CEITEC

Central European Institute of Technology

BRNO | CZECH REPUBLIC

Radim Chmelík

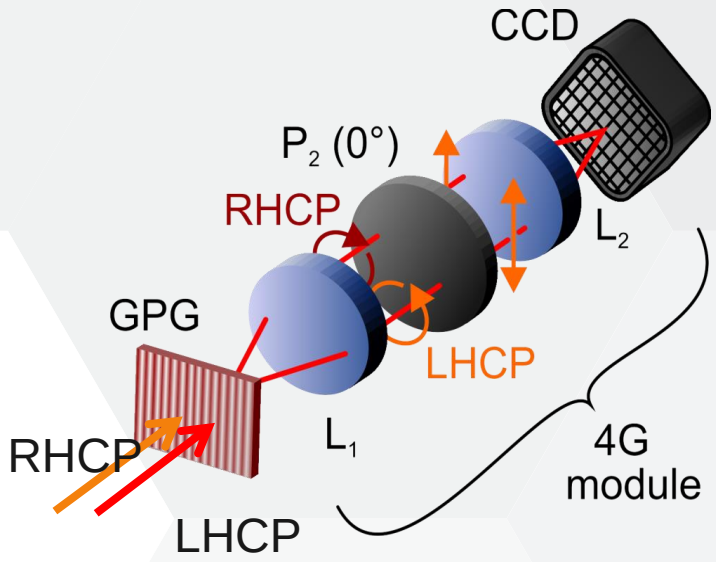
Experimental Biophotonics

workshop Českého optického klastru
Výhledy mikroskopie

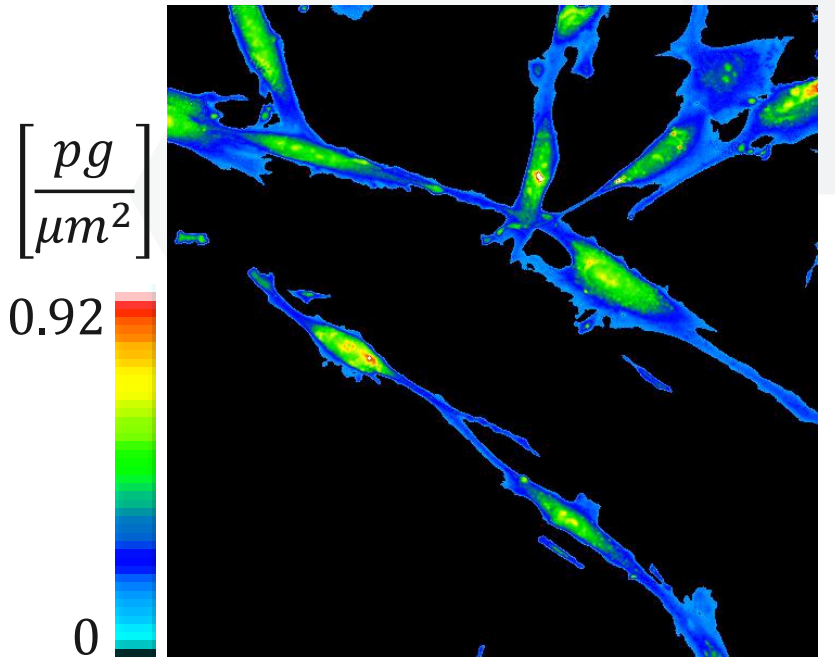
6/10/2021

Research Focus → Vision

- **Advanced Light Microscopy (ALM)**
  - novel optical systems, imaging approaches, image processing methods
  - focus on Holographic Incoherent-light-source Quantitative Phase Imaging (hiQPI)
  - → introducing hiQPI as a standard & popular microscopy technique

