OSA Laser Congress

Advanced Solid State Lasers (ASSL)

Laser Applications Conference (LAC)

4 November - 8 November 2018

The Westin Boston Waterfront

Boston, Massachusetts, USA

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Advanced Solid State Lasers Conference (ASSL)

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Thank you to all the Committee Members for contributing many hours to maintain the high technical quality standards of OSA meetings.

General Information

Registration
Harbor Wing Lobby

Please note: registration desk will be closed during lunch breaks.

Sunday, 4 November	08:00–18:00
Monday, 5 November	07:00–18:00
Tuesday, 6 November	07:00–18:00
Wednesday, 7 November	07:00–18:00
Thursday, 8 November	07:30–14:00

Access to the Wireless Internet
Activate your computer's wifi by selecting the available network and enter password listed below. Click connect.

Network: OSA Laser Congress
Password: Laser2018

OSA Laser Congress Press Room
Lewis Room

Monday, 5 November	07:30–18:00
Tuesday, 6 November	07:30–18:00
Wednesday, 7 November	07:30–18:00
Thursday, 8 November	07:30–12:00

About OSA Publishing's Digital Library
Registrants and current subscribers can access all of the meeting papers, posters and Postdeadline Papers on OSA Publishing's Digital Library. The OSA Publishing's Digital Library is a cutting-edge repository that contains OSA Publishing's content, including 16 flagship, partnered and co-published peer reviewed journals and one magazine. With more than 304,000 articles including papers from over 640 conferences, OSA Publishing's Digital Library is the largest peer-reviewed collection of optics and photonics.

Online Access to Technical Digest
Full Technical Attendees have both EARLY and FREE continuous online access to the Congress Technical Digest and Postdeadline Papers through OSA Publishing's Digital Library. The presented papers can be downloaded individually or by downloading .zip files (.zip files are available for 60 days).

1. Visit the conference website at osa.org/LasersOPC.
2. Select the "Access digest papers" link on the right hand navigation.
3. Log in using your email address and password used for registration. You will be directed to the conference page where you will see the .zip file link at the top of this page. [**Note**: if you are logged in successfully, you will see your name in the upper right-hand corner.]

Access is limited to Full Technical Attendees only. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

Poster Presentation PDFs
Authors presenting posters have the option to submit the PDF of their poster, which will be attached to their papers in OSA Publishing's Digital Library. Submit your poster PDF no later than 27 November 2018 to myishak@osa.org. Your PDF should be named using your presentation number with "-1" added at the end (##final_id## -1.pdf.). If submitted, poster PDFs will be available about three weeks after the meeting. While accessing the papers in OSA Publishing's Digital Library look for the multimedia symbol shown above.

Update Sheet
All technical program changes will be communicated in the on-site Congress Program Update Sheet. All attendees receive this information with registration materials and we encourage you to review it carefully to stay informed of changes in the program.

Special Events and Sessions

Events

Congress Networking Reception
Sunday, 4 November, 17:30-18:30
Harbor Ballroom Foyer, Harbor Wing

The event is open to all OSA Laser Congress registered participants.

Complimentary Lunch
Monday-Wednesday, 5-7 November
12:30-14:00 (Mon-Tues); 12:00-13:30 (Wed)
Galleria Hall

Complimentary lunch will be served in the Galleria Hall from Monday - Wednesday. The event is open to all OSA Laser Congress registered participants.

Tuesday’s lunch is sponsored by:

Congress Banquet
Wednesday, 7 November, 18:00-21:00
Spirit Cruise

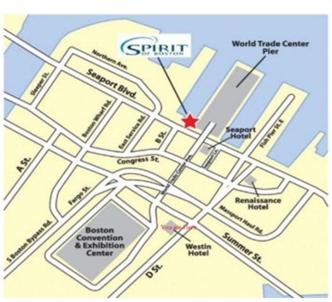
Boarding: 18:00-18:50
Departure: 19:00

One (1) banquet ticket is included in the Full Technical Congress Registration. There is a mandatory RSVP fee of $10.00 to attend.

Guest Tickets: $95 (onsite purchase only)

Spirit Cruises are fun and engaging. Designed for comfort and incredible harbor views, the Spirit of Boston is ready to show you the city of Boston. There’ll be great food, drinks, DJ entertainment and casino games to choose from onboard.

You'll love Spirit's panoramic skyline views, climate-controlled interior decks, delicious buffet-style meals, dance floor, DJ, and bar games.



Walking Directions:

From the Westin Boston Waterfront Hotel follow World Trade Center Avenue 2 blocks to the World Trade Center Pier. Go down one level to Seaport Boulevard. The Spirit of Boston is anchored on the north side of the pier. Entry clearly marked. Shuttles will be available; check Program Update Sheet for more information.

Sponsored By:

Sessions

Student & Early Career Professional Development & Networking Lunch and Learn
Monday, 5 November, 12:00-13:00
Marina I

Join us for an interactive lunch and learn program focused on professional development within the field. This program will engage students and early career professionals with the key leaders in the field who will share their professional development journey and provide useful tips to those who attend. Lunch will be provided.

Programs are open to OSA Members. There is limited space and we ask that you RSVP to attend. Please email Curtis Burrill at cburrill@osa.org to RSVP.

Sponsored by:

Student Poster Session
Monday, 5 November, 18:30-20:00
Galleria Hall, Harbor Wing

Selected student presenters will be presenting their research during this poster session. All attendees are welcome to network with students and learn about their work. Beverages and snacks served.

Sponsored by:

Poster Sessions
Tuesday, 6 November, 10:00-11:30
Thursday, 8 November, 10:00-11:30
Galleria Hall, Harbor Wing, Concourse Level

Poster presentations offer an effective way to communicate new research findings and provide a venue for lively and detailed discussion between presenters and interested viewers. Don’t miss this opportunity to discuss current research one-on-one with the presenters. Each author is provided with a board to display the summary and results of his or her paper.

Poster Set Up and Removal

All posters must be set by the start of the poster session, and placed in their assigned spots. Posters set in the incorrect spots may be marked as “No Shows” and will not be indexed. The presenter must remain in the vicinity of their poster for the duration of the session. All presenters must remove their posters at the conclusion of the session. Management will remove and discard any remaining posters after the time listed below.

Sessions (continued)

ASSL Postdeadline Papers Session

Tuesday, 6 November, 19:00-20:00
Harbor Ballroom I & II

The ASSL Technical Program Committee has accepted a limited number of Postdeadline Papers for oral presentations. The purpose of Postdeadline Papers is to give participants the opportunity to hear new and significant material in rapidly advancing areas. See the Update Sheet for the list of Postdeadline Papers. The Postdeadline Papers can be found in OSA Publishing's Digital Library by visiting www.osa.org/LaserOPC and selecting "Access Digest Papers" link on the right hand navigation.

Directed Energy Defense Special Session (Restricted Access)

Tuesday, 6 November, 08:00-10:00
Harbor Ballroom III

OSA, in conjunction with the Directed Energy Professional Society, will host a panel session that will explore the U.S. Dept. of Defense programs using High Energy Laser solutions to counter emerging threats to U.S. military operations, both domestically and abroad. The panel will discuss individual Service programs that address their respective mission sets, as well as the state-of-the-science that underlies High Energy Laser applications, from the Directed Energy Joint Transition Office.

Session is open to Laser Congress attendees from USA, NATO allies, EOP partners, Japan, South Korea, and Switzerland.

Speakers:

- Adam Aberle, *US Army Space & Missile Defense Command, USA*
- Larry Grimes, *DE Joint Transition Office, USA*
- David Kiel, *US Navy Directed Energy Weapons Office, USA*
- Nic Morley, *US Air Force Research Lab, USA*

Reaching for the Brightest Light: High-Intensity Ultrafast Lasers

Tuesday, 6 November, 20:15-21:15
Harbor Ballroom I & II

Momentum is building behind U.S. efforts to advance petawatt laser science and technology following the 2018 National Academy of Sciences report, "Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light." This session will describe existing U.S. and international capabilities and facilities and explore the scientific motivations and challenges for developing petawatt laser science and technology in the U.S. We will also discuss community efforts to organize and set out a strategic path for this field, emphasizing particular technical areas that need organizational attention. The session, held under the auspices of the National Photonics Initiative, will be conducted by Peter Moulton, MIT Lincoln Laboratory, and will feature short, invited presentations and time for audience participation.

OIDA Executive Forum

Thursday, 8 November, 08:00-13:30
Harbor Ballroom III

OIDA Executive Forum is a half-day program that focuses on the business aspects of the laser market, spanning finance to new product development, and complements the more technical nature of the collocated conferences on advanced solid-state lasers and laser applications. This executive-level event is a highly-interactive and intensive program focused on peer learning and information exchange that will help leaders in the industry plan for disruptors, capitalize on opportunities, and remain relevant to their audiences. A networking lunch will be provided at the conclusion of the program.

Short Courses

Short Courses cover a broad range of topic areas at a variety of educational levels. They are an excellent opportunity to learn about new products, cutting-edge technology and vital information at the forefront of your field. They are designed to increase your knowledge of a specific subject while offering you the experience of knowledgeable teachers.

Short Courses are complimentary for technical congress attendees, but a separate registration is required to attend, and space is limited.

SC467: Quadratic Nonlinear Optics

Sunday, 4 November
09:00-12:00

Instructor: Ady Arie; *Tel Aviv Univ., Israel*
Short Course Level: Advanced Beginner

Course Description

The course will focus on three wave mixing processes, which represent the strongest and most pronounced manifestation of nonlinearity in optics. It starts with the description of the material properties that govern nonlinear optical processes, followed by the analysis of the interaction of light waves in these materials, that enables to generate light at new frequencies through different up-conversion and down-conversion processes. The crucial role of phase matching and the two main methods to satisfy it are then discussed in detail. Finally, two advanced topics-nonlinear optical holography and adiabatic frequency conversion-are reviewed.

- Electrical susceptibility and induced polarization, Centro-symmetric and non-centro-symmetric materials, symmetry properties of the second order nonlinear susceptibility tensor.
- Coupled-wave equations in quadratic nonlinear media. The cases of sum frequency generation, difference frequency generation and second harmonic generation. Optical parametric amplification and oscillation.
- Phase matching: problem and solutions: Birefringent phase matching, quasi phase matching. Spatial modulation of the nonlinear coefficient in ferroelectrics and semiconductors.
- Nonlinear diffraction and nonlinear optical holography: Cerenkov and Raman-Nath nonlinear diffraction, Spatial and spectral shaping of light waves in nonlinear processes.
- Adiabatic frequency conversion-analogy with two-level systems, Bloch sphere representation, broadband frequency conversion.

Benefits and Learning Objectives
Participants of this course will learn:

- Understand the underlying concepts of nonlinear optical interactions.
- Evaluate the advantages and limitations of different nonlinear devices, crystals and phase matching options for nonlinear generation at a chosen wavelength
- Calculate propagation angles, polarizations and/or quasi-phase matched periods for satisfying phase matching conditions.
- Learn about the recent developments in the field.

SC471: Physics of Guided-Wave Light Propagation: Applications to Fiber Lasers and Nonlinear Optics

Sunday, 4 November
14:00-16:45

Instructor: Siddharth Ramachandran; *Boston Univ., USA*
Short Course Level: Intermediate

Course Description

A fiber may be characterised by the number of discrete spatial modes it carries, their effective modal areas, and the phase accumulated when they propagate, all of which control interactions between different modes *or* colours, due to the linear (via interference) or nonlinear (via, primarily, the $\chi^{(3)}$ nonlinearity in silica) coupling. These interactions are not unlike those encountered in bulk optical media, but with a fundamental distinction – owing to the revolutionarily low loss of optical fibers, interaction lengths can be several orders of magnitude greater than that feasible with bulk media, and hence no other medium facilitates, with such ease, remote delivery of light. This course will:

- Describe the physics of light propagation in optical fibers, which may guide light due to total internal reflection (as is the case with a majority of fibers, including most photonic crystal fibers) or due to band-gap effects (such as hollow-core bandgap fibers).
- Elucidate the key design parameters that allow achieving desired mode areas, nonlinear coefficients, phase and dispersion matching, and show how these can be connected with simple ray-optic and wave-optic theories.
- Explore the regimes in which single-mode, mono-mode, few-mode, and vastly multimode fibers, including their vector effects, are applied and exploited.
- Provide illustrative examples of applications in which specially designed fibers have been used, focusing on recent advances in nonlinear fiber optics, high-power lasers and imaging applications.

Benefits and Learning Objectives
Participants of this course will learn:

- The physics of guided wave light propagation in the linear as well as nonlinear regime.
- The ability to design fibers and waveguides for specific high-power lasers, nonlinear and imaging applications.
- An overview of emerging trends in the use of novel fiber designs and spatial modes for future applications.

Joint Plenary Session

Monday, 5 November, 08:15-10:30
Harbor Ballroom I & II

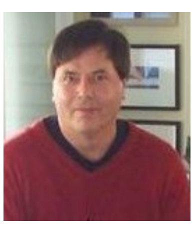
08:30-09:30

Margaret Murnane
JILA, Univ. of Colorado at Boulder and NIST, USA

Harnessing Quantum Light Science for Tabletop X-Ray Lasers, with Applications in Nanoscience and Nanotechnology

High harmonic generation (HHG) is a unique quantum light source with fundamentally new capabilities – producing fully spatially and temporally coherent beams with linear or circular polarization throughout the extreme ultraviolet (EUV) and soft X-ray region, all on a tabletop. This talk will introduce and review recent developments in HHG sources, as well as exciting advances in spectroscopy of materials. A host of applications in nanoscience and nanotechnology have now been demonstrated, including quantifying how nanoscale energy flow differs from bulk, measuring how fast a material can change its electronic or magnetic state, probing how spin currents can control and enhance magnetization in ultra thin films, and visualizing the dynamic band structure of material and electron-electron interactions on sub-femtosecond timescales. In particular, a new technique called attosecond-ARPES (angle resolved photoemission) harnesses HHG pulse trains to measure the fastest care and spin dynamics intrinsic to materials, making it possible to distinguish sub-femtosecond electron scattering and screening for the first time, or to identify new phases that traditional spectroscopies are blind to.

09:30-10:30



Norman Hodgson
Coherent Inc., USA

Industrial Femtosecond Lasers for Material Processing

Over the last decade, modelocked Yb-based laser architectures have matured to a point where they can reliably generate output powers in excess of 100 W with pulse energies of greater than 100 µJoules. This evolution has led to the development of femtosecond laser products which are now being deployed in various industrial applications that require material removal using sub-picosecond pulses.

This talk will provide an overview of the different femtosecond laser architectures, their state-of-the-art performance, and future developments. In addition, the current understanding of laser material interaction with ultrashort pulses is reviewed to find guidelines for the optimization of ultrafast processing in regards to pulse duration and laser wavelength. The talk will conclude with a presentation of the main industrial ultrafast laser applications.

Light the Future Talk (Joint Keynote Session)

Tuesday, 6 November, 11:30-12:30
Harbor Ballroom I & II

Philip Lubin
Univ. of California at Santa Barbara, USA

Directed Energy Propulsion - Enabling the First Interstellar Missions

Recent advances in photonics and directed energy systems allow us to begin the path to both extremely rapid solar system travel as well as relativistic flight for the first interstellar missions. From wafer-scale spacecraft capable of speeds greater than c/4 that could reach the nearest star in 20 years to 10 kg spacecraft travelling at c/50 to large missions capable of supporting human life for rapid interplanetary transit-all can be enabled by the same system. Photonics, like electronics, and unlike chemical propulsion is an exponential technology with a current double time of about 20 months. The same system can be used for many other purposes including kilometer scale telescopes for specialized applications including exoplanet searches and imaging, planetary defense, space debris mitigation among many others. This would be a profound change in human capability. We will discuss the results of our NASA Starlight and Breakthrough Starshot programs, the many technical challenges ahead, current laboratory prototypes and our recent data on kilometer baseline arrays as well as the many transformative implications of this program.

OSA The Optical Society 100 Since 1916

LIGHT THE FUTURE
SPEAKER SERIES

To celebrate the Optical Society's 100Th anniversary, OSA established the Light The Future speaker series. This program features visionaries, futurists and Nobel Prize winners who explore the future of science and innovation. Learn more at osa.org/lightthefuture.

Awards

IPG Student Presentation Contest

IPG, the Laser Congress's Premier Corporate Sponsor, provides funding for various paper presentation awards, which are determined by the ASSL General and Program Chairs. All current students presenting a paper during an ASSL session are eligible for these awards. ASSL will present several awards for outstanding poster and oral presentations by students.

A total of six awards winners will be selected during Laser Congress 2018: best contributed oral presentation and up to two runners ups, and best poster presentation and up to two runners ups.

OSA thanks the following corporate sponsor who has supported student awards for this conference for many years!

Manage Your Laser Congress Experience in a Sn-App

Use the conference app to plan your day by searching presentations, exploring the exposition by viewing a list of exhibitors and daily activities, and networking with attendees.

Download the app in one of three ways:

1. Visit assl.osa.org/app
2. Search for 'OSA Events' in the app store
3. Scan the QR code

Exhibits / Buyers' Guide

The Exhibits are located in Galleria Hall and open to all registered attendees. Visit a diverse group of companies, representing all aspects of solid-state laser system design and implementation. Coffee breaks, lunches and poster sessions will all be held in conjunction with the exhibition.

Monday, 5 November	
Exhibits & Coffee Break	10:00-10:30
Exhibits & Complimentary Lunch	12:30-14:00
Exhibits & Coffee Break	16:00-16:30
Exhibits & Student Posters	18:30-20:00
Tuesday, 6 November	
Exhibits, Posters & Coffee Break	10:00-11:30
Exhibits & Complimentary Lunch	12:30-14:00
Exhibits & Coffee Break	16:00-16:30
Wednesday, 7 November	
Exhibits & Coffee Break	10:00-11:00
Exhibits & Complimentary Lunch	12:00-13:30
Exhibits & Coffee Break	15:30-16:00
Thursday, 8 November	
Exhibits, Posters & Coffee Break	10:00-11:30

AdlOptica GmbH
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AdlOptica GmbH from Berlin, Germany develops and manufactures high efficient multifocal and laser beam shaping optics: product families foXXus and piShaper are applied in various industrial and scientific techniques. Other expertise includes laser techniques in printing industries, holography, interferometry, laser based measuring instruments, optical system designing.

AdValue Photonics, Inc.
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AdValue Photonics is a leading manufacturer of innovative fiber lasers and amplifiers, located in Arizona, USA. The company's products range from 0.5 µm and 1.0 µm, to 1.5 µm and 2.0 µm in wavelengths; picoseconds to nanoseconds in pulse width; and single frequency narrow linewidth to broadband sources.

Altechna
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Altechna is a producer and supplier of custom laser optics and laser accessories. It provides innovative technological solutions and custom designs of laser optics for academic and industrial customers worldwide. Its highly competent professionals have accumulated all the necessary know-how to evaluate and execute every order with attention to the finest detail.

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Amplitude Laser Group
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Amplitude Laser Group is a leading manufacturer of ultrafast and nanosecond lasers for scientific, medical and industrial applications. The group consists of three manufacturing locations in Bordeaux and Paris, France, and San Jose, USA. ranging from Yb High Energy & High Rep rate, OPA,Ti:sapphire, Nd:YAG, OPO and Dye lasers.

APE Angewandte Physik & Elektronik GmbH
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APE GmbH is a worldwide operating developer and manufacturer of instruments for the generation of ultrashort laser pulses with widely tunable wavelength as well as devices for pulse measurement and manipulation. APE´s product portfolio ranges from autocorrelators to harmonic generators, from acoustooptics to optical parametric oscillators (OPOs) and optical parametric Amplifiers (OPAs).

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Exhibits / Buyers' Guide

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Cryslaser, Inc.
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B2, No 199 Western Rd.
High Tech District Western Zone
Chengdu, Sichuan 611731, China
E: sales@cryslaser.com
URL: www.cryslaser.com

Cryslaser is one of the most professional and largest Laser Crystal manufacturers in China. Based on cooperation with Research Centers and Universities and more than 45 years experience in crystal growth, our main products include Laser Crystals (NdYAG, Cr4+YAG etc.), NLO Crystals (KBBF, LBO, BBO, etc.) and Diffusion-Bonded Crystals, Laser Components.

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OSA Industry Development Associates Member

We are an innovative manufacturer of solid-state, fiber lasers and components from unique custom systems to small OEM series. The in-house R&D team is able to tailor products for specific applications and according to specific requirements. Main products are: femtosecond, picosecond and nanosecond lasers, tunable wavelength systems, ultrafast fiber lasers, spectroscopy systems and laser electronics.

Electro-Optics Technology, Inc.
Tabletop 109
3340 Parkland Court
Traverse City, MI 49686, USA
E: sales@eotech.com
URL: www.eotech.com

EOT has been supplying enabling components and diagnostic equipment to manufacturers and users of high power laser systems since 1987. Current products include: Faraday rotators and optical isolators for use with laser diodes, fiber lasers, and solid-state lasers. EOT also stocks a complete line of photodetectors.

Forward Photonics, LLC
Booth 315
500 West Cummings Park, Suite 1900
Woburn, MA 01801, USA
E: info@forwardphotonics.com
URL: www.forwardphotonics.com

Forward Photonics employs wavelength beam combining (WBC) technology patented from MIT Lincoln Laboratory, which allows for brightness scaling with any semiconductor laser material. FP has experience building lasers at many wavelengths, from UV to LWIR, and up to kilowatts of power. FP has had particular success in using WBC with quantum cascade lasers.

Gentec-EO Inc.
Tabletop 506
445 St-Jean-Baptiste, Suite 160
Québec, G2E 5N7, Canada
E: info@gentec-eo.com
URL: www.gentec-eo.com

With a 45-years track record of providing quality solutions for laser measurement applications, Gentec-EO stands ready to serve you now and in the future! Laser power & energy meters, photo detectors, THz detectors, OEM solutions and beam diagnostics, we also have calibration centers on 3 continents for fast turn-around times.

