High-brightness Sources and Light-Driven Interactions Congress Program

Compact (EUV & X-ray) Light Sources (EUV & X-ray)
High-Intensity Lasers and High-Field Phenomena (HILAS)
Mid-Infrared Coherent Sources (MICS)

26 - 28 March 2018

Hilton Strasbourg
Strasbourg, France

Welcome to the 2018 High-brightness Sources and Light-driven Interactions Congress,

We hope that you enjoy your time in beautiful Strasbourg, France, and have an opportunity to explore this charming city! This year the Congress features three topical meetings that have been collocated to propel discourse on the latest advances in high-brightness sources, attosecond science, light-driven interactions and mid-IR laser technologies; and to understand the technical challenges in the development of high-brightness sources at all wavelengths, from x-ray to mid-IR. With exciting plenary speakers, strong representation from industry, stimulating presentations, networking opportunities and open discussions, the Congress aims to promote new ideas between researchers, engineers and managers.

This year's Congress features a multitude of educational, networking and social events to ensure all congress participants have ample time to engage in important discussions and critical knowledge sharing. We start on Monday morning with our three plenary speakers - Federico Capasso, Britt Turkot and Andreas Tünnermann. Monday evening join us for a special session dedicated to the emerging Extreme Light Infrastructure (ELI) facilities that are getting ready for user access and are in the process of growing together. We will discuss with their leadership vision, perspective and process for conducting experiments there and will have a Q&A session with them. Tuesday will feature postdeadline papers and the conference reception with the poster session across the street at the Strasbourg Convention Center. This is in addition to outstanding technical sessions for three full days.

The High-Intensity Lasers and High-Field Phenomena (HILAS) topical meeting aims to assemble a multidisciplinary community to present and exchange novel ideas and breakthrough achievements relating to the physics and technology of high field sources, and high-intensity laser-matter interaction.
Organizers have assembled an exciting program of 12 invited speakers, along with contributed oral and poster presentations this year.

Mid-Infrared Coherent Sources (MICS) topical meeting focuses on the most recent advances in mid-IR to THz science and technology, including the latest developments in solid-state, fiber, and semiconductor materials, novel laser sources, nonlinear frequency conversion techniques and parametric devices, as well as the application of mid-IR and THz sources in remote sensing, spectroscopy, frequency synthesis, imaging, and biomedicine. Attendees will hear numerous contributed talks in addition to 9 invited talks covering a range of topics.

The Compact (EUV & X-ray) Light Sources topical meeting aims to assemble experts in both source technologies and their applications, to introduce and exchange ideas and improve community-wide understanding of current and future source capabilities and current and future application needs. During these sessions, the latest results in the development of these sources will be presented. In addition, descriptions efforts to mature the technology so that they meet the requirements needed in order to transition the technology to industrial medical and research applications will be discussed.

We hope you will join us at all these events and that you enjoy your time in France!

High-brightness Sources and Light-driven Interactions Congress Meeting Chairs

Program Committees

Compact (EUV X-RAY) Light Sources

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High-Intensity Lasers and High-Field Phenomena (HILAS)

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Caterina Vozzi*, IFN-CNR, Italy*
Zhiyi Wei, *Institute of Physics, CAS, China*

Mid-Infrared Coherent Sources (MICS)

Majid Ebrahim-Zadeh, *ICFO -The Institute of Photonic Sciences*, *Spain,* General Chair
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Christian Pedersen, *DTU Fotonik, Denmark*
Peter Schunemann, *BAE Systems Inc., USA*
Brandon Shaw, *US Naval Research Lab, USA*
Chaitanya Kumar *Suddapalli, Radiantis, Spain*
Takunori Taira, *Institute for Molecular Science*, *Japan*
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Konstantin Vodopyanov, *University of Central Florida*, CREOL, *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

Bartholdi C, Hilton Strasbourg

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

Sunday, 25 March	15:00 – 18:00
Monday, 26 March	07:00 – 18:30
Tuesday, 27 March	07:30 – 16:00
Wednesday, 28 March	07:30 – 16:00

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1. Visit the conference website at www.osa.org/HighBrightnessOPC
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.]

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Access to the Wireless Internet

OSA has provided complimentary Wi-Fi for all conference attendees.

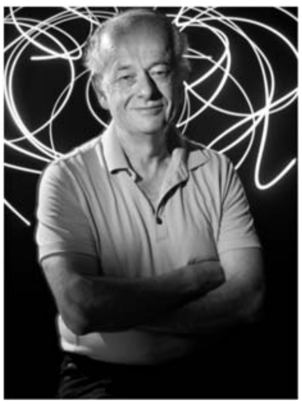
Network: HHonors
Password: OSA2018

Plenary Speakers

Britt Turkot, *Intel Corporation,* USA

Compact Sources and Chip-Making

Britt joined the Photolithography department at Intel's Portland Technology and Development organization in 1996 after completing her B.S. degree in Metallurgical Engineering and M.S. and Ph.D. degrees in Materials Science and Engineering from the University of Illinois at Urbana-Champaign. Britt has been involved in many aspects of lithography development in PTD, including her current role as program manager of Intel's EUV lithography program along with development of scanner reticle and frame graphics as well as the integration of new lithography tool platforms into Intel factories.



Federico Capasso, *Harvard University,* USA

Quantum Cascade Laser Renaissance

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 AAAS 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.

Andreas Tünnermann, *Fraunhofer Inst. for Applied Optics and Precision Engineering ,* Germany

Perfomance Scaling of Ultrafast Lasers via Coherent Combination

Andreas Tünnermann is Director of the Fraunhofer Institute of Applied Optics and Precision Engineering and Chair for the Insitute of Applied Physics at Friedrich-Schiller-University Jena. His main research interests include scientific and technical aspects associated with the tailoring of light. Research topics are the design and manufacturing of novel micro- and nano-optical photonic devices using high-end microlithography and its application for generation, amplification, steering and switching of light. In particular, his work on high power diode pumped fiber and waveguide lasers is widely recognized.

Andreas Tünnermann is member of the German Physical Society, European Physical Society and acatech, fellow of OSA and SPIE. His research activities on applied quantum electronics have been awarded with the Röntgen-Award, WLT-Award, Otto-Schott-Award, Leibinger Innovation Award and the Gottfried-Wilhelm-Leibniz-Award. Most recently, he received the ERC-Advanced Grand of the EU.

Exhibitor List / Buyers' Guide

Active Fiber Systems
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Notes

Explanation of Session Codes

EM2B.4

Meeting Name

E= EUV & X-ray
H= HILAS
M= MICS
J = Joint

Number

Presentation order within session

Day of the Week

M=Monday
Tu=Tuesday
W= Wednesday

Session Designation

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

Parallel Session

A=1st Parallel Session
B=2nd Parallel Session
C=3rd 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 EM2B.4 indicates that this paper is being presented as part of the EUV 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, 25 March	
15:00—18:00	Registration, *Bartholdi C*

Monday, 26 March			
	Orangerie CDE	Orangerie B	Orangerie A
	HILAS	EUV & X-ray	MICS
07:00—18:30	Registration, *Bartholdi C*		
08:00—10:00	JM1A • Plenary Session, *Orangerie CDE*		
10:00—10:30	Coffee Break with Exhibitors, *Foyer Orangerie*		
10:30—12:30	HM2A • Attosecond Science & Applications	EM2B • Compton Scattering Sources	MM2C• Solid-State and Fiber Lasers and Frequency Combs
12:30—14:00	*Lunch on your Own*		
14:00—16:00	HM3A • Laser Driven Particle Beams and Radiation	EM3B • Laser Plasma based Sources	MM3C • Laser Materials and Structures for Mid-IR
16:00—16:30	Coffee Break with Exhibitors, *Foyer Orangerie*		
16:30—18:30	HM4A • Ultrafast Dynamics I	EM4B • Free-electron Laser and Electron Beam Sources I	MM4C • Remote Sensing and Imaging
18:30—20:00	ELI Overview, *Orangerie CDE*		

Agenda of Sessions

Tuesday, 27 March			
	HILAS	EUV & X-ray	MICS
07:30—16:00	Registration, *Bartholdi C*		
08:00—10:00	HT1A • High Intensity Lasers at Average Power	ET1B • Compact Sources I	MT1C • MIR and THz Sources
10:00—10:30	Coffee Break with Exhibitors, *Foyer Orangerie,* Hilton Strasbourg		
10:30—12:30	HM3A • Laser Driven Particle Beams and Radiation	ET2B • Applications in Imaging	MT2C • Nonlinear Optical Materials and Structures for Mid-IR
12:30—14:00	*Lunch on your own*		
14:00—16:00	HM4A • Ultrafast Dynamics I	ET3B • EUV Lithography and Semiconductor Manufacturing 1	MT3C • Spectroscopy, Microscopy and Biophotonics
17:30—19:00	JT5A • Poster Sessions *Strasbourg Convention Center , Marie Curie Room*		
18:30—20:00	Welcome Reception *Strasbourg Convention Center , Marie Curie Room*		

Agenda of Sessions

Wednesday, 28 March				
	Orangerie C	Orangerie B	Orangerie A	Orangerie DE
	HILAS	EUV& X-ray	MICS	HILAS
07:30—16:00	Registration, *Bartholdi C*			
08:00—10:00	HW1A • Theoretical Advanced in High-Field Physics	EW1B • EUV Lithography and Semiconductor Manufacturing II	MW1C • Nonlinear Frequency Conversion and Parametric Sources I	
10:00—10:30	Coffee Break with Exhibitors, *Foyer Orangerie,* Hilton Strasbourg			
10:30—12:30	HW2A • UltraFast Dynamics II	EW2B • High Harmonic Generation	MW2C • Nonlinear Frequency Conversion and Parametric Sources II	
12:30—14:00	*Lunch on your Own*			
14:00—16:00	HW3A • Nonlinear phenomena and HHG	EW3B • Free-electron Laser and Electron Beam Sources II	MW3C • THz Generation and Frequency Combs	HW3D • Ultrashort Pulse Generation & characterization
16:00—16:30	Coffee Break with Exhibitors, *Foyer Orangerie,* Hilton Strasbourg			
16:30—18:30	HW4A • Extreme Light Infrastructure - Capabilities & Experiments	EW4B • Compact Sources II	MW4C • Comb Spectroscopy, Materials Processing	

07:00—18:30 • Registration, *Bartholdi C*

Orangerie CDE

08:00 -- 10:00
JM1A • Plenary Session

Plenary

JM1A.1 • 08:15
Quantum Cascade Laser Renaissance, Federico Capasso; *Harvard University, USA*. Parametric effects and ultrafast gain dynamics in QCLs lead to single mode instability, multimode operation and to a new regime, the "harmonic" state, which are opening up new frontiers in frequency combs and RF Photonics

Plenary

JM1A.2 • 08:45
Compact Sources and Chip-Making, Britt Turkot[1]; [1]*Intel Corp., USA.* In the past year, EUV LPP exposure sources have reached satisfactory power levels, achieving the long -established milestone of 250W. With EUV exposure tools, the source remains the leading cause of system down-time, including both routine scheduled maintenance as well as unplanned corrective actions. The nature of LPP source design leads to contamination, exposure dose errors, and the need for additional power to mitigate such effects. Compact sources offer possible opportunities in support of chip-making, including not only the option to replace the exposure source but also to provide sources for mask metrology (both lens and lens-less) as well as to support materials research and development.

Plenary

JM1A.3 • 09:15
Perfomance Scaling of Ultrafast Lasers via Coherent Combination, Andreas Tünnermann[1]; [1]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* Coherent combination of ultrashort laser pulses emitted from spatially-separated amplifiers is a promising power-scaling technique for ultrafast laser systems concerning peak power and average power. In this presentation, the status and prospects of coherently combined fiber-CPA systems will be discussed.

10:00—10:30 • Coffee Break with Exhibitors, *Foyer Orangerie*

Orangerie CDE	Orangerie B	Orangerie A
HILAS	EUV & X-ray	MICS

Orangerie CDE — HILAS

10:30 -- 12:30
HM2A • Attosecond Science & Applications
Presider: Caterina Vozzi; IFN-CNR, Italy

HM2A.1 • 10:30 Invited
New Frontiers in High Harmonic Spectroscopy, Nirit Dudovich[1]; *[1]Weizmann Inst. of Science, Israel.* Abstract not provided.

HM2A.2 • 11:00
Attosecond spatial interferometry for complete three-dimensional electric field reconstruction., Giuseppe Sansone[1,2], Paolo Carpeggiani[2], Maurizio Reduzzi[2], Antoine Comby[2], Hamed Ahmadi[2,3], Sergei Kuehn[4], Francesca Calegari[2], Mauro Nisoli[2], Fabio Frassetto[5], Luca Poletto[5], Dominik Hoff[6], Joachim Ullrich[7], Claus Dieter Schroeter[8], Robert Moshammer[8], Gerhard Paulus[6]; *[1]Albert-Ludwigs-Univ. Freiburg, Germany; [2]Politecnico Milano, Italy; Univ. of Tehran, Iran; [4]ELI-ALPS, Hungary; [5]Inst. of Photonics and Nanotech., CNR, Italy; [6]Institut für Optik und Quantenelektronik, Friedrich-Schiller-Univ. Jena, Germany; [7]Physikalisch-Technische Bundesanstalt, Germany; [8]Max-Planck-Inst. für Kernphysik, Germany.* We demonstrate the complete temporal reconstruction of visible pulses with a time-dependent polarisation state, using extreme ultraviolet spatial interferometry based on two coherent isolated attosecond pulses.

HM2A.3 • 11:15
Attosecond-Resolved Photoionization of Chiral Molecules, Samuel Beaulieu[2], Antoine Comby[2], Alex Clergerie[2], Jérémie Caillat[3], Dominique Descamps[2], Nirit Dudovich[4], Baptiste Fabre[2], Romain Géneaux[5], François Légaré[1], Stéphane Petit[2], Bernard Pons[2], Gil Porat[4], Theirry Ruchon[5], Richard Taïeb[3], Valérie Blanchet[2], Yann Mairesse[2]; *[1]Inst. National de la Recherche Scientifique, Canada; [2]Univ. de Bordeaux - CNRS - CEA, CELIA, France; [3]Sorbonne Univ., UPMC Univ. Paris , CNRS-UMR 7614, LCPMR, France; [4]Weizmann Inst. of Science, Israel; [5]LIDYL, CEA, CNRS, Univ. Paris-Saclay, CEA Saclay, France.* Using photoelectron interferometry, we have measured the angularly-resolved forward-backward asymmetry of the Wigner delays in chiral molecules, as well the asymmetric temporal profile of a photoelectron wavepacket liberated in the vicinity of an autoionizing resonance.

Orangerie B — EUV & X-ray

10:30 -- 12:30
EM2B • Compton Scattering Sources
Presider: Franz Kaertner; Universität Hamburg, Germany

EM2B.1 • 10:30 Keynote
Ultrabright Laser-Compton Light Sources and Novel Applications, Christopher P. Barty[1]; *[1]Univ. of California, Irvine, USA.* The development, optimization and applications of compact, high-peak and high-average brilliance laser-Compton x-ray and gamma-ray sources is reviewed. Potential applications range from nuclear photonics to precision medical imaging and theranostics.

EM2B.2 • 11:00 Invited
Commissioning of ASU Compact X-ray Light Source (CXLS), William Graves[1]; *[1]Arizona State Univ., USA.* CXLS is an x-ray source with predicted output of 1e11 photons/sec in 5% bandwidth, 500 fs length, and photon energy from 1 – 40 keV. The major subsystems are currently under test. Commissioning status will be reported.

Orangerie A — MICS

10:30 -- 12:30
MM2C • Solid-State and Fiber Lasers and Frequency Combs
Presider: Majid Ebrahim-Zadeh; ICFO -The Inst. of Photonic Sciences, Spain

MM2C.1 • 10:30 Invited
The Bright Future of Mid-Infrared Fiber Lasers, Real Vallee[1], Martin Bernier[1], Vincent Fortin[1], Simon Duval[1], Frédéric Maes[1], Jean-Christophe Gauthier[1], Yigit O. Aydin[1], Pascal Paradis[1], Frédéric Jobin[1], Louis-Rafael Robichaud[1], Louis-Philippe Pleau[1]; *[1]Universite Laval, Canada.* Mid-infrared fiber lasers based on rare-earth active ions or Raman gain are reviewed in terms of their wavelength coverage and their average and peak power scaling with respect to future technical challenges as well as application perspectives.

MM2C.2 • 11:00
Cr:ZnSe Hybrid Laser System for CEP-Stable Pulses, Pavel Komm[1], Uzziel Sheintop[2,1], Salman Noach[2], Gilad Marcus[1]; *[1]Hebrew Univ. of Jerusalem, Israel; [2]Applied Physics, Jerusalem College of Tech., Israel.* A hybrid laser scheme in which parametrically generated, carrier to envelope phase stable, mid-IR pulses with picojoule energies are amplified by three orders of magnitude in a Cr:ZnSe laser amplifier is presented.

MM2C.3 • 11:15
Power and Energy Scaling of Femtosecond Middle IR Pulses in Single-Pass Cr:ZnS and Cr:ZnSe Amplifiers, Sergey Vasilyev[1], Jeremy Peppers[1], Viktor Smolski[1], Igor Moskalev[1], Mike Mirov[1], Sergey Mirov[1,3], Valentin Gapontsev[2]; *[1]IPG Photonics Southeast Technology Center, USA; [2]IPG Photonics Corp., USA; [3]Center for Optical Sensors and Spectroscopies, Univ. of Alabama at Birmingham, USA.* We report compact ultrafast mid-IR sources based on single-pass cw and pulsed pumped polycrystalline Cr:ZnS/Se laser amplifiers exhibiting up to 37% efficiency, up to 30 dB small-signal gain, and spectral span of 1.6–4.5 um.

Orangerie CDE	Orangerie B	Orangerie A
HILAS	EUV & X-ray	MICS

HILAS (Orangerie CDE)

10:30 -- 12:30
HM2A • Attosecond Science & Applications - Continuing

HM2A.4 • 11:30
Straightforward Production of Bright, Polarization-Tunable Attosecond High-Harmonic Waveforms via Circularly Polarized High Harmonic Generation, Kevin Dorney[1], Tingting Fan[1], Jennifer Ellis[1], Daniel Hickstein[1], Christopher Mancuso[1], Nathan Brooks[1], Dmitriy Zusin[1], Christian Gentry[1], Patrik Grychtol[1], Ronny Knut[1], Tenio Popmintchev[1], Carlos Hernández-García[2], Dejan Milošević[3,4], Henry Kapteyn[1], Margaret Murnane[1]; *[1]JILA Univ. of Colorado at Boulder and NIST, USA; [2]Aplicada, Univ. of Salamanca, Spain; [3]Faculty of Science, Univ. of Sarajevo, Bosnia and Herzegovina; [4]Max Born-Inst., Germany.* We experimentally demonstrate straightforward methodologies for generating high harmonics of arbitrary polarization state. Polarization control is realized by adjusting the intensity ratio of the bicircular driving field or by exploiting chirally dependent Cooper minima transitions.

HM2A.5 • 11:45
Intense attosecond pulses from relativistic interaction of few cycle lasers with plasma mirrors, Subhendu KAHALY[1], Mojtaba Shirozhan[1]; *[1]Extreme Light Infrastructure, ALPS, Hungary.* Here we numerically study the optimal switching of relativistic high harmonic generation mechanisms and show that careful experiments can be designed by choosing appropriate parameter space where one can generate intense attosecond pulses from laser-plasmas.

HM2A.6 • 12:00
Nonlinear Interaction of 100-eV Attosecond XUV-Pulses with Core Electrons in Xenon, Boris Bergues[1,2], Daniel E. Rivas[1,2], Matthiew Weidman[1], Alexander A. Muschet[1,3], Wolfram Helml[2], Alexander Guggenmos[1,2], Pervak Vladimir[1,2], Ulf Kleineberg[1,2], Gilad Marcus[1,5], Reinhard Kienberger[1,6], Dimitris Charalambidis[4], Paraskevas Tzallas[4], Hartmut Schröder[1], Ferenc Krausz[1,2], Laszlo Veisz[1,3]; *[1]Max-Planck-Inst. fur Quantenoptik, Germany; [2]Ludwig-Maximilians-Univ. München, Germany; [3]Umeå Univ., Sweden; [4]Inst. of Electronic Structure and Laser, Foundation for Research and Technology-Hellas, Greece; [5]The Hebrew Univ. of Jerusalem, Israel; [6]Technische Univ. München, Germany.* We demonstrate multiphoton ionization of inner-shell electrons in Xenon with 100-eV attosecond pulses. This was achieved with a novel XUV source based on high-harmonic generation in the gas phase driven with multi-TW few-cycle laser pulses.

HM2A.7 • 12:15
The role of Gouy phase of Extreme ultraviolet in attosecond experiment, Byunghoon Kim[1,2], Jaeuk Heo[1], Dong Eon Kim[1,2]; *[1]Pohang Univ. of Science & Technology, South Korea; [2]Max Planck Center for Attosecond Science, Max Planck POSTECH/KOREA Res. Init, South Korea.* In the streaking experiment using isolated attosecond pulses, the role of the XUV Gouy phase is revealed by observing the neon gas and Cu_2O phase difference as the Cu_2O target is moved.

