Integrated butt-coupled membrane laser for Indium Phosphide on Silicon platform

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17th International Conference
“Laser Optics 2016”
Technical Program

Saint Petersburg, Russia
June 27 - July 1, 2016
On July 11, 2016, will be the 100th anniversary of the birth of Alexander Mikhailovich Prokhorov. Professor Prokhorov (1916-2002) was one of the founders of laser sciences, a Nobel prize winner, and for many years an Honorary Chair of the Laser Optics Conference. We dedicate the conference to his memory.
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JUNE 27 - JULY 1, ST. PETERSBURG, RUSSIA
THE 17TH INTERNATIONAL CONFERENCE «LASER OPTICS 2016»
IS TECHNICALLY CO-SPONSORED BY
IEEE Photonics Society
AND HOSTED BY:
Fund for Laser Physics
IPG Photonics Corporation
ITMO University
Russian Foundation for Basic Research
PhOOLIOS
Institute PhOOLIOS RC «Vavilov SOI»
The Union of Industrialists and Entrepreneurs (Employers) of St. Petersburg
We wish to thank the following for their contribution to the success of this conference:

- The Ministry of Education and Science of Russian Federation
- St. Petersburg Government
- NTO IRE-Polus
- Rozhdestvensky Optical Society
- «Photonika» Magazine
- «RITM» Magazine
- Laser Association
- GPI
- Prokhorov General Physics Institute of RAS
- Holiday Inn
- Moskovskiye Vorota

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V.Yu. Venediktov, SPbGETU “LETI”, Russia

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A.P. Zhevlakov, ITMO Univ., Russia

NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS
Yu.S. Kivshar, Australian National Univ., Australia; ITMO Univ., Russia
N.N. Rosanov, Vavilov State Optical Inst., Russia
D.V. Skryabin, Univ. of Bath, UK
S.K. Turitsyn, Aston Univ., UK

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«LASER OPTICS 2016»
TOPICS FOR LO`2016

R1. SOLID-STATE LASERS
DPSSL • Ultrafast • Mid-IR • CW and pulsed • Compact sources • Emerging applications • Guided wave lasers • Fiber lasers (excluding high power) • Tunable lasers • Parametric amplifiers

R2. HIGH POWER LASERS
Advances in high-power gas and solid-state lasers • Fundamental issues in high-power laser science • High power laser architectures • Terawatt lasers, including fusion lasers • Novel optical materials for high power applications and systems • Thermal and thermo-optical effects in lasers and their mitigation • CO₂/CO lasers • Iodine lasers • Slab gas lasers • Chemical lasers • Excimer lasers • Extreme-UV light sources • Alkali vapor lasers

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS
Quantum-well, wire, dash and dot lasers and devices • MID-IR and Quantum Cascade lasers • Ultrashort pulse lasers • VCSELs, VECSELs and superlattice structures • UV and Visible diode lasers and LEDs • Compact THz sources and applications • Silicon photonics • Optical coherent tomography • Multiphoton imaging • Novel semiconductor-based devices and emerging applications

R4. LASER BEAM CONTROL
Wavefront correction • Adaptive optics • Phase conjugation • Dynamic holography • Laser cavities • Stabilization and control of laser beam direction • Laser imaging • Coherent and non-coherent summation of laser beams • Singular laser optics • Optical limiting • Optical and laser elements based on nanostructured materials • Optics and electrooptics of liquid crystals

R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES
Generation of high-power, super short pulses • Problems of «Fast Ignition» for the ICF • Laser plasma X-ray sources • Fast particle generation and acceleration by laser pulses • Femtosecond laser technology and applications • Physics of ultrafast phenomena • Ultrafast devices and measurements

R6. LASERS FOR SATELLITE RANGING SYSTEMS, SPACE GEODESY, AND GLOBAL NAVIGATION
Advanced picosecond lasers for satellite laser ranging • High power solid-state lasers for space junk monitoring • Atmospheric effects on laser ranging • Laser ranging retroreflector systems • Single-electron photodetectors • Laser radiation processing • Time transfer via one-way laser ranging

R7. LASERS IN ENVIRONMENTAL MONITORING
Laser remote sensing technologies and methods • Lidar techniques and measurements for atmospheric remote sensing • Oil spill and ocean monitoring • Urban remote sensing • Laser sensing for geology • Remote sensing for agriculture and ecosystems • Space-based lidar for global observations • Laser applications in biophotonics

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS
Nonlinear optical devices, including microresonators, waveguides, and PT-symmetric systems • Multimode light propagation • Self-focusing, collapse dynamics and applications • Conservative and dissipative optical solitons, oscillons • Vortex solitons and optical angular momentum • Supercontinuum generation • Fiber optics and telecommunications

R9. OPTICAL NANOMATERIALS
Modeling of nanostructures • Advanced methods of nanostructure synthesis • One-dimensional growth of semiconductor nanowires • Wide band gap nanostructures • Epitaxial quantum dots and related structures • Nanostructures for single photon devices • Nanostructures for THz radiation • Nanostructures for solar cells • Microcavities and photonic crystals • Hybrid nanostructures with pre-defined properties

R10. FREE ELECTRON LASERS
X-ray and other free electron lasers (FELs) • Theory of FEL radiation • Linear electron accelerators • Undulators • Optics at photon-beam transport systems • Electron- and photon-beam diagnostics • Photon detectors • Data acquisition systems • Experimental stations and science at FELs
S1. 8TH INTERNATIONAL SYMPOSIUM
ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

High power fiber lasers for material processing applications • Cutting and welding with kW fiber lasers • Fiber laser cladding, sintering, heat treatment and additive technology • Fiber lasers for automotive applications • Mid power fiber laser applications • Pipe and thick section welding • Marking and engraving • Mid infra-red, 2 to 3 micron fiber lasers, processing including • Cutting and welding of plastics • Visible, UV and ultrafast fiber lasers and applications • Hybrid lasers • Life Sciences, medical, surgical, food production, agricultural pest and herbal control applications of fiber lasers • New materials and parts for fiber lasers: fibers, crystals, glasses, optics, nonlinear elements, etc.

S2. 4TH INTERNATIONAL SYMPOSIUM
«LASERS IN MEDICINE AND BIOPHOTONICS»

New medical applications and advanced laser medical systems for ophthalmology, dermatology, urology, endoscopic and microsurgery, dentistry, and other specialties autofluorescence and photodynamic diagnosis • Optical coherence tomography and diffuse optical imaging • New developments in non-invasive optical technologies, laser microscopy and spectroscopy of tissues • Optical clearing and light transport in cells and tissues • Laser trapping and manipulation of biological particles • Nonlinear interactions of light and tissues • Speckle phenomena in tissues • Quantification and imaging of cells, blood and lymph flows • Terahertz waves interaction with cells and tissues • Analytical biophotonics • Novel sensing principles, devices and instrumentation for medical diagnostics • Nanomaterials and nanosystems for diagnostics and therapy
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### POSTDEADLINE SESSION

**DEYNEKA**

**19.40-21.10**
### THURSDAY, 30 JUNE

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### FRIDAY, 1 JULY

10.00-17.00

A2. NEWLED CONSORTIUM MEETING

MUNTS

### SIDE-EVENT WORKSHOPS:

**A1. Advanced laser technology and equipment in industrial applications**

Official Language: Russian  
Brik Room, floor 3  
June 29, 2016  
09:00 - 17:00  
Registration: 08:30 – 09:00  
**Chair:** Nikolay N. Evtikheev, NTO “IRE-Polus”, Russia  
**Moderator:** Sergey N. Smirnov, Lasertech Ltd., Russia

**A2. NEWLED consortium meeting (by invitation only)**

Official Language: English  
Munts Room, floor 3  
June 30 and July 1, 2016  
10:00 - 17:00  
**Chair:** Edik Rafailov, Aston University, UK  
**Sponsor:** FP7 NEWLED Project
### THURSDAY, 30 JUNE

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#### GENERAL INFORMATION

- **Tu** = Tuesday, **We** = Wednesday, **Th** = Thursday, **Fr** = Friday
- **Paper number** for Posters Only
- **Session code** for Posters Only

### A2. NEWLED CONSORTIUM MEETING

**Location**: Levinson Hall, floor 2

**Date**: June 28, 2016

**Time**: 17:30 – 19:00

**Chair**: Ivan A. Shcherbakov, Prokhorov General Physics Inst. of RAS, Russia

**Official Language**: Russian

### SIDE-EVENT WORKSHOPS:


- **Official Language**: Russian
- **Location**: Levinson Hall, floor 2
- **Date**: June 28, 2016
- **Time**: 17:30 – 19:00
- **Chair**: Ivan A. Shcherbakov, Prokhorov General Physics Inst. of RAS, Russia
SECOND FLOOR

THIRD FLOOR

TO MUNTS AND BRIK CONFERENCE ROOMS

« LASER OPTICS 2016 »
3D Laser printing of nanoparticles and living cells
Boris Chichkov
Laser Zentrum Hannover e.V., Germany
11:20-11:55
Laser printing can be used for printing very small and delicate objects like nanoparticles and living cells. Nowadays, 3D printers can be bought for less than 500 Euro. They are able to print three-dimensional structures from thermoplastic and other materials. Here we report on laser printing of nanoparticles and living cells. We demonstrate a simple printing method allowing the generation and arrangement of spherical metal and dielectric nanoparticles in a very precise manner. For example, the printed silicon nanoparticles have a predefined size and are characterized by unique optical properties. With sizes in the range of 100-200 nm in diameter they exhibit pronounced electric and magnetic dipole resonances within the visible spectral range. Fabrication, characterization, and applications of the generated nanoparticle arrays will be discussed. In a series of publications on laser printing of living cells we proved that cells are not harmed by the printing process. The differentiation behavior and potential of laser printed stem cells are not affected. Stem cells can be printed in defined patterns and then differentiated within these patterns towards bone, cartilage or adipose tissue. With specific multi-cellular cell structures, studies of cell-cell and cell-environment interactions can be performed. Furthermore, fibroblast and keratinocyte cells have been printed layer-by-layer to form 3D skin tissue constructs. The skin tissue formation has been proven by visualizing intercellular junctions and verifying their functionality. The presented laser printing techniques are promising for a wide range of applications in nanophotonics and tissue engineering.

Why we need to replace the transistor, and what would be the newly required material properties?
Eli Yablonovitch
University of California, United States
11:55-12:30
In contemplating the headlong rush toward miniaturization represented by Moore's Law, it is tempting to think only of the progression toward molecular sized components. There is a second aspect of Moore's Law that is sometimes overlooked. Owing to miniaturization, the energy efficiency of information processing has steadily improved. But there is an inefficiency for internal communications in a chip. It is caused by the difference in voltage scale between the wires and the transistor switches. Transistors are thermally activated, leading to a required voltage >>kT/q. Wires are long, and they have a low impedance, allowing them to operate efficiently even at a few millivolts. Thus the main Figure-of-Merit for future transistors is low operating voltage or sensitivity, NOT mobility. The challenge then is to replace transistors with a new low-voltage switch that is better matched to the wires. I will present the new material quantum level properties, which are being explored by the NSF Science & Technology Center for Energy Efficient Electronics Science.
**Wave control with space-time manipulations**  
*Matthias Fink*  
*Institut Langevin, ESPCI Paris Tech, France*  
13:05-13:40

Time-reversal processing is based on Huygens principles and on wavefield manipulation on spatial boundaries. It provided an elegant way to back propagate a wave field towards its initial source allowing to create, through any complex medium, a wave pattern of any required shape restricted only by diffraction limits.

Here we want to revisit these approaches by introducing another point of view, the one that Loschmidt proposed in his famous argument to create a time-reversal experiment by inversing instantaneously all velocities of the particles in a gas. The extension of this concept to wave will be discussed through the concept of time boundaries manipulation. Experiments, conducted with water waves, validating this approach will be presented. We show that sudden changes of the medium properties generate instant wave sources that emerge instantaneously from the entire space at the time disruption. The time-reversed waves originate from these “Cauchy sources” which are the counterpart of Huygens virtual sources on a time boundary. It allows us to revisit the holographic method and introduce a new approach for wave control in complex media.

In the second part of this talk, we will discussed another approach to manipulate a wave field in reverberating medium by introducing tunable metasurfaces as spatial boundaries and we will emphasize this concept for microwaves.

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**Applications of plasmonic and dielectric nanoantennas in nanophotonics**  
*Stefan A. Maier*  
*Imperial College London, UK*  
12:30-13:05

Optical nanoantennas based on metallic nanostructures enable the controlled focusing of light from the far field to highly confined volumes below the diffraction limit, and furthermore form the basis of implementations of metamaterials and metasurfaces operating in the optical regime of the spectrum. Upon excitation of the plasmon oscillation, parts of the energy get dissipated via electron/hole pair formation, leading ultimately to dissipation into phonon modes. Here, we show how the vibrational frequencies of these modes can be controlled on the nanoscale, at the level of an individual nanoantenna. This is achieved via pinning certain parts of the antenna stronger to the substrate, utilizing oxide bar layers. Comprehensive finite element modelling combined with degenerate fs pump probe spectroscopy allows us to determine the ratio of the amplitudes of the underlying vibrational normal mode, demonstrating the tailoring. We believe that this work could be the start of a new avenue for control over electromagnetic - acoustic coupling in optical metasurfaces.

We further demonstrate the mapping of plasmonic hot spots using super-resolution far-field fluorescence spectroscopy, including a de-coupling of enhanced absorption and emission processes. The crucial role of the latter in determining the position of the emitter with respect to the antenna will be elucidated. Finally, we will present applications of dielectric nanoantennas for surface-enhanced spectroscopies, including antennas operating via localized surface phonon-polariton modes.
TUR1-07 Invited

Broadband ultrafast photonics in graphene
F. Rotermund; Department of Physics & Department of Energy Systems Research, Republic of Korea

Graphene has been widely investigated for a number of broadband photonic applications. In the present talk, recent progress in graphene-based saturable absorbers applicable for ultrafast solid-state lasers and terahertz nonlinear spectroscopy in graphene and graphene-based materials will be presented.

TUR1-08

Glass-ceramics with Co2+ + ZnO nanocrystals: novel saturable absorber for Er lasers
S.M. Vatnik1, I.A. Vedin1, V.V. Osipov2, K.E. Luk’yashin2, R.N. Maksimov2, O.S. Dymshits1, N.A. Skoptsov2, V.V. Vitkin3, A.A. Zhilin1, D.V. Shemchuk1, M.Ya. Tsetser1, P.A. Lozko1, A.M. Malyarevich1, K.V. Bogdanov1, I.V. Glazunov1, K.V. Yumashov1, 1 - NTIOM Vavilov State Optical Inst., Russia, 2 - Belarusian National Technical Univ., Belarus, 3 - ITMO Univ., Russia

Transparent glass-ceramics based on Co2+ + ZnO nanocrystals are synthesized in cobalt-doped glasses of the K2O-ZnO-Al2O3-SiO2 system. Passive Q-switching of an Er:Yb glass laser with 0.37 ml/100 ns pulses at ~1.54 μm is realized.

TUR1-09

NIR photoluminescence of Bi+ impurity center in RbY2C17 ternary chloride crystal
A.N. Romanov1, D.N. V'yurnov1, E.V. Haula1, D.P. Shashkin1, M.S. Kouznetsov1, I.S. Lisitsky1, N.A. Pimkin1, V.N. Korchak1, 1 - Semenov Inst. of Chemical Physics RAS, 2 - State Scientific-Research and Design Inst. of Rare-Metal Industry «Giredmet», Russia

Intense long-lived NIR photoluminescence, centered at 920 nm was observed from the single crystalline specimens of RbY2C17 ternary chloride containing Bi+ impurity centers. This crystal phase can be crystallized from the stoichiometric Lewis acidic melt, which promotes the formation of Bi+ ion in sufficient concentration.

TUR1-10

Optical properties and high-efficiency lasing of Nd:YAG and Ho:YAG ceramics
S.M. Vatnik1, I.A. Vedin1, V.V. Osipov2, K.E. Luk’yashin2, R.N. Maksimov2, V.I. Solomono2, Yu.L. Kopylov1, I.Sh. Steinberg1, P.E. Tverdokhleb1, A.A. Pavlyuk1, 1 - Inst. of Laser Physics SB RAS, 2 - Inst. of Electrophysics UB RAS, 3 - Kotel’nikov Inst. of Radio Engineering and Electronics RAS, 4 - Inst. of Automation and Electrometry SB RAS, 5 - Inst. of Inorganic Chemistry SB RAS, Russia

We report on optical properties and high-efficiency lasing of YAG ceramics synthesized at IREE (Fryazino) and IEP (Ekaterinburg). The best slope efficiency is to be 36% for 1% Nd:YAG ceramics and 40% for 1%Ho:YAG ceramics, in the latter case the emission was centered at 2090 nm. Internal losses in domestic ceramics prove to be a few percents per centimeter.

TUR1-11

The 2-μm waveband laser system based on Tm:YLF and Ho:YAG crystals with diode pumping

The experimental investigation results of the continuous-wave Tm:YLF laser based on the one cylindrical active element with the dual end pumping of the laser diode modules are represented. The σ- and π-polarized generation is obtained with the total pumping power up to 185 W.

TUR1-12

Efficient 10-J pulsed Fe:ZnSe laser at 4100 nm

Energies of over 10 J and efficiencies of over 44% have been demonstrated in single-shot operation of liquid nitrogen cooled single-crystalline Fe:ZnSe laser at 4100-nm wavelength.

TUR1-13

Multipass pump scheme for passively Q-switched eye-safe Er:YAG DPSSL
V.M. Polyakov, V.A. Buchenkov, A.V. Kovalev, V.V. Vitkin, A.A. Mak; ITMO Univ, Russia

We discuss an efficient Er:YAG DPSSL with passive Q-switch and analyze Er:YAG spectroscopic properties for efficient performance. The multipass pump scheme and multipass lasing scheme are discussed.
SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

Location: Petrov-Vodkin 1 Room, floor 2, 09:00 – 11:00

Quantum-well, wire, dash and dot lasers and devices
Session Chair: Grigori Sokolovskii, Ioffe Inst., Russia

Semiconductor laser based optical frequency combs - applications in communications and signal processing
P. Deiyett, S. Bhoslapur, A. Klee, E. Saratou, K. Bagwell, CREATe, The College of Optics & Photonics, Univ. of Central Florida, United States

Optical frequency combs from mode-locked lasers are developed and used for realizing unique functionality for applications in ultra-wide bandwidth communication and signal processing.

Novel approach for transverse mode engineering in edge-emitting semiconductor lasers

We review our novel approach based on coupled large optical cavity (CLOC) structures for effective suppression of high-order transverse modes in edge-emitting lasers with broadened waveguides. We discuss the main principles of the CLOC laser concept and present our recent numerical and experimental results of the laser operation.

Wavelength stabilized high-power diode lasers – design, manufacturing and applications
B. Sumpf, Ferdinand-Braun Inst., Germany

Wavelength stabilized high-power diode lasers are requested light sources in the field of laser based sensor systems. They are used as pump lasers for non-linear frequency conversion, e.g. second harmonic generation, to pump solid state lasers, and for diagnostic purposes in life sciences and they are applied directly as light sources for absorption or Raman spectroscopy. This paper presents recent developments concerning distributed Bragg reflector (DBR) ridge waveguide (RW) diode lasers for vibrational spectroscopy and high brightness DBR-tapered lasers for non-linear optics. The manufacturing and the electrooptical, spectral, and beam parameters of these devices will be presented together with a compact handheld Raman probe using an implemented dualwavelength DBR-RW diode laser for Shifted Excitation Raman Difference Spectroscopy (SERS).

Integrated butt-coupled membrane laser for Indium Phosphide on Silicon platform

In this work we present the design and technology development for an integrated butt-coupled membrane laser in the IMOS (Indium Phosphide Membrane on Silicon) platform. Laser is expected to have a small footprint (less than 50 µm2), 1 mA threshold current and a direct modulation frequency of 10 GHz.

Modulation response of double tunneling-injection quantum dot lasers
L.V Asryan, Virginia Polytechnic Inst. and State Univ., United States

The upper limit for the modulation bandwidth in a double tunneling-injection (DTI) quantum dot (QD) laser is discussed. While the maximum bandwidth is the same in DTI and conventional QD lasers, the optimum dc current, at which it is obtained, is lower in a DTI laser. Different factors limiting the modulation bandwidth in a DTI QD laser are also discussed.

- Coffee Break -

Semiconductor laser based optical frequency combs - applications in communications and signal processing
E. Berne, V. Moskalenko, S. Latkiowski, M. Llorens-Revull, K. Williams; Eindhoven Univ. of Technology, The Netherlands

The performance of integrated planar waveguide mode locked lasers can be enhanced using the available photonic integration platform technology in indium-phosphide. Extended cavity mode locked oscillators including DBR mirrors and phase modulators can be realized at telecom wavelengths to improve performance and control over the device. Integrated pulse shapers and special amplifiers can be used to improve the output properties further.

Mode-locking and Q-switching in 1.06 µm two-sectional QW lasers due to Stark effect

In two section lasers with 3 QWs passive mode-locking and Q-switching are realized. Frequency rate in mode-locking is 75 GHz with time-bandwidth product 0.49. The bleaching mechanism is induced by photocurrent in absorber at high reverse biases.

High-energy picosecond optical pulse generation with asymmetric-waveguide diode lasers
E.A. Avrutin, B.S. Rytkin, J.T. Kostamoavaara; 1 - Univ. of York, United Kingdom, 2 - Univ. of Oulu, Finland, 3 - Ioffe Inst., Russia

We report recent progress and discuss important issues in the design of gain-switched and combined gain/Q-switched asymmetric waveguide lasers with a large effective spot size for applications ranging from optical range finding (with a prototype system developed) to nonlinear optics. The role of the active layer material, the waveguide design, and the use of saturable absorber in the cavity are discussed.

Laser-thyrists as a source of high-power laser pulses with a pulse width of 1-100 ns
A.A. Podaskin, O.S. Soboleva, V.V. Zolotarev, D.A. Veselov, N.A. Pikhin, I.S. Tarasov, T.A. Bagaev, M.A. Ladugin, A.A. Marmalyuk, V.A. Simakov, S.O. Silchenko; 1 - Ioffe Inst., 2 - Steklov Research and Development Inst. «Polyus», Russia

A low-voltage ALGaAs/AlGaAs laser-thyristor heteroherection has been fabricated in order to have a compact source of high-power laser pulses at 900nm wavelength. Peak powers/pulse width of 55 W/100 ns and 8 W/10 ns from 200µm aperture and 1W/1ns from 20µm aperture have been demonstrated.

Frequency combs from InAs/InP quantum dash based mode-locked lasers for multi-terabit/s data transmission

InAs/InP quantum dash based mode locked lasers are particularly suited for frequency comb generation. Multi-terabit/s data transmission has been achieved using one single chip.

- Lunch Break -
TuR3-11 Invited
Dislocations in LD and LED semiconductor heterostructures
A.E. Romanov1, 2, J.S. Speck2; 1 - ITMO Univ., Russia, 2 - Ioffe Inst. Russia, 3 - UCSB, United States

We discuss misfit dislocations (MDs) and threading dislocations (TDs) in lattice-mismatched semiconductor heteroepitaxial layers, which are the key structural elements of light-emitting diodes (LEDs) and laser diodes (LDs). Novel approaches to modelling MD formation and TD reduction are considered. The behavior of dislocations in conventional III-V semiconductor compounds as well as in polar and semipolar III-nitride heterostructures are reviewed in detail.

TuR3-12 Invited
The most important issues in technology of AlGaN-based laser diodes and in array
M. Leszczynski, TopCAsn and Inst. of High Pressure Physics UNIPRESS, Poland

Despite the bright commercial future of nitride LDs, there is a number of technological issues which are being solved, and some of them will be discussed in the presentation.

TuR3-13 Fractional order of poling period for broadly tunable second harmonic generation
K.A. Fedorova1,2, G.S. Sokolovskii1, I.O. Bokshaya2, D.A. Livshitz2, E.A. Rafailov1; 1 - Atron Univ., United Kingdom, 2 - Ioffe Inst., Russia, 3 - Innolume GmbH, Germany

We demonstrate the possibility of using a fractional order of poling period of nonlinear crystal waveguides for tunable second harmonic generation. This approach allows for an extension of wavelength coverage in the visible spectral region by frequency doubling in a single nonlinear crystal waveguide.

TuR3-14 Invited
True yellow II-VI/ GaAs optically pumped laser structures for microchip laser diode converters
S.V. Sorokin1, I.V. Sedova1, S.V. Gronin2, S.V. Ivanov2, E.V. Lutisenko2, A.G. Vainilovich2, G.P. Yablonski2; 1 - Ioffe Inst., Russia, 2 - Stepanov Inst. of Physics NASB, Belarus

We report on recent progress in developing true-yellow (570-590nm) low-threshold (on for microchip laser diode converters.

TuR3-15 Infrared, green, and blue-violet pulsed lasers based on semiconductor structures pumped by low-energy electron beam
M.M. Zverev1, N.A. Gamov2, E.V. Zhdanova1, V.B. Studionov1, I.V. Sedova1, S.V. Sorokin1, S.V. Gronin2, S.V. Ivanov2, A.M. Ladoyugin2, A. Padalitsa1, V.V. Mazalov1, V. Kureshov1, A.A. Marmalyuk1; 1 - Moscow Technical Univ. Marburg, Germany, 2 - Ioffe Inst. Russia, 3 - RDI Polyus, Russia

Ultimate parameters of infrared, visible and blue-violet electron-beam-pumped lasers and laser arrays based on II-VI, III-V and III-N semiconductor heterostructures, obtained at electron energy below ~10keV are discussed.

Coffee Break

TuR3-16 Invited
Monolithic high-index contrast grating VCSELs
M. Gelski1, M. Marecki1, M. Deni2, J.A. Lott1, T. Czyszarnowski1; 1 - Lodz Univ. of Technology, Poland, 2 - Technical Univ. Berlin, Germany

A new and radically simplified construction of the vertical-cavity surface-emitting laser (VCSEL) with monolithic high-index contrast grating will be investigated. Instead of hundreds of epitaxial layers as in conventional VCSELs, the proposed design consists of a thin active zone capturing and recombining the carriers positioned between two monolithic cladding layers of p-doped and n-doped material. In these semiconductor lasers the optical feedback is provided by one or two planar monolithic subwavelength gratings etched into the cladding layers on either side of the optical cavity.

TuR3-17 VCSEL polarization control by rhomboidal selectively-oxidized current aperture
M.A. Bobrov1, N.A. Maleev1, A.A. Blokhin1, A.G. Kuzmenkov2, A.V. Pastiev1, K.A. Fedorova2, W. Stolz1,3, E.U. Rafailov2, M. Koch1; 1 - Philipps-Univ. Marburg, Germany, 2 - Ioffe Inst., Russia, 3 - Nanomaterials and Photonics GmbH, Germany

The new approach for single-mode (SM) VCSEL polarization control based on rhomboidal selectively-oxidized current aperture combined with intracavity contacts is discussed. MBE-grown VCSELs with aperture size of about 2.5 micron demonstrate lasing at 845-852 nm with SM output power exceeds 1.5 mW, SMSR high than 30 dB, and orthogonal polarization suppression ratio high than 20 dB for temperature of 20-80°C.

TuR3-18 Invited
Progress in high-power VCSELs: from material science to applications
M. Guina, Tampere Univ. of Technology, Finland

The presentation is focused on reviewing the major recent steps in the development of VCSEL technology. Emphasis is put on advances concerning power scaling, thermal management, and wavelength coverage. Ultimately, an outline of emerging applications in medicine and atom physics, is presented.

TuR3-19 1.3 µm InAs quantum dot semiconductor disk laser
S.A. Blokhin1, M.A. Bobrov1, A.A. Blokhin1, A.G. Kuzmenkov2, A.P. Vasil'ev1, N.A. Maleev1, V.V. Dudeliev1, K.K. Sobolev1, G.S. Sokolovskii2, A. Rantamaki3, O. Okhotnikov1, V.M. Ustinov1; 1 - Ioffe Inst., Russia, 2 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 3 - Tampere Univ. of Technology, Finland

We report an InAs/InGaAs quantum dot-based optically pumped vertical-external-cavity surface-emitting (VECSEL) at 1.3 μm. A fibre-coupled 808 nm laser diode and V-cavity configuration were used. Continuous wave output power over 200 mW is obtained at 7-15°C, which is the highest reported for such type of surface-emitting laser in this wavelength range.

TuR3-20 A serially-connected two-chip VECSEL for dual-wavelength emission
F. Zhang, M. Gaofar1, C. Möller, W. Stolz1,2, M. Koch1, A. Rahimi-Iman1, 1 - Philips-Univ. Marburg, Germany, 2 - NAsP III/V GmbH, Germany

We present a compact and flexible cavity design for high intracavity powers in vertical-external-cavity surface-emitting lasers (VECSELs), by serially connecting two different gain chips in one cavity. Such a device generates linearly polarized dual-wavelength emission with up to 640 W intracavity power at 10 nm wavelength spacing, which is tunable via a changing of the cavity angles on the chips. Furthermore, in this cavity, type-I second harmonic generation and sum-frequency generation have been performed in a LiNbO3 crystal.

TuR3-21 Self-mode-locked semiconductor disk laser
A. Rahimi-Iman1, M. Gaofar1, M. Vausel1, C. Möller1, F. Zhang1, D. Al-Nakdali1, K. A. Fedorova3, W. Stolz1,2, E.U. Rafailov1, M. Koch1, 1 - Philips-Univ. Marburg, Germany, 2 - Aston Univ., United Kingdom, 3 - NAsP III/V GmbH, Germany

In the last decade, vertical-external-cavity surface-emitting lasers (VECSELs) have become promising sources of ultrashort laser pulses. While the mode-locked operation has been strongly relying on costly semiconductor saturable-absorber mirrors for many years, new techniques have been found for pulse formation. Mode-locking VECSELs are nowadays not only achievable by using a variety of saturable absorbers, but also by using a saturable-absorber-free technique referred to as self-mode-locking (SML), which is to be highlighted here.
The second harmonic generation of the laser output was obtained.

Divergence of laser radiation at the level 1.3 of diffraction limit.

72% efficiency of the laser.

We developed a high-power diode-pumped Nd:YAG 1.064 µm laser with pulse duration of 100ps and repetition rate of 200 Hz. The laser was developed by the ITMO University and recent advancements include

- High-energy, high repetition rate regenerative amplifiers at 2 µm
- Russian Lunar Laser Rangefinder with Millimeter Accuracy
- Laser ranging technologies for control of the shape of the deflatable space-based antenna
- New one-way and two-way precision radio-laser ranging systems to increase the accuracy of global space geodesy and navigation systems
- New technologies for collecting sub-millimeter accuracy data to promote ephemeris-time support for global navigation and space geodesy.

The ways to use laser ranging systems to perform lunar ranging and space debris monitoring are reviewed. Technical specifications of high-accuracy measuring systems are given.

The article is devoted to wireless and fiber-optic transmission of laser energy for operation of special actuators and control of the shape of the deformable space-based antenna.

The system is designed for mid-orbit spacecrafts which consists of corner reflectors with the controlled camber of a single dihedral angle for a double-lobe pattern and thus compensating for the velocity aberration. It is shown that the circular retroreflector system has a number of advantages over the existing ones.

Test data on high-precision laser equipment for the synchronization of the time scales of distributed SLR-stations and GLONASS satellite.

We discuss the recent advances in creation of optical space-based frequency standards. We observe perspectives in the field as well as status of making the laser frequency standard of radio frequency range in ITMO University and recent experiments on launching optical frequency combs in space. The most important applications of space-based optical clocks are overviewed.

Multifactor optimization of the CPT miniature quantum frequency standards.

In this work is shown that the form and width of the laser spectrum on the input of the cell significantly affects the quality parameter of the CPT-resonance and, as a consequence, the stability of the frequency standard. We analyze two types of signal detecting: the signal of forward passed radiation and the fluorescence signal.

This report represents an advanced circular retroreflector system designed for mid-orbit spacecrafts which consists of corner reflectors with the controlled camber of a single dihedral angle for generating a double-lobe pattern and thus compensating for the velocity aberration. It is shown that the circular retroreflector system has a number of advantages over the existing ones.

This report represents results of high-precision (with the error of no more than 100 ps) comparison between the time scales of distributed SLR-stations using a GLONASS satellite equipped with the retroreflector system and laser pulse photodetector and also provides the guidelines to increase the laser time transfer availability based on the use of a radio laser network.

Debris removal systems based on known technologies and proven phenomenology are proposed to allow the required laser characteristics to be determined for each proposed configuration. We show that space debris can be relocated in space using lasers which could be achieved with currently-available technology.

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TuR8-01 Invited 09:00-09:30

**Space-time dynamics of nonlinear multimode fibers**
K. Krupa1, A. Tornel1, A. Barthélémy2, V. Couderc2, B.M. Shalaby2, A. Bendahmane2, G. Millot3, S. Wabnitz1; 1 - Univ. de Limoges, France, 2 - Tanta Univ., Egypt, 3 - Univ. de Bourgogne Franche-Comté, France, 4 - Univ. Brescia, and INO-CNR, Italy

The spatio-temporal dynamics of multimode waves in optical fibers leads to novel possibilities to shape the frequency and spatial content of laser beams.

TuR8-02 Invited 09:30-10:00

**Microscopy reconfigurable photonic circuits and buffers at the fibre surface**
M. Sumetsky1, A.V. Dmitriev1, N.A. Toropov1; 1 - ITMO Univ., Russia

Recent experimental and theoretical results on microscopic reconfigurable photonic circuits and buffers introduced at the fiber surface are reviewed.

TuR8-03 10:00-10:15

**Self-pulsating nonlinear systems via dissipative parametric instability**
A.M. Perego1,2, N. Tarasov3,4, D.V. Churkin1,4, S.K. Turitsyn1,2, K. Staliunas5,6; 1 - Novosibirsk State Univ., Russia, 2 - Inst. of Computational Technologies SB RAS, Russia, 3 - Inst. of Automation and Electrometry, 4 - Novosibirsk State Univ., Russia, 5 - Inst. Catalana de Recerca i Estudis Avançats, Spain

The recently discovered dissipative parametric instability is presented in the framework of the universal complex Ginzburg-Landau equation. The pattern formation associated with the instability is discussed in connection to the relevant applications in nonlinear photonics especially as a new tool for pulsed lasers design.

TuR8-04 10:15-10:30

**Generation in visible range using second harmonic of random distributed feedback fiber laser**
E.I. Donetsova1, S.I. Kalukhor1, I.D. Volniki1, S.A. Babkin2; 1 - Inst. of Automation and Electrometry, 2 - Novosibirsk State Univ., Russia

Frequency doubling of radiation generated by random distributed feedback (RDFB) Raman fiber laser (RFL) in MgO:PPLN crystal is studied experimentally for the first time. Second harmonic generation (SHG) power is compared for conventional and RDFB RFL configurations. The comparison shows, that higher SHG power (more than 100 mW at 654 nm) is generated with RDFB RFLs.

TuR8-05 10:30-10:45

**Broad green generation using adiabatically chirped (ch2) nonlinear photonic crystals**
H.-J. Lee1, C.-M. Lai2, W.-S. Tsai1, A.-H. Kung1, L.-H. Peng1; 1 - National Taiwan Univ., 2 - Ming Chuan Univ., 3 - National Chi Nan Univ., 4 - Academia Sinica and National Taiwan Univ., China

Broad green radiation from 500 to 565nm was observed on chirped (ch2) nonlinear photonic crystals made of periodically-poled lithium tantalate (PPLT) with single pass up-conversion efficiency ~10%. This was ascribed to simultaneous multi-wavelength SHG and SFG due to nonlinear interaction of (signal, idler) waves in the adiabatically chirped PPLT.

TuR8-06 10:45-11:00

**Towards three octave-spanning mid-IR supercontinuum generation in chalcogenide fibers with two zero dispersion wavelengths**
E.A. Anashkina1, V.S. Shyraev2, G.E. Snopatin2, A.V. Kim1; 1 - Inst. of Applied Physics, 2 - Inst. of Chemistry of High-Purity Substances, Russia

We have numerically demonstrated mid-IR supercontinuum generation spanning more than three octaves in all-solid chalcogenide glass fibers with two zero dispersion wavelengths pumped by 50-pl femtosecond pulses at 2 microns. We manufactured the proper step-index fibers with As39.4Se55.3Te5.3 core and As39.4Sb50.6 cladding having various core diameters and theoretically studied wavelength conversion up to 8 microns.

TuR8-07 Invited 11:30-12:00

**Statistics of rare events: errors in optical fiber communication systems**
I.R. Gabitov1,2, F. Kueppers3, M. Shkarayev4, 1 - Skolkovo Inst. of Science and Technology, Russia, 2 - Univ. of Arizona, United States (on leave), 3 - Technische Univ. Darmstadt, Germany, 4 - Iowa State Univ, United States

Statistics on bit-errors in optical fiber systems is studied. Obtained results are verified experimentally.

TuR8-08 Invited 12:00-12:30

**New area of the discrete photonics: the optical flat bands in waveguide arrays with alternating sign of refraction index**
A.I. Manimistov; Moscow Inst. of Physics and Technology, National Nuclear Research Univ., Russia

The waveguide bundles and two dimensional waveguide arrays in the case of the electromagnetic wave propagating along the waveguide only are discussed. The waveguide array consists of alternating waveguides of positive and negative refraction indexes. It is shown the features of the spectrum are depended on number of waveguides per cell.

TuR8-09 12:30-12:45

**Towards generation of multicolor dissipative solitons in telecom range**
A.E. Bednyakova1,2, D.S. Kharenko1, E.V. Pudlov1, M.P. Fedoruk1,2, A.A. Apolonski1, S.A. Babkin1, S.K. Turitsyn1,2; 1 - Novosibirsk State Univ., Russia, 2 - Inst. of Computational Technologies SB RAS, Russia, 3 - Inst. of Automation and Electrometry, 4 - Novosibirsk State Univ., Russia, 5 - Inst. Catalana de Recerca i Estudis Avançats, Spain

We study interaction of weak dispersive waves with broad class of nonlinear waves including dark solitons and second-order solitons. We show a possibility to control nonlinear waves with weak probe signals, polychromatic frequency conversion of weak dispersive waves, and demonstrate a way to emulate classical optical devices like Fabry-Perot and Bragg resonators.

TuR8-10 13:00-13:15

**Steering of solitons by resonant dispersive waves**
A.Y. Yulin1,7, ITMO Univ., Russia

It is shown that the effect of Cherenkov radiation can be inverted and the solitons can be pumped by the synchronous dispersive waves of low intensity. This effect is analogous to the effect of the acceleration of moving charges by resonant electromagnetic waves. The importance of mutual resonant interactions between the solitons and the dispersive waves for supercontinuum generation is discussed.

TuR8-11 13:15-13:30

**Three-photon spontaneous downconversion in highly nonlinear germania-silica optical fiber waveguides**
S.V. Tsvetkov1, K.G. Katamadze1,2, N.A. Borshchevskaia1,2, A.A. Sysolyatin1,2; 1 - Novosibirsk State Univ., Russia, 2 - Inst. of Automation and Electrometry, 3 - Inst. of Chemistry of High-Purity Substances, Russia, 4 - Moscow State Univ. of Information Technologies, Radioengineering and Electronics, Russia

Three-photon spontaneous parametric downconversion (TPSPDC) is a challenging problem in nonlinear quantum optics. A highly doped germania-silica optical fiber is a good candidate for the appropriate nonlinear medium, because of the big interaction length and tight field confinement. A principal condition for TPSPDC is the exact phase-matching between the pump and signal fiber modes.
Soliton fission and fusion in dispersion oscillating fiber and correlation properties of the pulses

L. Melnikov, Gagarin Saratov State Technical Univ., Saratov Branch of Kotel’nikov Inst. of Radioengineering and Electronics RAS, Russia

Comprehensive solitons dynamics in the fiber with periodically oscillating group velocity dispersion is demonstrated. Soliton fission and recently described solitons fusion are explained using the solitons spectra of inverse scattering problem solution. The fusion of one pair of solitons in a case of discrete spectral parameters of the solitons demonstrate collisions (anti-crossing) behavior during the pulse propagation along the fiber. The resulting pulses after fusion remain coupled and this coupling exists in spite of long temporal or longitudinal distance between the pulses. Possible scenarios of coupling are discussed and correlation properties of the pulses are investigated.

Dissipative Faraday instability mode-locking in a Raman fiber laser

N. Tarasov1,2, A.M. Perego1,2, D.V. Churkin1,2, M. Yu. Kopyrin1,2, M. Yu. Mironov1,2, A.V. Kornienko1,2; 1 ‑ Aston Univ., United Kingdom, 2 ‑ Inst. of Computational Technologies SB RAS, Russia, 3 ‑ Univ. Politécnica de Catalunya, Spain, 4 ‑ Novosibirsk State Univ., Russia, 5 ‑ Inst. Catalana de Recerca i Estudis Avançats, Spain

There is a new type of parametric instability that was recently theoretically predicted - dissipative Faraday instability. In this work we experimentally demonstrate this new type of instability by the means of achieving mode-locking in a simple configuration. The results not only open the possibilities for novel designs of mode-locked lasers, but also extend beyond the field of laser physics.

Generation of frequency combs in nonlinear SNAP fiber resonators

S.V. Suchkov1, M. Sumetsky1, A.A. Sukhorukov1; 1 ‑ Australian National Univ., Australia, 2 ‑ Aston Univ., United Kingdom

We suggest Surface Nanoscale Axial Photonic resonators for generation of frequency combs. We derive model equations, which describe propagation of fundamental guided mode in such a nonlinear resonator. Our simulations show that by appropriate variation of fiber radius along the millimeter long SNAP resonator, we can obtain a frequency comb, comparable to frequency combs generated by ring resonators of cm radius.

Mid-IR ultrashort Raman solitons and red-shifted dispersive waves in suspended-core tellurite fiber

E.A. Anashkina1, A.V. Andrianov1, V.V. Dorofeev1, A.V. Kornienko1; 1 ‑ Inst. of Applied Physics RAS, 2 ‑ Inst. of Chemistry of High-Purity Substances RAS, Russia

We have demonstrated numerically the possibility to obtain ultrashort laser pulses in the range beyond 4 microns due to soliton self-frequency shift and red-shifted dispersive wave generation in a suspended-core fiber made of specially synthesized high-purity SnO2-GeO2-WO3-La2O3 glass pumped by a standard fs pump laser source at 2 microns.

Broadband femtosecond fiber laser with ultrahigh repetition rate in the telecommunication range

A.S. Andrianov1, A.V. Anashkina1, M. Yu. Kopyrin1, M. Yu. Mironov1, A.V. Kornienko1; 1 ‑ Inst. of Applied Physics RAS, 2 ‑ Nizhny Novgorod State Univ., Russia

A new variant of the fiber laser for generation of ultrashort pulse bunches and sequences with repetition rate in the range of 8-260 GHz, which combines a nonlinear amplifying loop mirror and a comb spectral filter for stabilization of the pulse separation, was demonstrated. We showed that a well-ordered and equidistant structure of the pulse sequence is maintained on a nanosecond timescale.

