

# Quantitative Approaches to the Pathological Evaluation of Lung Cancer

Jessica C. Sieren, PhD

Assistant Professor of Radiology and Biomedical Engineering

Co-Director of the Division of Physiological Imaging

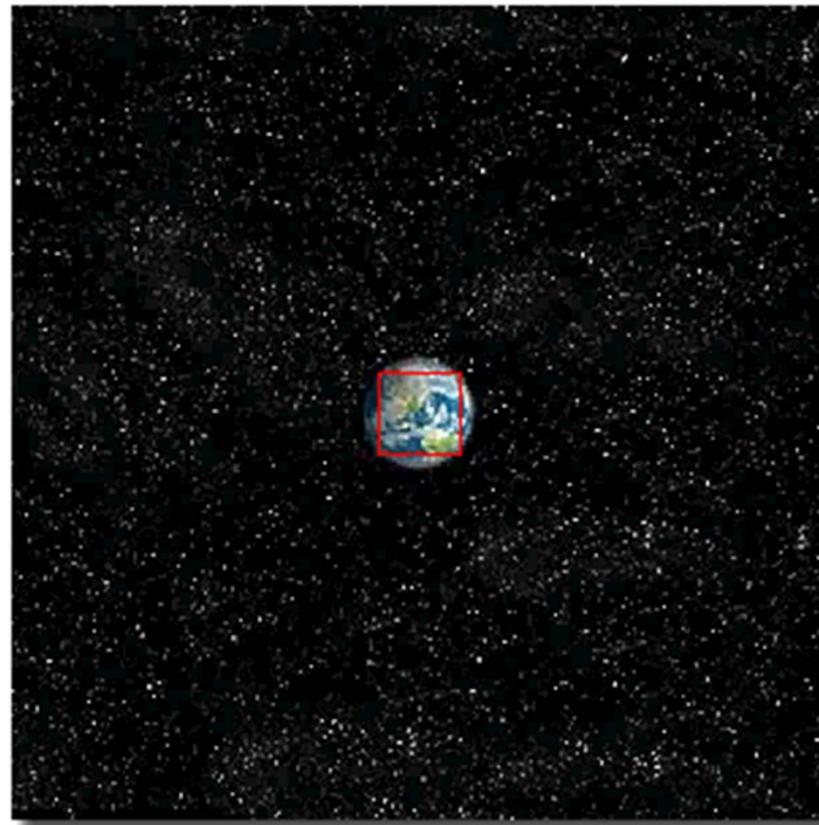
University of Iowa

# CT for characterization

- In November 2010, the National Lung Screening Trial was ended early due to the finding that 20% fewer cancer related deaths occurred in the group undergoing computed tomography (CT) screening for lung cancer compared to the group screened with chest x-ray.
- With the anticipated increased utilization of CT screening of the smoking population, comes a need to maximize the diagnostic power of the test.

# Inspiration: Linking the big picture to the details

The Earth from 100,000 Kilometers.



