8TH INTERNATIONAL A. M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS

will be held as a part of 21ST CONFERENCE LASER OPTICS ICLO 2024,
and is organized by
PROKHOROV GENERAL PHYSICS INSTITUTE OF RAS

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8TH INTERNATIONAL A. M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS

TOPICS

SYA Advanced laser medical systems and technologies
New medical applications and advanced laser medical systems for ophthalmology, dermatology, urology, endoscopic and micro surgery, dentistry, and other specialties

SYB Laser interaction with cells and tissues: clinical imaging and spectroscopy
Optical clearing and light transport in cells and tissues • Laser trapping and manipulation of biological particles; nonlinear interactions of light and tissues • Speckle phenomena in tissues • Quantification and imaging of cells, blood and lympth flows • Terahertz waves interaction with cells and tissues, autofluorescence and photodynamic diagnosis • Optical coherence tomography and diffuse optical imaging • New developments in non-invasive optical technologies, laser microscopy and spectroscopy of tissues

SYC Photonics and nanobiotechnology
Analytical biophotonics • Chemical and biosensing principles and instrumentation • Nanomaterials, methods and systems for diagnostics and therapy

SYD Photodynamic processes in biology and medicine
Photosensitizers for biology and medicine • Direct optical single oxygen generation • Photodynamic therapy • Photothermal action of laser radiation on bio-objects • Protection of organs and tissues against powerful and laser radiation • Photodynamic diagnosis • New photosensitizers for theranostic • Photodynamic action on pathogenic microflora

MONDAY, 1 JULY

11.00-13.30	**ICLO 2024 - PLENARY SESSION** *PIEDMONTE ROOM - FLOOR 3, P.1*
14:15-16:45	**8TH INTERNATIONAL A.M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS - PLENARY SESSION** *PIEDMONTE ROOM - FLOOR 3, P.75*
18.00-20.00	**WELCOME RECEPTION** *TOSKANA RESTAURANT - FLOOR 3*

TUESDAY, 2 JULY

9.00-11.00		***SYB*** TISSUE OPTICS 1 ***PETROV-VODKIN 1*** *P. 78*	***SYC*** PHOTONICS AND NANO-BIOTECHNOLOGY 1 ***PETROV-VODKIN 2*** *P. 80*	***SYA*** ADVANCED LASER MEDICAL SYSTEMS & TECHNOLOGIES 1 ***PETROV-VODKIN 3*** *P. 76*	***R5*** SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES 1 ***DEYNEKA*** *P. 6*
11.00-11.30	COFFEE BREAK				
11.30-13.30		**SYB** TISSUE OPTICS 2 ***PETROV-VODKIN 1*** *P. 78*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 2 ***PETROV-VODKIN 2*** *P. 80*	***SYA*** ADVANCED LASER MEDICAL SYSTEMS & TECHNOLOGIES 2 ***PETROV-VODKIN 3*** *P. 76*	***R5*** SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES 2 ***DEYNEKA*** *P. 7*
13.30-15.00	LUNCH BREAK				
15.00-17.00	**POSTER SESSION** **R7, R8, SYA, SYB** ***NIKOLSKY + LEVINSON FOYER*** *P. 15, 15, 82, 82*	**SYB** FLUORESCENCE AND APPLICATION ***PETROV-VODKIN 1*** *P. 79*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 3 ***PETROV-VODKIN 2*** *P. 81*	***SYA*** ADVANCED LASER MEDICAL SYSTEMS & TECHNOLOGIES 3 ***PETROV-VODKIN 3*** *P. 77*	***R5*** SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES 3 ***DEYNEKA*** *P. 7*
17.00-17.30	COFFEE BREAK				
17.30-19.30	**POSTER SESSION** **R7, R8, SYA, SYB** ***NIKOLSKY + LEVINSON FOYER*** *P. 15, 15, 82, 82*				***R7*** FREE ELECTRON LASERS ***DEYNEKA*** *P. 9*

WEDNESDAY, 3 JULY

9.00-11.00	**POSTER SESSION** **R2, R5, R6, R11, SYC** ***NIKOLSKY + LEVINSON FOYER*** *P. 37, 40, 42, 47, 90*	**SYB** OPTICAL CHARACTERIZATION OF BLOOD CELLS AND FLOW 1 ***PETROV-VODKIN 1*** *P. 84*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 4 ***PETROV-VODKIN 2*** *P. 85*	***SYD*** PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 1 ***PETROV-VODKIN 3*** *P. 87*	***R1*** SOLID STATE LASERS 1 ***DEYNEKA*** *P. 22*
11.00-11.30	COFFEE BREAK				
11.30-13.30	**POSTER SESSION** **R2, R5, R6, R11, SYC** ***NIKOLSKY + LEVINSON FOYER*** *P. 37, 40, 42, 47, 90*	**SYB** OPTICAL CHARACTERIZATION OF BLOOD CELLS AND FLOW 2 ***PETROV-VODKIN 1*** *P. 84*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 5 ***PETROV-VODKIN 2*** *P. 86*	***SYD*** PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 2 ***PETROV-VODKIN 3*** *P. 88*	***R1*** SOLID STATE LASERS 2 ***DEYNEKA*** *P. 22*
13.30-15.00	LUNCH BREAK				
15.00-17.00	**POSTER SESSION** **R1, R10, SYC** ***NIKOLSKY + LEVINSON FOYER*** *P. 33, 44, 90*	**SYB** PHOTOACOUSTIC ***PETROV-VODKIN 1*** *P. 85*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 6 ***PETROV-VODKIN 2*** *P. 87*	***SYD*** PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 3 ***PETROV-VODKIN 3*** *P. 89*	***R10*** NONLINEAR QUANTUM PHOTONICS 3 ***DEYNEKA*** *P. 31*
17.00-17.30	COFFEE BREAK				
17.30-19.30	**POSTER SESSION** **R1, R10, SYC** ***NIKOLSKY + LEVINSON FOYER*** *P. 33, 44, 90*	**POSTDEADLINE** ***PETROV-VODKIN 1+2+3*** *P. 33*			

MONDAY, 1 JULY

ICLO 2024 - PLENARY SESSION
PIEDMONTE ROOM - FLOOR 3, P.1

8TH INTERNATIONAL A.M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS - PLENARY SESSION
PIEMONTE ROOM - FLOOR 3, P.75

WELCOME RECEPTION
TOSKANA RESTAURANT - FLOOR 3

THURSDAY, 4 JULY					
9.00-11.00	**POSTER SESSION R3, R4** ***NIKOLSKY + LEVINSON FOYER*** *P. 60, 64*	**SYB** TERAHERTZ ***PETROV-VODKIN 1*** *P. 93*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 7 ***PETROV-VODKIN 2*** *P. 94*	***SYD*** PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 4 ***PETROV-VODKIN 3*** *P. 96*	***R1*** SOLID STATE LASERS 3 ***DEYNEKA*** *P. 49*
11.00-11.30	COFFEE BREAK				
11.30-13.30	**POSTER SESSION R3, R4** ***NIKOLSKY + LEVINSON FOYER*** *P. 60, 64*	**SYB** PHOTODYNAMIC AND PHOTOTHERMAL THERAPY ***PETROV-VODKIN 1*** *P. 93*	***SYC*** PHOTONICS AND NANOBIOTECHNOLOGY 8 ***PETROV-VODKIN 2*** *P. 95*	***SYD*** PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 5 ***PETROV-VODKIN 3*** *P. 97*	***R1*** SOLID STATE LASERS 4 ***DEYNEKA*** *P. 50*
13.30-15.00	LUNCH BREAK				
15.00-17.00	**POSTER SESSION R9, SYD** ***NIKOLSKY + LEVINSON FOYER*** *P. 66, 99*	**SYB** LASER MICROSCOPY AND OPTICAL COHERENCE IMAGING ***PETROV-VODKIN 1*** *P. 94*		***SYD*** PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 6 ***PETROV-VODKIN 3*** *P. 97*	
17.00-17.30	COFFEE BREAK				
17.30-19.30	**POSTER SESSION R9, SYD** ***NIKOLSKY + LEVINSON FOYER*** *P. 66, 99*				

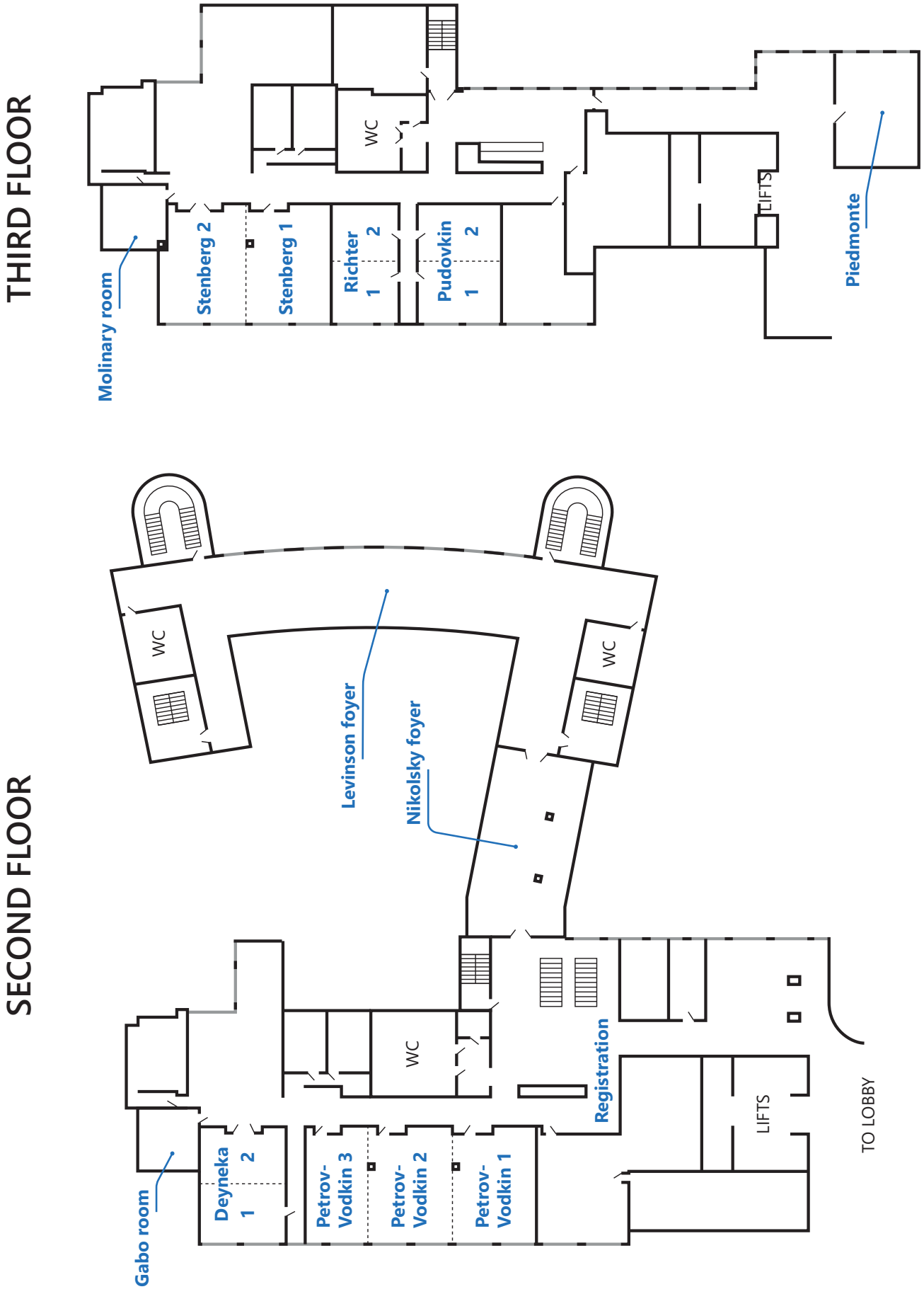
FRIDAY, 5 JULY					
9:00-11:00					
11.00-11.30	COFFEE BREAK				
13.30-15.00					

The venue of the Conference ICLO 2024 is the Hotel "Moskovskie Vorota"

FRIDAY, 5 JULY				
	SYB GENERAL ISSUES OF BIOPHOTONICS AND SIMULATION ***STENBERG 2*** *P. 101*			
COFFEE BREAK				
	SYB RAMAN SPECTROSCOPY ***STENBERG 2*** *P. 101*			

ICLO 2024 Venue:
Moskovskiye Vorota Hotel – St. Petersburg

MOSKOVSKIYE VOROTA



8TH INTERNATIONAL A. M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS

PLENARY SESSION

Location: Piedmonte room, floor 3

14:15–14:30 **Opening and welcome remarks**
Ivan A. Shcherbakov,
Prokhorov General Physics Institute of RAS, Russia

14:30–15:15 **Advancing 7TM-protein structural studies: from XFELs to light-enabled cell control**
Valentin I. Borshchevskiy,
Moscow Institute of Physics and Technology, Russia

15:15–16:00 **Laser radiation, ultrasound and nanostructured particles work together to realize the theranostic approach**
Dmitry Gorin,
Skoltech, Russia

16:00–16:45 **Multimodal spectro-imaging for human skin in vivo optical biopsy**
Walter Blondel
Université de Lorraine, France

Advancing 7TM-protein structural studies: from XFELs to light-enabled cell control

VALENTIN I. BORSHCHEVSKIY
Moscow Institute of Physics and Technology, Russia

Short bio:
Dr. Valentin I. Borshchevskiy (born June 12, 1984) is a specialist in structural biology and protein dynamics, focusing on retinal membrane proteins and G protein-coupled receptors. His research is dedicated to advancing optogenetic approaches and structure-based rational drug design. Dr. Borshchevskiy co-authors over 90 publication and has been nominated for the Yu. Struchkov Prize and the Young Scientist Award 2021 of the European Synchrotron. Dr. Borshchevskiy is the Head of the Laboratory for Biomolecular Structure and Dynamics, as well as the Vice-Head of the Research Center for Molecular Mechanisms of Aging and Age-Related Diseases, both located at the Moscow Institute of Physics and Technology.

The talk will focus on modern methods of studying the structure of 7-alpha-helical transmembrane proteins and their practical applications. The speaker will discuss the use of synchrotrons and XFELs, along with advancements in single-molecule FRET spectroscopy.

Laser radiation, ultrasound and nanostructured particles work together to realise the theranostic approach

DMITRY GORIN
Skoltech, Russia

The application of photonic and acoustic tools can be used for visualization, navigation of multifunctional carriers and remote-controlled release of bioactive substances. These particles will combine the ability to deploy drugs in a controllable manner with physical triggering, multimodal detection, and visualization as well as sensing of important biological markers.

Short bio:
Dmitry Gorin was born in Saratov, Russia, in 1975. He is a Professor at the Center of Photonic Science and Engineering at Skolkovo Institute of Science and Technology. Dmitry Gorin received his Diploma of Engineer-Physicist in 1997 and CSc and DSc degrees in Physical Chemistry in 2001 and 2011, respectively, from Saratov State University. From 2005 to 2009, he visited the Max-Planck Institute of Colloids and Interfaces (the group of Dr. G.B. Sukhorukov), before becoming a postdoc there from 2009 to 2010 in the group of Prof. Dr.H. Moehwald. He was then appointed professor at the Department of Nano- and Biomedical Technologies at Saratov State University from 2011 till 2017, after which he joined Skoltech as a Full Professor. He was the supervisor and co-supervisor of 11 CSc and 3 PhD theses and consultant of 2 DSc theses. His research interests are biophysics, biophotonics, and physics of colloids and interfaces. As a visiting scientist, he collaborated with the University of Arkansas for Medical Sciences (Little Rock), Charité University Hospital (Berlin), Queen Mary University of London, Ankara and Ghent Universities, Tomsk Polytechnic University, Bilkent University.

Multimodal spectro-imaging for human skin in vivo optical biopsy

WALTER BLONDEL
Université de Lorraine, France

Among skin cancers, 90% are non-melanoma skin cancers that are Basal Cell (BCC) and Squamous Cell (SCC) carcinoma arising from keratinocytes. They have the highest incidence whatever the anatomical site and strong impact on the body physical appearance with socially disabling and surgical consequences. In order to address the need for non-invasive methods of margin delineation and surgery guiding, optical biopsy tools have been investigated over more than two decades because of their potential to allow real-time characterization of skin tissue state and effective differentiation between malignant and non-malignant lesions. These tools probe the modifications of the optical properties of the skin tissues related to the pathological evolution of the latter e.g. epidermis hyperplasia, pleomorphism, nucleus to cell ratio, neovascularization, dermis extra-cellular matrix collagen enzymatic degradation, etc.

This presentation will review and discuss the techniques of human skin cancer optical spectroscopy and imaging (Optical Coherence Tomography, Multiphoton Microscopy, Diffuse Reflectance, Autofluorescence, Raman, and Terahertz spectro-imaging) including instrumentation, light-tissue interaction modelling and data processing/analysis challenges for their validation as in vivo diagnosis methods and their use as clinical real time peroperative tool for early stage characterization and surgical marging delineation.

Short bio:
Walter C.P.M. Blondel was born in Nancy, France, in 1968. He received the electrical engineering degree from ESIGELEC Rouen (France) in 1991, the M.Sc. degree in optoelectronics from Hertsfordshire University (U.K.) in 1992, and the Ph.D. degree in biological and medical engineering from the Université Henri Poincaré (France) in 2000. Currently, he is a Professor at Université de Lorraine (France), heading the M.Sc. in Health Engineering and the Health Sciences and Engineering department at the faculty of medicine in Nancy (France). He's leading the research group interactions of light with biological tissues at the CRAN laboratory (France) and his research fields of interest are in: UV-Vis-NIR optical spectroscopy and imaging for in vivo characterization of biological tissues, light-tissue interactions modelling, multidimensional data processing and machine learning.

8TH INTERNATIONAL A. M. PROKHOROV SYMPOSIUM ON BIOPHOTONICS

SYP: SYMPOSIUM PLENARY

Location: Piedmonte Room, Floor 3; Date: Monday, July 01, 2024

SYP: SYMPOSIUM PLENARY

Session Chair: Ivan Shcherbakov, Prokhorov General Physics Institute of RAS, Russia

14:15-14:30

Opening and welcome remarks

I.A. Shcherbakov; Prokhorov General Physics Institute of RAS, Russia

MoSYP-01 14:30-15:15

Advancing 7TM-protein structural studies: from XFELs to light-enabled cell control *(Plenary)*

V.I. Borshchevskiy; Moscow Institute of Physics and Technology, Russia

The talk will focus on modern methods of studying the structure of 7-alpha-helical transmembrane proteins and their practical applications. The speaker will discuss the use of synchrotrons and XFELs, along with advancements in single-molecule FRET spectroscopy.

MoSYP-02 15:15-16:00

Laser radiation, ultrasound and nanostructured particles work together to realise the theranostic approach *(Plenary)*

D. Gorin; Skolkovo Institute of Science and Technology, Russia

The application of photonic and acoustic tools can be used for visualization, navigation of multifunctional carriers and remote-controlled release of bioactive substances. These particles will combine the ability to deploy drugs in a controllable manner with physical triggering, multimodal detection, and visualization as well as sensing of important biological markers.

MoSYP-03 16:00-16:45

Multimodal spectro-imaging for human skin carcinoma in vivo optical biopsy *(Plenary)*

W. Blondel[1], V. Kupriyanov[1,2], S. Zaytsev[1], G. Khairallah[1,3], C. Perrin-Mozet[1], C. Fauvel[1], C. Daul[1], Y. Kistenev[2], M. Amouroux[1]; [1]Université de Lorraine, CNRS, CRAN UMR7039, France; [2]Tomsk State University, Russia; [3]Metz-Thionville Regional Hospital, Department of plastic, aesthetic and reconstructive surgery, France

Among skin cancers, 90% are non melanoma skin cancers that are Basal Cell (BCC) and Squamous Cell (SCC) carcinoma arising from keratinocytes. They have the highest incidence whatever the anatomical site and a strong impact on the body physical appearance with socially disabling and surgical consequences. In order to address the need for non invasive methods of margin delineation and surgery guiding, optical biopsy tools have been investigated over more than two decades because of their potential to allow real time characterization of skin tissue state and effective differentiation between malignant and non malignant lesions. These tools probe the modifications of the optical properties of the skin tissues related to the pathological evolution of the latter e.g. epidermis hyperplasia, pleomorphism, nucleus to cell ratio, neovascularization, dermis extra-cellular matrix collagen enzymatic degradation, etc.

This presentation will review and discuss the techniques of human skin cancer optical spectroscopy and imaging (Optical Coherence Tomography, Multiphoton Microscopy, Diffuse Reflectance, Autofluorescence, Raman, and Terahertz spectro-imaging) including instrumentation, light-tissue interaction modelling and data processing/analysis challenges for their validation as in vivo diagnosis methods and their use as clinical real time peroperative tool for early stage characterization and surgical marging delineation.