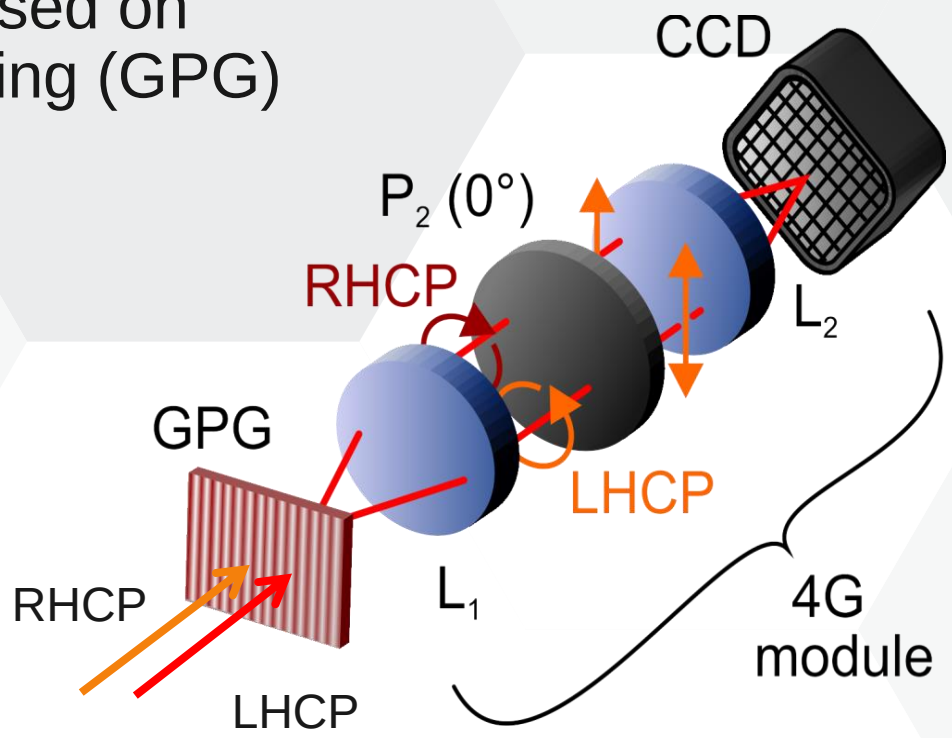


- **Applications of ALM in nanotechnology, cell biology and cancer research**
  - optical characterization of nanostructures
  - study of phase effects of nanostructured metasurfaces
  - search for biomarkers of malignancy in the behaviour of live cancer biopsy-derived cells
  - → introducing a novel nanostructure/ metasurface characterization tools
  - → complementing histopathology
  - → preclinical assessment of novel anti-metastatic drugs



Quantitative 4G-optics microscope (Q4GOM)

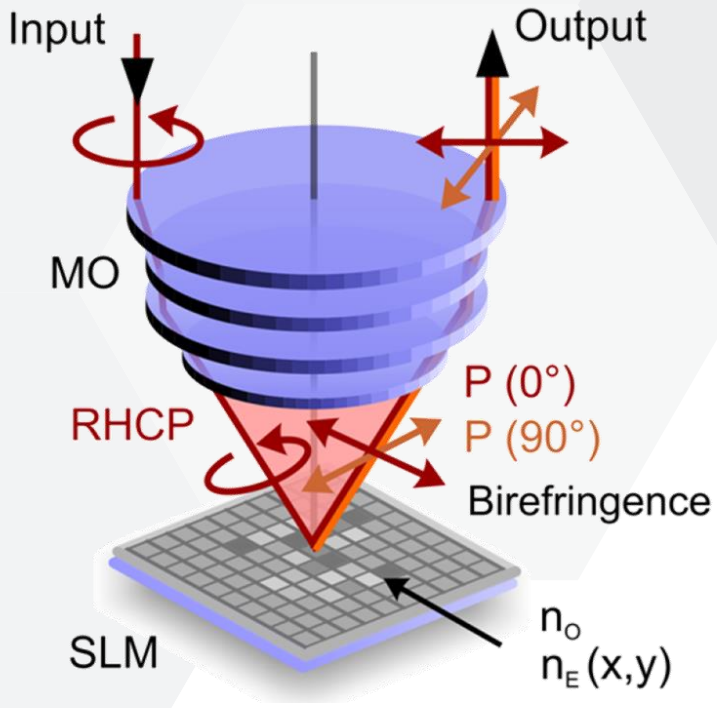
- novel hiQPI system based on Geometric Phase Grating (GPG)
- common-path off-axis holography
- patented



- *with Department of Optics, Palacký University*
- Bouchal et al. (2019)