EUV & X-ray (Orangerie B)

10:30 -- 12:30
EM2B • Compton Scattering Sources - Continuing

EM2B.3 • 11:30
The Munich Compact Light Source - Operating an Inverse Compton Source in User Mode, Martin Dierolf[1,2], Benedikt Günther[1,2], Regine Gradl[1,2], Christoph Jud[1,2], Elena Eggl[1,2], Bernhard Gleich[2], Klaus Achterhold[1,2], Franz Pfeiffer[1,2]; *[1]Chair of Biomedical Physics, Technical Univ. of Munich, Germany; [2]Munich School of BioEngineering, Technical Univ. of Munich, Germany.* Based on more than two years of operating the Munich Compact Light Source (MuCLS), we present our experiences concerning the everyday use of an inverse Compton device as an X-ray source for biomedical imaging.

EM2B.4 • 11:45
High-Energy Burst Mode Thin-disk Multipass Amplifier for Laser Compton X-ray Source, Siva Nagisetty[1,2], Michal Chyla[1], Martin Smrz[1], Akira Endo[1], Tomas Mocek[1]; *[1]HiLASE Centre, Inst. of Physics AS CR, v.v.i., Czechia; [2]Czech Technical Univ. in Prague, Czechia.* High-energy ps-laser pulses with excellent beam quality are required for efficient Compton X-ray source. We report on a thin-disk multipass amplifier operated in burst mode with output of 0.5 J burst energy.

EM2B.5 • 12:00
X-ray Beam Monitoring and Source Position Stabilization at an Inverse-Compton X-ray Source, Benedikt Günther[1,2], Martin Dierolf[1,3], Klaus Achterhold[1,3], Franz Pfeiffer[1,3]; *[1]Chair of Biomedical Physics, Technische Universität München, Germany; [2]Max-Planck-Inst. of Quantum Optics, Germany; [3]Munich School of BioEngineering, Germany.* Overlap between laser- and electron beam determines flux at inverse-Compton X-ray sources. Beam drifts deteriorate flux and source position. A closed-loop feedback system counteracting this movement was developed to stabilize source position.

EM2B.6 • 12:15
Analytical solutions for nonlinear Thomson scattering with radiation effects included., Marcel Ruijter[1], Sergey Rykovanov[1], Vasily Kharin[1]; *[1]Helmholtz Inst. Jena, Germany.* An analytical solution for the nonlinear Thomson scattering with classical radiation reaction is provided. Estimates on the emitted frequencies for a given harmonic order are given and additional spectral broadening is discussed.

MICS (Orangerie A)

10:30 -- 12:30
MM2C • Solid-State and Fiber Lasers and Frequency Combs - Continuing

MM2C.4 • 11:30
Comparative study of high power Tm:YLF and Tm:LLF slab lasers, Antoine Berrou[1], Daniel Morris[1], Oliver J. Collett[1], M.J. D. Esser[1]; *[1]EPS/IPAQS, Heriot-Watt Univ., UK.* High brightness diode stack end-pumped Tm:YLF and Tm:LLF slab lasers are compared under identical pump conditions in continuous-wave regime. A maximum output power of 160 W was obtained for 428 W of pump power.

MM2C.5 • 11:45
All-PM All-diode-pumped Mode-locked Holmium Fiber MOPA Laser System, Nikolai Tolstik[1,3], Ingrid K. Bakke[1], Evgeni Sorokin[2], Irina Sorokina[1,3]; *[1]Norges Teknisk Naturvitenskapelige Univ, Norway; [2]Inst. of Photonics, Vienna Univ. of Technology, Austria; [3]Atla Lasers AS, Norway.* We report a first all-PM mode-locked holmium-fiber MOPA, diode-pumped at 1150nm and generating at 2089nm linearly chirped picosecond pulses with 4.7 nJ pulse energy, 23 MHz repetition rate and 110 mW average output power.

MM2C.6 • 12:00
Nanojoule 100 fs Pulse at 3 µm Generated From a Fully Fusion-Spliced Fiber Laser, Hugo Delahaye[1], Mathieu Jossent[2], Geoffroy Granger[1], Sébastien Février[1]; *[1]87000, Univ. Limoges, CNRS, XLIM, UMR 7252, France; [2]87700, Novae, France.* We report on an all-fiber source of nanojoule 100-fs pulses at 3 µm based on the soliton frequency-shifting effect in a cascade of silica and germania fibers.

MM2C.7 • 12:15
High-energy self-frequency-shifted solitons in large mode area Bragg fiber pumped by 2 µm chirped pulse amplifier, Dmitry Gaponov[1], Hugo Delahaye[2], Laure Lavoute[1], Mathieu Jossent[1], Mikhail Salganskii[3], Mikhail Likhachev[4], Ammar Hideur[5], Geoffroy Granger[2], Sébastien Février[2]; *[1]Novae, France; [2]XLIM, France; [3]IHPS RAS, Russia; [4]Fiber Optics Research Center RAS, Russia; [5]CORIA, France.* 93 nJ 130 fs pulses are generated in the short wavelength infrared (2.3 µm) by pumping large mode area photonic bandgap fiber by a high repetition rate (150 kHz) multi-µJ CPA at 2 µm.

12:30—14:00 • Lunch on your Own

Orangerie CDE

HILAS

14:00 -- 16:00
HM3A • Laser Driven Particle Beams and Radiation
Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Sweden

Invited

HM3A.1 • 14:00
Laser-driven Particle Acceleration Performed with 4PW Laser at CoReLS, Chang Hee Nam[2,1]; [1]*Gwangju Inst. of Science & Technology, South Korea;* [2]*Center for Relativistic Laser Science, Inst. for Basic Science, South Korea.* A 20 fs, 4 PW Ti:sapphire laser with a repetition rate of 0.1 Hz was developed and its performance has been tested in laser-driven charged particle acceleration.

HM3A.2 • 14:30
High peak power lasers at INRS and application of laser -wakefield-based x-ray sources to global food security, Jean-Claude Kieffer[1], Sylvain Fourmaux[1], Emil Hallin[2]; [1]*INRS-Energie Materiaux et Telecom, Canada;* [2]*Global Inst. For Food Security, Univ. of Saskatchewan, Canada.* We will describe our program in developing high throughput phase contrast screening system based on LWFA X-ray sources for plant imaging through an initiative led by the Global Inst. for Food Security (GIFS) at the U of Saskatchewan.

HM3A.3 • 14:45
Recent Progress on kHz Laser-Plasma Acceleration Driven by Single Cycle Laser Pulses, Jerome Faure[1,2], Dominykas Gustas[1], Diego Guenot[1,3], Aline Vernier[1], Agustin Lifschitz[1], Rodrigo B. Lopez-Martens[1], Frederik Böhle[1]; [1]*LOA, France;* [2]*Physics Dept., Ecole Polytechnique, France;* [3]*Lund Univ., Sweden.* We have used kHz single cycle laser pulses in order to resonantly drive a plasma wakefield, resulting in the acceleration of relativistic electron beam with 5 MeV energies and >20 pC/shot charges. Simulations indicate that the electron bunch duration can be as short as 1 femtosecond, making this source unique for probing structural dynamics on ultrafast time scales.

Orangerie B

EUV & X-ray

14:00 -- 16:00
EM3B • Laser Plasma based Sources
Presider: Jorge Rocca; Colorado State Univ., USA

Keynote

EM3B.1 • 14:00
Laser-Plasma Accelerator Driven Compact Photon Sources, Cameron G. Geddes[1], Hai-En Tsai[1], Jeroen van Tilborg[1], Csaba Toth[1], Jean-Luc Vay[1], Carl Schroeder[1], Eric Esarey[1], Wim Leemans[1]; [1]*Lawrence Berkeley National Lab, USA.* A Thomson scattering photon source at MeV energies is being developed, incorporating compact plasma accelerators, scattering laser shaping and guiding for high brightness, and plasma deceleration of the e-beam to mitigate shielding needs.

Invited

EM3B.2 • 14:30
High Brightness X-ray Sources Based on Laser Accelerated Electrons, Ruxin Li[1], Wentao Wang[1], Jiansheng Liu[1], Zhizhan Xu[1]; [1]*State Key Lab of High Field Laser Physics, Shanghai Inst. of Optics and Fine Mech., China.* We demonstrated a MeV source based on the Compton scattering of laser accelerated electron beams. Meanwhile, a XUV-free electron laser based on a 0.5GeV level laser electron accelerator is at the final stage of experiments.

Invited

EM3B.3 • 15:00
Plasma-based high-power x-ray pulse generation and amplification, Julia Mikhailova[1]; [1]*Princeton Univ., USA.* We discuss plasma-based approaches to create, amplify, and compress laser-like, directed-energy radiation with extreme properties in intensity, wavelength, and pulse duration.

Orangerie A

MICS

14:00 -- 16:00
MM3C • Laser Materials and Structures for Mid-IR
Presider: Richard Moncorge; Universite de Caen, France

Invited

MM3C.1 • 14:00
Ultra-fast Modulation of Quantum Cascade Lasers and Infrared Detectors, Carlo Sirtori[1]; [1]*Universite Paris-Diderot Paris VII, France.* Mid-IR optoelectronic devices operating at ~ 10 µm wavelength, such as quantum cascade (QC) lasers, quantum well infrared photodetectors (QWIP) and QC detectors, are based on transitions between electronic bound states that have a very short excited state lifetime in the order of 1 ps. They have threofre a great potential as ultra fast devices with frequency bandwidth overcoming tens of GHz.

MM3C.2 • 14:30
Active Based-Metasurfaces for Mid-Infrared Optoelectronics Devices, Laurent Boulley[1], Thomas Maroutian[1], Pierre Laffaille[1], Raffaele Colombelli[1], Lianhe Li[2], Edmund Linfield[2], Adel Bousseksou[1]; [1]*Centre de Nanosciences et de Nanotechnologies, CNRS, Univ. Paris-Sud, Université Paris-Saclay, C2N – Orsay, France;* [2]*School of Electronic and Electrical Engineering, Univ. of Leeds, UK.* We develop low-temperature (450°C) deposition conditions for vanadium di-oxide phase change material. It permits implementation of tunable mid-infrared meta-surfaces on quantum cascade lasers based heterostructures.

MM3C.3 • 14:45
A compact Ge-rich graded-index SiGe platform with broadband low-loss propagation in the mid infrared, Joan Manel Ramirez[1], Qiankun Liu[1], Vladyslav Vakarin[1], Jacopo Frigerio[2], Andrea Ballabio[2], Xavier Le Roux[1], Laurent Vivien[1], Giovanni Isella[2], Delphine Marris-Morini[1]; [1]*Université Paris-Sud, France;* [2]*L-Ness Lab, Politecnico di Milano, Italy.* Ge-rich SiGe platforms with broadband and flat propagation loss of 2-3 dB/cm from $\lambda = 5.5$ µm to 8.5 µm are demonstrated. Such mid-IR integrated circuits are promising for many application including sensing or telecommunications.

MM3C.4 • 15:00
Mid-IR integrated cavity based on Ge-rich graded SiGe waveguides with lateral Bragg grating, Qiankun Liu[1], Joan Manel Ramirez[1], Vladyslav Vakarin[1], Jacopo Frigerio[2], Andrea Ballabio[2], Xavier Le Roux[1], Carlos Alonso-Ramos[1], Laurent Vivien[1], Giovanni Isella[2], Delphine Marris-Morini[1]; [1]*C2N, Universite Paris-Sud, France;* [2]*L-Ness, Politecnico Di Milano, Italy.* We report the design of a Bragg-mirror based Fabry-Perot cavity integrated on SiGe waveguides working at 7.25 µm. The demonstration of such resonant structures will be a major step forward for sensing applications in mid-infrared.

Orangerie CDE	Orangerie B	Orangerie A
HILAS	EUV & X-ray	MICS

HILAS — Orangerie CDE

14:00 -- 16:00
HM3A • Laser Laser Driven Particle Beams and Radiation - Continuing

HM3A.4 • 15:15
THz-Pulse-Driven Electron Post-Accelerators, Zoltan Tibai[1], Márta Unferdorben[1], Szabolcs Turnár[1], Bálint Kovács[1], Jozsef A. Fulop[1], Gábor Almási[1], János Hebling[1]; *[1]Univ. of Pécs, Hungary.* Because of their suitable wavelength and temporal period, THz pulses with extremely high field strength are ideal for driving particle accelerators. Here we give an overview of the possibilities and challenges of THz-pulse-driven electron post accelerators.

HM3A.5 • 15:30
Optimization of High-Field THz Pulse Generation by the Interaction of High Intensity Lasers with Aligned Nanorod Targets, Sudipta Mondal[1,2], Qiliang Wei[2], Muhammad Ashiq Fareed[2], Subhendu Kahaly[1], Shuhui Sun[2], Tsuneyuki Ozaki[2]; *[1]ELI-HU Non-Profit Ltd., Hungary; [2]ALLS, INRS-Énergie Matériaux Télécomm., Canada.* High-field THz pulse generation by the interaction of high intensity femtosecond laser with aligned nanorods target have been investigated experimentally and theoretically which shows 13.8

HM3A.6 • 15:45
Enhancement of Laser-Driven Proton Beams Using Nanostructured Solid Foils, Simon Vallières[1,2], Massimiliano Scisciò[1,3], Simona Veltri[1,3], Marianna Barberio[3,4], Emmanuel d'Humières[2], Patrizio Antici[1,4]; *[1]INRS-EMT, Inst. National de la Recherche Scientifique, Canada; [2]CELIA, Univ. of Bordeaux, France; [3]INFN-RM1 & Univ. of Rome "La Sapienza", Italy; [4]ELI-ALPS, Hungary.* We present recent advances in the field of laser-driven particle acceleration, using nanostructured targets as proton source. Results from 2D PIC simulations along with experimental validations are shown.

EUV & X-ray — Orangerie B

14:00 -- 16:00
EM3B • Laser Plasma based Sources - Continuing

EM3B.4 • 15:30
Characterisation of Tuneable Gas Target Profiles for Laser Wakefield Acceleration, Vidmantas Tomkus[1], Valdas Girdauskas[1,2], Juozas Dudutis[1], Valdemar Stankevic[1], Gediminas Raciukaitis[1]; *[1]Center for Physical Sciences and Tech., Lithuania; [2]Vytautas Magnus Univ., Lithuania.* In this report, tuneable gas target profiles for Laser Wakefield Acceleration controlled by fused silica micronozzle arrays and annular nozzles were simulated, manufactured by 3D laser inscription and characterised using interferometry and gas density reconstruction.

EM3B.5 • 15:45
Carrier-Envelope-Phase Stable Attosecond Pulse Generation Based on Laser-Plasma Electron Source, Zoltan Tibai[1], Gyorgy Toth[1], Anett Nagyváradi[1], Ashutos Sharma[2], Jozsef A. Fulop[1], Gábor Almási[1], János Hebling[1]; *[1]Univ. of Pécs, Hungary; [2]ELI-ALPS, Hungary.* A laser-plasma accelerator based carrier-envelope-phase stable attosecond source is investigated numerically. Pulses with tens-of-nJ energy and 90 to 240 attosecond duration are predicted in the 30–120 nm wavelength range.

MICS — Orangerie A

14:00 -- 16:00
MM3C • Laser Materials and Structures for Mid-IR - Continuing

MM3C.5 • 15:15
Fabrication and Spectroscopy Pr^{3+} doped Ceramic Calcium Lanthanum Sulfide for Mid-IR Laser Gain Material, Brandon Shaw[1], Michael Hunt[1], Woohong Kiim[1], Shyam Bayya[1], Darryl Boyd[1], Christopher Brown[2], Steve Bowman[1], Jas Sanghera[1]; *[1]US Naval Research Lab, USA; [2]Univ. Research Foundation, USA.* We report our progress in fabrication ceramic Praseodymium doped Calcium Lanthanum Sulfide for potential mid-IR laser gain material. Fabrication and spectroscopy of this new gain material will be

MM3C.6 • 15:30
Parametric Quantum-dash Source Around 3 µm, Alice Bernard[1,2], Marco Ravaro[1], Ivan Favero[1], Michel Krakowski[3], Olivier Parillaud[3], Bruno Gérard[3], Jean-Michel Gérard[2], Giuseppe Leo[1]; *[1]Université Paris 7, France; [2]INAC, Commissariat à l'Energie Atomique, France; [3]TRT, III-V Lab, France.* Based on an accurate characterization of InGaAsP waveguides in the mid-IR range, we design a tunable source around 3 µm based on intracavity spontaneous down-conversion (SPDC) in a telecom laser diode. Fabrication is underway.

MM3C.7 • 15:45
Femtosecond laser writing of the depressed cladding buried channel waveguides in ZnS crystal, Andrey G. Okhrimchuk[2,1], Michael Smayev[2], Vladislav Likhov[2], Irina T. Sorokina[3], Evgeni Sorokin[4], Nikolai Tolstik[3]; *[1]Fiber Optics Research Center of RAS, Russia; [2]International Centre of Laser Tech., D. Mendeleyev Univ. of Chemical Tech. of Russia, Russia; [3]Dept. of Physics, Norwegian Univ. of Science and Tech., Norway; [4]Institut für Photonik, TU Wien, Austria.* Direct laser writing of buried channel waveguides in ZnS single crystal is investigated. A depressed cladding wavegiude with propagation loss of 0.62 dB/cm at 1030 nm was inscribed. Spectral broadening at the waveguide output was found under pumping with

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16:00—16:30 • **Coffee Break with Exhibitors,** *Foyer Orangerie*

Orangerie CDE — HILAS

16:30 -- 18:30
HM4A • Ultrafast Dynamics I
Presider: Jean-Claude Kieffer; *NRS-Energie Materiaux et Telecom*, *Canada*

Invited

HM4A.1 • 16:30
Relativistic Laser-Plasma Interactions in Solid Density Hydrogen Jet Targets, Sebastian Goede[1]; *[1]European XFEL, Germany.* The talk presents results on laser-driven proton acceleration from cryogenic liquid jet targets in the relativistic regime. Technical challenges and the impact of laser and target parameters on the proton beam properties will be discussed.

HM4A.2 • 17:00
Two-Dimensional Control of Electron Localization in H_2 Dissociation with Elliptically Polarized Few-Cycle Laser Pulses, Sarayoo Kangaparambil[3], Vaclav Hanus[3], Seyedreza Larimian[3], Xinhua Xie[3], Markus Schoffler[1], Gerhard Paulus[2], Andrius Baltuska[3], Markus Kitzler[3]; *[1]Institut für Kernphysik , Germany; [2]Friedrich-Schiller-Universität , Germany; [3]TU Wien, Austria.* We experimentally achieve two-dimensional CEP-control of bond breaking in H_2 dissociation with elliptically polarized pulses. The lab and molecular frame of reference proton ejection asymmetries are compared.

HM4A.3 • 17:15
Electron Vortex States in High-Energy Ionization, Katarzyna Krajewska[1], Felipe Cajiao V\'elez[1], Jerzy Kami\'nski[1]; *[1]Univ. of Warsaw, Poland.* The generation of electron vortex states of large topological charge in high-energy ionization is demonstrated. To this end, the fully relativistic Dirac theory is used to determine the conditions to obtain such states.

HM4A.4 • 17:30
The Molecular Attoclock: Sub-cycle Control of Electronic Dynamics During H_2 Double Ionization, Vaclav Hanus[1], Sarayoo Kangaparambil[1], Seyedreza Larimian[1], Xinhua Xie[1], Markus Schoffler[2], André Staudte[3], Gerhard Paulus[4], Andrius Baltuska[1], Markus Kitzler[1]; *[1]TU Wien, Austria; [2]Institut für Kernphysik, J.W. Goethe-Universität, Germany; [3]Joint Attosecond Science Lab. of the National Research Council and the Univ. of Ottawa, Canada; [4]Friedrich-Schiller-Universität Jena, Germany.* We introduce and employ the molecular attoclock method. This allows us to simultaneously trace the nuclear and electron dynamics during H_2 fragmentation, and to CEP-control the two-electron emission dynamics on sub-cycle time scales.

Orangerie B — EUV & X-ray

16:30 -- 18:45
EM4B • Free-electron Laser and Electron Beam Sources I
Presider: Tetsuya Ishikawa; RIKEN, Japan

Invited

EM4B.1 • 16:30
FERMI: the first externally seeded Free Electron Laser in the extreme ultraviolet and soft X-ray spectral regions, Luca Giannessi[1,2]; *[1]Elettra Sincrotrone Trieste, Italy; [2]ENEA, Italy.* We present an overview of FERMI, the seeded Free Electron Laser facility at the ELETTRA-Sincrotrone Lab (Trieste): two FELs operating in the HGHG mode, characterized by desirable properties, such as stability, low jitter and longitudinal coherence.

Invited

EM4B.2 • 17:00
Towards Laser Plasma Acceleration Based Free Electron Laser and First Results on COXINEL, Thomas André[1]; *[1]Synchrotron SOLEIL, France.* The COXINEL project aims at demonstrate the Free electrons laser amplification using Laser plasma accelerator. The control of electron beam properties of such accelerators, permit an observation of the spontaneous emission light from the udulator.

Invited

EM4B.3 • 17:30
Development of Experimental Platform for Laser Wakefield Acceleration of Electrons and Possible Applications, Yuji Sano[1]; *[1]ImPACT Program, Japan Science and Tech. Agency, Japan.* Laser experimental facilities were established for achieving stable electron acceleration and generating X-rays with a monolithic undulator. Compact diode-pumped solid-state lasers have also been developed to downsize the facilities and promote applications.