SYA: ADVANCED LASER MEDICAL SYSTEMS AND TECHNOLOGIES

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Tuesday, July 02, 2024

SYA: ADVANCED LASER MEDICAL SYSTEMS AND TECHNOLOGIES 1

Session Chair: Vladimir Minaev, IRE-Polus Ltd., Russia

TuSYA-01 09:00-09:30

High-power erbium -doped pulsed fiber laser for non-ablative fractional photo-rejuvenation *(Invited paper)*

M.Yu. Koptev[1], A.N. Morozov[2], K.V. Shatilova[2], S.V. Muravyev[1], A.E. Zapryalov[1], M.E. Likhachev[3], A.V. Kim[1]; [1]Institute of Applied Physics RAS; [2]Melsytech LLC; [3]Fiber Optics Research Center RAS, Russia

A high-power erbium laser system for fractional photorejuvenation was presented. The system generated rectangular pulses with a duration varying from 200 μs to 5 ms and pulse energy up to 130 mJ. The novelty of the system was the use of a powerful seed source in combination with a synchronously pumped amplifier made on a single-mode erbium-doped LMA fiber.

TuSYA-02 09:30-10:00

Optical visualizer of the venous wall with a high degree of contrast *(Invited paper)*

P.A. Ryabochkina, M.V. Gerasimov, A.D. Taratynova, K.V. Prosvirin; National Research Mordovia State University, Russia

A real-time optical visualization system of the venous bed is presented, created using near infrared (NIR) vein finder technology with spectral division of the light flux (visible and infrared), using a combination of video images and their processing algorithms.

TuSYA-03 10:00-10:30

Perspectives on a 3050 nm fiber laser mediated ablative fractional laser treatments in dermatology *(Invited paper)*

V. Arkhipova[1], A. Mimov[2], V. Smolyannikova[3], I. Larionov[1], D. Paithankar[4], I. Yaroslavsky[4], V. Andreeva[1], G. Altshuler[4]; [1]IRE Polus; [2]TORI Clinic; [3]Sechenov University, Russia; [4]IPG Medical, USA

We have evaluated a novel laser emitting at a wavelength of 3050 nm. We analysed its effect on skin ablation and regeneration. Our data show that this system has a strong tissue regenerative effect and a great potential for use in dermatology.

TuSYA-04 10:30-10:45

Infrared fibers based on AgCl - $AgBr_{0.7}I_{0.3}$ for medical and laser technologies

A.A. Yuzhakova, A.E. Lvov, D.D. Salimgareev, P.V. Pestereva, I.V. Yuzhakov, A.S. Korsakov, L.V. Zhukova; Ural Federal University, Russia

For medical laser technologies, IR fibers based on single crystals of the AgCl – AgBr0.7I0.3 system have been developed. Using computer simulation, extrusion modes were determined and fibers with a diameter of 465 μm and a length of 1.4 m were obtained. They have a transmission range of 3.4–24.0 μm without absorption windows and low optical losses.

TuSYA-05 10:45-11:00

Are picosecond laser pulses applicable for microsurgery of zona pellucida of mammalian embryo?

D.S. Sitnikov[1], M.A. Filatov[2], M.V. Kubekina[2], Y.Y. Silaeva[3]; [1]JIHT RAS; [2]Center for Precision Genome Editing and Genetic Technologies for Biomedicine, IGB RAS; [3]Core Facility Centre, IGB RAS, Russia

Infrared picosecond laser pulses are used for microsurgery of mouse embryos at late stages of preimplantation development. The width of the cut made by a series of laser pulses at the zona pellucida of the mouse embryo is studied for different laser beam velocities and pulse energies.

- Coffee Break -

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Tuesday, July 02, 2024

SYA: ADVANCED LASER MEDICAL SYSTEMS AND TECHNOLOGIES 2

Session Chair: David Kochiev, Prokhorov General Physics Inst. RAS, Russia

TuSYA-06 11:30-12:00

Study of the possibility of using dielectric nanoparticles doped with rare earth ions for the treatment of tumors under non-contact exposure to near-IR laser radiation *(Invited paper)*

S.A. Khrushchalina[1], P.A. Ryabochkina[1], O.A. Kulikov[1], V.I. Shlyapkina[1], V.P. Ageev[1], N.Yu. Tabachkova[2], S.E. Kukarkina[1], E.E. Zimin[1]; [1]National Research Ogarev Mordovia State University; [2]National University of Science and Technology "MISIS", Russia

In this work, we investigated the possibilities of using Yb-containing particles (ZrO2-30 mol.% Yb2O3) when excited by laser radiation with a wavelength of 980 nm for the treatment of subcutaneous tumors. Cytotoxicity studies of these particles and in-vivo experiments (on mice) were conducted.

TuSYA-07 12:00-12:30

Endovenous laser coagulation of large diameter varicose veins *(Invited paper)*

V.Yu. Bogachev[1,2], V.P. Minaev[3]; [1]The First Phlebological Center; [2]Pirogov Russian National Research Medical University; [3]IRE-Polus Ltd., Russia

The purpose of this report is to justify the selection of the optimal method of endovenous laser coagulation (EVLC) of varicose veins of large (more than 2 cm) diameter.

TuSYA-08 12:30-13:00

Laser perforation of bones. Photothermal effects and clinical applications *(Invited paper)*

I.A. Abushkin[1,2], A.E. Anchugova[2,3], A.V. Lappa[3], V.P. Minaev[4], V.M. Chudnovsky[5]; [1]Center for Medical Laser Technologies; [2]South Ural State Medical Univ.; [3]Chelyabinsk State Univ.; [4]NTO IRE-Polus; [5]Pacific Oceanological Inst., Russia

The study investigates the mechanism and clinical effectiveness of laser osteoperforation using radiation with wavelengths of 0.97 and 1.9 μm. The key points of the technology implementation were intermittent contact of the optical fiber with the bone at adequate radiation power. The clinical effectiveness of laser osteoperforation has been confirmed in the treatment of various bone pathologies.

TuSYA-09 13:00-13:15

Laser technologies in the osteomyelitis treatment

A.V. Lychagin[1], N.A. Nabatchikov[1,2], O.D. Podkosov[2]; [1]Sechenov First Moscow State Medical Univ.; [2]Botkin Hospital, Russia

Currently, the treatment of distal tibia osteomyelitis remains a hot topic for discussion. Traditional method involves radical segmental bone resection to the level of healthy tissue, which in turn leads to bone defect, which significantly increases treatment and rehabilitation time. But nowadays we have a new treatment method – laser osteoperforation.

TuSYA-10 13:15-13:30

Laser formation of biointegrated electronic components based on carbon nanotubes and graphene

A.Yu. Gerasimenko[1,2], A.V. Kuksin[1], E.A. Gerasimenko[1], A.S. Morozova[1], M.S. Savelyev[1,2]; [1]Institute of Biomedical Systems, National Research University of Electronic Technology, [2]Institute for Bionic Technologies and Engineering, I.M. Sechenov First Moscow State Medical University, Russia

Based on the revealed features of the interaction of laser radiation with carbon nanotubes and graphene, a new approach is proposed for the fabrication of silicon electronic devices and flexible wearable/implantable bioelectronics. Laser radiation stimulates the formation of graphene-nanotube contacts. That led to the development of novel flexible electrically conductive constructs for tissue recovery and electrostimulation of cell growth.

- Lunch Break -

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Tuesday, July 02, 2024

SYA: ADVANCED LASER MEDICAL SYSTEMS AND TECHNOLOGIES 3

Session Chairs: Vladimir Minaev, IRE-Polus Ltd., Russia, Evgeny Shirshin, Lomonosov Moscow State University, Russia

TuSYA-11 15:00-15:30

Thulium fiber laser: experimental study on biological tissue *(Invited paper)*

M.A. Ryabova[1], M.Y Ulupov[1], G.Y. Yukina[2], E.G. Sukhorukova[2], J.O. Rakhmonov[1]; [1]Department of Otorhinolaryngology with Clinic of Pavlov First St. Petersburg State Medical University; [2]Research Center of the Laboratory of Pathomorphology of Pavlov First St. Petersburg State Medical University, Russia

One of the important issues, to develop an optimal mode for minimally invasive outpatient turbinoplasty surgery. In this paper, we select the optimal mode at a wavelength of 1.94 μm on calf kidney tissue to achieve maximum coagulation without ablation of the superficial and interstitial layer. The optimal mode of exposure is concluded.

TuSYA-12 15:30-16:00

Surgery guidance with optical spectroscopy: advances in clinical translation *(Invited paper)*

E.A. Shirshin; Lomonosov Moscow State University, Russia

Optical spectroscopy has been multiply shown to be capable of assisting surgery guidance based on differences in the detected signal from tissue. However, the progress in clinical translation of optical intraoperational diagnostics is not that obvious. In this talk, we will discuss the state-of-art results in optical surgery guidance in urology with a focus on recently developed clinical systems.

TuSYA-13 16:00-16:30

Dual channel video platform for fluorescence diagnostics in augmented reality *(Invited paper)*

M.V. Loshchenov[1], A.M. Udeneev[1,2], N.A. Kalyagina[1,3]; [1]Department of Laser Micro-nano and Biotechnology, National Research Nuclear University MEPhI, [2]Federal State Budgetary «Federal Scientific and Clinical Center for Medical Rehabilitation and Balneology of the Federal Medical and Biological Agency», [3]Prokhorov General Physics Institute RAS, Russia

The topic of the presentation is a wide overview of the diagnostic videosystem combining excitation white light in the red region of visible spectrum and usual white light to give the physician ability observing the area of interest in full or semi-full colors so the diagnostic data appears right on top of the picture in natural colors.

TuSYA-14 16:30-16:45

Optical methods for new medical application: identification of disorders in blood circulation and structure of urethral tissues

E.B. Kiseleva[1], A.S. Kuyarov[2], L.A. Matveev[3], V.V. Dudenkova[1], V.V. Elagin[1], O.S. Streltsova[2]; [1]Research Institute of Experimental Oncology and Biomedical Technologies; [2]E.V. Shakhov Department of Urology; [3]Nonlinear Geophysical Processes Department, Institute of Applied Physics RAS, Russia

This study presents for the first time the combined use of several optical methods for in vivo examination of women with primary urethral pain syndrome (PUPS). Laser Doppler flowmetry (LDF) and transvaginal Doppler ultrasound (TVDUS) allow identifying disorders of blood circulation. Collagen fibrosis were revealed by cross-polarization optical coherence tomography (CP OCT) and then confirmed by nonlinear confocal microscopy.

TuSYA-15 16:45-17:00

Erbium laser for modification of dentin surface of the tooth

Y.S. Kozlova, S.N. Razumova, A.S. Brago; Russia

Indications for usage of Erbium family lasers in dentistry are increasing. The success of root canal treatment depends on removing bacterias and smear layer for better adhesion of sealer. Usage lasers in endodontical treatment enhancing success for the treatment in long-term follow up.

TuSYA-16 17:00-17:15

Promising approaches to optimize the efficiency of laser hydroacoustic processing of biological tissues

A.V. Belikov[1,2], R. Nasser[1], S.N. Smirnov[1]; [1]ITMO University; [2]Pavlov First St. Petersburg State Medical University, Russia

The results of experimental study of the fiber tip end shape influence on the size of the Yb,Er:Glass-laser-induced cavitation bubble and the value of the bubble collapse pressure, as well as theoretical study of the possibility of using 1.45 μm and 1.54 μm laser radiation to pre-heat the liquid before high-intensity laser pulse action, are presented.

- Coffee Break -

SYB: LASER INTERACTION WITH CELLS AND TISSUES- CLINICAL IMAGING AND SPECTROSCOPY

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Tuesday, July 02, 2024

SYB SESSION # 1: TISSUE OPTICS 1

Session Chair: Valery Tuchin, Saratov National Research State Univ., Russia

TuSYB-01 09:00-09:30

Wide-band diffuse reflectance spectroscopy with a self-calibrating fiber-optic probe *(Invited paper)*

I.V. Turchin, V.V. Perekatova, A.B. Kostyuk, A.G. Orlova, A.V. Khilov, E.A. Sergeeva, M.Yu. Kirillin; Federal Research Center A.V. Gaponov-Grekhov Institute of Applied Physics RAS, Russia

A wide-band diffuse reflectance spectroscopy system with a fiber-optic contact probe with two source and two detection fibers has been created. Self-calibration approach made it possible to significantly reduce the influence of surface optical inhomogeneities of tissues and fluctuations of transient characteristics of the device on the obtained result, thus providing reliable data on tissue physiological characteristics.

TuSYB-02 09:30-10:00

Tissue exposure to laser pulses delivered by sapphire medical instruments: advantages for laser coagulation and ablation *(Invited paper)*

I.N. Dolganova[1], P.V. Aleksandrova[2], A.K. Zotov[1], A.A. Platonova[2], K.I. Zaytsev[2], V.N. Kurlov[1], D.G. Kochiev[2]; [1]Osipyan Institute of Solid State Physics RAS; [2]Prokhorov General Physics Institute RAS, Russia

We describe the advantages of sapphire shaped crystals for manufacturing of medical instruments, in particular, capillary needles for interstitial laser therapy. The application of them for tissue ablation and coagulation is discussed. The particular attention is paid to tissue exposure to short laser pulses delivered by these needles.

TuSYB-03 10:00-10:30

Theoretical and experimental study of the effect of laser heating on the optical characteristics of human skin *(Invited paper)*

A.V. Belikov[1,2], V.Yu. Chuchin[1,3], A.A. Masharskaya[1]; [1]ITMO University; [2]Pavlov First St. Petersburg State Medical University; [3]"NPP VOLO" LLC, Russia

For the first time in an in vivo experiment, the dependence of the reflectance spectrum of human skin when heated by laser radiation was measured. Theoretical interpretation of the experimental results is given, and it is shown that the change in reflectance observed in the experiment may be associated with the conversion of skin blood hemoglobin into methemoglobin.

TuSYB-04 10:30-10:45

Studies of the effects of hydrogen fluoride laser radiation on biological tissues

V.M. Fomin; JSC "NIIEFA", Russia

The effects were studied of HF-laser radiation on the eye cornea of primates, human skin - in vivo and on a human myocardial wall - in vitro. The obtained data the results of our previous works and the results of studies by other authors demonstrate the effectiveness and safety of the use of the HF lasers in surgery.

TuSYB-05 10:45-11:00

Study of the use of laser radiation with a wavelength of 450 nm to remove pigmented skin formations

S.A. Podurar[1], N.E. Gorbatova[1], A.V. Bryantsev[1], G.P. Kuzmin[2], A.A. Sirotkin[2], O.V. Tikhonevich[2], Yu.L. Kalachev[2], G.A. Varev[3]; [1]Research Institute of Emergency Pediatric Surgery and Traumatology, [2]Prokhorov General Physics Institute RAS, [3]Russian Engineering Club LLC, Russia

The optimal parameters of laser radiation for the removal and treatment of pigmented skin formations have been determined.

- Coffee Break -

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Tuesday, July 02, 2024

SYB SESSION # 2: TISSUE OPTICS 2

Session Chair: Ilya Turchin, Inst. of Applied Physics RAS, Russia

TuSYB-06 11:30-12:00

Determination of the spectral dispersion for the heart muscle - a Kramers-Kronig approach *(Invited paper)*

Luís M. Oliveira[1,2], Maria R. Pinheiro[2], Hélder P. Oliveira[2,3], Maria I. Carvalho[2,4], Valery V. Tuchin[5,6,7]; [1]Polytechnic of Porto, School of Engineering, Portugal; [2]Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), Portugal; [3]Porto University, Faculty of Science, Portugal; [4]Porto University, Faculty of Engineering, Portugal; [5]Institute of Physics and Science Medical Center, Saratov State University, Russia; [6]Laboratory of Laser Molecular Imaging and Machine Learning, Tomsk State University, Russia; [7]A. N. Bach Institute of Biophotonics, RC "Biotechnology of the Russian Academy of Sciences", Russia

The refractive index of the pigs heart was measured at wavelengths between 255 and 850 nm to calculate the dispersion. The total transmittance and total reflectance spectra of the pig heart were measured between 200 and 1000 nm to calculate the spectral absorption coefficient. Using Kramers-Kronig relations, the dispersion of the heart was matched to experimental refractive index values.

TuSYB-07 12:00-12:30

Optical monitoring of intradermal delivery of drug-loaded vaterite carriers *(Invited paper)*

Yu.I. Svenskaya, M.S. Saveleva, P.A. Demina, R.A. Verkhovskii, Yu.I. Surkov, R.A. Anisimov, I.A. Serebryakova, V.V. Tuchin; Saratov State University, Russia

Drug administration via skin appendages has gained great scientific interest, especially concerning delivery to specific targeted regions and the reduction of systemic toxicity. We propose a novel particulate system for the delivery of glucocorticoids into hair follicles aiming to treat inflammatory skin diseases. The system has been shown to be biodegradable and provide high intradermal concentration of the delivered drug.

TuSYB-08 12:30-13:00

Surgery guidance in orthopedics and dentistry *(Invited paper)*

G.S. Budylin[1], N.R. Rovnyagina[1], E.E. Nikonova[1], P.V. Dyakonov[1], V.A. Petrov[1], D.A. Davydov[1], A.Yu. Turkina[2], M.M. Lipina[3], A.V. Lychagin[3], P.S. Timashev[4], E.A. Shirshin[1,5]; [1]Laboratory of Clinical Biophotonics, Sechenov First Moscow State Medical University; [2]Therapeutic dentistry department, Sechenov First Moscow State Medical University; [3]Department of Trauma, Orthopedics and Disaster Surgery, Sechenov First Moscow State Medical University; [4]Institute for Regenerative Medicine, Sechenov First Moscow State Medical University; [5]Faculty of Physics, Lomonosov Moscow State University, Russia

The assessment of knee joint tissue condition during arthroscopy and the measurement of distance to the dental pulp when removing caries-infected dentin using a fiber-optic implementation of the diffuse reflectance spectroscopy method are investigated.

TuSYB-09 13:00-13:15

Study of liver parenchyma in obstructive jaundice using fluorescence and diffuse reflectance spectroscopy methods

K.Y. Kandurova[1], D.S. Sumin[1,2], A.V. Mamoshin[1,2], M.Yu. Kirillin[3], E.V. Potapova[1]; [1]Research & Development Center of Biomedical Photonics, Orel State University; [2]Orel Regional Clinical Hospital; [3]A.V. Gaponov-Grekhov Institute of Applied Physics RAS, Russia

We report on the application of fluorescence and diffuse reflectance spectroscopy for in vivo measurements during biliary drainage. The results show high potential in developing new diagnostic and prognostic markers in liver state evaluation.

TuSYB-10 13:15-13:30

Measurement and simulation of mouse head optical properties at optical clearing

V.V. Tuchin[1], P.A. Dyachenko[1], D.K. Tuchina[1], Yu.A. Zhavoronkov[2,3], S.V. Ul'yanov[3], V.L. Kuzmin[2]; [1]Institute of Physics and Science Medical Center, Saratov State University, [2]Peter the Great St. Petersburg Polytechnic University, [3]St. Petersburg State University, Russia

Results of ex vivo measurements of NIR laser beams delivery through the mouse head at immersion optical clearing of the scalp are presented. Monte Carlo radiative transfer simulations performed for a four-layer mouse head model well fit experimental distributions.

- Lunch Break -

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Tuesday, July 02, 2024

SYB SESSION # 3: FLUORESCENCE AND APPLICATION

Session Chair: Boris Yakimov, Sechenov First Moscow State Medical Univ., Russia

TuSYB-11 15:00-15:30

Biophotonics in endocrinology: surgery guidance, optical biopsy and point-of-care testing *(Invited paper)*

E.A. Shirshin[1,2]; [1]Lomonosov Moscow State University, [2]The National Medical Research Center for Endocrinology, Russia

In this talk applications of biophotonics in endocrinology will be discussed, namely (1) parathyroid detection and viability assessment for surgery guidance, (2) tumor cells identification with spectrally-resolved confocal microscopy and fluorescence saturation microscopy, (3) body composition analysis with NIR spectroscopy.

TuSYB-12 15:30-16:00

Discovery of novel fluorophores in the human organism with quantitative structure-property relationship approach *(Invited paper)*

B.P. Yakimov[1,2], A.A. Rubekina[2], L.S. Urusova[3], E.A. Shirshin[2,3]; [1]Laboratory of Clinical Biophotonics, Sechenov First Moscow State Medical University; [2]Faculty of Physics, Lomonosov Moscow State University; [3]Endocrinology Research Center, Moscow, Russia

This study explores the application of AI-approach to identify new fluorophores in the human organism. Trained on the multiple representations of the chemical structure of molecules, the approach accurately restored optical properties for known fluorophores and identified new sources in the human body using available databases. The predictions of the presented approach were experimentally validated for fluorophores identified in tissues.

TuSYB-13 16:00-16:30

Time-resolved fluorescence spectroscopy in differential diagnosis of liver cancer in vivo *(Invited paper)*

E.V. Potapova[1], V.V. Shupletsov[1], V.V. Dremin[1,2], A.V. Mamoshin[1,3], A.V. Dunaev[1]; [1]Research & Development Center of Biomedical Photonics, Orel State University, Russia; [2]College of Engineering and Physical Sciences, Aston University, UK; [3]Orel Regional Clinical Hospital, Russia

This work reports a machine-learning-based approach to interpret time-resolved fluorescence spectroscopy data acquired during optical biopsy of the liver. The approach allowed to differentiate between liver parenchyma and tumor with sensitivity and specificity above 0.91 and 0.79, respectively, providing differential diagnosis of liver cancer (primary malignant tumor, metastases, or benign) with sensitivity and specificity of at least 0.80 and 0.95.

