Russian Academy of Sciences
Institute of Applied Physics

VI International Symposium

TOPICAL PROBLEMS OF BIOPHOTONICS

28 July – 03 August , 2017
St.Petersburg – Nizhny Novgorod, Russia

PROGRAM and ABSTRACTS

Nizhny Novgorod, 2017

Organized by

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Symposium Web site: http://www.biophotonics.sci-nnov.ru

VI International Symposium

TOPICAL PROBLEMS OF BIOPHOTONICS

Topical Coferences

Optical Bioimaging

Biophotonics in Cancer Research

Novel Laser Applications in Biomedicine

Workshops

Clinical Biophotonics

Biophotonics in Stem Cell Research

PROGRAM

Friday, July 28

	Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
Chairs	**Martin Frenz (Switzerland)** **Ilya Turchin (Russia)** **Alex Vitkin (Canada)**	**Ammasi Periasamy (USA)** **Lothar Lilge (Canada)** **Elena Zagaynova (Russia)**	**Alexander Sergeev (Russia)** **Alfred Vogel (Germany)**
	Clinical Biophotonics	**Biophotonics in Stem Cell Research**	
Chairs	**Natalia Shakhova (Russia)** **Herbert Stepp (Germany)**	**Igor Adameyko (Sweden, Austria)** **Boris Chichkov (Germany)**	
18:00-21:00	**Registration**		
19:00-20:30	**Dinner**		
21:30	**Departure from St. Petersburg**		
21:30	**Welcome Party**		

Cruise map

Saturday, July 29

8:00-9:00	**Breakfast**		
9:00-9:30	**Opening session**		
	HALL A		
9:30-10:20	**Matthew O'Donnell** (*USA*). Light and sound: integrating photonics with ultrasonics for biomedical applications **(Plenary)**		
10:20:11:10	**Wolfgang Becker** (*Germany*). The multi-dimensional world of TCSPC FLIM **(Plenary)**		
11:10-11:30	**Coffee break**		
	HALL A	**HALL B**	**HALL C**
	Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
	Session: Optoacoustic imaging **Chair: Matthew O'Donnell**	**Session: Nanobiophotonics** **Chairs: Elena Zagaynova, Chia-Liang Cheng**	**Session: Laser-based technologies for biological, agriculture and medical applications 1** **Chair: Alfred Vogel**
11:30-13:30	**11:30-11:55 Martin Frenz** (*Switzerland*). Quantitative optoacoustic imaging **(Invited)**	**11:30-11:55 Nikolai Khlebtsov** (*Russia*). Optimal design of layered plasmonic nanostructures with embedded Raman reporters **(Invited)**	**11:30-11:55 Kenichi Ueda** (*Japan*). Bio-photonics research works in SA-KIGAKE program in Japan **(Invited)**
	11:55-12:20 Xose Luis Dean Ben (*Germany*). The promise of large-scale brain imaging with optoacoustics **(Invited)**	**11:55-12:20 Vladimir Chekhonin** (*Russia*). Internalization of vectorized liposomes into target-cells **(Invited)**	**11:55-12:20 Aleksei Zheltikov** (*Russia*). Fiber-optic neurointerfaces and multimodal optical neuroimaging in opto- and thermogenetic studies **(Invited)**
	12:20-12:45 Guenther Paltauf (*Austria*). Overcoming the trade-off between depth of field and lateral resolution in scanning photoacoustic imaging with focused detectors **(Invited)**	**12:20-12:45 Konstantin Sokolov** (*USA*). Mechanisms of molecular cancer imaging and therapy with ultra-small nanoparticles **(Invited)**	**12:20-12:45 Viacheslav Artyushenko** (*Germany*). Novel laser and fiber optics solutions in optical theranostics **(Invited)**
	12:45-13:00 Pavel Subochev (*Russia*). Image enhancement in acoustic resolution photoacoustic microscopy	**12:45-13:10 Sergey Deyev** (*Russia*). New strategies of cancer diagnostics and therapy **(Invited)**	
	13:00-13:15 Valeriya Perekatova (*Russia*). *In vivo* two-wavelength mapping of blood oxygen saturation by acoustic resolution photoacoustic microscopy	**13:10-13:25 Maxim Gongalsky** (*Russia*). Coherent anti-stokes Raman spectroscopy as imaging tool for interaction between silicon nanostructures and living systems	
13:30-15:00	**Lunch**		
15:00-20:30	**VALAAM**	**Tour**	
20:30-21:30	**Dinner**		
	Sponsor session I		
21:30-21:50	**Andrey Evteev** Innovative imaging solutions from PerkinElmer (BioLine LLC)		
22:00-00:00	**Dance studio**		

Sunday, July 30

8:00-9:00	**Breakfast**		
	HALL A		
9:00-9:50	**Kiminori Kondo** (*Japan*). Laser driven injector for a new generation heavy ion cancer therapy machine in Japan **(Plenary)**		
9:50:10:40	**Melissa Skala** (*USA*). Optical imaging of cell-level metabolism **(Plenary)**		
10:50-11:40	**HALL A**	**HALL B**	**HALL C**
	Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
	Session: Optoacoustic imaging **Chair: Martin Frenz**	**Session: Metabolic imaging** **Chairs: Melissa Skala, Vladislav Shcheslavskiy**	**Session: Laser-based technologies for biological, agriculture and medical applications 2** **Chair: Alexander Sergeev**
	10:50-11:15 Vladimir Zharov (*USA*). *In vivo* photoacoustic flow cytometry for early diagnosis and prevention of cancer, infections and cardiovascular disorders **(Invited)**	**10:50-11:15 Dhayn Chandra** (*USA*). Novel regulation of cancer cell death by OXPHOS complexes, cytokines, and unfolded protein response **(Invited)**	**10:50-11:15 Satoshi Wada** (*Japan*). Development of tunable MID-IR lasers for agriculture and health science applications **(Invited)**
	11:15-11:40 Stefan Andersson-Engels (*Ireland*). Ultrasound optical tomography **(Invited)**	**11:15-11:40 Ammasi Periasamy** (*USA*). Tryptophan as an alternative biomarker for cancer metabolism: FLIM-FRET microscopy **(Invited)**	**11:15-11:40 Yuri Kulchin** (*Russia*). Optical and sensory characteristics of oceanic biota and organic-inorganic natural and biomimetic materials **(Invited)**
11:40-14:00	**MANDROGY**	**Riverside outings**	
14:00-15:30	**Lunch**		
15:30-17:00	**HALL A**	**HALL B**	**HALL C**
	Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
	Session: Coherence domain optical methods and optical coherence tomography **Chair: Felix Feldchtein**	**Session: Metabolic imaging** **Chairs: Melissa Skala, Vladislav Shcheslavskiy**	**Session: XUV and X-ray sources for biomedical imaging** **Chairs: Satoshi Wada**
	15:30-15:55 Zhongping Chen (*USA*). Advances in optical coherence elastography **(Invited)**	**15:30-15:55 Hauke Studier** (*Australia, Germany*). Non-invasive metabolic imaging of melanoma progression **(Invited)**	**15:30-15:55 Makina Yabashi** (*Japan*). Status and perspective of an X-ray free electron laser SACLA **(Invited)**
	15:55-16:20 Kirill Larin (*USA*). Optical coherence elastography of soft tissue **(Invited)**	**15:55-16:20 Marina Shirmanova** (*Russia*). Tumor response to chemotherapy as a complex phenomenon: insight into functional characteristics using fluorescence imaging **(Invited)**	**15:55-16:20 Andrei Seryi** (*UK*). Recent developments in JAI and UK on X-Ray bioimaging based on laser-plasma acceleration **(Invited)**
	16:20-16:45 Alex Vitkin (*Canada*). Functional Optical Coherence Tomography: preclinical and clinical updates from the Nizhny Novgorod -Toronto collaboration **(Invited)**	**16:20-16:45 Richard Day** (*USA*). Intravital FRET and FLIM: monitoring biosensor activities and intrinsic metabolic states **(Invited)**	**16:20-16:45 Silvio Fuchs** (*Germany*). XUV coherence tomography with nanoscale resolution **(Invited)**
	16:45-17:00 Vladimir Zaitsev (*Russia*). Applications of optical coherence elastography in problems of laser reshaping of cartilages and cornea	**16:45-17:00 Maria Lukina** (*Russia*). Metabolic imaging of cancer cells using fluorescence life-time microscopy	
17:00-17:20	**Coffee break**		

	HALL A	HALL B	HALL C
	Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
	Session: Coherence domain optical methods and optical coherence tomography **Chair: Alex Vitkin**	**Session: FLIM/FRET/PLIM** **Chairs: Ammasi Periasamy, Alexander Savitsky**	**Session: Laser tissues and material interaction** **Chair: Alexander Heisterkamp**
17:20-19:00	**17:20-17:45 Mikhail Kirillin** (*Russia*). Optical coherence tomography in pathology recognition and monitoring of photodynamic therapy: benefits from numerical processing in clinical applications **(Invited)**	**17:20-17:45 Margarida Barroso** (*USA*). Novel insights into transferrin-mediated delivery into tumor cells using in vitro and *in vivo* FRET imaging **(Invited)**	**17:20-17:45 Alfred Vogel** (*Germany*). Cavitation bubble dynamics in plasma-mediated nanosurgery of cells and tissues **(Invited)**
	17:45-18:00 Felix Feldchtein (*Russia*). Cross-polarization optical coherence tomography in vulnerable atherosclerotic plaque detection	**17:45-18:10 Vladislav Shcheslavskiy** (*Germany*). Probing tumors with time-resolved spectroscopy **(Invited)**	**17:45-18:10 Michel Meunier** (*Canada*). Nanoplasmonics enhanced ultrafast laser nanosurgery: modeling and rational design **(Invited)**
	18:00-18:15 Pavel Shilyagin (*Russia*). Self-acting detection and compensation of the influence of media dispersion in SD OCT images	**18:10-18:25 Christopher Day** (*USA*). Live-cell single-molecule imaging reveals compounds that alter initiation dynamics and transcription kinetics	**18:10-18:35 Keiichi Inoue** (*Japan*). Novel classes of eubacterial light-driven ion pumping proteins for optical control tools of cells **(Invited)**
	18:15-18:30 Tulsi Anna (*Taiwan*). Full-field optical coherence microscopy for microstructral assessment of maple leaves	**18:25-18:40 Alena Rudkouskaya** (*USA*). Quantification of target engagement using non-invasive MFLI-FRET *in-vivo* imaging of breast cancer xenografts	**18:35-19:00 Nadya Bulgakova** (*Czech Republic*). Spatio-temporal modeling of femtosecond laser effects in transparent dielectrics based on solving Maxwell's Equations **(Invited)**
19:00-20:00	**Dinner**		

20:00-21:30	**Poster session**	
	[OB-1] **Elena Kiseleva**, (*Russia*). *In vivo* multimodal OCT study of human oral mucosa [OB-2] **Valeria Perekatova** (*Russia*). A combination of three-dimensional virtual point detector concept and fluence compensation in acoustic resolution photoacoustic microscopy [OB-3] **Irina Mihaylova** (*Russia*). Tikhonov deconvolution filtration in acoustic resolution photoacoustic microscopy [OB-4] **Daria Loginova** (*Russia*). The impact of measurement configuration on probing depth in optical diffuse reflectometry: A Monte Carlo study [OB-5] **Daria Loginova** (*Russia*). Perspectives of silicon nanoparticles in optical biomedical imaging [OB-6] **Ekaterina Lazareva** (*Russia*). Refraction properties of hemoglobin in a wide temperature and wavelength range [OB-7] **Valentin Gelikonov** (*Russia*). Cross-polarization coherent backscattering coefficient and its dependence on probe wave polarization [OB-8] **Marina Kochueva** (*Russia*). Quantitative evaluation of collagen radiation-induced changes by laser scanning microscopy [OB-9] **Marina Sirotkina** (*Russia*). Combined microstructural, polarization-sensitive and elastographic characterization of breast cancer by optical coherence tomography [OB-10] **Olga Bibikova** (*Germany, Finland, Russia*). Fiber spectroscopy methods for cancer diagnostics *ex-vivo* [OB-11] **Vladimir Zaitsev** (*Russia*). Mitigation of practical obstacles in realization of compressional optical coherence elastography [CB-1] **Elena Finagina** (*Russia*). Effects of Low-Level Laser Therapy (LLLT) in the prevention and treatment of radiation induced mucositis estimated by multimodal optical coherence tomography [CB-2] **Ksenia Korchagina** (*Russia*). Morphology in control of PDT with chlorine photosensitizers [CB-3] **Alina Meller** (*Russia*). Differential diagnostics of various forms of chronic rhinitis with Optical Coherence Tomography [CB-4] **Dmitry Sapunov** (*Russia*). The first clinical experience of photodynamic therapy of pharynx inflammatory diseases [CB-5] **Maria Lazareva** (*Russia*). OCT-based microangiography for estimation of functional vessels [CB-6] **Konstantin Yashin** (*Russia*). Ex vivo study of human gliomas with cross-polarization optical coherence tomography	[CB-7] **Natalia Gladkova** (*Russia*). Multimodal optical coherence tomography monitoring of basal cell carcinoma photodynamic therapy [CB-8] **Olga Streltsova** (*Russia*). Prevention of inflammatory complications of laser lithotripsy [CB-9] **Olga Streltsova** (*Russia*). Laser scanning microscopy study of the bladder extracellular matrix after radiation therapy [CB-10] **Nina Mitrakova** (*Russia*). Morpho-video endoscopic images in diagnostics of an early carcinoma of the stomach [CR-1] **Diana Yuzhakova** (*Russia*). The effect of OX40 ligand on CT26 tumors in mice [CR-2] **Nadezhda Aksenova** (*Russia*). Photodynamic properties of watersoluble porphyrin-amphiphilic polimer-chitosan systems [CR-3] **Svetlana Lermontova** (*Russia*). Fine-tuning of the photophysical and cytotoxic properties of novel fluorescent molecular rotors and PDT sensitizers based on the porphyrazine pigment platform [CR-4] **Vladimir Chernov** (*Russia*). Effect of blue low-level led light in oncogenesis [SC-1] **Nastasia Kosheleva** (*Russia*). Development of bioengineered construction based on osteoplastic material and VEGF-induced 3D culture of mesenchymal stromal cells (MSC spheroids) [SC-2] **Anastasiya Gorkun** (*Russia*). Obtainment of capillary-like network from MSC spheroids from umbilical cord MMSC in fibrin gel [SC-3] **Alexander Gulin** (*Russia*). Electron transfer between $Cd_{1-x}SeMn_x$ quantum dots and MV2+: coherent effects revealed by femtosecond laser spectroscopy [SC-4] **Anna Tsimokha** (*Russia*). Immunoproteasome inhibitor prevent reprogramming of mouse embryonic fibroblasts into induced pluripotent stem cells [SC-5] **Nikolay Bobrov** (*Russia*). Label free microstructural analysis of the healthy and diseased liver [SC-6] **Olga Rogovaya** (*Russia*). The study of the dermal cells cultured in collagen gel by optical and multiphoton tomography [SC-7] **Veronika Sysoeva** (*Russia*). Hormonal regulation of functional heterogeneity of mesenchymal stem cells
21:30-22:30	**Classical music concert**	

Monday, July 31

7:30-8:30	**Breakfast**		
8:30-12:00	**VYTEGRA**	**Leisure time**	
	HALL A	**HALL B**	**HALL C**
12:00-13:30	**Optical Bioimaging & Clinical Biophotonics**	**Biophotonics in Cancer Research**	
	Session: Optical imaging for clinical diagnostics and treatment monitoring **Chair: Ronald Sroka**	**Session: Nanobiophotonics** **Chairs: Konstantin Sokolov, Sergey Deyev**	
	12:00-12:25 Herbert Stepp (*Germany*). Optical spectroscopy for the detection of brain tumor and blood vessels to enhance accuracy and safety of stereotactic brain tumor biopsy **(Invited)**	**12:00-12:25 Chia-Liang Cheng** (*Taiwan*). Drug loading and efficiency of nanodiamond-anticancer drug complex in 2D and 3D cellular model **(Invited)**	
	12:25-12:50 Anna Maslennikova (*Russia*). Multimodal optical coherence tomography as a method of evaluation of normal tissue state during anticancer treatment **(Invited)**	**12:25-12:50 Yousuf Mohammed** (*Australia*). Zinc oxide nanoparticle penetration into *in vivo* and in vitro human skin. Simulating life like experimental conditions and using non-invasive MPT-FLIM imaging can provide accurate toxicological assessment **(Invited)**	
	12:50-13:05 Maria Shakhova (*Russia*). Optical monitoring for treatment personification in ENT	**12:50-13:05 Ekaterina Galanzha** (*USA*). *In vivo* targeted theranostics of circulating tumor cells	
	13:05-13:20 Mikhail Pavlov (*Russia*). Noninvasive evaluation of metabolism and blood supply in breast cancer polychemotherapy	**13:05-13:30 Elena Perevedentseva** (*Taiwan*). Multifunctional nanoparticles for bio-medical research and theranostics **(Invited)**	
	13:20-13:35 Arthur Voloveckiy (*Russia*). Fluorescent analysis of pharmacokinetics of chlorine E6 conjugate with BIS (dicarbollide) cobalt for BORon neutron capture therapy		
13:30-15:00	**Lunch**		
	HALL A		
15:00-15:50	**Francesco Pavone** (*Italy*). Large scale multidimensional and multilevel imaging of tissue disease: towards the 3D digital histology **(Plenary)**		
15:50-16:40	**Alexander Heisterkamp** (*Germany*). Optogenetic stimulation using nonlinear optics - Pacing hearts with light and other applications **(Plenary)**		
16:40-17:00	**Coffee break**		

Monday, July 31

	HALL A	HALL B	HALL C
17:00-19:00	**Optical Bioimaging & Clinical Biophotonics**	**Biophotonics in Cancer Research**	
	Session: Optical imaging for clinical diagnostics and treatment monitoring **Chair: Anna Maslennikova**	**Session: New microscopic technologies and probes** **Chairs: Francesco Pavone, Konstantin Lukyanov**	
	17:00-17:25 Karsten König (*Germany*). Clinical multiphoton/CARS tomography of skin, brain and eye **(Invited)**	**17:00-17:25 Alexander Savitsky** (*Russia*). Rational mutagenesis of new photoconvertable fluorescent protein for the live cell microscopy **(Invited)**	
	17:25-17:50 Michael Hammer (*Germany*). Fluorescence lifetime imaging at the retina in a clinical setting **(Invited)**	**17:25-17:50 Konstantin Lukyanov** (*Russia*). Deeper understanding of biology and photochemistry of fluorescent proteins for new probe development **(Invited)**	
	17:50-18:15 Tatiana Novikova (*France*). Tissue imaging with Mueller polarimetry for cancer detection **(Invited)**	**17:50-18:05 Natalia Klementieva** (*Russia*). A new way to efficient primed conversion of photoactivatable fluorescent protein dendra2	
	18:15-18:30 Tatiana Motovilova (*Russia*). Novel approach to endometrium evaluation in patients with chronic endometritis using optical coherence tomography	**18:05-18:20 Anastasiya Belova** (*Russia*). Cisplatin-induced hydrogen peroxide level changes as compared to total ROS level changes	
	18:30-18:45 Vladislav Toronov (*Canada*). Hyperspectral NIRS: development and applications		
	18:45-19:00 Yury Kistenev (*Russia*). Approaches of molecular imaging of bio-tissues and machine learning methods for medical applications		
19:00-20:00	**Dinner**		
	Sponsor session II		
20:00-21:40	**20:00-20:20 Viacheslav Artyushenko** (Art Photonics GmbH). Fiber photonics solutions for advanced medical applications **20:20-20:40 Paul Hoess** (Stanford Computer Optics). Extreme range extension of visual sight hampered by turbid media **20:40-21:00 Vladimir Pleshanov** (LLC "Optical Systems Alliance"). New advances of confocal microscopy **21:00-21:20 Wolfgang Becker** (Becker & Hickl GmbH). 25 years bh – 25 years of multidimensional TCSPC **21:20-21:40 Nikolay Buyanov** (Spectra-Physics). Multiphoton lasers and applications		
22:00-00:00	**Evening program and topical dancing**		

Tuesday, August 1

7:30-8:30	**Breakfast**		
8:30-12:00	**GORITSY**	**Bus tour**	
	HALL A		
12:30-13:20	**Zvi Malik** (*Israel*). The frontiers in ALA-PDT **(Plenary)**		
13:30-15:00	**Lunch**		
15:00-16:40	**HALL A**	**HALL B**	**HALL C**
	Optical Bioimaging	**Biophotonics in Cancer Research**	
	Session: Microscopy in the biomedical sciences **Chairs: Karsten Koenig**	**Session: New microscopic technologies and probes** **Chairs: Francesco Pavone, Konstantin Lukyanov**	
	15:00-15:25 Peter So (*USA*). Towards synaptomics **(Invited)**	**15:00-15:25 Paul J. Campagnola** (*USA*). Analysis of stromal alterations in ovarian cancers via Second Harmonic Generation microscopy **(Invited)**	
	15:25-15:50 Marcel Leutenegger (*Germany*). Parallelized RESOLFT nanoscopy **(Invited)**	**15:25-15:50 Richard Taylor** (*Germany*). High temporal and spatial resolution in tracking proteins on and through a cell membrane using iSCAT' **(Invited)**	
	15:50-16:15 Jörg Enderlein (*Germany*). Metal induced energy transfer and axial superresolution microscopy **(Invited)**	**15:50-16:15 Santhosh Chidangil** (*India*). Optical biopsy: journey from laboratory system to public health-care **(Invited)**	
	16:15-16:40 Alexander Priezzhev (*Russia*). Multimodal dynamic and structural imaging of erythrocytes and blood capillaries **(Invited)**		
16:40-17:00	**Coffee break**		

Tuesday, August 1

	HALL A	HALL B	HALL C
	Optical Bioimaging	**Biophotonics in Cancer Research**	
17:00-19:00	**Session: Microscopy in the biomedical sciences** **Chair: Peter So**	**Session: PDT and laser treatment, optical imaging of tumor response** **Chairs: Lothar Lilge, Marina Shirmanova**	
	17:00-17:25 Seemantini Nadkarni (*USA*). Intracoronary birefringence microscopy of atherosclerotic plaque **(Invited)**	**17:00-17:25 Lothar Lilge** (*Canada*). Photodynamic treatment planning and dosimetry: development of an universal applicable treatment optimization process **(Invited)**	
	17:25-17:40 Varvara Dudenkova (*Russia*). Quantitative analysis of SHG signal of collagen structure in models and tissue samples	**17:25-17:50 Mikako Ogawa** (*Japan*). New cancer therapy using near infrared light **(Invited)**	
	17:40-17:55 Emil Sobol (*Russia*). Structural illuminating microscopy and fluorescent markers in the imaging of laser-induced modification of cartilage and sclera structure	**17:50-18:05 Marina Sirotkina** (*Russia*). Monitoring of tumor treatment by multimodal optical coherence tomography	
	17:55-18:10 Matthias Eibl (*Germany*). Single pulse two-photon fluorescence lifetime imaging (SP-FLIM) with MHz pixel rate and an all fiber based setup	**18:05-18:20 Larisa Klapshina** (*Russia*). Novel-potential anticancer theranostic agents based on the porphyrazine framework for specifically personalized medicine	
	18:10-18:25 Sandeep Chakraborty (*Taiwan*). Fluorescence life-time imaging of senescing leaves	**18:20-18:35 Natalia Shilyagina** (*Russia*). Study of mechanisms of oxidative stress in response to photodynamic treatment	
	18:25-18:40 Shean-Jen Chen (*Taiwan*). Deep-biotissue imaging by temporal focusing widefield multiphoton microscopy	**18:35-18:50 Elena Kiseleva** (*Russia*). Multimodal OCT-guided detection of infiltrative tumor border in glioblastoma rat model	
	18:40-18:55 Vladimir Hovhannisyan (*Taiwan*). Drug delivery by natural zeolite particles	**18:50-19:05 Valentin Demidov** (*Canada*). Longitudinal assessment of single-dose radiation-induced tumor vascular changes with optical coherence tomography	
19:00-20:00	**Dinner**		
21:00-22:00	**Concert**		