Gooch & Housego, PLC
Booth 318
Head Office, Dowlish Ford
Ilminster, Somerset, TA19 0PF, UK
E: info@goochandhousego.com
URL: www.goochandhousego.com

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Gooch & Housego, or G&H, is a key supplier of complete optical system design, engineering and manufacturing services to the aerospace, defense & space; biomedical; industrial and scientific sectors. Manufacturing complex assemblies and components in Europe and the USA, the Group's technologies are based on acousto, electro, fiber and precision optics.

Ibsen Photonics A/S
Booth 314
Ryttermarken 15-21
3520 Farum, Denmark
E: inquiry@ibsen.com
URL: www.ibsen.com

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Inrad Optics Inc.
Tabletop 214
181 Legrand Ave.
Northvale, NJ 07647, USA
E: sales@inradoptics.com
URL: www.inradoptics.com

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Inrad Optics grows nonlinear crystals including BBO, DKDP, LiNbO3, and ZGP; Q-switches and Pockels Cell, and other custom optics for laser beam delivery applications. Other products include Transmission Flats, Waveplates, electro-opto-mechanical assemblies, UV Filter crystals; and Scintinel™ stilbene, a scintillation crystal for fast neutron detection.

IPG Photonics Corp.
Booth 310, Premier Corporate Sponsor
50 Old Webster Road
Oxford, MA 01540, USA
URL: www.ipgphotonics.com

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IPG Photonics is the leading developer/ manufacturer of high-performance fiber lasers & amplifiers for diverse applications in numerous markets. Diverse lines of low, medium & high power lasers & amplifiers are used in materials processing, communications, medical & advanced applications. IPG's products are displacing traditional applications while enabling new applications.

LAYERTEC GmbH
Tabletop 504
Ernst-Abbe-Weg 1
Mellingen, 99441, Germany
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URL: www.layertec.de

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Light Conversion, Ltd.
Tabletop 304
Keramiku 2B
Vilnius, 10233, Lithuania
E: sales@altosphotonics.com
URL: www.lightcon.com

Light Conversion delivers solid state femtosecond laser and OPA systems, enabling innovation and discovery across industrial and scientific applications. TOPAS and ORPHEUS series of OPA's are well known throughout ultrafast science. Our product portfolio forms a best-in-class set of devices for femtosecond applications in industry, medicine, and fundamental research.

Lumibird
Tabletop 201
49 Willow Peak Dr.
Bozeman, MT 59718, USA
E: sales@quantelusa.com
URL: www.quantel-laser.com

Lumibird is one of the world's leading specialists in lasers. With 50 years of experience and expertise in solid-state lasers, laser diodes and fiber laser technologies, the group (formerly Keopsys-Quantel) designs, manufactures and markets high performance lasers ranging from spectroscopy to atom cooling; LIBS to combustion research. Uniquely, Lumibird offers customers very flexible scientific lasers with user configurable wavelengths and performance parameters as well as "designed for purpose" ruggedized lasers for industrial applications.

Exhibits / Buyers' Guide

MegaWatt Lasers
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E: sales@megawattlasers.com
URL: www.megawattlasers.com

MegaWatt Lasers manufactures application specific solid-state lasers and components for medical, industrial, and defense applications. Standard products include a complete line of high-quality diffuse-reflector pump chambers for solid-state laser applications. MegaWatt Lasers is known for its line of Eyesafe Er:Glass microlasers for various remote sensing applications.

Nikon Corporation Glass Business Unit
Tabletop 216
Shinagawa Intercity Tower C, 2-15-3
Konan, Minato-ku
Tokyo, 108-6290, Japan
E: Glass.Sales@nikon.com
URL: www.nikon.com/products/glass/index.htm

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B2, 199 Western Rd. High-Tech Dist. Western Zone
Sichuan, 611700, China
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URL: www.orient-ir.com

Orientir, Inc. is a high-tech company specializing in infrared optical components research, producing, and marketing. Our main products include Co_2 laser optical components and infrared imaging components with materials: ZnSe, ZnS, CaF_2, BaF_2, Ge, Si and chalcogenide glasses.

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Explanation of Session Codes

AM2B.4

Meeting Name

A=ASSL
L=LAC
J=Joint

Number

Presentation order within session

Day of the Week

M=Monday
Tu=Tuesday
W= Wednesday
Th=Thursday

Series

1=1st of series
2=2nd of series
3=3rd of series
4=4th of series
5=5th of series

Session Designation

A=1st Parallel Session
B=2nd Parallel Session
C=3rd Parallel Session
D=4th Parallel Session

The first letter of the code designates the meeting. The second letter denotes the day of the week. The third element indicates the session series in that day (for instance, 1 would denote the first sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through the parallel session. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded AM2B.4 indicates that this paper is being presented as part of the ASSL meeting on Monday (M) in the second series of sessions (2), and is the second parallel session (B) in that series and the fourth paper (4) presented in that session.

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Sunday, 4 November	
08:00-18:00	Registration, *Harbor Wing Lobby* *(closed during lunch)*
09:00-16:15	Short Courses, *Marina I* SC467 - Quadratic Nonlinear Optics *(09:00—12:00)* SC471 - Physics of Guided-Wave Light Propagation: Applications to Fiber Lasers and Nonlinear Optics *(14:00—16:15)*
17:30-18:30	Congress Networking Reception, *Harbor Ballroom Foyer*

Monday, 5 November		
	Advanced Solid State Lasers *Harbor Ballroom I & II*	Laser Applications Conference *Harbor Ballroom III*
07:00-18:00	Registration, *Harbor Wing Lobby* (closed during plenary sessions and lunch)	
08:15-08:30	Welcome Remarks, *Harbor Ballroom I & II*	
08:30-10:00	JM1A • Joint Plenary Session, *Harbor Ballroom I &I I*	
10:00-10:30	Exhibits and Coffee Break, *Galleria Hall*	
10:30-11:30	AM2A • High Power and Beam Combination	LM2B • Brittle Materials
11:30-12:30		LM3B • Laser Surface Modification For Technology Frontiers
12:30-14:00	Complimentary Lunch in Galleria Hall	
14:00-16:00	AM4A • Laser Materials I (Crystals)	LM4B • Laser Processing for Microelectronic Devices
16:00-16:30	Exhibits and Coffee Break, *Galleria Hall*	
16:30-18:30	AM5A • Er and Tm lasers	LM5B • 16kW+ Laser Materials Processing
18:30-20:00	AM6A • Student Poster Session, *Galleria Hall* Sponsored by: IPG Photonics	

Tuesday, 6 November		
	Advanced Solid State Lasers *Harbor Ballroom I & II*	Laser Applications Conference *Harbor Ballroom III*
07:00-18:00	Registration, *Harbor Wing Lobby (closed during lunch)*	
08:00-10:00	ATu1A • Unconventional Techniques, *Harbor Ballroom I & II*	
08:00-10:00	Directed Energy Defense Special Session (Restricted Access), *Harbor Ballroom III*	
10:00-11:30	ATu2A • ASSL Poster Session with Exhibits and Coffee Break, *Galleria Hall*	
11:30-12:30	JTu3A • Light the Future Talk, *Harbor Ballroom I & II*	
12:30-14:00	Complimentary Lunch in Galleria Hall Sponsored by: IPG Photonics	
14:00-16:00	ATu4A • Novel Materials, Lasers and Processes	LTu4B • Lasers for Space Applications
16:00-16:30	Exhibits and Coffee Break, *Galleria Hall*	
16:30-18:30	ATu5A • Frequency Combs and Compact Systems	LTu5B • Extreme UV, X-Ray Generation and Particle Acceleration
19:00-20:00	ATu6A • ASSL Postdeadline Paper Session, *Harbor Ballroom I & II*	

Agenda of Sessions

Wednesday, 7 November		
	Advanced Solid State Lasers *Harbor Ballroom I & II*	Laser Applications Conference *Harbor Ballroom III*
07:00-18:00	Registration, *Harbor Wing Lobby* *(closed during lunch)*	
08:00-10:00	AW1A • Harmonic, Raman and THz Conversion	LW1B • Laser Applications for Mobility
10:00-11:00	Exhibits and Coffee Break, *Galleria Hall*	
11:00-12:00	AW2A • Joint Session: Vortex Sources and Applications *(Ends at 12:15)*	LW2B • Laser Induced Damage Threshold (LIDT) of Optical Coatings for Applications with High Intensity Lasers
12:00-13:30	Complimentary Lunch in Galleria Hall	
13:30-15:30	AW3A • Joint Session Mid-IR Transition Metal Doped II-VI Materials and Lasers	LW3B • Laser Shock Peening
15:30-16:00	Exhibits and Coffee Break, *Galleria Hall*	
16:00-17:45	AW4A • Mid-IR Sources	
18:00-21:00	Congress Banquet, *Spirit Cruise*	Sponsored by: IPG PHOTONICS

Thursday, 8 November		
	Advanced Solid State Lasers *Harbor Ballroom I & II*	OSA Industry Development Associates *Harbor Ballroom III*
07:30-14:00	Registration, *Harbor Wing Lobby* *(closed during lunch)*	
08:00-10:00	ATh1A • Fiber Materials and Processes	OIDA Executive Forum
10:00-11:30	ATh2A • ASSL Poster Session with Exhibits and Coffee, *Galleria Hall*	
10:45-12:30	OIDA Executive Forum, *Harbor Ballroom III*	
11:30-12:30	ATh3A • Laser Materials II (Ceramics), *Harbor Ballroom I & II*	
12:30-14:00	Lunch on Your Own	
14:00-16:00	ATh4A • Nonlinear Materials and Processes, *Harbor Ballroom I & II*	
16:00-16:30	Coffee Break, *Harbor Ballroom Foyer*	
16:30-16:45	ASSL Student Awards, *Harbor Ballroom I & II*	
16:45-18:30	ATh5A • Lasers for Biological and Other Applications, *Harbor Ballroom I & II*	

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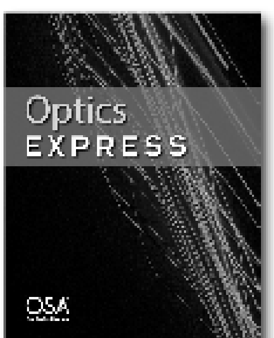

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07:00-18:00 • Registration, *Harbor Wing Lobby*

(closed during lunch)

Harbor Ballroom I & II

Joint Plenary Session

08:15—08:30
Welcome Remarks
Presiders: OSA Management and General Chairs

JM1A.1 • 08:30 –0 9:15 Plenary
Harnessing Quantum Light Science for Tabletop X-Ray Lasers, with Applications in Nanoscience and Nanotechnology, Margaret Murnane[1]; [1]*JILA, University of Colorado at Boulder and NIST, USA.* High harmonic generation (HHG) is a unique quantum light source with fundamentally new capabilities – producing fully spatially and temporally coherent beams with linear or circular polarization throughout the extreme ultraviolet (EUV) and soft X-ray region, all on a tabletop. This talk will introduce and review recent developments in HHG sources, as well as exciting advances in spectroscopy of materials. A host of applications in nanoscience and nanotechnology have now been demonstrated, including quantifying how nanoscale energy flow differs from bulk, measuring how fast a material can change its electronic or magnetic state, probing how spin currents can control and enhance magnetization in ultra thin films, and visualizing the dynamic band structure of material and electron-electron interactions on sub-femtosecond timescales. In particular, a new technique called attosecond-ARPES (angle resolved photoemission) harnesses HHG pulse trains to measure the fastest care and spin dynamics intrinsic to materials, making it possible to distinguish sub-femtosecond electron scattering and screening for the first time, or to identify new phases that traditional spectroscopies are blind to.

JM1A.2 • 09:15 – 10:00 Plenary
Industrial Femtosecond Lasers for Material Processing, Norman Hodgson[1]; [1]*Coherent, Inc., USA.* Over the last decade, modelocked Yb-based laser architectures have matured to a point where they can reliably generate output powers in excess of 100 W with pulse energies of greater than 100 µJoules. This evolution has led to the development of femtosecond laser products which are now being deployed in various industrial applications that require material removal using sub-picosecond pulses. This talk will provide an overview of the different femtosecond laser architectures, their state-of-the-art performance, and future developments. In addition, the current understanding of laser material interaction with ultrashort pulses is reviewed to find guidelines for the optimization of ultrafast processing in regards to pulse duration and laser wavelength. The talk will conclude with a presentation of the main industrial ultrafast laser applications.

10:00-10:30 • Exhibits and Coffee Break*, Galleria Hall*

Harbor Ballroom I & II

ASSL

10:30 - 12:30

AM2A • High Power and Beam Combination
Presider: Dale Martz; Massachusetts Inst of Tech Lincoln Lab, USA

AM2A.1 • 10:30
100J-level cryogenic gas cooled DPSSL for high energy density experiments at the European XFEL facility., Saumyabrata Banerjee[1]; [1]*STFC Rutherford Appleton Laboratory, UK.* We report on the development of a 100 J, 10 Hz cryogenic gas cooled multi-slab Yb:YAG DPSSL system capable of generating temporally shaped pulses from 2 ns to 15 ns. This system will be used for high energy density (HED) experiments at the European X-ray Free Electron Laser (XFEL) facility.

AM2A.2 • 10:45
A 4kW Fiber Amplifier with Good Beam Quality Employing Confined-Doped Gain Fiber, Chu Perng Seah[1], Wei Ying Wendy Lim[1], Song-Liang Chua[1]; [1]*DSO National Laboratories, Singapore.* A confined-doped ytterbium gain fiber was tested in a tandem-pump fiber amplifier. The fiber achieved an output power of 4.1kW and M^2=1.59, with optical efficiency of 84% and no sign of rollover at maximum power.

AM2A.3 • 11:00
Comparison Between Bidirectional Pumped Yb-doped All-fiber Single-mode Amplifier and Oscillator Setup up to a Power Level of 5 kW, Friedrich P. Möller[1], Ria G. Krämer[2], Christian Matzdorf[2], Stefan Nolte[1,2], Maximilian Strecker[1], Fabian Stutzki[1], Marco Plötner[1], Victor A. Bock[1], Thomas Schreiber[1], Andreas Tünnermann[1,2]; [1]*Fraunhofer IOF, Germany;* [2]*Inst. of Applied Physics, Germany.* We present and compare highly robust Yb-doped monolithic amplifier and -oscillator setups in 20/400 µm geometry achieving signal powers of 3.5 kW and 5 kW in a bidirectional pumping scheme while maintaining single mode beam quality of $M^2 \sim 1.3$.

AM2A.4 • 11:15
Monolithic multi-pass thin-disk laser amplifier providing near fundamental mode 2.3 mJ pulse energy at 1.4 kW average output power and 950 fs pulse duration, Thomas Dietz[1], Dominik Bauer[1], Michael Scharun[1], Helge Höck[1], Dirk Sutter[1], Alexander Killi[1], Alfred Leitenstorfer[2]; [1]*Trumpf Laser GmbH, Germany;* [2]*Department of Physics and Center for Applied Photonics, Univ. of Konstanz, Germany.* Monolithic multi-pass thin -disk laser amplifier pumped at 941 nm providing near fundamental mode 2.3 mJ pulse energy at 1.4 kW average output power and 950 fs pulse duration. Zero-phonon-line pumping at 969 nm further improves the beam quality.

AM2A.5 • 11:30
Self-Phase Modulation Cancellation in 210-W SESAM-Modelocked Thin-Disk Oscillator Operated in Air, Francesco Saltarelli[1], Andreas Diebold[1], Ivan J. Graumann[1], Christopher R. Phillips[1], Ursula Keller[1]; [1]*ETH Zurich, Switzerland.* We exploit cascaded-$\chi^{(2)}$ nonlinearities in an intracavity second-harmonic-generation crystal to cancel the self-phase modulation from air in a thin-disk oscillator. We obtain 210-W output power, a record value for a SESAM-modelocked laser operated in air.

AM2A.6 • 11:45
Phase Control of Two-dimensional Diffractive Pulse Combination Based on Beam Array Detection, Tong Zhou[1], Qiang Du[1], Tyler Sano[1], Russell Wilcox[1], Wim Leemans[1]; [1]*Lawrence Berkeley National Laboratory, USA.* A new phase control approach based on beam array detection is developed for large-array diffractive pulse combination. With this approach, a scalable, two-dimensional array of eight 120fs beams are coherently combined using two diffractive optics.

AM2A.7 • 12:00
Coherently combined femtosecond pulses from a multicore fiber amplifier, Arno Klenke[2,1], Michael Mueller[2], Henning Stark[2], Fabian Stutzki[3], Christian Hupel[3], Thomas Schreiber[3], Andreas Tünnermann[2,3], Jens Limpert[2,1]; [1]*Helmholtzinstitut Jena, Germany;* [2]*Inst. of Applied Physics, Friedrich-Schiller-Universität Jena, Germany;* [3]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We present a multicore fiber based amplifier that is suitable for coherent combination of broadband pulses supporting 250fs duration. A combination efficiency of 80% could be maintained up to the maximum average power of 105W.

AM2A.8 • 12:15
Highly Scalable Coherent Beam Combining of Femtosecond Fiber Chirped-Pulse Amplifiers, Anke Heilmann[1], Jérémy Le Dortz[2], Louis Daniault[1], Ihsan Fsaifes[1], Séverine Bellanger[1], Jérôme Bourderionnet[2], Christian Larat[2], Eric Lallier[2], Marie Antier[3], Eric Durand[3], Christophe Simon-Boisson[3], Arnaud Brignon[2], Jean-Christophe Chanteloup[1]; [1]*Ecole Polytechnique, France;* [2]*Thales Research & Technology, France;* [3]*Thales LAS France SAS, France.* We report on the coherent beam combining of seven fiber chirped-pulse amplifiers using a highly scalable architecture. In linear regime, a combining efficiency of 48% is demontrated, yielding 71 W pump-limited average power after compression.

Harbor Ballroom III

LAC

10:30 - 11:30

LM2B • Brittle Materials
Moderator: Dirk Mueller; Coherent Inc., USA

Brittle materials pose a significant challenge to mechanical machining. Lasers have a unique advantage in processing a variety of brittle materials as their wavelengths and pulse durations can be tailored to optimize the material interaction. Brittle materials such as glass and sapphire are increasingly benefitting from laser processing. Unique laser cutting and drilling methods are lowering the cost of machining these materials at unprecedented accuracy.

LM2B.1 • 10:30 Invited
Latest Advances in Machining of Transparent Brittle Materials Using Ultrashort Pulse Laser Processing, Jim Kafka[1]; [1]*Spectra-Physics, MKS Instruments, Inc., Austria.* We will give an overview of ultrafast laser cutting processes which allow to achieve unprecedented cutting speed and quality for wide variety of transparent brittle materials. For example, non-ablative, femtosecond laser process ClearShape™ from Spectra-Physics® will be presented.

LM2B.2 • 11:00 Invited
Lasers Speed Up Glass Cutting, Rainer Pätzel[1]; [1]*Coherent Inc., Germany.* Displays for handheld devices, such as smartphones and tablets, increasingly utilize thinner glass, as well as chemically strengthened glass. Many of these screens come with curved corners, contoured shapes and customized cutouts. These trends make traditional mechanical glass cutting a less effective method during display fabrication and therefore present a growing opportunity for laser glass cutting. This presentation gives an update on laser glass cutting using ultra-short-pulse laser by our patented SmartCleaveTM filamentation process. We discuss the filamentation process and the consecutive laser separation by CO_2 laser. Process results of ps- and fs-laser for thin display glass up to thick architectural glass will be presented.

11:30 -- 12:30

LM3B • Surface Modification for Technology Frontiers
Moderator: Lahsen Assoufid; Argonne National Lab, USA

LM3B.1 • 11:30 Invited
Laser Microfabrication for Advanced Particle Accelerator Research and Development, Sergey Antipov[1]; [1]*Euclid Techlabs LLC, USA.* Femtosecond laser microfabrication allows for precise dimension control and reduced thermal stress of the machined materials. It can be applied to a wide range of materials from copper to diamond. Combined with secondary operations like polishing laser microfabrication can be utilized in various state of the art components required for AAC community. In this presentation we will review several applications of laser microfabrication for Advanced Accelerator research and development. These will include wakefield structures (corrugated metal and dielectric loaded), plasma capillaries, x-ray refractive optics, high power laser optical components: mirrors, phase plates.

LM3B.2 • 12:00 Invited
Probing the Structural Dynamics of Surface-Modified Atomically-Thin Layered Materials and Nanofilms, Tony Karam[1]; [1]*Edmund Optics, USA.* The optical and mechanical properties of thin films and atomically-thin layered materials are remarkably affected by their surface properties. In this regard, the atomic-scale (chemical and mechanical) manipulation of these materials surfaces can lead to the fabrication of optimized devices for applications in electronics and optoelectronics. Recent progress made in temporal resolution of laser pulses, down to the atomic (femtosecond) and electronic (attosecond) scale has led to the development of ultrafast techniques that are able to elucidate the nature of light-matter interaction in nanostructures and to establish structure-functionality paradigms at the most fundamental level. Direct determination of surface structural dynamics requires the ability of imaging atomic motion with angstrom scale spatial resolution. Ultrafast electron microscopy (UEM) with femtosecond coherent electron packets provide unique windows into the correlated atomic motions, bond dilation, and structural transformation with atomic-scale, combined spatial and temporal resolution. Exotic dynamics such as lattice distortion, ultrafast symmetry breaking, quantum confinement, coherent acoustic vibration modes, and strongly-coupled electron dynamics are observed in surface-modified atomically-thin transition-metal dichalcogenides (TMDCs) semiconductors and nanofilms. Furthermore, these surface alterations are shown to significantly enhance the photonics and mechanical properties of these samples, leading to novel highly-optimized materials.

12:30-14:00 • Complimentary Lunch in Galleria Hall

Harbor Ballroom I & II

ASSL

14:00 - 16:00

AM4A • Laser Materials I (Crystals)

Presider: Sergey Mirov; University of Alabama at Birmingham, USA

AM4A.1 • 14:00 Invited

Large Scale Single Crystal Growth, Jana Preclikova[1], Karel Bartos[1], Jan Kubat[1], Michal Koselja[2], Bedrich Rus[2], Martin Divoky[3], Tomas Mocek[3], Jindrich Houzvicka[1]; *[1]Crytur Company, Czechia; [2]Extreme Light Infrastructure, Inst. of Physics, Czechia; [3]HiLASE, Inst. of Physics, Czechia.* A new crystal growth method CRIG (Crystal Improved Growth) has been developed to grow large core-free YAG single crystals. Yb:YAG crystals were used for production of laser slabs for ELI (Extreme Light Infrastructure) Beamlines project.

