



*The **CREA**tion of the Department of Physical Chemistry of Biological Sys**TE**ms [CREATE]*

666295 — CREATE — H2020-WIDESPREAD-2014-2015/H2020-WIDESPREAD-2014-2

2nd Report on tutoring and mentoring activity of ERA Chair holder towards his employees

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1. Overview of tutoring and mentoring activity of ERA Chair holder towards his employees

This document specifies the activities of the employees of the ERA Chair holder's team and other research groups of the Institute of Physical Chemistry PAS (IPC), aimed at gaining specific skills and knowledge.

Prof. Maciej Wojtkowski – the ERA Chair holder, and the Department of Physical Chemistry of Biological Systems (POB) employees, took part in several international conferences and laboratory visits. Participation in these actions, besides the educational and training aspect, also allowed establishing new contacts and international cooperation with centres that conduct top-class research on optical imaging methods in biological systems.

Additionally, Prof. Maciej Wojtkowski announced the competition "Lab visits under the CREATE project". The IPC PAS employees, who wished to take advantage of this initiative, prepared a proposal for a lab visit to a reputable research institution to strengthen their expertise in optics. The results of the competition were determined based on the evaluation made by Professor Wojtkowski.

This report covers the period: 1/03/2018 - 31/03/2021 (M30 – M66).

2. Activities of the ERA Chair holder's team

a) *Conferences & Seminars*

*SPIE Photonics West 2018**

Name: Michał Hamkała

Location: San Francisco, CA, USA

Organisers: SPIE – international society for optics and photonics

Type of event: conference

Date: 26/01-2/02/2018

The conference is the largest meeting of people from photonics and biomedical optics and allows discussing and seeing current progress in these fields. During the conference (OCT session), Michał Hamkała gave a talk, "Long-depth-range MHz OCT for structural and functional cardiac imaging at up to 100 volumes/s", and received a warm reception. MH also discussed new ideas for future research with prof. Huber and prof. Luther (prof. Wojtkowski's group collaborators) and prof. Fujimoto (the pioneer in the field of OCT). As a part of the conference, the exhibition prepared by important manufacturers and companies acting in optics took place. It gave an overview of state-of-the-art devices that can improve POB's experiments. MH had talked with a software engineer from the company that provided POB with cameras and obtained the beta version of new software for this camera, increasing data transfer by 25%.



**supplement to the deliverable 2.4 referring to the previous period*

Biophotonics Congress Biomedical Optics (OSA)

Name: Dawid Borycki

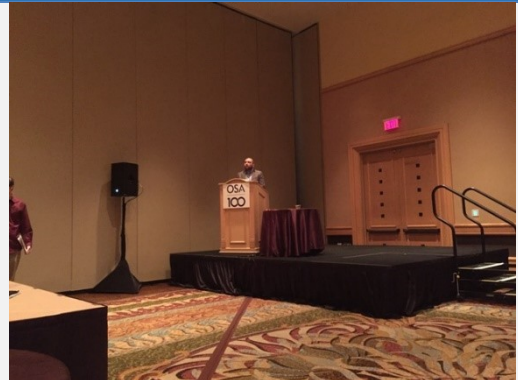
Location: Hollywood, USA

Organisers: OSA – The Optical Society of America

Type of event: conference

Date: 1-8/04/2018

Dawid Borycki participated in the Optical Society of America (OSA) Biophotonics Congress Biomedical Optics. On the course of this visit, DB gave a talk entitled "Correlation gating quantifies optical properties of dynamic media in transmission mode". The conference was also an excellent chance to learn about currently explored topics in optics, which are also related to research areas of prof. Wojtkowski lab. These topics include: (1) application of machine learning to improve the spatial resolution of optical microscopes, (2) speckle contrast optical tomography.



Microsoft Build 2018

Name: Dawid Borycki

Location: Seattle, USA

Organisers: Microsoft

Type of event: conference

Date: 6-12/05/2018

Dawid Borycki participated in the Microsoft Build 2018 conference. This visit aimed to learn about new software technologies that can be used in prof. Wojtkowski's lab. DB was particularly interested in artificial intelligence for computer vision and the intelligent edge. Prof. Wojtkowski's team currently explores cloud-based AI-powered computer vision for semi-automatic classification of the functional images produced by optical modalities assembled in their lab.

The intelligent edge is a technology that enables one to bring data processing capabilities (including advanced machine learning and stream analytics) from the cloud down to the local device in the form of the so-called container. This technology will further advance image processing by eliminating the need to transfer large datasets over the network employing state-of-the-convolutional neural networks (CNNs) to do all the processing locally. As a result, system latency will be significantly reduced, enabling images analysis in real time.



LABVIEW course

Name: Mounika Rapolu

Location: *Warsaw, Poland*

Organisers: National Instruments

Type of event: course

Date: 9-13/04/2018

Mounika Rapolu participated in the LABVIEW course composed of two parts:

LABVIEW core 1: This module provided knowledge on navigating through the LabVIEW environment, techniques to acquire, analyse and present data, creating projects, and dataflow programming model. Other topics touched in this module included: troubleshooting, Debugging Vis and using various editing and debugging techniques, Decision-Making Structures, Modularity (SubVIs), Acquiring Measurements with Hardware(creating applications that use data acquisition (DAQ) devices, creating applications that use GPIB and serial port instruments), accessing Files in LabVIEW, Sequential and State Machine Programming.

LABVIEW core 2: This module provided knowledge on how to pattern, successfully implement and distribute LabVIEW applications for research, engineering, and testing environments. It also gave knowledge on event-driven programming, programmatic control of your user interface, techniques to optimise reuse of existing code, file I/O functions and tools to create executables and installers, directly linking LabVIEW functionality to the application needs and provides immediate starts for application development.

MEDmeetsTECH 2018

Name: Łukasz Kornaszewski

Location: *Warsaw, Poland*

Organisers: innoMED

Type of event: conference

Date: 18/05/2018

Łukasz Kornaszewski attended the MEDmeetsTECH conference, which focused on bringing together Polish medical, financial, and technological professionals to understand these groups' needs and expected solutions to various problems. The event started with doctors' presentations describing the medical service market's situation from the inside and predictions concerning expected growth in senior care, rapid diagnostics, communication, and doctors' training. Next came talks of certification bodies' representatives and venture capitalists, who presented risks and startup creation mechanisms. The event ended with presentations of both startups and well-established businesses describing their way to their current market position.



ŁK established contacts with: (1) the representative of Warsaw Medical University, a co-owner of the investment group financing medical startups and helping them in the certification process, (2) a CEO of a PR agency working with the medical industry. ŁK also learned about existing mechanisms that support the growth of medical-

technological startups. He also learnt from health workers' environment about their needs, concerns, and predictions of "hot topics" in the future, i.e. efforts towards real life-relevant applications.

Code Europe Spring 2018

Name: Dawid Borycki

Location: Warsaw, Poland

Organisers: Absolvent.pl Group

Type of event: conference

Date: 24/04/2018

During the conference, Dawid Borycki gave two talks:

1. "Programming for Windows Mixed Reality": DB explained how to develop apps for Windows Mixed Reality (WMR) platform, i.e. HoloLens and new immersive headsets. He also told Virtual, Augmented from Mixed Realities, reviewed available programming tools for WMR and showed how to create apps applying selected approaches. In the end, DB presented a complete guide to creating WMR app with the tools chosen.



2. "Azure Machine Learning Time Series Analysis for Anomaly Detection": Anomaly Detection is one of the most important features of Internet of Things (IoT) solutions that collect and analyse temporal changes of data from various sensors. In many scenarios, sensor data doesn't change significantly over time. However, when it does, it usually means that your system has encountered an anomaly – and this anomaly can lead to a specific malfunction. In his presentation, DB showed how to use Azure Machine Learning Time Series Anomaly Detection to identify anomalous sensor readings and utilise this information in remote client apps.

The organisers recorded the presentations and published them on the YouTube channel. Apart from that, Dawid Borycki met young, motivated, and dedicated people interested in exploring their skills in signal/image processing of data received in professor Wojtkowski's lab.

159th seminar of the International Center of Biocybernetics: Optics in Neuromonitoring

Name: Dawid Borycki

Location: Warsaw, Poland

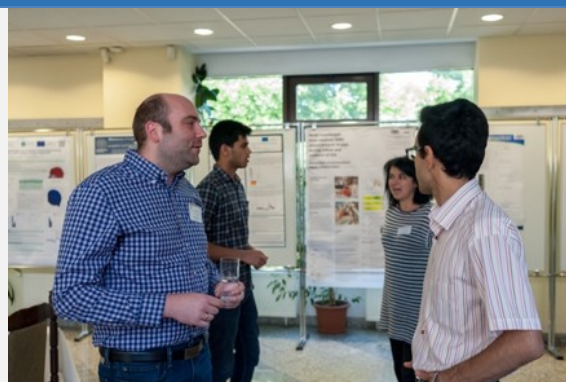
Organisers: Nalecz Institute Of Biocybernetics and Biomedical Engineering Polish Academy Of Sciences (IBIB PAN) and International Centre Of Biocybernetics

Type of event: seminar

Date: 28/05/2018

Dawid Borycki delivered the talk, "Monitoring time-of-flight-resolved temporal dynamics of optical field using interferometric near-infrared spectroscopy (iNIRS)":

Intensity fluctuations of light scattered from a turbid medium are the basis for sensing and imaging methods based on coherent light scattering. Rather than being measured directly, underlying optical field autocorrelations (OFA) are typically inferred from intensity autocorrelations (IA). DB showed that direct measurements of OFAs using interferometric near-infrared spectroscopy (iNIRS) provide multiple advantages. Besides improving the precision and accuracy of measurements, iNIRS also separates the OFA into static and dynamic components. POB uses this approach to non-invasively quantify dynamics in the nude mouse brain in vivo, avoiding contamination from non-ergodic scattering processes in the skull and superficial layers.



