

Automated analysis of tissue heterogeneity based on OCT images for improving personalized cancer therapy effectiveness

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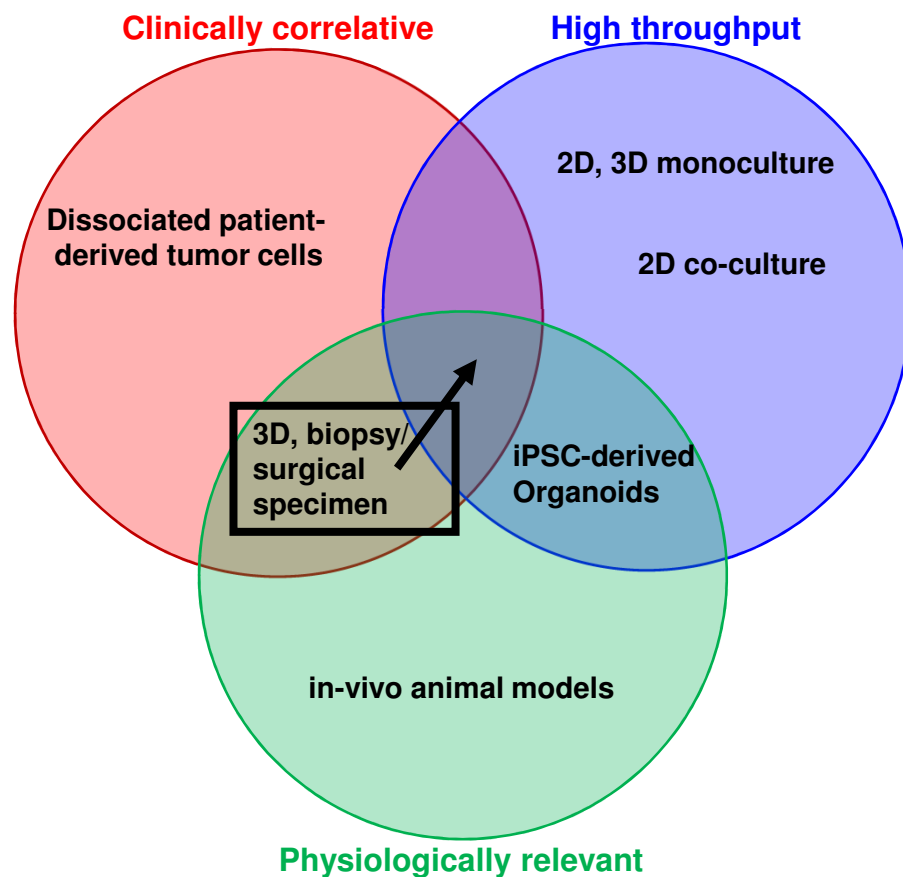
*Physical Sciences Inc., Andover, MA

SPIE, Photonics West, 02/04/2020

Outline

- Background & Introduction
 - Personalized cancer therapy (strategies and development)
- Brief Description of the Instrument and Methods
- Results
 - Image analysis and tumor content predictions
- Conclusion
- Future Work

Towards personalized cancer therapy



- Tumors can be highly heterogeneous, especially between patients.
- Cellular variation contributes to treatment ineffectiveness
- ~5% of anticancer drug candidates reach the market
- Cells behave differently in 2D than they do in 3D.
 - Particularly sensitive to microenvironment
- Must quantify spatial tumor heterogeneity for use in downstream assays