Femtosecond pulse propagation in the negative gain hollow-core revoler fiber

A.A. Klyosov1, Yu.P. Yatsenko1, A.D. Pyramikov1, A.F. Kosolapov1, A.N. Kolyadin1, A.V. Gladyshev1, I.A. Bufetov1; Fiber Optics Research Center RAS, Russia

For the first time femtosecond pulse propagation has been numerically and experimentally studied in the hollow-core revoler fiber with a non-coupled cylindrical capillaries-based cladding, fabricated for high-power ultra-short pulse delivery in the telecom band near 1.55 μm.

Short cavity Brillouin random laser

S.M. Popov2, O.V. Butov1, Yu.K. Chamarovsky1, P. Megret1, I.O. Zolotovskii1, A.A. Foladgi1,2; 1 ‑ Inst. of Radio Engineering and Electronics RAS, Russia, 2 ‑ Univ. of Mons, Belgium, 3 ‑ Ulyanov State Univ., Russia, 4 ‑ Ioffe Inst., Russia

We report on random lasing realized with 100-m-long Rayleigh fiber fabricated with multiple reflection centers inserted in the fiber core and uniformly distributed along the fiber length. Extended fluctuation-free spectral lines in the oscilloscope traces highlight good behavior typical for lasing.

Coffee Break -
TuR9-00 08:45-09:00
Opening remarks from session chairs
V.G. Dubrovskii1,2, F. Glas1, Ioffe Inst, ITMO Univ, Russia
TuR9-01 09:00-09:30
Interface dynamics and crystal phase switching in GaAs nanowires
F.M. Ross, IBM T. J. Watson Research Center, United States
In order to understand the mechanism that controls crystal phase, we use in situ electron microscopy to image catalytically-grown GaAs nanowires during growth as they are switched between polytypes by varying growth conditions. We find striking differences between the growth dynamics of the two phases, including differences in interface morphology, step flow, and catalyst geometry.
TuR9-02 09:30-10:00
Semiconductor nanostructures for lasers and optoelectronic applications
Cf. Jagadish; Australian National Univ, Australia
In this talk I will discuss about the synthesis of nanostructures and their characterization and device fabrication and testing. Role of plasmonic cavities in improving the quantum efficiency of nanostructures will be discussed. Strengths and weaknesses of each of these nanostructures will be presented and future perspective will be provided.
TuR9-03 10:00-10:30
Growth of organized III-V nanostructures for quantum technology and energy applications
A. Fontcuberta i Morral, Laboratory of Semiconductor Materials, Inst. of Materials, Ecole Polytechnique Federale de Lausanne, Switzerland
Nanostructures are filamentary crystals with a tailored diameter ranging from few to ~100 nm. The special geometry and reduced dimensions of these nanostructures result in interesting optical and electrical properties and provides a great potential for many applications of the XXI century. In this talk we will first review the growth mechanisms of Ga-assisted growth of GaAs nanowires by molecular beam epitaxy. We will follow by elucidating the photonic properties of single nanowires standing and lying on a substrate to show how they can be used for quantum science and technology and energy harvesting applications.
TuR9-04 10:30-10:45
Self-catalyzed growth of GaAs nanowires on silicon by HVPE
Zh. Dong1,2, Ya. Andre1,2, V. Dubrovskii3, C. Bougerol4, Monier1,2, R. Ramdani1,2, A. Trassoudaine1,2, Ch. Leroux1, D. Castellucci1, E. Gil1,1, Inst. Pascal, France, 2 - CNRS, UMR 6606, France, 3 - Ioffe Inst, Russia, 4 - Univ Grenoble Alpes, France
We report on the first self-catalyzed growth of GaAs nanowires on patterned and non-patterned silicon (111) wafers by hydride vapor phase epitaxy (HVPE) with a record elongation rate of 30 μm/h. The crystalline structure was analyzed using in situ electron microscopy to image catalytically-grown GaAs nanowires during growth as they are switched between polytypes by varying growth conditions. We find striking differences between the growth dynamics of the two phases, including differences in interface morphology, step flow, and catalyst geometry.
TuR9-05 10:45-11:00
MBE growth and optical properties of GaN nanowires on SiC/Si(111) hybrid substrate
R.R. Reznik1,2, K.P. Kotlyar1, V.I. Ilyin2, I.P. Soshnikov1, S.A. Kukushkin1, A.V. Ospanov1, E.V. Nikitina1, G.E. Cirlin1,2,4, - St.Petersburg Academic Univ, 2 - Peter the Great St.Petersburg Polytechnic Univ, 3 - Ioffe Inst, 4 - Inst. for Analytical Instrumentation RAS, 5 - St.Petersburg State Univ, 6 - Inst. of Problems of Mechanical Engineering RAS, Russia
The fundamental possibility of the growth of GaN nanowires by molecular-beam epitaxy on a silicon substrate with nanoscale buffer layer of silicon carbide has been demonstrated for the first time. Morphological and spectral properties of the resulting system have been studied and compared properties of GaN nanowires on silicon substrate.

date: June 27 - July 1, St. Petersburg, Russia
A. Povolotckaia3, A. Povolotskiy3, A. Manshina3; 1 ‑ Stoletov Vladimir State Univ., present the design, capabilities, scope of operation and installation schedule. At its core is an optical parametric amplifier optimized for 800nm emission. We burst-mode, emitting milli-Joule class few-cycle pulses at MHz repetition rates. Future experiments at the European XFEL. Like the XFEL, the laser operates in a mode-locking, emitting picosecond pulses at kHz repetition rates. We present a versatile and flexible ultrafast optical laser setup, developed for electron laser facility. The Ultrafast pump-probe laser for the European X-ray free-electron laser facility is currently under construction in Germany. The facility will generate new knowledge in almost all the technical and scientific disciplines that are shaping our daily life. The European XFEL is a new international research installation that is currently under construction in Germany, ITMO Univ., Russia. The facility will generate new knowledge in almost all the technical and scientific disciplines that are shaping our daily life. We have experimentally studied saturation behavior of Single-Walled Carbon Nanotube-based saturable absorbers at different temperatures and SWCNT concentrations in the carboxymetylcellulose polymer matrix and related it to the mode-locked erbium-doped fiber laser performance.

R10. FREE ELECTRON LASERS

TuR10-03 Invited 10:30-11:00 Measurements on 3D spatial distribution, spectral and coherent properties of focused XFEL beam.

Hard X-ray FEIs

Location: Rihter Room, floor 3, 09:00 – 11:00

TuR10-01 Invited 09:00-10:00 European XFEL: status and research instrumentation.

TuR10-02 Invited 16:00-16:30 Ultrafast pump-probe laser for the European X-ray free-electron laser facility.

TuR9-11 15:00-15:15 High-sensitivity side-coupled symmetric-shaft-shape photocathode crystal sensor arrays

Zh. Fu, J. Zhou, L. Huang, F. Sun, H. Tian; Beijing Univ. of Posts and Telecommunications, China

High-sensitivity symmetric-shaft-shape photocathode crystal sensor arrays (SSPCsAs) consisting of four cavities side-coupled to a W1 waveguide are designed. The sensitivities of the four sensor units are from 178 to 398 nm/RIU.

TuR9-12 Laser formation of the metal-carbon islands thin films for optical application

A. Kucherik1, A. Antipov, S. Arakelian1, S. Kutsyrevskaya1, A. Osipov1, T. Vartanyan1, A. Povolotskiy1, A. Manshina1; 1 ‑ Stoletov Vladimir State Univ., 2 ‑ ITMO Univ., 3 ‑ St. Petersburg State Univ., Russia

In this work a method for the laser formation of C-Au-Ag clusters and complexes on the surface of an optically transparent media is discussed.

TuR9-13 Saturation parameters studies of carbon nanotube-based thin-film saturable absorbers for erbium fiber laser mode-locking

A.A. Krylov1, S.G. Sazonkin1, N.R. Arutyunyan4, V.V. Grebenyukov1, A.S. Pasharova1, D.A. Dvoretskiy1, A.B. Pneev1, V.E. Karasik1, E.D. Obraztsova1, E.M. Dianov1; 1 ‑ Fiber Optics Research Center RAS, 2 ‑ Bauman Moscow State Technical Univ., 3 ‑ ITMO Univ., 4 ‑ St. Petersburg State Univ., Russia

We have experimentally studied saturation behavior of Single-Walled Carbon Nanotube-based saturable absorbers at different temperatures and SWCNT concentrations in the carboxymethylcellulose polymer matrix and related it to the mode-locked erbium-doped fiber laser performance.

TuR9-14 15:45-16:00 Novel hybrid materials based on various oxyquinoline organic phosphour complexes and oxyfluoride glass.

M.G. Anurova, C.V. Ermoelova, O.B. Petrova, A.V. Khramtsoy, A.A. Akkuzina, R.I. Aver'yanov, I.V. Aver'tyanov; Mendeleev Univ. of Chemical Technology, Russia

Novel luminescent organic-inorganic hybrid materials were synthesized by high temperature reaction between metalorganic phosphors and glass. In the present research we used a lead fluoroborate glass as an inorganic matrix and various luminescent oxyquinoline complexes as organic active agent.

TuR9-15 16:00-16:15 Laser correlation spectroscopy and nonlinear magnetooptic response of structures formed by nanoparticles in magnetic fluid.

E.K. Nepomniashchikhina1, A.V. Prokofiev1, E.T. Aksenov2, I.V. Pleshakova2, E.E. Bikik1, E.N. Velichko1, Yu.I. Kuzmin1; 1 ‑ Center for Emerging Device Technologies, McMaster Univ., Canada, 2 ‑ ITMO Univ., 3 ‑ St. Petersburg State Inst. of Technology. Russia

Investigations of the agglomeration process in liquid nanostructured materials (magnetic fluids) and its effect on their optical properties are presented.

TuR9-16 16:15-16:30 Laser correlation spectroscopy and nonlinear magneto-optic response of structures formed by nanoparticles in magnetic fluid.

E.K. Nepomniashchikhina1, A.V. Prokofiev1, E.T. Aksenov2, I.V. Pleshakova2, E.E. Bikik1, E.N. Velichko1, Yu.I. Kuzmin1; 1 ‑ Center for Emerging Device Technologies, McMaster Univ., Canada, 2 ‑ ITMO Univ., 3 ‑ St. Petersburg State Inst. of Technology. Russia

Investigations of the agglomeration process in liquid nanostructured materials (magnetic fluids) and its effect on their optical properties are presented.
Analytical approximate methods in optimization of optical systems for free-electron lasers
V.V. Kulaev; Budker Inst. of Nuclear Physics SB RAS, Russia
Analytical approximate methods in optimization of various optical resonators and transport beamlines for free-electron laser (FEL) were presented. Small signal gain, losses, optimal output coupling, and output FEL power are written as simple clear analytical functional of geometrical parameters of the FELs optical systems.

.Location: Rihter Room, floor 3, 11:30 – 13:15

Soft X-ray and THz FELs
Session Chair: Manfred Helm, Helmholtz-Zentrum Dresden-Rossendorf, Germany

The injection of an external seed to initiate the FEL amplification in a free electron laser is a concept initially introduced to improve the source spectral brightness. In the framework of the 4th generation light sources, FERMI was built with this unique distinguishing feature. We will provide an overview of the main recent developments seeded FEL facility.

.Location: Rihter Room, floor 3, 15:00 – 17:15

Science at FELs
Session Chair: Sergey Pikuz, Joint Inst. for High Temperatures RAS, Russia

Some applications of infrared and THz free electron lasers in solid state spectroscopy are discussed. In particular, nonlinear experiments on semiconductor quantum well excitons and pump-probe studies on carrier relaxation in graphene are presented.

.Location: Rihter Room, floor 3, 15:00 – 17:15

Solid state spectroscopy with THz free electron lasers
M. Helm; Helmholtz-Zentrum Dresden-Rossendorf, Germany
Some applications of infrared and THz free electron lasers in solid state spectroscopy are discussed. In particular, nonlinear experiments on semiconductor quantum well excitons and pump-probe studies on carrier relaxation in graphene are presented.

.Location: Rihter Room, floor 3, 15:00 – 17:15

Time-resolved X-ray spectroscopy with free-electron lasers
W. Wurth; Univ. of Hamburg, DESY Photon Science, Germany
We present the results and prospects for time-resolved photoelectron spectroscopy and time-resolved resonant inelastic X-ray scattering. We discuss on free electron lasers FLASH and European XFEL and their application to X-ray spectroscopy technics.

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**TuR1-p01**

**Stability of the misaligned MOPA Nd:YAG DPSSL**

V.M. Polyaakov, A.V. Kovalov, V.V. Viktin, A.A. Mak, ITMO Univ, Russia

We consider a compact MOPA DPSSL system for the space-based rangingfind. The plane cavity Nd:YAG master oscillator (MO) was passively Q-switched. The amplifier consisted of Nd:YAG active media in a ring cavity with two passes and polarization decoupling. The MO/PA system was used as a source for a space-based altimeter-roll stabilizer to control spacecraft landing process. The polarization decoder finite contrast leads to the parasitic lasing effect which acts as a seeding signal for the MO causing instabilities in the system output.

**TuR1-p02**

**10 W level Nd:YAG end-pumped CW amplifier**

A.P. Kornev, V.P. Pokrovskiy, S.S. Sobolev, S.S. Terekhov, ITMO Univ, Russia

End pumped CW Nd:YAG amplifier for low power stable single-frequency laser was built and investigated. High extraction efficiency ~30% in double-pass amplifier is achieved due to high small-signal gain provided with longitudinal pumping. Pumping of amplifier is near uniformly distributed along 2 laser rods with low concentration using two-lens relay between them in order to decrease end overheating.

**TuR1-p03**

**Pulse shaping in Yb doped all-in-fiber laser using fiber Bragg grating filter**

T. Barulevicius, N. Rusteika, EKSPA, Lithuania

In this work the minimization of gain narrowing in Yb doped all-in-fiber chirped pulse amplification (FCPA) system was investigated. Spectral filtering technique using fiber Bragg grating filter with desired transmission spectrum was demonstrated.

**TuR1-p04**

**Compact Yb:YAG crystal fiber CPA for fiber laser oscillator**

A.P. Rodin1, *, S. Franklin1, *, N. Rusteika1; 1 - Center for Physical Sciences and Technology, 2 - UAB Ekspla, Lithuania

We present results of experimental investigation of chirped pulse amplification in a single and double-pass Yb:YAG crystal fiber amplifier seeded with fiber laser pulses of 480 ps FWHM and ~ 350 mW average power at 100 kHz. High brightness fiber coupled laser diodes of 50 W power at 940 nm were used in a single and dual end-pumping geometry.

**TuR1-p05**

**Study of the thermooptical distortions of transversely diode pumped Yb:Er glass laser**

I.V. Chavkin, D.A. Abramov, ITMO Univ, Russia

Since the thermooptical distortions have a significant impact on the output characteristics of the laser, it is necessary to their detailed study. Investigation method of thermo-optical distortions in solid-state lasers was developed and presented. The method can be easily used for research of small diameter active elements.

**TuR1-p06**

**2.92 μm Cr2+:CdSe single crystal laser pumped by repetitively-pulsed Tm3+:Lu2O3 ceramics lasers**

O.E. Antipov1, *, I.D. Erano1, M.P. Frolo1, *, Yu.V. Korostin1, V.I. Kuzovkov1, *, A.A. Novikov1, Yu.P. Podmar’kov1, *, Yu.K. Skaskovsky1; 1 - Inst. of Applied Physics RAS, 2 - Nizhny Novgorod State University, 3 - Lebedev Physical Inst. RAS, 4 - Moscow Inst. of Physics and Technology (State (Unit) 5 - National Research Nuclear Univ. MEPhI, Russia

Laser oscillator based on Cr2+:CdSe single crystal pumped by radiation of Tm3+:Lu2O3-ceramic laser was created and investigated. Repetitively-pulsed oscillations at the wavelength of 2.92 μm with bandwidth of 80 nm were demonstrated. The output power was up to 3W at 15-30 kHz repetition rate with the pulse duration of ~40-300 ns in the good-quality beam.

**TuR1-p07**

**Thermal effects in eye-safe ring optical parametric oscillator based on KTiOPO4 crystal**

A.A. Runited Statesk, V.I. Dashkevich, G.I. Timofeeva, V.A. Orlovich, Stepanov Inst. of Physics NASB, Belarus

In eye-safe ring optical parametric oscillator (OPO) containing three KTiOPO4 crystals the crystal placed first in the path of pump radiation is subjected to the strongest thermal distortion caused by idler absorption. For the 10-Hz 35-mJ OPO, thermally induced lenses generate an increase in the signal beam divergence by 10% and moderate decrease in the signal energy.

**TuR1-p08**

**High energy compact-size diode-pumped Nd:YAG laser with self-pumped phase-conjugate dynamic cavity**

G.V.Burkovskiy1, A.S. Boreysho1, A.V. Fedin1, *, 1 - Baltic State Technical Univ, 2 - Laser Systems Ltd, Russia

Compact-size, mulitloop, self-phase-conjugated Nd:YAG laser pumped by 4D diode stacks was studied. The use of a passive LiF:F2 - Q-switch resulted in pulse train oscillation depending on the passive Q-switch position and length of diffractive feedback in the cavity. The laser energy of up to 2.55 J in trains of 13 pulses with 11-s ns duration was obtained.

**TuR1-p09**

**Compact laser schematics for generation of stable subnanosecond pulses with energy up to 1J**

M. Inachtin1, K. Fedin1, L. Khlopov1, V. Khramov1; ITMO Univ, Russia

Different schematics of compact Nd:YAG laser system capable to generate subnanosecond output pulses with energy up to 1J are described. Trade-offs and advantages of different laser schematics are discussed.

**TuR1-p10**

**Polarisation effects in lasers with intracavity second harmonic generation**

N. Belashenkov, M. Inochkin; ITMO Univ, Russia

Influence of different kind of polarization effects on intracavity second harmonic generation of powerful laser radiation is discussed. Theoretical predictions are compared with experimental data.

**TuR1-p11**

**High beam quality 4.5W Q-switched Nd:YAG laser operating up to 1 kHz**

A.S. Davityan, A.P. Kornev, V.P. Pokrovskiy, S.S. Sobolev, S.S. Terekhov; ITMO Univ, Russia

The study was to develop high-power stable Nd:YAG master oscillator for MOPA laser system. Output power of 4.5 W was achieved with 30 W of pump power for wide range of Q-switched lasing repetition rate. 15mJ@300Hz lasing of 10 ns pulses was achieved after optimization.

**TuR1-p12**

**Hollow glass waveguide transmittance for laser radiation at wavelengths 1.06, 1.32 and 1.44 μm**

N. Kapitch1, N. M. Nene1, K. Nejezchleb1, H. Jelinkov1; 1 - Crytur Ltd., 2 - Czech Technical Univ. Prague, Czech Republic

This study is to present the compact Nd:YAG three-wavelengths laser generating 1.06, 1.32 and 1.44 μm with delivery part presented by the special hollow glass waveguide which inner coating was made from silver layer covered with cyclic olefin polymer. The transmittance of waveguides with inner diameters 700 and 1000 μm at 1.06, 1.32 and 1.44 μm were measured.

**TuR1-p13**

**The amplification of transform-limited pulses in media with homogeneously broadened line**

V.A. Petrov1,2, G.V. Kuptsov1,2, V.V. Petrov1,2, A.V. Laptev1, A.V. Kiprichnikov1,2, E.V. Pestyakov1; 1 - Inst. of Laser Physics SB RAS, 2 - Novosibirsk State Technical Univ, 3 - Novosibirsk State National Research Univ, Russia

We propose the model of the amplification of the transform-limited pulses in a homogeneously broadened medium. The model provides the information about the output characteristics of an unchirped pulse after passing through an active homogeneously broadened medium and about the population inversion inside the medium at any moment of time.

**TuR1-p14**

**A parametric amplification unit based on nonlinear borate crystals for multiterawatt femtosecond laser system**

G.V. Kuptsov1,2, V.V. Petrov1,2, A.V. Petrov1,2, A.V. Laptev1, E.V. Pestyakov1; 1 - Inst. of Laser Physics SB RAS, 2 - Novosibirsk State National Research Univ, 3 - Novosibirsk State Technical Univ, Russia

The calculation of parametric amplification unit based on nonlinear borate crystals for multiterawatt femtosecond laser system has been carried out. A gaussian gain profile with a ~20% dip near the center is proposed to optimize the medium at any moment of time.

**TuR1-p15**

**Cavity dumping by the second harmonic generation**

R.I. Navitskaya, I.V. Stashkevitch; Belarusian State Univ, Belarus

This paper presents a method of cavity dumping by the second harmonic generation of powerful laser radiation. The method can be easily used for research of small diameter active elements.
R9. OPTICAL NANOMATERIALS

TuR9-p01 15:00-19:00
Precision UV vacuum spectral reflectivity test system
Y. Jiang, Sh. Xu, Engineering Univ. of CAIF, China
The optical reflectance of the remote sensing instrument must be calibrated in vacuum conditions before being launched. The system to test the reflectivity of less than 280 millimeter diameter optical element in vacuum is constructed and consists of a light source, the Seya-Namioka vacuum visible monochromator, the sample room as the main structural and electronic system components. The vacuum chamber work band is from 160 nm to 780 nm, spectral resolution is 0.5 nm. Dual optical compensation method is used to eliminate the source of time drift, improve the measurement accuracy with phase-locked weak signal amplification method. To ensure the precision detection, the phase-sensitive detector function can be adjustable. The output value is not more than 10 mV before each measurement, so it can be ensured that the stability of the measured radiation spectrum is less than 1 percent. The reflectivity test results show that the wavelength accuracy is 0.1 nm, and the wavelength repeatability is 0.035 nm, it high-precision measurement of optical components under vacuum can be achieved.

TuR9-p02 15:00-19:00
THz-wave propagation in asymmetric graphene-SiC hyperbolic metamaterial
O.N. Kozina1, L.A. Melnikov2, A.S. Zotkina1, I.S. Nefedov1, 1 - Kotel’nikov Inst. of Radio-engineering and Electronics RAS, Saratov Branch, Russia, 2 - Gagarin State Technical Univ., Russia, 3 - Aalto Univ., Finland
Investigation of the THz radiation propagation in hyperbolic graphene-semiconductor metamaterial is presented. Anisotropy of the hyperbolic media slab was taken into account. The 4x4 Berreman matrix method was adopted for arbitrary orientation of optical axis according to slab boundary.

TuR9-p03 15:00-19:00
Laser-assisted deposition of the bimetal thin films with pre-defined optical and electrical properties
S. Kukhryusha1, A. Antipov1, S. Arakelian1, A. Kucherik1, A. Osipov1, T. Vartanyan1, A. Istratov1, T. Itri1, 1 - Stoletov Vladimir State Univ, Russia, 2 - ITMO Univ, Russia, 3 - Hubert Curien Laboratory, France
In this work, we investigated the influence of morphology (particle diameter in the colloid, the distance between the deposited particles, the number of layers etc.) on the optical and electrical properties of the deposited thin film of bimetallic clusters.

TuR9-p04 15:00-19:00
Search of optimal conditions of Nd:Y2O3 nanopowder synthesis by using a powerful fiber ytterbium laser
G.S. Evustershenko1, V.V. Lisnevskii2, V.V. Osipov1, V.V. Platonov1, A.V. Poddub1, A.V. Spirina2, E.V. Trubnikov1, M.V. Trubnikova1, K.V. Fedorov1, 1 - Inst. of Electrophysics UB RAS, 2 - Zern Inst. of Atmospheric Optics SB RAS, 3 - National Research Tomsk Polytechnic Univ., Russia
We investigated the evaporation of the 1%Nd:Y2O3 with the help of 600W fiber laser and the synthesis by this method 1%Nd:Y2O3 nanopowder. It is shown that in monolithic and multilayered substance from the target is removed only by evaporation, but then also begins the spray droplets. These data helped to increase the productivity of this powder and its output with 15g/h to 23g/h and from 9wt.% to 30 wt.% respectively.
TuR9-p10
The copper nanostructures produced by in situ laser synthesis reveal catalytic activity
O.V. Simakova, D.S. Boyarchuk, M.S. Parov, D.I. Tumkin, A.G. Kuzmin, V.A. Kochemirovsky, I.A. Balova; 1 - St. Petersburg State Univ., 2 - Inst. for Analytical Instrumentation RAS, Russia
The laser-induced metal deposition technique attracts a great interest not only due to its application in microelectronics and manufacturing of electrochemical sensors but also due to its possible implementation for in situ laser synthesis of nanostructured metal catalysts directly in the reaction mixture. The synthesized nano-sized metal structures may take part in organic catalysis using solvent as a reaction medium.

TuR9-p11
The nanostructured membrane investigation by optical methods
A.A. Mikhaylyuk, A.V. Prikhod'ko, O.I. Konkor, N.N. Rozhkov; 1 - Inst. of Geology Karelian Research Centre RAS, 2 - Peter the Great St. Petersburg Polytechnic Univ., 3 - Ioffe Inst., Russia
The known technology for producing fullerenic membrane was applied to the natural carbon material. The basic structural elements of shungite carbon have been identified in the prepared nanostructured sample by optical methods.

TuR9-p12
The electric-dipole transitions in an emitter
K.K. Pukhov; General Physics Inst. RAS, Russia
Here we present the theoretical study of the electric-dipole emission rate modification of the luminescence centers inside and outside of the subwavelength core-shell nanoparticles.

TuR9-p13
Quantum dots luminescence in the photonic crystal fibers modified with polymer layers
S.A. Pidenko, S.D. Bondarenko, A.A. Chibrova, A.A. Shuvalo, N.A. Burmistrova, Y.S. Skibina, I.Y. Goryacheva; 1 - Saratov National Research State Univ., 2 - SPF Nanostructured Glass Technology Ltd, 3a - Saratov National Research State Univ., 5 - St.Petersburg State Univ., Russia
The luminescence of the quantum dots of different colors glow in the samples of photonic crystal fibers modified with self-organizing layers of polyaniline was studied.

TuR9-p14
NO2 gas sensor based on Au-tZnPc-OH Langmuir-Blodgett thick film
D.M. Krichevsky, A.V. Zasedatelev, A.Yu. Tolbin, T.V. Dubinina; 1 - National Research Nuclear Univ. «MEPhI», 2 - Lomonosov Moscow State Univ., 3 - Prokhorov General Physics Inst. RAS, 4 - Inst. of Physically Active Compounds RAS, Russia
As a result of increased toxic gas production in chemical industry and its influence on human health an effective detection of CO2, NO2, NO, NH3, and other gases becomes a crucial task in environmental safety. The most spread gas sensors are based on organic or inorganic thin films, however, they have some drawbacks, such as low selectivity and high power consumption. In contrast, optical sensors are potentially more selective and have fast response time. Optical gas sensors based on organic thin films can operate at room temperatures without external thermal stabilization. Among promising starting compounds for NO2 gas detection phthalocyanines (Pc) have found good application due to their thermal and chemical stability, as well as low production costs.

TuR9-p15
Eu3+−doped transparent lead fluoroborate glass-ceramics
T.S. Soldatova, E.V. Zhukova, A.V. Khomyakov, O.B. Petrova; Mendeleev Univ. of Chemical Technology, Russia
Lead fluoroborate glasses doped with Eu3+ were synthesized. Glass-ceramics were made by heat-treatment. In a glass-ceramic the rare-earth ions were located on the nanosized particles. The optical properties were studied. The fluorescence decay lifetime of dye in asbestos is longer that in the bulk material. The optical properties of the cyanine dye in nanotubes of the chrysotile asbestos are studied. The fluorescence decay lifetime of dye in asbestos is longer that in the bulk material. The optical properties of the cyanine dye in nanotubes of the chrysotile asbestos are studied. The fluorescence decay lifetime of dye in asbestos is longer that in the bulk material.

TuR9-p16
Yb3+−doped glasses and glass ceramics based on Bi2O3 and GeO2 in different proportions
I.V. Stepanova, A.V. Khomyakov; Mendeleev Univ. of Chemical Technology, Russia
The glass ceramics was produced by heat-treatment of xBi2O3-(1-x)GeO2 glasses doped with Yb3+. Both glasses and glass ceramics were researched by X-ray diffraction analysis, optical and luminescence spectroscopy methods. The glass ceramics contain no xBi2O3+(1-x)GeO2 phases according to xinitial oxidation ratio. It’s shown that spectral properties depend on only Yb3+ ions concentration and do not affected by glass matrix.

TuR9-p17
Synthesis condition influence on stability of metal-organic phosphor based on 8-hydroxyquinoline
A.A. Akhutina, A.V. Khomyakov, R.E. Avetisov, I.Ch. Avetissov; Mendeleev Univ. of Chemical Technology, Russia
Tris(8-hydroxyquinoline) aluminum (Al3q) powders were synthesized under controlled 8-Hq partial pressure. It was shown that the P8-Hq increase resulted to changes in the photoluminescence characteristics and the life-time of the Al3q phosphor.

TuR9-p18
Synthesis and study of efficient up-conversion luminophores based M1-x-yYbxEryF2+x+y (M = Ca, Ba) for biomedical applications
M.N. Mayakova, E.O. Soloyev, R.G. Vahrenev, S.V. Kuznetsov, D.V. Pomarina, N.I. Kuznetsova, V.Y. Rydov, V.V. Voronov, P.P. Fedorov, 1 - Prokhorov General Physics Inst. RAS, 2 - Mendeleev Univ. of Chemical Technology, 3 - Lomonosov Moscow State Univ., Russia
Study of phase composition, morphology and up-conversion luminescence of ytterbium- and erbium-doped barium and calcium fluoride nanopowders has revealed the influence of their synthetic conditions on their up-conversion luminescence energy yields.

TuR9-p19
New type of nanocomposite material for SERS
N.V. Mitetela, A.I. Maydzykovsky, S.E. Svakhovsky, A.A. Tepanov, A.D. Garton, T.V. Murzina; Lomonosov Moscow State Univ., Russia
We experimentally observe effects of second harmonic generation, nonlinear absorption in porous quartz with metallic nanoparticles in order to find a possibility to make a new device for SERS-experiments.

TuR9-p20
The obtaining and deposition of silicon nanoparticles: size control, luminescence in visible spectra
A. Osipov, A. Kucherik, S. Kuroskyuk, A. Elyukhina, B. Chichkov; 1 - Stolovet Vladimir State Univ., Russia, 2 - Laser Zentrum Hannover e.V., Germany
In this work we have used a CW-laser ablation for nanoparticle synthesis. Laser ablation allow to control particle sizes according to the irradiation parameters. For the particle deposition we have used the nanosecond laser. This method of deposition allows to sediments the silicon clusters very precisely.

TuR9-p21
Optical properties of cyanine dyes in the nanoporous chrysotile asbestos
The optical properties of the cyanine dye in nanoparticles of the chrysotile asbestos are studied. The fluorescence decay lifetime of dye in asbestos is longer that in the bulk material. The optical properties of the cyanine dye in nanoparticles of the chrysotile asbestos are studied. The fluorescence decay lifetime of dye in asbestos is longer that in the bulk material.

TuR9-p22
Novel transparent glass-ceramics based on CoLi(Al,Ga)5O8 nanocrystals for passive Q-switching of Er lasers
Transparent glass-ceramics of the lithium gallium aluminosilicate system based on cobalt-doped Li(Al,Ga)5O8 spinel nanodoped crystals were developed. Their structure and optical properties were evaluated. Passive Q-switching of an Er Yb/glass laser with 1 mJ/45 ns pulses at 1.54 μm is realized.

TuR9-p23
Photodesorption of Rb atoms from glass and sapphire surfaces
We presents results of ours researches and calculations of dependence between kinetic energy of desorbed atoms and desorb pulse wavelength.

TuR9-p24
Glass-ceramics with Yb,Tm:YNbO4 nanocrystals: novel NIR-to-NIR upconversion phosphor
Transparent lithium aluminosilicate glass-ceramics containing nanosized (8-15 nm) crystals of rare-earth orthophosphates, Yb,Tm:YNbO4, and β-quartz solid solutions are synthesized. Under the near-IR excitation by an InGaAs diode, they demonstrate intense near-IR upconversion luminescence at ~800 nm. The efficiency of Yb3+ → Tm3+ energy transfer is ~90%.
WeR1-14 Invited
09:00-09:30
Octave spanning pulses based on adiabatic frequency conversion
H. Suchowskis, Tel Aviv Univ., Israel
Adiabatic frequency conversion, a recent advance in frequency conversion, allowed the achievement of efficient scalable and robust broadband frequency conversion. In recent years, it was successfully applied to the conversion of ultrashort pulses, demonstrating near-100% efficiency for ultrabroadband spectrum. Also, it offers pulse shaping for coherent control experiments. Here we review the development and recent advances in the field.

WeR1-15
09:30-09:45
Novel approach table-top Vis-NIR OPCPA system
R. Daniellieczuk1, A. Zaukevičius1, A. Michailovas2,3, N. Rusteika1; 1 - Ekspla Ltd., 2 - Center for Physical Sciences and Technology, Lithuania
In this work we developed femtosecond tunable wavelength OPCPA system with a novel front-end. Picosecond all-in-fiber source is used for seeding DPSS pump laser and parametrical amplifier based white light supercontinuum generator. We measured up to 0.85 mJ and less than 40 fs pulses at the system output performing the wavelength tuning from 680 nm to 930 nm.

WeR1-16
09:45-10:00
Diode-pumped solid state Nd:KGW laser for eye-safe optical parametrical oscillator
Compact eye-safe pulsed optical parametrical oscillator based on Nd:KGW laser with two orthogonal diode pump modules has been developed. The oscillator is characterized by output energy at 1.57 μm in excess of 30 mJ and the pulse repetition rate up to 20 Hz.

WeR1-17
10:00-10:15
Front-end system for few cycle OPCPA amplification
I.V. Mukhin, U. Kuznetsov, E.A. Perevezentsev, O.V. Palashov; Inst. of Applied Physics RAS, Russia
A front-end laser system with optical synchronization is developed for OPCPA amplification. A pulse duration in femtosecond part is less than 35 fs and this signal may be compressed to few cycle duration. The signal in pump part is amplified to 0.1 mJ for further developing of high energy pump laser based on Yb:YAG disks.

WeR1-18
10:15-10:30
High power picosecond Nd:YVO4 laser with 671, 447 and 224 nm output at 300 kHz repetition rate
A.M. Rodin1,2, A. Michailovas1,2, G. Chazevskis1; 1 - Center for Physical Sciences and Technology, 2 - UAB Ekspla, Lithuania
Fundamental output radiation from the NIR high power ps Nd:YVO4 laser was converted to the 2nd, 3rd and 6th harmonics at 671, 447 and 224 nm wavelength with the average power in excess of 6 W, 5 W and 0.7 W respectively.

WeR1-19
10:30-10:45
Spatiotemporal distortions in nonlinear optical parametric chirped-pulse amplifiers
A. Giree1,2, F.J. Furch1, M. Mero1, M.J.J. Vrakking1; 1 - Max Born Inst., Germany, 2 - Amplitude Technologies, France
We perform numerical simulations to study spatiotemporal distortions in nonlinear optical parametric chirped-pulse amplifiers under different amplification conditions and show that pulse front tilt is always present.

WeR1-20
10:45-11:00
Compact 1 mJ high repetition rate eye-safe OPO laser
V. V. Vitkin, A.V. Polischuk, A.A. Krylov, V.M. Polyakov; ITMO Univ., Russia
A compact high repetition rate eye-safe laser for atmospheric lidar was developed. The device is Nd:YAG laser with KTP OPO, wavelength is 1.57 μm, Q-switched pulse energy is 1.1 μJ and pulse duration is 10 ns. The laser rod and laser diodes are conductive cooled. The 100 Hz operation with good beam quality is demonstrated.

- Coffee Break -

WeR1-21 Invited
11:30-12:00
Subharmonic GaAs OPO pumped by a Cr:ZnS laser with an instantaneous bandwidth 3.6-5.6 μm
V.D. Smolik1,2, V. Sasiliev1, P.G. Schunemann1, S.B. Mirnov3, K.L. Vodopyanov4; 1 - Inst. of Applied Physics RAS, 2 - Lobachevsky State Univ. of Nizhniy Novgorod, Russia, 3 - BAE Systems, 4 - Univ. Alabama Birmingham, United States
High-power (110 mW) mid-IR output suitable for producing ultra-broadband frequency combs in the mid-infrared portion of the spectrum was produced in a subharmonic optical parametric oscillator (OPO) based on orientation patterned GaAs. The OPO was synchronously pumped by a compact 0.5-W femtosecond Cr:ZnS oscillator with the central wavelength 2.38 μm at pulse repetition frequency 175 MHz.

WeR1-22
12:00-12:15
Optimization of 37-W Q-switched Ho:YAG laser at 2100 nm pumped by Tm-fiber laser
O.L. Antipov1,2, I.D. Enanov2, R.I. Kositsyn1, A.A. Novikov1, V.V. Sharkov2; 1 - Inst. of Applied Physics RAS, 2 - Lobachevsky State Univ. of Nizhniy Novgorod, Russia
High efficient CW and Q-switched oscillations at 2097 nm were achieved in Ho:YAG laser pumped by a Tm fiber laser. Stable repetitively-pulsed oscillations (with the repetition rate of 10-30 kHz and the pulse duration of 26-50 ns) in a high-quality beam with the average power up to 37.5 W and total efficiency of 67.5% were obtained.

WeR1-23
12:15-12:30
Comparison of Tm:YLF laser with and without composites in thermal stress and laser performance
P.B. Meng1,2, F.J. Yan1, B.Q. Yao1; 1 - Beijing Inst. of Space Mechanics & Electricity, 2 - Harbin Inst. of Technology, China
Compared with non-composite Tm:YLF laser theoretically and experimentally, diode-pumped composite Tm:YLF laser's peak stress and output power was decreased and increased about 86% and 42.3%, respectively, generating 37 W at 42.4% slope-efficiency and M2<2.

WeR1-24 Invited
12:30-13:00
High-power femtosecond Kerr-lens mode-locked thin-disk oscillators
O. Pronin; Max-Planck Inst. of Quantum Optics, LMU Munich, Germany
Recent progress in the development of femtosecond thin-disk oscillators is reported. A novel mode-locking technique relying on distributed Kerr-lenses is presented. Applications such as the generation of high-power mid-infrared and extreme ultraviolet frequency combs are addressed.

WeR1-25
13:00-13:15
Laser action of pulsed Nd-YAG laser with multilopov cavity and laser pulse injection diffusely reflected from plasma mirror
V.F. Lebedev; ITMO Univ., Russia
Self-Q-switch and self-Q-switched mode lock regimes with multilopov phase-conjugate cavity were obtained. It was shown that these regimes are caused by diffusely reflected laser pulse from plasma laser that produced via interaction of the focused laser beam with solid target.
WeR2-01 Invited
11:30-12:00
Optically pumped rare gas lasers
M.C. Heaney, Emory Univ., United States
WeR2-02 Invited
12:00-12:30
High power lasers application for the substances rheological properties research
V. Rogachev, RFNC – VNIIEF, Russia
Experimental setup and results of laser experiments on researching rheological properties of various substances are discussed.

WeR2-03 Invited
12:30-13:00
High power femtosecond laser systems for industrial and biomedical applications
G.N. Kim, J. Yang, B. Lee, B. Hong, S.A. Chizov\(^1\), E.G. Sall\(^1\), V.E. Yashin\(^1\); 1 - Korea Electrotechnology Research Inst., Republic of Korea, 2 - Vavilov State Optical Inst., Russia
We presented that a high power femtosecond laser system was developed and applied for industrial applications. The system is based on a MOPA structure of master oscillator and dual-crytall regenerative amplifier in the configuration of chirped pulse amplification. It is capable to operate with average power of 15W at the repetition rate of 1MHz and pulse length of 250fs. Details of laser system will be presented and its industrial application, for example, making a very small hole on a diamond will be discussed.

WeR2-04 Invited
13:00-13:30
«White light» mid-infrared gas laser systems
Mid-infrared laser systems consisting of CO and CO2 lasers with frequency conversion of laser radiation in nonlinear crystals were developed. The laser systems can operate within wavelength range from 2.5 to 16.6 microns, which by analogy with the visible range can be called «white light» in the mid-IR range.

- Lunch Break -

WeR2-05 Invited
15:00-15:30
High power laser system of a visible range with output XeF(C-A) amplifier
C. Laser\(^1\), S.V. Alekseev\(^1\), N.G. Ivanov\(^1\), M.A. Mesyats\(^1\), L.D. Mikheev\(^1\), Y. Gao, Y. Wang, A. Chan, M. Dawson, B. Greene; EOS Space Systems Pty Ltd, Australia
It is not objective of report to enumerate all known media and all domestic manufacturers of Tb- and Yb-doped media. Objective of report is to draw attention to the progress made in the development of such materials in Russia and to share results (TSAG, Tb2O3, NTF, ...) obtained by our team over the past couple of years.

WeR2-06 Invited
15:30-16:00
Characterization of Tb- and Yb- doped media, produced in Russia
O.V. Palasov; Inst. of Applied Physics RAS, Russia

WeR2-07 Invited
16:00-16:30
Modern compensation methods of thermally induced optical distortions
I.I. Snegirev, Inst. of Applied Physics RAS, Russia
The report presents an overview of compensation methods of thermally induced depolarization and thermal lens in optical elements of high-average power lasers. An analytical description of the compensation process is presented and the question about the possibility of a complete compensation of optical distortion is considered. Using the suggested methods has allowed realizing optical components for lasers with high average power with record characteristics.

WeR2-08 Invited
16:30-17:00
New generation of ultra-high peak and average power laser systems with thin disk Ti:sapphire amplifiers
V. Chykov\(^2\), H. Cao\(^1\), R.S. Nagymihaly\(^1\), M. Kalashnikov\(^3\), K. Osavy\(^1\); 1 - EL-I Hu Nkt., Hungary, 2 - Max-Born-Inst., Germany
New technology utilized the combination Extraction During Pumping (EDP) method and thin disc amplifiers (EDP-TD) applied to PW-level Ti:Sapphire laser systems for increasing of the repetition rate will be presented. Proof-of-principal experiment results, when EDP-TD final amplifier was inserted in to 100TW/10Hz laser system will be discussed.

- Coffee Break -

Location: Petrov-Vodkin 1 Room, floor 2, 17:30 – 18:45
High Power Lasers III
Session Chair: Vladimir E. Yashin, Vavilov State Optical Inst., Russia
WeR3-22 Invited 09:00-09:30
Brillouin and Raman scattering in silicon and silicon nitride photonic integrated circuits
R. Boets; Ghent Univ., Belgium
Silicon photonics has gained considerable momentum as a platform for the on-chip integration of advanced photonic functions on the basis of CMOS-technology, especially in the fields of telecom and datacom. Here we report on the use of this platform for photon-phonon interaction in nanophotonic silicon or silicon nitride waveguides. We discuss the first demonstration of Brillouin gain in silicon waveguides as well as Raman spectroscopy taking advantage of silicon nitride photonic circuits.