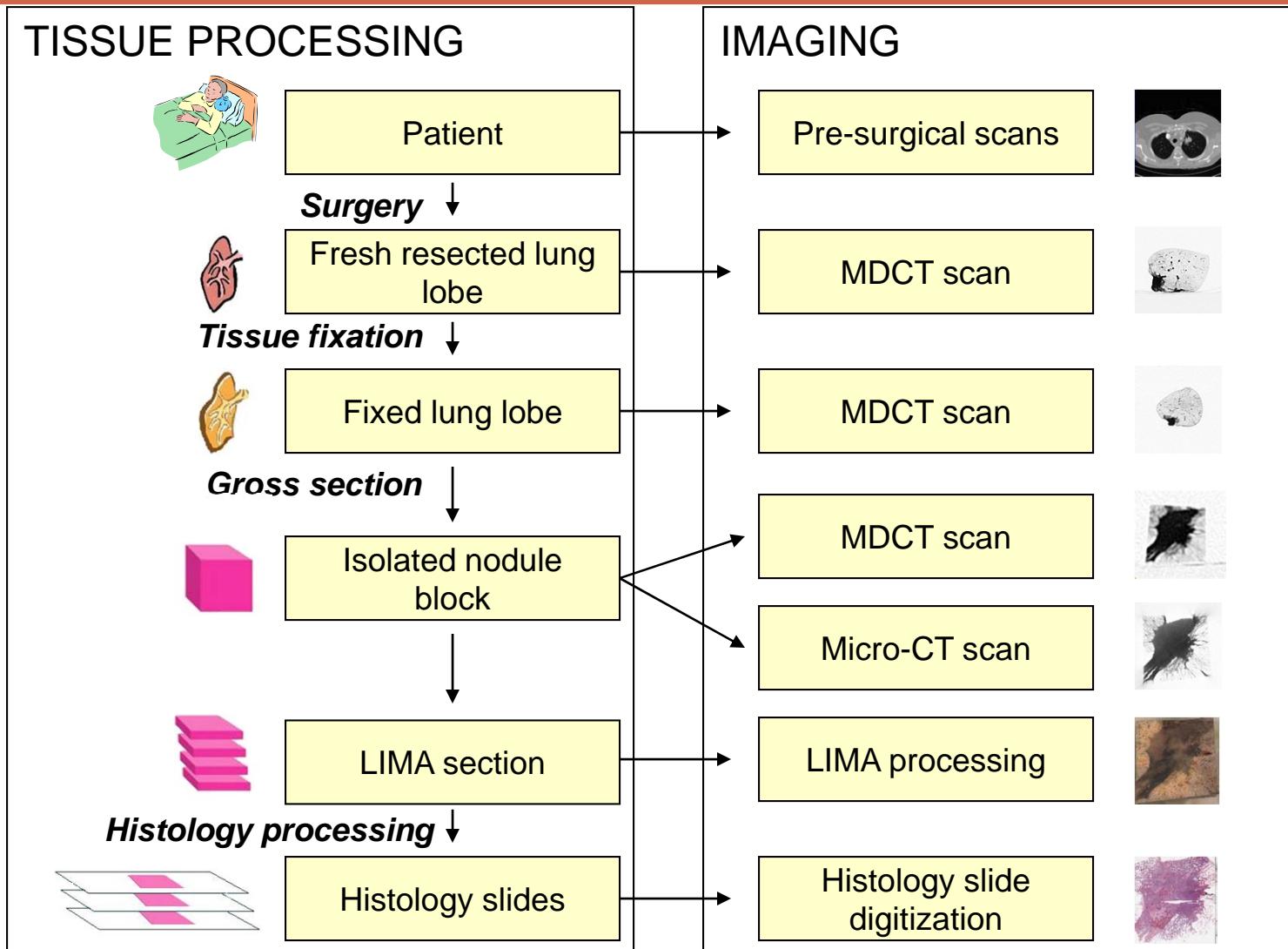
$10^{+8}$  meters

$10^8$  100,000 kilometers

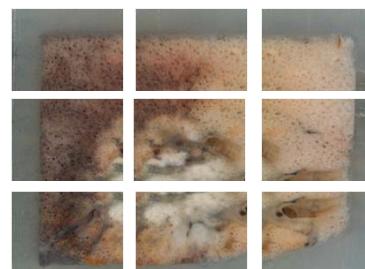
# METHODOLOGY

Developing a tissue processing and imaging pipeline

# Developed approach



# Specialized Sectioning



LIMA post  
processing

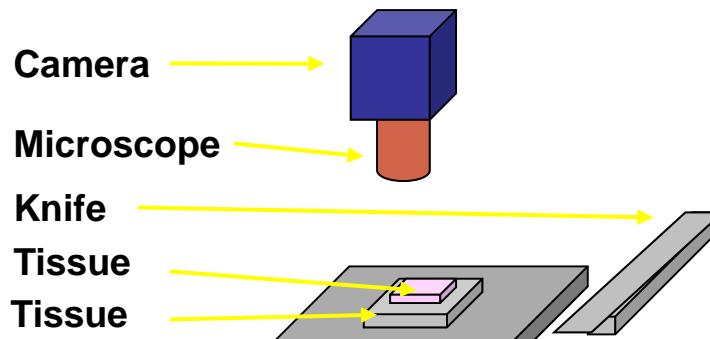
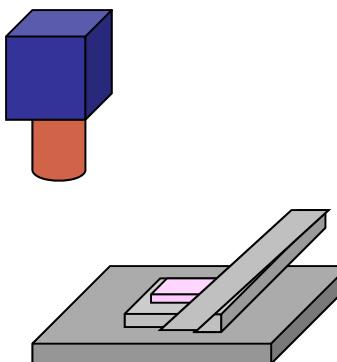
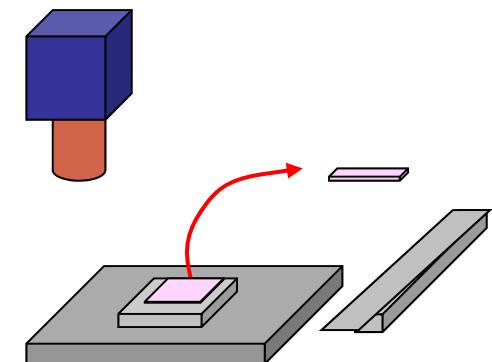