TuSYB-14 16:30-16:45

Development of dual-mode hyperspectral/fluorescence lifetime imaging system

V.V. Shupletsov, I.A. Goryunov, E.V. Potapova, V.V. Dremin; Research & Development Center of Biomedical Photonics, Orel State University, Russia

This paper presents a microscopic diagnostic system that combines hyperspectral and frequency domain fluorescence lifetime imaging to record the content of chromophores and high-speed changes in cell and tissue metabolism. The efficiency of the system was tested on liver tumor slices of a laboratory mouse.

TuSYB-15 16:45-17:00

Optical express biopsy of lymph nodes with time-resolved fluorescence macroimaging

A.M. Mozherov[1], A.A. Plekhanov[1], P.A. Kochetkova[3], D.S. Myalik[1,2], A.Yu. Vorontsov[2], B.P. Yakimov, A. Gayer, E.A. Shirshin[4], S.V. Gamayunov[2], V.I. Shcheslavskiy[1]; [1]Privolzhskiy Research Medical Univ.; [2]Nizhny Novgorod Regional Oncologic Hospital; [3]Lobachevsky State Univ.; [4]Lomonosov Moscow State Univ., Russia

We present a simple and fast approach to perform lymph nodes biopsy in a clinical setting using fluorescence time-resolved macroimaging. Histologic analysis is used as the reference standard. We demonstrate that the obtained data allow us to differentiate healthy and metastatic lymph nodes.

- Coffee Break -

SYC: PHOTONICS AND NANOBIOTECHNOLOGY

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Tuesday, July 02, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 1

Session Chair: Petr Nikitin, Prokhorov General Physics Inst. RAS, Russia

TuSYC-01 09:00-09:30

Confined surface-enhanced Raman scattering for bio-objects detection *(Invited paper)*

A.K. Sarychev[1], A.V. Ivanov[1], I.V. Bykov[1], K.E. Mochalovv[2], M.S. Shestopalova[2,3], V.A. Oleinikov[2,3]; [1]Institute of Theoretical and Applied Electrodynamics RAS, [2]Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry RAS, [3]National Research Nuclear University MEPhI, Russia

Analytical theory and experimental results for surface enhanced Raman scattering of molecules confined in a spherical metal resonator is presented. The EM mechanism of the scattering enhancement is investigated. Raman scattering in silver-coated polystyrene spheres, which model bio-objects, is in agreement with our theory.

TuSYC-02 09:30-10:00

Determination of gold concentration in colloids by UV -vis spectroscopy: universality for various nanoparticles and clusters *(Invited paper)*

N.G. Khlebtsov; Institute of Biochemistry and Physiology of Plants and Microorganisms, Saratov Scientific Centre RAS (IBPPM RAS), Saratov State University, Russia

The UV-vis extinction method universality is demonstrated with six experimental and theoretical Au models: nanospheres, nanosphere clusters, nanorods, 2D nanotriangles and nanoplates, and 3D nanostars. In total, we fabricated 34 samples with different nanoparticle sizes, shapes, morphology, and Au concentrations. From simulated and experimental data we derived a universal relation between gold concentration and extinction [Au0](mM) = 0.44×A(400).

TuSYC-03 10:00-10:15

Laser-induced fabrication of nanostructures to probe biomolecule Raman and fluorescence spectra

X. Zhu, E.I. Ageev, D.A. Zuev; ITMO Univ., Russia

"Hot spots" generated by laser-induced surface nanostructures help to efficiently enhance Raman and fluorescence signals and improve the accuracy and sensitivity of biomolecules in viruses to be detected, in the hand of composition and structure.

TuSYC-04 10:15-10:30

Plasmon-enhanced chemiluminescence of lucigenin due to interaction with colloidal gold nanoparticles

D.V. Kononov, A.V. Palehova, A.V. Kochakov, A.V. Afanasieva, T.A. Vartanyan, D.R. Dadadzhanov; ITMO University, Russia

Chemiluminescence enhancement of lucigenin in the vicinity of colloidal gold nanoparticles was studied. The chemiluminescence intensity was found to increase twice independent of the nanoparticle's concentration in the range of 10-4 to 10-8 M.

TuSYC-05 10:30-10:45

Development of biosensors based on surface plasmon resonance imaging technique

I.R. Rodin, I.N. Pavlov; National Research University "MPEI", Russia

The work is devoted to the development of a biosensor based on the phenomenon of surface plasmon resonance. In the process of the work, multiple measurements were carried out at the SPRi facility. The values sensitivity of the method and resolution limit were found to be comparable to the sensitivity and resolution of the frustrated total internal reflection method.

TuSYC-06 10:45-11:00

Lateral flow assay dynamics monitoring with real-time optical and magnetic registration: rapid and quantitative tumor marker detection

A.M. Skirda[1,2], V.A. Bragina[1], S.L. Znoyko[1], A.V. Orlov[1]; [1]Prokhorov General Physics Institute RAS; [2]Moscow Institute of Physics and Technology, Russia

This study presents an innovative biosensor for point-of-care molecular biomarker detection using lateral flow assay dynamics monitoring with real-time optical and magnetic registration. Spectral interferometry analyzes antibody kinetics targeting the tumor marker CYFRA21-1, leading to the development of rapid quantitative lateral flow tests. A novel tool is proposed for controlling label quantities, enhancing the robustness of real-time dynamics-based quantitative systems.

- Coffee Break -

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Tuesday, July 02, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 2

Session Chair: Valentin Borshchevskii, Moscow Institute of Physics and Technology, Russia

TuSYC-07 11:30-12:00

Targeted PLGA nanoparticles as versatile platfrom for the delivery of oncotherapeutic compounds *(Invited paper)*

V.O. Shipunova[1,2], E.N. Komedchikova[1], A.V. Pushkarev[1], M.A. Yurchenko[1], D.A. Maedi[1], A.M. Skirda[1,3], M.P. Nikitin[1,2]; [1]Moscow Institute of Physics and Technology; [2]Sirius University of Science and Technology; [3]Prokhorov General Physics Institute RAS, Russia

In this study, we present the creation of targeted polymer nanoparticles, targosomes, which are loaded with paclitaxel for imaging and treatment of HER2-positive cancer. These synthesized nanoparticles were employed for targeted delivery to tumors and tumor growth reduction in vivo.

TuSYC-08 12:00-12:30

Genetically engineered nanocapsules with fluorescent and magnetic markers for cell tracking and targeted drug delivery *(Invited paper)*

A.N. Gabashvili[1], D.D. Namestnikova[2], I.L. Gubskiy[2], S.S. Vodopyanov[3], M.V. Efremova[4], P.I. Makarevich[5], V.A. Sarkisova[6], P.I. Nikitin[1]; [1]Prokhorov General Physics Inst. RAS; [2]Department of Neurology, Neurosurgery and Medical Genetics, Russia; [3]Department of Microbiology & Immunology, Albert Einstein College of Medicine, New York City, United States; [4]Department of Applied Physics and Science Education, Eindhoven Univ. of Technology, Netherlands; [5]Faculty of Medicine, Lomonosov Moscow State Univ.; [6]Cell Proliferation Laboratory, Engelhardt Inst. of Molecular Biology RAS, Russia

Currently, various functionalized nanocarrier systems are extensively studied for biomedical diagnostics and targeted drug delivery. Joining the approaches of genetic and chemical engineering novel carriers have been produced based on encapsulins, which are capsid-like protein structures, consisting of a shell and various payload inside. A range of potential applications of encapsulins have been developed.

TuSYC-09 12:30-12:45

Glutathione-loaded magnetic nanoparticles as a aprotective theranostic carrier in oncology

V.V. Barinova[1,3], D.A. Tarasova[1,3], V.S. Fedorov[1,2,4], L.Y. Yakovleva[1], N.M. Yudintseva[1,2], D.E. Bobkov[1,2], B.P. Nikolaev[1,2], M.A. Shevtsov[1,2]; [1]Institute of Cytology RAS; [2]Almazov National Medical Research Centre; [3]St. Petersburg State Institute of Technology (Technical University); [4]Department of Inorganic Chemistry and Biophysics, St. Petersburg State University of Veterinary Medicine, Russia

Gluthatione-conjugated magnetic nanoparticles were proposed as a protective drug carrier in theranostics. During the course of work, a stable conjugate was synthesized and had its physico-chemical and antioxidant poperties investigated.

TuSYC-10 12:45-13:00

Laser synthesis of iron-based nanoparticles in gaseous media and magnetic field by nanosecond pulses

D.A. Kochuev[1], A.S. Chernikov[1], M.A. Dzus[1], U.E. Kurilova[1,2,3], A.A. Voznesenskaya[1], A.F. Galkin[1], D.V. Abramov[1], A.V. Kazak[1,4], A.Yu. Gerasimenko[2,3], K.S. Khorkov[1]; [1]Vladimir State University; [2]National Research University of Electronic Technology MIET; [3]I.M. Sechenov First Moscow State Medical University; [4]Moscow Polytechnic University, Russia

The paper presents the results of the ablative synthesis of iron nanoparticles in an argon medium under the action of nanosecond laser pulses. Nanoparticles were collected and deposited using a magnetic field.

TuSYC-11 13:00-13:15

Imaging photoplethysmography to study blood supply in patients with systemic lupus erythematosus and systemic scleroderma

N.P. Podolyan[1], A.V. Belaventseva[1], A.V. Sakovskaia[1,2], O.V. Mamontov[1,3,4], R.V. Romashko[1], A.A. Kamshilin[1]; [1]Laboratory-24, Institute of Automation and Control Processes FEB RAS, [2]Institute of Therapy and Instrumental Diagnostics, Pacific State Medical University, [3]Department of Circulation Physiology, Almazov National Medical Research Centre, [4]Pavlov First St. Petersburg State Medical University, Russia

The parameters of facial blood supply were studied in patients with systemic lupus erythematosus and systemic scleroderma using a non-contact imaging photoplethysmography method synchronized with an electrocardiogram. Statistically significant differences in the amplitude and time of arrival of the pulse wave to different areas of the face were revealed in sick patients compared with the control group.

- Lunch Break -

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Tuesday, July 02, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 3

Session Chair: Petr Nikitin, Prokhorov General Physics Inst. RAS, Russia

TuSYC-12 15:00-15:30

Nanoparticles in optical bioanalytical techniques: finding efficient labels and formats of application *(Invited paper)*

A.V. Zherdev, B.B. Dzantiev; A.N. Bach Institute of Biochemistry, Research Centre of Biotechnology RAS, Russia

The use of nanoparticles as carriers and labels in optical bioanalytical systems will be discussed. Comparison of nanoparticles differing in composition, size and shape, content of immobilized bioreceptors (antibodies, aptamers) will be presented; criteria for reaching minimal limits of detection will be formulated. The effectiveness of the selected preparations in agglutination and lateral flow test systems will be demonstrated. The study was supported by the RSF grant 23-46-10011.

TuSYC-13 15:30-16:00

Low-dimensional magnetic structures as sensing nanoprobes for advanced bioapplications *(Invited paper)*

A.V. Orlov; Prokhorov General Physics Institute RAS, Russia

This research explores the potential of one- and two-dimensional magnetic nanomaterials in bioanalytical applications. Here, innovative methods are presented for advanced sensing, including ultrafast biomarker detection, electronic and optical quantification of anisotropic magnetic nanostructures, and simultaneous determination of various materials in a single sample. These methods hold the promise of faster targeting, advanced diagnostics, and new optical and magnetic bioimaging.

TuSYC-14 16:00-16:15

Ensemble methods for analyzing Raman spectra of macromolecular complexes with a small amount of additives

O.A. Mayorova, M.S. Saveleva, D.N. Bratashov, E.S. Prikhozhdenko; Science Medical Center, Saratov State University, Russia

Combining Raman spectroscopy and machine learning is a great way to study the chemical structure of macromolecules and their complexes. Random forest and gradient boosting approaches were implemented in solving regression and classification problems in analysis of WPI:HA Raman spectra with low HA amount. Feature importance obtained could highlight the Raman bands that differ the most among the samples.

TuSYC-15 16:15-16:30

Strategies for miRNA delivery to stimulate liver regeneration: nanocarriers and metabolic imaging

S. Rodimova[1], D. Kozlov[1,2], D. Krylov[1,2], A. Mozherov[1], V. Elagin[1], L. Mikhailova[3], M. Zyuzin[3], D. Kuznetsova[1]; [1]Privolzhsky Research Medical University; [2]National Research Lobachevsky State University; [3]ITMO University, Russia

We present a new strategy to develop a controlled method to stimulate liver regeneration. The method is based on the use of nanocarriers with microRNAs. Nanoparticle-based complexes represent a tool not only for therapy, but also for visualizing the distribution of the therapeutic agent.

TuSYC-16 16:30-16:45

Universal and flexible design for high-sensitivity and wide-ranging surface plasmon resonance sensors based on a three-dimensional tuning hypersurface

Shiqi Hu[1], Yaofei Chen[1], Gui-shi Liu[1], Lei Chen[1], Yunhan Luo[1], Zhe Chen[2]; [1]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Department of Optoelectronic Engineering, College of Science and Engineering, Jinan University; [2]JiHua Laboratory, Foshan, Guangdong, China

This work uses a hypersurface concept to freely tune the PSPR wavelength, expanding the sensor's operating region from curve to surface. Experiments demonstrated higher sensitivity and wider refractive index range compared to conventional PSPR sensors.

SYA: ADVANCED LASER MEDICAL SYSTEMS AND TECHNOLOGIES - POSTERS

Location: Nikolsky + Levinson Foyer, Floor 2; Date: Tuesday, July 02, 2024

TuSYA-p01 15:00-18:30

IR spectroscopy for hematology

L.V. Plotnikova[1], A.D. Garifullin[1,2], A.Y. Kuvshinov[2], S.V. Voloshin[2,3,4], R.V. Butyaev[1], A.D. Kartashova[1], A.M. Polyanichko[1,5]; [1]St. Petersburg State University, [2]Russian Research Institute of Hematology and Transfusiology, [3]Kirov Military Medical Academy, [4]Mechnikov Northwestern State Medical University, [5]Institute of Cytology RAS, Russia

Currently, there is an increase in the number of oncohematological diseases. Simple and reliable screening methods are required for their effective diagnosis. One of the promising and rapidly developing approaches is IR spectroscopy of various samples of biomaterials.

TuSYA-p02 15:00-18:30

Fiber pyrometer based on AgCl.25Br.75-AgI fiber for measuring temperature in hard-to-reach places

A.E. Lvov, A.A. Yuzhakova, D.D. Salimgareev, P.V. Pestereva, A.S. Korsakov, L.V. Zhukova; Ural Federal University, Russia

The work is devoted to the manufacture of a fiber pyrometer based on AgCl0.25Br0.75 – AgI fibers and using it to measure the temperature of objects in the range of 36-50 °C.

TuSYA-p03 15:00-18:30

Studying thermal effects of infrared femtosecond laser pulses applied for laser assisted hatching procedure on mouse embryos

D.S. Sitnikov[1], M.A. Filatov[2], M.V. Kubekina[2], Y.Y. Silaeva[3]; [1]JIHT RAS; [2]Center for Precision Genome Editing and Genetic Technologies for Biomedicine, IGB RAS; [3]Core Facility Centre, IGB RAS, Russia

Infrared femtosecond laser pulses are used for microsurgery of zona pellucida of mouse embryos at late stages of preimplantation development. Safety of the procedure is studied through embryo viability and heat shock proteins (HSP) gene expression assessment methods. Expression levels of the genes encoding HSPs were shown to increase slightly compared to the negative control group.

TuSYA-p04 15:00-18:30

Histophysiological study of the skin after exposure to holmium laser radiation

V.V. Astashov[1], P.V. Novokreshchenov[1], M.S. Kopyeva[1,2], S.A. Filatova[2], V.I. Kozlov[1], V.A. Duvanskiy[1]; [1]Peoples' Friendship University of Russia, RUDN University; [2]Prokhorov General Physics Institute RAS, Russia

A histophysiological investigation of the experimental animals skin was performed on day 3 after exposure to holmium-doped fiber laser continuous-wave radiation at different power intensities. Using histologic and functional research methods, changes characteristic of the exudative stage of aseptic inflammation were revealed, the severity of which depended on the radiation dose.

TuSYA-p05 15:00-18:30

Raman spectroscopy as a tool for helicobacter pylori diagnostics

E.E. Popov, A.V. Polishchuk, A.V. Kovalev, V.V. Vitkin; ITMO University, Russia

Raman spectroscopy was studied as a diagnostic tool for detecting Helicobacter pylori infection. We suggested a new methodology to account the changes in the spectrum of Raman scattering caused by pressure variations, which enabled us to measure the 13CO2 fraction with a relative error 2.1%. The results showed a positive correlation with a blood test for H. pylori antibodies.

SYB: LASER INTERACTION WITH CELLS AND TISSUES- CLINICAL IMAGING AND SPECTROSCOPY - POSTERS

Location: Nikolsky + Levinson Foyer, Floor 2; Date: Tuesday, July 02, 2024
Session Chair: Evgeny Shirshin, Lomonosov Moscow State University, Russia

TuSYB-p01 15:00-18:30

The effect of optical clearing agents on the results obtained with the digital nailfold capillaroscopy

P.A. Moldon, A.E. Lugovtsov, P.B. Ermolinskiy, Y.I Gurfinkel, A.V. Priezzhev; Lomonosov Moscow State University, Russia

In this work the influence of optical clearing agents (OCA) on the blood flow in nailfold capillaries was studied. It was shown that parameters obtained by nailfold capillaroscopy technique depend on OCAs used for visualization of capillaries.

TuSYB-p02 15:00-18:30

Two approaches to estimate the depth of light penetration into biotissues

A.P. Tarasov[1,2], D.A. Rogatkin[1]; [1]Moscow Regional Research and Clinical Institute (MONIKI); [2]National Research Centre "Kurchatov Institute", Russia

The work compares two approaches to evaluate the depth, based, respectively, on the exponential decay, and on the estimation of a volume, where 95% of absorbed light is accumulated. It is shown that the approach, which uses the conventional exponential decay, underestimates the penetration depth in more than 2 times.

TuSYB-p03 15:00-18:30

In vivo study of vascularization and oxygenation of tumor xenografts

A.M. Glyavina[1,2], K.G. Akhmedzhanova[1,2], A.A. Kurnikov[1], Yu.A. Khochenkova[1,3], D.A. Khochenkov[1,3], I.V. Turchin[1], P.V. Subochev[1], A.G. Orlova[1]; [1]Inst. of Applied Physics RAS; [2]Lobachevsky State Univ. of Nizhny Novgorod; [3]N.N. Blokhin National Medical Research Center of Oncology, Russia

A combination of OA and DOS methods has been proposed to assess the vascular structure and oxygenation level of renal (SN-12C) and colon (Colo320, HCT116) cancer models. Differences in the structure of the vascular bed are shown; high vascularity was found for Colo320 and SN-12C. Colo320 showed increased hemoglobin and decreased oxygen saturation compared to SN-12C and HCT116.

TuSYB-p04 15:00-18:30

Validation and comparative analysis of off-axis digital holographic microscopy and SLIM for biological applications

I.V. Semenova[1], A.V. Belashov[1], A.A. Zhikhoreva[1], M.V. Belashov[2], P.S. Butorin[1]; [1]Ioffe Inst.; [2]ITMO Univ., Russia

The paper presents analysis of the performance of two quantitative phase imaging methods implemented on the model object of polystyrene beads dissolved in water. Phase images obtained using two realizations of SLIM technique and off-axis digital holographic microscopy were compared with the expected phase shift image from spherical transparent phase objects.

TuSYB-p05 15:00-18:30

Fast Spectroscopic Technique of Optical Biopsy of Intracranial Tumors

I.D. Romanishkin[1], T.A. Savelieva[1,2], A. Ospanov[2], S.V. Shugai[3], S.A. Goryajnov[3], G.V. Pavlova[3,4], I.N. Pronin[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS, [2]National Research Nuclear University MEPhI, [3]N.N. Burdenko National Medical Research Center of Neurosurgery, [4]Institute of Higher Nervous Activity and Neurophysiology RAS, Russia

The possibility of differentiation of glial and meningeal tumors on the basis of the proposed method of optical-spectral analysis was shown. For non-fluorescing tumors, the most significant indicators were the intensity of elastic light scattering, carotenoid content, and the change in lipid/protein ratio.

