# OSA Laser Congress

*Advanced Solid State Lasers (ASSL)*

*Application of Lasers for Sensing & Free Space Communication (LS&C)*

*Laser Applications Conference*

30 October - 3 November 2016

The Westin Boston Waterfront

Boston, Massachusetts, USA

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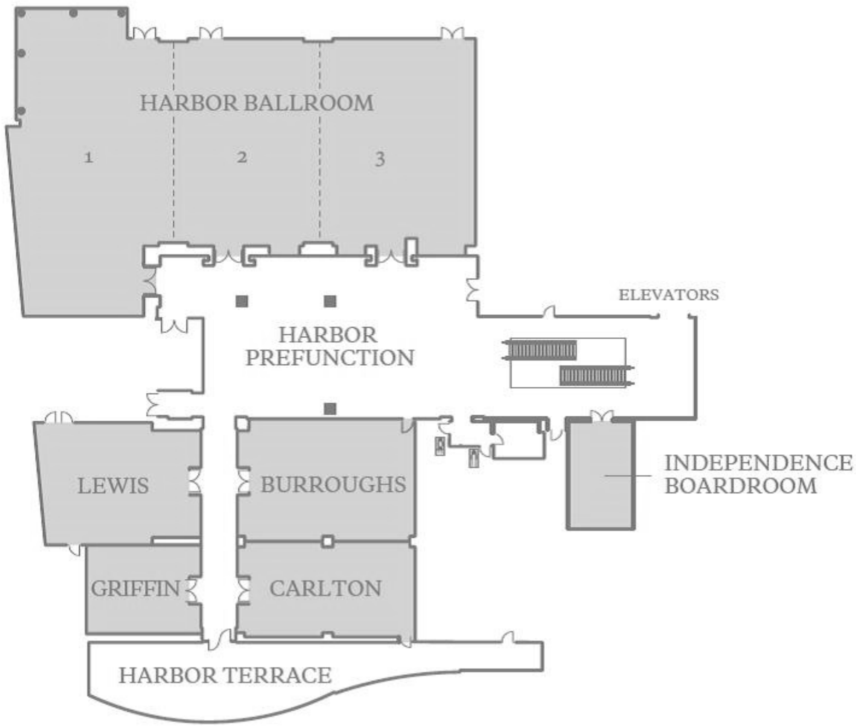
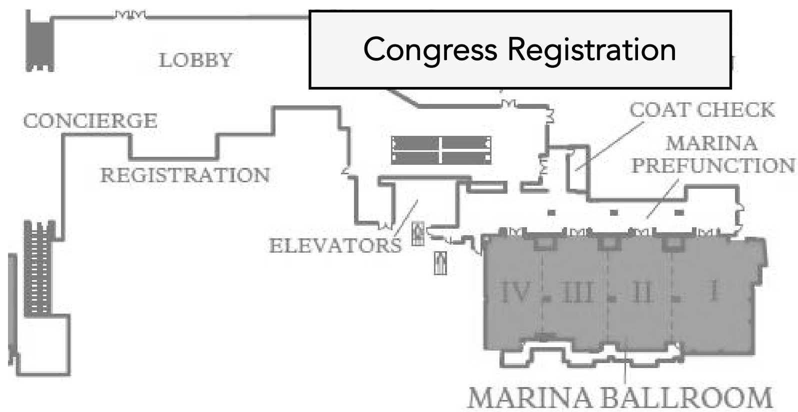
# Hotel Map

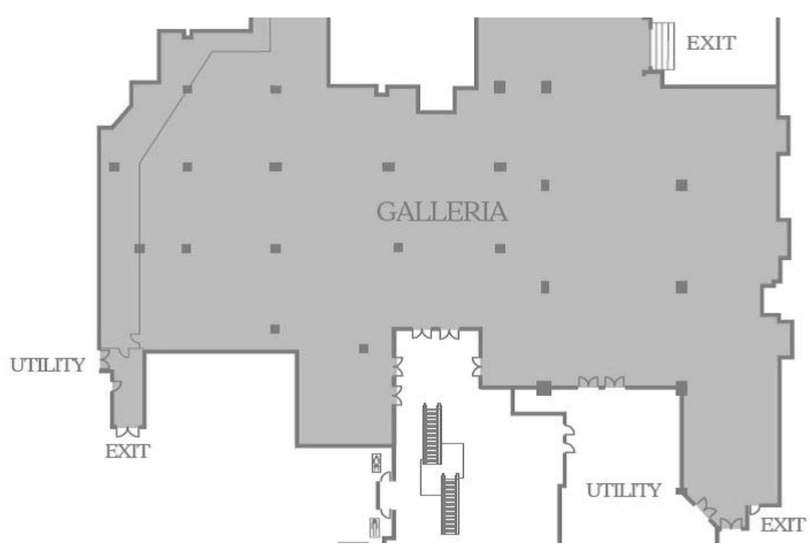
Conference Level




Lobby Level




Concourse Level



OSA Laser Congress
30 October – 3 November 2016
Boston, Massachusetts, USA

Welcome to Boston and the OSA Laser Congress! This year we have co-located the Advanced Solid State Lasers Conference and the Application of Lasers for Sensing & Free Space Communication meeting with the new industrial-centered meeting, the Laser Applications Conference. During the next five days, these meetings will feature the latest worldwide advances in solid state lasers and related technologies, as well as developments in free-space laser communication, laser-based sensing, and numerous industrial, defense and research applications for lasers. The Program Committees for the meetings, with broad, international membership, have worked to provide the high-quality content that characterizes OSA-based conferences. To start, the Congress will feature four plenary speakers—Federico Capasso, Marlan O. Scully, Constantin Haefner, and Christopher Marshall. On Thursday, we will be joined by the US Assistant Secretary of Commerce for Export Administration, Kevin Wolf, to discuss US Export Control Reform.

The Advanced Solid State Lasers Conference (ASSL) represents the world's premier forum for presenting the most recent advances in the fields of Materials and Laser Sources. Materials this year will include laser crystals and ceramics, laser fibers and thin-films as well as nonlinear crystals for UV, visible and mid-IR spectral ranges, and ion-doped crystals and nano-materials for ultra-fast laser devices. Laser Sources will cover both free-space and fiber sources, including nonlinear sources, narrow-line and semi-conductor lasers, near-IR and mid-IR sources, as well as high-average power, ultra-short pulse lasers and beam combining. The meeting will feature 11 invited speakers, 75 contributed oral presentations and 100 poster presentations.

The Application of Lasers for Sensing & Free Space Communication (LS&C) meeting is designed to report on important technical advances realized in these areas over the last few years. This meeting will feature 27 invited talks and 16 contributed talks from around the world, as well as one special topic tutorial. We will have dynamic sessions on lidar and remote sensing & communication technologies, discussing the latest activities in these technical areas. This year we will have a special session thread on quantum aspects of active sensing and optical communication presented by well-known leaders in quantum optics.

The Laser Applications Conference (LAC) will cover a broad range of topics for applications of high power and high intensity lasers. Session topics include Laser Materials Processing, Ultrafast Laser Machining, Laser Peening, Extreme UV Lithography and High Intensity Lasers for Defense. LAC consists of mainly invited speakers, in addition to two keynotes. Each session will conclude with a panel discussion allowing audience questions and interaction with the session presenters. LAC will conclude with an OIDA Executive Forum which focuses on the business aspects of the laser market, spanning finance to new product development.

We hope you enjoy all the meetings, and take full advantage of the scientific sessions and networking opportunities before you.

Sincerely,

ASSL
Ruxin Li, Shanghai Institute of Optics and Fine Mechanics, *China*, General Chair
Richard Moncorge, *Universite de Caen, France*, General Chair
Peter Moulton, *MIT Lincoln Laboratory, USA*, General Chair
Benoit Boulanger, *CNRS, France*, Program Chair
Gregory Goodno, *Northrop Grumman Aerospace Systems, USA*, Program Chair
Shibin Jiang, *AdValue Photonics, Inc., USA*, Program Chair
Alphan Sennaroglu, *Koc University, Turkey*, Program Chair

LS&C
Walter Buell, *The Aerospace Corporation, USA,* Chair
Edward Watson, *University of Dayton, USA,* Chairs

LAC
David Mordaunt, *Raytheon Space and Airborne Systems*, *USA*, Chair
Johannes Trbola, *Dausinger & Giesen GmbH, Germany*, Chair

# Program Committees

## Advanced Solid State Lasers Conference (ASSL)

### General Chairs
Ruxin Li, Shanghai Institute of Optics and Fine Mechanics, *China*
Richard Moncorge, *Universite de Caen, France*
Peter Moulton, *MIT Lincoln Laboratory, USA*

### Materials Program Committee
Benoit Boulanger, *CNRS, France*, ***Program Chair***
Shibin Jiang, *AdValue Photonics, Inc.*, USA, ***Program Chair***
Gerard Aka, *Ecole Nationale Supérieure de Chimie de Paris, France*
Ady Arie, *Tel-Aviv Univ., Israel*
Jay Dawson, *Lawrence Livermore National Lab*, USA
David Hagan, *University of Central Florida, CREOL*, USA
Helena Jelinkova, *Czech Technical Univ., Czech Republic*
Christian Kraenkel, *Universität Hamburg, Germany*
Jacob Mackenzie, *Univ. of Southampton, UK*
Sergey Mirov, *Univ. of Alabama at Birmingham*, USA
Yasutake Ohishi, *Toyota Technological Institute, Japan*
Jasbinder Sanghera, *US Naval Research Laboratory*, USA
Ichiro Shoji, *Chuo Univ., Japan*
Stefano Taccheo, *Swansea Univ., UK*
Takunori Taira, *Institute for Molecular Science, Japan*
Haohai Yu, *Shandong Univ., China*
Long Zhang, *Shanghai Inst. of Optics and Fine Mech., China*

### Sources Program Committee
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Alphan Sennaroglu, *Koc University, Turkey*, ***Program Chair***
Iyad Dajani, *Air Force Research Lab, USA*
Frederic Druon, *Institut d'Optique, France*
Almantas Galvanauskas, *Univ. of Michigan, USA*
Ingmar Hartl, *DESY Hamburg, Germany*
Eric Honea, *Lockheed Martin Laser and Sensor Systems, USA*
Jiro Itatani, *The Institute of Solid State Physics, Univ. of Tokyo, Japan*
Stuart Jackson, *Sydney University, Australia*
Yoonchan Jeong, *Seoul National Univ., South Korea*
Dale Martz, *MIT-Lincoln Laboratory, USA*
Johan Nilsson, *Univ. of Southampton, UK*
Norihiko Nishizawa, *Nagoya University, Japan*
Helen Pask, *Macquarie Univ., Australia*
Alan Petersen, *Spectra-Physics, USA*
Valentin Petrov, *Max Born Institute, Germany*
Thomas Schreiber, *Fraunhofer IOF, Germany*
Thomas Südmeyer, *Université de Neuchâtel, Switzerland*

## Application of Lasers for Sensing & Free Space Communication (LS&C)

### General Chairs
Walter Buell, *The Aerospace Corporation, USA*
Edward Watson, *University of Dayton, USA*

### Members
Claudine Besson, ONERA, France
Bob Boyd, *University of Ottawa, Canada; University of Rochester, USA*
Timothy Carrig, *Lockheed Martin, USA*
Sammy Henderson, *Beyond Photonics, USA*
Tom Karr, *DARPA Strategic Technology Office, USA*
Joseph Marron, *Raytheon Company, USA*
Paul McManamon, *Exciting Technology LLC, USA*
David Rabb, *US Air Force Research Laboratory, USA*
Zhimin Shi, *University of South Florida, USA*
Abbie Watnik, *US Naval Research Laboratory, USA*

## Laser Applications Conference (LAC)

### Chairs
David Mordaunt, *Raytheon Space and Airborne Systems, USA*
Johannes Trbola, *Dausinger & Giesen GmbH, Germany*

### Program Committee
Ali Gökhan Demir, *Politecnico di Milano, Italy*
Pierre-Mary Paul, *Continuum, USA*
Danijela Rostohar, *Inst. of Physics ASCR, Prague*
Gerald Uyeno, *Raytheon, USA*
Rudolph Weber, *Univ. of Stuttgart, Germany*
Sascha Weiler, *TRUMPF, USA*

### Executive Forum Program Committee
Christoph Harder, *Harder and Partner, Switzerland*
Fred Leonberger, *EOvation Advisors, USA*
Martin Seifert, *Nufern, USA*

Thank you to all the

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

# General Information

## Registration
*Main Lobby Harborside*
Please note: Registration desk will be closed during lunch breaks.

| | |
|---|---|
| Sunday, 30 October | 12:00—18:00 |
| Monday, 31 October | 07:00—18:30 |
| Tuesday, 1 November | 07:00—18:30 |
| Wednesday, 2 November | 07:30—18:30 |
| Thursday, 3 November | 07:30—17:00 |

## Access to the Wireless Internet
Activate your computer's wireless radio and select available network and enter password listed below. Click connect.

Network: Laser Congress
Password: LASERS

## 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 www.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.

## 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 1 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.

## 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.

## Online Access to Program Playback: Recorded Presentations
We are delighted to announce this valuable enhancement free to Congress full technical registrants. Select presentations are being digitally captured for on-demand viewing. Session content will be available for on demand viewing until late December 2016. All captured session content will be live for viewing within forty-eight hours of being recorded. Just look for the play symbol next to the abstracts to easily identify the presentations being captured. Access to the recorded sessions is limited to full technical attendees only.

1. Visit the conference website at www.osa.org/LasersOPC
2. Select the Essential Links "Access meeting presentations/ slidecasts" on the right side of the web page
3. Log in using your email and password used for registration.

## 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. If submitted, poster PDFs will be available about two weeks after the meeting. While accessing the papers in OSA Publishing's Digital Library look for the multimedia symbol shown above.

## CAM Lounge
*Independence Boardroom*

OSA is turning 100 in 2016! We're asking all OSA members to be a part of the celebration by participating in short videos. CAM (Centennial Authentic Moments) is an ongoing program of collecting scientific selfies where members will talk about what it means to be an OSA Member, how has OSA helped in their careers, what inspired them to get into the field of optics and what excites them about their current work in three minutes or less. The collection of these short videos will be featured on OSA's centennial website.

# Awards

## OSA Foundation Travel Grant

In keeping with its mission to *promote the generation, application, archiving and worldwide dissemination of knowledge in optics and photonics*, The Optical Society (OSA) established the OSA Foundation in 2002 to carry out a wide range of charitable activities. The OSA Foundation benefits more than 7,000 people a year. The Foundation inspires future optics innovators, supports career development for optics students, recent graduates and young professionals, and recognizes distinguished achievement in the field through the presentation of awards and honors.

The OSA Foundation Student Travel Grant Program is designed to provide career development opportunities by assisting students who wish to attend conferences and meetings. The grants are given to students working or studying science in qualifying developing nations so they can attend OSA-managed technical meetings and conferences

We are pleased to announce The OSA Foundation Travel Grant recipient for Advanced Solid State Lasers Conference

*Jie Guo, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, China*

*Konstantin Gorbachenya, Center for Optical Materials and Technology, Belarus*

OSA Foundation | Inspire Students. Reward Success.

*OSA would like to thank the following corporate sponsors who have supported student awards for this conference for many year!*

## IPG Student Paper 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 Chair. All current students presenting a paper during an ASSL session are eligible for these awards.

IPG PHOTONICS®

## Lockheed Martin Student Paper Award

Lockheed Martin sponsors the Best Student Presentation Award. All papers presented by a current student are considered for this award.

LOCKHEED MARTIN

# Special Events

## Building FUNctional Professional Relationships

*Sunday, 30 October, 12:00-16:00*
*Calton, Harbor Wing Conference Level*

Are you tired of not knowing what to say about your work? Interested in having a fun time with colleagues and getting to know them in new, productive ways? improvscience is facilitating a workshop for OSA members, which will have scientists building new kinds of professional relationships. Using discovery-focused conversation and improvisational theater, a context is created in which participants develop their communication skills and generate and explore ideas with their colleagues. One of the primary benefits of improvscience trainings is learning to build with the contributions of others. This is an essential skill for leadership in Optics and Photonics. Space is limited, please check at registration to see if space is available.

## Networking Reception

*Sunday, 30 October, 18:00-19:00*
*Harbor Ballroom Foyer*

Join us for networking , drinks and light appetizers with your fellow colleagues to kick off the 2016 Laser Congress!

## Poster Sessions

*Monday, 31 October—Thursday, 3 November*
*Exhibit Hall / Galleria*

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.

| | |
|---|---|
| *Monday, 31 October | 18:00—19:30 |
| Tuesday, 1 November | 10:00—11:30 |
| Thursday, 3 November | 10:00—11:30 |

* Student Poster Session sponsored by IPG.
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.

**Poster Set-Up and Removal**

All posters must be set by the start of the poster session. 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.

## Women in Optics and Photonics Networking Reception

Tuesday, 1 November, 16:30–18:30
*Burroughs, Harbor Wing Conference Level*

Please join us for a Women in Optics and Photonics reception for networking among all career stages and a panel discussion that will offer interesting insights into career experiences and strategies for women in optics today.

## ASSL Postdeadline Papers Session

Tuesday, 1 November, 18:30–19:30
*Harbor Ballroom I & II, Conference Level*

The ASSL Technical Program Committees have 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 select "Access Digest Papers" link on the right hand navigation.

## Conference Banquet

*Wednesday, 2 November*
*18:30—21:00*
*Seaport Hotel, 200 Seaport Boulevard, Boston*

Sponsored by IPG PHOTONICS

Join your fellow attendees for a festive evening and another opportunity to network with your colleagues. During the banquet prepare to be amazed by David Hall's Magic/Mentalist Show. Guest should be prepared to interact with the perform in magic, mental telepathy and other unique experiences. Stop by registration for a walking map to the Seaport Hotel.

Guest tickets are available for $95 USD, as extra guest tickets are limited, please check registration for availability.

# 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.

## SC419 Crystal Parametric Nonlinear Optics: Modelling, Materials and Devices

Benoit Boulanger; *Grenoble Univ., CNRS-NEEL Institute, France*

Course Description: This lecture focuses on fundamental crystal parametric optics that is one of the most fascinating field of nonlinear optics involving corpuscular and wave aspects of light in strong interaction with the electrons of matter, and leading to optical frequency synthesis and mixing at the origin of numerous applications.

- Constitutive relations and Maxwell equations.
- Classification of the nonlinear interactions through the corpuscular approach: fusion and splitting involving three or four photons, spontaneous and stimulated processes.
- Calculation of the electric susceptibility by Lorentz model: perturbation approach leading to the definition of the different orders of the electric susceptibility, wavelength dispersion, intrinsic symmetries (Kleinman and ABDP), implications of spatial symmetry on the susceptibility tensors (Neumann principle).
- Tensor algebra and calculation of the first, second and third order polarizations.
- Modelling of the macroscopic nonlinearities of matter from the microscopic scale using the bond charge model and *ab initio* calculation, Miller index.
- Basics in linear crystal optics: propagation equation, index surface, birefringence, double refraction, eigenmodes.
- Amplitude equations in the nonlinear regime, Manley-Rowe relations.
- Calculation of the effective coefficient based on the field tensor formalism.
- Types and topology of collinear and non-collinear Birefringence Phase-matching and Quasi-Phase-Matching in bulk media and whispering-gallery-mode resonators.
- Conversion efficiency calculation of second harmonic generation (SHG), direct and cascaded third harmonic generation (THG), and optical parametric interactions: fluorescence, amplification (OPA), chirped pulse amplification (OPCPA), generation (OPG), oscillation (OPO).
- Angular, spectral and thermal acceptances.
- Techniques of characterization of nonlinear crystals for the determination of phase-matching and quasi-phase-matching loci, magnitude and relative signs of the nonlinear coefficients, acceptances.

### Benefits and Learning Objectives

This course aims at giving guidelines and tools for the design, characterization and use of crystals for parametric generation. This course should enable participants to:

- Explain the main lines and key parameters of fundamental crystal parametric optics.
- Compare the figures of merit of various nonlinear materials.
- Compute phase-matching directions, quasi-phase-matching periodicities, angular and spectral acceptances, effective coefficients, conversion efficiencies.
- Measure nonlinear coefficients, phase-matching directions, spectral and angular acceptances, a figure of merit, a conversion efficiency.
- Define the relevant parameters for the design of new nonlinear crystal.
- List the main nonlinear materials enabling parametric generation.
- Identify the right crystal corresponding to the targeted application.
- Design up-conversion and down-conversion parametric devices.

Intended Audience: This course is specifically built for physicists as well as chemists interested in crystal parametric optics: crystal growers and designers wanting to identify the relevant parameters, laser physicists aiming at working in nonlinear optics or users willing to go deeper in the field at the frontier of crystal physics, coming from industry or universities and other academic institutes. Various job levels are concerned: PhD students, postdocs, engineers, researchers, professors. The basics of electromagnetism, solid state and laser physics are recommended.

## SC427 Frequency Combs and Applications

Ingmar Hartl; DESY, Germany

Course Description: At the beginning of this century frequency combs revolutionized optical frequency metrology by providing a direct link between optical and microwave oscillators, ultimately leading to the Nobel Prize of John Hall and Ted Hänsch. This course will give an introduction in optical frequency combs. The course focuses on modelocked-laser based comb sources, non-oscillator based combs will be discussed only briefly. First the basic principles of the frequency comb spectrum of a modelocked laser oscillator will be given. Different designs of frequency comb lasers, carrier-envelope offset frequency measurement, passive and active stabilization and feedback control techniques and noise considerations will be explained. Techniques to the extent of the spectral coverage beyond the gain spectrum of the laser medium will be described, including XUV and mid-infrared frequency comb sources. The second half of the course will focus on applications: Optical frequency measurement, optical clocks, astrocombs, distance-measurement, low-noise microwave generation, transfer of timing and frequency information in optical fibers, different methods of frequency comb spectroscopy, time-domain applications and others.

### Benefits and Learning Objectives

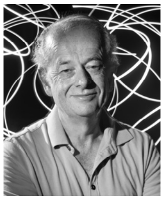
- Explain frequency comb sources and frequency comb techniques.
- Construct a basic frequency comb laser with carrier-envelope-offset sensing and feedback control circuitry.
- Characterize noise properties of a frequency comb source.
- Become familiar with numerous applications of frequency combs
- Identify the important comb parameters for a specific application.

### Intended Audience:

This course is intended for persons familiar with basic laser and ultrafast optics principles who intend to construct a frequency comb, characterize a frequency comb or use a frequency comb laser.

# Plenary and Keynote Speakers

## Joint Plenary Session I
*Monday, 31 October, 08:30—10:00*
*Harbor Ballroom I & II*



Federico Capasso
*Harvard University, USA*

**High Performance Quantum Cascade Lasers from the Mid-IR to the Far-IR and their impact on Science and Technology**

Federico Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after 27 years at Bell Labs where his career advanced from postdoctoral fellow to Vice President for Physical Research. He is a member of the National Academy of Sciences, the National Academy of Engineering, a fellow of the American Academy of Arts and Sciences and a foreign member of the Accademia dei Lincei. His awards include the IEEE Edison Medal, the American Physical Society Arthur Schawlow Prize in Laser Science, the King Faisal Prize, the SPIE Gold Medal, the AAAS Rumford Prize, the IEEE Sarnoff Award, the Materials Research Society Medal, the Franklin Institute Wetherill Medal, the European Physical Society Quantum Electronics Prize, the Rank Prize in Optoelectronics, the Optical Society Wood Prize, the Berthold Leibinger Future Prize, the Julius Springer Prize in Applied Physics, the Institute of Physics Duddell Medal, the Jan Czochralski Award for lifetime achievements in Materials Science, and the Gold Medal of the President of Italy for meritorious achievement in science.

Marlan O. Scully
*Texas A&M University and Baylor University, USA*

**Remote Sensing of Trace Concentrations**

Marlan Scully has worked on a variety of problems in laser physics and quantum optics, including the first quantum theory of the laser with Lamb, the laser phase transition analogy and its applications to the Bose condensate, experimental demonstrations of lasing without inversion, and ultraslow light in hot gases via quantum coherence. His introduction of entanglement interferometry to quantum optics has shed light on the foundations of quantum mechanics, e.g., the quantum eraser. Recently he and his colleagues have applied quantum coherence to remote sensing of anthrax and probing through turbid mediums, such as skin and plant tissue. Scully is currently a Distinguished University Professor at Texas A&M University and also holds positions at Baylor and other universities. He has been elected to the U.S. National Academy of Sciences and the Max Planck Society and has recently been awarded the DPG/OSA Herbert Walther Award and the OSA Frederic Ives Medal/Quinn Prize.

## Joint Plenary Session II
*Monday, 31 October, 10:30—12:00*
*Harbor Ballroom I & II*

Constantin Haefner
*Lawrence Livermore National Laboratory, USA*

**Application-enabling kiloWatt Average Power Petawatt Lasers**

Constantin L. Haefner is the Program Director for Advanced Photon Technologies in NIF & Photon Science at Lawrence Livermore National Laboratory. Key program elements are research and development of high average power and high peak power laser systems for scientific user facilities and industrial applications. APT is currently building the High Repetition Rate Advanced Petawatt Laser System (HAPLS) for delivery to the European Extreme Light Infrastructure Facility in the Czech Republic. HAPLS will be the world's highest average power petawatt laser system, capable of delivering energetic femtosecond laser pulses with 1015 watts of peak power at 10-Hz repetition rate. Dr. Haefner has more than 15 years of experience in developing and delivering energetic solid state, high energy, short pulse laser systems for laboratory high energy density physics research.

Christopher Marshall
*Lawrence Livermore National Laboratory, USA*

**National Ignition Facility Science Applications**

Christopher David Marshall is currently serving as Chief Systems Engineer for the National Ignition Facility (NIF), DoD Technologies Programs in NIF and Photon Sciences at LLNL. Chris received his Ph.D. in Chemical Physics in 1992 from Stanford University where he specialized in ultrafast nonlinear laser spectroscopy on condensed matter. Chris took a Post- Doctoral position at Lawrence Livermore National Laboratory (LLNL) where he worked on a variety of applied physics and materials science of optical materials in Inertial Confinement Fusion (ICF) lasers. In 1994, Chris became the Laser Science and Technology Deputy Associate Program Leader for Advanced Lasers where he developed and led high average power diode pumped laser technology development. In 1997 Chris moved to a position, in the National Ignition Facility Project, becoming the Lead Scientist for the NIF Amplifier System and then the Deputy Systems Engineer responsible for integrating the laser technology across the NIF project and finally after the first laser beamline construction was complete, he served as a first generation NIF shot director responsible for early commissioning and operations. In recent years he has been the Systems Engineer for the High Repetition Rate Advanced Petawatt Laser System (HAPLS) to be delivered to the European Extreme Light Infrastructure Facility in the Czech Republic. Over the past 30 years Chris has co-authored over 60 journal papers and conference proceedings.

# Plenary and Keynote Speakers

## LAC Keynote Session I

*Tuesday, 1 November, 11:30—12:30*
*Harbor Ballroom I & II*

**Valentin Gapontsev**
CEO and Chairman of the Board, *IPG, USA*

Valentin P. Gapontsev, Ph.D., founded IPG in 1990 and has been Chief Executive Officer and Chairman of IPG's Board of Directors since the Company's inception. Prior to that time, he served as senior scientist in laser material physics and head of the laboratory at the Soviet Academy of Science's Institute of Radio Engineering and Electronics in Moscow. He has over thirty years of academic research experience in the fields of solid state laser materials, laser spectroscopy and non-radiative energy transfer between rare earth ions and is the author of many scientific publications and several international patents. Dr. Gapontsev holds a Ph.D. in Physics from the Moscow Institute of Physics and Technology. In 2006, he was awarded the Ernst & Young ® Entrepreneur of the Year Award for Industrial Products and Services in New England. In 2009, Dr. Gapontsev was presented the Arthur L. Schawlow Award and recognized as the "The Father of the Fiber Laser Industry." In 2011, he received the Russian Federation National Award in Science and Technology, and he was selected as a Fellow of The Optical Society. Dr. Gapontsev holds a Ph.D. in Physics from the Moscow Institute of Physics and Technology.

