

Disorder strength calculation for label-free diagnosis of tissue biopsies using quantitative phase imaging

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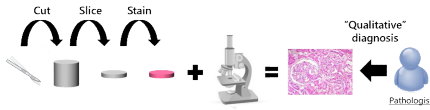
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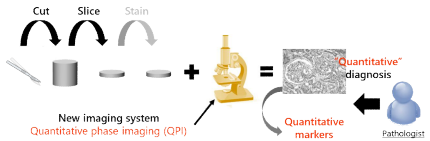
INTRODUCTION

Standard breast tissue diagnosis



Problems in standard tissue diagnosis
 ✓ Variation in staining quality
 ✓ Inter-observer variability

Breast tissue diagnosis using QPI



Label-free and quantitative diagnosis.

➕
New quantitative markers

QPI are sensitive to sub-wavelength fluctuations in refractive index map in both space and time.

Purpose

We propose to **extract sub-wavelength morphological information** from fixed tissue core, and demonstrate classification benign and malignant breast tissue

Sub-wavelength morphological information

(1) Disorder strength

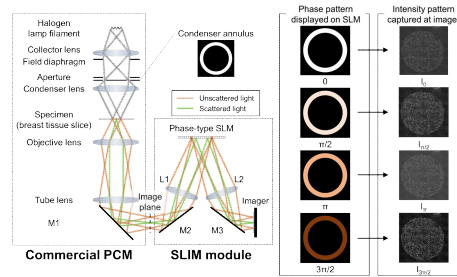
- Proposed by H. Subramanian et. al. (Opt. Lett., 34, 518 (2009))
- Proven its effectiveness as a quantitative marker for several types of disease
- How to extract disorder strength from QPI image (cell) has been proposed by W. J. Eldridge et. al. (Biophysical Journal 112, 692 (2017))

(2) Local spatial autocorrelation length

→ see poster 10503-82

METHODS

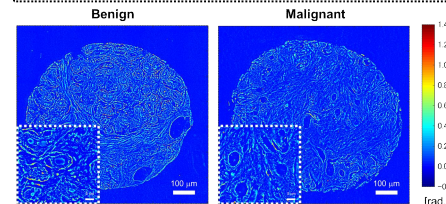
Spatial Light Interference Microscopy (SLIM)



G. Popescu: Quantitative Phase Imaging of Cells and Tissues: McGraw Hill; 2011.

Imaging target

- ✓ Breast tissue microarray (TMA)
- ✓ Thickness = 400 μm
- ✓ Diagnosed as either benign or malignant by pathologist
- ✓ 20 benign and 20 malignant cores are used for analysis
- ✓ UIUC - IRB Protocol Number 13900



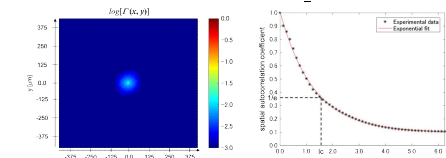
Disorder strength

$$L_d(x, y) = \langle \Delta n(x, y)^2 \rangle_w l_c$$

Thickness: constant

$$L_d(x, y) = \frac{\langle \Delta \phi(x, y)^2 \rangle_w}{\langle \phi(x, y) \rangle_w^2} n_{\text{mean}}^2 l_c$$

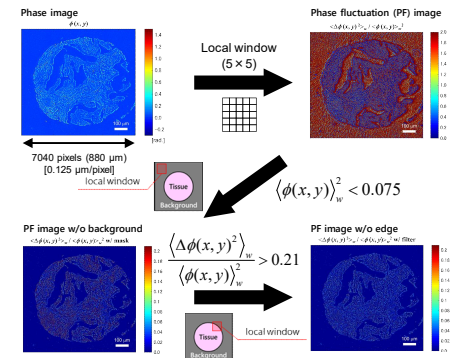
Disorder strength can be extracted from QPI
 Spatial autocorrelation length: l_c



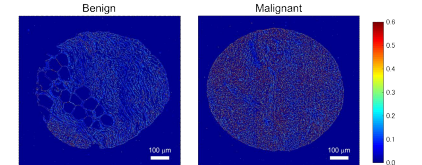
$$n_{\text{mean}} = 1.38, l_c = 1.91 [\mu\text{m}]$$

RESULTS

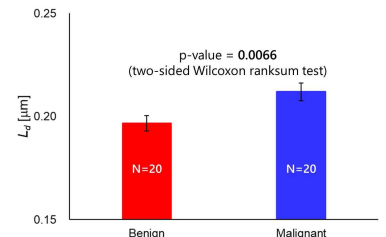
Procedure



Disorder strength map



Benign and malignant breast tissue screening



CONCLUSIONS

We showed that the disorder strength measured from QPI can be used as a quantitative marker of nanoscale morphological alteration and demonstrated classification between benign and malignant breast cores.

[Read also] M. Takabayashi et al., "Disorder strength measured by quantitative phase imaging as intrinsic cancer marker in fixed tissue biopsies", PLOS ONE (in press)