Orangerie A — MICS

16:30 -- 18:30
MM4C • Remote Sensing and Imaging
Presider: Irina Sorokina; Norges Teknisk Naturvitenskapelige Univ., Norway

Invited

MM4C.1 • 16:30
Mid-Infrared Imaging using Upconversion – Principles and Applications, Peter Tidemand-Lichtenberg[1], Peter John Rodrigo[1], Christian Pedersen[1]; *[1]Danmarks Teknishe Universitet, Denmark.* Different schemes for mid-infrared hyperspectral imaging using upconversion detection is implemented and compared in terms of spectral coverage, field-of-view, resolution and speed. Both broadband and narrowband, continuous wave and pulsed imaging systems are considered.

MM4C.2 • 17:00
Long-wave Infrared Upconverter, Yu-Pei Tseng[1], Christian Pedersen[1], Peter Tidemand-Lichtenberg[1]; *[1]Technical Univ. of Denmark, Denmark.* An upconverter is demonstrated for long-wave infrared (LWIR) detection, potentially used for LWIR spectroscopy. The LWIR signal is frequency converted using an $AgGaS_2$ crystal. This allows for efficient, high-speed detection using a standard silicon detector.

MM4C.3 • 17:15
Atmospheric CO_2 sensing by DIAL using a high energy, high purity and high stability parametric source, Myriam Raybaut[1], Erwan Cadiou[1,3], Jean-Baptiste Dherbecourt[1], Jean-Michel Melkonian[1], Antoine Godard[1], Jacques Pelon[2]; *[1]Onera, The French Aerospace Lab, France; [2]LATMOS, France; [3]CNES, France.* We report on the development of a tunable parametric source emitting 10-mJ, 10-ns-long, Fourier-transform-limited pulses with high frequency stability, and its implementation in a direct detection lidar operating at 2051 nm for carbon dioxide sensing.

MM4C.4 • 17:30
Point-Spread Function Engineering in Upconversion Imaging, Saher Junaid[1], Peter John Rodrigo[1], Peter Tidemand-Lichtenberg[1], Christian Pedersen[1]; *[1]DTU FOTONIK, Denmark.* We demonstrate an upconversion based 4-f imaging system and investigate how its point-spread function can be altered by spatially manipulating the amplitude and/or phase profiles of the otherwise Gaussian mixing field.

Orangerie CDE	Orangerie B	Orangerie A
HILAS	EUV & X-ray	MICS

16:30 -- 18:30
HM4A • Ultrafast Dynamics I - Continuing

HM4A.5 • 17:45
Emergence of a Higher Energy Structure in Strong Field Ionization with Inhomogeneous Laser Fields, Marcelo F. Ciappina[8,1], Jose Perez-Hernández[2], Lisa Ortmann[3], Johannes Schötz[1], Alexis Chacón[4], G Zeraouli[2], Matthias Kling[1,5], Luis Roso[2], Maciej Lewenstein[4,6], Alexandra Landsman[3,7]; *[1]Max Planck Inst. for Quantum Optics, Germany; [2]CLPU, Spain; [3]MPIPKS, Germany; [4]ICFO, Spain; [5]LMU, Germany; [6]ICREA, Spain; [7]Max Planck POSTECH, South Korea; [8]ELI-Beamlines, Czechia.* We demonstrate that using a time-varying spatial dependence in the laser electric field creates a prominent higher energy peak in the photoelectron spectra, originates by direct electrons ionized within a narrow time window.

HM4A.6 • 18:00
Frustrated Double Ionization of Argon Atoms, Seyedreza Larimian[1], Sonia Erattupuzha[1], Christoph Lemell[2], Joachim Burgdörfer[2], Andrius Baltuška[1], Markus Kitzler[1], Xinhua Xie[1]; *[1]Photonics Inst., Technische Universität Wien, Austria; [2]Inst. for Theoretical Physics, Technische Universität Wien, Austria.* We report kinematically complete measurements of frustrated double ionization of argon atoms with a reaction microscope. Experimental results show much higher electron trapping probability during the strong-field double ionization than that during the single ionization.

HM4A.7 • 18:15
Sub-wavelength trapping and accelerating of neutral atoms with intense light carrying orbital angular momentum, Jamal Berakdar[1], Dominik Schulze[1]; *[1]Martin Luther Univ. Halle Wittenberg, Germany.* We study the trapping and steering of neutral atoms in focused, high-intensity optical vortices. Appropriate combinations of Laguerre-Gaussian beams result in sub-wavelength, dynamical radial traps for atoms, controllable by the waist and the wavelength of the laser pulses.

16:30 -- 18:45
EM4B • Free-electron Laser and Electron Beam Sources - Continuing

Invited
EM4B.4 • 18:00
Nano-modulated electron beams via electron diffraction for coherent x-ray generation, Emilio A. Nanni[1]; *[1]SLAC National Accelerator Lab, USA.* A new method for generation of relativistic electron beams with current modulation on the nanometer scale will be presented in addition to its use for coherent x-ray generation, performance parameters and ongoing preliminary experiments.

EM4B.5 • 18:30
XFEL based on Tapered RF Undulators Driven by Laser Plasma Wakefield Accelerator, Sergey Antipov[1], A Liu[1], A Vikharev[2], A Savilov[2], S Kuzikov[1,2]; *[1]Euclid TechLabs LLC, USA; [2]Inst. of Applied Physics, Russian Academy of Sciences, Russia.* Microwave undulators are proposed for FELs due to large beam aperture and short undulator period. The development of tapered microwave undulator for EUV FEL is presented. Tapering allows to achieve an unprecedented 10% conversion efficiency.

16:30 -- 18:30
MM4C • Remote Sensing and Imaging - Continuing

MM4C.5 • 17:45
S/N Ratio of an Upconversion Detector Dominated by Upconverted Spontaneous Parametric Down-conversion Noise, Lichun Meng[1], Lasse Høgstedt[2], Peter Tidemand-Lichtenberg[1], Christian Pedersen[1], Peter John Rodrigo[1]; *[1]DTU Fotonik, Denmark; [2]NLIR ApS, Denmark.* We designed an upconversion detector (UCD) for 1575 nm operation. The signal-to-noise ratio of the UCD is investigated by considering the dependence of upconversion efficiency and upconverted spontaneous parametric down-conversion noise on pump power.

MM4C.6 • 18:00
Narrow-Linewidth Picosecond Optical Parametric Oscillator for Backscatter Absorption Gas Imaging, Guillaume Walter[1], Jean-Baptiste Dherbecourt[1], Jean-Michel Melkonian[1], Myriam Raybaut[1], Didier Henry[1], Cyril Drag[2], Antoine Godard[1]; *[1]ONERA - The French Aerospace Lab, France; [2]aboratoire de Physique des Plasmas, France.* A picosecond OPO combining an aperiodically-poled nonlinear crystal and a chirped VBG is used for backscatter absorption gas imaging of N_2O at atmospheric pressure. The tunability is 215 nm around 3.82 μm in 130 ms.

MM4C.7 • 18:15
7.3-10.5 μm Tunable Single-frequency Parametric Source for Standoff Detection of Gaseous Chemicals, Julie Armougom[1], Jean-Michel Melkonian[1], Myriam Raybaut[1], Jean-Baptiste Dherbecourt[1], Guillaume Gorju[1], Antoine Godard[1], Riaan Cotzee[2], Valdas Pašiškevičius[2], Jiri Kadlčák[3]; *[1]ONERA - The French Aerospace Lab, France; [2]Dept. of Applied Physics, Royal Inst. of Technology, Sweden; [3]CBRN Protection Division, VVU, Czechia.* We report on the first single-frequency parametric source tunable in the longwave infrared with an output energy of 1 mJ. The source is then used in a lidar to detect chemicals in the vapor phase.

Orangerie CDE

18:00 -- 20:00

Extreme Light Infrastructure (ELI) — Future and Opportunities

A pan-European project, ELI is moving into full operational mode in 2018. Attend two special sessions to learn about operational aspects of ELI and presentations from researchers working at the three facilities.

ELI-ERIC and Future Experimental Access to ELI Facilities

Carlo Rizutto, *ELI Delivery Consortium AISBL, Belgium*

The three research centers of ELI are now entering the operational phase, and will be integrated into a single European Research Infrastructure, ELI-ERIC. User applications and access will be managed through a single access point and will be based on the quality of proposals as evaluated by international review panels. Rizzuto, Director General of the ELI Delivery Consortium, on behalf of all the facilities, updates on the current status of ELI ERIC, organisational planning and governance.

ELI Facilities: Progress on Construction and Commissioning

Roman Hvezda, *ELI-Beamlines, Czech Republic*

The three ELI facilities are all installing and commissioning systems. The progress and current state of each project will be reported along with a look at the remaining challenges and milestones. Hvezda, ELI-Beamlines Project Manager presents a high-level view of all the ELI construction

ELI Systems Availability and the User Programme

Karoly Osvay, *ELI-ALPS, Hungary*

The Attosecond Light Pulse Source (ALPS) facility of the pan-European ELI project is designed to build a laser based research infrastructure in which light pulses of few optical cycles are generated and used for basic and applied research. Osvay, the Research Technology Director at ELI-ALPS will present an overview of the status of systems and the planned availability for each of those systems across the three facilities. He will highlight new developments, testing and technical opportunities in the coming months and years.

User Access at ELI ERIC: Opportunities for World Leading Science

Dan Stutman, *ELI-NP, Romania*

Overview of the approach to User Access at ELI ERIC. User applications and access will be managed through a single access point and will be based on the quality of proposals as evaluated by international review panels.

Panel Discussion

Panel Moderators:

Gregory Quarles, *The Optical Society, USA*

Constantin Haefner, *Lawrence Livermore National Lab, USA*

Panel Members:

Roman Hvezda, *ELI-Beamlines, Czech Republic;*

Karoly Osavay, *ELI-ALPS, Hungary*,

Carlo Rizzuto, *ELI-ERIC, Belgium*;

07:30—16:00 • Registration, *Bartholdi C*

Orangerie CDE

HILAS

08:00 -- 10:00
HT1A • High intensity lasers at average power
Presider: Eiji Takahashi; RIKEN, Japan

HT1A.1 • 08:00
Cost-Effective Pumping Source for 1 TW-class OPCPA, Paulius P. Mackonis[1], Aleksej Rodin[1,2], Augustinas Petrulenas[1]; *[1]Center for Physical Sciences and Tech., Lithuania; [2]Ekspla, Lithuania.* We report on the current development state of a compact and cost-effective pumping source configuration for 1 TW-class OPCPA containing a fiber seed laser, two-cascaded double-pass CPA based on Yb:YAG rods and a pulse compressor.

HT1A.2 • 08:15
High Power Optical Parametric Amplifier Driven by a Sub-ps Yb:Thin-Disk System, Alexander-Cornelius Heinrich[1], Jonathan Fischer[1], Dominik-Pascal Ertel[1], Alfred Leitenstorfer[1], Daniele Brida[1]; *[1]Dept. of Physics and Center for Applied Photonics, Univ. of Konstanz, Germany.* 615fs pulses with 17mJ energy at 3kHz repetition rate are generated by an Yb:thin-disk laser to pump a mJ-class near-IR OPA delivering 25fs pulses. This system targets the generation of intense THz radiation.

HT1A.3 • 08:30
Stabilization of a High-energy Optical Parametric Amplifier with High-speed Adaptive Deformable Lenses, Martino Quintavalla[4], Anna Gabriella Ciriolo[1,2], Jacopo Mocci[3], Matteo Negro[1], Michele Devetta[1], Riccardo Muradore[3], Salvatore Stagira[2], Stefano Bonora[4], Caterina Vozzi[1]; *[1]IFN-CNR, Italy; [2]Dipartimento di Fisica, Politecnico di Milano, Italy; [3]Dipartimento di Informatica, Università di Verona, Italy; [4]IFN-CNR, Italy.* We report on the first application of adaptive deformable lenses to the stabilization of a high-energy mid-IR parametric source. Fluctuations of output pulse intensity and CEP were significantly suppressed by the adaptive optics system.

HT1A.4 • 08:45 Invited
Scaling High Intensity Laser Systems from State-of-the-Art to MW Class Enabling Next Generation Light Sources, Andy J. Bayramian[1], David Alessi[1], Diana Chen[1], Kyle Chesnut[1], Alvin Erlandson[1], Thomas Galvin[1], Dan Mason[1], Hoang Nguyen[1], Margareta Rehak[1], Paul Rosso[1], Kathleen Schaffers[1], Craig Siders[1], Emily F. Sistrunk[1], Thomas Spinka[1], Constantin L. Haefner[1]; *[1]Lawrence Livermore National Lab, USA.* Evolving discovery science to deliver a continuous flux of secondary radiation for applications necessitates a new perspective on laser systems design to achieve robust operational capability at high average power.

Orangerie B

EUV & X-ray

08:00 -- 10:00
ET1B • Compact Sources I
Presider: Bob Hettel; Stanford Univ., USA

ET1B.1 • 08:00 Invited
Developments in X-ray and DUV Spectral Imaging in Heritage Science, Loic Bertrand[1]; *[1]Synchrotron SOLEIL, France.* Imaging from high-brightness sources (synchrotrons, compact Lab sources) provide new opportunities for the study of the heterogenous systems encountered in Heritage science. We will present and discuss recent studies on objects and samples from archaeology, paleontology and the arts that exemplify these exciting possibilities.

ET1B.2 • 08:30
Compact gain-saturated soft X-ray lasers down to 6.85 nm and gain down to 5.85 nm and enabling pump laser, Shoujun Wang[1], Yong Wang[1], Alex Rockwood[1], Mark Berrill[2], Vyacheslav Shlyaptsev[1], Jorge J. Rocca[1]; *[1]Colorado State Univ., USA; [2]Oak Ridge National Lab, USA.* We have extended the wavelength of compact, repetitive, gain-saturated x-ray lasers to 6.89 nm in Ni-like Gd, and observed amplification in several lower wavelength transitions down to 5.9 nm in Ni-like Dy ions.

ET1B.3 • 08:45
Compact arrangement for femtosecond laser induced generation of broadband hard x-ray pulses, Rene Nome[1], CARLOS GILES[1], Rafael Celestre[1], Kelin Tasca[1], CARLOS Dias[1], Rafael Vescovi[1], Guilherme Faria[1], Guilherme Ferbonink[1]; *[1]State Univ. of Campinas, Brazil.* We present details of compact x-ray generation setup design, construction and spatio-temporal femtosecond laser pulse characterization. We show measurements of femtosecond laser induced x-ray fluorescence spectra and time traces, together with analysis and discussion.

Orangerie A

MICS

08:00 -- 10:00
MT1C • MIR and THz Sources
Presider: Sergey Mirov; Univ. of Alabama at Birmingham, USA

MT1C.1 • 08:00 Invited
THz-wave Coherent Sources, Hiromasa Ito[1]; *[1]Center for Advanced Photonics, RIKEN, Japan.* Nonlinear optics based monochromatic THz-wave sources have superior characteristics with wide range tuning, spectral purity, and high-power capability. I will report the recent state of art achievement of THz-wave generation/ detection. Importance of nonlinear materials, and their developements are also presented.

MT1C.2 • 08:30
Frequency Comb Quantum Cascade Lasers, Olivier Landry[1], Yves Bidaux[2], Jérôme Faist[2], Stéphane Blaser[1], Tobias Gresch[1], Richard Maulini[1], Antoine Müller[1], Ilia Sergachev[1]; *[1]Alpes Lasers, Canada; [2]ETH Zürich, Switzerland.*
Optical Frequency Combs are devices emitting light on a wide spectrum consisting of equidistant peaks in frequency space. They can be used as rulers in the frequency domain for Frequency Comb Spectroscopy.

MT1C.3 • 08:45
Characterization of infrared pulses using upconversion, Laurent R. Huot[1,2], Peter Moselund[1], Peter Tidemand-Lichtenberg[2], Christian Pedersen[2]; *[1]NKT Photonics, Denmark; [2]Technical Univ. of Denmark, Denmark.* We demonstrate and discuss the advantages of a novel system performing time resolved spectral characterization of mid-infrared supercontinuum pulses using electronically synchronized delay-tuned pulsed upconversion.

Orangerie CDE

HILAS

08:00 -- 10:00
HT1A • High intensity lasers at average power - Continuing

HT1A.5 • 09:15
High flux soft X-ray source driven on Yb laser amplifier for resonant magnetic diffraction application, Guangyu Fan[1], Vincent Cardin[2], Katherine Legare[2], Edgar Kaksis[1], Giedrius Andriukaitis[1], Audrius Pugzlys[1], Tsuneto Kanai[1], Bruno Schmidt[3], Pervak Vladimir[4,5], François Légaré[2], Andrius Baltuska[1], Tadas Balciunas[1,6]; *[1]Inst. of Photonics, TU Wien, Austria; [2]Institut National de la Recherche Scientifique, Canada; [3] few-cycle, Inc, Canada; [4]Ludwig-Maximilian Universität München, Germany; [5]Ultrafast Innovations GmbH, Germany; [6]GAP -Biophotonics, Université de Genève, Switzerland.* We demonstrated high flux table-top 220eV HHG source (>10^9photons/s/1% bandwidth) driven directly by a <20fs, 10mJ, kHz Yb laser amplifier system. Resonant magnetic diffraction of Terbium N-edge at 155eV is performed first time using this soft-x-ray source.

HT1A.6 • 09:30
Multi-kW Thin-Disk Amplifiers, Catherine Teisset[1], Christoph Wandt[1], Marcel Schultze[1], Sandro Klingebiel[1], Matthias Häfner[1], Stefan Prinz[1], Sebastian Stark[1], Christian Grebing[1], Jan-Philipp Negel[2], Helge Höck[2], Michael Scharun[2], Thomas Dietz[2], Dominik Bauer[2], Aleksander Budnicki[2], Christian Stolzenburg[2], Dirk Sutter[2], Aleksander Killi[2], Thomas Metzger[1]; *[1]TRUMPF Scientific Lasers, Germany; [2]TRUMPF Laser, Germany.* We report on commercial picosecond thin-disk regenerative amplifiers with up to 200-mJ pulses and 1kW. Using a monolithic mirror array in a multipass scheme, a ns seed was scaled to 3kW. By merging both technologies and using nonlinear compression, sub-50-fs pulses are feasible at a multi-kW level.

HT1A.7 • 09:45
Pump-induced wavefront aberrations in Yb^{3+}-doped materials, Issa Tamer[1,2], Sebastian Keppler[1,2], Marco Hornung[1,2], Jörg Körner[2], Joachim Hein[1,2], Malte Kaluza[1,2]; *[1]Helmholtz-Institut Jena, Germany; [2]Inst. of Optics and Quantum Electronics, Germany.* An extensive investigation, including all contributions and relevant material parameters, on the full spatio-temporal profiles of pump-induced wavefront aberrations in Yb-doped materials is described, with an excellent agreement between simulated and experimental results.

Orangerie B

EUV & X-ray

08:00 -- 10:00
ET1B • Compact Sources I - Continuing

ET1B.4 • 09:00
Towards Millijoule Narrowband Terahertz Generation Using Chirp-and-Delay in Periodically Poled Lithium Niobate, Spencer W. Jolly[1,2], Frederike Ahr[3,4], Nicholas Matlis[3], Vincent Leroux[1,2], Timo Eichner[1], Koustuban Ravi[5], Hideki Ishizuki[6], Takunori Taira[6], Franz X. Kaertner[3,4], Andreas Maier[1]; *[1]CFEL and Univ. of Hamburg, Germany; [2]ELI - Beamlines, Czechia; [3]DESY and CFEL, Germany; [4]Dept. of Physics, Univ. of Hamburg, Germany; [5]RLE, MIT, USA; [6]Inst. for Molecular Sciences, National Inst. of Natural Science, Japan.* We show improvement of narrowband terahertz generation in periodically poled lithium niobate crystals using chirped-and-delayed pulses from a high energy laser. THz pulses of combined energy above 0.5 mJ at 0.361 THz are generated.

ET1B.5 • 09:15
LUX – A Plasma-Driven Undulator Beamline, Andreas R. Maier[1], Niels Delbos[1], Irene Dornmair[1], Timo Eichner[1], Björn Hubert[1], Lars Hübner[1], Sören Jalas[1], Spencer W. Jolly[1,2], Manuel Kirchen[1], Vincent Leroux[1,2], Sebastian Mahncke[1], Philipp Messner[1], Matthias Schnepp[1], Maximilian Trunk[1], Paul A. Walker[1,3], Christian Werle[1], Paul Winkler[3,1]; *[1]Univ. of Hamburg, Germany; [2]ELI Beamlines, Czechia; [3]DESY, Germany.* We present experimental results from the LUX Beamline, that recently generated first X-rays at few-nm wavelength from a plasma-driven undulator. We report on stable laser and beamline operation and discuss first experiments.

ET1B.6 • 09:30
High photon flux XUV source driven by high repetition rate > 100 kHz fiber laser, Aura I. Gonzalez[1,4], Loïc Lavenu[1,3], Florent Guichard[3], Yoann Zaouter[3], Patric Georges[1], Marc Hanna[1], Thierry Ruchon[2]; *[1]Laboratoire Charles Fabry, Institut d'Optique Graduate School, France; [2]LIDYL, CEA, CNRS, Unversité Paris-Saclay, France; [3]Amplitude Systemes, France; [4]Amplitude Technologies, France.* We report on the advantage of Yb-lasers at high repetition rate (>100kHz) to drive a XUV source based on HHG. We discuss the optimization of XUV parameters respect to the driving laser post-compression (down to-14fs).