## LAC Keynote Session II

*Wednesday, 2 November, 11:30—12:30*
*Harbor Ballroom I & II*

**Berthold Schmidt**
Managing Director*, TRUMPF Photonics, Inc., USA*

Berthold Schmidt is currently the Managing Director for TRUMPF Photonics, Inc. near Princeton, NJ. The US premises is TRUMPF's central production and development line for high power III-V diode lasers. Earlier he was Head of Corporate Research for the TRUMPF GmbH + Co. KG, located in Ditzingen, Germany. In this roll he supported development activities around innovative laser- and machine tool concepts. Furthermore he established a corporate venturing effort at TRUMPF to promote disruptive technologies in early startup companies outside the holding. Prior to joining TRUMPF, Berthold Schmidt was CEO of Intense Ltd. in Scotland, UK. He gained a fundamental understanding for the diode laser industry when working for more then ten years in R&D and marketing at JDSU in Zurich, Switzerland, which later became Nortel, respectively Bookham.

Berthold Schmidt received his PhD from the Technical University in Munich (TUM). He holds a Masters degree form SUNY, Albany, and an executive BBA from the GSBA in Zurich, Switzerland. Since 2005 Berthold Schmidt supports the Swiss Commission for Technology and Innovation (CTI) in the field of micro- and nanotechnologies.

## Special Lunch Session

*Thursday, 3 November, 12:24-13:45*
*Harbor Ballroom I & II*

**Kevin J. Wolf**
Assistant Secretary of Commerce for Export Administration, *U.S. Department of Commerce, USA*

Kevin Wolf has been leading the Administration's rewrite of Category XII of the United States Munition List (USML) – an amendment to the International Traffic in Arms Regulations (ITAR). Category XII encompasses fire control, range finder, optical and guidance and control equipment that the United States considers critical to national security. The goal of the proposed rule change was to move dual-use items with both military and commercial applications from the State Department USML list to the less restrictive Commerce Control list, thereby reducing or eliminate confusion and jurisdictional classifications between the USML and CCL. After several years of work, the Administration anticipates releasing the final rule in the late Fall. Participants will have the opportunity to hear firsthand from the Assistant Secretary the changes and impacts this rule will have on the optics and photonics industry.

Kevin J. Wolf was sworn in as Assistant Secretary of Commerce for Export Administration on February 19, 2010. Prior to his joining the Obama Administration, he was a partner in the Washington, D.C. office of Bryan Cave LLP. His practice over the course of his nearly 17 years with the firm covered most aspects of the law and policy of international trade, but focused on the Export Administration Regulations (EAR), the International Traffic in Arms Regulations (ITAR), sanctions administered by the Office of Foreign Assets Control (OFAC), the antiboycott regulations, the Foreign Corrupt Practices Act (FCPA), and multilateral trade controls. From 1996-1997, he was the Assistant Special Counsel to the House Committee on Standards of Official Conduct. He has a B.A. degree from the University of Missouri-Columbia, a M.A. from the University of Minnesota's Humphrey Institute of Public Affairs, and a J.D. from the University of Minnesota Law School.

The Assistant Secretary assists and advises the Under Secretary on the development of policies pertaining to Export Administration issues. The Assistant Secretary also provides overall direction to and management of the national security, nonproliferation, foreign policy, national defense, and strategic industrial resource functions delegated to BIS, which include issuing related regulations, representing the Department on interagency committees dealing with BIS issues, representing the Department in domestic and international fora that address such issues, and chairing the Advisory Committee on Export Policy. In addition, the Assistant Secretary directs the Office of Strategic Industries and Economic Security (SIES), the Office of Nonproliferation and Treaty Compliance (NPTC), the Office of National Security and Technology Transfer Controls (NSTTC), the Office of Exporter Services (OExS), and the Office of Technology Evaluation (OTE).

# Exhibition / Buyers' Guide

The Exhibition is located in the Galleria and is 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, 31 October** | |
| Exhibition & Coffee Break | 10:00—10:30 |
| Exhibition & Lunch | 12:00—13:30 |
| Exhibition & Coffee Break | 15:30—16:00 |
| Exhibition, Posters & Reception | 18:00—19:30 |
| **Tuesday, 1 November** | |
| Exhibition, Posters & Coffee Break | 10:00—11:30 |
| Exhibition & Lunch | 12:30—14:00 |
| Exhibition & Coffee Break | 16:00—16:30 |
| **Wednesday, 2 November** | |
| Exhibition & Coffee Break | 10:00—11:00 |
| Exhibition & Lunch | 12:00—13:30 |
| Exhibition & Coffee Break | 15:30—16:00 |
| **Thursday, 3 November** | |
| Exhibition, Posters & Coffee Break | 10:00—11:30 |

## AdlOptica GmbH
Berlin, Germany
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AdlOptica GmbH works in field of refractive Laser Beam Shaping Optics transforming Gaussian to flattop intensity profiles and finding applications in numerous industrial and scientific techniques. Result of multi year developments is realized in family of piShaper systems numbering today more than 60 models.

## AdValue Photonics, Inc.
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AdValue Photonics is the leading manufacturer of 2 μm fiber lasers for the scientific, materials processing and medical markets. We are focused on being the leading developer and manufacturer of high quality, innovative, cost-effective fiber lasers, fiber amplifiers, fiber based broadband light sources, and components.

## ALPhANOV
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ALPhANOV brings together expertise in opto-mechanics, electronics, optics, lasers and microscopy, skills that are put to use to help you design and develop a range of subsystems and optical systems, optoelectronic and laser.

## Altechna
Vilnius, Lithuania
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Altechna is a supplier of laser related products and solutions, specializing in the following key fields of activity: distribution of well-known photonics industry brands in local markets, R&D solutions in laser optics, manufacturing of laser related components, quality assurance and measurements to guarantee the highest quality.

## American Elements
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American Elements is the world's largest materials science company with a catalogue of 15,000+ products including high purity chemicals and metals, semiconductors, nanoparticles and isotopes for high technologies such as battery & hydrogen storage, solar energy and automotive/aerospace.

## APE Angewandte Physik & Elektronik GmbH
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www.ape-berlin.de

APE Angewandte Physik & Elektronik 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 management. APE´s product portfolio ranges from autocorrelators to harmonic generators, from acoustooptics to synchronously pumped optical parametric oscillators (OPOs).

## ASLD GmbH
Erlangen, Bavaria, Germany
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ASLD is a software package for the design and simulation of solid-state lasers. It is able to analyze various complex physical effects inside the laser resonator and amplifier.

# Exhibition / Buyers' Guide

## Asphericon
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OSA Industry Development Associates

As an independent and recognized specialist, asphericon is among the technological leaders in the field of asphere manufacture. Asphericon assists its customers from the initial optic design, via manufacturing and coating, full-surface interferometric measuring and documentation, through to the assembly of optical modules and their optical characterization.

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Avo Photonics provides exclusive, custom optoelectronic design, prototyping and production services for military, aerospace, medical, industrial, and communications applications. Through its pure-service business model, Avo produces confidential, client-owned products and systems that launch its customers to the forefront of their markets.

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COHERENT.

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Continuum offers a full line of standard and custom high energy solid state lasers for scientific, industrial and commercial applications, ranging from spectroscopy, materials analysis and PIV to x-ray generation and high power plasma physics. Continuum also offers high peak power femtosecond systems and high average power ultrafast lasers.

## CorActive High-Tech, Inc.
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OSA Industry Development Associates

CorActive develops and manufactures advanced Specialty Optical Fiber (SOF) products including Double Clad, Erbium doped, Mid- to Far-IR transmission and laser module for OEM customers serving the industrial laser, telecommunications, sensor, defense, and aerospace industries.

## Cristal Laser
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www.cristal-laser.com

Cristal Laser, for more than 25 years, has manufactured top quality non-linear Crystals such as LBO, KTP, KTP.fr, KTA for frenquency conversion. Also RTP Pockel cells for electro-optics applications: Qswitches or Pulsepickers. We offer the best expertise to propose top rank Crystals for most demanding applications. We sell worldwide.

## Cryslaser, Inc.
Chengdu, China
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www.cryslaser.com

Cryslaser is one of the most professional and largest laser crystal manufacturers in China with more than 40 years of experience in crystal growth. With more than 80 staff who have been dedicated to the electro-optic industry for years, Cyrslaser grows large diameter YAG series crystals using the Czochralski technique.

## Dausinger & Giesen GmbH
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D+G develops, produces and sells ThinDisk Lasers as well as its components for Industry, Science and Research and Development. We offer Laser Material Processing with these lasers as well as helical drilling optics.

## Directed Energy Professional Society
Albuquerque, NM, USA
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www.deps.org

The Directed Energy Professional Society (DEPS) was founded to foster research, development and transition of Directed Energy (DE) technology for national defense and civil applications through professional communication and education. We strive to be recognized as the premier organization for exchanging information about and advocating research, development and application of Directed Energy.

## EKSMA Optics
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EKSMA Optics is a manufacturer of laser components for high power laser applications. We produce laser optics, laser and frequency conversion crystals for 193-20.000nm range, Pockels cells and ultrafast pulse picking systems. The company owns IBS coating, optics and crystals polishing facilities, spherical and aspherical lenses production and clean room facilities.

# Exhibition / Buyers' Guide

### Electro-Optics Technology, Inc.

Traverse City, MI, USA
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EOT has been supplying enabling components and diagnostic equipment for manufacturers and users of high power laser systems since 1987. Current products include: Faraday rotators, optical isolators, and fiber collimators for use with laser diodes, fiber lasers, and solid-state lasers.

### Energetiq Technology, Inc.

Woburn, MA, USA
P: +1.781.939.0763
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www.energetiq.com

Energetiq is a developer and manufacturer of advanced light sources that enable the manufacture and analysis of nano-scale structures and products. Used in complex scientific and engineering applications, Energetiq's light products are based on new technology that generates high brightness and high power light in the 1nm to 1000nm range with high reliability, high stability, and long life, all in a compact package.

### Fraunhofer UK Research, Ltd.

Technology & Innovation Centre
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www.fraunhofer.co.uk

Fraunhofer UK Research Ltd is a not-for-profit research and technology organization providing professional R&D services for industry through its Centre for Applied Photonics specialising in research on a wide variety of novel laser sources, such as solid-lasers, semiconductor disk lasers, OPOs, ultrafast lasers and fibre photonics and their applications.

### Gooch & Housego, PLC

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Gooch & Housego designs and manufactures control devices and precision optics for laser systems used for applications in aerospace and defense, life and health sciences, materials processing, oil and gas drilling and pipeline security, space, undersea and avionic communications and scientific research.

### Imagine Optic, Inc.

Boston, MA, USA
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www.axiomoptics.com

Imagine Optic/Axiom Optics is a distributor of optical instrumentation based in North America. We offer adaptive optics solutions for laser & microscopy, Confocal Chromatic sensors and 3D metrology solutions, Laser Beam Profiling solutions for UV, Visible, IR Lasers and Intensified, Low-light, high speed & SWIR InGaAs Cameras.

### Inrad Optics Inc.

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Inrad Optics manufactures exceptional crystalline materials, precision glass and metal optical components and photonic devices. Vertically integrated from growth through systems, products include non-linear crystals, Q-Switches, MWIR OPOs, UV filters, neutron scintillators, X-ray toroids, transmission flats, windows, mirrors, wave plates, aluminum and beryllium aspheric mirrors, and polygons.

### Interfiber Analysis

Sharon, NJ, USA
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Interfiber Analysis is an industry leading provider of optical fiber characterization equipment including the FMA-100 Fiber Mode Analyzer and the IFA-100 Multiwavelength Fiber Refractive Index Profiler. We also offer an optical fiber measurement service and consulting solutions.

### IPG Photonics Corp.

*SPONSOR*
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www.ipgphotonics.com

IPG Photonics is the leading manufacturer of high-performance fiber lasers and amplifiers for diverse applications in numerous markets. IPG's diverse lines of lasers are used in materials processing and other diverse applications. IPG's vertically-integrated development & manufacturing capabilities enable us to meet customer requirements, accelerate development, manage costs & improve yields.

### ISOWAVE

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Isowave designs and manufactures Optical Isolators and Wavelength Conversion Chips. Wavelength range is 400nm to 4microns. Offered are Clear Apertures (0.6mm to 16mm), several isolation levels, Wide-Band and/or Tunable. High-Power: Now available! Wavelength Conversion Chips of PP-SLT; PP-SLN; PP-CLN are made from Crystal growth to finished chip.

### Laser Focus World

PUBLICATION BIN

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Laser Focus World is a global resource for engineers, researchers, scientists and technical professionals providing comprehensive coverage of optoelectronics and photonics technologies, applications and markets. Laser Focus World reports on and analyzes the latest developments and significant trends in both technology and business in the world wide optoelectronics and photonics industry.

# Exhibition / Buyers' Guide

## Laser Quantum, Inc.
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Laser Quantum is a world-class manufacturer of revolutionary solid-state and ultrafast lasers. Our products boast industry-leading performance specifications, reliability, compactness and operational lifetime. Laser Quantum lasers are used in laboratories and integrated into systems worldwide, enabling scientists to push boundaries in applications from attosecond physics to forensics and genomics.

## LAYERTEC GmbH
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LAYERTEC GmbH designs and manufactures laser optics for high power laser applications in CW, ns, ps and fs laser systems. Our optics cover the wavelength range from the VUV (157 nm) to the NIR (about 4000 nm). Layertec manufactures its own substrates, provides various coating techniques and has its own measurement tools.

## Lumentum
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Lumentum is a market-leading manufacturer of innovative optical photonic products enabling optical networking and commercial laser customers worldwide. Lumentum's optical components and systems are part of virtually every type of telecom, enterprise and data center network. Lumentum's lasers enable advanced manufacturing tech and applications including next-generation 3D-sensing capabilities.

## Masimo Semiconductor
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Masimo Semiconductor specializes in wafer epitaxy, foundry services, and device fabrication for the defense, biomedical, telecommunications and consumer products markets. Applying our extensive experience in compound semiconductor epitaxy and device processing, the scientists, engineers and technicians at Masimo Semiconductor work with clients to design and fabricate components that give our clients' products an edge in the marketplace.

## MegaWatt Lasers
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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.

## Norlase ApS
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## Northrop Grumman Corp. Synoptics
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www.as.northropgrumman.com/synoptics

OSA Industry Development Associates

Northrop Grumman SYNOPTICS is the world's leading manufacturer of crystals for use in solid-state lasers. We also manufacture a line of specialty crystals and air spaced polarizers for use at 1064nm. Products are used in applications in the military, medical, industrial and scientific markets.

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Nufern is a leading U.S. manufacturer of optical fibers, fiber optical gyroscopes, fiber lasers and amplifiers serving diverse markets. Current products include over 1500 standard and custom fibers. Nufern has the experience, resources and facilities required to design, manufacture, test and qualify highly-engineered optical fibers and fiber-based products.

## NYFORS
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www.nyfors.com

OSA Industry Development Associates

NYFORS is an innovative developer and supplier of advanced glass processing and optical fiber preparation equipment for high strength and specialty splicing operations. Our latest products include the SMARTSPLICER and the enhanced CLEAVEMETER 3D – developed for CO2 laser splicing applications and advanced end face inspection of fibers.

## Onefive GmbH
Regensdorf, Switzerland
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Onefive GmbH is a Swiss company which provides femtosecond and picosecond lasers for different industrial applications. A team of R&D laser physicists and electrical engineers with versatile fields of expertise are working together to provide solid, reliable, and cost-effective ultrafast laser solutions.

## OptiGrate
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OptiGrate's full range of products include transmitting (TBG), reflecting (RBG) and chirped (CBG) volume Bragg gratings. We offer volume Bragg gratings (VBG's) with the widest range of specifications in the world and can manufacture VBG's with efficiencies greater than 99.9%. We also offer the narrowest line-widths, largest dimensions, lowest absorption and other record parameters.

### Orientir, Inc.
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ORIENTIR specializes in producing high-precision IR optical components for Medical & Life Sciences, Defense & Security, Semiconductor, Aerospace, and Industrial OEM markets.

### OSA – Optics and Photonics News
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OPN is the monthly magazine and website produced by The Optical Society (OSA). Total readership is nearly 35,000 when taking into account OSA members, pass-along readership and the digital edition, and its readers have a high degree of purchasing power. The OPN website has enjoyed steadily growing traffic, with more than 150,000 unique visitors and over 340,000 page views per year.

### The Optical Society (OSA)
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Founded in 1916, The Optical Society (OSA) is the leading professional organization for scientists, engineers, students and entrepreneurs who fuel discoveries, shape real-life applications and accelerate achievements in the science of light. Through world-renowned publications, meetings and membership initiatives, OSA provides quality research, inspired interactions and dedicated resources for its extensive global network of optics and photonics experts. For more information, visit www.osa.org/100.

### Oxalis-Laser
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Oxalis-Laser provides a full software package dedicated to lasers and complex optical systems design. Commod Pro software simulates beam generation for cavities (multimode, CW, passive/active Q-switched, OPOs) and beam propagation in amplifier chains. Non-linear Optics and frequency conversion (OPA, OPCPA) are handled by Commod Pro.

### Oxide Corporation
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Oxide supplies high performance single crystals and original technology products. NLO crystals such as CLBO, LBO, LBGO, etc.; MgSLN, for THz generation; TSAG, TGG and YIG, for isolator materials; GSO and LGSO for Scintillator; QPM devices including PPMgSLT/SLN and PP-LBGO; Wavelength Converters and Optical Modules; CW DUV lasers.

### Photonics Media/Laurin Publishing
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Photonics Media invites you to explore the world of light-based technology in print, online and on our mobile apps. As the publisher of Photonics Spectra, Industrial Photonics, BioPhotonics, and EuroPhotonics magazines, the Photonics Buyers' Guide and Photonics.com we offer news, research and applications articles to help you succeed.

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PI (Physik Instrumente) LP is a leading manufacturer of precision motion control equipment, piezo motors, air bearing stages and hexapod parallel-kinematics for semiconductor applications, photonics, bio-nano-technology and medical engineering. PI has been developing and manufacturing standard & custom precision products with piezoceramic and electromagnetic drives for 4 decades.

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www.quantel-laser.com

Quantel is a global leader in the design and manufacture of high-power, solid-state lasers. With design centers in Paris and the USA (Bozeman, MT), Quantel lasers are used in applications ranging from spectroscopy to atom cooling; PIV to combustion research. Uniquely, Quantel offers customers very flexible scientific lasers with user configurable wavelengths and performance parameters as well as "designed for purpose" ruggedized lasers for industrial applications.

### Raicol Crystals Ltd.
Rosh Haayin, Israel
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www.raicol.com

Raicol Crystals Ltd. was founded in 1995 in Israel to become a leading manufacturer of nonlinear optical crystals and electro-optic devices. Our worldwide reputation is based on the reliability of our products, our technical innovation and the responsiveness of the Raicol Crystals team.

### Scientific Materials Corp
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E: sales@scientificmaterials.com
www.scientificmaterials.com

At Scientific Materials Corp. (SMC) we provide a complete line of high-purity low-loss laser materials. SMC's research has led to numerous discoveries resulting in laser materials that have demonstrated increased efficiency, increased output power, increased damage resistance, and reduced thermal lensing, higher brightness, and higher TEM00 output.

# Exhibition / Buyers' Guide

### Southern Photonics, Ltd.
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www.southernphotonics.com

Southern Photonics supplies femtosecond lasers for research, nonlinear microscopy and icromachining applications. The lasers are based on an all fiber architecture with no SESAM or free space optics, offering unprecedented reliability.

### TelAztec
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P: +1.781.229.9905
E: JNole@TelAztec.com
www.TelAztec.com

TelAztec anti-reflection microstructures (ARMs) are sub-wavelength surface relief textures etched directly into the bulk optical material providing unsurpassed optical performance. ARMs textures provide extreme bandwidth coverage from UV-IR, reflection losses as low as 0.01%, and with mechanical, laser damage, and chemical durability similar to or greater than the bulk material.

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TeraDiode is leading a disruptive change in the High Power Laser market by introducing the first Direct Diode Laser with a beam quality that matches the most demanding applications in cutting and welding. With low power consumption and the highest product efficiency, our lasers are also the least costly to manufacture and enable new applications in new markets.

### Thales Optronique S.A.
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www.thalesgroup.com

For more than 30 years Thales has been driving innovative solutions through a large patents portfolio and scientific collaborations. Thales is committed to satisfying the most demanding industrial and scientific applications by providing reliable and easy-to-use lasers with exceptional technical performances.

### Thorlabs
Newton, NJ,  USA
P: +1. 973.300.2554
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www.thorlabs.com

Thorlabs provides photonics tools and instruments to researchers and commercial customers around the world. Our product offering spans from vibration isolating optical tables, industry-leading optomechanical and optical components to complex instruments like multiphoton microscopes and femtosecond lasers. Thorlabs takes pride in its customer service, shipping 90% of all orders same day.

### TOPTICA Photonics, Inc.
Victor, NY, USA
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E: sales@toptica-usa.com
www.toptica.com

TOPTICA is the industry leader in diode laser and ultrafast technology for both scientific and industrial markets.  We offer the widest range of single mode tunable light in the 190-2900 nm and 0.1-2.7 THz spectral region.  With our Passion for Precision - TOPTICA delivers!

### TRUMPF Scientific Lasers GmbH + Co. KG
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www.trumpf-scientific-lasers.com

TRUMPF Scientific Lasers focuses on high-power picosecond and femtosecond laser technology especially on optic parametric amplifiers and regenerative amplifiers. Base technology is the TRUMPF thin-disk laser technology. TRUMPF Scientific Lasers offers customized, innovative and high quality products for scientific and industrial applications.

### UltraFast Innovations
Munich, Germany
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UltraFast Innovations provides customized premium ultrafast optics and devices. Our optics can be found in the laser sources of most major femtosecond OEM manufacturers. Our optics portfolio features: Ultra-broadband mirrors for pulse compression down to sub-4 femtoseconds, highly dispersive and high-reflectance mirrors.

### Xsoptix
Methuen, MA, USA
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XSoptix was established as a vehicle to support customers that needed flexibility in trading in their (XS) excess equipment and receiving a credit towards the purchase of equipment for their current needs.  Today, XSoptix continues to offer our customers flexible purchasing options including trade-ins and has evolved into a trusted US Distribution Channel for our business partners and a trusted sourcing option.

# Explanation of Session Codes

**AM2B.4**

**Meeting Name**

A= ASSL
L=LS&C
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 element 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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# Agenda of Sessions

| Sunday, 30 October | |
|---|---|
| 12:00—18:00 | Registration, *Main Lobby Harborside* |
| 12:00—16:00 | Building FUNctional Professional Relationships, *Calton* Sponsored by OSA Foundation Inspire Students. Reward Success. |
| 14:00—18:00 | Short Course 419: Crystal Parametric Nonlinear Optics: Modeling, Materials and Devices<br>Short Course: 427 Optical Frequency Combs: Basics, Sources and Applications |
| 18:00—19:00 | Networking Reception, *Harbor Ballroom Foyer* |

| Monday, 31 October | | | |
|---|---|---|---|
| | Harbor Ballroom I & II (Conference Level) | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III (Conference Level) |
| | Advanced Solid State Lasers | Lasers for Sensing & Free Space Communication | Laser Applications Conference |
| 07:00—18:30 | Registration, *Main Lobby Harborside* (closed during plenary sessions and lunch) | | |
| 08:30—10:00 | JM1A • Joint Plenary Session I, *Harbor Ballroom I & II* | | |
| 10:00—10:30 | Coffee Break in the Exhibit Hall, *Galleria* | | |
| 10:30—12:00 | JM2A • Joint Plenary Session II, *Harbor Ballroom I & II* | | |
| 12:00—13:30 | Lunch in the Exhibit Hall, *Galleria* | | |
| 13:30—15:30 | AM3A • Laser Materials I | LM3B • Active Sensing Systems I | High Brightness, High Power Applications |
| 15:30—16:00 | Coffee Break in the Exhibit Hall, *Galleria* | | |
| 16:00—18:00 | AM4A • Coherent Combining *(ends at 17:45)* | LM4B • Active Sensing Systems II *(ends at 16:45)* | Laser Peening: Future Development of Lasers and Applications |
| 18:00—19:30 | AM5A • Student Poster Session in Exhibit Hall, *Galleria* Sponsored by IPG Photonics | | |

# Agenda of Sessions

| Tuesday, 1 November | | | |
|---|---|---|---|
| | Harbor Ballroom I & II (Conference Level) | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III (Conference Level) |
| | Advanced Solid State Lasers | Lasers for Sensing & Free Space Communication | Laser Applications Conference |
| 07:00—18:30 | Registration, *Main Lobby Harborside* (closed during lunch) | | |
| 08:00—10:00 | ATu1A • Modelocked Sources | LTu1B • Synthetic Aperture Imaging *(begins at 8:30)* | Fast and Ultrafast Micro Machining Session I |
| 10:00—11:30 | JTu2A • Tuesday Poster Session in the Exhibit Hall, *Galleria* (Coffee Break 10:00-10:30) | | |
| 11:30—12:30 | ATu3A • Saturable Absorbers and Graphene | LTu3B • 3D Imaging and Lidar *(end at 12:15)* | LAC Keynote Session—Valentin Gapontsev |
| 12:30—14:00 | Lunch in Exhibit Hall, *Galleria* Sponsored by IPG PHOTONICS | | |
| 14:00—16:00 | ATu4A • High Average Power Sources | LTu4B • Quantum Protocols for Sensing and Communication I *(ends at 15:30)* | Fast and Ultrafast Micro Machining Session II |
| 16:00—16:30 | Coffee Break in the Exhibit Hall, *Galleria* Sponsored by IPG PHOTONICS | | |
| 16:30—18:30 | ATu5A • Nonlinear Materials I | LTu5B • Quantum Protocols for Sensing and Communication II | 16kW+ Laser Materials Processing |
| 16:30—18:30 | Women in Optics and Photonics Networking Reception, *Burroughs* Sponsored by OSA Foundation Inspire Students. Reward Success. | | |
| 18:30—19:30 | ASSL Postdeadline Paper Sessions, *Harbor Ballroom I & II* | | |

# Agenda of Sessions

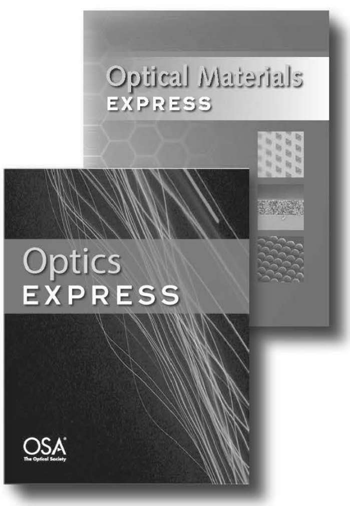
| Wednesday, 2 November | | | |
|---|---|---|---|
| | Harbor Ballroom I & II (Conference Level) | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III (Conference Level) |
| | Advanced Solid State Lasers | Lasers for Sensing & Free Space Communication | Laser Applications Conference |
| 07:30—18:30 | Registration, *Main Lobby Harborside* (closed during lunch) | | |
| 08:00—10:00 | AW1A • Mid-IR Sources I | LW1B • Quantum Protocols for Sensing and Communication III *(begins at 8:30)* | High Intensity Lasers for Applications in Science and Research |
| 10:00—11:00 | Coffee Break in the Exhibit Hall, *Galleria* | | |
| 11:00—12:00 | AW2A • Nonlinear Materials II | LW2B • Quantum Protocols for Sensing and Communication IV | LAC Keynote Session—Berthold Schmidt |
| 12:00—13:30 | Lunch in Exhibit Hall, *Galleria* | | |
| 13:30—15:30 | AW3A • Laser Materials II *(end at 15:00)* | LW3B • Components for Sensing and Communication I | High Intensity Lasers for Applications in Defense |
| 15:30—16:00 | Coffee Break in the Exhibit Hall, *Galleria* | | |
| 16:00—18:00 | AW4A • Mid-IR Sources II | LW4B • Components for Sensing and Communication II | Extreme UV Lithography and X-ray Generation |
| 18:30—21:00 | Conference Banquet, *Seaport Hotel, 1 Seaport Boulevard, Boston* | | |

# Agenda of Sessions

| Thursday, 3 November | | | |
|---|---|---|---|
| | Harbor Ballroom I & II (Conference Level) | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III (Conference Level) |
| | Advanced Solid State Lasers | Lasers for Sensing & Free Space Communication | Laser Applications Conference |
| 07:30—17:00 | Registration, *Main Lobby Harborside* (closed during lunch) | | |
| 08:00—10:00 | ATh1A • Nonlinear Fiber Sources | LTh1B • Free Space Optical Communications I | Executive Forum Panel 1: Market for Lasers over 10 Kilowatts |
| 10:00—11:30 | JTh2A • Thursday Poster Session in the Exhibit Hall, *Galleria* (Coffee Break 10:00-10:30) | | |
| 11:30—12:30 | ATh3A • Fiber CPA *(end at 12:15)* | LTh3B • Free Space Optical Communications II | Executive Forum Panel 2: Market for Lasers under 10 Kilowatts |
| 12:45—13:45 | Special Lunch Session with Kevin J. Wolf, Assistant Secretary of Commerce for Export Administration *Harbor Ballroom I & II* | | |
| 14:00—16:00 | ATh4A • Free Space NIR sources | | |
| 16:00—16:30 | Coffee Break, *Harbor Ballroom Foyer* | | |
| 16:30—18:15 | ATh5A • Narrow-line & Semi-conductor Lasers | | |

# Call for Papers
## ADVANCED SOLID-STATE LASERS 2016

**Submission Deadline:** 15 December 2016




- Oral or poster papers accepted for the conference are eligible
- Submissions will undergo peer review and should include substantial or significant new information compared to the conference summary
- Benefit from the open-access and rapid-publication format of either *Optical Materials Express* or *Optics Express*

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## 07:00—18:30 • Registration, *Main Lobby Harborside*

Harbor Ballroom I & II

08:30 -- 10:00
**JM1A • Plenary Session 1**
*Presiders: Richard Moncorge, Universite de Caen, France*
*Walter F. Buell, The Aerospace Corp., USA*

Plenary

JM1A.1 • 08:30
**High Performance Quantum Cascade Lasers from the Mid-IR to the Far-IR and their impact on Science and Technology,** Frederico Capssso[1]; [1]*School of Engineering and Applied Sciences, Harvard Univ., USA.* The mid-infrared regions of the spectrum (3-30 μm) for a long time did not realize its full potential, scientifically and technologically, notwithstanding its paramount importance for chemistry, spectroscopy and a myriad of potential applications, until the advent of the Quantum Cascade Laser (QCL) in 1994. I will highlight the impact of QCLs in spectroscopy, chemical physics, atmospheric chemistry and technology, present and future, ranging from IR countermeasures to a wide range of sensors.

