



The CREAtion of the Department of Physical Chemistry of Biological SysTEms [CREATE]

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

**Report on the visit of Dr. Egidijus Auksorius
[WP3]**

Level of dissemination: PUBLIC

Warsaw, October 2017



This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 666295



TABLE OF CONTENT

INTRODUCTION	3
COURSE OF THE VISIT	3
ANNEX 1	7
SCIENTIFIC PROFILE OF DR. EGIDIJUS AUKSORIUS	8
ANNEX 2	9
AGENDA	10

INTRODUCTION

The visit of Dr. Egidijus Aukorius at the Institute of Physical Chemistry of the Polish Academy of Sciences (IPC PAS) was held under a series of cyclical lectures on interdisciplinary emerging research.

Dr. Aukorius was invited to IPC PAS by ERA Chair holder, to:

- deliver a lecture on his studies;
- participate in meetings with synergetic teams to support mentoring activity of the ERA Chair holder.

Dr. Egidijus Aukorius currently works on 'Subsurface Fingerprint Imaging' Project at Institute Langevin in Paris, France. His research interests focus on Medical Physics, Optics and Biophysics. The scientific profile of the researcher is included in annex 1.

COURSE OF THE VISIT

The visit took place between 19-20 October 2017 [see [annex 2 for agenda](#)]. On the first day, Dr Aukorius participated in the general meeting with the Physical Optics and Biophotonics Group, run by the ERA Chair Holder. Prof. Wojtkowski briefly presented scope of the research, and all group members gave short individual presentations regarding projects they are currently involved in. In the end of the first day of the visit, a long conversation with prof. Wojtkowski took place and resulted in some new ideas concerning possible future directions of the research conducted at the Physical Optics and Biophotonics Group.

In the first part of the second day, Dr. Aukorius visited selected laboratories. The aim of these visits was to familiarize him with IPC PAS, establish contacts with synergic groups supporting the ERA Chair holder team and discuss the possibility for future cooperation:



*Department of Soft Condensed Matter
Characterization of processes in first atomic layers of a solid surface*
Dr Pisarek showed his experimental setup with vacuum STM, AFM and other microscopic techniques.



*Department of photochemistry and spectroscopy,
Laser Centre*

Laser Centre Group is focused on development and exploration of experimental techniques to study ultrafast physical and chemical processes. In Dr. Stepanenko laboratory, the petawatt laser and all the setups connected with its energy laser illumination were presented to the IPC PAS' guest.



*Department of Soft Condensed Matter,
Microfluidics and Complex Fluids Research Group*

Microfluidics and Complex Fluids Group conducts research aimed at development of new techniques dedicated to guide the evolution of bacteria.

During a short visit in prof. Garstecki's laboratory, Dr. Karol Makuch presented the basic ideas of microfluidic research.



*Photochemistry and Spectroscopy Department
Photophysics and spectroscopy of photoactive systems:
structure and reactivity of systems with hydrogen bonds*

Research in this group encompasses various aspects of physical organic chemistry. A subject of particular interest is proton/hydrogen transfer, intra-molecular as well as intermolecular, occurring in the ground and excited electronic states. Dr. Agnieszka Michota-Kamińska discussed with Dr. Aukorius the medical application of Raman spectroscopy.

After visiting synergetic groups, Dr. Aukorius delivered a seminar entitled *“Full-field optical coherence tomography: from micro to macro imaging”*. The seminar was held in the assembly hall of the IPC PAS. All researchers and PhD students employed in the IPC PAS were invited to participate in this seminar.

During this seminar Dr. Aukorius introduced several different imaging techniques, beginning with Stimulated emission depletion (STED) microscopy, the Fluorescence Lifetime Imaging (FLIM), which was joined with STED in the experimental system, and then focusing on Optical Coherence Tomography (OCT) and Structured Illumination Microscopy (SIM), with a detailed presentation of an experimental setup connecting these two techniques. Multiple results from biological samples showed during the seminar were already published in scientific journals.

The last part of the seminar was dedicated to the full-field OCT and the novel application of this technique, including the latest experimental setup, able to image an internal fingerprint of human finger. The high level of optimization of this system allowed for the final version of the setup being considered as an official fingerprint analyzer by European Union authorities.



The seminar of Dr. Egidijus Aukorius, assembly hall, 20th October, 2017.



Abstract of the seminar

Optical coherence tomography (OCT) has become an established tool in biomedical imaging. Standard OCT is a point-scanning interferometric technique capable of fast in vivo visualization of tissue architecture. Full-field optical coherence tomography (FF-OCT), on the other hand, uses a camera instead of a point detector and a conventional incoherent light source instead of a laser that enables parallelized detection, and thus, fast en face imaging. FF-OCT can be useful in a range of applications that require either high resolution or/and en face imaging. Thanks to its high isotropic resolution ($< 1 \mu\text{m}$ in 3D), it can be used in applications that normally require the preparation of histology slides, such as in studying the enteric nervous system [1]. Spatial resolution can be traded-off for a larger field-of-view ($>1 \text{cm}^2$) that is necessary, for example, in subsurface fingerprint imaging [2].

Images of subsurface fingerprints are of great interest in biometrics since they contain more details than the surface fingerprints and, most importantly, can be partly free of imaging artifacts caused by damage, moisture or dirt on the surface. We have built an FF-OCT subsurface fingerprint sensor based on a novel silicon camera that allowed acquisition of high quality subsurface fingerprints, and subsequently, identification of individuals with high accuracy from a single finger [3].

