„*Biomolecular electrodynamic interactions for future nanoelectronics and photonics*”
Brussels, 29th April 2013

Bio-photonics research activities at Warsaw University of Technology

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Photonics Society of Poland President

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Photonics Research and Development Perspectives in Poland

An insight into the world of photonics in Poland

INFO

Established in 2007, the **Photonics Society of Poland (PSP)** transformed from the SPIE Poland Chapter (existing since 1988), with its about 250 members is the largest and the most powerful optics-optoelectronics-photonics organization in Poland. PSP members are mainly from the academia and from governmental institutes; but also from industrial and business communities. PSP aims to integrate national photonics community and to undertake research, technical, organizational, and business endeavors in relations to the industry, international partners, consortia and technological platforms. Since September 2012, PSP has become a partner in the Photonics Optoelectronics Network PHOENIX, a project within the framework of the "Network formation in Central and East Europe" funding program of the State of Berlin.

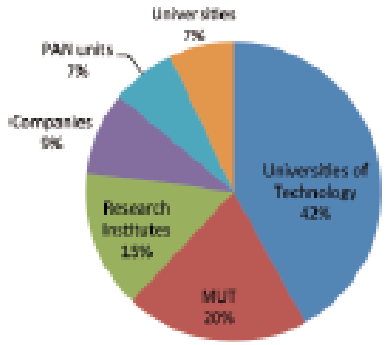
http://photonics.pl/

THE AUTHORS

TOMASZ R. WOLIŃSKI

Tomasz R. Woliński, PhD in Physics (1985), DSc in Physics-Optics (1995), Professor of Physics (2002); Optics and Photonics Division Head, Faculty of Physics, Warsaw Univ. of Technology; 300 papers, 7 patents (U.S., Canada, Poland); 4 review chapters (Progress in Optics, Enc. of Opt. Eng., Wiley, Springer); Photonics Society of Poland President (2008); SPIE Fellow (2004); OSA, IEEE member; Photonics Letters of Poland publisher; FNP "Mistrz" Laureate in Photonic Liquid Crystals Fibers (2010-2012).

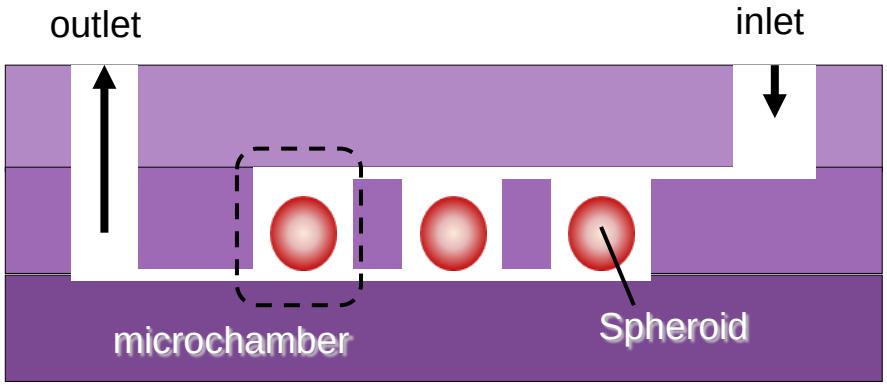
Photonics Research teams

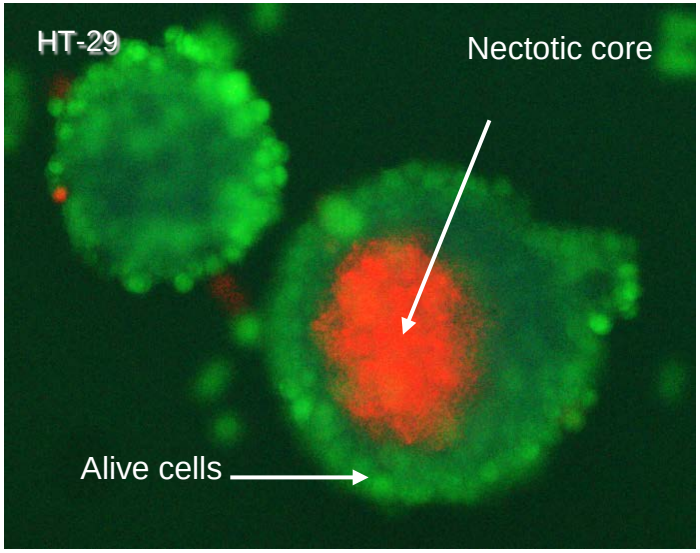


Warsaw University of Technology
20 Faculties

- Faculty of Architecture,
- Faculty of Automotive and Construction Machinery Engineering,
- Faculty of Chemical and Process Engineering,
- Faculty of Chemistry,
- Faculty of Civil Engineering,
- Faculty of Electrical Engineering,
- Faculty of Electronics and Information Technology,
- Faculty of Environmental Engineering,
- Faculty of Geodesy and Cartography,
- Faculty of Mathematics and Information Science,
- Faculty of Mechatronics,
- Faculty of Physics,
- Faculty of Power and Aeronautical Engineering,
- Faculty of Production Engineering,
- Faculty of Transport,
- Faculty of Materials Science and Technology,
- Faculty of Civil Engineering, Mechanics and Petrochemistry (Płock),
- Faculty of Management,
- Faculty of Admin. and Social Science,
- College of Economics and Social Sciences (Płock).

Multicellular tumor spheroids





- Flow-through microchambers – vol. 0.2 µL
- Microchannels 300 µm x 50 µm
- 3D structure

Microsystems (lab-on-a-chip) for bioanalytics

Contact: **Prof. Artur Dybko,** dybko@ch.pw.edu.pl
Chemical Sensors Research Group, Faculty of Chemistry
csrg.ch.pw.edu.pl