Image  
acquisition

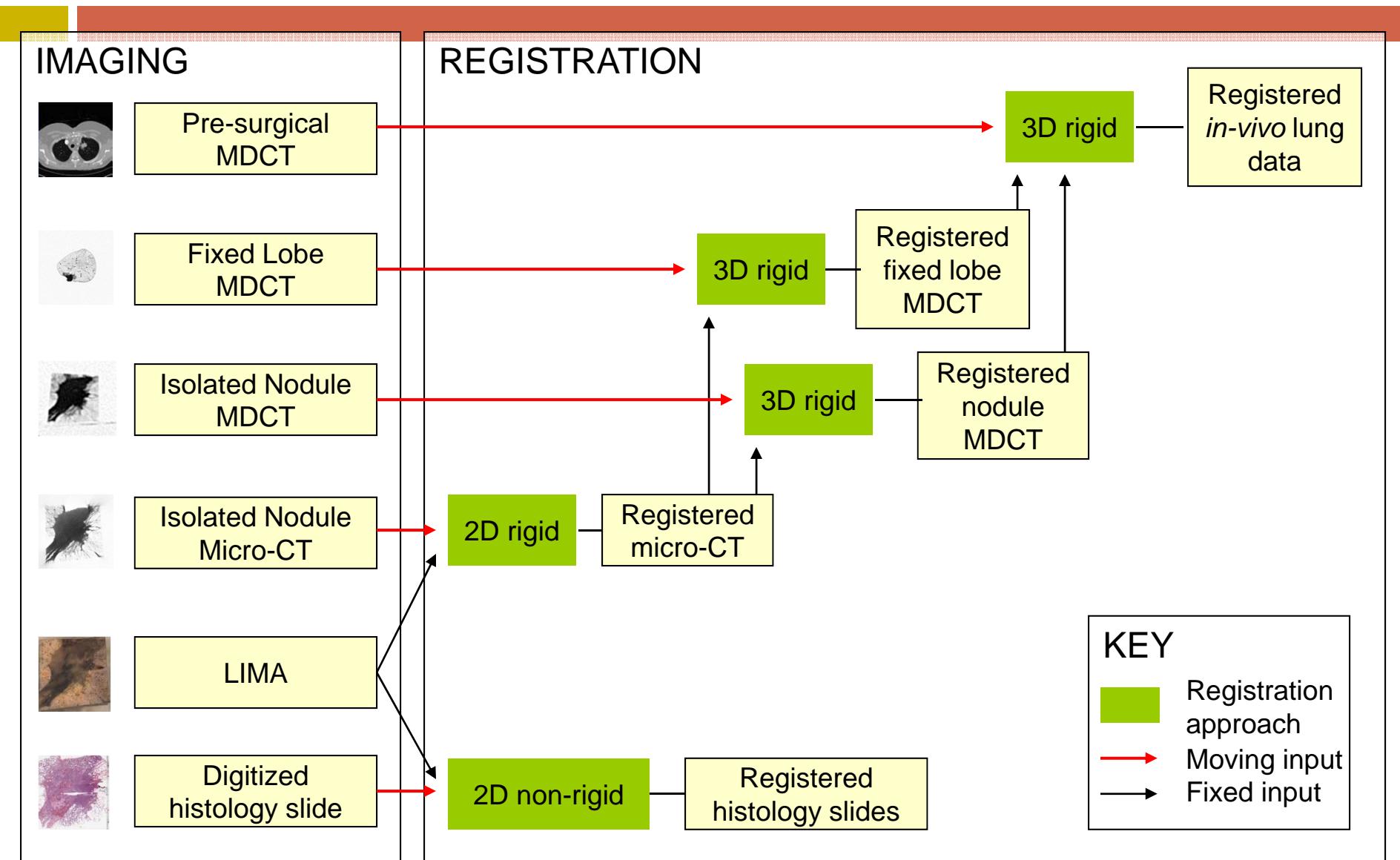


Tissue  
sectioning



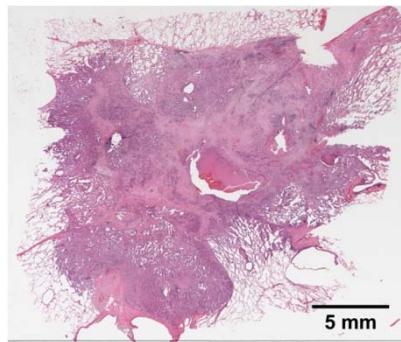
Section  
removal

# Registration

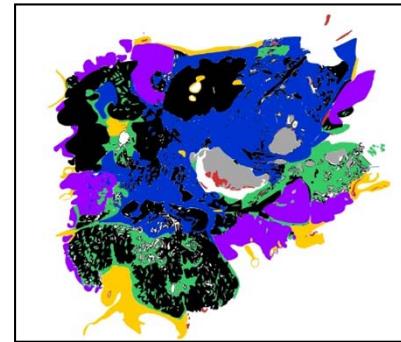


# Quantitative Histology

Digitized H&E section



Tissue type map

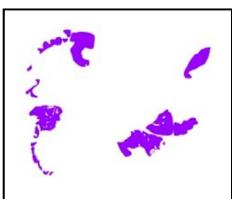


Pathologist manual tracing

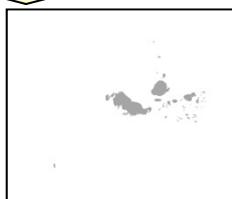
Combine individual tissue type maps



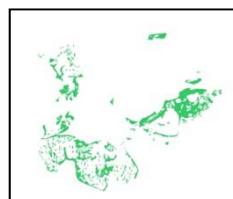
Cancerous tumor  
(Solid)



