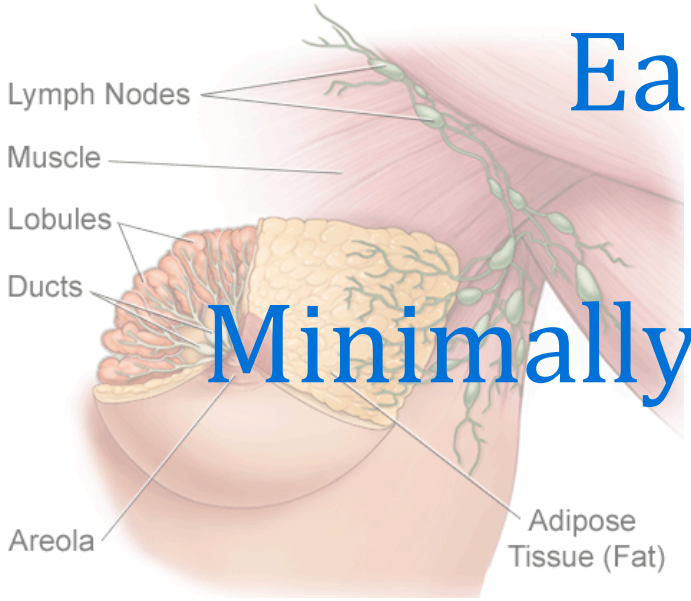
UC San Diego
SCHOOL OF MEDICINE

Ultrasound and Breast Cancer:

Early Detection
and
Minimally Invasive Treatment

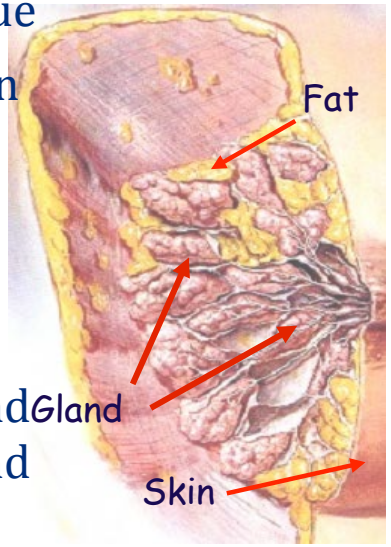


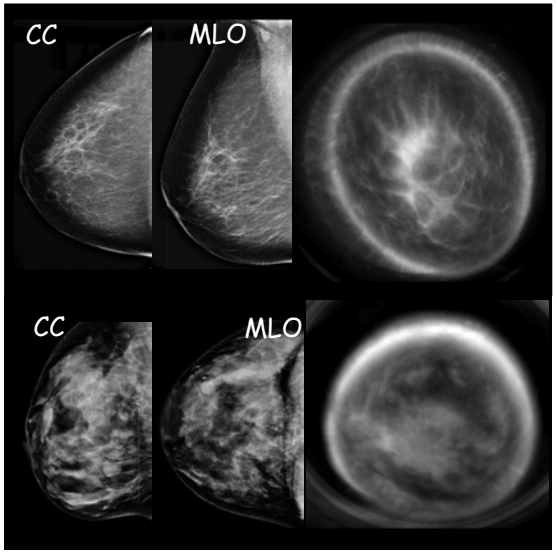
Thomas R. Yellen-Nelson, Ph.D.
Departments of Radiology and Bioengineering