WeR3-23 09:30-09:45
AFM visualization of half-disk WGM laser modes
P.A. Alekseev1, M.S. Dunkevsky1, A.M. Manakhy2, V.V. Dudevlev1, G.S. Sokolovskii1, A. Baranov, R. Teissier1; 1 - Ioffe Inst., Russia, 2 - ITMO Univ., Russia, 3 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 4 - Inst. d’Electronique du Sud, France
By means of atomic force microscopy (AFM) the spatial mapping of the laser intensity was performed on the cleavage of the whispering gallery modes (WGM) half-disk laser. The study was carried out in the near- and far-field regime. It showed a strong spatial divergence of different modes in the laser.

WeR3-24 Invited 09:45-10:15
Compact external cavity laser with photonic crystal cavity reflector
L. O’Faolain1,2, A.A. Liles1, A.P. Bakoz2,3, A.A. Gonzalez-Fernandez1, S.P. Hegarty1,2; 1 - Univ. St. Andrews, United Kingdom, 2 - Tyndall National Inst., Ireland, 3 - Cork Inst. of Technology, Ireland
Energy efficient Wavelength Division Multiplexing (WDM) is the key to satisfying the future bandwidth requirements of datacentres. As the silicon photonics platform is regarded the only technology able to meet the required power and cost efficiency levels, the development of silicon photonics compatible narrow linewidth lasers is now crucial. We discuss the requirements for such laser systems and report the experimental demonstration of an external-cavity hybrid lasers consisting of a III-V Semiconductor Optical Amplifier and Photonic Crystal (PhC) based resonant reflector.

WeR3-25 10:15-10:30
Photonic crystal reflector laser
A.P. Bakoz1, A.A. Liles1, E.A. Vlasov1, I.O. Foolan1, G. Hueyt1, S.P. Hegarty2, 1 - Cork Inst. of Technology, Ireland, 2 - Tyndall National Inst., Ireland, 3 - Univ. St Andrews, United Kingdom, 4 - ITMO Univ., Russia, 5 - Univ. Libre de Bruxelles, Belgium
We describe the lasing characteristics of a semiconductor laser device, utilising a reflective semiconductor amplifier as a combined gain/mirror component, and a high Q photonic crystal reflective filter as the second cavity mirror.

WeR3-26 Invited 10:30-11:00
Photonic crystal surface emitting lasers – coherent arrays and external feedback
R.J.E. Taylor1, G. Li2, P. Ivanov1, D.T.D. Childs1, B.J. Stevens1, N. Babazadeh1, G. Ignatova1, N. Kano1, T. Tanemura1, R.A. Hogg2; 1 - Univ. of Tokyo, Japan, 2 - Univ. of Glasgow, United Kingdom, 3 - Univ. of Sheffield, United Kingdom
Electronic control of coherence in 2D arrays of photonic crystal surface emitting lasers is discussed.

- Coffee Break -

WeR3-27 Invited 11:30-12:00
Light sheet microscopy for visualising fast biological dynamics in 3D
High resolution and fast dynamic visualisation in 3D can be achieved by combining light sheet and wavefront coding. This results in a system that allows the light sheet to be positioned at different distances from the focus plane. By scanning the light sheet through the sample, it is possible to produce high-resolution volumetric images of living samples at unprecedented speeds.

WeR3-28 Invited 12:00-12:30
The use of angular momentum of light for characterization of biological tissues
A. Bakov1, A. Popov1, A. Doronin1, I. Meglinski1; 1 - Univ. of Oulu, Finland, 2 - Yale Univ., United States
We investigate the applicability of use of Laguerre-Gaussian laser beams for optical biopsy. In current presentation a Monte Carlo based numerical simulation of complex vector light beams propagating that undergoing anisotropic scattering in turbid tissue-like scattering media will be presented in comparison with the plane wave light beams. Several basic phenomena associated with the anisotropic scattering of the vector light beams in turbid media are discussed, including the mutual influence of light’s polarization and its directional awareness during the multiply scattering.

WeR3-29 12:30-12:45
Development of a US laser system for the gravitational wave mission LISA
J. Camp, K. Numata; NASA Goddard Space Flight Center, United States
A highly stable and robust laser system is a key component of the space-based, Gravitational Wave mission LISA architecture. In this talk I will describe our plans to demonstrate a TRL 5 LISA laser system at Goddard Space Flight Center by 2017. The laser system includes a low-noise oscillator followed by a power amplifier. The oscillator is a low-mass, compact 10 mW External Cavity Laser, consisting of a semiconductor laser coupled to an optical cavity, built by the laser vendor Redfern Integrated Optics. The amplifier is a diode-pumped Yb fiber with 2.5 W output, built at Goddard. I will show noise and reliability data for the full laser system, and describe our plans to reach TRL 5 by 2017.

WeR3-30 12:45-13:00
Conical refraction with low-coherent light sources
G.S. Sokolovskii1, V.V. Mylnikov2, S.N. Losev3, K.A. Fedorova1, E.U. Rafailov1; 1 - Ioffe Inst., Russia; 2 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 3 - Uni. Libre de Bruxelles, Belgium
We report on conical refraction (CR) experiments with low-coherent light sources such as light-emitting diodes (LEDs) that demonstrated different CR patterns. Variation of the pinhole size from 25 to 100 μm reduced the spatial coherence of the LED radiation and resulted in disappearance of the dark Poggendorf ring. This is attributed to the interference nature of the Lloyd's distribution.

WeR3-31 Invited 13:00-13:30
All semiconductor akinetic swept source for optical coherence tomography
Z. Chen1, M. Bonesi1, H. Sattmann1, L. Ginner1, R. Leitgeb1, E. Hoover1, K. Nammari1, M. Crawford2, J. Ensor1, M. Mannenmaa, W. Drexler1; 1 - Medical Univ. Vienna, Austria, 2 - Insight Photonics Solutions, Inc., United States
All-semiconductor, all-electronic tunable, akinetic (without any form of movement in the tuning mechanism) compact and cost-effective swept source laser technology is used for demonstrating OCT and OCT angiography at 1550nm and 1300 nm with unprecedented imaging performance.

- Lunch Break -
WeR3-32 Invited
Broadly tunable dual-wavelength InAs/GaAs quantum-dot laser for THz generation
K.A. Fedorova1,2,3, A.A. Gorodecky1,3, D.A. Livshits1, N.A. Maleev4, S.A. Blkhin1, K.K. Sobolev1,2, M. Ustinov1, E.U. Rafailov1
1 - Univ. of St Andrews, United Kingdom, 2 - Inst. of Ultrahigh Frequency Semiconductor Electronics, Russia, 3 - Microelectronics, Research Engineering Center RAS, Russia

WeR3-33
15:30-15:45
Broadly tunable dual-wavelength InAs/GaAs quantum-dot laser for THz generation
K.A. Fedorova1,2,3, A.A. Gorodecky1,3, D.A. Livshits1, N.A. Maleev4, S.A. Blkhin1, K.K. Sobolev1,2, M. Ustinov1, E.U. Rafailov1
1 - Univ. of St Andrews, United Kingdom, 2 - Inst. of Ultrahigh Frequency Semiconductor Electronics, Russia, 3 - Microelectronics, Research Engineering Center RAS, Russia

WeR3-34 Invited
15:45-16:15
Generation of intense sub-100 fs pulses from Yb-doped solid-state lasers based on nanostructured semiconductor saturable absorbers
A. Major; Univ. of Manitoba, Canada

Results on dual action of semiconductor saturable absorber and Kerr-lens mode locking of Yb-ion doped solid-state lasers will be reported. Using both quantum-dot and quantum-well nanostructured semiconductor saturable absorbers, the developed approach enabled demonstration of record high performance of Yb:KGW and Yb:CALGO lasers among other Yb-ion materials in sub-100-fs regime with peak powers ranging from >100 kW to >1 MW.

WeR3-35
16:15-16:30
Generation of THz radiation in epitaxial InGaAs films on InP substrates of various crystallographic orientations
G.B. Galiev1, G.H. Kitayev1, E.A. Klimov1, V.V. Kornienko1, K.A. Kuznetsov1, A.N. Klishkov1, S.S. Pushkarev1; 1 - Inst. of Ultrahigh Frequency Semiconductor Electronics RAS, 2 - Moscow State Univ., Russia

WeR3-36
16:30-16:45
Wavelength-swept laser based on semiconductor optical amplifier for dynamic optical fiber sensors
M. Yong Jeon, J. Woo Park, M. Ock Ko; Chungnam National Univ., Republic of Korea

WeR3-37 Invited
Directly-modulated lasers monolithically integrated with an optical filter for long-range access network
N. Chiman, S. Joshi, J.-G. Provost, K. Mekhazni, F. Lelarge; 3-5 Lab, a joint laboratory Nokia Bell Labs France, Thales Research and Technology, CEA Leti, France

The future access networks requires to develop key innovative transmitters operating at 10Gb/s around 1550nm and capable of transmitting data in extended reach passive optical networks (>60km). In this contribution, we demonstrate a novel cost-effective transmitter based on the monolithic integration on InP substrate of a directly modulated laser and a ring resonator compatible with the NGPON2 requirements.

WeR3-38 Invited
Light interaction with colloidal photonic crystals: theoretical and experimental studies
S.O. Yurchenko, E.A. Gorbunov, K.I. Zaytsev; Bauman Moscow State Technical Univ., Russia

WeR3-39 Invited
Extreme events in laser systems
M. Aguiro1, C. Bonzato1, M. Kovalsky2, A. Hrala2, C. Metayer2, J.R. Tredicce1; 1 - CEILAP, CITEDEF‑CONICET, Argentina, 2 - Univ. de la Nouvelle Calédonie, France

WeR3-40 Invited
Slow and Fast Graphene Oxide Photonics
R. M. De La Rue1, C.K. Lai2, W.H. Lim2, H. Ahmad2, WY. Cheong2, YK. Yap3; 1- Univ. of Glasgow, United Kingdom, 2 - Univ. of Malaya, Malaysia, 3 - Heriot-Watt Univ, Malaysia

Graphene oxide is a 2D material that can be used in a variety of applications of photonics - both as a mono-layer and in multi-layer formats. The presentation will explore how the anisotropic material properties of graphene oxide multi-layers can be exploited to obtain useful photonic functionality, with response times that can be very fast – but also much slower.

- Coffee Break -
WeR4-01 Invited
Measurements of the second hyperpolarizability and nuclear rotational response of liquids and gases
D.J. Hagan, M. Reichert, F. Zhao, E.W. Van Stryland, Univ. of Central Florida, United States
A beam deflection technique is used to separate the bound-electronic and molecular rotational components of nonlinear refractive transients of molecular gases. Coherent rotational revivals from air and carbon disulfide (CS2) vapor are identified. Dephasing rates, rotational and centrifugal distortion constants of each species are measured. Polarization-resolved studies allow unambiguous measurement of the bound-electronic nonlinear refractive index of air and second hyperpolarizability of CS2. Agreement between gas and liquid phase second hyperpolarizability measurements is found using the Lorentz-Lorenz local field correction.

WeR4-02 Invited
Ultrafast modulators of light beams based on pristine or modified single-wall carbon nanotubes
E.D. Obraztsova1, R.A. Arutyunyan1, P.A. Obraztsov2, E.P. Khartonova3, D.-I. Liu4, 1 - Prokhorov General Physics Inst. RAS, Russia, 2 - National Taiwan Univ. of Science and Technology, Taiwan
In this work a procedure for formation of homogeneous thermostable composites "polyimide + single-wall carbon nanotubes" has been developed. With such composite (used as a saturable absorber) the mode-locking regime was realized in Yb fiber laser.

WeR4-03 Invited
Two-dimensional semiconductors for nonlinear optical modulation
J. Wang, Shanghai Inst. of Optics and Fine Mechanics CAS, China
Realized that the sizable and thickness-dependent bandgap offers transition metal dichalcogenides (TMDCs) a huge potential in the development of photonic devices with high performance and unique functions, we studied extensively the ultrafast NLO property of a range of TMDCs. TMDCs with high-quality layered nanosheets were prepared using liquid-phase-exfoliation technique. Ultrafast saturable absorption, two-photon-absorption were observed from the 2D nanostructures.

WeR4-04
Spectral shift of the transparency line of a semiconductor multilayer resonator under pulsed laser radiation
A.A. Ryzhov1, E.I. Gacheva1, S.Yu. Mironov1, A.K. Poteomkin1, V.V. Zelenogorsky1, A.V. Andrianov1, 1 - ITMO Univ., Russia
Multilayer microresonators are of interest as low-threshold nonlinear optical devices. Such a resonator for near IR in the form of GaAs/AlAs heterostructure was fabricated and tested. The spectral shift of its transparency line accompanied by the transmittance peak reduction was experimentally observed as a function of the laser pulse energy. Optical limiting characteristic of the resonator was measured as well.

WeR4-05
Enhancement of optical limiting by polymer doping of aqueous nano-carbon suspensions
A.V. Sokolov1, I.M. Kislyakov1, S.A. Povarov2, C.S. Yelleswarapu3, 1 - ITMO Univ., Russia, 2 - Vavilov State Optical Inst., Russia, 3 - Univ. of Massachusetts Boston, United States
We report on augmenting materials for optical limiting of laser power radiation by introduction of polymers into nano-carbon aqueous suspensions, the throughput being controllable healing of the solid optical material and higher bleaching resistibility of the fluid state.

WeR4-06 Invited
Holographic recording of relief-free infrared diffractive optics based on semiconductor nanomaterials
S.G. Krivoshlykov, ANTEOS, Inc., United States
A broad technology platform for holographic recording of various infrared diffractive optical elements in semiconductor materials for application in spectral devices, telecom components and lasers is described. The room temperature process of photo-modification of the material refractive index at low light intensity is applied to fabrication of the infrared diffractive optics based on polycrystalline ZnSe and single-crystal GaAs semiconductor materials.

WeR4-07
Interference comb-spectroscopy with increasing sensitivity
S.A. Pulkin1, E.N. Borisov1, D.V. Venediktov1, V.Yu. Venediktov2, M.V. Balabas3, S. Saveleva1, S.V. Uvarova1, I.N. Strelinkov2, V. Arnaudov2, V. Shevtsov4, O.Tret’yak5, A. Kolchin6, 1 - Vavilov State Optical Inst., Russia, 2 - St. Petersburg State Univ, 3 - St. Petersburg State Electrotechnical Univ., Russia
The wide spectrum from comb – generator of femtosecond laser was applied for illuminating of Michelson interferometer with atomic vapor. The method of holographic interferometry with increasing sensitivity using phase modulator was applied for treatment of digital hologram.

WeR4-08
Digital correction of distortions in holographic interferometer
A.A. Sveruygin1, S.A. Pulkin2, I.M. Tursunov3, D.V. Venediktov4, V.Yu. Venediktov5, 1 - St. Petersburg State Electrotechnical Univ., 2 - St. Petersburg State Univ, 3 - ITMO Univ., Russia
The paper considers the use of holographic interferometer for hologram recording with correction of distortions. This is done with spatially combined interferograms using matrix spatial light modulator and digital image processing of the interferograms recorded by CMOS camera.

WeR4-09
3D ellipsoidal beam shaping in laser drivers for photoinjectors
E.I. Gacheva1, S.Yu. Mironov1, A.K. Poteomkin1, V.V. Zelenogorsky1, A.A. Khazanov1, M. Krasilnikov1, F. Stephan1, 1 - Inst. of Applied Phys. RAS, Russia, 2 - Deutsches Elektronen-Synchrotron, Germany
Ellipsoidal laser pulses with central wavelength of 1030 nm and duration of 40 ps were obtained. It is expected that after conversion into the fourth harmonic this will reduce appreciably emittance of the electron beam, injected by the laser.

WeR4-10
Direction measurement by means of dynamic goniometer method
Yu.V. Filatov1, E.D. Bohman2, P.A. Ivanov3, R.A. Larichev2, P.A. Pavlov4, St. Petersburg State Electrotechnical Univ., Russia
The angle measurement system intended for measuring angles between some directions set in the space by reflectors is presented in the report. The system operates by continuous rotation of platform with the autocollimating null-indicator. The angle measurements are provided by the ring laser or the holographic optical encoder.

WeR4-11
The influence of rotation on the parameters of the whispering gallery modes resonator
Yu.V. Filatov1, E.V. Shalymov2, V.Yu. Venediktov3, 1 - St. Petersburg State Electrotechnical Univ., 2 - St. Petersburg State Univ, Russia
The review of the various effects arising in resonators of whispering gallery modes is provided in the paper.
Super-Intense Light Fields and Ultra-Fast Processes I

Session Chair: Alexander A. Andreev, Vavilov State Optical Inst., Russia, MBI, Germany, ELI-ALPS, Hungary

WeR5-01 Invited
Science with a petawatt laser
L. Rosa, Centro de Láseres Pulsados, Spain
What kind of new science can be done with a petawatt laser? There are some applications as particle acceleration, extreme plasmas, or basic QED analysis. But each of them depends on many laser parameter, much more than just an outrageous laser peak power. Probably it is the time to begin to design ad hoc lasers for each of the applications.

WeR5-02 New generation of ultra-high power laser systems for super-intense light fields
V. Chvykov1, M. Kalashnikov2, K. Osowy1; 1 - ELI-Hu NikiFT., Hungary, 2 - Max-Born-Instit, Germany
Super-intense light field can be produced combining three properties inherent to the laser light which are the high energy, short pulse duration and sharp focusing. Our report will be devoted all of them, namely higher energy extraction and shortening of the pulse duration of the final large aperture amplifiers and utilization of the adaptive optics for wave front compensation.

WeR5-03 Beam combining with nonlinear frequency conversion for petawatt class laser systems
S.A. Frolov, V.I. Trunov; Inst. of Laser Physics SB RAS, Russia
Beam combining with nonlinear frequency conversion for noncollinear second harmonic generation for high energy pump beams and multibeam pumped parametric amplification are investigated theoretically. Prospects of creation of high repetition rate petawatt class laser system with parametric amplification stages are discussed. Parasitic wave mixing effects influence are analyzed with numerical simulation.

WeR5-04 Characterization of TW-power UV sub-picosecond pulses produced at GARPU-MTW Ti:Sapphire/KrF laser facility for target irradiation experiments
V.D. Zvorykin, A.A. Ionin, A.O. Levchenko, D.V. Mokrousova, L.V. Seleznev, A.V. Shutov, E.S. Sunchugovahev, N.N. Ustinovskii, Lebedev Physical Inst. RAS, Russia
Initial experiments on targets irradiation by sub-picosecond UV pulses with peak intensity ~2*10^16 W/cm^2 at GARPU-MTW Ti:Sapphire / KrF laser facility are reported.

WeR5-05 Femtosecond Raman lasers with double pulse pumping
N.V. Didenko, A.V. Konyashchenko, P.V. Kostryukov, L.L. Losin, V.S. Pazyuk, S.Yu. Teryakaev, V.V. Molchanov, S.I. Chizhkov, K.B. Yashkov; 1 - Lebedev Physical Inst., 2 - Avesta Ltd., 3 - National Univ. of Science and Technology (MISIS), Russia
We present our experimental research on femtosecond Raman lasers pumped by two orthogonally polarized chirped pulses. It was developed technique for generation of femtosecond Stokes pulses with duration closed to pump one. The shortest 40 fs Stokes pulses were generated at stimulated Raman scattering in hydrogen.

WeR5-06 Invited
Compression of powerful femtosecond pulses under compressor
V.N. Grinburg, S.Yu. Mironov, I.V. Yakovlev; Inst. of Applied Physics RAS, Russia
Spectrum broadening by self-phase modulation (SPM) may be used for increasing PW-class laser pulse power. The influence of high-order spectral phase on SPM and compression of intensity pulses will be discussed. The results of compression of sub-PW pulses of the PEARL laser will be presented.

- Coffee Break -
WeR7-01 Invited
15:00-15:30
Application of tunable diode laser absorption spectroscopy for planetary studies, on lander board for planned missions to Moon, Mars and Venus

I.I. Vinogradov1, V.V. Barke1, V.A. Kazakov1, Yu.V. Lebedev1, A.V. Rodin1, O.Z. Rostov2, G.V. Benderov2, A.Y. Klimchali3, V.M. Semenov4, A.A. Zakharchova5, A.V. Kalyuzhnaya6, A.I. Nadezhda7, Ya. Yu. Panurovskiy5, V.V. Spirdonova7, J. Cousins7, D. Gurry7, L. Joly7, 1 - Space Research Inst. RAS, Russia, 2 - Moscow Inst. of Physics and Technology, 3 - Russian Space Agency Special Design Bureau of Space Device Engineering of IKI RAS, Russia, 4 - Prokhorov General Physics Inst. RAS, Russia, 5 - Univ. de Reims, France

In a couple of years, researchers of IKI RAS, together with colleagues from MIPT, GPI RAS, and from GSMA team (University of Reims, France) are developing TDALAS instruments for carrying out in situ measurements for several future space missions to our neighbor planets. In the report, we discuss TDALS instrument adaptation to actual lander probes, scheduled for research missions to Moon, Mars and Venus.

WeR7-02 Invited
15:30-16:00
Ozone horizontal resolution spectroscopy using FTIR and TDL techniques for atmospheric research

C. Janssen1, C. Bourisier1, H. Elandaloussy1, P. Jesseck1, M. Minissale1-2, Y. Tél2, T. Zanon2, 1 - LERMA-IPSL, Sorbonne Univ., UPMC Univ Paris 6, CNRS, 2 - Aix Marseille Univ., CNRS3 - Inst. Fresnel UMR 7249, France

Atmospheric remote sensing of ozone is of major concern for understanding atmospheric change and the climate system. We present recent results of ground based atmospheric FTIR measurements that illustrate the limitations of current spectroscopic data. New measurement strategies, which cope with these requirements, and first results based on different high resolution spectroscopic systems are presented, in particular the study of ozone line intensities, pressure-shifts and time-resolved ozone isotope kinetics using an interferometrically stabilized TDL spectrometer and a free running QCL (Quantum Cascade Laser) at 10 μm.

WeR7-03 Invited
16:00-16:15
Carbon monoxide concentration mesurement on the base of GaAsSb heterolaser

Ya. Lebiadok1, D. Kabanov1, Yu. Yakovlev1, A. Irenkon2; 1 - SSPA "Optics, Optoelectronics & Laser Technology", Belarus, 2 - Ioffe Inst. Russia

The method of detection of carbon monoxide on the base of GaAsSb quantum active layer and its characteristics are discussed in the report.

WeR7-04 Invited
16:15-16:30
Ice thickness measurements by Raman & Rayleigh scattering techniue

S.M. Pershin1, V.N. Lednev2, R.N. Yulmetov2, A.F. Bunkin2, M.Ya. Grishin1, 1 - Prokhorov General Physics Inst. RAS, Russia, 2 - National Univ. of Science and Technology MISiS, Russia

An efficient technique for ice thickness measurements by Raman & Rayleigh scattering is suggested. The elastic scattering is used for air-to-sample borders indication but fails to detect floating ice border. The Raman spectroscopy is used to detect interfaces between transparent materials such as ice-water interface. This approach is a promising express and non-invasive technique for remote thickness measurements in field experiments.

WeR7-05 Invited
16:30-16:45
Raman lidar measurements of the alkane molecules concentration

V.G. She Mann1, V.E. Privatlov1; 1 - Novorossiysk Polytechnic Inst., KubSTU, 2 - Peter The Great St. Petersburg Polytechnic Univ. Russia

This paper is about the accounting of the laser line and apparatus function widths in the Raman lidar equation for the hydrocarbon molecules sensing in the atmosphere and an assessment of the relative error of such a concentration measurements. The isometric images are used as a diagnostic. All of the above results show that the laser line width and the of the Raman lidar instrumental function width leads to increase the relative error of the concentration measurements for the studied molecules in the atmosphere in all the ranging distance.

WeR7-06 Invited
16:45-17:00
Coordinate measuring systems based on solid chip and microlasers

A.A. Grishkanich1, D. N. Redka1; 1 - ITMO Univ, 2 - St. Petersburg Electrotechnical Univ. Russia

According to the current great interest concerning Large-Scale Metrology applications in many different fields of manufacturing industry, technologies and techniques for dimensional measurement accuracy show a substantial improvement. Ease-of-use, logistic and economic issues, as well as metrological performance, are assuming a more and more important role among system requirements. The project is planned to create experimental study aimed at identifying the impact of the application of the basic laws of chip and microlasers as radiators on the linear-angular characteristics of existing measurement systems.

- Coffee Break -

JUNE 27 - JULY 1, ST. PETERSBURG, RUSSIA
Nonlinearities for Optical and Terahertz Radiation
Session Chair: Andrey A. Sukhorukov, Australian National Univ, Australia

WeR8-27 Invited
Nonlinear refractive index for crystals in terahertz spectral range
S.A. Balov⁴, A.A. Druzd⁴, K. Dolgoleva⁴, R.W. Boyd⁴; 1 - ITMO Univ, Russia, 2 - Univ. of Ottawa, Canada

We develop a simple analytical model for calculating the vibrational contribution to the nonlinear refractive index n² of a crystal at terahertz frequencies in terms of known crystalline parameters such as the coefficient of thermal expansion, atomic density, and vibrational oscillation frequency of the vibrational modes of the crystal lattice. Theoretical methods of analysis and features of self-action of few-cycle terahertz waves in nonlinear media are discussed.

WeR8-28 Invited
Interaction of intense laser pulses
A.V. Balakin¹, A.V. Borodin¹,², M.S. Dzhidzhoev¹, V.M. Gorkienko¹, M.N. Esaulkov¹, I.A. Zhvanija¹, K.A. Ivanov¹, I.A. Kotelnikov¹, N.A. Kuzeev⁴, I.A. Ozhezerov¹, A.Yu. Sidorenkov¹, A.B. Saveliev¹, P.M. Solyanikin¹, A.P. Shkurinov¹; 1 - Lomonosov Moscow State Univ, Russia, 2 - Inst. on Laser and Information Technologies RAS, Russia, 3 - Budker Inst. of Nuclear Physics RAS, Russia

We present the results of experimental and theoretical study of interaction of intense femtosecond laser pulses with gas cluster beam aimed to the generation of terahertz (THz) and X-ray emission. Clusters were produced by partial condensation of various gases during the expansion through a conical nozzle into vacuum: pure Ar, mixtures CF₂Cl₂+He, Ar+He etc. We analyze the use of two laser pulse excitation schemes in our experiments, single- and two-color geometries (fundamental frequency mixed with its second harmonic) for the generation of high power terahertz (THz) radiation.

WeR8-29 Invited
A method for nonlinear-optical calibration of the terahertz wave spectral brightness
G.Oh. Koteaeva¹, V.V. Kornienko¹, Yu.A. Mitryugov¹, A.N. Penin¹; 1 - Lomonosov Moscow State Univ, 2 - Lebedev Physical Inst. RAS, Russia

Experimental results are presented for the detection of 0.22 THz radiation from a frequency-doubled impact ionization avalanche transit-time (IMPATT) diode. A novel method is discussed for standard-less measurement of the terahertz wave spectral brightness. The method is based on the use of spontaneous parametric down-conversion of light under the nonlinear-optical detection of terahertz wave radiation.

WeR8-30 Invited
Polarization of THz radiation generated during two-color filamentation of arbitrarily polarized laser pulses
V.A. Andreeva¹, M.N. Esaulkov¹, N.A. Panin¹, P.M. Solyanikin¹, V.A. Makarov¹, D.E. Shipilo¹, A.P. Shkurinov¹; 1 - Lomonosov Moscow State Univ, 2 - Inst. on Laser and Information Technologies RAS, Russia, 3 - Univ. Laval, Canada

We examined experimentally and theoretically the polarization of THz radiation generated during dual-color co-propagation of femtosecond laser pulses in gases. We reveal that THz radiation polarization is predominantly defined by the generation of the nonlinear photocurrent in the self-induced laser plasma and ions relatively stable with respect to the change of the initial polarization angle between the 800 and 400 nm fields.

WeR8-31 Invited
Optimization of the laser plasma source of terahertz radiation and interferometric study of its spatio-temporal field distribution
A.A. Usikov¹,², F.A. Chizhov¹, R.V. Volkov¹,², V.V. Bukin¹, S.V. Garnov¹, A.B. Saveliev¹; 1 - Prokhorov General Physics Inst. RAS, 2 - Lomonosov Moscow State Univ, 3 - International Laser Center, Lomonosov Moscow State Univ, Russia

The efficiency of terahertz radiation generation induced by focusing two-color femtosecond laser pulses in the air with different polarization state of the pump fields was studied. A new measurement technique for the detection of the spatio-temporal THz electric field strength distribution in an electro-optic crystal using optical interferometry was demonstrated.

WeR8-32 Invited
Femtosecond supercontinuum generation and superfilamentation in liquids and supercritical fluids
V.M. Bagrait¹, A.M. Gorkienko¹, M.N. Esaulkov², F.V. Potemkin¹, A.V. Rogulskaya; Lomonosov Moscow State Univ, Russia

We for the first time report a generation of multioctave supercontinuum in supercritical CO₂ at 80°C and 1900 bars in pure liquids and have a plateau-like behavior in the range 1400-1900 nm, besides 50% of energy is transferred to the first Stokes component. The increase of laser energy and focusing lens numerical aperture in liquids and the formation of supercontinuum in supercritical water and supercritical CO₂ waves generation, caviation bubble formation and provides tightly divergent supercontinuum.
**POSTER SESSION**

**R1. SOLID-STATE LASERS**

**WeR1-p20**

Evolution of Cr⁴⁺, Cr³⁺ and Cr²⁺ contents in Cr:Mg₂SiO₄ crystals during those oxidizing annealing

K.A. Subbotin; V.V. Slavkina; D.A. Lis; O.N. Lis; E.V. Zharkov; 1 - Prokhorov General Physics Inst. RAS, Russia

The evolution of Cr⁴⁺, Cr³⁺ and Cr²⁺ contents in Cr:Mg₂SiO₄ crystals during those prolonged high-temperature oxidizing annealing have been studied. The concentration of Cr⁴⁺ increases by factor of 1.5-2.5, whereas the parasitic Cr²⁺ ions practically disappear during such annealing. Therefore this post-growth treatment of Cr:Mg₂SiO₄ crystal considerably enhances their spectroscopic properties as the active laser media.

**WeR1-p21**

Quantum cutting of UV emission in Yb doped NaGd(MoO₄)₂ and NaLa(MoO₄)₂ crystals

K.A. Subbotin, Yu.N. Osipova, D.A. Lis, D.A. Nikolaev, E.V. Zharkov, I.A. Scherbakov; 1 - Prokhorov General Physics Inst. RAS, Russia

The efficient 1 μm Yb luminescence in Scheelite-like molybdate Yb:NaGd(MoO₄)₂ and Yb:NaLa(MoO₄)₂ single crystals was found at UV-excitation. The character of dependence of Yb luminescence intensity on its content in the samples at UV excitation indicates that the mechanism of cooperative down-conversion (quantum cutting) switches on at high Yb concentrations. It can be used for increase the efficiency of photovoltaic cells at crystalline silicon.

**WeR1-p22**

Spectroscopic properties of UV active media Ce₃⁺:LiCa₁₋ₓSrxAlF₆

A.A. Shvelev, A.S. Nizamutdinov; V.V. Semashko, M.A. Marisov; Kazan Federal Univ, Russia

Optical absorption spectroscopy studies have shown that mixed crystals Ce₃⁺:LiCa₀.₃Sr₀.₇AlF₆ grown by Bridgeman technique exhibit more than 3 times higher absorption coefficient compared to Ce₃⁺:LiCaAlF₆ sample. An important result is based on the fact that this enhancement was achieved for two types of Ce³⁺ centers in a multisite CeLiSr₀.₃Ca₀.₇AlF₆ system.

**WeR1-p23**

Investigations of a highly efficient and compact diode-pumped Yb:KYW laser

S.A. Kuznetsov; V.S. Pivovarov; 1 - Inst. of Laser Physics SB RAS, Russia

Record high differential efficiency (53.2%) and full optical efficiency (48%) for a multimode diode-pumped Yb:KYW laser have been achieved. Preliminary results of investigations with a distributed Bragg reflector tapered diode laser (DBR TDL) pumping have been obtained. The characteristics of the laser and methods for improving its efficiency are discussed.

**WeR1-p24**

The diode-pumped Nd:SmO₄: self-Raman-parametric laser generation of shortened 300-picossecond pulses without any mode-locking device

N.P. Rakhimov; A.S. Nizamutdinov; V.V. Semashko, M.A. Marisov; S.A. Shnaidman; Kazan Federal Univ, Russia

Here we discuss the opportunity of using Ce-doped fluoride-type crystals as basis for amplitude photonic crystals with modulation of color centers absorption due to complex picture of the dynamic processes occurring in this medium under UV pump. The results of time resolved absorption saturation studies and key parameters of dynamic processes evaluation are presented. Also discuss the results of experiments of creating periodic inhomogeneities of the absorption coefficient of color centers and the gain in mixed crystals with the fluoride structure CaF₂-LuF₃, doped Ce³⁺ and Yb³⁺.

**WeR1-p25**

Light-induced periodic structures and their characteristics in crystals CaF₂-LuF₃ activated by Ce³⁺ and Yb³⁺ ions

N.E. Rakhimov; A.S. Nizamutdinov; D.N. Semashko, M.A. Marisov, S.A. Shnaidman; Kazan Federal Univ, Russia

Investigation of thermal distribution in end-pumped solid-state lasers based on NaGd(MoO₄)₂ and NaLa(MoO₄)₂ crystals

K.A. Subbotin, Yu.N. Osipova, D.A. Lis, D.A. Nikolaev, E.V. Zharkov, I.A. Scherbakov; 1 - Prokhorov General Physics Inst. RAS, Russia

WeR1-p27

Q-switched Tm:Ho:YbAG laser pumped at 1678 nm

Yu.D. Zavartsev, A.I. Zagumennyi, Yu.L. Kalachev, S.A. Kutoy; V.A. Mikhailov, I.A. Scherbakov; Prokhorov General Physics Inst. RAS, Russia

Lasing of the acousto-optically Q-switched Tm:Ho:YbAG laser was realized. Laser demonstrated a good slope ~ 30% and total 11% efficiencies and output power up to 80 mW at pulse repetition rate of 50 kHz. It was found a great influence of upconversion effects on laser efficiency.

**WeR1-p28**

Dual wavelength tunable LiF:F₂-color center laser

P.G. Zverev, N.N. Skryabin; Prokhorov General Physics Inst. RAS, Russia

The dual wavelength LiF:F₂-color center laser working in near IR spectral region with smoothly tunable frequency shift from 1 to 10 THz was demonstrated.

**WeR1-p29**

High-efficiency thin-disk lasers based on Tm:KLu(WO₄)₂ crystals

S.M. Vatsnik, I.A. Vedon; P.F. Kurbatov, A.A. Pavlyuk; 1 - Inst. of Laser Physics SB RAS, Russia

We report on a high-efficiency room-temperature thin-disk lasers based on the monoclinic 5%M:KLu(WO₄)₂ crystals, epitaxial layers, and composite structures all of which are pumped at 355 nm. The output spectra and oscillation performances of various types of thin-diisk active elements are comparatively studied.

**WeR1-p30**

Synthesis, structure and Q-switching behaviour of transparent glass-ceramics based on a mixture of Co₃Zn₂SiO₄ and Co₃ZnO nanocrystals

O.A. Pavlyuk; T.A. Loiko; N.A. Skoptsov, A.A. Zhilin; 1 - Institute of General Physics SB RAS, Russia

Six absorption bands of Tm:SSO crystal were analyzed on the basis of decomposition of each band to a number of Lorentz peaks. The result is performed as a table of peak parameters: (wavelength, height, width).

**WeR1-p31**

The spectroscopic study of a Tm:Sc₂SiO₅ crystal

Yu.D. Zavartsev, A.I. Zagumennyi, Yu.L. Kalachev, S.A. Kutoy; V.A. Mikhailov, I.A. Scherbakov; Prokhorov General Physics Inst. RAS, Russia

WeR1-p32

Spectroscopy of monoclinic Eu:KLu(WO₄)₂: promising crystal for red lasers

E.V. Vileshikova, P.A. Loiko, V.I. Dashkevich, V.A. Orlovich, A.S. Yasukevich, K.V. Yumashev; 1 - Institute of Inorganic Chemistry SB RAS, Russia

WeR1-p33

1.34-µm Nd:YAG laser with an open-loop self-adaptive cavity

M.N. Ershkov; S.A. Solokin, A.E. Shpelev, S.N. Smetanin; 1 - Desytsarev Kovrov State Technical Academy, Russia

For the first time, operation of the 1.34-µm Nd:YAG laser with an open-loop self-adaptive cavity is demonstrated. In free-running and passive Q-switching regimes output energy and temporal laser parameters were studied.

**WeR1-p34**

Investigation of thermal distribution in end-pumped composite laser rods by finite difference method

I. Osman, F. Lakhdir, O. Khala, Ferhat Abbas Univ, Algeria

Temperature distribution of diode-pumped solid-state lasers based on conventional and YAG:Nd:YAG:YAG composite crystal is studied by using of finite difference method. The simulation results show that the peak temperature of composite rod is obviously reduced to less than 49% comparing with non-composite crystal.
Q-switch Er:YLF-laser generation control through dual-wave diode pumping

The results of investigations of multivalve generation of dual-wavelength diode pumped Q-switch Er:YLF-laser are presented. The analysis of 3um range laser generation spectrum using the mathematical model based on rate equations was implemented. The theoretical optimization of power and time parameters of dual-wave diode pumping for achievement of selective lasing on wavelengths 2.66, 2.71, 2.81µm was carried out.

Polarization instability in Nd:YAG laser with linearly polarized pump

We propose a model of a bipolarized solid-state laser, taking into consideration real positions of active Nd³⁺ centers in the unit cells of yttrium aluminum garnet, which adequately describes the basic features of the gain anisotropy effect induced by linearly polarized pump radiation observed in experiment. The model predicts a new type of instability arising due to two competing pump channels.

The research of dispersion mirrors for ultrafast laser system

We report on first nonlinear mirror mode-locked praseodymium based solid-state laser. As an active medium, the Pr:YAlO₃ crystal was used. For mode-locking, a nonlinear BBO crystal together with a properly designed dichroic mirror were employed. Using 1W InGaN pump laser diode, 22 mW of mean output power of the single-longitudinal-mode laser was 1.07 W, and the linewidth was less than 0.1 GHz.

Q-switched 946 nm Nd:YAG laser with cavity dumping

946 nm Nd:YAG end-pumped Q-switched master oscillator with a pulse duration of 3 ns, repetition rate 50 Hz was developed. The problem of obtaining a short pulse associated with a high saturation energy Es = 5.7 J/cm², resolved by using the cavity dumping. The lasing energy was up to 5 mJ.

Principles of influence on the spectral properties of solid-state laser with loop cavity

Principles of spectral narrowing of radiation of laser with loop cavity due to phase conjugation phenomenon are discussed. The gain gratings in active media results in competition in longitudinal modes and spectral selectivity.

Tunable diode-pumped Er:GGAG laser

Lasing and wavelength tunability of laser based on Er-doped mixed gadolinium-gallium-aluminium garnet Gd₃Ga₃Al₂O₁₂ crystal was investigated for the first time. A fiber coupled laser diode (emission 1463 nm) was used for pumping. Tuning was accomplished by MgF₂ birefringent filter placed inside laser resonator. The laser was tunable in three bands in spectral region from 1610 nm to 1650 nm.

Actively Q-switched Nd:YAG twisted-mode cavity laser with a RTP electro-optic modulator

A single-longitudinal-mode Nd:YAG laser was demonstrated using a twisted-mode cavity and an etalon. Stable laser pulses at 10 kHz were obtained with a RTP electro-optic modulator. Under an incident pump power of 8.1 W, the maximum output power of the single-longitudinal-mode laser was 1.07 W, and the linewidth was less than 0.1 GHz.

Longitudinal modes lock-in in YAG:Cr⁴⁺ laser gyroscope at mode locking regime and its influence on lock-in of counterpropagating waves

In this paper we present the results of research the dynamics of longitudinal modes frequencies lock-in on mode locking and its influence on lock-in of counter waves in laser gyroscope on YAG:Cr⁴⁺. We have performed the analysis of mode locking regimes, lock-in of counter waves and possibilities of angular value registration for gyroscopes on YAG:Cr⁴⁺.
WeR5-p01 15:00-19:00
Traps split induced by nonlinear polarization in femtosecond laser trapping
Yu. Jin1, L. Huang2, Yu. Jiang3, 1 - Inst. of Genetics and Developmental Biology, CAS, 2 - South China Normal Univ., China

A phenomenon called “trap split” had been found when gold nanoparticles were trapped by femtosecond laser pulses, and the trap split was demonstrated strongly dependent on the polarization, energy and wavelength of the laser pulses. The 3-dimension distribution of trap split and its mechanism were systematically investigated in this work.

WeR5-p02 15:00-19:00
Modelling of spatial characteristics of internal modifications by means of optical delay in cases of femtosecond micromachining of materials
D.V. Ganin1,2, K.E. Lapshin1, F.Z. Obidin1, S.K. Vartapetov1, 1 - Physics Instrumentation Center, Prokhorov General Physics Inst. RAS, 2 - National Research Nuclear Univ. «MEPhI», Russia

The paper presents the results of direct managing of spatial characteristics of the modifications in the case of focusing of femtosecond laser pulses in a bulk of material. Managing performed by inserting optical delay into different parts of the focused beam.

WeR5-p03 15:00-19:00
Direct femtosecond-pulse inscription of fiber Bragg gratings with special characteristics for sensing and laser applications
A.A. Wolf1, A.V. Dostovalov1,2, A.V. Perygin1, M.I. Skvortsov1, S.S. Yakushin1, S.A. Bobin1,2, 1 - Inst. of Automation and Electrometry SB RAS, 2 - Novosibirsk State University, Novosibirsk, Russia

The paper presents the results on inscription of long (up to 100 mm) fiber Bragg gratings with point-by-point technique and phase-shifted gratings inscription with continuous core-scanning technique by femtosecond laser pulses.

WeR5-p04 15:00-19:00
Study of optimal regimes and oxide type at formation of thermochemical LIPSS on Ti film under fs irradiation
A.V. Dostovalov1,2,2, V.A. Zhdanov2,2, K.A. Okotrub1, S.A. Balbin1, 1 - Inst. of Automation and Electrometry SB RAS, 2 - Novosibirsk State University, Novosibirsk, Russia

The paper presents the results of investigation of the thermochemical laser-induced periodic surface structures formation on Ti film at femtosecond irradiation with different spot sizes, pulses powers, polarization directions.

