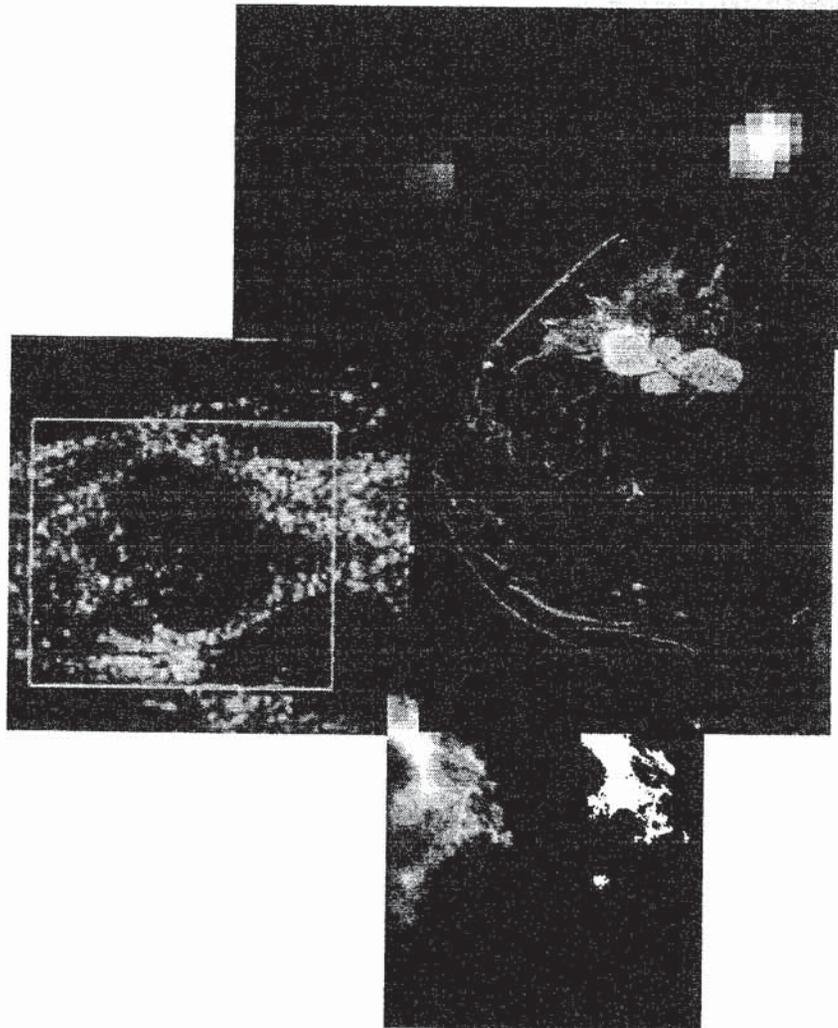


# *New approaches to Breast Imaging*



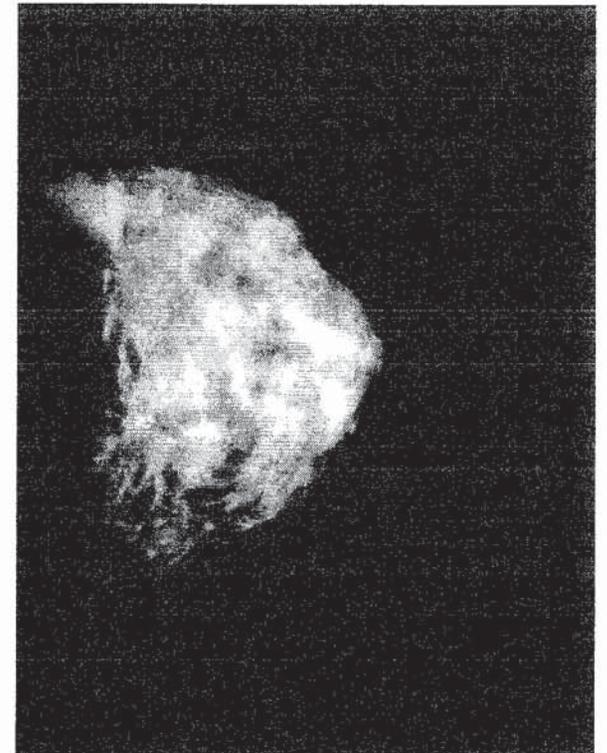
Mitchell Schnall MD, PhD  
Dept of Radiology  
University of Pennsylvania