TuSYB-p06 15:00-18:30

Advanced optoacoustic imaging capabilities using piezopolymer detectors: increased sensitivity, wide reception bandwidth, high numerical aperture

A.A. Kurnikov[1], A.G. Sanin[1], G.P. Volkov[1], A.G. Orlova[1], A.V. Kovalchuk[1], D. Razansky[2], P.V. Subochev[1]; [1]Inst. of Applied Physics RAS, Russia; [2]ETH Zurich, Switzerland

Optoacoustic (OA) angiography is a non-invasive imaging technique that involves probing tissue with laser pulses and recording ultrasound signals. This study focuses on analyzing the sensitivity, reception bandwidth, and numerical aperture of piezoelectric transducers used for ultrasound detection. Through numerical simulations and experiments, the effectiveness of piezopolymer detectors in providing detailed OA visualization of complex vascular networks has been demonstrated.

TuSYB-p07 15:00-18:30

Monte Carlo modeling of the red blood cell aggregation in photoplethysmography

D.G. Lapitan, A.P. Tarasov; Moscow Regional Research and Clinical Institute ("MONIKI"), Russia

The effect of red blood cell (RBC) aggregation on the photoplethysmography (PPG) signal at a wavelength of 810 nm was investigated using the Monte Carlo method. It was found that the main contribution to the formation of the PPG signal is made by scattering variations due to changes in the rouleaux size (84% versus 16% absorption, respectively).

TuSYB-p08 15:00-18:30

OCT monitoring of scattering kinetics in tissue phantoms at optical clearing with depth resolution

I.A. Serebryakova[1,2], Y.I. Surkov[1,2], E.A. Genina[1,2], V.V. Tuchin[1,2,3]; [1]Optics and Biophotonics Department, Saratov State University; [2]Laboratory of Laser Molecular Imaging and Machine Learning, Tomsk State University; [3]Laboratory of Laser Diagnostics of Technical and Living Systems, Institute of Precision Mechanics and Control RAS, Russia

A method for reconstructing and monitoring the scattering coefficient with a depth resolution of homogeneous samples with optical clearing of the sample has been developed and tested on a gelatin phantom. The proposed method makes it possible to track changes in the scattering coefficient at different depths.

TuSYB-p09 15:00-18:30

Channel shape inside sapphire capillary needles and its impact on transmitted laser beam

I.A. Shikunova, D.O. Strukov, Yu.N. Zubareva, I.N. Dolganova, V.N. Kurlov; Osipyan Institute of Solid State Physics RAS, Russia

In sapphire needle capillaries, we analyze the form of the internal channel and the needle tip and their influence on the shape of the outcoming beam. We propose some methods of alteration of the capillary shape via growth conditions that contribute to obtaining the required geometry.

TuSYB-p10 15:00-18:30

Development of optical modules to existing laboratory devices for biomarker detection in vivo

M.A. Makhortov[1], O.V. Grishin[1], S.A. Perkov[2], O.I. Gusliakova[1,3], D.N. Bratashov[1], E.S. Prikhozhdenko[1]; [1]Science Medical Center, Saratov State University; [2]Photonics Center, Skolkovo Institute of Science and Technology; [3]Vladimir Zelman Center for Neurobiology and Brain Rehabilitation, Skolkovo Institute of Science and Technology, Russia

Usually, existing laboratory devices for conducting in vitro studies require modification to carry out in vivo measurements. We have developed the fiber probe connected to Raman spectrometer Renishaw inVia and the external optical circuit for in vivo photoacoustics cytometer which allows measuring photoacoustics signal of biological fluids either in laboratory tubes, or in vivo in laboratory animals.

TuSYB-p11 15:00-18:30

129Xe nuclear spin laser hyperpolarizer

V.M. Vodovozov, R.F. Kurunov, A.V. Pavlenko, V.M. Baev, M.V. Kuleshov, V.A. Chumichev, V.V. Eremkin, A.A. Baturina; JSC "NIIEFA", Russia

The experimental model of the 129Xe laser hyperpolarizer for MRI diagnostics of human organs inaccessible for examination by classical proton tomography is presented. Spin Exchange Optical Pumping (SEOP) is used to develop the hyperpolarized state of 129Xe. A polarization level of 40% has been achieved with a gas capacity of ~1,2 l/hour.

TuSYB-p12 15:00-18:30

Mathematical simulation of uniform heating of biological tissues by laser radiation

K.V. Sovin[1,2], N.V. Kovalenko[1,2], V.S. Anpilov[1,2], O.A. Ryabushkin[1,2]; [1]Moscow Inst. of Physics and Technology (National Research University); [2]Fryazino branch of Kotelnikov Inst. of Radio-Engineering and Electronics, Russia

The description of thermal damage to biological tissues is based on the Arrhenius formalism. Measurements of Arrhenius parameters are conducted under the assumption of homogeneously degraded samples. We simulated the degradation processes under conditions of heating with air, water and optical radiation. Optical heating demonstrated high accuracy in the retrieving degradation kinetics parameters at different sample thicknesses and degradation times.

SYB: LASER INTERACTION WITH CELLS AND TISSUES- CLINICAL IMAGING AND SPECTROSCOPY

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Wednesday, July 03, 2024

SYB SESSION # 4: OPTICAL CHARACTERIZATION OF BLOOD CELLS AND FLOW 1

Session Chair: Alexander Priezzhev, Lomonosov Moscow State University, Russia

WeSYB-16 09:00-09:30

Microcirculatory-tissue systems of the human body as an object of study in space research *(Invited paper)*

A.V. Dunaev; Orel State University, Russia

This paper presents the results of the study of changes in microcirculatory-tissue systems under spaceflight and isolation experiment conditions. For the first time, a technique has been developed for measuring microcirculatory-tissue systems in the limbs of cosmonauts during the period of acute adaptation to microgravity conditions and readaptation after the completion of a spaceflight.

WeSYB-17 09:30-10:00

The problem of data reproducibility in laser diffractometry of erythrocytes *(Invited paper)*

S.Yu. Nikitin; Physics Faculty of Lomonosov Moscow State University, Russia

Two algorithms for measuring the red blood cell mean radius and red blood cell distribution width (RDW) are proposed, based on the analysis of the diffraction pattern that occurs when a laser beam is scattered on a blood smear.

WeSYB-18 10:00-10:30

Experimental comparison of imaging photoplethysmography and laser speckle contrast imaging for blood flow assessment *(Invited paper)*

A.A. Kamshilin; Institute of Automation and Control Processes FEB RAS, Russia

In this work, responses of cortical vessels to administration of a metabolic agent were measured in rats using contactless imaging photoplethysmography and laser speckle contrast imaging systems providing full-field of view visualization of blood flow. It was found that blood-flow changes detected by two systems are significantly different due to different nature of light interaction with tissues underlying these methods.

WeSYB-19 10:30-10:45

Optically measured blood microcirculation parameters and their correlation with endothelium function in healthy volunteers and patients suffering from cardiovascular diseases

A.V. Priezzhev, P.B. Ermolinskiy, Yu.I. Gurfinkel, E. Sovetnikov, A.E. Lugovtsov; Lomonosov Moscow State University, Russia

The objective of this work was to examine and compare the microcirculation in healthy volunteers and two groups of patients suffering from cardiovascular diseases, specifically coronary heart disease (CHD) and atrial fibrillation (AF).

WeSYB-20 10:45-11:00

Imaging of microcirculation enhanced with optical clearing agents and evaluation of their effect on blood microrheology

A.E. Lugovtsov[1], P.B. Ermolinskiy[1], P.A. Moldon[1], D.A. Umerenkov[1], Yu.I. Gurfinkel[1], P.A. Timoshina[2], Pengcheng Li[3], A.V. Priezzhev[1]; [1]Lomonosov Moscow State University, Russia; [2]Saratov State University, Russia; [3]Huazhong University of Science and Technology, China

The efficiency of 15 optical clearing agents (OCAs) that are widely used for enhancement of imaging of tissues was investigated. We show a significant impact on elevating the transparency and improving the visualization of the nail bed capillaries. A significant effect of OCAs on microrheological parameters of blood was shown.

- Coffee Break -

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Wednesday, July 03, 2024

SYB SESSION # 5: OPTICAL CHARACTERIZATION OF BLOOD CELLS AND FLOW 2

Session Chair: Andrei Lugovtsov, Lomonosov Moscow State University, Russia

WeSYB-21 11:30-12:00

Optical measurements in vitro and in vivo of erythrocyte aggregation parameters in patients with different pathologies *(Invited paper)*

P.B. Ermolinskiy[1], M.K. Maksimov[1], D.A. Umerenkov[1], Yu.I. Gurfinkel[2], L.I. Dychuk[2], A.E. Lugovtsov[1], A.V. Priezzhev[1]; [1]Department of Physics, Lomonosov Moscow State University; [2]Medical Research and Education Center, Lomonosov Moscow State University, Russia

Blood microrheological parameters are essential for understanding blood microcirculation. In this study, we applied different laser-optical techniques to measure aggregation parameters in blood samples from healthy donors and patients suffering from cardiovascular diseases. We identified significant differences in aggregation parameters between groups, demonstrating the effectiveness of these methods for assessing erythrocyte aggregation both in vivo and in vitro.

WeSYB-22 12:00-12:15

Cerebral blood flow dynamics in rats with blood loss

N.V. Golubova[1,2], I.A. Ryzhkov[2], K.N. Lapin[2], V.N. Prizemin[1], A.V. Dunaev[1], V.V. Dremin[1], E.V. Potapova[1]; [1]Research & Development Center of Biomedical Photonics, Orel State University, [2]Federal Research and Clinical Center of Intensive Care Medicine and Rehabilitology, Russia

This paper presents the results of investigating the blood flow dynamics using the laser speckle contrast imaging method in rats with blood loss and without it. The results indicate that under such conditions, there was no significant decrease in speckle perfusion values.

WeSYB-23 12:15-12:30

Intraoperative assessment of blood flow during esophageal resection using fluorescence diagnostics and diffuse scattering spectroscopy

A.A. Krivetskaya[1,2], D.M. Kustov[1], V.V. Levkin[3], S.V. Osminin[3], S.S. Kharnas[3], E.V. Eventeva[3], F.P. Vetshev[3], R.N. Komarov[3], A.S. Gorbunov[3], K.G. Linkov[1], T.A. Savelieva[1,2], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS; [2]Institute of Engineering Physics for Biomedicine, National Research Nuclear University MEPhI; [3]Department of Faculty Surgery No.1, I.M. Sechenov First Moscow State Medical University, Russia

The assessment of tissue blood supply during surgery can reduce the risk of postoperative complications. This work proposes the use of fluorescence diagnostics and diffuse scattering spectroscopy for the accomplishment of the desired aim.

WeSYB-24 12:30-12:45

Wearable multimodal analyzers in the microcirculatory-tissue systems monitoring during different sleep stages

Y.I. Loktionova[1], E.V. Zharkikh[1], D.F. Kleeva[2], V.S. Yanushin[1], V.V. Sidorov[3], A.I. Krupatkin[4], A.V. Dunaev[1]; [1]Research & Development Center of Biomedical Photonics, Orel State University; [2]National Research University Higher School of Economics; [3]SPE "LAZMA" Ltd.; [4]Priorov Central Research Institute of Traumatology and Orthopedics, Russia

This paper presents the first results of the study of changes in microcirculatory-tissue systems functioning during different sleep stages. Wearable multimodal devices were used to monitoring the microcirculatory-tissue systems during night sleep simultaneously with electroencephalography to separate the sleep stages.

WeSYB-25 12:45-13:00

Wearable multimodal laser analyzers in assessing of microcirculatory disorders in the long COVID syndrome

E.V. Zharkikh[1], Y.I. Loktionova[1], V.E. Parshakova[1], A.A. Fedorovich[1,2], A.V. Dunaev[1]; [1]Research & Development Center of Biomedical Photonics, Orel State University; [2]National Medical Research Center for Therapy and Preventive Medicine of the Ministry of Healthcare of the Russian Federation, Russia

The paper presents the results of the study of the effect of long COVID on the functional state of microcirculatory-tissue systems of the human body using wearable multimodal laser analyzers.

- Lunch Break -

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Wednesday, July 03, 2024

SYB SESSION # 6: PHOTOACOUSTIC

Session Chair: Daniil Bratashov, Saratov National Research State Univ., Russia

WeSYB-26 15:00-15:30

Revolutionizing vascular diagnostics: the role of wideband ultrasound detectors in optoacoustic visualization technologies *(Invited paper)*

P.V. Subochev; Institute of Applied Physics RAS, Russia

This presentation explores the transformative impact of wideband ultrasound detectors in optoacoustic angiography, combining optical imaging's molecular specificity with ultrasound's depth. We'll discuss advancements in piezopolymer detector design and the potential of these detectors in enhancing image quality, resolution, and real-time diagnostic capabilities in biomedical optoacoustic imaging.

WeSYB-27 15:30-16:00

Photoacoustic technologies for visualizing tumors and searching for foreign objects in the blood stream *(Invited paper)*

D.N. Bratashov, N.A. Shushunova, M.A. Makhortov, E.S. Prikhozhdenko; Saratov State University, Russia

Development of tumors at different stages in an animal model with engrafted tumors and study the number of circulating tumor cells produced by the tumors was investigated.The in vivo photoacoustic flow cytometry setup was developed for second task. It can work with the blood flow in a large vessel of an animal or the human body.

WeSYB-28 16:00-16:30

In vivo applications of raster-scan optoacoustic angiography *(Invited paper)*

A.G. Orlova[1], K.G. Akhmedzhanova[1,2], A.A. Kurnikov[1], A.M. Glyavina[1,2], D.A. Khochenkov[1,3], Yu.A. Khochenkova[1,3], A.V. Maslennikova[1,2,4], S.V. Nemirova[1,4], I.V. Turchin[1], P.V. Subochev[1]; [1]A.V. Gaponov-Grekhov Institute of Applied Physics RAS; [2]N.I. Lobachevsky State University of Nizhny Novgorod; [3]N.N. Blokhin National Medical Research Center of Oncology; [4]Privolzhsky Research Medical University, Russia

Vascular network of human and animal tissues was studied using raster-scan system with 532 nm laser source and wideband PVDF detector. Experimental tumors of different origin were compared. Changes in vascularity of tumors after radiation therapy were demonstrated. For patients with post-thrombotic syndrome changes in blood volume, vessel diameter and tortuosity were revealed.

WeSYB-29 16:30-16:45

A reduction in the required laser energy for optical resolution photoacoustic microscopy using PVDF-TrFe piezopolymer ultrasonic detectors

D.A. Voitovich, A.A. Kurnikov, A.G. Orlova, P.V. Subochev; Institute of Applied Physics RAS, Russia

Optical resolution photoacoustic microscopy (OR-PAM) is a high-resolution in-vivo imaging that based on the photoacoustic effect. This study introduces OR-PAM setup incorporating a PVDF-TrFe film in the ultrasonic detector. By employing this film, the sensitivity of the piezoelectric detector is enhanced. Additionally, it allows for a reduction in the required laser radiation energy for safety reasons.

SYC: PHOTONICS AND NANOBIOTECHNOLOGY

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Wednesday, July 03, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 4

Session Chair: Dmitry Gorin, Skolkovo Inst. of Science and Technology, Russia

WeSYC-17 09:00-09:30

Multispectral fluorescence lifetime imaging microscopy of endogenous fluorophores at a single excitation wavelength *(Invited paper)*

B. Yakimov[1,2], A. Komarova[3], E. Nikonova[1], A. Mozherov[3], L. Shimolina[3], M. Shirmanova[3], W. Becker[4], E. Shirshin[1,2], V. Shcheslavskiy[3,4]; [1]Sechenov First Moscow State Medical University, Russia; [2]Lomonosov Moscow State University, Russia; [3]Privolzhsky Research Medical University, Russia; [4]Becker&Hickl GmbH, Germany

We present experiments on multi-wavelength fluorescence lifetime imaging microscopy of NAD(P)H and flavins at a single wavelength of 750 нм. We show the advantages and limitations of using single photon counting spectral detectors for metabolic imaging of cells and tumor spheroids.

WeSYC-18 09:30-10:00

Time-resolved fluorescence microscopy of QDs in investigations of endolysosome acidification *(Invited paper)*

E.S. Kornilova[1,2,3], I.K. Litvinov[1], A.V. Salova[1], T.N. Belyaeva[1]; [1]Institute of Cytology RAS; [2]Peter the Great St. Petersburg Polytechnic Univ.; [3]St. Petersburg State Univ., Russia

Endolysosome acidification was assessed by time-resolved fluorescence microscopy (FLIM) using quantum dots targeted by EGF (EGF-QDs). It has been shown that the interpretation of the results of changes in the QD lifetime using the proton pump inhibitor BafA1 depends on the method of its administration. Also, some additional factors in endolysosomes can affect lifetime of QDs besides pH.

WeSYC-19 10:00-10:15

Targeted magnetic nanoparticles for cancer diagnosis and treatment

O.A. Kolesnikova[1], E.N. Komedchikova[1], M.A. Yurchenko[1], D.A. Maedi[1], A.M. Skirda[1,3], V.O. Shipunova[1,2]; [1]Moscow Institute of Physics and Technology, [2]Sirius University of Science and Technology, [3]Prokhorov General Physics Institute RAS, Russia

Over the past few years, nanomaterials have garnered considerable attention, in particular, targeted nanoformulations due to their high specificity of delivery to molecular targets and reduced systemic toxicity for the organism. Here we report the study of the cellular delivery of targeted fluorescent magnetic nanoparticles to human epidermal growth factor receptor 2, clinically significant oncomarker.

WeSYC-20 10:15-10:30

Ir(III) complexes - sensors for hypoxia detection

I.S. Kritchenkov[1,2], M. Samandar[1], N.A. Zharskaia[1], S.A. Silonov[1,3], E.E. Galenko[1], D.O. Karpitskaya[1], S.P. Tunik[1]; [1]Institute of Chemistry, St Petersburg State University, [2]Faculty of Science, Peoples' Friendship University of Russia (RUDN University), [3]Institute of Cytology RAS, Russia

In this work, two new Ir(III) complexes were synthesized. All complexes exhibit efficient phosphorescence with pronounced sensitivity to the presence of oxygen. For the most promising complex the phosphorescence lifetime imaging experiments were conducted, revealing that this sensor markedly changes the phosphorescence lifetime values in cells from 1.8 to 4.1 μs upon transition from normoxia to simulated hypoxia.

WeSYC-21 10:30-10:45

Monitoring cellular uptake of gold nanoparticles by stationary absorption spectroscopy

A.V. Kochakov[1], A.A. Mitusova[2], D.R. Dadadzhanov[1], D.V. Kononov[1], N.S. Petrov[1]; [1]ITMO University, [2]Pavlov First Saint Petersburg State Medical University, Russia

Gold plasmonic nanoparticles were synthesized by the reduction of chloroauric acid (HAuCl4) followed by surface modification using a biocompatible polymer (PEG). Nanoparticles were introduced into tumor cells of leukemia and melanoma lines. Verification of endocytosis of nanoparticles by cancer cells is approved by stationary absorbance spectroscopy.

WeSYC-22 10:45-11:00

Green and red emissive N, O-doped chiral carbon dots functionalized with L-cysteine

A.A. Vedernikova[1], S.A. Shipilovskikh[2], E.V. Ushakova[1]; [1]International Research and Education Center for Physics of Nanostructures, ITMO University, [2]School of Physics and Engineering, ITMO University, Russia

Chiral carbon dots (CDs) are promising nanoparticles for sensing and bioimaging. Herein, the green and red emissive chiral CDs are fabricated via surface modification treatment of achiral CDs at room temperature. The treated CDs demonstrate an intense chiral signal in the region of 200–300 nm with dissymmetry factor up to 2.3×10 4.

- Coffee Break -

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Wednesday, July 03, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 5

Session Chair: Petr Nikitin, Prokhorov General Physics Inst. RAS, Russia

WeSYC-23 11:30-12:00

Design and interactions of luminescent nanoparticles in analytical systems *(Invited paper)*

I.Y. Goryacheva, D.D. Drozd, P.D. Strokin, D.A. Kornilov, Y.A. Podkolodnaya, O.A. Goryacheva; Saratov State University, Russia

Luminescent nanoparticles and nanoclusters represent a promising tool for imaging and bioanalysis. The sophisticated design of nanoparticles allows them to be used as active and passive labels to detect the presence of various components. The potential of nanoparticles to alter the optical signal in response to the presence of analytes and their analytical applications are discussed.

WeSYC-24 12:00-12:30

Upconversion nanoparticles for diagnosis and targeted treatment of cancer *(Invited paper)*

N.Yu. Shilyagina[1], E.L. Guryev[1], D.K. Bausheva[1], L.V. Krylova[1], A.B. Voloveckiy[2], V.A. Vodeneev[1], I.V. Balalaeva[1], S.M. Deyev[3] and A.V. Zvyagin[1,2,3]; [1]Lobachevsky State Univ. of Nizhny Novgorod, [2]The Institute of Molecular Medicine, I.M. Sechenov First Moscow State Medical Univ., [3]Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry RAS, Russia

Theranostics is one of the fastest growing areas in cancer therapy. We have created a new type of theranostic complexes based on up-conversion nanoparticles and the recombinant targeted toxin DARPin-LoPE. We demonstrated selective binding of the complexes to cells, demonstrated the ability to intravitally visualize the biodistribution and accumulation of complexes in tumors, and demonstrated specific toxicity to tumor cells.