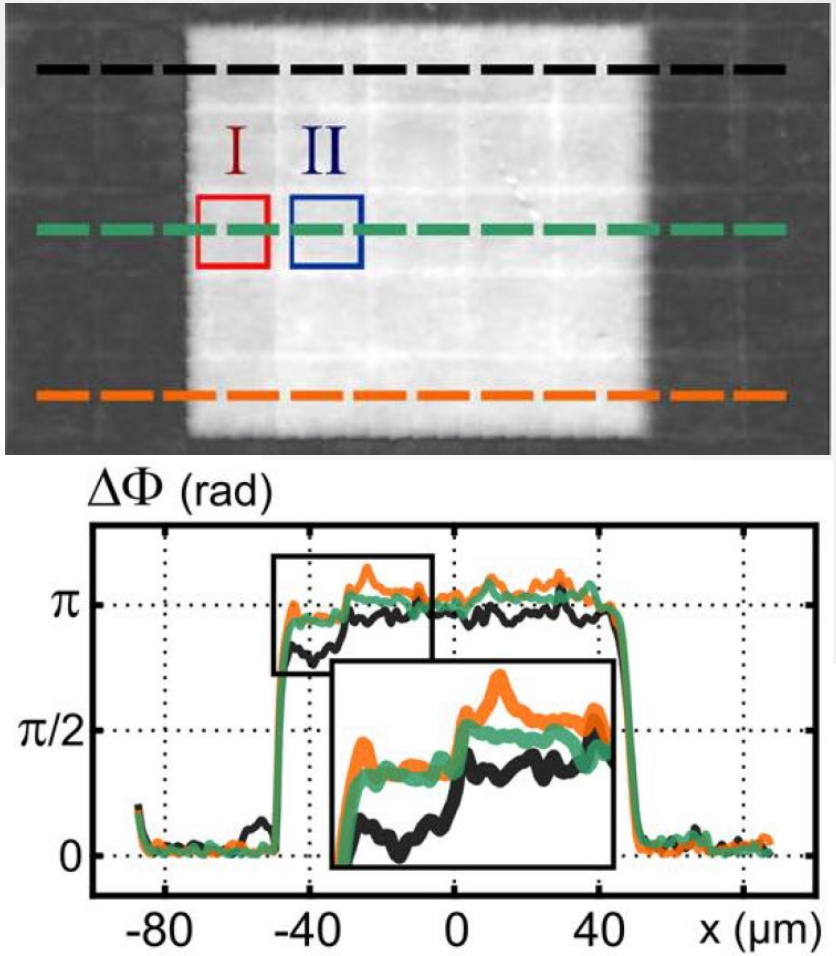
SCIENTIFIC REPORTS

Q4GOM hiQPI of a birefringent specimen



← based on a standard microscope objective

→ quantitative retardance imaging of birefringent liquid crystal cells of a SLM

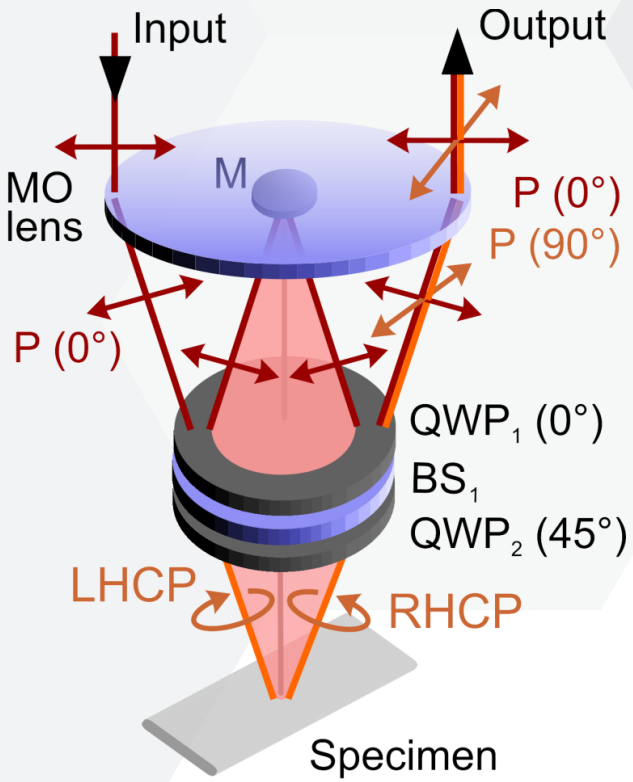


- Bouchal et al. (2019)