AM4A.2 • 14:30

Characterization of Absorption Bands in Ti:sapphire Crystals, Peter F. Moulton[1], Jeffrey Cederberg[1], Kevin Stevens[2], Greg Foundos[2], Michal Koselja[3], Jana Preclikova[4]; *[1]Massachusetts Inst of Tech Lincoln Lab, USA; [2]Northrop Grumman Synoptics, USA; [3]Inst. of Physics, Czech Academy, Czechia; [4]Crytur, Czechia.* We have measured and characterized, over a wide range of doping levels, the UV-near-IR (190 -1800-nm) absorption properties of Ti:sapphire crystals. Our results have particular application to the design of lasers pumped by blue-green, InGaN diode lasers.

AM4A.3 • 14:45

Investigation of Optical Defects in Titanium Doped Sapphire Crystals Grown by the Kyropoulos Technique, Carmen Stelian[1], Gourav Sen[1], Nicolas Barthalay[2], Matias Velázquez[3], Thierry Duffar[1]; *[1]Université Grenoble Alpes, CNRS, SIMAP, France; [2]Le Rubis SA, France; [3]ICMCB, UMR 5026 CNRS-Université de Bordeaux-Bordeaux INP, France.* Two optical defects responsible for intensity variations of the emitted laser beam are observed in Ti-doped sapphire crystals grown by Kyropoulos method. These defects are investigated and explained by means of numerical modeling and experiments.

AM4A.4 • 15:00

Laser Crystals Luminescence Parameters under the Influence of an External High Voltage Electrical Field, Vladimir V. Chvykov[1], Konstantin Zemskov[2]; *[1]ELI-HU Non-Profit Ltd., Hungary; [2]Lebedev Physical Inst., Russian Academy of Science, Russia.* Experiments of the electrical field impact on Ti: Sapphire crystal optical parameters are reported. Luminescence spectral amplitude reduction and bandwidth increase with the red-shift of the maximal amplitude after high voltage application are demonstrated.

AM4A.5 • 15:15

Tm,Ho:LiYF$_4$ planar waveguide laser at 2.05 µm, Pavel Loiko[1], Rémi Soulard[1], Gurvan Brasse[1], Jean-Louis Doualan[1], Alain Braud[1], Aleksey Tyazhev[2], Ammar Hideur[2], Patrice Camy[1]; *[1]CIMAP, France; [2]Coria, France.* The first Holmium fluoride waveguide laser is reported using a 25-µm-thick Tm,Ho:LiYF$_4$ layer grown by liquid phase epitaxy. Pumped at 797.2 nm, it generates 81 mW at 2051 nm with a slope efficiency of 24%.

AM4A.6 • 15:30

Demonstration of Adhesive-Free Bonded Crystalline Yb:YAG for High Energy Laser Applications, Mariastefania De Vido[1,2], David Meissner[3], Stephanie Meissner[3], Jonathan Phillips[1], Klaus Ertel[1], Paul Mason[1], Saumyabrata Banerjee[1], Thomas Butcher[1], Jodie Smith[1], Chris Edwards[1], Cristina Hernandez-Gomez[1], John Collier[1]; *[1]STFC Rutherford Appleton Laboratory, UK; [2]Heriot-Watt Univ., UK; [3]Onyx Optics Inc., USA.* We describe the application of the adhesive-free bonding (AFB) technique to form crystalline Yb:YAG gain media slabs. We demonstrate that the AFB technique is a viable alternative for producing large aperture slabs for high-energy lasers.

AM4A.7 • 15:45

84-fs Pulse Generation from a Mode-Locked Tm,Ho:CLNGG Laser at 2080 nm, Yongguang Zhao[1,2], Zhongben Pan[2], Yicheng Wang[2], Ji Eun Bae[3], Sun Young Choi[3], Fabian Rotermund[3], Hualei Yuan[4], Xiaojun Dai[4], Huaqiang Cai[4], Pavel Loiko[5], Wei Zhou[1], Deyuan Shen[1], Josep Maria Serres[6], Xavier Mateos[6], Uwe Griebner[2], Valentin Petrov[2]; *[1]Jiangsu Normal Univ., Germany; [2]Max-Born-Inst., Germany; [3]Korea Advanced Inst. of Science and Technology, South Korea; [4]China Academy of Engineering Physics, China; [5]ITMO Univ., Russia; [6]Universitat Rovira i Virgili (URV), Spain.* We report on a mode-locked Tm,Ho:CLNGG laser employing SWCNTs as saturable absorber. Transform-limited 84-fs pulses are generated at ~2080 nm for a repetition rate of ~102 MHz with an average output power of 69 mW.

Harbor Ballroom III

LAC

14:00 - 16:00

LM4B • Laser Processing for Microelectronic Devices

Moderator: Dirk Mueller; Coherent Inc., USA

With Moore's Law pushing against physical limits more emphasis is given to sophisticated packaging of ICs in order to improve performance and reduce cost & size. As features sizes in advanced IC packaging shrink, lasers are finding increased use in applications such as wafer dicing, package singulation, debonding, µ-via drilling, RDL structuring, soldering, annealing and laser assisted bonding, to name just a few. In addition, manufacturing of mobile devices such as smartphones and wearables are increasingly relying on laser process to improve precision and reduce manufacturing cost.

LM4B.1 • 14:00 Invited

Laser Based Micro Fabrication Systems for Electronics Manufacturing, Haibin Zhang[1]; *[1]ESI, USA.* As devices and packages shrink in size, advanced packaging has become a critical avenue in semiconductor and consumer electronics manufacturing industry. Laser based micro-fabrication systems provide benefits in quality, speed, cost, and are playing important roles as the feature sizes in packages shrinks at a increasing rate. In this presentation, we will review several laser based key applications in packaging, including via drilling, wafer cutting, patterning. We also discuss the key technologies for high precision laser systems that enables next generation feature minimization with extremely high speed and low overall cost.

LM4B.2 • 14:30 Invited

High-Precision Optical Scanning Technologies for Microelectronic Applications, Megan MacNeil[1]; *[1]Novanta, USA.* Precise and consistent laser beam steering is critical when manufacturing components in many of today's electronic devices. State-of-the-art scanners, intelligent trajectory planning, and timed laser control enable high throughput manufacturing with accurate micro-features. In this talk, we will discuss key aspects of commonly used scanning patterns in microelectronic manufacturing, including drilling, trepanning, and large-area processing.

LM4B.3 • 15:00 Invited

Novel Laser Processing for Electronic Devices, Ronald Schaeffer[1]; *[1]HH Photonics, USA.* Lasers are used increasingly in manufacturing environments because they can do things no other technology can do, they can do things cheaper and faster than other technologies and they can be used in conjunction with other manufacturing technologies in hybrid machining applications. What was once a small market is growing rapidly and now there are legitimately at least 6 Billion dollar laser companies. A wide array of available choices in pulse length, wavelength and power output provide manufacturing engineers with a multitude of possibilities. This talk will discuss some novel applications using high peak and average power lasers that are enabling in the electronics industry.

LM4B.4 • 15:30 Invited

Laser for Advanced Microelectronics Packaging, Chong Zhang[1]; *[1]Intel, USA.* Industry trend of microelectronics packaging, and advance packaging options are presented. Laser applications in packaging are listed and role of laser for packaging advancement is discussed. Challenges and opportunities of laser in future packaging application are summarized.

16:00-16:30 • Exhibits and Coffee Break, *Galleria Hall*

Harbor Ballroom I & II

ASSL

16:30 - 18:30

AM5A • Er and Tm Lasers

Presider: Johan Nilsson; Univ. of Southampton, UK

AM5A.1 • 16:30

High Power Resonantly-Diode-Pumped Fiber Laser Based on Er-Nanoparticle-Doped Fiber, Jun Zhang[1], Colin Baker[2], Radha Pattnaik[1], Edward Friebele[3], Ashley Burdett[4], Daniel Rhonehouse[2], Woohong KIm[2], Jasbinder Sanghera[2], Mark A. Dubinskii[1]; *[1]US Army Research Laboratory, USA; [2]US Naval Research Laboratory, USA; [3]Sotera Defense Solutions, USA; [4]Univ. Research Foundation, USA.* We report ~140 W of power from the laser based on Er-nanoparticle-doped fiber with direct diode pumping at 1528 nm. This is believed to be the highest power ever reported from resonantly diode-pumped Er-fiber laser.

AM5A.2 • 16:45

Mode-locked Erbium-doped Fiber Laser with High Average Power and Ultra-short Pulse Duration, Victor A. Bock[1,2], Marco Plötner[2], Till Walbaum[2], Thomas Schreiber[2], Ramona Eberhardt[2], Andreas Tünnermann[1,2]; *[1]Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany; [2]Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We present an amplified mode-locked erbium fiber oscillator reaching high average powers of 20 W combined with an ultra-short pulse length of 305 fs and well-controlled peak powers by monolithic divided pulse amplification.

AM5A.3 • 17:00

55 W Actively Q-switched Single Oscillator Tm^{3+}, Ho^{3+}-codoped Silica Polarization Maintaining 2.09 µm Fiber Laser, Nicolas DALLOZ[1], Thierry Robin[2], Benoît Cadier[2], Christelle Kieleck[1], Marc Eichhorn[1], Anne Dhollande[1]; *[1]ISL , France; [2]iXBlue, France.* A 793 nm diode-pumped actively Q-switched Tm^{3+}, Ho^{3+}-codoped PM 2.09 µm fiber laser emitting 55 W of average power with 100 ns pulse width and 200 kHz repetition rate is reported. End-caps spliced on fiber tips enable laser power scaling with good power stability and beam quality factors ($M^2 < 1.7$).

AM5A.4 • 17:15

Kerr-lens Mode-locked and Graphene Mode-locked Operations of a 2.3-µm Tm^{3+}:YLF Laser, Ferda Canbaz[1], Ismail Yorulmaz[1], Ji Eun Bae[2], Sun Young Choi[2], Fabian Rotermund[2], Alphan Sennaroglu[1,3]; *[1]Koç Univ., Turkey; [2]Korea Advanced Inst. of Science and Technology (KAIST), Korea; [3]Koç Univ. Surface Science and Technology Center (KUYTAM), Turkey.* We report, what is to our knowledge, the first demonstration of Kerr-lens mode-locked and graphene mode-locked operations of a 2.3-µm Tm^{3+}:YLF laser, yielding ultrashort pulses of 514 fs and 2 ps, respectively, at 2303 nm.

AM5A.5 • 17:30

Gigawatt peak power centered at 1940 nm from a diode-pumped ring cavity Tm:YAP regenerative amplifier, Seyed Ali Rezvani[1], Makoto Suzuki[4], Pavel Malevich[2], Clement Livache[1,3], Jean Vincent de Montgolfier[1,3], Yutaka Nomura[1], Noriaki Tsurumachi[4], Andrius Baltuska[2], Takao Fuji[1]; *[1]Inst. for molecular science, Japan; [2]Photonics Inst., Vienna Univ. of Technology, Austria; [3]Ecole Nationale Superieure de Chimie de Paris, France; [4]Engineering, Kagawa Univ., Japan.* We present a 2 GW peak power ring cavity diode-pumped Tm:YAP regenerative amplifier operating at 1 kHz repetition rate and centered at 1940 nm with 360 fs pulse duration.

AM5A.6 • 17:45

790 W average power from an ultrafast Tm-doped fiber CPA, Christian Gaida[1], Martin Gebhardt[1,2], Tobias Heuermann[1,2], Fabian Stutzki[3], Cesar Jauregui[1], Jens Limpert[1,2]; *[1]Inst. of Applied Physics, Germany; [2]Helmoltz-Inst. Jena, Germany; [3]Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We present a thulium-doped fiber chirped pulse amplifier delivering 790 W average power, 250 fs pulses with diffraction-limited beam quality and a relative intensity noise of 0.23% (RF-band 10 Hz to 1 MHz) .

AM5A.7 • 18:00

Generation of intense sub-two cycle pulses by nonlinear post compression of a high repetition rate Tm:fiber CPA, Martin Gebhardt[1,2], Christian Gaida[1], Tobias Heuermann[1,2], Cesar Jauregui[1], Jose Antonio-Lopez[3], Axel Schülzgen[3], Rodrigo Amezcua-Correa[3], Jens Limpert[1,2]; *[1]Inst. of Applied Physcis, Germany; [2]Helmholtz-Inst. Jena, Germany; [3]CREOL, College of Optics and Photonics, USA.* We present nonlinear self-compression of ultrashort pulses from a powerful thulium-doped fiber laser using a gas-filled antiresonant hollow-core fiber. 104 µJ, sub-2 cycle pulses have been generated around 1.85 µm at 98 kHz repetition rate.

AM5A.8 • 18:15

50 fs-pulses emitted by a Tm-doped nonlinear fiber amplifier at 20 W of average power, Tobias Heuermann[1,2], Christian Gaida[1], Martin Gebhardt[1,2], Jens Limpert[1,2]; *[1]Friedrich-Schiller-Univ. Jena, Germany; [2]Helmholtz-Inst. Jena, Germany.* We present an analysis on the optimization of nonlinear amplification in the anomalous dispersion regime, resulting in high-quality 50 fs-pulses at 20 W of average power and 80 MHz repetition rate.

Harbor Ballroom III

LAC

16:30 - 18:30

LM5B • 16kW+ Laser Materials Processing

Moderator: Rudolf Weber, Univ. of Stuttgart, Germany

Lasers with an average power of 16 kW are on the move from basic application development at the universities and application labs to the industry. Moreover, welding processing experiments with up to 100 kW have been reported. The 16 kW+ session will focus on latest applications showing the potential of the next average-power level.

LM5B.1 • 16:30 **Invited**

Challenges in Controlling High Laser Beam Powers in Atmosphere and in Vacuum, Fatma Akyel[1]; *[1]RWTH Aachen Univ., Germany.* Laser beam welding with high beam power (more than 12 kW) and at the same time high depths of welding have been challenging users for years. The process is usually difficult to control. The higher the desired welding depth, the more porosity and cracking will occur. The formation of a freely solidified root is also made more difficult.

LM5B.2 • 17:00 **Invited**

Benefits of High-Speed Welding with 16 kW Lasers, Florian Fetzer[1]; *[1]Univ. of Stuttgart, Germany.*

LM5B.3 • 17:30 **Invited**

Double-Sided Hybrid Welding of 45 mm Thick Structural Steel with a 15 kW Fibre Laser, Alexander F. H. Kaplan1; 1Luleå University of Technology, Sweden. Laser beam welding with high beam power (more than 12 kW) and at the same time high depths of welding have been challenging users for years. The process is usually difficult to control. The higher the desired welding depth, the more porosity and cracking will occur. The formation of a freely solidified root is also made more difficult. In this presentation two alternatives will be presented with which the welding process can be controlled with a 16 kW solid-state laser. On the one hand, laser submerged arc hybrid welding is presented for double-side welding up to 50 mm sheet thickness, and on the other hand, laser beam welding under vacuum (LaVa). A wide range of materials (Cu, Al, Ti, steel) and welding depths (50 mm single layer, 80 mm double-side welding) is presented.

LM5B.4 • 18:00 **Invited**

Novel Optical Concept for Large Area Rapid Thermal Processing, Henrikki Pantsar[1]; *[1]TRUMPF Inc., USA.* We report on a novel optical concept for laser-based large area rapid thermal processing. The unique feature of this modular concept is the capability to precisely combine optical units to realize a line beam dimension of 0.065 mm x 3300 mm.

Galleria Hall

18:30 - 20:00

AM6A • Student Poster Session

AM6A.1
Interaction of Laser Beam with colloidal suspension of plasmonic nanoparticles for high photonic applications, Avesh Kumar[1,2]; *[1]Department of Chemistry, Dr. B. R. Ambedkar Univ., Agra, India; [2]AMOPH, Physical Research Laboratory, India.* Interaction of input laser beams with colloidal suspensions of plasmonic nanoparticles is studied. It results in different types of structures after propagation through a suspension.

AM6A.2
Spherical Approximation for combination of Mechanical Deformation & Optical Path Difference thermal lenses in Nd: YAG slab amplifier, ehsan tanhaee[1,2], Mohamad Mahdi Majidof[2,3], Mohana Najafii[2], Farshad Abedzade[2,3], Seyed Hassan Nabavi[4]; *[1]Univesity of Tehran, Iran (the Islamic Republic of); [2]Iranian National Center for Laser, Iran (the Islamic Republic of); [3]Shahid Beheshti Univ., Iran (the Islamic Republic of); [4]physics and photonic nano science, Tarbiyat Modares Univ., Iran (the Islamic Republic of).* we pave the way for preconception of thermal lens by amalgamation of Mechanical Deformation and Optical Path Difference via Spherical Approximation with analytical and experimental results at Nd:YAG slab amplifier up to 420W pump power.

AM6A.3
Novel CW and actively Q-switched 1066 nm laser with Nd:GdYNbO$_4$ under direct pumping, Xudong Li[1], Guichuan Xu[1]; *[1]Harbin Inst. of Technology, China.* CW and acousto-optically Q-switched operations with a novel Nd:Gd$_{0.69}$Y$_{0.3}$NbO$_4$ mixed crystal were demonstrated under direct pumping.

AM6A.4
Reconfigurable Sum-Frequency Phase-Matching by Temperature Gradient in Step-Chirped MgO:PPLN, Dismas Choge[1]; *[1]Chinese Academy of Sciences, China.* We demonstrate reconfigurable broadband orange laser in a step-chirped MgO:PPLN crystal using temperature-gradient technique. Multiple wavelengths at 600 nm spectral region are achieved using a 20 mm long MgO:PPLN crystal via sum frequency generation.

AM6A.5
A femtosecond pulse fiber laser using a CoSb$_3$ skutterudite-based passive mode-locker, Jinho Lee[1], Yoontaek Kim[1], Kuyngtaek Lee[1], Ju Han Lee[1]; *[1]Univ. of Seoul, Korea.* We experimentally demonstrate a femtosecond pulse fiber laser incorporating a CoSb$_3$ skutterudite-based passive mode-locker. Using the mode-locker, stabel soliton pulses with a ~833-fs femporal width is shown to be obtainable from an erbium fiber cavity.

AM6A.6
Room Temperature Infrared Photo- and Electroluminescence from Ion Implanted Silicon-Germanium, Nikolay S. Balakleyskiy[1], Nikolay N. Gerasimenko[1], Vadim Pirogov[1]; *[1]National Research Univ. MIET, Russia.* We report strong IR photo- and electroluminescence in the temperature range of 225 to 303 K as well as morphology measurements in Ge quantum dots layer being grown by ion beam implantation technique via high temperature annealing

AM6A.7
Sellmeier equations for periodically poled LaBGeO$_5$, Yasuhiro Nakahara[1], Junji Hirohashi[2], Yasunori Furukawa[2], Nobuhiro Umemura[1]; *[1]Chitose Inst of Science and Technology, Japan; [2]Oxide Corporation, Japan.* We report the accuracy Sellmeier equations for LaBGeO$_5$, which reproduce well the quasi-phase-matching conditions at 22°C in the 0.266-1.0642µm range. This index formula is highly useful for designing the period of periodically poled LaBGeO$_5$.

AM6A.8
Depressed cladding waveguides in Pr:CaF$_2$crystal fabricated by femtosecond laser inscription, Limu Zhang[2], Taiyong Guo[2], Yinging Ren[2], Mark Mackenzie[1], Ajoy Kumar Kar[1], Feng Chen[3]; *[1]Heriot-Watt Univ., UK; [2]Shandong Normal Univ., China; [3]Shangdong Univ., China.* We report on the fabrication via femtosecond laser inscribed of cladding waveguides in Pr:CaF$_2$crystal. Micro-photoluminescence mapping shows that the original fluorescence properties in the waveguide region are very well preserved.

AM6A.9
Thermal diffusion of Erbium in ZnS under hot isostatic pressing, Ozarfar Gafarov[1], Vladimir Fedorov[1], Sergey B. Mirov[1]; *[1]Univ. of Alabama at Birmingham, USA.* Thermal diffusion or Erbium in ZnS in a mixture of ErF3 and ZnS powders under hot isostatic pressing was studied. Obtained Er:ZnS ceramics featured strong visible-near-IR photoluminescence of Er ions.

AM6A.10
Gigahertz Mode-Locked Waveguide Lasers Modulated by PtSe$_2$ Saturable Absorber, Ziqi Li[1], Rang Li[1], Ningning Dong[2], Jun Wang[2], Haohai Yu[1], Feng Chen[1]; *[1]Shandong Univ., China; [2]Shanghai Inst. of Optics and Fine Mechanics, Chinese Academy of Sciences, China.* We demonstrate Q-switched mode-locked waveguide laser modulated by platinum diselenide (PtSe$_2$) saturable absorber, achieving 8.820 GHz fundamental repetition rate and 27 ps pulses. Our work indicates the promising applications of PtSe$_2$ for on-chip ultrafast photonics.

AM6A.11
Saturation spectroscopy of NV$^-$ centers in diamond, Shova Subedi[1], Vladimir Fedorov[1], Sergey B. Mirov[1], Linbo Shao[2], Marco Loncar[2]; *[1]Physics, Univ. of Alabama at Birmingham, USA; [2]Engineering and Applied Sciences, Harvard School of Engineering and Applied Sciences, USA.* We report saturation of NV$^-$ centers resulting in ~40% inversion level under 632nm pumping. $\Delta k/k_o$ kinetics revealed long recovery time of NV$^-$ centers after photoionization under 532nm pump, which involved different relaxation channels depending on the probe beam wavelengths.

AM6A.12
Application of Gas Cluster Ion and Accelerated Neutral Atom Beam Surface Treatments to Yb:YAG Gain Material, Mariastefania De Vido[1,2], Michael Walsh[3], Richard Svrluga[3], Sean Kirkpatrick[3], Klaus Ertel[1], Jonathan Phillips[1], Paul Mason[1], Saumyabrata Banerjee[1], Jodie Smith[1], Thomas Butcher[1], Chris Edwards[1], Cristina Hernandez-Gomez[1], John Collier[1]; *[1]STFC Rutherford Appleton Laboratory, UK; [2]Heriot-Watt Univ., UK; [3]Exogenesis Corporation, USA.* We propose the application of the Gas Cluster Ion Beam (GCIB) and of the Accelerated Neutral Atom Beam (ANAB) surface treatments to ceramic Yb:YAG gain material and demonstrate their suitability for high energy laser applications.