*Breast Imaging is critical to many aspects of breast cancer care*

- Screening
  - Identify potential abnormalities
- Diagnosis
  - Determine need for biopsy (bx guidance)
- Staging
  - Extent of disease
- Follow up
  - Detect recurrence

## *Current Film Screen Mammography Limitations*

- Limited Soft tissue contrast
- Projection Image
- Mammographically dense breast
- Limited specificity
  - In part the result of high sensitivity demands



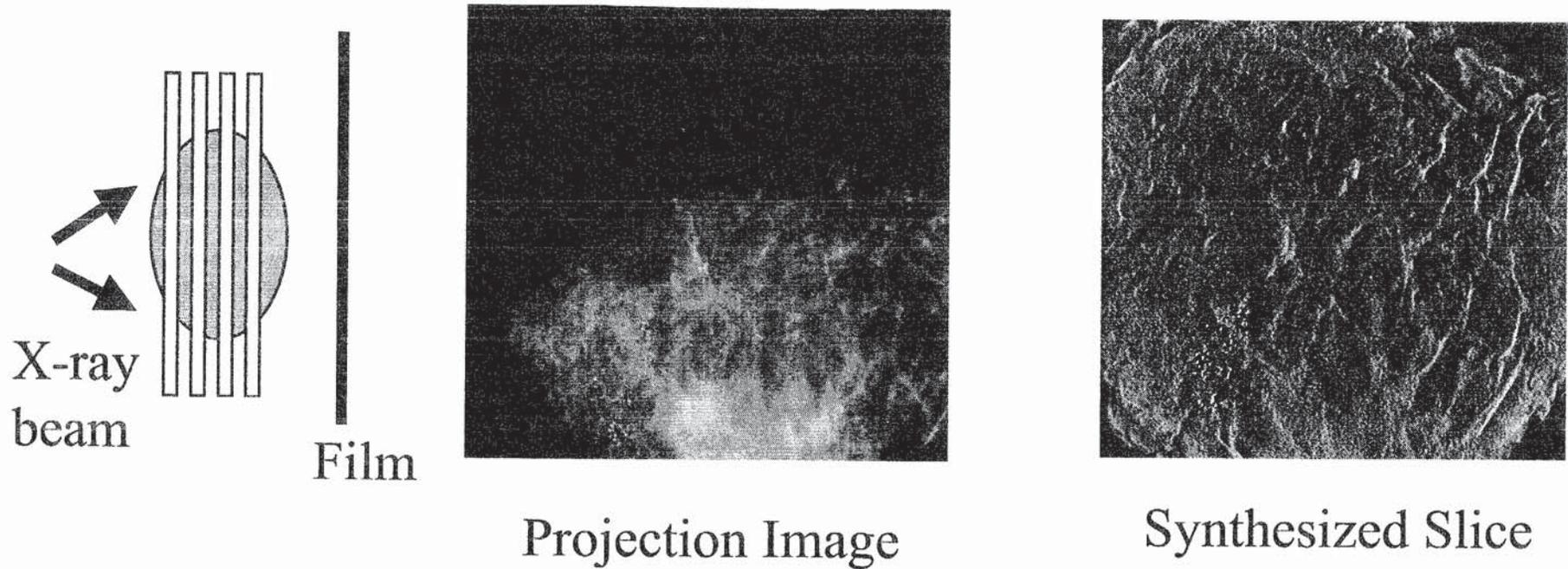
# *Technical Innovations in Breast Imaging*



- Improve Mammography
  - Digital mammo, tomo-synthesis, CAD, Contrast enhanced digital subtraction
- New Image Acquisition Technology
  - Ultrasound
  - MRI
  - Nuclear Techniques: PET, Sestamibi
  - Optical Imaging
  - Speculative technology

# *Tomosynthesis*

Loren Niklason et al. (MGH)



