16th International Conference

"Laser Optics 2014"

Technical Program

Saint-Petersburg, Russia
June 30 - July 4, 2014

16th International Conference on Laser Optics 2014

Technical Program

St.Petersburg
2014

CONTENTS

THE 16TH INTERNATIONAL CONFERENCE «LASER OPTICS 2014» IS TECHNICALLY CO-SPONSORED BY

IEEE Photonics Society

AND HOSTED BY:

Fund for Laser Physics

IPG Photonics Corporation

St.Petersburg National Research University of Information Technologies, Mechanics and Optics (ITMO)

Laser Association

Rozhdestvensky Optical Society

Russian Foundation for Basic Research

The Union of Industrialists and Entrepreneurs (Employers) of St. Petersburg

Vavilov State Optical Institute (SOI)

We wish to thank the following for their contribution to the success of this conference:

LASER OPTICS
ОПТИКА ЛАЗЕРОВ
2014

St.Petersburg Government

The Ministry of Industry and Trade of the Russian Federation

МИНПРОМТОРГ РОССИИ

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ

The Ministry of education and science of Russian Federation

NTO IRE-Polus

IPG IRE-POLUS

GPI

Prokhorov General Physics Institute of RAS

Laser Center Ltd.

ЛАЗЕРНЫЙ ЦЕНТР LASER CENTER

СНП

Technological Design Institute of ScientificInstrument Engineering of SB RAS

OSA

OSA

VNIGRI

DLSLAB Inc.

DLS LAB

Holiday Inn

«Photonika» Magazine

ФОТОНИКА

«RITM» Magazine

РИТМ

JUNE 30 - JULY 4, ST.PETERSBURG, RUSSIA

ADVISORY COMMITTEE

CHAIR

Vladimir N. Vasilev
St.Petersburg National Research University of ITMO, Russia

Sergey N. Bagayev
Institute of Laser Physics of SB RAS, Russia

Yuri V. Chugui
Technological Design Institute of Scientific Instrument Engineering of SB RAS, Russia

James Coleman
University of Texas at Dallas, USA

Valentin P. Gapontsev
IPG Photonics Corporation, USA

Sergey G. Garanin
Russian Federal Nuclear Center - The All-Russian Research Institute of Experimental Physics (RFNC - VNIIEF), Russia

Aleksandr V. Gurov
Rostec State Corporation, Russia

Aleksandr A. Kaplyanskii
Ioffe Physical-Technical Institute of RAS, Russia

Ivan B. Kovsh
Laser Association, Russia

Mikhail A. Lobin
The Union of Industrialists and Entrepreneurs of St. Petersburg, Russia

John Marsh
University of Glasgow, UK

Gennadiy A. Mesyats
Lebedev Physical Institute of RAS, Russia

Vladislav Ya. Panchenko
Russian Foundation for Basic Research, Russia

Vladimir P. Savchenko
JSC «Academician A.L.Mints Radiotechnical Institute», Russia

Ivan A. Shcherbakov
Prokhorov General Physics Institute of RAS, Russia

Konstantin A. Tarabrin
The Ministry of Industry and Trade of the Russian Federation, Russia

Zhu Xiao
Chinese Laser Association, P.R. China

CONFERENCE HONORARY CHAIRS

Zhores I. Alferov
Russian Academy of Science, Russia
Artur A. Mak
Institute for Laser Physics of Vavilov SOI, Russia
Charles H. Townes
University of California, Berkeley, USA

PROGRAM COMMITTEE

CHAIR

Nikolay N. Rosanov
Institute for Laser Physics of Vavilov SOI, Russia

VICE-CHAIRS

Alexandr A. Andreev
Institute for Laser Physics of Vavilov SOI, Russia
Richard M. De La Rue
University of Glasgow, UK
Vladimir Yu. Venediktov
St.Petersburg State Electrotechnical University «LETI», Russia
St.Petersburg State University, Russia

SECRETARY

Anastasiya A. Mirzaeva
Institute for Laser Physics of Vavilov SOI, Russia

CONFERENCE CHAIR

Andrey A. Mak

Research Institute of Physical Optics, Optics of Lasers and Informative Optical Systems of Research Center «S.I. Vavilov State Optical Institute», Russia

CONFERENCE VICE-CHAIR

Evgeny A. Viktorov

Institute for Laser Physics of Vavilov SOI, Russia
St.Petersburg National Research Univ. of ITMO, Russia

CONFERENCE DIRECTOR

Olga V. Khapova

Institute for Laser Physics of Vavilov SOI, Russia

ORGANIZING COMMITTEE

Vladimir M. Arpishkin

Rozhdestvensky Optical Society, Russia

Oleg D. Gavrilov

Institute for Laser Physics of Vavilov SOI, Russia

Ivan M. Kislyakov

Institute for Laser Physics of Vavilov SOI, Russia

Sergey A. Kozlov

St.Petersburg National Research Univ. of ITMO, Russia

Roman F. Kurunov

Vavilov SOI, Russia

Sergey N. Leonov

Dom Programm, Ltd., Russia

Anatoly G. Purin

Vavilov SOI, Russia

Aleksey V. Sergeev

St. Petersburg State University, Russia

Lyudmila K. Sukhareva

Vavilov SOI, Russia

TOPICAL COMMITTEES

SOLID-STATE LASERS FOR SYSTEM APPLICATIONS

Co-chairs:
V.M. Polyakov, St.Petersburg National Research Univ. of ITMO, Russia;
L.N. Soms, Inst. for Laser Physics of Vavilov SOI, Russia

HIGH POWER LASER SYSTEMS AND FACILITIES

Co-chairs:
O.B. Danilov, Inst. for Laser Physics of Vavilov SOI, Russia
A.A. Ionin, Lebedev Physical Inst. of RAS, Russia
Ja. Kodymova, Inst. of Physics, Czech Republic
S.A. Sukharev, Russian Federal Nuclear Center-VNIIEF, Russia
V.E. Yashin, Vavilov SOI, Russia

SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

Co-chairs:
G. Huyet, Tyndall National Inst. and Cork Inst. of Techn., Ireland
E.U. Rafailov, Aston Univ., UK
G.S. Sokolovskii, Ioffe Physical-Technical Inst. of RAS, Russia

LASER BEAM CONTROL

Co-chairs:
V.P. Lukin, Inst. of Atmospheric Optics of SB RAS, Russia
M.S. Soskin, Inst. of Physics of NAS, Ukraine
V.Yu. Venediktov, Inst. for Laser Physics of Vavilov SOI, Russia

SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES

Co-chairs:
A.A. Andreev, Inst. for Laser Physics of Vavilov SOI, Russia
P. McKenna, Univ. of Strathclyde, UK
A.M. Sergeev, Inst. of Applied Physics of RAS, Russia

NANOPHOTONICS AND BIOPHOTONICS

Co-chairs:
S.M. Bachilo, Rice Univ., USA
I.M. Belousova, Inst. for Laser Physics of Vavilov SOI, Russia
W.J. Blau, Trinity College Dublin, Ireland
E.A. Katz, Ben-Gurion Univ. of the Negev, Israel
A.A. Krasnovsky Jr, Bach Inst. of Biochemistry of RAS, Russia
D.V.G.L.N. Rao, Univ. of Massachusetts Boston, USA

TOPICAL COMMITTEES

LASERS IN ENVIRONMENTAL MONITORING

Co-chairs:
A.W. Mantz, Connecticut College, USA
A.I. Nadezhdinsky, Prokhorov General Physics Inst. of RAS, Russia
M.W. Sigrist, ETH Zurich Inst. of Quantum Electronics, Switzerland
A.P. Zhevlakov, Inst. for Laser Physics of Vavilov SOI, Russia

NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

Co-chairs:
Yu.S. Kivshar, Australian National Univ., Australia;
St.Petersburg National Research Univ. of ITMO, Russia
N.N. Rosanov, Inst. for Laser Physics of Vavilov SOI, Russia
S.K. Turitsyn, Aston Univ., UK

MICROWAVE PHOTONICS (MWP)

Co-chairs:
I.Yu. Denisyuk, St.Petersburg National Research Univ. of ITMO, Russia
A.I. Kurapov, Radio Technical Inst. Ltd., Russia
I. Ledoux-Rak, Inst. d'Alembert - Ecole Normale Superieure de Cachan, France

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Chair:
V.P. Gapontsev, IPG Photonics Corporation, USA
Vice-Chair:
N.N. Evtikhiev, NTO IRE-Polyus, Russia

3RD INTERNATIONAL SYMPOSIUM ON LASERS IN MEDICINE

Co-chairs:
I.A. Shcherbakov, Prokhorov General Physics Inst. of RAS, Russia
R. Sroka, Laser Research Center, Munich Univ. Clinic, Germany

7TH INTERNATIONAL CONFERENCE ON LASER OPTICS FOR YOUNG SCIENTISTS (LOYS'2014)

Co-chairs:
S.A. Kozlov, St.Petersburg National Research Univ. of ITMO, Russia
V.A. Makarov, Lomonosov Moscow State Univ., Russia

TOPICS FOR LO`2014

R1. SOLID-STATE LASERS FOR SYSTEM APPLICATIONS

Diode pumped solid state lasers • Free-space optical communication links • Linewidth reduction • Amplitude and frequency stabilization • Eye-safe lasers • Beam quality characterization • Frequency-comb generation • Novel laser materials

R2. HIGH POWER LASER SYSTEMS AND FACILITIES

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

R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES

Generation of high-power, super short pulses • Atto-physics, ELI-project presentation • 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. NANOPHOTONICS AND BIOPHOTONICS

Nonlinear optics of nanostructures • Spectroscopy of nanostructures • Optical power limiting • Photonic crystals • Nanoplasmonics • Nanostructures for solar energy utilization • Photodynamic processes in biology and nanophotonics • Nanoimaging and bioimaging Biosensing

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

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

Nonlinear optical devices • Tunable, active, and nonlinear optical metamaterials • Conservative and dissipative optical solitons • Supercontinuum generation • Fiber optics and telecommunications

R9. MICROWAVE PHOTONICS (MWP)

High-speed and/or broadband microwave photonic devices • Integration technologies for microwave photonic devices • Optical analog-to-digital converters • Optical probing and sensing of microwave properties • Optical generation of RF, microwave, millimeter-wave and THz waves and optoelectronic oscillators • 2D stadium-shaped and 3D dielectric cavities for microlaser application

TOPICS FOR LO`2014

SY1. 7TH 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 and heat treatment • 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 • Life sciences, medical, surgical, food production, agricultural pest and herbal control applications of fiber lasers

SY2. 3RD INTERNATIONAL SYMPOSIUM ON LASERS IN MEDICINE

Advanced laser systems for medicine and clinical laser applications
Optical biomedical diagnostics
Laser tissue interaction

7TH INTERNATIONAL CONFERENCE

ON LASER OPTICS FOR YOUNG SCIENTISTS

(LOYS'2014)

SM1. SEMINAR ON OPTOELECTRONICS

3D Micro/Nano-Measurements, Metrology and Fabrication Techniques • Dimensional and Surface Measurements • Novel Measurement and Diagnostic Methods • Measurement and Metrology for the Humanitarian Fields • Laser Remote Sensing Techniques and Measurements

SM2. SEMINAR ON TERAHERTZ PHOTONICS

Gyro-oscillators and amplifiers, plasma diagnostics • Free electron lasers and synchrotron radiation • THz Quantum cascade and gas lasers • Electronic components for the sub-THz and THz ranges • Novel THz materials and components • THz spectroscopy • Ultrafast and nonlinear measurements • THz plasmonics and meta-materials • THz applications in biology and medicine • THz applications in astronomy, atmospheric and environmental science • THz applications in security and defense

		Congress Hall	Hall Petrov-Vodkin 1	Hall Petrov-Vodkin 2	Hall Petrov-Vodkin 3	Hall Levinson
30.06 MONDAY	09:00-10:30					
	10:30-11:00	Opening the conference				
	11:00-14:00	Plenary				
	14:00-15:00					
	15:00-18:00		SM2			
	18:00-19:00					
	19:00-20:30	Welcome party				
01.07 TUESDAY	09:00-11:00		R8	SY1		
	11:30-13:30					A2
	15:00-17:00	Poster session: YS, R8	R1			
	17:30-19:30	Exhibition				
02.07 WEDNESDAY	09:00-11:00	Poster session: R1	R8	SY1		
	11:30-13:30	Exhibition				A3
	15:00-17:00	Poster session: R4, R6, SM2				
	17:30-19:30	Exhibition				PD
03.07 THURSDAY	09:00-11:00	Poster session: R2, R5	SY2	SY1	SY1	
	11:30-13:30	Exhibition				R8
	15:00-17:00	Poster session: R3, R9, SY2				MS
	17:30-19:30	Exhibition				
04.07 FRIDAY	09:00-11:00		SY2	SY2-C		
	11:30-13:30					
	15:00-17:00					
	17:30-19:30					

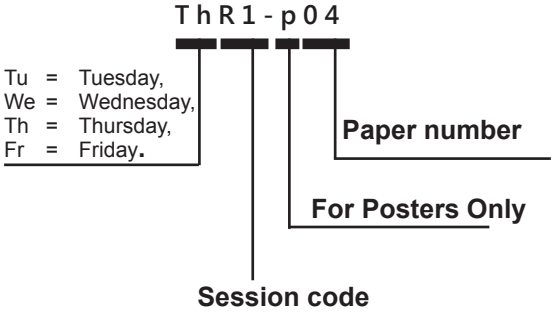
A1. Advanced laser technology in industrial applications (in Russian)
10:00, July 2, Stenberg Hall

A2. Russian-Chinese cooperation in lasers (in Chinese and Russian)
11:30, July 1, Levinson Hall

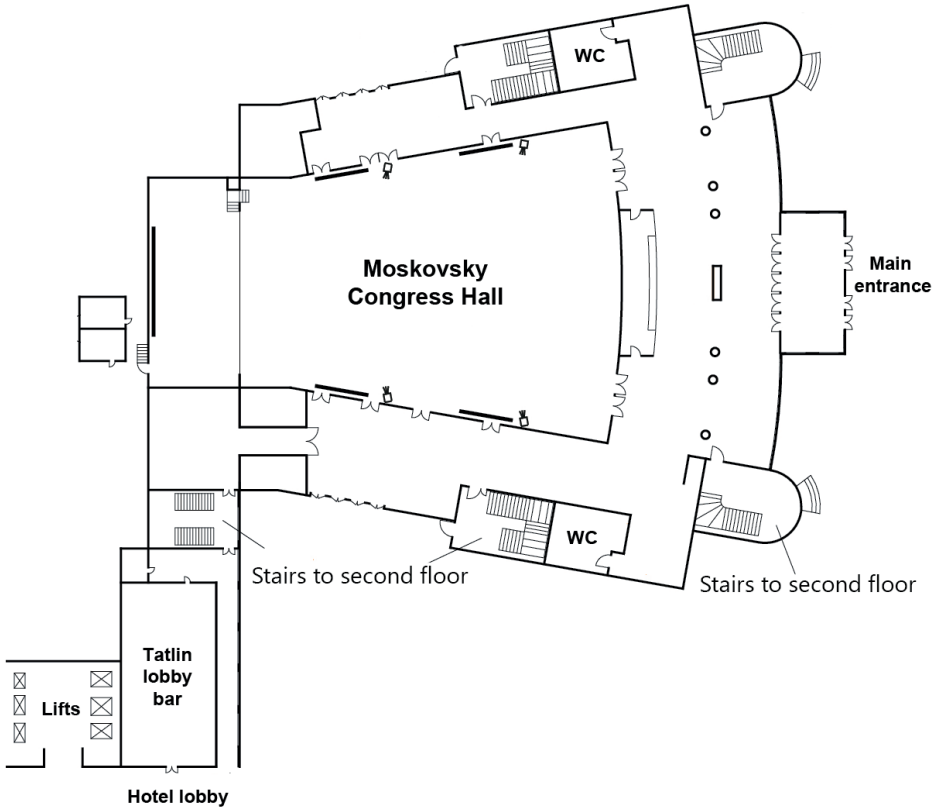
A3. Innovative methods and technologies in the oil and gas industry (in Russian)
11:30 July 2, Levinson Hall

MS. Memorial session Professor A.P. Sukhorukov and nonlinear optics
15:00 July 3, Levinson Hall

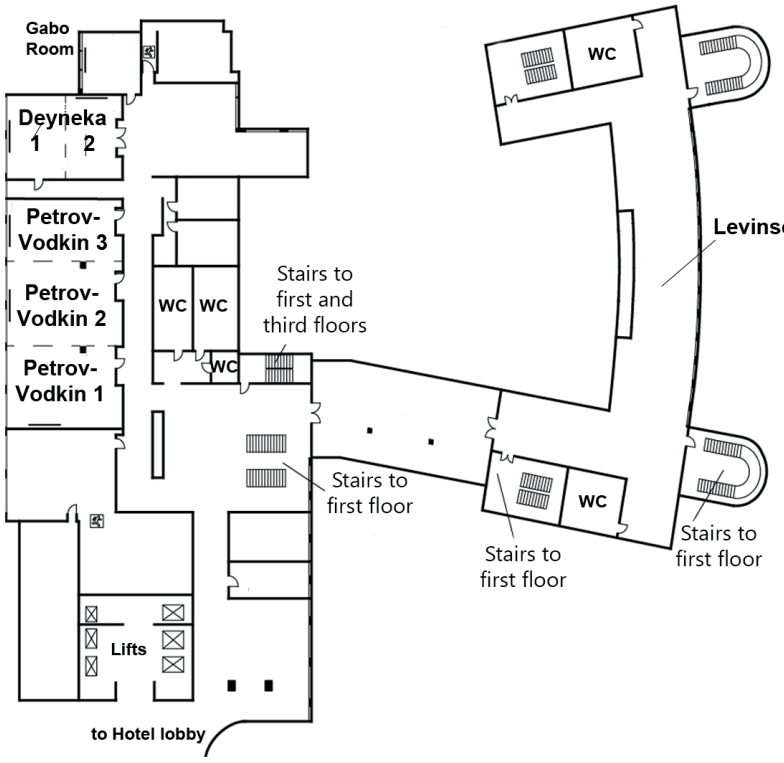
Hall Deyneka	Hall Stenberg 1	Hall Stenberg 2	Hall Richter	Hall Pudovkin	
					30.06 MONDAY
R6	YS	SM2	SM1	R3	01.07 TUESDAY
	R4				
R6	A1		YS	R5	02.07 WEDNESDAY
R2			R7		
R6	R4	R1	R9	R3	03.07 THURSDAY
R2			R7	R5	
					04.07 FRIDAY



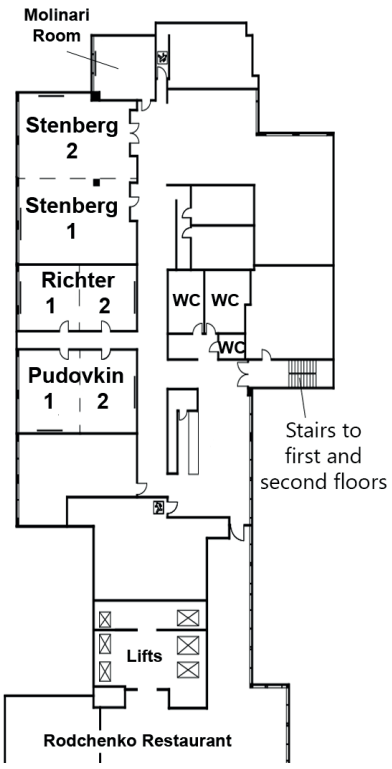
FIRST FLOOR



SECOND FLOOR



THIRD FLOOR



JUNE 30 - JULY 4, ST.PETERSBURG, RUSSIA

PLENARY

Congress Hall

Session Chair: N.N.Rosanov, Institute for Laser Physics of Vavilov SOI, Russia

MoPl-01 **11:00-11:45**

Shaping light with metamaterials. From nonlinear response to all-dielectric nanophotonics

Yu. Kivshar, Nonlinear Physics Center, Australian National Univ., Australia; St.Petersburg National Research Univ. of ITMO, Russia

We review the recent progress in the field of metamaterials--artificial structures for controlling electromagnetic waves from microwaves to visible frequencies. The topics discussed will include optically-induced magnetic response, the effects of structure geometry, nonlinear properties originating from electric and magnetic response, emission control, and hyperbolic metamaterials. A special attention will be paid to the recently emerged new field of all-dielectric metamaterials and nanophotonics.

MoPl-02 **11:45-12:30**

Real-Time Observation and Control of Electron Motion

F. Krausz; Max-Planck-Inst. für Quantenoptik; Ludwig-Maximilians-Univ., Germany

Electrons are key players in physical, chemical or life sciences. Insight into and control over microscopic electron motion are likely to be important for developing brilliant sources of X-rays, understanding molecular processes relevant to the curing effects of drugs, the transport of bioinformation or the damage and repair mechanisms of DNA at the most fundamental level where the borders between physics, chemistry and biology disappear.

MoPl-03 **12:30-13:15**

Interference of single photons (What is a photon?)

O.N. Krokhin; Lebedev Physical Inst. of RAS, Russia

Photon is a relativistic particle. If the number of photons is small, they should be considered as a quantum objects, but in the opposite case - as the classic field. The Schrödinger equation for the photon is the wave Maxwell equation, and the electromagnetic field should be considered as the wave function. The photon may be considered as a particle having the size ~λ, but localized in a long «packet».

MoPl-04 **13:15-14:00**

The serendipity of ultrashort guided lightwaves: from quantum physics to life sciences

A.M. Zheltikov; Lomonosov Moscow State Univ., Russia

Microstructure fibers – new optical fibers with tailored dispersion and nonlinearity – provide a constantly growing platform for the development of advanced fiber-format devices and components for ultrafast photonics, offering unique options for efficient supercontinuum generation, frequency conversion, and pulse compression to subcycle pulse widths and suggesting new approaches in nonlinear microscopy, bioimaging, and quantum sensing.

R1. SOLID-STATE LASERS FOR SYSTEM APPLICATIONS

Petrov-Vodkin 1 Hall

Session Chair: 09:00-13:30 V.M. Polyakov, St.Petersburg National Research Univ. of ITMO, Vavilov State Optical Inst., Russia

TuR1-01 Invited **14:30-15:00**

KW-level Q-switched Nd:YAG MOPA lasers

A.F. Kornev, Vavilov State Optical Inst., Russia;

We report on the development of kW-level Q-switched flashlamp pumped and LD pumped Nd:YAG MOPA lasers with SBS phase conjugated mirror. We compare pump efficiency, pump distribution and thermally induced aberrations for Nd:YAG laser rods with flashlamp and LD pumping. The possibilities of increasing the average power of LD pumped Nd:YAG lasers compared with flashlamp pumped lasers are discussed.

TuR1-02 **15:00-15:15**

Periodical double frequency YAG:Nd laser for pumping parametric amplifier

Yu.D. Arapov[1] , A.V. Berezin[1], A.V. Bochkov[1], S.G. Grechin[2], A.V. Isaev[1], A.F. Ivanov[1], I.V. Kasyanov[1], A.V. Kolegov[1], A.V. Lukin[1]; 1 - RFNC – Zababakhin All-Russia Research Inst. of Technical Physics, 2 - Bauman Moscow State Technical Univ., Russia;

The goal of this work is to build pulse periodic laser for pumping parametric amplifier of signal radiation with wavelength 1054 nm and energy in the pulse 1 nJ up to the values of several tens mkJ.

TuR1-03 **15:15-15:30**

High-power thin-disk laser with composite Yb:YAG/YAG active element

I. Kuznetsov, I. Mukhin, O. Palashov; Inst. of Applied Physics of RAS, Russia

Thin-disk laser on the basis of the composite Yb:YAG/YAG active element with 30W average power and 50 % slope efficiency is developed. Investigations of thermal effects in active element showed the perfect laser scalability to the kilowatt power range.

TuR1-04 **15:30-15:45**

Thin-rod amplifier for fiber lasers scaling

I. Kuznetsov, I. Mukhin, O. Palashov; Inst. of Applied Physics of RAS, Russia;

Thin-rod Yb:YAG active element is investigated in the terms of thermal effects, gain, lasing and scalability through the theoretical and experimental analysis. Low temperature, great gain and huge thermal lens are found in the thin rod. Lasing with 6 W average power and 45 % slope efficiency is obtained.

TuR1-05 Invited **15:45-16:15**

Study of the Key Aspects in Developing kW-Level Diode Lasers for Solid State Laser Pumping

X. Li, J. Wang, W. Cai, B. Hao, D. Hou, H. Liu, P. Zhang, X. Liu; Xi'an Inst. of Optics and Precision Mechanics of CAS; Focuslight Technologies Co. Ltd., P.R. China

In this paper, the key aspects, such as thermal management, thermal stress analysis and management, processes development, failure analysis and reliability evaluation, in developing kW-level diode lasers for solid state laser pumping are studied.

TuR1-06 **16:15-16:30**

Development of High-Power Disk Laser

A.B. Kozlov, N.P. Badalyan, A.V. Shestakov, I.A. Shestakova; RDI «Polyus», Russia

A series of experiments with high-power YAG: Yb3+ disk laser was carried out. And in this series of experiment attention was paid to two main tasks: to increase the efficiency of output laser generation and to achieve fundamental mode. As an active element we used disk element, that was developed in our group with composite design of high reflection mirror.

TuR1-07 **16:30-16:45**

High-Energy, Passively Q-Switched, Diode-Pumped Nd:YAG Laser with Reciprocal Multiloop, Self-pumped Phase-Conjugate Cavity

V.F. Lebedev[1, 2], A.P. Pogoda[1, 2], A.S. Boreysho[1, 2], V.A. Konjushkin[3], S.N. Smetanin[4], A.V. Fedin[4]; 1 - Baltic State Technical Univ., 2 - Laser Systems Ltd., 3 - Prokhorov General Physics Inst. of RAS, 4 - Kovrov State Technological Academy, Russia

Passive Q-switching in a reciprocal multiloop, self-phase-conjugated Nd:YAG laser pumped by 2D diode stacks was studied. The use of a passive F2–:LiF Q-switch resulted in pulse train oscillation depending on the passive Q-switch position and the number of diffractive feedback loops in the cavity. The laser energy of up to 0.6 J in trains of 12 pulses with 12-ns duration was obtained.

TuR1-08 **16:45-17:00**

Influence of input laser spectrum widths on extracting powers in Nd:YAG laser amplifiers

D. Wang, L. Tong, T. Zhou, J. Wang, H. Hu, Q. Gao, Ch. Tang; Inst. of Applied Electronics CAEP, P.R. China

The relationship between extracting powers and spectrum widths of input beams in Nd:YAG amplifiers is obtained both in theory and experiments. A theoretical model of laser amplifier is established by considering spectral homogeneous broadening, gain saturation and amplified spontaneous emission. The results in theory and experiments show the difference of extracting powers under two spectrum widths exists the extreme value.

-COFFEE BREAK -

TuR1-09 Invited **17:30-18:00**

Laser system for generation 3D ellipsoidal UV pulses

S. Mironov[1], E. Gacheva[1], A. Poteomkin[1], V. Zelenogorsky[1], A. Andrianov[1], E. Khazanov[1], M. Krasilnikov[2], F. Stephan[2], E. Syresin3; 1 - Inst. of Applied Physics of RAS, Russia; 2 - DESY, Germany; 3 - JINR, Russia;

An original concept of the cathode laser for irradiation of the photocathode to generate electron beams with small transverse emittance of space charge was developed. Constructively the possibility of simultaneous management of temporal and spatial profile of the optical pulses for generation 3D ellipsoidal structure of the light field is provided in the laser. The laser system is in the final stage of installation and alignment.

TuR1-10 **18:00-18:15**

Universal femtosecond fiber-optic clockwork

B.N. Nyushkov, V.S. Pivtsov, N.A. Koliada, I.I. Korel, V.I. Denisov, S.N. Bagayev; Inst. of Laser Physics of SB RAS, Russia

We report on development of an universal optical clockwork based on a fiber-optic femtosecond frequency comb generator with an advanced stabilization system. The clockwork can ensure ultra-low relative instability (less than 1E-17) of generated frequencies provided that a proper optical frequency standard is applied. The clockwork is approved for operation with molecular (I2), and single-ion (Yb+) optical standards.

TuR1-11 **18:15-18:30**

Sub-100 fs similariton generation in the hybrid mode-locked erbium-doped fiber ring laser

S.G. Sazonkin[1], A.A. Krylov[2], S.O. Leonov[1], D.A. Dvoretskiy[1], V.V. Grebenyukov[3], A.S. Pozharov[3], E.D. Obraztsova[3]; 1 - Bauman Moscow State Technical Univ.; 2 - Fiber Optics Research Center of the RAS; 3 - Prokhorov General Physics Inst. of RAS; Russia

We have obtained, for the first time to the best of our knowledge, sub-100 fs similariton generation in the erbium-doped all-fiber ring laser hybrid mode-locked with Boron Nitride Single- Walled Nanotubes in the co-action with a nonlinear polarization evolution.

TuR1-12 **18:30-18:45**

High average power high repetition rate chirped pulse amplifier for OPCPA pumping

K. Michailovas[1], A. Michailovas[1], A. Zaukevicius[1], V. Smilgevicius[2]; 1 - EKSPLA and Center for Physical Science and Technology, 2 - Laser Research Center, Vilnius Univ.; Lithuania

We present a high average power (~100W) picosecond pulses amplifier operating at 1 kHz repetition rate based on Nd:YAG active medium that should be an effective pump source for an OPCPA system.

TuR1-13 **18:45-19:00**

High Energy Hybrid Mode-Locked Thulium-doped Fiber Laser

M.A. Chernysheva[1], A.A. Krylov[1], E.M. Dianov[1], C. Mou[2], R.N. Arif[2], A. Rozhin[2], S.K. Turitsyn[2], M.H. Ruemmeli[3]; 1 - Fiber Optics Research Center of the RAS, Russia; 2 - Aston Inst. of Photonics Technology, Aston Univ., UK; 3 - IFW Dresden, Germany;

Thulium-doped fiber laser mode-locked by nonlinear polarization evolution and single- walled carbon nanotubes operates at 9.5 MHz repetition rate with 17.5% efficiency. Laser generates 500-fs pulses with 10.87-nJ pulse energy and 21.7-kW pulse peak power.

TuR1-14 **19:00-19:15**

A RF standard based on a longitudinal modes beat note of a frequency locked laser

V.M. Polyakov[1], E.A. Viktorov[1], A.V. Kovalev[1], O. Orlov[2]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Mendeleyev Inst. for Metrology, Russia;

We demonstrate a new approach to designing a compact RF standard based on longitudinal mode beating. We use frequency doubled Nd:YVO4 laser operating in mode-locked regime stabilized to hyperfine transitions in molecular iodine. A similar system is used for estimating the standard Allan deviation of RF signal which is 2.1 x 10–14 at the time 100 s.

TuR1-15 **19:15-19:30**

Cavitation and shock waves in water, stimulated by laser filament

F.V. Potemkin, E.I. Mareev; Lomonosov Moscow State Univ., Russia;

Using shadow photography technique we have observed shock acoustic wave from optical breakdown, excited in water by tightly focused Cr:Forsterite femtosecond laser beam, and have found two different regimes of shock wave generation by varying only the energy of laser pulse. From shadow pictures we also estimated maximal velocity in the shock wave front of 3200±150m/s and pressure of 240±30 MPa.

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

Pudovkin Hall

Session Chairs: *09:00-11:00 E.U. Rafailov, Aston Univ., UK*
11:30-13:30 J.H. Marsh, School of Engineering, Univ. of Glasgow; UK

TuR3-01 Invited **09:00-09:30**

Mode-Locked Semiconductor Lasers: from Giga-Hertz to Tera-Hertz

J.H. Marsh, L. Hou; School of Engineering, Univ. of Glasgow; UK

Mode-locked lasers operating at 1.5 microns are described, in particular the evolution in the laser design as the mode-locked frequency is increased from ~10 GHz to 1.4 THz. Novel DBR constructions and nonlinear conversion are required to reach the highest frequencies.

TuR3-02 Invited **09:30-10:00**

Intradot Relaxation and Modulation Bandwidth in Quantum Dot Lasers

L.V. Asryan[1], Yu. Wu[1], R.A. Suris[2]; 1 - Virginia Polytechnic Inst. and State Univ., USA; 2 - Ioffe Physical Technical Inst. of RAS, Russia;

Excited-to-ground-state relaxation delay in quantum dots is shown to strongly limit the ground-state modulation bandwidth of a quantum dot laser. The longest tolerable intradot relaxation time exists, beyond which the direct modulation of the laser optical output becomes impossible.

TuR3-03 Invited **10:00-10:30**

Dynamics of semiconductor ring lasers and its applications

J. Danckaert, R.M. Nguimdo, M. Khoder, L. Mashal, W. Coomans, S.K. Takougang, L. Gelens, G. Van der Sande, G. Verschaffelt; Vrije Univ. Brussel, Belgium;

Our contribution reviews the nonlinear dynamical behavior of single transverse mode SRLs, putting emphasis on the experimentally observable dynamic features that are often a consequence of the ring symmetry.

TuR3-04 **10:30-10:45**

Dynamical interplay between ground and excited states in quantum dot laser

G.S.Sokolovskii[1], V.V.Dudelev[1], E.D.Kolykhalova[2], A.G.Deryagin[1], A. Bakoz[3], I.I.Novikov[1], M.V.Maximov[1], A.E.Zhukov[4], V.M.Ustinov[1], V.I.Kuchinskii[1], W.Sibbett[5], E.U.Rafailov[6], E.A.Viktorov[3,7], T.Erneux[7]; 1 - Ioffe Physical Technical Inst. of RAS, 2 - St.Petersburg State Electrotechnical Univ. "LETI", 3 - St.Petersburg National Research Univ. of ITMO, 4 - Academic Univ., Russia; 5 - Univ. of St.Andrews, 6 - Aston Univ., UK; 7 Univ. libre de Bruxelles, Belgium.

We study damping relaxation oscillations in QD laser simultaneously operating at two transitions, and find that under various pumping conditions, the frequency of oscillations may decrease, increase or stay without change in time.

TuR3-05 **10:45-11:00**

Dynamics of frequency swept sources

B. Kelleher[1,2], S. Slepneva[1,2], B. O'Shaughnessy[1,2], S.P. Hegarty[2], A. Vladimirov[3], G. Huyet[1,2]; 1 - Cork Inst. of Technology, 2 - Univ. College Cork, Ireland; 3 - Weierstrass Inst. for Applied Analysis and Stochastics, Germany;

An analysis of the dynamical features in the output of two swept source lasers are presented. An experimental study of the wavelength sweep-direction asymmetry in the output of these devices is undertaken. A mathematical model based on a set of delay differential equations is developed and shown to agree well with experiment.

-COFFEE BREAK -

TuR3-07 Invited **11:30-12:00**

Using SESAMs as fast opto-optical modulators for low-noise CEO stabilization of ultrafast lasers

S. Schilt, M. Hoffmann, Th. Südmeyer; Univ. de Neuchâtel, Switzerland;

We present a CEO-stabilization technique based on optical feedback to an intra-cavity SESAM with significantly improved bandwidth compared to standard pump current control, enabling a CEO-locked Er:Yb:glass laser with ten times lower residual phase noise.

TuR3-06 Invited **12:00-12:30**

Experimental Observation for New Polymorphs of Silicon Formed through Ultrafast- Laser-Induced Microexplosion

L. Rapp[1], B. Haberl[2], Ch. Pickard[3], J.E. Bradby[2], E.G. Gamaly[1], J.S. Williams[2], A.V. Rode 1; 1,2 - The Australian National Univ., Australia; 3 - Univ. College London, UK;

In this presentation the new experimental results evidencing the formation of novel structures in laser-induced confined micro-explosion in silicon will be highlighted. Electron diffraction pattern of the shock wave isochorically affected areas reveals the presence of a mixture of silicon phases with a number of previously unidentified diffraction spots. Indexation of the diffraction patterns from various microexplosion sites demonstrate close correlation between the numerically predicted phases and the observed diffracted spots.

TuR3-08 **12:30-12:45**

Semiconductor lasers with fast broadband tuning in 750-1100 nm spectral range

M.V. Shramenko[1], A.Yu.Chamorovskiy[1], A.A. Lobintsov[1], S.D. Yakubovich[2]; 1 - Superlum, Cork, Ireland; Superlum Moscow, Russia; 2 - MSTU MIREA, Russia;

A series of tunable lasers of the 750-1100 nm spectral range is developed based on the novel broadband semiconductor optical amplifiers (SOAs) and acousto-optic tunable filters (AOTFs) in an external fiber ring cavity. Mode-hop free tuning ranges of up to 100 nm and tuning speeds of up to 105 nm/s are demonstrated. Instantaneous linewidths in the range of 0.05-0.15 nm, side-mode suppression of more than 50 dB and polarization extinction ratio of more than 18 dB are observed. Output optical power of 1-3 mW in single-mode fiber can be further amplified up to 30 mW utilizing external amplification based on the same SOAs.

TuR3-09 **12:45-13:00**

200 Mbps Real-time True Random Bit Generator Based on Polarization Noise in a VCSEL

V.N. Chizhevsky[1], A.S. Maloshtan[1], A.V. Glejm[2]; 1 - Stepanov Inst. of Physics of NAS, Belarus, 2 - St.Petersburg National Research Univ. of ITMO, Quantum Communications Ltd, Russia;

We report a prototype of real-time physical true random bit generator based on a polarization noise in a vertical-cavity surface-emitting laser (VCSEL) with a bit rate more than 200 Mbps. A comprehensive statistical analysis of bits sequences performed by means of three standard tests of randomness (ENT, Diehard and NIST) shows a high quality of generated random bit sequences.

TuR3-10 **13:00-13:15**

Optimization of laser heterostructures for mid-infrared

L.V. Danilov, G.G. Zegrya; Ioffe Physical Technical Inst. of RAS, Russia;

Theoretical analysis of radiative and non-radiative recombination in deep QWs was done and the design of new mid-IR lasers with high quantum efficiency was proposed.

TuR3-11 **13:15-13:30**

Epitaxially intergrated power efficient switch for high power laser pulse generation in semiconductor heterostructures of 900 nm wavelength

S.O. Slipchenko[1], A.A. Podoskin[1], A.V. Rozhkov[1], N.A. Pikhtin[1], I.S. Tarasov[1], T.A. Bagaev[2], M.V. Zverkov[2], V.P. Konyaev[2], Y.V. Kurniavko[2], M.A. Ladugin[2], A.A. Marmalyuk[2], A.A. Padalitsa[2], V.A. Simakov[2]; 1 - Ioffe Physical Technical Inst. of RAS; 2 - RDI "Polyus", Russia;

New type of high power laser pulse generator of ns-range duration based on epitaxial intergration of laser heterostructure into thyristor heterostructure has been investigated. Generation of laser pulse of 28W amplitude is done by applying a control current pulse with amplitude of 3.4 A/cm2 only. The minimal energy of control signal reaches 1,4 nJ.

-BREAK FOR LUNCH -

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

Pudovkin Hall

Session Chairs: *15:00-17:00 G. Huyet, Tyndall National Inst. and Cork Inst. of Techn., Ireland*
17:30-18:45 G.S. Sokolovskii, Ioffe Physical-Technical Inst. of RAS, Russia

TuR3-12 Invited **15:00-15:30**

II-VI/III-N based micro-chip green-yellow laser converters

S.V. Ivanov[1], S.V. Sorokin[1], S.V. Gronin[1], I.V. Sedova[1], A.G. Vainilovich[2], E.V. Lutsenko[2]; 1 - Ioffe Physical Technical Inst. of RAS, Russia; 2 - Stepanov Inst. of Physics of NAS, Belarus;

We report on recent progress in developing green-yellow II-VI/III-N laser converters comprising low-threshold (nGaN LD, mounted in a micro-chip package. Novel design and technological approaches in further reducing threshold power density of the II-VI structures and extending their wavelength to yellow range are discussed.

TuR3-13 Invited **15:30-16:00**

Nonlinear optics with diode lasers

F. Laurell, KTH, Sweden;

Diode lasers are under constant development and we see broader spectral coverage, increased output power and higher reliability. Nonlinear optical applications sets special requirement on the laser source, which not always are easily compatible with diode lasers. In this presentation a review will be given of the possibilities and difficulties of using diode lasers in nonlinear optics.

TuR3-14 **16:00-16:15**

73 nm wavelength tuning from a frequency-doubled quantum-dot laser in PPKTP waveguides

K.A. Fedorova[1,2], G.S. Sokolovskii[2], Ph.R. Battle[3], D.A. Livshits[4], E.U. Rafailov[1]; 1 - Aston Univ., UK, 2 - Ioffe Physical Technical Inst. of RAS, Russia; 3 - AdvR Inc, USA; 4 - Innolume GmbH, Germany;

A compact all-room-temperature CW 73-nm tunable laser source in the visible spectral region (574nm-647nm) has been demonstrated by frequency-doubling of a broadly-tunable InAs/GaAs quantum dot external-cavity diode laser in periodically-poled potassium titanyl phosphate waveguides with a maximum output power in excess of 12mW and a maximum conversion efficiency exceeding 10%. Three waveguides with different cross-sectional areas (4x4μm2, 3x5μm2 and 2x6μm2) were investigated.

TuR3-15 **16:15-16:30**

Novel Evaluation Procedure for Internal and Extraction Efficiency of High-Power Blue LEDs

I.E. Titkov[1], A. Yadav[1], V.L. Zerova[1], M. Zulonas[1], E.U. Rafailov[1], S.Yu. Karpov[2], M. Strassburg[3], I. Pietzonka[3], H.-J. Lugauer[3], B. Galler[3]; 1 - Aston Univ., UK; 2 - STR Group – Soft-Impact Ltd, Russia; 3 - Novel Technologies, Germany;

Internal quantum efficiency (IQE) of a high-brightness InGaN/GaN blue LED was evaluated from the external quantum efficiency measured as a function of current at the room temperature. Processing the data with a novel evaluation procedure based on the ABC-model, we have determined IQE of the LED structure and light extraction efficiency of UX:3 chip.

TuR3-16 **16:30-16:45**

Semiconductor disk laser with a semiconductor-dielectric-metal mirror

A. Rantamäki, E.J. Saarinen, J. Lyytikäinen, K. Lahtonen, M. Valden, O.G. Okhotnikov; Optoelectronics Research Centre, Tampere Univ. of Technology; Finland

We present optically pumped semiconductor disk lasers with a thin dielectric layer placed between the semiconductor distributed Bragg reflector and the metallization interface. The thin dielectric layer is shown to introduce negligible penalty to the thermal resistance of the device while allowing high reflectivity with a reduced number of distributed Bragg reflector layer pairs.

TuR3-17 **16:45-17:00**

Improvement of light-current characteristic linearity in a quantum well laser with asymmetric barriers

F.I. Zubov[1], A.E. Zhukov[1], Yu.M. Shernyakov[1], M.V. Maximov[1], N.V. Kryzhanovskaya[1], L.V. Asryan[2], E.S. Semenova[3], K. Yvind 3; 1 - St.Petersburg Academic Univ., Russia; 2 - Virginia Polytechnic Inst. and State Univ., USA;

The effect of asymmetric barriers on the light-current characteristic of a quantum well laser was studied theoretically and experimentally. It is shown that the utilization of asymmetric barriers in a waveguide prevents the nonlinearity of light-current characteristic and, consequently, allows rising of the maximum output power.

-COFFEE BREAK -

TuR3-19 Invited **17:30-18:00**

Towards THz-Class Pulse Train Semiconductor Disk Lasers

O.G. Okhotnikov, E.J. Saarinen; Optoelectronics Research Centre, Tampere Univ. of Technology, Finland

The potential of scaling up the pulse repetition rate of semiconductor disk lasers through harmonic mode locking has been discussed. The unprecedented ultracoarse frequency comb shaped with an intracavity etalon integrated with a semiconductor mirror would improve the accuracy and speed of optical switching and applications dealing with waveform manipulation.

TuR3-20 Invited **18:00-18:30**

Engineering Quantum Cascade Lasers as single-mode, regular beam profile and narrow-linewidth source across the far-infrared

M.S. Vitiello, NEST, CNR - Inst. Nanoscienze and Scuola Normale Superiore, Italy;

Recent advances on quasi-crystal or distributed feedback Terahertz quantum cascade laser with quantum limited linewidths and high-power performance will be discussed.

TuR3-21 **18:30-18:45**

Quantum Dot-Based Terahertz Photoconductive Antennas

A. Gorodetsky[1], R.R. Leyman[2], E.U. Rafailov[1]; 1 - Aston Univ., 2 - Univ. of Glasgow, UK;

We present novel Terahertz (THz) emitting optically pumped quantum qot photoconductive materials and antenna structures on their basis both for pulsed and CW pumping regimes.

R4. LASER BEAM CONTROL

Stenberg 1 Hall

Session Chairs: *15:00-17:00 V.P. Lukin; Inst. of Atmospheric Optics of SB RAS, Russia*
17:30-19:30 P. Artal; Univ. de Murcia, Spain

TuR4-01 Invited **15:00-15:30**

Adaptive optics for pulse shaping and image optimization

S. Bonora, Inst. of Nanotechnologies and Photonics, Italy;

Abstract is not available.

TuR4-02 Invited **15:30-16:00**

Adaptive optics: the future of visual testing

P. Artal; Univ. de Murcia, Spain;

Adaptive optics allows to manipulate optical wavefronts reaching the eye and perform non invasive visual testing. A revision of the history of this emerging field and the current state of the art will be presented.

TuR4-03 Invited **16:00-16:30**

Thermal-piezoelectric deformable mirror (TPDM) for high power lasers

C. Reinlein, M. Appelfelder; Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany;

We introduce the 2nd generation TPDM with piezoelectric and thermal actuator functionality. Additionally, TPDM feature buried temperature sensors to enable the control of laser-induced thermal lensing. We will give the results of the characterization of the piezoelectric and thermal actuators including the temporal behavior.

TuR4-04 Invited **16:30-17:00**

Closed loop adaptive system with Hartmann wavefront sensor for CO2 laser radiation correction

A. Kudryashov[1], A. Alexandrov[1], V. Samarkin[1], A. Rukosuev[1], P. Galarneau[2]; 1 - Moscow Univ. of Mechanical Engineering, Russia; 2 - INO, Canada;

We present the results of co2 laser beam correction by means of adaptive optics.

-COFFEE BREAK -

TuR4-05 **17:30-17:45**

Experimental and theoretical study of thin plate uniform, bimorph and membrane adaptive mirrors, which reflecting surface is under deformable control by piezoceramic and magnetostrictive actuators

S.A. Chetkin 1. A.B. Egorov[1], A.G. Safronov[2]; 1 - Prokhorov General Physics Inst. of RAS; 2 - New Energy Technologies LLC, Russia;

We discuss an experimentally determined characteristics of: the developed 21 - actuator piezoceramic bimorph mirror; a mirror on the periphery as a clamped thin plate with 5 point like discrete piezo actuator; a deformable mirror in the form of a thin plate with a free edge, based on a circular internal support with 12 point like discrete magnetostrictive actuators; and a single-channel membrane deformable mirror with a reflective surface of the variable curvature. We consider the efficiency of their application for correction of stationary and dynamic phase distortions of light waves.

TuR4-06 **17:45-18:00**

Phase correction of laser beam passed through turbid medium

I. Galaktionov, J. Sheldakova, A. Kudryashov; Moscow State Univ. of Mechanical Engineering, Russia;

Model of laser beam propagation in turbid medium with variable parameters was suggested. Phase and intensity distribution of scattered light with different wavelengths and various whether conditions (particles sizes, concentrations, refractive indices and medium depths) were obtained.

TuR4-07 Invited **18:00-18:30**

Turbulence as a resource in Quantum Communications

G. Vallone, A. Dall'Arche, D. Bacco, D. Marangon, M. Tomasin,F. Gerlin, M. Canale, N. Laurenti, P. Villoresi; Univ. of Padova, Italy;

The study of optimal design of Quantum Communications (QC) transmitter optics has been tested on very long links, including the 144 km path between Tenerife and La Palma Islands. Schemes for the aiming and the turbulence mitigation has been devised for the purpose of advancing QC in free space and toward space channels.

TuR4-08 Invited **18:30-19:00**

The digital laser

A. Forbes, National Laser Centre, South Africa;

In this talk I will recap the steps towards creating the world's first digital laser. The digital laser has a small LCD screen as one of the laser mirrors. This means that changing a picture on the screen immediately changes the properties of the light that comes out of the laser. This is a significant departure from the standard laser design where the output is fixed. To illustrate the paradigm shift required, we play a movie inside a laser for the first time, and observe a dynamically changing output beam. I will discuss what the future might hold for this new technology.

TuR4-09 **19:00-19:15**

Gain Controlling Method Based on Electro-Optical Switch for ASE Suppression of Excimer Laser

Yu. Hu, X. Zhao, D. Wang, Yo. Zhu, Yo. Zhang; Northwest Inst. of Nuclear Technology, P.R. China

Combination of electro-optical switch and gain controlling method was used for ASE suppression in high power excimer laser system. Signal contrast ratio up to 40300:1 was obtained for the second pre-amplifier. This method can achieve ASE suppression at both front and back edge of the waveform simultaneously, with less energy loss and no further damage threshold request.

TuR4-10 **19:15-19:30**

Automatic alignment of angularly multiplexed beams in excimer laser MOPA system

D. Wang, H. Qian, L. Ma, X. Zhao,Yo. Zhang, G. Feng, B. Shao, A. Yi, Ju. Zhao; Northwest Inst. of Nuclear Technology, P.R. China

Study on multiplexed beams automatic alignment of high efficiency excimer laser is described. Experiments are carried out in pre- amplifier II with three beams and double passes in excimer laser MOPA system. Results indicate that the error of the automatic alignment beam is 0.54% of the diameter of the windows. Meanwhile, the whole process of automatic alignment just takes 40 seconds, which achieve the aim of intelligent and high effective integration of automatic alignment system.

R6. NANOPHOTONICS AND BIOPHOTONICS

Deyneka Hall

Session Chairs: 09:30-13:30 I.M. Belousova, Vavilov State Optical Inst., Russia

TuR6-01 Invited **09:30-10:00**

Nanocarbon-Based Materials for Non-Linear Optical Applications and Ultrafast Laser Applications

A.A. Murray, J.J. Magan, W.J. Blau; Trinity College Dublin, Ireland;

Femtosecond and nanosecond optical saturation and optical limiting is measured in a range of nanocarbon and nanohybrid materials. Significant enhancement effects are observed in quasi-periodic plasmonic structures.

TuR6-02 Invited **10:00-10:30**

Carbon Nanotubes photonics: towards integrated LASER

A. Noury[1], X. Le Roux[1], E. Gaufrès[2], L. Vivien[1], N. Izard[1]; 1 - Univ. Paris Sud, France; 2 - Univ. de Montréal, Canada;

Semiconducting carbon nanotubes were successfully extracted by polymer assisted ultracentrifugation method. Carbon nanotubes' photoluminescence was highly enhanced by this process, and few-chiralities sorting was achieved. Under such extraction conditions, optical gain was demonstrated. Such an optical-quality material was then integrated on silicon photonic waveguide, while maintaining excellent emission properties. Stability of the emission was studied, and we concluded over promising integrability, with coupling efficiency as high as 10%. Finally, we integrated carbon nanotubes on ring resonators. We demonstrated that carbon nanotubes' emission was highly enhanced, with photoluminescence quality factors as high as 4000, which is the highest reported value so far.

TuR6-03 Invited **10:30-11:00**

Linear and non-linear optical properties of filled single-wall carbon nanotubes

E.D. Obraztsova[1], A.A. Tonkikh[2], P.V. Fedotov[1], A.S. Alekseev[1], P.A. Obraztsov[1], V.I. Tsebro[2], K. Kaunisto[3], A.G. Nasibulin[4], E.I. Kauppinen[4], A.L.Chuvilin[5]; 1 - Prokhorov General Physics Inst. of RAS, 2 - Lebedev Physical Inst. of RAS, Russia; 3 - Technical Univ. of Tampere, 4 - Aalto Univ., Finland; 5 - CIC nanoGUNE Consolider, Spain;

A new approach for modification of optical and electronic properties of single-wall carbon nanotube films via a gas phase filling of nanotubes with the stranger acceptor molecules (iodine, CuCl) is presented. The modified films are characterized by techniques of linear (UV-vis- NIR optical absorption and Raman scattering) and non-linear (pump-probe) optical spectroscopy.

-COFFEE BREAK -

TuR6-05 Invited **11:30-12:00**

Photo-physical processes in systems containing SWCNT-based hybrids with regard to optical power limiting

A.Yu. Vlasov[1], I.M. Belousova[2], I.M. Kislyakov[3]; 1 - St.Petersburg State Univ., 2 - Vavilov State Optical Inst., 3 - St.Petersburg National Research Univ. of ITMO, Russia;

We report on the optical power limiting phenomena in fluid systems containing binary hybrid photo-active agents on the platform of SWCNTs in fluid matrices.

TuR6-06 Invited **12:00-12:30**

Angle restriction of photon emission for ultraefficient photovoltaics: experimental proof of concept

E.A. Katz[1], A. Braun[1], D. Feuermann[1], J.M. Gordon[1], B.M. Kayes[2]; 1 - Ben-Gurion Univ. of the Negev, Israel; 2 - Alta Devices Inc., USA;

Experimental evidence of enhancing the performance of ultra-efficient solar cells by external recycling of photon emission is presented – predicated on the strategy of increasing cell open-circuit voltage by reducing radiative recombination. It is equivalent to restricting the angular range of photon emission, and can only be effective in photovoltaics with high external luminescent efficiency. This has precluded the voltage enhancement from being observable in today's photovoltaic technologies. As shown here, however, it is attainable with the latest generation of champion single-junction one-sun thin-film GaAs cells. The measurements are understandable in terms of basic photovoltaic thermodynamics.

TuR6-07 Invited **12:30-13:00**

Hybrid structures of shungite nanocarbon

N.N. Rozhkova, S.S.Rozhkov, A.A. Mikhailina; Inst. of Geology Karelian Research Centre of RAS, Russia;

The condensation of aqueous shungite carbon (ShC) nanoparticles dispersion was accompanied by the formation of a 3-dimensional net with nodules in the form of distinct globules. The globules are formed of nonplanar graphenes ~ 1 nm, kept together due to the confined water. Substitution of water by non-polar molecular solvents transforms globules into stacks and flakes. The dispersion was used in preparation of ShC hybrids. Structural and physical chemical properties of the new hybrid materials would be discussed.

