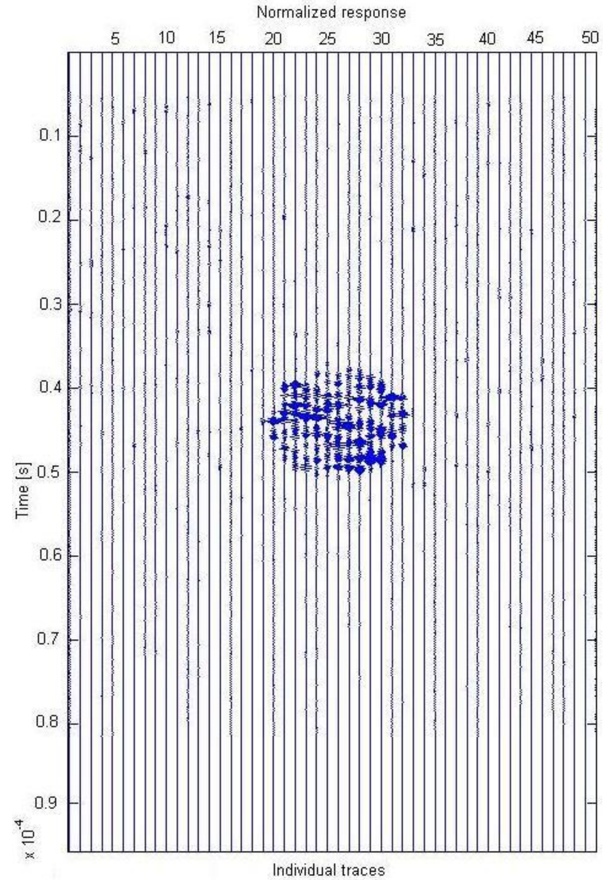
* Guenther D.A., Walker W.F. A method for accurate *in silico* modeling of ultrasound transducer arrays // Ultrasonics. – 2009. – Vol. 49 – P. 404–412