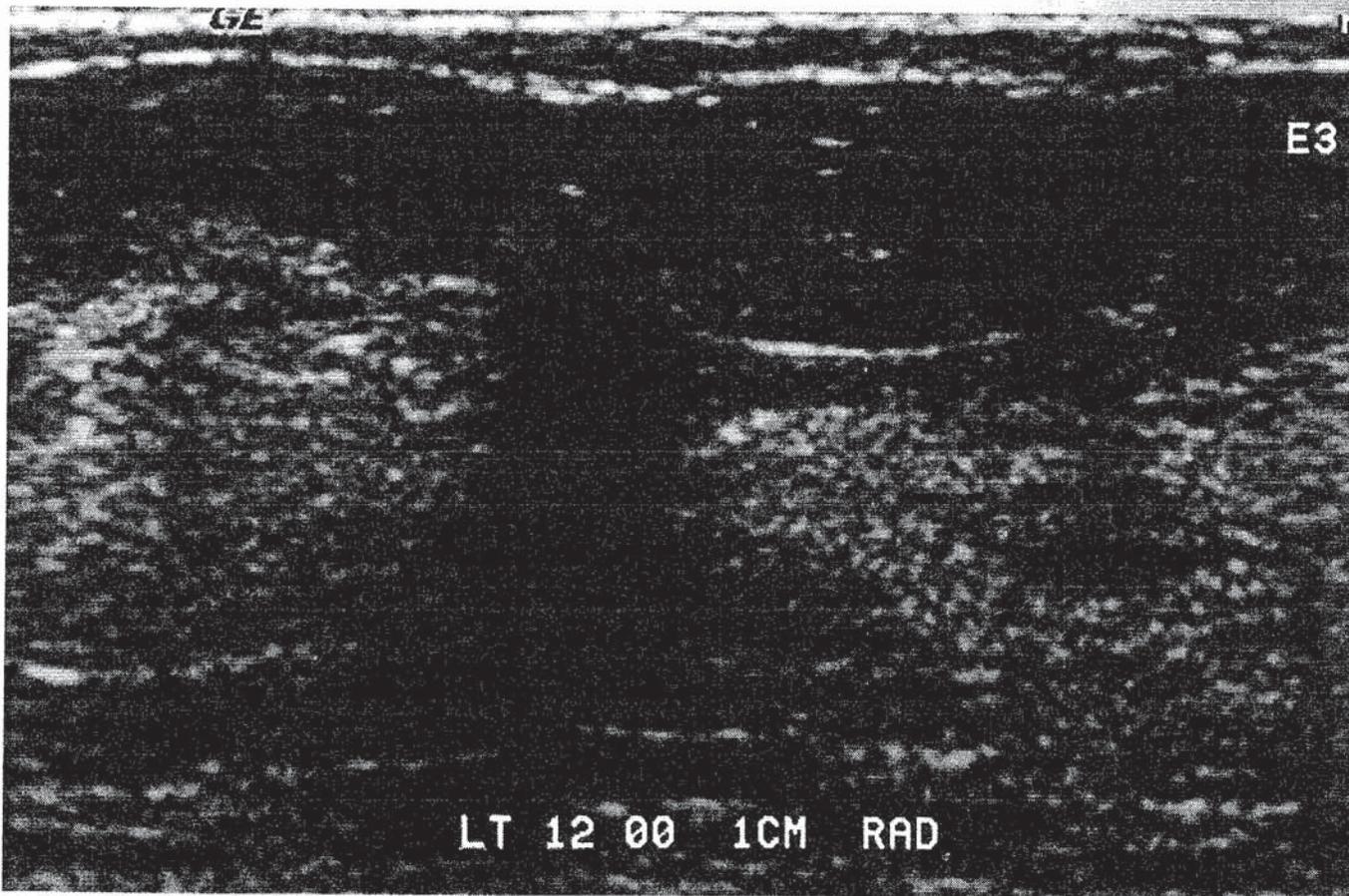
# *Breast Sonography*

- images the reflection of soundwaves passed into the breast
- no ionizing radiation
- real time
- portable, inexpensive
- radiologist intensive, user dependent

# *Breast Sonography: current status*

- Routinely used for diagnostic evaluation
  - Diagnose Cysts
  - Stavros criteria (64% specificity for cancer)
- Pilot data on screening (women with radiographically dense breasts) (*Kaplan, SS. Dec 2001 Radiol; 221:641-649.*)
  - 6 (.3%) cancers in 1,862 mammo/ PE negative women
    - 3% biopsy rate
    - 4% follow up rate