AM6A.13
Fabrication of broadband antireflection microstructures on ZnSe single crystal for mid-IR applications, Mikhail K. Tarabrin[1,2], Andrey A. Bushunov[1], Vladimir A. Lazarev[1], Valery E. Karasik[1], Dmitriy Sviridov[2], Yuri V. Korostelin[2], Mikhail P. Frolov[2], Yan K. Skasyrsky[2], Vladimir I. Kozlovsky[2,3]; *[1]Bauman Moscow State Technical Univ., Russia; [2]P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; [3]National Research Nuclear Univ., Russia.* We report the method of microstructure formation on ZnSe single crystal surface for reflectivity reduction in a wide spectral range of 3 to 14 µm up to 10% by using dry etching in CH3 ion plasma through a Ti-mask fabricated by a femtosecond laser ablation.

AM6A.14
Symmetrically-Cooled Ti:sapphire Thin-Disk Laser Using Single-Crystal Diamond Heat Spreaders, Jan-Hinnerk Wolter[1], Andreas Voss[1], Richard Balmer[2], Sandrine Ricaud[3], Marie Antier[3], Christophe Simon-Boisson[3], Thomas Graf[1], Marwan Abdou Ahmed[1]; *[1]Institut für Strahlwerkzeuge (IFSW), Germany; [2]Element Six Ltd, UK; [3]THALES LAS FRANCE SAS, France.* We report on a novel laser concept with symmetrical cooling of a Ti:sapphire thin-disk using transparent heat spreaders made out of large area single-crystal diamond. First results of laser operation are presented.

AM6A.15
Mode-locked oscillator phase stabilization using a Gires -Tournois interferometer, Yifan Cui[1], Hanzhang Pei[1], John Nees[1], Almantas Galvanauskas[1]; *[1]Univ. of Michigan, USA.* Mode-locked oscillator pulse phase is stabilized and locked to an external cavity in a novel way by using a phase-sensitive peak power response of the Gires-Tournois interferometer, which enables significant increase in phase-measurement sensitivity.

AM6A.16
High-energy pulse amplification in partly quenched highly Er^{3+}-doped fiber, Pablo R. Hernandez[1], Colin Baker[2], Shankar Pidishety[1], Mohammad Belal[1], Edward Friebele[3], Ashley Burdett[4], Daniel Rhonehouse[2], Brandon Shaw[2], Jasbinder Sanghera[2], Johan Nilsson[1]; *[1]Univ. of Southampton, UK; [2]Naval Research Laboratory, USA; [3]Sotera Defense Solutions, USA; [4]Univ. of Research Foundation, USA.* We investigate high-energy pulse amplification in a counter-directionally cladding-pumped partly-quenched heavily erbium-doped fiber. Despite the quenching, we reach a pulse energy of 0.56 mJ, several times the saturation energy at the 1563-nm signal wavelength.

AM6A.17
High Energy, 100 Hz, Picosecond Laser for OPCPA Pumping, Hongpeng Su[1,2], Yujie Peng[1], Junchi Chen[1], Xinlin Lv[1,2], Yanyan Li[1], Pengfei Wang[1,2], Yuxin Leng[1]; *[1]Shanghai Inst. of optics and Fine Mechanics, China; [2]Univ. of Chinese Academy of Science, China.* A diode-pumped picosecond laser system for OPCPA pumping was demonstrated, which can deliver laser pulses with energy of 316.5 mJ, pulse duration of 50 ps were obtained at 100 Hz repetition rate.

AM6A.18
4-kilowatt all-fiber distributed side-pumped oscillators, Heng Chen[1], Jianqiu Cao[1], Zhihe Huang[1], Yankun Ren[1], Aimin Liu[1], Jinbao Chen[1]; *[1]National Univ of Defense Technology, China.* The 4-kW all-fiber distributed side-pumped oscillator are firstly demonstrated with the distributed side-coupled cladding-pumped (DSCCP) fiber, to the best of our knowledge. Using four cascaded gain sections, the 3.96-kW output power with 73.0% slope efficiency is obtained.

18:30 -- 20:00

AM6A • Student Poster Session (Continued)

AM6A.19

Demonstration of Two Generation Regimes in High Power Passively Mode-locked Thulium-doped All-fiber Ring Laser at Fully Negative Intracavity Dispersion, Vasiliy Voropaev[1], Alexander I. Donodin[1], Andrei I. Voronets[1], Vladimir A. Lazarev[1], Mikhail K. Tarabrin[1,2], Valery E. Karasik[1], Alexander Krylov[3]; *[1]Bauman Moscow State Technical Univ., Russia; [2]P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; [3]Fiber Optics Research Center of the Russian Academy of Sciences, Russia.* Two generation regimes of bandwidth-limited femtosecond pulses with an average power and energy of 560 mW and 45 nJ were demonstrated in a passively mode-locked thulium-doped all-fiber ring laser at fully negative intracavity dispersion.

AM6A.20

High-energy, Quasi-CW 355 nm UV Pulses Generation From A Diode-Pumped Sub-nanosecond Nd:YAG System, Xinlin Lv[1,2], Hongpeng Su[1,2], Yujie Peng[1], Yuxin Leng[1]; *[1]State Key Laboratory of High Field Physics, Shanghai Inst. of Optics and Fine Mechanics, China; [2]Univ. of Chinese Academy of Sciences, China.* We demonstrated a 50 mJ, 100 Hz, 355 nm laser. Energy stability is better than 2.5% RMS. The third harmonic generated in a diode-pumped 200 mJ, 500 ps Nd:YAG laser system centered at 1064 nm.

AM6A.21

Hybrid Quasi-phasematched and Birefringently Phasematched Parametric Frequency Conversion Architectures, Sean P. Kelley[1,2], Kenton Green[1]; *[1]Northrop Grumman Mission Systems, USA; [2]Electro Optics Department, Univ. of Dayton, USA.* We present spectrally bright, scalable hybrid QPM/BPM NLO architectures down-converting from ~1μm and pumping ZGP OPOs to cover a broad range of the Mid -IR spectrum.

AM6A.22

Continuous-wave operation of LED-pumped Nd: YAG laser with thermal isolated and light guided design, Hong-Ru Chiang[1], Kuan-Yan Huang[1], Yen-Chieh Huang[1]; *[1]National Tsing Hua Univ., Taiwan.* We report a continuous-wave 810-nm LED pumped Nd: YAG laser with thermal isolated and light-guided pump scheme. At 14-W pump power, we generated 370-mW power with slope efficiency of 5.3%.

AM6A.23

Quantum-Dash Semiconductor Laser Characterization Using Continuous Tuning Optical Swept Source, Mokhtar Korti[1,2], Svetlana Slepneva[3,4], Tatiana Habruseva[3,4], Kamel Merghem[5], Guillaume Huyet[3,4], Yaneck Gottesman[1], Abderrahim Ramdane[5], Badr-Eddine Benkelfat[1], Omar Seddiki[2]; *[1]Telecom SudParis, France; [2]Univ. of Tlemcen, Algeria; [3]Cork Inst. of technology, Ireland; [4]Tyndall national Inst., Ireland; [5]Centre de Nanosciences et de Nanotechnologies, France.* Device characterization of Quantum-Dash semiconductor mode-locked laser using a continuous tuning swept source is presented. This technique is linear, simple and does not require any prior information about the signal under test.

AM6A.24

Experimental study of transverse mode instability in a high power monolithic tapered fiber laser oscillator, Baolai Yang[1], Chen Shi[1], Hanwei Zhang[1], Xiaolin Wang[1], Pu Zhou[1], Zhiyong Pan[1], Xiaojun Xu[1]; *[1]College of Advanced Interdisciplinary Studies, National Univ. of Defense Technology, China.* We have constructed a monolithic fiber laser oscillator based on tapered double cladding ytterbium-doped fiber. The performance of the output laser, especially on the aspect of the transverse mode instability (TMI) was studied in details.

AM6A.25

Pulse fragmentation and multi-soliton states in mid-infrared mode-locked fiber laser, Jiapeng Huang[1], Meng Pang[1], Xin Jiang[1], Philip Russell[1]; *[1]Max-Planck Inst. for the Science of Light, Germany.* We observe, in a highly-pumped 2.8 μm mode-locked fiber laser, a variety of stationary multi-soliton states, including phase-locked soliton-pair and soliton-triplet states and stable harmonic mode-locking at two and three times the round-trip frequency.

AM6A.26

Ultra-short wavelength thulium doped mode-locked fiber laser in both soliton and noise-like pulse regimes., Zhengqi Ren[1], Shaoxiang CHEN[1,2], Raghuraman Sidharthan[2], Seongwoo Yoo[2], David Richardson[1], Shaif-ul Alam[1]; *[1]Univ. of Southampton, UK; [2]Nanyang Technological Univ., Singapore.* We demonstrate an ultra-short wavelength mode-locked thulium-doped fiber laser (TDFL) based on nonlinear-loop mirror (NOLM) in both soliton and noise-like pulse regimes. Stable soliton and noise-like pulses at ultra-short wavelength of 1656 nm are achieved.

AM6A.27

Generation of Self-Q-Switching in a Diode-Pumped Monolithic Yb:KGW Laser, Tzu-Lin Huang[1], Hsing-Chih Liang[2], Kuan-Wei Su[1], Kai-Feng Huang[1], Yung-Fu . Chen[1]; *[1]National Chiao Tung Univ., Taiwan; [2]National Taiwan Ocean Univ., Taiwan.* Mode-to-pump size ratio of the laser system was experimentally found to be the key factor leading to self-Q-switching. The maximum pulse energy was estimated to be 1.4 μJ at the repetition rate of 880 kHz.

AM6A.28

Single-mode Yb-doped Double-clad All-solid Photonic Bandgap Fiber Laser Generating 27.8W at 976nm, Turghun Matniyaz[1], Monica T. Kalichevsky-Dong[1], Thomas W. Hawkins[1], Joshua Parsons[1], Guancheng Gu[2], Wensong Li[3], Max Faykus[1], Bradley Selee[1], Jonathan A. Dong[4], Liang Dong[1]; *[1]Clemson Univ., USA; [2]Coherent/Nufern, USA; [3]Department of Electronic Engineering, Xiamen Univ., China; [4]Daniel High School, USA.* We achieved 27.8W from a single-mode Yb-doped all-solid photonic bandgap fiber laser with slope efficiencies of 36.3% and 75.6% with respect to launched and absorbed pump powers respectively, setting new records for coiled fiber lasers.

AM6A.29

Modal Decomposition of Optical Fiber Output in OAM Basis Using Optical Correlation Technique, Pachava Srinivas[1], Awakash Dixit[1], Balaji . Srinivasan[1]; *[1]Indian Instisute of Technology Madras, India.* We represent the optical fiber output beam as a linear superposition of orbital angular momentum (OAM) modes to quantify its purity. Through controlled experiments, we observe good agreement between the experimentally measured OAM and simulated spectrum.

AM6A.30

Green wavelength-tuning and -switching operation in holmium-doped all-fiber lasers, Wensong Li[1,2], Zhiping Cai[1], Xiaofeng Guan[1], Huiying Xu[1]; *[1]Department of Electronic Engineering, Xiamen Univ., China; [2]Holcombe Department of Electrical and Computer Engineering/Center for Optical Materials Science and Engineering Technologies, Clemson Univ., USA.* We experimentally developed tunable and switchable Ho^{3+}-doped all-fiber lasers operating at green wavelengths. With an increase of incident pump powers, tunable single-wavelength and switchable multi-wavelength emissions between 542.6 nm and 549.9 nm are achieved, respectively.

AM6A.31

A watt-level efficient continuous wave Er:YAP laser at 2.92 μm, Hiroki Kawase[1], Ryo Yasuhara[1,2]; *[1]SOKENDAI (The Graduate Univ. for Advanced Studies), Japan; [2]National Inst.s of Natural Sciences, National Inst. for Fusion Science, Japan.* A watt-level CW operation at 2.92μm was demonstrated by diode-pumped Er:YAlO3 laser. The near quantum defect slope efficiency of 30% was obtained without optimization. These results show the great potential for high power mid-IR lasers.

AM6A.32

High energy, high beam quality active multipass stretcher for chirped-pulse amplification, Hongpeng Su[1,2], Yujie Peng[1], Junchi Chen[1], Xinlin Lv[1,2], Yanyan Li[1], Pengfei Wang[1,2], Yuxin Leng[1]; *[1]Shanghai Inst. of optics and Fine Mechanics, China; [2]Univ. of Chinese Academy of Science, China.* An active multipass chirped pulse stretcher is demonstrated, which can deliver pulses with 5 mJ energy and 12 ns duration. The stretched pulses also feature good beam quality with M^2 factor of 1.1.

AM6A.33

Exploring the Stress-Induced Birefringence in Dual-Central-Wavelength Single-Longitudinal-Mode Monolithic Nd:YAG Laser at 1319 nm and 1338 nm, Hao-Ping Cheng[1], Hsing-Chih Liang[2], Kuan-Wei Su[1], Kai -Feng Huang[1], Yung-Fu Chen[1]; *[1]National Chiao Tung Univ., Taiwan; [2]National Ocean Univ., Taiwan.* The single-longitudinal-mode operation with dual-wavelength emission at 1319 and 1338 nm are realized by carefully designing coating specification for monolithic Nd:YAG lasers. The beat frequency can be linearly varied by increasing the external force.

AM6A.34

Spontaneous Laser Line Sweeping in Tm Doped Fiber Laser, Jiang Hongbo[1], Lei Jin[1], Sze. Y Set[1], Shinji Yamashita[1]; *[1]The Univ. of Tokyo, Japan.* A thulium doped fiber ring laser with spontaneous laser line sweeping is reported for the first time. Laser wavelength sweeps around 1970 nm and bounds for short wavelength periodically. The laser can transfer from chaotic regime to CW regime by only change the polarization state.

AM6A.35

Study on Thermal-Lens Induced Coupling of Transverse Modes in High-Power Fiber Amplifiers, Jianqiu Cao[1], Wenbo Liu[1], Jinbao Chen[1]; *[1]National Univ of Defense Technology, China.* Thermal-lens induced coupling between the fundamental and higher-order modes in the high-power fiber amplifier is revealed firstly, to the best of our knowledge, and the variation of pertinent coefficient is discussed.

AM6A.36

Investigation of a Large Mode Area Pulsed 1550 nm Laser System, Michael Klopfer[2], Leanne J. Henry[1], Ravinder Jain[2]; *[1]Air Force Research Laboratory, USA; [2]Univ. of New Mexico, USA.* An erbium doped fiber having 52 micron core was investigated as high power stage of 1550 nm pulsed fiber system. Pulse energies of 360 and 130 μJ at 2 and 10 kHz, respectively, were found.

07:00-18:00 • **Registration**, *Harbor Wing Lobby*

(closed during lunch)

Harbor Ballroom I & II

ASSL

08:00 -- 10:00

ATu1A • Unconventional Techniques

Presider: Norihiko Nishizawa; Nagoya Univ., Japan

ATu1A.1 • 08:00
Low-birefringence 120 W Yb fiber amplifier producing linearly polarized pulses with 69-GHz linewidth at 1083 nm, Zhimeng Huang[1], Shankar Pidishety[1], Thomas W. Hawkins[2], Yujun Feng[1], Yutong Feng[1], Sheng Zhu[1], Liang Dong[2], Johan Nilsson[1]; *[1]Univ. of Southampton, UK; [2]Clemson Univ., USA.* A low-birefringence 5-m-long fiber amplifier with a highly Yb-doped 40-µm, 0.028-NA phosphosilicate core produces linearly polarized (7.2-dB PER) 20-ns, 0.8-mJ pulses with 69-GHz linewidth, $M^2 = 1.2$, and 120 W of average output power at 1083 nm.

ATu1A.2 • 08:15 Invited
LED Pumping of Solid-state Lasers, Francois Balembois[1], Pierre Pichon[1,2], Frédéric Druon[1], Jean-Philippe Blanchot[2], Patrick Georges[1]; *[1]Institut d'Optique, France; [2]Effilux, France.* With the recent development of LED-pumped luminescent concentrators, we report the recent advances on LED-pumping of transition-metal-doped crystals lasers (Alexandrite, Cr:LiSAF and Ti:Sapphire). Laser performances, tunability and small-signal gain measurements are reported in free-running operation.

ATu1A.3 • 08:45
Sub-100-fs pulse generation from a Kerr-lens mode-locked Alexandrite laser, Can Cihan[1], Abdullah Muti[1], Isinsu Baylam[2], Askin Kocabas[1], Umit Demirbas[3], Alphan Sennaroglu[1,2]; *[1]Koç Univ., Turkey; [2]Koç Univ. Surface Science and Technology Center (KUYTAM), Turkey; [3]Antalya Bilim Univ., Turkey.* We report, to the best of our knowledge, the shortest pulses obtained from a Kerr-lens mode-locked multipass-cavity Alexandrite laser operating near 750 nm. The resonator produced 70-fs pulses with a time-bandwidth product of 0.331.

ATu1A.4 • 09:00
Femtosecond Mamyshev Oscillator at 1550 nm, Michel Olivier[1,2], Vincent Boulanger[1], Félix Guilbert-Savary[1,2], Pavel Sidorenko[3], Frank W. Wise[3], Michel Piché[1]; *[1]Centre d'optique, photonique et laser (COPL), Universite Laval, Canada; [2]Physique, Cégep Garneau, Canada; [3]School of Applied and Engineering Physics, Cornell Univ., USA.* We demonstrate an environmentally stable Mamyshev Oscillator at 1550 nm. The oscillator delivers 19 nJ linearly chirped pulses compressed externally to 125 fs using a grating pair to achieve a peak power of 67 kW.

ATu1A.5 • 09:15 Invited
Optimized (Quantum) Photonics, Jelena Vuckovic[1]; *[1]Stanford Univ., USA.* Our inverse design approach offers a powerful tool to implement classical and quantum photonic circuits with superior properties, including robustness to errors in fabrication and temperature, compact footprints, novel functionalities, and high efficiencies. We illustrate this with a number of demonstrated devices in silicon and in diamond.

ATu1A.6 • 09:45
Thresholdless superradiance laser, Kyungwon An[1]; *[1]Seoul National Univ., Korea.* We present a thresholdless laser by time-separated coherent superradiance. Contrary to the conventional approach of maximizing the beta factor, we utilized collective interaction of phase-aligned atomic dipoles in a high-Q cavity to achieve thresholdless lasing.

08:00-10:00 • **Directed Energy Defense Special Session (Restricted Access)**, *Harbor Ballroom III*

Please note pictures and recording of presentations are not allowed.

10:00 - 11:30

ATu2A • ASSL Poster Session with Exhibits and Coffee Break

ATu2A.1
Surface modification of Invar via polarization mixing by a femtosecond laser irradiation, Seunghwan Kim[1], Jungyu Hur[1], Doh Hoon Kim[1], Jong Kab Kim[1]; [1]*AP systems, Korea.* We report the surface modification of Invar film through perpendicularly switching of the polarization direction using the scanning of femtosecond laser to eliminate the micro holes and surface ripples, which are unwillingly generated by LIPSS.

ATu2A.2
Ni^{2+}:$KZnF_3$ Glass-Ceramics Waveguide Beam Splitters Inscribed by Femtosecond Laser, Jiabei Tang[1], Quan Hu[1], Junli Wang[1], Changgui Lin[2], shixun dai[2], Jiangfeng Zhu[1], Zhiyi Wei[1]; [1]*Xidian Univ., China;* [2]*Ningbo Univ., China.* The 1 × 2 beam splitters with different beam splitting angles are fabricated in the Ni^{2+}:$KZnF_3$ glass-ceramics by femtosecond laser. The minimum propagation loss is determined at 1030nm, and its guiding properties are investigated.

ATu2A.3
Laser-Induced Periodic Surface Structures in GaP, Reza Sanatinia[1], Alexander W. Raymond[1], Eric Mazur[1]; [1]*Harvard Univ., USA.* Laser-induced periodic surface structures (LIPSS) in GaP with high and low spatial frequencies were systematically investigated. We fabricated these structures using a fs laser as a feasible alternative method to realize nonlinear photonic metasurfaces.

ATu2A.4
Fluorescence spectrum of an Yb:Er:Tm:Ho Doped Germanate Glass, Ali Albalawi[1], Marcin Kochanowicz[2], Jacek Zmojda[2], Piotr Miluski[2], Dominik Dorosz[3], Stefano . Taccheo[1]; [1]*Swansea Univ., UK;* [2]*Bialystok Univ. of Technology, Poland;* [3]*AGH - Univ. of Science and Technology, Poland.* In this paper we present preliminary fluorescence measurement of a Yb:Er:Tm:Ho. We show a flat emission spectrum of about 450 nm and, in principle, continuous emission from 1500 nm to about 2200 nm.

ATu2A.5
Absorption measurement of layer or material: how to calibrate?, Hervé Piombini[1]; [1]*CEA Le Ripault, France.* The purpose of this paper is to provide a method for measuring the absorption of material with a low extinction coefficient and to establish simple ratios for estimating the absorption of materials or thin layers.

ATu2A.6
Infrared emissions around 8µm in rare-earth doped chalcogenide fibers, Alain Braud[1]; [1]*CIMAP, France.* The long wave-infrared (LWIR) emission around 8µm of Sm^{3+} and Tb^{3+} doped chalcogenide fibers is reported. These rare-earth doped fibers exhibit a significant emission band from 6.5 to 8.5µm with a maximum emission around 7.3 µm with the Sm^{3+} doping while the Tb^{3+} emission is centered at 8µm.

ATu2A.7
Withdrawn

ATu2A.8
Maintaining high performance of optical parametric amplification in a chalcogenide hybrid microstructured optical fiber, Hoang Tuan Tong[1], Nguyen P. Hoa[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan.* FOPA signal gain spectrum with broad bandwidth ~5540 nm at 20 dB can be maintained even when fiber structure fluctuation occurs by using a chalcogenide hybrid microstructured optical fiber with buffer layer.

