# Book of Abstract

# MEDOPTICS 2024

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# 3rd International Conference on Medical Optics (MEDOPTICS 2024)

**8-11 October 2024**

## Plenary Speakers

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|---|---|
| Meltem Izzetoglu | Villanova University, USA |

## Invited Speakers

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|---|---|
| Christos Boutopoulos | Université de Montréal, Canada |
| A. V. Feofanov | Lomonosov Moscow State University, Russian Federation |
| Horace Crogman | California State University Dominguez Hills, USA |
| Kostadinka Bizheva | University of Waterloo, Canada |
| M. L. Thakur | Sidney Kimmel Cancer Center, USA |
| N. Daldosso | University of Verona, Italy |

## Chair

Ersin Kayahan Kocaeli University, Turkey

## Scientific Committee

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| Ahmet Yavuz Oral | Gebze Technical University, Turkey |
| Mehmet Alper Şahiner | Seton Hall University, USA |
| Ozzy Mermut | York University, Canada |

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| Ahmet Yavuz Oral | Gebze Technical University, India |
| Ozcan Gundogdu | Kocaeli University, Turkey |
| Yury I. Gurfinkel | Lomonosov Moscow State University, Russia |

**PLENARY PRESENTATION**

**Id-613**

# Multimodal Diffuse Optical Methods for The Assessment of Brain Function and Injury

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**Abstract:** Diffuse optical technologies based on near infrared spectroscopy (NIRS) and diffuse correlation spectroscopy (DCS) have increasingly been deployed for the study of human cognition and brain health. Such methodologies provide real time monitoring of cerebral oxygenation, blood volume and flow in the field and clinical settings. Recent studies involve multimodal use of diffuse optical methods for more accurate and robust assessment of cognitive activations and brain injury which can guide clinicians, scientists and researchers in improving the diagnosis, treatment and prevention of brain disorders, cognitive impairments, and neurological damage. NIRS technology uses light in the red and near infrared range to assess changes in blood oxygenation and volume in the cerebral cortex which allows the design of safe, portable, wearable, noninvasive, and affordable neuromonitoring systems with rapid application time, superior immunity to movement noise, and near-zero run time cost. On the other hand, DCS method implements long coherence light source to measure the temporal fluctuations in the speckle pattern in terms of temporal autocorrelation function whose decay rate carries information on the flow rates of moving particles in tissue such as red blood cells. Hence, DCS technique can provide information on the cerebral blood flow in the microvasculature. This talk will introduce the principles of NIRS and DCS methodologies, sensor development and evolution, data analysis techniques for noise removal and biomarker extraction using novel signal processing algorithms, innovative physical and digital optical head model designs for device and algorithm testing, and single- and multi-modal use of NIRS and DCS markers in machine learning models for intelligent and automated decision making in different fields and clinical applications. Various functional and physiological neuromonitoring studies using NIRS and DCS methods carried out on animal models and humans of different age and disease groups will be covered in the context of cognitive activity monitoring, and brain injury assessment.

**Keywords:** Optical Brain Imaging, Near Infrared Spectroscopy, Diffuse Correlation Spectroscopy, Cognitive Activity Monitoring, Brain Injury Detection, Phantom, Animal and Human Testing.

## REFERENCES

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[3] Reddy, P., Izzetoglu, M., Shewokis, P. A., … & Izzetoglu, K. (2021). Evaluation of fNIRS signal components elicited by cognitive and hypercapnic stimuli. Scientific reports, 11(1), 23457.

**INVITED PRESENTATION**

**Id-606**

# Epigallocatechin Gallate (EGCG) Mitigates the Effects of Camptothecin-induced Oxidative Stress on Bone-like Cancer Cells (UMR 106-01 BSP)

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**Abstract:** Various medical treatments aim to counteract the impact of oxidants on mammalian cells. One such antioxidant is EGCG, an active ingredient in green tea, which has demonstrated protective effects against cellular oxidants like camptothecin (CAMPT). This study examines how EGCG mitigates CAMPT's effects on UMR cells, focusing on cell proliferation and biophysical parameters. UMR cells were treated with different CAMPT concentrations and incubated for 72 hours. Subsequently, cell proliferation and viability were assessed. In a separate experiment, UMR cells were co-treated with CAMPT and varying EGCG concentrations to evaluate EGCG's ability to mitigate CAMPT's oxidative effect. Electric Cell-Substrate Impedance Sensing (ECIS) technology was also used to assess the biophysical parameters of CAMPT-treated UMR cells, including cell membrane resistance, cell spreading, and cell attachment. The results showed a concentration-dependent decrease in cell proliferation for CAMPT-treated UMR cells. However, co-treatment with EGCG reversed CAMPT's oxidative effects in a concentration-dependent manner. ECIS technology revealed a decrease in biophysical parameters when UMR cells were treated with CAMPT alone. Statistical analysis indicated significant differences with p-values $<0.05$. This study suggests that EGCG effectively protects UMR cells from oxidative stress and highlights its potential role in mitigating oxidative stress in mammalian cells. Additionally, the use of ECIS technology validates its application in corroborating the biological effects of CAMPT and EGCG on UMR cells.

