Overview of Diagnostic Technologies

UC Davis

Laura Marcu, Ph.D.

Professor of Biomedical Engineering and Neurological Surgery

Co-Leader Biomedical Technology Program Cancer Center UCDMC

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BIOMEDICAL ENGINEERING

Biomedical Technology Program:
Themes & Participation

RESEARCH THEMES

1. Research and Diagnostic Technologies (9)
2. Technologies for Whole Body/Organ Imaging (9)
3. Technologies for Cancer Therapy (5)
4. Biomarker Discovery & Development (6)
5. Biosensing Technologies (4)

ACADEMIC/RESEARCH HOMES

- College of Engineering
- School of Medicine
- CBST
- LLNL

EXPERTISE

- Engineering Sciences
- Physical Sciences
- Medical Sciences

Biomedical Technology Program

- **Multi-Scale**
  - Molecules → Cells → Tissue → Organ → Body
- **Translational**
  - Benchtop → Animal Models → Humans
- **Broad Clinical Impact**
  - Breast, brain, prostate, head & neck cancer, etc.

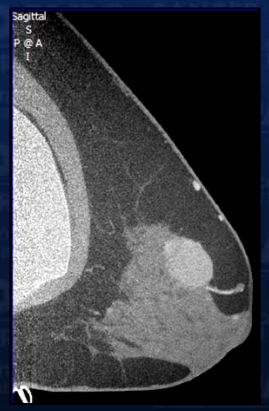
Breast CT and PET/CT (Theme 2)

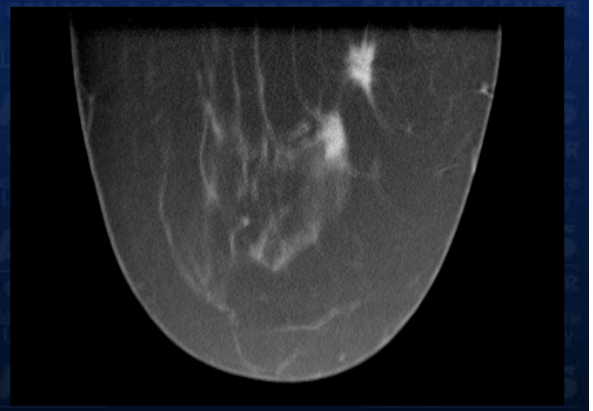
Clinical Impact: Earlier Detection & Predicting Response to Therapy

John Boone, Ramsey Badawi, Simon Cherry, Abhijit Chaudhari, Jinyi Qi,
Karen Lindfors, Rosalie Hagge, Steve Martinez
***Radiology*, Biomedical Engineering, Surgical Oncology**

Breast CT
Comparison to mammography for detection (>350 patients, 2 centers)
R01 EB002138

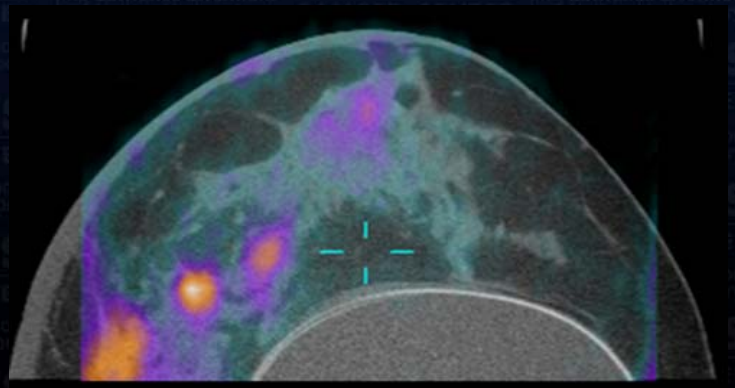
Lindfors et al. *Radiology*. 2008
Prionas et al. *Radiology*. 2010





Breast PET/CT
Neoadjuvant chemotherapy: correlation of PET/CT with pathology (3 patients)
R01 CA129561