ATu2A.9
Suppression of high order modes in large mode area optical fiber using highly-absorbing inclusions, Svetlana Aleshkina[1], Mikhail M. Bubnov[1], Mikhail Melkumov[1], Mikhail E. Likhachev[1]; [1]*Fiber Optics Res. Ctr the RAS, Russia.* We propose a new approach for high order mode suppression in few-mode optical fibers. The technique is based on distortion and absorption of undesirable modes by additional highly-absorbing rods incorporated in to the fiber cladding.

ATu2A.10
Understanding of crazing of sol-gel layers and improvement for components submitted to high power laser, Hervé Piombini[1]; [1]*CEA Le Ripault, France.* The laser MégaJoule needs numerous optical components coated by sol gel which need a post-treatment that induces crazing. We are going to present the characterizations made to understand the phenomenon and suggest solutions.

ATu2A.11
Hot-wire CVD Based SiN Films For Linear and Nonlinear Photonics Device Applications, Kentaro Furusawa[1], Yoshimi Yamashita[1], Kanna Aoki[1], Norihiko Sekine[1], Akifumi Kasamatsu[1], Yoshinori Uzawa[2,1]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*National Astronoical Observatory Japan, Japan.* Optical properties of SiN photonic devices based on the hot-wire chemical vapor deposition (HWCVD) method are reported. Microring resonators exhibiting their quality factors in excess of 10^5 were successfully demonstrated in the telecommunication L band.

ATu2A.12
Observation of Intensity Distribution of Second Harmonic Generation in PPLN waveguide by Microscopy, Tadashi Kishimoto[1], Hitoshi Murai[1], Hironori Sasaki[1], Yoshihiro Ogawa[2]; [1]*Oki Electric Industry Co., Ltd., Japan;* [2]*Department of Physics, Joetsu Univ. of Education, Japan.* We observed SHG intensity distribution along a PPLN waveguide by a microscopy technique. We demonstrated that the SHG conversion efficiency is not proportional to the square of the device length due to non-negligible propagation losses.

ATu2A.13
Efficient Nonlinear Cross-Polarized Wave Conversion in Photonic Band-gap Structure, Prathan Buranasiri[1], Surawut Wicharn[2]; [1]*KMITL, Thailand;* [2]*Physics, Srinakharinwirot Univ., Thailand.* We demonstrated an enhancement of cross-polarized wave generation in a photonic band-gap structure composed of two periodic arrangement of barium-fluoride and silicon-dioxide numerically. We found that the conversion efficiency of XPW generation is obviously enhanced by band-edge field enhancement.

ATu2A.14
Spectral and Lasing Characteristics of Er:YAP Crystal in Temperature Range 80 to 300 K, Michal Nemec[1], Richard Švejkar[1], Jan Šulc[1], Helena Jelinkova[1]; [1]*Czech Technical Univ. in Prague, Czechia.* Spectral and laser characteristics of Er:YAP active material are presented in the temperature range from 80 to 300 K. The laser generation at 1623 nm pumped by fiber coupled 1453 nm laser diode was obtained.

ATu2A.15
Withdrawn

ATu2A.16
Uni-Wavelength Cascade Lasing ~1900 nm from $^4F_{3/2}$ to $^4I_{15/2}$ Nd Transitions?, George Dube[1], Roland E. Juhala[1]; [1]*MetaStable Instruments, Inc, USA.* A search for $^4F_{3/2}$ to $^4I_{15/2}$ Nd lasing between 1850 nm and 1960 nm is reported. Forty possible materials were identified; seven were tested. The possibility of uni-wavelength cascade lasing was indentified for two materials.

ATu2A.17
Bonding condition for sapphire/Nd:YAG composite by pulsed electric current technique, Hiroaki Furuse[1], Yuki Koike[1], Ryo Yasuhara[2]; [1]*Kitami Inst. of Technology, Japan;* [2]*National Inst. for Fusion Science, Japan.* Pulsed electric current bonding condition for Sapphire/Nd:YAG composite was studied to improve optical and laser quality. Further, bonding of a sapphire-sandwich structure was demonstrated.

ATu2A.18
Co-doping Nd :CaF_2 with buffer ions for inertial fusion application, Rémi Soulard[1], Diane Stoffel[2], Jean-Louis Doualan[1], Alain Braud[1], Sébastien Montant[2], Jean-Paul goossens[2], Patrice Camy[1]; [1]*CIMAP, France;* [2]*CEA, CESTA, France.* The incorporation of non active ions like Lu^{3+}, Gd^{3+}, Y^{3+}, La^{3+}, Ce^{3+} or Sc^{3+} in Nd:CaF_2 significantly shapes the broadband emission around 1.053µm. considering the high thermal conductivity of these crystals, this may lead to new efficient gain materials in inertial fusion facilities.

ATu2A.19
Withdrawn

ATu2A.20
Broadly-tunable Diode-pumped Tm:$Ca_3(VO_4)_2$ Laser, Jan Sulc[1], Jan Kratochvíl[1], Michal Nemec[1], Helena Jelinkova[1], Maxim E. Doroshenko[2], Alexander G. Papashvili[2], Irina S. Voronina[2], Lyudmila I. Ivleva[2]; [1]*Czech Technical Univ. in Prague, Czechia;* [2]*Prokhorov General Physics Inst. of Russian Academy of Sciences, Russia.* Diode-pumped laser based on new Tm:$Ca_3(VO_4)_2$ crystal (2 wt.% of Tm_2O_3) was investigated at 300 K. Smooth continuous tuning from 1834 up to 2072 nm was reached using quartz plate as a tuning element.

Galleria Hall

10:00 -11:30

ATu2A • ASSL Poster Session with Exhibits and Coffee Break(Continued)

ATu2A.21
Growth, spectroscopy and laser operation of "mixed" Tm:Ca(Gd,Lu)AlO_4 – A novel crystal for mode-locked lasers, Zhongben Pan[4,2], Josep Maria Serres[5], Pavel Loiko[3], Hualei Yuan[4], Xiaojun Dai[4], Huaqiang Cai[4], Yicheng Wang[4], Yongguang Zhao[2,1], Magdalena Aguilo[5], Francesc Diaz[5], Xavier Mateos[5], Uwe Griebner[2], Valentin Petrov[2], Esrom Kifle[5]; *[1]Jiangsu Normal Univ., China; [2]Max-Born-Inst., Germany; [3]ITMO Univ., Russia; [4]China Academy of Engineering Physics, China; [5]Universitat Rovira i Virgili (URV), Spain.* A tetragonal "mixed" Tm:Ca(Gd,Lu)AlO_4 crystal is grown by the Czochralski method. The Lu^{3+}-doping broadens the Tm^{3+} gain spectra. A diode-pumped Tm:Ca(Gd,Lu)AlO_4 laser generated 1.82 W at 1945 nm with a slope efficiency of 29%.

ATu2A.22
Investigation of the Ultrafast Response and Saturable Absorption of Voltage-Controlled Graphene, Isinsu Baylam[1], Melisa N. Cizmeciyan[1], Nurbek Kakenov[2], Coskun Kocabas[2], Alphan Sennaroglu[1,3]; *[1]Koç Univ. Surface Science and Technology Center, Turkey; [2]Physics, Bilkent Univ., Turkey; [3]Physics and Electrical-Electronics Engineering, Koç Univ., Turkey.* Ultrafast pump-probe measurements show that at a bias voltage of 1V, voltage reconfigurable graphene supercapacitors can operate as fast saturable absorbers with adjustable insertion loss over an ultrabroad spectral range from 630 to 1100 nm.

ATu2A.23
Withdrawn

ATu2A.24
Nonlinear Beam Shaping via the Geometric Phase in Sum Frequency Generation, Aviv Karnieli[1], Ady Arie[1]; *[1]Tel-Aviv Univ., Israel.* We propose and analyze the generation of a controllable and robust adiabatic geometric phase via a quadratic nonlinear optical process. This approach enables wavefront shaping tasks such as focusing and mode conversion in sum-frequency process.

ATu2A.25
Two micron All-normal-dispersion NPR mode-locked Tm:ZBLAN fiber laser, Hiromu Sagara[1], Anna Suzuki[1], Shotaro Kitajima[1], Masaki Tokurakawa[1]; *[1]Univ. of Electro-communications,ILS, Japan.* We demonstrated a two micron all-normal-dispersion nonlinear polarization rotation mode-locked Tm:ZBLAN fiber laser. An output power of 57 mW at 70.6MHz repetition rate with a cat-ear like shape spectrum of 50 nm bandwidth were obtained.

ATu2A.26
Experimental Demonstration of the Coherent Mid-IR Supercontinuum Source Using All-normal Dispersion Engineered Tellurite Fiber, Than Singh Saini[1], Tong H. Tuan[1], Luo Xing[1], Nguyen P. Hoa[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]Toyota Technological Inst., Japan.* Broadband coherent mid-infrared supercontinuum spectrum spanning 1.34–2.84 μm is demonstrated using all-normal tellurite step-index fiber. Spectrum is obtained with 200 fs laser pulse of coupled peak power of 5.5 kW at 2.0 μm.

ATu2A.27
Nonlinear-mirror mode-locked Er^{3+}:ZBLAN fiber laser, Lina Zhao[1], Jiarong Wang[1], Shu-wei Huang[1]; *[1]Univ. of Colorado Boulder, USA.* We report the first nonlinear-mirror mode-locked Er^{3+}:ZBLAN fiber laser at 2.8 μm. Continuous-wave mode-locking with an 88-mW average power at 33 MHz is observed. Simulation suggests a 300-fs pulse duration, which remains to be characterized.

ATu2A.28
High performance Ho:YAG single-crystal fiber laser inband pumped by a Tm-doped all-fiber laser, Jianglei Li[1], Qingsong Song[1], Yongguang Zhao[1,2], chongfeng Shen[1], Weichao Yao[1], Li Wang[3], Wei Zhou[1], Dongzhen Li[1], Xiaodong Xu[1], Jun Xu[4], Deyuan Shen[1]; *[1]Jiangsu Normal Univ., China; [2]Max-Born-Inst., Germany; [3]Chinese Academy of Sciences, China; [4]Tongji Univ., China.* We report on a Ho:YAG SCF laser inband pumped by an all-fiber Tm-laser. CW laser of 12.5 W output power and Q-switched laser with 1.44 mJ pulse energy and 7.5 ns pulse duration are demonstrated.

ATu2A.29
Extreme ultrafast pulsation in Tm/Ho mode-locked linear cavity fiber lasers, Ahmet E. Akosman[1], Junjie Zeng[1], Michelle Y. Sander[1]; *[1]Boston Univ., USA.* In a Tm/Ho-doped ultrafast linear cavity fiber laser, extreme optical pulsation is demonstrated. Single-pulsing behavior at the fundamental repetition rate is maintained while the level of chaotic pulsation is adjusted by an intracavity polarization controller.

ATu2A.30
Q Switched Tunable milli-Joule Level Tm Laser, Salman Noach[1], Uzziel Sheintop[1], Rotem Nahear[1], Eytan Perez[1]; *[1]Jerusalem College of Technology, Israel.* High energy continuous tunable Q switch Tm laser is demonstrated for the first time. Tuning range of 33 nm and 11 nm in active and passive Q switch, respectively, was achieved around 1.9 μm.

ATu2A.31
Passively Mode-locked (Tm,Ho):YLF Laser, Aleksey Tyazhev[1], Marlène Paris[1], Rémi Soulard[2], Pavel Loiko[2], Jean-Louis Doualan[2], Gurvan Brasse[2], Alain Braud[2], Thomas Godin[1], Patrice Camy[2], Ammar Hideur[1]; *[1]UMR 6614 CORIA, Université de Rouen, France; [2]Centre de recherche sur les Ions, les Matériaux et la Photonique (CIMAP), UMR 6252 CEA-CNRS-ENSICAEN, Normandie Université, 6 Blvd Maréchal Juin, 14050 Caen, France, France.* A passively mode-locked (Tm,Ho):YLF laser is reported for the first time. The laser is pumped with a high-power multimode laser diode and mode-locked with a graphene saturable absorber, delivering 52 mW of output power with a repetition rate of 75 MHz at a central wavelength of 2051 nm.

ATu2A.32
Efficient bulk and waveguide Tm:$LiYF_4$ lasers at 2306 nm, Rémi Soulard[1], Pavel Loiko[1], Gurvan Brasse[1], Jean-Louis Doualan[1], Alain Braud[1], Aleksey Tyazhev[2], Ammar Hideur[2], Blandine Guichardaz[3], Lauren Guillemot[4], Frédéric Druon[4], Patrice Camy[1]; *[1]CIMAP, France; [2]CORIA, France; [3]FEMTO ST, France; [4]LCF, France.* The $^3H_4 \rightarrow ^3H_5$ transition of Tm^{3+} in $LiYF_4$ is characterized. Efficient 2.3-μm bulk and waveguide lasers are demonstrated. A CW diamond-saw-diced channel waveguide laser generated 147 mW at 2306 nm with a slope efficiency of 33.5%.

Harbor Ballroom I & II

Light the Future Talk

JTu3A.1 • 11:30 –12:30
Directed Energy Propulsion - Enabling the First Interstellar Missions, Philip Lubin[1], *[1]UC Santa Barbara, USA.* Recent advances in photonics and directed energy systems allow us to begin the path to both extremely rapid solar system travel as well as relativistic flight for the first interstellar missions. From wafer-scale spacecraft capable of speeds greater than c/4 that could reach the nearest star in 20 years to 10 kg spacecraft travelling at c/50 to large missions capable of supporting human life for rapid interplanetary transit - all can be enabled by the same system. Photonics, like electronics, and unlike chemical propulsion is an exponential technology with a current double time of about 20 months. The same system can be used for many other purposes including kilometer scale telescopes for specialized applications including exoplanet searches and imaging, planetary defense, space debris mitigation among many others. This would be a profound change in human capability. We will discuss the results of our NASA Starlight and Breakthrough Starshot programs, the many technical challenges ahead, current laboratory prototypes and our recent data on kilometer baseline arrays as well as the many transformative implications of this program.

12:30—14:00 • Complimentary Lunch in Exhibits Hall

Harbor Ballroom I & II

ASSL

14:00 -16:00

ATu4A • Novel Materials, Lasers and Processes

Presider: Long Zhang; Shanghai Inst of Optics and Fine Mechanics, China

ATu4A.1 • 14:00 Invited

Dynamics of Nanoscale Light Emitters, Yeshaiahu Fainman[1]; *[1]Univ. of California San Diego, USA.* We discuss nanoscale metal-dielectric-semiconductor resonant gain geometries to create a new type of light emitters focusing on three key aspects: second order intensity correlation characterizations, direct modulation and electromagnetic isolation in a dual nanolaser system.

ATu4A.2 • 14:30

Telecommunication-Wavelength Lasing in Er-doped GaN Multiple Quantum Wells at Room Temperature, Vinh Ho[1], Talal Al Tahtamouni[2], Yizhou Wang[1], Hongxing Jiang[3], Jingyu Lin[3], John Zavada[4], Nguyen Vinh[1]; *[1]Physics, Virginia Tech, USA; [2]Qatar Univ., Qatar; [3]Texas Tech Univ., USA; [4]New York Univ., USA.* We report the realization of room-temperature, stimulated-emission in Er-doped-GaN multiple-quantum-wells at the 1.5-um. Structures were grown by MOCVD and lasing was confirmed by threshold-behaviors of emission-intensity as functions of pump-fluence, spectral-linewidth-narrowing, excitation-length.

ATu4A.3 • 14:45

Efficient Excitation of Mid-Infrared Emission in Pr:$RbPb_2Cl_5$ by “Three-for-One” Cross-Relaxation, Larry D. Merkle[1,2], Ei Ei Brown[1,3], Jason McKay[1,2], Zackery Fleischman[1], Mark Dubinskii[1]; *[1]US Army Research Laboratory, USA; [2]General Technical Services, USA; [3]Oak Ridge Associated Universities, USA.* We observe strikingly strong 3.5-5.5-micron fluorescence from Pr:$RbPb_2Cl_5$ following 1.5-micron excitation. Its dependence on temperature and concentration indicates that ion-ion interactions excite up to three ions to the emitting state for each ion initially excited.

ATu4A.4 • 15:00 Invited

Adiabatic QPM processes and frequency comb generation, Christopher R. Phillips[1], Leonard Kruger[1], Aline Mayer[1], Ursula Keller[1]; *[1]ETH Zurich, Switzerland.* Self-defocusing nonlinearities enabled by an adiabatic QPM device suppress Q-switching-damage and thereby enable a repetition-rate stabilized SESAM-modelocked 10-GHz Yb:CALGO laser delivering 127 fs at 0.81 W from a compact straight laser cavity with normal dispersion.

ATu4A.5 • 15:30

Highly-efficient sub- μm periodically poled RKTP for mirrorless OPO: fabrication, characterization and performance, Carlota Canalias[1], Valdas Pasiskevicius[1], Andrius Zukauskas[1], Riaan Coetzee[1]; *[1]Kungliga Tekniska Hogskolan, Sweden.* We present a highly-reliable fabrication technique for sub-μm PPRKTP demonstrating periodicities as short as 500 nm. The crystals are used for counter-propagating three-wave mixing interactions with a conversion efficiency exceeding 50% and mJ-level output energy.

ATu4A.6 • 15:45

Recent advances in all-epitaxial growth and processing of OP-GaAs, Peter G. Schunemann[1]; *[1]BAE Systems Inc, USA.* Orientation-patterned GaAs has the highest nonlinearity and deepest infrared transparency of any demonstrated quasi-phasematched material. Continued efforts are reported towards achieving larger apertures (>3.5 mm), improved grating propagation, and lower linear and nonlinear absorption losses.

Harbor Ballroom III

LAC

14:00 -16:00

LTu4B • Lasers for Space Applications

Moderator: Thomas Dekorsy; DLR, Inst. of Technical Physics, Germany

The space industry is presently undergoing a strong change - often referred to as “new space” - driven by new aerospace companies and ventures. Mega constellations of satellites are planned for distributing internet worldwide, laser communication to and between satellites allows a drastic increase of the available communication bandwidth, space based laser sensors enable monitoring a variety of important parameters on Earth, new and cheaper launch systems are developed, etc. Laser technology plays an important role in many of these applications which will be addressed in this session.

LTu4B.1 • 14:00 Invited

Power Scaling Lasers for Space-Based Applications, Floyd Hovis[1]; *[1]Fibertek, Inc., USA.* The reported highest power space-based lasers are the 20 W class lasers used in the Ice, Cloud and land Elevation Satellite-2 (ICESat-2) and the Cloud Aerosol Transport System on the International Space Stations (CATS-ISS) missions. We will discuss our ongoing activities for scaling this and other laser technologies to the 100 W class and beyond.

LTu4B.2 • 14:30 Invited

Progress in Developing Satellite and UAV Laser Communication Modules and Sub-Systems, Efstratios Kehayas[1]; *[1]Gooch & Housego, UK.* Photonics is expected to play a key role in space applications as optics and fiber-optics penetrate into satellite payloads and photonic components and sub-systems become integral functional parts of telecommunication, on-board signal distribution and/or remote sensing instrumentation. During this talk we will review the progress in developing and qualifying photonic components and sub-systems for communication and sensing in space.

LTu4B.3 • 15:00 Invited

Laser Guide Stars for Atmospheric Corrections, Frank Lison[1]; *[1]TOPTICA Projects GmbH, Germany.* Atmospheric distortions limit seeing from earth into space, affecting optical astronomy and optical communication to satellites. Adaptive optics can compensate these distortions using measurements from guide stars. Bright natural guide stars are only available in a fraction of the sky. Instead, one can use lasers for creating artificial guide stars, either by Rayleigh scattering in the atmosphere or using fluorescence from a naturally occurring atomic sodium layer in the mesosphere. Only latter allows full compensation of the atmospheric distortions and requires a high power narrow line with laser resonant with the D2 sodium transition (589.2 nm). Today, most big telescopes use so-called 3rd generation sodium guide star lasers. These lasers use a diode laser as master oscillator, which is amplified in a Raman fiber amplifier and then resonantly frequency doubled delivering more than 20 W of optical output at 589 nm. In this presentation, we will review the current state of guide star lasers, their current use in astronomy as well as upcoming applications such as optical communication.

The session will end with a 30 minute round table discussion.

16:00-16:30 • **Exhibits and Coffee Break**, *Galleria Hall*

Harbor Ballroom I & II	Harbor Ballroom III
ASSL	LAC

ASSL — Harbor Ballroom I & II

16:30 -18:30

ATu5A • Frequency Combs and Compact Systems

Presider: To Be Announced

ATu5A.1 • 16:30
High Power Frequency Comb at 1.7-2.2 µm Wavelength, Christian Gaida[1], Tobias Heuermann[1,2], Martin Gebhardt[1,2], Evgeny Shestaev[1], Thomas Butler[3], Daniel Gerz[4], Nikolai Lilienfein[3,4], Marc Fischer[5], Ronald Holzwarth[5,3], Alfred Leitenstorfer[7], Ioachim Pupeza[3], Jens Limpert[1,6]; *[1]Inst. of Applied Physics, Germany; [2]Helmoltz-Inst. Jena, Germany; [3]Max Planck Inst. of Quantum Optics, Germany; [4]Ludwig Maximilians Univ. Munich, Germany; [5]Menlo Systems GmbH, Germany; [6]Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany; [7]Department of Physics and Center for Applied Photonics, Germany.* A Tm-doped fiber chirped-pulse amplifier delivers 60 W average power at 100 MHz pulse-repetition rate and <30 fs pulses featuring low RIN <0.5% and high phase stability <320 mrad (10 Hz to 50 MHz RF-band).

ATu5A.2 • 16:45
Generation and Characterization of Wavelength Tunable Narrow Linewidth Comb in Two Schemes, Nozomu Ohta[1], Youichi Sakakibara[2], Emiko Omoda[2], Hiromichi Kataura[2], Norihiko Nishizawa[1]; *[1]Nagoya Univ., Japan; [2]AIST, Japan.* 1.6-1.95 µm wavelength tunable, narrow linewidth comb was generated in two different schemes. Comb properties with high SNR were experimentally confirmed using heterodyne beat measurement with cw-LD, and dual comb beat measurement with supercontinuum comb.