To increase the sensor's performance further in terms of the signal-to-noise ration (SNR) dark-field detection can be implemented in the FF-OCT configuration [4]. It can reject spurious signal, such as specular reflections from a sample and other optical elements, that effectively allows a more efficient use of camera's detection bandwidth. Since some of the genuine signal is also rejected in the process, a brighter light source or a configuration that utilizes the limited light budget more efficiently is thus needed. To this end, I will present a configuration that involves an asymmetric interferometer with a 10:90 beamsplitter allowing near $\times 4$ more efficient signal detection. The developed instrument could be used in a number of other en face deep-tissue imaging applications thanks to its high sensitivity and speed. Naturally, it could be used for imaging various skin conditions, such as cancer and other dermatological diseases.



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ANNEX 1.

SCIENTIFIC PROFILE OF DR. EGIDIJUS AUKSORIUS



SCIENTIFIC PROFILE OF DR. EGIDIJUS AUKSORIUS

Academic Training:

- Ph.D in Physics, Imperial College London, UK. 2004 – 2009. Thesis title: 'Multidimensional Fluorescence Imaging and Super-resolution Exploiting Ultrafast Laser and Supercontinuum Technology'

Academic Experience and Previous Positions:

- Research Fellow at Massachusetts General Hospital, USA, Gary Tearney's Lab (Apr 2010 – Apr 2014)
- PhD Student (Nov 2004 – Dec 2008) and Research Associate (Feb 2009 – Apr 2010) at Imperial College London, UK, Paul French's Lab
- Marie Curie Fellow at Ecole Polytechnique, France, E. Beaulieu's Lab (Feb 2004 – Aug 2004)

Present Position:

- Postdoc at ESPCI, Paris, France, Claude Boccara's Lab (Apr 2014 – Present)

Selected publications and presentations:

- E. Aukorius, and A. Claude Boccara, "Fast subsurface fingerprint imaging with full-field optical coherence tomography system equipped with a silicon camera," *Journal of Biomedical Optics* (2017).
- E. Aukorius and A. Claude Boccara, "Dark-field full-field optical coherence tomography," *Optics Letters* (2015).
- E. Aukorius and A. Claude Boccara, "Fingerprint imaging from the inside of a finger with full-field optical coherence tomography," *Biomedical Optics Express* (2015).
- E. Coron, E. Aukorius* et al., "Full-field optical coherence microscopy is a novel technique for imaging enteric ganglia in the gastrointestinal tract," *Neurogastroenterology & Motility*, 24, 611-621 (2012). *Co-first Author.
- E. Aukorius, et al., "Dual-modality fluorescence and full-field optical coherence microscopy for biomedical imaging applications," *Biomedical Optics Express* 3, 661-666 (2012).
- E. Aukorius, et al., "Stimulated emission depletion microscopy with a supercontinuum source and fluorescence lifetime imaging," *Optics Letters* 33, 113-115 (2008). Cited over 150 times.

- E. Aukorius, "Full field optical coherence tomography and its application," in National Lithuanian Physics Conference (Vilnius, Lithuania, 2017). Invited talk.
- E. Aukorius and C. Boccara, "Internal fingerprint imaging with full-field optical coherence tomography," in *Imaging and Applied Optics* (Heidelberg, Germany, 2016). Invited talk.
- E. Aukorius and C. Boccara, "Internal fingerprint imaging with visible light full-field optical coherence tomography," in *BIOMED* (Ford Lauderdale, USA, 2016).
- E. Aukorius, J-M. Chassot, C. Boccara, "Large field of view full field optical coherence tomography for fingerprint imaging," in *BiOS, Photonics West* (San Francisco, USA, 2015).
- E. Aukorius and G. Tearney, "New concepts in ultrahigh resolution in vivo imaging," in *Photonics North 2013* (Ottawa, Canada, 2013). Invited talk.



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ANNEX 2.

Full agenda of the visit



AGENDA

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CREATE lectures

The Institute of Physical Chemistry of the Polish Academy of Sciences

Agenda

October 19th, 2017

around 2pm	Lunch with Prof. Maciej Wojtkowski
4:00 – 5:40 pm	Lab visit and meetings with POB group members <i>Physical Optics and Biophotonics Group (POB), Department of Physical Chemistry of Biological Systems</i>
4:00 – 4:20	Dawid Borycki, PhD
4:20 – 4:40	Michał Hamkało
4:40 – 5:00	Paulina Niedźwiedziuk
5:00 – 5:20	Kinga Szost
5:20 – 5:40	Mounika Rapolu
8:00 – 11:30 pm	Dinner with POB Group members

October 20th, 2017

10:15 – 11:40 am	Lab visits
10:15-10:40	Marcin Pisarek, PhD; Marcin Hołdyński, PhD <i>Characterization of processes in first atomic layers of a solid surface, Department of Soft Condensed Matter</i>
10:40-11:00	Karol Makuch, PhD <i>Microfluidics and Complex Fluids Research Group, Department of Soft Condensed Matter</i>



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11:00-11:20	Yuriy Stepanenko, PhD <i>Laser Centre, Department of photochemistry and spectroscopy</i>
11:20-11:40	Agnieszka Michota-Kamińska, PhD <i>Photophysics and spectroscopy of photoactive systems, Department of photochemistry and spectroscopy</i>
12:00 – 1:00 pm	Seminar - Egidijus Aukorius, PhD <u>„Full-field optical coherence tomography: from micro to macro imaging”</u>
1:00 - 2.30 pm	Lunch



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