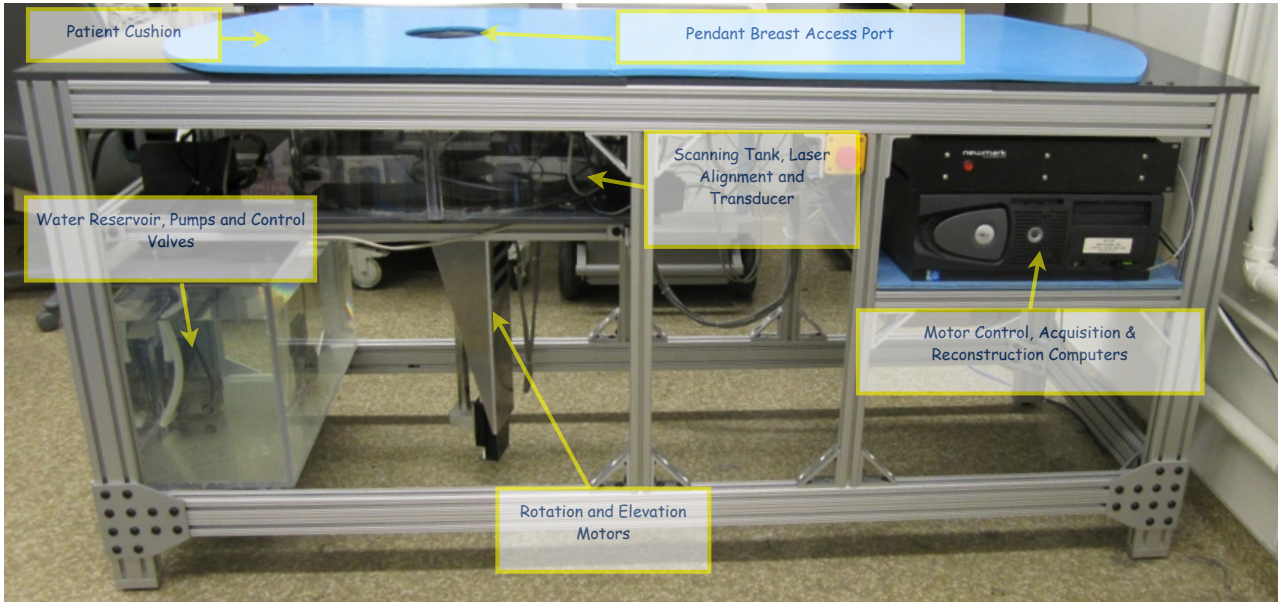
UC San Diego
SCHOOL OF MEDICINE

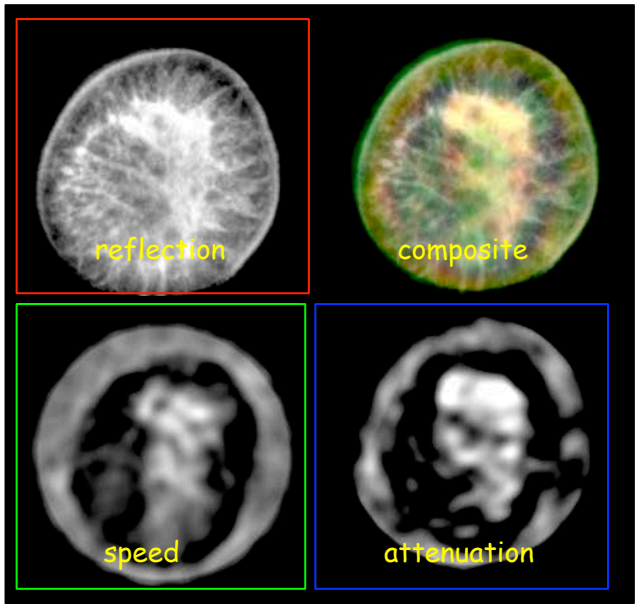
Ultrasound Breast Tomography

- Most cancers arise in dense ductal/glandular tissue
- Breast tissue reflectivity, sound speed, attenuation and elasticity properties can be measured using ultrasound
- Most cancers show increased sound speed compared to gland and fat
- We have designed and built a dedicated ultrasound breast scanner that can measure reflectivity, sound speed, and attenuation
- Parametric images can be used to improve visualization of tumors





