Ultrasonic Imaging Laboratory

Department of Electrical Engineering
National Taiwan University

Ultrasonic Imaging Laboratory: Members

Advisor: Dr. Pai-Chi Li

Ph. D. student: 9

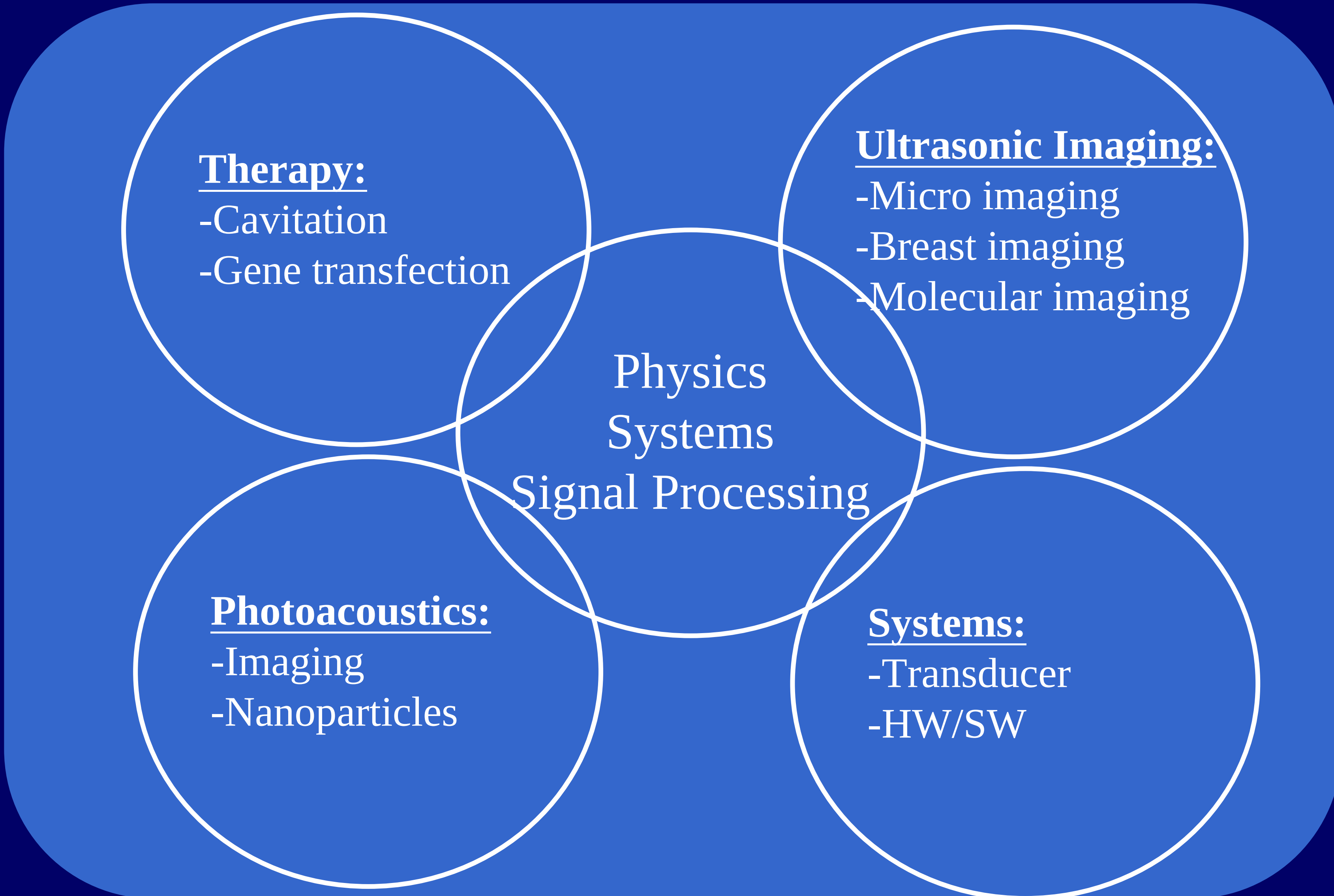
Master student: 11

Research assistant: 2

Administrative assistant: 1

Objective

- Development of ultrasonic techniques that improve the utility of ultrasound as a diagnostic tool in medicine.
- Towards this goal, the laboratory specializes in the use of non-invasive ultrasound
  - Physics
  - Systems
  - Signal processing

