

PhotonHub Experience Centre

True QPI – Metrology of quantitative phase imaging systems for biomedical applications

Course Provider

Institute of Micromechanics and Photonics
Warsaw University of Technology
Poland

Course Overview

The proposed Experience Centre is devoted to metrological assessment of quantitative phase imaging (QPI) systems using bio-inspired phantoms manufactured via two-photon polymerization. The QPI is a rapidly growing segment of 2D/3D microscopy market. An increasing number of companies deliver phase measurement systems worldwide. QPI systems are applied as efficient noninvasive (marker-free) measurement and monitoring tool in biomedical applications at cellular level (e.g. in drug administration and interaction studies). However, there is no unified approach to metrology of QPI systems, making measurement validation and standardization challenging, but also demanded by the market.

For this reason, in True_QPI Experience Centre participants will learn about core advantages of QPI in biomedical imaging, how to setup metrological validation of their QPI instruments, how to use existing calibration object to maximise their potential and how to design and use new, complex, bio-mimicking phantoms. Through these activities the participants will gain insight into limitations and uncertainty of phase measurements, which is vital for the QPI community and a unique opportunity for this industry to grow.

Target Audience

The course is ideally suited to the attendees from the two target groups:

1. Developers and manufacturers of phase microscopy products;
2. Laboratories and companies providing biomedical diagnostic services and pharmaceutical companies introducing new medicines and utilize or plan to utilize QPI methods

It is desirable but not essential that course attendees have a basic understanding of photonics.

Expected Outcomes

- 1) Gain knowledge and hands-on experience in 2D and 3D QPI methods
- 2) Design, manufacture and characterize calibration structures for 2D and 3D QPI
- 3) Learn how to evaluate quantitative phase measurement systems
- 4) Learn and recognize the limitations of the QPI tools and microfabrication methods

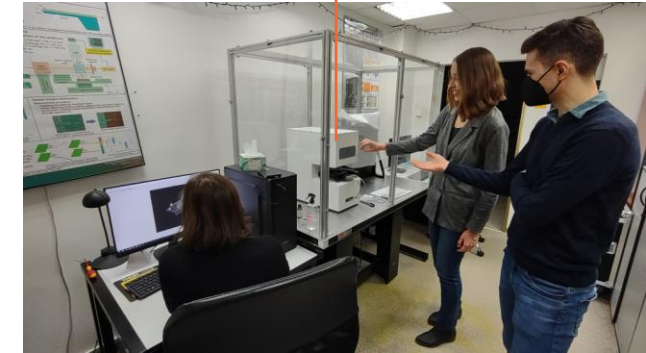
Course Equipment & Infrastructure

Laser lithography system

Stereo microscopy

Vacuum coating

Tomographic phase microscope



Scanning electron microscope

Data processing

Biological sample preparation and handling

Course Schedule

Day & Time	Training Activity
Day 1 (09:00 – 12:00)	Orientation, Course Introduction & Tutorials (lectures)
Day 1 (14:00 – 17:00)	QPI bio measurements (hands-on)
Day 2 (09:00 – 12:00)	Microstructure design and manufacturing (hands-on)
Day 2 (14:00 – 17:00)	Microstructure characterization and validation (hands-on)
Day 3 (09:00 – 12:00)	2D QPI Metrology (hands-on)
Day 3 (14:00 – 17:00)	3D QPI Metrology (hands-on)

Course Details (Day 1)

Day 1a. WUT Orientation, PhotonHub Training, Course Introduction & Theoretical background (lectures)

Location: CeZaMAT/ Mechatronics conference room

Details: Lectures on QPI applications and metrology, phantom manufacturing and supporting techniques

Training Duration: 3 Hours

09:00



17:00

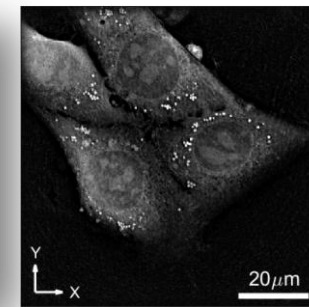
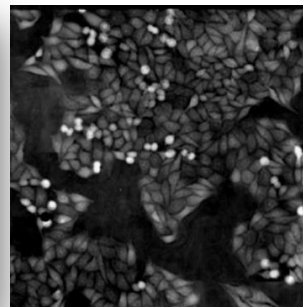