**Keywords:** Epigallocatechin Gallate (EGCG), Camptothecin, Cell Viability, Electric Cell-Substrate Impedance Sensing (ECIS), Oxidative Stress.

**INVITED PRESENTATION**

**Id-607**

# Improving The Safety and Precision of Eye Surgery Interventions with "Smart" Fiber-Based OCT Systems

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**Abstract:** This talk will cover our efforts towards the development and validation of fiber-based technologies that can help surgeons perform eye surgery interventions of improved safety, precision, and efficacy [1-3]. These technologies exploit biomedical imaging (Optical Coherence Tomography) to improve surgeons' ability to control instrumentation inside the eye. Optical Coherence Tomography (OCT) systems employ a technique known as low-coherence interferometry to generate tomographic images of tissue. Over the last 20 years, OCT systems have had tremendous impact on the diagnosis and treatment of eye disorders. Recently, miniaturized fiber-based OCT probes have been introduced as complementary endoscopic visualization tools for guiding eye surgery. Attached to intraocular surgical instrumentation, these probes can provide real-time positioning feedback as well as tremor compensation capabilities. Surgical systems that integrate such feedback can improve the safety and efficacy of challenging surgical maneuvers. In the talk, I will present two "smart" OCT-based eye surgery systems developed in our lab: (i) an OCT-guided subretinal injection cannula [3] and (ii) a modified vitrector ("smart" vitrector) integrating a fiber-based sensor [2]. I will focus on the development and preclinical (pig and mouse models) validation of these technologies.

**Keywords:** Fiber-Based OCT, Smart Vitrector, Vitreoretinal Surgery, Subretinal Injection.

## REFERENCES

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**INVITED PRESENTATION**

**Id-608**

# Line-Scan Optical Coherence Tomography for In-Vivo Cellular Resolution Imaging of The Human Cornea and Limbus

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**Abstract:** At their early stages of development when treatment is most beneficial, corneal diseases alter the corneal morphology at cellular level. Therefore, early and correct diagnosis of corneal pathologies is contingent on the availability of optical imaging technologies that can image corneal tissue in-vivo, volumetrically and with cellular level resolution using non-contact, and non-invasive methods. We have developed a novel, Line-Scan Optical Coherence Tomography (LS-OCT) technology that combines high spatial resolution (~ 2 μm) sufficient to visualize individual cells in corneal tissue, and high image acquisition rate (> 2,500 fps) that can reduce significantly the effect of involuntary eye motion artefacts in the OCT images. The LS-OCT technology was first tested on healthy, normal human subjects. This study has received full ethics clearance by the University of Waterloo Office of Research Ethics and subjects provided informed consent. Volumetric LS-OCT images were acquired from both the central and peripheral cornea (so called limbus). The limbus contains fibrous structures called Pallisades of Vogt (POV) that encase the limbal crypts that contain the stem cells responsible for the regeneration of the corneal epithelium. Volumetric LS-OCT images of the human cornea revealed the cellular structure of the cornea and the limbal crypts, as well as the vasculature and innervation of the limbus and the peripheral cornea (Fig.1).

Recently we received ethics clearance to conduct a large clinical study on patients with Limbal Stem Cell Dysfunction (LSCD). Currently we are recruiting and imaging LSCD subjects.