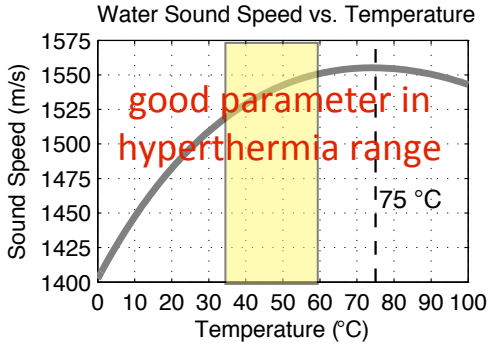


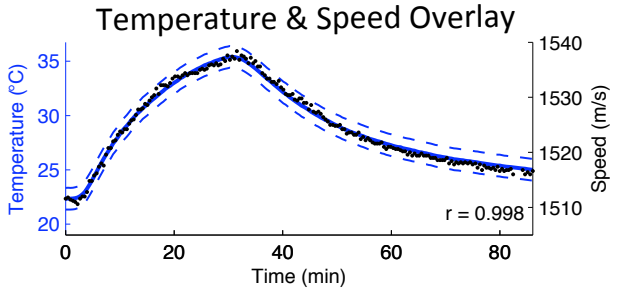


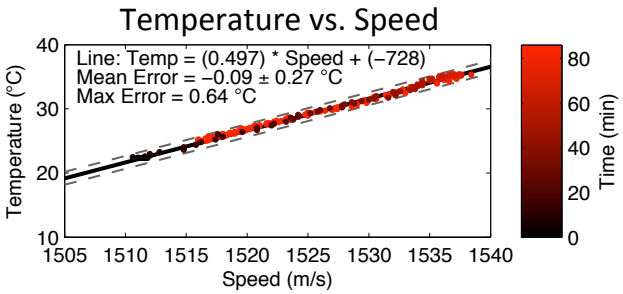
Ultrasound Thermometry

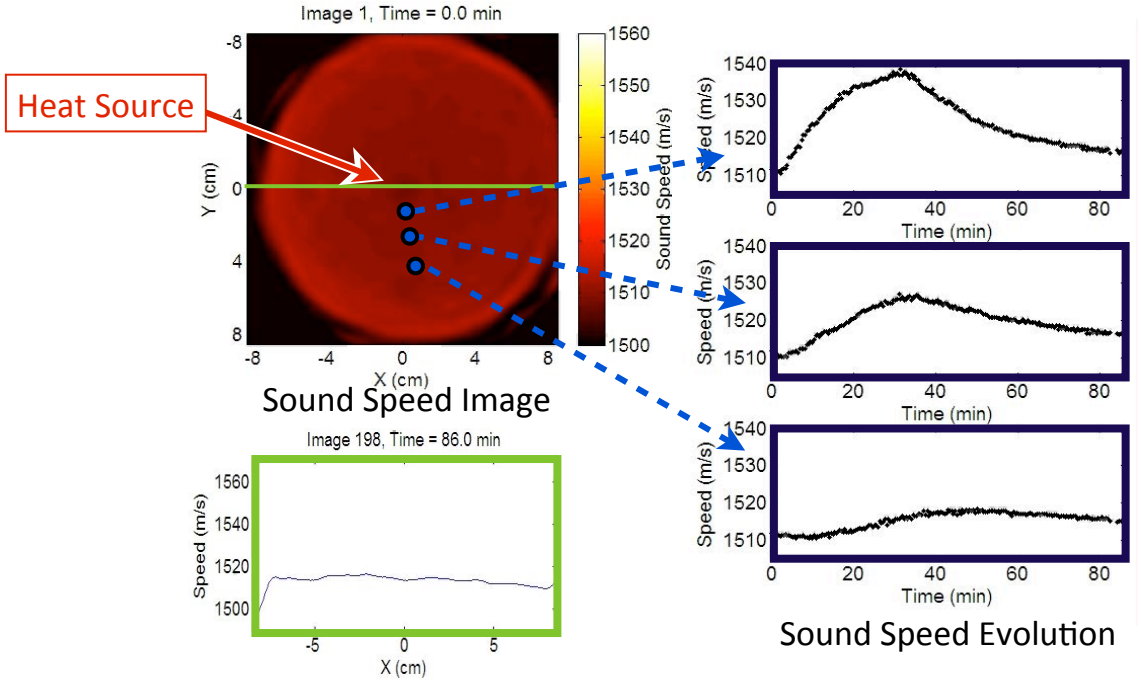
Sound Speed

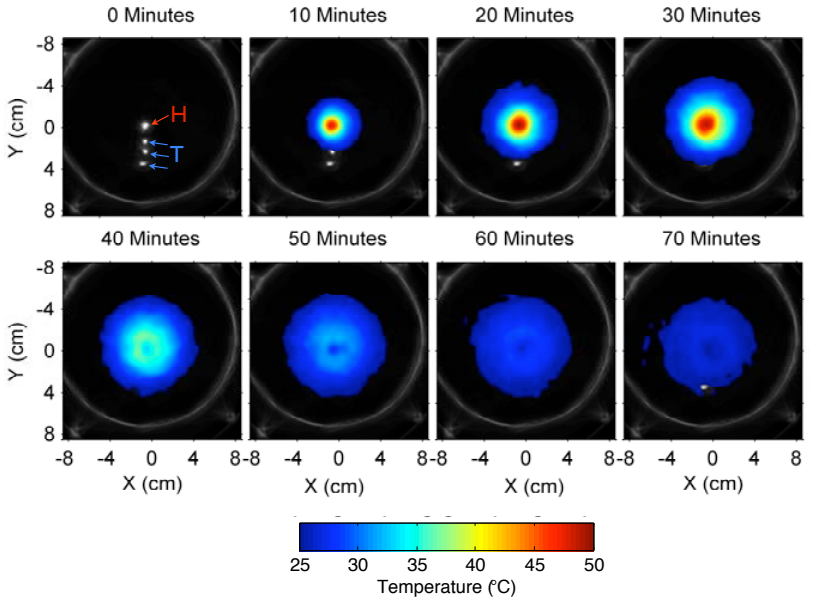
- Diagnostic value
  - cancer has elevated sound speed
- Temperature dependent parameter
  - monitor temperature in tissue
- Ultrasound Breast Tomography
  - measure image sound speed