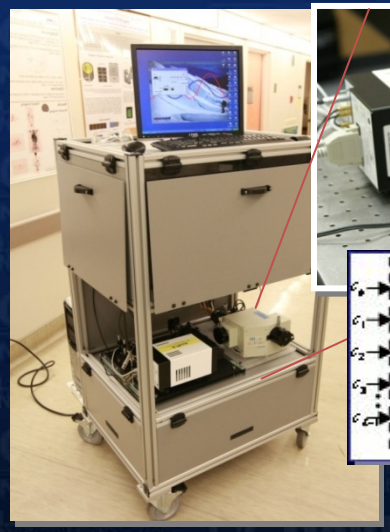
Bowen et al. *J Nucl Med*. 2009
Wu et al. *Phys Med Biol*. 2009

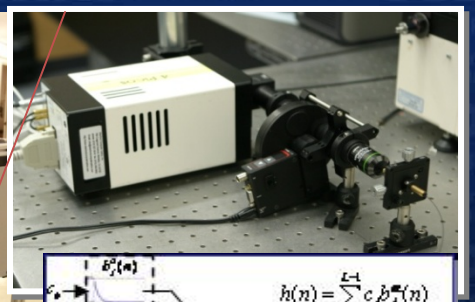


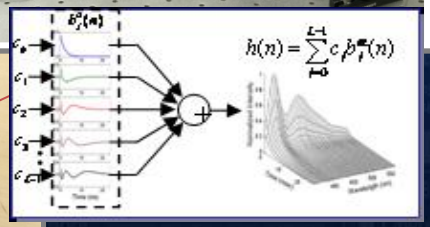
Optical Systems for Image-Guided Interventions (Theme 1)

Clinical Impact: Identifying surgical margins in real time

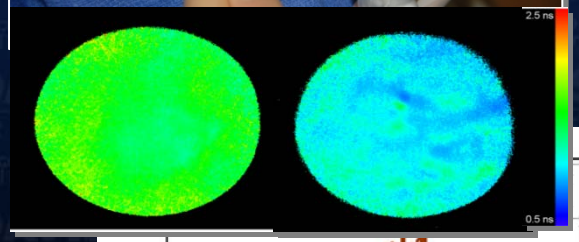
Laura Marcu, Gregory Farwell, and Rudolph Schrot – BME *& Surgery*

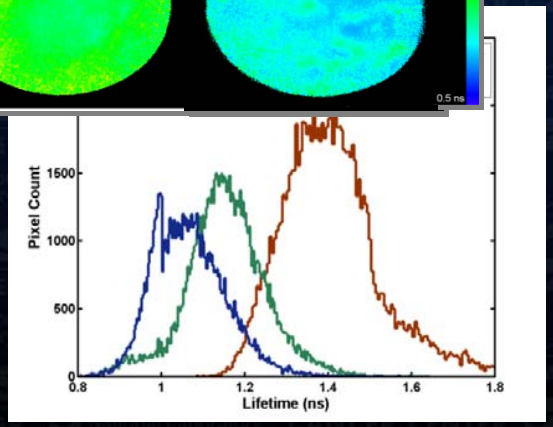




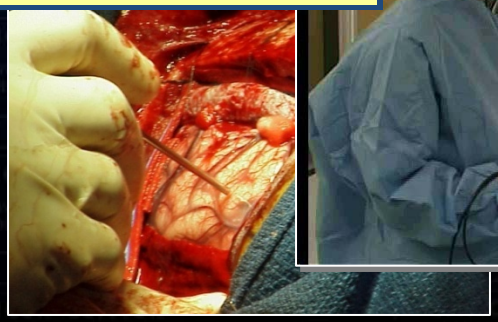


Head & Neck Tumor (20 patients)





Brain Tumor (40 patients)