Plenary

JM1A.2 • 09:15
**Remote Sensing of Trace Concentrations,** Marlan Scully[1]; [1]*Texas A&M Univ., USA.* The use of quantum coherence in molecular photonics is a hot topic, for example the FAST CARS [1] approach. It will be shown that such a scheme has much in common with single photon Dicke superradiance [2]. An interesting possible extension is backward superradiant amplification,[3] which would provide another tool for remote sensing.

## 10:00—10:30 • Exhibition Opening and Coffee Break, *Exhibit Hall / Galleria*

Harbor Ballroom I & II

10:30 -- 12:00
**JM2A • Plenary Session 2**
*Presider: Peter Moulton, MIT Lincoln Lab, USA*
*David W. Mordaunt , Raytheon Space and Airborne Systems, USA*

Plenary

JM2A.1 • 10:30
**Application-enabling kiloWatt Average Power Petawatt Lasers,** Constantin Haefner[1]; [1]*Lawrence Livermore National Lab, USA.* A new generation of high power lasers is enabled by recent advancement of optical materials and processing techniques, laser performance modeling and laser control systems, diode technology and new laser architectures. One of the most remarkable and promising opportunities of these light sources is the combination of high peak intensity, high energy, short pulses, and high repetition rate that allow experiments of unprecedented fidelity and new commercial applications.

Plenary

JM2A.2 • 11:15
**National Ignition Facility Science Applications,** Christopher Marshall[1]; [1]*Lawrence Livermore National Lab, USA.* The National Ignition Facility (NIF) at Lawrence Livermore National Lab (LLNL) is the latest in a series of large-scale pulsed fusion lasers that was the result of 50 years of work in the US Inertial Confinement Fusion (ICF) Program. The NIF is directed toward providing an experimental user facility that supports high energy density (HED) science activities in fundamental science and thermonuclear burn in a Lab environment. This was accomplished by thousands of people who contributed the technical ideas and innovations over several generations of scientists and engineers at LLNL and other ICF Labs, such as the Univ. of Rochester LLE, Sandia Natl. Lab., Los Alamos Natl. Lab., and the Naval Research Lab., as well as a broad set of industrial partners. Topics of this talk will include: laser development history and overview of NIF, summary results of ignition on NIF to date, other science applications enabled by HED capabilities of NIF, and the underlying laser technologies that are enabling applications of lasers to industrial and scientific applications.

## 12:00—13:30 • Exhibition and Lunch, *Exhibit Hall / Galleria*

Harbor Ballroom I & II

ASSL

13:30 -- 15:30
**AM3A • Laser Materials I**
*Presider: Shibin Jiang; AdValue Photonics, USA*

AM3A.1 • 13:30 Invited
**Nanoparticle Doping for High Power Lasers at Eye Safer Wavelengths,** Colin Baker[1], E. Joseph Friebele[1], Charles G. Askins[1], Barbara Marcheschi[1], John Peele[2], Woohong Kim[1], Jasbinder Sanghera[1], Jun Zhang[3], Mark A. Dubinskii[3], Youming Chen[3]; [1]*Naval Research Lab, USA;* [2]*Sotera Defense Systems, USA;* [3]*Army Research Lab, USA.* Nanoparticle doping was used for making erbium doped fibers. We report luminescence lifetimes greater than for solution doped fibers, and high optical-to-optical slope efficiencies, with a maximum value greater than 71%.

AM3A.2 • 14:00
**Continuous Wave and Wavelength Tunable Green $Tb^{3+}:CaF_2$ Laser,** Christian Kraenkel[1,2], Philip W. Metz[1], Günter Huber[1,2]; [1]*Institut für Laser-Physik, Universität Hamburg, Germany;* [2]*The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany.* We obtained up to 100 mW of cw green output around 541 nm with $Tb^{3+}$(10%),$Na^{+}$(10%):$CaF_2$ under pumping with a 2ω-OPSL at 486 nm and a continuous wavelength tuning between 540 nm and 550 nm.

AM3A.3 • 14:15
**Laser Performance of Yb-doped-Garnet Thin Films Grown by Pulsed Laser Deposition,** Stephen J. Beecher[1], James A. Grant-Jacob[1], Ping Hua[1], David Shepherd[1], Robert W. Eason[1], Jacob I. Mackenzie[1]; [1]*Optoelectronics Research Centre , UK.* Growth and planar-waveguide laser (PWL) performance of garnet-crystal-films are reported. Demonstration of 70% slope efficiency with >16.5W realized with Yb:YAG, along with the first Yb:GGG and Yb:YGG PWLs. Thickness and performance scaling will be discussed.

AM3A.4 • 14:30
**Highly doped Tm:YLF LPE crystalline layers for 1.9µm lasers,** Rémi Soulard[1], Mohamed Salhi[1], Gurvan Brasse[1], Jean-Louis Doualan[1], Alain Braud[1], Richard Moncorge[1], Mathieu Laroche[1], Aleksey Tyazhev[2], thomas godin[2], Ammar Hideur[2], Patrice Camy[1]; [1]*CIMAP, France;* [2]*DOL, CORIA, France.* Laser operation at 2 µm is reported using an epitaxial, highly Tm-doped, 240 µm thick $LiYF_4$ layer grown by liquid phase epitaxy. Simulation of laser operation is compared to experiments.

AM3A.5 • 14:45
**Refined Orientation of the Optical Axes as a Function of Wavelength in Monoclinic Double Tungstates,** Benoit Boulanger[1,2], Patricia Segonds[1,2], Patricia Loren Inácio[1,2], Alexandra Peña[2,1], Jerome Debray[2,1], Daniel Rytz[3], Valery Filippov[4], Konstantin Yumashev[5], Pavel Loiko[5], Maria Cinta Pujol[6], Xavier Mateos[6], Magdalena Aguiló[6], Francesc Diaz[6], Marc Eichhorn[7]; [1]*Université Grenoble Alpes, France;* [2]*Centre National de la Recherche Scientifique, France;* [3]*FEE GmbH, Germany;* [4]*National Academy of Sciences of Belarus, Belarus;* [5]*Center for Optical Materials and Tech., Belarus;* [6]*Univ. Rovira i Virgili , Spain;* [7]*French-German Research Inst. of Saint-Louis, France.* We measured the rotation of the dielectric frame and determined the orientation of the optical axes in $KRE(WO_4)_2$ (RE = Gd, Y, Lu) crystals, as a function of wavelength in the 0.4–1.6 µm range.

AM3A.6 • 15:00
**Laser Material Research in the Czech Republic Stimulated by ELI-BEAMLINES Project,** Michal Koselja[1]; [1]*Inst. of Physics of the ASCR, Czech Republic.* ELI-BAMLINES Project has stimulated a new trend in material research in the Czech Republic. Recent development of crystal growth technology, allow producing a core free YAG matrices up to 5 inches. Basic optical properties of Yb:YAG laser crystal elements will be compared with ceramics ones.

AM3A.7 • 15:15
**Record-low Quantum Defect Operation of the Eye-safe Er-doped Laser,** Nikolay Ter-Gabrielyan[1], Viktor Fromzel[1], Mark A. Dubinskii[1]; [1]*US Army Research Lab, USA.* Several new laser transitions in resonantly-pumped $Er^{3+}:YVO_4$ have been demonstrated. Laser operation with a QD as low as 0.8 % has been obtained, which is believed to be the lowest QD for an eye-safe laser.

Marina I & II Ballroom (Lobby Level)

LS&C

13:30 -- 15:30
**LM3B • Active Sensing Systems I**
*Presider: Edward Watson; Univ. of Dayton, USA*

LM3B.1 • 13:30 Invited
**Active Optical Remote Sensing Sensors/ Instrumentations for NASA's Future Earth Science Missions,** Upendra Singh[1]; [1]*NASA Langley Research Center, USA.* This presentation will provide an overview of enabling active optical remote sensing technologies and techniques, NASA's future vision for Earth science missions for global observations, and the challenges associated in applying them for societal benefit.

LM3B.2 • 14:00 Invited
**2016 Decadal Update of the NASA ESTO LIDAR Technologies Investment Strategy,** Azita Valinia[1]; [1]*NASA, USA.* We describe the 2016 update of the NASA Earth Science Technology Office (ESTO) investment strategy in the area of lidar technologies as pertaining to NASA's Earth Science measurement goals in the next decade.

LM3B.3 • 14:30 Invited
**Applications and Future Trends in Laser Sensing and Communication at Airbus Group,** Nikolaus P. Schmitt[1]; [1]*Airbus Group Innovations, Germany.* An overview on laser sensing and laser communication at Airbus Group is given. Exemplary aerospace applications, work performed within Airbus Group and its subsidiaries as well as trends are discussed.

LM3B.4 • 15:00 Invited
**Next Generation Coherent Detection Laser Doppler Velocimetry,** Duane D. Smith[1], Joanna Austin[2], Joseph Shepherd[2]; [1]*Raytheon, USA;* [2]*California Institute of Technology, USA.* This presentation covers an innovative approach to probing equilibrium and non-equilibrium (non-Maxwell Boltzmann velocity distribution) gas flow via coherent detection of elastically and inelastically scattered laser light.

Harbor Ballroom III

LAC

13:30 -- 15:30
**High Brightness, High Power Applications**
*Moderator: Ali Gökhan Demir, Politecnico di Milano, Italy*

High brightness laser sources have become a work horse in many industries for material processing. Fiber, discs and the new-coming high brightness diode lasers, enable high efficiency in existing applications, such as cutting, and have become enabling technologies for the newer ones, such as, welding of highly reflective metals and additive manufacturing. The session will give a broad view of new sources and applications developed by the laser source manufacturers and end-users. The topics will cover different manufacturing processes, as well as, monitoring possibilities. The future tendencies whether higher powers or different wavelengths, higher reliability or higher flexibility will be addressed.

**Concepts and Application of 10s KW High Power Diode Lasers,** Oleg Raykis, Wolfgang Todt, Laserline, Germany

**Recent Advances on High Power Direct Diode Laser Applications,** Francisco Villarreal, *TeraDiode Inc., USA.* High power, high brightness direct diode laser sources have become commercially available only a couple of years ago. By means of using Wavelength Beam Combining (WBC) Technology. And now is possible to extend the power delivery to 8kW power level. This unique laser source from TeraDiode Inc. has demonstrated to be a versatile tool offering a number of advantages when compared to more traditional laser sources like the fiber, disk and CO2 laser sources. Where benefits such as: BPP of 4mm.mrad, 40% Wall plug Efficiency, 970nm +-20 nm, Pluggable Fiber, Insensitive to back reflection, come as standard. TeraDiode's Direct Diode Lasers are already being used for metal processing applications like cutting, welding and additive manufacturing resulting on faster processing speeds, bigger range and superior quality to counterpart technologies. In this presentation we introduce the Dynamic Beam Shaper (DBS), and present some of the benefits of using this technology that allows you to modify the laser beam properties for optimum processing results.

15:30—16:00 • Exhibition and Coffee Break, *Exhibit Hall / Galleria*

| Harbor Ballroom I & II | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III |
|---|---|---|
| ASSL | LS&C | LAC |

16:00 -- 17:45
**AM4A • Coherent Combining**
*Presider: Gregory Goodno; Northrop Grumman Aerospace Systems, USA*

AM4A.1 • 16:00 Invited
**Coherent Beam Combining of Fiber Amplifiers,** Tso Yee Y. Fan[1]; *[1]MIT Lincoln Lab, USA.* Beam combining of laser arrays has become increasing viable over the past decade as the community has developed a better understanding of the requirements imposed by beam combining. Coherent beam combining (CBC) enables scaling the brightness by large amounts, in principle by as much as the number of elements.

AM4A.2 • 16:30
**Hybrid Yb-doped-fiber/Yb:YAG architecture for high-energy, high-power, picosecond source tunable in duration,** Julien Pouysegur[2], Florent Guichard[2], Yoann Zaouter[2], Quentin Mocaer[2], Marc Hanna[1], Frederic P. Druon[1], Clemens Hönninger[2], Eric Mottay[2], Patrick Georges[1]; *[1]Lab Charles Fabry, France; [2]Amplitude Systemes, France.* Hybrid ytterbium-doped fiber/Yb:YAG-bulk laser source generating pulse in duration from 3 ps to 20 ps is reported. 116 MW peak power is demonstrated for 3-ps pulses with employment of divided pulse architecture generating 4 temporal replicas.

AM4A.3 • 16:45
**12 mJ and 1 kW Ultrafast Fiber-Laser System using Spatial and Temporal Coherent Pulse Addition,** Marco Kienel[1,2], Michael Müller[1], Arno Klenke[1,2], Jens Limpert[1,3], Andreas Tünnermann[1,3]; *[1]Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany; [2]Helmholtz Inst. of Jena, Germany; [3]Fraunhofer Inst. for Applied Optics Precision Eng., Germany.* We present on an ultrafast fiber-chirped-pulse-amplification system utilizing beam- and pulse-multiplexing. With this, fs-pulses with up to 1 kW average power and 1 mJ pulse energy and up to 12 mJ pulse energy at 700 W average power have been achieved.

AM4A.4 • 17:00
**Turn-Key and Robust Stabilization of Scalable, N-GTI Resonator Based Coherent Pulse Stacking Systems,** Morteza Sheikhsofla[1], John Ruppe[1], John Nees[1], Dar Dahlen[2], Russell Wilcox[2], Almantas Galvanauskas[1]; *[1]Univ. of Michigan, USA; [2]Lawrence Berkeley National Lab, USA.* A turn-key, robust, all-digital, and software-based control system based on stochastic parallel gradient descent algorithm is demonstrated to efficiently stabilize N-cascaded optical cavities of coherent pulse stacking systems.

AM4A.5 • 17:15
**High-Energy Pulse Stacking via Regenerative Pulse-Burst Amplification,** Ignas Astrauskas[1], Edgar Kaksis[1], Tobias Flöry[1], Giedrius Andriukaitis[1], Audrius Pugzlys[1], Andrius Baltuska[1], John Ruppe[2], Siyun Chen[2], Almantas Galvanauskas[2], Tadas Balciunas[1]; *[1]Photonics Inst., Vienna Univ. of Technology, Austria; [2]Center for Ultrafast Optical Science, Univ. of Michigan, USA.* Output of a burst-mode regenerative Yb:$CaF_2$ amplifier, designed to overcome intracavity optical damage by colliding pulse replicas, is coherently combined into a single mJ pulse. Thresholds of pulse-burst-induced damage of optical elements are experimentally investigated.

AM4A.6 • 17:30
**Multiplexed Coherent Pulse Stacking of 27 Pulses in a 4+1 GTI Resonator Sequence,** John Ruppe[1], Siyun Chen[1], Morteza Sheikhsofla[1], Russell Wilcox[2], John Nees[1], Almantas Galvanauskas[1]; *[1]Univ. of Michigan, USA; [2]Lawrence Berkeley National Lab, USA.* Coherent stacking of 27 equal-amplitude pulses is achieved in 5-GTI sequence, with 4 cavities having rountrip of 1 ns, and one cavity - 9ns. Compression of effectively ~27ns long stretched-pulses down to 330fs is demonstrated.

16:00 -- 17:00
**LM4B • Active Sensing Systems II**
*Presider: Edward Watson; Univ. of Dayton, USA*

LM4B.1 • 16:00 Invited
**Volumetric phase imaging using Fourier ptychography,** Roarke Horstmeyer[1,2]; *[1]California Inst. of Technology, USA; [2]Bioimaging and Neurophotonics Lab, Charite Medical School, Germany.* Fourier ptychography uses angularly varying illumination and post-processing algorithms to create gigapixel images. Here, we extend this work to measure the 3D refractive index profile of thick specimens at high resolution.

LM4B.2 • 16:30
**Partially Coherent Vortex Beams of Arbitrary Order,** Gregory J. Gbur[1]; *[1]Univ of North Carolina at Charlotte, USA.* Analytic solutions for partially coherent vortex beams (PCVBs) of any azimuthal order are presented. Coherence and singular properties of these beams and their possible use in free-space optical communication are discussed.


16:00 -- 18:00
**Laser Peening: Future Development of Lasers and Applications**
*Moderator: Gerald Uyeno, Raytheon, USA*

This session focuses on Applications of High Energy Lasers to tailor the properties of compressible materials using Laser Peening. Laser Peening creates layers of residual compressible beneath the surface which enables the components to resist fatigue and corrosion. This session will include presentations on the theory, principles and application of laser peening followed by a Panel Discussion.

**Laser Peening: Optical Systems and Current Applications**
Lloyd Hackel, *Curtiss Wright – Metal Improvement Company, USA.*

**Laser Peening: Residual Stress, Microstructure and Properties for Aero Engines and Nuclear Alloys,** S. R. Mannava, *Univ. of Cincinnati, USA.*

Exhibit Hall / Galleria

18:00 -- 19:30
AM5A • Student Poster Session

Sponsored by IPG PHOTONICS

**AM5A.1 • Dissipative Soliton Resonance of a Fiber Laser Using Bulk-structured $Bi_2Te_3$ Topological Insulator,** Junsu Lee[1], Joonhoi Koo[1], Ju Han Lee[1]; [1]*Univ. of Seoul, Korea (the Republic of).* We experimentally demonstrate nanosecond pulsewidth-tunable mode-locking of a fiber laser incorporating a bulk-structured $Bi_2Te_3$ topological insulator (TI). It is shown that pulse width-tunable mode-locked pulses are readily obtainable with increasing a pump power from an erbium fiber ring cavity.

**AM5A.2 • Detailed Analysis of $Nd^{3+}$,$Lu^{3+}$ Codoped $CaF_2$ Laser Crystals for Broadband Laser Operation,** Simone Normani[1], Alain Braud[1], Jean-Louis Doualan[1], Richard Moncorge[1], Diane Stoffel[1,2], Jean-Paul Goossens[2], Patrice Camy[1]; [1]*CIMAP-ENSICAEN, France;* [2]*CEA CESTA, France.* Distinct stimulated emission and absorption cross-sections for the two main emitting centers in $Nd^{3+}$,$Lu^{3+}$:$CaF_2$ laser crystals are identified along with their respective lifetimes and concentrations enabling the development of high peak power diode-pumped amplifiers.

**AM5A.3 • Fiberized plasmonic Fresnel-zone plate for radially polarized focused light generation with focal-length tunability,** Hyuntai Kim[1], Haechan An[1], Yohan Lee[1], Gunyeol Lee[1], Jinseob Kim[1], Kyoungyoon Park[1], Hansol Kim[1], Luis A. Vazquez-Zuniga[1], byoungho lee[1], Yoonchan Jeong[1]; [1]*Seoul National Univ., USA.* We propose a fiberized plasmonic Fresnel-zone plate that can efficiently generate a radially polarized focused light in free space. The position of the focused beam is readily controlled by tuning the incident beam's wavelength.

**AM5A.4 • Electro Optic Q switching using Thermal Lensing,** Loyiso Maweza[1,2], Gary King[1], Cobus Jacobs[1], Hencharl J. Strauss[1]; [1]*CSIR National Laser Centre, South Africa;* [2]*Physics, Stellenbosch Univ., South Africa.* We demonstrate a new Q switching technique that exploits the polarization dependence of the thermal lens effect of a cut uniaxial gain media within a range of pump powers.

**AM5A.5 • Unidirectional all-fiber thulium-doped laser based on theta cavity and fiber Bragg grating as filtering element,** Svyatoslav Kharitonov[1], Camille-Sophie Brès[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We present first all-fiber unidirectional ring thulium-doped laser, based on isolator-free theta cavity configuration and fiber Bragg mirror as filtering element. Laser provides 1W output power with 30% slope efficiency, and linewidth of about 0.2nm.

**AM5A.6 • Polarization and Crystal-Orientation Dependency of Thermal Effects in Cryogenically Cooled Yb:$CaF_2$,** Kevin Genevrier[1], Dimitrios N. Papadopoulos[2], Patrice Camy[3], Jean-Louis Doualan[3], Richard Moncorge[3], Patrick Georges[1], Frederic P. Druon[1]; [1]*Laboratoire Charles Fabry, Institut d'Optique CNRS, Univ Paris Sud, 2 av. A. Fresnel, 91127 Palaiseau France, France;* [2]*Laboratoire d'Utilisation des Lasers Intenses, CNRS, Ecole Polytechnique, Univ P. & M. Curie, Palaiseau, France, France;* [3]*Centre de Recherche sur les Ions les Matériaux et la Photonique, CNRS, CEA, ENSI Caen, Univ de Caen, France, France.* We study beam polarization and crystallographic-orientation dependency of thermal effects in Yb:$CaF_2$ crystals at LN2 temperature. AtypicalSignificant anisotropy for a cubic crystal is demonstrated resulting in polarization-dependent thermal-astigmatism or asymmetric depolarization pattern.

**AM5A.7 • Spectroscopic properties and laser operation of Pr,Gd:$CaF_2$ crystal,** Hao Yu[1], Liangbi L. Su[1], Bin Xu[2], Dapeng Jiang[1], wen . Ju[1], Jun Xu[3]; [1]*Shanghai Inst. of Ceramics, Chinese, China;* [2]*Dept. of Eleectronic Engineering, Xiamen Univ., Xiamen 361005, People's Republic of China, China;* [3]*School of Physics Science and Engineering, Inst. for Advanced Study, Tongji Univ., Shanghai 200092, China, China.* The spectroscopic properties of Pr:$CaF_2$ and Pr,Gd:$CaF_2$ crystals were measured. We report on cw laser oscillation at 642nm of Pr,Gd:$CaF_2$ crystal. The highest laser power of 22.2mW is achieved with slope efficiency of 7.5%.

**AM5A.8 • Generation of high-brightness spectrally flat supercontinuum in 1900-2450 nm range inside a small core thulium-doped fiber amplifier,** Sida Xing[1], Svyatoslav Kharitonov[1], Thibault North[1], Davide Grassani[1], Camille-Sophie Brès[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We demonstrate the generation of high-brightness supercontinuum inside thulium-doped fiber amplifier in 1950-2450nm spectral range with 1.7W output power and 32% slope efficiency, seeded by tunable 2000nm mode-locked laser and assisted by $^3H_4$-$^3H_5$/$^3F_4$-$^3H_6$ thulium transitions.

**AM5A.9 • Pump Beam Engineering for Vortex Beam in a Ho:YAG Rod Amplifier,** Yuan Li[1], Wenzhe Li[1], Keith Miller[1], Eric G. Johnson[1]; [1]*Clemson Univ., USA.* Different pump beam profiles are utilized for pumping optical vortex beams in a Ho:YAG amplifier. Pump beam profile engineering is discussed for the optimized amplification results.

**AM5A.10 • Polarized Wavelength-Tunable Narrow Linewidth Emission from a Diode-Pumped Mid-IR Microspherical Laser,** Behsan Behzadi[1], Mani Hossein-Zadeh[1], Ravinder K. Jain[1]; [1]*Center for High Technology Materials, Univ. of New Mexico, USA.* We describe wavelength-tunable narrow linewidth (< 50pm) polarized mid-IR (2.7 μm) emission from a diode-pumped microspherical laser made from heavily-doped Er: ZBLAN glass.

**AM5A.11 • Use of a $MoSe_2$ Saturable Absorber for Harmonically Mode-locked Fiber Laser,** Joonhoi Koo[1], Junsu Lee[1], Ju Han Lee[1]; [1]*Univ. of Seoul, Korea (the Republic of).* We experimentally demonstrate the $MoSe_2$ saturable absorber (SA) for femtosecond harmonic mode-locking. The mode-locked pulses with a temporal width of 737 to 798 fs can be generated at various harmonic frequencies from erbium-doped fiber cavity.

**AM5A.12 • Enhancement of Cr and Fe Diffusion in ZnSe/S Laser Crystals via Annealing in Vapors of Zn and Hot Isostatic Pressing,** Ozarfar Gafarov[1], Vladimir Fedorov[1], Sergey B. Mirov[1]; [1]*Univ. of Alabama at Birmingham, USA.* Chromium and Iron ions diffusion in Zn vapors and under high Argon pressure are studied. The diffusion coefficient of Fe in ZnS was improved by 60 times under hot isostatic pressing at 3000 atm.