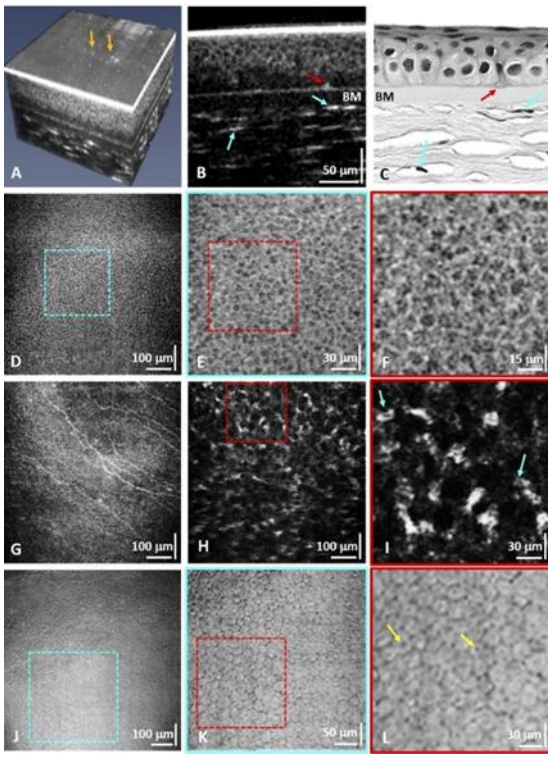


Figure 1: (A) Flattened 3D LS-SD-OCT image of the anterior cornea from a healthy volunteer. (B) Cross-sectional image of the anterior cornea showing the cellular structure of the epithelium, the Bowman's membrane, cross-sections of sub-basal corneal nerves (red arrow), and keratocyte nuclei in the anterior stroma (blue arrows). The same morphological features are resolved in the cross-sectional H&E corneal histology ex-vivo (C). (D) Enface image of the corneal epithelium with magnified views (E, F) of the regions of interest (ROIs) marked with the blue and red dashed lines that show individual epithelial cells. (G) Enface images of sub-basal corneal nerves. (H, I) Enface images of the anterior stroma showing keratocyte nuclei. (J) Enface maximum intensity projection image of the corneal endothelium. (K, L) Zoomed ROIs showing individual endothelial cells.

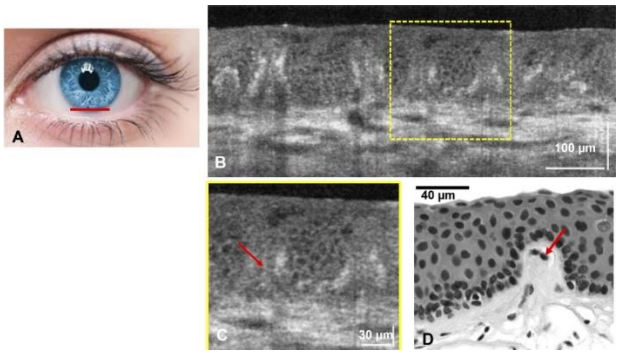


Figure 2: (A) Human healthy inferior limbus (imaged location marked with red line). (B) Cross-sectional LS-SD-OCT image that shows the POVs and the cellular structure of the limbal crypts located in between the POVs. (C) Magnified view of the ROI marked with yellow line in (B). (D) H&E histological image of the a single palisade and the surrounding
limbal crypts.

**Keywords:** OCT, Ophthalmic Imaging.

**INVITED PRESENTATION**

**Id-609**

# Light Emitting Porous Nano-Silicon as A Multimodal Platform for Theranostics

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**Abstract:** Porous silicon (pSi) is an ideal traceable carrier for both therapy and diagnostics purposes thanks to its unique properties: visible photoluminescence at room temperature, large surface-to-volume ratio and large porosity, together with biodegradability, biocompatibility and absence of immunogenicity and toxicity. Along the last years, we contributed to the overcoming of its optical and structural degradation in aqueous media by developing organic and inorganic coatings. Moreover, from the therapy point of view, we achieved interesting results by coupling the pSi particles with different anticancer and immunotherapeutic molecules (i.e., doxorubicin, docetaxel and Pam3CSK4). The treatment of selected cancer cell lines resulted in an anti-proliferative effect when the delivery of the chemotherapeutics drugs was mediated by pSi. While the incubation of human-derived dendritic cells with our drug delivery system loaded with an immunologic adjuvant allowed to obtain an enhancement of the immune response thanks to a delayed internalization due to the release enabled by pSi. From the diagnostics point of view, both the intrinsic optical and the combined magnetic properties (thanks to the inclusion of magnetic nano particles) have been used to demonstrate the feasibility of multimodal diagnostic system.

**Keywords:** Porous Silicon, Luminescence, Theranostics, In Vitro Studies.

**INVITED PRESENTATION**

**Id-611**

# Nanobiophotonics: Decoding Molecular Interactions in Chromatin

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**Abstract:** The complexity of the mechanisms underlying chromatin function, and the large number of different molecules involved in this process necessitate the use of a diverse range of methods and approaches for studying chromatin at different levels of structural organization. These studies are of both fundamental and biomedical importance, helping to validate molecular targets and develop advanced drugs that affect the processes occurring within chromatin. Optical methods, although they have a relatively low resolution compared to some other techniques, are able to provide valuable information about the molecular interactions, structure and functional activity of the forming complexes. Rapidly developing nanobiophotonics techniques significantly enhance the informative value of these studies. This report discusses methods for analyzing the fluorescence intensity and efficiency of Förster resonance energy transfer in single supramolecular complexes formed by nucleosomes (basic structural units of chromatin), functionally important nuclear proteins and some drugs. These methods allow one to study high-affinity molecular interactions, which require research at nanomolar concentrations of interacting partners. They help to determine the efficiency of intermolecular interactions, reveal the stoichiometry of the complexes formed, and recognize structural and functional changes that occur in the complexes. Nanobiophotonics approaches allow one to detect and analyze complexes that differ in structure and composition, which are present simultaneously in the reaction mixture, and to evaluate their relative content under different conditions. The studies were supported by Russian Science Foundation (grant 19-74-30003).