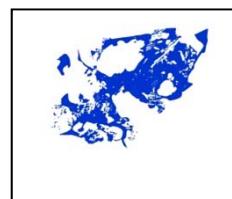
Cancerous tumor  
(BAC)



Necrosis



Active fibroblastic stroma



Inactive fibrosis



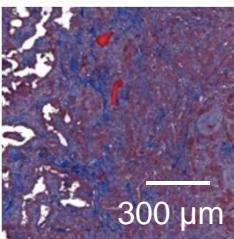
Red blood cells



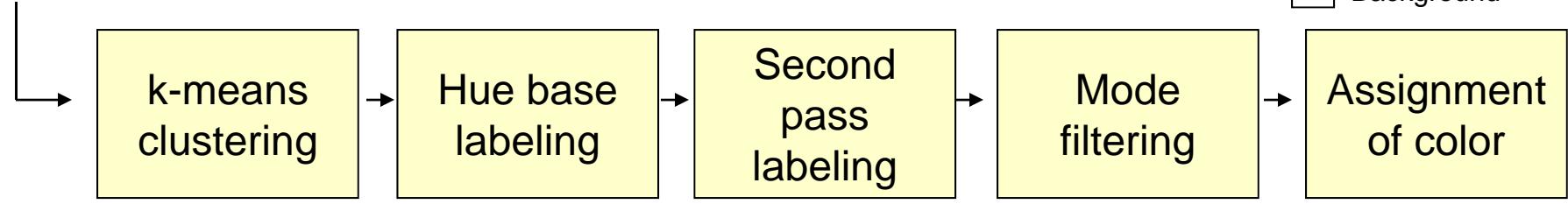
Normal tissue

# Automated histology segmentation

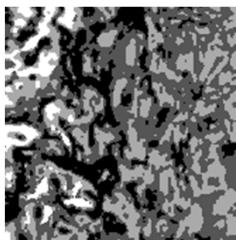
Histopathology data



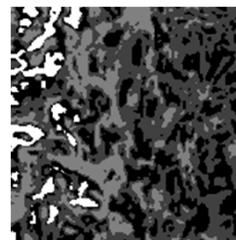
■	Cancerous Tumor
■	Active Fibrosis
■	Inactive Fibrosis
■	Red Blood Cells
■	Background