WeR5-p05 15:00-19:00
More than 500 nm deformable mirrors for high-power laser beam correction
V. Samarkin1, A. Aleksandrov1, A. Kudryashov2, P. Romanov1, G. Borsoni2, J. Sheldakova1, 1 - Moscow State Univ. of Mechanical Engineering, Russia, 2 - AKAptics SAS, France

Deformable mirrors with the size of 410x470 mm for high power lasers was developed. The results of the measurements of the response functions of all the actuators and of the surface shape of the deformable mirror are presented in this paper. The study of the mirror with a Fizeau interferometer and a Shack-Hartmann wavefront sensor has shown that it was possible to improve the flatness of the mirror surface to a residual roughness of 0.033 µm (RMS). The possibility of correction of the aberrations in high power lasers was numerically demonstrated.

WeR5-p06 15:00-19:00
Electron acceleration in vacuum by optimized nonlinearly chirped laser pulse

Electron acceleration in vacuum by a nonlinearly chirped laser pulse is studied and it is shown that utilizing optimized higher order chirp functions leads to enhancement of the electron energy gain.

WeR5-p07 15:00-19:00
Optical-to-THz conversion and scattering in metals
I.V. Oladyshkin, D.A. Faddeev, V.A. Mironov; Inst. of Applied Physics RAS, Russia

Laser induced terahertz waves generation from metals is a result of thermal nonlinear effects in the electrons gas near the surface. We discuss the generation mechanism and the possibility of electron scattering investigation with a help of nondestructive optical-to-THz conversion on the surface. It is shown that THz response can be used to determine electron scattering frequency for electron gas temperatures up to 1-2 eV.

WeR5-p08 15:00-19:00
Passively mode-locked fiber laser at 1 µm with tungsten disulphide absorber
Ya. Song, H. Guoyu, K. Li, Zh. Dous; Beijing Univ. of Technology, China

A passively yb-doped mode-locked fiber laser around 1 µm with an WS2 film SA is demonstrated. The stable mode-locking was obtained with a pulse width of 2.5 ns. The 3-dB bandwidth was 1.1 nm at 1030.3 nm and the repetition rate was 2.84 MHz. At the maximum pump power of 350 mW, the average output power was 8.02 mW, corresponding to pulse energy of 2.82 nJ.

WeR5-p09 15:00-19:00
Calculation of optimal parameters of the laser radiation in metal ablation by femtosecond pulses
R.V. Davydov, Vl. Antonov; Peter the Great St. Petersburg Polytechnic Univ, Russia

In this paper a mathematical model for femtosecond laser ablation of metals is proposed, based on standard two-temperature model connected with 1D hydrodynamic equations. A good agreement for numerical results of simulation ablation of several metals with experiment shows that this model can be employed in choosing laser parameters for better accuracy in nanoparticles production by this method.

WeR5-p10 15:00-19:00
Filamentation of four beams under focusing in air
A. Andreescu1,3, A.A. Ion1, O.G. Kozareva1, D.V. Makrousova1,3, N.A. Panov1, A.B. Savelyev1, L.V. Seleznov1, D.E. Shiple1, E.S. Sunchugashvili1, 1 - Lomonosov Moscow State Univ, 2 - Lebedev Physical Inst. RAS, 3 - Moscow Inst. of Physics and Technology, Russia

The interaction of four focused beams under filamentation was studied both experimentally and numerically. In this case single axial filament formation near the geometrical focus of the system takes place.

WeR5-p11 15:00-19:00
PIC simulation and physical interpretation of the formation and evolution of an electrostatic shock in a collisionless plasma produced by a fs laser pulse
A. Nechaev, M. Garaniev, V. Kocharovsky, 1 - Inst. of Applied Physics RAS, 2 - Lobachevsky State Univ of Nizhny Novgorod, Russia

We carry out 1D and 2D PIC-simulation of the formation and evolution of a (quasi)electrostatic shock in a dual-temperature collisionless plasma with parameters typical for the laboratory femtosecond-laser experiments. We consider various profiles of a transition layer between the cold background and hot bulk expanding plasma and analyzed how their parameters influence the properties and dynamics of the shock.

WeR5-p12 15:00-19:00
Controlling parameters of the accelerated particles by target relief choice for short relativistic laser pulse
A.M. Platno1,2, A.A. Andreescu1,3,1 - Vavilov State Optical Inst., Russia, 2 - St. Petersburg State Technical Univ, Russia, 3 - St. Petersburg State Univ, Russia, 4 - ITMO Univ, Russia, 5 - Max-Born Inst, Germany

By means of analytical and numerical modeling we constructed the dependences of numbers and temperatures of hot and cold electrons from the parameters of a focused laser pulse irradiated by a short laser pulse of relativistic intensity. It is shown, that changing of a relief size, period and a thickness of a target substrate, it is possible to manipulate parameters of two temperature electron energy distribution function and to increase selectively transformation of laser energy into K-radiation or into proton acceleration.

WeR5-p13 15:00-19:00
Modeling of the characteristic plasma emission produced by the interaction between nanostructured targets and ultrashort laser pulse of relativistic intensity
M.V. Sedov1, A.A. Andreescu1,2,3, K.Yu. Platno1, 1 - St. Petersburg Univ, Russia, 2 - Vavilov State Optical Inst., Russia, 3 - Max-Born Inst, Germany

We provide the laser-plasma interaction with a Particle-In-Cell code (LPIC) and a hydrodynamic simulation of the plasma expansion (MEDUnited) to provide the plasma density profile for the PIC simulation. We use a Monte Carlo code to calculate the scattering of the hot electrons in the solid and the production of x-rays.

WeR5-p14 15:00-19:00
High-intensity femtosecond pulse ionization effect on prepulse induced preplasma
D.A. Krestovskikh, K.A. Ivanov, I.N. Tsymbalov, S.A. Shulyapov, R.V. Volkov, A.B. Savelyev; Lomonosov Moscow State Univ, Russia

The expansion dynamics of high power nanosecond laser-induced plasma plume is studied. The effect of field ionization of preformed plasma at irradiation by femtosecond laser pulse is demonstrated, leading to the increase of plasma electron density.

WeR5-p15 15:00-19:00
Novel bright melted-metal based laser-driven X-ray source for phase contrast imaging
K.M. Platnov1,2, A.A. Andreescu1,2,3, V.A. Andreev1,2, 1 - Lomonosov Moscow State Univ, 2 - Lebedev Physical Inst. RAS, 3 - Inst. for Nuclear Research RAS, Russia

The possibilities of laser-driven hard X-ray source utilizing melted metal target are demonstrated. The size, brightness and stability of the source are experimentally investigated. The numerical simulations indicate, that such source may be used for X-ray phase contrast imaging.
WeR8-p01 09:30-13:30
Output beam quality improvement in broad-area class-B lasers subject to optical injection
A.V. Pakhmanov\textsuperscript{1,2}, N.E. Molevich\textsuperscript{2}, A.A. Kretov\textsuperscript{1,2}, D.A. Achinkov\textsuperscript{1}, 1 - Samara State Aerospace Univ, 2 - Lebedev Physical Inst, Samara, Russia
We study analytically and numerically the spatio-temporal dynamics of class-B broad-area lasers under external optical injection into the cavity. It is shown that weak external optical injection can enable stabilization of transverse instabilities inherent for class-B broad-area lasers. The coherent optical injection can be also applied for the effective suppression of the relaxation oscillations and spiking behaviour.

WeR8-p02 09:30-13:30
Quantum entanglement of vectorial optical self-diffraction in ion-implanted silicon quantum dots
C. Torres-Torres\textsuperscript{1}, J. Bonacelli\textsuperscript{1}, R. Rangel-Rojas\textsuperscript{1}, A. Oliver\textsuperscript{1}, 1 - National Polytechnic Inst, 2 - National Autonomous Univ of Mexico, 3 - Optics Dept, CICESE, Mexico
Entangled multi-spatial-optical fields provided by a multi-wave mixing process in silicon quantum dots were analyzed. The samples were nucleated by an ion-implantation method in a silica matrix. It is highlighted that configurable quantum correlations can be tailored by controlling the physical mechanisms responsible for the third order optical nonlinearities.

WeR8-p03 09:30-13:30
Polarizing properties of Ti-indiffused lithium niobate optical waveguides
M. Parfenov\textsuperscript{1}, P. Karaveev\textsuperscript{2}, P. Agruzov\textsuperscript{2}, I. Ilichev\textsuperscript{2}, A. Shamray\textsuperscript{2,3}, 1 - Ioffe Inst, 2 - ITMO Univ, 3 - Peter the Great St. Petersburg Polytechnic Univ, Russia
Methods for selection, transformation, and control of light polarization in Ti-indiffused lithium niobate waveguides on lithium niobate (LiNbO\textsubscript{3}) substrates are described. The influence of technological parameters and waveguide topology is considered. The polarization extinction ratio higher than 40 dB/cm was experimentally demonstrated.

WeR8-p04 09:30-13:30
Stationary and dynamically persistent modes in nonlinearly-coupled three-dimensional harmonic oscillators
R. Driben\textsuperscript{1}, V.V. Konotop\textsuperscript{3}, B.A. Malomed\textsuperscript{1}, T. Meier\textsuperscript{1}, 1 - ITMO Univ, Russia, 2 - Univ. of Paderborn, Germany, 3 - Univ. de Lisboa, Portugal, 4 - Tel Aviv Univ, Israel
The dynamics of a pair of three-dimensional matter-wave harmonic oscillators (HOs) coupled by a repulsive cubic nonlinearity is investigated through direct simulations of the respective Gross-Pitaevskii equations (GPEs) and with the help of the finite-mode Galerkin approximation (GA).

WeR8-p05 09:30-13:30
Generation of high extinction optical pulses by means of LiNbO\textsubscript{3} Mach-Zehnder modulators
V.V. Lebedev\textsuperscript{1}, A.V. Tronev\textsuperscript{1,2}, A.N. Petrov\textsuperscript{1}, P.M. Agruzov\textsuperscript{1}, I.V. Ilichev\textsuperscript{2}, A.V. Shamray\textsuperscript{2,3}, 1 - Ioffe Inst, 2 - ITMO Univ, 3 - Peter the Great St Petersburg Polytechnic Univ, Russia
High extinction optical pulse generation via cw modulation in lithium niobate Mach-Zehnder integrated optical modulators is discussed, and methods for bias point stabilization and pulse shape measurements are presented. Generation of high dynamic extinction (\textgges\ 40 dB) optical pulses by a high static extinction lithium niobate modulator was experimentally demonstrated.

WeR8-p06 09:30-13:30
Threshold effect in the substance with carbon nanotubes and graphene oxide within optical limiting
M.S. Sibilev\textsuperscript{1}, A.Yu. Gerasimenko\textsuperscript{1}, S.A. Terehchenko\textsuperscript{1}, V.M. Podgaetsky\textsuperscript{1}, National Research Univ of Electronic Technology (MIET), Russia
Determination of nonlinear optical characteristics of active substances of the limiters of high-power laser radiation was carried out with the help of non-threshold and new threshold models. Experimental data of z-scan with open aperture was obtained, which helped to determine values of the nonlinear optical characteristics for dispersion media with carbon nanotubes and graphene oxide. Advantages of threshold model experimental data processing in comparison with non-threshold model was shown.

WeR8-p07 09:30-13:30
Nonlinear band-structure of an exciton-polariton condensate in a one-dimensional lattice
I.Yu. Chestnov\textsuperscript{1}, A.V. Vulin\textsuperscript{1}, A.P. Aloidants\textsuperscript{1,2}, I.A. Sheisky\textsuperscript{3}, O.A. Egorov\textsuperscript{1}, 1 - Stoletsov Vladimír State Univ, Russia, 2 - ITMO Univ, Russia, 3 - Univ of Iceland, Iceland, 4 - Friedrich-Schiller-Univ, Jena, Germany
We study steady-states and nonlinear band structure of dissipative incoherently damped exciton-polariton condensate localized in periodic one-dimensional potential. Within the framework of mean-field description we predict existence of the persistent current Bloch states at the edge of Brillouin zone. Influence of the nonlinear band-structure on exciton-polariton condensate dynamics is discussed.

WeR8-p08 09:30-13:30
Laser processing of materials in the multiple filamentation mode
The phenomenon of filamentation of femtosecond laser pulses enables to implement controlled redistribution of intensity in the cross section of the laser beam. Spatial distribution of radiation intensity after passing through the transparent medium shows further spread the multiple filaments that allows realize laser microprocessing of materials.

WeR8-p09 09:30-13:30
Non-trivial regimes of a polariton Rabi oscillator
N.S. Voronova\textsuperscript{1,2}, A.A. Elistratov\textsuperscript{1}, Yu.E. Lazovik\textsuperscript{1}, 1 - National Research Nuclear Univ MEPhI, 2 - Russian Quantum Center, 3 - Inst for Nanotechnologies in Microelectronics RAS, 4 - Inst for Spectroscopy RAS, Russia
We analyze the effects of detuning, gain, and dissipation on Rabi oscillations in semiconductor microcavities, assuming a cw pumping via excitonic reservoir. We show the existence of non-trivial regimes reminiscent of internal Josephson effect, Van de Pol oscillations with amplitude-dependent damping, and the inverted stationary state with polaritons accumulating at the upper polariton branch while the lower branch becomes unstable.

WeR8-p10 09:30-13:30
Slow soliton-like elastic waves in metals: one more observation and application
E.M. Kudravius\textsuperscript{1}, S.D. Zotoy\textsuperscript{1}, A.A. Lebedev\textsuperscript{1}, V.V. Rashchupkin\textsuperscript{1}, 1 - Lebedev Physical Inst, RAS, 2 - Baykov Inst of Metallurgy and Material Science RAS, Russia
To decrease the number of defects in preliminary deformed sample of nickel, it was annealed in vacuum furnace (during 5 hours at T=1000°C). This time period could be markedly decreased by help of previous sample irradiation with the 2 Hz CO2 laser pulses during 30 hours but now at room temperature.

WeR8-p11 09:30-13:30
Investigation of nonlinear properties of media with Kerr nonlinearity by imaging of an amplitude object with powerful laser radiation
A.A. Muranov, V.O. Martynov, Inst. of Applied Physics RAS, Russia
Propagation of the powerful radiation through the optical system may be accompanied by a number of distortions in the transmitted image. We characterize the nonlinear phase of the laser beam for the media with instantaneous local Kerr nonlinearity by characterization of distortions in the image transferred through the nonlinear optical system.

WeR8-p12 09:30-13:30
Influence of classic noise on entangled state formation in nonequilibrium systems
V.D. Martynov, V.A. Maranov, L.A. Sminov, Inst. of Applied Physics RAS, Russia
Features of high-temperature entangled states formation have been studied in a system consisting of two parametrically coupled identical quantum harmonic oscillators, each of which is placed in a separate independent thermal bath, in the conditions of partially coherent pumping.

WeR8-p13 09:30-13:30
Temperature dependence of SHG efficiency by focusing of laser radiation
A.L. Bondarenko\textsuperscript{1}, S.G. Grechini\textsuperscript{1}, D.G. Kochiev\textsuperscript{1,2}, A.N. Sharikov\textsuperscript{1,2}, 1 - Space Research Inst RAS, 2 - Bauman Moscow State Technical Univ, 3 - Prokhorov General Physics Inst RAS, Russia
The paper presents the peculiarities of the temperature dependence for the second harmonic generation efficiency of focusing laser radiation. It is shown that an asymmetry of the dependence is the result of the vector phase-matching process near the crystal axis.

WeR8-p14 09:30-13:30
Damage of an AR-coated LBO crystal by laser pulses of microsecond duration
S.G. Grechini\textsuperscript{1}, D.G. Kochiev\textsuperscript{1,2}, A.E. Kohli\textsuperscript{1}, A.N. Sharikov\textsuperscript{1,2}, 1 - Bauman Moscow State Technical Univ, 2 - Prokhorov General Physics Inst RAS, 3 - Sobolev Inst of Geology and Mineralogy SB RAS, Russia
The optical damage of an LBO crystal by laser pulses of microsecond duration at 1.0796 µm and 0.5398 µm is investigated.
**R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS**

**WeR8-p15**

**Numerical simulation of image inversion of small-scale opaque object by the phase contrast technique with adaptive nonlinear Kerr filter**

E.L. Bubis¹, V.O. Martynov¹, A.A. Murzanev, V.V. Lozhkarev, O.A. Malshakova, A.N. Stepanyan, A.I. Smirnov; 1 - Inst. of Applied Physics RAS, 2 - Lobachevski State Univ., Russia

Numerical simulation of the process of inversion of the small-scale image of the object in phase-contrast scheme with nonlinear Kerr filter described.

**WeR8-p16**

**Advanced scheme of amplifier similaritoner laser**

D.A. Karobko¹, O.G. Oktintinov; 1, I.O. Zolotovskii; 1 - Ulyanovsk State Univ. Russia, 2 - Tamper University of Technology, Finland

We propose an advanced scheme of amplifier similaritoner laser providing an output pulse spectrum much wider than the gain bandwidth. The proposed scheme demonstrates a drastic increase of the output pulse spectrum width, reduction of the pulse duration, and increase of the output pulse peak power after compression.

**WeR8-p17**

**Growth and characterization of new laser & nonlinear optical crystal Nd0,83Y0,22Sc2,95(BO3)4**

A.E. Kohi¹, N.G. Konanova¹, K.A. Kohki², A.B. Kuznetsov³, A. Maillard³; 1 - Stepanov Inst. of Physics UNIP, 2 - PSL Research Univ. Inst. de Recherche de Chimie Paris IRC France

Single crystals of Nd0,83Y0,22Sc2,95(BO3)4 (NdYSB) have been grown in LiBO2-LiF system. NdYSB crystals is nano centro symmetrical huitite-like structure with space group R32. The nonlinear optical coefficient d(1) = d11 has determined to be 1.77 pm/V. Fluorescence spectra of the NdYSb by the exciting at A=811 nm shows F43/2 → 411/2 transition of the Nd3+ ions expected NdYSb crystal to laser oscillations at 1061nm. In fact NdYSb crystal can investigate as self doubling laser material.

**WeR8-p18**

**Raman gain coefficients in potassium-gadolinium tungstate at the wavelength of 532 nm**

R. Chulkov¹, V. Markевич¹, V. Orlovitch¹, M. El-Desouki²; 1 - Stepanov Inst. of Physics NASB, Belarus, 2 - King Abdulaziz City for Science and Technology (KACST), Saudi Arabia

Experimental and numerical data on Stokes generation under the spectrally limited nanosecond pulse excitation are collated to find the steady-state Raman gain coefficients. The approach is tested for barium nitrate. For potassium-gadolinium tungstate, the coefficients values of 14.3 and 11.3 cm/GW are determined in the p[pmn] and p[ggp] sample orientations, respectively, at 532 nm wavelength.

**WeR8-p19**

**Dispersive distortions of signals in an analog fiber-optic link with direct intensity modulation**

V.V. Shcherbakov¹, A.F. Solodkov¹, A.A. Zadernovsky; 1 - JSC “Center VOSPI”, 2 - Bauman Moskow State University, Russia

We present experimental results on transmission of signals in an analog fiber-optic link with direct intensity modulation and direct detection of photocurrent. It was found that the output signals reveal either power suppression or power revival depending on the modulation frequency. We also observed nonlinear distortions of the signals. Theoretical interpretation of the experimental results is presented.

**WeR8-p20**

**Approach for producing the nanocrystalline sitall samples with distributed refractive index**

I.L. Vinogradova, A.I. Salihov, R.V. Kutiuyarov, A.Kh. Sultanov, Ufa State Aviation Technical Univ., Russia

We have explored a novel technique for producing transparent volumetric nanocrystalline sitall by means of intensive plastic deformation. This material is intended to be used for components of fiber optic devices, including various applications in all-optical networks. We have examined properties of the material experimentally and by means of the proposed analytical model.

**WeR8-p21**

**Numerical modeling of the dynamics of bidirectional long ring Raman fiber laser**

S.V. Sukhanov, L.A. Melnikov, Yu.A. Mazhirina; Gagarin State Technical Univ. of Saratov, Russia

We demonstrate the numerical model which allows investigation of gyroscopic effect in hybrid mode-locked bidirectional Erbium-doped fibre ring laser. The model is based on transport theory with accounting of dispersion, gain in EDFA and saturable absorption. The predictions of gyroscopic effect are also presented for the particular laser cavity.
WeR8-p29 09:30-13:30
Optical vortex generation using photoinduced orientational defects in nematic liquid crystals
I.A. Budagovsky1, S.A. Shvetsov2,3, M.P. Smygov1, A.S. Zolot'ko1; 1 - Lebedev Physical Inst. RAS, 2 - Moscow Inst. of Physics and Technology, 3 - Shubnikov Inst. of Crystallography RAS, Russia
Optical vortices were generated by means of photoinduced point defects in orientation of the nematic liquid crystal (NLC). The axisymmetric distribution of NLC director field was produced due to photorefractive effect in NLC or due to isotropic channel formation in light absorbing NLC.

WeR8-p30 09:30-13:30
Nonlinear polarization in comb-spectroscopy
S. Uvarova, A. Antipov, S. Puikin, E. Borisov, V. Arnautov; St. Petersburg State Univ., Russia
Two methods were applied to compute the 2-level atom driven by a polychromatic field. The first method is a direct numerical solution of the density matrix equations and the second one is a harmonic basis decomposition resulting in an infinite linear algebraic equation system. It is showed the resonance frequency mostly follows the transition frequency. But some frequency pulling or pushing is observed depending on the transition frequency inside the field component bounds or not.

WeR8-p31 09:30-13:30
On diagnostic capability of scattered laser radiation in internal defect analysis of conduct pipe
V.A. Vologdin1, V.V. Davydov1, E.N. Velichko2, V.V. Nikolaev3; 1 - Peter the Great Saint Petersburg Polytechnic Univ., 2 - ITMO Univ., Russia
A new method of diagnostics of defects on internal parts of pipelines by scattered laser radiation on flowing fluid is considered. A coordinate of junction point of laser beams in section plane of pipeline with fluid flow was calculated.

WeR8-p32 09:30-13:30
Swift C5+ ion irradiated optical ridge waveguides in nonlinear Yb:YCOB crystal
Ya. Cheng1, Sh. Zhou2, F. Chen1; 1 - Shandong Univ., China, 2 - Inst. of Ion Beam Physics and Materials Research, Germany
We report on the fabrication of optical ridge waveguides in Yb:YCOB crystal. The ridge waveguide structures show good guiding properties at 1064 nm along TM polarization and the lowest propagation loss is measured to be 1.7 dB/cm.

WeR8-p33 09:30-13:30
Induced modulation instability of surface plasmon polaritons in an ultra-thin metal film
S. Moiseev1,2, D. Korobko1, I. Zolotovskii2; 1 - Ulyanovsk State Univ., 2 - Kotel’nikov Inst. of RadioEngineering and Electronics RAS, Russia
The effect of the modulation instability of surface plasmon polariton waves in an ultra-thin metal film is demonstrated. It is shown that the modulation instability effect could be used for the generation of signals with a repetition rate in the terahertz range and ultrafast trains of picosecond optical pulses.

WeR8-p34 09:30-13:30
Numerical modeling of gyroscopic effect in bidirectional ultrafast erbium-doped fibre laser
S. Sukhanov1,2, L. Melnikov1, M. Chernysheva2; 1 - Gagarin State Technical Univ. of Saratov, Russia, 2 - Aston Univ., United Kingdom
We demonstrate the numerical model which allows investigation of gyroscopic effect in hybrid mode-locked bidirectional erbium-doped fibre ring laser. The model is based on transport theory with accounting of dispersion, gain in EDFA and saturable absorption. The predictions of gyroscopic effect are also presented for the particular laser cavity.

WeR8-p35 09:30-13:30
Collision of 3D bipolar light pulses in an array of carbon nanotubes
A.V. Zhukov1, R. Bouffanais2, B.A. Malomed3, H. Leblond3, D. Mihalache4,5,6,7,8,9; 1 - Singapore Univ. of Technology and Design, Singapore, 2 - Tal Aviv Univ., Israel, 3 - Univ. of Angers, France, 4 - Academy of Romanian Scientists, Romania, 5 - Horia Hulubei National Inst. of Physics and Nuclear Engineering, Romania, 6 - Technion-Israel Inst. of Technology, Israel, 7 - Vavilov State Optical Inst., Russia, 8 - ITMO Univ., Russia, 9 - Ioffe Inst., Russia, 10 - Volgograd Intrad Inst. of Business, Russia, 11 - Volgograd State Univ., Russia
We study the propagation and collision of extremely short electromagnetic pulses in an array of semiconductor carbon nanotubes. The mathematical model takes into account non-uniformity of the pulses' fields and redistribution of electron concentration in the system. We establish a possibility of stable post-collision propagation of pulses over distances much greater than their sizes.
A new beam shaping technique implemented in 260 watt 1 kilohertz repetition rate picosecond pulse laser J. Adamonis\textsuperscript{1}, A. Aleknavicius\textsuperscript{1}, S. Balickas\textsuperscript{1}, T. Gertus\textsuperscript{2}, A. Michailovas\textsuperscript{2}\textsuperscript{-} \textsuperscript{4}. We present a practical implementation of a novel beam shaping technique (based on partially variable phase retardation plate inscription in fused silica glass by femtosecond pulses) in a high power average picosecond pulse amplifier.

ThR1-28 Thermal distortions and heat sources in disk laser active element M.R. Volkov\textsuperscript{1}, I.U. Kuznetsov\textsuperscript{1}, I.B. Mukhin\textsuperscript{1}, Inst. of Applied Physics RAS, Russia Thermally induced phase distortions of disc laser active element are measured and calculated. Theoretical model shows deviation from experiment. Extra heat sources are expected to be the reason of the deviation.

ThR1-29 All-solid-state laser system with coherent combining of independent channels via common laser beam A.P. Pogoda, A.V. Fedin, A.S. Boreysho, Baltic State Technical Univ., Laser Systems LTD, Russia The multichannel laser system with coherent combining as a result of fourwave mixing in active laser media is proposed.

ThR1-30 Single frequency MOPA based on Nd:YAG bulk and fiber single crystals Z. Liu, S. Men, Y. Liu, H. Rao, Z. Cong, S. Zhang, X. Zhang; Shandong Univ., China By employing Nd:YAG single crystal fiber and rods, single frequency 1064-nm master oscillator power amplifier is realized. Output power is 31.3 W with peak power of 464 kW and linewidth of less than 130 MHz.

ThR1-31 Thin-tapered-rod Yb:YAG amplifier for fiber oscillator I.I. Kuznetsov, I.B. Mukhin, O.V. Palaschov, Inst. of Applied Physics RAS, Russia The high average power and high-gain laser amplifier based on thin-tapered-rod Yb:YAG crystal with waveguide diode pumping is realized. Signal of the subpicosecond fiber oscillator is amplified up to 15 W average power with 20% optical efficiency.

ThR1-32 A 13 W LD-pumped narrow-linewidth linearly polarized Yb-doped fiber laser operating at 1152 nm L. Huang, H. Zhang, X. Wang, R. Su; P. Zhou; National Univ. of Defense Technology, China We demonstrate a 1152 nm narrow linewidth linearly polarized all-fiber laser directly pumped by laser diodes at 976 nm. When temperature of gain fiber is increased to about 115 °C, a maximum output power of 13 W is obtained and corresponding slope efficiency is ~45%. The polarization extinction ratio and 3dB linewidth at the maximum output power are 18 dB and 0.14 nm respectively, which is an attractive result for some special applications such as nonlinear conversion.

- Coffee Break -

ThR1-33 Invited High-power Yb:amplifiers seeded by a femtosecond Er:fiber laser D. Brda, J. Fischer, P. Storz, A. Leitenstorfer; Univ. of Konstanz and Center for Applied Photonics, Germany We present two alternative implementations of high-power Yb-amplifiers designed for advanced applications in ultrafast science. The seed is generated by ultrabroadband Er:fiber laser technology. Our fiber-based setup produces pulses at 1030 nm with energies of 6 µJ at a repetition rate of 10 MHz and duration of 145 fs. The thin-disk amplifier is operated at 3 kHz repetition rate and generates 655-fs pulses with energies up to 17 µJ.

ThR1-34 Dispersion-managed soliton generation in the hybrid mode-locked Erbium-doped All-fiber ring laser D.A. Dvuretsky\textsuperscript{1}, S.G. Sazonkin\textsuperscript{1}, V.S. Voropaea\textsuperscript{1}, S.O. Leonov\textsuperscript{1}, A.B. Preve\textsuperscript{2}, V.E. Kurasik\textsuperscript{2}, A.A. Krylov\textsuperscript{2}, E.D. Obraztsova\textsuperscript{3}. We report on the ultra-short dispersion-managed soliton generation in the erbium-doped all-fiber ring laser hybrid mode-locked with Carbon: Boron Nitride Single-Walled Nanotubes in the co-action with a nonlinear polarization evolution.

ThR1-35 Uni- and bidirectional hybrid mode-locked Erbium-doped isolator-free fibre laser M. Chernysheva\textsuperscript{1}, M. Al Arai\textsuperscript{2}, S. Sukhanov\textsuperscript{2}, R. Arifi\textsuperscript{2}, A. Rozhin\textsuperscript{2}; 1 - Aston Inst. of Photonics Technologies, Aston Univ., United Kingdom, 2 - Al MUnited Statesnna College of Technology, Sultanate of Oman, 3 - Gagarin Saratov State Technical Univ., Russia, 4 - Univ. of Sulaimani, Iraq. We have investigated a hybrid mode-locked Erbium-doped fibre laser without optical isolator. Creating different losses in the cavity for counter-propagating pulses via net birefringence adjusting, the laser can operate in both unidirectional regimes with extinction over 22 dB, as well as can establish stable bidirectional generation.

ThR1-36 Generation of harmonic oscillations in ring resonator with high Q-factor S.A. Kolpakov, H. Khodsh, Yu. Loaka, S. V. Sergeyev; Aston Univ., United Kingdom. We report on generation of harmonic oscillations with frequencies of hundreds of MHz and radio-frequency linewidth of 13 Hz in unidirectional ring laser oscillator. This high stability makes these oscillators a suitable substitute for existing quartz resonators used in high frequency optoelectronics applications.

ThR1-37 All-fiber hybridly mode-locked similariton ring laser for frequency metrology V.A. Lazarev\textsuperscript{1}, A.A. Krylov\textsuperscript{1}, S.G. Sazonkin\textsuperscript{1}, A.B. Preve\textsuperscript{2}, S.O. Leonov\textsuperscript{1}, D.A. Shelistov\textsuperscript{2}, M.K. Tarabin\textsuperscript{2}, V.E. Kurasik\textsuperscript{2}, A.N. Kireev\textsuperscript{3}, M.A. Gubin\textsuperscript{3}, M. Al Arai\textsuperscript{2}; 1 - Bauman Moscow State Technical Univ., 2 - Fiber Optics Research Center RAS, 3 - Lebedev Physical Institute, Russia. We demonstrate the generation of stable 127 fs selfsimilar pulses at a central wavelength of 1560 nm with 7.14 mW average output power. Similarator lasers have low repetition rate deviation in the averaging time interval 1 – 10^3 s, a low relative intensity noise ~125 dBc/Hz, a narrow single comb line width of 32 kHz, and high reliability. Thus, such lasers are highly promising for further development of the stabilized combs.

ThR1-38 Highly compact stretcher-compressor module for ultrafast chirped pulse amplification laser system B. Lee\textsuperscript{1}, B. Jeong\textsuperscript{1}, S.A. Chizhov\textsuperscript{1}, E.G. Sall\textsuperscript{2}, J. Yang\textsuperscript{2}, V.E. Yashin\textsuperscript{2}, G.H. Kim\textsuperscript{2}; 1 - Korea Electrotechnology Research Inst., Republic of Korea, 2 - Vavilov State Optical Inst., Russia. We introduce and demonstrate a simple, compact stretcher-compressor module that uses a single transmission diffraction grating. Three stretcher-compressor modules with different compression ratio have been compared.

- Lunch Break -
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T E C H N I C A L  S E S S I O N

R1. SOLID-STATE LASERS

Location: Stenberg Room, floor 3, 15:00 – 17:00

Solid-State Lasers VII
Session Chair: Maximilian Lederer,
European XFEL GmbH, Germany

ThR1-39 15:00-15:15
1 kHz, 10 mJ Q-switched diode pumped Nd:YAG laser with a variable reflectivity mirror
B. Oreshkov1, K. Popov2, S. Gagarsky3, N. Belashenkov4, I. Buchvarov5; 1 - Sofia Univ., Bulgaria, 2 - IBPhotonics Ltd., Sofia Univ., Bulgaria, 3 - ITMO Univ., Russia

We demonstrate 1 kHz, 10mJ actively Q-switched Nd:YAG laser with 15 ns pulse duration at 1 kHz repetition rate. A smooth output beam intensity distribution is achieved by the use of variable reflectivity Gaussian output mirror.

ThR1-40 15:15-15:30
Post-pulse generation effect in Q-switched lasers
K.F. Burdonov, E.A. Khazanov, A.A. Shaykin; Inst. of Applied Physics, Russia

We revealed experimentally the generation of a second giant pulse at the neighboring longitudinal mode in an Nd:YLF Q-switched laser and implemented a new method of longitudinal mode selection based on this effect.

ThR1-41 15:30-15:45
6 mJ@3.3kHz Q-switched single mode single-frequency Nd:YAG end pumped laser
A.F. Kornev, V.P. Pokrovsky, S.S. Sobolev, S.S. Terekhov; ITMO Univ., Russia

End pumped MOPA Nd:YAG pulsed laser was built and investigated. High extraction efficiency ~50% in single-pass amplifier is achieved due to high small-signal gain provided with longitudinal pumping. Pumping of amplifier is near uniformly distributed along 2 laser rods with low concentration using two-lens relay between them in order to decrease end overheating.

ThR1-42 15:45-16:00
946 nm Nd:YAG regenerative amplifier 20 mJ/3 ns
E.A. Buslaeva1,2, S.V. Gagarsky1, P.A. Gnatyuk3, A.S. Kovalyov4; 1 - Lasers and optical systems, Ltd., 2 - ITMO Univ., Russia

Laser is based on scheme “master oscillator with cavity dumping (MO) → regenerative amplifier (RA)”. It produces 20 mJ with pulse repetition rate 50 Hz and pulse length 3 ns. High-speed drivers were used. The radiation divergence close to the diffraction-limited and high stability of output signal were obtained.

ThR1-43 16:00-16:15
Diode-pumped Pr:LiY0.3Lu0.7F4 and Pr:LiYF4 red laser at 640 nm
A.A. Lyapin1, P.A. Ryabochkina1, V.V. Semashko2, V.G. Gorieva2; 1 - Inst. of Physics and Chemistry, Ogarov Mordovia State Univ., 2 - Kazan Federal Univ., Russia

The laser quality Pr:LiY0.3Lu0.7F4 and Pr:LiYF4 fluoride single crystals have been prepared by Bridgman method. Laser oscillations of Pr:LiY0.3Lu0.7F4 crystal was obtained at 640nm under diode pumping at 442nm, with the slope efficiency of 9%. Also, the continuous-wave laser have been obtained for Pr:LiYF4 crystal at 640nm pumped by a diode laser with the slope efficiency of 8.5%.

ThR1-44 16:15-16:30
On the nature of donor centres involved into the down-conversion in Yb doped Scheelite-like crystals
K.A. Subbotin, Yu.N. Osipova, D.A. Lis, D.A. Nikolaev, V.A. Smirnov, E.V. Zharikov, I.A. Shcherbakov; Prokhorov General Physics Inst. RAS, Russia

The efficient 1 µm Yb3+ luminescence was found in Scheelite-like molybdate and tungstate crystals at UV-excitation. The presentation is devoted to discussion about the nature of optical donor centres in the crystals, which absorb the UV excitation and non-radiatively transfer their excited state energy to the 2F5/2 excited state of Yb3+ ions.

ThR1-45 16:30-16:45
Color centers transient absorption and ultra-short pulse lasing from LiLu0.7Y0.3F4:Ce3+ active medium
I.I. Farukhshin, A.S. Nazmutdinov, V.V. Semashko, S.L. Korobleva, M.A. Marisov; Kazan Federal Univ., Russia

We have obtained the single pulse laser oscillation with 400±10 ps pulse duration at 311 nm from LiLu0.7Y0.3F4:Ce3+ crystal was obtained from intracavity loss modulation via pump-induced color centers bleaching. Modulation of intracavity losses is regulated via color centers concentration.

ThR1-46 16:45-17:00
A tunable laser near 535 nm
X. Liu, G. Fang, X. Zhang, Zh. Cong, X. Chen, Z. Qin, Zh. Liu, J. Lu; Shandong Univ., China

This paper presents a tunable laser near 535 nm. It is obtained by the intracavity frequency doubling of the tunable Stokes laser emission based on the stimulated polariton scattering in MgO:LiNbO3 crystal. The tunable green laser wavelength range was from 534.8 nm to 536.9 nm. The maximum output energy at 535.7 nm was 4.48 mJ.
R2. HIGH POWER LASERS

Location: Petrov-Vodkin 1 Room, floor 2, 09:00 – 11:00
High Power Lasers IV
Session Chair: Oleg B. Danilov, Vavilov State Optical Inst., Russia

ThR2-14 09:00-09:15
Pressure broadening of Ar (811.5 nm) by neon
A.G. Gladkov1,2, PA. Mikheyev2, A.K. Chemshyov2, N.I. Ufimtsev2, V.N. Atyazov2, M.C. Heven1,2, 1 – Samara State Aerospace Univ., 2 – Lebedev Physical Inst. RAS, Samara Branch, Russia, 3 – Emory Univ., United States
Results of systematic measurements of pressure broadening for argon in 40 MHz RF discharge plasma in neon are presented. Using the tunable diode laser spectroscopy, we obtained the experimental data on pressure broadenings for argon 811.5 nm line by neon and pressure broadening coefficient was determined for the first time.

ThR2-15 09:15-09:30
A non-chain HF laser with repetitive rate of 100Hz
H. Chao, H. Ke, Y. Ai-ping, T. Ying, Zh. Feng, M. Lian-ying, L. Gao-peng; Northwest Inst. of Nuclear Technology, China
The non-chain HF laser with the self-acting ultraviolet preionization was developed. A pair of like Chang profiled electrodes defines a 12×17×480 mm3 discharge volume through which gas flow is forced in the direction transverse to the optical axis. In 100Hz pulse repetitive operation, the average power obtained was 40W in a 92% SF6:8% C2H6 gas mixture.

ThR2-16 09:30-09:45
Vibrational kinetics of molecular singlet oxygen
A.R. Torbin1,2, PA. Mikheyev2, M.C. Heven1,2, V.N. Atyazov2, 1 – Samara State Aerospace Univ., 2 – Lebedev Physical Inst. RAS, Samara Branch, Russia, 3 – Emory Univ., United States
Experimental study of vibrationally-excited singlet oxygen O2(a,v) kinetics have been performed. Rate constant of O2(a,v)-1 quenching by CO2 was measured. It was shown that vibrational excitation of singlet oxygen molecule accelerates the rate of reaction between O2(a,v) and O3 molecules.

ThR2-17 09:45-10:00
Long-term mode degradation in ytterbium-doped pulsed fiber lasers
K.K. Bokhov, M.M. Bubnov, S.S. Aleshkina, M.E. Likhachev; Fiber Optics Research Center RAS, Russia
A novel effect of long-term mode degradation in a low-average-power high-peak-power ytterbium-doped pulsed fiber lasers based on large mode area step-index fibers has been reported for the first time.

ThR2-18 10:00-10:15
10–60 kHz operation mode of waveguide CO2-laser with wavelength selection option
A.A. Boyko1, A.I. Karapuzikov2, S.S. Chernikov2, V.V. Spitsin2, K.G. Zenov2, T.V. Kotereva3, T.V. Kotereva3, D.V. Savin3, N.A. Timofeeva3; 1 – Prokhorov General Physics Inst. RAS, Russia
Possible of obtaining the pulse-periodic lasing mode with 100% modulation at pulse repetition rates from 10 kHz to 60 kHz is reported.

ThR2-19 10:15-10:30
Absorption in N2O and CH4 of overtone CO laser radiation measured by using the a topographic target and receiving telescope
The trace remote sensing scheme of atmospheric gas components (nitrous oxide and methane) with emission lines of pulsed first-overtone CO laser is tested using a topographic target and receiving telescope. Results of the measurements and calculation of absorption on 20 selected emission lines in gas mixtures with the studied gases at various configurations of the experimental scheme are presented.

ThR2-20 10:30-10:45
Optimization of the parameters of gas-discharge active medium and optical resonator of RF excited planar CO2-laser at room temperature
A.P. Mineev, S.M. Nefedov, P.P. Pashinin, P.A. Goncharov, V.V. Kiselev; Prokhorov General Physics Inst. RAS, Russia
An output power of CO2-lasers has been studied for operation at room temperature of the cooling running water from +7 to +160°C. A cw output power of 41 W for stable resonator and 21 W for unstable resonator has been achieved. The new configuration of hybrid waveguide-unstable optical resonator with the external additional mirror for the lasers is proposed and realized. We carried out experiments about the possibility of the optimization of the coupling coefficient of optical resonator with the aid of the external mirror, that is plane-parallel plate with different reflection coefficients.

JUNE 27 - JULY 1, ST. PETERSBURG, RUSSIA
Influence of atmospheric turbulence on multichannel laser radiation and correction for distortion

A. Lylova, A. Kudryashov, Ju. Sheldakova, G. Borsoni; 1 - Moscow State Univ. of Mechanical Engineering, Russia, 2 - AKAoptics SAS, France

The performance of multiphoton microscopes is limited by both aberrations and pulse broadening. In this talk, adaptive optics and pulse compression procedures used to improve multiphoton imaging will be described. The implementation of these techniques enhances the quality of the acquired multiphoton images for different experimental conditions. The results of this talk are discussed.

Adaptive optics for ultrashort pulse manipulation

C. Marzioni, A. Cantaluppi, S. Bonora, G. Cerullo; 1 - Politecnico di Milano, Italy, 2 - Max Planck Inst. for the Structure and Dynamics of Matter, Germany, 3 - Univ. degli studi di Padova, Italy

Shaping of femtosecond light pulses is typically performed in the frequency domain, by manipulation of the pulse spectral intensity and phase. One tool for pulse control uses a deformable mirror in the Fourier plane of a 4-f stretcher. In this post we show the ability of adaptive optics to shape femtosecond pulses. By including the shaper and the characterization block in a closed loop, it is possible to correct spectral phase distortions accumulated in an optical chain in few automatic iterations.

