Wide-field, High-resolution Fourier ptychographic microscopy (FPM)

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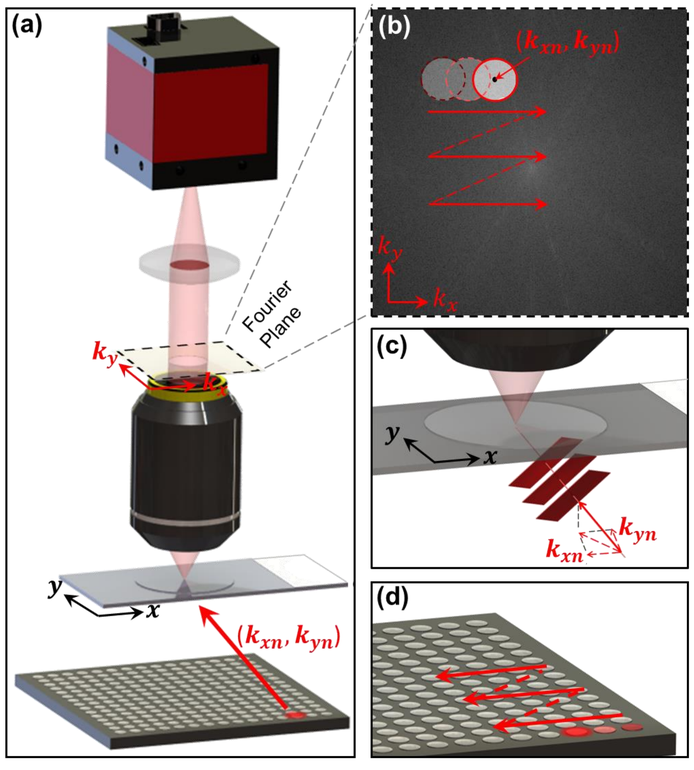
Motivation: Increase the space–bandwidth product (SBP) of a conventional microscope system

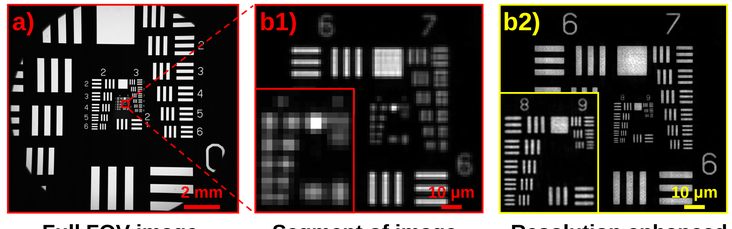
- **Wide field-of-view**: 12mm in diameter (~120mm^2)
- **High resolution**: ~0.78 μm resolution
- **Large depth of focus**: 0.3 mm resolution-invariant depth of focus
- **Complete information of the sample**: both intensity and phase
- **Free from mechanical scan**
- **Compatible to most conventional microscopes system**

Principle and method

- **Angularly varying illumination**: modulate high frequency information of the sample into the pass band of the objective lens
- **Phase retrieval algorithm**: achieve both resolution enhancement and complex image recovery



Resolution enhancement

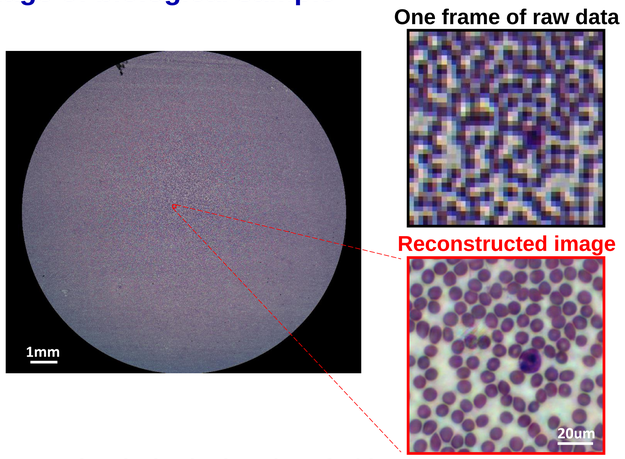


Full FOV image using a 2X objective USAF target

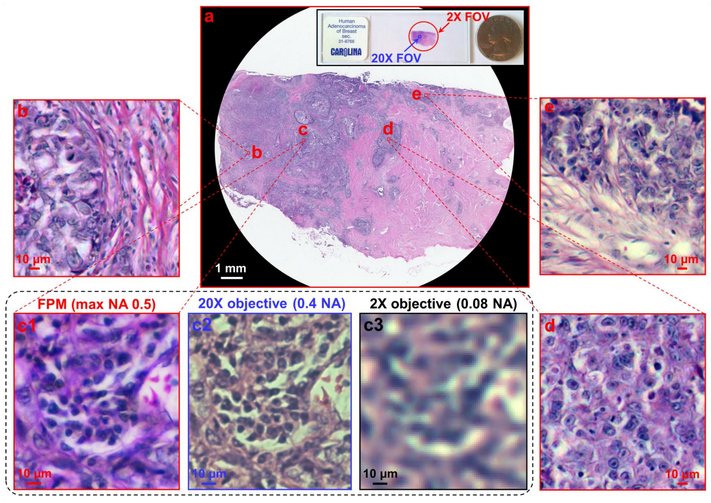
Segment of image with normal illumination Resolution: ~3.9um