**AM5A.13 • High-power, widely tunable, green-pumped femtosecond BIBO optical parametric oscillator,** Wenlong Tian[2], Xianghao Meng[1], Ninghua Zhang[2], Zhaohua Wang[1], Jiangfeng Zhu[2], Zhiyi Wei[1]; [1]*Chinese Academy of Sciences, China;* [2]*School of Physics and Optoelectronic Engineering, Xidian Univ., China.* We report a 515 nm pumped femtosecond optical parametric oscillator based on BIBO for the first time. Tunable pulses from 688-1900 nm were obtained with the maximum power of 1.09 W at 705 nm.

**AM5A.14 • Temporal dynamics and shot-to-shot stability characteristics of three distinctive partially-mode-locked operation regimes in a fiber ring cavity,** Youngchul Kwon[1], Seungjong Lee[1], Luis A. Vazquez-Zuniga[1], Hanbyul Chang[1], Kyoungyoon Park[1], Haechan An[1], Yoonchan Jeong[1]; [1]*Seoul National Univ., Korea (the Republic of).* We numerically and experimentally study three distinctive partially-mode-locked regimes in a fiber ring laser. We discuss their temporal dynamics and shot-to-shot stability characteristics, which offers a clue to the existence of the partial coherence in such regimes.

**AM5A.15 • Intra-cavity Passive Coherent Combining in a Crossed-Porro Resonator Configuration,** Ziv Alperovich[2], Oded Buchinsky[1], Shmuel Greenstein[1], Amiel A. Ishaaya[2]; [1]*Elbit Systems Ltd., Israel;* [2]*Ben-Gurion Univ. of the Negev, Israel.* We investigate passive coherent beam combining of two pulsed multimode Nd:YAG laser channels in a crossed-Porro resonator configuration, and measure the misalignment sensitivities. We obtain 97% combining efficiency with reduced sensitivities compared to plano-plano configuration.

**AM5A.16 • Repetition-rate-variable ytterbium-doped fiber MOPA for waveguide direct writing in transparent materials,** Hiroki Tanaka[1], Kenichi Hirosawa[1], Fumihiko Kannari[1]; [1]*Keio Univ., Japan.* We present an ytterbium-doped fiber master oscillator power amplifier which has a repetition rate tunability from 1 kHz to 10 MHz. The repetition rate is controlled by a semiconductor optical amplifier driven in pulsed mode.

**AM5A.17 • High Beam Quality, Single-Polarization Output from a mJ Energy Level, kHz rep-rate 1550 nm Fiber Laser,** Ravinder K. Jain[1], Mike Klopfer[1], Leanne Henry[2]; [1]*Univ. of New Mexico, USA;* [2]*Air Force Research Labs, USA.* Pulse energies of over 0.3 mJ are demonstrated from a single-polarization 1550 nm fiber laser system at a 3 kHz rep rate, with an $M^2$ of 1.12, a PER of 15 dB, , and an SNR of 20 dB.

**AM5A.18 • Yb:GGG Thin-Disk Oscillator with High Power Continuous Wave Operation,** Andreas Diebold[1], Zhitai Jia[2], Ivan Graumann[1], Yanru Yin[2], Florian Emaury[1], Clara Saraceno[1], Xutang Tao[2], Ursula Keller[1]; [1]*ETH Zurich, Switzerland;* [2]*State Key Lab of Crystal Materials, Shandong Univ., China.* We present a Yb:GGG thin-disk laser for the first time. We demonstrate more than 50 W of output power in multimode operation at 67% slope efficiency, which is similar to values achieved with Yb:YAG.

**AM5A.19 • Pulsed Laser Deposition of Relaxed $ZnS_xSe_{1-x}$ Thin Films for Waveguiding Applications in Mid-IR Active $Cr^{2+}$:ZnSe Multilayered Structures,** Zachary R. Lindsey[1], Matthew Rhoades[1], Vladimir V. Federov[1], Sergey B. Mirov[1], Renato P. Camata[1]; [1]*Physics, Univ. of Alabama at Birmingham, USA.* Several films of $ZnS_xSe_{1-x}$ were deposited at various temperatures and compositional parameters by pulsed laser deposition. Films were characterized via x-ray diffraction for crystal quality and impact of sulfur incorporation on epitaxy and defect density.

**AM5A.20 • Band Gap Dependence of Continuous-Wave Laser Induced Damage Threshold of Optics with Absorptive Contamination,** Andrew K. Brown[1], Albert Ogloza[2], Kyle Olson[1], Jeffrey Thomas[3], Joseph Talghader[1]; [1]*Univ. of Minnesota Twin Cities, USA;* [2]*Naval Postgraduate School, USA;* [3]*Electro Optics Center, Pennsylvania State Univ., USA.* The laser damage threshold of optical coatings with differing band gaps was measured with carbon contamination. DBRs and half-wave coatings were tested. For both coating types damage thresholds increased for larger band gaps.

18:00 -- 19:30
AM5A • Student Poster Session

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**AM5A.21 • Resonant-tunneling Transport of Holes in Terahertz GaAs/AlGaAs Quantum Cascade Superlattices,** Le Zhao[1], Liang Gao[1], John L. Reno[2], Sushil Kumar[1]; *[1]Lehigh Univ., USA; [2]Center of Integrated Nanotechnologies, Sandia National Labs, USA.* Design and experiments for a hole-based GaAs/AlGaAs terahertz quantum-cascade structure are reported. Sequential resonant-tunneling transport is demonstrated, which indicates effective quantum-transport for heavy-holes and is promising toward development of the first hole-based intersubband laser.

**AM5A.22 • Graphene Q-Switched Er,Yb:GdAl $_3(BO_3)_4$ Laser at 1550 nm,** Konstantin Gorbachenya[1], Viktor Kisel[1], Anatol Yasukevich[1], Pavel Loiko[2,3], Xavier Mateos[2,3], Viktor Maltsev[4], Nikolai Leonyuk[4], Nikolai Kuleshov[1], Magdalena Aguiló[2], Francesc Díaz[2], Valentin Petrov[3], Uwe Griebner[3]; *[1]Center for optical materials and technol, Belarus; [2]Física i Cristallografia de Materials i Nanomaterials (FiCMA-FiCNA), Spain; [3]Max Born Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany; [4]Moscow State Univ., Russia.* A single-layer graphene saturable absorber is employed for passive Q-switching of a diode-pumped $Er^{3+}$,$Yb^{3+}$:$GdAl_3(BO_3)_4$ compact laser. Stable ~1 µJ/130 ns pulses are achieved at 1.55 µm at a repetition rate of 0.4 MHz.

**AM5A.23 • Nd:$GdVO_4$ Innoslab amplifier with discrete path for parasitic lasing suppression,** Jie Guo[3,1], Hua Lin[3], Xiaoyan Liang[3,2]; *[1]Graduate School of Chinese Academy of Sciences, China; [2]School of Physical Science and Technology, Shanghai Tech Univ., China; [3]State Key Lab of High Field Laser Physics, Shanghai Inst. of Optics and Fine Mechanics, China.* We propose a technique for eliminating self-lasing and suppressing amplified spontaneous emission in partially pumped slab amplifier with a discrete path configuration. A 99 W, 12.4 ps, $TEM_{00}$ Nd:$GdVO_4$ laser output was achieved with a 42% extraction efficiency and diffraction limited beam quality.

**AM5A.24 • High-Power Nd:YAG Pump Laser System for OPCPA,** Tiago Pinto[1], Stefan Witte[1], Kjeld Eikema[1]; *[1]ARCNL, Netherlands.* We are developing a multi-stage Nd:$YVO_4$/Nd:YAG -based amplifier producing up to 250mJ with ps-durations. With tunable duration, flat-top intensity profile and low fluorescence, this system is well suited to pump a near- and mid-IR OPCPA.

**AM5A.25 • Accurate measurement of electro-optic coefficients of stoichiometric $LiNbO_3$,** Shota Nakano[1], Kazuki Akiyama[1], Ichiro Shoji[1]; *[1]Chuo Univ., Japan.* We accurately measure the electro-optic coefficients of stoichiometric $LiNbO_3$ using a high-quality crystal and a reliable AC-field applying method. The values of $r_{33}$ and $r_{13}$ at 633 nm are 30.2±0.6 and 9.1±0.2 pm/V, respectively.

**AM5A.26 • Arbitrary Temporal Shaping of Nanosecond Pulses at the Joule Level,** Randy Meijer[1], Aneta Stodolna[1], Kjeld Eikema[1], Stefan Witte[1]; *[1]ARCNL, Netherlands.* We demonstrate a laser system capable of generating arbitrary temporally shaped pulses with 1 ns resolution at 100 Hz repetition rate. Amplification after shaping results in a unique combination of high-energy pulses with complex shapes.

**AM5A.27 • Preparation of Few-Layer Bismuth telluride films by Spin Coating-Coreduction Approach(SCCA) and laser test,** Peng Lee[1], Hua Y. Sang[2], Yue Zhao[2,3], Jin -Long Xu[4], Hong Liu[2,5], Chao-Yang Tu[4], Chao-Kuei Lee[1,6]; *[1]Dept. of Photonics, Taiwan; [2]Key Lab of Crystal Materials, China; [3]Key Lab of Science and Technology, China; [4]Key Lab of Optoelectronic Materials Chemistry and Physics of CAS, China; [5]Beijing Inst. of Nanoenergy and Nanosystems, China; [6]Dept. of Physics, Taiwan.* In this work, using Spin Coating-Coreduction Approach (SCCA), high-purity few layers Bi2Te3 thin film was successfully prepared and with high optical quality. Additionally, low threshold Q-switched mode-locked 1.06um solid state laser was also demonstrated.

Tuesday, 1 November

07:00—18:30 • Registration, *Main Lobby Harborside*

| Harbor Ballroom I & II | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III |
|---|---|---|
| ASSL | LS&C | LAC |

08:00 -- 10:00
**ATu1A • Modelocked Sources**
*Presider: Almantas Galvanauskas; Univ. of Michigan, USA*

ATu1A.1 • 08:00
**First Detection and Stabilization of the Carrier Envelope Offset Frequency of a Diode-Pumped Femtosecond Ti:Sapphire Laser,** Kutan Gurel[1], Valentin Wittwer[1], Sargis Hakobyan[1], Stephane Schilt[1], Thomas Sudmeyer[1]; [1]*Universite de Neuchatel, Switzerland.* So far, Ti:Sapphire-based frequency comb systems required complex bulk green pump lasers. Here we show that green diode pumping enables compact and cost-efficient femtosecond Ti:Sapphire lasers for coherent octave-spanning supercontinuum generation and frequency comb stabilization.

ATu1A.2 • 08:15
**Sub-20 Femtosecond Pulse Generation with a Graphene Mode-locked Solid-State Laser,** Ferda Canbaz[1], Nurbek Kakenov[2], Coskun Kocabas[2], Umit Demirbas[3], Alphan Sennaroglu[1]; [1]*Koç Univ., Turkey;* [2]*Bilkent Univ., Turkey;* [3]*Antalya International Univ., Turkey.* We generated 19-fs pulses with a low-threshold, diode-pumped graphene mode-locked Cr:LiSAF laser near 850 nm. To the best of our knowledge, these represent the shortest pulses generated to date with a graphene mode-locked laser.

ATu1A.3 • 08:30
**High-Power Modelocked Yb:$Lu_2O_3$ Thin-Disk Laser with 10-MW sub-500 fs Pulses,** Ivan Graumann[1], Andreas Diebold[1], Florian Emaury[1], Bastian Deppe[2,3], Christian Kraenkel[2,3], Clara Saraceno[1], Ursula Keller[1]; [1]*ULP - IQE - ETH Zürich, Switzerland;* [2]*Institut fuer Laser-Physik, Germany;* [3]*The Hamburg Center for Ultrafast Imaging, Germany.* We present a SESAM-modelocked thin-disk laser based on the material Yb:$Lu_2O_3$, delivering record high peak powers up to 10 MW and pulse energies up to 6.5 µJ at pulse durations down to sub-500 fs.

ATu1A.4 • 08:45
**Towards a Pulse Energy of 100 µJ Inside a Kerr Lens Mode-locked Thin-disk Ring Oscillator,** Abdolreza Amani Eilanlou[1], YASUO Nabekawa[1], Makoto Kuwata-Gonokami[2,3], Katsumi Midorikawa[1,2]; [1]*RIKEN, Japan;* [2]*Inst. for Photon Science and Technology, The Univ. of Tokyo, Japan;* [3]*Graduate School of Science, The Univ. of Tokyo, Japan.* We report an upgrade of our Kerr lens mode-locked thin-disk ring oscillator, which has so far yielded an unprecedented intra-cavity pulse energy of ~75 µJ with a pulse duration of 498 fs at 13.4 MHz.

ATu1A.5 • 09:00
**Development and characterization of 1.0-2.1 um octave spanning, coherent supercontinuum comb based on Er-doped ultrashort pulse fiber laser,** Toshiki Niinomi[1], Yoshitaka Nomura[1], Lei Jin[1], Masahito Yamanaka[1], Yasuyuki Ozeki[2], Volker Sonnenschein[1], Hideki Tomita[1], Tetsuo Iguchi[1], Norihiko Nishizawa[1]; [1]*Nagoya Univ., Japan;* [2]*Univ. of Tokyo, Japan.* Octave spanning, coherent supercontinuum comb with high flatness was realized with normal dispersion highly nonlinear fiber, similariton amplifier, and stabilized Er-doped fiber laser comb. Highly coherent properties were confirmed after 1.4 km fiber delivery.

ATu1A.6 • 09:15
**High-Energy Infrared Femtosecond Optical Parametric Oscillator Synchronously Pumped by a Thin-Disk Laser,** Travis Petersen[1], Jon Zuegel[1], Jake Bromage[1]; [1]*Lab for Laser Energetics, USA.* An optical parametric oscillator has been constructed to test energy scalability using a 1.0-ps, thin-disk–based pump producing 455-fs pulses at 7.08 MHz tunable from 1.99 to 2.20 µm with energies up to 345 nJ.

08:30 -- 10:00
**LTu1B • Synthetic Aperture Imaging**
*Presider: Claudine Besson; ONERA, France*

LTu1B.1 • 08:30 **Tutorial**
**Digital Hologrphy and Aperture Synthesis,** David J. Rabb[1]; [1]*US Air Force Research Lab, USA.* Digital holography and aperture synthesis techniques have the ability to dramatically enhance the achievable resolution in standoff sensing applications. A review of relevant work from multiple groups will be presented.

08:00 -- 10:00
**Fast and Ultrafast Micro Machining Session I**
*Moderator: Sascha Weiler, TRUMPF, USA*

Fast and ultrafast lasers with pulse durations from ns to fs have become established for industrial applications. Yet their wide parameter space of power, pulse duration, pulse energy, wavelength combined with proper beam delivery optics still holds potential for more applications. At the same time a deep understanding of the interaction between laser pulse and material is required to explore said potential. The "Fast and Ultrafast Micro Machining" sessions aims to combine the fundamentals with real world applications.

**Discovering New Properties and Applications of Ultrafast Laser Direct Writing,** Peter Kazansky, *Univ. of Southampton, UK.* Formation of sub-wavelength periodic structures in bulk transparent materials irradiated with intense ultrashort light pulses remains a mystery almost two decades since the discovery. Nevertheless the phenomenon has enabled unique applications ranging from geometrical phase optics to eternal data storage.

**2nd Generation Acousto-optic Deflector Based Laser Drilling,** Jan Kleinert, *Electro Scientific Industries Inc., USA.* As available laser power continues to grow exponentially, laser beam positioning is increasingly becoming the bottleneck in micromachining tool productivity. While splitting the laser into multiple heads or systems mitigates this somewhat, this alone doesn't necessarily suffice. Acousto-optic deflectors provide a different way to scale processing speeds than polygon scanners due to their non-mechanical nature. The first generation of AOD based tools provided higher bandwidth positioning speeds, the second generation now enables processes that are not quite possible without them.

**USP Lasers for Drilling of GDi Fuel Injectors,** Mike Lerner, *GF Machining Solutions, Microlution Inc, USA.* This presentation discusses the application of USP lasers for drilling micro-holes in GDi fuel injectors, and how this project is evidence that USP lasers can be exceptionally precise, fast, and reliable for industrial micro machining.

**Surface Texturing with Ultra Short Laser Pulses: Ways to Scale Up Throughput** Beat Neuenschwander, *Bern University of Applied Sciences, Switzerland.* Abstract not available.

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| Harbor Ballroom I & II | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III |
|---|---|---|
| ASSL | LS&C | LAC |

**ASSL**

08:00 -- 10:00
ATu1A • Modelocked Sources—Continued

**ATu1A.7 • 09:30**
**Stabilized Microwave Frequency Comb from a Dual-Comb Modelocked Semiconductor Disk Laser ,** Sandro M. Link[1], Dominik Waldburger[1], Cesare G. Alfieri[1], Matthias Golling[1], Ursula Keller[1]; [1]*ETH Zurich, Switzerland.* We present a dual-comb semiconductor disk laser generating simultaneously two modelocked pulse trains. The resulting down-converted microwave frequency comb is fully stabilized with only two feedback-loops, representing a simple, compact, and cost-efficient tool for spectroscopy.

**ATu1A.8 • 09:45**
**High-power 100-fs SESAM-modelocked VECSEL,** Dominik Waldburger[1], Sandro M. Link[1], Cesare G. Alfieri[1], Matthias Golling[1], Ursula Keller[1]; [1]*Dept. of Physics, Inst. for Quantum Electronics, ETH Zurich, Switzerland.* A high-power, 100-femtosecond, optically pumped SESAM-modelocked VECSEL is presented and power limitations due to multi-pulse behavior are explored. With the presented record performance the generation of self-referenceable frequency combs directly from SDLs should become possible.

**LS&C**

08:30 -- 10:00
LTu1B • Synthetic Aperture Imaging —Continued

**LTu1B.2 • 09:30** Invited
**Compressive Sensing for Ladar Remote Sensing and Imaging,** Joe Buck[1]; [1]*Lockheed Martin, USA.* The sparsity of a typical ladar signal enables application of compressive sensing techniques to reduce computational and storage requirements. These techniques apply to both the spatial and temporal domain for remote sensing and imaging.

**LAC**

08:00 -- 10:00
Fast and Ultrafast Micro Machining Session I—Continued

10:00 -- 11:30

## JTu2A • Tuesday Poster Session in Exhibit Hall

(Coffee Break 10:00-10:30)

**JTu2A.1 • Prospects of ytterbium-doped, monoclinic magnesium tungstate crystal for optical vortex laser,** Weidong Chen[1], Jie-Ling Lu[1], Li-Zhen Zhang[1], Zhou-Bin Lin[1], Ge Zhang[1], Yung-Fu Chen[2]; [1]*Fujian Inst of Res Structure of Matter, China;* [2]*Dept. of Electrophysics, National Chiao Tung Univ., Taiwan.* We first present an efficient multi-watt Yb:$MgWO_4$ vortex laser. The robust first-order Laguerre-Gaussian doughnut beam with well -determined spiral phase-front trajectory was excited without using any specific intracavity spiral chirality selection components.

**JTu2A.2 • High Repetition Rate for Ultra-High Peak Power Laser Systems,** Vladimir Chvykov[1], Huabao Cao[1], Roland Nagymihaly[1], Mikhail Kalashnikov[2], Nikita Khodakovskiy[2], Richard Glassock[1], Lutz Ehrentraut[2], Matthias Schnuerer[2], Karoly Osvay[1]; [1]*ELI-ALPS, USA;* [2]*Max-Born-Institut for Nonlinear Optics and Short Pulse Spectroscopy, Germany.* We will present the results of the proof-of-principal experiments where the combination of the scheme of Extraction During Pumping (EDP) and the Thin Disk (TD) technology were tested for the first time, according to our knowledge.

**JTu2A.3 • Coupled Optical Parametric Oscillators Based on Oppositely-Oriented Nonlinear Crystal Twins,** Yujie J. Ding[1]; [1]*Lehigh Univ., USA.* We have investigated a novel configuration of coupled optical parametric oscillators: signal twins and idler twins are simultaneously generated by both of two oppositely-oriented nonlinear crystal twins. Our theory is supported by our experiment.

**JTu2A.4 • Coherent Beam Combining for Ultrashort Intensity Laser Systems,** YAN-QI Gao[1]; [1]*Shanghai Inst. of Laser Plasma, China.* Three kinds of factors, including phase distribution, spectral dispersion and longitudinal chromatism, are investigated for ultra-short beam combining. The general control requirements are given. High-quality combining is realized, and the time jitter is less than 150 attosecond.

**JTu2A.5 • Diode-pumped Femtosecond Tm-doped $Lu_2O_3$ Ceramic Laser,** Alexander A. Lagatsky[1], John-Mark Hopkins[1]; [1]*Fraunhofer UK Research Ltd, UK.* Femtosecond-pulse operation of a diode-pumped Tm:$Lu_2O_3$ ceramic laser at 2068 nm is reported. Transform-limited pulses of 242 fs are generated with an average output power of 500 mW at 75 MHz pulse repetition rate.

**JTu2A.6 • New Design of 1 μm Large Mode Area Fiber With $Sm^{3+}$ Doped Loss Coupled Core Structure,** Chunlei Yu[1]; [1]*Shanghai Inst of Optics & Fine Mechanics, China.* $Sm^{3+}$ doped side-cores are introduced in fiber cladding as couplers to separate high-order modes from center-core by resonance and attenuate them. The side-core in the fiber also has the ability to clear cladding mode.

**JTu2A.7 • Self-Swept Holmium-Doped Fiber Laser near 2100 nm,** Jan Aubrecht[1], Pavel Peterka[1], Pavel Honzatko[1], Pavel Koška[1], Ondrej Podrazky[1], Filip Todorov[1], Ivan Kasik[1]; [1]*Inst. of Photonics and Electronics, Czech Republic.* Self-sweeping of Laser wavelength corresponding to holmium emission near 2100 nm is reported for the first time. The sweeping occurred in ~4 nm interval with rate ~0.7 nm/s and was registered by FTIR spectrometer.

**JTu2A.8 • 94-fs Polarization-Maintaining Chirped-Pulse-Amplification System using a Fiber Stretcher,** Robert Herda[1], Armin Zach[1], Lars Grüner-Nielsen[2]; [1]*TOPTICA Photonics AG, Germany;* [2]*OFS, Denmark.* We present a polarization-maintaining monolithic chirped-pulse amplification system delivering 94-fs pulses with 200 nJ pulse energy. Using a polarization maintaining fiber stretcher the second and third order dispersion of the stretcher is matched to a grating compressor.

**JTu2A.9 • Multiple-beam Ceramic Nd:YAG Pulse-burst Laser,** Yufei Ma[1], Xudong Li[1], Jiahui huang[1], Ying He[1], Jiang Li[2], Renpeng Yan[1], Xin Yu[1], Rongwei Fan[1], Zhiwei Dong[1], Yubai Pan[2], Rui Sun[1]; [1]*Harbin Inst. of Technology, China;* [2]*Chinese Academy of Sciences, China.* A novel four-beam output ceramic Nd:YAG laser under 2×2 micro-lens array pumping together with pulse-burst mode in which both high repetition rate and high pulse energy can be realized simultaneously were demonstrated for LIPI.

**JTu2A.10 • $Nd^{3+}$ Doped Phosphate Glass Waveguides for Pulsed Laser Applications,** Nadia G. Boetti[1], Diego Pugliese[2], Edoardo Ceci-Ginistrelli[2,3], Joris Lousteau[3], Francesco Poletti[3], Daniel Milanese[2]; [1]*Istituto Superiore Mario Boella, Italy;* [2]*DISAT, Politecnico di Torino, Italy;* [3]*Optoelectronics Research Centre, Univ. of Southampton, UK.* Two phosphate glass compositions were designed and fabricated with the aim of realizing core/clad waveguides for high power pulsed laser applications. Preforms and waveguides (rods and fibers) manufacturing by preform drawing is reported.

**JTu2A.11 • 30 W Thin Yb:YAG Rod Chirped Pulse Amplifier with High Output Beam Quality,** Aleksej Rodin[1], Nerijus Rusteika[1], Nerijus Slavinskis[1]; [1]*FTMC, Lithuania.* Double-pass Yb:YAG single crystal fiber CPA seeded with fiber laser pulses of > 350 mW power at 21 - 500 kHz provides ~ 30 W output of M2 < 1.13 in dual-end-pumped configuration with high brightness laser diodes of 120 W overall power.

**JTu2A.12 • Modal content analysis of hollow core Kagome fibers,** Marco Plötner[1], Oliver de Vries[1], Johannes Nold[1], Nicoletta Haarlammert[1], Thomas Schreiber[1], Ramona Eberhardt[1], Andreas Tünnermann[1]; [1]*Fraunhofer IOF, Germany.* We report on quantitative modal content measurements by S2 measurements in a Kagome type hollow core fiber depending on bending and in-coupling optimization. The higher order mode content could not be completely suppressed impacting important applications.

**JTu2A.13 • About 400 kW Peak-Power, 7.5 GHz Linewidth, 1.5 μm Fiber Gas Raman Source,** Zefeng Wang[1], yubin chen[1], bo gu[1], fei yu[2], chaofan zhang[1]; [1]*National Univ of Defense Technology, China;* [2]*Univ. of Bath, UK.* A 400 kW peak-power and 7.5 GHz linewidth 1553 nm fiber gas Raman source , using an ethane-filled hollow-core fiber pumped with a 1064 nm laser, is demonstrated for the first time.

**JTu2A.14 • High-repetition-rate, high-pulse-energy burst mode laser from a Nd:$YVO_4$/Nd:YAG MOPA system,** Renpeng Yan[1], Xudong Li[1], Xin Yu[1], Yufei Ma[1], zhongxiang zhou[1]; [1]*Harbin Inst. of Technology, China.* We report a 10-100kHz, burst mode laser from a Nd:$YVO_4$/Nd:YAG MOPA system. 73mJ per pulse is achieved in 10kHz pulse burst laser with a pulse width of 9.3ns and a peak power of 7.8MW.

**JTu2A.15 • New Scheme for Pumping Solid–state Lasers Based on LED–pumped Luminescent Concentrators.,** Adrien BARBET[1], Amandine Paul[2], Thomas Gallinelli[3], François Balembois[1], Jean-Philippe Blanchot[2], Sébastien Forget[3], Sébastien Chénais[3], Frederic P. Druon[1], Patrick Georges[1]; [1]*Institut d'Optique Graduate School, France;* [2]*Effilux, France;* [3]*Laboratoire de Physique des Lasers, France.* We report the first solid –state laser pumped by a LED concentrator. This Ce:YAG concentrator emits up to 1 kW peak power with an irradiance reaching 7 kW/$cm^2$ with optical efficiency of 25%, which is suitable to pump a Nd:$YVO_4$ crystal.

**JTu2A.16 • Mode Selection in High-Power Diode-Pumped Raman Fiber Laser by Means of Fs-Inscribed FBG,** Sergey A. Babin[1], Ekaterina A. Zlobina[1], Sergey I. Kablukov[1], Alexey A. Wolf[1], Alexander V. Dostovalov[1]; [1]*Inst. of Automation and Electrometry, Russia.* Single transverse mode is selected by FBGs inscribed by femtosecond technique in a graded-index fiber. High beam quality and narrow spectrum have been obtained in the Raman fiber laser with multimode 915-nm laser diode pumping.

**JTu2A.17 • Tunable Bismuth-Doped Fiber Laser for a Spectral Region of 1360-1510 nm,** V M. Paramonov[1], M I. Belovolov[1], Mikhail A. Melkumov[1], Sergei V. Firstov[1], V F. Khopin[2], A N. Guryanov[2], Evgeny M. Dianov[1]; [1]*Fiber Optics Research Center RAS, Russia;* [2]*Inst. of Chemistry of High-Purity Substances, Russian Academy of Sciences, Russia.* A Bismuth-doped fiber laser tunable in the new wavelength range 1360-1510 nm with the output power 50 mW has been developed for the first time. The tuning of the laser was carried out by rotating diffraction grating.