Wednesday, August 2

8:00-9:00	**Breakfast**		
	HALL A		
9:00-9:50	**David Boas** (*USA*). Optical imaging of oxygen delivery and consumption: novel physiological insights and guiding interpretation of BOLD fMRI **(Plenary)**		
9:50-10:40	**Boris Chichkov** (*Germany*). Laser printing of stem and iPS cells **(Plenary)**		
10:40-11:00	**Coffee break**		
	HALL A	**HALL B**	**HALL C**
	Optical Bioimaging	**Biophotonics in Stem Cell Research**	**Novel Laser Applications in Biomedicine**
	Session: Optical diffuse diagnostics **Chair: David Boas**	**Session: Stem cell technologies** **Chairs: Andrei Chagin, Aleksey Tomilin**	**Session: Laser acceleration of ions for cancer therapy** **Chair: Kiminori Kondo**
11:00-13:30	**11:00-11:25 Maria Angela Franceschini** (*USA*). Measuring cerebral oxygen delivery & consumption with diffuse correlation spectroscopy in African children **(Invited)**	**11:00-11:25 Aleksey Tomilin** (*Russia*). Basic and applied sides of pluripotent stem cells **(Invited)**	**11:00-11:25 Walter Assmann** (*Germany*). The sound of protons — ionoacoustic range monitoring in proton therapy **(Invited)**
	11:25-11:50 H. Gunhan Akarçay (*Switzerland*). Optical extinction measurements on strongly scattering samples by way of imaging **(Invited)**	**11:25-11:40 Aleksandra Meleshina** (*Russia*). Metabolic plasticity of mesenchymal stem cells during differentiations by two-photon FLIM	**11:25-11:50 Umar Masood** (*Germany*). Ion beam therapy with laser-accelerated proton beams — Challenges and solutions **(Invited)**
	11:50-12:15 Igor Meglinski (*Finland*). Towards application of angular momentum of light for tissue diagnosis **(Invited)**	**11:40-11:55 Alexander Gulin** (*Russia*). A new approach for single cell imaging: mammalian oocyte case	**11:50-12:05 Artem Korzhimanov** (*Russia*). Negative impact of self-generated magnetic fields on energies of ions accelerated by ultra-high intensity laser pulse
	12:15-12:40 Valery Tuchin (*Russia*). Enhanced imaging of tissues by immersion clearing/contrasting: from X-ray to TeraHertz **(Invited)**	**Session: Tissue engineering and biomaterials** **Chairs: Boris Chichkov, Viktor Bagratashvili**	
		11:55-12:20 Anastasia Koroleva (*Germany*). Two-photon polymerization for fabrication of tissue engineering scaffolds **(Invited)**	
	12:40-13:05 Heidrun Wabnitz (*Germany*). Performance characterization of instrumentation for diffuse optical imaging and spectroscopy **(Invited)**	**12:20-12:45 Yury Rochev** (*Ireland*). Temperature-responsive biomaterials design for tissue engineering and drug delivery **(Invited)**	
	13:05-13:20 Anna Orlova (*Russia*). Diffuse optical spectroscopy monitoring of oxygen state of growing experimental tumor	**12:45-13:10 Peter Timashev** (*Russia*). Collagen morphology in the extracellular matrix by AFM technique as a marker of tissue damage **(Invited)**	
		13:10-13:25 Daria Kuznetsova (*Russia*). The involvement of allogeneic mesenchymal stem cells in bone formation	

Wednesday, August 2

13:30-15:00	**Lunch**		
15:00-17:30	**HALL A**	**HALL B**	**HALL C**
	Clinical Biophotonics and Optical Bioimaging	**Biophotonics in Stem Cell Research**	
	Session: Photodynamic therapy **Chair: Herbert Stepp**	**Session: Developmental biology** **Chairs: Igor Adameyko, Irina Larina**	
	15:00-15:25 Stephen Bown (*UK*). Bioluminescence-mediated photodynamic therapy: A novel treatment for grade 4 astrocytoma **(Invited)**	**15:00-15:25 Igor Adameyko** (*Sweden, Austria*). Single cell transcriptomics reveals fate selection points and early heterogeneity of the neural crest **(Invited)**	
	15:25-15:50 Georges Wagnieres (*Switzerland*). *In vivo* measurement of the tissue oxygenation by time-resolved luminescence spectroscopy: strategies to minimize artefact associated with photosensitization and photoproducts **(Invited)**	**15:25-15:50 Jan Krivanek** (*Austria*). Understanding of developmental and regeneration pathways of tooth using single cell transcriptomics **(Invited)**	
	15:50-16:15 Andrey Akopov (*Russia*). Contribution of photodiagnostics and photodynamic therapy to the treatment of lung cancer: Saint-Petersburg experience **(Invited)**	**15:50-16:15 Andrei Chagin** (*Sweden*). 3D visualisation of synovial joints revealed novel progenitor cells, which form entire adult articular cartilage in mice **(Invited)**	
	16:15-16:30 Sergey Gamayunov (*Russia*). Intravesical PDT for non-muscle-invasive bladder cancer	**16:15-16:40 Irina Larina** (*USA*). Reproduction and development *in vivo* with OCT **(Invited)**	
	16:30-16:45 Alexander Khilov (*Russia*). Estimation of tumor invasion depth for PDT procedure with chlorine photosensitizers from two-wavelength probing	**16:40-17:05 Artashes Karmenyan** (*Taiwan*). Noninvasive monitoring of living early mammalian embryo development **(Invited)**	
	16:45-17:00 Alexander Mitrakov (*Russia*). The palliative role of endoscopic PDT in inoperable cancer	**17:05-17:30 Shinzi Ogasawara** (*Japan*). Precise control of protein expression by light **(Invited)**	
	17:00-17:15 Konstantin Yashin (*Russia*). Photodynamic therapy in the treatment of glioma		
17:30-18:00	**Coffee break**		
18:00-20:00	**PLES**	**Walking tour**	
20:30-00:00	**Dinner Party**		

Thursday, August 3

8:00-9:00	**Breakfast**		
9:00-11:10	**HALL A**	**HALL B**	**HALL C**
	Novel Laser Applications in Biomedicine and Clinical Biophotonics		
	Session: Laser surgery and forced therapy **Chair: Natalia Shakhova**		
	9:00-9:25 Holger Lubatschowski (*Germany*). Frontiers of femtosecond laser applications in ophthalmology **(Invited)**		
	9:25-9:50 Ralf Brinkmann (*Germany*). Automatic feedback guided retinal laser therapies **(Invited)**		
	9:50-10:15 Ronald Sroka (*Germany*). Developments of 2µm-laser applications for clinical use **(Invited)**		
	10:15-10:40 Vladimir Minaev (*Russia*). The possibilities realized in surgery and forced therapy by means of devices based on the fiber and diode lasers **(Invited)**		
	10:40-11:05 Xueding Wang (*USA*). Antivascular effects induced by photo-mediated ultrasound **(Invited)**		
11:10-11:30	**Coffee break**		
	HALL A		
11:30-13:00	**Closing session**		
13:30-15:00	**Lunch**		
15:00	**Arrival in Nizhny Novgorod**		
15:00-21:00	**Departure**		

ABSTRACTS OF PLENARY TALKS

(HALL A)

Saturday, July 29

9:30–10:20

Matthew O'Donnell (*USA*). Light and sound: integrating photonics with ultrasonics for biomedical applications

In this talk, the history of integrated photonic-ultrasonic systems will be presented, focusing on examples where light generates sound, light detects sound, and sound "tickles" light. Specific applications of integrated photonic-ultrasonic techniques will be presented, including photoacoustics for molecular imaging, non-contact laser ultrasound systems, and optical coherence elastography (OCE) in which air-coupled ultrasound stimulates propagating shear waves in the eye and skin tracked with real-time, 3-D optical coherence tomography. The talk will conclude by discussing current barriers to clinical translation of these systems and possible ways to overcome the obstacles.

10:20–11:10

Wolfgang Becker (*Germany*). The multi-dimensional world of TCSPC FLIM

TCSPC FLIM delivers a photon distribution over the image coordinates and the time after the excitation pulses. The technique not only reaches an extraordinary time resolution and photon efficiency, it also records the decay data in the individual pixels into a large number of time channels. Such data can be characterised in a multi-parameter data space, yielding complex information on the systems investigated. A new level of multi-dimensionality is reached by extending the photon distribution of TCSPC FLIM with additional parameters of the photons. The technique then opens the way to entirely new experiments, such as recording of fast physiological processes or dynamic protein interaction experiments.

Sunday, July 30

9:00-9:50

Kiminori Kondo (*Japan*). Laser driven injector for a new generation heavy ion cancer therapy machine in Japan

In National Institutes for Quantum and Radiological Science and Technology (QST), the project for developing a new generation heavy ion cancer therapy machine, which is called "Quantum Scalpel", has been started. Quantum Scalpel is a very compact and cheap heavy ion cancer therapy machine based on not only the superconducting magnet technology, but also the laser driven ion acceleration technology. The recent Peta-Watt-class power laser technology will make it possible to produce enough number of carbon ions for the compact ion injector to the main synchrotron accelerator in Quantum Scalpel.

9:50–10:40

Melissa Skala (*USA*). Optical imaging of cell-level metabolism

Many cancer patients do not respond to first line therapies, and therefore suffer toxicities from ineffective treatments. We have developed single-cell optical metabolic imaging technologies, and applied them to novel 3D tumor macro-suspensions ("organoids") derived from the patient's tumor. This platform allows for high-sensitivity tests of multiple candidate therapies for each patient, and could provide a personalized predictive screen of optimal therapies for each patient. We have validated this approach in animal models and begun pilot tests in patients with breast, pancreas, and colon cancers. Ongoing work will validate this approach for accuracy in the clinical setting.

Monday, July 31

15:00–15:50

Francesco Pavone (*Italy*). Large scale multidimensional and multilevel imaging of tissue disease: towards the 3D digital histology

Modern optics and spectroscopy are offering promising non-invasive solutions to potentially improve diagnostic capability on tissues, as demonstrated by the extensive use of non-linear laser scanning microscopy for tissue imaging in the past decade.

15:50–16:40

Alexander Heisterkamp (*Germany*). Optogenetic stimulation using nonlinear optics - Pacing hearts with light and other applications

Optogenetics is a powerful technique using light sensitive molecules within living cells to control cell behavior by light. Dominating field in optogenetics is currently neurobiology in which molecules like Channelrhodopsin-2 (ChR2) are expressed in neuronal cells to induce action potentials upon blue light irradiation. Here we demonstrate the use of laser light to pace cardiomyocytes (heartm muscle cells) expressing ChR2. In order to increase the penetration depth of light, nonlinear excitation like two-photon absorption and other nonlinear techniques using nanoparticles were studied. As an outlook optogenetics allows even more general optical control of cells like gene expression, growth or other cellular functions.

Tuesday, August 1

12:30-13:20

Zvi Malik (*Israel*). The frontiers in ALA-PDT

Topical ALA-PDT has gained remarkable success after decades of research, but its medical impact is limited and not the treatment of choice in oncology. It is well documented that topical ALA-PDT enables the treatment of multiple lesions simultaneously with excellent cosmetic results; no acquired multidrug resistance was reported, and the treatment can be repeated with the same efficacy each time in the event of tumor recurrence. Most important, fluorescence-guided resection during surgery is a practical and simple tool that provides straightforward visualization of intraoperative procedures with mm accuracy. The future objectives are to amplify critical, evidence-based results of PDT safety and efficacy, and to validate its unique advantages over other technologies. Strong statistical PDT documentation and the positive predictive values of PpIX-guided surgery can persuade the medical community to implement ALA-based therapeutics into routine oncological treatment and surgery.

Wednesday, August 2

9:00-9:50

David Boas (*USA*). Optical imaging of oxygen delivery and consumption: Novel physiological insights and guiding interpretation of BOLD fMRI

BOLD fMRI is used extensively to map out brain activity patterns elicited by varied stimuli. BOLD fMRI measures the vascular response to neuronal activity and is thus not a direct measure of the underlying neuronal response to stimulus. A detailed understanding of neurovascular coupling is required to understand this relationship. Further, BOLD fMRI is an uncalibrated measure of the changes in deoxygenated hemoglobin during brain activation. BOLD is usually calibrated with a hypercapnic procedure and a model of the BOLD signal that itself is not well validated. I will review our efforts to understand the vascular response to neuronal activity at a macroscopic level and our procedures to cross-validate the BOLD calibration procedure.

9:50-10:40

Boris Chichkov (*Germany*). Laser printing of stem and iPS cells

For arranging living cells in 3D patterns, we use laser-assisted bioprinting based on the laser-induced forward transfer. Printing of different cell types, including primary cells, stem cells, and iPS cells embedded in hydrogels as extra-cellular matrix, have been investigated. Laser printing technique is capable of advancing 3D cell culture towards CAD defined and precisely arranged 3D cell models and “organ-on-chip” systems. Printed tissue, for example skin, can be used for analyzing the effect of agents like pharmaceuticals or cosmetics *ex vivo* and, by applying human primary cells it might be applied instead of animal tests. We have proven skin tissue formation by visualizing intercellular junctions and verifying their functionality. We also have observed basal lamina formation. Implanted in mice, the printed skin constructs show an ingrowth of blood vessels and differentiation of the epidermal keratinocytes. Compared to nozzle-based printing techniques such as extrusion or ink-jet printing, laser printing of cells provides the higher resolution and cell densities required for tissue formation.

ABSTRACTS

Saturday, July 29

HALL A	HALL B	HALL C
Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
11:30 M. Frenz (*Switzerland*), L. Ulrich, L. Ahnen, K.G. Held, M. Jaeger, S. Sanchez Majos, M. Wolf, and H.G. Akarcay **Quantitative optoacoustic imaging (*Invited*)** Quantitative optoacoustic (OA) imaging exploits the wavelength-dependent absorption of, for example hemoglobin, to determine spatially resolved the local blood oxygen saturation, due to the distinct optical absorption spectra of oxy- and deoxygenated hemoglobin. Wavelength-dependent optical attenuation in the bulk tissue, however, distorts the spectral OA signal of the blood and thus renders absolute oxygenation measurements challenging. We show that correction of the spectral distortion is possible without requiring a priori knowledge of the tissue optical properties. Two different techniques will be presented and compared: (i) Multiple-irradiation sensing and (ii) Near-infrared optical tomography. The experimental results demonstrate that both techniques are promising for quantitative OA imaging combined with handheld clinical ultrasound.	**11:30** N.G. Khlebtsov (*Russia*) **Optimal design of layered plasmonic nanostructures with embedded Raman reporters *(Invited*)** Recently, several research groups reported on highly efficient multi-layer SERS tags (also called nanomatryoshkas, NMs), in which Raman molecules were embedded in a nanometer-sized interior gap between the metallic core and shell. Here, we report a detail analysis of EM enhancement in a (core/gap/shell) Au NMs as a function of NM structure, including the core size, the gap and shell thicknesses, and the gap refractive index.	**11:30** K. Ueda (*Japan*) **Bio-photonics research works in SA-KIGAKE program in Japan (*Invited*)** I introduce our SAKIGAKE program supported by JST. One of the major research targets is bio-medical and bio-photonics. We have many excellent young scientists challenging the critical scientific front using advanced photonics technology. Some of them will present their latest results in this conference. I introduce interesting research works of other members in my SAKIGAKE team.
11:55 X.L. Deán-Ben (*Germany*), S. Gottschalk, S. Shoham, and D. Razansky **The promise of large-scale brain imaging with optoacoustics (*Invited*)** Non-invasive observation of fast spatiotemporal activity patterns of large neural populations is a longstanding goal of neuroscience. We demonstrate a novel optoacoustic imaging platform for direct imaging of fast neural activity across entire light-scattering brains using genetically-encoded calcium indicators. By virtue of combining the contrast abilities of both microscopic and macroscopic functional neuroimaging methods with its unprecedented spatio-temporal resolution performance, our functional optoacoustic neuro-tomography (FONT) method fills an important performance gap in the current neuroimaging technology and opens new prospects for large-scale observations of neural networks.	**11:55** V.P. Chekhonin (*Russia*), P.V. Mel'nikov, and V.P. Baklaushev **Internalization of vectorized liposomes into target-cells (*Invited*)** It is known that development of targeted nanocontainers en-hances the bioavailability and the selectivity of the delivered therapeutic and diagnostic products. Internalization of vector-ized nanocontainers loaded with antitumor metabolites into glioma C6 cells was studied in our research.	**11:55** A.A. Lanin, M.S. Pochechuev, I.V. Fedotov, Y.G. Ermakova, A.B. Fedotov, D.A. Sidorov-Biryukov, O.I. Ivashkina, K.V. Anokhin, V.V. Belousov, and A.M. Zheltikov (*Russia*) **Fiber-optic neurointerfaces and multimodal optical neuroimaging in opto- and thermogenetic studies (*Invited*)** We demonstrate multimodal optical imaging framework that combines single-neuron fluorescence microscopy with a variety of nonlinear-optical imaging techniques, including two-photon fluorescence, second- and third-harmonic generation, as well as coherent and stimulated Raman scattering. This provides a unique arsenal of tools for single-cell imaging of neurons expressing opto- and thermogenetic channels and/or fluorescent reporters in neuronal cultures, ex vivo brain slices, and precisely targeted regions inside the brain of awake transgenic mice and within the nervous system of zebrafish models.

12:20 G. Paltauf (*Austria*), P. Torke, and R. Nuster **Overcoming the trade-off between depth of field and lateral resolution in scanning photoacoustic imaging with focused detectors (*Invited*)** Photoacoustic imaging with a scanning, focused detector yields images with high resolution and signal to noise ratio. However, there is a trade-off between the lateral resolution and the depth of field, similar to optical microscopy techniques. Several methods to overcome this trade-off are presented, including reconstruction of out-of-focus structures from scanning data and hardware solutions, where the focusing element has an extended focal region. The latter include annular arrays of flat or inclined piezoelectric elements.	**12:20** S. Han, R. Bouchard, S. Emelianov, and K. Sokolov (*USA*) **Mechanisms of molecular cancer imaging and therapy with ultra-small nanoparticles (*Invited*)** This work explores the application of 5nm diameter gold nanoparticles for molecular photoacoustic (PA) imaging of cancer micrometastasis. Isolated 5nm particles exhibit negligible PA signal in the near-infrared (NIR) spectral region. However, our results show that trafficking and processing of antibody-targeted 5nm gold particles in cancer cells lead to a strong PA signal in the NIR region, allowing for highly specific and sensitive cancer imaging. Furthermore, nanoparticles can also suppress proliferation of cancer cells, opening exciting opportunities for theranostic applications. Confocal microscopy studies revealed that specific mechanism of 5nm gold nanoparticle interactions with cancer cells is essential for their applications in cancer imaging and therapy.	**12:20** V. Artyushenko (*Germany*) **Novel laser and fiber optics solutions in optical theranostics (*Invited*)** Various biomedical applications of fiber optics in a broad spectral range 0.4-16μm span more and more – from endoscopic imaging and Photo Dynamic Diagnostics (PDD) to laser power delivery for minimal invasive laser surgery, tissue coagulation and welding, Photo Dynamic Therapy (PDT), etc. The present review will highlight the latest results in advanced fiber solutions used for more precise diagnostics and intraoperative control of several therapy methods – for the so called "theranostics".
12:45 P. Subochev (*Russia*), I. Mihailova, M. Kirillin, V. Perekatova, M. Jaeger, A. Orlova, and I. Turchin **Image enhancement in acoustic resolution photoacoustic microscopy** Acoustic resolution photoacoustic microscopy (or raster-scan optoacoustic mesoscopy) is based on mechanical scanning of a sample with a focused ultrasonic detector tuned to optimal frequency and geometry defining the system spatial resolution. However, practical realization of an efficient AR-PAM system faces several challenges related to the limited depth of focus, frequency-dependent ultrasonic attenuation, and inhomogeneous spatial distribution of optical fluence within sample. In this presentation we review the experience of our group in AR-PAM image enhancement by means of Fourier reconstruction, Tikhonov deconvolution filtration, and optical fluence compensation based on Monte Carlo simulations.	**12:45** S. Deyev (*Russia*) **New strategies of cancer diagnostics and therapy (*Invited*)**	
13:00 V.V. Perekatova (*Russia*), P.V. Subochev, M.Yu. Kirillin, A.G. Orlova, and I.V. Turchin ***In vivo* two-wavelength mapping of blood oxygen saturation by acoustic resolution photoacoustic microscopy** Spectral approach in optoacoustic (OA) imaging allows simultaneous mapping of the structure and oxygenation status of the vasculature, which makes this approach well suited for different biomedical applications. We report on the novel OA system operating at the wavelengths of 658 and 1069 nm, which enabled *in vivo* blood oxygen saturation mapping in rabbit ear at depths up to 1.5 mm.	**13:10** M.B. Gongalsky (*Russia*), D.A. Muftieva, J. Saarinen, A. Isomaki, L. Peltonen, C.J. Strachan, H.A. Santos, and L.A. Osminkina **Coherent anti-Stokes Raman spectroscopy as an imaging tool for the interaction between silicon nanostructures and living systems** Silicon nanoparticles (SiNPs) are known to be promising biocompatible and biodegradable agents for both diagnostics and therapy of cancer. Here we apply a powerful non-linear optical imaging technique (coherent anti-Stokes Raman spectroscopy – CARS) for bioimaging SiNPs in vitro. A very efficient contrast was provided by SiNPs because of high third-order non-linear susceptibility of silicon by comparison with biological medium. All the images were obtained for the concentration below cytotoxic concentration of SiNPs. The proposed approach may be used for drug release and SiNPs biodegradation studies *in vitro*, and also for investigation of antibacterial or antiviral activity of SiNPs.	

21:30-21:50

Sponsor session I

Andrey Evteev (BioLine LLC). **Innovative imaging solutions from PerkinElmer**

HALL A	HALL B	HALL C
Optical Bioimaging	**Biophotonics in Cancer Research**	**Novel Laser Applications in Biomedicine**
10:50 V.P. Zharov (*USA*) ***In vivo* photoacoustic flow cytometry for early diagnosis and prevention of cancer, infections and cardiovascular disorders (*Invited*)** This report summarizes our novel concept of early disease diagnosis with ~1000-fold improved sensitivity using *in vivo* noninvasive photoacoustic (PA) flow cytometry (PAFC) platform for detection of circulating biomarkers with intrinsic PA contrasts (e.g., melanin in melanoma and hemozoin in malaria) or molecularly targeted with the functionalized nanoparticles. The integration in real-time diagnosis and therapy (called theranostics) can eradicate circulating abnormal cells, and thus can potentially prevent, or at least inhibit deadly metastasis, sepsis or stroke. Recent advances of this theranostic platform are presented with focus on the pre-clinical and clinical trials associated with cancer, malaria, thrombosis, and stroke.	**10:50** S. Kumar, A. Chaudhary, N. Yadav, R. Kumar, and D. Chandra (*USA*) **Novel regulation of cancer cell death by OXPHOS complexes, cytokines, and unfolded protein response (*Invited*)** Apoptotic cell death machinery is defective in cancer leading to the development of resistance to current therapy. Thus cancer cells develop resistance to multiple types of anticancer agents, however, whether they adopt similar or differential mechanisms to evade cell death in response to a broad spectrum of cancer therapeutics is not fully defined. We recently demonstrated that DNA-damaging agents (etoposide and doxorubicin), endoplasmic reticulum stressor (thapsigargin), and histone deacetylase inhibitor (apicidin) target oxidative phosphorylation (OXPHOS) for apoptosis induction, whereas other anticancer agents including staurosporine, taxol, and sorafenib induced apoptosis in an OXPHOS-independent manner. Thapsigargin-induced caspase activation was reduced upon abrogation of complex-I or gross-complexes, whereas a reverse trend was observed with apicidin.	**10:50** S. Wada (*Japan*), T. Ogawa, M. Yumoto, and N. Saito **Development of tunable MID-IR lasers for agriculture and health science applications (*Invited*)** Agriculture and health are of importance to keep human society and life of human. We develop optical systems using our original lasers, such as tunable MID-IR lasers and introduce them to plant factory and health checking systems with human breath.
11:15 J. Gunther and S. Andersson-Engels (*Ireland*) **Ultrasound optical tomography (*Invited*)** Ultrasound optical tomography has a potential to provide molecular contrast information at many centimeters in tissue with tenths of micrometers resolution. The presentation will include a review of the UOT field. It will also include simulation results. The signal contrast-to-noise ratio (CNR) was modeled using Monte Carlo simulations both in reflection and transmission geometries. The target volume contrast in absorption was 50%. In the reflection geometry (using a source-detector distance of 4 cm) the CNR was >1 for depths down to 4.75 cm, while all depths showed a CNR >1 for a 10 cm thick tissue slab.	**11:15** A. Periasamy (*USA*), H. Wallrabe, Z. Svindrych, and S.R. Alam **Tryptophan as an alternative biomarker for cancer metabolism: FLIM-FRET microscopy (*Invited*)** Tryptophan (Trp) is another endogenous fluorophore that can be considered as a biomarker in cancer investigation. In this study we investigated the quenching of Trp in the presence of NAD(P)H in the prostate cancer cells using three-photon excitation FLIM and FRET Microscopy. We developed an image segmentation analysis and correlated the E% (energy transfer efficiency) with FLIM based optical redox ratio. The quenching of Trp clearly shows the drug response between Caucasian-American and African-American prostate cancer cell lines.	**11:15** Yu.N. Kulchin (*Russia*) and S.S. Voznesenskiy **Optical and sensory characteristics of oceanic biota and organic-inorganic natural and biomimetic materials (*Invited)*** This work is devoted to a review of marine biota research as the most promising sources of energy, mineral and biological resources that are produced in the Far Eastern Branch of the Russian Academy of Sciences, including in cooperation with the Far Eastern Federal University.