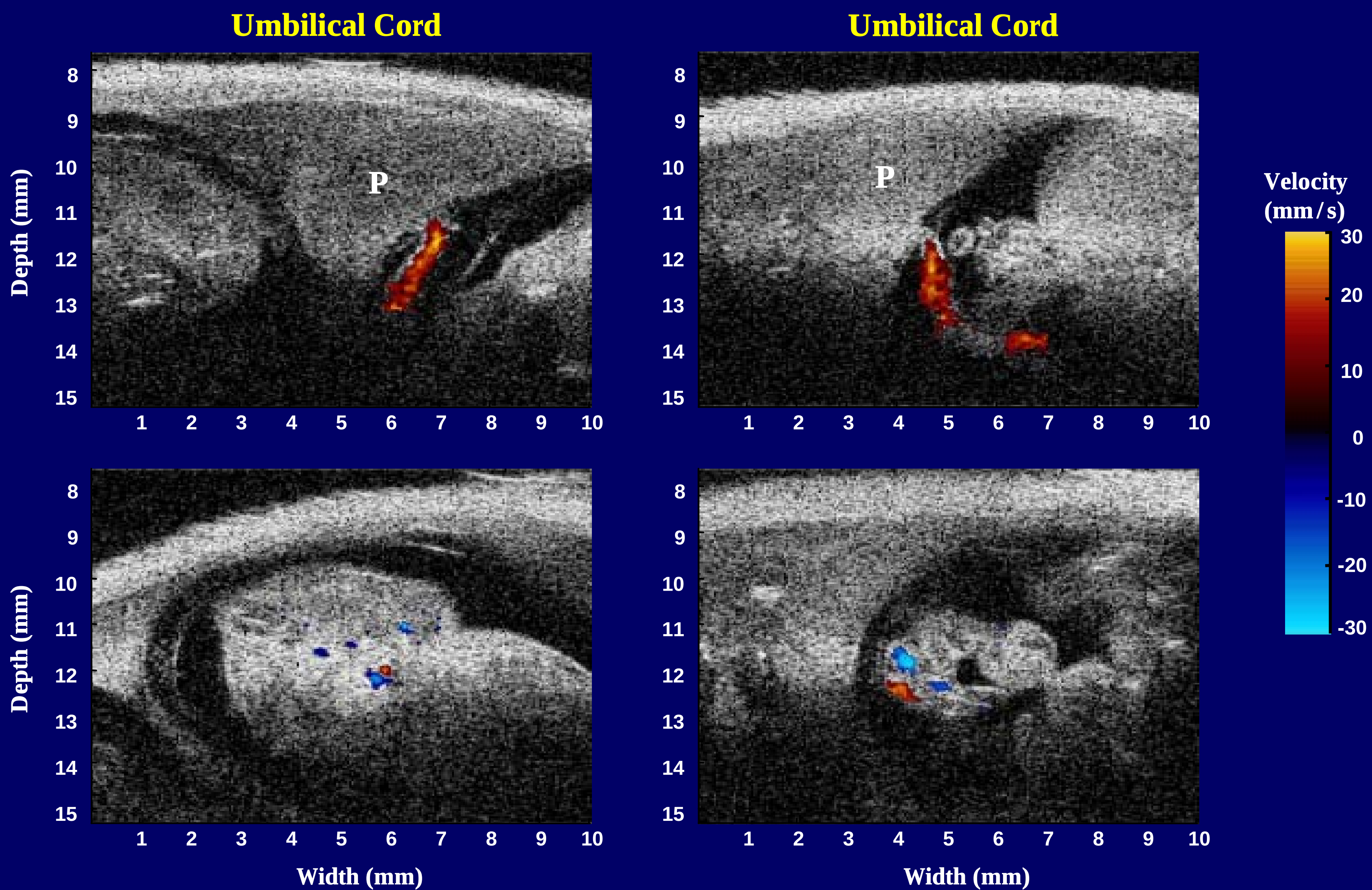


Collaborators: NTU Hospital, Genome Center, Nano Center, NHRI, NCKU, NTNU, NCCU, NCNU,…etc.

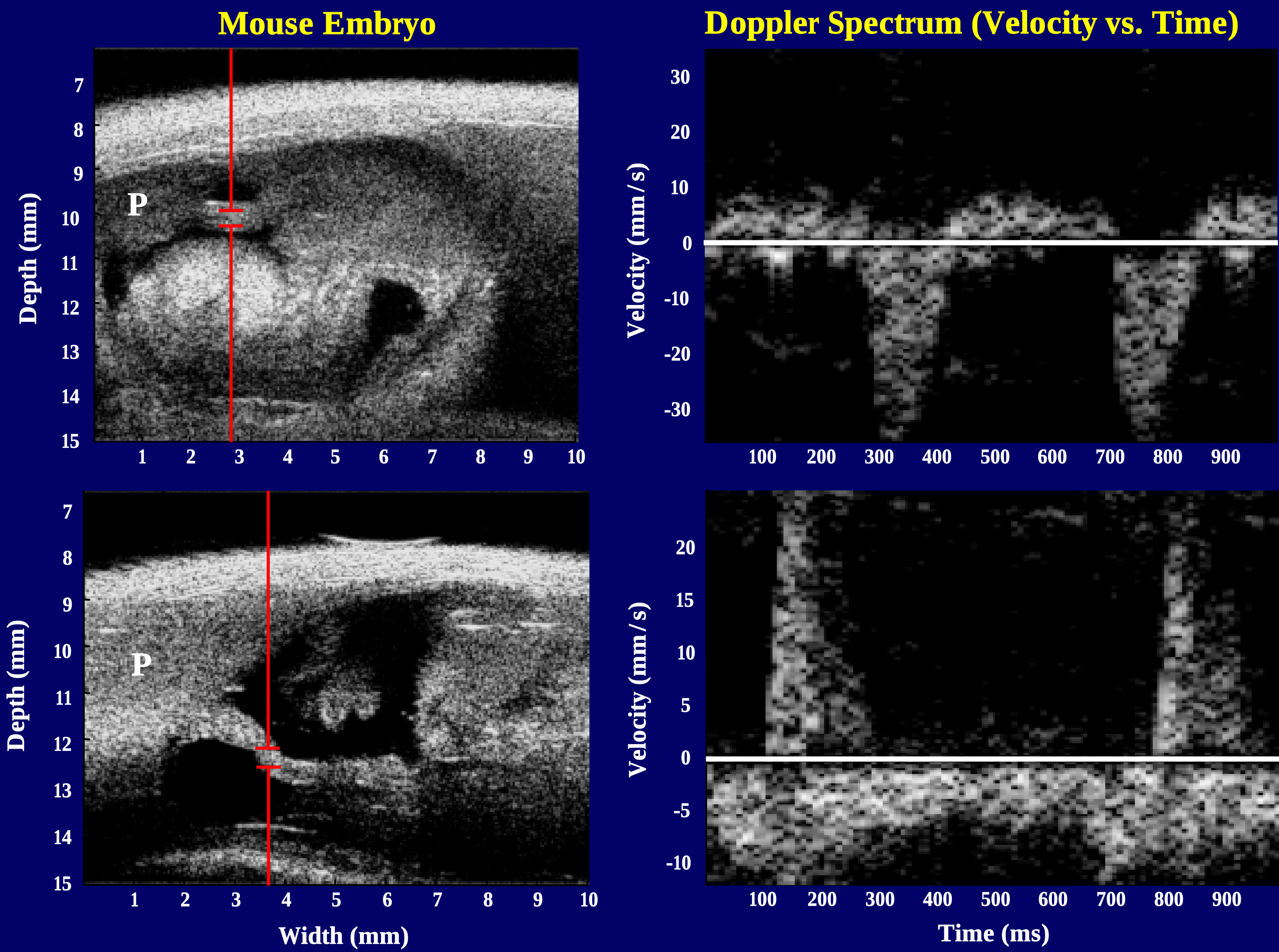
Multi-disciplines: Electronics, Physics, Medicine, Life Sciences, Chemistry, Nano-materials, …etc.