EGAS 50

Name: Julia Sudyka

Location: Krakow, Poland

Organisers: The European Physical Society

Type of event: conference

Date: 9-13/07/2018

The conference topics are atomic, molecular, and optical physics. During the conference, Julia Sudyka presented a poster, "Optically induced Bloch-Siegert shift in magneto-optical resonances". JS showed non-resonant frequency shift results (the Bloch-Siegert effect; BSE) of magnetic resonance signals in an all-optical magnetometric setup. Experimental results appeared consistent with the numerical model based on Liouville equations for the atomic system's density matrix. Besides the fundamental aspects, such as analysis of the rotating wave approximation limits in light-atom interactions, the contrast between classical and optical BSE, this investigation may have significant consequences for precise metrology by reducing systematic errors of optical magnetometers. This relatively simple alkali-metal vapour approach Presented material met other participants' interests. JS held several conversations about IPC current research projects and received two invitations for seminars in different departments of Jagiellonian University, the Institute of Physics.



Laser Technology Symposium 2018

Name: Jakub Bogusławski

Location: Jastarnia, Poland

Organisers: Military Technical Academy

Type of event: conference

Date: 25-28/09/2018

The conference was devoted to the latest achievements of laser physics and lasers applications to spectroscopy, medicine, military, and scientific use. Jakub Bogusławski gave a talk "Active mode-locking using graphene modulators". During the presentation, he discussed differences between passive and active mode-locking, characterises the design of graphene modulators and the principle of operation. He also described the application of the modulator to actively mode-lock a fibre laser. For his talk, JB received first prize in the competition for the best conference presentation.



The 7 International Conference on Speckle Metrology – SPECKLE2018

Name: Maciej Wojtkowski, Michał Hamkało, Mounika Rapolu

Location: Janów Podlaski, Poland

Organisers: Photonics Society of Poland/The International Society for Optics and Photonics (SPIE)/Warsaw University of Technology/Institute of Micromechanics and Photonics

Type of event: conference

Date: 9-12/09/2018

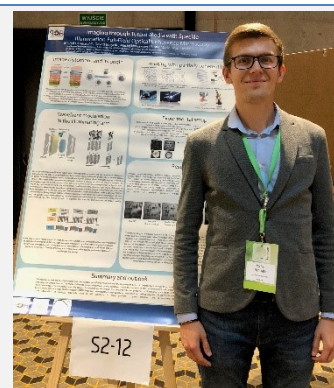
The conference goal was to exchange ideas between scientists, engineers, and students dealing with speckle metrology and related techniques. This three-day conference, filled with high-level presentations from scientists from Europe, America and Asia, was an excellent platform for interaction with various optics specialists and have discussions. This conference focused on the latest innovations and challenges of speckle metrology and related techniques, e.g., fringe pattern analysis and phase retrieval, data retrieval in speckle metrology, digital speckle pattern interferometry, digital holography, holographic interferometry, computational imaging, optical

diffraction tomography, speckle pattern photography, digital image correlation, 3D/4D imaging and measurement, biomedical applications, Micro- and Nanometrology, speckle as a tool in security techniques.

Prof. Maciej Wojtkowski gave a talk, "Spatio-Temporal Optical Coherence techniques for in vivo tissue imaging".

Mounika Rapolu, M.Sc. presented a poster "Enhanced Image processing of OCT data for Global Ischemia and Glioblastoma".

Dr. Michał Hamkało presented a poster "Imaging through turbid media with speckle illumination optical coherence tomography" (1. award for the best poster).



36th Congress of the European Society of Cataract & Refractive Surgeons (ESCRS)/EURETINA Congress

Name: Maciej Wojtkowski

Location: Vienna, Austria

Organisers: European Society of Cataract & Refractive Surgeons

Type of event: conference

Date: 22-26/09/2018

This visit had two main objectives:

- participation in the 36th Congress of the European Society of Cataract and Refractive Surgeons (ESCRS), and delivering a lecture "Two-Photon Vision, Molecular Retinal Imaging and, Speckless OCT";
- meeting the Optopol (Polish market leader in the construction of ophthalmic devices) representatives at the 18th Congress of the European Society of Retina Specialists. The European Society of Retina Specialists was established in 1999 to promote knowledge among European Vitreoretinal and Macula specialists. The annual EURETINA congress is internationally renowned as the largest retina meeting worldwide.

Single-pixel camera - Seminar

Name: Julia Sudyka

Location: Krakow, Poland

Organisers: Jagiellonian University, the Atomic Optics dept.

Type of event: seminar

Date: 8/10/2018

Dr. A. Kosior invited Julia Sudyka to give a talk on her research. During the seminar, JS presented her project of a single-pixel camera. Single-pixel imaging is a novel method for two-dimensional image acquisition with significant data compression and a singular photodetector. JS explained the classical and quantum version of the single-pixel camera. She also shed light on why this technique is worth investigating. The presentation met the interest of students and Institute staff. After the talk, the participants discussed how to employ the single-pixel imaging system concept.



Fractal Geometry and Stochastics 6 (FGS 6) 2018

Name: Mounika Rapolu

Location: Bad Herrenalb, Germany

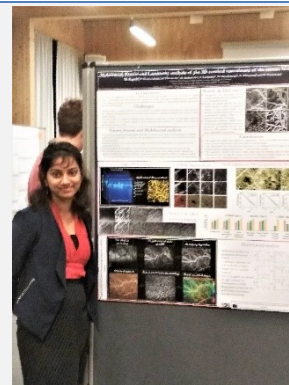
Organisers: German Research Foundation (DFG)/Karlsruhe Institute of Technology (KIT)/University of Stuttgart

Type of event: conference

Date: 29/09-07/10/2018

FGS 6 is an international conference that has grown into a leading platform connecting researchers working in fractal geometry and related fields. Mounika Rapolu presented a poster "Multifractal, Fractal and Lacunarity analysis of the three-dimensional cerebral vasculature of the mouse brain in vivo" (1. award for the best poster).

This five-day conference consisted of 12 keynotes and 15 invited talks by highly renowned experts and promising young talents. The conference set an excellent platform to interact with various experts in mathematics and fractals. MR also had several conversations with the experts in the field of fractal. The presented results resulted in very useful feedback, interesting discussions, new ideas for improvements, and application in the work's further progression. This conference mostly focused on the classical fractal geometry, stochastics, and mathematical physics on fractals and metric measure spaces, Stochastic models with fractal properties, dynamical systems, and ergodic theory and multifractals, and local dimension theory.



EOSAM 2018

Name: Maciej Wojtkowski, Michał Hamkała, Mounika Rapolu, Paulina Niedźwiedziuk, Dawid Borycki

Location: Delft, the Netherlands

Organisers: European Optical Society

Type of event: conference

Date: 8-12/10/2018

During the conference, attended by 400 people, the specialists in optics and photonics delivered over 350 talks. Simultaneously, leading experts from the optical field (e.g., Zeiss company) gave practical information on optics design or optimal data processing.

Prof. Maciej Wojtkowski was the Program Committee Member and a host of a Topical Meetings: *Bio-Medical Optics*. Biomedical optics remarkable grew over the past years. Taking advantage of a plethora of new techniques, e.g., optical coherence tomography, light-sheet microscopy, fibre sensors, and multi-photon microscopy, we can see and sense tissue in a new way. This topical meeting focused on bringing together researchers working on new fundamental image and sensing system improvements and clinicians that apply these techniques in practice.

Additionally, during the "Microscopy" session, Paulina Niedźwiedziuk presented her work entitled "*OCM based analysis of cytoplasm dynamics in cancer cells.*"

Mounika Rapolu gave a talk on "*Imaging of cortical vessels of mouse brain: Bessel vs. Gaussian beams*". She had an opportunity to interact with experts in the fields and get new ideas, improvements, and suggestions to proceed with further experiments.

Michał Hamkała gave an invited talk, "*Structural and functional cardiac Megahertz OCT imaging at up to 100 volumes/s,*" and obtained broad knowledge about recent optics novelties.

Dawid Borycki gave a talk "*Spatiotemporal optical coherence (STOC) manipulation suppresses coherent cross-talk in full-field swept-source optical coherence tomography*".



SPIE Photonics West 2019

Name: Maciej Wojtkowski, Dawid Borycki, Karol Karnowski, Egidijus Auksorius

Location: San Francisco, CA, USA

Organisers: The International Society for Optics and Photonics SPIE

Type of event: conference

Date: 2-7/02/2019

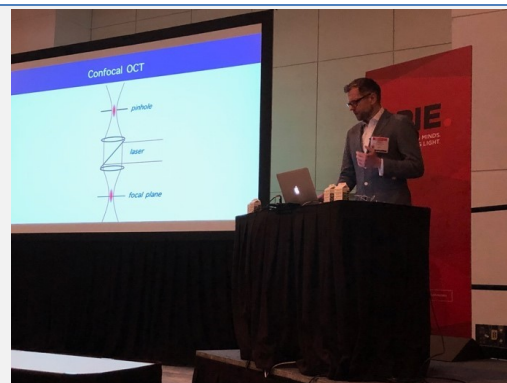
SPIE Photonics West, the leading global event for the photonics and laser industries, took place in San Francisco in early February 2019. Attendees enjoyed a week full of cutting-edge research (over 5,000 presentations) and courses, two world-class exhibitions (1,300 companies), a robust industry program, and plenty of networking opportunities. This conference gave participants a unique opportunity to learn the state-of-the-art of biomedical imaging techniques.