TuR6-08 Invited **13:00-13:30**

Practical Limits of Excimer Laser Lithography/ Advanced Optical Technologies in fabrication of 20nm, 14nm and 10nm IC structures using 193nm Eximer Laser Projection Imaging

E. Barash[1], R.P. Seisyan[2]; 1 - GLOBALFOUNDRIES, USA, 2 - Ioffe Physical Technical Inst., Russia;

The End of Optical Lithography domination has been announced many times over last 3 decades and every time it was premature. KrF Eximer Laser Lithography extended feature size to a sub-wavelength dimension; ArF Eximer Laser scanners continued Moor's Law thru 65nm technology node; immersion ArF Eximer Laser technologies increased NA up to 1.35 and enabled 32nm technology node, at which point both wavelength shortening and NA limits were reached. Combination of Light Source and reticle target optimization (SMO), Reticle Enhancement Technologies, new resist films and double/triple patterning will extend Eximer Laser Patterning to 20nm, 14nm and perhaps 10nm – challenges and trade-offs will be discussed in this presentation.

-BREAK FOR LUNCH -

R6. NANOPHOTONICS AND BIOPHOTONICS

Deyneka Hall

Session Chair: 15:00-18:45 E.A. Katz, Department of Solar Energy and Environmental Physics, Ben-Gurion Univ. of the Negev, Israel

TuR6-09 **15:00-15:15**

Scaling reciprocal of nanotubes aggregation degree in aqueous suspensions against nonlinear optical properties of the systems

A. Venediktova[1], E. Obraztsova[2], D. Videnichev[3], E. Katz[4]; 1 - St.Petersburg State Univ., 2 - Prokhorov General Physics Inst. of RAS, 3 - Vavilov State Optical Inst., Russia; 4 - Ben Gurion Univ. of the Negev, Israel;

Nonlinear optical limiting of suspensions of single-wall carbon nanotubes with varied degree of debundling and various stabilizing surfactants has been studied.

TuR6-10 **15:15-15:30**

Nonlinear optical properties of pyrrolic organic dyes

M. Hatamimoslehabadi, Ch.S. Yelleswarapu, M. Frenette, J. Rochford; Univ. of Massachusetts Boston, USA;

Synthesizing materials with enhanced third order nonlinear optical parameters has been of great interest in view of many practical applications. We have developed a series of pyrrolic compounds based on BODIPY chromophores and studied their nonlinear optical properties using the z-scan technique. Results show that the new compound – MeO2BODIPY has a greater nonlinear absorption coefficient compared to a standard pyrrolic dye material such as zinc-phthalocyanine

TuR6-11 **15:30-15:45**

Nonlinear multilayer Fabry-Perot resonators as narrowband optical limiters

A.A. Ryzhov, I.M. Belousova, G.A. Muranova; Vavilov State Optical Inst., Russia;

Multilayer structures which can be considered as one-dimensional photonic crystals are very promising in the context of low-threshold nonlinear optical devices. That generally takes place by the two reasons: local multiple enhancing of optical field in crystal defects and sharp spectral characteristics of such structures. Multilayer Fabry-Perot resonators have been theoretically and experimentally studied as narrowband optical limiters.

TuR6-12 **15:45-16:00**

Self-assembled PbS QDs of different size

E.V. Ushakova[1], V.V. Golubkov[2], A.P. Litvin[1], P.S. Parfenov[1], S.A. Cherevkov [1], A.V. Fedorov[1], A.V. Baranov[1]; 1 - St.Petersburg National Research Univ. of ITMO; 2 - Inst. of Silicate Chemistry RAS, Russia;

In this work self-organized nanostructures from PbS quantum dots of different size, fabricated by the evaporation of solvent on the mica substrate, are investigated. It is shown that, the obtained structures posses SAXS patterns similar to ones from real atomic crystals.

TuR6-13 **16:00-16:15**

Magneto-optic effects in microstructured fiber with ferrofluid cladding in the pulsed mode

P.M. Agruzov[1], I.V. Pleshakov[1], E.E. Bibik[2], A.V. Shamray[1]; 1 - Ioffe Physical Technical Inst. of RAS, 2 - St.Petersburg State Inst. of Technology, Russia;

Studies of the pulse response of magneto-optic effects in a silica-core microstructured fiber with a ferrofluid-filled cladding are reported. Both the even and odd magneto-optic effects were investigated in the longitudinal magnetic field geometry. It was found that the rise and fall times of the even field effect were 12 and 20 microseconds respectively, and the odd effect rise time was below 2 microseconds.

TuR6-14 **16:15-16:30**

Laser formation of collodial alloys of the noble nanoparticles and deposition of the microclusters on the glass substrate

A. Kucherik[1], A. Antipov,[1], S. Arakelian[1], S. Kutrovskaya[1], K. Khorkov[1], A. Povolotckaia[2], A. Povolotskiy[2], A. Manshina[2]; 1 - Stoletov's Vladimir State Univ., 2 - St.Petersburg State Univ., Russia;

In this work, a method for the formation of Au, Ag and bimetallic Au-Ag clusters on the surface of an optically transparent media is discussed. Nanoparticles of noble metals were obtained by laser ablation targets of gold and silver in liquid.

TuR6-15 **16:30-16:45**

Studies of short pulse propagation in 1D porous silicon based photonic crystals with spatially modulated photonic band gap

D.A. Kopylov, E.A. Mamonov, S.E. Svyakhovskiy, A.I. Maydykovsky; Lomonosov Moscow State Univ., Russia;

We study the propagation and periodical regeneration of short laser pulses in 1D porous silicon based photonic crystals (PC) with spatially modulated photonic band gap. The effective potential of this PC is analogous to that of an optical harmonic oscillator. The results of computer simulations of this effect and optical properties of the composed PC with the corresponding photonic band gap are discussed.

TuR6-16 **16:45-17:00**

Rayleigh-Wood's Resonances in the Near-Field Scattering by Periodic Array of Nanowires

L.L. Frumin[1,2], A.V. Nemykin[1,2], D.A. Shapiro[1,2], S.V. Perminov[3]; 1 - Inst. of Automation and Electrometry of SB RAS, 2 - Novosibirsk State Univ., 3 - Rzhanov Inst. of Semiconductor Physics of SB RAS, Russia;

The results of both analytical and numerical calculations of the light scattering by periodic array (either finite or infinite) of gold nanocylinders are compared. Surprisingly, the dipole approximation appears to be well applicable down to the distance between the cylinders only twice exceeding their diameter.

-COFFEE BREAK -

TuR6-17 Invited **17:30-18:00**

Optics of thin composite films: plasmon enhanced resonance response or coupling induced shift of the plasmon band?

T.A. Vartanyan, A.O. Orlova; St.Petersburg National Research Univ. of ITMO, Russia;

Planar arrays of silver nanoparticles covered by thin layers of organic dye molecules or semiconductor quantum dots are investigated from the point of view of electrodynamics interactions between the constituents of the composite films.

TuR6-18 **18:00-18:15**

Spectral mapping, tracking and utilizing

S. Kudryashov, P. Danilov, A. Ionin, S. Makarov, P. Saltuganov, L. Seleznev, E. Sunchugasheva, V. Yurovskikh, D. Zayarny; Lebedev Physical Inst. of RAS, Russia;

Intense femtosecond laser excitation of materials surfaces enabled spectral mapping of their narrow and strongly dissipative surface plasmon resonances, their tracking with femtosecond supercontinuum radiation and utinlizing for ultimate surface nanostructuring.

TuR6-19 **18:15-18:30**

Optical Multiple Bistability in Metal-Insulator-Metal Plasmonic Waveguides Side- coupled with Twin Resonators

R.-Ch. Shiu,1,2 Yu.-Ch. Lan[2], G.-Yu Guo[1]; 1 - National Taiwan Univ., 2 - National Cheng Kung Univ, Taiwan;

In this contribution, multi-bistable effect in two third-order non-linear optical resonators side-coupled to a metal-insulator-metal plasmonic waveguide is demonstrated theoretically.

TuR6-20 **18:30-18:45**

Parabolic-like nanoantennas fabrication by femtosecond laser pulses for strong-field plasmonics

M.A. Gubko[1], A.A. Ionin[1], S.I. Kudryashov[1], S.V. Makarov[1], A.A. Rudenko[1], L.V. Seleznev[1], D.V. Sinitsyn[1], I.V. Treshin[1], W. Husinsky[2], C.S.R. Nathala[2]; 1 - Lebedev Physical Inst. of RAS, Russia; 2 - Vienna Univ. of Technology, Austria;

We have demonstrated for the first time that an array of nanoantennas on an aluminum surface, fabricated using a double-pulse femtosecond laser irradiation scheme, results in a 28- fold enhancement of electron photoemission yield, driven by a third femtosecond laser pulse. The numerical electrodynamic modeling indicates that the electron emission is increased owing to instant local electromagnetic field enhancement near the nanoantenna, contributed by both the tip's "lightning rod" effect and the focusing effect of the pit as a microreflector in parabolic nanoantenna.

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

Petrov-Vodkin 1 Hall

Session Chair: 09:00-13:30 A. Chipouline; FSU Jena; Germany

TuR8-01 Invited **09:00-09:30**

Optical Parametric Amplifiers for Communications

K.J. Blow; Aston Univ., UK;

In this talk I will discuss the prospects for using optical parametric amplifiers in multi channel transmission systems. The low dispersion required for gain also phase matches inter channel four wave mixing which will limit multi channel system performance. I will begin by reviewing their quantum properties. I will also show that a classical numerical simulation can reproduce the quantum result for the noise figure.

TuR8-02 **09:30-09:45**

Nonstationary coherent optical effects in acetylene-filled hollow core photonic crystal fibers

M. Ocegueda[1], E. Hernandez[1], P. Agruzov[2], A. Shamray[2], S. Stepanov[1]; 1 - CICESE, Mexico; 2 - Ioffe Physical Technical Inst. of RAS, Russia;

We report studies of the nonstationary coherent effects, i.e., free optical induction, optical nutation, and photon echo, in a hollow-core photonic crystal fiber filled with acetylene. Nanosecond optical pulses were used in the experiments. The transverse relaxation time was estimated to be about 3 nanoseconds.

TuR8-04 **09:45-10:00**

Cooperative Rayleigh-Brillouin scattering in long optical fibers

A.A. Fotiadi[1], I. Lobach[2], P. Mégret[1]; 1 - Univ. of Mons, Belgium; 2 - Inst. of Automation and Electrometry of SB RAS, Russia;

We report on experimental and theoretical studies of random lasing achieved in optical fibers due to Brillouin amplification and Rayleigh backscattering employed as a distributed feedback instead of a cavity mirror. The observed competition between classical Brillouin scattering and Brillouin lasing is explained as the effects of external acoustic and temperature noise. The model of Brillouin - Rayleigh cooperative process taking into account the environment noise is discussed.

TuR8-05 **10:00-10:15**

Thermal enhancement of optical harmonic generation in a fiber-coupled nematic liquid crystal

S.I. Trashkeev[1], B.N. Nyushkov[1,2]; 1 - Inst. of Laser Physics of SB RAS, 2 - Novosibirsk State Univ., Russia;

The temperature impact on the optical harmonic generation in a fiber-coupled nematic liquid crystal (NLC) pumped by femtosecond laser radiation was explored. A strong thermal enhancement of the third harmonic generation (THG) was revealed. Upon heating to a certain temperature (near the upper limit of the mesophase), the NLC-based convertor features a spike of the THG efficiency in excess of 10%. This effect may be attributed to non-critical phase matching. Also appreciable forth harmonic generation in the ultraviolet occurred upon the thermal enhancement of THG.

TuR8-06 **10:15-10:30**

Effect of SBS on the dynamics of ring fiber laser

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

Oscillations of the intensities of oppositely running weak-coupled waves in ring fiber laser due to generation SBS components is investigated using full space time numerical model.

TuR8-07 **10:30-10:45**

Vector Solitons with Fast and Slowly Evolving States of Polarization in Mode Locked Fiber Lasers

S.V. Sergeyev[1], T. Habruseva[1], V. Tsatourian[1], Ch. Mou[1], G. Jacobsen[2], S. Popov[3], S.K. Turitsyn[3]; 1 - AIPT, Aston Univ., UK; 2 - Acreo, Sweden; 3 - KTH, Sweden;

Our experimental and theoretical study reveal new families of vector solitons for fundamental, multi-pulsing, harmonically mode locked and bound-state soliton operations in erbium doped fiber laser mode locked with carbon nanotubes.

TuR8-09 **10:45-11:00**

HgGa2S4 optical parametric oscillator

N.Yu. Dukhovnikova[1,2], A.A. Boyko[1], K.G. Zenov[1], D.B. Kolker[1], I.V. Sherstov[1], I.B. Miroshnichenko[1], M.K. Starikova[1], A.A. Karapuzikov[1], A.I. Karapuzikov[1], Yu.V. Kistenyov[3], D.A.Kuzmin[3]; 1 - Special Technology, LTD, 2 - Novosibirsk State Technical Univ., 3 - Siberian State Medical Univ., Russia;

We report about nanosecond HgGa2S4 optical parametric oscillator is pumped by Nd:YLF laser. The wide tuning range (4.2-10.73 μm) is provided by paired utilization of two HgGa2S4 crystals. The auto calibration system based on multi-component gas reference photoacoustic cell is applied.

-COFFEE BREAK -

TuR8-08 Invited **11:30-12:00**

Self-phase modulation in lithium niobate waveguides

R. Schiek; OTH Regensburg, Germany;

Self-phase modulation in lithium niobate waveguides with cascaded quadratic and cubic nonlinearities is characterized by comparison of amplitude and phase of input and output pulse envelopes and spectra. Cubic nonlinear susceptibility coefficients of lithium niobate were determined from the measured nonlinear phase shifts.

TuR8-10 **12:00-12:15**

Two-photon interband absorption coefficients in tungstate and molybdate crystals

V.I. Lukanin, A.Ya. Karasik; Prokhorov General Physics Inst. of RAS, Russia;

Two-photon absorption coefficients were measured in tungstate and molibdate crystals using 25ps laser pumping with 523.5 nm and 349 nm wavelengths.

TuR8-11 **12:15-12:30**

Peculiarities of second harmonics generation with linearly varying wave-number mismatch along a nonlinear crystal

K. Regelskis, J. Želudevicius, V. Žvirblyte; Center for Physical Sciences & Technology (CPST), Lithuania;

We investigated the second harmonics generation when a constant gradient of the wave-number mismatch was imposed along a nonlinear crystal. Behavior of the complex amplitude of the second harmonic signal was geometrically visualized by means of the Cornu spiral. Phase-matching bandwidths and conversion efficiencies of the second harmonics generation in low-conversion approximation with and without wave-number mismatch gradient are compared.

TuR8-12 **12:30-12:45**

Narrowing of angular spectrum of second harmonic beam generated from incoherent conical pump

V. Pyragaite, P. Stanislovaitis, A. Narmonatas, V. Smilgevièius; Vilnius Univ., Lithuania

Second harmonic generation can serve for improvement of coherence in two-dimensional case. Incoherent pump beams should obey conical geometry. Then, the angular spectrum of the generated second harmonic beam narrows during the propagation in nonlinear crystal.

TuR8-13 **12:45-13:00**

Investigation of limiting properties of nonlinear materials

M.S. Savelyev, A.Yu. Gerasimenko, S.A. Tereshchenko, V.M. Podgaetsky; National Research University of Electronic Technology (MIET),

Nanocomposite and disperse optical materials based on single-walled carbon nanotubes (SWCNT) of semiconducting and metal types with a high perfection of the crystal structure were investigated. A new method of simultaneous calculation of the beam waist radius and nonlinear absorption coefficient from the Z_scan data is proposed. The value of nonlinear optical characteristics of ZnSe, porphyrin–graphene (Graphene–TPP), fullerene–graphene (Graphene–60), polyethylene oxide containing multilayer carbon nanotubes (PEO/MWNT), along with polymethine dyes PD–792 and PD–7098 and dicyanomethylene pyran dyes DCM–627 and DCM–684, are obtained.

TuR8-14 **13:00-13:15**

CO and CO2 Laser Radiation Frequency Conversion in GaSe and ZGP: Broadband Laser Source Emitting within 2.5 – 13.1 Microns

A.A. Ionin[1], I.O. Kinyaevskiy[1], Yu.M. Klimachev[1], A.A. Kotkov[1], A.Yu. Kozlov[1], Yu.M. Andreev[2], 1 - Lebedev Physical Inst. of RAS, 2 - Inst. of Monitoring of Climatic and Ecological Systems of SB RAS, Russia;

A broadband laser source with frequency conversion (sum and difference frequency generation) of CO and CO2 laser radiation in ZnGeP2 and GaSe nonlinear crystals emitting within 2.5-13.1 microns was developed.

TuR8-15 **13:15-13:30**

Magnetic response of thick dielectric rings

S.M. Kuznetsova, A.V. Maslov, M.I. Bakunov; Univ. of Nizhny Novgorod; Russia

We analyze the magnetic response of a dielectric ring of arbitrary width and thickness to an applied time-harmonic magnetic field. The self-consistent polarization current distribution and multiple resonances of magnetic moment are studied.

-BREAK FOR LUNCH -

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

Congress HALL

TuR8-p01 15:00-19:00

Investigation of Spectral Broadening Associated with a Raman Resonator Cavity

L.J. Henry, J. Grosek, M. Klopfer, R. Jain; Air Force Research Lab. and the Univ. of New Mexico, USA;

A large amount of spectral broadening associated with the 1121 nm resonator cavity in a dual 1069, 1178 nm seeded Raman laser system has been observed. Leakage of 1121 nm power spectrally around the fiber Bragg gratings significantly affects the performance of the laser system. Previous attempts to model the system using the nonlinear Schrödinger equation significantly under predict the amount of 1121 nm power leakage. This paper will further investigate the source of the linewidth broadening both experimentally and through modeling.

TuR8-p02 15:00-19:00

High Average Power Mid-Infrared Supercontinuum Generation in a Fluorozirconate Fiber

J. Swiderski, M. Michalska, L. Galecki; Inst. of Optoelectronics, Military Univ. of Technology; Poland

We report on mid-infrared supercontinuum generation in a step-index fluorozirconate fiber. The output power of over 5 W in a 3-octave spanning spectrum is presented.

TuR8-p03 15:00-19:00

Investigation of laser limiters based on disperse and composite nanomaterials

A.Yu. Gerasimenko, I.I. Bobrinetskiy, E.A. Gerasimenko, L.P. Ichkitidze, M.S. Savelyev, V.M. Podgaetsky, S.A. Dolgushin; Zelenograd Innovation and Technology Centre (ZITC), Russia

Work is devoted to the search new materials of laser irradiation limiter. Were created nanomaterials (dispersion and composites) for limiters based on multiwalled and single-walled carbon nanotubes. Were carried out studies of the structure of nanomaterials by atomic force microscopy. Investigated the thermal and photo - stability of the samples. Measured and calculated nonlinear optical properties of nanomaterials by direct scanning and Z- scan. A comparison of theoretical and practical nonlinear optical characteristics. And also investigated the electrical conductivity of liquid and solid nanomaterials.

TuR8-p04 15:00-19:00

Spatial oscillations of index of refraction in the atomic medium with Doppler broadening

K.A. Barantsev, A.N. Litvinov; St.Petersburg State Polytechnical Univ., Russia;

In this work we built the theory of closed scheme of excitation of the three-level atom in the optically dense medium with Doppler broadening of spectral lines. It is shown that spatial quasi-periodic dependence of the index of refraction takes place for low temperature and ebbs with increasing of temperature. We identified the temperature range in which such quasi-periodic dependence is most pronounced.

TuR8-p05 15:00-19:00

Influence of thermal deformation processes on temperature parameters of nonlinear optical frequency conversion in LBO crystal

Yu.D. Arapov[1], V.A. Dyakov[2], S.G. Grechin[3], I.V. Kasyanov[1]; 1 - RFNC – Zababakhin All-Russia Research Inst. of Technical Physics, 2 - Lomonosov Moscow State Univ., 3 - Bauman Moscow State Technical Univ., Russia;

High values and high anisotropy of thermal expansion coefficients proved to be the properties of lithium triborate (LiB3O5, LBO) crystal. The aim of this work was to measure how crystal working face varies with temperature. Our results show that the working face inclination leads to a greater change in the direction of laser radiation propagation if compared with angular phase-matching bandwidth.

TuR8-p06 09:45-10:00

Constructive interference of fundamental solitons in dispersion oscillating optical fiber

M. Dorokhova, L. Melnikov, A. Konyukhov; Yu. Gagarin State Technical Univ.of Saratov; Russia

Constructive interference of the pair of fundamental optical solitons is studied numerically. The pair of optical solitons can be converted into a single one using dispersion oscillating fiber. Under appropriate conditions the peak amplitude of output pulse is twice higher than the same for input pulses.

TuR8-p07 15:00-19:00

Vortex Mode Soliton Propagation in Graded-Index Optical Fiber with Longitudinal Inhomogeneity

M.A. Bisyarin, I.M. Oreshnikov; St.Petersburg State Univ., Russia;

Propagation of a vortex mode of a short pulse in the graded-index optical fiber is studied with an analytical technique taking into account either nonlinearity of the propagation process and longitudinal inhomogeneity of the fiber. Quantitative estimates are obtained for differences in the soliton envelope dynamics of vortex and azimuthal modes.

TuR8-p08 15:00-19:00

Two-Photon Recording of Stable Luminescent Centers in Chromone-Doped Polymer Films

A. Ayt[1], V.A. Barachevsky[1], O.I. Kobeleva[1], T.M. Valova[1], S.V. Gagarskiy[2], V.V. Kiyko[2], A.N. Sergeev[2], A.V. Veniaminov[2], V.V. Zakharov[2], M. Krayushkin[3], H. Iglev[4]; 1 - Photochemistry Center of RAS, 2 - St.Petersburg National Research Univ. of ITMO, 3 - Zelinsky Inst. of Organic Chemistry, Russia; 4 - Technical Univ. of Munich, Germany;

The study defines threshold values of energy density required for two-photon writing of stable fluorescent bit patterns within polymer layers containing chromones class chemical compounds by visual laser pulses in range of pulse widths from nanoseconds to femtoseconds. Photo-regrouping of non-luminescent chromones to fluorescent products is shown as the result of true type two-photon absorption (TPA) and stepwise TPA as well. In the latter case writing beam fluence can be reduced due to increase of the effective TPA coefficient, but laser-induced thermal damage of matrix becomes more probable too.

TuR8-p09 15:00-19:00

Impact of Kerr Effect on the Performance of Optical Invisibility Cloak Designed by Transformation Optics

P.-H. Fu, H.-Ch. Yeh, W.-Ch. Hsu, D.-W. Huang; National Taiwan Univ., Taiwan

The impact of the Kerr effect on an optical invisibility cloak designed by transformation optics is studied. For the annular cloak made of meta-materials with Kerr nonlinearity, the refractive index of the cloak may vary with the intensity of the probing electromagnetic waves. As the probing intensity increases, the refractive index distribution of the annular cloak deviates from its original optimal value. As a result, the cloaking performance of the optical invisibility cloak is impaired severely.

TuR8-p10 15:00-19:00

Thermo-Optical Properties of LBO Crystal for Angular Non-Critical Phase Matching for Second Harmonic Generation Along X Axis

Yu.D. Arapov[1], S.G. Grechin[2], I.V. Kasyanov[1]; 1 - RFNC – Zababakhin All-Russia Research Inst. of Technical Physics, 2 - Bauman Moscow State Technical Univ., Russia;

Thermo-optical parameters allow defining the temperature bandwidth of phase matching, as well as the temperature tuning characteristics. For lithium triborate (LiB3O5, LBO) crystal, there is a possibility to realize the angular non-critical phase matching for second harmonic generation (SHG) along x axis (ssf type of interaction). In this case, one observes both the maximum value of effective nonlinearity coefficient, and the high values of angular bandwidths for two angular coordinates. This possibility is realized in a wide range of wavelengths with variation of crystal temperature.

TuR8-p11 15:00-19:00

Nonlinear Polarization of Two-Level Atomic Medium in the Weak Polichromatic Field

A. Sumarokov, A. Antipov, A. Kalinichev, S. Pulkin, S. Uvarova; St.Petersburg State Univ., Russia;

The numerical solution for population difference and polarization for two - level atoms driving by polyharmonic field was made. The analytical solution for partial symmetrical case was confirmed numerical one. The results can be used for nonlinear comb - spectroscopy.

TuR8-p12 15:00-19:00

Effect of Finite Relaxation Rates and Round-trip Times on Regimes of Few-cycle Pulses in a Laser with Coherent Passive Mode-locking

M.R. Yusupov[1], N.V. Vysotina[1], N.N. Rosanov[1,2,3]; 1 - Vavilov State Optical Inst., 2 - St.Petersburg National Research Univ. of ITMO, 3 - Ioffe Physical Technical Inst. of RAS, Russia;

Generation of single or several few-cycle pulses in a laser by the technique of passive coherent mode-locking is numerically demonstrated for the case when the cavity round-trip time is comparable with the relaxation times of active (with gain) and passive (saturable absorber) media.

TuR8-p13 15:00-19:00

Quantum Fluctuations of Dark Dissipative Solitons in Wide-Aperture Nonlinear Interferometers

L.A. Nesterov[1,2], N.A. Veretenov[1,2], N.N. Rosanov[1,2,3]; 1 - Vavilov State Optical Inst., 2 - St.Petersburg National Research Univ. of ITMO, 3 - Ioffe Physical Technical Inst. of RAS, Russia;

Various types of stationary dissipative solitons in a wide-aperture interferometer with defocussing Kerr nonlinearity and cw homogeneous holding radiation are demonstrated. Quantum fluctuations of coordinate and momentum of fundamental dark solitons have been investigated. The parameter region with large value of squeezing in soliton momentum was found.

TuR8-p14 **15:00-19:00**

Stimulated Raman scattering of picosecond laser pulses at 532 nm in light and heavy water

A.I. Vodchits[1], V.A. Orlovich[1], V.S. Gorelik[2], Y.P. Voinov[2]; 1 - Stepanov Inst. of Physics of NAS, Belarus; 2 - Lebedev Physical Inst. of RAS, Russia;

Stimulated Raman scattering (SRS) of picosecond laser radiation at 532 nm in light and heavy water was studied. Raman thresholds have been determined and SRS spectra have been obtained. Several Stokes and anti-Stokes components were observed. In addition, librational modes were excited resulting in some additional Raman bands in low frequency region and also as combining tones.

TuR8-p15 **15:00-19:00**

Molybdate crystals as host for downconversion materials

D.A. Lis[1], K.A. Subbotin[1], E.V. Zharikov[2], A.V. Khomyakov[2], 1 - General Physics Inst. of RAS, 2 - Mendeleyev Univ. of Chemical Technology; Russia;

This paper presents the first results of our research of Yb-doped double molybdate crystals as a materials for down-conversion. Under the excitation of UV light, a broad emission of molybdate complexes centered at 435 nm was observed. Also we found intense Yb luminescence, i.e. excitation energy transfer from the molybdate matrix to the ytterbium ions was observed.

TuR8-p16 **15:00-19:00**

Multi-resonant optical parametric oscillator based on 2D-PPLT nonlinear photonic crystals

M. Lazoul[1], Kh. Ladour[1], L. Mokhtar Simohamed[1], A. Boudrioua[2], L.-H. Peng[3]; 1 - École Militaire Polytechnique Bordj El Bahri, Algeria; 2 - Univ. de Paris, France; 3 - National Taiwan Univ., Taiwan

The aim behind this work is to achieve a multi-resonant optical parametric oscillator based on two dimensional periodically poled crystals, designed to allow multiple wavelength generation. Two dimensional nonlinear photonic crystals are characterized by multiple reciprocal lattice vectors contribution to the quasi-phase matching scheme. We are particularly interested by the multi-wavelength parametric generation to achieve a multi-resonance optical parametric oscillator. The performances the optical parametric oscillator are studied in terms of generation efficiency and multi-wavelength generation.

TuR8-p17 **15:00-19:00**

Raman Spectra and Structure Transformation of LBO Crystals During Heating and Melting

Yu. Voronko, A. Sobol', V. Shukshin; General Physics Inst. of RAS, Russia;

The Raman spectra of LBO single crystals as well as LO- and TO-phonon lines separating have been done accurately at 20 and 300K. The incongruent melting of LBO single crystals and transformations of the boron oxygen groups in glasses and melts with the compositions Li2O*2B2O3 and Li2O*3B2O3 have been studied by High Temperature Raman spectroscopy.

TuR8-p18 **15:00-19:00**

Diffraction properties of optically modulated laser-written 1D waveguide array in lithium niobate

A. Kanshu[1], V. Kruglov[1], A. Perin[1], D. Petnev[1], V. Shandarov[1], F. Chen[2]; 1 - State Univ. of Control Systems and Radioelectronics, Russia; 2 - Shandong Univ., P.R. China;

Optical modulation of one-dimensional waveguide array obtained in lithium niobate using femtosecond laser radiation is studied to modify the discrete diffraction characteristics of light beam within this waveguide system. It has been shown that such a modulation is available at relatively low optical power due to the photorefractive nonlinearity of this crystal.

TuR8-p19 **15:00-19:00**

Source of single correlated photons at 1.06-mkm wavelength

S. Magnitskiy[1], V. Firsov[1], N. Nagorskiy 1; I. Protsenko[2], M. Saygin[2]; 1 - Lomonosov Moscow State Univ., 2 - Lebedev Physical Inst. of RAS, Russia;

We describe the source of correlated photon pairs at 1.06 micron wavelength based on spontaneous parametric down-conversion. The events corresponding to the photons in the pair are correlated with time accuracy better than 1 ns. Apart from wavelength, another distinctive feature of our set-up is that the "signal" photons can be delayed by passing the additional distance (up to 10 m) in the air.

TuR8-p20 **15:00-19:00**

Theoretical Analysis of Coherent Passive and Self Mode-Locking in Lasers

R.M. Arkhipov[1], M.V. Arkhipov[2]; 1 - Weierstrass Inst. for Applied Analysis and Stochastics, Leibniz Inst., Germany; 2 - St.Petersburg State Univ., Russia;

In the present work we perform numerical analysis of coherent mode-locking in lasers containing either coherent gain and absorbing medium or only one gain medium. Our numerical simulations indicate the possibility of mode-locked pulse formation when coherence time of the medium is larger than the pulse duration.

TuR8-p21 **15:00-19:00**

Generation of pulse trains with high-repetition-rate in anomalous dispersion decreasing fibers

D.A. Korobko[1], O.G. Okhotnikov[1,2], A.A. Sysolyatin[3], I.O. Zolotovskii[1]; 1 - Ulyanovsk State Univ., Russia; 2 - Tampere Univ. of Technology, Finland; 3 - General Physics Inst. of RAS, Russia;

Optical pulse generation and compression have been numerically studied in anomalous dispersion decreasing fibers (DDF). We show that evolution of modulation instability observed with chirped wave packets in tapered fibers produces the mechanism for generation of ultra-short pulses with high repetition rates. The new method for increasing the pulse train repetition rate through frequency modulation of the seed wave has been proposed.

TuR8-p22 **15:00-19:00**

Nonlinear optical properties of semiconductor thin films and multilayer structures containing such films

A.D. Makarov, A.A. Ryzhov, A.N. Baranov; Vavilov State Optical Inst., St.Petersburg National Research Univ. of ITMO, Russia;

Refraction and absorption indices dependencies on the optical field intensity for deposited thin films of certain semiconductors and some other materials in the near-infrared range have been experimentally obtained by using Z-scan technique. Multilayer structures containing such films with high nonlinear coefficients as one or several constituent layers are very promising in the context of low-threshold nonlinear optical devices.

TuR8-p23 **15:00-19:00**

Multipartite entangled quantum states in coupled optical parametric interactions: density matrix and entropy characterization

A.S. Chirkin, M.Yu. Saygin, T.V. Tlyachev; Lomonosov Moscow State Univ., Russia;

We focus on the so called normal ordering method (NOM) for constructing the density matrix of multipartite entangled CV states generated via coupled parametric interactions in running wave regime. The method allows us to construct a simple way of getting the state vector and density matrix for multipartite field in parametric optical interactions. We demonstrate application of the NOM by calculation of the density matrix for three coupled parametric processes in which the four partite entangled state is formed. We analyze von Neuman entropy, conditional entropy and mutual information for this interaction.

R2. HIGH POWER LASER SYSTEMS AND FACILITIES

Deyneka Hall

Session Chairs: *14:30-19:30 O.B. Danilov, Vavilov State Optical Inst., Russia*

14:30-19:30 Ja. Kodymová; Inst. of Physics, Academy of Sciences CR, Czech Republic;

WeR2-23 Invited **14:30-15:00**

Oxygen-Iodine lasers: advanced related technologies for pumping

Ja. Kodymová; Inst. of Physics, Academy of Sciences CR, Czech Republic;

The Oxygen-Iodine Lasers (COIL/DOIL) passed a huge development since a few milliwatts to multikilowatts was recorded. This was supported by enormous, fascinating basic research on many problems covering the multidisciplinary science and technology. Our laboratory participated in the worldwide effort to contribute to this development. In this talk, some research results will be highlighted, concerning mainly the most advanced technologies for laser pumping by the new concepts of singlet oxygen generators, alternative method of atomic and molecular iodine generation, advanced optical diagnostics and computational modeling as an inherent tool of the experimental work.

WeR2-01 Invited **15:00-15:30**

High peak and high average power Yb:KGW laser systems for industrial applications

G.H. Kim[1], J. Yang[1], S.A. Chizov[2], A.V. Kulik[1], E.G. Sall[1], V.E. Yashin[2], U. Kang[1]; 1 - Korea Electro-technology Research Inst., Republic of Korea; 2 - Vavilov State Optical Inst., Russia;

We present a results of dual-crystal Yb:KGW laser development that is capable to operate as a actively Q-switched oscillator with output power up to 24 W and pulse length of 20 ns, or as a regenerative amplifier with output power up to 21 W and pulse duration below 200 fs after compression of chirped pulses. Both lasers have excellent beam quality with beam parameter M2

WeR2-02 Invited **15:30-16:00**

Alkali vapor lasers: history, current state and perspectives

B.V. Zhdanov, R.J. Knize; USAF Academy, USA;

This paper presents a short historical review of optically pumped alkali laser research and development and analysis of the most important achievements and existing problems in Diode Pumped Alkali Laser development and scaling to high power.

WeR2-03 Invited **16:00-16:30**

Short Pulse CO Laser Systems and their Applications in Nonlinear IR Optics

A.A. Kotkov, A.A. Ionin, I.O. Kinyaevskiy, Yu.M. Klimachev, A.Yu. Kozlov; Lebedev Physical Inst. of RAS, Russia;

Carbon monoxide laser systems emitting laser pulses with duration from milliseconds down to nanoseconds were developed and applied for the frequency conversion of CO laser spectrum due to sum and difference frequency generation in nonlinear crystals.

WeR2-04 Invited **16:30-17:00**

Optical (solar) pumped oxygen – iodine laser

M.S. Yur'ev, O.B. Danilov, A.P. Zhevlakov; Vavilov State Optical Inst., Russia;

We present the results of theoretical and experimental researches, showing the possibility of the development of oxygen–iodine laser with a direct optical pumping of molecular oxygen by realization of molecule-donor (buffer gas) to molecule-acceptor (oxygen) intermolecular charge-transfer interaction.

-COFFEE BREAK -

WeR2-05 Invited **17:30-18:00**

High repetition rate cryogenic disk laser for OPCPA applications

I. Mukhin; Inst. of Applied Physics of RAS, Russia;

The cryogenic disk laser has been developed with a high energy capacity and average power and possibility of using this laser as a pump source for OPCPA amplification is discussed

WeR2-06 Invited **18:00-18:30**

Space-to-time pulse shaping in the high energy high efficiency solid state laser amplifiers

A. Shaykin; Inst. of Applied Physics of RAS, Russia;

A method of obtaining steplike pulses at the output of high energy high efficiency amplifiers, i.e., in the high saturation regime is proposed.

WeR2-07 Invited **18:30-19:00**

Faraday isolators for high (>1kW)average power lasers

O.V. Palashov; Inst. of Applied Physics of RAS, Russia

Faraday isolators for high average power lasers are surveyed. Four devices with the most known optical schemes are considered: traditional scheme, schemes with compensation of thermally induced depolarization inside magnetic field and outside magnetic field and cryogenic Faraday isolators.

WeR2-08 **19:00-19:30**

Pulsed inductive discharge HF laser

A. Razhev[1,2], D. Churkin[1,2], E. Kargapol'tsev[1]; 1 - Inst. of Laser Physics of SB RAS; 2 - Novosibirsk State Univ.; Russia

Pulsed, high voltage inductive discharge as an alternative method of pumping gas lasers has been suggested and experimentally realized for creation of HF laser. For the mixture of H2-(NF3)SF6 one has managed to obtain lasing in the infrared spectrum around 2.7 microns. Maximum generation energy of 10 mJ was obtained by using Ne instead He as buffer gas.

R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES

Pudovkin Hall

Session Chairs: *09:00-11:00 A.A. Andreev; Vavilov State Optical Inst., St.Petersburg State Univ., Russia; Max Born Inst., Germany*

11:30-13:30 P. McKenna, Univ. of Strathclyde, UK

15:00-17:00 S.V. Bulanov, Kansai Photon Science Inst., JAEA, Japan

17:30-19:00 V.Yu. Bychenkov, Lebedev Physical Inst. of RAS, Russia

WeR5-01 Invited **09:00-09:30**

ELI-ALPS - unique European laser facility

D. Charalambidis[1,2], E. Cormier[1,3], Z. Diveki[1,4], Jo.A. Fülöp[1,5], M. Kalashnikov[1,6], R. Lopez-Martens[1,7], K. Osvay[1,8], E. Racz[1,9]; 1 - ELI-Hu Nkft, Hungary; 2 - FORTH, Greece; 3 - CELIA, France; 4 - Imperial College, UK; 5 - MTA-PTE High-Field THz Research Group, Pecs, Hungary; 6 - Max-Born Inst., Germany; 7 - Lab. d'Optique Appliquee, France; 8 - Univ. of Szeged, Hungary; 9 - Obuda Univ., Hungary;

ELI-ALPS, the Attosecond Light Pulse Source is one of the four pillars of the Extreme Light Infrastructure (ELI) - the ambitious pan-European laser research project with the major mission to make a wide range of cutting-edge ultrafast light.

WeR5-02 Invited **09:30-10:00**

LFEX High Energy Peta-Watt Laser and Its Potential for High Field Science

H. Azechi; Inst. of Laser Engineering, Osaka Univ., Japan;

A high energy peta-watt laser called LFEX (Laser for Fusion EXperiment) has been commissioned at the Institute of Laser Engineering, Osaka University; It consists of a 4-beam and 4-path Nd:glass amplifier system with a 40-cm square aperture in each beam; The design goal of LFEX is to deliver 10-kJ energy in 10-ps width at 1- μm wavelength, while it also delivers 4-kJ energy in 1-ps width. Currently, 3 among 4 beams are in operation, and the fourth beam will be completed in the year of 2014. After the first phase, LFEX laser will be fully open to the world for basic science study including relativistic plasmas, particle acceleration, radiation damping, and non-linear QED.

WeR5-03 Invited **10:00-10:30**

Ultraintense laser-plasma interactions in the relativistic transparency regime

P. McKenna[1], R.J. Gray[1], D.A. MacLellan[1], B. Gonzalez-Izquierdo[1], H.W. Powell[1], D.C. Carroll[2], C.D. Murphy[3], L.C. Stockhausen[4], D.R. Rusby[1,2], G.G. Scott[1,2], R. Wilson[1], N. Booth[2], D.R. Symes[2], S.J. Hawkes[2], R. Torres[4], M. Borghesi[5], D. Neely[2]; 1 - Univ. of Strathclyde, UK; 2 - STFC Rutherford Appleton Laboratory, UK; 3 - Univ. of Edinburgh, UK; 4 - Centro de Laseres Pulsados (CLPU), Spain; 5 - Queens Univ. Belfast, UK;

Measurements of the collective dynamics of electrons in the relativistically-induced transparency regime are reported. The 2D profile of the beam of accelerated electrons is shown to form an ellipse aligned along the laser polarization direction in the case of limited transparency, and adopts other asymmetric profiles when a significant fraction of the laser pulse co-propagates with the electrons.

WeR5-04 Invited **10:30-11:00**

Laser Particle Acceleration at Relativistic Laser Intensity

Ch.H. Nam[1,2], J. Kim[1,3], H.T. Kim[1,3], K.H. Pae[1,3], W. Choi[1,3], Ch.M. Kim[1,3], S.K. Lee[1,3], J.H. Sung[1,3], T.M. Jeong[1,3]; 1 - Center for Relativistic Laser Science, Inst. for Basic Science, Korea; 2 - Dept. of Physics and Photon Science, GIST, Korea; 3 - Advanced Photonics Research Inst., GIST, Korea;

Laser-driven particle acceleration has been investigated using a 30 fs, PW laser. By applying circularly polarized laser pulses at an intensity of 6x1020 W/cm2, 80-MeV protons were produced.

-COFFEE BREAK -

WeR5-05 Invited **11:30-12:00**

Laser Ion Acceleration for Hadron Therapy

S. V. Bulanov, Kansai Photon Science Inst., JAEA, Japan;

We discuss using laser plasma as a source of high-energy ions for the purposes of proton therapy. The approach is based on the efficient ion acceleration observed in laboratory, theory and numerical experiments (in silico) on the high-power laser interaction with matter. Compared to standard accelerators of charged particles used in the present day hadron therapy centers the laser ion acceleration is more advantageous owing to compactness and relatively low cost of laser accelerators and due to possibility to develop the all-optical scheme with transportation and rotation of photon beams instead of high energy ions with magnetic transportation lines and gantries.

WeR5-06 Invited **12:00-12:30**

Optimized sources of laser-triggered ions from ultra-thin foils

V.Yu.Bychenkov, A.V.Brantov, E.A.Govras; Lebedev Physical Inst. of RAS, Russia;

Here we present the results of 3D optimization study with PIC code Mandor for acceleration of ions from thin targets triggered by femtosecond laser pulses. The dependence of maximum ion energies which are for a volumetric heating of the targets with optimum thicknesses versus laser intensity shows very universal scaling ~ I0.7 for wide intensity range and different pulse durations and spot sizes of practical interest. More sharp dependence of maximum ion energy as compared to popular scaling ~ I0.5 is a result of absorption increase with laser intensity for semi-transparent foils. The correspondence between PIC simulations and recent theory is demonstrated.

WeR5-07 Invited **12:30-13:00**

Laser Ion Acceleration Control

S. Kawata, T. Nagashima, M. Takano, D. Kamiyama, D. Barada, Y.Y. Ma, Q. Kong, P.X. Wang*, Y. J.Gu*, X. Li*; Utsunomiya Univ., Japan; *Fudan Univ., China;*

Issues in laser ion accelerator include an energy efficiency from laser to ions, ion beam collimation, ion energy spectrum control, ion beam bunching and ion particle energy control. In this study each component is designed to control the ion beam quality. The energy efficiency from the laser to ions is improved by using a solid target with a fine sub-wavelength structure or a near- critical density gas plasma. The ion beam collimation is performed by holes behind the solid target or a multi-layered solid target. The control of the ion energy spectrum and the ion particle energy, and the ion beam bunching are successfully realized by a multi-stage laser-target interaction.

WeR5-08 Invited **13:00-13:30**

Low- and mid-Z ion acceleration by ultraintense femtosecond lasers in structured targets

A.V. Korzhimanov, E.S. Efimenko, A.V. Kim, S.V. Golubev; Inst. of Applied Physics of RAS, Russia;

The recent progress in theoretical investigation of ion acceleration by high-intensity lasers irradiating multicomponent structured targets will be presented with the emphasis on the possibility to produce monoenergetic beams of highly charged mid-Z ions.

-BREAK FOR LUNCH -

WeR5-09 Invited **15:00-15:30**

Proton Beam Generation with Nanotube Accelerator

M. Murakami[1], M. Tanaka[2], T. Kaneko[3], T. Kato[3], K. Yamanoi[1]; 1 - Inst. of Laser Engineering, Osaka Univ., 2 - Chubu Univ., Aichi, Tohoku Univ., Japan;

We here propose a novel ion acceleration scheme using carbon nanotubes, where embedded hydrogen-rich fragments - which could be water ice, paraffin, or some other low-Z material but were modeled as hydrogen nanotubes - are irradiated by an intense laser to eject substantial numbers of electrons.

WeR5-10 **15:30-15:45**

Ion Acceleration from Laser-Irradiated Thin Targets

E.A. Govras[1,2]. V.Yu. Bychenkov[1,2]. A.V. Brantov[1,2]; 1 - Lebedev Physics Inst. of RAS, 2 - Center for fundamental and applied research, VNIIA, Rosatom, Russia;

This work examines interaction of a powerful ultrashot laser pulses with thin foils of submicron scales. Ion acceleration during such interaction is of interest. Found is ion maximum energy for arbitrary electron temperature which is defined by the main laser pulse parameters.

WeR5-11 Invited **15:45-16:15**

Laser wakefield electron acceleration to multi-GeV energies in guiding structures.

N.E. Andreev, Joint Inst. for High Temperatures of RAS, Russia;

Electron acceleration mechanisms in view of current and future experiments are discussed. Generation of energetic electron bunches in the laser interaction with preplasma created by laser prepulses at grazing incidence to solid targets is investigated. It is demonstrated that an externally injected electron bunch can achieve an energy gain up to 100 GeV in the weakly non-linear regime of laser wakefield acceleration in guiding structures. The effect of non-symmetric focusing of the laser radiation into a capillary waveguide on the effectiveness of the electron bunch acceleration is studied.

WeR5-12 Invited **16:15-16:45**

Compact X ray beams produced with laser plasma accelerators

V. Malka, Lab. d'Optique Applique'e, ENSTA-ParisTech, CNRS, France;

I present here a review of the different schemes that allow to produce bright X ray beams (betatron, Compton, Bremsstrahlung) and I will discuss about their applications. I'll also discuss on a new concept that allows to extend and control the photon energy range and the number of the emitted X-ray using without requiring additional laser energy or additional laser beam.

WeR5-13 **16:45-17:00**

Generation of Terahertz and Infrared Relativistic Half-Cycle Pulses in Laser Pulse Interaction with Nanodimensional Targets

V.V. Kulagin[1,2], V.A. Cherepenin[2], D.N. Gupta[3]; 1 - Sternberg State Astronomical Inst., Lomonosov Moscow State Univ., 2 - Inst. of Radioengineering and Electronics of RAS, 3 - University of Delhi, India;

A method for generation of intense infrared and terahertz radiation during interaction of powerful laser pulses with nano-dimensional targets (nanofilms, nanowires, and nanoclusters) was proposed and studied. It was shown that the temporal profile of radiation strongly depends on laser pulse amplitude and duration, electron density of the target and its geometry. Particularly, half- cycle infrared or terahertz pulses can be generated. The parameters of radiation were derived such as polarization, frequency, amplitude, etc. It was shown that the amplitude of the radiation can be on relativistic level for modern petawatt laser systems.

-COFFEE BREAK -

WeR5-15 Invited **17:30-18:00**

Generation of X-ray and transport of fast electrons in nano-structured targets irradiated by relativistic intense laser pulses

A.A. Andreev [1,2,3], K.Yu. Platonov[1,4]; 1 - Vavilov State Optical Inst., Russia; 2 - Max Born Inst., Germany; 3 - St.Petersburg State Univ., Russia; 4 - St.Petersburg State Technical Univ. , Russia;

Interaction of an ultrashort, ultraintense laser pulse with a bunch of parallel or tapered nanofibers is considered. Such targets generate effectively a big current of relativistic electrons, propagating along the fibers and following their curvature. Focussing the laser beam in one fiber allows to reduce the transverse size of electron cloud. Generation of X-ray radiation by fast electrons is considered.

WeR5-16 Invited **18:00-18:30**

Target charging and electromagnetic field emission in the short pulse laser-plasma experiments

V.T. Tikhonchuk[1], J.-L. Dubois[2], F. Lubrano-Lavaderci[2], J. Gazave[2], D. Raffestin[2], J. Ribolzi[2], A. Compant La Fontaine[3], E. d'Humières[1], S. Hulin[1], Ph. Nicolai[1], A. Poyé[1]; 1 - Centre Lasers Intenses & Applications, Univ. Bordeaux, CNRS, CEA, France; 2 - CEA/DAM/CESTA, France; 3 - CEA/DAM/DIF, France;

A detailed model of the target electric polarization induced by a short and intense laser pulse and escaping energetic electrons is presented. A specially designed experiment provides direct measurements of the target polarization and the discharge current in function of the laser energy, pulse duration, and target material. Large-scale numerical simulations describe the energetic electron generation and their emission from the target. The model, experiment, and numerical simulations explain the polarization charge accumulation and its relation with the characteristics of the electromagnetic pulse.

WeR5-17 Invited **18:30-19:00**

Laser plasma sources of soft X-rays and extreme ultraviolet (EUV) for application

H. Fiedorowicz, I. Ul Ahad, A. Bartnik, T. Fok, R. Jarocki, B. Korczyc, J. Kostecki, A. Szczurek, M. Szczurek, P. Wachulak, L. Wegrzynski; Military Univ. of Technology, Poland

Application of laser plasma sources of soft X-rays and extreme ultraviolet (EUV) developed in our laboratory in various areas of plasma physics, nanotechnology and biomedical engineering are presented. The sources are based on interaction of high-intensity nanosecond laser pulses from commercial Nd:YAG lasers with gas puff targets formed by pulsed injection of gas under high-pressure. The use of a gas puff target instead of a solid target makes possible to generate plasmas emitting soft X-ray and EUV radiation without target debris production.

R6. NANOPHOTONICS AND BIOPHOTONICS

Deyneka Hall

Session Chair: 09:00-13:30 E.D. Obraztsova, Prokhorov General Physics Inst. of RAS, Russia

WeR6-22 Invited **09:00-09:30**

Quantum Dots and Quantum Dot Based Polymer Composites

C. Hanley[1], Yu.K. Gun'ko[1,2]; 1 - Trinity College Dublin, Ireland; St.Petersburg National Research Univ. of ITMO, Russia.

The main goal of our work is the development of new nanomaterials based on fluorescent semiconducting nanoparticles (quantum dots). In our work a range of various cadmium selenide and ternary core cadmium - zinc selenide quantum structures have been synthesised and investigated using spectroscopic techniques. Various quantum loaded polymer composite materials have been fabricated and tested. We expect that the new materials developed here will find many potential applications.

WeR6-23 Invited **09:30-10:00**

Nonlinear absorption and nonlinear refraction of two-dimensional transition metal dichalcogenides

Ju. Wang; Key Lab. of Materials for High-Power Laser, Shanghai Inst. of Optics and Fine Mechanics, CAS; P.R. China

Following the same vein on the graphene study, researchers have started the exploration of graphene analogue - material comprising stacked atomic or molecular layers. The layered transition metal dichalcogenides (TMDCs) are the most representative 2D graphene analogues. Nonlinear absorption and nonlinear refraction properties were investigated using Z-scan and spatial self-phase modulation techniques, respectively. NLO properties were revealed by interacting the TMDCs with various laser sources at different wavelengths (Vis-NIR) and pulses durations (fs, ps, ns, cw). Versatile ultrafast NLO responses verify the 2D TMDCs a huge potential in the development of nanophotonic devices, such as, mode lockers, optical switches and optical limiters.

WeR6-24 **10:00-10:15**

Influece of active region and resonator design on characteristics of microdisk lasers.

N.V. Kryzhanovskaya[1], M.V. Maximov[1], A.M. Nadtochiy[1], A.E. Zhukov[1], E.I. Moiseev[1], I.I. Shostak[1], A.V. Savel'ev[1], A.A. Lipovskii[1], D.V. Karpov[1], M.M. Kulagina[2], K.A. Vashanova[2], J. Laukkanen[3], J. Tommila[4]; 1 - St Petersburg Academic Univ., Russia; 2 - Ioffe Physical Techical Inst. of RAS, Russia; 3 - Univ. of Eastern Finland, 4 - Tampere Univ. of Technology, Finland;

Microdisks with various active region and different design are studied. Lasing up to 100°C is demonstrated in microrings with outer diameter 2 μm based on InAs/InGaAs quantum dots. Room temperature single-mode lasing in 9 μm microdisk lasers with InGaAs quantum dots active region is achieved.

WeR6-25 **10:15-10:30**

Luminescence and Morphology Study of PbS Quantum Dots in Porous Matrix

P.S. Parfenov, A.P. Litvin, E.V. Ushakova, A.V. Fedorov, A.V. Baranov; St.Petersburg National Research Univ. of ITMO, Russia;

We present some results obtained by steady-state and time-resolved fluorescence analysis of PbS quantum dots in solution and in a porous matrix. Distribution of QDs in the porous matrix was investigated by atomic-force and confocal microscopy to clarify an energy transfer in formed closed packed structures. Hardware and software for fluorescence measurements in near infrared region also are discussed.

WeR6-26 **10:30-10:45**

Ultrafast Spectroscopy of CuInSeS Colloidal Quantum Dots: Auger Recombination, Carrier Multiplication, and Electron Transfer

N.S. Makarov, H. McDaniel, I. Robel, V.I. Klimov; Center for Advanced Solar Photophysics, Chemistry Division, Los Alamos National Lab., USA;

We study size- and composition- dependent optical properties of CuInSexS2-x quantum dots, including biexciton Auger recombination, carrier multiplication, and electron transfer to TiO2. We show that this material is promising for photovoltaic applications due to a fairly large carrier multiplication yields and efficient electron transfer, which is fast compared to nonradiative losses.

WeR6-27 **10:45-11:00**

Efficient Auger-Assisted Up-Conversion in Engineered PbSe/CdSe Core/Shell Colloidal Quantum Dots

N.S. Makarov, Q. Lin, K. Velizhanin, V.I. Klimov; Center for Advanced Solar Photophysics, Chemistry Division, Los Alamos National Lab., USA;

Efficient up-conversion in colloidal quantum dots (QDs) is of immediate interest for three-dimensional microscopy and solar energy conversion. We demonstrate that appropriately engineered PbSe/CdSe core/shell QDs allow for highly efficient up-conversion of infrared radiation via a novel mechanism of Auger re-excitation. Specifically, we show that even with moderate pump fluences, that can be achieved with a 1000-fold concentration of solar radiation, we can up-convert almost 75% of absorbed infrared photons. Our findings suggest that these novel core/shell nanostructures may be utilized for enhancing power conversion efficiency of practical photovoltaic devices by allowing for more efficient harvesting of low-energy solar photons.