WeSYC-25 12:30-13:00

Metabolic and oxygen measurements in tumors in vivo using fluorescence and phosphorescence lifetime imaging *(Invited paper)*

M.V. Shirmanova[1], A.D. Komarova[1], A.M. Mozherov[1], A.A. Plekhanov[1], M.A. Sirotkina[1], L.E. Shimolina[1], M. Lukina[1], L.N. Bochkarev[2], V.I. Shcheslavskiy[1]; [1]Privolzhsky Research Medical University; [2]Razuvaev Institute of Organometallic Chemistry RAS, Russia

Glycolysis and hypoxia are the critical features of solid tumors, however the relationships between oxygenation and the metabolic state of tumor cells are not entirely clear. We present the results of in vivo fluorescence and phosphorescence lifetime imaging to probe metabolic state and oxygen level in tumor models upon natural growth and anti-cancer therapy.

WeSYC-26 13:00-13:15

Effect of administration route on biodistribution of PLGA nanoparticles

E.N. Komedchikova[1], O.A. Kolesnikova[1], E.N. Mochalova[1,2], A.S. Drozdov[1], J.A. Malkerov[3], V.R. Cherkasov[1], V.O. Shipunova[1,2]; [1]Moscow Institute of Physics and Technology; [2]Sirius University of Science and Technology; [3]Prokhorov General Physics Institute RAS, Russia

In this study, we compared the biodistribution of PLGA nanoparticles 4h after intravenous or intraperitoneal injections – two commonly used administration routes.

WeSYC-27 13:15-13:30

Multifunctional hybrid nanoparticles as vectors for regulating the expression of target genes

P.I. Nikitin[1], A.M. Skirda[1,2]; [1]Prokhorov General Physics Inst. RAS; [2]Moscow Inst. of Physics and Technology, Russia

Multifunctional hybrid nanoparticles have been developed for gene therapy and addresses the need for carriers of minimal cytotoxicity. The obtained nanoparticles exhibit optical and superparamagnetic properties, biomolecule binding, form stable complexes with therapeutic nucleic acids, and can serve as carriers for gene regulation. They demonstrate high efficiency in targeted siRNA delivery and offer biocompatibility and potential for controlled intracellular applications.

- Lunch Break -

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Wednesday, July 03, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 6

Session Chair: Alexey Orlov, Prokhorov General Physics Inst. RAS, Russia

WeSYC-28 15:00-15:30

Rigidochromic porphyrazine dyes: smart molecules for sensing and cancer treatment *(Invited paper)*

I.V. Balalaeva[1], N.N. Peskova[1], L.N. Shestakova[1], N.Yu. Shilyagina[1], V.I. Plekhanov[2], S.A. Lermontova[3], L.G. Klapshina[3]; [1]Lobachevsky State Univ. of Nizhny Novgorod, [2]Gaponov-Grekhov Inst. of Applied Physics RAS, [3]Razuvaev Inst. of Organometallic Chemistry RAS, Russia

Tetracyanotetra(aryl)porphyrazines are a unique group of dyes combining properties of molecular rotors and photodynamic agents. The fluorescence lifetime and quantum yield of these compounds are highly dependent on local viscosity, so they can be used as sensors of intracellular viscosity. The rigidochromic behaviour of the compounds provides a tool to quantify cell damage in real time during photodynamic cancer treatment.

WeSYC-29 15:30-16:00

Polymer optic fiber photoluminescent probe for cortisol continuous monitoring with metal-enhanced displacement fluoroimmunoassay *(Invited paper)*

P.A. Kusov, Yu.V. Kotelevtsev, V.P. Drachev; Skolkovo Institute of Science and Technology, Russia

The application and optimization of the surface-specific fluoroimmunoassay for real-time cortisol monitoring to novel substrate and setup – polymer optic fiber probe functionalized by gold nanoparticles and immobilized antibodies was achieved by our group. Free cortisol and fluorescently labelled carrier protein conjugated with cortisol hapten compete in binding with limited sites of surface-immobilized antibodies.

WeSYC-30 16:00-16:15

Immunofluorescence module for liquid biopathogen analysis in an aerosol sampler

A.E. Akmalov, S.K. Belenok, G.E. Kotkovskii, I.L. Martynov, E.V. Osipov, Yu.A. Kuzishchin, A.A. Chistyakov; National Research Nuclear University MEPhI, Russia

A prototype of an optical module for immunofluorescence analysis based on evanescent waves under laser excitation of a antigen-antibody complex on the surface of the fiber core was developed and tested. The optical scheme, a fiber sensing element, a high-sensitivity photodetector were elaborated, and algorithms for the prototype operation were tested. The limit of detection was found.

WeSYC-31 16:15-16:30

Detection and analysis of protein compounds based on Raman scattering and machine learning

E.Y. Ponkratova[1], A.S. Shtumpf[1], L.I. Fatkhutdinova[1], G.I. Bikbaeva[2], A.Y. Kokhanovskiy[1], A.A. Bogdanov[1], A.A. Manshina[2], D.A. Zuev[1]; [1]Faculty of Physics, ITMO Univ.; [2]Institute of Chemistry, St. Petersburg State Univ., Russia

Proteins are integral to cellular function within the human body. However, conventional techniques such as immunoassay and chromatography may not always provide accurate results in detecting biological compounds. This study proposes the utilization of Raman spectroscopy for the identification of individual amino acids and protein compounds, followed by machine learning-based quantitative and qualitative analysis of the acquired data.

WeSYC-32 16:30-16:45

Logic-gate-controlled density of antibody binding sites on sensing surface for immunoassays with improved analytical performance

N.A. Belyakov[1,2], D.O. Novichikhin[1], B.G. Gorshkov[1]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Russia

This study tackles the analytical performance balance in biosensing systems. Introducing a universal approach, we propose a surface with a logic gate molecularly controlled density of antibody binding sites. Experimental demonstration with spectral interferometry on glass sensor chips with adjustable biosensitive element density showed the ability to detect antibiotic chloramphenicol. This innovative method provides controlled analytical characteristics for developing biosensors.

WeSYC-33 16:45-17:00

Optical manipulation of microdroplets for precise imaging and manipulation of nanostructures

X. Chen; Jinan University, China

Optical manipulation has emerged as a pivotal tool in soft matter research. This presentation focuses on its research on precise formation/dissolution, shaping, and repositioning of microdroplets, enabling accurate imaging and manipulation of nanostructures. It also covers the physical mechanisms of interaction between Gaussian beams and droplet materials, along with fabrication methods of droplets using both artificial and natural biological materials.

- Coffee Break -

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Wednesday, July 03, 2024

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 1

Session Chair: Inna Belousova, Vavilov State Optical Inst., Russia

WeSYD-01 09:00-09:40

Targeted photodynamic therapy treatment on colorectal tumour spheroids *(Keynote presentation)*

H. Abrahamse, N.W.N. Simelane; Laser Research Centre, Faculty of Health Sciences, University of Johannesburg, South Africa

Despite conventional therapeutic approaches, mortality from colorectal cancer (CRC) remains high, which is a major concern worldwide. Multifunctional bio nanoconjugates (MBNC) show promise as more effective targeted photosensitizer delivery systems in photodynamic therapy of colorectal cancer. Our findings highlight the synthesis and characterization of a MBNC for targeted PS delivery to irradicate colorectal cancer cells.

WeSYD-02 09:40-10:00

Photosensitization of singlet molecular oxygen by bacterial C_{40} carotenoids

A.A. Krasnovsky Jr.[1], A.S. Benditkis[1], A.A. Ashikhmin[2], A.A. Moskalenko[2]; [1]A.N. Bach Institute of Biochemistry, Federal Research Center of Biotechnology RAS; [2]Pushchino Scientific Center for Biological Research RAS, Institute of Basic Biological Problems RAS, Russia

Time-resolved measurement of photosensitized luminescence of singlet oxygen (SO) has been applied to studies of SO generation and quenching by C40 carotenoids (phytoene, zeta-carotene, neurosporene, lycopene, rhodopin and spirilloxanthin) having (5-13) conjugated double bonds (CDB) in their molecules. It was found that these carotenoids combine the property of strong SO quenching with an abilitiy of SO generation upon photoexcitation.

WeSYD-03 10:00-10:15

Sub-nanosecond excited state relaxation in FAD bound with bacterial diaphorase

I.A. Gorbunova, D.A. Volkov, D.V. Yashkov, M.E. Sasin, O.S. Vasyutinskii; Ioffe Institute, Russia

We present the results of analysis of polarized fluorescence decay in FAD bound with enzyme diaphorase. The analysis revealed isotropic and anisotropic fluorescence depolarization processes related with sub-nanosecond relaxation in FAD excited states. The significant differences in excited state dynamics in free FAD and FAD-diaphorase complexes was found.

WeSYD-04 10:15-10:30

AlPcS$_4$Cl is effective against Squamous cell carcinomas

A. Crous; Laser Research Centre, University of Johannesburg, South Africa

Squamous cell carcinomas, or SCCs, are frequently occurring cancers. SCCs are caused by both non-squamous and squamous epithelial tissues. This study investigated the impact of gold nanoparticles (AuNPs)-based AlPcS4Cl - nanoPDT on melanoma, oesophageal, lung, and cervical cancers. The findings show that therapeutic chemical is more extensively absorbed and localised in cancer cells.

WeSYD-05 10:30-11:00

Spectroscopic intraoperative diagnostics of tumors during photodynamic therapy *(Invited paper)*

K.T. Efendiev[1,2], P.M. Alekseeva[1], A.A. Shiryaev[3], T.N. Pisareva[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University "MEPhI"; [3]Sechenov First Moscow State Medical University, Russia

Methods of intraoperative diagnostics of tumors in the process of photodynamic therapy have been developed, which include the use of a single light source for fluorescence diagnostics and photodynamic therapy. The obtained results demonstrate the possibility of tumor phototheranostics with simultaneous monitoring of photosensitizer photobleaching, blood oxygen level and the state of the vascular system of irradiated tumor tissues.

- Coffee Break -

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Wednesday, July 03, 2024

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 2

Session Chair: Victor Loshchenov, Prokhorov General Physics Inst. RAS, Russia

WeSYD-06 11:30-11:45

Synthesis of core-shell ternary quantum dots - porphyrin conjugates and its photodynamic therapy application

O.S Oluwafemi; Department of Chemical Sciences (formely Applied Chemistry), University of Johannesburg; Centre for Nanomaterials Science Research, University of Johannesburg, South Africa

In this presentation, a large-scale aqueous synthesis of ternary quantum dots (QDs) and its conjugation to porphyrin as an efficient way to overcome photosensitizer shortcomings will be discussed. The singlet oxygen generation of this highly aqueous soluble novel conjugate and its cell viability against different cancer cell lines, which shows its potential for PDT applications, will be discussed.

WeSYD-07 11:45-12:15

Impacts of quantum dots in photodynamic processes *(Invited paper)*

A.O. Orlova; ITMO University, Russia

Luminescent quantum dots (QDs) and their composites are currently being widely studied as generators of reactive oxygen species (ROS). Binary and ternary QDs with different chemical compositions have been shown to be efficient energy or charge donors in QD-based composites. A method to enhance the energy or charge transfer efficiency because of photoinduced modification of the QD surface is proposed.

WeSYD-08 12:15-12:45

Cannabidiol enhances photodynamic therapy effects on breast cancer cells *(Invited paper)*

B.P. George, D.R. Mokoena, H. Abrahamse; Laser Research Centre, Faculty of Health Sciences, University of Johannesburg, South Africa

Cannabidiol (CBD) is a derivative of Cannabis sativa with several therapeutic applications. In this study, hypericin photosensitizer was adsorbed on gold nanoparticles. CBD was utilized to treat MCF-7 breast cancer cells, followed by in vitro photodynamic combination therapy. This study proposes that the CBD and PDT combination is effective in killing breast cancer cells in vitro by inducing apoptosis.

WeSYD-09 12:45-13:15

Effect of microenvironment on photophysical properties of Radachlorin photosensitizer *(Invited paper)*

I.V. Semenova, A.V. Belashov, A.A. Zhikhoreva; Ioffe Institute, Russia

The paper presents an analysis of the dependence of major photophysical properties of Radachlorin photosensitizer on such microenvironment properties as acidity, viscosity and polarity, as well as on the presence of albumin molecules. Experiments were performed in solutions and in living cells of five established lines.

WeSYD-10 13:15-13:45

Mechanisms of the photodynamic effect with polycationic photosensitizers on the foci of bacterial and oncological diseases *(Invited paper)*

G.A. Meerovich[1,2], E.V. Akhlyustina[2], E.A. Makarova[3], E.A. Kogan[4], S.Sh. Karshieva[5,6], I.D. Romanishkin[1], I.G. Tiganova[7], Yu.M. Romanova[7], Zhi-Long Chen[8], V.B. Loschenov[1,2], I.V. Reshetov[4]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University MEPhI; [3]Organic Intermediates and Dyes Institute; [4]I.M. Sechenov First Moscow State Medical University; [5]National University of Science and Technology MISIS; [6]N.N. Blokhin National Medical Research Center of Oncology; [7]Gamaleya National Research Centre for Epidemiology and Microbiology, Russia; [8]Huadong Hospital, Fudan University, China

This work presents the results of studies of the features, mechanisms and effectiveness of the photodynamic effect of PS based on polycationic derivatives of long-wave phthalocyanines and synthetic bacteriochlorin on bacteria, bacterial biofilms, tumor cells and experimental animal tumor model.

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Wednesday, July 03, 2024

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 3

Session Chair: Victor Loshchenov, Prokhorov General Physics Inst. RAS, Russia

WeSYD-11 15:00-15:30

Intraoperative fluorescent imaging of peripheral pulmonary nodules *(Invited paper)*

A. Akopov, G. Papayan, D. Fedotova, A. Gerasin; Pavlov First St. Petersburg State Medical Univ., Russia

This presentation is devoted to the discussion of various aspects of the intraoperative fluorescent imaging of lung cancer. The current situation based on the use of indocyanine green, the issues of using new targeted drugs are examined, as well as the possibility of increasing the depth of probing and combining with related treatment methods.

WeSYD-12 15:30-16:00

Robot-assisted photodynamic therapy *(Invited paper)*

T.G. Grishacheva[1], A.S. Vasiliev[2], A.V. Grabovskiy[3], S.A. Nikitin[3], V.V. Kharlamov[3], N.N. Potrahov[4], A.D. Obornev[5], N.N. Petrishchev[1]; [1]Laser Medicine Center, Pavlov First St. Petersburg State Medical University; [2]LLC Renomed; [3]LLC Medical Robotics; [4]Department of Electronic Instruments and Devices, St. Petersburg Electrotechnical University «LETI»; [5]Department of Thoracic Surgery, St. Petersburg State Research Institute of Phthisiopulmonology, Russia

Medical robot assisted fluorescence diagnostics (FD) and photodynamic therapy (PDT) of malignant lesions of external localizations, as well as intraoperative PDT is presented. This technique provides accuracy and uniformity of laser radiation distribution on the object and safety of treatment protocol.

WeSYD-13 16:00-16:15

Clinical and immunologic results of photodynamic therapy for HPV -associated cervical diseases

M.S. Afanasiev[1], A.D. Dushkin[2], T.G. Grishacheva[3], O. Svitich[4], P. Kukina[4], A. Avagyan[4], E. Biryukova[1], A. Khangeldie[5], A. Karaulov[1]; [1]Sechenov University, Clinical Immunology and Allergology; [2]Moscow City Oncology Hospital No62; [3]Pavlov First State Medical University; [4]Mechnikov Research Institute of Vaccines and Sera, Russia; [5]NJSC "Astana Medical University", Kazakhstan

Chlorine E6 photodynamic therapy (PDT) was used to treat 183 patients with HPV-related cervical diseases. The main of this study was to characterize the local immune response during treatment with PDT in patients with persistent HPV infection, LSIL, HSIL and cervical cancer. PDT is able to stimulate antiviral innate immune response, being important to treatment effectiveness.

WeSYD-14 16:15-16:45

Metabolic stress of tumor microenvironment during photothermal therapy: activation of an immune antitumor response *(Invited paper)*

A.V. Ryabova[1,2], D.V. Pominova[1,2], I.V. Markova[2], I.D. Romanishkin[1], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS, [2]National Research Nuclear University MEPHI, Russia

The work presents a study of intracellular temperature and metabolic stress during photothermal therapy, affecting the triggered cell death processes of different types. The obtained data will make it possible to optimize the laser exposure parameters for photothermal therapy, increasing the thermosensitivity of cancer and immune cells triggering the process of immunogenic cell death.

WeSYD-15 16:45-17:00

The dynamic changes in the membranes microviscosity of cancer cells during PDT with photoditazine

L.E. Shimolina[1], A.E. Khlynova[1], A.M. Mozherov[1], M.K. Kuimova[2], M.V. Shirmanova[1]; [1]Institute of Experimental Oncology and Biomedical Technologies, Privolzhsky Research Medical University, Russia; [2]Department of Chemistry, Imperial College London, United Kingdom

The aim was to analyze the viscosity changes in tumor cell membranes after PDT. The microviscosity of the tumor cell membranes was assessed by molecular rotor BODIPY2 with FLIM microscopy. It was found that PDT causes changes in membrane microviscosity. These results improve the understanding of the biophysiological mechanisms of PDT and may be useful to monitoring its effectiveness.

- Coffee Break -

SYC: PHOTONICS AND NANOBIOTECHNOLOGY - POSTERS

Location: Nikolsky + Levinson Foyer, Floor 2; Date: Wednesday, July 03, 2024

WeSYC-p01 10:00-13:30

On-chip multisensor array based on phosphorylated graphene for the alcohols selective detection

V.S. Gabrelian[1], N.S. Struchkov[2], M.A. Solomatin[3], S.D. Saveliev[1,3], S.A. Ryzhkov[1,3], P.D. Cherviakova[1], A.S. Varezhnikov[3], S.I. Pavlov[1], D.A. Kirilenko[1], V.V. Sysoev[3], M.K. Rabchinskii[1]; [1]Ioffe Institute, [2]National Research University of Electronic Technology, [3]Yuri Gagarin State Technical University of Saratov, Russia

Herein, we consider the fabrication and gas-sensing properties of On-chip multisensor arrays based on a phosphorylated graphene (Gr-P) film with a gradually changed thickness. Selective detection of the alcohols, from methanol to butanol, mixed with air to match permissible exposure OSHA limits is demonstrated for the chip operating at room temperature.

WeSYC-p02 10:00-13:30

Dynamic of the absorption spectra of biological active substances of Tagetes flowers extract in visible wavelength region

E.S. Zemlyakova[1,2], A.V. Tsibulnikova[1], V.A. Slezkhin[1,2], I.G. Samusev[1], V.V. Bryukhanov[1], D.A. Artamonov[1]; [1]Immanuel Kant Baltic Federal University, [2]Kaliningrad State Technical University, Russia

In this work, spectral studies of marigold flower extract have been carried out. The extraction was prepared by maceration method. The triglycerides of fatty acids were used as an extractant. The resulting extract was diluted and the absorption spectra were measured. Absorption spectra show bands in the blue wavelength range, what is caused by the presence of the carotenoids.

WeSYC-p03 10:00-13:30

Enhancement of magnetic dipole emission in the presence of a spherical particle

A.D. Utyushev[1], R. Gaponenko[1], S. Sun[2,3], A.A. Shcherbakov[1], A. Moroz[4], I. L. Rasskazov[5]; [1]School of Physics and Engineering, ITMO University, Russia; [2]Microsystem and Terahertz Research Center, China Academy of Engineering Physics, China; [3]Institute of Electronic Engineering, China Academy of Engineering Physics, China; [4]Wave-scattering.com; [5]SunDensity Inc., Rochester, USA

We discover regimes for promoting fluorescence of magnetic light by four orders of magnitude due to magnetic dipole (MD) transitions of trivalent rare-earth ions Eu3+ located inside or near dielectric homogeneous spheres.

WeSYC-p04 10:00-13:30

Study of the temperature stability of the parameters of a fiber-optic resonator with preservation of polarization

K.A. Ovchinnikov[1,2], D.G. Gilev[1], V.V. Krishtop[1,2]; [1]Perm Scientific-industrial Instrument Making Company; [2]Perm National Research Polytechnic University, Russia

The temperature dependences of FSR, FWHM, Finesse, Q-factor and the output power of a fiber-optic resonator assembled on an optical polarization maintaining Panda-type fiber in the temperature range of -30...+50 °C were obtained. The studied resonator demonstrated stability of parameters within 10% for a given temperature range. Such resonator can be useful as a sensitive element of resonator fiber-optic gyroscopes.

WeSYC-p05 10:00-13:30

Laser-pumping attack on QKD sources

M. Fadeev[1,2], A.A. Ponosova[1], R. Shakhovoy[3,4,5], V. Makarov[1,5,6]; [1]Russian Quantum Center, Skolkovo; [2]ITMO University; [3]QRate, Skolkovo; [4]NTI Center for Quantum Communications, National University of Science and Technology MISIS; [5]Moscow Technical University of Communications and Informatics, Russia; [6]University of Science and Technology of China, China

We demonstrate a new type of attack on QKD systems based on laser pumping of a photon source. It includes injection of cw laser emission into a source at a wavelength that shorter than the system operating one. Particularly, we show that laser emission at 1310 nm induces increase in power at 1550 nm, changes in pulse energy and width.