Prof. Wojtkowski, as a Program Committee Member of the conference, chaired the session "OCM and Full Field". He was also a co-author of two talks:

- "Spatiotemporal optical coherence (STOC) manipulation suppresses coherent cross-talk in full-field swept-source optical coherence tomography",

- "Full field optical coherence tomography with multiple pinholes".

and a co-author of the poster "Speckle free full field swept source OCT".



Dawid Borycki promoted research performed by POB in a talk, "Spatiotemporal optical coherence (STOC) manipulation suppresses coherent cross-talk in full-field swept-source optical coherence tomography".

Egidijus Auksorius gave a talk, "Full-field optical coherence tomography with multiple pinholes" in the "Optical Coherence Tomography and Coherence Domain Optical Methods in Biomedicine XXIII" session.

Karol Karnowski gave a talk, "Imaging of anterior segment pathologies: challenges and future opportunities" and co-authored other presentations, among others: "Versatile, all-fibre, side-viewing imaging probe for applications in catheter-based optical coherence tomography" or "Local optic axis mapping for airway smooth muscle assessment in catheter-based polarisation-sensitive optical coherence tomography".

OSA Biophotonics Congress 2019

Name: Maciej Wojtkowski, Egidijus Auksorius, Jakub Bogusławski, Paulina Niedzwiedziuk, Julia Sudyka

Location: Tucson, USA

Organisers: Optical Society of America OSA

Type of event: conference

Date: 10-19/04/2019

This event provided researchers with the opportunity to discuss the design, fabrication, and application of biomedical optical technologies for life sciences. Prof. Wojtkowski, as the Program Committee Member of "Bio-Optics: Design and Application (BODA)", chaired the session "DT2B • Optical Imaging Technologies II".

The team also delivered the talks:

- "Speckle-free and cross-talk-free imaging in Fourier domain fullfield optical coherence tomography" (co-authores: Patrycjusz

Stremplewski, Egidijus Auksorius - presenter, Pawel Wnuk, Lukasz Kozon, Piotr Garstecki, Maciej Wojtkowski) on a system that can significantly reduce cross-talk and speckle noise in Fourier domain full-field optical coherence tomography due to employing fast phase modulation of a laser wavefront and angular compounding.

- "Speckle decorrelation for cell's dynamics" (Paulina Niedzwiedziuk - presenter, Maciej Wojtkowski, Karol Karnowski) on measuring lung cancer cells using Optical Coherence Microscopy setup.

Apart from the above, the CREATE team also presented posters:

- "Application of single-pixel camera for imaging in turbid media" (Julia Sudyka - presenter, Michal Hamkalo, Maciej Wojtkowski) on an imaging technique based on the single-pixel camera concept.

- "Optofluidic Platform for Bacteria Screening in Nanoliter Droplets" (Jakub Boguslawski - presenter, Natalia Pacocha, Michal Horka, Maciej Wojtkowski, Piotr Garstecki) on a microfluidic platform for an optical, label-free screening of bacteria growth in nanoliter droplets.



2019 Conference on Lasers and Electro-Optics Europe, European Conference on Biomedical Optics, trade fairs Laser World of Photonics

Name: Jakub Bogusławski

Location: Munich, Germany

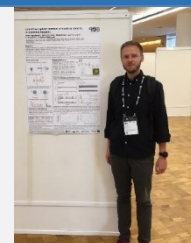
Organisers: EPS, OSA, and IEEE Photonics Society

Type of event: conference

Date: 22-27/06/2019

This conference offered many specialised lectures in the field of photonics and laser technology. Jakub Bogusławski presented the poster, "Label-free optical readout of bacteria density in nanoliter droplets".

JB also attended sessions of European Conference on Biomedical Optics, which SPIE organised at the same time, and visited trade fairs Laser World of Photonics, Munchen.



ECBO 2019 - European Conferences on Biomedical Optics

Name: Maciej Wojtkowski, Egidijus Auksorius, Dawid Borycki, Marcin Marzejon, Mounika Rapolu

Location: Munich, Germany

Organisers: SPIE The international society for optics and photonics

Type of event: conference

Date: 23-27/06/2019

The event brought scientists, engineers, and clinicians who work with optics and photonics to solve biomedicine problems. It also gave an excellent opportunity to learn new trends in Biomedical Optics, mainly referring to diffuse correlation spectroscopy, functional FF-SS-OCT, wavefront shaping, digital adaptive optics, and speckle dynamics for blood flow quantification. The participants attended lectures, poster sessions, and an exhibition dedicated to industry companies and their new products. Talks of POB members:



- "Optical coherence imaging: New methods and computational developments" by Maciej Wojtkowski,
- "Glioblastoma (GBM) tumour of mouse brain microvasculature studies using OCT and enhancement of cerebrovascular with contrast agents using 800nm and 1300nm OCT system" by Mounika Rapolu,
- "Solid state vs. picosecond lasers applied to two-photon vision tests" by Marcin Marzejon,
- "Spatiotemporal optical coherence tomography suppresses coherent cross-talk noise and low-order geometrical aberrations in full-field swept-source optical coherence tomography" by Dawid Borycki,
- "Towards improving imaging depth and speed in full-field optical coherence tomography" by Egidijus Auksorius.

Additionally, Professor M. Wojtkowski, as a member of the Executive Organizing Committee, chaired two sessions: Optical Coherence Imaging Techniques & Imaging in Scattering Media and Brain Imaging.

Be-Optical Final conference 2019

Name: Mounika Rapolu, Piotr Węgrzyn

Location: Göttingen, Germany

Organisers: Max Planck Institute for Dynamics and Self-Organisation

Type of event: conference

Date: 3-4/07/2019

Topics covered by the conference included Biophotonics, Biomedical Imaging, Cardiac Electrophysiology, and Optogenetics. This conference allowed participants to learn about the new image analysis techniques in the biomedical imaging field. Mounika Rapolu delivered a presentation "In-vivo longitudinal imaging of glioblastoma (GBM) tumour in mouse brain microvasculature using 800nm OCT system".

Piotr Węgrzyn presented the "Two implementations of Spatiotemporal Optical Coherence Manipulation (STOC)" topic. The talk allowed interacting with the audience and engaging them in the discussion on exciting ideas for the future experiments. Participants also visited a few laboratories at Max Planck Institute for Dynamics and Self-Organization and discussed their research.



The Siegman International School on Lasers

Name: Mounika Rapolu, Piotr Węgrzyn

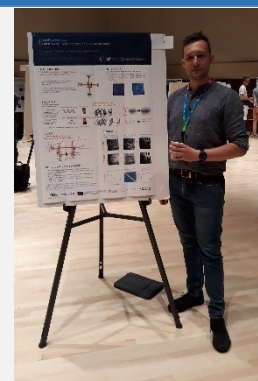
Location: New York, USA

Organisers: OSA Foundation

Type of event: school

Date: 26/07-4/08/2019

The Siegman International School on Lasers is a one-week-long program that exposes students to in-depth learning of lasers and their applications from internationally recognised academic and industry leaders in the field. The programme envisaged the talks of pioneering laser researchers and experts from leading laser companies, highly-regarded professors, and fellow students. Mounika Rapolu presented her research in the form of a poster, "Contrast enhancement in optical coherence angiography for brain imaging". Piotr Węgrzyn presented a poster, "Spatial Coherence. To destroy or not to destroy – that is the question".



MR and PW also had the opportunity to meet Ian Walmsley (Imperial College London, UK), the pioneer in measuring the ultrafast laser pulse width using Spectral Phase Interferometry for Direct Electric-field Reconstruction (SPIDER) technique. They also attended a lecture, "Femtosecond Molecular Fieldoscopy and Its Enabling Laser Technology" of Hanieh Fattahi, Max Plank Institut fur Quantenoptik, Germany.

Microsoft Build 2019

Name: Dawid Borycki

Location: Seattle, WA, USA

Organisers: Microsoft

Type of event: conference

Date: 5-11/05/2019

Dawid Borycki attended Microsoft Build 2019 to learn new research techniques related to signal and image processing. DB was particularly interested in new approaches and tools for machine learning, artificial intelligence, and cloud computing for image classification and recognition. DB participated in various workshops. Some of them (including selected machine learning algorithms) he has already applied to his processing pipeline.



XVII Scientific and Training Conference of the Polish Society of Pediatric Nephrology

Name: Maciej Wojtkowski

Location: Krakow, Poland

Organisers: Polish Society for Child Nephrology

Type of event: conference

Date: 26-27/05/2019

Prof. Wojtkowski opened the XVII Conference of Polish Society of Paediatric Nephrology presenting a plenary lecture, "Non-invasive vital imaging in biology and medicine". The aim of the conference was to present the latest reports in the field of children's nephrology and related fields. Leading topics were hypertension, urination disorders, and urinary tract infections. An important aspect of the conference was also creating opportunities for young nephrologists to establish scientific contacts with specialists from other centres. During this annual

scientific and training meeting, specialists from Poland treating children with kidney disease and hypertension presented scientific achievements and exchanged clinical experiences. The conference was also a great occasion to listen to foreign guests' lectures from Lithuania and the USA. The event also envisaged workshops on hypertension, urinary incontinence, and the use of Doppler tests in paediatric nephrology.