Photodynamic therapy

photosensitizer

+

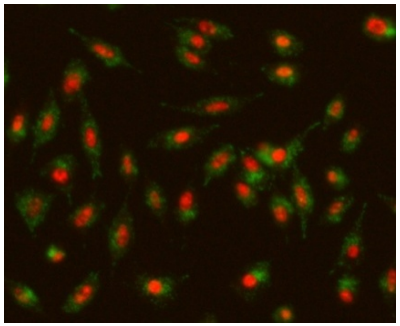
intracellular oxygen

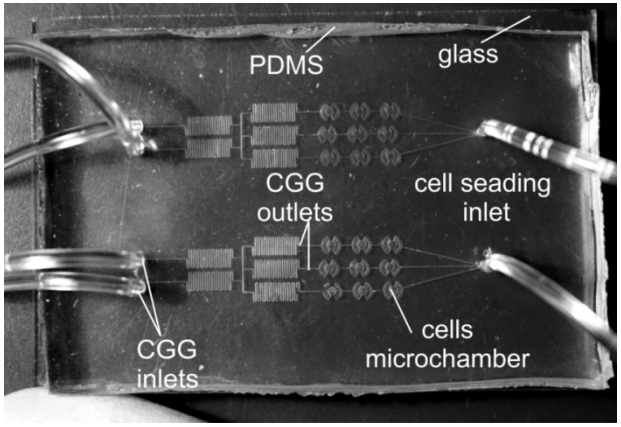
+

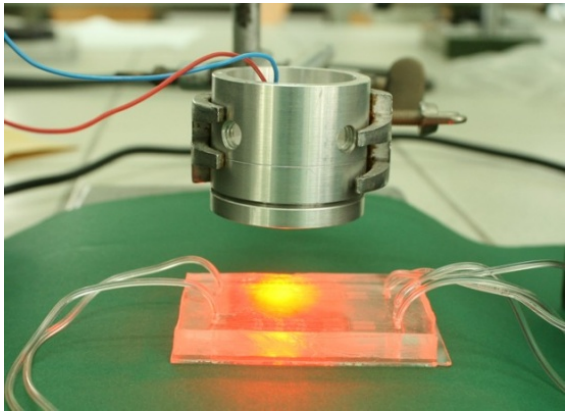
irradiation

→ Reactive oxygene species →

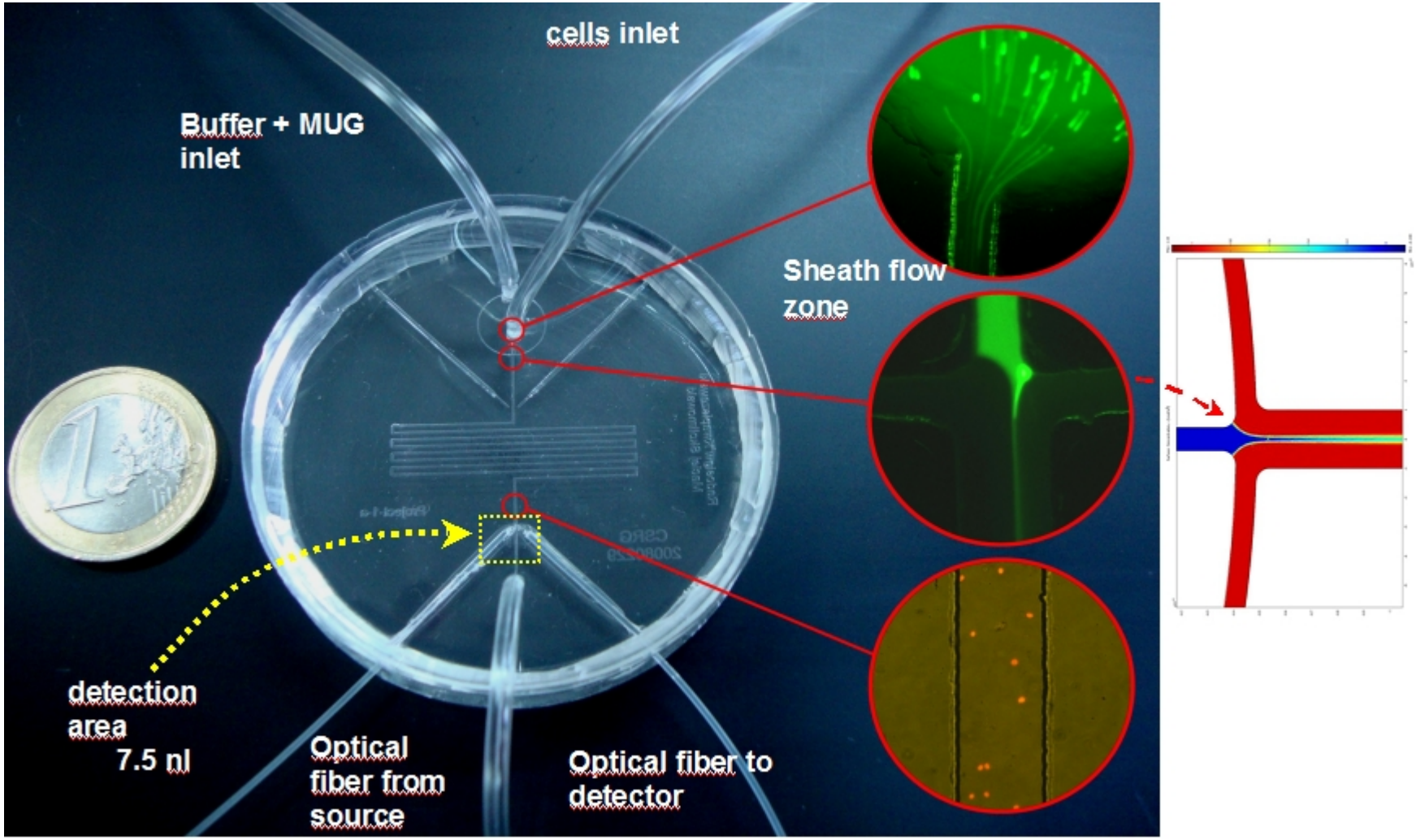
Cells dead (necrosis, apoptosis)