15:30

Zhongping Chen (*USA*)

Advances in Optical Coherence Elastography (*Invited*)

We report on the development of an acoustic radiation force optical coherence elastography (ARF-OCE) technology to image and characterize tissues biomechanical properties. We have applied the ARF-OCE to image post-mortem human coronary artery with atherosclerosis. The result demonstrates the potential of the ARF-OCE as a non-invasive method for imaging and characterizing vulnerable plaques. The ARF-OCE technology have a broad range of clinical applications, including imaging and characterizing cardiovascular atherosclerotic lesions, imaging and diagnosing of early stage cancer, imaging and evaluating ophthalmic diseases such as keratoconus and age-related macular degeneration, and imaging and assessing blood coagulation.

15:30

H. Studier (*Australia, Germany*), M. Pastore, W. Becker, and M.S. Roberts

Non-invasive metabolic imaging of melanoma progression (*Invited*)

Skin cancer is associated with abnormal cellular metabolism which if identified early introduces the possibility of intervention to prevent its progress to a deadly metastatic stage. This study combines multiphoton microscopy with FLIM using a melanoma mouse model, to detect changes in redox states of single epidermal cells as a metabolic marker to monitor the progress of tumor growth. We found a significant increase in the free-to-bound NADH ratio with the growth of the tumor, while concurrently the short and long lifetime components remained constant. These results demonstrate the potential of FLIM for rapid, non-invasive assessment of melanoma progression.

15:30

M. Yabashi (*Japan*)

Status and perspective of an X-ray free electron laser SACLA (*Invited*)

After the inauguration in 2012, an X-ray free electron laser facility SACLA (SPring-8 Compact Angstrom free-electron LAser) in Harima, Japan has steadily provided hard X-ray FEL light for users. In this presentation, I will report the latest status of SACLA and their scientific achievements, which include investigation of structural change of photosystem II (PSII) in a water oxidation process, and observation of atomic motions in bacteriorhodopsin in a wide temporal range in nano- to milli-second after triggering of flash light.

15:55

K.V. Larin (*USA*)

Optical coherence elastography of soft tissue (*Invited*)

Optical coherence elastography (OCE) is a relatively new emerging method allowing to assess biomechanical properties of tissues in situ and *in vivo* in 3D. In this talk I will overview recent progress made in the quantitative assessment of viscoelasticity of ocular and cardiac tissues.

15:55

M.V. Shirmanova (*Russia*), M.M. Lukina, I.N. Druzhkova, T.F. Sergeeva, L.E. Shimolina, L.B. Snopova, V.V. Dudenkova, A.I. Gavrina, M.K. Kuimova, V.I. Shcheslavskiy, and E.V. Zagaynova

Tumor response to chemotherapy as a complex phenomenon: insight into functional characteristics using fluorescence imaging (*Invited*)

Recent advances in our understanding of cancer behaviour have suggested that multiple drug-induced physiological changes are involved in the development of therapeutic responses. The focus of our studies is multimodal fluorescence imaging of cancer cell reactions to treatment with cytotoxic agents with different mechanisms of action to identify relevant biomarker(s) of early therapeutic effects.

15:55

A.A. Seryi (*UK*)

Recent developments in JAI and UK on X-Ray bio-imaging based on laser-plasma acceleration (*Invited*)

The research directions of John Adams Institute for Accelerator Science range from gigantic future colliders to compact energy recovery linacs. Plasma acceleration is one of the central areas of JAI research. Our researchers have pioneered many breakthrough results such as higher than a GeV mono-energetic laser-plasma accelerated beam. Our present work on plasma acceleration is focused on creating higher brightness and higher efficiency compact light sources and using them for various applications. In this talk an overview will be given about the JAI and UK progress in the area of laser plasma acceleration in application to bio-imaging.

16:20

A. Vitkin (*Canada*)

Functional Optical Coherence Tomography: preclinical and clinical updates from the Nizhny Novgorod –Toronto collaboration (*Invited*)

Functional monitoring of treatment response could enable patient-specific treatment adjustments thereby improving therapy effectiveness. In this Nizhny Novgorod + Toronto collaboration, optical coherence tomography (OCT) is being extended to include structural, polarization-sensitive, angiographic, and elastographic regimes. The ability of these complimentary information channels to detect treatment-induced changes is investigated in normal and tumour-bearing small animals (mice, hamsters) undergoing chemo-, radio-, and photodynamic therapies. Representative project results, including initial human studies, will be highlighted in this presentation. The multimodal OCT technologies and treatment response metrics thus developed may help usher in the era of "personalized cancer treatments" of the 21st century.

16:20

R.N. Day (*USA*)

Intravital FRET and FLIM: monitoring biosensor activities and intrinsic metabolic states (*Invited*)

Intravital microscopy (IVM) is an imaging tool capable of detecting subcellular signaling or metabolic events as they occur in tissues in the living animal. Imaging in highly scattering biological tissues, however, is challenging, and quantitative measurements by IVM require methods that use internal standardization, or alternatively, a completely different way of evaluating the signals. For example, ratiometric imaging of genetically encoded biosensor probes can provide quantitative measurements of changes in cell signaling pathways in intact tissues. Alternatively, lifetime imaging of intrinsic fluorescence can be used for label-free measurements of the metabolic states of cells within the living animal.

16:20

S. Fuchs (Germany), M. Wünsche, J. Nathanael, J.J. Abel, Ch. Rödel, J. Reinhard, and G.G. Paulus

XUV coherence tomography with nanoscale resolution (*Invited*)

We present a novel method for cross sectional imaging with nanometer resolution, which is referred to as XUV coherence tomography (XCT). XCT uses extreme ultraviolet light (XUV), e.g., from laser-driven high harmonic generation (HHG). In XCT, the coherence length of a few nanometers of broadband XUV sources is exploited. Thus, XCT extends optical coherence tomography (OCT) by improving the axial resolution from micrometers to nanometers. Axial resolutions down to 3 nm have been demonstrated in the water transmission window (wavelength range 2-4 nm) and 12 nm in the silicon transmission window (20-40 nm) highlighting possible applications in life sciences and semiconductor industry.

16:45

V.Y. Zaitsev (*Russia*), A.L. Matveyev, L.A. Matveev, G.V. Gelikonov, A.I. Omelchenko, D.V. Shabanov, A.A. Sovetsky, A. Vitkin, O.I. Baum, and E.N. Sobol

Applicatons of optical coherence elastography in problems of laser reshaping of cartilages and cornea

In the context of the development of emerging laser-assisted thermo-mechanical technologies of non-destructive reshaping of avascular collagenous tissues (cartilages and cornea), we demonstrate the application of phase-sensitive optical coherence tomography (OCT) for visualizing transient strains involving supra-wavelength inter-frame displacements of scatterers. The proposed approach allows direct estimation of elevated strains ~10^{-2} (close to the onset of intense speckle blinking) obviating the necessity of averaging and phase unwrapping for supra-wavelength inter-frame displacements. We demonstrate a possibility of mapping aperiodic thermally-induced transient strains with resultant large deformations >10%. Such strains are typical in laser tissue reshaping, but are far beyond the range of conventionally discussed OCT-based strain mapping.

16:45

M.M. Lukina (*Russia*), M.V. Shirmanova, V.V. Dudenkova, N.P. Pavlova, L.B. Snopova, and E.V. Zagaynova

Metabolic imaging of cancer cells using fluorescence life-time microscopy

The aim of our work was to investigate metabolic activity of cancer cells by FLIM. Cellular metabolism was examined by monitoring the fluorescence lifetimes NAD(P)H and FAD. Cellular metabolism was analyzed in Hela cancer cells co-cultured with fibroblasts and in Hela tumor xenografts transplanted to nude mice. In the co-culture we observed a metabolic shift from OXPHOS toward glycolysis in cancer cells, and a reverse shift in fibroblasts. Metabolic heterogeneity within a tumor node was detected in the tumor tissue.

17:20

M. Kirillin (*Russia*), M. Shakhova, A. Meller, D. Sapunov, P. Agrba, E. Kiseleva, D. Loginova, A. Khilov, O. Kondratieva, K. Chikalova, T. Motovilova, E. Sergeeva, I. Turchin, and N. Shakhova

Optical coherence tomography in pathology recognition and monitoring of photodynamic therapy: benefits from numerical processing in clinical applications (*Invited*)

Optical coherence tomography (OCT) is a modern imaging modality providing structure visualization with spatial resolution down to units of microns. However, efficient clinical applications of OCT often require additional diagnostic image processing or quantification. In this paper we overview different approaches to OCT image numerical processing that allow enhancing applications of OCT in gynecology, otolaryngology, and aesthetic medicine.

17:20

M. Barroso (*USA*), A. Rudkouskaya, K. Tubbesing, N. Sinsuebphon, K. Chen, and X. Intes

Novel insights into transferrin-mediated delivery into tumor cells using *in vitro* and *in vivo* FRET imaging (*Invited*)

Our main goal is to integrate basic cell biology with methodological advances in imaging technology to develop novel approaches to visualize, quantitate and optimize receptor-mediated targeted delivery into tumor cells. By integrating our knowledge on the endocytic trafficking of receptor-ligand complexes with our expertise on Förster Resonance Energy Transfer (FRET) and fluorescence lifetime (FLIM) imaging, we have developed novel *in vivo* and *in vitro* imaging approaches to measure target engagement in tumors, a crucial parameter to accelerate the prioritization of the most efficient targeted anticancer therapy.

17:20

A. Vogel (*Germany*), X.-X. Liang, S. Freidank, and N. Linz

Cavitation bubble dynamics in plasma-mediated nanosurgery of cells and tissues (*Invited*)

The dynamics of cavitation bubbles in the µm and nm range such as occurring in plasma- and nanoparticle-mediated cell surgery is investigated experimentally and theoretically. Radius-times curves are recorded by interferometric single-shot measurements with nm accuracy and ps time resolution. Modeling provides information on the bubble size dependence of breakdown and collapse pressures and the partitioning of laser energy into vaporization, shock wave and bubble energy, and energy needed to overcome viscous damping.

17:45
F.I. Feldchtein (*Russia*), A.A. Moiseev, N.D. Gladkova, M.Yu. Kirillin, G.V. Gelikonov, V.V. Dudenkova, E.B. Kiseleva, E.G. Sharabrin, and E.V. Gubarkova

Cross-polarization optical coherence tomography in vulnerable atherosclerotic plaque detection

Different types of atherosclerotic plaques were visualized *ex vivo* using cross-polarization OCT (CP OCT). The developed approach to numerical processing of images allows for automatic detection and classification of vulnerable plaques. A weighted linear combination of average brightness and depolarization factor derived from OCT images is found to be an accurate predictor of plaque vulnerability, better than each of these parameters alone. This finding could be a step towards *in vivo* detection of vulnerable plaques using OCT.

17:45
M. Lukina, A. Orlova, A. Pavlikov, D. Shirokov, A. Neubauer, H. Studier, E. Zagaynova, W. Becker, V. Yakovlev, M. Shirmanova, and V. Shcheslavskiy (*Germany*)

Probing tumors with time-resolved spectroscopy (*Invited*)

Time-resolved fluorescence and phosphorescence spectroscopy of a tumor based on Time-Correlated Single Photon Counting (TCSPC) may deliver valuable information about its metabolic and oxygen states. We present the results on optical interrogation of tumors *in vivo* based on the novel fiber optical probes. We also discuss the potential of the TCSPC approach for label-free spectroscopy of biological samples.

17:45
M. Meunier (*Canada*)

Nanoplasmonics enhanced ultrafast laser nanosurgery: modeling and rational design (*Invited*)

Nanobubbles generated by ultrafast laser irradiation of plasmonic nanoparticles can induce highly localized damage to targeted cells, which makes them valuable for nanomedicine applications. In this presentation, we present a complete model that successfully describes all interactions occurring during the irradiation of plasmonics nanostructures by an ultrafast laser of various pulse widths and fluences. We have also developed a computational framework to screen for optimized nanostructures that are not damaged upon laser irradiation. Using this rational design approach, we demonstrate theoretically and experimentally that nanoshells can reduce significantly the cavitation threshold in the near-infrared.

18:00
P.A. Shilyagin (*Russia*), V.A. Matkivskiy, A.A. Moiseev, S.Yu. Ksenofontov, I.V. Kasatkina, G.V. Gelikonov, D.V. Shabanov, and V.M. Gelikonov

Self-acting detection and compensation of the influence of media dispersion in SD OCT images

A method for determining and correcting distortions in SD OCT images caused by medium dispersion was developed. The method is based on analysing the phase distribution of the interference signal recorded by an OCT device using the iteration approach to find and compensate the influence of medium chromatic dispersion on PSF broadening in OCT. This allows compensating the impact of medium dispersion to an accuracy of tens of fractions of radian (units of percent) avoiding additional measurements and solution of the optimization problem. The robustness of the method was demonstrated experimentally on model and biological objects.

18:10
C.R. Day (*USA*), J. Rodriguez, D.R. Larson, and A. Martin

Live-cell single-molecule imaging reveals compounds that alter initiation dynamics and transcription kinetics

Transcription is a highly-ordered process involving distinct steps of coordinated enzyme activities. Using a reporter gene with PP7 and MS2 stem loops we have developed a high-throughput single-cell imaging screen to identify compounds that alter the kinetics of each step in the transcription process. To further understand how endogenous genes are regulated we have used CRISPR to integrate MS2 stem loops into the endogenous loci of an estrogen-responsive gene, *TFF1*. By live-cell imaging of the MS2 tagged *TFF1* locus the dynamics of ER-dependent gene expression were studied in single cells over long time courses.

18:10
K. Inoue (*Japan*)

Novel classes of eubacterial light-driven ion pumping proteins for optical control tools of cells (*Invited*)

Microbial rhodopsins are the photoreceptive membrane proteins of various types of bacteria. The ion-transporting rhodopsins are used as molecular tools to control neuronal activity. This technique is called "optogenetics". Recently, we have discovered new classes of microbial rhodopsins, light-driven outward sodium pump and inward proton pump. The specific ion transports by these rhodopsins are expected to enable more efficient or low toxic optogenetic approach, and their molecular mechanism was studied to obtain basic insight to develop new optogenetic tools.

18:15
Tulsi Anna (*Taiwan*), S. Chakraborty, A. Chiou, and W.C. Kuo

Full-field optical coherence microscopy for microstructural assessment of maple leaves

We present a full-field optical coherence microscopy (FF-OCM) using a single broadband LED to investigate the microstructural changes in senescing maple leaves. Due to senescence/aging, the leaf color changes from green to red. The 2D-interferograms at different depths of the green and red leaves were obtained using CMOS camera and subsequently reconstructed *via* a fast and efficient 4-step derivative algorithm. The axial and lateral resolutions of the present system were 0.9 and 1.4 μm respectively. Our results showed the microstructure of epicuticular wax and upper epidermis layer in red leaves has a significant deterioration as compared to green leaves.

18:25
A. Rudkouskaya (*USA*), N. Sinsuebphon, X. Intes, and M. Barroso

Quantification of target engagement using non-invasive MFLI-FRET *in-vivo* imaging of breast cancer xenografts

We employ Macroscopy Fluorescence Lifetime Imaging (MFLI) FRET to quantify the internalization of NIR labeled transferrin in T47D breast cancer xenografts *in vivo*. We report that *in vivo*MFLI-FRET data correlate with transferrin accumulation in dissected tumors based on quantification analysis of immunofluorescent staining. In contrast, no correlation between FRET levels and transferrin receptor density was found. This study demonstrates MFLI-FRET as a robust non-invasive quantitative measure of the target engagement of ligand-dimerized receptor in cancer cells which could accelerate the optimization of targeted drug delivery efficacy.

18:35
N.M. Bulgakova (*Czech Republic*) and V.P. Zhukov

Spatio-temporal modeling of femtosecond laser effects in transparent dielectrics based on solving Maxwell's equations (*Invited*)

This talk will overview the results of modeling ultrashort laser pulse propagation in absorbing transparent media based on Maxwell's equations with demonstrating advantages of the approach compared to other models. The majority of simulations have been performed for fused silica irradiated by laser beams with linear and radial polarization. Effects of spatiotemporal coupling in ultrashort laser beams and pump-probe irradiation on laser energy absorption will be analyzed. Based on the absorbed laser energy balance, post-irradiation evolution of material will be discussed, including thermoelastic stresses and their consequences. First results of application of the model to water breakdown will be presented.

POSTER SESSION

[OB-1]	E.B. Kiseleva (*Russia*), A.A. Moiseev, E.S. Finagina, M.A. Sirotkina, A.V. Maslennikova, D.V. Shabanov, E.V. Zagaynova, F.I. Feldchtein, L.A. Matveev, A.A. Vitkin, and N.D. Gladkova ***In vivo* multimodal OCT study of human oral mucosa** Development of the OCT microangiography (OCT MA) allows new potential clinical applications, in particular, studying the human oral mucosa response to different therapies. Such new applications are more sensitive to tissue motion and compression artifacts. Therefore, correction of the previously developed methodology and study of protocols may be required to improve mechanical stabilization of the probe relative to the patient. Also, better tissue compression compensation is needed in case of contact OCT scanning. The objective of this work was to characterize human cheek mucosa using real-time multimodal (MM: cross-polarization and MA) OCT. Some original devices were constructed and several conditions were revealed to be controlled to achieve the goal and optimize *in vivo* MM OCT study of human cheek mucosa.
[OB-2]	V.V. Perekatova (*Russia*), M.Yu. Kirillin, I.V. Turchin, and P.V. Subochev **A combination of three-dimensional virtual point detector concept and fluence compensation in acoustic resolution photoacoustic microscopy** We report on combined application of the synthetic aperture focusing technique approach and fluence compensation in acoustic resolution photoacoustic microscopy. Both software post-acquisition procedures are performed in full-3D allowing significant enhancement of resultant image quality.
[OB-3]	I. Mikhailova (*Russia*), M. Jaeger, I. Fiks, I. Turchin, and P. Subochev **Tikhonov deconvolution filtration in acoustic resolution photoacoustic microscopy** Acoustic resolution photoacoustic microscopy (AR-PAM) is a raster-scan imaging technique based on focused ultrasonic detection of wideband optoacoustic (OA) transients thermoelastically induced by nanosecond laser pulses in light-absorbing tissue chromophores. However, a spatial low-pass filter provided by frequency-dependent ultrasonic attenuation of the tissue limits the effective bandwidth of the detected OA pulses reducing spatial resolution. Our poster presentation will be devoted to one-dimensional Tikhonov deconvolution filtration allowing 2-fold improvement in spatial resolution for both phantom and *in vivo* objects.
[OB-4]	D.A. Loginova (*Russia*), I.I. Fiks, E.A. Sergeeva, and M. Yu. Kirillin **The impact of measurement configuration on probing depth in optical diffuse reflectometry: A Monte Carlo study** We report on Monte Carlo study of the probing volume in diffuse optical spectroscopy and its modification employing structured illumination. Different configurations of probing illumination including collimated point source, one-dimension sinusoidal and rectangular patterns with various spatial characteristics are considered. Simulation has been performed for a turbid medium with optical properties corresponding to cutaneous tissues at 600 nm and their variations in the range of ±60%.
[OB-5]	D.A. Loginova (*Russia*), E.A. Sergeeva, P.D. Agrba, S.V. Zabotnov, F.V. Kashaev, D.E. Presnov, M.B. Gongalsky, L.A. Golovan, and M.Yu. Kirillin **Perspectives of silicon nanoparticles in optical biomedical imaging** We study the optical properties of silicon nanoparticle suspensions and demonstrate their efficiency as contrasting agents in different optical bioimaging techniques in experiment and in Monte Carlo simulations. Upon administration, the silicon nanoparticles locally change biotissue optical properties thus affecting images acquired by optical techniques.
[OB-6]	E.N. Lazareva (*Russia*) and V.V. Tuchin **Refraction properties of hemoglobin in a wide temperature and wavelength range** Precise measurement of refractive index (RI) of biological materials is of great interest in many areas of biomedical science and engineering, including design and development of optical measurement instruments for biology and medicine, i.e., optical tomography and biopsy. This study is focused on measuring the RI of hemoglobin at different temperatures for visible and near infrared regions. Measurements were carried out using the multi-wavelength Abbe refractometer (Atago, Japan). The RI specific increments for concentration and temperature variations and coefficients for Sellmeier dispersion formula were estimated.
[OB-7]	V.M. Gelikonov (*Russia*), V.N. Romashov, D.V. Shabanov, S.Yu. Ksenofontov, D.A. Terpelov, P.A. Shilyagin, G.V. Gelikonov, and A. Vitkin **Cross-polarization coherent backscattering coefficient and its dependence on probe wave polarization** A common path OCT setup capable of controlling probe wave polarization state was developed to obtain co- and cross-polarized OCT images. The dependence of the coefficient of cross-polarization coherent backscattering on probe wave polarization state was investigated in experiment. For circularly polarized probe light, this coefficient was shown to be independent of the reciprocal orientation of the probe and object and was 50% higher than for linearly polarized probe light.