Better throughput via spatial verification

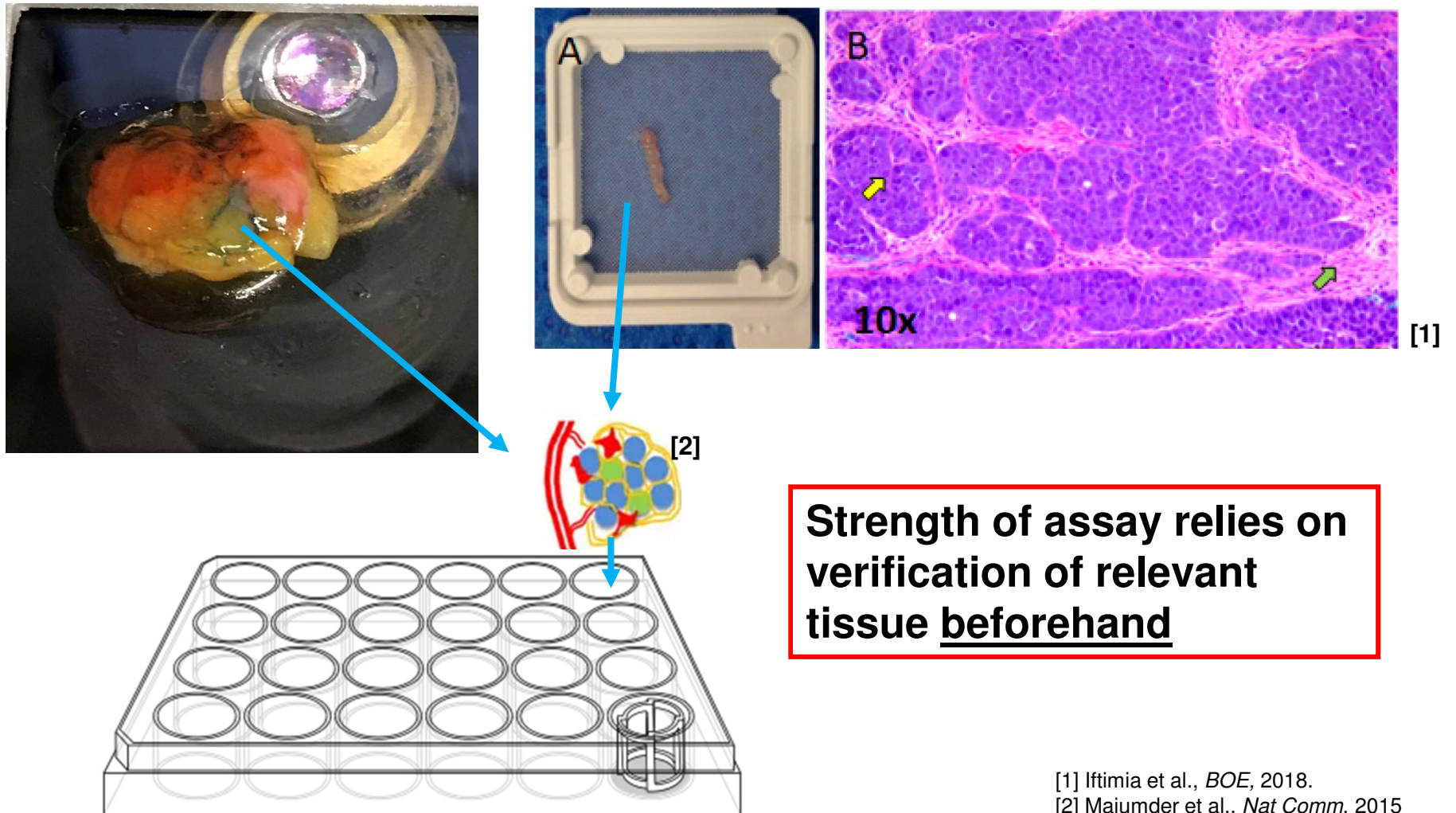
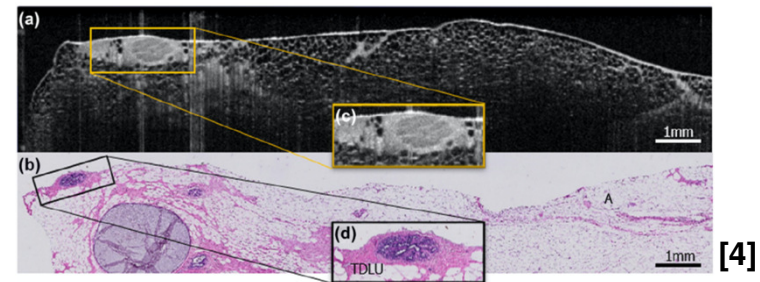
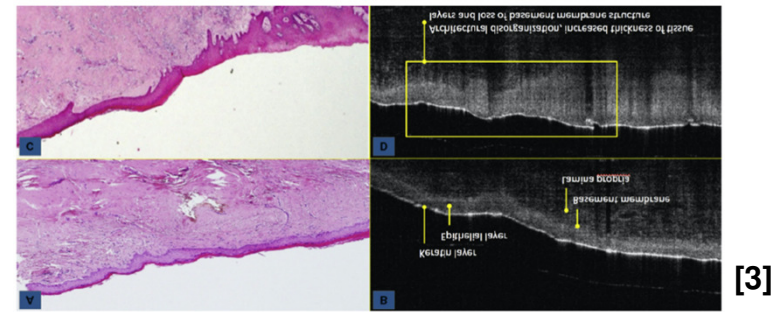
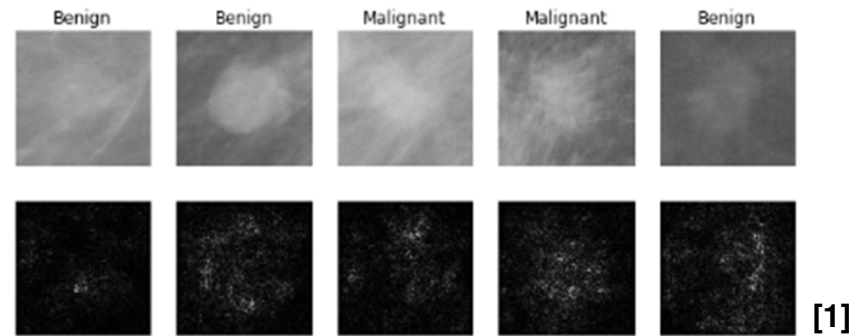
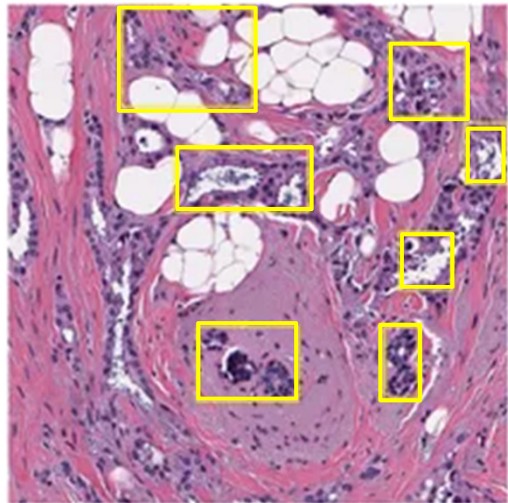


Image Analysis and Computer Vision for Tumor Recognition

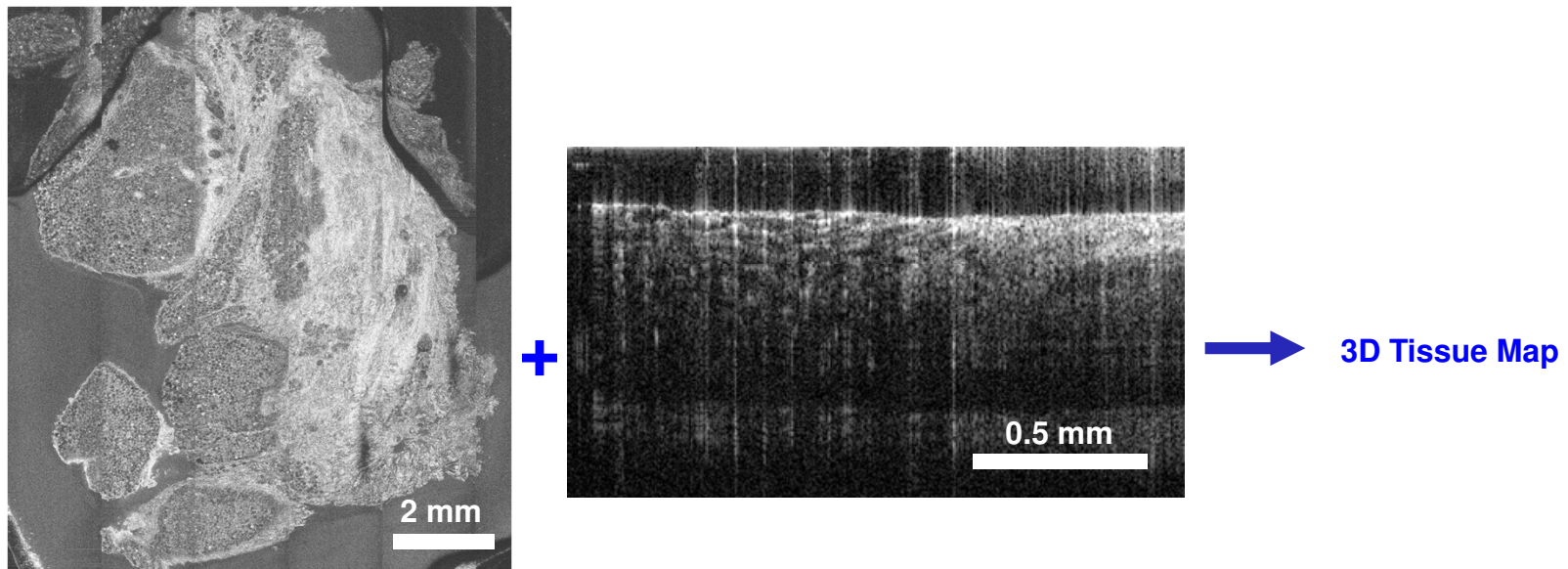
- Mammography [1]
- Histopathology [2]
- OCT[3,4]