Day 1b. QPI bio measurements (hands-on)

Equipment Used: Digital holographic microscope, Tomographic phase microscope

Details: Sample preparation and handling, measurement scenarios, acquiring and processing data used to design and manufacture phantoms

Training Duration: 3 Hours



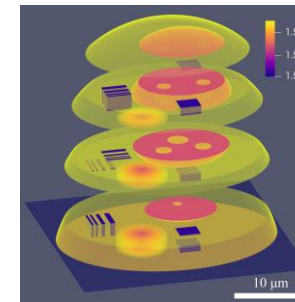
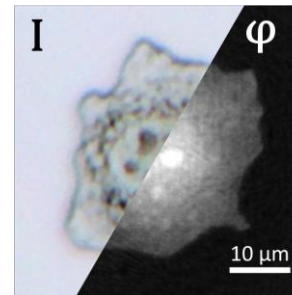
Course Details (Day 2)

Day 2a. Two photon polymerization – design and manufacturing (hands-on)

Equipment Used: Nanoscribe Photonic Professional GT2, processing software (Matlab, Describe, Nanowrite)

Details: The attendees will learn how to process 2D and 3D data to design and fabricate calibration objects with predetermined phase and refractive index characteristics

Training Duration: 3 Hours



09:00



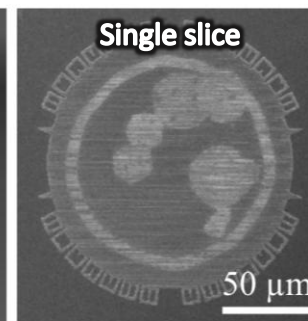
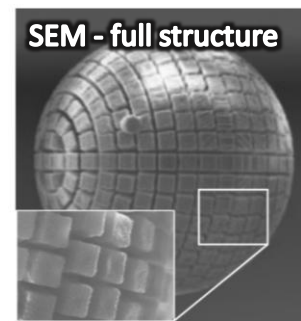
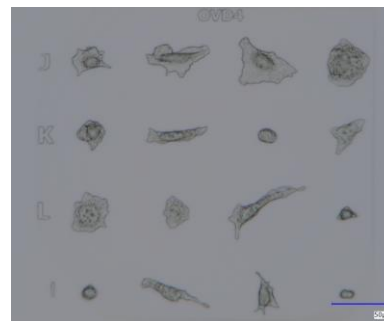
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Day 2b. Two photon polymerization - characterization (hands-on)

Equipment Used: Vacuum coater, scanning electron microscope, white light interferometer, stereo microscope

Details: The attendees will learn how to use the tools at the fabrication lab to perform multimodal characterization of the microstructures

Duration: 3 Hours



Course Details (Day 3)

09:00



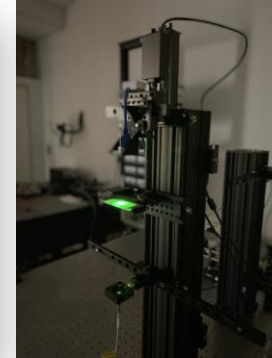
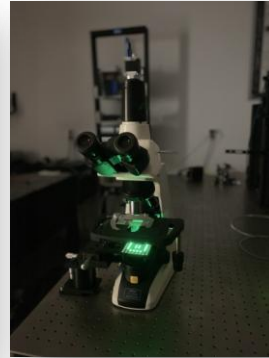
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Day 3a. 2D QPI metrology (hands-on)

Equipment Used: WUT Scope (ptychography), WUT lensfree microscope, WUT digital holographic microscope

Details: 2D test structures and calibration objects will be used to characterize and compare three systems

Training Duration: 3 Hours

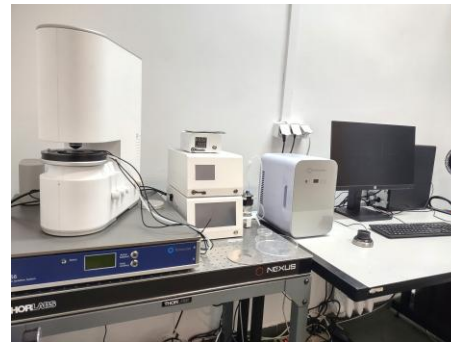


Day 3b. 3D QPI metrology (hands-on)