**JTu2A.18 • Ultra-broad band glass for short pulsed laser applications,** Simi George[1]; [1]*SCHOTT North America, Inc., USA.* Sensitized luminescence from rare-earths resulting from coupling interactions is utilized to develop a new laser glass capable of emitting into a broad spectrum. Emission characteristics are evaluated in detail and direct pumped laser performance is demonstrated.

**JTu2A.19 • Efficient Harmonic Conversion of 2-um Holmium Lasers into Near-IR, Visible and UV,** Michael Bethel[1], Alex Dergachev[1], Dan Perlov[1]; [1]*IPG Photonics Corporation, USA.* We report highly-efficient 2$^{nd}$, 4$^{th}$ and 8$^{th}$ harmonic conversion of a pulsed, kHz-rate, 2-um, Ho -laser to produce multi-mJ pulse energies in near-IR (1025 nm), visible (512.5 nm) and UV (256 nm) spectral ranges.

**JTu2A.20 • Spectral Beam Combining and Dispersion Compensation of Superfluorescent Fiber Source Array to 10.8 kW,** yifeng Yang[1], ye Zheng[1], bing He[1], yunxia Jin[1], jun zhou[1]; [1]*China Academy of Science, China.* We report an 8-element spectral beam combination of all-fiber superfluorescent sources using a polarization-independent multilayer dielectric reflective grating. 10.8 kW output power is achieved with 94% diffraction efficiency. Dual grating dispersion compensation scheme have been performed.

**JTu2A.21 • 5 MW Peak Power 10 ps Fiber-solid Hybrid Laser from an Aberration Self-compensated Double-pass Two-stage Nd:$YVO_4$ Amplifier.,** Chong Liu[1], Bin Liu[1]; [1]*Zhejiang Univ., China.* A delicately designed double-pass two-stage Nd:$YVO_4$ amplifier is reported that produces 5 MW peak power when seeded by a 0.1 mw fiber laser at repetition rate of 100 kHz with pulse duration of 10 ps.

10:00 -- 11:30
## JTu2A • Tuesday Poster Session in Exhibit Hall
(Coffee Break 10:00-10:30)



**JTu2A.22 • Semiconductor Saturable Absorber Q-Switching of a Holmium Microchip Laser,** Ruijun Lan[2], Xavier Mateos[1,2], Yicheng Wang[2], Pavel Loiko[3,1], Josep M. Serres[1], Jiang Li[4], Yubai Pan[4], Konstantin Yumashev[3], Valentin Petrov[2], Uwe Griebner[2]; [1]*Universitat Rovira i Virgili, Spain;* [2]*Max Born Inst., Germany;* [3]*Belarusian National Technical Univ., Belarus;* [4]*Shanghai Inst. of Ceramics, China.* A Ho:YAG ceramic microchip laser Q-switched by a semiconductor saturable absorber generated 450 mW at 2089 nm with 37% slope efficiency. Stable 89 ns/3.2 μJ pulses are achieved at a repetition rate of 141 kHz.

**JTu2A.23 • Tm:$(Lu_xGd_{1-x})_3Ga_5O_{12}$ Disordered Garnet for Continuous-Wave and Passively Q-switched Microchip Lasers,** Pavel Loiko[2,1], Xavier Mateos[2,1], Stefano Veronesi[3], Zhitai Jia[6], Sun Choi[4], Fabian Rotermund[4], Wenxiang Mu[6], Yanru Yin[6], Mauro Tonelli[3], Xutang Tao[6], Konstantin Yumashev[5], Uwe Griebner[1], Valentin Petrov[1]; [1]*Max Born Inst., Germany;* [2]*Universitat Rovira i Virgili, Spain;* [3]*NEST, Italy;* [4]*Ajou Univ., Korea (the Republic of);* [5]*Belarusian National Technical Univ., Belarus;* [6]*Shandong Univ., China.* A microchip laser based on a disordered Tm:$(Lu_xGd_{1-x})_3Ga_5O_{12}$ garnet generated 1.71 W at 2015 nm with a slope efficiency of 55%. This laser is passively Q-switched by SWCNTs delivering 15.7-μJ, 190-ns pulses.

**JTu2A.24 • Microresonator ECDL for super-cavity stabilization,** Jinkang Lim[1], Shu-Wei Huang[1], abhinav vinod[1], anatoliy savchenkov[2], andrey matsko[2], lute maleki[2], chee wei wong[1]; [1]*Univ. of California Los Angeles, USA;* [2]*OEwaves Inc, USA.* We report on the development of a tunable microresonator-based sub-kHz ECDL optimized for stabilization using an ultrastable super-cavity. We demonstrate the ECDL generating an undistorted error signal at the ring-down time-scale of the super-cavity and realize locking the laser to the super-cavity.

**JTu2A.25 • Scalar and Vector Vortex Beams from the Source,** Darryl Naidoo[1], Filippus Roux[1,2], Angela Dudley[1,2], Igor Litvin[1], Bruno Piccirillo[3], Lorenzo Marrucci[3,4], Andrew Forbes[2]; [1]*National Laser Centre, CSIR, South Africa;* [2]*School of Physics,, Univ. of the Witwatersrand, South Africa;* [3]*Dipartimento di Fisica, Universit`a di Napoli Federico II, Italy;* [4]*Consiglio Nazionale delle Ricerche (CNR)-SPIN, Italy.* We introduce a laser for generating all states on the Higher -order Poincaré sphere by coupling spin angular momentum to orbital angular momentum and we demonstrate that the OAM degeneracy of a laser may be broken.

**JTu2A.26 • Application of optical frequency comb based on laser-diode pumped Kerr-lens mode-locked Yb:KYW laser to optical frequency measurement and phase locking to optical reference frequency,** Masatoshi Mitaki[1], Kazuhiko Sugiyama[1], Masao Kitano[1]; [1]*Dept. of Electronic Science and Engineering, Graduate School of Engineering, Kyoto-Univ., Japan.* We demonstrate frequency measurement of a clock laser for the $^2S_{1/2}$ - $^2D_{3/2}$ transition in $^{171}Yb^+$ by using a comb based on a mode-locked Yb:KYW laser. Phase locking of the comb to the laser is also achieved.

**JTu2A.27 • High average and high peak power MOPA laser based on Yb:YAG elements of different geometries,** Ivan Kuznetsov[1], Ivan Mukhin[1], Evgeny Perevezentsev[1], Mikhail Volkov[1], Olga Vadimova[1], Oleg Palashov[1]; [1]*Inst. of Applied Physics of the RAS, Russia.* High average and high peak power laser composed of ytterbium fiber oscillator, two Yb:YAG thin-tapered-rod preamplifiers and Yb:YAG thin-disk multipass amplifier is under development. 50 W average power at 10 kHz repetition rate is achieved.

**JTu2A.28 • Correction parameter for the phase-matching properties of 5mol.% MgO doped congruent $LiNbO_3$,** Nobuhiro Umemura[1], Daisuke Matsuda[3], Tomosumi Kamimura[2]; [1]*Chitose Inst of Science and Technology, Japan;* [2]*Dept. of Electronics, Information and Communication Engineering, Osaka Inst. of Technology, Japan;* [3]*Technical Dept. Manufacturing Technology Division, Nanosystem Solutions Inc., Japan.* To predict precisely the phase-matching conditions of each $LiNbO_3$ crystal, we suggest the correction parameters based on refractive indices of mixed crystal. The improved extraordinary Sellmeier equation of undoped congruent $LiNbO_3$ is also presented.

**JTu2A.29 • Efficient Chirped Bragg Gratings for Stretching and Compression of High Power Ultra Short Laser Pulses for Spectral Region 800 to 2500 nm,** Vadim I. Smirnov[1]; [1]*OptiGrate Corp , USA.* New generation of stretchers/compressors based on chirped volume Bragg gratings in PTR glass with enhanced diffraction efficiency is developed for spectral range 800-2500 nm with bandwidth up to 200 nm.

**JTu2A.30 • Laser Performance of the New IR NLO Crystal $BaGa_4Se_7$,** yao j. yong[1]; [1]*Technical Inst. of Phys. & Chem. CAS, China.* $BaGa_4Se_7$ is a very promising new IR NLO crystal.Our OPA experiments have achieved high efficiency and high peak power "3-12μm" laser output. OPO pumped by a 2090 nm laser has achieved output power of 1.55 W.

**JTu2A.31 • High Repetition Rate, Femtosecond and Picosecond Laser Induced Damage Thresholds of $Rb:KTiOPO_4$ at 1.03 μm,** Florian Bach[1], Mark Mero[1], Valdas Pasiskevicius[2], Andrius Zukauskas[2], Valentin Petrov[1]; [1]*Max Born Inst., Germany;* [2]*Dept. of Physics, Royal Inst. of Technology, Sweden.* Laser-induced damage threshold (LIDT) measurements were performed on blank, uncoated $Rb:KTiOPO_4$ (RKTP) samples at 1.03 μm with pulse durations of 330 and 930 fs and a repetition rate of 100 kHz, including temperature dependence.

**JTu2A.32 • Low-Dimensional Saturable Absorbers for Watt-Level Q-Switching of $Er:Lu_2O_3$ at 3 μm,** Christian Kraenkel[1,2], Mingqi Fan[3], Tao Li[3], Kejian Yang[3], Dechun Li[3]; [1]*Institut für Laser-Physik, Universität Hamburg, Germany;* [2]*The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Germany;* [3]*Shandong Univ., China.* Watt-level passively Q-switched $Er:Lu_2O_3$ lasers at 2.84 μm were realized with low-dimensional $MoS_2$ and BP saturable absorbers. Stable pulses of ~300 ns were generated, indicating a great potential of these materials for mid-infrared pulsed lasers.

**JTu2A.33 • Lutetium Based Oxides as New Laser Crystal Hosts at Cryogenic Temperatures,** Joseph W. Kolis[1], David C. Brown[2], Duminda Sanjeewa[1], Cheryl Moore[1]; [1]*Clemson Univ., USA;* [2]*Snake Creek Lasers, USA.* The crystal growth, rare earth doping and spectroscopy of lutetium based oxide crystals ($Lu_3Al_5O_{12}$ and $Lu_2O_3$) is described, with a goal toward designing more effective high power lasers, especially at cryogenic temperatures.

**JTu2A.34 • Pathways to a 4 μm $Dy^{3+}$ Fluoride Glass Fiber Laser,** Richard S. Quimby[1], Mohammed Saad[2]; [1]*Worcester Polytechnic Inst., USA;* [2]*Thorlabs, USA.* Nonradiative quenching in $Dy^{3+}$ is found to be much stronger than predicted by the multiphonon exponential gap law. There are nonetheless possible approaches to achieving lasing at ~4 μm in a Dy-doped fluoride fiber laser.

**JTu2A.35 • Continuously pulse width tunable Nd:YAG ceramic micro giant-pulse laser for laser induced breakdown,** Hwanhong Lim[1], Takunori Taira[1]; [1]*Inst. for Molecular Science, Japan.* We present a compact, high peak-power, and widely pulse-width tunable monolithic Nd:YAG/Cr:YAG ceramic micro laser by cavity-length control. Pulse-width dependent fluence threshold of air-breakdown is investigated in sub-ns region showing a local breakdown threshold.

**JTu2A.36 • Hybrid spatiotemporal coherent pulse addition of a picosecond flashlamp-pumped Nd:YAG laser,** Ahmad Azim[1], Benjamin Webb[1], Nathan Bodnar[1], Michael Chini[1], Lawrence Shah[1], Martin Richardson[1]; [1]*Univ. of Central Florida, USA.* We demonstrate active and passive coherent pulse addition in a flashlamp-pumped Nd:YAG amplifier chain for pumping OPCPA systems. The amplification of 200 ps pulses to 216 mJ is achieved with a 79% combination efficiency.

**JTu2A.37 • Sub-keV Electron Gun Driven by Ultrafast THz Pulses,** W Ronny Huang[1], Arya Fallahi[2], Xiaojun Wu[2], Huseyin Cankaya[2], Anne-Laure Calendron[2], Koustuban Ravi[1], Dongfang Zhang[2], Emilio Nanni[1], Kyung-Han Hong[1], Franz X. Kaertner[2]; [1]*MIT, USA;* [2]*Center for Free Electron Laser Science, DESY, Germany.* Strong-field, single-cycle THz fields accelerate electrons with peak energies of up to 0.8 keV in a ultracompact THz gun with bunch charge of 45 fC. Energy spreads as low as 5.8% were also achieved.

**JTu2A.38 • Stealth dicing with Bessel beams and beyond,** Rémi Meyer[1], Ludovic Rapp[1], Jassem Safioui[1], Luca Furfaro[1], John M. Dudley[1], François Courvoisier[1]; [1]*FEMTO-ST, France.* In the context of laser cutting of transparent materials, we investigate glass cleaving with Bessel beams and report that a modification of the beam with 3 main lobes drastically enhances cleavability and reduces defects.

**JTu2A.39 • Coherent beam combining of 19 fibers in femtosecond regime,** Marie Antier[1], Jeremy Le Dortz[2], Jerome Bourderionnet[2], Christian Larat[2], Anke Heilmann[3], Ihsan Fsaifes[3], Louis Daniault[3], Severine Bellanger[3], Christophe Simon-Boisson[1], Jean-Christophe Chanteloup[3], Eric Lallier[2], Arnaud Brignon[2]; [1]*Thales Optronique SA, France;* [2]*Thales Research & Technology, France;* [3]*Ecole Polytechnique, France.* Coherent beam combining of a record number of 19 fibers is demonstrated with 310fs pulses. This result is achieved by controlling both phase and delay variations on each fiber channel in an interferometric measurement setup.

| Harbor Ballroom I & II | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III |
|---|---|---|
| ASSL | LS&C | LAC |

## ASSL — Harbor Ballroom I & II

11:30 -- 12:30
**ATu3A • Saturable Absorbers and Graphene**
*Presider: Haohai Yu; Shandong Univ., China*

ATu3A.1 • 11:30 Invited
**Graphene Photonics and Optoelectronics,** Andrea C. Ferrari[1]; [1]*Univ. of Cambridge, UK.* Graphene has great potential in photonics and optoelectronics, where the combination of its unique optical and electronic properties can be fully exploited. This enables applications in light modulation and detection across a wide frequency range.

ATu3A.2 • 12:00
**Femtosecond Pulse Generation with Graphene-Gold Supercapacitor Saturable Absorbers near 800 nm,** Isinsu Baylam[1], Abdullah Muti[1], Can Cihan[1], Sarper Ozharar[2], Coskun Kocabas[3], Alphan Sennaroglu[1]; [1]*Koc Univ., Turkey;* [2]*Bahcesehir Univ., Turkey;* [3]*Bilkent Univ., Turkey.* We report, what is to our knowledge, the shortest operation wavelength for graphene based supercapacitor saturable absorbers, generating 52-fs pulses from a Ti:sapphire laser near 830 nm with bias voltages less than 1.2 V.

ATu3A.3 • 12:15
**Polarization dependence of saturable absorption characteristics in $Cr^{4+}$:YAG,** Yoichi Sato[1], Takunori Taira[1]; [1]*Inst. for Molecular Science, Japan.* Polarization dependence of saturable absorption in $Cr^{4+}$:YAG was investigated. We theoretically proposed and experimentally proved its notation given by the function of the angle $\theta$ between representative axes of incident surfaces and the polarization.

## LS&C — Marina I & II Ballroom (Lobby Level)

11:30 -- 12:15
**LTu3B • 3D Imaging and Lidar**
*Presider: Claudine Besson; ONERA, France*

LTu3B.1 • 11:30
**3D Imaging Flash Lidar System by Polarization Modulating,** Bo Liu[1], Zhen Chen[1], ZhangXian Peng[1]; [1]*Inst. of Optics and Electronics,CAS, China.* Based on polarization-modulating, a 3D imaging lidar system was established. System developing, imaging procedure and an elementary result were presented.

LTu3B.2 • 11:45
**Trace Gas Detection based on Planar Laser QEPAS Sensor,** Yufei Ma[1], Ying He[1], Jingbo Zhang[1], Xin Yu[1], Frank Tittel[1], Rui Sun[1]; [1]*Harbin Inst. of Technology, China.* A novel planar laser based QEPAS sensor is realized by using a cylindrical lens to shape laser beam as a planar line. It has the advantages of easier beam alignment and reduction of stability requirement.

LTu3B.3 • 12:00
**Holographic Underwater Sensing**, Andrey Kanaev[1], Kyle Judd[1], Paul Lebow[1], Abbie T. Watnik[1], Kyle Novak[2], James lLndle[1]; [1]*US Naval Research Lab, USA;* [2]*Tekla Research, USA.* We introduce an approach to active underwater imaging that utilizes ballistic photon detection realized via light-in-flight holography. Experimental holographic system and corresponding numerical model are presented.

## LAC — Harbor Ballroom III

11:30 -- 12:30
**LAC Keynote Session**
*Presider: Johannes Trbola, Dausinger & Giesen GmbH, Germany*

***Valentin Gapontsev, CEO and Chairman of the Board, IPG, USA***

Valentin P. Gapontsev, Ph.D., founded IPG in 1990 and has been Chief Executive Officer and Chairman of IPG's Board of Directors since the Company's inception. Prior to that time, he served as senior scientist in laser material physics and head of the laboratory at the Soviet Academy of Science's Institute of Radio Engineering and Electronics in Moscow. He has over thirty years of academic research experience in the fields of solid state laser materials, laser spectroscopy and non-radiative energy transfer between rare earth ions and is the author of many scientific publications and several international patents. Dr. Gapontsev holds a Ph.D. in Physics from the Moscow Institute of Physics and Technology. In 2006, he was awarded the Ernst & Young ® Entrepreneur of the Year Award for Industrial Products and Services in New England. In 2009, Dr. Gapontsev was presented the Arthur L. Schawlow Award and recognized as the "The Father of the Fiber Laser Industry." In 2011, he received the Russian Federation National Award in Science and Technology, and he was selected as a Fellow of The Optical Society. Dr. Gapontsev holds a Ph.D. in Physics from the Moscow Institute of Physics and Technology.

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12:30—14:00 • Exhibition and Lunch, *Exhibit Hall / Galleria* Sponsored by IPG PHOTONICS

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## ASSL — Harbor Ballroom I & II

14:00 -- 16:00
### ATu4A • High Average Power Sources
*Presider: Thomas Sudmeyer; Université de Neuchâtel, Switzerland*

**ATu4A.1 • 14:00**
**100 W Femtosecond UV Laser for High-Flux XUV Generation,** Michael Müller[1], Jan Rothhardt[1,3], Carolin Rothhardt[2,1], Arno Klenke[1,3], Marco Kienel[1,3], Stefan Demmler[1,3], Tino Elsmann[4], Manfred Rothhardt[4], Jens Limpert[1,2], Andreas Tünnermann[1,2]; *[1]Inst. of Applied Physics, Germany; [2]Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany; [3]Helmholtz-Inst. Jena, Germany; [4]Inst. of Photonic Technology, Germany.* We demonstrate a frequency tripled ultrafast laser delivering up to 100 W average power at 343 nm. Direct bonded Sapphire-BBO-stacks used for the frequency conversion minimize thermal beam distortions, allowing for close to diffraction-limited beam quality.

**ATu4A.2 • 14:15**
**Towards monolithic single-mode Yb-doped fiber amplifiers with >4 kW average power,** Stefan Kuhn[1], Sigrun Hein[1], Christian Hupel[1], Franz Beier[1,2], Johannes Nold[1], Bettina Sattler[1], Nicoletta Haarlammert[1], Thomas Schreiber[1], Ramona Eberhardt[1], Andreas Tünnermann[1,2]; *[1]Fraunhofer IOF, Germany; [2]Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany.* We present our latest results of a newly developed low-NA Yb-doped fiber with single-mode 4.3 kW average output power. Additionally, a matched passive fiber is introduced to enable beam delivery and components towards monolithic integration.

**ATu4A.3 • 14:30**
**Regime-dependent Photo-darkening-induced Modal Degradation in High Power Fiber Amplifier,** Johan Boullet[1], Cyril Vinçont[1], Claude Aguergaray[1], Alain Jolly[1]; *[1]Alphanov, France.* We report on the dependence of the photo-darkening equilibrium level on the operation regime in high power fiber amplifier and reveal its impact on the threshold of the recently discussed fiber modal degradation effect.

**ATu4A.4 • 14:45**
**Toward Kilowatt-Level Ultrafast Regenerative Thin-Disk Amplifiers,** Marcel Schultze[1], Christoph Wandt[1], Sandro Klingebiel[1], Catherine Y. Teisset[1], Matthias Häfner[1], Robert Bessing[1], Tobias Herzig[1], Stephan Prinz[1], Sebastian Stark[1], Knut Michel[1], Thomas Metzger[1]; *[1]TRUMPF Scientific Lasers GmbH + Co. KG, Germany.* A thin-disk based regenerative amplifier with a compressed output power of more than 540 W is presented. Energies >10 mJ are demonstrated at 50 kHz with durations <1.2 ps. Further preliminary scaling at 5 kHz led to 900 W of average power before compression.

**ATu4A.5 • 15:00**
**Second Generation Thin-Disk Multipass Amplifier Delivering Picosecond Pulses with 2 kW of Average Output Power,** Jan-Philipp Negel[1], André Loescher[1], Dominik Bauer[2], Dirk Sutter[2], Alexander Killi[2], Marwan Abdou Ahmed[1], Thomas Graf[1]; *[1]IFSW, Univ. of Stuttgart, Germany; [2]TRUMPF Laser GmbH, Germany.* We report on the first demonstration of an ultrafast laser system with more than 2 kW of average output power at picosecond pulse duration and 300 kHz repetition rate using a thin-disk multipass amplifier.

**ATu4A.6 • 15:15**
**High Efficiency, 154 W CW, Diode-pumped Raman Fiber Laser with Brightness Enhancement,** Yaakov Glick[2,1], Viktor Fromzel[2], Jun Zhang[2], Nikolay Ter-Gabrielyan[2], Mark A. Dubinskii[2]; *[1]Soreq Nuclear Research Center, Israel; [2]Army Research Lab, USA.* We demonstrate a 154 W CW Raman fiber laser directly diode-pumped with 65% efficiency. We believe this is the highest power and highest efficiency Raman fiber laser reported in any configuration permitting brightness enhancement (i.e. either cladding pumped or with GRIN fiber).

## LS&C — Marina I & II Ballroom (Lobby Level)

14:00 -- 15:30
### LTu4B • Quantum Protocols for Sensing and Communication I
*Presider: Walter Buell; The Aerospace Corp., USA*

**LTu4B.1 • 14:00** Invited
**Advances in Quantum Nonlinear Optics,** Robert W. Boyd[1,2]; *[1]Univ. of Ottawa, Canada; [2]The Inst. of Optics, Univ. of Rochester, USA.* We review recent advances in the field of quantum nonlinear optics. One specific example is the development of secure communication systems based on the quantum properties of structured light fields.

**LTu4B.2 • 14:30** Invited
**An enabling source for quantum sensing and metrology: fiber-based broadband entangled photons,** Li Qian[1]; *[1]Univ. of Toronto, Canada.* Due to the low birefringence and low differential group delay of the optical fiber, extremely broadband emission of spontaneous parametric downconverted photon pairs can be created in quasi phase-matched thermally-poled optical fibers.

**LTu4B.3 • 15:00** Invited
**High-resolution interferometric quantum sensing with spectrally engineered broadband entanglement,** Alexander V. Sergienko[1]; *[1]Boston Univ., USA.* The asymmetric poling in a titanium diffused periodically poled lithium niobate waveguide mitigates phase distortions associated with strong chirping. It broadens significantly the entangled source bandwidth while preserving a high visibility of quantum interferometric sensing.

## LAC — Harbor Ballroom III

14:00 -- 16:00
### Fast and Ultrafast Micro Machining Session II
*Moderator: Sascha Weiler, TRUMPF, USA*

Fast and ultrafast lasers with pulse durations from ns to fs have become established for industrial applications. Yet their wide parameter space of power, pulse duration, pulse energy, wavelength combined with proper beam delivery optics still holds potential for more applications. At the same time a deep understanding of the interaction between laser pulse and material is required to explore said potential. The "Fast and Ultrafast Micro Machining" sessions aims to combine the fundamentals with real world applications.

**Short Pulse Laser Hole Making and Surface Treatment for Jet Engine Parts,** Hongqiang Chen, *General Electric Global Research, USA*

**Title to be Determined,** Peter Herman, Univ. of Toronto, Canada

**Spot-Beam Crystallization of Si Films Using Ultra-High-Frequency Solid-State Lasers for Manufacturing Advanced OLED Displays,** James Im, *Columbia Univ., USA.*

**Industrial Micro Manufacturing with Ultrafast Lasers,** Andrew Webb, *OpTek Systems, USA*

| Harbor Ballroom I & II | Harbor Ballroom III |
|---|---|
| ASSL | LAC |

14:00 -- 16:00
ATu4A • High Average Power Sources—Continued

**ATu4A.7 • 15:30**
**115 W, 10 GHz, Femtosecond Pulses From a Very-Large-Mode-Area Er-Doped Fiber Amplifier,** Jeffrey W. Nicholson[1], Raja Ahmad[1], Anthony DeSantolo[1]; [1]*OFS Labs, USA.* We demonstrate amplification of pulses with 10 GHz repetition rate to 115 W average power and 130 fs pulse width using a very-large-mode-area, erbium-doped fiber amplifier.

**ATu4A.8 • 15:45**
**Few-cycle Laser with 216 W Average Power and 6.3 fs Pulses,** Marco Kienel[1,2], Steffen Hädrich[1,2], Michael Müller[1], Arno Klenke[1,2], Jan Rothhardt[1,2], Robert Klas[1,2], Thomas Gottschall[1], Tino Eidam[3], András Drozdy[5], Péter Jójárt[5], Zoltán Várallyay[5], Eric Cormier[5,6], Károly Osvay[5], Andreas Tünnermann[1,4], Jens Limpert[1,4]; [1]*Inst. of Applied Physics, Friedrich-Schiller-Universität Jena, Germany;* [2]*Helmholtz Inst. Jena, Germany;* [3]*Active Fiber Systems GmbH, Germany;* [4]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany;* [5]*ELI-ALPS, ELI-HU Non-Profit Ltd., Hungary;* [6]*CELIA, Université Bordeaux-CNRS-CEA-UMR 5107, France.* A fiber-chirped-pulse-amplifier system delivers 660 W of average power 260 fs pulses that are used for two-stage nonlinear compression yielding 408 W, 30fs, 320 µJ pulses and 216 W, 6.3 fs, 170 µJ pulses, respectively.

14:00 -- 16:00
Fast and Ultrafast Micro Machining Session II—Continued

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16:00—16:30 • Exhibition and Coffee Break, *Exhibit Hall / Galleria* Sponsored by IPG Photonics

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Harbor Ballroom I & II

ASSL

16:30 -- 18:30
### ATu5A • Nonlinear Materials I
*Presider: Benoit Boulanger; Université Grenoble Alpes, France*

ATu5A.1 • 16:30 Invited

**Nonlinear Optics in Photonic Crystal Fiber: Recent Developments,** Philip S. Russell[1]; [1]*Max-Planck-Inst Physik des Lichts, Germany.* Tight field confinement and dispersion control in PCF enables supercontinuum generation in the deep UV, efficient generation of tunable vacuum/deep UV light in gases, broadband Raman wavelength conversion and GHz optomechanical mode-locking of fiber lasers.