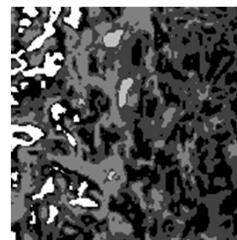
*Initial four regions*



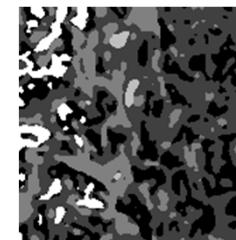
*Initial labeling*



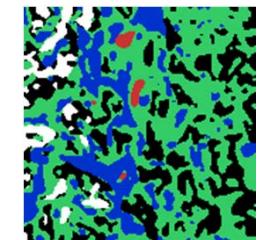
*Final labeling*



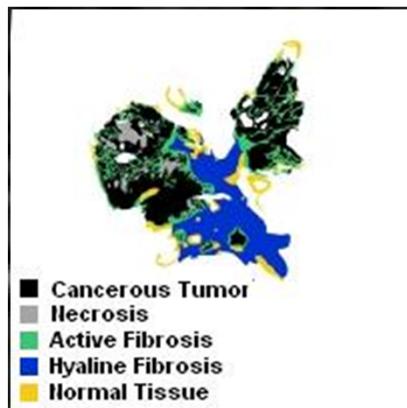
*Smoothed regions*



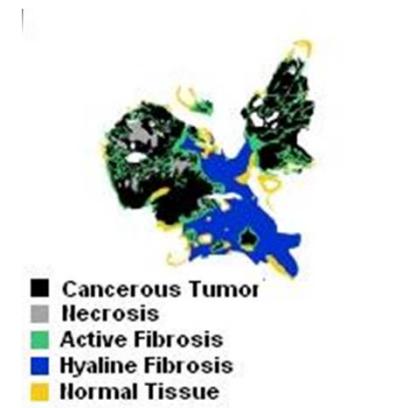
*Final tissue type map*



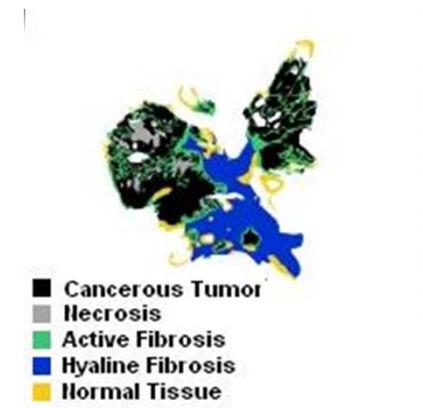
# Link histology to CT



Fixed Lobe MDCT



Isolated Nodule MDCT



Micro-CT

## Histogram Statistics

Mean HU

Median HU

HU  
Standard  
Deviation

HU Skew

HU Kurtosis

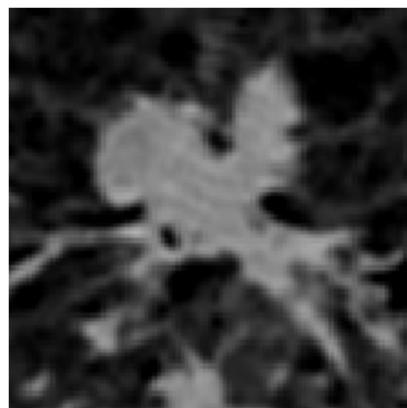
# RESULTS

How complex is the composition of lung cancer  
and can the composition be correlated to CT HU?