ATu5A.3 • 17:00 Invited
Ultra-low-noise Monolithic Mode-locked Solid-state Lasers, Mamoru Endo[1], Thomas R. Schibli[1]; *[1]Univ. of Colorado at Boulder, USA.* We demonstrate GHz repetition-rate, monolithic mode-locked lasers, with a short-term, free-running phase noise performance rivalling actively stabilized lasers at a fraction of the system complexity. These lasers are robust and quick to assemble.

ATu5A.4 • 17:30
Raman laser gyroscope based on 100 kHz resonance, Jinkang Lim[1], Chee Wei Wong[1], Andrey Mmatsko[2], Anatoliy Savchenkov[2]; *[1]Univ. of California Los Angeles, USA; [2]OEwaves Inc., USA.* We investigate amplitude and frequency noise of a resonant Raman micro-laser and study its impact on the rotation detection. Feasibility of reaching tactical grade performance with the device is discussed.

ATu5A.5 • 17:45
Surface Activated Bonding (SAB) based Sub-nanosecond Distributed Face Cooling (DFC) Handheld Laser, Lihe Zheng[1], Takunori Taira[1]; *[1]Inst. for Molecular Science (IMS), National Inst.s of Natural Science (NINS), Japan.* A sub-nanosecond (666 ps) Distributed Face Cooling (DFC) handheld laser has been demonstrated with pulse energy of 21 mJ, depolarization ratio of 1.56% and brightness of 20 $TW.cm^{-2}.sr^{-1}$ at 10Hz.

ATu5A.6 • 18:00
100Hz operation in the PW/sr/cm²class Micro-MOPA, Taisuke Kawasaki[1], Vincent Yahia[1], Takunori Taira[1]; *[1]Inst. for Molecular Science, Japan.* 100Hz operation in the PW/sr/cm^2-class Micro-MOPA was achieved by evaluating thermal lens effect of highly excited Nd:YAG-rod in sub-ns 100-mJ class main amplifier and optimizing optics design.

ATu5A.7 • 18:15
High-Energy Diode-Pumped Alexandrite Oscillator and Amplifier Development for Satellite-Based Lidar, Alexander Coney[1], Ara Minassian[2], Michael J. Damzen[1]; *[1]Imperial College London, UK; [2]Unilase Ltd, UK.* Development of a Q-switched diode-pumped Alexandrite oscillator producing 3.8mJ pulse energy is described with wavelength and temperature optimisation of a diode-pumped Alexandrite slab amplifier as part of a future Alexandrite design for satellite-based lidar.

LAC — Harbor Ballroom III

16:30 -18:30

LTu5B • Extreme UV, X-Ray Generation and Particle Acceleration

Moderator: Lahsen Assoufid; Argonne National Lab, USA

The rapid progress in extreme-power laser technology opened a path to the development of a new generation of small-scale EUV, X-ray, and Gamma-ray light sources with unprecedented brightness and short pulses. These sources, which could fit on a tabletop or in a small-scale laboratory, will revolutionize many industrial, research, medical, defense, and security applications. Their development relies on the progress in laser technology and performance. This session will give an update on the latest development, needs and challenges in high-power laser technologies tailored to methods for short (EUV, X- and Gamma-ray) wavelength generation (laser-produced plasma, high harmonic generation, inverse Compton scattering), and laser plasma acceleration.

LTu5B.1 • 16:30 Invited
From Nuclear Security to Medicine: Development and Applications of Compact Laser-Compton Light Sources, Christopher Barty[1]; *[1]Univ. of CA, Irvine, USA.* The development and optimization of compact, high-peak and high-average brilliance laser-Compton x-ray and gamma-ray sources is reviewed. Markets span a wide range of precision imaging and material identification applications including; nuclear security, high-efficiency mining, additive manufacturing, precision medical imaging, rapid drug development and theranostics.

LTu5B.2 • 17:00 Invited
High Average Power and High Energy Picosecond Thin-Disk Amplifiers, Christian Grebing[1]; *[1]TRUMPF Scientific Lasers GmbH + Co. KG, Germany.* Industrial high power thin-disk laser technology was originally developed by TRUMPF for laser cutting and laser welding. Up to 10 kW of average power can be obtained from a single thin-disk. Today this technology is also routinely used for ultrafast amplifiers. Pulse durations < 1.5 ps, multi-millijoule pulse energies at kilohertz repetition rates, average powers beyond 1 kW can be easily achieved with near-diffraction-limited output beams. Already in 2015, pulse energies of 220 mJ were demonstrated at 1 kHz and recently record values >1 kW average power with up to 200 mJ. Further increase of the pulse peak power can be obtained via spectral shaping resulting in pulse durations below 700 fs. Efficient non-linear pulse compression schemes can result in even shorter pulses well below 50 fs. Moreover, new developments with thin-disk based multipass amplifiers should lead to multikilowatt average output powers with pulse energies reaching even the Joule level, uncovering new perspectives of applications. Besides pumping optical parametric amplifiers (OPA), Laser lightning rod, X-ray lasers, inverse Compton scattering and particle acceleration are among them. Lately, TRUMPF Scientific Lasers has been developing a Joule class thin-disk based multipass amplifier at 1 kHz. The talk will give an overview of the current status and development at TRUMPF Scientific Lasers regarding ultrafast thin-disk amplifiers.

19:00-20:00 • ASSL Postdeadline Paper Session, *Harbor Ballroom I & II*

07:00—18:00 • **Registration**, *Harbor Wing Lobby*

(closed during lunch)

Harbor Ballroom I & II

ASSL

08:00 -10:00

AW1A • Harmonic, Raman and THz conversion

Presider: Mark Bowers; Lockheed Martin Aculight Corp, USA

AW1A.1 • 08:00
180 W picosecond green laser from a frequency-doubled rod fiber amplifier, Zhi Zhao[1]; *[1]Brookhaven National Laboratory, USA.* We report on a 180 W picosecond green laser from a frequency-doubled Ytterbium-doped rod fiber amplifier. The fiber laser is designed to generate 270 W infrared and 180 W green power through efficient frequency doubling.

AW1A.2 • 08:15
Picosecond Ultraviolet Pulses at 257 nm with Variable Transform Limited Linewidth and Flexible Repetition Rate, Daniel Kiefer[1], Thomas Walther[1]; *[1]Technische Universität Darmstadt, Germany.* We present a fiber-based laser system generating transform limited pulses with adjustable duration (240 - 735 ps) and repetition rate (1 - 10 MHz). The pulses are frequency quadrupled to the ultraviolet at 257 nm.

AW1A.3 • 08:30
Ti:Sa CEP-Stabilized Laser System Allowing Wavelength Tunability or 1kHz, sub-18fs, TW-class Level Amplification., Anna Golinelli[1,2], Xiaowei Chen[1], Emilien Gontier[1], Benoit Bussiere[1], Pierre Mary Paul[3,1], Olivier Tcherbakoff[2], Pascal D'Oliveira[2], Jean-Francois Hergott[2]; *[1]Amplitude Laser Group - Lisses operations, France; [2]LIDYL, CEA, CNRS, Université Paris-Saclay, UMR 9222, CEA-SACLAY, France; [3]Amplitude Laser Group – San Jose operations, USA.* We present a Ti:Sa laser system based on an original 10 kHz front-end design allowing either CEP-stabilized (350 mrad), 1 kHz, 17.8 fs TW-class pulses amplification or direct 80 nm wavelength tunability range.

AW1A.4 • 08:45
High power 1st and 2nd Stokes diamond Raman frequency conversion, Matthias Heinzig[1], Till Walbaum[1], Gonzalo Palma Vega[1,2], Thomas Schreiber[1,2], Ramona Eberhardt[1], Andreas Tünnermann[1,2]; *[1]Fraunhofer IOF, Germany; [2]Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany.* We report high power frequency conversion in a diamond Raman laser operating on the first and second Stokes shift. At the first Stokes, a maximum output power of 125 W at 1178 nm was achieved.

AW1A.5 • 09:00
External Cavity Diamond Raman Laser at 2.52 µm, Giorgos Demetriou[1], Vasili Savitski[1], Alan Kemp[1]; *[1]Inst. of Photonics, Strathclyde Univ., UK.* An external-cavity diamond Raman laser at 2.52 µm, pumped by a home-built Tm:YLF laser, is reported. The maximum output pulse energy is 1.1 mJ for 4.74 mJ incidence yielding a total conversion efficiency of 23%.

AW1A.6 • 09:15
Hundred watt 10th order random Raman fiber laser, Jinyan Dong[1], Lei Zhang[1], Huawei Jiang[1], Yan Feng[1]; *[1]Shanghai Inst of Optics & Fine Mechanics, China.* With a high power Yb doped fiber laser as pump source, 10th cascaded Raman scattering to 1.95 µm in a half-open random fiber laser is demonstrated with an output power of 110 W.

AW1A.7 • 09:30
High Repetition-Rate Fiber Laser Driven THz Source Based on Two-Color Air-Plasma, Joachim Buldt[1], Cesar Jauregui[1], Michael Mueller[1], Jens Limpert[1,2]; *[1]Friedrich Schiller Universität Jena, Germany; [2]Helmholtz-Inst. Jena, Germany.* We demonstrate a first fiber-laser driven two-color air-plasma based THz source operating at 30 kHz repetition rate. The generated THz spectrum covers 0.1 – 5 THz and has an average power in the mW-range.

AW1A.8 • 09:45
Mode-Locked Thin-Disk Oscillator Driven THz Generation at 106 W of Average Power, Frank Meyer[1], Negar Hekmat[1], Samira Mansourzadeh[1], Martin Hoffmann[1], Clara J. Saraceno[1]; *[1]Photonics and Ultrafast Laser Science, Ruhr Universität Bochum , Germany.* We demonstrate THz generation in GaP driven by a mode-locked thin-disk oscillator delivering 120 W average power. We measured up to 78 µW at 0.8 THz. This result paves the way towards compact Watt-level, ultrafast oscillator pumped THz sources.

Harbor Ballroom III

LAC

08:00 - 10:00

LW1B • Laser Applications for Mobility

Moderator: Gerald Uyeno, Raytheon, USA

LW1B.1 • 08:00 Invited
Holographic HUD and LIDAR Systems, Pierre-Alexandre Blanche[1]; *[1]Univ. of Arizona, USA.* Holography can offer unique solutions to the specific problems faced by embarked optical systems. Head up display (HUD) and LIDAR for autonomous vehicles are two of these systems where we have used diffractive optical elements to provide original answers.

LW1B.2 • 08:20 Invited
Component and Module Technologies for Rugged and Low Cost LiDAR, Scott Davis[1]; *[1]Analog Devices Inc., USA.* The combined move toward increased automation and improved safety has created a market opportunity for low cost, rugged, Light Detection and Ranging systems. At Analog Devices Inc., we are developing component and module technologies to support this emerging market. These include non-mechanical laser beamsteering devices, high current laser drivers, detection and digitization electronics, and others. In this talk we will discuss our strategy for technology development to support LiDAR and give details of some new emergent capabilities. In particular we will present our non-mechanical beamsteering technology and how it can be implemented into a LiDAR system to meet automotive sensing requirements.

LW1B.3 • 08:45 Invited
Diode Laser Requirements and Challenges for Enabling TOF and FMCW Lidars for Autonomous Vehicles, Umar Piracha[1]; *[1]IMEC, Belgium.* This talk will give a brief overview of two different lidar implementations: Time of Flight (TOF) and Frequency Modulated Continuous Wave (FMCW). The challenges and performance required from diode lasers to enable a compact solid state lidar system suitable for autonomous vehicles will be discussed.

LW1B.4 • 09:10 Invited
Self-Driving Cars and Lidar, Simon Verghese[1]; *[1]WAYMO, USA.* Before graduating from X as Waymo, Google's self-driving car project had been using custom lidars for several years. In their latest revision, the lidars are designed to meet the challenging requirements we discovered in autonomously driving over 6 million highly-telemetered miles on public roads. Our goal is to make them affordable while meeting the performance needed for driverless operation in different cities and weather conditions. This talk will review some history of the project and describe a few use-cases for lidars on Waymo cars. Out of that will emerge key differences between lidars for self-driving and traditional applications (e.g. mapping) which may provide opportunities for semiconductor lasers and detectors.

LW1B.5 • 09:35 Invited
A Systems Approach to Perception Focused High Fidelity LiDAR, Matt Weed[1]; *[1]Luminar, USA.* The computational cores of autonomous vehicles dominate their cost and power consumption roadmaps, not the sensors themselves. Explore how highly representational 3D data, over range, accelerates the commercialization of self-driving vehicles.

10:00-11:00 • **Exhibits and Coffee Break**, *Galleria Hall*

Harbor Ballroom I & II	Harbor Ballroom III
ASSL	LAC

11:00 -12:15

AW2A • Joint Session: Vortex Sources and Applications

Presider: Balaji Srinivasan; Indian Inst. of Technology, India

AW2A.1 • 11:00 Invited

Versatile Vortex Laser Sources and Their Application, Takashige Omatsu[1]; [1]*Chiba Univ., Japan.* We review wavelength versatile optical vortex sources in an ultraviolet~THz wavelength region. Such wavelength versatile vortex sources should open an avenue towards advanced sciences and innovative technologies, including nondestructive super-resolution molecular spectroscopy and chiral microfabrication of organic materials.

AW2A.2 • 11:30

Vortex Laser Output with a Fundamental Gaussian Internal Mode using a Sagnac Interferometer, William R. Kerridge-Johns[1], Jan W. Geberbauer[1], Andrea Volpini[1], Michael J. Damzen[1]; [1]*Photonics Group, Imperial College London, United Kingdom*. We experimentally demonstrate a simple technique to convert any linear laser cavity into an optical vortex source using a Sagnac interferometer as an output coupler. No specialist optics are needed, the vortex has controlled handedness.

AW2A.3 • 11:45

Generation of polygonal vortex beams in quasi-frequency-degenerate states of Yb:CALGO laser, Yijie Shen[1], Zhensong Wan[1], Yuan Meng[1], Xing Fu[1], Mali Gong[1]; [1]*Tsinghua Univ., China.* We originally demonstrate the vortex beams carrying large OAM with exotic patterns of closed polygons, which is generated by a Yb:CALGO laser resonator with astigmatic transformation in quasi-frequency-degenerate SU(2) states.

AW2A.4 • 12:00

15-dB Raman Amplification of an Optical Orbital Angular Momentum Mode in a Step -Index Fiber, Sheng Zhu[1], Shankar Pidishety[1], Johan Nilsson[1]; [1]*Univ. of Southampton, UK.* We experimentally demonstrate 15-dB Raman amplification of 1115-nm, 20-ns pulses of charge $l = +2$ orbital angular momentum mode in a 5-m multimode-pumped step-index fiber with measured mode purity of 83.2%.

11:00 -12:00

LW2B • Laser Induced Damage Threshold (LIDT) of Optical Coatings for Applications with High Intensity Lasers

Moderator: Danijela Rostohar, Inst. of Physics ASCR, Czech Republic

In the era of new generation high intensity lasers and their application, development and testing of new optical components and their coatings plays a crucial importance. Laser Induced Damage Threshold (LIDT) measurements are an essential part in understanding a very complex mechanism of damage occurrence. LIDT is a function of various parameters including laser wavelength, pulse duration, pulse repetition frequency, spot size, temporal and spatial profile, and angle of incidence. The purpose of this session is to bring attention to existing limitations in development of optical components and their coatings as well as requirements for establishing new techniques and standards on their LIDT testings.

LW2B.1 • 11:00 Invited

Laser Induced Damage Threshold (LIDT) of Optical Coatings for Applications with High Intensity Lasers, Helmut Kessler[1]; [1]*Manx Precision Optics, UK.* The development of high power and intensity lasers has driven the need for increased laser-induced damage thresholds in optical components. This talk gives an overview of the development of such coatings, detailing the considerations and challenges.

LW2B.2 • 11:30 Invited

A Study of Laser-Induced Damage and Color Center Formation by Multiple Laser-Pulses Irradiation, Shinji Motokoshi[1]; [1]*Inst. for Laser Technology, Japan.* We will present about the database construction on damage threshold for optics in Japan, and the causes of that damage threshold by multiple laser pulses is lower than that by single pulse.

12:00-13:30 • Complimentary Lunch in Galleria Hall

Harbor Ballroom I & II	Harbor Ballroom III
ASSL	LAC

13:30 -15:30

AW3A • Joint Session: Mid-IR Transition Metal Doped II-VI Materials and Lasers

Presider: Peter Schunemann, BAE Systems Inc, USA

AW3A.1 • 13:30
27 Watt Middle-IR Femtosecond Laser System at 2.4 μm, Sergey Vasilyev[1], Igor Moskalev[1], Viktor Smolski[1], Jeremy Peppers[1], Mike Mirov[1], Sergey Mirov[1,2], Valentin Gapontsev[3]; *[1]IPG Photonics Southeast Technology Center, USA; [2]Department of Physics, Univ. of Alabama at Birmingham, USA; [3]IPG Photonics Corporation, USA.* We demonstrate an approach to power scaling of middle-IR femtosecond pulses at the wavelength 2–3 μm to multi ten-Watt level in simple and robust single-pass spinning ring amplifier based on polycrystalline Cr:ZnSe.

AW3A.2 • 13:45
Broadband dispersive mirrors for Cr:ZnS/Cr:ZnSe laser, Vladimir Pervak[1], Tatiana Amotchkina[1], Qing Wang[1], Ka Fai Mak[1], Oleg Pronin[2], Michael Trubetskov[2]; *[1]Ludwig-Maximillians-Universität Munchen, Germany; [2]Max Plank Inst. for Quantum Optics, Germany.* The broadband dispersive mirror based on Si/SiO_2 thin-film materials and providing group delay dispersion of -200 fs^2 in the spectral range from 2 to 3.2 μm have been successfully developed and produced for the first time.

AW3A.3 • 14:00
Visible-Near-Middle Infrared Spanning Supercontinuum Generation in a Silicon Nitride Waveguide, Dmitry Martyshkin[1,2], Vladimir Fedorov[1,2], Taylor Kesterson[1], Sergey Vasilyev[2], Hairun Guo[3], Jinqiu Liu[3], Wenle Weng[3], Clemens Herkommer[3], Konstantin Vodopyanov[4], Tobias Kippenberg[3], Sergey B. Mirov[1,2]; *[1]Univ. of Alabama at Birmingham, USA; [2]Southeast Technology Center, IPG Photonics, USA; [3]Ecole Polytechnique Federale de Lausanne, Switzerland; [4]The College of Optics and Photonics, CREOL, USA.* We demonstrate the generation of a supercontinuum spanning more than 1.5 octaves over 1.2-3.7 mm range in a silicon nitride waveguide using sub-40-fs pulses at 2.35 mm generated by 75 MHz Cr:ZnS laser.

AW3A.4 • 14:15
Middle Infrared Electroluminescence of Cr^{2+} ions in n-type Al:Cr:ZnSe crystal, Ozarfar Gafarov[1], Rick Watkins[1], Vladimir Fedorov[1], Sergey B. Mirov[1]; *[1]Univ. of Alabama at Birmingham, USA.* Middle-infrared electroluminescence of n-type Cr:ZnSe single crystal induced by impact excitation is reported. Conductivity was achieved via thermal diffusion doping of ZnSe with Al. An estimation of the threshold current density for lasing was performed.

AW3A.5 • 14:30
A 4.1 micron mode-locked Fe:ZnSe laser, Andrew Ongstad[1], Evan Lang[2], Hoeffner Erica[2], Adrian Lucero[1], Jonathan Evans[1], Andreas Schmitt-Sody[1]; *[1]Air Force Research Laboratory, USA; [2]Leidos, USA.* We report on the first demonstration of a cryogenically cooled, mode-locked Fe:ZnSe laser. A Brewster angle mounted Fe:ZnSe polycrystal, cooled to ~78 K lased near 4.1 μm and was passively mode locked generating 8.9 ps pulses.

AW3A.6 • 14:45
Gain Switched and Q-switched Fe:ZnSe Lasers tunable over 3.60-5.15 μm, Vladimir Fedorov[1], Dmitry Martyshkin[1], Krishna Karki[1], Sergey B. Mirov[1]; *[1]Univ. of Alabama at Birmingham, USA.* We report on gain-switched room temperature Fe:ZnSe laser tunable over 3.60-5.15 μm pumped by Er:YAG laser operating at 2.94 mm. The maximum output energy was measured to be 5 mJ under 15mJ of pump energy.

AW3A.7 • 15:00
Energy Transfer in Fe:Cr:ZnSe mid-IR laser materials, Tristan Carlson[1], Ozarfar Gafarov[1], Vladimir Fedorov[1], Sergey B. Mirov[1]; *[1]Univ. of Alabama at Birmingham, USA.* The room-temperature kinetics of Fe:Cr:ZnSe under 1560nm excitation shows that the energy transfer among Fe-Cr centers is as fast as 290ns and is promising as pump mechanism for Fe lasing.

AW3A.8 • 15:15
Highly efficient continuous wave single mode Cr^2+:CdSe laser with output power more than 2W, Mikhail K. Tarabrin[1,2], Dmitry V. Ustinov[1], Sergey M. Tomilov[1,2], Vladimir A. Lazarev[1], Valery E. Karasik[1], Vladimir I. Kozlovsky[2,3], Yuri V. Korostelin[2], Yan K. Skasyrsky[2], Mikhail P. Frolov[2]; *[1]Bauman Moscow State Technical Univ., Russia; [2]P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; [3]National Research Nuclear Univ. MEPhI, Russia.* We report on more than 2 W continuous wave single mode Cr2+:CdSe laser generation. For the first time, luminescence lifetime dependence on temperature for Cr2+:CdSe single crystal in 236-391 K range was obtained.

13:30 -15:30

LW3B • Laser Shock Peening

Moderator: Danijela Rostohar; Inst. of Physics ASCR, Czech Republic
Yuji Sano; Japan Science and Technology Agency, Japan

Laser peening has great potential to prolong the service life of various products and components, and is expanding the application area based on the advancement in high-power laser technology. The purpose of this session is to provide a forum for exchanging the latest results of research, development and innovation in laser peening and related technologies including high-power lasers, new processes such as adhesion/damage testing, laser interaction models and application to different types of materials and components with emerging interest.

