Monday, 16 September 2019

9:30-10:30	Ronald Sroka, Hospital of University of Munich, Germany
Techniques for Photodiagnosis and Photodynamic in Neurosurgery: Photoactive drugs and their use for fluorescence guided resection, optical guided biopsy and photodynamic therapy supports innovative treatment modalities in neurosurgery. Besides the medical needs, requests and boundary conditions the physics and technical research and developments will be presented aiming in clinical applications. Preliminary study results as well as the potential of optical dosimetry concepts based on light-tissue interaction and light-photosensitizer interaction are included summarizing the latest developments in this field.	
11:00-12:00	**Mangirdas Malinauskas, Vilnius University, Lithuania**
Ultrafast laser 3D mesoscale lithography for bio-applications: In this lecture the basic principles and the most recent advances of ultrafast laser 3D mesoscale lithography will be introduced. An emphasis on advanced additive manufacturing of bio-derived, bio-compatible and bio-degradable cross-linkable materials will be given. Applications of laser made 3D micro-structured scaffolds for biological studies in vitro and in vivo by seeding cells and medical implantation will be demonstrated. Finally, microfluidic devices employing passive actuation and their chemical sensing properties will be shown.	
12:00-13:00	**Andreas Möglich, Universität Bayreuth, Germany**
Phytochrome Photoreceptors in Nature and Optogenetics: Sensory photoreceptors underpin diverse adaptations of organismal behavior, lifestyle and physiology to incident light. Phytochromes, originally discovered in plants, represent one photoreceptor class that sense red and near-infrared light to modulate a cohort of physiological processes. Beyond their eminent natural role in many organisms, phytochromes can be harnessed for the spatiotemporally precise and reversible regulation by red/near-infrared light of cellular processes and phenomena in heterologous organisms, an approach known as optogenetics. Against this backdrop, we investigate signal transduction by bacterial and plant phytochromes, and engineer novel light-gated tools for deployment in optogenetics. Bacterial phytochromes are mostly associated with enzymatic output, and we have devised bimodally photo-activatable cyclases and phosphodiesterases that produce or hydrolyze, respectively, cyclic mononucleotides which serve as widespread second messengers. By contrast, plant phytochromes exhibit light-dependent protein:protein interactions with partner proteins. We have deconstructed the interactions that phytochrome B enters and thereby devised a suite of interaction modules with varying size, oligomeric state, and affinity. These novel interaction modules provide the foundation for light-regulated gene expression and membrane recruitment at enhanced efficiency. As phytochromes, be they of bacterial, be they of plant origin, can be photoreversibly actuated by long-wavelength light, they are particularly applicable to optogenetic use in vivo.	
14:00-15:00	**Giacomo Mazzamuto, LENS, Italy**
Large-scale high-resolution imaging of biological samples with advanced microscopy techniques: Advanced high-resolution microscopy techniques include Light-Sheet Fluorescence Microscopy (LSFM) and Two-Photon Fluorescence Microscopy (TPFM). Such techniques bring several advantages as they allow to investigate biological samples at great depths. Furthermore, especially with light-sheet microscopy, it is possible to image large biological samples in their entirety, for example a whole mouse brain or a whole mouse heart. On the other hand, some challenges need to be faced for their proper operation. First of all, in order to allow light to penetrate deep inside the tissues, samples have to go through a chemical clearing protocol which, by removing lipids and other scattering centers, renders them transparent to light. Secondly, imaging macroscopic samples (one cubic centimeter) at sub-micron resolution means that these microscopes generate data with rates as high as 1 GB / s and more. After acquisition, processing this massive amounts of data is not a trivial task, given that a single dataset can be as big as 10 TB of data. In this talk I will briefly introduce	

the techniques mentioned above and their related benefits and challenges. By presenting some of our latest results, I will also demonstrate what kind of quantitative data can be extracted from those datasets, often using automated techniques (e.g. based on machine learning) considering the extent of the generated data.	
15:00-16:00	**Grigorii S. Sokolovskii, Ioffe Institute, Russia**
2018: Photonics meets the Nobel Prize: In 2018, Photonics met the Nobel Prize once again. That year, the Nobel Prize in Physics was awarded "for groundbreaking inventions in the field of laser physics". It was divided in two halves, one of which was given to Arthur Ashkin "for the optical tweezers and their application to biological systems". The other half was awarded jointly to Gérard Mourou and Donna Strickland "for their method of generating high-intensity, ultra-short optical pulses". In this lecture, I'll try to explain in layman-terms how these inventions have revolutionised laser physics and lifted biophotonics and optical medicine to the new heights.	