Ultrasonic Micro-Imaging

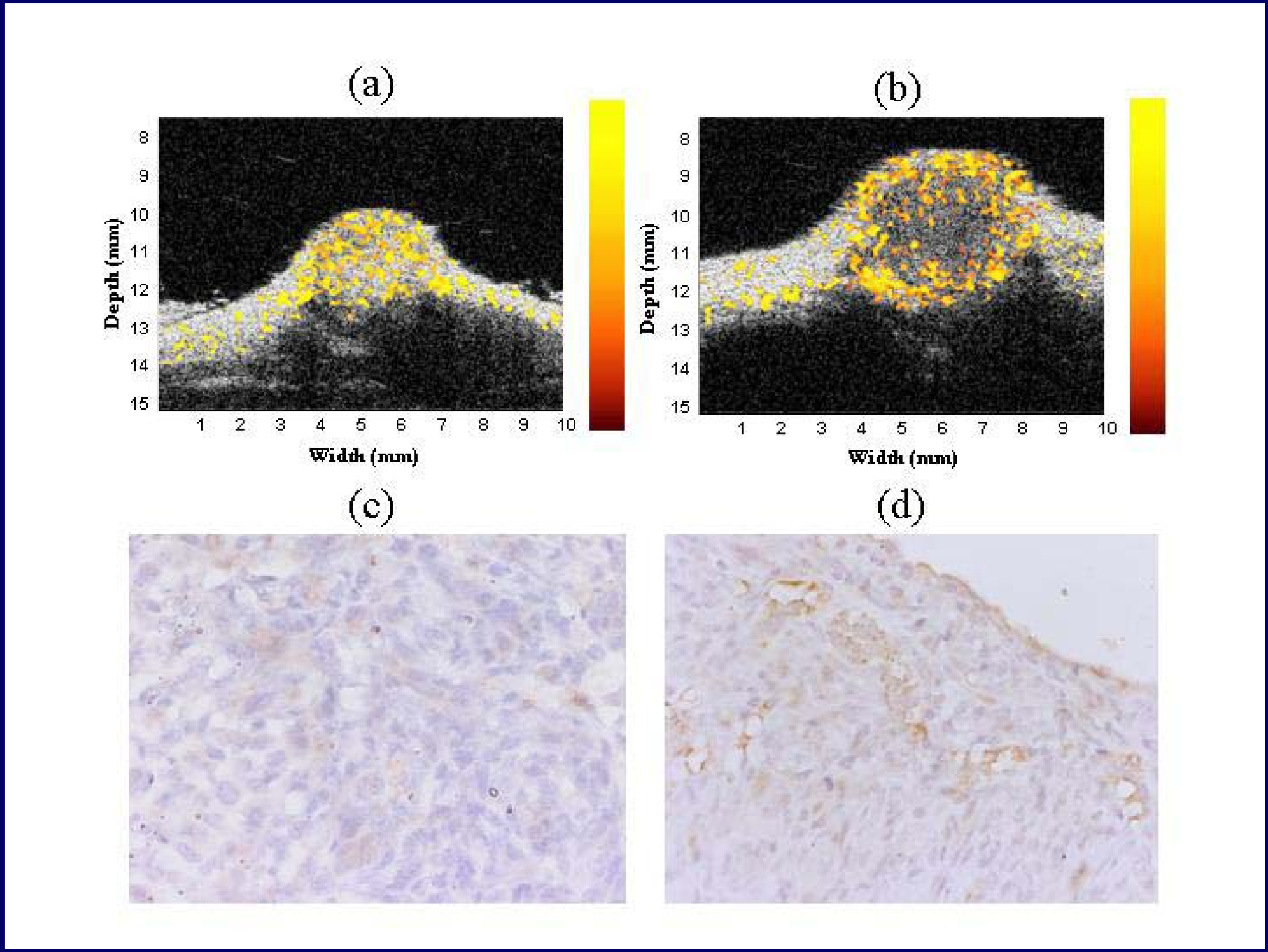
Mouse Embryo Micro-Imaging



Mouse Embryo Micro-Imaging



Mouse Tumor Micro-Imaging

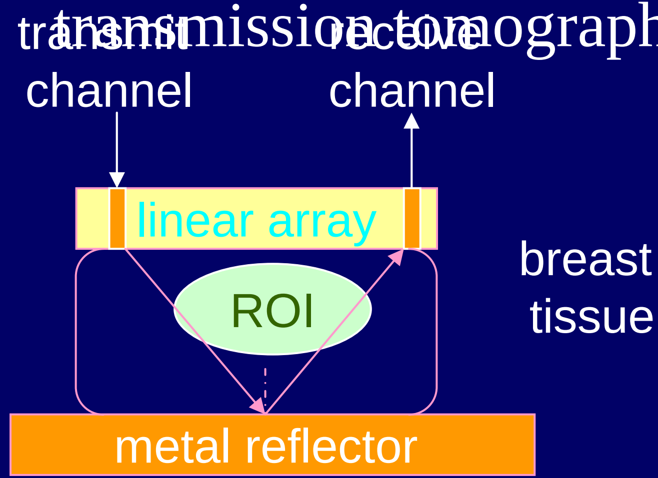


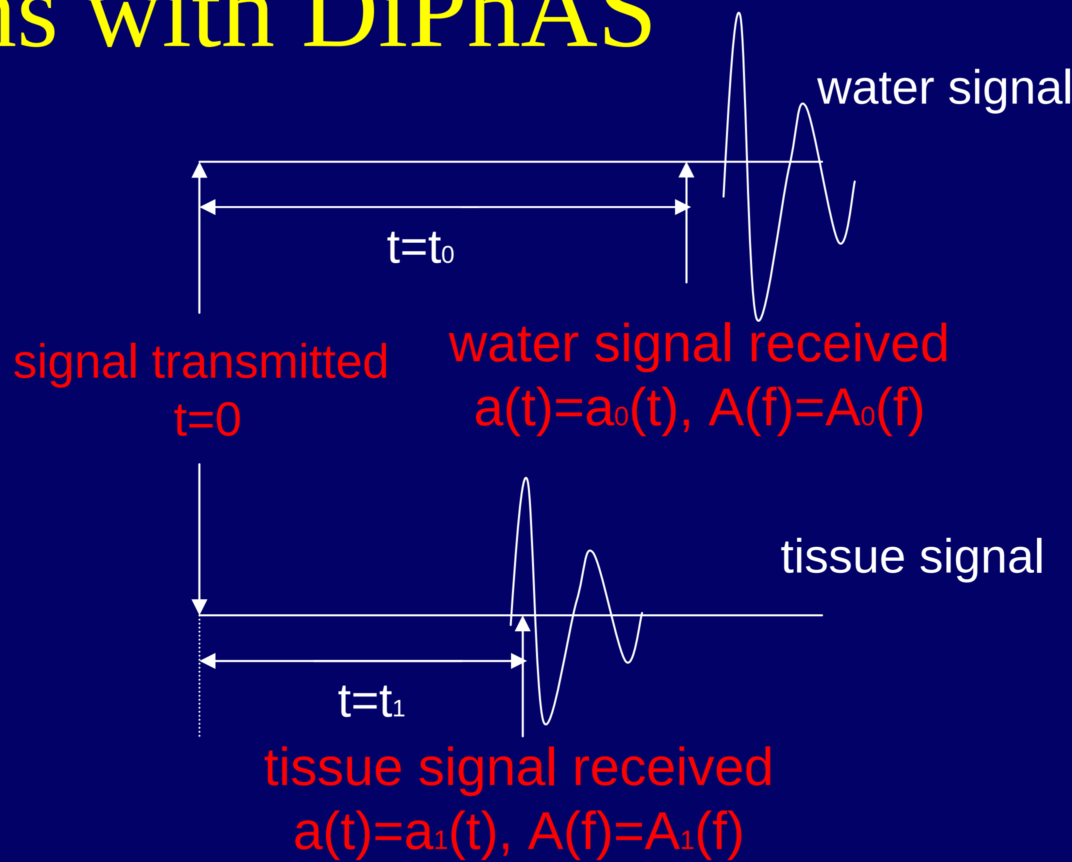
Cover of IEEE Trans. on UFFC, Jan. 2004

Applications with DiPhAS

- Ultrasonic sound velocity and attenuation coefficient reconstruction using linear array transducer:

  -Tomography using linear array=>as a limited-angle transmission tomography





Time of flight

$$\Delta t = t - t_0 = \int_L [s(x,y) - s_0]\, dl$$

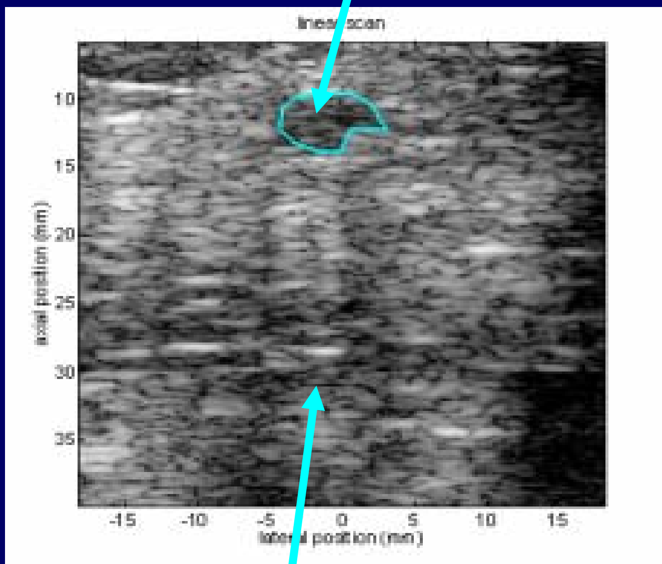
Attenuation

$$\Delta A = -20 \log_{10} \left| \frac{A}{A_0} \right| = \int_L \alpha(x,y)\, dl$$

Results of reconstruction

- Region of interest: fat

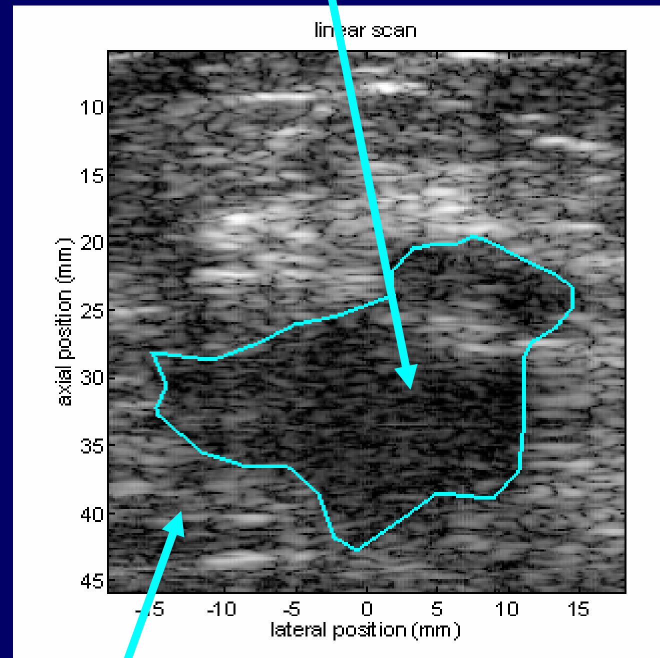
ROI: 1379.3±14.7m/sec
1.45±0.17 dB/cm/MHz



background: 1500.0±0.08m/sec
1.66±0.00 dB/cm/MHz

- Region of interest: cancer

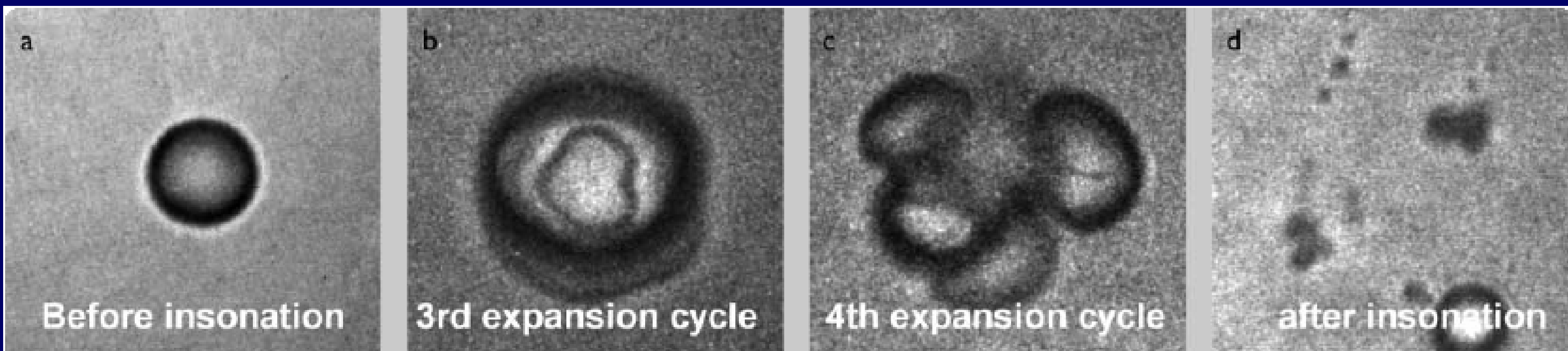
ROI: 1554.7±5.9m/sec
0.95±0.09 dB/cm/MHz