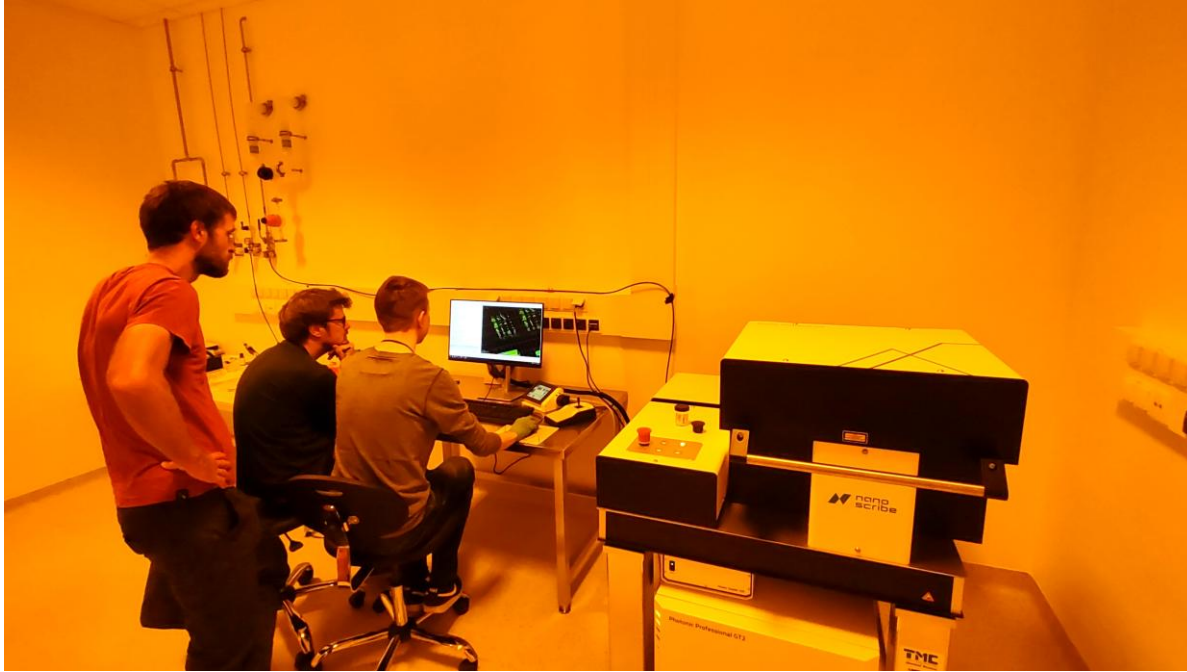
Equipment Used: WUT tomographic microscope, Tomocube HT-1

Details: Testing of two 3D refractive index measurement systems, demonstration of key differences influenced by hardware and processing strategies

Training Duration: 3 Hours



Course Trainers



Course Director: Dr Arkadiusz Kuś

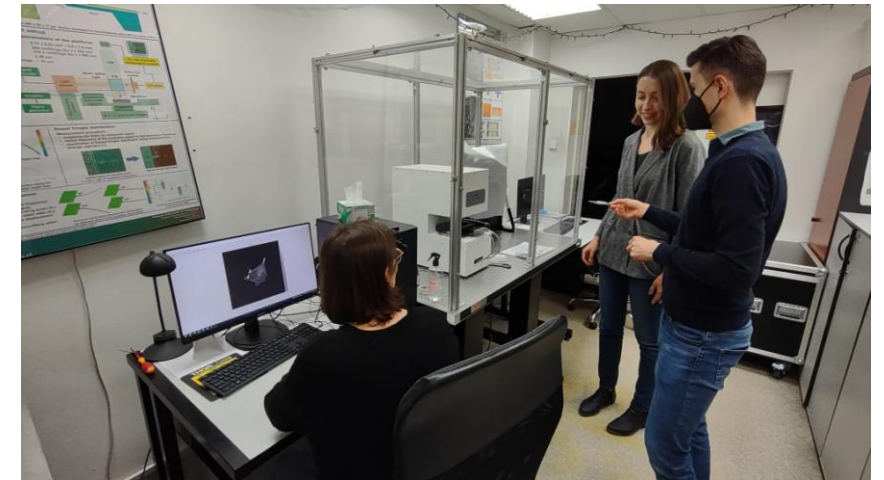
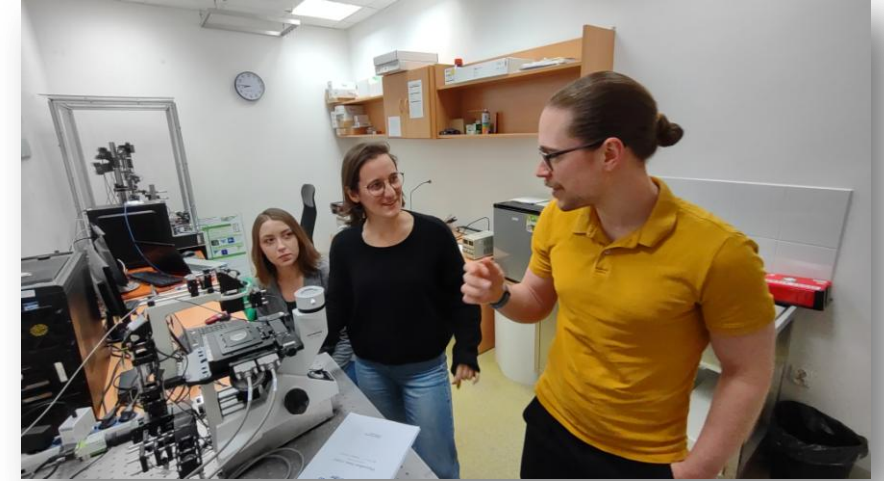
Course Manager: Dr Anna Pakuła