Uniform focal spot formation in adaptive system with Shack-Hartmann sensor and M2 sensor

J. Shedlakova, A. Kudryashov, A. Rukausov, A. Lylova; Moscow Univ. of Mechanical Engineering, Russia

Recent results of formation of uniform beam intensity distribution at the focal plane of a lens by means of bimorph deformable mirrors are presented. An approach based on the use of Shack-Hartmann wavefront sensor together with focal spot sensor (M2 meter) is suggested. Advantages and disadvantages are discussed.

The laser beam focusing closed-loop control system on the long-range dynamic point target, implementing the method of double frequency of the spherical wave front probing

V.S. Denkevich, A.N. Klyemenov, Ya.I. Malashko, A.V. Nazarenko, A.O. Skvortsov; PISCO «SPA-Almaz», Russia

Control capabilities of an adaptive focusing loop on the plane of the distant dynamic point target using algorithm of maximizing the ratio of signal amplitudes on the doubled frequency and probe frequency is considered. Difference of control algorithm from earlier offered by us consists in use of small part of angular distribution of laser power. Physical modeling results of flight experiment for the purpose of focusing of powerful laser radiation on the distant dynamic point target without adaptive circuit are provided.

A new method of the real-time atmospheric turbulence modeling

A. Lylova, A. Kudryashov, Ju. Sheldakova, G. Barsoni; 1 - Moscow State Univ. of Mechanical Engineering, Russia, 2 - AKA Optics (SAS), France

It is suggested to reconstruct the real-time atmospheric turbulence in the lab by means of the stacked-actuator deformable mirror and the bimorph deformable mirror. The characteristics of the spatial reconstruction are shown. The phase screens interpolation methods are presented. The problems of the reconstruction are discussed.

Influence of atmospheric turbulence on quality of multichannel laser radiation and correction for distortion

V.P. Lukin, O.I. Antipov, P.Yu. Kaney, N.A. Makarenko; 1 - Zuev Inst. of Atmospheric Optics SB RAS, 2 - Inst. of Applied Physics RAS, Russia

Influence of atmospheric turbulence on multichannel laser radiation is considered theoretically in the report. The model of turbulence is verified by comparison of numerical results with published theoretical and experimental data. The review of current investigations is also included into the report which allowed us to show the essence of results obtained by our group. To correct for distortion we used a flexible mirror with continuous reflecting surface and phase modulation in channels of the system. It was shown that influence of atmospheric turbulence on quality of correction depends on number of optical fibres. Distortion decreases with increase of the number of channels and adaptive correction results in two-times increase of energy concentration for systems with 9 and 81 channels. For systems with greater number of channels (200 and more) the results of correction do not depend on turbulence intensity.

Coffee Break
Super-Intense Light Fields and Ultra-Fast Processes III

Session Chair: Luis Roso
Centro de Lésieres Pulsados, Spain

ThR5-13 Invited
15:00-15:30
Collective particle dynamics driven by a relativistic plasma aperture in an ultra-thin foil
P. McKenna1, J. Gonzalez-Izquierdo1, R.J. Gray1, M. King1, P.J. Dance1, R. Wilson1, J. McCreadle1, N.M.H. Butler1, R. Capdessus2, S. Hawkes2, J.S. Green2, M. Borghesi3, D. Neely1; 1 - Univ. of Strathclyde, 2 - STFC Rutherford Appleton Laboratory, 3 - The Queen's Univ. of Belfast, Northern Ireland

We report on experiment and simulation results which show that a relativistic plasma aperture is produced in intense laser pulse interactions with an ultrathin foil target. Diffraction of the laser propagating through this aperture produces a near-field diffraction pattern, to which electrons collectively respond. Static and rotating beam profiles can be induced by variation of the laser polarization.

ThR5-14
15:30-15:45
Generation of attosecond relativistic electron jets in laser pulse interaction with gas targets
V.V. Kukulin1, V.A. Cherepenin1, V.N. Kornienko1; 1 - Sternberg Astronomical Inst. of Lomonosov Moscow State Univ., Russia, 2 - Kotel'nichkov Inst. of RadioEngineering and Electronics RAS, Russia

Formation of attosecond relativistic electron jets from tape gas targets of submicron concentration with a powerful ultra-short laser pulse is considered. Achievable characteristics of the jets are found. It is shown that for some range of parameters, a single relativistic electron mirror can be formed, which is appropriate for generation of coherent attosecond x-ray pulse using the counter reflection of the probe laser pulse.

ThR5-15
15:45-16:00
Laser energy absorption and hot electrons generation in near-critical plasma at relativistic intensities
I.N. Tsymbalov1, K.A. Ivanov1, S.A. Shulyapov1, D.A. Krestovskih1, R.V. Volkov1, A.B. Saveliev1, P.A. Ksenofontov1, A.V. Brantov1, Yu.V. Bychenkov1, 1 - Lomonosov Moscow State Univ., 2 - Lebedev Physical Inst. RAS, Russia

Strong dependence of hot electron yield and energy in relativistic laser-plasma interaction on the pre-plasma properties is demonstrated. Experimental data and numerical simulation results are presented.

ThR5-16
16:00-16:15
Dynamics of inhomogeneous plasma expansion in intense femtosecond laser-ablated aluminum plumes
A. Stepanov1, M. Garasev, A. Korytin, V. Kocharovsky, Yu. Mal'tov, A. Murzanev, A. Nechaev, D. Yashunin; Inst. of Applied Physics RAS, Russia

Dynamics of an inhomogeneous plasma expansion generated by intense fs laser radiation from a metal Al foil was investigated experimentally and simulated numerically. A shock wave-like structure moving at a constant velocity $V = 1.5\times10^7$ cm/s (close to ion-acoustic one) was observed and explained as a quasi-electrostatic collisionless shock owing to inhomogeneous pre-plasma swept by a flow of hot electrons.

ThR5-17 Invited
16:15-16:45
Ion acceleration with PW-ultrashort laser pulse
S. Ter-Avetyan; Inst. for Basic Science, Gwangju Inst. of Science and Technology, Republic of Korea

The unique exploratory mission of this research is to build the scientific foundation needed to develop high energy laser particle accelerators, to expand the fundamental understanding of matter at very high temperature and density conditions and its dynamics. After short survey of relevant background, this presentation will discuss the recently obtained experimental results on PW laser system available at CoReLS, IBS, Korea.

ThR5-18
16:45-17:00
Use of super-intensive lasers for research in the field of nuclear laboratory astrophysics
A.P. Motolkin1, V.S. Belyaev1, B.V. Zagrivin1, A.V. Lobanov1, S.A. Shulyapov1, A.B. Saveliev1; 1 - Central Research Inst. for Machine Building, 2 - Lomonosov Moscow State Univ., Russia

The main problems of nuclear astrophysics which can be studied with the lasers of 10^18 W/cm^2 or more intensity are identified: lithium problem, the sources of neutrons in p-processes of the heavy element production, synthesis of neutron-deficient stable p-nuclei, nuclear reactions with isotopes used in astronomy for diagnostics. The results of the proposals and experiments for further research are presented.

- Coffee Break -

Super-Intense Light Fields and Ultra-Fast Processes IV

Session Chair: Sargia Ter-Avetissyan, European XFEL GmbH, Germany

ThR5-19 Invited
17:30-18:00
Laser-driven ion acceleration and application to ultrahigh dose rate radiobiology
M. Borghesi1, S. Kar1, D. Doria1, H. Ahmed1, P. Chaudray2, R. Lomagnani1, A. Spatani2, M. Cherchez1, R. Pradat1, S. Brauckmann1, F. Hantori2, D. Gwynne2, C. Maziono2, H. Poddar1, C. Scullion1, A. Macchi1, P. McKenna1, O. Willi1, K. Prise1; 1 - Centre for Plasma Physics, The Queen's Univ. of Belfast, Northern Ireland, 2 - Centre for Cancer Research and Cell Biology, The Queen's Univ. of Belfast, Northern Ireland, 3 - LULI, Ecole Polytechnique, CNRS, CEA, UPMC, Palaiseau, France, 4 - Univ. of Strathclyde, United Kingdom, 5 - Heinrich-Heine-Univers, Germany, 6 - Department of Physics E. Fermi, Italy

An intense research activity is currently devoted worldwide to the development of laser-driven ion acceleration, in view of a number of applications, including potential use in future cancer therapy. We will report on the activities of the UK-wide A-SAIL consortium towards developing novel acceleration mechanisms, as well as applying the ions in a range of radiobiology investigations.

ThR5-20 Invited
18:00-18:30
Femtosecond X-rays from laser plasma accelerators
K. To Phuoc, B. Mathieu, A. Döpp, C. Thury, S. Corde, J. Gautier, E. Guillaume, V. Maia, A. Rousse, L. Lecherbourg, N. Jourdain, F. Dorchies, A. Lifschitz; Laboratoire d'Optique Appliquée, ENSTA ParisTech, CNRS, Ecole Polytechnique; CEA, CELIA, France

We will present the principle of these sources, their characterization, recent developments and a few application examples.

ThR5-21
18:30-18:45
Turbulence in relativistic plasma - from magnetohydrodynamic to kinetic regime
Makoto Takamoto, Univ. of Tokyo, Japan

In this presentation, we report our recent finding on turbulence in relativistic plasma. We performed a series of 3-dimensional numerical simulations of turbulence using relativistically magnetohydrodynamics code, and investigated properties of each characteristic mode. We also report our recent results of 3-dimensional Weibel turbulence obtained by Particle-in-Cell simulations.

ThR5-22
18:45-19:00
Intense ultrafast laser-plasma source of quazimonochromatic Mo-Kx X-radiation
V. Tcheremysine, V. Azamoun, R. Clady, L. Charmasson, A. Ferre, N. Sanner, O. Uteza, M. Sentis; Aix-Marseille Univ, CNRS, France

Characteristics of intense ultrafast quasi-monochromatic laser-plasma x-ray source at 17.4 keV produced using solid Mo/Be target are studied. The source is generated by Ti:Sa laser system “ASUR” capable to deliver 10 TW laser pulses of 25 fs duration with 100 Hz repetition rate and temporal contrast of >10^9. Fluxes of k-alpha X-radiation of 10^9 photon/sr per shot and energy conversion efficiency >10^-4 are obtained.

ThR5-23
19:00-19:15
Electron-free UV laser pulse filamentation under coherent rotational SRS in air
I.V. Smetenin1, A.O. Levchenko1, A.V. Shutov1, N.N.ustinovskii1, V.D. Zver'kin1; 1 - Lebedev Physical Inst.RAS, 2 - National Research Nuclear Univ. MEPhI, Russia

Coherent stimulated rotational Raman self-scattering is proposed as the mechanism of electron-free filamentation of the ultra-short KrF laser pulse in air.

ThR5-24
19:15-19:30
Ultrafast laser pulse multifilamentation in fused silica: plasma channels statistics
A.A. Zemlyanov, Yu.E. Geints; Zuev Inst. of Atmospheric Optics SB RAS, Russia

The regime of multiple filamentation of gigawatt-power femtosecond laser pulses in fused silica bar is theoretically investigated. The dependence of the number, plasma channels statistics as well as applying the ions in a range of radiobiology investigations.
**TECHNICAL SESSION**

**R7. LASERS IN ENVIRONMENTAL MONITORING**

**Lasers in environmental monitoring III**
*Session Chair: Alexandr A. Cheremisin, Irkutsk State Univ. of Railway Engineering, Krasnoyarsk Railway Inst., Siberian Federal Univ., Russia*

**Lasers in environmental monitoring IV**
*Session Chair: Alexandr P. Zhevlakov, ITMO Univ., Russia*

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**ThR7-13 11:30-11:45**
**Using of laser scanner for mobile scanning of environment in work of earthmoving and construction machines and for control of deformation of pit’s slopes**
*T.V. Galubeva, S.V. Kornshin, E.G. Zaytsev, Almaty Univ. of Power Engineering & Telecommunications, Kazakhstan*

The authors propose the use of laser scanning for positioning earthmoving and construction machines relative to terrain and environment, including the objects that are in the places of construction works to eliminate the human factor and increase the quality and speed of the given work.

**ThR7-14 11:45-12:15**
**Cavity enhanced spectroscopy in application to spectral line shape study**
*A. Cygan, Nicolaus Copernicus Univ., Poland*

Three cavity enhanced spectroscopy methods are presented: well-known cavity ring-down spectroscopy and two recent techniques: cavity mode-width spectroscopy and one-dimensional cavity mode-dispersion spectroscopy. Application of these techniques to spectral line shape and atmospheric research is discussed.

**ThR7-15 12:15-12:45**
**Identification of the sources of aerosol contamination using laser methods**
*A. Nagy, M. Veres, A. Kerekes, A. Czitrovszky; Wigner Research Centre for Physics of the HAS, Hungary*

Optical aerosol instrumentation was utilized to identify the sources of aerosol contamination in the air of Budapest. The results of the size distribution and absorptivity measurements show clear correlation with weather conditions, indicating the differences between the locations in the neighborhoods.

**ThR7-16 12:45-13:00**
**Gold-plated silicon nanostructures for surface-enhanced Raman scattering (SERS)**
*I. Rigo, L. Himics, A. Nagy, A. Czitrovszky, S. Toth, P. Furjes, G. Singh, M. Veres; 1 - Wigner Research Centre for Physics HAS, Hungary, 2 - Centre for Energy Research HAS, Hungary, 3 - Mulaivaja National Inst. of Technology, India*

Surface-Enhanced Raman Scattering (SERS) with its single molecule sensitivity is a promising tool for the detection of very low amounts of substances. The effective use of the technique requires specific substrates offering high levels of Raman enhancement. This work compares the performance of gold coated silicon SERS arrays of different morphology.

**ThR7-17 13:00-13:15**
**Temperature measurement by projection on latent structures of fluorescence spectra of potassium-alumina-borate glasses with copper-containing molecular clusters**
*M.A. Khodasevich, A.N. Babkina, P.S. Shirshnev; 1 - Stepanov Inst. of Physics NASB, Belarus, 2 - ITMO Univ., Russia*

The use of projection on latent structures allows to reduce the relative error of temperature measurement via a wideband fluorescence spectra of potassium-alumina-borate glasses with copper-containing molecular clusters to value about 1%. These glasses are shown to be a promising material as a temperature sensor head.

**ThR7-18 13:15-13:30**
**Remote determination of size of surface heterogeneity and displacements of diffusely scattering objects**
*D.V. Kiesewetter, V.I. Maluygin, N.V. Ilyin; 1 - Peter the Great St. Petersburg Politehnich Univ., 2 - Dalian Univ. of Technology, China*

The spectral correlation method for determining the height of the optical inhomogeneities and speckle-interferometer based on optical vortices for increasing sensitivity to longitudinal displacements of the scattering objects are presented.

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**Lasers in environmental monitoring V**
*Session Chair: Alexandr P. Zhevlakov, ITMO Univ., Russia*

**ThR7-19 15:00-15:30**
**SERS identification of labile products in the system «phenol-semiquinone-quinone»**
*E.A. Lasenko, V.P. Chelibarsov, A.M. Marugin, M.Z. Kasalimov; 1 - ITMO Univ., Russia, 2 - JSC OPTEC, Russia, 3 - JSC OPTEC (US Office), United States*

The paper presents the results of SERS studies of the dynamic behavior of «phenol - semiquinone - quinone» system. This system is a key in the formation of precursors of the electronic excitations of the composite materials and chromophore-containing sensors of the reactive oxygen species. The ThR range of Raman spectrums were registered for the labile products formed in the processes initiated by a proton transfer. A mechanism of the reaction initiated by a proton transfer has been proposed.

**ThR7-20 15:30-16:00**
**Use of wavelength-scanned cavity ring-down spectroscopy to obtain high-precision gas mixtures with micro-concentrations of formaldehyde**
*L.A. Konopetko, V.V. Beloborodov; 1, Y.K. Chubchenko, V.V. Beloborodov; 2 - Mendeleev Inst. for Metrology (VNIIM), 2 - ITMO Univ., Russia*

The article reviews the work in the field of provision comparability of formaldehyde in the air by preparation of reference gas mixtures for the transfer of mole fraction of formaldehyde. Verification and study of the gas mixture stability were carried out by wavelength-scanned cavity ring-down spectroscopy analyzer (WS-CRDS).

**ThR7-21 16:00-16:15**
**Metrological problems of 13C/12C measurements in the environment and food**
*L.A. Konopetko, V.V. Beloborodov; 1, Y.K. Chubchenko; 1 - Mendeleev Inst. for Metrology (VNIIM), 2 - ITMO Univ., Russia*

A new approach for combined Raman and Laser induced breakdown (LIBS) spectrometry measurements within a single laser event was suggested. A double pulse mode lasing (two nanosecond laser pulses with microsecond delay) was used to combine two spectrometry methods. The feasibility of combined Raman and LIBS spectrometry measurements was demonstrated for solid and liquid samples.

**ThR7-22 16:15-16:30**
**Combined LIBS and Raman measurements within a single laser event**
*V.N. Ledenev, M.Ya. Grishin, A.N. Fedorov, V.I. Bukin, S.M. Pershin; 1 - Prokhorov General Physics Inst. BAS, 2 - National Univ. of Science and Technology MSIS, 3 - Moscow Inst. of Physics and Technology (State Univ), Russia*

Here, the performance of OPOs, QCLs and near infrared lasers for trace gas sensing is demonstrated. We analyzed human breath detecting CH4, C2H6, CO and LIBS spectrometry measurements was demonstrated for solid and liquid samples.

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**Gift Certificate**

**Coffee Break**

**Location: Petrov-Vodkin 3 Room, floor 2, 17:30 – 18:00**

**Lasers in environmental monitoring VI**
*Session Chair: Alexandr P. Zhevlakov, ITMO Univ., Russia*

**ThR7-23 16:30-17:00**
**Laser-based trace gas detection with applications in biology and medical science**
*F.J. Harren, Radboud Univ. Netherlands*

Here, the performance of OPOs, QCLs and near infrared lasers for trace gas sensing is demonstrated. We analyzed human breath detecting CH4, C2H6, CO (marker for Heme degradation).

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**Tea Break**

**Location: Petrov-Vodkin 3 Room, floor 2, 15:00 – 17:00**

**Lasers in environmental monitoring IV**
*Session Chair: Alexandr P. Zhevlakov, ITMO Univ., Russia*

**ThR7-24 17:30-17:45**
**Real-time automatic recognition of solids using laser-induced breakdown spectroscopy**
*V.F. Lebedev, P.S. Makarchuk, ITMO Univ., Russia*

Real-time automatic recognition by laser-induced breakdown spectroscopy of both solid and granular materials at distances up to 5 m was performed. As a radiation source diode-side-pumped passively Q-switched Nd:YAG laser with a multiloop self-adaptive reciprocal cavity was used. The possibility of materials recognition by means of self-Q-switching on plasma mirror was demonstrated.

**ThR7-25 17:45-18:00**
**Lidar scanning module for remote environmental monitoring**
*V.V. Elizarov, A.S. Grishkanich, S.V. Kascheev, A.A. Mak, A.P. Zhevlakov, ITMO Univ., Russia*

Lidar module that allows to perform spiral scanning of the investigated area was developed. Software for managing and reading the angular coordinates of the laser beam was created. An example of implementation of such a module performing a combined scan in wide and narrow angle fields was shown.
The physics of ultra-low power conservative and dissipative polariton solitons in GaAs photonic structures is reviewed. Polariton solitons form on a short length scale of 10's of micrometers and can be manipulated within few picoseconds. The effect of spin-dependent polariton nonlinearity on soliton formation is also discussed.

**R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS**

**Location:** Pudovkin Room, floor 3, 09:00 – 11:00

**Nonlinear Cavities and Traps**
Session Chair: Leonid Melnikov, Gaugirin Saratov State Technical Univ., Saratov Branch of Kotel’nikov Inst. of Radioengineering and Electronics RAS, Russia

**ThR8-40 Invited**
Applications of VCSELs in optical transmission lines and vortex generation
A. Chipouline1, V.S. Lyubopytov2, Y. von Lerber3, M. Lassay4, S. Paul1, M.F. Schumaner1, J. Cesar1, M. Wegener3, F. Küppers1; 1 - Technische Univ. Darmstadt, Germany, 2 - Ufa State Aviation Technical Univ, Russia, 3 - Karlruhe Inst. of Technology, Germany, 4 - Univ. of Helsinki, Finland

The VCSEL (Vertical Cavity Surface Emission Laser) can generate phase replica of the phase modulation of the seeding signal and at the same time suppress its amplitude modulation. This phenomena is pretty universal for nonlinear auto-oscillating systems. Various applications could be forecasted. Rectification of the phase modulated signal from the residual amplitude modulation and consequent B(ER Bit Error Rate) improvement and doubling of the information capacity have been experimentally proven. The MEMS (Micro Electro Mechanical System)-VCSELs can be used for wavelength-tunable vortex beam generation, providing an ideal solution for the simultaneous OAMand wavelength-division multiplexed optical communications.

**ThR8-41 Invited**
Dissipative Kerr combs in microresonators: from chaos to solitons
M.L. Gorodetsky1, Lomonosov Moscow State Univ., Russian Quantum Center, Russia

Optical frequency combs, generated with mode-locked femtosecond lasers and microstructured fibers produced in recent years a revolution in metrology and experimental physics. A new phenomenon of nonlinear optics was discovered recently - spontaneous formation of similar combs in passive optical microresonators with continuous wave pumping. Such microresonator Kerr combs result from multiple hyper-parametric four-wave mixing processes. The report presents the results of theoretical and experimental studies, leading to the development of compact and integrated coherent frequency comb sources.

**ThR8-42**
Phase-dependent stimulated emission in a polymer
M. Saito1, Y. Nishimura, Ryukoku Univ., Japan

Weak spontaneous emission and strong stimulated emission were switched reversibly by melting and freezing a polyethylene-glycol solution of rhodamine 6G, which exhibited a phase transition from transparent liquid to turbid solid.

**ThR8-43 Invited**
Bose-Einstein condensate of exciton-polaritons in photonic crystals
E.A. Ostrovskaya1, The Australian National Univ., Australia

Exciton-polaritons in semiconductor microcavities can be driven to condensation, confined, and manipulated by a spatially structured optical pump. Using an off-resonant pump, we create micron-scale resonators for nonlinear exciton-polariton waves, which enable exploration of multi-mode behavior, quantum chaos, and non-Hermitian quantum physics. In particular, exceptional points and the associated topological Berry phase are observed in this quantum many-body system.

**ThR8-44**
Hysteric behavior of matter-wave solitons in dynamic cavities
N.N. Rosanov1,2,3, N.V. Vysotina1; 1 - Vavilov State Optical Inst., 2 - ITMO Univ., 3 - Ioffe Inst., Russia

We present the analysis of hysteresis for motion of soliton of Bose-Einstein condensate (i) between two oscillating atomic mirrors and (ii) above one oscillating mirror in presence of gravitational force.

- **Coffee Break -**

**Location:** Pudovkin Room, floor 3, 11:30 – 13:30

**Nonlinear Surfaces, Waveguides and Cavities**
Session Chair: Arkadi Chipouline, Technische Univ. Darmstadt, Germany

**ThR8-45 Invited**
Ultra-low-power polariton solitons in semiconductor waveguides and microcavities
P.M. Walker1, C. Whittaker1, T. Tinkler1, M. Sich1, E. Cancelleri1, D.V. Skryabin1, A. Garbacz2, A. Yulina2, B. Royall1, J. Farrer1, D.A. Ritchie2, M.S. Skolnick3, D.N. Krizhanovski1, T. - Univ. of Sheffield, United Kingdom, 2 - Univ. of Bath, United Kingdom, 3 - ITOU Univ., Russia, 4 - Univ. of Cambridge, United Kingdom, 5 - Present address: Univ. of Sheffield, United Kingdom

The physics of ultra-low power conservative and dissipative polariton solitons in GaAs photonic structures is reviewed. Polariton solitons form on a short length scale of 10's of micrometers and can be manipulated within few picoseconds. The effect of spin-dependent polariton nonlinearity on soliton formation is also discussed.

- **Lunch Break -**

**Location:** Pudovkin Room, floor 3, 15:00 – 17:00

**Nonlinear Frequency Conversion**
Session Chair: Boris I. Mantsyzov, Lomonosov Moscow State Univ., Russia

**ThR8-51 Invited**
Quasi-phase-matching second harmonic generation caused by pendulum effect in photonic crystals
D.A. Kopylov1, L.V. Dergacheva1, A.I. Madykovskiy1, S.E. Syukhovskiy1, VO. Kompanets1, S.Y. Chekalin1, V.A. Bushuev1, T.V. Murzina1, B.I. Mantsyzov1; 1 - Lomonosov Moscow State Univ., 2 - Inst. for Spectroscopy RAS, Russia

Second harmonic generation (SHG) in the Laue scheme of the dynamical Bragg diffraction in 1D photonic crystal (PHC) is studied. The experiments are performed for partially annealed porous-silicon PHC containing 250 periods of the structure. Our measurements confirm phase-matched SHG under the Bragg condition. Possible types of phase- and quasi-phase-matching realized in the studied PHC are discussed.
R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

ThR8-52 15:30-15:45
Phase-matched second harmonic generation in one-dimensional photonic crystals in the Laue geometry
V.B. Novikov, I.I. Mantysyov, A.I. Maiguskovski, T.V. Murzina; Lomonosov Moscow State Univ., Russia
We experimentally observe phase-matched second harmonic generation under Bragg diffraction in the Laue geometry in one-dimensional porous silica based photonic crystals infiltrated by a ferroelectric salt.

ThR8-53 15:45-16:00
Frequency conversion of multi-line carbon monoxide laser in PbIn6Te10 crystal
A.A. Ionin1, I.O. Kinyaevsky1, Yu.M. Klimachev1, A.Yu. Kozlov1, A.A. Kotkov1, V.V. Badikov1, K.V. Milit1; 1 - Lebedev Physical Inst. RAS, 2 - Kuban State Univ., 3 - Astrophysica, National Center for Laser Systems & Complexes, Russia
Frequency conversion of carbon monoxide laser was for the first time obtained in PbIn6Te10 nonlinear crystal. Laser-induced damage threshold, sum and different frequency generation efficiency under multi-line CO laser pumping were measured.

ThR8-54 16:00-16:15
Stimulated low-frequency Raman scattering in viruses
O.V. Karpova1, A.D. Kudryavtseva1, V.N. Lednev2, V.V. Oshturok2, S.M. Pershin2, E.K. Petrova1, N.V. Tcherniega2, K.I. Zemskov2; 1 - Lomonosov Moscow State Univ., 2 - Lebedev Physical Inst. RAS, 3 - Prokhorov General Physics Inst. RAS, 4 - Moscow Technical Univ. ‘STANKIN’, Russia
Stimulated low-frequency Raman scattering (SLFRS), caused by laser pulses interaction with the radial breathing modes of tobacco mosaic virus (TMV) in Tris-HCl pH7.5 buffer was registered. SLFRS frequency shift, conversion efficiency and threshold are measured.

ThR8-55 16:15-16:30
Extraordinary time-depended processes in the parametric interaction of counter-propagating waves
V.A. Tkachenko1, A.K. Pagov, S.A. Myslivets1, V.V. Stabko1; 1 - Siberian Federal Univ., Russia, 2 - Purdue Univ., United States, 3 - Kirensky Inst. of Physics SB RAS, Russia
Three-wave mixing of ordinary and backward electromagnetic waves in the pulsed regime is investigated. It is shown that opposite direction of phase velocity and energy flux in the backward wave gives rise to extraordinary transient processes in the greatly enhanced optical parametric amplification and frequency-shifting nonlinear reflectivity.

ThR8-56 16:30-16:45
Wide tunable BaGa4Se7 optical parametric oscillator pumped by Nd:YLF laser
N. Kostyukova1, A. Bobylev2, A. Boyko2,2, K. Zenkov1, A. Shadrin2, N. Tret’yakov1, V. Badikov1, D. Badikov1, D. Kol’ker2; 1 - Special technology LTD, 2 - Novosibirsk State Univ., 3 - Inst. of Laser Physics SB RAS, 4 - Kuban State Univ., Russia
BaGa4Se7 optical parametric oscillator (OPO) pumped by compact nanosecond Nd:YLF laser was demonstrated. Wides tuning range from 2.93 up to 3.93 mkm is shown for first time of our knowledge.

ThR8-57 16:45-17:00
Optical nonlinear response of liquid crystal spin valve
I.A. Budogovsky1, V.N. Ochkin1, S.A. Shtevkov1; 1 - Moscow State Univ. of Communication and Technology, 2 - Moscow State Univ., Russia
Optical nonlinearity of nematic liquid crystal polymer caused by molecular reorientation was found and investigated. Under the action of light on the polymer film, director of polymer reorient to light field increasing the refractive index. If the polymer is doped with an azobenzene compound, nonlinear response dramatically increases; in this case, the light-induced refractive index becomes negative.

- Coffee Break -
Location: Pudovkin Room, floor 3, 17:30 – 19:30
Nonlinearity of Solids, Gases and Plasmas
Session Chair: Alexander P. Shkurinov
Lomonosov Moscow State Univ., Inst. on Laser and Information Technologies RAS, Russia

ThR8-58 17:30-17:45
Time-resolved non-linear optical response and photosensitivity of glassy semiconductors
E.A. Romanoval, Yu.S. Kuzyutkin1, S. Guizard1, T.M. Benson1, A.B. Seddon1; 1 - Saratov National Research State Univ., Russia, 2 - Ecole Polytechnique, France, 3 - riv. of Nottingham, United Kingdom
An interferometric pump-probe method with the femtosecond resolution in time is used to study the third-order non-linear optical response and photosensitivity of a variety of chalcogenide glasses of the system As-S-Se.

ThR8-59 17:45-18:00
Saturation-saturable-absorption effect in subphthalocyanines caused by plasmonic nanoparticles
A.V. Zasedatelev1, T.V. Dubinina1, V.I. Krasovskii2, A.B. Karpo3; 1 - National Research Nuclear Univ. ‘MEPhI’, 2 - Prokhorov General Physics Inst. RAS, 3 - Lomonosov Moscow State Univ., Russia
Nonlinear optical properties of subphthalocyanines coupled with gold nanoparticles have been studied. We have found out many-fold enhancement in the saturable-absorption effect which originated from the strong near-field and great increase in the decay rate of excited states. Such plasmon-induced phenomenon gives the unique opportunity to reduce saturation intensity and boost absorption modulation depth of organic saturable absorbers.

ThR8-60 18:00-18:15
Nonlinear polarization effects on 2D rf-SQUID arrays
I.R. Gabitov1, Zh.A. Kudyshev1, A.I. Maimiston2; 1 - Skolkovo Inst. of Science and Technology, 2 - National Research Nuclear Univ., Moscow, Russia
Electromagnetic field scattering on a 2D array of rf-SQUIDs is considered. Within thin film approximation, we demonstrated bifurcation in the number of reflection states depending on the incident field. Difference in refraction and polarization characteristics of reflection states gives an opportunity to switch the direction of propagation and polarization of the electromagnetic wave with a device of ultrathin thickness.

ThR8-61 18:15-18:30
Giants Giocch-Hanchen effect and focusing of Gaussian light beam by one-dimensional photonic crystal with modulated band gap
S.E. Suyakovskaya1, E.A. Kekkonen, A.A. Konovko, A.V. Andreev, T.V. Murzina; Lomonosov Moscow State Univ., Russia
We present the theoretical and experimental studies of the giant Goos-Hanchen effect and the effect of focusing of light beam in one-dimensional photonic crystals with spatial modulation of photonic band gap position. We show that the photonic crystal with slow exponentially modulated band gap applies the second-order phase modulation to the reflected light and can focus or defocus the light beam.

ThR8-62 18:30-18:45
Spectral dependence of the (2+1) resonance-enhanced multiphoton ionization (REMPI) of atmospheric oxygen around 248 nm laser wavelength
A.V. Shutov1, S.A. Goncharov1, A.O. Leveckh1, V.S. Ryabchuk1, I.V. Smetanin1, N.N. Ustinovskii1, V.D. Zvorkyn1; 1 - Lebedev Physical Inst. RAS, 2 - National Research Nuclear Univ. ‘MEPhI’, Russia
The spectral dependence of resonance-enhanced multiphoton ionization (REMPI) of oxygen in the atmospheric air was studied around the 248 nm laser wavelength. It is shown that (2+1) REMPI through the 31u intermediate Rydberg state took place. Rotational constant B of the 31u state was measured.

ThR8-63 18:45-19:00
Two-photon absorption bandwidth determination in the 420-750 nm wavelength range for ZnTe and ZnSe crystals
M.O. Osipova, E.A. Makarov, V.G. Bespalov; ITMO Univ., Russia
Two-photon absorption bandwidth in the 420-750 nm wavelength range for ZnTe and ZnSe crystals was investigated using femtosecond pump-probe technique with supercontinuum, generated in a water jet.

ThR8-64 19:00-19:15
Energy accumulation and transformation of laser radiation in PbWO4 crystal
V.I. Lukarrin, A.A. Karasuk, Prokhorov General Physics Inst. RAS, Russia
Picosecond interband two-photon laser excitation of PbWO4 crystal at wavelength of 10K leads to 100% induced absorption (450-750-nm spectral range) with ~100min relaxation time. Electronic excitation energy accumulated within thin film approximation, director of polymer reorient to light field increasing the refractive index. If the polymer is doped with an azobenzene compound, nonlinear response dramatically increases; in this case, the light-induced refractive index becomes negative.

ThR8-65 19:15-19:30
Third order nonlinear optical response of plasmonic nanomoppr arrays
H. Zanichelli-Delureau1, K. Ryggpoyzoi1, B. Kalinici1, M. Michieli1, G. Mattei1, T. Cesca1, R. Rongel-Rajo1,3; 1 - CICESE, Mexico, 2 - Univ. degli Studi di Padova, Italy
One of the most promising Metallic Nanoparticle (MNPs) geometries is the 2D ordered Plasmonic Nanoprop Array (PNPA), on which the plasmonic effects present in an array of thin triangular MNPs are used to provide greatly increased third-order Nonlinear Optics (NLO) effects. In this work, gold and silver 2D ordered PNPs were fabricated using the Nanosphere Lithography (NSL) method. The third-order nonlinear response of these two samples was then observed in the Dipolar regime by the use of the Z-Scan technique. These experiments were performed by using a chopped ultra-short-pulse train at a wavelength of 821 nm. The sample NLO phenomena dependence with intensity and thermal load are presented.

<< LASER OPTICS 2016 >>
ThR2-p01 15:00-19:00

120W single-frequency laser based on active LMA double-clad fiber amplifier
A.I. Trinkshe, V.B. Tsetkov, Prokhorov General Physics Inst. RAS, Russia

We present CW single-frequency laser at 1080 nm (linewidth used for the first, second and third stages of amplifier. A large mode area double-clad fiber is used for the fourth stage of amplifier.

ThR2-p02 15:00-19:00

Prospect of optically pumped oxygen laser
M.V. Zagidullin, N.S. Malyshev, N.A. Khvatov, 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst., Samara branch, Russia

O2–12 gas is irradiated by light near 500nm and further pumped by light at wavelength 1315 nm in resonance with 2P3/2–2P1/2 transition of atomic oxygen. A set of chemical and energy exchange reactions result in generation of inverse population and gain of 0.04 m-1 on β–X transition of molecular oxygen.

ThR2-p03 15:00-19:00

Experimental study of iodine dissociation in active medium of oxygen–iodine laser
M.V. Zagidullin, M.S. Malyshev, N.A. Khvatov, 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst., Samara, Russia

Results of experiments on dissociation of iodine molecules in oxygen–iodine laser medium are presented. Rates constant of key reactions have been reexamined. The experiments confirmed mechanism of iodine dissociation proposed in (J. Phys. Chem., 87, 2348 (1983)). The experiments did not reveal the contribution of vibrationally excited oxygen molecules or three body reactions in the dissociation of iodine.

ThR2-p04 15:00-19:00

Coherent combining of high average power nanosecond pulse laser beams

Four high average power, high repetition rate, ns pulse laser beams have been coherently combined by single-detector, binary-tree filled-aperture coherent beam combining technique. For the present photonic crystal fiber based MOPO system, over 400 Watts combined average output power with 0.75 combining efficiency has been obtained. Combining efficiency degradation sources have been identified and its dependence on some specific misalignments discussed.

ThR2-p05 15:00-19:00

High power CPA cryogenic Yb:YAG laser
E.A. Perevezentsev, I.B. Mukhin, G.V. Pastoshkov, Inst. of Applied Physics RAS, Russia

For a few femtosecond pulse OPCPA amplification several picosecond pump is required. To develop such pump a laser system for a stretched picosecond pulse amplification is created in the Institute of Applied Physics RAS. It is then planned to prepare for the integration of a femtosecond seed laser with the cryogenic amplifier.

ThR2-p06 15:00-19:00

TEA–CO2 laser with pulse repetition rates up to 5 kHz for technological applications
B.A. Kazlov, Ryazan State Radio Engineering Univ., Russia

Some investigation results, directed to the creation of sealed–off TEA–CO2 laser with pulse repetition rates from 1 to 5 kHz for technological applications are given. In TEA–CO2 laser with active volume V ~28x0.5x0.2 m3 maximum values of radiation energy per pulse 20–25 mJ at 2–3 kHz are obtained. At the 5 kHz the laser energy decreases up to 5–6 mJ. Perspectives of increasing of pulse repetition rates up to 20 kHz are discussed.

ThR2-p07 15:00-19:00

Super-atmospheric metal–ceramic small–sized sealed–off TE–CO2 laser with PRR up to 25 Hz
B.A. Kazlov, D. Kuang Mohel, 1 - Ryazan State Radio Engineering Univ., Russia, 2 - Vietnam

The main interrelations of “electrical wind” velocity in supersonic atmosphere pressure CO2–laser mixtures are investi-gated. For the first time “electrical wind” effect was used for increasing pulse repetition rates (PRR) in TE–CO2 laser at total pressures 1–12 atmospheres. Generation characteristics milli–sized–sealed–off TE–CO2 laser at pulse repetition rates 1–25 Hz are studied. Laser energy per pulse 5–6 mJ at PRR 20–25 Hz with duration 4–5 nanoseconds from active volume V = 5x0.8x0.8 cm3 are obtained.

ThR2-p08 15:00-19:00

Carrier-envelope offset phase control and stabilization of kilohertz solid-state laser system
A.V. Kirpichnikov, V.V. Petrov, G.V. Kuptsov, A.V. Laptev, V.A. Petrov, E.V. Pestryakov, 1 - Inst. of Laser Physics SB RAS, 2 - Novosibirsk State Technical University, 3 - Novosibirsk State National Research Univ., Russia

The operating modes of the solid-state laser system with 1 kHz pulse repetition rate consisting of a master oscillator and nine-pass amplifier were investigated and parameters optimization has been carried out. A carrier-envelope offset phase stabilization system was developed and implemented allowing one to achieve residual instability ~6.17 radian (rms) for the 30 fs-pulse. It is considered to be sufficient to generate attosecond pulses in subsequent experiments.

ThR2-p09 15:00-19:00

Products of reaction Rb with C2H6 or CH4
G.I. Tolstov, S.N. Naumkin, A.R. Torbin, A.M. Mebbl, M.C. Heaven, V.N. Azayzov, 1 - Samara State Aerospace Univ., Russia, 2 - Lebedev Physical Inst. RAS, Samara branch, Russia, 3 - Florida International Univ., United States, 4 - Emory Univ., United States

Diode-pumped alkali vapor lasers (DPAL) commonly use CH4 or C2H6 to induce energy transfer between n2P3/2 and n2P1/2 levels. A complication is that the alkali metal reacts with the hydrocarbons. High-level ab initio calculations have been used to study the reactive interactions between Rb and CH4 or C2H6.

ThR2-p10 15:00-19:00

Ablation of optical transparent materials using picosecond laser pulses
A.G. Verkhogliad, M.F. Stupak, Technological Design Inst. of Scientific Instrument Engineering SB RAS, Russia

We present experimental results of the different processes that can give from focusing of ultrashort laser pulse in two-picosecond regime on a host of transparent materials, e.g., a silica, a silica glass and dielectric films. We summarize the physical processes and surface and bulk applications and highlight how picosecond lasers can be used to process various materials. Throughout this paper, we will show the advantages and disadvantages of using ultrashort lasers demonstrate their potential for the precision processing of materials and structures.

ThR2-p11 15:00-19:00

Electrohydrodynamic flow in gas discharge laser circulation system
I.E. Breborow, D.V. Dreenan, Yu.V. Khonich, V.A. Yamshchikov, Inst. for Electrophysics and Electric Power RAS, Russia

Electric discharge N2-laser with circulation system based on electrohydrodynamic (EHD) flow is described. Experimental studies and mathematical modeling of EHD flow considering configuration of circulation chamber and discharge gap have shown value of a stream more then 15 l/s.

ThR2-p12 15:00-19:00

Evolution of optical quality of Chemical Oxygen–Iodine Laser (COIL) active medium
Yu.A. Adamenkov, M.I. Bezrukov, M.A. Garbunov, M.L. Leonov, A.V. Selezniev, D.V. Sokolov, RFNC–VNIIEF, Russia

We have developed optical techniques for supersonic Chemical Oxygen–Iodine Laser (COIL) active medium exploration using focal spot methods. It has been found out that optical impurities of active medium density in optical resonator area were less than resolution limit of out apparatus, that is An/m.

ThR2-p13 15:00-19:00

Modeling of photolysis oxygen-iodine laser
S.Yu. Pichugin, A.A. Pershin, V.N. Azayzov, 1 - Lebedev Physical Inst., Samara Branch, 2 - Samara State Aerospace Univ., Russia

A theoretical model for predicting of the pulsed photolysis oxygen-iodine laser (POIL) performance has been developed. The calculated output energies of the POIL are in good agreement with experimental ones. Pathways in which the energy of O(1D) is converted to excitation energy of singlet oxygen molecule are discussed.

ThR2-p14 15:00-19:00

Radio frequency and microwave excited planar inert gas mixture infrared lasers
A.P. Mineev, S.M. Nefedov, P.P. Pashinov, P.A. Goncharov, V.V. Kiselev, Prokhorov General Physics Inst. RAS, Russia

Radiation characteristics of planar diffusion-cooled RF excited IR-lasers (Xe-He, Ar–He, Kr–He) created using the same design and excited by a large-aperture RF discharge (2.7x40x385 mm) at a frequency of 40.68 MHz in dependence on gas mixture composition and pressure have been studied. As a result of our experiments we were the first to produce a generation of a planar Ar–He and Kr–He lasers with the transverse cylindrical discharge. Planar laser with the transverse cylindrical RF discharge is shown as promising radiation source at a wavelength of 1.79–3.65 μm. The characteristics of the radiation of a planar Xe-laser excited by MW discharge with diffusive cooling of the active medium have been investigated. An average lasing power of 50 mW (pulse power 2.5 W) is obtained.
The efficiency research of laser energy conversion to the third harmonic for ‘Iskra 5’ iodine laser
A.V. Zubkov, S.V. Kalipanov, V.P. Kovalenko, S.P. Kurmopyalov, V.S. Fayzullin, RFNC - VNIIEF, Research Inst. of Laser Physics, Russia

The phase-matching angles for 3w generation in DKDP crystals have been obtained experimentally. Experimental results on the research of 3w generation have been presented for ‘Iskra 5’ laser conditions.

