Research interests (by imaging modality)

I. High resolution radionuclide imaging:
   - positron emission tomography (PET)
   - single photon emission computed tomography (SPECT)

II. Optical tomography:
   - Bioluminescence tomography (BLT)
   - Fluorescence tomography (FLT)

Research interests (by imaging technology)

- New photon sensors
- Low noise electronics
- Data acquisition systems and software
- Computer simulation and modeling
- Image reconstruction algorithms
- Image analysis algorithms
- Integrating components into new imaging systems

Two new radionuclide cameras under development

I. Miniature gamma ray camera for surgical cancer staging

II. Dedicated breast PET system to help resolve difficulties with breast cancer detection, diagnosis and staging
I. Cancer staging problem

Localization and biopsy of “sentinel” lymph node is important for cancer staging (e.g., melanoma and breast cancer) to avoid unnecessary dissection of the lymphatic system.

Sentinel node negative → Cancer has not spread

Identification of sentinel node requires:
- Radiotracer that accumulates in node
- Pre-operative Lymphoscintigraphy
- Sensitive Radiation Detector Probe

Standard Non-imaging Radiation Detector Probe for Surgical Cancer Staging

Features:
- Audio tone generator
- LCD display
- Digital count readout
- Automated energy windowing

Neoprobe, Inc.

SUMMARY OF THE GAMMA PROBE METHOD

Summary of the Sentinel Node Method

Desirable characteristics (STICK):
- High accumulation in the sentinel node(s)
- High detection sensitivity of the non-imaging radiation detector
- Location of sentinel node(s) can be identified prior to any incisions

Limitations of the method:
- Poor labeling efficiency
- Inappropriate size of colloid particle
- Disruption of lymphatic flow
- Inappropriate injection dose or volume
- Procedure is time consuming and at times quite invasive
- Learning curve is significant
- Sentinel node is not identified during lymphoscintigraphy
- Node is within or near the injection site or bolus activity
- Node relatively deep within tissue
- Node cannot be distinguished from other secondary nodes or colloid migration path in lymphatic channels
- Node is too small or its activity is too low

Could be resolved with a small camera.
II. Difficulties with breast cancer detection, diagnosis and staging

Detection: ~25% of screened cases are inconclusive (due to dense/distorted tissue)

Diagnosis: Mammographic breast cancer signatures are only 20-30% specific

Staging: Missed nodes and unnecessary axillary lymph node dissections

Need to investigate sensitive, specific, non-invasive techniques
Can radionuclide imaging help with breast cancer screening/diagnosis/staging?

- Can the lesion/node be easily detected (high sensitivity)?
- Does the radiotracer have a very high affinity/accumulation for cancer/nodes (high specificity)?
- Is the cost of the imaging procedure reasonable?
- Can the study be performed reasonably quick?

Drawbacks of the Standard PET Camera for Breast Imaging

- Large and awkward for breast and axilla imaging
- Inability for close-proximity imaging → poor spatial resolution (6-12mm) → poor detection efficiency (<1%)
- Accepts activity from outside organs → background haze
- Relative high cost per study
PET camera dedicated to breast imaging

Potential Roles:
• Screening indeterminate cases?
• Reducing rate of false positives??
• Staging of axillary nodes?
• Detecting recurrence?
• Monitoring therapy?

PET camera dedicated to breast cancer imaging

Simulations predict: can see 3 mm tumors in 10 sec.
With background activity in breast, heart, and torso
Activity concentration ratio—Tumors:Breast:Heart:Torso=10:1:1:10:1