ATu5A.2 • 17:00

**Quaternary $BaGa_2GeS_6$ and $BaGa_2GeSe_6$ Nonlinear Crystals for the Mid-IR Spectral Range,** Valeriy Badikov[2], Dmitrii Badikov[2], Vladimir Laptev[3], Konstantin Mitin[4], Galina Shevyrdyaeva[2], Nadezhda Shchebetova[4], Valentin Petrov[1]; [1]*Max Born Inst., Germany;* [2]*High Technologies Lab, Russia;* [3]*Inst. of Spectroscopy, RAS, Russia;* [4]*Astrophysika National Laser Centre, Russia.* Non-centrosymmetric crystals of $BaGa_2GeS_6$ and $BaGa_2GeSe_6$ are grown in large sizes with good optical quality which enabled the characterization of their linear (transmission, dispersion, and birefringence) and nonlinear (second-order susceptibility) optical properties.

ATu5A.3 • 17:15

**Harmonic Generation in Periodically Oriented Gallium Nitride,** Steven R. Bowman[1], Christopher G. Brown[1], Jennifer Hite[1], Jaime Freitas[1], Francis Kub[1], Charles R. Eddy[1], Jerry Meyer[1], Igor Vurgaftman[1], Jacob Leach[2], Kevin Udwary[2]; [1]*US Naval Research Lab, USA;* [2]*Kyma Technologies, USA.* Periodically oriented GaN (PO-GaN) devices have been fabricated and tested in order to obtain quasi-phase matched frequency conversion. This report discusses recent measurements of second harmonic generation resonances and characterization of the PO-GaN devices.

ATu5A.4 • 17:30

**Long-wave Infrared Parametric Generation and Amplification in Orientation Patterned GaP,** Daniel J. Creeden[1], Peter Schunemann[1], Leonard A. Pomeranz[1], Katherine Snell[1], Scott D. Setzler[1]; [1]*BAE Systems North America, USA.* We report what we believe is the first demonstration of nanosecond parametric generation and amplification in Op-GaP, producing 8µm light when pumped at 1.55µm. We also examine its temperature dependence in the long-wave infrared region.

ATu5A.5 • 17:45

**Phase-Matching Properties of the Monoclinic Crystal $BaGa_4Se_7$,** Benoit Boulanger[3,2], Elodie Boursier[1,2], Patricia Segonds[1,2], Bertrand Menaert[2,1], Valeriy Badikov[3], Vladimir Panyutin[4], Dmitrii Badikov[3], Valentin Petrov[4]; [1]*Université Grenoble Alpes, France;* [2]*Centre National de la Recherche Scientifique, France;* [3]*Kuban State Univ., Russia;* [4]*Max-Born-Inst. for Nonlinear Optics and Ultrafast Spectroscopy, Germany.* We studied the new acentric monoclinic crystal $BaGa_4Se_7$. We measured the angles of second harmonic and difference frequency generations up to 12 µm, refined the Sellmeier equations and calculated the conditions of supercontinuum generation.

ATu5A.6 • 18:00

**Fabrication of Quasi-phase-matching Stack of GaAs Plates Using a New Technique: Room-temperature Bonding,** Terumitsu Kubota[1], Hiroki Atarashi[1], Ichiro Shoji[1]; [1]*Chuo Univ., Japan.* Using the room-temperature bonding, we have succeeded in fabricating a quasi-phase matching stack of thirty 106 µm-thick GaAs plates. This technique can realize large aperture high-power wavelength-conversion devices with low loss.

ATu5A.7 • 18:15

**Temperature stable operation of YCOB crystal for giant-pulse green micro-laser,** Arvydas Kausas[1], Pascal Loiseau[2], Gerard Aka[2], Yanqing Zheng[3], Takunori Taira[1]; [1]*IMS, Japan;* [2]*PSL Research Univ., Inst. de Recherche de Chimie Paris IRCP, France;* [3]*Shanghai Inst. of Ceramics, Chinese Academy of Sciences, China.* 5MW green pulse with 70% conversion efficiency was achieved in Bridgman grown YCOB crystal. Also for the first time the temperature tuning in YCOB material is presented with the slope of -0.057%/degC for the range from 30 degC to 220degC.

Marina I & II Ballroom (Lobby Level)

LS&C

16:30 -- 18:30
### LTu5B • Quantum Protocols for Sensing and Communication II
*Presider: Walter Buell; Aerospace Corp., USA*

LTu5B.1 • 16:30 Invited

**Floodlight Quantum Key Distribution,** Jeffrey H. Shapiro[1], Quntao Zhuang[1], Zheshen Zhang[1], Justin Dove[1], Franco N. Wong[1]; [1]*MIT, USA.* Floodlight quantum key distribution (FL-QKD) is capable of Gbit/s secret-key rates over metropolitan area distances without multiplexing. This talk summarizes the FL-QKD protocol, its potential secret-key rates, and its proof-of-principle experimental demonstration.

LTu5B.2 • 17:00 Invited

**Twin Beams from Noble Gas Filled Kagomé-PCF,** Maria Chekhova[1], Martin Finger[1], Nicolas Joly[1], Philip S. Russell[1]; [1]*Max-Planck-Inst Physik des Lichts, Germany.* We generate twin beams through modulational instability in Ar-filled hollow-core kagomé-PCF. The observed sidebands show photon-number correlations below the shot-noise level, no Raman noise, a single spatial mode, and tunable frequency mode content.

LTu5B.3 • 17:30 Invited

**Weak Values and Precision Measurements,** John C. Howell[1]; [1]*Univ. of Rochester, USA.* I will discuss the use of weak values for performing precision deflection, spectral, velocity and gravimetric measurements. I will show that the concepts behind weak values can lead to technical noise suppression.

LTu5B.4 • 18:00 Invited

**Quantum LIDAR,** Jonathan P. Dowling[1]; [1]Physics and Astronomy Dept, Louisiana State University, USA. We explore LIDAR systems that utilize coherent states of light, combined with quantum detection schemes, in order to beat the Rayleigh diffraction limit in resolution.

Harbor Ballroom III

LAC

16:30 -- 18:30
### 16kW+ Laser Materials Processing
*Moderator: Johannes Trbola, Dausinger & Giesen GmbH, Germany*

Lasers with an average power in the range of 6 kW are still the primary workhorse for industrial laser applications such as cutting and welding. However, the average power of cw lasers available on the market is continuously increasing. Today, 16 kW lasers are on the move from basic application development at the Universities and application labs to the industry. The 16 kW+ session will focus on latest applications showing the potential of the next average-power level.

**High Power Disk Lasers: Robust and Versatile Solid State Lasers for Industrial Applications,** Narasimhan Sreenivasan, *TRUMPF, USA.* This presentation gives an overview of high power disk lasers evolution and the extensive usage of this laser in different industrial environments. Further, this presentation will focus more on heavy industrial applications (e.g. deep penetration welding of Copper).

**High Power Laser Welding for Several Applications,** Sarah Nothdurft, *Laser Zentrum Hannover e.V, Germany.* Report about current and future research activities into welding with high power lasers: shipbuilding, tube manufacture; mixed components (steel/aluminum); combined and hybrid processes.

Tuesday, 1 November

## 07:30—18:30 • Registration, *Main Lobby Harborside*

### Harbor Ballroom I & II — ASSL

08:00 -- 10:00
**AW1A • Mid-IR Sources I**
*Presider: Valentin Petrov; Max Born Inst., Germany*

AW1A.1 • 08:00 Invited
**Recent Developments in Ultrafast Fibre-based Mid-infrared Lasers,** Michel . Piche[1], Simon Duval[1], Jean-Christophe Gauthier[1], Michel Olivier[1,2], Vincent Fortin[1], Martin Bernier[1], Réal Vallée[1]; [1]*Universite Laval, Canada;* [2]*Physics, CEGEP Garneau, Canada.* We describe a soliton fiber laser that generates 270-femtosecond pulses at 2.8 µm with 23-kW peak power. Numerical simulations agree with measurements and reveal the impact of water absorption on laser dynamics.

AW1A.2 • 08:30
**Kerr-Lens Mode-Locked Middle IR Polycrystalline Cr:ZnS Laser with a Repetition Rate 1.2 GHz,** Sergey Vasilyev[1], Igor Moskalev[1], Mike Mirov[1], Viktor Smolski[1], Sergey Mirov[1,2], Valentin Gapontsev[3]; [1]*IPG Photonics Corp., Mid-IR Lasers, USA;* [2]*Center for Optical Sensors and Spectroscopies, Univ. of Alabama at Birmingham, USA;* [3]*IPG Photonics Corporation, USA.* We report flexible design of femtosecond middle-IR lasers with a broad range of repetition rates 0.08–1.2 GHz. The lasers emit few-cycle pulses with 4–16.4 THz bandwidth, 0.1–21 nJ energy at 2.4 µm wavelength.

AW1A.3 • 08:45
**Mid-Infrared Difference Frequency-Generation with Synchronized Fiber Lasers,** Robert T. Murray[1], Timothy Runcorn[1], Edmund J. Kelleher[1], Shekhar Guha[2], James R. Taylor[1]; [1]*Imperial College London, UK;* [2]*Wright Patterson Air Force Base, Air Force Research Lab, Materials and Manufacturing Directorate,, USA.* We present results on high-average power difference frequency generation of pulsed Yb/Er fiber systems to the mid-IR (6.2 W at 3.35 µm), and use focused Gaussian beam theory to validate our experimental results.

AW1A.4 • 09:00
**High-power nonlinear compression stage delivering sub-50 fs, 0.25 mJ pulses, 15 W at 2 µm wavelength for HHG,** Martin Gebhardt[1,2], Christian Gaida[1], Robert Klas[1,2], Fabian Stutzki[1], Steffen Hädrich[1,2], Stefan Demmler[1,2], Jan Rothhardt[1,2], Cesar Jauregui-Misas[1], Jens Limpert[1,2], Andreas Tünnermann[1,2]; [1]*Inst. of Applied Physcis, USA;* [2]*Helmholtz-Inst.-Jena, Germany.* We present the nonlinear compression of ultrashort pulses at 2 µm wavelength to sub-50 fs, >3 GW at 15.4 W of average power. This source was used for HHG in an argon gas jet.

AW1A.5 • 09:15
**Strong-Field Few-Cycle 2-µm pulses via Kagome-Fiber Compression of Picosecond Ho:YLF Laser Pulses,** Krishna Murari[1], Giovanni Cirmi[1], Benoit Debord[2], Huseyin Cankaya[1], Frederic Gerome[2], Axel Ruehl[1], Ingmar Hartl[1], Fetah Benabid[2], Oliver Muecke[1], Franz X. Kaertner[3]; [1]*Deutsche Electron Synchrotron, Germany;* [2]*Xlim, France;* [3]*MIT, USA.* We present strong-field few-cycle 2-µm pulses based on air-filled Kagome-fiber compression of 140-µJ, 3.3-ps pulses from Ho:YLF amplifier to 48 fs and 11 µJ energy. This is the first demonstration of 70-fold compression from Kagome fibers at 2 µm.

AW1A.6 • 09:30
**55 mJ Picosecond Ho:YLF Chirped Pulse Amplification System at 1 kHz Repetition Rate,** Lorenz von Grafenstein[1], Martin Bock[1], Dennis Ueberschaer[1], Uwe Griebner[1], Thomas Elsaesser[1]; [1]*Max Born Inst., Germany.* A 2.051-µm CPA source based on a Ho:YLF amplifier chain generates 55 mJ picosecond pulses at a 1 kHz repetition rate. The system is distinguished by an excellent stability with a pulse-to-pulse rms <0.6%.

### Marina I & II Ballroom (Lobby Level) — LS&C

08:30 -- 10:00
**LW1B • Quantum Protocols for Sensing and Communication III**
*Presider: Robert Boyd; Univ. of Ottawa, Canada*

LW1B.1 • 08:30 Invited
**Continuous Variable Free Space Quantum Communication,** Gerd Leuchs[2,3], Christoph Marquardt[1,2]; [1]*Max Planck Inst. Science of Light, Germany;* [2]*Institut für Optik, Univ. of Erlangen-Nuremberg, Germany;* [3]*Univ. of Ottawa, Canada.* Continuous variable free space quantum communication offers high speed distribution of quantum states for quantum key distribution under daylight condition. We report our activities on experimental investigations ranging from intra-city links to satellite based communication.

LW1B.2 • 09:00 Invited
**High-Dimensional Encoding for Quantum Key Distribution and Random Number Generation,** Franco N. Wong[1], Tian Zhong[1], Feihu Xu[1], Jeffrey H. Shapiro[1]; [1]*MIT, USA.* Entanglement and encoding multiple bits per photon detection in the temporal degree of freedom enable quantum key distribution to increase its secret-key rate and quantum random number generation to produce random bits at higher rate.

LW1B.3 • 09:30 Invited
**Photon Number Parity: Applications in Quantum Metrology and QIS,** Christopher Gerry[1]; [1]*Lehman College, USA.* In this talk, I review the application of the photon number parity operator to photonic tests of a Bell inequality, quantum optical interferometry, and I propose its application to a quantum random number generating scheme using laser light.

### Harbor Ballroom III — LAC

08:00 -- 10:00
**High Intensity Lasers for Applications in Science and Research**
*Moderator: Johannes Trbola, Dausinger & Giesen GmbH, Germany*

Lasers are a fast moving subject. Not so much physically, but their performance parameters are developing into new parameter ranges making it possible to explore completely new fields of applications. One of these areas is the fundamental research in physics. The talks in this session are to inform about the newest possibilities and applications of the most advanced systems installed and being installed in the near future.

**The Photon Sources of the Extreme Light Infrastructure,** Károly Osvay, *ELI-ALPS, Hungary.* The major research equipment of the European distributed research facility, the Extreme Light Infrastructure, is based on short pulse laser sources operating in the 100 W average power regime. The peak power and the repetition rate range from 1 TW at 100 kHz up to multiple PW at few Hz. The systems are designed for stable and reliable operation, yet to deliver pulses with unique parameters, especially with unmatched fluxes and extreme bandwidths. This exceptional performance will give ways to a set of secondary sources with incomparable characteristics, including light sources ranging from the THz to the X-ray spectral ranges, and particle sources.

Harbor Ballroom I & II — Marina I & II Ballroom (Lobby Level) — Harbor Ballroom III

ASSL — LS&C — LAC



**ASSL, Harbor Ballroom I & II**

08:00 -- 10:00
**AW1A • Mid-IR Sources I—Continued**

AW1A.7 • 09:45
**Hollow-Core-Waveguide Compression of 22-mJ 3.9-μm Pulses,** Tadas Balciunas[1], Skirmantas Alisauskas[1], Valentina Shumakova[1], Guangyu Fan[1], Audrius Pugzlys[1], Alexander Mitrofanov[2,3], Dmitry Sidorov-Biryukov[4,2], Aleksei Zheltikov[2,4], Bruno E. Schmidt[5], François Légaré[6], Andrius Baltuska[1]; [1]*TU Wien, Austria;* [2]*Skolkovo, Russian Quantum Center, Russia;* [3]*Inst. of Crystallography and Photonics, Russia;* [4]*Physics, Moscow State Univ., Russia;* [5]*few-cycle, Inc., Canada;* [6]*Institut National de la Recherche Scientifique, Centre Énergie Matériaux et Télécommunications, Canada.* We present post-compression of 22-mJ 90-fs pulses at 3.9 μm via spectralbroadening in a noble-gas-filled 1 mm core diameter 3 meter long capillary with over 60% throughput and recompressed.= in a bulk BaF2 plate down to 33 fs.

**LS&C, Marina I & II Ballroom (Lobby Level)**

08:30 -- 10:00
**LW1B • Quantum Protocols for Sensing and Communication III—Continued**

**LAC, Harbor Ballroom III**

08:00 -- 10:00
**High Intensity Lasers for Applications in Science and Research—Continued**

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**10:00—11:00 • Exhibition and Coffee Break,** *Exhibit Hall / Galleria*

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Harbor Ballroom I & II — Marina I & II Ballroom (Lobby Level) — Harbor Ballroom III

ASSL — LS&C — LAC

**ASSL, Harbor Ballroom I & II**

11:00 -- 12:00
**AW2A • Nonlinear Materials II**
*Presider: Ichiro Shoji; Chuo Univ., Japan*

AW2A.1 • 11:00 Invited
**Semiconductor Fibres for Infrared Nonlinear Photonics,** Anna C. Peacock[1]; [1]*Univ. of Southampton, UK.* Recent advancements in the fabrication and application of semiconductor optical fibers will be reviewed. Particular focus will be placed on novel materials and device designs for use in nonlinear optical applications across the infrared spectral region.

AW2A.2 • 11:30
**Picosecond high-power 355-nm UV generation in $CsLiB_6O_{10}$,** Kentaro Ueda[1], Yosuke Orii[2], Yoshinori Takahashi[1], George Okada[2], Yusuke Mori[1], Masashi Yoshimura[3]; [1]*Osaka Univ., Japan;* [2]*Spectronix Corporation, Japan;* [3]*Inst. of Laser Engineering, Osaka Univ., Japan.* $CsLiB_6O_{10}$ (CLBO) with/without prism-coupling generates 30-W output of 355-nm UV lights based on a picosecond laser system. The conversion efficiency from the fundamental is 48.3%, which is about 1.2 times higher than that of LBO.

AW2A.3 • 11:45
**Phase-Matching, Sellmeier Equations and Nonlinear Coefficients of the New Nonlinear Crystal $NaI_3O_8$,** Benoit Boulanger[1,2], Feng Guo[1,2], Patricia Segonds[1,2], Julien Zaccaro[2,1], Jerome Debray[2,1], Isabelle Gautier-Luneau[1,2]; [1]*Université Grenoble Alpes, France;* [2]*Centre National de la Recherche Scientifique, France.* We performed the first study of phase-matching conditions in the new tetragonal crystal $NaI_3O_8$. We determined the refractive indices dispersion equations, calculated the tuning curves of optical parametric generation, and estimated the involved nonlinear coefficients.

**LS&C, Marina I & II Ballroom (Lobby Level)**

11:00 -- 12:00
**LW2B • Quantum Protocols for Sensing and Communication IV**
*Presider: Robert Boyd; Univ. of Ottawa, Canada*

LW2B.1 • 11:00 Invited
**Chirped-pulse Quantum Nonlinear Optics ,** Kevin Resch[1]; [1]*Univ. of Waterloo, Canada.* Shaped laser pulses are essential in ultrafast optics and are emerging as a powerful tool in the quantum regime. We will describe using shaped pulses and nonlinearities to compress the bandwidth of single photons, as a time-to-frequency converter, and to manipulate energy-time entanglement.

LW2B.2 • 11:30 Invited
**Fast Gated InGaAs/InP Single-Photon Detector for Gigahertz Quantum Communications and Atmospheric Sensing,** Joshua L. Bienfang[1], Alessandro Restelli[1], Alan L. Migdall[1]; [1]*NIST, USA.* Advanced harmonic-subtraction gating with an InGaAs/InP avalanche diode supports high-efficiency (>40%) single-photon counting at rates >108 s-1 with noise-count-per-gate probabilities ≈ 10-4, and we demonstrate its suitability as a receiver for free-space LIDAR.

**LAC, Harbor Ballroom III**

11:00 -- 12:00
**LAC Keynote Session**
*Presider: Johannes Trbola, Dausinger & Giesen GmbH, Germany*

***Berthold Schmidt, Managing Director, TRUMPF Photonics, Inc., USA***

**TRUMPF's Laser Systems Portfolio - The Power of Choice ,** Berthold Schmidt, *Managing Director, TRUMPF Photonics, Inc., USA.* Industrial laser systems experience a high momentum in terms of new, better suited light sources and their emergent fields of use. The talk overviews developments in TRUMPF's high-power laser portfolio serving latest trends in cutting, welding and USP applications.

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**12:00—13:30 • Exhibition and Lunch,** *Exhibit Hall / Galleria*

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Wednesday, 2 November

| ROOM 1 | Room 2 | ROOM 3 |
|---|---|---|
| ASSL | LS&C | LAC |

13:30 -- 15:00

AW3A • Laser Materials II

*Presider: Jay Dawson; Lawrence Livermore National Lab, USA*

AW3A.1 • 13:30 Invited

**Dielectric Coatings for High Energy Lasers,** Lars Jensen1,Stefan Günster[1], Detlev Ristau[1]; *[1]Laser Zentrum Hannover e.V., Germany.* An introduction on dielectric coatings for high energy and high power lasers. Particular emphasis is put on the physical processes which initiate laser-induced breakdown in thin films ranging from femtosecond pulses to cw radiation.

AW3A.2 • 14:00

**Functionally Graded Solid-State Laser Gain Media Fabricated by Direct Ink Write and Ceramic Processing,** Ivy Krystal Jones[1]; *[1]Lawrence Livermore National Lab, USA.* Transparent ceramic fabrication can offer a route to functionally structured solid-state laser gain media. We report here on high transparency, fully-dense transparent optical ceramics with compositional gradients, fabricated by direct ink write (DIW) methods.

AW3A.3 • 14:15

**Successful Fabrication of a Nd:YAG/diamond Composite Structure with an Anti-reflection Coating Layer at the Bonded Interface for Highly Efficient Laser Oscillation,** Hiromasa Ichikawa[1], Yohei Okuyama[1], Ichiro Shoji[1]; *[1]Chuo Univ., Japan.* We have successfully fabricated a Nd:YAG/diamond composite structure with an anti-reflection coating layer to suppress Fresnel loss at the bonded interface by using the room-temperature-bonding technique. Higher-power and highly efficient laser oscillation is expected.

AW3A.3 • 14:30

**$Cr^{2+}$:ZnSe Fiber Lasers,** Stephen C. Aro[1], Justin R. Sparks[1], Sean A. McDaniel[2,3], Michael G. Coco[1], Alex T. Hendrickson[1], Venkatraman Gopalan[1], Gary Cook[2], John V. Badding[1]; *[1]Pennsylvania State Univ., USA; [2]Air Force Research Lab, USA; [3]Leidos, USA.* To date, efforts to power scale $Cr^{2+}$:ZnSe gain media have been limited by its high thermo-optic coefficient. We demonstrate the first continuous wave $Cr^{2+}$:ZnSe fiber lasers, providing a path forward for high power systems.

AW3A.4 • 14:45

**Hollow Core Fibers with Single and Double Nested Capillaries Cladding and Fiber Based Raman Lasers,** Igor A. Bufetov[1], Alexey F. Kosolapov[1], Alexey V. Gladyshev[1], Anton N. Kolyadin[1], Yuri P. Yatsenko[1], Andrey D. Pryamikov[1], Alexandr S. Biriukov[1], Evgeny M. Dianov[1]; *[1]Fiber Optics Research Center of RAS, Russia.* The revolver hollow core fibers of three different types were fabricated, including fibers with double nested capillaries in the cladding. Efficient hydrogen Raman lasers (1064 ⇒1907 nm) based on all of these fibers were demonstrated.

13:30 -- 15:30

LW3B • Components for Sensing and Communication I

*Presider: David Rabb; US Air Force Research Lab, USA*

LW3B.1 • 13:30 Invited

**High-power Laser Transmitters for Ladar Applications ,** Fabio Di Teodoro[1]; *[1]Raytheon SAS, USA.* We review architectures for high-power LADAR transmitters relying on fiber and hybrid fiber/bulk waveguide lasers. Multi-mJ/MW pulse energies/peak-powers are demonstrated in combination with good spatial/spectral beam quality and average output powers > 100 W.

LW3B.2 • 14:00

**Nanosecond-Pulsed, mJ-Level Single-Mode Fiber Master Oscillator Power Amplifier with Polarization Maintaining Tapered Gain Fiber,** Xiaodong Mu[1], Paul Steinvurzel[1], Paul Belden[1], Todd Rose[1], William Lotshaw[1], Steven Beck[1]; *[1]The Aerospace Corporation, USA.* We have demonstrated mJ pulse energy with nanosecond pulses, narrow linewidth, and single-mode beam quality operation in a master oscillator power amplifier (MOPA) fiber laser system using an Yb-doped polarization maintaining tapered amplifier.

LW3B.3 • 14:15

**High Peak Power Fiber Laser for Long Range Lidar Applications,** Claudine Besson[1], Agnes Dolfi-Bouteyre[1], Anne Durecu[1], Julien Le Gouet[1], Laurent Lombard[1], Guillaume Canat[1]; *[1]ONERA, France.* High peak power, narrow linewidth pulsed fiber lasers are key components for the design of long range Lidar. Examples of recent developments for wind monitoring for airport surveillance and gas sensing from space are described.

LW3B.4 • 14:30

**Fabrication of a Tapered Optical Fiber with Nanostructure Produced by Optical Tweezing,** J. Trevisanutto[1], G. Das[1]; *[1]Lakehead Univ., Canada.* The authors report a novel technique to create a plasmonic nanostructure on the surface of a tapered optical fiber by optical tweezing of gold nanorods. A multimode fiber was etched to produce the tapered fiber.

LW3B.5 • 14:45

**Optical-stabilized hybrid mode-locked Er-fiber frequency comb with broad repetition rate tuning range,** Honglei Yang[1], Xuejian Wu[2], Hongyuan Zhang[1], Shijie Zhao[1], Lijun Yang[1], Haoyun Wei[1], Yan Li[1]; *[1]Tsinghua Univ., China; [2]Univ. of California, USA.* We demonstrate an optical-stabilized hybrid mode-locked Er-fiber frequency comb with broad repetition rate tuning range. The duplication of a second comb source is significantly simplified to compose a robust dual-comb setup.

LW3B.6 • 15:00

**Mitigation of Self-Phase Modulation in High-Peak-Power Lasercom Systems,** Todd Ulmer[1], Jeffrey M. Roth[1], Jeffrey R. Minch[1], John Chang[1], John D. Moores[1], George Nowak[1], Frederick G. Walther[1]; *[1]Massachusetts Inst of Tech Lincoln Lab, USA.* We demonstrate a reduction in the power penalty caused by self-phase modulation in free-space lasercom systems with peak powers of 400 W by pre-compensation with a phase modulator driven sinusoidally at the slot rate.

LW3B.7 • 15:15

**Flat Lens based on Continuous Nano-apertures,** Xiangang Luo[1], Mingbo Pu[1], Xiong Li[1], Xiaoliang Ma[1]; *[1]CAS Inst. of Optics and Electronics, China.* We proposed a flat lens based on continuous nano-apertures perforated in metallic screens. The lens is characterized by its broadband operation capability as well as long depth of focus.

13:30 -- 15:30

High Intensity Lasers for Applications in Defense

*Moderator: David Mordaunt, Raytheon Space and Airborne Systems, USA*

This session will provide an overview of technology and systems for defense applications of high energy lasers for defense. While low power laser systems have been fielded for decades, high energy laser weapon systems are now transitioning from scientific research and prototype demonstrations into fully fielded systems for military environments. Topics covered in this rapidly developing field include the history of lasers for defense, key technology development and system demonstrations of high energy lasers.

**Spectral Beam Combining of Fiber Lasers for High Brightness Power Scaling,** Eric Honea, *Lockheed Martin Laser and Sensor Systems, USA.*

**Myths, Legends & Facts, From Strategic to Tactical Battlefield Lasers: Reflections of a "Star Warrior"**, Jim Horkovich, *Directed Energy Professional Society, USA.* An extensive historical and technical presentation of the development of high power lasers as potential military systems and their evolution from laboratory devices to "Star Wars" concepts to today's tactical battlefield concepts.