Optical components testing of powerful laser facility based on wavefront and surface profile analysis

The report presents the results of testing of wide aperture elements of powerful laser facility based on wavefront and surface profile analysis. Some features of interferometric measurements and data processing are presented. The inspection results used in 3D modeling of optical scheme. The simulation aimed on improvement of the laser channel structure and predicting of the beam quality at its output, and optimizing the requirements to quality of optics as well.

The system for uniform irradiation of targets applying partially coherent light generated in multimode waveguide at the Luch facility
I.A. Belov, S.A. Belkov, I.N. Voronich, S.G. Garanin, V.N. Derkach, B.G. Zimin, V.V. Evtikhiev

The system for spatial and temporal smoothing of laser radiation by multimode optical fiber was developed at the laser facility Luch. The system consist of broadband master oscillator, smoothing fiber and preamplifiers. Experiments on the third harmonic generation and conversion into second harmonic have been conducted. Integral over pulse small-scale uniformity of the target irradiation with the use of lens raster was decreased by 1-2 orders of magnitude as compared with the unsmoothed beam.
**R4. LASER BEAM CONTROL**

**ThR4-p01** 15:00-19:00

**Characterizing photonic nanojets from phase diffraction gratings**

A.A. Zemlyanov, Yu.E. Geints; Zuev Inst. of Atmospheric Optics SB RAS, Russia

We investigated numerically the specific spatially localized intense optical fields produced by diffraction gratings with the saw-tooth, grating. We investigated numerically the specific spatially localized intense optical fields produced by diffraction gratings with the saw-tooth, grating.

**ThR4-p02** 15:00-19:00

**Analysis of optical fiber complex propagation matrix in the basis of vortex modes**

V.S. Lyubaytsov1, A. Tatarczak, X. Lu, R.V. Kutlyuarov, S. Romanov1, A.Kh. Sultanov, J. T. Monroy2; 1 - Ufa State Aviation Technical Univ., Russia, 2 - Technical Univ. of Denmark, Denmark

We propose and experimentally demonstrate a novel method for reconstruction of the complex propagation matrix of optical fibers supporting propagation of multiple vortex modes. This method is based on the azimuthal decomposition approach and allows the complex matrix elements to be determined by direct calculations. We apply the proposed method to demonstrate the feasibility of optical compensation for coupling between vortex modes in optical fiber.

**ThR4-p03** 15:00-19:00

**Correction of wavefront distortion in YAG:Nd active elements in oblique geometry**

Yu.D. Arapol, V.P. Korolov, R.K. Nasirov, A.I. Malyshev, I.M. Ustynytev, I.V. Kaz’yanov; 1 - RFNC-VNIITF, 2 - Inst. of Automation and Electromechanics SB RAS, Russia

The paper is devoted to correction of wavefront distortion in large-aperture YAG:Nd active elements in oblique geometry by means of conformal correctors.

**ThR4-p04** 15:00-19:00

**Specific features of defects image in doped lithium niobate crystals in polarized light**

V.A. Maksimenko, Far Eastern State Transport Univ., Russia

This paper presents the experimental investigation of the photo-induced defects in doped lithium niobate crystals with various polarizations of inducing and testing laser beams. How do the forms of defect images depend on the light polarization is being discussed.
**POSTER SESSION**

**R4. LASER BEAM CONTROL**

**ThR4-p05**

Discrimination caused spatial noise occurring in multiple pass laser amplifier

A.V. Kovalov, V.M. Polyakov, A.A. Mak; ITMO Univ., Russia

We overview methods for numerical analysis of distortion patterns from arbitrary shaped apertures and for arbitrary beams. We present the FFT-based convolution calculation method modification and the results of numerical analysis of noise in a spatial intensity profile of a beam from a compact multiple pass laser amplifier.

**ThR4-p06**

Optical vortex array in broad-area laser

A.A. Krents\(^1\), D.A. Archikov\(^1\), N.E. Molevich\(^2\), A.V. Pakhomov\(^2\); \(^1\) - Samara State Aerospace Univ., \(^2\) - Lebedev Physical Inst. RAS, Russia

The formation of optical vortex array in broad-area laser is studied using the Maxwell-Bloch equations. The square optical vortex array solution was obtained analytically. Stability of the vortex array solution was investigated both analytically and numerically. Instability leads to oscillations in the vortex array. The frequency of vortexes oscillations was obtained.

**ThR4-p07**

Measurement and correction of the wavefront of laser beam propagated through scattering medium

I.G. Galaktionov, Ju. Sheldakova, A. Kudryashov, A. Byalko, G. Kalenkov; Moscow State Univ. of Mechanical Engineering, Russia

Laser beam propagation through the scattering suspension of polystyrene microspheres in distilled water was investigated both theoretically and experimentally. Dependence of the wavefront aberrations on the turbid medium concentration was obtained. The existence of low-order and high-order symmetric wavefront aberrations of the laser beam passed through scattering suspension was shown. The investigation showed that with the use of bimorph deformable mirror the wavefront aberrations of scattered light could be effectively corrected.

**ThR4-p08**

100 KW noncontact CW laser parameter measurement device

A.N. Lobanov, O.V. Cherepkova; Electrosteklo LLC, Russia

BeamWatch instrument is the first noncontact laser beam profiler that can measure CW laser beams with 980 to 1080 nm wavelengths with power levels from 1 kW to 100 kW on beam sizes up to 12.5 mm.

**ThR4-p09**

Visualization of transparent microinhomogeneity in the nonlinear optical crystals by phase-contrast technique with adaptive photothermal Zernike filter

E.I. Baba, V.V. Lashkarev, V.N. Portnov, A.P. Prohorov, I.V. Kuzmin, O.A. Malashkov; Inst. of Applied Phys. RAS, Russia

Visualization of growth-sector boundary and point defects in non-linear optic crystal (KDP) was performed by phase-contrast method with adaptive photothermal Zernike filter.

**ThR4-p10**

Low cost adaptable laser transmitter for ground-based orbital observation

F. Sroll, D. Hängl, P. Wagner, L. Humbert, W. Riede; Inst. of Technical Physics, German Aerospace Center, Germany

Several theoretical laser transmitter concepts for low Earth orbit free space optical applications were investigated. A suitable, cost effective design including a beam steering unit as well as a fully automated laser divergence control was realized and characterized. For this only commercial off the shelf components were used.

**ThR4-p11**

Fiber-array-based vortex beams propagation through a turbulent atmosphere

V.P. Aksenov, V.V. Dudorov, V.V. Kolesov\(^1\); \(^1\) - Zuev Inst. of Atmospheric Optics SB RAS, 2 - Tomsk Scientific Center SB RAS, Russia

We suggest a technique for generation of optical vortex beams with a variable orbital angular momentum based on a fiber laser array. Requirements for the number of subbeams and the spatial arrangement for the vortex beam generation are determined. The propagation dynamics of a vortex beam synthesized is compared with that of a continuous Laguerre-Gaussian beam in free space and in a turbulent atmosphere. Spectral properties of a beam synthesized, which is represented as a superposition of different azimuth modes, are determined.

**ThR4-p12**

Development and production of complicated electrode topologies for SAW-based inertial sensors

D.V. Safonov; Laser Center, Russia

A novel method of surface acoustic wave-based sensors production using laser ablation method is proposed. It provides excellent matching of topologies on opposite sides of wafers and a possibility to correct electrode structure after packaging. An experimental delay line is produced and tested.

**ThR4-p13**

Design of axial aberration compensation on picosecond pulsed laser machining system

Y. Liu, Z.W. Fan, J. Wang, T.Z. Zhao; W.R. Lin, Academy of Opto-Electronics CAS, China

Through the axial aberration compensation design, the maximum distance of axial focus compensation reaches 0.4 mm with the focus spot size of 3 μm in diameter. The results show that the picosecond laser micro-machining is able to reach the precision of microns with good quality.

**ThR4-p14**

The accuracy of the cross-wind speed calculation by the Shack-Hartmann wavefront sensor

L.V. Antoshkin, L.N. Lavrinova, V.V. Lavrinov; Zuev Inst. of Atmospheric Optics SB RAS, Russia

The method to calculate the cross-wind speed at the entrance aperture of an adaptive optical system from the centroid coordinates measured by Shack-Hartmann wavefront sensor is presented. It is shown that the method accuracy can improved by using the vernier method.

**ThR4-p15**

The assessment of noise in the algorithm for calculating the speed of the cross-wind transfer of phase distortion

N.V. Goleneva\(^1\), L.N. Lavrinova, V.V. Lavrinov; \(^1\) - Zuev Inst. of Atmospheric Optics SB RAS, 2 - Tomsk National Research State Univ, Russia

Calculation the cross-wind speed at the entrance aperture of an adaptive system is performed based on the correlation analysis of the centroids coordinates measured by a Shack–Hartmann wavefront sensor. To ensure the accuracy of the algorithm that calculate cross-wind speed, it must be resistant to noise caused by the sensor construction and performance of mathematical operations. Results of the numerical simulation are presented.

**ThR4-p16**

Statistically optimal control algorithm for the adaptive optics system

V.V. Lavrinov; Zuev Inst. of Atmospheric Optics SB RAS, Russia

We present optimized predictive controller for adaptive optics system (AOS) that used hypothesis of «frozen» turbulence and Kalman filtering to predict turbulent phase distortions.

**ThR4-p17**

Focusing of the laser beam by the conical axicon and the matched linearly layered lens

D.A. Sovetov\(^1\), A.V. Ushenin\(^2\), S.N. Khain\(^2\); \(^1\) - Samara State Aerospace Univ., \(^2\) - Image Processing Systems Inst. RAS, Russia

The paper considers the action of conical axicon and the matched linearly layered lens on focusing of the laser beam with using FDTD method.

**ThR4-p18**

Research of temperature-induced laser emission characteristics in large-area VCSEL

D.A. Archikov, A.A. Krents\(^2\), A.V. Pakhomov\(^2\), N.E. Molevich\(^2\); \(^2\) - Samara State Aerospace Univ., 2 - Samara Branch of Physical Inst. RAS, Russia

We report on the investigation of temperature induced laser dynamics in the model of wide-aperture vertical cavity surface emitting semiconductor laser based on two-dimensional Maxwell-Bloch equations with circular and square aperture. The results of numerical simulation in near and far fields are shown in dependence on frequency detuning, which can be presented as function of temperature in VCSEL.

**ThR4-p19**

Suppression of self-mode-locking and control of mode-locking regime of neodymium laser with single crystal GaAs into the cavity

M.V. Kazdov, A.M. Smirnov, R.M. Al-Khuzairi, V.N. Mantschev, V.S. Dneprovskii, Lomonosov Moscow State Univ., Russia

A simple way of suppression of self-mode-locking in a nanosecond Nd\(^3\)+:YAlO\(_3\) laser by placing single-crystal GaAs introducing a negative feedback into the laser cavity, exhibiting two-photon absorption, is implemented. Placing the element into the cavity of a pulse-induced picosecond Nd\(^3\)+:YAG\(_2\)O\(_2\) laser allowed an increase in the number of pulses and a change in the energy distribution between the pulses.

**ThR4-p20**

Measurement of laser cavity loss with algorithmic processing of dynamic effects

V.V. Azarova, A.S. Bessonov, A.L. Bondarev, A.P. Makeev, E.A. Petrukhin; R&D Inst. «Polus», Russia

We propose a dual-channel method for the measuring of a loss in a ring optical cavity. The loss value in a measured cavity is determined by comparing with intensity resonance of exemplary cavity. The algorithm of the intensity resonance processing takes into account the distortion of resonance shape by the dynamic effect.
R4. LASER BEAM CONTROL

ThR4-p22 15:00-19:00
Thermo-optical phase distortions analysis in high power fiber laser systems
P.A. Semenov, I.P. Zhigan, V.P. Kiselev, A.S. Filatov; KB «Kuntsevo», Russia
This work provides theoretical and experimental results of thermo optical phase distortions analysis in 5 kW high power fiber laser with various optical systems. The comparative analysis of beam formation system with various optical materials is conducted. Optimal parameters of various systems are defined.

ThR4-p23 15:00-19:00
Image processing by means of orientational self-action of light in nematic liquid crystal
E.L. Bubis1, I.V. Kuzmin1, I.A. Budagovsky1, S.A. Shvetsov2, M.P. Snayeva1, A.S. Zolotar1, A.Yu. Babrovs'kiy3; 1 - Inst. of Applied Physics RAS, 2 - Lebedev Physical Inst. RAS, 3 - Moscow Inst. of Physics and Technology, Russia

ThR4-p24 15:00-19:00
Assessment of the microoptical gyro parameters for provision of the given limiting sensitivity
Yu.V. Filatov1, E.V. Shalymov1, V.V. Venediktov1; 1 - St. Petersburg State Electrotechnical Univ., St. Petersburg State University, Russia
The paper considers the assessment of the parameter values of microoptical gyro, that uses amplitude and phase characteristics of the passive ring resonator, are required to achieve the limiting sensitivity 1°/h.

ThR4-p25 15:00-19:00
The results of experimental research adaptive optical system at different wavelengths
V.Yu. Venediktov1, A. Gorelov1, E. Shubenko1, D. Dmitriev1, I. Lovchik2, A. Tverkov1; 1 - St. Petersburg State Electrotechnical Univ., 2 - St. Petersburg State Univ., Russia
The paper presents the first results of investigations of implementation of the closed-loop adaptive optical system at the beamlet segment with the different length optic path, and research operation on different optical wavelengths.

ThR4-p26 15:00-19:00
The gradient method of deformable mirror, surface calculation and method realization in «Luch» facility wavefront correction system
I.N. Voronich, V.V. Gladkii, M.A. Gluhov, V.N. Derkach, I.N. Derkach, R.S. Kuzin, I.E. Chernov, RFNC-VNIIEF, Russia
The new method of deformable mirror surface calculation based on rms phase gradient minimization is described. The method introduced on «Luch» allows to minimize laser beam divergence using adaptive system and to decrease calculation time up to 1-2ms at the same time. The experimental dependence of laser beam divergence on rms phase gradient for «Luch» facility is given.

ThR4-p27 15:00-19:00
Auto alignment system for 100 Hz Nd:YAG laser
A.N. Pogorelov1, V.M. Polyakov1, A.V. Kovalev1, A.U. Karseev1, S.V. Kruzhakov1; 1 - ITMO Univ., 2 - FSUE “RI PhOOLJOIS” of RC “S.I. Vavilov SOI”, 3 - Peter the Great St. Petersburg Polytechnic Univ., Russia
The optical corrector for beam stabilization is investigated. We use galvo motors and position-sensitive photodetector for real time optical axis guiding. The system is developed for the purpose of 1.064 μm 100 Hz pulsed laser auto alignment system.

ThR4-p28 15:00-19:00
Spectral and optical limiting properties of ZnS nano and bulk crystals
A.A. Ryzhor2, I.M. Belousova2, D.A. Videnichev2, A.C. Panfutov2, S.K. Estradiyev2; 1 - Image Processing Systems Inst. RAS, Russia
Some features of spectral and non-linear optical properties of ZnS quantum dots stabilized by high-molecular polyvinylpyrrolidone have been studied. It is shown that the absorption spectra of ZnS composite materials (sols, coatings) in UV spectral region are determined by quantum confinement effect, exhibiting the dependence of the absorption edge of the size of the ZnS nanocrystals.

ThR4-p29 15:00-19:00
Propagation of vortex eigenfunctions of bounded Hankel transform in a parabolic fiber
M.S. Kirilenko2, O.A. Massoulina1, S.N. Khanina2; 1 - Samara State Aerospace Univ., 2 - Image Processing Systems Inst. RAS, Russia
The fractional Fourier transform (FrFT) was considered in the paper. The vortex singular eigenfunctions of bounded Hankel transform and its propagation through FrFT were studied.

ThR4-p30 15:00-19:00
Quantum dots as luminescent label for immunoassay
A.M. Sobolev1, M.V. Pazharov1, N.V. Beloglazova1, L.Yu. Goryacheva2; 1 - Saratov National Research State Univ., Russia, 2 - Ghtent Univ., Belgium, 3 - St. Petersburg State Univ., Russia
Luminescent semiconductor quantum dots are popular labels for immunoassay. Synthesis and application of quantum dots as luminescent label and also acceptor for fluorescence resonance energy transfer is described.

R7. LASERS IN ENVIRONMENTAL MONITORING

ThR7-p01 09:30-13:30
A twin path laser interferometer for the contact-free length measurement of absorption cells at the ten micrometer accuracy level
H. Elamdaltassi, C. Roullet, P. Marie-Jeanne, C. Janssen; LERMA-IPSL, Sorbonne Univ., France
We present a new twin path laser interferometer for length measurements of absorption cells using the optical path length change due to the refractive index diminution when the cell originally filled with nitrogen gas is evacuated. At a absorption cells using the optical path length change due to the refractive index diminution when the cell originally filled with nitrogen gas is evacuated.

ThR7-p02 09:30-13:30
Characterisation of 4.329 and 4.439 μm tunable interband cascade lasers (ICL) for CO2 clumped isotope analysis by direct absorption spectroscopy
J. Prokhorov1, T. Kluge1, Ch. Janssen1; 1 - Helidelberg Univ., Germany, 2 - Heidelberg Graduate School of Fundamental Physics, Germany, 3 - Sorbonne Univ., UPMC Univ. Paris 06, CNRS, Observatoire de Paris, France
Precise clumped isotopes analysis of carbon dioxide opens up new horizons in atmospheric and biogeochemical research. Recent advances in laser and spectroscopic techniques allow to develop the instrumentation necessary to access extremely low sub-permill variations of multiply-substituted isotopologues.

ThR7-p03 09:30-13:30
Use of adaptive nonlinear Zernike filter in phase-contract technique for registration of weak absorption of the medium
E.L. Bubis1, V.V. Lozhkarev1, I.V. Kuzmin1, Yu.A. Mamoev1, V.O. Martynov1, A.I. Smirnov1; 1 - Inst. of Applied Physics RAS, 2 - Lobachevsky State Univ., Russia
The use of photothermal Zernike phase-contrast filter for measuring the absorption of the medium proposed. Results of numerical simulation are given. It is shown that the efficiency is comparable to the imaging scheme that uses linear filters, with a significant simplification of the process of its adjustment.

ThR7-p04 09:30-13:30
About Zernike method visualization of transparent objects by laser beam reflection from thin layer of oil
E. Bubis; Inst. of Applied Phys. RAS, Russia
The Zernike method visualization of transparent objects by laser beam reflection from thin layer of oil.
Influence of physical factors on the zero drift of laser gyroscope at displacement of the optical path
Yu.Yu. Brolavets, E.A. Polukeev, A.A. Fomtchev, Moscow Inst. of Physics and Technology (State Univ.), Russia

In this article it is under investigating the influence of the shift of optical path in nonplanar cavity on the laser gyroscope drift characteristics magnitude involving magnetic field gradients, non-uniform gas flow and the diffraction nonreciprocity.

Photoactivation of giberellin influenced by radiation on the surface of plant tissues
A.A. Yakovlev1,2, A.S. Durov1,2, A.S. Grishkanich1, S.V. Kascheev2, A.A. Mak1, J.S. Ruzankina1, 1 - St. Petersburg State Forest Technical Univ., 2 - ITMO Univ., Russia

The mechanisms of their thermal, photo-decomposition and confirmation of touch element serviceability and suitability. Experiment realization and obtaining the experimental data. The durability against light and aging dynamics of heteroatomic aromatic molecules has been shown.

Increase of steel corrosion resistance by photonics
I.S. Ruzankina1, S.V. Kascheev1, O.S. Vasilyev1,2, V.A. Parfenov1,2, 1 - ITMO Univ., 2 - LLC “Laser center”, 3 - St.Petersburg State Electrotechnical Univ., Russia

The study is devoted to metal corrosion resistance increase possibility by means of laser oxidation. There are represented the results of experimental research of metal surface anti-corrosion protection while oxidizing it by constant fiber laser emission on wavelength λ = 1064 nm. Several tests were carried out to define the optimal processing parameters providing the high anti-corrosion protection of irradiated metal surface.

Creation platinum nanostructures for pH environment analyzer
V.V. Stepianov, V.V. Elizarov, A.S. Grishkanich, A.P. Zhevlakov, ITMO Univ., Russia

Role and value of pH measurement in bionanotechnologies. Development of pH element on the basis of Pt-nanofilms created by the LED method. Manufacture Pt-nanofilm by LED method, agreement with the hypothesis and confirmation of touch element serviceability and suitability. Experiment realization and obtaining the experimental data.

The investigation of aging process of writing inks printed on paper using Raman spectroscopy
K.G. Gorshkova1, L.I. Tumkin1, A.S. Toerjanovich2, E.R. Rossinskaya2, V.A. Kochenirovsky1, 1 - St. Petersburg State Univ., 2 - Kutafin Moscow State Univ. of Law, Russia

The durability against light and aging dynamics of heteroatomic aromatic colorants containing nitrogen atoms used in writing inks was studied using Raman spectroscopy. The mechanisms of their thermal, photo-decomposition were proposed and the rates of these processes were determined. The results obtained in this study can be used for the age estimation of the paper documents up to 15 years.

Eye-safe DPSSL-based TOF-camera for geodesy
A.V. Kovalov, V.M. Polyakov, V.A. Buchenkov, ITMO Univ., Russia

We present a new TOF camera design based on a compact actively Q-switched diode pumped solid-state laser operating in 1.5 um range and a receiver system based on a short wave infrared InGaAs PIN diodes focal plane array with an image intensifier and a special readout integration circuit. The compact camera is capable of depth imaging up to 4 kilometers with 10 frame/s and 2.5 m resolution. The camera could be applied for airborne and space geodesy location and navigation.

Imaging of hidden objects in millimeter wavelength range
G.S. Rogozhnikov, I.V. Mishina; RFNC-VNIIEF, Russia

Electromagnetic radiation of millimeter and sub-millimeter wavelength range can penetrate through the sufficient number of constructional and domestic materials, that's why it is widely used in remote sensing of objects hidden behind the opaque barriers. Present-day technologies and methods make it possible to obtain information both about the appearance of the hidden object with spatial resolution on the order of wavelength and its structure. In this paper we show some ways of enhancing the self-descriptiveness of images being registered at 139-141 GHz frequencies by taking into account barrier features and object location behind the barrier.

SERS-platforms based on alumina and silica with embedded Ag nanoparticles for pre-concentration and detection
N.S. Yurova, A.V. Markin, T.Yu. RUnited Statesnova; Saratov National Research State Univ, Russia

New SERS-active materials were obtained by preparation of alumina and silica with embedded silver nanoparticles. Synthesized materials were applied for pre-concentration of model analytes and their SERS detection directly within the sorbents. The optimal conditions (ionic strength of Ag nanoparticles solution, conditions of silica and alumina synthesis and conditions of analyte pre-concentration) for maximum SERS signal enhancement were chosen.

Self-visualization and self-inverting of objects and structures when focusing spatially-phase-modulated laser radiation in weakly absorbing air environment
E.L. Bubis1, A.M. Kiselev1, I.V. Kuzmin1, S.A. Gusev1, E.V. Skorohodov1, 1 - Inst. of Applied Physics RAS, 2 - Inst. for Physics of Microstructures RAS, Russia

Processes of self-visualization and self-inverting of objects and structures when focusing spatially – phase-modulated laser radiation in weakly absorbing air environment about addition of small amount of vapors of molecular bromine are realized. The required power of laser radiation for realization of processes doesn't exceed 200 mW. Processes can be useful when developing laser ladar techniques and measurements for atmospheric remote sensing.

Detecting of thin oil films on water surface via UV filaments
A.A. Ionin1, D.V. Mokrousova1,2, V.A. Seleznev1, D.V. Sinitstyn1, E.S. Sunchugasheva1,2, 1 - Lebedev Physical Ins. RAS, 2 - Moscow Inst. of Physics and Technology, Russia

Femtosecond UV laser pulse induced fluorescence of thin oil films located on water surface was studied experimentally. Wide range of laser pulse intensity including filamentation mode was studied. This method was implemented for femtosecond UV pulses of two central wavelengths of 248 or 372 nm. Spatial resolution of the fluorescence localization was demonstrated to be not worse than 30 cm.

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8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

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KEY TOPICS OF THE SYMPOSIUM

• High power fiber lasers for material processing applications
• Cutting and welding with kW fiber lasers
• Fiber laser cladding, sintering, heat treatment and additive technology
• Fiber lasers for automotive applications
• Mid power fiber laser applications
• Pipe and thick section welding
• Marking and engraving
• Mid infra-red, 2 to 3 micron fiber lasers, processing including
• Cutting and welding of plastics
• Visible, UV and ultrafast fiber lasers and applications
• Hybrid lasers
• Life Sciences, medical, surgical, food production, agricultural pest and herbal control applications of fiber lasers
• New materials and parts for fiber lasers: fibers, crystals, glasses, optics, nonlinear elements
**TECHNICAL SESSION**

**8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS**

**PLENARY SESSION**
Location: Petrov-Vodkin 2+3 Rooms, floor 2, 09:00 – 11:00
Session Chair: Nikolay N. Evtikhiev
NTO “IRE-Polus”, Russia

TuS1P-01 Plenary 09:00-09:40
Modern state and prospects of applications high-power fiber lasers
V.P. Gapontsev; IPG Photonics Corp., United States
Modern accessories of fiber lasers - their designs and manufacturing techniques. New opportunities of application over powerful lasers.

TuS1P-02 Plenary 09:40-10:20
New developments for laser beam welding with high power fiber laser
J. Standfuss1, E. Beyer1, D. Dittrich1, B. Brenner1, S. Nowotny1, S. Thieme1, F. Brueckner1, C. Leyens1; 1 - Fraunhofer Inst. for Material and Beam Technology, IWS, 2 - Technical Univ. Dresden, Germany
New fiber laser offers a wide range for new advanced laser beam welding technologies for hard-to-weld materials like aluminum or for precise built-up welding. The paper will describe different possibilities and technologies. The brilliant beam quality allows multi-pass welding with extremely narrow gap of less than 5 mm for welding depth up to 50 mm and above. With high frequent beam oscillation of up to 4 kHz and resulting keyhole stabilization pressure die casting aluminum are weldable with tight weld seams. Furthermore new optical configurations like processing heads with coaxial wire feeding allow new applications for welding, cladding and additive manufacturing.

TuS1P-03 Plenary 10:20-11:00
Theory and technology of high productive direct laser deposition by means of high power fiber laser
The article deals with physical processes of material transfer and shape formation in direct laser deposition. Mathematical model of deposition process, joined jet dynamics, powder transfer and heating by laser beam, melt pool formation and stability was developed. Experimental installation was designed on the base of 5 kW fiber laser. Calculation results were verified by comparison with experimental ones.
Stimulated Brillouin scattering. A new thulium laser module with hybrid Tm:Lu₂O₃ booster is presented. This module operates in pulsed mode and has the following characteristics: pulse width 10ns, maximum pulse energy up to 1μJ, pulse repetition rate up to 20kHz.

TuS1A-04 12:30-12:50
Two μm hybrid lasers based on Tm³⁺:Lu₂O₃ ceramics in band pumped by Raman-shifted erbium fiber lasers and their OPO frequency conversion
O. Antipov¹, O. Larin², S. Larin³, I. Obronov²; 1 - Inst. of Applied Physics RAS, 2 - NTO “IRE-Polus”, Russia

High efficient 2-μm laser oscillators based on Tm³⁺:Lu₂O₃ ceramics in band pumped at 1670 nm by Raman-shifted erbium fiber laser were investigated. Both 2 μW CW and 15 W active Q-switched oscillations with 40 ns pulse duration and 15-30 kHz repetition rate were achieved in high quality beam. Evolution of two generated waves at 1966 nm and 2064 nm in dependence on pump power was studied. The mid-infrared frequency conversion of the ceramics laser radiation generated waves at 1966 nm and 2064 nm in dependence on pump power was realized. A OPO based on ZGP-based optical parametric oscillator was used. This work presents an overview on the latest advancements in the understanding of the physics and technology of high power fiber laser systems (RFLs), including direct pumping of gradient-index fibers by multimode LDs and their investigation. Some drawbacks of conventional model have been revealed in my work. Addition of continuous emission to numerical model was shown to give much better correspondence with experiment.

TuS1A-05 12:50-13:10
Millijoule level nanosecond hybrid thulium pulsed laser
I.V. Borovkov¹, V.E. Sypin¹, S.V. Larin¹, D.V. Myasnikov², O.I. Antipov¹; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia

New thulium laser module with hybrid Tm:Lu₂O₃ booster is presented. Module operates in pulsed mode and has following characteristics: pulse width 10ns, pulse energy up to 1μJ, pulse repetition rate up to 20kHz.

TuS1A-06 13:10-13:30
Single-mode broadband red fiber laser
O.A. Byalkovskiy¹, V.A. Tyryshnyy², E.S. Golubyatnikov³; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia

18 W of red laser radiation at 0.63 μm with 3 nm spectral bandwidth was achieved by sum frequency generation (SFG) of Er and Yb pulsed fiber lasers radiations at 1.55 μm and 1.06 μm wavelengths respectively. Noncritical phase matching in lithium triborate (LBO) crystal at 16°C of temperature was used.

Lunch Break

TuS1A-07 15:00-15:20
Simulation of nonlinear polarization rotation laser with consideration of continuous wave emission
D.V. Protasenya¹, A.I. Baranov², D.V. Myasnikov²; 1 - NTO “IRE-Polus”, Russia

Simulation of mode-locked lasers operation became an indispensable part of their investigation. Some drawbacks of conventional model have been revealed in my work. Addition of continuous emission to numerical model was shown to give much better correspondence with experiment.

TuS1A-08 15:20-15:40
High power ultrashort fiber laser system at 1.55 μm
A.I. Baranov¹, D.V. Myasnikov¹, D.V. Protasenya¹, A.S. Demkin¹, V.P. Gapontsev²; NTO “IRE-Polus”, Russia

Ultrashort erbium fiber laser system is presented. Optical module is integrated in IPG standard rack. Pulses with energy up to 20 μJ are obtained, whereas maximum pulse repetition rate is 2 MHz. One of the main features of the system is high individual pulse energy modulation. Burst mode of several pulses with specified pulse energy is also supported.

TuS1A-09 15:40-16:00
High power QCW Raman fiber laser at 1246 nm
A.V. Pigarev¹, A.A. Surin², D.V. Myasnikov¹; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia

A quasi-continuous-wave all-fiber Raman fiber laser is demonstrated with a master oscillator power amplifier scheme. Ytterbium-doped booster is seeded with wavelengths 1069 and 1246 nm at the same time. Amplified pump at 1069 nm converts to signal Raman wavelength in phosphosilicate passive fiber. A 510 W peak power Raman fiber laser at 1246 nm with an optical efficiency of 58% for the respect to semiconductor multimode laser diode pump is demonstrated.

TuS1A-10 16:00-16:20
Pulsed erbium fiber laser with second harmonic generation in PPLT crystal
A.S. Demkin¹, A.I. Baranov¹, V.T. Ahtyamov², D.V. Myasnikov²; 1 - NTO “IRE-Polus”, 2 - Moscow Inst. of Physics and Technology, Russia

Nanosecound erbium fiber laser with frequency doubling in PPLT crystal at 780 nm is presented. Laser operates in the regime of constant pulse energy of 5 μJ and pulse duration of 2 ns at different frequencies in the range of 0.5–5 MHz. Average output power of 20 W was reached at the of 780 nm with 70% conversion efficiency.

TuS1A-11 16:20-16:40
Ultra-wide wavelength tuning of fiber lasers
Yt. Feng¹, Shanghai Inst. of Optics and Fine Mechanics CAS, China
In the talk, we will review the recent development on ultra-wide wavelength tuning of fiber lasers based on stimulated Raman scattering and Rayleigh scattering.

TuS1A-12 16:40-17:00
Thermal optimization of high power fiber laser systems
C. Jauregui¹, H.-J. Otto¹, C. Stihler², J. Limpert¹, A. Tünnermann¹, 2 - Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany
This work presents an overview on the latest advancements in the understanding of transverse mode instabilities (TMI) together with guidelines to optimize high power fiber laser systems from the thermal point of view.
TuS1B-01
Fiber laser in stainless steel tube manufacturing
A. Cavallini, IPG Photonics, Italy
The laser technology offers a higher welding speed (specially at higher material thickness), with less heating and a smaller heat affected zone. Higher processing speed of stainless steel is not only a matter of productivity, but also of quality.

TuS1B-02 Invited
Welding of high-strength aluminum alloys by high-power fiber lasers
I.N. Shiganov, Bauman Moscow State Technical Univ., Russia
Welding of high-strength aluminum alloys by fiber laser is investigated. The possibility of laser cleaning of welded edges is shown. The features of welding with filler wire and hybrid laser-arc welding are studied. Microstructural researches and tests of mechanical properties are carried out.

TuS1B-03
Technological features of welding by powerful fiber lasers
I. Begunov, N. Grezev, E. Shamov, Yu. Markushov, NITs «IRE-Polus», Russia
We present results of our experimental welding by powerful fiber lasers different metals and alloys.

TuS1B-04
Formation of qualitative welding joints by hybrid laser arc welding of hull structures using high power fiber lasers
N.A. Nosyrev; Laser Center of Shipbuilding, JSC "Shipbuilding and Shiprepair Technology Center", Russia
The key features of qualitative welding joints formation using hybrid laser arc welding technology investigated in this work including estimation of influencing parameters, numerical modeling and full scale experiments.

TuS1B-05
Characteristics of yttrium oxide ablation by high-power fiber ytterbium laser
V.V. Platonov, E.A. Kochurin, V.V. Lisemkov, V.V. Osipov, E.V. Tikhonov, N.M. Zubarev; Inst. of Electrophysics, Ural Branch RAS, Russia
Characteristics of neodymium activated yttrium oxide ablation by high-power fiber ytterbium laser have been investigated. The high-speed photography of laser plume glow was carried out. The parameters of crater formed by laser radiation were measured. On the basis of obtained data we can conclude that the main part substance is removed from a target as liquid drops. The mechanism of formation of these drops was proposed and studied theoretically in the paper.

TuS1B-06
Research of process of laser welding of thin titanium plates by modeling the distribution of thermal fields
A.B. Lyukhten1, A.V. Gromyko2, D.A. Kochuev, P.A. Polkov1, A.N. Shlegel1; 1 - Vladimir State Univ., 2 - Engineering Centre at VGU, Russia
The paper deals with the research of the problem of thin titan plates laser welding by calculating the distribution of thermal fields with the method of the final element analysis for predicting structural phase state of the weld. The results of modeling were being checked by experiments. The patterns obtained were being investigated for phase-structural transformations, efforts to tear. There were found the modes enabling to weld thin titan plates with a high quality of the weld.

- Lunch Break -

TuS1B-07
Advanced YLS-5000-BR laser developed for brazing applications
E. Scherbakov, V. Fomin, A. Abramov, D. Yagodkin, D. Mochalov, V. Mironov; IPG Laser GmbH, Germany
High efficient, low footprint, industrial-grade fiber laser for brazing application was developed. The solution offers the following advanced features: unique replaceable three-core Process Fiber, independent power control via industrial field bus interfaces, high WPE thanks to usage of ECO-grade laser modules, advanced IPG Power Supply with integrated safety, integrated water-water chiller. The laser is fully compatible with all types of industrial processing heads thanks to usage of LCA (QD) output connector.

TuS1B-08 Invited
The features of gear teeth hardening process using fiber laser
O.G. Devoino, V.V. Gorskij; Belarusian National Technical Univ., “RUCH Servomotor”, Belarus
Results of theoretical analysis of possibility surface laser hardening of gear teeth have been presented. It’s shown that necessary properties of hardening layers may be obtain by using special scanning optic system. It is established that optimal distribution of micro hardness on hardening layers depth it is necessary for exploitation in contact stress loading conditions.

TuS1B-09 Invited
High spatial adaptability beam delivery system for the laser surface hardening of automotive components by high power fiber lasers
P. Sancho1, J. Dominguez2, J. Isaza1, F. Cordoveilla1, A. García Beltrán1, J.L. Ocaña1; 1 - IKERKUNE A.I.E., 2 - Talens Systems, 3 - Polytechnical Univ. of Madrid, Spain
One of the major challenges for laser hardening is finding a way to deal with geometrical singularities of the treated components. In the present paper, developments are presented in the way of dynamical conformation of the laser beam assuring a high treatment quality in the treatment of automotive components by high power fiber lasers.

TuS1B-10
Approaches for profitable ultrashort pulse micromachining
B. Resan1, C. Fuhrer1, A. Stumpf1, F. Senn1, R. Witte2, R. Holtz1,2; 1 - Univ. of Applied Sciences and Arts, 2 - Class 4 Laser Professionals AG, Switzerland
We will review several approaches for ultrashort pulse micromachining applications: new market development, competing in the existing application of direct machining with other conventional laser technologies, high volume replication using a micromachined tool, and parallel macro and micromachining. We will discuss advantages and disadvantages of each approach and report on our progress in development of a machine for parallel macro and micro machining.

TuS1B-11
Applications of fiber lasers for personalization of high security ID documents
V. Elakhin, V. Goltib, I. Korzhavin, Scientific Instruments JSC, Russia
We present the technologies and apparatus for laser personalization of high security ID documents based of fiber lasers, including new security element utilizing enclosed laser ablation technique.
SECTION S1A. FIBER LASERS AND COMPONENTS

LOCATION: Petrov-Vodkin 2 Room, floor 2, 09:00 – 11:00

Fiber Lasers and Components III
Session Chair: Nikolay N. Evtkhiev
NTO "IRE-Polus", Russia

WeS1A-13
09:00-09:20
QCW thulium fiber laser for medical application
V. Syatin1, V. Volkov2, D. Myasnikov1, F. Scherbina1, A. Bashkin1; 1 - NTO "IRE-Polus", Russia, 2 - Moscow Inst. of Physics and Technology, Russia, 3 - IPG Laser GmbH, Germany

New compact thulium fiber laser module is presented. Module operates in millisecond-pulse mode with peak power up to 500W, average power up to 50W, and pulse energy up to 5J. The module is air-cooled and can be easily integrated in laser system.

WeS1A-14
09:20-09:40
Multi-kilowatt CW fiber laser systems with record wallplug efficiency exceeding 50%
V. Gapontsev1, E. Shcherbakov, V. Fornin1, A. Abramov, M. Abramov, A. Ferrin1, M. Vironov, A. Darokhin1; 1 - IPG Photonics, United States, 2 - IPG Laser GmbH, Germany

The new family of industrial-grade fiber lasers having wall-plug efficiency (WPE) exceeding 50% in 1 – 10 kW CW optical power range is presented. Maximal achieved WPE value is world’s record 51.2%. Laser concept is based on the preliminary selection of laser components and matching of optimal operation ranges of different laser parts.

WeS1A-15
09:40-10:00
5 kW average power nano pulse fiber laser
V.P. Puju1, V. Gapontsev1, E. Scherbakov, V. Fornin1, A. Unte1, S. Maryashev1, M. Abramov1, M. Vironov1, A. Ferrin1, V. Khlobutkin1; 1 - IPG Photonics, United States, 2 - IPG Laser GmbH, Germany

Parallel combining of multiple nanosecond pulse fiber lasers by means of fused fiber combiners is proposed to scale up the output power of pulse fiber lasers. The radiation of 7 laser modules is coupled into 300 µm core delivery fiber with BPP equalled to 18 mm x mrad. The achieved peak power 0.5 MW and pulse energy 50 mJ correspond to the average power 5 kW within 1064 nm wavelength range.

WeS1A-16
10:00-10:20
Industry grade ultrafast ytterbium fiber lasers for glass and sapphire
A. Yusim1, O. Shkurikhin1, D. Myasnikov1, A. Podvyaznuy1, A. Sevian1, A. Bordenyuk1, I. Samartsev1, N. Platonov1, V. Gapontsev1; 1 - IPG Photonics, United States, 2 - NTO "IRE-Polus", Russia

We report an industrial grade picosecond pulse Yb fiber lasers with >100 µJ pulse energy and 100 fs of average pulse width for improved laser machining speed of sapphire and glass. The highly efficient laser with >25% wallplug efficiency resides in a compact 3U rack mountable configuration. Customer controllable features such as repetition rate, pulse duration, burst mode and adjustable pulse energy permit the customer to tailor the laser to their application.

WeS1A-17
10:20-10:40
Theoretical modeling of Er/Yb-doped fiber laser
A.M. Volkov, V.E. Syatin, A.I. Baranov, D.V. Myasnikov; NTO "IRE-Polus", Moscow Inst. of Physics and Technology, Russia

High power Er/Yb-doped fiber laser generation is analyzed. Parameters of rate equations are clarified. Upconversion and excited state absorption coefficients are measured.

WeS1A-18
10:40-11:00
Compact broadly tunable high energy nanosecond Ti:Sapphire laser for photacoastical applications

We introduce TiSon GS - a novel gain-switched Ti:Sapphire laser. The laser outputs up to 1 mJ pulses energies with 10 ns pulse duration and 0.5 nm line width at 1 kHz repetition rate. Wavelength is automatically tuned in the range of 700-900 nm. Random wavelength access is possible with less than 1 ms switching time per any wavelength change.

Coffee Break

WeS1A-19
11:30-11:50
Looking for efficient compressor for high pulse energy femtosecond fiber laser
S. Frankinas, A. Michailovas, N. Rusteika; Ekspla Ltd, Center for Physical Sciences and Technology, Lithuania

The results of pulse compression using different stretcher/compressor configurations of the laser chirped pulse amplification system are demonstrated.

WeS1A-20
11:50-12:10
Influence of a backward optical signal on mode instability in Yb3+ doped fiber amplifier
D.A. Alekseev1, V.A. Tyrtysny, M.S. Kuznetsov2, O.L. Antipov3; 1 - NTO "IRE-Polus", 2 - Moscow Inst. of Physics and Technology, 3 - Inst. of Applied Physics RAS, 4 - Nizhniy Novgorod State Univ, Russia

Influence of both backward reflections and laser radiation of independent source propagating in backward direction of ytterbium fiber amplifier on mode instability was investigated. Dependences of mode instability threshold on both power and wavelength of the backward signal were measured. In order to explain threshold behavior we took into account backward signal in our theoretical model.

WeS1A-21
12:10-12:30
Mode instability observation in fiber amplifier of single-frequency radiation at 1560 nm wavelength
P.K. Paju1, M.Z. Zelenova, V.A. Tyrtysny; NTO "IRE-Polus", Russia

Mode instability was observed in fiber amplifier of single-frequency radiation at 1560 nm wavelength. Mode instability threshold is 3.5 W at 20 mW input signal and 12 W pump power. High order modes intensity, measured using fast photodiode, oscillates at 2 – 3 kHz frequency.