Two photon polymerization: Dr Michał Ziemczonok

Digital holographic microscopy: Dr Maria Baczevska

2D QPI: Dr Piotr Zdańkowski

3D QPI: Dr Arkadiusz Kus, Msc. Martyna Mazur



Course Material (technical hand-outs)

WARSAW UNIVERSITY OF TECHNOLOGY



PhotonHub Experience Centre

HANDS-ON TRAINING

QPI Experience Centre Ex. 1 : Holographic tomography

Warsaw University
of Technology

QPI Experience Centre Ex. 1

PhotonHub Experience Centre

6 Hands-on demonstration

6.1 Measurement system description

The measurement system used in this training is a technology demonstrator built at Warsaw University of Technology, depicted in Fig. 6. The system follows a geometry of a Mach-Zehnder interferometer with a galvo mirror as a scanning component as depicted in Fig. 3. However, in this case a MEMS mirror is used for stability.

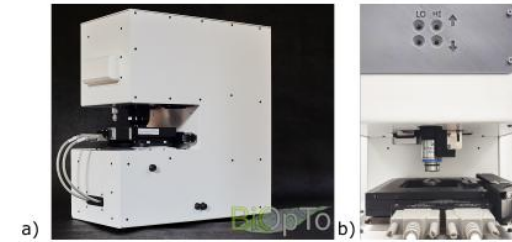


Figure 6: a) The technology demonstrator - initial version, b) HT system used in the demonstration, with sample holder removed. The gray panel is used in order to control the position of the upper microscope objective at high (HI) speed for fast retraction and low (LO) speed for position adjustment.

The prototype used in this training is equipped with two high numerical aperture microscope objectives (NA=1.3, oil immersion lenses) that leave 0.4 mm working distance, which can be used for sample chamber. Typically the sample chamber thickness is limited by a 150 μm thin film separator placed between two 0.17mm coverslips. However, if cells in Petri dishes are studied, the top coverglass and separator are not used and the upper lens is placed directly in the cell culture medium. The parameters of the measurement system are directly comparable to other devices available on the market, as presented in Tab. 1. The WUT demonstrator is equipped with a 3D motorized stage system, which allows to perform volume stitching for objects larger than nominal field of view.



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Course Location, Schedule & Cost



Mechatronics Faculty, WUT



CeZaMat: Centre for Advanced Materials and Technologies, WUT



Two convenient airports: Warsaw (F. Chopin airport, WAW) and Modlin (WMI)

WMI,
WAW



- Course Schedule (March/November– exact dates to be confirmed)
- Number of people (Groups of 3x3 people per course)
- Course Cost (500 Euros per person, includes catering and project consumables)

Further Information

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- <http://biophase.pl>
- www.photonhub.eu

Keywords

Quantitative Phase Imaging, Biomedical applications, Digital holographic microscopy, Optical Diffraction Tomography, 3D Refractive Index, 3D nano printing, Two-photon Polymerization, Biology inspired phantoms, Metrology, Calibration, QPI Validation