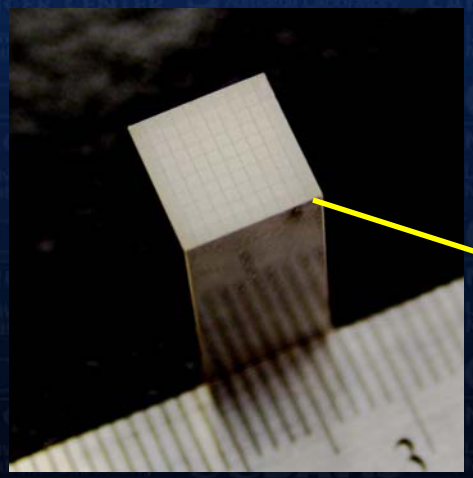
Sun et al, *Journal of Biomedical Optics*, 2010
Meier et al, *Otolaryngology Head and Neck Surgery*, 2010
Butte et al, *Neuroimage,* 2010

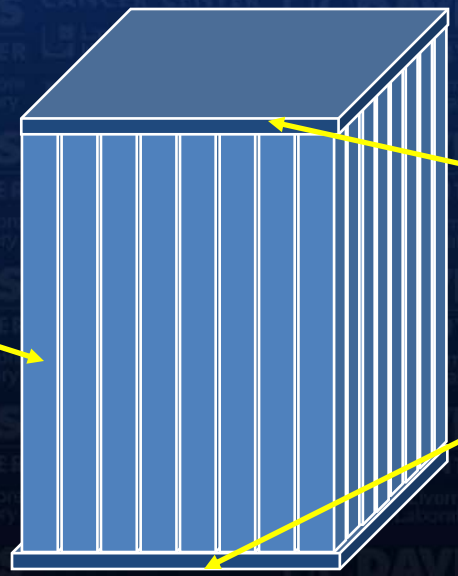
High Resolution Solid State Detectors for Positron Emission Tomography (Theme 1)

Target: Small animal imaging and human breast cancer imaging

Impact: Higher resolution and sensitivity of detection

Highly pixelated scintillator arrays





Position-sensitive avalanche photodiodes

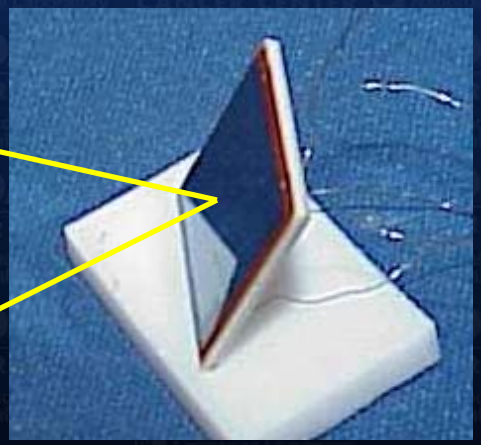
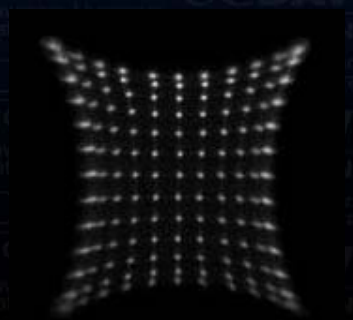


Image from detector showing all scintillator elements resolved



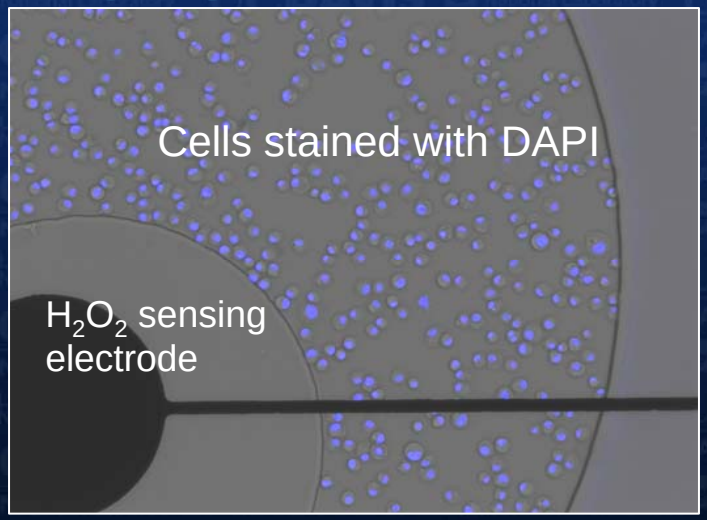
- Higher spatial resolution will allow smaller tumors to be detected and quantified
- Compact detector design, also reduces scanner cost