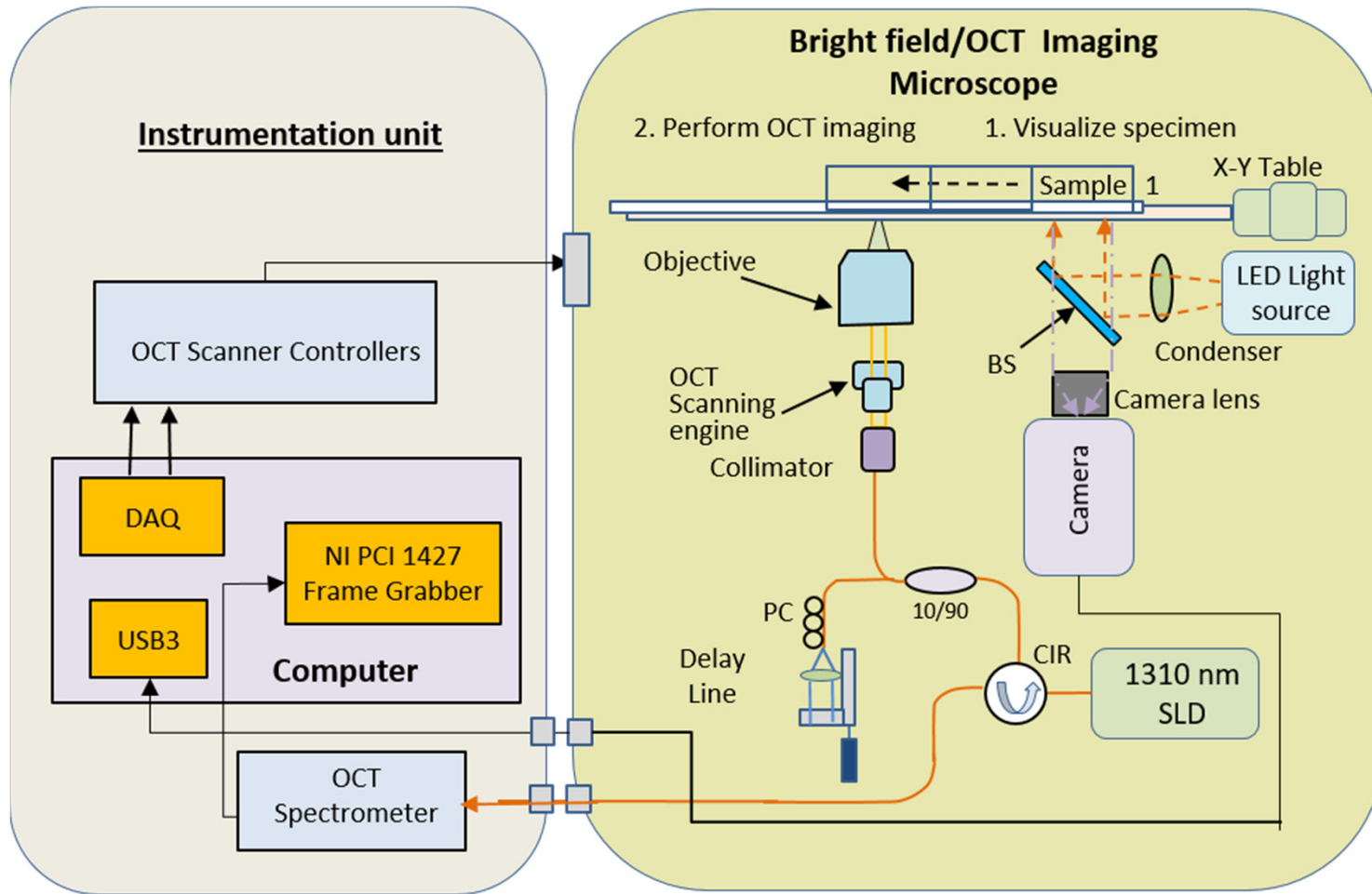
- [1] Lévy and Jain, *NIPS*, 2016.
 [2] Han et al., *Sci Rep*, 2017
 [3] Hamdoon et al., *Photodiagnosis and Photodynamic Therapy*, 2016
 [4] Ha et al., *Acad Radiol*, 2018

OUR APPROACH

- **Using a brightfield/OCT inverted microscope, provide spatial quantification of tumor percentage and heterogeneity for increased throughput of personalized cancer treatment and drug development assays.**
 - Algorithmic image segmentation based on cluster analysis of spatial texture parameters