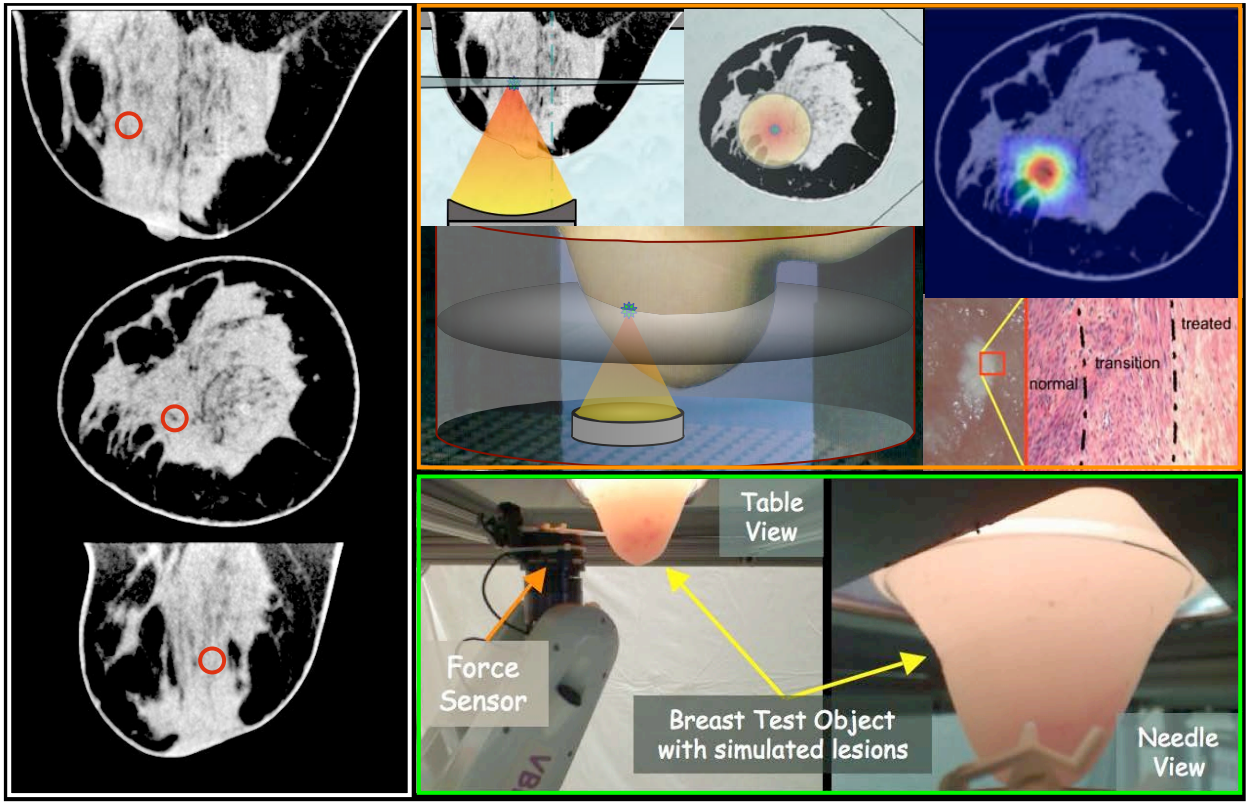
UC San Diego
SCHOOL OF MEDICINE

Breast Tumor Ablation

Growing need for minimally invasive treatments and reduced hospitalization

Two approaches for breast tumor ablation:

- High-intensity-therapeutic-ultrasound (HITU)
  - Hyperthermia ablation requires accurate temperature quantification to confirm tumor tissue destruction
  - Breast ultrasound tomography offers a non-invasive approach to temperature monitoring
  - Volume data provide targeting data for HITU treatment
- Robotic Breast Biopsy
  - Targeting and guidance algorithms localize tumor in volume data and show insertion trajectory
  - Force feedback data / breast stabilization improves small lesion targeting
  - Positions device adjacent to skin surface with insertion under physician direction
  - Lesion targeting accuracy within ±1 mm



Conclusions & Opportunities

Key Concepts and Opportunities for Research:

- Automated *volume breast ultrasound* (VBUS) scanning standardizes imaging and improves tumor localization
- VBUS data provides tumor coordinates to accurately locate tumors
- Image-guided HITU provides a precision method for targeting and treating small tumors without surgery
- VBUS measures tissue temperature distributions based on sound speed
- Robotic Biopsy guided by volume data can accurately sample breast tumors
- Precision robotic biopsy can improve biopsy yield reduce patient trauma