Simon Cherry – BME

Biosensors for *In Vitro* Monitoring of Cancer Cell Metabolism (Theme 5)

Impact: cancer drug screening or personalized cancer therapies

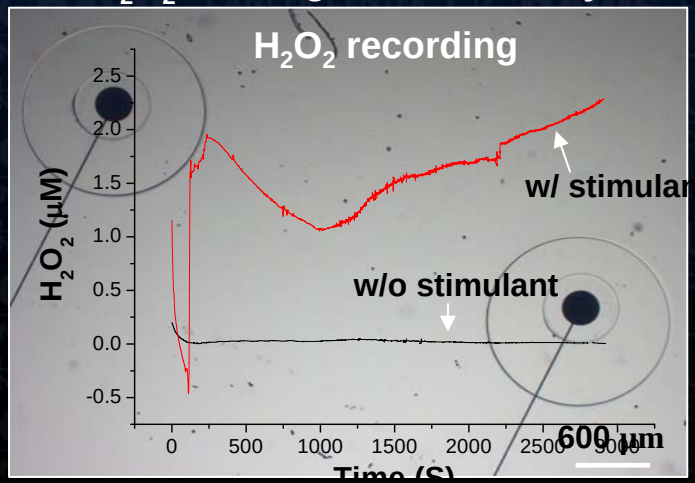
Alex Rezvin – BME



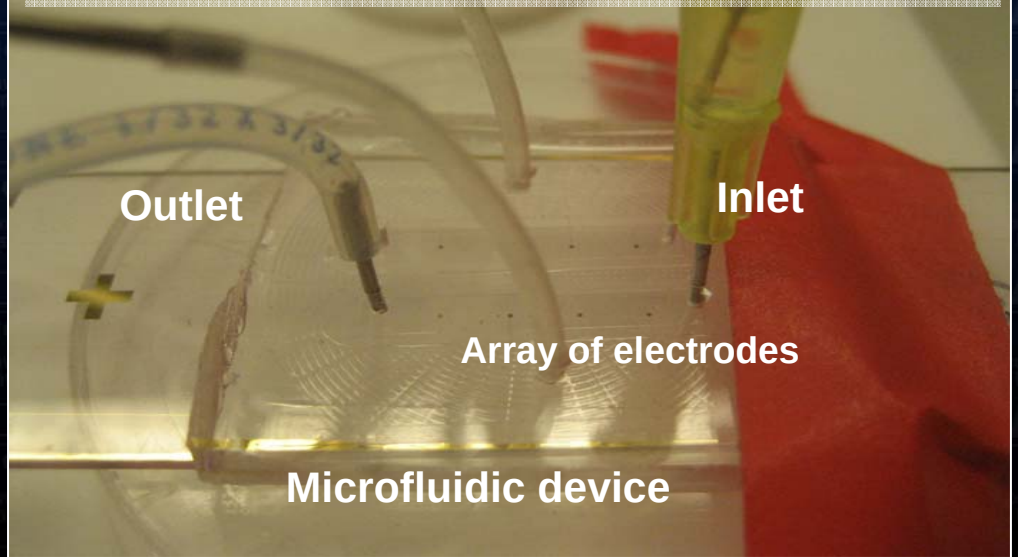
Goal: Develop a microsystem for monitoring changes in cancer cell metabolism in response to drug stimulation.

Design criteria: 1) Detect metabolites (glucose, H2 O2) secreted by a smaller number of cells, 2) Integrate cells with microfluidic devices to enable screening of multiple drug candidate types or concentrations.