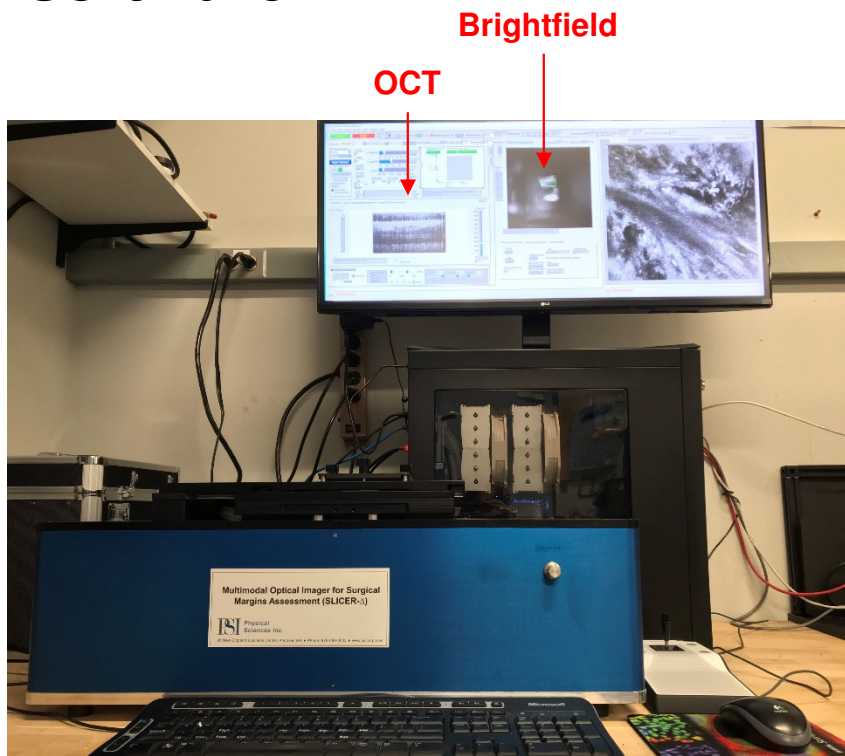


Instrument Schematic



Instrument Overview

Side view + LabVIEW software

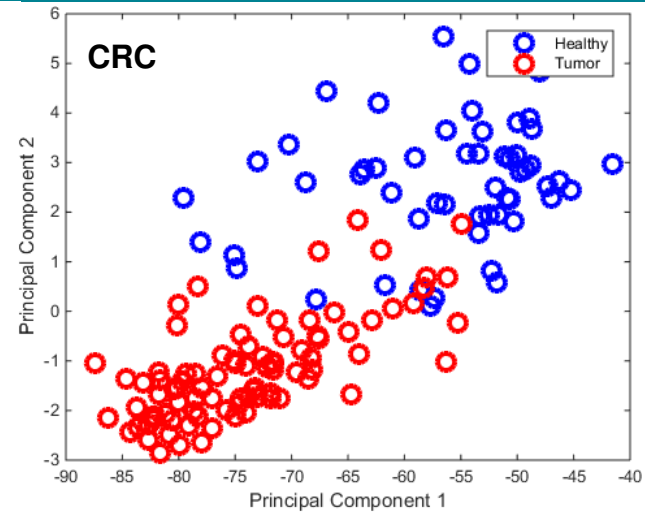
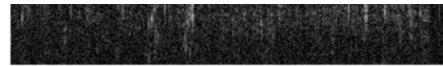
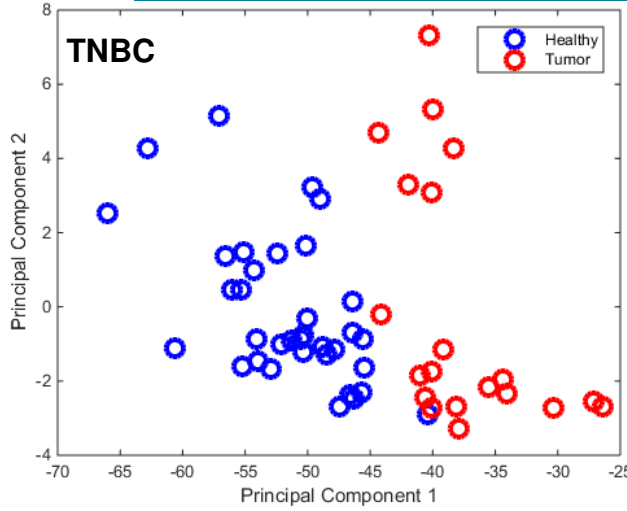


View from above



Image Analysis: Texture and Clustering

Cross-sectional



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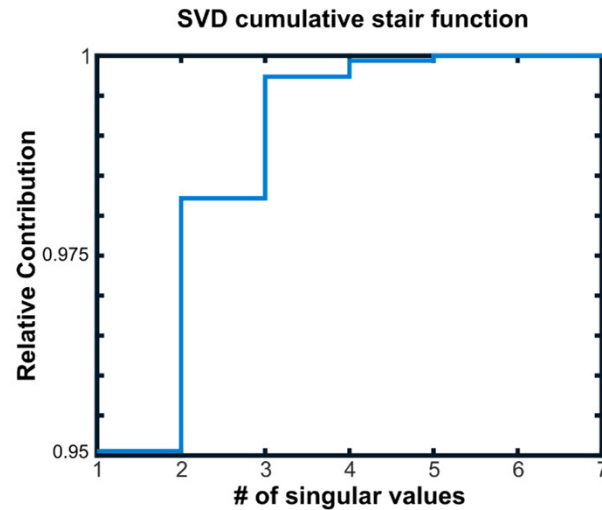
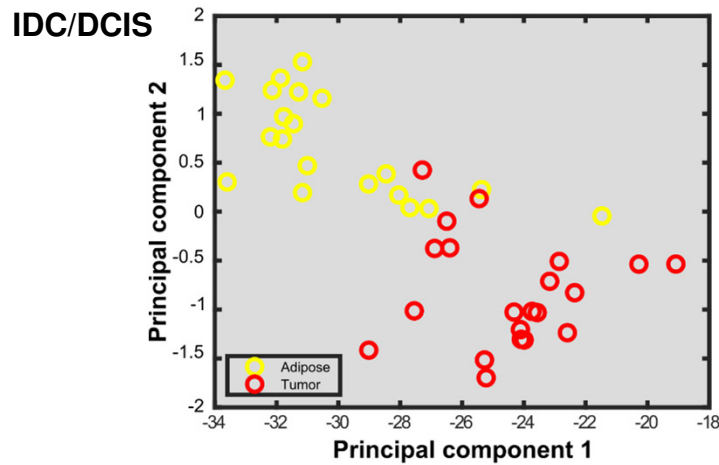
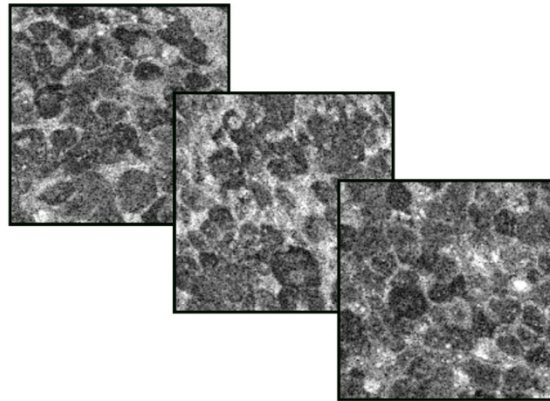