SCIENTIFIC REPORTS

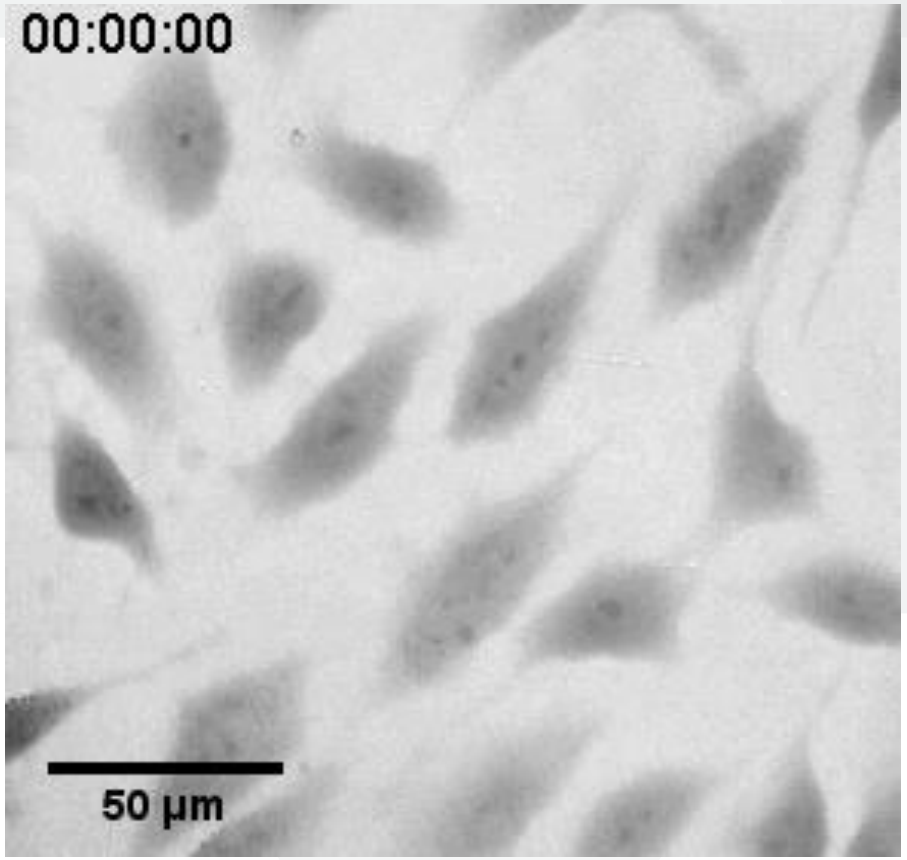
Q4GOM: Quantitative 4G-Optics Microscope hiQPI: Holographic Incoherent Quantitative Phase Imaging

Q4GOM hiQPI of live cells



based on adapted Mirau interference objective

morphological changes of LW3K12 cells induced by phosphate-buffered saline



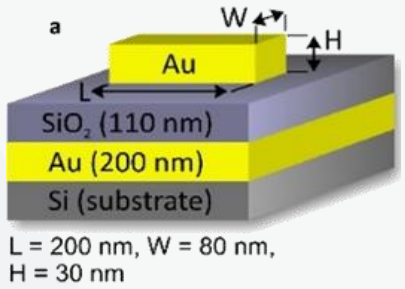
- Bouchal et al. (2019)