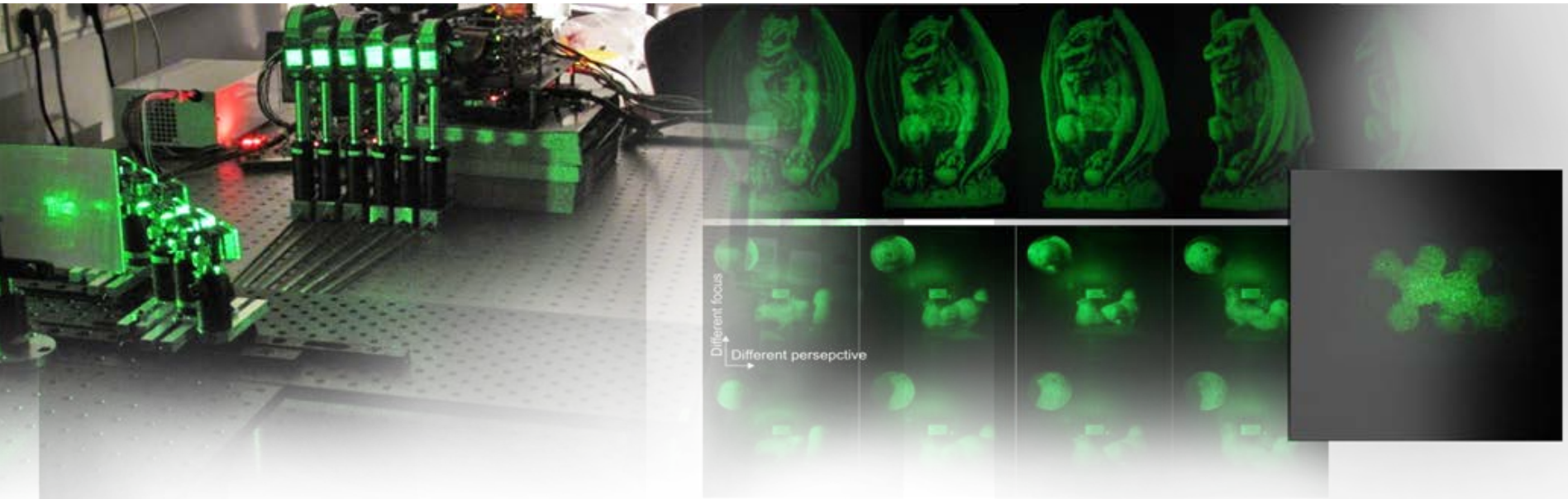




Microsystem for Gaucher disease diagnostics



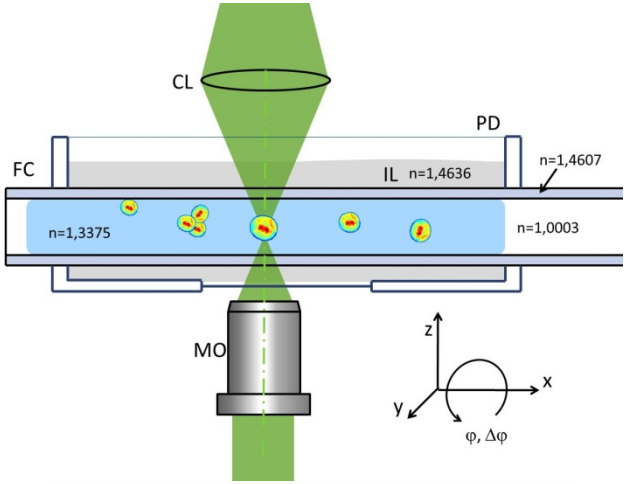
Photonics at
Faculty of Mechatronics

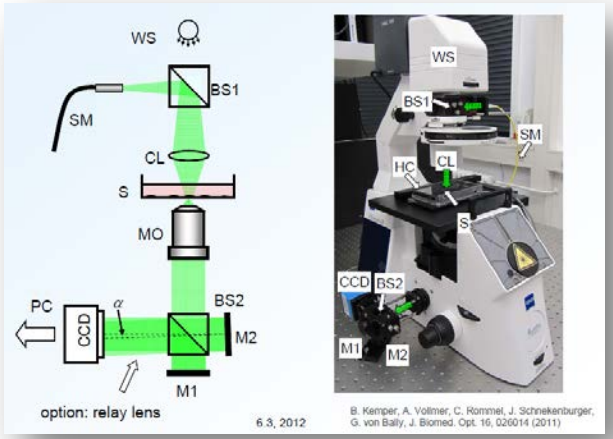


TRUE 3D DIGITAL HOLOGRAPHIC DISPLAY AND VIDEO OF REAL WORLD OBJECTS

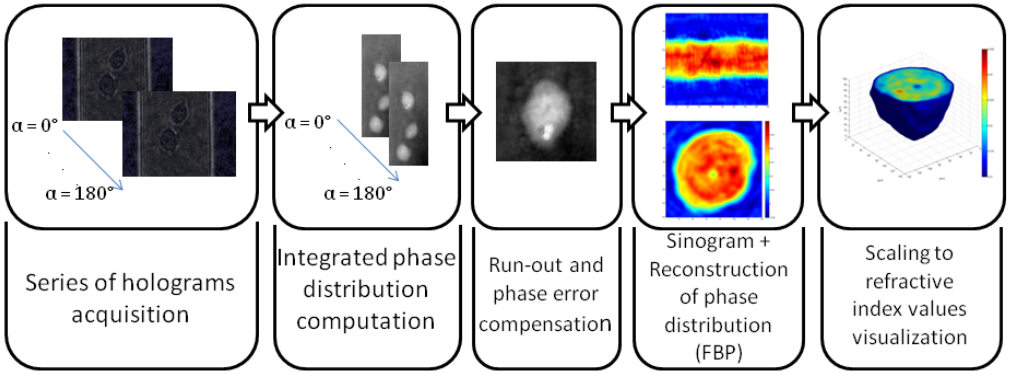
- design and development holographic displays;
- opto-numerical image data processing;
- DH interferometry and remote full 3D measurements.

TOMOGRAPHIC STUDIES OF BIOLOGICAL OBJECTS





- Rotation-based projection acquisition
- Filtered back projection algorithm
- Three-dimensional phase and amplitude objects imaging and numerical refocusing
- Biological micro-objects integrated phase reconstruction
- Measurement of 3D refractive index distribution in biological micro-objects