-COFFEE BREAK -

WeR6-28 Invited **11:30-12:00**

Coherent laser control of current via molecular nanojunctions with semiconductor and graphene contacts

B.D. Fainberg; Holon Inst. of Technology; Israel

We propose new approaches to coherent control of transport via molecular junctions. The first method is based on the application of intrinsic semiconductor contacts and optical frequencies below the semiconductor bandgap. Our analytical theory predicts a new phenomenon, referred to as coherent destruction of induced tunneling, which extends the phenomenon of coherent destruction of tunneling frequently discussed in the previous literature. We also propose to use graphene electrodes as a platform for effective photon assisted tunneling through molecular conduction nanojunctions. Our results illustrate the potential of semiconductor and graphene contacts in coherent control of photocurrent.

WeR6-29 Invited **12:00-12:30**

Development of New Photonic and Plasmonic Devices Based on Nanostructured Glasses and Glassceramics

N.V. Nikonorov; St.Petersburg National Research Univ. of ITMO, Russia;

Novel photonic and plasmonic elements and devices like holographic and gradient optical elements, optical and plasmonic waveguides, fluidic channels, thermo-and biosensors, phosphors, up- and down-converters, cut-off filters and limiters have been designed and fabricated based on new photo-thermo-refractive, oxyfluoride, fluorophospate and potassium-alumina-borate glasses and glassceramics

WeR6-30 Invited **12:30-13:00**

Advanced Narrow Band Filters in PTR Glass for Raman Spectroscopy

V. Smirnov[1], O. Mokhun[1], V. Koulechov[1], A. Glebov[1], L. Glebov[2]; 1 - OptiGrate Corp, 2 - College of Optics/CREOL, Univ. of Central Florida, USA;

Volume Bragg gratings in Photo-Thermo-Refractive (PTR) glass provide unmatched performance for RAMAN spectroscopy. High diffraction efficiency combined with narrow bandwidth provide simultaneous access to Stokes and anti-Stokes Raman modes with frequencies as low as 5 cm-1 Recent advances in the technology of diffractive elements in PTR glass enabled fabrication of filters having optical density >5.

WeR6-31 **13:00-13:15**

Luminescence of Erbium Ions in Transparent Glass-Ceramics Containing (Er,Yb)NbO4 Nanocrystals

N.A. Skoptsov[1], K.V. Yumashev[1], O.S. Dymshits[2], A.A. Zhilin[2], I.P. Alekseeva[2]; 1 - Belarusian National Technical Univ., Belarus; 2 - Vavilov State Optical Inst., Russia;

Transparent glass-ceramics containing nanocrystals of (Er,Yb)NbO4 and β-quartz solid solution have been prepared; their IR and up-conversion luminescence spectra have been studied. Spectral-luminescent characteristics prove these materials to be promising media for 1.5 μm laser generation.

WeR6-32 **13:15-13:30**

New scanning probe microscopy near-field imaging method for laser radiation intensity mapping

P.A. Alekseev[1], M.S. Dunaevskiy[1], A.M. Monahov[1], A.N. Titkov[1], A.N. Baranov[2], P. Girard[2], R. Teissier[2]; 1 - Ioffe Physical Technical Inst. of RAS, Russia; 2 - Inst. d'Electronique du Sud UM2-CNRS Montpellier, France;

Novel scanning probe microscopy method of near field imaging of laser radiation is proposed. The method providing a submicron spatial resolution is based on detection of a shift of the probe resonance related to its heating by absorbed radiation. The method has been realized with a conventional silicon probe and has been employed for visualization of infrared emission from a half-disk semiconductor whispering gallery mode laser.

-BREAK FOR LUNCH -

R7. LASERS IN ENVIRONMENTAL MONITORING

Richter Hall

Session Chairs: *15:00-17:00 A.P. Zhevlakov, ITMO Univ., Lasers and Optical Systems JSC, Russia*
17:30-19:30 A. Nadezhdinskii; Prokhorov General Physics Inst. of RAS, Russia

WeR7-01 Invited **15:00-15:30**

Remote sensing of seawater and drifting ice by compact Raman lidar

A.F.Bunkin, Prokhorov General Physics Inst. of RAS, Russia;

Remote sensing in the Shpitsbergen fjords was carried out by compact LIDAR system. The system was installed on a small ship but can be installed on any vehicle. Possible applications of the compact Raman LIDAR for express monitoring of seawater properties in the places with high concentration of floating ice in the ocean will be discussed.

WeR7-02 **15:30-15:45**

LIF LIDAR for in situ, in vivo assessment of algal communities and higher plants

A.B. Utkin[1], P. Cartaxana[2], C. Gameiro[2]; 1 - Technical Univ. of Lisbon, 2 - Centro de Oceanografia, Faculty of Sciences of Lisbon Univ.; Portugal

The current state of the laser induced fluorescence – light detection and ranging (LIF LIDAR) technique for in situ assessment of algal communities and higher plants and its prospective as a cost-effective tool for algae and vegetation mapping and monitoring are discussed.

WeR7-03 **15:45-16:00**

Mapping of Algal Communities in Tagus Estuary Using Mobile LIF LIDAR Sensor

C. Gameiro[1], P. Cartaxana[1], A.B. Utkin[2]; 1 - Centro de Oceanografia, Faculty of Sciences of Lisbon Univ.; 2 - INOV, Technical Univ. of Lisbon, Portugal;

We discuss application of the recently developed portable LIF LIDAR (laser induced fluorescence – light detection and ranging) sensor for mapping algal communities in the Tagus Estuary during the experimental campaign of July 2013

WeR7-04 Invited **16:00-16:30**

Design and development of underwater laser spectroscopic system for hydrocarbon deposits exploration

V.G. Bespalov[1], E.A. Makarov[1], A.P Zhevlakov[2], Yu.I. Soldatov[2]; 1 - St.Petersburg National Research Univ. of ITMO; 2 - Vavilov State Optical Inst., Russia;

The structural scheme of underwater laser spectroscopic system for hydrocarbon deposits exploration was considered. This equipment can be used to scan from the ship in aqueous environments with limited visibility, and spectral-temporal analysis of the Raman scattering of the hydrocarbons in these environments.

WeR7-05 **16:30-16:45**

Oceanological Monitoring of Fishing Areas using Lidars

V.I. Chernook[1], A.N. Vasilyev[1], Yu.A. Goldin[2], B.A. Gureev[2], V.S. Goryainov[3], A.A. Buznikov[3]; 1 - JSC "Giprorybflot", 2 - Inst. of Oceanology of RAS, 3 - St.Petersburg Electrotechnical Univ. "LETI"; Russia;

Some advantages of lidar remote sensing methods are described along with the tasks for solving which these methods are used. Examples of modern lidar systems designed for the oceanological monitoring are also given.

WeR7-06 **16:45-17:00**

Monitoring of methane emissions in the Arctic by laser sensing to assess climate change

A.S. Grishkanich[1,2], A.A. Buznikov[1], V.V. Elizarov[1], S.V. Kascheev[2], A.P. Zhevlakov[2]; 1 - St.Petersburg Electrotechnical Univ. «LETI», 2 - St.Petersburg National Research Univ. of ITMO, Russia;

Over the past 100 years, the rate of temperature in the Arctic increases almost twice higher than the average rate of warming of the planet (IPCC, 2007). Identifying methane anomalies responsible for the temperature increase, by hiking trails in the Arctic requires great human labor. It is necessary to use lidar methods for search and identification of methane from permafrost.

-COFFEE BREAK -

WeR7-07 Invited **17:30-18:00**

Multilayered clouds monitoring during blizzard by eye-safe Lidar-prototype for NASA mission "Mars Polar Lander-99"

S.M. Pershin; Prokhorov General Physics Inst. of RAS; Russia;

The prototype of lidar which was developed for Mars study (NASA project) was used for environmental monitoring. Multilayered clouds under snowstorm were detected by eye-safe lidar for the first time. The key point of this breakthrough technology is a new fully digital scheme that is based on single photon counting technique for scattered laser pulses at eye-safe energy level.

WeR7-08 **18:00-18:15**

Trouble free eye-safe lidar based on pulsed diode laser& quantum counter for environmental monitoring

S.M. Pershin[1], V.N. Lednev[1], V.S. Makarov[2], A.V. Turin[2]; 1 - Prokhorov General Physics Inst. of RAS, 2 - Space Research Inst. of RAS; Russia;

The compact eye-safe LIDAR system for an environmental remote sensing (ocean and atmosphere) was developed. LIDAR is based on low energy diode pulsed laser in combination with single photon avalanche diode (SPAD) which operates in Geiger mode. A review of applications for both climate change detection and ecology monitoring by eye-safe LIDAR is presented.

WeR7-09 **18:15-18:30**

Synthetic wavelength interferometer for absolute distance measurements on Earth and in space

M. Astrua, M. Pisani, M. Zucco; INRIM, Italy;

An absolute interferometer based on a pair of ECDL lasers generating a synthetic wave up to 40 GHz has been developed at the Italian Metrologic Research Institute (INRIM). The device has been designed to monitor reciprocal movements of large satellite parts, and has been validated in atmosphere up to 137 m distance with a resolution better than 7 nm/sqrt(Hz) and an accuracy of tens of micrometers.

WeR7-10 Invited **18:30-19:00**

Problems of Perfecting and Metrological Assurance of Laser Gas Analyzers

L. Konopelko, V. Beloborodov, D. Rumiantsev, Ya. Chubchenko; Mendeleyev Metrology Inst. (VNIIM); Russia

In view of the need of ambient air quality control, occupational health control, authenticity of food and gases, and for medical purposes, laser gas analyzers must provide high accuracy of measurement. Development of traceability of measurement for carbon monoxide, carbon dioxide, methane, formaldehyde, and carbon dioxide isotopes ratio laser gas analyzers is discussed in this presentation.

WeR7-11 **19:00-19:15**

Laser sensor for airborne prospecting method of oil & gas deposits

A.S. Grishkanich[1,2], V.G. Bespalov[2], S.A. Bogoslovsky[3], V.V. Elizarov[2], A.A. Il'inskiy[3], S.V. Kascheev[2], E.A. Makarov[2], A.P . Zhevlakov[2]; 1 - St.Petersburg Electrotechnical Univ. «LETI», 2 - St.Petersburg National Research Univ. of ITMO, 3 - All Russia Petroleum Research Exploration Inst., Russia;

Remote laser spectroscopy availability for airborne search of the oil-and-gas deposits has been examined. Experiments were carried out under the CARS circuit. Minimal concentrations of heavy HG of 200 ppb are remotely measured in laboratory. As estimations have shown the reliability of heavy HG detection can exceed 80 % at the integration method of seismic prospecting and remote laser sensing in CARS circuit.

WeR7-12 **19:15-19:30**

Laser sensor for radiation monitoring

A.S. Grishkanich[1,2], A.A. Buznikov[1], V.V. Elizarov[1], S.K. Vasiliev[3], S.V. Kascheev[2], A.P. Zhevlakov[2]; 1 - St.Petersburg Electrotechnical Univ. «LETI», 2 - St.Petersburg National Research Univ. of ITMO, 3 - Emergency Technical Center Rosatom, Russia;

Remote laser spectroscopy availability for airborne search of radionuclides polution has been examined. Experiments were carried out under the CARS circuit. The method of remote detection a radionuclide in atmosphere from container burial places and in places of recycling the fuel waste of the atomic power station is elaborated. Preliminary results of investigation show the real possibility to register of leakage of a radionuclide with concentration at level of 10^12-10^13 cm-3 on a safe distance from the infected object.

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICATIONS

Petrov-Vodkin 1 Hall

Session Chairs: 09:00-13:30 A.I. Maimistov, Moscow Inst. of Physics and Technology, National Nuclear Research Univ., Russia
15:00-19:15 A.K. Popov, Purdue Univ., Univ. of Wisconsin-Stevens Point, USA

WeR8-16 Invited **09:00-09:30**

Quantum Control Spectroscopy: Nonlinear (micro) spectroscopy with tailored pulses

A. Wipfler, L. Brückner, J. Rehbinder, T. Buckup, M. Motzkus; Ruprecht-Karls-Univ. Heidelberg, Germany

We demonstrate the use of shaped 10 fs pulses for multimodal microscopy. The combination of a broadband oscillator and a pulse shaper provides a flexible light source that can be optimized for various nonlinear effects produced in the sample either for signal intensity or selectivity. Switching between narrowband and broadband Multiplex CARS, elimination of unwanted two-photon fluorescence or direct determination of the linear Raman spectrum can be easily achieved.

WeR8-17 Invited **09:30-10:00**

Generation of entangled photon pairs on a nonlinear chip

J.G. Titchener, Ch. Wen Wu, A.S. Solntsev, D.N. Neshev, A.A. Sukhorukov; Australian National Univ., Australia;

We propose a design for an integrated photonic circuit capable of generating photon pairs in any path entangled quantum state, and develop a robust method of pump filtering based on adiabatic coupling.

WeR8-18 **10:00-10:15**

Biphoton generation and pump filtering in nonlinear adiabatic waveguiding structures

Ch. Wen Wu, A.S. Solntsev, D.N. Neshev, A.A. Sukhorukov; Australian National Univ., Australia

We develop a novel integrated scheme for on-chip generation of Bell states, which allows simultaneous spatial filtering of pump photons. It is achieved through spontaneous parametric down-conversion in a system of nonlinear adiabatically coupled waveguides. Importantly, the adiabatic couplers maintain the purity of generated Bell states in a relatively fabrication-fault-tolerant way.

WeR8-19 Invited **10:15-10:45**

Time-Resolved Surface-Enhanced Coherent Sensing of Nanoscale Molecular Complexes

G.R. Welch, D.V. Voronine, A.M. Sinyukov, X. Hua, K. Wang, P.K. Jha, E. Munusamy, S.E. Wheeler, A.V. Sokolov, M.O. Scully; Texas A&M Univ., USA

Nanoscale real-time molecular sensing requires large signal enhancement, small background, short detection time and high spectral resolution. We demonstrate a new vibrational spectroscopic technique which satisfies all of these conditions. This technique combined with quantum chemistry simulations may be used for the investigation of complex mixtures at the nanoscale and surface environment of artificial nanostructures and biological systems.

WeR8-20 **10:45-11:00**

Modulational Instability, Switching Waves, Bistability and Dissipative Solitons at Resonance Excitation of Molecular J-aggregates

N.A. Veretenov[1,2], L.A. Nesterov[1,2], N.N. Rosanov[1,2,3], A.N. Shatsev[1], S.V. Fedorov[1,2]; 1 - Vavilov State Optical Inst., 2 - St.Petersburg National Research Univ. of ITMO, 3 - Ioffe Physical Technical Inst. of RAS, Russia;

It was studied analytically and numerically the excitation of modulation instability and dissipative solitons, and also bistability phenomena in molecular j-aggregates at resonance optical pumping. Three-particle molecular interactions connected with exciton-exciton annihilation in chains were taking into account. Modulation instability boundaries both in the bistability region and outside it were determined. The investigation of various soliton types was carried out.

-COFFEE BREAK -

WeR8-21 Invited **11:30-12:00**

Spontaneous and Stimulated Transitions in the Atoms Embedded into Hyperbolic Metamaterials

L.A. Melnikov[1], M.V. Ryabinina[1], I.S. Nefedov[2]; 1 - Yu. Gagarin State Technical Univ. of Saratov, Russia; 2 - Aalto Univ., Finland;

Atom –field interaction models including density matrix description and polarization issues are presented. The peculiarities of eigenmodes of different metamaterials with hyperbolic or hyperbolic-like dispersion are discussed. Numerical results for populations and medium polarization dynamics are presented.

WeR8-22 **12:00-12:15**

Polychromatic directional emission in Rb vapour for remote sensing

A. Akulshin[1], D. Budker[2],3, E. Mikhailov[3], I. Novikova[3], R. McLean[1]; 1 - Swinburne Univ. of Technology, Australia; 2 - Univ. of California, USA; 3 - Johannes Gutenberg Univ., Germany; 4 - College of William & MaryWilliamsburg, USA;

Conversion of low-power cw diode laser radiation in alkali vapours into spatially and temporally coherent light with different wavelengths using a mirrorless scheme shows promise for remote sensing and even for enhancing the sensitivity of laser-guide-star techniques.

WeR8-23 **12:15-12:30**

Raman spectroscopy investigation of alkene-based anti-relaxation coating

O.Yu. Tretiak, M.V. Balabas, P.K. Olshin; St. Petersburg State Univ., Russia;

New alkene-based anti-relaxation coating of alkali metal vapor cell demonstrated up to 10 times longer relaxation time then the same time for classical alkane-based coating. In this paper the interaction of Cs vapor with the surface of the alkene in vacuum is studied by optical Raman spectroscopy. Isomerization of alkene (double bound of C=C moving to center) was found.

WeR8-24 Invited **12:30-13:00**

When disorder is just right: on complexity-driven photonics

A. Fratalocchi; KAUST Univ., Saudi Arabia;

Disorder and chaos are ubiquitous expressions of nature that are mostly unwanted in applications, as they introduce unpredictability and make difficult to explain experimental results. On the contrary, if properly understood, they can be the basis on a completely new technology that is sustainable, scalable and extremely cheap. In this talk I will summarize my research in this field, discussing about the recent results of my group in the field of chaotic energy harvesting, light condensation effects and nanolasing

WeR8-25 Invited **13:00-13:30**

Mimicking Frequency-mixing in Nonlinear Optical Negative-index Metamaterials: Unidirectional Raman Amplification and Shaping of Optical Pulses

A.K. Popov[1], S.A. Myslivets[2], M.I. Shalaev[3], V.V. Slabko[3]; 1 - Purdue Univ., Univ. of Wisconsin-Stevens Point, USA; 2 - Inst. of Physics of SB RAS, 3 - Siberian Federal Univ., Russia;

The possibility of mimicking of huge enhancement of coherent nonlinear optical frequency-mixing processes, is investigated in Raman crystals. Negative dispersion of optical phonons plays a key role for such an analogy. A possibility to greatly enhance frequency conversion efficiency of stimulated Raman scattering is shown by making use of extraordinary properties of three-wave mixing of ordinary optical and backward elastic waves. Specific properties of the indicated nonlinear optical process in short- pulse regime are investigated and the possibility to eliminate such a fundamental detrimental effect as fast damping of optical phonons on the process concerned is shown.

-BREAK FOR LUNCH -

WeR8-26 Invited **15:00-15:30**

The positive-negative index coupled waveguides systems: couplers, arrays and bundles

A.I. Maimistov[1,2], E.V. Kazantseva[2], I.R. Gabitov[3,4]; 1 - Moscow Inst. of Physics and Technology, 2 - National Nuclear Research Univ., Russia; 3 - Univ. of Arizona, USA; 4 - Landau Inst. for Theoretical Physics, Russia;

The coupled electromagnetic waves propagating in a waveguide array, which consists of alternating waveguides of positive and negative refraction indexes, are discussed. The pair of positive-negative waveguides acts as oppositely directional coupler. The stop band in the spectrum of linear waves occurs. When pairs of these waveguides are collected in array or bundle the spectral properties of the resulted device is modified. We study spectral gaps in these waveguide system demonstrate that the number of waveguides and helical spatial twist of the array can be used to control the size of the gap.

WeR8-27 Invited **15:30-16:00**

Dynamics of structured light in singular photonic lattices

A. Desyatnikov; Australian National Univ., Australia;

Singularities in the spectra of photonic lattices lead to novel phenomena such as pseudo-spin angular momentum and conical diffraction. Imprinting specific structure on a light field allows excitation of selected modes of photonic elements and we discuss recent theoretical and experimental results on conical diffraction of structured light in photonic graphene and Lieb lattices.

WeR8-28 **16:00-16:15**

Theoretical Study of Transient Chrenkov Radiation from Periodic Resonance Medium Excited at the Superluminal Velocity

R.M. Arkhipov[1], I. Babaushkin[2], Yu.A. Tolmachev[3], M.V. Arkhipov[3]; 1 - Weierstrass Inst., Germany; 2 - Inst. of Mathematics, Humboldt Univ. of Berlin, Germany; 3 - St.Petersburg State Univ., Russia;

we consider an optical response of one-dimensional string made of dipoles with a periodically varying density excited by a laser pulse moving along the string at the superluminal velocity. We demonstrate that the Cherenkov radiation arising in such system is rather unusual, possessing both transient and resonant character. Our analysis indicates that in addition to the resonance frequency of the medium another Doppler-like frequency appears in the radiation spectrum.

WeR8-29 **16:15-16:30**

High-accuracy Sellmeier equations for LiInS2 and its applications to the nonlinear optics in LiIn(SxSe1-x)2

K. Kato[1], N. Umemura[1], K. Miyata[2]; 1 - Chitose Inst. of Science and Technology, 2 - MegaOpt, Co. Ltd.; Japan

This paper reports the high-accuracy Sellmeier equations for LiInS2 that provide excellent reproduction of our new experimental results for second-harmonic (SHG) and sum- frequency generation (SFG) in the 0.8018-10.5910μm range as well as the published difference- frequency generation (DFG) data points for cw Ti:Al2O3 lasers in the 6.5851-6.9896μm range. In addition, the feasibility of 90° phase-matched type-2 SFG between 10.5910 and 5.2955μm in LiIn(S0.8Se0.2)2 is briefly reported.

WeR8-30 Invited **16:30-17:00**

Surface Nanoscale Axial Photonics (SNAP) Devices

M. Sumetsky, Aston Inst. of Photonics Technologies, Aston Univ., UK;

Miniature slow light devices based on the recently developed Surface Nanoscale Axial Photonics (SNAP) technological platform is reviewed. The theory and experimental demonstration of the SNAP bottle resonator dispersionless delay line and dispersion compensator are presented.

-COFFEE BREAK -

WeR8-31 **17:30-17:45**

Influence of the light propagation direction on the diffraction structures self-induced within the nonlinear Fabry-Perot interferometer

A.S. Perin, V.M. Shandarov, V.G. Kruglov, V.F. Batrshin; Tomsk State Univ. of Control Systems and Radioelectronics, Russia

Formation of regular 1D patterns at the output surface of Fabry-Perot interferometer has been experimentally studied using the samples of X- and Z-cut lithium niobate. The initial light fields were light beams with the circular cross section characterized by the Gaussian profile and the almost homogeneous light field.

WeR8-32 Invited **17:45-18:15**

PT-symmetric systems in optics

A.P. Vinogradov[1,2,3], A.A. Zyablovsky[1,2], A.A. Pukhov[1,2,3], A.V. Dorofeenko[1,2,3], A.A. Lisyansky[4]; 1 - FSUE All-Russia Research Inst. of Automatics, 2 - Moscow Inst. of Physics and Technology (State Univ.), 3 - Inst. for Theoretical and Applied Electromagnetics of RAS, Russia; 4 - Queens College of the City, Univ. of New York, USA;

We consider pseudo-hermitian quantum-mechanical and optical systems. We focus on PT-symmetric optical systems. We show that almost all unusual properties of PT-symmetric systems may be observed in usual systems. An exception is the phase transition with PT- symmetry breaking. It is very difficult to experimentally observe the phenomenon whereas a "hidden" PT-transition in lossy systems may exist.

WeR8-33 Invited **18:15-18:45**

Dynamics of localized structures in broad area semiconductor cavities

M. Tlidi, Univ. Libre de Bruxelles, Belgium;

Control of the motion of cavity solitons is one the central problems in nonlinear optical pattern formation. We report on the impact of the phase of the time-delayed optical feedback and carrier lifetime on the self-mobility of localized structures of light in broad area semiconductor cavities. We show both analytically and numerically that the feedback phase strongly affects the drift instability threshold as well as the velocity of cavity soliton motion above this threshold. In addition we demonstrate that non-instantaneous carrier response of the semiconductor medium is responsible for the increase of the critical feedback rate corresponding to the drift instability.

WeR8-34 **18:45-19:00**

Fermi-Ulam Problem for Classical and Quantum Particles in Dynamical Traps

N.N. Rosanov, G.B. Sochilin, V.D. Vinokurova, N.V. Vyssotina; Vavilov State Optical Inst., Russia;

We analyze and compare regular and chaotic dynamics of classical and quantum particles in traps with periodically oscillating walls. For classical particles, effect of collisions' inelasticity is taken into account. For quantum particles, quasienergy states are found and studied; in the resonance (two-level) approximation the Rabi oscillations of levels' populations are demonstrated.

WeR8-35 **19:00-19:15**

Fermi-Ulam Problem for Solitons in Dynamical Cavities

N.N. Rosanov, N.V. Vyssotina; Vavilov State Optical Inst., Russia;

We analyze regular and chaotic dynamics of optical solitons and solitons of matter waves in a cavity with periodically oscillating mirrors. For wide-aperture nonlinear cavities different types of spatial vector solitons are found. Their collisions can change the soliton type.

R1. SOLID-STATE LASERS FOR SYSTEM APPLICATIONS

Congress Hall

WeR1-p01 **09:00-13:30**

Stable generation of high-power subnanosecond laser pulses

S. Gagarsky, P. Gnatyuk, M. Inochkin, K. Fedin, L. Khloponin, V. Khramov;

St.Petersburg National Research Univ. of ITMO, Russia;

A compact Nd:YAG laser with pulse energy more than 700mJ at 1064nm wavelength with individual spike duration less than 0.8ns was build. Supershort-term quasiperiodic Q-modulation of laser cavity was used for generation of stable subnanosecond pulses.

WeR1-p02 **09:00-13:30**

Picosecond Laser System 193 nm Based on Solid State ND:YAG Laser, Parametric Oscillator and ARF Amplifier.

S.P. Sadovskiy, P.A. Chizhov, V.V. Bukin, V.M. Brendel, T.V. Dolmatov, Y.N. Polivanov, S.N. Orlov, S.V. Garnov, S.K. Vartapetov; Prokhorov General Physics Inst. of RAS, Russia;

Realized method of producing high-power picosecond UV pulses at a wavelength of 193 nm. Nd: YAG laser is used, followed by radiation and nonlinear transformations in the excimer gain medium to an energy of 10 mJ, a wavelength of 193 nm.

WeR1-p03 **09:00-13:30**

High Energy 3450-4150 nm Fe:ZnS Laser

M.P. Frolov, Yu.V. Korostelin, V.I. Kozlovsky, Yu.P. Podmar'kov, S.A. Savinova, Ya.K. Skasyrsky; Lebedev Physical Inst. of RAS, Russia;

As high as 2.7 J of output energy at 3600 nm with 44% absorbed pump energy slope efficiency was demonstrated from Fe:ZnS laser operating at 85 K. With an intracavity prism, the Fe:ZnS laser was tuned from 3450 to 4150 nm.

WeR1-p04 **09:00-13:30**

Ultra low threshold gain-switched Cr:ZnSe laser

L. Gorajek, J. Jabczynski; Military Univ. of Technology, Poland;

An ultra-low threshold Cr:ZnSe laser generating pulses as short as 1.75 ns has been investigated. In a short resonator we obtained more than 0.5 mJ of output energy and 300 kW of corresponding peak power with threshold energy less than 0.01 mJ.

WeR1-p05 **09:00-13:30**

The study of a Tm:YbAG laser pumped at 1678 nm

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

The laser crystal Tm3+:Yb3Al5O12 (Tm:YbAG) was grown by the Czochralski method and was investigated under pumping by a Raman-shifted erbium fiber laser at a wavelength of 1.678 um. Absorbance and luminescence spectra were recorded and the luminescence lifetime of the upper lasing level 3F4 was measured to be 4,7 ms. Lasing of this crystal at a wavelength of 2.02 um was obtained for the first time. The laser slope efficiency reached 41% at the output power up to 330 mW at room temperature.

WeR1-p06 **09:00-13:30**

Multiwave diode pumped Q-switch ErYLF-laser

N.A. Fedorov, M.V. Inochkin, L.V. Khloponin, V.Yu. Khramov, V.V. Nazarov, D.Yu. Sachkov; St.Petersburg National Research Univ. of ITMO, Russia;

The results of theoretical and experimental investigations of spectral and power parameters of diode pumped multiwave Q-switch Er:YLF-laser are presented. The series of giant pulses on 2.66, 2.71, 2.81um wavelengths at peak power up to 100kW and pulse duration 30ns were obtained. The theoretical optimization of laser resonator to improve of laser radiation brightness and beam quality was carried out.

WeR1-p07 **09:00-13:30**

1.64 mkm Er:YAG laser resonantly pumped by a solid state Er:glass laser

V.A. Buchenkov, D.I. Zhuk, S.I. Klimentev, V.M. Polyakov, A.Yu. Rodionov, St.Petersburg National Research Univ. of ITMO, Russia;

It's reported on theoretical and experimental studies of Er +3 YAG pulsed laser working in a quasi-three-level scheme. A numerical simulation of an optical multiple laser scheme is carried out. Electro-optically Q-switched operation of an Er:YAG laser at 1645 nm end-pumped by a laser Er-Yb phosphate glass is reported. Pulse energies up to 3 mJ have been generated at a pulse repetition frequency of 10 Hz.

WeR1-p08 **09:00-13:30**

Temperature dependence of upconversion fluorescence intensity ratio of Er,Yb:YVO4 and Er,Yb:YGdVO4 crystals

M. Khodasevich[1], Y. Varaksa[1], G. Sinitsyn[1], N. Shereshovets[1], V. Aseev[2]; 1 - Stepanov Inst. of Physics of NAS, Belarus; 2 - St.Petersburg National Research Univ. of ITMO, Russia;

Green upconversion fluorescence of Er,Yb:YVO4 and Er,Yb:YGdVO4 are studied in the spectral range of 520-560 nm in the temperature range from room temperature to 150°C under 967 nm pumping. It is shown that the temperature measurement sensitivity of fluorescence intensity ratio sensors on the base of these crystals is about 0.008 K-1 and is comparable with the corresponding values for Er-doped silica fiber.

WeR1-p09 **09:00-13:30**

Spectroscopic Characterization of Eu3+:KY(WO4)2 Laser Crystal

P.A. Loiko[1], N.V. Kuleshov[1], K.V. Yumashev[1], V.I. Dashkevich[2], V.A. Orlovich[2], S.N. Bagaev[3], S.M. Vatnik[3], A.A. Pavlyuk[4]; 1 - Belarusian National Technical Univ., 2 - Stepanov Inst. of Physics of NAS, Belarus; 3 - Inst. of Laser Physics of SB RAS, 4 - Nikolaev Inst. of Inorganic Chemistry of SB RAS, Russia;

Monoclinic Eu:KY(WO4)2 laser crystals are grown by TSSG method; polarization- resolved absorption and stimulated- emission cross-section spectra are determined for this crystal. Spectroscopic properties are modeled within ASCI theory. Under UV excitation, Eu:KY(WO4)2 provides intense red emission with CIE coordinates x = 0.670, y = 0.329.

WeR1-p10 **09:00-13:30**

High Efficiency 50 mJ/1000 Hz Ho:YLF MOPA With Multi-pass Amplifier

A.F. Kornev, A.S. Narivonchik, A.L. Pavlova, V.A. Serebryakov; Lasers and Optical Systems JSC; St.Petersburg National Research Univ. of ITMO; Russia;

Two types of Ho:YLF power amplifier were investigated: three-laser-rods single-pass amplifier of 170 mm Ho:YLF total crystal length and one-laser-rod multi-pass amplifier of 50 mm length. With both amplifiers we obtained > 40 mJ at 1000 Hz repetition rate, the overall extraction efficiency reached 60 % in multi-pass amplifier, in three-laser-rods amplifier – 45 %.

WeR1-p11 **09:00-13:30**

On the possibility of solid-state 946 nm Nd:YAG laser with high peak and average power development

A.S. Davtian, A.S. Kovyarov, E.A. Pruntseva; Lasers and Optical Systems JSC, Russia;

We investigated the possibility of a solid-state 946 nm Nd:YAG laser with high peak and average power with target parameters: 70 mJ, 50 Hz development. For Q-switching we applied the electro-optical modulator, based on RKTP. In this paper we report about the enhancing of system efficiency and output energy.

WeR1-p12 **09:00-13:30**

Solid-State Blue Laser by Nonlinear Frequency Conversion of 1.338-μm Nd:YAG Laser Radiation

M.N. Ershkov[1], A.V. Gavrilov[1], S.A. Solokhin[1], S.N. Smetanin[2], A.O. Schukina[1], A.V. Fedin[1]; 1 - Kovrov State Technological Academy, 2 - Prokhorov General Physics Inst. of RAS, Russia;

Solid-state blue-laser generation by nonlinear frequency conversion of the 1.338-μm Nd:YAG laser MOPA system is experimentally investigated. The 0.446-μm blue radiation is obtained by frequency-tripling technique as the frequency doubling (0.669 μm) with the sum- frequency oscillation (1.338 μm + 0.669 μm). The blue laser pulse output energy of 2 mJ with 20-ns duration and 2-% conversion efficiency is achieved allowing for laser power scaling.

WeR1-p13 **09:00-13:30**

Passive V:YAG Q-Switching Operation of 1.34-μm Nd:YAG Laser with Loop Cavity

M.N. Ershkov[1], A.V. Gavrilov[1], A.V. Fedin[1], S.N. Smetanin[1], S.A. Solokhin[1]; 1 - Kovrov State Technological Academy, 2 - Prokhorov General Physics Inst. of RAS, Russia;

Passive Q-switching operation of the flash-lamp pumped 1.34-μm Nd:YAG laser with loop cavity is experimentally investigated. Using a passive 47-% V:YAG Q-switch the laser generated the 380-mJ trains of 260-ns laser pulses with an individual pulse energy of 27 mJ.

WeR1-p14 **09:00-13:30**

Longitudinally diode pumped Raman solid state lasers based on Gd3Ga5O12:Nd3+, Y3Al5O12:Nd3+ and KGd(WO4)2:Nd3+ active crystals

P.S. Ivanov[1,2], I.V. Mochalov[2], A.V. Sandulenko[2]; 1 - Research and Technology Inst. of Optical Material Science, 2 - St.Petersburg National Research Univ. of ITMO, Russia;

The realization of solid-state Raman longitudinally diode pumped lasers, generating first and second Stokes components has been researched. The crystals of Gd3Ga5O12: Nd3 +, Y3Al5O12: Nd3 + and KGd (WO4) 2 : Nd3+ have been applied as an active elements . The first and second Stokes component conversion was performed using intracavity Raman conversion scheme with crystals KGd (WO4) 2 and KY (WO4) 2 Raman conversion elements. The possibility of an effective solid-state Raman conversion laser with end diode pumping emitting at the wavelength of 1.3152 microns has been demonstrated.

WeR1-p15 **09:00-13:30**

1.5 μm miniature and chip longitudinally diode pumped passively Q-swiched Raman laser

P.S. Ivanov[1,2], I.V. Mochalov[2], A.V. Sandulenko[1]; 1 - Research and Technology Inst. of Optical Material Science, 2 - St.Petersburg National Research Univ. of ITMO, Russia;

The possibilities of lasing at eye-safe wave length of 1.54 μm have been studied for longitudinally diode pumped passively q-switched laser based on KGd(WO4)2:Nd3+emitting at 4F3/2-4I13/2 transition of Nd3+ ion followed by Raman self-conversion for miniature and chip cavity configuration.

WeR1-p16 **09:00-13:30**

Study of the activator impurity distribution by the length of the solid-state laser active element

S.V. Boritko; STC UI RAS, Russia;

Spectra of the Raman scattering of yttrium aluminum garnet (Y3Al5O12) doped neodymium (Nd3+) an active element of solid-state laser are given in different points by the length. Interpretation of spectrograms allowed to separate the peaks directly correlate with the crystal matrix and with impurities in it. Assuming that the intensity of the Raman scattering by ions is proportional to their concentration, the distribution of average concentration of neodymium ions and the deviation from average value along the laser element was estimated. It appeared that the neodymium ions distribution nonuniformity by the laser element length didn't exceed 9-12%.

WeR1-p17 **09:00-13:30**

Modeling of Gain Anisotropy Induced by a Linearly Polarized Pump in Nd:YAG Laser

P. Khandokhin[1], N. Milovsky[2]; 1 - Inst. of Applied Physics of RAS, 2 - Lobachevsky State Univ., Russia

We present a new model of a bipolarized laser taking into consideration the real orientation of the absorption and emission dipoles in Nd:YAG active media to describe the experimentally observed effect of the gain anisotropy induced by the linearly polarized pump

WeR1-p18 **09:00-13:30**

Two-Photon Recording of Stable Luminescent Centers in Chromone-Doped Polymer Films

A. Ayt[1],V.A. Barachevsky[1], S.V. Gagarskiy[2], V.V. Kiyko[2], O.I. Kobeleva[1], M. Krayushkin[3], A.N. Sergeev[2], A.V. Veniaminov[2], T.M.Valova[1], V.V. Zakharov[2], Hristo Iglev[4];
1 - Photochemistry Center of RAS; 2 - St.Petersburg National Research Univ. of ITMO, 3 - Zelinsky Inst. of Organic Chemistry, Russia; 4 - Technical Univ. Munich, Germany;

The study defines threshold values of energy density required for two-photon writing of stable fluorescent bit patterns within polymer layers containing chromones class chemical compounds by visual laser pulses in range of pulse widths from nanoseconds to femtoseconds. Photo-regrouping of non-luminescent chromones to fluorescent products is shown as the result of true type two-photon absorption (TPA) and stepwise TPA as well. In the latter case writing beam fluence can be reduced due to increase of the effective TPA coefficient, but laser-induced thermal damage of matrix becomes more probable too

WeR1-p19 **09:00-13:30**

Efficient and compact pulsed-periodic Cr2+:CdSe laser radiating within 2.8 and 3.3 micron wavelength range

N.G. Zakharov[1], Yu.N. Frolov[1], A.V. Muhin[1], C.V. Vorontsov[1], A.V. Larionov[1], V.A. Garyutkin[1], Yu.V. Korostelin[2]; 1 - RFNC - VNIIEF, 2 - LPI of RAS, Russia;

Cr2+:CdSe laser was used to achieve pulsed-periodic generation at 2,85 and 3,3 micron wavelengths with effective transformation of crystal-absorbed pumping, exceeding 50% and 25% correspondingly. Spectrum of the output radiation was necked using Lyot filter and absorption lines for ethanol and methanol were finely adjusted.

WeR1-p20 **09:00-13:30**

High-accuracy Sellmeier Equations for GaSxSe1-x (x=0, 0.09, 0.40, and 1)

K. Kato[1], T. Mikami[2] - ; 1 - Chitose Inst. of Science and Technology, 2 - Okamoto Optics Works, Inc.; Japan

This paper reports the high-accuracy Sellmeier equations for GaSxSe1-x (x=0, 0.09, 0.40, and 1) that provide excellent reproduction of the phase-matching angles for SHG to 5HG of CO2 laser radiation at 10.5910 μm in GaSxSe1-x (x=0, 0.40, and 1) as well as SHG of a Ti:Al2O3 laser-pumped BBO/OPG at 2.14-2.9 μm and CO2 laser radiation at 9.2-10.7 μm achieved in GaSxSe1-x (x=0.09 and 0.41).

WeR1-p21 **09:00-13:30**

Investigation of Possibility of Oscillation and Amplification of Laser Radiation in Ceramic Samples ND:YAG

E.V. Pozdnyakov, I.V. Timonin; RFNC - VNIIEF, Research Inst. of Laser Physics, Russia;

Investigation and creation of solid-state lasers based on laser ceramic lately occupies an important place in the field of laser technology. An important element of these studies is to obtain samples of transparent ceramic with a large size. The results of investigations of laser parameters Nd:YAG ceramic samples are given. Studies have helped to create laboratory oscillator prototype based on ceramic samples produced by the Institute of Electrophysics, Russian Academy of Sciences, Yekaterinburg.

WeR1-p22 **09:00-13:30**

Increase of active ions concentration in Cr:Mg2SiO4 Laser crystals by the prolonged oxidizing annealing

K.A. Subbotin[1], D.A. Lis[1], E.V. Zharikov[1], A.A. Ivanov[2]; 1 - Prokhorov General Physics Inst. of RAS; 2 - Photochemistry center RAS, Russia;

The results of our attempts to improve the characteristics of Cr:Mg2SiO4 laser crystals by the prolonged oxidizing annealing are presented in this talk. The evolution dynamics of chromium content in different oxidation states during the series of prolonged oxidizing annealings of forsterite single crystals grown in different growth conditions and having the initially different ratios of Cr2+: Cr3+: Cr4+ concentrations was studied.

WeR1-p23 **09:00-13:30**

Second harmonic generation in langasite crystal

P.G. Zverev, G.V. Shilova; Prokhorov General Physics Inst. of RAS, Russia;

The second order nonlinear susceptibility was measured in langasite crystal. It was found to be 7 times larger than that in quartz.

WeR1-p24 **09:00-13:30**

Investigation of the influence of various factors on the efficiency of upconversion processes in BaY2F8:Yb3+,Pr3+,Ce3+ with diode-pumped

A. Pushkar[1], T. Uvarova[1], E. Komarnitskaya[2], A.Uvarova[2], A.Ovchinnikov[1];
1 - Prokhorov General Physics Inst. of RAS, 2 - National Univ. of Science and Technology "MISIS", Russia;

This report presents an analysis of the parameters affecting the efficiency of up- conversion UV luminescence excitation in a single crystal BaY2F8: (Yb3+,Pr3+,Ce3+) with a diode-pumped.

WeR1-p25 **09:00-13:30**

Spectroscopic study of Pr3+-doped sodium-yttrium double fluoride crystals (Pr3+:NYF)

A.M. Tkachuk[1], S.E. Ivanova[1], A.A. Mirzaeva[2], M.F. Joubert[3], Y. Guyot[3];
1 - St. Petersburg National Research Univ. of ITMO, 2 - Vavilov SOI, Russia;
3 - Inst. Lumiére Matiére, Univ. Lyon, France

Spectroscopic characteristics of intracenter transitions in disordered crystals of sodium-yttrium double fluoride Pr3+:Na0.4Y0.6F2.2 (Pr:NYF) with cubic structure, grown by Stockbarger-Bridgeman method, are investigated theoretically and experimentally in order to evaluate their potential for application as active media of solid state lasers emitting in visible spectral range .

WeR1-p26 **09:00-13:30**

High quality dielectric coatings for solid-state lasers and laser components

V.V. Novopashin, A.V. Shestakov; RDI «Polyus», Russia;

Using only electron-beam seems to be not enough to produce high density films. The considerable improvement was observed if ion-beam source assisted technology applied. Various types of coatings that were obtained possessed with rather improvement optical and physical properties. This method was successfully used for coatings on rods and non-liner crystals in broad spectral range, from ultra-violet to far infrared region.

WeR1-p27 **09:00-13:30**

Under sampled target range Estimation in 3D Flash imaging ladar

W. Zhao, Sh. Han; School of Optoelectronics, Beijing Institute of Technology; P.R. China

The goal of this work is to enhance the under sampled target range estimate in 3D Flash imaging ladar. We develop an algorithm using an expectation maximization (EM) approach to estimate pulse-shape, point spread function and bias with a 3-D LADAR system. The range estimate accuracy is improved through fusion of 2D intensity image and 3D image data. Simulation examples show that the EM object restoration improves range estimation over traditional linear and cubic interpolator method by 50% and 45% respectively without known the point spread function. In the laboratory experiment, the EM object restoration improves range estimation by 32% and 21% over the traditional linear and cubic interpolator method respectively.

WeR1-p28 **09:00-13:30**

Gain-Switched Tm-doped Fiber Laser and Amplifier with Simultaneous Mode-Locked- Like Operation

J. Swiderski, M. Michalska, L. Galecki, W. Pichola, J. Kwiatkowski, M. Mamajek; Inst. of Optoelectronics, Military Univ. of Technology; Poland

We report on an all-fiber, fast gain-switched, Tm-doped fiber laser and amplifier system operating at 1994.4 nm. For 26 kHz repetition rate, stable 25-ns pulses with an energy of 0.28 mJ corresponding to a peak-power of 10.5 kW were achieved. Gain-switched pulses with simultaneous mode-locked-like operation were also demonstrated. The peak-power of the highest subpulses from the train was over 30 kW.

WeR1-p29 **09:00-13:30**

High repetition rate Q-switched Ho:YLF laser pumped by Tm:fiber laser

J. Kwiatkowski, W. Zendzian, J.K. Jabczynski, M. Kaskow, L. Gorajek; Military Univ. of Technology, Poland;

A study of Ho:YLF laser in continuous-wave (CW) and Q-switched operation, single- pass end-pumped by a Tm: fiber laser is presented. For 1 kHz PRF (pulse repetition frequency), pulse energies of 5.7 mJ with a 11 ns FWHM pulse width corresponding to almost 520 kW peak power were recorded. The laser operated at the wavelength of 2050.08 nm delivering a near- diffraction-limited beam with M2 values of 1.05 and 1.09 in the x and y directions, respectively.

WeR1-p30 **09:00-13:30**

A highly efficient compact Yb:KYW laser

S.A. Kuznetsov, V.S. Pivtsov; Inst. of Laser Physics SB RAS, Russia;

A promising scheme of ytterbium mode-locked laser using a multimode pump source has been developed. Record differential efficiency (40%) and full optical efficiency (35%) have been obtained. This makes it possible to develop compact laser systems, such as precision mobile femtosecond synthesizers. The characteristics of the laser and ways of improving its efficiency are discussed.

WeR1-p31 **09:00-13:30**

Diode-side-pumped, Nd:YVO4 slab laser with four-wave mixing resonator

M. Kaskow, W. Zendzian, L. Gorajek, Lukasz Galecki, J. Kwiatkowski, M. Piasecki, K. Kopczynski, J.K. Jabczynski; Military Univ. of Technology, Poland;

Diode-side-pumped, self-adaptive Nd:YVO4 slab laser with near diffraction-limited output is reported. Pulse energy of 26 mJ with slope efficiency 28.4 % and M2 parameter less than 1.7 was obtained

WeR1-p32 **09:00-13:30**

Investigations of room temperature, diode-side-pumped Yb:LuAG slab laser

M. Kaskow[1], L. Gorajek[1], Lukasz Galecki[1], M. Piasecki[1], J. Kwiatkowski[1], W. Zendzian[1], Krzysztof Kopczynski[1], Jan K. Jabczynski 1; Helena Jelinkova[2], Ja Sulc[2], M. Nemec[2]; 1 - Inst. of Optoelectronics, Military Univ. of Technology, Poland; Faculty of Nuclear Physics and Physical Electronics, Czech Technical Univ., Czech Republic;

High gain, side pumped by fast axis collimated laser diode stack, Yb:LuAG slab laser was examined. 87 mJ of energy with 20.9 % slope, small signal gain of 6.1 was demonstrated in room temperature

WeR1-p33 **09:00-13:30**

Passive Q-switched Nd:YAG single-frequency laser with tunable pulse shape and pulse duration

V. Pokrovsky, S. Terekhov, S. Sobolev, A. Davtian; Vavilov State Optical Inst., Russia;

The stable Nd:YAG laser with 12mJ@100Hz and M2<1.2 was designed. RMS fluctuation of pulse energy was less than 1%. Pulse shape was set by unloads Cr4+:YAG polarizing output alignment. For pulse duration tuning the Cr4+:YAG orientation was used. The optical-to-optical efficiency of 14% was achieved.

WeR1-p34 **09:00-13:30**

3 mJ@3.3 kHz single mode single-frequency end pumped pulsed Nd:YAG ring laser

A.S. Davtian, Z. V. Gorelova, V.P. Pokrovskyi, S.S. Sobolev, S.S. Terekhov; Vavilov State Optical Inst., Russia;

Solid-state end pumped Nd:YAG ring laser with electro-optical Q-switch at wavelength 1.064 microns was designed. 3 mJ pulse energy and 10 ns pulse duration was achieved at repetition rate 3300 Hz. Single-frequency and unidirectional performance of laser is provided with injection seeding. End overheating of active rod and thermo-optic distortions were reduced or compensated. Pumping is provided by two high-power laser diode modules coupled in high-brightness fiber.

WeR1-p35 **09:00-13:30**

A modern CW DPSS-laser for Raman spectrometric method of wood identification

R.V. Balmashnov, St.Petersburg National Research Univ. of ITMO, Russia;

The paper concerns the problems of construction a solid-state lasers with diode pumping tailored for Raman spectrometric method of identification of wood and, probably, other organic objects. The main emphasis is on the laser's optics and modern electronics. Also the proposals for the selection of the individual components of the laser and the issues associated with their correct layout and configuration are described.

WeR1-p36 **09:00-13:30**

Robust eye-safe compact laser

V.M. Polyakov[1], V.V. Vitkin[1], V.A. Buchenkov[2], A.U. Rodionov[2]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Vavilov State Optical Inst., Russia;

A compact eye-safe laser for atmosphere lidar was developed. The device is Nd:YLF laser with KTP OPO, wavelength is 1,54 μm, repetition rate is 50 Hz and Q-switched pulse energy is 8 mJ. The laser rod and laser diodes are conductive cooled. The device has run tests with 5^10+5 shots without parameter decrease

WeR1-p37 **09:00-13:30**

Numerical Simulation of a Passive Q-Switching Operation of the Diode-Pumped Solid- State Laser with a Multiloop Self-Phase-Conjugate Cavity

M.N. Ershkov[1], A.Yu. Vasiliev[1], S.N. Smetanin[2], A.V. Fedin[1], V.F. Lebedev[3], A.P. Pogoda[3], A.S. Boreysho[3]; 1 - Kovrov State Technological Academy; 2 - Prokhorov General Physics Inst. of RAS; 3 - Baltic State Technical Univ., Laser Systems LTD, Russia;

Numerical simulation of a passive Q-switching operation in the multiloop self-phase- conjugated Nd:YAG laser pumped by 2D diode stacks is carried out. The Q-switching operation is caused firstly by gain-grating diffraction efficiency modulation that is intensified and stabilized by modulation of the passive Q-switch transmission.

WeR1-p38 **09:00-13:30**

Laser parameters measuring devices

A.N. Lobanov, O.V. Chesnokova; «Electrosteklo Ltd»; Russia

The line M2 of power an energy meters, based on photodiodes, pyroelectric and thermal sensors affords measurements of power in the range from 10pW up to 30KW, laser pulse energy in the range from 2 nJ up to 40 J. All the devices are calibrated against the NIST standards. Laser beam profilers in the visual and near IR range based on the CCD camera provide the dynamical range of 61 dB, spatial resolution of 4 microns and linearity 1%. Pyroelectric camera cover the range 13-355 nM and 1.06-3000 micrometers with spatial resolution 30 micrometers. The dynamical range is 1000:1.

R4. LASER BEAM CONTROL

Congress Hall

WeR4-p01 **15:00-19:00**

Contrast Inversion by Focusing Laser Beam in an Absorbing Medium

*E.L. Bubis, V.V. Lozhkarev, I.E. Kozhevatov, V.O. Martynov, D.E. Silin, A.N. Stepanov, S.A. Gusev *; Inst. of Applied Physics of RAS, * Inst. for Physics of Microstructures of RAS; Russia*

Method for obtaining an inverted brightness image of opaque objects is described. Obtained transformation to a positive image up to 350%, relative to the intensity of the incident beam, is in agreement with numerical calculations.

WeR4-p02 **15:00-19:00**

Filled-aperture Coherent Summation Technique for Multiple High Average Power Laser Beams

G. Khosrovian[1], S. Taniguchi[1], M. Fujita[1], Y. Izawa[1], K. Tsubakimoto[2], H. Yoshida[2], N. Miyanaga[2]; 1 - Inst. for Laser Technology, ALPROT, 2 - Inst. of Laser Engineering; Japan

Single-detector, filled-aperture coherent beam combining technique for CW and high repetition rate ns pulse laser beams has been proposed. Proof of principle experiments have been performed for four beams. The combining efficiency for the present laser system was estimated to be 0.9. The proposed CBC technique can accommodate kW level average power beams, be integrated into various MOPA architectures and perform with high speed and accuracy.

WeR4-p03 **15:00-19:00**

Holographic medium for the mid-IR narrow-band filters

A.S. Shcheulin, A.E. Angervaks, A.I. Ryskin; St.Petersburg National Research Univ. of ITMO, Russia;

Holographic medium for fabrication of narrow-band holographic filters for mid-IR spectral range is proposed. It can be used for stabilization of diode lasers radiation.

WeR4-p04 **15:00-19:00**

Propagation and focusing of modes of the dielectric resonator of terahertz laser

O.V. Gurin, A.V. Degtyarev, V.A. Maslov, V.S. Senyuta, V.A. Svich, A.N.Topkov; Karazin Kharkov National Univ., Ukraine;

Theoretically on the basis of the vectorial Rayleigh-Sommerfeld theory and experimentally using terahertz radiation of the waveguide laser the physical features of propagation and «moderate» or «sharp» focusing of laser beams of radiation are investigated in free space which described by modes of circular hollow dielectric waveguide with different spatial polarization.

WeR4-p05 **15:00-19:00**

Influence of distortions on quality of radiation generated by multichannel optical system

F. Kanev[1], E. Tsyro[1], O. Antipov[2]; 1 - Zuev Inst. of Atmospheric Optics of SB RAS, 2 - Inst. of Applied Physics of RAS; Russia

Analysis of modern coherently-combined multichannel optical systems is presented in the report along with the results of numeric simulation of radiation propagation under conditions of free diffraction and in a turbulent atmosphere. Specifically, the distance is defined on which application of the optical system to transfer energy is feasible. Also influence of aberrations developed in the system is assessed on the quality of radiation on the object as well as possibility to compensate for these aberrations with adaptive optics methods.

WeR4-p06 **15:00-19:00**

High-resolution Shack-Hartmann sensor for measuring variations of high-power laser beams

A.G. Poleshchuk[1], A.G. Sedukhin[1], V.V. Cherkashin[1], V.G. Maksimov[2], V.A. Tartakovsky[2], V.I. Trunov[3]; 1 - Inst. of Automation and Electrometry of SB RAS, 2 - Inst. of monitoring climatic and ecological systems of SB RAS, 3 - Inst. of Laser Physics of SB RAS, Russia;

A high-resolution Shack-Hartmann sensor is developed, which enables one to perform the fast time sampling and measuring both the wavefronts and the intensity distributions of high power lasers over the square entrance pupils up to 15x15 mm. The sensor has a flexible program interface with two built-in algorithms for reconstructing the laser wavefronts.

WeR4-p07 **15:00-19:00**

Optimization of structuring silicon-based thin film solar modules using means of laser scribing

D.N. Redka[1], V.A. Parfenov[1], V.P. Afanasjev[1], A.V. Kukin[1], F.S. Egorov[3], A.S. Grishkanich[1,2]; 1 - St.Petersburg Electrotechnical Univ. «LETI»; 2 - St.Petersburg National Research Univ. of ITMO, 3 - Chuvash State Univ., Russia;

At the moment search, production and use of renewable energy sources is a very actual task. One of approaches, which allow to resolve this problem is development of high-effective thin-film solar cells based on silicon. Recently laser technologies have been widely used to increase energy conversion efficiency. However some disadvantages of use of laser processing are that the areas of the solar cell, treated by laser, become unable to participate in the transformation of energy. Therefore, it is, necessary to minimize the area of the solar cell treated by laser.