Tuesday, 17 September 2019

9:30-10:30	Boris Chichkov, Leibniz Universität Hannover, Germany

Laser printing of cells and microorganisms for research, tissue models, and cancer therapy: In a series of publications on laser printing of living cells, different cell types, including primary cells, stem cells, iPS cells, differentiated iPS cells, and microorganisms have been printed. I will report on our recent progress and ongoing research in this field. Printing of skin, cardiac, nervous, and corneal tissues will be discussed. Related to cancer therapy, there is a growing interest in the development of new methods based on the application of specific types of microorganisms for stimulation of the immune system and selective elimination of cancer cells. It has been discovered that several bacterial strains possess inherent oncolytic potentials to invade and colonize tumors in vivo. I will review the current progress in this field and will discuss possibilities for laser printing of cancer and immune cells together with different bacteria for investigations of their interactions and oncolytic potentials. The arena of using bacteria as an anti-cancer agent is still new and laser printing can help to identify novel promising directions in this field.

11:00-12:00	Attila Sik, Institute of Transdisciplinary Discoveries, Hungary

Ways to load cells with stuff: from electroporation to magnofection: To visualize protein or gene expression in live cells engineered DNA segments or small organic compounds need to be introduced to cells. Various methods have been developed to achieve this goal including electrical current, organic, inorganic chemical products, viruses and nanoparticles to name some. The talk gives an overview of the various loading techniques focusing on mammalian cells.

12:00-13:00	Ronald Sroka, Hospital of University of Munich, Germany

2µm-laser applications in endourology: The application of high power laser pulses are in clinical use to perform laser induced stone fragmentation. After a brief historical overview, different laser sources used in clinical operation are presented. Based on clinical experiences different fragmentation mechanisms are described. Newest investigations show the impact of laser parameter on fragmentation and dusting capabilities as well as on the observed propulsion. Related laser parameters and the need for reproducible objective experiments will be discussed. Optical technologies with potential of feedback to reduced side effects will be shown.

14:00-15:00	Mercè Masana, University of Barcelona, Spain

Unravelling neuronal network alterations in Huntington's Disease: Neuronal death is a hallmark of neurodegenerative disorders. However, neuronal plasticity defects and circuits dysfunction appear much before any cellular death. Thus, understanding brain circuit alterations prior to cell death is essential to isolate and characterize disease signatures before irreversible damage occurs. Here, I will explain how we study neuronal networks in vitro and in vivo in mice models of Huntington's Disease. I will talk about calcium imaging in vitro to explore neuronal network dynamics in vitro from primary cultures. In addition, I will explain how we can study and modulate specific neuronal circuits in vivo using optogenetic approaches.

15:00-16:00	Peter Zehetmayer, ACQUIFER, Germany

Big Image Data in Microscopy - Handling, Storage and Processing: The fast evolution of microscopy techniques, the used detectors and the multiplexing of experiments led to an exponential increase of image data over the last years. Light sheet microscopy, microscopy based screening or long-term experiments with multiple fluorescent markers have the potential to create data in the 10 TB regime within a few hours. The transport and the processing of this data challenge the existing infrastructure. The concept of local private cloud computing opens a sustainable way to cope with the growing demands.

Wednesday, 18 September 2019

9:30-10:30	Oksana Semyachkina-Glushkovskaya, Saratov State University, Russia

Photobiomodulation for brain theranostics: Brain theranostics is a novel growing field, which integrates diagnosis and therapy of brain disease. Progress in the field holds great promise for treatment of brain cancer, motor or memory impairments, stroke, and other brain disorders. However, significant challenges remain, such as overcoming the blood–brain barrier, targeted delivery to specific brain regions and controlled delivery.
In this talk, we will discuss: 1) a recent discovery of application of transcranial photobiomodulation (tPBM) as a novel non-invasive technology for brain drug delivery and therapy of brain tumor; 2) the pioneering strategies of laser activation of cerebral lymphatic clearance of toxic molecules from the brain for therapy of Alzheimer disease, stroke and traumatic brain injury.