WeSYC-p06 10:00-13:30

Particle characterization by analyzing light scattering signals with a machine learning approach

W. Schaefer[1], V. Dulin[2], S. Abdurakipov[2]; [1]ai-quanton GmbH, Germany; [2]Kutateladze Institute of Thermophysics, SB RAS, Novosibirsk State University, Russia

We present a new instrument in combination with a machine learning approach to achieve a more cost-effective measurement instrument for particle characterization based on the established measurement technique known as the Time-Shift-Time-of-Flight technique. We propose a machine learning model capable of using only a single signal to determine the same information about particles, traditionally obtained from the classical measurement device.

WeSYC-p07 10:00-13:30

Nanocomposite coatings to improve the hemocompatibility of medical devices

K.D. Popovich[1,2], S.V. Selishchev[1], A.Yu. Gerasimenko[1,2], E.A. Gerasimenko[1]; [1]Inst. of Biomedical Systems, National Research Univ. of Electronic Technology, MIET, [2]Inst. for Bionic Technologies and Engineering, I.M. Sechenov First Moscow State Medical Univ., Russia

This paper presents a method for the formation of nanocomposite hemocompatible coatings based on carbon nanotubes in a collagen polymer matrix using laser radiation. A microfluidic system was developed as a tool for in vitro testing of the coatings under dynamic flow conditions. Optical profilometry and Raman spectroscopy were used to evaluate the stability and hemocompatibility of the fabricated coatings.

WeSYC-p08 10:00-13:30

Low-coherence interferometry biosensors: real-time molecular detection with glass sensor chips

D.O. Novichikhin[1], M.N. Zaikina[1], Z.G. Zaitseva[1,2], N.A. Belyakov[1,2]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Russia

Compact biosensor devices have been developed based on low-coherence interferometry. These devices are characterized by high energy efficiency and offer ultrasensitive real-time registration of changes in the thickness of biomolecular complexes on widely available disposable sensor chips.

WeSYC-p09 10:00-13:30

Biocompatible pH sensors based on the Re(I) luminophores containing oligo(ethylene glycol) groups

K.S. Kisel[1], N.A. Zharskaia[1], S.A. Silonov[1,2], J.R. Shakirova[1]; [1]St. Petersburg State University, [2]Institute of Cytology RAS, Russia

Herein we present the synthesis of the rhenium(I) systems containing the diimine ligands with pH-sensitive carboxyl functions, as well as the auxiliary phosphine ligands containing oligo(ethylene glycol) (OEG) groups which impart biocompatibility and solubility in the physiological media to the target compounds. The obtained hydrophilic emitters display sensitivity of emission quantum yield and lifetime to the variations in media acidity.

WeSYC-p10 10:00-13:30

Investigation of NV center ensemble in dense carbon-13 diamond for quantum sensing

V.V. Soshenko[1,2], O.R. Rubinas[3,4], I.S. Cojocaru[1,2,5], S.V. Bolshedvorskii[1,2], P.G. Vilyuzhanina[5,6], E.A. Primak[5,7], S.M. Drofa[5,7], A.M. Kozodaev[5,6], V.G. Vins[8], V.N. Sorokin[1,2], A.N. Smolyaninov[2], A.V. Akimov[1,2,5]; [1]Sensor Spin Technologies; [2]Lebedev Physical Institute RAS, Russia; [3]IMOMEC, Belgium; [4]IMO, Hasselt University, Belgium; [5]Russian Quantum Center; [6]NRNU "MEPhI"; [7]Moscow Institute of Physics and Technology; [8]LLC Velman, Russia

Current work is devoted to investigation of Nitrogen-vacancy centers in diamond, doped by carbon-13 isotope (~30%). ODMR spectrum of such a diamond was analyzed with possible determination of magnetic field vector from the spectrum. A novel method to extract carbon isotope concentration in diamond was developed.

WeSYC-p11 10:00-13:30

Temperature stabilized microfluidic chip for plasmonic fiber biosensor

L.I. Fatkhutdinova, D.O. Gagarinova, A.F. Cherednikova, A. Kokhanovskiy, M.V. Zyuzin; School of Physics and Engineering, ITMO University, Russia

We developed a plasmonic fiber biosensor with microfluidic chip with thermostabilization. The biosensor includes a tilted fiber Bragg grating covered in gold to generate surface plasmon resonance. Temperature stability is ensured using a Peltier cell with an active PID-controller. Specific proteins are immobilized to the fiber's surface to selectively detect biomarkers in biofluids, based on changes in refractive index.

WeSYC-p12 10:00-13:30

Laser synthesis of cobalt-based nanoparticles in gaseous media and magnetic field

M.A. Dzus, A.S. Chernikov, A.V. Kharkova, D.A. Kochuev, E.S. Oparin, D.V. Abramov, A.F. Galkin, K.S.Khorkov; Vladimir State University, Russia

This paper presents the results of laser ablation of cobalt targets in a magnetic field in argon and air. The experimental setup, processing parameters are described and the results of scanning electron microscopy are presented, which allow us to estimate the size and shape of particles.

WeSYC-p13 10:00-13:30

Laser formation of a carbon conductive network for a gesture recognition system

A.S. Morozova[1], N.A. Nikitina[1], D.I. Ryabkin[1,2], V.V. Suchkova[1], A.V. Kuksin[1], E.S. Pyankov[1], L.P. Ichkitidze[1,2], E.A. Gerasimenko[1], S.V. Selishchev[1], A.Yu. Gerasimenko[1,2]; [1]National Research Univ. of Electronic Technology, [2]I.M. Sechenov First Moscow State Medical Univ., Russia

The study introduces a method to create conductive network of multi-walled carbon nanotubes in a silicone elastomer for strain-sensitive sensors. Laser radiation improves sensor characteristics, reducing initial resistance by 6 times than non-irradiated sensors. This enhancement enables a touch gesture recognition system with 94% accuracy. Data is processed through a developed electronic unit.

WeSYC-p14 10:00-13:30

Interferometric studies of nanoparticle conjugates for ultrasensitive detection of zearalenone in food

J.A. Malkerov[1,2], A.S. Rakitina[1,2], G.M. Sorokin[3], A.I. Nikitin[4], A.G. Burenin[1], M.V. Milovanova[1,2], I.A. Bakhratov[1]; [1]Prokhorov General Physics Institute RAS, [2]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), [3]Chuvash State University, [4]Volga branch of MADI, Russia

Zearalenone (ZEA) is a mycotoxin affecting human and animal health. The research explores various magnetic nanoparticle types, employing low coherence interferometry to study antibody kinetics. Monoclonal antibodies against ZEA are characterized, selected and immobilized on magnetic nanoparticles. A rapid, ultrasensitive lateral flow assay for on-site ZEA detection in food is developed, showcasing determination in real contaminated samples.

WeSYC-p15 15:00-18:30

Modeling of the quantum dynamics of nitrogen-vacancy centers in the spectrum for quantum sensors

V.V. Soshenko[1,2], L.S. Cojocaru[1,2,3], A.M. Kozodaev[3,4], S.V. Bolshedvorskii[1,2], V.N. Sorokin[1,2], A.N. Smolyaninov[2], A.V. Akimov[1,2,3,5]; [1]Lebedev Physical Institute RAS; [2]Sensor Spin Technologies; [3]Russian Quantum Center; [4]National Research Nuclear University MEPhI; [5]National University of Science and Technology MISIS, Russia

The system on the basis of which a quantum sensor can be built, must have a long coherence time, be technologically advanced in manufacturing, and have the ability to prepare and read states efficiently. The nitrogen-vacancy coloring center (NV center) in diamond possesses all these properties. In addition, NV center-based sensors can operate at room temperature.

WeSYC-p16 15:00-18:30

Influenza A virus detection via Ag@c-Si SERS and machine learning.

K. Prigoda[1], A. Ermina[1], A. Tabarov[2], V. Levitskii[3], O. Andreeva[2], A. Gazizulin[2], V. Bolshakov[1], S. Pavlov[1], A. Zheltukhina[4], D. Danilenko[4], Yu. Zharova[1], V. Vitkin[2]; [1]Ioffe Institute; [2]ITMO University; [3]RnD Center TFTE; [4]Smorodintsev Research Institute of Influenza, Russia

This study demonstrates the synthesis of SERS substrates with Ag@c-Si dendritic structures for the detection of the influenza A virus using machine learning. Spectra from the pure buffer medium and the buffer medium with influenza A virus were obtained. Subsequently, machine learning classification (PCA and SVM) was performed, resulting in a classification accuracy of 76.6 ± 4.2% for the spectra.

WeSYC-p17 15:00-18:30

Secure laser source for QKD systems

M. Fadeev[1,2], A.A. Ponosova[1], A. Huang[3], R. Shakhovoy[4,5,6], V. Makarov[1,5,7]; [1]Russian Quantum Center, Skolkovo; [2]ITMO University, Russia; [3]National University of Defense Technology, China; [4]QRate, Skolkovo; [5]NTI Center for Quantum Communications, National University of Science and Technology MISIS; [6]Moscow Technical University of Communications and Informatics, Russia; [7]University of Science and Technology of China, China

In practical quantum key distribution systems, single photon sources take laser-seeding attacks. Typically, some amount of isolation is recommended as the countermeasure against these attacks. Here, we demonstrate a new approach of QKD system protection against laser seeding based on internally seeded photon source scheme, resilient to external perturbations.

WeSYC-p18 15:00-18:30

The new aplanat condenser of the line-scanning chromatic confocal microscopy

Jun Zhang[1,2], Ruixue Zhuang[1,2], Zhe Chen[1,2], Jianhui Yu[1,2], Wenguo Zhu[1,2], Huadan Zheng[1,2], Yongchun Zhong[1,2], Jieyuan Tang[1,2], Yi Xiao[1,2], Mengyuan Xie[1,2], Jinfeng Wang[3]; [1]Guangdong Provincial Engineering Technology Research Center on Visible Light Communication, Jinan University; [2]Guangzhou Municipal Key Laboratory of Engineering Technology on Visible Light Communication, Jinan University; [3]Dongguan Shenzhou Vision Technology Co., Ltd., China

A new aplanat condenser was designed based on the analysis of the traditional cylindrical lens. The angle magnification of 0.23 was achieved in the 450nm to 750nm wavelength range. More than 80% of the energy from the light source enters the slit, significantly increasing the amount of light entering the system and providing assurance for subsequent high-speed image acquisition.

WeSYC-p19 15:00-18:30

Separation of probe beam dichroism and birefringence in polarization-modulation pump-probe spectroscopy

D.A. Volkov, M.E. Sasin, I.A. Gorbunova, O.S. Vasutinskii; Ioffe Institute, Russia

For the first time we experimentally separated probe beam dichroism and birefringence in stimulated Raman scattering by using polarization-modulation pump-probe spectroscopy. This method can be used for compound analysis of mixtures and biological systems.

WeSYC-p20 15:00-18:30

Surface-enhanced Raman scattering of electrospun non-woven fibers: synthesis of silver nanoparticles and their effect on the properties of SERS materials

V. Bakal, A.M. Kartashova, P.A. Demina, I.O. Kozhevnikov, E.S. Prikhozhdenko; Science Medical Center, Saratov State University, Russia

In this study, electrospun non-wovens were used as the templates for SERS sensors. The functionalization of sensor surface was performed by either in situ synthesis of AgNP or using of pre-synthesized AgNP. Then, SERS substrates were modified with glucose oxidase enzyme to provide the sensitivity and specificity for glucose detection. Machine learning approaches was implemented in spectra analysis.

WeSYC-p21 15:00-18:30

Silver nanoparticles for therapy HER2-positive breast cancers

T.V. Rozhnikova[1], A.M. Skirda[1,3], A.O. Antonova[1], V.O. Shipunova[1,2]; [1]Moscow Institute of Physics and Technology, [2]Sirius University of Science and Technology, [3]Prokhorov General Physics Institute RAS, Russia

The research is derected toward the development of HER2-targeted silver nanoparticles for breast cancer treatment.

WeSYC-p22 15:00-18:30

Evaluating carbon dots as trace element detection systems

L.I. Fatkhutdinova[1], H. Barhum[2], E.N. Gerasimova[1], D.S. Kolchanov[2], I.I. Vazhenin[1], P. Ginzburg[2], M.V. Zyuzin[1]; [1]School of Physics and Engineering, ITMO University, Russia; [2]Department of Physical Electronics, Tel Aviv University, Israel

Trace elements like Fe2+, Fe3+, and Co2+ are vital for body function. Fe2+, Fe3+ distribute oxygen, Co2+ aids metabolism and nervous system function. Health monitoring requires detecting these ions. Carbon dots (CDs) with stable fluorescence and water solubility can detect them. This study explored CDs' optical properties and their sensitivity to Fe2+, Fe3+, Co2+, aiding selective detection in medical diagnostics.

WeSYC-p23 15:00-18:30

Fluorescently controlled investigation of super-enhancers with CRISPR interference and CRISPR prime editing systems

N.N. Orlova[1], M.G. Gladkova[1,2], G.A. Ashniev[1], A.V. Orlov[1]; [1]Prokhorov General Physics Institute RAS; [2]Faculty of Bioengineering and Bioinformatics, Lomonosov Moscow State University, Russia

In the evolving landscape of genomic research, our study delves into the intricate exploration of super-enhancers, pivotal and controversial elements exerting profound influence over gene expression. Utilizing CRISPR interference and CRISPR prime editing systems, our work yields promising results and opens avenues for future research to refine and expand these approaches across diverse cell types.

WeSYC-p24 15:00-18:30

Method for measuring pairwise affinity of substantially non-complementary oligonucleotides

V.I. Arkhipova[1], E.S. Korenkov[2], M.Sh. Makhmuryan[1], M.A. Gubaidullina[1], Y.P. Chebotareva[1], E.N. Mochalova[1,2], D.O. Novichikhin[3], M.P. Nikitin[1,2]; [1]Nanobiomedicine Division, Sirius University of Science and Technology; [2]Moscow Institute of Physics and Technology; [3]Prokhorov General Physics Institute RAS, Russia

Strand commutation based on low-affinity interactions of non-complementary nucleic acids is a unique tool for data processing through DNA. Here we demonstrate a method for measuring pairwise oligonucleotide affinity, which allows us to create accurate predictive resources. We used a range of optical techniques, including UV- and fluorescence spectroscopy, to determine the binding constant in DNA duplex of non-complementary strands.

WeSYC-p25 15:00-18:30

Biocompatible composite material for the regeneration of large tissue defects

U.E. Kurilova[1,2], E.A. Gerasimenko[2], I.A. Suetina[3], M.V. Mezentseva[3], L.I. Russu[3], G.Yu. Galechyan[4], A.Yu. Gerasimenko[2,4]; [1]World-Class Research Center "Digital Biodesign and Personalized Healthcare", I.M. Sechenov First Moscow State Medical University, [2]Inst. of Biomedical Systems, National Research Univ. of Electronic Technology, [3]Inst. of Virology, National Research Center for Epidemiology and Microbiology Named after the Honorary Academician N.F. Gamaleya, [4]Inst. for Bionic Technologies and Engineering, I.M. Sechenov First Moscow State Medical Univ., Russia

This paper presents a technology for formation of biocompatible material for bone defect regeneration based on carbon nanotubes and biopolymers. Studies of the structure of the formed samples indicate the presence of the necessary characteristics. Biocompatibility studies have shown the applicability of the developed material for the regeneration of large tissue defects.

SYB: LASER INTERACTION WITH CELLS AND TISSUES- CLINICAL IMAGING AND SPECTROSCOPY

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Thursday, July 04, 2024

SYB SESSION # 7: TERAHERTZ

Session Chair: Olga Cherkasova, Inst. of Automation and Electrometry SB RAS, Russia

ThSYB-30 09:00-09:30

Terahertz-wave scattering in turbid biological tissues *(Invited paper)*

K.I. Zaytsev[1], A.S. Kucheryavenko[2], N.V. Chernomyrdin[1], D.R. Il'enkova[1], I.N. Dolganova[2], V.V. Tuchin[3,4,5]; [1]Prokhorov General Physics Institute RAS; [2]Osipyan Institute of Solid State Physics RAS; [3]Institute of Physics and Science Medical Center, Saratov State University; [4]Laboratory of Laser Molecular Imaging and Machine Learning, Tomsk State University; [5]Institute of Precision Mechanics and Control, FRC "Saratov Scientific Centre RAS", Russia

In our research, we combine the terahertz (THz) pulsed spectroscopy, superresolution THz solid immersion microscopy with methods of the Lorentz-Mie scattering theory and radiation transfer theory to shine the light on the THz-wave – turbid tissue interactions.

ThSYB-31 09:30-10:00

Terahertz spectroscopy of blood plasma for cancer diagnosis *(Invited paper)*

O. Cherkasova[1,2], N. Nikolaev[1,3]; [1]Laboratory of Terahertz Photonics, Institute of Automation and Electrometry SB RAS; [2]Department of Data Acquisition and Processing Systems, Novosibirsk State Technical University; [3]Laboratory of Laser Biophysics, Institute of Laser Physics SB RAS, Russia

Cancer is one of the major diseases that seriously affect human health. The early cancer diagnosis has of great significance and can be achieved by analyzing blood plasma. In the report, we will consider ways to increase the sensitivity of THz pulsed spectroscopy to cancer diagnosis.

ThSYB-32 10:00-10:30

Terahertz spectroscopy and machine learning for medical and ecological applications *(Invited paper)*

Yu. Kistenev, V.V. Prishepa, V. Skiba, V. Nikolaev, G. Rasponin, D. Makashev, A.K. Tretyakov, A. Borisov; LMIML Laboratory, Tomsk State University, Russia

The aim of the report is to demonstrate the usefulness of machine learning methods applications in qualitative and quantitative analysis of spectral data on examples of medical diagnostics and the atmosphere state monitoring. The work was conducted with the financial support of the Ministry of Science and Higher Education of Russia (Agreement No. 075-15-2024-557 dated 04/25/2024)

ThSYB-33 10:30-10:45

Terahertz-wave scattering in tissues: tissue-mimicing scattering phantom

A.S. Kucheryavenko[1], I.N. Dolganova[1], N.V. Chernomyrdin[2], A.A. Gavdush[2], V.M. Masalov[1], V.S. Nozdrin[2], V.V. Tuchin[3,4,5], K.I. Zaytsev[2]; [1]Institute of Solid State Physics RAS; [2]Prokhorov General Physics Institute RAS; [3]Institute of Physics and Science Medical Center, Saratov State University; [4]Laboratory of Laser Molecular Imaging and Machine Learning, Tomsk State University; [5]Institute of Precision Mechanics and Control, FRC "Saratov Scientific Centre RAS", Russia

Heterogeneity of biological tissues at the terahertz-wavelength scale can result in the non-Rayleigh scattering and doubts the applicability of effective medium theory for such tissues. For this reason, a tissue mimicking scattering phantom is developed, and the effective optical properties of the proposed phantom are still determined by EMT over wide ranges of scatterers' diameters and volume fractions.

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Thursday, July 04, 2024

SYB SESSION # 8: PHOTODYNAMIC AND PHOTOTHERMAL THERAPY

Session Chair: Elena Zagainova, Lopuchin Federal Research and Clinical Center of Physical-Chemical Medicine (FMBA), Russia

ThSYB-34 11:30-12:00

Antibacterial photodynamic therapy. Role of endogenous Zn -coproporphyrin in the sterilization of M. tuberculosis *(Invited paper)*

A. Savitsky[1], M.O. Shleeva[1], I.A. Linge[2], A.S. Apt[2], A.S. Kaprelyants[1]; [1]Federal Research Centre of Biotechnology RAS, [2]Central Tuberculosis Research Institute, Russia

In the live and dormant forms of M. tuberculosis, the synthesis Zn-porphyrines significantly increased in the presence of 5-aminolevulinic acid and viability of dormant Mtb reduced by more than 99.99% under illumination with 565 nm as well accumulation of active Mtb cells in lung macrophages cells give the same results.These findings create a perspective for the treatment multidrug-resistant tuberculosis.

ThSYB-35 12:00-12:30

Combined photodynamic/photothermal cancer therapy accompanied by optical clearing *(Invited paper)*

E.A. Genina[1,2], A.B. Bucharskaya[3], V.D. Genin[1,2], N.A. Navolokin[3], D.A. Mudrak[3], G.N. Maslyakova[3], B.N. Khlebtsov[4], N.G. Khlebtsov[4], V.V. Tuchin[1,2,5]; [1]Saratov State University, [2]Tomsk State University, [3]Saratov State Medical University named after V. I. Razumovsky, [4]Institute of Biochemistry and Physiology of Plants and Microorganisms RAS; [5]Institute of Precision Mechanics and Control RAS, Russia

Combined technology of photodynamic therapy and laser plasmon photothermal therapy accompanied by optical clearing was developed for rats with tumor. Temperature monitoring and spectral measurements were made. Morphological studies were performed with standard and immunohistochemical methods. We observed pronounced necrotic changes in the tumor tissue. 21 days after the therapy, the tumor growth inhibition index by tumor mass was 77.4%.