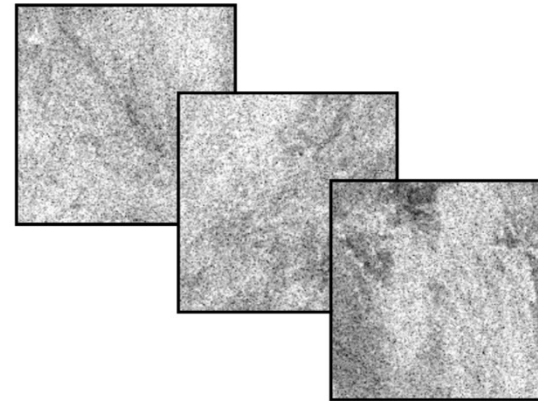
Image Analysis: Texture and Clustering

En-face

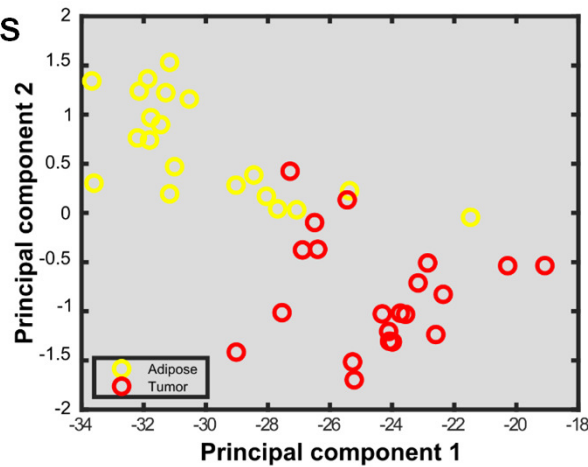
Adipose



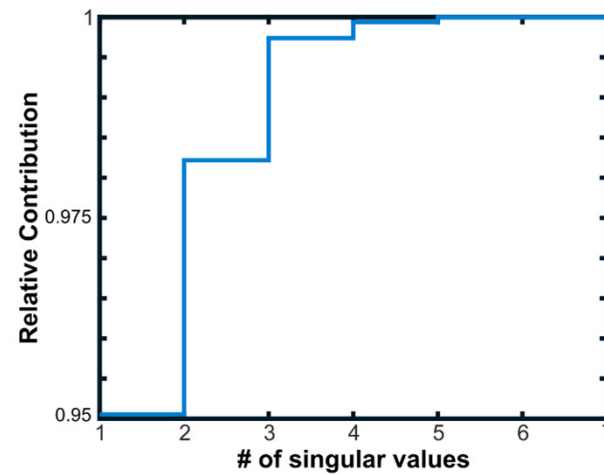
Tumor



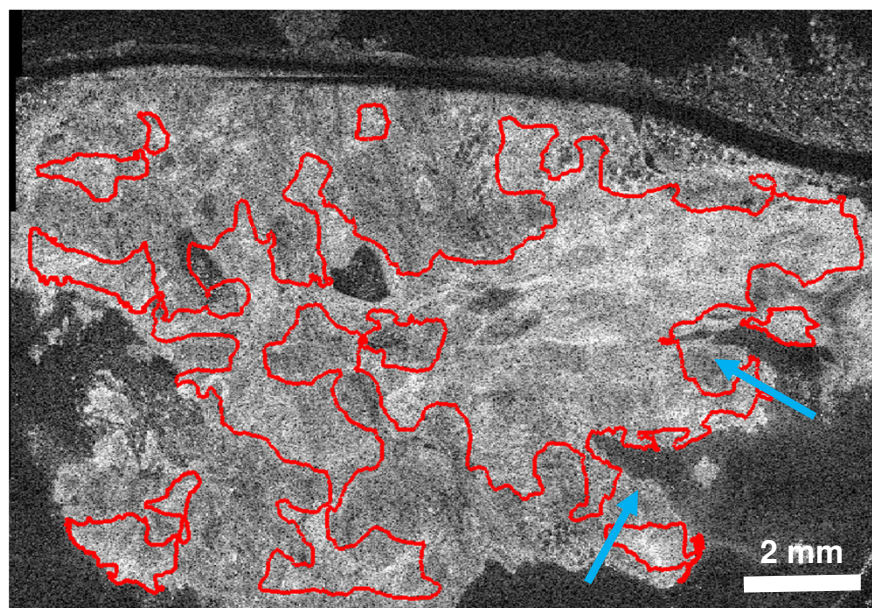
IDC/DCIS



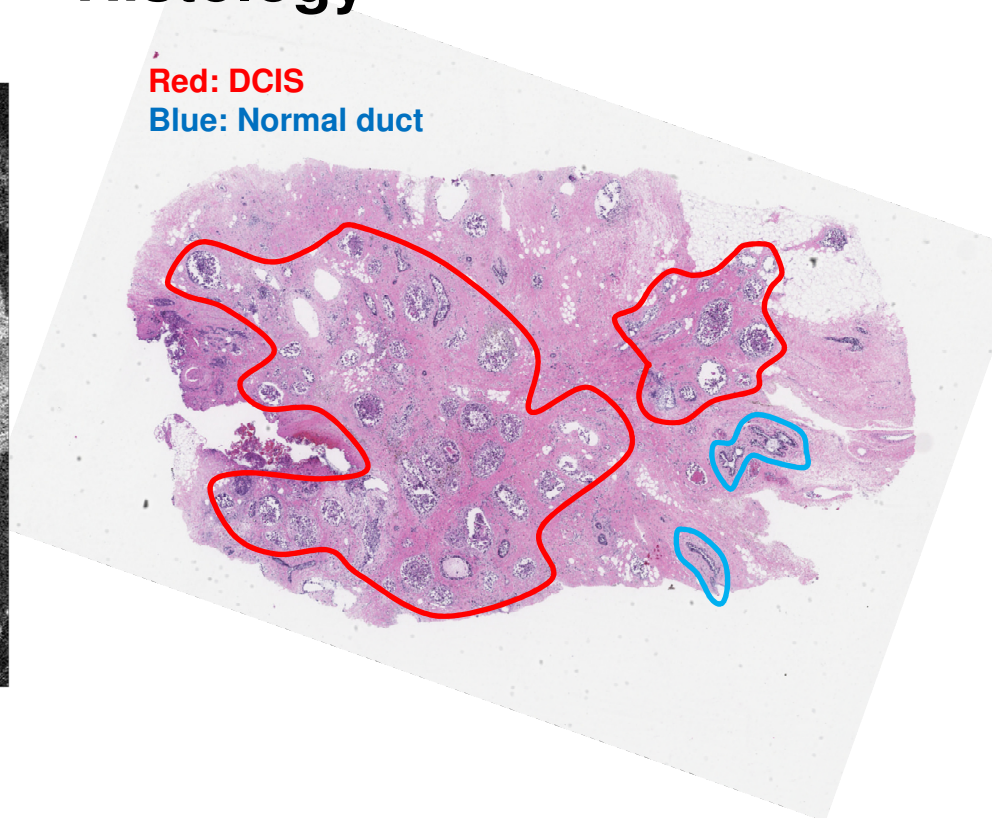
SVD cumulative stair function



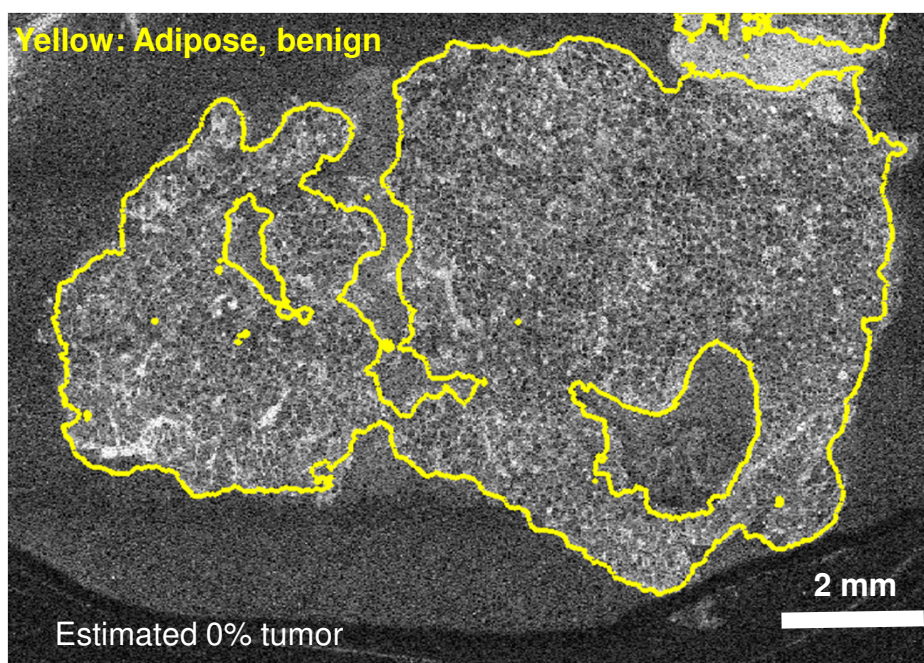
OCT



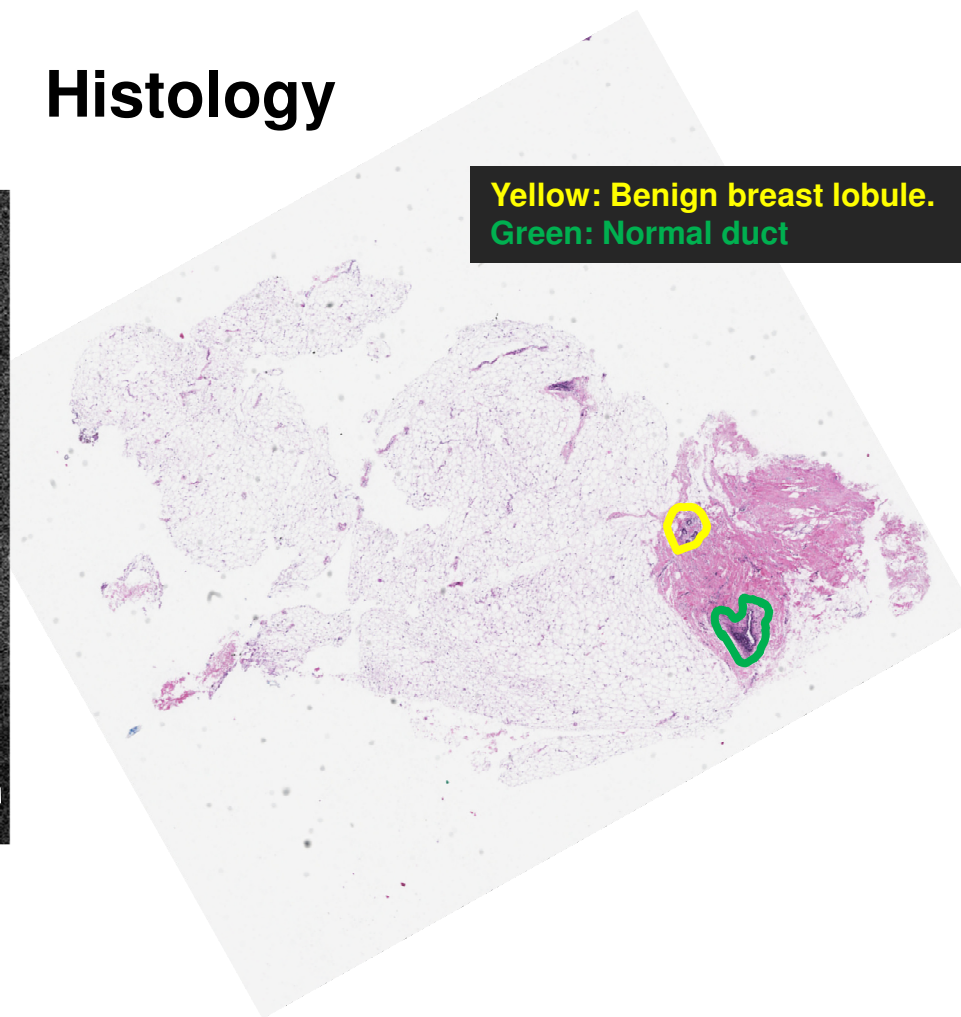
Histology



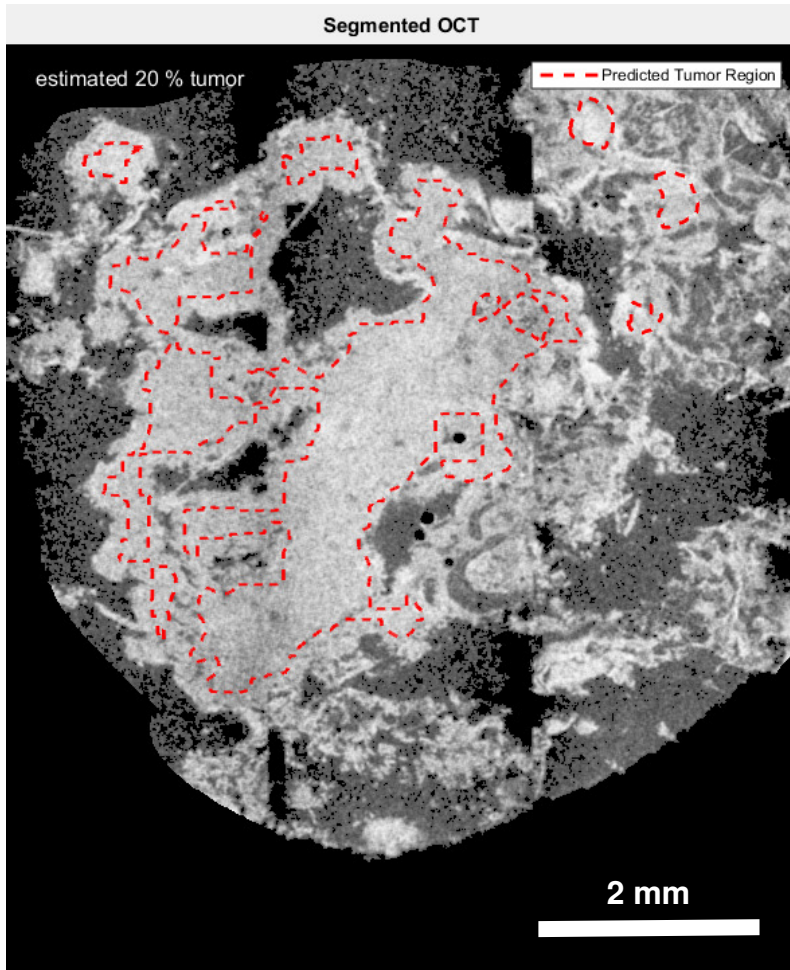