11:00-12:00	Emilio Gualda, ICFO, Spain

Imaging fast dynamics in 3D of biological samples using light sheet microscopy: Light sheet fluorescence microscopy (LSFM) is based on sending a thin sheet of excitation light into the sample. The fluorescence emitted from this thin plane, called light sheet, is collected using a microscope objective. This produces a 2D optical section of the sample and allows measuring the several dynamics occurring in that plane with relative high resolutions. However, accessing the fast dynamics in the full 3D sample, while keeping the resolution high is not straight forward. Here, several strategies are presented for measuring, in the volume of the sample, the different dynamics with high resolution.
First, I will present our efforts for combining LSFM with fluidic approaches. Then, I will present the use of electrically tunable lenses for fast imaging without having to move the sample. Finally, I will present the use of wavefront coding (WFC) techniques with LSFM microscopy for visualizing the fast volumentric dynamics.

12:00-13:00	David Childs, Glasgow University, UK.

Mid infrared spectroscopy applied to mosquito populations: Vector-borne diseases are a well-known threat to public health and mosquitoes spread malaria, with around 219,000,000 cases and 435,000 deaths globally in 2017. As part of an integrated vector control program to control existing and emerging epidemics, rapid assessment of age, species and insecticide resistance is crucial. An optical based measurement is ideal in this case as it allows for stand-off measurement of unprepared samples, and a biological fingerprint region in the mid-infrared enables tissue identification and discrimination. I shall discuss mid-infrared spectroscopy using both Fourier transform infrared (FTIR) and swept laser systems for this application.

14:00-15:00	Teemu Myllylä, University of Oulu, Finland

Optical sensing of the brain and its applications: Optics based sensing of the brain has been utilised for over a quarter of a century as a non-invasive tool for monitoring blood circulation related parameters, particularly cerebral oxygenation, which is linked to brain function. This is done using techniques based on functional near-infrared spectroscopy (fNIRS). Another interesting brain imaging technique, diffuse correlation spectroscopy (DCS), is used for measurements of blood flow. It relies on the sensitivity of the temporal autocorrelation function of diffusively scattered light to red blood cell mean square displacement. This lecture explains the basic principle of these techniques and presents their current clinical and pre-clinical applications.

15:00-16:00	Rhein Parri, Aston University, UK

Interrogating astrocyte-neuron interactions with light: When we think of "brain cells" we usually think of neurons, which take part in fast millisecond scale signalling and processing. However, there are many other types of cells in the brain which are essential for normal function. One of these, astrocytes had until a decade ago been assumed to have mainly supportive roles for neuronal function, such as maintenance of local ionic environment. A major reason for a lack of recognition for astrocyte

roles was that astrocytes are in contrast to neurons, electrically inexcitable. It is now known however, that astrocytes exhibit elevations and waves of calcium, which are the basis for their "excitability". This means that traditional electrophysiological techniques used to detect neuronal function are not applicable to determine astrocyte activity. Instead, optical probes and approaches have been developed. These include the development of calcium sensitive dyes such as Fluo4 to monitor cellular calcium activity, and optogenetic constructs that can induce the elevation of calcium in specific cells. These approaches enable us to investigate the roles of astrocytes in controlling neuronal activity and importantly in complex processes such as learning and memory.