H_2O_2 sensing electrode array



Working device: microfluidic chamber (3 μl) integrated with 4 H_2O_2 sensing electrodes



Advanced Multimodality Molecular Probes (Theme 4)

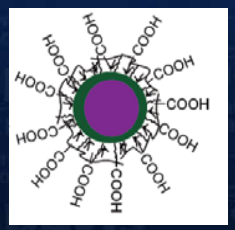
Impact: increase diagnosis/detection specificity

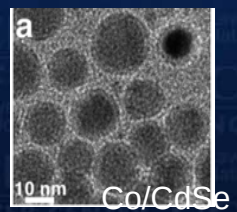
Angelique Louie – BME

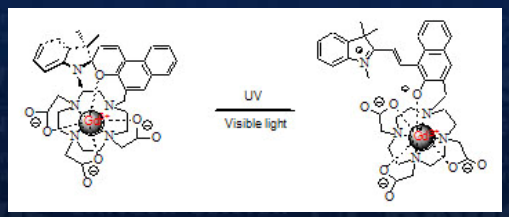
MRI/Optical:
paramagnetic QD

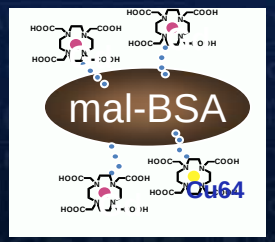
MRI/Optical:
Activatable small molecule

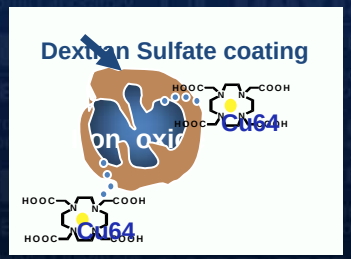
MRI/PET:
Plaque imaging
Particulate pollution tracking