WeR4-p08 **15:00-19:00**

Interferometric measurements of optical inhomogeneities in an alkali vapor laser active medium

A.A. Babin, O.I. Beloshitskaya, V.A. Bogachev, S.G. Garanin, G.N. Kachalin, A.V. Kopalkin, S.M. Kulikov, A.S. Safronov, F.A. Starikov, S.A. Sukharev, V.V. Feoktistov, V.A. Shotniev; RFNC - VNIIEF, Russia;

The results of measurements of optical inhomogeneities in a cesium vapor laser active medium by means of a Michelson interferometer are presented.

WeR4-p09 **15:00-19:00**

Investigation of the laser beam smoothing system using optical waveguide

V.N. Derkach, D.V. Sizmin, P.V. Starodubtsev; RFNC - VNIIEF, Russia;

We conducted simulations and experimental research in system of spatial and temporal laser beam smoothing based on the incoherency induced in the multimode optical fiber. The propagation of partially coherent light through the amplification path is studied.

WeR4-p10 **15:00-19:00**

Influence of Zeeman laser gyro optical circuit deformation on its drift.

Yu.Yu. Broslavets, E.A. Polukeev, A.A. Fomichev; Moscow Inst. of Physic and Technology, Russia;

In this article we study the effect of the optical circuit deformation of nonplanar Zeeman laser gyro cavity on its accuracy. It's defined the degree of influence of various factors on gyro drift at the displacement of optical circuit.

WeR4-p11 **15:00-19:00**

Tilt corrector based on bimorph piezolectric actuators

V.V. Kijko[1,2], A.G. Suzdal'tsev[1], D.A. Mikhaylov[1, 2]; 1 - Prokhorov General Physics Inst. of RAS; 2 - St.Petersburg National Research Univ. of ITMO, Russia;

This work is devoted to fast wavefront tilt corrector (tip/tilt mirror) that can be applied in Free Space Optic (FSO) equipment or laser beam stabilization systems. Wavefront corrector is compact; it's light aperture 25mm and frequency range 0 to 700 Hz at whole dynamic range.

WeR4-p12 **15:00-19:00**

Formation of Predefined Microrelief of Optical Surface by Coating Deposition through Laser Pyrolysis of Organosilicon Vapor

A.Yu. Golyaeva[1], E.V. Dorofeeva[2], P.Yu. Lobanov[1], I.S. Manuylovich[1], O.E. Sidoryuk[1]; 1 - RDI «Polyus»; 2 - Shemyakin and Ovchinnikov Inst. of Bioorganic Chemistry of RAS, Russia;

This paper deals with the development of technology of predetermined optical surfaces microrelief formation. The technology may be applied to glass-ceramic substrates for different reflectors and mirrors. The possibilities of technology for optical surfaces modification are considered by means of varying coating thickness through local deposition of silicon dioxide film because of laser pyrolysis of tetraethoxysilane vapors.

WeR4-p13 **15:00-19:00**

Sub-nano precision optical surfaces, thin films, heterostructures and laser mirrors

V. Azarova, T. Tsvetkova, V. Fokin; RDI «Polyus», Russia;

There are analyzed the light measurement methods used in the technological processes of the precision laser mirrors and the laser heterostructures creation. These methods are light scattering (LS), white light interferometry (WLI), spectroscopic ellipsometry (SE) and variable angle spectroscopic ellipsometry (VASE). All these methods are nondestructive powerful technique to investigate the optical response of materials and to measure precision substrates surfaces parameters, such as roughness and shape, and to measure simultaneously the layers thickness, composition and dielectric parameters of multilayer systems.

R6. NANOPHOTONICS AND BIOPHOTONICS

Congress Hall

WeR6-p02 **15:00-19:30**

Definition of covalence parameters in trigonal systems on optical spectrum

A. Kornienko[1], E. Dunina[1], L. Fomicheva[2]; 1 - Vitebsk State Technological Univ., 2 - Belarusian State Univ. of Informatics and Radioelectronics, Belarus;

For the Pr3+ doped trigonal systems it is shown, that the application of a new crystal field Hamiltonian allows not only essentially to improve description of Stark multiplet splitting, but also to define the covalence parameters and odd symmetry crystal field parameters on optical spectrum. In the new Hamiltonian the influence of excited configurations with a charge transfer and opposite parity configurations is in more details taken into account.

WeR6-p03 **15:00-19:30**

Hybrid nanofilms with laser-control luminescence

R. Saifutyarov, A. Khomyakov, A. Akkuzina, R. Avetisov, O. Petrova, I. Avetissov; Mendeleyev Univ. of Chemical Technology, Russia;

Hybrid material films were produced by layer-by-layer thermal vacuum sputtering of 50 nm Alq3, 50 nm B2O3, and 100 nm Al on a glass substrate. Photoluminrscence properties of as- prepared and laser beam (785 mn) treated films showed the significant difference which allowed to form 3D mapping of PL intensity

WeR6-p04 **15:00-19:30**

Spectral properties of CdTe-CdSe powders with controlled nonstoichiometry

A. Khomyakov, E. Mozhevitina, V. Kuzmin, N. Konjkova, I. Avetissov; Mendeleyev Univ. of Chemical Technology, Russia;

Intensity of radiosity spectra at 1000-1100 nm wavelength regions of powdered preparation of CdTe and CdSe depend on preparation's non-stoichiometry.

WeR6-p05 **15:00-19:30**

Effect of micro deformation on photonic bandgap fibre transmission

A. Plastun, A. Konukhov; Saratov State Univ.; Russia

A vectorial Fourier based beam propagation method is applied for modelling of transmission spectrum of solid-core photonic band gap fibre. Attenuation spectrum of photonic band gap fibre is calculated directly from the propagation analysis.

WeR6-p06 **15:00-19:30**

Transparent glass-ceramics doped with Nd3+ or Er3+ based on lead-barium fluoroborate

O.B. Petrova, T.S. Sevostjanova, M.O. Anurova, A.V. Khomyakov; Mendeleyev Univ. of Chemical Technology, Russia;

Lead-barium fluoroborate (PbF2–BaF2–B2O3) glasses doped with RE (Nd3+ or Er3+) were synthesized and researched. Glass-ceramics, where the ions RE are hosted by fluoride crystal nanoparticles embedded in borate glass, made by heat-treatment. The changes in the structural and optical properties of the glass-ceramics comparatively to initial glasses were revealed by X-ray diffraction, Raman spectroscopy and luminescence spectroscopy of RE ions. Spectral properties of polycrystalline fluoride containing Pb, Ba and RE are investigated also.

WeR6-p07 **15:00-19:30**

Bismuth-germanium oxide glasses and glass-ceramics doped with Nd3+ or Yb3+

I.V. Stepanova, A.V. Khomyakov, K.G. Gavrish; Mendeleyev Univ. of Chemical Technology, Russia;

The glass-ceramics containing ferroelectric and non-linear optic Bi2GeO5-phase was created by the heat-treatment of 1Bi2O3-1GeO2 glasses doped with rare-earth ions (Nd3+ or Yb3+). Both glasses and glass-ceramics were researched by X-ray diffraction analysis, optical and luminescence spectroscopy methods.

WeR6-p08 **15:00-19:30**

Transparent Cr:LiGaSiO4 nano-glass-ceramics as the promising laser material

K.A. Subbotin, V.V. Voronov, D.A. Nikolaev, E.V. Zharikov; Prokhorov General Physics Inst. of RAS, Russia;

The fabrication technology of transparent Cr:LiGaSiO4 nano-glass-ceramics was optimized after the investigation of the crystallization dynamics of Cr-Li-Ga-Si-O precursors. The samples with increased Cr4+ content are obtained

WeR6-p09 **15:00-19:30**

Microscopic approach to calculation of the spontaneous decay of an excited atom located near an atomic cluster

A.S. Kuraptsev, I.M. Sokolov; St.Petersburg State Polytechnical Univ.; Russia

We report the microscopic method for the calculation of the spontaneous decay of an excited atom located near a nanoparticle. The spontaneous decay dynamics, the atomic transition line shape as well as its shift have been analyzed. Different form, sizes and densities of the atomic cluster have been considered.

WeR6-p10 **15:00-19:30**

Laser Diagnostics of Dispersive Systems with Supercritical Component

S. Chekmasov, D. Zimnyakov; Saratov State Technical Univ.; Russia

Proposed a novel approach to diagnostics of nanostructured multiphase systems with supercritical components with the use of statistical and correlation analysis of speckle-modulated laser light.

WeR6-p11 **15:00-19:30**

Transient photoluminescence from semiconductor nanodumbbells

M.Yu. Leonov[1], I.D. Rukhlenko[1,2], A.S. Baimuratov[1], A.V. Baranov[1], A.V. Fedorov[1]; 1 - St.Petersburg National Research Univ. of ITMO, Russia; 2 - Monash Univ., Australia;

We developed the theory of time-resolved secondary emission from semiconductor nanodumbbells. We reveal conditions that the signal of secondary emission is described by a simple formula regardless of the pulse shape. This formula may prove useful for studying the dephasing and relaxation parameters of the nanodumbbell electronic subsystem.

WeR6-p12 **15:00-19:30**

Nonlinear optical properties of open-ended armchair single-wall carbon nanotubes (SW-CNT)

I.L. Plastun, D.A. Zimnyakov, A.N. Bokarev, S.A. Yuvchenko; Gagarin State Technical Univ., Russia;

Optical properties of carboxylic acid functionalized open-ended armchair single-wall carbon nanotubes (SW-CNT) are studied by numerical simulations and in experiments. The polarizability, extinction, saturated absorbance and non-linear refraction are analyzed in various conditions for different types of SW-CNT and compared with experimental data.

WeR6-p13 **15:00-19:30**

Phonon-induced photoluminescence from a single quantum dot in the regime vibrational resonance

A.S. Baimuratov[1], V.K. Turkov[1], M.Yu. Leonov[1], Yu.K. Gun'ko[1], A.V. Baranov[1], A.V. Fedorov[1], I.D. Rukhlenko[2], 1 - St.Petersburg National Research Univ. of ITMO, Russia; 2 - Monash Univ., Australia;

We develop a theory of phonon-induced photoluminescence from a quantum dot in the regime of vibrational resonance. Using the generalized model for renormalization of the quantum dot's energy spectrum and the density matrix formalism, we derive an expression for the differential cross-section of the phonon-induced photoluminescence from a quantum dot.

WeR6-p14 **15:00-19:30**

Numerical studies of the photosynthetic reaction center femtosecond transient absorption

R.Y. Pishchalnikov, S.M. Pershin; Prokhorov General Physics Inst. of RAS, Russia;

Femtosecond transient absorption spectroscopy is an effective technique to study fast chemical reactions and the energy transport in the reaction centers isolated from photosynthetic organisms. In order to get a proper fit of the pump-probe kinetics up to 10 ps, the Redfield relaxation theory had been taken into account. The proposed mechanism that allows explanation of specific modulations of stimulated emission at 900 nm and 940 nm is discussed in detail.

WeR6-p15 **15:00-19:30**

Investigation of open-ended armchair single-wall carbon nanotubes (SWCNT) properties by numerical simulations

A.N. Bokarev, I.L. Plastun; Gagarin State Technical Univ., Russia.;

Properties of armchair single-wall carbon nanotubes (SW-CNT) with carboxylic group are investigated by numerical simulation. The tenzor of polarizability, extinction spectra, saturated absorbance and non-linear refraction are analyzed for various positions of carboxylic group (COOH) and different types of SW-CNT.

WeR6-p16 **15:00-19:30**

Synthesis and study of barium fluoride powder doped with scandium as scintillation ceramics charge

M.N. Mayakova[1], P.P. Fedorov[1], S.V. Kuznetsov[1], V.V. Voronov[1], A.E. Baranchikov[2], P.A. Rodnyi[3]; 1 - Prokhorov General Physics Inst. of RAS, 2 - Kurnakov Inst. of General and Inorganic Chemistry of RAS, 3 - St. Petersburg State Polytechnical Univ.; Russia

Nanopowders of barium fluoride doped scandium were synthesized and studied. The fast component of emission was improved as well as slow component was suppressed with scandium doping into barium fluoride matrix. Variations of the synthesis conditions also affected the intensity ratio fast and slow component of emission.

WeR6-p17 **15:00-19:30**

Free-base and metallated bis-tetraphenylporphyrin covalent ensembles for optical power limiting

I.M. Kislyakov[1], I.M. Belousova[1], S.A. Povarov[1], I.S. Sheiko[1], A.S. Konev[2], D.A. Lukyanov[2], A.F. Khlebnikov[2]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - St.Petersburg State Univ.; Russia;

Nonlinear absorption of metallated tetraphenylporphyrin (TPP), halogene substituted TPP and bis-TPP covalent ensembles is studied in a wide spectral range of visible and infrared light. Advantages of complexation with Pb and pi-conjugation of bis-porphyrin ensembles for reverse saturable and two-photon absorptions were demonstrated. The compounds are useful for optical power limiting applications.

TECHNICAL SESSION

R1. SOLID-STATE LASERS FOR SYSTEM APPLICATIONS

Petrov-Vodkin 1 Hall

Session Chair: 09:00-13:30 L.N. Soms, Vavilov State Optical Inst., Russia
15:00-17:00 A. Arie, Tel-Aviv University, Israel

ThR1-16 Invited **09:00-09:30**

Adiabatic Frequency Conversion

A. Arie; Tel-Aviv Univ., Israel;

Adiabatic frequency conversion is a nonlinear process in which the coupling between the interacting waves changes slowly with respect to the internal system dynamics. It enables efficient (near 100%) scalable broadband frequency conversion using a single adiabatic process, as well as complete frequency conversion through an opaque intermediate level by multiple adiabatic processes.

ThR1-17 **09:30-09:45**

Dual-wavelength laser emitting at 1617 nm and 1645 nm in a resonantly pumped Er:YAG laser

R. Wang, Q. Ye, M. Gao, W. Li, L. Liu, Ch. Gao; Beijing Inst. of Technology; P.R. China

Dual-wavelength laser emitting at 1617 nm and 1645 nm in a resonantly pumped Er:YAG laser is reported. An 8 mm thick uncoated etalon was inserted to optimize 1617 nm and 1645 nm oscillation. The laser yielded 1.06 W dual-wavelength output at an incident pump power of 5.06 W.

ThR1-18 **09:45-10:00**

Laser Properties of In-band Pumped Er:YVO4 and Er:KY(WO4)2 Crystals

K.N. Gorbachenya[1], V.E. Kisel[1], A.S. Yasukevich[1], N.V. Kuleshov[1], A.A. Pavlyuk[2], V.N. Matrosov[3]; 1 - Center for Optical Materials and Technologies; 2 - Nikolaev Inst. of Inorganic Chemistry of SB RAS, 3 - Solix Ltd; Belarus

Efficient continuous-wave laser operation of in-band pumped Er3+:YVO4 and Er3+:KY(WO4)2 crystals was demonstrated. Maximum slope efficiency of 61 % and output power of 50 mW at 1603 nm was obtained for Er3+:YVO4 crystal, for Er3+:KY(WO4)2 crystal maximum slope efficiency of 27 % with output power of 35 mW at 1609 nm was realized.

ThR1-19 **10:00-10:15**

Pulse Periodic 1.54 μm Raman Laser Based on Atermal KGW:Nd3+ Active Element

V.N. Ivanov2, A.V. Sandulenko2, E.K. Serdyuk1, O.B. Storoshuk3, A.N. Titov1, I.V. Mochalov[1]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Research and Technology Inst. of Optical Material Science, 3 - Research and Production Company «Karat», Russia

The experimental comparative studies of thermal optical distortion are presented for standard-cut and athermal-cut KGd(WO4)2:Nd3+ active rods. It has been shown that at similar pumping conditions the cline deformation is considerably lower for athermal-cut KGd(WO4)2:Nd3+toward standard-cut active rod. The comparison was performed for lasing properties in Raman self-conversion laser at the wave length of 1.54 micron.

ThR1-20 **10:15-10:30**

BaWO4 Intracavity Pumped Eye-safe Raman Laser

K. Nejezchleb[1], N. Kapitch[1], V. Škoda[1], H. Jelínková[2], L. Koubíková[2], Ja. Šulc[2], P. Bohácek[3], Z. Remešc[3]; 1 - Crytur Ltd., 2 - FNSC CTU Prague, 3 - Inst. of Physics; Czech Republic

We present a compact Raman laser emitting short pulses with high energy in the wavelength region of 1.5 μm. We utilize intracavity conversion of giant pulses at the wavelength of 1.34 microns in a BaWO4 Raman crystal. For pumping energy of 28 J, stable vertically polarized generation of the 1st Stokes radiation at 1528 nm was reached. The output energy of 9.7 mJ in 1.9 ns pulses was reached in single mode operation.

ThR1-21 **10:30-10:45**

Testing of Cr:ZnSe Laser with Intracavity Methane Cell in 77-300 K Temperature Range

M.K. Tarabrin[1], M.P. Frolov[2,3], M.A. Gubin[2], A.N. Kireev[2], Yu.V. Korostelin[2], V.I. Kozlovsky[2], V.A. Lazarev[1], A.B. Pniov[1], Yu.P. Podmar'kov[2,3], D.A. Shelestov[1], A.S. Shelkovnikov[2], D.A. Tyurikov[2]; 1 - Bauman Moscow State Technical Univ., 2 - Lebedev Physical Inst. of RAS, 3 - Moscow Inst. of Physics and Technology, Russia;

The mid-IR cw tunable solid state two-mode Cr2+:ZnSe laser with intracavity methane cryocell was developed. The laser was applied for sub-Doppler spectroscopy of (ν1+ν4) vibrational-rotational band of methane and observation of narrow resonances of saturated dispersion at λ = 2.36 μm. The new technique of low pressure methane gas cooling was used instead of liquid nitrogen "jacket" design applied in our previous work. Parameters of saturated dispersion resonances were estimated in 77-300 K temperature range. The experiments confirmed that laser with the new "dry cooled" methane cell has prospectives for reaching a short-term frequency stability at the level of 10^15 – 10^16 and can be used as a compact device

ThR1-22 **10:45-11:00**

High-efficiency oscillations at 1940 nm and 2070 nm in diode-pumped Tm:Lu2O3 ceramics lasers and their OPO frequency conversion

O.L. Antipov[1], A.A. Novikov[1], I.D. Eranov[1], D.B. Kolker[2]; 1 - Inst. of Applied Physics of RAS, 2 - Novosibirsk State Technical Univ., Russia;

CW and repetitively-pulsed oscillations at 1940 nm or 2070 nm in diode-pumped Tm:Lu2O3 ceramics lasers were studied and optimized. Mid-IR optical parametric oscillators based on AgGaSe or ZnGeP nonlinear crystals pumped by the Tm:Lu2O3 laser radiation were examined.

-COFFEE BREAK -

ThR1-23 **11:30-11:45**

100 mJ/100 Hz Mid-IR laser source

A.G. Kalintsev, U.V. Katsev, A. F. Kornev, A. S. Narivonchik, D.O. Oborotov, A. L. Pavlova, V.P. Pokrovskyi, V. A. Serebryakov, V.K. Stupnikov, S.S. Terekhov; Vavilov State Optical Inst., Russia;

Two pulsed lasers: 1.064 μm Nd:YAG and 2.05 μm Ho:YLF were used to pump KTP OPA and ZGP OPO/OPA system. The result laser source provided 100 mJ/100 Hz output in 3.5-5 μm range with the beam quality M2 ~ 5-8. The conversion efficiency achieved values up to 70% for KTP OPA and 40% for ZGP OPA.

ThR1-24 **Invited** **11:45-12:15**

Europium-Doped Double Tungstates: Novel Crystals for Visible Lasers

P.A. Loiko[1], N.V. Kuleshov[1], K.V. Yumashev[1], V.I. Dashkevich[2], V.A. Orlovich[2], S.N. Bagaev[3], S.M. Vatnik[3], A.A. Pavlyuk[4]; 1 - Belarusian National Technical Univ., 2 - Stepanov Inst. of Physics of NAS, Belarus; 3 - Inst. of Laser Physics of SB RAS, 4 - Nikolaev Inst. of Inorganic Chemistry of SB RAS, Russia;

Crystal growth, optical absorption and stimulated-emission are studied for Eu-doped monoclinic double tungstates, KRE(WO4)2 (with RE = Gd or Y). Free-running and Q-switched pulsed visible (702.8 nm, 5D0->7F4 transition) lasers, as well as quasi-CW and real-CW ones are realized with this crystal family, for the first time, to our knowledge.

ThR1-25 **12:15-12:30**

Up-conversion on the low concentrated rare-earth ions in KGW crystal

I.A. Khodasevich[1] A.S. Grabtchikov[1], A.A. Kornienko[2], E.B. Dunina[2]; 1 - Stepanov Inst. of Physics of NAS, Belarus, 2 - Vitebsk State Technological Univ., Belarus;

We discuss results of investigations of up-conversion on residual Er ions in KGW crystal. Concentration of Er ions was measured and possible channels of up-conversion were considered.

ThR1-26 **12:30-12:45**

Specific properties and optical anisotropy parameters measurements of BaF2 and SrF2 materials

I. L. Snetkov, A. I. Yakovlev, O. V. Palashov; Inst. of Applied Physics of RAS, Russia;

Optical anisotropy parameter of the material determines thermally induced birefringence in the optical element, its dependence on the direction of the crystallographic axes and the feasibility and effectiveness of compensation of thermally induced birefringence. Using the original method, the optical anisotropy parameters of the BaF2 and SrF2 materials were measured, which with the experimental accuracy at room temperature coincided and amounted –0.34. Numerical comparisons of the effectiveness of various compensation schemes of thermally induced depolarization depending on the parameter of the optical anisotropy were done.

ThR1-27 **12:45-13:00**

Spectroscopic and laser properties of Tm3+ ions in fluoride crystals and ceramics.

M.E. Doroshenko[1], V.A. Konyushkin[1], N.A. Nakladov[1], P.P. Fedorov[1], V.V. Osiko[1], K.A. Martynova[1], H. Jelinkova[1], J. Sulc[1]; 1 - Prokhorov General Physics Inst. of RAS, Russia; 2 - Czech Technical Univ., Czech Republic;

Fluoride crystals and ceramics doped with Tm3+ ions were developed and spectroscopic and laser properties in 2 μm spectral region were investigated. Slope efficiency about 20% was demonstrated in 2 μm spectral region under 790 nm laser diode pumping.

ThR1-28 **13:00-13:15**

Laser Properties Of Thulium Doped Calcium Fluoride Crystal

A.A. Lyapin[1], P.A. Ryabochkina[1], A.N. Chabushkin[1], S.N. Ushakov[2], P.P. Fedorov[2]; 1 - Ogarev Mordovia State Univ., 2 - Prokhorov General Physics Inst. of RAS, Russia;

Room temperature laser operation of thulium doped calcium fluoride single crystal was obtained around 1890 nm. The crystal was pumped laser diode at about 798 nm. A slope efficiency of 20 % is achieved.

ThR1-29 **13:15-13:30**

The special aspects of neodymium and copper-containing phosphate glasses production for large-scaled disk active elements of power high-energy lasers and radiation amplifiers.

L.I Avakyants[1], V.I. Arbuzov[1,2], M.V. Voroshilova[2], A.V. Dmitryuk[2], A.N. Ignatov[1], S.I. Kramarev[2], E.Yu. Krekhova[1], S.I. Nikitina[2], A.E. Pozdnyakov[1], V.F. Surkova[1], Yu.K. Fyodorov[2]; 1 - JSC LZOS, 2 - Research and Technology Inst. of Optical Material Science, Russia;

The necessity of creating the power high-energy radiation amplifiers requires the production of increasingly large disk active elements (DAE). Increasing the size of the required DAE leads to certain problems while their multistage production. Some of them, primarily related to the terms of melting were reviewed.

-BREAK FOR LUNCH -

ThR1-30 **15:00-15:15**

Specific aspects of figuring the large-scale disc active elements for lasers and power high energy amplifiers

M. Abdulkadyrov, A. Azerbaev, N. Dobrikov, E. Kurakina, V. Patrikeev, A. Semenov, I. Sudarikov, Y. Sharov; JSC LZOS, Russia;

The main stages of figuring the large-scaled disc active elements (DAE) from laser phosphate glass include: milling and preliminary polishing the DAE and cladding elements; gluing the DAE with additional elements (claddings); grinding, polishing and finishing the flat surfaces of DAE; testing the figure of transmitted wavefront and other optical parameters in special testing benches; final DAE certifying.

ThR1-31 **15:15-15:30**

Analytic solution for multichannel fiber Bragg grating

A.V. Nemykin[1], D.A. Shapiro[1], S. V. Perminov[2]; 1 - Inst. of Automation and Electrometry of SB RAS, 2 - Rzhanov Inst. of Semiconductor Physics of SB RAS, Russia;

The principle of discrete Fourier transform is applied to minimize the maximum absolute value of coupled mode coefficient for multichannel FBG. Phase constants for each uniform grating imprinting in one fiber core section are found analytically. The described approach allows refractive index optimization of multichannel FBG with arbitrary number of equidistantly distributed spectral peaks.

ThR1-32 **15:30-15:45**

Three Methods for Calculation of Thermally Induced Beam Distortions in Laser Ceramics

A.G. Vyatkin, E.A. Khazanov; Inst. of Applied Physics of RAS, Russia;

Methods for calculating thermally induced beam distortions in laser ceramics are discussed. The ranges of applicability and the quantities calculated are compared.

ThR1-33 **15:45-16:00**

Compact stable passively Q-switched flash lamp pumped Nd:YAG laser with Graded Reflectivity Mirror

N. Kapitch, K. Nejezchleb, V. Škoda; Crytur Ltd.; Czech Republic

In this article we present a compact stable passively Q-switched Nd:YAG laser resonator with natural cooling. The major advantage of this laser is beam profile with rather small divergence which could be reached by applying a Graded Reflectivity Mirror as an output coupler in the laser cavity. In this work we show the testing of such a laser resonator with different Graded Reflectivity Mirrors. During the testing of this laser cavity, maximum output energy of 35 mJ was reached in the pulse duration of 14ns. The beam divergence is not more than 1.2 mrad.

ThR1-34 **16:00-16:15**

Multiwave LD–pumped solid–state lasers for aerosol lidar application

G.I. Ryabtsev, M.V. Bogdanovich, A.V. Grigor'ev, V.V. Kabanov, V.S. Kalinov, O.E. Kostik, Y.V. Lebiadok, K.V. Lepchenkov, F.P. Osipenko, A.G. Ryabtsev, A.P. Chaikovsky, L.L. Teplyashin, U.S. Tsitavets, M.A. Shchemelev[1]; Stepanov Inst. of Physics of NAS; 1 - Belarusian State Univ., Belarus

The work is devoted to the development and creation of the powerful all solid–state air– cooled multiwave Nd:YAG laser integrated with the output telescope system and to the development of the LD-pumped solid–state source with the extremely narrow lasing linewidth. The laser sources are meant for operation with the multiwave aerosol LIDAR (atmosphere probing altitude is up to 40 km).

ThR1-35 **16:15-16:30**

Novel, external cavity free, design of Er-Yb laser based on photo-thermo-refractive (PTR) glass

S.A. Ivanov, V.A. Aseev; St.Petersburg National Research Univ. of ITMO, Russia;;

In this work, possibility of combining laser and holographic properties was demonstrated. Was shown opportunity to use recorded holographic Bragg gratings as a resonator mirrors inside rare earth doped glass. Advantages of using holographic Bragg gratings recorded on same medium where the gain is obtained was demonstrated. Was shown that spectral and luminescent characteristics of poly-functional PTR glass doped with Er-Yb and recorded holograms are comparable to the traditional laser barium phosphate glass.

ThR1-36 **16:30-16:45**

Compact Q-switched high repetition rate Nd:YLF laser with 100 mJ pulse energy for airborne lidars

V.V. Vitkin[1], V.M. Polyakov[1], D.I. Lychagin[1], A.A. Krylov[1], V.A. Buchenkov[2], S.V. Kashcheev[2]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Vavilov State Optical Inst., Russia;

A compact laser for airborne lidar was developed. Laser wavelength is 1047 nm and it's suggested further to pump SHG and FHG. Pulse energy is 100 mJ Q-switched, repetition rate is 250 Hz. We use efficient pump system with 67% absorption efficiency, fluid coolant for laser rods and laser diodes. The laser head volume is 5 cube decimeter.

ThR1-37 **16:45-17:00**

Ultra compact eye-safe laser for rangefinding

V.M. Polyakov[1], A.A. Kharitonov[1], V.A. Buchenkov[2]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Vavilov State Optical Inst., Russia;

We demonstrate an eye-safe diode pumped cube centimeter Yb:Er:glass laser with 3 mJ pulse energy in free running mode with repetition rate 1 Hz. We investigate phototropic gates for Yb:Er:glass lasers and choose the most appropriate passive Q-switch among them. The developing laser operates in a wide temperature range.

-COFFEE BREAK -

TECHNICAL SESSION

R2. HIGH POWER LASER SYSTEMS AND FACILITIES

Deyneka Hall

Session Chairs: 15:00-18:45 A.A. Ionin, Lebedev Physical Inst. of RAS, Russia;
15:00-18:45 V.E. Yashin, Vavilov State Optical Inst., Russia;

ThR2-09 **15:00-15:15**

Research on Luch facility in increasing of the pressure developed in laser experiments

S.A. Bel`kov[1], A.Yu. Voronin[1], I.N. Voronich[1], S.G. Garanin[1], S.Yu. Golovkin[1], S.Yu. Guskov[2], N.N. Demchenko[2], V.N. Derkach[1], N.V. Zmitrenko[3], V.M. Izgorodin[1], N.A. Kudasheva[1], V.B. Rozanov[2], K.V. Starodubtsev[1], A.E. Chaunin[1]; 1 - RFNC - VNIIEF, 2 - Lebedev Physical Inst. of RAS, 3 - Keldysh Inst. of Applied Mathematics of RAS, Russia;

Experimental study has been carried out on Luch facility directed on increasing of the pressures up to 50 Mbars and more. At the same absorbed energy of laser radiation we achieved 2.5-4 times growth of pressure applying the complex target construction instead of the simple flat target. At intensity of radiation 10^14 W/cm2 and pulse duration 2 ns we got 1D stationary shock with the pressure 100 Mbar behind the front of the shock.

ThR2-10 **15:15-15:30**

Status of the SG-II-UP Laser Facility

Ya.-Q. Gao[1], W.-X. Ma[1], Zh.-D. Cao[1], J. Zhu[1], X.-D. Yang[1], Ya.-P. Dai[1], B.-Q. Zhu[1], Z.-Q. Lin[2]; 1 - Shanghai Inst. of Laser Plasma, 2 - Shanghai Inst. of Optics and Fine Mechanics of CAS, P.R. China

The SG-II-UP laser facility, which is being constructed in shanghai, China, contains eight identical beamlines. It is designed to deliver 40KJ (1ω) and 24KJ (3ω) for square pulse of 3ns with the output beam aperture 310mm x 310mm.

ThR2-11 **15:30-15:45**

Recent Status of the Petawatt Laser Facility for SG-II Upgrade Program

G. Xu, T. Wang, Zh. Li, D. Li, N. Hua, J. Yu, X. Li, J. Zhu,Y. Dai, Z. Lin, and J. Zhu; Shanghai Inst. of Optics and Fine Mechanics of CAS, P.R. China

The SG-II upgrade (SG-II-U) Petawatt (PW) laser facility is designed to deliver 1kJ/1- 10ps compressed pulse with the focused intensity of 1019~1020W/cm2. In this paper, the performance and progress of the SG-II-U PW laser facility have been presented.

ThR2-12 **15:45-16:00**

Simultaneous generation of laser radiation at 337.1 nm and Lewis-Rayleigh afterglow in inductive nitrogen laser

A. Razhev[1,2], D. Churkin[1,2], E. Kargapol'tsev[1]; 1 - Inst. of Laser Physics SB RAS; 2 - Novosibirsk State Univ., Russia

The emergence of Lewis-Rayleigh afterglow under conditions of UV laser radiation formation and absence of any IR lasing in nitrogen pumped by a pulsed inductive discharge is demonstrated. The dependence of Lewis-Rayleigh afterglow intensity on pumping conditions and the reasons of IR lasing absence in inductive discharge nitrogen laser are experimentally investigated.

ThR2-13 **16:00-16:15**

High Power Cryogenic Yb:YAG Disk Laser with Nanosecond Output Pulse Duration

E. A. Perevezentsev, I. B. Mukhin, O. V. Palashov, I. I. Kuznetsov, O. L. Vadimova; Inst. of Applied Physics of RAS, Russia

OPCPA amplification of pulses that are several femtosecond order of magnitude requires pumping with picosecond pulses. For a simulation of such pump a laser system for a stretched picosecond pulse amplification has been created in the Institute of Applied Physics RAS: seed laser has been upgraded, a new high average power active cooling cryogenic disk laser head has been developed. New Main amplifier scheme based on this laser heads has been created.

ThR2-14 **16:15-16:30**

Time multiplexing technology for laser amplifier based on Yb-doped materials

M.-Zh. Li, X.-Ju. Zhang, Zh.-G. Wang, J.-G. Zheng, X.-Y. Jiang, X.-W. Yan, M. Li, Ju. Zhang, .-Sh. Wu, Q.-H. Zhu, J.-Q. Su, K.-X. Zheng, D.-X. Hu, X.-M. Zhang; Research Center of Laser

Fusion, P.R. China
In order to effectively solve the security risk from energy extraction of high sasuration fluency materials such as Yb-doped materials, a noval time-multiplexing amplification technology is given.

ThR2-15 **16:30-16:45**

Specificities of laser pulse amplification in multi-pass amplifiers

O. Vadimova, I. Mukhin, O. Palashov; Inst. of Applied Physics of RAS, Russia;

The laser pulse amplification was considered with accounting temporal and spatial profiles under various pulse parameters. It was shown that using of multiple passes amplifier allows increasing efficiency and reducing temporal profile distortion. The possible ways to decreasing of temporal profile distortion were considered.

ThR2-16 **16:45-17:00**

Mechanisms of population of the levels in some gas lasers pumped by ionizing radiation

M.U. Khasenov; Nazarbayev Univ. Research and Innovation System, Kazakhstan;

Characteristic properties of the inverse population forming processes in lasers with ionizing pumping are considered. Results obtained by research of the laser active media on p-s– transitions of atoms of neon, mercury and cadmium are presented.

-COFFEE BREAK -

ThR2-17 **17:30-17:45**

600 Watt-Level All-Fiber Polarization-Maintained Fiber Amplifier with

P. Ma, R. Tao, Ya. Ma, X. Wang, R. Su, P. Zhou; National Univ. of Defense Technology, P.R. China

We demonstrate a 600 watt-level all-fiber polarization maintained fiber amplifier with narrow linewidth and near-diffraction-limited beam quality. At maximum output power, the optical to optical conversion efficiency of the laser is 82.6% and the polarization extinction ratio (PER) of the configuration is higher than 93%. The linewidth is narrowed approximately an order than reported high power (>500 W) polarization maintained amplifiers.

ThR2-18 **17:45-18:00**

Multi-Petawatt Pulse Compression Gratings

A. Cotel[1], A. Liard[1], Y. Bernard[1], F. Desserouer[1], J-L. Domanchin[2]; 1 - HORIBA Jobin Yvon SAS, France; 2 - HORIBA Jobin Yvon, Representative office, Russia;

We present an overview of diffraction gratings technology and recent results for Terawatt to Multi-Petawatt laser pulse compression. The two main grating types: gold-coated and Multi-Layer Dielectric (MLD) are detailled. Diffraction gratings are a key optical component in a high-intense and high-energy laser. They have to exhibit high performances in diffraction efficiency, damage threshold, wavefront quality and size up to meter length.

ThR2-20 **18:00-18:15**

Double Channel Faraday Isolator with Single Optical Element for High-power Unpolarized Lasers

A.V. Starobor, D.S. Zheleznov, O.V. Palashov; Inst. of Applied Physics of RAS, Russia

Thermal depolarization in TGG-based Faraday isolator for 2 spatially separated beams was calculated. Depolarization reduced 6.7 times in the slab geometry of the magnetooptical element relative to 1-beam Faraday isolator

ThR2-21 **18:15-18:30**

Progress of large-aperture plasma Pockels cell for high power laser in CAEP

Zh. Xiongjun, L. Mingzhong, W. Dengsheng, Zh. Jun, L. Donghui, Zh. Jiangang, Zh. Kuixing; Research Center of Laser Fusion of CAS, P.R. China

We have demonstrated a single-pulse driven 4x1 Pockels cell (PPC) with 400x400mm aperture for SGIII laser facility and four 2x1 PPCs modules with 350x350mm aperture which have been operated in SGII update laser facility. With optimized operation parameters, the PPCs meet the SGII-U laser requirement of four-pass amplification control. To further reduce the insert loss of the PPC, research on the large-aperture PPC based on DKDP crystal driven by one pulse is developed.

ThR2-22 **18:30-18:45**

Development of high performance optical coatings for laser systems

M. Zhu, K. Yi, H. Qi, W. Zhang, Yu. Zhao, J. Shao; Shanghai Inst. of Optics and Fine Mechanics of CAS, P.R. China

High performance optical coatings are essential for the laser systems. To increase the performance of the laser coatings, including optical and mechanical properties, as well as the laser induce damage resistance, many efforts have been done. The developments of the coating design, deposition process and post treatment process, as well as the understanding of mechanical and laser damage mechanism have promoted the advance the laser coatings, various coatings with high performance have been developed.

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

Pudovkin Hall

Session Chairs: *09:30-11:00 J. Danckaert, Vrije Univ. Brussel, Belgium*

11:30-13:30 R.A. Hogg, Department of Electronic & Electrical Engineering, Univ. of Sheffield, UK;

ThR3-23 Invited **09:30-10:00**

Electrically Driven Polaritonic Lasing

A. Rahimi-Iman; Philipps-Univ. Marburg, Germany;

A new type of electrically pumped semiconductor laser has been demonstrated which promises an energy efficient laser operation: Recent achievements in the field of 'polariton laser' development are presented and an outlook is given.

ThR3-24 Invited **10:00-10:30**

All-Semiconductor Photonic Crystal Surface Emitting Lasers.

R.J.E. Taylor[1], D.M. Williams[1], D.T.D. Childs[1], P.S. Ivanov[1], K.M. Groom[1], L. Shepherd[1], A.J. Crombie[1], P.Ivanov[1], B.J. Stevens[1], S. Khamas[1], R.A. Hogg[1], N. Ikeda[2], Y. Sugimoto[2]; 1 - Univ. of Sheffield, UK; 2 - Nanotechnology Innovation Center, National Inst. for Materials Science, Japan;

We report on the design, manufacture, and operating characteristics of photonic crystal surface emitting lasers.

ThR3-25 **10:30-10:45**

Impact of amplitude-phase coupling on optical feedback induced timing jitter reduction in passively mode-locked lasers

L. Jaurigue, K. Lüdge, E. Schöll; Inst. of Theoretical Physics, Technical Univ. Berlin, Germany;

Optical feedback can be used to reduce the timing jitter of passively mode-locked lasers. Using a delay differential equation model, we investigate the effect of optical feedback on a passively mode-locked laser. We find that longer feedback delay times lead to more effective jitter reduction. However, with non-zero amplitude-phase coupling in the laser sections, long delay feedback can give rise to destabilized pulse streams.

ThR3-26 **10:45-11:00**

Evolution of multi-mode emission from vertical-external-cavity surface-emitting lasers

M. Wichmann[1], M.K. Shakfa[1], B. Heinen[1], A. Rahimi-Iman[1], S.W. Koch[1,2], M. Koch[1], M. Scheller[2], J.V. Moloney[2]; 1 - Philipps-Univ. Marburg, Germany; 2 - Univ. of Arizona, USA;

We present a systematic investigation of the longitudinal multi-mode emission in a vertical-external-cavity surface-emitting laser using both streak camera measurements and interferometric measurement techniques. We observe a steep increase of the emission bandwidth close to the laser threshold with only minor variances at higher pump powers. Additionally, we show that in our configurations the stability of a two-color emission process is linked to a sufficiently high number of longitudinal modes participating in the laser emission.

-COFFEE BREAK -

ThR3-27 Invited **11:30-12:00**

Novel Narrow Linewidth & Ultrafast Solid State & Semiconductor Disk Lasers

G. Malcolm; M Squared Lasers, UK;

Abstract is not available.

ThR3-28 Invited **12:00-12:30**

High Pulse Repetition Rate Lasers Modelocked with Quantum Dot SESAMs

B. Resan; Time-Bandwidth Products AG, Switzerland;

We discuss challenges of the high-repetition-rate lasers and focus on quantum-dot SESAMs at 1550 nm. We report on 10 GHz ERGO laser delivering 2 ps pulses when modelocked by InAs/GaAs QD SESAM with saturation fluence of 9 microJ/cm2.

ThR3-29 **12:30-12:45**

Spatially single-mode reliable superluminescent diodes with CW output power of up to 100 mW

S.N. Il'chenko[1], Yu.O. Kostin[1], S.D. Yakubovich[2]; 1 - SUPERLUM DIODES Ltd., 2 - MSTU MIREA; Russia

Highly efficient and reliable single-mode superluminescent diodes (SLDs) with median wavelengths of 795, 840, 960 and 1060 nm and free-space output optical power (PFS) of up to 100 mW are developed. Main parameters of lightemitting modules based on these SLDs are presented.

ThR3-30 **12:45-13:00**

SLD-based light-emitting modules at 1300 nm operable in temperature range from – 55°C to +125°C

S. N. Ilchenko[1], Yu.O. Kostin[1], S.D. Yakubovich[2] - ; 1 - SUPERLUM DIODES Ltd., 2 - MSTU MIREA; Russia

Using single-mode fiber for harsh environment and two-stage thermoelectric coolers in standard Butterfly package, superluminescent diode (SLD)-based modules with 1300 nm emission median wavelength operable in extremely wide temperature range were realized. The results of performance and stability tests of the devices are presented.

ThR3-31 **13:00-13:15**

Low-cost Multimodal Analyzer on Wavelength and Power Measurement

S. Hann[1], Yo.-E. Im[1], Yu.H. Kim[1], S.-Ju Kim 2; 1 - Korea Photonics Technology Inst., 2 - LS Tech Co., Ltd.;

We propose and demonstrate the low-cost multimodal analyzer of wavelength and power. To analyze both wavelength and power with incoming light through free space or fiber, the analyzer has dual detectors with difference window filters. The resolution is achieved up to 0.02nm over 100nm range.

ThR3-32 **13:15-13:30**

High brightness and power fiber coupled diode laser based on multiple beam combining technologies

L. Guo, Ju. Yu, Zh. Wang, H. Tan, S. Gao, D. Wu, K. Zhang; Inst. of Applied Electronics, CAEP, P.R.China

Since high brightness, high power fiber coupled diode lasers are increasingly desired by many applications. In this paper, a novel method is proposed for this purpose, in which precision beam collimation, free space beam combining are used to improve output power and optical quality. 280W single polarization output from 200μm core and 0.22NA fiber has been achieved with corresponding 5.87MW/(cm2•sr) brightness and 45.0% wall plug efficiency. In addition, polarization combining is already underway to further improve performance.

-BREAK FOR LUNCH -

R4. LASER BEAM CONTROL

Stenberg 1 Hall

Session Chairs: *09:00-11:00 M. Soskin, Inst. of Physics of NAS, Ukraine*

11:30-13:30 V.Yu. Venediktov; St.Petersburg State Electrotechnical Univ. «LETI», St.Petersburg State Univ., Russia;

ThR4-11 **09:00-09:30**

Efficiency of adaptive correction application for laser beam formation in atmosphere with the use of incoherent images as reference

V.P. Lukin; Inst. of Atmospheric Optics of SB RAS, Russia

The adaptive focusing of coherent radiation beams in a turbulent atmosphere is considered theoretically. The averaged intensity distribution of the laser beam field is calculated for an adaptive focusing system in a turbulent medium, using an incoherent source image as a reference source. Phase measurements in such a scheme can be carried out with a correlation Hartmann wavefront sensor. Keywords - correction, reference source, image, phase, coherence

TuR4-12 **09:30-09:45**

High precision adaptive auto-focusing system for laser beam based on method of double frequency of the spherical wave front probe.

A.N. Kleymenov, Ya.I. Malashko, A.V. Nazarenko, A.O. Skvortsov; MSDB «Almaz-Antey», Russia;

Authors have developed and studied closed-loop laser beam focusing system, operating by a control signal at the doubled frequency of modulation of the spherical wave front [1, 2, 3]. System operates by the method of aperture probing. Theoretical limit of the accuracy of the method has been achieved. For beam aperture 0.7 m and angular divergence φgauss=1.8•10-5 rad focusing error is less than 10-5 diopters was shown.

TuR4-13 **09:45-10:00**

Method of laser angular divergence measurement by reflected signal from distant point object

S.I. Krisanov, Ya.I. Malashko, A.V. Nazarenko, P.A. Morgunov; MSDB «Almaz-Antey», Russia

A method of laser angular divergence measurement by reflected signal from distant point object has been theoretically developed and experimentally confirmed. The conditions for required series length and maximum systematic error are found.

ThR4-14 **10:00-10:15**

Active Coherent Combining Method Based on Multi-aperture Wave Front Sensors

S.D. Pol'skikh, P.A. Semenov; National center of laser systems and complexes "Astrophysics"; Russia

The method of active phase-locking of lasers in multichannel laser system based on the Gerchberg–Saxton algorithm has been reported. The paper proposes the strategy of reconstruction of phase information, based on the global optimization Methods. The mathematical modeling of the system for various numbers of phased channels has been made.

ThR4-15 **10:15-10:30**

Magnification of Interferogram with the Use of Digital Holography

V. Ivanov[1], S. Pul'kin[1], A. Sevryugin[2], V. Venediktov[1,2]; 1 - St.Petersburg State Electrotechnical Univ. «LETI», 2 - St.Petersburg State Univ., Russia;

The method of holographic interferometry with the increased sensitivity was applied for measurements of height of nano-steps (from 10 nm and higher) with standard uncertainty about 0.5 nm. The increasing of sensitivity is obtained by interference of waves with mutually complex conjugated phases.

ThR4-16 **10:30-10:45**

New applications of Adaptive Fiber-Optics Collimator in Fiber Coupling and Beam Pointing

Ch. Geng, X. Li, W. Luo, Yi Tan, H. Liu, Ji. Mu; Inst. of Optics and Electronics of CAS, P.R. China

We report two kinds of new applications of adaptive fiber-optics collimator, a wavefront tip/tilt corrector, in fields of fiber coupling and beam pointing, respectively.

ThR4-17 **10:45-11:00**

Research Progress on Beam Combining of Fiber Amplifiers in IOE, CAS

X. Li, Ch. Geng, W. Luo, Yi Tan, H. Liu, Ji. Mu; Inst. of Optics and Electronics of CAS, P.R. China

We report the most recent progress on beam combining (BC) of fiber amplifiers in IOE, CAS. Experiments of coherent and incoherent BC based on new-style correctors and novel tip/tilt control strategy have been demonstrated.

-COFFEE BREAK -

ThR4-18 Invited **11:30-12:00**

Topology of laser beams.

M. Soskin, V. Vasil'ev; Inst. of Physics of NAS, Ukraine;;

The 3D topology of vortex line in developing laser speckle fields are investigated by numerical simulation and experiment. It's was found the basic scenario of vortex line transformation during speckle field evolution. They explain completely observed experimental results.

ThR4-19 **12:00-12:15**

Investigation of Beam Quality in Nd:YAG Crystal Fiber Amplifier

A. Rodin[1], A. Dement'ev[1], D. Brickus[1], K. Sasnauskas[1], A. Michailovas[2], A.Aleknavicius[2], J. Didierjean[3]; 1 - Center for Physical Sciences and Technology, 2 - Ekspla lab, Lituania; 3 - Fibercryst SAS, France; Lithuania

We present results of numerical and experimental investigation of beam distortions induced in the single-pass Nd:YAG crystal fiber amplifier injected by ns and ps laser pulses counter-propagating to continuous pump beam of up to 110 W power at 808 nm emitted from the fiber coupled laser diode with spectral narrowing by Bragg grating.

ThR4-20 **12:15-12:30**

Experimental testing of the diffraction method for optical wavefield recording

S.E. Stukachev, I.E. Kozhevatov; Inst. of Applied Physics of RAS, Russia

The novel diffraction method for optical wavefield recording is proposed. The experimental testing of the method was carried out. It was shown that the diffraction method provides wavefront measurements with high accuracy and spatial resolution.

ThR4-21 **12:30-12:45**

Tailored polarization eigenstates of liquid crystal SLM to generate Laguerre-Gaussian beams

M.Favier[1], S.Popov[2]; 1 - Inst. d'Optique, France, 2 - Royal Inst. of Technology, Sweden;

We use an SLM to generate laser beams of variable orbital angular momentum, also referred as Laguerre-Gaussian beams. Input beam polarization should match local birefringence of each pixel of the SLM. We identify the beam polarization eigenstates allowing generate L-G beams of different order owing to matching variable birefringence of separate pixels. Experimental results demonstrate an excellent agreement with simulations.

ThR4-22 **12:45-13:00**

Polarization structure of an optical vortex beam near the unfolding point using a modified birefringent interferometer

M.M. Brundavanam[1], Y. Miyamoto[2]; 1 - Indian Inst. of Technology Kharagpur, India, 2 - Univ. of Electro-Communications, Japan;

In the present paper, we discuss the construction of a modified optical vortex birefringent interferometer to reconstruct the unfolding point of an optical vortex beam propagating through a birefringent crystal. The polarization structure near the unfolding point is mapped by measuring the phase difference between the eigen beams of birefringent crystal.

ThR4-23 **Invited** **13:00-13:30**

Photonic Nanojets from Microspheres: A Step to Superfocusing of Light

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

In this report we review the problem of photon Nanojet (PNJ) control and present our recent results concerning the temporal dynamics of a PNJ emerging in the scattering of ultrashort laser radiation by a transparent spherical microparticle. Using numerical simulations we show that the late phases of PNJ development are characterized by a tight subdiffraction spatial localization of the optical field near the particle.

-BREAK FOR LUNCH -

R4. LASER BEAM CONTROL

Stenberg 1 Hall

Session Chair: 15:00-18:45 Ya.I. Malashko, MSDB «Almaz-Antey», Russia

ThR4-24 **15:00-15:15**

Novel laser cavity design by way of transmitting volume Bragg gratings

B. Anderson[1], I. Divliansky[1], L. Glebov[1], V. Smirnov[2], G. Venus[1]; 1 - Univ. of Central Florida, 2 - OptiGrate Corp., USA;

We propose to use transmitting volume Bragg gratings recorded in photo-thermo- refractive glass as high efficient intracavity angular filters in order to achieve high beam quality while using large aperture active medium. The paper describes implementation of novel compact cavity design for solid state lasers, laser diodes, fiber crystal lasers and others.

ThR4-25 **15:15-15:30**

Control of beam profile of high power laser by knife-edge mechanism

N.G. Kokodii[1,2], Li Zhenhua[1], M.V.Kaydash[2], V.A. Timanyuk[2]; 1 - Karazin Kharkov National Univ., 2 - National Univ. of Pharmacy, Ukraine

Method of measuring the intensity distribution by knife-edge mechanism is proposed. The algorithm and program for handling of the signal from receiver are developed. Method is proved that it can accurately recover a complicated energy distribution.

ThR4-26 **15:30-15:45**

Experimental investigation on aero-optic effects under laser irradiating

L. Zhang, Ya. Tao, G. Wang, G. Liu, Ch. Wang, X. Kuang, Ji. Li, H. Liu, Ya. Gui; Inst. of Fluid Physics, P.R. China

We adopted the physical model for high energy laser beams crossing through three-dimensional high speed flow. A two-dimensional Hartmann wavefront sensor was used to measure the aero- optic effects when the high energy laser beam passed through high speed airflow in the wind tunnel. The flow field is governed by the the 3-D Reynolds averaged Navier-Stokes (N-S) equations. The results show that the interaction between lasers and the high speed airflow has little influence on the temperature and density of the airflow when the air is not ionized.

ThR4-27 **15:45-16:00**

Research on the beam cleanup of slab laser by one-dimensional arrangement deformable mirror

Ji. Wu[1,2], R. Xiang[1,2], G. Li[1,2], Yu. Yang[1,2], Zh. He[1,2]; 1 - Inst. of Applied Electronics CAEP, 2 - Key Laboratory of Science and Technology on High Energy Laser, CAEP, P.R. China

Spatial wave-front distortion of MOPA slab laser system is not evenly distributed in the two directions; under this condition, an 11 elements deformable mirror with active cooling system is developed to satisfy the demand of beam quality control. The experiment of wave-front correction of the MOPA slab laser is carried out with this deformable mirror. The intensity distributions at the image plane of distorted wave-front are effectively improved. The average value of beam quality has been improved from 10 to 5.3.

ThR4-28 Invited **16:00-16:30**

Experimental activity toward GINGER (Gyroscopes IN GEneral Relativity)

J. Belfi[1], F. Bosi[1], A. Di Virgilio[1], N. Beverini[2], G. Carelli[2], E. Maccioni[2], R. Santagata[3], D. Cuccato[4], A. Ortolan[5]; 1 - INFN, sezione di Pisa; 2 - Univ. of Pisa; 3 - Univ. of Siena; 4 - Univ. of Padova; 5 - INFN Legnaro; Italy

We report about the recent progresses toward the development of a laser gyroscope detector for a ground based measurement of the Earth's relativistic frame dragging. The main part of the presented activity involves the control of the systematic errors related to the fluctuation of the cavity geometry and the active medium parameters. A new square ring laser 1.6 m in side, named "GP2", has been built with the aim of setting its cavity shape as close as possible to a "perfect square". This kind of setup will be the building block for an ultra-sensitive tri-axial rotation detector aiming at fundamental Physics applications.

ThR4-29 Invited **16:30-17:00**

Ring Laser Gyroscope for accurate angle metrology

N. Beverini[1], G. Carelli[1], E. Maccioni[1], J. Belfi[2], A. Di Virgilio[2], M. Pisani[3], A. Ortolan[4]; 1 - Dipartimento di Fisica dell'Univ. di Pisa; 2 - INFN-sezione de Pisa, 3 - INRIM, 4 - INFN Legnaro; Italy

An apparatus for high precision angle metrology, based on a mid-scale ring laser gyroscope, is in development at the Italian Metrologic Research Institute (INRIM). The aim is to build a portable instrument with an accuracy in the range of some tens nanoradiants.