ET1B.7 • 09:45
Commissioning and Initial Experiments of an EUV Capillary Discharge Laser, Sarah A. Wilson[1], Greg Tallents[1]; *[1]York Plasma Inst., UK.* The commissioning and initial experiments with an extreme ultra-violet (EUV) capillary discharge laser (46.9nm) are presented. We investigate the reflectivity and focusability of gold mirrors at 46.9nm and the ability of the EUV laser to ablate solid targets.

Orangerie A

MICS

08:00 -- 10:00
MT1C • MIR and THz Sources - Continuing

MT1C.4 • 09:00
Temperature- and Current-dependent Repetition Frequency of a 2 µm InGaSb/AlGaAsSb Mode-locked Quantum Well Laser, Xiang Li[1], Hong Wang[1], Zhongliang Qiao[1], Xin Guo[1], Wanjun Wang[1], Geok Ing Ng[1], Chongyang Liu[2]; *[1]School of Electrical and Electronic Engineering, Nanyang Tech. Univ., Singapore; [2]Temasek Labs, Nanyang Tech. Univ., Singapore.* Mode locking is achieved in a 2 µm monolithic GaSb-based laser. The repetition frequency of the laser, as a function of temperature and injection current, is investigated. The reasons for the frequency tuning are discussed.

MT1C.5 • 09:15
Characteristic Temperature of a 2 µm InGaSb/AlGaAsSb Mode-locked Quantum Well Laser, Xiang Li[1], Hong Wang[1], Zhongliang Qiao[1], Xin Guo[1], Wanjun Wang[1], Geok Ing Ng[1], Chongyang Liu[2]; *[1]School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore; [2]Temasek Labs, Nanyang Technological Univ. , Singapore.* Mode locking is achieved in a 2 µm GaSb-based laser up to 60 °C. The laser has a T_0 of ~82 K at room temperature, and the absorber bias voltage has little effect on T_0.

MT1C.6 • 09:30
High power Y-branch MOPA-system with 9.7 nm wavelength tunability for IR up-conversion detection, Mahmoud Tawfieq[1], André Müller[1], Jörg Fricke[1], Pietro Della Casa[1], Peter Ressel[1], Arnim Ginolas[1], David Feise[1], Bernd Sumpf[1], Günther Tränkle[1]; *[1]Ferdinand-Braun-Institut, Germany.* A high power widely tunable master oscillator power amplifier (MOPA) laser system will be presented, which will serve as a single pass pump source for IR up-conversion detection and hyperspectral imaging.

MT1C.7 • 09:45
Tunable 2.4 – 4.4 µm coherent pulse source for seeding OPCPA, Scott Domingue[1], David G. Winters[1], Matthew Kirchner[1], Sterling Backus[1,2], Seth Cousin[1,3], Henry Kapteyn[1,3]; *[1]Kapteyn-Murnane Labs, USA; [2]Electrical and Computer Engineering, Colorado State Univ., USA; [3]JILA and Dept. of Physics, Univ. of Colorado, USA.* We present a monolithic, ultrafast, mid -infrared laser designed specifically for seeding an optical parametric chirped pulse amplifier. The compact laser system output nearly transform-limited pulses with MW class peak powers at repetition rates of ≥1MHz.

10:00—10:30 • Coffee Break with Exhibitors, *Foyer Orangerie*

Orangerie CDE

HILAS

10:30 -- 12:30
HT2A • Relativistic Intensity generation and experiments
Presider: Giuseppe Sansone; Albert-Ludwigs-Universität Freiburg, Germany

HT2A.1 • 10:30
Sub-5-fs laser-driven nanophotonics in the relativistic intensity regime, Laszlo Veisz[2,1], Daniel Cardenas[1,4], Laura Di Lucchio[3], Tobias Ostermayr[1,4], Luisa Hofmann[1,4], Matthias Kling[1,4], Jörg Schreiber[1,4], Paul Gibbon[3,5]; *[1]Max-Planck-Institut fur Quantenoptik, Sweden; Umea Univ., Sweden; [3]Inst. for Advanced Simulation, Forschungszentrum Jülich GmbH, Germany; [4]Ludwig-Maximilian-Universität München, Germany; KU Leuven, Belgium.* We investigated the interaction of nanometric tungsten targets with ultra-relativistic-intensity sub-5-fs laser pulses. Electrons accelerated to multi-MeV energy with electric fields exceeding the TV/m range and dependence on the laser waveform (carrier-envelope phase) were observed.

HT2A.2 • 10:45
Time resolved dynamics of sub-micron liquid sheet interaction with a relativistic intensity kHz laser, Enam Chowdhury[2,3], John Morrison[1], Kyle Frische[1], Scott Feister[4], Joseph Smith[2], Chris Orban[2], William Roquemore[5]; *[1]Innovative Scientific Solutions, Inc., USA; [2]Physics, The Ohio State Univ., USA; [3]Intense Energy Solutions LLC, USA; [4]Flash Center, Univ. of Chicago, USA; [5]Aerospace Systems Directorate, Air Force Research Lab, USA.* Time resolved dynamics of a sub-micron liquid sheet interacting with a 10^{19} Wcm^{-2} kHz laser focus at 780 nm wavelength, accelerating MeV electrons and protons, was captured using shadowgraphy with synchronized 80 fs pulses.

HT2A.3 • 11:00
Relativistic-Intensity Near-Single-Cycle KHz Laser Driver, Marie Ouillé[1], Frederik Boehle[1], Maxence Thévenet[5], Maimouna Bocoum[1], Aline Vernier[1], Magali Lozano[1], Jean-Philippe Rousseau[1], Aurélie Jullien[1], Stefan Haessler[1], Mate Kovacs[4], Peter Simon[3], Tamas Nagy[6,2], Rodrigo B. Lopez-Martens[1]; *[1]Laboratoire d'Optique Appliquée, France; [2]Laser Zentrum , Germany; [3]Laser-Laboratorium Gottingen, Germany; [4]ELI Attosecond Light Pulse Source, Hungary; [5]Lawrence Berkeley National Lab, USA; [6]Institut für Quantenoptik, Germany.* We generate high-temporal-contrast, CEP-stable, 1.3-optical-cycle laser pulses with TW peak power at 1 kHz, which are then used to drive relativistic attosecond surface-plasma dynamics.

Invited

HT2A.4 • 11:15
Coherent Pulse Stacking Amplification – An Enabling Pathway Towards Fiber Based Multi-TW Peak Power Sources, Almantas Galvanauskas[1]; *[1]Univ. of Michigan, USA.* Abstract not provided.

Orangerie B

EUV & X-ray

10:30 -- 12:30
ET2B • Applications in Imaging
Presider: Hans Hertz; Kungliga Tekniska Hogskolan, Sweden

Invited

ET2B.1 • 10:30
Nanoscale chemical imaging by extreme ultraviolet laser ablation time of flight spectrometry, Carmen S. Menoni[1]; *[1]Colorado State Univ., USA.* Elemental composition imaging in inorganic solids with a spatial resolution of 80 nm and actinide trace analysis by extreme ultraviolet laser ablation time-of-flight mass spectrometry are demonstrated.

Invited

ET2B.2 • 11:00
Sub-wavelength Resolution, Wide Field-Of-View, and Quantitative 13nm Imaging in Reflection and Transmission with a Tabletop High Harmonic Source, Christina Porter[1], Michael Tanksalvala[1], Dennis Gardner[1], Giulia Mancini[1], Michael Gerrity[1], Galen Miley[2], Xiaoshi Zhang[3], Naoto Horiguchi[4], Elisabeth Shanblatt[1], Benjamin Galloway[1], Yuka Esashi[1], Charles Bevis[1], Robert Karl[1], Peter Johnson[1], Daniel Adams[1], Henry Kapteyn[1,3], Margaret Murnane[1,3]; *[1]Univ. of Colorado at Boulder, USA; [2]Chemistry, Northwestern Univ. , USA; [3]KMLabs, USA; [4]imec, Belgium.* We demonstrate high-resolution and wide field-of-view imaging using tabletop 13nm HHG sources in transmission and reflection. Additionally, we present preliminary simulations and results of complex 13nm imaging reflectometry allowing highly-sensitive, non-destructive 3D composition determination.

Orangerie A

MICS

10:30 -- 12:30
MT2C • Nonlinear Optical Materials and Structures for Mid-IR
Presider: Delphine Marris-Morini; Univ. de Paris-Sud, France

MT2C.1 • 10:30
Magnitude of the nonlinear coefficients of the monoclinic crystal $BaGa_4Se_7$, Benoit Boulanger[2,1], Feng Guo[1,2], Patricia Segonds[2,1], Jerome Debray[1], Valeriy Badikov[3], Vladimir Panyutin[3], Dmitrii Badikov[3], Valentin Petrov[4]; *[1]Neel Inst., France; [2]Univ. Grenoble Alpes, France; [3]Kuban State Univ., Russia; [4]Max-Born-Inst., Germany.* We report the magnitude of the quadratic nonlinear coefficients of the monoclinic crystal $BaGa_4Se_7$ from the study of second-harmonic generation using a tunable fundamental beam in slabs kept fixed at normal incidence.

MT2C.2 • 10:45
Refined Sellmeier equations up to the near-infrared in the organic N-benzyl-2-methyl-4-nitroaniline (BNA) crystal, Benoit Boulanger[2], Cyril Bernerd[1], Jerome Debray[2,1], Takashi Takashi Notake[3], Mio Koyama[3], Hiroaki Minamide[3], Hiromasa Ito[3], Patricia Segonds[2,1]; *[1]Neel Inst., France; [2]Univ. Grenoble Alpes, France; [3]RIKEN, Japan.* We directly measured phase-matching second-harmonic and sum-frequency generation conditions and refined the Sellmeier equations of BNA up to the near-infrared. We improved the calculated phase-matching curve for THz emission from difference-frequency generation.

MT2C.3 • 11:00
Large mode area low-loss orientation-patterned GaAs waveguides for frequency conversion to the mid-infrared, Arnaud Grisard[1], Myriam Bailly[1], Eric Lallier[1], Bruno Gérard[2]; *[1]Thales Research & Technology, France; [2]III-V Lab, France.* We designed and fabricated low loss orientation-patterned gallium arsenide waveguides suited to versatile frequency conversion from fiber lasers to the mid-wave and long-wave infrared.

MT2C.4 • 11:15
Femtosecond nonlinear interactions in the Langatate LGT: Characterization of a new middle infrared nonlinear crystal., Elodie Boursier[1,2], Giedre M. Archipovaite[1], Jean-Christophe M. Delagnes[1], Stéphane Petit[1], Guilmot Ernotte[5], Philippe Lassonde[5], Patricia Segonds[2,4], Benoit Boulanger[2,4], Yannick Petit[1], François Légaré[5], Dmitry Roshchupkin[3], Eric Cormier[1]; *[1]Univ Bordeaux, France; [2]Institut Neel, France; [3]Inst. of Microelectronics Tech., Russian Academy of Sciences, Russia; [4]Université Grenoble Alpes, France; [5]INRS, INF, ALLS, Canada.* We measured broad tunable spectra between 1.4 and 4.7 µm in the nonlinear crystal $La_3Ga_{5.5}Ta_{0.5}O_{14}$ (LGT). They were generated in the femtosecond regime from phase-matched difference frequency generation and optical parametric amplification.

Orangerie CDE — HILAS

10:30 -- 12:30
HT2A • Relativistic Intensity generation and experiments - Continuing

HT2A.5 • 11:45
Self-Filtering and Small-Scale Self-Focusing Suppression of High-Intensity Laser Beams, Efim A. Khazanov[1], Valdislav Ginzburg[1], Anton A. Kochetkov[1]; [1]*Inst. of Applied Physics, Russia.* The experimental study based on direct and indirect measurements of spatial noise gain of intense radiation propagating in a glass plate confirms that free space run acts as a spatial filter and leads to small-scale self-focusing suppression.

HT2A.6 • 12:00
Wavefront Degradation of a 200 TW Laser from Heat-Induced Deformation of In-Vacuum Compressor Gratings, Vincent Leroux[1,2], Spencer W. Jolly[1,2], Matthias Schnepp[1], Timo Eichner[1], Sören Jalas[1], Manuel Kirchen[1], Philipp Messner[1], Christian Werle[1], Paul Winkler[1], Andreas R. Maier[1]; [1]*Center for Free-Electron Laser Science and Dept. of Physics, Univ. of Hamburg, Germany;* [2]*Institue of Physics of the ASCR, ELI-Beamlines project, Czechia.* We report laser wavefront degradation of a 200 TW laser from heat absorbed by the in-vacuum compressor gratings. Systematically scanning laser energy and rep-rate, we define an average power limit for keeping an undisturbed wavefront.

HT2A.7 • 12:15
4PW laser beam interaction with near-critical density plasma and study of astrophysical phenomena in Lab, Bo Ram Lee[1]; [1]*Inst. for Basic Science, South Korea.* High power laser beam of 4 PW is focused onto a near-critical density plasma and the light-matter interaction as well as its physical mechanism is studied.

Orangerie B — EUV & X-ray

10:30 -- 12:30
ET2B • Applications in Imaging - Continuing

ET2B.3 • 11:30
MetalJet Technology for High-End Diffraction and Imaging Techniques, Emil Espes[1], Björn A. Hansson[1], Julius Hållstedt[1], Daniel H. Larsson[1], Ulf Lundström[1], Mikael Otendal[1], Andrii Sofiienko[1], Björn Sundman[1], Tomi Tuohimaa[1], Per Takman[1]; [1]*Excillum AB, Sweden.* X-ray analysis/metrology rely heavily on the x-ray source brightness for resolution/exposure-time. Traditional x-ray tubes are limited by when the e-beam power-density melts the anode. The MetalJet overcomes this limitation by using a liquid anode.

ET2B.4 • 11:45
Optimisation of Compact Laser Driven Accelerator X-ray Sources for Industrial Imaging Applications, Daniel Symes[1], Ceri Brenner[1], Dean Rusby[1], Chris Armstrong[1], Chris Thornton[1], Nicolas Bourgeois[1], Yiftach Katzir[1], Chris Gregory[1], David Neely[1], Rajeev Pattathil[1], Ric Allott[1], Jonathan Wood[2], Nelson Lopes[2,3], Jan-Niclas Gruse[2], Jason Cole[2], Stuart Mangles[2], Zulfikar Najmudin[2], Chris Murphy[4], Chris Baird[4], Chris Underwood[4], Matthew Streeter[5], Silvia Cipiccia[6]; [1]*STFC Rutherford Appleton Lab, UK;* [2]*John Adams Inst. for Accelerator Science, Imperial College London, UK;* [3]*GoLP, IPFN, Instituto Superior Tecnico, Portugal;* [4]*Univ. of York, UK;* [5]*Lancaster Univ., UK;* [6]*Diamond Light Source, UK.* Compact laser-driven electron accelerators can produce coherent x-ray beams with high brightness, small source-size and femtosecond duration. We will discuss the suitability of these sources to address challenges in industrial imaging.

ET2B.5 • 12:00
Ptychographic Coherent Diffractive Imaging using High Photon Flux Table-top XUV Sources, Getnet K. Tadesse[2,1], Wilhelm Eschen[1], Robert Klas[2,1], Maxim Tschernajew[1], Frederik Tuitje[3], Christian Spielmann[2,3], Andreas Tünnermann[1,4], Jens Limpert[1,2], Jan Rothhardt[2,1]; [1]*Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany;* [2]*Helmholtz Inst. Jena, Germany;* [3]*Inst. of Optics and Quantum Electronics, Friedrich-Schiller-Univ. Jena, Germany;* [4]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We present a table-top coherent imaging setup at 18 nm that achieves resolution close to one-wavelength in an extended field of view. A Siemens-star pattern is used as an ultimate resolution test on non-periodic

ET2B.6 • 12:15
Full-Field Functional Imaging of Acoustic Waves Using Tabletop High Harmonics, Robert M. Karl[1], Giulia Mancini[1], Dennis Gardner[1], Elisabeth Shanblatt[1], Joshua Knobloch[1], Travis Frazer[1], Jorge N. Hernandez-Charpak[1], Begoña Abad Mayor[1], Michael Tanksalvala[1], Christina Porter[1], Daniel Adams[1], Henry Kapteyn[1], Margaret Murnane[1]; [1]*Univ. of Colorado at Boulder JILA, USA.* We report the first stroboscopic full-field EUV microscope using high harmonics. Specifically, we demonstrate nanoscale movies of acoustic wave propagation in nanostructures with ≈0.1nm axial resolution, 90nm lateral resolution, and 10fs time resolution.

Orangerie A — MICS

10:30 -- 12:30
MT2C • Nonlinear Optical Materials and Structures for Mid-IR - Continuing

MT2C.5 • 11:30
Angular Quasi-Phase-Matching in a Sphere of PPRKTP, Dazhi Lu[1], Alexandra Pena[1], Patricia Segonds[2], Jerome Debray[1], Andrius Zukauskas[3], Fredrik Laurell[3], Valdas Pasiskevicius[3], Carlota Canalias[3], Benoit Boulanger[2,1]; [1]*Neel Inst., France;* [2]*Universte Grenoble Alpes, France;* [3]*KTH, Sweden.* We report the first measurements of angular quasi-phase-matching directions of second-harmonic generation performed in the periodically-poled Rb-doped $KTiOPO_4$ biaxial crystal cut as a sphere.

MT2C.6 • 11:45
Chalcogenide Based Active and Passive Devices for Mid-IR Applications, Brandon Shaw[1], Rafael Gattass[1], Jesse Frantz[1], Jason Myers[1], Christopher Spillmann[1], Jawad Naciri[1], Woohong Kim[1], Shyam Bayya[1], Dan Rhonehouse[1], Lynda Busse[1], Kevin Major[1], Ken Ewing[1], Dan Gibson[1], Vinh Nguyen[1], Robel Bekele[2], Jakub Kolacz[3], Henry Gotjen[1], Rajesh Thapa[2], Fred Kung[4], Jason Auxier[1], Jas Sanghera[1]; [1]*US Naval Research Lab, USA;* [2]*Sotera Defense Solutions, USA;* [3]*ASEE, USA;* [4]*Univ. Research Foundation, USA.* We report on progress in development of chalcogenide based fiber and waveguide active and passive devices for routing, switching, and modulation of mid-IR sources for mid-IR applications. Optical performance of the devices will be reported.

MT2C.7 • 12:00
Horizontal Gradient Freeze Growth of Barium Thio- and Selleno-gallates for Mid-Infrared Frequency Conversion, Peter G. Schunemann[1], Kevin Zawilski[1]; [1]*BAE Systems Inc., USA.* We report extremely favorable HGF growth of high-optical quality barium thiogallate ($BaGa_4S_7$) and barium sellenogallate ($BaGa_4Se_7$): two recently reported nonlinear optical crystals with notably wide band gaps, deep infrared transparency, and moderately high nonlinear coefficients.

MT2C.8 • 12:15
Coherent Supercontinuum Generation in a Silicon-Germanium Waveguide in the Mid Infrared, Milan Sinobad[2,1], Christelle Monat[2], Barry Luther-Davies[3], Pan Ma[3], Stephen Madden[3], David J. Moss[4], Arnan Mitchell[1], Regis Orobtchouk[2], Alberto Della Torre[2], Salim Boutami[5], Jean-Michel Hartmann[5], Jean-Marc Fedeli[5], Christian Grillet[2]; [1]*RMIT Univ., France;* [2]*Lyon Inst. of Nanotechnology, France;* [3]*Australian National Univ., Australia;* [4]*Swinburne Univ. of Tech, Australia;* [5]*CEA-Leti, France.* We report high brightness coherent supercontinuum extending from 2.8 to 5.0µm in an air cladded Si0.6Ge0.4/Si waveguide with all-normal dispersion. Dispersion engineering and low propagation loss allowed us to achieve supercontinuum with 5mW on-chip power.

12:30—14:00 • Lunch on your own

Orangerie CDE

HILAS

14:00 -- 16:00
HT3A • Ultrafast and Parametric Amplifiers
Presider: Gunter Steinmeyer; Max Born Inst., Germany

HT3A.1 • 14:00
Scalable Concepts for THz Generation by Tilted-Pulse-Front Pumping, Jozsef A. Fulop[1,3], László Pálfalvi[2], Gyorgy Toth[1], Gyula Polónyi[2,1], Balázs Monoszlai[3], Levente Tokodi[2], Gábor Almási[2], János Hebling[2,1]; *[1]MTA TKI, Hungary; [2]Univ. of Pécs, Hungary; [3]ELI-ALPS, Hungary.* A monolithic contact-grating semiconductor source and a hybrid $LiNbO_3$ stair-step echelon are presented for efficient THz pulse generation by optical rectification. They enable excellent focusability of the THz beams and are scalable to mJ-level THz pulse energies.