[OB-8]	M.V. Kochueva (*Russia*), S.S. Kuznetsov, V.V. Dudenkova, A.V. Varlamova, and A.V. Maslennikova **Quantitative evaluation of collagen radiation-induced changes by laser scanning microscopy** The objective of our study was quantitative evaluation of the dose-time dependences of changes occurring in the extracellular matrix of bladder and rectum after gamma-irradiation by laser scanning microscopy. LSM microscopy with the detection of second-harmonic generation (SHG) signal allows evaluating radiation-induced changes of normal tissues in addition to standard and special histological staining. Numerical calculation of SHG signal intensity provides additional information about the processes of collagen degradation and subsequent remodeling.
[OB-9]	E.V. Gubarkova, A.A. Sovetsky, V.Yu. Zaitsev, A.A. Moiseev, L.A. Matveev, A.L. Matveyev, S.S. Kuznetsov, D.A. Vorontsov, A.Yu. Vorontsov, N.D. Gladkova, and M.A. Sirotkina (*Russia*) **Combined microstructural, polarization-sensitive and elastographic characterization of breast cancer by optical coherence tomography** We have studied feasibility of multimodal OCT (MM OCT) that combines cross-polarization imaging and elastographic stiffness mapping to assess spatial structural organization and heterogeneity of breast cancer (morphological and immuno-histochemical) in the tumor center in comparison with normal mammary gland tissue.
[OB-10]	O. Bibikova (*Germany, Finland, Russia*), U.J. Zabarylo, A. Melenteva, V. Belikova, I. Usenov, T. Sakharova, G. Danielyan, A. Bogomolov, O. Minet,H.J. Eichler, and V. Artyushenko **Fiber spectroscopy methods for cancer diagnostics *ex-vivo*** In this study we developed and applied various single and combined fiber probes for four key spectroscopy methods used in the 0.2-16 μm range: Raman scattering, Mid IR-absorption, Diffuse NIR-reflection, and fluorescence – to compare them and select the best one (or their combination) for an *ex-vivo* detection of malignant tissue for cancer surgeries. The most promising fiber spectroscopy methods were defined for selected organs after their tests in laboratory and clinical environment.
[OB-11]	V.Y. Zaitsev (*Russia*), A.L. Matveyev, L.A. Matveev, E.V. Gubarkova, A.A. Sovetsky, M.A Sirotkina, G.V. Gelikonov, E.V. Zagaynova, N.D. Gladkova, and A. Vitkin **Mitigation of practical obstacles in realization of compressional optical coherence elastography** In this presentation we point out some practical obstacles arising in realization of compressional optical coherence elastography (OCE) that have not attracted sufficient attention before. Specifically, we discuss (i) complications in quantification of the Young modulus of tissues related to partial adhesion between the OCE probe and soft intervening reference layer-sensor, (ii) distorting influence of tissue surface curvature/corrugation on the subsurface strain distribution mapping, (iii) ways of signal-to-noise ratio (SNR) enhancement in OCE strain mapping when periodic averaging is not realized, and (iv) potentially significant influence of tissue elastic nonlinearity on quantification of its stiffness. Potential practical approaches to mitigate the effects of these complications are also described.
[CB-1]	E.S. Finagina (*Russia*), E.B. Kiseleva, A.A. Moiseev, M.V. Sirotkina, A.V. Maslennikova, D.V. Shabanov, S. Ksenofontov, G. Gelikonov, L. Matveev, V. Zaitsev, E.V. Zagaynova, N.D. Gladkova, and A. Vitkin **Effects of Low-Level Laser Therapy (LLLT) in the prevention and treatment of radiation induced mucositis estimated by multimodal optical coherence tomography** Low-level laser therapy (LLLT) is a non-pharmacological method of treatment and prevention of mucositis induced by radio(chemo)therapy of oral and pharyngeal cancer. We monitored the effectiveness of LLLT using multimodal optical coherence tomography (OCT). A spectral domain OCT system with microvascular visualization was used. Twelve patients were included in the control group, and nine patients in the LLLT group. All patients in the LLLT group have shown less pain and duration of mucositis than in the control group. Structural OCT images for a longer time remain unchanged in comparison with the control ones. The density of the vasculature and the number of small vessels that increased as a result of the appearance of mucositis symptoms was much less in the LLLT group. Optical coherence tomography allows detecting early and "subtle" changes in living tissues and studying the "application points" and mechanisms of the action of therapy modalities.
[CB-2]	K.S. Korchagina (*Russia*), S.V. Gamayunov, S.S. Kuznetsov, V.V. Dudenkova, E.A. Sergeeva, and N.M. Shakhova **Morphology in control of PDT with chlorine photosensitizers** The results of studying tumor response to photodynamic therapy skin cancer with chlorine photosensitizers (PS) are presented. The study was performed using routine histological approaches. We demonstrate morphological changes in tumor typical for different time intervals after PDT. The obtained data allow dividing the morphological changes into two groups: early changes which occur within 24-48 hours, and late changes which develop in two days. For morphological verification of chlorine PS biodistribution in human tumors, a preliminary study of PS detection in biopsy samples of human skin carcinoma was carried out. Using laser scanning microscopy we show that PS is primarily distributed in the paratumoral zone.
[CB-3]	A. Meller (*Russia*), M. Shakhova, D. Sapunov, P. Agrba, A. Shakhov, and M. Kirillin **Differential diagnostics of various forms of chronic rhinitis with Optical Coherence Tomography** Differential diagnostics of various forms of chronic rhinitis is necessary for elaboration of treatment tactics. OCT-rhinoscopy was performed for 85 patients with chronic rhinitis. OCT images of unaltered nasal mucosa (relative norm) were obtained from healthy volunteers. The features of OCT images of relative norm and two morphologically different chronic rhinitis forms were revealed. The potential of OCT in objectification of adrenalin test results is demonstrated. Numerical processing of OCT images allowed additional enhancement of diagnostic accuracy.

[CB-4]	D. Sapunov (*Russia*), A. Meller, M. Shakhova, A. Shakhov, and M. Kirillin **The first clinical experience of photodynamic therapy of pharynx inflammatory diseases** The first results of antimicrobial photodynamic therapy (PDT) of chronic pharynx inflammatory diseases (acute and chronic pharyngitis, chronic tonsillitis, 45 patients) are reported. At the diagnostic stage of the study, all patients underwent microbiological examination and PCR diagnostics of the mucosal detachable samples from posterior pharyngeal wall and palatine tonsils. PDT was performed with a local application of a photosensitizer of the chlorine series. The laser irradiation was performed at a wavelength of 405 nm. The efficacy of treatment was assessed based on patient complaints, pharyngoscopy data and control of microbiological examination.
[CB-5]	M.A. Lazareva (*Russia*), A.Moiseev, and N.M. Shakhova **OCT-based microangiography for evaluation of functional vessels** Female breast reconstruction after surgical treatment of breast cancer is currently a standard. Combined treatment negatively affects the results of reconstruction inducing disorders in blood supply of the reconstructed tissues. For timely control of neovascularization process, effective and accessible monitoring techniques are required. The abilities of optical coherence tomography (OCT) in imaging of microcirculatory net vessels are demonstrated in this study. OCT-angiography of skin of different localizations is performed. In model studies the ability of monitoring vessel changes after functional tests is demonstrated. OCT-angiography technique is also demonstrated to be efficient for monitoring microcirculation in skin of reconstructed breast in the course of combined treatment.
[CB-6]	K.S. Yashin (*Russia*), E.B. Kiseleva, E.V. Gubarkova, A.A. Moiseev, S.S. Kuznetsov, M.M. Karabut, I.A. Medyanik, L.Ya. Kravets, and N.D.Gladkova ***Ex vivo* study of human gliomas with cross-polarization optical coherence tomography** Optical coherence tomography (OCT) is a promising method of glial tumors borders diagnostics. This paper presents the results of cross-polarization OCT (CP OCT) usage for the glial tumors and their peritumoral area visualization. CP OCT detected the scattering and polarization properties of tissues and thereby it can be more informative method for tumor borders imaging than traditional OCT.
[CB-7]	E.V. Gubarkova, S.V. Gamayunov, E.V. Zagaynova, E.S. Finagina, M.A. Sirotkina, L.B. Timofeeva, A.A. Moiseev, S.Yu. Ksenofontov, A. Vitkin, and N.D. Gladkova (*Russia*) **Multimodal optical coherence tomography monitoring of basal cell carcinoma treatment with photodynamic therapy** Nowadays, photodynamic therapy (PDT) is a common and efficacious method for basal cell carcinoma (BCC) treatment. In this study, a tissue monitoring method is introduced based on multimodal optical coherence tomography (MM OCT) as a combination of microangiographic and structural OCT modalities for tumor microvessel network and tissue structure visualization, respectively. It was demonstrated that MM OCT is a promising method of *in vivo* visualization of the different microvasculature in normal skin, BCC, in the scar formed after treatment, and assessment of the PDT tumor impact based on vascular changes.
[CB-8]	O.S. Streltsova (*Russia*), D.P. Pochtin, I.D. Eranov, R.I. Kositsyin, V.I. Bredichin, O.L. Antipov, and V.A. Kamensky **Prevention of inflammatory complications of laser lithotripsy** Development of infectious and inflammatory processes in the kidney is one of common complications of lithotripsy. The study of different regimes of laser action on kidney stones is presented. It is demonstrated that laser exposure at a wavelength of 2000-2100 nm with a small pulse energy (from units to tens of mJ) and pulse duration of 20-50 ns at a high pulse repetition rate (tens of kHz) allows controlled destruction of concrements into large fragments without disseminating their content. The use of strongly absorbing coatings (SAC) of the laser fiber tip also provides controlled destruction and allows achieving an antimicrobial effect on the stone-associated biofilms. The presented approaches can ensure prevention of microbial dissemination in the course of contact lithotripsy.
[CB-9]	O.S. Streltsova (*Russia*), V.V. Dudenkova, M.V. Kochueva, E.A. Tararova, D.K. Malikov, A.S. Vorobieva, E.B. Kiseleva, K.E. Yunusova, V.N. Krupin, and A.V. Maslennikova **Laser scanning microscopy study of the bladder extracellular matrix after radiation therapy** The results of inspection of the bladder extracellular matrix state in 75 patients with complications after radiotherapy are reported. Imaging of biopsy bladder samples is performed by laser scanning microscopy (LSM) in second harmonic generation (SHG) and two-photon autofluorescence excitation (TPEF) modes to study the state of collagen and elastin. Radiation damage is studied in comparison with bladder alterations in patients with chronic cystitis (80 patients). Verification of LSM data is performed by comparison with histology analysis. As a result, the difference in the state of collagen and elastin structures is demonstrated for different grades of bladder radiation damage. The obtained results can become a basis for the technique for diagnostics of bladder radiation damage.
[CB-10]	N. Mitrakova (*Russia*), M. Gremyakina, V. Nefedov, A. Rozhentsov, and A. Mitrakov **Morpho-video endoscopic images in diagnostics of an early carcinoma of the stomach** Oncologic diseases are among the main causes of high mortality rate all over the world. The identification of early forms of cancer of the upper parts of digestive tract, most accessible for visualization is very difficult for the majority of endoscopists. The standard research in white light is capable of diagnosing only mucosa pathology and early carcinoma of the stomach. Modern endoscopic devices with high resolution, possibility of magnification and spectral endoscopy allow to detect early forms of cancer of the upper parts of the gastrointestinal tract (GIT) with high precision. But differences in the level of resolving power of endoscopic equipment in medical institutions, and also differences in the level of training experts dictate the need for automation of processing video endoscopic images in white light.

[CR-1]	D.V. Yuzhakova (*Russia*), M.V. Shirmanova, E.O. Serebrovskaya, I.N. Druzhkova, S.A. Lukyanov, and E.V. Zagaynova **The effect of OX40 ligand on CT26 tumors in mice** The OX40 ligand (OX40L) is a potential agent for immunotherapy, a promising therapeutic strategy for cancer. The purpose of this study was to investigate the effect of soluble extracellular domain of OX40L (OX40Lexo) on CT26 colon carcinoma in mice. Our results showed that gene transfer of OX40L into tumor cells resulted in lower tumor incidence, resistance to spontaneous metastases and development of immunological memory. Therefore, we report for the first time on the antitumor effect of OX40Lexo in a mouse tumor model.
[CR-2]	N.A. Aksenova (*Russia*), V.V. Kardumjan, N.N. Glagolev, P.S. Timashev, A.L. Spokoynyy, and A.B. Solovieva **Photodynamic properties of watersoluble porphyrin-amphiphilic polimer-chitosan systems** The aim of this study was to create effective porphyrin-containing photosensitizing systems based on chitosan and amphiphilic polymer (AP) Pluronic F127. The photosensitizing activity of porphyrin–AP–chitosan systems was estimated in the reaction of tryptophan oxidation in solution. The photosensitizing systems based on chitosan are effective for use in the photodynamic therapy (PDT) of various skin injuries (purulent wounds, tumors).
[CR-3]	S.A. Lermontova (*Russia*), I.S. Grigoryev, N.N. Peskova, I.V. Balalaeva, and L.G. Klapshina **Fine-tuning of the photophysical and cytotoxic properties of novel fluorescent molecular rotors and PDT sensitizers based on the porphyrazine pigment platform** Novel fluorescent molecular rotors based on the porphyrazine framework have been obtained in the form of free bases via a template assembly of a variety of aryltricyanoethylenes as structural units of the macrocycle. The unique combination of photodynamic activity with high sensitivity of the fluorescent properties to viscosity has been demonstrated for the prepared series of fluorophores which have a good prospect to be applied in biomedicine as optical sensors of intracellular viscosity and highly efficient PDT sensitizers.The chemical modification of macrocycle peripheral frame is found to be an effective tool for fine-tuning of the required photophysical properties and photodynamic activity enhancement.
[CR-4]	E.S. Plekhanova, I.A. Chernigina, V.V. Chernov (*Russia*), and T.G. Shcherbatyuk **The effect of low-level blue LED light in oncogenesis** The impact of low-level LED light (LLL) at the wavelengths of 400 nm and 460 nm on outbred rats (healthy animals and with transplanted tumor) was studied in experiments *in vitro* and *in vivo*. The photolytic action of LLL on nitrosyl complexes of hemoglobin of red blood cells, the antitumor effect and the restoration of oxidative homeostasis in animals with transplanted tumor were demonstrated.
[SC-1]	I.M. Zurina, A.A. Gorkun, A.F. Fidarov, N.V. Kosheleva (*Russia*), and I.N. Saburina **Development of bioengineered construction based on osteoplastic material and VEGF-induced 3D culture of mesenchymal stromal cells (MSC spheroids)** In the current research rat adipose-derived stromal cells in the presence of vascular endothelial growth factor (VEGF) were placed in non-adhesive conditions to form spheroids. 7-day VEGF-induced MSC spheroids were then placed on osteoplastic apatite-silicate composition material BAC-1000. 7 days later cells formed a dense layer as well as tubule-like structures both on the surface and in the pores of matrix. The current research describes a promising technology for obtainment of bioequivalents of vascularized bone tissue for fast and effective restoration of vast bone injuries.
[SC-2]	A.A. Gorkun (*Russia*), I.M. Zurina, A.I. Shpichka, A.V. Koroleva, N.V. Kosheleva, D.V. Butnaru, P.S. Timashev, I.N. Saburina, and V.S. Repin **Obtainment of capillar-like network from MSC spheroids from umbilical cord MMSC in fibrin gel** In the current research, spheroids containing population of CD31+ cells were obtained from multipotent mesenchymal stromal cells from umbilical cord (MMSC UC) using induction with VEGF. After placing spheroids in the gel composed on the basis of fibrin, these cells activated the process of angiogenesis, which resulted in an active growth of tubules from MSC spheroids into the gel. In 7 days a primitive branched tubular network formed. The obtained results can become the basis for the development of the technology of 3D bio-printing of micro-vascularized tissues.
[SC-3]	A.A. Gulin (*Russia*), I.V.Shelaev, F.E.Gostev, N.N. Deniso, A.V. Aybush, and V.A.Nadtochenko **Electron transfer between $Cd_{1-x}SeMn_x$ quantum dots and MV^{2+}: Coherent effects revealed by femtosecond laser spectroscopy** The exciton and charge carrier dynamics in CdSe, $Cd_{1-x}Mn_xSe$, and $Cd_{1-x}Mn_xSe$ / MV^{2+} systems was studied by the fs pump-probe laser spectroscopy technique. The excitation was carried out to the low-lying exciton transition 1S (e) - 1S (h) 3/2 band (red edge of the CdSe absorption). The coherent wave packet oscillations were revealed in transient kinetics of CdSe, $Cd_{1-x}Mn_xSe$, and $Cd_{1-x}Mn_xSe$ / MV^{2+}. The oscillations correspond to the optical phonon of 206 cm^{-1}. The interfacial electron transfer from $Cd_{1-x}Mn_xSe$ to acceptor MV^{2+} occurs with time constant close to 100 fs.

[SC-4]	A.S. Tsimokha (*Russia*), A.V. Selenina, S.A. Sinenko, A.A. Kuzmin, and A.N. Tomilin **Immunoproteasome inhibitor prevents reprogramming of mouse embryonic fibroblasts into induced pluripotent stem cells** The ubiquitin-proteasomal system plays an important role in several processes including maintenance of cellular quality control, transcription, cell cycle progression, DNA repair, cell stress and immune responses, apoptosis and development. The proteasome is a multi-subunit protease complex consisting of 20S core and one or two 19S regulatory particles. Under certain conditions, the constitutive catalytic subunits of the 20S particle β1, β2 and β5 can be replaced by alternative subunits – β1i, β2i and β5i. In this case, the proteasome is called immunoproteasome and plays a role in antigen presentation. It is known that there is an increased gene expression of the immunoproteasome subunits in embryonic stem cells (ESCs), while the expression of these subunits discernibly decreases during differentiation of these cells. This implies that immunoproteasomes take an active part in the maintenance of pluripotency of ESCs. Role of the immunoproteasomes in the induction of pluripotent cell state is also an interesting issue.
[SC-5]	N. Bobrov (*Russia*), D. Kuznetsova, V. Dudenkova, F. Kulagin, N. Kiselev, M. Lukina, V. Zagaynov, and E. Zagaynova **Label free microstructural analysis of the healthy and diseased liver** A cholestatic liver disease is one of the most common liver diseases and can potentially progress to liver cirrhosis or even cholangiocarcinoma. Conventional techniques are insufficient to precisely describe the complex internal structure, heterogeneous cell populations and the dynamics of biological processes of the liver. In this study we investigated metabolic changes in the healthy and cholestatic liver based on the fluorescence of the metabolic co-factors NADH and FAD. Cellular metabolism was examined by monitoring the optical redox ratio (FAD/NADH), the fluorescence lifetime contributions of the free and bound forms of NADH and FAD. Two-photon fluorescence microscopy combined with FLIM and SHG was used to analyze this fluorescence in living hepatic cells of the healthy and cholestatic liver. The data can be used to develop new criteria for the identification of hepatic pathology at the level of hepatocyte changes directed to personalized medicine in the future.
[SC-6]	O.S. Rogovaya (*Russia*), V.V. Dudenkova, A.S. Bystrova, M.M. Lukina, E.A. Vorotelyak, E.V. Zagaynova, and A.V. Meleshina **The study of the dermal cells cultured in collagen gel by optical and multiphoton tomography** There are common mechanisms of connective tissue development in the course of various pathological processes. These processes are better studied in skin wounds and all types of regeneration and growth of connecting tissue. The contraction is one of the processes providing wound healing. We utilized the model of dermal equivalent (DE) manufactured from collagen gel containing stromal cells which contracted the gel within two weeks of cultivation in vitro. Murine dermal fibroblasts (DFB) and cells from the dermal papilla (DP) were used. In this system, collagen gel acted as an analog of a stroma which should be strengthened and contracted by cells to form collagen fibrils. The contraction of collagen gel and its structure were studied by standard laboratory and modern hardware methods with the use of optical coherence tomography (OCT) and a multiphoton tomography (MPT).
[SC-7]	V.Yu. Sysoeva (*Russia*), N.I. Kalinina, P.A. Tyurin-Kuzmin, L.V. Ageeva, and V.A. Tkachuk **Hormonal regulation of functional heterogeneity of mesenchymal stem cells** Mesenchymal stem cells (MSCs) are necessary for renewal and regeneration of the most if not all tissues in human body. They closely interact with tissue-specific stem cells and control their functioning as well as differentiate into different cell lineages. These cells represent a functionally heterogeneous population; however, molecular mechanisms involved in the establishment and maintenance of MSCs heterogeneity remain poorly understood. Using MSCs isolated from human adipose tissue we have analyzed if hormones and their receptors could be involved in functional heterogeneity of these cells.

HALL A	HALL B
Optical Bioimaging and Clinical Biophotonics	**Biophotonics in Cancer Research**
12:00 H. Stepp (*Germany*), N. Markwardt, A. Rühm, M. Goetz, P. Zelenkov, V. Loschenov, P.Grachev, and R. Sroka **Optical spectroscopy for the detection of brain tumor and blood vessels to enhance accuracy and safety of stereotactic brain tumor biopsy (*Invited*)** Objective: Increase accuracy and safety of brain tumor biopsy. Improved accuracy may be achieved by fiberoptic detection of protoporphyrin IX fluorescence. Fiberoptic recognition of blood vessels by remission spectroscopy promises to increase safety. To these ends, 3 or 4 optical fibers with outer diameters of 240 µm were integrated in a standard stereotactic biopsy needle. Fluorescence of protoporphyrin IX is preferentially excited with 635 nm. For detection of blood vessels, light transmitted between two fiber tips, separated by approx. 2 mm, was analyzed at two wavelengths with very different blood absorption, 578 nm and 650 nm, respectively.	**12:00** Z.- R. Lin, Y.- C. Lin, K.-T. Wu, E. Perevedentseva, and C.- L. Cheng (*Taiwan*) **Drug loading and efficiency of nanodiamond-anticancer drug complex in 2D and 3D cellular model (*Invited*)** Nanodiamond (ND) has been considered as a biocompatible and feasible platform for efficient cancer drug delivery. Examples have been successfully demonstrated for various cellular and animal models. However, to date, very few or no studies have included assessment on the effects and efficiency in a quantitative fashion; and the transportation of these ND-drugs to the cancer/tumor sites are still in a less understood state. For drug delivery, ND can interact with blood circulatory system and enter the peripheral tissues; where ND interacts with target cells. When cell encounters and engulfs ND, the cell may try to digest it in a process named autophagy, a survival mechanism for cells.
12:25 A. Maslennikova (*Russia*), E. Finagina, M. Sirotkina, M. Lazareva, A. Moiseev, S. Ksenofontov, G. Gelikonov, L. Matveev, E. Kiseleva, V. Zaitsev, N. Shakhova, E. Zagaynova, N. Gladkova, and A. Vitkin **Multimodal optical coherence tomography for evaluation of the normal tissue state during anticancer treatment (*Invited*)** Expedite *in vivo* evaluation of microvasculature state has many applications in oncology, in particular, for assessing the viability of tissues during surgery; in transplantology; in plastic surgery, for evaluating wound healing and for monitoring the response of tissue to damage. A spectral domain OCT system with microvascular visualization, outfitted with an imaging probe, was used for *in vivo* monitoring of oral mucosa during the radiation therapy and for assessing the state of tissues in the area of plastic surgery after mastectomy. Fifteen patients were imaged longitudinally. Quantitative processing of OCT images demonstrated changes of vascular parameters before the appearance of clinical signs of mucositis. These were statistically significant compared to initial pre-treatment levels in patients that subsequently developed grade two or three mucositis.	**12:25** Y. Mohammed (*Australia*), W. Sanchez, D. Liu, V.R. Leite-Silva, A. Holmes, H. Studier, I. Haridass, E. Ryan, J. Grice, and M. Roberts **Zinc oxide nanoparticle penetration into *in vivo* and *in vitro* human skin. Simulating life like experimental conditions and using non-invasive MPT-FLIM imaging can provide accurate toxicological assessment (*Invited*)** Zinc oxide nanoparticles (ZnO-NP) have been widely used in sunscreens and provide good broad spectrum protection against UV induced photo damage and skin cancer. Recent encouraging findings have attributed better sun protection to a slight reduction in Melanoma cases in Australia. However, controversies surrounding the safety of nanoparticles applied topically to the skin remain. We have over the last several years looked at simulating real life experimental conditions when assessing nanoparticle penetration into the human skin. Non-invasive Multiphoton Microscopy coupled with Florescence Lifetime Imaging Microscopy enables real-time, accurate detection of NP penetration into volunteer skin *in vivo*.
12:50 M. Shakhova (*Russia*), A. Meller, D. Sapunov, A. Novozhilov, A. Shakhov, and M. Kirillin **Optical monitoring for personalization of ENT diseases treatment** To personalize management of patients with chronic ENT pathologies at diagnosis and treatment stages optical coherence tomography (OCT) was employed. OCT manifestations of different forms of chronic rhinitis, pharyngitis, and otitis were revealed. OCT is demonstrated to be an efficient tool for detecting alterations in nasal mucosa after drug treatment. When employing physical treatment techniques (cryotherapy and photodynamic therapy (PDT)) the OCT monitoring allowed correcting the treatment protocol in accordance with individual reaction to treatment. OCT diagnostics data was employed for individual planning of otitis treatment. For minimization of cosmetic complications of PDT of skin cancer localized at the most vulnerable areas of the ENT organs (nose wing and auricle) the OCT was used to study individual morphological features.	**12:50** M.V. Novoselova, D.N. Bratashov, S.V. German, M. Sarimollaoglu, D.A. Nedosekin, B.N. Khlebtsov, D.A. Gorin, V.P. Zharov, and E.I. Galanzha (*USA*) ***In vivo* targeted theranostics of circulating tumor cells** Approximately 90% of all cancer deaths are caused by metastases produced by circulating tumor cells (CTCs). Detection and therapy (theranostics) of CTCs holds promise to prevent metastasis. However, the existing methods including the FDA-approved CellSearchsystem (Veridex, LLC) are only able to detect CTCs and evaluate whether their amount is associated with a worse prognosis. Our findings show that PAFC with nanoparticles and NMs as PA, PT and MRI contrast agents provides unique multifunctional and clinically-relevant platform for early theranostics of CTCs for prevention of metastasis, which is unachievable with the existing techniques.