-COFFEE BREAK -

ThR4-30 Invited **17:30-18:00**

Gyroscopic effect in the bidirectional femtosecond erbium-doped fiber ring laser

D. Chernykh, A. Krylov; Fiber Optics Research Center RAS, Russia;

We have demonstrated for the first time to the best of our knowledge the gyroscopic effect in the rotating erbium-doped bidirectional ultrashort pulse fiber ring laser. Detected angular velocities ranged from 0.1 to 90 deg/sec at the equivalent gyroscope sensitivity of 7 KHz/(deg/sec).

ThR4-31 Invited **18:00-18:30**

Precision Cavity Control for the Stable Operation of a Large Ring Laser Gyroscope

K.U. Schreiber[1], A. Gebauer[1], A. Velikoseltsev[2], J.-P.R. Wells[3]; 1 - Forschungseinrichtung Satellitengeodaesie Technische Univ. Muenchen, Germany; 2 - St.Petersburg State Electrotechnical Univ. «LETI», Russia; 3 - Univ. of Canterbury, New Zealand

Currently the sensor performance of large ring laser gyroscopes is limited more by stability in the long term rather than measurement resolution. This is mostly because of a variable contribution of backscatter coupling between the two counter- propagating laser beams inside the square ring laser cavity. In the absence of sufficient control over the backscatter process or sufficiently precise numerical estimate of the backscatter variation, a tight control of the length of the four individual arms of the gyroscope, in addition to the precision perimeter control appears to be a viable experimental approach. Monitoring the phase relationship between the ring laser beat note, taken at different corners of the gyroscope, provides the necessary access to the desired cavity control. This paper reports the first results of this investigation.

ThR4-32 **18:30-18:45**

On the Possibility of Phase Measurements in Microoptical Gyro

Yu.V. Filatov[1], E.V. Shalymov[1], V.Yu. Venediktov[1,2]; 1 - St.Petersburg State Electrotechnical Univ. «LETI», 2 - St.Petersburg State Univ., Russia;

The paper considers the possibility to organize the phase measurements of the rotation speed in the ring-shaped single mode passive cavity, supplied by lone power divider (directed coupler).

R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES

Pudovkin Hall

Session Chairs: 15:00-17:00 V.T. Tikhonchuk, Centre Lasers Intenses & Applications, Univ. Bordeaux, CNRS, CEA, France

17:30-19:00 Ch.H. Nam, Center for Relativistic Laser Science, Inst. for Basic Science, Dept. of Physics and Photon Science, GIST, Korea

ThR5-18 Invited **15:00-15:30**

Non-linear processes in the XUV: An advanced tool for attosecond pulse metrology and applications

D. Charalambidis; FORTH-IESL and Univ. of Crete, Greece;

In the last 12 years we have systematically developed the means for the generation of energetic XUV pulses with 1fs to sub-fs pulse duration. These pulses have been exploited in the temporal characterization of attosecond pulses as well as in the first proof of principle XUV-pump-XUV-probe experiments for the study of 1fs scale electron dynamics in atoms as well as electronic, vibrational and ionization dynamics in molecules. I will review these developments and addresses opportunities that are opening up in these and related scientific topics by the up-coming Extreme Light Infrastructure - Attosecond Light Pulse Source (ELI-ALPS) one of the three pillars of the ESFRI roadmap European Research Infrastructure ELI.

ThR5-19 **15:30-15:45**

Enhancement of optical harmonic generation by free-state electrons in a long wavelength driver field

E.E. Serebryannikov[1,2], A.M. Zheltikov[1,2,3]; 1 - Lomonosov Moscow State Univ., 2 - Russian Quantum Center, Russia; 3 - Texas A&M Univ., USA;

Ultrafast ionization dynamics within the field half-cycle is shown to be the key physical factor that controls the properties of optical nonlinearity as a function of the carrier wavelength and intensity of a driving laser field. Schrödinger-equation analysis of a generic hydrogen-like quantum system reveals universal tendencies in the wavelength dependence of optical nonlinearity, shedding light on unusual properties of optical nonlinearities in the mid-infrared. For high-intensity low-frequency fields, free-state electrons are shown to dominate over bound electrons in the overall nonlinear response of a quantum system. In this regime, semiclassical models are shown to offer useful insights into the physics behind optical nonlinearity.

ThR5-20 **15:45-16:00**

Numerical Simulations on Self-focusing and Filamentation of Multi-Terawatt Picosecond CO2-Laser Pulse in Air

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

We present the results of our numerical simulations on the nonlinear propagation of TW picosecond laser radiation at 10.6 μm carrier wavelength in air upon Kerr self-focusing and beam filamentation. We show that in contrast to the near-infrared femtosecond pulse filamentation, the self-action of mid-infrared radiation results in the formation of millimeter- wide filaments accompanied by extremely elongated and continuous plasma columns. The cause is the change of air ionization regime by picosecond CO2-laser pulse toward impact ionization and electron avalanche. This alters the character of plasma influence on the laser radiation by enhancing the role of physical processes attributed to liberated electrons.

ThR5-21 **16:00-16:15**

Femtosecond filament plasma channel formation and decay study by transverse optical interferometry.

P.A. Chizhov, V.V.Bukin, S.V. Garnov; Prokhorov General Physics Inst. of RAS, Russia;

Electron density dynamics in gases is studied from ionization to hundreds of picoseconds after it by interferometry method. Optical refractive index anisotropy, which precedes and accompanies ionization, related with intense pulse propagation is revealed. Electron density dynamics in gases is studied from ionization to hundreds of picoseconds after it by interferometry method. Optical refractive index anisotropy, which precedes and accompanies ionization, related with intense pulse propagation is revealed.

ThR5-22 **16:15-16:30**

Filamentation of IR and UV double femtosecond laser pulses

A.A. Ionin[1], S.I. Kudryashov[1], D.V. Mokrousova[1,2], L.V. Seleznev[1], D.V. Sinitsyn[1], E.S. Sunchugasheva[1, 2]; 1 - LPI of RAS, 2 - MIPT; Russia

An influence of plasma channel created by a filament of focused femtosecond laser pulse with wavelength λ=248 nm or 740 nm on characteristics of other plasma channel formed by a femtosecond pulse at the same wavelength following the first one with varied time delay was experimentally studied.

ThR5-23 **16:30-16:45**

Filamentation of focused femtosecond laser pulse and plasma channel formation in the vicinity of geometric focus

A.A. Ionin[1], D.V. Mokrousova[1,2], L.V. Seleznev[1], A.P. Shustikova[1,2], D.V. Sinitsyn[1], E.S. Sunchugasheva[1,2], A.A. Dergachev[3], V.P. Kandidov[3], S.A. Shlenov[3]; 1 - Lebedev Physical Inst. of RAS, 2 - Moscow Inst. of Physics and Technology, 3 - Lomonosov Moscow State Univ.; Russia;

Filamentation of focused femtosecond laser pulse in the vicinity of the geometric focus is studied both theoretically and experimentally.

ThR5-24 **16:45-17:00**

Femtosecond laser pulse filamentation with wavefront modulation via pass-through optics

A.A. Ionin[1], D.V. Mokrousova[1,2], L.V. Seleznev[1], A.P. Shustikova[1,2], D.V. Sinitsyn[1], E.S. Sunchugasheva[1,2], A.A. Dergachev[3],V.P. Kandidov[3], S.A. Shlenov[3]; 1 - Lebedev Physical Inst. of RAS, 2 - Moscow Inst. of Physics and Technology, 3 - Lomonosov Moscow State Univ.; Russia

Influence of transparent dielectric media in the beam optical path on plasma channel characteristics formed during intense femtosecond laser pulse filamentation was numerically and experimentally studied. Total length of plasma channel proved to be longer with additional pass- through optics.

-COFFEE BREAK -

ThR5-25 **17:30-17:45**

Dual-Channel Multiterawatt Laser System with Coherent Beam Combining

S.N. Bagayev, V.I. Trunov, E.V. Pestryakov, S.A. Frolov, V.E. Leshchenko, V.A. Vasiliev; Inst. of Laser Physics of SB RAS, Russia;

The dual-channel femtosecond laser system with each channel consisting of three BBO and LBO crystals based broadband parametric amplification stages of Ti:Sa laser radiation and relative jitter stabilization system to 110 as level is presented. For the first time coherent combining of two sequences of parametrically amplified femtosecond pulses with energy of ~ 150 mJ, 10 Hz repetition rate is experimentally realized. Coherent combining efficiency of over 90% is reached.

ThR5-26 **17:45-18:00**

Optical inspection of microchannels formed by femtosecond laser on glass

V.P. Bessmelsev, E.D. Bulushev, A.V. Dostovalov; Inst. of Automation and Electrometry of SB RAS, Russia;

The aim of the research was to provide precise inspection of surface of optically transparent materials micromachined by a femtosecond laser. We found that despite the fact that pulse durations are in a femtosecond range in case of non optimal processing modes cleavages may be formed at the border of heat affected zone, and profiles of micro channel are not uniform. For measurement of micro channels the optical inspection technique based on fluorescent confocal laser scanning microscopy and data analysis algorithms was developed.

ThR5-27 **18:00-18:15**

Reverse and compensation approach of the deposition thickness in manufacturing chirped mirrors

Ya. Wang, K. Yi, H. Qi, G. Hu, Ji. Shao; Shanghai Inst. of Optics and Fine Mechanics; P.R. China

The chirped mirrors of a -100fs2 GDD in the wavelength 700-1400nm with high trassimission in the wavelength 505-540nm are designed and manufactured by ion beam sputtering. Time control is used in manufacture process. Based on the reverse layers thickness, the fitted actual manufactured every layer depositin velocity is obtained to compensate deposition thickness and realize the precise control in manufacturing chipred mirrors.

ThR5-28 **18:15-18:30**

Spectral dependence of a picosecond anisotropic photoconductivity in cubic semiconductor

Y. Malevich[1], R. Adomavicius[1], A. Krotkus[1], V. Pacebutas[1], V. Malevich[2]; 1 - Center for Physical Sciences and Technology, Lithuania; 2 - Inst. of Physics of NAS, Belarus;

Spectral dependence of the transient anisotropic photoconductivity in InGaAs excited by femtosecond laser pulses has been studied with the use of a Monte Carlo simulation method and optical pump — THz probe technique. It has been shown that the magnitude of the anisotropy reaches its peak when the excess energy of the optically excited electrons approaches the threshold for the intervalley transfer.

ThR5-29 **18:30-18:45**

Nonlinear Doppler-Free Comb-spectroscopy in counter-propagating fields

S.A. Pulkin, A. Kalinichev, V. Arnautov, S.V. Uvarova, S. Savel'eva; St.Petersburg State Univ., Russia;

The method of Doppler – free comb – spectroscopy for dipole transitions was proposed. The calculations for susceptibility spectrum for moving two-level atoms driving by strong counter propagating combs have been done. The used theoretical method based on the Fourier expansion of the components of density matrix on two rows on kv (v-velocity of group of atoms, k-projection of wave vector) and Ω (frequency between comb components). The narrow peaks with homogeneous width arise on the background of Doppler counter.

ThR5-30 **18:45-19:00**

Three-level Photon Echo for Quasi-degenerated Levels

T. Ahmadi, S.A. Pulkin, V. Shevtsov; St.Petersburg State Univ., Russia;

Quantum optical data storage is a key element in quantum information processing. However, most modified photon echoes protocols are still limited by lack of resonance signal to explain time scales of different systems. In this paper, we studied three-pulse photon-echo system by using density matrix in Λ-scheme. It will be shown that the time position of three- pulse echo signals is proportional to ratio of detuning frequencies from the resonance frequencies of transitions in a non-uniform distribution. In the last part of paper, you can see the importance effect of frequency distance between two degenerate levels (d) on the delay time of signal.

ThR5-31 **19:00-19:15**

Femtosecond point-by-point inscription of fiber Bragg gratings through the polyimide coating

A.V. Dostovalov[1], A.A. Wolf[1], S.A. Babin[1,2]; 1 - Inst. of Automation and Electrometry of SB RAS; 2 - Novosibirsk State Univ., Russia;

The paper presents the results on Bragg gratings inscription in non-photosensitive optical fibers through the polyimide protective coating by femtosecond radiation with the wavelength of 1026 nm. The Bragg gratings inscribed by a point-by-point method in specialized optical fibers: high-temperature resistant Fibercore SM1500(9/125)P and hydrogen resistant Fibercore SM1500SC(9/125)P have reflectivity 50-90%.

R6. NANOPHOTONICS AND BIOPHOTONICS

Deyneka Hall

Session Chairs: *09:00-11:00 I.M. Kislyakov, St.Petersburg National Research Univ. of ITMO, Russia*
11:30-12:45 A.A. Krasnovsky, Bach Inst. of Biochemistry, Russia

ThR6-33 Invited **09:00-09:30**

Molecular photoacoustic contrast agents for biomedical imaging

Ch.S. Yelleswarapu, M. Frenette, M. Hatamimoslehabadi, S. Bellinger-Buckley, S. Laoui, S. Bag, D.V.G.L.N. Rao, J. Rochford; Univ. of Massachusetts, USA

Cancer is the most prevalent disease throughout the world. For successful diagnostics and prevention, complete understanding of cancer cell growth is necessary. Recently photoacoustic imaging/tomography (PAI) has been developed to aid in understanding cancer physiology. Advantageously PAI does not require ionization radiation and can provide the location and metabolic activities of tumors with the help of contrast agents. The talk details our efforts in the development of molecular photoacoustic contrast agents (MPACs) through chemical modification of efficient and established fluorescent probes. Optical and photoacoustic characterization of our MPACs demonstrates a stronger photoacoustic signal compared to the corresponding fluorescent probes.

ThR6-34 Invited **09:30-10:00**

Laser photochemistry of oxygen: application to studies of oxygen photonics.

A.A. Krasnovsky; Bach Inst. of Biochemistry, Russia;

The IR absorption spectra corresponding to the singlet-triplet transitions in O2 molecules dissolved in organic and aqueous media were studied under ambient conditions, using oxygenation of singlet oxygen traps upon direct laser excitation of oxygen molecules. The data are compared with the luminescence properties of the singlet-triplet transitions in O2 molecules. Significance of the obtained spectroscopic data for biological action of lasers is discussed.

ThR6-35 Invited **10:00-10:30**

A multimodal approach to time-resolved optical spectroscopy for biomolecular detection

F. Banfi, C. Giannetti, G. Ferrini; Univ. Cattolica del Sacro Cuore, Italy;

The investigation of surface chemical reactions in biological samples, avoiding sample preparation treatments, is important to access the complex chemical machinery of living cells. Therefore, non-invasive techniques that allow in vivo study of chemical processes located at surfaces are fundamental tools. Optical spectroscopy techniques, tailored to image surface molecular complexes, are a possible answer to these issues.

ThR6-36 **10:30-10:45**

The Phenomenon of Laser-Induced Oxyhemoglobin Photodissociation and its Biomedical Application

M.M. Asimov[1], R.M. Asimov[2], D.B. Vladimirov[1], A.N. Rubinov[1]; 1 - Stepanov Inst. of Physics of NAS, Belarus, 2 - Sensotronica Ltd., Stepanov Inst. of Physics of NAS, Belarus;

The results of experimental in vivo investigation the phenomenon of blood oxyhemoglobin photodissociation are presented. Novel technology of tissue oxygenation due to additional oxygen extraction is developed. A significant increase in tissue oxygen concentration directly at the irradiating zone by laser radiation is obtained. Different biomedical applications of the effect of laser radiation on gas exchange processes in biological tissue are discussed

ThR6-37 **10:45-11:00**

Particular Features of Time-Dependent Diffusion Models Applied in Optical Methods for Medical Diagnostics

S.A. Dolgushin[1], S.A. Titenok[1], S.A. Tereshchenko[1], Jorge Bouza Domínguez[2]; 1 - National Research Univ. of Electronic Technology, Russia; 2 - Bishop's Univ., Canada;

In the presented work the absorption coefficient and reduced scattering coefficient of the homogeneous tissue-like biological phantoms are determined using three various types of the diffusion model (classical, refined and extrapolated) in the case of the scattering slab geometry which is commonly used for the optical mammography. The nonlinear relationships of the scattering and absorption coefficients from the slab thickness were obtained for each of the examined models. We suggest that this effect was originated by the inadequate approximation of the scattering phase function features employed in the diffusion models. This interpretation was confirmed by Monte Carlo simulations, where almost the similar type relationships were obtained.

-COFFEE BREAK -

ThR6-38 **11:30-11:45**

Biomedical Application of Laser-Induced Muscle Oxymyoglobin Photodissociation

M.M. Asimov, R.M. Asimov[1], A.N. Rubinov; Stepanov Inst. of Physics of NAS, Belarus, 1 - Sensotronica Ltd., Belarus, Stepanov Inst. of Physics of NAS, Belarus;

The results of numerical simulation the interaction of low intensity laser radiation with muscle myoglobin (Mb) and oxymyoglobin (MbO2) are presented. It is shown that photodissociation of MbO2 allows regulate the concentration of oxygen (O2) in muscles in the zone of laser irradiation. In space medicine they may find application for prevention and elimination of negative effects of weightlessness on muscular activity of astronauts during long space flights.

ThR6-39 **11:45-12:00**

Fiber-optic Electric field sensor based on wavelength-swept laser

M. Ock Ko[1], S.-Jo Kim[1], Jo.-H. Kim[1], M. Yong Jeon[1], B. Wan Lee[2]; 1 - Chungnam National Univ., 2 - FiberPro Inc.; Rep. of Korea;

We report a dynamic fiber-optic electric field sensor using a nematic liquid crystal (LNC) Fabry-Perot etalon and a wavelength-swept laser (WSL). The WSL has a linear relationship between the wavelength measurement and the time measurement. When a modulated electric field of the proper amplitude and frequency is applied to the NLC, the transmission wavelength peaks for the ordinary mode are maintained, while the transmission peaks for the extraordinary mode are modulated. By measuring the modulation frequency of the transmission peaks in the temporal domain, the frequency of the modulated electric field could be estimated.

ThR6-40 **12:00-12:15**

Self-organized aggregation simulation of resonant nanoparticles in a laser field

V.V. Slabko[1], A.S. Tsipotan[1], M.A. Gerasimova[1],A.S. Aleksandrovsky[1,2]; 1 - Siberian Federal Univ., Russia; 2 - Kirensky Inst. of Physics of SB RAS, Russia;

Self-organized aggregation of nanoparticles in external resonant laser field is considered using Brownian dynamics model. Formation probabilities are calculated for the pair of particles in dependence on laser wavelength and mutual orientation of particles. Times required for aggregation are calculated. Possibility of efficient aggregation using pulsed laser is deduced.

ThR6-41 **12:15-12:30**

The spontaneous emission rate of emitter outside and inside of the core-shell nanoparticle

K.K. Pukhov[1], S.K. Sekatskii[2]; 1 - Prokhorov General Physics Inst. of RAS, Russia; 2 - Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland;

Here we present the theoretical study of the emission rate modification of rare-earth ions inside and outside of the subwavelength core-shell nanoparticles.

ThR6-42 **12:30-12:45**

Influence of configuration interaction on absorption transition intensities of rare-earth ions in laser materials

E. Dunina[1], A. Kornienko[1], L. Fomicheva[2]; 1 - Vitebsk State Technological Univ., 2 - Belarusian State Univ. of Informatics and Radioelectronics, Belarus;

On an example of holmium doped crystals and glasses the influence of excited configurations with a charge transfer and opposite parity configurations on oscillator strengths of absorption transitions is investigated. The deduction about the most adequate approximation for description of experimental results is made.

TECHNICAL SESSION

R7. LASERS IN ENVIRONMENTAL MONITORING

Richter Hall

Session Chairs: *15:00-17:00 A. Nadezhdinskii; Prokhorov General Physics Inst. of RAS, Russia*
17:30-19:30 A.P. Zhevlakov, ITMO Univ., Lasers and Optical Systems JSC

ThR7-13 Invited **15:00-15:30**

Application THz-Raman Spectroscopy for identification of chemical, and biological products

E. Iasenko[1], V. Chelibanov[1], A. Marugin[2], M. Kozliner[3]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - JSC OPTEC Ltd., Russia; 3 - JSC OPTEC Ltd., USA;

Present paper reports on the development of a mobile Raman system for the analytical applications using low-frequency Raman scattering (Terahertz Raman Spectroscopy - TRS). The system is capable to analyze trace amounts of various compounds using stokes and anti- stokes lines in laboratory and in field conditions. The paper presents the results of the application of TRS to study molecular structures of different polymorphic forms.

ThR7-14 **15:30-15:45**

Compact Sensor for Photoacoustic Monitoring and Photochemical Dissociation of NO2

M. Lassen, A. Brusch, D. Balslev-Clausen, Ja. C.Petersen; Danish Fundamental Metrology; Denmark

A compact and easy to use photoacoustic (PA) detector has been developed for the detection of nitrogen dioxide (NO2). The detector is based on an integrating sphere as the PA absorption cell and LEDs as light sources. Combined with low-cost microphone the PA sensors provide a highly sensitive and low-cost solution for NO2 monitoring. The PA sensor can easily be modified to measure many different atmospheric trace gasses simply by changing the wavelength of the light source.

ThR7-15 Invited **15:45-16:15**

Laser sensing of aerosol flows

V.G. Shemanin; Novorossiysk Polytechnical Inst., Kuban State Technological Univ.; Russia

This paper is about the laser radiation spectral transmittance signal, Mi scattering indicatrix and the lidar signal for the aerosol particles in the air flows at the various wavelengths experimental studies for this particles concentration level and its size distribution function measurements in our experimental conditions. All of these results show that the aerosol lidar can serve as the powerful instrument in the atmosphere cement particles pollution monitoring under the city area.

ThR7-16 **16:15-16:30**

Profiling of the forest fire aerosol plume with multiwavelength Raman lidar

A.S. Suvorina[1], I.A. Veselovskii[1], D.N. Whiteman[2], M.Yu. Korenskiy[1]; 1 - Prokhorov General Physics Inst. of RAS, Russia; 2 - NASA Goddart Space Flight Center, USA;

Vertical profiles of biomass burning aerosol parameters, such as effective radius, volume density and the complex refractive index, during forest fire in North America in August 2013 are studied. Aerosol extinction and backscattering coefficients measured at multiple wavelengths by Raman lidar based on tripled Nd:YAG laser are inverted to the particle microphysical properties.

ThR7-17 **16:30-16:45**

Acoustic Sensitivity of the Negative Curvature Hollow Core Fiber

S.N. Turtaev, M.I. Belovolov, A.E. Levchenko, A.F. Kosolapov, A.D. Pryamikov, A.N. Kolyadin; Fiber Optics Research Center of RAS, Russia;

Acoustic sensitivity of the novel negative curvature hollow core fiber (NCHCF) has been investigated both experimentally and theoretically. The normalized response of NCHCF is shown to be 6 dB higher than in case of the conventional fiber.

ThR7-18 **16:45-17:00**

Upgraded Raman Lidar with Ultraspectral Resolution

S.V. Kascheev[1], V.V. Elizarov[1], A.S. Grishkanich[1,2], D.V. Kosachev[4], S.B. Petrov[1],3, A.P. Zhevlakov[1,3]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - St.Petersburg Electrotechnical Univ. «LETI», 3 - Lasers and Optical Systems JSC, 4 - Gazprom-Transgaz-Ugorsk; Russia;

Upgraded Raman Lidar with spectral resolution of $d\lambda/\lambda \leq 10\text{-}3$ has been elaborated for the aerosearch of leaks on the main gas pipelines. Lidar measures the leaks of CH4 with concentration of 2 ppm and above. Scanning at frequency of 20 Hz in angles of $\pm 30^{o}$ allows to carry out remote measurements on inclined courses.

-COFFEE BREAK -

ThR7-19 Invited **17:30-18:00**

Analytical Applications of Tunable Diode Laser Spectroscopy

A. Nadezhdinskii; Prokhorov General Physics Inst. of RAS, Russia;

Tunable diode laser spectroscopy analytical applications will be considered. The applications classification and optimization will be given. Development of several diode laser based analytical instruments will be discussed. Test results of instruments developed will be presented.

ThR7-20 **18:00-18:15**

Combining PIV and PDV Methods for Investigation of Dispersion Media Parameters

V.G. Kamenev, O.N. Koltovoy, K.V. Bandurkin, V.P. Andrianov; Research Inst. of Automatics, Russia;

The report addresses the possibility of the simultaneous application of two experimental methods for recording parameters of dispersion medium. These methods are PIV (Particle Image Velocimetry) and PDV (Photon Doppler Velocimetry). The application of two methods in one experiment allows to expand the abilities of both techniques of measurement.

ThR7-21 **Invited** **18:15-18:45**

High resolution laser absorption spectroscopy in the 10 micron window - from the lab to the atmosphere

C. Janssen[1], H. Elandaloussi[1], Y. Té[1], P. Jeseck[1], C. Boursier[1], C. Rouillé[1], P. Marie-Jeanne[1], X. Zeng[2], H. Willner[2]; 1 - Sorbonne Univ., Univ. Paris, CNRS, Observatoire de Paris, IPSL, France; 2 - FB C - Anorganische Chemie, Bergische Univ., Germany;

We describe a narrow band tunable laser diode spectrometer in the 10 μm region, with step scanning Michelson interferometer control at a resolution of about 10-9. An Allan variance analysis shows that this allows to reaching a relative frequency stability of about 5x10-9 (1σ) over 1 hour. We present first absolute line-strengths of the 16O16O18O ozone isotopomer and discuss atmospheric implications.

ThR7-22 **18:45-19:00**

Principles and Applications of Laser Refractography

B.S. Rinkevichyus, I.L. Raskovskaya, A.V. Tolkachev; National Research Univ. «MPEI», Russia;

Considered in this report is the principle of a novel measurement technique laser refractography used to diagnose near wall and boundary layers developing in liquids as a result of temperature or concentration gradients occurring therein. This technique is based on the probing of the transparent liquid of interest with a structured optical radiation produced by means of diffraction optical elements and the digital recording and processing of the refraction patterns obtained.

ThR7-23 **19:00-19:15**

Laser Interferometer System for Recording Variations of Light Wavelength

P. Brazhnikov, V. Andrianov, O. Koltovoy, A. Tikhov; Dukhov Research Inst. of Automatics, Russia;

An interferometer system for frequency shift of light is based on a Fabry-Perot interferometer. The methods developed for enhancing the system efficiency are described: the method for increasing the illumination of a registration line to enhance the system sensitivity and the method for eliminating the blurring of interferometric maxima because of non-parallelism of mirrors.

ThR7-24 **19:15-19:30**

Features processing lidar signals in the GHz frequency range

V.V. Elizarov, A.S. Grishkanich, S.V. Kascheev, A.P. Zhevlakov, St.Petersburg National Research Univ. of ITMO, Russia;

Features processing and registration of lidar signals in the GHz frequency range have been studies. Model of the interaction between the components of the system with the required level of performance and accuracy was developed.

R8. NONLINEAR PHOTONICS: FUNDAMENTALS AND APPLICAT IONS

Levinson Hall

Session Chair: 11:30-13:45 A.A. Fotiadi, Univ. of Mons, Belgium

ThR8-36 Invited **11:30-12:00**

Graphene Plasmonic Heterostructures for Terahertz Device Applications

T. Otsuji[1], A. Satou[1], S. Boubanga Tombet[1], V. Ryzhii[1], V.V. Popov[2], M.S. Shur[3]; 1 - Tohoku Univ., Japan; 2 - Kotelnikov Inst. of Radio Engineering and Electronics of SB RAS, Russia; 3 - Rensselaer Polytechnic Inst., USA;

This paper reviews recent advances in graphene plasmonic heterostructures for terahertz (THz) device applications. A double graphene-layer (DGL) core-shell structure with a tunnel-barrier layer is sandwiched between the outer gate stack layers at both sides. Cooperative double-resonant excitation of photon-assisted resonant tunneling and graphene plasmon modes in the proposed graphene heterostructures gives rise to various smart THz device implementations.

ThR8-37 **12:00-12:5**

Light propagation characteristics of hyperbolic graphene-semiconductor multilayered medium

L. Melnikov[1], O.Kozina[2], I. Nefedov[3]; 1 - Yu. Gagarin State Technical Univ. of Saratov, Russia; 2 - Kotel'nikov Inst. of Radio Engineering and Electronics of SB RAS, Russia; 3 - School of Electrical Engineering, Aalto Univ., Finland;

The light propagating characteristic of the hyperbolic metamaterial consists of graphene and semiconductor layers titled in relation to outer boundary are presented. Promising combination of the graphene and SiC, due to realistic technology condition was investigated. Possibility of control of the light propagating through such structure will be discussed.

ThR8-38 Invited **12:15-12:45**

Enhancing the nonlinear response of metamaterials

M. Kauranen[1], R. Czaplicki[1], J. Mäkitalo[1], H. Husu[1], M. Zdanowicz[1], R. Siikanen[1], K. Koskinen[1], J. Lehtolahti[2], J. Laukkanen[2], and M. Kuittinen[2]; 1 - Tampere Univ. of Technology, 2 - Univ. of Eastern Finland; Finland

We discuss ways to control the second-order nonlinear optical response of plasmonic metamaterials consisting of arrays of metal nanoparticles. The response depends on sample quality and detailed particle ordering and can be enhanced by passive particles with no nonlinear response as such.

ThR8-39 Invited **12:45-13:15**

Interaction of plasmonic nanostructures and quantum system: recent results

A. Chipouline; FSU Jena; Germany

The results of analytical, numerical, and experimental investigations of the resonantly coupled dynamics of the classical system (strip resonator, plasmonic nanoresonator) and quantum systems (Josephson Junction (JJ), quantum dots, dye molecules, etc.) are presented. The wide range of the physical phenomena appearing in these coupled system, is analysed in the frame of the unified approach.

ThR8-40 **13:15-13:30**

Modes of Collective Lasing of a Chain of Spasers

S.V. Fedorov[1,2], A.V. Chipouline[3], N.N. Rosanov[1,2,4]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Vavilov State Optical Inst., Russia; 3 - Friedrich Schiller Univ., Germany; 4 - Ioffe Physical Technical Inst. of RAS, Russia;

We analyze lasing of chains of gold nanoparticles and active quantum dots (QDs) regularly situated and resonantly interacting. It is shown that the minimal threshold of lasing can be close to zero, and the width of lasing line in the dependence of lasing spectral position on the resonance frequency of QDs can be essentially narrower than the plasmon resonance line.

ThR8-41 **13:30-13:45**

Nonlinear optical effects in the near-IR range of semiconductor quantum structures in solutions

V.V. Danilov[1], A.I. Khrebtov[1], A.S. Panfutova[1], A.D. Bouraulev[1], V.Dhaka[2], H. Lipsanen[2]; 1 - Vavilov State Optical Inst., 2 - St.Petersburg State Transport Univ., 3 - St.Petersburg Academic Univ., Russia; 4 - Aalto Univ., Finland;

We have investigated the optical limiting effect in colloidal solutions of III-V nanowires and PbS quantum dots by applying laser radiation with 2 discrete wavelengths: 1.06 and 1.54 μm. By using the Z-scan technique we defined third order nonlinear refraction coefficients and nonlinear absorption coefficients both colloidal solutions of zero-dimensional and quasione- dimensional semiconductor structures. Better limiting characteristics were obtained in the solutions by adding of special organic chemical compounds. Different mechanisms responsible for an optical limiting effect are considered.

R9. MICROWAVE PHOTONICS (MWP)

Richter

Session Chair: 09:00-13:15 I. Denisyuk, St.Petersburg National Research Univ. of ITMO, Russia

ThR9-01 Invited **09:00-09:30**

Linear and nonlinear THz spectroscopy of materials and metamaterials

A.V. Lavrinenko; Technical Univ. of Denmark; Denmark

We report on our activity in time-domain terahertz spectroscopy. We perform broadband (0.2 – 18 THz) or nonlinear (with THz fields amplitudes up to 400 kV/cm) tests of material properties of chalcogenide glasses and transparent conductive oxides. Also we address design and characterization of different polarization-controlling devices, whose performance is based on the principles of metamaterials functioning

ThR9-02 Invited **09:30-10:00**

Polymer-based photonic structures and applications in nonlinear optics

M. Trang Do, Th. Thanh Ngan Nguyen, Q. Li, I. Ledoux-Rak, N. Diep Lai; École Normale Supérieure de Cachan, France;

We demonstrate two important fabrication techniques, namely interference and low one-photon absorption direct laser writing, which present different advantages and allow to obtain desired sub-micrometric 2D and 3D structures. The fabricated polymer-based photonique structures are also proposed for different applications, for example, laser, nonlinear optics, plasmonics, as well as quantum optics

ThR9-03 Invited **10:00-10:30**

Engeneering of Acentric Materials for NLO and THz Applications

T.V. Timofeeva[1], M.S. Fonari[1,2], S. Draguta[1], I. Denisyuk[3], M. Fokina[3]; 1 - New Mexico Highlands Univ., USA; 2 - Inst. of Applied Physics Academy of Sciences, Moldova; 3 - St.Petersburg National Research Univ. of ITMO, Russia;

A series of novel noncentrosymmetric adducts obtained by co-crystallization of para-nitrophenol with several aminopyridines was studied using X-ray diffraction method. The proton transfer from 4-nitrophenol oxygen to the pyridine nitrogen was registered by the X-ray and IR studies. Second harmonic generation was observed experimentally for these compounds; non-linear coefficients were measured.

ThR9-04 **10:30-10:45**

Molecular nanocrystals for electro-optic application

Ju. Burunkova, I. Denisyuk, M. Fokina; St.Petersburg National Research Univ. of ITMO, Russia;

NLO nano- materials based on DAST (4-dimethylamino-N-methyl-stilbazolium tosylate) and aminopyridines derivatives were investigated: crystalline forms, nlo proprieties. Were investigated dynamic of nanocrystals transformation after precipitation. SHG of nanocomposites were measured

ThR9-05 **10:45-11:00**

Microstrip optical waveguides made by RIE process

V. Balia, I. Denisiuk, V. Bulgakova, S. Pozdnyakova, D. Zhuk; St.Petersburg National Research Univ. of ITMO, Russia;

The method of fabrication of microstrip optical waveguides with varying height by the combined RIE polymer cladding and core was investigated. The possibility to form the connecting focons and microstrip waveguide in the same technological process was demonstrated. The influence of processing conditions on the roughness was investigated.

-COFFEE BREAK -

ThR9-06 **11:30-11:45**

Self-organization processes in nanocomposite materials at holographic recording for photonic crystal fabrication

V.Bulgakova, N. Vorzobova, I. Denisyuk; St.Petersburg National Research Univ. of ITMO, Russia;

Researches of holographic recording kinetics for various photopolymerized composite materials were conducted. Dependence of holographic characteristics of diffractive structure on composition, frequency of the interference pattern, wavelength, exposure conditions and post- exposure processing was investigated. Periodic structures with diffraction efficiency up to 80% were obtained.

ThR9-07 **11:45-12:00**

Gold nanocomposites preparation and applications

H. Laszewski [1,2], J.Paulo Coelho [2], A. Guerrero-Martínez [2], 1 - Wroclaw University of Technology, Poland, 2 - Univ. Complutense de Madrid, Spain

Nanocomposite materials are a dynamically developing field of science and have a growing impact on the industry. Technologies based on gold nanoparticides are highly interesting due to their biocompability, stability and the presence of plasmon resonance meaning they can be used in many ways, such as biosensors, drug delivery systems, optical elements, or efficient catalysts.

ThR9-08 **12:00-12:15**

Comparison study of non-centrosymmetric materials from aminopyridines

I. Pavlovetc[1], I. Denisyuk[1], M. Fokina[1], T.V. Timofeeva[2], M. Fonari[2], S. Draguta[2]; 1 - St.Petersburg National Research Univ. of ITMO, Russia; 2 - New Mexico Highlands Univ., USA;

Performed study on the co-crystallization of heterocyclic molecules of aminopyridine series with a nonlinear optical chromophore (4-Nitrophenol) and receiving molecular crystals with non-centrosymmetric crystal lattice based on them. Experiments on the growth of single crystals of these substances by slow evaporation technique in a closed volume. The dependence of the crystal symmetry on the growing conditions. A comparative study of nonlinear optical properties of crystals based on aminopyridines and measured their nonlinear optical coefficients.

ThR9-09 **12:15-12:30**

Gain optimization of a fiber-optic link with an external electrooptical modulator and erbium doped fiber amplifier

A.Petrov[1], I. Ilichev[1], P.Arguzov[1], V. Lebedev[1], A. Shamray[1], E. Velichko[2]; 1 - Ioffe Physical Technical Inst. of RAS, 2 - St.Petersburg State Polytechnical Univ., Russia;

Gain optimization of a radio-frequency fiber-optic link by biasing an external modulator to the transmission minimum was studied. The increase in the gain by up to 5 dB as compared with the conventional quadrature point operation was demonstrated. Dependences of nonlinear distortions on the bias voltage of the electrooptical modulator were investigated.

ThR9-10 **12:30-12:45**

Optical nanocomposite materials for applications in Photonics

S. Pozdnyakova, I. Denisiyk, Ju. Burunkova; St.Petersburg National Research Univ. of ITMO, Russia;

The transparent optical medium for recording photonic crystals by holographic lithography method was developed. Optical and rheological properties of the nanocomposite material were investigated. Application of these materials in integrated optics were demonstrated.

ThR9-11 **12:45-13:00**

Photonic-electronic terahertz frequency comb spectroscopy

A.S. Skryl, D.G. Pavelyev, and M.I. Bakunov; Univ. of Nizhny Novgorod, Russia;

We report a new approach to the terahertz frequency comb spectroscopy (TFCS) based on nonlinear mixing of a photonically generated terahertz pulse train with a continuous wave signal from an electronic synthesizer. Unlike the standard TFCS technique, this approach does not require a complex double laser system. It still retains the advantages of TFCS – high spectral resolution and wide bandwidth.

ThR9-12 **13:00-13:15**

Terahertz Cherenkov radiation from a focused laser beam in an electro-optic medium

S.A. Sychugin, M.I. Bakunov; Univ. of Nizhny Novgorod, Russia;

We develop a theory of terahertz Cherenkov radiation from a femtosecond laser pulse propagating as a Gaussian beam in an electro-optic medium. We show that for a fixed energy of the laser pulse there is an optimal size of the beam waist, which maximizes the terahertz yield.

R2. HIGH POWER LASER SYSTEMS AND FACILITIES

ThR2-p01 **09:00-13:30**

Optical specification and control of elements at UFL-2M laser facility

S.A. Bel`kov, I.N. Voronich, I.N. Derkach, A.A. Yeremin, I.E. Chernov; RFNC-VNIIEF, Russia;

The questions discussed of determining of the requirements to quality of fabrication and materials of optical elements of amplifying channel of powerful neodymium laser system UFL-2M. The requirements are justified in terms of their effect on operation of the facility and features of radiation spatial distribution. The problems highlighted of the input controlling and testing of optical elements with large size.

ThR2-p02 **09:00-13:30**

Numerical modeling of the optical system of UFL-2M laser facility

S.A. Bel`kov[1], I.N. Voronich[1], A.L. Voronov[1], N.A. Voronina[1], I.N. Derkach[1], I.V.Epatko[2], R.V. Serov[2], N.A. Filatova[1], I.E. Chernov[1]; 1 - RFNC-VNIIEF, 2 - General Physics Inst. of RAS, Russia;

Results are presented of the work on developing of 3D calculating models of the optical system of amplifying channel of powerful neodymium laser UFL-2M. Calculations performed of ray tracing and radiation propagation using the models to optimize the structure of laser channel and determine the requirements for optical elements fabrication.

ThR2-p03 **09:00-13:30**

The efficiency research of radiation energy conversion to the third harmonic for "Iskra 5" iodine laser

V.E. Gaganov, S.V. Kalipanov, V.P. Kovalenko, S.P. Kurnopyalov, V.S. Fayzullin, A.V. Zubkov; 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.

ThR2-p04 **09:00-13:30**

Experimental Study on Operation at Room Temperature of RF Excited Planar CO- Laser

A.P. Mineev[1], S.M. Nefedov[1], P.P. Pashinin[1], P.A. Goncharov[1], V.V. Kiselev[1], V.B. Shuvalov[2]; 1 - Prokhorov General Physics Inst. of RAS; 2 - National Research Nuclear Univ.; Russia

Radiation characteristics of RF excited planar CO-lasers have been studied. A cw output CO-laser power of 72 W with an efficiency of ~10% in the spectral range 5.3-6.0 μm at electrodes temperature -80oC has been achieved. An output power and conversion efficiency CO-laser has been studied for operation at room temperature of the cooling running water from +8 to +24oC. A cw output power of 18 W with an efficiency of ~ 4.5% at electrodes temperature +8oC has been achieved.

ThR2-p05 **09:00-13:30**

Radio Frequency Excited Planar Inert Gas Mixture Infrared Lasers

A.P. Mineev[1], S.M. Nefedov[1], P.P. Pashinin[1], P.A. Goncharov[1], V.V. Kiselev[1], V.B. Shuvalov[2]; 1 - General Physics Inst. of RAS, 2 - National Research Nuclear Univ.; Russia;

Radiation characteristics of planar diffusion-cooled IR-lasers (Xe-He, Ar-He and Kr-He) created using the same design and excited by a large-aperture RF discharge (2.8o38o385 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 cw RF discharge. Planar laser with the transverse cw RF discharge is shown as promising radiation source at a wavelength of 1.79-3.65 μm.

ThR2-p06 **09:00-13:30**

Implementation of Multiterawatt Femtosecond Laser System at Kilohertz Repetition Rate

V.V. Petrov, A.V. Laptev, E.V. Pestryakov, G.V. Kuptsov, V.A. Petrov, S.A. Frolov, V.I. Trunov, A.V. Kirpichnikov; Inst. of Laser Physics of SB RAS, Russia;

The report presents the basic principles of creation, scheme and the components of multiterawatt laser system at kilohertz repetition rate based on parametric amplification of femtosecond pulses and laser amplification of picosecond pulses for pumping of stages of parametric amplifier. On developed element base in pump channel of laser system, parameters of regenerative amplifier with output energies about 1 mJ at repetition rate of 1 kHz and central wavelength 1030 nm are experimentally investigated. Optical scheme of multipass cryogenic amplifier based on diode pumped Yb:Y2O3 laser ceramics is developed and parameters for increasing of output energy up to ~ 0.25-0.35 J are determined.

ThR2-p07 **09:00-13:30**

Research in effect of optical elements inhomogeneity on a spatial distribution of laser radiation on laser facility Luch

S.A. Bel'kov[1], O.A. Buchirina[1], N.A. Voronina[1], I.N. Voronich[1], I.N. Derkach[1], V.N. Derkach[1], A.A. Eremin[1], I.V. Epatko[2], R.V. Serov[2], D.V. Sizmin[1], N.A. Filatova[1], I.E. Chernov[1]; 1 - RFNC-VNIIEF, 2 - General Physics Inst. of RAS, Russia;

Comparison is presented of the results of experimental investigations and numerical modeling of several channels of laser facility Luch. Goal of the work concludes in developing of algorithms of experimental data processing for assessing of the current state of optical channel of powerful laser facility. The results will be used at UFL-2M creation.

ThR2-p08 **09:00-13:30**

Reduction of Third Order Dispersion Mismatch Between Fiber Stretcher and Grating Compressor by Using Split-Second-Grating Compressor Design

R. Danilevicius, J. Zeludevicius, K. Viskontas, N. Rusteika, K. Regelskis; Center for Physical Sciences & Technology, Lithuania;

In this work split-second-grating compressor design is investigated numerically. Significant improvement of pulse compression by using this method is numerically demonstrated in fiber chirped pulse amplification system when using optical fiber as pulse stretcher.

ThR2-p09 **09:00-13:30**

High Power Femtosecond CPA System With TOD Compensating Chirped Fiber Bragg Grating Stretcher

S. Frankinas, R. Danilevicius, N. Rusteika; Inst. of Physics, Lithuania;

We present theoretical and experimental results of femtosecond fiber CPA system incorporating chirped fiber Bragg grating as a stretcher and a third order dispersion compensator for significant pulse contrast improvement with high beam quality conservation.

ThR2-p11 **09:00-13:30**

Kinetics of Er 3+ Emission under Laser-thermal Excitation of Er2O3

V.M. Marchenko, Yu.A. Shakir; General Physics Inst. of RAS, Russia;

Kinetics of emission of Er3+ ions in Er2O3 polycrystals in visible and NIR ranges was investigated under excitation by ~30 s and 300 ns pulses of intensive CO2 laser radiation at wavelength λ = 10.6 μm. A delay time of Er3+ emission pulses relative laser pulses of ~1.5 μs comparable with multiphonon relaxation time of 4I13/2 states was detected and explained as the time of multiphonon excitation of the states. The delay effect is confirmed by comparison of experimental and calculated kinetics of Er2O3 emission and looks to be a base of laser-thermal method of measurement of multiphonon excitation times of vibronic states of ions in rare-earth oxides.

ThR2-p12 **09:00-13:30**

Study Of The Temperature Distribution In Diode-End-Pumped Solid State- Lasers

S. Tabet, F. Lakhdari, I. Osmani, M. Khammar; Centre for Development of Advanced Technologies, Unit of Research in Optics and Photonics; Algeria;

The Finite Difference Method (FDM) was used to resolve the heat differential equation in order to calculate the temperature generated in Yb:YAG with diode-end-pumped configuration. The effect of the conductance was studied by using two methods of the cooling system. In the first method the crystal is directly in contact with water. In the second method the crystal is surrounding by a copper to keep the cylindrical surface at the define temperature. The temperature generated reduced to half by using the second method and we can conclude that it is the best choice for high power end pumping system.

ThR2-p13 **09:00-13:30**

Theoretical Study of High Power Mode Instabilities in 2μm Thulium-Doped Fiber Amplifiers

R. Tao, P. Zhou, H. Xiao, X. Wang, Z. Liu; National Univ. of Defense Technology, P.R. China

We studied the high power mode instabilities (MI) in 2μm thulium-doped fiber amplifier theoretically. The MI threshold powers of two kinds of thulium-doped fiber are studied. It revealed that the threshold power of thulium-doped fiber with core/inner cladding diameter being 20/400 is about 1.3kW while that of 25/400 thulium-doped fiber is about 610W, which means that the power level of 2μm thulium-doped fiber amplifiers is about to running into MI issues.

ThR2-p14 **09:00-13:30**

Performance of Nonlinear Ultra-Short Pulse Fiber CPA System Using Power Amplifiers with Core Diameter from 12 to 33 μm

J. Želudevicius, R. Danilevicius, K. Viskontas, N. Rusteika, K. Regelskis; Center for Physical Sciences & Technology, Lithuania;

In this work nonlinear fiber CPA system is investigated, in which self-phase modulation is utilized both in stretcher fiber and power amplifier in order to achieve femtosecond output pulses. System performance using different power amplifier designs with core diameters ranging from 12 to 33 μm is experimentally investigated. Achieved results are compared and analyzed.

R3. SEMICONDUCTOR LASERS, MATERIALS AND APPLICATIONS

ThR3-p01 **15:00-19:30**

Lasing peculiarities of compounds AlxGa1-xN at pumping up with electron beams and UV radiation of the second harmonics of copper vapor laser

P.A. Bokhan, Dm.E. Zakrevsky, V.A. Kim, K.S. Zhuravlev, T.V. Malin, I.V. Osinnykh; Inst. of Semiconductor Physics of SB RAS; Russia

Investigations of lasing and luminescence characteristics for AlxGa1-xN compounds and epitaxial films 0.5…1.2 μm wide on the sapphire substrate were carried out. The main characteristics of superradiance in the broad band, which can be used for both the creation of waveguide lasers in a wide range and of those with the femtosecond pulse duration, are presented.

ThR3-p02 **15:00-19:30**

Investigation of lasers generation characteristics in compounds ZnS, CdS, ZnSe at pumping up with the electron beam generated in an open discharge

P.A. Bokhan, Dm.E. Zakrevsky, P.P. Gugin, V.I. Solomonov, A.V. Spirina; 1 - Inst. of Semiconductor Physics of SB RAS, 2 - Inst. of Electrophysics of Ural Branch RAS, Russia; Inst. of Semiconductor Physics of SB RAS;

The investigation results for luminescence and lasing characteristics in compound A2B6, when pumping up electrons with the energy from 5 to 20 keV and pulse duration of 10…100 ns, are presented. Comparative studies of monocrystals and film lasing (superradiance) characteristics were carried out. The luminescence and lasing characteristics, when pumping up with the high-energy electron beam at the energy of 170 keV and duration of 2 ns, were also investigated for comparison. The main characteristics of both luminescence and generation are shown to be similar.

ThR3-p03 **15:00-19:30**

Active mode locking in laser gyroscope on semiconductor optical amplifiers and long fiber cavity

Yu.Yu. Broslavets, V.P. Duraev, A.A. Fomichev; Moscow Inst. of Physics and Technology (State Univ.), Russia;

In this paper we present the results of research on generation regimes in laser gyroscope on semiconductor optical amplifiers with the use of long fiber cavities. Physical-mathematical model of generation dynamics has been made. This model describes processes in the gyroscope on semiconductor optical amplifier and external fiber cavity. The study of the competition and intercoupling degree of the counterpropagating waves has been conducted.

ThR3-p04 **15:00-19:30**

High power 1550 nm Multijunction Laser Emitters Based On Integrated Heterostructure

P. Gorlachuk, I. Yarotskaya, Yu. Ryaboshtan, M. Ladugin, A. Padalitsa, A. Marmalyuk, A. Ivanov, V. Kurnosov, K. Kurnosov, O. Zhuravleva, R. Chernov, V. Romantsevich, A. Lobintsov, V. Simakov; RDI «Polyus», Russia

Multijunction 1550 nm lasers based on AlGaInAs/InP integrated heterostructures pulsed performance is demonstrated. Optical characteristics are given. The maximum optical output power exceeded 200 W.

ThR3-p05 **15:00-19:30**

Triple-wavelength Laser Diodes Based on Epitaxially Stacked AlGaAs/GaAs Heterostructures

T. Bagaev, A. Padalitsa, A. Marmalyuk, M. Ladugin, I. Yarotskaya, A. Lobintsov, S. Sapozhnikov, E. Davydova, A. Morozyuk, V. Konyaev, V. Simakov; RDI «Polyus», Russia

In present paper the device characteristics of the laser diodes based on epitaxial integrated heterostructures AlGaAs/GaAs emitting at three different wavelengths in needed spectral range of 800-830 nm have been demonstrated.

ThR3-p06 **15:00-19:30**

Relaxation Oscillations in a Quantum Dot Laser

I.V. Koryukin; Inst. of Applied Physics of RAS, Russia;

We study relaxation oscillations in a semiconductor quantum dot laser using the electron-hole asymmetry model. Two relaxation oscillation frequencies are found in the regime of simultaneous lasing at the ground and excited states. Low-frequency relaxation oscillations are antiphase oscillations at some laser parameters.

ThR3-p07 **15:00-19:30**

Operational Characteristics of Intracavity Singly-Resonant Optical Parametric Oscillator Pumped by Vertical External Cavity Surface-Emitting Laser

Yu.A. Morozov[1], M.Yu. Morozov[1], V.I. Kozlovsky[2], O. Okhotnikov[3]; 1 - Kotelnikov Inst. of Radio Engineering and Electronics of SB RAS; 2 - Lebedev Physical Inst. of RAS, Russia; 3 - Optoelectronics Research Centre, Finland;

The operational characteristics of a novel continuous-wave compact intracavity singly- resonant optical parametric oscillator pumped by a vertical external cavity surface-emitting laser are numerically analyzed.

ThR3-p08 **15:00-19:30**

The effect of mercury lamp irradiation on the threshold current density of electron beam pumped ZnSe-based lasers

M.M. Zverev[1], N.A. Gamov[1], E.V. Zhdanova[1], D.V. Peregoudov[1], V.B. Studionov[1], S.V. Gronin[2], I.V. Sedova[2], S.V. Sorokin[2], S.V. Ivanov[2]; 1 - Moscow State Technical Univ. (MIREA), 2 - Ioffe Physical Technical Inst. of RAS, Russia;

It has been demonstrated that after 3 - 5 minutes irradiation of the MBE grown ZnSe- based electron beam pumped laser heterostructures with the light intensity of mercury lamp of 40- 60 W/cm2, the luminescence intensity increased by ~20-50 % , whereas the threshold current density reduced by 20-40 %. Evidently, the results could be explained by the annealing (or optical transformation) the initial point defects in the active area of the laser heterostructure induced by low-temperature growth.

ThR3-p09 **15:00-19:30**

Pulsed Electron Beam Pumped Laser Based on ZnCdSe MQW Structure With High Threshold of Catastrophic Degradation

M.M. Zverev[1], N.A. Gamov[1], E.V. Zhdanova[1], D.V. Peregoudov[1], V.B. Studionov[1], S.V. Gronin[2], I.V. Sedova[2], S.V. Sorokin[2], S.V. Ivanov[2]; 1 - Moscow State Technical Univ. (MIREA), 2 - Ioffe Physical Technical Inst. of RAS, Russia;

The parameters of electron beam pumped RT lasers based on ZnSe-containing MQW structures were studied. Maximum value of output pulse power as high as 82W per laser facet has been demonstrated. Both the high value of Pmax and the threshold of catastrophic degradation in comparison with the earlier results could be explained by the relatively low level of defect density (~104 cm-2) in the laser structure.

ThR3-p10 **15:00-19:30**

Compact Autonomous LIDAR for Fire and Intrusion Detection

A.B. Utkin, F. Piedade, V. Beixiga, P. Mota, P. Lousa; INOV - INESC Inovação and ICEMS IST, Technical Univ. of Lisbon, Portugal;

This work discusses robust and cost effective elastic LIDAR sensor for automatic intrusion detection and fire surveillance, built around a laser diode and an avalanche photodiode detector.

R5. SUPER-INTENSE LIGHT FIELDS AND ULTRA-FAST PROCESSES

ThR5-p01 **09:00-13:30**

Relativistic laser driven hot particles generation in undercritical pre-plasma of solid targets

I.N. Tsymbalov[1], K.A. Ivanov[1], S.A. Shulyapov[1], P.A. Ksenofontov[1,2], R.V. Volkov[1], A.B. Savel'ev[1], A.V. Brantov[2], V.Yu. Bychenkov[2]; 1 - Lomonosov Moscow State Univ., 2 - Lebedev Physical Inst. of RAS; Russia;

The appreciable enhancement of relativistic plasma parameters (hot electron generation and hard X-Ray yield) by controlling the pre-plasma scalelength with complementary laser pulse is demonstrated. Experimental data and numerical simulation results are presented.