# *7 mm Invasive Ductal Carcinoma*

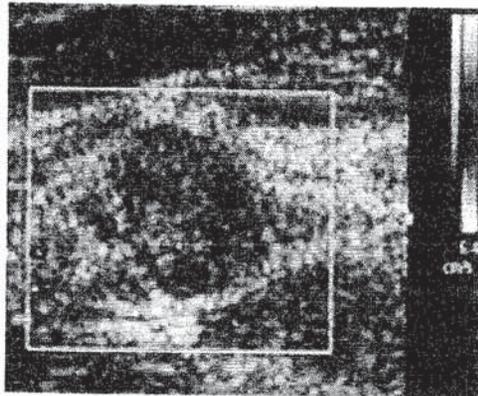


# *Sonography Technical Innovations*

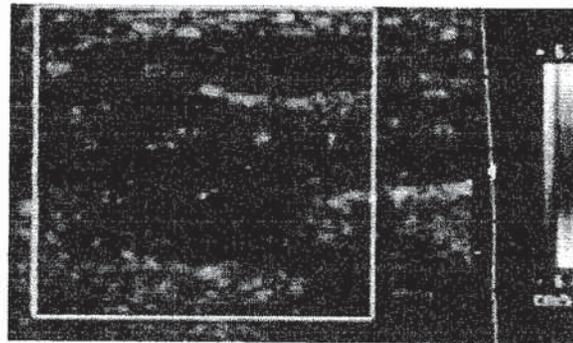


- Doppler Blood flow quantification
- Ultrasound contrast agents
- Elastography
- 3D Ultrasound
- Calcification detection

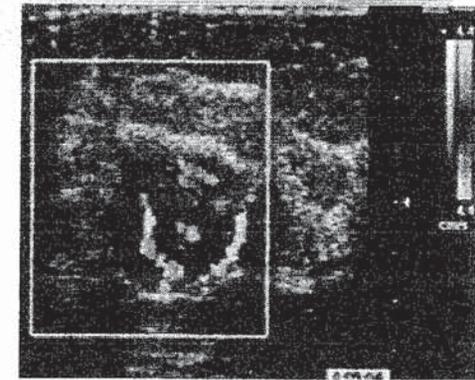
# Quantitative Doppler Imaging



Benign



Malignant



	Power Doppler			Color Doppler		
	MCL (0-100)	% Area (0-100)	CWFA (0-100)	MCL (0-100)	% Area (0-100)	CWFA (0-100)
Represents ->	Blood Vol. per Col. Pixel	Area of Perfusion	Blood Volume thru X-section	Mean Flow Vel. Col. Pixel	Area of Perfusion	Mean Blood flow thru X-section
Benign (B)	6.8 ± 5.5	8.9 ± 8.4	0.9 ± 0.9	27.2 ± 14.2	4.9 ± 5.2	2.2 ± 2.3
Malignant (M)	9.3 ± 5.2	12.8 ± 17.4	1.8 ± 2.8	34.7 ± 16.9	6.5 ± 4.5	3.8 ± 3.5
Ratio M/B	1.37	1.43	2	1.28	1.33	1.73
% Difference	37	43	100	28	33	73

C. Sehgal et al

## *Clinical Trial Initiatives*

- American College of Radiology Ultrasound Breast Lexicon Working Group
- ACRIN: Breast Sonography for screening in women at high risk screening for breast cancer (collaboration with AVON)