13:05

M.V. Pavlov (*Russia*), P.V. Subochev, T.I. Kalganova, G.Yu. Golubyatnikov, V.I. Plekhanov, O.E. Ilyinskaya, A.G. Orlova, N.M. Shakhova, and A.V. Maslennikova

Noninvasive evaluation of metabolism and blood supply in breast cancer polychemotherapy

Modern approaches to breast cancer treatment suggest assessment not only of structural but also metabolic changes of tumor tissue in the course of neoadjuvant chemotherapy. In our study, the dynamics of tumor oxygenation was determined by optical diffuse spectroscopy imaging (DOSI); ultrasound investigation (USI) in power Doppler mode was used to determine blood flow dynamics. Changes of these indicators were compared with pathologic tumor response. Dynamics of tumor oxygenation and changes in the number of vessels during chemotherapy demonstrated various changes depending on the tumor response to treatment.

13:20

A.B. Voloveckiy (*Russia*), V.S. Sukhov, N.Y. Shilyagina, V.V. Dudenkova, A.V. Feofanov, I.V. Balalayeva, and A.V. Maslennikova

Fluorescent analysis of pharmacokinetics of chlorine E6 conjugate with BIS (dicarbollide) cobalt for BORon neutron capture therapy

The study objective was the evaluation of tissue distribution of boron-containing chlorin e6 derivative by detecting the fluorescence signal intensity in tumor and normal tissues ex vivo, and developing a descriptive mathematical model for the accumulation and excretion of boron based on experimental data. The study was performed on 20 tumor-bearing Balb/c mice. The solution of preparation was injected into a tail vein in a dose of 10 mg/kg of body weight. Animals were euthanized 1, 3, 6 and 24 hours after injection. Ex vivo microscopic fluorescent imaging of tumor, liver and muscle was performed. Analysis of the content of boron in blood, tumor, liver and muscle was performed by inductively coupled plasma mass spectrometry. A strong positive correlation between the fluorescence value and the content of boron in tissues was shown.

13:05

E. Perevedentseva (*Taiwan*), A. Karmenyan, Y.-C. Lin, C.-Y. Song, Z.-R.Lin, L.-C. Liu, Ashek-I-Ahmed, and C.-L.Cheng

Multifunctional nanoparticles for bio-medical research and theranostics (*Invited*)

Recently, an important trend is the development of multifunctional nanoparticles (NP) for bio-medical applications. To integrate diverse functionalities, the methods to vary particles surface properties, size, shape and structure, composition, optical-spectroscopic and other physical properties are developed. Number of NP can reveal wide variability of the properties: noble metals nanoparticles, C- and Si- based NP of different structure, polymer NP, etc., as well as their composites. Among these NP nanodiamond (ND), noble metal and ND-metal NP reveal promising variability of the properties. Some examples, including magnetic-, Au-, fluorescent drug-modified ND, are considered in the presented work.

17:00

K. König (*Germany*)

Clinical multiphoton/CARS tomography of skin, brain and eye (*Invited*)

17:00

I.D. Solviev, T.V. Ivashina, L.M. Vinokurov, and A.P. Savitsky (*Russia*)

Rational mutagenesis of new photoconvertable fluorescent protein for the live cell microscopy (*Invited*)

GFP-like fluorescent proteins are widely used as markers for the visualization of intracellular processes and for sub-difractional localization microscopy. In this work we describe a new photoconvertible protein, SAASOti, obtained from the Stylocoeniellaarmata coral.

17:25

M. Hammer (*Germany*), L. Sauer, J. Schmidt, S. Peters, L. Kreilkamp, and M. Klemm

Retinal autofluorescence lifetime for ophthalmic diagnostic – what can we learn from *in-vivo* and *in-vitro* FLIM? (*Invited*)

Fluorescence lifetime imaging ophthalmoscopy (FLIO) may provide a metabolic mapping of the retina. Full understanding of *in vivo* measured lifetimes, however, needs the in vitro investigation of pathologic processes, underlying fluorescence changes. FLIO images were obtained from patients suffering from diabetic retinopathy, age-related macular degeneration, macular holes, and Alzheimer's disease. Various pathologic alterations of ocular fundus fluorophore composition, such as lipofuscin accumulation, modification, and clearing from retinal pigment epithelium cells, retinal atrophy, and protein glycation, may contribute to an extension of fluorescence lifetimes.

17:25

K. Lukyanov (*Russia*)

Deeper understanding of biology and photochemistry of fluorescent proteins for new probe development (*Invited*)

17:50

T. Novikova (*France*), M. Kupinski, J. Rehbinder, S. Deby, A. Pierangelo, F. Moreau, B. Teig, and A. Nazac

Tissue imaging with Mueller polarimetry for cancer detection (*Invited*)

Due to the population growth and aging, the cancer cases worldwide increased by 33% in the last decade (2005-2015). Cancer mortality is the second largest worldwide after cardiovascular diseases. Early detection of cancer may significantly increase the survival rate and quality of patient life. We explore the potential of Mueller multi-wavelength wide-field imaging system to increase the contrast between imaged cancerous and non-cancerous zones and become a non-invasive technique for optical biopsy of tissue. The results of the studies of colon and cervical tissues will be presented, discussed and compared to the gold standard diagnosis of pathologist.

18:15

T.M. Motovilova (*Russia*), N.M. Shakhova, K.I. Chikalova, O.A. Kondratieva, S.S. Kuznetsov, O.V. Kachalina, P.A. Shilyagin, and M.Yu. Kirillin

Novel approach to endometrium evaluation in patients with chronic endometritis using optical coherence tomography

Sclerosis in endometrium stroma and nearby vessels is a common indicator of chronic endometritis. However, hysteroscopy allows revealing chronic endometritis only in 35% of cases. The perspectives of optical coherence tomography (OCT) in diagnosing and grading endometritis in female patients with infertility have been studied. OCT is shown to increase the diagnostic accuracy of the endoscopic inspection and in particular cases to allow avoiding biopsy.

18:30

V.Y. Toronov (*Canada*), S. Lin, R. Botero, H. Andrade-Caicedo, and T.N. Nguyen

Hyperspectral NIRS: Development and applications

We present a novel portable hyperspectral system for near-infrared spectroscopy of tissue and demonstrate its suitability in several clinical applications.

18:45

Yu.V. Kistenev (*Russia*), A.V. Borisov, V.V. Nikolaev, D.A. Vrazhnov, L.V. Spirina, and O.S. Kurochkina

Approaches of molecular imaging of bio-tissues and machine learning methods for medical applications

The presentation is focused on content analysis of 2D spectroscopic images of bio-tissues using Machine Learning methods. The analysis includes evaluation of the hierarchy of informative features of initial image and classification. The examples of this approach to malignant tumor tissues classification and other applications will be presented.

17:50

N.V. Klementieva (*Russia*), K.A. Lukyanov, E.V. Zagaynova, and A.S. Mishin

A new way to efficient primed conversion of photoactivatable fluorescent protein Dendra2

Dendra2 is one of the most useful and effective fluorescent tools both for confocal and single-molecule detection live-cell microscopy. However, this protein requires phototoxic violet light to be photoactivated. Recently, a strategy utilizing blue and near-infrared lasers for the so-called primed conversion of Dendra2 was reported. In our study we suggested a new way to induce primed conversion by co-illumination with blue and red light sources that are more available for researchers. The efficiency of the proposed approach has been proved using various imaging modes, including super-resolution microscopy of living cells.

18:05

A.S. Belova (*Russia*), A.G. Orlova, K.S. Shchukina, I.V. Balalaeva, N.O. Antonova, and E.V. Zagaynova

Cisplatin-induced hydrogen peroxide level changes as compared to total ROS level changes

Cisplatin is a chemotherapeutic drug which causes not only DNA damage, but also induces production of reactive oxygen species (ROS) that can initiate tumor cell death. Using genetically encoded fluorescent sensor, apoptosis marker and vital dye, dose-dependent increase of hydrogen peroxide level was demonstrated by flow cytometry under cisplatin action in viable and apoptotic tumor cells separately. In parallel, a decrease of total ROS amount was demonstrated using DCFH-DA.

20:00-21:40
Sponsor session II

20:00 **Viacheslav Artyushenko** (Art Photonics GmbH). **Fiber photonics solutions for advanced medical applications**

20:20 **Paul Hoess** (Stanford Computer Optics). **Extreme range extension of visual sight hampered by turbid media**

20:40 **Vladimir Pleshanov** (LLC "Optical Systems Alliance"). **New advances of confocal microscopy**

21:00 **Wolfgang Becker** (Becker & Hickl GmbH). **25 years bh – 25 years of multidimensional TCSPC**

21:20 **Nikolay Buyanov** (Spectra-Physics). **Multiphoton lasers and applications**

HALL A

Optical Bioimaging

15:00

P.T.C. So (*USA*), Y. Xue, K. Barry, C.J. Rowlands, Y. Takiguchi, and E. Nedivi

Towards synaptomics (*Invited*)

Synaptomics: we seek to study how a single neuron in the brain integrates, processes, and responses to all tis inputs. Toward this goal, we are developing a novel multiphoton holographic microscope that is capable of monitoring up to hundreds of locations simultaneously in living brain offering functional studies with unprecedented signal to noise ratio.

15:25

M. Leutenegger (*Germany*)

Parallelized RESOLFT nanoscopy (*Invited*)

Optical nanoscopy based on the RESOLFT concept has recently been parallelized to image larger fields of view more rapidly. This advance relies on using light patterns with arrays of intensity minima for discerning objects by switching their fluorophores between fluorescent and non-emissive states. We demonstrate highly parallelized, multicolor RESOLFT nanoscopy in living cells at 80–100 nm resolution and discuss novel image reconstruction algorithms that incorporate background rejection and image formation models.

15:50

J. Enderlein (*Germany*), N. Karedla, A. Chizhik, and A. Chizhik

Metal induced energy transfer and axial superresolution microscopy (*Invited*)

We have developed a new method for resolving fluorescence structures with nanometer accuracy along the optical axis. It is called Metal Induced Energy Transfer or MIET and used the fact that, when placing a fluorescent molecule close to a metal film, its fluorescence intensity and lifetime strongly depends on its distance to the metal. This is due to the efficient electromagnetic coupling of its excited state to surface plasmons in the metal, which is similar to Förster Resonance Energy Transfer (FRET), where the energy of an excited donor molecule transfers into the excited state of an acceptor molecule. We use this effect for localizing fluorescent single molecules or fluorescently labeled structures with nanometer accuracy.

16:15

A.V. Priezzhev (*Russia*), K. Lee, F. Yaya, C. Wagner, A.N. Semenov, A.E. Lugovtsov, S.Yu. Nikitin, and E.A. Shirshin

Multimodal dynamic and structural imaging of erythrocytes and blood capillaries (*Invited*)

Several optical techniques were used to make a complex study of various parameters related to the fundamental properties of erythrocytes, aggregation and deformation, by means of imaging and measurement. Diffuse light scattering, laser diffractometry, and dual- and multiple channel laser tweezers were applied in the experiments *in vitro*. Computerized capillaroscopy and laser two-photon lifetime imaging microscopy were used for imaging the structure of the terminal capillaries and papillary dermis in the fingernail bed and the inner forearm area *in vivo.*

HALL B

Biophotonics in Cancer Research

15:00

P.J. Campagnola (*USA*)

Analysis of stromal alterations in ovarian cancers via second harmonic generation microscopy (*Invited*)

Ovarian cancer is the most deadly gynecological cancer with a poor aggregate survival rate. To improve upon this situation, we utilized collagen-specific Second Harmonic Generation (SHG) imaging microscopy to probe structural differences in the extracellular matrix of normal stroma, benign tumors, endometrioid tumors, and low and high-grade serous (LGS and HGS) tumors. We extract quantitative differences at all levels of assembly using texture analysis for fiber pattern classification, SHG creation physics for fibril size and packing, and polarization resolved SHG for changes in macromolecular structure across this spectrum of disease type and grade.

15:25

R. Taylor (*Germany*)

High temporal and spatial resolution in tracking proteins on and through a cell membrane using iSCAT' (*Invited*)

15:50

A. Patil, V.K. Unnikrishnan, K.M. Pai, R. Ongole, K. Pai, V.B. Kartha, and S. Chidangil *(India)*

Optical biopsy: journey from laboratory system to public health-care (*Invited*)

Under-developed countries constitute 85% of the world population and almost 80% of them live in rural areas. More than 60% of this population are in conditions of grossly inadequate health care, without any modern medical facilities for diagnosis from conditions (e.g. cancers) which remain clinically silent for long periods. The solution for this issue is the development of screening methods, which can be used in small hospitals or medical camps. The paper will discuss development of non-invasive *Optical Biopsy* systems for early detection of epithelial cancers (oral and cervical cancers), capable of repeated application and screen large susceptible population groups.

17:00

S. Nadkarni (*USA*)

Intracoronary birefringence microscopy of atherosclerotic plaque (*Invited*)

17:00

J. Cassidy, V. Betz, and L. Lilge (*Canada*)

Photodynamic treatment planning and dosimetry: development of an universal applicable treatment optimization process (*Invited*)

Personalized Cancer Therapy is the focus of a concerted research effort in North America and other high-income countries. The aim is to improve survival while simultaneously reduce toxicity to normal organs. While local, minimally invasive physical therapies would satisfy these requirements, planning their implementation for an individual patient is but in its infancy. Here we present a workflow for Photodynamic Therapy, leading to personalized therapy delivery.

17:25

V.V. Dudenkova (*Russia*), A.S. Bystrova, A.V. Meleshina, O.S. Rogovaya, E.V. Gubarkova, and E.V. Zagaynova

Quantitative analysis of SHG signal of collagen structure in models and tissue samples

We propose a combined use of coherence and energy parameters for complex quantitative analysis of SHG signal of a collagen structure both in models and tissue samples. It minimizes potential disadvantages of using a single method, and provides ideal information profile for clinical and research applications. For studying collagen formation on a model structure we used collagen gels constructed by combining dermal fibroblasts or dermal papilla cells and identified the increase in the values of coherence and energy in 3,10,12, and 14 days in collagen gels with fibroblast in comparison with dermal papilla. These parameters were also used for human intraoperative bladder diagnostics and allowed differentiating normal bladder with mild inflammation, severe inflammation, low-grade cancer and cancer on the scar.

17:25

M. Ogawa (*Japan*)

New cancer therapy using near infrared light (*Invited*)

Near infrared photoimmunotherapy (NIR-PIT) is a new cancer therapy using antibody and hydrophilic photosensitizer conjugates. However, the mechanisms for killing the cells are not elucidated yet, and it is necessary to elucidate them for developing better NIR-PIT. In this study, we investigated the mechanism of NIR-PIT by evaluating cell membrane damage, immunologic reactions induced by NIR-PIT.

17:40

E. Sobol (*Russia*), O. Baum, and S. Wachsmann-Hogiu

Structural illuminating microscopy and fluorescent markers in the imaging of laser-induced modification of cartilage and sclera structure

Recent results in laser modification of pore system structure of the tissues toward development of new methods for healing of osteoarthritis and glaucoma are presented. The effect of 1.56 mcm laser radiation on porcine articular cartilage and eye sclera was studied using atomic force microscopy and super resolution structured irradiation microscopy with fluorescent markers. The stabilization of laser-assisted gas and pore systems in the tissues can explain the long lasting healing effect in laser reconstruction of spine discs and in laser creation the uveoscleral pathway for aqueous in glaucomatous eyes.

17:50

M.A. Sirotkina (*Russia*), A.A. Moiseev, S.S. Kuznetsov, M.V. Shirmanova, V.Yu. Zaitsev, V.V. Elagin, G.V. Gelikonov, E.V. Zagaynova, A. Vitkin, and N.D. Gladkova

Monitoring of tumor treatment by multimodal optical coherence tomography

The study objective was to monitor the microcirculation reaction on photodynamic therapy using multimodal OCT. Using OCT microangiography on an experimental tumor model we investigated the microvascular reaction in the tumor side and in the collateral tissue. The dependence of tumor response on the initial state of tumor microvasculature was studied. Complete disappearance of vessels in OCT images within 24 hours after exposure led to the total tumor necrosis on the 7^{th} day. 40% of poorly vascularized tumors and 87% of highly vascularized tumors were killed by PDT, and OCT microangiography can visualize vascular changes related to the PDT treatment and correlate them with clinical outcome.

17:55

M. Eibl (*Germany*), S. Karpf, H. Hakert, D. Weng, and R. Huber

Single pulse two-photon fluorescence lifetime imaging (SP-FLIM) with MHz pixel rate and an all fiber based setup

We present a two photon microscopy setup using a sub-nanosecond pulsed fiber laser synchronized to a high analog bandwidth signal detection for two-photon-excited fluorescence (TPEF) and single shot fluorescence lifetime imaging (SP-FLIM). Compared to typically used femtosecond excitation, both configurations should yield the same number of fluorescence photons on average when used for TPEF imaging if the same duty cycle and cw-power is applied. However, due to our longer pulse length, more fluorescence photons are generated per shot. In this presentation, we show that this higher number of fluorescence photons together with a high analog bandwidth detection makes it possible to not only use a single pulse per pixel for TPEF imaging but also to acquire FLIM images with pixel rates of 1 MHz.

18:05

L.G. Klapshina (*Russia*), S.A. Lermontova, I.S. Grigoryev, N.Yu. Shilyagina, M.S. Muravyeva, D.V. Yuzhakova, I.V. Balalaeva, M.V. Shirmanova, E.V. Zagaynova, and M.K. Kuimova

Novel-potential anticancer theranostic agents based on the porphyrazine framework for specifically personalized medicine

We report on a series of novel tetracyanotetra(aryl) porphyrasine dyes which are found to be red-emitting fluorescent 'molecular rotor' *i.e.* the fluorescence lifetime and the quantum yield of these macrocycles strongly increase as a function of environment viscosity. They work also as an efficient PDT agent. Photosensitizers prepared on the cyano-aryl porphyrazine pigment platform bound to gadolinium cation demonstrate the potential to become an extraordinarily effective multimodal agent for theranostics, representing a new approach to PDT based on real-time monitoring of the therapy in combination with precise MRI /fluorescence diagnostics of tumor.

18:10

S. Chakraborty (*Taiwan*), T. Anna, A. Karmenyan, W. C. Kuo, and A. Chiou

Fluorescence life-time imaging of senescing leaves

Two-photon fluorescence lifetime imaging microscopy (2P-FLIM) was used to monitor the fluorescence life-time of *Acer palmatum 'Hogyoku'* leaves. The Hogyoku plant leaves change color from green to red (leaf senescence or aging) due to autumn phenology. With 760 nm excitation of the blue fluorescence, the average fluorescence lifetime of the red leaves was ~1.442 ns, which is 22% longer ($P < 0.05$) than the corresponding value (1.12 ns) of the green leaves. The source of blue fluorescence may be attributed to hydroxycinnamic acids, NADPH etc. Hence, blue fluorescence lifetime may be used as a signature of ageing in senescing leaves.

18:20

N.Y. Shilyagina (*Russia*), N.N. Peskova, A.V. Utkina, A.A. Gorokhova, S.A. Lermontova, L.G. Klapshina, and I.V. Balalaeva

Study of the mechanisms of oxidative stress in response to photodynamic treatment

Photodynamic therapy (PDT) is a modern minimally invasive treatment technique, which provides selective damage of tumor tissue. Despite extensive use of PDT in clinical practice, there is still no clear understanding of the nature of photodynamic response development. It is true for both initial physicochemical processes and subsequent chain of events developing at the level of the whole organism and leading to a recorded local tissue and systemic response. The present work is devoted to the study of the hydrogen peroxide production dynamics during photodynamic reaction and its correlation with cell functional state using viscosity-sensitive photosensitizes.

18:25

Chia-Yuan Chang, Yong-Da Sie, and Shean-Jen Chen (*Taiwan*)

Deep-biotissue imaging by temporal focusing widefield multiphoton microscopy

A developed temporal focusing-based multiphoton excitation microscope (TFMPEM) has a digital micromirror device (DMD) which is adopted not only as a blazed grating for light spatial dispersion but also for patterned illumination simultaneously. The TFMPEM has been extended to implement spatially modulated and digital holographic illumination to increase the beam coverage at the back-focal aperture of the objective lens. The axial excitation confinement (AEC) of TFMPEM can be condensed from 3.0 μm to 1.5 μm. By using the TFMPEM with HiLo technique, reconstructed deep-biotissue images according to the condensed AEC structured illumination are shown to be obviously superior in contrast and better scattering suppression.

18:35

E.B. Kiseleva (*Russia*), K.S. Yashin, A.A. Moiseev, M.A. Sirotkina, L.B. Timofeeva, V.M. Gelikonov, V.V. Fedoseeva, A.I. Alekseeva, and N.D. Gladkova

Multimodal OCT-guided detection of infiltrative tumor border in glioblastoma rat model

Determining the boundaries of infiltrative glial tumors is still a challenging problem in neurooncology. Optical coherence tomography (OCT) with cross-polarization and real-time microangiography visualization is a promising technique for a possible surgical guidance. This study is aimed to develop a robust quantitative approach for multimodal OCT data to differentiate cancer from non-**cancer** tissues in glioblastoma rat model. Processing of structural and microvasculature images gave an advantage for more accurate determination of tumor borders.

18:40

V.A. Hovhannisyan (*Taiwan*) and S.J. Chen

Drug delivery by natural zeolite particles

Using multiphoton microscopy (MPM), we demonstrated that clinoptilolite type of zeolite (CZ) produced two-photon excited fluorescence (TPEF) and second harmonic generation (SHG) signals by femtosecond laser excitation. In addition, adsorption of PDT active dyes (hypericin, methylene blue, etc) and they release from CZ pores in the presence of biomolecules have been shown. Furthermore, magnetic CZ particles were tested as an effective material for drug delivery and controlled release in biological systems. The results may open new perspectives in application of CZ in biomedical imaging, and introducing optical approaches into the clinical environment.

18:50

V. Demidov (*Canada*), A. Maeda, M. Sugita,V. Madge, C. Flueraru, and I.A. Vitkin.

Longitudinal assessment of single-dose radiation-induced tumor vascular changes with optical coherence tomography

Here we report the optical coherence tomography (OCT) quantitative assessment of early (up to 6 weeks) microvascular response of engrafted tumors in mouse dorsal skin window chamber model, subjected to a high-dose single-fraction radiation treatment of 10, 20, and 30Gy. Acquisition of structural images of tumor tissues with OCT and their real-time processing with speckle variance (svOCT) algorithm to obtain vascular volumetric images provided highly detailed view of vasculature remodeling in tumors following RT. OCT pre-clinical evaluation of tumor vascular response offers a shedding light opportunity on early RT effects and is likely to be extended into the clinic.