77th Annual PIASA Meeting

Name: Maciej Wojtkowski

Location: Gdansk, Poland

Organisers: Polish Institute of Arts & Sciences of America

Type of event: conference

Date: 14-16/06/2019

259 lecturers from the U.S., Poland, Canada, Great Britain, Germany, Belgium, the Netherlands, and France participated in the Seventh World Congress on Polish Studies organised jointly by the Polish Institute of Arts and Sciences of America (PIASA) and the Institute of History of the University of Gdansk. Maciej Wojtkowski presented a plenary lecture titled "2 Photons in Human Eye".

The conference was one of a series of events supported by the U.S. Embassy to highlight US-Polish relations and celebrate the re-establishment of a democratic Poland 30 years ago. During the event and under the Seventh World Congress on Polish Studies 2019, one of the significant collaborators of Maciej Wojtkowski – prof. Krzysztof Palczewski - was awarded the Casimir Funk Natural Sciences Award.

OPTO2019

Name: Piotr Węgrzyn

Location: Torun, Poland

Organisers: SPIE Chapter Torun

Type of event: conference

Date: 23-25/07/2019

Piotr Węgrzyn attended the annual polish OSA-SPIE-EPS student chapters meeting - OPTO2019:Toruń hosted by the Faculty of Physics, Astronomy Informatics at Nicolaus Copernicus University in Toruń. OPTO 2019 is an international conference organised by students for students. The topics of the meeting include optics, photonics, and related fields. At the conference, Piotr delivered an oral presentation - "Spatial Coherence. To destroy or not to destroy that is the questions". He also chaired the "Spin-wave" conference session.



Photonics for Health 2019

Name: Egidijus Aukorius

Location: Vilnius, Lithuania

Organizers: MITA, LIC, LITEK, FTMC

Type of event: conference

Date: 23-24/05/2019

Egidijus Aukorius participated in 'Photonics for Health' two-day meeting in Vilnius. This meeting aimed to learn needs of the photonics industry and medical sector and check research cooperation opportunities. Egidijus Aukorius have also participated in the round table discussion and visited some laboratories.

"Ethics in research" training

Name: Marcin Marzejon

Location: Warsaw, Poland

Organisers: IPC

Type of event: training

Date: 11/07/2019

Marcin Marzejon was delegated to work at Research Foundation Baltic Institute of Technology in Gdynia and the Gdańsk University of Technology using system for psychophysiological and electrophysiological studies of two-photon vision (at that time not available in Warsaw). However, he found a training on ethics organized at IPC was very useful for his research so he decided to take part in it.

The training focused legal and ethical aspects of research at its different stages – from planning till execution stage. The lecturer explained the process of obtaining the consent of the bioethical commission, ethical issues arising from conducting research on animals, humans, tissues and processing, storage, and protecting personal and sensitive data.

OSA Frontiers in Optics

Name: Piotr Węgrzyn

Location: Washington, DC, USA

Organisers: OSA The Optical Society, APS physics

Type of event: conference

Date: 14-20/09/2019

Piotr Węgrzyn attended the conference OSA Frontiers in Optics + Laser Science which is an annual meeting of The Optical Society (OSA). Each year, this conference highlights the latest advances in optics and photonics, ranging from physics and chemistry to biology and medicine. During the conference, Piotr delivered an oral presentation, "Shedding Light Onto Two Spatiotemporal Optical Coherence Manipulation (STOC) Implementations". Apart from that, the conference plan comprised numerous meetings on a variety of ongoing and future problems. PW also attended a working meeting of the Organising Committee of OSA Siegman International Summer School on Lasers.



Imaging in Wave Physics: Multi-Wave and Large Sensor Networks 2019

Name: Piotr Węgrzyn

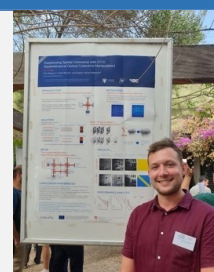
Location: Cargèse, France

Organizers: Institut d'Études Scientifiques de Cargèse and Institute Langevin

Type of event: summer school

Date: 21-29/09/2019

Piotr Węgrzyn participated in Summer School "Imaging in wave physics: multi-wave and large sensor networks organised by Institut d'Études Scientifiques de Cargèse and Institute Langevin. Participation in the school allowed him to expand his knowledge about modern imaging techniques and signal processing algorithm. On its course, PW also presented the poster "Suppressing Spatial Coherence with Spatiotemporal Optical Coherence Manipulation (STOC)" covering an advanced research project implemented by POB.



45. Congress of Polish Physicists

Name: Maciej Wojtkowski

Location: Cracow, Poland

Organisers: Polish Physical Society

Type of event: conference

Date: 13-18/09/2019

The main goal of Prof. Maciej Wojtkowski's visit was to present the lecture: "Two photons in the eye" within the "Atomic, molecular and optical physics, photonics, quantum information" session.

The congress in Krakow allowed meeting scientists from physics and related fields, physics teachers, representatives of industry and institutions financing research and their implementation, students, and amateurs - physics enthusiasts. Conference sessions covered a wide range of research topics in many branches of physics and interdisciplinary and general physics issues. Separate sessions were devoted to teaching physics at various levels of education. The congress offered ca. 30 plenary lectures, over 200 lectures, and a poster session. The speakers were outstanding Polish scientists and foreign guests, including two Nobel Prize Laureates.

In the lecture "Two photons in the eye", Prof. Wojtkowski presented POB current work on two-photon vision.

The Annual Conference of the IEEE Photonics Society

Name: Dawid Borycki

Location: San Antonio, TX, USA

Organisers: IEEE Photonics Society

Type of event: conference

Date: 28/09-4/10/2019

IEEE is the world's largest technical professional organisation for the advancement of technology. The purpose of this business trip was to chair a session on computational imaging (TuA2) and present a talk, "Spatiotemporal optical coherence (STOC) manipulation improved imaging with full-field swept-source OCT". The talk aimed to promote the research performed at POB. Additionally, this conference has a unique session on computational imaging. Thus, Dawid Borycki learned about new developments in this field, especially on using deep learning to improve the spatial resolution of imaging microscopes.



ESULaB 2019

Name: Łukasz Kornaszewski

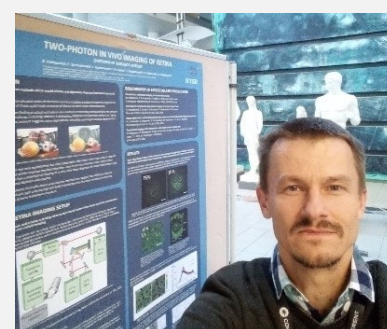
Location: Jena, Germany

Organizers: Leibniz Institute of Photonic Technology

Type of event: conference

Date: 3-6/09/2019

Łukasz Kornaszewski attended a conference organised jointly by Leibniz Institute of Photonic Technology in Jena and a laser manufacturing company, Coherent. The conference name was European Symposium on Ultrafast Laser driven Biophotonics (ESULaB). During three days, he took part in scientific talk sessions. He presented a poster, "Two-photon in vivo imaging of retina". The poster attracted some attention, and ŁK had an opportunity to discuss the group's activities with some European scientists, including specialists in human bones and brain imaging. He also visited the exhibition and brought information about potentially useful fast cameras and broadband spectrum lasers.



XI International Workshop on EPR in Biology and Medicine

Name: Maciej Wojtkowski

Location: Cracow, Poland

Organisers: Jagiellonian University in Kraków/Medical College of Wisconsin/Polish Academy of Art and Sciences

Type of event: workshop

Date: 7-8/10/2019

XIth International Workshop on Applications of EPR in Biology and Medicine was designed to stimulate interest in young and experienced researchers in EPR technology development, applications of EPR to understanding biological problems and in the application of spin and fluorescence probes, and techniques for the detection of reactive intermediates in free radical biology and medicine. Prominent researchers from around the world met to present lectures and discuss a wide range of topics.

Prof. Maciej Wojtkowski main goal of a visit was to give - at the invitation of the organisers - a lecture: "In vivo eye imaging. To see the morphology and the function" within a section: Advanced spectroscopy and microscopy methods. In the lecture, he described possibilities and perspectives of developing new diagnostic techniques and tools dedicated to the progression and treatment of degenerative diseases in the context of the enormous global impact of blindness and visual impairment, especially in the ageing population.

SPIE/COS Photonics Asia 2019

Name: Mounika Rapolu

Location: Hangzhou, China

Organisers: The International Society for Optics and Photonics

Type of event: conference

Date: 20-23/10/2019

The SPIE/COS Photonics Asia is an international conference organised by the international society for optics and photonics held at Hangzhou International Expo Center in Hangzhou, China. This conference consisted of a series of interdisciplinary talks, including *High-Power Lasers and Applications, Optoelectronic Devices, or Advanced Optical Imaging Technologies*. The main goal of Mounika Rapolu's visit was to give a lecture: "Longitudinal growth and progression studies of in-vivo mouse brain Glioblastoma (GBM) tumor microvasculature using OCT. She also learnt new imaging techniques and data processing.