ThSYB-36 12:30-13:00

Controlled photosensitizer-free singlet oxygen release for biomedical applications *(Invited paper)*

I.N. Makovik[1], A.V. Dunaev[1], E.U. Rafailov[2], V.V. Dremin[1,2]; [1]Orel State University, Russia; [2]Aston University, UK

Although various studies reporting the initiation of apoptosis or optimization of mitochondrial respiration by laser illumination and generation of singlet oxygen in various types of cells and tissues have been published, there is still a huge gap in knowledge and an essential need to identify the exact mechanism by which laser irradiation leads to these effects.

ThSYB-37 13:00-13:15

Laser-induced singlet oxygen stimuates bioenergetics of insulin-producing cells

L.V. Eratova, I.N. Makovik, A.Y. Vinokurov, V.V. Dremin; Research & Development Center of Biomedical Photonics, Orel State University, Russia

The paper presents the results of the study of the effect of singlet oxygen induced by 1267 nm laser exposure without the use of photosensitizers on the bioenergetics of rat insulinoma RINm5F. Differences in changes of analysed parameters of the investigated cells after laser treatment were revealed in comparison with the control group that were not exposed to laser.

ThSYB-38 13:15-13:30

Plasmonic agents for bioimaging and photothermal therapy with red and NIR lasers

E.V. Solovyeva, V.O. Svinko, A.I. Demenshin, A.N. Smirnov; St. Petersburg State University, Russia

This work is addressed to the development of hybrid systems which are considered as new means of imaging and therapy of malignant neoplasms. We represent here the study of a wide range of combinations of morphologically different gold nanoparticles and various molecular probes (fluorophores or Raman reporters).

- Lunch Break -

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Thursday, July 04, 2024

SYB SESSION # 9: LASER MICROSCOPY AND OPTICAL COHERENCE IMAGING:

Session Chair: Vladimir Zaitsev, Inst. of Applied Physics RAS, Russia

ThSYB-39 15:00-15:30

Optical coherence elastography with osmotically-induced strains for assessing degradation of cartilage samples *(Invited paper)*

Y.M. Alexandrovskaya[1,2], A.A. Sovetsky[2], E.M. Kasianenko[2,3], A.L. Matveyev[2], D.A. Atyakshin[4], O.I. Patsap[4], M.A. Ignatiuk[4], A.V. Volodkin[4], V.Y. Zaitsev[2]; [1]A.V. Gaponov-Grekhov Institute of Applied Physics RAS, Russia; [2]Terra Quantum AG, Switzerland; [3]National Research Center Kurchatov Institute, Russia; [4]Scientific and Educational Resource Center "Molecular Morphology", RUDN University, Russia

A new variant of Optical Coherence Elastography is presented, in which osmotically-induced strains are used instead of such auxiliary stimuli as compression or elastic-wave excitation. The method efficiency is demonstrated to differentiate cartilage samples with various stages of proteoglycan-component degradation. The method also looks promising for utilization with other tissue types, e.g., for express assessment of biopsy-needle samples.

ThSYB-40 15:30-16:00

New mechanisms in stem cells differentiation and tissue regeneration discovered by optical imaging *(Invited paper)*

E. Zagaynova[1,2], A. Meleshina[1], D. Kuznetsova[1], S. Rodimova[1], A. Kashirina[1], P. Ermakova[1], V. Zagainov[1,3], V. Shcheslavskiy[1]; [1]Institute of Biomedical Technologies, Privolzhskiy Medical Research University; [2]Lopukhin FRCC PCM; [3]Nizhny Novgorod Regional Clinical Oncological Dispensary, Russia; [4]Becker&Hickl GmbH, Germany

Using FLIM and multiphoton fluorescence microscopy we have made investigation of metabolic status in mesenchymal stem cell during adipogenic, osteogenic and chondrogenic differentiation, metabolic activity and intracellular pH in iPSC differentiating in dermal, epidermal, neuronal directions, in 3D neurospheres from iPSCs, in neural spheroids with Down syndrome, metabolic changes in living islets of Langerhans, and during liver regeneration.

ThSYB-41 16:00-16:30

Adapting laser microscopy to life sciences *(Invited paper)*

H. Schneckenburger; Aalen University, Germany

Transmission, scattering and fluorescence microscopy are adapted to various requirements of life sciences, e.g. angular resolution, 3D resolution and limitation of light exposure to a non-phototoxic level. Applications include scattering microscopy, Light Sheet Fluorescence Microscopy (LSFM), Structured Illumination Microscopy (SIM) in combination with TIRFM, Axial Tomography and laser-assisted micromanipulation.

ThSYB-42 16:30-16:45

OCT-based feature analysis of brain tissue ex vivo: rat gliomas 101.8, C_6 and human gliomas of different grades

P.V. Aleksandrova[1], K.I. Zaytsev[1], P.V. Nikitin[2], A.I. Alekseeva[3], P.A. Karalkin[4], I.V. Reshetov[4], I.N. Dolganova[5]; [1]Prokhorov General Physics Institute RAS, Russia; [2]University of Houston, USA; [3]Avtsyn Research Institute of Human Morphology of Federal State Budgetary Scientific Institution "Petrovsky National Research Centre of Surgery", Russia; [4]Institute for Cluster Oncology, Sechenov University, Russia; [5]Osipyan Institute of Solid State Physics RAS, Russia

Optical coherence tomography (OCT) is fast-noninvasive and label-free method for imaging the internal structure of biological tissues. In our research we applied commercial system OCT1300Y to study the ability of OCT for the intraoperative diagnosis of brain gliomas. We analyze ex vivo human gliomas of different grades and Wistar rat glioma models - glioma C6 and glioma 101.8.

SYC: PHOTONICS AND NANOBIOTECHNOLOGY

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Thursday, July 04, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 7

Session Chair: Petr Nikitin, Prokhorov General Physics Inst. RAS, Russia

ThSYC-34 09:00-09:30

Laser engineering of microbial systems: a new tool for microbiology *(Invited paper)*

N.V. Minaev[1], V.S. Zhigarkov[1], V.S. Cheptsov[1,2], V.I. Yusupov[1]; [1]Institute of Photon Technologies of Kurchatov Complex Crystallography and Photonics, NRC "Kurchatov Institute"; [2]Soil Science Faculty, Lomonosov Moscow State University, Russia

We present laser engineering of microbial systems (LIMS) technology - a new promising tool which allows significant progress towards solving the ambitious task of microbiology associated with expanding the base of cultivable microorganisms. The technology is based on laser-induced forward transfer (LIFT) of microscale gel droplets with living microorganisms from various natural environments while preserving their natural microenvironment.

ThSYC-35 09:30-09:45

Optical sorting via surface and volumetric modes of periodic structures

N.A. Kostina, M.P. Petrov; Faculty of Physics, ITMO University, Russia

In this work we consider the auxiliary layered structure to provide optical pulling of the nanoparticle placed above. The structure providing both optical force direction switching (inherent to the photonic crystals) and enhanced magnitude of the optical pulling (inherent to the hyperbolic metamaterials) is described. We also demonstrate the optimized geometry and permittivities for experimental realization of the particles' sorting.

ThSYC-36 09:45-10:00

Wettability control on glass surface by laser-induced nanostructures for nanoparticles self-assembly

Chunyu Li, M.A. Gremilov, E.I. Ageev, D.A. Zuev; ITMO Univ., Russia

To control the self-organized assembly of nanoparticles on substrate, which are distributed in solution, the LIPSS technology is used for the wettability controllable template fabrication. The template with adjustable period and morphology of nanostructures will help organize the alignment of nanoparticles. And these will provide an important step for development of metasurfaces.

ThSYC-37 10:00-10:15

Water transportation across membrane aquaporin channels by monomer H_2O

S.M. Pershin[1], Eu.V. Stepanov[1], D.G. Artemova[1], B.G. Katsnelson[2]; [1]Prokhorov General Physics Institute RAS, Russia; [2]University of Haifa, Israel

P. Agre (Nobel Prize, 2003) said that water transportation across membrane aquaporin channel by monomer H2O occurs with intensity around 3E9 monomer/s. It's still unknown till now where this monomer amount may storage? We have observed that water-air interface layer consists of a two water fraction: it has high/low meniscus height when capillary touch the surface/bulk water.

ThSYC-38 10:15-10:30

Sapphire THz waveguides for sensing and endoscopy applications

G.M. Katyba[1], S.P. Lebedev[2], A.S. Kucheryavenko[1], I.N. Dolganova[1], A.V. Kaledin[1], A.K. Zotov[1], M.G. Burdanova[1,3], K.I. Zaytsev[2], V.N. Kurlov[1]; [1]Institute of Solid State Physics RAS; [2]Prokhorov General Physics Institute RAS; [3]Moscow Institute of Physics and Technology, Russia

THz technologies developments into practice are limited by the absence of commercially available THz endoscopic systems. Previously, the transmission properties of waveguides, fibers and even fiber bundles based on shaped sapphire were studied. Sapphire hollow-core waveguides are suitable for efficient radiation transmission with minimal losses and for applications in endoscopy of hard-to-access objects and high-resolution imaging.

ThSYC-39 10:30-10:45

Laser functionalization of carbon nanotubes with LaB_6 particles

A.V. Kuksin[1], A.Yu. Gerasimenko[1,2]; [1]National Research University of Electronic Technology MIET; [2]Institute for Bionic Technologies and Engineering, I.M. Sechenov First Moscow State Medical University, Russia

This work experimentally investigates the effect of functionalization of carbon nanotubes array with LaB6 nanoparticles on the electrophysical properties. Resulting hybrid nanomaterial was based on a vertical nanotubes array functionalized with LaB6 nanoparticles. Nanotubes were structured by pulsed laser irradiation with an energy density of 0.15 J/cm2. The functionalized hybrid nanomaterial had a maximum field emission current of 55 μA.

ThSYC-40 10:45-11:00

Modeling of tubular aggregates of the chlorosome antenna complexes

R.Y. Pishchalnikov[1], V.A. Kurkov[1,2], D.D. Chesalin[1]; [1]Prokhorov General Physics Institute RAS; [2]Moscow Institute of Physics and Technology (National Research University), Russia

Green sulfur bacteria that live in low-light environment are characterized by the specific light-harvesting complexes, chlorosomes. The structural unit of the chlorosome is a tube consisting of pigments packed in a special way. We performed the simulation of linear optical response and calculated the distribution of excitation for each exciton state considering tubular aggregates of different lengths.

- Coffee Break -

Location: Petrov-Vodkin 2 Room, Floor 2; Date: Thursday, July 04, 2024

SYC: PHOTONICS AND NANOBIOTECHNOLOGY 8

Session Chair: Anatoly Zherdev, Bach Institute of Biochemistry RAS, Research Centre of Biotechnology RAS, Russia

ThSYC-41 11:30-12:00

Fluorescence polarization immunoassay for detection of pesticides in food products *(Invited paper)*

S.A. Eremin[1,2], M.K. Kolokolova[2]; [1]A.N. Bach Institute of Biochemistry, Research Centre of Biotechnology RAS, [2]Faculty of Chemistry, Lomonosov Moscow State University, Russia

Fluorescence Polarization Immunoassay (FPIA) is immunochemical method based on the application of antibodies as recognition element and fluorophore as label for detection by measurement of fluorescence polarization. FPIA is simple method for organic compounds monitoring. Developments of FPIA for detection of pesticides 2,4-Dichlorophenoxyacetic acid and Glyphosate in food stuffs will be presented. The study was supported by RSF grant №24-43-00196.

ThSYC-42 12:00-12:15

Optical-magnetic characterization of IgG and nanoparticles for rapid biosensor development: detection of cardiac markers and mycotoxins

J.A. Malkerov[1,2], S.L. Znoyko[1], V.A. Bragina[1], B.G. Gorshkov[1]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University MEPhI, Russia

This study introduces a novel method for characterizing IgG and nanoparticles in biosensor development. Using label-free low-coherence interferometry and magnetic lateral flow immunoassay, it enables kinetic studies, IgG sorption density quantification, and functional nanoparticle characterization. Demonstrating efficacy in sensitive assays for mycotoxins and cardiovascular biomarkers underscores its potential. Promising results in analytical characteristics highlight versatility for rapid biosensor advancement.

ThSYC-43 12:15-12:30

Chlorophyll fluorescence parameters of maize plants grown under linearly polarized light

Yu.N. Kulchin[1], S.O. Kozhanov[1], A.S. Kholin[1], E.P. Subbotin[1], K.V. Kovalevsky[2], N.I. Subbotina[1], A.S. Gomolsky[2]; [1]Institute of Automation and Control Processes, Far Eastern Branch RAS; [2]Advanced Engineering School "Institute of Biotechnologies, Bioengineering and Food Systems", Far Eastern Federal University, Russia

Chlorophyll fluorescence parameters are presented for three varieties of maize plants grown under polarized light. It is shown that there was no stress in groups grown under polarized radiation. The maize plants of Ranyya lakomka and Zolotoy Batam varieties grown under polarized treatment demonstrated greater values of photosynthesis parameters than plants grown under non-polarized treatment.

ThSYC-44 12:30-12:45

Estimation of the contribution of all-trans and cis-isomers to carotenoid absorption

V.A. Kurkov[1,2], D.D. Chesalin[1], U.A. Shkirina[1,3], R.Y. Pishchalnikov[1]; [1]Prokhorov General Physics Institute RAS, [2]Moscow Institute of Physics and Technology (National Research University), [3]Department of Mechanics and Mathematics, Moscow State University, Russia

We propose an original approach to determine the concentration of cis-isomers of carotenoids in solvents by performing the fitting of experimental data with the help of differential evolution. The total contribution of cis-isomers to the resulting optical response was modelled by a Gaussian curve, whereas the spectrum of the all-trans isomer was calculated within the framework of semi-classical theory.

ThSYC-45 12:45-13:00

Photophoresis-assisted transport administration of a micron-sized capsule: theoretical simulation

Yu.E. Geints, E.K. Panina; V.E. Zuev Institute of Atmospheric Optics SB RAS, Russia

We present the numerical model of photophoresis of a microcapsule illuminated by an intense laser pulse.

ThSYC-46 13:00-13:15

Limiting factors affecting the precision and stability of a quantum gyroscope based on NV centers in diamond and strategies to overcome them

I. Cojocaru[1,2,3], V.V. Soshenko[1,2], A.M. Kozodaev[2], S.V. Bolshedvorskii[1,2], O.R. Rubinas[1,2,3], V.N. Sorokin[1,2], A.N. Smolyaninov[2], A.V. Akimov[1,2,3]; [1]Lebedev Institute RAS; [2]LLC Sensor Spin Technologies; [3]Russian Quantum Center, Skolkovo Innovation Center, Russia (The work was supported by Rosatom in the framework of the Russian Roadmap for Quantum computing (Contract No. [868]1.3-15/15-2021 dated October[5, 2021]))

Nitrogen-vacancy (NV) centers nuclear spins show great potential as candidates for an innovative gyroscope. The precision and stability of this system depend on various parameters at each stage of the measurement protocol, including temperature fluctuations and the magnetic field of the environment. We characterize the influence of some of these parameters and propose protocols that could surpass these limitations.

- Lunch Break -

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Thursday, July 04, 2024

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 4

Session Chair: Alexander Krasnovskii, Bach Inst. of Biochemistry RAS, Russia

ThSYD-16 09:00-09:30

Picosecond anisotropic relaxation in biomolecules studied by polarization-modulation pump-and-probe spectroscopy *(Invited paper)*

O.S. Vasyutinskii; Ioffe Institute, Russia

Transient monitoring and Stimulated Raman Scattering attract much attention as effective methods for investigation of the dynamics of biologically relevant molecules in solutions and living cells. The lecture presents the results of experimental and theoretical studies of ultrafast relaxation and energy transfer in biologically relevant molecules using a novel polarization-modulation pump-and-probe femtosecond spectroscopy developed recently by the authors.

ThSYD-17 09:30-10:00

Microscopy techniques for the enhancement of localized photodynamical processes *(Invited paper)*

Meisam Sadeghpour Karimi, Lishin Thottathi, Gabriele Ferrini; Università Cattolica del Sacro Cuore, Italy

We report on progress regarding light localization, light collection, and scanning capabilities of microscope objectives aided by single dielectric microspheres. Selective enhancement of photodynamic and thermo-mechanical processes at surfaces will be discussed.

ThSYD-18 10:00-10:15

Method of deep joint formation at laser welding of biological tissues

D.I. Ryabkin[1,2], V.V. Suchkova[1,2], E.A. Gerasimenko[1], A.Yu. Gerasimenko[1,2]; [1]Institute of Biomedical Systems, National Research Univ. of Electronic Technology, [2]Institute of Bionic Technology and Engineering, Sechenov First Moscow State Medical Univ., Russia

A new method of weld irradiation in the process of laser soldering of biological tissues is proposed. The method will allow transporting laser radiation to the area of weld formation with fewer losses, which allows minimizing the formation of temperature necrosis of the tissue. Modelling has shown the possibility of forming deeper welds compared to stationary irradiation methods.

ThSYD-19 10:15-10:45

Spectral properties of crystalline aluminum phthalocyanine nanoparticles and the possibility of their use in biophotonics *(Invited paper)*

V.I. Makarov[1,2], D.V. Pominova[1,2], A.V. Ryabova[1,2], I.D. Romanishkin[1], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University MEPhI, Russia

The use of AlPc nanoparticles as photosensitizers makes it possible to significantly increase the selectivity of the procedure. Using time-resolved laser spectroscopy, analysis of multispectral fluorescence microimages, microstructural and X-ray diffraction methods, we studied the occurrence of optical effects manifested in the interaction of crystalline AlPc NPs with the microenvironment and laser radiation.

ThSYD-20 10:45-11:00

Feasibility of photodynamic effect assessment by means of microcirculation optical monitoring during laser activation

A.S. Machikhin[1], A.V. Guryleva[1], T.G. Grishacheva[2], N.N. Petrishchev[2]; [1]Acousto-Optic Spectroscopy Lab. STC UI RAS; [2]Department of Pathophysiology. Pavlov University, Russia

Conventional non-invasive in vivo methods for studying photodynamic therapy mechanisms do not implement monitoring directly during photoactivation. Our study was aimed at evaluating the feasibility of such monitoring using videocapillaroscopy and photoplethysmography. We proposed an approach, designed its hardware and software, and approved it when studying the response of skin microcirculation in rats under various modes of laser activation.

- Coffee Break -

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Thursday, July 04, 2024

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 5

Session Chair: Alexander Krasnovskii, Bach Inst. of Biochemistry RAS, Russia

ThSYD-21 11:30-11:45

Methylene blue-mediated photodynamic therapy and tissue oxygen saturation control of postoperative mammary gland scars

D.M. Kustov[1], P.M. Alekseeva[1], A.S. Moskalev[1], L.Yu. Loschenova[2], A.V. Voitova[2], P.V. Pimanchev[3], A.A. Shiryaev[3], V.B. Loschenov[1,4]; [1]Prokhorov General Physics Institute RAS; [2]Biospec LTD; [3]I.M. Sechenov First Moscow State Medical University; [4]National Research Nuclear University MEPhI, Russia

Wounds are major health care problem. Photodynamic therapy (PDT) is a non-invasive procedure, can be applied to stimulate healing of skin wounds resulting from mammary gland surgery. The development of approaches to treatment of postoperative scars with PDT and simultaneous tissue oxygen saturation control will reduce the time of tissue healing and decrease the incidence of postoperative scars inflammation.

ThSYD-22 11:45-12:15

Method for rapid intraoperative analysis of the optical properties of multilayered walls of hollow organs *(Invited paper)*

T.A. Savelieva[1,2], A.A. Krivetskaya[1,2], V.V. Levkin[3], D.M. Kustov[1], A.S. Gorbunov[3], A.A. Shiryaev[3], S.S. Harnas[3], K.G. Linkov[1], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS; [2]Institute of Engineering Physics for Biomedicine, National Research Nuclear University MEPhI; [3]Department of Faculty Surgery No.1, Sechenov First Moscow State Medical University, Russia

The optical properties of tissues are important information that allows planning various types of laser-induced effects on biological tissues. In this work, we propose an approach to simultaneous intraoperative measurements of the spectra of diffuse reflectance and transmittance of light through intestinal wall tissue to restore the optical properties of these tissues with customized variant of Kubelka-Munk model.

ThSYD-23 12:15-12:45

Experimental models of photodynamically-induced thrombi in blood vessels *(Invited paper)*

I.A. Mikhailova, N.N Petrishchev, T.G. Grishacheva, S.G. Meloyan, S.G. Chefu, G.Yu. Yukina; Pavlov First State Medical University, Russia

The review of commonly used experimental in vivo models of photothrombosis of vascular bed is presented. Herein we discuss some of their advantages and disadvantages of these models being applied to different areas of vascular bed.