OCT



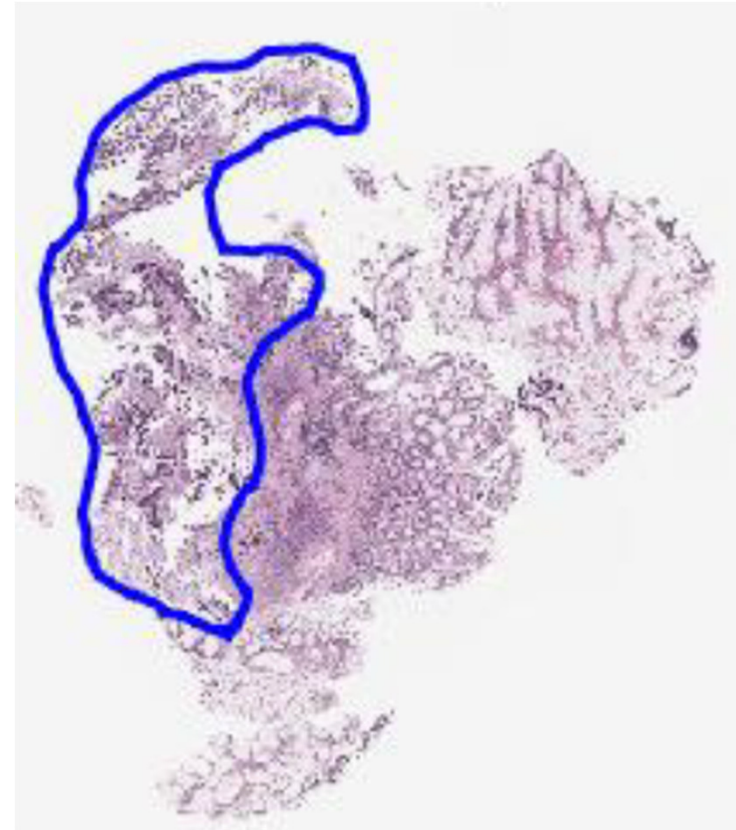
Histology



OCT

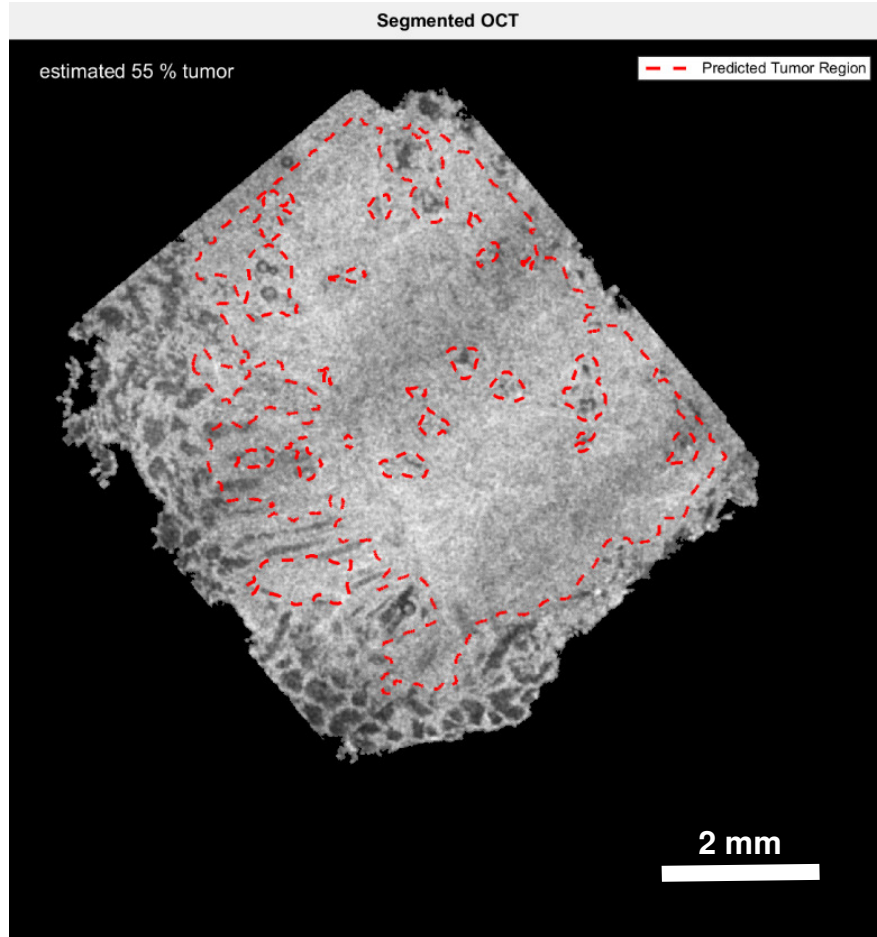


Histology

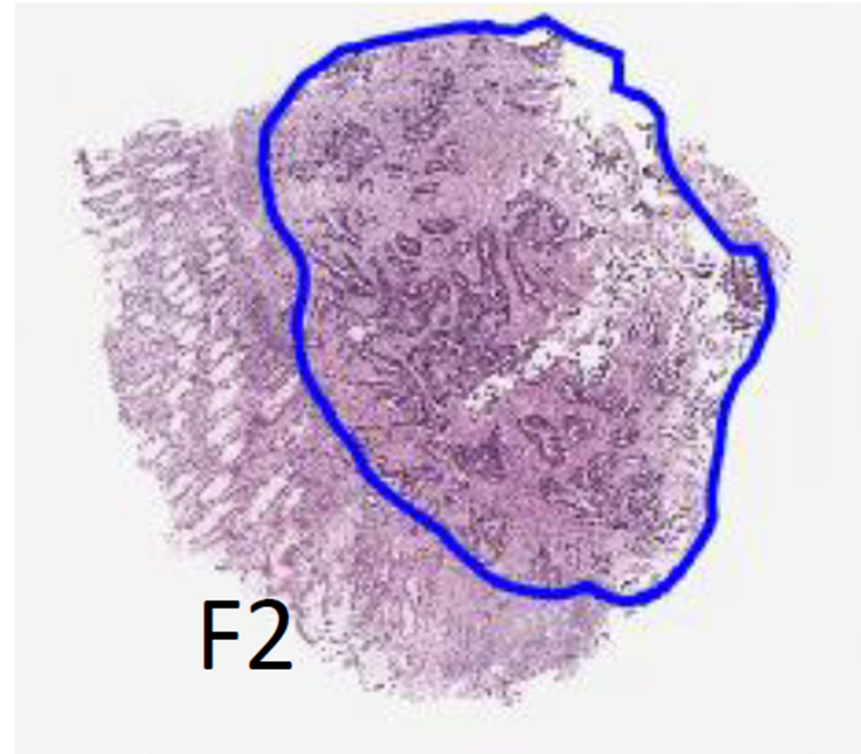


20% reported tumor cellularity

OCT

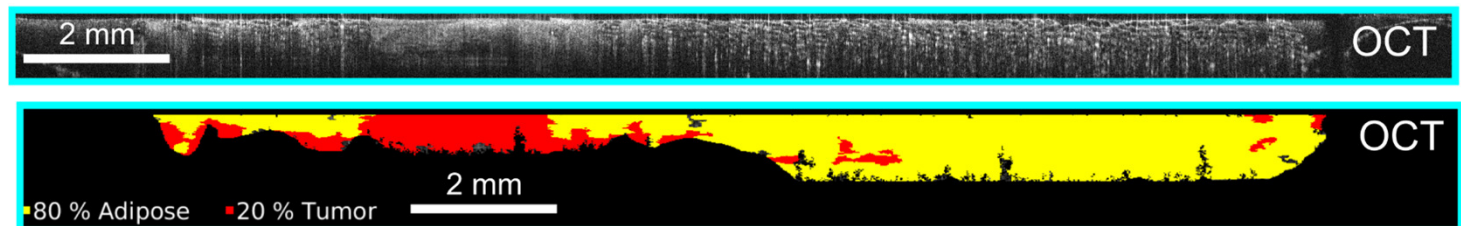
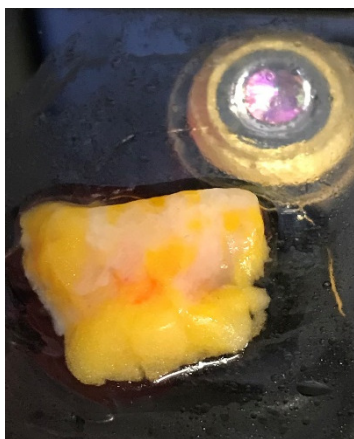
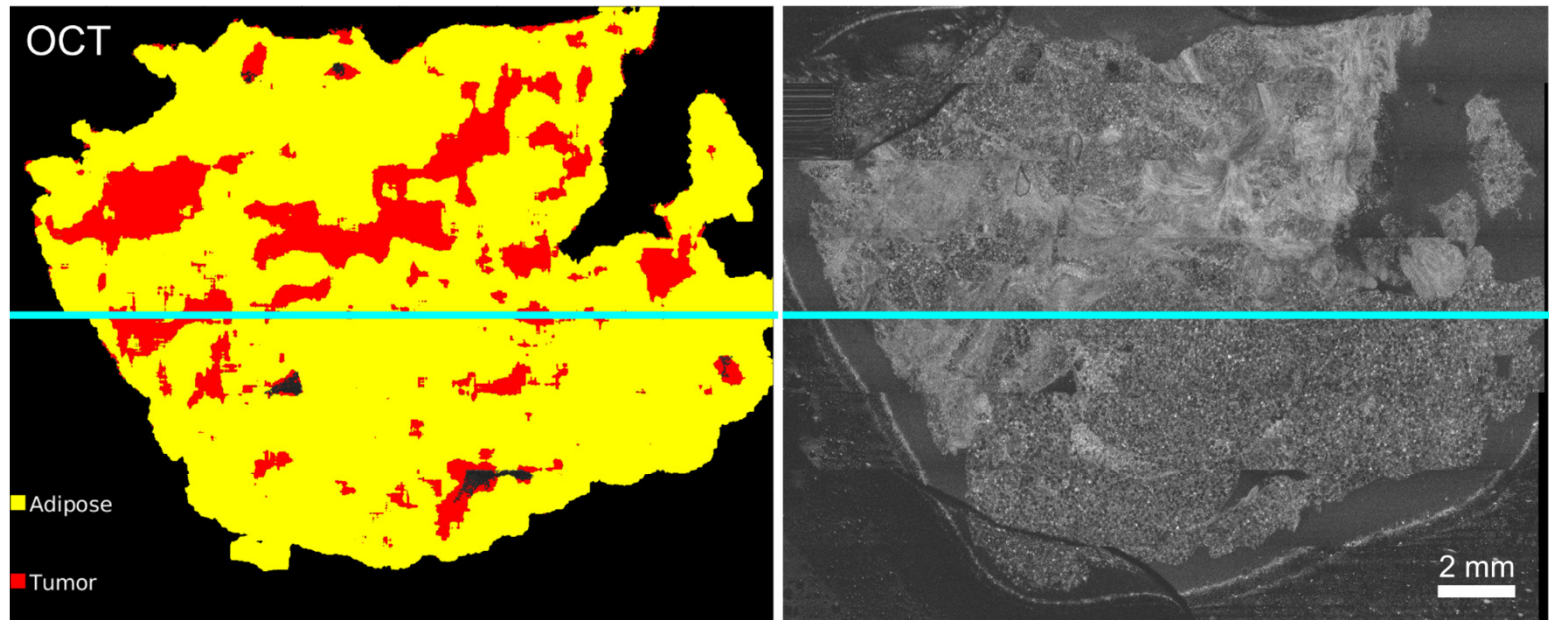


Histology



60% reported tumor cellularity

Segmenting tumor extent in depth



Conclusions

- **Optical coherence tomography enables high-resolution, non-destructive imaging up to 1 mm in depth.**
- **Full 3D reconstructions allow for visualization of the full extent of tumor**
- **Estimation of tumor content allows for spatial exclusion in important personalized cancer treatment assays.**
 - Also useful for relevant 3D drug development assays

- **Continue comparing with histological ground-truth**
 - Larger datasets will improve models.
 - Ongoing CRC and BC specimen histological analysis
- **Integrate with tissue sectioning technology**
- **Including RCM data in areas of low confidence**
 - Much higher resolution can tell a more detailed picture in area of high scattering or in dense, homogenous tumor types.

Acknowledgements



N. Iftimia



G. Maguluri



J. Park



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Instrument details will be covered at 11AM [11229-42]

Thank you

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