# *MRI of the breast*

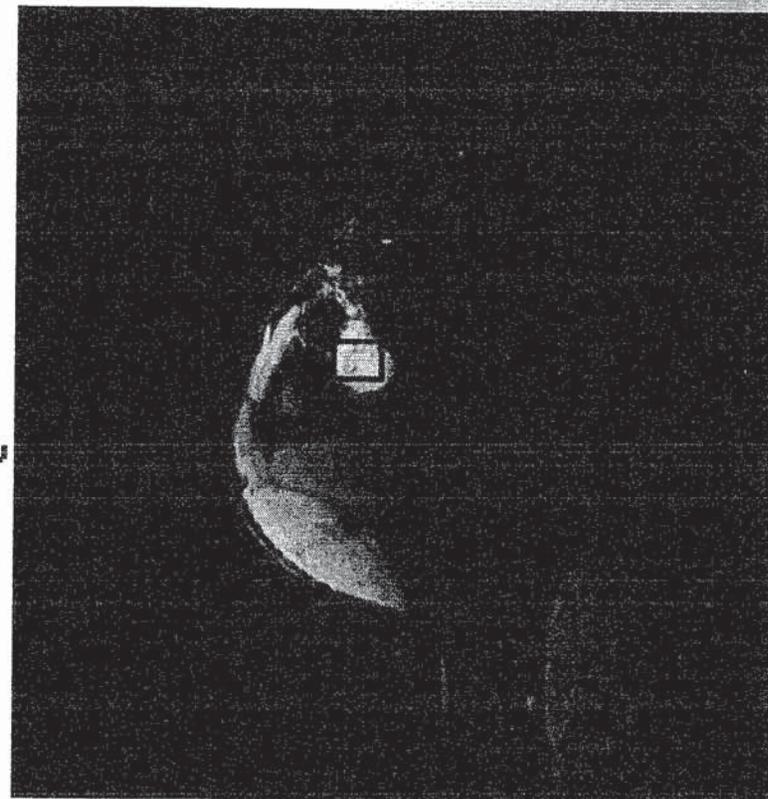
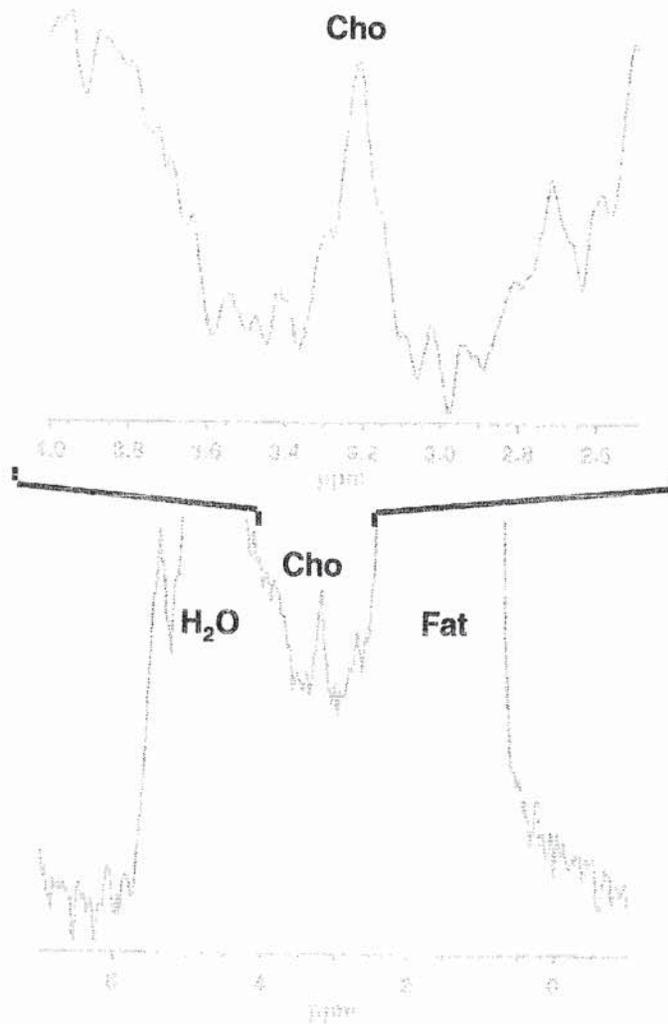
- Uses radiowaves to collect signals from  $1\text{H}$  nuclei and form an image
- Contrast agent (Gd) injected to enhance regions of high vascularity
- Strengths:
  - High soft tissue contrast
  - 3D image
  - functional image
- Challenges:
  - specificity
  - cost



# *Technical Innovation in Breast MRI*

- Increased Imaging Speed
  - Pharmacokinetic Modeling
- Spectroscopic Imaging
  - Choline as a marker of malignancy
- Improved contrast agents
- Dedicated scanner development