HALL A	HALL B	HALL C
Optical Bioimaging	**Biophotonics in Stem Cell Research**	**Novel Laser Applications in Biomedicine**
11:00 M.A. Franceschini (*USA*) **Measuring cerebral oxygen delivery & consumption with diffuse correlation spectroscopy in African children (*Invited*)** With the foundation of our seminal near-infrared spectroscopy (NIRS) and diffuse correlation spectroscopy (DCS) work on infants, we have developed a novel integrated system, which simultaneously acquires cerebral oximetry and blood flow measurements. We have deployed the device in Africa to assess the feasibility of NIRS studies in low resource settings. Results will be presented.	**11:00** A. Tomilin (*Russia*) **Basic and applied sides of pluripotent stem cells** Pluripotent stem cells have gained considerable interest during the past decades because they represent a formidable tool for human disease modeling, drug screening and testing, and notably, because they possess a tremendous potential in regenerative medicine. During the talk I will give an overview of the field of pluripotent stem cell research with an emphasis on embryonic stem (ES) and induced pluripotent stem (iPS) cells as the most prominent pluripotent stem cell types. I will highlight three major issues standing on the way of efficient introduction of these cells into practical medicine (safety, immunogenicity, and oncogenic transformation) and will address possible ways of solving these issues. Basic and applied iPS/ES cell-related projects that are currently under way in the lab will be also incorporated into the talk.	**11:00** W. Assmann (*Germany*) **The sound of protons – ionoacoustic range monitoring in proton therapy (*Invited*)** Range verification is the crucial issue in ion beam therapy to enable full clinical exploitation of its characteristic advantages over photon therapy. Detection of the ultrasound signal induced by the incident ions (ionoacoustics) promises a simple and direct possibility to measure the ion range. Here we demonstrate in experiments with proton beams of 20 MeV and 230 MeV the achievable accuracy and precision of this approach.
11:25 P. Stähli, J. Ricka, M. Frenz, and H.G. Akarçay (*Switzerland*) **Optical extinction measurements on strongly scattering samples by way of imaging (*Invited*)** Optical extinction measurements can be challenging to perform on strongly scattering media: this is attributable to the difficulty in distinguishing the scattered light from the illumination beam, which is attenuated upon transmission through said media. We present here a novel approach, where a compact and inexpensive imaging system is used to unambiguously filter out forward-scattered light, without having to recourse to sophisticated calculations. The applicability thereof has been ascertained with experiments on non-interacting, colloidal suspensions, whose optical extinction coefficient can be calculated by means of Mie theory. The scattering cross-section of the suspensions can be determined with < 0.3% error for line number densities of particles up to 0.25 spheres/micron.	**11:25** A.V. Meleshina (*Russia*), V.V. Dudenkova, A.S. Bystrova, M.V. Shirmanova, and E.V. Zagaynova **Metabolic plasticity of mesenchymal stem cells during differentiations by two-photon FLIM** Metabolic plasticity and the versatilityof different lineages of stem cells as they satisfy their energy demands are not completely understood. In this study we investigated the metabolic changes in mesenchymal stem cells undergoing differentiation in three directions, adipogenic, osteogenic and chondrogenic, using the two-photon fluorescence microscopy combined with FLIM. Based on the data for the FAD/NAD(P)H redox ratio and on the fluorescence lifetimes of protein-bound NAD(P)H we registered a metabolic switch from glycolysis to OxPhos in adipocytes, consistent switch from glycolysis to OxPhos to glycolysis in osteoblasts and switch to more glycolytic status in chondrocytes.	**11:25** U. Masood (*Germany*), T.E. Cowan, W. Enghardt, M. Gotz, T. Herrmannsdörfer, K. M. Hofmann, L. Karsch, F. Kroll, U. Schramm, M. Schürer, J.J. Wilkens, K. Zeil, and J. Pawelke **Ion beam therapy with laser-accelerated proton beams – Challenges and solutions (*Invited*)** Proton acceleration on µm scale via high intensity laser has become a compelling alternative to conventional accelerators and gained interests for its potential to reduce size and costs for proton therapy (PT) facilities. Next generation petawatt lasers promise laser-driven protons (LDP) with therapeutic energies. But, in contrast to conventionally accelerated quasi-continuous mono-energetic pencil beams with about 30 Gy/sec dose rate, LDP beams have diverse properties, i.e. ultra-intense pico-sec bunches with up to 10^{10} Gy/sec dose rate, large energy spread and divergence, and with only up to 10 Hz repetition rate. These properties make it challenging to adapt LDP beams directly for medical applications. The presented work is an ongoing joint translational research project of several institutions aiming to establish laser-driven PT. We will present the recent progress in design concepts and the status of the development.

11:50

I. Meglinski (*Finland*), A. Bykov, N.O. Vera Paz, J.P. Staforelli, A. Doronin, T. Novikova

Towards application of angular momentum of light for tissue diagnosis (*Invited*)

We investigate how the spin-orbit interaction leads to the mutual influence of the polarization and the trajectories of twisted photons (or vector beams) propagating in turbid tissue-like scattering media, and how sensitive are the vector light beams to subtle alterations in biological tissue morphology. An overall aim of the study is to explore the potential applicability of vector light beams for non-invasive tissue diagnosis (optical biopsy) and provide the proof of concept by developing the operating prototype of the instrument for the characterization of complex scattering anisotropic and/orchiral media with vector light beams.

11:40

A.A. Gulin (*Russia*), A.V. Aybush, A.A. Astafiev, A.E. Solodina, A.G. Pogorelov, V.N. Pogorelova, A.I. Panait, and V.A. Nadtochenko

A new approach for single cell imaging: Mammalian oocyte case

Combining imaging mass spectrometry with different microscopy techniques for the same sample on the same holder enables complex analysis of the sample morphology and chemical composition. A new sample preparation protocol was developed allowing complex analysis of germinal vesicles mice oocytes minimizing cellular chemistry redistribution and cell structure distortion. Mammalian oocytes can contain nucleolus-like body (NLB) units which were investigated. A domain structure of densely packed granules inside NLBs was revealed. Mass spectrometry shows increased amino acids and phosphate ions signal from the granules compared to cytoplasm area.

11:50

A.V. Korzhimanov (*Russia*), M. Nakatsutsumi, L. Grimellet, and J. Fuchs

Negative impact of self-generated magnetic fields on energies of ions accelerated by ultra-high intensity laser pulse

Ion beams accelerated by hot electrons produced in solid targets irradiated by high-intensity laser pulses are widely believed to become a valuable tool for hadron cancer therapy. The current challenge is to reach therapeutic energies, *i.e.* above 200 MeV, which is commonly thought to be possible by increasing the laser intensity. Here, we present numerical results demonstrating that at intensities exceeding 10^{21} W/cm^2 magnetostatic fields self-generated in the sheath may have a detrimental effect on the ion energies and may pose a fundamental limit to target normal sheath ion acceleration for high enough laser intensities. We also discuss possible mechanisms of this effect.

12:15

V.V. Tuchin (*Russia*)

Enhanced imaging of tissues by immersion clearing/contrasting: from X-ray to TeraHertz (*Invited*)

Optical immersion clearing/contrasting technology is aimed to enhance imaging of living tissues and cells. The method explores controllable and reversible modification of tissue/cell properties by their impregnation with a biocompatible clearing/contrasting agent (CCA). The multimodal diagnostic medical technologies with the targeting by a unified CCA (THz/optical, x-ray/optical, MRT/optical) is discussed.Water transport and modification of tissue mechanical properties under CCA action is analyzed. The enhancement of probing depth and image contrast for human and animal tissues is demonstrated using diffuse spectroscopy, OCT, photoacoustic, linear and nonlinear fluorescence, SHG and Raman microscopies, polarization and speckle imaging.

11:55

A. Koroleva (*Germany*), A. Deiwick, P. Timashev, D. Kuznetsova, and B. Chichkov

Two-photon polymerization for fabrication of tissue engineering scaffolds (*Invited*)

Two-photon polymerization (2PP) with femtosecond lasers provides many advantages for the fabrication of high quality 3D microstructures with complex geometries. 2PP technique uses non-linear absorption of femtosecond laser pulses to selectively polymerize photosensitive materials. Three-dimensional microstructuring by the 2PP technique provides many interesting possibilities for biomedical applications. This microstructuring technique is suitable for many biocompatible polymeric materials, such as polyethylene glycol, polylactic acid, polycaprolactone, gelatin, zirconium-based hybrids, and others. The flexibility in controlling geometries and feature sizes and the possibility to fabricate structures without the addition of new material layers makes this technique particularly appealing for fabrication of 3D scaffolds for tissue engineering. Our recent progress in application of 2PP scaffolds for tissue engineering will be reported.

12:40

H. Wabnitz (*Germany*)

Performance characterization of instrumentation for diffuse optical imaging and spectroscopy (*Invited*)

The quantitative assessment of system performances based on tissue-like phantoms plays an important role in the validation and quality assurance of diffuse optics instrumentation for clinical diagnostics and monitoring. Several dedicated protocols and guidelines have been developed and applied for performance comparison of instrumentation in multilaboratory efforts, in particular the nEUROPt protocol. Two sets of tests will be discussed in detail, (1) the quantification of the responsivity of the detection system in diffuse optics, (2) the assessment of sensitivity, spatial resolution and quantification of localized absorption changes in the context of time-domain functional brain imaging.

13:05

A.G. Orlova (*Russia*), M.Yu. Kirillin, A.B. Volovetsky, N.Yu. Shilyagina, E.A. Sergeeva, G.Yu. Golubiatnikov, and I.V. Turchin

Diffuse optical spectroscopy monitoring of oxygen state of growing experimental tumor

In vivo monitoring of oxygenation level and blood content in the course of experimental tumor growth was performed using the diffuse optical spectroscopy (DOS) technique. Results of oxygen saturation measurements were confirmed by measurements of pO_2. Differences in the level of oxygenation and blood content between experimental tumor and normal tissue were revealed. Rapid decrease of oxygenation level preceded the acceleration of tumor growth during which oxygen state has remained low. The increase of tumor volume was accompanied by the gradual increase in blood content.

12:20

Yu. Rochev (*Ireland*)

Temperature-responsive biomaterials design for tissue engineering and drug delivery (*Invited*)

The regeneration of cells and cell sheets mediated by thermoresponsive substrates represents an important and ever growing area in tissue engineering. This presentation seeks to track the development of this field from inception to the present day by highlighting the most significant breakthroughs as well as focusing on important physical and chemical characterization of substrates produced for this specific purpose. Furthermore, a critical evaluation encompassing the advantages and disadvantages of different techniques used for producing such surfaces will be included as well as suggestions for possible future directions.

12:45

P.S. Timashev (*Russia*), S.L. Kotova, T.M. Zharikova, D.V. Butnaru, and A.B. Solovieva

Collagen morphology in the extracellular matrix by AFM technique as a marker of tissue damage (*Invited*)

We have applied atomic force microscopy (AFM) to diagnose morphological changes in the extracellular matrix of connective tissue caused by different pathological processes. AFM has been shown to reveal visible deviations from the normal morphology of the extracellular matrix in diseased tissues. The AFM data were found in a good agreement with the data of conventional histological studies. Thus, AFM may serve as either an independent, or a complementary diagnostic tool for tracking pathological changes in the connective tissue.

13:10

D.S. Kuznetsova (*Russia*), N.N. Prodanets, P.S. Timashev, V.N. Bagratashvili, and E.V. Zagaynova

The involvement of allogeneic mesenchymal stem cells in bone formation

Currently there are three key elements in tissue engineering to treat bone defects: cells, scaffolds and growth factors. The cell approach consists of the preliminary seeding of cells onto scaffolds. Mesenchymal stem cells (MSCs) are thought to be the most attractive for making bone repair. However, much is unknown about MSCs which needs to be elucidated before this treatment can be widely applied in clinical situations. The goal of the present work was to study the involvement of seeded allogeneic MSCs in bone formation using the model of transgenic mice and genetically labeled cells.

HALL A	HALL B
Clinical Biophotonics and Optical Bioimaging	**Biophotonics in Stem Cell Research**
15:00 J. Ng, N. Henriquez, N. Kitchen, and S. Bown (*UK*) **Bioluminescence-mediated photodynamic therapy: a novel treatment for grade 4 astrocytoma (*Invited*)** Treatment for grade 4 astrocytoma is rarely curative due to infiltration of the tumour into adjacent normal brain. Photodynamic Therapy (PDT) can selectively destroy glioma cells, but is limited by light penetration through brain tissue. This new approach uses light generated chemically (bioluminescence). U87 glioma cells, transfected to express luciferase, could be killed *in vitro* with the photosensitiser mTHPC by adding luciferin for light generation on individual glioma cells. Transplanting these cells into mice, evidence of necrosis could be documented *in vivo* following administration of mTHPC and subsequent infusion of luciferin – the first evidence of bioluminescence activated PDT *in vivo*.	**15:00** M. Kaucka, R. Soldatov, T. Chontorotzea, J. Petersen, M.E. Kastriti, N. Akkuratova, V. Dyachuk, K. Fried, P. Kharchenko, and I. Adameyko (*Sweden, Austria*) **Single cell transcriptomics reveals fate selection points and early heterogeneity of the neural crest (*Invited*)** Lately, single cell transcriptomics methods bloomed and enabled a new approach to classify the cell types as well as to analyze developmental transitions. We took advantage of single cell transcriptomics to resolve neural crest heterogeneity and fate choice mechanisms. The results of our analysis showed that fate switches operate as sequential bifurcations of choices, and that prior to the fate selection, fate-specific gene clusters are heterogeneously activated in the early delaminating and migrating neural crest populations. Indeed, neural crest cells show the existence of active and passive differentiation-related biases operating at the gene expression level.
15:25 E. Gerelli, V. Huntosova, D. Horvath, and G. Wagnieres (*Switzerland*) ***In vivo* measurement of the tissue oxygenation by time-resolved luminescence spectroscopy: Strategies to minimize artefacts associated with the photosensitization and photoproducts (*Invited*)** Protoporphyrin IX (PpIX) is an interesting probe to measure pO_2 in tissues by time-resolved luminescence spectroscopy. However, this probe is phototoxic and generates luminescent photoproducts. Consequently, we studied their influence on the PpIX lifetime *in vivo*. We established that this influence can be avoided if the PpIX emission is detected between 630±10 nm, or if the excitation dose at 405 nm is less than 1 J/cm^2. We also studied *in vivo* the oxygen sensitivity and phototoxicity of dichlorotris(1,10-phenantroline)-Ruthenium(II) Hydrate (Ru(phen)), a poorly (photo)toxic probe. We established that its phototoxic threshold is hundred times larger than the fluence necessary for pO_2 measurements.	**15:25** J. Krivanek (*Austria*), T. Chontorotzea, K. Fried, and I. Adameyko **Understanding of developmental and regeneration pathways of tooth using single cell transcriptomics (*Invited*)** Mouse incisor as a continuously growing tooth serves as an excellent model system to study stem cell niche, developmental differentiation pathways and importantly to study mutually interdependent epithelial to mesenchymal interactions. In our study we used single cell transcriptomics method by which we can elucidate levels of gene expression of all genes in each single selected cell. We analyzed obtained data by advanced algorithms which enabled us to distinguish different cell types, estimate their proportion and cluster them into different families. We characterized new cell subtypes and suggested cell differentiation pathways influenced by specific key factors.
15:50 A. Akopov (*Russia*), G. Papayan **Contribution of photodiagnosis and photodynamic therapy to the treatment of lung cancer: Saint-Petersburg experience (*Invited*)** Fluorescence diagnostics in combination with a variety of traditional and new methods of treatment has considerable potential to resolve of the complex medical issues. Its use in conjunction with photodynamic therapy is particularly effective, since it is easy to combine technically, allowing to perform the diagnosis and treatment of lung cancer as a single procedure. The possibility of photodynamic theranostics with various methodological improvements in experimental and clinical studies is shown as the use of tumour specific conjugates with biological nanocarriers; two-wavelength excitation; fluorescence image-guided surgery; stereotactic fluorescent biospectroscopy; using the near-infrared light to detect the tumour and sentinel lymph nodes; photodynamic irradiation in a pulsed radiation mode.	**15:50** A.S. Chagin (*Sweden*) **3D visualisation of synovial joints revealed novel progenitor cells which form entire adult articular cartilage in mice (*Invited*)** Articular cartilage has limited regenerative capacity. Here, we describe novel chondrocyte progenitors responsible for formation of articular cartilage. 3D visualization with micro-CT revealed quantitative dynamics of cartilage growth and reshaping. Clonal genetic tracing revealed that chondro-progenitors generate chondrocytes and facilitate cartilage reshaping. Furthermore, chondro-progenitors renew their number by symmetric division, express mesenchymal stem cell marker CD73, and generate chondrocytes via both asymmetric division and symmetric differentiation. Finally, we found that adult articular cartilage is entirely formed by the progeny of chondro-progenitors. We conclude that chondro-progenitors are postnatal stem cells capable of maintaining their own population and form adult articular cartilage.

16:15

S.V. Gamayunov (*Russia*), E.A. Tararova, and O.S. Streltsova

Intravesical PDT for non-muscle-invasive bladder cancer

Non-muscle-invasive bladder cancer (NMIBC) can be effectively treated via transurethral resection and intravesical agents, although recurrence is common. Intravesical PDT has perspectives as one of new treatment approaches. This study aims at determining the optimal parameters of laser exposure for treatment of NMIBC with intravesical PDT. The following applied laser irradiation doses were tested: 10 J/cm^2 (group I, 5 cases); 20 J/cm2 (group II, 10 cases); 40 J/cm^2 (group III, 5 cases). It is shown that the most safe and efficient regime is achieved with the dose of 20 J/cm^2.

16:30

A.V. Khilov (*Russia*), M.Yu. Kirillin, D.A. Loginova, and I.V. Turchin

Estimation of tumor invasion depth for PDT procedure with chlorine photosensitizers from two-wavelength probing

Photodynamic therapy (PDT) is a modern treatment technique efficient for many medical applications, in particular, for tumor treatment. Chlorine series photosensitizers (PSs), such as Fotoditazin, have two absorption peaks, corresponding to 405 nm and 660 nm providing an opportunity to employ multispectral excitation of PS during PDT. For correct choice of the treatment protocol knowledge of depth of tumor invasion into the tissue is required. We present analytical and numerical investigations of the possibility to determine tumor depth by multispectral excitation of PS.

16:45

A.A. Mitrakov (*Russia*), R.S. Alieva, V.A. Kryazhov, N.N. Mitrakova, and S.V. Gamayunov

The palliative role of endoscopic PDT in inoperable cancer

The cancer of lungs, stomach, esophagus and larynx takes a leading position among oncological diseases. Photodynamic therapy (PDT) is an alternative method in situations of contraindications to standard treatment. In our study we demonstrate the results of endoscopic PDT as a minimal invasive palliative procedure.

17:00

I.A. Medyanik, M.G. Volovik, A.V. Dydykin, K.S. Yashin (*Russia*), S.N. Bugrov, and N.N. Karyakin

Photodynamic therapy of malignant brain tumors

Photodynamic therapy (PDT) is a promising method for local tumor control in surgery og malignant brain tumors. Nevertheless the thermal effect in PDT is known to have no damaging action and in general oncology this side effect can be paid no particular attention, in neurosurgery even relatively slight increase of brain tissue temperature, especially in eloquent brain areas, can lead to complications. In this study we present the role of the control of the temperature of tumor bed during PDTto prevent significant postoperative brain edema.

16:15

I.V. Larina (*USA*)

Reproduction and development *in vivo* with OCT (*Invited*)

Understanding the dynamic process of reproduction is essential to advance the understanding and improve the management of reproductive disorders. However, the majority of what we know about the dynamics of these events is assumed based on histological analysis of extracted organs and studies in invertebrate animal models. To address this lack of knowledge, we developed a set of OCT-based imaging methods for *in vivo* structural, dynamic and functional visualization of the mouse reproductive tract, cilia function and sperm activity, which previously have not been accessible. These approaches reveal puzzling observations, which might contribute to uncovering the mechanisms of mammalian reproduction.

16:40

A.V. Karmenyan (*Taiwan*), A.S. Krivokharchenko, E.V. Perevedentseva, H.-H. Chang, Ashek-i-Ahmed, L.-C. Liu, and C.-L. Cheng

Noninvasive monitoring of living early mammalian embryo development (*Invited*)

Optical methods are developed for applications in embryologic studies and practical use in artificial reproductive technologies (ART). These methods are nondestructive, low-invasive and informative and allow studying various structural and molecular biochemical processes inside living cells, without interfering in the living processes. Thus, new effective ways can be suggested for monitoring the status of ova with the aim to estimate developmental ability without losing quality for ART and investigation of fundamental mechanisms of early mammalian development. In presented work these methods were used to analyze impact of nanoparticles on ova. The main limiting factors for the laser-based analytical methods are discussed.

17:05

S. Ogasawara (*Japan*)

Precise control of protein expression by light (*Invited*)

A photoresponsive cap that can be reversibly *cis-trans* isomerized by light irradiation was. developed for the reversible photoregulation of translation.The photoresponsive mMe-2PA-cap in the *trans* form silences translation in zebrafish embryo, whereas treatment with the *cis* form provided a 7.1 times larger amount of translated protein compared to the *trans* form. An application of this approach in developmental biology was demonstrated by photo-inducing the development of double-headed zebrafish by controlling the expression period of squint protein.

HALL A

Novel Laser Applications in Biomedicine and Clinical Biophotonics

9:00

H. Lubatschowski (*Germany*)

Frontiers of femtosecond laser applications in ophthalmology (*Invited*)

Ophthalmic femtosecond lasers promote safe surgery and fast healing times because they can process tissue and other materials within a 3-D volume without altering its surface. The success of this platform in refractive and, more recently, cataract surgery is based on two unique characteristics: the nonlinear absorption process and extremely high precision and low side effects, resulting from the low energy level needed for photodisruption. Consequently femtosecond lasers have potentially many more new ophthalmic applications, which are discussed in this presentation**.**

9:25

R. Brinkmann (*Germany*)

Automatic feedback guided retinal laser therapies (*Invited*)

Laser photocoagulation of the retina is a very well establish standard of care for several retinal diseases over more than 40 years to date. However, with new methods and emerging precision of retinal diagnostics a demand for less invasive but as effective therapies arises. Therefore two minimal invasive retinal laser therapies with real-time feedback guidance in order to compensate for the inter and intra-individual variability in light scattering and absorption within the eye will be presented: Selective retina therapy (SRT) aiming to selectively damage the retinal pigment epithelium (RPE), and temperature controlled retinal stimulation and coagulation.

9:50

R. Sroka (*Germany*)

Developments of 2 µm-laser applications for clinical use (*Invited*)

Based on lab-investigation and specified parameters, lasers emitting in the spectral range of 2µm could be translated into different clinical applications for the envisioned clinical usage. Laser emitting at this wave-length range showed a lot of improvements and achievements in clinical routine of a variety of medical disciplines.

10:15

V.P. Minaev (*Russia*)

The possibilities realized in surgery and forced therapy by means of devices based on the fiber and diode lasers (*Invited*)

The characteristics and possible applications in surgery and forced therapy of devices developed with diode and fiber lasers emitting at wavelengths 0.97; 1.06; 1.55; 1.94 and 1.68 µm are presented.

10:40

X. Wang (*USA*), H. Zhang, J. Li, Z. Hu, Y. Paulus, and X. Yang

Antivascular effects induced by photo-mediated ultrasound (*Invited*)

A novel antivascular technology, namely photo-mediated ultrasound therapy (PUT), was developed. By applying synchronized laser and ultrasound pulses simultaneously, PUT can treat microvessels in biological samples with excellent precision and controllability. Taking advantage of the high optical absorption of hemoglobin, PUT can selectively target microvessels without causing unwanted damages to surrounding tissue. PUT working at different optical wavelengths can selectively treat veins or arteries by utilizing the optical contrast between deoxy- and oxy-hemoglobin. Through the experiments on phantoms, chicken embryos, and rabbit eyes *in vivo*, the mechanism of PUT was studied, and its potential application in ophthalmology clinic was explored.

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"Development of new technologies of optical coherence tomography for problems of individual cancer therapy"

Leading scientist – Alex Vitkin

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as well as by a number of Russian and foreign companies producing optical and medical equipment

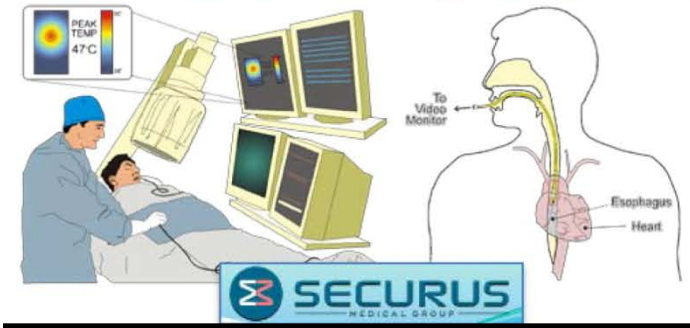
broad spectra fiber solutions

art photonics

art photonics GmbH is the world's leading manufacturer and supplier of InfraRed chalcogenide and polycrystalline specialty optical fibers, spectroscopy fiber probes & fiber bundles, high power fiber cables for industrial and medical applications. The Company's goals to engineering, designing and manufacturing the highest quality, cost-effective optical fiber solutions of a broad spectral range (from 200nm to 18µm) for OEM market are met through developing a patented Polycrystalline IR-fiber technologies, which allows to design and produce the one of most competitive product line **FlexiSpec®** – PIR-fiber spectroscopy probes for remote process-control of molecular composition of any liquid, gas or solid mixtures even under harsh environmental conditions. The **line FlexiRay®** includes high power laser cables, IR-fiber coupled detectors, IR-imaging bundles and various fiber sub-systems provides the optimum solution for specific customer requirements.