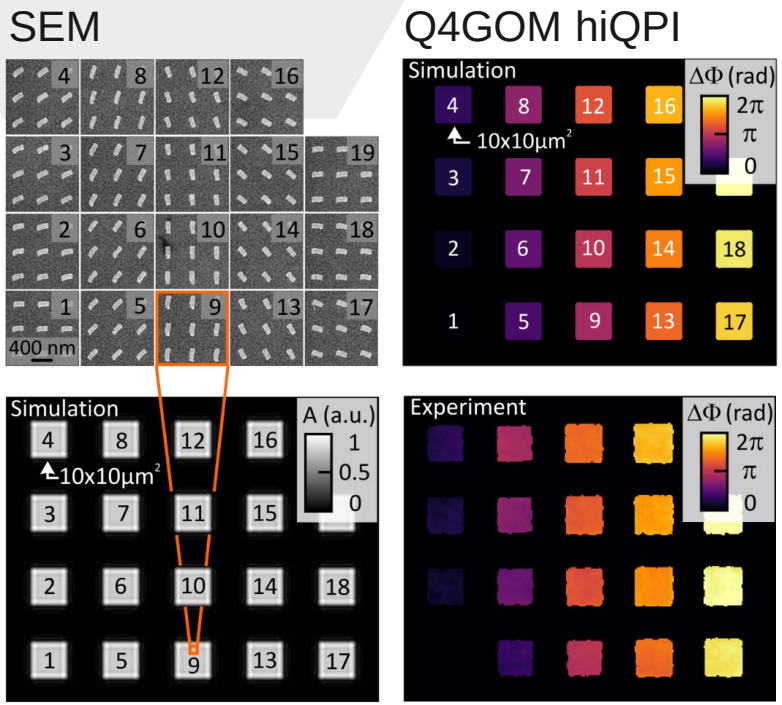
SCIENTIFIC REPORTS

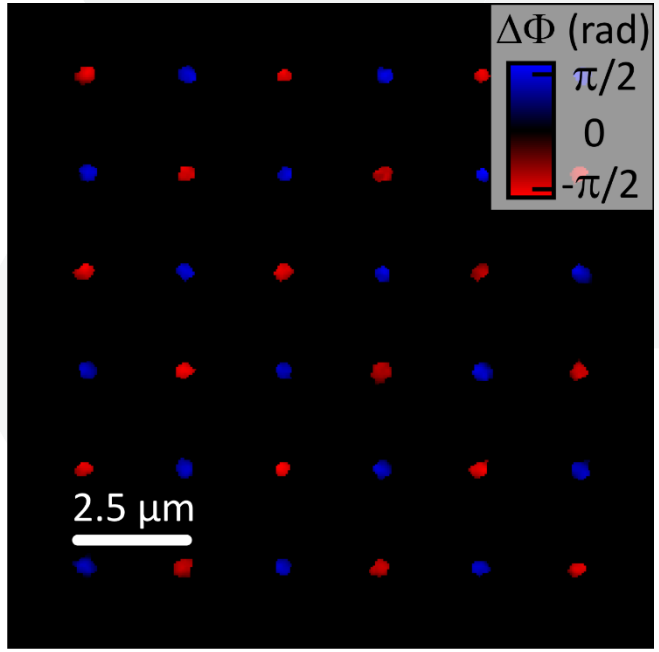
Q4GOM: Quantitative 4G-Optics Microscope hiQPI: Holographic Incoherent Quantitative Phase Imaging

Q4GOM hiQPI of plasmonic metasurfaces

- quantitative phase imaging of nanoantenna arrays with varying angular orientation & their phase effects
- resolution down to a single nanoantenna







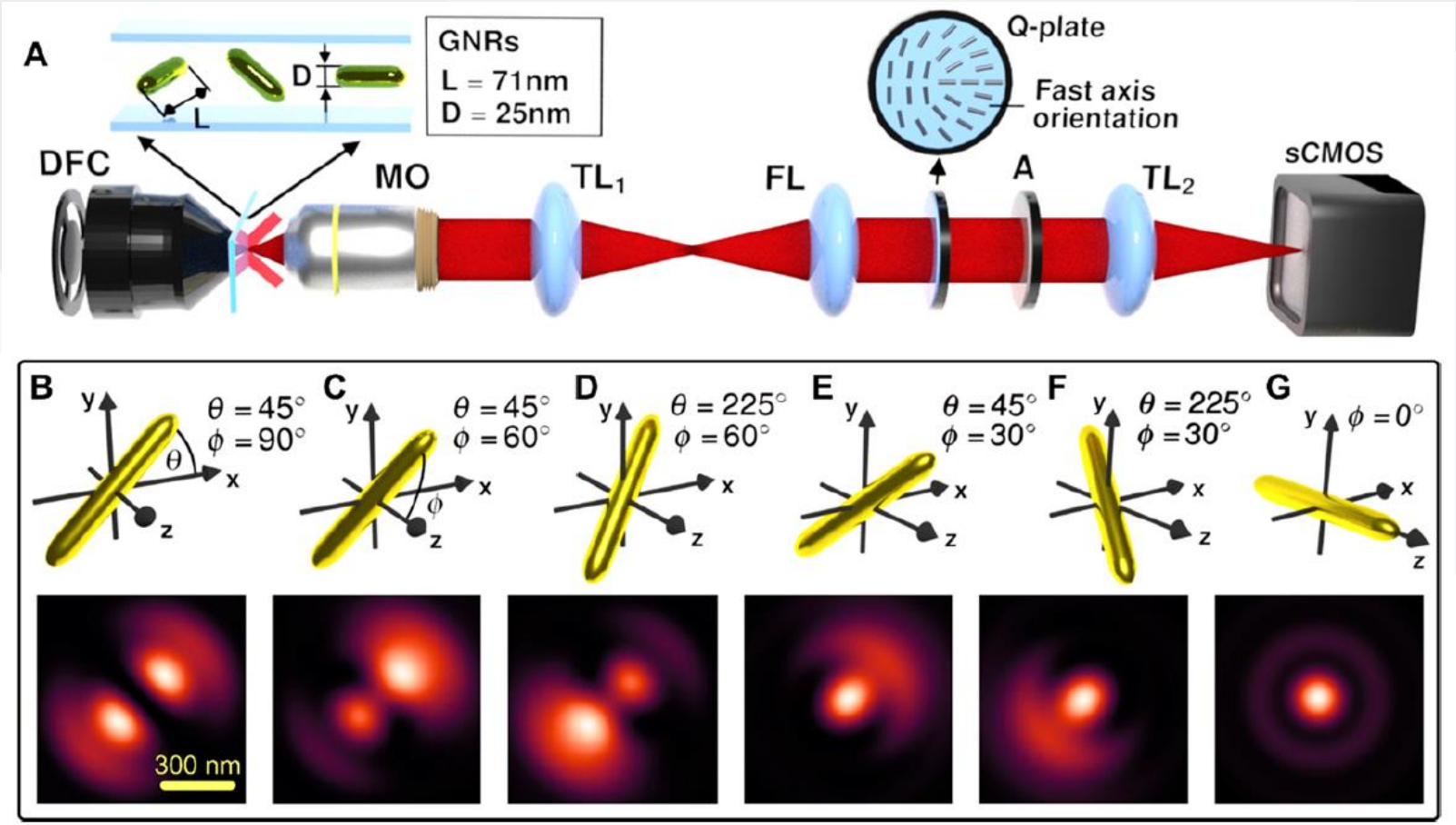
- Bouchal et al. (2019)