ThR5-p02 **09:00-13:30**

Investigation of interactions of soft x-ray laser pulses with matters

M. Ishino[1], N. Hasegawa[1], M. Nishikino[1], M. Yamagiwa[1], T. Kawachi[1], T.A. Pikuz[2], A.Ya. Faenov[2], I.Yu. Skobelev[2]; 1 - Japan Atomic Energy Agency, Japan; 2 - Joint Inst. for High Temperatures of RAS, Russia;

Soft x-ray laser (SXRL) pulses were irradiated to the material surfaces. On all irradiated target surfaces, the surface modifications were confirmed. However, the optical emission (visible range) from the surfaces were not observed. The model calculation reveals the spallative ablation of target surface without plasma production. The experimental result investigated by our study is consistent with the theoretical calculations.

ThR5-p03 **09:00-13:30**

On the possibility of neutron yield enhancement in fusion targets at laser energy ~ 1 MJ

I.G. Lebo, A.I. Lebo; Moscow State Technical Univ. (MIREA), Russia;

We propose a conceptual design of thermonuclear laser target for obtainment of large neutron yield from compressed DT plasma. It allows to increase a proportion of energy, which α - particles pass on thermal ions of DT plasma. The numerical simulations illustrate this effect. The neutron yield up to 10^17 could be obtained at laser pulse energy ~ 1 MJ.

ThR5-p04 **09:00-13:30**

Laser driven ultra-wideband microwave pulse generetor numerical simulation

V. M. Brendel, V.V. Bukin, S.V. Garnov, T.V. Dolmatov, O.T. Loza, S.P. Sadovskiy, P.A. Chijov, V.P. Tarakanov; Prokhorov General Physics Inst. of RAS, Russia;

Results of numerical simulation of laser driven UWB microwave pulse generator using PIC code KARAT are presented. Calculation results compared with analytical estimations.

ThR5-p05 **09:00-13:30**

Modification of photomasks substrates by ultrashort laser pulses in modern lithography

S. Oshemkov, V. Dmitriev, E. Graitzer, G. Ben-Zvi, V. Kruglyakov; Carl Zeiss SMS Ltd., Israel;

The possibilities to improve the yield of the lithography process due to controllable change of photomasks properties by processing of bulk fused silica mask substrate with ultrashort laser pulses are discussed. We applied laser processing of photomasks substrates for intra field critical dimensions uniformity (CDU) improvement, for registration errors correction and for correction of substrates surface flatness.

ThR5-p06 **09:00-13:30**

Investigation of hard X-ray generation at oblique incidence of femtosecond laser pulses on the copper foil targets.

A.A. Goriaev[1], A.A. Andreev[1,2], N. Zhavoronkov[2], K.Yu. Platonov[3], M.V. Sedov[1]; 1 - St.Petersburg State Univ., Russia; 2 - Max-Born Inst., Germany; 3 - St.Petersburg State Polytechnical Univ., Russia;

In this report we analyze in experiment and theory the possibility to enhance the monochromatic X-ray conversion efficiency by changing the incident angle of the laser radiation in the interaction of 1 kHz repetition rate and intensity up to 1017 W/cm2 femtosecond laser pulses with (up to 30 microns) thickness copper foil. This analysis provide us additional information about the changing the conversion efficiency from the laser to the X-ray radiation and help to determine other optimal parameters, such as target material, thickness and shape of the surface.

ThR5-p07 **09:00-13:30**

Two-stage ion bunch acceleration in electric field of a foil targets irradiated by intensive laser pulses

A.A. Andreev[1,2], P.Nickles[1], K.Yu. Platonov; 1 - Max-Born Inst., Germany; 2 - St.Petersburg State Univ., Russia;

The scheme of two-stage proton laser accelerator with two targets and two laser pulses is discussed. It is shown, that for optimal distance between targets monochromatic protons energy distribution is obtained. The two-stage scheme allows obtain higher acceleration efficiency and protons energy, than acceleration by one pulse with the energy equal to total energy of two pulses. By means of analytical model optimum distance between targets, second laser pulse delay time and pulse intensities are defined. Analytical model results are verified by 2D PIC-simulation of proton bunch, moving through laser spot on foil target surface.

R9. : MICROWAVE PHOTONICS (MWP)

ThR9-p01 **15:00-19:00**

Numerical model for investigation of dynamics of short-cavity two-color fiber laser for THz generation

L.A. Kochkurov, L.A. Melnikov, Yu.A. Mazhirina; Saratov State Technical Univ.; Russia

Numerical model of two-color short-cavity fiber laser with nonlinear crystal inside the cavity for terahertz generation is proposed. THz field generation is due to down- frequency conversion. Proposed model is based on the transport- type equations, spatial discretization along the cavity axis, and calculation of temporal variations both electric field amplitude and active media inversion at these points.

ThR9-p02 **15:00-19:00**

Optical resonators based on carbon nanotubes for photonics applications

P. Salzenstein[1], T. Makaryan[2]; 1 - CNRS FEMTO-ST, France, 2 - Faculty of Radiophysics Yerevan State Univ., Armenia, Univ. of Cambridge, UK;

By performing experiments and modelizations, we investigate the use of Carbon nanotubes for photonics applications.

ThR9-p03 **15:00-19:00**

Application of modern method of calculating uncertainty to microwaves and opto- electronics

E. Pavlyuchenko[1,2], P. Salzenstein[1]; 1 - CNRS FEMTO-ST, France; 2 - Donetsk Univ., Ukraine;

Recent approach is used to calculate uncertainty for an microwave and optoelectronic system. The deduced global uncertainty on spectral density of phase noise in the range of 2 dB is improved.

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Organized & Sponsored by

IPG PHOTONICS®

«LASER OPTICS 2014»

Chair

V. Gapontsev
IPG Photonics Corporation, USA

Vice-Chair

N.N. Evtikhiev
NTO IRE-Polyus, Russia

KEY TOPICS OF THE SYMPOSIUM

- High power fiber lasers for material processing applications
- Cutting and welding with kW fiber lasers
- Fiber laser cladding, sintering and heat treatment
- 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
- Life sciences, medical, surgical, food production, agricultural pest and herbal control applications of fiber lasers

TuSy1-01 Invited **09:00-09:40**

New achievments in fiber laser industry

V. Gapontsev, IPG Photonics, USA

Abstract is not available.

TuSy1-02 Invited **09:40-10:20**

Bismuth-doped optical fibers - a new promising active medium for the near IR Spectral region

E. Dianov, Fiber Optics Research Center RAS, Russia

This paper reviews the recent results on the luminescence properties of various Bi-doped optical fibers and the development of Bi-doped fiber lasers and optical amplifiers for the spectral regions 1150-1550nm and 1625-1775nm.

TuSy1-03 **10:20-11:00**

High power laser diodes for pumping of fiber lasers

A. Ovtchinnikov, IPG Photonics Corporation, USA

Over the last few years fiber lasers became the biggest consumer of high power multimode laser diode pumps. We report on the state of the art AlGaInAs/GaAs diodes used for fiber laser pumping. Recent advancements leading to significant improvements in pumps' performance, reliability, reproducibility, efficiency and yield are discussed in details. We discuss on the most recent cost-effective industrial solutions and techniques used in high-volume manufacturing of laser diode pumps. We also demonstrate how these advancements enable new applications for fiber lasers through improving their efficiency and cost.

-COFFEE BREAK -

TuSy1-04 Invited **11:30-11:50**

100 kW CW Fiber Laser for Industrial Applications

V. Fomin, V. Gapontsev, E. Shcherbakov, A. Abramov, A. Ferin, D. Mochalov, IPG Laser GmbH, Germany

The world's most powerful laser system for industrial applications would be presented. Ytterbium fiber laser combines record 101.3 kW output power, continuous-wave operational mode and an excellent beam quality. Beam parameter product (BPP) does not exceed 16 mm x mrad, when we use 300 m x 10 m feeding fiber, or near 25 mm x mrad, when fiber-to-fiber output coupler with 500 m x 50 m process fiber is used. Emission wavelength is 1070 nm. High wall-plug efficiency 35.4%, compact laser cabinet and total weight less than 3600 kg open the new opportunities in different industrial and mobile applications.

ThSy1-05 **11:50-12:10**

Multi-kilowatt Average Power Nano Pulse Fiber Lasers

A. Ferin, V. Gapontsev, E. Shcherbakov, V. Fomin, A. Unt, S. Maryashin, A. Abramov, M. Abramov, IPG Laser GmbH, Germany

This article describes latest results achieved by IPG Photonics in the development of multi-kilowatt average power nanosecond pulse fiber lasers. Main factors limiting both power and energy scaling will be discussed. Also we report novel all-fiber concept based on parallel combining of multiple nanosecond pulse fiber lasers by means of fused fiber combiners. This approach allows modular system design where the number of laser modules can be adjusted to fit the desired power level. The radiation of 19 laser modules was coupled into 500 m core delivery fiber with BPP equalled to 31.6 mm x mrad. Peak power 0.4 MW and pulse energy 40.5 mJ were achieved. Average power was 4.05 kW within 1064 nm wavelength range.

ThSy1-06 **12:10-12:30**

New schemes of Raman fiber lasers

S. Babin, Inst. of Automation and Electrometry SB RAS, Novosibirsk State Univ., Russia

A brief review of recent results obtained in new schemes of Raman fiber lasers (RFLs) is given. It is shown that cavity-free random lasing based on Rayleigh backscattering provides ultimate pump-to-Stokes conversion efficiency and broad-range wavelength tuning. Direct pumping of gradient-index fibers by multimode LDs offers high-power RFL operation below 1 μm. Combination of both approaches is also treated.

ThSy1-07 **12:30-12:50**

New multi-kilowatt QCW fiber lasers

O. Shkurikhin, A. Mashkin, IPG Photonics Corporation, USA, IPG Laser GmbH, Germany

Recent advances in IPG high power pump laser diodes and optimization of fiber configuration resulted in development of new compact and cost effective QCW single or low mode fiber laser modules with pulse power/energy from 1.5kW/15J to 4.5kW/45J. Combining outputs of these modules into multi-mode fiber allowed to design multi-kilowatt QCW fiber lasers with pulse power energy up to 20kW/200J. This new generation of highly efficient QCW fiber lasers not only replaced the old solid-sate lamp pumped lasers but revolutionized laser industry and stimulated development of new welding cutting and drilling applications.

ThSy1-08 **12:50-13:10**

Record average power CW and QCW green and UV fiber lasers

A. Avdokhin, V. Gapontsev, P. Kadwani, A. Vaupel, I. Samartsev, IPG Photonics Corp., USA

We report a single-mode (SM) green fiber laser based on single-pass frequency doubling of a linearly-polarized (LP) narrow-linewidth Yb fiber laser in LBO crystal, and configured to operate in a range of regimes from continuous-wave (CW) to high-repetition-rate quasi-continuous-wave (QCW). Adjusting the duty cycle, we maintained high second harmonic generation (SHG) efficiency for various output powers. Average powers of over 550W in QCW and over 350W in CW regimes were obtained with the wall-plug efficiency up to 24%, opening the possibility to creating new class of simple, compact and efficient single-mode green lasers with output power up to 1kW and above. We also report a nearly single-mode ultraviolet (UV) fiber laser source based on cascaded single-pass frequency tripling of LP narrow-linewidth high-repetition-rate QCW Yb fiber laser in two LBO crystals. Average power of over 90W at 355nm was obtained with the THG efficiency of up to 30% and wall-plug efficiency of up to 10%. No changes in the shape and divergence of the UV beam were observed over the whole range of output powers. Utilizing 1kW narrow-linewidth ytterbium fiber laser, we plan to increase output UV power to 300W in the near future.

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Petrov-Vodkin 2 Hall

09:00 - 17:20

TuSy1-09 **13:10-13:30**

Kerr-lens mode-locked mid-IR fs oscillators based on Cr-doped polycrystalline ZnS and ZnSe

S. Vasilyev[1], M. Mirov[1], V. Gapontsev[2], 1 - IPG Photonics, Mid-IR Lasers, 2 - IPG Photonics, USA

We report the Kerr-lens mode-locked polycrystalline Cr2+:ZnS and Cr2+:ZnSe lasers emitting around 2.3 - 2.4 μm. The mode-locked lasers were pumped at 1560 nm by a radiation of Er-fiber laser. The long-term stable laser oscillations with 67 fs transform limited pulses and the average output power of 2 W were obtained at 95 MHz pulse repetition rate. That corresponds to 21 nJ pulse energy and 275 kW peak power. The pulse duration as short as 46 fs was obtained at 0.6 W output power. Specific feature of the developed fs oscillators is the strong second order nonlinear effects in polycrystalline laser medium.

-BREAK FOR LUNCH -

TuSy1-10 **15:00-15:20**

Single crystal fibers for laser amplification

Jean-Marie Fourmigué[1], Igor Martial[1], Julien Didierjean[1], Xavier Délen[2], Loic Deyra[2], François Balembois[2], Patrick Georges[2], 1 - Fibercryst SAS, 2 - Univ. Paris-Sud, France

We present in this paper a review of experimental results achieved for high power average power and high peak power laser amplification with single-crystal fiber technology.

Reg.#: 737 11

TuSy1-11 **15:20-15:40**

High power single-mode red fiber lasers

O.A. Byalkovskiy, NTO IRE-Polyus, Russia

Red laser radiation of 15 W power at 0.63 μ was obtained by sum frequency generation of 1.55 μ and 1.06 μ radiation wavelengths from Er and Yb pulsed fiber lasers with 1 MHz pulse repetition rate respectively. Noncritical phase matching of lithium triborat (LBO) crystal at temperature 13°C was employed for sum frequency generation. The optical-to-optical conversion efficiency of 40 % was achieved. The proposed technique allows obtaining high-power pulsed single-mode laser red radiation in 0.6 μ - 0.65 μ spectral region.

TuSy1-12 **15:40-16:00**

14 W SHG in MgO: sPPLT at 589 nm from high power CW linearly polarized RFL

A.A. Surin[1,2], S.V. Larin[1], 1 - NTO IRE-Polus, 2 - MIPT, Russia

We have developed efficient, single mode, linearly polarized Raman Fiber Laser (RFL), operating at 1178 nm in CW regime, with a maximum output power of 70 W and narrow linewidth 0.1 nm. Single-pass SHG from 60 W of RFL radiation in 20 mm long MgO:sPPLT to 589 nm was demonstrated and resulted in 14 W of a with 22 % conversion efficiency, no crystal degradation was observed. We expect, that it is possible to obtain 20 W of 589 nm radiation with further optimizations.

TuSy1-13 **16:00-16:20**

High power supercontinuum fiber source

A.V. Doronkin, NTO IRE-Polyus, Russia

Pulsed supercontinuum fiber source with more than 10 W average output power have been demonstrated. Output spectrum has short wavelength edge less than 400 nm and long wavelength edge more than 2200 nm. Spectral power density in the visible spectral region is 3-10 dBm/nm. Short-term pulse energy stability in 1 nm visible spectral band is ± 3% RMS. To the best of our knowledge supercontinuum fiber source under discussion have the optimal combination of output characteristics in the industry.

TuSy1-14 **16:20-16:40**

Comparison of a Broadband Fiber Optic Source

G.E. Sandoval-Romero, E.F. Pinzon-Escobar, Centro de Ciencias Aplicadas y DesarrolloTecnologico-UNAM, Mexico

We present an experimental work of a broadband amplifier centered at 1550 nm using erbium doped fiber and ytterbium doped fiber pumped at 976.8 nm. The experimental results show that the gain is practically independent of the state of polarization of the pump and the signal. We propose that the Ytterbium doped fiber could be used as an option to filter the pump power. These amplifiers are based on the telecommunications amplifiers and could have direct application in wavelength multiplexed arrangements of fiber sensors, fiber gyroscopes or in general, in any sensors in which a broad wavelength and stable light source is required.

TuSy1-15 **16:40-17:00**

Comparison of novel all-fiber-format and hybrid thulium pulse fiber lasers

S. Larin, O. Vershinin, V. Sypin, NTO IRE-Polus, Russia

Our recent progress in development of all-fiber-format and hybrid thulium fiber laser is presented and discussed.

TuSy1-16 **17:00-17:20**

Multilayer W-type Optical Fibers for High-power Fiber Lasers.

V.E. Ustimchik[1,2], A.E. Ulanov[1,2] , S.A. Nikitov[1,2], Yu.K. Chamorovskii[1], V.N. Filippov[3], 1 - Institute of Radio-engineering and Electronics RAS, 2 - Moscow Institute of Physics and Technology, Russia, 3 - Tampere University of

Technology, Finland

We produced numerical and experimental investigation of multilayer W-type optical fibers. These fibers provide near singlemode propagation of radiation with output beam quality parameter upto M2=1.4 for 1.06 μm and M2=1.03 for 1.28 μm for core diameter about 50μm

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Petrov-Vodkin 2 Hall

09:00 - 17:40

WeSy1-17 Invited **09:00-09:40**

Recent progress in 1.9 - 6 μm mid-IR lasers based on Cr and Fe doped II-VI chalcogenides

S. Vasilyev[1], M. Mirov[1], V. Gapontsev[2], V. Fedorov[3], D. Martyshkin[3], 1 - IPG Photonics, Mid-IR Lasers, 2 - IPG Photonics, 3 - Univ. of Alabama at Birmingham, USA

We report the recent experimental results on optically pumped lasers based on Cr and Fe doped II-VI wide band semiconductors providing access to the 1.9-6 μm spectral range with a high (up to 70%) efficiency, multi-Watt-level (18 W in gain switch and 30 W in pure CW) output powers, tunability in excess of 1000nm, short-pulse (<50 fs) multi-watt oscillation, multi-Joule long-pulse output energy, and narrow spectral linewidth (<100 kHz).

WeSy1-18 Invited **09:40-10:20**

New Generation of Industry Grade Ultrafast Ytterbium Fiber Lasers

A. Yusim, I. Samartsev, A. Bordenyuk, V. Gapontsev, IPG Photonics Corp., USA

We report on industrial grade picosecond and femtosecond pulse Yb fiber lasers with >100μJ pulse energy output. The compact and rugged fiber laser configuration is designed with >15nJ pulse energy, passively modelocked fiber laser seed. Customer reconfigurable features such as controllable repetition rate, fine pulse duration control, burst mode operation and adjustable pulse energy permit the customer to tailor the laser to their application.

WeSy1-19 Invited **10:20-11:00**

Progress in pulse fiber lasers of UV range

P. Tzankov[1], M. Leonardo[1], A. Babushkin[2], 1 - Silicon Valley Technology Center, 2 - IPG Photonic, USA

We will report on the recent progress of the nanosecond laser development in the ultraviolet spectral range at IPG Photonics. The development of high-energy single-mode Yb:fiber lasers with 1-2 nanosecond pulse duration and excellent polarization and spectral characteristics recently enabled highly efficient non-linear optical frequency conversion to third and fourth harmonics at 355nm and 266nm, respectively. Up to 50% conversion efficiency was achieved at 355nm and 30% at 266nm. A comparative study of fourth harmonic generation using BBO and LBO crystals will be presented.

-COFFEE BREAK -

WeSy1-20 **11:30-11:50**

Erbium FCPA system for ophthalmology and micromachining applications

D.V. Myasnikov, A.I. Baranov, D.V. Protasenya, NTO IRE-Polus, Russia

A compact, robust, turnkey femtosecond fiber chirped pulse amplification system is presented. 400-fs pulses are obtained in the broad range of repetition rates and pulse energies up to 10 microjoules at 1.55 micron wavelength.

WeSy1-21 **11:50-12:10**

All-fiber, high-power, picosecond Yb double clad tapered fiber amplifier

R. Gumenyuk[1], V. Filippov[1], Yu. Chamorovskii[2], A. Vorotinskii[1], K. Golant[2], O.G. Okhotnikov[1], 1 - Tampere University of Technology, Finland, 2 - Institute of Radio and Electronics RAS, Russia

We demonstrate picosecond all-fiber system utilizing Yb-doped tapered power amplifier. The system is capable of producing 6 ps pulses with average power of 60 W and peak power of 0.4 MW.

WeSy1-22 **12:10-12:30**

Sum frequency generation of UV laser radiation at 266 nm in LBO Crystal

D.G. Nikitin, NTO IRE-Polus, Russia

We report about investigation of laser generation at 266 nm in LBO crystal by frequency mixing of fundamental (1064 nm) and third harmonic (355 nm) of an ytterbium pulsed fiber laser radiation. UV output power of 3.3 W at 266 nm was achieved with 14% conversion efficiency in respect to fundamental pump radiation.

WeSy1-23 **12:30-12:50**

Ytterbium Mode-locked fiber laser with single-wall nanotubes as saturable absorber

I. Ulyanov[1], D. Myasnikov[1], S. Larin[1], Petr Obraztsov[1,2], N. Arutyunan[2], E. Obraztsova[2], 1 - NTO IRE-Polyus, 2 - General Physics Insti. RAS, Russia

We report on development of 1mkm master oscillator generating 6.6 ps, 250 pJ soliton-like pulses. The selfstarting CW mode-locking is realized in ytterbium all-fiber ring laser with PM architecture using specially designed saturable absorber based on single-wall carbon nanotubes.

WeSy1-24 **12:50-13:10**

Absorption studies of ring core double clad fiber

Wenn Jing Lai, Nanyang Technological University, Singapore

We studied the absorption efficiencies of ring doped core DCF (double clad fiber), and found out that the fiber gives excellent results. This will help to better manage the nonlinear effects in the high power working regimes.

WeSy1-25 **13:10-13:30**

Nanosecond square pulses with triangular spectral profile generated from an all- normal-dispersion passively mode-locked Yb-doped fiber laser

Hailong Yu, Xiaolin Wang, Pu Zhou, Xiaojun Xu, and Jinbao Chen, College of Optoelectric Science and Engineering, National University of Defense Technology, P.R. China

We report on the generation of a new kind of nanosecond high-energy square pulses in passively mode-locked Yb-doped fiber laser with all-normal-dispersion ring cavity configuration. The generated square pulses have a triangular spectrum with a 3 dB spectral bandwidth of only 0.18 nm. The square pulses are wave-breaking-free and have pulse energy of 34 nJ at the pump power of 323 mW.

-BREAK FOR LUNCH -

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Petrov-Vodkin 2 Hall

09:00 - 17:40

WeSy1-26 **15:00-15:20**

Expansion of pulsed laser process limits through pulsed fiber lasers

N. Dury[1], C. Ruettimann[1], R. Holtz[2], 1 - Rofin Lasag AG, 2 - Class 4 Laser Professionals AG, Switzerland

This paper gives an overview of the new possibilities offered by the pulsed fibre laser technology with a particular focus on welding applications.

WeSy1-27 **15:20-15:40**

Precise Metrology of New Materials for High Power Lasers

E. Tsidilkovski, I. Samartsev, L. Klebanov, IPG Photonics Corp., USA, IPG Photonics Corp.

Various materials exposed to high power laser radiation show gradual degradation as well as catastrophic failures. Two main mechanisms responsible for laser-induced damage are: 1) non-uniform light absorption leading to localized overheating and non-uniform thermal expansion and 2) concentration of electromagnetic field in small volumes of material. The well-known causes of these effects are material contamination and structural imperfections. We present here both methods of investigation and results of study of laser-induced damage in various optical components, such as non-linear optical crystals and optical coatings.

Reg.#: 730 28

Model of bulk solid state opticaal amplifier with fiber combined single-mode signal and pump

D.V. Myasnikov, S.V. Larin, NTO IRE-Polyus, Russia

A model is presented that allows to calculate parameters of a bulk solid-state optical amplifier pumped by a nearly single-mode fiber laser. More specifically, thulium ceramic amplifier is considered. It is shown that more than 10 dB single-pass amplification and more than 40% slope efficiency can be achieved in the proposed scheme.

WeSy1-29 **16:00-16:20**

Investigation of the features of supercontinuum generation in single-mode hassive fibers

I.V. Obronov[1,2], N.V. Voronkov[1,2], 1 - NTO IRE-Polyus, 2 - MIPT, Russia

The series of experiments of supercontinuum generation in different single-mode optical fibers has been done. Pulse laser with wavelength 1558nm, adjustable PRR in range 50-200kHz and pulse duration 5ns has been used as source of pump radiation injected into the test loop of fiber.

WeSy1-30 **16:20-16:40**

Long-period and fiber Bragg gratings fabricated by high-energy femtosecond pulses

A.V. Dostovalov[1], A.A. Wolf[1], S.A. Babin[1,2], 1 - Institute of Automation and Electrometry SB RAS, 2 - Novosibirsk State Univ., Russia

The paper presents the results on long-period and fiber Bragg gratings inscription in non-photosensitive optical fibers by femtosecond radiation with the wavelengths of 513 nm and 1026 nm. The slit beam shaping method is proposed for LPG fabrication to increase the resonant peak amplitude and to reduce the out-of band losses due to smoother profile of refractive index change. The Bragg gratings were inscribed by a point-by-point method through plastic coating of various single mode fibers, SMF-28e+, Fibercore SM1500(9/125)P, Fibercore SM1500SC(9/125)P.

WeSy1-31 **16:40-17:00**

Numerical stabiliry computation of ultrashort pulse generation in erbium fiber laser passively mode locked through nonlinear polarization rotation

A.I. Baranov, D.V. Myasnikov, NTO IRE-Polyus, Moscow Inst. of Physics and Technology, Russia

Nowadays ultra-short pulse lasers are of the great interest in laser physics and material science. The popular scheme of ultra-short pulse fiber laser is based on nonlinear polarization rotation. However, the big drawback of this scheme is pulse generation dependence on resonator parameters. In our work, we have simulated process of pulse generation with different external parameters, such as dispersion, nonlinearity, birefringence, pump power and round-trip losses.

WeSy1-32 **17:00-17:20**

Mode Instability in Yb 3+-doped LMA Fiber Amplifiers of Continuous and Pulsed Signal

O. Vershinin[1], V. Tyrtyshnyy[1], M. Kuznetsov[2], O. Antipov[2], 1 - NTO IRE-Polus, 2 - Inst. of Applied Physics RAS, Russia

Spatio-temporal instability of fundamental mode in Yb3+-doped large mode area polarization-maintaining fiber amplifiers was analyzed. Limitations of the amplifier output power and gain were investigated depending on the input signal parameters: spectral width, power level and polarization. The influence of backward reflection of the optical waves on the mode-instability threshold was also examined. The traveling electronic and thermal refractive index gratings following the optically-induced population gratings were found to provide the energy transfer from the main mode to the higher-order modes.

WeSy1-33 **17:20-17:40**

Design of mobile hybrid laser-arc welding system on the base of 20 kW fiber laser

G. Turichin, O. Velichko, A. Kuznetsov, J. Pevzner, O. Grinin, M. Kuznetsov, Inst. of Laser and Welding Technology, St.Petersburg State Polytechnic Univ., Russia

Abstract is not available.

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Petrov-Vodkin 2 Hall

09:00-13:30

ThSy1-34 **09:00-09:40**

Advances in Fiber Laser Beam Delivery

Y. Grapov, N.N. Nair, M.S. Sauter, M. Digiantommaso, IPG Photonics Corp., USA:, IPG Photonics Corp.

IPG has developed a complete range of high power beam delivery components such as couplers, beam switches, collimators, cutting and welding heads to complement its revolutionary high power fiber lasers. Along with our success of super high power 100 kW Beam Coupler and mid power half inch couplers and beam switches, this presentation will showcase our advancements in high power laser process heads such as the 30kW welding head, developments on the 50kW welding head and advantages of welding with IPG's beam wobble module. This presentation will also highlight advancements in IPG's cutting heads such as cutting at 10kW, spot adjustment on the fly with our zoom collimator and fine feature cutting with our micro-cutting heads. This places IPG in the rare position of being in full control of every step needed to achieve our mission of delivering innovative, reliable, high quality and high performance fiber lasers at a cost-effective price.

ThSy1-35 **09:40-10:00**

Laser machine of precision treatment

Joe Dallarosa, IPG Photonics Corporation, USA

Abstract is not available.

TuSy1-36 **10:00-10:20**

Pulse control and pulse jitter stabilization in Cr:ZnSe-passsively Q-switched Ho:YAG lasers

O. Vershinin [1], I. Golubev [1], S. Larin [1], I. Moskalev [2], M. Mirov [2], S. Mirov [2], V. Gapontsev [3], 1 - NTO IRE-Polus, Russia, 2 - IPG Photonics, Mid-IR Lasers, USA, 3 - IPG Photonics, USA

We report on experimental investigation of various methods for pulse control and pulse jitter stabilization in Cr:ZnSe passively Q-switched Ho:YAG lasers. We explore methods of synchronous pump power modulation and application of dual passive/active Q-switch. Pulse jitter <0.1% and precise pulse control of PQS Ho:YAG laser has been achieved.

ThSy1-37 **10:20-10:40**

Investigation of high power SHG in MgO:PPLN crystal pumped by 1178 nm radiation from Raman fiber laser

T.E. Borisenko, A.A. Surin, MIPT (SU), NTO IRE-Polyus, Russia

We established that limit power level of 589nm radiation obtained by single-pass frequency doubling in MgO doped PPLN crystal is related to temperature tuning curve distortion. The criterion of damage threshold of a periodically poled nonlinear crystal was suggested.

ThSy1-38 **10:40-11:00**

Recent advances in microstructured optical fibers

S.L. Semionov, Fiber Optics Research Center RAS, Russia

Recent results obtained in Fiber Optics Research Center RAS in the field of microstructured optical fibers are reviewed

-COFFEE BREAK -

ThSy1-39 **11:30-11:50**

Spectrum shift of ultrashort pulses generated in erbium passively mode-locked fiber laser

D.V. Protasenya, A.I. Baranov, D.V. Myasnikov, NTO IRE-Polyus, Moscow Inst. of Physics and Technology, Russia

Nowadays erbium-doped fibers are actively used in ultrafast lasers as gain media. As a rule, pulses of these lasers have spectra in 1560 nm range. In our work, we propose a way of laser generation shift into a short wavelength area.

ThSy1-40 **11:50-12:10**

Visualization of UV-induced photorefractive damage in LBO crstals

P.V. Puyu, D.G. Nikitin, O.A. Byalkovskiy, O.I. Vershinin, V.A. Tyrtysnyy, NTO IRE-Polyus, Russia

UV-induced bulk degradation in LBO crystals was discovered. Long term generation of third or fourth harmonics of Yb pulsed fiber laser result in to bulk defects formation. Different approaches were used to visualize them and estimate their dimensions. The defects microstructure was observed by using the dark field method. Optical absorption in the crystals with defects was measured by using photothermal methods (PCI-3 device).

ThSy1-41 **12:10-12:30**

Anisotropy of UV-induced degradation of LBO crystal

O. Vershinin, O. Byalkovskiy, V. Tyrtyshnyy, D. Nikitin, NTO IRE-Polyus, Russia

We investigated ultraviolet-induced bulk degradation of nonlinear optical crystal LBO. We measured time of the defect formation induced by long-term high power pulsed laser radiation at 355 nm. Strong dependence on the directions of the beam and its polarization was found. We also measured temperature dependence of the crystal lifetime. Model of crystal degradation under higher order harmonics generation is suggested.

ThSy1-42 **12:30-12:50**

New Perspective Applications of Fiber Lasers

Y. Erokhin, IPG Photonics Corp., USA

Abstract is not available.

ThSy1-43 **12:50-13:10**

Cleaning and Surface Treatment with Pulsed High Power Fiber Lasers

M. Grupp, IPG Laser GmbH, Germany

Surface treatment with high power pulsed fiber lasers gets more and more interesting to wide range of applications due to higher available average power and pulse energy. The average power is either increased by higher repetition rates or higher pulse energy. New laser concepts allow the parallel combining of several fiber laser modules up to an average power of several kilowatts. These lasers increase the efficiency of the processes by high removal rates. This paper gives an overview on the various applications of surface treatment such as cleaning of molds, depainting and surface preparation for welding and gluing.

ThSy1-44 **13:10-13:30**

Urine stone fragmentation by short-pulse thulium fiber laser

A. Vinnichenko, NTO IRE-Polyus, Russia

Thulium pulse fiber laser with pulse energy up to 200 uJ and 100 nsec pulse width for urine stone fragmentation was examined. Complex fracture process in Urine-Acid stones is indicated by non-proportional dependence of fragmentation rate vs pulse repetition rate.

7TH INTERNATIONAL SYMPOSIUM ON HIGH-POWER FIBER LASERS AND THEIR APPLICATIONS

Petrov-Vodkin 3 Hall

09:00-13:30

ThSy1-45 Invited **09:00-09:40**

Theory and technology of welding of dissimilar materials by high power fiber laser

G. Turichin, O. Klimova, K. Babkin, E. Valdaytseva, Inst. of Laser and Welding Technology, St. Petersburg State Polytechnic Univ., Russia

Abstract is not available.

ThSy1-46 **09:40-10:00**

Selective laser melting and direct metal deposition: from process fundamentals

I. Smurov[1], M. Doubenskaia[1], Grigoriev[2], D. Kotaban[2], 1 - Université de Lyon, France, 2 - Moscow State Technological Univ. "STANKIN", Russia

Selective Laser Melting (SLM) is a powder-based and laser assisted additive manufacturing technology capable to produce parts layer-by-layer from a 3D CAD model. Nowadays SLM is used in various industrial domains including aerospace, automotive, electronic, chemical and biomedical, as well as other high-tech areas. Industrial interest is focused on manufacturing of fully functional objects with high geometrical complexity and excellent mechanical properties that depend strongly on each single laser-melted track and each single layer, as well as the strength of the connections between them.

ThSy1-47 **10:00-10:20**

High power fiber laser for hulls production in shipbuilding

N.A. Nosyrev, JSC "Shipbuilding and Shiprepair Technology Center", Russia

Application of modern cost-effective laser technologies for the hulls production instead of existing techniques allows increasing productivity and manufacturing accuracy. A 16 kW fiber laser based complex of equipment for shipbuilding industry will be presented. The report describes the experimental work results on flat sections production using laser cutting and hybrid laser-arc welding technologies.

ThSy1-48 **10:20-10:40**

Behavior of composite materials submitted to a 1.07 µm laser irradiation in the range of 100 to 2 kW/cm2

Olivier Muller, ISL, France

Many prototypes of 20 to 100 kW laser weapons systems based on IPg fiber lasers have been demonstrated in the past few years. Those systems could be used as defense against RAMs and any aerial threats, and in particular UAVs. The laser susceptibility of composite materials, the most commonly used ones for UAVs, is investigated in this publication. Speaking about countering a target located at a few kilometers from a laser source, the realistic range of the laser power density on the target should be between 0.1 and 2 kW/cm2. In such a range of power densities only a few data are available because of a lack of industrials applications. Our study has been focused toward epoxy-based composite, since it is the most commonly found in aeronautic applications. We have studied the behavior of such resin submitted to a laser irradiation at 1.07 µm wavelength representative to the current laser weapons prototypes. The two typical epoxy resins tested are transparent at this laser wavelength and are heated slowly by the irradiation but they are ablated at ~570°C. For comparison carbon epoxy composite samples have been irradiated as well. The front surface of this material has reached about ~3300°C in a few ms. The back surface has been gradually warmed up by thermal diffusion but no hole has been drilled into a 4 mm thick sample with a power density of 1.5 kW/cmI. Carbon epoxy materials could be seen as a perfect protection against a laser attack. However the resin disappears quickly and the mechanical properties of the composite materials fall down with the resin ablation.

ThSy1-49 **10:40-11:00**

Structure and characteristics of thin sheet laser welded joints of nitrogen content austenitic and martensitic steels

M.V. Kostina[1], S.O. Muradjan[1], E.V. Blinov[1], Yu. Petrov[1], S.D. Voronchuk[2], V.I. Krivorotov[2], L.V. Shamova[2], 1 - IMET RAS, 2 - NTO IRE-Polus, Russia

There were tested thin sheet joint welds of nitrogen content, austenitic and martensitic steels with 0,5 and 0,13% nitrogen (N) respectively, which have been obtained by laser welding.

-COFFEE BREAK -

ThSy1-50 **11:30-11:50**

High power fiber laser welding of thin sheet Al-Li alloy 2060-T8

Xinyi Zhang, Rongshi Xiao, Beijing University of Technology, China

This study is aimed to investigate high-brightness solid laser beam welding technology for hard weld to new type, high strength 2060-T8 aluminum alloy containing lithium for potential aerospace applications.

ThSy1-51 **11:50-12:10**

Reflection Characteristic and Cutting Speed Calculation During Laser Cutting With High Power Fiber Laser in Air, Oxygen and Nitrogen Atmosphere

Y. Q. Zhang, J. He, Y. H. Tao, Institute of Fluid Physics, China Academy of Engineering Physics, China, P.R. China

The reflectance of 30CrMnSiA steel during laser cutting in air, oxygen and nitrogen atmosphere was measured by integrating sphere absolute measurement method. The results show that the charge of reflectance is slower and the inflection temperature values of reflectance decrease is higher in oxygen-deficient atmosphere such as nitrogen and vacuum atmosphere, the infection temperature values is about 300C in oxygen-deficient atmosphere. Because of the higher absorptance at the same temperature from 300C to the melting temperature of steel in oxygen- enriched atmosphere, the calculation results show that cutting speed values of 3mm 30CrMnSiA steel increases up to 1.5 times in oxygen-deficient atmosphere.

ThSy1-52 **12:10-12:30**

Mathematical model of penetration of the laser beam into the molten pool

I.V. Shilov, M.A. Tsibina, Kovrov State Technological Academy, Russia

The method of the vapour channel shape definition for a given surface temperature distribution offered. Simulation showed that at beam exposure of less than 1 mm diameter and more than 3 kW the nature of distribution of heat fluxes in the material is largely determined by rearrangement of heat sources and the channel's size than the convective heat transfer

ThSy1-53 **12:30-12:50**

Laser micro applications with pulsed fiber lasers

R. Holtz, D. Naman, Class 4 Laser Professionals AG, Switzerland

Abstract is not available.

ThSy1-54 **12:50-13:10**

Fiber lasers in technological processes

V.N. Petrovskiy[1], A.O. Andreev[1], V.P. Biryukov[2,3], N.N. Evtikhiev[1,2], P.S. Dzhumayev[1], V.D. Mironov[1], M.A. Murzakov[1,2], V. I. Polskiy[1], S.A. Uspenskiy[1], 1 - National Research Nuclear Univ. MEPhI, 2 - NTO IRE-Polyus, 3 - IMASH RAS, Russia

Results of use fiber are given in various technological processes of laser processing: weldings, cladding, polishings, milling, modification of internal structure of special alloys. Results of researches with use of radiation of fiber lasers of various type of processes of welding of refractory materials, steel special structure are presented. Polishings of products from alloys of the titanium also became, cladding of powders of various structure with additives of nanopowder of carbide of tantalum, milling of oxide of zirconium. Engineering of external and internal interfaces of solid bodies for management of structure and physicomechanical properties of metal alloys are presented.

ThSy1-55 **13:10-13:30**

Performance assessment of full strength and tension of laser welds of nitrogen content, austenitic and martensitic steels

S.D. Voronchuk[1], V.I. Krivorotov[1], L.V. Shamova[1], M.V. Kostina[2], S.O. Muradjan[2], Yu. Petrov[2], 1 - NTO IRE-Polyus, 2 - IMET RAS, Russia

The report contains the results of the evaluation of full strength and tension of laser welds of nitrogen content, austenitic and martensitic steels.

3RD INTERNATIONAL SYMPOSIUM ON LASERS IN MEDICINE

Symposium Chair

I. Shcherbakov

Prokhorov General Physics Institute of RAS, Russia

Co-Chair

Ronald Sroka

Laser Research Center, Munich University Clinic, Germany

Program Committee

Chair

B. Denker

Prokhorov General Physics Institute of RAS, Russia

W.Blondel

Univ. de Lorraine, CNRS CRAN, France

N.Bulgakova

Prokhorov General Physics Institute of RAS, Russia

D.Kochiev

Prokhorov General Physics Institute of RAS, Russia

L.Lilge

Univ. Health Network Princess Margaret Cancer Centre, Canada

V.Loschenov

Prokhorov General Physics Institute of RAS, Russia

V.Minaev

NTO "IRE-Polus", Russia

T.Savelieva

Prokhorov General Physics Institute of RAS, Russia

S.Vartapetov

Prokhorov General Physics Institute of RAS, Russia

Organizing Committee

Chair

V. Pustovoy

Prokhorov General Physics Institute of RAS, Russia

Conference Secretary

N.Khakamova

Prokhorov General Physics Institute of RAS, Russia

Sections:

Section A. Advanced Laser Systems for Medical Applications *(Joint Section of ISLM'14 and the 7th International Symposium on High-Power Fiber Lasers and Their Applications)*

Chairs: *D.Kochiev, Prokhorov General Physics Institute of RAS, Russia , V.Minaev, NTO "IRE-Polus", Fryazino, Moscow reg. Russia, S.Vartapetov, Prokhorov General Physics Institute of RAS, Russia*

Section B. Optical Biomedical Diagnostics

Chair*: N. Bulgakova, Prokhorov General Physics Institute of RAS, Russia*

Section C. Laser Tissue Interaction

Chair*: V.Loschenov, Prokhorov General Physics Institute of RAS, Russia*

Course on Biomedical Optics in Clinical Applications

This short lecture course devoted to the clinical applications of biomedical optics and intend to provide PhD students, postdoctoral fellows and practitioners using methods of optical diagnostics with newest information on this subject and learning from leading scientists in this field.

Chair: *T.A. Savelieva, Prokhorov General Physics Institute of RAS, Russia*

ADVANCED LASER SYSTEMS FOR MEDICAL LASER APPLICATIONS

Petrov-Vodkin 1 Hall

Session Chairs: 09:10-11:15 S. Vartapetov, Prokhorov General Physics Inst. of RAS, Russia
11:30-13:25 V. Minaev, NTO "IRE-Polus", Russia

ThSY2-01 Invited **09:10-09:35**

New Laser and RF Technologies for Medical Applications

Yu.K. Danileiko, V.V. Ezhov, V.V. Osiko, A.M. Shulutko; Prokhorov General Physics Inst. of RAS, Russia

New laser and RF technologies for different kinds of surgery are described. The innovative medical equipment, some examples of the application of the new techniques in surgical operations together with gystological results and clinical statistics will be also presented.

ThSY2-02 Invited **09:35-10:00**

1940nm Tm:fiber laser assisted treatment of hyperplastic nasal turbinates

R. Sroka, M. Havel, C. Betz, A. Leunig; LIFE-Centre at Hospital of Univ. Munich, Germany

The need for reduction of post-tonsillectomy hemorrhage has led to promotion of tonsillotomy techniques for tonsil tissue reduction in obstructive tonsillar hypertrophy. A first study compares ablative tissue effects using 1470nm diode laser and CO2-laser for tonsillotomy in an intraindividual design. A number of different laser systems have been used for volume reduction of hyperplastic nasal turbinates. The aim of a 2nd clinical feasibility study was to show the coagulative and tissue reducing effects using a novel Tm: fiber laser system emitting at 1940 nm.

ThSY2-03 Invited **10:00-10:25**

Laser-stimulated Cavitation and Tissue Regeneration

V. Bagratashvili; Inst. of Laser and Information Technologies, Russia

The effects of laser-stimulated cavitation on the proliferation of human and rabbit multipotent mesenchymal stromal cells (MMSC) were studied in vitro. It is shown, that laser-stimulated cavitation stimulates the increase of proliferation activity of «suppressed» human MMSC up to 80%. Possible mechanisms of the effect of effect of laser-stimulated cavitation on biotissue regeneration are discussed.

ThSY2-04 Invited **10:25-10:50**

Fractional laser treament: a new method of tissue regeneration

G.B. Altshuler[1], A.V. Belikov[2]; 1 - Dental Photonics, Inc., USA; 2 - St.Petersburg National Research Univ. of ITMO; Dental Photonics, Inc.

Experience in using fractional technology in dermatology for treatment of scars, wrinkles, pigmented and vascular lesions will be reviewed. New results of using fractional technology for regeneration of gingival tissues to treat periodontitis will be presented. Future applications of fractional technology in other medical fields will be discussed.

ThSY2-05 Invited **10:50-11:15**

Medical Devices with Fiber Lasers and their Applications

V.P. Minaev; NTO IRE-Polus; Russia

There is presented information on medical laser devices used fiber lasers with wavelengths 1.06; 1.45; 1.56; 1.68, 1.9 μm and examples of medical techniques, used this devices.

ThSY2-06 Invited **11:30-11:55**

Smart laser medical systems for cardiosurgery and oncology

V.Ya. Panchenko[1], I.I. Berishvili[2], V.V. Vasiltsov[1], V.A. Ul'yanov[1]; 1 - Inst. of Laser and Information Technologies of RAS, 2 - Bakulev Center of Cardiovascular Surgery, Russia

The physico-technical and medical aspects of new laser technologies for cardiovascular surgery and oncology based on smart CO2 laser medical systems are discussed.

ThSY2-07 Invited **11:55-12:20**

Potential of Synergetic Effect in Medical Laser Applications

D. Boutoussov; Biolase, Inc., USA

Wavelength of laser radiation is the most significant parameter that characterises laser-tissue interaction for any particular procedure. Use of multiple wavelengths has been utilized by several medical laser companies, trying to address multiple tissue responses and therefore increase the value of their devices. However, there are only a few reports of use of multiple laser wavelengths and especially multiple laser technologies simultaneously.

ThSY2-08 Invited **12:20-12:45**

0.97 and 1.56 μm lasers in treatment of degenerative-dystrophic bone diseases in children

I.A. Abushkin[1], V.A. Privalov[1], A.V. Lappa[2], N.V. Noskov[1], E.A. Neizvestnykh[1], A.N. Kotlyarov[1], Yu.G. Shekunova[1]; 1 - South Ural State Medical Univ., 2 - Chelyabinsk State Univ., Russia

Two laser technologies for treatment of degenerative-dystrophic bone diseases in children are presented: transcutaneous osteoperforation for aseptic osteonecroses and intracystic thermotherapy for bone cysts. There were applied a 0.97 μm laser in the first case and 0.97 and 1.56 μm lasers in the second one. Results are good in majority of cases.

ThSY2-09 **12:45-13:05**

Power Tm-doped Fiber Lasers for Medical Applications

S. Larin[1], A. Mashkin[2], F. Shcherbina[2]; 1 - NTO IRE-Polus, Russia; 2 - IPG Laser GmbH, Germany

A history and present view of bench-top devices and OEM modules for medical applications provided by IPG are presented at this work. Some classification depending on particular application is proposed and discussed. Variety in laser power modules and accessories provides effective and power tools for end-users.

ThSY2-10 **13:05-13:25**

Experience of application of diode surgical laser «Lika-khirurg M» with a wavelength 445 nm in the field of aesthetic medicine

N. Tarasov[1], L. Tarasova[1], S. Goroshko[1], V. Holin[2], V. Pantyo[3]; 1 - Center of laser and Esthetic Medicine, 2 - Enterprise «Photonica Plus», 3 - GVUZ «Uzhgorod National University», Ukraine

The a laser coagulator «Lika-khirurg M» with a wavelength by 445 nm (dark blue radiation) and output power till 7 W is used for treatment of varicose extended veins, vascular malformations of skin (telangiectases, vascular spider, hemangiomas), cutaneous pigmented lesions (nevuses, pigment stains) and benign tumors of the skin (papilloma, keratoma, warts etc.).

OPTICAL BIOMEDICAL DIAGNOSTICS

Petrov-Vodkin 1 Hall

Session Chairs: *14:30-16:50 N. Bulgakova,. Prokhorov General Physics Inst. of RAS, Russia*
17:10-19:00 K.Larin, Department of Biomedical Engineering, Univ. of Houston, USA

ThSY2-11 Invited **14:30-14:55**

Investigations on fluorescence guided stereotactic biopsy

R. Sroka[1], G. Hennig[1], A. Johansson[1], A. Rühm[1], H. Stepp[1], W. Goebel[2], M. Goetz[3], J. Herms[4]; 1 - LIFE-Centre at Hospital of Univ. Munich, 2 - Karl Storz GmbH & Co KG, 3 - MRC Systems GmbH, 4 - Inst. of Neuropathology, Germany

Fluorescence detection during stereotactic biopsy might increase safety and precision of the procedure significantly. For the envisaged modalities of tumor and blood vessel detection, light power limits for an application-relevant fiber configuration have been determined. The power limit for 405 nm excitation lies significantly below the one according to present legal regulations for skin tissue.

ThSY2-12 Invited **14:55-15:20**

Coherent Imaging from Tissue to Cell

Th. Lasser; EPFL, Switzerland

We will present selected examples ranging from retina blood flow, diabetes, Alzheimer's disease to brain research and include new concepts for cell imaging with an emphasis on the underlying optical concepts.

ThSY2-13 Invited **15:20-15:45**

Tissue Diagnostics using Optical Coherence Elastography

K.V. Larin, Univ. of Houston, USA;

Here we describe novel quantitative optical elastographic method based on shear wave imaging optical coherence tomography (SWI-OCT) for biomechanical characterization of ocular and cardiac muscle tissues through noncontact elasticity measurement. Phase information from the SWI-OCT is used to reconstruct 3-D depth-resolved shear wave propagation inside the tissues. Measurement of the shear wave group velocity allowed quantification of the Young's modulus of thick tissues.

ThSY2-14 Invited **15:45-16:10**

Diagnostics of radiation induced tissue damage and remodeling by laser scanning microscopy with second harmonic generation

A. Maslennikova[1], M. Kochueva[1], S. Kuznetsov[1], E. Kiseleva[1], V. Kamensky[2], N. Ignatjeva[3], O. Zakharkina[3], K. Babak[4], V. Dudenkova[4]; 1 - Nizhny Novgorod State Medical Academy, 2 - Inst. of Applied Physics of RAS, 3 - Inst. of Laser Information Technologies of RAS, 4 - Lobachevsky State Univ., Russia

The study objective was evaluation the dose-time dependences of collagen changes of rat rectum and bladder after gamma-irradiation. The study of collagen state after irradiation was carried out by laser scanning microscopy with second harmonic generation in a week and a month after radiation. The method allowed evaluating changes of normal tissues after ionizing radiation in addition to standard and special histological staining.

ThSY2-15 Invited **16:10-16:30**

Spatially resolved multimodal in vivo spectroscopy data fusion for discriminating precancerous states

W. Blondel[1,2], F. Abdat[1,2], M. Amouroux[1,2], Ya. Guermeur[3,4]; 1 - Univ. de Lorraine, CRAN, 2 - CNRS CRAN, 3 - Univ. de Lorraine, LORIA, 4 - CNRS, LORIA, France;

The current study deals with new perspectives to perform more efficient classification of mouse skin precancerous stages by exploiting the spatial resolution of multimodal spectroscopic data in a decision fusion scheme based on belief functions.

ThSY2-16 **16:30-16:50**

Imaging the human microcirculation

M.J. Leahy; National Univ. of Ireland, Ireland

Structural and functional imaging of the microcirculation is necessary to understand many diseases such as diabetes mellitus, heart disease, peripheral vascular disease and arteriosclerosis . We have developed several methods for assessment of both the structural and dynamic properties of the capillaries in the upper dermis and the vessels which supply them.

ThSY2-17 Invited **17:10-17:35**

Biosensors based on Spectral Correlation Interferometry for Biomedical Research and Diagnostics

P.I. Nikitin, A.V. Orlov, M.P. Nikitin, T.I. Ksenevich, B.G. Gorshkov; Prokhorov General Physics Inst. of RAS, Russia

Biosensors based on the spectral correlation interferometry (SCI) with assistance of magnetic nanoparticles (MP) have been developed for medical diagnostics. The SCI has been adapted for studies of affinity constants of MP covered by antibodies and for detection of protein molecules in human serum. The 50-nm MP employed as labels yield 100-fold amplification of the SCI signals to meet the requirements for myocardial infarction diagnostics.

ThSY2-18 Invited **17:35-18:00**

Application of lasers for high-sensitive breath content analysis and noninvasive biomedical diagnostics

E.V.Stepanov; Prokhorov General Physics Inst. of RAS, Russia

The methods of laser based highly sensitive gas analysis of molecular biomarkers in exhaled air will be reviewed. Characteristics of the spectral gas analysis based on tunable diode lasers will be analyzed in details. The possibility of applying diode laser spectroscopy to biomedical diagnostics based on highly sensitive gas analysis of human breath will be discussed.

ThSY2-19 **18:00-18:20**

Optical tissue spectroscopy for stratification of entry into advanced cancer screening programs; Here demonstrated for the Breast

L. Lilge, J. Walter, J. Street, B. Ornelas-Lilge; Univ. Health Network Princess Margaret Cancer Centre, Canada

Cancer screening program commonly have a static recommended entry age and screening frequency. In order to reduce the ability to miss true positive cases screening onset is early in age and continues for 20-30 years despite the fact the the probability of being diagnose throughout the 2 decades is >0.1. Risk of a radiologically suspicious lesion is increased when symmetry in the bilateral organ is lost or the rate of changes or metabolic changes is very high. We demonstrated that symmetry and rate of change can be determined on an individual basis using red and near infrared based non-imaging volumetric interrogation. BrCa carriers and hence women with an extreme risk of developing breast cancer are readily identified by this technique.

ThSY2-20 **18:20-18:40**

Laser-induced fluorescence in dentistry

I.A. Schugailov[1], M.D. Egorjan[1], A.N. Makximenko[1], N.N. Bulgakova[2]; 1 - Russian Medical Academy of Postgraduate Education, 2 - Prokhorov General Physics Inst. of RAS, Russia

This fluorescence study is aimed to obtain the information regarding photosensitizer's uptake and retention by gingival mucosa which is necessary to choice an adequate protocol for antimicrobial photodynamic therapy of mild and moderate paradontitis with chlorine e6-based photosensitizer.

ThSY2-21 **18:40-19:00**

Fiber Bragg Grating Based Vascular Localization Device

S.Ch.M. Ho[1], M. Razavi[2], G. Song[1]; 1 - Univ. of Houston, 2 - Texas Heart Inst., USA

The study described in this paper lays the foundation work for a device that utilizes strain sensitive fiber Bragg grating (FBG) sensors in order to achieve a vascular localization device that has a higher success rate and a lower cost compared to current techniques.

SY2. 3RD INTERNATIONAL SYMPOSIUM ON LASERS IN MEDICINE

Congress Hall

ThSY2-p01 **19:00-20:30**

Ophthalmic system based on excimer KrCl laser (223 nm)

A.M. Razhev[1,2], V.V. Chernykh[3], S.V. Kostenev[3], D.S. Churkin[1,2], E.S. Kargapol'tsev[1]; 1 - Inst. of Laser Physics of SB RAS, 2 - Novosibirsk State Univ., 3 - The S.N. Fyodorov FSI IRTC «Eye Microsurgery»; Inst. of Laser Physics of SB RAS; Russia

Review of development and clinical trials conclusions of the ophthalmic KrCl (223 nm) laser system is presented. Medical safety, physical and technical advantages of the new laser system in comparison with widespread ArF (193 nm) laser systems for refractive surgery are demonstrated. The method of eye virus diseases treatment by usage of the KrCl laser radiation is proposed.