High Power Cables based on Silica & PIR-fibers provide flexible delivery for laser radiation in a broad spectrum for various lasers – from Excimer & other UV-lasers up to different Diode and solid state Ho- & Er:YAG , and even for CO- & CO_2-gas lasers. Design of High Power connectors enables long life of robust HP-cables, including the special SMART-treatment of PIR-fiber ends required for good suppression of too high Fresnel reflection during laser power delivery.

Thermographic Imaging System for Esophageal IR-Thermography



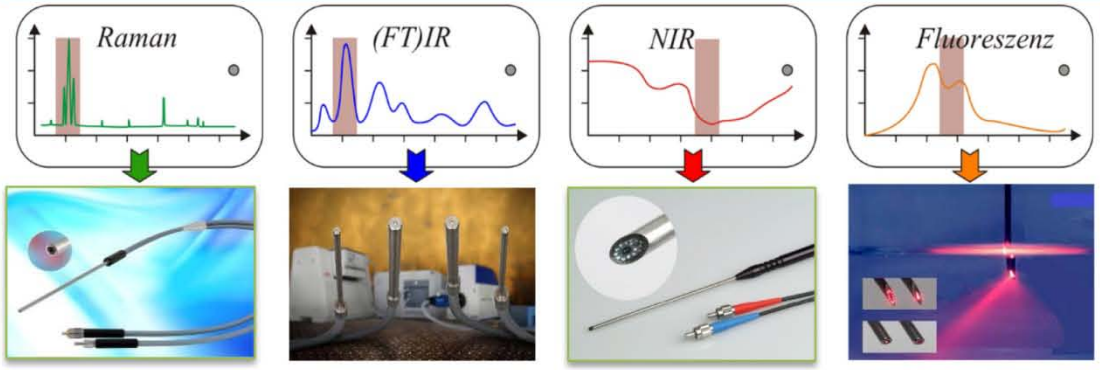
Real time monitoring of the high-resolution thermal image on internal Esophagus wall to prevent heart tissue overheating during the radiofrequency ablation of atrial fibrillation

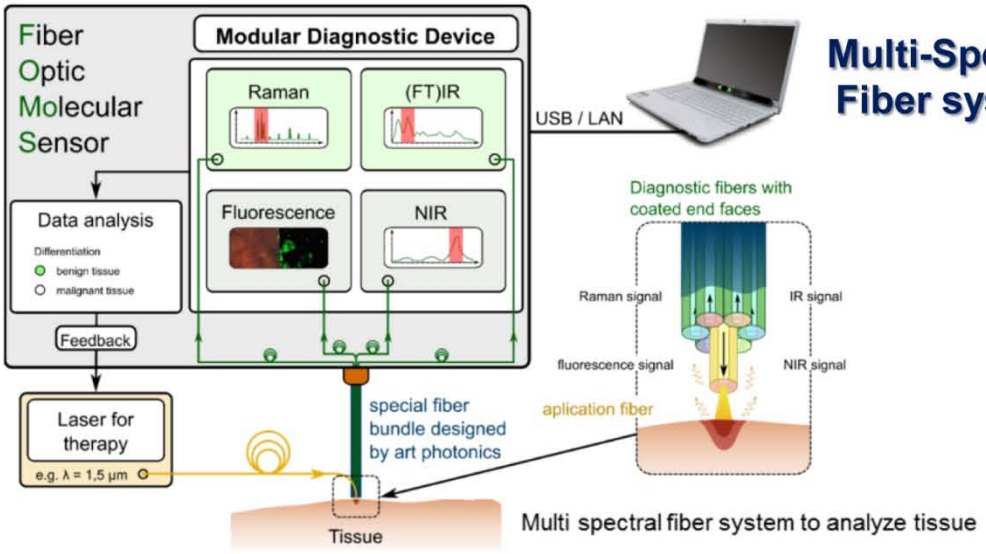
TEC-cooled MCT system coupled with disposable flexible probe of 9 Fr (3mm) based on PIR-fiber and scanning mirror

broad spectra fiber solutions

art photonics

Spectral fiber methods enables to secure minimal invasive, but complete cancer removal due to the more precise tumor margins definition - using fluorescence or molecular spectroscopy: Raman scattering, IR-absorption or diffuse NIR-reflection. Multi-Spectral Fiber systems help to select the most sensitive, specific and accurate methods for any tumor of selected organ and to develop special fiber sensor for it.

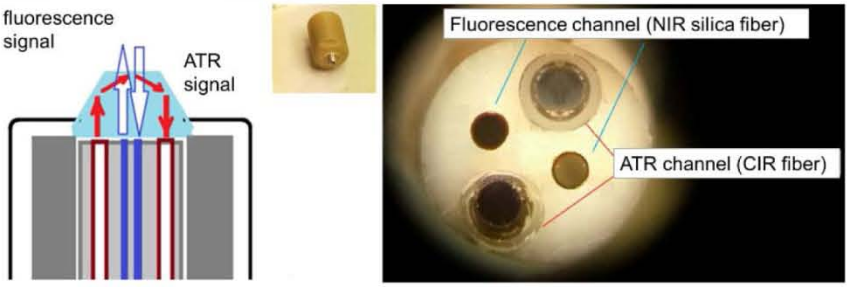




Multi-Spectral Fiber system

Multi spectral fiber system to analyze tissue

Combined ATR-MIR and fluorescence probe: optical scheme (links), ZrO_2 ATR head (middle) and fiber bundle front surface photo (right)



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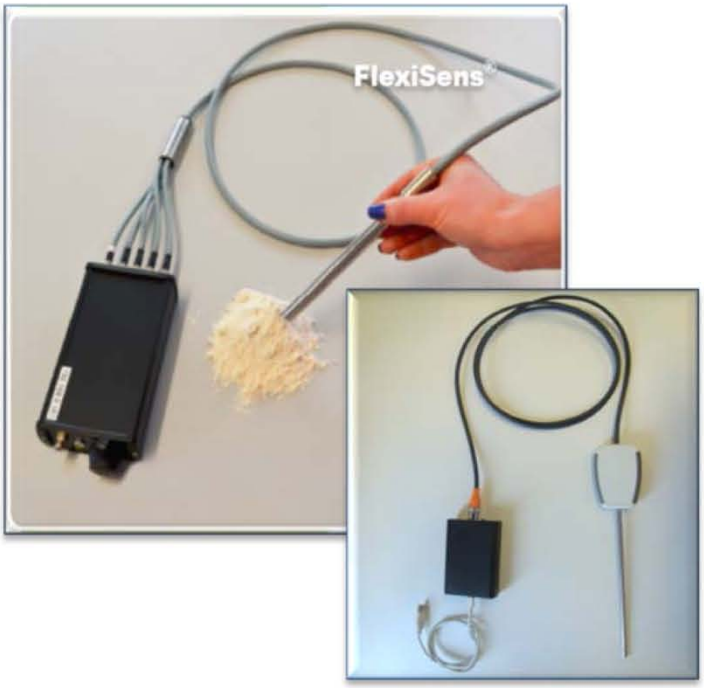
broad spectra fiber solutions

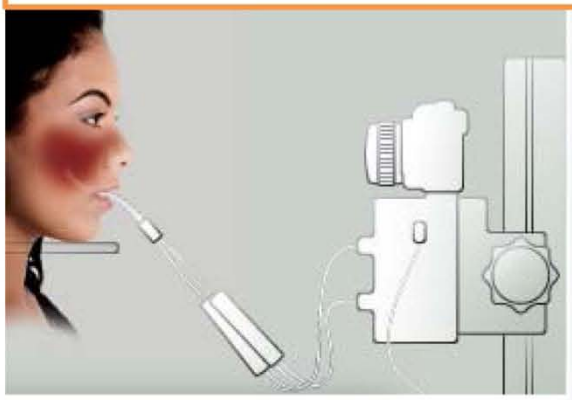
art photonics

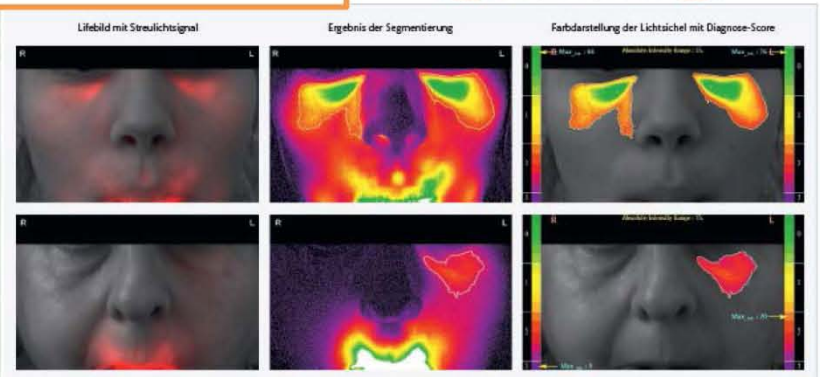


Innovative Spectral Fiber Moisture Sensor (MoiSens) is the 1st prototype of FlexiSens® family - based on rapid scan of specific LED wavelengths used to illuminate media with fiber probe and collect diffused reflection or transmission signal with it. Each LED-sensor is made with IP-address - to collect the data in iCloud and to run selected process optimization in real time.
LED-platform of Spectral Fiber sensors enables to vary LED-set to match them to a various spectral applications, including tumor edges detection in medical diagnostics

Digital Diaphanoscopy

- ✓ Portable, optical diagnostic tool with simple set-up
- ✓ Low production costs of applicator
- ✓ No shielding of the examination room needed
- ✓ Fills the gap between CT & ultrasound diagnostics
- ✓ Training of the medical staff is minimal
- ✓ Automatic diagnosis scoring proposal
- ✓ Useful for follow-up examinations
- ✓ No radiation exposure, non-invasive.



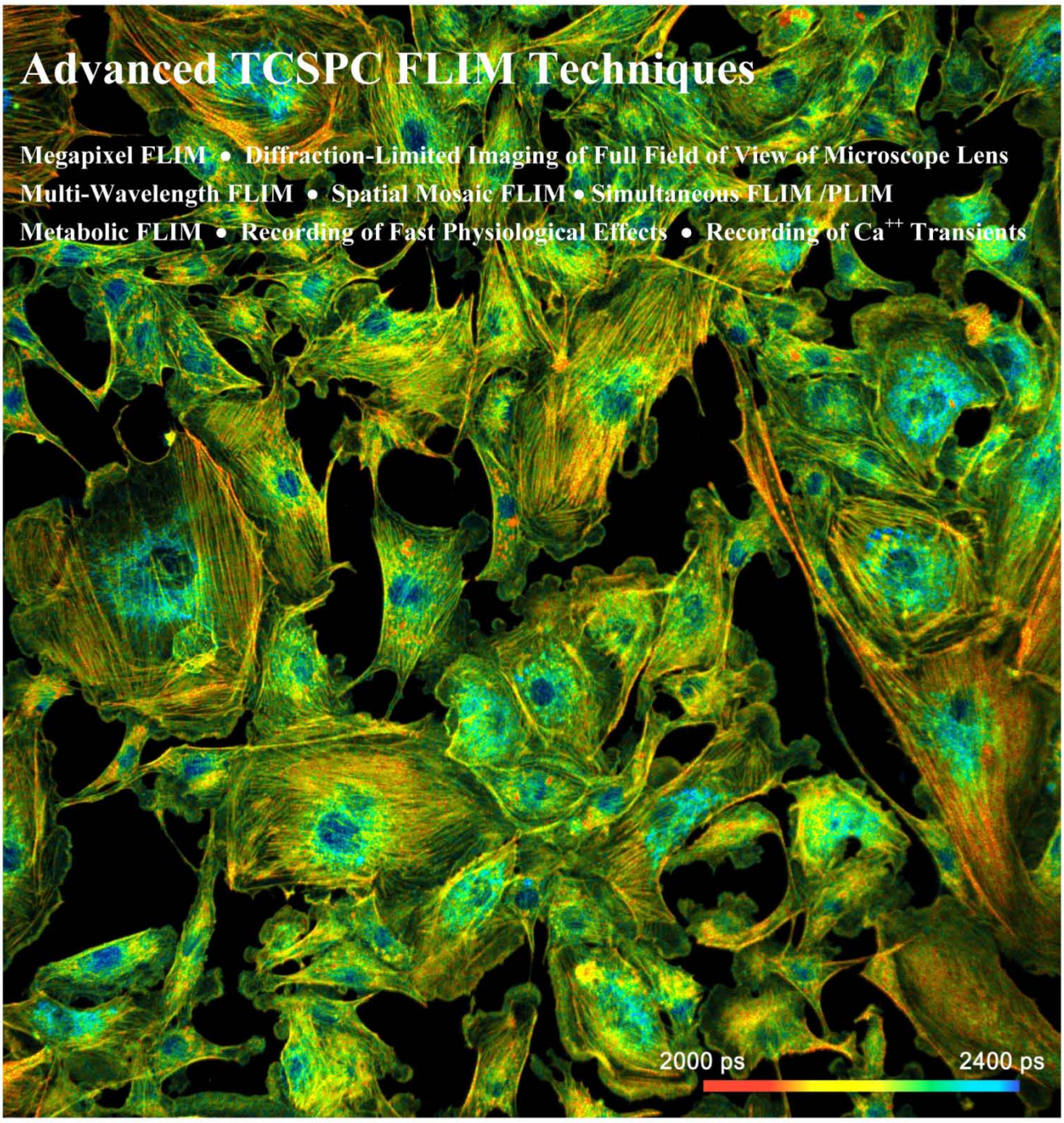


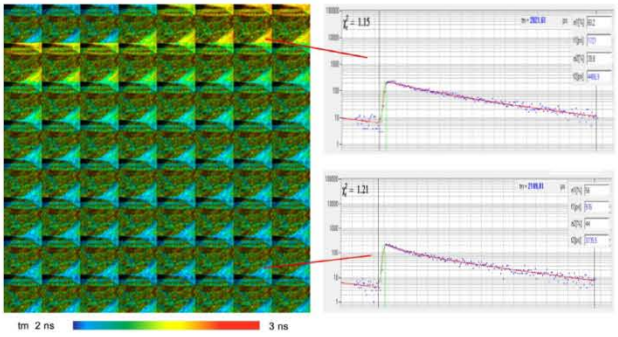
Oben: Gesunder Proband. Unten: Patient mit beidseitiger Sinusitis und Empyem des rechten Sinus maxillaris.

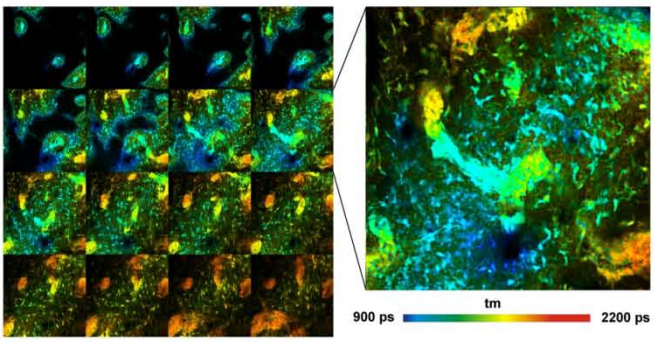
Becker & Hickl GmbH

Advanced TCSPC FLIM Techniques

Megapixel FLIM • Diffraction-Limited Imaging of Full Field of View of Microscope Lens
Multi-Wavelength FLIM • Spatial Mosaic FLIM • Simultaneous FLIM /PLIM
Metabolic FLIM • Recording of Fast Physiological Effects • Recording of Ca^{++} Transients







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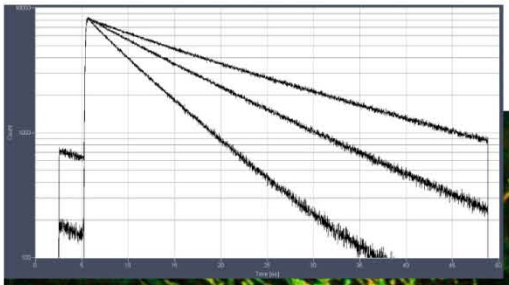
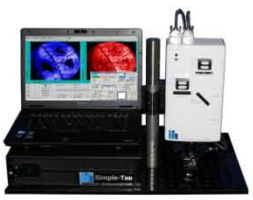


TCSPC Systems Detectors FLIM Systems Laser Scanning Systems ps Diode Lasers



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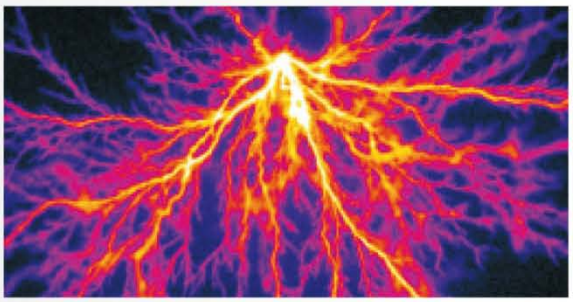

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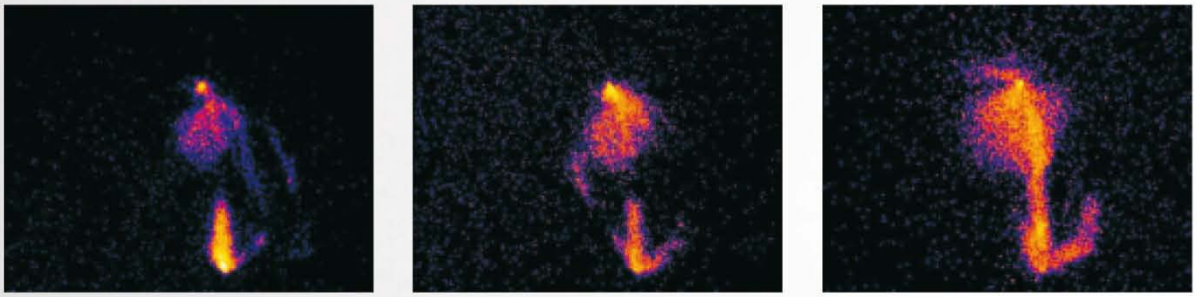

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4 Picos

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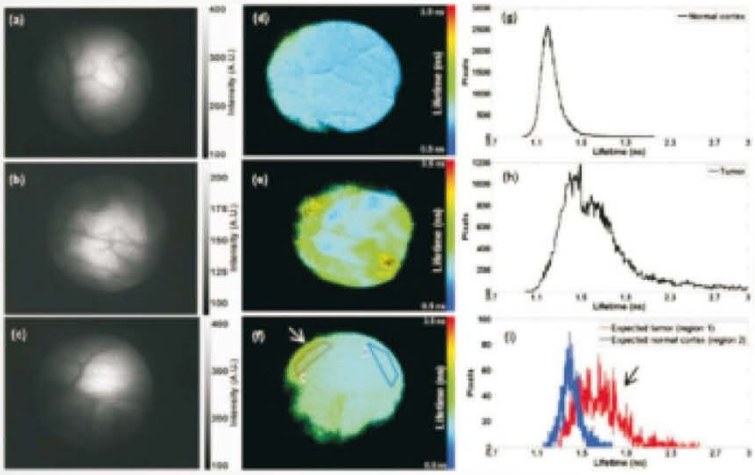

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EXTREME RANGE EXTENSION OF VISUAL SIGHT HAMPERED BY TURBID MEDIA

P. Hoess

Paul Hoess KG, Munich, Germany, phoess@stanfordcomputeroptics.com
Stanford Computer Optics, Inc., Berkely, CA-USA

Abstract. Range limitations in strongly scattering media are apparent. The visibility can be limited to even less than a few centimeters. Compact pulsed lasers open gated viewing to civil applications. These systems are able to take images with short (200 ps) gate times and delay steps down to 10 ps, highly reducing interference of scattered light and getting accuracy down to sub-mm-region. A visibility simulation is based on a 10 µJ laser for illumination and a 1.2 ns gated camera. The image was obtained through an opal glass diffuser causing scattering equivalent to over 2000 m thick sea water.

Summary

Driving a car through dense fog, searching for victims in smoke filled rooms or scanning the ocean floor for sunken objects as RMS Titanic or the body of MH370 are all bound through well known limits of hampered visibility.

Since the invention of the laser there are proposals for gated (active) imaging, but mainly for military applications.

The primary purpose of our work was the proof that the otherwise invisible bottom of CO2 cooling tubes for spent nuclear fuel elements in a power plant, filled with a dusty atmosphere, will get visible and the exact depth of a potential dust layer can be determined.

We use a simulation setup as a replacement of real water or dusty air. It shall demonstrate the capabilities of gated imaging systems to get images through extremely high scattering media.

A milky ground glass plate is used as a diffuser. The laser beam is spread out to a spot of 1 m (FWHM) diameter in a distance of 11 m.The glass plate being in the optical path twice results in a reduction of the signal by a factor of around $5 \cdot 10^{6}$. The laser with a pulse length of 800 ps is set for a total illumination energy of 200 mJ for one recording.

The gate of the intensified CCD camera (4 Quik E) is triggered by the laser. From the time of receiving the trigger signal the camera needs around 70 ns before it turns the photocathode on. The first reflecting surface is 11 m from the laser, the roundtrip time to the camera right at the same place is roughly 73 ns. Minimum gate time is 1.2 ns, any multiple of 100 ps can be added. The delay can be programmed with a minimum of 100 ps steps.

The signal attenuation is linked to the distance in turbid media by the law of Lambert-Beer:

The extinction coefficient e in pure destilled water ranges from a minimum of 0.00442 m^{-1} at 417.5 nm up to 1.678 m^{-1} at 727.5 nm, being higher in muddy water. The water depths corresponding to our measured $5 \cdot 10^{-6}$ attenuation are 1750 m in the case of working with a fiber laser in the deep blue range. In the red regime this same intensity decrement would be reached at a water depth of only 4.5 m.

There is only a very weak wavelength dependency of scattering in air. Corresponding extinction coefficient numbers for smoke are 0.25 m^{-1} in the case of light and up to 4 m^{-1} in very dense smoke.

The range of values for e in air is much wider than what is observable in clear water. First noticable reductions of the visual range occur at a sighting distance of 10 km with an extinction coefficient of 4×10^{-4}, this being considered slightly hazy. It ranges up to a highest documented maximum of 13 m^{-1}, observed at the Great Smog in London in 1952. The resulting visibility was then only one foot.

Under such extreme foggy conditions a laser with a separated head at an optical fiber could still improve the sight range. With a detached output collimator that is connected through a few meters of fiber optic extension, the light source can be placed closer to the object.

Although the laser power used for the experiment presented in this paper was only 100 mW, a maximum visible range above 1000 m could be demonstrated. With multi-kW lasers and increased summation times a depth range of 5000 to 6000 m can be reached. An ocean floor telescope with an array of lasers in the high kW power range can be synchronized through individual lengths of the output fibers and therefore compensate for time of flight differences in between the center and the corners of the field of view.In such way the search for sunken objects from the ocean surface is in reach as a potential option.

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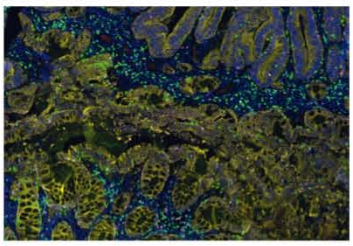

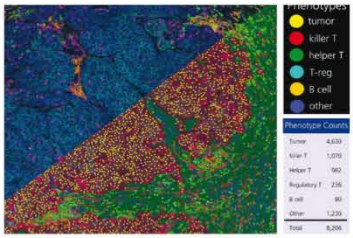

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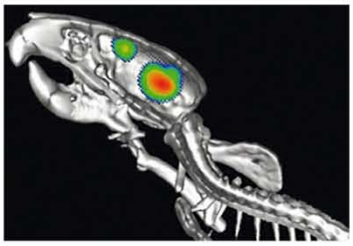

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High-Performance Delay Line Stages

DL SERIES

- Excellent delay sensitivity and bi-directional repeatability
- Low angular deviation where it counts (pitch)
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- Small footprint
- No moving cable
- Easy to use (Delay line GUI, LabVIEW drivers)

The DL linear stage series is a high performance but very affordable, linear motor driven stage with an integrated motion controller. Optimized for small loads, repeatable positioning and fast traverse speeds, it is an ideal solution for spectroscopy applications that require delay lines. With travels of 125 mm, 225 mm and 325 mm, this offering covers almost all possible delay needs from femtosecond to nanosecond delays. Spectroscopy applications range from pump-probe, interferometry, 2DIR, etc. To facilitate setups, beam kits consisting of retroreflectors, mirrors, mounts and other optomechanical parts, are available to suit various wavelengths and delay line configurations.