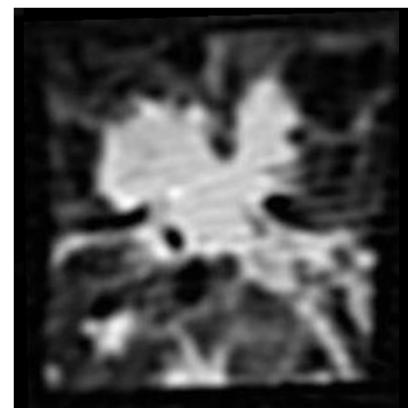
# Resulting dataset



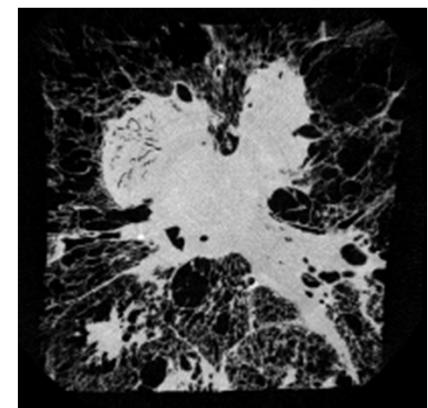
***In vivo* MDCT**



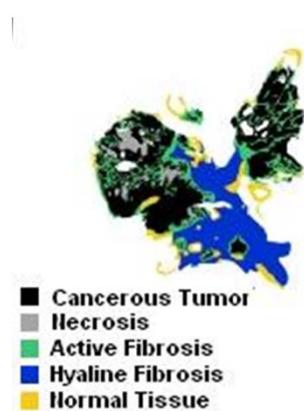
**Fixed Lobe  
MDCT**



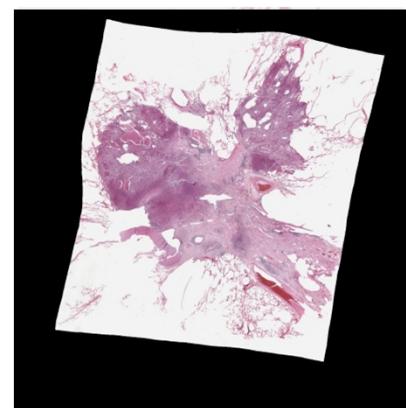
**Isolated Nodule  
MDCT**



**Micro-CT**



**Tissue type map**

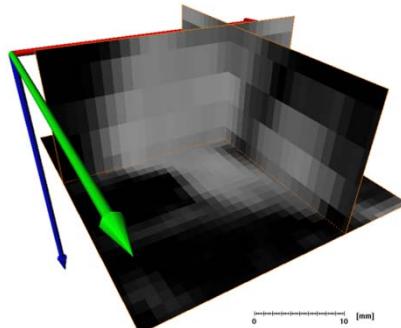


**Histology**

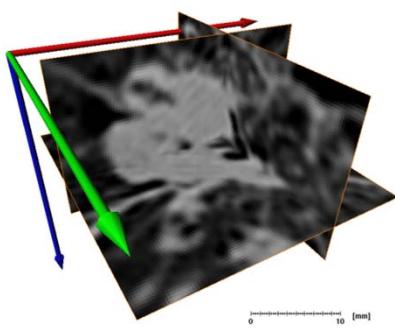


**LIMA**

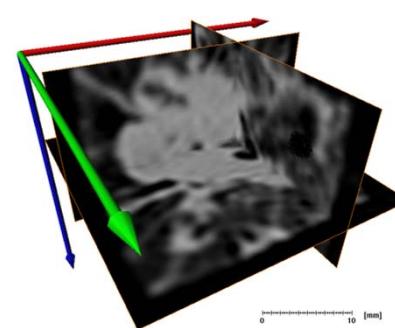
# 3D view



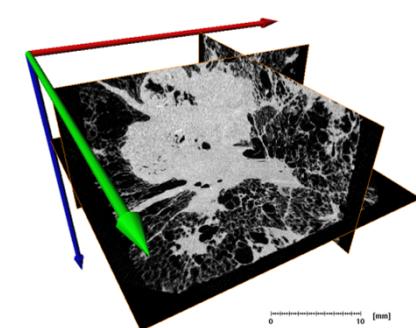