ThSY2-p02 **19:00-20:30**

Laser Spectroscopy Study Of The Distribution Of Photosensitizers In Biological Models

J.O. Kuznetsova[2], A.S. Saidov[1], N.A. Kalyagina[2], D.M. Yagudaev[1,3] ; 1 - FGBI «Teaching and Research Medical Center», 2 - Prokhorov General Physics Inst. of RAS, 3 - State Clinical Hospital 151; Russia

The purpose of this work is to develop a method of quantifying the accumulation of photosensitize (PS) in various organs of the mouse, in accordance with their optical properties using fluorescent methods. To realize this aim the optical properties of mouse organs have been studied with and without PS. Spectral differences between the organs were taken into consideration.

ThSY2-p03 **19:00-20:30**

Detection of hypoxia and inflammatory processes in tissues by fluorescence spectroscopy in vivo

E. Petritskaya, L. Abaeva, D. Lapitan, D. Kulikov, O.Smirnova, I. Guseva, D. Rogatkin; Vladimirskiy Moscow Regional Research & Clinical Inst. «MONIKI»; Russia

In experiments with the use of laser fluorescence spectroscopy (LFS) in vivo both for endogenous porphyrin at occlusive ischemia and for exogenous phthalocyanine of aluminum at induced inflammatory processes the enhanced autofluorescence in the red waveband was detected. It means that the LFS in vivo can be an effective tool for the registration of both the ischemic hypoxia and inflammatory processes in clinics.

ThSY2-p04 **19:00-20:30**

Modeling of the input signal in Laser Doppler Flowmetry

D.G. Lapitan, D.A. Rogatkin; Vladimirsky Moscow Regional Research and Clinical Inst. "MONIKI"; Russia

Theoretical modeling of the input signal in the Laser Doppler Flowmetry was carried out taking into account the effect of amplitude modulation of the reference beam. The deposit of the amplitude modulation in the total detected signal can be of the same order or more than the magnitude of the light-beating Doppler-shifted part of the total signal.

ThSY2-p05 **19:00-20:30**

Photodynamic therapy of bacterial biofilms using new cationic photosensitiser.

I.G. Tiganova[1], G.A. Meerovich[2], T.V. Stepanova[1], J.S. Koloskova[3], S.S. Brusov[3], M.A. Grin[3], A.F. Mironov[3], J.M. Romanova[1]; 1 - Gamaleya Research Inst. for Epidemiology and Microbiology, 2 - Prokhorov General Physics Inst. of RAS, 3 - Lomonosov Moscow State Univ. of Fine Chemical Technology, Russia

The emergence of antibiotic resistance among pathogenic bacteria, especially, in biofilm state, has led to efforts to find alternative antimicrobial therapeutics to which bacteria will not be easily able to develop resistance. One of these may be combination of nontoxic chemical substance - photosensitizer (PS) and visible light known as photodynamic antibacterial chemotherapy (PACT). In this study we were shown that new PS is effective against planktonic cells and biofilms of Pseudomonas aeruginosa.

LASER TISSUE INTERACTION

Petrov-Vodkin 1 Hall

Session Chairs: 09:00-11:00 V.Loschenov, Prokhorov General Physics Inst. of RAS, Russia
11:30 – 13:25 R.Sroka, Laser Research Center, Munich Univ. Clinic, Germany

FrSY2-22 Invited **09:00-09:25**

Multimodal intraoperative navigation in neurosurgery

A.A. Potapov[1], S.A. Goryaynov[1], T.A. Saveleva[2], V.B. Loschenov[2]; 1 - Burdenko Inst. of Neurosurgery of RAMS, 2 - Prokhorov General Physics Inst. of RAS, Russia

Different techniques are used today in neurosurgery for intraoperative navigation, including metabolic guidance using 5-aminolevulinic acid (5-ALA). The article focuses on history of intraoperative photodynamic diagnosis (PDD), mechanisms of 5-ALA action, possibilities of its application in different areas of neurosurgery. In addition to visual assessment of fluorescence, laser biospectroscopy significantly increases the diagnostic value of PDD. Laser biospectroanalysis is described in details, wide perspectives of its application in neurosurgery are demonstrated.

FrSY2-23 Invited **09:25-09:50**

Augmentation of ALA mediated PDT of GBM by use of hypothermia and Tyrosine Kinase inhibitors.

C. Fisher, C. Nui, L. Lilge; Princess Margaret Cancer Inst./Univ. of Toronto, Canada

Strategies to improve the therapeutic index of the therapy are being investigated to extend the treatment selectivity and the treatable volume comprising of normal brain and microinvasions of the tumor. The strategies pursued are to reduce the sensitivity of normal neurons by hypothermia and to increase the sensitivity of primary brain tumours using co-therapy with tyrosine kinase inhibitors. Either treatment does not increase the normal neurons ability to synthesis PPIX from its prodrug ALA, however, the majority of the tested GBM cell lines show significant increases in cellular PPIX. This was also confirmed in vivo.

FrSY2-24 Invited **09:50-10:15**

Mechanism of endovenous laser ablation

C.V. Masayshvili[1], Yu.M. Stoyko[1], V.B. Loshenov[2], G.A. Meerovich[2], A.V. Tsyplyashchuk[1]; 1 - Pirogov Medical and Surgery center, 2 - Prokhorov General Physics Inst. of RAS, Russia

The mechanism EVLA can be nominally divided in three phases: 1) Vaporization of blood and carbonization of fiber tip. 2) The direct influence of laser radiation on venous wall. It is the main factor in mechanism of EVLA. 3) If there is no traction of fiber or it is too slow, the overheated fiber tip damaged the vein wall. This mechanism is universal and independent from the wavelength.

FrSY2-25 Invited **10:15-10:40**

Promising alliance of photodynamic therapy and nanotechnologies

N.F. Gamaleia; Kavetsky Inst. for Experimental Pathology, Oncology and Radiobiology of NAS, Ukraine

Photodynamic therapy of tumors is prospective branch of laser medicine which unlike radio- and chemotherapy is free from serious traumatic and side reactions. Nanotechnology employment for PDT allows to better visualize tumors and to enhance photosensitizer transportation to and light interaction with tumor tissues due to plasmonic effects. This opens the way to extend a scope of PDT clinical applications.

FrSY2-26 **10:40-11:00**

Novel Ru and Os based NIR activatable Photosensitizers, therapeutic index under normoxic and hypoxic conditions and initial in vivo results

G. Shi, J. Fong, S. Monro, K. Kasimova, R. Hennigar, R. DeCoste, C. Spencera, Ju. Colpitts, L. Chamberlain, A. Mandel, L. Lilge, Sh.A. McFarland; Acadia Univ., Theralase Technologies, Inc., Princess Margaret Cancer Inst./Univ. of Toronto, Canada

These Ru(II) and OS(II) dyads derived from organic units that impart low-lying 3IL excited states enable generation of singlet oxygen and other ROS. using red or NIR (808nm) light the LD50 following light activation with 90 and 600 J/cm^2 respectively is in the 100nM to 10uM range for most tested cell lines and bacteria strains, whereas the LD50 for Dark toxicity for the same cell lines is >>1mM, providing an excellent safety profile. Bacterial inactivation of over 8 logs cell kill in solution was demonstrated for green, red and NIR light activation.

-COFFEE BREAK -

FrSY2-27 Invited **11:30-11:55**

Combined videofluorescent and spectroscopic aproaches in optical diagnostics of nervous system malignancies

M.V. Loshchenov, A.A. Potapov, P.V. Zelenkov, S.A. Goryaynov, D.A. Gol'bin, A.V.Borodkin, K.G. Linkov; Prokhorov General Physics Inst. of RAS, Burdenko Inst. of Neurosurgery of RAMS, Russia

In this work we present a combined method of diagnostic allowing fluorescent imaging together with point-of-interest spectroscopy approach as well as a hardware prototype featuring both imaging and spectroscopy on one diagnostic screen in real-time. Clinical approbation results are presented and discussed. Fluorescence imaging excitation is done in 635nm with use of 1.5W LD illumination system, both endoscopic and surgical microscopic ways of diagnostic are utilized. 5-ALA induced PP9 is used as a contrast fluorescent agent for tumor boundaries detection.

FrSY2-28 Invited **11:55-12:20**

Videofluorescent navigation during arthroscopic PDT of major joints

S.V. Ivannikov[1], M.V. Loshchenov[2], A.V. Borodkin[2], T.A. Zharova[1], V.I. Makarov[2], A.M. Tonenkov[1]; 1 - Sechenov First Moscow State Medical Univ., 2 - Prokhorov General Physics Inst. of RAS, Russia

The method and apparatus are designed allowing fluorescent diagnostics of preliminarily photosensitized inflamed tissues of major human joints (shoulder and knee joints). The method is unique because the system provides registration of two kinds of images, fluorescent and color, which are displayed simultaneously as superposition of them. Excitation of fluorescence is initiated by a laser light source with wavelength of 635 nm. Control of a therapeutic dose of laser irradiation is monitored by photo bleaching in the red wavelength range, which allows providing diagnostics even when thin layers of the blood over analyzed tissue screen the fluorescence signal.

FrSY2-29 **12:20-12:45**

OCT Imaging-characterization and medical applications

J.O. Kuznetsova[1,2], G. Scheib[2], R. Sroka[2], M. Trottmann[2], R. Leeb[2], C. Homann[2]; 1 - Prokhorov General Physics Inst. of RAS, Russia; 2 - Laser-Forschungslabor Klinikum der Univ. Munich, Germany

OCT systems of different companies (Thorlabs, Imalux, Michelson Diagnostics, AGFA) were included for this study. As standards an USAF test target, commercial available OCT phantoms, and a home-built structure were used. For experiments the standards were partly incorporated in scattering and absorbing media to measure the achievable resolution in different depths and in dependence of various optical parameter conditions

FrSY2-30 **12:45-13:05**

Particle swarm optimisation algorithm for Monte Carlo-based inverse problem solving

M.N. Kholodtsova[1,2,3], V.B. Loschenov[1], C. Daul[2,3], W. Blondel[2,3]; 1 - Prokhorov General Physics Inst. of RAS, Russia; 2 - CRAN, France

For the estimation of in vivo tissue optical parameters based on spatially-resolved diffuse reflectance spectroscopy measures, a non-derivative Particle Swarm Optimisation approach was successfully applied as part of the inverse problem solving associated to forward Monte Carlo simulations to avoid trapping in local minima.

FrSY2-31 **13:05-13:25**

Different photodynamic effect between continuous wave and pulsed laser irradiation modes in k562 cells in vitro

V.V. Klimenko[1], A.A. Bogdanov[1], N.A. Knyazev[1], A.A. Rusanov[2], M.V. Dubina[1]; 1 - St.Petersburg Academic Univ., 2 - First Pavlov State Medical Univ., Russia

Abstract is not available.

COURSE ON BIOMEDICAL OPTICS IN CLINICAL APPLICATIONS

Petrov-Vodkin 2 Hall

Session Chair: 09:00 – 13:00 T.A. Savelieva, A.M. Prokhorov General Physics Institute RAS, Russia

FrC1-01 **09:00-09:45**

Confocal fluorescence microscopy and force-volume imaging in atomic force microscopy: A signal processing perspective

Ch. Soussen; Univ. of Lorraine, CRAN, France

This lecture deals with signal processing methods dedicated to hyperspectral data recorded in confocal fluorescence microscopy and atomic force microscopy (AFM), with applications to biological imaging. We first address two typical inverse problems arising in confocal microscopy, namely hyperspectral image restoration (or deconvolution) and hyperspectral unmixing. The second part of the lecture is dedicated to the analysis of force curves and force-volume images recorded in AFM. Their interpretation is done using physico-chemical models, e.g., electrostatic and mechanical models. The quantitative estimation of parameters from experimental force curves is based on fully automated tools. This leads us to reconstruct a set of images at the nanoscale, each corresponding to a specific physico-chemical parameter.

FrC1-02 **09:45-10:30**

Videofluorescent devices for intraoperative diagnostics

M.V. Loschenov; Prokhorov General Physics Inst. of RAS, Russia

Abstract is not available.

FrC1-03 **10:30-11:15**

Endovascular laser treatment and optical coherence tomography

R. Sroka[1], K. Siegrist[1], M. Heide[1], T. Pongratz[1], C.G. Schmedt[2]; 1 - LIFE-Centre at Hospital of Univ. Munich, 2 - Diakonie-Klinikum Schwäbisch Hall GmbH, Germany

Several optical changes for on-line-monitoring of signals during endovenous laser therapy (ELT) showed potential to serve as feedback mechanism. Up to now, only the measurement of the endoluminal temperature could be realized. Further investigations are needed to find suitable technical realization to prevent for under- or overheating during ELT.

FrC1-04 **11:30-12:15**

Processing of diffuse reflectance signal for spectroscopy and spectral imaging

T.A. Savelieva; Prokhorov General Physics Inst. of RAS, Russia

Variety of biological media and their complexity cause scientific interest to study of them from physical point of view. Facilities of noninvasive analysis of biological tissue with optical methods call forth a great interest to application of optical spectroscopy in biology and medicine. In this lecture fundamental basis for developing of spectral data processing algorithms are presented for both fiber optic and CCD based spectroscopic systems.

FrC1-05 **12:15-13:00**

What is the potential benefit for PDT treatment planning and real time dosimetry on the attainable outcome?

L. Lilge; Princess Margaret Cancer Inst./Univ. of Toronto, Canada

Abstract is not available.

7TH INTERNATIONAL CONFERENCE ON LASER OPTICS FOR YOUNG SCIENTISTS

(LOYS'2014)

TECHNICAL SESSION

7TH INTERNATIONAL CONFERENCE ON LASER OPTICS FOR YOUNG SCIENTISTS

Stenberg 1 Hall

Session Chairs: *09:00-13:30 X.-Ch. Zhang; Univ. of Rochester, USA*

09:00-13:30 S.A.Kozlov, St.Petersburg National Research Univ. of ITMO, Russia

TuYS-01 Invited **09:00-09:45**

The Institute of Optics, OSA and Optics Letters

X.-Ch. Zhang; Univ. of Rochester, USA;

I will show you why The Institute of Optics at University of Rochester is called "A Jewel in the Crown"? On behalf of the Optical Society (OSA) and Optics Letters (OL), I am honored to meet to the young scientists to present about OSA and OL.

TuYS-02 Invited **09:45-10:15**

Recent Advances in Terahertz Technology

A. Gorodetsky; Aston Univ., UK;

This talk presents short overview for students, that are not very much familiar with the topic, covering briefly main aspects and applications of Teraherz (THz) technology.

TuYS-03 **10:15-10:30**

Universal terahertz time-domain spectrometer for transmission and reflection measurements in life science: health and food testing

Y.V. Grachev, S.V. Smirnov, A.N. Tcypkin, V.G. Bespalov; St.Petersburg National Research Univ. of ITMO, Russia;

Universal terahertz time-domain spectrometer for transmission and reflection measurements demonstrated. Both of reflected by and transmitted through sample THz signals are detected in same time. This removes errors in fine measurements of absorption and refraction coefficients caused by inaccuracy in sample position in separated reflection and transmission spectrometers and long-time changes in sample. Furthermore, such set-up geometry allows to consider reflection losses in absorption coefficient computation based on experimental measurements. Such opportunities are very important in life science research and food quality testing.

TuYS-04 **10:30-10:45**

Electromagnetic metamaterial devices for terahertz frequency range

M. Khodzitsky; St.Petersburg National Research Univ. of ITMO, Russia;

New approach to design beam splitter on basis of the transformation optics using angle constitutive parameters distribution of medium was proposed for terahertz (THz) frequency range. Magneto-tunable photonic crystal with graphene layer as narrow band filter was investigated for THz frequency range. The magneto-tunable peaks of transmissivity in band-gaps of photonic crystal that caused by excitation of surface waves were obtained. The band-gap structure of photonic crystal made of metasurface/ sitall/teflon layers was discussed for THz frequency range.

TuYS-05 **10:45-11:00**

Experimental set-up for holographic multiwavelength phase imaging

N.V.Petrov[1], M.S.Kulya[1], A.N.Tcypkin[1], A.A.Gorodetsky[2], V.G. Bespalov[1]; 1 - St.Petersburg National Research Univ. of ITMO, Russia; 2 - Aston University, UK;

We demonstrate experimental set-up allowing to measure terahertz (THz) pulse field spatial distribution at some distance behind the object in time-domain layout. Feature of the set-up is that we scan the diffraction field of an object placed in the THz wide collimated beam producing direct registration of temporal shapes of pulse at every scan point.

-COFFEE BREAK -

TuYS-06 Invited **11:30-12:00**

Optimization of On-Chip Blood Coagulation Sensor

S. Cheemalapati, H. Tuazon, A. Pyayt; Univ. of South Florida, USA;

We present a new design of an on-chip blood coagulation sensor and provide detailed 3D FDTD simulations for the design optimization and assessment of the noise caused by presence of blood cells.

TuYS-07 **12:00-12:15**

Stimulation of neurite growth under influence of broadband terahertz pulsed radiation

M.V. Duka (Tsurkan)[1], M.I. Sulatskiy[1], V.A. Penniyaynen[2], A.V. Kipenko[2], E.V. Lopatina[2], B.V. Krilov[2], O.A. Smolyanskaya[1]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Pavlov Inst. of Physiology, Russia;

The question about the fundamental justification of the possibility of using THz radiation effects on biological systems, particularly the nervous, is still open. Our research was devoted to the impact of broadband pulsed THz radiation in the frequency range of 0.05 to 1,2 THz on the neurite growth. Dependence of changes in functional responses of cells on the average output power has been found.

TuYS-08 **12:15-12:30**

Terahertz spectral characteristics and optical properties of normal and pathological skin, cornea and their components

O.A. Smolyanskaya; St.Petersburg National Research Univ. of ITMO, Russia;

Experimentally shown that some reflectance lines of the skin coincide with some amino acids and water. Preliminary tests noncontact imaging on subcutaneous tissue, including a skin tumor located underneath the skin at the frequencies of 0.5 and 1.8 THz. It was shown a correlation between the presence of skin tumors and the amplitude of the reflection coefficient at these frequencies.

TuYS-09 **12:30-12:45**

Numerical Simulation of Contrast Inversion Process when Focusing Laser Beam in the Absorbing Medium

E.L. Bubis, V.O. Martynov; Inst. of Applied Physics of RAS, Russia;

A numerical simulation of the inverse image formation of opaque objects by focusing the transmitted radiation into the absorbing medium is performed. It is shown that the process strongly dependents on the ratio of the size of the object and the illuminating beam. Inverse image conversion exceeds 350% for small-scale objects, relative to the initial intensity of the beam.

TuYS-10 **12:45-13:00**

Ordered vortex lattice in wide-aperture lasers

D.A. Anchikov, A.A. Krents, N.E. Molevich, A.V. Pahomov; Samara State Aerospace Univ., Samara branch of Physical Inst. of RAS, Russia;

we report on the dynamics and stability of structures, which represents an ordered array of optical vortices in wide-aperture lasers. By means of the linear analysis and method of the bifurcation diagrams parametric areas of stability for the corresponding decision have been found. Using numerical simulation, the destruction scenario of vortex lattice is considered.

TuYS-11 **13:00-13:15**

MID-IR Broadband Frequency Conversion OF Laser Radiation in ZnGeP2, GaSe AND AgGaSe2 Crystals

A.A. Ionin[1], I.O. Kinyaevskiy[1], Yu.M. Klimachev[1], A.A. Kotkov[1], A.Yu. Kozlov[1], Yu.M. Andreev[2]; 1 - Lebedev Physical Inst. of RAS, 2 - Inst. of Monitoring of Climatic and Ecological Systems SB RAS, Russia;

Parametric interaction processes resulting to broadband emission in spectral range 2.5- 9.0 μm are considered for ZnGeP2, GaSe, AgGaSe2 crystals. Radiation of fundamental and first- overtone carbon monoxide lasers is suggested as crystal pumping.

TuYS-12 **13:15-13:30**

Prospect of optically pumped oxygen-iodine lasers

M. Malyshev[1], M. Zagidullin[2]; 1 - Samara State Aerospace Univ., 2 - Lebedev Physical Inst. of RAS; Russia

In this paper two-step optical pumping process is proposed for oxygen-iodine lasers systems. Basic parameters and key implementation challenges of such system are discussed.

-BREAK FOR LUNCH -

7TH INTERNATIONAL CONFERENCE ON LASER OPTICS FOR YOUNG SCIENTISTS

Congress Hall

TuYS-p01 **15:00-19:30**

Er-doped oxychalcogenide glasses – materials for nonlinear infrared optics

V. Parchanski[1], L. Støižík[1], B. Frumarova[2], J. Oswald[2]; 1 - Univ. of Pardubice, 2 - Czech Academy of Sciences Prague; Czech Republic

Several types of oxychalcogenide glasses from system GeS2-Sb2S3 doped by Er3+ ions were prepared. Glasses consist mainly from GeS4 and SbS3 structural units according to Raman spectroscopy. Optical properties (refractive index, extinction and absorption coefficient, optical band gap, χ(3) coefficient) were calculated from ellipsometric parameters. Luminescence band around 1.55 μm was observed after 1.064 μm excitation.

TuYS-p02 **15:00-19:30**

Spiral waves in large aperture laser model

A.A. Krents[1,2]; D.A. Anchikov[1,2]; N.E. Molevich[1,2]; A.V. Pahomov[1,2]; 1 - Samara State Aerospace Univ., Russia; 2 - Samara branch of Physical Inst. of RAS, Russia.;

In this paper spontaneous formation of spiral waves in large aperture laser model has been reported. As a mathematical model the system of Maxwell-Bloch equations has been used. Linear stability and Floquet analyses were done. This analysis allows us to plot a bifurcation diagram and predict a characteristic size of exited spiral waves. Numerical simulations are in good according with theoretical analysis.

TuYS-p04 **15:00-19:30**

Four-wave optical parametric oscillator with two different BBO crystals

D. Goman, N. Kondratyuk, A. Protasenya; Solar Laser Systems, Belarus;

The present report describes the results of studies double-crystals BBO optical parametric oscillator pumped at 355 nm. The first 18 mm BBO crystal generated two waves: signal at 637 nm and idler 804 nm. The second 14 mm BBO crystal generated two waves: signal at 472 nm and idler at 1427 nm. Between the two signal waves there is a strong competition, which is manifested in the fact that the energy of the laser pulse will depend on the location of the crystals with respect to the pump beam.

TuYS-p05 **15:00-19:30**

Laser Induced Breakdown Spectroscopy of Single Wall Carbon Nanotubes and Gold Nanoparticles in Aqua Solutions

S.M. Pershin[1], A.N. Fedorov[1], A.A. Serkov[1], R.N. Yulmetov[1], S.I. Kudryashov [2], S.V. Makarov, A.A. Ionin[2]; 1 - Prokhorov General Physics Inst. of RAS; 2 - Lebedev Physical Inst. of RAS, Russia;

Laser induced breakdown spectroscopy have been used for quantitative analysis of impurities in single wall carbon nanotubes and gold nanoparticles in aqua solutions.

TuYS-p06 **15:00-19:30**

The Seed Signal for the Parametric Amplification Channel of Multiterawatt Femtosecond Laser System

A.V. Laptev[1], E.V. Pestryakov[1], G.V. Kuptsov[1,2], V.A. Petrov[1,2], V.V. Petrov[1,2]; 1 - Inst. of Laser Physics of SB RAS; 2 - Novosibirsk State Technical Univ., Russia;

The progress in the development of a multiterawatt femtosecond diode-pumped system with high pulse repetition rate based on Yb3+-doped media is reported. An ultrabroadband supercontinuum using highly-nonlinear photonic crystal fibre is generated

TuYS-p07 **15:00-19:30**

Spectroscopic ellipsometry metrology of precision optical surfaces and thin films

V. Azarova, A.Kulagin, V. Fokin; R&DI «Polyus», Russia; ;

There is shown that using of the spectral ellipsometrical metrology methods and metrology device M-2000 makes it possible to improve the technology process of thin films production.

TuYS-p08 **15:00-19:30**

Collimation and focusing of initially single-cycle paraxial optical beams

D.N. Puzyrev, A.A. Drozdov; St.Petersburg National Research Univ. of ITMO, Russia;

The paper reports theoretical results of collimation and focusing of spatio-temporal eld structure that is forming due to far- eld di raction of paraxial wave packet emitted by single-cycle source of radiation.

TuYS-p09 **15:00-19:30**

Particularities of Femtosecond Radiation Interaction with Biological Objects

P. Rogov, V. Bespalov; St.Petersburg National Research Univ. of ITMO, Russia;

Femtosecond laser pulses provide a minimally aggressive effect on inorganic and biological objects and thus make it possible to achieve high intensities of electromagnetic radiation. Currently there is a need to identify safe energy levels, the average power and the power for such a single pulse of radiation.

TuYS-p10 **15:00-19:30**

Multicolor pump-probe system with the broadly tunable range frequency difference for THz vibrations studies

P.D. Rudych, Inst. of Automation and Electrometry of SB RAS, Russia

Solvations of molecules in water is at the heart of understanding of cemical reactions and biological processes. Study of THz vibrations in water is a clue to the process understanding. We report the method of pumping THz vibrations in water and the measurements of its interactions with probe light.

7TH INTERNATIONAL CONFERENCE ON LASER OPTICS FOR YOUNG SCIENTISTS

Richter Hall

Session Chair: 09:00-13:00 A. Gorodetsky; Aston Univ., UK

WeYS-13 Invited **09:00-09:30**

Ultrafast spectroscopy helps optimize third-generation quantum dot solar cells

N.S. Makarov[1], Q. Lin[2], H. McDaniel[1], K.A. Velizhanin[3], C.M. Cirloganu[1], L.A. Padilha[1], W.-K. Koh[1], N. Fuke[4], I. Robel[1], J.M. Pietryga[1], V.I. Klimov[1]; 1 - Center for Advanced Solar Photophysics, Los Alamos National Labs, 2 - New Mexico State Univ., 3 - Theoretical Division, Los Alamos National Labs, USA; 4 - Materials & Energy Technology Laboratories, Sharp Corporation, Japan;

We apply femtosecond transient absorption (TA) and photoluminescence (PL) spectroscopies to study optical properties of various colloidal quantum dots (QDs) relevant to processes such as carrier multiplication (CM), up-conversion (uC) of infrared radiation, and electron transfer (ET) to mesoporous titania. These studies are conducted in the context of applications of QDs as active layers in solar cells. This work provides demonstrations of how ultrafast spectroscopies can be used to first probe and then optimize optical properties of QDs relevant for their applications in photovoltaics.

WeYS-14 **09:30-09:45**

Investigation of Mirrors Anisotropy Effect on the Gyro Non Plane Ring Laser

V.Azarova, A.Makeev; RDI «Polyus», Russia;

In this work, multilayer reflecting coatings are simulated with allowance for possible errors during sputtering layers and the effect of these errors on the polarization and losses of eigenmodes and cavity mode spectrum was investigated. The results of the simulation and experimental measurements of the characteristics of laser mirrors, mode spectra and energy characteristics of practically important four mirrors cavities with a non planar symmetric axial contour are compared. It is shown that the proposed mathematical model can be applied to optimal selection of lasers for laser cavities with allowance for their real parameters.

WeYS-15 **09:45-10:00**

Optical properties of heterostructures with deep quantum wells AlSb/InAs0.86Sb0.14/AlSb

N.V. Pavlov, G.G. Zegrya; Ioffe Physical Technical Inst. of RAS, Russia;

This paper the dimentional quantization energies, the absorption coefficient and the radiative recombination rate in the heterostructure with deep quantum well AlSb/InAs0,86Sb0,14/AlSb are calculated with the Kane model and with the simple parabolic model. It is shown that the carriers energy spectra nonparabolicity leads to sufficient corrections to the dimentional quantization energies, the absorption coefficient and the radiative recombination rate values in deep quantum wells.

WeYS-16 **10:00-10:15**

Strict single-mode high power 1018 nm fiber laser operating in multimode Yb-doped fiber

H. Xiao, J. Leng, X. Wang, Ya. Ma, P. Zhou; National Univ. of Defense Technology, P.R. China

We demonstrate single-mode 1018nm laser emission from a monolithic fiber laser that employs multimode gain fiber. Efficient high order mode suppression is achieved by using a pair of fiber Bragg grating that scribed in the core of single mode fiber. 85 W single-mode 1018 nm laser is obtained with a slope efficiency of 80%. The M2 value is measured to be 1.06.

TuYS-17 **10:15-10:30**

Spatially resolved speckle correlometry in application to media structure characterization

A.A. Isaeva[1], E.A. Isaeva[2]; 1 - St.Petersburg National Research Univ. of ITMO, 2 - Saratov State Technical Univ., Russia;

WWe propose an original speckle-correlometry method for the structural analysis through of a random multiple scattering media with complex dynamics and structure. The use of a localized radiation source and spatial ring filtration of scattered field ring give the opportunity to select the partial components of scattered field. In this work, the dynamic process of gel formation beginning from the stage of sol to the stage of gelling are investigated and the experimental data are presented.

WeYS-18 **10:30-10:45**

Linear optical properties of quantum dots – gold particle hybrid nanostructures.

A.V. Zasedatelev[1], V.S. Vasileva[1], A.N. Generalova[2], A.B. Karpo[3], V.I. Krasovskii[1],3, I.N. Feofanov [4], A.A. Chisryakov[1], V.A. Oleynikov[2]; 1 - National Research Nuclear Univ. «MEPhI», 2 - Shemyakin–Ovchinnikov Inst. of Bioorganic Chemistry of RAS, 3 - Prokhorov General Physics Inst. of RAS, 4 - Lebedev Physical Inst. of RAS, Russia;

In the present paper hybrid nanoparticles were synthesized and their linear photophysical properties were studied. The prepared hybrid nanoparticle consists of a gold nanoparticle's core with a mean 18 nm diameter, which was covered with a layer of dioxide silicon or other dielectric spacers, and the outer shell being a layer of quantum dots (QDs) CdSe / ZnS.

WeYS-19 **10:45-11:00**

Storage of Optical Information in Nano-size Cavity Arrays Under The Qubit-Light Interaction

E.S. Sedov, A.P. Alodjants, S.M. Arakelian; Stoletovs Vladimir State Univ., Russia;

We propose the model of 1D polaritonic lattice representing the chain of weakly coupled optical nano-cavities, each containing clusters of qubits. We revealed a variety of both localized and spreading dynamical regimes. We suggest a new physical algorithm for the spatially distributed storage of optical information where various localized dynamical states are used.

-COFFEE BREAK -

7TH INTERNATIONAL CONFERENCE ON LASER OPTICS FOR YOUNG SCIENTISTS

Richter Hall

Session Chair: 09:00-13:00 A. Gorodetsky; Aston Univ., UK

WeYS-20 **11:30-11:45**

Optical Properties of Quantum-Dimensional Probes of Scanning Probe Microscopes

P.V.Kolesnichenko, S.A. Pulkin, St.Petersburg State Univ., Russia;

The main idea of a quantum computer is use of a solid-state matrix with embedded array of quantum dots. Such quantum dots could theoretically be the tips of the probes of scanning probe microscopes. Here we consider some theoretical approaches in order to describe optical properties of the tip. First, we consider a tip as a box with infinitely high potential at the faces. Then, in the same way we consider cylindrical and cone shapes.

WeYS-21 **11:45-12:00**

Subcarrier wave quantum cryptography system with loss-loss polarization compensation unit

A. Gleim, V. Egorov, Yu. Nazarov, S. Kynev, A. Rupasov, S. Chivilikhin; St.Petersburg National Research Univ. of ITMO, Russia;

In this work we present practical implementation of a sub-carrier-wave quantum key distribution system. The system allows performing key distribution through standard telecommunication fiber to distances from several meters (> 500 Kbit/s) to 200 km (180 bit/s). A new phase modulator polarization dependence compensation mechanism greatly reducing system loss is suggested. The system is unidirectional, stable, polarization insensitive and designed to be used with standard telecommunication optical fibers.

WeYS-22 **12:00-12:15**

One-and-half-cycle pulse duration evolution in nonlinear media

Yu.A. Kapoyko; St.Petersburg National Research Univ. of ITMO, Russia;

Arithmetic expressions for center of mass movement velocity and duration evolution of initial one-and-half-cycle pulse in nonlinear medium with dispersion are obtained. It is shown that propagation of that pulse in fused silica because of the extremely wide spectrum can be self- focusing under the influence of nonlinearity even if its central frequency is in the region of medium normal group dispersion.

WeYS-23 **12:15-12:30**

Theoretical study of nonliear Fabry-Perot interferometer for few-cycle pulses

E. Buyanovskaya, E. Kryshkovets; St.Petersburg National Research Univ. of ITMO, Russia;

In this work we aim to theoretically investigate transmission of few-cycle pulses by Fabry-Perot interferometer created by a nonlinear dielectric between two metal mirrors.

WeYS-24 **12:30-12:45**

Effect of Raman nonlinearity on forward and backward waves of intense few-cycle laser field in optical fibre

L.S. Konev, Yu.A. Shpolyanskiy; St.Petersburg National Research Univ. of ITMO, Russia;

Bidirectional equations for forward and backward waves of intense few-cycle femtosecond pulses are solved numerically for single-mode optical fibre with dispersion and cubic nonlinearity including Raman mechanism. Appearance of a weak backward wave which was absent in the initial distribution is shown. The role of Raman nonlinearity on the amplitude and profile of forward and backward waves is investigated.

WeYS-25 **12:45-13:00**

Surface modification of refractory metals by femtosecond laser radiation

D.A. Kochuev, K.S. Khorkov, D.V. Abramov, Affilation1, Vladimir State Univ., Russia;

In paper the results of nanostructuring of surfaces of tungsten and molybdenum by femtosecond laser radiation in the air and liquid nitrogen are shown.

SM1: SEMINAR ON OPTOELECTRONICS

SM1: SEMINAR ON OPTOELECTRONICS

Richter Hall

Session Chairs: *09:00-19:15 O.V. Angelsky, Chernivtsy National Univ., Ukraine;*

09:00-19:15 Yu.V. Chugui, Technological Design Inst. of Scientific Instrument Engineering of SB RAS, Novosibirsk State Univ., Novosibirsk State Technical Univ., Russia

TuSm1-01 Invited **09:00-09:30**

Measurement of microstructures to super resolution by focus probe

Kuang-Chao Fan, Liang-Chia Chen; National Taiwan Univ., Taiwan;

The edge detection of microstructures by microscopes is poor in resolution due to the effect of diffraction limit. This paper proposes a new technique by using the focus probe in association with a nanopositioning stage. The edge is detected by the total energy reflection principle and the step height is detected by the astigmatic principle. Both methods can realize the resolution of 1 nm.
Experimental results show that for the edge detection of micro cavities and the measurement of microlinewidth, the standard deviation is less than 40 nm. For the step height measurement, the standard deviation is less than 22 nm. This novel super resolution technique is a breakthrough of the conventional diffraction limit.

TuSm1-02 Invited **09:30-10:00**

Atomic scale silicon surface processing for nanostructuring and precise surface measurements

S.S. Kosolobov[1,2], S.V. Sitnikov[1,2], A.V. Latyshev[1,2], E.V. Sysoev[3], Yu.V. Chugui[2,3,4];
1 - Rzhanov Inst. of Semiconductor Physics of SB RAS; 2 - Novosibirsk State Univ.,
3 - Technological Design Inst. of Scientific Instrument Engineering of SB RAS,
4 - Novosibirsk State Techn. Univ., Russia;

Atomic processes, that governing the formation of crystalline surface morphology, attracted the considerable attention for possible applications in manufacturing of nanometer scale objects and providing accurate measurements in metrology and calibration techniques. In this paper some new results on the nanostructuring of the atomically clean silicon surface by means of in situ ultrahigh vacuum reflection electron microscopy technique are presented. The formation of an extremely flat silicon surfaces with two-dimensional nanoislands as a reference metrology tool for optical and laser measurements is demonstrated.

TuSm1-03 **10:00-10:15**

Metrological and technological limitations for correction of wavefront distortion in laser crystals by 3D photolithographic surface shaping

V.P. Korolkov[1], R.K. Nasyrov[1], A.G. Poleshchuk[1], Yu.D. Arapov[2], A.F. Ivanov[2];
1 - Inst. of Automation and Electometry of SB RAS, Russia; 2 - RFNC – the All-Russian Research Inst. of Technical Physics, Russia;

The correction of YAG:Nd3+ active element with diameter 45 mm by conformal optical element is presented. Halftone mask and proximity printing were used for fabrication. Experimental results show an improvement of the wavefront by 3 times. Impossibility to measure interferometrically some types of wavefront distortion in the crystal results in metrological limitation of the technique. Low etching rate limits dynamic range of the wavefront distortion.

TuSm1-04 **10:15-10:30**

The use of optical correlation algorithm to solve phase problem of complex optical fields

O.V. Angelsky, M.P. Gorsky, C.Yu. Zenkova, P.A. Ryabiy; Chernivtsy National Univ., Ukraine;

We propose an optical correlation algorithm for reconstructing the phase skeleton of complex optical fields from the measured two-dimensional intensity distribution. The essence of the algorithm consists in location of the saddle points of the intensity distribution and connecting such points into nets by the lines of intensity gradient that are closely associated with the equiphase lines of the field. This algorithm provides a new partial solution to the inverse problem in optics commonly referred to as the phase problem.

TuSm1-05 **10:30-10:45**

Development of in-situ one-shot confocal surface profilometry using double-slit chromatic differential confocal microscopy (CDCM)

Liang-Chia Chen, Jiun-Da Lin, Kuang-Chao Fan, National Taiwan University, Taiwan;

This study presents a broadband differential confocal surface profilometer using new double-slit chromatic confocal measurement for in-situ microscopic surface inspection. In-situ automatic optical inspection (AOI) on microstructures has become extremely important to ensure manufacturing quality in modern manufacturing fields. A multi-wavelength differential confocal surface profilometer is developed by employment of double-slit conjugate configuration for generating the differential gradient in confocal measurement. Two different sizes of slits with individual opening sizes are placed in front of their corresponding imaging unit and designed to conjugate with an object surface underlying inspection. The differential gradient is generated by correlating two focus-depth-response curves which are measured by the two imaging units with their corresponding slits. The developed system can achieve one shot inspction for line-scan profilometry without vertical scanning frequently required by conventional confocal measurement. The vertical measurement range can be designed for a range of a few hundreds of micrometers while its vertical resolution is capable of reaching a level of less than 0.5 micrometers. The measuring speed can match tight tact time requirements in in-situ AOI.

TuSm1-06 **10:45-11:00**

Fiber-optic bend sensor based on a section of double-cladding fiber

O.V. Ivanov[1], I.V. Zlodeev 2; 1 - Ulyanovsk Branch of Kotel'nikov Inst. of Radio Engineering and Electronics of RAS, 2 Ulyanovsk State Univ.; Russia;

A fiber-optic structure based on a section of a double-clad fiber with depressed inner cladding is investigated for bend sensing. The structure is formed by splicing a section of SM630 fiber between two standard fibers SMF-28. The operation principle relies on the sensitivity of cladding modes that are induced at a splice of fibers having different refractive index profiles. The transmission spectra of the structure demonstrate a shift of dips to long wavelengths with increasing curvature of the fiber. The sensitivities of the spectral dips to the bend curvature are measured. A fiber-optics scheme with two light sources is proposed for bend sensing.

-COFFEE BREAK -

TuSm1-07 **11:30-11:45**

Testing of optical homogeneity of materials in IR spectral region

V.I. Venzel, A.V. Gorelov, V.S. Obraztsov, M.I. Sinel'nikov, E.S. Egorova, N.Ya. Kuznetsova, Ye.S. Lavrent'ev; Scientific Research Inst. for Optoelectronic Instrument Engineering, PLC, Russia;

Diffractometer and interferometer devices for optical homogeneity testing of materials in the middle and far IR spectral region are described. Data on measuring inaccuracy calculation of optical homogeneity made by different techniques are given. Measuring data for optical homogeneity of large work pieces made of optical crystals in IR spectral region are presented.

TuSm1-08 **11:45-12:00**

Is it possible to enhance music influence by colour accompaniment?

K.V. Sapozhnikova, R.E. Taymanov, Mendeleyev Inst. for Metrology, Russia;

The paper deals with perception of colour and acoustic signals. Hypotheses, which relate to regularities of the relationship between music and colour, are analyzed. Some colour musical compositions and shows are under consideration too. The difference between the evolution of acoustic signals and that of colour ones is noted. The main scientific problems, which should be solved for achievingstrong and adequate emotional experience under such a complex influence, is considered. These problems are of an interdisciplinary character covering neuropsychology, biology, neurophysiology, physiological optics, and metrology.

TuSm1-09 **12:00-12:15**

Optic-electronic autocollimator for deformations inspection of the axle at the millimeter wave range radiotelescope

I.A. Konyakhin, A.A. Usik, F.V. Molev, Renpu Li; St.Petersburg National Research Univ. of ITMO, Russia;

Researches in the millimetre wave range require the high accuracy for position of the mirror components of the radiotelescope. A mirror weight is the cause of the three-dimension angular deformation of the elevation axle and azimuth axle relatively bearings. For the measuring roll, pitch and yaw angular deformations of the axles the autocollimator with new type of the reflector are used. Reflector as the composition of the anamorphic prism and tetrahedral reflector is described. New methods for roll, pitch, yaw angles measuring are discussed. Equations for the static characteristic of the measuring system are shown.

TuSm1-10 **12:15-12:30**

Overcoming the diffractive limit of lateral resolution under 3D nanorelief measurements

E.V. Sysoev[1], I.A. Vykhristyuk[1], R.V. Kulikov[1], Yu.V. Chugui[1,2,3]; 1 - Technological Design Inst. of Scientific Instrument Engineering of SB RAS, 2 - Novosibirsk State Univ.,
3 - Novosibirsk State Technical Univ., Russia;

The method of overcoming the diffractive limit of lateral resolution of 3D nanorelief measurement is proposed. Algorithm for digital processing of measurement data based on deconvolution operation using Wiener filtration is presented. Results of theoretical researches, numerical and optical experiments are given.

TuSm1-11 **12:30-12:45**

The use of nanoparticles of the Rayleigh light scattering mechanism in the metrology of optical currents and fields

C.Yu. Zenkova, I.V. Soltys; Chernivtsi National Univ., Ukraine;

Theoretical and experimental approaches to diagnosing of internal optical flows and corresponding optical forces caused by these flows are offered. These approaches are based on the investigation of the motion of tested particles in the formed optical field. The possibility of using kinematic values defining the motion dynamics of particles of the Rayleigh light scattering mechanism for making a quantitative assessment of the degree of coherence of mutually orthogonal linearly polarized in the incidence plane waves is demonstrated.

TuSm1-12 **12:45-13:00**

Optical measuring technologies and systems for scientific and industrial applications

Yu.V. Chugui[1,2],3, A.G. Verkhoglyad[1], P.S. Zavyalov[1]; 1 - Technological Design Inst. of Scientific Instrument Engineering of SB RAS, 2 - Novosibirsk State Univ., 3 - Novosibirsk State Technical Univ., Russia;

Solving many actual safety problems in atomic, electrotechnical, space, railway, and oil industries as well as in science takes noncontact optical measurement technologies with micron resolution and productivity from 500 to 100 000 meas./s. We have developed, implemented and tested in real workshop and outside conditions some novel optical measuring systems, which are operating successfully in many scientific and industrial fields. The technical performances of these systems are presented.

TuSm1-13 **13:00-13:15**

Spectral-selective Mueller-matrix images of laser autofluorescence of biological tissues

A.D. Arkhelyuk, Yu.A. Ushenko; Chernivtsi National Univ., Ukraine;

The results of diagnostic efficiency investigation of a new azimuthally stable Mueller-matrix method of analysis of laser autofluorescence coordinate distributions of biological tissues histological sections. A new model of generalized optical anisotropy of biological tissues protein networks is proposed in order to define the processes of laser autofluorescence. The influence of complex mechanisms of both phase anisotropy (linear birefringence and optical activity) and linear (circular) dichroism is taken into account. The interconnections between the azimuthally stable Mueller-matrix elements characterizing laser autofluorescence and different mechanisms of optical anisotropy are determined. The statistic analysis of coordinate distributions of such Mueller-matrix rotation invariants is proposed. Thereupon the quantitative criteria (statistic moments of the 1st to the 4th order) of differentiation of histological sections of uterus wall tumor – group 1 (dysplasia) and group 2 (adenocarcinoma) are estimated.

TuSm1-14 **13:15-13:30**

Monitoring of reactive ion etching of computer-generated holograms by specular spectroscopic scatterometry

A.S. Konchenko[1], V.P. Korolkov[1,2], A.I. Malyshev[1], A.R. Sametov4; 1 - Inst. of Automation and Electometry of SB RAS, 2 - Novosibirsk State Univ., Russia;

Specular spectroscopic scatterometry is used to measure zeroth-order diffraction intensity spectrum of white light reflected at a fixed angle from diffractive structure. Extremes location in the spectrum depends on profile depth. However, chromium film used as a mask at reactive ion etching of fused silica substrate at hologram fabrication contributes unknown phase shift to the reflected light. The paper is devoted to the behavior of the phase shift during dry etching and checking an applicability of the specular spectroscopic scatterometry for measurement of binary amplitude-phase grating at iterative monitoring of the etching process.

-BREAK FOR LUNCH -

TuSm1-15 **15:00-15:15**

About metrology and applications of precision laser surfaces & mirrors

V.V. Azarova; R&DI "Polyus" named by M.F. Stelmakh; Russia;

The characteristics and the statistic parameters of the precise optical surfaces are discussed. The connection of the measured by the various metrological methods parameters with PSD function was theoretically described. It is shown the correlation between of many layers coated mirrors surfaces profiles and surfaces profiles of their substrates by the comparison of PSD functions. The modern method for testing of the precision optical details surface structure using the white light interferometer is considered. Measurement results of laser gyroscopic mirrors and mirrors substrates profiles, received with help of the surface structures analyzer New View 6200, are compared with total integral scattering (TIS) of these mirrors.

TuSm1-16 **15:15-15:30**

Apparatus for analyzing the spectral characteristics of reflection, albedo and color parameters of flat objects

E.V. Gorbunova, V.V. Korotaev, E.A. Lastovskaya, A.N. Chertov; St. Petersburg National Research Univ. of ITMO, Russia;

This work is devoted to the description of apparatus for analyzing the spectral characteristics of reflection and color parameters of flat object's surface. The basic operation principles of mentioned apparatus and its functional diagram are examined as well. Also some features of data processing, which are used in the estimation technique of spectral characteristics of reflection, albedo and color parameters of analyzed objects, are presented.

TuSm1-17 **15:30-15:45**

Polarization selection of birefringence polycrystalline networks of blood plasma layers

Yu.O. Ushenko, A.V. Dubolazov, A.O. Karachevtsev, V.O. Savich, V.P. Prysiazhniuk; Chernivtsi National Univ., Ukraine;

The principles of optical model of human bile polycrystalline structure are described. The results of investigation the interrelation between the values of statistical, correlation and fractal parameters are presented. They characterize the coordinate distributions of mutual polarization degree of the points of laser images of bile smears of cholelithiasis patients in combination with other pathologies. The diagnostic criteria of the cholelithiasis nascency and its severity degree differentiation are determined.

TuSm1-18 **15:45-16:00**

System for blade's output edge measuring in low pressure cylinder of closed turbine

D.V. Apehtin, A.A. Gorbachev, St.Petersburg National Research Univ. of ITMO, Russia;

System that will allow visual and measuring inspection of blades is proposed. Geometrical characteristics of the system are given. Theoretical error of system measurement is calculated. The physical model of inspection method is developed. The results of experiments with metal object are presented.

TuSm1-19 **16:00-16:15**

Evolution of Mueller matrix Images of the myometrium for the optical anisotropy oncological changes

Yu.O. Ushenko, A.V. Dubolazov, A.O. Karachevtsev, O.I. Olar, V.O. Savich; Chernivtsi National Univ., Ukraine;

The optical model of polycrystalline networks of myometium is suggested. The results of investigation the interrelation between the values correlation (correlation area, asymmetry coefficient and autocorrelation function excess) and fractal (dispersion of logarithmic dependencies of power spectra) parameters are presented. They characterize the distributions of Mueller matrix elements in the points of laser images of myometrium histological sections. The criteria of differentiation of death coming reasons are determined.

TuSm1-20 **16:15-16:30**

Polarization properties of crystal and polymer phase plates at their collimation turns in space

V.V. Korotaev, V.A. Ryzhova, A.V. Trushkina, St.Petersburg National Research Univ. of ITMO, Russia;

The comparative analysis of polarization properties of chromatic linear crystal andpolymer phase plates at their small collimation turns in space is presented. Thedependences on changes of polarization state parameters from an azimuth of input linearly polarized radiation and from its angle of incidence on refracting side of aphase plate are performed.

TuSm1-21 **16:30-16:45**

Fourier-stokes polarimetry of fields scattered by birefringence biological tissues

Yu.O. Ushenko, A.V. Dubolazov, A.O. Karachevtsev, O.Yu. Novakovska, V.O. Savich; Chernivtsi National Univ., Ukraine;

The optical model of polycrystalline networks of histological sections of rectum wall is suggested. The results of investigation the interrelation between the values of statistical (statistical moments of the 1st-4th order) parameters are presented. They characterize the coordinate distributions of the fourth parameter of Stokes vector of Fourier transforms of laser images of rectum wall histological sections and oncological changes. The diagnostic criteria of rectum cancer are determined.

TuSm1-22 **16:45-17:00**

Laser thickness gauges calibration

V.I. Shlychkov, Ural Federal State Univ., Russia;

Calibration procedure of triangulation gauge for surface object distance determination is discussed. Obtained data from the gauge help to calculate by means of the least-squares method the calibration coefficients for the upper and the lower triangulation module of the laser thickness gauge. Thickness standard samples realize a discrete displacement in the measuring zone with fixation of the elements numbers by the modules. The obtained data are used when searching by the numerical methods of local minimum of thickness measurement error with respect to the thickness standard samples and also it helps to calculate calibration coefficients for the laser thickness gauge.

-COFFEE BREAK -

SM1: SEMINAR ON OPTOELECTRONICS

Richter Hall

Session Chairs: *09:00-19:15 O.V. Angelsky, Chernivtsy National Univ., Ukraine;*

09:00-19:15 Yu.V. Chugui, Technological Design Inst. of Scientific Instrument Engineering of SB RAS, Novosibirsk State Univ., Novosibirsk State Technical Univ., Russia

TuSm1-23 **17:30-17:45**

Polymer-dispersed liquid crystals filter of spatial-frequency

P.P. Maksimyak, A.L. Nehrych; Chernivtsi National Univ., Ukraine;

We have investigated the spatial-frequency filtering on polymer-dispersed liquid crystals (PDLC). Partial beams passed through liquid crystals (LC) droplets and polymer matrix may be considered as plane waves passing different optical paths and interfering in the far zone. Changing the voltage results in changing the LC effective refractive index is leading to a change of the path difference between the interfering beams. The effect of interference decreases of some spectral components of the radiation passing through PDLC sample can be used for space- frequency filtering of images.

TuSm1-24 **17:45-18:00**

Polarimetry and spectropolarimetry techniques in biotissue's cancer changes diagnostics

S.B.Yermolenko[1], O.P.Peresunko[2], N.V. Zelinska[2]; 1 - Chernivtsi National Univ.; 2 - Bukovinian State Medical Univ., Ukraine;

The aim of the study is combining polarimetry and spectropolarimetry techniques for identifying the changes of optical-geometrical structure in different kinds of biotissues with solid tumours. It is researched that a linear dichroism appears in biotissues (human esophagus, muscle tissue of rats, human prostate tissue, cervical smear) with cancer diseases, magnitude of which depends on the type of the tissue and on the time of cancer process development.

TuSm1-25 **18:00-18:15**

The investigation of thrombus formation process in blood plasma by correlation-optical technique

M.S. Gavrylyak P.P. Maksimyak; Chernivtsi National Univ., Ukraine;

The method of laser express diagnostics of thrombus formation process in a blood plasma is presented. This method is based on analysis of image correlation of blood plasma during thrombus formation process. The technique of experimental researches of scattering laser radiation by blood plasma is shown. It is established that the dynamic of intensity fluctuations of radiation of scattered by blood plasma decreases under the influence of thrombin that causes increasing correlation coefficient and gives the possibility to estimate continuance of thrombus formation process.

TuSm1-26 **18:15-18:30**

Spectropolarimetry diagnostic of blood plazma in patients with breast cancer

O.P. Peresunko[1], T.V. Kruk[1], S.B. Yermolenko[2], P.V. Ivashko[2]; 1 - Bukovinian State Medical Univ., 2 - Chernivtsi National Univ., Ukraine;

The possibility of using the polarimetry methods for performance evaluation of blood plasma of patients with breast cancer was studied and also has been investigated the spectroscopy method in the diagnosis of breast cancer. The criteria for their use in non-invasive screening the problems were determined.

TuSm1-27 **18:30-18:45**

Modelling of light scattering in biotissue

P.V. Ivashko, Chernivtsi National Univ., Ukraine;

Different statistical modeling techniques of radiation propagation in epithelial tissue are considered. The two main approaches are: modified classical Monte Carlo method for light propagation in turbid medium and the coherent inverse ray tracing method. Classical Monte Carlo method was modified to taking into account polarization of propagated radiation and birefringence which can occur due to tissues commonly found under epithelium. As a supplementary method modified version of classical ray tracing technique is used which takes into account phase of radiation during its propagation in tissue.

TuSm1-28 **18:45-19:00**

Laser light scattering by the cement during hydration process

M.P. Gorsky, P.P. Maksimyak; Chernivtsi National Univ., Ukraine;

This paper is devoted to simulation of speckle field dynamics during coherent light scattering by cement surface in the process of hydration. Cement particles are represented by the spheres whose sizes and reflection indices are changing during the hydration process. The study of intensity fluctuations of scattered coherent radiation is suitable technique for the analysis both fast and slow processes of mineral binders hydration and forming polycrystalline structures in the process of hardening. The results of simulation are in good agreement with the experimental data.