MEDmeetsTECH 2019

Name: Łukasz Kornaszewski

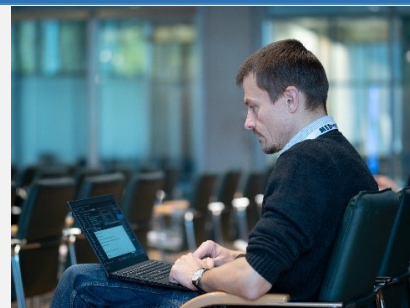
Location: Warsaw, Poland

Organizers: MEDmeetsTECH

Type of event: conference

Date: 7/11/2019

Łukasz Kornaszewski participated in a MEDmeetsTECH conference organised on the Warsaw Stock Exchange. This conference focused on the practical aspects of setting up a medical device manufacturing company. Among the speakers were CEOs, managers, and engineers responsible for product development and certification. Another group of attendees was medical doctors who described their perspectives on applying novel solutions. Łukasz Kornaszewski gained access to valuable contacts and sources of important information related to the commercialisation of medical devices.



The Perspektywy Women in Tech Summit

Name: Julia Sudyka/Alejandra Consejo/Paulina Niedźwiedziuk

Location: Warsaw, Poland

Organisers: Perspektywy Education Foundation

Type of event: conference

Date: 13-14/11/2019

Julia Sudyka, Alejandra Consejo and Paulina Niedźwiedziuk participated in Women in Tech Summit conference. This event is the most important meeting of women working in technology - female inventors, IT students, and representatives of the high-tech industry in Europe and Asia.

AC and PN attended workshops, listened to plenary speeches about self-motivation and women's role in technology. They also broadened her business network. Additionally, Paulina attended Amazon workshops and learned about four discussion styles and how to talk with people manifesting any of those styles.

JS took part in a discussion on climate change and participated in lectures on women in the scientific community. She also took part in the workshops "Programming in Python – machine learning in the analysis of brain imaging data", and "Work hard. Have fun. Create a story. How to successfully interview".

During the event, the participants interacted with many IT and STEM-related company representatives discussing future career prospects.



IONS Conference on Optics, Atoms and Laser Application

Name: Piotr Węgrzyn

Location: Dunedin, New Zealand

Organisers: University of Otago, The Optical Society

Type of event: conference

Date: 28/11-9/12/2019

During the conference Piotr Węgrzyn presented a talk based on his research conducted in Physical Optics and Biophotonic Research Group from IPC PAS - "Spatiotemporal Optical Coherence Manipulation (STOC) – a new tool for microscopy". The audience very well received the presentation, and during coffee breaks, Piotr received numerous questions regarding the potential application of the STOC technique in other areas of science. As part of the conference, he also visited local laboratories at the University of Otago.



Adaptive Optics Ophthalmoscopy and OCT & EURETINA meeting

Name: Egidijus Auksorius

Location: Paris, France

Organisers: Université Paul Sabatier Toulouse/European Society of Retina Specialists

Type of event: conference

Date: 3-8/09/2019

Egidijus Auksorius attended two different events during this trip. First, he has participated in the "Adaptive Optics Ophthalmoscopy and OCT Meeting". He has presented a poster: "Fast and crosstalk-free in vivo volumetric retinal imaging with Fourier-domain full-field OCT". It was also a training course/tutorial on eye imaging with different hospital imaging techniques (Quinze-Vingts). EA also participated at the EURETINA meeting. He listened to various talks on retina imaging. He also participated in the exhibition at the EURETINA conference, where multiple manufacturers exhibited their commercial instruments for eye imaging. EA got an opportunity to use devices of 5 different manufacturers for retina imaging.



SPIE Photonics West 2020

Name: Maciej Wojtkowski, Egidijus Auksorius, Dawid Borycki, Jakub Bogusławski, Mounika Rapolu, Piotr Węgrzyn

Location: San Francisco, USA

Organisers: The international society for optics and photonics SPIE

Type of event: conference

Date: 31/01-09/02/2020

This conference offers a unique capability to learn about new developments in biomedical imaging performed by top researchers in the world. Especially on the following topics: adaptive optics, machine learning, artificial intelligence, optical coherence tomography, and more.

The main goal of Professor Maciej Wojtkowski's visit to the SPIE Photonics West 2019 was participation as the Program Committee Member in the conference: "Optical Coherence Tomography and Coherence Domain Optical Methods in Biomedicine XXIV". He chaired the session "Brain and Neural Imaging" and co-authored six talks and three posters presented by his group.

Dawid Borycki gave two talks:

- *"Spatiotemporal optical coherence (STOC) imaging"*,
- *"Time-domain diffuse correlation spectroscopy of turbid media with mixed dynamics"*.

Jakub Bogusławski gave a talk, *"Autofluorescence-based label-free monitoring of bacteria proliferation in droplet microfluidics for antibiotic susceptibility testing"* and presented a poster *"Multi-gigahertz harmonic mode-locking in all-polarisation maintaining fiber laser enabled by Sb₂Te₃ saturable absorber"*.

Egidijus Auksorius presented an oral presentation, *"Crosstalk-free in vivo volumetric retinal imaging with Fourier-domain full-field OCT"* in "Optical Coherence Tomography and Coherence Domain Optical Methods in Biomedicine XXIV" session.

Piotr Węgrzyn presented a poster, *"Spatiotemporal optical coherence (STOC) manipulation achieves better performance than angular compounding in full-field swept-source optical coherence tomography"*.

Mounika Rapolu presented a talk on the *"Effect of contrast agents and enhancement of cerebrovascular on mouse brain microvasculature studies using 800nm Gaussian and Polarisation sensitive (PS) OCT system"*.

All talks aimed to promote research of POB members.

b) Lab visits of Professor Wojtkowski's group members

Biomedical Photonics Imaging Lab, Korea Advanced Institute of Science and Technology

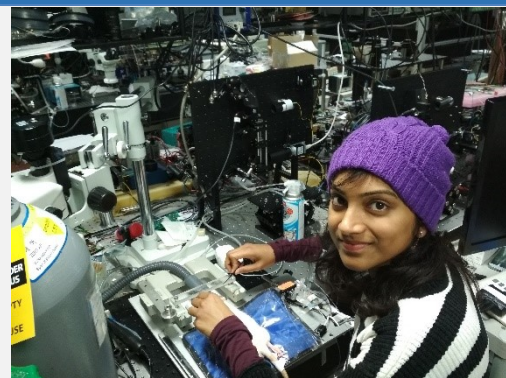
Name: Mounika Rapolu

Location: Daejeon, South Korea

Type of event: lab visit

Date: 22/12/2018-22/01/2019

Mounika Rapolu participated in the lab visit to the BIOMEDICAL PHOTONIC IMAGING LAB headed by Professor Wang-Yuhl (William) Oh at Korea Advanced Institute of Science and Technology. The Institute develops techniques for in-vivo mouse brain surgery protocol to achieve high-quality cranial window and imaging with contrast agent intralipid with 1300 nm optical coherence microscopy (OCM). Mounika Rapolu learnt how to perform incision and surgery on the rat brain. She also explored how to stabilise the mouse in vivo, which requires anaesthesia and a home mouse brain holder to reduce the motion artefacts.



Center of Translational Vision Research, University of California Irvine

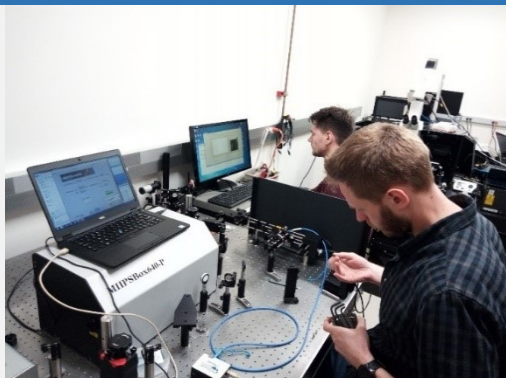
Name: Jakub Bogusławski, Piotr Ciąćka, Łukasz Kornaszewski

Location: Irvine, CA, USA

Type of event: lab visit

Date: 9/02-3/03/2019

J. Bogusławski, P. Ciąćka and Ł. Kornaszewski spent three weeks at the University of California Irvine on a research visit to Palczewski Lab (part of the Center of Translational Vision Research). The visit aimed to build a custom two-photon-excited-fluorescence scanning light ophthalmoscope (SLO) for murine eyes. Before Palczewski Lab moved to UC Irvine, a prototype of such a device had been built by the Wojtkowski team at Case Western Reserve University in Cleveland based on a 1-um femtosecond laser. This time J. Bogusławski, P. Ciąćka and Ł. Kornaszewski successfully delivered a working device in close-to-final configuration employing a 740 nm laser source.



Another goal of their stay were rigorous measurements of group-velocity dispersion in the setup. A crucial issue for two-photon fluorescence excitation, delivering the shortest possible pulses to the sample, requires the dispersion of various optical components in the setup. The collected data, used to validate computations, will further serve as a guide in constructing a dedicated, cost-effective pulse compression solution.

The researcher also planned to test the correct operation of the setup and characterised its performance. Researchers checked the setup in terms of non-linear fluorescence response vs. average power, obtaining quadratic scaling expected for a two-photon process. Various fluorescent samples, including murine retina preparations, were imaged with their setup. An important point was benchmarking the device against another two-photon SLO available in the lab. Based on the commercial Leica microscope, that setup has by its nature several drawbacks that their dedicated system aims to overcome. On the other hand, for the dedicated set up to be a worthwhile replacement for Leica, its performance has to match or exceed the latter in terms of sensitivity, signal to noise ratio, and image quality. Benchmarking the limits of sensitivity in both setups performed during the visit using standardised samples, matched imaging systems, and similar excitation laser sources should inform our setup's future choice of an optimal detection scheme.