background: 1507.0±2.7m/sec
1.05±0.02 dB/cm/MHz

Ultrasound Assisted Therapy

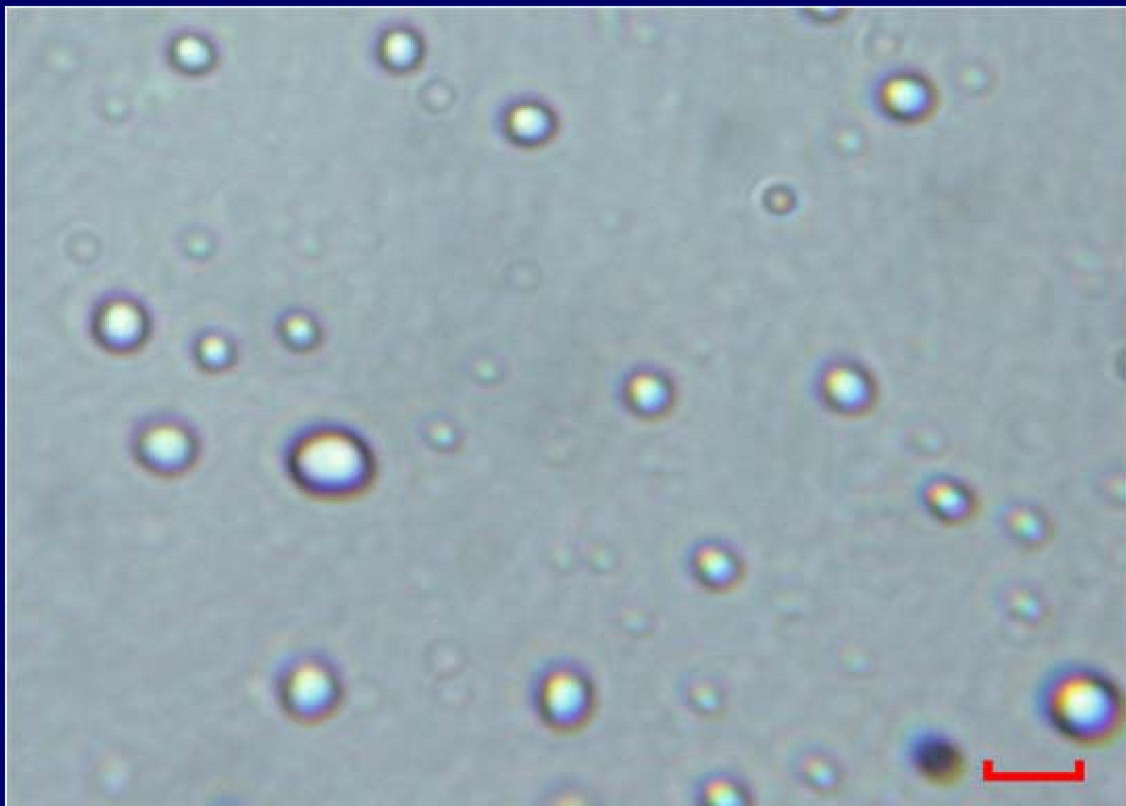
Microbubbles and Cavitation



From UC Davis

Liposome Microbubbles

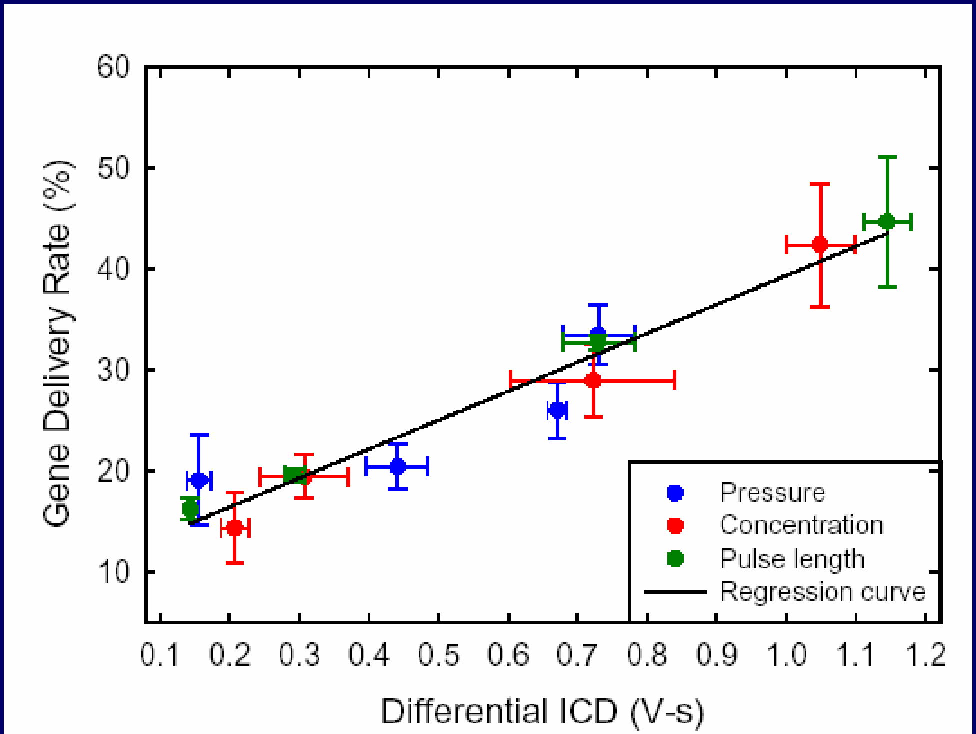
- PC : PE : PG : CH = 69 : 8 : 8 : 15 (mol %)

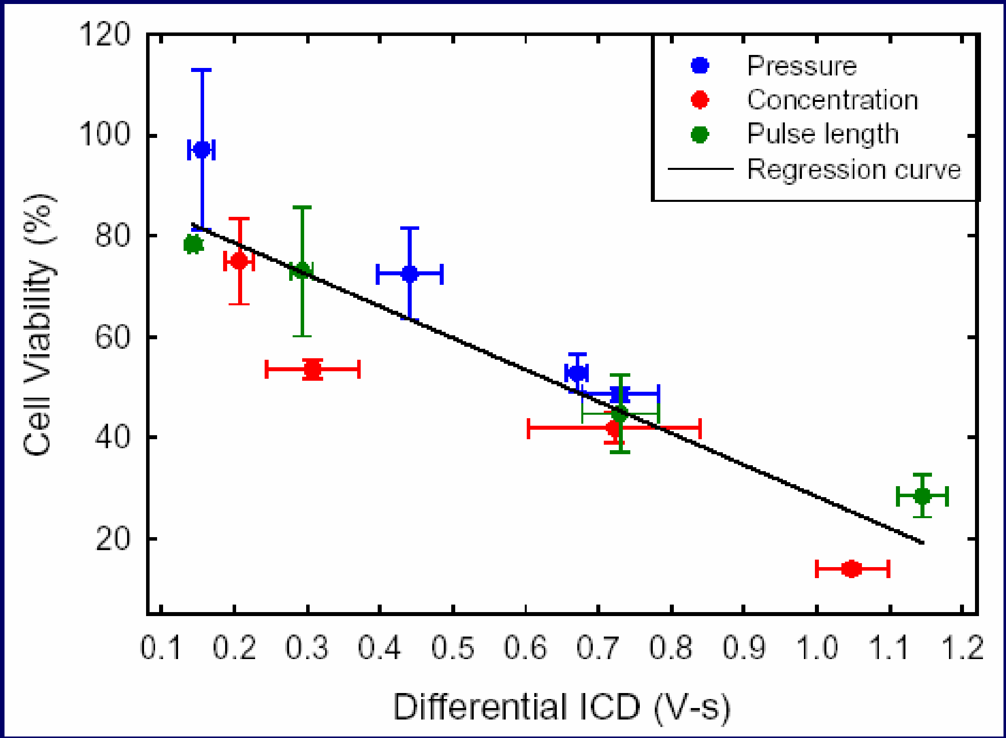


bar = 5μm

- B-mode image

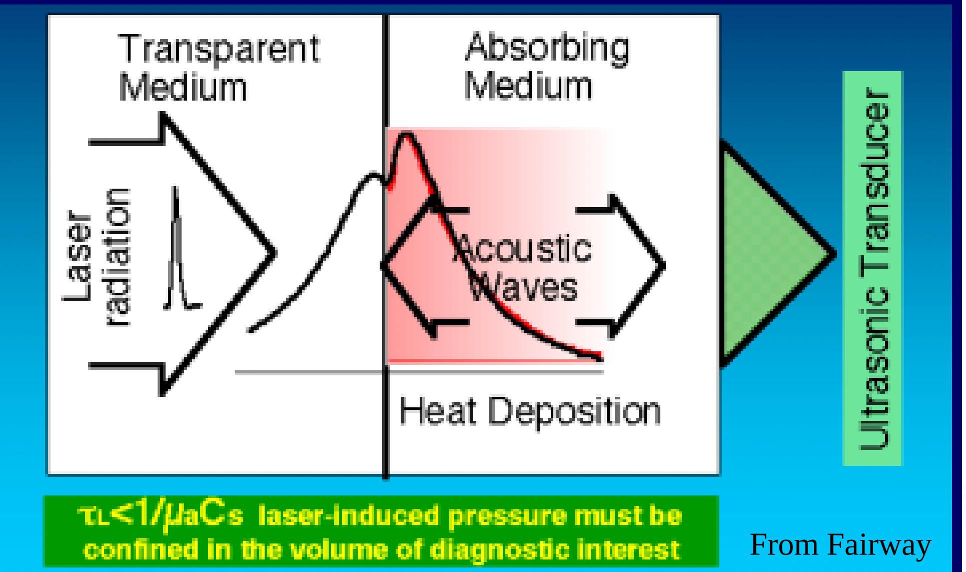
Cavitation vs.
Gene Transfection/Cell Viability