ThSYD-24 12:45-13:15

The use of mid-infrared lasers in ophthalmology: prospects and advantages, a look at future development *(Invited paper)*

Yu.N. Yusef[1], D.V. Petrachkov[1], E.N. Korobov[1], I.M. Belousova[2], A.P. Zhevlakov[2], A.S. Narivonchik[2]; [1]Dept. Innovation Vitreoretinal Technology, Krasnov Research Institute of Eye Diseases; [2]Nanophotonics Department, Vavilov Optical Institute, Russia

We are evaluate the effect of laser radiation with a wavelength of 3 μm on the tissues of cadaver eyes and compare it under similar parameters with the 532-nm laser. The impact of laser radiation on eye tissues was assessed using a scanning electron microscope.

ThSYD-25 13:15-13:45

Singlet and triplet oxygen detection by time-correlated single photon counting *(Invited paper)*

P. Morozov[1], V.S. Andreev[1], M.V. Shirmanova[2], V.I. Shcheslavskiy[2,3], G.N. Goltsman[1]; [1]Scontel; [2]Privolzhskiy Research Medical University, Russia; [3]Becker&Hickl GmbH, Germany

We present the technique for molecular oxygen measurements both in ground and excited states. It is based on time-correlated single photon counting technique and use of a superconducting nanowire single-photon detector that has a high quantum efficiency and an extremely low dark count rate.

Location: Petrov-Vodkin 3 Room, Floor 2; Date: Thursday, July 04, 2024

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE 6

Session Chair: Alexander Krasnovskii, Bach Inst. of Biochemistry RAS, Russia

ThSYD-26 15:00-15:30

The role of water in the biological activity of shungite carbon nanoparticles *(Invited paper)*

N.N. Rozhkova[1], S.P. Rozhkov[2]; [1]Institute of Geology KarRC RAS, [2]Institute of Biology KarRC RAS, Russia

The role of the network of water hydrogen bonds in the regulation of intermolecular interaction responsible for colloidal stability of dispersions has been studied in order to search for general patterns of interaction between water, nanoparticles and biomacromolecules. Raman spectra for dispersions of bovine serum albumin and its hybrids with shungite carbon nanoparticles were analyzed in the high wavenumber region.

ThSYD-27 15:30-15:45

New materials for photodynamic inactivation of viruses

I.M. Belousova[1], I.V. Bagrov[1], V.V. Zarubaev[2], V.M. Kiselev[1], I.M. Kislyakov[3], T.K Krisko[1], A.M. Starodubtsev[1]; [1]Joint Stock Company «Scientific and Production Association S.I. Vavilov State Optical Institute», Russia; [2]St. Petersburg Pasteur Research Institute of Epidemiology and Microbiology, Russia; [3]Photonic Integrated Circuits Center, Shanghai Institute of Optics and Fine Mechanics CAS, China

The studies carried out in this work on the effective generation of singlet oxygen in the volume and on the surface of polytetrafluoroethylene (fluoroplastic-4, also known under the trade mark as Teflon) when irradiated with ultraviolet and visible radiation made it possible to clarify the mechanisms and features of the antiviral action of this fluoropolymer under specific experimental conditions.

ThSYD-28 15:45-16:00

The combined use of methylene blue and chlorin E6 photosensitizers for photodynamic therapy and correction of the tumor microenvironement

D.V. Pominova[1,2], A.V. Ryabova[1,2], A.S. Skobeltsin[1,2], I.V. Markova[2], I.D. Romanishkin[1]; [1]Prokhorov General Physics Institute RAS, [2]National Research Nuclear University MEPhI, Russia

In this work we report the results of the study of combined use of methylene blue with chlorin e6 photosensitizer for tumor oxygenation control and the tumor microenvironment correction during photodynamic therapy in vitro and in vivo. Targeted destruction of macrophage cells of tumor-associated phenotype and synergistic effects due to the influence of methylene blue on tumor oxygenation were studied.

ThSYD-29 16:00-16:15

Photodynamic therapy and photodiagnosis of glioblastomas with combined use of 5-ALA and Chlorin e6

E.I. Kozlikina, I.S. Trifonov, O.V. Levchenko; Federal State Budgetary Educational Institution of Higher Education "Russian University of Medicine", Russia

The study presents the preliminary results of the combined use of 5-ALA and Chlorin e6 photosensitizers for photodiagnosis and photodynamic therapy of glial brain tumors.

ThSYD-30 16:15-16:30

Spectroscopic verification of contrast enhancement methods in fluorescence diagnostics of basal cell carcinoma with scar tissue

A.A. Febenchukova[1], A.M. Udeneev[1,2], A.M. Kulichenko[1,3], N.A. Kalyagina[1,3], K.T. Efendiev[1,3], M.V. Loshchenov[1]; [1]National Research Nuclear University MEPhI, [2]Federal State Budgetary «Federal Scientific and Clinical Center for Medical Rehabilitation and Balneology of the Federal Medical and Biological Agency», [3]Prokhorov General Physics Institute RAS, Russia

Fluorescent diagnosis of skin malignancies requires contrast enhancement of fluorescent images. The contrast enhancement methods of dividing the chlorine e6 fluorescence by the auto fluorescence and subtracting the auto fluorescence from the drug fluorescence were tested spectrometrically. Both methods have shown the possibility of enhancing tumor-healthy tissue contrast, with localization more easily determined by subtraction and accumulation assessed by division.

ThSYD-31 16:30-16:45

Photodynamic therapy for cancer of external and visceral localizations in Russia

E.Ph. Stranadko[1], A.V. Baranov[1], T.I. Malova[2], M.V. Riabov[1], M.A. Andreeva[1]; [1]Skobelkin Scientific and Practical Center for Laser Medicine FMBA; [2]"VETA-GRAND" LLC, Russia

Photodynamic Therapy (PDT) for cancer at various stages and locations has been practiced in Russia for 32 years. PDT is utilized in the majority of oncology clinics. The effectiveness of PDT reached 95-96%. PDT fundamentally changes the status of a significant group of inoperable patients with various cancer localizations.

ThSYD-32 16:45-17:00

Endoscopic photodynamic recanalization for inoperable obstructive esophageal cancer

E.Ph. Stranadko[1], V.A. Duvansky[2], V.L. Shabarov[3], M.V. Riabov[1], T.I. Malova[4], M.A. Andreeva[1]; [1]Skobelkin Scientific and Practical Center for Laser Medicine FMBA, [2]RUDN University, [3]Moscow Regional Research and Clinical Institute ("MONIKI"), [4]"VETA-GRAND" LLC, Russia

PDT is effective in advanced obstructive esophageal cancer, improving the outcomes for this challenging group of patients and enhancing their quality and duration of life. The recanalization effect lasts for 6-7 months. In cases of dysphagia recurrence after stenting, PDT is the only possible method for eliminating the tumor stricture.

- Coffee Break -

SYD: PHOTODYNAMIC PROCESSES IN BIOLOGY AND MEDICINE - POSTERS

Location: Nikolsky + Levinson Foyer, Floor 2; Date: Thursday, July 04, 2024

ThSYD-p01 15:00-18:30

Comparison of Ce6 photobleaching rate on the surface and in the depth of basalioma during photodynamic therapy at a wavelength of 660 nm using registration of fluorescence excited in the red and violet ranges

A.M. Udeneev[1,2], A.A. Febenchukova[2], N.A. Kalyagina[1,2,3]; [1]Federal State Budgetary «Federal Scientific and Clinical Center for Medical Rehabilitation and Balneology of the Federal Medical and Biological Agency», [2]National Research Nuclear University MEPhI, [3]Prokhorov General Physics Institute RAS, Russia

The photobleaching measuring at different tissue depths is important for photodynamic therapy monitoring. Photodynamic therapy of basaliomas was conducted with a 660 nm LED source. Photobleaching was measured with camera and with violet and red LEDs. Dependencies of a photosensitizer bleaching rate at the depth and surface of the basalioma tissue were obtained and analysed.

ThSYD-p02 15:00-18:30

Singlet oxygen generation by Radachlorin photosensitizer in albumin-containing solutions

D.M. Beltukova[1], V.P. Belik[1], K.A. Chudakov[2], O.V. Smirnov[1], I.V. Semenova[1], O.S. Vasyutinskii[1]; [1]Ioffe Inst.; [2]Peter the Great Polytechnic Univ., Russia

We present experimental analysis of singlet oxygen (SO) generation by Radachlorin photosensitizer (PS) in solutions with human serum albumin (HSA) at different relative concentrations of PS and HSA molecules. The gradual decrease of the SO phosphorescence signal with rising amount of albumin molecules has been observed and interpreted.

ThSYD-p03 15:00-18:30

Study of photo-oxidation of tetrahydrobiopterin with the addition of Pt - Pd nanoparticles

D.A. Makarova[1], A.S. Nizamutdinov[1], T.A. Telegina[2], Yu.L. Vechtomova[2], A.A. Buglak[3]; [1]Institute of Physics, Kazan Federal University; [2]A.N. Bach Institute of Biochemistry, Research Center of Biotechnology RAS; [3]Faculty of Physics, St. Petersburg State University, Russia

In the work, it was shown that the addition of platinum and palladium nanoparticle suspension promotes the formation of dihydropterin dimers when irradiated with ultraviolet light (325 nm) in the presence of oxygen.

ThSYD-p04 15:00-18:30

Picosecond to millisecond transient absorption spectroscopy of carboxy- and oxyhemoglobin in the visible and mid-infrared spectral region

S.V. Lepeshkevich[1], I.V. Sazanovich[2], M.V. Parkhats[1], S.N. Gilevich[3], B.M. Dzhagarov[1]; [1]B.I. Stepanov Institute of Physics NAS Belarus, Belarus; [2]Central Laser Facility, Research Complex at Harwell, STFC Rutherford Appleton Laboratory, UK; [3]Institute of Bioorganic Chemistry NAS Belarus, Belarus

Picosecond to millisecond laser time-resolved transient absorption spectroscopy in the visible and mid-infrared spectral region was used to study carbon monoxide and molecular oxygen rebinding as well as conformational relaxation following ligand photodissociation in human hemoglobin. Significant functional non-equivalence of the alpha and beta subunits of hemoglobin in both the geminate ligand rebinding and concomitant structural relaxation was revealed.

ThSYD-p05 15:00-18:30

Optimization of energy parameters for laser-induced photodynamic therapy of cervical tissues using numerical simulation and fluorescent monitoring

P.M. Alekseeva[1], K.T. Efendiev[1,2], T.A. Savelieva[1,2], A.S. Moskalev[1], A.V. Gilyadova[3], V.B. Loschenov[1,2]; [1]Prokhorov General Physics Institute RAS; [2]National Research Nuclear University MEPhI; [3]Sechenov First Moscow State Medical University, Russia

The main problem in the photodynamic therapy of tumors is insufficient light exposure to tissue depth or the appearance of undesirable surface effects. It is required to investigate the influence of energy density and radiation spot diameter on the photosensitizer photobleaching efficiency by depth.

ThSYD-p06 15:00-18:30

Absorption spectra of molecular oxygen at 800 - 1300 nm in aerated organic solvents and water

A.S. Kozlov[1], S.G. Zhuravlev[2], O.N. Egorova[2], O.I. Medvedkov[2], A.A. Krasnovsky[1]; [1]Federal Research Center of Biotechnology RAS; [2]Prokhorov General Physics Institute RAS, Russia

Fiber and diode lasers (800 -1300 nm) were applied to investigation of the quantum efficiency of singlet oxygen trapping in aerated organic and aqueous media. Two main absorption bands at 1070 and 1273 nm corresponding to the 0-1 and 0-0 transitions in oxygen molecules were revealed with the relative intensities of 1:100.

ThSYD-p07 15:00-18:30

Extracorporeal treatment of carbon monoxide poisoning stimulated by laser radiation. Model of physical and chemical processes

A.V. Smirnov, N.V. Kovalenko; Moscow Institute of Physics and Technology, Russia

One of the promising methods of treatment of carbon monoxide poisoning is to use the effect of photodissociation of carboxyhemoglobin with parallel oxygenation of blood. This paper considers the simplest device realizing this principle and develops a mathematical model of physical processes occurring in the device.

ThSYD-p08 15:00-18:30

Comparison of SERS spectra of intact and inactivated viruses via machine learning algorithms for the viral disease's diagnosis application

O. Andreeva[1], D. Danilenko[2], A. Tabarov[1], K. Grigorenko[1], A. Dobroslavin[1], A. Gorshkov[2], A. Zheltukhina[2], N. Gavrilova[2], A. Gazizulin[1], V. Vitkin[1]; [1]ITMO University; [2]Smorodintsev Research Institute of Influenza, Russia

This study explores using inactivated influenza A viruses instead of intact ones for creating a spectral database in a diagnostic method with SERS and machine learning. Spectral differences between the forms reveal limitations in using inactivated viruses for database creation and ML training for virus detection, but the data obtained can be utilized for vaccine quality monitoring technology.

ThSYD-p09 15:00-18:30

Effect of folic acid on photophysical properties and photosensitized singlet oxygen formation by cationic tetrapyridyl porphyrins

M.V. Parkhats[1], S.V. Lepeshkevich[1], M.V. Verameichyk[2], L. Mkrtchyan[3], T. Seferyan[3], A.A. Zakoyan[3], G.V. Gyulkhandanyan[3], B.M. Dzhagarov[1]; [1]B.I. Stepanov Institute of Physics, NASB, Belarus; [2]Belorussian State University, Belarus; [3]Institute of Biochemistry NAS of Armenia, Armenia

The effect of folic acid on photophysical properties and photosensitized singlet oxygen formation by cationic tetrapyridyl porphyrins was investigated. It was found a strong quenching of the porphyrin fluorescence and the efficiency of singlet oxygen formation in the presence of folic acid. The reasons for the observed changes are discussed.

ThSYD-p10 15:00-18:30

Wireless chronic electrical stimulation of peripheral nerves via organic optoelectronic device.

E.A. Iusupovskaia[1], G.A. Piavchenko[2], A.N. Konovalov[1,3], D.V. Telyshev[1,4], A.G. Markov[1]; [1]Institute for Bionic Technologies and Engineering, I. M. Sechenov First Moscow State Medical University, Russia; [2]Department of Histology, Cytology and Embryology, I.M. Sechenov First Moscow State Medical University (Sechenov University), Russia; [3]National Medical Research Center of Neurosurgery named after N.N. Burdenko, Russia; [4]Institute of Biomedical Systems, National Research University of Electronic Technology, Russia

Here we report chronic wireless electrical stimulation of the sciatic nerve in rats by an implanted multilayered organic semiconductor optoelectronic device that transduces deep-red light (625 nm) into electrical signals. In freely moving rats, fixation of the cuff around the sciatic nerve, 10 mm below the surface of the skin, allowed stimulation of the nerve for over 90 days.

SYB: LASER INTERACTION WITH CELLS AND TISSUES- CLINICAL IMAGING AND SPECTROSCOPY

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Friday, July 05, 2024

SYB: SESSION # 10: GENERAL ISSUES OF BIOPHOTONICS AND SIMULATION

Session Chair: Mikhail Kirillin, Inst. of Applied Physics RAS, Russia

FrSYB-43 09:00-09:30

Made-to-order organ: the common future of biophotonics and biofabrication *(Invited paper)*

Peter Timashev; Science and Technology Park for Biomedicine of the Sechenov Medical University; Faculty of Chemistry, Lomonosov Moscow State University, Russia

Various strategies have been developed to produce biocompatible tissue-engineered constructs, including the use of natural biomaterials like collagen or functionalization of synthetic biomaterials. There is a trend towards bioactive constructs that stimulate tissue remodeling and integration. Challenges include quality control and imaging without destruction. Biophotonics offers instant tissue visualization. These approaches hold promise for revolutionizing regenerative medicine.

FrSYB-44 09:30-09:45

Plasmonic sensors for detection of protein aging in solution

A.A. Rubekina[1], V.I. Kukushkin[2], E.A. Shirshin[1]; [1]Physics department, Lomonosov Moscow State University; [2]Institute of Solid State Physics RAS, Russia

The aging process of proteins is accompanied by their oxidation and the formation of post-translational modifications. Their optical properties changes due to its oxidation: they acquire a fluorescent response in the near-infrared regions of the spectrum. This work examines the possibility of using plasmonic sensors to monitor the fluorescence of proteins during their aging process.

FrSYB-45 09:45-10:00

Singlet oxygen prevents the mitochondrial NADH depletion in β-amyloid induced neurotoxicity

O.A. Stelmashchuk[1], V.V. Dremin[1], A.Y. Abramov[1,2]; [1]Research & Development Center of Biomedical Photonics, Orel State University, Russia; [2]Department of Clinical and Movement Neurosciences, UCL Queen Square Institute of Neurology, UK

This paper demonstrates the results of the application of singlet oxygen in β-amyloid induced neurotoxicity. The experimental results of the use of 1267 nm laser for generating singlet oxygen in primary co-culture of cortical cells addition β-amyloid peptide fragment 25-35 (5 μM) are described.

FrSYB-46 10:00-10:30

Advanced Monte Carlo simulations in spectral and fluorescence optical diagnostics *(Invited paper)*

M.Yu. Kirillin[1], D.A. Kurakina[1], A.A. Getmanskaya[1,2], A.V. Khilov[1], V.V. Perekatova[1], V.A. Shishkova[1], I.V. Turchin[1], E.A. Sergeeva[1]; [1]A.V. Gaponov-Grekhov Institute of Applied Physics RAS; [2]N.I. Lobachevsky State University of Nizhny Novgorod, Russia

We report on the development of Monte Carlo based models of signal formation in systems of spectral and fluorescence imaging. Numerical simulations allow tracking photon trajectories providing imaging volume analysis, while parallel processor architecture allows to significantly speed up calculations.

FrSYB-47 10:30-10:45

Simulation of infrared radiation backscattering in multylayer tissue models

V.L. Kuzmin[1], Yu.A. Zhavoronkov[1,2], S.V. Ul'yanov[2]; [1]Peter the Great St. Petersburg Polytechnic University; [2]St. Petersburg State University, Russia

Calculating and studying the characteristics of infrared radiation scattered by multilayer systems expands the possibilities of noninvasive diagnostics. We present Monte Carlo simulation results of backscattering from a four-layer bio-tissue model based on the solution of the Bethe-Salpeter equation. The calculations reveal that backscatter intensity are extremely sensitive to the penetration of blood into the cerebrospinal fluid layer.

Location: Petrov-Vodkin 1 Room, Floor 2; Date: Friday, July 05, 2024

SYB SESSION # 11: RAMAN SPECTROSCOPY

Session Chair: Evgeny Shirshin, Lomonosov Moscow State University, Russia

FrSYB-48 11:30-12:00

Human serum SERS analysis for non-infectional diseases detection: avoiding overestimation of classification models *(Invited paper)*

I.A. Bratchenko[1], Yu.A. Khrisoforova[1], P.A. Lebedev[2], M.A. Skuratova[3], L.A. Bratchenko[1]; [1]Laser and Bbiotech Dept., Samara National Research University; [2]Therapy Dept. Samara State Medical University; [3]Samara Regional Clinical Hospital named after VD Seredavin, Russia

The in vitro analysis of human serum was performed for more than 500 subjects for the detection of chronic heart failure, chronic kidney failure and other non-communicable diseases. Analyzed groups separation was performed based on deep learning was implemented using a separate one-dimensional convolutional neural network, projection on latent structures combined with discriminant analysis and other machine learning approaches.

FrSYB-49 12:00-12:30

Development of SERS-active substrates for Raman investigations of microorganisms *(Invited paper)*

V.V. Tregulov[1], E.V. Perevedentseva[2], A.I. Ivanov[1], D.S. Kostsov[2], N.N. Melnik[2]; [1]Ryazan State University named after S. Yesenin; [2]Lebedev Physical Institute RAS, Russia

The developing of active substrates for surface enhancement Raman scattering (SERS) based on porous silicon with Fano resonance is presented. Such structures provide both high amplification of the Raman signal and obtaining reproducible and clearly interpretable results for using SERS like a tool for detection, identification and research of pathogenic and non-pathogenic microorganisms.

FrSYB-50 12:30-12:45

Assignment of low-frequency bands in micro-Raman spectra of hair keratins

E.I. Travkina, N.N. Brandt; Faculty of Physics, Lomonosov Moscow State University, Russia

We identify conformation-sensitive bands in the low-frequency micro-Raman spectra of human hair keratins. A comparison of hair spectra measured at different orientations of the sample relative to the exciting radiation reveals changes in an interval of 110-190 cm-1, corresponding to vibrations of polarization sensitive α-helical structures. It was also shown that spectral interval of 235-353 cm-1 characterizes vibrations of β-structures.

FrSYB-51 12:45-13:00

Plasmon based tags for Raman bioimaging in silent region

A.I. Demenshin, V.N. Sorokoumov, E.V. Solovyeva; St. Petersburg State University, Russia

Surface-enhanced Raman scattering is characterized by high specificity, spatial resolution and signal-to-noise ratio which make it attractive for bioimaging purposes. The use of alkynes in combination with plasmonic materials opens up the possibility of multifunctional diagnostic agents. In this work, the tags based on gold nanorods functionalized with 4-aminotolan via covalent conjugation are developed for alkyne-targeted bioimaging and photothermal therapy.

- Lunch Break -