Center of Translational Vision Research, University of California Irvine

Name: Jakub Bogusławski, Piotr Ciąćka

Location: Irvine, CA, USA

Type of event: lab visit

Date: 23/08-12/09/2019

P. Ciąćka and J. Bogusławski visited the University of California Irvine. They spent two and a half weeks at Palczewski Lab (part of the translational Vision Research Center). During that time, researchers aimed to implement a photon-counting-based detection scheme into their custom-built two-photon-excited-fluorescence scanning light ophthalmoscope (SLO) for murine eyes, obtain images of mouse retina and test the feasibility of replacing the MIIPS dispersion control device with a dedicated pulse compressor.



On their previous visit, they determined a detection scheme based on photon counting is optimal and necessary for improving the signal-to-noise ratio to aid imaging using minimal light doses. Before the visit, they implemented a custom photon counting. Employing National Instruments card-based counters for easy interfacing with custom Lab-View software, the scheme was carefully tested, characterised, and benchmarked against the alternatives. Upon installing the detector and Software at UCI, all the components interfaced without any problems. Crucially, the improvement in sensitivity of the device was readily evident.

Piotr and Jakub proceeded to obtain images of murine retinas in vivo. After a couple of unsuccessful trials where no retina features could be discerned, they discovered that an additional high optical power element inserted before the relay telescope is needed to aid the focusing of light on the retina. Despite some aberrations limiting the resolution, they obtained the first two-photon excited fluorescence retinal images from their setup.

Additionally, a MIIPS device, present in their setup for group-velocity dispersion compensation, was replaced with a pulse compressor prototype. Tests benchmarking the laser pulse width at the sample were performed for both devices, with satisfactory results. The murine retina in vivo images was also collected with the compressor present in the system.

Center of Translational Vision Research, University of California Irvine

Name: Jadwiga Milkiewicz

Location: Irvine, CA, USA

Type of event: lab visit

Date: 28/01-5/04/2020

This main goal of the visit of Jadwiga Milkiewicz was to build a high-resolution two-photon excited fluorescence microscope for retinal imaging in-vivo.

Imaging autofluorescence from the eye fundus is used by ophthalmologists to diagnose the retinal pigment epithelium (RPE). This technique can be used without using an additional contrast agent because the retina's naturally occurring pigments can emit fluorescence after absorption of the light. The energy of the light needed for this process corresponds to the range of UV and short wavelengths of the visible light. In practice, such devices use bright blue light, which can excite some of these pigments.

The approach of prof. Wojtkowski's team is slightly different than usually used. Red light (or even infrared) is used to stimulate the fluorescence of retinal pigments. This is possible if the molecule simultaneously absorbs two consecutive photons; therefore, we need to use short-pulse lasers as a light source. In this phenomenon, fluorescence occurs at a shorter wavelength than the wavelength of the exciting light itself. Using far-red light has its advantages, as it is not very disturbing (or even unpleasant) for the patient, as the intense blue light, and it is less scattered by the front of the eye.

The laboratory that Jadwiga Milkiewicz visited has a commercial version of such a two-photon excited fluorescence microscope for detailed ophthalmic research of small mammals. This microscope is huge and expensive. Our goal was to build one with similar performance but much smaller and cheaper, which could be later adapted to humans and easily used by medical doctors. The main construction of the small microscope has already been built during this lab visit.

School of Medicine in the Department of Ophthalmology and Department of Anatomy and Neurobiology, University of California Irvine

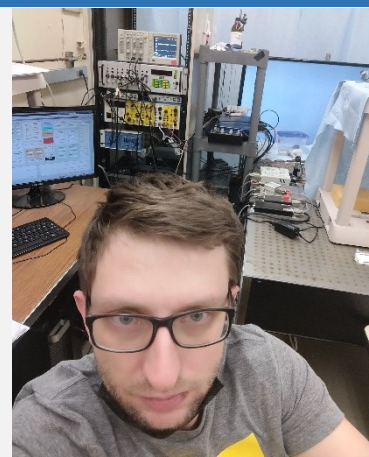
Name: Andrzej Foik

Location: Irvine, CA, USA

Type of event: lab visit

Date: 01/02-31/03/2020

Andrzej Foik visited the University of California Irvine (UCI, US). The visit was a continuation of the collaboration with prof. Krzysztof Palczewski, prof. David Lyon and dr. Dorota Skowonska-Krawczyk to develop therapies for retinal diseases. Dr. Foik performed several projects related to vision restoration and investigating changes in the brain due to vision loss. In one of the projects, Andrzej studied detailed visual responses after gene therapy using viral vectors and cutting-edge adenine base editing technique performed in prof. Palczewski laboratory. Another project was related to the changes happening in the entire visual system in the animal model of acute glaucoma. In this model increased ocular pressure causes the death of retinal ganglion cells. The research time wanted to find out the global impact on visual information processing caused by such changes in the retina and optic nerve and whether those visual functions can be restored using a particular treatment. In each of these projects, he used electrophysiological techniques to characterise single neurons' visual properties in the visual cortex and superior colliculus. Two main structures in the visual system in rodents. Between experiments, Andrzej analysed collected data and worked on manuscripts for publication. The research will be continued.



3. "Lab visits under CREATE project" (competition laureates)

Below we specify lab visits of the laureates of the competition "Lab visits under CREATE project". Each applicant prepared a short proposal of a visit to any external lab, showing intercorrelations between their research activities and the research profile of the ERA Chair.

OPEN COMPETITION-Lab visit under the CREATE project



Do you want to explore the world of OPTICS ?

Here is your chance!

*The competition "Lab visits under the **CREATE** project"- OPENS 12th September, 2018*

LAB VISIT DURATION: 2 weeks - 3 months

FUNDING: up to **EUR 3,500.00** /month

HOW TO APPLY: applications should be sent directly to mwojtkowski@ichf.edu.pl

CAUTION: Limited number of awards is available. "First come - first served" rule applies.

For more information see:

[Announcement](#)

[Rules](#)

[Poster](#)

Information at the CREATE webpage promoting the competition (for more information see: [here](#))

Prof. Wojtkowski assessed the proposals against eligibility criteria and selected laureates. The winners obtained funds to cover the costs of their visits to the prominent laboratories (financial conditions in line with generally applicable in Poland legal provisions on settling business trips in public institutions).

Princeton University

Name: Łukasz Richter

Location: NJ, USA

Type of event: lab visit

Date: 26/11-9/12/2018

The main goal of Łukasz Richter trip was a lab visit in a group of Prof. Howard A. Stone at Princeton University (NJ, USA). In collaboration with Paweł Żuk from Prof. Stone lab, he started theoretical analysis of results obtained on the surface forces apparatus (SFA) during his previous visit to Centre de Recherche Paul Pascal in Bordeaux. Subsequently, they created a simplified model of the flat capacitor with two dielectric coatings covering both electrodes. By solving the Nernst-Planck equations coupled with the Poisson equation, researchers proved that upon applying the alternating electric field, there is an excess of both anions and cations in the vicinity of electrodes. This difference in ion concentrations inside and outside the centre of the system creates osmotic pressure, explaining forces measured in the SFA.

During his stay at Princeton University, Łukasz also gave a talk at the group meeting and learned current research of this group. This trip resulted in interesting scientific results and potential future cooperation with a world-class scientific facility.



New York University, Prof. Rothenberg's lab

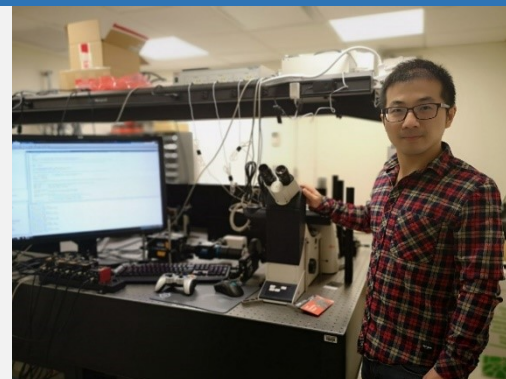
Name: Xuzhu Zhang

Location: New York, USA

Type of event: lab visit

Date: 25/11/2018-9/03/2019

Single-Molecule Localization Microscopy (SMLM) has emerged as a leading superresolution imaging approach for nanoscale visualisation of molecular structures in cells. During the visit to Prof. Rothenberg's lab at New York University, Xuzhu Zhang learned to perform SMLM experiments regarding DNA damage response (DDR) of U2OS cells treatment of chemical drug Hydroxyurea (HU). In comparison with conventional fluorescence microscopy, SMLM provides much more details on spatial structures of DNA, proteins, as well as their colocalisation within a single nucleus. By analysing the images using the auto-pair correlation method for SMLM, researchers quantitatively determined the molecular density of nascent DNA (labeled by EdU) and immunofluorescence-labeled proteins such as RNase, TOP1, and PCNA in each nucleus. They found that EdU and RNase density decreased gradually (Fig. 1(E, F)) as the increase of HU concentrations (from 0 to 0.5 μ M) demonstrating the reduction of nascent DNA and RNase concentrations due to the stalled DNA replication resulted from HU treatment. These preliminary results provide the experimental basis for the future study of DNA repair in cancer therapy at the single-molecule level.