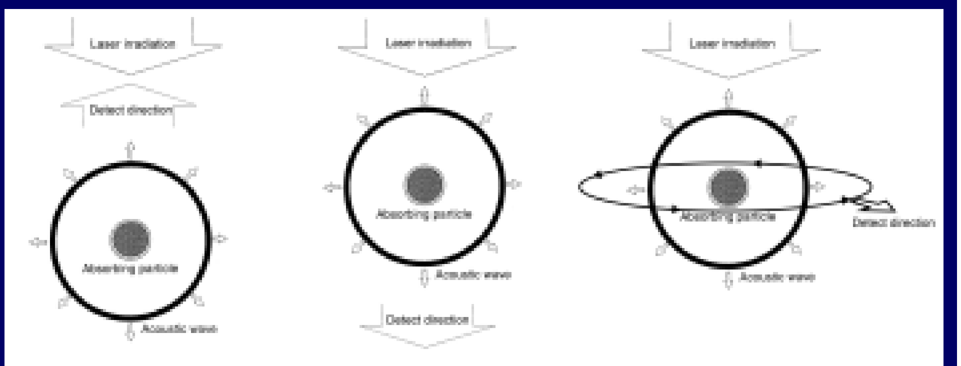


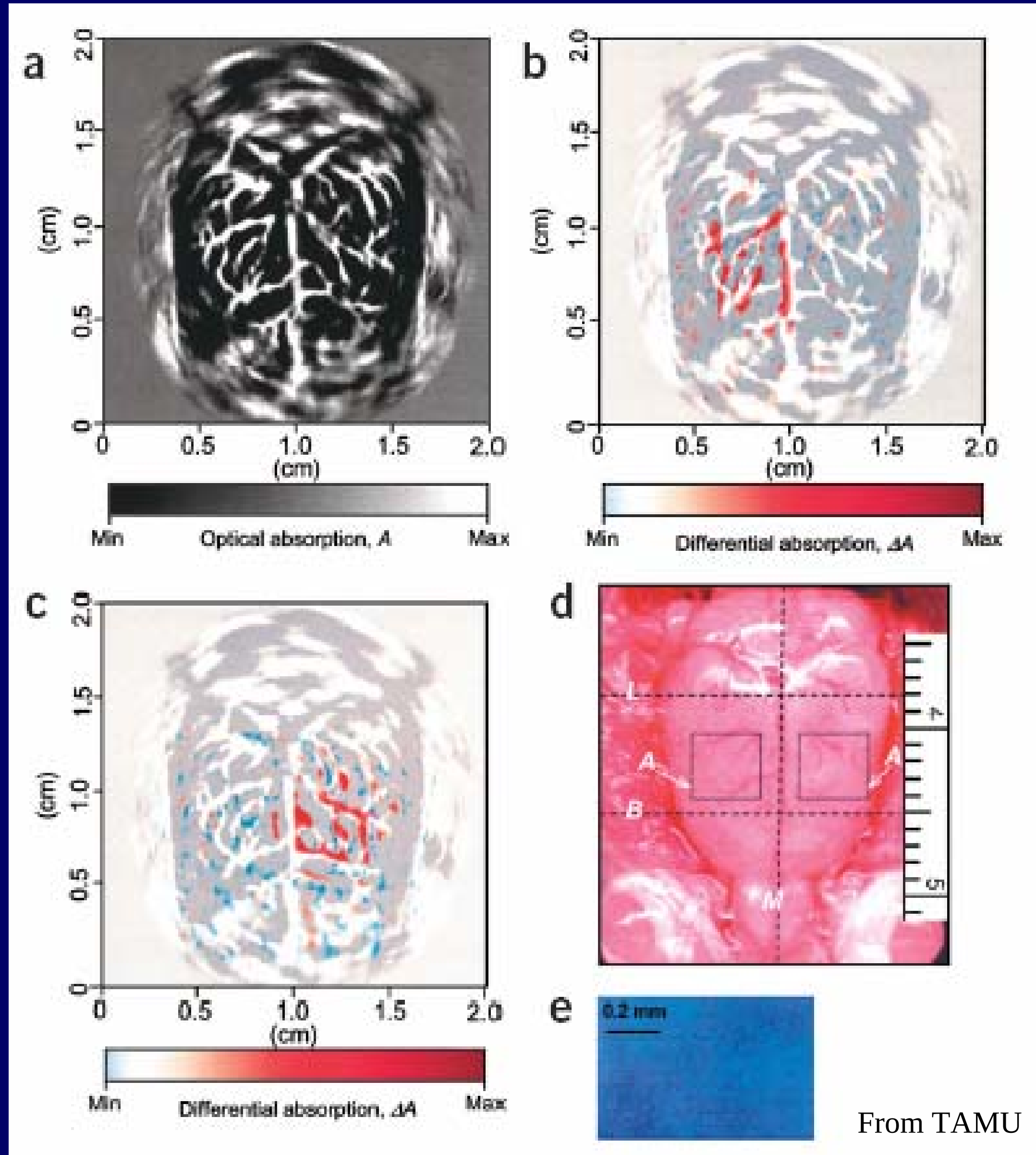
Optoacoustic Imaging and Gold Nanoparticles

Optoacoustic (Photoacoustic) Imaging



From Fairway

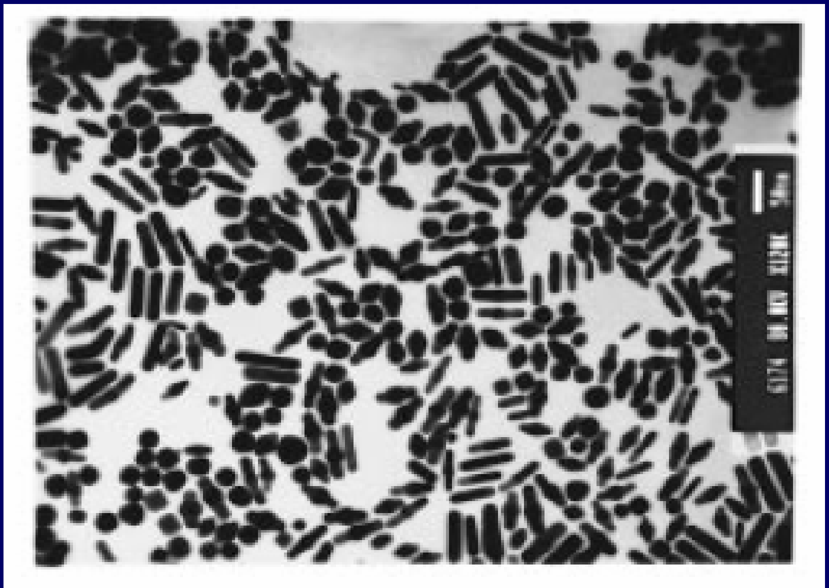




From TAMU

Properties of Gold Nanorods

- Strong absorptions at specific wavelengths
  - – Effective contrast agent or indicator
- Photo-induced shape transition