DESIGN DETAILS

Base Material	Extruded Aluminum
Bearings	Recirculating bearings
Drive System	3-phase synchronous ironless linear motor (without Hall effect sensors)
Motor Initialization	Done by the controller.
Motor Commutation	Done by the controller on encoder feedback
Feedback	Linear glass scale, 80 µm signal period, 1 V_{PP}
Limit	Optical
Home Switch	Optical, on encoder's fiducial track, located at the minus end of travel
Controller Compatibility	DL Controller
Cable	3 m long pigtail cables included
MTBF	20,000 hours

SPECIFICATIONS

		DL125	DL225	DL325
Travel Range (Single Pass)	(mm)	125	225	325
	(ns)	0.8	1.5	2.2
Minimum Incremental Motion	(nm)	75	75	75
(Single Pass)	(fs)	0.5	0.5	0.5
Bi-directional Repeatability, Guaranteed [1]	(µm)	±0.15	±0.15	±0.15
Accuracy, Guaranteed [1] [2]	(µm)	±1.5	±2	±2.5
Encoder Resolution (nm)		50	50	50
Origin Repitability (µm)		0.4	0.4	0.4
Maximum Speed [3]	(mm/s)	500	500	500
Maximum Acceleration, No Load	(m/s^2)	7500	7500	7500
Pitch, Typical (Guaranteed) [1] [2] [4]	(µrad)	±60 (±100)	±60 (±100)	±90 (±150)
Yaw, Typical (Guaranteed) [1] [2] [4]	(µrad)	±30 (±60)	±40 (±90)	±50 (±120)

[1] Shown are peak to peak, guaranteed specifications or ±half the value as sometimes shown. For the definition of typical specifications which are about 2X better than the guaranteed values, visit www.newport.com for the Motion Control Metrology Primer.
[2] For a travel of 325 mm.
[3] With DL controller.
[4] To obtain arcsec units, divide µrad value by 4.8.

			Single Pass	Dual Pass	Quad Pass
Delay	DL125	(ns)	0.8	1.7	3.3
	DL225	(ns)	1.5	3.0	6.0
	DL325	(ns)	2.2	4.3	8.7
MIM		(fs)	0.5	1.0	2.0

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The InSight X3 Advantage

- *Field proven with largest installed base*
- *Broadest tuning range: 680 nm to 1300 nm for deepest imaging*
- *High power across tuning range: >2 W at 900 nm, >1.4 W at 1200 nm*
- *Dual output at 1045 nm with optional pre-compensation for two-color imaging*
- *Short pulse width and highest peak power for maximum fluorescence*
- *Integrated DeepSee to deliver short pulses to the sample*
- *Ideal beam characteristics optimized for multiphoton imaging*

The new InSight® X3™ is the third generation of Spectra-Physics' industry leading InSight platform, specifically designed for advanced multiphoton microscopy applications.

Based on patented technology[1], InSight X3 features a broad 680 nm to 1300 nm continuous, gap free tuning from a single source, nearly double the tuning range of legacy Ti:Sapphire ultrafast lasers. InSight X3 delivers high average and peak power levels across the tuning range, including critical near infrared wavelengths above 900 nm for deepest penetration in-vivo.

With Spectra-Physics' integrated patented DeepSee™, the industry standard dispersion pre-compensator, the short pulses are optimally delivered through a microscope to the sample for maximum fluorescence and penetration depth. InSight X3 also has exceptional beam pointing stability, beam quality and output power stability, as well as fast wavelength tuning, making it ideal for microscopy.

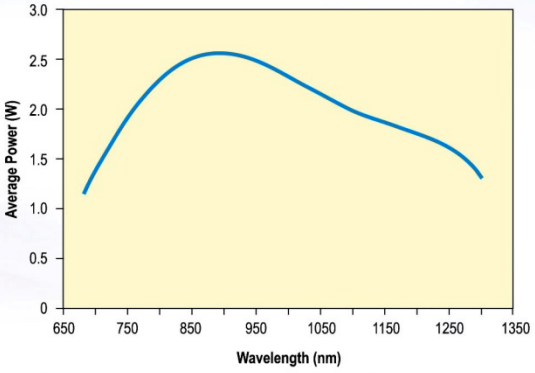
When equipped with the fixed 1045 nm dual beam option, InSight X3 fully supports the diverse needs of multimodal imaging. The two synchronized output beams enable easy simultaneous imaging of various fluorescence proteins (for example GFP and mCherry) and genetically encoded calcium indicators (GCaMP6 and jRGECO1a), SHG/THG imaging, and advanced imaging techniques such as CARS and SRS.

InSight X3 is designed, manufactured and tested according to the same stringent quality standards as for our industrial lasers used in 24/7 manufacturing environments. Robust and fully automated, InSight X3 provides hands-off operation, freeing users to focus on their critical research.

Applications

- *Multiphoton microscopy*
- *Multimodal imaging including CARS, SRS, SHG, THG*
- *Optogenetics*
- *Time-resolved photoluminescence*
- *Non-linear spectroscopy*
- *Optical computed tomography*
- *Surface second harmonic generation*
- *Terahertz imaging*
- *Semiconductor metrology*

Typical Tuning Curve*



* Typically measured performance; not a guaranteed or warranted specification.

Spectra-Physics®

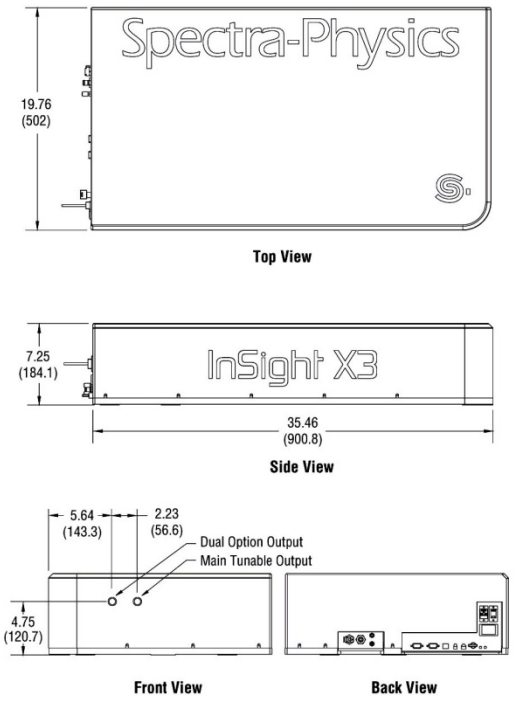
1. The InSight X3 technology is protected by US patents 7,962,04 6 and 8,902,939.

InSight® X3™

Specifications[1, 8]

Output Characteristics	InSight X3	Dual Option
Tuning Range	680 nm–1300 nm	1045 nm (fixed)
Average Power[2]	>1.0 W at 700 nm >1.6 W at 800 nm >2.0 W at 900 nm >1.8 W at 1000 nm >1.6 W at 1100 nm >1.4 W at 1200 nm >1.0 W at 1300 nm	>2.0 W at 1045 nm
Pulse Width[3, 6]	<120 fs	<200 fs
Repetition Rate	80 MHz ±0.5 MHz	
Noise[3, 4]	<0.5%	
Stability[5]	<±1%	
Spatial Mode	TEM_{00}, M^2 <1.2	
Polarization[3]	>500:1 horizontal	
Beam Divergence, full angle[3]	<1.5 mrad	
Beam Diameter ($1/e^2$)[3]	1.1 ±0.2 mm	
Beam Roundness[3]	0.8–1.2	
Beam Pointing Stability	<350 µrad full range	
Tuning Speed	>50 nm/sec full range	
Pre-compensation Dispersion Range[2]	680 nm: -12,000 fs^2 to -40,000 fs^2 800 nm: 0 fs^2 to -25,000 fs^2 1050 nm: 0 fs^2 to -10,000 fs^2 1300 nm: -3,000 fs^2 to -8,000 fs^2	Optional 1045 nm: – 15,000 fs^2 fixed
Environmental Requirements		
Altitude	Up to 2000 m	
Temperature, Operating	20–25°C	
Relative Humidity, Operating	Maximum 75% non-condensing up to 25°C	
Temperature, Storage	15–35°C	
Relative Humidity, Storage	<65% for 15–35°C	
Cooled Water Temperature in Closed-loop Chiller	21°C typical[7]	

InSight X3 Dimensions



Dimensions in inch (mm)

1. Due to our continuous improvement program, specifications may change without notice.
2. Specifications only apply to the wavelength noted.
3. Specification applies only to 900 nm (tunable) or 1045 nm (fixed), respectively.
4. Specification represents rms noise measured in a 10 Hz to 10 MHz bandwidth.
5. Percent power drift in any 2-hour period with less than ±1°C temperature change after a 1-hour warm up.
6. A $sech^2$ pulse shape is used to determine the pulse width as measured with a Newport PulseScout® autocorrelator.
7. Avoid obstructing the air exhaust grills which will result in the recirculation of hot exhaust air. Cooling air enters through the front panel and exits through the rear fan apertures.
8. InSight X3 is a Class IV – High-Power Laser, whose beam is, by definition, a safety and fire hazard. Take precautions to prevent exposure to direct and reflected beams. Diffuse as well as specular reflections can cause severe skin or eye damage.

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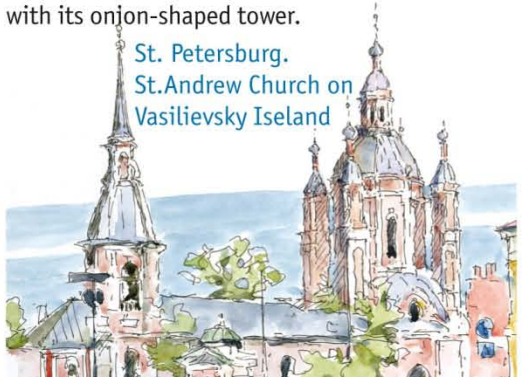
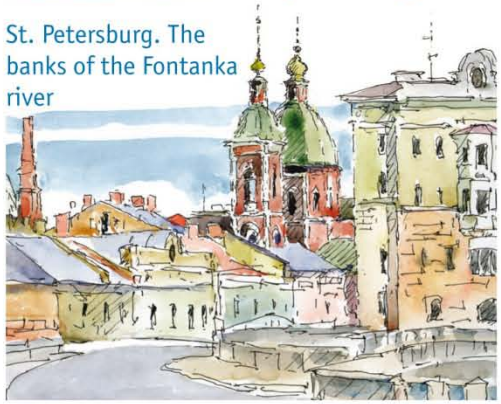
ST. PETERSBURG was founded in 1703 by Peter the Great. The majestic appearance of St. Petersburg is created by a variety of architectural details including long, straight boulevards, vast spaces, gardens and parks, decorative wrought-iron fences and sculptures. The Neva River itself, together with its many canals and their granite embankments and bridges, gives the city a unique and striking ambience.

The most famous of St. Petersburg's museums are *the Hermitage* and *the Russian Museum*. St. Petersburg has been known as the city of palaces. One of the earliest of these is the Summer Palace, a modest house built for Peter I in *the Summer Garden* (1710–1714). Much more imposing are the baroque residences of their associates, such as *the Kikin Hall* and *the Menshikov Palace* on the Neva Embankment designed by *Domenico Trezini* in 1710–1716. The most illustrious of imperial palaces is the baroque *Winter Palace* (1754–1762), a huge building with dazzlingly luxurious interiors, now housing *the Hermitage Museum*.

The largest church in the city is *St Isaac's Cathedral* (1818–1858), one of the biggest domed buildings in the world, constructed under supervision of *Auguste de Montferrand*. Another magnificent church in the Empire style is *the Kazan Cathedral* (1801–1811), situated in the Nevsky prospect. No tourist can miss *the Church of the Savior on Blood* (1883–1907), a gorgeous monument in the old Russian style which marks the spot of *Alexander II's* assassination. As *Peter the Great* forbade building onion domes, this church is exceptional in the city with its onion-shaped tower.



St. Petersburg. St.Andrew Church on Vasilievsky Iseland



St. Petersburg. The banks of the Fontanka river

St. Petersburg. Lutheran's St. Anna Church

NIZHNY NOVGOROD was founded in 1221. The dominating feature of the city skyline is the grand *Kremlin* (1500-11), with its red-brick towers. The only ancient building left within the Kremlin walls is the hip-roofed *Cathedral of Michael Archangel* (1624-31).

A building of great beauty is *the Nativity Church* (1719) built by *the Stroganov family* in the nascent baroque style. In 1817, *the Makariev fair*, one of the busiest in the world in its time, was transferred to Nizhny Novgorod, which thereupon started to attract millions of visitors annually. By the mid-19th century, the city on the Volga was firmly established as the trade capital of the Russian Empire. The huge complex of warehouses and canals built specially for the Fair was destroyed almost completely after the 1917 Revolution. Only the *Main Fair House* and *the Fair Cathedral* survived the demolition.

Dismal life of the Nizhny Novgorod proletariat was described realistically in the novels of *Maxim Gorky*. Even during his lifetime, the city was renamed Gorky following his return to the USSR in 1932 and was known as such until 1991. All that time the city was closed to foreigners for security of the Soviet military research.

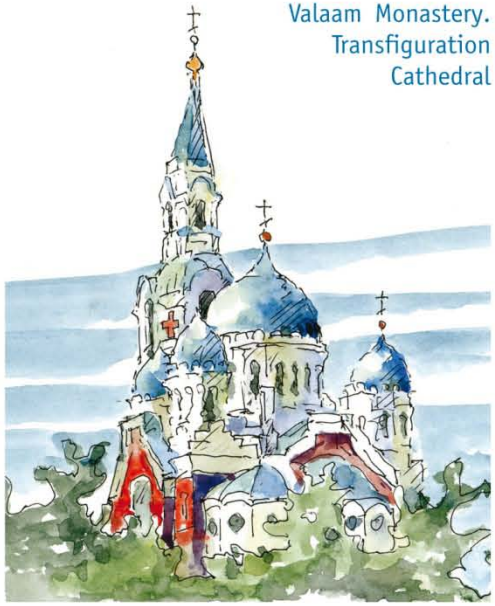
The famous physicist *Andrei Sakharov* was exiled here to live in banishment until 1986 to limit his contacts. The name of the mathematician *Nicolay Lobachevsky* is connected with Nizhny Novgorod and Nizhny Novgorod University. In 1918-1928 *Nizhny Novgorod Radio laboratory* headed by *Mikhail Bonch-Bruevich* became the cradle of the national radio engineering and electronics. In 1945 the efforts of scientists *Alexander Andronov, Maria Grekhova, Gabriel Gorelik* and *Vitaly Ginzburg* resulted in creation of the *Nizhny Novgorod school of radiophysics* , which was later headed by Academician *Andrey Gaponov-Grekhov*.

Now Nizhny Novgorod is one of the largest scientific, industrial, and cultural centres with population of about million citizens. The city industries include aircraft, automobile, and ship building, as well as biochemestry and electronics.

View on the Volga river in Nizhny Novgorod

Nizhny Novgorod. Rozhdestvenskaya St.

Valaam Monastery. Transfiguration Cathedral



VALAAM ARCHIPELAGO is staggeringly beautiful due to the fantastic maze of its coves, lakes, and rocks. The ancient *Valaam Monastery* is situated here; it was first mentioned in chronicles in the 10th century.

The Monastery was completely self-sufficient and monks produced all the necessary products themselves while working at small factories, saw-mills and farms, constructing buildings. At the beginning of the 20th century the Valaam Monastery became one of the wealthiest Russian Monasteries, comprising a kind of a small state with 13 smaller monasteries under control.

During the Second World War the Archipelago was under control of Finland and returned back to the USSR in 1944. Since that time the Monastery was closed until 1989. Now it is functioning again. The monastery, hermits' huts, and chapels built in the Russian-Byzantine style are architectural masterpieces.

The ensemble created by these buildings matching the stern nature of the islands, by the monastery gardens and alleys is inimitably beautiful.

VYTEGRA. Located at the crossing of a waterway connecting central Russia with Lake Onega and a road connecting St. Petersburg with Arkhangelsk, Vytegra was once an important transit point for cargo. The idea to build a canal connecting the drainage basins of the Neva and the Volga River was already discussed by *Peter the Great*, but the canal, formerly the *Mariinsky System*, was only built in 1810.

In the 20th century, it was reconstructed and renamed *the Volga–Baltic Waterway*. The remains of *the Mariinsky System*, a few dwelling houses of the 19th century, *the Presentation Church* and *B440 Foxtrot-class submarine* are the main sites of interest in Vytegra.

Vytegra. Presentation Church

GORITSY. This picturesque village near Beloozero was set in the center of one of the largest accumulations of monasteries in Russia. The Ferapontov convent situated not far from Goritsy is one of the examples of Russian medieval art. All its interior walls are covered with frescoes by the great painter Dionisius that have survived since 1490.

Goritsy Nunnery founded in 1554 was turned by Ivan the Terrible into his own personal harem for wives and abducted Russian beauties.

Vytegra. Submarine-museum

Goritsy. Churches

But the best known is Kirillo-Belozersky monastery in the nearby town of Kirillov on Lake Siverskoye not far from Goritsy.

The monastery was founded by monk Kirill Belozersky at the end of the 14th century. The icons in the Assumption Cathedral date back to the 15th century, and the murals in the cathedral telling the story of Virgin Mary's life, to the 17th century. The Apocalypse murals in the porch that were painted at the same time are not less interesting.

The magnificent ensemble of the monastery comprises the Churches of Baptism of Our Saviour, of John the Baptist, and of the Archangel, farmeries, fortress walls with high bartizans and two over-the-gate churches.

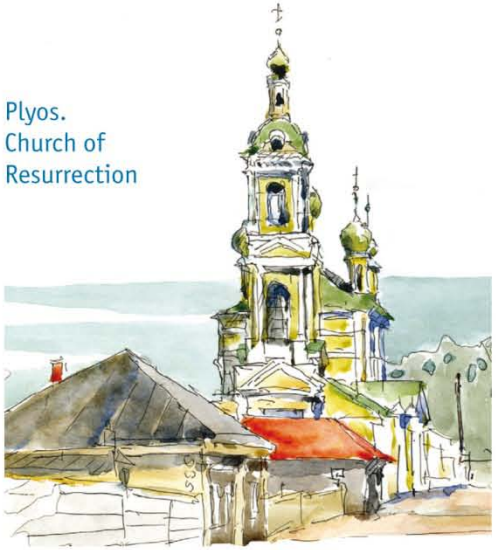
The local museum has collections of manuscripts, ancient utensils, samples of wooden carving and traditional embroideries.

Kirillo-Belozersky Monastery

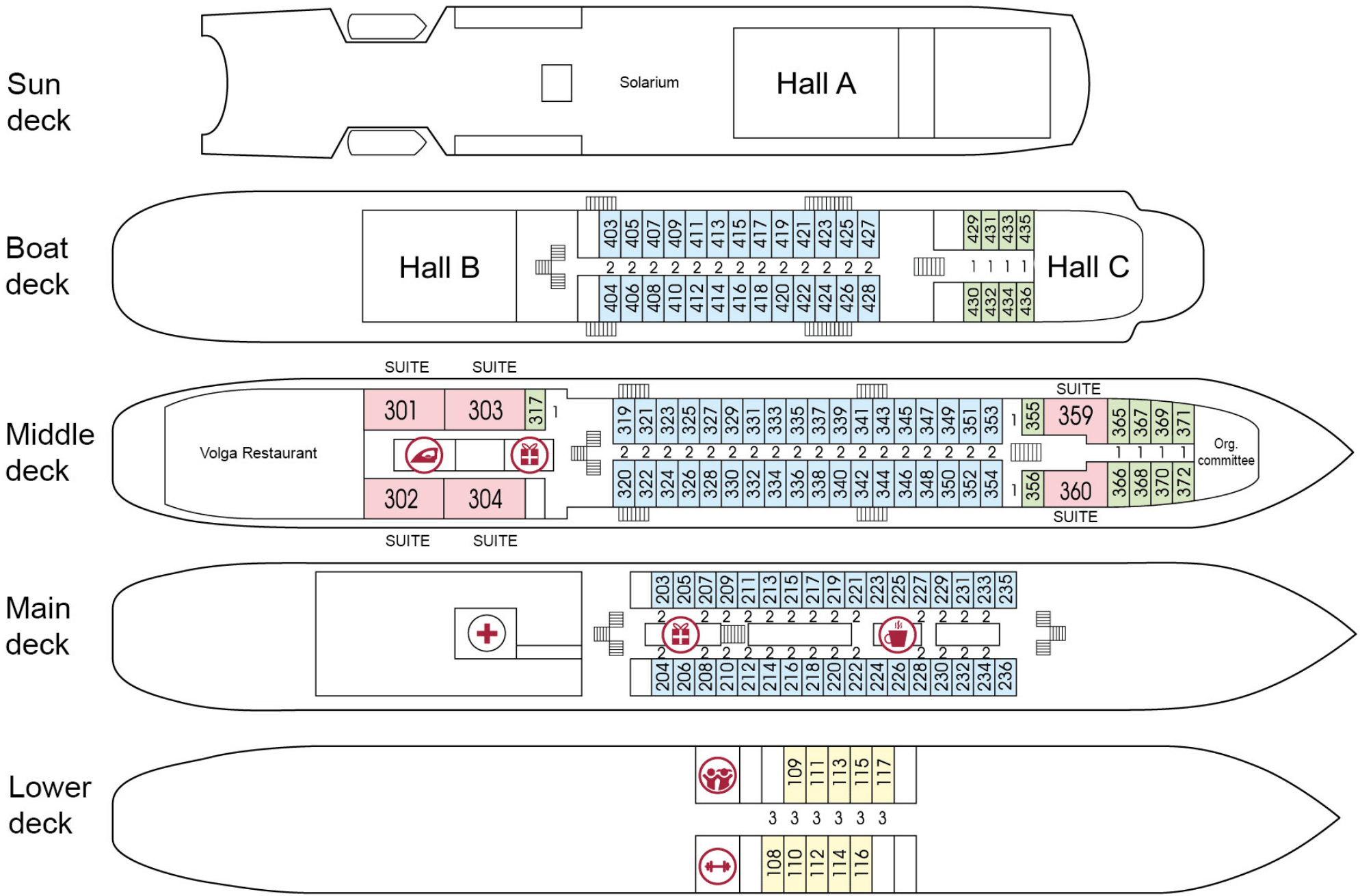
Lock-gate near Rybinsk

PLYOS, the admirable Pearl of the Volga, preserves the memory of the Russian painter Isaac Levitan. This town is about six hundred years old. For a long time it served as a citadel beating off enemy attacks. Later it became a trading center. *The Church of Resurrection, Church of St. Barbara, Church of Transfiguration, the Trinity Cathedral*, the shopping arcade, fire station and numerous mansions in Plyos date back to the middle of the 19th century.

Plyos. Church of Resurrection



The town is situated in a very nice place, the view from the hill top overlooking the town is one of the most beautiful sites on the Volga river.


Sun deck
Solarium
Hall A
Boat deck
Hall B
Hall C
403 405 407 409 411 413 415 417 419 421 423 425 427
404 406 408 410 412 414 416 418 420 422 424 426 428
429 431 433 435
430 432 434 436
Middle deck
SUITE SUITE
Volga Restaurant
301 303 317
302 304
SUITE SUITE
319 321 323 325 327 329 331 333 335 337 339 341 343 345 347 349 351 353
320 322 324 326 328 330 332 334 336 338 340 342 344 346 348 350 352 354
355 359 365 367 369 371
356 360 366 368 370 372
SUITE SUITE
Org. committee
Main deck
203 205 207 209 211 213 215 217 219 221 223 225 227 229 231 233 235
204 206 208 210 212 214 216 218 220 222 224 226 228 230 232 234 236
Lower deck
109 111 113 115 117
108 110 112 114 116