Max Planck Institute for Biochemistry, the group of Prof. Petra Schwille

Name: Łukasz Piątkowski

Location: Planegg, Germany

Type of event: lab visit

Date: 1-15/04/2019

During the two-week stay, Łukasz Piątkowski worked together with Dr. Henri Franquelim, a senior postdoctoral fellow studying the mechanical properties of lipid bilayers. The purpose of the visit was to learn how to prepare various kinds of lipid bilayers and experimental techniques used to study their properties. Firstly, he explored multiple protocols to prepare solid-supported lipid bilayers of different compositions (including fluorescent labels). They prepared samples in various conditions to obtain different structural properties, i.e. different sizes and distribution of ordered and disordered domains. Next, Łukasz visualised these membranes using fluorescence microscopy in combination with atomic force microscopy. A coupled experimental setup allowed him to obtain fluorescence and topography images simultaneously from the same area of the sample. These samples dynamic properties were then explored using fluorescence recovery after the photobleaching approach and fluorescence correlation spectroscopy. These experiments allowed Łukasz to get familiar with several new techniques to deal with biomimetic cell membranes. The researchers decided to continue collaboration.



Institute of Photonic Sciences - group of Prof. Valerio Pruneri / Ludwig Maximilians-Universität - group of Prof. Tinnefeld

Name: Izabela Kamińska

Location: Barcelona, Spain/München, Germany

Type of event: lab visit

Date: 4-19/04, 30/04-26/05, 19/07-11/08/2019

The main goal of the next two visits in the group of Prof. Tinnefeld was a development of an optical sensor for single viral DNA detection. Izabela has investigated several DNA origami structures and their potential application

to construct biosensors. In the end, she decided to design a new shape of DNA origami, with dimensions and the location of the sensor active part concerning graphene, which ensure the highest sensitivity of the device. A new DNA origami structure's initial measurements proved that the designed dynamic part works appropriately and is ready for further investigation as a viral DNA biosensor. She carried out the measurements with pillar-shaped DNA origami with two dye molecules immobilised on graphene in parallel. She demonstrated that by measuring fluorescence intensity and lifetime in graphene presence, the accuracy of the axial localisation of single nanometers can be ensured. It shows that graphene might become the substrate of choice for superresolution microscopy involving fluorescence lifetime measurement for determining the z-position of dyes. The new structures and obtained results show that we are on the right way towards developing sensitive and reliable sensors and biological assays based on graphene by using DNA nanotechnology.



Mineral Physics Institute (MPI) at Stony Brook University

Name: Haijing Meng

Location: New York, USA

Type of event: lab visit

Date: 23/07-26/08/2019

The Mineral Physics Institute was founded in 1989 and has since served as the launching pad for the Center for High-Pressure Research (CHiPR), a National Science Foundation Science and Technology Center. They have world-famous high-pressure laboratories.

During the visit, Haijing Meng got the opportunity to access the synchrotron X-ray diffraction, which is a superpower tool in structure determination, allowing for tiny samples to be studied due to high flux. The MPI has developed its specific X-ray beamline in Brookhaven National Laboratories to precisely match high-pressure cells. The visit allowed Haijing Meng to find out how to measure the sound velocity of mantle minerals in multi-anvil apparatuses at high pressure and high temperature and further investigate the Earth's interior.



California Institute of Technology, NASA, astrochemical laboratory of Prof. Murthy Gudipati at the Jet Propulsion Lab.

Name: Joanna Zapala

Location: Pasadena, USA

Type of event: lab visit

Date: 01/07-22/10/2019

In our solar system, sulfur is volcanically produced on Io, and sulfur ions are accelerated and bombarded in Europe (Jupiter's moon). The reaction with the ice-water surface generates more complex chemical compounds. Understanding radiation-induced sulfur chemical processes are therefore crucial for NASA's mission to Europe.

Joanna Zapala studied the reactions occurring in H₂S suspended in water matrices after its excitation with an electron beam or hydrogen lamp (simulating solar wind or cosmic rays). The tests were carried out at temperatures of 4 and 100 K to simulate processes occurring in interstellar space and in the ices of Europe. To collect data on products, Joanna used a whole range of techniques and instruments available



in the laboratory. She adapted to the needs of experiments, ranging from infrared, UV, and mass spectrometry to laser ablation.

Max-Planck Institute of Polymer Research, Department of soft-condensed matter

Name: Airit Agasty

Location: Mainz, Germany

Type of event: lab visit

Date: 01-26/09/2019

Within the scope of Airit Agasty's research, it is essential to study the elastic effects in a macroscopic gel and the viscous flow cross-over at the nano-scale and work on the viscosity of polymer solutions. The SPM lab is well-equipped with techniques and the group of Dr. Kaloian Koynov has a great expertise. Over the period of three weeks, Airit learnt dual-focus FCS techniques, AFM, and confocal microscopic techniques different from those available at our institute (for example, Zeiss setups as opposed to PicoQuant setups available at IPC). Airit also learnt operating highly specialised. Finally, Airit met renowned polymer physicists with whom he could have discussed his work and obtain some helpful suggestions.



Quantum and Molecular Photonics Laboratory (LPQM), Clément Lafargue's Lafargue's group

Name: Yu-Kai Lai

Location: Paris, France

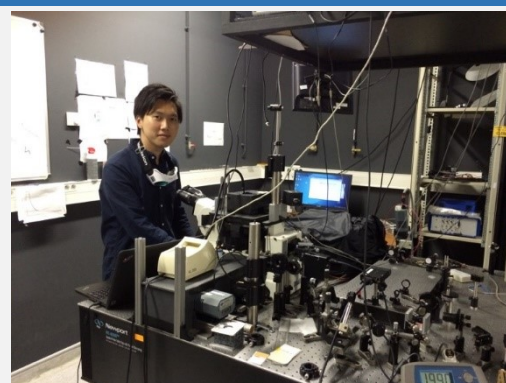
Type of event: lab visit

Date: 08/06-21/07/2019

The work of Yu-Kai Lai, Ph.D. student, oscillates around the optical system and plays an essential role in modern research fields such as biology and chemistry physics. The optical system provides fast, non-invasive, and reliable analysis, which is beneficial for most experimental setups.

Few directions in LPQM are Ultrafast Plasmonics in Metallic Nanoparticles, Photo-induced Heat Transfers on Small Time and Space Scales, Heat Nanosources for Chemistry, Biology, and Light-heat Nanoconversion: Photonic Applications. First, Yu-Kai Lai, with scientists from LPQM, decided to practice optical traps for micro/nanoparticles for two reasons: firstly, the setup is partly ready, and it is easy to add new optical elements for further analysis. Secondly, because the optical trap has an extraordinary ability for operating micro/nanoparticles, which is commonly used in the microfluidic system, it is worth learning for further possible integration.

During the stay, Yu-Kai Lai managed to trap optically gold nanoparticles and living algae cells. For gold nanoparticles, he observed and recorded second harmonic generation. Furthermore, he made some modifications on the light path and added up spatial light modulator and quarter-wave plate in advance to the detector for capturing signal for the orientation of the nanoparticles.



University of California Irvine, to Palczewski Lab (Center of Translational Vision Research)

Name: Adam Kubas

Location: Irvine, CA, USA

Type of event: lab visit

Date: 4-17/08/2019

The visited group actively works on the E/Z-isomerization of retinoid derivatives. Adam provides quantum chemical support for their studies, and his calculations allow for an in-depth understanding of various mechanical aspects of studied transformations. The aim of Adam's visit was to learn experimental techniques used in the

Palczewski Lab to investigate (photo)catalytical E/Z-isomerization of retinoid derivatives. The knowledge of experimental details is key to design and interpret quantum chemical simulations of studied processes. Mainly, during his stay, Adam worked with Shirin Kahremany, a senior postdoctoral fellow. Shirin presented experimental setups used for gram-scale transition metal-catalysed isomerisation. Adam explored a photochemical approach for the catalytic Z-isomerization of retinoids, using monochromatic wavelength UV irradiation treatment. Adam's mechanistic insights stimulated further discussion about the possible use of some types of metal photocatalysts to increase the reaction yield and selectivity. Additionally, in close collaboration with Prof. Philip Kiser, Adam built a multi-level quantum model of the active site of the retinoid isomerase RPE65.



The visit was highly successful and paved the way for a long-term collaboration that will eventually explain some details of the vertebrate vision process in detail at the most basic molecular level. A. Kubas and Prof. Palczewski also discussed a joint grant application to cover further costs related to this challenging project.

Tallinn University of Technology, laboratory of Professor Scheler

Name: Adam Opalski

Location: Tallinn, Estonia

Type of event: lab visit

Date: 1-31/08/2019

Adam tackles the problem of bacteria becoming resistant to drugs and how to combat that adversity. His visit aimed to learn the fundamentals of barcoding aqueous droplets suspended in fluorinated oil. Adam found out the principles of choosing the fluorescent markers or requirements for the droplets used in the assay. He also learnt how to execute the experimental protocol. Adam managed to achieve all the goals set before arrival. He learnt how to use colour-code droplets to produce barcoded droplet populations.



University of Geneva, the Physical Chemistry Department

Name: Idaresit Mbakara

Location: Geneva, Switzerland

Type of event: lab visit

Date: 1/09-02/12/2019

During the visit, Idaresit Mbakara aimed to deepen knowledge on ultrafast spectroscopic processes to investigate excited states' dynamics in ultra-short time scales. Prof. Eric Vauthey engages ultrafast spectroscopic techniques (transient absorption, fluorescence upconversion, photon echo, and transient second-harmonic generation, among others) with a time resolution from a few femtoseconds to several nanoseconds in investigating the mechanism of vibrational relaxation in the excited states, dynamics of ion pairs and photo-induced electron transfer processes. During her visit to this laboratory, Idaresit performed femtosecond transient absorption measurements to investigate some porphycenes' excited state dynamics derivatives. This, in general, involves the mechanism of radiative and non-radiative relaxation in electronically excited states of these molecules. By extension, she was able to determine the photophysical properties of these sets of porphycenes. The research of Idaresit revolves around



understanding the mechanism of relaxation in the electronically excited states of these porphycenes, determining the mechanism of tautomerism, and characterising the photostability of these porphycenes.