Contact: **Prof. Małgorzata Kujawińska**
m.kujawinska@mchtr.pw.edu.pl

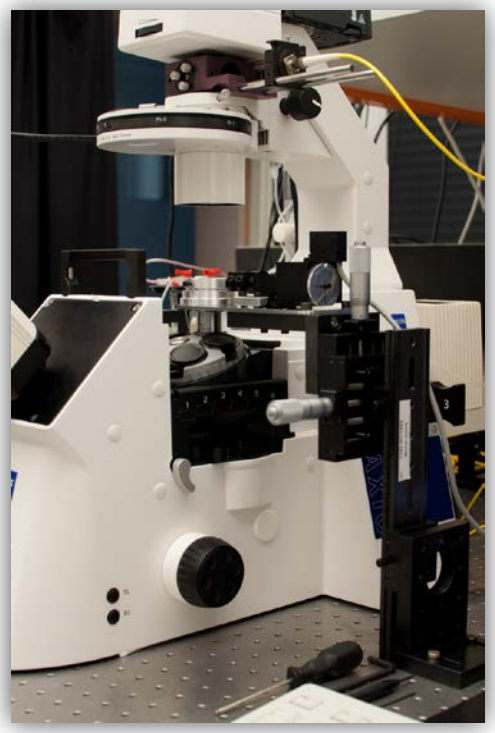
INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

FNP
Foundation for Polish Science

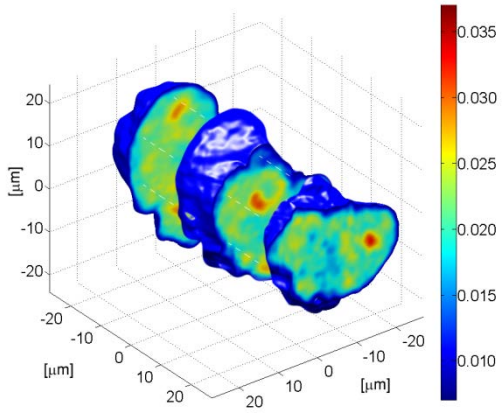
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

TOMOGRAPHIC PHASE MICROSCOPE

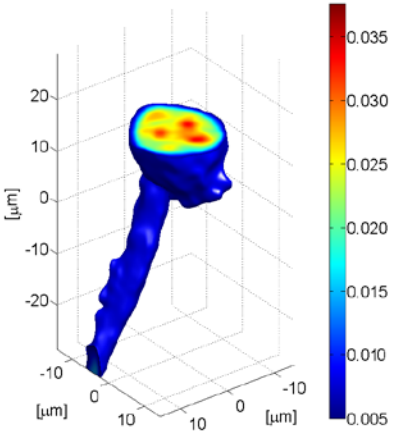
Digital holography: experimental Results



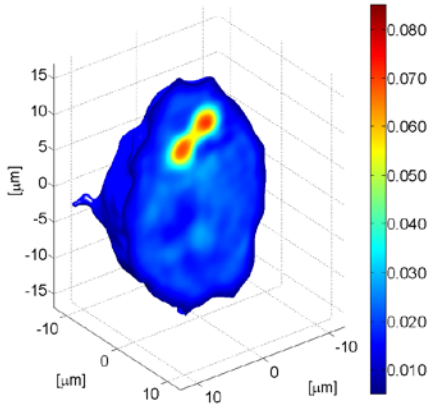
Measurements and monitoring of 3D refractive index changes



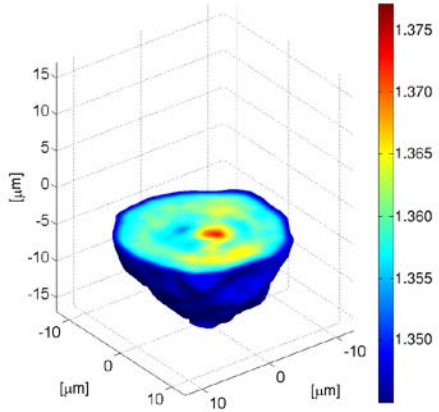
The refractive index distribution in an HT1080 cell group at several cross-sections



HT1080 cell with a developed extension.



Cross-section of an HT1080 cell with calibration microspheres inside.



Cross-section of an HT1080 cell scaled to absolute refractive index values,

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

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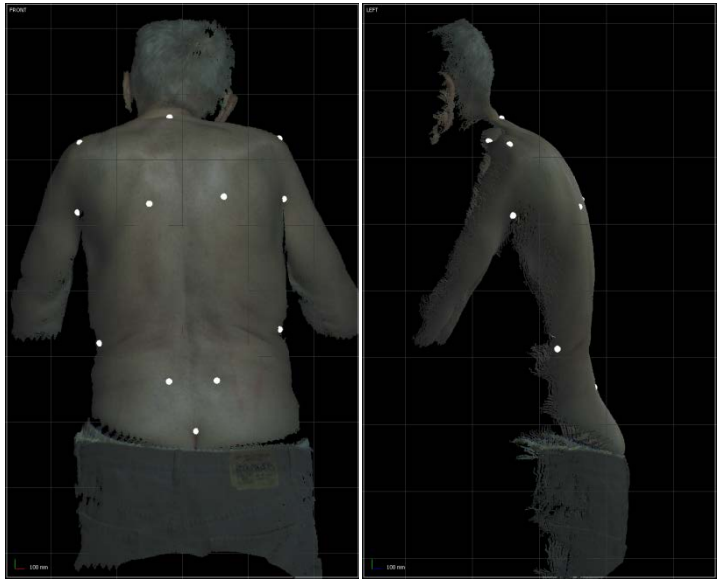
Foundation for Polish Science

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

3D ORTHOSCREEN

automated system for posture screening

Measurement system (structured light)



Anatomical landmark detection

Computer-aided posture examination

Patient information

Name:	John Doe
Date of birth:	1999-04-30
Sex:	M

Examination details

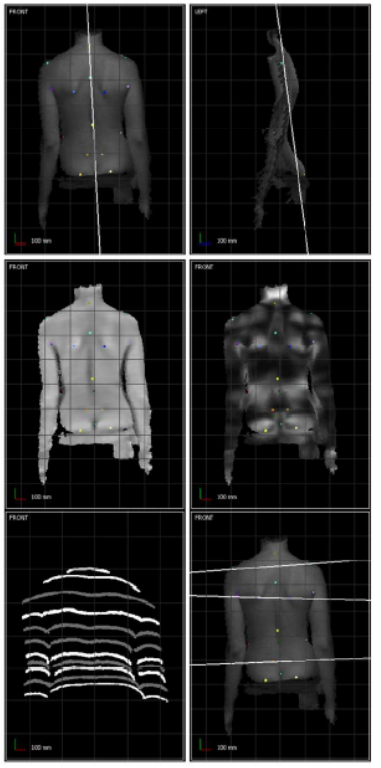
Location:	Szpital Dzieciątka Jezus, Lindleya 5, Warszawa
Date:	2012-04-04 12:25:04

Examination results

Weight:	59 kg
Height:	178 cm
Frontal plane	
POTSI:	45% > 27,9%
Shoulders asymmetry:	4°
Scapula asymmetry:	-1°
PSIS asymmetry:	2°
Torso inclination:	2°
Sagittal plane	
Kyphosis angle:	17°
Lordosis angle:	44°
Torso inclination:	7°
Axial plane	
DAPI:	0,96% < 3,9%
sATR:	9° (6°, 1°, 1°)
SHS:	6
Description:	

Additional description.