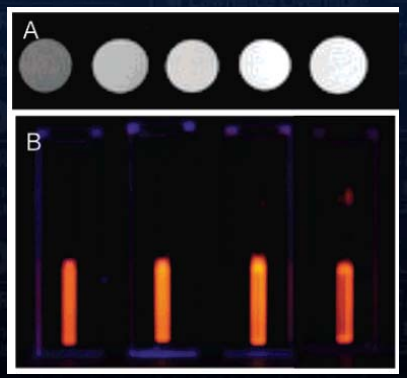


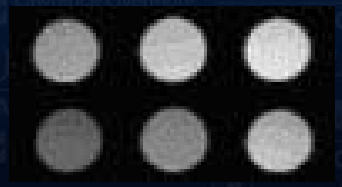


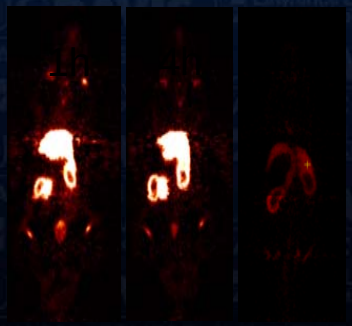


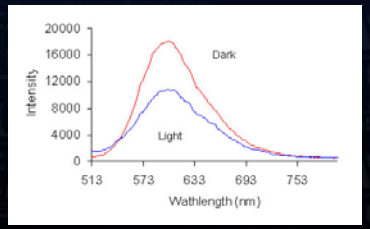












- Wang 2006 SPIE & 2007 JACS
- Zhang 2007 Nanotechnology

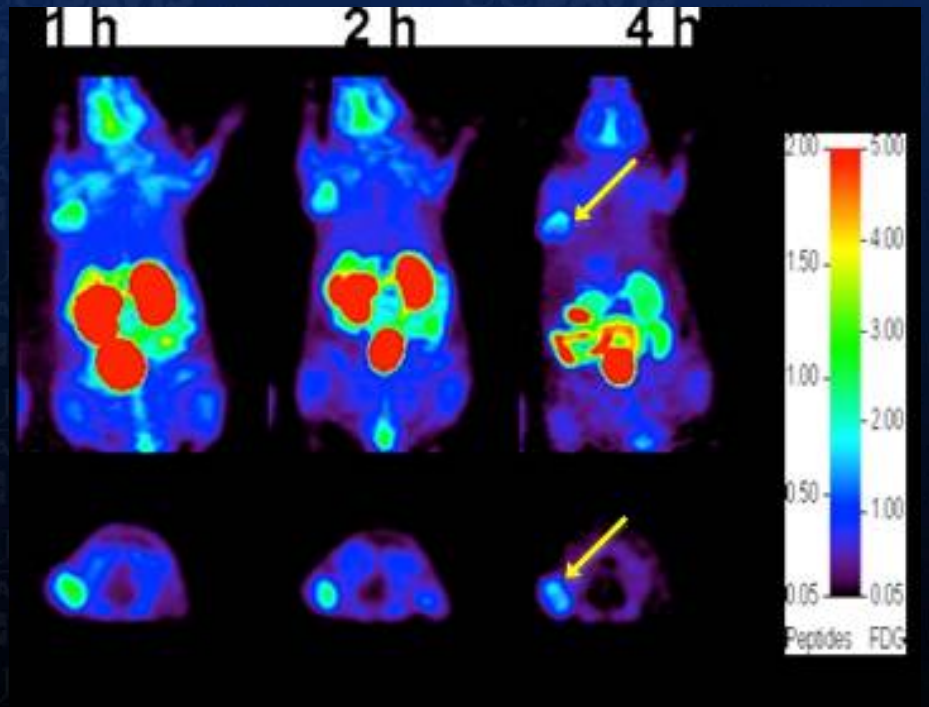
- Tu 2007 Chem Comm

- Gustafsson 2006 Bioconj Chem
- Jarrett 2007 Nanotechnology

Design of Targeted Molecular Cancer Imaging Agents (Theme 4)

Impact: Improved specificity of PET

Julie Sutcliffe – BME



Biodistribution of radiotracer [18F[A20FMDV2, targeted to tumor (arrow) expressing the integrin avb6.

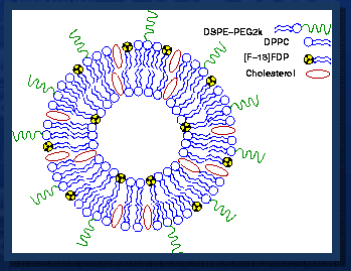
The High-Throughput Design of Targeted Molecular Cancer Imaging Agents

Goal: To design, synthesize and perform *in vivo* evaluation of targeted molecular imaging agents for PET.

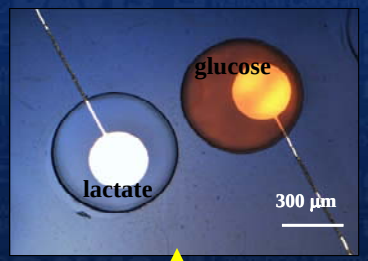
Diagnostic Technologies: Translational Significance

Diagnostic Technologies

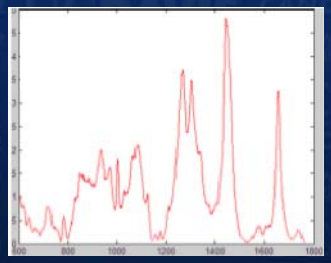
Targeted probes:
Improved diagnostic specificity



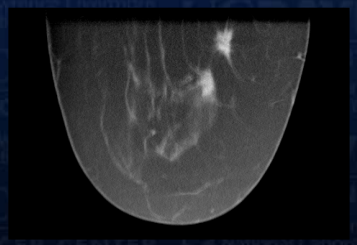
Microfabricated Biosensors
Monitor cell metabolic response to therapies



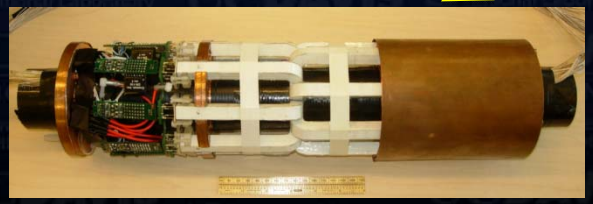
Raman Spectroscopy:
Assay directed, patient-specific treatment of leukemia



Breast CT:
Earlier tumor detection



Other Projects



PET/MRI:scanner
Improved assessment of therapeutic response

PET detectors:
Improved resolution specificity of cancer diagnostic

Time-Resolved Fluorescence:
Improved delineation of tumor margins