Leibniz Institute for Tropospheric Research (TROPOS)

Name: Kumar Sarang

Location: Leipzig, Germany

Type of event: lab visit

Date: 24/09-23/12/2019

During his previous visits at TROPOS, Kumar focused on the kinetics of the aqueous-phase reaction between GLVs and atmospherically relevant radicals. In contrast, this time, his main objective was to learn and investigate the oxidation products from the aqueous-phase reactions. Kumar worked in Laser Lab where he studied the photo-oxidation products and completed the screening using GC-MS. The visits to TROPOS allowed him to understand the use of photolysis techniques in atmospheric chemistry, emphasising kinetics and product studies of the atmospheric aqueous-phase reactions. The visit also tightened the cooperation between Polish and German partners in applications of home-built optical facilities of TROPOS in the field of atmospheric chemistry, including mechanistic descriptions of the origin of tropospheric smog phenomena.



Institute for Laser Technology in Medicine and Measurement Technique

Name: Yu-Ting Kao

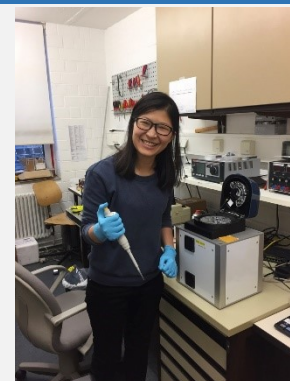
Location: Ulm, Germany

Type of event: lab visit

Date: 01/09-30/11/2019

Yu-Ting Kao aimed to find out the limit of detection (LOD) of the Light-up Player by using the well-known fluorophores and reconditioning the software connected to the Light-up Player more user-friendly. She deployed Light-up Player system developed by the Institute for Laser Technology in Medicine and Measurement Technique (ILM) for the droplet detection of recombinase polymerase amplification (RPA) and loop-mediated isothermal amplification (LAMP) assays. Besides, Yu-Ting aims to develop a novel and fast method for cell permeabilisation in the droplet-FISH assay. For market competitiveness, the developed assays need to be sensitive, selective and provide a good ration of time-to-results. A single laser pulse efficiently permeabilising cells and transferring interesting markers to the targeted cell could help secure those market features.

Yu-Ting's second objective was to use a single laser pulse to transfer molecules/plasmids into immunocytes (e.g., THP-1 cells) for biomedical applications. This also can be applied to the microfluidic platforms for other purposes.



École Polytechnique Fédérale de Lausanne, "The Supramolecular Nano-Materials and Interfaces Laboratory" of prof. Francesco Stellacci

Name: Łukasz Richter

Location: Lausanne, Switzerland

Type of event: lab visit

Date: 11-30/08/2019

During this visit Łukasz Richter continued the project started during his previous visit to that group, i.e. the development of charged nanoparticles and compounds for bacteriophage deactivation. Such nanoparticles would be useful against common, however, dangerous phage infections in the biotechnology industry. The created solution will not only increase the safety of bio-related products but also decrease financial losses caused by such infections. Łukasz was able to perform additional experiments focused on the analysis of the influence of gold



nanoparticles covered with charged ligands on bacteriophages T4, T7, MS2, and M13. The lab visit allowed not only to strengthen the collaboration between IPC and world-class university EPFL but will also contribute to the manuscript.

Kyushu Institute of Technology

Name: Karolina Książarczyk

Location: Fukuoka, Japan

Type of event: lab visit

Date: 14/10-14/12/2019

The visit aimed to apply optical methods to characterise new organic compounds synthesised in the Department of Applied Chemistry and to create new biological materials applicable for the stabilisation of viral capsids. It is worth recalling that viral capsids and viral-like particles may have multiple applications to biomedicine, biotechnology, and nanotechnology, primarily upon the development of chemically and/or genetically engineered viruses. Potential uses include new vaccines, vectors for gene therapy and targeted drug delivery, contrast agents for molecular imaging, and building blocks for the construction of nanostructured materials and electronic nanodevices.



Due to the fact that chemical stabilisation of viruses is part of Karolina Książarczyk Ph.D. project, the visit gave her the opportunity to learn the synthesis of new specific organic compounds. Their specificity lies in the strong binding to DNA (obtained from calf thymus), which Karolina was able to check by using optical methods, among others, determination of binding affinity by UV-VIS titration. During her stay, she was able to learn many methods of synthesis of chemical compounds while maintaining the highest standards of organic synthesis.

Karolina Książarczyk also took part in *The International University Exchange Symposium on Chemistry 2019*. and presented her work "Chemical modulation of phages" during the 2nd Asian Symposium on Cutting-edge Biotechnology and Chemistry.

Ecole Polytechnique Federale de Lausanne, prof. Francesco Stellacci group

Name: Karolina Paszkowska

Location: Lausanne, Switzerland

Type of event: lab visit

Date: 26/10-21/12/2019

Karolina Paszkowska worked with bacteriophages and nanoparticles. Her main goal was to find a nanoparticle, which would deactivate bacteriophages and not kill bacteria. Karolina synthesised nanoparticle and conducted NMR and TEM analysis. She checked the effect of various charged nanoparticles on the activity of bacterial viruses. The relationship between the ratio of hydrophobic and hydrophilic ligands and the efficiency of nanoparticle activity in terms of phage inactivation was also determined. After selecting the most effective nanoparticle, she performed a dose-response analysis and determined the EC50 for each of the phages tested (T4, T7, and T1).

Karolina also analysed her samples using the cryo-TEM technique, which resolution allows phage view and precise observation of interactions between viruses and nanoparticles. Obtained results suggest that used nanoparticles form a trap for bacteriophages, in which they are later inactivated. This phenomenon is worth further studies.

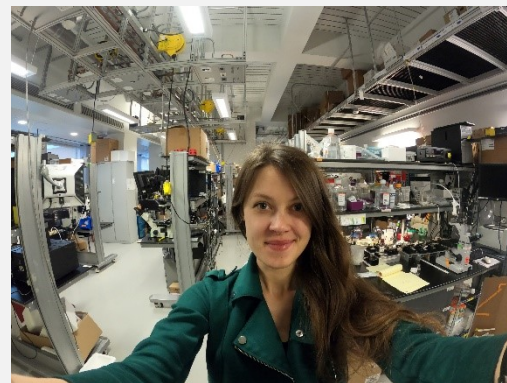


Harvard University, Professor David Weitz's group

Name: Natalia Pacocha

Location: Cambridge, USA

Natalia Pacocha aimed to learn new methods for the detection of fluorescence intensity in picoliter droplets. An initial assumption was to create an optical system to detect fluorescence intensity in the droplets containing amplified DNA of bacteria. Unfortunately, this project was suspended, and Natalia has finally worked on the directed evolution of enzymes. A library of bacteria mutants was encapsulated in the droplets together with a substrate, and enzymatic activity was observed by detection of fluorescence intensity of the created product. Thanks to that internship, she learnt new techniques for detecting fluorescence intensity in picodroplets, and she became acquainted and gained experience in confocal microscopy. Besides, Natalia had an opportunity to learn new methods in microfluidics and molecular biology and share her research results in the form of the presentation "*High-throughput and precise methods for bacteria counting and susceptibility testing*".



Ecole Polytechnique Federale de Lausanne, the group of Professor Pablo Rivera-Fuentes

Name: Krzysztof Bielec

Location: Lausanne, Switzerland

Type of event: lab visit

Date: 27/02-23/03/2020

Date: 01/10-18/12/2020

The group focuses on designing, preparing, and using chemical probes to understand physiological and pathological processes in living cells. Those interactions are observed by exploiting varieties of superresolution fluorescence-based techniques (i.e., TIRF, STORM, spinning disk confocal microscopy). The main principle of single-molecule localisation microscopy methods is to reconstruct images by plotting the centers of fluorescent point sources from a series of frames in which only a few molecules are fluorescing at a time. For this purpose, photoactivated and self-blinking dyes were used. Their main feature is the time between bright and dark states (On/Off state).

The main goal of Krzysztof Bielec's project was to combine advantages of single-molecular localisation and observation of real-time interaction of non-covalent complexes (e.g., protein-protein interactions, DNA hybridisation etc.). Krzysztof analysed previously synthesised compounds and characterised their On/Off equilibrium state in in-vitro experiments. The data collected from measurements on various synthesised compounds would determine the interaction with the finest substituents. After selecting synthesised targeted dyes, Krzysztof applied them to image microtubules in living cells with a superresolution TIRF camera.

Krzysztof also investigated various pre-synthesised compounds and applied them as fluorescent tags to various biochemical constructs. The obtained compounds were then tested in-vitro to select an appropriate algorithm for analysing such systems. In the future, these studies will provide a deeper understanding of the biochemistry of the cell.

The visit to EPFL provided an invaluable contribution to extending Krzysztof's competence and skill set. During the visit, Krzysztof Bielec attended two seminars with invited guests. He worked with superresolution techniques in both in-vitro and in-vivo experiments to characterise the physicochemical properties of isolated molecules.