WeS1A-22
12:30-12:50
Experimental comparison of mode instability threshold in high power fiber amplifier and oscillator
X. Wang, H. Zhang, R. Su, R. Tao, P. Zhou, X. Xu; National Univ. of Defense Technology, China

We investigated the behavior and threshold of mode instability both in high power fiber amplifier and oscillator experimentally. Fiber oscillator and fiber amplifier using the same fiber with core/cladding diameter of 21/400µm and all pumped by laser diodes with center wavelength of 976nm. Results shows that fiber laser oscillator holds a lower mode instability threshold than that in fiber amplifier.

WeS1A-23
12:50-13:10
Laser and supercritical fluid technologies for optical nano-composite materials fabrication
N.V. Minev1, A.O. Rybatovskiy1, V.N. Bagratashvili1; 1 - Inst. of Laser and Information Technologies RAS, 2 - Moscow State Univ, Russia

The technology of structured nanocomposite materials fabrication using supercritical fluid and laser approaches is elaborated. Different types of structures from Ag and Au nanoparticles in polymer and porous optical materials are produced:periodic layered nanostructures (horizontal to film surface) from Ag nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles in polymer and porous optical materials are produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks produced:periodic layered nanostructures (horizontal to film surface) from Ag and Au nanoparticles with unexpectedly short period (90 - 180 nm); filamentary tracks.

Lunch Break
8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

SECTION S1A. FIBER LASERS AND COMPONENTS

Location: Petrov-Vodkin 2 Room, floor 2, 15:00 – 17:00

Fiber Lasers and Components V
Session Chair: Nikolay N. Evtikhiev
NTO “IRE-Polus”, Russia

WeS1A-25 Invited
CVD diamond-prospective optical material
V.I. Konov, Prokhorov General Physics Inst. RAS, National Research Nuclear Univ. MEPhi, Russia

It will be shown that diamond films and plates produced by plasma chemical deposition technique (CVD diamond) have a number of unique properties such as broadband transparency, record hardness and thermal conductivity. This combination makes CVD diamond extremely attractive for optics, in particular for high power laser systems. Examples of such applications will be demonstrated. Possibility of precise and productive surface and bulk micro and nanostructuring of diamond will be also considered.

WeS1A-26
Holmium doped fiber amplifier in the spectral region 2-2.15 µm
V.A. Kamynin1,2, S.A. Filatova1, I.V. Zhukhtova1, V.B. Tsvetkov1,2; 1 - General Physics Inst. RAS, 2 - Perm Scientific Center, Ural Branch RAS, 3 - Moscow Technological Univ., 4 - National Research Nuclear Univ. MEPhi, Russia

We have demonstrated the amplification of the small signals in a spectral range of 2-2.15 µm by all-fiber Ho-doped amplifier pumped at 1125 nm. Maximum gain more than 35 dB was achieved.

WeS1A-27 16:00-16:20
Investigation of the reasons of spectrum distortion of the ytterbium femtosecond fiber laser, working by the Nonlinear Polarization Evolution effect
I.S. Ulyanov, I.N. Bychkov, A.I. Baranov, D.V. Mysnikov, Moscow Inst. of Physics and Technology (State Univ.), NTO “IRE-Polus”, Russia

In this work we have investigated an influence of intracavity polarizer extinction ratio on the spectral shape of an Ytterbium mode-locked fiber laser, working by the Nonlinear Polarization Evolution effect. We have established both experimentally and theoretically, that reducing this extinction ratio causes distortion of the laser pulse specific ripple occurs. In present work physics involved in this process is explained.

WeS1A-28 16:20-16:40
Error analysis and experimental verification of a fiber based displacement interferometer
X.C. Zhao1, Z.N. Li1, X.S. Tao1, Y.F. Wu1, N.W. Liu1; 1 - Inst. of Fluid Physics, CAEP, 2 - Univ. of Electronic Science and Technology of China, China

The error structure of fiber based displacement interferometers was studied, and an error compensation system developed. Experimental verification was achieved, contrasting gravitational acceleration between theoretical and measured results. The effective measurement velocity range was large with excellent precision.

WeS1A-29 Invited
Double-clad Yb-free Er-doped fibers for high average and peak power lasers
L.V. Kotov1, M.M. Bubnov1, L.D. Lipatov2, M.V. Yashkov2, A.N. Guryanov2, M.E. Likhachev1; 1 - Fiber Optics Research Center RAS, 2 - Inst. of High Purity Substances RAS, Russia

An overview of recent progress in development of highly efficient, high average and peak power lasers based on Yb-free Er-doped double clad fibers is presented. The most promising applications of such devices are discussed.
8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

SECTION S1A. FIBER LASERS AND COMPONENTS

**ThS1A-30 Invited**

**Bismuth-doped fiber lasers and amplifiers: review and prospects**

**M.A. Mel'nikov**

1 - Voronezh State Univ., Russia
2 - Moscow Inst. of Physics and Technology, Russia

We review recent results on bismuth-doped fiber lasers and amplifiers. Bismuth-doped fluoride fibers have been used for amplification in the wavelength range from 1.0 to 1.4 µm. Bismuth-doped chalcogenide fibers have been used for amplification in the wavelength range from 1.5 to 1.8 µm.

**ThS1A-33**

**High power CW visible laser radiation at 623 nm generated by single pass SHG in PPeCL crystal pumped by Raman fiber laser**

**Y.S. Stirmannov**

1 - NTO «IRE-Polus», Moscow, Russia
2 - Moscow Inst. of Physics and Technology, Russia

We introduce efficient, linearly polarized, continuous wave Raman fiber laser (RFL) operating at 1246 nm with maximum output power 94 W and narrow spectral linewidth 0.17 nm. Single pass second harmonic generation (SHG) was demonstrated using 20 mm long MgO:PPeCL crystal and 28 W of 623 nm radiation with 34 % conversion efficiency from 80 W of RFL radiation was achieved.

**ThS1A-34**

**State of polarization in anisotropic tapered fiber with extremely large core diameter**

**V.E. Ustinchuk**

1,2 - Voronezh State Univ., Russia
2 - Moscow Inst. of Physics and Technology, Russia

We produced numerical and experimental research of polarization maintaining properties of adiabatic anisotropic tapered optical fiber with extremely large output core diameter. Results show that polarization state of light coupling in the narrow end did not degrade dramatically through whole fiber length (while core diameter increasing adiabatically up to tens of wavelengths).

**ThS1A-35**

**Revolver hollow core fibers: optical properties and outlook**

**A.F. Kosolapov**

Fiber Optics Research Center, Russia

The optical properties and applications of low-loss revolver hollow core fibers are reviewed. The revolver fiber with nested capillaries with core diameter as low as 25 µm and minimum optical losses of 75 dB/km is demonstrated for the first time.

**ThS1A-36**

**Large mode area W-type double clad fiber as high order mode filters**

**W.J. Lai**

Nanyang Technological Univ., Singapore

We studied the mode behavior of large mode area (LMA) W-type double clad fiber (DCF), and identified its potential as high order mode filter in high power fiber laser systems. This will help to improve the output beam quality of the fiber lasers.

**ThS1A-37**

**High power picosecond ytterbium tapered fiber MOPA**

**A. Vorotinskii**

1 - NTO «IRE-Polus», Moscow, Russia
2 - Moscow Inst. of Physics and Technology, Russia
3 - IPG Photonics, United States

We introduce novel approach for precise power measurement of high power fiber lasers. It is based on detecting of thermal shift of piezoelectric crystal vibration mode frequencies. Sensing crystal is heated by laser radiation scattered from the curved section of laser output optical fiber. Measured sensitivity of the crystal sensor was near 140 Hz/Watt.

**ThS1A-38 Invited**

**Precise power measurement of laser radiation propagating along optical fiber**

**O.A. Ryabushkin**

1 - NTO «IRE-Polus», Moscow, Russia
2 - Moscow Inst. of Physics and Technology, Russia

We describe composite optical fibers with Yb and Er/Yb co-doped phosphate-glass core and silica cladding. Due to high RE-ion concentration in phosphate glass core fiber length can be reduced in comparison with silica fibers. The silica cladding permit to achieve high mechanical strength and easy handling of this type of fibers.

**ThS1A-39**

**Measurement of longitudinal temperature distribution inside active optical fiber in losting conditions**

**O.A. Ryabushkin**

1 - NTO «IRE-Polus», Moscow, Russia
2 - Moscow Inst. of Physics and Technology, Russia

A novel method for precise measurement of temperature in active fibers at different optical pump powers. The novel method allows the determination of longitudinal temperature distribution in active fibers at different optical pump powers.
The paper presents a metallographic investigation of preparations obtained by laser cladding using a layer by layer strategy of powder alloying.

Fiber Laser Technologies and Components VIII
Session Chair: Nikolay N. Evtikhiev
NTO "IRE-Polus", Russia

ThS1A-45
16:00-16:20
Fast local photorefractive response in doped strontium barium niobate crystals
N.V. Bogodvorov, NTO "IRE-Polus", Russia

Fast local photorefractive effect in doped SRN crystals were found. The investigation of the interaction the laser longitudinal modes by two-wave mixing in photorefractive medium outside laser cavity located ware carry out.

ThS1A-46
16:20-16:40
New approach to growth of lithium triborate crystals for laser applications
A.P. Sadovskiy1, S.V. Konstantinov1, V.A. Sukharev1, M.N. Artyshezko1, I.S. Zhrykov1, D.D. Perov1; 1 - NTO "IRE-Polus", Russia, 2 - IPG Photonics Corporation, United States

New approach to growth of lithium triborate (LBO) crystals for laser applications was submitted. LBO crystal growth conditions are presented. Estimation of properties of crystals LBO was held.

ThS1A-47
16:40-17:00
Generation of single-mode blue radiation by two steps sum frequency mixing in LBO crystal
E.S. Golubatnikhnikov1,2, O.A. Byalkovskiy1, V.A. Tyrtshyny1; 1 - NTO "IRE-Polus", 2 - Moscow Inst. of Physics and Technology, Russia

Blue laser radiation of 0.7 W power at 0.448 μm was obtained by cascading sum frequency generation of radiations with 1.55 μm and 0.63 μm wavelengths. Red radiation was obtained by summing the frequencies mixing of radiations of an erbium (1.55 μm) and an ytterbium (1.06μ) pulsed fiber lasers with 100 kHz pulse repetition rate and 1.5 ns pulses duration.

8TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS
SECTION S1B. FIBER LASER TECHNOLOGIES AND EQUIPMENT

Location: Petrov-Vodkin 3 Room, floor 2, 09:00 – 10:40
Fiber Laser Technologies and Equipment III
Session Chair: VD Gorbach, Central Research Inst. of Structural Materials "Prometey"
4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»
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Prokhorov General Physics Inst. of RAS, Russia

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PLENARY SESSION

Location: Levinson Hall, floor 2, 09:00 – 11:00
Session Chair: Ivan A. Shcherbakov, Prokhorov General Physics Inst. RAS, Russia

TuS2P-01 Plenary
**The physics of perfect skin-enhancing the integument through laser**
E. Victor Ross; Scrips Clinic, UCSD Medical Center, United States

As an example of this problem based method, a specific new approach to tattoo removal will be discussed. Also, recent works and future strategies for scar reduction will be presented.

TuS2P-02 Plenary
**Laser technologies in ophthalmic surgery**
S.K. Vartapetov, I.A. Shcherbakov, A.V. Dogt; 1 - Prokhorov General Physics Inst. RAS, 2 - Fedorov Eye Microsurgery Federal State Inst., Russia

Modern lasers technologies and systems on the base excimer and femto lasers for refractive surgery are described.

TuS2P-03 Plenary
**Enhanced optical imaging and laser treatment in medicine: from UV to terahertz**
V.V. Tuchin; Saratov National Research State Univ., Russia

Fundamentals and advances of tissue optical clearing (OC) technology that provides enhanced imaging and treatment of living tissues are presented.

TuS2P-04 Plenary
**“New” photons for existing and new medical applications**
G. Altshuler, V. Gapontsev; 1 - IPG Medical Corp., 2 - IPG Photonics Corp., United States

We will review existing and potential new medical application of fiber laser, QCW diode laser (currently used for pumping fiber laser) fiber laser and fiber laser pumped solid–state laser (hybrid laser) in ophthalmology, dermatology, urology and dentistry.
TuS2A-00 Invited 11:30-11:50
Spaser as smallest laser and best cellular probe to break the diffraction, spectral and detection limits
E.I. Galanina1, D.A. Nedaeskin1, A.I. Plekhanov1, M.I. Stockman1, V.P. Zharov2; 1 - Univ. of Arkansas for Medical Sciences, United States, 2 - Inst. of Automation and Electrometry SB RAS, Russia
The unique combination of superbright monochromatic emission and strong absorption of the spaser allows to consider this smallest laser as one of the best multifunctional super-contrast low toxicity optical probes that can overcome the spectral, diffraction, and other optical limits with focus on super-resolution spectral microscopy, in vivo flow cytometry, and early theranostics of cancer, infections, and cardiovascular diseases.

TuS2A-01 Invited 11:50-12:10
Pulsed transverse discharge CO2 laser for medical applications
S. Nikiforov1, Ya. Simonovsky1, A. Pento1, K. Moshkunov2, N. Garbatorov2, S. Zolotov3, S. Alimpiev1; 1 - Prokhorov General Physics Inst. RAS, Russia, 2 - «Energomashtechnica» Electrometry SB RAS, Russia, 3 - Georgia State Univ., United States
Transverse discharge CO2 laser is characterized by high pulse power and high pulse energy. It provides effective ablation of various materials. We have designed a medical laser with pulse energy up to 40 mJ, repetition rate up to 100 Hz and pulse duration 5-20 µs. This laser is used in plastic surgery, otolaryngology and organic tissue laser mass spectrometry.

TuS2A-02 Invited 12:10-12:30
1.56 µm laser therapy in treatment of venous and arteriovenous malformations
I.A. Abushkin1, A.G. Denis2, V.O. Lapin1, V.A. Privalov1, O.A. Romanova1; 1 - South Ural State Medical Univ., 2 - Iver Regional Children's Hospital, 3 - Chelyabinsk Regional Children's Hospital, Russia
Treatment results of severe vascular pathologies: venous and arteriovenous malformations, with using of two types lasers, 1.56 and 0.97 µm wavelengths, are presented in this work. They are good for both these types, but the results of 1.56 µm laser are better.

TuS2A-03 Invited 12:30-12:50
Possible fiber lasers applications in urology
A.Z. Vinarov1, A.M. Dymov2; 1 - Sechenov First Moscow State Medical Univ., Russia, 2 - IPG Medical Corporation, Marlboro, United States
Tendency for minimally invasive treatment of the urological malignances (kidney and prostate cancer) leads for use of lasers for focal thermal tissue coagulation, through a percutaneous approach to the tumor under ultrasound or CT or MRI guidance. Fiber lasers applications play a tremendous role in the treatment of urological patients, but physical properties of fiber lasers could open new horizons.

TuS2A-04 Invited 12:50-13:10
Complex measurement of aerosol drug deposition using laser methods
A. Czirr6v6cz1, A. Nagy5, M. Veres3, A. Kerekes1, I. Rigo1; Wigner Research Centre for Physics of the HAS, Hungary
Optical and spectroscopic methods were developed and applied for the investigation of aerosol drug delivery in idealized and realistic human airway models.

TuS2A-05 Invited 13:10-13:30
Prospects of fiber lasers use in the ENT surgery
V.M. Sztuczinski1, E.V. Sinkov1; Sechenov First Moscow State Medical Univ., Russia
Laser scalpel-coagulator produced by NTO "IRE-Polus" with Er-doped fiber laser (wavelength 1.56 µm) is actively used in our clinic. We use it for treatment patients with exudative otitis, benign tumors of ear, throat and nose removal and nasal septum correction via laser cartilage thermoplastics. Now we develop in clinic some surgical treatment ENT techniques, used new laser with Ti:2smd fiber with wavelength 1.94 µm.

TuS2A-06 Invited 15:00-15:20
Recent advances in fiber and hybrid lasers widen opportunities for medical applications
S.V. Larin1, D.V. Myasnikov1, NTO «IRE-Polus», Russia
Recent developments of fiber and hybrid lasers covering broad spectral range are reported. Family of high power narrow-linewidth Raman fiber lasers for the treatment of biological tissues and drug composites is presented. Hybrid systems comprising fiber pump laser and solid-state wavelength converter for visible to mid-IR range are proposed. Medical applications for these sources are discussed.

TuS2A-07 15:20-15:35
Minimally-invasive percutaneous nephrolithotomy in the management of staghorn stones
O.V. Teodorovich1,2, S.A. Naryshkin1, G.G. Borisenko2, D.G. Kochiev4; 1 - Central Clinical Hospital No1 JSC RZHD «Russian Railways», 2 - Russian Medical Academy of Postgraduate Education, 3 - Prokhorov General Physics Inst. RAS, Russia
We report our experience of minimally invasive percutaneous nephrolithotomy (Mini PCNL) in the management of staghorn kidney stones. Mini PCNL by laser lithotripter with microsecond pulse duration and second harmonic generation is effective and safe procedure in treatment of staghorn nephrolithiasis.

TuS2A-08 15:35-15:50
The laser for the precise selective photodestruction of the vascular structures of the skin and subcutaneous tissue
N.E. Garbatorov1, A.G. Dorodov2, G.P. Kuzmin1, A.A. Sirokin1, O.V. Tichonov1, S.A. Zolotov1; 1 - Prokhorov General Physics Inst. RAS, Russia, 2 - Inst. of Emergency Children's Surgery and Traumatology, Russia
The authors carried out work on creation of diode pumped solid state laser for the treatment of benign vascular lesions of the skin and subcutaneous tissue by precise selective photodecomposition.

TuS2A-09 15:50-16:05
Super Pulse diode and diode-pumped fiber lasers for fast and precise tissue surgery and regeneration
I.V. Yaraslavsky1, K.S. Magid2, D.M. Boutilouas1, A.F. Schuler1, V.P. Gapontsev1; 1 - IPG Medical, United States, 2 - Advanced Dentistry of Westchester, United States, 3 - Biolase Inc, United States
Super Pulse diode-based laser systems were evaluated for precision soft-tissue surgery and fractional treatment. Disruptive potential of the technology has been demonstrated.

TuS2A-10 16:05-16:20
In vitro comparison of 1m fiber laser vs Ho:YAG laser for lithotripsy
V.A. Zamyanina1, A.A. Kovalenko1, A.M. Dymov2, D.V. Enikeev1, V.P. Minaev3, N.N. Sorokin1, A.Z. Vinarov1, I.V. Yaraslavsky1, V.G. Altshuler3, V.P. Gapontsev1; 1 - NTO «IRE-Polus», Russia, 2 - Sechenov First Moscow State Medical Univ., Russia, 3 - IPG Photonics, United States
A new thulium (Tm) fiber laser with a peak power up to 500 W for lithotripsy has been designed and prototype built. Performance has been evaluated vs. industry-leading Ho:YAG lithotripsy system in in vitro setting. Tm laser has demonstrated significantly increased stone fragmentation rate, decreased retropulsion effect, and reduced procedure time vs Ho system.
TuS2A-12  16:35-16:50
Tm fiber laser application for soft tissue surgery
A.R. Sadykov¹, A.M. Dymov¹, N.N. Enikeev¹, A.A. Kovalenko¹, V.P. Minaev¹, N.N. Sorokin¹, A.Z. Vinarov¹, V.A. Zamoytina¹, G.B. Altshuler¹; 1 - IPG Medical, United States, 2 - Sechenov First Moscow State Medical Univ., Russia, 3 - NTO "IRE-Polus", Russia

A new thulium (Tm) fiber laser with a peak power up to 500 W for soft tissue surgery has been built. This system allows increase efficiency of soft tissue ablation and decrease collateral damage in comparison with modern Tm fiber laser with peak power up to 120 W and holmium (Ho) laser systems (experiment ex-vivo).

TuS2A-13  16:50-17:05
Terahertz reflectometry for the corneal tissue hydration sensing
A.A. Angeluts¹, A.V. Balakin¹, M.D. Mishchenko¹, I.A. Ozheredov¹, T.N. Saphonova¹, A.P. Shkurinov¹; 1 - Lomonosov Moscow State Univ., 2 - FGBNU NIIGB, Russia

The cornea is one of the most important external structure of the human eye. Its transparency is an important factor for visual function and depends on the tissue hydration. For cornea hydration sensing we use terahertz reflectometer based on difference frequency generation of a pair of continuous semiconductor lasers. Spectral sensitive measurements are obtained by fine frequency tuning of terahertz source.

TuS2A-14  17:05-17:20
Architecture of a new fiber laser for applications in soft tissue surgery and lithotripsy
A.V. Vinnichenko¹, S.V. Larin¹, A.A. Mashkin¹; 1 - NTO «IRE-Polus», Russia, 2 - IPG Laser GmbH, Germany

During the last decades, applications of lasers in medicine enjoyed stable growth. Surgical lasers are developed very intensively and today they occupy a significant market share. In this paper, we present a novel concept of an all-fiber-laser architecture for surgical applications.

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4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»
A3. MEMORIAL SESSION IN HONOUR OF ALEXANDER PROKHOROV (1916-2002)

Location: Levinson Hall, floor 2, 17:30 – 18:30

Advanced laser systems for medical applications II
Chair: Ivan A. Shcherbakov, Prokhorov General Physics Inst. of RAS, Russia

Official Language: Russian
TuS2A-p01 15:00-19:00  
**Laser percutaneous nephrolithotomy for bilateral staghorn stones**  
O.V. Teodorovich1,2, S.A. Naryshkin1, G.G. Borsenko1, M.N. Shatohin1, S.Y. Dalgaliev1, S.A. Davlatbiev1;  
1 - Central Clinical Hospital No1 JSC RZhD “Russian Railways”, 2 - Russian Medical Academy of Postgraduate Education, Russia  
The improving outcomes of surgical treatment for bilateral staghorn kidney stones by using laser lithotriptor with microsecond pulse duration and second harmonic generation is investigated.

TuS2A-p02 15:00-19:00  
**The effectiveness of the clinical application of the multiwavelength laser medical installation with antibacterial and therapeutic effect**  
K.K. Baranov2,3, N.E. Gorbatova2,3, G.P. Kuzmin1,3, A.A. Sirotkin1,3, O.V. Tichonevich1,3, S.A. Zolotov2,3;  
1 ‑ Prokhorov General Physics Inst. RAS, 2 ‑ Inst. of Emergency Children’s Surgery and Traumatology, 3 ‑ Advanced Energy Technologies LTD, Russia  
In this paper, we proposed a method for the treatment of chronic middle purulent otitis. after the introduction of the optical fiber through the perforations of the tympanic membrane was carried out under the supervision of an endoscope processing structures of the middle ear laser irradiation.

TuS2A-p03 15:00-19:00  
**Improved two-channel laser Doppler flowmeter**  
D.G. Lapitan, D.A. Rogatkin; Vladimirsky Moscow Regional Research and Clinical Inst. «MONIKI», Russia  
Noise in the differential-channel setup of a laser Doppler flowmeter was studied. Formation of false spectral components in the output signal due to electrical signals beating was found out. The improved block-diagram of the flowmeter allowing to reduce the noise was developed.

TuS2A-p04 15:00-19:00  
**Sapphire shaped crystals allow combining tissue cryodestruction, laser coagulation and diagnosis**  
I.A. Shikunova1, V.N. Kurlov1, K.I. Zaytsev2,3,4, I.V. Reshetov3,4;  
1 - Inst. of Solid State Physics RAS, 2 - Bauman Moscow State Technical Univ., 3 - Inst. of Improvement of Professional Skill of the Federal Medico-Biological Agency of Russia, 4 - Sechenov First Moscow State Medical Univ., Russia  
Approach to combine tumor cryosurgery with laser therapy and optical diagnosis using sapphire shaped crystals has been demonstrated. Unique properties of sapphire shaped crystals (thermal, mechanical, and chemical strength complemented with high optical transparency and thermal conductivity) allow performing tissue destruction, or therapy, and optical diagnosis simultaneously.

TuS2A-p05 15:00-19:00  
**Human retina model for laser safety during corneal surgery with a femtosecond laser**  
H. Sun, Zh. Fan; Academy of OPTO-Electronics CAS, China  
Femtosecond lasers are widely used in everyday clinical procedures to perform minimally invasive corneal refractive surgery. In the present study a numerical simulation was developed to quantify the temperature rise in the retina during femtosecond intracorneal surgery. Also, ex-vivo retinal heating due to laser irradiation was measured with an infrared thermal camera as a validation of the simulation.
Clinical optical imaging and spectroscopy I
Session Chair: Natalia N. Bulgakova, Prokhorov General Physics Inst. RAS, Russia

WeS2B-01 Invited
09:00-09:20
Modern fluorescence and other optical methods for early cancer of aerodigestive tract endoscopic diagnostics
V.V. Sokolov, D.V. Sokolov, S.S. Pirogov, Herzen Moscow Oncological Research Inst., Russia

From 1984 through 2015 - 176 early central lung cancer (ECLC) lesions were found in 128 patients, early squamous-cell esophageal carcinoma (EEC) - 43 patients. We have investigated possibilities of combination of white-light (WLI), autofluorescence (AFI), narrow-band imaging (NBI), local fluorescence spectroscopy (LFS), intelligent hemoglobin index (IhIb), probe-based confocal laser endomicroscopy (pCLE) and endocytoscopy (EC) in ECLC and EEC diagnostics.

WeS2B-02 Invited
09:20-09:40
Spectroscopic analysis of the interaction between antioxidants and free radicals in human skin

In the presentation various studies on the interaction between antioxidants and free radicals in human skin are presented which were performed at the Center of Experimental and Applied Cutaneous Physiology at the Department of Dermatology, Venerology and Allergology of the Charité – Universitätsmedizin Berlin.

WeS2B-03 Invited
09:40-10:00
Autofluorescence spectroscopy techniques for skin cancer diagnostics
E. Borisova1, Al. Zhelyazkova1, Ts. Genova1, P. Tzoyanova1, E. Pavlova1, V. Pastkov1, L. Avramov1, 1 - Inst. of Electronics BAS, 2 - Univ. Hospital «Queen Giovanna-ISUL», Bulgaria

A review of the recent achievements in the field of autofluorescence spectroscopy of cutaneous neoplasia will be presented. Excitation-emission matrices, synchronous fluorescence spectroscopy and other steady-state approaches are used for development of whole picture of the autofluorescent properties of benign, dysplastic and malignant lesions. Spectral peculiarities and fluorophores' content changes are used for development of differentiation algorithms for diagnostic needs.

WeS2B-04 Invited
10:00-10:20
Advances in imaging human skin
M.J. Leahy; National Univ. of Ireland, Ireland

The skin is the body's largest and most accessible organ. It can act as a surrogate for other organs due to its similar immunosponse. Nonetheless, substantial challenges have to be overcome for imaging the skin. This paper will review the challenges and progress in advanced imaging of human skin.

WeS2B-05
10:20-10:35
Hyperpectral imaging for skin neoplasms detection
L.A. Zherdeva1, I.A. Bratchenko1, O.G. Myakonov1, A.A. Morzhatov, S.V. Kazlov1, V.P. Zhakhov1, 1 - Samara State Aerospace Univ, 2 - Samara State Medical Univ, Russia

Experimental results for skin neoplasms detection in vivo and ex vivo in a visible spectral range are presented using hyperpectral imaging. Blood supply degree of a capillaries and a melanization degree of skin area are chosen as controlled criteria.

WeS2B-06 Invited
10:35-10:55
The novel horizons in prediction of stroke: optical «instruments» and innovative strategies
O.V. Semenychkina-Glushkovskaya1, A.S. Abdurashitov1, E.G. Borisova1, V.V. Tuchin1; 1 - Saratov National Research State Univ., Russia, 2 - Inst. of Electronics BAS, Bulgaria, 3 - Tomsk National Research State Univ, Russia

We show the current multi-modal technologies that are widely used in clinics and experiments for the study of brain hemorrhages (BH) in newborns: magnetic resonance imaging, ultrasonography, near infrared spectroscopy, laser Doppler, laser speckle contrast imaging and photon correlation spectroscopy. We discuss the advantages and disadvantages of these methods and show areas for future research of BH in term newborns.

- Coffee Break -

Clinical optical imaging and spectroscopy II
Session Chair: Katerina Borisova, Inst. of Electronics, Bulgarian Academy of Sciences, Bulgaria

WeS2B-07 Invited
11:30-11:50
Combined optical and terahertz imaging for intraoperative delineation of nonmelanoma skin cancers
A.N. Yaroslavsky1, C. Joseph1, R. Patel1, B. Fan1, A. Musikansky1, J.A. Neel1, R. Giles1, 1 - Univ. of Massachusetts at Lowell, 2 - Massachusetts General Hospital, United States

Nonmelanoma skin cancers are the major cause of morbidity in fair-skinned population worldwide. We investigated the feasibility of combining terahertz and optical imaging for accurate intraoperative delineation of these cancers. Fresh thick skin excisions were used for the experiments. The tissue was imaged within four hours after surgery. Obtained images were compared to the corresponding histopathology, which was considered a gold standard. The results of the study indicate that combination of cross-polarized continuous wave terahertz imaging and polarized light optical imaging has potential as an intraoperative bedside tool for controlling the completeness of surgical excision.

WeS2B-08
11:50-12:05
Application of terahertz time-domain spectroscopy for blood glucose monitoring
D.P. Cherkasova1, M.M. Nazarov2, A.P. Shkurinov1; 1 - Inst. of Laser Physics SB RAS, 2 - Inst. on Laser and Information Technologies RAS, 3 - Lomonosov Moscow State Univ, Russia

Human skin optical properties were studied in vivo using terahertz time-domain spectroscopy. For the attenuated total internal reflection, the silicon Dow Corning prism was used. The measurements were carried out on volunteers with normal blood glucose concentration and after glucose intake. The variations of the reflection spectra of human skin were correlated with the changes in blood glucose level.

WeS2B-09
12:05-12:20
Medical diagnosis based on terahertz pulsed spectroscopy and imaging
K.I. Zaytsev1,2,3, N.V. Chemomyrdin1,2, S.O. Yurchenko1,2, V.N. Kurolov1, I.A. Shikunov1, G.M. Kataka1, K.G. Kudrin1,2, V.E. Korasik1,2, V.S. Reshetov1,2, 1 - Bauman Moscow State Technical Univ., 2 - Inst. of Improvement of Professional Skill of the Federal Medico-Biological Agency of Russia, 3 - Sechenov First Moscow State Medical Univ, 4 - Inst. of Solid State Physics RAS, Russia

We discuss recent results of our research in the area of biomedical applications of THz pulsed spectroscopy and imaging. We introduce THz aspherical lenses for high-resolution medical imaging and THz photonic crystalline waveguides for THz endoscopy. We consider the results of studying the THz dielectric characteristics of photonic and non-photonic skin nevi in vivo.

WeS2B-10
12:20-12:35
The study of terahertz radiation biologic effects as premise for creating of diagnostic and treatment methods
V.I. Fedorov; Inst. of Laser Physics SB RAS, Russia

The report emphasizes the importance of the study of terahertz radiation biological effects as another direction in the creation of diagnostic and therapeutic methods, along with terahertz imaging and terahertz spectroscopy. Therapeutic and diagnostic use of laser terahertz radiation based on the results of pre-conducted fundamental research of biological effects of terahertz radiation at the organismic, cellular and molecular levels presents.

WeS2B-11 Invited
12:35-12:55
Bag-of-Features approaches for combined classification of laser scanning microscopy and spectroscopy data sets
S.G. Stanici1, R. Boriga1, A.C. Dascalu2, R. Hristu1, G.A. Stanici1, 1 - Univ. Politehnica of Bucharest, 2 - Univ. of Bucharest, 3 - "Titu Maiorescu" Univ, Romania

The Bag-of-Features (BoF) paradigm represents a solid solution for the automated classification of digital images. Several BoF approaches for classification of microscopy data have been reported in the past decade, but their number is very low considering the potential that BoF methods hold with respect to this subject. In this contribution we discuss strategies for using BoF architectures for the automated classification of 1D and 2D data sets collected using Laser Scanning Microscopy techniques.

TECHNICAL SESSION
4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»
SECTION S2B. CLINICAL OPTICAL IMAGING AND SPECTROSCOPY

Location: Rihter Room, floor 3, 09:00 – 10:55
Clinical optical imaging and spectroscopy I
Session Chair: Natalia N. Bulgakova, Prokhorov General Physics Inst. RAS, Russia

Location: Rihter Room, floor 3, 11:30 – 13:40
Clinical optical imaging and spectroscopy II
Session Chair: Katerina Borisova, Inst. of Electronics, Bulgarian Academy of Sciences, Bulgaria
New generation fluorescence and laser spectral analysis colposcope for early detection of cervix cancer
N.N. Bulgakova1, E.G. Novikova2, V.V. Smirnov1, O.I. Trushina2, V.I. Fabelinsky3, 1 - Prokhorov General Physics Inst. RAS, 2 - Herzen Moscow Oncology Research Inst., 3 - Inlife LLC, Russia

The system has been developed to perform colposcopic examinations on a new level. It acquires high-quality color and fluorescence images and laser-excited fluorescence spectra taken by a fiberoptical probe from the points selected in course of analyzing acquired images. The colposcope is processed by special software that delivers several evaluated diagnostically-valuable parameter. Preliminary tests show that technical implementation is adequate for early cancer detection.

Optical alignment of component signals in assay of low proteinuria
A.I. Kuznetsov1, A. Frorip1, M. Ots-Rosenberg2, A. Sünter1; 1 - AS Ldiamon, Tartu Science Park, 2 - Tartu Univ., Estonia

To overcome high selectivity of automated assay methods in low proteinuria a combined fractionation-optical method is proposed. Urine fractionation in the gel columns PD-10 is followed by immediate measurement of protein absorption at 280 nm. The method can be applied in the wide range of total protein concentrations 0.05 – 10 g/L.

Triple-modality imaging of optoacoustic pressure, ultrasonic scattering, and optical diffuse reflectance with improved resolution and speed
P.V. Subochev, I.V. Turchin; Inst. of Applied Physics, Russia

The method of cost-effective upgrade from an acoustic resolution photoacoustic microscope to a triple-modality imaging system is presented. The newly-developed experimental setup is based on a diode-pumped laser coupled to a fiber bundle with a spherically focused polyvinylidene fluoride detector integrated into the center of a ring-shaped optical illuminator. Each laser pulse illuminating the sample performs two functions. While the photons absorbed by the sample provide a measurable optoacoustic (OA) signal, the photons absorbed by the detector provide the measurable diffuse reflectance (DR) from the sample and the probing ultrasonic (US) pulse. At a 3 mm imaging depth the axial resolution of the OA/US modalities is 38μm/26μm, while the lateral resolution of the DR/OA/US modalities is 3.5mm/50μm/35μm. At LO conference we will present the imaging capabilities of the developed DR/OA/US system using the results on phantom and in vivo experiments.
Actinic keratosis (AK) is considered as squamous cell carcinoma in situ (SCC), healthy human skin using two-photon tomography. In vivo imaging for detection and discrimination of cancer based on cellular vehicles loaded with plasmonic nanomaterials. Over recent years, gold nanorods (GNRs) have emerged as a promising material in biomedical optics and have been proposed as contrast agents for the photothermal therapy and the photoacoustic imaging of tumors. A pioneering approach to target tumors is the use of cellular vehicles, i.e., cells of the immune system that exhibit an innate tropism to tumors and that can be serve as Trojan horses. This strategy relies on cell types, such as tumor-associated macrophages or T cells, that are recruited by or naturally traffic to the microenvironment of tumors and that can be isolated from a patient and loaded with plasmonic nanoparticles in vitro. In this work, GNRs were synthesized and designed to combine high optical and photo-stability and the ability to accumulate into cells of the immune system. Particles were silanized, PEGylated and conjugated with catonic moieties. Different cationic compounds were tested and the cell viability and uptake of the particles were studied on complementary cell types. Moreover, in this work we focus on how the gold nanorods photostability is affected when these particles are modified for cellular uptake, by investigating their stability and photoacoustic conversion efficiency under near infrared pulsed irradiation at different laser fluences.

We are developing a method which will allow simultaneous monitoring of key apoptosis (programmed cell death) processes, drug distribution, such as photodynamic agents, as well as oxygen concentration, which is a critical parameter determining the efficiency of photodynamic therapy. We demonstrate the up-regulation of a fluorescent protein-based sensor combined with FLIM-FRET for imaging of caspase 3, which is activated by different antitumor drugs in vitro and in vivo.

Multimodal embryonic imaging using selective plane illumination microscopy, optical projection tomography and optical coherence tomography. The murine model is a common model for studying developmental diseases. Different optical techniques have been developed to investigate mouse embryos, but each has its own set of limitations and restrictions. In this study, we compare the performance of the relatively new methods of Optical Projection Tomography (OPT) and Selective Plane Illumination Microscopy (SPIM) to the well-established technique of Optical Coherence Tomography (OCT) to assess murine embryonic development at different stages. While all methods can provide spatial resolution at the micrometer scale in 3D, SPIM, based on fluorescence contrast mechanism, is able to image shallow regions with great details. OCT can provide superior imaging depth, however, it requires samples to be fixed, placed in an immobilization media such as agar, and cleared before imaging. It does not require fixing, it can be used to image embryos in vivo and in utero. In this study, we compare the efficacy of SPIM, OPT, and OCT for imaging murine embryonic development. The data demonstrate the superior capability of SPIM and OPT for imaging fine structures with high resolution while only OCT can provide structural and functional imaging of live embryos with micrometer scale resolution.

In vivo imaging of reproductive events and cilia function in mammalian reproductive tract with optical coherence tomography. While the role of cilia in the reproductive tract is well recognized, ciliary dynamics in the oviduct is not well understood, largely owing to the lack of live imaging approaches. We report in vivo micro-scale mapping of cilia and cilia beat frequency (CBF) in the mouse oviduct using optical coherence tomography (OCT).

In vivo imaging for detection and discrimination of actinic keratoses and squamous cell carcinoma from healthy human skin using two-photon tomography. Actinic keratosis (AK) is considered as squamous cell carcinoma in situ (SCC), which is developing after a cumulative exposition to ultraviolet radiation. The noninvasive in vivo imaging of healthy human skin and skin affected by AK and SCC is presented using two-photon tomography (TPT). Figure 1 shows images obtained in vivo at different depths.

- Coffee Break -
12:55-13:10
The influence of optical tissue clearing on polarization properties for different anisotropic media
D. Chen1, N. Zeng1, Yu. Wang1,2, H. He1, H. Ma1,2,1 - Shenzhen Key Laboratory for Minimal Invasive Medical Technologies, Inst. of Optical Imaging and Sensing, Graduate School at Shenzhen, Tsinghua Univ., 2 - Department of Physics, Tsinghua Univ, China

According to our previous research publications, there are two type tissue anisotropy resources: the interstitial birefringence and the fibrous scatterers. During optical clearing process, different tissue anisotropy may show different polarization change. In our simulation, based on the refractive index matching, we respectively apply Mueller matrix polar decomposition (MMPD) method in a backward scattering configuration on two anisotropic tissue models: one is composed of spherical scatterers embedded in a birefringent medium, and the other is composed of a mixture of spherical and cylindrical scatterers. It can be seen that the phase retardance induced by the interstitial birefringence increases, but the slope of retardance change with the depth is constant, implying the increased retardance from the improved penetration depth by clearing. However, for cylindrical scatterers, the response by clearing is different. Due to the decreased scattering numbers, both the cylinder scattering induced retardance from superficial and deep depth decline. Furthermore, we combine the above simulation and partial experimental results to explain and discuss the real tissue clearing process.

13:10-13:25
Monte Carlo simulations of photon diffusion in time and frequency domains
V.L. Kuzmin1, A.Yu. Valkov2, A.D. Oskirko1, L.A. Zubkov1, 1 - Peter the Great St. Petersburg Polytechnic Univ., Russia, 2 - St. Petersburg State Univ., Russia, 3 - Drexel Univ., United States

The Monte Carlo simulations of the photon migration in tissue models are performed for the time and frequency domains. The simulation results turn out to be in an excellent agreement with measurements for aqueous solutions of Intralipid mostly used as bio-phantoms. WeS2C-13

- Lunch Break -

Location: Levinson Hall, floor 2, 15:00 – 16:20

15:00-15:20
Novel phonotrons in biomedical imaging: modern tools, emerging trends and applications
G. Zacharakis, Laser Interactions and Photonics Division, FORTH – IESL, Greece

Modern tools in biophotonics have revolutionized biological, preclinical and clinical research, providing new insights into the function of living organisms and disease. Technologies such as light-sheet microscopy, optical micro-tomography, optoacoustics and others can be used in labelfree and targeted imaging from the single cell to the whole organism level.

15:20-15:35
Diagnostics characteristics of channel formation in biotissue under CO2 laser radiation
V.V. Vasiltsov, M.G. Galushkin, V.A. Ulyanov, Inst. on Laser and Information Technologies RAS, Russia

The procedure of transmyocardial laser revascularization that presents an alternative approach in treatment of the patients with end-stage coronary artery disease finds wide clinical application in the world, particularly in Russia. There exist only two systems based on high-power CO2 lasers – “Heart Laser” produced in the United States and “Perfocor” developed in Russia – which have been authorized for wide clinical application. This makes very topical further investigation into the physical processes of channel formation in myocardium and other blood-filled organs under the action of powerful (several tens of joules) laser pulses. The analysis has been performed of temporal characteristics of the mechanism of channel formation in biotissue, this channel being produced by high-power waveguide CO2 laser radiation. The velocities of evaporation front movement and the typical times of gas-vapor channel deepening have been determined. The influence of laser beam expansion on the dynamics of channel depth increase has been estimated. An important role of the excess of evaporation front velocity over the characteristic fluid velocity is noted.

15:35-15:50
Development of the experimental setup model to quantify meat product polarization characteristics
A.A. Blokhina, V.A. Ryzhova, ITMO Univ, Russia

Designed and implemented a model of the experimental setup, the phase difference distribution is obtained in the cross section of the output beam. Theoretical principles and methods of the experiment were given as applied to the food industry.

15:50-16:05
Noninvasive measurement of cell nucleus by backscattered light
K.G. Domnir, E.T. Aksonov, Peter the Great St. Petersburg Polytechnic Univ, Russia

The combination of two methods (diffractionmetry and polarimetry) based on light scattering was discussed. An experimental setup was suggested.