LW3B.1 • 13:30 Invited
Diode-Pumped Production Laser Peening Equipment, Jeff Dulaney[1]; *[1]LSP Technologies Inc., USA.* Dr. Dulaney will discuss the advancement in production laser peening equipment and its increasing adoption throughout the commercial manufacturing sector. This presentation will cover the technological innovations of LSP Technologies' high-repetition-rate production laser peening systems.

LW3B.2 • 14:00 Invited
A New Additive Manufacturing Hybrid Process Combining Selective Laser Melting with Laser Shock Peening, Roland Logé[1]; *[1]EPFL, Switzerland.* 3D LSP is a hybrid process resulting from the combination of Selective Laser Melting (SLM) with Laser Shock Peening (LSP). It consists in applying LSP periodically, during 3D printing of metallic alloys, and leads to the 3D control of residual stresses. This is used to improve fatigue life of SLM parts, and leads to enhanced results compared to standard 2D LSP treatments, due to the increased penetration depth of LSP induced compressive stresses. Other benefits of 3D LSP include reduced process failure related to cracking, and improved geometrical accuracy. The approach also provides new degrees of freedom for the 3D control of material hardness and grain size.

LW3B.3 • 14:30 Invited
Laser Shock Peening Technology Development: a South African Initiative, Claudia Polese[1]; *[1]Univ. of the Witwatersrand, South Africa.* Laser Shock Peening (LSP) is a cutting edge technology capable of drastically extending the operative life of critical metallic components. The synergic collaboration within the South African LSP Group succeeded in establishing a research work cell, a total first for a laboratory in Africa and probably in the entire Southern Hemisphere. Excellent performances for aluminum airframe structures were obtained and innovative process features were characterized, spearheading the group at the forefront of this rapidly emerging technology.

The current group activity is aimed at further extending the potential applications of LSP for the national and international aerospace and power generation industries. A more robust technology demonstrator is under development on a Thales laser platform, integrating a prototype of a patented "heartbeat" diagnostic system. This innovative monitoring device is based on the unique acoustic signature of the LSP process, which is directly proportional to the laser-material interaction.

15:30—16:00 • Exhibits & Coffee Break, *Galleria Hall*

16:00 -17:45

AW4A • Mid-IR sources

Presider: Jim Kafka; Spectra-Physics Lasers, USA

AW4A.1 • 16:00

Highly-Stable 2.8 μm MOPA System with Fluoride-Fiber-Based Pump Combiners, Hiyori Uehara[1], Daisuke Konishi[2], Christian Schäfer[2], Kenji Goya[1], Masanao Murakami[2], Shigeki Tokita[1]; [1]*Osaka Univ., Japan;* [2]*Mitsuboshi Diamond Industrial Co., Ltd., Japan.* We have demonstrated a stable CW operation with output power of 24 W by an Er:ZBLAN fiber MOPA system at 2.8 μm wavelength. It is our unique technology that fabrication of a fluoride-fiber-based pump combiner which inhibits thermal loading of the fiber.

AW4A.2 •
Withdrawn

AW4A.3 • 16:15 Invited

2.3-12 μm Tunable, Sub-10 Optical Cycle, ZnGeP2-based OPA Directly Pumped by a Tm:fiber Laser at 1.96 μm and 100 kHz, Matthias Baudisch[1], Marcus Beutler[1], Martin Gebhardt[2,3], Christian Gaida[2], Fabian Stutzki[2], Steffen Hädrich[4], Robert Herda[5], Kevin Zawilski[6], Peter G. Schunemann[6], Armin Zach[5], Jens Limpert[2,7], Ingo Rimke[1]; [1]*APE Angewandte Physik & Elektronik GmbH, Germany;* [2]*Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany;* [3]*Helmholtz-Inst. Jena, Germany;* [4]*Active Fiber Systems GmbH, Germany;* [5]*TOPTICA Photonics AG (Germany), Germany;* [6]*BAE Systems, MER15-1813, P.O. Box 868, Nashua, New Hampshire 03061, USA;* [7]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We demonstrate the first ZnGeP2-based, femtosecond OPA system driven directly by a Thulium-based fiber-laser system operated at 100 kHz. The OPA delivers mid-to-long-infrared tunable pulses with idler energies up to 2.2 μJ (23% quantum efficiency).

AW4A.4 • 16:45

Multi-μJ, 8.8 μm, Mid-infrared Laser with a Flat Spectrum Supporting Single-cycle Pulses from a GaSe-based Optical Parametric Amplifier, Kun Liu[1,2], Houkun Liang[1], Lifeng Wang[1], Shizhen Qu[1,2], Hao Li[1], Qijie Wang[2], Ying Zhang[1]; [1]*Precision Measurements Group, Singapore Inst. of Manufacturing Technology, Singapore;* [2]*Centre for OptoElectronics and Biophotonics, School of Electrical & Electronic Engineering & The Photonics Inst., Nanyang Technological Univ. , Singapore.* We report an 8.8 μm, carrier-envelope phase stable, mid-infrared optical parametric amplifier based on a GaSe nonlinear crystal, with 3.4-μJ idler pulse energy, and a flat spectrum covering 4.2-to-16 μm which supports single-cycle pulses.

AW4A.5 • 17:00

High-Average-Power, 100-kHz OPCPA System with Dual Output at 1.55/3.1 μm, Mark Mero[1], Zsuzsanna Heiner[2,3], Valentin Petrov[1], Horst Rottke[1], Federico Branchi[1], Gabrielle M. Thomas[1], Marc J. Vrakking[1]; [1]*Max Born Inst., Germany;* [2]*School of Analytical Sciences Adlershof SALSA, Humboldt-Universität zu Berlin, Germany;* [3]*Department of Chemistry, Humboldt-Universität zu Berlin, Germany.* We present a 100-kHz OPCPA system based on noncollinear KTA booster amplifiers delivering 43-W, 51-fs, CEP-stable pulses at 1.55 μm and angular-dispersion-compensated, 12.5-W, 73-fs pulses at 3.1 μm.

AW4A.6 • 17:15

Multi-mJ sub-100 fs Midwave-infrared OPCPA at a 1 kHz Repetition Rate, Lorenz von Grafenstein[1], Martin Bock[1], Kevin Zawilski[2], Peter G. Schunemann[2], Uwe Griebner[1], Thomas Elsaesser[1]; [1]*Max Born Inst., Germany;* [2]*BAE Systems, USA.* The parametric generation of 2.5 mJ ultrashort pulses at 5 μm is reported using a 2-μm pump source which delivered pulses with 43 mJ energy and 2.8 ps duration at a 1 kHz repetition rate.

AW4A.7 • 17:30

High-Average-Power Few-Cycle Pulses at 2.5 μm, Nicolas Bigler[1], Justinas Pupeikis[1], Stefan Hrisafov[1], Lukas Gallmann[1], Christopher R. Phillips[1], Ursula Keller[1]; [1]*Department of Physics, Inst. of Quantum Electronics, ETH Zurich, Switzerland.* We present a high-power mid-infrared (mid-IR) optical parametric chirped-pulse amplifier (OPCPA) generating 13.4 fs pulses centered at 2.5 μm at an average power of 12.2 W and a repetition rate of 100 kHz.

18:00-21:00 • Congress Banquet, *Spirit Cruise*

07:30-14:00 • **Registration**, *Harbor Wing Lobby*

(closed during lunch)

Harbor Ballroom I & II

ASSL

08:00 -10:00

ATh1A • Fiber Materials and Processes

Presider: Stefano Taccheo, Swansea University, UK

ATh1A.1 • 08:00 Invited

Advances in Semiconductor-core Fiber, Ursula J. Gibson[1,2]; *[1]Norges Teknisk Naturvitenskapelige Univ, Norway; [2]Applied Physics, KTH, Sweden.* Silicon, silicon-germanium and GaSb-core fibers fabricated with the molten-core drawing technique demonstrate non-linear effects, long wavelength transmission, and potential as fiber-based sources. Material processing aspects of these fibers will be discussed.

ATh1A.2 • 08:30

Efficient Lasers at 1.6-1.8 µm Based on Bismuth-Doped Germanosilicate Fibers with Thermally Induced Active Centers, Evgeny M. Dianov[1], Sergei Firstov[1,2], Aleksandr Kharakhordin[1], Sergey Alyshev[1], Konstantin Riumkin[1], Mikhail Melkumov[1]; *[1]Fiber Optics Research Center, RAS, Russia; [2]Ogarev Mordovian State Univ., Russia.* The laser performance at the wavelength 1700 nm with a slope efficiency of 18% has been demonstrated using a 8.5-m long bismuth-doped fiber containing thermally induced active centers.

ATh1A.3 • 08:45

Tapered photonic crystal fiber for wide repetition rate tuning of optoacoustically mode-locked fiber laser, Dung-Han Yeh[1], Wenbin He[1], Meng Pang[1], Xin Jiang[1], Gordon Wong[1], Philip Russell[1]; *[1]MPI Science of Light, Germany.* Tapering a few-m length of solid-core PCF results in a three-times-broader optoacoustic gain bandwidth, enabling the GHz repetition rate of an optoacoustically mode-locked fiber laser to be continuously tuned over more than 50 MHz.

ATh1A.4 • 09:00

Study of fiber fuse induced damage in chalcogenide photonic crystal fibers, Sida Xing[1], Svyatoslav Kharitonov[1], Jianqi Hu[1], Camille-Sophie Brès[1]; *[1]École polytechnique fédérale de Lausanne, Switzerland.* We observed fiber fuse in relatively low-melting temperature chalcogenide photonic crystal fibers at 7MW/cm^2 intra-core intensity. The voids structure and period were investigated. Chalcogenide vapor traveling in air -holes modified fiber dispersion beyond fiber fuse region.

ATh1A.5 • 09:15

Large-mode-area Photonic Crystal Fiber Towards Pulse Laser Amplification Based on YbAl/P/F Codoped Silica Glass, Fan Wang[1,2], Meng Wang[1], Suya Feng[1], Shikai Wang[1], Chunlei Yu[1], Lili Hu[1]; *[1]Shanghai Inst of Optics & Fine Mech Lib, China; [2]Univ. of Chinese Academy of Sciences, China.* A low NA heavily Yb-doped large-mode-area photonic crystal fiber based on YbAl/P/F codoped silica glass with a 50-µm diameter core has been prepared. The laser oscillation and pulsed laser amplification behaviors has been investigated.

ATh1A.6 • 09:30

Large-Core Hollow-Core Antiresonant Fiber with Low-Loss and Truly Single-Mode Guidance for N-IR Wavelengths, Laurent Provino[1], Adil Haboucha[1], Mélanie Havranek[1], Achille Monteville[1], David Landais[1], Olivier Le Goffic[1], Xavier Insou[2], Margaux Barbier[2], Thierry Chartier[2], Monique Thual[2], Thierry Taunay[1]; *[1]PERFOS, RTO of Photonics Bretagne, France; [2]Univ Rennes, CNRS, Institut FOTON – UMR 6082, France.* We report on the modeling and characterization of a truly single-mode hollow-core antiresonant fiber with a transmission band covering part of the near-infrared spectral region. Measured losses are 0.075 dB/m and 0.052 dB/m at 1.55 µm and 2.0 µm respectively.

ATh1A.7 • 09:45

High Average Power Transmission Through Hollow-core Fibers, Gonzalo Palma Vega[1,2], Franz Beier[1,2], Fabian Stutzki[1], Simone Fabian[1], Thomas Schreiber[1], Ramona Eberhardt[1], Andreas Tünnermann[1,2]; *[1]Fraunhofer Inst. for Applied Optics and Precision Engineering , Germany; [2]Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany.* We present our latest test of hollow-core fibers for applications in high-power beam delivery. A negative-curvature hollow-core fiber has been tested with a single mode fiber laser, with up to 1.2 kW average power transmission.

Harbor Ballroom III

OIDA Executive Forum

08:00 -12:30

OIDA Executive Forum

08:00-8:15

Welcome Remarks

8:15-09:00

Keynote Presentation: Lasers and Human Progress; How Much Further?

David Townes*; Needham & Company, LLC*

Energy use and energy efficiency is the engine of human progress. Lasers in multiple applications are central to the more useful and efficient use of energy. We are still in early stages of reaping the benefits of lasers in many different market applications. Talk will focus on the dynamics, size and growth outlook of different applications of lasers and the fundamental energy drivers of the outlook for key applications.

09:10-10:00

Session: Financial Perspective on the Laser Industry

Conard Holton; *Laser Focus World*

Linda Smith; *Ceres Technology Advisors*

This panel will feature presentations followed by a moderated panel discussion on the laser industry from a financial perspective. The panel will feature speakers from private investment banking and M&A (mergers and acquisitions) and corporate investment. It will address perennial questions about consolidation, the availability or challenges to obtaining financial resources, and trends in the field that will affect the trajectory of the laser market.

10:00-10:45

Coffee Break

10:45-11:30

Keynote Presentation: OEM Perspective on Laser Technologies for the Next Generation Vehicles

Stefan Kienzle; *Daimler AG*

Based on the challenges of next generation vehicles (e.g. connectivity/autonomy/shared/electric) and the requirements for future body structures the growing importance of laser technology and use cases are explained.

11:30-12:30

Session: Lasers for Manufacturing Mobile Platforms

Ralf Kimmel, TRUMPF

Sri Venkat, Coherent

This panel will feature presentations followed by a moderated panel discussion of the opportunities and challenges to the commercialization of lasers for future mobile platforms. The latter include electric powered or hybrid cars, trains, aircrafts, new power grids, autonomous robots, and so forth. Those technologies are enabled by ultralightweight engines, batteries, and autonomous control systems which require new material combinations, sensors, and smart design approaches. What are the opportunities and challenges for lasers in this new manufacturing environment in terms of wavelengths, power, mode of operation, connectivity, and I4.0. What are the price points for these items that need to be met to make it really happen? Is there new territory where laser-based tools can displace other technologies or expand on current ones?

12:30-13:30 • **OIDA Executive Forum Networking Lunch** *(Event Attendees Only)*

10:00 -11:30

ATh2A • ASSL Poster Session

ATh2A.1
Dual comb laser system for time-resolved spectroscopy of laser induced plasmas from the UV to VUV, Caroline Lecaplain[1], Reagan Weeks[1], Yu Zhang[1], Jeremy Yeaks[2], Sivanandan Harilal[3], Mark C. Philipps[3], R. Jason Jones[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Opticslah, USA;* [3]*Pacific Northwest National Laboratory, USA.* A dual-comb Yb laser system is used to measure the time-resolved evolution of absorption spectra from multiple atoms/ions following laser ablation of metal alloys. These results will be extended into the VUV utilizing high-harmonic generation.

ATh2A.2
Reconversion of Higher-Order-Mode (HOM) Output from a Cladding-Pumped Hybrid Yb:HOM Amplifier, Kazi S. Abedin[1], Raja Ahmad[1], Anthony DeSantolo[1], Jeffrey Nicholson[1], Paul Westbrook[1], Clifford Headley[1], David DiGiovanni[1]; [1]*OFS Laboratories, USA.* We demonstrate reconversion of HOM output from an Yb:HOM amplifier to Gaussian-shaped beam by use of axicon based re-converter. Clean Gaussian-like beam was achieved with ~67% efficiency, close to theoretical value.

ATh2A.3
High Peak Power Tunable DUV Source around 275 nm from a Frequency quadrupled Nanosecond Yb-doped fiber MOPA, Jing He[1], Di Lin[1], Lin Xu[1], Martynas Beresna[1], Michalis Zervas[1], Shaif-ul Alam[1], Gilberto Brambilla[1]; [1]*Optoelectronics Research Center, UK.* A kW-class peak power wavelength tunable DUV source operating in the range of 272-276 nm is demonstrated by frequency quadrupling a diode-seeded, nanosecond, polarization-maintaining (PM), Yb-doped fiber master oscillator power amplifier (MOPA) system.

ATh2A.4 • 10:00
Nonlinear pulse compression in single-mode Yb-doped hybrid fiber with high anomalous dispersion at 1.064 µm, Svetlana Aleshkina[1], Mikhail Y. Salganskii[2], Denis S. Lipatov[2], Andrei K. Senatorov[1], Mikhail M. Bubnov[1], Alexey N. Guryanov[2], Mikhail Melkumov[1], Mikhail E. Likhachev[1]; [1]*Fiber Optics Res. Ctr the RAS, Russia;* [2]*Inst. of High Purity Substances of the Russian Academy of Sciences, Russia.* We demonstrate nonlinear pulse compression down to 250 fs and peak power of up to 3 kW using newly developed asymptotically single-mode Yb-doped hybrid fiber with extremely high (~400 ps/(nm×km)) anomalous dispersion at 1.064 µm

ATh2A.5
Sub-40 fs, 2 W Kerr-lens mode-locked Yb:CYA laser, Wenlong Tian[1], Jiangfeng Zhu[1], Zhaohua Wang[2], Xiaodong Xu[3], Jun Xu[4], Zhiyi Wei[2]; [1]*Xidian Univ., China;* [2]*Inst. of Physics, CAS, China;* [3]*Jiangsu Normal Univ., China;* [4] *Tongji Univ., China.* We demonstrate a high power single-mode fiber laser pumped Kerr-lens mode -locked Yb:CYA solid-state laser. As high as 2.1 W average power with down to 36 fs pulse duration is obtained after extra-cavity compression.

ATh2A.6
Enhancement Cavity with Elliptical Focussing for CW UV Generation Eliminating the Degradation Problem in BBO, Daniel Kiefer[1], Daniel Preissler[1], Thorsten Führer[1], Thomas Walther[1]; [1]*Technische Universität Darmstadt, Germany.* We present a novel design for an efficient enhancement cavity for frequency doubling into the UV. Radiation of 150 mW has been generated at 257 nm and remained stable for more than 15 hours.

ATh2A.7
Narrow-Linewidth Operation of Folded VECSEL Cavity with Twist-Mode Configuration, Yushi Kaneda[1], Michael L. Hart[2], Stephen H. Warner[2], Jussi-Pekka Penttinen[3], Mircea Guina[3]; [1]*Univ. of Arizona, USA;* [2]*Hart SCI, USA;* [3]*Vexlum Ltd, Finland.* VECSELs exhibit much different longitudinal mode behavior when the device is placed at a fold of a standing wave cavity. Lasing spectrum can be narrowed by employing mode-twisting, stabilizing the standing-wave pattern at the VECSEL.

ATh2A.8
14 MW doughnut beam Nd:YAG/Cr:YAG ceramic microchip laser with unstable cavity, Hwanhong Lim[1], Takunori Taira[1]; [1]*Inst. for Molecular Science, Japan.* We present a high-brightness doughnut beam laser based on a passively Q-switched monolithic Nd:YAG/Cr:YAG ceramic microchip laser with unstable cavity having the pulse-energy of 8.3 mJ, pulse-width of 570 ps, and M^2 value of 2.

ATh2A.9
50 Watts Single-Frequency Ytterbium MOPA Fiber Laser Operating at 1013 nm, Benoit Gouhier[1], Sergio Rota-Rodrigo[1], Germain Guiraud[2], Nicholas Traynor[2], Giorgio Santarelli[1]; [1]*LP2N, IOGS -CNRS- Univ. de Bordaux, France;* [2]*Azur Light Systems, France.* We have developed a 50W all-fiber, single-frequency, low-noise Yb-based master oscillator power amplifier laser operating at 1013nm, with an efficiency of 67%, an optical signal-to-noise ratio of 50dB and excellent noise properties.

ATh2A.10
Optical Frequency Divider and Synthesizer Based on Ti:sapphire Lasers, Long-Sheng Ma[1]; [1]*East China Normal Univ., China.* An Optical frequency divider (OFD) with division uncertainty of 1.4×10^{-21} has been realized based on a Ti:sapphire femtosecond laser. Using the OFD and CW Ti:sapphire laser, an optical frequency synthesizer with resolution of 1 Hz has been demonstrated in 700-990 nm.

ATh2A.11
SWCNT-Based Bismuth-Doped Fiber Laser at 1.32 µm, Aleksandr Khegai[1,2], Mikhail Melkumov[1], Sergei Firstov[1], Konstantin Riumkin[1], Yury Gladush[3,4], Sergey Alyshev[1], Alexey Lobanov[5], Vladimir Khopin[5], Fedor Afanasiev[5], Albert Nasibulin[4,6]; [1]*Fiber Optics Research Center of the Russian Academy of Sciences, Russia;* [2]*A M Prokhorov General Physics Inst. of the Russian Academy of Sciences, Russia;* [3]*Inst. for Spectroscopy of the Russian Academy of Sciences, Russia;* [4]*Skolkovo Inst. of Science and Technology, Russia;* [5]*Inst. of Chemistry of High-Purity Substances of the Russian Academy of Sciences, Russia;* [6]*Aalto Univ., Finland.* Stable self-starting bismuth-doped fiber laser mode-locked by polymer-free single-walled carbon nanotubes is described. Dissipative solitons as short as 7.8 ps and energy of ~110 pJ was obtained. Evolution of pulsed regime on pump power is presented.

ATh2A.12
Switchable single-dual-wavelength Yb,Na:CaF_2waveguide lasers operating in continuous-wave and pulsed regimes, Ajoy Kumar Kar[1], Yinging Ren[2], Mark Mackenzie[1], Feng Chen[3]; [1]*Heriot-Watt Univ., UK;* [2]*Shandong Normal Univ., China;* [3]*Shandong Univ., China.* Depressed-cladding waveguides are produced in Yb,Na:CaF_2laser crystal by applying ultrafast laser inscription. Under pumping at 946 nm, continuous-wave (CW) and Q-switched laser oscillations with switchable single- and dual-wavelength are realized in these waveguide structures.