Resolution enhanced by FPM method Resolution: ~0.78um

FPM image of biological sample

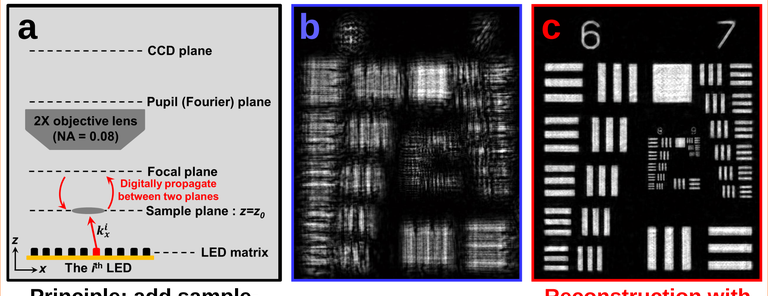


Gigapixel color imaging of a blood smear



Gigapixel color imaging of a pathology slide, vignettes shows the detail and comparison with conventional microscope image

Extending the depth of focus with digital refocusing

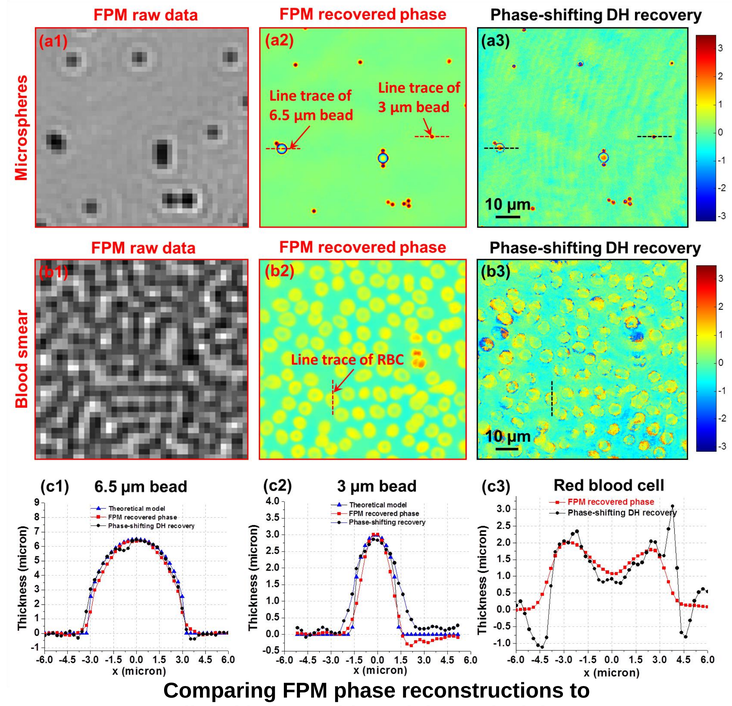


Principle: add sample-focal plane propagation in reconstruction

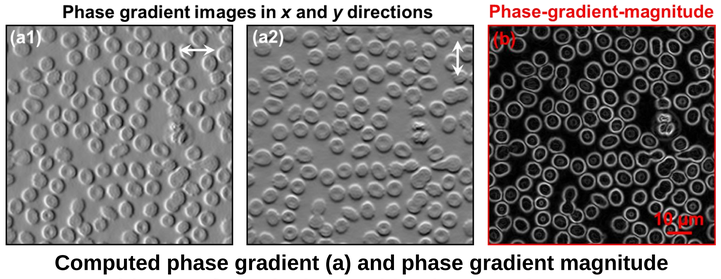
Reconstruction without inter-plane propagation

Reconstruction with inter-plane propagation (z0 = -150 μm)

Quantitative phase imaging capability



Comparing FPM phase reconstructions to digital holographic and theoretical data



Computed phase gradient (a) and phase gradient magnitude (b) images from the human blood smear phase map

Acknowledgement

This work is supported by National Institutes of Health (grant no.1DP2OD007307-01).

Reference

[1] Guoan Zheng, Roarke Horstmeyer and Changhuei Yang; Wide-field, high-resolution Fourier ptychographic microscopy; Nature Photonics doi:10.1038/nphoton.2013.187

[2] Xiaoze Ou, Roarke Horstmeyer, Changhuei Yang, and Guoan Zheng; Quantitative phase imaging via Fourier ptychographic microscopy (FPM), submitted