HT3A.2 • 14:15
Wavelength-Independent Coherence Cleaning by Parametric Plasma Amplification, Matthew Edwards[1], Kenan Qu[1], Julia Mikhailova[1], Nathaniel Fisch[1]; *[1]Princeton Univ., USA.* Although incoherence generally suppresses stimulated scattering processes in plasma, we show that this requirement relaxes for parametric amplification in the pump-depletion regime, including for x rays, providing a compact wavelength-independent source of high-peak-power radiation.

HT3A.3 • 14:30
High Conversion Efficiency Optical Parametric Amplifiers for SG-II 5PW Laser System, Xinglong Xie[1], Jianqiang Zhu[1], Meizhi Sun[1], Jun Kang[1], Haidong Zhu[1], Qingwei Yang[1], Ailin Guo[1], Ping Zhu[1], Qi Gao[1], Xiao Liang[1], Shunhua Yang[1]; *[1]SIOM,China, China.* By optimization, the first two OPCPA amplifiers of SGII 5PW laser have reached the conversion efficiency of 42.8% and 41.9% respectively. These are the highest values among the ever reported OPCPA laser systems.

HT3A.4 • 14:45
Tailored Light for Laser Material Processing: Example Applications, Olivier J. Allegre[1]; *[1]Univ. of Manchester, UK.* This paper presents methods to produce tailored light fields in the focal region of ultrashort-pulse lasers. As a proof of concept, various vector field landscapes are generated such as radial polarization, vortices, Bessel or tailored Fresnel beams and used for laser material processing.

Orangerie B

EUV & X-ray

14:00 -- 15:45
ET3B • EUV Lithography and Semiconductor Manufacturing 1
Presider: Donald Smith; Energetiq, USA

ET3B.1 • 14:00 Keynote
Laser Produced Plasma EUV Sources for Lithography: Technology, Performance and Prospects, Igor Fomenkov[1]; *[1]ASML US LP, USA.* Laser produced plasma extreme-ultraviolet sources at 250 W power, integrated with ASML's NXE:3400B scanners enable high volume manufacturing EUV Lithography. We'll provide an overview of key technologies and performance data of the sources, and describe prospects of power scaling towards 500W.

ET3B.2 • 14:30 Invited
Challenges to realize EUV-FEL high power light source exceeding 10 kW by ERL accelerator technology, Hiroshi Kawata[1], Eiji Kako[1], Kensei Umemori[1], Hiroshi Sakai[1], Norio Nakamura[1], Ryukou Kato[1], Tsukasa Miyajima[1]; *[1]High Energy Accelerator Research Org., Japan.* A high power EUV-FEL light source based on an Energy Recoveryl Linac (ERL) is one of the most promisinglight sources for future lithography. Several feasibility studies and challenges will be presented.

Orangerie A

MICS

14:00 -- 16:00
MT3C • Spectroscopy, Microscopy and Biophotonics
Presider: Irina Sorokina; Norges Teknisk Naturvitenskapelige Univ., Norway

MT3C.1 • 14:00
Detection of isotopic $^{12}CH_4$ and $^{13}CH_4$ using cavity ring -down spectroscopy coupled with an external-cavity quantum cascade laser, Mithun Pal[1], Abhijit Maity[1], Sanchi Maithani[1], Manik Pradhan[1]; *[1]CBMS, S N Bose National Centre for Basic Sciences, India.* We developed a mid-infrared continuous-wave cavity ring-down spectroscopy technique coupled with an external-cavity mode-hop-free quantum cascade laser working at 7.5 µm. We, subsequently, tested the system by measuring $^{12}CH_4$ and $^{13}CH_4$ isotopes of methane (CH_4).

MT3C.2 • 14:15
Application of Quantum Cascade Laser Absorption Spectroscopy for Correlation Studies in Plasma Etching Processes in the Semiconductor Industry, Norbert Lang[1], Sven Zimmermann[2], Henrik Zimmermann[1], Uwe Macherius[1], Benjamin Uhlig[3], Matthias Schaller[4], Stefan S. Schulz[5], Jürgen Röpcke[1], Jean-Pierre H. van Helden[1]; *[1]Leibniz Inst. for Plasma Science and Tech., Germany; [2]Chemnitz Univ. of Tech., Germany; [3]Center Nanoelectronics Tech., Fraunhofer IPMS, Germany; [4]Globalfoundries Dresden Module Two, Germany; [5]Fraunhofer Inst. for Electronic Nano Systems, Germany.* Applying quantum cascade laser absorption spectroscopy a correlation could be demonstrated between the concentration of the etching products SiF_4 and CO and the etching rate of porous SiCOH in a low-pressure rf plasma containing CF_4.

MT3C.3 • 14:30
Human Breath Acetone Analysis by Mid-IR Laser Spectroscopy: Development and Application, Bela Tuzson[1], Herbert Looser[2], Ferdinand Felder[3], Fabian Bovey[4], Luc Tappy[4], Lukas Emmenegger[1]; *[1]Empa, Switzerland; [2]FHNW, Switzerland; [3]Camlin Technologies Ltd., Switzerland; [4]Université de Lausanne, Switzerland.* A broadly tunable mid-IR VECSEL based spectrometer is developed and used in a pilot clinical study to investigate the correlation between exhaled acetone concentration and negative energy balance induced by lifestyle interventions.

MT3C.4 • 14:45
Intracavity Gas Detection with an extended-cavity Quantum Cascade Laser emitting @ 7.6 µm, Laurent Bizet[1], Raphael Vallon[1], Bertrand Parvitte[1], Gregory Maisons[2], Mathieu Carras[2], Virginie Zeninari[1]; *[1]GSMA, France; [2]MirSense, France.* We report the development of an extended-cavity quantum cascade laser emitting in the mid-infrared region and its use to the detectorless intracavity detection of atmospheric molecules such as methane and water vapor.

Orangerie CDE

HILAS

14:00 -- 16:00
HT3A • Ultrafast and Parametric Amplifiers - Continuing

HT3A.5 • 15:00
Frequency resolved measurement of population inversion induced refractive index changes in Ti:Sapphire, Roland Nagymihály[1], Huabao Cao[1], Peter Jojart[1], Viktor Zuba[2], Mikhail Kalashnikov[1,3], Adam Borzsonyi[1], Vladimir Chvykov[1], Karoly Osvay[1]; [1]*ELI-HU Non-Profit Ltd., Hungary;* [2]*Dept. of Optics and Quantum Electronics, Univ. of Szeged, Hungary;* [3]*Max Born Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany.* Inversion induced refractive index changes have been experimentally investigated for broad spectral range along the two axes of Ti:Sapphire. Results are crucial for understanding and management of CEP stabilization and compression of few cycle pulses.

HT3A.6 • 15:15
Few-tens-mJ, few-cycle mid-infrared pulses from $MgO:LiNbO_3$ dual-chirped optical parametric amplification, Yuxi Fu[1], Bing Xue[1], Kotaro Nishimura[1,2], Akira Suda[2], Katsumi Midorikawa[1], Eiji J. Takahashi[1]; [1]*RIKEN Center for Advanced Photonics, RIKEN, Japan;* [2]*Tokyo Univ. of Science, Japan.* We demonstrate 3.3 µm mid-infrared pulses operating at 10 Hz with 29 mJ and 73 fs pulse duration using a dual-chirped optical parametric amplification (DC-OPA) scheme. We will further increase the pump pulse energy for DC-OPA to obtain a TW-class mid-infrared laser pulse.

HT3A.7 • 15:30
Strong Field Laser Induced Surface Structuring in Mid-IR Wavelengths, Enam Chowdhury[1], Noah Talisa[1], Kevin Werner[1], Shler Irani[1], Drake Austin[1]; [1]*Physics, The Ohio State Univ., USA.* Strong field mid-IR laser (l = 2 – 4.2 µm, Dt = 100-200 fs) surface interactions were studied in Si, Ge, ZnSe, InSb. Periodic surface structures and features with sizes down to < l/40 were observed.

HT3A.8 • 15:45
260-mJ Ho:YLF pump for a 7-µm OPCPA, Ugaitz E. Etxano[1], Tsuneto Kanai[1], Daniel Sánchez[1], Kevin Zawilski[2], Peter G. Schunemann[2], Olivier Chalus[3], Guillaume Matras[3], Christophe Simon-Boisson[3], Jens Biegert[1]; [1]*Instutut de Ciencies Fotoniques. ICFO, Spain;* [2]*BAE Systems, USA;* [3]*THALES Optronique, France.* We report on the generation of 260-mJ pulses at 2 µm wavelength from a Ho:YLF MOPA system for pumping a millijoule-class 7-µm OPCPA.

Orangerie B

EUV & X-ray

14:00 -- 15:45
ET3B • EUV Lithography and Semiconductor Manufacturing 1 - Continuing

ET3B.3 • 15:00
Withdrawn

ET3B.4 • 15:15
Physics of Laser-Produced Plasma Sources of Extreme Ultraviolet Radiation, Oscar Versolato[1], Dmitry Kurilovich[1,2], Francesco Torretti[1,2], Ruben Schupp[1,2], Joris Scheers[1,2], Mart Johan Deuzeman[1,3], Alex Bayerle[1], Ronnie Hoekstra[1,3], Wim Ubachs[1,2]; [1]*ARCNL, Netherlands;* [2]*Physics and Astronomy, Vrije Universiteit Amsterdam, Netherlands;* [3]*Zernike Inst. for Advanced Materials, Univ. of Groningen, Netherlands.* Laser-produced tin plasmas are used for the generation of extreme ultraviolet light for nanolithography. We use an extensive diagnostic toolset to characterize and understand the physics of these plasma light sources at the atomic level.

ET3B.5 • 15:30
A Compact High-Brightness Accelerator-based EUV Source for Actinic Mask Inspection, Terence Garvey[1], Yasin Ekinci[1], Leonid Rivkin[1], Andreas Streun[1], Albin Wrulich[1]; [1]*Paul Scherrer Inst., Switzerland.*
The design of a compact electron storage ring for the production of high-brightness EUV radiation is presented. Such a source has potentially important metrology applications in the semiconductor industry.

Orangerie A

MICS

14:00 -- 16:00
MT3C • Spectroscopy, Microscopy and Biophotonics -
Continuing

MT3C.5 • 15:00
Recent Advances in Macro ATR-FTIR Microspectroscopic Technique for High Resolution Surface Characterisation at Australian Synchrotron IR Beamline, Jitraporn Vongsvivut[1], Vi Khanh Truong[2], Nishar Hameed[2], David A. Beattie[3], Marta Krasowska[3], Sally Gras[4], Gregory S. Watson[5], Jolanta A. Watson[5], David Perez-Guaita[6], Philip Heraud[6], Bayden R. Wood[6], Junko Morikawa[7], Saulius Juodkazis[2], Elena P. Ivanova[2], Mark J. Tobin[1]; [1]*Infrared Microspectroscopy (IRM) Beamline, Australian Synchrotron, Australia; Swinburne Univ. of Tech., Australia;* [3]*Univ. of South Australia, Australia;* [4]*ARC Dairy Innovation Hub, Univ. of Melbourne, Australia;* [5]*Univ. of the Sunshine Coast, Australia;* [6]*Centre for Biospectroscopy, Monash Univ., Australia; Tokyo Inst. of Tech., Japan.* This work presents advances in surface characterisation achieved using in-house developed synchrotron macro ATR-FTIR microspectroscopic devices at Australian Synchrotron. Successful applications include single fibres, surface coatings, food and biomedical sciences as well as zoology and entomology.

MT3C.6 • 15:15
Enhanced off-axis integrated cavity output spectroscopy using optical reinjection in the mid-IR wavelength region, Faisal Nadeem[1], Julien mandon[1], Simona Cristescu[1], Frans Harren[1]; [1]*Radboud Univ., Netherlands.* A novel approach to enhance the signal-to-noise ratio in off-axis integrated cavity output spectroscopy, centered around 8µm is demonstrated. This work exhibits cavity-enhanced spectroscopy using a compact size, with absorption sensitivity comparable to longer absorption cells.

MT3C.7 • 15:30
Label-free, Chemically Selective Mid-Infrared (MIR) Microscopy for Targeted Therapy, Rabah Mouras[3], Aladin Mani[3], Enrico Bagnoli[1], Tewfik Soulimane[2], Christophe Silien[3], Syed A. Tofail[3]; [1]*CURAM, Univresity of Galway, Ireland;* [2]*Chemical sciences, Bernal Inst., Univ. of Limerick, Ireland;* [3]*Dept. of Physics, Bernal Inst., Univ. of Limerick, Ireland.* A bench-top confocal microscope employing a fast mid-infrared laser has been developed and used to monitor in a label-free manner the uptake of biologically-compatible drug polyelectrolyte capsules containing anticancer drug by MCF-7 breast cancer cells.

MT3C.8 • 15:45
Advances in Mid-Infrared Spectroscopic Imaging for Analysis of Breast Cancer Associated Microcalcifications, Pascaline Bouzy[1], Yu-Pei Tseng[2], Christian Pedersen[2], Peter Tidemand-Lichtenberg[2], Palombo Francesca[1], Nick Stone[1]; [1]*Univ. of Exeter, UK;* [2]*Fotonik, DTU, Technical Univ. of Denmark, Denmark.* Microcalcifications are an important hallmark of breast cancer and their composition correlates with the degree of pathology. This study used mid-infrared spectroscopic imaging to assess the chemical composition of breast microcalcifications to aid disease diagnosis.

16:15 -- 17:15
JT4A • Postdeadline Papers

JT4A.1 • 16:15
Pulse Duration Artifact in Linear Autocorrelation Measurements of Partially Coherent XUV Sources, Annie Klisnick[1,2], Andréa Le Marec[1,2], Olivier Larroche[3]; *[1]ISMO, CNRS, France; [2]Université Paris-Sud, Université Paris-Saclay, France; [3]DAM/DIF, CEA, France.* We present a quantitative analysis and interpretation of the presence of shoulder features at delays larger than the coherence time in the linear autocorrelation traces of partially coherent, ultrashort pulse laser sources.

JT4A.2 • 16:27
Cavitation-induced expansion dynamics of tin microdroplet target in EUV light sources, Dmitry Kurilovich[1,2], Tiago Pinto[1,2], Ruben Schupp[1], Francesco Torretti[1,2], Joris Scheers[1,2], Aneta Stodolna[1,2], Kjeld S. Eikema[1,2], Stefan Witte[1,2], Wim Ubachs[1,2], Ronnie Hoekstra[1,3], Oscar Versolato[1]; *[1]ARCNL, Netherlands; [2]Department of Physics and Astronomy, VU Amsterdam, Netherlands; [3]Zernike Institute for Advanced Materials, University of Groningen, Netherlands.* Laser-induced cavitation in tin microdroplets can be used to obtain optimized laser targets in EUV sources for nanolithography. We present our experimental analysis of microdroplet expansion and find good agreement with a fluid dynamics model.

JT4A.3 • 16:39
THz Pulse Generation by Relativistic Plasmas, Jeremy Dechard[1], Arnaud Debayle[1], Xavier Davoine[1], Laurent Gremillet[1], Luc Bergé[1]; *[1]CEA-DAM, DIF, France.* Terahertz generation by underdense relativistic plasmas created by two-color laser pulses are investigated. PIC simulations shows that transverse photocurrents is dominated by coherent transition radiation. The later is due to wakefield-accelerated electrons and provides mJ level THz energies.

JT4A.4 • 16:51
High Harmonic Generation in 2D and 3D semiconductors, Hamed Merdji[1]; *[1]Commissariat a l'Energie Atomique, France.* We show the amplification of non-perturbative harmonics by local field enhancement in 3D semiconductors. Then, we investigate high harmonic generation in free standing 2D graphene. Finally, we propose routes for spatio-temporal coupling using 3D nanostructured semiconductors.

JT4A.5 • 17:03
GHz Heterodyne generation using Two DFB Mid-IR QCL lasers on a 9µm QWIP, Djamal Gacemi[1], azzurra Bigioli[1], Allegra Calabrese[1], Daniele Palaferri[1], Yanko todorov[1], Angela Vasanelli[1], Jérôme Faist[2], Carlo Sirtori[1]; *[1]Laboratoire MPQ and CNRS, France; [2]ETH zurich, Switzerland.* We report the implementation of a heterodyne measurement setup using two DFB Mid-IR QC lasers on a 9µm Quantum Well Infrared Photodetector. High sensitivity and high speed 9µm QWIP are shown, thanks to heterodyne technique.

17:30-19:00

JT5A • Poster Session

JT5A.1
A Source to Deliver Mesoscopic Particles for Laser Plasma Studies, Ram Gopal[1], Rakesh K. Yembadi[2], krishna M. M[1]; [1]*Dept. of nuclear and atomic sciences, Tata Inst. of Fundamental research, India;* [2]*Dept. of physics, Indian Inst. of technology, India.* The idea of suspending mesoscopic particles of desired size/shape in vacuum for laser plasma acceleration is a sparsely explored domain. In the following report we outline the development of a delivery mechanism of microparticles into an effusive jet in vacuum

JT5A.2
HHG Beamline, a Unique Turnkey System Delivering a Brilliant XUV Beam, Fabio Giambruno[1], Stephane Reyne[1], Alexandre Pacholski[1], Jaroslav Nejdl[2], Adam Wolf[2], Victoria Nefedova[2], Mathias Le Pennec[1]; [1]*ARDOP, France;* [2]*ELI-Beamlines, Czechia.* A High Harmonic Generation Beamline has been designed, delivered, installed and commissioned by ARDOP at ELI Beamlines pillar in Czech Republic, as a turn-key system generating a broadband XUV beam from 5nm to 120nm.

JT5A.3
Generation of single-cycle attosecond pulses based on Thomson scattering of terahertz pulses, Gyorgy Toth[1,2], Zoltan Tibai[2], Ashutos Sharma[3], Jozsef A. Fulop[1], János Hebling[2]; [1]*MTA-PTE High-Field THz Research Group, Hungary;* [2]*Univ. of Pécs, Hungary;* [3]*ELI-ALPS, ELI-Hu Nkft., Hungary.* According to calculations, single-cycle attosecond pulses can be generate with few nJ energy by Thomson scattering of terahertz pulse on ultrathin electron layer, produced by a laser-plasma wakefield accelerator and some suitable magnetic devices.

JT5A.4
The LUNEX5 Project, Marie-Emmanuelle Couprie[1]; [1]*Synchrotron SOLEIL, France.* LUNEX5 aims at generating short, intense, coherent 40-4 nm Free Electron Laser with a high repetition rate superconducting Linear Accelerator, advanced multi-FEL lines with pilot user applications, and a Laser Plasma Accelerator for its qualification.

JT5A.5
Enhancement of Laser-Compton X-ray by Crab Crossing, Yuya Koshiba[1], Shogo Ota[1], Ryosuke Morita[1], Kazuyuki Sakaue[2], Masakazu Washio[1], Takeshi Higashiguchi[3], Junji Urakawa[4]; [1]*Waseda Univ., Research Inst. for Science and Engineering, Japan;* [2]*Waseda Univ., Waseda Inst. for Advanced Study, Japan;* [3]*Utsunomiya Univ., Japan;* [4]*High Energy Accelerator Research Organization, Japan.* Crab crossing of electron beam and laser pulse enables head-on collision in laser-Compton scattering. We will report prospects of crab crossing laser-Compton scattering and a suitable laser system based on a thin-disk regenerative amplifier.

JT5A.6
Numerical study of laser-produced plasma extreme ultraviolet light emission using dual-pulse scheme, Po-Yen Lai[1], Shih-Hung Chen[1], Chia-Ying Hsieh[1]; [1]*Physics, National Central Univ., Taiwan.* We numerically demonstrated effects of pre-pulse properties on extreme ultraviolet emission from laser-produced Sn plasmas using a dual-pulse scheme, which increases the EUV conversion efficiency from 3.6% with the single-pulse scheme to 5.9%.

JT5A.7
Tunable high harmonics from nanorings swirled by intense optical vortices, Jamal Berakdar[1]; [1]*Martin Luther Univ Halle Wittenberg, Germany.* Irradiating intercalated ring by optical vortices generates a circulating current that emits high harmonic bursts with well-defined polarization charactisitics and with frequencies and time structures controllable by the driving optical vortex winding number.

JT5A.8
MIR Generation from 3D $c^{(2)}$ Nonlinear Photonic Crystals, KaiHsun Chang[1], Jhih-Yong Han[1], Azzedine Boudrioua[2], L.-H. PENG[1]; [1]*Graduate Inst. of Photonics and Optoelectronics and Dept. of Electrical Engineering, National Taiwan Univ., Taiwan;* [2]*LPL, Institut Galilée , Université Paris 13, France.* We propose dual signal/idler wavelength generation using bi-layered PPLT-OPO crystal with refractive index modulation along the depth direction. It can serve as pump to facilitate THz surface emission when monolithically integrated with a QPM-DFG section.

JT5A.9
Tunability of Low-doped Tm:CaF_2 Crystal at Cryogenic Temperatures, Jan Sulc[1], Michal Nemec[1], Richard Svejkar[1], Helena Jelínková[1], Maxim E. Doroshenko[2], Vasilii A. Konyushkin[2], Andrey N. Nakladov[2], Vyacheslav V. Osiko[2]; [1]*Czech Technical Univ. in Prague, Czechia;* [2]*Laser Materials and Technology Research Center, AM Prokhorov General Physics Inst. of RAS, Russia.* The temperature influence on diode-pumped Tm(0.4 mol%):CaF_2 laser performance and tunability was investigated down to cryogenic temperatures. Laser efficiency up to 21 % and wide, red-shifted, tuning range (1783-1915 nm) was demonstrated at 80 K.