**DEPS interpretation of the DE Roadmap for the Department of Defense** , Mark Neice, *Directed Energy Professional Society, USA.*

**Developments in Laser Weapon Systems - MBDA Germany**, Jürgen Zoz, *MBDA Deutschland GmbH, Germany.*

15:30—16:00 • Exhibit Hall and Coffee Break, *Exhibit Hall / Galleria*



Harbor Ballroom I & II — ASSL

16:00 -- 18:00
**AW4A • Mid-IR Sources II**
*Presider: Alphan Sennaroglu; Koc Univ., Turkey*

AW4A.1 • 16:00 Invited

**Mid-Infrared OPCPA Based on Two-Dimensional Quasi-Phase-Matching Devices,** Nicolas Bigler[1], Christopher R. Phillips[1], Justinas Pupeikis[1], Lukas Gallmann[1,2], Ursula Keller[1]; [1]*ETH Zürich, Switzerland;* [2]*Inst. of Applied Physics, Univ. of Bern, Switzerland.* We investigage OPCPA using two-dimensionally-patterned quasi-phase-matching devices for use in bandwidth- and power-scalable systems in the mid-infrared. We demonstrate an off-axis structure for amplification and momentum-transfer, and a 2D chirped design for ultra-broadband DFG.

AW4A.2 • 16:30

**Widely Tunable in the Mid-IR $BaGa_4Se_7$ Optical Parametric Oscillator Pumped at 1064 nm,** Nadezhda Y. Kostyukova[1,2], Andrey A. Boyko[1,2], Valeriy Badikov[3], Dmitrii Badikov[3], Galina Shevyrdyaeva[3], Vladimir Panyutin[1], Georgi M. Marchev[1], Dmitry Kolker[4], Valentin Petrov[1]; [1]*Max Born Inst., Germany;* [2]*Special Tech., Russia;* [3]*High Tech. Lab, Russia;* [4]*Novosibirsk State Univ, Russia.* A $BaGa_4Se_7$ optical parametric oscillator shows extremely wide idler tunability (2.7-17 µm) under 1.064-µm pumping. The ~10-ns pulses at ~7.2 µm have an energy of 3.7 mJ corresponding to a quantum conversion efficiency of 40%.

AW4A.3 • 16:45

**1-GHz Mid-Infrared Frequency Comb Based on PPLN-Waveguide Optical Parametric Amplification,** Christopher R. Phillips[1], Aline Mayer[1], Carsten Langrock[3], Alexander Klenner[1,4], Adrea Johnson[4], Kevin Luke[2], Yoshitomo Okawachi[4], Michal Lipson[4], Alexander Gaeta[4], Martin Fejer[3], Ursula Keller[1]; [1]*ETH Zurich, Switzerland;* [2]*Cornell Univ., USA;* [3]*Stanford Univ., USA;* [4]*Columbia Univ., USA.* We generate tunable offset-free gigahertz combs from 2.5 to 4.2 µm by supercontinuum generation in a $Si_3N_4$ waveguide followed by parametric amplification in PPLN waveguides with 35-dB gain. Noise and nonlinear dynamics are also investigated.

AW4A.4 • 17:00

**Sub 100-fs, 5.2-micron ZGP Parametric Amplifier Driven by a ps Ho:YAG Chirped Pulse Amplifier and its application to high harmonic generation,** Tsuneto Kanai[1], Pavel Malevich[1], Sarayoo Kangaparambil[1], Kakuta Ishida [2], Makoto Mizui [2], Kaoru Yamanouchi[2], Heinar Hoogland[3], Ronald Holzwarth[3], Audrius Pugzlys[1], Andrius Baltuska [1]; [1]*Vienna Univ. of Technology, Austria;* [2]*The Univ. of Tokyo, Japan;* [3]*Menlo Systems GmbH, Germany.* We demonstrate a sub-100-fs, 5.2-micrometer parametric amplifier driven by a ps 2.1-micrometer Ho:YAG chirped-pulse amplifier and its application to high harmonic generation. We also present a novel approach for further pulse compression.

AW4A.5 • 17:15

**19-nJ Five-Cycle Pulses from a 2-µm Degenerate Optical Parametric Oscillator,** Stephen Wolf[1], Alireza Marandi[1], Ken Leedle[1], Marc Jankowski[1], Michel Digonnet[1], Robert L. Byer[1]; [1]*Stanford Univ., USA.* We report generation of 19-nJ, 35-fs pulses at 2 µm from a degenerate optical parametric oscillator pumped by a 2.6-W 1-µm laser. Near transform-limit operation was achieved with a conversion efficiency of 65%.

Marina I & II Ballroom (Lobby Level) — LS&C

16:00 -- 18:00
**LW4B • Components for Sensing and Communication II**
*Presider: David Rabb; US Air Force Research Lab, USA*

LW4B.1 • 16:00 Invited

**Detection, Analysis and Reconstruction of Sub-Noise Wideband Signal,** Stojan Radic[1]; [1]*Univ. of California, San Diego, USA.* Randomly occurring signals are often masked by noise in astronomy, biology and chemistry. While their detection poses fundamental challenge, recent advances in photonics processing have allowed for analysis and full reconstruction of wideband sub-noise information channel.

LW4B.2 • 16:30 Invited

**Time Resolved Infrared Detection with HgCdTe Avalanche Photodiodes,** Eric de Borniol[1], Johan Rothman[1], Xavier Lefoul[2]; [1]*CEA-LETI, France;* [2]*Sofradir, France.* We present Focal plane arrays (FPAs) and single element detectors using HgCdTe avalanche photodiodes. We report performances of some of these sensors dedicated to atmospheric LIDAR, free-space optical communication and infrared active imaging.

LW4B.3 • 17:00 Invited

**Asynchronous InGaAsP Geiger-Mode APD Cameras With Free-Running Pixel Operation,** Mark A. Itzler[1], Mark Entwistle[1], Xudong Jiang[1], Gennaro Salzano[1], Mark Owens[1], Brian Piccione[1], Sam Wilton[1], Krys Slomkowski[1], Peter Zalud[2], Thomas Senko[2], John Armer[2], Michael O'Neal[2], John Tower[2]; [1]*Princeton Lightwave Inc, USA;* [2]*SRI International, USA.* We describe 32x32 Geiger-mode avalanche photodiode focal plane arrays (FPAs) with single-photon sensitive pixels and asynchronous free-running operation. These FPAs support direct detection and coherent LIDAR imaging and other applications such as free-space optical communications.

Harbor Ballroom III — LAC

16:00 -- 18:00
**Extreme UV Lithography and X-ray Generation**
*Moderators: Lahsen Assoufid, Argonne National Laboratory, USA Pierre-Mary Paul, Continuum, USA*

The rapid progress in extreme-power laser technology opened a path to the development of a new generation of small-scale EUV and X-ray light sources with unprecedented brightness and short pulses. These sources, which could fit on tabletop or small-scale laboratory, will revolutionize many industrial, research, medical, defense, and security applications. This session will give an update on the latest progress as well as the challenges in the developments in high-power laser technology tailored to methods for EUV and X-ray generation ranging from laser-driven plasma, through HHG and inverse Compton scattering.

**High Power, Pulsed CO2 Laser Technology for Laser-Produced-Plasma EUV Source**, Krzysztof Nowak, *Laser Scientist, Gigaphoton, Japan*. Successful merger of quantum-cascade lasers with CO2 laser technology brought new qualities into mid-IR domain. These qualities, such as ns-pulse duration, high average power (>20kW), high repetition frequency, excellent stability and pulse waveform control became available from our MOPA system.

**High-Power, High-Repetition-Rate Pulsed CO2 Lasers and Their Application in EUV Lithography Sources**, Slava Rokitski, *Senior Manager, Cymer and ASML Company, USA*. Stable, dose controlled EUV power has been successfully demonstrated by ASML using CO2 laser systems of high intensity, short pulse duration, high repetition rate, and high average power. Development of high power CO2 lasers used for EUV sources with power of 250 W and beyond is determined by requirements for CO2 laser parameters, generation and amplification of short duration CO2 laser pulses, as well as target formation to ensure CO2 laser absorption and high EUV emission. We will report on the elements of the high-power CO2 laser design and associated scaling studies.

**A High-energy Attenuation System and the Application to X-ray Generation at Ultra-high Intensity**, Baozhen Zhao, *Univ. of Nebraska-Lincoln, USA*. We demonstrated an energy attenuation system to control the output energy of a highenergy ultrafast pulse laser system by an order-of-magnitude. This technique was used to control the brightness of an Inverse-Compton x-ray source.

## Harbor Ballroom I & II — ASSL

16:00 -- 18:00
**AW4A • Mid-IR Sources II—Continued**

**AW4A.6 • 17:30**
**600 µJ, 5 µm, 1 kHz Femtosecond Optical Parametric Chirped Pulse Amplifier Pumped at 2 µm,** Lorenz von Grafenstein[1], Martin Bock[1], Uwe Griebner[1], Thomas Elsaesser[1]; [1]*Max Born Inst., Germany*. A 1 kHz mid-IR OPCPA operating at 5 µm is presented. The 2-µm pumped $ZnGeP_2$ parametric amplifiers deliver 600 µJ pulses with a compressed duration of 166 fs.

**AW4A.7 • 17:45**
**Mid-infrared sub-single-cycle pulse synthesis from a parametric amplifier covering the wavelength of 2.5-9.0 um,** Peter Krogen[1], Houkun Liang[1], Kevin Zawilski[2], Peter Schunemann[2], Kyung-Han Hong[1], Franz X. Kaertner[3,4]; [1]*MIT, USA;* [2]*BAE Systems, USA;* [3]*Center for Free-Electron Laser Science, Univ. of Hamburg, Germany;* [4]*The Hamburg Center for Ultrafast Imaging, Germany.* We present the generation and characterization of carrier-envelope -phase-stable sub-single-cycle pulses, synthesized from an optical parametric amplifier covering the 2.5-9.0 um range. A 0.77-optical-cycle pulse at ~5 um with 33 uJ energy is measured using XFROG.

## Marina I & II Ballroom (Lobby Level) — LS&C

16:00 -- 18:00
**LW4B • Components for Sensing and Communication II—Continued**

**LW4B.4 • 17:30** Invited
**High Speed Avalanche Photodiodes Beyond their Traditional Buildup Time,** Majeed M. Hayat[1]; [1]*Univ. of New Mexico, USA.* Due to their buildup time, the use InGaAs avalanche photodiiodes has been limited to 10-Gbps optical receivers. We review a patented technique that combats the buildup time and reduces the BER by orders of magnitude.

## Harbor Ballroom III — LAC

16:00 -- 18:00
**Extreme UV Lithography and X-ray Generation—Continued**

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18:30—21:00 • Conference Banquet
*Seaport Hotel, 200 Seaport Boulevard, Boston*

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## 07:30—17:00 • Registration, *Main Lobby Harborside*



| Harbor Ballroom I & II | Marina I & II Ballroom (Lobby Level) | Harbor Ballroom III |
|---|---|---|
| ASSL | LS&C | LAC |

### 08:00 -- 10:00
### ATh1A • Nonlinear Fiber Sources
*Presider: Yoonchan Jeong; Seoul National Univ., Korea*

**ATh1A.1 • 08:00** Invited

**Multimode Nonlinear Fiber Optics with Structured Light,** Siddharth Ramachandran[1]; [1]*Boston Univ., USA.* Intermodal nonlinear interactions with higher-order modes circumvent the dispersion-versus-nonlinearity tradeoff of single-mode waveguides. We review advances in this platform that enables nonlinear optics in fibers to realise energy-scalable sources at non-traditional colours, for applications such as biomedical imaging, or wide-band frequency conversion, for applications such as quantum networks.

**ATh1A.2 • 08:30**

**Generation of Carrier-Envelope Phase-Stable 8.1-fs Infrared Pulses at 20 kHz in a $BiB_3O_6$-based Optical Parametric Amplifier,** Florian Geier[1], Justinas Pupeikis[1,2], Henning Geiseler[1], Nobuhisa Ishii[1], Teruto Kanai[1], Jiro Itatani[1]; [1]*Inst. for Solid State Physics, Japan;* [2]*Inst. of Quantum Electronics, ETH, Switzerland.* A $BiB_3O_6$-based optical parametric amplifier was developed to produce carrier-envelope phase(CEP)-stable 12-μJ, 8.1-fs pulses centered at 1600 nm. Above threshold ionization experiments revealed the focused intensity >$10^{14}$ W/cm$^2$ with a clear CEP dependence.

**ATh1A.3 • 08:45**

**Watt-level Nanosecond 589 nm Source by SHG of a Cascaded Raman Amplifier,** Timothy Runcorn[1], Robert T. Murray[1], Edmund J. Kelleher[1], James R. Taylor[1]; [1]*Femtosecond Optics Group, Dept. of Physics, Imperial College London, UK.* We present a power-scalable nanosecond source operating at 589 nm by frequency-doubling a cascaded Raman amplifier that is pulse-pumped by an ytterbium-fiber master oscillator power amplifier system and seeded with a narrow linewidth CW signal.

**ATh1A.4 • 09:00**

**SPM-enabled fiber laser source beyond 1.2 μm,** Gengji Zhou[1], Ming Xin[1], Yizhou Liu[1], Franz X. Kaertner[1], Guoqing Chang[1]; [1]*Center for Free-Electron Laser Science, DESY,, Germany.* Using a home-built, 500-nJ Yb-fiber laser system and large mode area fibers, we demonstrate that SPM-enabled ultrafast fiber source can generate ultrashort pulses with 16.5-nJ pulse energies at 1225 nm.

**ATh1A.5 • 09:15**

**Energy scalable ultrafast fiber laser sources tunable in 1030-1200 nm for multiphoton microscopy,** Wei Liu[1,2], Shih-Huan Chia[1,2], Hsiang-Yu Chung[1,2], Franz X. Kaertner[1,2], Guoqing Chang[1,2]; [1]*Deutsches Elektronen-Synchrotron , Germany;* [2]*Physics Dept., Univ. Hamburg, Germany.* We demonstrate an energy scalable, Yb -fiber laser based ultrafast source for multiphoton microscopy imaging. The source emits 55-MHz, ~100 fs pulses widely tunable in 1030-1200 nm with up to 20-nJ pulse energies.

**ATh1A.6 • 09:30**

**High Power Spatially Coherent Pulse Formation via Intermodal Soliton Interactions in Fiber,** Lars Rishoj[1], Boyin Tai[1], Poul Kristensen[2], Siddharth Ramachandran[1]; [1]*Boston Univ., USA;* [2]*OFS-Fitel Denmark, Denmark.* We demonstrate a process for frequency conversion between solitons of differing transverse modes with large $A_{eff}$ ~1500 μm$^2$, yielding 87-fs, 60-nJ, (0.7-MW) pulses directly out of fiber at the biologically important ~1300-nm spectral window.

**ATh1A.7 • 09:45**

**Highly coherent tunable mid-infrared optical frequency comb seeded by high power supercontinuum at 1 μm,** Lei Jin[1], Masahito Yamanaka[1], Volker Sonnenschein[1], Hideki Tomita[1], Tetsuo Iguchi[1], Atsushi Sato[2], Akane Omori[2], Akira Ideno[2], Toshinari Oh-hara[2], Norihiko Nishizawa[1]; [1]*Nagoya Univ., Japan;* [2]*Sekisui Medical Co. Ltd., Japan.* A highly coherent mid-infrared optical frequency comb was generated through DFG pumped by supercontinuum from Yb-doped fiber laser system. MIR wavelength can be tuned continuously from 2.9 to 4.7 μm by a delay line.

### 08:00 -- 10:00
### LTh1B • Free Space Optical Communications I
*Presider: Paul McManamon; Exciting Tech., USA*

**LTh1B.1 • 08:00** Invited

**Arbitrary Optical Waveform Generation in Temporal, Spectral, and Spatial Domains for Future Free-Space Optical Communications,** S. J. Ben Yoo[1]; [1]*Univ. of California Davis, USA.* We discuss dynamic optical waveform generation using line-by-line coherent modulation of optical frequency combs, and arbitrary spatial beam forming utilizing 2D/3D photonic integrated circuits. Free-space optical communications and electronic warfare applications will also be discussed.

**LTh1B.2 • 08:30** Invited

**True Capacity Limit in Nonlinear Fiber Transmission,** Nikola Alic[1]; [1]*Univ. of California, San Diego, USA.* Abstract to available.

**LTh1B.3 • 09:00**

**Lasers for Deep Space Optical Communications,** Malcolm Wright[1], Michael Peng[1]; [1]*JPL, USA.* Deep space optical communications places unique requirements on the laser transmitters. Recent developments for both a multi-Watt average power downlink laser source and candidates for a kW class uplink laser source will be discussed.

**LTh1B.4 • 09:15**

**Free-space communication with over 100 spatial modes,** Carmelo Rosales-Guzmán[2], Abderrahmen Trichili[3], Angela L. Dudley[1,2], Bienvenu Ndagano[2], Amine Ben Salem[3], Mourad Zghal[3,4], Andrew Forbes[2]; [1]*CSIR National Laser Centre, South Africa;* [2]*Univ. of the Witwatersrand, South Africa;* [3]*Univ. of Carthage, Tunisia;* [4]*Institut Mines-Télécom SudParis, France.* By combining both the azimuthal and radial components of Laguerre-Gaussian modes with wavelength division multiplexing, we generated >100 information channels. We implemented a Lab free-space link using 35 Laguerre-Gaussian modes and three wavelengths.

**LTh1B.5 • 09:30**

**A Phase Estimation Algorithm in Coherent Wireless Optical Communication Systems,** Kaiyue Wang[1], Jiankun Zhang[1], Anhong Dang[1]; [1]*Peking Univ., China.* This paper proposes a novel phase estimation algorithm for coherent wireless optical communications, based on block-level maximum likelihood estimation combined with Kalman filter. Simulation results show its superiority in bit error rate performance.

**LTh1B.6 • 09:45**

**Experimental Study of A Coherent Wireless Optical Communication System,** Shengli Ding[1], Jiankun Zhang[1], Anhong Dang[1]; [1]*Peking Univ., USA.* Experimental research of a coherent wireless optical communication system was implemented with 1Gbps transmission rate. The results show that the system performs strong ability for mitigating the turbulent effects in moderate to strong turbulence.

### 08:00 -- 10:00
### Executive Forum

**8:00-8:15 • Welcome Remarks**

**8:15-8:50 • Overview of the Investment Landscape for Industrial Lasers**
David Townes, Needham & Co.

**8:50 - 10:00 • Panel 1: Market for Lasers over 10 Kilowatts**
Moderator: Martin Seifert, Nufern

This panel will feature presentations of the opportunities and challenges to commercialization of lasers with output powers greater than 10 kilowatts. Key questions are: Is this a limited, niche market or one that expands as more applications are proven? Where are the kilowatt "sweet spots" where the cost-performance matches the applications? What market obstacles remain to expand the market? Can there be a common technology to these applications that can lower costs?

Presenters:

Stan Ream, *Laser Technology Leader, EWI, USA*

Slava Rokitski, *Senior Manager, Cymer, an ASML Company, USA*

CDR Ricardo Vigil, *Principal Assistant Program Manager, Directed Energy Weapon Systems, US Navy, PEO Integrated Warfare Systems, USA*

10:00—11:30
JTh2A • Thursday Poster Session in the Exhibit Hall
(Coffee Break 10:00-10:30)



**JTh2A.1 • Monolithic Mid-IR Supercontinuum Source,** Brandon Shaw[1], Rajesh Thapa[2], Rafael R. Gattass[1], Vinh Nguyen[1], Geoff Chin[3], Dan Gibson[1], Woohong Kim[1], Jasbinder S. Sanghera[1]; [1]*US Naval Research Lab, USA;* [2]*Sotera Defense Solutions, USA;* [3]*Univ. Research Foundation, USA.* We review our recent work on fusion splicing of silica fiber to $As_2S_3$ chalcogenide fiber to enable a monolithic all fiber based mid-IR supercontinuum source.

**JTh2A.2 • Development of Diode-Pumped Green Laser for Low-Jitter OPCPA Pumping,** Yasuhiro Miyasaka[1], Hiromitsu Kiriyama[1], Maki Kishimoto[1], Michiaki Mori[1], Masaki Kando[1], Kiminori Kondo[1]; [1]*National Inst.s for Quantum and Radiological Science and Technology (QST), Japan.* We report recent progress on the development of stable pump laser for OPCPA in petawatt-class laser system. Stable seed pulses in power and spectrum are generated, and amplified by a diode-pumped regenerative amplifier.

**JTh2A.3 • Sub-100 fs pulse generation from a diode-pumped Kerrlens mode-locked Yb:LuAG ceramic laser,** Kai Liu[1], Jiangfeng Zhu[1], Jiang Li[2], Yang Yu[1], Huibo Wang[1], Ziye Gao[1], Junli Wang[1], Zhiyi Wei[1,3]; [1]*Xidian Univ., China;* [2]*Chinese Academy of Sciences, China;* [3]*Beijing National Lab for Condensed Matter Physics, Inst. of Physics, Chinese Academy of Sciences, China.* We demonstrate a diode-pumped Kerr-lens mode-locked Yb:LuAG ceramic laser with a pulse duration of 98 fs. The laser is centered at 1053 nm with 14.1 nm bandwidth, and the average output power was 121 mW.

**JTh2A.4 • Nonlinear pulse broadening based on Ar-filled large mode hollow-core photonic crystal fiber with kagome lattice,** Zhenkai Fan[2,1], zhiguo Lv[2], Peilong Yang[2], SHAOBO FANG[2], Hao Teng[2], Shuguang Li[1], Zhiyi Wei[2]; [1]*Yanshan Univ., China;* [2]*Chinese acadamy of science, Inst. of physics , China.* A kind of flattened dispersion of large mode hollow-core photonic crystal fiber (HC-PCF) with kagome lattice is proposed. These demonstrate a promising potential in broadening spectrum and pulse post-compressed by using high-power Yb doped fiber or solid laser.

**JTh2A.5 • Second-order Raman Shift with Multiple Peaks in a Hundred-meter Tellurite Fiber,** Tonglei Cheng[1], Weiqing Gao[1], Xiaojie Xue[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*ofmlab, Japan.* When the tellurite fiber is pumped by a nanosecond laser at ~1545 nm, second-order Raman shift with multiple Raman peaks is observed. Especially for the first-order Raman shift, six obvious Raman peaks are observed.

**JTh2A.6 • 9% optically eficient, 750-nm LED-pumped Nd:YAG laser,** Kuan-Yan Huang[1], Cheng-Kuo Su[1], Meng-Wei Lin[1], Yu-Chung Chiu[1], Yen-Chieh Huang[1]; [1]*National Tsing Hua Univ., Taiwan.* We report generation of 1.15-mJ/pulse energy at 1064 nm from a single-transverse-mode Nd:YAG laser pumped by 13-mJ energy in a 1-ms pulse width from an array of 750-nm LED dies.

**JTh2A.7 • Orthogonally polarized dual-wavelength cryogenic Nd:YLF laser and the investigation to the passive Q-switching,** Chun-Yu Cho[1], Hao-Ping Cheng[1], Tzu-Lin Huang[1], Kuan-Wei Su[1], Kai-Feng Huang[1], Yung-Fu Chen[1]; [1]*National Chiao Tung Univ., Taiwan.* A Nd:YLF laser is cryogenically cooled for the demonstration of orthogonally polarized dual-wavelength emissions at 1047 nm and 1053 nm. The approach of passively Q-switching with less thermal effect is also experimentally investigated.

JTh2A.8 • WITHDRAWN

**JTh2A.9 • Er:YGG Planar Waveguide Amplifiers for LIDAR Applications,** Stephen J. Beecher[1], James A. Grant-Jacob[1], Ping Hua[1], David Shepherd[1], Robert W. Eason[1], Jacob I. Mackenzie[1]; [1]*Optoelectronics Research Centre , UK.* Er:YGG is a promising candidate for greenhouse-gas LIDAR due to fortuitous transitions around key absorption lines of carbon-dioxide and methane. We present growth of crystal films by pulsed-laser-deposition, their spectroscopy and initial characterization as amplifiers.

**JTh2A.10 • Wideband wavelength tunable narrow linewidth source by spectral compression with improved comb profiled fiber and ultrashort pulse fiber laser with single wall carbon nanotube,** Norihiko Nishizawa[1], Yoshimichi Andou[1], Emiko Omoda[2], Hiromichi Kataura[2], Youchi Sakakibara[2]; [1]*Nagoya Univ., Japan;* [2]*AIST, Japan.* Wideband wavelength tunable narrow linewidth source was demonstrated with comb profiled fiber and Er-doped ultrashort pulse fiber laser with single wall carbon nanotube. Dramatic improvement of sidelobe suppression was achieved with improved comb profiled fibers.

**JTh2A.11 • Comparative Study of Tm:Li*Ln*$F_4$ (*Ln* = Y, Gd, and Lu) Crystals for Microchip Lasers at ~2 µm,** Xavier Mateos[2,1], Pavel Loiko[2,1], Simone Tacchini[1], Alberto di Lieto[3], Mauro Tonelli[3], Stefano Veronesi[3], Konstantin Yumashev[4], Uwe Griebner[1], Valentin Petrov[1]; [1]*Max Born Inst., Germany;* [2]*Universitat Rovira i Virgili, Spain;* [3]*NEST, Italy;* [4]*Belarusian National Technical Univ., Belarus.* Spectroscopic and thermo-optic properties of Tm:Li*Ln*$F_4$ (*Ln* = Y, Gd, and Lu) crystals are studied. The Tm:Li$YF_4$ microchip laser generated 3.1 W at 1904 nm with a slope efficiency of 72%.

**JTh2A.12 • Observation of bright-dark pulse pairs in an optically pumped semiconductor laser,** Hsing-Chih Liang[1], Chia-Han Tsou[2], Kai-Feng Huang[2], Yung-Fu Chen[2]; [1]*National Taiwan Ocean Univ., Taiwan;* [2]*National Chiao Tung Unervisity, Taiwan.* It is experimentally demonstrated that the reflection feedback can lead the optically pumped semiconductor laser (OPSL) to be operated in a self-mod-locked (SML) state with bright-dark pulse pairs.

**JTh2A.13 • Parametric Mid-IR Source Pumped by a High Power Picosecond Thin-Disk Laser,** Ondrej Novak[1], Michal Vyvlečka[1,2], Martin Smrz[1], Taisuke Miura[1], Akira Endo[1], Tomas Mocek[1]; [1]*HiLASE, Inst. of Physics AS CR, Czech Republic;* [2]*Faculty of Mathematics and Physics, Charles Univ. in Prague, Czech Republic.* The 100-kHz, 100-W, Yb:YAG thin-disk regenerative amplifier pumps the parametric mid-IR source. The OPG stage (PPLN) is followed by OPA stages (KTP). The idler of 2.2 µm wavelength is taken from final amplifier.

**JTh2A.14 • Exploring vortex structures of circularly geometric beams from off-axis pumped solid-state lasers with an external mode converter,** Jung-Chen Tung[1], P. H. Tuan[1], Chun-Yu Cho[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.* We employ a plane wave to perform interference with the circularly geometric beam from off-axis pumped solid-state lasers. The good agreement between the experimental and calculated interference patterns indicates vortex structures of circularly geometric beams.

**JTh2A.15 • Shaping and detecting mid-IR light with a Spatial Light Modulator,** Loyiso Maweza[1,3], Lucas Gailele[1,2], Henchарl Strauss[1], Igor Litvin[1], Andrew Forbes[2], Angela L. Dudley[1,2]; [1]*CSIR National Laser Centre, South Africa;* [2]*Univ. of the Witwatersrand, South Africa;* [3]*Stellenbosch Univ., South Africa.* We demonstrate the operation and calibration of a spatial light modulator in the mid-IR region by creating and measuring the modal content and wavefront of structured light fields at 2um for the first time.