Thursday, 19 September 2019

9:30-10:30	**Viacheslav Artyushenko, art photonics GmbH, Germany**
Fiber optic probes for biomedical diagnostics of the common diseases: We developed single and combined fiber optic probes for the following set of spectroscopy methods: Mid IR-absorption, Raman scattering, Diffuse NIR-reflection, and auto-fluorescence. We benchmarked these methods and selected the optimal one (or their combination), that differentiate between healthy and malignant tissue, based on optical spectra. We tested cancer-normal tissue pairs of human body such as colon, kidney, brain as well as cartilages with and without injuries. Equines cartilage samples with and without osteoarthritis were tested as well. To detect cartilage degradation in Mid IR range, we develop first QCL coupled with PIR-fiber arthroscopic probe.	
11:00-12:00	**Ekaterina Borisova, Bulgarian Academy of Sciences, Bulgaria**
Photodiagnosis of gastrointestinal tumours - novel approaches to solve old problems: Photodiagnostics using photosensitizers for fluorescent diagnosis is an innovative tool in the medical procedures and is found promising as appropriate tool for gastrointestinal tumours diagnostics. However, photosensitizers also accumulate in inflammatory and benign areas leading to false-positive signals. The GIT neoplasia was induced in laboratorial rats using prolonged exposure to social (overpopulation) and chemical stress (nitrosamine diet). Different aspects of applications of porphyrins and phthalocyanines, as possible photodiagnostic markers in GIT tumor diagnostics are investigated using specific drug carriers with higher selectivity to malignant cells, functionalization of photosensitizers with sugars and amino acids and improvement of delivery using vasodilatation drugs.	
12:00-13:00	**Miklos Veres, Hungarian Academy of Sciences, Hungary**
Stimulated Raman spectroscopy with spectral focusing detection: In SRS microscopy with femtosecond lasers and spectral focusing pump and Stokes beams are chirp matched so the two pulses have equal energy difference in any moment of time and excite the same vibrational transition. A spectrum can also be recorded by changing the delay between the pulses. This method is capable of high-speed spectral imaging of different samples ranging from single cells to tissues.	
14:00-15:00	**Valdas Pasiskevicius, KTH - Royal Institute of Technology, Sweden**
Nonlinear optical methods for biophotonics applications: The lecture will first aim at giving an understanding of very basic principles of the nonlinear optical response in molecules. Following this basic framework, number of examples will be given of how these optical nonlinearities can be utilized in bioimaging, molecular sensing, cell surgery and other applications. The lecture will aim at eliciting discussion on pros and cons of some of the nonlinear optical methods as well as their possible applicability limits in the context of living cells.	
15:00-16:00	**Christoph Skrobol, TOPTICA Photonics AG, Gräfelfing Germany**
How new Technological Innovations meet real Business Considerations: In this talk we will present the life cycle process of a product during its development phase. We will highlight the departments and their function, which are involved in this process and discuss the different steps undertaken in order to develop an idea until the finished laser system. In the frame of this talk we will share you a detailed insight into the structures and processes at TOPTICA Photonics AG.	

Friday, 20 September 2019

9:30-10:30	Sergei Sokolovski, Aston University, UK

Digesting Light: All living creatures on the Earth are consumers of the Sun energy directly or indirectly. We are mostly second order energy consumers when eating carbohydrates (CH) produced in photosynthesising organisms, e.g. plant, algae, etc. However, "digesting" the light energy stored in CHs and grass-eaters means we can't percept light directly acquiring its features intensities and frequencies. Why we not only seeing the object around of us but also can define the time of the day, etc. There are many ways our body can percept the light including co-called intrinsic and artificial photobiomodulations. I will mostly address my presentation to the latte.

11:00-12:00	Andrey Dunaev, Orel State University, Russia

Multiparametric Optical Diagnostics for the Assessment of Microcirculatory and Tissue Systems Functional State: The lecture considers the possibilities and prospects of approach in the multiparametric optical non-invasive diagnostic (OND) techniques for the detection and evaluation of the severity of microcirculatory and metabolic disorders in some medical applications – functional diagnostics, rheumatology, endocrinology, dermatology and minimally invasive abdominal surgery. The combined using of OND technologies with functional (provocative) tests allows increasing the repeatability of results and accuracy of diagnostics. The sensitivity and specificity of the some proposed diagnostic procedures will be shown. Further problem solving of the outlined issues will bring OND closer to standardized diagnostic technologies and to wider application in real medical practice.

12:00-12:300	Andrey Y. Abramov UCL Institute of Neurology, UK

Unraveling of mitochondrial physiology pathology using live cell imaging and flash photolysis: The most prominent and disabling features in patients with mitochondrial disease are often due to neuronal dysfunction and neurodegeneration. Mitochondrial dysfunction shown to be associated with most common age related neurodegenerative diseases, such as Alzheimer's and Parkinson's Diseases. To address the mitochondrial health and function there are several bioenergetic parameters reflecting either whole mitochondrial functionality or individual mitochondrial complexes. Particularly, metabolism of nutrients in the tricarboxylic acid cycle provides substrates used to generate electron carriers (nicotinamide adenine dinucleotide [NADH] and flavin adenine dinucleotide [$FADH_2$]) which ultimately donate electrons to the mitochondrial electron transport chain. The levels of NADH and $FADH_2$ can be estimated through imaging of NADH/NAD(P)H or FAD autofluorescence. Combination of the measurements of autofluorescence and mitochondrial membrane potential in single cells help to identify the mechanism of the mitochondrial dysfunction. One of the major mitochondrial function is buffering of Ca^{2+} in physiological calcium signaling. Mitochondrial Ca^{2+} overload is critically important as a determinant of irreversible cell injury by inducing of the permeability transition pore (mPTP) opening. This results in rapid depolarization of the mitochondrial membrane and cessation of mitochondrial oxidative phosphorylation. Prevention of mPTP opening can prevent cells from dying during ischemia and reperfusion injury.