JT5A.10
The growth and properties of a novel mid-IR laser crystal: $Yb^{3+}/Er^{3+}/Pr^{3+}$:$LiNbO_3$, Peixiong Zhang[1]; [1]*SIOM, China.* The use of Pr^{3+} codoping for enhancement of the 2.7 μm emissions was investigated in the Er/Yb codoped $LiNbO_3$ crystal for the first time. The 2.7 μm emission characteristics and energy transfer were also investigated.

JT5A.11
Design of Highly Coherence MIR Supercontinuum Generation in W-type Index Chalcogenide Fiber, Mustafa A. Khamis[1,2], Ruben Sevilla[1], Karin Ennser[1]; [1]*Swansea Univ., UK;* [2]*Baquba Technical Inst., Middle Technical Univ., Iraq.* This paper proposes the W-type index chalcogenide fiber to generate fully coherent MIR supercontinuum generation. Our fiber design has high nonlinear coefficient, flattened dispersion profile and a tight confinement of the mode within the core

JT5A.12
Simulation of dual-wavelength pumped 3.5 μm CW laser operation of Er:CaF_2 in waveguide configuration, Saiyu Luo[2], Rémi Soulard[1], Richard Moncorge[1], Christophe Labbe[1], Jean-Louis Doualan[1], Zhiping Cai[2], Huying Xu[2]; [1]*Universite de Caen, France;* [2]*Xiamen Univ., China.* Based on a detailed spectroscopic investigation including excited-state absorption and fluorescence measurements, a simulation is developed to demonstrate multiwatt CW laser operation of an Er:CaF_2 crystalline waveguide using single- or dual-wavelength pumping.

JT5A.13
Applications of IR Laser Spectrometry to the Monitoring of Gaseous CO_2 in the Headspace of Champagne Glasses, Raphael Vallon[1], Anne-Laure Moriaux[1], Bertrand Parvitte[1], Clara Cilindre[1], Gérard Liger-Belair[1], Virginie Zeninari[1]; [1]*GSMA, France.* We report the development, the validation and the application of an infrared laser spectrometer devoted to the measurement of gaseous carbon dioxide in the headspace of Champagne and sparkling wines glasses.

JT5A.14
Tunable Diode-pumped Er:SrF_2 Laser at 2.7 μm, Richard Svejkar[1], Jan Šulc[1], Helena Jelínková[1], Václav Kubeček[1], Weiwei Ma[2], Dapeng Jiang[2], Qinghui Wu[2], Liangbi Su[2]; [1]*Czech Technical Univ. in Prague, Faculty of Nuclear Sciences and Physical Engineering, Czechia;* [2]*Key Lab of Transparent and Opto-functional Inorganic Materials, Shanghai Inst. of Ceramics, Chinese Academy of Sciences, China.* Mid-infrared 2.73 μm radiation was obtained with diode-pumped Er:SrF_2 at room-temperature. Output power amplitude was 1.3W with slope efficiency 9.2% and new maximal tuning range 123 nm (2690 nm - 2813 nm) was reached.

JT5A.15
Long Wavelength External Cavity Quantum Cascade Laser for Spectroscopic Application, Sylvain Mathonnière[1], Ján Tomko[1], Yohei MATSUOKA[1], Sven Peters[2], Jan Kischkat[1], Mykhaylo P. Semtsiv[1], Ted W. Masselink[1]; [1]*Physics, Humboldt Univ. of Berlin, Germany;* [2]*SENTECH, Germany.* We present a long wavelength external cavity quantum cascade laser. The fabrication of the external cavity laser is described including anti-reflection coating design, simulations, and results. Spectroscopic feasibility is proven by measurement of ammonia absorption.

17:30-19:00

JT5A • Poster Session

JT5A.16

2-μm Soliton Molecule Sources in a Monolayer MoS_2 Mode-Locked Fiber Laser, Changxi Yang[1]; [1]*Tsinghua Univ., China.* We report on the generation of stable soliton molecules composed of two, three, and four solitons at 2-μm in a monolayer MoS_2 mode-locked fiber laser.

JT5A.17

Stable, High-Average-Power, Degenerate Optical Parametric Oscillator at 2.1 μm, Hanyu Ye[1], Biplob Nandy[1], Chaitanya Kumar Suddapalli[2], Majid Ebrahim-Zadeh[1,3]; [1]*ICFO-Institut de Ciencies Fotoniques, Spain;* [2]*Radiantis, Spain;* [3]*Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain.* We describe a degenerate 1.064-μm-pumped pulsed optical parametric oscillator based on MgO:PPLN in compact Littrow-grating cavity configuration, providing 2.7W of average power at 2.1μm with high spectral and power stability in good spatial beam quality.

JT5A.18

Optical Properties of Highly Excited Monolayer MoS_2 by Few-cycle Femtosecond Laser Pulse Irradiation, Xiaoxing Su[1], Lan Jiang[1]; [1]*Beijing Inst. of Technology, China.* The dielectric responses of monolayer MoS_2 to few-cycle femtosecond laser pulse with vary parameters are demonstrated by using time-dependent density functional theory. Dielectric properties of the material are modulated on the femtosecond time scale.

JT5A.19

Test and Development of an OPO-Based Spectrometer for SAFESIDE – An INTERREG V Project for Gases Detection, Florent Defossez[1,2], Raphael Vallon[1], Bertrand Parvitte[1], Sylvain Brohez[2], Sébastien Guillemet[3], Yves Hernandez[3], Virginie Zeninari[1]; [1]*GSMA, France;* [2]*Université de Mons, Belgium;* [3]*MULTITEL, Belgium.* In the framework of the INTERREG V research program SAFESIDE, we report the test and development of a mid-infrared laser source for fume and gases detection by infrared laser spectroscopy.

JT5A.20

Cascaded Extraction OPCPA – A Highly Efficient Power Amplifier Design, Szabolcs Tóth[1], Huabao Cao[1], Mikhail Kalashnikov[1], vladimir chvykov[1], Karoly Osvay[1]; [1]*ELI-ALPS, ELI-HU Nonprift Ltd., Hungary.* The effectiveness of the proposed design is demonstrated by a 4D numerical simulation and compared to conventional OPCPA. According to the results 10% higher conversion efficiency and increased energy stability is predicted in CE-OPA.

JT5A.21

Laser-induced forward transfer of aluminium particles in different gaseous environment, Mohammad Hossein Azhdast[1], Hans Joachim Eichler[1], Klaus-Dieter Lang[2], Veronika Glaw[2], Martin Kossatz[3]; [1]*Technical Univ. of Berlin, Germany;* [2]*IZM Fraunhofer, Germany;* [3]*PacTech GMBH, Germany.* Laser-induced forward transfer is a novel technique used for Aluminium implementing on wafer substrates in different gaseous environments: vacuum, room atmosphere, Argon and Arcal (F5). The laser pulse energy is optimized during the process.

JT5A.22

Novel Method of Measuring Longitudinal Temperature Distribution in End-Pumped Laser Medium, Andrei Korolkov[1,2], Dmitrii Belogolovskii[1], Alexey Konyashkin[1,2], Oleg Ryabushkin[1,2]; [1]*Moscow Inst. of Physics and Technology, Russia;* [2]*Kotelnikov Inst. of Radio-engineering and Electronics of RAS, Russia.* Laser gain medium temperature distribution is crucial for laser operation. Here we demonstrate a novel method of measuring longitudinal temperature distribution in end-pumped laser medium avoiding additional heating of temperature sensors by scattered radiation.

JT5A.23

Laser-Generated Particles for Advanced Material Science, Patrizio Antici[1], Marianna Barberio[1], Massimiliano Sciscio[1], Simona Veltri[1]; [1]*INRS-EMT, Canada.* The advent of high-power ultra-short lasers has opened up the field of laser-driven particle acceleration, with numerous applications in different fields. I will present different applications using laser-generated particles in Material Science.

JT5A.24

Space-born high brightness solid state phase-conjugate lasers, Anastasiya Pogoda[1,2], Stanislav Ivakin[1,2], Anatoly Boreysho[1,2]; [1]*Ustinov Baltic State Technical Univ., Russia;* [2]*Laser systems LLC, Russia.* The article presents an overview of several steps in the development of high -brightness lasers for space applications: from pulsed solid-state phase conjugate laser with different multiloop cavity configurations to coherent combining of such lasers.

JT5A.25

Piezoelectric Resonance Laser Calorimetry for Determination of Low Optical Absorption Coefficients of Polyhedron Crystal Boules, Georgii A. Aloian[1], Nikita V. Kovalenko[1], Irina V. Shebarshina[1], Alexey Konyashkin[1,2], Oleg Ryabushkin[1,2]; [1]*Moscow Inst. of Physics and Technolo, Russia;* [2]*Kotelnikov Inst. of Radio-engineering and Electronics of RAS, Russia.* Novel technique for measuring low optical absorption coefficients of massive crystal boules of arbitrary shape is proposed. Theoretical model that describes processes of heat transfer from the boule to surrounding air was developed.

JT5A.26

Q-switched Er-doped all-fiber laser based on $W_{0.5}Mo_{0.5}S_2$ saturable absorber, Chenxi Dou[1], Junli Wang[1], lei chen[1], haiting yan[2], lingjie meng[2], Zhiyi Wei[3]; [1]*Xidian Univ., China;* [2]*xi'an Jiaotong Univ., China;* [3]*Inst. of physics, China.* A Q-switched Er-doped all fiber laser based on a novel saturable absorber W0.5Mo0.5S2 is demonstrated. We obtain an output of the pulse energy of 256.5 nJ and 1.9 μs of pulse width at 1560nm central wavelength.

JT5A.27

Surface Temperature Distribution of Optical Materials Heated by Laser Irradiation, Nikita V. Kovalenko[1], Georgii A. Aloian[1], Irina Shebarsina[1], Alexey Konyashkin[1,2], Oleg Ryabushkin[1,2]; [1]*Moscow Inst. of Physics and Technology, Russia;* [2]*Kotelnikov Inst. of Radio-engineering and Electronics of RAS, Russia.* Equivalent temperature of the silica lens surface was measured at several points during laser irradiation using temperature detectors made of small transparent piezoelectric crystals. Theoretical model for the lens temperature distribution measurement is considered.

JT5A.28

Withdrawn

JT5A.29

Dual-chirped optical parametric amplifier for pumping multicycle tunable terahertz pulse source, Gyorgy Toth[1,2], Jozsef A. Fulop[1], János Hebling[2]; [1]*MTA-PTE High-Field THz Research Group, Hungary;* [2]*Univ. of Pécs, Hungary.* DC-OPA is proposed for generation of periodically intensity-modulated-pulses by interference of the signal and the idler. These pulses allows to tunable THz-pulse generation by the chirp and the delay between the pump and the signal.

07:00—18:30 • Registration, *Bartholdi C*

Orangerie C

HILAS

08:00 -- 10:00
HW1A • Theoretical Advanced in High-Field Physics
Presider: Hartmut Ruhl; LMU, Germany

HW1A.1 • 08:00 **Invited**
***Ab Initio* Description of High-harmonic Generation in Solids,** Nicolas Tancogne-Dejean[1]; *[1]Theory, Max-Planck Inst. for Structure and Dynamics of Matter, Germany.* Recently the possibility to generate high-order harmonics in solids has attracted a lot of attention. In this talk, we show that ab initio calculations help unraveling the microscopic mechanisms responsible for HHG in solids.

HW1A.2 • 08:30
Many-body effects upon high-harmonic generation in solid-state materials, Takuya Ikemachi[1], Yasushi Shinohara[1], Takeshi Sato[1], Junji Yumoto[1], Makoto Kuwata-Gonokami[1], Kenichi L. Ishikawa[1]; *[1]Univ. of Tokyo, Japan.* Based on the time-dependent Hartree-Fock simulations, we reveal the electron-hole interaction qualitatively affects the solid-state high-harmonic spectra. We identify its origin in terms of electron-hole polarization.

HW1A.3 • 08:45
Intraband and interband decomposition of high-order-harmonic spectra from bulk GaSe by an *ab-initio* simulation, Yasushi Shinohara[1], Keisuke Kaneshima[2], Kengo Takeuchi[2], Nobuhisa Ishii[2], Kotaro Imasaka[3], Tomohiro Kaji[3], Satoshi Ashihara[3], Jiro Itatani[2], Kenichi L. Ishikawa[1]; *[1]School of Engineering, Univ. of Tokyo, Japan; [2]Inst. for Solid State Physics, Univ. of Tokyo, Japan; [3]Inst. of Industrial Science, Univ. of Tokyo, Japan.* We have developed an ab-initio simulation for high-order-harmonic generation from bulk GaSe. The simulation shows even-order harmonics are exclusively generated from the interband current while odd-order ones are dominated by intraband current below the band-gap.

HW1A.4 • 09:00
Ab Initio Simulations of Photoelectron Energy Spectra Emitted from Multielectron Systems, Yuki Orimo[1], Takeshi Sato[1], Kenichi L. Ishikawa[1]; *[1]Univ. of Tokyo, Japan.* We report accurate ab initio simulations of photoelectron energy spectra from multielectron systems subject to an intense and ultrashort laser pulse with significantly reduced computational costs.

Orangerie B

EUV & X-ray

08:00 -- 9:30
EW1B • EUV Lithography and Semiconductor Manufacturing II
Presider: Igor Fomenkov; ASML. San Diego, USA

EW1B.1 • 08:00 **Invited**
X-ray metrology for semiconductor manufacturing: Ready for Prime Time?, Carsten Hartig[1]; *[1]Global Foundries, USA.* Abstract not provided

EW1B.2 • 08:30 **Invited**
13 nm FEL Prospects for Lithography, Eleonore Roussel[1]; *[1]Laboratoire de Physique des Lasers, Atomes et Molécules, France.* Free-Electron Lasers appear to be an alternative to overcome the power limitation of the present extreme ultraviolet (EUV) laser sources. We will present the possible FEL configurations that can meet the requirement for EUV lithography.

EW1B.3 • 09:00
Actinic Mask Inspection System Using HHG EUV Source, Hiroo Kinoshita[1]; *[1]Univ. of Hyogo, Japan.* A coherent scatterometry microscope (CSM) has been developed, in which high-order harmonic generation (HHG) is employed to produce coherent 13.5 nm light. The HHG -CSM is used to inspect absorber pattern defects and phase defects.

Orangerie A

MICS

08:00 -- 10:00
MW1C • Nonlinear Frequency Conversion and Parametric Sources I
Presider: Benoit Boulanger; Neel Inst., France

MW1C.1 • 08:00
Efficient optical parametric generation pumped by a sub-nanosecond MOPA source, Hideki Ishizuki[1], Takunori Taira[1]; *[1]Inst. for Molecular Science, Japan.* Efficient PPMgLN-OPG for both 1.5-μm and 3.3-μm generation was demonstrated. Maximum output energy of 2.06mJ and 0.71mJ for signal and idler waves could be obtained with 46% conversion efficiency at 5.98mJ sub-nanosecond-pulse pumping.

MW1C.2 • 08:15
Tunable, Continuous-Wave, Multi-Milliwatt Mid-Infrared Source Across 4.6-4.7 μm Based on Orientation-Patterned GaP, Kavita Devi[1], Anuja Padhye[1], Peter G. Schunemann[2], Majid Ebrahim-Zadeh[1,3]; *[1]ICFO -The Inst. of Photonic Sciences, Spain; [2]BAE Systems, Inc., USA; [3]Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain.* We report the first demonstration of tunable continuous-wave difference-frequency generation across 4608-4694 nm in OP-GaP, with maximum power of 43 mW at 4608 nm and passive power stability of 2.5% rms (1.5 mins), in good beam quality.

MW1C.3 • 08:30
High-peak-power, picosecond, mid-infrared optical parametric generator and amplifier pumped by Tm:fiber laser, Lin Xu[1], Qiang Fu[1], Sijing Liang[1], David Shepherd[1], David Richardson[1], Shaif-ul Alam[1]; *[1]Univ. of Southampton, UK.* A Tm:fiber laser pumped OP:GaAs optical parametric generator generates mid-infrared (2550-8300 nm) pulses with 3 kW of peak power. With a seed injection, a maximum peak power up to 13.3 kW is obtained from the optical parametric amplifier.

MW1C.4 • 08:45
A Femtosecond 8.5 μm Source Based on Intrapulse Difference-Frequency Generation of 2.1 μm Pulses, Ondrej Novak[1], Peter Krogen[2,3], Tobias Kroh[2,3], Tomas Mocek[1], Franz X. Kaertner[2,3], Kyung-Han Hong[2]; *[1]HiLASE Centre, Inst. of Physics of the Czech Academy of Sciences, Czechia; [2]Research Lab of Electronics, MIT (MIT), USA; [3]Center for Free-Electron Laser Science and Deutsches Elektronen-Synchrotron (DESY), Germany.* We generate ~8.5 μm, ~2 μJ femtosecond pulses via intrapulse DFG of 26 fs, 2.1 μm pulses in a type-II $AgGaSe_2$ crystal with ~1% efficiency. Intrinsically CEP-stable pulses cover the wavelengths of ~7-11 μm.

MW1C.5 • 09:00
High-Average-Power, Deep-Infrared, Ti:sapphire-Pumped Femtosecond Optical Parametric Oscillator Based on $CdSiP_2$, Callum F. O'Donnell[1,2], Chaitanya Kumar Suddapalli[1,2], Kevin Zawilski[3], Peter G. Schunemann[3], Majid Ebrahim-Zadeh[2,4]; *[1]Radiantis, Spain; [2]ICFO - Institut de Ciencies Fotoniques, Spain; [3]BAE Systems, USA; [4]ICREA, Spain.* We report a femtosecond optical parametric oscillator across 6654–8329 nm based on $CdSiP_2$ pumped directly by a Ti:sapphire laser, generating 19 mW of average power at 7317 nm in ~300-fs pulses at 80.5 MHz.

Orangerie C	Orangerie B	Orangerie A
HILAS	EUV & X-ray	MICS

Orangerie C — HILAS

08:00 -- 10:00
HW1A • Theoretical Advanced in High-Field Physics -Continuing

HW1A.5 • 09:15
Scaling Soliton Dynamics in Hollow Fibers, John C. Travers[1], Teodora F. Grigorova[1], Federico Belli[1]; [1]*Heriot -Watt Univ., UK.* Soliton dynamics in the visible and near -infrared can be scaled to millijoule energy levels and terrawatt peak powers in simple hollow capillary fibers. We describe subfemtosecond pulse self-compression and very high-brightness vacuum ultraviolet generation.

HW1A.6 • 09:30
Time-dependent multiconfiguration methods for intense laser-driven multielectron dynamics, Takeshi Sato[1], Kenichi L. Ishikawa[1]; [1]*Univ. of Tokyo, Japan.* We have developed time-dependent multiconfiguration methods for ab initio descriptions of multielectron dynamics in intense laser fields. This report describes our efficient implementation and numerical applications of these methods for many-electron atoms.

HW1A.7 • 09:45
Tunneling Site of H_2^+ in Strong Circularly Polarized Laser Fields, Kunlong Liu[1], Ingo Barth[1]; [1]*Max Planck Inst. of Microstructure Physics, Germany.* The tunneling site of molecules in strong laser fields has a large impact on the ultrafast dynamics of the ionizing electron on the polyatomic Coulomb potential and can be identified with lateral photoelectron momentum distributions.

Orangerie B — EUV & X-ray

08:00 -- 9:30
EW1B • EUV Lithography and Semiconductor Manufacturing II - Continuing

EW1B.4 • 09:15
Characterization of Cross-sectional Profile of Periodic Surface Nanostructure Using CD-SAXS, Yoshiyasu Ito[1], Kazuhiko Omote[1]; [1]*Rigaku Corp., Japan.* We applied CD-SAXS to cross-sectional profile measurements of various surface nanostructures on quartz substrates. We compared the results with SEM and TEM, and it was shown that the results well reproduced the electron microscope results.

Orangerie A — MICS

08:00 -- 10:00
MW1C • Nonlinear Frequency Conversion and Parametric Sources I - Continuing

MW1C.6 • 09:15
Optimally Output-coupled, Deep-infrared, Picosecond Optical Parametric Oscillator Based on $CdSiP_2$, Chaitanya Kumar Suddapalli[1,3], Josep Canals Casals[1], Shahrzad Parsa[1], Kevin Zawilski[2], Peter G. Schunemann[2], Majid Ebrahim-Zadeh[1,4]; [1]*ICFO -The Inst. of Photonic Sciences, Spain;* [2]*BAE Systems Inc., USA;* [3]*Radiantis, Spain;* [4]*Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain.* High-repetition-rate picosecond OPO based on $CdSiP_2$ is demonstrated achieving tunable idler across 6205-6724 nm and tunable signal across 264-1284.2 nm, providing 95 mW at 6205 nm and 44 mW at 1284 nm at 80 MHz, with good beam-quality.