# Breast Spectroscopy



Roebuk, Cecil, Lenkinski et al

# *Major Clinical Trial Initiatives*

- International Breast MRI Consortium
  - 1000 women diagnostic trial
  - 400 women pilot (high risk screening)
  - 200 women pilot of screening the contra-lateral breast
  - IBMC/CGN collaboration
- ACRIN
  - MRI early response to neoadjuvant therapy

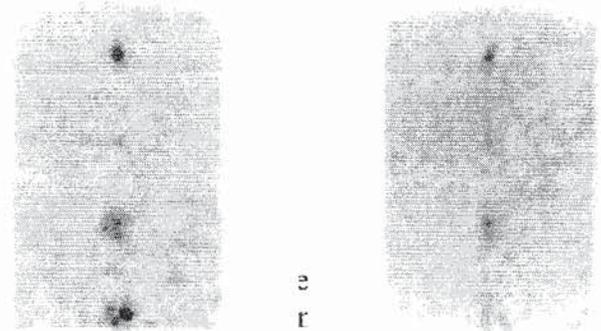
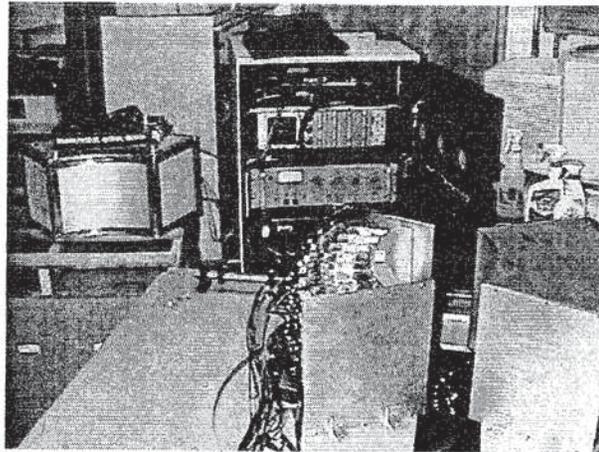
# *Nuclear Imaging*

- Radio labeled tracers to target tumors
- Minimal x-ray dose
- Single photon agents (Scinti-mammography)
  - Sestimibi (FDA approved for breast cancer diagnosis)
- PET
  - Fluro-deoxyglucose



# *Nuclear Imaging: Technical developments*

- Dedicated Detectors (single photon and PET)
- Innovative tracers (molecular target)



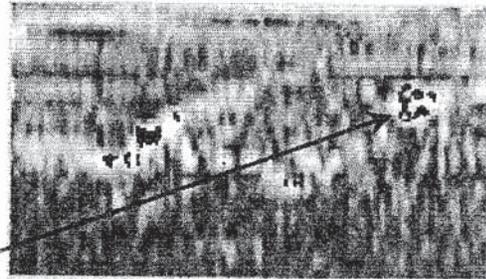
# *Optical Imaging*



- Images scattered light
- Very complex image reconstruction
- Low spatial resolution
- High contrast potential
  - Wavelength specific
  - Molecular targeted Contrast agents