**Keywords:** Nanobiophotonics, Fluorescence, Single Molecule, FRET, Nucleosome, Drugs.

**INVITED PRESENTATION**

**Id-612**

# Biophotonic Imaging for Noninvasive Detection and Therapy of Oncologic Diseases

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**Abstract:** Despite the great strides made during the past few decades in understanding and treating cancer, it remains one of the most formidable diseases of mankind. Cancer is a highly heterogenous disease in its biology, biochemistry, pathology and even in its presentation. Although approaches to diagnosing and treat cancer vary considerably, the notion that early and accurate diagnosis of cancer saves lives remains undisputable. Our laboratories, in part, are engaged in developing novel approaches to detect cancer, early, accurately, and also non-invasively. Early data from one of our approaches in which we target certain genomic receptors that are expressed in high density on malignant cells at the onset of oncogenesis, but not on normal epithelial cells, and use biophotonic imaging strongly suggest that i) not only various cancers can be detected early, non-invasively and with high sensitivity but can also determine, ii) the severity of the disease and iii) be used to determine the effectiveness of its therapeutic intervention. The approach targets genomic receptors VPAC (combined for vasoactive internal peptide and pituitary adenylate cyclase activating peptide) expressed on malignant cells shed in easily available biofluids, using a VPAC specific biomolecule labeled with a near infrared fluorophore. Biofluids such as voided urine to detect prostate cancer, bladder cancer and ovarian cancer, saliva to detect cancers of the head and neck are nipple discharge to detect breast cancer, are collected from consenting patients, cells are separated by cytocentrifugation and are treated with the biomolecule developed in our laboratory. The biophotonic imaging allows us to detect malignant cells depicting the presence of the disease and the associated AI software permits us to quantify the malignant cells and the fluorescence intensity around them. The data suggests that this simple and completely noninvasive assay i) detects cancer with thigh sensitivity ii) distinguishes

malignant lesions from benign masses, iii) determines the severity of disease and iv) may assess the effectiveness of therapeutic intervention. Supported by NIH, 5RO1, CA249921.

**Keywords:** Non-Invasive Cancer Detection, Biophotonic Imaging, VPAC Receptors, Genomic Biomarkers.

**ORAL PRESENTATION**

**Id-614**

# Characterization of DNT/TNT Specific Binding Peptides Immobilized on Laser-Induced Graphene

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**Abstract:** Bio/chemical sensors need to detect specific targets with high selectivity. Carbon nanomaterials, especially those based on graphene, are ideal for this because they have excellent electrical and mechanical properties as well as high sensitivity. Laser-induced graphene (LIG) is particularly useful for sensors due to its sensitivity, ease of use, flexibility, and lightweight structure. This study focuses on attaching DNT and TNT-specific peptides to LIG films. The characterization results of LIG films functionalized with EDC+NHS show a decrease in carboxyl groups (COOH) and an increase in C-N/C=N/C-O groups. The N1s XPS spectra reveal that DNT-specific peptides remove more NHS-esters, leading to fewer N-C=O groups and more protonated nitrogen. This suggests that DNT-specific peptide attachment is more effective than TNT-specific peptide attachment, resulting in better biofunctionalization.

**Keywords:** Laser-Induced Graphene (LIG), DNT-Specific Binding Peptides, TNT-Specific Binding Peptides, Immobilization.

## 3rd International Conference on Medical Optics

## SUBMISSIONS & TOPICS

| TOPIC | TITLE |
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| **Optical Coherence Tomography** | Id 607 - Improving the Safety and Precision of Eye Surgery Interventions with “Smart” Fiber-based OCT Systems |
| | Id 608 - Line-Scan Optical Coherence Tomography for in-vivo Cellular Resolution Imaging of the Human Cornea and Limbus |
| **Photobiology** | Id 611 - Nanobiophotonics: Decoding Molecular Interactions in Chromatin |
| | Id 612 - Biophotonic Imaging for Noninvasive Detection and Therapy of Oncologic Diseases |
| | Id 606 - Epigallocatechin Gallate (EGCG) Mitigates the Effects of Camptothecin-induced Oxidative Stress on Bone-like Cancer Cells (UMR 106-01 BSP) |
| **Lasers in Diagnostic** | Id 609 - Light Emitting Porous Nano-silicon as a Multimodal Platform for Theranostics |
| | Id 614 - Characterization of DNT/TNT Specific Binding Peptides Immobilized on Laser-Induced Graphene |
| **Time-Resolved Imaging in Diffusive Media** | Id 613 - Multimodal Diffuse Optical Methods for The Assessment of Brain Function and Injury |