MW1C.7 • 09:30
High-power broadband mid-IR difference-frequency generation driven by a Tm-doped fiber laser, Tobias Heuermann[1,2], Christian Gaida[1], Martin Gebhardt[1,2], Fabian Stutzki[1,3], Cesar Jauregui[1], Jose Antonio-Lopez[4], Axel Schülzgen[4], Rodrigo Amezcua-Correa[4], Ioachim Pupeza[5], Jens Limpert[1,2], Andreas Tünnermann[1,3]; [1]*Friedrich-Schiller-Univ. Jena, Germany;* [2]*Helmholtz-Inst. Jena, Germany;* [3]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany;* [4]*Univ. of Central Florida, USA;* [5]*Max-Planck-Inst. of Quantum Optics, Germany.* We present efficient, ultrabroadband intrapulse difference-frequency generation driven by a Tm-doped fiber laser resulting in an average mid-infrared output power of 450 mW spanning more than one octave (-10 dB width) at a central wavelength of 12 µm.

MW1C.8 • 09:45
Single-cycle, high-power, mid-IR optical parametric chirped amplifier, Ugaitz E. Etxano[1], Matthias Baudisch[1], Tobias Steinle[1], Hugo Pires[1], Francesco Tani[2], Michael H. Frosz[2], Felix Köttig[2], Alexey Ermolov[2], Philip S. Russell[2], Jens Biegert[1,3]; [1]*The Inst. of Photonic Sciences ICFO, Spain;* [2]*Max Planck Inst. for the Science of Light, Germany;* [3]*ICREA, Spain.* We demonstrate efficient generation of 1.35-optical-cycle (14.5 fs) and 60 µJ mid-IR pulses at 160 kHz repetition rate. The CEP -stable, 21 W mid-IR waveforms are self-compressed inside a gas-filled antiresonant-reflection photonic crystal fiber (ARR-PCF).

10:00—10:30 • Coffee Break with Exhibitors, *Foyer Orangerie*

Orangerie C

HILAS

10:30 -- 12:15
HW2A • Ultrafast dynamics II
Presider: Daniele Brida; Univ. of Konstanz, Germany

HW2A.1 • 10:30 Invited
Quantum Spectrometer in the XUV Spectral Range: High-order Harmonics Measured by Counting the Photons of the IR Driving Laser Field, Paraskevas Tzallas[1]; *[1]FORTH-IESL, Greece.* We demonstrate a quantum-optical approach for the description of strong -field laser atom interaction. The approach, was used for the measurement of the high-order-harmonics emitted by gases without the use of conventional XUV grating spectrometer.

HW2A.2 • 11:00
Quantum-Path-Sensitive Inline XUV Interferometry, David T. Lloyd[1], Adam S. Wyatt[2,1], Richard Chapman[2], Chris Thornton[2], Paulina Majchrzak[2], Alfred Jones[2], Emma Springate[2], Kevin O'Keeffe[3]; *[1]Dept. of Physics, Univ. of Oxford, UK; [2]Central Laser Facility, STFC Rutherford Appleton Lab, UK; [3]Dept. of Physics, Swansea Univ., UK.* An XUV interferometer composed of two inline high harmonic generation regions is used to characterize different ionized electron quantum paths. We unambiguously observe interference between long and short trajectories, revealing their attosecond-scale relative timing.

HW2A.3 • 11:15
Single-shot diffractive imaging of individual helium nanodroplets with intense multicolor XUV pulses, Nils Monserud[1], Bruno Langbehn[2], Mario Sauppe[2], Julian Zimmermann[1,2], Annabelle Spanier[2], Pablo Nuñez von Voigt[2], Bernd Schütte[1], Yevheniy Ovcharenko[3], Thomas Möller[2], Fabio Frassetto[4], Luca Poletto[4], Andrea Trabattoni[5], Francesca Calegari[5,6], Mauro Nisoli[6,7], Katharina Sander[8], Christian Peltz[8], Marc Vrakking[1], Thomas Fennel[1,8], Arnaud Rouzée[1], Daniela Rupp[1,2]; *[1]Max-Born Inst., Germany; [2]TU Berlin, Germany; [3]European XFEL, Germany; [4]CNR, Istituto di Fotonica e Nanotech. Padova, Italy; [5]CFEL, DESY, Germany; [6]CNR, Istituto di Fotonica e Nanotech. Milano, Italy; [7]Politecnico di Milano, Italy; [8]U Rostock, Germany.* We report on single-shot coherent diffractive imaging of isolated helium nanodroplets obtained with intense multicolor XUV pulses from a high harmonic source. The wide-angle scattering patterns yield the droplets' shapes and refractive indices.

HW2A.4 • 11:30 Invited
Ultrafast Point-Projection Electron Microscopy of Photoelectron Emission from a Single Plasmonic Nanoresonator, Christoph Lienau[1]; *[1]Carl V. Ossietzky Univ. Oldenburg, Germany.* The ultrafast motion of electrons that are photoemitted from a nanoresonator is filmed using plasmon-driven electron microscopy with unprecedented spatio-temporal resolution.

Orangerie B

EUV & X-ray

10:30 -- 12:30
EW2B • High Harmonic Generation
Presider: Annie Klisnick; CNRS, France

EW2B.1 • 10:30 Invited
High harmonic generation as an ultrafast EUV source for circular dichroism and attosecond photoionization spectroscopies, Pascal L. Salieres[1]; *[1]CEA, CNRS, Paris-Saclay Univ., France.* I will review our recent studies where photoionization: i) is used to measure the complete polarization state of the high harmonic source, and ii) is studied close to autoionizing resonances with attosecond resolution.

EW2B.2 • 11:00 Invited
Generation of high-order harmonics at 100 kHz for attosecond science experiments, Federico J. Furch[1], Felix Schell[1], Tobias Witting[1], Peter Šušnjar[1], Fabio Cavalcante[2], Carmen S. Menoni[2], Claus P. Schulz[1], Marc J. Vrakking[1]; *[1]Max Born Inst., Germany; [2]Dept. of Electrical and Computer Engineering, Colorado State Univ., USA.* The progress in the development of a high acquisition rate attosecond XUV-IR pump-probe beamline is discussed. A high repetition rate parametric amplifier allows driving the harmonic generation process at a repetition rate of 100 kHz.

EW2B.3 • 11:30
Towards Generation of Ultrahigh Energy XUV Pulses, Mathieu Dumergue[1], Sergei Kuehn[1], Arjun Nayak[1], Emmanuel Skantzakis[2], John Makos[2], John Orfanos[2], Dimitris Charalambidis[2,1], Paraskevas Tzallas[2,1]; *[1]ELI-HU Nonprofit Ltd., Hungary; [2]FORTH-IESL, Greece.* We present conditions, based on loose focusing geometries, which can be used for the generation of ultrahigh power XUV pulses. Preliminary data regarding the approach's feasibility will be presented.

Orangerie A

MICS

10:30 -- 12:30
MW2C • Nonlinear Frequency Conversion and Parametric Sources II
Presider: Giuseppe Leo; Univ. Paris-Diderot Paris VII, France

MW2C.1 • 10:30 Invited
Broadband and High Power Mid-Infrared Optical Parametric Amplification via Quasi-Phase-Matching Devices, Ursula Keller[1], Christopher R. Phillips[1]; *[1]ETH Zurich, Switzerland.* We present ultra-broadband, high power, high-repetition-rate mid-infrared optical parametric chirped pulse amplification (OPCPA) based on quasi-phase-matching (QPM) devices. Our system utilizes patterned and large-aperture QPM devices to yield a near-octave-spanning spectrum around 2.2 mm wavelength.

MW2C.2 • 11:00
Broadband Noncollinear Optical Parametric Amplification in GaSe Pumped at 1.5µm, Rimantas Budriunas[1,2], Dainius Kučinskas[1,2], Tomas Stanislauskas[1], Darius Gadonas[1], Anne-Lise Viotti[3], Andrius Zukauskas[3], Fredrik Laurell[3], Valdas Pašiškevičius[3], Arunas Varanavicius[2]; *[1]Light Conversion Ltd., Lithuania; [2]Laser Research Center, Vilnius Univ., Lithuania; Royal Inst. of Tech., Sweden.* A noncollinear parametric amplification scheme using the highly nonlinear and damage-resistant GaSe crystal is demonstrated. Amplification bandwidths allowing 10-15fs compressed pulse durations are achieved at 2µm signal wavelength.

MW2C.3 • 11:15
Intracavity-pumped, cascaded optical parametric oscillator based on $BaGa_2GeSe_6$, Andrey Boyko[1,2], Valeriy Badikov[3], Galina Shevyrdyaeva[3], Dmitrii Badikov[3], Valdas Pasiskevicius[4], Andrius Zukauskas[4], Valentin Petrov[1]; *[1]Max Born Inst. , Germany; [2]Special Tech., Russia; [3]High Tech. Lab, Russia; [4]Royal Inst. of Tech., Sweden.* We employ the new chalcogenide crystal $BaGa_2GeSe_6$ for the first time for frequency down-conversion into the mid-IR, in an optical parametric oscillator (OPO), intracavity pumped by the signal wave of a 1.064-µm pumped Rb:PPKTP OPO.

MW2C.4 • 11:30
High-Pulse Energy Mid-IR ZGP OPO with Divergence Compensation and High Beam Quality, Martin Schellhorn[1], Gerhard Spindler[2], Marc Eichhorn[1]; *[1]Inst. Franco-Allemand Recherches St. Louis, France; [2]Retired, Germany.* Using a Galilean telescope inside the OPO ring cavity, 36 mJ of mid-infrared pulse energy is obtained with 92 mJ of pump energy on crystal with M^2 = 1.5 for signal and idler beam.

Orangerie C	Orangerie B	Orangerie A
EUV & X-ray	HILAS	MICS

Orangerie C — EUV & X-ray

10:30 -- 12:30
HW2A • Ultrafast dynamics II - Continuing

HW2A.5 • 12:00
Absolute Gas Density Profiling In High Order Harmonic Generation, Antoine Comby[1], Samuel Beaulieu[1,2], Eric Constant[3], Dominique Descamps[1], Stephane Petit[1], Yann Mairesse[1]; [1]*CELIA, France;* [2]*INRS, Canada;* [3]*Laboratoire de Spectrométrie Ionique et Moléculaire, France.* We retrieve the full density profile of a gas jet by imaging the plasma induced by an intense laser. Thanks to this imaging we are able to monitor and optimize the high order harmonic generation.

Orangerie B — HILAS

10:30 -- 12:30
EW2B • High Harmonic Generation - Continuing

EW2B.4 • 11:45
Separation of High Average Power Driving Lasers from Higher Order Harmonics Using an Annular Beam, Robert Klas[1,2], Alexander Kirsche[1], Maxim Tschernajew[1,2], Andreas Tünnermann[1,3], Jan Rothhardt[1,2], Jens Limpert[1,2]; [1]*Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany;* [2]*Helmholtz Inst. Jena, Germany;* [3]*Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* Annular beams are applied as an effective separation method for HHG with high average power driving lasers, showing a comparable conversion efficiency to HHG with a Gaussian beam.

EW2B.5 • 12:00
A Novel High Order Harmonic Source for Time- and Angle-Resolved Photoemission Experiments, Paolo Miotti[1,2], Federico Cilento[3], Riccardo Cucini[4], Aleksander De Luisa[4], Andrea Fondacaro[4], Fabio Frassetto[1], Damir Kopić[3], Daniel Payne[3], Andrea Sterzi[3], Tommaso Pincelli[4,5], Giancarlo Panaccione[4], Fulvio Parmigiani[6], Giorgio Rossi[4,5], Luca Poletto[1]; [1]*CNR-IFN Luxor, Italy;* [2]*Dept. of Info. Engineering, Univ. of Padova, Italy;* [3]*Elettra - Sincrotrone Trieste, Italy;* [4]*Lab. TASC, IOM-CNR, Italy;* [5]*Dept. di Fisica, Univ. degli studi di Milano, Italy;* [6]*Dept. of Physics, Univ. degli Studi di Trieste, Italy.* The design and characterization of a HHG source conceived for Time and Angle Resolved PhotoElectron Spectroscopy (TR-ARPES) experiments are presented. The harmonics are selected through a grating monochromator with an innovative design able to provide XUV radiation for two distinct TR-ARPES setups.

EW2B.6 • 12:15
User-oriented kHz Laser Driven Sources of XUV and X-rays at ELI Beamlines, Jaroslav Nejdl[1], Victoria Nefedova[1]; [1]*ELI Beamlines project, Inst. of Physics, Czechia.* Research on coherent XUV HHG source will be presented as a starting point for the user-oriented HHG Beamline that is being commissioned together with the Plasma X-ray Source at ELI Beamlines.

Orangerie A — MICS

10:30 -- 12:30
MW2C • Nonlinear Frequency Conversion and Parametric Sources II - Continuing

MW2C.5 • 11:45
Singly-Resonant Optical Parametric Oscillator Based on Orientation-Patterned Gallium Phosphide, Hanyu Ye[1], Chaitanya Kumar Suddapalli[2], Junxiong Wei[1], Peter G. Schunemann[3], Majid Ebrahim-Zadeh[1,4]; [1]*ICFO-Inst. de Ciencies Fotoniques, Spain;* [2]*Radiantis, Spain;* [3]*BAE Systems, Inc., USA;* [4]*Inst. Catalana de Recerca i Estudis Avancats (ICREA), Spain.* We report a pulsed singly-resonant optical parametric oscillator based on orientation-patterned gallium phosphide pumped by a Q-switched Nd:YAG laser. The mid-IR idler can be tuned across 2.8-3.1 µm with an average power of 20 mW.

MW2C.6 • 12:00
High-Power, High-Beam-Quality, Idler-Resonant Mid-Infrared Picosecond Optical Parametric Oscillator, Shahrzad Parsa[1], Chaitanya Kumar Suddapalli[2], Kavita Devi[1], Majid Ebrahim-Zadeh[1,2]; [1]*ICFO-Institut de Ciencies Fotoniques, Spain;* [2]*Radiantis, Spain.* An Yb-fiber-pumped idler-resonant picosecond optical parametric oscillator based on MgO:PPLN is presented providing up to 3.5 W mid-IR output power tunable across 2198-4028 nm in excellent spatial beam quality over the entire tuning range.

MW2C.7 • 12:15
Single-Cycle or Arbitrarily Shaped Octave-Spanning Mid-Infrared Pulses: Intrinsic and Extrinsic Pulse Shaping in Adiabatic Frequency Conversion, Noah Flemens[1], Peter Krogen[2], Haim Suchowski[4], Houkun Liang[2], Kyung-Han Hong[2], Franz X. Kaertner[2,3], Jeffrey A. Moses[1,2]; [1]*School of Applied & Engineering Physics, Cornell Univ., USA;* [2]*Dept. of Electrical Engineering & Computer Science , MIT, USA;* [3]*Center for Free-Electron Laser Science, DESY & Physics Dept., Univ. of Hamburg, Germany;* [4]*Raymond & Beverly Sackler School of Physics & Astronomy, Tel Aviv Univ., Israel.* Adiabatic frequency conversion following parametric chirped-pulse amplification generates a greater-than-octave-spanning energetic mid-IR pulse of single-cycle duration or with complex programmable pulse shaping. For some applications, intrinsic dispersion engineering can eliminate the pulse shaper.

12:30—14:00 • Lunch on your own

Orangerie B — HILAS

14:00 -- 15:45
HW3A • Nonlinear Phenomena and HHG
Presider: Yann Mairesse; Centre Lasers Intenses et Applications, France

HW3A.1 • 14:00
Circular Dichroism in High Harmonic Generation from Chiral Molecules, Yoichi Harada[1], Eisuke Haraguchi[1], Keisuke Kaneshima[1], Taro Sekikawa[1]; *[1]Hokkaido Univ., Japan.* Circularly polarized high harmonic generation from a chiral molecule was found to significantly depend both on the chirality and on the rotating direction of the circularly polarized counter-rotating two-color driving laser fields.

HW3A.2 • 14:15
Anomalies observed in the cut off law of High-order Harmonics Generation. Are spatially inhomogeneous fields the key for this change?, Enrique Neyra[3], Fabian Videla[3], Marcelo F. Ciappina[1], Jose Perez-Hernández[2], Luis Roso[2], Maciej Lewenstein[4], Gustavo Torchia[3]; *[1]ELI-Beamlines, Czechia; [2]CLPU, Spain; [3]CIOP, Argentina; [4]ICFO, Spain.* We studied HHG in gases driven by plasmonic-enhanced fields. We demonstrated that the spatial inhomogeneous and bounded character of the electric field, modeled by Gaussian -shaped functions, leads to an unexpected relationship between the HHG cutoff and the laser wavelength.

HW3A.3 • 14:30
Spectral Selection of High Harmonics via Spatial Filtering, Constance Valentin[1], Ludovic Quintard[1], Jan Vabek[1], Frederic Burgy[1], Clément Péjot[1], Fabrice Catoire[1], Eric Constant[2,1], Eric Mevel[1]; *[1]CNRS - CELIA, France; [2]ILM - CNRS, France.* High order harmonics generated in gas provide a coherent XUV source with spatial profiles depending on the harmonic order. Spatial filtering is a way to select few harmonics without any metallic filter or XUV mirror.

Orangerie C — EUV & X-ray

14:00 -- 16:00
EW3B • Free-electron Laser and Electron Beam Sources II
Presider: Zhentang Zhao; Shanghai Inst. of Applied Physics, China

EW3B.1 • 14:00 Invited
A Compact Wakefield Accelerator for a High Repetition Rate Multi User X-ray Free-Electron Laser Facility, Alexander Zholents[1]; *[1]Argonne National Lab, USA.* A concept is presented for a multi beamline x-ray FEL user facility driven by an array of highly efficient compact collinear wakefield accelerators (CWA) where Čerenkov radiation of a 400 MeV high charge drive bunch is used to accelerate a low charge witness bunch to 2 GeV to produce soft x-rays in the FEL.

EW3B.2 • 14:30 Invited
Laser Acceleration of Electrons on a Chip, Peter Hommelhoff[1], Joshua McNeur[1], Martin Kozak[1,2], Roy Shiloh[1], Peyman Yousefi[1], Norbert Schönenberger[1], Ang Li[1], Johannes Illmer[1]; *[1]Friedrich-Alexander-Universität Erlangen, Germany; [2]Charles Univ., Czechia.* Pulsed laser fields at nanophotonic structures allow efficient acceleration of electrons with large gradients, potentially enabling miniscule accelerators for various purposes. We will present an update of the Accelerator on a Chip International Program (ACHIP).

Orangerie A — MICS

14:00 -- 16:00
MW3C • THz Generation and Frequency Combs
Presider: Hiroaki Minamide; RIKEN, Japan

MW3C.1 • 14:00 Invited
High-Energy THz Generation and Electron Acceleration, Franz X. Kaertner[1,2]; *[1]Universität Hamburg, Germany; [2]Center for Free-Electron Laser Science, Deutsches Elektronen Synchrotron, Germany.* Approaches towards efficient high-energy THz pulse generation and its use in THz electron acceleration are discussed. Theoretical and experimental results towards THz guns and accelerators are presented.

MW3C.2 • 14:30 Invited
Mid Infrared Kerr Frequency Comb and Coherent Super-Continuum Generation in Silicon Nitride Integrated Waveguides, Tobias J. Kippenberg[1]; *[1]Ecole Polytechnique Federale de Lausanne, Switzerland.* Abstract not provided.

Orangerie D-E — HILAS

14:00 -- 16:00
HW3D • Ultrashort pulse generation & characterization
Presider: Tamas Nagy; Max Born Inst., Germany

HW3D.1 • 14:00 Invited
Spatio-Temporal Couplings of Ultrashort Lasers: Metrology and Applications, Fabien Quéré[1]; *[1]CEA Saclay, France.* This talk will present two simple techniques for the complete spatio-temporal characterization of ultrashort laser beams, and summarize the results of recent measurements performed on lasers of peak power of up to 1 PW.

HW3D.2 • 14:30
XPW and SHG d-scan characterization of sub-1.5-cycle pulses, Ayhan Tajalli[1], Marie Ouillé[2], Aline Vernier[2], Frederik Böhle[2], Esmerando Escoto[3], Janos Csontos[4], Rosa Romero[5], Uwe Morgner[1,6], Helder Crespo[5,7], Rodrigo Lopez Martens[2], Gunter Steinmeyer[3], Tamas Nagy[3]; *Leibniz University Hannover, Germany; [2]Lab. d'Optique Appliquée, Ecole Nationale Superieur de Techniques Avancées-Paristech, Ecole Polytechnique, France; [3]Max Born Inst. , Germany; [4]ELI-HU Non-Profit Ltd., Hungary; [5]Sphere Ultrafast Photonics, LDA, Portugal; [6]Laser Zentrum Hannover e.V., Germany; [7]IFIMUP-IN , Univ. do Porto, Portugal.* We characterized 4fs pulses of a high-energy Ti:Sa system under vacuum condition by d-scan arrangements using second harmonic generation and cross-polarized wave generation as nonlinearities. Both methods deliver similar temporal shapes and consistent pulse durations.

Orangerie B	Orangerie C	Orangerie A	Orangerie D-E
HILAS	EUV & X-ray	MICS	HILAS

14:00 -- 15:45 HW3A • Nonlinear Phenomena and HHG - Continuing (Orangerie B, HILAS)

HW3A.4 • 14:45 Invited

High Harmonic Generation (HHG) inside an ultrafast thin disk laser: a new approach for compact megahertz coherent XUV sources, Thomas Sudmeyer[1]; [1]*Université de Neuchâtel, Switzerland.* Abstract not avaialable.