Measurement data



Description of parameters available at: http://teleposture.eu

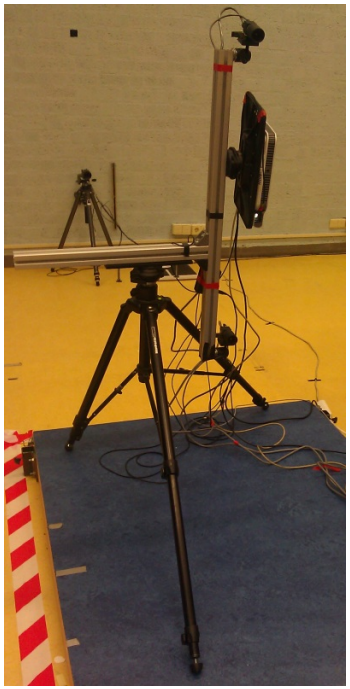
Report generation

Michoński, J., Glinkowski, W., Witkowski, M., Sitnik, R. **Journal of Biomedical Optics**, *17(5), 056015, 2012*

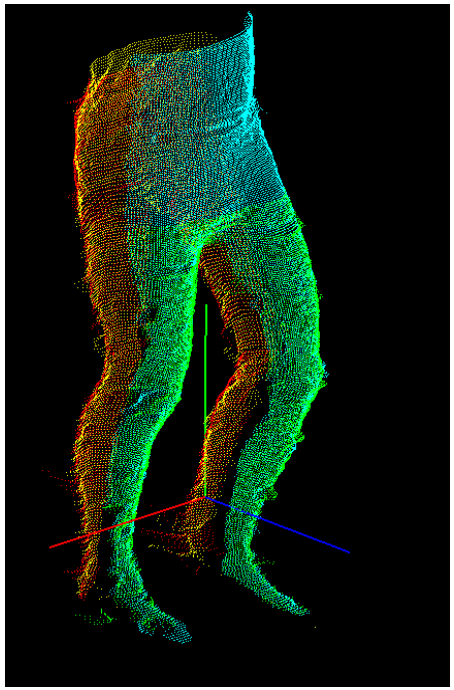
Contact: **Prof. Robert Sitnik** r.sitnik@mchtr.pw.edu.pl

4D SCANNER

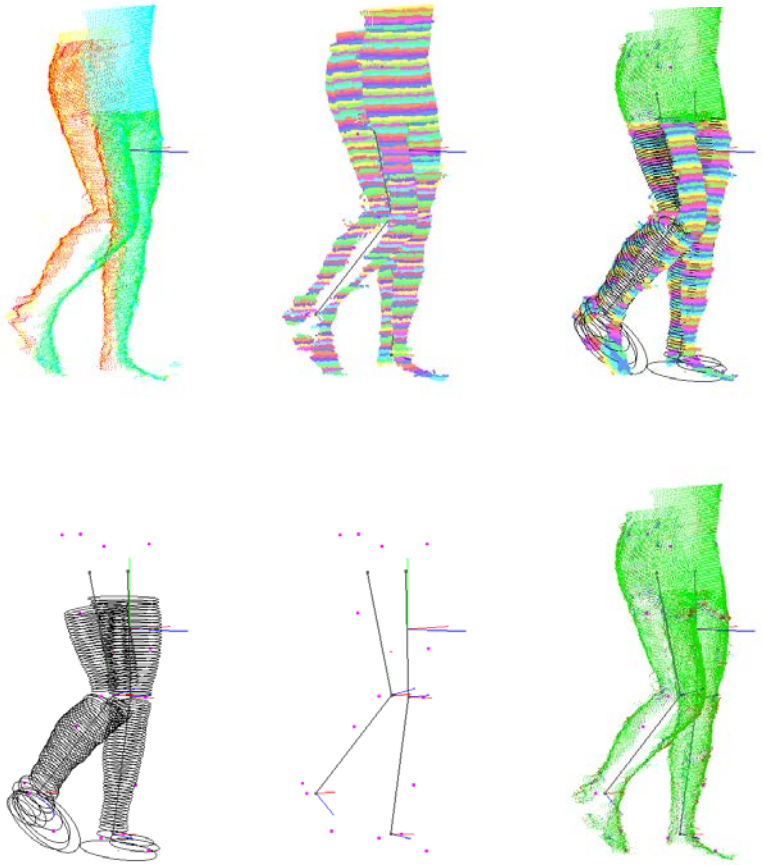
markerless human movement measurement (60Hz)



Measurement head
(1 projector, 2 cameras)



Bi-directional
cloud of 3D points



Virtual markers evaluation.
Surface points → Vicon-compliant markers

Lenar J., Witkowski M., Carbone V., Kolk S., Adamczyk ., Sitnik R., van der Krogt M., Verdonschot N.,
Journal of Biomedical Optics, *paper accepted, 2013*

Photonics at
Faculty of Physics

EXTENDED DEPTH-OF-FIELD IMAGING

- designing of diffractive and refractive imaging elements;
- presbyopic human eye modeling and correction methods analysis;
- development of machine vision techniques.