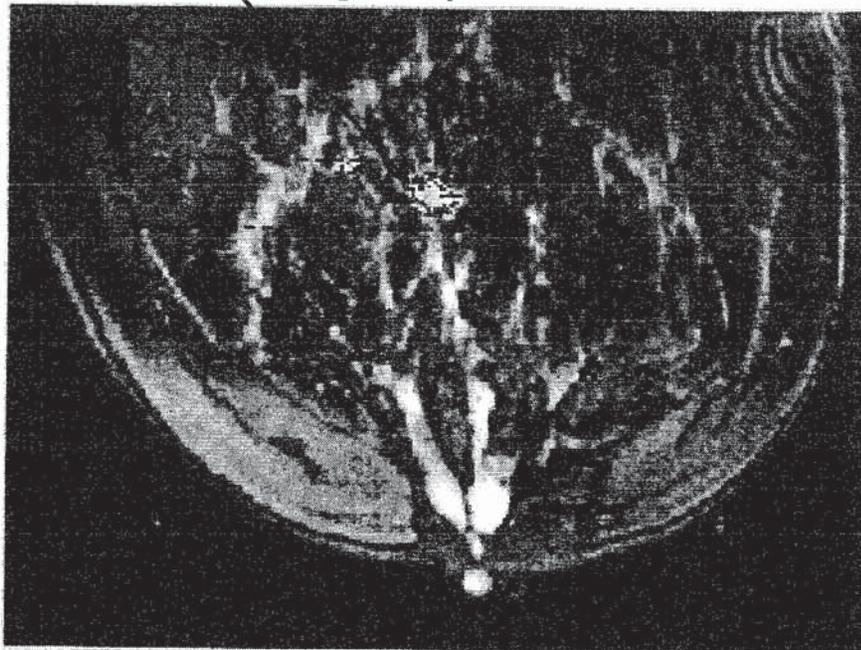
# Case I : Intrinsic contrast

coronal plane

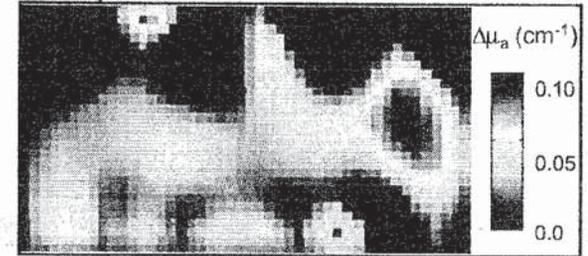


ductal carcinoma

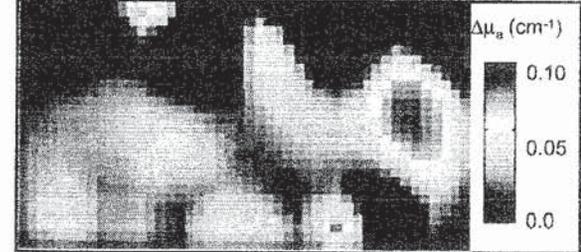
sagittal plane



Absorption coefficient 780 nm



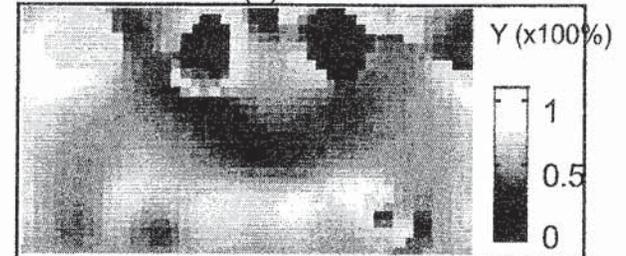
Absorption coefficient 830 nm



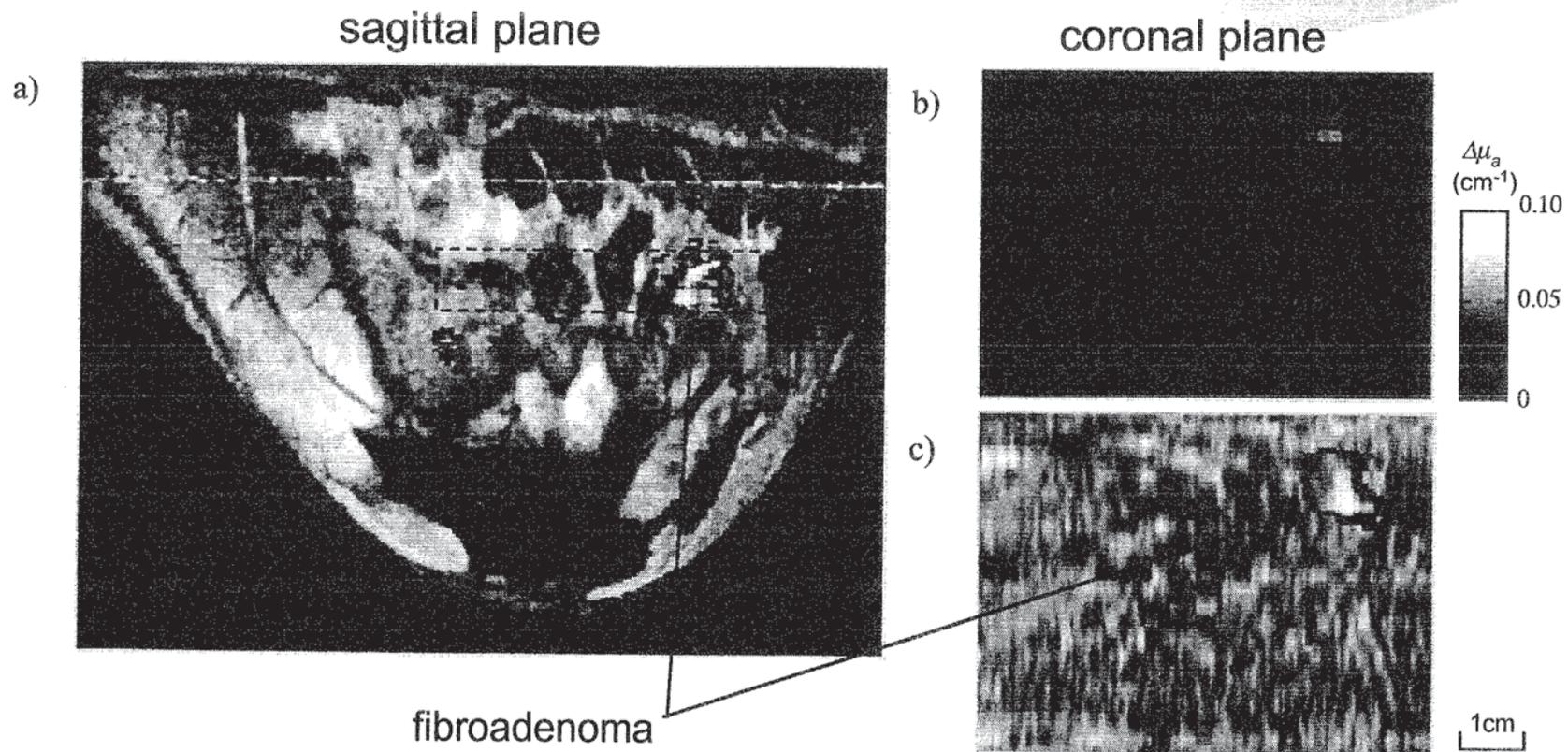
Hemoglobin Concentration [HB]



Blood Saturation (Y)



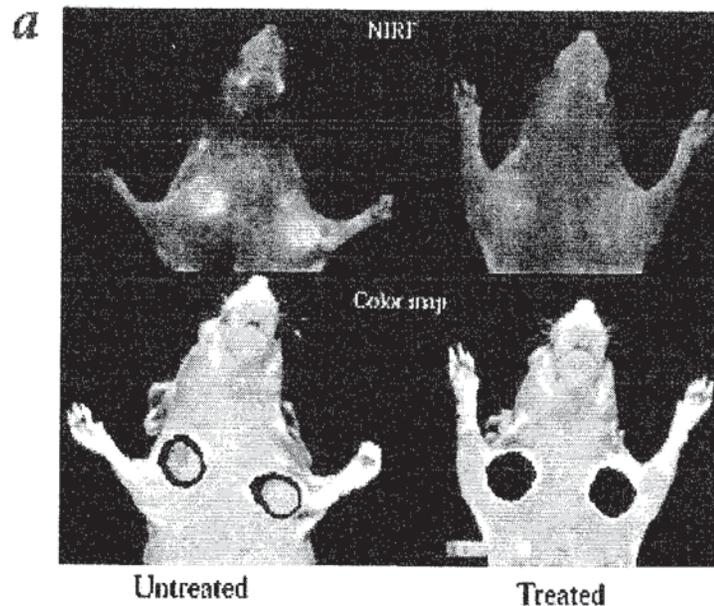
# *Optical imaging with contrast agent*



# Molecular targeting

Probe targeting  
metalloproteinase:  
imaging of metastatic potential

*Bremer C, Tung CH, Weissleder R.  
Nat Med 2001 Jun;7(6):743-8*



# *Speculative technology*

- Electrical impedance imaging
  - Measures the resistance to current flow in the breast; cancer may decrease the resistance.
- Infrared thermography
  - Measures heat with infrared detectors
- Electrical potential measurement
  - Measures electrical potential at skin to detect tumor in the breast
- Electronic palpation
  - Palpation of breast using pressure sensors

## *Conclusions*

- There is extensive research into methods for detection and characterization of breast cancer
- Many promising techniques are starting to see clinical use
- Clinical trials to establish relative efficacy are important