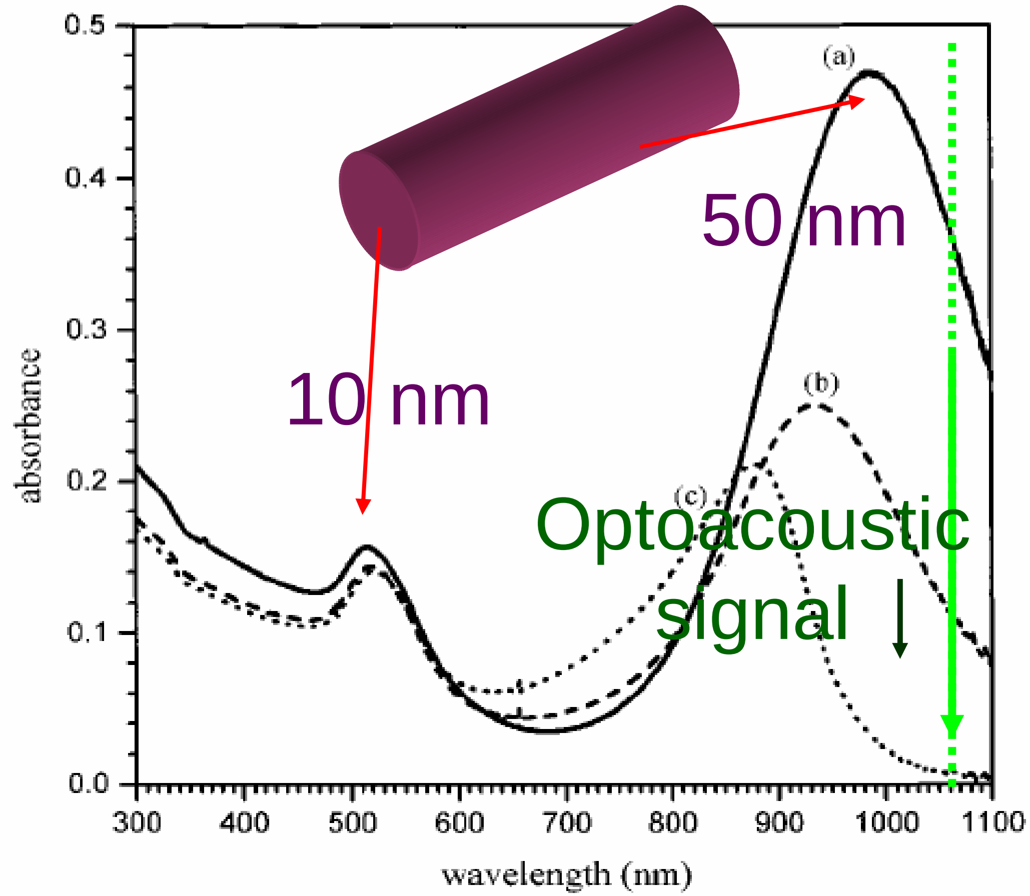
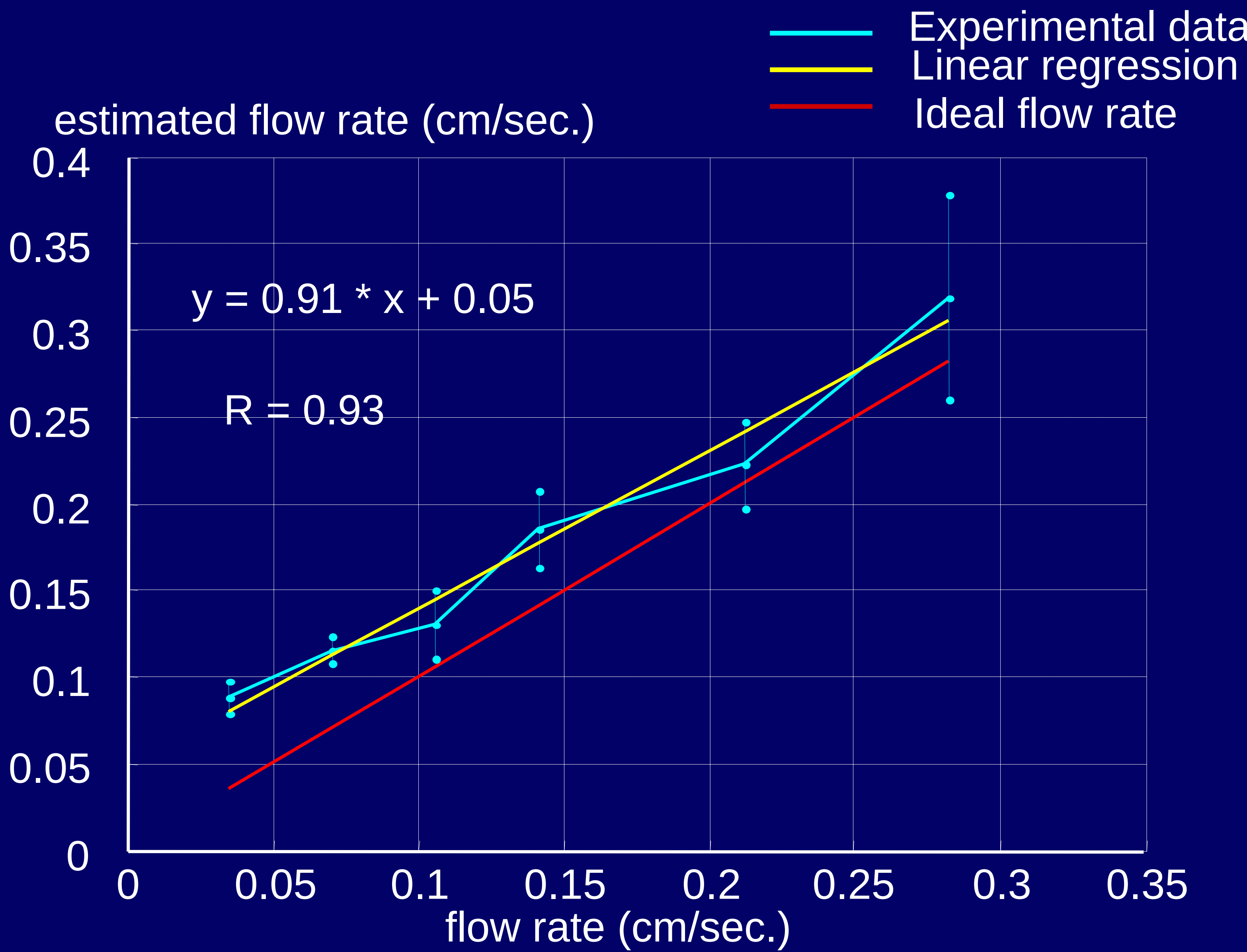