Optical tweezers

Biomedical applications

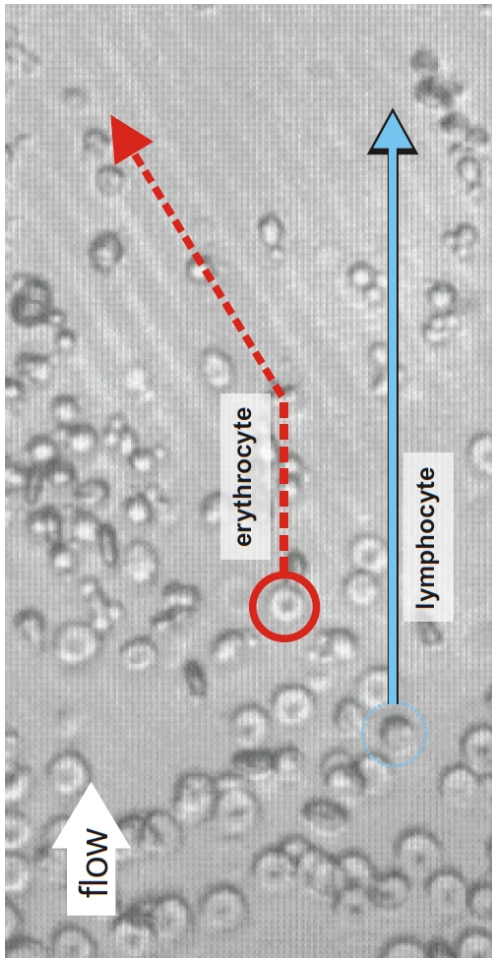
A non-invasive method for trapping and manipulating microscopic biological samples

Pharmaceutical applications

The study of the effects of drugs on the molecular level

Physics applications

Provides an accessible testing ground for ideas at the atomic scale



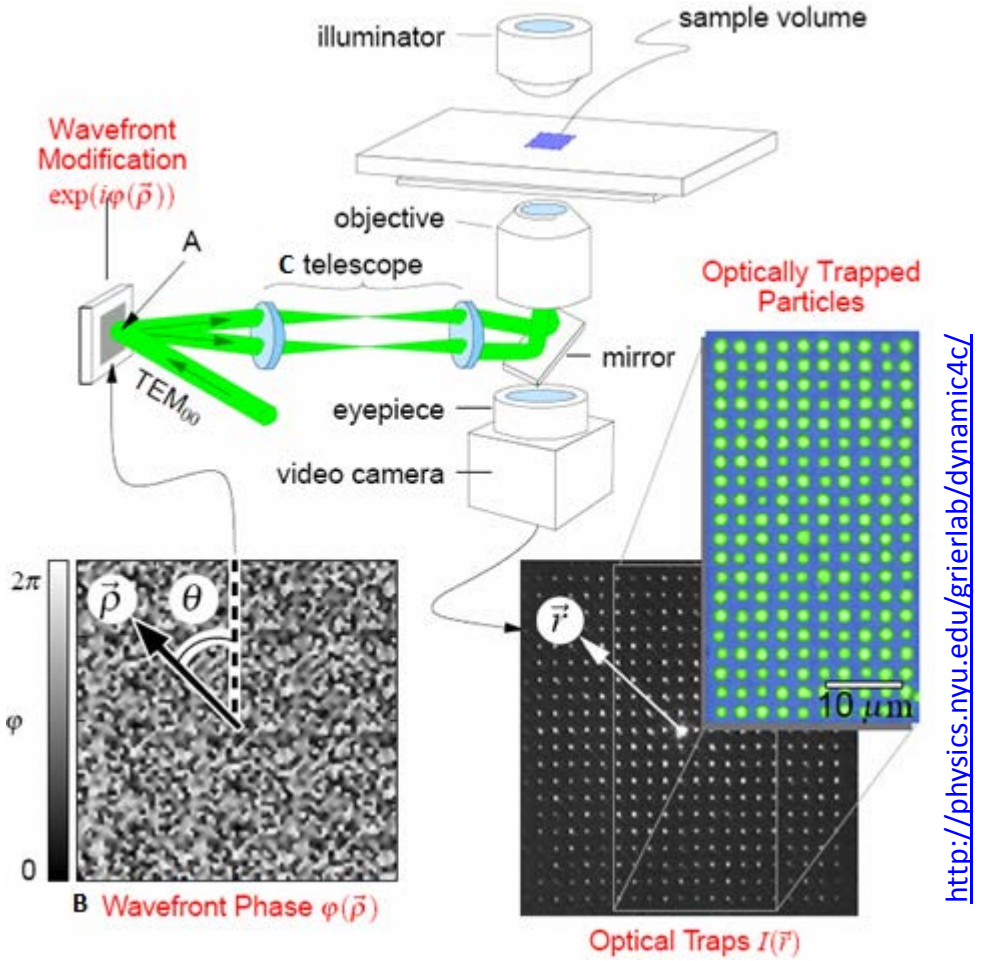
www.laserfocusworld.com/articles/2009/06/optical-tweezers-optical-trapping-empowers-biophysics.html

Holographic Optical Tweezers HOT

A. The HOTs used a reflective SLM to diffract the beam.

B. The insert phase grating (hologram) encodes an array of traps.

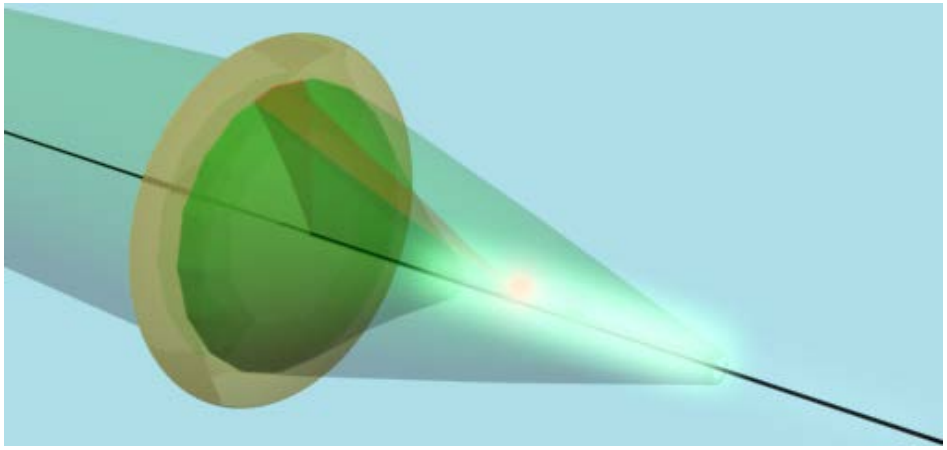
C. A telescope relays the diffracted beams to a high numerical aperture objective which focused them into optical traps