NANO LETTERS

Q4GOM: Quantitative 4G-Optics Microscope
hiQPI: Holographic Incoherent Quantitative Phase Imaging

Orientation imaging of nanorods

- novel optical system based on Q-Plate
- 3D orientation imaging of sub-100 nm nanorods



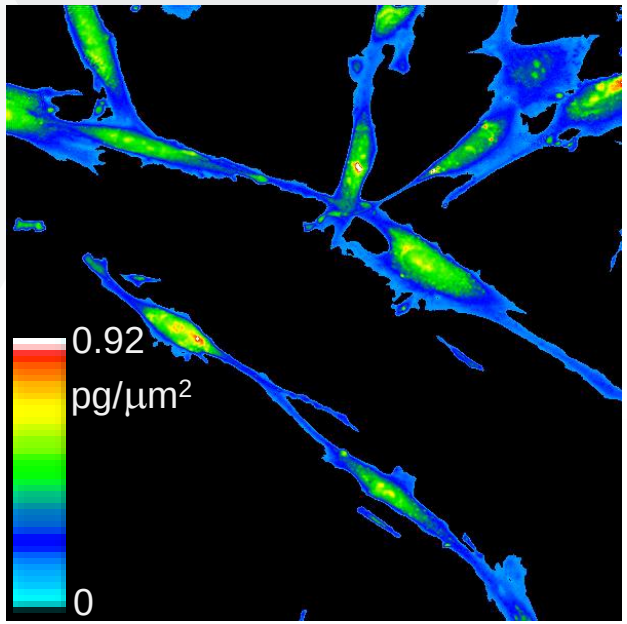
- Bouchal et al. (2021)