**JTh2A.16 • Examination of Iron Doped Gallium Nitride as a Near-IR Laser Material,** Christopher G. Brown[1], Steven R. Bowman[2], Jacob Leach[3], Kevin Udwary[3]; [1]*Univ. Research Foundation, USA;* [2]*U.S. Naval Research Lab, USA;* [3]*Kyma Technologies, USA.* Iron doped Gallium Nitride is a promising candidate for high power laser operation at 1µm. We report novel spectroscopic characterization on samples with iron doping densities ranging from 1.0 x $10^{16}$ ions/$cm^3$ to 9.0 x $10^{19}$ ions/$cm^3$.

**JTh2A.17 • Efficient 355-nm Beam Generation through a Double Walk-off Compensation,** Changsoo Jung[1], Kun-Kook Kim[1], Bong-Ahn Yu[1], Yeung Lak Lee[1], Woojin Shin[1], Young-Chul Noh[1]; [1]*Gwangju Inst of Science & Technology, Korea (the Republic of).* We demonstrate a novel method for efficient frequency tripling of 1064-nm infrared beam. The walk-off in the frequency mixing is doubly compensated for, resulting in an improvement of the conversion efficiency and ultraviolet beam profile.

**JTh2A.18 • Design Model of Thermally Insensitive Convex-Concave Cavities for High-Power Diode-End-Pumped Solid-State Lasers,** P. H. Tuan[1], Chuan-Ching Chang[1], C. Y. Lee[1], Chun-Yu Cho[1], Jung-Chen Tung[1], Kuan-Wei Su[1], Kai-Feng Huang[1], Yung-Fu Chen[1]; [1]*National Chiao Tung Univ., Taiwan.* The thermally insensitive feature of convex-concave cavity is confirmed that can achieve power scaling in a wide-range cavity length. The influence of cavity length on the self-mode-locking behavior in this cavity is further explored.

**JTh2A.19 • Terahertz parametric amplification using KTiOPO $_4$,** Ming-Hsiung Wu[1], Yu-Chung Chiu[1], Tsong-Dong Wang[2], Gang Zhao[3], Andrius Zukauskas[4], Fredrik Laurell[4], Yen-Chieh Huang[1]; [1]*National Tsing Hua Univ., Taiwan;* [2]*Chung-Shan Inst. of Science and Technology, Taiwan;* [3]*Peking Univ., China;* [4]*Applied Physics, Royal Inst. of Technology, Sweden.* We show superior terahertz parametric generation from potassium titanyl phosphate over lithium niobate and lithium tantalate, and demonstrate seeded parametric amplification in KTP with a ~5W peak output power at 5.7 THz.

10:00—11:30
JTh2A • Thursday Poster Session in the Exhibit Hall
(Coffee Break 10:00-10:30)



**JTh2A.20 • Temporal Shaping of High Peak Power Pulse Trains from aBurst-Mode Laser System,** Jürgen Reiter[1,2], Jörg Körner[1], Joachim Hein[1,2], Malte C. Kaluza[1,2]; [1]*Institut für Optik und Quantenelektronik, Germany;* [2]*Helmholtz Inst. Jena, Germany.* We present a new shaping technique for pulsed lasers operating in "burst mode", which allows to produce arbitrary energy distributions within the burst by pre-shaping the seed pulse burst with a Pockels cell.

**JTh2A.21 • Fabrication of an all-solid tellurite disordered optical rod for transverse localization of light,** Hoang Tuan Tong[1], Tonglei Cheng[1], shunei Kuroyanagi[1], Shunta Tanaka[1], Kenshiro Nagasaka[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan.* Transverse localization of light has been observed after a probe beam propagated in a 5-cm-long all-solid tellurite optical rod with a disordered transverse refractive index profile fabricated in this work for the first time.

**JTh2A.22 • Wavelength Conversion Performance in a Tellurite Step-Index Optical Fiber,** Hoang Tuan Tong[1], Lei Zhang[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan.* Wavelength conversion performance in a tellurite step-index optical fiber pumped by a femtosecond laser was demonstrated. The wavelength spacing can be as broad as 966 nm and a maximum gain of 17.5-dB can be obtained.

**JTh2A.23 • High-energy femtosecond all-fiber oscillator with increased cavity length and mode-field diameter,** Denis S. Kharenko[1,2], Vlad A. Gonta[2], Sergey A. Babin[1,2]; [1]*Inst. of Automation and Electrometry, Russia;* [2]*Novosibirsk State Univ., Russia.* The all-fiber all -normal-dispersion cavity length and mode-field diameter have been increased simultaneously up to 40 -m and 10-µm. By suppressing Raman effect, highly-chirped pulses with energy >50 nJ at 250 fs compressed duration are generated.

**JTh2A.24 • High repetition rate, high pulse energy, Raman shifted wavelength selectable fiber laser source in the visible,** Lin Xu[1], Shaiful Alam[1], Qiongyue Kang[1], David Shepherd[1], David Richardson[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK.* We have demonstrated a Raman-shifted wavelength-selectable fiber laser source with fundamental spatial-mode output producing ~1-µJ pulse-energy at 1-MHz repetition-rate with 1.3-ns pulse-width using a large-core photonic crystal fiber.

**JTh2A.25 • Acousto-Optically Tuned CW Cr:ZnS Mid-IR Laser,** Dmitry V. Martyshkin[1], Taylor M. Kesterson[1], Vladimir Fedorov[1], Sergey B. Mirov[1]; [1]*Univ. of Alabama at Birmingham, USA.* We report on CW Cr:ZnS laser electronically tuned with acousto-optic tellurium dioxide filter operating with 20-30 GHz drive frequencies. The tuning range was over 1.9-2.8 mm with slope efficiency >40% and oscillation linewidth <1 nm.

**JTh2A.26 • Resonantly pumped single-frequency Q-switched Ho:YAG ceramic laser,** Chunqing Gao[1], Yan Li[1], Quanxin NA[1], Yixuan Zhang[1], Mingwei Gao[1], Qing Wang[1]; [1]*Beijing Inst. of Technology, China.* A resonantly pumped single-frequency Q-switched Ho:YAG ceramic laser is reported. The seed laser is a Ho:YAG NPRO at 2090 nm. The slave laser is a Ho:YAG ceramic laser. Single frequency Q-switched laser with energy of 8.5 mJ and pulse repetition rate of 200 Hz were obtained at 2090nm.

**JTh2A.27 • Highly Efficient Dual-wavelength CW Mid-infrared Laser in Diode-pumped Er:SrF $_2$ Crystals,** Weiwei Ma[1], Xiaobo Qian[1], Jingjing Liu[2], Xiuwei Fan[2], Jie Liu[2], Jun Xu[3], Liangbi L. Su[1]; [1]*Shanghai Inst. of Ceramics, CAS, China;* [2]*Shandong normal Univ., China;* [3]*Tongji Univ., China.* Dual-wavelength CW lasers around 2.8 µm were demonstrated in both 4at.% and 10at.%Er:SrF$_2$ single crystals. 4at.%Er:SrF$_2$ had better laser performance, with an maximum output power of 0.470 W and a slope efficiency of 16.8%.

**JTh2A.28 • High Peak-Power Narrow Linewidth 1.9 µm Fiber Gas Raman Source,** Zefeng Wang[1], bo gu[1], yubin chen[1], fei yu[2], chaofan zhang[1]; [1]*National Univ of Defense Technology, China;* [2]*Bath Uiniversity, UK.* A >18 kW peak power and <0.05 nm linewidth 1.9 µm fiber Raman source has been reported for the first time, using hydrogen-filled hollow-core fiber pumped with a 1064 nm pulse laser.

**JTh2A.29 • A stable ultra-broadband OPG/OPA source for the testing of 20 Petawatt Optical Parametric Chirped Pulse Amplifiers,** Waseem Shaikh[1], Pedro Bernardino Machado Andrade Oliveira[1], Ian Musgrave[1], Marco Galimberti[1], Adam Wyatt[1], Cristina Hernandez-Gomez[1]; [1]*CLF, STFC, UK.* A LBO based OPG/OPA source is demonstrated with an energy exceeding 90mJ with a 6% RMS energy stability and tunability of 300nm between 750 to 1050nm. This novel source will facilitate the testing of MultiPetawatt OPCPA amplification schemes.

**JTh2A.30 • Optimization of Low Quantum Defect Lasers,** Steven R. Bowman[1]; [1]*US Naval Research Lab, USA.* A new analysis of quasi-three level laser systems reveals the practical limits of the performance improvements possible with reduction of the laser quantum defect.

**JTh2A.31 • Examination of Iron Doped Gallium Nitride as a Near-IR Laser Material,** Christopher G. Brown[1], Steven R. Bowman[2], Jacob Leach[3], Kevin Udwary[3]; [1]*Univ. Research Foundation, USA;* [2]*U.S. Naval Research Lab, USA;* [3]*Kyma Technologies, USA.* Iron doped Gallium Nitride is a promising candidate for high power laser operation at 1µm. We report novel spectroscopic characterization on samples with iron doping densities ranging from 1.0 x 10$^{16}$cm$^{-3}$ to 9.0 x 10$^{19}$cm$^{-3}$.

**JTh2A.32 • Ultrafast Green Pulse Generation from Yb-doped Fiber Laser System,** Hideyuki Takada[1], Yuhei Chiba[2], Dai Yoshitomi[1], Kenji Torizuka[1], Kazuhiko Misawa[2]; [1]*Natl Inst of Adv Industrial Sci & Tech, Japan;* [2]*Tokyo Univ. of Agriculture and Technology, Japan.* We report ultrafast green pulse generation from an Yb-doped fiber laser with gain-narrowing compensation. The CPA system outputs repetitive 3 MHz pulses with energies of 32 nJ and transform limit pulse width of 46 fs.

**JTh2A.33 • Amplitude Noise Reduction in Yb-doped Fiber Amplifiers,** Michael Müller[1], Cesar Jauregui-Misas[1], Marco Kienel[1], Florian Emaury[2], Clara Saraceno[2], Ursula Keller[2], Jens Limpert[1,3], Andreas Tünnermann[1,3]; [1]*Inst. of Applied Physics, Germany;* [2]*Inst. of Quantum Electronics, ETH Zurich, Switzerland;* [3]*Fraunhofer Inst. of Applied Optics and Precision Engineering, Germany.* The propagation of amplitude noise in a fiber amplifier chain is analyzed. Low-frequency seed noise is attenuated by amplifier saturation, whereas for pump noise the opposite applies. Guidelines for low-noise fiber amplifier configurations are derived.

**JTh2A.34 • Mode selection in a double-pass Nd-doped fiber amplifier at 910 nm,** Mathieu Laroche[1]; [1]*CIMAP, France.* We investigated mode selection by a fiber Bragg grating in a Nd-doped LMA fiber amplifier at 910 nm. The selective amplification of the LP01 fundamental mode was demonstrated by measuring a M$^2$ factor of 1.06.

**JTh2A.35 • Compact visible- through mid-IR laser system based on a DFB diode, fiber amplifiers, PPLN and BIBO crystals,** Igor V. Melnikov[1,2], Nikolay Balakleyskiy[2,1], Andrey Machnev[2]; [1]*Moscow Inst. of Physics and Technology, Russia;* [2]*National Research Univ. of Electronic Technology, Russia.* We report a compact and robust laser source capable of generating diffraction-limited light ranged from the red to mid-IR, using repetiton-rate switchable DFB diode, and two-cascade single-pass OPO architecture.

**JTh2A.36 • Self-frequency-doubled visible Yb:YCOB lasers at the wavelengths of 523 and 570 nm,** Haohai Yu[1], Qiannan Fang[1], Huaijin Zhang[1], JIyang Wang[1]; [1]*Shandong Univ., China.* Visible lasers are playing significant roles in the modern technology and daily life. Here, we demonstrated the 710 mW green laser and 1.08 W yellow laser based on Yb:YCOB crystal with the self-frequency-doubling effect.

**JTh2A.37 • A Single-Frequency Tunable Tapered Amplifier Laser Near 1010 nm,** Yi J. Haung[1], Yung Chun Chan [2], Li-Bang Wang[2], Jow-Tsong Shy[1,2]; [1]*Institue of Photonics Technologies, National Tsing Hua University, Taiwan;* [2]*Department of Physics, National Tsing Hua University, Taiwan.* A near 1010 nm single-frequency tunable tapered amplifier laser (TAL) employing an intra -cavity interference filter is constructed. It has an optical power of 1.2 W and a tuning range of 990-1030 nm.

**JTh2A.38 • 100-W few-cycle Yb-fiber laser source based on pre-chirp managed amplification employing circular polarization,** Yizhou Liu[2,1], Wei Liu[2,1], Damian Schimpf[2,5], Tino Eidam[3,4], Jens Limpert[3,4], Andreas Tünnermann[3,4], Franz X. Kaertner[2,1], Guoqing Chang[2,5]; [1]*Hamburg University, Germany;* [2]*Deutsches Elektronen-Synchrotron, Germany;* [3]*Friedrich-Schiller-Universität Jena, Germany;* [4]*Helmholtz Institut Jena, Germany;* [5]*The Hamburg Centre for Ultrafast Imaging, Germany.* We demonstrate that seeding pre-chirp managed amplification by circularly polarized seeding pulses can increase the amplified pulse energies. Using this method, we generate 100-W, 26-fs pulses at 23.7-MHz repetition rate.

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Harbor Ballroom I & II — ASSL

11:30 -- 12:15
**ATh3A • Fiber CPA**
*Presider: Norihiko Nishizawa; Nagoya Univ., Japan*

ATh3A.1 • 11:30
**Prospects for peak power scaling of Tm-doped fiber CPA systems,** Christian Gaida[1], Martin Gebhardt[1,2], Fabian Stutzki[1], Cesar Jauregui -Misas[1], Jens Limpert[1,2], Andreas Tünnermann[1,3]; [1]*Inst. of Applied Physics, Germany;* [2]*Helmoltz-Inst., Germany;* [3]*Fraunhofer-Inst. , Germany.* We have achieved a record pulse peak power of ~2 GW from a thulium-doped fiber CPA system at 2 µm wavelength. This is a 10 times improvement compared to any other result presented to date.

ATh3A.2 • 11:45
**Generation of 59-fs 89-W average power pulses from a third-order dispersion managed self-similar fiber amplifier at 500-MHz repetition rate,** Yang Liu[1], Wenxue Li[1], Daping Luo[1], Chao Wang[1], Heping Zeng[1]; [1]*East China Normal Univ., China.* We report on a high-power third-order dispersion managed amplifier, delivering 59 -fs pulses with 89-W at 500-MHz repetition rate. Detail experiments show that the use of grism pre-chirper enhances the quality of the compressed pulses significantly.

ATh3A.3 • 12:00
**Radially polarised Yb-fiber MOPA producing 10 W output using SLM based pulse shaping for efficient generation of arbitrary shaped picosecond pulses,** Betty M. Zhang[2,1], Yunjun Feng[2,3], Di Lin[2], Jonathan Price[2], Shaiful Alam[2], Johan Nilsson[2], Perry Shum[1], David Payne[2], David Richardson[2]; [1]*School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore;* [2]*Optoelectronics Research Centre, Univ. of Southampton, UK;* [3]*Dept. of Engineering Physics, Tsinghua Univ., China.* We demonstrate beyond 10W simultaneous temporal and spatial pulse-shaping on a picosecond fiber laser system. Our proposed technique can substantially enhance the capability and efficiency of the existing ultrashort fiber laser systems for high precision material processing.

Marina I & II Ballroom (Lobby Level) — LS&C

11:30 -- 12:30
**LTh3B • Free Space Optical Communications II**
*Presider: Paul McManamon; Exciting Tech., USA*

LTh3B.1 • 11:30 Invited
**Long Distance Free-Space Propagation of Light Carrying Orbital Angular Momentum,** Martin P. Lavery[1], Christian Peuntinger[2], Kevin Guenthner[2], Thomas Bauer[2,4], Peter Banze[2], Dominique Elser[2], Robert W. Boyd[3], Miles Padgett[1], Christoph Marquardt[2], Gerd Leuchs[2]; [1]*Univ. of Glasgow, UK;* [2]*Max Planck Inst. for the Science of Light, Germany;* [3]*The Inst. of Optics, Univ. of Rochester, USA;* [4]*Dept.artment of Physics, Univ. of Ottawa, Canada.* We present an analysis of the technical challenges faced when deploying long-distance free-space links and orbital angular momentum multiplexing, e.g. for the purpose of communication. Our analysis indicates atmospheric mitigation techniques and the consideration of the modal purity the system design.

LTh3B.2 • 12:00
**Measuring Multiplexed OAM Modes with Convolutional Neural Networks,** Timothy Doster[1], Abbie T. Watnik[1]; [1]*U.S. Naval Research Lab, USA.* Multiplexing beams with distinct OAM modes allows for increased channel bandwidth. We demonstrate a convolutional neural network approach, using only intensity imagery, for demultiplexing OAM beams with various mode spacings, beam types, and turbulences.

LTh3B.3 • 12:15
**Experimental Setup of a Blind Detection Algorithm for Free Space Optical Communication,** Ruijie Li[1], Jiankun Zhang [1], Anhong Dang[1]; [1]*Peking Univ., China.* A blind detection algorithm for free space optical communication is proposed, which exploits temporal correlation of channel. Simulation and experimental results prove that the performance is comparable to that of detection with perfect channel information.

Harbor Ballroom III — LAC

11:30 -- 12:30
**Executive Forum**
Moderator: Christoph Harder, *Harder and Partner*

**11:30 - 12:30 • Panel 2: Market for Lasers under 10 Kilowatts**
This panel will feature presentations of the opportunities and challenges to the commercialization of lasers with output powers less than 10 kilowatts. Key questions are: what is the outlook for diode lasers to displace fiber and solid-state lasers in mainstream cutting applications? Where is new territory where laser-based tools can displace other technologies or expand on current ones?

Presenters:

Parviz Tayebati, *TeraDiode, USA*

Berthold Schmidt, *Managing Director, TRUMPF Photonics, Inc., USA*

Toby Strite, *IPG Photonics, USA*

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## 12:45—13:45 • Special Lunch Session, *Harbor Ballroom I & II*

### Export Control Reform and Category XII

We are pleased to invite you to a special presentation by Kevin J. Wolf, Assistant Secretary of Commerce for Export Administration, U.S. Department of Commerce, USA. He will provide an overview of the Export Control Reform initiative and discuss the final rules revising USML Category XII and making corresponding changes to the Export Administration Regulations.

14:00 -- 16:00
## ATh4A • Free Space NIR sources
*Presider: Alan Petersen; Spectra-Physics, USA*

ATh4A.1 • 14:00
**High Gain, High Efficiency Cryogenic Yb:YAG Ceramics Amplifier for Several Hundred Joules DPSSL,** Takashi Sekine[1], Yasuki Takeuchi[1], Takashi Kurita[1], Yuma Hatano[1], Yuki Muramatsu[1], Yoshio Mizuta[1], Yuki Kabeya[1], Yoshinori Tamaoki[1], Yoshinori Kato[1]; [1]*Hamamatsu Photonics K. K., Japan.* A cryogenic Yb:YAG ceramics laser amplifier with high small-signal-gain of 33 and high stored energy of 170 J has been developed. A 55 J output energy with 10 ns pulse duration has been demonstrated.

ATh4A.2 • 14:15
**Energy Scaling Nanosecond Pulsed Yb:YAG Cryo-cooled DPSSL Amplifier Technology to 100J-level,** Jodie Smith[1], Saumyabrata Banerjee[1], Paul D. Mason[1], Klaus Ertel[1], Thomas J. Butcher[1], P. Jonathan Phillips[1], Mariastefania De Vido[1], Oleg Chekhlov[1], Martin Divoky[2], Jan Pilar[2], Waseem Shaikh[1], Chris Hooker[1], Antonio Lucianetti[2], Cristina Hernandez-Gomez[1], Tomas Mocek[2], Chris Edwards[1], John Collier[1]; [1]*Rutherford Appleton Lab, UK;* [2]*HiLASE, Czech Republic.* In this paper we describe the progress of energy scaling cryogenic gas-cooled Yb:YAG amplifier technology from a 10 J, 10 Hz prototype to delivering 100 J pulses at 1 Hz.

ATh4A.3 • 14:30
**Addressing Spectral Narrowing in Cryogenic Yb:YAG: a 10 mJ Cryogenic Yb:YLF Regenerative Amplifier,** Michaël Hemmer[1], Luis Zapata[1], Yi Hua[1], Franz X. Kaertner[1,2]; [1]*Deutsches Elektronen Synchrotron, Germany;* [2]*The Center for Ultrafast Imaging, Univ. Hamburg, Germany.* We report a Yb:YLF based 10 mJ-class cryogenically-cooled regenerative amplifier with 2.1 nm FWHM spectral bandwidth. This system demonstrates the feasibility of high energy, sub-ps cryogenic lasers as an alternative to room temperature Yb:YAG.

ATh4A.4 • 14:45
**Cryogenically Cooled 30-mJ Yb:$CaF_2$ Regenerative Amplifier,** Giedrius Andriukaitis[1], Edgar Kaksis[1], Tobias Flöry[1], Audrius Pugzlys[1], Andrius Baltuska[1]; [1]*Photonics Inst., Vienna Univ. of Technology, Austria.* We report on the design and performance of a cryogenic cw-pumped Yb:$CaF_2$ CPA producing 30-mJ, 200-fs pulses. Operation in the repetition frequency range of 0.5—10 kHz is demonstrated, sustaining >15 W average power.

ATh4A.5 • 15:00
**130 fs – Multiwatt Yb:$CaF_2$ regenerative amplifier pumped by a fiber laser,** Dominique Descamps[1], Pierre Sevillano[1], Patrice Camy[2], Jean-Louis Doualan[2], Richard Moncorge[2], Eric Cormier[1]; [1]*CELIA,Université Bordeaux-CNRS-CEA, France;* [2]*CIMAP, CEA-CNRS-ENSICaen, France.* An Yb:$CaF_2$ regenerative amplifier is pumped with a diffraction-limited fiber laser. It delivers more than 4.3 W of 130 fs pulses when operating between 5 and 50 kHz with a maximum energy of 0.9 mJ.

ATh4A.6 • 15:15
**Efficient Near-IR Tm:YLF Laser,** Charles X. Yu[1]; [1]*MIT Lincoln Lab, USA.* We demonstrate an efficient cw Tm:YLF laser at 816 nm. The optical slope efficiency is 44% at 77 K, and cw lasing is achieved up to 200 K. Co-lasing at 816 nm and 1876 nm is employed to reduce population trapping and to improve the laser efficiency.

ATh4A.7 • 15:30
**Actively controlled Q-switched laser using domains in magnetooptical garnet film,** Taichi Goto[1,2], Ryohei Morimoto[1], John Pritchard[3], Hiroyuki Takagi[1], Yuichi Nakamura[1], Hironaga Uchida[1], Mani Mina[3], Takunori Taira[4], Mitsuteru Inoue[1]; [1]*Toyohashi Univ. of Technology, Japan;* [2]*JST PRESTO, Japan;* [3]*Iowa State Univ., USA;* [4]*Inst. for Molecular Science, Japan.* A 14 mm cavity laser including 690 mm thick domain-controlled optical Q-switch was demonstrated. The peak power of about 2 kW, the repetition rate of 1 kHz, the pulse width of 30 ns were shown.

ATh4A.8 • 15:45
**>2 MW peak power at 1560 nm from micro giant-pulse laser/amplifier with PPMgLN OPG,** Jianglin Yue[1], Tomoki Tamada[1], Masanao Kamata[1], Lihe Zheng[2], Hideki Ishizuki[2], Takunori Taira[2]; [1]*Sony Global M&O Corporation, Japan;* [2]*Laser Research Center, Inst. for Molecular Science, Japan.* We demonstrate 2.6 MW peak power at 1560 nm from Nd:YAG/$Cr^{4+}$:YAG micro giant-pulse laser/amplifier with PPMgLN optical parametric generation. It is the first report of micro giant-pulse laser exceeding 2 MW peak power in eye-safe wavelength.

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

Thursday, 3 November

16:30 -- 18:15
ATh5A • Narrow-line & Semi-conductor Lasers
*Presider: Ingmar Hartl; DESY, Germany*

ATh5A.1 • 16:30 Invited
**Single-Frequency Lasers for Gravitational Wave Detection,** Peter Wessels[1,2], Jörg Neumann[1,2], Dietmar Kracht[1,2]; [1]*Laser Zentrum Hannover e.V., Germany;* [2]*Centre for Quantum-Engineering and Space-Time Research - QUEST, Germany.* An overview over the solid-state laser development for different generations of large-scale earth-bound gravitational wave detectors is presented. In addition, developments of fiber amplifiers as potential laser sources for next-generation detectors are highlighted.

ATh5A.2 • 17:00
**Single-Mode and High-Speed 850nm MEMS-VCSEL,** Demis D. John[1], Ben Lee[3], Benjamin Potsaid[3,2], Amanda C. Kennedy[1], Martin E. Robertson[1], Christopher B. Burgner[1], Alex E. Cable[2], James Fujimoto[3], Vijaysekhar Jayaraman[1]; [1]*Praevium Research Inc., USA;* [2]*Thorlabs Inc., USA;* [3]*Electrical & Computer Engineering, MIT, USA.* We present an 850nm Vertical-Cavity Surface-Emitting Laser (VCSEL) with electrostatically-actuated top mirror. Developed to target the water-transmission window for ophthalmic imaging, the light source achieves 37.7nm of tuning at 347kHz unamplified, and 5.4mW amplified power.

ATh5A.3 • 17:15
**Single Longitudinal Mode Yb:YAG DFB Laser Fabricated by Ultrafast Laser Inscription,** Thomas Calmano[1,2], Martin Ams[3], Benjamin F. Johnston[3], Peter Dekker[3], Christian Kraenkel[1,2], Michael J. Withford[3]; [1]*Institut für Laser-Physik, Universität Hamburg, Germany;* [2]*Hamburg Centre for Ultrafast Imaging, Germany;* [3]*CUDOS, MQ Photonics Research Centre, Macquarie Univ., Australia.* We report on single longitudinal mode Yb:YAG waveguide lasers with 2 W of output power and high efficiency. The distributed feedback (DFB) lasers are based on ultrafast laser inscribed waveguide Bragg gratings.

ATh5A.4 • 17:30
**Development of DBR-free semiconductor disk lasers,** Zhou Yang[1], Alexander R. Albrecht[1], Jeffrey G. Cederberg[2], Mansoor Sheik-Bahae[1]; [1]*Univ. of New Mexico, USA;* [2]*MIT Lincoln Lab, USA.* DBR-free optically-pumped semiconductor disk lasers are demonstrated by direct bonding of the gain chip to various thermal substrates. This allows broad tunability, potential for compact monolithic cavities, and high power scaling.

ATh5A.5 • 17:45
**Compact Lasing with Bound States in the Continuum,** Ashok Kodigala[1], Thomas Lepetit[1], Qing Gu[1], Babak Bahari[1], Yeshaiahu Fainman[1], Boubacar Kante[1]; [1]*Univ. of California San Diego, USA.* We have designed a high quality factor cavity that is based on a bound state in the continuum and harnessed its properties to demonstrate a novel type of surface emitting laser in the c-band (~1550nm).

ATh5A.6 • 18:00
**Nearly-octave continuously wavelength tuning of a fiber laser,** Lei Zhang[1], Huawei Jiang[1], Xuezong Yang[1], Weiwei Pan[1], Shuzhen Cui[1], Yan Feng[1]; [1]*Shanghai Inst of Optics & Fine Mechanics, China.* A random distributed feedback Raman fiber laser which is continuously tunable from 1 to 1.9um is reported. The ultra-wide wavelength tunability is enabled because of the broadband stimulated Raman scattering gain and Rayleigh scattering feedback.

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