Overview

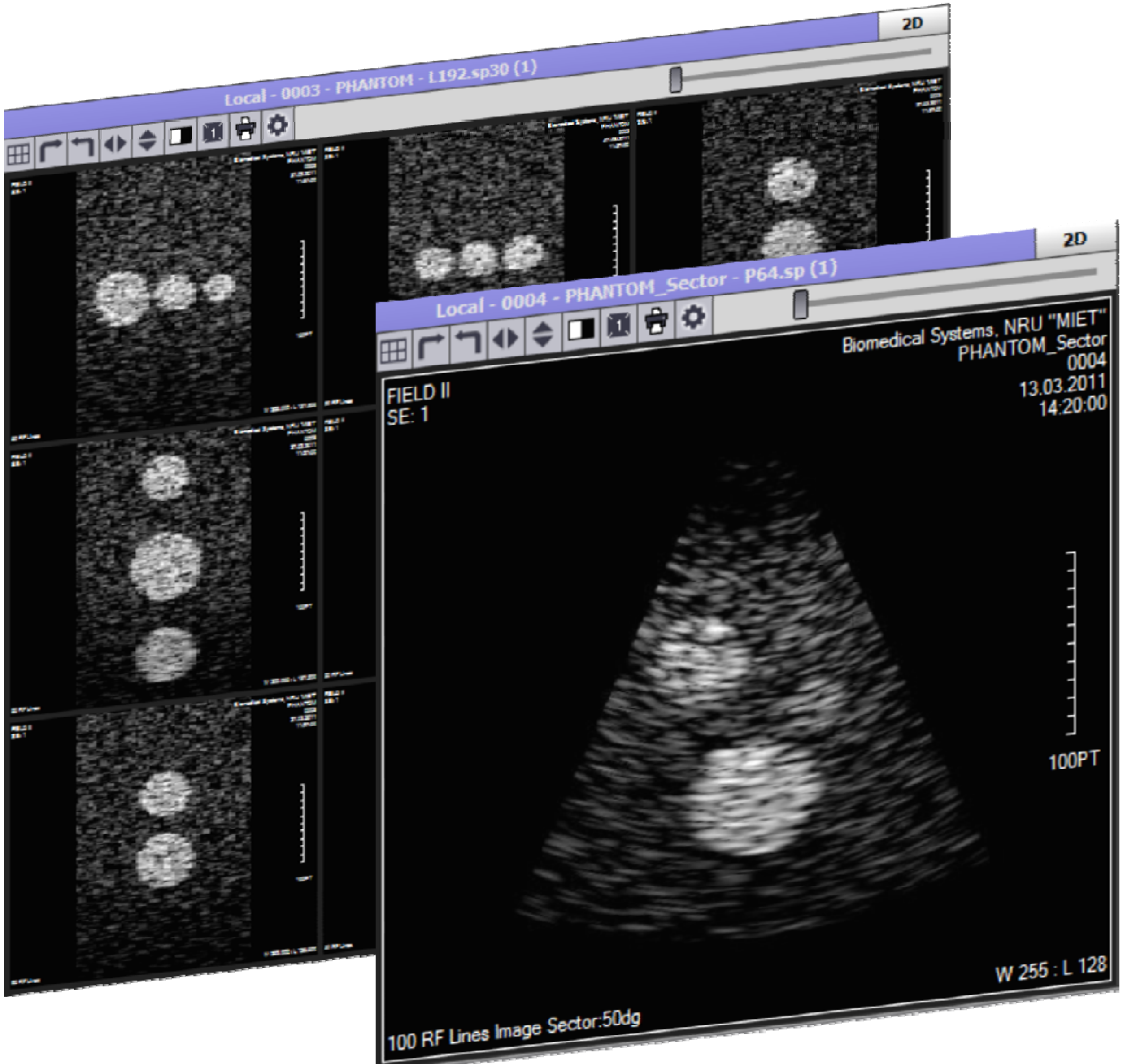
3.1 Algorithm of Image Simulation



Simulated A-lines



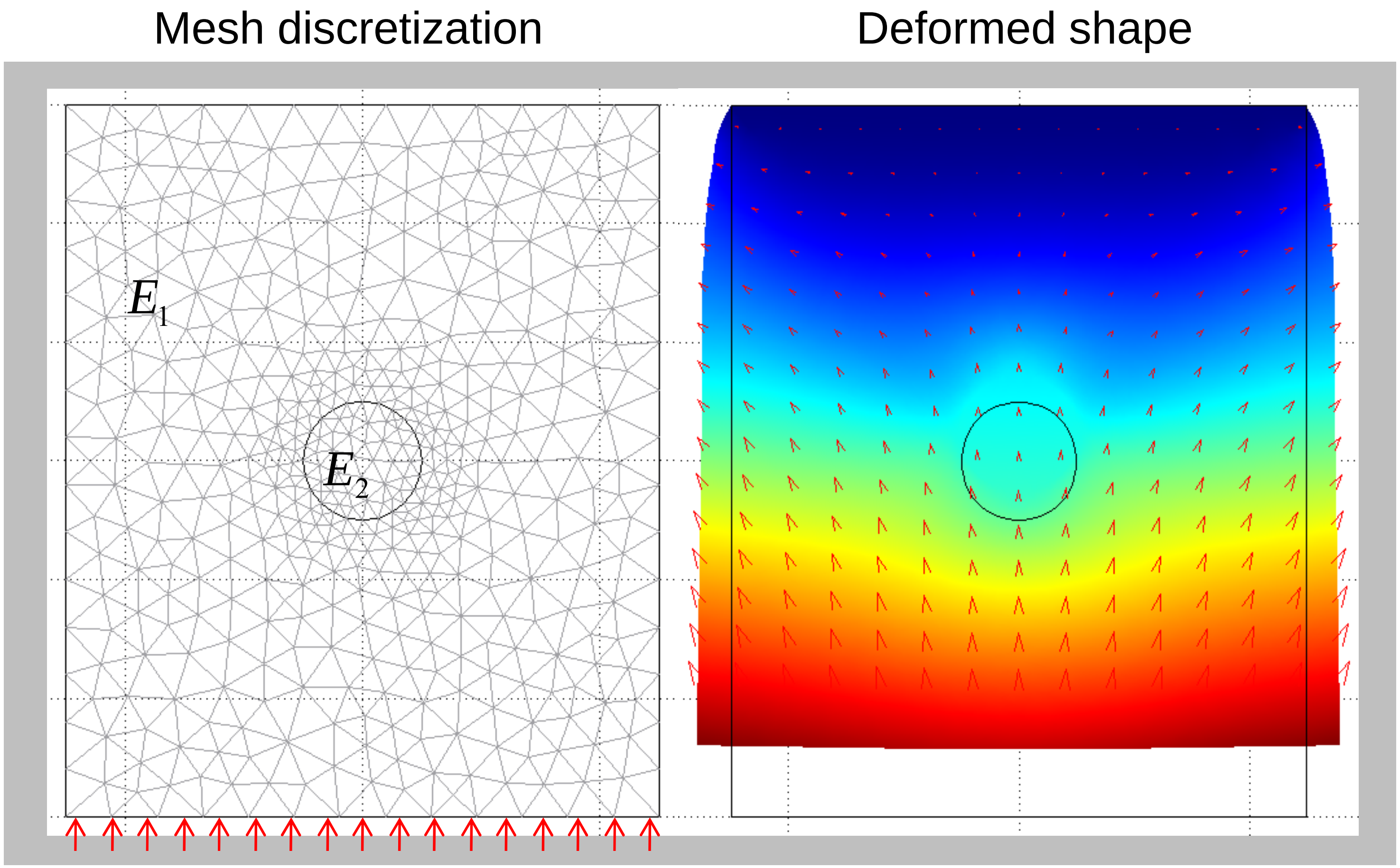
3.2 Data Storage



DICOM format

- Accurate identification
- and easy access
  to large volume
  of simulated images

4. Deformation Modeling



E_1, E_2 - The Young's Modulus of regions

$$E_2 / E_1 = 2 \ldots 5$$

5. Conclusion

- GUI for linear array modeling allows fine control over the key transducer parameters

- Through effective optimization of simulated transducer a satisfactory agreement with measured acoustic pressure is observed in the focal plane and far-field

- Ultrasound images can be simulated for a variety of phantoms and stored in DICOM data base for later use

- Deformed state of phantom can be modeled using FEM and corresponding RF-signals can then be used for tissue motion analysis

Thank you for your attention!