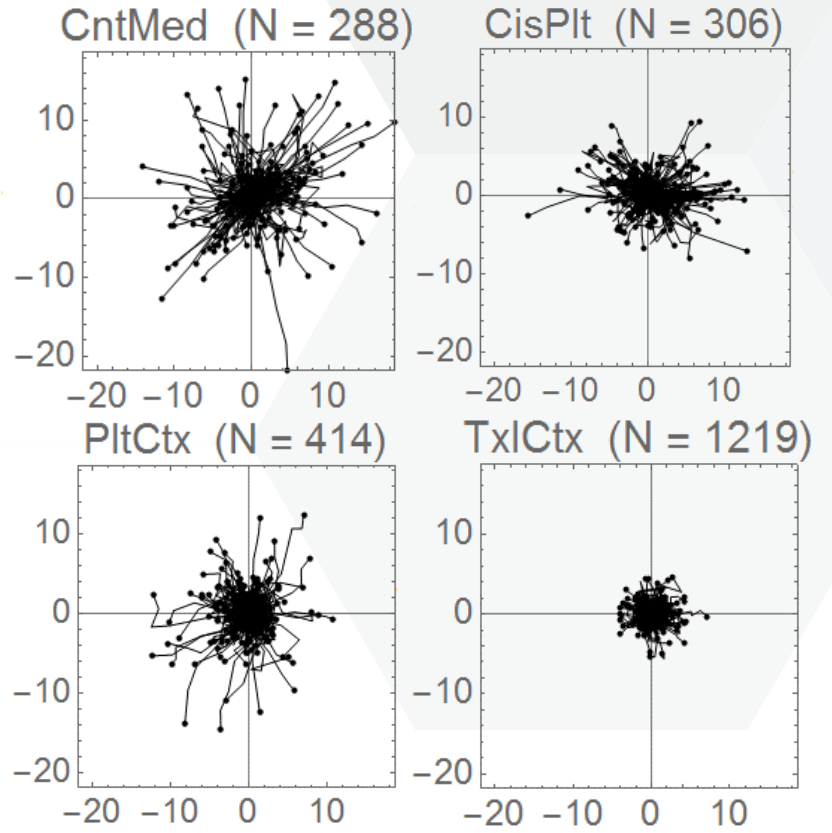
NANO LETTERS

Q-Plate: a space-variant anisotropic element provided by 4G technology performing mutual conversion between SAM and OAM

Q-Phase hiQPI of live biopsy-derived carcinoma cells

- analysis of responses of 5-day primary culture from a neck cancer tissue explant to chemotherapeutic drugs: personalized cancer treatment
- *with Otolaryngology, St. Anne's University Hospital*





- Gal et al. 2017, Zicha 2018 Phase in Brno

PLOS ONE

hiQPI: Holographic Incoherent Quantitative Phase Imaging

Q-Phase hiQPI through scattering layer

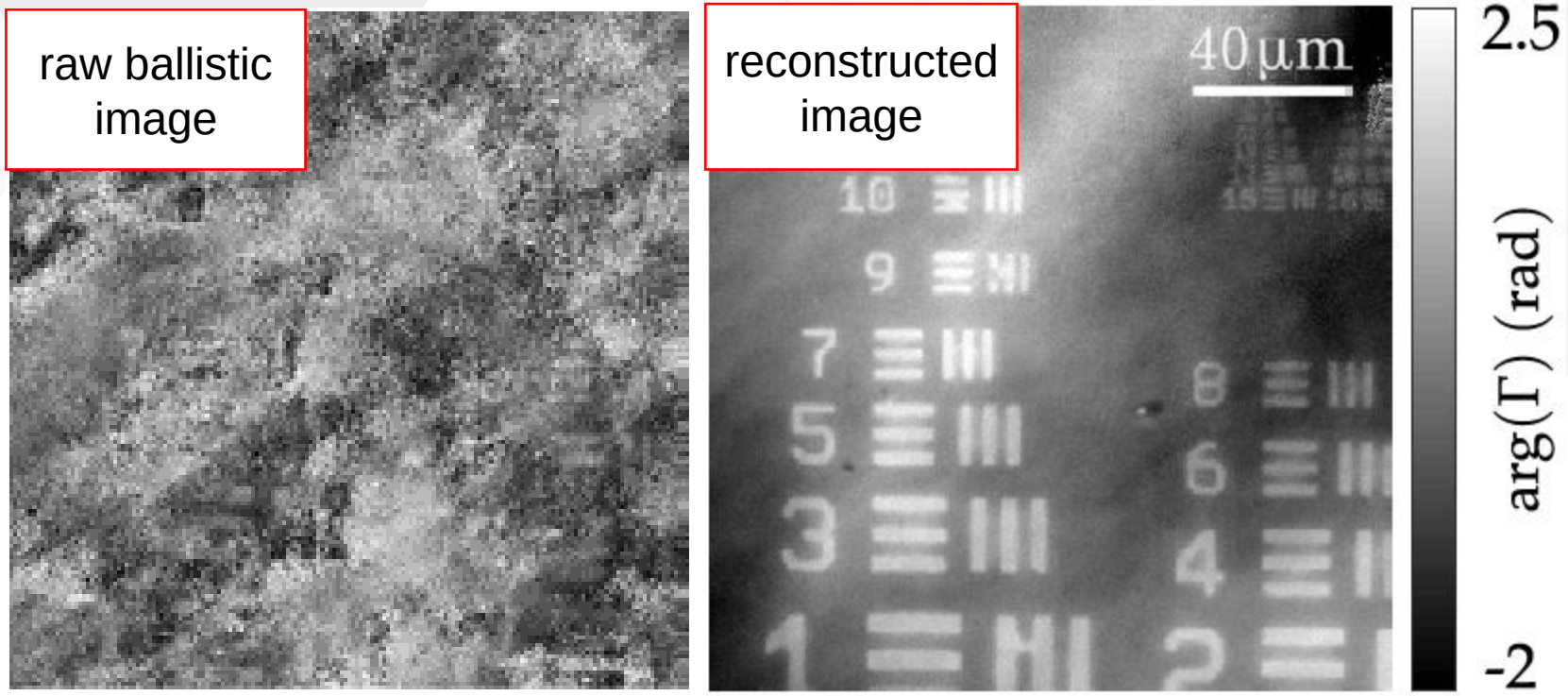
- hiQPI through scattering layer (chicken breast slab 1 mm thick)
- combination of ballistic and non-ballistic images acquired with transversal coherence-gate shifting