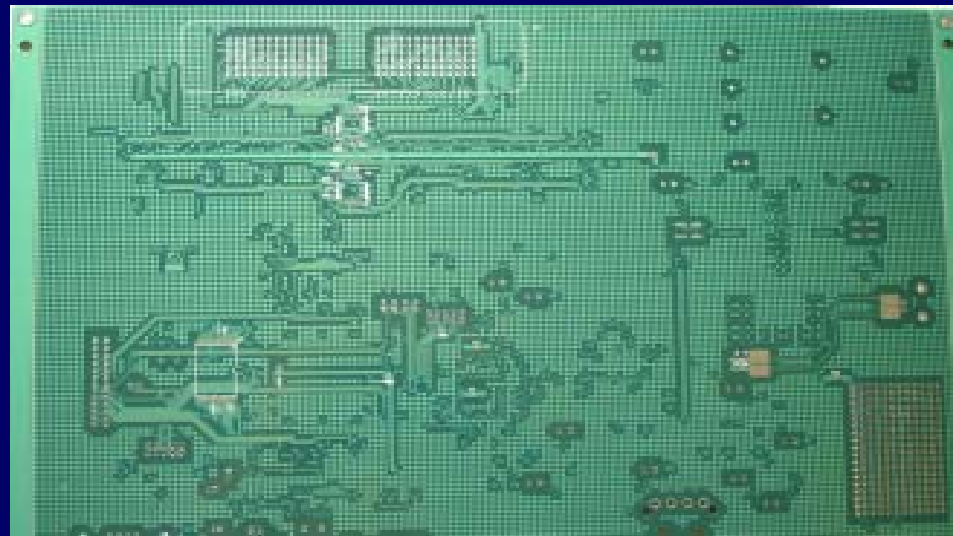
Figure 7. Absorption spectra of the Au nanorods recorded before and after 1064-nm laser irradiation: (a) the original sample (before laser irradiation); (b) after a single laser pulse of 42.5 mJ/cm^2 (dashed curve); (c) after consecutive 2000 shots of laser pulses (repetition rate = 10 Hz) at an averaged laser power of 18.5 mJ/cm^2/pulse (dotted curve).

Wash-In Analysis (Single Energy)

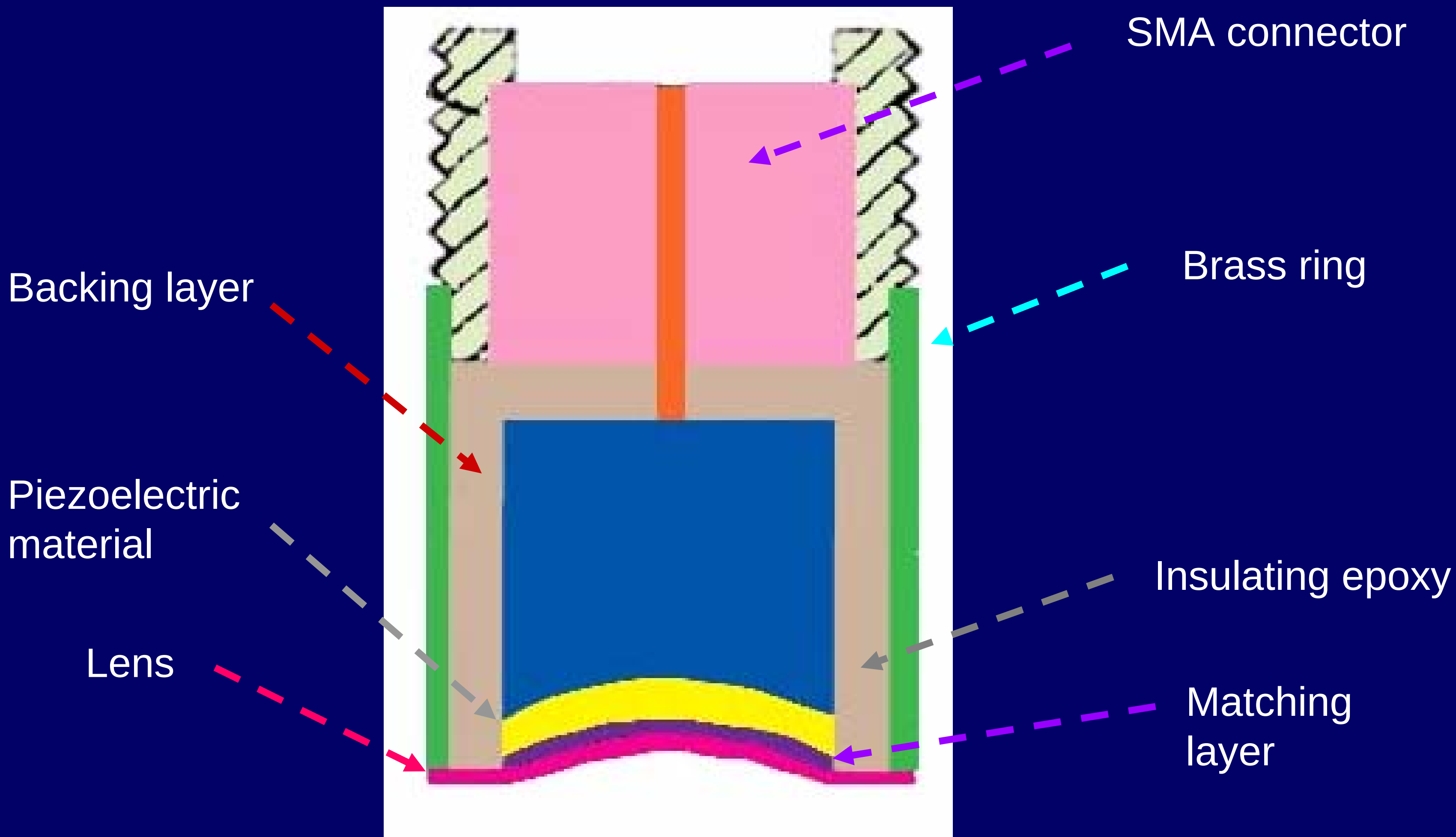


Systems and Probes

System Development



High Frequency Transducer



High Frequency Transducer

Importance of Contribution

- Ultrasonic micro-imaging
  - To combine with micro-PET
  - Genomics research, drug development and developmental biology
- Next generation ultrasonic breast imaging
  - Computer aided breast cancer detection

Importance of Contribution

- Biomedical photoacoustics with nanoparticles
  - optoacoustic functional and molecular imaging using gold nanoparticles
  - excellent example of the impact of the combination of nanotechnology and biotechnology
- Cavitation based therapy
  - significant academic contributions to prevention, diagnosis and therapy of cancer

Future Development with Electronics echnology

- To improve the next generation ultrasound system using advanced electronics technology.
  - Higher frequency
  - Multi-channel
  - High speed processing
  - Fusion with other medical imaging modalities
  - Wireless communication