HW3A.5 • 15:15

High-order Harmonic Generation in a Femtosecond-laser-micromachined Chip, Anna Gabriella Ciriolo[1], Rebeca Martinez Vazquez[2], Davide Faccialà[2], Matteo Negro[2], Michele Devetta[2], Diogo Pereira Lopes[1,2], Aditya Pusala[1], Prasannan Geetha Prabhash[1,2], Caterina Vozzi[2], Roberto Osellame[1,2], Salvatore Stagira[1,2]; [1]*Politecnico di Milano, Italy;* [2]*Istituto di Fotonica e Nanotecnologie, CNR, Italy.* We demonstrate the generation of high-order harmonics in a fused-silica chip produced by femtosecond laser micromachining. This achievement paves the way to the miniaturization of HHG applications from large-scale Labs to microdevices.

14:00 -- 16:00 EW3B • Free-electron Laser and Electron Beam Sources II - Continuing (Orangerie C, EUV & X-ray)

EW3B.3 • 15:00 Invited

Attosecond Metrology of Partially Coherent Photoelectron Wavepackets, Charles Bourassin-Bouchet[1], Lou Barreau[2], Vincent Gruson[2], Fabien Quéré[2], Theirry Ruchon[2], Pascal L. Salieres[2]; [1]*Institut d'Optique, France;* [2]*LIDYL, CEA, CNRS, Univ. Paris-Saclay, CEA Saclay, France.* We developed a novel experimental technique named Mixed-FROG for the metrology of attosecond XUV pulses. This method provides information on both the coherent and incoherent phenomena that take place during the pulse characterization.

14:00 -- 16:00 MW3C • THz Generation and Frequency Combs - Continuing (Orangerie A, MICS)

MW3C.3 • 15:00 Invited

Broadband THz Quantum Cascade Laser Frequency Combs, Giacomo Scalari[1]; [1]*ETH Zurich, Switzerland.* Latest results on frequency combs based on THz quantum cascade lasers will be presented including the monolithic integration of octave-spaced combs and the broadband comb operation up to 1.1 THz bandwidth centered at 3.0 THz.

14:00 -- 16:00 HW3D • Ultrashort pulse generation & characterization - Continuing (Orangerie D-E, HILAS)

HW3D.3 • 14:45

Generation of Ultrashort Pulses by Four Wave Mixing in a Gas-filled Hollow Core Fiber, Anna Gabriella Ciriolo[1], Giacomo Mariani[1], Matteo Negro[2], Michele Devetta[2], Davide Faccialà[2], Aditya Pusala[1], Caterina Vozzi[2], Salvatore Stagira[1,2]; [1]*Politecnico di Milano, Italy;* [2]*CNR-IFN, Italy.* We report on the implementation of a tunable source of ultrashort tens-μJ-level pulses based on Four-Wave-Mixing inside a gas-filled hollow-core-fiber for few-cycle pulse generation from the visible to the mid-IR.

HW3D.4 • 15:00

Role of Intrapulse Coherence in Carrier -Envelope Phase Stabilization, Nils Raabe[1], Tianli Feng[1], Tobias Witting[1], Ayhan Demircan[2,3], Carsten Brée[4], Gunter Steinmeyer[1]; [1]*Max Born Inst., Germany;* [2]*Leibniz Univ. Hannover, Germany;* [3]*Hannover Centre for Optical Tech., Germany;* [4]*Weierstrass Inst. for Applied Analysis and Stochastics, Germany.* The concept of intrapulse coherence is defined for judging a fixed phase relation between different spectral components within a laser pulse. This new criterion plays an important role for passive CEP stabilization of OPA systems.

HW3D.5 • 15:15

Long-Lived Index Changes Induced by Femtosecond Ionization in Ar-Filled Hollow-Core PCF, Johannes R. Koehler[1], Francesco Tani[1], Barbara M. Trabold[1], Felix Köttig[1], Mallika I. Suresh[1], Philip S. Russell[1]; [1]*Max Planck Inst. for the Science of Light, Germany.* We observe long-lived refractive index changes in the hollow core of an argon -filled anti-resonant-guiding photonic crystal fiber, caused by plasma formation through femtosecond pulse compression and probed interferometrically through the fiber cladding.

Orangerie B	Orangerie C	Orangerie A	Orangerie D-E
HILAS	EUV & X-ray	MICS	HILAS
14:00 -- 15:45 HW3A • Nonlinear Phenomena and HHG - Continuing	14:00 -- 16:00 EW3B • Free-electron Laser and Electron Beam Sources II - Continuing	14:00 -- 16:00 MW3C • THz Generation and Frequency Combs - Continuing	14:00 -- 16:00 HW3D • Ultrashort pulse generation & characterization - Continuing

HW3A.6 • 15:30
Spatio-Spectral Structures in High Harmonic Generation Driven by High Repetition Rate Laser Sources, Aura I. Gonzalez[1,2], Gaëtan Jargot[1,3], Philippe Rigaud[1], Loïc Lavenu[1,4], Florent Guichard[4], Antoine Comby[6], Thierry Auguste[2], Olivier Sublemontier[5], Michel Bougeard[2], Yoann Zaouter[4], Patric Georges[1], Marc Hanna[1], Theirry Ruchon[2]; [1]*Institut d'Optique Graduate School, Lab. Charles Fabry, France;* [2]*LIDYL, CEA, CNRS, Univ. Paris-Saclay, France;* [3]*Fastlite, France;* [4]*Amplitude Systemes, France;* [5]*NIMBE, CEA, CNRS, Univ. Paris-Saclay, France;* [6]*CELIA, Univ. de Bordeaux - CNRS - CEA, France.* We investigate the spatio-spectral properties of HHG driven by two laser systems based on Yb-fiber amplifiers (high-rep.rate >100kHz), centered at 1.55µm and 1.03µm. Ring-like structures are observed and explained by the transverse atomic-induced phase.

EW3B.4 • 15:30 Invited
A Compact High-Power Radiation Source Based on Steady-State Microbunching Mechanism, Alexander W. Chao[1]; [1]*Tsinghua Univ., China.* An initial effort is being made at the Tsinghua Univ., Beijing, to design a small electron storage ring that incorporates the Steady-State Microbunching (SSMB) mechanism for the purpose to generate high-power CW radiation in the frequency range from IR to EUV. In this talk, the principle of the SSMB is first reviewed and the status of the design effort is then presented.

MW3C.4 • 15:30
100-kHz-Repetition-Rate Terahertz-Wave Parametric Generator for Imaging Applications, Yoshikiyo Moriguchi[1,2], Yu Tokizane[1], Yuma Takida[1], Kouji Nawata[1], Shigenori Nagano[2], Taizo Eno[2], Masahiro Akiba[2], Hiroaki Minamide[1]; [1]*Tera-Photonics Research Team, RIKEN Center for Advanced Photonics (RAP), RIKEN, Japan;* [2]*Topcon Corp., Japan.* We investigated the performance of an injection-seeded THz-wave parametric generator at a repetition frequency in the 100-kHz regime. We obtained a THz-wave output of ~30 µW in the range of 1.0–2.8 THz.

HW3D.6 • 15:30
Electric-field induced second-harmonic generation in atmospheric air with quasi-phase matching, Tianli Feng[1], Nils Raabe[1], Pascal Rustige[1], Gunter Steinmeyer[1]; [1]*Max Born Inst., Germany.* Frequency doubling of an amplified laser is experimentally demonstrated with electric-field induced second-harmonic generation in air. The method promises application with unattenuated terawatt laser and offers wavelength conversion beyond the ultraviolet limit of nonlinear crystals.

MW3C.5 • 15:45
Multi-mW, Few-Cycle Mid-Infrared Continuum Spanning From 500 to 2250 cm^{-1}, Jinwei Zhang[2], Ka Fai Mak[2], Nathalie Nagl[1], Marcus Seidel[1], Dominik Bauer[3], Dirk Sutter[3], Pervak Vladimir[1], Ferenc Krausz[2,1], Oleg Pronin[2]; [1]*Ludwig-Maximilians-Universität München, Germany;* [2]*Max Planck Inst. of Quantum Optics, Germany;* [3]*Trumpf Laser GmbH, Germany.* We report a 2-octave mid-infrared continuum simultaneously spanning from 500 cm-1 to 2250 cm-1 at 24 mW of average power. It is based on difference frequency generation driven by a newly developed femtosecond Ho:YAG thin-disk oscillator.

HW3D.7 • 15:45
Experimental Demonstration of High-Energy Deep Ultraviolet Pulse Generation Through Soliton Dynamics in Gas-Filled Hollow Capillary Fibers, Teodora F. Grigorova[1], Federico Belli[1], John C. Travers[1]; [1]*Heriot-Watt Univ., UK.* Using soliton dynamics in 250 µm diameter Ne-filled hollow capillaries, we generate tunable, > 5 µJ, ultrafast pulses in the deep ultraviolet (200-330 nm). Further energy scaling and extension to the vacuum ultraviolet is predicted.

16:00—16:30 • **Coffee Break with Exhibitors,** *Foyer Orangerie*

Orangerie B

HILAS

16:30 -- 18:30
HW4A • Extreme Light Infrastructure - Capabilities & Experiments
Presider: Emily Sistrunk; Lawrence Livermore National Lab., USA

Invited

HW4A.1 • 16:30
The ELI ALPS Research Infrastructure: Scaling Attosecond Pulse Generation for a Large Scale Infrastructure, Balazs Major[1], Balázs Farkas[1], Mathieu Dumergue[1], Katalin Kovacs[2], Sergei Kuehn[1], Anne L'Huillier[3], Balazs Nagyillés[1], Piotr Rudawski[3], Valer Tosa[2], Paraskevas Tzallas[1], Dimitris Charalambidis[1], Karoly Osvay[1], Giuseppe Sansone[1], Katalin Varjú[1]; *[1]ELI-ALPS, Hungary; [2]National Inst. for R&D of Isotopic and Molecular Tech., Romania; [3]Dept. of Physics, Lund Univ., Sweden.* Along with the review of the technological frame that will be available at the Extreme Light Infrastructure Attosecond Light Pulse Source (ELI-ALPS) we present considerations applicable to large-scale attosecond sources driven by high-power laser pulses.

HW4A.2 • 17:00
Progress in Development of High-Repetition Rate, High-Power Short-Pulse Lasers for ELI-Beamlines, Pavel Bakule[1]; *[1]Inst. of Physics ASCR, ELI Beamlines, Czechia.* Abstract not provided.

HW4A.3 • 17:15
Prospects on 10PW Lasers Technologies at ELI-NP, Daniel Ursescu[1]; *[1]Horia Hulubei National Inst. of Physics and Nuclear Engineering, Extreme Light Infrastructure, Romania.* ELI-NP facility implements a dual arm 10PW laser system based on OPCPA front-end and subsequent amplification in Ti:Sapphire. Related technical developments concerning laser, beam transport, diagnostics, beam conditioning and components qualification will be briefly reviewed.

HW4A.4 • 17:30
A 15 W, Few-Cycle and Ultra-Stable Mid-infrared Parametric Source for ELI-ALPS, Nicolas Thiré[1], Raman Maksimenka[1], Balint Kiss[2], Clément Ferchaud[1], Pierre Bizouard[1], Sebastian Jarosch[3], Vittorio Di Pietro[1], Eric Cormier[2], Karoly Osvay[2], Nicolas Forget[2]; *[1]Fastlite, France; [2]ELI-HU Non-Profit Ltd, Hungary; [3]Imperial College London, UK.* A 100-kHz, 15-W, CEP-stable OPCPA delivering 4-cycle pulses at ~3.2 μm was installed at ELI-ALPS. Ultra-stable operation over >8 h including a pulse-to-pulse energy stability <0.7% rms, CEP noise of 65 mrad rms is reported.

Orangerie C

EUV & X-ray

16:30 -- 18:15
EW4B • Compact Sources II
Presider: Marie-Emmanuelle Couprie; Synchrotron SOLEIL, France

Keynote

EW4B.1 • 16:30
The Munich Compact Light Source (MuCLS): Principles and Application Examples, Franz Pfeiffer[1]; *[1]Munich School of BioEngineering, Technische Univ. Munchen, Germany.* The Munich Compact Light Source is the first user-dedicated compact laser-undulator synchrotron source, and was installed a few years ago at the Technical Univ. in Munich for Biomedical Imaging Applications. This talk will review the basic principals of the machine, the challenges in installation and operation, and provide an overview of the first successful biomedical application experiments carried out so far.

EW4B.2 • 17:00
A New Method of Generating Femto- and Attosecond Pulses of Coherent EUV and X-ray Radiation, Vitaly Papadichev[1]; *[1]Lebedev Physical Inst., RAS, Russia.* A new method of generating femto- and attosecond pulses of coherent EUV and X-ray radiation is proposed. The laser pulses are reflected by a moving oppositely equidistantly arranged electron mirrors, created using field emission.

EW4B.3 • 17:15
Generating intense coherent EUV radiation via three-dimensional manipulation of the electron beam in storage rings, Chao Feng[1], Bocheng Jiang[1], Changliang Li[1], Xiaofan Wang[1], Zhentang Zhao[1], Alexander W. Chao[2]; *[1]SINAP, China; [2]Tsinghua Univ., China.* We consider a compact storage-ring-based EUV light source with the recently proposed electron beam manipulation technique. Theoretical analysis and numerical simulations demonstrated that this technique can be used for the generation of intense fully temporal coherent EUV in storage rings.

EW4B.4 • 17:30
Twisted X-rays and Gamma-rays for Atomic and Nuclear Spectroscopy, Andrei Afanasev[1], Carl E. Carlson[2], Maria Solyanik[1]; *[1]George Washington Univ., USA; [2]College of William and Mary, USA.* Twisted photons, or photons with additional angular momentum along their propagation direction were experimentally demonstrated to defy conventional quantum selection rules for photo-absorption by atoms. We discuss physics implications of the twisted-photon sources at higher energies.

Orangerie A

MICS

16:30 -- 18:15
MW4C • Comb Spectroscopy, Materials Processing
Presider: Angela Vasanelli; Univ. Paris Diderot, France

Invited

MW4C.1 • 16:30
Mid-Infrared Dual-Comb Spectroscopy for Atmospheric Gas Sensing, Nathan R. Newbury[1], Gabriel Ycas[1], Fabrizio Giorgetta[1], Esther Baumann[1], Ian Coddington[1], Daniel Herman[1], Eleanor Waxman[1], Kevin Cossel[1], Scott A. Diddams[1]; *[1]NIST, USA.* Mid-infrared dual-comb spectroscopy has the potential to provide high resolution open path measurements of multiple atmospheric gases. I will discuss progress on a dual-comb spectrometer that operates from 2.6—5.2 μm, designed for open-path spectroscopy.

MW4C.2 • 17:00
In-bulk silicon processing with ultrashort pulsed lasers: Three-photon-absorption versus two-photon-absorption, Roland A. Richter[1], Nikolai Tolstik[1], Irina T. Sorokina[1]; *[1]NTNU, Norway.* We report the results of the numerical study of three-photon-absorption versus two-photon-absorption for in-bulk modification of silicon and show benefits of using longer wavelengths (>2.1 microns) for efficient and kerfless silicon processing with femtosecond lasers.

MW4C.3 • 17:15
Spectroscopic Investigations of Plasma Nitrocarburizing Processes with a Mid-infrared Frequency Comb, Norbert Lang[1], Alexander Puth[1], Grzegorz Kowzan[2], Stephan Hamann[1], Jürgen Röpcke[1], Piotr Maslowski[2], Jean-Pierre H. van Helden[1]; *[1]Leibniz Inst. for Plasma Science & T, Germany; [2]Nicolaus Copernicus Univ., Poland.* A mid-infrared frequency comb is utilized for spectroscopic investigations of plasma nitrocarburizing processes with a carbon mesh as an active screen. The parameter-dependent behaviour of species such as HCN, CH_4, and NH_3 will be discussed.

MW4C.4 • 17:30
2 μm Dual-Comb Generation by Modulation Instability for Spectroscopic Applications, Alexandre Parriaux[1], Kamal Hammani[1], Guy Millot[1]; *[1]Université de Bourgogne, France.* We experimentally demonstrate a new way of converting frequency combs in a highly nonlinear fiber. Using fourth order modulation instability, we converted around 2 μm an electro-optic modulated dual-comb setup to perform spectroscopy.

Orangerie B

HILAS

16:30 -- 18:30
HW4A • Extreme Light Infrastructure - Capabilities & Experiments - Continuing

HW4A.5 • 17:45
Robust Few-Cycle, CEP Stabilized, High Contrast OPCPA System with Average Power Exceeding 50W at 1kHz, Tomas Stanislauskas[1], Rimantas Budriūnas[1,2], Jonas Adamonis[3], Aidas Aleknavičius[3], Gediminas Veitas[1], Darius Gadonas[1], Stanislovas Balickas[3], Andrejus Michailovas[3], Arunas Varanavicius[2]; *[1]Light Conversion Ltd., Lithuania; [2]Vilnius Univ. Laser Research Center, Lithuania; [3]Ekspla Ltd., Lithuania.* We present a table-top OPCPA system driven by diode-pumped Yb:KGW and Nd:YAG lasers, delivering ~3 cycle, CEP stabilized pulses with >5.5 TW peak power at 1kHz.

HW4A.6 • 18:00
5J Broadband OPCPA System with Repetition Rate 5 Hz, František Batysta[1]; *[1]Inst. of Physics ASCR, ELI Beamlines, Czechia.* Abstract not provided.

HW4A.7 • 18:15
Laser Beam Circulator for the Generation of a High Brilliance Gamma Beam at ELI-NP, Kevin Cassou[1], Cheikh Fall Ndiaye[1,2], Nicolas Beaugerard[2], Kevin Dupraz[1], Franck Falcoz[3], Denis Douillet[1], Titouan Le Barillec[1], Aurélien Martens[1], Yann Peinaud[1], Hervé Rocipon[2], Alessandro Variola[4], Fabian Zomer[1]; *[1]LAL, France; [2]ALSYOM/SEIV - ALCEN, France; [3]Amplitudes Technologies, France; [4]LNF INFN, Italy.* We present the results of a 32 passes laser beam circulator commissioning aiming to bring a 100Hz, 40W average power frequency double Yb:Yag laser to more than 1kW average power for the inverse Compton scattering Gamma source of ELI-NP.

Orangerie C

EUV & X-ray

16:30 -- 18:15
EW4B • Compact Sources II - Continuing

EW4B.5 • 17:45
Development of Cryogenic Undulators at SOLEIL, Amin Ghaith[1], Mathiéu Valléau[1], Chamseddine Benabderrahmane[2], Fabien Briquez[1], Fabrice Marteau[1], Philippe Berteaud[1], Olivier Marcouille[1], Manuel Tilmont[1], Keihan Tavakoli[1], Nicolas Bechu[1], Jose Veteran[1], Christian Herbeaux[1], Mourad Sebdaoui[1], Marie Emmanuelle Couprie[1]; *[1]Synchrotron SOLEIL, France; [2]European Synchrotron Radiation Facility, France.* CPMUs enable to reduce the period, have additional number of periods within a given length, and thus achieve higher brightness at lower wavelength. CPMU are also suitable for future compact FEL applications.

EW4B.6 • 18:00
High Power Lasers for Gamma Source, Magali M. Durand[1], Pierre Sevillano[1], Olivier Alexaline[1], Alexis Casanova[1], Adrien Aubourg[1], Abdelhak Saci[1], Antoine Courjaud[1]; *[1]Amplitude Systèmes, France.*
A high intensity Gamma source required for Nuclear Spectroscopy can be delivered by the interaction between accelerated electron and intense laser beams. Those interactions lasers, based on multi-stage amplification, deliver 300mJ, 5ps pulses at 100Hz.

Orangerie A

MICS

16:30 -- 18:15
MW4C • Comb Spectroscopy, Materials Processing - Continuing

MW4C.5 • 17:45
Octave-spanning Infrared Frequency Combs: Synthesis and Spectroscopy, Abijith Kowligy[1], Henry Timmers[1], Alex Lind[1,5], Nima Nader[2], Flavio Cruz[1], Myles Silfies[3], Daniel Hickstein[1], David Carlson[1], Gabriel Ycas[2], Thomas Allison[3], Peter G. Schunemann[4], Scott Papp[1], Scott A. Diddams[1,5]; *[1]Time and Frequency Division, NIST, USA; [2]Applied Physics Division, NIST, USA; [3]Stonybrook Univ., USA; [4]BAE Systems, USA; [5]Dept. of Physics, Univ. of Colorado, USA.* Using an amplified single-branch Er:fiber laser (100 MHz), we generate infrared (3—12 um) frequency combs in a combination of lithium niobate and orientation-patterned gallium phosphide. Dual-comb spectroscopy of trace gases and alcohol vapors is demonstrated.

MW4C.6 • 18:00
Mid-infrared Dual-Comb Spectroscopy at High Signal-to-Noise Ratio around 3 µm, Zaijun Chen[1,2], Theodor Hänsch[1,2], Nathalie Picqué[1,2]; *[1]Max-Planck Inst. of quantum optics, Germany; [2]Fakultät für Physik, Ludwig-Maximilians-Universität München, Germany.* Multiheterodyne spectroscopy with difference frequency combs demonstrates 130000 resolved comb lines spanning more than 10 THz in the region centered at 90 THz. Signal-to-noise ratios higher than 1300 provide accurate molecular line parameter measurements.

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