ATh2A.13
Comparative Study of Techniques for Measurement of Linewidth and Frequency Noise of Single-Frequency Lasers, Gerald M. Bonner[1], Craig Hunter[1,2], Brynmor E. Jones[1], Matthew S. Warden[1], Jack Thomas[1], Loyd J. McKnight[1], Alexander A. Lagatsky[1], David J. Stothard[1], Jonathan M. Jones[3], Yeshpal Singh[3], Kai Bongs[3], Fedor V. Karpushko[4]; [1]*Fraunhofer Centre for Applied Photonics, UK;* [2]*Inst. of Photonics, Department of Physics, Univ. of Strathclyde, UK;* [3]*School of Physics and Astronomy, Univ. of Birmingham, UK;* [4]*UniKLasers Ltd, UK.* Measuring the linewidth of single-frequency lasers is challenging, and great care must be taken to understand the capabilities and limitations of different measurement techniques to obtain consistent results. A detailed comparative study will be presented.

ATh2A.14
High-Power Synchronized Dual-Channel Laser Enabling Fast 2- and 3-Photon *in vivo* Brain Imaging, Robert Riedel[1], Michael Schulz[1], Ivanka Grguras[1], Torsten Golz[1], Mark Prandolini[1]; [1]*Class 5 Photonics, Germany.* To study the *in vivo* functional dynamics of deep brain tissue, a high power, synchronized dual-channel laser has been developed providing laser pulse parameters: 3.8 W (4.7 MHz) at 960 nm (< 90 fs) and 1.2 W (1 MHz) at 1300 nm (< 70 fs). Both channels are synchronized to within 5 fs (rms).

ATh2A.15
High Power Picosecond Parametric Mid-IR Source Tunable Between 1.5 and 3.2 µm, Ondrej Novak[1], Bianka Csanakova[1,2], Lukas Roskot[1,2], Michal Vyvlecka[1], Jiri Muzik[1,2], Martin Smrz[1], Akira Endo[1], Helena Jelinkova[2], Tomas Mocek[1]; [1]*Inst. of Physics, AS CR, v.v.i., Czechia;* [2]*Faculty of Nuclear Sciences and Physical Engineering, Czech Technical Univ., Czechia.* Picosecond parametric mid-IR source pumped by a thin -disk laser delivers up to 9 W signal and 5 W idler beam. The signal and idler tuning ranges are 1.52 – 1.98 µm and 2.14 – 3.15 µm, respectively.

ATh2A.16
Optical Parametric Amplification Using Dual Chirps, Michael H. Helle[1]; [1]*Naval Research Laboratory, USA.* A new type of optical parametric amplifier based on dual chirps is presented. Simulations indicate an increase in bandwidth when compared to existing systems as well as the potential for active carrier envelop phase control.

ATh2A.17
**Simulations and Experimental Demonstration of Large Aperture Harmonic Generation Energy Clamping Due to Wavefront Distortion/Defocus in Glass Amplifier Systems for Nanosecond Pulses at 1 GW/cm², ** Waseem Shaikh[1], Pedro Oliveira[1], Ian musgrave[1], Marco Galimberti[1], Trevor Winstone[1], Christina Hernandez.Gomez[1]; [1]*CCLRC, UK.* The efficient frequency doubling is needed in the next generation of long pulse OPCPA amplification schemes. We model and observe energy clamping in thick crystals due to wavefront distortion in the Nd:Glass amplifier systems.

10:00 -11:30

ATh2A • ASSL Poster Session with Coffee

ATh2A.18

532 nm Random Laser Based on Yb-Assisted Random Distributed Fiber Laser Frequency Doubling, Sergio Rota-Rodrigo[1], Benoit Gouhier[1], Clément Dixneuf[2,1], LAura Antoni-Micollier[1], Germain Guiraud[2], Daniel Leandro[3], Manuel Lopez-Amo[3], Nicholas Traynor[2], Giorgio Santarelli[1]; *[1]LP2N, IOGS -CNRS- Univ. de Bordaux, France; [2]Azur Light Systems, France; [3]UPNA / ISC, Spain.* We have developed a Watt-level random laser at 532nm based on second harmonic generation of a 1064nm random distributed ytterbium-gain assisted fiber laser. The laser exhibits instability <1%, OSNR>70dB, 0.1nm linewidth and excellent beam quality .

ATh2A.19

69 fs SESAM mode-locked Yb:GdYCOB oscillator, Weidong Chen[1], Haifeng Lin[1], Zhanglang Lin[1], Ruxue Bai[1], lizheng Zhang[1], Zhoubin Lin[1], Ge Zhang[1]; *[1]Fujian Inst of Res Structure of Matter, China.* We present an efficient femtosecond SESAM mode-locked oscillator based on a “mixed” Yb:GdYCOB crystal. Near Fourier transform limited pulse duration of 69 fs was obtained under the pulse repetition rate of 109 MHz.

ATh2A.20

Passively *Q*-switched $Er:Lu_2O_3$ Ceramic Laser at 2.8 µm using Graphene Saturable Absorber, Hiyori Uehara[1], Shigeki Tokita[1], Junji Kawanaka[1], Daisuke Konishi[3], Masanao Murakami[3], Seiji Shimizu[3], Ryo Yasuhara[2]; *[1]Osaka Univ., Japan; [2]National Inst. for Fusion Science, Japan; [3]Mitsuboshi Diamond Industrial Co., Ltd., Japan.* We have demonstrated a passively *Q*-switched $Er:Lu_2O_3$ ceramic laser using a monolayer graphene saturable absorber. The stable pulsed operation with watt-level average power was performed, and the maximum pulse energy of 9.4 µJ and peak power of 33W were achieved in 250 ns pulse duration.

ATh2A.21

Diode End Pump External KGW/ Tm:YLF Raman Laser, Salman Noach[1], Uzziel Sheintop[1], Daniel Sebbag[1], Pavel Komm[2], Gilad . Marcus[3]; *[1]Jerusalem College of Technology, Israel; [2]Hebrew Univ. , Israel; [3]Hebrew Univ. , Israel.* A dual wavelength external cavity Raman laser emitting at 2197 nm and 2263 nm is presented, for the first time, with a KGW crystal pumped by Tm:YLF laser, yielding 0.25 mJ maximum output energy.

ATh2A.22

Cr:ZnSe hybrid laser system for µJ level CEP-stable pulses with spectral tunability, Gilad . Marcus[1], Pavel Komm[1], Uzziel Sheintop[1], Salman Noach[2]; *[1]The Hebrew Univ., Jerusalem, Israel; [2]Jerusalem College of Technology, Israel.* A hybrid laser scheme in which parametrically generated, carrier to envelope phase stable, mid-IR pulses with picojoule energies are amplified by three to six orders of magnitude in a Cr:ZnSe laser amplifier is presented.

ATh2A.23

Small-sized Er,Yb: glass planar waveguide laser amplifier pumped by a laser diode bar, Yukari Takada[1], Kenichi Hirosawa[1], Shumpei Kameyama[1], Takayuki Yanagisawa[1]; *[1]Mitsubishi electric corporation, Japan.* We developed a small-sized Er,Yb:glass planar waveguide laser amplifier pumped by a laser diode bar with the butt joint configuration. We demonstrate the signal amplification operation and the output power of 3.2W in continuous-wave mode.

ATh2A.24

SESAM mode-locked femtosecond $Yb:Bi_4Si_3O_{12}$ laser, Haifeng Lin[1], Zhanglang Lin[1], Yujin Chen[1], Yidong Huang[1], Ge Zhang[1], Weidong Chen[1]; *[1]Fujian Inst of Res Structure of Matter, China.* We report on the first femtosecond pulse generation from a SESAM mode-locked $Yb:Bi_4Si_3O_{12}$ (Yb:BSO) laser pumped with a single-mode fiber-coupled diode laser at 976 nm. Near Fourier transform limited 165-fs pulses centered at 1037.8 nm were obtained.

ATh2A.25

Diode Pumped Nd:Glass Rods for LULI2000 100 J Sub 1 ps CPA System, Loïc MEIGNIEN[1]; *[1]91128, CNRS, France.* We demonstrate a high contrast sub-picosecond CPA front end at 1 Hz to seed a 100 J Nd:Glass (1053 nm) laser chain by using a modified commercial diode pumped module from Cutting Edge Optronics.

ATh2A.26

Temperature dependence of the resonance line of optically pumped distributed-feedback lasers, Cristine C. Kores[1], Nur Ismail[1], Dimitri Geskus[1], Meindert Dijkstra[2], Edward Bernhardi[1], Markus Pollnau[3]; *[1]KTH - Royal Inst. of technology, Sweden; [2]Univ. of Twente, Netherlands; [3]Univ. of Surrey, UK.* We characterize experimentally and theoretically a distributed-feedback laser resonator subject to a thermal chirp. The total accumulated phase shift determines the resonance wavelength. The reflectivities (outcoupling losses) at the resonance wavelength govern the resonance linewidth.

ATh2A.27

Accumulation of distributed phase shift in distributed-feedback lasers, Cristine C. Kores[1], Nur Ismail[1], Meindert Dijkstra[2], Edward Bernhardi[1], Markus Pollnau[3]; *[1]KTH - Royal Inst. of technology, Sweden; [2]Univ. of Twente, Netherlands; [3]Univ. of Surrey, UK.* In distributed-feedback lasers, a distributed phase shift of $p/2$, seemingly placing the resonance at the Bragg wavelength, is not accumulated because of light confinement and asymmetry, leading to a systematic resonance shift to shorter wavelengths.

ATh2A.28

Studying on the $KGd(WO_4)_2$ crystal based Raman laser with output energy reaching 800mJ, Junchi Chen[1], Yujie Peng[1], Hongpeng Su[1], Xinlin Lv[1], Yingbin long[1], Yuxin Leng[1]; *[1]Shanghai Inst of Optics and Fine Mech, China.* **The Raman oscillator and amplifier based on $KGd(WO_4)_2$ crystals pumped by the 1064nm laser is established. Under the 3.5J energy of 1064nm laser, the maximum energy of the Raman laser are about 800mJ.**

ATh2A.29

Investigation of the End Pump Surface Gain Medium Slab Laser, Chao Wang[1], Yang Liu[1], Ke Wang[1], Wentao Wang[1], Jiao Liu[1], Xiaojun Tang[1], Hong Zhao[1]; *[1]Science and Technology on solid-state laser laboratory, China.* We present a design and analysis for the surface gain medium slab laser. This single slab laser is potential to output 12kW class laser. The experiment already achieved 5kW CW laser power output.

ATh2A.30

Actively Q-switched operation of a fiber laser in-band pumped Ho:YAG ceramic laser, Zhao Ting[1], Xiaofang Yang[2]; *[1]Nanjing Xiaozhuang Univ., China; [2]Yancheng Inst. of Technology, China.* A 1.5 at.% Ho-doped YAG ceramic laser with 1.90 mJ energy per pulse, 280 kW peak power, and 6.8 ns pulse duration at pulse repetition frequency (PRF) of 500 Hz, were demonstrated.

ATh2A.31

A Highly Adaptable Gain Switched Fiber Laser with Improved Efficiency, Vid Agrez[1], Rok Petkovšek[1]; *[1]Univ. of Ljubljana, Slovenia.* Highly adaptable fiber laser with pulse on demand and precision pulse duration tuning option at retained peak power is presented. It is based on compact optical design originated from gain switching approach with improved efficiency.

ATh2A.32

Brillouin Comb Generation in a Half-open Fiber Laser with a Tellurite Single-Mode Fiber, Luo Xing[1], Tong H. Tuan[1], Than Singh Saini[1], Nguyen P. Hoa[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan.* A linear half-open erbium fiber laser is demonstrated for frequency combs generation. Cascaded Brillouin Stokes and anti-Stokes lines are generated and evolve into broadband frequency combs with the frequency spacing of 7.93GHz.

ATh2A.33

An All-solid Large-mode-area Multicore Fiber Laser with A Pinhole for Mode Selection, Junhua Ji[1], Raghuraman Sidharthan[1], Xiaosheng Huang[1], yanyan zhou[1], Jichao Zang[1], daryl Ho[1], Yehuda Benudiz[2], Udi Ben Ami[2], Amiel A. Ishaaya[2], Seongwoo Yoo[1]; *[1]Nanyang Technological Univ., Singapore; [2]Ben-Gurion Univ. of Negev, Israel.* We demonstrate a multicore Yb-doped fiber laser with an all-solid large-core fiber fabricated in-house and a pinhole in the laser cavity for mode selection. 33.9 W output power with a nearly 52% slope efficiency was achieved.

Harbor Ballroom I & II

ASSL

11:30 -12:30

ATh3A • Laser Materials II (Ceramics)

Presider: Brandon Shaw, US Naval Research Laboratory, USA

ATh3A.1 • 11:30 Invited

Transparent magneto-optic ceramic Faraday rotator, Ryo Yasuhara[1]; [1]*National Inst. for Fusion Science, Japan.* Transparent magneto-optic ceramics can realize the unique function by superior material properties and capability of large size fabrication. It should accelerate developments of high-pulse-energy lasers, high-power lasers, and their applications with wide wavelength range.

ATh3A.2 • 12:00

Sub-100 fs Kerr-Lens Mode-Locked Thin-Disk Lasers Based on Ceramic Gain Media, Shotaro Kitajima[1], Akira Shirakawa[1], HIdeki Yagi[2], Takagimi Yanagitani[2]; [1]*Univ. of Electro-communications, Japan;* [2]*Knoshima Chemical Co. Ltd., Japan.* KLM thin-disk lasers with Yb:LuAG ceramic and Yb:Lu_2O_3 ceramic were demonstrated. The output power of 13 W in 151 fs pulses and 3.7 W in 97 fs were obtained from Yb:LuAG and Yb:Lu_2O_3 ceramics, respectively.

ATh3A.3 • 12:15

Suppression of the Secondary Phase at Grain Boundaries in Yb:FAP Anisotropic Laser Ceramics, Yoichi Sato[1], Takunori Taira[1]; [1]*Inst. for Molecular Science, Japan.* By energy dispersive x-ray spectroscopy we identified the source of the secondary phase in Yb:FAP ceramics that limit the lasing volume. We also found that the reduction of Yb^{3+}-concentration drastically reduced this secondary phase.

12:30-14:00 • Lunch on Your Own

ASSL

14:00 -16:00

ATh4A • Nonlinear Materials and Processes

Presider: Alan Petersen; Spectra-Physics, USA

ATh4A.1 • 14:00

Measurement of d-coefficients of $CdSiP_2$ and $ZnGeP_2$, Shekhar Guha[1], Jean Wei[1], Joel Murray[1], Kevin Zawilski[2], Peter G. Schunemann[2]; *[1]US Air Force Research Laboratory, USA; [2]BAE Systems, USA.* A novel experimental approach, based on re-derivation of the Maker-fringe technique using only controllable physical variables, yielded d-coefficient values d_{14}, d_{25} and d_{36}, for CdSiP2 and ZnGeP2 from measured 2137-nm second harmonic generation data.

ATh4A.2 • 14:15

Magnitude and Relative Sign of the Quadratic Nonlinear Coefficients of the BGSe Monoclinic Acentric Crystal, Feng Guo[1], Patricia Segonds[1], Elodie Boursier[1], Jerome Debray[1], Valeriy Badikov[2], Vladimir Panyutin[3], Dmitrii Badikov[2], Valentin Petrov[3], Benoit Boulanger[1]; *[1]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, France; [2]High Technologies Laboratory, Kuban State Univ., Russia; [3]Max-Born-Inst. for Nonlinear Optics & Ultrafast Spectroscopy, Germany.* By combining out of phase-matched and phase-matched SHG conversion efficiencies recorded as a function of wavelength, we determined the magnitude and relative sign of five of the six nonlinear coefficients of the BGSe crystal.

ATh4A.3 • 14:30

Phase-Matching Conditions and Refined Sellmeier equations up to the near-infrared for THz generation in BNA, Cyril bernerd[1], Patricia Segonds[1], Jerome Debray[1], Takashi Notake[2], Mio Koyama[2], Hiroaki Minamide[2], Hiromasa Ito[2], Benoit Boulanger[1]; *[1]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, France; [2]Tera-photonics laboratory, RIKEN Sendai, 519-1399, Aramaki-aoba, Aoba-ku, , Japan.* Measurements of the phase-matching conditions from second-harmonic and sum-frequency generation allowed us to refine the Sellmeier equations of BNA up to the near-infrared and to improve the tuning curve of THz emission from difference-frequency generation.

ATh4A.4 • 14:45

Advantages of noncritical modal quasi-phase-matching in χ^2 based nonlinear integrated optics devices, Maxim Neradovskiy[1], Elizaveta Neradovskaia[1], Martin Richter[1], Ulrich Kuhl[1], Pierre Aschiéri[1], Hervé Tronche[1], Florent Doutre[1], Pascal Baldi[1], Marc D. Micheli[1]; *[1]INPHYNI, France.* Combining quasi-phase-matching and modal phase-matching allows designing nonlinear devices presenting a noncritical phase-matching configuration. Presenting numerical and experimental studies dedicated to Soft Proton Exchanged waveguides on PPLN, we illustrate he advantages of this configuration.

ATh4A.5 • 15:00

Angular Quasi-Phase-Matching in the biaxial crystal PPRKTP, Dazhi Lu[1], Alexandra Pena[2], Patricia Segonds[1], Jerome Debray[1], Simon Joly[3], Andrius Zukauskas[4], Fredrik Laurell[4], Valdas Pasiskevicius[4], Haohai Yu[6], Jiyang Wang[5], Huanijin Zhang[6], Carlota Canalias[4], Benoit Boulanger[1]; *[1]Neel Inst., France; [2]Neel Inst., France; [3]Univ. of Bordeaux, France; [4]KTH, Sweden; [5]Tianjin Univ. of Technology, China; [6]Shandong Univ., China.* We performed the first measurements of angular quasi-phase-matching (AQPM) of second-harmonic generation in the periodically-poled Rb-doped $KTiOPO_4$ crystal cut as a sphere, which validates the theory of AQPM in the case of a biaxial crystal.

ATh4A.6 • 15:15

A flux grown KTP crystal ridge optical waveguide for birefringence phase-matched second-harmonic generation, Augustin Vernay[1], veronique boutou[1], Corinne Felix[1], Florent Bassignot[2], Mathieu Chauvet[2], Dominique Lupinski[3], Benoit Boulanger[1]; *[1]Neel Inst., France; [2]FEMTO-ST, France; [3]CRISTAL LASER SA, France.* Birefringence phase-matched type II second-harmonic generation has been achieved in a ridge waveguide cut in a KTP crystal. A good agreement is obtained between experiments and simulations, which opens new opportunities for integrated photonics waveguides.

ATh4A.7 • 15:30

Study on QPM quartz for intense-laser pumped 266 nm generation, Hideki Ishizuki[1], Takunori Taira[1]; *[1]Inst. for Molecular Science, Japan.* Second-harmonic 266 nm generation was demonstrated using QPM-structured quartz. The QPM structure was constructed by stacking of multi quartz plates, and high-intensity microchip laser with sub-nanosecond pulse duration was used as a pump source.

ATh4A.8 • 15:45

Scalable Approach for Continuous-Wave Deep-Ultraviolet Laser at 213nm, Yushi Kaneda[2,1], Tsuyoshi Tago[2], Toshiaki Sasa[2], Masahiro Sasaura[2], Hiroaki Nakao[2], Junji Hirohashi[2], Yasunori Furukawa[2]; *[1]Univ. of Arizona, USA; [2]Oxide Corp., Japan.* We present a novel approach for generation at 213nm, corresponding to the fifth harmonic of common 1064nm laser, in pure continuous-wave mode. Starting from two infrared fiber laser sources, we demonstrated 0.45W output at 213nm.

16:00—16:30 • **Coffee Break**, *Harbor Ballroom Foyer*

16:30-16:45 • **ASSL Student Best Presentation Awards**, *Harbor Ballroom I & II*

16:45 -18:30

ATh5A • Lasers for Biological and Other Applications

Presider: Clara Saraceno; Ruhr Universität Bochum, Germany

ATh5A.1 • 16:45 Invited

Engineering Laser Coherence for Imaging Applications, Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA.* We develop lasers with low spatial coherence to achieve speckle-free full-field imaging. We also invent a fast and efficient method of switching the spatial coherence of a laser for multimodality microscopy.

ATh5A.2 • 17:15

Novel fiber-based ultrafast platform for multimodal optical virtual skin biopsy, Hsiang-yu Chung[1,2], Wei Liu[1,2], Rüdiger Greinert[3], Franz Kärtner[1,2], Guoqing Chang[1,4]; [1]*DESY, Germany;* [2]*Physics, Universität Hamburg, Germany;* [3]*Skin Cancer Center Buxtehude, Germany;* [4]*The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany.* We demonstrate a fiber-based ultrafast platform generating energetic femtosecond pulses at 1250 nm and 775 nm simultaneously, which enables label-free second-harmonic generation, third-harmonic generation, and two-photon excitation fluorescence imaging in human skin.

ATh5A.3 • 17:30 Invited

Semiconductor Laser Micro-particles for Bio Imaging, Seok-Hyun A. Yun[1]; [1]*Harvard Medical School, USA.* Laser particles with sizes of optical wavelengths that are injectable and implantable into biological systems are new, promising light sources and probes. We present biocompatible semiconductor laser disks for tracking many cells.

ATh5A.4 • 18:00

Sub-kHz linewidth VECSEL for cold atom experiments, Paulo Hisao Moriya[1], Jennifer E. Hastie[1]; [1]*Inst. of Photonics, Department of Physics, SUPA, Univ. of Strathclyde, UK.* We report sub-kHz linewidth operation of a frequency-stabilized, AlGaInP-based vertical-external-cavity surface-emitting laser (VECSEL) at 689nm, suitable for Strontium cold atom experiments. 170mW was emitted with linewidth ≤200Hz, determined via an optical beat note measurement.

ATh5A.5 • 18:15

1 to 18 GHz tunable intra-burst repetition rate high-power picosecond fiber laser for ultrafast material processing, Denis Marion[1], Jérôme Lhermite[1], Lilia Pontagnier[1], Adrien Aubourg[1,2], Pierre Héricourt[1], Giorgio Santarelli[2], Eric Cormier[1]; [1]*CELIA, Université Bordeaux-CNRS-CEA, France;* [2]*LP2N, UMR5298, CNNRS-IOGS-Université Bordeaux, France.* We report on a laser system emitting picosecond pulses at repetition rates tunable from 1 to 18 GHz. The system emits up to 20 W at 1030 nm in burst mode. Application to ablation is demonstrated.

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