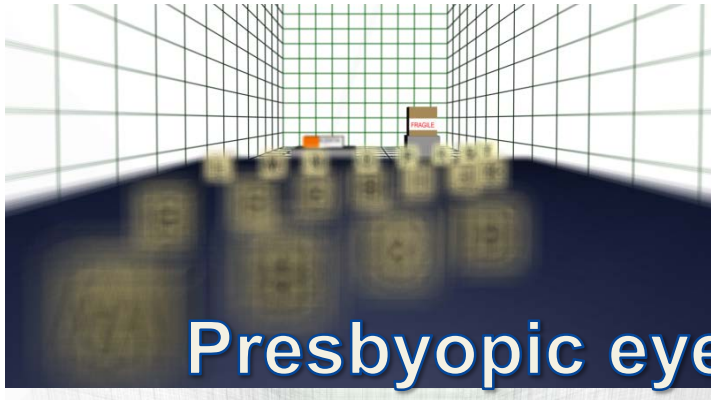


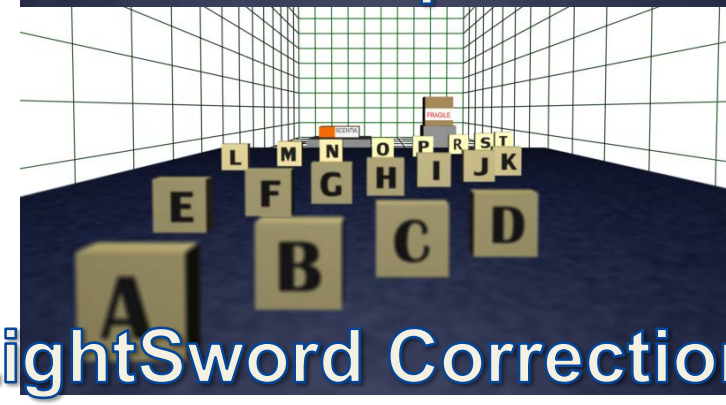
Contact: **Prof. Andrzej Kołodziejczyk** kolodz@if.pw.edu.pl

Imaging with extended depth of focus:

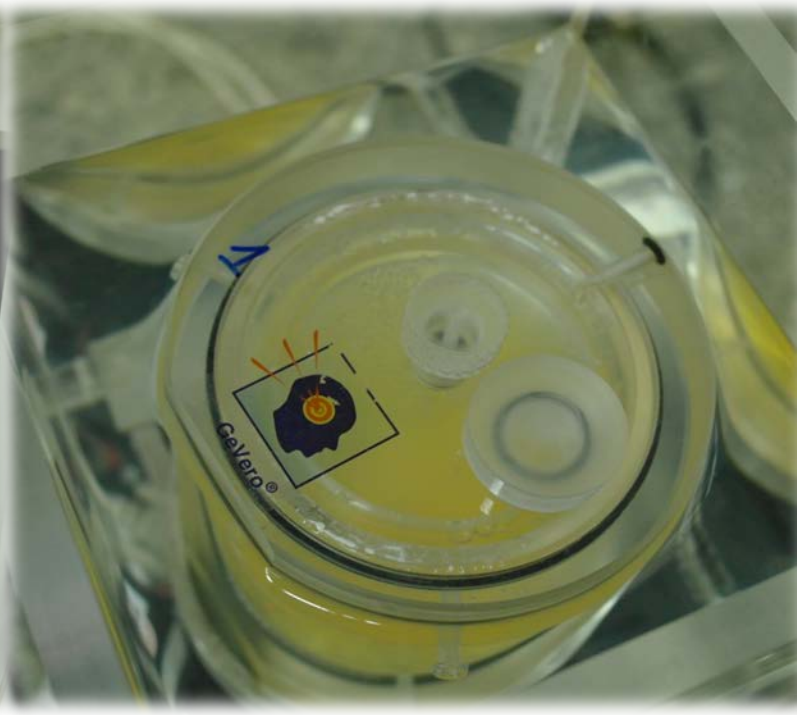
- Machine vision
- Photography and CCTV
- Mobile phones photo objectives
- **Presbyopia Compensation in ophthalmology as Intraocular or Contact lenses**