**In vivo MDCT**



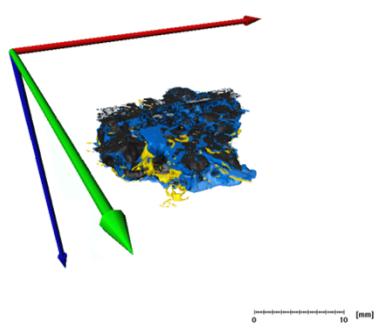
**Fixed Lobe  
MDCT**



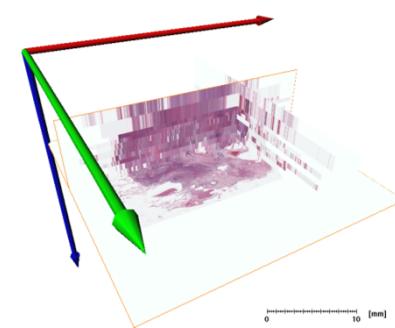
**Isolated Nodule  
MDCT**



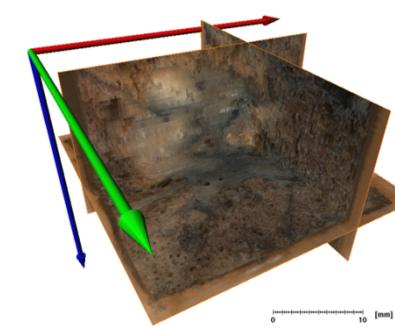
**Micro-CT**



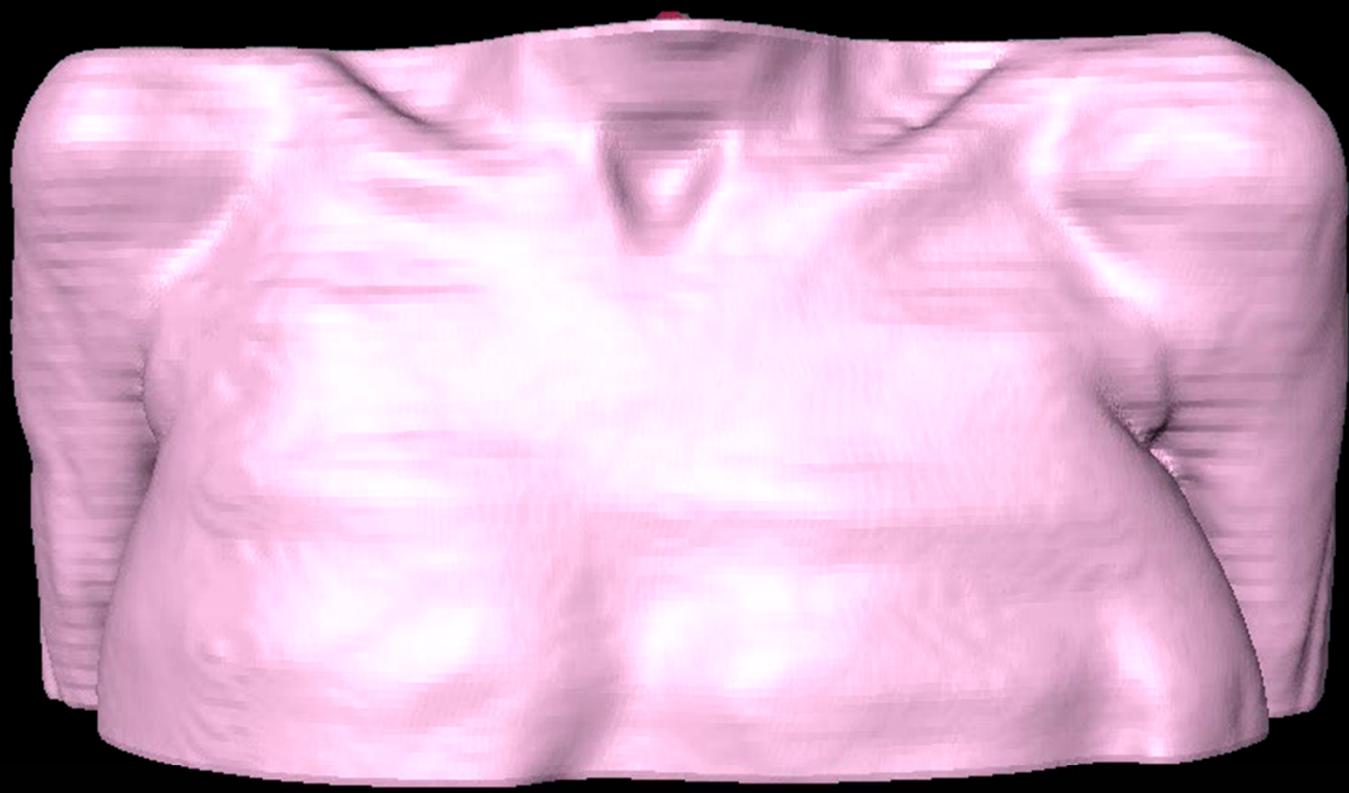
**Tissue type  
map**



**Histology**

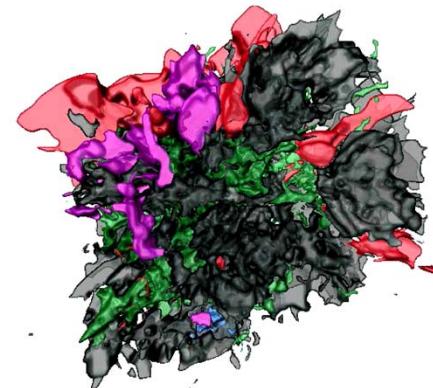


**LIMA**



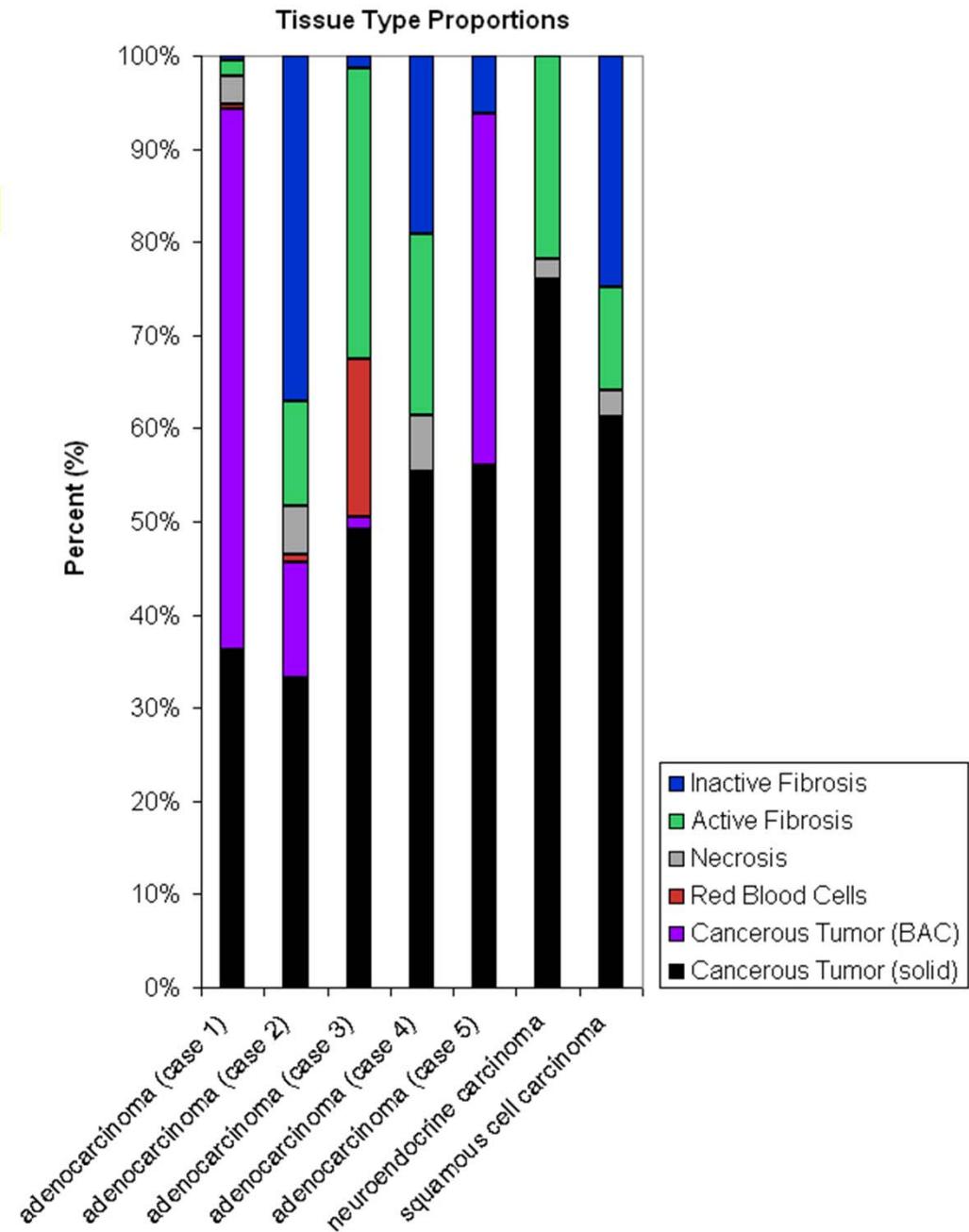
# 3D tissue type maps

- Clear visualization of the tissue types
- Can quantitatively investigate relationship and connectivity between tissues