- Duris et al. 2021

Optics Letters

raw ballistic image

reconstructed image



hiQPI: Holographic Incoherent Quantitative Phase Imaging

Thank you for your attention!

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biophotonics.ceitec.cz

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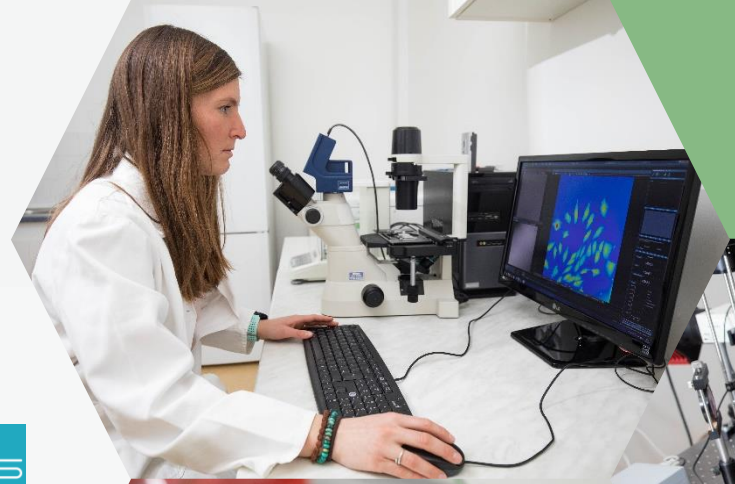

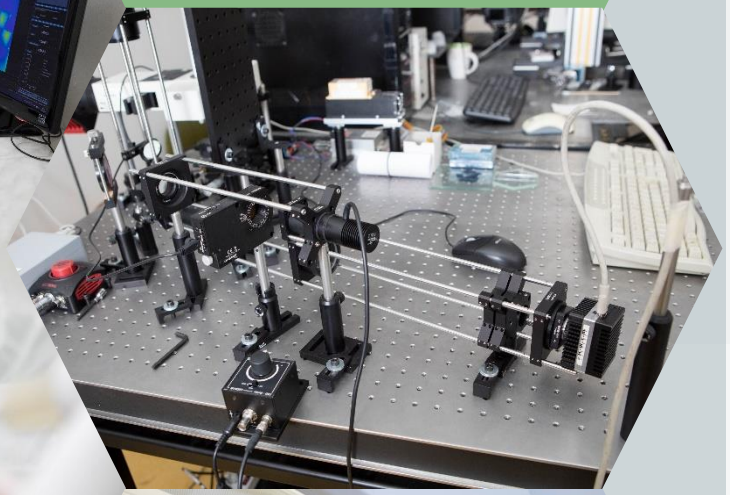

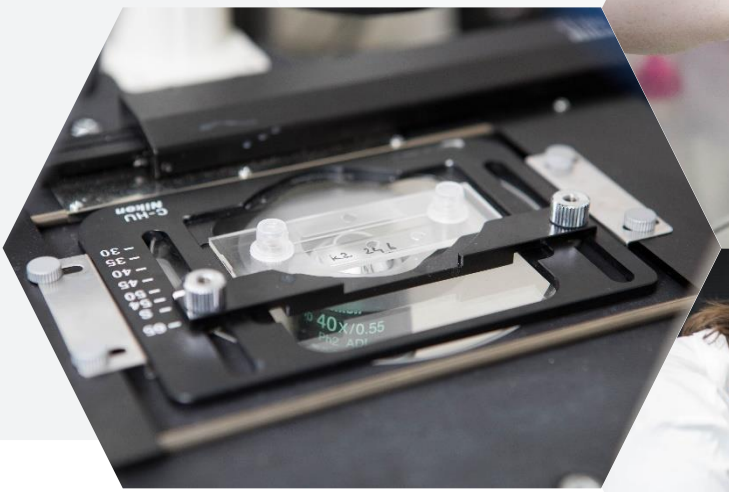

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Liga proti rakovině Praha