12:30-13:00	Plamena R. Angelova, UCL Institute of Neurology, London

Delivery of singlet oxygen into neurons by 1267 nm laser stimulates mitochondrial energy metabolism: The most prominent and disabling features in patients with mitochondrial disease are often due to neuronal dysfunction and neurodegeneration. Mitochondrial dysfunction shown to be associated with most common age-related neurodegenerative diseases, such as Alzheimer's and Parkinson's Diseases. Energy generation in the form of ATP in the cells of our body meets energy demands in specific tissues. Relatively small brain (~1-2% of body weight) consumes ten times more oxygen and glucose for energy need than other tissues. Oxygen consumes predominantly in mitochondria in electron transport chain in the process which coupled with production of ATP in

oxidative phosphorylation. Singlet oxygen is the common name of an electronically excited state of molecular oxygen (lowest excited state of the dioxygen molecule) which is less stable than molecular oxygen in the electronic ground state. We have found that irradiation of primary co-culture of neurons and astrocytes with 1267 nm laser produce high level of singlet oxygen inside of cells. We also found that 1267 laser irradiation increase mitochondrial membrane potential, stimulate NADH and FADH dependent respiration and significantly increase efficiency oxidative phosphorylation. It results to increase in ATP level in mitochondria of neurons and astrocytes. It should be noted that these effects were dependent on the dose of irradiation and increase of the dose lead to the toxic effects.

14:00-15:00	**Ahne Myklatun, Nature Communications**

The Nature journals aim to publish some of the most exciting research for the community, and as one of these, *Nature Communications* is an open access journal that publishes important advances across all natural sciences. In this talk I will shed some light on the editorial process and give authors the necessary tools to prepare their work for publication in a Nature journal. I will begin with a general introduction to *Nature Communications,* focusing on its position within the Nature Publishing Group, before discussing the journal's editorial criteria including the role of the authors, reviewers and editors.

15:00-16:00	**Peter E. Andersen, DTU Health Tech, Technical University of Denmark, Denmark**

Optical Coherence Tomography for Improved Detection of Melanoma: Optical coherence tomography (OCT) provides cross-sectional tomographic, 3-D visualization of internal microstructure in biological systems[1] at resolutions of 1-5 μm, i.e., essentially an optical biopsy, providing an image similar to histology stains patterns. It provides real-time, video-rate imaging, and it is fibre-borne. Within specialties such as ophthalmology, cardiology and dermatology, OCT is a clinical standard.

Malignant melanoma is by far the most dangerous type of skin cancer. Currently, the gold standard to diagnose melanoma in the clinic is excisional biopsy followed by histopathologic analysis. Among several imaging techniques developed to enhance melanoma diagnosis, OCT with its high-resolution and intermediate penetration depth can potentially provide the required diagnostic information noninvasively. We propose a novel image analysis algorithm that drastically improves the specificity and sensitivity of OCT by identifying unique optical radiomic signatures pertinent to melanoma detection [2]. We test the OPE algorithm with sixty-nine human subjects and demonstrate that melanoma can be differentiated from benign nevi with 97% sensitivity, and 98% specificity [2].

The first part of the lecture aims at providing a basic understanding of OCT and tissue optics. The second part links tissue optics to melanoma diagnosis proposing a novel, non-invasive modality [2].

References:

1. W. Drexler, M. Liu, A. Kumar, T. Kamali, A. Unterhuber, and R. A. Leitgeb, "Optical coherence tomography today: speed, contrast, and multimodality," J Biomed Opt. **19**(7):071412 (2014). doi: 10.1117/1.JBO.19.7.071412.
2. Z. Turani, E. Fatemizadeh, T. Blumetti, S. Daveluy, A. F. Moraes, W. Chen, D. Mehregan, P. E. Andersen, and M. Nasiriavanaki, "Optical Radiomic Signatures Derived from OCT Images to Improve Identification of Melanoma," Cancer Res **79**(8), 2021-2030 (April 15 2019); DOI:10.1158/0008-5472.CAN-18-2791