16:05-16:20
Diagnostics of the pulmonary diseases using spectral analysis of exhaled air
Yu.V. Kisteney1, A.V. Borisov2, A.V. Shapovalov1, D.A. Vrazhnov2, V.V. Nikolaev3, D.A. Kuzmin1, A.A. Bulanov2; 1 - Tomsk National Research State Univ, 2 - Siberian State Medical Univ, 3 - Tomsklabs PTE LTD, Russia

Pulmonary diseases are widespread, symptoms are non-specific, diagnostics is based on registration of already occurred functional changes. Screening methods provide more opportunities to prevent deterioration and reduction of the societal burden of the disease. We will discuss approaches to diagnostics of pulmonary diseases based on control of the volatile metabolites-markers in the exhaled air and ability of IR laser absorption spectroscopy for screening diagnostics of these diseases.
Application of method autofluorescence diagnosis in endoscopy for investigation mucosal structure in gastrointestinal tract
D.A. Abramov, I.V. Chavkin; ITMO Univ., Russia

Promising for the early diagnosis of malignant diseases of the respiratory organs and the gastrointestinal tract (GIT) is now considered a fluorescence method. The aim is to develop a fluorescent light source (illuminator FLU) for videodenscopy complex and determining on the basis of scientific research and prototyping capability for creating fluorescence video endoscopy.

Influence of structured illumination aperture shape in numerically focused Fourier domain optical coherence microscopy: a comparison
A.A. Grebenshchikov, Saratov National Research State Univ., Russia

The use of structured illumination in optical coherence microscopy (OCM) allows combining increased transverse resolution with small attenuation of the signal with defocus. This paper presents a comparative analysis of the properties of numerically focused imaging in Fourier domain OCM with different types of structured illumination aperture.

The plasma protein fractions research by Raman spectroscopy method
A.A. Lykina, D.N. Artemyev, Yu.A. Kristoforova, L.L. Davydkir, T.P. Kuzmina, V.P. Zakharov; 1 - Samara State Aerospace Univ., 2 - Samara State Medical Univ., Russia

This work is dedicated to the analysis of plasma proteins concentration using Raman spectroscopy setup. The obtained Raman spectra showed significant variation of intensities of certain spectral bands 940, 1005, 1330, 1450 and 1650 cm-1 for different protein fractions and concentrations. Partial least squares regression analysis was used for determination of correlation coefficients. We have shown that proposed method represents the structure and biochemical composition of albumin and immunoglobulins A and G.

NIR autofluorescence skin tumor diagnostics
Y.A. Kristoforova, I.A. Bratchenko, D.N. Artemyev, O.G. Myakinin, A.A. Moraytov, S.V. Kozlov, V.P. Zakharov; 1 - Samara State Aerospace Univ., 2 - Samara State Medical Univ., Russia

A method for skin tumors diagnostics based on the analysis of changes in the AF spectrum in the near infrared region is proposed. The analysis of the AF spectrum was implemented via its exponential approximation. Proposed approach allows for malignant melanoma diagnosis with an accuracy of 88.4% for ex vivo studies, and 86.2% for the in vivo studies.

Multimodal detection of phase transition in adipose tissue
V.V. Tuchin, V.V. Tuchin, O.V. Polschikova, A.G. Ramazanova; Scientific and Technological Center of Unique Instrumentation RAS, Russia

Phase transitions are revealed macroscopically through measurements of relevant parameters. Temperature-mediated phase transitions of lipid components of the adipose tissues has been observed by combined use of the Abbe refractometry, optical coherence tomography (OCT), and fluorescence spectroscopy.
The advances in micro- and nanofabrication technologies are enabling increasingly smaller mechanical transducers capable of detecting the forces, motion, mechanical properties and masses that emerge in biomedical interactions and fundamental biological processes. Thus, biosensors based on nanomechanical systems have gained considerable relevance in the last decade. This talk will provide insight into the mechanical phenomena that occur in suspended mechanical structures when both biological adsorption or interactions take place on their surface. In addition, I will show how coupling nanomechanics and nanoptics allows to achieve sensing devices with higher performance and novel transduction paradigms. I will describe some relevant experiments running in our laboratory that harness nanomechanical and optomechanical systems for cancer research in three battlefronts: (i) ultrasound detection of cancer biomarkers in blood, (ii) opto-nanomechanical spectrometry and (iii) cancer cell nanomechanics.

Nanomechanical and optomechanical systems for cancer research
J. Tomaya, Inst. de Microelectronic de Madrid CSIC, Spain

Conceptually novel approach has been demonstrated to create nanorobotic structures for targeted drug delivery and biosensing. The proposed nanostructures are capable of performing multi-parameter molecular analysis of the microenvironment of a therapeutic target (e.g., a cancer cell) and react to it in a pre-programmed way.

New laser-based technology for circulating biomarker discovery: applications for early diagnosis and prevention of cancer
E.I. Galanazh2, V.V. Tuchir1, V.P. Zhavor3; 1 - Inst. of Physics of the CAS, Czech Republic, 2 - ITMO Univ., Russia

This report summarizes our recent advances of in vivo flow cytometry (FC) by the integration of photoacoustic, photothermal, Raman, fluorescent and photoswitchable FCs, high-pulse-rate multicolor lasers and multifunctional nanoprobes. Taking into account clinical relevance of photoacoustic FC, we anticipate its quick translation for use in humans to break down limit in early diagnosis and therapy of metastasis in cancer patients.

Laser-induce co-deposition of copper with cobalt as signal amplification method for biochemical microbiosensors
A.V. Smikhovskaia, E.M. Khairullina, I.I. Tumkin, S.S. Ermakov, O.V. Navalotskaya, St.Petersburg State Univ., Russia

The influence of cobalt (II) chloride on laser-induced copper deposition was studied. Copper deposition experiments in aqueous solutions containing various concentrations of cobalt(II) chloride upon 532 laser irradiation were performed. The influence of additives on the deposition rate, the topology, electrochemical properties of the deposited microstructures was investigated. Sensory activity of these structures towards hydrogen peroxide and glucose was studied.

Application of surface-enhanced infrared spectroscopy for steroids analysis
O.P. Cherkasova1,2, A.G. Milekhina1,2, I.A. Milekh2,2, A.A. Kuznetsov2, E.E. Rodyukina2, A.V. Lobachev2,2; 1 - Inst. of Laser Physics SB RAS, 2 - Novosibirsk State Univ., 3 - Rihanov Inst. of Semiconductor Physics, Russia

The surface-enhanced infrared spectroscopy was used for analysis of steroid hormone cortisol in biological samples. The concentration dependence of the intensity of the IR absorption modes of cortisol deposited on the metal nanogaps inside Au NMs was investigated and the minimum detectable concentration of steroid hormone was determined.
**TECHNICAL SESSION**

**4TH INTERNATIONAL SYMPOSIUM «LASERS IN MEDICINE AND BIOPHOTONICS»**

**SECTION S2D. PHOTONICS AND NANOBIOTECHNOLOGY**

**Session Chair:** Germano Iannacchione, Worcester Polytechnic Inst. United States

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**ThS2D-13 Invited**

*Digital image capture and analysis for simultaneous static and dynamic light scattering for biological systems*

G.S. Iannacchione¹, S. Algarni² - Worcester Polytechnic Inst. United States, 2 - King Saud Univ., Saudi Arabia

The Area Recorded Generalized Optical Scattering (ARGOS) approach to light scattering employs large image capture array allowing for a well-defined geometry in which images may be manipulated to extract structure with intensity at a specific scattering wave vector ($I(q)$) and dynamics with intensity at a specific scattering wave vector over time ($I(q,t)$). The ARGOS method provides morphological dynamics noninvasively over a long time period and allows for a variety of aqueous conditions. This is important because traditional growth models do not provide for conditions similar to the natural environment. The present study found that the population dynamics of bacteria do not follow a traditional growth model and that the ARGOS method allowed for the observation of bacterial changes in terms of individual particles and population dynamics in real time. The observations of relative total intensity suggest that there is no stationary phase and that the bacterial population demonstrates sinusoidal type patterns consistently subsequent to the log phase growth. These observation were compared to shape changes by modeling fractal dimension and size changes by modeling effective radius.

- Lunch Break -

**Photons and nanobiotechnology IV**

Session Chair: Germano Iannacchione, Worcester Polytechnic Inst. United States

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**ThS2D-14 Invited**

*Hybrid gold-based nanoparticles and atomic clusters for analytic and theranostic applications*

N.G. Khlebtsov¹,², B.N. Khlebtsov¹,², L.A. Dykman³, V.A. Khanadeev¹,², 1 - Inst. of Biochemistry and Physiology of Plants and Microorganisms RAS, 2 - Saratov National Research State Univ., 3 - Saratov Scientific Research Veterinary Inst. RAS, Russia

Multifunctional nanocomposites combine therapeutic, diagnostic, and sensing modalities in a single nanostructure, thus constituting the technological basis of theranostic – a rapidly growing and promising field at the crossroads of plasmonics and nanomedicine. In this talk, we summarize our recent efforts in fabrication of hybrid gold-based nanocomposites for analytical and theranostic applications. We discuss also fabrication, optical properties, and applications of multifunctional fluorescent Au nanoclusters.

**ThS2D-15**

*Supersolution optical imaging multimodal system*

G.A. Stanciu¹, C. Stoichita², A. Nigro³, M. Manfredi³, S.G. Stanciu¹, D.E. Tranca², R. Hristu¹, 1 - Univ. Politehnica of Bucharest, Romania, 2 - GNR SRL-Analytical Instruments Group, Agrate Conturbia, Italy

In our work we present a new supersolution optical imaging multimodal system which includes several microscopy techniques working in far field or in near field;this multimodal system integrated several optical microscopy techniques which offer the possibility for investigations at micro and nanoscale on the same area by using laser scanning microscopy techniques. It also included an atomic force microscope.

**ThS2D-16**

*Trends in biosensor development: multifunctional platforms and enhanced labels*

I.Yu. Goryacheva¹,², V.O. Shipunova¹,², M.P. Nikitin¹,², P.I. Nikitin³, S.M. Deyev¹; 1 – Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, 2 – Moscow Inst. of Physics and Technology (State Univ.), 3 – Prokhorov General Physics Inst. RAS, Russia

Interactions between lectin-modified nanoparticles and various glycoproteins were investigated for development of effective nanoagents for therapy and diagnostics. We screened a variety of lectin-glycoprotein pairs both in cell-free mode and in vitro in human cell culture to create a number of highly specific nanoparticle-lectin conjugates. We showed that the obtained conjugates can be successfully used as biomarker-specific agents for specific cell visualization in biomedical diagnostics.

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**ThS2D-18**

*Quantum dots in basic research and practical applications: the role of size and quasi-multivalency*

A.V. Salova¹, T.N. Belyaeva², V.V. Kosheverova¹, E.A. Leontieva¹, M.V. Kharchenko¹, E.S. Kornilova, Inst. of Cytology RAS, Russia

Quantum Dots (QDs) attract attention as possible fluorescent markers with unique optical properties suggesting their applications for multi-color simultaneous staining of intracellular targets and their detection in live cells. However, their size and quasi-multivalency could affect the overall physiological response. We have shown requirements for endocytically effective EGF-QD complexes formation and analyzed the limiting stages in their interaction with cells.

**ThS2D-19**

*Lectin-based nanoagents for specific cell labelling and optical visualization*

V.O. Shipunova¹, M.P. Nikitin¹,², P.I. Nikitin³, S.M. Deyev¹, 1 – Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, 2 – Moscow Inst. of Physics and Technology (State Univ.), 3 – Prokhorov General Physics Inst. RAS, Russia

Interactions between lectin-modified nanoparticles and various glycoproteins were investigated for development of effective nanoagents for therapy and diagnostics. We screened a variety of lectin-glycoprotein pairs both in cell-free mode and in vitro in human cell culture to create a number of highly specific nanoparticle-lectin conjugates. We showed that the obtained conjugates can be successfully used as biomarker-specific agents for specific cell visualization in biomedical diagnostics.
ThS2E-01 Invited 09:00-09:20
Photoinduced processes in fullerenes and other carbon nanostructures
E.A. Katz; Univ. of the Negev, Israel
I will review the fundamental mechanisms of photoinduced charge generation, separation (charge transfer) and collection in solar cells based on fullerenes and other carbon nanomaterials (carbon nanotubes, buckycones, etc.). I will demonstrate that process in fullerene-based systems for photoinduced inactivation of pathogens can be described with the same language.

ThS2E-02 Invited 09:20-09:40
Organic nanoparticles for tissue diagnostics and PDT
R. Steiner1, C. Scafì-Happ1, R. Wittig2, A. Ryabova3, S. Greif4, V. Loshchenov5; 1 - Inst. of Laser Technologies in Medicine and Metrology at the Univ. of Ulm, Germany, 2 - Prokhorov General Physics Inst. RAS, Russia, 3 - Biologit Research GmbH, Germany, 4 - National Research Nuclear Univ. (MEPhI), Russia
Organic crystalline nanoparticles (NPs) are prepared from AIPCD and mTHPC raw material. Such NPs are non-fluorescent. After cellular uptake molecules are distributed into the cells, fluorescence and are photoactive. This process and the role of macrophages are evaluated and will be presented. Therefore, such crystalline NPs can be used for tissue diagnostics and PDT.

ThS2E-03 Invited 09:40-10:00
Direct laser excitation of oxygen molecules: application to studies of oxygen photodynamics in systems of biomedical importance
A.A. Krasnovsky; Bach Inst. of Biochemistry RAS, Russia
Oxygenation rates of singlet oxygen traps were compared upon direct laser excitation of dissolved oxygen molecules using continuous and pulse laser radiation and under photostimulation by porphyrins. Novel procedure of data processing was developed and accurate absorption coefficients were obtained for the main IR absorption maxima of molecular oxygen under ambient conditions. Biomedical importance of the data is discussed.

ThS2E-04 Invited 10:00-10:20
Ru(II) complex mediated PDT for bladder cancer, biology and dosimetry
P. Kaspers1, S. Lazic1, Y. Arenas2, A. Mandel1, L. Lüge1; 1 - Theratalase Inc., 2 - Univ. Health Network, Canada
We present data showing that premixing the Ru2+-complex TLD14331,2 with transferrin increases the inactivation of pathogens can be described with the same «language».

ThS2E-05 Invited 10:20-10:40
Nanophotosensitisers for theranostics
V.B. Laschenov; Prokhorov General Physics Inst., National Research Nuclear Univ. MEPhI, Russia
The limits of tumor detection by means of nuclear medicine do not exceed: 3 mm for X-ray tomography and MRI; 4 mm for PET; 1.5 mm in diameter by ultrasound. Clinical investigation among the United States citizens. Thus at least 3 problems remain unsolved: diagnosis and consequent treatment of the one third of all malignant tumors, i.e. their early states, squamous cell carcinoma of mucous tissue, and the third one problem: a long way and expensive. The limit of tumor detection by means of optical spectroscopy is around 1-2 mm, although the principle it is possible to reach pathologies 5-10 µm in diameter. The problem formation: it is possible to diagnose and conduct treatment of those types of pathologies which could be reached by irradiation or could selectively accumulate a photosensitizer.

ThS2E-06 Invited 10:40-11:00
Completed characterization of detonation nanodiamond and cancer chemotherapy using nanodiamond as drug delivery platform
E. Osawa1, D. Ho2, T. Minagawa3; 1 - Shinshu Univ., Japan, 2 - UCLA, United States, 3 - Shinshu Univ. School of Medicine, Japan
We finished characterization of the primary particles of detonation nanodiamond (PPDND, 2.8 nm) in highly purified and monodisperse state. In parallel we have well progressed in evaluating PPDND for drug carrier platform, beginning from cell toxicity tests, to safety and chemotherapy examinations on small to large animals. Now we are preparing for pricininal safety tests on human.

- Coffee Break -

ThS2E-07 Invited 11:30-11:50
Photothermal effects of nanoparticles in liquid media
B. Eberle, C. Hege, M. Körber, A. Azarian, S. Dengler; Fraunhofer IOSB, Germany
We evaluate a variety of different kinds of nanoparticles suspended in various solvents regarding their nonlinear attenuation characteristics with respect to near-infrared laser pulses.

ThS2E-08 Invited 11:50-12:10
mTHPC-based photoactive nanoparticles: basic and pre-clinical research
L. Bezdetnaya1, H.-P. Lassalle1, S. Marchal2, G. Dolivet1, V. Zarin1; 1 - Univ. of Lorraine, France, 2 - Inst. de Cancérologie de Lorraine, France, 3 - Belarussian State University, Belarus
Tumor selectivity of mTHPC could be enhanced using drug delivery systems or carriers, like liposomes and cyclodextrins (CDs). Rapid accumulation of liposomal mTHPC in the xenografted tumors and reduced damage to normal tissues was inferred to liposomal formulations. CDs accelerate mTHPC mobility increasing its bioavailability. Injection of mTHPC-CD complexes resulted in reduced mTHPC accumulation in skin along with its better accumulation in the tumor.

ThS2E-09 Invited 12:10-12:30
Ultrafast photothermal action in nano dimensions
A. Ronchi1, S. Petri1, M. Chiuri1, C. Finetti1, M. Rucci1, C. Giaiattini1, P. Baroni1, G. Ferrari1; 1 - Univ. Cattolica del Sacro Cuore, 2 - Inst. of Chemistry of Molecular Recognition, CNR, 3 - NEST, Scuola Normale Superiore, Italy
The thermomechanical dynamics of complex biologically-related systems is investigated with ultrafast optical techniques. The extraction of information from experiments is accomplished through data mining techniques. Singular value decomposition (SVD) and a Hierarchical Cluster Analysis provide the basis for the analysis of both a single and ensemble of nano-objects. Paradigmatic examples are shown where ultrafast optoacoustic traces allow to discriminate the dimensions and predict the influence of the environment on nanoparticles bonded to surface chemical complexes, without previous knowledge of the investigated system. These techniques bear great potential as screening platform, to evidence casual or systematic errors and reveal patterns hidden in the data.

ThS2E-10 Invited 12:30-12:50
Photodynamic inactivation of enveloped virus in protein plasma preparations by solid-phase fullerene-based photosensitizer
I.M. Belousova1, I.M. Kislakov2, T.D. Muraviova1, A.M. Starodubtsev3, T.K. Krikzo1, E.A. Selivanova1, N.P. Sivakova1, S.S. Golovanov2, S.D. Volkov3, A.A. Shtra1, V.V. Zarubov2; 1 - Vavilov State Optical Inst., 2 - Inst. of Hematology and Transfusiology, 3 - National Research Nuclear Univ. MEPhI, Russia
The ability of fullerene to inactivate influenza virus in protein fraction of donor blood when irradiated with visual light has been studied. The complete inactivation was achieved after 30 min of irradiation. This process did not lead to the toxicity of that albumin. The data suggest that the method described is prospective for inactivation of viruses in the preparations of donor blood.

ThS2E-11 Invited 12:50-13:10
Design and optimization of molecular photoacoustic contrast agents (MPACs) for in vivo imaging of breast cancer tumors
M. Hatami1, M. Frenette1, S. Buckley-Bollinger2, J. Rochford, Ch.S. Yelleswarapu; Univ. of Massachusetts Boston, United States
Design and characterization of BODIPY inspired molecules as photoacoustic contrast agents (MPACs) for in vivo imaging of breast cancer tumors
A. Akopov, G. Papayan, N. Petrischke; Pavlov First State Medical Univ, Russia
Demonstrate the possibility of photoacoustic theranostics with various methodological improvements in experimental and clinical studies: the use of tumour specific conjugates with biological nanocarriers; two-wavelength excitation; fluorescence image-guided surgery; stereotactic fluorescent bioreporter; using the near-infrared light to detect the tumour and sentinel lymph nodes; photodynamic irradiation in a pulsed mode. Fluorescent visualization in radiation therapy improves the tumor treatment efficacy.
The photodynamic properties of a new photosensitizer—dimegin (disodium salt of 2,4-di(α-methoxyethyl)-deuteroporphyrin-IX)—are studied in comparison with the properties of photosensitizers used in medical practice, namely, Photoditazine (dimethylglyucamine salt of chlorin et) and Radachlorin (trisodium salt of chlorin et). The spectral characteristics, singlet oxygen generation ability, luminescence efficiency, and photo-stability of these photosensitizers are studied upon irradiation by light-emitting diode arrays in different spectral ranges.

Multimode lasers as analogues of complex biological systems

Modeling of operation of complex biological systems and, in particular, a human brain, is a topical problem to be solved both for a brain functioning understanding, and for the development of new classes of computers based on principles of operation of brain. Some specific features and analogues in operation of laser systems and brain are discussed that can be useful in design of new generation of computers. An appropriateness of such analogies is justified by a fact that both laser systems and brain belong to opened (interacting with an environment) dissipative space-distributed nonlinear systems. Thereby, laser systems and, in particular, systems with dissipative optical solitons, afford an opportunity to an experimental and theoretical modeling of some important cognitive functions of brain. One of special features of an activity of brain is its capability to operate by images. So some problems of generation, amplification and transformation of space-inhomogeneous patterns of electromagnetic field (images) in multimode lasers are discussed, as well as interaction of proper laser modes with weak external signals.

Use of hypothermia during PDT treatment of malignant gliomas

The ability to improve the selectivity of ALA mediated Photodynamic Therapy in mixed Glioma with normal brain structures using 32 degree C Hypothermia is presented. Hypothermia increases ALA synthesis in most glioma cells and improves normal brain structure resistance to the PDT generated cytotoxic shock.

The method of laser forming of nanocarbon biocompatible coatings for artificial ligaments

The work is devoted to laser method of biocompatible coatings forming to create implants of the human body ligaments. Coating is a carbon nanotubes scaffold formed in the water-protein dispersion by the electric field of the laser radiation. Study has been conducted on the structure and properties of carbon nanotubes coatings and proliferative activity of biological cells on its surface.

Increasing the conductivity of the carbon nanotube-based layers by laser radiation

The 5-50 µm-thick layers of a nanomaterial consisting of acrylic paint and multilayer carbon nanotubes (~3 mass.%) are investigated. It is shown that laser radiation and heat treatment enhance the conductivity of the layers by a few orders of magnitude. The layers remain stable in water for over 200 h and exhibit a conductivity of ~ (100−1000) S/m, which make them promising for application in biomedical electrodes and wearable electronics.
ThS2D-p01 15:00-19:00

Determination of nanorods aspect ratio using depolarized light scattering
S.A. Dolgushin1, I.S. Bumaevskiij1, V.A. Deshabo1, P.V. Shaleev1, I.K. Yudin1, B.N. Khlebtsov2, S.A. Tereleshchenko1; 1 - National Research Univ. of Electronic Technology, 2 - Oil and Gas Research Inst. RAS, 3 - Inst. of Biochemistry and Physiology of Plants and Microorganisms, RAS, Russia

The method for a determination of geometric parameters of nanorods in liquid dispersions based on the depolarized light scattering is described. There is presented a model for randomly oriented cylindrical nanoparticles. The model describes the depolarization ratio for the scattered light of the aspect ratio. A number of experiments was carried out to verify the proposed model. The results of experimental studies are presented.

ThS2D-p02 15:00-19:00

Biosensors based on magnetic nanolabels: optimization with spectral interferometry and highly-sensitive electronic registration
A.V. Orlov1, V.A. Bragina1, S.L. Znoyko2, K.G. Shevchenko1; 1 - Prokhorov General Physics Inst. RAS, 2 - Moscow Inst. of Physics and Technology (State Univ.), Russia

A new rapid method based on immunochromatographic assay in combination with the electronic registration of nanolabels by their non-linear magnetization has been developed. The method is designed to provide highly accurate measurements of the concentration of protein molecules (e.g. markers, which indicate the onset or development of a disease) in various samples, including opaque solutions or strongly colored liquids. The optimization of the assay parameters is carried out using real-time monitoring of all the immunoassay steps with the spectral-correlation interferometry.

ThS2D-p03 15:00-19:00

Real-time sensitive detection of low molecular weight compounds by optical immunosensors
A.V. Orlov1, A.G. Burennik2, N.V. Gutenev2, G.B. Gorkovik2; 1 - Prokhorov General Physics Inst. RAS, 2 - Moscow Inst. of Physics and Technology (State Univ.), Russia

Highly sensitive label-free methods have been developed for detection of low molecular weight compounds. The methods are based on real-time detection of biomolecular interactions on the surface of standard microscopic cover glass slips used as affordable single-used sensor chips. The assay performance was successfully validated for detection of antibiotic chloramphenicol which is used in medicine and veterinary as well as for determination of natural toxins in real samples. The proposed methods are an attractive solution for medical monitoring of antibiotics in the organism and for toxicological control of food.

ThS2D-p04 15:00-19:00

Luminescence method to study the growth of CuInS2 quantum dots in real time
A.A. Skapssov1, A.S. Novikova1, A.H.M. Mohammed1, V.V. Galushka1, I.Yu. Goryacheva1, V.I. Kochubei1, Saratov National Research State Univ., Russia

Developed luminescence method to study the growth mechanism of CuInS2 quantum dots in real time is demonstrated.

ThS2D-p05 15:00-19:00

Spectral method of real-time monitoring of gold nanorods growth
A.A. Skapssov1, O.A. Savenko1, V.I. Kochubei1, Saratov National Research State Univ., Russia

The developed spectral method of real-time monitoring the growth mechanism of gold nanorods is demonstrated.

ThS2D-p06 15:00-19:00

Silanized liposomes loaded with luminescent quantum dots as label for mycotoxin detection
O.A. Goryacheva1, N.V. Beloglazova1, S. De Saeger1, I.Y. Goryacheva1; 1 - Saratov National Research State Univ., 2 - St. Petersburg State Univ., Russia

Silanized liposomes loaded with luminescent quantum dots was developed as a perspective label for immunoassay. Silica coverage ensures the stability of the liposomes against fusion and internal leakage and also simplifies bioconjugation.

ThS2D-p07 15:00-19:00

New enzymatic glucose and hydrogen peroxide sensors based on metal structures produced by laser-induced deposition from solution
E.M. Khairullina1, A.V. Smikhovskaya1, S.V. Safonov1, M.S. Panov1, L.S. Logunov1, S.S. Ermakov1, V.A. Kochemirovsksy1, St. Petersburg State Univ., Russia

The method of laser-induced metal deposition was applied to synthesize nano- and microstructured metal electrodes for non-enzymatic glucose and hydrogen peroxide sensing. These electrodes were characterized by SEM, EDX, SIMS, XRD and EIS. Copper electrodes have a linear dependence of the current-concentration in the range of 10-100 μmol/L for hydrogen peroxide and 0.6 - 3.0 mmol/L for D-glucose.

ThS2D-p08 15:00-19:00

Near infrared luminescent-magnetic nanoparticles for bimodal imaging in vivo
I.V. Zelepukina1,2, M.P. Nikitina1,2, A.V. Nechaeva1, A.V. Zyagin1, P. Nikitin1; 1 - Shemyakin-Ovchinnikov Inst. of Bioorganic Chemistry RAS, Russia, 2 - Moscow Inst. of Physics and Technology (State Univ.), Russia, 3 - Lobachevsky Nizhny Novgorod State Univ., Russia, 4 - Prokhorov General Physics Inst. RAS, Russia, 5 - Moscow State Univ. of Fine Chemical Technologies, Russia, 6 - Macquarie Univ., Australia

The methods of multimodal imaging are very attractive for a variety of applications in the field of life science. Here, we report synthesis of luminescent magnetic nanostuctures based on upconversion nanophosphors and superparamagnetic iron oxide nanoparticles for their bimodal detection in vivo. Poly(lactic-co-glycolic acid) copolymer matrix was used for stabilization of nanoparticles in physiological pH and influence of reaction conditions on final size of nanomaterials was investigated. The particles were studied by dynamic light scattering and transmission electron microscopy methods. The obtained particles are attractive for bimodal imaging inside animals in vivo by the methods of optical tomography and magnetic particle quantification methods.

ThS2D-p09 15:00-19:00

Stimuli-responsive nano- and microstructures based on gold nanoparticles
K.G. Shevchenko1, V.R. Cherkasov2, I.L. Sokolov1, M.P. Nikitin1; 1 - Moscow Inst. of Physics and Technology (State Univ.), 2 - Prokhorov General Physics Inst. RAS, Russia

Gold nanoparticles (GNPs) is a well established tool for a wide range of applications in different research fields. Here, we demonstrate the possibility for their effective use in stimuli-responsive enzyme-based logic-gated systems. Such smart materials can be the promising as a base for novel nanorobotics devices that enable changes of physical properties of the environment (light, temperature, etc.) as logical inputs.

ThS2D-p10 15:00-19:00

Optical method for studying self-assembly of various nanoparticles in liquids
V.R. Cherkasov2, K.G. Shevchenko1, P. Nikitin1; 1 - Moscow Inst. of Physics and Technology (State Univ.), 2 - Prokhorov General Physics Inst. RAS, Russia

We demonstrate that the localized surface plasmon resonance applied for studying the colloidal noble metal particle interactions can be also used for investigation of metal/non-metal nanoparticle interactions. Using the spectral shift of resonance as a criterion of colloid complex formation, the method can be adapted for exploration of bio-modulated self-assembly processes to be used in life science, for development of smart materials, etc.

ThS2D-p11 15:00-19:00

Colloidal gold nanoparticles change energy transfer standard scheme of a photosensitiser
M.N. Kholodtsova1,2,3, V.I. Makarov1, I.D. Romanishkin1, W.C.P. Blondel2,3, V.B. Loschenv5,6,7, V. P. of Prokhorov General Physics Inst. RAS, Russia, 2 - Univ. de Lorraine, France, 3 - CNRS, CRAN, France, 4 - National Research Nuclear Univ. 'MEPhI', Russia

In this contribution the use of nanoparticles to change energy transfer scheme in fluorophore is investigates by means of lifetime measurements. It was shown that in the vicinity of gold nanoparticle, lifetime drastically decrease, thus leaving less probability to energy relaxation from singlet to triplet level and reducing consequent transfer to singlet oxygen, which drives PhotoDynamic Therapy (PDT) effect.

ThS2D-p12 15:00-19:00

The plasmatic photothermal therapy of transplanted tumors in rats using gold nanorods
A.B. Bucharskaya1, G.N. Masiyakova1, N.I. Dikht1, N.A. Navalokin1, G.S. Terytuk2, A.N. Bashkatov1,2,3,5, E.A. Genina2,5, B.N. Khlebtsov2,4, N.G. Khlebtsov2,4, V.V. Tuchin2,3,5; 1 - Prokhorov General Physics Inst. RAS, 2 - Moscow Inst. of Physics and Technology (State Univ.), 3 - Inst. of Precision Mechanics and Control RAS, 4 - Inst. of Biochemistry and Physiology of Plants and Microorganisms RAS, 5 - Tomsk National Research State Univ., Russia

The study of morphological changes in transplanted liver tumors of rats after plasmatic photothermal therapy (PPTT) was conducted. The gold nanorods (GNs) functionalized with polyelectylyme glycol were injected by one-, two- and three-step intravenous administration. A day after injection tumors were irradiated by the NIR 808-nm diode laser. The most pronounced damage effect of PPTT was observed after triple intravenous injection of GN.
The optimal pair of bands in the fine structure of nanoparticles luminescence spectra measured for using local temperature of biological tissue had been determined.

In this paper we consider the laser irradiation of the ensemble of absorbing nanoparticles localized in macroscopically-sized area of the tissue sample. The simple formula for estimation of distribution of the local temperature is presented.

This work is concerned with dissecting the technique of disected tissue welding using a specific facility and nanosolder. The technique performance was studied on the hog stomach mucous membrane samples. Laser solder compositions that allow maximal durability of the tissue welding were revealed and its 3D structure was studied using x-ray microtomography. Biocompatibility of the laser nanosolder was proved.

Photodynamic therapy (PDT) is an effective treatment for cancer. Laser irradiation parameters strongly influence the singlet oxygen generation during PDT. The optimum pair of bands in the fine structure of nanoparticles luminescence spectra measured for using local temperature of biological tissue had been determined. The spectrum contains the fluorescence peak centered at 660 nm, the phosphorescence band centered at 940 nm and a low intensity band centered at about 1300 nm. The interpretation of the data obtained is presented.

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The modeling of local distribution of the temperature photo-induced by ensemble of nanoparticles Yu.A. Avetisyan1, A.N. Yakunin1, A.A. Bykov3, V.V. Tuchin1,2,3,1 - Inst. of Precise Mechanics and Control Inst. RAS, Russia, 2 - Chernyshevsky Saratov National Research State Univ., 3 - Tomsk State National Research University, Russia

This work open the door to novel advances for miniaturized total analysis systems based on microcapillaries with the add-on of mechanical transduction.

We demonstrate in this work that commercially available microcapillaries can be used as highly sensitive density sensors. The capillary vibration is detected here by measuring the optical forward scattering of a laser beam. The results of this work open the door to novel advances for miniaturized total analysis systems based on microcapillaries with the add-on of mechanical transduction.

In this work we investigate the effectiveness of pulse laser heating of Dy3+ doped YPO4 nanocrystals for laser induced hyperthermia I.O. Romanshikin1, A.S. Vanetsiev2, A.V. Ryabov3, Yu.V. Orlovskii1,3,1 - Prokhorov General Physics Inst. RAS, Russia, 2 - Univ. of Tartu, Estonia, 3 - National Research Nuclear Univ. MEPhI, Russia

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In this work we investigate the effectiveness of pulse laser heating of Dy3+ doped phosphate nanoparticles by the effect of multiphonon relaxation. The results have shown rapid rise and fall of nanoparticle powder temperature suggesting their potential application as hyperthermia agents.

The development of fiber-optic scaffold for the glioblastoma diagnosis and prevention Yu.S. Makygina1, A.V. Borodkin1, G.M. Yusubaliev2, V.B. Loschenov3,1 - Prokhorov Inst. of General Physics RAS, 2 - Serbskij State Research Center of Forensic and Social Psychiatry, 3 - National Research Nuclear Univ. MEPhI, Russia

The main goal of the research is creation of the unique fiber-optical multipurpose system created on the basis of porous optical fibers. The fiber-optical scaffolds would perform the role of the structure which is promoting and setting the of global cells growth. Also this system acts as a port for delivery of a photosensitizers and laser radiation for the purpose of cellular processes monitoring. So developed system allows to carry out a regular fluorescent diagnostics and timely photodynamic therapy of the probed area.

The simple formula for estimation of distribution of the local temperature is presented.

The modeling of local distribution of the temperature photo-induced by ensemble of nanoparticles Yu.A. Avetisyan1, A.N. Yakunin1, A.A. Bykov3, V.V. Tuchin1,2,3,1 - Inst. of Precise Mechanics and Control Inst. RAS, Russia, 2 - Chernyshevsky Saratov National Research State Univ., 3 - Tomsk State National Research University, Russia

This work is concerned with dissecting the technique of disected tissue welding using a specific facility and nanosolder. The technique performance was studied on the hog stomach mucous membrane samples. Laser solder compositions that allow maximal durability of the tissue welding were revealed and its 3D structure was studied using x-ray microtomography. Biocompatibility of the laser nanosolder was proved.

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Federal State Unitary Enterprise "Russian Federal Nuclear Center - Zababakhin All-Russia Research Institute of Technical Physics" ("RFNC-VNIITF") is one of two world level nuclear centers operating in Russia. It is the advanced center for scientific research having well-developed high-tech production facility; offering innovation products and technologies for all key industries of the Russian Federation.

RFNC-VNIITF has enormous scientific and technology potential and practical experience in development and production of diode-pumped lasers. It produces unique devices of record-breaking parameters on the level with the best world examples:
- repetitively pulsed laser-diode matrices;
- pump modules with fiber output for fiber lasers pumping;
- continuous fiber erbium laser with narrow laser spectrum (less than 20 kHz);
- continuous ytterbium fiber lasers;
- optical amplifying diode-pumped heads;
- powerful repetitively-pulsed solid-state diode-pumped lasers;
- low-peak power diode-pumped lasers of low mass and sizes working under extreme operation conditions.

IC Specpostavka is a specialized distributor of electronic components and equipment for fiber lasers and amplifiers, microwave photonics, quantum cryptography, laboratories and manufacturing facilities.

IC Specpostavka is an official representative of leaders of industry: LightComm, BWT Beijing, Altechna.

LightComm (China) - world leading Passive Optical Fiber Components manufacturer with 15+ years of operation history and cyclical turnaround.

LightComm’s product line:
- High power pump combiners Nx1, (N+1)x1, PM, more than 300 configurations, power up to 6 kW
- Mode field adapter (Forward and Backward version)
- PM combiner (2x2, 1x3, different wavelength, mini size)
- High power isolator, power up to 100 W

BWT Beijing (China) – manufacturer of high performance diode laser systems and subsystems with wavelength in range of 450-1550 nm and output power up to 300W

Altechna (Lithuania) – manufacturer and supplier of optics, polarization optics, laser and non-linear crystals, optomechanics.

FEDAL, RUSSIA
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FEDAL develops and produces laser electronics:
1. Laser power supplies for fiber and solid lasers with:
   - diode pumping:
     - pumping current - up to 450 A; output voltage - up to 300 V;
     - pulse duration - 10-500 μs; operating voltage over the diodes - up to 250V; frequency up to 1kHz
   - average output power:
     - for 1 channel – до 5 kW; multichannel –до 200 kW
   - - addition - TEC controllers
   - lamp pumping
   - pumping current - up to 1600A; average output power - up to 6 kW; pulse rate - up to 30 Hz; power charge - up to 6500J/s,
2. Laser multichannel electric power supplied system (MEPSS)
3. Diode drivers
   - CW/ pulsed mode
   - output voltage - up to 30B /200V
   - average output power - up to 150W/5kW
4. Charging modules (Single-phase / Three-phase)
5. Accessories (Thermostabilization / Smoothing current / Energy measurement / Synchronization / Remote control / Lamp ignition)

LOS is an industrial company producing the solid state laser systems. We combine the science and the industrial experience to meet the consumer demand and to innovate the cutting-edge technologies into the commercial products. We produce the diode pumped solid state lasers, eye-safe lasers, environmental lidars and other laser systems. Over 20 years we are on the market and our brand is well known both in Russia and abroad.

LASERS AND OPTICAL SYSTEMS, RUSSIA
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LASERTRACK, RUSSIA

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Lasertrack represents COHERENT, INNOLAS, OWIS, HAMAMATSU, THORLABS and some other companies who deal with lasers and laboratory equipment in Russia and CIS. Our business is lasers and equipment for scientific researches and lasers for Industry. Our specialists can provide you information about all production of our partner companies. We responsible for sales, warranty service and after warranty service of the equipment what we are selling.

LASER-COMPACT/ LASER-EXPORT, RUSSIA

3 Vvedensky St. 117342, Moscow, Russia Phone: +7 499 578 05 48 Fax: +7 499 578 05 49 E-mail: sales@laser-export.com www.laser-export.com

LASER-EXPORT specializes in R&D and manufacture of DPSS lasers for use in analytical, scientific and industrial applications. The biggest Russian exporter of DPSS lasers. The company represents LASER-COMPACT group with 24-year custom design experience. The products include:
- new compact tunable nanosecond ‘TiSon’-lasers (710-890 nm) for biomedical applications (phacoacoustics);
- high-energy (up to 2 mJ@1 kHz) Q-switched IR, green and UV ‘TECHNOLOGY’-series lasers for materials testing and micromachining, marking, mass-spectrometry, laser-ultrasound nondestructive evaluation, LIDAR, spectroscopy etc.;
- miniature single-frequency CW lasers for Raman and interferometry and others.

The group sells its products through distributors and OEMs all over the world. Over 48,000 of lasers have been produced and delivered in 40 countries, the main share in the USA, Germany, France, and Japan.

QC system of Laser-export is certified to comply with ISO 9001:2008.

CEDRAT TECHNOLOGIES, RUSSIA

30 Komendantsky Pr. 197372, Saint Petersburg, Russia Phone: +7 950 023 73 89 Phone/Fax: +7 812 348 17 18 ext.115 E-mail: karev_p@metrology-spb.ru http://metrology-spb.ru

CEDRAT TECHNOLOGIES (CTEC) is an internationally recognized mechatronics specialist and manufacturer of piezo and magnetic actuators offering a wide range of standard products: amplified (APA’), pre-stressed piezo actuators, XY piezo stages, stepping motors, shutters, magnetic actuators, the associated electronics and also customized products. CTEC has a strong experience in developing Compact Dynamic & Precise solutions for the optronics and photonics fields for demanding clients. The following functions are frequently offered:
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- Optical image, laser or line of sight (LOS) stabilization & anti shaking or anti blurring functions for precise target pointing & better image quality,
- Auto Focus function for continuous correction of the image focus.

Industrial Metrology Co is the official representative of CTEC on the Russian territory.

NUFERN, USA

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Nufern is a leading U.S. manufacturer of specialty optical fibers, gyro coil winding, fiber lasers and high performance fiber amplifiers serving diverse markets. Our products include over 1500 standard and custom specialty fibers, scientific fiber amplifiers and a full range of pulsed fiber lasers. Custom and OEM lasers and amplifiers available on request.
**SPECIAL SYSTEMS LLC, RUSSIA**

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Special Systems company specializes in the distribution of the laser-optic and fiber-optic components, optomechanics, laboratory equipment and laser systems for various applications and markets.

Our mission is technology transfer and consulting, implementation of advanced technologies to the organizations of photonics industry, universities and research institutions in Russia and the CIS.

We have our own test lab with various equipment and components for the testing and analysis of fiber-optic components and systems. Also our company works in the fields of fiber-optic distributed sensing systems and RFOF (microwave photonics).

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**SOL INSTRUMENTS Ltd., BELARUS**

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SOL instruments® is a Belarusian innovation - focused developer and manufacturer of technologically advanced instruments for light measuring, elemental analysis and nano-scale microscopy. For two decades we inbreed our knowledge and expertise in spectroscopy, microscopy and lasers and create robust tools for scientific and industrial applications in three core segments: analytic equipment, spectroscopy instruments and laser systems.

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**VICON STANDA, RUSSIA**

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For more than 10 years we have successfully presented opto-mechanical equipment of company Standa to research laboratories and industry in Russia.

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**TOPTICA PHOTONICS AG, GERMANY**

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TOPTICA is a privately held technology driven company, which develops, produces and sells diode and ultrafast fiber lasers for scientific and industrial applications. The company sets its own challenge to regularly present exciting product innovations and world firsts.
OXAPA GmbH

Glass Processing Technologies

OXAPA GmbH, GERMANY

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ELEKTROSTEKLO, RUSSIA

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Official distributor of companies: Ophir – Spiricon - Photon - global leader in laser measurement equipment and precision IR optics components, CVI Laser Optics and Melles Griot, Continuum and Quantronix companies - manufacturers of solid-state lasers.
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LASERS AND OPTICAL SYSTEMS

LOS participates in the ITER Project and in the European Fusion Programme

- lasers for material treatment & plasma diagnostics (Nd:YAG, 6 J, 200 Hz, 10 ns, 10^4 rad)
- diode-pumped solid-state lasers for range finding (Yb:Er:Glass, Q-switched, eye-safe range, compact, high brightness, short-pulse)
- airborne lidars for ecological and radionuclides monitoring (oil exploration, pipeline leakage detection, DPSSL Nd:YLF laser 262 nm, 250 Hz, 20 mJ)

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