## Tissue Type Key

<span style="color: green;">■</span>	Active Fibrosis
<span style="color: black;">■</span>	Cancerous Tumor (solid)
<span style="color: red;">■</span>	Red Blood Cells
<span style="color: blue;">■</span>	Inactive Fibrosis
<span style="color: purple;">■</span>	Cancerous Tumor (BAC)

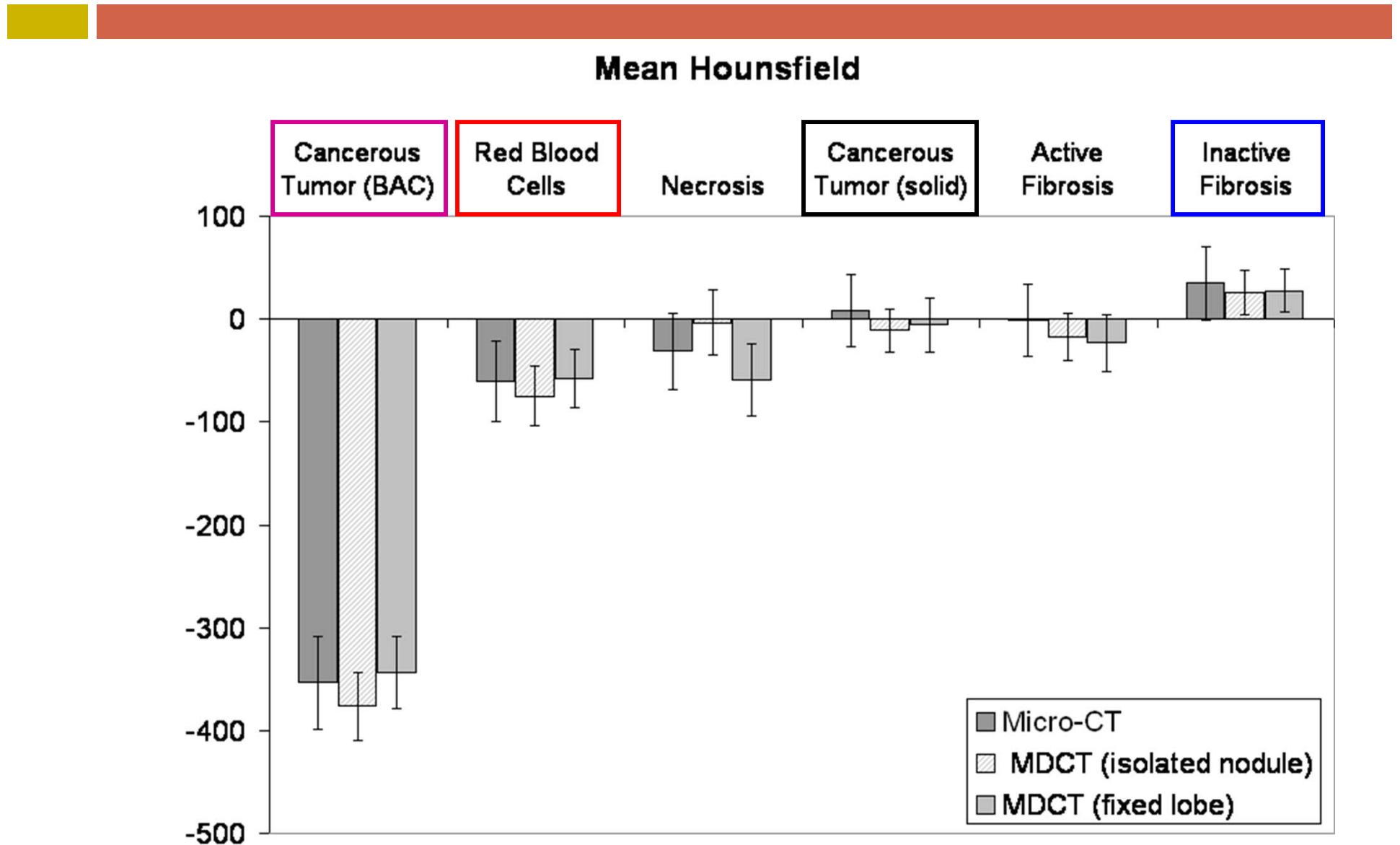


- Previous studies have qualitatively assessed proportions of tissue types in 2D histopathology and drawn connections to patient prognosis
- Quantitative assessment has great potential

# Link histology to CT

- Used histogram statistics for each tissue type, over 3 CT datasets (lobe CT, nodule CT and micro-CT)
- Linear mixed model analysis was used to compare mean histogram parameters among the tissue types
- Tukey's test was used for pairwise comparison of the means

# Mean HU



# Current Status

- 
- Identify patients earlier to incorporate benign
  - High resolution, perfusion CT – quantification of CD31 and
  - Small animal model – CT and PET
  - Large animal model

# Acknowledgements

## **Pulmonary (UI)**

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Dr. Lynch

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# QUESTIONS ?

Need clarification?

Have feedback or an idea?