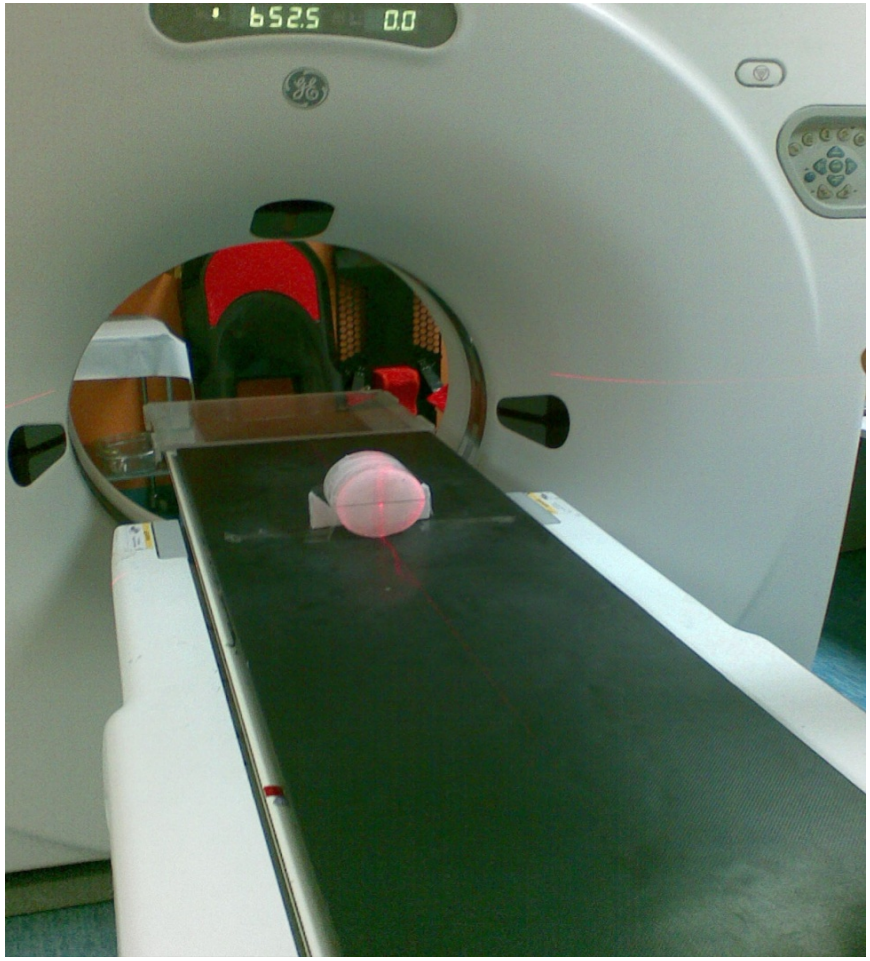
Photonics at
Faculty of Physics



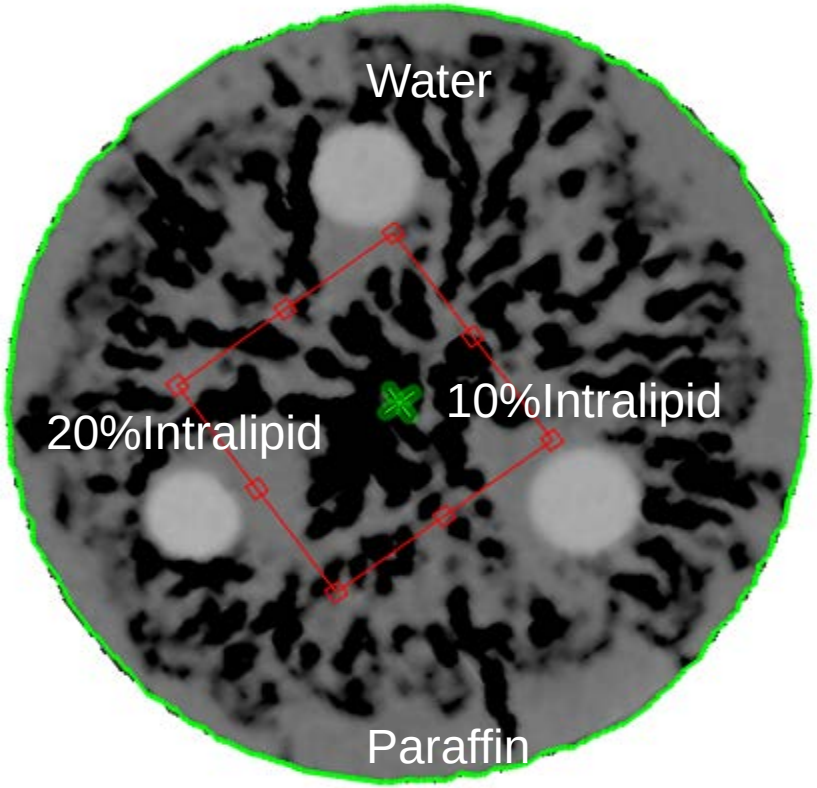
OPTICAL TOMOGRAPHY

- polarimetric tomography (Mueller matrices)
- breast cancer recognition;
- gel dosimetry with Optical Computed Tomography.

Comparison of X-ray and optical tomography imaging

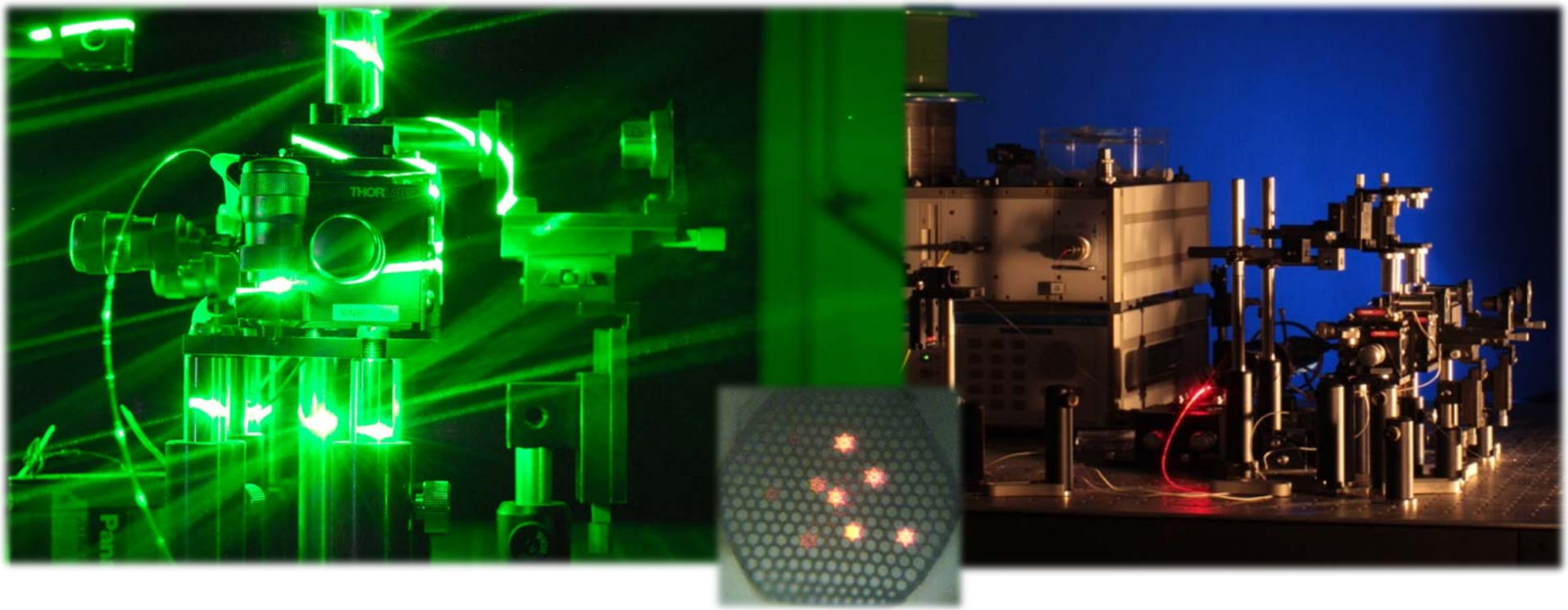


OT contrary to X-ray allows to recognize different solutions of Intralipid



Contact: **Prof. Andrzej Domanski**
domanski@if.pw.edu.pl

Photonics at
Faculty of Physics



PHOTONIC LIQUID CRYSTAL FIBERS – **Fiber Optofluidics**

- photonic crystal fibers and liquid crystals
- design and characterization of photonic liquid crystal fibers

Contact: **Prof. Tomasz Wolinski** wolinski@if.pw.edu.pl