SM2: SEMINAR ON TERAHERTZ PHOTONICS

SM2: SEMINAR ON TERAHERTZ PHOTONICS

Stenberg 2 Hall

Session Chairs: *15:00-18:00 J.-L. Coutaz, University of Savoie, France*
15:00-18:00 A.P. Shkurinov, Lomonosov Moscow State University, Russia

MoSm2-01 Invited **15:00-15:30**

NovoFEL – tunable high power source of terahertz radiation: new results and perspectives

G. Kulipanov[1], E. Chesnokov[2], B. Knyazev[1,5], V. Kubarev[1,5], S. Peltek[3], A. Petrov[2], V. Popik[1], O. Shevchenko[1], S. Veber[4], N. Vinokurov[1,5]; 1 - Budker Inst. of Nuclear Physics of RAS, 2 - Inst. of Chemical Kinetics and Combustion of SB RAS, 3 - Inst. of Cytology and Genetics of SB RAS, 4 - International Tomography Center of SB RAS, 5 - Novosibirsk State Univ., Russia;

Status of NovoFEL with planned range of wavelength from 240 to 5 micrometers based on four-track energy recovery linac with maximum energy 40 MeV is described. Experimental results of using of high power THz radiation in physics, chemistry, biology are presented: ultrasoft THz ablation of biological substances; plasmon spectroscopy of surfaces and films; time-resolved superfast time domain spectroscopy; flame diagnostics.

MoSm2-02 Invited **15:30-16:00**

Novel Versions of Terahertz Electron Devices

V.L. Bratman, A.E. Fedotov, Yu.K. Kalynov; Inst. of Applied Physics of RAS, Russia;

Following types of vacuum Terahertz electron devices will be discussed in the presentation: 1.gyrotrons with a very low voltage (gyrotrinos) and Large Orbit Gyrotrons, 2.weakly-relativistic Cherenkov devices with hollow beams, 3.sources of picosecond pulses based on use of ultrarelativistic bunches formed in photo-injector linacs. Their realization can simplify high-field DNP/NMR spectrometers, and make possible promising pump-probe experiments.

MoSm2-03 Invited **16:00-16:30**

Ultrafast Real-Time THz Time-domain Spectroscopy on NovoFEL

V.V. Kubarev[1,2], E.N. Chesnokov[3], and P.V. Koshlyakov[3]; 1 - Budker Inst. of Nuclear Physics; 2 - Novosibirsk State Univ.; 3 - Inst. of Chemical Kinetics and Combustion, Russia;

Development and applications of the ultrafast real-time THz time-domain spectroscopy are described. Polarization spectrometer with Fabry-Perot etalon or standart gas cell in a reference branch illuminated by the powerful NovoFEL radiation can be used both for one-pulse diagnostics of the side-band instabilities and for real-time study of the nonrepetitive chemical reactions. Spectral resolution was found to be directly proportional to a measuring time (Fourier limit). It was equal to 800 and 55 000 for 0.4 ns and 25 ns measuring time respectively.

MoSm2-04 Invited **16:30-17:00**

The development of THz gyrotrons and their applications for plasma science and diagnostics of various media

M.Yu. Glyavin[1], G.G. Denisov[1], V.E. Zapevalov[1], E.M. Tai[2]; 1 - Inst. of Applied Physics of RAS, 2 - GYCOM Ltd, Russia;

Results of experimental investigations of demountable high power pulsed gyrotron are presented. This gyrotron has been successfully used for initiation of localized gas discharges in studies aimed to create a point source of extreme ultraviolet light. Design and experimental test of CW 0.26 THz gyrotrons are discussed. Some possibilities to improve mode selectivity such as multi beam electron optics and planar geometry are discussed.

MoSm2-05 Invited **17:00-17:30**

THz Quantum Cascade Lasers For High Resolution Spectroscopy

V. Vaks; Inst. for Physics of Microstructures of RAS, Russia;

We report on application of the radiation source based on quantum cascade lasers for THz gas spectrometer based on nonstationary effects (free dumping polarization). The phase lock loop system and frequency stabilization system by gas absorption line for quantum cascade lasers of THz frequency range were developed.

MoSm2-06 **17:30-17:45**

High refractive polymer materials based on the silicon nano- and micro- particles.

M.M. Nazarov[1], E.V. Khaydukov[1], V.I. Sokolov[1], A.G.Savelyev[1], A.P. Shkurinov[2], V.Ya. Panchenko[1]; 1 - Inst. of Laser and Information Technologies of RAS, 2 - Lomonosov Moscow State Univ., Russia;

For developing THz technologies transparent materials with controllable refractive index are requested. We create such materials by incorporation of micro-and nano - particles of high refractive semiconductors into a transparent polymer. With THz time-domain spectroscopy composite materials based on nano-and micro-particles of silicon are investigated. The ultimate achievable value of absorption, refraction and scattering, as well spectral tuning due to laser illumination are discussed.

MoSm2-07 **17:45-18:00**

Terahertz surface plasmon polaritons: new results at the Novosibirsk free-electron laser

V.V. Gerasimov[1], V.O. Gorovoy[2]; 1 - Budker Inst. of Nuclear Physics of SB RAS, 2 - Novosibirsk State Univ., Russia

The terahertz surface plasmon polaritons propagating on plane and curved metal-dielectric surfaces with air gaps using radiation of Novosibirsk free-electron laser were studied. The recent results are discussed.

TECHNICAL SESSION

SM2: SEMINAR ON TERAHERTZ PHOTONICS

Stenberg 2 Hall

Session Chairs: *09:00-13:30 J.-L. Coutaz, University of Savoie, France*

15:00-19:30 A.P. Shkurinov, Lomonosov Moscow State University, Russia

TuSm2-08 Invited **09:00-09:30**

Challenges in Medical Applications using Terahertz Waves

Jo.-H. Son; Univ. of Seoul, Korea;

Various applications in medicine utilizing terahertz technology are presented. Technical challenges in such applications are discussed in terms of limited penetration depth, blurred spectral features, and deficient contrast and the feasible solutions to the problems are also suggested.

TuSm2-09 Invited **09:30-10:00**

Prospects for Terahertz Optics and Spectroscopy with Tunable Monochromatic Radiation Sources

B.A. Knyazev[1,2], G.N. Kulipanov[1], N.A Vinokurov[1,2]; 1 - Budker Inst. of Nuclear Physics of SB RAS, Russia; 2 - Novosibirsk State Univ., Russia;

Results obtained during ten years past from first lasing of Novosibirsk free electron laser open a new view on prospects for using tunable terahertz radiation in optics and spectroscopy.

TuSm2-10 **10:00-10:15**

Terahertz Image Processing for the Skin Cancer Diagnostic

A. Balakin[1], A. Kolesnikov[2], P. Solyankin[1], A. Angeluts[1], M. Nazarov[1], M. Evdokimov[1], M. Spencer[4], A. Nikitin[2], A. Shkurinov[1], V. Tuchin[2,3], A. Yaroslavsky[4]; 1 - Lomonosov Moscow State Univ., 2 - Saratov State Univ., Russia; 3 - Univ. of Oulu, Finland; 4 - Univ. of Massachusetts Lowell, USA;

The results of the study of THz imaging of soft (skin) and hard tissues (teeth and nail sections) are presented. THz images of tissue specimens and the results of various image-processing technologies are discussed.

TuSm2-11 **10:15-10:30**

Signal Processing and Algorithms for Inverse Problem in THz Time-Domain Spectroscopy

K.I. Zaytsev[1], V.E. Karasik[1], N.V. Chernomyrdin[1], A.A. Gavdush[1], I .N. Fokina[1], P.A. Nosov[1], S.O. Yurchenko[1], K.G. Kudrin[2], I.V. Reshetov[2]; 1 - Bauman Moscow State Technical Univ., 2 - Gertsen Moscow Research Inst. of Oncology, Russia;

The present paper reviews the recent results of novel algorithm development for terahertz pulsed spectroscopy (TPS) signal processing. Methods for wavelet-domain de-nosing of TPS data, sample permittivity profile reconstruction, and high accurate material parameter determination were offered

TuSm2-12 **10:30-10:45**

Simulation of THz scattering in partly-ordered medium

I.N. Fokina, K.I. Zaytsev, S.O. Yurchenko, V.E. Karasik, V.S. Gorelik; Bauman Moscow State Technical Univ., Russia

Interaction of THz radiation with inhomogeneous matter was considered. The study of scattering effects in various structures was done, including random, partly-ordered and periodic structures. Numerical modeling of radiation propagation was performed by FDTD method and Monte-Carlo simulation of radiation transfer. For periodic 2D structures, the results of FDTD and Monte-Carlo approaches were compared. Impact of structure factor was estimated.

TuSm2-13 **10:45-11:00**

Near-Field Terahertz Scanning Optical Microscope with Frustrated Total Internal Reflection Module

A. G. Verkhogliad[1], V.V. Gerasimov[2,3], M.A. Zavyalova[1,3], B.A. Knyazev[2,3], S.N. Makarov[1,3], M.F. Stupak[1,3], D.G. Rodionov[2,3,4], Yu.Yu. Choporova[2,3]; 1 - Technological Design Inst. of Scientific Instrument Engineering of SB RAS; 2 - Budker Inst. of Nuclear Physics of SB RAS; 3 - Novosibirsk State Univ.; 4 - Novosibirsk State Technical Univ.; Russia;

The first near-field terahertz scanning optical microscope (NFSOM) with frustrated total inner reflection (FTIR) module and a free electron laser as a radiation source were constructed. In the touch sensor, a new method for determining the distance between the probe and conducting surface from the current of the corona discharge was implemented. Tests of all of the microscope's elements were conducted, demonstrating their operability.

-COFFEE BREAK -

TuSm2-14 Invited **11:30-12:00**

THz real-time imaging with specifically designed uncooled silicon bolometer 2D array camera

F. Simoens; CEA Leti-MINATEC, France;

Uncooled microbolometer focal plane arrays (FPAs) tailored specifically for THz sensing are nowadays recognized as a relevant technology for fast 2D image acquisition by compact and hand-held cameras. The author's group has designed and prototyped a proprietary bolometer technology. After a review of video-like THz cameras, this paper describes the bolometer 2D array design with focus on its specific properties. Some examples of real-time 2D imaging are then presented.

TuSm2-15 Invited **12:00-12:30**

THz probing of local electron states in doped lead telluride-based semiconductors

D.R. Khokhlov[1,2], L.I. Ryabova[1], 1 - Lomonosov Moscow State Univ., Russia, 2 - Lebedev Physical Inst. of RAS, Russia;

We review the main results related to unusual local electron states observed in doped lead telluride-based semiconductors. It is demonstrated that in contrary to traditional impurity states possessing some definite position in the energy spectrum, the observed local electron states are linked to the quasi-Fermi level position and may shift together with this level. Dependence of the density of these states as a function of the alloy composition, magnetic field and electric current is considered. It is shown that these local electron states are responsible for appearance of the persistent photoconductivity in the terahertz spectral region.

TuSm2-16 Invited **12:30-13:00**

Overview of recent results for superconducting NbN terahertz and optical detectors and mixers

G.N. Gol'tsman; Moscow State Pedagogical Univ. , Russia;

We present our recent achievements in the development of sensitive and ultrafast thin- film superconducting sensors: hot-electron bolometers (HEB), HEB-mixers for terahertz range and infrared single-photon counters. These sensors have already demonstrated a performance that makes them devices-of-choice for many terahertz and optical applications.

TuSm2-17 Invited **13:00-13:30**

Superconducting Integrated Terahertz Spectrometers

V.P. Koshelets[1], P.N. Dmitriev[1], L.V. Filippenko[1], N.V. Kinev[1], O.S. Kiselev[1], K.I. Rudakov[1], G. de Lange[2], V.L. Vaks[3], J. Yuan[4], H.B. Wang[4]; 1 - Inst. of Radio Engineering and Electronics of RAS, Russia; 2 - SRON Netherlands Inst. for Space Research, The Netherlands; 3 - Inst. for Physics of Microstructure of RAS, Russia; 4 - National Inst. for Materials Science, Japan;

A Superconducting Integrated Receiver (SIR) comprises on one chip all elements needed for heterodyne detection. Light weight and low power consumption combined with nearly quantum limited sensitivity and a wide tuning range of the superconducting local oscillator make SIR a perfect candidate for many practical applications.

-BREAK FOR LUNCH -

TuSm2-18 Invited **15:00-15:30**

Semiconductor beating sources for tunable continuous-wave terahertz generation and its industrial application

K.H. Park[1], N. Kim[1], K. Moon[1], E. Su Lee[1], I.-M. Lee[1], H. Ko[1], Je.-W. Park[1], S.-P. Han[1], M.Yo. Jeon[2], H.-Ch. Ryu 3; 1 - THz Photonics Creative Research Center, 2 - ChungNam National Univ., 3 - Samyook Univ.; THz Photonics Creative Research Center; Korea

Compact and cost-effective photonics technologies for THz system are explored for a wide range of possibilities in the real industrial applications.

TuSm2-19 Invited **15:30-16:00**

Measurement of the spectral brightness under nonlinear-optical terahertz wave detection

G.Kh. Kitaeva, P.V. Yakunin, V.V. Kornienko, A.N. Penin; Lomonosov Moscow State Univ., Russia;

A new method of self-calibrated measurement of the terahertz wave spectral brightness in the course of nonlinear-optical detection is discussed and an experimental proof for its theoretical background is demonstrated.

TuSm2-20 Invited **16:00-16:30**

Terahertz vectorial antennas based on cubic electro-optic crystals

G. Gaborit, A. Biciunas, J.-L. Coutaz, IMEP-LAHC, Univ. of Savoie, France;

Using cubic electro-optic crystals whose cut is <111>, we demonstrate both theoretically and experimentally that the polarization of THz beams emitted by optical rectification and detected by electro-optic sampling can be nicely controlled and measured by acting on the polarization of the optical pump or test beam. These techniques are a nice substitute to missing easy-to-use and highly-performing THz waveplates.

TuSm2-21 Invited **16:30-17:00**

Cherenkov-type terahertz emission spectroscopy of ultrafast optomagnetic effects

M.I. Bakunov[1], S.D. Gorelov[1], R.V. Mikhaylovskiy[2], S.B. Bodrov[1], E.A. Mashkovich[1], M.V. Tarev[1];1 Univ. of Nizhny Novgorod, Russia; 2 - Radboud Univ. Nijmegen, The Netherlands;

We put forward measuring Cherenkov-type terahertz emission from a moving pulse of magnetization as a method to explore ultrafast magnetic phenomena triggered in solids by femtosecond laser pulses. By applying the method to terbium-gallium-garnet, we discover the paramagnetic nature of ultrafast inverse Faraday effect in this material with the Verdet constant 3- 10 times smaller than its table quasistatic value.

SM2: SEMINAR ON TERAHERTZ PHOTONICS

Stenberg 2 Hall

Session Chairs: *09:00-13:30 J.-L. Coutaz, University of Savoie, France*
15:00-19:30 A.P. Shkurinov, Lomonosov Moscow State University, Russia

TuSm2-22 **Invited** **17:30-18:00**

Nonlinear strong field THz effects

S. Tzortzakis[1,2]; 1 - Institute of Electronic Structure and Laser (IESL), 2 - Univ. of Crete, Greece;

We present experimental and theoretical results on the induced THz nonlinearities in transparent media. Exciting spatiotemporal effects are revealed enriching the era of THz nonlinear optics.

TuSm2-23 **Invited** **18:00-18:30**

Coherent THz Radiation Emitted from Femtosecond Filaments in Gases

O.G. Kosareva[1], N.A. Panov[1], V.A. Andreeva[1], A.P.Shkurinov[1], V.A. Makarov[1], L.Berge[2], S.L. Chin[3]; 1 - Lomonosov Moscow State Univ., Russia; 2 - CEA, DAM, DIF, France; 3 - Univ. Laval, Canada;

We study THz emission from a single filament and the square matrix of multiple filaments. We show the possibility of the control of the THz radiation divergence by varying the number of filaments in the matrix. In addition we demonstrate the backward THz emission from the bunch of long filaments

TuSm2-24 **18:30-18:45**

THz generation from rough metall surfaces irradiated by femtosecond laser pulses

D.A. Fadeev, V.A. Mironov, I.V. Oladyshkin, E.V. Suvorov, R.A. Akmedzhanov, I.E. Ilyakov, B.V. Shishkin; Inst. of Applied Physics of RAS, Russia;

Laser driven generation of ultra-short terahertz pulses from the surface of metal is discussed. Some analytical results for plane surface are given. Numerical simulations for rough metal are compared to results concerning plane metal surface.

TuSm2-25 **18:45-19:00**

Infrared and terahertz radiation generation under filamentation of two-color femtosecond laser pulse

V.A. Andreeva, N.A. Panov, O.G. Kosareva; Lomonosov State Univ., International Laser Center, Russia;

Numerical simulation of infrared (IR) and terahertz (THz) radiation generation under filamentation of two-color femtosecond laser pulse in argon is made. Spatial and temporal properties of generated IR and THz radiation were studied.

TuSm2-26 **19:00-19:15**

Cherenkov radiation of the laser pulse envelope in the process of the semimetal reflection

V. A. Mironov, I.V. Oladyshkin; Inst. of Applied Physics of RAS, Russia;

The possibility of Cherenkov generation of the broadband terahertz radiation in the reflection of p-polarized femtosecond laser pulse from semimetal sample is considered. A model for nonlinear polarization response of electrons near the semimetal surface is proposed. The low-frequency surface current is found and its irradiated energy is calculated. It is shown that while passing from conventional metals to semimetals one should expect a noticeable increase of the THz generation efficiency via both decreasing of the charge carrier effective mass and weakening of optical and terahertz fields skinning.

TuSm2-27 **19:15-19:30**

Investigation of methods enhancing weak terahertz signals detection effectiveness

A. A. Mamrashev, N. A. Nikolaev; Inst. of Automation and Electrometry, Russia;

We study and compare the effectiveness of different methods of enhancement of weak terahertz signals detection in a conventional terahertz time-domain spectroscopy setup.

SM2: SEMINAR ON TERAHERTZ PHOTONICS POSTER SESSION

Congress Hall

WeSm2-p01 **15:00-19:30**

Simple Terahertz Continuous-wave Applications based on a Compact Dual Mode Laser

H.-Ch. Ryu[1], K.H. Park[2]; 1 - Sahmyook Univ., 2 - ETRI, Korea;

We demonstrated simple terahertz applications using a coherent homodyne continuous- wave (CW) terahertz (THz) system. The system was developed based on a compact semiconductor dual-mode laser diode (DML). The DML was used for an optical beat source to generate a THz CW. The two lasing modes from the DML are well correlated and generate a high-purity THz CW signal. The system was applied to measure the absorption spectrum of lactose and the thickness of polyethylene; it showed the possibility of a compact, simple, and cost-effective CW THz system for practical applications.

WeSm2-p02 **15:00-19:30**

The study of correlation properties of optical-terahertz biphoton pairs generated by the spontaneous parametric down-conversion

S.A. Germanskiy, G.Kh. Kitaeva, V.V. Kornienko, A.N. Penin; Lomonosov Moscow State Univ., Russia;

Basic correlation functions and noise reduction factor for optical-terahertz biphoton pairs are calculated, governing the 'degree of non-classicality'. A possibility of experimental proof of the calculated results is discussed.

WeSm2-p03 **15:00-19:30**

The study of THz wave generation dependence on mutual polarization of two-color pump fields

A. Ushakov[1], P. Chizhov[2], R. Volkov[1], V. Bukin[2], S. Garnov[2], A. Savel'ev[1]; 1 - Lomonosov Moscow State Univ., 2 - Prokhorov General Physics Inst. of RAS, Russia;

The generation of terahertz radiation by focusing two-color femtosecond laser pulses is studied. The dependence of terahertz radiation power on polarization states of fundamental and second harmonics is studied and compared with calculated transient photocurrent power. The obtained experimental results are in good agreement with the theoretical ones.

WeSm2-p04 **15:00-19:30**

Application of terahertz spectroscopy in biomedical research

O.P. Cherkasova[1], M.M. Nazarov[2], A.A. Angeluz[3], I.N. Smirnova[4], A.P. Shkurinov[3]; 1 - Inst. of Laser Physics of SB RAS, 2 - Inst. on Laser and Information Technologies of RAS, 3 - Lomonosov Moscow State Univ., Russia; 4 - Nagoya Univ., Japan;

The absorption and reflection spectra of blood plasma were studied in the frequency range 0.1-2.0 THz. To obtain frequency dependent complex dielectric function of the samples, the inverse problem for complex reflection coefficient was solved. It was found that the variations of optical constants depend on biochemical disturbances caused by diabetes having different degree of severity.

WeSm2-p05 **15:00-19:30**

Non-Faraday Rotation of the Free Induction Decay in Terahertz Region.

E.N. Chesnokov[1], V.V. Kubarev[1,2], P.V. Koshlyakov[1]; 1 - Inst. of Chemical Kinetics and Combustion, 2 - Budker Inst. of Nuclear Physics of SB RAS, 3 - Novosibirsk State Univ., Russia;

Effect of rotation of the polarization plane of Free Induction Decay in magnetic field is observed. Experiments were performed using short pulse of terahertz Free Electron Laser in the region of pure rotation transitions of NO molecule. Rotation of polarization was observed in real time using ultra-fast Schottky diode detectors. Angle of rotation depends on time after the laser pulse and exceeds 1800 in field

WeSm2-p06 **15:00-19:30**

Classic Holography in the Terahertz Range: Recording and Reconstruction Techniques

Yu. Choporova, M. Mitkov; Budker Inst. of Nuclear Physics of SB RAS, Russia;

Classical variant of in-line and reference-beam terahertz holography has been implemented using monochromatic radiation of Novosibirsk free electron laser. Three recording devices were applied: an IR thermal recorder, temperature-sensitive phosphor plates with a visible-range camera, and an uncooled microbolometer array. Feasibility of real-time imaging in the ATR spectroscopy was demonstrated.

SIDE-EVENT WORKSHOPS

A1. Advanced laser technology in industrial applications

Official Language: Russian

July 2, 2014

Stenberg Hall (3rd floor)

10:00-17:30

Registration 9:30 to 10:00

CHAIR

Sergey Gorny
Laser Center, LTD, Russia

A1. Внедрение передовых лазерных технологий и оборудования в промышленность

Рабочий язык: русский

2 июля 2014 года

зал Стенберг (3-й этаж)

Начало работы семинара: 10-30

Окончание работы семинара 17-30

Регистрация с 10-00 до 10-30

РУКОВОДИТЕЛЬ СЕМИНАРА

Сергей Горный
Лазерный центр, Россия

A2. Russian-Chinese cooperation in lasers

Official Language: Russian and Chinese
July 1, 2014
Hall Levinson
11.30-13.30

Co-Chairs

Ivan B. Kovsh
Laser Association, Moscow, Russia

Xiao Zhu
Wuhan Laser association of Optics Valley of China, P.R. China

A2. Российско-китайское сотрудничество в области лазеров

Рабочий язык: русский и китайский

1 июля 2014 года

Зал Левинсон
11.30-13.30

Руководитель семинара

Иван Б. Ковш
Лазерная Ассоциация, Москва, Россия

Чжу Сяо
Лазерная ассоциация, г. Ухань, Китай

Chinese laser technology, industry and market - today and tomorrow
Xiao Zhu[1,2]; 1 - Huazhong University of Science and Technology, P.R. China, 2 - Wuhan Laser association of Optics Valley of China, P.R. China

The typical application of laser surface hardening in auto die industry
Mo Hengyang; Wuhan Wisco-HG Laser Large Scale Equipment Co., Ltd, P.R. China

Analysis of thermal aberration in end-pumped Yb:YAG thin disk laser
Guangzhi Zhu[1], Xiao Zhu[1], Yun Zhu[2], Mu Wang[1], Yufan Feng[1], Changhong Zhu[1]; 1 - Huazhong University of Science and Technology, P.R. China, 2 - Wuhan Ji-Yuan Technical Service Co. Ltd., P.R. China

Joint Chinese-Russian projects in lasers and laser applications: how to start?
Yun Zhu; Hubei Wuhan China-Russia Cooperation Centre of S&T, P.R. China

Laser peening of metals. China-Russian mutual search.
V.A. Serebryakov; National Research University of Information Technologies, Mechanics and Optics, Russia, Vavilov State Optical Institute, Russia

Cutting application single mode fiber laser: prospective and limitation
M.V. Volkov, A.A. Kishalov; Scientific and Manufacturing Company of Fiber Optics and Laser Equipment, VOLO Ltd., Russia

A3. Innovative methods and technologies in the oil and gas industry

Round table discussion
Official Language: Russian

July 2, 2014
Levinson Hall
11:30 – 13:30
Registration 10:30 to 11:30

Chair

Alexander Il'inskiy
All Russia Petroleum Research Exploration Institute, Russia

А3. Инновационные методы и технологии в нефтегазовом комплексе

Круглый стол
Рабочий язык: русский
2 июля 2014
зал Левинсон
11:30 – 13:30
регистрация участников: с 10-30 до 11-30

Руководитель

Александр Ильинский
ФГУП Всероссийский нефтяной научно-исследовательский геологоразведочный институт, Россия

Участники:

ФГУП «Всероссийский нефтяной научно-исследовательский геологоразведочный институт», Россия
О.М. Прищепа
А.А. Ильинский

ООО «Тимано-Печорский научно-исследовательский центр», Россия
Е.Л. Теплов

ОАО «Тоталь Разведка Разработка Россия», Россия
О. Стихеева

Сибирский НИИ геологии, геофизики и минерального сырья, Россия
Г.М. Тригубович

ФГУП "Всероссийский научно-исследовательский геологический институт им. А.П. Карпинского", Россия
К.Г. Скачек
О.В. Бострикова
С.В. Видик
А.В. Брылина

Шелл Эксплорейшн энд Продакшн Сервисиз (РФ) Б.В.
П.В. Галактионов

Китайский нефтяной университет, Китай
Пан Чанвэй

Китайская Национальная нефтегазовая корпорация, Китай
Чэнь Ихуа
Го Цзюньгуан

ОАО «Лазеры и оптические системы», Россия
А.П. Жевлаков

Федеральное агентство по науке и инновациям, Россия
В.Д. Булавин

Санкт-Петербургский государственный экономический университет, Россия
И.А. Садчиков

MS. МЕМОРИАЛЬНАЯ СЕКЦИЯ

ПРОФЕССОР А.П. СУХОРУКОВ И НЕЛИНЕЙНАЯ ОПТИКА

Зал Левинсон

ThMs-01 15.00-15.25
А.П.Сухоруков – выдающийся ученый Московского государственного университета
В.А. Макаров; МГУ им. М.В. Ломоносова, Россия

ThMs-02 15.25-15.50
Нелинейная оптика и А.П.Сухоруков
А.С. Чиркин; МГУ им. М.В. Ломоносова, Россия

ThMs-03 15.50-16.05
А.П.Сухоруков и конференция «Оптика лазеров»
Н.Н. Розанов; ОАО «ГОИ им. С.И. Вавилова», Россия

ThMs-04 16:05-16:20
Оптические солитоны и самофокусировка света
Ю.С. Кившарь; НИУ ИТМО, Россия

ThMs-05 16:20-16:35
Параметрические процессы и солитоны: как предсказания Анатолия Петровича Сухорукова стали сбываться
М.В. Комиссарова; МГУ им. М.В. Ломоносова, Россия

ThMs-06 16:35-16:50
Нелинейно-индуцированные структуры в оптике: от полного внутреннего отражения к оптическому бильярду
Д.О. Игнатьева; МГУ им. М.В. Ломоносова, Россия

MS. MEMORIAL SESSION

PROFESSOR A.P. SUKHORUKOV AND NONLINEAR OPTICS

Levinson Hall

ThMs-01 15:00-15:25
A.P. Sukhorukov as distinguished scientist of M.V. Lomonosov Moscow State University
V. Makarov; Lomonosov Moscow State University, Russia

ThMs-02 15:25-15:50
Nonlinear optics and A.P. Sukhorukov
A. Chirkin; Lomonosov Moscow State University, Russia

ThMs-03 15:50-16:05
A.P. Sukhorukov and conference "Laser Optics"
N. Rosanov; Vavilov State Optical Institute, Russia

ThMs-04 16:05-16:20
Optical solitons and light self-focusing
Yu. Kivshar; Nonlinear Physics Center, Australian National Univ., Australia; National Research University ITMO, Russia

ThMs-05 16:20-16:35
Parametric processes and solitones. As predictions of Anatoly Petrovich Sukhorukov are coming true
M. Komissarova; Lomonosov Moscow State University, Russia

ThMs-06 16:35-16:50
Nonlinear-induced structures in optics: from total internal reflection to the optical billiards
D. Ignatyeva; Lomonosov Moscow State University, Russia

OptiGrate Corp, USA

562 S Econ Cir
Oviedo, Florida 32765-4311, USA
Phone: +1 407 542-77-04; Fax: +1 407 542-78-04
E-mail: Info@OptiGrate.com; Web: www.OptiGrate.com

OptiGrate Corp is a pioneer and world leader in commercial and scientific volume Bragg gratings (VBGs). For 15 years, OptiGrate has designed and manufactured a wide range of VBG-based products from inorganic photosensitive silicate glass. OptiGrate supplies holographic optical elements to more than 400 customers on 5 continents in optoelectronic, analytical, medical, security, and other industries. Our gratings are used in laser systems for eye surgery, car manufacturing, explosive detection, nano-materials studies, and many others. OptiGrate is located in Orlando, Florida, and is the only vertically integrated VBG production plant in the World. Our state of the art technology enables production of diffractive components with unmatched performance. OptiGrate has received William Schwartz Industry Innovation Award; was honored as Small Manufacturer of the Year by the Manufacturing Association of Central Florida; and was elected one of the 50 Florida Companies to Watch.

EKSPLA, LITHUANIA

Savanoriu Av. 231 LT-02300 Vilnius, Lithuania
Phone: +370 5 264-96-29; Fax: +370 5 264-18-09
E-mail: sales@ekspla.com; Web: http://www.ekspla.com

EKSPLA is manufacturer of lasers and systems for basic research and industrial applications. Employing 30 years experience and close partnership with scientific comunity, EKSPLA is focused on high performance advanced solutions.

Strong R&D team enables to customize and supply products from single unit to OEM series. In house design and manufacturing ensures operative development and manufacturing of the new products. Products are available from several standard units to series customized solutions for OEM (Original Equipment Manufacturers).

Company's products gained trust among famous universities and research centers. CERN (Switzerland), NASA, National Institute of Standards and Technology (NIST), Lawrence Livermore National Laboratory (USA), Cambridge University (UK) are just a few of them.

Main products include: Solid-state lasers, systems and accessories for scientific applications; Ultrafast fiber lasers; Industrial DPSS lasers; High energy laser systems; Laser optoelectronics

Optogear Oy, FINLAND

Kuormatie 14, FI-03100 Nummela, Finland
Phone: +358 9 222-77-99; Fax: +358 9 222-77-89
E-mail: optogear@optogear.fi Web: http://www.optogear.fi

Optogear is a global supplier of innovative solutions for Photonics industry. Optogear provides equipment for optical waveguide research, specialty optical fiber manufacturing, telecom fiber manufacturing and optical component manufacturing. Offers high-temperature related products for the semiconductor industry.

Optogear people have decades of experience of optical equipment building. Strong machine building tradition together with solid scientific back-up result new high performance equipment and new processes. Tailoring of equipment and finding solutions to our customer's problems are standard procedures at Optogear.

OPTICAL MATERIALS RI, RUSSIA

Street Babushkina 36, building 1, 192171, St.-Petersburg, Russia
Phone/Fax: +7 812 560-10-22
E-mail: info@goi.ru

Starting from 1915, the institute developed and introduced to model shop and then to large-scale production manufacturing technologies of practically all the inorganic materials used in the domestic industry. The scientific school of optical materials' science and unique research and manufacturing capabilities of the institute allows the institute even now to develop and produce in a small scale any state of the art modern optical material.

Laser Components Ltd., RUSSIA

2/2 Balaklavsky Prospect, 117639, Moscow, Russia
Phone: +7 495 258-10-58; Fax: +7 495 258-10-58,
E-mail: olga@lasercomponents.ru Web: http://www.lasercomponents.ru

Our company offers different optoelectronic and laser equipment from Chinese manufacturers. We offer highest quality products at reasonable price. With our wide range of laser diodes, laser modules, active elements, exiting lamps, DPSS lasers from the best Chinese manufacturers you can find an element basis practically for any field of application (industrial lasers, information systems, medicine etc.).

We have many years of experience in supplying active elements based of yttrium aluminum garnets or YAGs (Nd:YAG, Er:YAG). The supplied elements have proved to be a perfect basis for any solid-state laser.

The exiting lamps that we supply have convenient design and sizes corresponding to the domestic analogues. These high quality lamps also have a long service life period.

Besides the above products we also offer any component manufactured by the Chinese industry: DPSS lasers, monomode lasers with the a slot for optical fiber, nonlinear crystals, optic elements, laser glass piping for CO2 lasers, holders, adjusting benches, laser power units, cooling systems – chillers, laser machines and many others. We are looking forward to be your partners!

Avesta Project, RUSSIA

11 Fizicheskaya Street, 142190, Troitsk, Moscow, Russia
Phone: +7 495 967-94-73; Fax: +7 495 646-04-95
E-mail: fs@avesta.ru Web: www.avesta.ru

Avesta Project Ltd. produces femtosecond lasers and relevant measurement equipment. We offer Ti:S and Yb solid-state fs and CW lasers, Ti:S and Cr:F fs mJ-level amplifiers up to multi-TW level, fiber lasers (Er, Yb and frequency-doubled). The diagnostics include autocorrelators, VIS and IR spectrometers, cross-correlators, SPIDER. Additional components like pulse pickers, pulse compressors, THz generators, attenuators and harmonic generators are also available. We also develop customized systems based on customer requirements.

Our optomechanics division produces a broad range of optomechanical products like adjustable mirror mounts, translation stages, rotation stages, motorized components.

Open Joint Stock Company "S.I. Vavilov State Optical Institute", RUSSIA

Bldg.2/5, Kadetskaya Line, V.O., 199053, Saint Petersburg, Russia
Phone: +7 812 331-75-50; Fax: +7 812 331-75-58
E-mail: leader@soi.spb.ru Web: http://npkgoi.ru

Open Joint Stock Company "S.I. Vavilov State Optical Institute"was organized on the base of the State Optical Institute founded in 1918 on initiative of Dmitry S. Rozhdestvensky.

- carries out the fundamental and exploring research in prospective directions of development of optics and photonics within the frameworks of federal goal-oriented programs, grants of Russian Foundation for Basic Research, international scientific and technical programs, and based on initiative activities;
- develops and manufactures the samples of new optical, electro-optical, and laser equipment by request of the state, by request of Russian enterprises, and within the frameworks of export contracts;

Laser-Compact Laser-Export, RUSSIA

Vvedensky Street, 3 117342, Moscow, Russia
Phone.: +7 499 578 05 48; Fax: +7 499 578 05 49,
E-mail: sales@laser-export.com Web: www.laser-export.com

Laser-compact group specializes in research, development and manufacturing of diode-pumped solid-state (DPSS) lasers.

Founded in 1992 Laser-compact has 22-year experience of custom-design projects in the field of DPSS lasers. Over 45,000 of DPSS lasers have been produced for world-leading industrial companies.

Laser-compact group is the exporter of DPSS lasers to 40 countries worldwide. The main part of the production volume is distributed in Germany, USA and France.

At present time Laser-export Co. (manufacturing company of Laser-compact group) offers Q-switched and CW infrared, green and ultraviolet lasers for use in mass spectrometry (MALDI TOF), laser microdissection, laser microscopy, Raman spectroscopy, interferometry, holography, micro materials processing, LIDAR, industrial & medical alignment/positioning, quality control of crystals etc.

In November 2009 the Quality Management System of Laser-export Co. was certified as compliant with the requirements of ISO 9001:2008.

www.photonics.su hν научно-технический журнал
ФОТОНИКА

Magazine «Photonics», RUSSIA

Krasnoproletarskaya st., 16, entrance 5 125319, Moscow, Russia
Phone: +7 495 234-01-10; Fax: +7 495 956-33-46
E-mail: rec-knigi@electronics.ru Web: www.photonics.su

"Photonics", magazine is dedicated to all types of optical systems (electro-optical, fiber-optical, laser, fully optical), to their components and technologies. The goal of the magazine is a deep and detailed presentation of items concerned with optical communication systems, optical technologies, optical materials and components, equipment and machines used in optical systems.

Periodicity: 6 issues a year. Size- 104 bands. Circulation: 4000 copies. Distribution: a subscription, mailing, exhibitions in Russia and abroad.

IPG IRE-POLUS

IPG IRE-Polus, RUSSIA

The square of. Academician B.A.Vvedensky 1, bld. 3
141190, Fryazino, Moscow Region, Russia
Phone: +7 496 255-74-46, +7 496 255-74-48
Fax: +7 495 702-95-73, +7 496 255-74-59
E-mail: mail@ntoire-polus.ru Web: www.ntoire-polus.ru

TA "IRE-Polus" is the founder and one of the basic companies of the transnational scientific technical group "IPG Photonics Corporation"

STA "Ire-Polus", together with other companies of the Group, is developing and mass-producing fiber and laser optical components, units , modules, devices, subsystems and systems for fiber, atmospheric and satellite communication, cable TV, laser material processing, optical detection, industrial facilities and atmosphere remote monitoring , for monitoring and metering, sensoring, scientific research and biomedicine. STA "Ire-Polus" is also producing specialized equipment for testing and endurance testing of fiber-optical and laser components and modules.

STA "Ire-Polus" Ltd is the biggest laser equipment producer in Russia; the company develops and produces complex specialized laser equipment for welding, cladding, metal processing, plane and 3D cutting, classic laser and hybrid welding, spot welding, marking, engraving, thermo hardening, drilling and 3D prototyping.

STA "Ire-Polus" offers more than 600 advanced products on the Russian market. Many of which do not have their analogues on the international high-tech market. All end products for the Russian Market are manufactured in Russia.

Currently STA "Ire-Polus" Ltd. is actively expanding production industrial capacities; its goal is to increase overall turnout. New working places are being created, which lately has reached the mark of 800 employees.

Ocean Optics

Ocean Optics, The Netherlands

6921 EW Duiven, Geograaf 24, The Netherlands
Phone: +31 26 319-05-00; Fax: +31 26 319-05-05
E-mail: Info@OceanOptics.com Web: www.oceanoptics.com

Ocean Optics is the inventor of the world's first miniature spectrometer and a global leader in photonics for research, life sciences, quality assurance, education and OEM applications. Ocean Optics' extensive line of complementary technologies includes spectrometers, chemical sensors, metrology instrumentation, optical fibers and thin films and optics. Recognized as an industry innovator, Ocean Optics has specified and delivered more than 200,000 modular miniature spectrometers and systems throughout the world and has enabled thousands of different applications – from cancer detection and color matching to plasma monitoring and particle size analysis. Our spectrometers have been to the Moon and inside active volcanos and follow our mission to help our customers change the world through optical sensing.

B.I. Stepanov Institute of Physics National academy of sciences of Belarus

Nezavisimosti Ave., 68 220072 Minsk, Belarus
Phone: +375 17 284-03-98; Fax: +375 17 284-08-79
E-mail: ryabtsev@ifanbel.bas-net.by Web: http://ifanbel.bas-net.by www.dple.by

Institute of Physics is well-known leader in the field of laser physics and techniques in Belarus with over 50-year history. Since 1997 much attention is devoted to development, manufacturing and investigations of diode-pumped solid state lasers. As a result a group of highly qualified scientists, designers and engineers ready for practical realization of different customized diode pumped solid state laser systems was formed. Own mechanical and optical departments enable manufacturing of lasers with required characteristics in the shortest time periods.

Diode-Pumped Laser Engineering group deals with pulsed eye-safe erbium lasers for wide-temperature range, pulsed eye-safe optical parametrical oscillators, pulsed high-energy Nd:YAG lasers with harmonics for LIDAR systems, LIBS and other applications and Ti:sapphire lasers. Optical components such as lenses, prisms, dielectric mirrors and beamsplitters, interferometers, interference filters and polarization optics are available.

Vicon Standa

Leninskiy pr. B. 81 198332, Saint-Petersburg, Russia
Phone/Fax: +7 812 408-81-75
E-mail: sales@vicon-se.ru Web: www.vicon-se.ru

For more than 10 years we have successfully presented opto-mechanical equipment of company Standa to research laboratories and industry in Russia.

You can find more than 3000 items in our catalogue, including optical tables, opto-mechanics, motorized positioners, lasers and other optical laboratory equipment.

We have successfully implemented over 600 projects since we started representing Standa. We are currently in relationship with leading Russian universities and companies: Lomonosov Moscow State University, Moscow State Technical University n.a. N.E. Bauman, Ioffe Physical Technical Institute and many others.

OEM Tech, BELARUS

Rm #209, Tchkalova 14, 220039, Minsk, Belarus
Phones: +375 17 213-40-51, +375 29 752-80-64
Fax: +375 17 213-40-32
E-mail: info@oem-tech.by Web: www.oem-tech.by

OEM Tech's main field is the development and manufacturing of embedded components for different kinds laser systems. Our experience covers both laser electronics and laser optics. Our customer spectra spreads from industrial customers like Thales Optronique [France] or Coherent [USA] to scientific ones like CalTech [USA] or Imperial College London [UK]. We produce laser electronics of different kinds (for flash lamps, for laser diodes, for electro-optical crystals).

Lasertrack, RUSSIA

Busines-park «Rumjantsevo», office #719»B»,
Kievskaya highway, 142784, Moscow, Russia
Phone/Fax: +7 495 775-38-63
E-mail: lasertrack@lasertrack.ru Web: www.lasertrack.ru

Lasertrack represents COHERENT, INNOLAS, OWIS, HAMAMATSU, THORLABS and some other companies who deal with lasers and laboratory equipment in Russia and SIS. Our business is lasers and equipment for scientific researches and lasers for Industry. Our specialists can provide you an 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.

ООО "ОЭС Спецпоставка"

52D, Fontanka river emb., 191002, St-Petersburg, Russia
Phone/Fax: +7 812 777-70-80
E-mail: sales@icspecpostavka.ru Web: www.icspecpostavka.ru

IC Specpostavka is one of the leader in distribution of measuring equipment, electronic, microwave, optoelectronic, laser and optic components for high-reliable applications (aerospace, industrial, scientific, etc.) The company was founded in 2009 with headquarter in St.-Petersburg and sales office in Moscow.

IC Specpostavka is more than just another electronic components distributor: we guaranty reliability, competence and reasonable price policy for our customers.

The company line-card includes the main following manufactures:

- Active components: Xilinx, Texas Instruments, Maxim, Micron, D3Ci
- Microwave: Transcom, Diconex, Mini-Circuits
- Electromechanics: HLT, Axon, Comtronic, FCT
- Power supplies: Vitec Power, Power System Technology, Excelsys
- Display systems: Multi-Inno, etc.

In laser optics and optoelectronic industry we cooperate with the following companies: Altechna, Oxxius, Phoenix Photonics, AC Photonics, OSI LaserDiode, Finisar, Teraxion, Microwave photonic systems, Thorlabs and many others.

SOL Instruments, BELARUS

58-10, Nezavisimosti ave. 220005, Minsk, Belarus
Mailing address: 220005, Minsk, BY P.O. Box 235
Phone: +375 17 290-07-17; Fax: +375 17 290-07-16
E-mail: sales@solinstruments.com Web: www.solinstruments.com

SOL instruments Ltd. is an 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.

SOL instruments Ltd. is an authoritative manufacturer of Raman confocal systems, CARS systems, optical emission elemental analyzers, broad-band optical monitors, LPSS and DPSS solid-state lasers, tunable lasers and laser systems, monochromators, spectrographs and applied spectroscopy solutions.

The trained service engineers are available for your support and service all over the world.

ELEKTROSTEKLO, RUSSIA

113-106, Vernadskogo Prospect, 119571, Moscow, Russia
Phone: +7 495 234-59-51/52; Fax: +7 495 433-51-15
E-mail: sales@elektrosteklo.ru Web: http://www.elektrosteklo.ru

Optics manufacturing from CaF2, BaF2, MgF2, LiF, KRS-5, Sapphire, Fused Silica, NaCl, KCl, KBr, Si, Ge, ZnSe, ZnS, Cu, Mo, Al and different types of glass. Solid state active elements.

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.

Lasers and Optical Systems, Russia

2nd line of Vasilievsky Island., 5 B 199034, Saint-Petersburg, Russia
Postal address: 199053, post office box 606, Saint-Petersburg, Russia
Phones: +7 812 323-04-51, +7 812 323-15-20; Fax: +7 (812) 3231783
E-mail: info@los.su Web: www.los.su

Main directions of Company activities are the diode pumped solid state lasers (lasers, emitting in the eyesafe spectral range; high stability lasers; short-pulse lasers).

Laser sources on the base of erbium glass and neodymium ions' doped crystals are developed for the use in advanced range-finding, lidar and radar systems.

The design concept provides high accuracy measurements at large ranges as well as eye safety. The Company is well known both in Russia and abroad due to the high level of its developments. The Company actively participates in Russian and international exhibitions.

Fedal, RUSSIA

Serdobol'skaya, 65 A 197342, St. Petersburg, Russia
Phone: +7 812 326-07-48; Fax: +7 812 326-07-48
E-mail: office@fedalel.com Web: www.fedalel.com

Development and production of laser electronics and electronics for optical devices. Our products are: laser power supply equipment for lamp-pumped lasers and diode-pumped lasers; high voltage charging modules; diode-drivers; multichannel electric power supplied system for diode-pumped lasers; motion control system; CNC system, temperature controllers for Peltier (TEC controllers).

We are ready to produce laser supply units and related devices according to individual customer's requests by modification of our standard products or even by designing absolutely new one.

Time-Bandwidth Products AG, Switzerland

Ruetistrasse 12, 8952 Schlieren, Switzerland
Phone: 0041 44 501-10-00; Fax: 0041 44 501-10-01
E-mail: info@tbwp.com Web: www.time-bandwidth.com

Time-Bandwidth Products produces high-quality industrial and scientific ultrafast lasers for applications in manufacturing, diagnostics, and communication. Based on an approach providing reliable, precise, and high-performance ultrafast lasers since the mid-1990s, the company continues to provide innovative solutions using diode-pumped solid-state lasers, passively mode-locked with SESAM® technology. Applications include precision micromachining, diagnostics, measurements, and sensing, optoelectronic testing, optical communication, clocking and switching, medical and life science imaging and diagnostics. The company was acquired by JDSU in January 2014 and is located near Zurich, Switzerland.

QGLex Inc., Canada

105 Schneider Rd., Suite 111, Ottawa, ON, Canada K2K 1Y3
Phone: 613 800-50-67; Fax: 613 800-50-67
E-mail: info@qglexinc.com Web: www.QGLexInc.com

QGLex Inc. is an innovative company dedicated to the design and manufacture of new generation of Optical Amplifiers, ASE sources, CW and Pulse Fiber Lasers. QGLex's fiber amplifiers and lasers deliver high output power – up to 50W CW or 20kW peak power in 1 micron and 1.5 micron bands. QGLex is a leading developer of cost efficient integrated fiberoptic products and services, which find their applications in Industrial, Material Processing, LIDAR, CATV, Telecom, Medical, and Military environments.

ATC-Semiconductors Devices , RUSSIA

Av. Engelsa, 27 194156, Saint-Petersburg, Russia
Phone: +7 812 294-25-32; Fax: +7 812 703-15-26
E-mail: sales@atcsd.ru Web: http://www.atcsd.ru/

Manufacturer of high power laser diodes (up to 15 W in CW mode and 250 W in QCW mode), laser diode drivers, additional optics for laser diodes and laser medical devices on their base.

HORIBA Jobin Yvon S.A.S., FRANCE

Avenue de la Vauve - Passage Jobin Yvon CS 45002 - 91120 Palaiseau, France
Phone: +33 0 1 69 74-72-00; Fax: +33 0 1 69 31-32-20
E-mail: info-sci.fr@horiba.com Web: www.horiba.com/scientific

HORIBA Scientific is the new global team created to better meet customers' present and future needs by integrating the scientific market expertise and resources of HORIBA.

HORIBA Scientific offerings encompass elemental analysis, fluorescence, forensics, GDS, gratings for Lasers and Space/Synchrotron or scientific applications, ICP, particle characterization, Raman, spec tral ellipsometry, sulfur-in-oil, water quality, and XRF. Prominent absorbed brands include Jobin Yvon, Glen Spectra, IBH, SPEX, Instruments S.A, ISA, Dilor, Sofie, SLM, and Beta Scientific. By combining the strengths of the research, development, applications, sales, service and support organizations of all, HORIBA Scientific offers researchers the best products and solutions while expanding our superior service and support with a truly global network.

Смарт Системс
Smart Systems, RUSSIA

22 line VO, 3 199106, Saint-Petersburg, Russia
Phone: +7 812 320-25-88; Fax: +7 812 320-75-10
E-mail: info@smart-systems.su Web: www.smart-systems.su;
www.gigahertz-optik.su; www.technoteam.su

LLC «Smart Systems» is the official representative in Russia and CIS of companies Gigahertz-Optik GmbH (Germany) and TechnoTeam Bildverarbeitung GmbH (Germany). Our aim is to offer our customers latest and future-oriented measurement technology now and in the future.

Gigahertz-Optik GmbH (Germany) develops and produces measurement devices, traceable to international standards, for measuring optical radiation which is one of the most important elements in nature and technology. Gigahertz-Optik carries a complete line of light meters, radiometers, photometers, detectors, filters, input devices, integrating spheres and associated accessories.

TechnoTeam Bildverarbeitung GmbH (Germany). The exciting LMK series of static and dynamic imaging photometers and its innovative user-driven application software excels at a wide variety of challenging light measurement applications. Coupled with TechnoTeam's integrated automated Rigo 801 Goniophotometer, it can be used for near field measurements of angular and spatial distribution of extended sources in high growth applications, such as LED luminaires and automotive lighting, which would be otherwise impossible in test facilities where space is at a premium.

NRU ITMO, RUSSIA

Kronverkskiy pr.49 197101, Saint Petersburg, Russia
Phone: +7 812 232-97-04
E-mail: international@mail.ifmo.ru Web: http://en.ifmo.ru/

ITMO University is one of the leading higher education institutions in Russia, providing training and research in advanced science, humanities, engineering and technology. Founded in 1899, it has earned its name "National Research University," blending the culture of innovation and discovery with world-class education. Our 14 departments offer undergraduate, graduate, doctoral and-doctorate research programs in fundamental and applied disciplines. Some of our best-known work is in Photonics, Precision Mechanics, Computer Science and Information Technology. Our International Doctorate program allows students to obtain dual PhD degrees with partner institutions.

ЛАЗЕРНЫЙ ЦЕНТР LASER CENTER
Laser Center Ltd., RUSSIA

Office 316, 25, Piskarevskiy prospect 195176, Saint-Petersburg, Russia
Phones: + 7 812 332-06-59, +7 812 326-78-92; Fax: +7 812 380-4361
E-mail: Info@newlaser.ru Web: www.newlaser.ru

Design and manufacture of laser marking, engraving, cutting, wielding systems for industrial enterprises. Laser systems include laser engravers and modern high capacity marking systems, laser units for cutting and microlevel wielding, fiber-based units, as well as mechanical and electrochemical marking systems. Laser treatment services of materials and complete products.

GPI
Prokhorov General Physics Institute, Russian Academy of Sciences (GPI RAS), RUSSIA

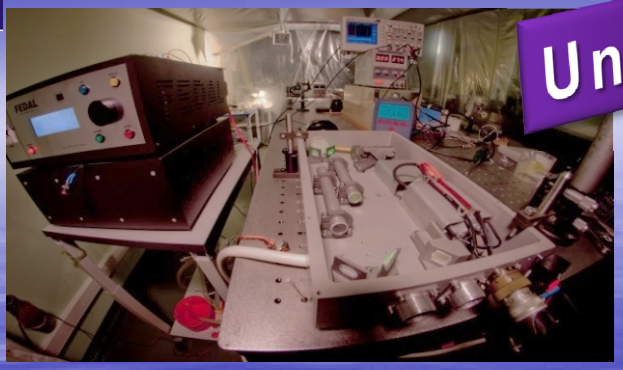
Vavilov Str., 38 119991, Moscow, Russia
Phone: +7 499 132-60-56; Fax: +7 499 503-87-74
E-mail: bzubov@nsc.gpi.ru, gldan@yandex.ru Web: http://www.gpi.ru

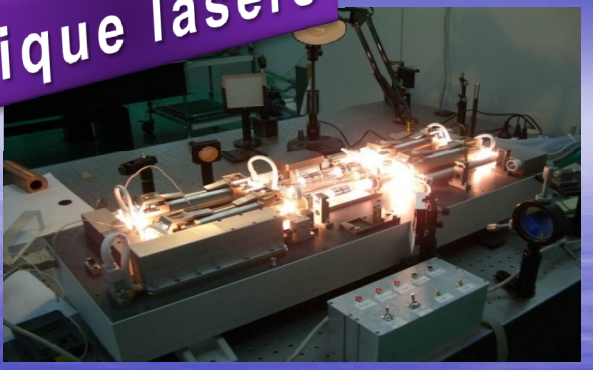
Research and development: Fiber Optic Systems, Fiber Optic Cables, Optical Fibers, Spectral Probes, Fiber Bundles. Devices and Instruments, based on high power LEDs for Biomedical research and applications.

LOS

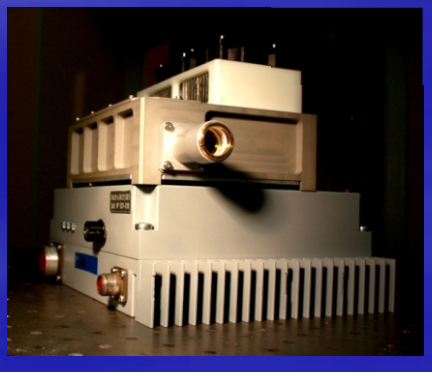
Lasers and Optical Systems

Unique lasers





- **diode-pumped solid-state lasers for range finding**
  (eye-safe range, high-stable, short-pulse, high brightness, compact, efficient, Q-switched, Yb-Er:Glass)
- **airborne lidars for ecological and radionuclides monitoring, oil exploration, pipeline leakage detection**
  (DPSSL Nd:YLF laser 262 nm, 250 Hz, 20 mJ)
- **lasers for remote sensing, chemical pollution detection, spectroscopy, directive countermeasure systems**
  (MID-IR (2 μm (Ho:YLF, 50mJ/1000Hz, 80 mJ/100 Hz, 18 ns, M^2~1.5), 3-5 μm (100 mJ, 100Hz, 10 ns, M^2~5-8) SSL OPO-OPA)
- **lasers for material treatment & plasma diagnostics**
  (Nd:YAG laser 6 J, 200 Hz, 10 ns, 10^{-4} rad)



St.Petersburg, Russia
www.los.su
e-mail: info@los.su